

Amplitude Modulation



Early History

The discovery that electromagnetic waves are capable of transmitting information sparked the invention of radio. The amplitude modulation technique is originated from the experimental and theoretical work of Leblanc, back in 1886, Mayer (1875) and Rayleigh (1894).

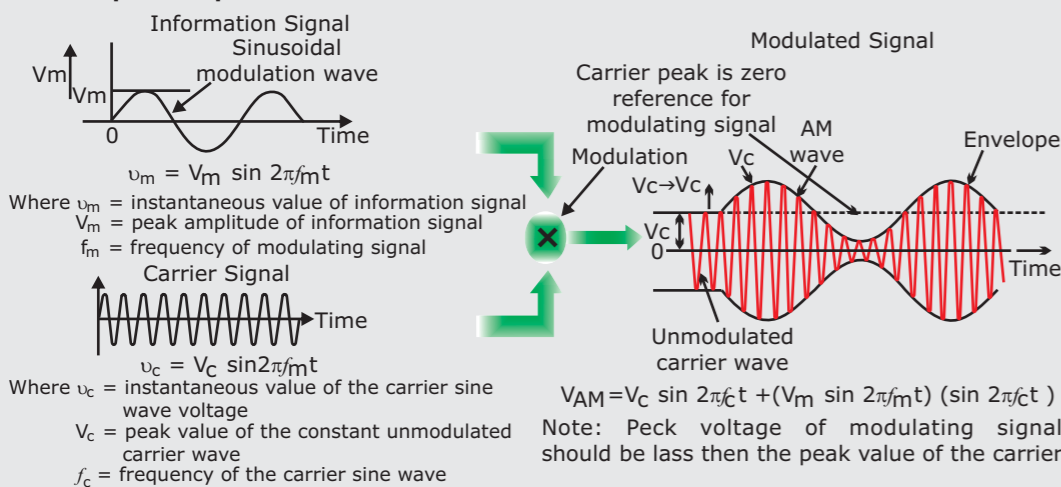
The Advent of AM Radio

The development of the technique is attributed to Lee de Forest and Reginald Fessenden. First transmission took place 1906 from a garage in Brant Rock, Massachusetts by Reginald Fessenden, a Canadian inventor transmitted the world's first voice message by using an Alexanderson alternator and a rotary spark-gap transmitter. His message was heard by radio-equipped ships within a range of several hundred miles away from the transmission point.

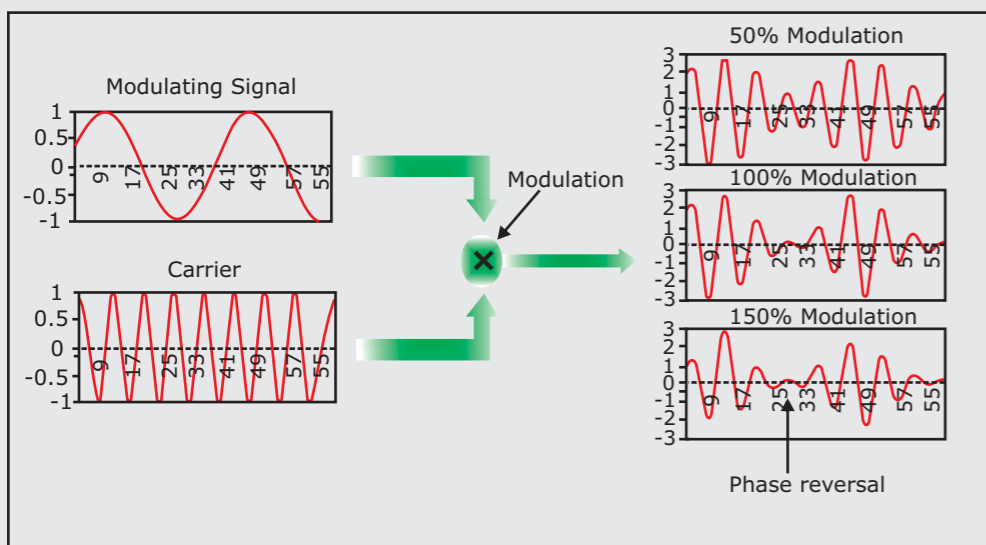
Introduction:

Amplitude Modulation is a process where the amplitude of a carrier signal is altered according to information in a message signal. The frequency of the carrier signal is usually much greater than the highest frequency of the input message signal. The carrier frequency remains constant during the modulation process, but its amplitude varies in accordance with the modulating signal. An increase in the amplitude of the modulating signal causes the amplitude of the carrier to increase.

