PCS NOTES UNIT 3

FM transmission and reception for signal tone

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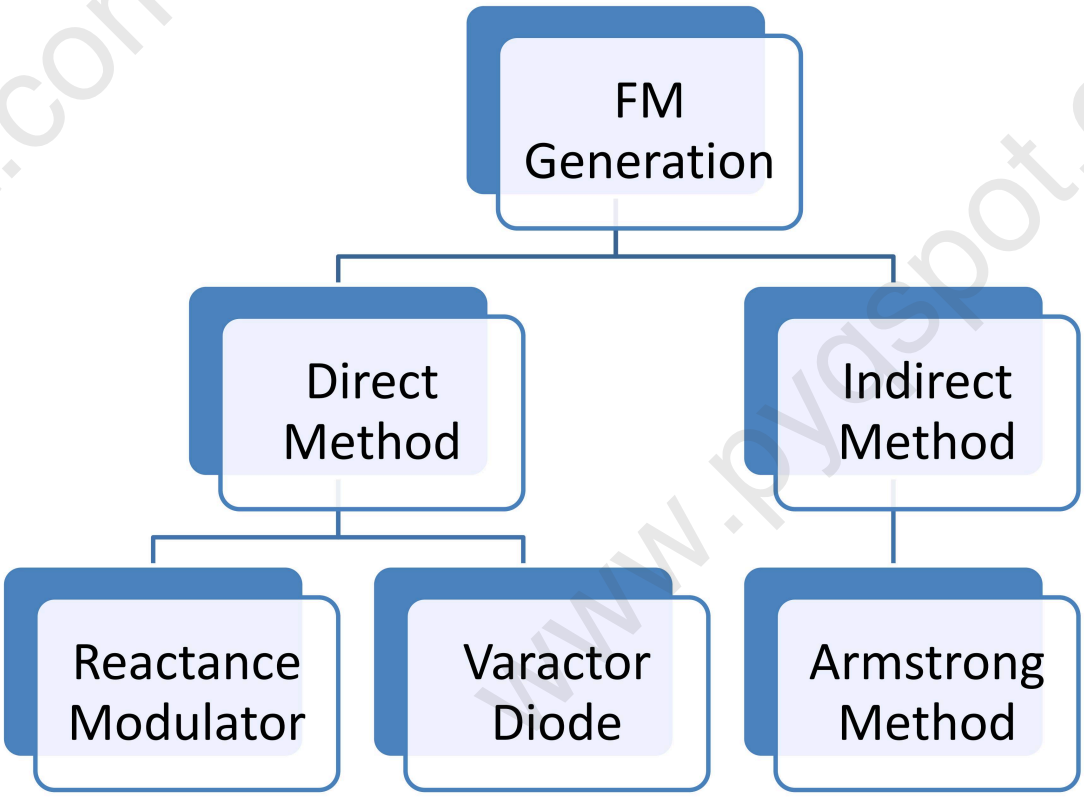
Unit No.3

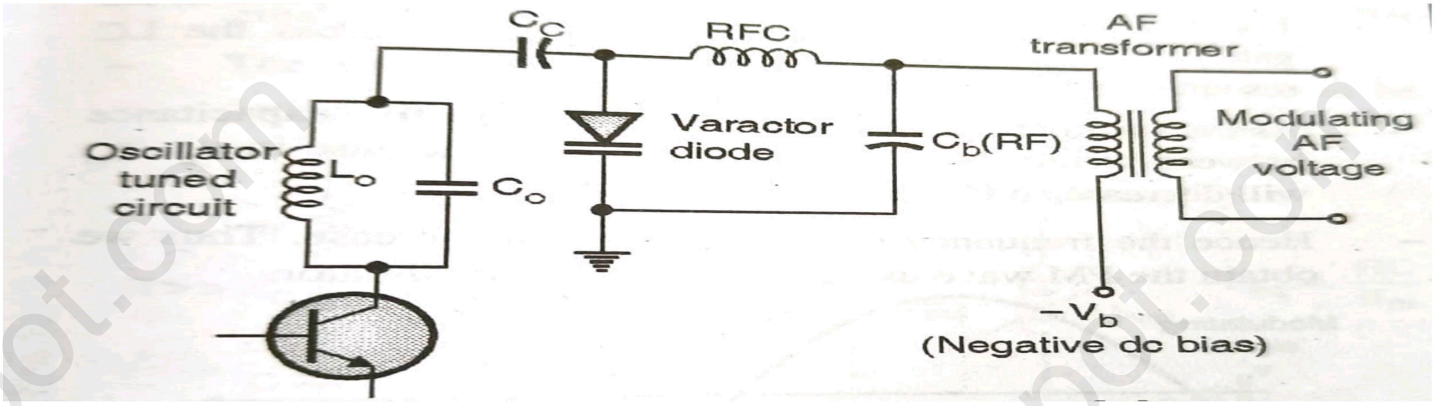
FM transmission & reception for signal tone:

Phase Modulation (PM) and Frequency Modulation (FM), Relationship between Phase and Frequency Modulation, Modulation Index, Spectrum of FM (single tone): Feature of Bessel Coefficient, Power of FM signal, Bandwidth of tone modulated FM signal, modulation index : AM vs. FM, Spectrum of constant Bandwidth' FM, Narrowband and Wideband FM. FM Modulators and Demodulators: FM generation by Armstrong's Indirect method, frequency multiplication and application to FM, FM demodulator.

