Indirect Method - Armstrong FM modulator

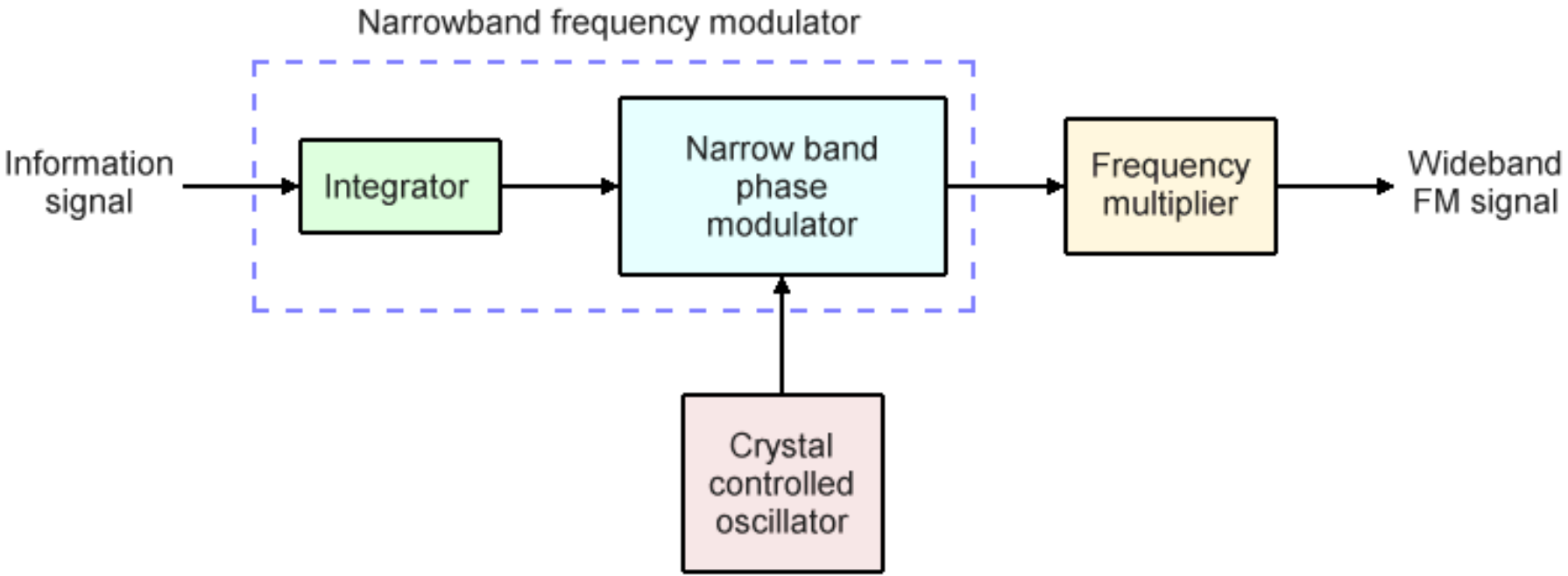
Indirect (NBFM to WBFM & PM to FM)

In the direct methods of generation of FM, LC oscillators are to be used. The LC oscillators are not stable enough for the communication or broadcast purpose.

