Principle of Communication (BEC-28)

Amplitude Modulation

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UNIT-1

- Overview of Communication system
- Communication channels
- Need for modulation
- Baseband and Pass band signals
- Comparison of various AM systems
- Amplitude Modulation
  - Double side-band with Carrier (DSB-C)
  - Double side-band without Carrier
  - Single Side-band Modulation
  - SSB Modulators and Demodulators
  - Vestigial Side-band (VSB)
  - Quadrature Amplitude Modulator.

AM DEMODULATORS

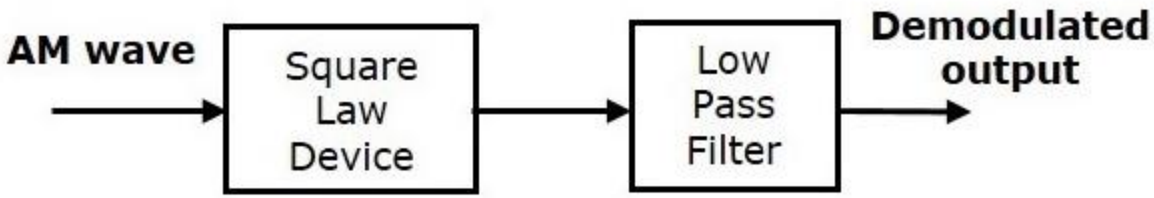
- Demodulation: Process of extracting origin signal from modulated signal.
- Demodulators: Circuit that demodulate the modulated signal.
- AM Demodulators:

  Square Law Demodulator (SLD)

  Envelope Detector (ED)
- SLD are used to demodulate low level AM signal.
- ED are used to demodulate high level AM signal

Square Law Demodulator

- Block Diagram:



AM SIGNAL $V_1(t) = A_c[1 + k_a m(t)]\cos(2\pi f_c t)$

Input-Output Relation of SLD: $V_2(t) = k_1 V_1(t) + k_2 V_1^2(t)$

$$\Rightarrow V_2(t) = k_1 A_c \cos(2\pi f_c t) + k_1 A_c k_a m(t)\cos(2\pi f_c t) + \frac{K_2 A_c^{\,2}}{2} +$$

$$\frac{K_2 A_c^{\,2}}{2}\cos(4\pi f_c t) + \frac{k_2 A_c^{\,2} k_a^{\,2} m^2(t)}{2} + \frac{k_2 A_c^{\,2} k_a^{\,2} m^2(t)}{2}\cos(4\pi f_c t) +$$

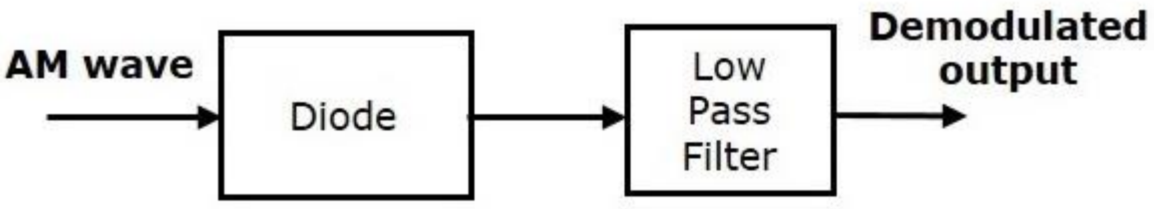
$$k_2 A_c^{\,2} k_a m(t) + k_2 A_c^{\,2} k_a m(t)\cos(4\pi f_c t)$$

$k_2 A_c^{\,2} k_a m(t)$ is the scaled version of the message signal.

- Can be extracted by LPF
- DC term neglected through coupling capacitor.

Envelope Detector

- Block Diagram:



- Diode: Main detecting element.
- Also known as Diode detector.
- Low pass filter: Parallel connection of resistor and capacitor.
- Standard AM wave

$$s(t) = A_c [1 + k_a m(t)] \cos(2\pi f_c t)$$

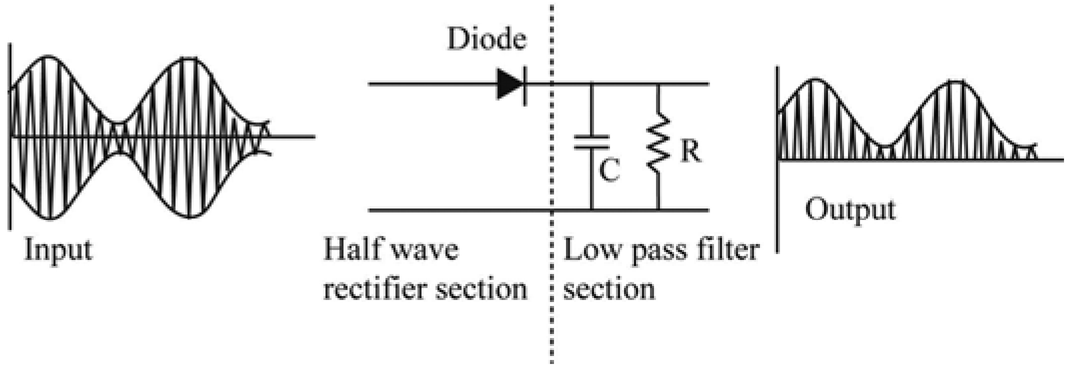
In Positive half cycle → Diode conducts → Capacitor charges to the peak value of AM signal

