MSc III (Electronics)

DSE 2: Advanced communication system -2 lab
Course code: PL PCLDI
Credit: 2(0+0+2)

Name of experiments:

1. Study the operation of phase locked loop detector (IC 4046 based).
2. Study the frequency modulation using VCO based frequency modulator (IC XR 2206).
3. Study the faced locked loop detector (IC LM 565 based) frequency modulator.
4. Study of frequency deviation and modulation index using VCO based frequency modulator (IC XR 2206).
5. Time division multiplexing and demultiplexing of two signals.
6. Study of Optical and Transmitter and Receiver.

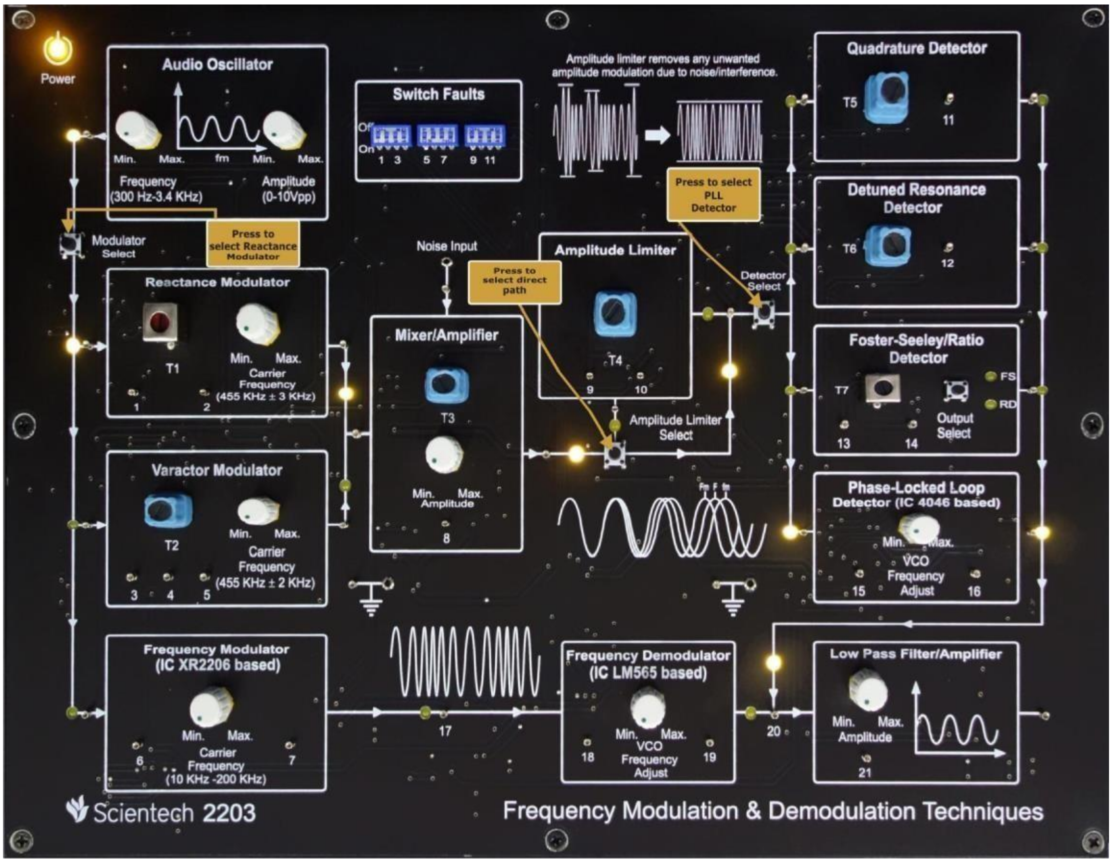
Experiment 1

Objective: Study the operation of Phase-Locked Loop Detector (IC4046 based)

Equipments Required:

- Scientech 2203 TechBook with Power Supply cord
- Scientech Oscilloscope with connecting probe

Selection diagram:

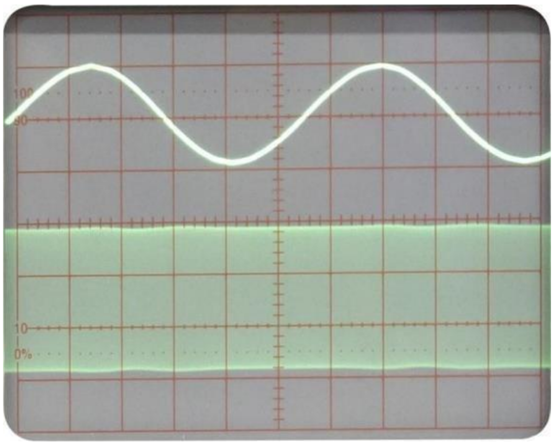


Procedure:

This experiment investigates how the phase-locked loop detector block performs frequency demodulation. The operation of this detector circuit will be described in detail and its sensitivity to noise on the incoming FM signal will be investigated. On-board Amplitude Limiter will then used to remove any amplitude modulations due to noise, before they reach the detector. This allows the student to draw conclusions as to whether it is necessary to precede this type of detector with an Amplitude Limiter stage, in a practical FM receiver.

1. Ensure that the following initial conditions exist on the **Scientech 2203** TechBook:
   a) All Switch Faults in 'Off' condition.
   b) Amplitude potentiometer of Audio Oscillator block in minimum position.
   c) Frequency potentiometer of Audio Oscillator block in maximum position.
   d) Carrier Frequency potentiometer of Reactance Modulator block in center position.
   e) Carrier Frequency potentiometer of Varactor Modulator block in center position.
   f) Amplitude potentiometer of Mixer/Amplifier block in maximum position.
   g) VCO frequency Adjust potentiometer of Phase-Locked Loop detector (IC4046 based) block in minimum position.
   h) Carrier Frequency potentiometer of Frequency Modulator (IC XR2206 based) block in minimum position.
   i) VCO Frequency Adjust potentiometer of Frequency Demodulator (IC LM565 based) block in minimum position.
   j) Amplitude potentiometer of Low pass filter/Amplifier block in center position.
2. Turn on power to the **Scientech 2203** TechBook.
3. Check that Reactance modulator block is selected for operation which is indicated by glowing LEDs at the input and output of this block. If not, press the 'Modulator Select' switch to select it.
4. Also check that direct path is selected to connect the Mixer/Amplifier output to Detector input (bypassing the Amplitude Limiter block). If not, press the 'Amplitude Limiter Select' switch to select it.
5. Now press the 'Detector Select' switch to select Phase-Locked Loop Detector block for operation which is indicated by glowing LEDs at the input and output of this block. The output of Phase-Locked Loop Detector is connected to Low pass filter input which is also indicated by a glowing LED at the input of low pass filter.
6. The audio oscillator's output signal is now being used by the Reactance modulator for frequency modulation of a 455 KHz carrier sine wave.

7. Now adjust the amplitude of the Audio oscillator block to 4Vpp and observe the FM waveform at the output socket of the Mixer/Amplifier block. Also observe the same signal at input test point of Phase-Locked Loop Detector block.

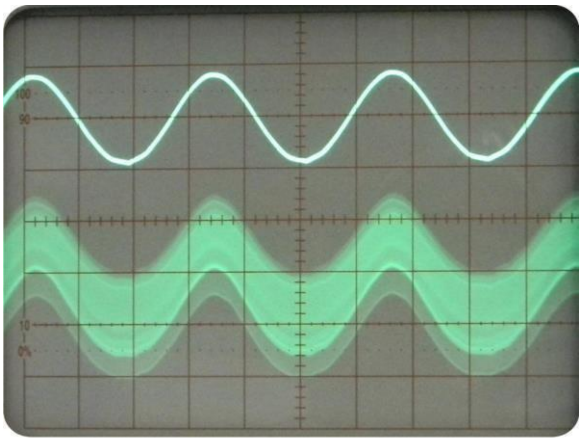


Audio oscillator output signal & FM signal

8. Observe the output of Low pass filter block and adjust the 'VCO Frequency Adjust' potentiometer until the demodulated signal is locked.

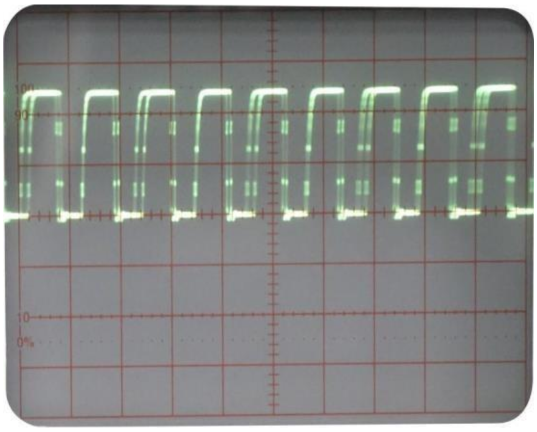
9. Now monitor modulating input signal to the Reactance modulator block together with the output from the Phase-Locked Loop. The signal at output should contain two components.

   - Apositive DC offset voltage.
   - Asine wave at the same frequency as the audio signal.
   - Ahigh - frequency ripple component.

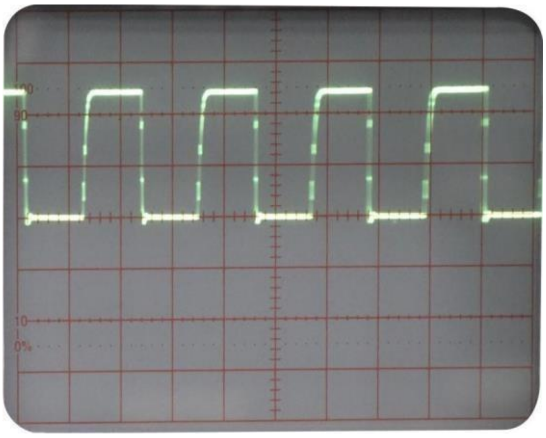


Modulating signal and detector output signal

10. Observe the VCO output signal and Comparator output signal at the test points 15 and 16 respectively of Phase-Locked Loop detector block.

