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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGG.

EC-405 ANALOG COMMUNICATION – LAB

LIST OF EXPERIMENT

1. TO STUDY THE OPERATION OF A DSB AM MODULATOR & SINGLE SIDE BAND GENERATION.

2 TO OBSERVE AND MEASURE FREQUENCY DEVIATION AND MODULATION INDEX OF FM

3. TO STUDY FREQUENCY MODULATION USING REACTANCE MODULATOR.

4. STUDY OF SENSITIVITY AND SELECTIVITY OF A RADIO RECEIVER.

5. STUDY OF AVC AND AFC

6. TO STUDY THE PHASE LOCKED LOOP DETECTOR.

7. TO PLOT THE CHARACTERISTICS OF THE PRE-EMPHASIS AND DE-EMPHASIS CIRCUIT.

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EXPERIMENT NO:

OBJECTIVE:-

To study the operation of a DSB AM Modulator & Single Side Band Generation.

EQUIPMENT:-

- Power supply.
- 20MHz Oscilloscope.
- Connective links
- Frequency Counter

THEORY:-

AMPLITUDE MODULATION

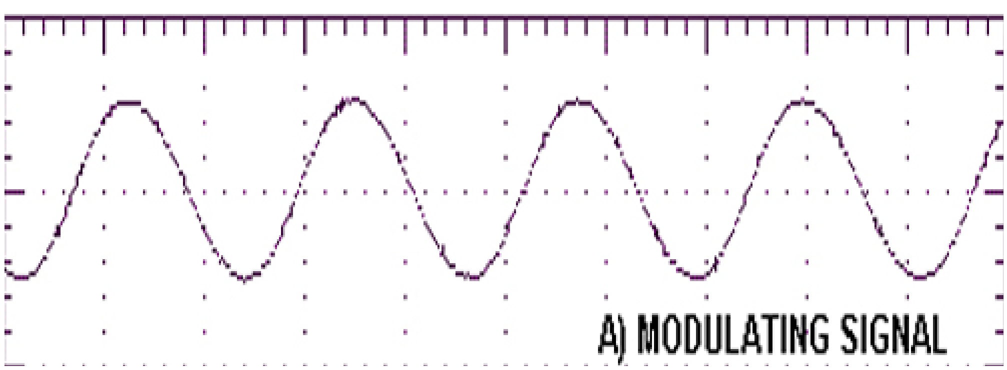
In Amplitude Modulation the amplitude of high frequency sine wave (carrier) is varied in accordance with the instantaneous value of the modulating signal. Refer FIG.
Consider a sine signal Vm(t) with frequency f(FIG).
$Vm(t)=B \cdot \sin(2\pi f \cdot t)$
And another sine signal vc(t) is called modulating signal, the signal Vc(t) is called carrier signal.
$Vc(t) = A \cdot \mathrm{Sin}\ (2\pi F \cdot t)$
The signal Vm(t) is called modulating signal; the signal Vc(t) is called carrier signal.
Vary the amplitude of the carrier Vc(t) adding the modulating signal Vm(t) to A.
You obtain a signal vM(t) amplitude modulated, which can be expressed by:
$vM(t)=[A+k) \cdot B \cdot \sin(2\pi f \cdot t)] \cdot \sin(2\pi F \cdot t) = A \cdot [1+m) \cdot \sin(2\pi f \cdot t)] \cdot \sin(2\pi F \cdot t)$
With k=constant of proportionality.
Percentage modulation signal is defined as
$m=((K \cdot B)/A) \cdot 100$

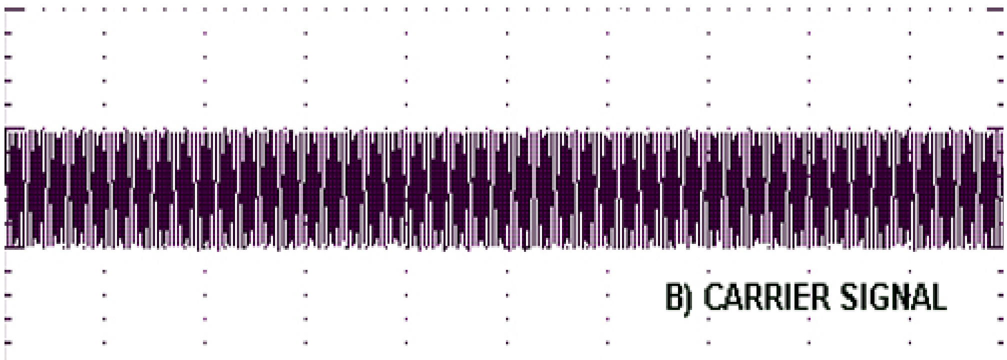
SPECTRUM OF THE MODULATED SIGNAL

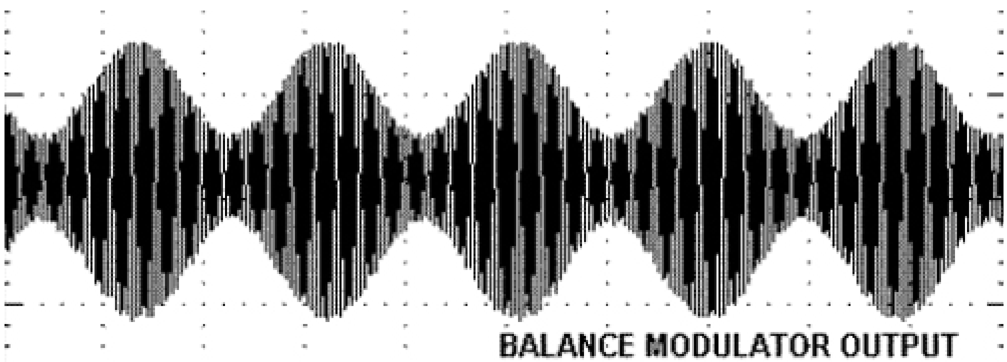
With simple trigonometric passages, the relation expressing the modulated signal vM becomes:
$vM(t)=A \cdot \sin(2\pi F \cdot t)+m \cdot A/2 \cdot \cos\ [(2\pi\ (F-f) \cdot t]-m \cdot A/2 \cdot \cos[(2\pi\ (F+f) \cdot t)]$
From which we can deduce that the signal modulated in amplitude by a sine modulator consists of three sine components:
$A \cdot \sin(2pF \cdot t)$ Carrier
$m \cdot A/2 \cdot \cos[(2\pi\ (F-f \cdot \cdot t)]$
Lower side band
$m \cdot A/2 \cdot \cos[(2\pi\ (F+f) \cdot t)]$

PROCEDURE FOR DSB :-

- Connect SINE OUT post of FUNCTION GENERATOR SECTION to the i/p of Balance Modulator1 SIGNAL IN Post.
- To connect o/p of VCO RF OUT post to the input of Balance modulator 1 CARRIER IN post
- Connect the power supply with proper polarity while connecting this; ensure that the power supply is OFF.
- Keep switch SW1 towards 1-10 KHz position.
- Keep Out post LEVEL about 0.5Vpp; FREQ. About 1 KHz.
- Keep switch SW2 towards 500 KHz position.
- Keep RF out LEVEL about 1 Vpp; FREQ. about 450 KHz, Switch on 500 KHz.
- BALANCED MODULATOR1: CARRIER NULL completely rotated clockwise or counter clockwise, so as “unbalance” the modulator and to obtain an AM signal with not suppressed carrier across the output; OUT LEVEL in fully clockwise.
- Observe the AM Modulator wave.
- Move the probe from post SIG to post OUT (output of the modulator), where signal modulated in amplitude is detected. Note that the modulated signal envelope corresponds to the wave form of the DSB AM modulating signal.
- Vary the amplitude of the modulating signal and check the 3 following conditions: Modulation percentage lower than the 100%, equal to the 100% , superior to 100% (over modulation).
- Vary the frequency and amplitude of the modulating signal, and check the corresponding variations of the modulated signal.
- Vary the amplitude of the modulating signal and note that the modulated signal can result saturation or over modulation.







