**SRI VENKATESWARA COLLEGE OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)**

**R. V. S NAGAR CHITTOOR-517 127**

***DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING***

# LABORATORY MANUAL

**LAB CODE : 20AEC13**

**LAB NAME : ANALOG COMMUNICATIONS LAB**

**YEAR & SEMESTER : II - II**

**REGULATIONS : R-20**

**Prepared by**

Dr.A.Maheswary,
Associate Professor,
Department of ECE,
SVCET (A).

## Vision and Mission of the Institute

**Vision**

- To carve the youth as dynamic, competent, valued and knowledgeable professionals who shall lead the Nation to a better future and to mould the institution into a Center of Academic Excellence and Advanced Research.

**Mission**

- To provide quality education, student-centered teaching-learning processes and state-of-art infrastructure for professional aspirants hailing from both rural and urban areas.
- To impart technical education that encourages independent thinking develops strong domain of knowledge, contemporary skills and positive attitudes towards holistic growth of young minds.

## Vision and Mission of the ECE Department

**Vision**

- To become a centre of excellence in the field of electronics and communications offering higher order of learning and conducting contemporary research thereby producing globally competitive and ethically strong engineering professionals.

**Mission**

- Establish a scintillating learning environment to produce quality graduates with passion for knowledge and creativity in the field of Electronics and Communication Engineering.
- Impart quality education through periodically updated curriculum to meet the challenges of the industry and research at the global level.
- Enhancing employability of the students by providing skills through comprehensive experiential learning.
- Developing professional etiquette and ethical integrity among the students to face real-time life challenges.
- Empower the faculty through continuous training in domain, research and pedagogy for enhancing learning outcomes of the students and Research output.

## Programme Educational Objectives (PEOs)

| | |
|---|---|
| PEO1 | Utilize knowledge, skills, and resources to enrich professional careers to pursue higher studies in the electronics and communication engineering and allied areas. |
| PEO2 | Develop entrepreneurship skills to achieve professional success with start-ups. |
| PEO3 | Develop attitude in lifelong learning and practice the profession with Integrity and responsibility. |

## Programme Outcomes (POs)

| | |
|---|---|
| PO1 | **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| PO2 | **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and Engineering sciences |
| PO3 | **Design/development of solutions**: Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. |
| PO4 | **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| PO5 | **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. |
| PO6 | **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. |
| PO7 | **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| PO8 | **Ethics:** Apply ethical principles and commit to professional ethics and Responsibilities and norms of the engineering practice. |
| PO9 | **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| PO10 | **Communication:** Communicate effectively on complex engineering Activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| PO11 | **Project management and Finance:** Demonstrate knowledge and Understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multi disciplinary environments. |
| PO12 | **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest Context of technological change. |

# SYLLABUS

## Course Outcomes:

After completion of the course students will be able to

CO1: Analyze the characteristics of different modulation and demodulation techniques.

CO2: Analyze different pulse modulation and demodulation schemes.

CO3: Analyze the spectrum characteristics and parameter of modulated signal

## List of Experiments:

**Minimum Ten Experiments to be conducted:**

1. Amplitude modulation and Demodulation.
2. Frequency modulation and Demodulation.
3. Characteristics of Mixer.
4. Pre-emphasis & De-emphasis.
5. Pulse Amplitude Modulation and Demodulation.
6. Pulse Position Modulation and Demodulation
7. Pulse Width Modulation and Demodulation
8. Radio Receiver measurements – Sensitivity, Selectivity and Fidelity
9. Spectrum Analysis of Modulated signal using Spectrum Analyzer
10. Time division Multiplexing and demultiplexing
11. Frequency synthesizer

## LIST OF EXPERIMENTS

| S.I No. | NAME OF THE EXPERIMENT |
|---|---|
| 1 | Amplitude modulation and Demodulation. |
| 2 | Frequency modulation and Demodulation. |
| 3 | Characteristics of Mixer. |
| 4 | Pre-emphasis & De-emphasis. |
| 5 | Pulse Amplitude Modulation and Demodulation. |
| 6 | Pulse Width Modulation and Demodulation. |
| 7 | Pulse Position Modulation and Demodulation. |
| 8 | Radio Receiver measurements – Sensitivity, Selectivity & Fidelity. |
| 9 | Spectrum Analysis of Modulated signal using Spectrum Analyzer |
| 10 | Time division Multiplexing and demultiplexing |
| 11 | Frequency synthesizer |

# INDEX

| Sl. No | Date | NAME OF THE EXPERIMENT | Pg. No. | Faculty Signature |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Exp. No. : 1** **Date:**

**AMPLITUDE MODULATION AND DEMODULATION**

**AIM**

To verify amplitude modulation and demodulation and to calculate the modulation index of an AM modulated wave

**EQUIPMENTS:**

- Modules ACL-AM & ACL-AD.
- Power supply
- 20MHz Oscilloscope.
- Connecting Links.
- Frequency counter

**THEORY**

In Amplitude Modulation the amplitude of high frequency sine wave (carrier) is varied in accordance with the instantaneous value of the modulating signal.

Consider a sine signal vm(t) with frequency f

$V_m(t) = B \cdot \sin(2\pi f \cdot t)$

And another sine signal Vc(t) is called modulating signal, the signal Vc(t) is called carriersignal.

$V_c(t) = A \cdot \sin(2\pi F \cdot t)$

The signal Vm(t) is called modulating signal; the signal Vc(t) is called carrier signal.

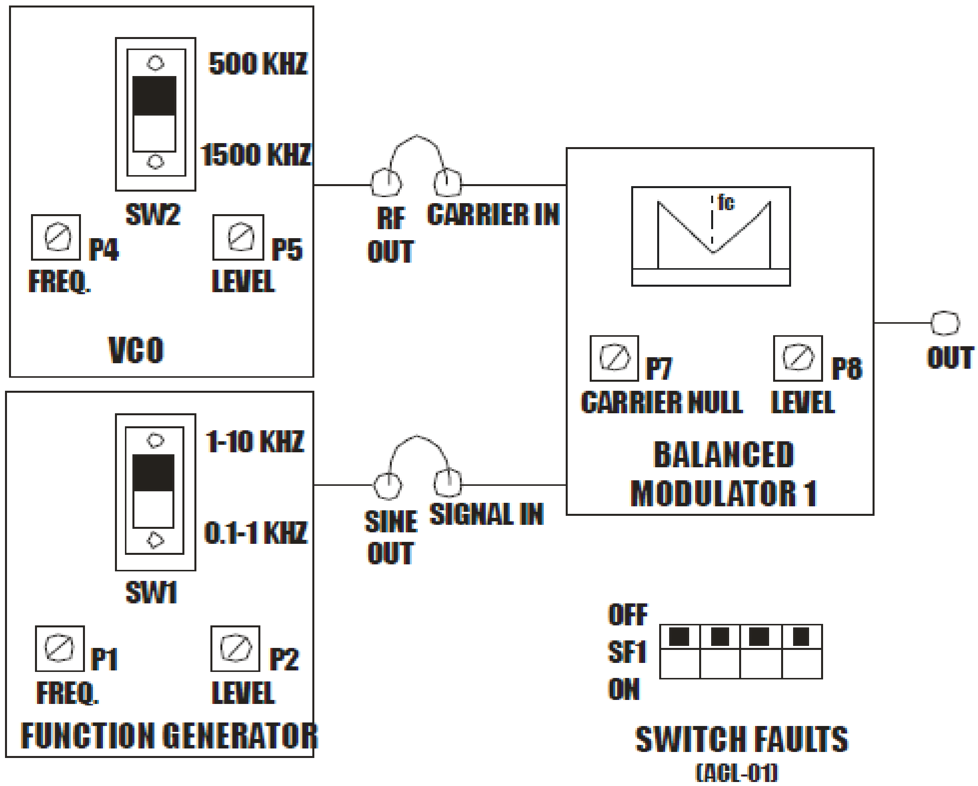
Vary the amplitude of the carrier Vc(t) adding the modulating signal Vm(t) to A. You obtain asignal vM(t) amplitude modulated, which can be expressed by:

$V\,m(t) = [A+k \cdot B \cdot \sin(2\pi f \cdot t)] \cdot \sin(2\pi F \cdot t) = A \cdot [1+m \cdot \sin(2\pi f \cdot t)] \cdot \sin(2\pi F \cdot t)$

With k = constant of proportionality.

The modulation index m can be calculated by using $m = \frac{Vmax - Vmin}{Vmax + Vmin} \text{X}100$

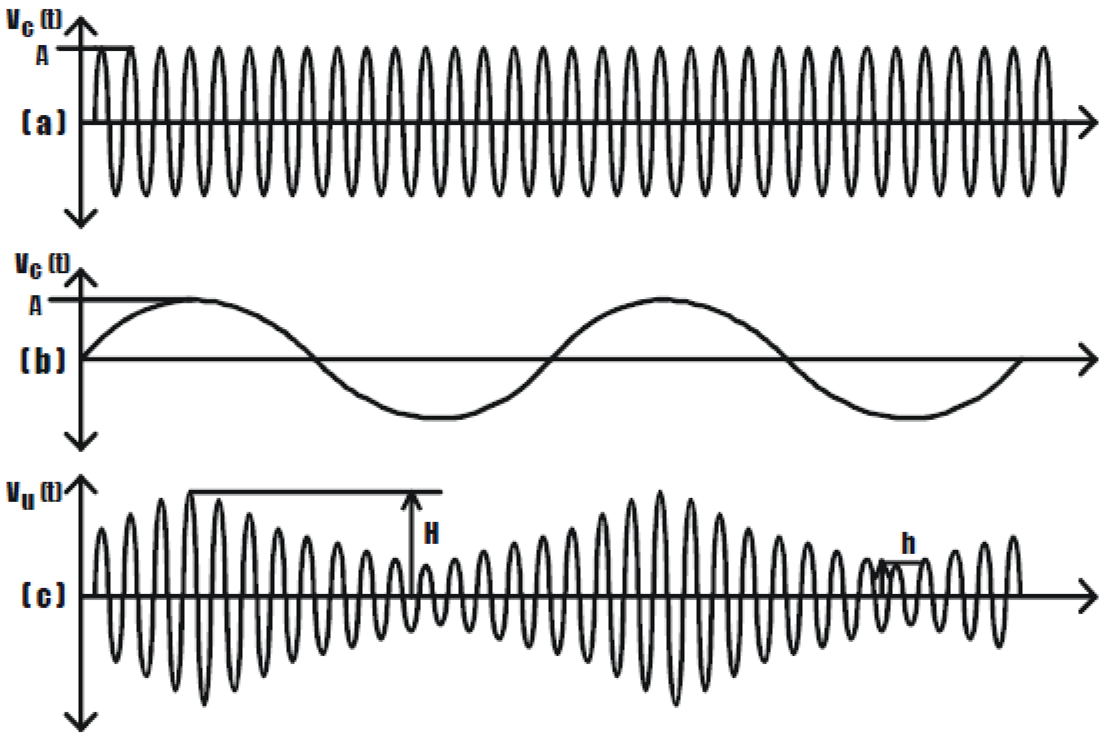
BLOCK DIAGRAM FOR AM MODULATION



**PROCEDURE FOR MODULATION:**

1. Connect **SINE OUT** post of **FUNCTION GENERATOR** SECTION (ACL-AM) to the i/p of BalanceModulator1 (ACL-AM) **SIGNAL IN** Post.
2. Connect o/p of **VCO** (ACL-AM) **RF OUT** post to the input of Balancemodulator1 **CARRIER IN** post (ACL-AM).
3. Connect the power supply with proper polarity to the kit ACL-AM & ACL-AD, while connecting this; ensure that the power supply is OFF.
4. Switch on the power supply and Carry out the following presetting:
   **FUNCTION GENERATOR:** LEVEL about 0.5Vpp; FREQ. about 1 KHz. **VCO:** LEVEL about 1 Vpp; FREQ. about 450 KHz, Switch on 500KHz **BALANCED MODULATOR1:** CARRIER NULL completely rotated
   Clockwise or counter clockwise, so as to "unbalance" the modulator and to obtain an AM signal with not suppressed carrier across the output; OUT LEVEL in fully clockwise.
5. Connect the oscilloscope to the inputs of the modulator post (SIG and CAR) and detect the modulating signal and the carrier signal
6. 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.
7. Vary the frequency and amplitude of the modulating signal, and check the corresponding variations of the modulated signal.
8. Vary the amplitude of the modulating signal and note that the modulated signal can result saturation or over modulation.