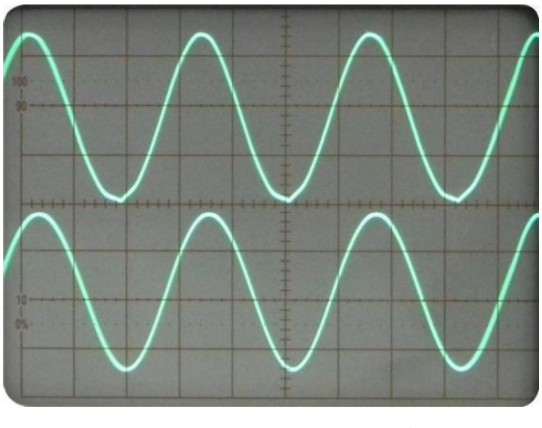


VCO output signal at test point 15



Comparator output signal at test point 15

11. The Low Pass filter/Amplifier block strongly attenuates the high-frequency ripple component at the detector's output and also blocks the DC offset voltage. Consequently the signal at the output of the low- pass filter/amplifier block (at TP73) should be very closely resemble the original audio making signal, if not then slowly adjust the frequency adjust potentiometer of PLL block.
12. Monitor the modulating input to the Reactance modulator and the output of the Low Pass filter/Amplifier block and adjust the gain potentiometer in the Low Pass filter/Amplifier block, until the amplitudes of the two monitored audio waveforms are the same.



Modulating signal and Low pass filter output

13. Now vary the frequency of the modulating signal and observe the demodulated signal. To minimize the shape distortion at lower frequencies, decrease the amplitude of modulating signal to 1Vpp and observe the signal. Also adjust the carrier frequency potentiometer of modulator block, if required to adjust the shape.

14. We will now investigate the effect of noise on the system.

    b) Take an external signal generator and adjust it for a sinusoidal output of amplitude 200m Vpp, and frequency 2 KHz, this will be our 'noise' input.

    c) Connect the output of the signal generator to the 'Noise Input' socket of Mixer/Amplifier block. Monitor the noise input and the FM output.

    d) Note that the FM signal is now being amplitude-modulated by the 'noise' input, in addition to being frequency-modulated by the modulating input from the audio oscillator block.

    e) The amplitude modulations simulate the effect that transmission path noise would have on the amplitude of the FM waveform reaching the receiver. This allows us to demodulated audio signal.

13. Monitor the modulating signal and the output of the Low Pass filter/Amplifier block. Note that there is now an additional component at output, a sine wave at the frequency of the 'noise' input. To see this clearly, it may be necessary to slightly adjust the frequency of the signal generator's output, until the superimposed 'noise' sine wave can be clearly seen.

14. To overcome the problem of the effect of noise, we can connect an Amplitude Limiter block between the FM output and the input to the Foster-Seeley/Ratio circuit.

15. Press 'Amplitude Limiter Select' switch to connect an Amplitude Limiter block between the FM output and the input to the Phase-Locked Loop detector so that the effect of amplitude variations can be reduced.

16. The Amplitude Limiter removes amplitude variations from the FM output signal, so that the input signal to the Phase-Locked Loop detector has constant amplitude.

17. Monitor the output at the output test point Amplitude Limiter block. Note that the amplitude modulations due to the 'noise' input have been removed.

18. Observe the output from the Low Pass filter/Amplifier block and note that amplitudes now have no effect on the final audio output.

Questions:

- What is PLL?
- Draw the block diagram of PLL?
- What is the function of VCO?
- Draw the frequency response of PLL?
- Write the applications of PLL?

Experiment 2

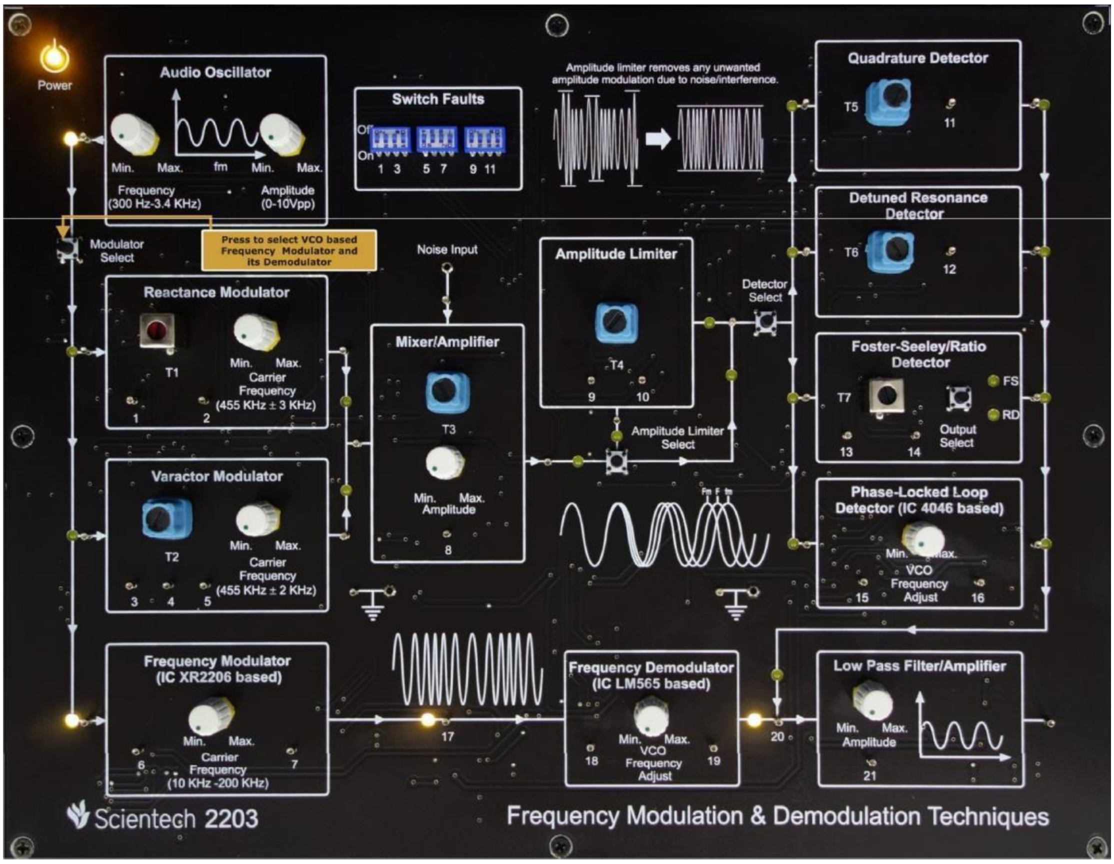
Objective:

Study of Frequency Modulation using VCO based Frequency modulator (IC XR2206 based)

Equipments Required:

- Scientech 2203 TechBook with Power Supply cord
- Scientech Oscilloscope with connecting probe

Selection diagram:



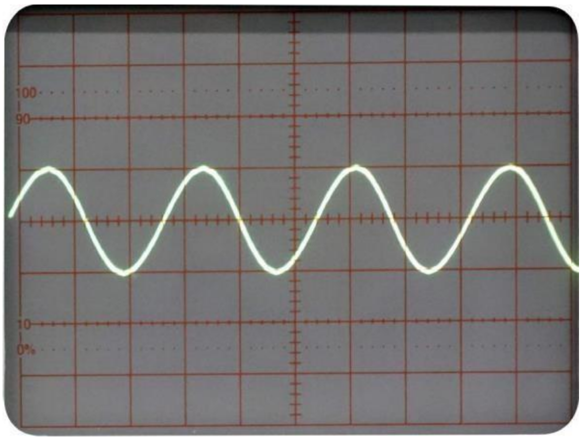
Procedure:

This experiment investigates how **Scientech 2203**'s VCO based Frequency modulator circuit performs frequency modulation. This circuit modulates the frequency of a carrier sine wave, according to the audio signal applied to its modulating input.

1. Ensure that the following initial conditions exist on the **Scientech 2203** board.
   a) All Switch Faults in 'Off' condition.
   b) Amplitude potentiometer of Audio Oscillator block in minimum position.
   c) Frequency potentiometer of Audio Oscillator block in maximum position.
   d) Carrier Frequency potentiometer of Reactance Modulator block in center position.
   e) Carrier Frequency potentiometer of Varactor Modulator block in center position.
   f) Amplitude potentiometer of Mixer/Amplifier block in maximum position.
   g) VCO frequency Adjust potentiometer of Phase-Locked Loop detector (IC4046 based) block in minimum position.
   h) Carrier Frequency potentiometer of Frequency Modulator (IC XR2206 based) block in minimum position.
   i) VCO Frequency Adjust potentiometer of Frequency Demodulator (IC LM565 based) block in minimum position.
   j) Amplitude potentiometer of Low pass filter/Amplifier block in center position.

1. Turn on power to the **Scientech 2203** TechBook.

2. Audio oscillator block generates a sine wave (frequency: 300 Hz to 3.4 KHz approximately and amplitude: 0 to 10Vpp). This signal is used as a modulating signal. Observe this signal at the output test point of this block and vary the amplitude and the frequency with the respective potentiometers.



Audio oscillator output signal

4. Return the amplitude potentiometer to its minimum position.

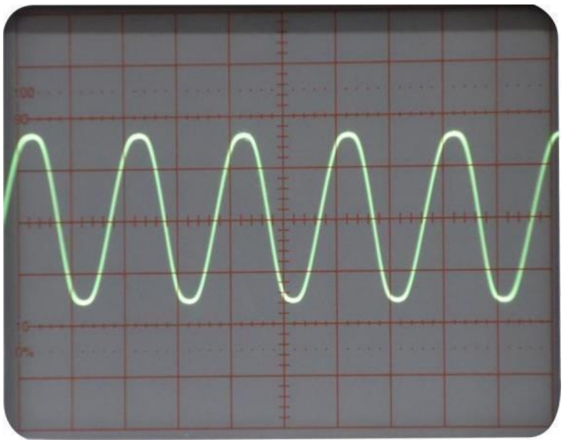
5. Press the 'Modulator Select' switch to select Frequency modulator (IC XR2206 based) block and check that it is selected for operation which is indicated by glowing LEDs at the input and output of this block.

6. The carrier signal from the Frequency modulator block appears at the output test point of this block.

7. Vary the Carrier Frequency potentiometer and check that carrier frequency is varied within its range from minimum to maximum frequency. The frequency range of carrier signal is approximately from 10 KHz to 200 KHz.

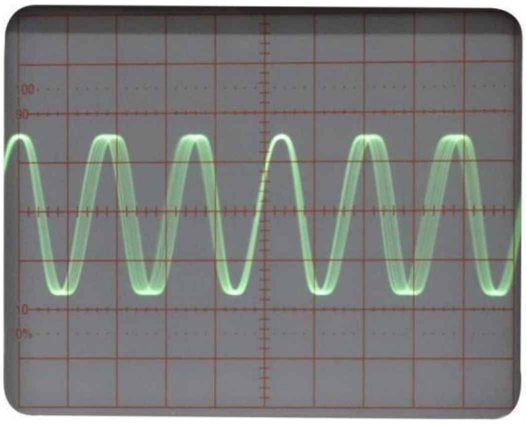
Note: The monitored signal is a sine wave of approximately 6Vpp. This is our FM carrier, and it is presently un-modulated since the amplitude of the modulating signal in Audio Oscillator block is set to 0V.

