

FM Generation

Staff: Dr. R.Kalidoss



Objective

1. To discuss about FM generation using direct and Indirect Method



They are two basic methods of generating frequency Modulated signals

- Direct Method(VCO)
- Indirect Method

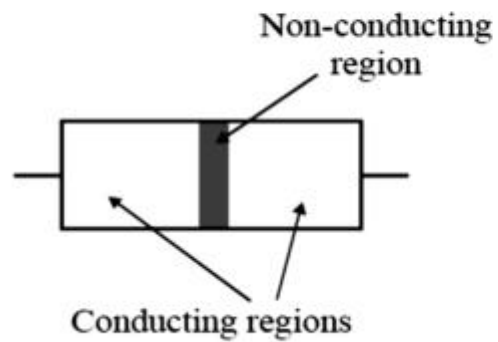


Direct Method(VCO)

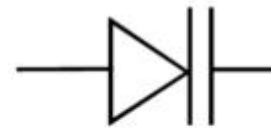
- A frequency modulator is a circuit that varies carrier frequency in accordance with the modulating signal
- The carrier is generated by **LC or crystal oscillator** circuits.
- In LC oscillators, the carrier frequency can be changed by **varying** either the **inductance or capacitance**
- the objective is to find a circuit or component whose capacitance will change in response to the modulating signal
- The component most frequently used for this purpose is a **varactor**.



Varactor diode



$$c = \epsilon A / d$$



Symbol

Low voltage applied



Narrow non-conducting region



- more capacitance.