Generation Methods of FM

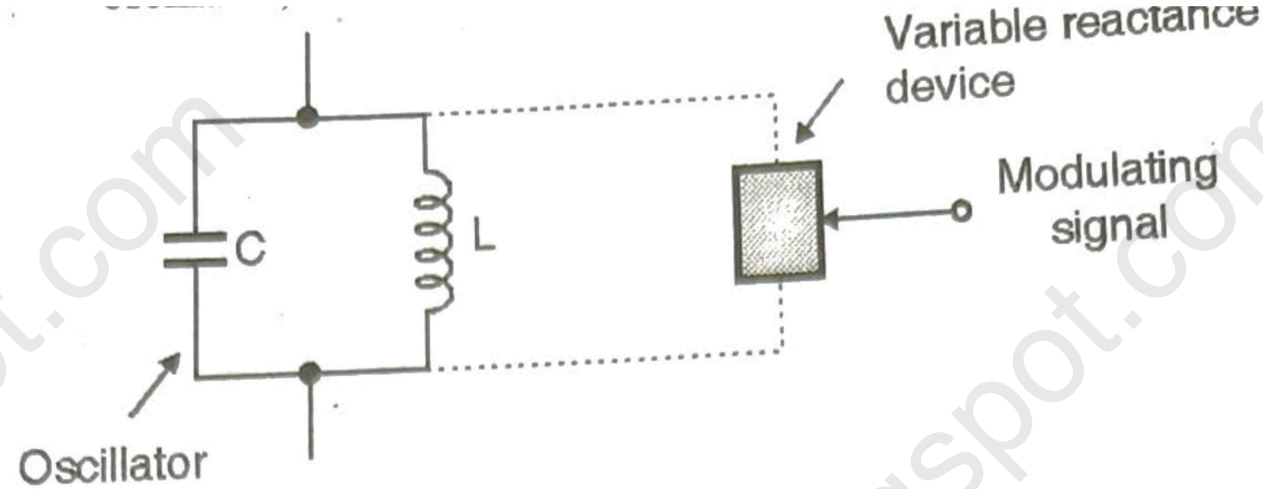


Varacter Diode Modulators



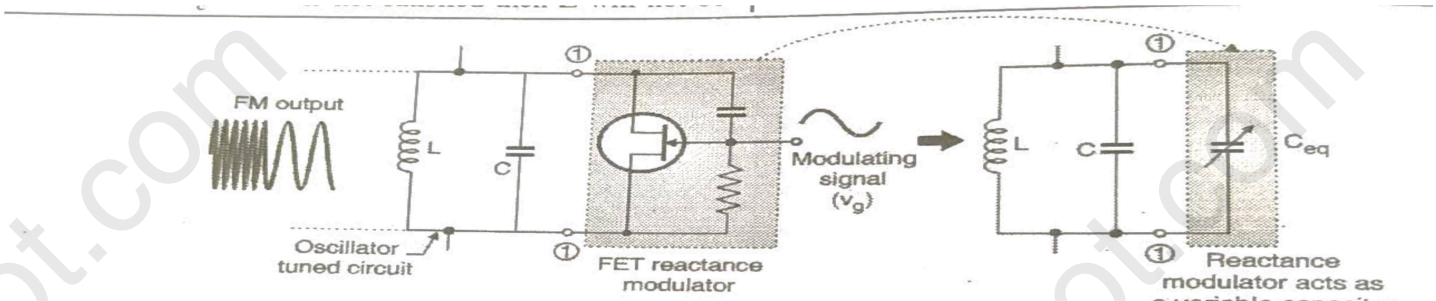
- The varactor diode is reverse biased by the negative dc source -Vb.
- The modulating AF voltage appears in series with the negative supply voltage. Hence the voltage applied across the varactor diode varies in proportion with the modulating voltage
- This will vary the junction capacitance of the varactor diode.
- The varactor diode appears in parallel with the oscillator tuned circuit. Hence the oscillator frequency will change with change in varactor diode capacitance and FM wave is produced.
- The RFC will connect the dc and modulating signal to the varactor diode but it offers a very high impedance at high oscillator frequency. Therefore the oscillator circuit is isolated from the dc bias and modulating signal.

Reactance Modulator



(D-187) **Fig. 5.8.1 : Principle of reactance modulator**

- In the reactance modulators, a transistor or FET is operated as a variable reactance Device.
- This Device connected across the tuned circuit of as an oscillator, so If change the oscillator frequency to produce FM Wave.



