DEPARTMENT OF PURE AND APPLIED PHYSICS

M.Sc. (Electronics) Course Syllabus under CBCS/LOCF

Academic year 2023-24

Semester- II

DSE 1: Advanced Communication System I Lab

Course Code: PEPBLD1 Credit: 2 (0+0+2)

Name of the experiments :

1. Study the sample signal and sample hold signal and its reconstructions.
2. ASK/FSK/PSK generation and detection.
3. Study of Frequency Modulation using Reactance Modulator.
4. Study of Frequency Modulation using Varactor modulator.
5. Study the operation of Quadrature Detector.
6. Study the operation of Detuned Resonance Detector.
7. Study the operation of Foster - Seeley Detector
8. Study the operation of Ratio Detector

Experiment No. 01

NAME : Sampling and Re-construction of Signals.

Object:-

(a) Experimentally verify the Sampling Theorem and observe the Aliasing effect, using the Scientech **Sampling Trainer Kit model ST-2101.** Trace the "Sampled signal at any three different sampling frequencies.

(b) Observe the effect of the variation of duty cycle of the sampling puises and the order of the low- pass filter on the re-construction of the sampled signal, Trace the wave-shapes of the re-constructed signal using 2 order and 4 order LPF.

Apparatus Used:-

1. Sampling and Reconstruction Trainer kit, model ST-2101 (Scientech Technologies)

2. A 20 MHz, dual channel Oscilloscope.

BRIEF THEORY

NYQUIST CRITERION (Sampling Theorem)-

The Nyquist criterion states that a continuous signal band limited to f_m Hz, can be completely represented by and reconstructed from, the samples taken at a rate greater than or equal to 2 f_m samples per second. This minimum frequency is called as **"Nyquist Rate"** Thus, for the faithful reconstruction of the information signal from its samples, it is necessary that the sampling rate, f_s must be greater than $2f_m$.

Aliasing:-

If the information signal is sampled at a rate lower than that stated by Nyquist criterion, than there is an overlap between the information signal and the side bands of the harmonics. Thus the lower and the higher frequency components get mixed and cause unwanted signals to appear at the demodulator output. This phenomenon is termed as Aliasing or Fold-over Distortion. The various reasons for aliasing and the ways for its prevention may be summarized as under:-

A) Aliasing due to under-Sampling-

If the signal is sampled at a rate lower than 21, then it causes aliasing, as illustrated in the following figure, where a sinusoidal signal of frequency f is being sampled at a rate $<2f$, and the dots represent the sample points.

The LPF at demodulator effectively joins the sample causing an unwanted frequency component to appear at the output. This unwanted component has a frequency (fs-fm)

B) Aliasing due to wide band signal :-

The system is designed to take samples at a frequency slightly greater than that stated ny Nyquist rate. If higher frequencies are ever present in the information signal, or it is affected by H. F, noise, then the aliasing will occur. To prevent the aliasing, Anti-aliasing filters are usually installed prior to sampling. In telephone networks, the speech signals are band-limited by filters before sampling to avoid the effect of aliasing.

C) Aliasing due to noise:- If very small duty cycle is used in sample-and-hold circult, aliasing may occur if the signal has been affected by the noise. High frequency noise generally mix with the High frequency component of the signal, and hence causes undesirable frequency components to appear at the output. This type of aliasing may, therefore, be prevented by slightly increasing the duty cycle of the sampling pulses.

D) Aliasing due to Filter Roll-off :-

Aliasing may also occur, if appropriate filter response is not chosen and the frequencies above the nominal cut-off frequency of the filter, have significant amplitudes at the filter's output. This is called Aliasing due to Filter Roll-off.

Brief Description of the Kit

The lay out thegram of the experimental bit is shown on the next page The bit contains the circuits for the following five sections :-

1. Sampling Frequency Selector Section :-

By default, the sampling frequency is set to 32 Kitz. But pushing successively the sampling frequency selector switch can change it and the value of the selected frequency is one tenth of the frequency Indicated by the corresponding glowing 150 for example, if the LED corresponding to 20 His glowing then the selected value of the sampling frequency is 2 KHz.

2. Duty cycle control section-

Here the duty cycle of the sampling puises can be varied from 10% to 90%.

3. Sampling Section :-

It provides Sampled outout at TP 37 and the "sample and hold output at TP:39. The input sampling pulses are also selected in this section by the INTERNAL/EXTERNAL sampling selector switch.

NB:- The internal pulses are usually selected, because the external pulses need to be synchronized with the information signal (1 Kiiz internally generated sinusoidal signal available at TP-12 on the sampling frequency selection circult board) to get the stable trace on the CRO screen.

4. Two Low-pass Filter sections

The 2nd order and Ath order LPI's, which provide the reconstructed signal at their outputs, TP 42 and TP-46 respectively.

The 4th order and the 2nd order Low Pass Filters The nth order filter has a rate of fall off of in dB/Octave or 20rid/decade and one Lapacitor or inductor is required for each pole (order). The following table summarizes the effect of fall off gradient on a signal such as square wave :-

PROCEDURE :-

1. Set the INTERNAL/EXTERNAL sampling selector switch in INTERNAL position.

2. Put the DUTY CYCLE SELECTOR switch in position 5 (to set 50% duty cycle).

3. Connect 1 KHz Internally generated sinusoidal signal available at tp12 to SIGNAL INPUT on the Sampling Circuit board.

4. Now turn the ON/OFF switch of the kit to ON.

5. Observe the information signal (1 KHz at tp12) on one channel and the Sample output (at TP-37) on the other channel of the CRO.

6. Connect the Sample Output (TP-37) to the input of 4th order LPF.

7. Trace the Sampled output at TP-37. Note that 32 samples are appearing in one cycle of the information signal, as the default value of the sampling frequency is 32 KHz.

8. Now, keep on reducing the sampling frequency in steps and trace the sampled output at any other t values of the sampling frequencies.

9. Observe the reconstructed signal at the output of the 4th order LPF at tp46 on setting the sampling frequency equal to 2 KHz. Note that it is distorted as fs = 2 fm

10. Now, Connect the Sample Output (T-37) to the input of 2nd order LPF, and observe the reconstructed signal at the output of the 2nd order LPF (TP-42) at different values of samping frequencies. Compare the outputs of both the LPFs for the same value of sampling frequency. Which one is better and willy? This completes the first part of the experiment.

11. For the second part, keep the sampling rate constant at some appropriate value (sav Bor 16 KHz), and vary the position of DUTY CYCLE SELECTOR switch, and observe the Sampled signal (TP-37) and the reconstructed signal at the output of the 4th order LPF (TP-46) and also at the output of the 2nd order LP (TP-42) at different values of the duty cycle varying from 40% (position 4) to 90% (position 9 of duty cycle selector switch). Record your observations. How does the amplitude of the reconstructed signal vary with the variation of the duty cycle?

12. Now, disconnect the sample output (TP-37) from the input of the LPF and connect "Sample and Hold output (TP-39) to the inputs of the LPFs, and observe the reconstructed signals at their outputs one by one

13. Vary the duty cycle again and observe that the reconstructed signal has now become independent of duty cycle variation Measure the amplitude of the reconstructed signal at (TP-46) and at (TP-42) one by one.

14. Comment on the results obtained by using the 4th order LPF and the 2nd order LPF.

OBSERVATIONS:-

For a 1 KHz sine wave (internal information signal at TP-12) and for 50% duty cycle pulses, Minimum sampling rate for undistorted reconstructed signal using 4th order LPF = Minimum sampling rate for undistorted reconstructed signal using 2nd order LPF = Tabulate your observations for the second part of the experiment:

RESULTS & Comments:

References:-

1) B. P. Lathi: Communication Systems

2) Scientech Technologies Pvt. Ltd.: WORK BOOK of Sampling and Reconstruction Trainer ST-2101 WB

3) Scientech Technologies Pvt.Ltd.: Operating Manual of Sampling and Reconstruction Trainer ST-2101 OM.

EXPERIMENT : 02

NAME: QUADRATURE PHASE SHIFT KEYING MODULATION TECHNIQUES

OBJECTIVE: Study of Carrier Modulation Techniques try Quadrature Phase Shift Keying method.

THEORY:

In this modulation, called Quadrature PSK (OPSK) or 4 PSK the sine carrier takes 4 phase values, separated of 90 deg. and determined by the combinations of bit pair (Dibit) of the binary data signal. The data are coded into Dibit by a crout generating:

- A data signal 1 (in phase) consisting in voltage levels corresponding to the value of the first bit of the considered pair, for duration equal to 2 bit intervale.
- A data signal Q (in quadrature) consisting in voltage levels corresponding to the value of the second bit of the pair, for duration equal to 2 bit intervals.

The block diagram of the modulator used on the module is shown in the fig.4.1 four 500KHz sine carriers, shifted between them of 90 deg, are applied to modulator. The data (signal 1 & 0) reach the modulator from the Dibit generator. The instantaneous value of I and O data bit generates a symbol. Since I and O can take either 0 or 1 value, maximum 4 possible symbols can be generated (00. 01, 10, and 11). According to the symbol generated one of the four-sine carrier will be selected. The relation between the symbol generated and sine carrier is shown in table.

DIBIT	PHASE SHIFT
00	180 deg
01	90 deg
10	270 deg
11	0 deg

A receiver for the OPSK signal is shown in fig. synchronous detection is required and hence it is necessary to locally regenerate the carriers. The scheme for carrier regeneration is similar to that employed in BPSK. In that earlier case we squared the incoming the signal, extracted the waveform at twice the carrier frequency by filtering, and recovered the carrier by frequency dividing by two, In the present case, it is required that the incoming signal be raised to the fourth power after which filtering recovers a waveforms at four times the carrier.

The incoming signal also applied to the sampler followed by an adder and envelope detectors. Two adders add the sampled OPSK signal, sampled by the clock having different phases. At the output of adder the signals consisting ligh envelope corresponds to the & a bit. Envelope detector then filters Frequency components and recovers 1 & O bil. These recovered & bits having axactly same phase bits then applied to d & frequency compared to data decoder logic transmitter & bit. These 1& O to recover the original NRZ-L data pattern.

EQUIPMENTS :

Experimenter Kits ADCL-02 & ADCL-03

Connecting Chords. Power supply

20MHz Dual Trace Oscilloscope.

NOTE: KEEP THE SWITCH FAULTS IN OFF POSITION.

PROCEDURE:

1. Refer to the block diagram (Fig 4.1) and carry out the following connections and switch settings.

2. Connect power supply in proper polarity to the kits **ADCL-02** and **ADCL-03** and switch it on.

3. Select Data pattern of simulated data using switch SW1

4. Connect **SDATA** generated to **DATA IN** of the **NRZ-L CODER.**

5. Connect **NRZ-L DATA** to **DATA IN** of the **DIBIT CONVERSION.**

6. Connect **SCLOCK** to **CLK IN** of the **DIBIT CONVERSION.**

7. Connect the dibit data 1 & Q bit to control input **C1** and **C2 MODULATOR** respectively **NOTE:** Adjust 1 & Q bit as shown in Fig.4.2A by operating RST Switch on ADCL-02 before connecting it to C1 & C2.

8. Connect carrier component to input of **CARRIER MODULATOR** as follows:

   a. **SIN 1** to **IN 1**

   b. **SIN 2** to **IN 2**

   c. **SIN 3** to **IN 3**

   d. **SIN 4** to **IN 4**

9. Connect QPSK modulated signal **MOD OUT** on **ADCL-02** to the **MOD IN** Of the QPSK DEMODULATOR on **ADCL-03. NOTE:** Adjust Recovered | & Q bit on ADCL-03 as per ADCL-02 by RST Switch on ADCL-03.

10. Connect **I BIT, Q BIT & CLK OUT** outputs of QPSK Demodulator to **I BIT IN, Q BIT IN & CLK IN** posts of Data Decoder respectively.

11. Observe various waveforms as mentioned below (Fig. 4.2). **NOTE:** If there is mismatch in input & Recovered Data, then adjust that Data by RST Switch on ADCL-03

OBSERVATION: Observe the following waveforms on oscilloscope and plot it on the paper.

ON KIT **ADCL-02**

1. Input **NRZ-L** Data at **DATA INPUT.**

2. Carrier frequency **SIN 1** to **SIN 4.**

3. Dibit pair generated data **I bit & Q bit at DIBIT CONVERSION.**

4. QPSK modulated signal at **MOD OUT.**

ON KIT **ADCL-03**

1. Output of first squarer at **SQUARER 1.**
2. Output of second squarer at **SQUARER 2.**
3. Four sampling clocks at the output of **SAMPLING CLOCK GENERATOR**.
4. Two adder outputs at the output of **ADDER.**
5. Recovered data bits (I & Q bits) at the output of **ENVELOP DETECTORS.**
6. Recovered NRZ-L data from I & Q bits at the output of **DATA DECODER.**

SWITCH FAULTS:

Note: Keep the connections as per the procedure. Now switch corresponding fault switch button in ON condition & observe the different effect on the output. The faults are normally used one at a time.

1. Put switch 1 of **SF1 (ADCL-02)** in Switch Fault section to ON position. This will open capacitor for filtering of SIN 1. Thus amplitude of SIN 1 and SIN 3 gets reduced.

2. Put switch 2 of SF1 **(ADCL-02)** in Switch Fault section to ON position. This will disable control signal C1 going to Modulator IC. Modulator will not able to modulate the signal properly.

3. Put switch 3 of **SF1 (ADCL-02)** in Switch Fault section to ON position. This will open the input of EX OR gate used in differential encoder 1. Due to this random data is generated at the output of differential encoder 1

4. Put switch 4 of **SF1 (ADCL-02)** in Switch Fault section to ON position. This will remove the clock signal (125 KHz-180 deg.) in the generation of Q bit data. This disable the generation of Q bit data at the output of dibit conversion.

5 Put switch 2 of **SF1 (ADCL-03)** in Switch Fault section to ON position. This will remove Pull up resistor from envelope detector of I-Bit. I-Bit generation gets disabled.

6. Put switch 3 of **SF1 (ADCL-03)** in Switch Fault section to ON position. This will remove one of the sampling clocks to sampler. Thus QPSK signal doesn't get sampled properly and due to this QPSK demodulated data also gets disturbed.

7. Put switch 4 of **SF1 (ADCL-03)** in Switch Fault section to ON position. This will remove the sampling input of sample. So I bit can not be observed and recovered data also gets disturbed.

CONCLUSION:

In BPSK we deal individually with each bit of duration Tb. In QPSK we lump two bits together to form a SYMBOL. The symbol can have any one of four possible values corresponding to two-bit sequence 00, 01, 10, and 11. We therefore arrange to make available for transmission four distinct signals. At the receiver each signal represents one symbol and, correspondingly, two bits. When bits are transmitted, as in BPSK, the signal changes occur at the bit rate. When symbols are transmitted the changes occur at the symbol rate which is one-half the bit rate. Thus the symbol time is Ts = 2Tb.

