JYOTHISHMATHI INSTITUTE OF TECHNOLOGY & SCIENCE

PPT ON AMPLITUDE MODULATION

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Amplitude Modulation

Modulation: What and Why?

- The process of shifting the baseband signal to passband range is called *Modulation*.
- The process of shifting the passband signal to baseband frequency range is called *Demodulation*.
- Reasons for modulation:
  - Simultaneous transmission of several signals
  - Practical Design of Antennas
  - Exchange of power and bandwidth

Types of (Carrier) Modulation

- In modulation, one characteristic of a signal (generally a sinusoidal wave) known as the *carrier* is changed based on the information signal that we wish to transmit (*modulating signal*).
- That could be the amplitude, phase, or frequency, which result in Amplitude modulation (AM), Phase modulation (PM), or Frequency modulation (FM). The last two are combined as Angle Modulation

Types of Amplitude Modulation (AM)

- **<u>Double Sideband with carrier (we will call it AM)</u>**: This is the most widely used type of AM modulation. In fact, all radio channels in the AM band use this type of modulation.
- **<u>Double Sideband Suppressed Carrier (DSBSC):</u>** This is the same as the AM modulation above but without the carrier.
- **<u>Single Sideband (SSB):</u>** In this modulation, only half of the signal of the DSBSC is used.
- **<u>Vestigial Sideband (VSB):</u>** This is a modification of the SSB to ease the generation and reception of the signal.

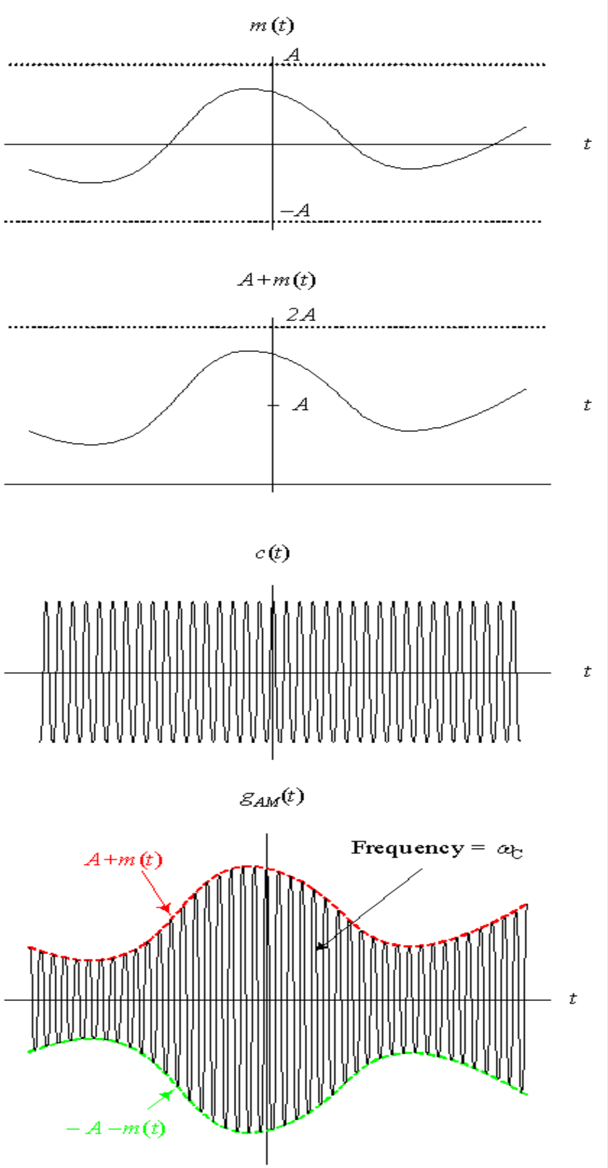
Definition of AM

- Shift $m(t)$ by some DC value "A" such that $A+m(t) \geq 0$. Or $A \geq m_{peak}$