(D-189) (a) Frequency modulation using FET reactance modulator (b) Equivalent circuit

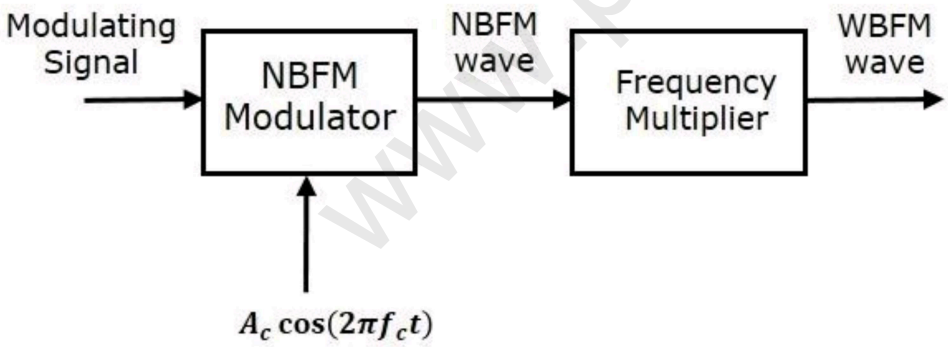
Fig. 5.8.3

Modulating Signal is applied at the gate and terminal and 1-1 ' is Connected to Oscillator Tuned ckt (Resorant ckt) .
modulating voltage change, the capacitance between 1-1 ' will change with increse vg gm. & will decrease Ceq' .
Hence the freq of oscillation increase we obtain Fm wave Using FET modulator.

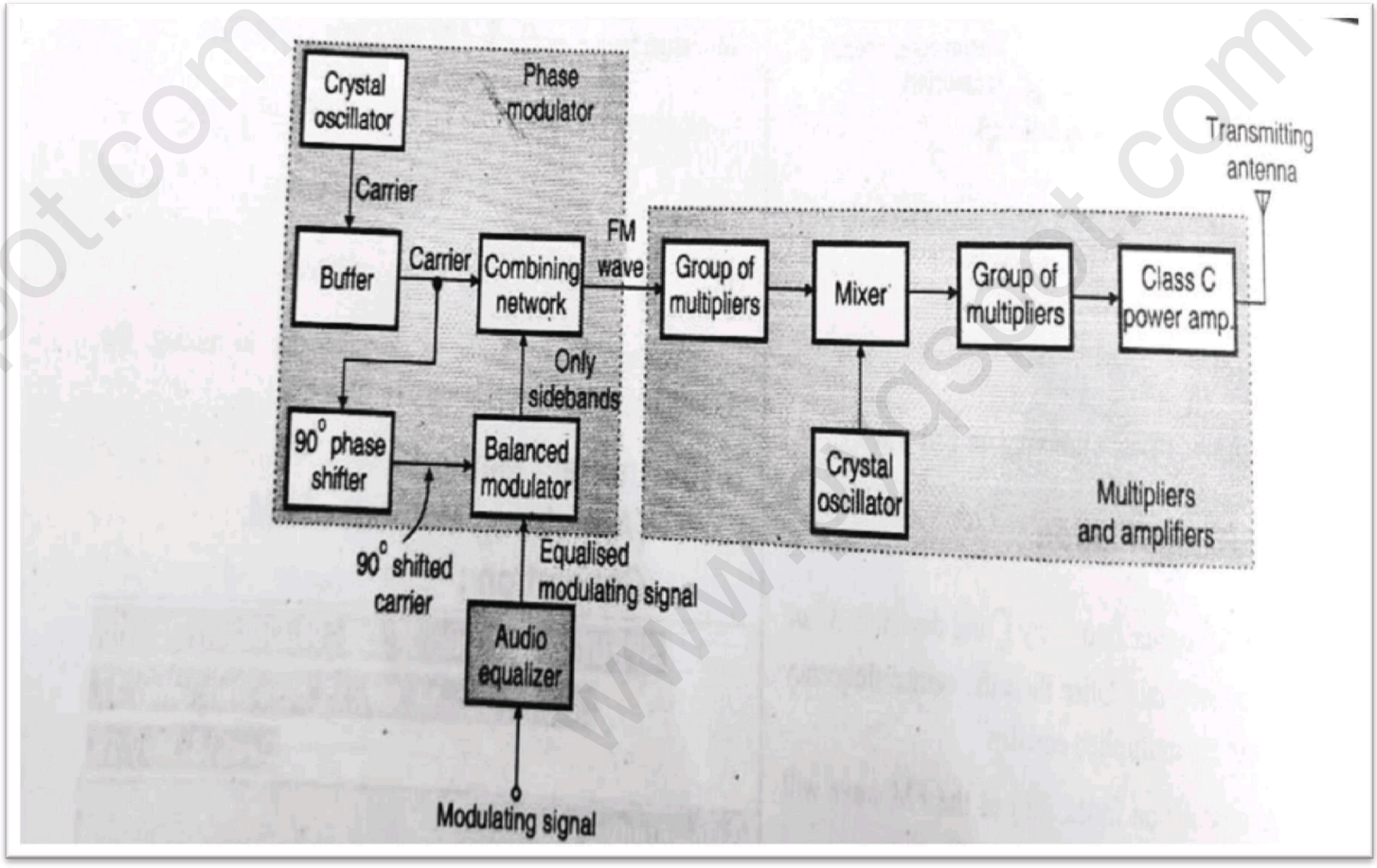
Advantage of Disect Fm genation 1) simplicity of the modulator.2) Low Cost
Disadvantage :1) LC oscillator freq not Stable
2) We have use the automatic foreqControl Scheme

Indirect Method

- This method is called as Indirect Method because we are generating a wide band FM wave indirectly.
- First we will generate NBFM wave using phase modulator and then with the help of frequency multipliers we will get WBFM wave.



