Analog Communication Systems
EC-413-F

Lecture no 2

Topics to be covered

- FM modulation
- VCO

Q

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

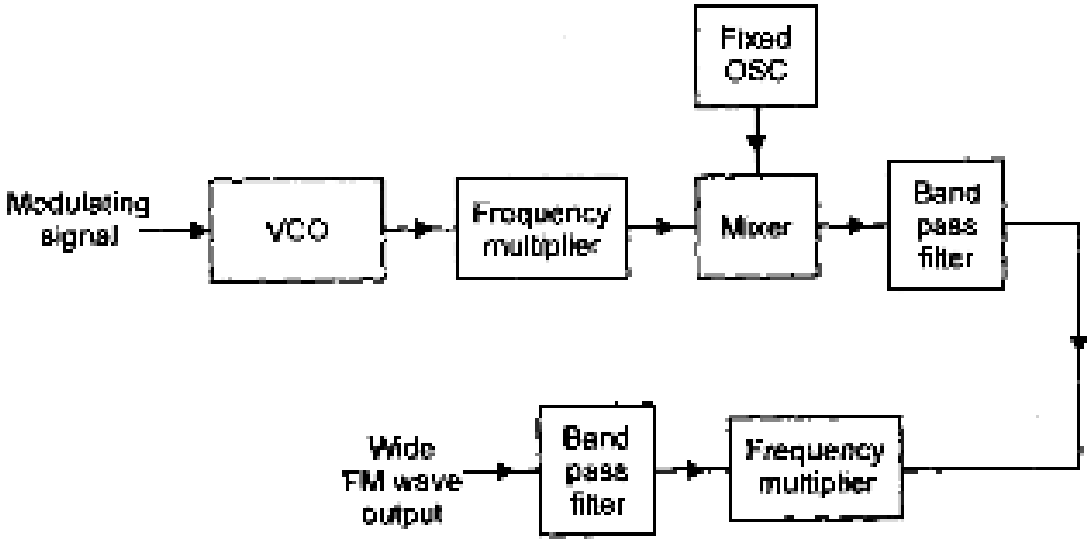
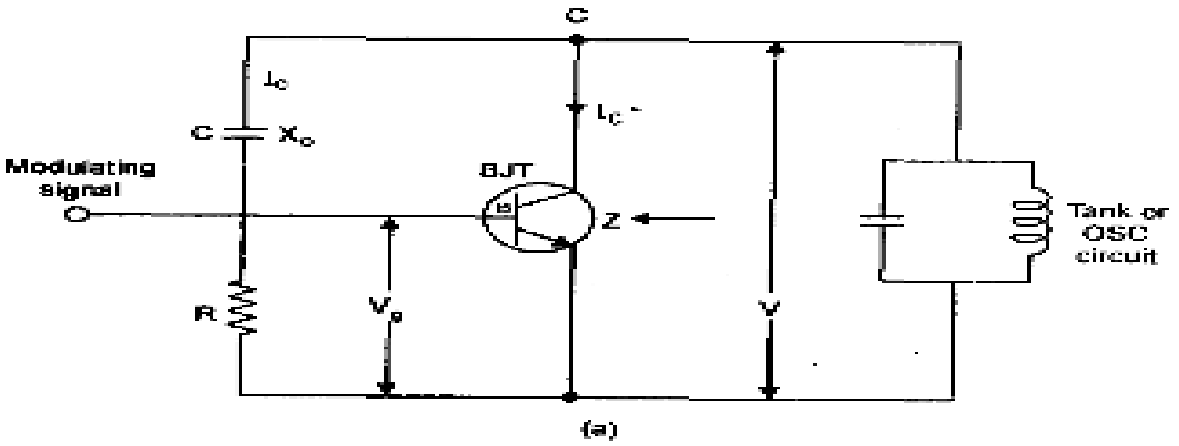


Fig. 2


C
I_C
C X_C
I_C
Modulating signal
BJT
B
Z
Tank or OSC circuit
R
V_e
V
(a)