PROCEDURE FOR SSB :-

- Refer to the FIG and Carry out the following connections.
- Keep all the switch faults in OFF position.
- Connect o/p of SINEWAVE section (ACL-01) OUT post to the i/p of Balance Modulator (ACL-01) SIGNAL post.
- Connect o/p of VCO (ACL-01) OUT post to the input of Balance modulator CAR. (ACL-01) post.
- Connect power supply with proper polarity to the kit ACL-01, while connecting this, and ensure that the power supply is OFF.
- Switch on the power supply.
- Keep switch SW1 towards 1-10 KHz position.
- Keep sine level about 1 Vpp, Freq. about 1 KHz.
- Keep switch SW2 towards 500 KHz position.
- Keep VCO level about 1 Vpp , freq. about 450 KHz.
- Keep Balanced Modulator Carrier null in central position, so that the modulator is" balanced" and obtain an AM signal across the output with suppressed carrier. OUT LEVEL in fully clockwise position.
- Connect the oscilloscope to the inputs of the modulator (posts SIG and CAR.) and detect the modulating signal and the carrier signal

- Move the probe from post SIG. to post OUT. where the modulated signal is detected.
- Vary the amplitude of the modulating signal and check the corresponding variation of the modulated signal amplitude. Note that, differently from the AM modulation where the modulated signal is never null, the modulated signal annuls when the modulating signal is null.
- Vary frequency and waveform of the modulating signal, and check the corresponding variations of the modulated signal.

RESULT:

VIVA QUESTIONS

Q1. What is the BW for AM wave?
Q2. Define Modulation index for AM wave in AM system?
Q3. Define transmission efficiency in AM wave?
Q4. How can you obtain a DSB-SC signal?
Q5. What are the demodulation method for DSB- SC signal?
Q6. What are the generating method for SSB-SC signal?

EXPERIMENT NO:

OBJECTIVE:-

To observe and measure frequency deviation and modulation index of FM

THEORY:-

FREQUENCY MODULATION:

It is a type of modulation in which the frequency of the high frequency (Carrier) is varied in accordance with the instantaneous value of the modulating signal.

MAIN ASPECTS:

Consider a sine wave signal vm(t) with pulse w **FIG-1**.
vm(t) = B • sin(W•t)
and another sine wave vc(t) with upper W pulse:
vc(t) = A • sin(W•t)
The signal vm(t) is called modulating signal, the signal vc(t) is called carrier signal.
Vary the frequency of the carrier vc(t) in a way proportional to the amplitude of the modulating signal vm(t). You obtain a vm(t) frequency modulated diagonal, which can be expressed by the relation:
vm(t) = A • sin [q(t)]
with q(t) instantaneous angle function of vm(t).

MATHEMATICAL EXPRESSION OF THE FREQUENCY MODULATED SIGNAL:

The instantaneous pulse W(t) of the FM signal, by definition, is as follows:-

W(t) = W + K• vm(t)
with W= carrier pulse
K= modulation sensitivity

The instantaneous angle W(t) to be used as subject of the sine to obtain the mathematical operation of the FM signal, is detected by integrating W(t):

(t) =Integral [W(t) dt]
In the case of modulating sine wave signal [vm (t) = B.sin (W.t)], q (t) it results:
q(t) = W•(t) – (K•B/w) • cos(w•t)
The expression of the frequency modulated signal vm (t) becomes:
vm(t) = A • sin[W • (t)- (K•B/w) • cos(w•t)]

FREQUENCY DEVIATION DF AND MODULATION INDEX MF:

The instantaneous frequency F(t) of the carrier modulated by a sine wave, results:

F(t) = W(t)/2p= W2p + K•B•sin(w•t)
and oscillates between a minimum Fmin and a maximum value Fmax:
Fmin = W/(2p) - (K•B)/(2p)
Fmax = W/(2p) + (K•B)/(2p)
The frequency deviation DF represents the maximum shift between the modulated signal frequency, over and under the frequency of the carrier:
DF = (Fmax – Fmin)/2
We define modulation index mf as the ratio between DF and the modulating frequency f:
mf = DF/f

RESULT:

VIVA QUESTIONS

1. What is a modulation index of fm?

2. What is a frequency deviation?

3. What is a bandwidth of fm?

4. What is the definition of frequency modulation?

EXPERIMENTS NO:

OBJECTIVE:-

To study frequency modulation using reactance modulator

EQUIPMENT:-

- ACL-03 Kit.
- Power supply.
- Connective links.
- Frequency meter.

THEORY:-

FREQUENCY MODULATION GENERATION:-

The circuits used to generate a frequency modulation must vary the frequency of a high frequency signal (carrier) as function of the amplitude of a low frequency Signal (modulating signal). In practice, there are two main methods used to Generate the FM:

DIRECT METHOD:-

An oscilloscope is used in which the reactance of one of the elements of the resonant circuit depends on the modulating voltage. The most common device with variable reactance is the Varactor or Varicap, which is a particular diode whose capacity varies as a function of the reverse bias voltage.

INDIRECT METHOD:-

In this case, FM is done by Phase Modulation, after the modulating signal has

been integrated. In the phase modulator the carrier can be generated by quartz Oscillator and so its frequency stabilization is easier.
In the circuit used for the exercise, the frequency modulation is generated by a Hartley oscillator, whose frequency is determined by a fixed inductance and by a Capacitance (variable) supplied by Varicap diodes.

<u>AN FM TRANSMITTER:-</u>

The audio oscillator supplies the information signal and could, if we wish, be Replaced by a microphone and AF amplifier to provide speech and music instead of the sine wave signals that we are using with ACL-03.
The FM modulator is used to combine the carrier wave and the information Signal in the same way as in the AM transmitter. The only difference in this case is that the generation of the carrier wave and the modulation process is carried out in the same block. It doesn’t have to be, but in our case, it is.

The only real difference between the AM and FM transmitters are the Modulators, so we are only going to consider this part of the transmitter.
We are going to investigate three types of modulator, they are called the **VARACTOR MODULATOR, REACTANCE MODULATOR** and the FM is obtained in this case by a Phase Modulation.

