Comparison Between FM & AM

Ans. Table 1

S. No.	AM Broadcasting	FM Broadcasting
1.	It requires smaller transmission bandwidth	It requires larger bandwidth.
2.	It can be operated in low, medium and high frequency bands.	It needs to be operted in very high and high frequency bands.
3.	It has wider coverage.	Its range is restricted to 50 km.
4.	The demodulation is simple.	The process of demodulation is complex.
5.	The stereophonic transmission is not possible.	In this, stereophonic transmission is possible.
6.	The system has poor noise performance.	It has an improved noise performance.
7.	The AM signal reception does not have any threshold in the useful range of signal noise ratio (SNR).	The FM signal recepition exhibits a three the useful range of signal noise ratio (SM, SNR value should be higher than the ????

FM generation using VCO

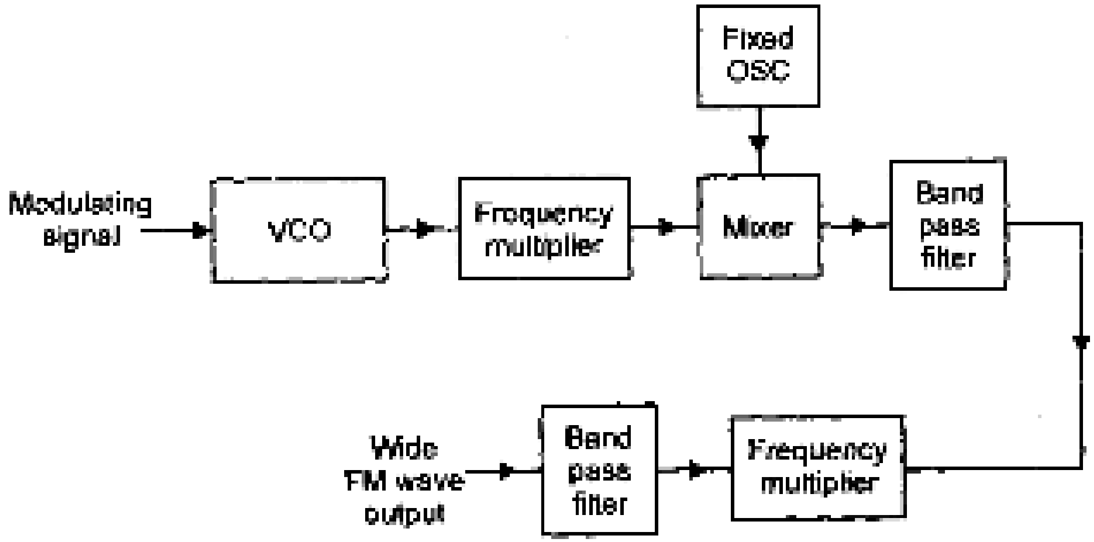


Fig. 2

Reactance Modulator

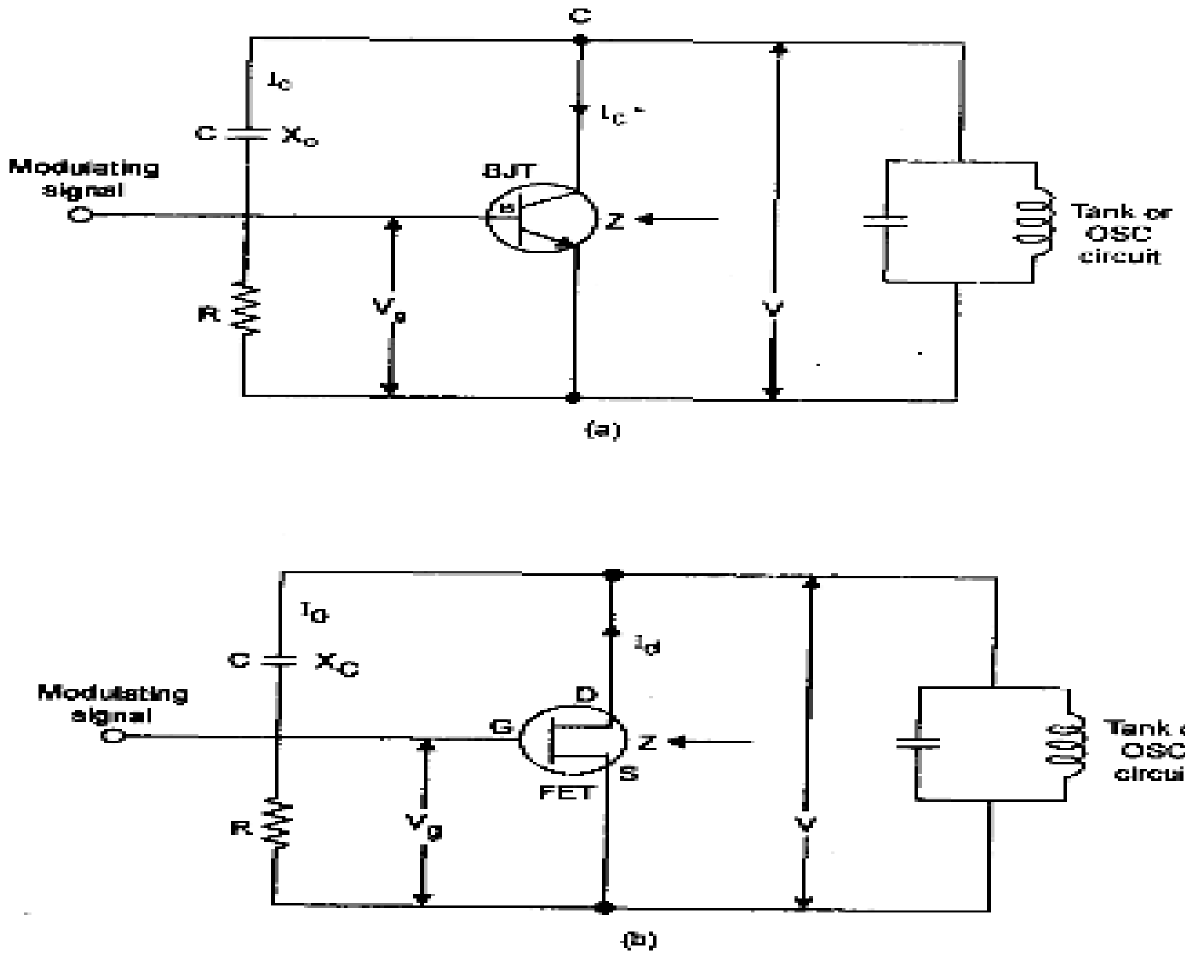


Fig. 4

Varactor Modulator