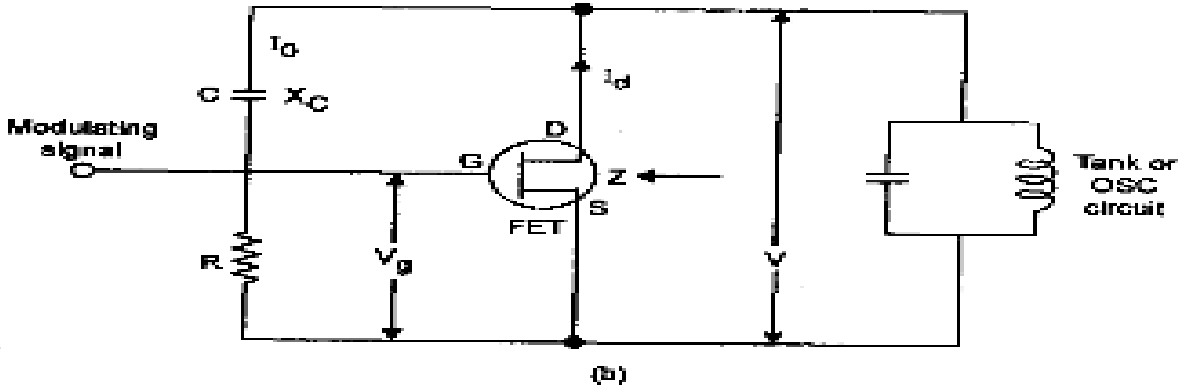

I_G
C X_C
I_d
Modulating signal
D
G
Z
S
FET
Tank or OSC circuit
R
V_g
V
(b)