<u>THE VARICAP DIODE:-</u>

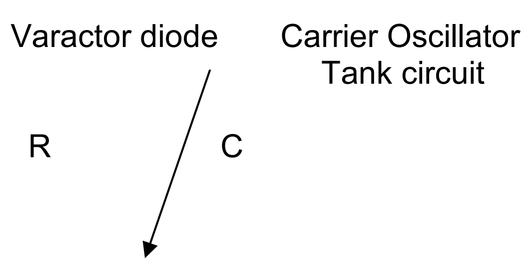
The Varicap (or Varactor) is a diode whose terminals are supplied with a capacity depending on the applied reverse voltage. The symbol and the equivalent circuit of the varicap diode are shown in FIG.4, where:

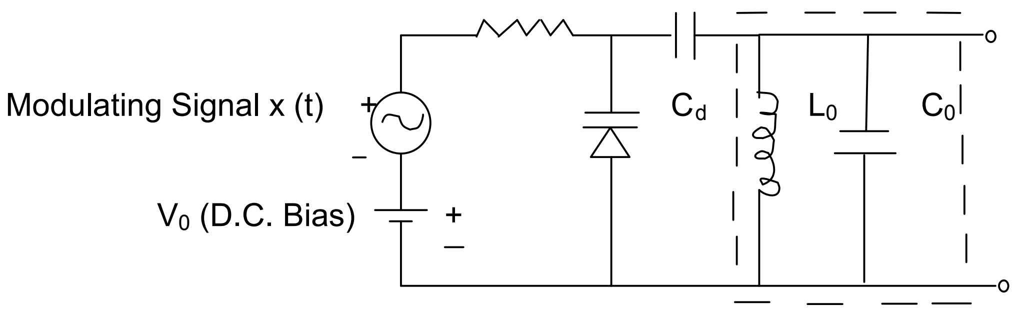
· C_j = junction capacity
· R_s= series resistance (it drops as the applied reverse voltage increases)

The junction capacity C_j depends on the reverse voltage V_R applied to the diode, according to the relation:

$C_j = C_0 (1 + V_R)/V_D \times h$

where:
V_R = reverse voltage applied to Varicap
C_0 = junction capacity for V_R=0
V_D = junction potential (0.6 V in the silicon diodes)
h = it depends on the manufacturing process; it ranges between 0.3 and 0.6approx.

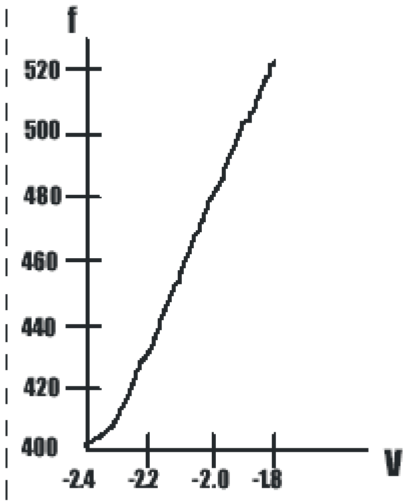




Varactor diode method of FM generation

PROCEDURE:-

- Connect the power supply with proper polarity and Switch it on.
- Keep all Switch Faults in OFF position.
- Keep switch at 1500 KHz position.
- Using pot P5 keep frequency at minimum and using pot P6 keep Amplitude at 2Vpp.
- Connect the oscilloscope and frequency meter to the output of the Modulator FM/RF OUT.
- Connect the voltmeter to the cursor of the frequency regulation Potentiometer post V_f below SWITCH
- Vary the voltage in steps of 0.5 Volt and fill a table with the voltage values and the corresponding frequencies.
- Plot a graph with the measured voltage and frequency values.



VOLTAGE [V]	FREQUENCY [KHZ]
- 2.4	404
- 2.3	410
- 2.2	432
- 2.1	458
- 2.0	480
- 1.9	502
- 1.8	523

FIG. 1.7

RESULT:

VIVA QUESTIONS

1. What do you mean by angle modulation?
2. Define phase modulation
3. Define frequency modulation?
4. What are the disadvantages of FM modulation?
5. What is Carson rule?

EXPERIMENTS NO:

OBJECTIVE:-

Study of Sensitivity and Selectivity of a Radio receiver.

EQUIPMENT:-

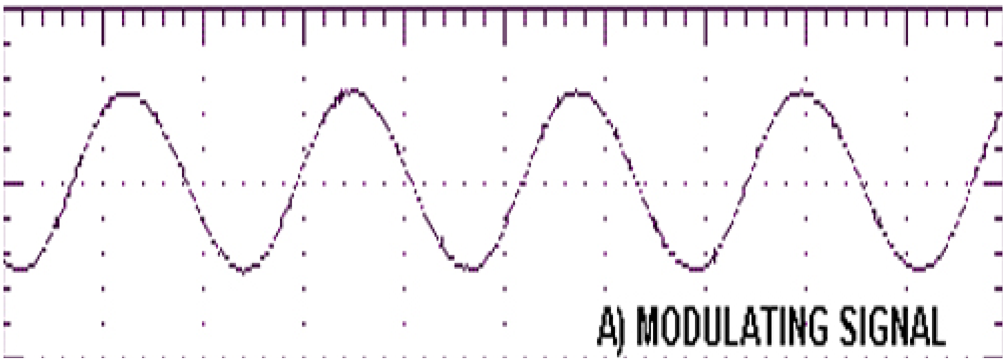
- Power supply GND, +5, +/-12V
- Connecting Links.
- Frequency Counter