Increased voltage applied

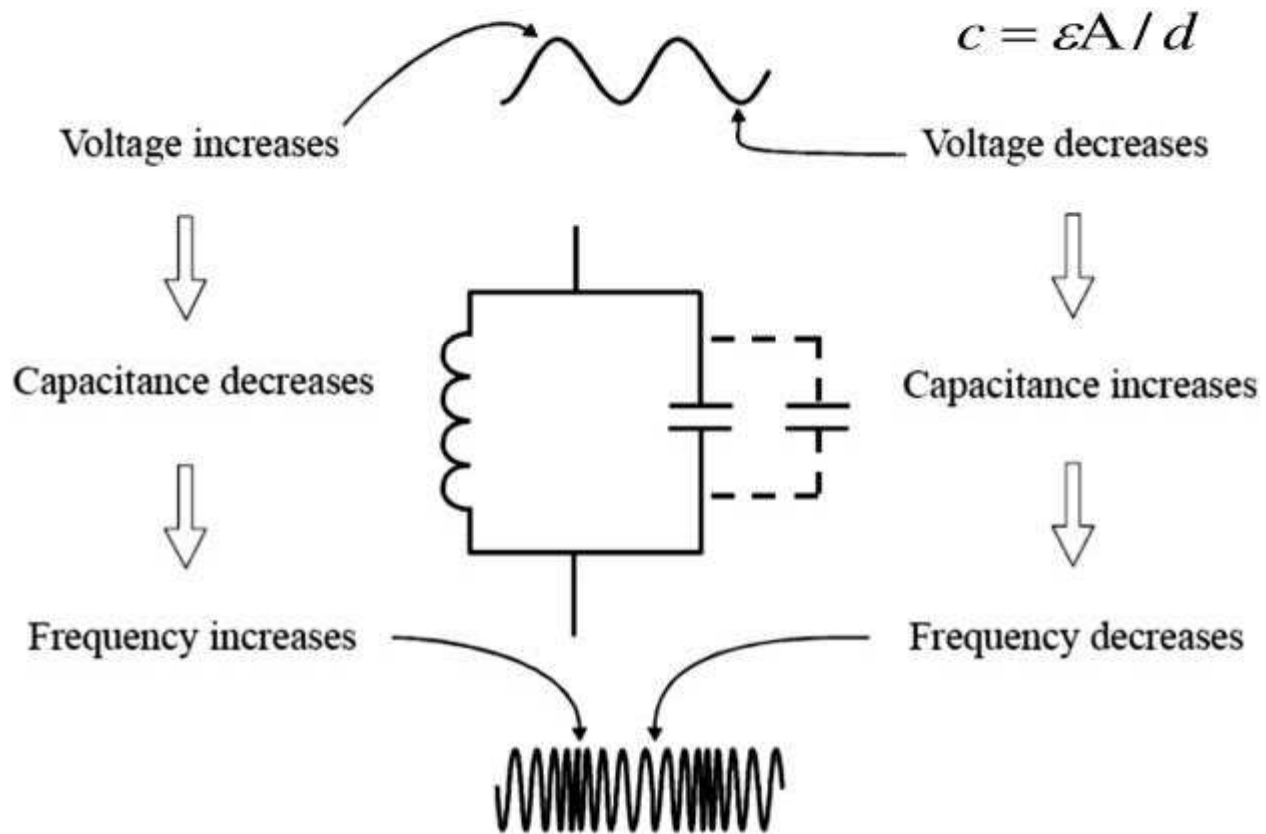


Wider non-conducting region

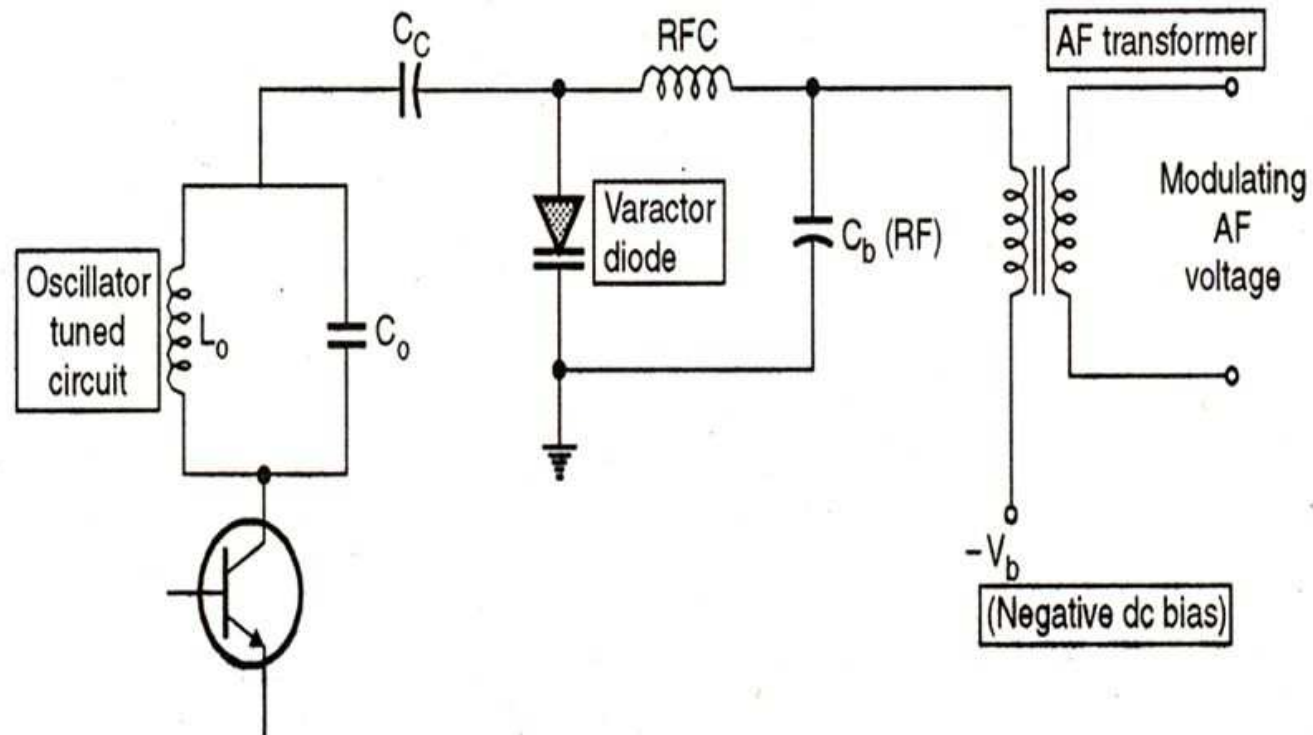


- less capacitance.

