Experiment 4

Objective:

1. Study of Frequency Modulation using Varactor modulator

2. Study of Frequency Modulation Using Reactance Modulator

Equipment Required

1. ST2203 with power supply cord

2. CRO with connecting probe

3. Connecting cords

Theory

Objective : **Study of Frequency Modulation using Varactor modulator**

Procedure :

This experiment investigates how ST2203's 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 ST2202 board.

a. All Switched Faults in 'Off' condition.

b. Amplitude potentiometer (in mixer amplifier block) in fully clockwise position.

c. VCO switch (in phase locked loop detector block) in 'Off' position.

2.Make the connections as shown in figure 13.

3.Switch On the power.

4.Turn the audio oscillator block's amplitude potentiometer to its fully clockwise position, and examine the block's output TP1 on an Oscilloscope. This is the audio frequency sine wave, which will be used as our modulating signal. Note that the sine wave's frequency can be adjusted from about 300Hz to approximately 3.4 KHz, by adjusting the audio oscillator's frequency potentiometer.

Note also that the amplitude of this modulating signal is adjusted by audio oscillator amplitude potentiometer Leave the amplitude potentiometer in minimum position.

5.Connect the output socket of the audio oscillator block to the audio input socket of the modulator circuit’s block.

6.Set the reactance / varactor switch to the varactor position. This switch selects the varactor modulator and also disables the reactance modulator to prevent any interference between the two circuits.

7.The output signal from the varactor modulator block appears at TP24 before being buffered and amplified by the mixer/amplifier block, any capacitive loading (e.g. due to Oscilloscope probe) may slightly affect the modulators output frequency. In order to avoid this problem we monitor the buffered FM output signal the mixer / amplifier block at TP34.

8.Put the varactor modulator's carrier frequency potentiometer in its midway position, and then examine TP34. Note that it is a sine wave of approximately 1.2 Vpp, centered on 0V. This is our FM carrier, and it is un-modulated since the varactor modulators audio input signal has zero amplitude.

9.The amplitude of the FM carrier (at TP34) 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 fully clockwise position.

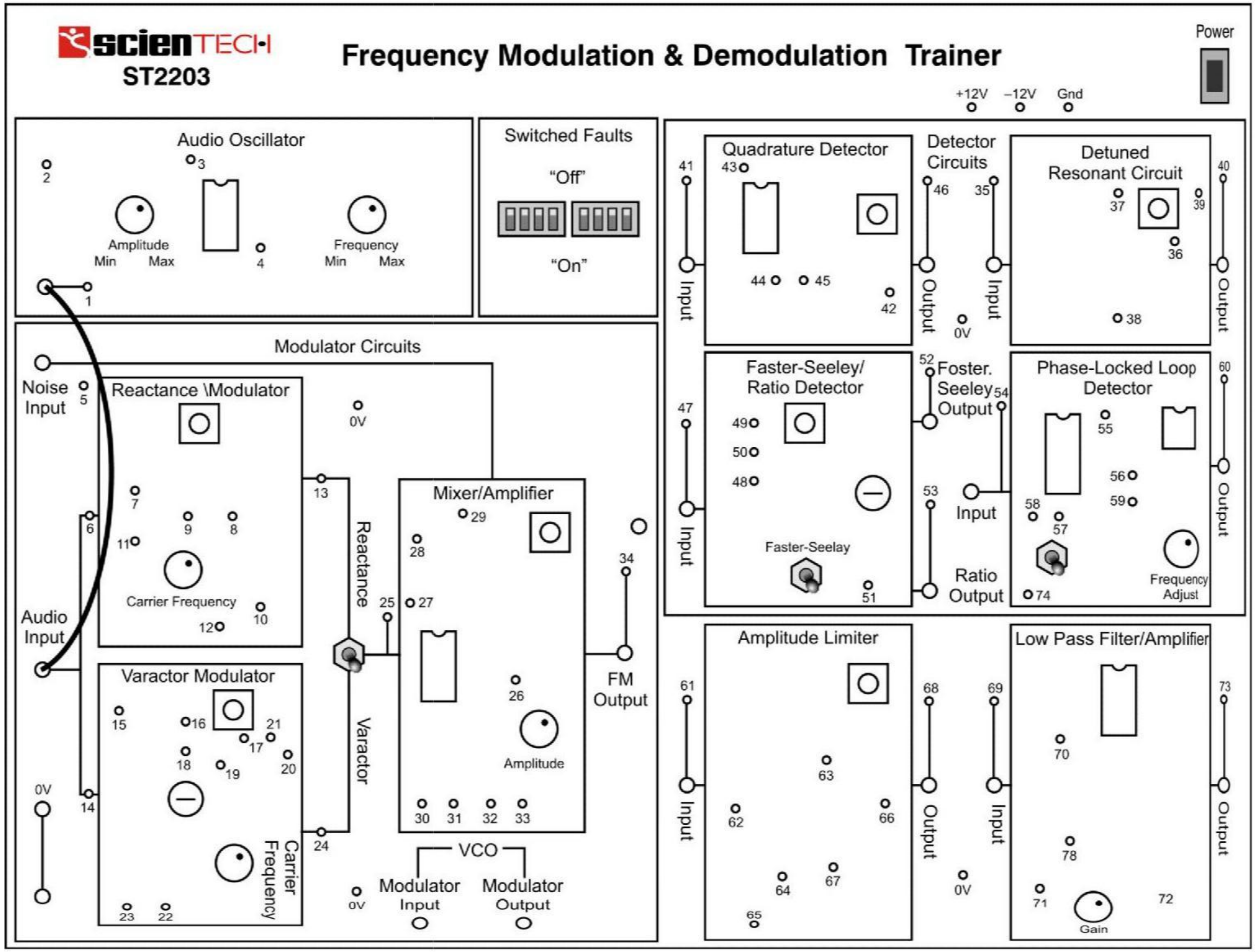
10. Try varying the carrier frequency potentiometer and observe the effects.