Armstrong indirect FM transmitter



- The crystal oscillator produces a stable unmodulated carrier which is applied to the "90° phase shifter" as well as the "combining network" through a buffer.
- Buffer is used for to provide isolation between two stage.
- The 90° phase shifter produces a 90° phase shifted carrier.
- It is applied to the balanced modulator.
- The modulating signal is applied to the audio equalizing circuit and produce equalizing modulating signal .
- Thus the carrier used for modulation is 90° shifted with respect to the original carrier.
- At the output of the balanced modulator we get DSB-SC signal i.e. A.M. signal without carrier.
- The two sidebands and the original carrier without any phase shift are applied to a combining network.
- combining network will combine carrier along with two sidebands and produce FM Wave.
- This FM wave has a low carrier frequency and low value of the modulation index.
- The carrier frequency and the modulation index are then raised by passing the FM wave through the first group of multipliers.
- The carrier frequency is then raised by using a mixer and then the f, and m, both are raised to the required high values using the second group of multipliers.
- The FM signal with high f, and high m, is then passed through a class C power amplifier to raise the power level of the FM signal.

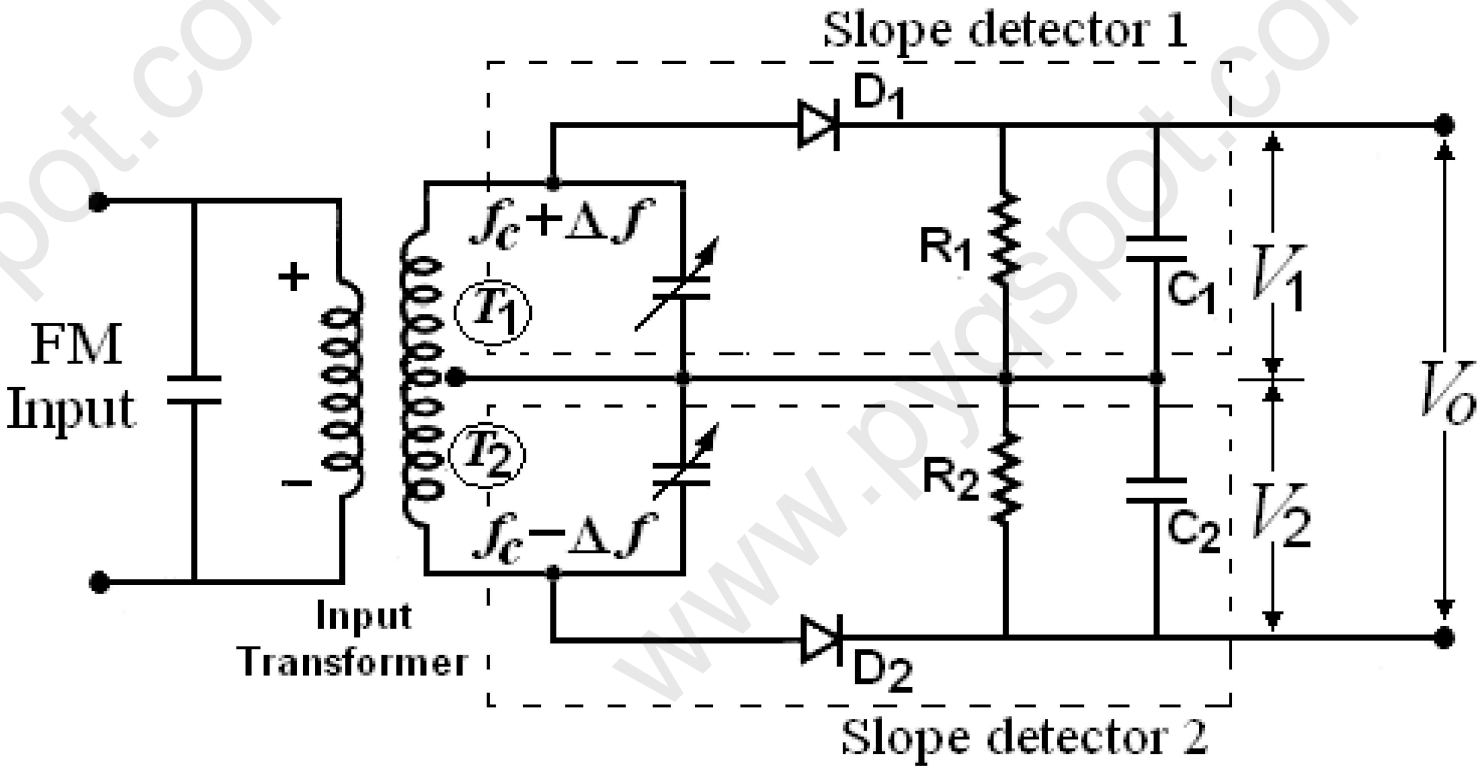
FM detectors

There are different types of FM detectors.

FM Detectors Types

I. Balanced Slope Detector
II. Phase Discriminator (Foster seeley Discriminator)
III. Ratio Detector
IV. PLL Detector

Balanced Slope Detector



Operation for fin=fc:

- When the input frequency(Fin) is equal to fc, the voltage of secondary winding of T1 is exactly equal to that in the winding T2.
- Thus the input voltages to both the diodes D1 and D2 will be the same.
- output voltages Vo1 and Vo2 will also be equal but they have opposite polarities. Hence the net output voltage $V_1 = 0$.