**MODEL WAVE FORMS**




**PROCEDURE FOR DEMODULATION:**

**PROCEDURE:**

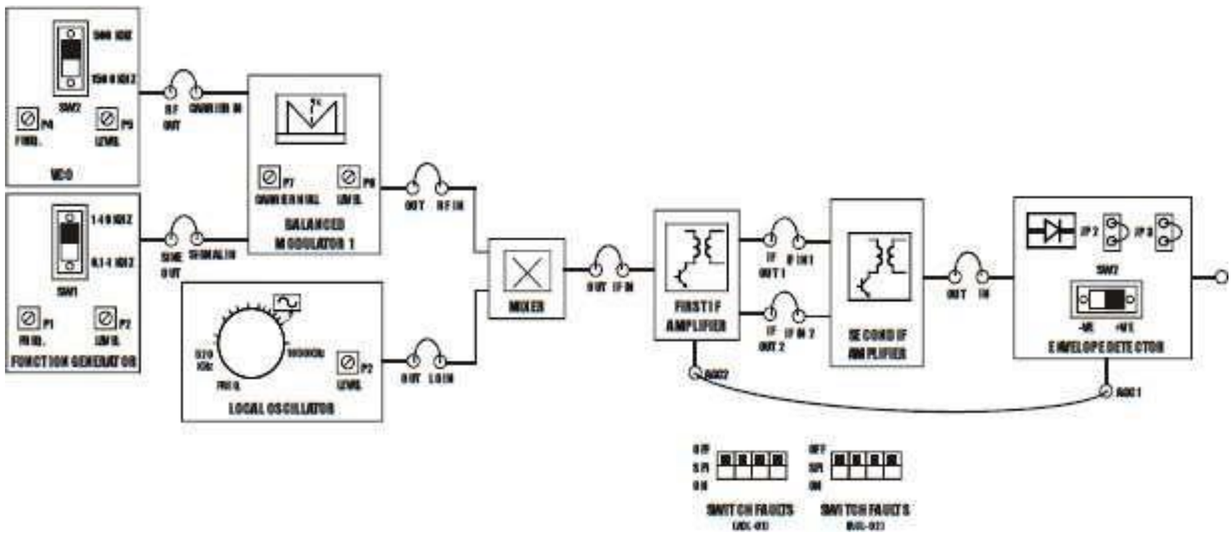
**1.** Refer to the FIG. 2.8 & Carry out the following connections.

**2.** Connect o/p of **FUNCTION GENERATOR** section (ACL-AM) **OUT** post to the i/p of BalanceModulator1 (ACL-AM) **SIGNAL IN** post.

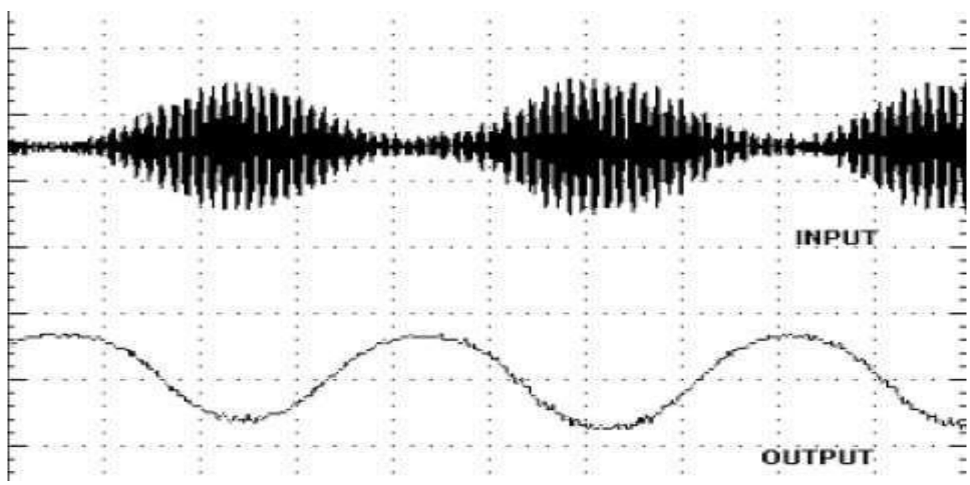
**3.** Connect o/p of VCO (ACL-AM) **OUT** post to the input of Balance modulator 1 (ACL-AM) **CARRIER IN** post.

**4.** Connect the power supply with proper polarity to the kit ACL-AM & ACL -AD, While connecting this, ensure that the power supply is OFF.

**5.** Switch on the power supply and Carry out the following presetting:




## MODEL WAVE FORMS




**Result:**

**Exp. No. :2** **Date:**

**FREQUENCY MODULATION AND DEMODULATION**

**AIM**

To verify Frequency Modulation and Demodulation

To measure frequency deviation and modulation index of FM.

**EQUIPMENTS**

ACL-FM & ACL-FD Kits.

Power supply.

Oscilloscope.

Volt meter.

Frequency meter.

Connecting Links.

**THEORY**

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.

Consider a sine wave signal $v_m(t)$ with pulse w

$$v_m(t) = B \cdot \sin(w \cdot t)$$

and another sine wave vc(t) with upper □ pulse:

$$v_c(t) = A \cdot \sin(w□ \cdot t)$$

The signal $v_m(t)$ is called modulating signal, the signal $v_c(t)$ 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: $v_m(t) = A \cdot \sin[□(t)]$

with□(t) instantaneous angle function of vm(t).

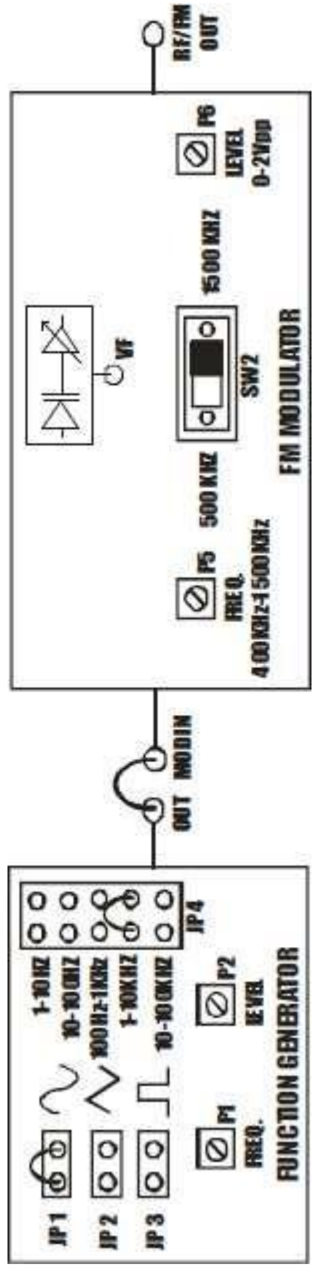
The instantaneous pulse F(t) of the FM signal by definition:

$$□(t) = □ + K \cdot v_m(t)$$

The frequency deviation □F represents the maximum shift between the modulated signal frequency, over and under the frequency of the carrier:□ $F = \frac{F_{max} - F_{min}}{2}$

We define as modulation index mf the ratio between □**F** and the modulating frequency f: $mf = \frac{□F}{}$

**BLOCK DIAGRAM**



**PROCEDURE**

1. Connect the power supply with proper polarity to the kit ACL-FM while connecting this; ensure that the power supply is OFF.

2. Connect the o/p of function generator **OUT** post to the modulation **IN** of FREQUENCY MODULATOR **MOD IN** post.

3. Switch ON the power supply and Carry out the following presetting:-

**FUNCTION GENERATOR**: sine wave (JP1); LEVEL about 100mV; FREQ**.** about 1KHz.

- **FREQUENCY MODULATOR** LEVEL about 2Vpp; FREQ**.** on the center; switch on1500KHz. 4.Connect the oscilloscope to the output of the modulator FM/RF OUT.

5. The frequency deviation _ F can be calculated as follows

- From the oscilloscope evaluate FM and Fm, detecting the periods of the respective sine waves

- The frequency deviation □**F** is defined as: □**F** = (FM – Fm)/2

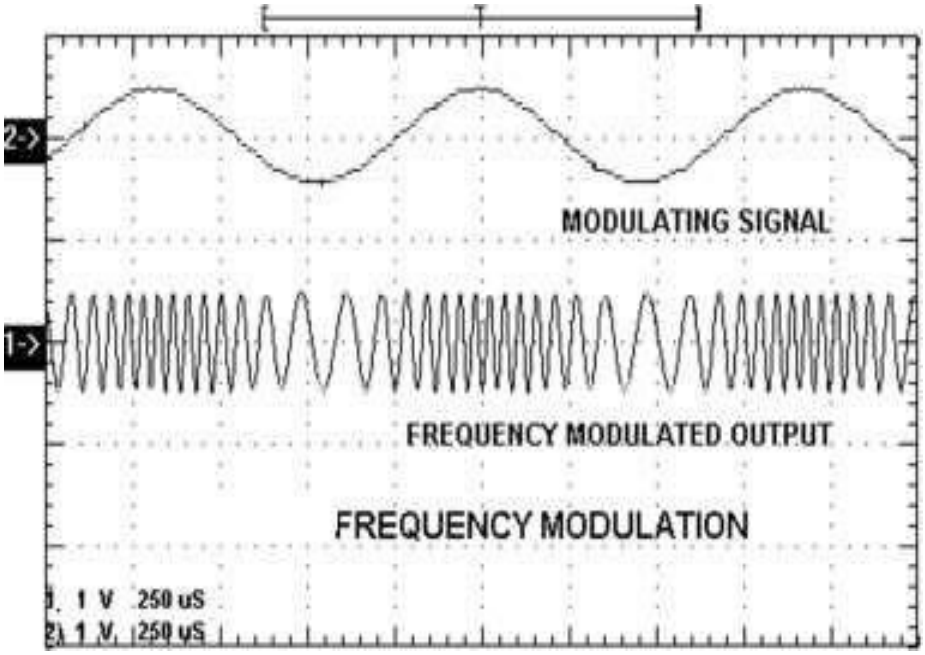
You can note that if the modulator operates in a linear zone so FM and Fm are over and under the central frequency F of the same quantity □**F** , otherwise this does not occur.

6. The value of the modulation index mf is calculated by the relationmf = □**F**/f, where f is the frequency of the modulating signal.

7. Then observe the FM signal as shown in FIG.

8. To observe the FM at lower frequencies apply Sine wave of 1KHz and 1Vpp from external function generator to **MOD IN** post of onboard Function Generator and keep JP4 at 10-100KHz position and adjust the frequency at about 20-25KHz and output level of Function generator at 2Vpp.

**MODEL WAVE FORMS**



**DEMODULATION PROCEDURE**

1.Connect the o/p of Function Generator (ACL-FM) **OUT** post to the **MOD IN**(ACL-FM) post.

2.Connect the o/p of FREQUENCY MODULATOR **FM/RF OUT** post to the I/p ofRF IN of mixer

3. Connect the power supply with proper polarity to the kit ACL-FM & ACL-FD,while connecting this; ensure that the power supply is OFF.

4. Switch ON the power supply and Carry out the following presetting:

- **Frequency Modulator:** Switch on 500KHz; LEVEL about 1 Vpp;FREQ. about 450 KHz.
- Frequency demodulator in Foster-Seeley mode (jumpers in FSposition).
- **Function Generator:** Sine wave (JP1); LEVEL about 100mVpp;FREQ. about 1 KHz.
- **Local Oscillator:** LEVEL about 1 Vpp; FREQ. About1000 KHz on(Center).

□□ Connect the LOCAL OSCILLATOR **OUT** to the **LO IN** of the MIXER and MIXER **OUT** to the LIMITER **IN** post with the help of shorting links.

