The Hashemite University

Faculty of Engineering

Department of Electrical Engineering

Experiment Number (2)

"Introduction to Amplitude Modulation"

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Objectives:

- ✓ To recognize the functions of the main parts of the ANACOM 1/1 and 1/2 boards.
- ✓ Learn basic concepts of AM modulation.

Equipment:

- ✓ Oscilloscope.
- ✓ DC power Supply.
- ✓ ANACOM 1/1 DSB/SSB AM transmitter.

Theory:

In communication systems information is transmitted from one place to other using electrical signals (telephone, TV and radio broadcast etc.).

The basic communication system consists of three main components:

- ✓ Transmitter
- ✓ Channel
- ✓ Receiver

What is modulation?

Modulation is the process of encoding information from a message source in a way that is suitable for transmission. This is achieved by altering the characteristics of a wave. By superimposing a message on to a high frequency signal known as a carrier wave (or sinusoidal signal), video, voice and other data can be transmitted.

Any sinusoidal signal can be expressed as:

$$x(t) = A\,cos(2\pi f t + \varphi)$$

Where are:

$x(t)$: $the\ voltage\ of\ the\ signal\ as\ function\ of\ time$.

A: $the\ amplitude\ of\ the\ signal$.

f: $the\ frequency\ of\ the\ signal$.

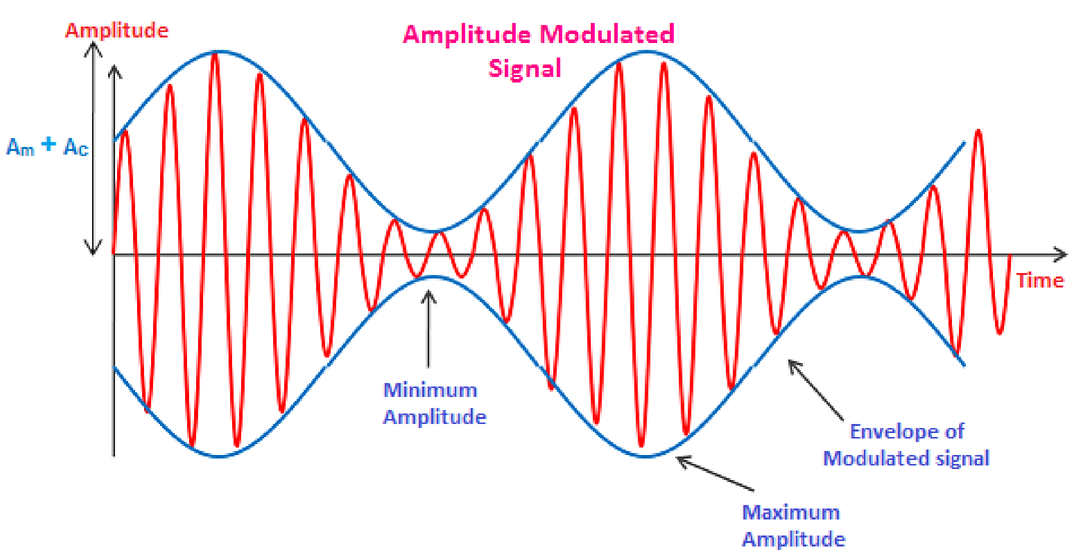
φ: $te\ phase\ of\ the\ signal$.

when we modulate a signal, we need to systematically vary one of the three parameters of the signal (A, f, $and\ \varphi$) , so the type of modulation can classify to:

- ✓ amplitude modulation (AM).
- ✓ frequency modulation (FM).
- ✓ phase modulation (PM).

What is the Amplitude Modulation (AM)?

when we edit the amplitude of the carrier wave with respect to the message signal it is called amplitude modulation.



Type of Amplitude Modulation:

- ✓ Double Side Band (DSB).
- ✓ Single Side Band (SSB).
- ✓ Vestigial Side Band (VSB).