8. Return the Frequency modulator's potentiometer in its minimum position then examine the signal at the output test point of this block.



Carrier frequency output signal

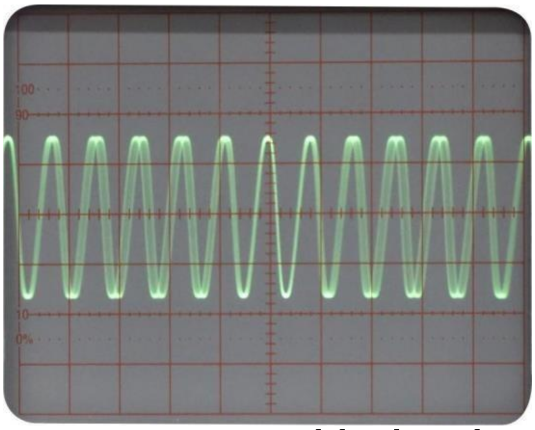
9. Now increase the amplitude of modulating signal from the Audio oscillator block using the amplitude potentiometer and observe the frequency modulated waveform at the output test point of frequency modulator's block.



Frequency modulated signal

10. Also vary the frequency of the modulating signal from the Audio oscillator block using the frequency potentiometer and observe the variations in the frequency deviation of FM signal.

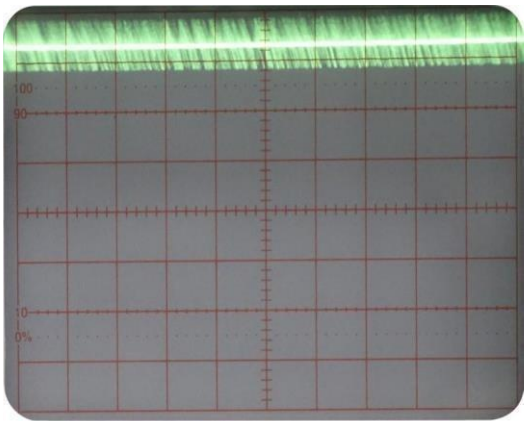
11. Now vary the carrier frequency of the frequency modulator and observe the variations in the frequency deviation of FM signal.



Frequency modulated signal

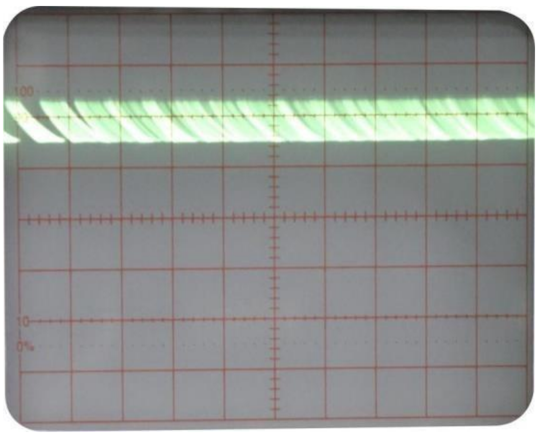
Observe that for lower frequency of the carrier small amount of amplitude produces much frequency deviation while higher frequency carrier requires more amplitude for the same.

12. Observe the timing capacitor output signal of FM VCO circuit at test point 6.



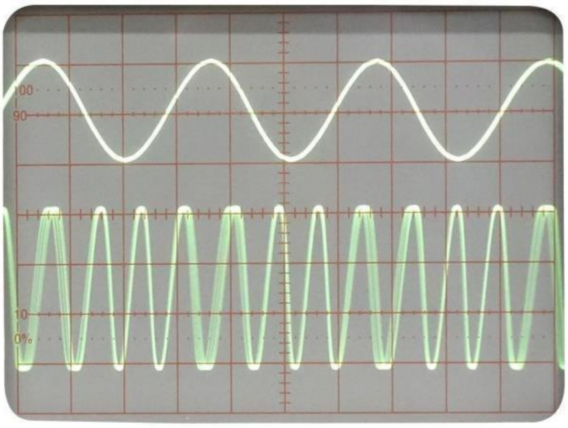
Timing capacitor output signal of FM VCO circuit

13. Observe the timing resistance input signal of FM VCO circuit at test point 7.



Timing resistance input signal of FM VCO circuit

14. Monitor the audio input and the FM output triggering the Oscilloscope on the audio input signal. Turn the audio oscillator's amplitude potentiometer throughout its range of adjustment, and note that the amplitude of the FM output signal does not change. This is because the audio information is contained entirely in the signals frequency and not in its amplitude.



Modulating signal with FM signal

Questions:

- What is a VCO?
- How VCO is used for generation of frequency?
- Explain the functioning of a VCO?

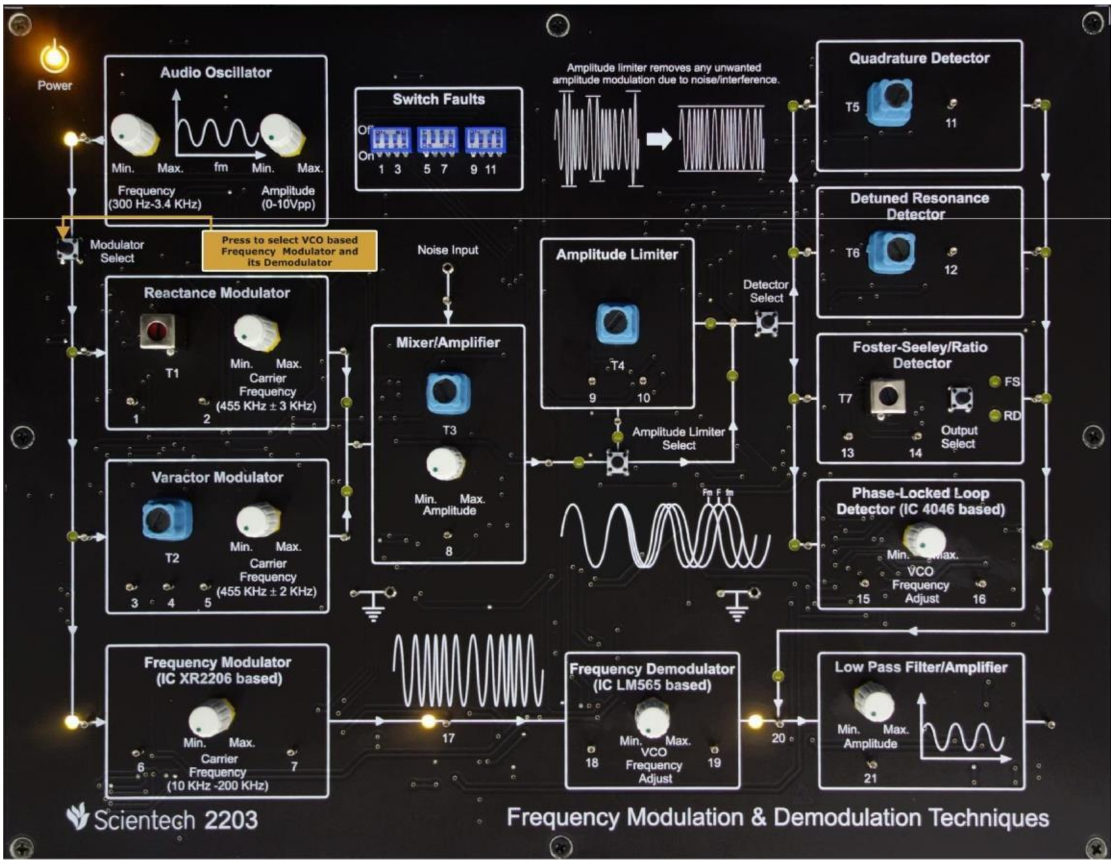
Experiment 3

Objective: Study of IC LM565 based Phase -Locked Loop detector as Frequency Demodulator

Equipments Required:

- Scientech 2203 TechBook with Power Supply cord
- Scientech Oscilloscope with connecting probe

Selection Diagram:



Procedure:

This experiment investigates how IC LM565 based Frequency demodulator circuit performs frequency demodulation. This circuit demodulates the FM signal and gives audio signal same applied as modulating input to modulator.

1) Ensure that the following initial conditions exist on the **Scientech 2203** TechBook:

   a) All Switch Faults in 'Off' condition.

   b) Amplitude potentiometer of Audio Oscillator block in minimum position.

   c) Frequency potentiometer of Audio Oscillator block in maximum position.

   d) Carrier Frequency potentiometer of Reactance Modulator block in center position.

   e) Carrier Frequency potentiometer of Varactor Modulator block in center position.

   f) Amplitude potentiometer of Low pass filter/Amplifier block in center position.

   g) VCO frequency Adjust potentiometer of Phase-Locked Loop detector (IC4046 based) block in minimum position.

   h) Carrier Frequency potentiometer of Frequency Modulator (IC XR2206 based) block in minimum position.

   i) VCO Frequency Adjust potentiometer of Frequency Demodulator (IC LM565 based) block in minimum position.

   j) Amplitude potentiometer of Mixer/Amplifier block in maximum position.

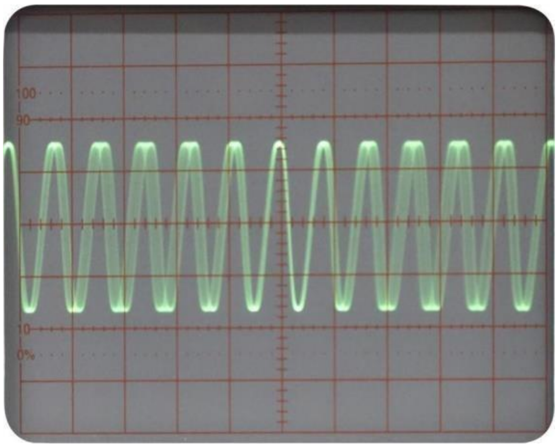
2) Turn on power to the **Scientech 2203** TechBook.

3) Press 'Modulator Select' switch to select the Frequency Modulator (IC XR2206 based) and Frequency Demodulator (IC LM565 based) for operation which is indicated by glowing LEDs at the input and output of these blocks.

4) The audio oscillator's output signal is now being used by the Frequency Modulator (IC XR2206 based) for frequency modulation of a carrier sine wave.

5) Now adjust the carrier frequency to center position (approximately 20 KHz).

