Slope Detector and Balanced Slope Detector

- Frequency modulation is a technique in which the amplitude of the carrier wave is kept constant, while the frequency is varied in accordance with the modulating signal.
- The radio receiver recovers the modulated signal and recovers the message signal in its original form by the process of demodulation.
- The function of FM demodulator, is to change the frequency deviations of the carrier wave into AF amplitude variations. The basic requirement of an FM detector is that the conversion should be linear and insensitive to amplitude variations.

- **Slope detector** is a tuned circuit, whose resonant frequency is set at one side of the centre frequency of FM signal, say $f_c + \delta f$. To get good linearity in the response of the detector circuit, this frequency is chosen greater than the highest frequency deviation in the incoming FM wave. Fig 1 shows circuit of slope detector in which FM signal is applied to the tuned transformer (combination of T1,C1 and C2).

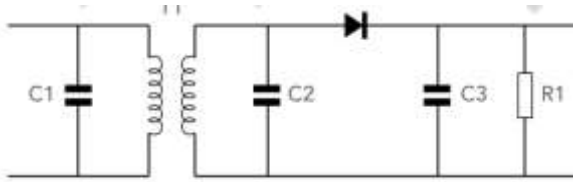
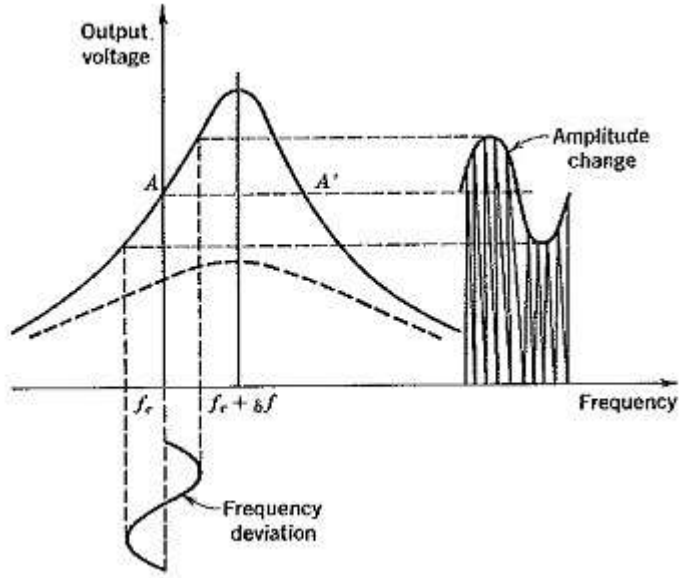


Fig 1

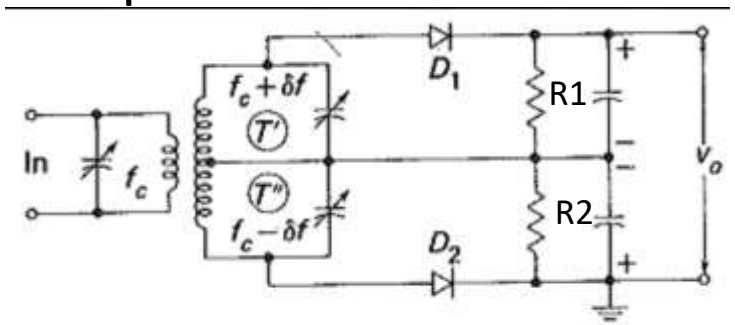


- The output of the tuned circuit will have an amplitude that depends on the frequency of the incoming signal. The resonant frequency is kept much higher than the largest frequency deviation in the FM wave to ensure that the entire frequency range falls in the linear part of the selectivity curve.
- As the frequency of the signal varies up and down the central frequency, signal moves up and down the selectivity curve (Fig 2). This causes the amplitude of the output voltage to vary in line with the frequency variations. At this point, the signal is somewhat like an AM wave. The final stage in the process is to demodulate the amplitude modulated wave using a simple diode detector circuit with an RC load of suitable time constant. This circuit is, in fact, identical to that of an AM detector. The time constant of circuit C3 R1 must be slow enough to keep the RF ripple as small as possible, but sufficiently fast for the detector circuit to follow the fastest variations.

- Slope detector circuit is not widely used but enables one to understand the basic concept of FM demodulation used in advanced techniques.
- The main disadvantage is its lack of linearity as the output is dependent on the linearity of the selectivity curve and it is linear only along a very limited frequency range.
- It responds to all amplitude changes in the incoming signal resulting in high level of noise at the output.
- It is relatively difficult to adjust primary and secondary windings of the transformer to two slightly different frequencies.
- The only virtue is its simplicity and providing a good explanation of basic concept of FM demodulation.

Balanced Slope Detector

- The balanced slope detector, also known as Travis detector, is a combination of two slope detectors. They are connected to the opposite ends of the secondary of the transformer, hence fed 180 degree out of phase



$Vo=V_{R1}-V_{R2}$

- The primary coil of the transformer is tuned at central frequency f_c (carrier frequency) of the incoming signal. The upper half of the secondary coil T' is tuned at $f_c + \delta f$ and the lower half T" is tuned at $f_c - \delta f$, where δf is higher in value than the largest frequency deviation in the incoming FM signal to make sure that the entire range of frequency variation in the incoming signal falls in the linear part of selectivity curve of the tuned circuit.