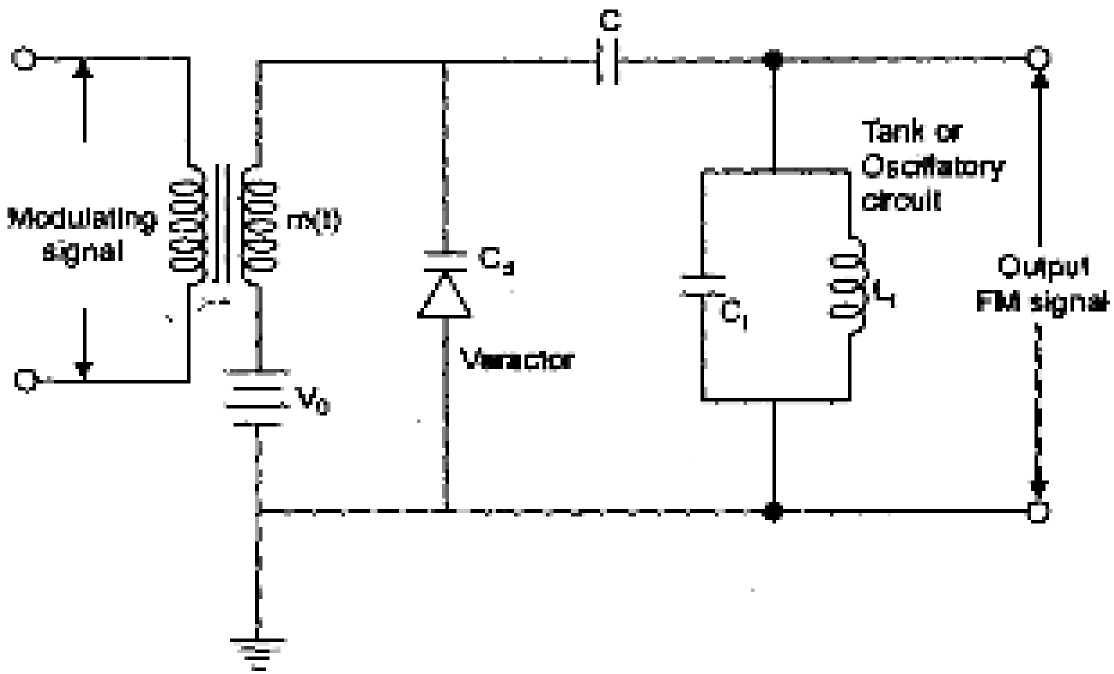


Fig. 5

(*b*) Hence the frequency of oscillation is given by

$$f = \frac{1}{2\pi\sqrt{L_1\left(C_1 + C_d\right)}}$$

Indirect-Armstrong Method

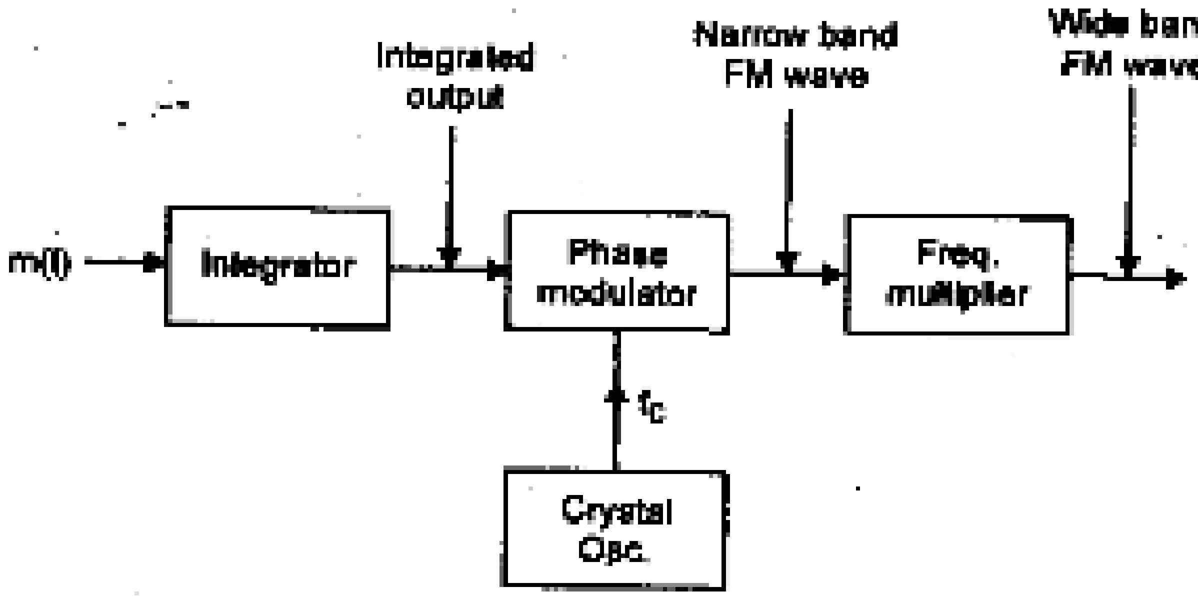


Fig. 9

- **Part 1: Generation of NBFM using phase modulator.**

- **Part 2: Use frequency multiplier & Mixer to obtain required values of frequency deviation, carrier & modulation index.**

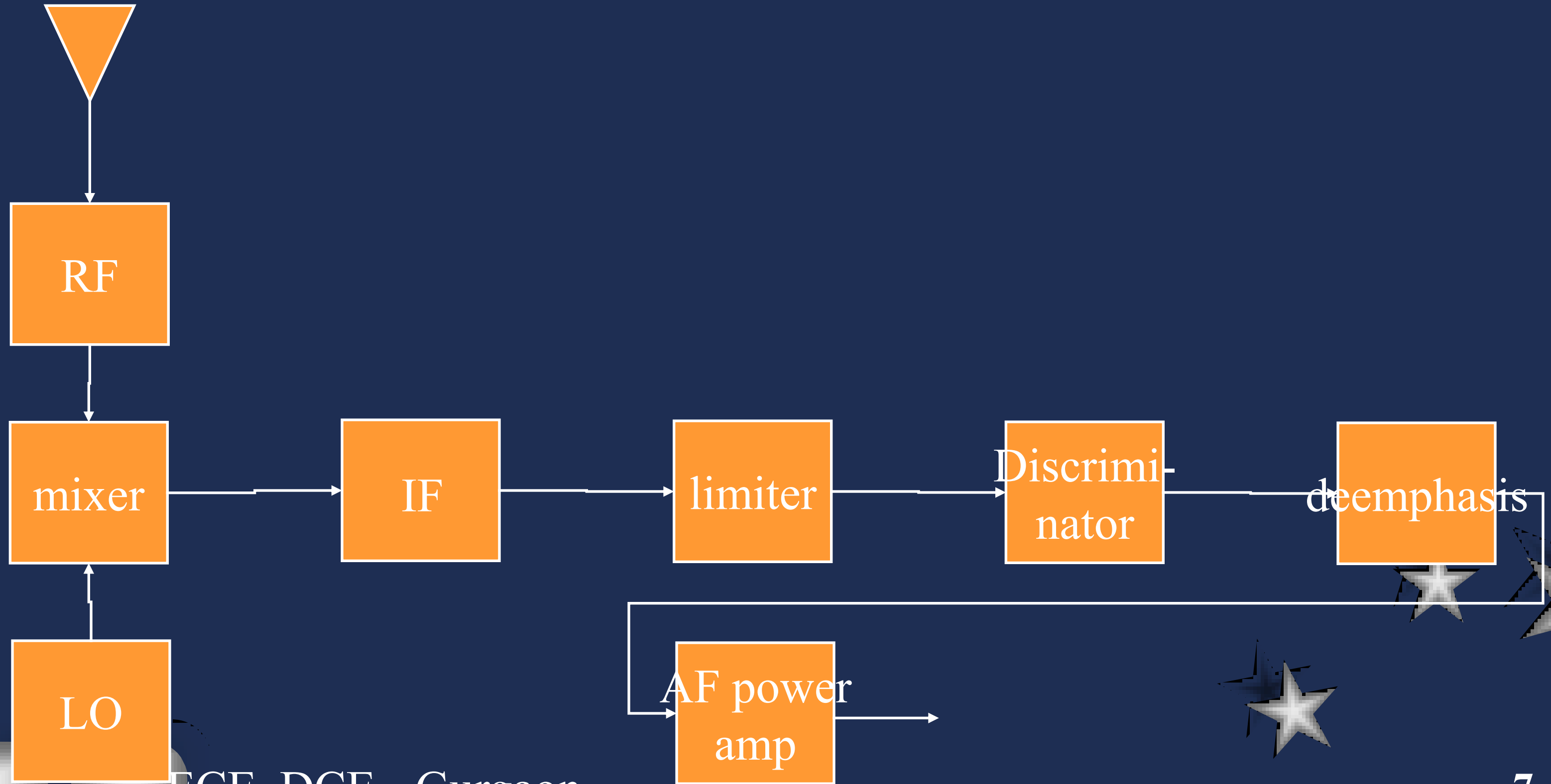
$$e_o(t) = E_c \cos[2\pi f_c t + \beta_1 \sin(2\pi f_m t)]$$

$$e(t) = E_c \cos[2\pi n f_c\, t \times \beta_2 \sin 2\pi f_m t)]$$

where $\beta_2 = n \cdot \beta_1$

FM receiver

- **FM receiver is similar to the superhet layout**



Frequency demodulation

- **Remember that message in an FM signal is in the instantaneous frequency or equivalently derivative of carrier angle**

$$s(t) = A_c \cos\left[2\pi f_c t + 2\pi k_f \int_0^t m(t)dt\right]$$

$$s'(t) = A_c\left[2\pi f_c + 2\pi k_f m(t)\right]\sin\left(2\pi f_c t + 2\pi k_f \int_{-\infty}^{t} m(t)dt\right)$$