???Then connect the LIMITER **OUT** post to the **FM IN** of FOSTER- SEELEY DETECTOR and **FS OUT** to the **IN** of LOW PASS FILTER.

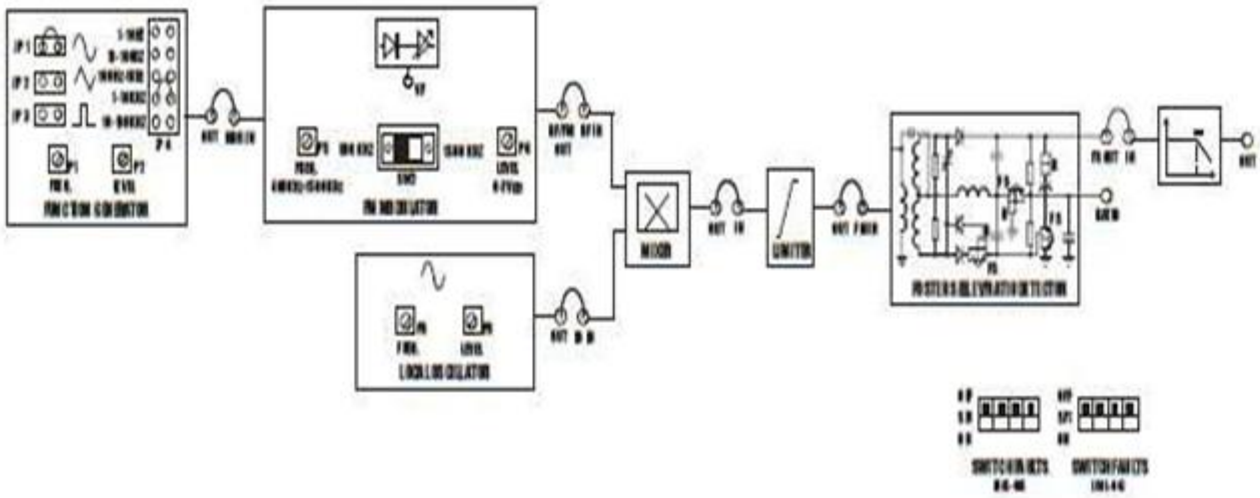
7. Then observe frequency modulated signal at FM/RF **OUT** post of FREQUENCY MODULATOR and achieve the same signal by settingfrequency of LOCAL OSCILLATOR at **OUT** post of **MIXER,** then observe LIMITER OUT post where output is clear from noise and stabilize around a value of about 1.5Vpp.

8. Connect the oscilloscope across post **FS OUT** of ACL-FD (detected signal) and FUNCTION GENERATOR **OUT** post (modulating signal) of ACL-FD. If the central frequency of the discriminator and the carrier frequency of the FM signal and local oscillator frequency coincide, you obtain two signals The fact that there is still some high-frequency ripple at the output of the FOSTERSEELEY DETECTOR block indicates that the passive low pass filter circuit atthe block's output is not sufficient to remove this unwanted high-frequency component. We use the LOW PASS FILTER block to overcome this problem. 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.

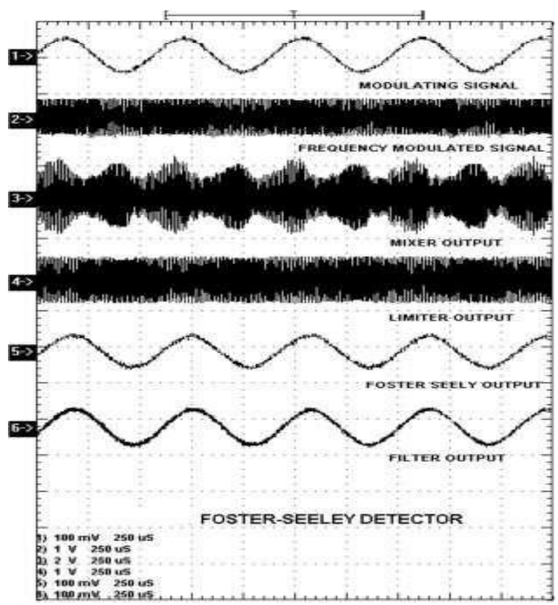
9. Note that the demodulated signal has null continuous component. Vary the amplitude of the FM signal and check that the amplitude of the detected signal varies, too.

10. Increase the carrier frequency and note that a positive voltage is added to the detected signal. Still increasing the frequency, the detected signal presents a distortion

**BLOCK DIAGRAM**



**MODEL WAVE FORMS**




RESULT:

**Exp. No. :3** **Date:**

# Characteristics of a Mixer

## Aim:

To verify the process of Characteristics of a Mixer.

## Apparatus:

1) Mixer kit
2) Connecting wires

## Theory:

The fundamental principal of modulating involves the mixing or multiplying of a low frequency signal with a higher frequency signal such as an AM or FM carrier this enables the information in the low frequency signal to be transmitted through space as high frequency electromagnetic waves. Commercial radios use 455 kHz as intermediate frequency for commercial AM. These IF carrier contains all the information available to the receiver but in order to obtain this information, mixing must take place to obtain the lower frequency signals up to IF or RF frequencies.

The purpose of this experiment is to observe the effect of mixing two frequencies using a non-linear single transistor mixer and to demonstrate the use of a band stop and a 2 pole low pass filter in a practical application.

## Procedure:

1). Measure the output voltage of regulator power supply and observe the signal frequency of $f_m$ and $f_c$.

2). Adjust the level of $f_m$ to 0.5Vpp.

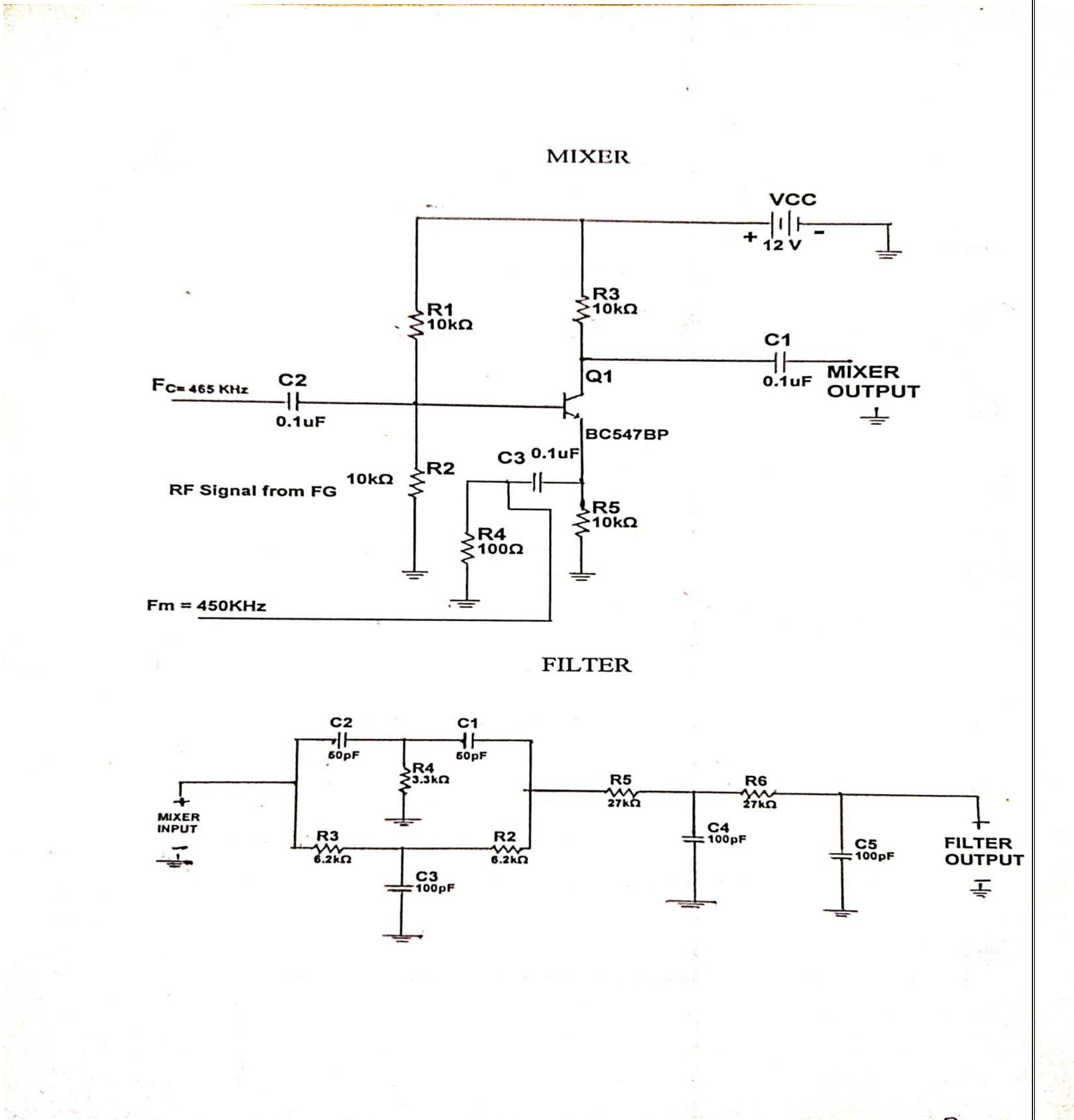
3). Connect $f_m$ and $f_c$ to modulator inputs.

4). Observe the output of modulator distortion may be found in the modulator signal which generates the intermediation products.

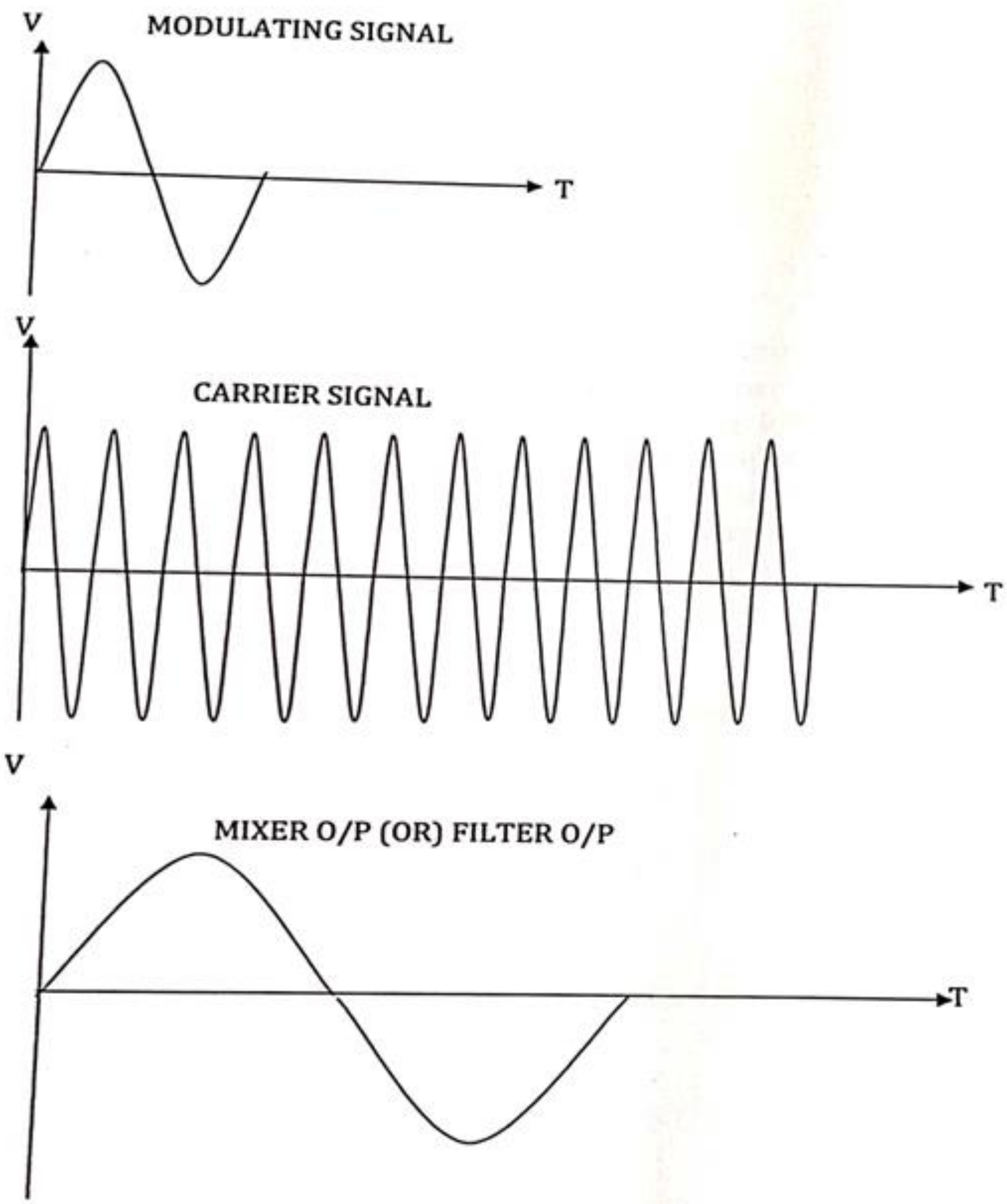
5). Apply the output of the filter, maximize it's amplitude by varying the levels of $f_m$ and $f_c$.