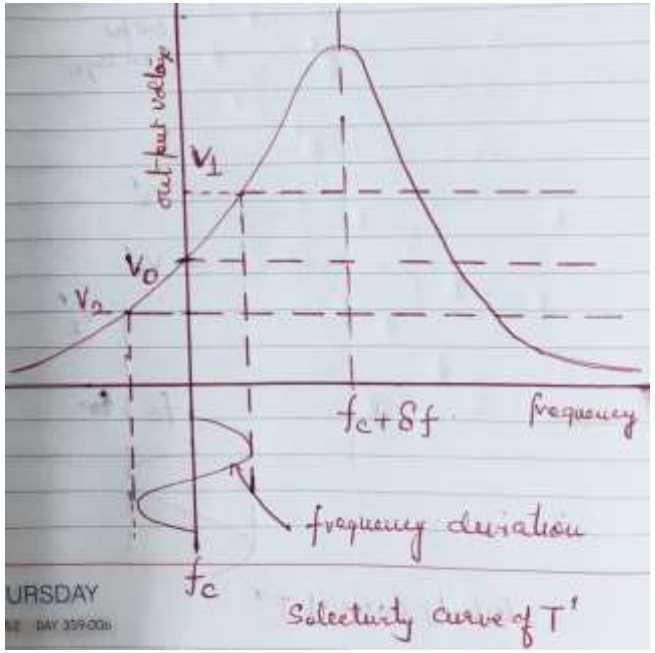


Fig a

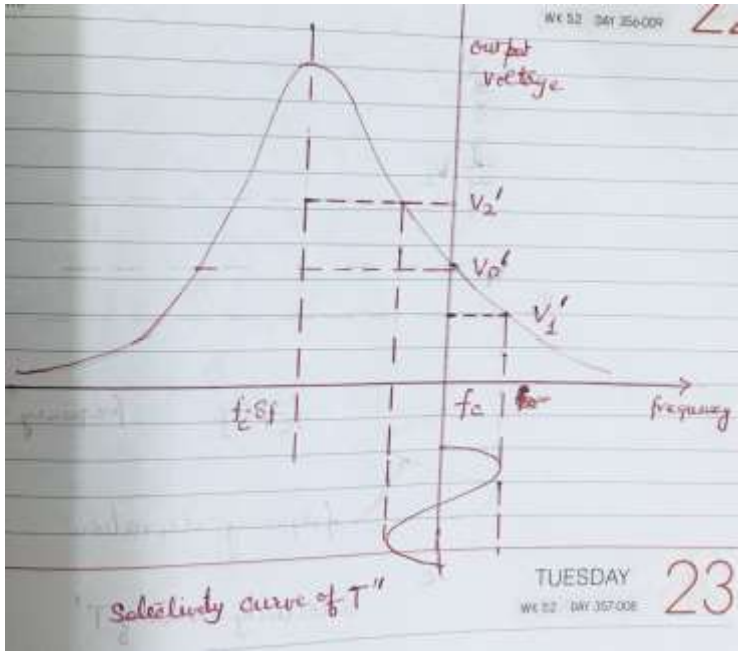
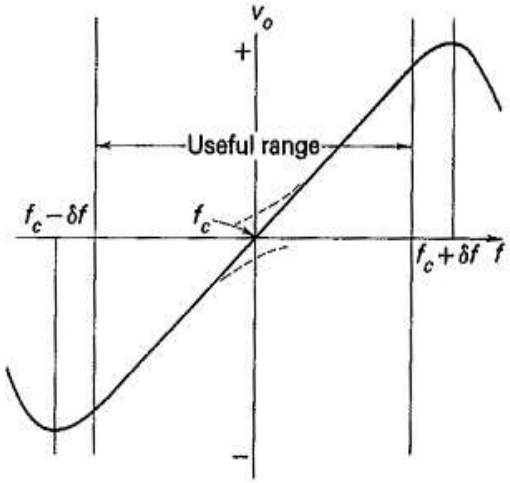


Fig b

- When the input frequency is equal to f_c , the voltage across T' is Vo Fig a. A similar condition exists across T" at this frequency producing voltage Vo' which happens to be equal to Vo as f_c lies as much away from $f_c + \delta f$ as it is from $f_c - \delta f$. Hence the voltages applied to the two diodes are equal leading to equal but opposite currents across the resistors R1 and R2. So, the output voltage will be zero as it is the difference of these two voltages.

- When the input frequency is higher than the carrier frequency fc, the voltage across T' is V_1 (Fig a) and the voltage across T" at this frequency is V_1' (Fig b). As can be seen from the above figs, $V_1 > V_1'$. The current in the diode D1 is greater than that in D2 leading to positive output voltage for fi >fc
- When the input frequency is lower than the carrier frequency fc, the voltage across T' is V_2 (Fig a) and voltage across T" is V_2' (Fig b). As can be seen from the above figs, $V_2 < V_2'$ leading to negative output voltage for fi <fc.
- In the figs a and b, the cases discussed are of maximum and minimum frequency deviations in the FM wave. When the instantaneous frequency lies in between these two extremities, the output will have some intermediate value.



- The output voltage will be positive or negative depending on which side of fc the input frequency happens to lie.
- If the input frequency goes outside the prescribed range, the output will start falling. The S-shaped frequency response shown in the above fig. is obtained.
- The main disadvantage of Balanced modulator is to manage three resonant frequencies in the primary and secondary of the transformer.
- Though linearity in frequency response is better than that of slope detector, it is not good enough.
- Amplitude limiting is not provided.