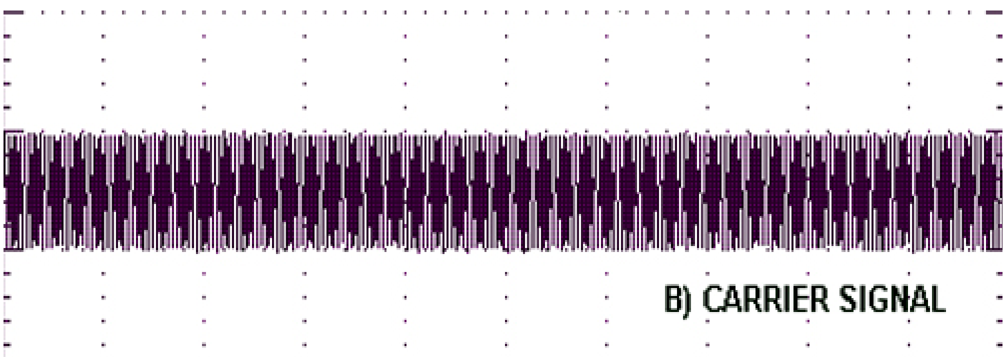
PROCEDURE:-

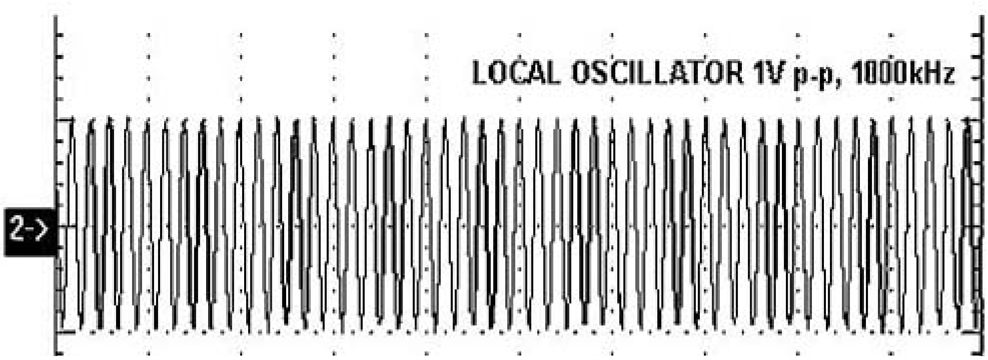
- Connect o/p of FUNCTION GENERATOR section (ACL-01) OUT post to the i/p of Balance Modulator1 (ACL-01) SIGNAL IN post.
- Connect o/p of FUNCTION GENERATOR section (ACL-01) OUT post to the i/p of Balance Modulator1 (ACL-01) SIGNAL IN post.
- Connect power supply with proper polarity.
  While connecting this, ensure that the power supply is OFF.
- Switch on the power supply.
- Keep switch SW1 towards 1-10KHZ position.
- Keep Sine out LEVEL about 0.5 Vpp; FREQ. About 1 KHZ.
- Keep switch SW2 towards 1500KHz position
- Keep LEVEL about 1.5Vpp; FREQ. About 600 KHz.
- BALANCED MODULATOR 1: CARRIER NULL completely rotates clockwise or counter clockwise, so that the modulator is “unbalanced” and an AM signal with not suppressed carrier is obtained across the output: adjust OUTLEVEL to obtain an AM signal across the output whose amplitude is about 200mVpp.
- OUTPUT AMPLIFIER (ACL-01): LEVEL fully clock wise.
- Keep LOCAL OSCILLATOR (ACL-02)signal at 1050KHz,1 v
- Connect local oscillator OUT post to LO IN of the mixer section.
- Connect balance modulator1 out to RF IN of mixer section in ACL-02.
- Connect mixer OUT to IF IN of 1st IF AMPLIFIER in ACL-02.
- Connect IF OUT1 of 1st IF to IF IN 1 and IF OUT2 of 1st IF to IF IN 2 of 2ND IF AMPLIFIER.
- Connect OUT post of 2nd IF amplifier to IN post of envelope detector.
- Connect post AGC1 to post AGC 2 and jumper position as per diagram.
- Observe the modulated signal envelope, which corresponds to the wave form of the modulating signal at OUT post of the balanced modulator1 of ACL-01. Connect the oscilloscope to the IN and OUT post of ENVELOPE DETECTOR and detect the AM signal.
- Check that the detected signal follows the behavior of the AM signal envelope vary the amplitude of the balanced modulator output, and check

the corresponding variations at the demodulated signal.

- Adjust the input to RF IN post by vaying the output of BM1 in such a way that you should get minimum detected output of about 0.3Volt at the output of Envelope detector.
- You can take the readings as per the table mentioned below for various carrier frequencies and corresponding Local Oscillator frequency settings.







RESULT:

VIVA QUESTIONS

Q1. Write the drawback of tuned radio frequency (TRF) receiver?
Q2. What do you mean by sensitivity?
Q3. Define selectivity for a receiver?
Q4. Write the advantages of a RF amplifier?

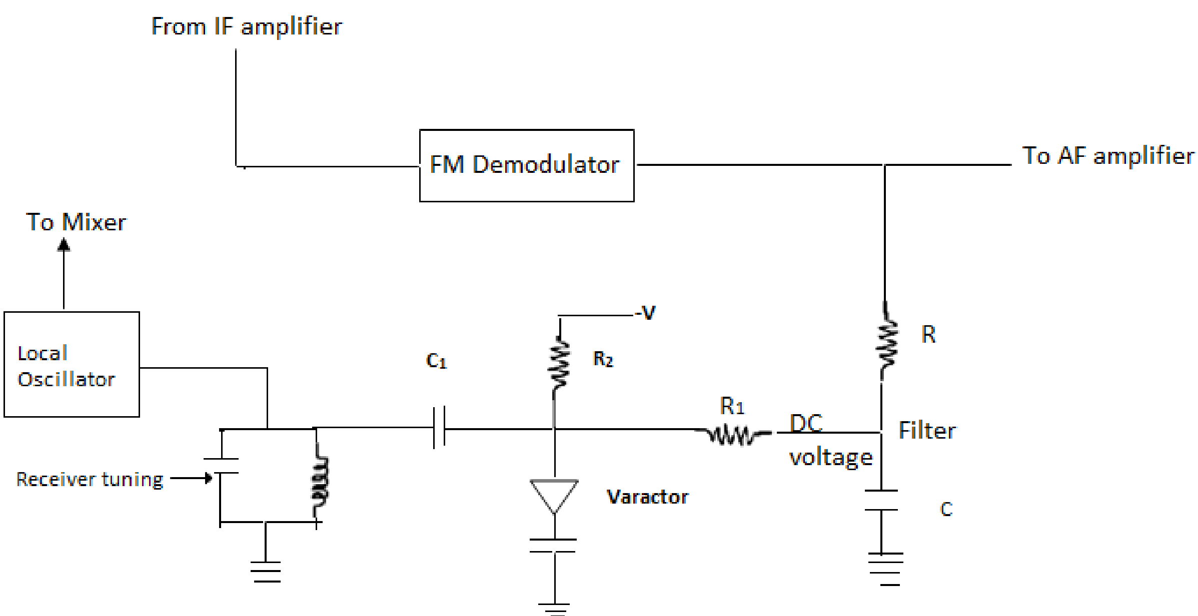
EXPERIMENT NO:-

AIM :– To study of AFC & AVC.

Apparatus Required: –

Theory: –

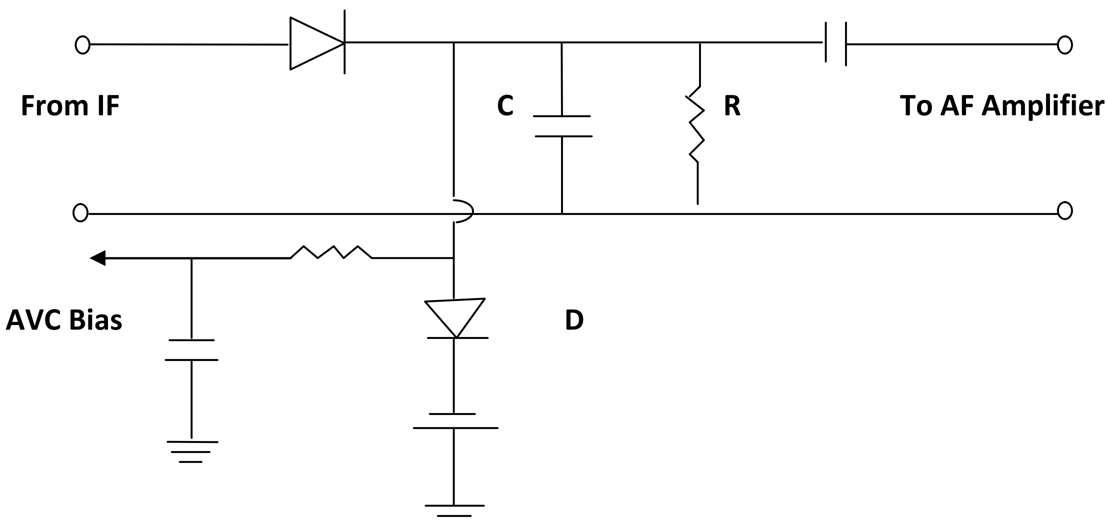
AFC- In AFC, some of the signal from the output of demodulator is filtered to get a D.C. voltage. This D.C. voltage is then used to control a varactor diode. As shown in fig. , the D.C. bias applied to the varactor will vary with the drift in frequency. It can be positive or negative. This D.C. voltage will then vary the capacitance of the varactor diode, which is connected across the oscillator tank circuit. Thus, the local oscillator frequency will be changed automatically to reduce the error to zero. If the local oscillator frequency increases above the desired frequency, then IF will increase. This produces a positive D.C. voltage at the output of the demodulator. This will cause the capacitance of varactor diode to increase and the local oscillator frequency to decrease. Thus, automatic frequency control is achieved.