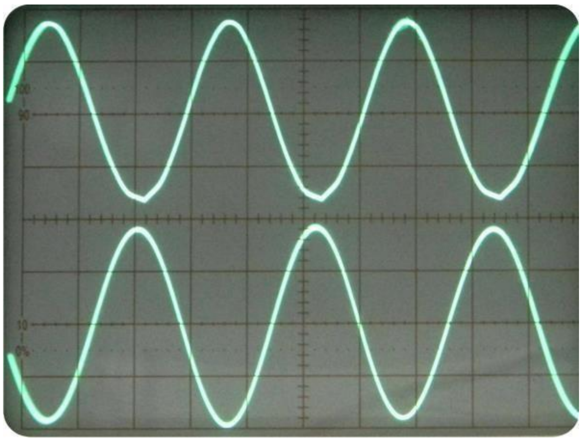
6) Now adjust the amplitude of the Audio oscillator block to 10Vpp and observe the FM waveform at the output test point 17 of the FM modulator block.



FM signal at test point 17

7) Now observe the output at Low pass filter/Amplifier section and start the VCO Frequency Adjust potentiometer to vary gradually so that a clear audio signal waveform with minimum distortion is detected. Adjust the gain potentiometer in the Low Pass filter/Amplifier block, until the amplitudes of the two monitored audio waveforms are the same.

Note: For lower carrier frequencies from 10 KHz to 20 KHz the detected signal has some distortion because the Frequency difference between the carrier and the modulating signal was very less. As the carrier frequency increases the detected signal improves.

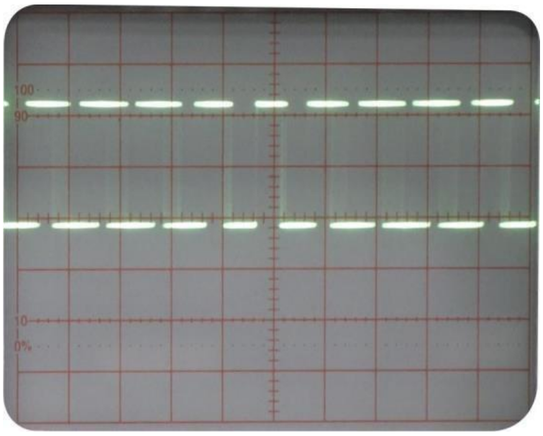


Modulating signal and Low pass filter output signal.

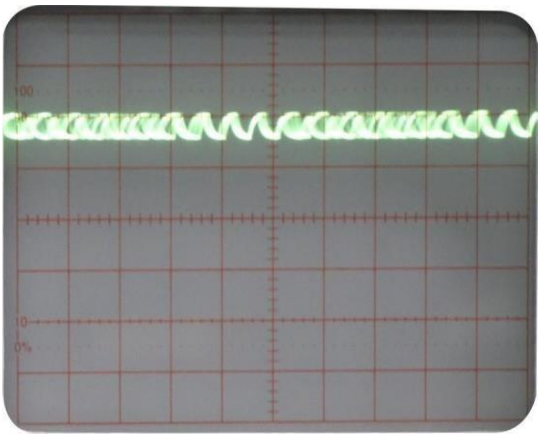
8) Now vary the carrier frequency till the detected signal get distorted and then vary the VCO frequency adjust potentiometer gradually till the clear audio signal waveform with minimum distortion is detected. Also adjust the gain potentiometer of the Low pass filter block until the amplitudes of the two monitored audio waveforms are the same.

9) Repeat the procedure for different value of carrier frequency and again vary the VCO frequency adjust potentiometer to detect the signal.

10) Also observe the VCO signal and timing signal at test points 18 and 19 respectively of Frequency demodulator (IC LM565 based) block.



VCO signal at test point 18



Timing signal at test point 19

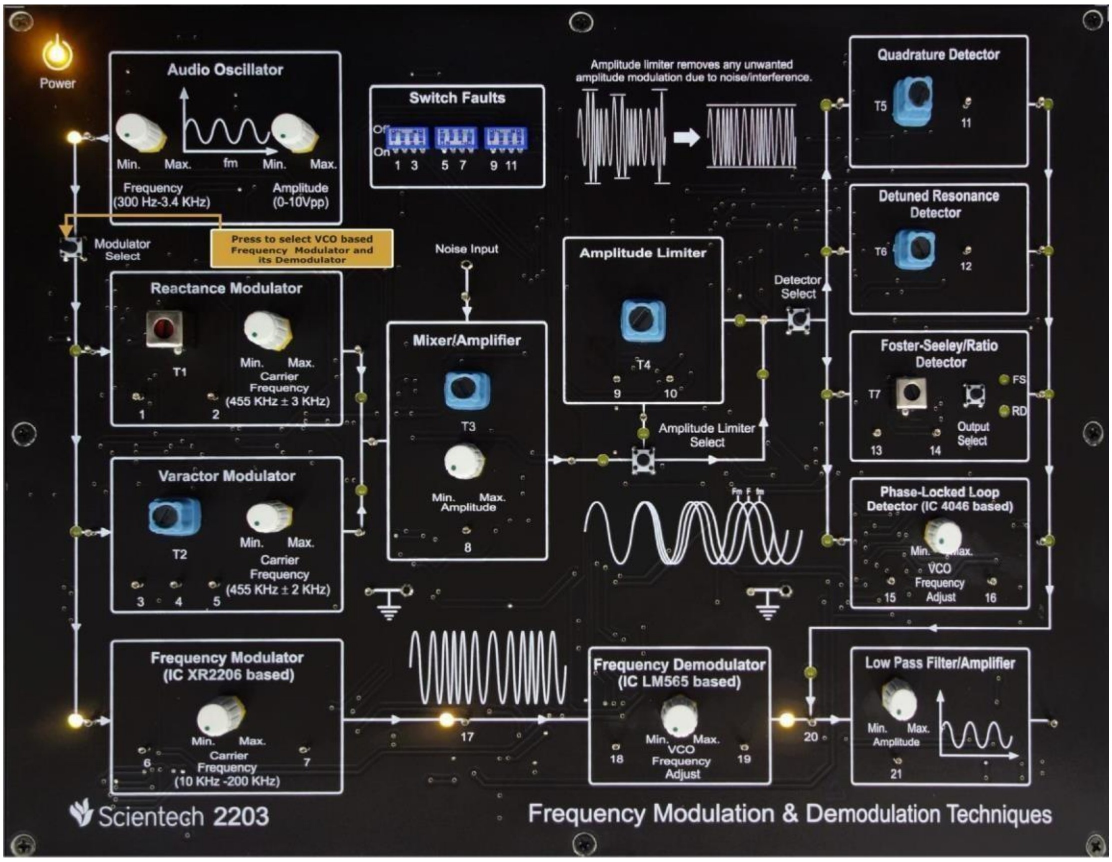
Experiment 4

Objective: Study of Frequency deviation and modulation index using VCO based Frequency Modulator (IC XR2206 based)

Equipments Required:

- Scientech 2203 TechBook with Power Supply cord
- Oscilloscope with connecting probe

Selection Diagram:



Procedure:

This experiment investigates how IC XR2206 based Frequency Modulator circuit performs frequency modulation. This circuit modulates the frequency of a carrier sine wave, (variable from 10 KHz to 200 KHz approx.) according to the audio signal applied to its modulating input.

1) Ensure that the following initial conditions exist on the **Scientech 2203** TechBook:

   a) All Switch Faults in 'Off' condition.

   b) Amplitude potentiometer of Audio Oscillator block in minimum position.

   c) Frequency potentiometer of Audio Oscillator block in maximum position.

   d) Carrier Frequency potentiometer of Frequency Modulator (IC XR2206 based) block in minimum position.

   e) Frequency Adjust potentiometer of Frequency Demodulator (IC LM565 based) block in minimum position.

   f) VCO frequency Adjust potentiometer of Phase-Locked Loop detector (IC4046 based) block in minimum position.

   g) Carrier Frequency potentiometer of Frequency Modulator (IC XR2206 based) block in minimum position.

   h) VCO Frequency Adjust potentiometer of Frequency Demodulator (IC LM565 based) block in minimum position.

   i) Amplitude potentiometer of Low pass filter/Amplifier block in center position.

2) Turn on power to the **Scientech 2203** TechBook.

3) Press 'Modulator Select' switch to select the Frequency Modulator (IC XR2206 based) for operation which is indicated by glowing LEDs at the input and output of this block.

4) The audio oscillator's output signal is now being used by the Frequency Modulator (IC XR2206 based) for frequency modulation of a carrier sine wave.

5) As the amplitude of the audio oscillator block is set to minimum position, the output of the frequency modulator block is the carrier sine wave without any modulation. This is the carrier signal generated by VCO which can be varied from 10 KHz to 200 KHz approx. using the Carrier Frequency potentiometer.

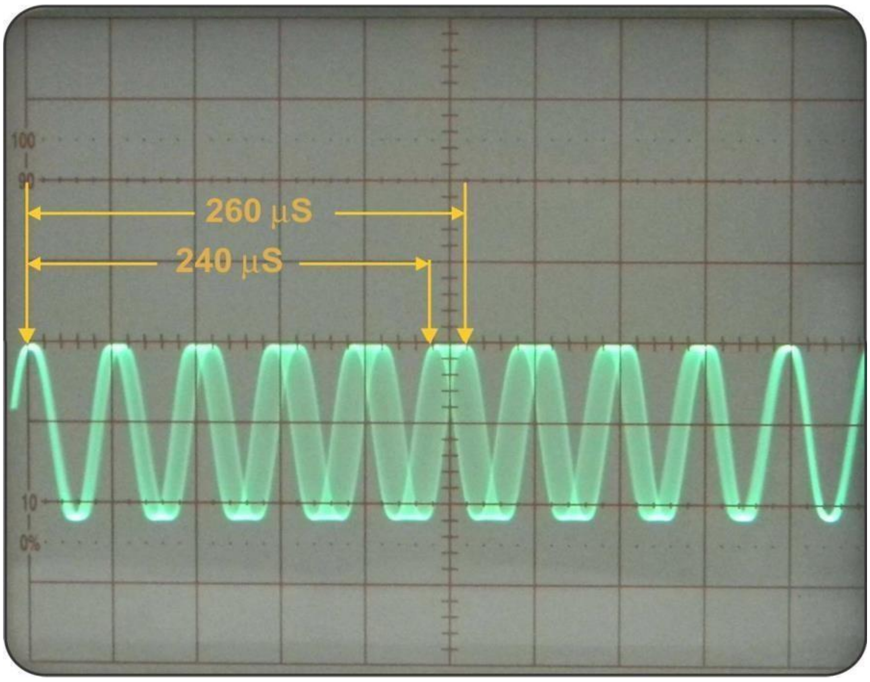
6) Now adjust the following.

   Carrier frequency = 20 KHz.

   Modulating signal = 2 KHz & 1.5Vpp

7) Observe the FM waveform at the output test point of the Frequency modulator (IC XR2206 based) block.