Fig. 4

Varactor Modulator

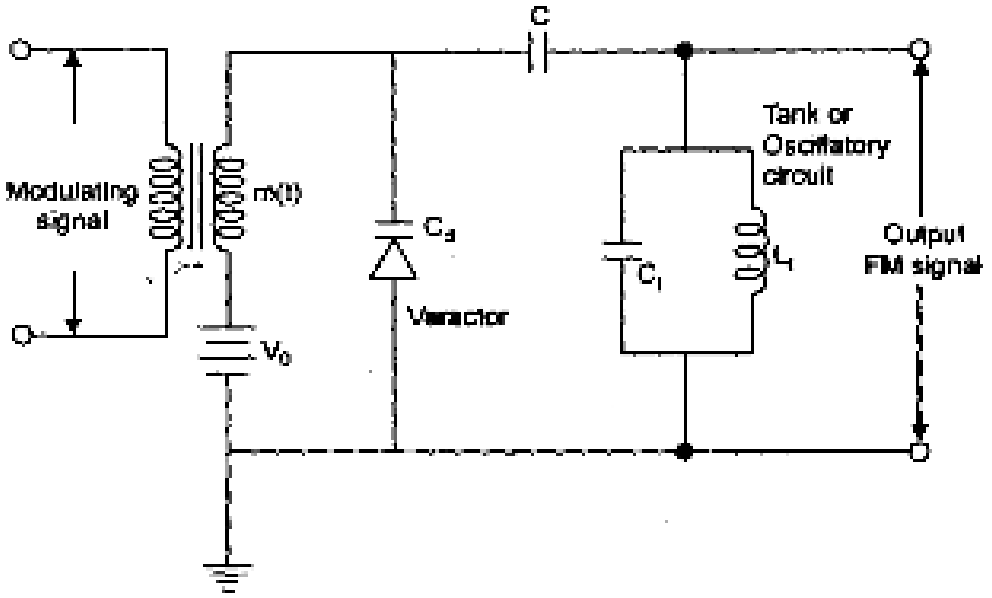


Fig. 5

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

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

Indirect-Armstrong Method

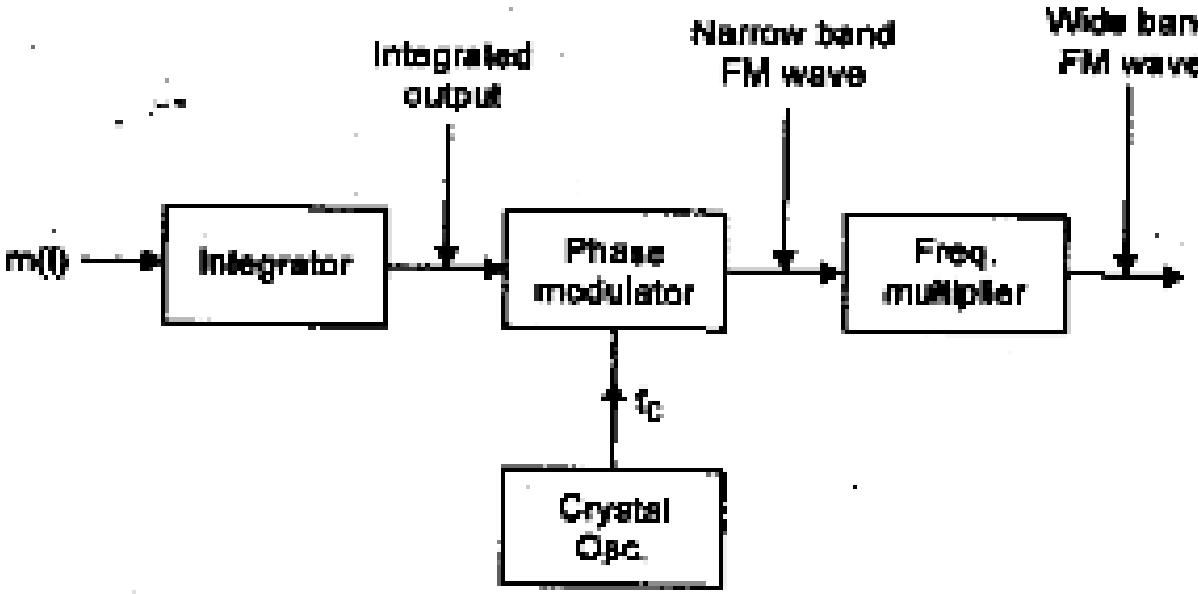


Fig. 9

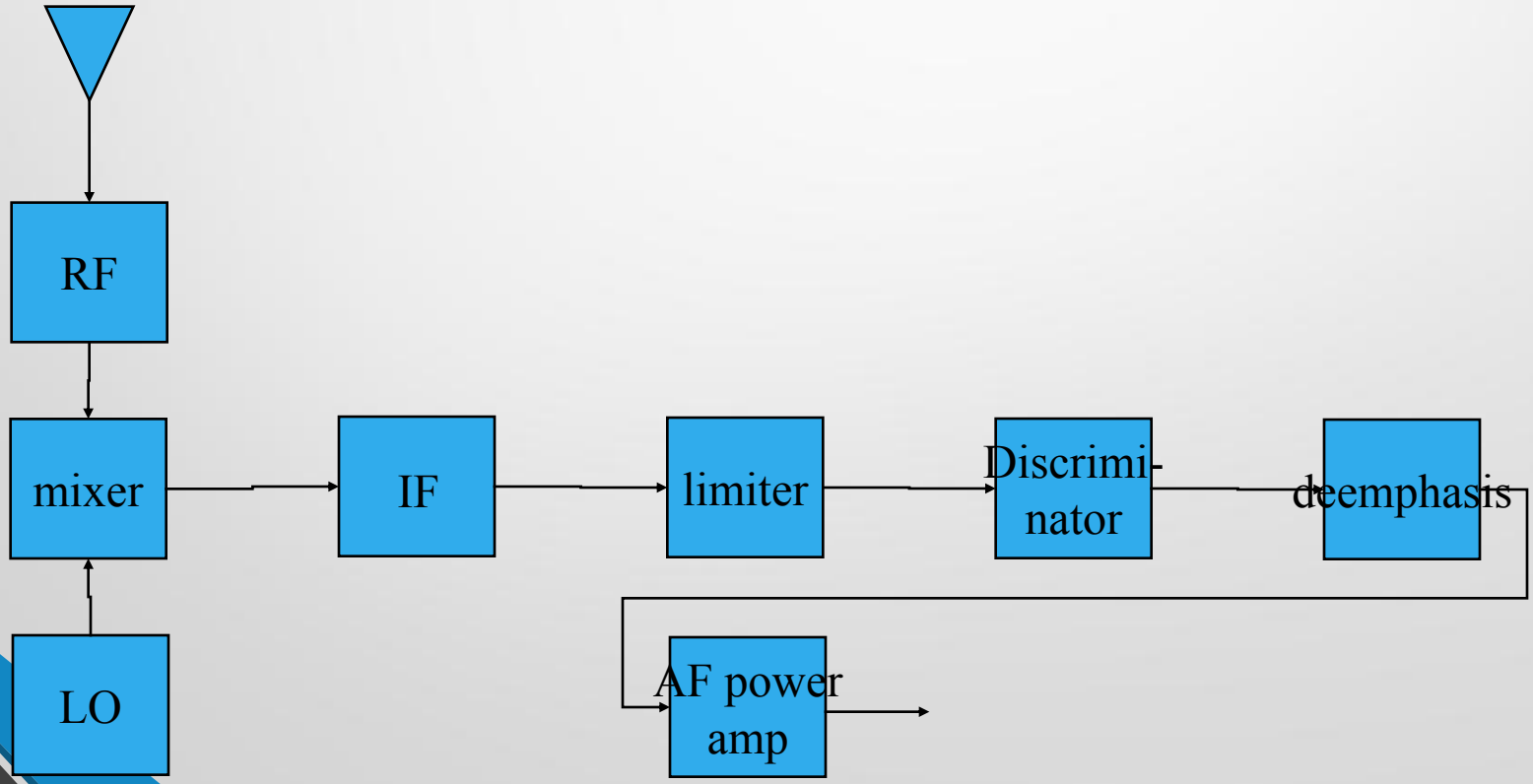
$$e_0(t) = E_c \cos [2\pi f_c t + \beta_1 \sin (2\pi f_m t)]$$