- # Procedure:

Part 1: AM Transmitter

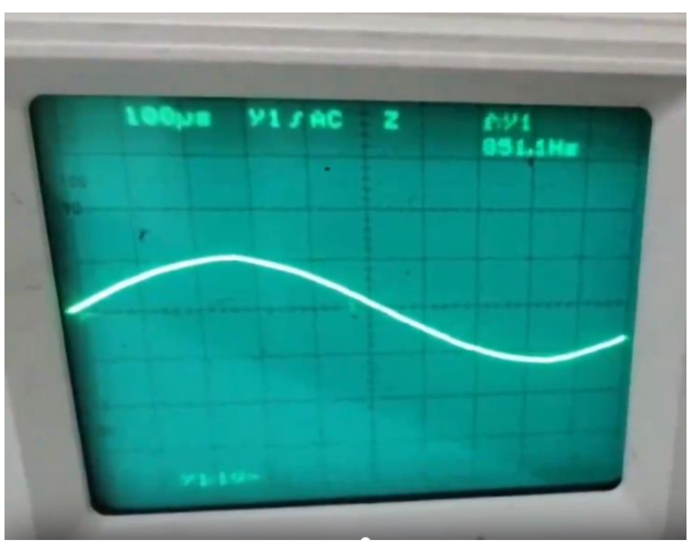
1. Using CH1 oscilloscope examine the output of the AUDIO OSCILLATOR block at TP14. What is the range of the frequency and the amplitude you can get for the modulating signal?
   - **Sol:**

     Range of voltage: $0 < V < 2.34$ (V)

     Range of frequency: $240.7 \text{ Hz} < f < 3.514 \text{ KHZ}$

     (and it almost in the audio signal.)

2. In the AUDIO OSCILLATOR block turn the amplitude knob to its maximum and the frequency knob until you get a frequency of 850 Hz.
   - **Sol:**



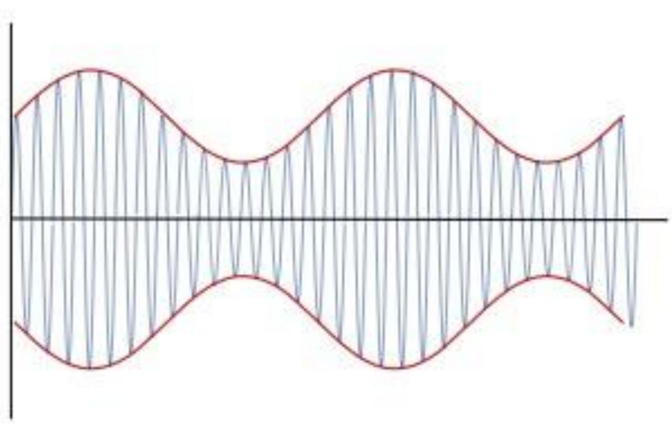
3. Connect CH2 to TP9, observe and record the carrier signal. What is the amplitude and frequency of the carrier?
   - **Sol:**

     The amplitude and frequency of the carrier are:
     (1 MHz, 117 mV) respectively.

4. Turn the BALANCE knob in the BALANCED MODULATOR & BANDPASS FILTER CIRCUIT block to its fully clockwise position.
   - **Sol:**

     (It is done in the lab)

5. Connect CH1 to TP1 and CH2 to TP3. Observe the output signal. Always use CH1 as trigger channel.
   - **Sol:**



6. Calculate the modulation index.
   - **Sol:**

$$\mu = \frac{D - E}{D + E}$$

From the Lab: D = 3.15

E = 1.73

$$\mu = 0.2909$$

7. Switch the oscilloscope to XY mode. Record the trapezoidal pattern. Find the modulation index from the trapezoidal pattern.
   - **Sol:**