11.Also, see the effects of varying the amplitude and frequency potentiometer in the audio oscillator block.

12. Turn the carrier frequency potentiometer in the varactor modulator block slowly clockwise and note that in addition to the carrier frequency increasing there is a decrease in the amount of frequency deviation that is present.

13. Return the carrier frequency potentiometer to its midway position, and monitor the audio input (at TP6) and the FM output (at TP34) 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.

14. By using the optional audio input module ST2108 the human voice can be used as the audio modulating signal, instead of using ST2203's audio oscillator block. If you have an audio input module, connect the module's output to the audio input socket in the modulator circuit’s block. The input signal to the audio input module may be taken from an external microphone be (supplied with the module) or from a cassette recorder, by choosing the appropriate switch setting on the module. Consult the user manual for the audio input module, for further details.


scienTECH
ST2203
Frequency Modulation & Demodulation Trainer
Power
+12V
−12V
Gnd
Audio Oscillator
Amplitude
Min
Max
Frequency
Min
Max
Switched Faults
"Off"
"On"
Modulator Circuits
Noise Input
Audio Input
0V
Reactance \Modulator
Carrier Frequency
Varactor Modulator
Carrier Frequency
Reactance
Varactor
Mixer/Amplifier
Amplitude
VCO
Modulator Input
Modulator Output
FM Output
Quadrature Detector
Detector Circuits
Detuned Resonant Circuit
Faster-Seeley/ Ratio Detector
Faster-Seelay
Foster. Seeley Output
Ratio Output
Phase-Locked Loop Detector
Frequency Adjust
Amplitude Limiter
Low Pass Filter/Amplifier
Gain
Input
Output

Reactance Modulator

Figure 17 shows a complete reactance modulator.