$$g_{AM}(t) = [A + m(t)]\cos(\omega_C t)$$

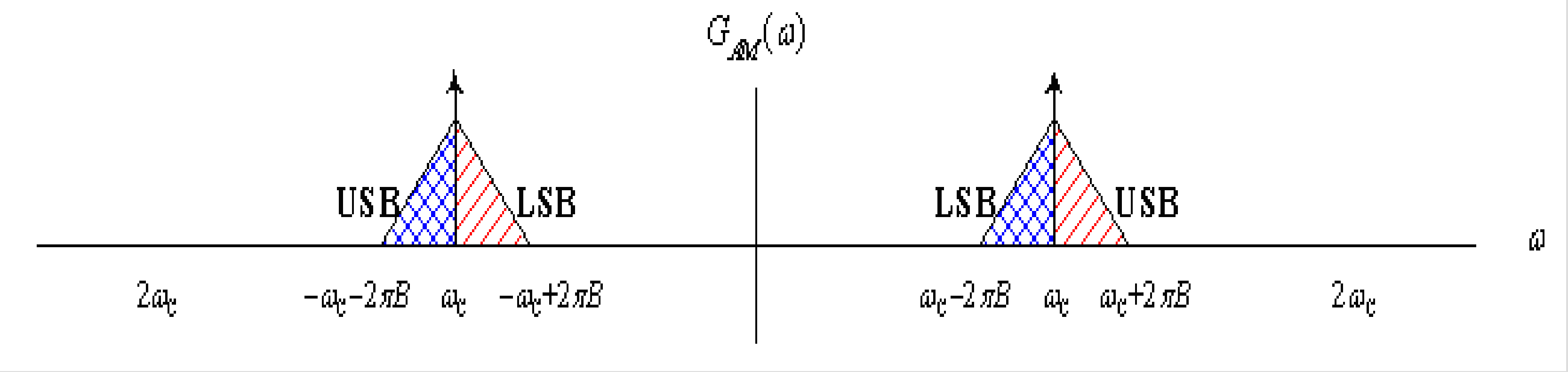
$$= A\cos(\omega_C t) + m(t)\cos(\omega_C t)$$

- Called DSBWC. Here will refer to it as Full AM, or simply AM
- Modulation index $\mu = m_p/A$.
- $0 \leq \mu \leq 1$



Spectrum of AM

$$g_{AM}(t) \Leftrightarrow \pi A\left[\delta(\omega-\omega_C)+\delta(\omega+\omega_C)\right]+\frac{1}{2}\left[M(\omega-\omega_C)+M(\omega+\omega_C)\right]$$



The “Buy” and “Price” of AM

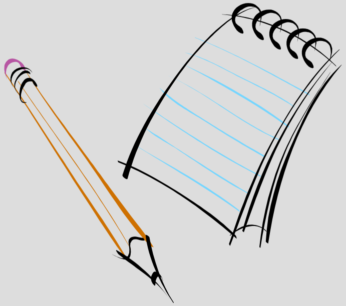
- Buy: Simplicity in demodulation.
- Price: Waste in Power

$g_{AM}(t) = A\cos\omega_c t + m(t)\cos\omega_c t$

Carrier Power $P_c = A^2/2$ (carries no information)

Sideband Power $P_s = P_m/2$ (useful)