[CH1(Y) – 2V; Time Base – 50 uS]



FM signal at test point 17

8) The frequency deviation can be calculated as follows:

a) From the waveform of figure given above, evaluate F_M and F_m detecting the periods of the respective sine waves.

b) Here F_M and F_m are calculated as follow:

Time base is 50 us;

5 Cycles of F_M are completed in 240 uS; hence time period of 1 Cycle is 240/5 = 48 uS.

Hence F_M = 1/48 uS = 20.83 KHz

5 Cycles of F_m are completed in 260 uS; hence time period of 1 Cycle is 260/5 = 52 uS.

Hence F_m = 1/52 uS = 19.23 KHz

c) You can note that if the modulator operates in a linear zone so F_M and F_m are over and under the central frequency F_c by the same Δf.

d) The frequency deviation is defined as $\Delta f = (F_M - F_m) / 2$.

=> $\Delta f = (20.83 – 19.23) / 2 = 1.6 /2 = 0.8$ KHz

e) Modulation index m_f is calculated by the relation.

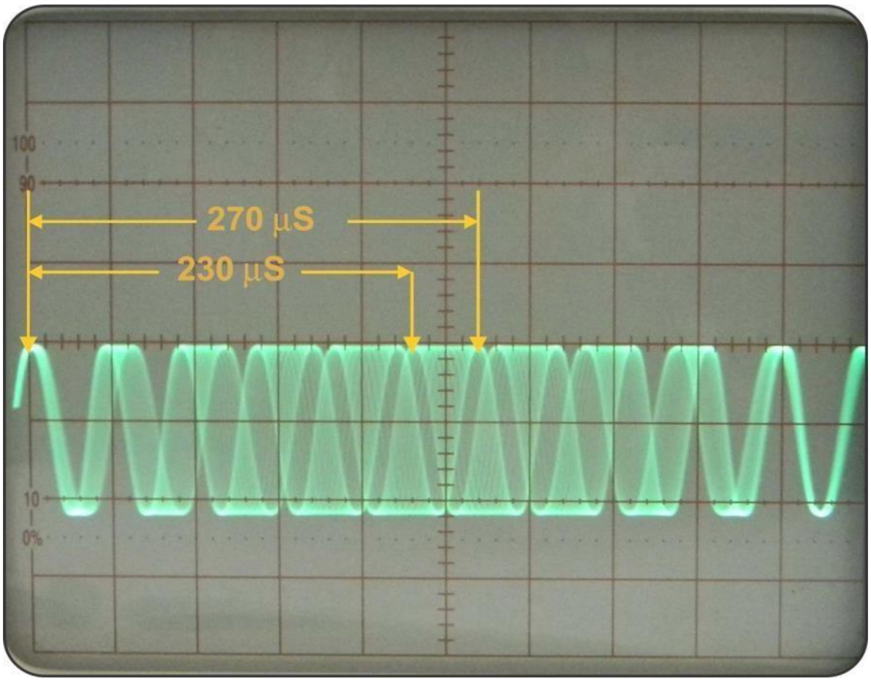
$m_f = \Delta f / f_m$ (Where, f_m is the frequency of the modulating signal = 2KHz)

$m_f = 0.8 /2 = 0.4$

9) The variation in the frequency Deviation and modulation index can be monitored with variation in the amplitude of the modulating signal.

Set the amplitude to 3Vpp and frequency to 2 KHz of modulating signal.

[CH1(Y) – 2V; Time Base – 50 uS]



FM signal at test point 17

a) From the waveform of figure, evaluate F_M and F_m detecting the periods of the respective sine waves.

b) Here F_M and Fm are calculated as follow:

Time base is 50 us;

5 Cycles of F_M are completed in 230 uS; hence time period of 1 Cycle is 230/5 = 46 uS.

Hence F_M = 1/46 uS = 21.74 KHz

5 Cycles of Fm are completed in 270 uS; hence time period of 1 Cycle is 270/5 = 54 uS.

Hence F_m = 1/54 uS = 18.52 KHz

c) The frequency deviation is defined as $\Delta f = (F_M - F_m) / 2$.

=> $\Delta f = (21.74 – 18.52) / 2 = 3.22 /2 = 1.61$ KHz

d) Modulation index m_f is calculated by the relation.

$m_f = \Delta f / f_m$ (Where, f_m is the frequency of the modulating signal)

$m_f = 1.61 /2 = 0.81$ approx.

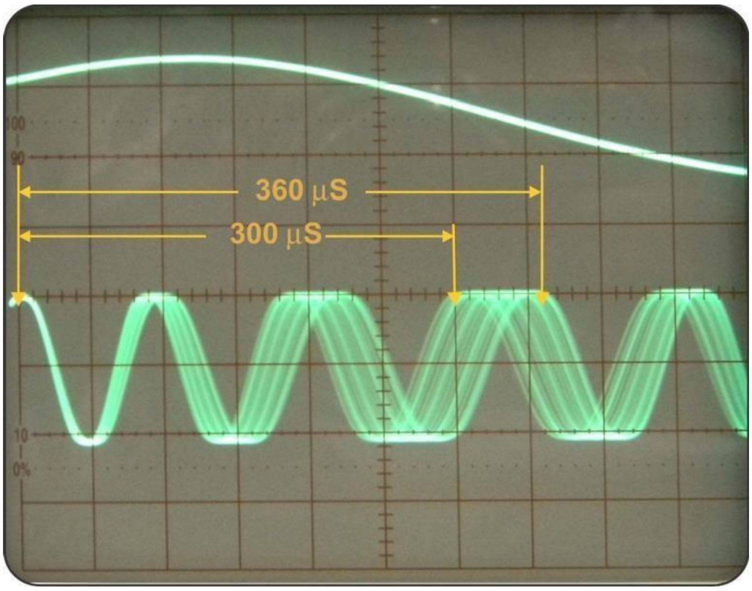
10) The variation in the Frequency Deviation and Modulation index can also be monitored with variation in the Frequency and amplitude of the modulating signal.

Set the Carrier signal frequency to 10 KHz.

Set the Modulating input signal amplitude to 4Vpp and frequency to 1 KHz.

[CH1(Y) – 2V; CH2(X) – 2V; Time Base – 50 uS]

Use Alternate Trigger Mode and adjust auto trigger level to get the below waveform.



FM signal at test point 17

a) From the waveform of figure, evaluate F_M and F_m detecting the periods of the respective sine waves.

b) Here F_M and F_m are calculated as follow:

Time base is 50 us;

3 Cycles of F_M are completed in 300 uS; hence time period of 1 Cycle is 300/3 = 100 uS.

Hence F_M = 1/100 uS = 10 KHz

3 Cycles of F_m are completed in 360 uS; hence time period of 1 Cycle is 360/3 = 120 uS.

Hence F_m = 1/120 uS = 8.33 KHz

c) The frequency deviation is defined as $\Delta f = (F_M - F_m) / 2$.

=> $\Delta f = (10 – 8.33) / 2 = 1.667 /2 = 0.83$ KHz

d) Modulation index m_f is calculated by the relation.

$m_f = \Delta f / f_m$ (Where, f_m is the frequency of the modulating signal = 1KHz)

$m_f = 0.83/1 = 0.83$

Switched Faults

This chapter lists the switched faults on the **Scientech 2203** TechBook. There are 12 fault switches on the TechBook. The component references given below refer to the circuit diagrams at the end of this manual.

Open circuit faults:

1. Open circuits the 68mH choke from transistor's collector in the varactor modulator block, preventing any reverse bias from being applied across the BB329 varactor diode. This causes the varactor modulator's output to be an un-modulated sine wave, whose output frequency is fixed at approximately 455 KHz, irrespective of the position of the block's carrier frequency potentiometer

2. Fault disables the output from the Detuned Resonance circuit, by disconnection the grounded end of its transformer coil's's secondary winding from 0 Volts.

3. Fault disconnects the Quadrature detector's input socket from the 10nf Capacitor which drives the 'carrier +' input of IC1496. This prevents the non phase - shifted FM signal from reaching the IC1496, so that phase comparison with the phase - shifted signal cannot take place. The result is a vast reduction in the amplitude of the output signal at the output.

4. Fault removes the base bias voltage of all three transistors in the Amplitude Limiter block, by open circuiting the non-supply end of 56 K bias resistor. Causes the block's output amplitude to drop to 0 volts peak to peak.

5. Fault shorts out the 1 K feedback resistor between the output (pin 1) and the inverting input (pin 2) of the Reactance modulator block's driver op-amp (IC34084). This prevents the Reactance modulator's output from being frequency-modulated by the signal applied to the audio input socket.

6. Fault shorts the base of the Mixer/Amplifier's modulating transistor 0 V. This causes the output amplitude from the Mixer/Amplifier block to drop to 0 Vpp, irrespective of the position of the block's amplitude potentiometer

7. Fault shorts TP48 in the Foster-Seeley/Ratio detector block to 0 volts. This prevents any signal from appearing across transformer coil's resonant circuit, and disables the outputs from the block for both Foster-Seeley/Ratio modes of operation.

8. sFault shorts out the Phase-Locked loop detector block's frequency adjust potentiometer. This increases the free - running frequency of the Voltage Controlled Oscillator (VCO) to approximately 500 KHz, preventing the Phase-Locked loop from locking into the incoming 455 KHz FM carrier, irrespective of the setting of the frequency adjust potentiometer Consequently, the block's output no longer contains a component at the original audio modulating signal frequency.

9. Fault disconnects the Vcc supply (+12V) from the pin 4 of IC XR2206 (frequency modulator), causes to stop the functioning of the circuit, hence no carrier generation take place.

10. Fault disconnects the Carrier frequency potentiometer from the Timing resistor pin 8 of IC XR2206, causes to stop the carrier generation and frequency modulation.

11. Fault disconnects the Vcc supply (+12V) form pin 10 of IC LM565 (Frequency demodulator), causes to stop the demodulation functioning of the circuit.

12. Fault disconnects the VCO Frequency adjust potentiometer from the Timing resistance pin 8 of IC LM565, causes to stop the free running frequency of PLL circuit.

Frequently Asked Questions

Q. What is frequency range for speech information?

Ans: The frequency range for speech information is 300 Hz to 3.4 KHz.

Q. What is modulation?

Ans: Modulation is the process of putting information onto a high frequency carrier for Transmission (frequency translation). Modulation occurs at the transmitting end of the system.

Q. Why to modulate the analog signals?

Ans: All audio signals occupy the same frequency band i.e. between 0 and 20 kHz. Before being broadcast an audio signal (speech or music) must be moved, or frequency translated to a specific frequency range in order to use the available frequency spectrum. To do this the audio signal (or modulating signal) modulates a much higher radio frequency (the carrier frequency). Each audio signal is assigned a carrier – defining a channel – so that it is possible for the receiver to discriminate between all the streams of signals coming in.