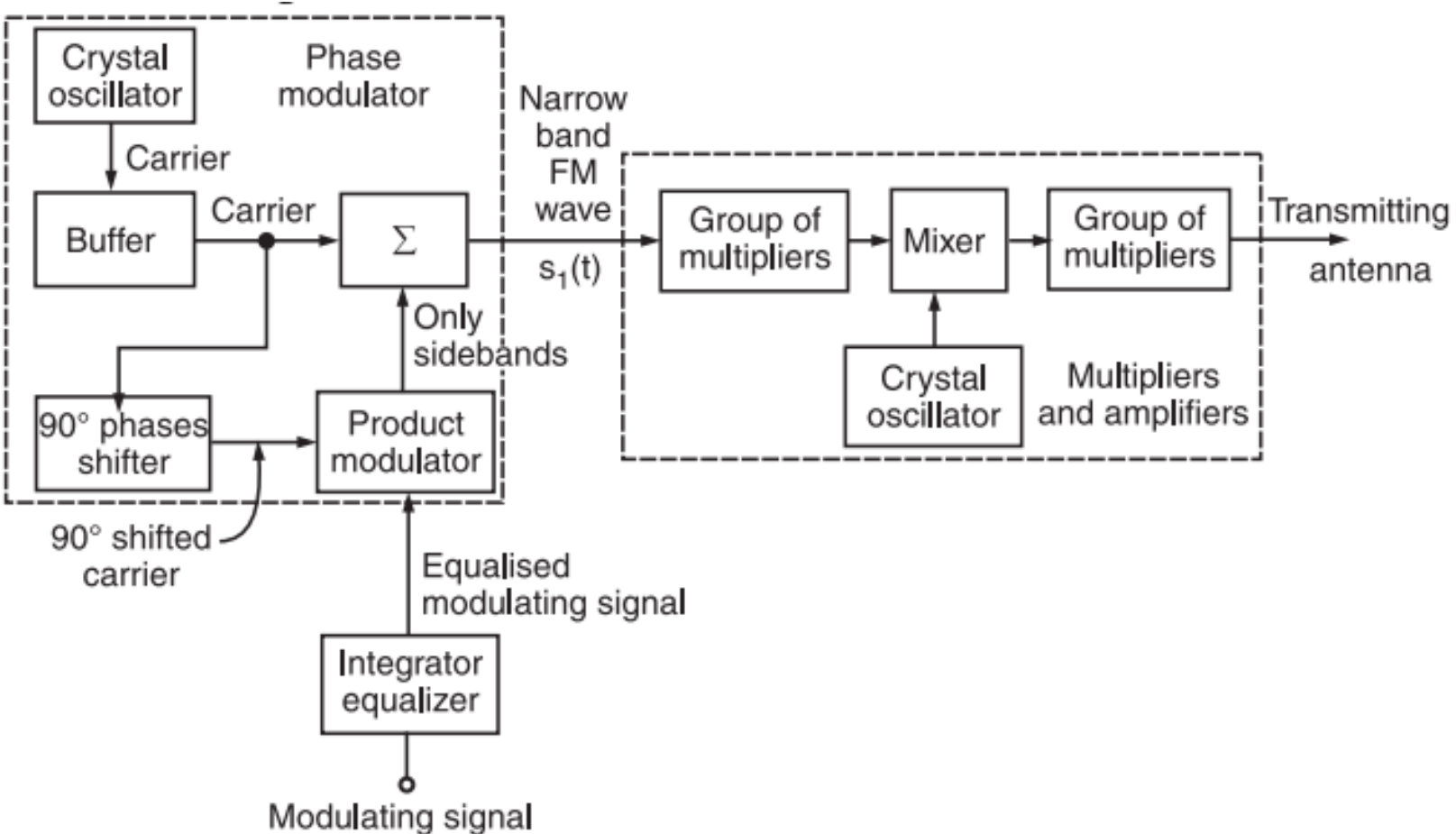
The alternative method is to use the indirect method called as the Armstrong method of FM generation.

In this method, the FM is obtained through phase modulation. A crystal oscillator can be used hence the frequency stability is very high and this method is widely used in practice.

Indirect Method - Armstrong FM modulator



Indirect Method - Armstrong FM modulator



Indirect Method - Armstrong FM modulator

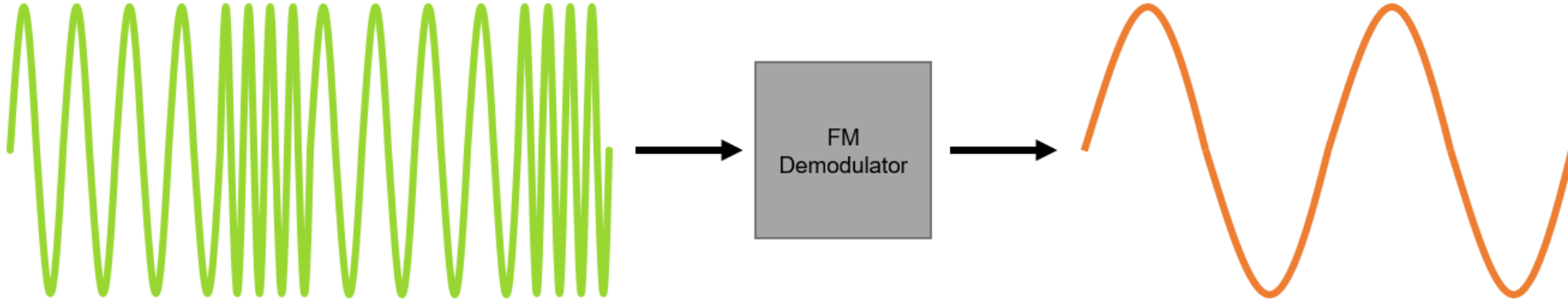
Working Principle:

Part I: Generate a narrow band FM wave using a phase modulator.
Part II: Use the frequency multipliers and mixer to obtain the required values of frequency deviation, carrier and modulation index.

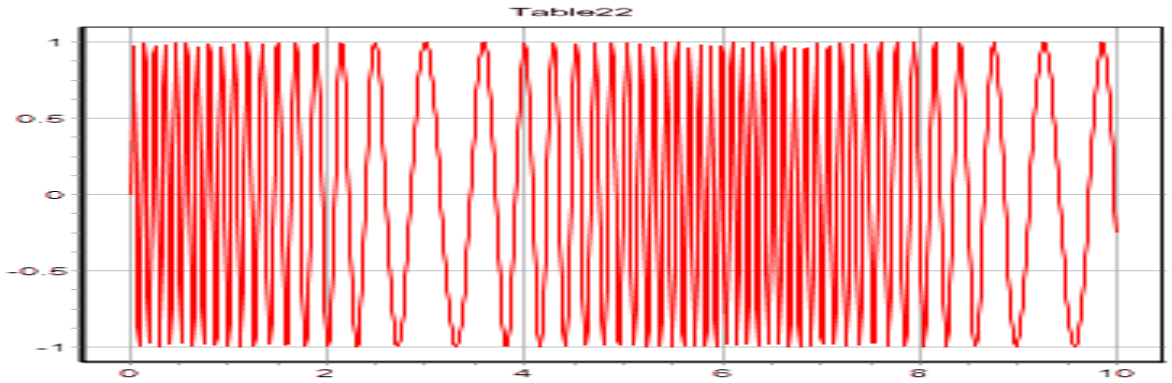
*** Mathematical Equations can be obtained from FM/PM single tone modulations**

FM Demodulators

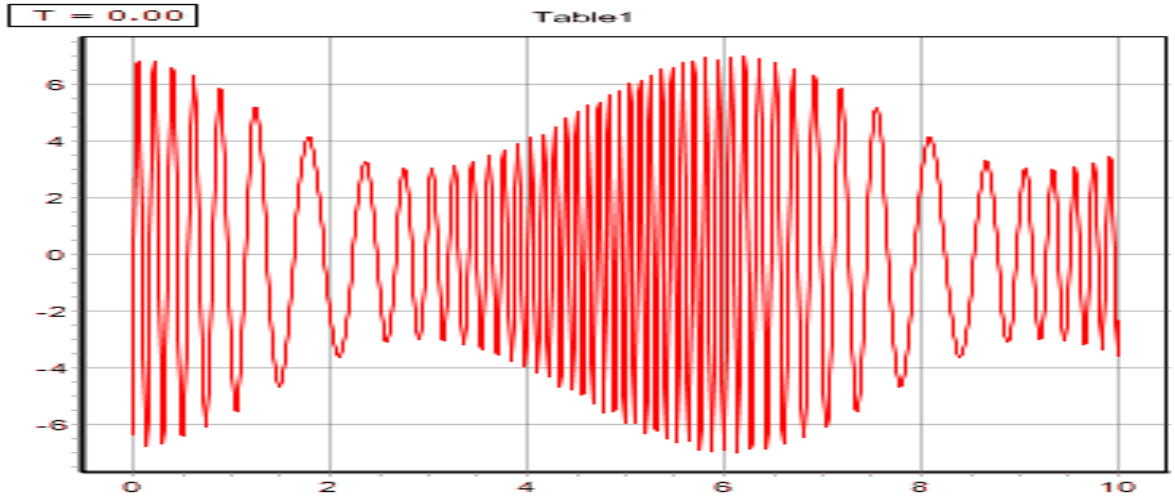
- Slope Detector
- Balanced Slope Detector
- Foster-Seeley Phase Discriminator
- Ratio Detector