where

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

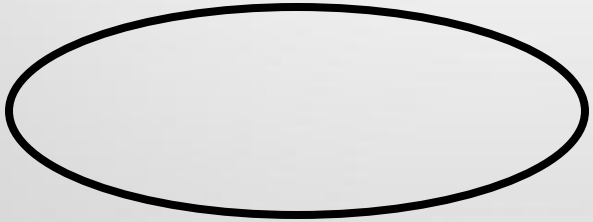
$$\beta_2 = n . \beta_1$$

FM receiver


RF
mixer
IF
limiter
Discrimi-
nator
deemphasis
LO
AF power
amp

Frequency demodulation

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



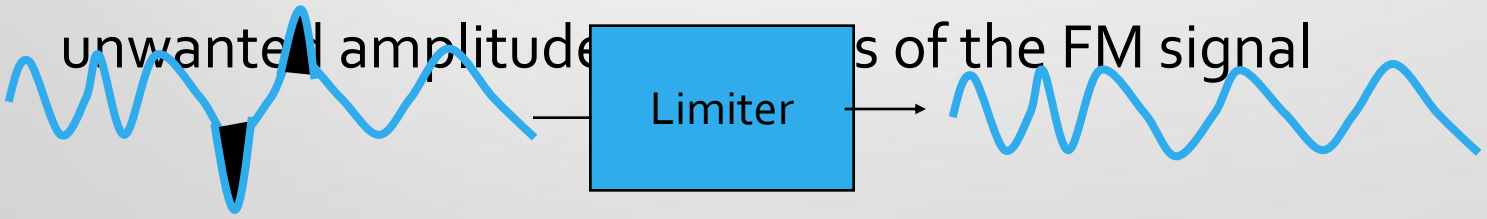
Do envelope detection on s’(t)