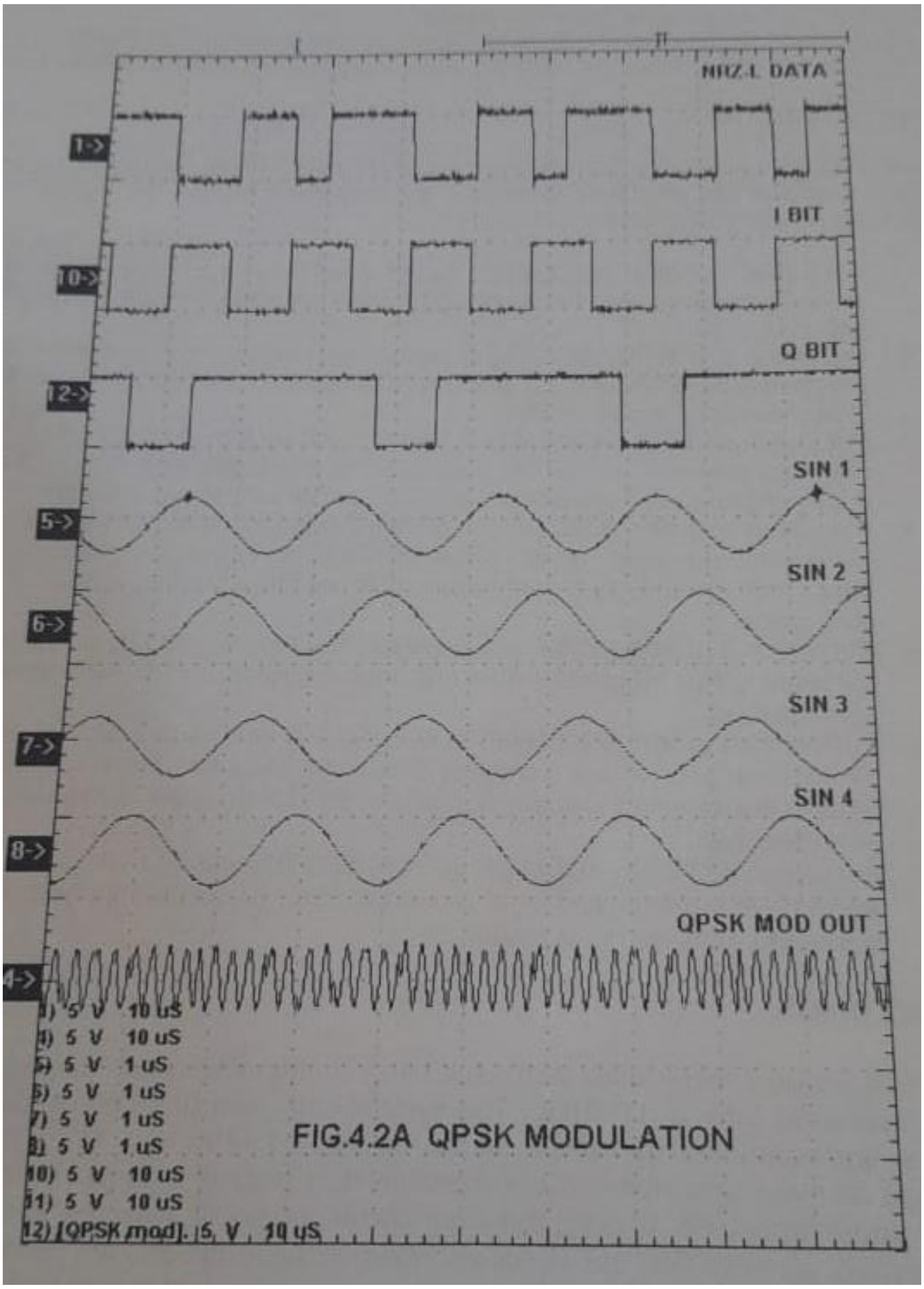


FIG.4.2A QPSK MODULATION

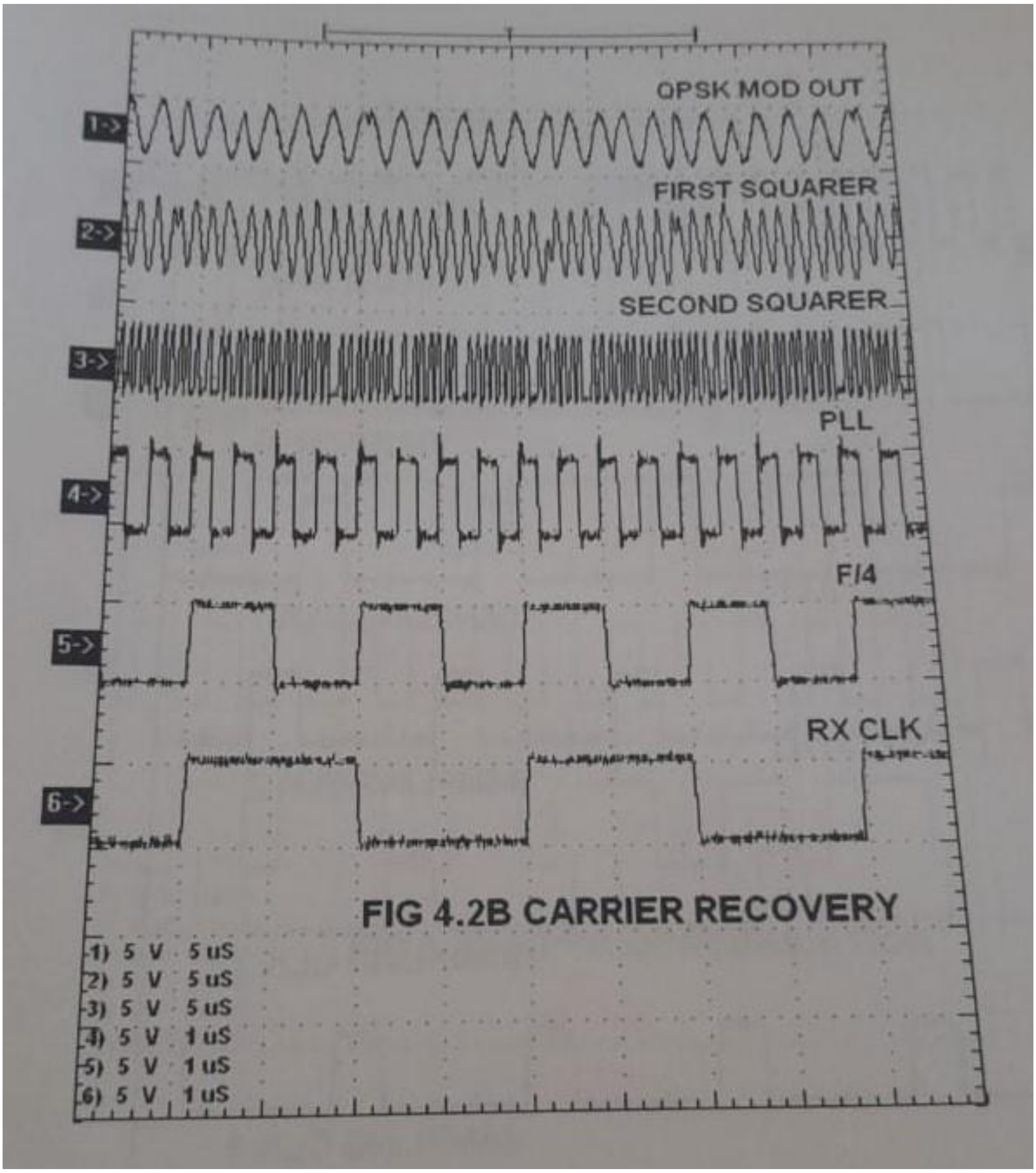


FIG 4.2B CARRIER RECOVERY

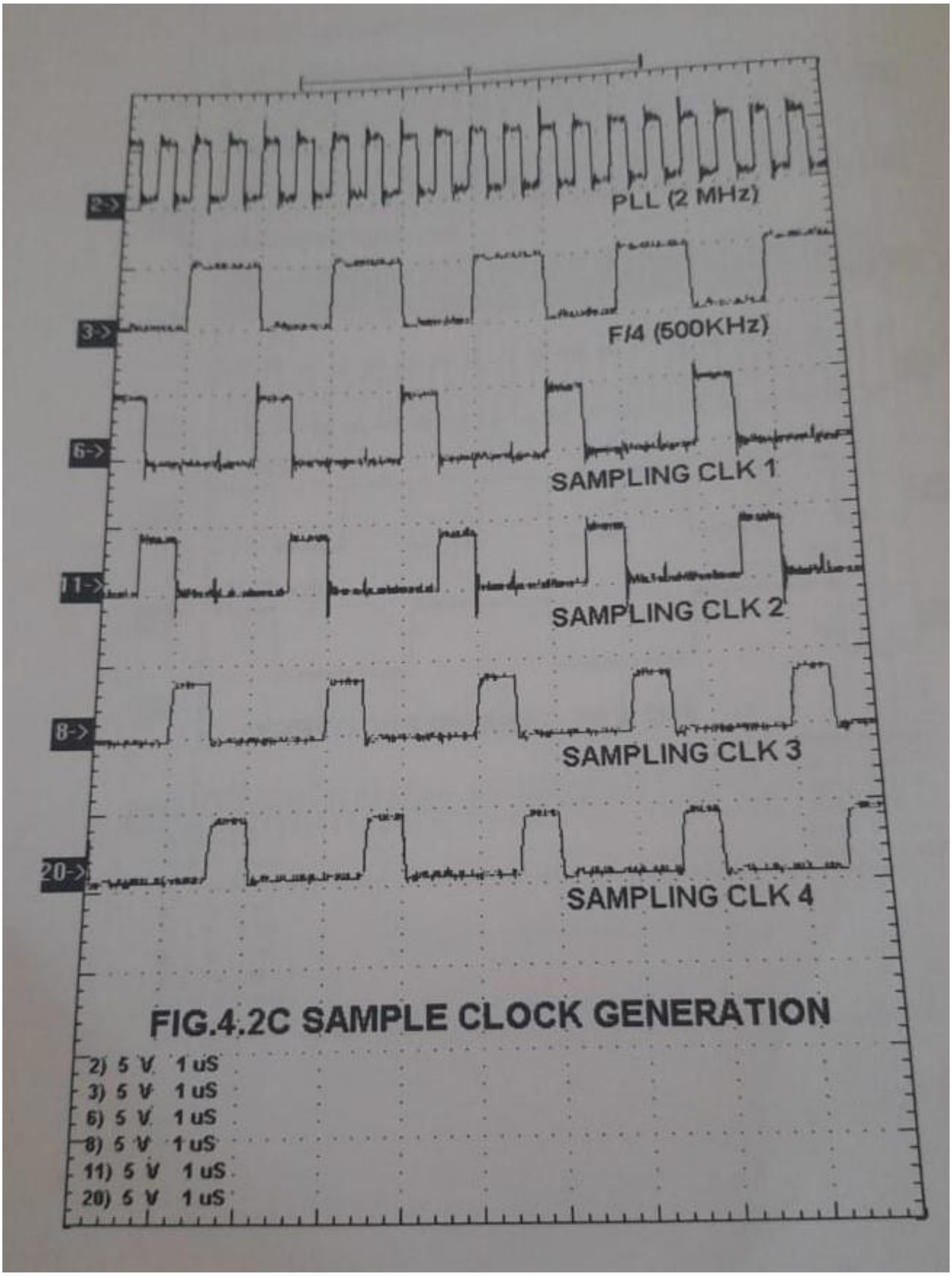


FIG.4.2C SAMPLE CLOCK GENERATION

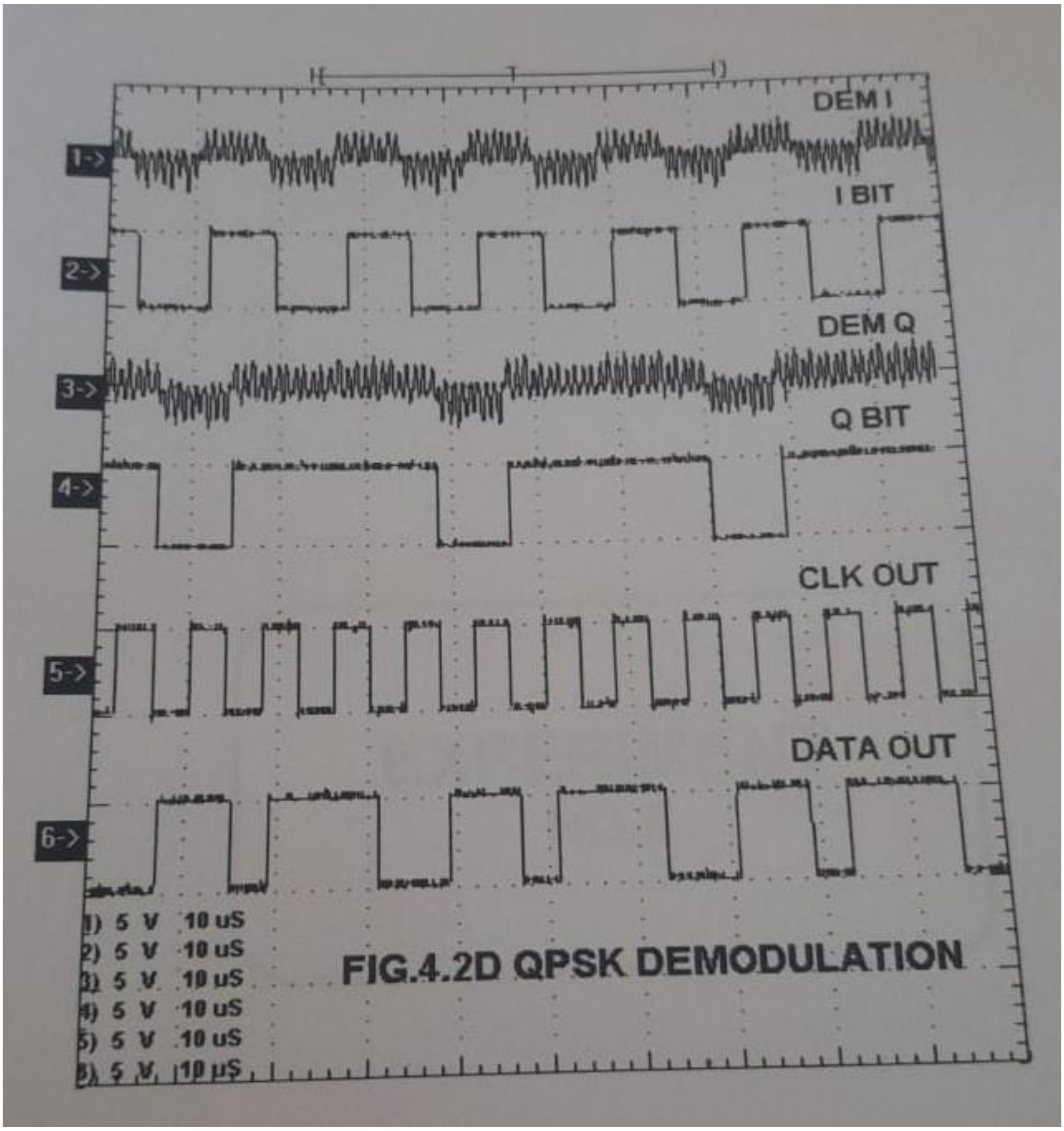


FIG.4.2D QPSK DEMODULATION

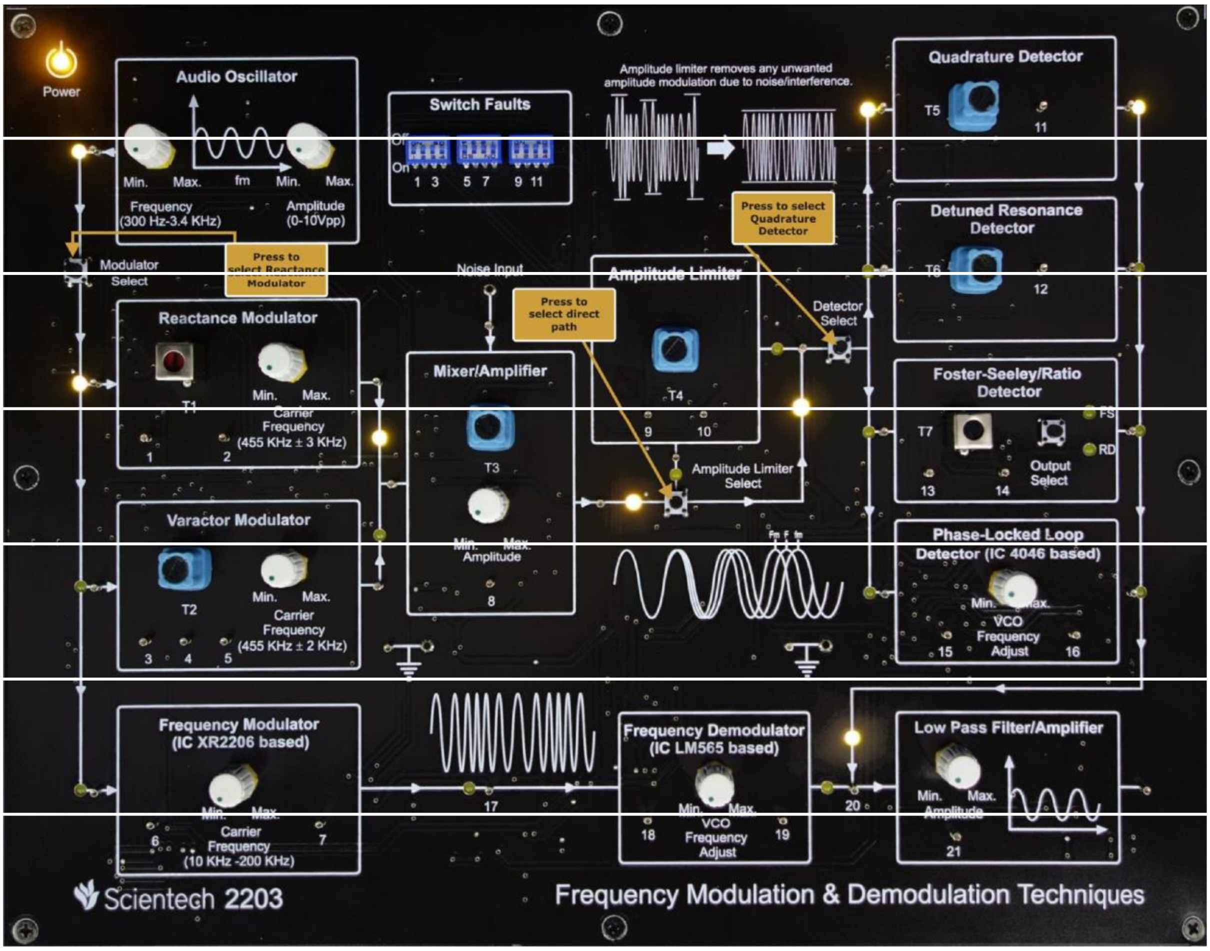
Experiment 3

Objective: Study of Frequency Modulation using Reactance Modulator.

Equipments Required:

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

Selection diagram:



Procedure:

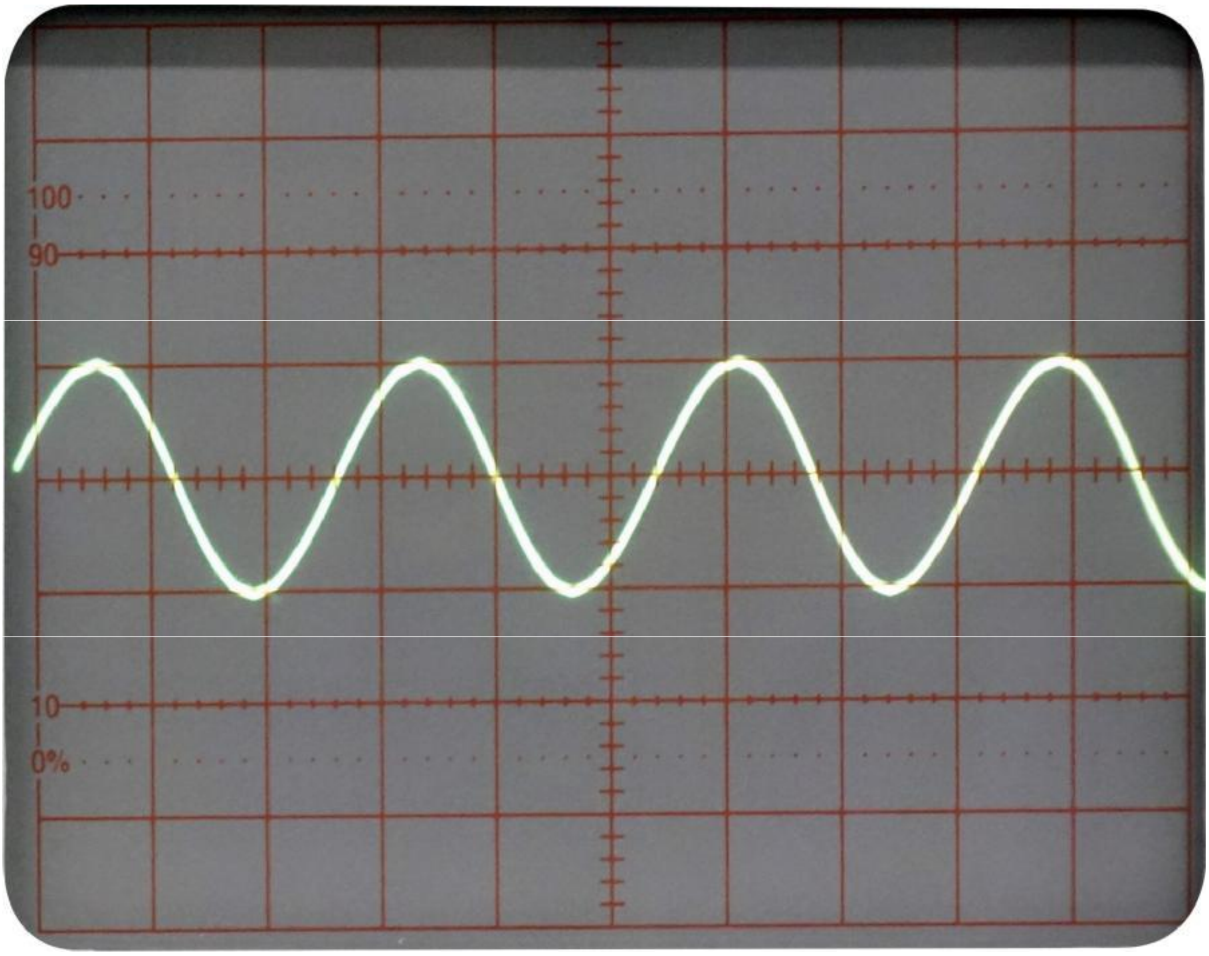
This experiment investigates how Reactance modulator circuit performs frequency modulation. This circuit modulates the frequency of a carrier sine wave, according to the audio signal applied to its modulating output.

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. 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.



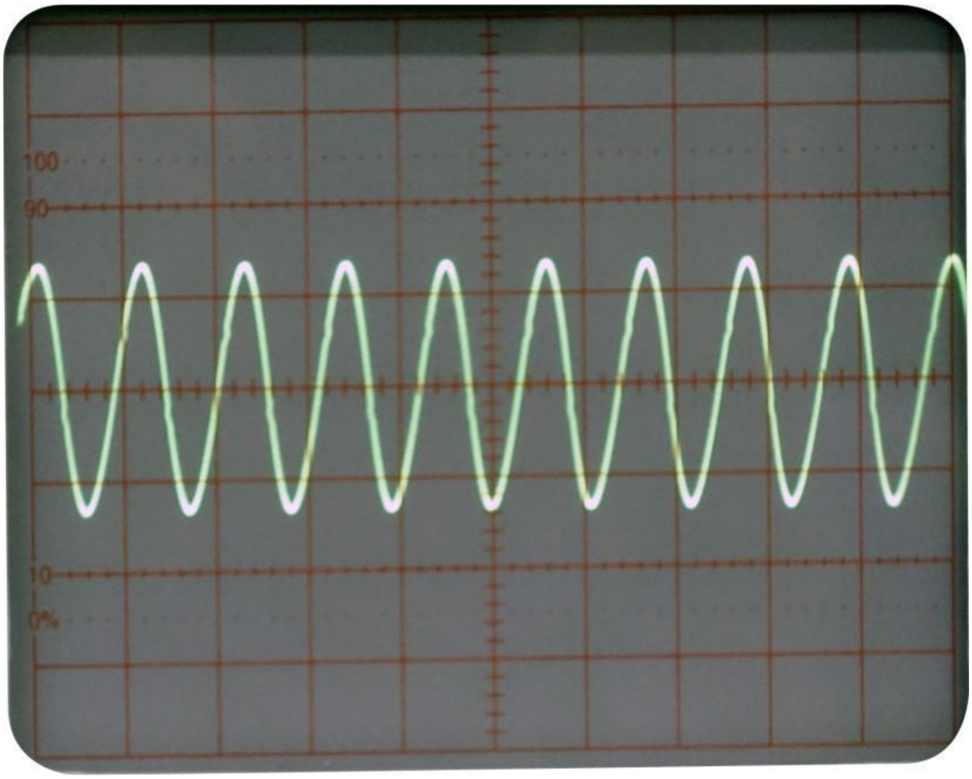
Audio Oscillator output signal

4. Return the amplitude potentiometer to its minimum position.
5. 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. This selection switches the output of the Reactance modulator through to the input of the Mixer/Amplifier block.
6. The carrier signal from the Reactance modulator block appears at output test point of this block, before being buffered and amplified by the Mixer/Amplifier block. Although the output from the Reactance modulator block can be monitored directly at test point, any capacitive

loading affect this point (e.g. due to an Oscilloscope probe) may slightly affect the modulator's output frequency. In order to avoid this problem we will monitor the buffered FM output signal at the output test point of the Mixer/Amplifier block.

7. Put the Reactance modulator's Carrier Frequency potentiometer in its midway position then examine the signal at the output test point of the Mixer/Amplifier block.

Note: The monitored signal is a sine wave of approximately 1.2Vpp centered on 0 volts DC. 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.

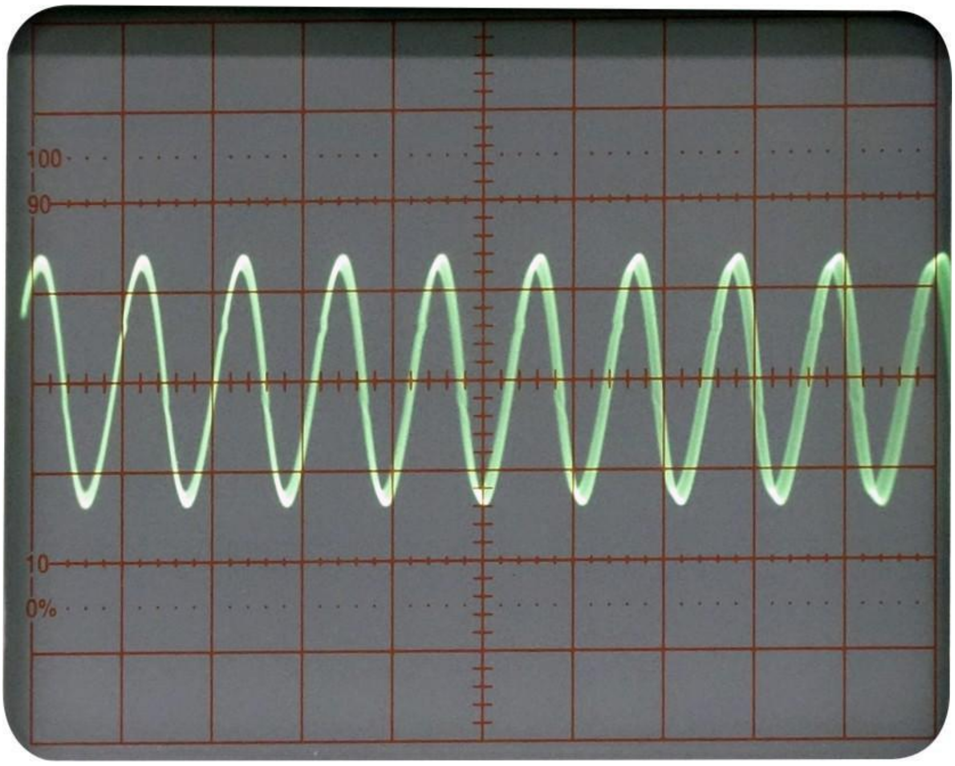


Carrier frequency output from Reactance modulator

8. The frequency of the FM carrier signal should be approximately 455 KHz at the moment. This carrier frequency can be varied from 452 KHz to 458 KHz (approximately) by adjusting the carrier frequency potentiometer in the Reactance modulator block to maximum and minimum position respectively.

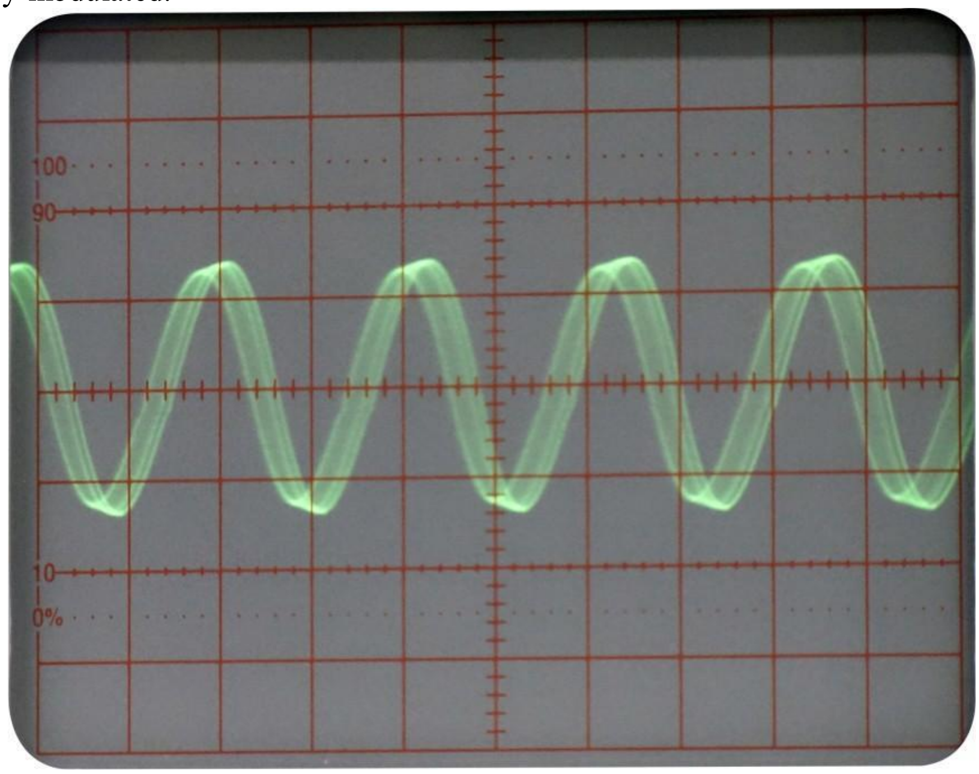
9. The amplitude of the FM carrier is adjustable by means of the Mixer/Amplifier block's amplitude potentiometer. Try turning this potentiometer slowly anticlockwise, and note that the amplitude of the FM signal can be reduced to zero. Return the amplitude potentiometer of Mixer/Amplifier block to its maximum position.

10. Now gradually 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 Mixer/Amplifier block. At higher amplitude the FM signal gets over-modulated hence the waveform distorts.

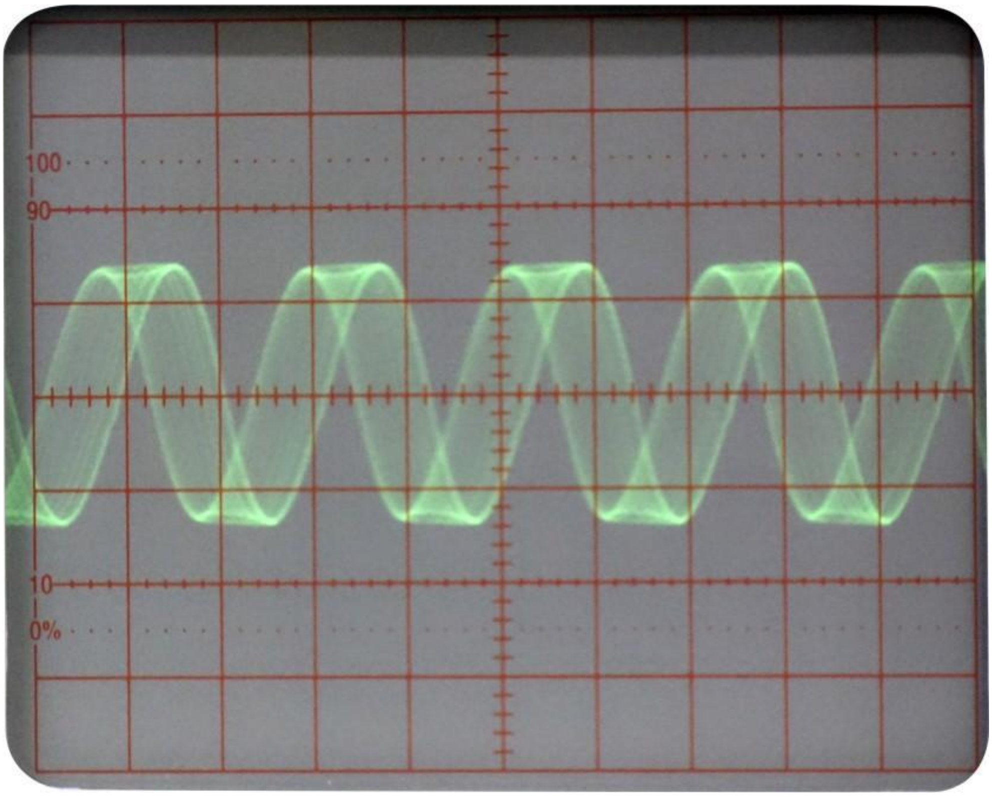


Frequency modulated waveform

If you have such a control, display 20-25 cycles of the waveform on the Oscilloscope, and then use the X-expansion control to 'expand up' the right most cycles of the display. There should be a slight ambiguity in the positions of these cycles, indicating that the sine wave is being frequency-modulated.



Frequency modulated waveform in expanded mode in middle position

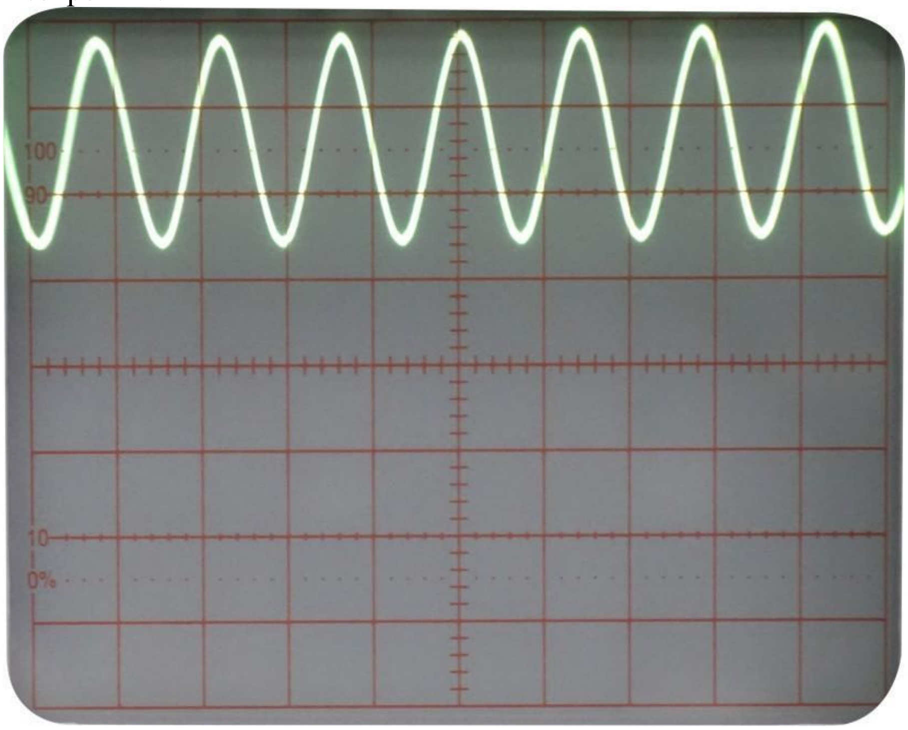


Frequency modulated waveform in expanded mode at right most position

11. Try varying the amplitude & frequency potentiometer in audio oscillators block and observe the variations in the frequency deviation of FM signal.