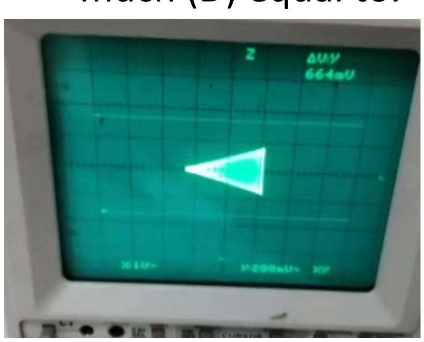
$$\mu = \frac{D - E}{D + E}$$

From the Lab: D = 664
E = 346

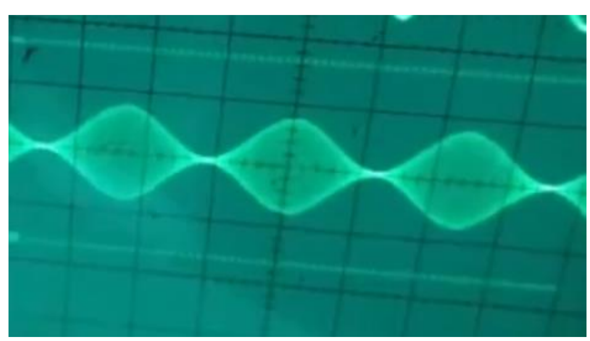
$$\mu = 0.3148$$

8. Use the trapezoidal pattern change the BALANCE knob to get 100 % modulation. Record the resulting waveforms the modulated AM signal and the trapezoid pattern.
   - **Sol:**

   we can get 100% modulation by have μ equal to 1.
   we can get (μ = 1) by make (E = 0) and it does not matter how much (D) equal to.



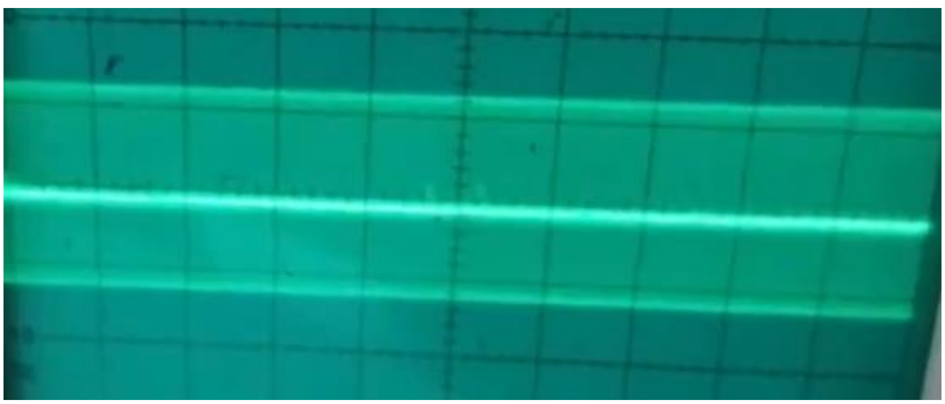
trapezoidal pattern to get 100% modulation.



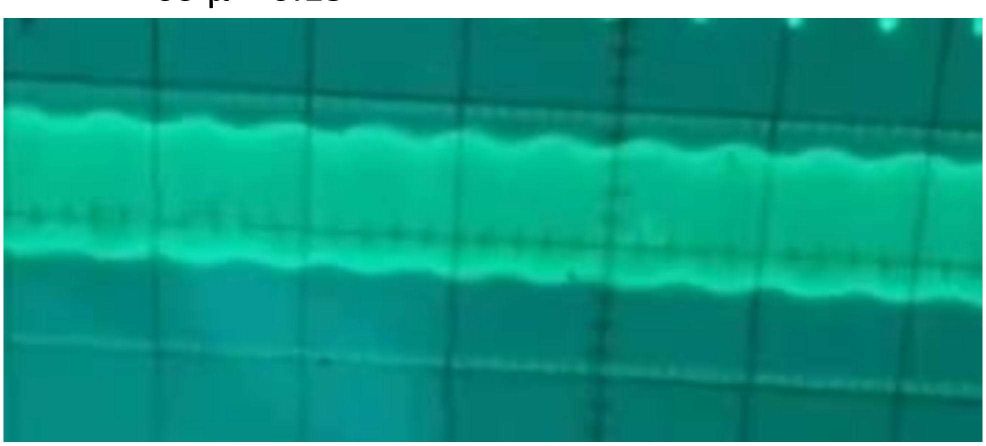
the resulting waveforms the modulated AM signal