Basic FM Demodulator



FM Wave



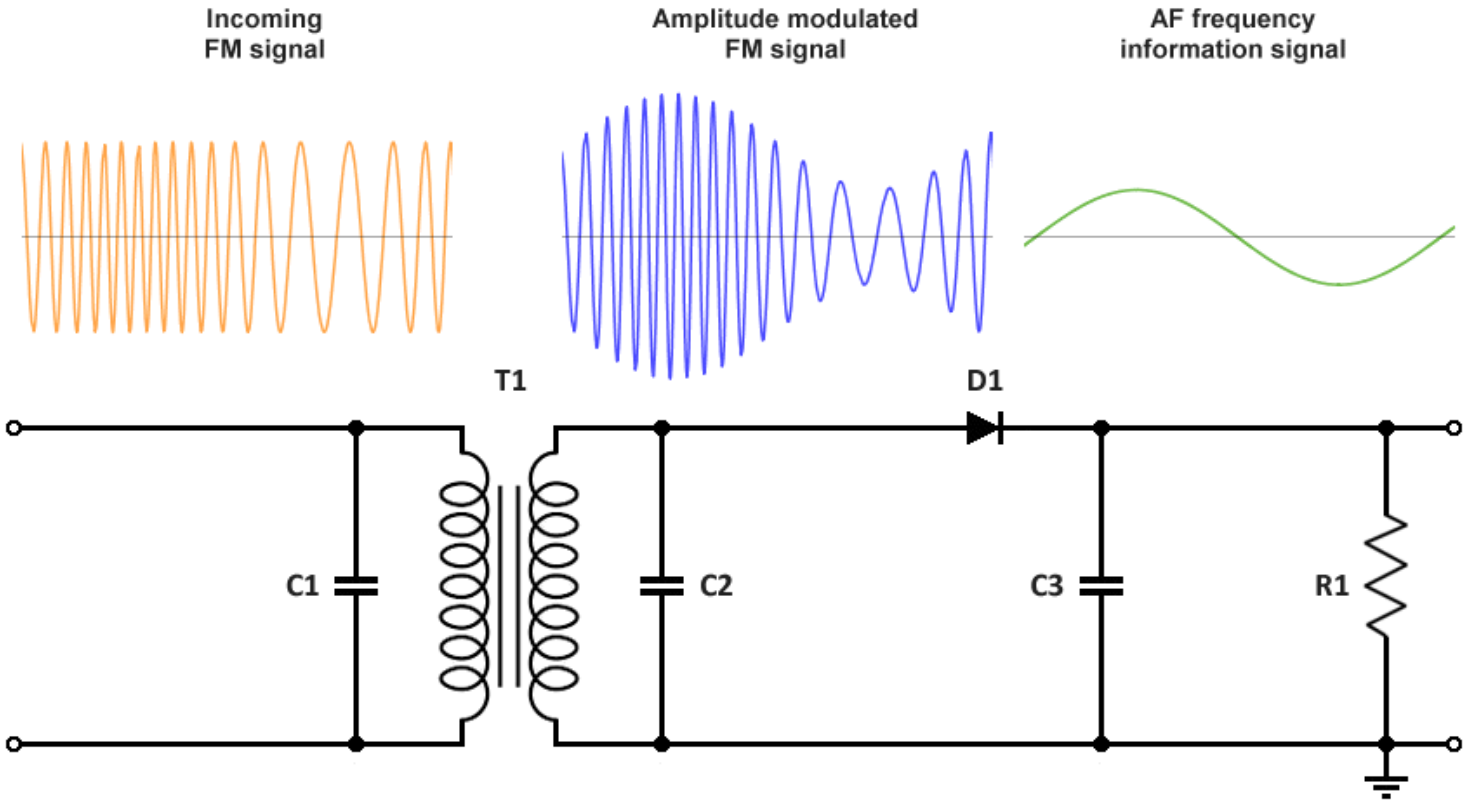
Output of Tuned Circuit

Basic FM Demodulator

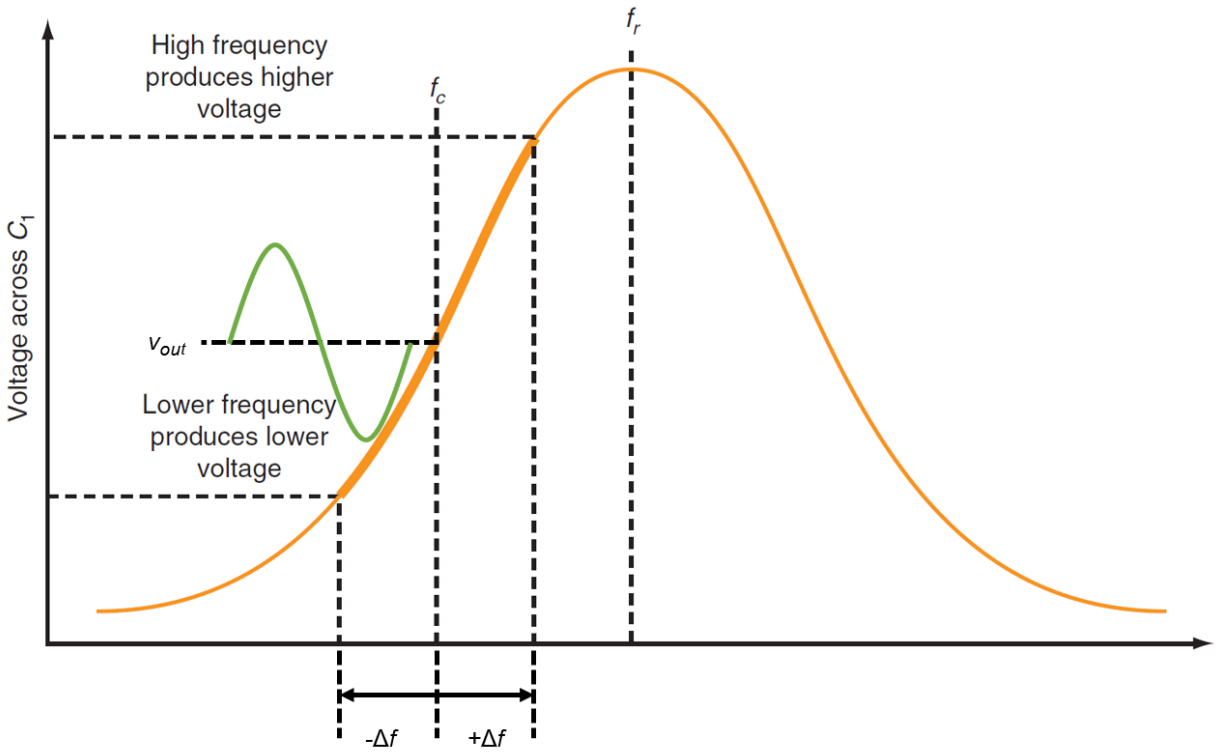
- The function of FM demodulator is to change the frequency deviation of the incoming carrier into an AF amplitude variation.

- The later is applied to a detector which reacts to amplitude changes and ignores frequency changes.