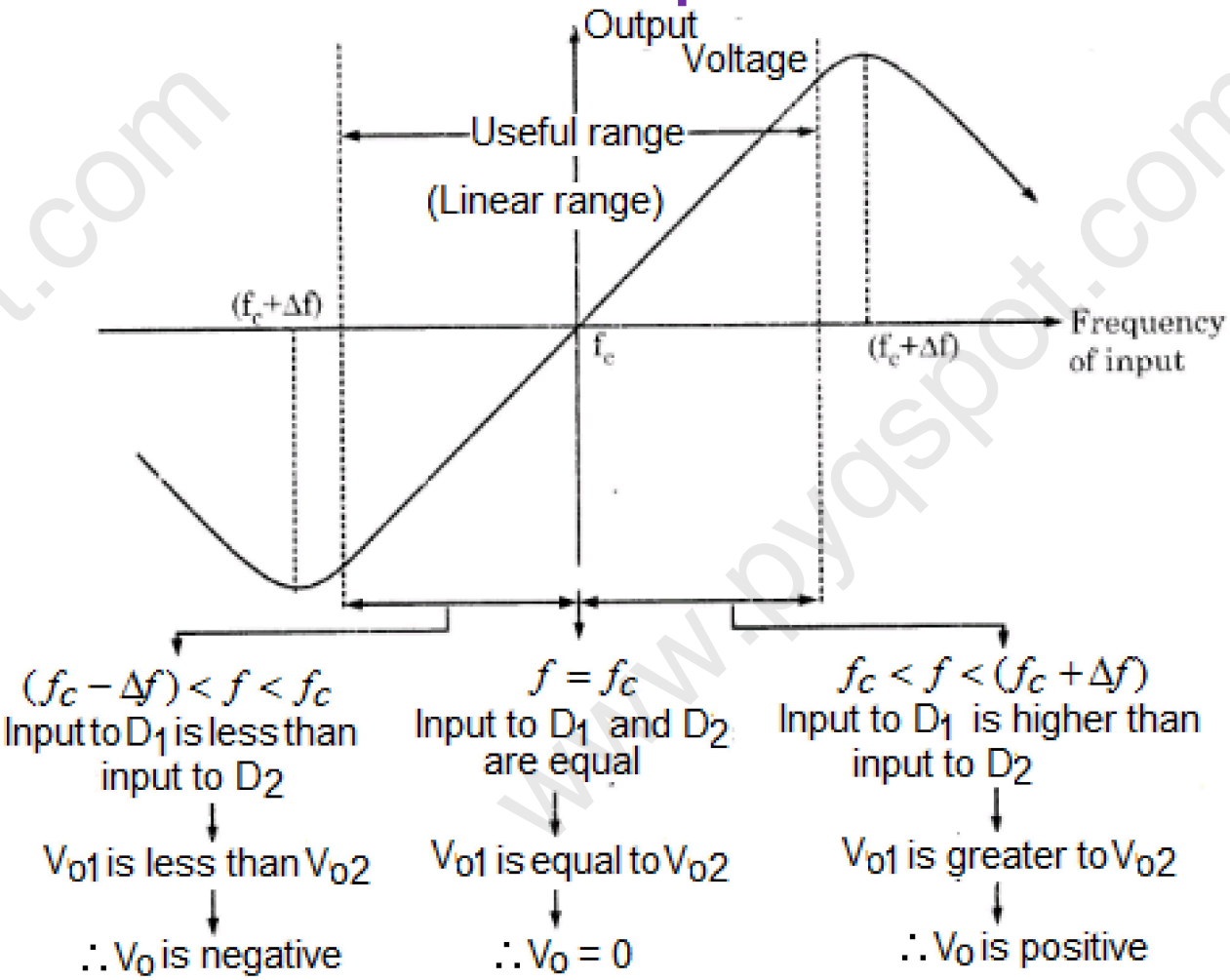
Operation for fc<fin < (fc+∆f):

- The induced voltage in the winding T1 is higher than T2.
- Therefore the input voltage to D1 is higher than D2.
- Hence the positive output Vo1 of D1 is higher than negative output Vo2 of D2.
- Therefore the output voltage V1 is positive.

Operation for (fc+∆f) < fin<fc :

- The induced voltage in winding T2 is higher than that in T1
- Therefore the input voltage to D2 is higher than D1.
- Hence the Negative output Vo2 of D2 is higher than negative output Vo1 of D1.
- Therefore the output voltage V2 is Negative.

Balanced Slope Detector



Balanced Slope Detector

***Advantages*:**

(i) This circuit is more efficient than simple slope detector.

(ii) It has better linearity than the simple slope detector.