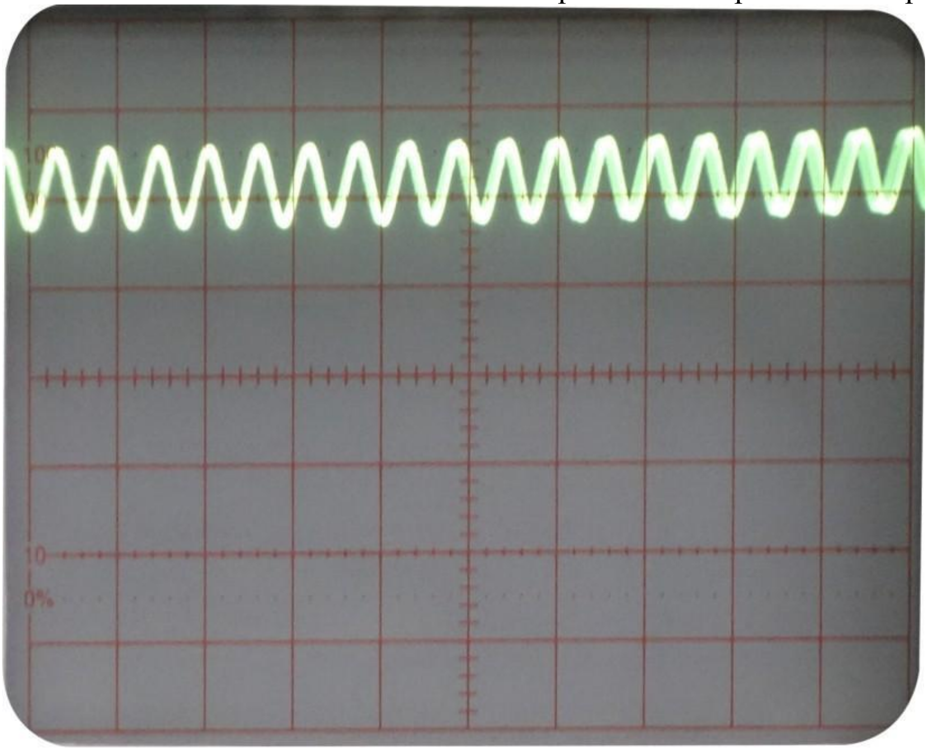
12. Also observe the effect of varying the carrier frequency potentiometer in the Mixer/Amplifier block on FM signal. Return the carrier frequency potentiometer to its midway position.

13. Observe the modulating signal processed with proper biasing voltage for FM operation at test point 2.



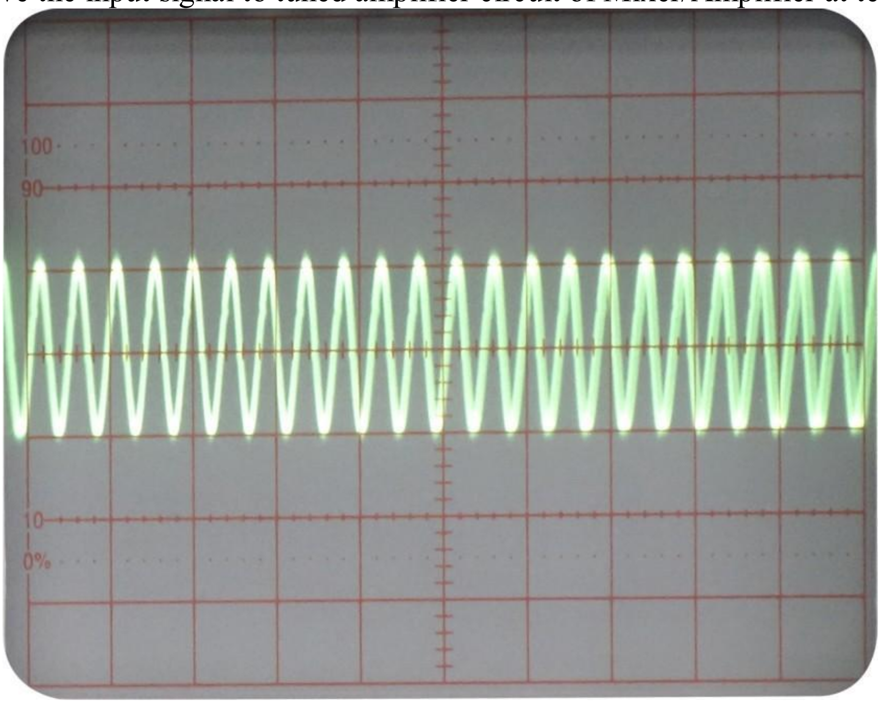
Modulating signal input to oscillator circuit

14. Observe the Tuned oscillator circuit's FM output before amplifier at test point 1.

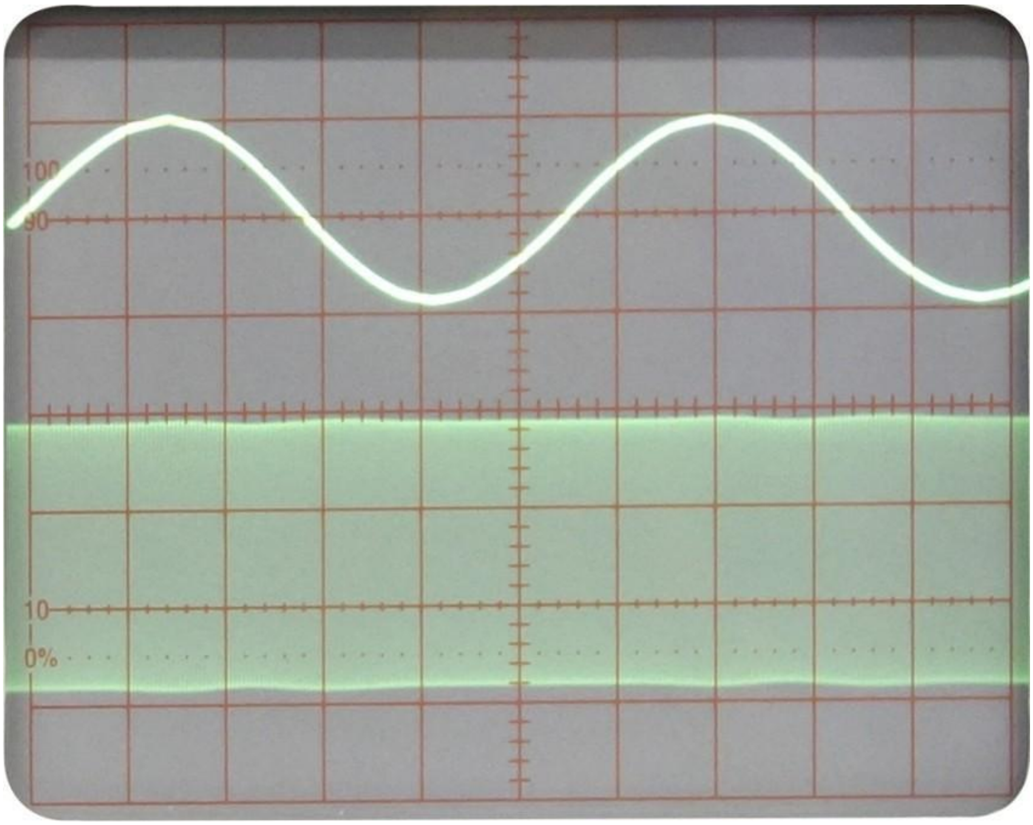


Output of the tuned oscillator before amplifier

15. Observe the input signal to tuned amplifier circuit of Mixer/Amplifier at test point 8.



16. Monitor the audio oscillator output and the FM output triggering the Oscilloscope on the audio output 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 signal's frequency, and not in its amplitude.



Frequency modulated waveform with modulating signal

Questions:

- What is the function of Reactance modulator?
- What is tuned circuit?
- What is the effect of using capacitor in Reactance modulator?
- What is the function of variable capacitor?
- What are the applications of Reactance modulator?

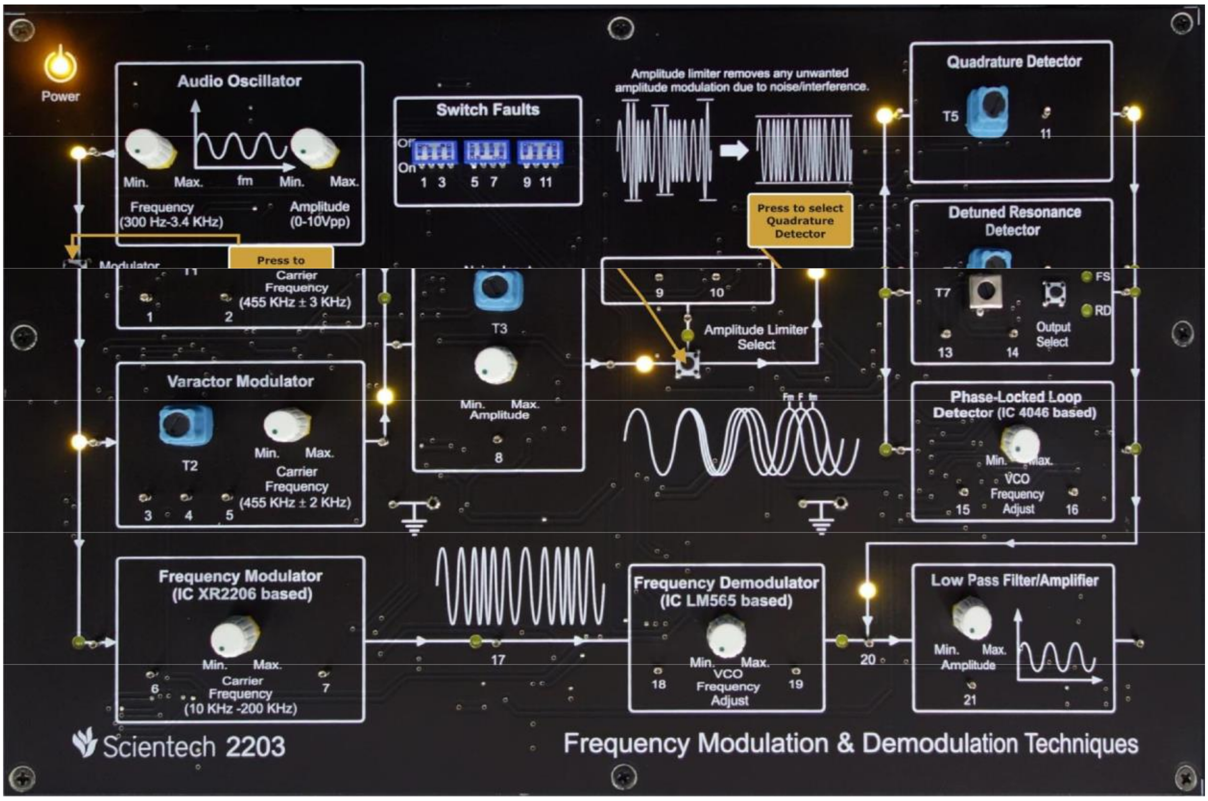
Experiment 4

Objective: Study of Frequency Modulation using Varactor modulator.

Equipments Required:

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

Selection diagram:



Procedure:

This experiment investigates how Varactor 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 Low pass filter/Amplifier block in center position.

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

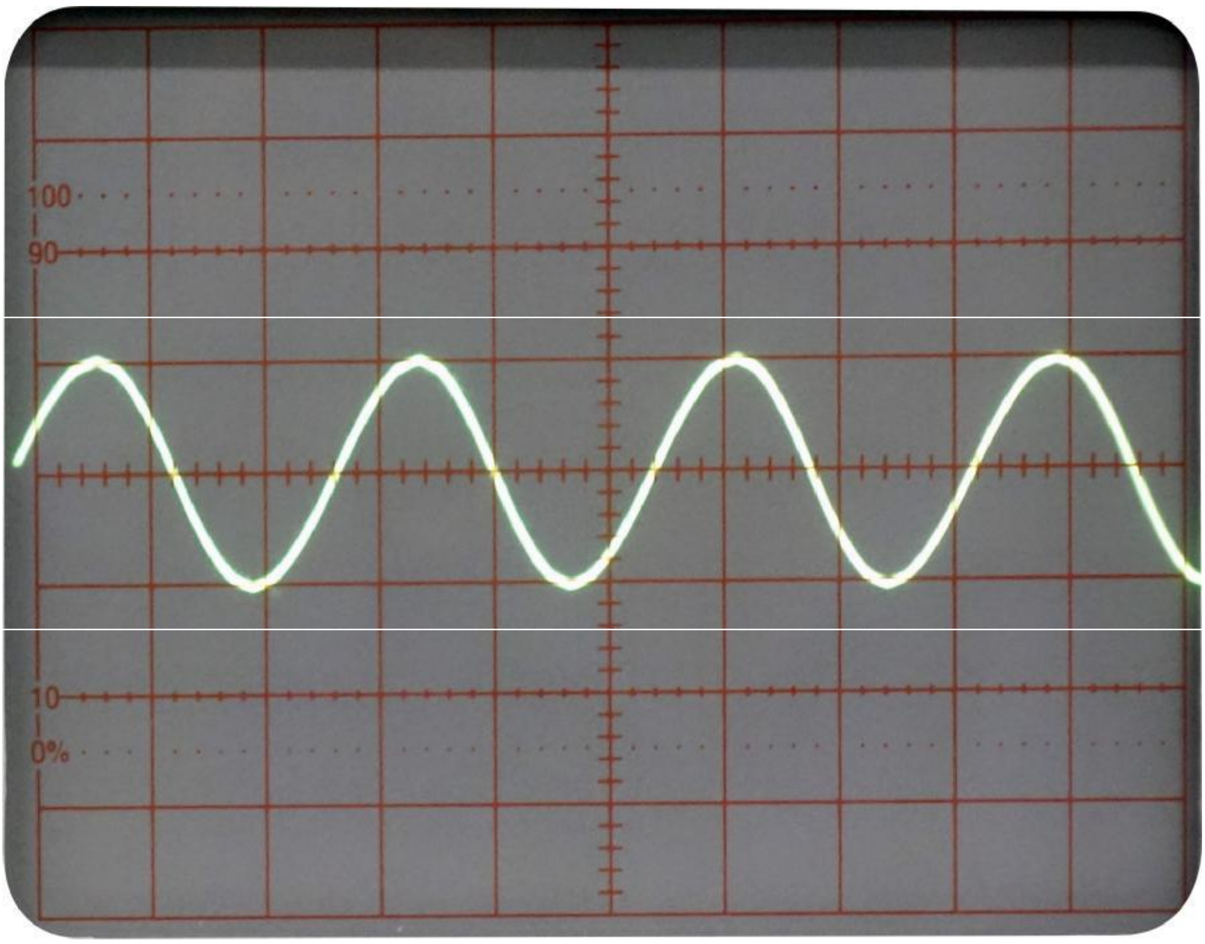
h) Carrier Frequency potentiometer of Frequency Modulator (IC XR2206 based) block in minimum position.

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. 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

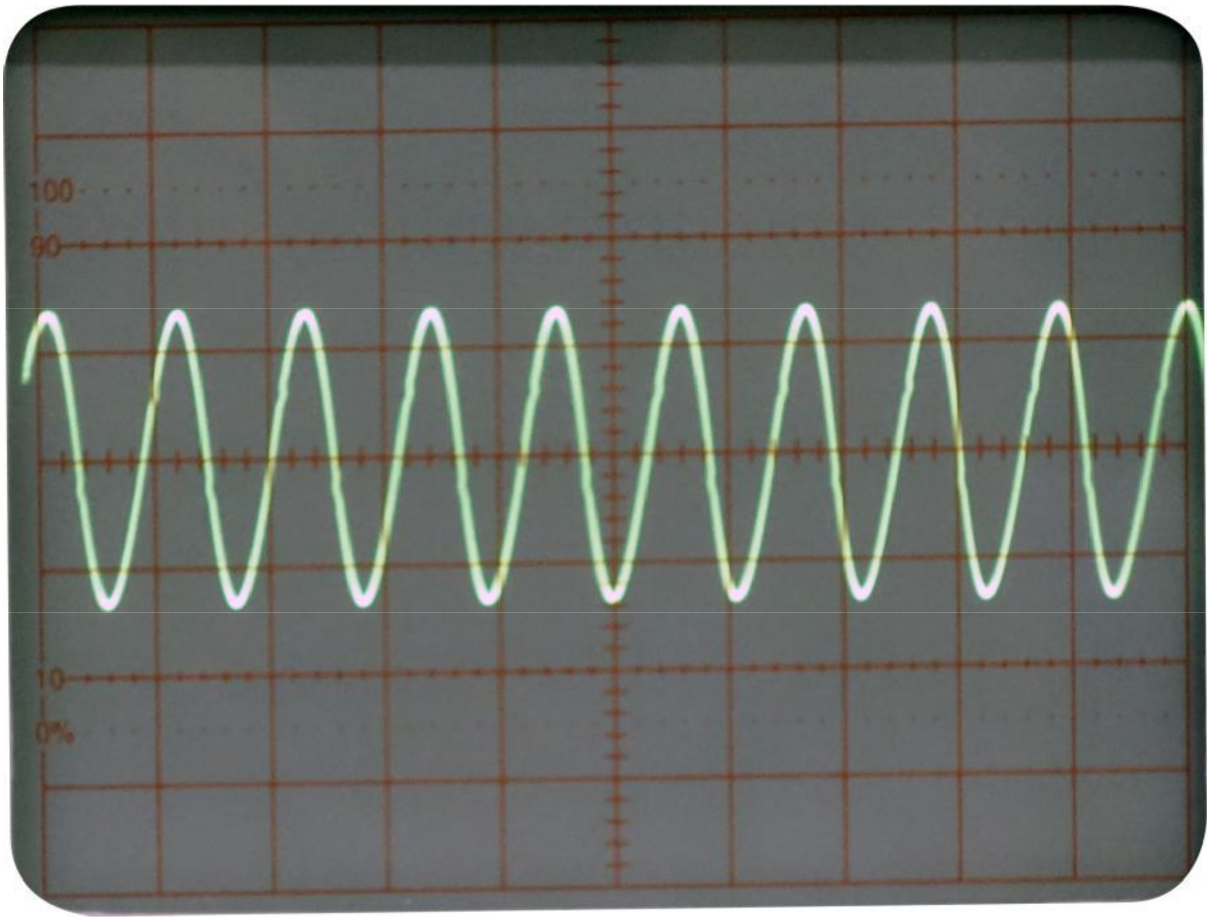
4. Return the amplitude potentiometer to its minimum position.

5. Press the 'Modulator Select' switch to select Varactor modulator block and check that it is selected for operation which is indicated by glowing LEDs at the input and output of this block. This selection switches the output of the Varactor modulator through the Mixer/Amplifier block.

6. The carrier signal from the Varactor modulator block appears at output test point of this block, before being buffered and amplified by the Mixer/Amplifier block. Although the output from the Varactor modulator block can be monitored directly at test point, any capacitive loading affect this point (e.g. due to an Oscilloscope probe) may slightly affect the modulator's output frequency.
In order to avoid this problem we will monitor the buffered FM output signal at the output test point of the Mixer/Amplifier block.

7. Put the Varactor modulator's potentiometer in its midway position then examine the signal at the output test point of the Mixer/Amplifier block.

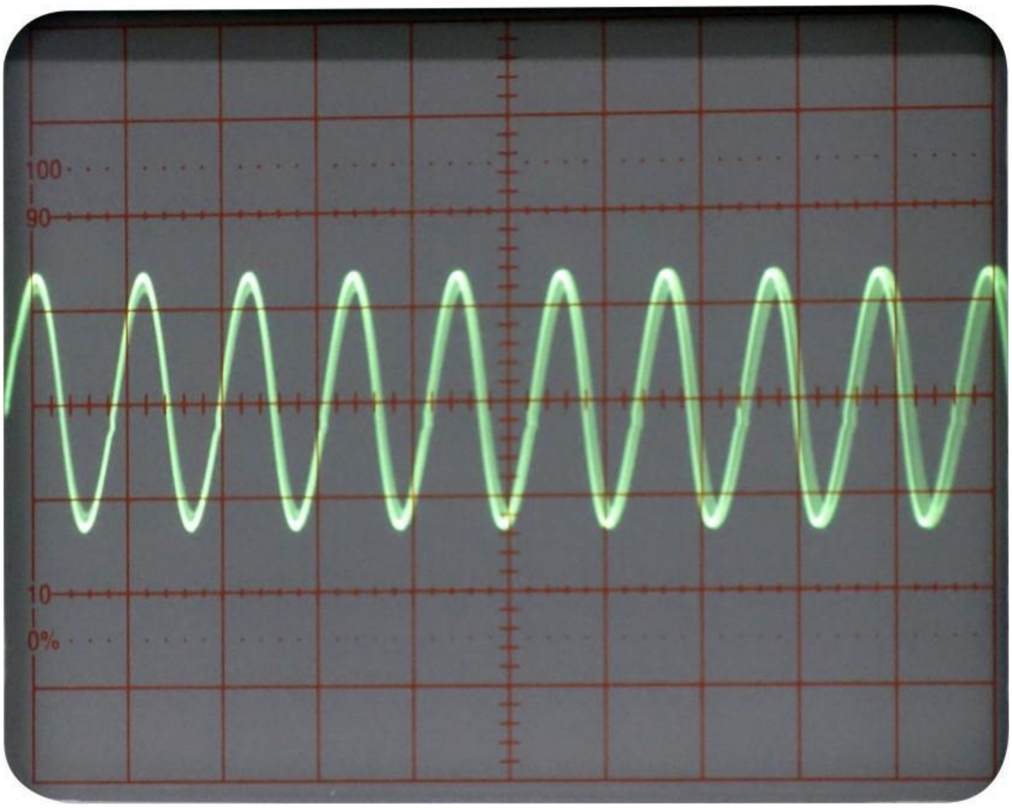
Note: The monitored signal is a sine wave of approximately 1.2Vpp centered on 0 volts DC This is our FM carrier, and it is presently un-modulated since the amplitude of the modulating signal in Audio Oscillator block is set to 0V.



8. The frequency of the FM carrier signal should be approximately 455 KHz at the moment. This carrier frequency can be varied from 454 KHz to 457 KHz (approximately) by adjusting the carrier frequency potentiometer in the Varactor modulator block to maximum and minimum position respectively.

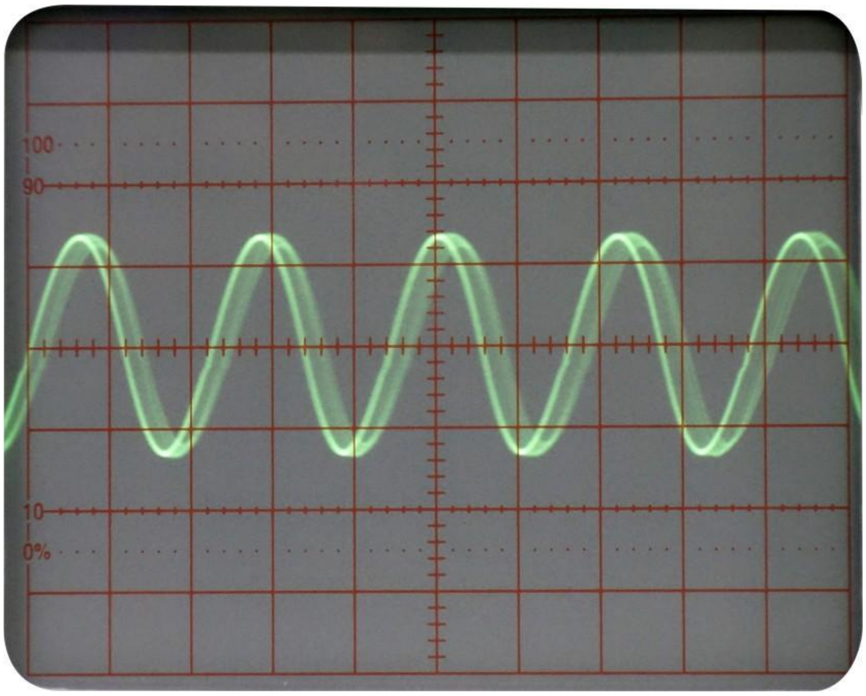
9. The amplitude of the FM carrier is adjustable by means of the Mixer/Amplifier block's amplitude potentiometer, from zero to its potentiometer level. Try turning this potentiometer slowly anticlockwise, and note that the amplitude of the FM signal can be reduced to zero. Return the amplitude potentiometer to its maximum position.

10. Now gradually 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 Mixer/Amplifier block. At higher amplitude the FM signal gets over-modulated hence the waveform distorts.

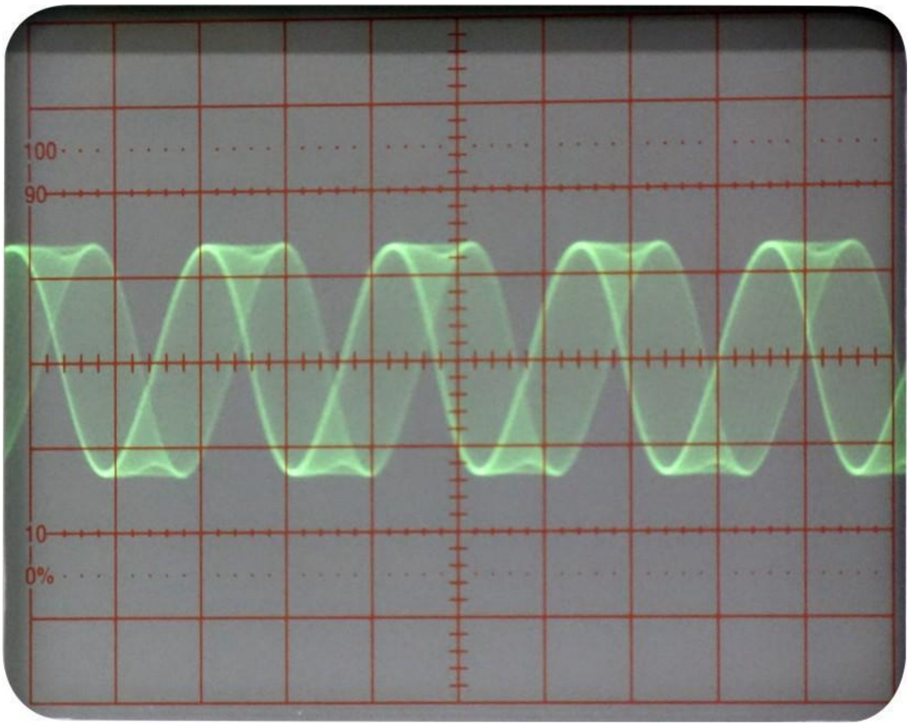


Frequency modulated waveform

If you have such a control, display 20-25 cycles of the waveform on the Oscilloscope, and then use the X-expansion control to 'expand up' the right most cycles of the display. There should be a slight ambiguity in the positions of these cycles, indicating that the sine wave is being frequency-modulated.