Automatic frequency control (AFC)

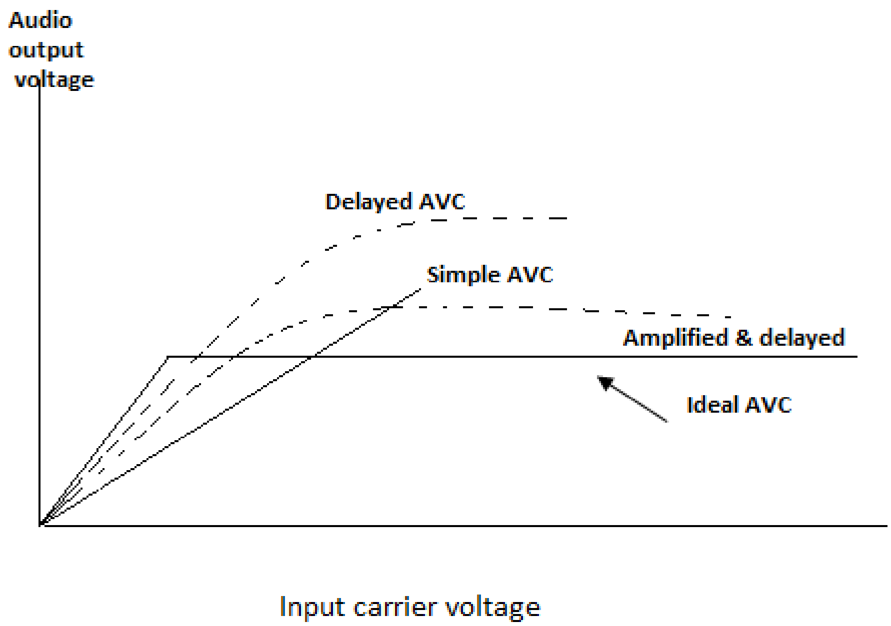
AVC- The automatic volume control (AVC) bias is obtained from this stage in order to keep the receiver output substantially constant with time for any variations in receiver input voltage . The magnitude of the receiver input voltage varies with time due to fading, or when the receiver is tuned from one station to another having different signal strength. The AVC eliminates the effect of these variations. Fig. provides a "simple AVC" bias if diode D in AVC circuit is removed.

The AVC circuit samples a fraction of the detector output and converts it to AVC bias voltage. The AVC bias is applied to RF and IF stages to provide them a negative bias. As the input of receiver signal increases, the AVC bias voltage also increases, and in turn, the negative bias to RF and IF amplifiers is increased, thereby reducing their gain. The output of the receiver is, thus maintained constant The AVC is operative only if the signal is more than the diode bias voltage. The AVC characteristics can be further improved by amplifying the delayed AVC bias with the help of D.C. amplifier. The is known as amplified and delayed AVC.



A Detector Circuit with AVC

(a)



Audio output voltage
Delayed AVC
Simple AVC
Amplified & delayed
Ideal AVC
Input carrier voltage

(b)

EXPERIMENT NO:

OBJECTIVE:-

To Study the phase locked loop Detector.

EQUIPMENT:-

- Power supply.
- Connective links.
- Volt meter
- Frequency meter.

THEORY:-

THE PHASE LOCKED LOOP (PLL) DETECTOR

This is another demodulator that employs a phase comparator circuit. It is a very good demodulator and has an advantage that it is available as a self-contained integrated circuit, so no setting is required. You just plug it in and it works. For these reasons, it is often used in commercial broadcast receivers. It has very low of distortion. Altogether a very nice circuit.
The overall action of the circuit may, at first, seem rather pointless. As we can see in **FIG.1** there is a voltage-controlled oscillator (VCO). The DC output voltage from the output of the low pass filter controls the frequency of this oscillator. Now, this DC voltage keeps the oscillator running at the same frequency as the original input signal but 90° out of phase.
The question often arises why we would want the oscillator to run at the same frequency and 90° out of phase. And if we did, then why not just add phase shifting circuit at the input to give the 90° phase shift?
The answer can be got by imagining what happens when the input frequency changes – as it would with an FM signal.
If the input frequency increases and decreases, the VCO frequency is made to follow it. To do this, the input control voltage must increase and decrease. These changes in DC voltage level form the demodulated signal.
The AM signal then passes through a signal buffer to prevent any loading effect from disturbing the VCO and then through an audio amplifier if necessary.
The Frequency response is highly linear.