6). Measure the frequency of the output signal and verify that it is equal to $f_c$-$f_m$,

**Block Diagram;**



**Model Waveforms:**




**Result:**

**Exp. No. :4** **Date:**

## PRE-EMPHASIS AND DE-EMPHASIS

**AIM**

To verify Pre-Emphasis and De- emphasis Circuit and it's Response

**EQUIPMENTS**

- ACL-FM & ACL-FD Kits
- Power supply
- Oscilloscope
- Frequency meter
- Connecting links

**THEORY**

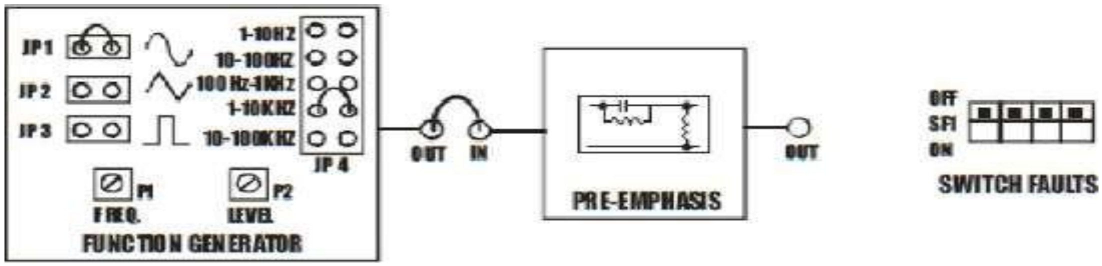
**Need For Pre Emphasis**

Frequencies contain in human speech mostly occupy the region from 100 to 10,000 Hz, but most of the power is contained in the region of 500 Hz for men and 800 Hzfor women. Common voice characteristics emit low frequencies higher in amplitudethan higher frequencies. The problem is that in FM system the noise output of thereceiver increases linearly with the frequency, which means that the signal to noiseratio becomes poorer as the modulating frequency increases. Also, noise can make radio reception less readable and unpleasant. This noise is greatest in frequencies above 3KHz.The high frequency noise causes interference tothe already weak high frequency voice. To reduce the effect of this noise and ensurean even power spread of audio frequencies,

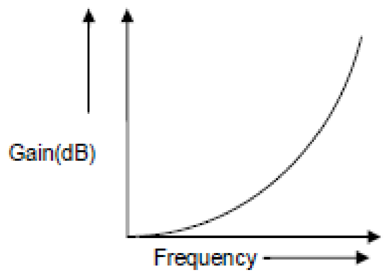
**Pre emphasis is used at the Transmitter Side**

A pre-emphasis network in the transmitter accentuates the audio frequencies above3 KHz, so providing the higher average deviation across the voice spectrum, thus improving the signal to noise ratio. 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.

**BLOCK DIAGRAM**




**MODEL WAVE FORM**




**PROCEDURE:**

The characteristic of pre-emphasis circuit is given by output voltage of the pre-emphasis Circuit as the function of instantaneous input frequency. It is possible to plot the curve of fig. By varying the input frequency and measuring the corresponding output voltage.

1 Make the connections as shown in the block diagram Fig.2.1.

2. Connect the power supply with proper polarity to the kit ACL-FM while connecting this; ensure that the power supply is OFF.

3. Connect the output of function generator to the IN of pre-emphasis circuit.

4. Switch on the power supply and carry out the following presetting.

FUNCTION GENERATOR: Frequency about 1KHz and level of 100mV p-p sine wave. Now vary the frequency in steps of 500Hz and note down the output voltage at the OUT post of pre-emphasis circuit.

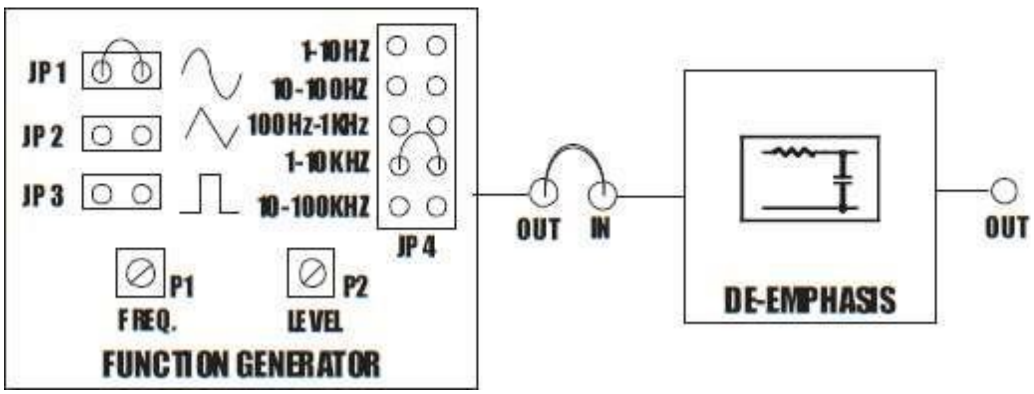
5. Plot the graph of output voltage v/s input frequency on graph paper. The response should come as shown in the theory above.

6. From the response you can easily understand that using the pre-emphasis Circuit we can increase the amplitude of modulating signal at higher frequencies thus improving the Signal to Noise ratio at higher frequencies of the pre-emphasis.

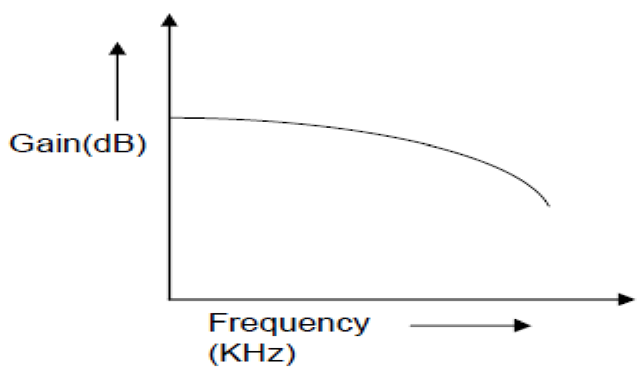
**De emphasis:**

The problem in FM broadcasting is that noise and hiss tends 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. 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 tends to be at the higher frequencies, the de emphasis removes a lot of this. Pre emphasis and deemphasis 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 de emphasis circuit can be understood from the following graph:

**BLOCK DIAGRAM**




**MODEL WAVEFORM**



**PROCEDURE**

The characteristic of de-emphasis circuit is given by output voltage of the deemphasize circuit as the function of instantaneous input frequency. It is possible toplot the curve of fig. By varying the input frequency and measuring the corresponding output voltage.

1. Make the connections as shown in the block diagram .
2. Connect the power supply with proper polarity to the kit ACL-FD while connecting this; ensure that the power supply is OFF.
3. Connect the output of function generator(ACL-FM) to the IN of de-emphasis' circuit(ACL-FD).
4. Switch on the power supply and carry out the following presetting.
5.FUNCTION GENERATOR: Frequency about 1KHz and level of 100mV p-psine wave
6. Now vary the frequency in steps of 500Hz and note down the output voltage at the OUT post of de-emphasis circuit.
7. Plot the graph of input frequency v/s output voltage on graph paper. The response should come as shown in theory.

RESULT

**Exp. No. :5** **Date:**

# PULSE AMPLITUDE MODULATION AND DE MODULATION

**AIM:**

To verify Pulse Amplitude Modulation and Demodulation

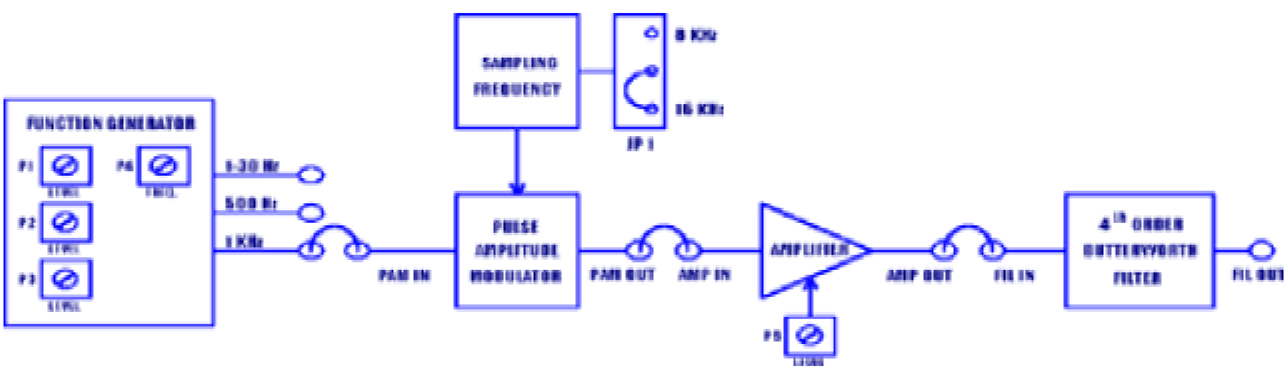
**EQUIPMENTS**

Experimenter kit DCL-08.
Connecting Chords Power
supply
20 MHz Dual trace oscilloscope

**THEORY**:

In Pulse Amplitude Modulation, the signal is sampled at regular intervals and the amplitude of each sample is made proportional to the amplitude of the signal at that instant of sampling. This amplitude of each sample is hold for the sample duration to make pulses flat top. The Pulse Amplitude Demodulator consists of Active Low Pass Butterworth filter. It filters out the sampling frequency and their harmonics from the modulated signal and recovers the base band by integrated action.