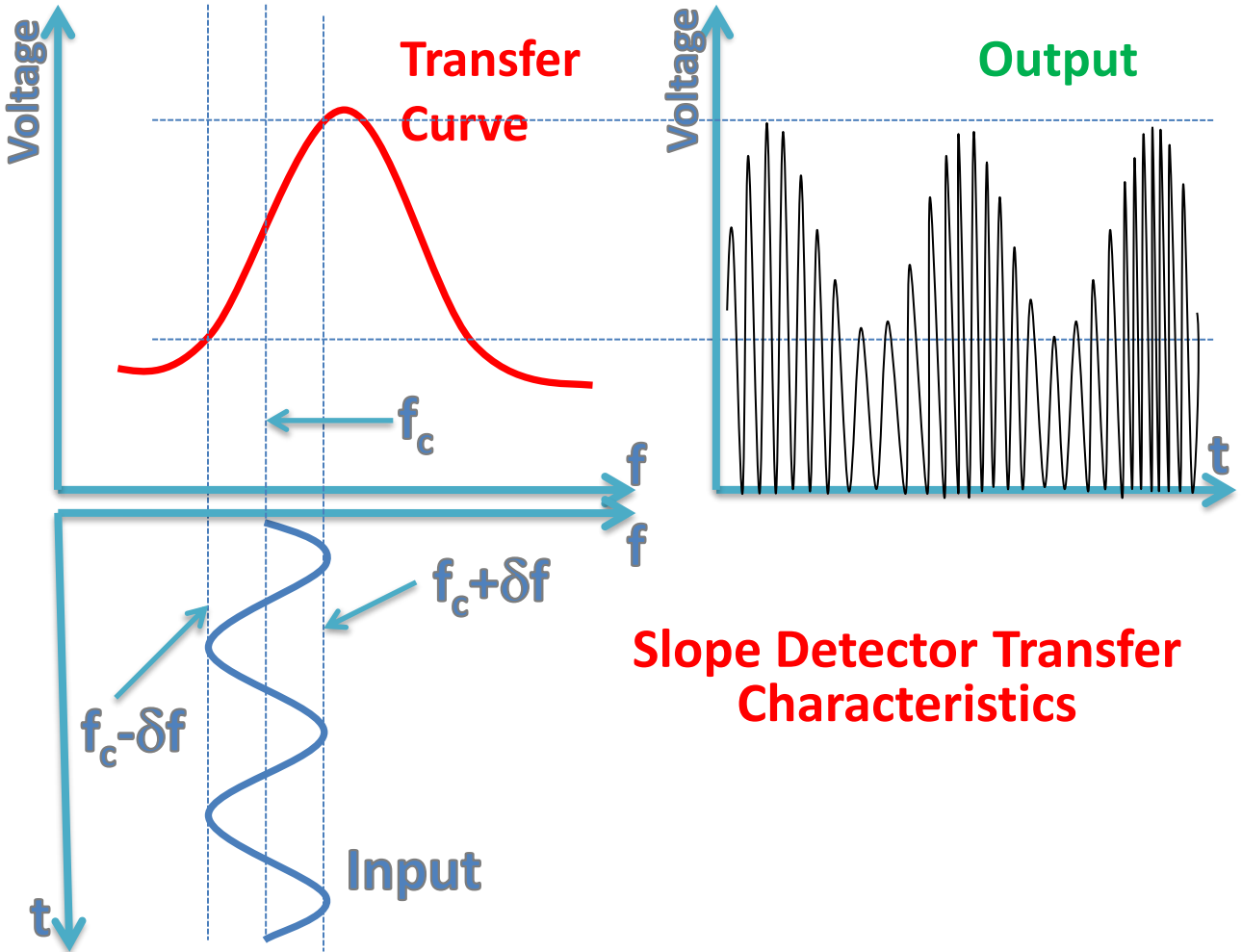
FM Demodulator – Slope Detector



Frequency Response Characteristics of Tuner



FM Demodulator – Slope Detector



Slope Detector Transfer Characteristics

Basic FM Demodulator

- The most basic circuit employed as FM demodulator is parallel tuned LC circuit, often known as slope detector.
- The carrier frequency should fall on one side of resonant frequency and
- The entire frequencies should fall on linear region of transfer curve of tuned circuit.

Limitations of Slope Detector

- It is inefficient, as it is linear in very limited frequency range.
- It reacts to all amplitude changes(input FM signal).
- It is relatively difficult to tune, as tuned circuit must be tuned to different frequency than carrier frequency.