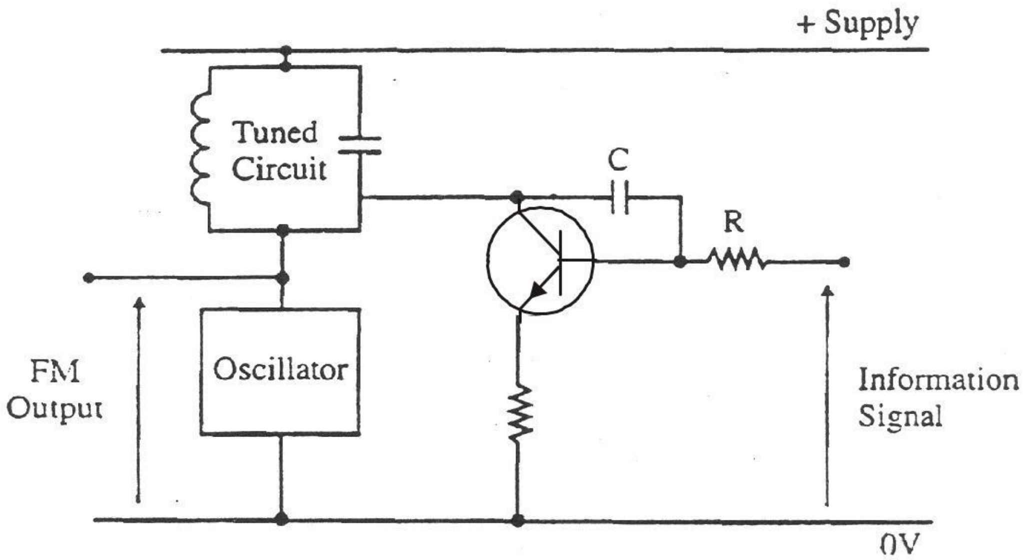


Figure 1

In figure 1, the left hand half is the previous varactor modulator simply an oscillator and a tuned circuit, which generates the un-modulated carrier. The capacitor C and the resistor R are the two components used for the phase shifting, and together with the transistor, form the voltage controlled capacitor. This voltage-controlled capacitor is actually in parallel with the tuned circuit. This is not easy to see but figure 18 may be helpful.

In the first part of the figure the capacitor and associated components have been replaced by the variable capacitor, shown dotted.

In the next part, the two supply lines are connected together. We can justify this by saying that the output of the DC power supply always includes a large smoothing capacitor to keep the DC voltages at a steady value.

This large capacitor will have a very low reactance at the frequencies being used in the circuit less than a milliohm. We can safely ignore this and so the two supply lines can be assumed to be joined together. Remember that this does not affect the DC potentials, which remain at the normal supply voltages.

Objective :

Study of Frequency Modulation Using Reactance Modulator

Procedure :

This experiment investigates how **ST2203**'s 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. To avoid unnecessary loading of monitored signals, X10 Oscilloscope probes should be used throughout this experiment.

1. Ensure that the following initial conditions exist on the **ST2203** Module.

   a. All Switch Faults in ‘Off’ condition.

   b. Amplitude potentiometer (in the mixer/amplifier block) in fully clockwise.

   c. VCO switch (in phase-locked loop detector block) in ‘Off’ position.

2. Make the connections as shown in figure 19.

3. Turn on power to the **ST2203** module

4. Turn the audio oscillator block's amplitude potentiometer to its fully clockwise (Maximum) positions, and examines the block's output (TP1) on an Oscilloscope.

   This is the audio frequency sine wave, which will be used as our modulating signal. Note that the sine wave's frequency can be adjusted from about 300 Hz to approximately 3.4 KHz by adjusting the audio oscillator's frequency potentiometer Note also that the amplitude of this audio modulating signal can be reduced to zero, by turning the audio oscillator's amplitude potentiometer to its fully counter clockwise position.

5. Connect the output socket of the audio oscillator block to the audio input socket of the modulator circuit’s block, as shown in figure 19.

6. Put the reactance /varactor switch in the reactance position. This switches the output of the reactance modulator through to the input of the mixer/amplifier block~ and also switches off the varactor modulator block to avoid interference between the two modulators.

7. The output signal from the reactance modulator block appears at TP13, before being buffered and amplified by the mixer/amplifier block. Although the output from the reactance modulator block can be monitored directly at TP13, 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 from the mixer/amplifier block at TP34.

8. Put the reactance modulator's potentiometer in its midway position (arrow pointing towards top of PCB) then examine TP34.

   Note : that 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 reactance modulator's audio input signal has, zero amplitude.

9. The amplitude of the FM carrier (at TP34) is adjustable by means of the mixer/amplifier block's amplitude potentiometer, from zero to its present 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 fully clockwise position.

10. The frequency of the FM carrier signal (at TP34) should be approximately 455 KHz at the moment This carrier frequency can be varied from 453 KHz to 460 KHz (approximately) by adjusting the carrier frequency potentiometer in the reactance modulator block.