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

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

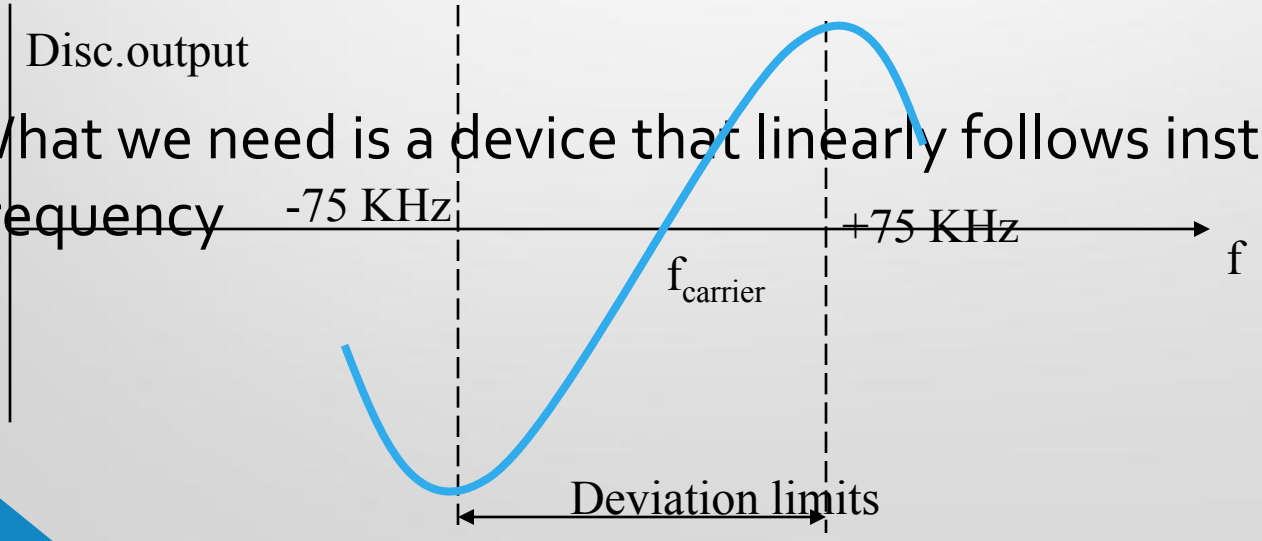
200 mV/200,000= 1μV->sensitivity

Discriminator

$$f_i(t)=f_c+k_f m(t)$$

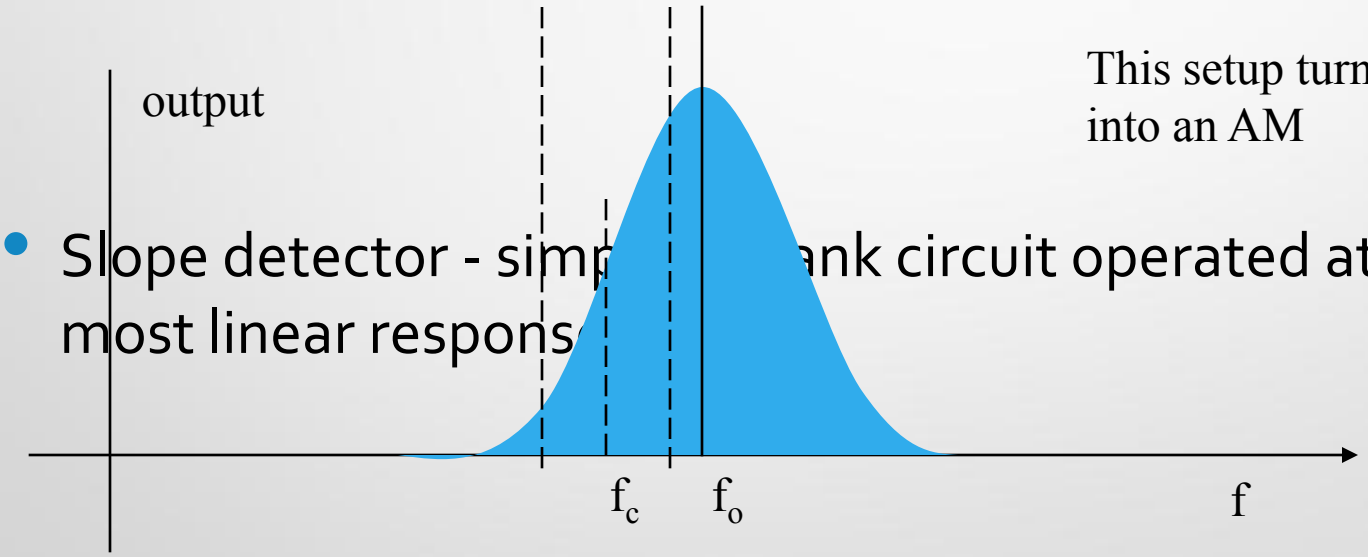
- The heart of FM is this relationship

$f_{carrier}$ is at the IF frequency Of 10.7 MHz