Q. What are the reasons to modulate the analog signal or low frequency signal?

Ans: There are 3 main reasons to modulate a signal on to a high frequency carrier:

- Audio is in the range approx. 30 – 20000 kHz. If an electromagnetic signal with a frequency of 30 Hz is transmitted it will have a wavelength of (speed of light /frequency) = 300,000/30 km = 10,000 km. To pick up this signal an aerial of size approx. 2,500 km will be required – impractical. If this signal is used to modulate a carrier of 1 MHz the wavelength will be 300,000/1,000,000 km = 300 m, and an aerial of 75 m will suffice. If the carrier is 100 MHz, the wavelength is 3 m and a 750 cm aerial is sufficient.

- A large number of radio transmitters are trying to transmit at the same time. It is necessary for the receiver to pick up only the wanted signal and to reject the rest. One way to do to this is to assign a carrier with a known frequency to each transmitter, modulate this carrier with the signal, and then design the receiver to pick up only that known carrier frequency and reject the rest, using appropriate filtering methods. Then the original signal is removed from the received carrier. The same concept is used in carrying a large number of telephone conversations over a single pair of wires or optical fiber.

- Using appropriate modulation techniques it is possible at the receiver to remove a lot of the noise and other distortions which the transmission medium would impose on the signal.

Q. How many types of analog Modulation are there?

Ans: In analog communication systems, we use the sinusoidal signal as the frequency carrier. And as the sinusoidal wave can be represented in three parameters; amplitude, frequency and phase, these parameters may be varied for the purpose of transmitting information giving respectively the modulation methods:

(a) Amplitude Modulation (AM):

The amplitude of the carrier waveform varies with the information signal

(b) Frequency Modulation (FM):

The frequency of the carrier waveform varies with the information signal

(c) Phase Modulation (PM):

The phase of the carrier waveform varies with the information signal.

Q. What is the disadvantage of amplitude modulation?

Ans: A major problem in AM is its susceptibility to noise superimposed on the modulated carrier signal.

Q. How Angle modulation is classified, explain in short?

Ans: Angle modulation can be classified as frequency modulation (FM) and phase modulation (PM).

In Frequency Modulation, the carrier's instantaneous frequency deviation from its un modulated value varies in proportion to the instantaneous amplitude of the modulating signal

In Phase Modulation, the carrier's instantaneous phase deviation from its un modulated value varies as a function of the instantaneous amplitude of the modulating signal

Q. How many sidebands are there in FM?

Ans: FM have infinite number of sidebands.

Q. Define modulation index in FM?

Ans: The modulation index for an FM signal is defined as the ratio of the maximum frequency deviation to the modulating signal frequency.

Q. What is band width requirement for FM?

Ans: FM wave contains an infinite number of sidebands, thus suggesting an infinite bandwidth requirement for transmission or reception. In practice, the bandwidth of the FM depends on the modulation index. The higher the modulation index, the greater the required system bandwidth.

Q. What are the Advantages of frequency modulation, FM?

Ans: There are three advantages of frequency modulation for a communication system.

- **Resilience to noise:** One particular advantage of frequency modulation is its resilience to signal level variations. The modulation is carried only as variations in frequency. This means that any signal level variations will not affect the audio output, provided that the signal does not fall to a level where the receiver cannot cope. As a result this makes FM ideal for mobile radio communication applications including more general two-way radio communication or portable applications where signal levels are likely to vary considerably. The other advantage of FM is its resilience to noise and interference. It is for this reason that FM is used for high quality broadcast transmissions.

- **Easy to apply modulation at a low power stage of the transmitter:** Another advantage of frequency modulation is associated with the transmitters. It is possible to apply the modulation to a low power stage of the transmitter, and it is not necessary to use a linear form of amplification to increase the power level of the signal to its final value.

- **It is possible to use efficient RF amplifiers with frequency modulated signals:** It is possible to use non-linear RF amplifiers to amplify FM signals in a transmitter and these are more efficient than the linear ones required for signals with any amplitude variations (e.g. AM and SSB). This means that for a given power output, less battery power is required and this makes the use of FM more viable for portable two-way radio applications.

Q. What are the disadvantages of frequency modulation, FM?

Ans: This requires the wide bandwidth of the transmission.

Q. How many types of FM modulators are used?

Ans: There are two types of modulator; they are called as Varactor modulator and the Reactance modulator.

Q. What is Varactor diode?

Ans: The Varactor diode is a semiconductor diode that is designed to behave as a voltage controlled capacitor. When a semiconductor diode is reversing biased, no current flows and it consists of two conducting regions separated by non-conducting region. This is very similar to the construction of a capacitor.

If the information signal is applied to the Varactor diode, the capacitance will therefore be increased and decreased in sympathy with the incoming signal.

Q. Explain the operation of Varactor modulator?

Ans: The operation of the Varactor modulator:

- The information signal is applied to the base of the input transistor and appears amplified and inverted at the collector.
- This low frequency signal passes through the RF choke and is applied across the Varactor diode.

- The Varactor diode changes its capacitance in according to the information signal and therefore changes the total value of the capacitance in the tuned circuit.
- The changing value of capacitance causes the oscillator frequency to increase and decrease under the control of the information signal. The output is therefore a FM signal.

Q. Explain the operation of Reactance modulator?

Ans: Operation of the Reactance Modulator:

- The oscillator and tuned circuit provide the un-modulated carrier frequency and this frequency is present on the collector of the transistor.
- The capacitor and the resistor provide the 90° phase shift between the collector voltage and current. This makes the circuit appear as a capacitor.
- The changing information signal being applied to the base has the same effect as changing the bias voltage applied to the transistor and, this would have the effect of increasing and decreasing the value of this capacitance.

Q. What is the function of low pass filter?

Ans: The function of low pass filter is to reduce the amplitude of any high-frequency ripple and blocks the DC offset. Consequently, the signal at the output closely resembles the original input signal.

Warranty

- We guarantee this product against all manufacturing defects for 12 months from the date of sale by us or through our dealers.
- The guarantee will become void, if
  - The product is not operated as per the instruction given in the Learning Material.
  - The agreed payment terms and other conditions of sale are not followed.
  - The customer resells the instrument to another party.
  - Any attempt is made to service and modify the instrument.
- The non-working of the product is to be communicated to us immediately giving full details of the complaints and defects noticed specifically mentioning the type, serial number of the product and date of purchase etc.
- The repair work will be carried out, provided the product is dispatched securely packed and insured. The transportation charges shall be borne by the customer.

List of Accessories

1. Patch Cord 16".. 2 Nos.
2. Mains Cord .... 1 No.
3. TechBook Power Supply.. 1 No.
4. Product Tutorial (CD) .... 1 No.

EXPERIMENT 5

TIME DIVISION MULTIPLEXING

OBJECT-

1. OBJECTIVE

To demonstrate Time Division Multiplexing and demultiplexing process using Pulse amplitude modulation signals.

2. HARDWARE REQUIRED

1. TDM Trainer Kit-ST2102

2. CRO

3. Patch Chords

4. Probes

1.3. INTRODUCTION

An important feature of pulse-amplitude modulation is a conservation of time. That is, for a given message signal, transmission of the associated PAM wave engages the communication channel for only a fraction of the sampling interval on a periodic basis. Hence, some of the time interval between adjacent pulses of the PAM wave is cleared for use by the other independent message signals on a time-shared basis. By so doing, we obtain a time-division multiplex system (TDM), which enables the joint utilization of a common channel by a plurality of independent message signals without mutual interference.

Each input message signal is first restricted in bandwidth by a low-pass pre-alias filter to remove the frequencies that are nonessential to an adequate

signal representation. The pre-alias filter outputs are then applied to a commutator, which is usually implemented using electronic switching circuitry. The function of the commutator is two-fold: (1) to take a narrow sample of each of the N input messages at a rate is that is slightly higher than 2W, where W is the cutoff frequency of the pre-alias filter, and (2) to sequentially interleave these N samples inside a sampling interval Ts 1/fs. Indeed, this latter function is the essence of the time-division multiplexing operation. Following the commutation process, the multiplexed signal is applied to a pulse-amplitude modulator, the purpose of which is to transform the multiplexed signal into a form surtable for transmission over the communication channel.

At the receiving end of the system, the received signal is applied to a pulse-amplitude demodulator, which performs the reverse operation of the pulse amplitude modulator. The short pulses produced at the pulse demodulator output are distributed to the appropriate low-pass reconstruction filters by means of a decommutator, which operater in synchronism with the commutator in the transmitter.. This synchronization is essential for satisfactory operation of the TDM system, and provisions have to be made for it.

1.4 BLOCK DIAGRAM

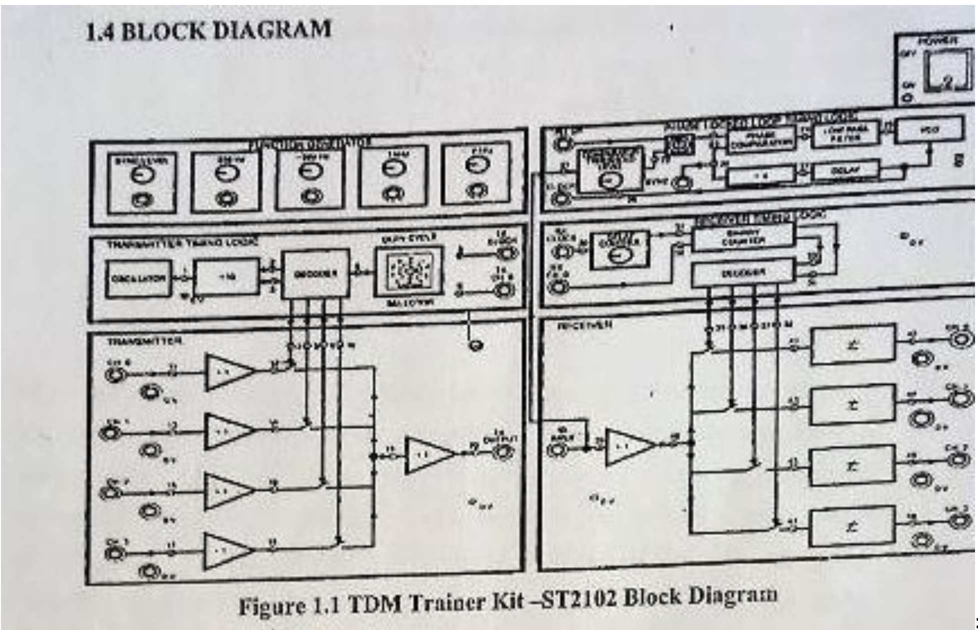


Figure 1.1 TDM Trainer Kit –ST2102 Block Diagram

=1

1.5 PRELAB QUESTIONS

1. What is multiplexing?

2. Mention the types of multiplexing?

3. What is the need for multiplexing?

4. What is the bit rate of T1, T2,T3 and 14 carrier systems?

5. Compare synchronous and asynchronous TDM.

6. What are the functions of commutator switch?

7. Give the advantages of multiplexing.

1.6 TEST PROCEDURE:

1.Take the signals from the function generator and give it to the channels (CHO CH3) present in the transmitter using patch chords. Note down the amplitude and time period of each signal.