Do envelope detection on s'(t)

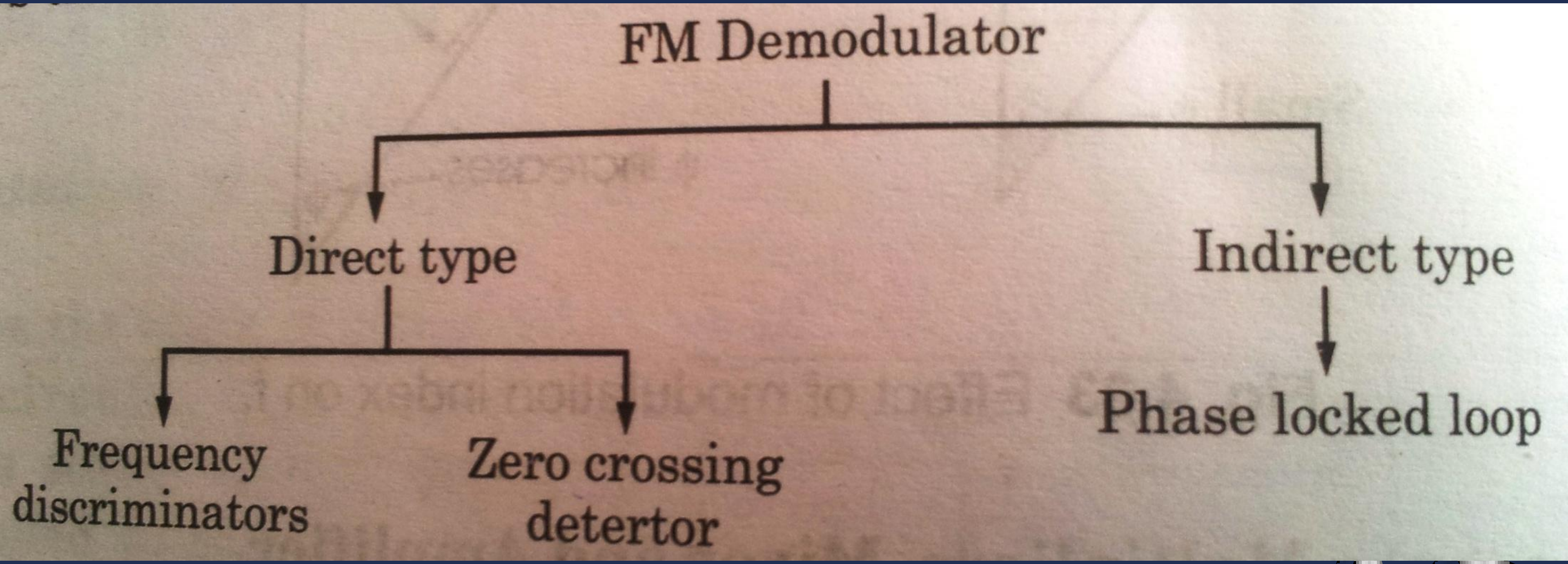
Receiver components:RF amplifier

- AM may skip RF amp but FM requires it
- FM receivers are called upon to work with weak signals (~1μV or less as compared to 30 μV for AM)
- An RF section is needed to bring up the signal to at least 10 to 20 μV before mixing

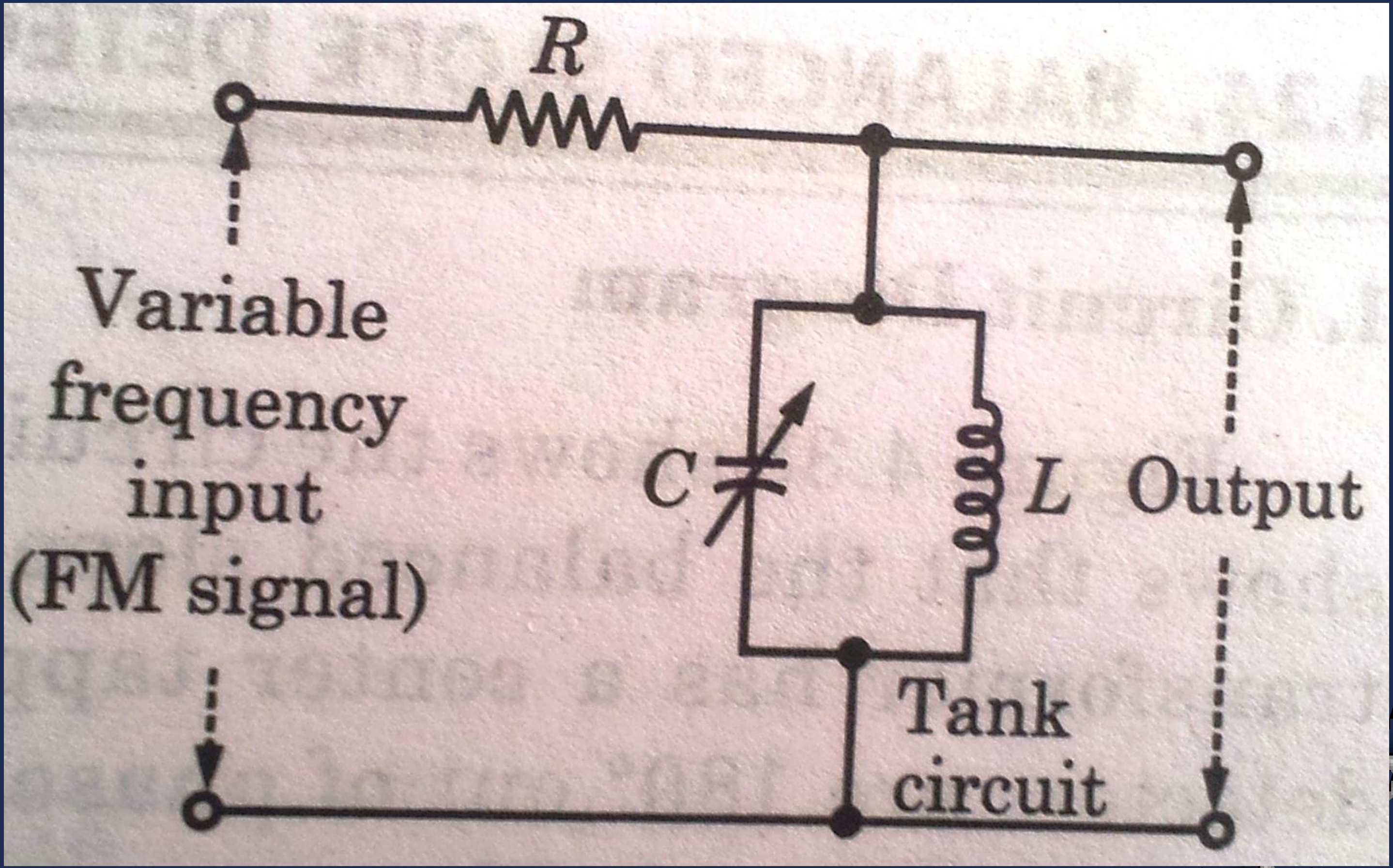
Requirements of FM Demodulator

- It must converts frequency variations into amplitude variations. (means, AM detector is basically a rectifier where FM detector is basically frequency to amplitude converter).
- Conversion must be linear and efficient.
- FM demodulator ckt should be insensitive to amplitude changes. It should respond only to the frequency changes.
- Should no be too critical in its adjustment and operation.