- What we need is a device that linearly follows inst. frequency

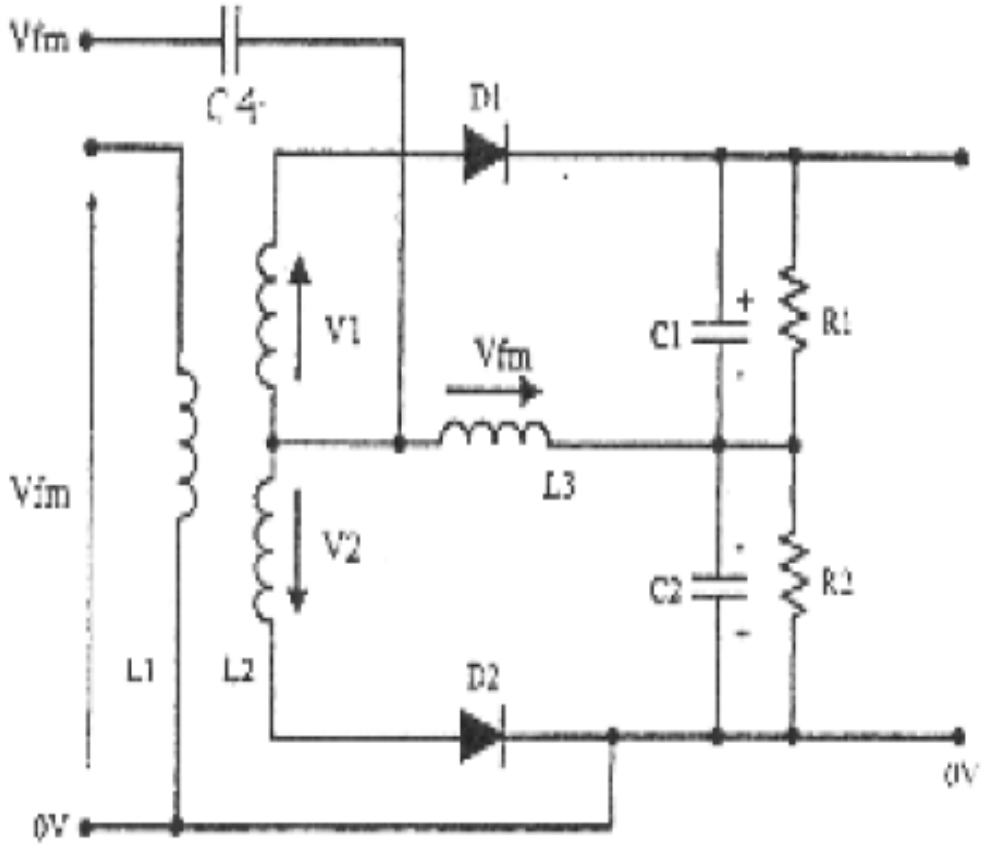
Examples of discriminators



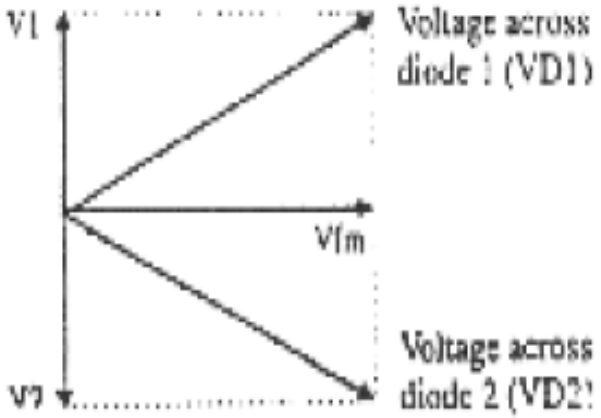
This setup turns an FM signal into an AM

- Slope detector - simp[illegible]ank circuit operated at its most linear respons[illegible]