Balanced Slope Detector

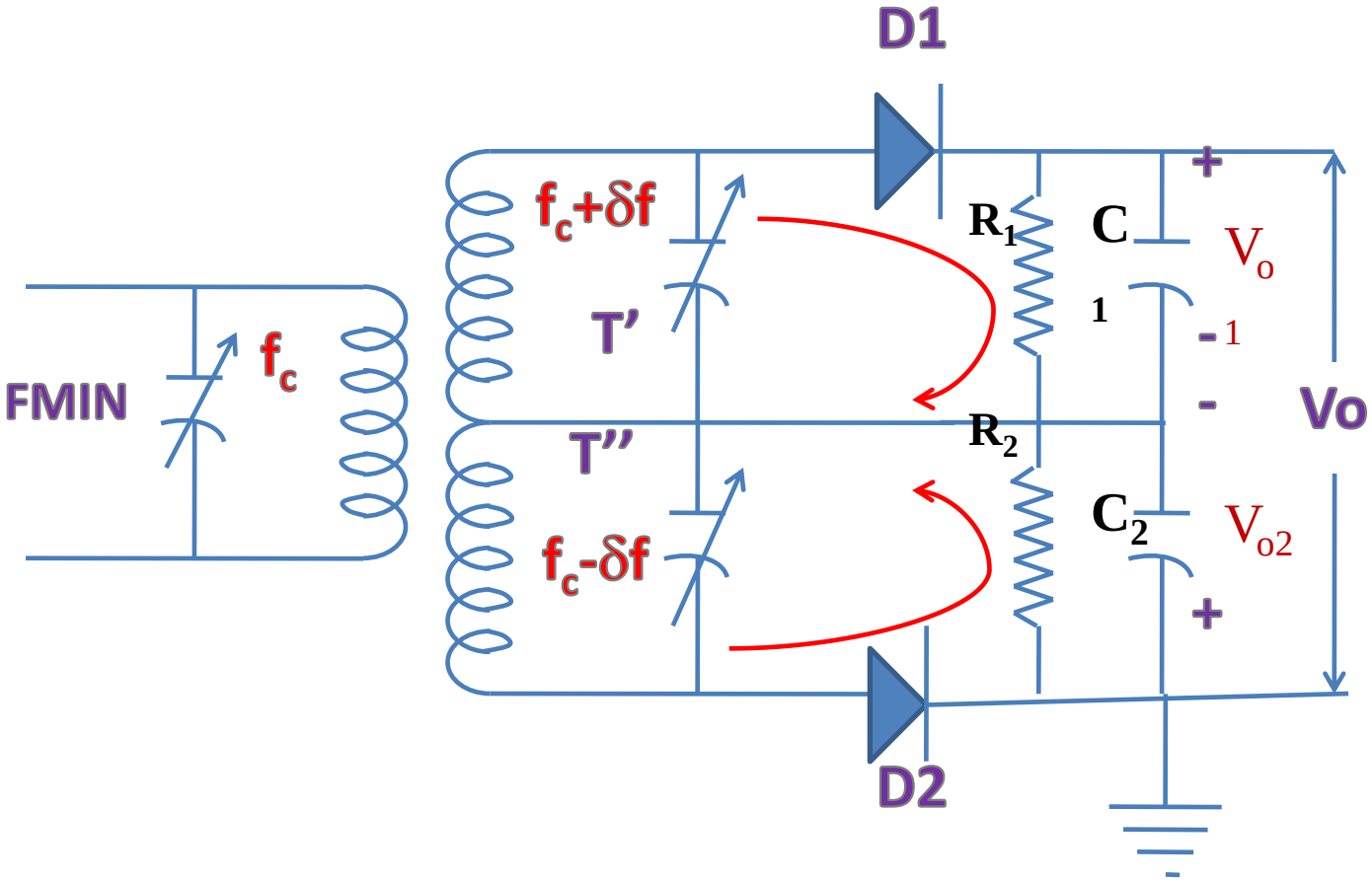
- This circuit uses two slope detectors, connected in back to back fashion, to opposite ends of center-tapped transformer.

- And hence fed 180^0 out of phase.

Balanced Slope Detector

- The top secondary circuit is tuned above the IF(carrier frequency)by an amount δf, and bottom circuit is tuned below IF by δf.
- Each circuit is connected to diode detectors with suitable RC loads.
- The output is taken across series combination of loads, so that it is sum of the individual outputs.

Balanced Slope Detector



Balanced Slope Detector

- When input frequency = f_c

  Then output of T'(+Ve)= output of T'' (-Ve)

  V_o= Zero

- When input frequency = $f_c+\delta f$

  Then output of T'(+Ve) > output of T'' (-Ve)