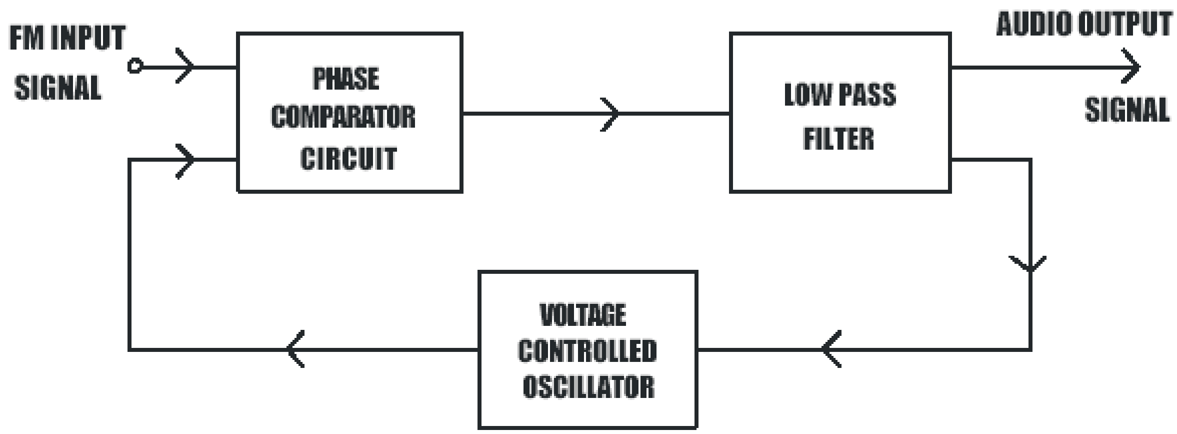


FIG.3.9 BLOCK DIAGRAM FOR PHASE LOCKED LOOP DETECTOR

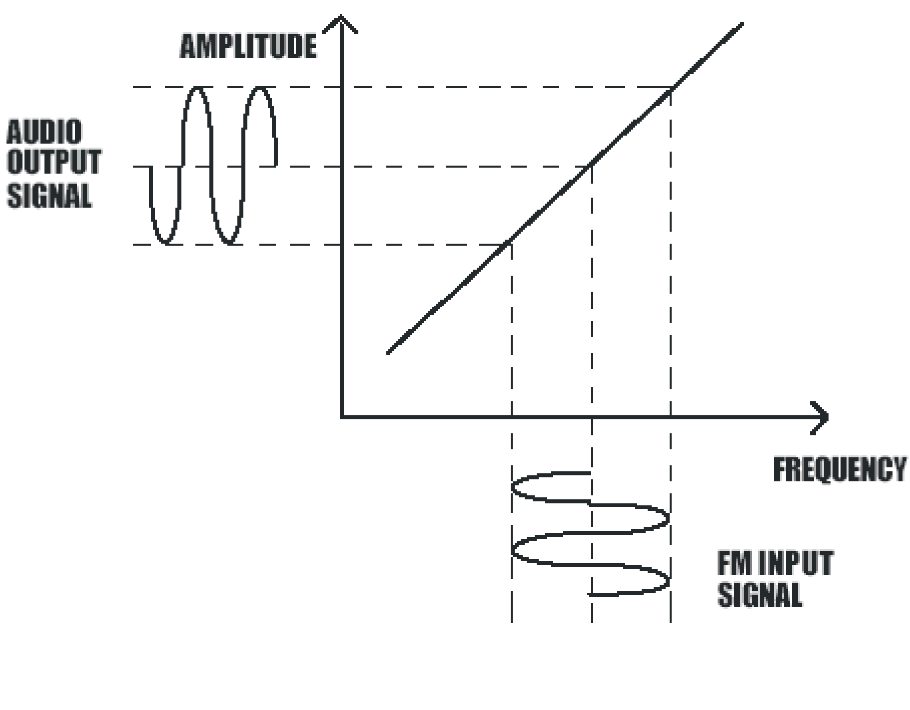
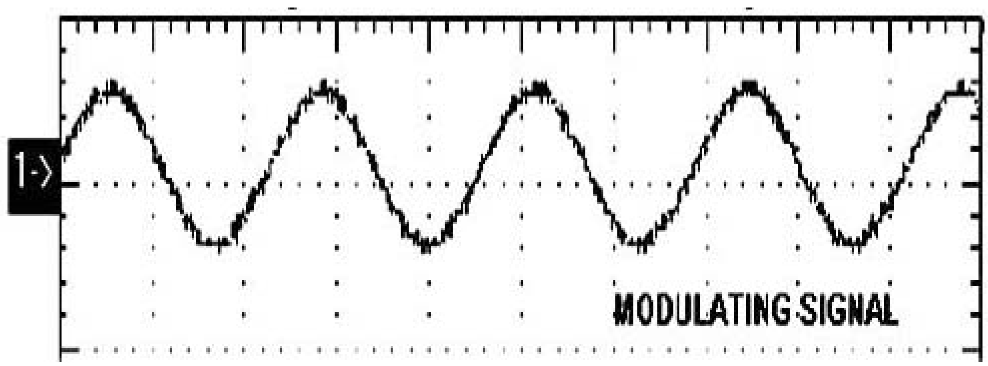


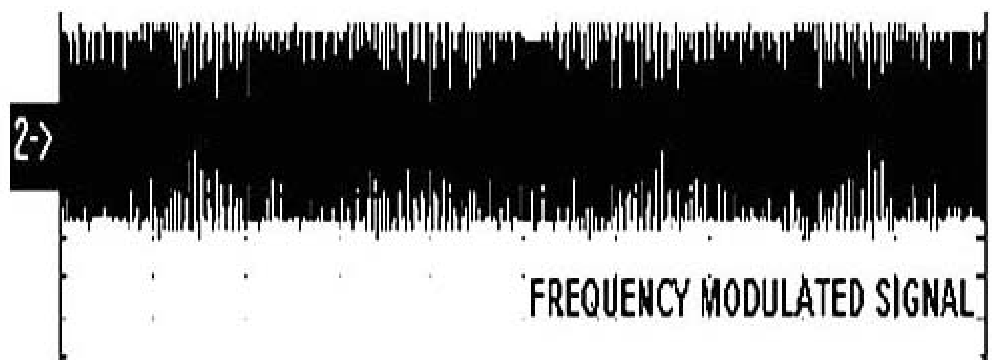
FIG.3.9A CHARACTERISTICS OF PHASE LOCKED LOOP DETECTOR

PROCEDURE:-

- Connect the power supply with proper polarity to the kit ACL-03 and ACL-04 switch it on.
- Keep all Switch Faults in OFF position.
- Select Sine wave signal using jumper JP1 shorted.
- Select frequency range 0.1-1KHz using JP4.
- Using pot P1 keep frequency at 500Hz and using pot P2 keep amplitude at 0.1Vpp.
- Keep switch SW2 at 500 KHz position.
- Using pot P5 keep frequency at 450KHz and using pot P6 keep amplitude at 1Vpp.
- Connect the output of function generator OUT post to the modulation IN post of FREQUENCY MODULATOR.
- Connect the output of FREQUENCY MODULATOR FM/RF OUT post to the input of RF IN of mixer in ACL-03.
- Using pot P8 keep Local Oscillator frequency at 1000KHz and using pot
- P9 keep amplitude at 1Vpp.
- Connect the LOCAL OSCILLATOR OUT to the LO IN of the MIXER.
- Observe signal at MIXER OUT post and achieve the same signal as Frequency modulator output by setting frequency of LOCALOSCILLATOR.
- Connect the MIXER OUT to the LIMITER IN post with the help of shorting links.
- Observe LIMITER OUT post where output is clear from noise and stabilize around a value of about 1.5Vpp.
- Connect the LIMITER OUT post to the FM IN of RATIO DETECTOR.
- Connect the oscilloscope across post OUT of PLL Detector. If the central frequency of the detector and the carrier frequency of the FM signal and local oscillator frequency coincide, you obtain demodulated signal. The fact that there is still some high-frequency ripple at the output of the PLL DETECTOR block indicates that the passive low pass filter circuit at the block's output is not sufficient to remove this unwanted high-frequency component. We use the LOW PASS FILTER block to overcome this problem.
- Connect the OUT post of PLL detector to the IN post of LOW PASS FILTER.
- The LOW - PASS FILTER block strongly attenuates the high-frequency ripple component at the detector's output, and also blocks the d.c. offset voltage. Consequently, the signal at the output of the LOW - PASS FILTER block should very closely resemble the original audio modulating Signal.