Frequency modulated waveform in expanded mode at middle position

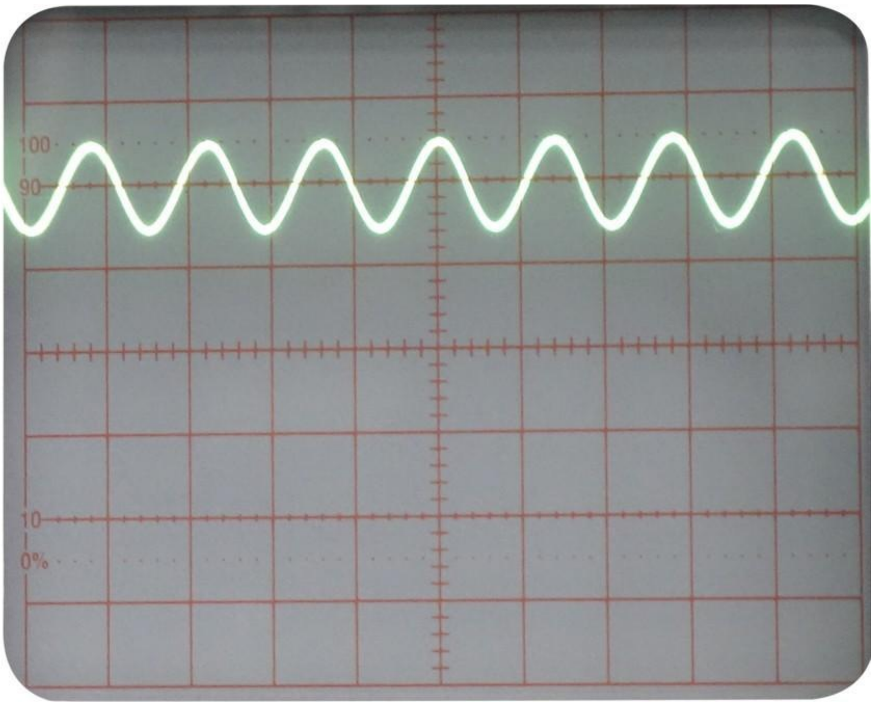


Frequency modulated waveform in expanded mode at right most position

11. Try varying the amplitude & frequency potentiometer in audio oscillators block and observe the variations in the frequency deviation of FM signal.

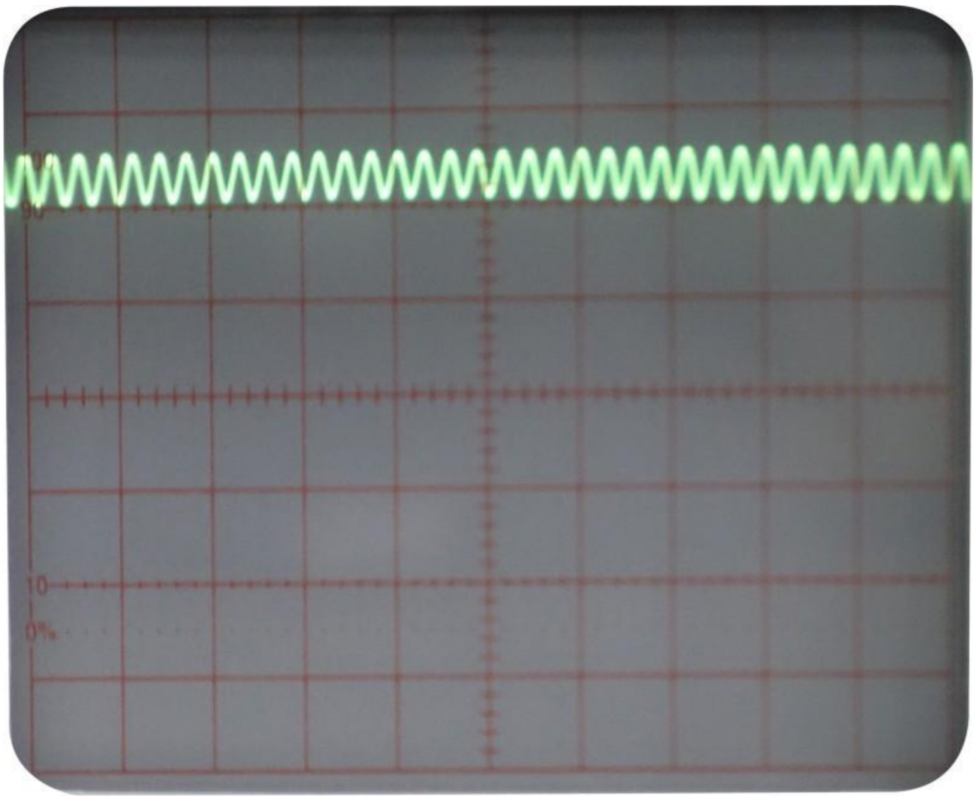
12. Also observe the effect of varying the carrier frequency potentiometer in the Mixer/Amplifier block on FM signal.
Return the carrier frequency potentiometer to its center position.

13. Observe the modulating signal processed with proper biasing voltage for FM operation at test point 5.



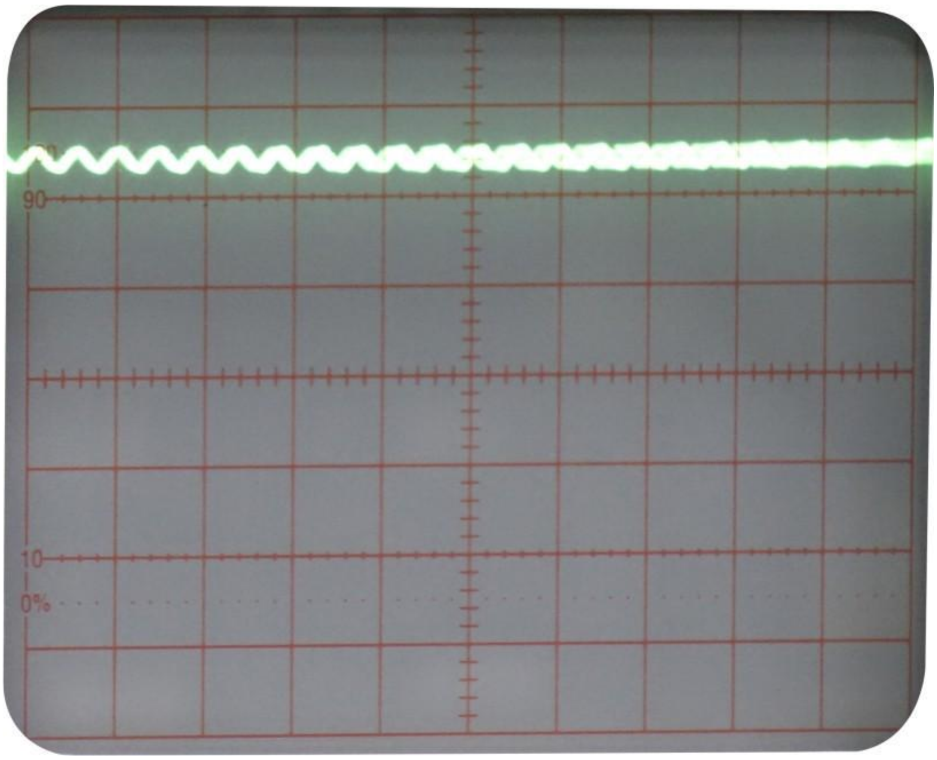
Modulating signal input to Oscillator circuit

14. Observe the signal applied across the Varactor diode from FM generation at test point 4.



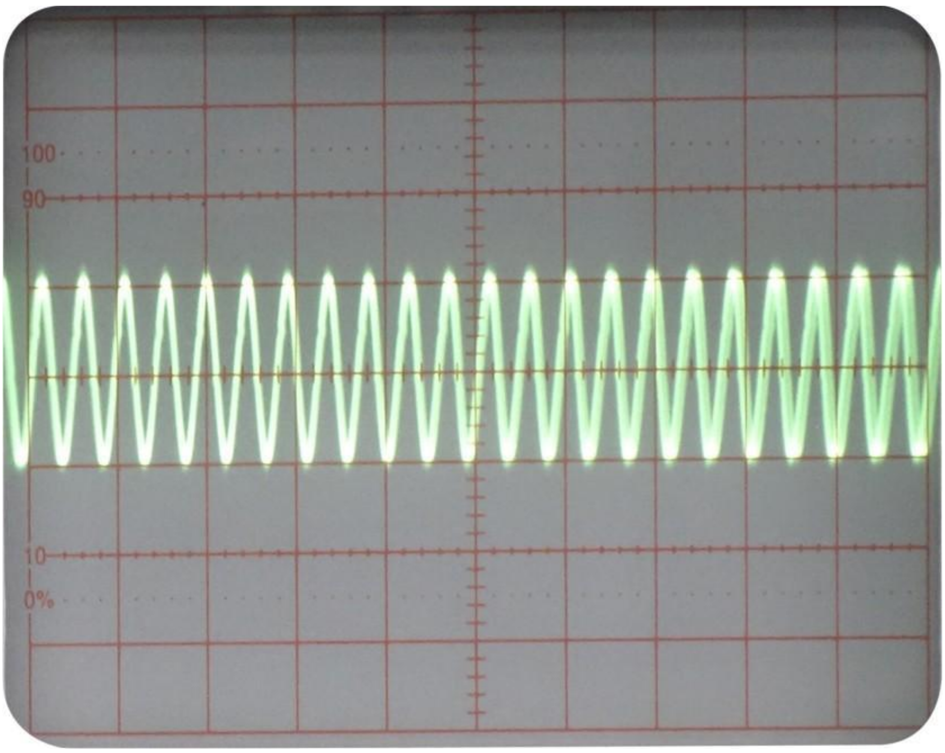
Modulating signal input to Varactor diode

15. Observe the Tuned oscillator circuit's FM output before amplifier at test point 3.



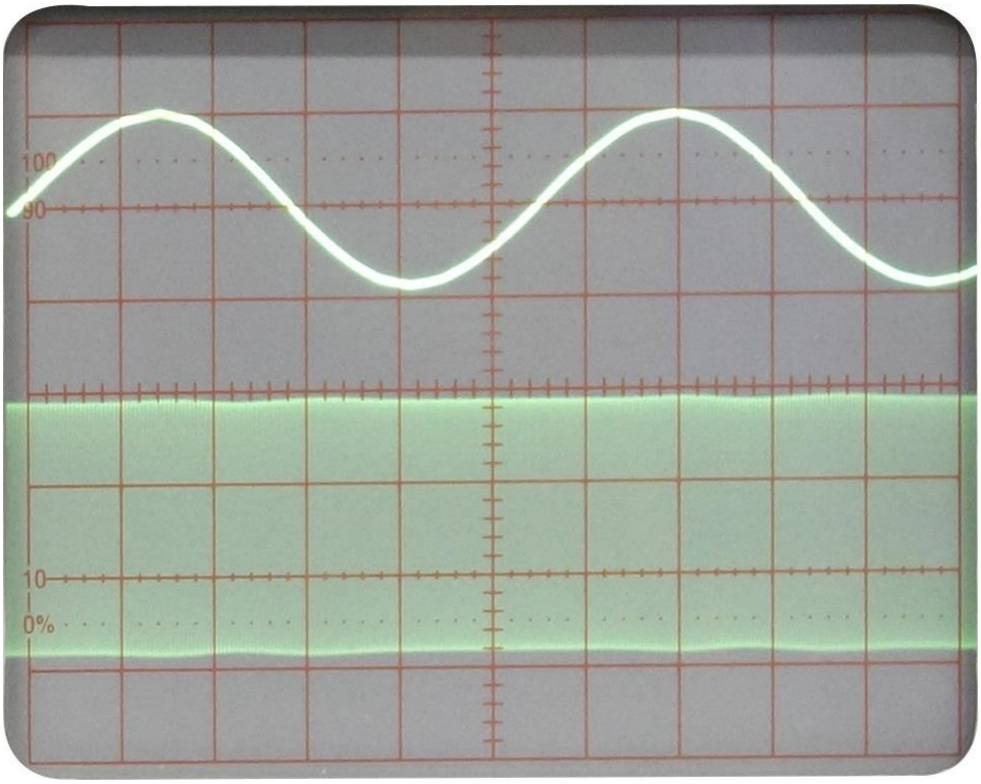
FM signal at test point 3

16. Observe the input signal to tuned amplifier circuit of Mixer/Amplifier at test point 8.



FM signal at test point 8

17. 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.



Frequency modulated waveform with modulating signal

Questions:

- What is Varactor diode?
- How Varactor diode is best suited for generation of frequency?
- Draw the VI characteristics of Varactor diode?
- Varactor diode works in …………………….condition?
- Explain the construction of Varactor diode?

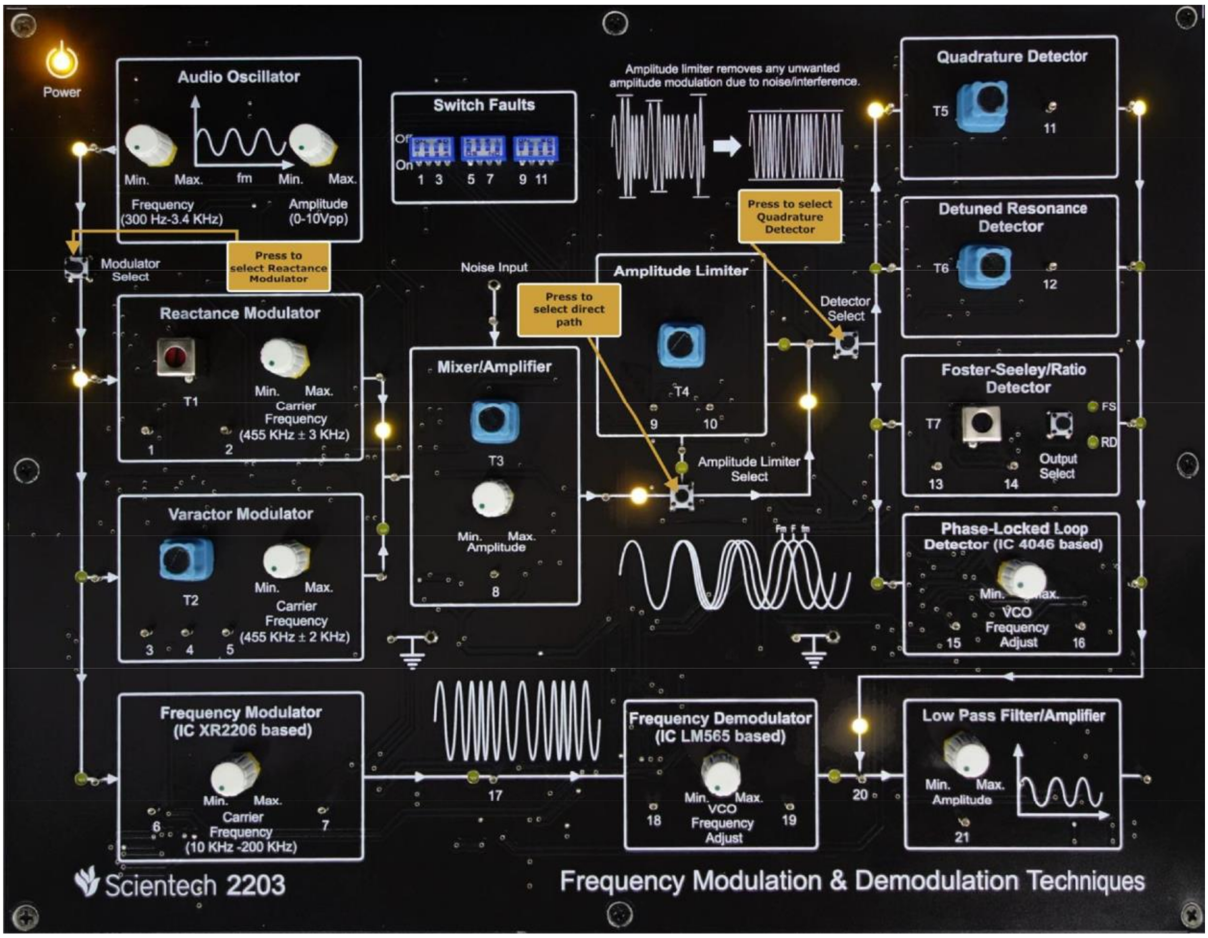
Experiment 5

Objective: Study the Operation of Quadrature Detector

Equipments Required:

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

Selection diagram:



Procedure:

This experiment investigates how the Quadrature 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. The on-board Amplitude Limiter will then be 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 state, 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.

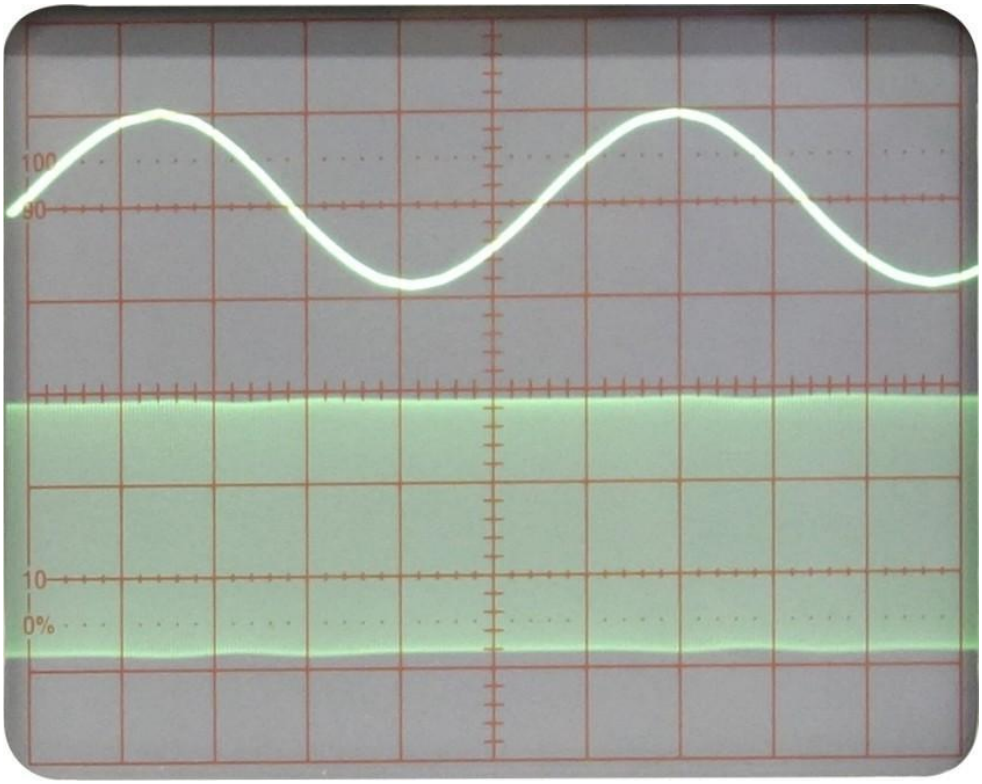
g) VCO frequency Adjust potentiometer of Phase-Locked Loop detector (IC4046 based) block in minimum position.

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.

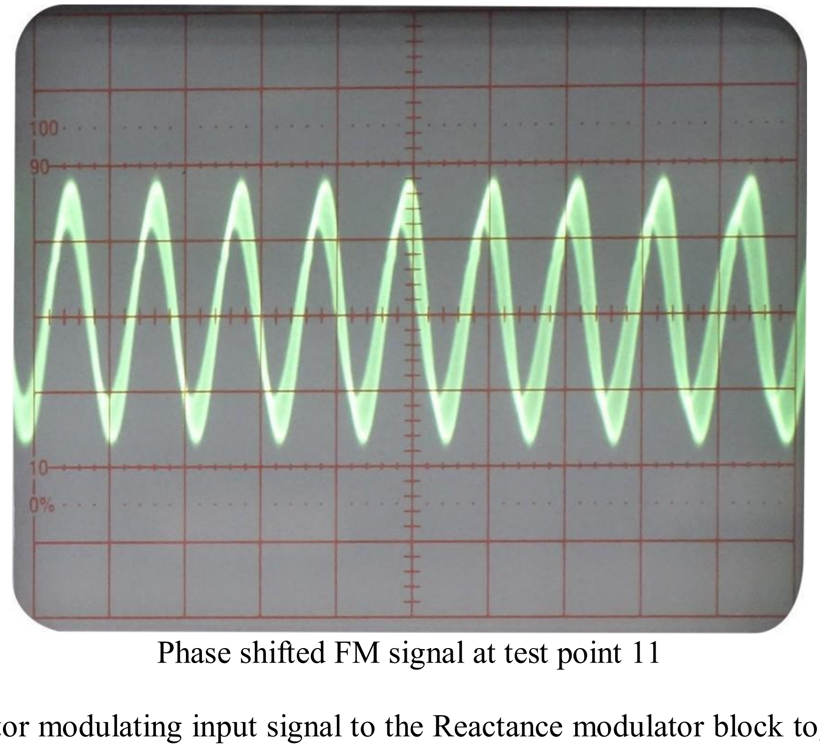
j) Amplitude potentiometer of Low pass filter/Amplifier block in center position.

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. Also check that Quadrature Detector block is selected for operation which is indicated by glowing LEDs at the input and output of this block. If not, press the 'Detector Select' switch to select it.
6. The output of Quadrature Detector is connected to Low pass filter input which is also indicated by a glowing LED at the input of low pass filter.
7. The audio oscillator's output signal is now being used by the Reactance modulator for frequency modulation of a 455 KHz carrier sine wave.
8. 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 the input test point of Quadrature detector.



Audio oscillator output signal & FM signal

9. Observe the phase shifted FM signal at the test point 11 of Quadrature detector block.



Phase shifted FM signal at test point 11

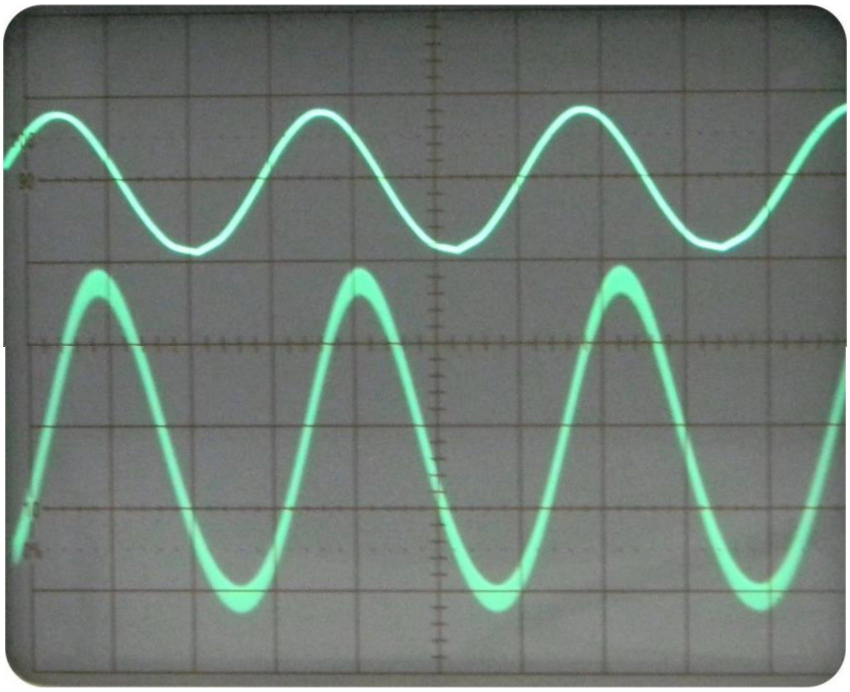
10. Now monitor modulating input signal to the Reactance modulator block together with the output from the Quadrature detector block. The signal at output should contain three components.

a. A positive DC offset voltage.

b. A sine wave at the same frequency as the modulating signal.

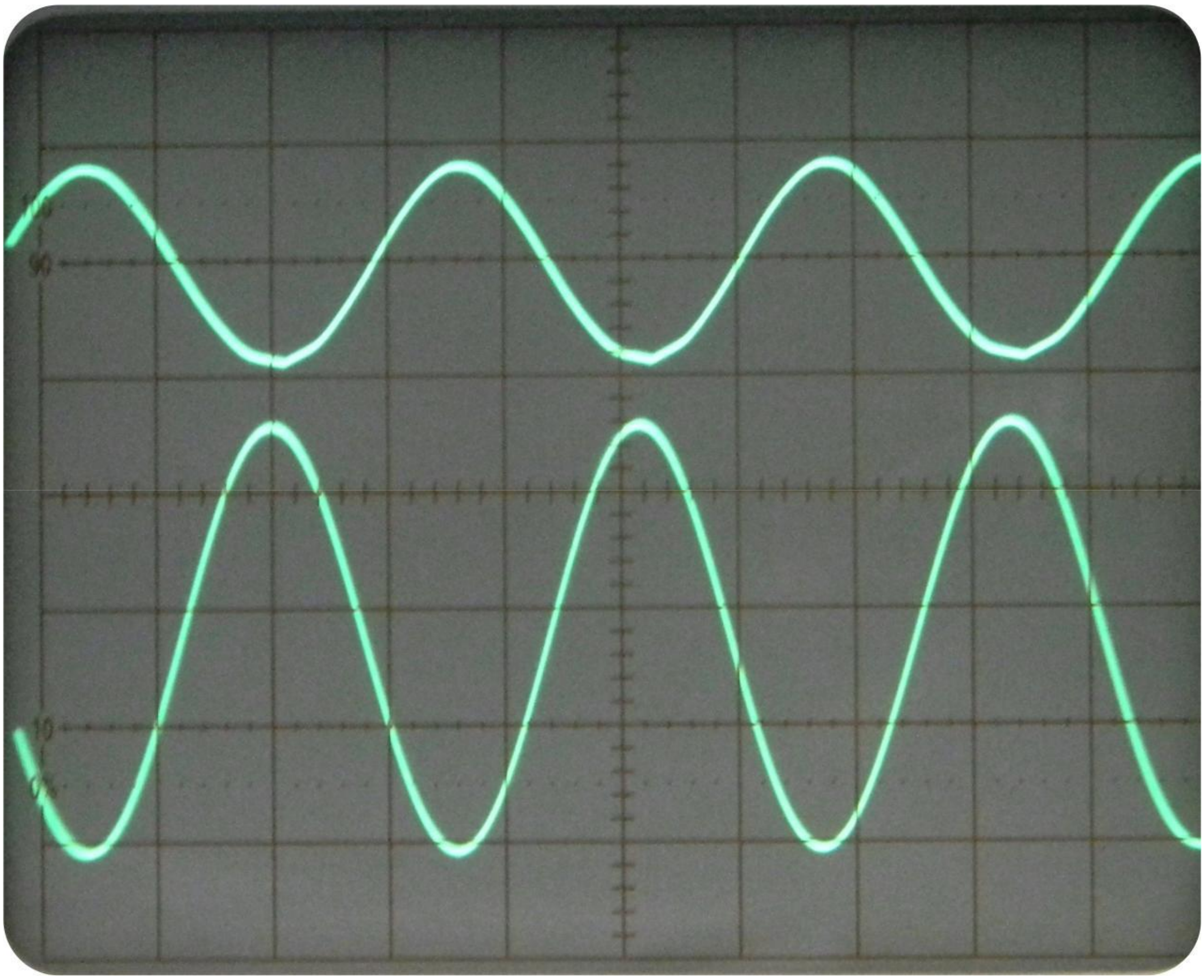
c. A high-frequency ripple component of small amplitude.