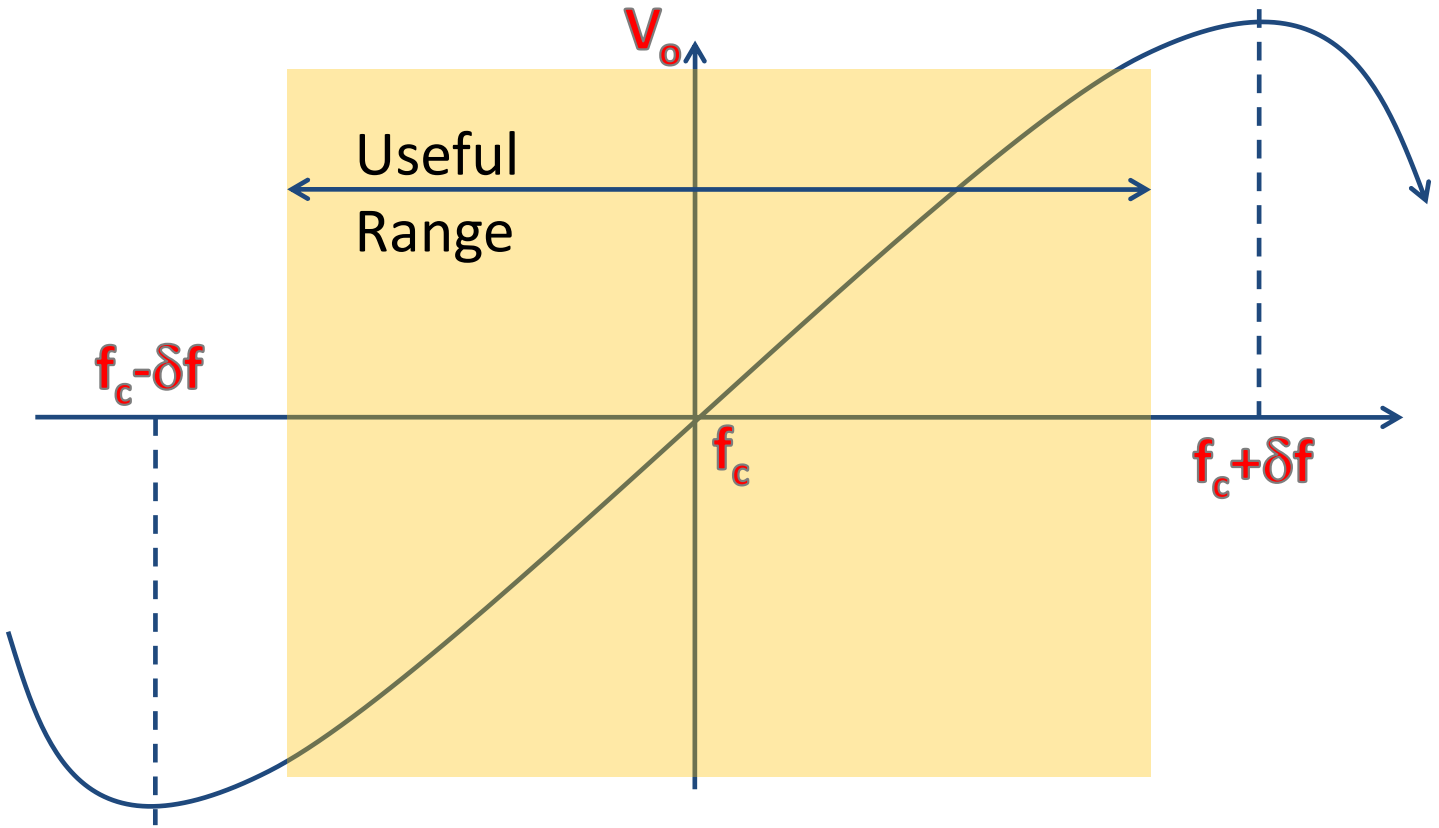
  V_o= +Ve

- When input frequency = $f_c-\delta f$

  Then output of T'(+Ve) < output of T'' (-Ve)

  So sum of outputs of T' and T'' (V_o) = -Ve

Transfer Curve of Balanced slope Deter



A 107.6 MHz carrier is frequency modulated by a 7 kHz sine wave. The resultant FM signal has a frequency deviation of 50 kHz. a). Find the carrier swing of the FM signal. b) Determine the highest and lowest frequencies attained by the modulated signal. c). What is the modulation index of FM?

$$\text{Carrier swing} = 2\Delta f$$

$$= 2 \times 50 \times 10^3 = 100 \text{ kHz}$$

$$f_H = f_c + \Delta f$$

$$= 107.6 \times 10^6 + 50 \times 10^3 = 107.65 \text{ MHz}$$

$$f_L = f_c - \Delta f$$

$$= 107.6 \times 10^6 - 50 \times 10^3 = 107.55 \text{ MHz}$$

$$m_f = \frac{\Delta f}{f_m}$$

$$= \frac{50 \times 10^3}{7 \times 10^3} = 7.143$$