9. Reverse the X-Y inputs at the scope. Describe the effects that occur in relation to the trapezoidal pattern.
   - **Sol:**
     (Skipped)

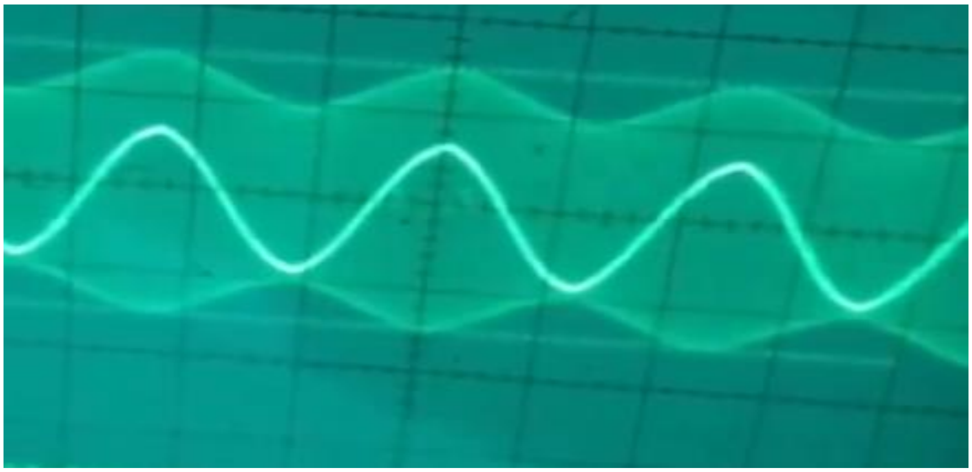
10. Change the message amplitude by varying the modulation level and find the modulation index for the message amplitudes (0, 0.5, 1.5 VPP). Plot a graph of message amplitude vs. modulation index.
   - **Sol:**
     a) If the message amplitude = 0 V, we get (E = D), so μ = 0.



b) If the message amplitude = 0.5 V,
we get D = 222 m
E = 164 m
so μ = 0.15



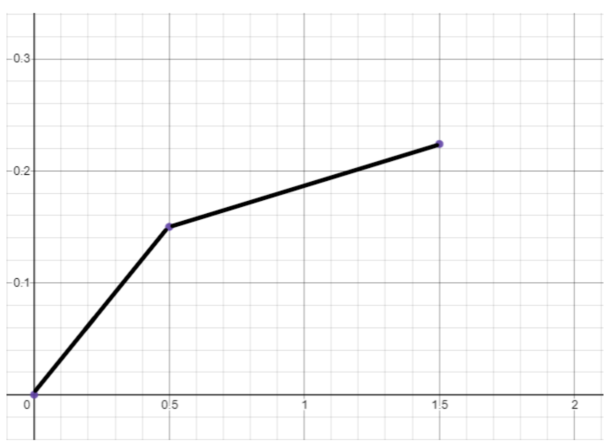
c) If the message amplitude = 0.5 V,
   we get D = 3
   E = 1.9
   so μ = 0.224



By comparing between the previous value

when m(t) = 0, μ = 0
when m(t) = 0.5, μ = 0.15
when m(t) = 1.5, μ = 0.224

We can note that there is direct relationship between amplitude of the message signal and μ, and we can represent it in the figure below:



▪ Conclusion:

1) Modulation is such important process to transfer information from transmitter to receiver.
2) Amplitude Modulation has two sidebands so that the AM has narrow channel bandwidth which is 2fm.
3) In AM most of the transmitted power is in carrier which contains no information.
4) In AM whatever the value of the amplitude of the message signal m(t) it will directly proportional with the modulation index μ.