Check that the detected frequency component is a reasonable sine wave.



Modulating signal with Demodulated signal

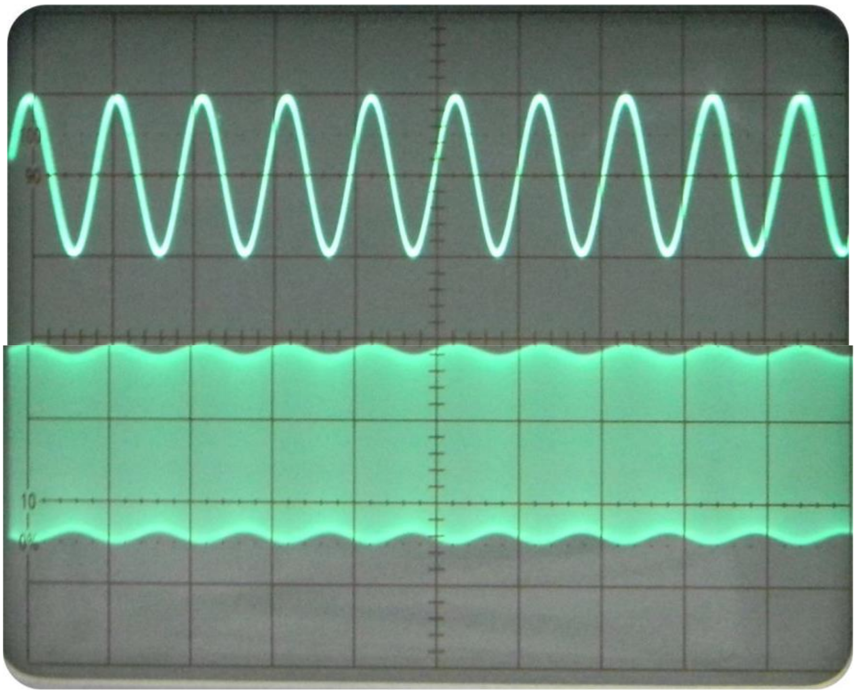
11. The Low Pass filter/Amplifier block strongly attenuates the high frequency ripple component at the detector's output, and also blocks the DC offset voltage. Consequently, the signal at the output of the Low Pass filter/Amplifier block should very closely resemble the original audio modulating signal.
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 monitored audio waveforms are the same.



Modulating signal and Low pass filter output

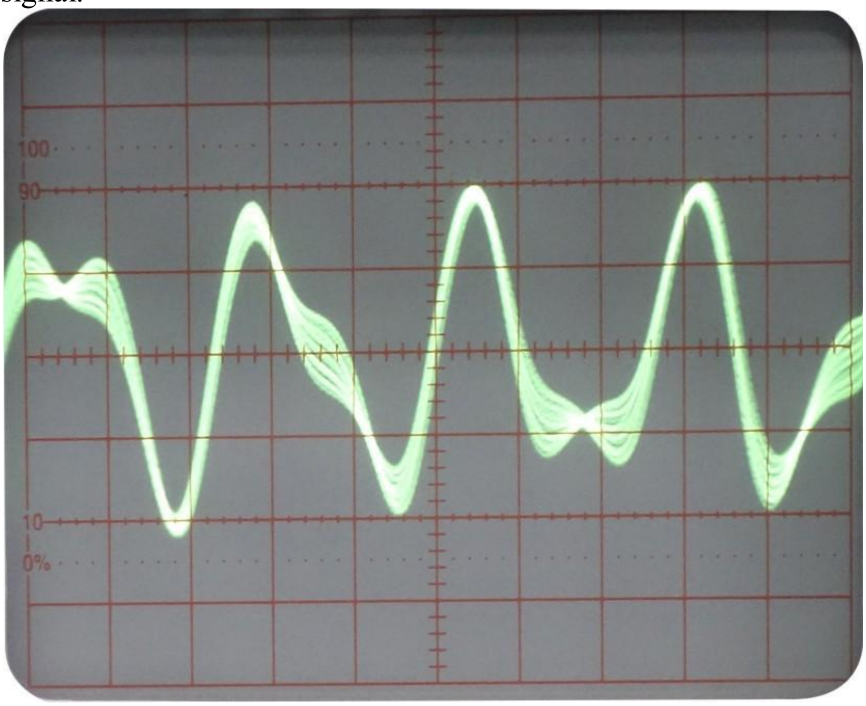
13. Now vary the frequency of the modulating signal and observe the demodulated signal. To minimize the shape distortion at lower frequencies, decrease the amplitude of modulating signal to 1Vpp and observe the signal. Also adjust the carrier frequency potentiometer of modulator block, if required to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

14. We will now investigate the effect of noise on the system.
a) 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.
b) Connect the output of the signal generator to the 'Noise Input' socket of Mixer/Amplifier block. Monitor the noise input and the FM output.
c) 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.
d) 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.



Noise input and affected FM waveform

15. Now observe the output of the Low Pass filter/Amplifier block. Note that the 'noise' has distorted the signal.



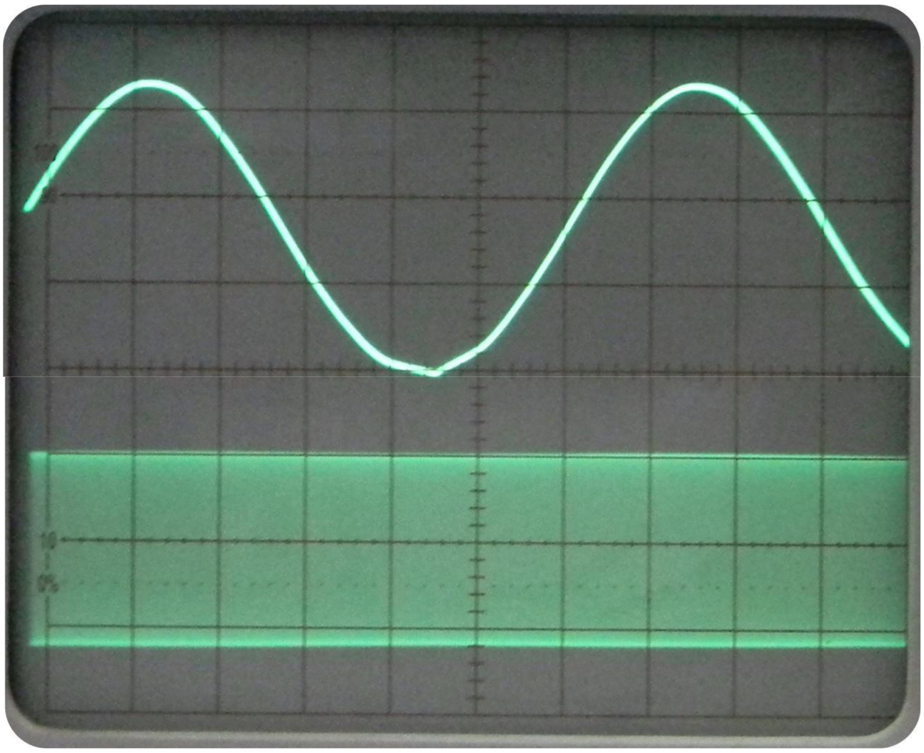
Noise affected demodulated signal

16. Now to overcome the effect of noise Amplitude Limiter block will be used in between Mixer/Amplifier and Quadrature detector.

17. Press 'Amplitude Limiter Select' switch to connect an Amplitude Limiter block between the FM output and the input to the Quadrature detector so that the effect of amplitude variations can be reduced.

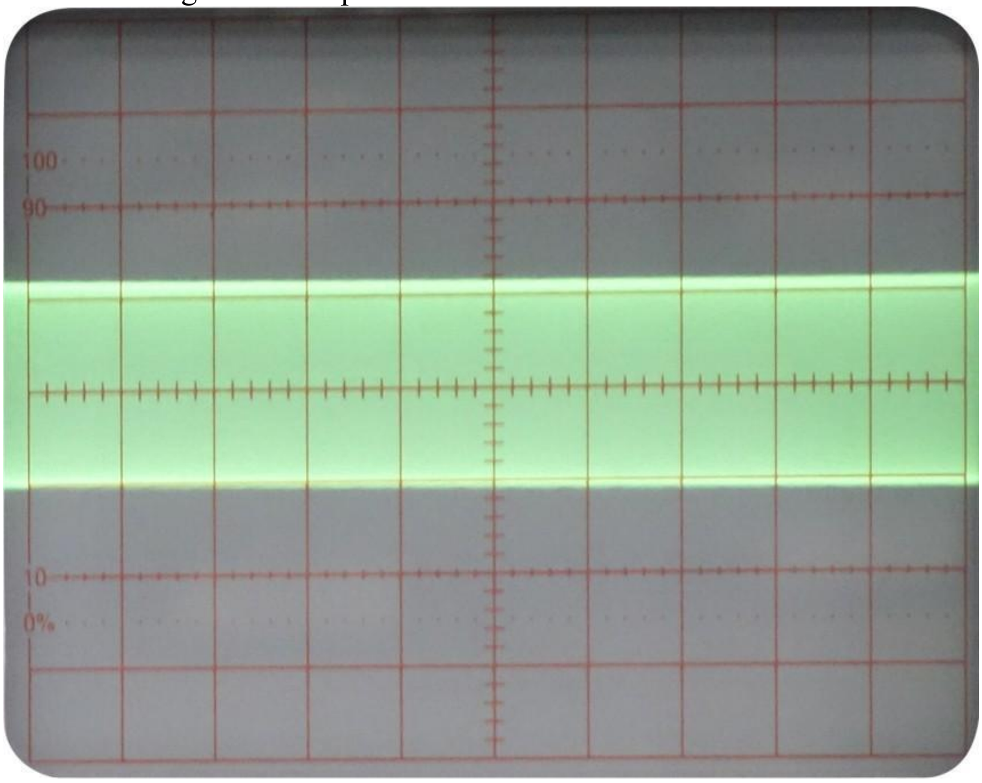
The Amplitude Limiter removes amplitude variations from the FM output signal, so that the input signal to the Quadrature detector has constant amplitude.

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

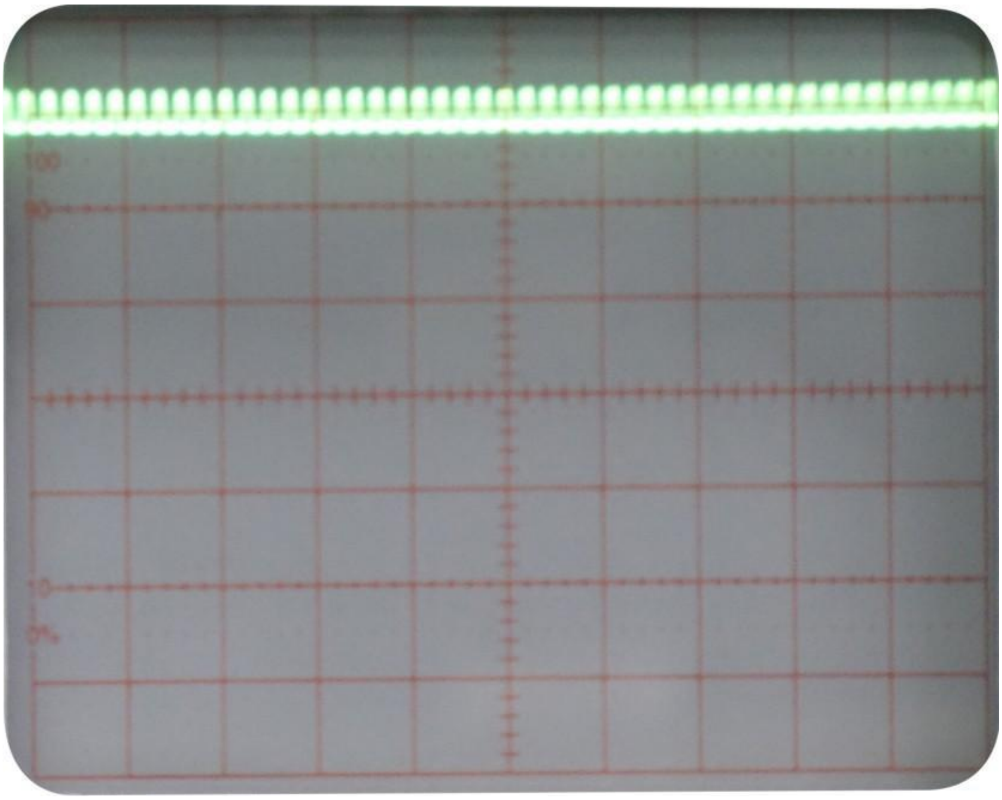


FM signal after Amplitude Limiter

19. Also observe the signals at test points 9 and 10 as follows.

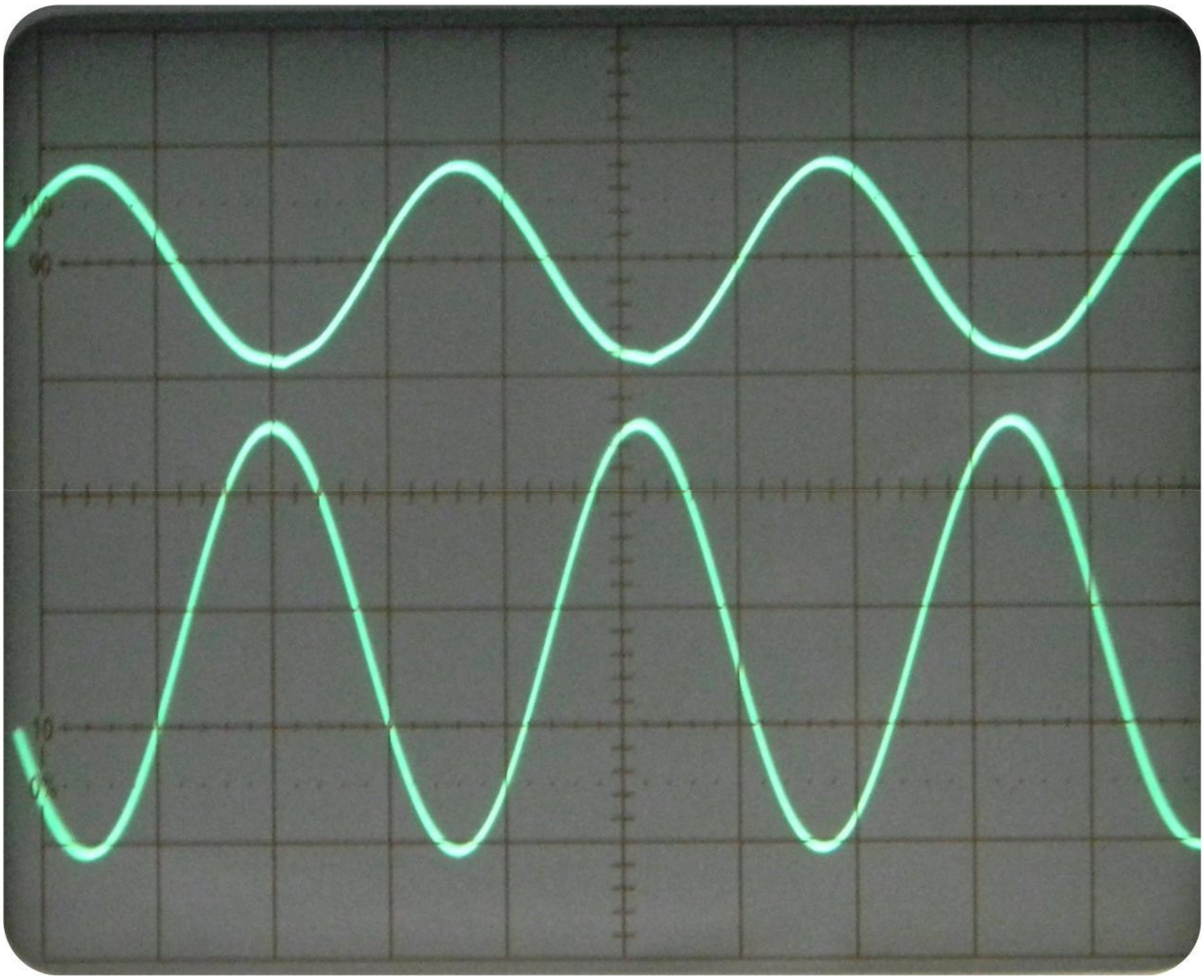


FM signal at test point 9



FM signal at test point 10

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



Modulating signal and Demodulated signal

21. Throughout this experiment, frequency modulation has been performed by **Scientech 2203**'s Reactance modulator block. Now repeat the complete procedure with Varactor modulator and observe the results.

Questions:

· Explain the operation of Quadrature Detector?
· List the rules for the degree of phase shift?
· Draw the block diagram of Quadrature Detector?
· Explain the Single tuned detector with its demerits?
· Explain the Balance slope detector with a neat block diagram.

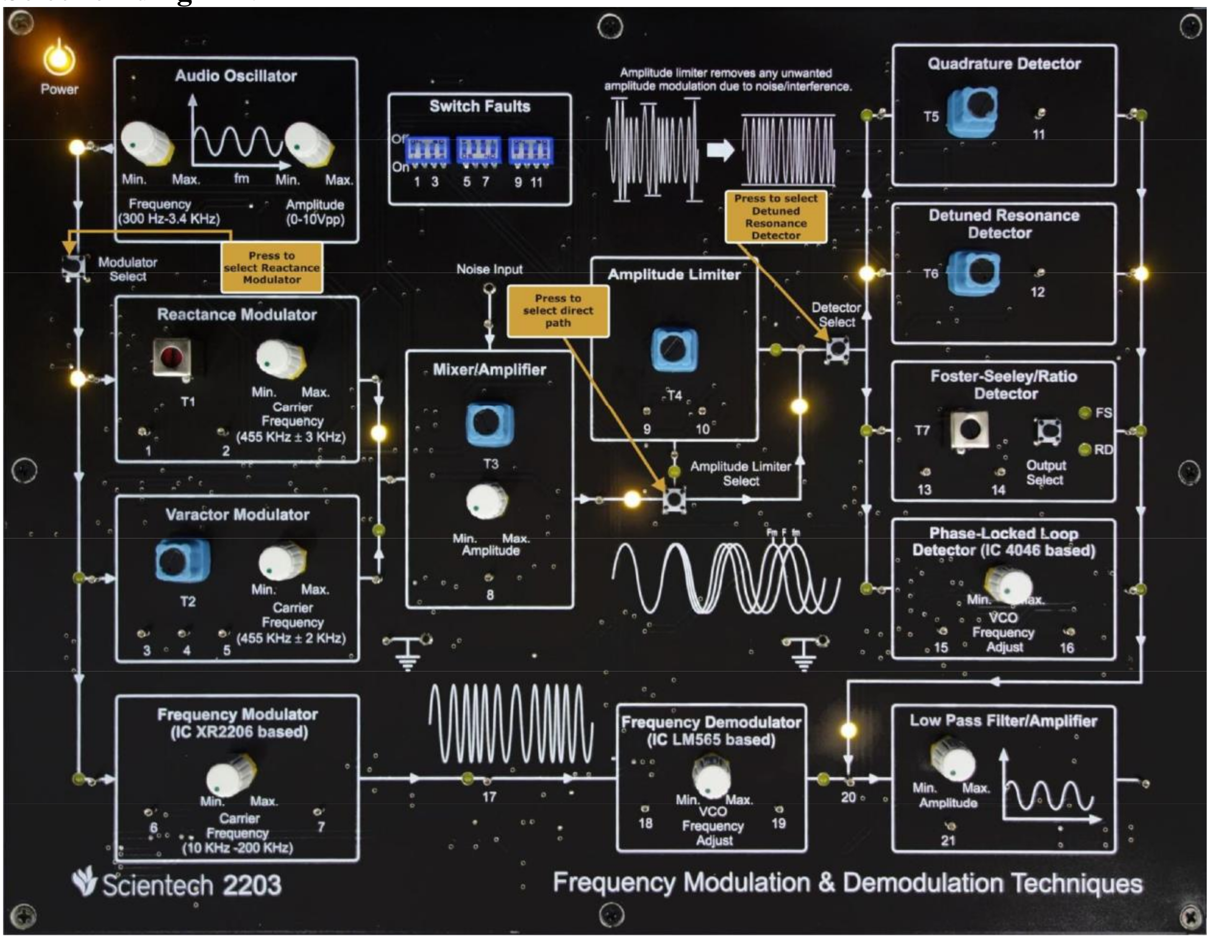
Experiment 6

Objective: Study the operation of Detuned Resonance Detector

Equipments Required:

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

Selection diagram:



Procedure:

This experiment investigates how the Detuned Resonance 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.

The on-board Amplitude Limiter will then be used to remove any amplitude variations 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 p4ass filter/Amplifier block in center position.

2. Switch on the power to the **Scientech 2203** TechBook.

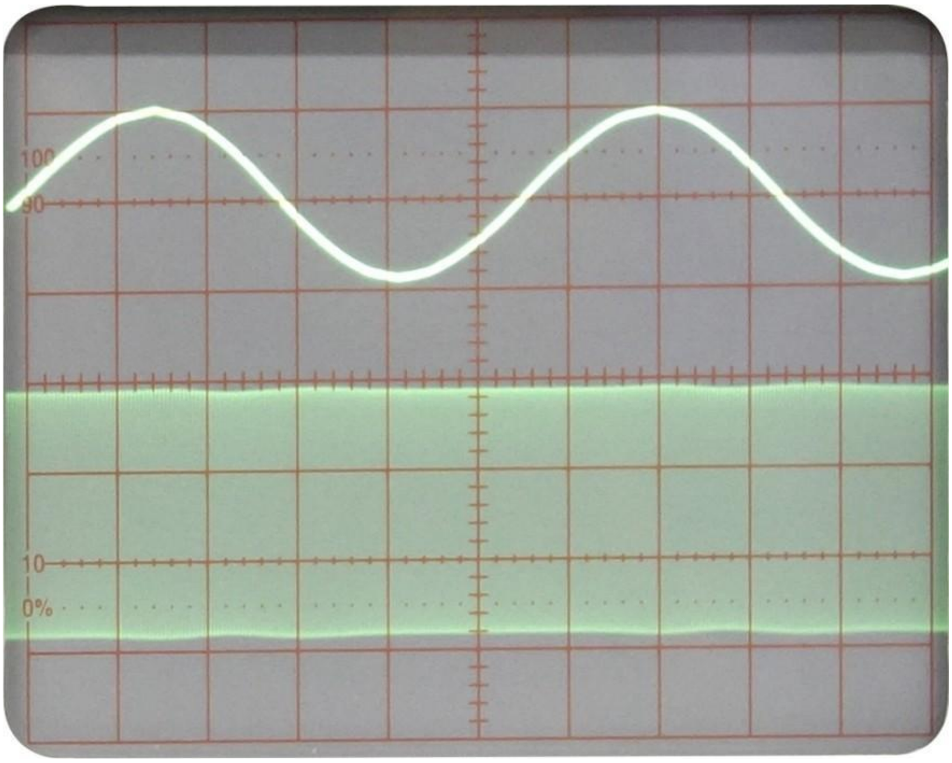
3. Check that Reactance modulator block is selected for operation which is indicated by glowing LEDs at the input and output of this block. If not, press the 'Modulator Select' switch to select it.

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 Detuned Resonance Detector block for operation which is indicated by glowing LEDs at the input and output of this block. The output of Detuned Resonance Detector is connected to Low pass filter input which is also indicated by a glowing LED at the input of low pass filter.

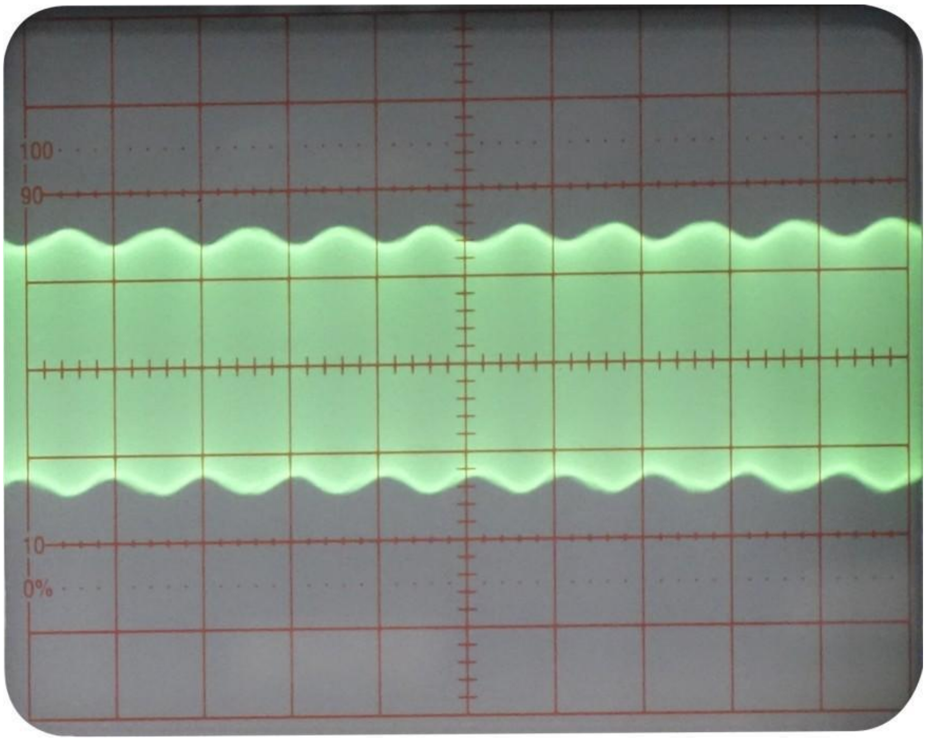
6. The audio oscillator's output signal is now being used by the Reactance modulator for frequency modulation of a 455 KHz carrier sine wave.