→ When value of AM wave is less than peak charged value → Diode will not conduct → Capacitor will discharge through R

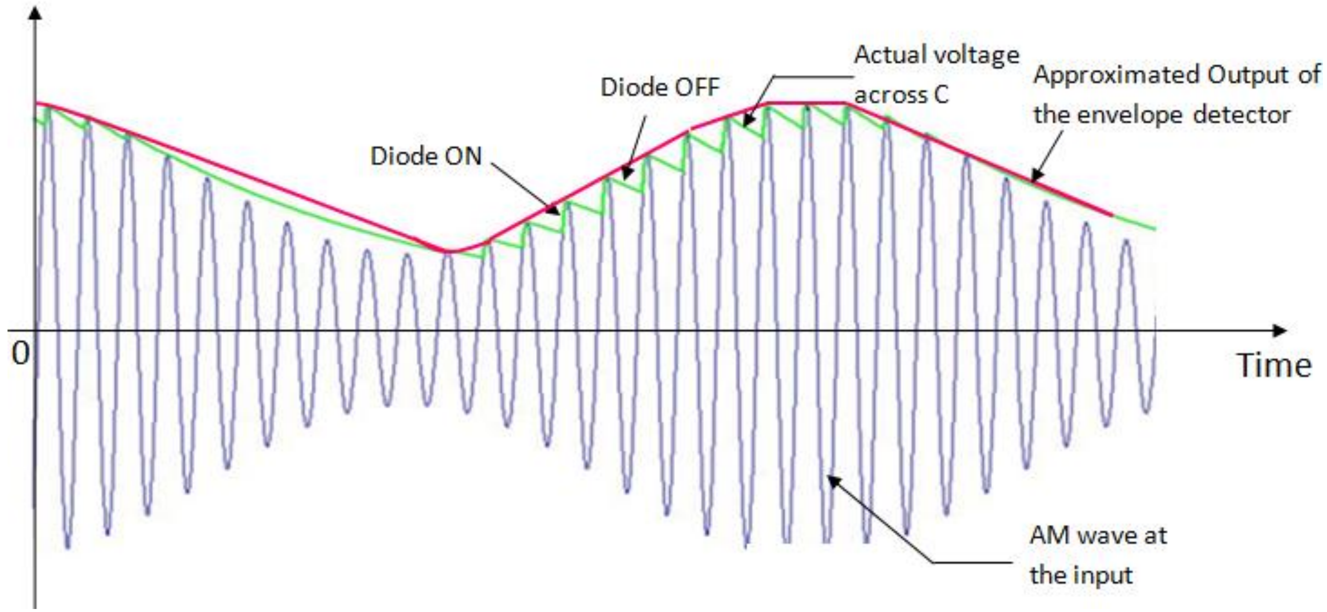
When value of AM wave is greater than capacitor value ←

Envelope Detector

- CIRCUIT DIAGRAM:



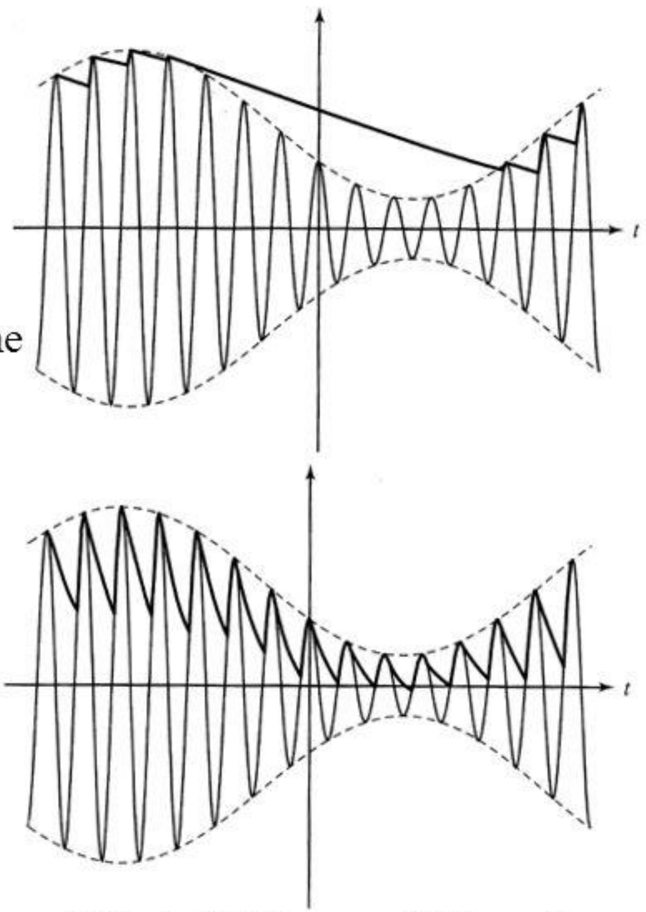
Envelop Detector



Envelope Detector

- The time constant RC must be selected to follow the variations in the envelope of the modulated signal
  - **If RC is too large**, then the discharge of the capacitor is too slow and again the output will not follow the envelope
  - **If RC is too small**, then the output of the filter falls very rapidly after each peak and will not follow the envelope closely
  - For good performance of the envelope detector,

$$\frac{1}{f_c} \ll RC \ll \frac{1}{W}$$

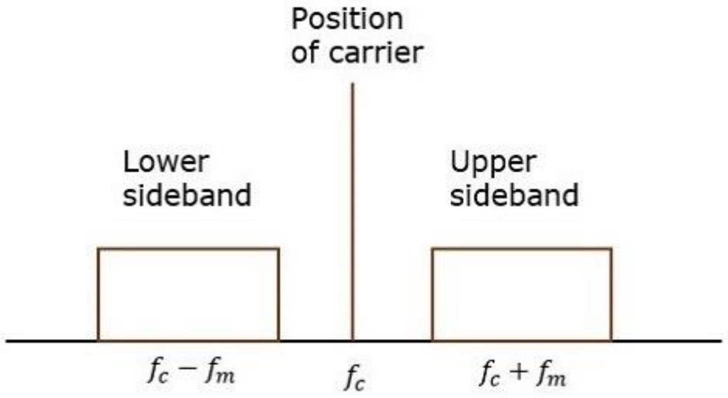


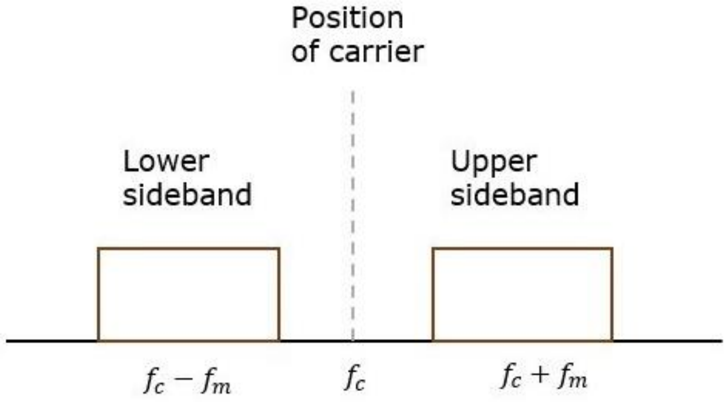
Effect of (a) large and (b) small RC values on the performance of the envelope detector.

DSB-SC

DSBSC MODULATION

- Carrier wave and two sidebands.
- Information only in the sidebands.
- **Sideband** is a band of frequencies.
- The lower and higher frequencies of the carrier frequency.





DSBSC MODULATION…

- Modulating signal:

$$m(t) = A_m \cos(2\pi f_m t)$$

- Carrier signal:

$$c(t) = A_c \cos(2\pi f_c t)$$

- DSBSC wave:

$$s(t) = m(t)\,c(t)$$

$$\Rightarrow s(t) = A_m A_c \cos(2\pi f_m t)\cos(2\pi f_c t)$$

$$\Rightarrow s(t) = \frac{A_m A_c}{2}\cos[2\pi(f_c + f_m)t] + \frac{A_m A_c}{2}\cos[2\pi(f_c - f_m)t]$$

- Bandwidth:

$$BW = f_{max} - f_{min}$$

$$BW = f_c + f_m - (f_c - f_m)$$

$$\Rightarrow BW = 2f_m$$

DSBSC MODULATION…

- Power Calculations:

$$s\left(t\right) = \frac{A_m A_c}{2}\cos[2\pi\left(f_c + f_m\right)t] + \frac{A_m A_c}{2}\cos[2\pi\left(f_c - f_m\right)t]$$

$$P_t = P_{USB} + P_{LSB}$$

$$P = \frac{{v_{rms}}^2}{R} = \frac{\left(v_m\sqrt{2}\right)^2}{R}$$

$$P_{USB} = \frac{\left(A_m A_c/2\sqrt{2}\right)^2}{R} = \frac{{A_m}^2{A_c}^2}{8R}$$

$$P_{LSB} = \frac{{A_m}^2{A_c}^2}{8R}$$

$$\Rightarrow P_t = \frac{{A_m}^2{A_c}^2}{4R}$$

- the power required for transmitting DSBSC wave is equal to the power of both the sidebands.

Thank You