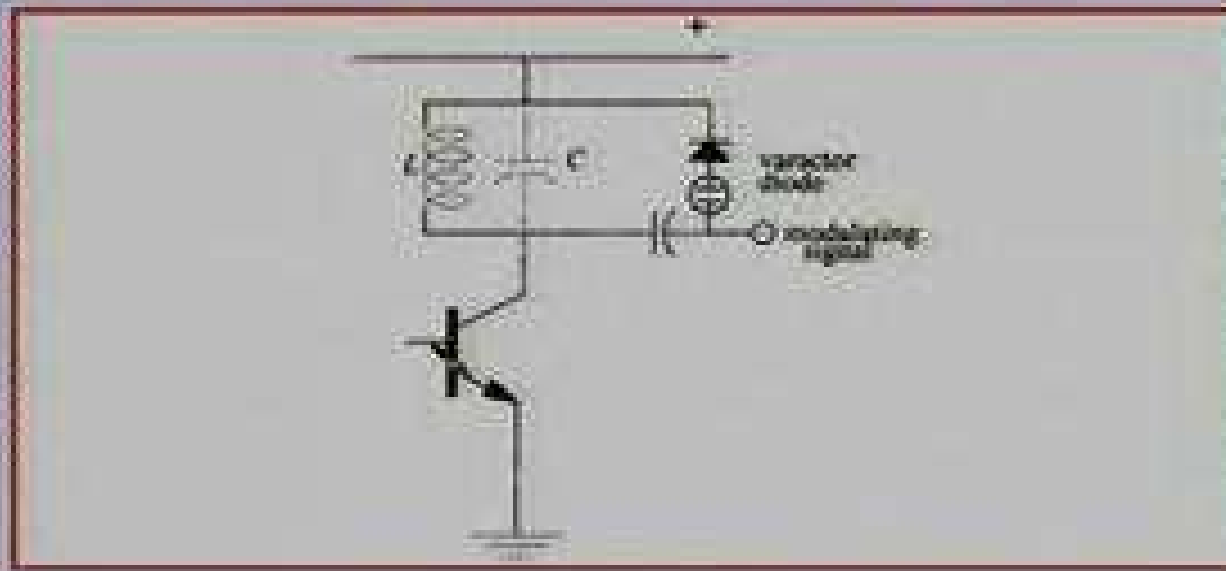
Varactor Diode FM modulator



CIRCUIT DIAGRAM OF VARACTOR DIODE MODULATOR



Direct Method



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

In a direct FM system the instantaneous frequency is directly varied with the information signal. To vary the frequency of the carrier is to use an Oscillator whose resonant frequency is determined by components that can be varied. The oscillator frequency is thus changed by the modulating signal amplitude



Advantages & Limitations

- So simply by changing the input here, you can obtain a modulated signal
- So it is extremely easy to use.
- **Limitations**
- It works only for narrowband scenarios.



Indirect FM

- FM and PM are interrelated; one cannot change without the other changing.
- Phase modulation produces frequency modulation. Since the amount of phase shift is varying, the effect is that, as if the frequency is changed.
- Since FM is produced by PM , the later is referred to as indirect FM



Indirect method or Armstrong method

Wireless Communications

Indirect Method

- Proposed by Armstrong
- Approximate narrowband FM
Carrier + SSB (90° out of phase)

$$S_{FM}(t) = [A_c \cos 2\pi f_c t] - [A_c \theta(t) \sin 2\pi f_c t]$$
$$S_{FM}(t) = A_c \cos[2\pi f_c t + \theta(t)]$$
$$= A_c \cos\left[2\pi f_c t + 2\pi k_f \int_{-\infty}^t m(\eta) d\eta\right]$$

Taylor Series Expansion

Indian Institute of Technology
Delhi

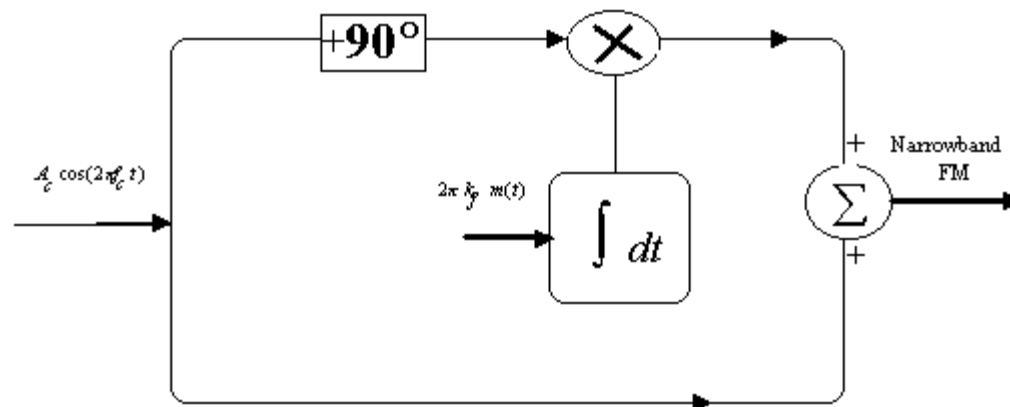
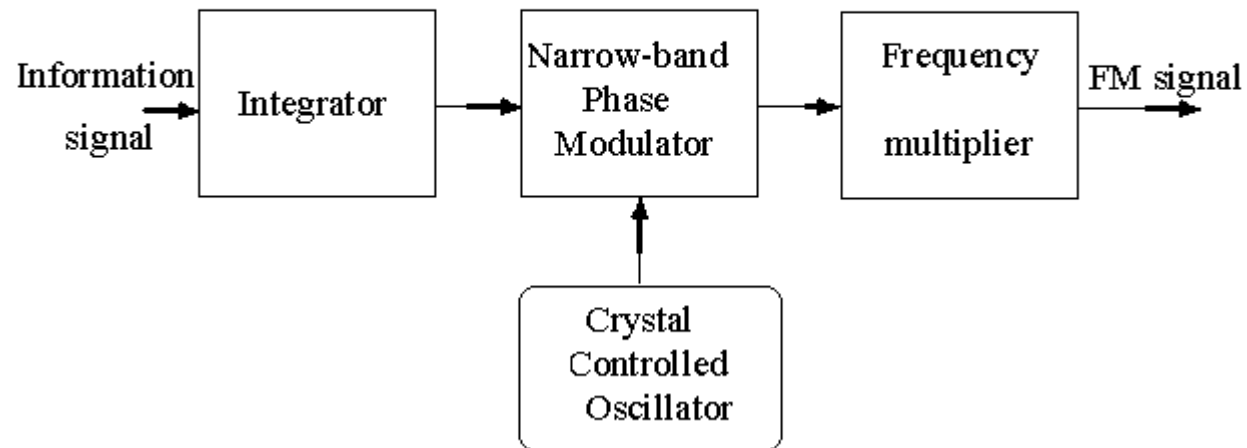
Ranjana Bose
Department of Electrical Engineering