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 FM signal at the input test point of Detuned Resonance detector.



Audio oscillator output signal & FM signal

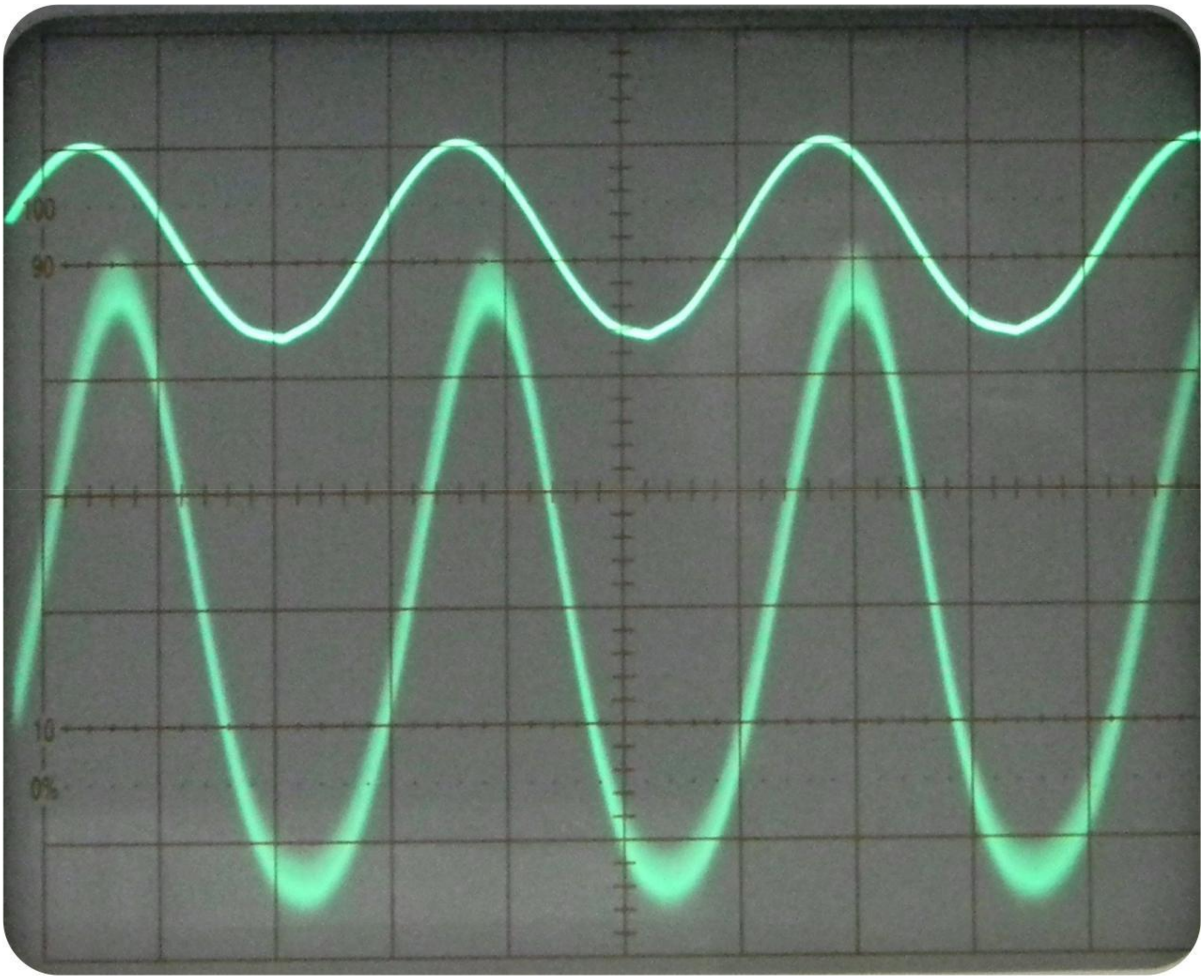
8. Observe the AM converted signal at the test point 12 of the Detuned Resonance detector block.



FM to AM converted signal at test point 12

9. Now monitor modulating input signal to the Reactance modulator block together with the output from the Detuned Resonance detector block. The signal at output should contain three components.

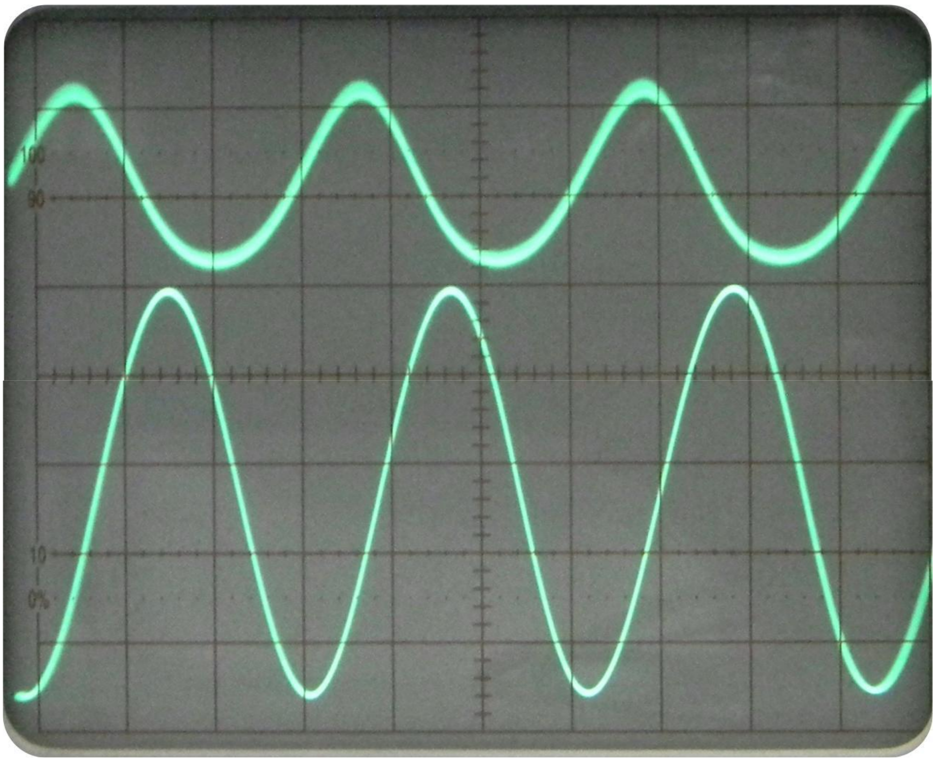
a) A positive DC offset voltage.
b) A sine wave at the same frequency as the modulating signal.
c) A high-frequency ripple component of small amplitude.
d) Check that the detected frequency component is a reasonable sine wave.



Modulating signal with Demodulated signal

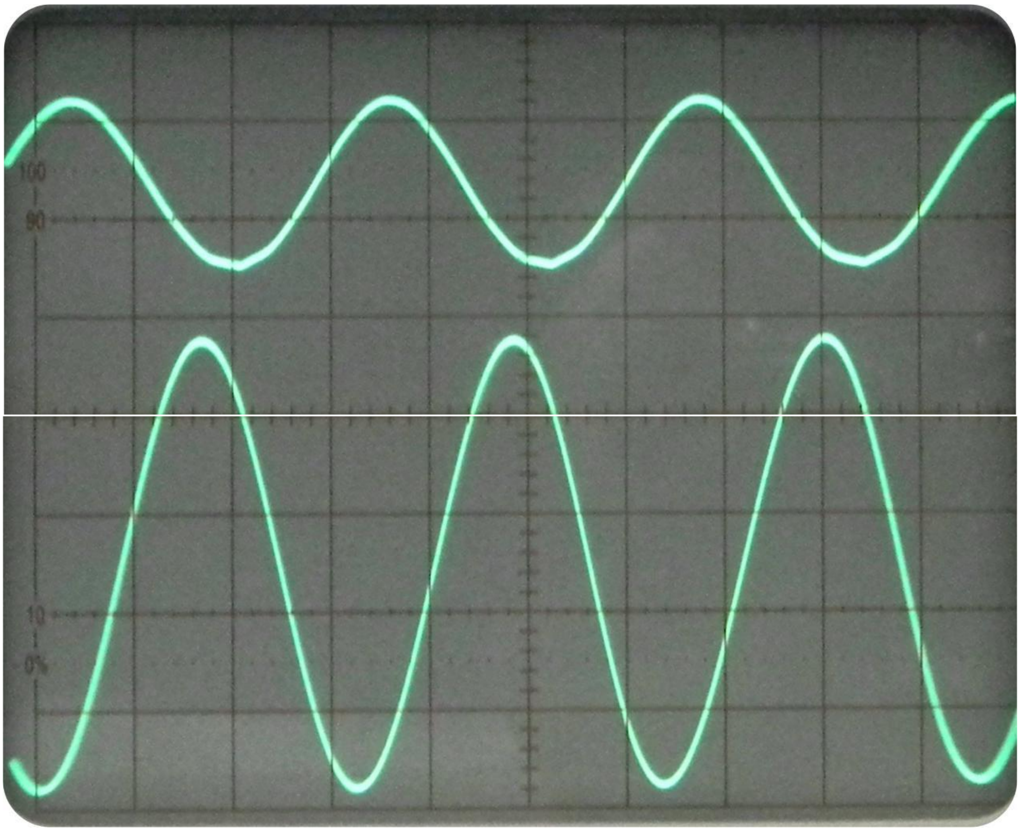
10. The Low Pass filter/Amplifier block strongly attenuates the high frequency ripple component at the detector's output, and also blocks the DC offset voltage. Consequently, the signal at the output of the Low Pass filter/Amplifier block should very closely resemble the original audio modulating signal.

11. Monitor the input and output of the Low Pass filter/Amplifier block and note how the quality of the detector's output signal has been improved by low pass filtering. Note also that the DC offset has been removed.



Input and output signals of Low pass filter

8. 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

9. 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.

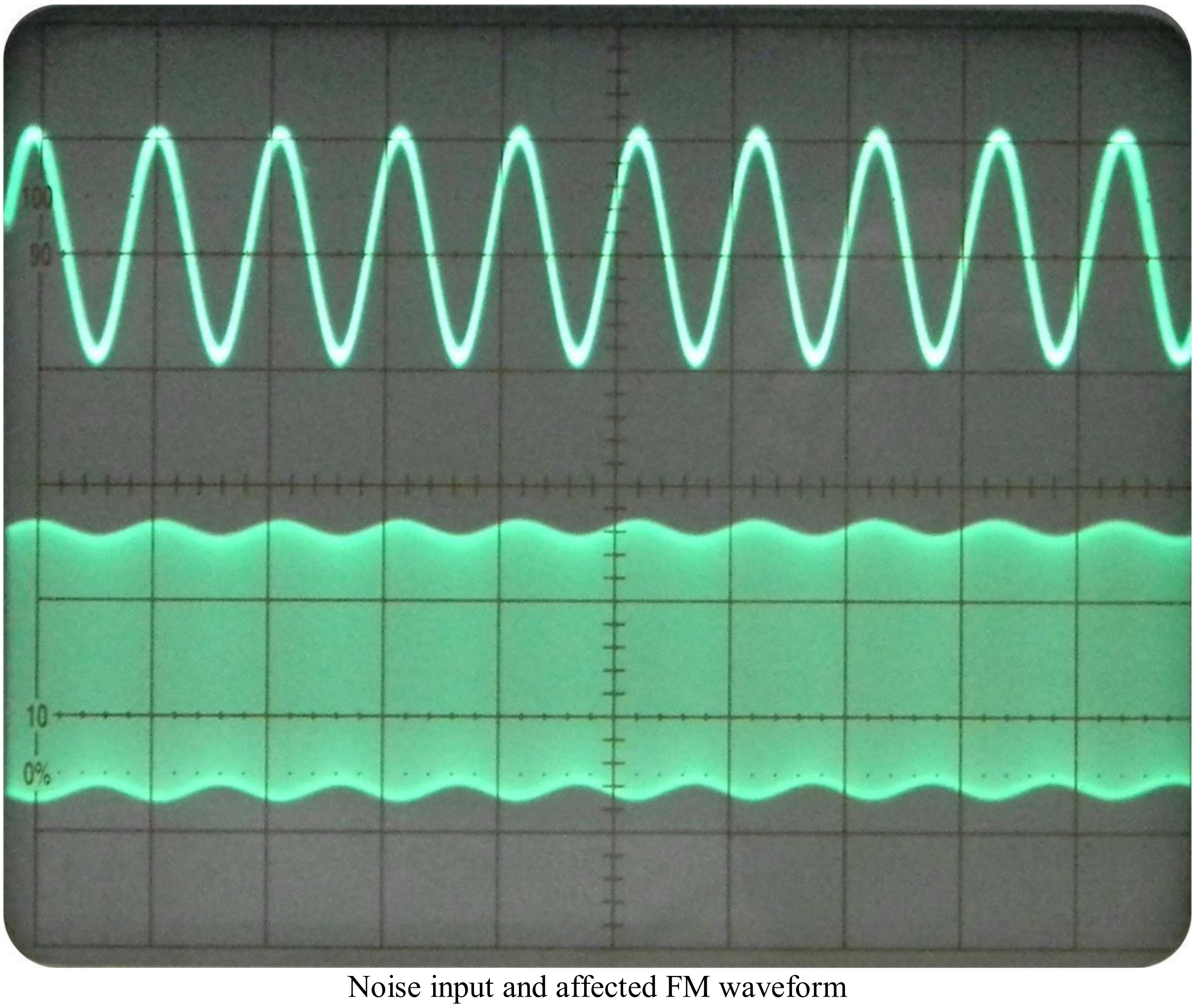
10. We will now investigate the effect of noise on the system.

a) 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.

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

c) 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.

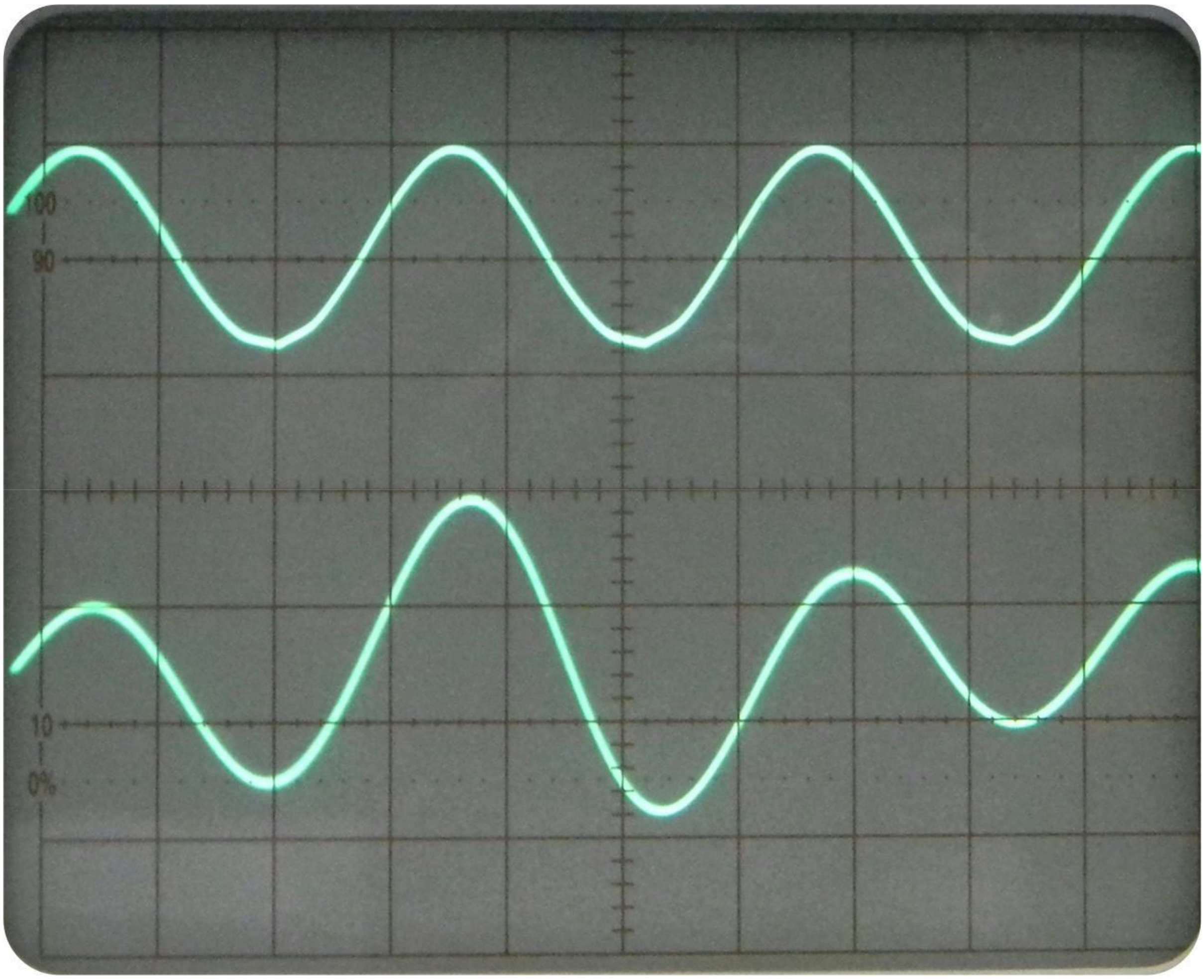
d) The amplitude modulations simulate the effect that transmission path noise would have on the amplitude of the FM waveform reaching the receiver. This allows us to demodulated audio signal.



Noise input and affected FM waveform

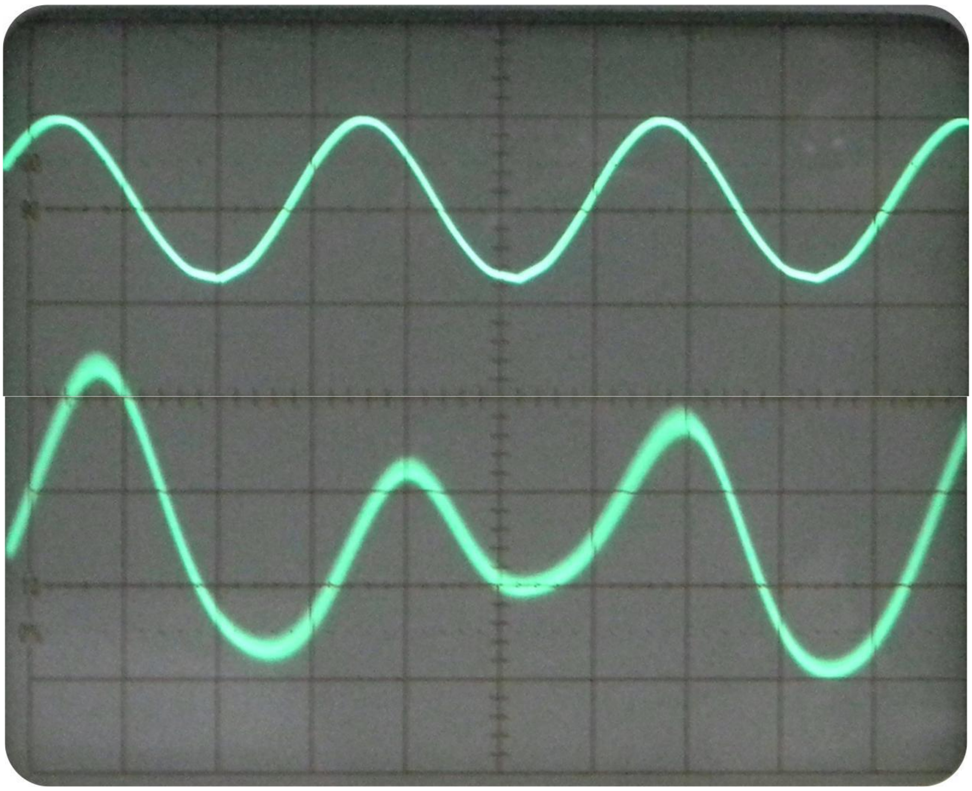
8. Monitor the modulating signal and the output of the Low Pass filter/Amplifier

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.

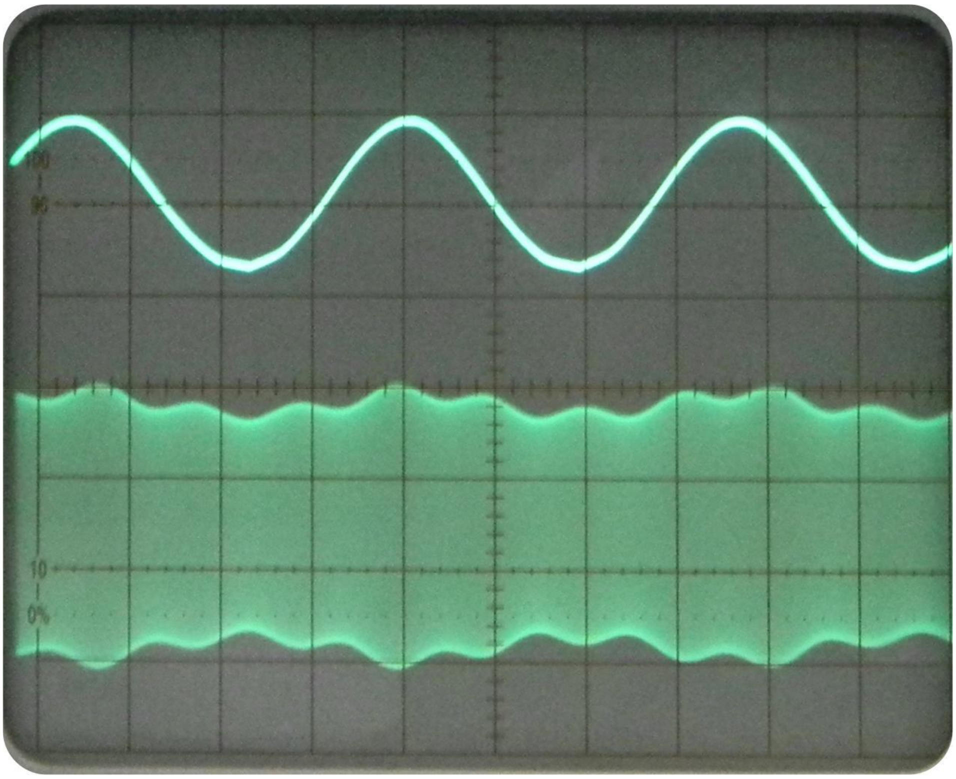


Noise affected demodulated signal

9. Observe the output at the Detuned Resonance circuit detector. Note that the 'noise' component is still present, illustrating that this type of detector is very susceptive to amplitude variations in the incoming FM signal.



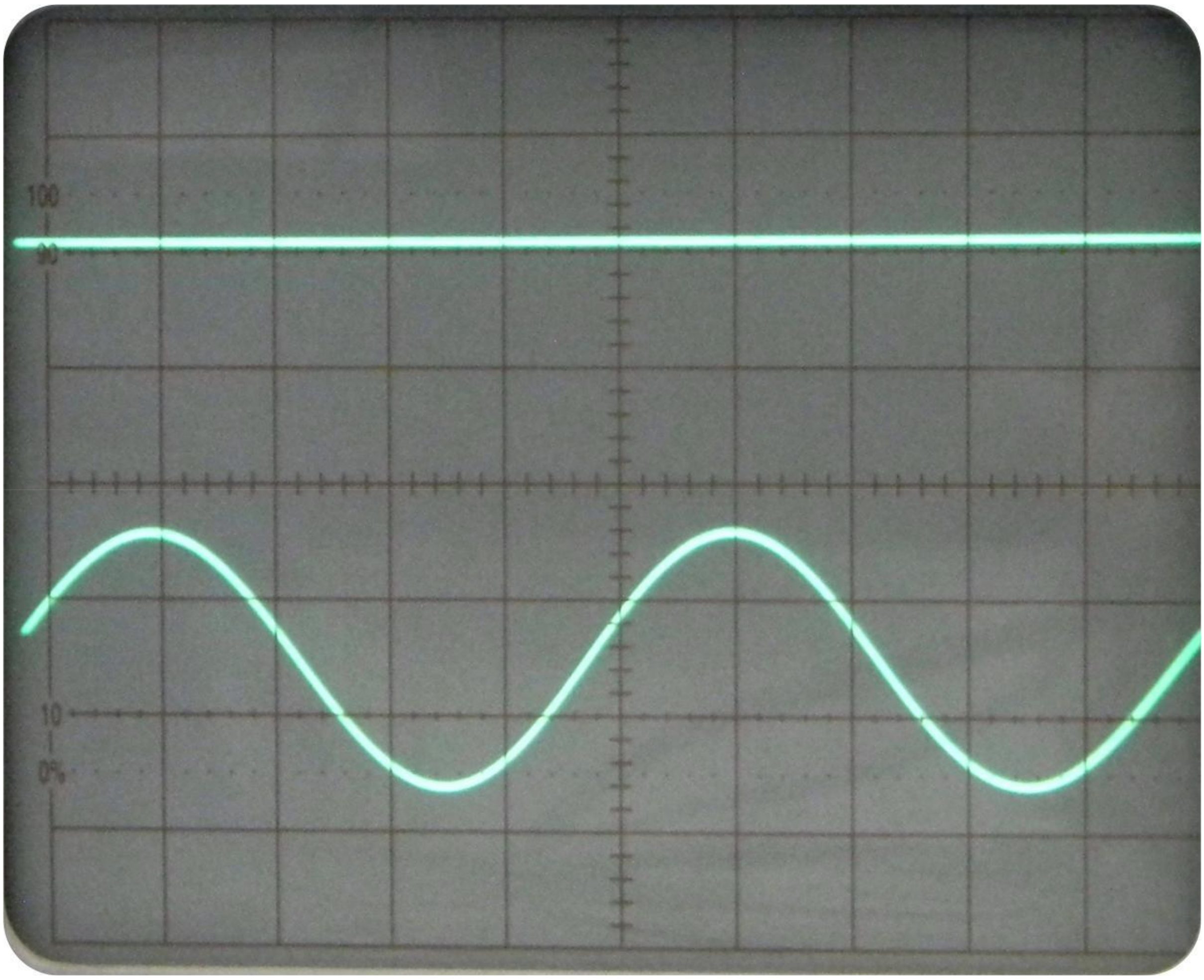
Modulating signal and Noise affected detector output signal



Noise affected AM signal at test point 12

10. Turn the audio oscillator block's amplitude potentiometer to its minimum position, so that no frequency modulation takes place. Then monitor the 'noise' input and the output from the Low Pass filter/Amplifier block.