Power efficiency = $\eta = P_s/(P_c + P_s) = P_m/(A^2 + P_m)$



Tone Modulation

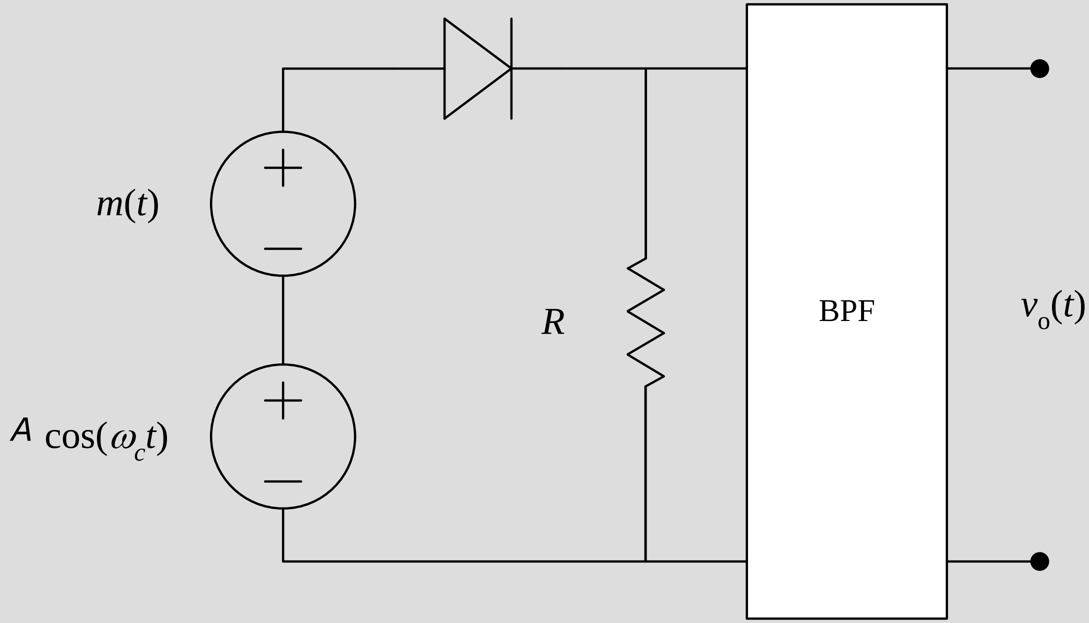
- $m(t) = B\cos(\omega_m t)$
- $g(t)=[A+ B\cos(\omega_m t)] \cos\omega_c t = A[1+\mu \cos(\omega_m t)] \cos\omega_c t$
- $\eta = (B^2/2)/(B^2/2 + A^2) = \mu^2/(2+\mu^2)$
- Under best conditions, $\mu=1$ ➔ $\eta_{max} = 1/3 = 33\%$
- For $\mu = 0.5$, $\eta = 11.11\%$
- For practical signals, $\eta < 25\%$

? Would you use AM or DSBSC?

Generation of AM

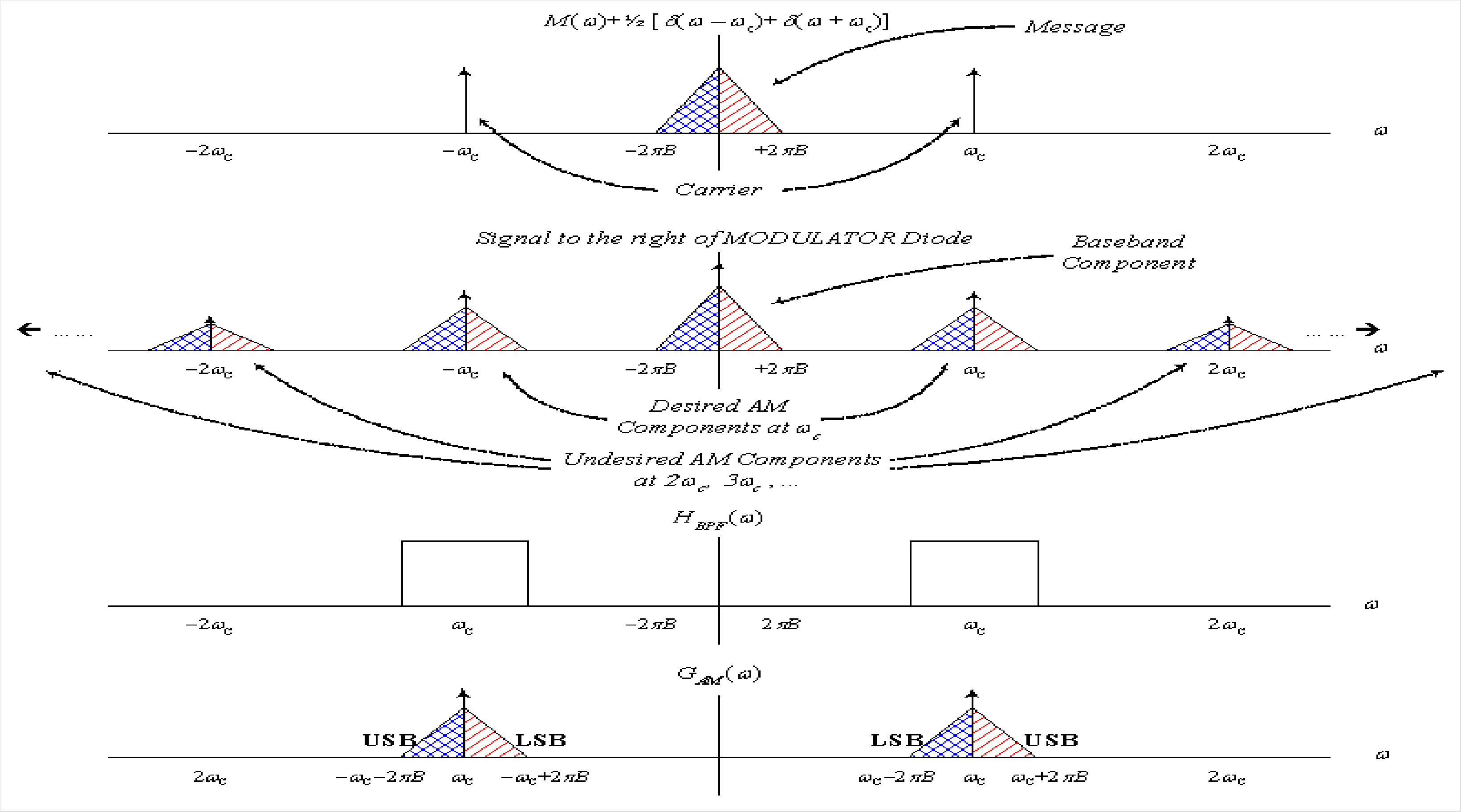
- AM signals can be generated by any DSBSC modulator, by using $A+m(t)$ as input instead of $m(t)$.
- In fact, the presence of the carrier term can make it even simpler. We can use it for switching instead of generating a local carrier.
- The switching action can be made by a single diode instead of a diode bridge.