1->
MODULATING SIGNAL


2->
FREQUENCY MODULATED SIGNAL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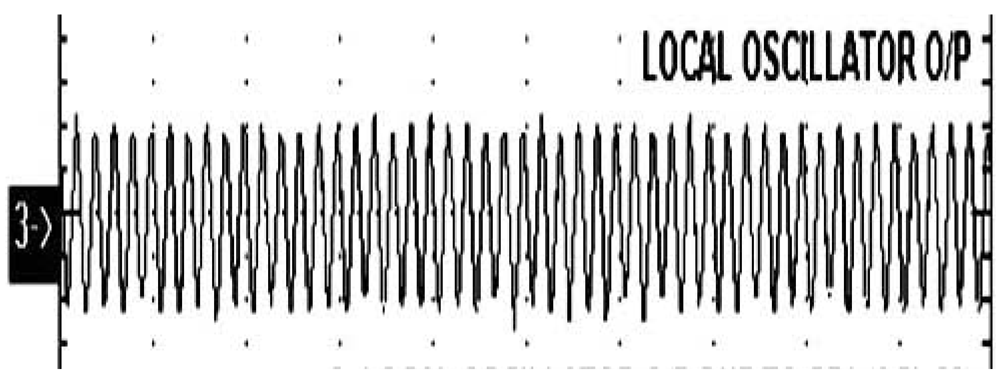
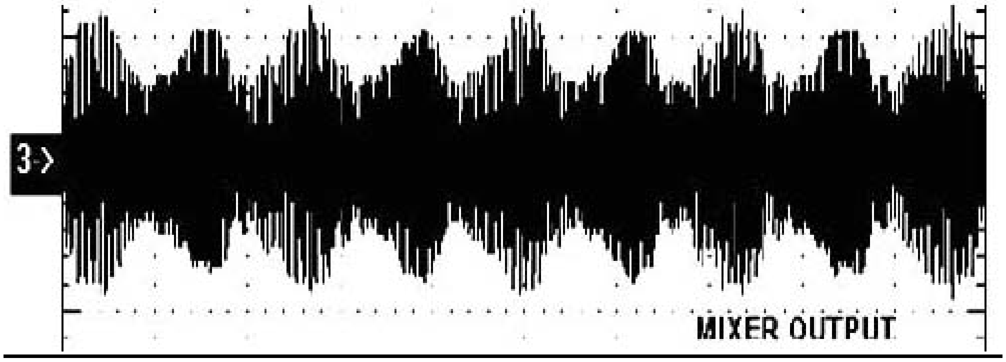
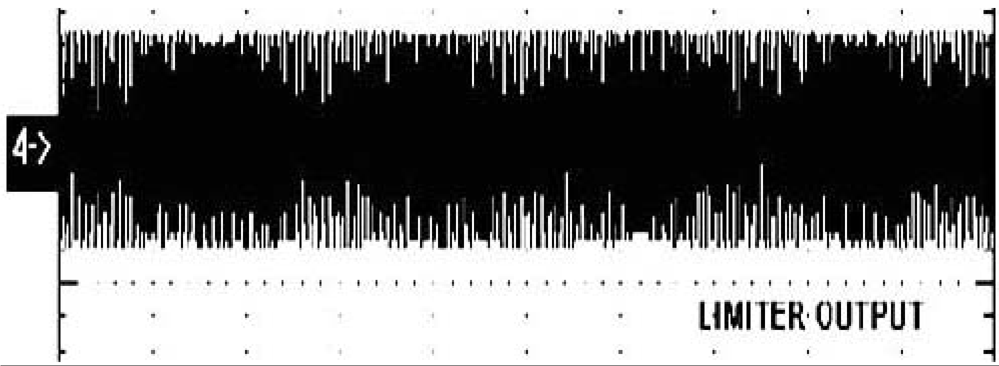
FREQUENCY MODULATED SIGNAL


LOCAL OSCILLATOR O/P
3->


3->
MIXER OUTPUT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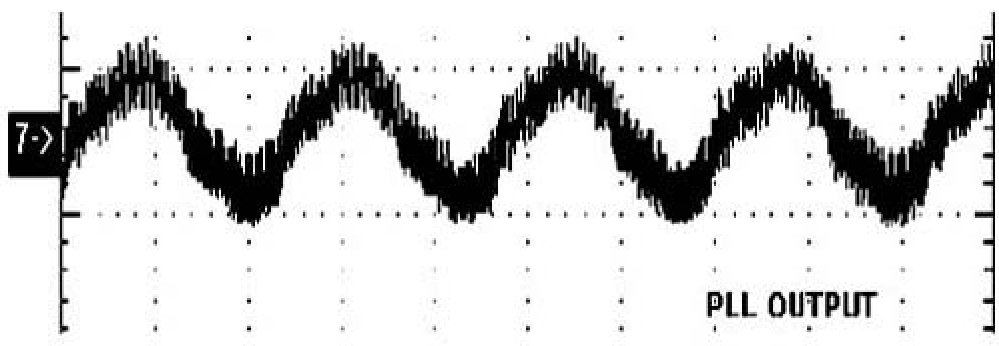
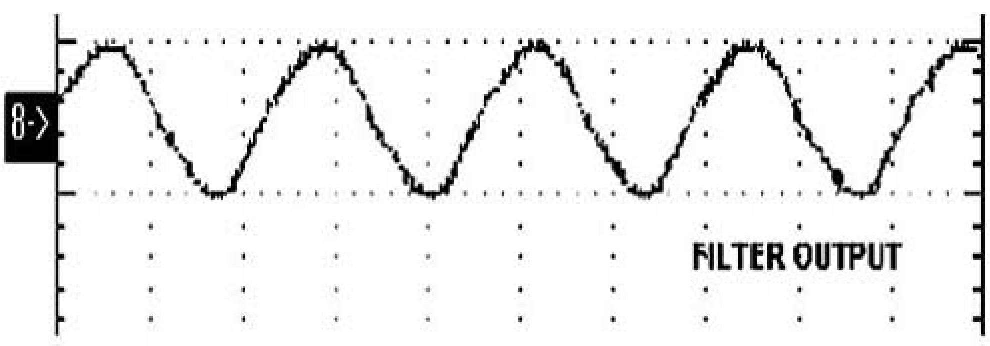
LIMITER OUTPUT


7->
PLL OUTPUT


8->
FILTER OUTPUT

RESULT:

VIVA QUESTIONS

Q.1 What is PLL detector?

EXPERIMENT NO:

OBJECTIVE:-

To plot the characteristics of the pre-emphasis and de-emphasis circuit

EQUIPMENT:-

- ACL-03 Kit.
- Power supply.

THEORY:-

PRE-EMPHASIS CIRCUIT:-

The problem in FM broadcasting is that noise and hiss tend to be more Noticeable, especially when receiving the weaker stations. To reduce this effect, The treble response of the audio signal is artificially boosted prior to transmission. This is known as pre-emphasis
The pre-emphasis is obtained by using the simple audio filter, even simple RC filter will do the job. The pre-emphasis circuit produces higher output at higher frequencies Because the capacitive reactance is decreased as the frequency increases.

