AMPLITUDE MODULATION (AM) AND DETECTION

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CONTENTS

1.0.0. OBJECTIVE;

1). To study and evaluate on the modulated AM wave.
2). To study the effect on the modulation index by changing the modulation frequency.
3). To ensure the value of modulation index
4). To study a technique to detect an AM Signal

2.0.0 THEORY

2.1.0. AM Signal & Modulation Index.

AM is one of the modulation techniques where the amplitude of the carrier signal is changed accordingly to the modulating signal.

If Fig. 1a is a modulation signal and Fig.1b is the carrier signal, the modulation wave is as shown Fig. 1c.

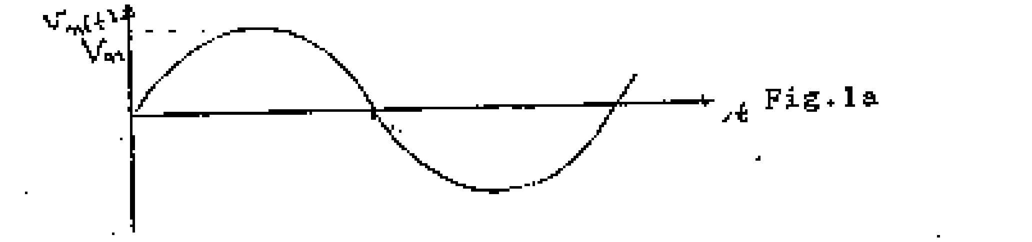

Fig .1a

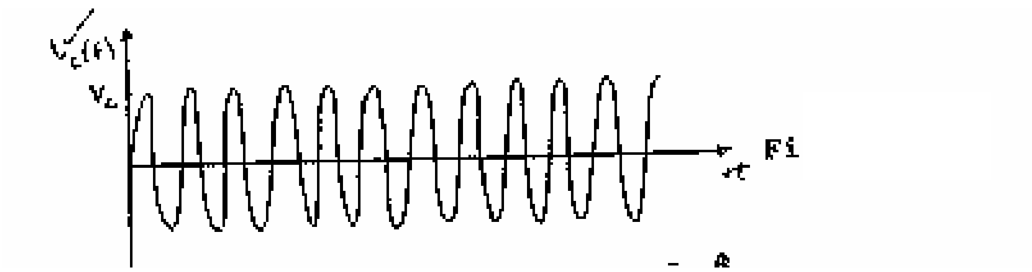

Fig .1b

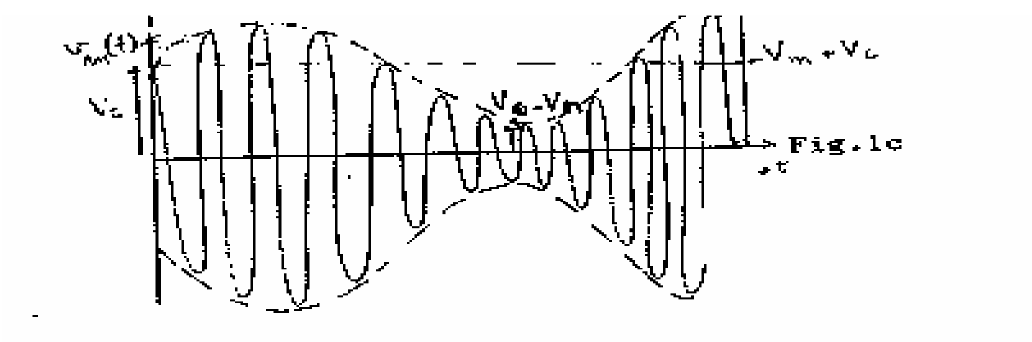

Fig .1c

2.2.0. Trapezium Method;

Trapezium diagram can be obtained by connecting the modulation signal to the X- input and the modulated signal to the Y- input.