Turn this potentiometer over its range of adjustment and note that the frequency of the monitored signal can be seen to vary slightly. Note also that the carrier frequency is maximum when the potentiometer is in fully clockwise position.

11. Try varying the amplitude & frequency potentiometer in audio oscillators block, and also sees the effect of varying the carrier frequency potentiometer in the mixer/amplifiers block.

12. Monitor the audio input (at TP6) and the FM output (at TP34) 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 signal's frequency, and not in its amplitude.

13. The complete circuit diagram for the reactance modulator is given at the end of operating manual. If you wish, follow this circuit diagram and examine the test points in the reactance modulator block, to make sure that you fully understand how the circuit is working.

14. By using the optional audio input module, the human voice can be used as the audio modulating signal, instead of using **ST2203**'s audio oscillator block.

If you have an audio input module, connect the module's output to the audio input socket in the modulator circuit's block

The input signal to the audio input module may be taken from an external microphone (supplied with the module), or from a cassette recorder, by choosing the appropriate switch setting on the modules.

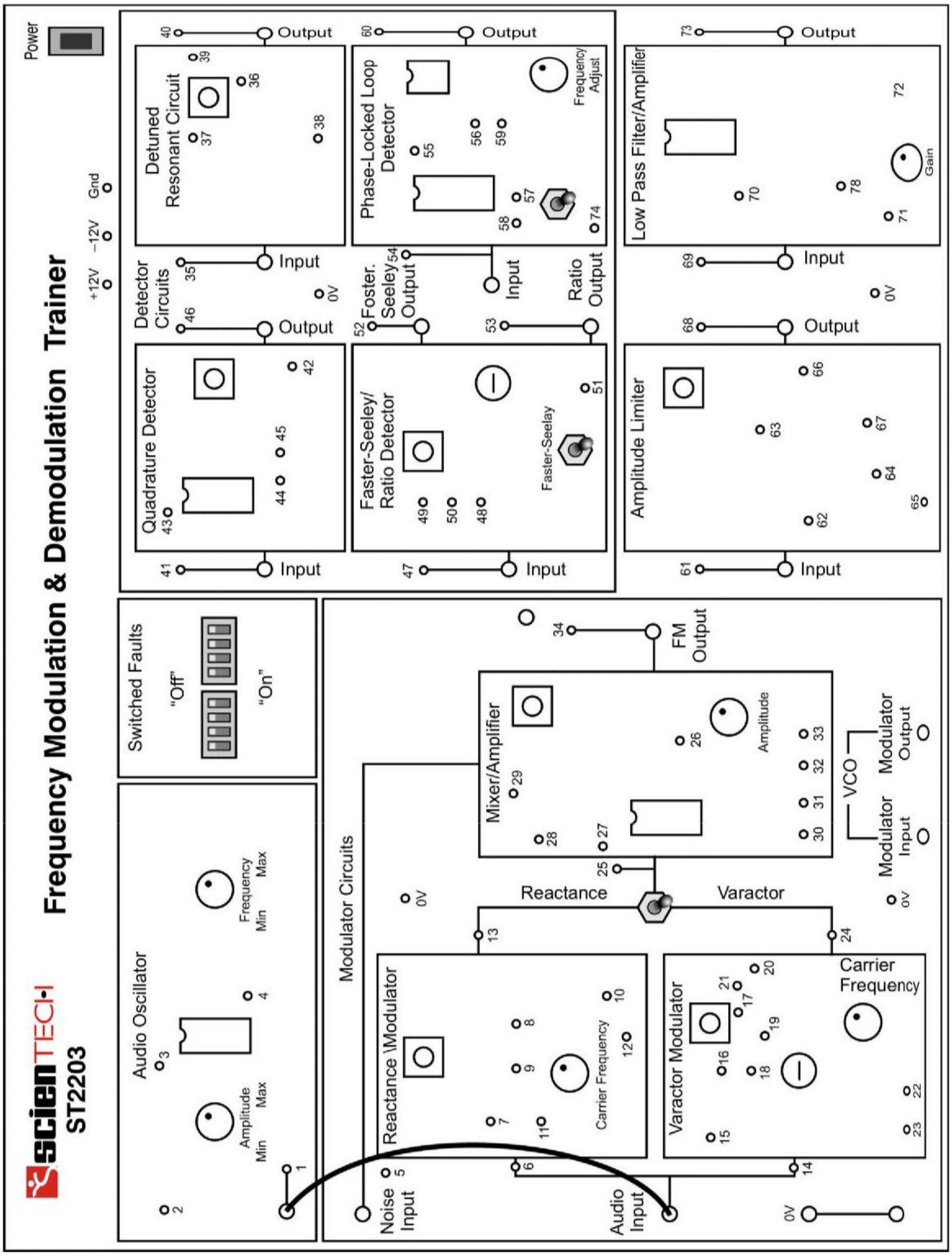
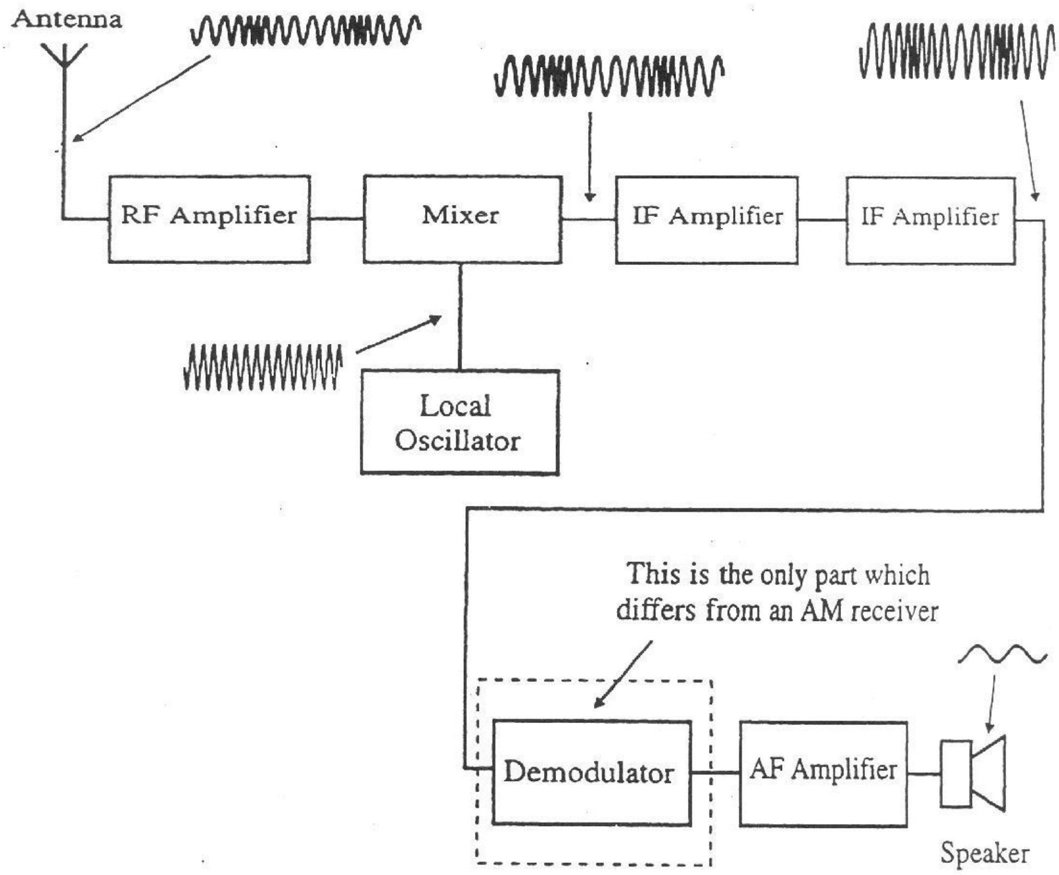

scientech
ST2203
Frequency Modulation & Demodulation Trainer
Power
+12V
−12V
Gnd
Detector Circuits
Detuned Resonant Circuit
Quadrature Detector
Phase-Locked Loop Detector
Frequency Adjust
Faster-Seeley/ Ratio Detector
Faster-Seelay
Foster. Seeley Output
Ratio Output
Low Pass Filter/Amplifier
Gain
Amplitude Limiter
Input
Output
0V
Switched Faults
"Off"
"On"
Audio Oscillator
Amplitude
Frequency
Min
Max
Modulator Circuits
Mixer/Amplifier
FM Output
Reactance
Varactor
Reactance \Modulator
Carrier Frequency
Varactor Modulator
VCO
Modulator Input
Modulator Output
Noise Input
Audio Input

Figure 19

Demodulation on FM Signals

A FM receiver is very similar to an AM receiver. The most significant change is that the demodulator must now extract the information signal from a frequency rather than amplitude modulated wave.