2. Measure the amplitude and time period at the transmitter output point.

3. Using a patch chord, connect transmitter output to receiver input.

4.For synchronization purpose, connect the transmitter clock and receiver clock and also transmitter CHO andh receiver CHO.

TRANSMITTER SECTION

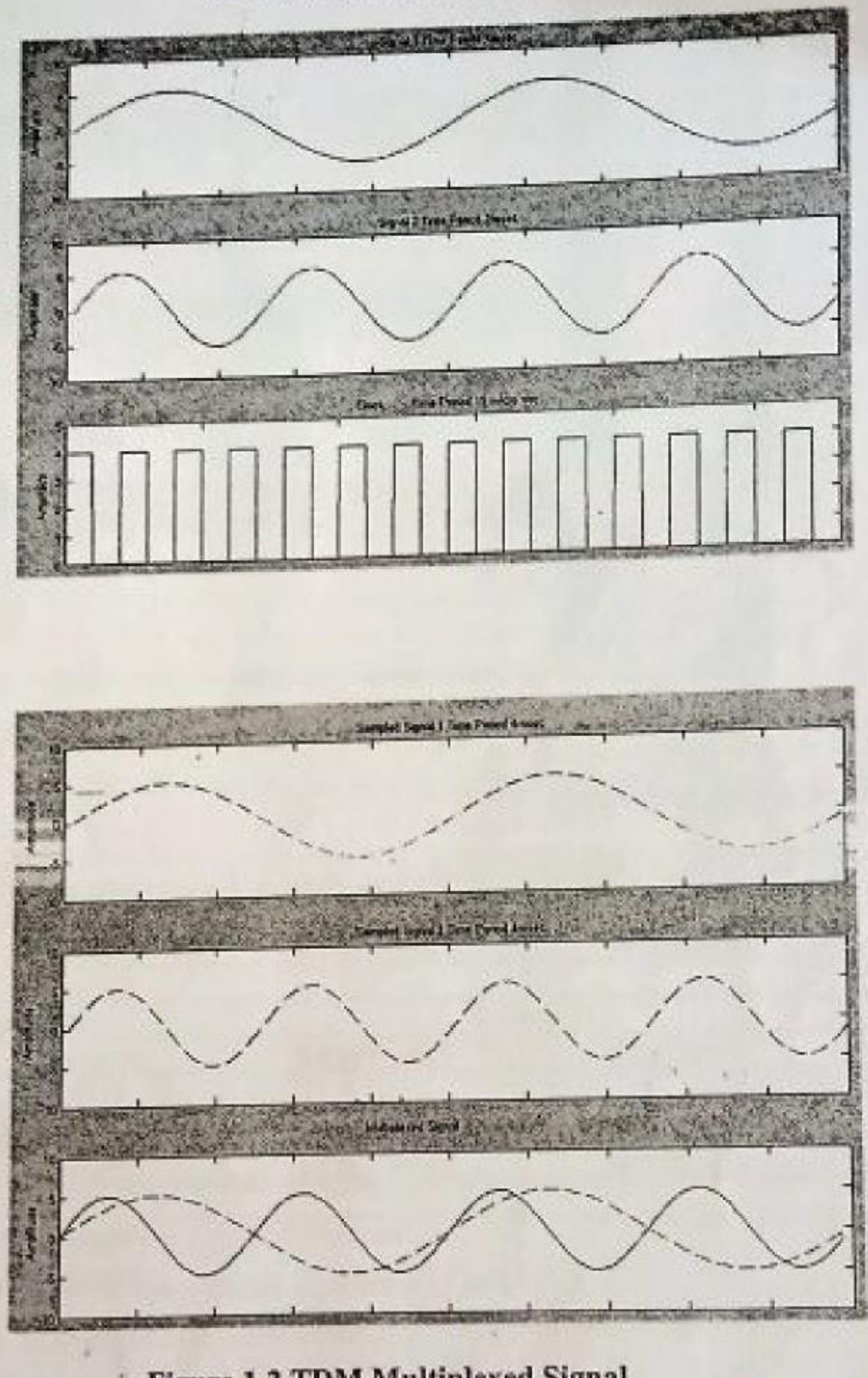


Figure 1.2 TDM Multiplexed Signal

MODEL GRAPH:

RECEIVER SECTION

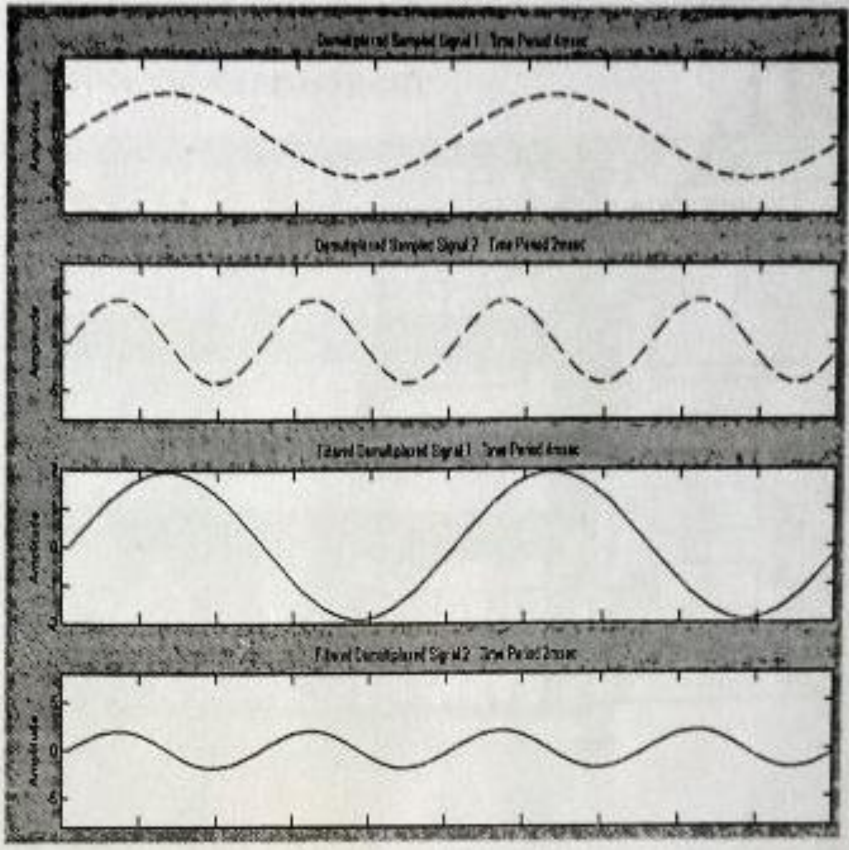
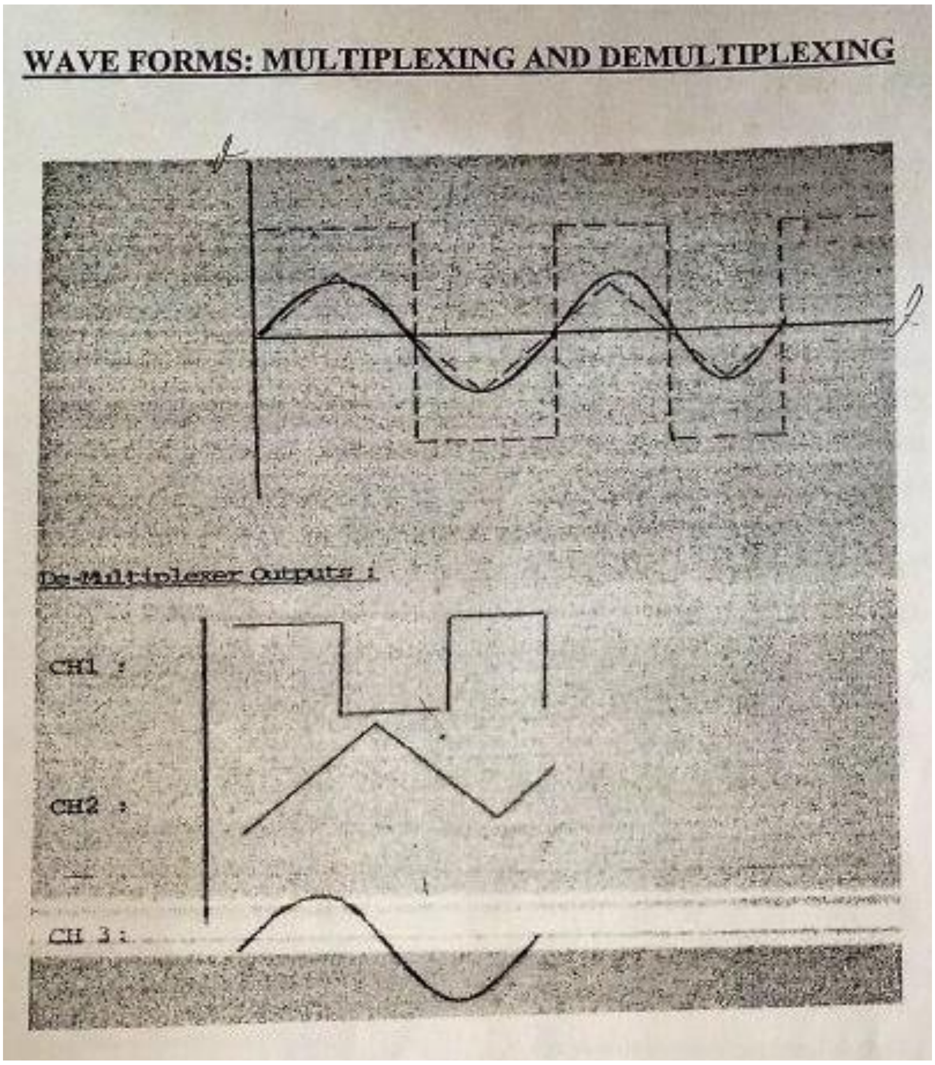


Figure 1.3 TDM Received Signal

1.8. OBSERVATION

Transmitter Section		Receiver Section	
Signal 1		**Demultiplexed Signal 1**	
Amplitude	**Time Period**	**Amplitude**	**Time Period**
Signal 2		**Demultiplexed Signal 2**	
Amplitude	**Time Period**	**Amplitude**	**Time Period**
Transmitter Output		**Filtered Demultiplexed Signal 1**	
Amplitude	**Time Period**	**Amplitude**	**Time Period**
		Filtered Demultiplexed Signal 1	
		Amplitude	**Time Period**



1

Procedure:

1. Switch on Time Divisie Multiplexing and De Multiplexing Trainer

2.Conect the channel-prwtonnel and triangle wave to channel-3 terminals of 8 to 1 Multiplexer

3. Cheerve the multiple cannel of a CRO

1. Cheene composite of CRO

Results

The operation of TDM served and there verified

EXPERIMENT - 6

Aim- study the optical transmitter and Receiver.