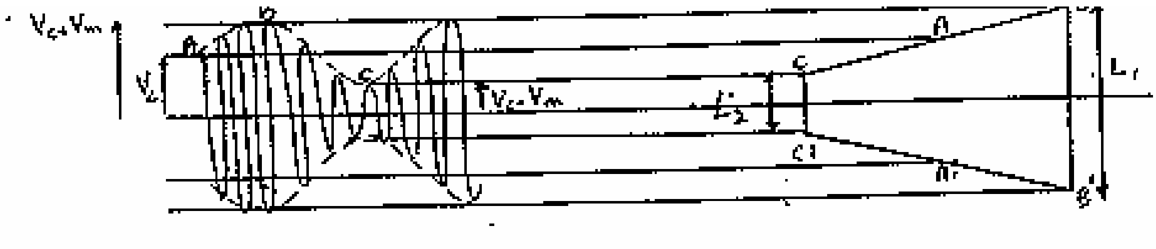

Fig. 2

From Fig.2

$L1 = 2 (V_c + V_m)$; $L2 = 2 (V_c - V_m)$

$$L1 / L2 = \frac{(V_c + V_m)}{(V_c - V_m)}$$

$$= \frac{1 + (V_m / V_c)}{1 - (V_m / V_c)}$$

$$= \frac{1 + m_a}{1 - m_a}$$

$$\text{or } m_a = \frac{L1 - L2}{L1 + L2}$$

<u>2.3.0 AM Detection</u> ;

AM demodulation or detection is a process to detect or to get back the information from the modulated signal. Semiconductor diode can be used for this purpose.

Fig. 3 shows a diode envelope detector circuit. Time constant τ = RC, must be chosen correctly so that the original modulating signal can be detected. The waveform across R follows the envelope of the modulated signal which is caused by the process of charging and discharging of the capacitor C.

Fig.3

Fig.3

The main characteristic to have the best detection is $RC < \frac{\sqrt{1 - m_a}}{w_m m_a}$

If RC is too small , the carrier wave produced at the output is shown in Fig. 4a.

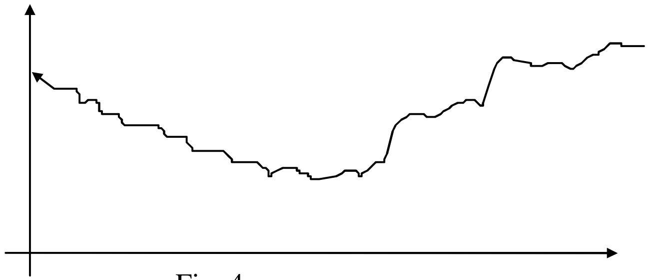

Fig. 4a.

If RC is too large , the voltages or the signal at the output does not follow the envelope as is Fig. 4b.

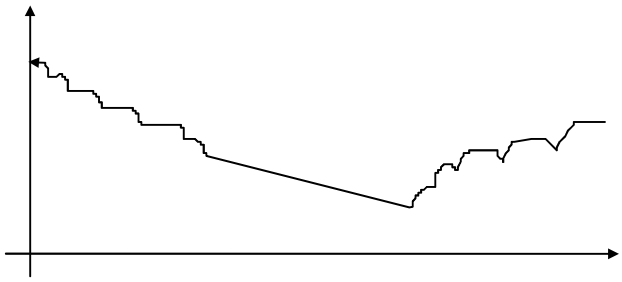

Fig. 4b

Switch excluded nearly for explanation . Diode D1 acts as the half wave rectifier. If the S1 is open the wave form across R . If S1 is closed capacitor C quickly changes through diode D1 to the peak of each positives path . Between pulses C attempt to discharge through R. The discharging time , T = RC is adjust so that C discharge only slightly .The result is the voltage across capacitor C follow the envelope of the AM wave form. The ripple (due to charging and discharging) is not notice, because the carrier frequency is many times high than the envelope frequency. The time constant must be chosen correctly so that the original modulation signal can be detect.
Refer Fig 3.