The signal at output of low pass filter is now purely composed of the 'noise' output resulting from amplitude variations occurring at the input to the Detuned Resonance circuit.
Measure and record the peak-to-peak amplitude of the 'noise' output; this measurement will be valuable in allowing us to compare the Detuned Resonance circuit with other types of FM detector, as far as susceptibility to amplitude modulation is concerned.



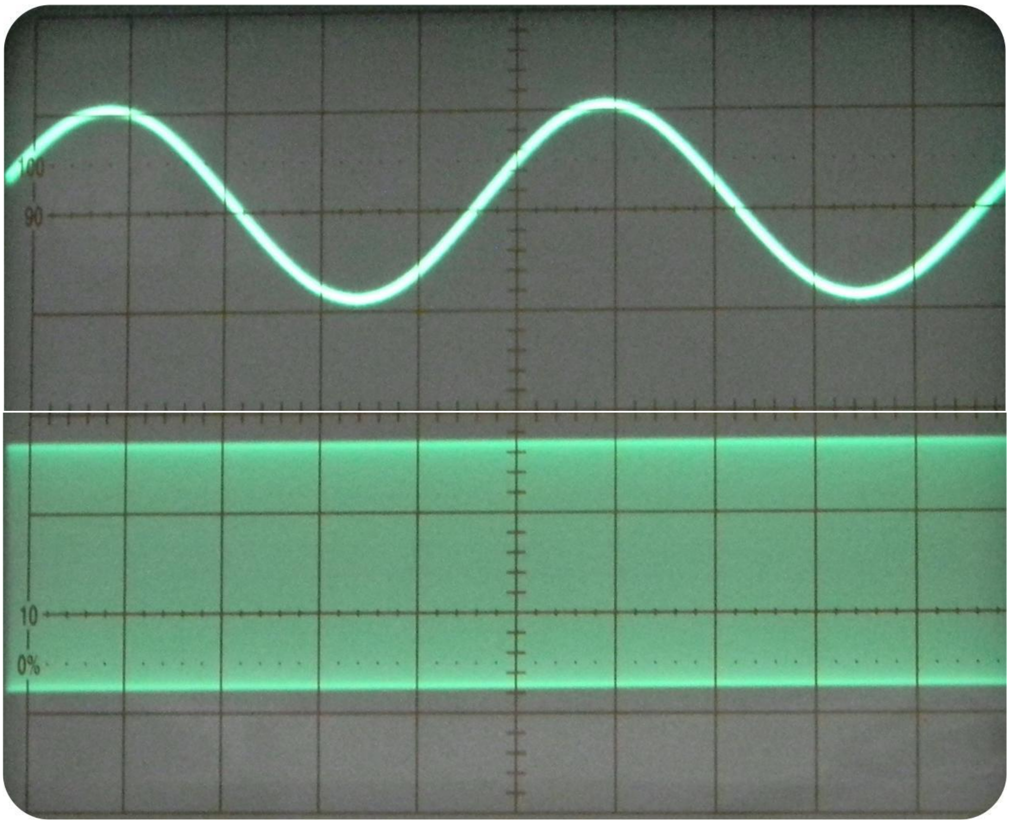
Noise output with zero modulating signal input

11. To overcome the problem of the Detuned Resonance circuit detector's susceptibility to noise, we can connect an Amplitude Limiter block between the FM output and the input to the Detuned Resonance circuit.

12. Press 'Amplitude Limiter Select' switch to connect an Amplitude Limiter block between the FM output and the input to the Detuned Resonance detector so that the effect of amplitude variations can be reduced.

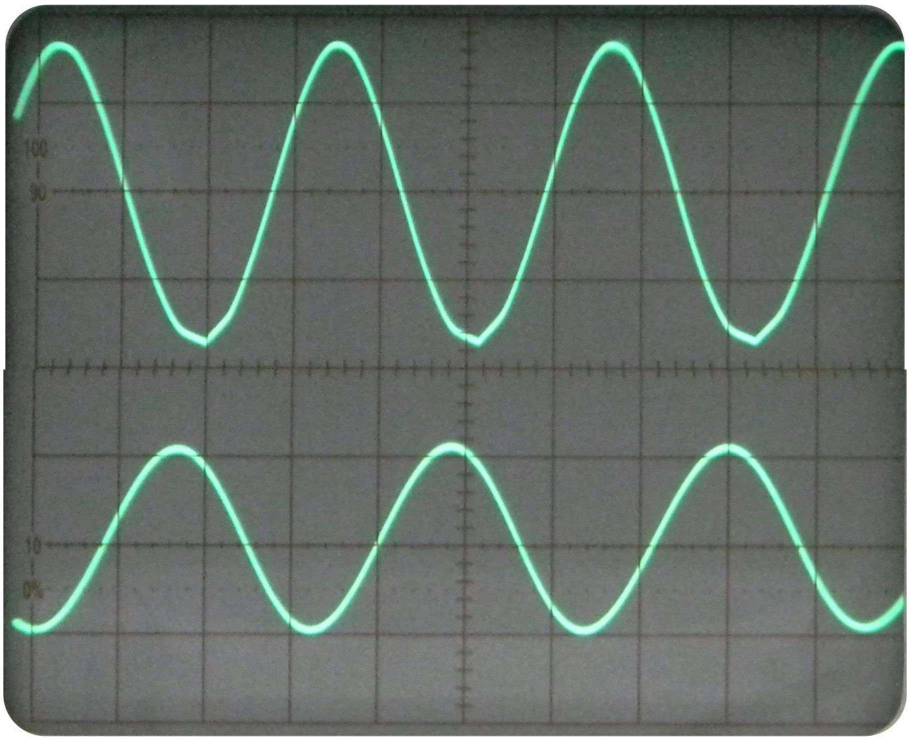
The Amplitude Limiter removes amplitude variations from the FM output signal, so that the input signal to the Detuned Resonance circuit detector has constant amplitude.

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



FM signal after Amplitude Limiter

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



Modulating signal and Low pass filter output

15. This shows how an Amplitude Limiter can be used in a practical FM receiver, to remove amplitude variations caused by noise, before they reach the detector.

16. Throughout this experiment, frequency modulation has been performed by **Scientech 2203**'s Reactance modulator block. Now repeat the complete procedure with Varactor modulator and observe the results.

Questions:

· Explain the Operation of Detuned Resonance circuit?
· What is resonant circuit?
· What is LC tank circuit?
· What is the function of transistor in Detuned Resonance circuit?
· What is the function of Diode detector?

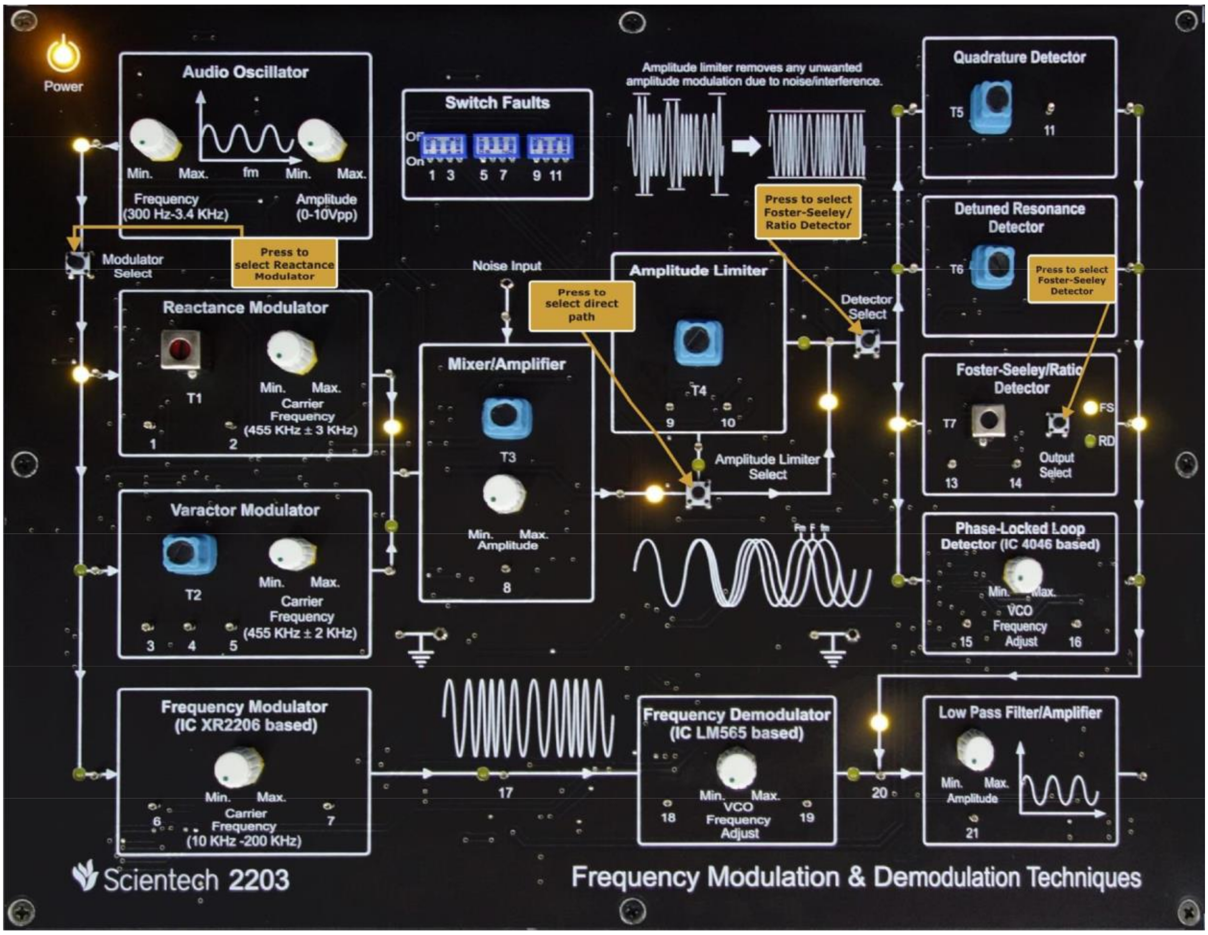
Experiment 7

Objective: Study the operation of Foster - Seeley Detector

Equipments Required:

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

Selection diagram:



Procedure:

This experiment investigates how the Foster-Seeley detector 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. The onboard Amplitude Limiter will then be 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 state 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.

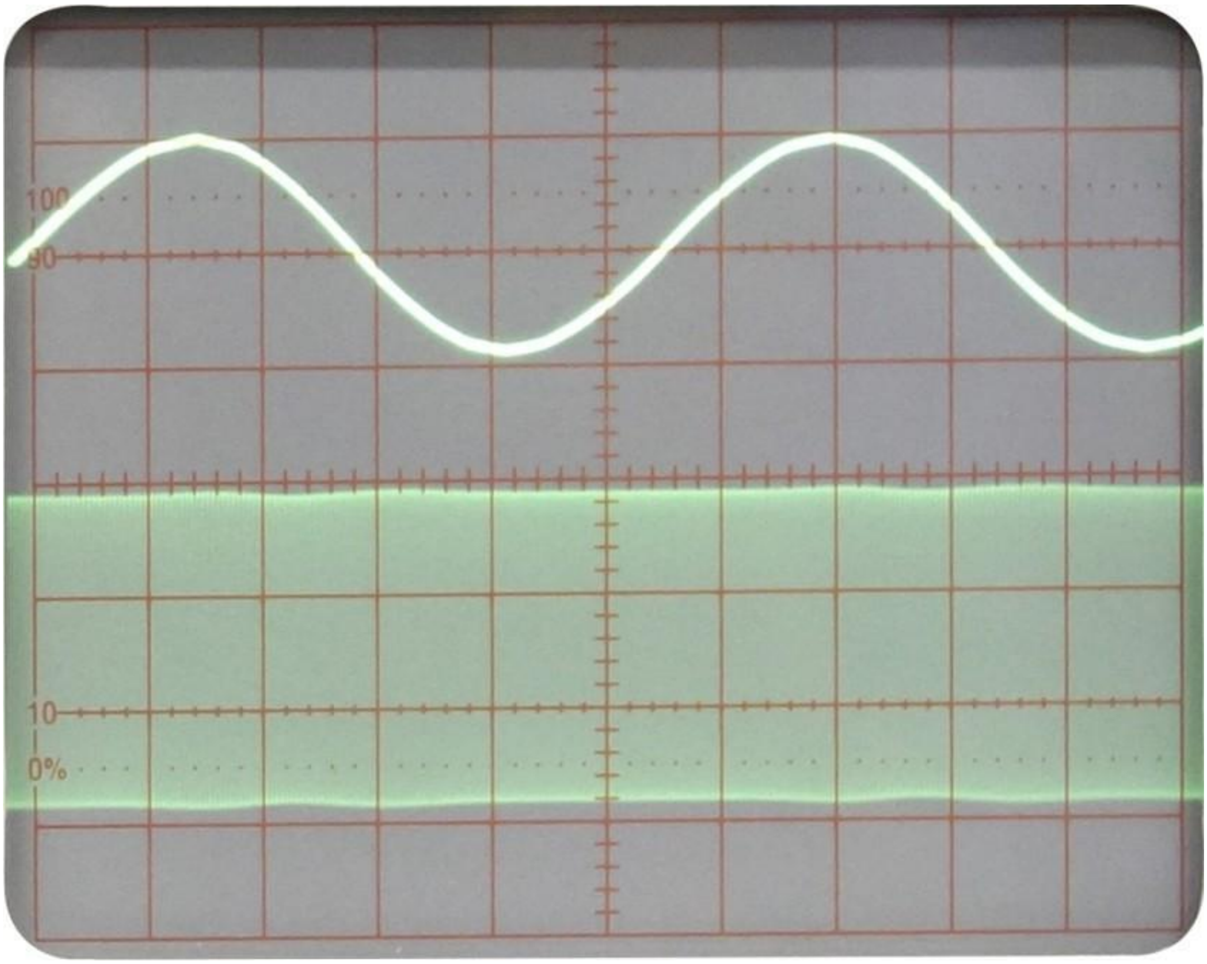
4) Also check that direct path is selected to connect the Mixer/Amplifier output to Detector input (bypassing the Amplitude Limiter block). If not, press the 'Amplitude Limiter Select' switch to select it.

5) Now press the 'Detector Select' switch to select Foster-Seeley/Ratio Detector block for operation which is indicated by glowing LEDs at the input and output of this block. The output of Foster-Seeley/Ratio Detector is connected to Low pass filter input which is also indicated by a glowing LED at the input of low pass filter.

6) Also check that in the Foster-Seeley/ratio detector block, the Foster-Seeley detector is selected which is indicated by a glowing LED at FS. If not press 'Output Select' switch to select it.

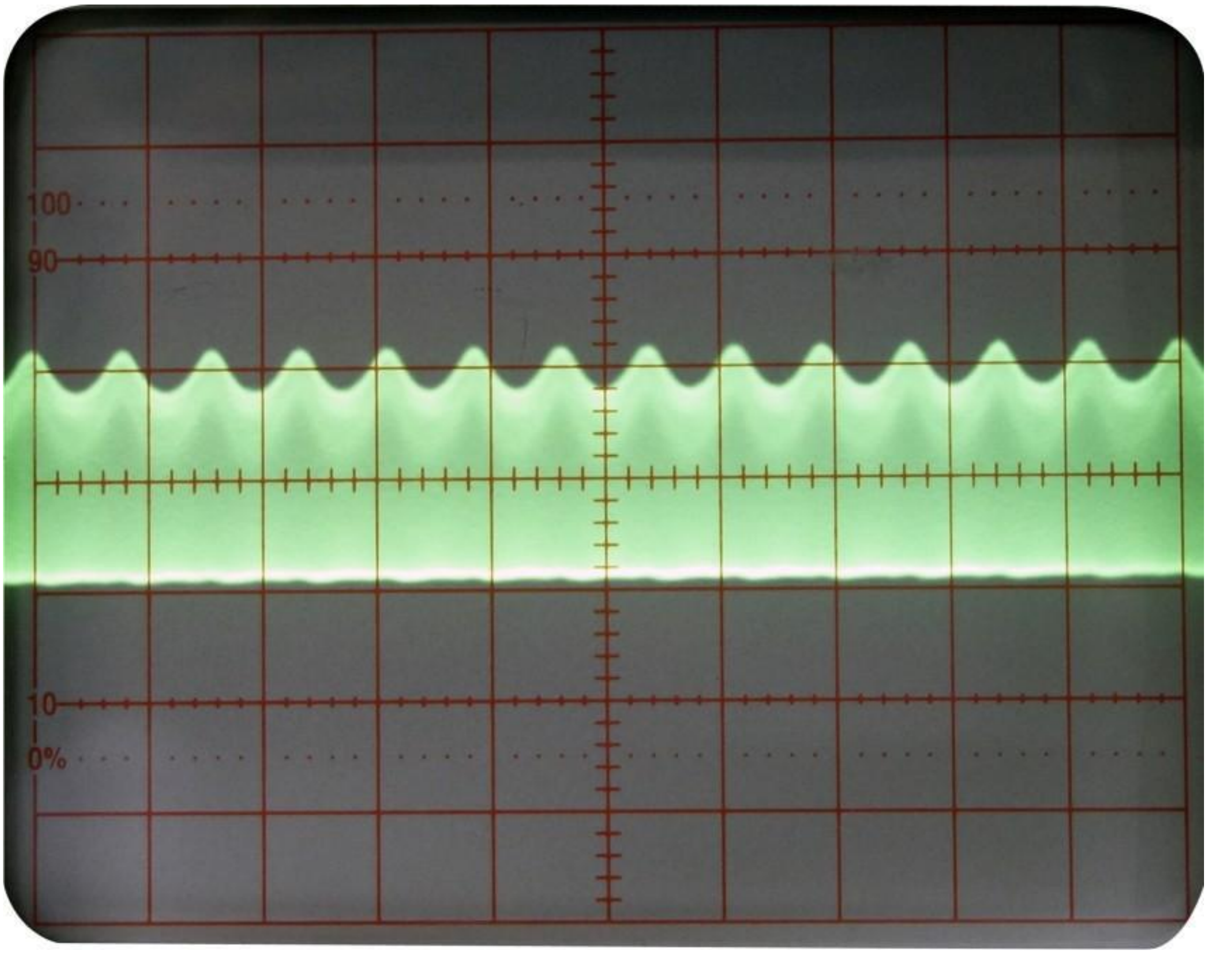
7) The audio oscillator's output signal is now being used by the Reactance modulator for frequency modulation of a 455 KHz carrier sine wave.

8) 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 the input test point of Foster-Seeley/Ratio detector.

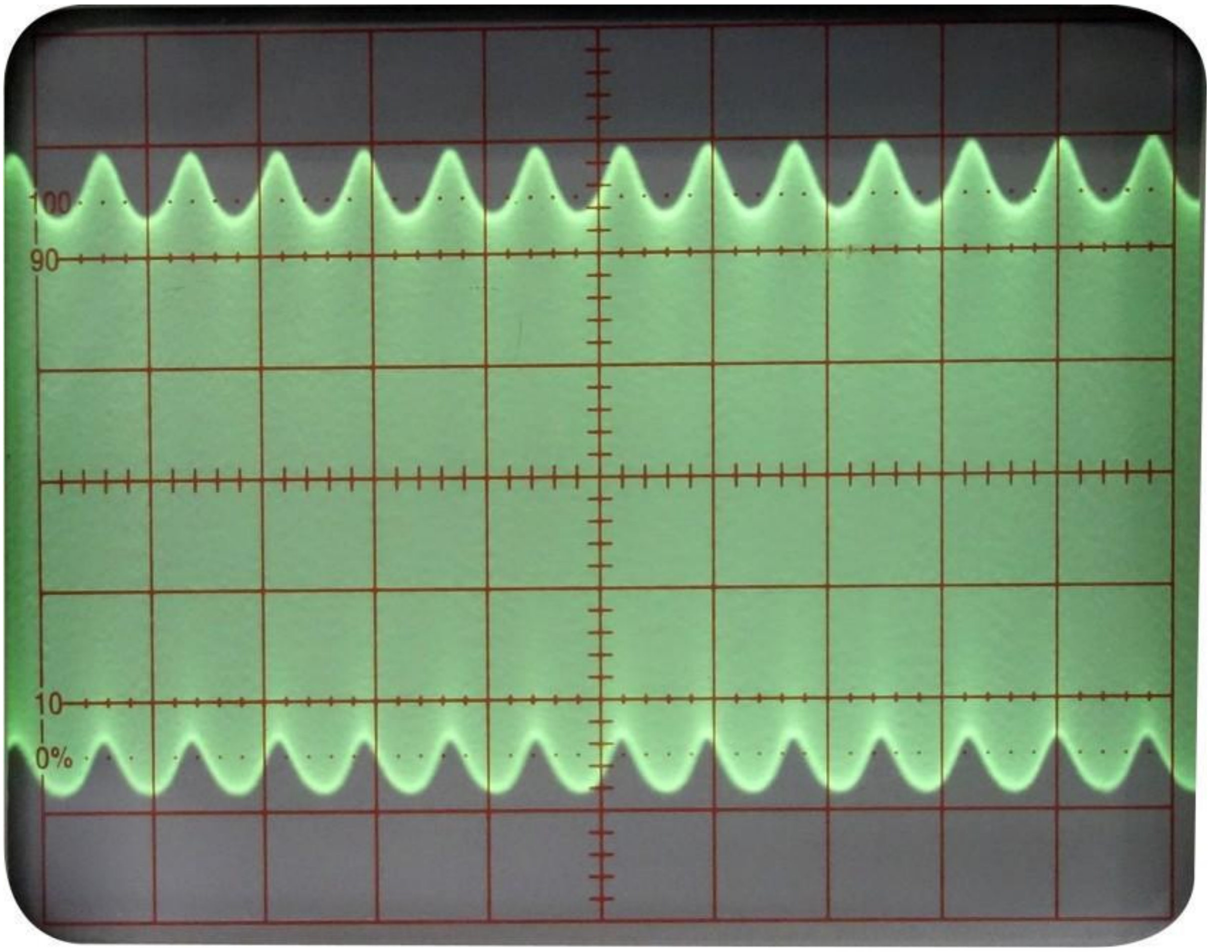


Audio oscillator output signal & FM signal

9) Observe the output signals of tuned transformer applied across the diode and coil at test points 13 and 14 respectively in the same block.



FM signal at test point 13

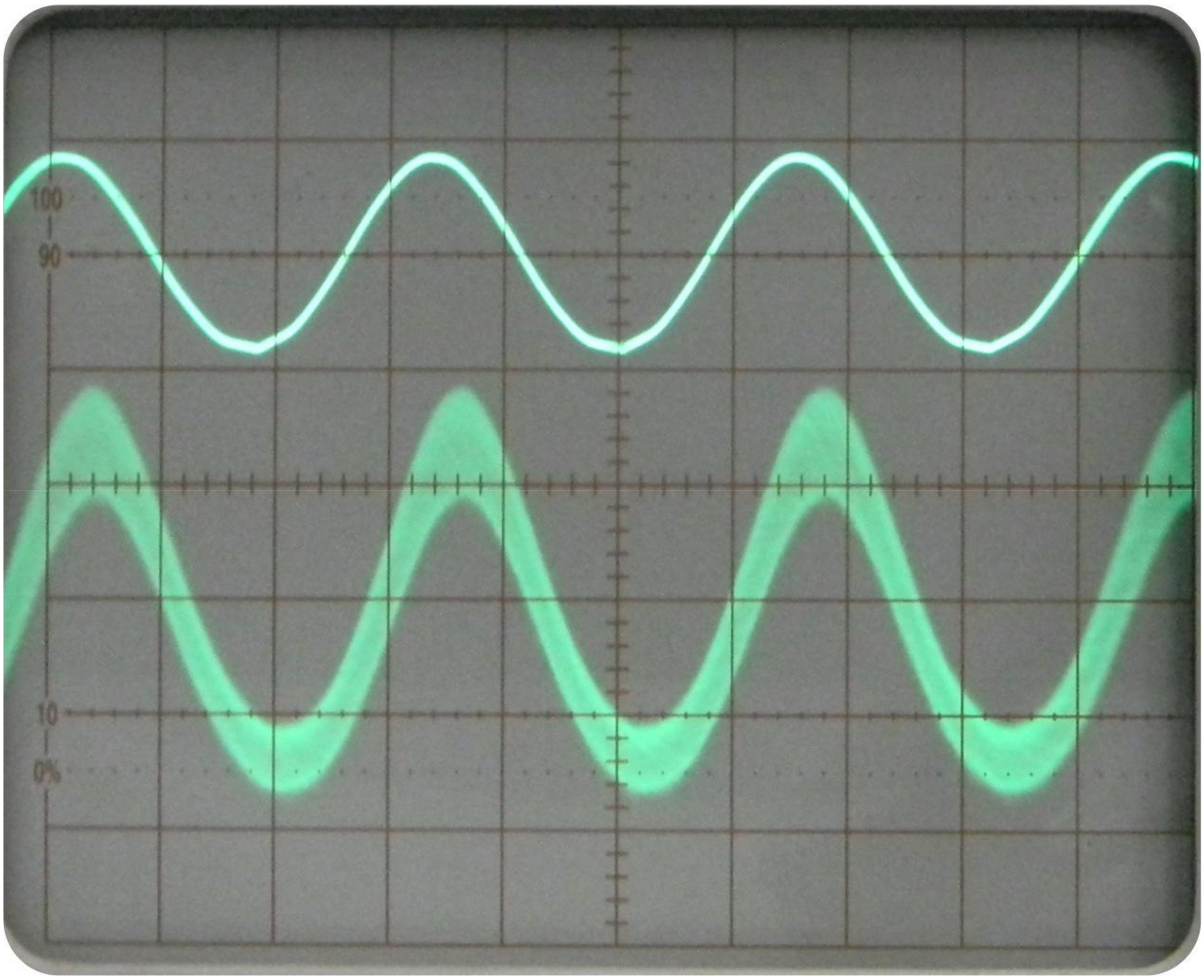


FM signal at test point 14

10) Now monitor modulating input signal to the Reactance modulator block together with the output from the Foster-Seeley detector.