**BLOCK DIAGRAM**

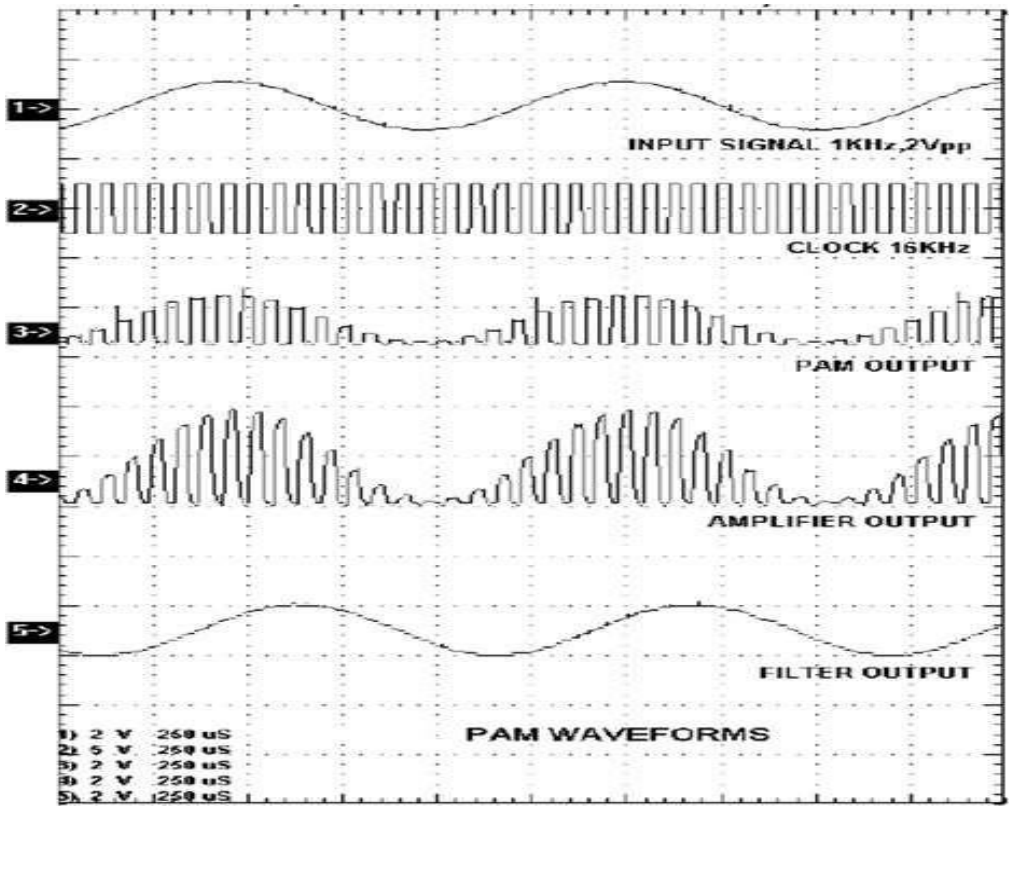


**PROCEDURE**

1.Connect the Power Supply with proper polarity to the kit **DCL-08** and switch it on.
2. Select **16 KHz** sampling frequency by jumper **JP1**.
3.Connect the **1 KHz**, 2Vp-p sine wave signal generated onboard to **PAM IN** Post.
4. Observe the Pulse Amplitude Modulation output at **PAM OUT** Post.
5.Short the following posts with the Connecting chords provided as shown in block diagram.
**PAM OUT** and **AMP**
**INAMP OUT** and **FIL**
**IN**

6.Keep the amplifier gain control potentiometer **P5** to maximum completely clockwise.
7.Observe the Pulse Amplitude Demodulated signal at **FIL OUT**, which is same as the input signal.
8. Repeat the experiment for different input signal and sampling frequencies

**MODEL WAVE FORMS**




**RESULT**

**Exp. No. :6** **Date:**

# PULSE WIDTH MODULATION AND DEMODULATION

## AIM

To verify Pulse Width Modulation and Demodulation

## EQUIPMENTS

Experimenter kit DCL-08.

Connecting Chords Power

supply

20 MHz Dual trace oscilloscope

## THEORY

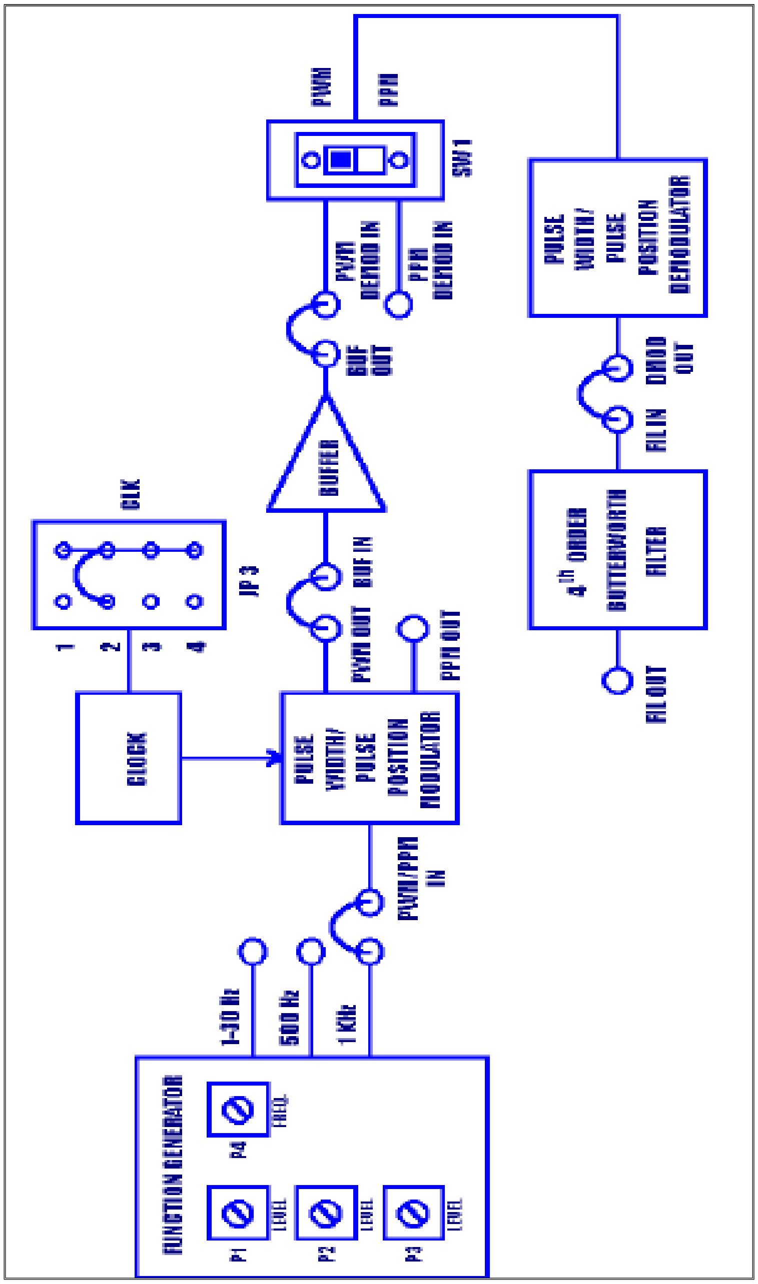
### Pulse Width Modulation

This technique of modulation controls the variation of duty cycle of the square wave (With some fundamental frequency) according to the input modulating signal. Here the amplitude variation of the modulation signal is reflected in the ON period variation of square wave. Hence, it is a technique of V to T conversion.

### Pulse Width Demodulation

The input signal is Pulse Width Modulated, so the ON time of the signal is changing according to the modulating signal. In this demodulation technique during the ON time of PWM signal one counter is enabled. At the end of ON time, counter gives a particular count, which directly corresponds to the amplitude of input signal. Then this count is fed to a DAC. The output of DAC corresponds to the amplitude of input signal. Thus train of varying pulse widths gives varying count values and accordingly DAC give outputs, which is directly proportional to amplitude of input signal. This is then filtered to get original signal. Thus at the output we get the original modulating signal extracted from PWM wave.

**BLOCK DIAGRAM**



**PROCEDURE**

1. Connect the Power Supply with proper polarity to the kit **DCL-08** and switch it on. DCL-08: PAM / PWM / PPM MODULATION & DEMODULATION KIT
2. Put jumper **JP3** to 2nd position.
3. Select **1KHZ** 1v-pp sine wave signal generated onboard.
4. Connect this signal to **PWM/PPM IN**.

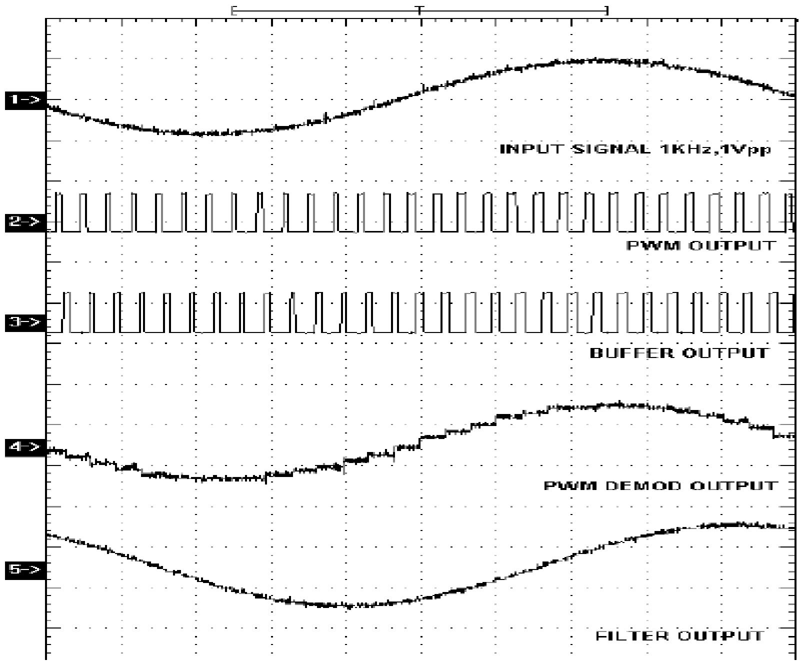
Observe the Pulse Width Modulated output at **PWM OUT** post. Note that since the sampling frequency is high, only blurred band in waveform will be observed due to persistence of vision. In absence of input signal only square wave of fundamental frequency and fixed on time will be observed and no width variation are present. To observe the variation in pulse width, apply 1-30Hz sine wave signal to **PWM/PPM IN** post. Vary the frequency from 1-30 Hz.

5.Short the following posts with the Connecting chords provided as shown in block diagram for demodulation section.

**PWM OUT** and **BUF IN**
**BUF OUT** and **PWM DMOD**
**INDMOD OUT** and **FIL IN**

6. Observe the Pulse Width Demodulated output at **FIL OUT**.
7. Repeat the experiment for different input signal and different sampling clocks.

**MODEL WAVE FORMS**




**RESULT:**

**Exp. No. :7** **Date:**

# PULSE POSITION MODULATION AND DEMODULATION

**AIM**

To verify Pulse Position Modulation and Demodulation.

**EQUIPMENTS**

Experimenter kit DCL-08.

Connecting Chords Power

supply

20 MHz Dual trace oscilloscope

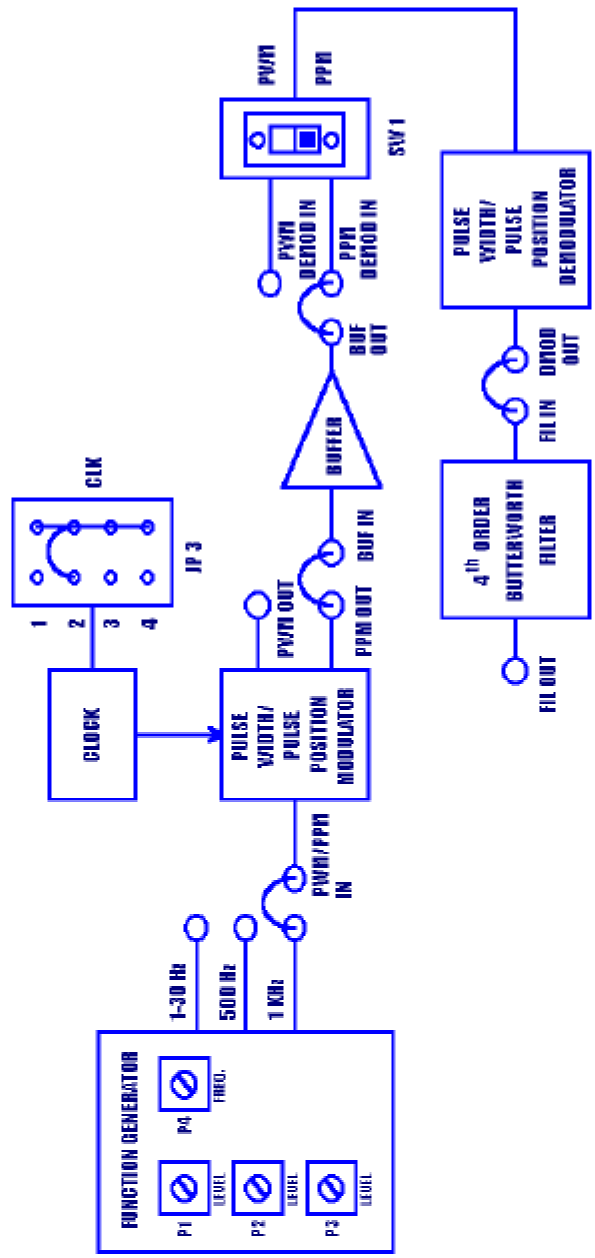
**THEORY**

The position of the TTL pulse is changed on time scale according to the variation of input modulating signal amplitude, Width of the pulses and Amplitude of the pulses remain same.