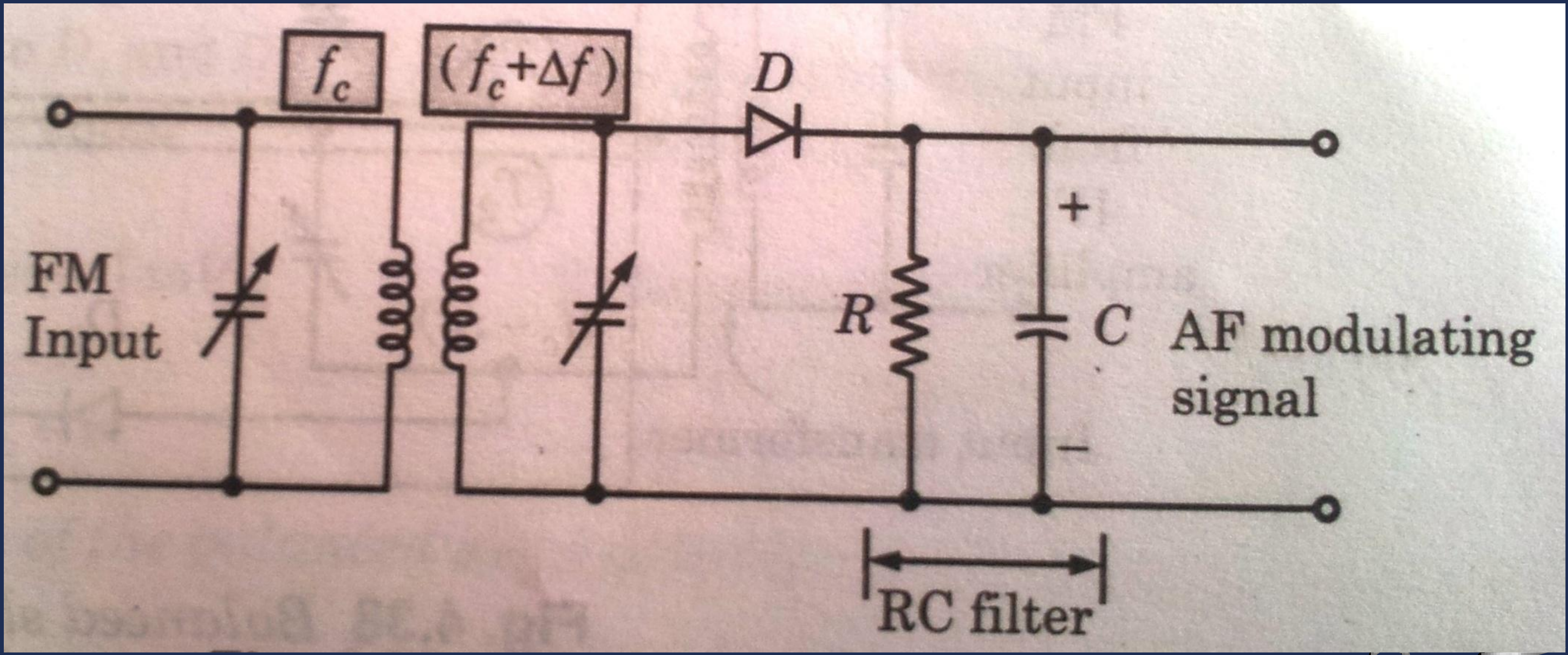
Classification of FM Demodulator



Balanced Frequency Discriminator – PRINCIPLE OF SLOPE DETECTION



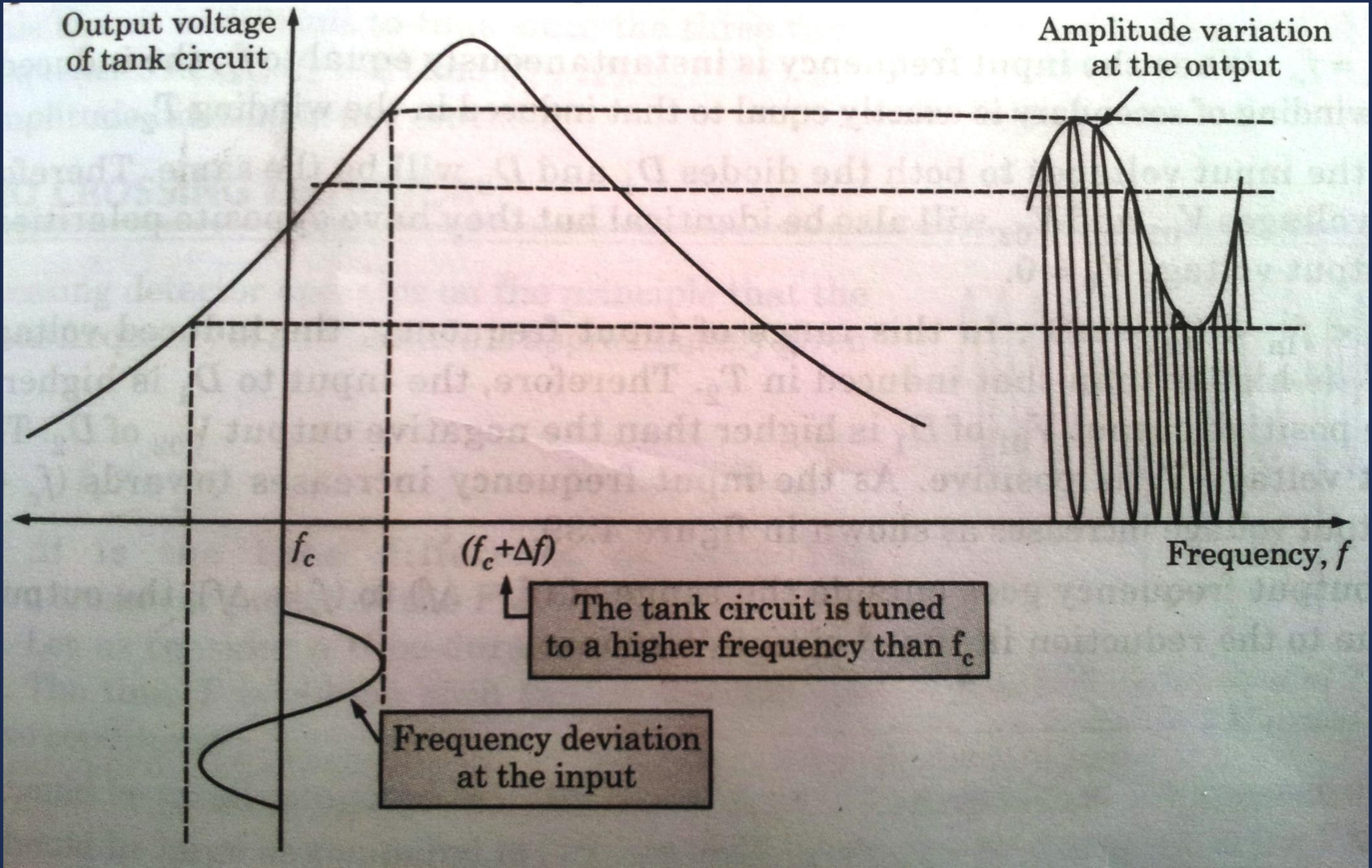
Simple Slope Detector



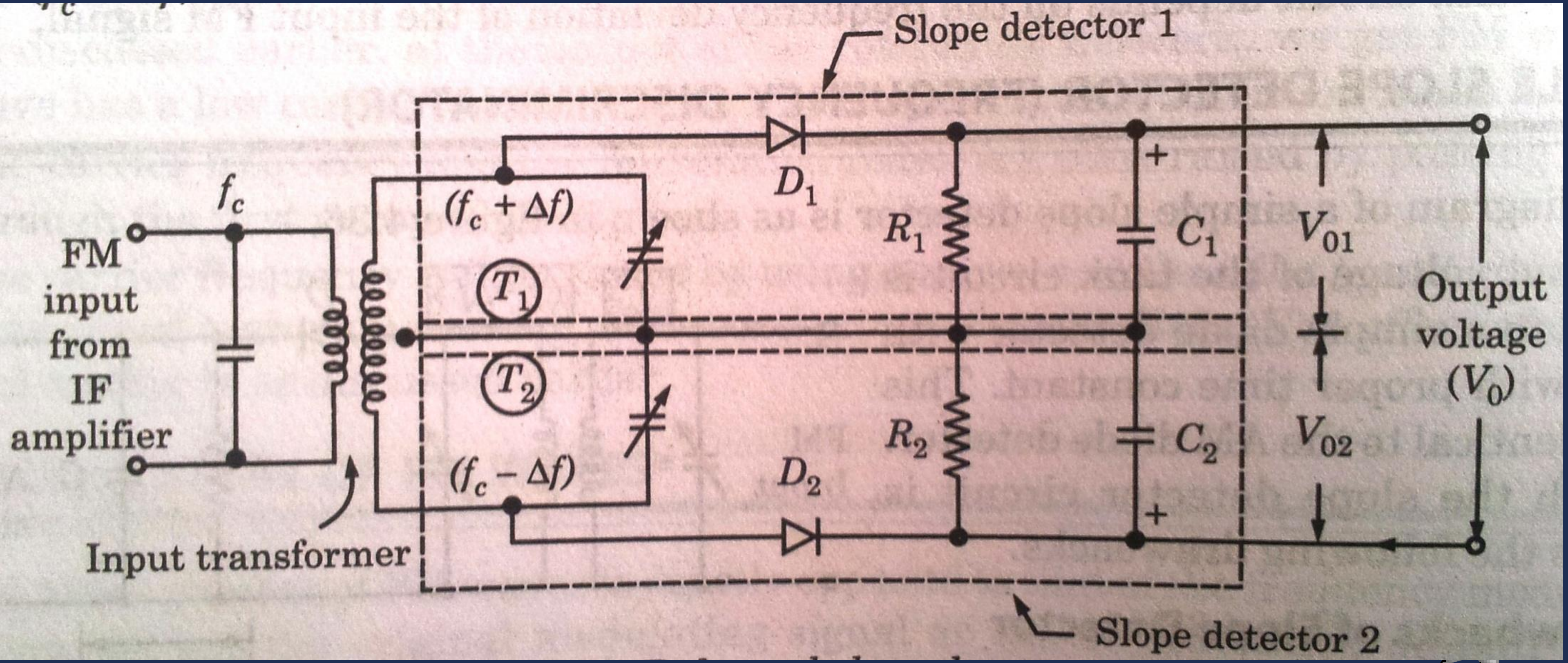
DRAWBACKS

- It is inefficient
- Linear only over a limited frequency range.