FM Receiver

Figure 2

The basic requirement of any FM demodulator is therefore to convert frequency change into change in voltage, with the minimum amount of distortion. To achieve this, it should ideally have a linear voltage/frequency characteristic, similar to that shown in figure 2. A demodulator can also be called a 'discriminator' or a 'detector'.

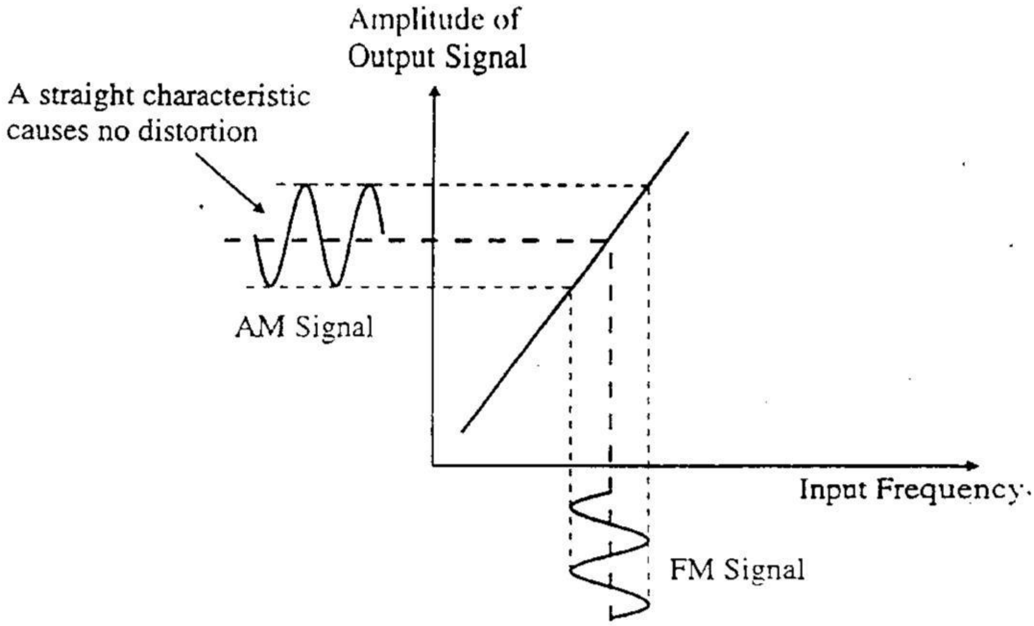


Figure 2

Any design of circuit that has a linear voltage/frequency characteristic would be acceptable and we are point to consider the five most popular types. In each case the main points to look are :

- How do they convert FM signals into AM signals?
- How linear is their response-this determines the amount of distortion in the final output.
- How good are they at rejecting noise signals?

Frequently Asked Questions

Que 1.What is Frequency modulation (FM)?

Ans :Frequency Modulation is the process of varying frequency of a periodic waveform, called the carrier signal, with respect to the frequency of modulating signal that typically contains information to be transmitted.

Que 2.What is a use of Varactor diode?

Ans: tuning **diode**, also known as a **varactor diode**, variablcapacitance **diode**,**varicap diode** or variable reactance **diode**, is a **diode** that has a variable capacitance which his a function of the voltage that is impressed on its terminals. Tuning / **varactor** diodes are operated reverse-biased, and therefore no current flows.

Que.3.What is the reactance modulator?

A **reactance modulator** is a circuit that uses a transistor amplifier that acts like either a variable capacitor or an inductor. When the circuit is connected across the tuned circuit of an oscillator, the oscillator frequency can be varied by applying the modulating signal to the amplifier.