Foster-Seeley Discriminator

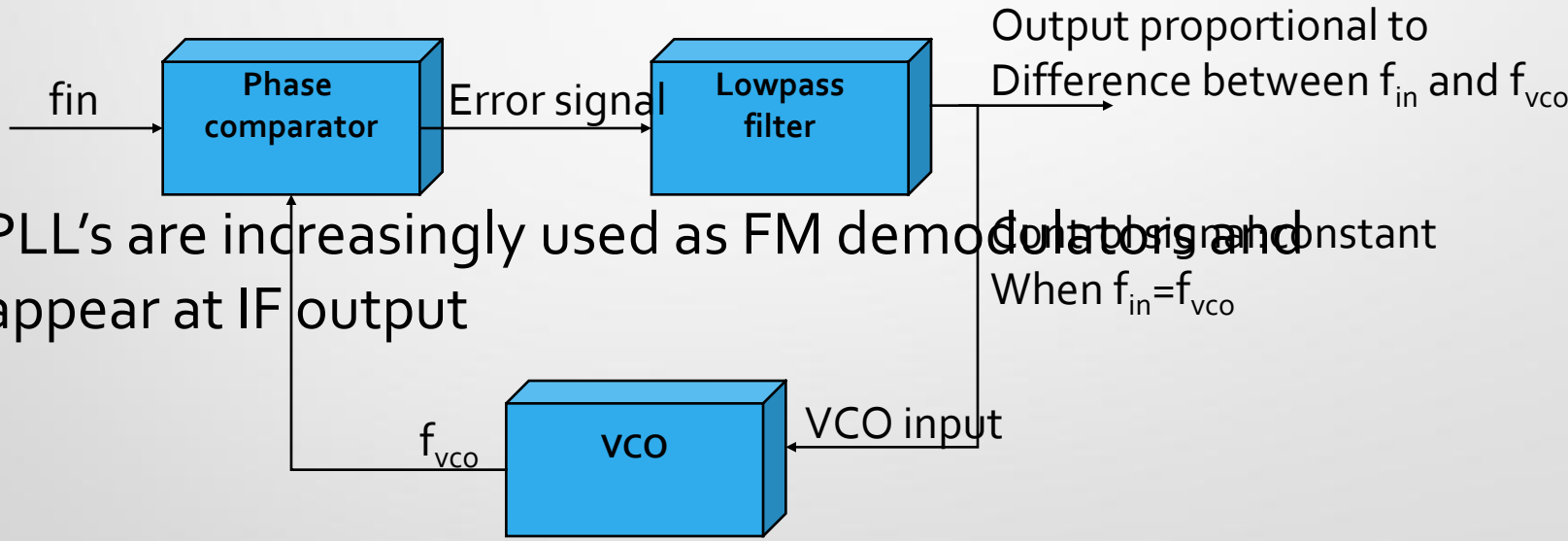


Circuit diagram



Phasor diagram

Phase-Locked Loop



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

PLL states

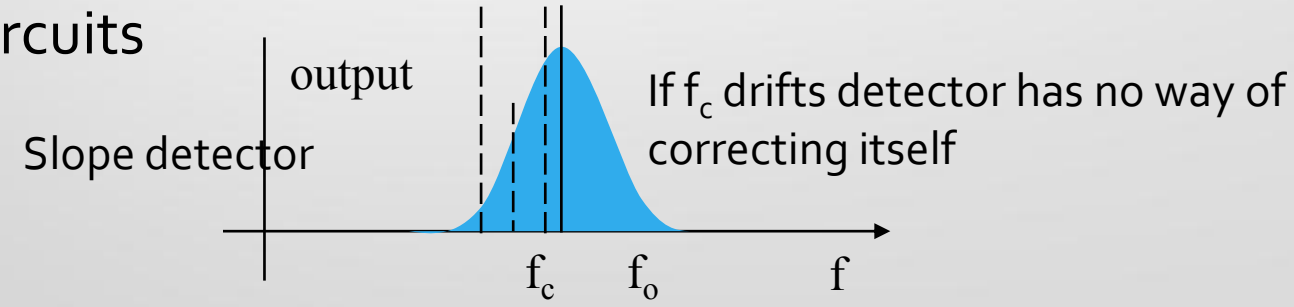
- Free-running
  - If the input and VCO frequency are too far apart, PLL free-runs
- Capture
  - Once VCO closes in on the input frequency, PLL is said to be in the tracking or capture mode
- Locked or tracking
  - Can stay locked over a wider range than was necessary for capture