2.3.0. CHARACTER;

1. From the experiment , AM modulated wave form will obtained by setting the carrier frequency and modulating frequency at 400 kHz and 400Hz . The detector circuit connected as shown in Fig 3 . By choosing the variable capacitor and resistor the best value of time constant selected to have the output wave form with minimum distortion.
2. Below shown the output wave form for different value of time constant.
3. The efficiency of the detector calculated by ;

$$n = \frac{\text{output voltage}}{\text{input voltage}} \times 100\%$$

3.0.0. EQUIPMENT;

1). Oscillator.
2). Signal Generators
3). Cathode Ray Oscilloscope
4). Decade Resistor Box (0-1 MΩ)
5). Decade Capacitors Box (0-1μF)
6). Diode - OA 202

4.0.0 PROCEDURE

4.1.1 Connect the equipment as shown in Fig.5.

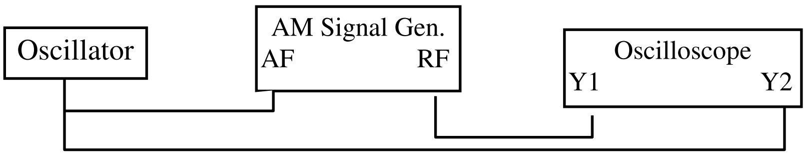

Fig. 5.

4.1.2. Get an AM modulated signal at the CRO screen at one value of modulation index (shown by a meter on the signal generator). From the AM waveform obtained on the screen, find the modulation index by using ;

$$Ma = \frac{Vmax - Vmin}{Vmax + Vmin}$$

4.1.3 Repeat produces (2) for three different values of modulation index.

4.1.4. Change the value of modulating frequency at 1 Khz and repeat procedures (2) & (3). Put the result in the table form.

4.1.5. Increase the amplitude of modulating signal to maximum and observe what is happening.

4.2.0. Trapezium Method;

4.2.1. Set a suitable amplitude and frequency for both carrier and modulating signals. Obtain a trapezium shape at the X-Y of the CRO. Find the values of L1 and L2.

4.2.2 Repeat procedure (1) for three amplitudes of the modulating signal. Observe the readings of modulation index on the meter.

4.2.3. Tabulate the results and compare the values of modulation index both from the calculation and from the meter reading.

4.3.0. AM Detection;

From the connection as in Fig.5,obtain an AM modulated waveform by setting the carrier frequency and modulating frequency at 400kHz and 400Hz respectively.
Connect the detector circuit as shown in Fig.3.By choosing variable capacitor and resistor, select the best value of time constant to have the output waveform with minimum distortion.
Sketch the output waveform for different values of time constant.
Calculate the efficiency of the detector by using,
N = (output voltage/input voltage) x 100
When does the diagonal clipping happen in the demodulation process? Sketch.

5.0.0. RESULT;

5.1.1. **FM = 400Hz and FC = 400KHz .**

Vm	V max (mV)	V min (mV)	Ma (Cal)	Ma (Meter)	Error (%)
2	500	350	17.65	15	17.60
4	600	250	41.18	44	41.00
6	700	175	60.00	66	60.00
8	800	55	87.10	83	87.00

5.1.2. **FM =1kHz and FCM = 400KHz**

Vm	Vmax	Vmin	Ma(Cal)	Ma (Meter)	Error (%)
2	560	290	0.179	14	98.0
4	630	320	0.326	34	99.0
6	700	250	0.474	47	99.0
8	740	160	0.640	63	98.9
10	710	100	0.773	72	98.9

5.1.3. **Trapezium**

Vm	LI (mV)	L2 (mV)	Ma (Cal)	Ma (Meter)	Error (%)
2	1100	900	0.10	14	99.28
4	1300	750	0.27	31	99.12
6	1500	600	0.43	46	99.06
8	1600	500	0.52	61	80.64
10	1700	300	0.70	75	99.06

5.2.0. **AM Detection;**

Fm = 400 Hz.