- It is difficult to adjust as primary & secondary windings of transformer must be tunned to slightly different frequencies.

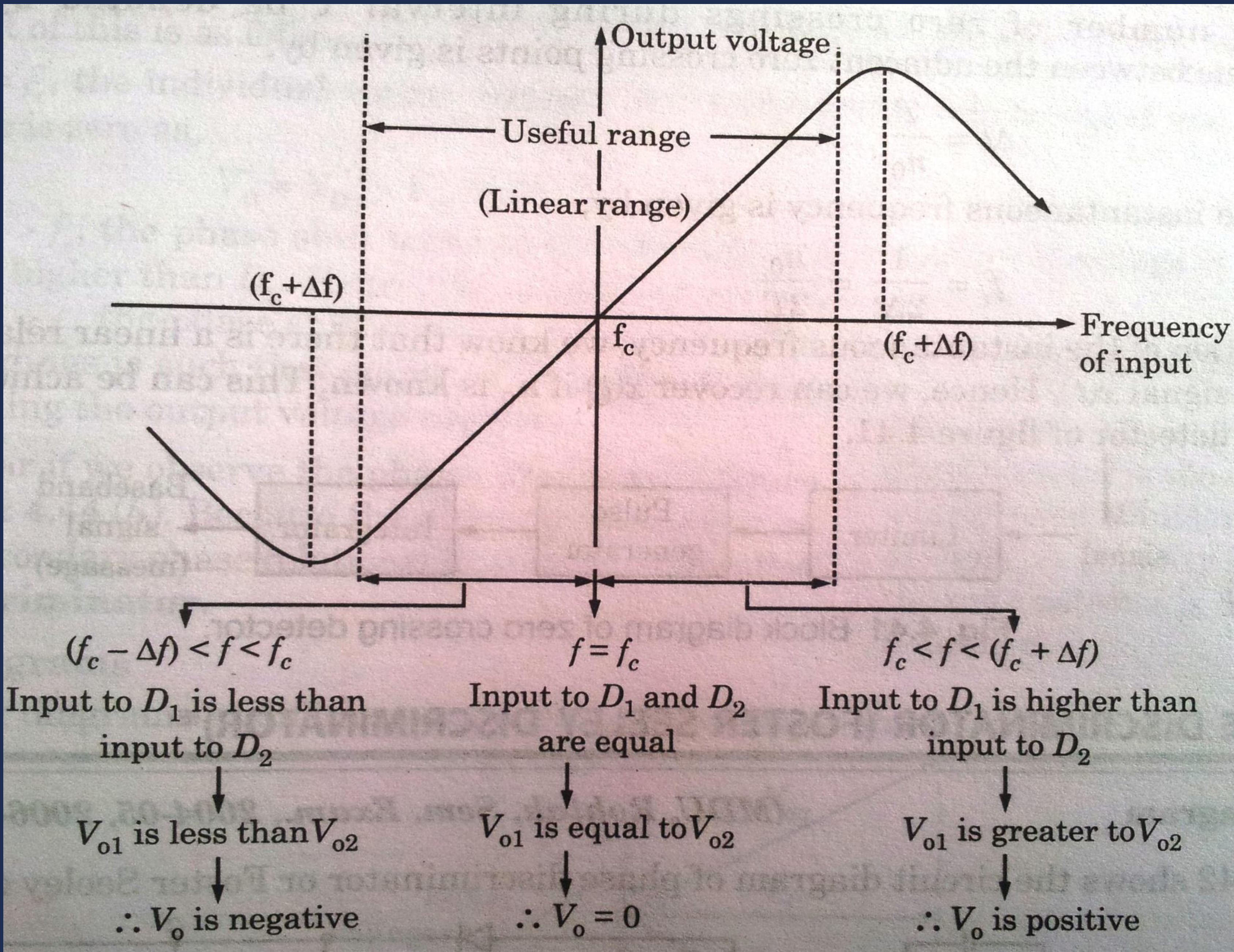
Characteristics of Slope Detector



Balanced Slope Detector



Working operation of circuit



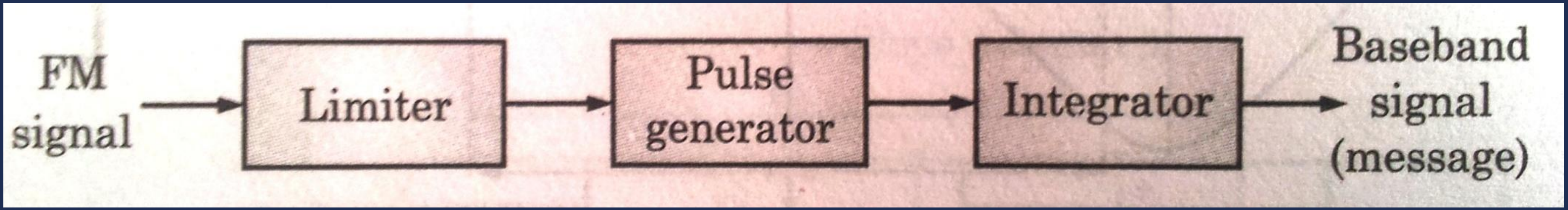
Advantages:

- Ckt Is more efficient than simple slope detector.
- It has better linearity than the simple slope detector.