AM Generator



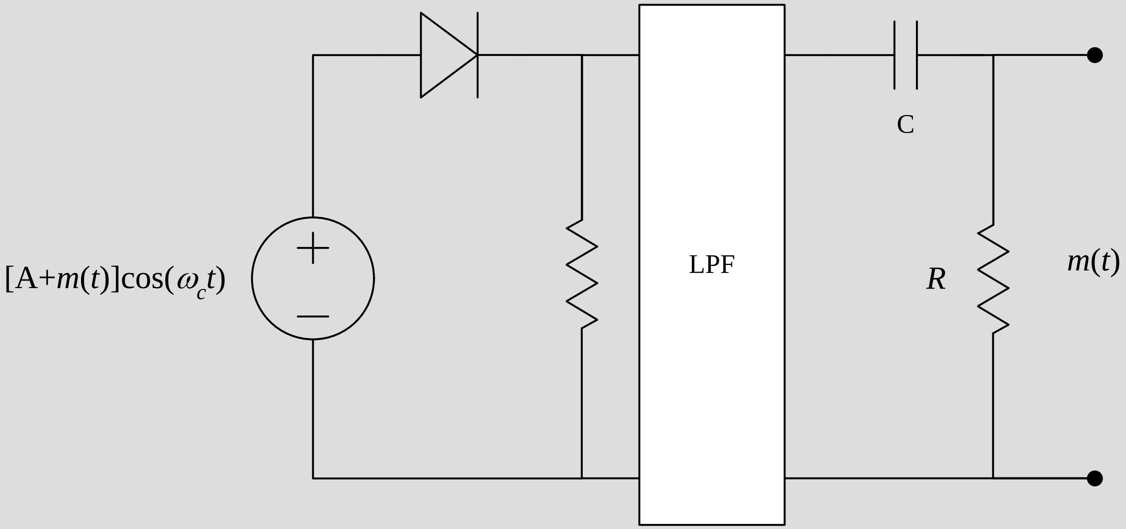
- $A >> m(t)$
  (to ensure switching at every period).
- v_R=[cos$\omega_c t + m(t)$][1/2 + 2/π(cos$\omega_c t$-1/3cos3$\omega_c t$ + …)]
  =(1/2)cos$\omega_c t$+(2/π)$m(t)$ cos$\omega_c t$ + other terms (suppressed by BPF)
- $v_o(t)$ = (1/2)cos$\omega_c t$+(2/π)$m(t)$ cos$\omega_c t$

AM Modulation Process (Frequency)



AM Demodulation: Rectifier Detector

- Because of the presence of a carrier term in the received signal, switching can be performed in the same way we did in the modulator.



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