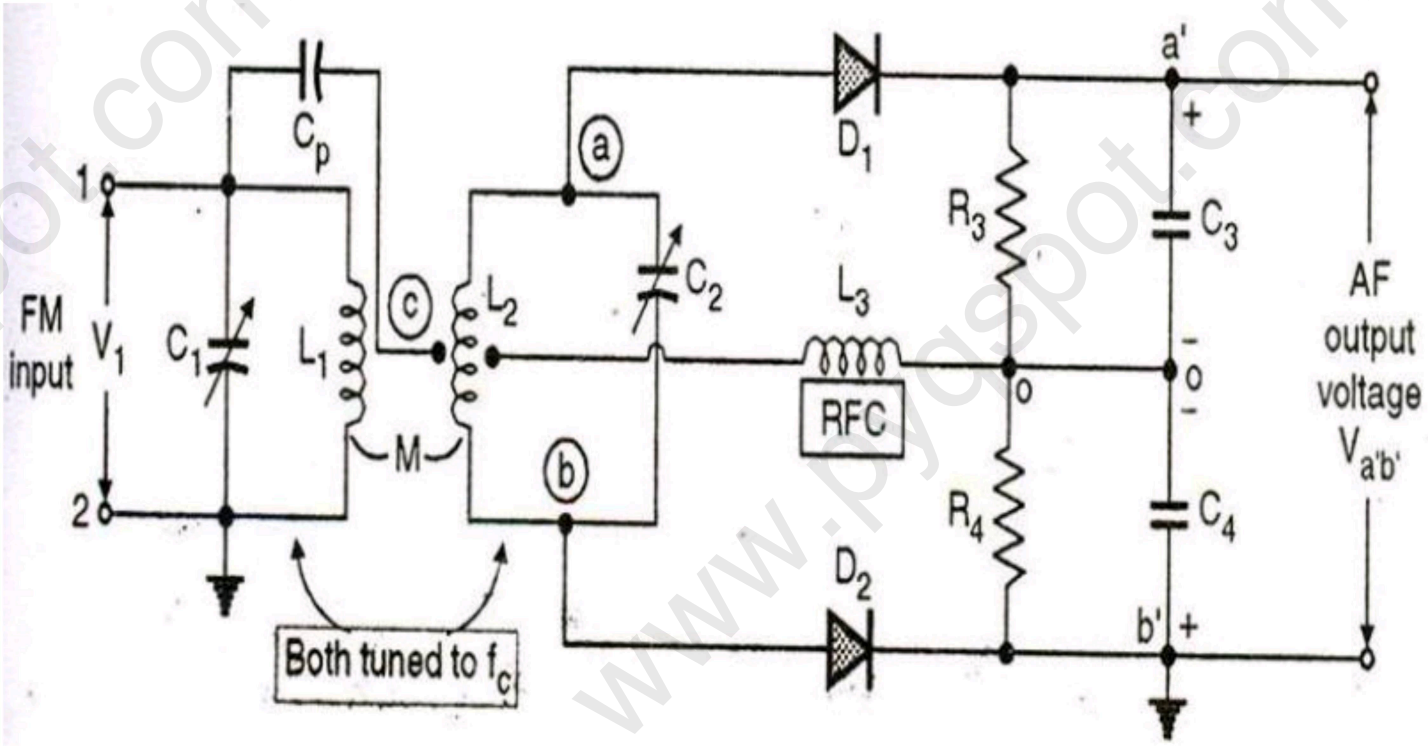
***Limitations*:**

(i) Even though linearity is good, it is not good enough.

(ii) This circuit is difficult to tune since the three tuned circuits are to be tuned at different frequencies, and

(iii) Amplitude limiting is not provided.

2) Foster-Seeley Discriminator



Working:

Output voltage at fin=fc:

- When the input frequency is equal to the center frequency (fc), the phase shift between the primary and secondary voltages is exactly 90°.
- Therefore the input voltages to both the diodes will be equal .
- Therefore the outputs of both the diodes will be equal.
- Hence the output voltage will be zero.

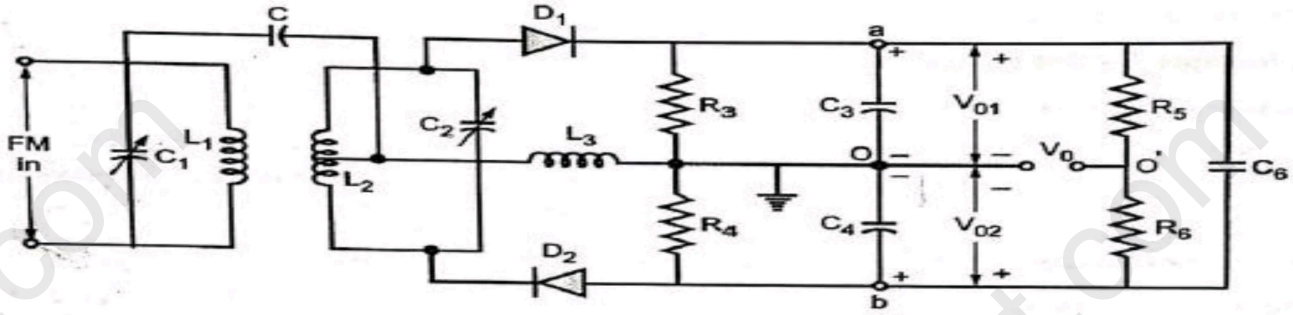
Output voltage at fin>fc:

- At input frequencies is grater than center frequency fc, secondary voltage Vab leads the primary voltage V1 by less than 90°.
- Hence input voltage to D1 i.e. Vao is higher than input to D_2 i.e. Vbo.
- The output voltage will be positive for fin>fc