Drawbacks:

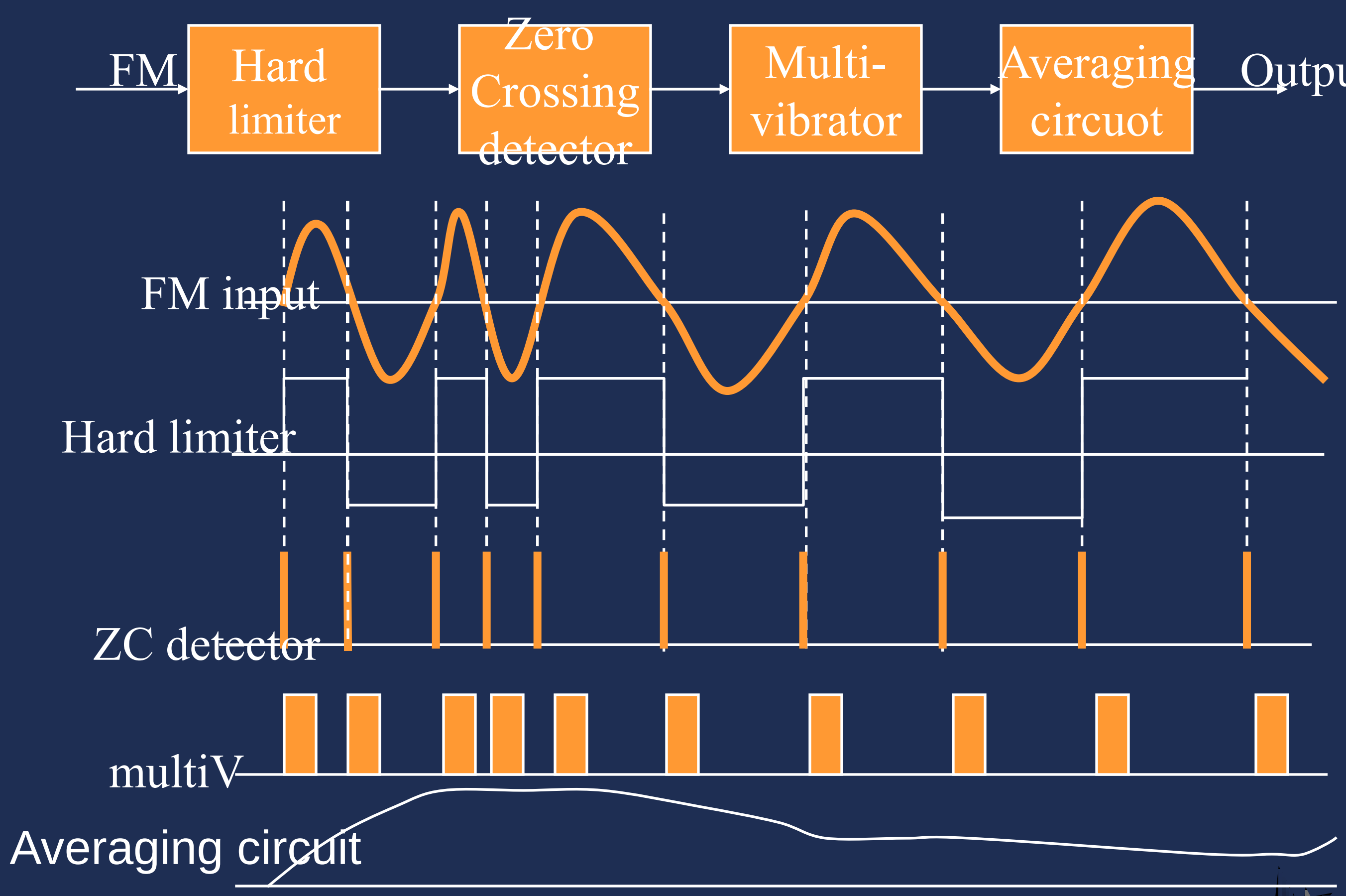
- Event hough linearity is good, it is not good enough.
- Ckt is difficult to tune because of three tunned ckt.
- Amplitude limiting is not provided.

Zero Crossing Detector



- This operates on the principle that the instantaneous frequency of an FM wave is approximated to 1/2 t.
- Where, delta ‘t’ is the time difference b/w the adjacent zero cross over points of the FM wave.

Zero crossing detector



more frequent ZC's means higher inst freq in turn means Larger message amplitudes

Limiter

- A limiter is a circuit whose output is constant for all input amplitudes above a threshold
- Limiter's function in an FM receiver is to remove unwanted amplitude variations of the FM signal

Limiting and sensitivity

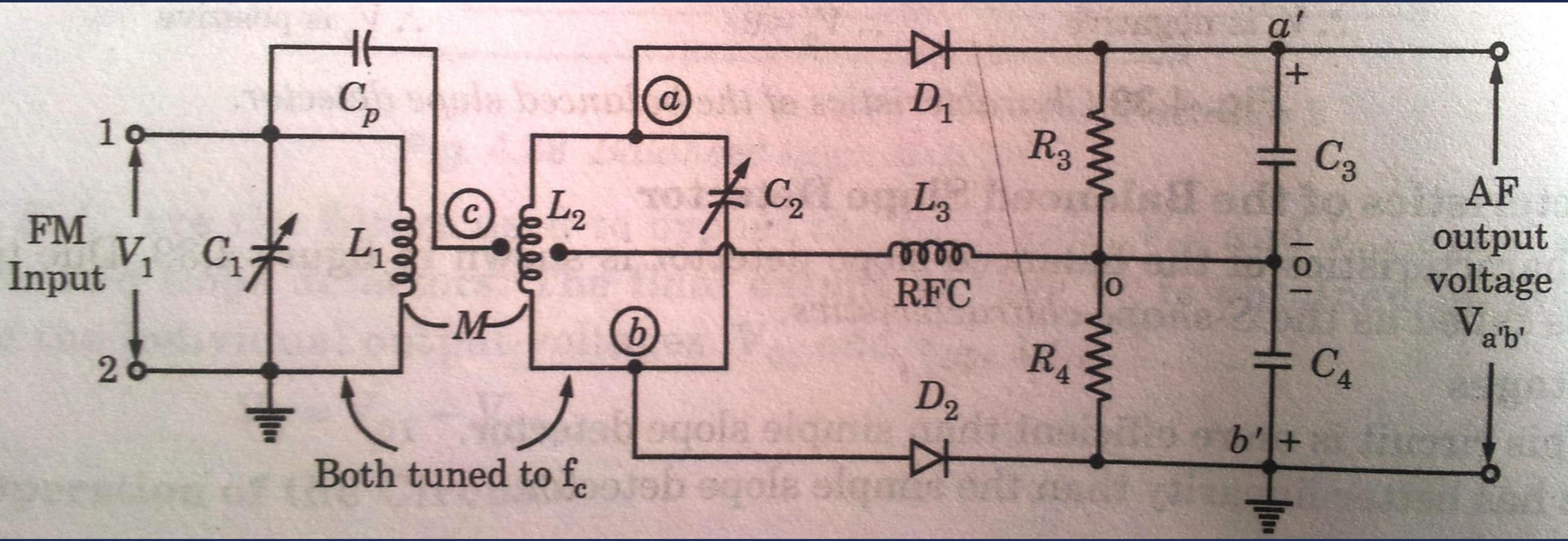
- **A limiter needs about 1V of signal, called *quieting* or *threshold* voltage, to begin limiting**
- **When enough signal arrives at the receiver to start limiting action, the set quiets, i.e. background noise disappears**
- **Sensitivity is the min. RF signal to produce a specified level of quieting, normally**

Sensitivity example

- An FM receiver provides a voltage gain of 200,000(106dB) prior to its limiter. The limiter’s quieting voltage is 200 mV. What is the receiver’s sensitivity?
- What we are really asking is the required signal at RF’s input to produce 200 mV at the output