**Demodulation**

This pulse position modulated signal is converted into PWM pulse form using Monostable multivibrator. This signal is then demodulated using the same technique of PWM demodulation. In this demodulation technique during the ON time of PWM signal one counter is enabled. At the end of ON time, counter gives a particular count, which directly corresponds to the amplitude of input signal. Then this count is fed to a DAC. The output of DAC corresponds to the amplitude of input signal. Thus train of varying pulse widths gives varying count values and accordingly DAC gives outputs, which is directly proportional to amplitude of input signal. This is then filtered to get original signal. Thus at the output we get the original modulating signal extracted from PWM wave

**BLOCK DIAGRAM**



**PROCEDURE**

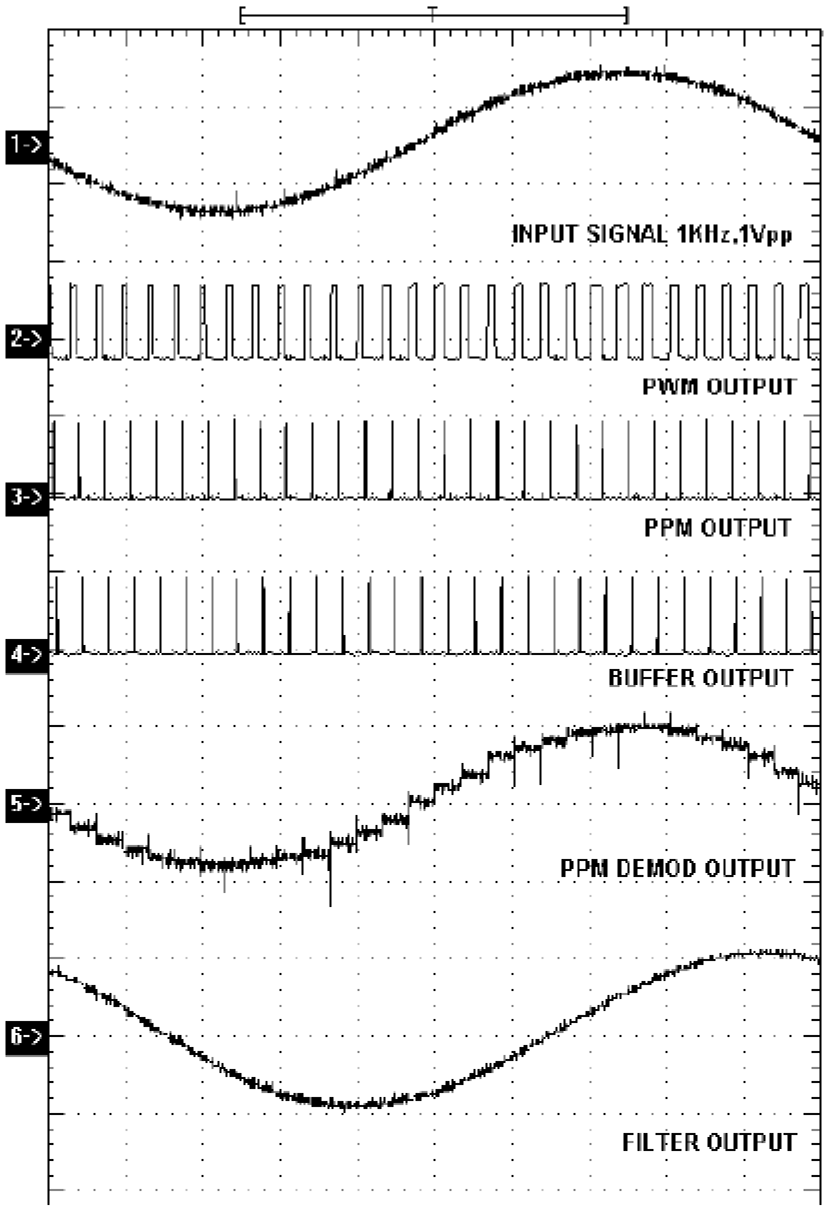
1. Connect the Power Supply with proper polarity to the kit **DCL-08** and switch it on.
2. Put jumper **JP3** to 2nd position.
3. Select **1KHZ**, 1v-pp sine wave signal generated onboard.
4. Connect the selected signal to the **PWM/PPM IN.**
5. Observe the Pulse Position Modulated output at **PPM OUT** post with shifted position on time scale. Please note amplitude and width of pulse are same and there is shift in position which is proportional to input Analog signal.
6. To observe the variation in pulse positions, apply 1-30Hz sine wave signal to **PWM/PPM IN** post vary the frequency from 1-30 Hz and observe the signal on oscilloscope in dual for posts **PPM OUT** and **PWM OUT** simultaneously.
7. Then short the following posts with the link provided as shown in block diagram for Demodulation section.

   **PPM OUT** and **BUFIN**

   **BUFOUT** and **PPM DMOD**

   **INDMOD OUT** and **FIL IN**
8. Observe the Pulse Position Demodulated signal at **FIL OUT**.
9. Repeat the experiment at different input signal and different sampling frequencies.

**MODEL WAVE FORMS**




**Result:**

**Exp. No. :8** **Date:**

# RADIO RECEIVER MEASUREMENTS – SENSITIVITY, SELECTIVITY AND FIDELITY

**AIM:** To study the Sensitivity, Selectivity and Fidelity of a radio receiver.

**EQUIPMENT REQUIRED:**

1. Trainer Kit
2. CRO
3. Probes
4. Patch cards

**CIRCUIT OPERATION:**

**Sensitivity:**

The sensitivity of a receiver is its ability to amplify weak signals. The sensitivity of a receiver is the minimum voltage required at the input of the receiver to produce the original signal.

It is often defined in terms of the voltage that must be applied to the receiver input terminals to give a standard output power, measured at the output terminal.

For an AM broadcast receivers, several relevant quantities have been standardized. The most important factors determining sensitivity of a receiver is the Gain of the receiver.

**Selectivity:**

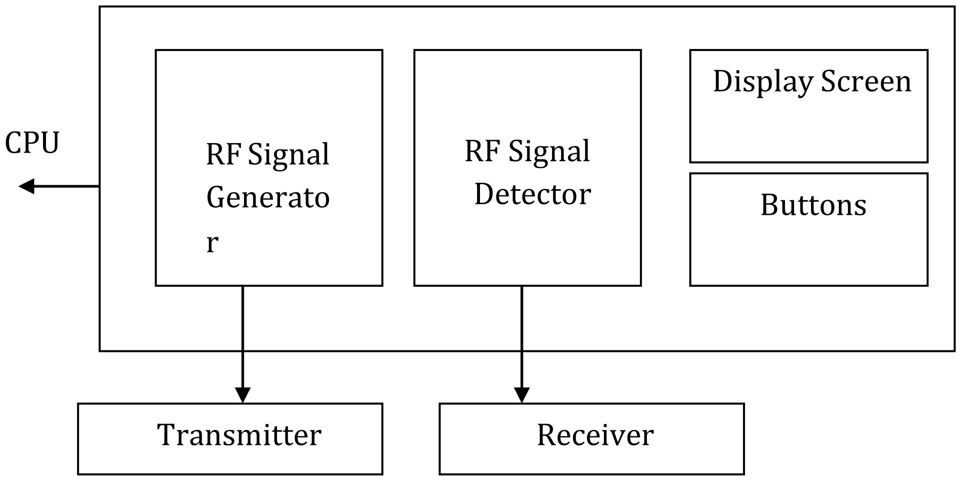
A parallel tuned circuit has its greatest impendence at resonance and decreased at higher and lower frequencies. If a tuned circuit is induced in the circuit design of an amplifier, it results in the amplifiers, which offers more gain at the frequency of resonance and reduced amplification above and below this frequency. This is called selectivity.The radio receiver is tuned to a frequency of 820 KHz and at this frequency the ampliferprovides a gain of five.

**PROCEDURE:**

**Sensitivity:**

1. Refer to the figure and carry out the following connections
2. Connect the output of function generator section (ACL-AM) outpost to the input of balance modulator (ACL-AM) signal post.
3. Connect the output of VCO (ACL-AM) outpost to the input of balance modulator (ACL-AM) carrier in post.
4. Connect the power supply with proper polarity to the kit ACL-AM & ACC-AP, while connecting. Ensure that power supply is OFF.

**BLOCK DIAGRAM:**




**TABULAR COLUMN:**

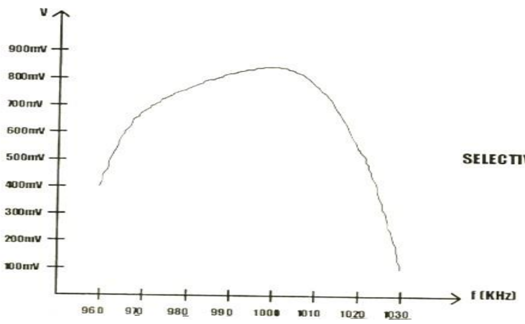
**For sensitivity:**

| Carrier Freq.(KHz) VCO | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 |
|---|---|---|---|---|---|---|---|---|
| Local OSC. Freq.(KHz) | 1050 | 1150 | 1250 | 1350 | 1450 | 1550 | 1650 | 1750 |
| Output of Mixer(V) | | | | | | | | |

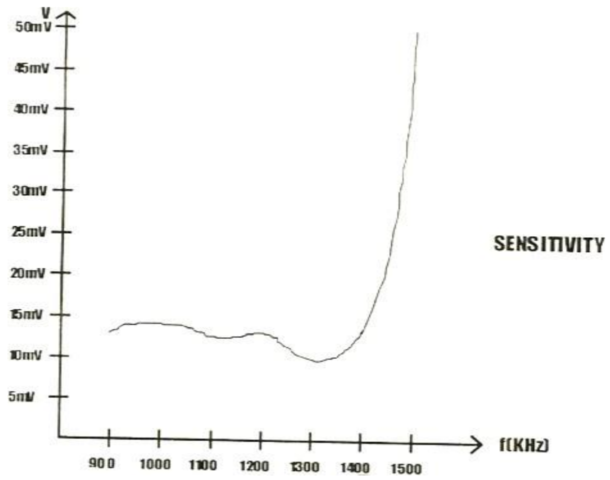
**For selectivity:**

| Carrier Freq.(KHz) VCO | 860 | 870 | 880 | 890 | 900 | 910 | 920 | 930 | 940 | 950 |
|---|---|---|---|---|---|---|---|---|---|---|
| Output of Envelope Detector(mV) | | | | | | | | | | |

**MODEL GRAPHS:**




SELECTIVITY




**Function generator:**

Sine wave about 0.5 $V_{P-P}$ Frequency about 1KHz $V_{CO}$ level about 2 $V_{P-P}$ Frequency about 600 KHzSwitch on 1500 KHz

**Balanced modulator:**

Carrier null completely rotates clockwise or counter clockwise so that the modulator is unbalanced and an AM signal without suppressed carrier is obtained across the output which amplitude is 200 $V_{P-P}$.

**Local Oscillator:**

ACL-AD is 1050 KHz, 2 V

5. Connect load oscillator outpost to $LO_{IN}$ of micro-mixer section.
6. Connect balance modulator-1 OUT to $RF_{IN}$ of micro-section in ACL-AD.
7. Connect the mixer output to $IF_{IN}$ of first IF amplifier in ACL-AD , connect IF OUT of first $IF_{IN1}$ and IF OUT 2 of first IF to $IN_2$ of second IF amplifier.
8. Observe the modulated signal envelope which corresponds to the waveform of the modulating signal at output of the balanced modulator of ACC-AM. Connect the oscilloscope to the IN & OUT POST of envelope detector and detect the AM signal.
9. Check that detected signal follows the behavior of AM signal envelope, vary the amplitude of the balanced modulator output and check the corresponding variations of demodulated signal.
10. Adjust the input to $RF_{IN}$ POST by varying the output of AM in such a way that you should getminimum detected output of about 0.3 V at the output of envelope detector.
11. Take the readings as per the table mentioned below for various carrier frequencies& corresponding local oscillator frequency settings.