Output voltage at fin<fc:

- For input frequencies less than the center frequency fc, the secondary voltage Vab leads the primary voltage V1 by more than 90°.
- Hence input voltage to D2 i.e. Vbo is higher than input to D1 i.e. Vao .
- Therefore the output voltage will be negative for fin<fc

3) Ratio Detector



- The capacitor C1 and primary of the transformer are tuned to the center frequency of FM signal.
- The capacitor C2 and secondary windings L2 form tank circuit and it is also tuned to center frequency of FM signal , Capacitor C is coupling capacitor.
- The tertiary winding L3 is RFC (Radio Frequency Choke) and it is used to avoid loading of secondary winding L2.
- The capacitor C3 and C4 determine the polarity and magnitude of the output signal.
- Diode D1 is forward biased and diode D2 is reverse biased and they are used in rectification mode.
- Due to this, voltage at point 'o' will be positive with respect to 'b', therefore Vab is the sum voltage Hence when operating frequency goes beyond center frequency, diode D1 conducts more than D2 and Vao becomes grater than Vbo and Vo Becomes more Positive.
- when operating frequency goes below center frequency, diode D_2 conducts more than D1 Hence Vbo becomes greater than Vao and V0 becomes more negative

Continued….

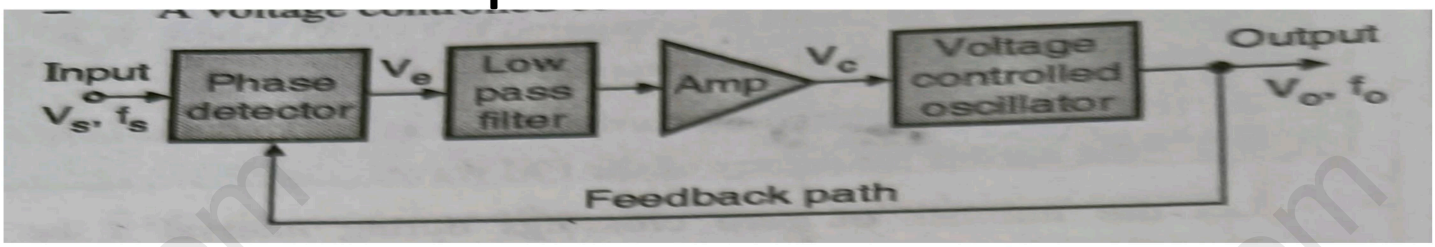
Advantages:

- Easy alignment.
- Good linearity.
- Amplitude limiting is provided so that additional limiter is not required.

Disadvantages:

- Complicated operation.
- More components are required.

Operation of PLL



Phase Detector / Comparator: FM signal hav

The two inputs to a phase detector or comparator are the input voltage Vs at frequency fs and the feedback voltage from a voltage controlled oscillator (VCO) at frequency fo.

The phase detector compares these two signals and produces a Error voltage (Ve) which is proportional to the phase difference between fs, and fo.

The output voltage Ve of the phase Once detector is called as "error voltage".

This error voltage is then applied to a low pass filter.

Low pass filter:

The low pass filter removes the high frequency noise present in the phase detector output and produces a ripple free de level.

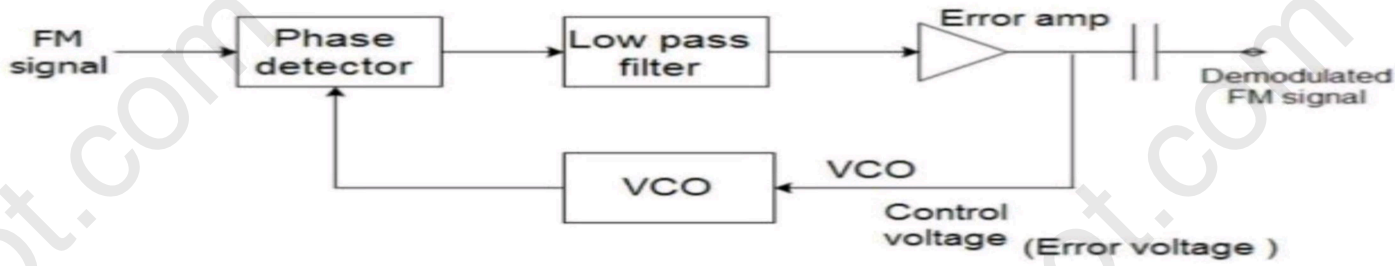
The dc Level is amplified to an adequate level and applied to a voltage controlled oscillator and produce control voltage(Vc).

voltage controlled oscillator:

The control voltage Vc is applied at the input of a VCO.