The response of the pre-emphasis circuit will be as follows:
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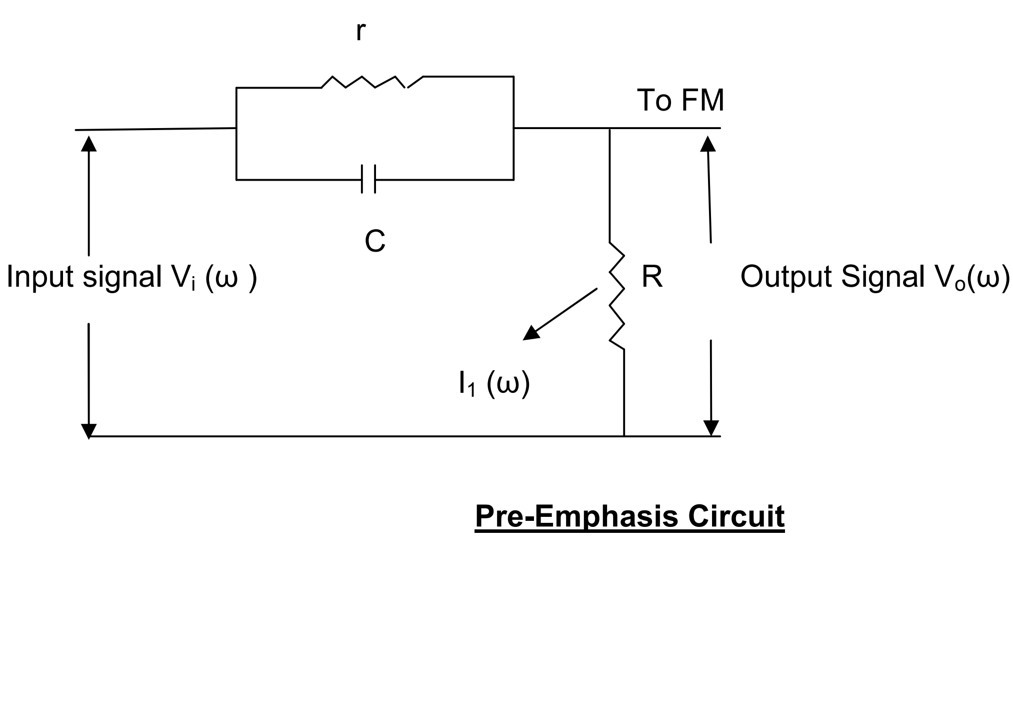
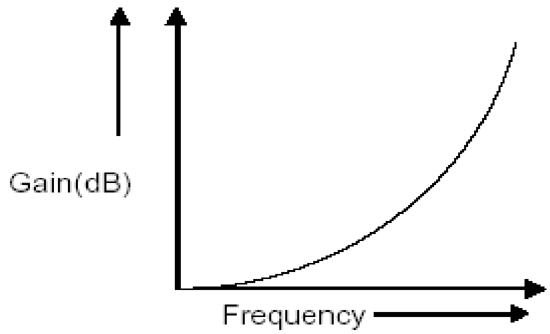


Pre-Emphasis Circuit



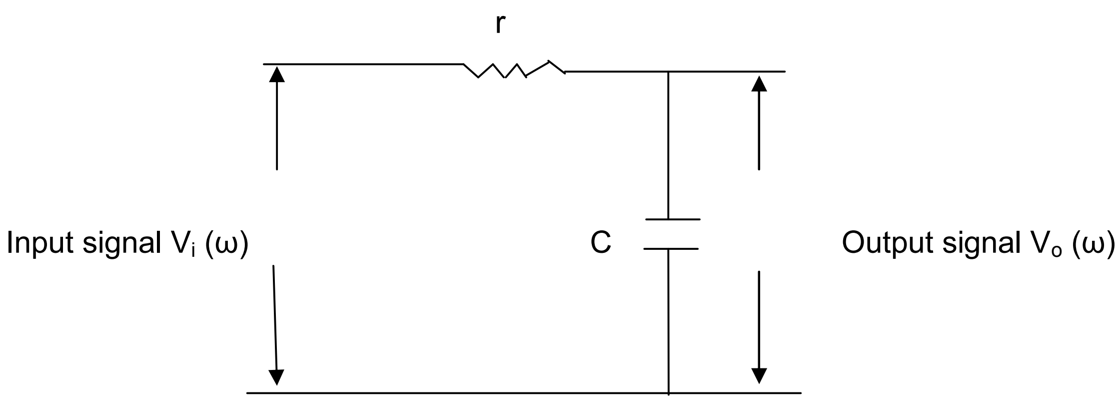
PROCEDURE:-

- Connect the power supply with proper polarity to the kit ACL-03 and switch it on.
- Keep all Switch Faults in OFF position.
- Select frequency range 1-10 KHz using JP4.
- Using pot P1 keep frequency at 1 KHz and using pot P2 keep amplitude at 0.1Vpp.
- Connect the output of function generator to the IN post of pre-emphasis circuit.
- Observe output voltage at the OUT post of pre-emphasis circuit.
- Vary the frequency in steps of 500Hz and note down the output voltage at the OUT post of pre-emphasis circuit.
- Plot the graph of output voltage v/s input frequency on graph paper.

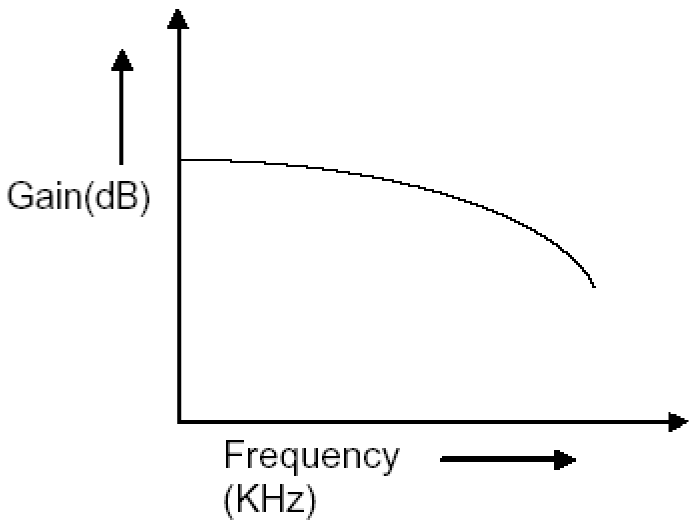
DE-EMPHASIS CIRCUIT:-

At the receiver side a corresponding filter or “de-emphasis” circuit is required to reduce the treble response to correct level. Since most noise and hiss tend to be at the higher frequencies, the de-emphasis removes a lot of this. Pre-emphasis and de-emphasis thus allow an improved signal to noise ratio to be achieved while maintaining the frequency response of the original audio signal. The de-emphasis Stage is used after the detector stage.

The response of the emphasis circuit can be understood from the following Graph:



De-Emphasis Circuit



PROCEDURE:-

- Connect the power supply with proper polarity and switch it on.
- Select Sine wave signal using jumper JP1 shorted.
- Select frequency range 1-10 KHz using JP4.
- Using pot P1 keep frequency at 1 KHz and using pot P2 keep amplitude at Vpp.
- Connect the output of function generator to the IN post of De-emphasis circuit.
- Observe output voltage at the OUT post of De-emphasis circuit.
- Plot the graph of output voltage v/s input frequency on graph paper.

RESULT:

VIVA QUESTIONS

1. What is pre-emphasis?
2. Which type of filter is used?
3. What is De-emphasis?
4. Which type of filter is used?