**PROCEDURE:**

**Selectivity:**

1. Refer to the figure and carry out the following connections
2. Connect the output of function generator section (ACL-AM) outpost to the input of balance modulator (ACL-AM) signal inpost.
3. Connect the output of VCO (ACL-AM) outpost to the input of balance modulator (ACL-AM) carrier in post.
4. Connect the power supply with proper polarity to the kit ACL-AM & ACC-AW, while connecting. Ensure that power supply is OFF.
5. Switch on the power supply and carryout the following presetting.

**Function generator:**

Sine wave about 0.5 $V_{P-P}$ Frequency about 1KHz $V_{CO}$ level about 2 $V_{P-P}$ Frequency about 850 KHzSwitch on 1500 KHz

**Balanced modulator:**

Carrier null completely rotates clockwise or counter clockwise so that the modulator is unbalanced and an AM signal without suppressed carrier is obtained across the output which amplitude is 50mm VP-P.

**Local Oscillator:**

ACL-AD is 1300 KHz, 2 V

1. Connect load oscillator outpost to $LO_{IN}$ of micro-mixer section.
2. Connect balance modulator-1 OUT to $RF_{IN}$ of micro-section in ACL-AD.
3. Connect the mixer output to $IF_{IN}$ of first IF amplifier in ACL-AD , connect IF OUT of first IFand IF W and IF OUT 2 of first IF to $IN_2$ of second IF amplifier.
4. Connect OUT POST of second IF amplifier to IN POST 2 of second amplifier to IN POST of envelop detector.
5. Connect the post AGC1 to post AGC2 and jumper position as per diagram.
6. Connect the oscilloscope to the IN and OUT post of envelop detector and detect AM signal.
7. Check the defected signal follows the behavior of the AM signal envelop, measure the detected signal amplitude.

**RESULT:**

**Exp. No. :9** **Date:**

## Study of Spectrum Analyzer

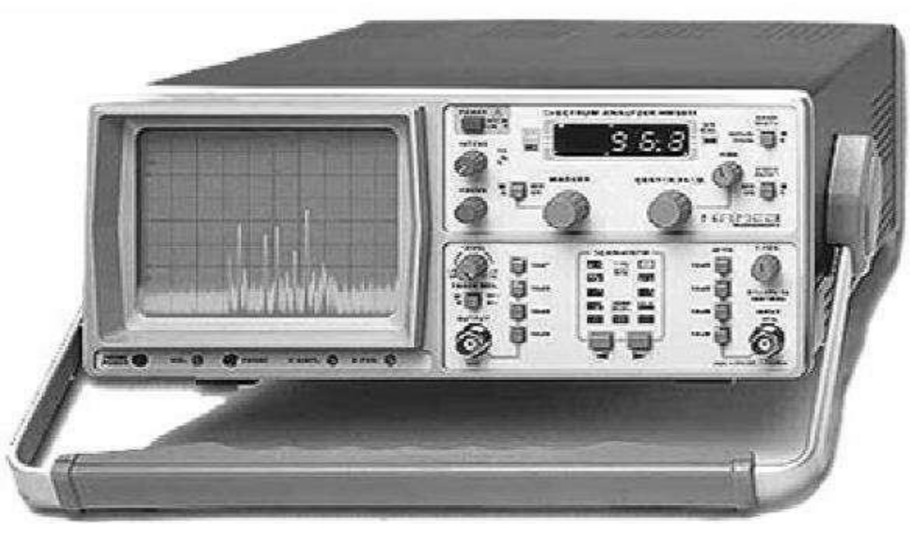
**Aim:** To Study the operation of Spectrum Analyzer.

**Equipment required:**

| | | |
|---|---|---|
| Spectrum Analyzer | -------- | 1 |
| Any modulation system kit | | 1 |
| Connecting wires. | ------- | Required |

**Introduction**

To analyze the AM and FM waveform using spectrum analyzer. The oscilloscope is the most common device used to display the signals, with time as x-axis. The signals which require time as x-axis, to display them are time domain signals. The signals which require frequency as x-axis, to display them are called frequency domain signals. Frequency domain display of signal consists of information of energy distributed of the signal. The analysis of such a frequency domain display of the signal is called spectral analysis of the signal. Thus the study of the energy distribution across the frequency spectrum if a given signal is defined as the spectral analysis. The instrument which graphically provides the energy distribution of a signal as a function of frequency on its CRT is called spectrum analyzer. It provides a calibrated graphical display with the frequency on horizontal axis and the signal component on the vertical axis, the sinusoidal components of which, the signal is made up of, are displayed as the vertical lines against frequency coordinates. The frequency of each vertical line gives the absolute amplitude if the component while the horizontal location gives that particular frequency.




HAMEG 5010 SPECTRUM ANALYZER

The analysis of electrical signals is a fundamental problem for many engineers and scientists. Even if the immediate problem is not electrical, the basic parameters of interest are often changed into electrical signals by means of transducers. The rewards for transforming physical parameters to electrical signals are great, as many instruments are available for the analysis of electrical signals in the time and frequency domain. The traditional way of observing electrical signals is to view them in time domain using oscilloscope. The time domain is used to recover relative timing and phase information which is needed to characterize electrical circuit behavior. How ever, not all circuit can be uniquely characterized from just time domain information. Circuit elements such as amplifiers, oscillators, mixers, modulators, detectors and filters are best characterized by their frequency response information. This frequency information is best obtained by viewing electrical signals in frequency domain. To display the signal in the frequency domain requires a device that can discriminate between frequency domains is the spectrum analyzer. It graphically displays the voltage or power as a function of frequency on a CRT. In the time domain, all frequency components of a signal are seen summed together. In the frequency domain, complex signals are separated in to their frequency components, and power level at each frequency is displayed. The frequency domain is a graphical representation of signal amplitudes as a function of frequency. The frequency domain contains information not found in time domain.

**Types Of Spectrum Analyzers**

There are two basic types of spectrum analyzers, swept-tuned and real time analyzers. The swept-tuned analyzers are tuned by electrically sweeping them over their frequency range. Therefore the frequency components of a spectrum are sampled sequentially in time. This enables periodic and random signals to be displayed, but makes it impossible to display transient response. Real time analyzers, on the other hand, simultaneously display the amplitude of all signals in the frequency range of the analyzer: hence the name real-time. This preserves the time dependency between signals which permits information to be displayed. Real time analyzers are capable of displaying transient response as well as periodic and random signals. The swept tuned analyzers are usually of the TRF (tuned radio frequency) or super heterodyne type. A TRF analyzer consists of a frequency range, a detector to produce vertical deflection on a CRT, and a horizontal scan generator used to synchronize the tuned frequency to the CRT horizontal deflection. It is a simple, inexpensive analyzer with wide frequency coverage, but lacks resolution and sensitivity. Because TRF analyzers have swept filter they are limited in sweep width.

**Applications Of Spectrum Analyzers:**

1. **Modulation measurements:**

When the frequency scan of spectrum analyzer is set to zero and x-axis is representing time instead of frequency, it operates as a fixed tuned receiver to measure amplitude against time. This is called its synchroscope mode. When analyzer is tuned to carrier frequency with bandwidth at least twice that of modulation frequency and with a linear display, the envelop of an AM signal is observed. Measuring the peak VP and through VT, modulation index can be determined. When operated in normal mode, two sidebands separated from the carrier by modulation frequency fm are observed. The modulation index can be calculated from the sidebands and carrier amplitude. Similarly it can be used to calculate the distortion occurring in modulation process. The sideband configuration in frequency modulation enables observer to calculate the frequency modulation index.

**2. Continuous wave signal frequency stability**

The frequency drift of a signal can be measured by observing the excursions of the signal across the display. Over period of minutes, it gives long term stability while over period of seconds it gives short term stability.

**3. Harmonic distortion measurement**

The distortion affects the frequency components of a signal to be transmitted. The harmonics appear as the additional signals in the spectrum analyzer at multiples of the carrier frequency. To keep it low, its measurement plays an important role. The spectrum analyzer can be used to make such distortion measurements.

**4. Noise measurement**

The noise can be measured with very straightforward method using the spectrum analyzer. Similarly the measurement of impulse noise also can be measured using spectrum analyzer. The examples of impulse noise in the generation of voltage spikes due to engine ignition and electric motor commutation.

**5. Examining Pulse Modulation**

This is the first application of spectrum analyzer. The spectrum analyzer can be used to measure or evaluate the quality of the pulse modulation. The difficult task of measuring pulse Modulation of radar transmitters is possible due to spectrum analyzer. Apart from these common applications it is used in the following applications as well.It is used to analyze the water and air pollution.

- It is used to measure the antenna pattern.
- It is used to tune the parametric amplifier.
- It is used to examine the vibration signals from the automobiles, airplanes, space vehicles bridges and other mechanical systems.
- It provides useful information about mechanical integrity, unbalance and bearing, gear wear.

- It finds number of applications in the field of electronic testing related to trouble shooting and quality control.

**RESULT**

**Exp. No. :10** **Date:**

# TIME DIVISION MULTIPLEXING

## AIM

To verify Time Division Multiplexing

## EQUIPMENTS

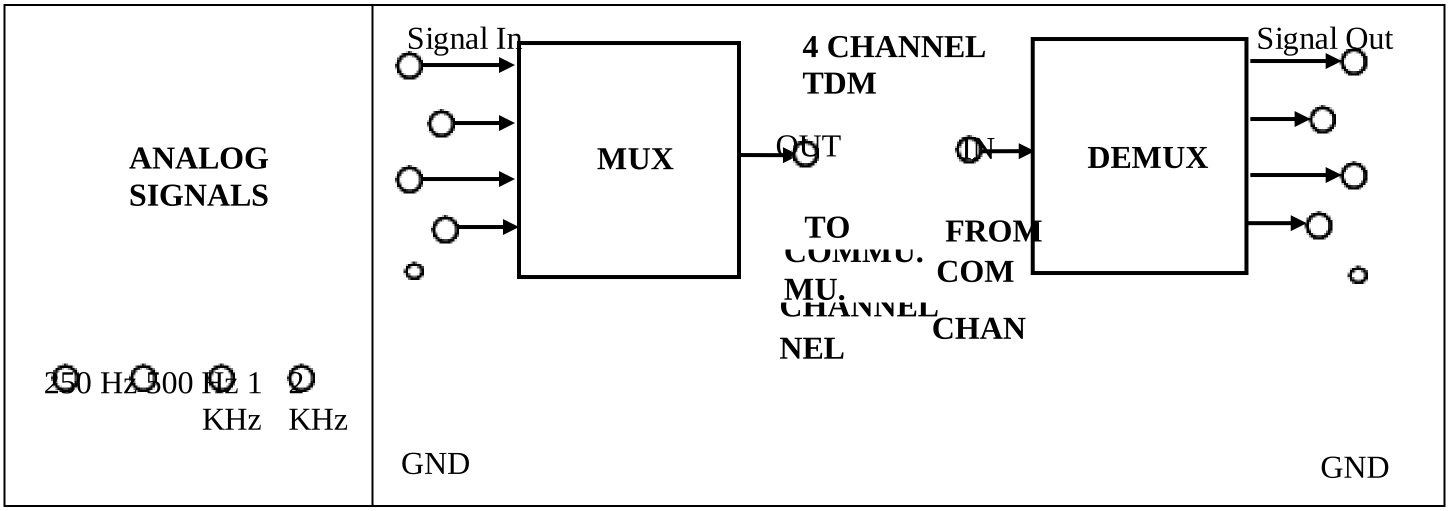
- Experimenter kit
- Connecting Chords
- Power supply
- 20 MHz Dual Trace Oscilloscope