Concept of Amplitude Modulation

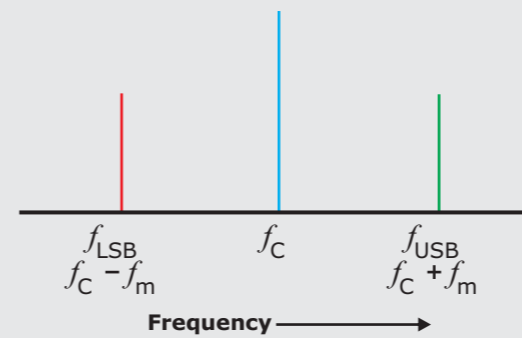


Over Modulation

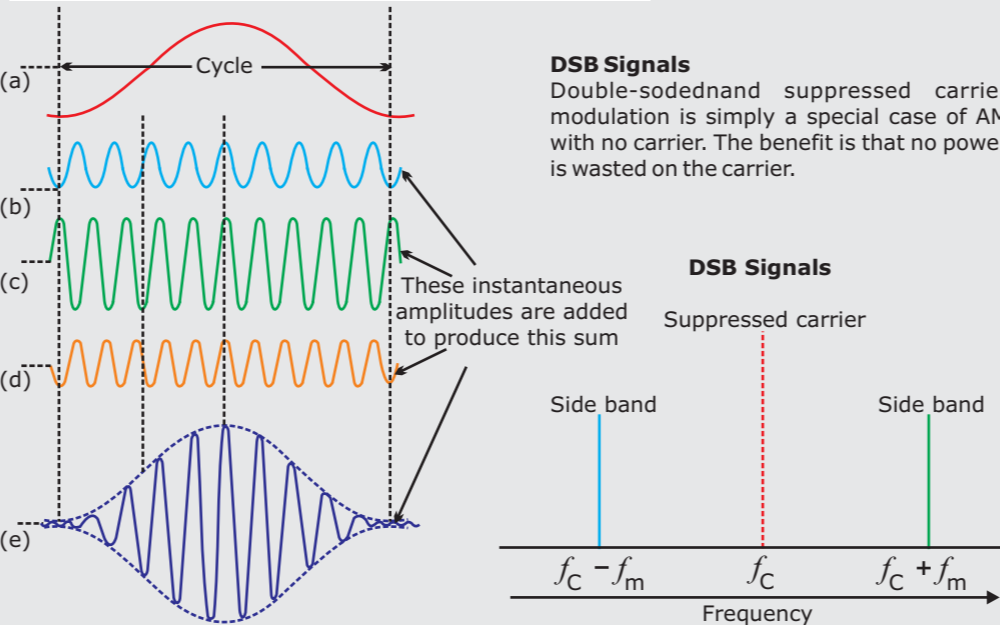


Sidebands and Frequency Domain

Whenever a carrier is modulated by an information signal, new signals at different frequencies are generated as part of the process. These new frequencies, which are called side frequencies, or sidebands, occur in the frequency spectrum directly above and directly below the carrier frequency.



$$v_{AM} = V_c \sin 2\pi f_c t + \frac{V_m}{2} \cos 2\pi(f_c - f_m)t - \frac{V_m}{2} \cos 2\pi(f_c + f_m)t$$



SSB Signals

In DSB transmission, since the sidebands are the sum and difference of the carrier and modulating signals, the information is contained in both sidebands. As it turns out, there is no reason to transmit both sidebands in order to convey the information. One sideband can be suppressed; the remaining sideband is called a single-sideband suppressed carrier (SSB or SSB) signal. SSB signals offer four major benefits:

- * Spectrum space it occupies is only one-half that of AM and DSB signals
- * SSB transmitters can be made smaller and lighter
- * SSB signals occupy a narrower bandwidth, the amount of noise in the signal is reduced
- * Selective fading is not a problem with SSB