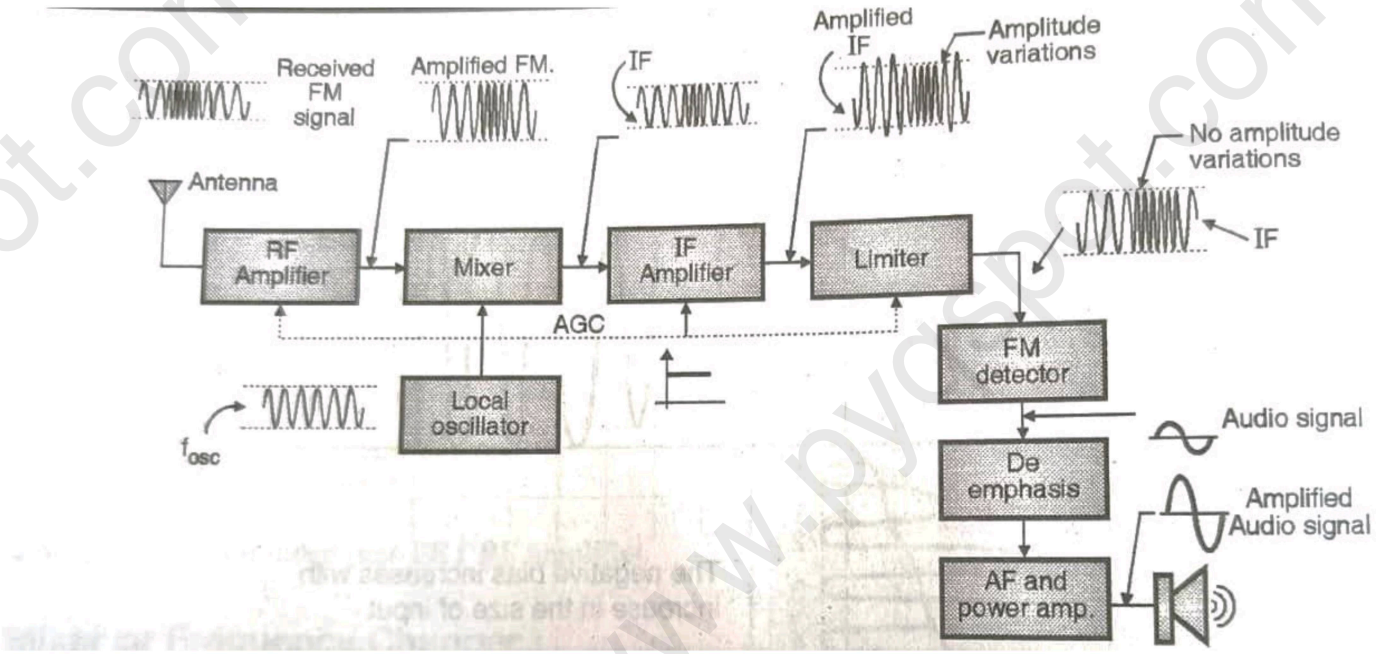
The VCO frequency "fo" is compared with the input frequency "fs" by the phase detector/ Compareter and it (VCO frequency) is adjusted continuously until it is equal to the input frequency fs, i.e. fo=fs

FM Demodulator using PLL



- The FM signal which is to be demodulated is applied at the input of the PLL.
- As the PLL is locked to the FM signal, the VCO starts tracking the instantaneous frequency in the FM input signal.
- The error voltage produced at the output of the amplifier is proportional to the deviation of input frequency from the center frequency of FM.
- Thus the ac component of the error voltage represents the modulating signal.
- Thus at the error amplifier output we get demodulated FM output.

Super heterodyne FM Radio Receiver



De empesis: Artificially boosted high freq. signal are brought to their original amplitude.

Heterodyning

- The process of mixing two signal having different Frequency to produce new frequency Called Heterodyning

Antenna:

- The FM Signal transmitted by transmitter & and it travel and reached through the air to the receiving antenna.
- The signal is in the form of electromagnetic wave

RF stage:

- The RF stage is an amplifier which is used to select wanted signal and reject other out of many.
- it also reduce effect of noise. At the o/p of RF amplifier we get desired signal (fs)

Mixer :

- The mixer receive the signal from RF amplifier at frequency (fs) and From local oscillator at from (fo).

Intermediate Freq. (IF) :

- The mixer will mix this signal and Produce Signal hawing frequency fs, fo (fo+fs) and (fo-fs) out of these difference Frequency Component i.e (fo-fs) is selected and all other rejected.
- This Freq. is Called intermediate Frequency **IF = (fo-fs)**

If amplifier :

- IF Frequency Signal is amplified by using If amplifier stage.

Amplitude Limiter:

- It is used for avoid the variation on amplified IF signal and produce constant IF signal.

FM detector:

- The amplified If signal is detected by FM detector to recover signal modulating signal.

De-emphesis Circuit:

- it is used for Artificially boosted high freq. signal are brought to their original amplitude.

AF & Power Amplifier :

- This signal is amplified and rise the power level of signal and applied to loudspeaker

Comparison of FM (or PM) to AM

#	Frequency Modulation (FM)	Amplitude Modulation (AM)
1	FM receivers have better noise immunity	AM receivers are very susceptible to noise
2	Noise immunity can be improved by increasing the frequency deviation	No such option exists in AM
3	Bandwidth requirement is greater and depends upon modulation index	Bandwidth is less than FM or PM and doesn't depend upon a modulation index
4	FM (or PM) transmitters and receivers are more complex than for AM	AM transmitters and receivers are less complex than for FM (or PM)
5	All transmitted power is useful so FM is very efficient	Power is wasted in transmitting the carrier and double sidebands in DSB (but DSB-SC addresses this)