Indirect Method

- The approximate narrowband FM is basically carrier + SSB (90 degrees out of phase)
- Taylor series expansion on this equation, you can get an approximate value of S_{FM} .



**Block diagram of the indirect method of generating
a wide-band FM-signal**



The information signal is first integrated and then used to phase modulate a crystal-controlled oscillator, which provides frequency stability.

In order to minimize the distortion in the phase modulator, the modulation index is kept small, thereby resulting in a narrow-band FM-signal

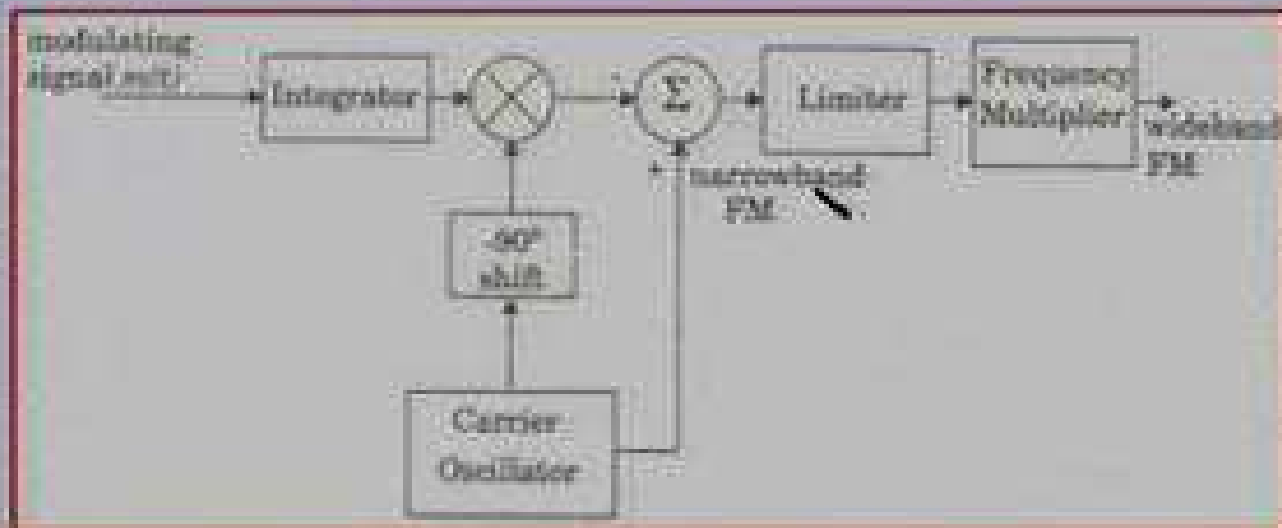
The narrow-band FM signal is multiplied in frequency by means of frequency multiplier so as to produce the desired wide-band FM signal.

The frequency multiplier is used to perform narrow band to wideband conversion.

The frequency deviation of this new waveform is “M” times that of the old, while the rate at which the instantaneous frequency varies has not changed



Indirect Method



Advantage & Limitation

- It can be used obtain wideband FM

Limitation

It has phase noise in the system.