The signal at output should contain two components.

- A sine wave at the same frequency as the modulating signal.
- A high-frequency ripple component of small amplitude.



Modulating signal with detector output

11) The Low Pass filter/Amplifier strongly attenuates this high-frequency ripple component, and blocks any small DC offset voltage that might exist at the detector's output. Consequently, the signal at the output of the Low-Pass Filter/ amplifier block should very closely resemble the original audio modulating signal.

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.

a) 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.

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

c) 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.

d) 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.

15) 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.

16) 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.

17) Press 'Amplitude Limiter Select' switch to connect an Amplitude Limiter block between the FM output and the input to the Foster-Seeley/Ratio detector so that the effect of amplitude variations can be reduced.

18) The Amplitude Limiter removes amplitude variations from the FM output signal, so that the input signal to the Foster-Seeley/Ratio circuit detector has constant amplitude.

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

The Amplitude Limiter removes amplitude variations from the FM output signal, so that the input signal to the Quadrature detector has constant amplitude.

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

Questions:

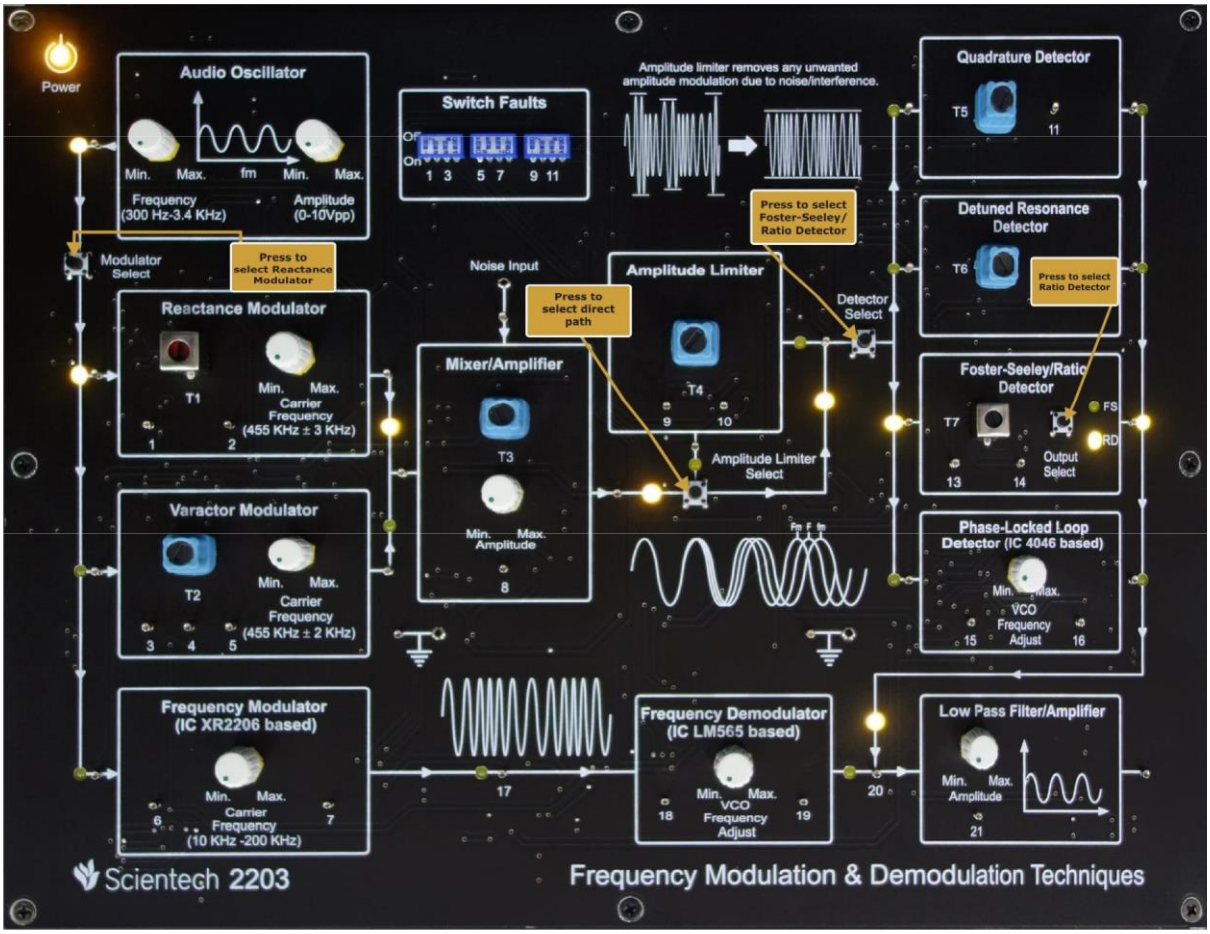
- Explain the operation of Foster – Seeley detector?
- Draw the circuit diagram of Foster – Seeley detector?
- Draw the phasor diagram of Foster – Seeley detector?
- What is the effect of adding the capacitor in Foster – Seeley detector?
- What happens When the input Frequency changes?

Experiment 8

Objective: Study the operation of Ratio Detector

Equipments Required:
- Scientech 2203 TechBook with Power Supply cord
- Scientech Oscilloscope with connecting probe

Selection diagram:



Procedure:

This experiment investigates how the ratio detector 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. The on-board Amplitude Limiter will then be used to remove any amplitude modulations due to noise, before they reach the detector. This allows the student to draw conclusions as the whether it is necessary to precede this type of detector with and 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.

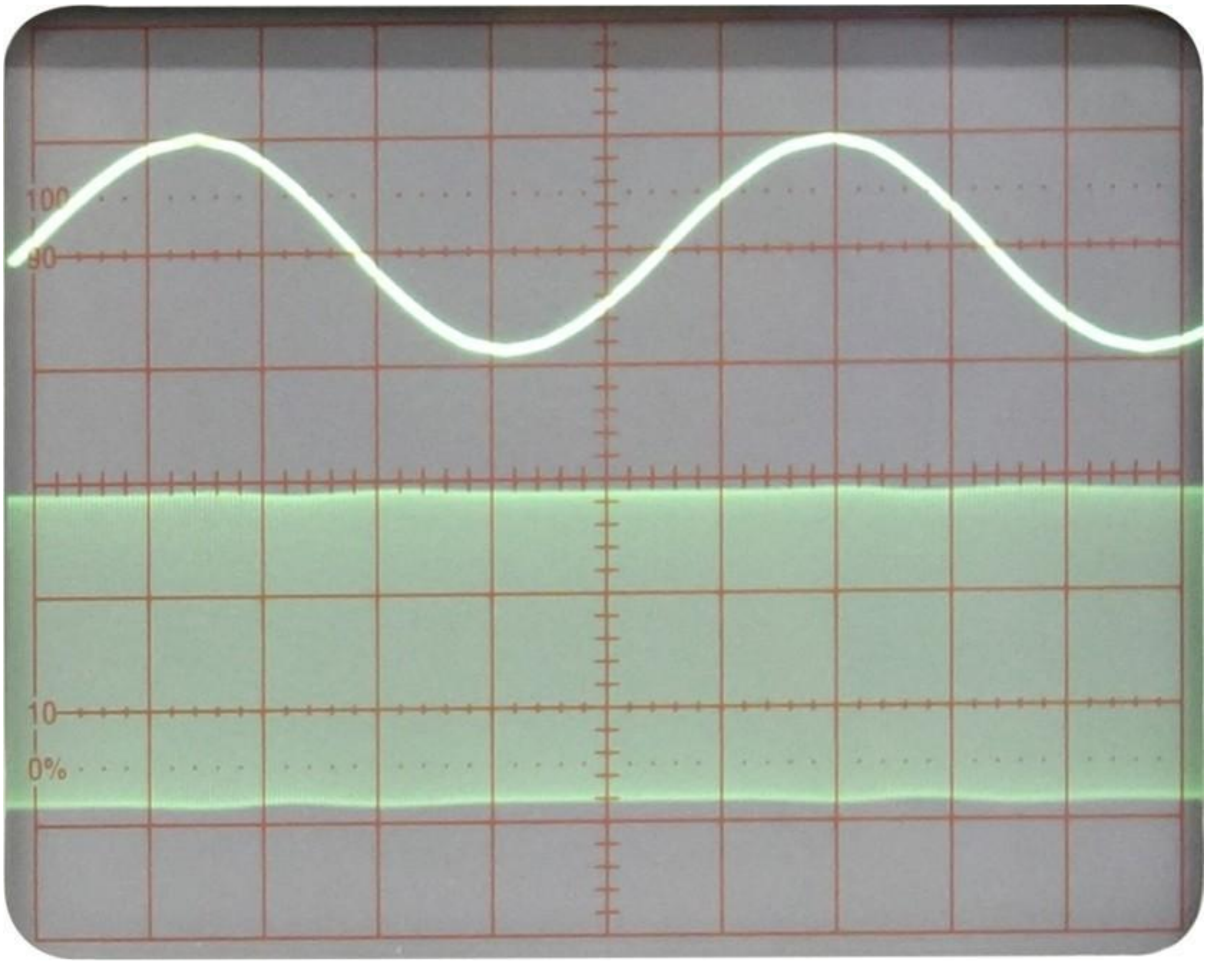
4) Also check that direct path is selected to connect the Mixer/Amplifier output to Detector input (bypassing the Amplitude Limiter block). If not, press the 'Amplitude Limiter Select' switch to select it.

5) Now press the 'Detector Select' switch to select Foster-Seeley/Ratio Detector block for operation which is indicated by glowing LEDs at the input and output of this block. The output of Foster-Seeley/Ratio Detector is connected to Low pass filter input which is also indicated by a glowing LED at the input of low pass filter.

6) Press 'Output Select' switch in the Foster-Seeley/ratio detector block, to select the Ratio detector which is indicated by a glowing LED at 'RD'.

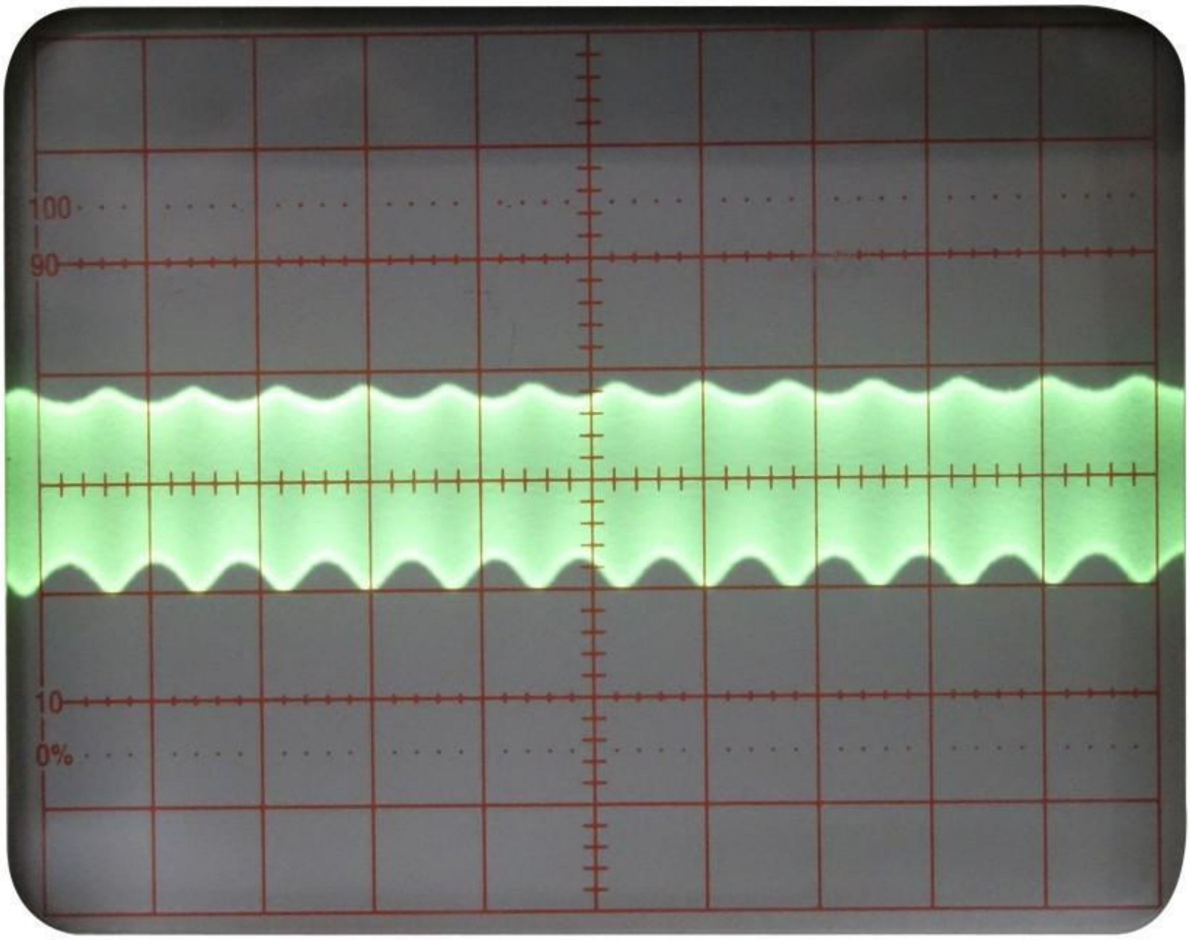
7) The audio oscillator's output signal is now being used by the Reactance modulator for frequency modulation of a 455 KHz carrier sine wave.

8) 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 the input test point of foster-Seeley/Ratio detector.

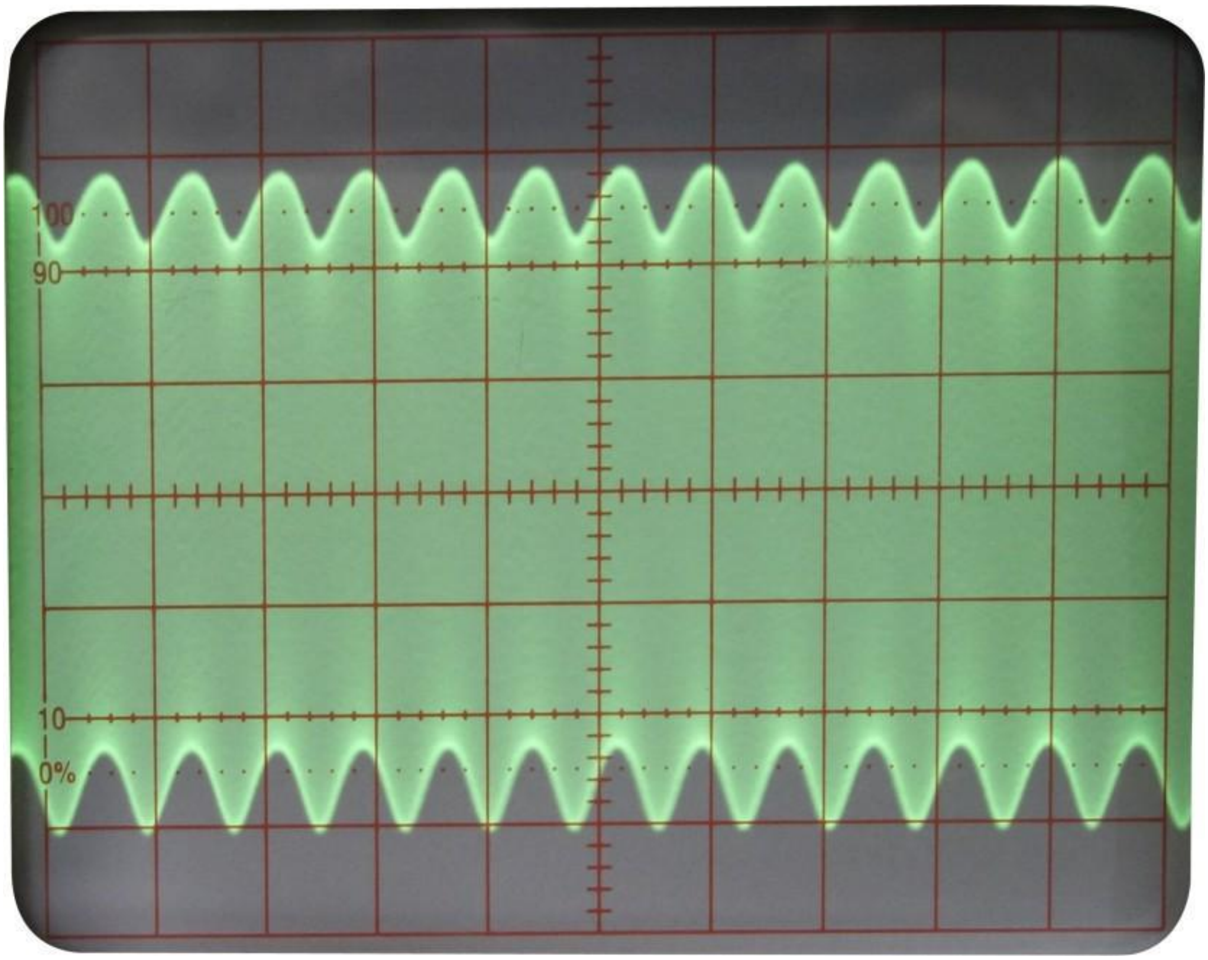


Audio oscillator output signal & FM signal

9) Observe the output signals of tuned transformer applied across the diode and coil at test points 13 and 14 respectively in the same block.



FM signal at test point 13

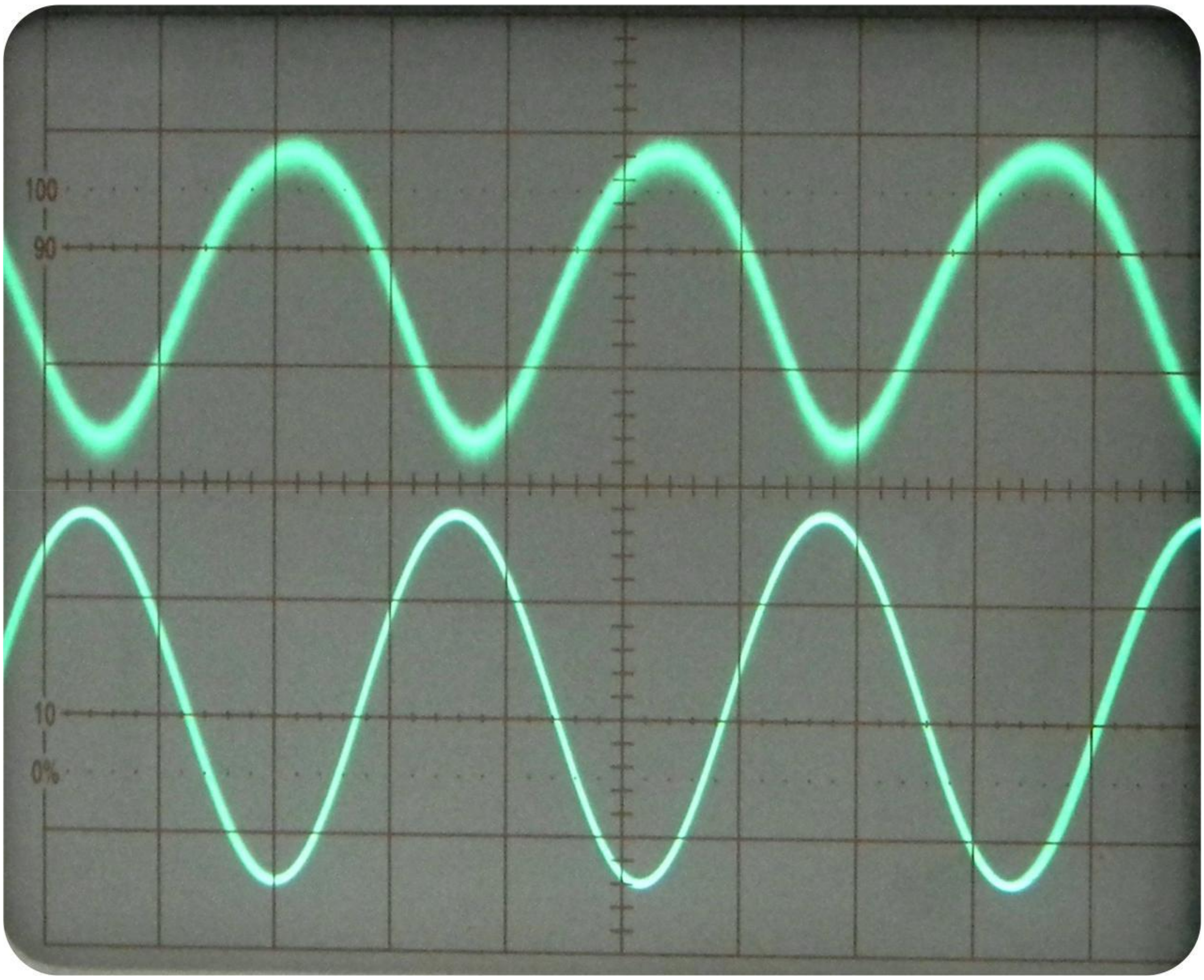


FM signal at test point 14

10) Now monitor modulating input signal to the Reactance modulator block together with the output from the Ratio detector.

The signal at output should contain two components.

- A positive DC offset voltage:
- A sine wave at the same frequency as the audio signal, but shifted in phase by 180°

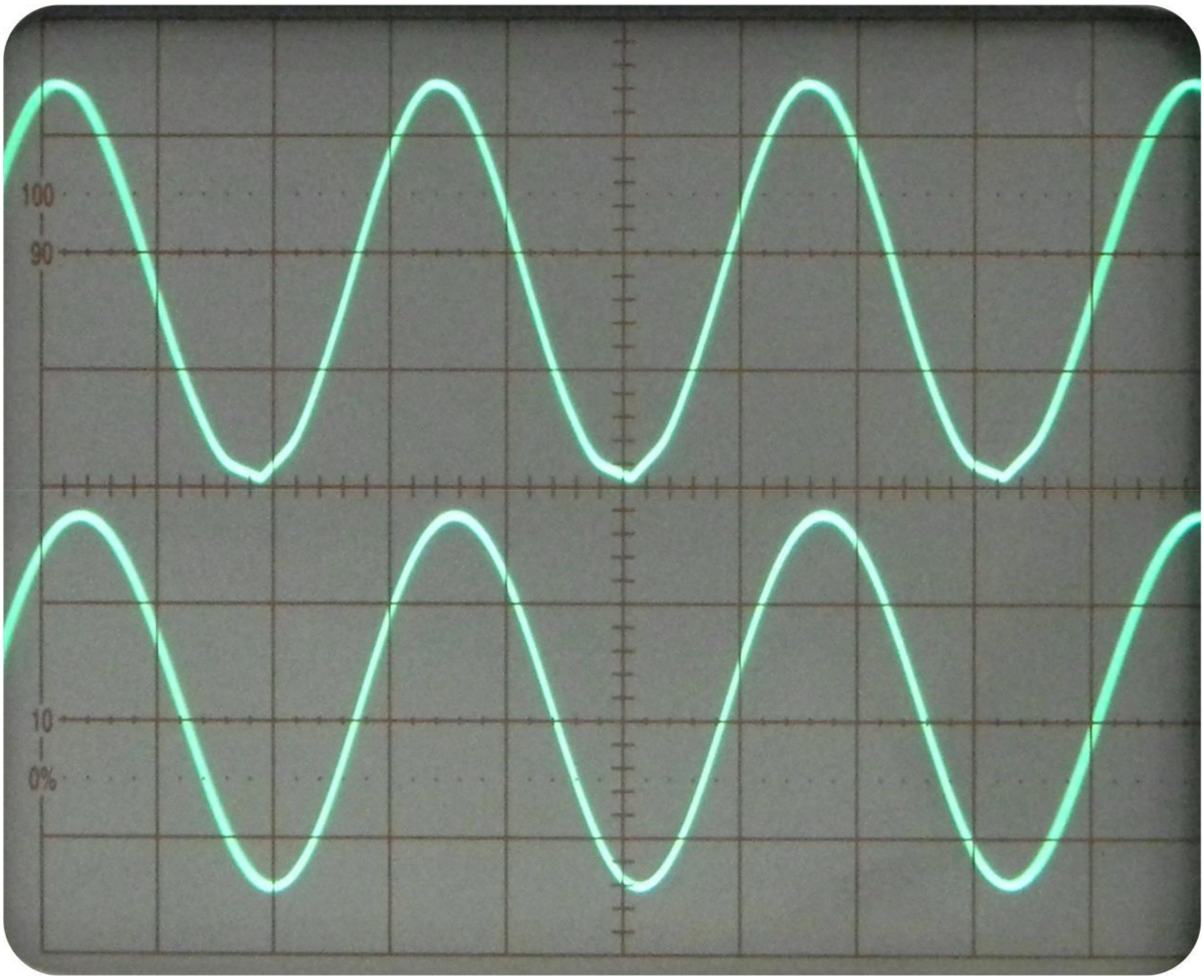


Modulating signal and Detector output signal

11) The Low Pass filter/Amplifier block removes the DC offset voltage at the detector's output, and strongly attenuates any residual high-frequency ripple that may be present.

12) Consequently, the signal at the output of the Low Pass filter/Amplifier block should very closely resemble the original audio-modulating signal. Monitor the input and output of the Low Pass filter/Amplifier block and note how the two signals differ.

13) 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

14) 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.

15) We will now investigate the effect of noise on the system.

a. 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.

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

c. 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.

d. 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.

16) 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.

17) 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.

18) Press 'Amplitude Limiter Select' switch to connect an Amplitude Limiter block between the FM output and the input to the Foster-Seeley/Ratio detector so that the effect of amplitude variations can be reduced.

19) The Amplitude Limiter removes amplitude variations from the FM output signal, so that the input signal to the Foster-Seeley/Ratio circuit detector has constant amplitude.

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

21) 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 ratio detector?

- Write the advantages of ratio detector over Foster – Seeley discriminator?

- Draw the circuit diagram of ratio detector?

- Draw the phasor diagram of ratio detector?

- How the effect of noise can be reduced?