## THEORY

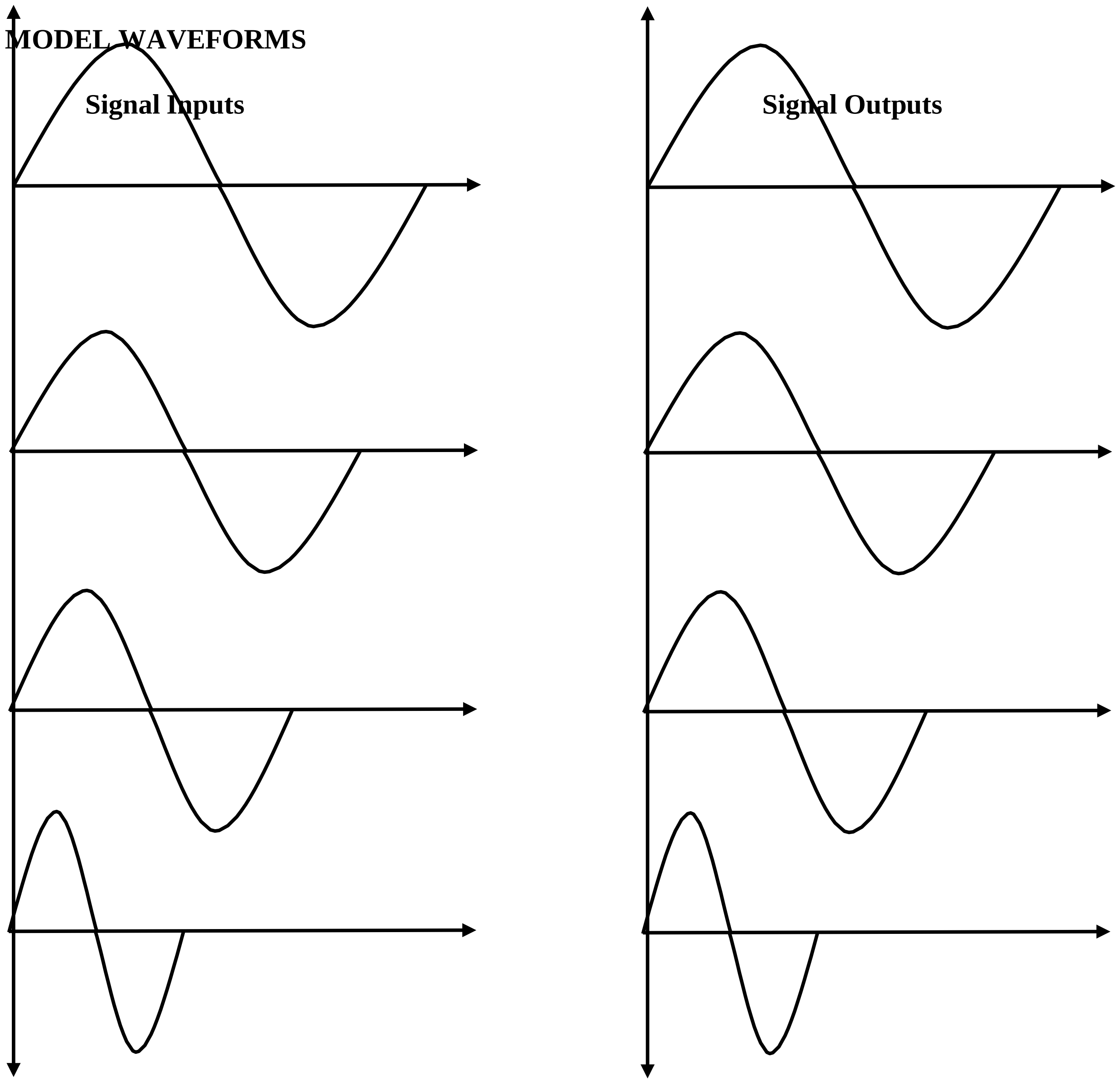
Time-division multiplexing (TDM) is a method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern. It is used when the data rate of the transmission medium exceeds that of signal to be transmitted. This form of signal multiplexing was developed in telecommunications for telegraphy systems inthe late 19th century, but found its most common application in digital telephony in the second half of the 20th century.

Time-division multiplexing is used primarily for digital signals, but may be applied in analog multiplexing in which two or more signals or bit streams are transferred appearing simultaneously as sub-channels in one communication channel, but are physically taking turns on the channel. The time domain is divided into several recurrent *time slots* of fixed length, one for each sub-channel. A sample byte or data block of sub-channel 1 is transmitted during time slot 1, sub-channel 2 during time slot 2, etc. One TDM frame consists of one time slot per sub- channel plus a synchronization channel and sometimes error correction channel before the synchronization. After the last sub-channel, error correction, and synchronization, the cyclestarts all over again with a new frame, starting with the second sample, byte or data block from sub-channel 1, etc.

**BLOCK DIAGRAM**




**MODEL WAVEFORMS**



## PROCEDURE

1. Refer to the Block Diagram & Carry out the following connections and switch settings.
2. Connect power supply in proper polarity to the kit & switch it on.
3. Connect **250Hz**, **500Hz**, **1 KHz**, and **2 KHz** sine wave signals from the Function Generator tothe multiplexer inputs channel by means of the connecting chords provided.
4. Connect the multiplexer output of the transmitter section to the demultiplexer input of the receiver section.
5. Take observations as mentioned.

## RESULT

**Exp. No. :11** **Date:**

# FREQUENCY SYNTHESIZER

**AIM :**

To study the PLL as a frequency synthesizer.

**Apparatus Required :**

1. PLL trainer kit
2. CRO
3. Patch chords

**Theory :**

Phase locked look (PLL) can be used as a variable frequency generator is as frequency synthesizer.

The voltage controlled oscillator is generating the frequency with respect to the feedback control voltage. When the input signal was not given at initial stage the control voltage Vc was zero. Now the Vco producing the centre frequency with the help of RC tuned circuits.

The R & C used for the oscillation of Vco is known as timing resister $R_T$ and timing capacitor $C_T$ .

The O/P frequency Fo, generate by Vco when Vc is zero is given by

$$Fo = 0.25/ R_T C_T$$

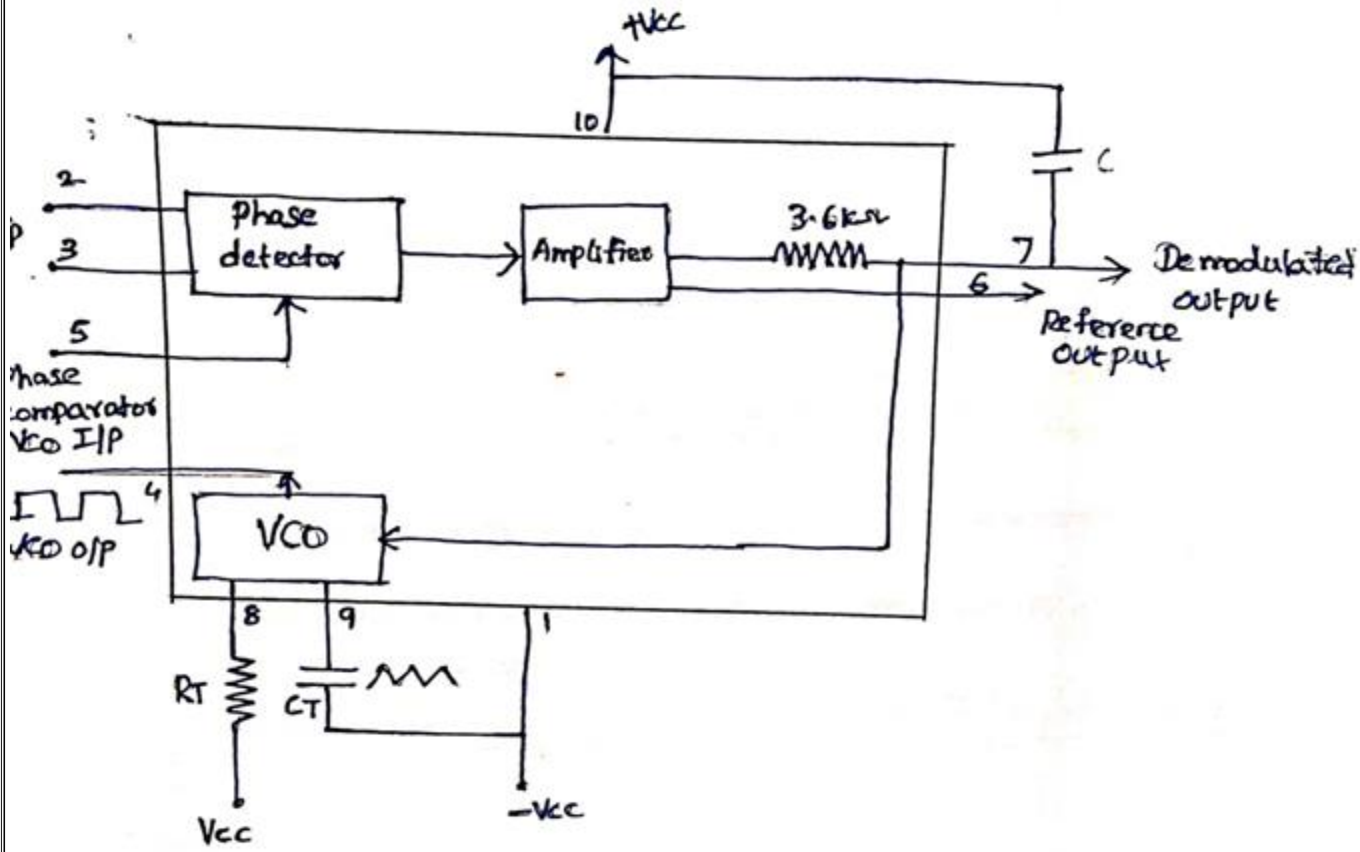
Thus the frequency and Rc circuit were indirectly proportional to each other. By changing the resistance and capacitance, we can generate variable frequency. The variable tabulated and the graph was plotted.

**Procedure :**

1. Connections are given as per the circuit diagram.
2. The resistance RT value is varied by using the potentiometer can variable resistor.
3. Now the wave forms are obtained in CRO and the corresponding frequency values are tabulated.
4. By using the formula we can verify the theoretical value and the practical value of the frequency in the frequency synthesizer.

:

Block Diagram



**Tabular Column:**

| $R_T$(Ohms) | $C_T$(Farads) | Frequency ($f_0$) | |
|---|---|---|---|
| | | Theoretical Value(Hz) | Practical Value (Hz) |
| | | | |

**Calculations:**

Theoretical Frequency ($f_0$) = $(\frac{0.25}{RTCT})$=

Practical Frequency (f0)= $\frac{1}{T}$ =

**RESULT**

## VIVA QUESTIONS AND ANSWERS:

1. What are the disadvantages of Analog communication?

A. Its not reliable, Noise effect is more on the signals, Power required for signaltransmission also more, Circuit complexity is more and costly.

2. How to convert an analog signal into digital signal?

A. Blocks: Anti aliasing filter, Sampler, Quantizer, encoder.

3. What is Sampling?

A. Converting a continuous time signal into discrete in time signal is called as Sampling (similarto cutting a bread into slices)

4. What are the Analog pulse modulation methods?

A. Pulse amplitude modulation, pulse width modulation and pulse position modulation..

5. Define Pulse amplitude modulation?

A. The carrier pulse height (amplitude) proportional to amplitude of message signal.

6. Define Pulse width modulation?

A. The carrier pulse width proportional to amplitude of message signal.

7. Define Pulse position modulation?

A. The carrier pulse position proportional to amplitude of message signal.

8. Compare PAM, PWM, PPM?

| | PAM | PWM | PPM |
|---|---|---|---|
| Pulse amplitude | variable | constant | constant |
| Pulse width | constant | variable | constant |
| Pulse position | constant | constant | variable |
| Bandwidth | less | High | High |
| Power required | Low | Moderate | Highest |
| Complexity | Low | Moderate | Highest |

9. What is multiplexing? How many types of multiplexing possible in communication?

A. Combining two or more signals to pass through a channel is called as multiplexing.

The different Multiplexing techniques are:1) Frequency division Multiplexing, 2) Time division Multiplexing, 3) Wavelength division multiplexing, 4) Orthogonal frequency division multiplexing.