

Department of Electronics & Telecommunication Engineering Jnan Chandra Ghosh Polytechnic

Semester – 4

FM Detector or Demodulator

(Foster Seely Discriminator, Ratio Detector, PLL)

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ECE- Class-3 In this class we will cover the following topic:

1. Foster Seeley Discriminator: FM detector / demodulator:

- a) Basic circuit diagram.
- b) Circuit explanation.
- c) Circuit operation at Resonance
- 2. Ratio Detector :
 - a) Circuit diagram
 - b) Circuit explanation

3. FM DETECTOR- Phase Lock Loop (PLL)

- a) Block Diagram of PLL
- b) Operation of a phase-locked loop
- c) PLL FM Demodulator performance



Foster Seeley Discriminator: FM detector / demodulator

- The Foster Seeley FM discriminator, detector or demodulator enabled audio to be recovered from frequency modulated signals using a relatively simple circuit.
- The FOSTER-SEELEY DISCRIMINATOR is also known as the PHASE-SHIFT DISCRIMINATOR.
- It uses a double-tuned RF transformer to convert frequency variations in the received fm signal to amplitude variations.
- These amplitude variations are then rectified and filtered to provide a dc output voltage. This voltage varies in both amplitude and polarity as the input signal varies infrequency.





Circuit Explanation

According to circuit diagram-

- Primary tank circuit is C1 & L1
- Secondary tank circuit is C2 & L2
- Both Tank circuits are tuned to the centre frequency of incoming Fm signal
- Choke L3 is the DC return path of diode rectifier D1 & D2
- V1 & V2 are out of phase voltage to each other.
- Output voltage Vo = |V02| |V01|
 - ~ Va1 = V3 +V1

~ Va2 = V3 –V2

• Resistors R1 & R2 are the load resistors and bypassed by C3 & C4 to remove RF

Tuned Amplifier





Foster Seeley Discriminator: (CIRCUIT OPERATION AT RESONANCE)

Case -1 : At resonance FM is tuned at Frequency fc (fin=fc)





Case -2 : At Off resonance FM is tuned at Frequency (fc + Δ f) or (fc Δ f)



In case – Va2>Va1, Vo= |Vo2| - |Vo1| = + Vc

Ratio Detector -1

The **ratio detector** is a type of detector circuit , commonly used in radio receiver for demodulating frequency modulated (FM) signal.







Another type FM demodulator :

- The ratio detector is a variant of the Foster-Seeley discriminator ,but one diode conducts in an opposite direction (D2), and using a tertiary winding in the preceding transformer.
- The output in this case is taken between the sum of the diode voltages and the center tap (Vo).
- The two output voltages are such that their sum is constant & their ratio is proportional to the ratio of the two applied frequency dependent voltages.

Ratio Detector -2

- The output across the diodes is connected to a large value capacitor (C5), forming a dynamic filter.
- The ratio detector has the advantage over the Foster-Seeley discriminator that it does not respond to AM signals, thus potentially saving a limiter stage; however, the output is only 50% of the output of a discriminator for the same input signal.
- The ratio detector has wider bandwidth, but more distortion than the Foster-Seeley discriminator.



FM DETECTOR- Phase Lock Loop (PLL)



PLL FM DEMODULATOR BLOCK DIAGRAM

A phase-locked loop is a circuit consisting of a phase-sensitive detector, a Voltage Controlled Oscillator(VCO), and amplifiers, connected in a Closed Loop System as shown above. In a VCO, the oscillation frequency is proportional to the applied voltage.

Operation of a phase-locked loop is as follows:

The phase-sensitive detector compares the phase of the amplified input signal with the phase of the VCO output. Any phase difference generates an error signal, which is amplified and fed back to the VCO. This adjusts the frequency of the VCO until the error signal goes to zero, and thus the VCO becomes locked to the frequency of the input signal. The DC output from the VCO is then proportional to the input signal frequency.

Phase Lock Loop (PLL)



- The output frequency of VCO is equal to the frequency of unmodulated carrier
- □ The Phase detector
 - Compares fin & fo
 - The output of the phase detector is proportional to phase difference between fin & fo
 - Output of phase detector is DC or minimum frequency signal, so it is reflected as the error voltage

LPF (Low Pass Filter): -It removes high frequency noise. - It produces DC signal (Active or passive LPF may be used)

□ VCO (Voltage Controlled Oscillator) – It generates high frequency signal

- The Instantaneous VCO frequency is controlled by input voltage fo= f+KWm (it is based on input voltage)
- The frequency of VCO is directly controlled by DC input voltage .
- Works on Three states Free Running , Capture, Phase Lock

AMPLIFIER : To amplify the signal for desired output.

PLL FM demodulator performance

The PLL FM demodulator is normally considered a relatively high performance form of FM demodulator or detector. Accordingly they are used in many FM receiver applications.

The PLL FM demodulator has a number of key advantages:

- Linearity: One of the advantages of the PLL FM demodulator is its high degree of linearity. This is governed by the voltage to frequency characteristic of the VCO within the phase locked loop. Normally the phase locked loop will be able to operate over a wide bandwidth normally this is much wider than the bandwidth of the FM signal or even the IF stages of the FM receiver. As the frequency deviation of the incoming FM signal covers only a small portion of the PLL bandwidth the overall conversion is very linear.
- Insensitive to amplitude noise: In general the phase locked loop FM demodulator is very insensitive to amplitude noise.
- Ease of incorporation into ICs: Phase locked loops are very easy to implement in an integrated circuit. PLLs have long been available as ICs and this has meant that the technology is easy to implement
- Manufacturing costs: As the phase locked loop FM demodulator lends itself to integrated circuit technology, only a few external components are required to complete the FM demodulator. One particular advantage is that often no inductor is required for the VCO circuit.