  ➡ 200 mV/200,000= 1μV->sensitivity

Phase Discriminator (Foster Seeley Discriminator)



Principle of operation: With phasor

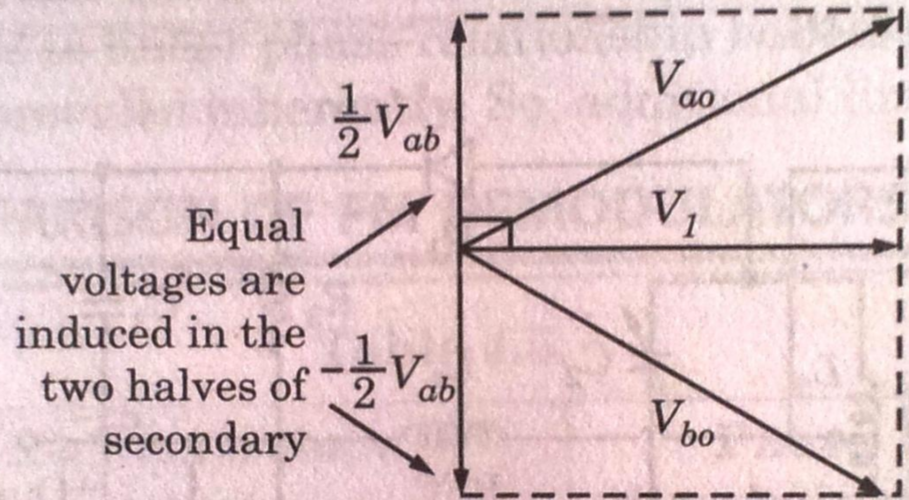
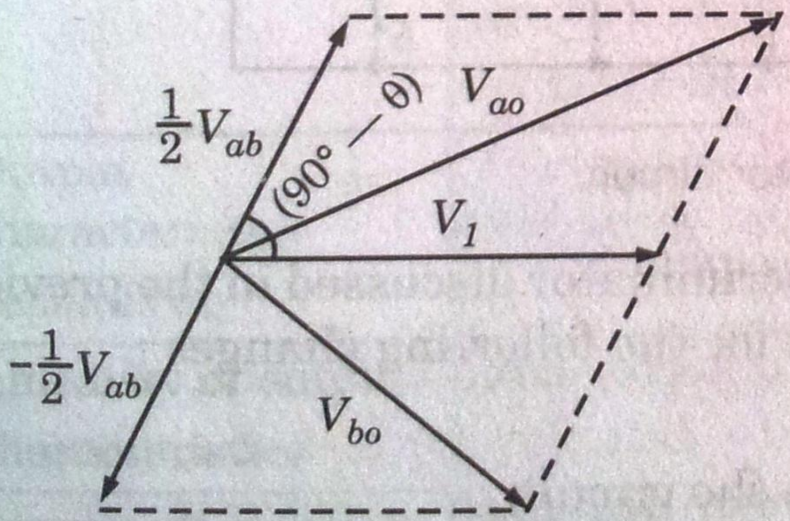
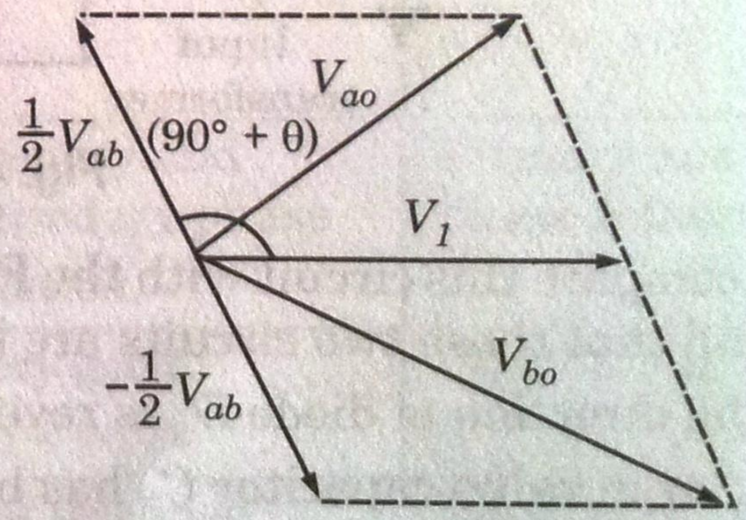