Apparatus Required - Trainr kit with power supply cords, optical fibre cable, cathode ray oscilloscope with necessary connecting probe

Theary- Fibre optics links can be used for transmisión of digital as well as analog signals. Bosically a fibre optic link contains three main elements a transmitter, an optical fibre and a receives the transmitter module takes the input signal in electrical form and then transforms it into optical energy containing the same information.

The optical fibre & the medium which takes the energy to the receiver

At the receiver light is converted back Into electrical form with the same pattern as fed to the Transmitter.

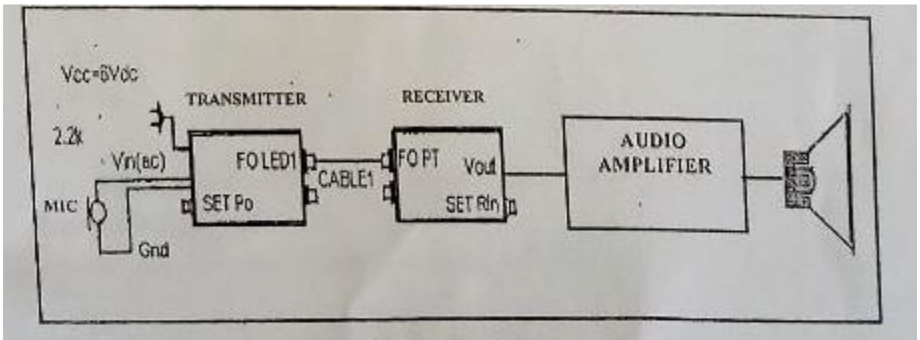
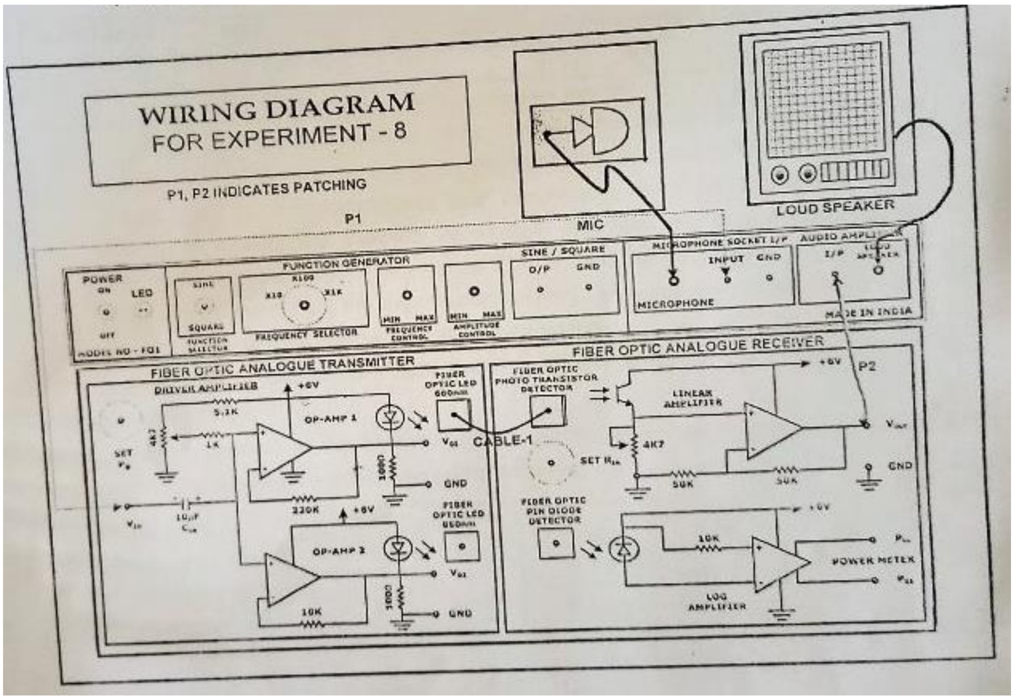


FIGURE - 11

Transmitter -

Fibre optic transmitters are composed of a butter, driver and optical source. The buffer provides both an electrical connection and Isolation b/w the transmitter and the electrical system the data. The driver provides electrical power to the optical source. Finally the optical source converts the electrical current to the light energy with the same pattern. The optical source used is LED. Simple LED circuit for along transmission is shown below the transmitter section comprises of function generator which generates Input signals that are going to be used as information to transmit through optical fibre

THE FIBRE OPTIC LINC: Emitter and detector circuit on board form the fibre optic. link this section provides the light source for the optic fibre and the light detester at the far end of the fibre optic links. The optic fibre plugs Into the connectors provided in this part of the board tow separate links are provided



THE RICEIVER:- The ac amplifier circuit from receiver on the board.

PROCEDURE:- 1. Connect the power supply to the board.

2. Ensure that all switched fouls are off

3. Make the following connections.

- .Connect the function generation 1kHx sine wave output in emitter's Input.

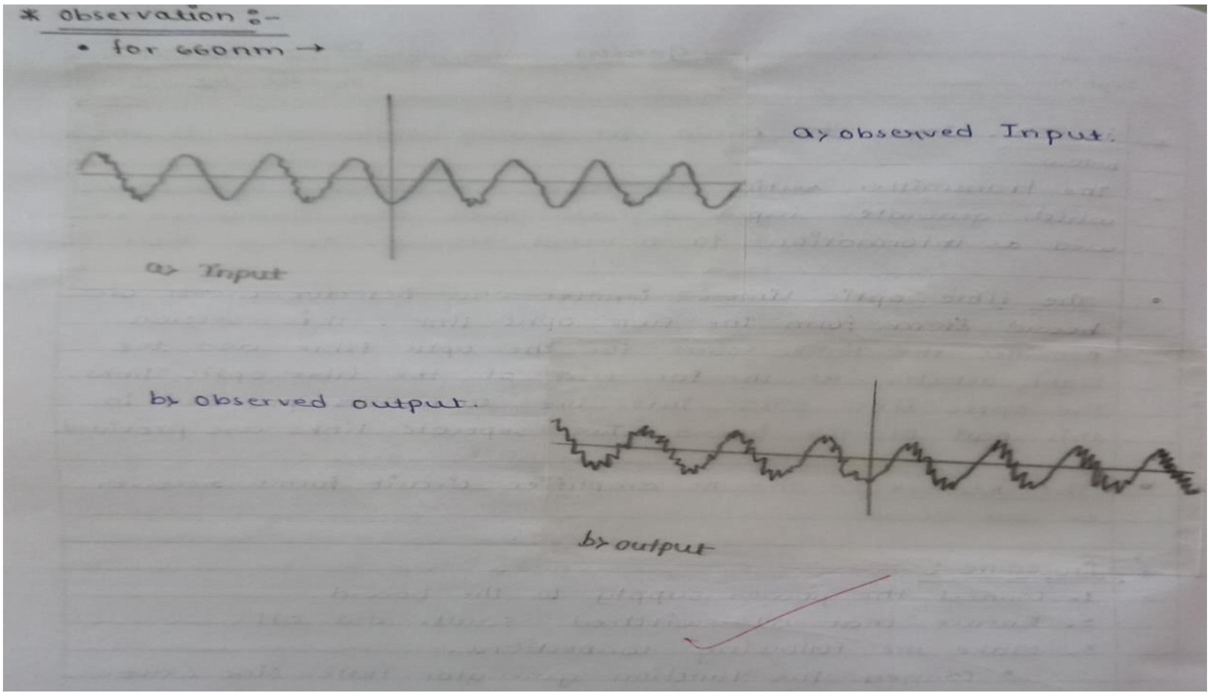
- connect the fibre optic cable b/w emitter o/p and detectors input.

• Detector's output to AC amplifier input.

4. On the board, switch emitter's driver to analogue mode

5. switch on the power.

6. Obverse the Input in emitter with the output from ac amplifies and note that the tow signals are same.



Result - The observed Input graph and observed output graph of ……………….nm is approximately same

Precautions -

1, Don't touch the apparatus in wet hand

2, Turn off the apparatus use.

3, check all the connection properly.

SAMPLE DIAGRAM AND OBSERVATION TABLE

* Diagram :-

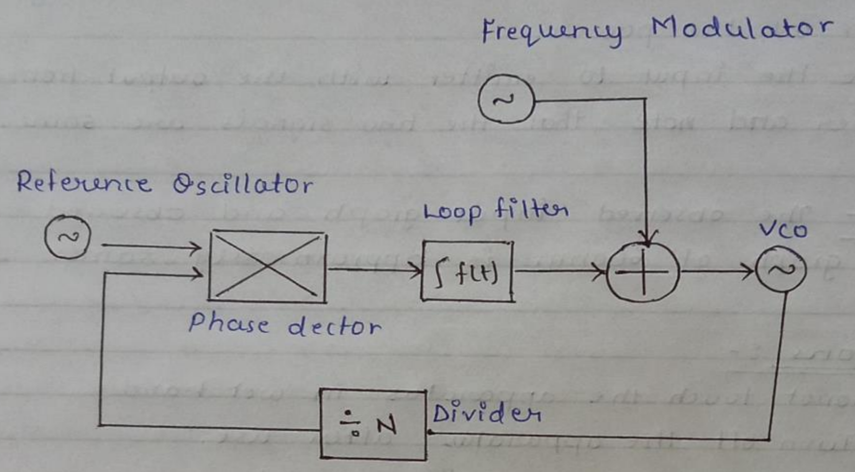


Fig :- Phase - Locked Loop Detector

* Observation Table :-

S.No		Volts/Div	Sec/Div	Frequency $f = \frac{1}{T}$ Hz
1.	Audio Oscillator (o/p) (output)	2000 V	200µs	5×10^3 Hz
2.	Reactance Modulator (Input)	2.00V	200µs	5×10^3 Hz
3.	Reactance Modul. (output)	200mV	2.00µs	5×10^5 Hz
4.	Phase Looked Loop Detector (I/P)	5000 mV	10.0ns	10×10^7 Hz
5.	Phase Looked Loop Detector (O/P)	500 mV	1.00µs	1×10^6 Hz