PLL example

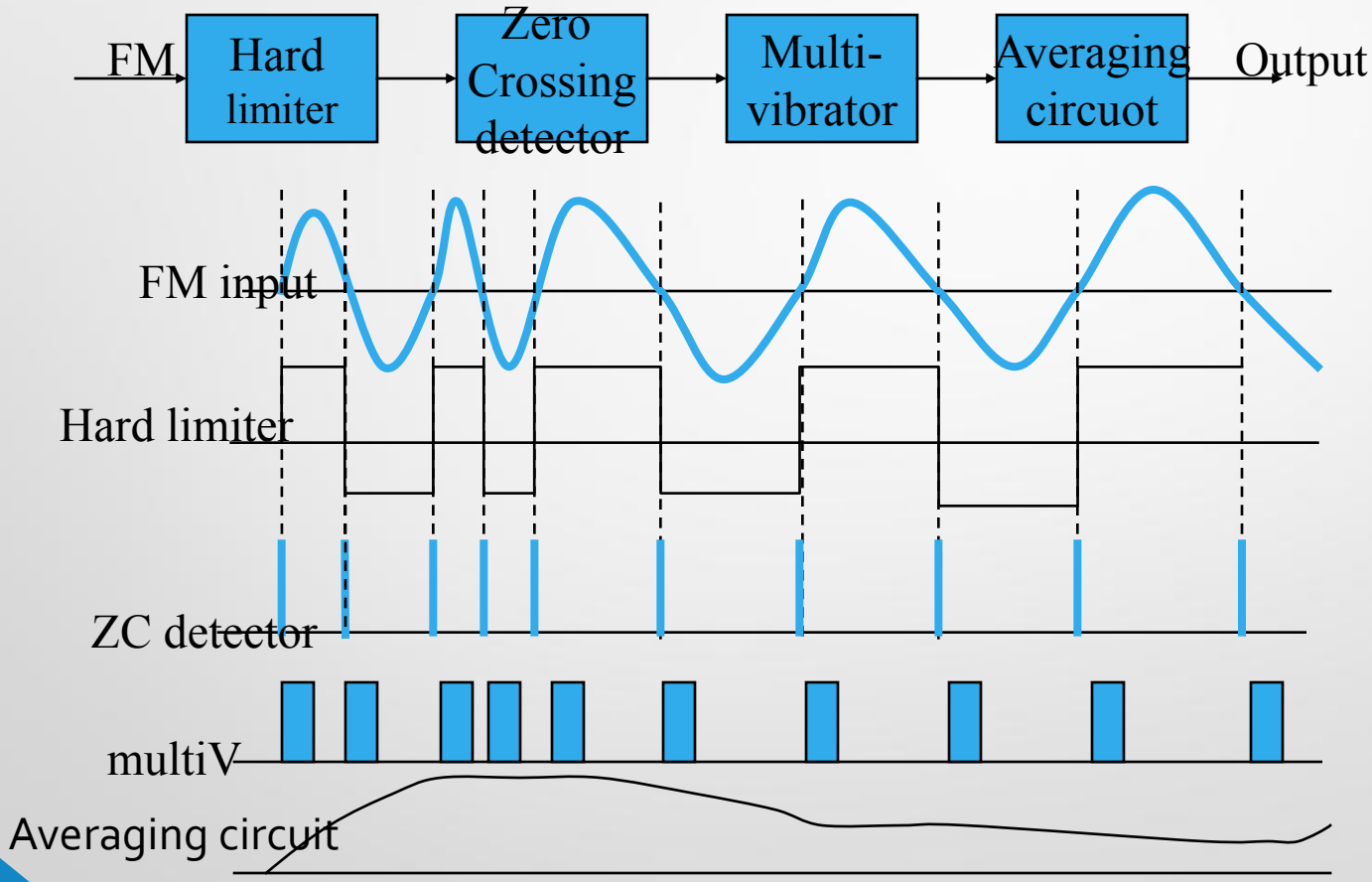
- VCO free-runs at 10 MHZ. VCO does not change frequency until the input is within 50 KHZ.
- In the tracking mode, VCO follows the input to ±200 KHz of 10 MHz before losing lock. What is the lock and capture range?
  - Capture range= 2x50KHz=100 KHz
  - Lock range=2x200 KHz=400 KHz

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



Zero crossing detector



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