C = 0.18

During done this experiences a small value of error can be seen when we compare the result obtained from the theory and practical . The error can get with this calculation

$$\text{Error } \% = \frac{\text{Ma (meter)} - \text{Ma (calculation)}}{\text{Ma (meter)}} \times 100\%$$

$$\text{Eg.} \quad : \quad \frac{15 - 0.158}{15} \times 100\,\%$$

$$: \quad \mathbf{98.9\ \%}$$

For the result :

$$\text{Ma } \% = \frac{\text{Vmax} - \text{Vmin}}{\text{Vmax} + \text{Vmin}} \times 100\,\%$$

$$\text{Eg} \quad : \quad \frac{550 - 400}{152 + 400} \times 100\,\%$$

$$: \quad \mathbf{27.17\ \%}$$

6.0.0. DISCUSSION

6.1.1. Amplitude modulation Theory.

In amplitude modulation , the amplitude of a carries signal is varies by the modulating voltages , whose frequency is invariable lower than that of the carrier. In practice the carries may be high frequency (HF) while the modulation is audio, Am is define as a system of modulation in which the amplitude of the carries is made proportional to the instantaneous amplitude of the modulating voltages.

The carries voltages and the modulating voltages, Vc and Vm , respectively be represent by :

$$V_c = V_c \sin W_c t \quad \text{and} \quad V_m = V_m \sin W_m t$$

Note that phase angle has been ignore in both expressions since it is unchanged by the amplitude modulation process.. Its inclusion here would merely compliment the proceeding , without affecting the result . However it will certainly not be possible to ignore phase angle when we deal with frequency and phase modulation.

From the defination it can see that the maximum amplitude Vc of the unmodulated carrier will have to be made proportional to the instantaneous modulating voltage $V_m \sin W_m t$ when the carrier is amplitude modulated.

6.1.2. Representation Of AM.

AM is one of the modulation techniques of the carrier signal is changed accordingly to the modulating signal. AM is shown simply as consisting of three discrete frequencies. Of these centre frequencies, the carrier has the highest amplitude and the other two are disposed symmetrically about it, having amplitudes which are equal to each other but which can never exceed half the carrier amplitude.

The appearance of the amplitude modulated wave is great interest and it is in Fig 1c. for one cycles modulating sine wave. Fig 1a. is a modulating signal and Fig 1b. is a carrier signal. Fig1d.which shown the amplitude called the top envelope of the AM wave . This can be shown by the relation $A = V_c + V_m \sin W_m t$. The modulated wave extent between these two limiting envelope given by $-A = -(V_c + V_m \sin W_m t)$. The modulated wave extents between these two limiting envelope and has a repetition rate equal to the unmodulated carrier frequency.

It can be recall that V = mV and it is now possible to use this relation to calculated the index (or percent) of modulation from the wave form of Fig1c. as the shown.

$$V_m = \frac{V_{max} - V_{min}}{2}$$

and

$$V_c = V_{max} - V_m$$

$$= \frac{V_{max} - V_{max} - V_{min}}{2}$$

$$= \frac{V_{max} + V_{min}}{2}$$

$$m = V_m = \frac{V_{max} - V_{min}}{2}$$

$$Vc = \frac{Vmax - Vmin}{2}$$

$$= \frac{Vmax - Vmin}{Vmax + Vmin}$$

Finally , if the main interest is the instantaneous modulated voltage , the phasor diagram depicting the three individual component of the AM wave may be drawn.

7.0.0 CONCLUSION;

From this experiment we have examined the principle of amplitude modulation and their application to various system. The AM and it derivative scheme basically involve the controlled shifting of the signal spectrum to various point along the frequency scale. We saw that the fundamental, FC basically requires multiplication by a carrier wave of the form of COS 2p fct (or SIN 2p fct)

The modulation properties can be used to generate amplitude modulated waveform and to demodulated them again. It s because such waveform have no separate carrier frequency , they are called double side band

The additional of a carrier frequency is used to aid in waveform demodulation. If the added value carrier amplitude is large, an envelope detector can correctly demodulate the waveform . This principle is used in commercial AM broadcasting .

It has serious deficiencies in dynamics range and it noise immunity to improve matter we need to go an entirely different method of modulation FM . So for the AM demodulation or detection is process to detect or get the information from the modulated signal.

APPENDIXES

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