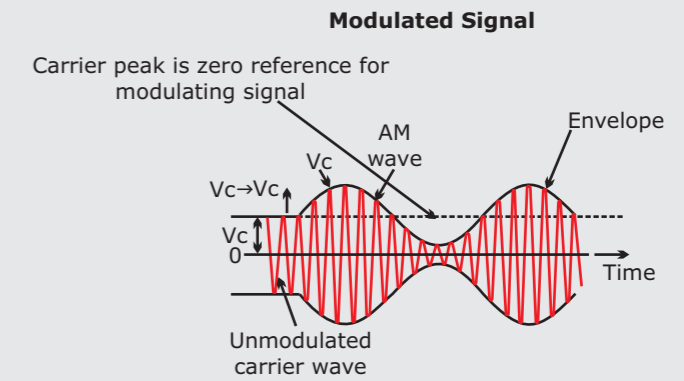
Disadvantages of DSB and SSB

DSB and SSB signals are harder to recover at the receiver. If the carrier is not present, then it must be regenerated at the receiver and reinserted into the signal. To faithfully recover the intelligence signal, the reinserted carrier must have the same phase and frequency as those of the original carrier.

Applications of DSB and SSB

SSB signals are used for two-way radios, marine, military. DSB signals are used in FM and TV broadcasting.

Concept of Amplitude Demodulation

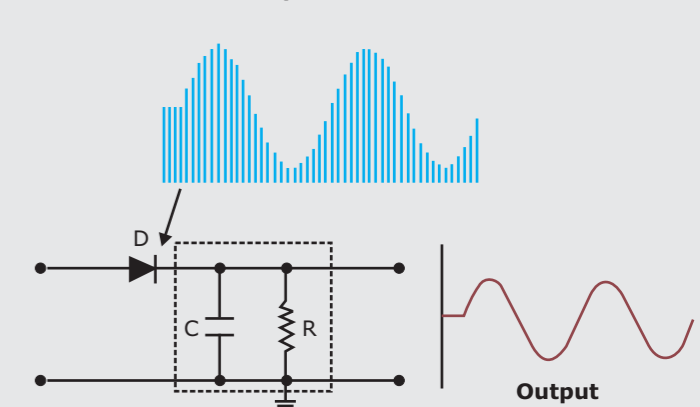


$$V_{AM} = V_c \sin 2\pi f_c t + (V_m \sin 2\pi f_m t) (\sin 2\pi f_c t)$$

Note: Peak voltage of modulating signal should be less than the peak value of the carrier

Input

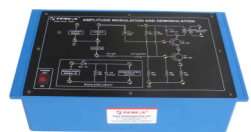
Rectified o/p from diode



The process of detection provides a means of recovering the modulating signal from the modulated signal. Demodulating is the reverse process of modulation. The detector circuit is employed to separate the carrier wave and eliminate the side bands. Since the envelope of an AM wave has the same shape as the message, independent of the carrier frequency and phase, demodulation can be accomplished by extracting the envelope.

Various Terms Used

Modulation Index The ratio of the modulating signal amplitude to the carrier signal amplitude	$m = \frac{V_m}{V_c}$
Lower sideband frequency	$f_{LSB} = f_c - f_m = \frac{\omega_c}{2\pi} - \frac{\omega_m}{2\pi}$
Minimum bandwidth required	$BW_{min} = f_{USB} - f_{LSB} = \frac{2\omega_m}{2\pi}$
Carrier power	$P_c = \frac{(V_{c(rms)})^2}{R_c}$, where $v_{c(rms)} = \frac{V_{c(peak)}}{\sqrt{2}}$
One sideband power	$P_{sb} = \frac{(\frac{1}{2} m V_{c(rms)})^2}{R_c}$, where $v_{c(rms)} = \frac{V_{c(peak)}}{\sqrt{2}}$
Total power to load	$P_{total} = P_c (1 + \frac{m^2}{2})$



40501
Amplitude
Modulation & Demodulation



40502
Frequency
Modulation & Demodulation



40512
Pulse Code
Modulation & Demodulation



40516
DSB / SSB Amplitude
Modulation & Demodulation



40517
DSB / SSB AM Transmitter
Trainer



40518
DSB / SSB AM Receiver
Trainer



40519
Advanced Frequency
Modulation & Demodulation



40536
PAM-PPM-PWM
Modulation/Demodulation