Fig. 4.43 *Relation between primary and secondary.*

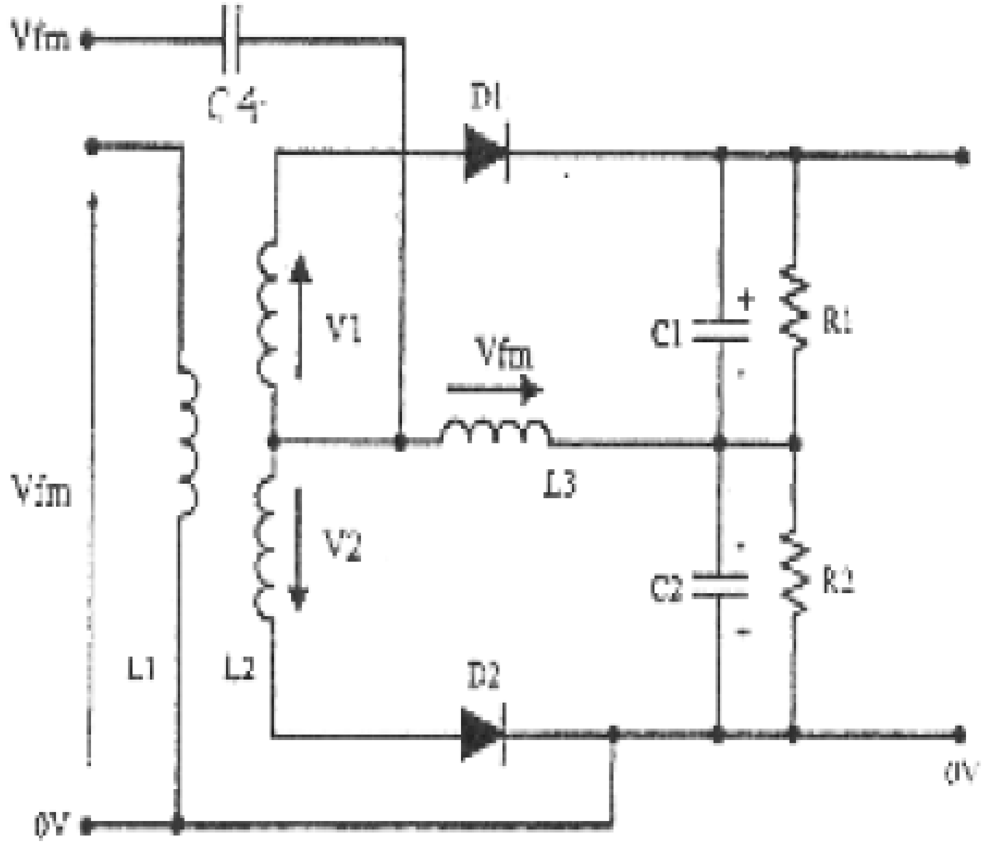


(a) Secondary equivalent circuit

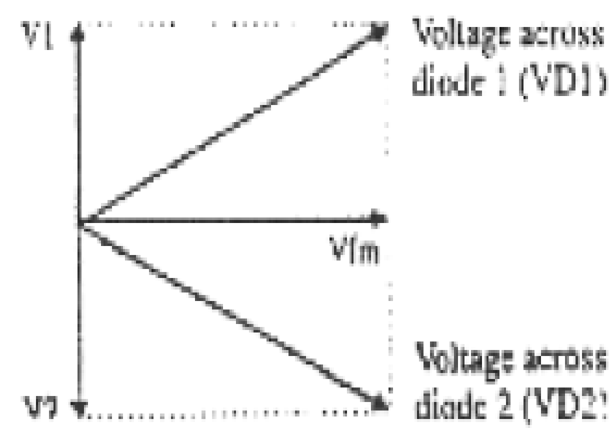


(b) Phasor diagram for $f_{in} = f_c$

Foster-Seeley Discriminator

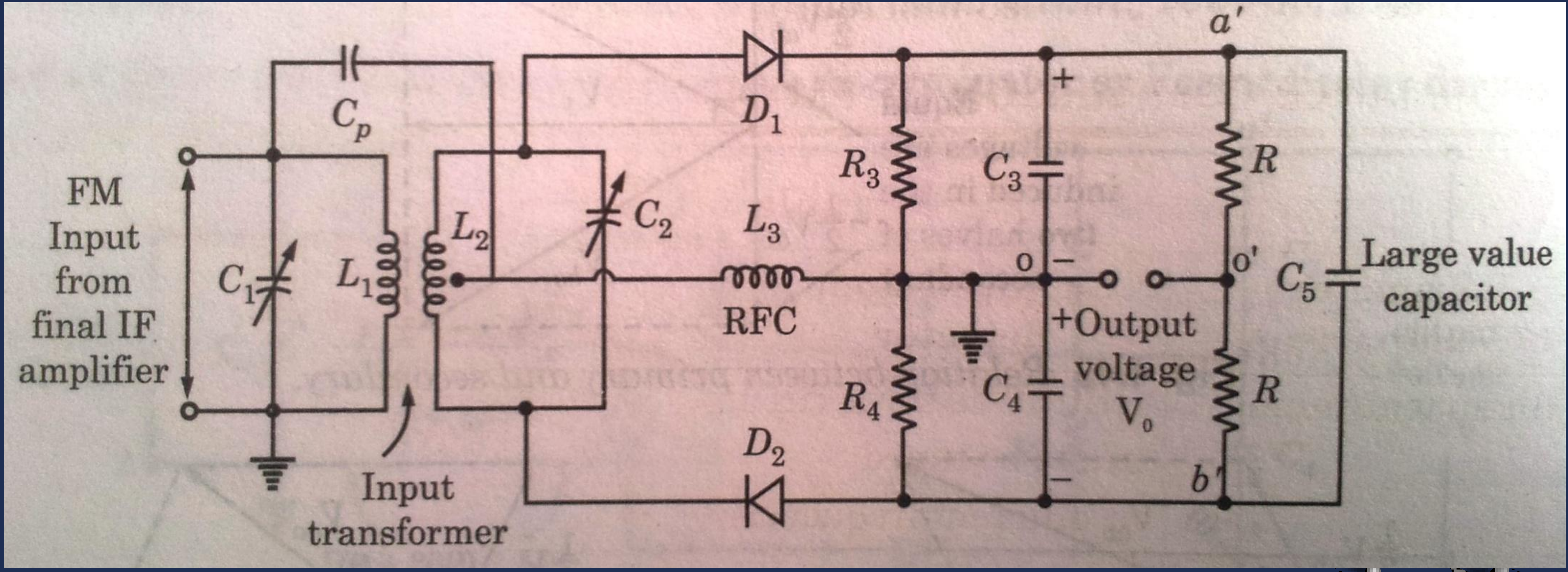


Circuit diagram



Phasor diagram

Ratio Detector

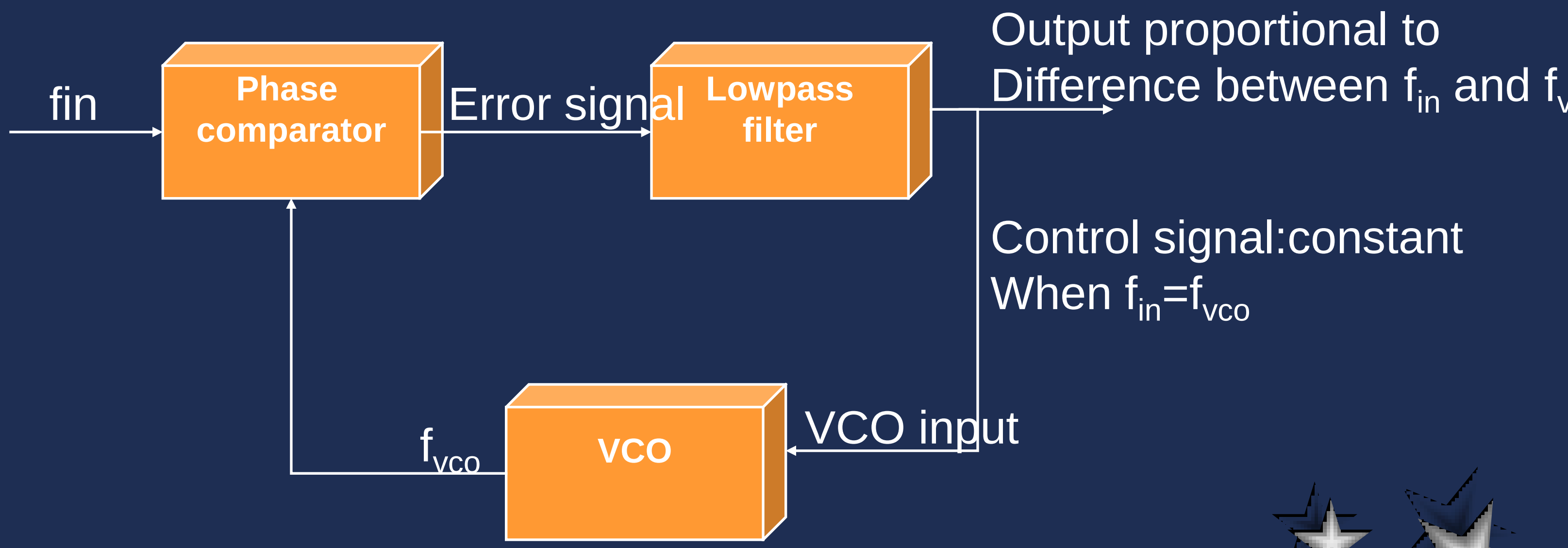


Advantages of Ratio Detector

- Easy to align
- Very good linearity, because of the linear phase relation between primary and secondary.
- Amplitude limiting is provided inherently , so additional limiter is not required.

Phase-Locked Loop

- **PLL's are increasingly used as FM demodulators and appear at IF output**



PLL states

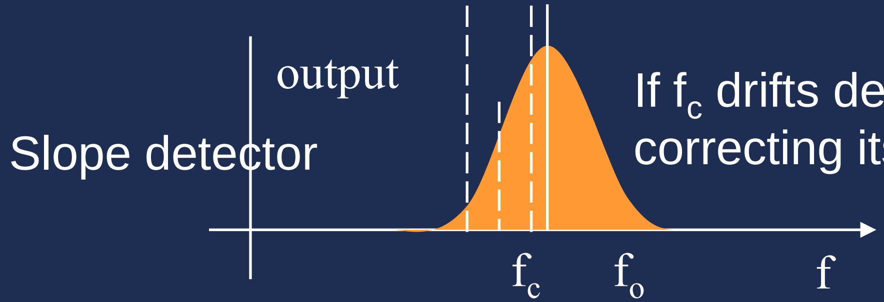
- **Free-running**
  - If the input and VCO frequency are too far apart, PLL free-runs
- **Capture**
  - Once VCO closes in on the input frequency, PLL is said to be in the tracking or capture mode
- **Locked or tracking**
  - Can stay locked over a wider range than was necessary for capture

PLL example

- **VCO free-runs at 10 MHZ. VCO does not change frequency until the input is within 50 KHZ.**
- **In the tracking mode, VCO follows the input to ±200 KHz of 10 MHz before losing lock. What is the lock and capture range?**
  - Capture range= 2x50KHz=100 KHz
  - Lock range=2x200 KHz=400 KHz

Advantages of PLL

- If there is a carrier center frequency or LO frequency drift, conventional detectors will be untuned
- PLL, on the other hand, can correct itself. PLL's need no tuned circuits



If f_c drifts detector has no way of correcting itself