Amplitude Modulation

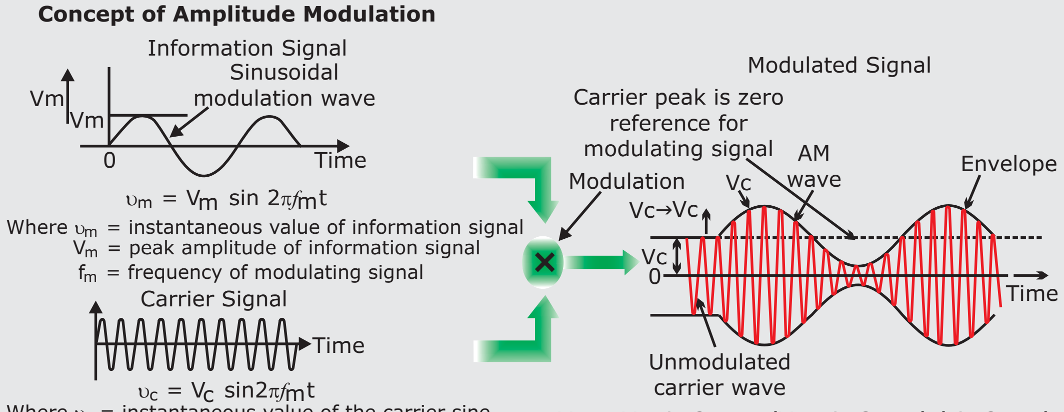
Tesca Technologies Pvt. Ltd.

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 Leblane, 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



$\upsilon_m = V_m \sin 2\pi f_m t$

Where υ_m = instantaneous value of information signal
V_m = peak amplitude of information signal
f_m = frequency of modulating signal

$\upsilon_c = V_c \sin 2\pi f_m t$

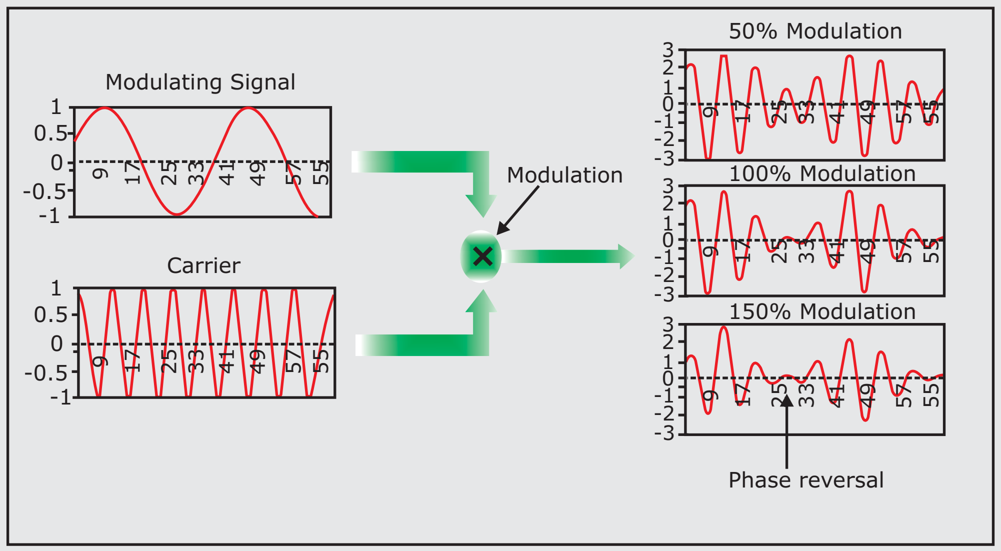
Where υ_c = instantaneous value of the carrier sine wave voltage
V_c = peak value of the constant unmodulated carrier wave
f_c = frequency of the carrier sine wave

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

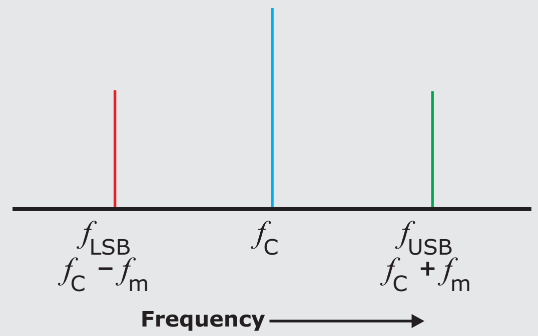
Note: Peck voltage of modulating signal should be lass then the peak value of the carrier

Modulation Index:
In AM, Modulation index is also called modulation depth, indicates how much the modulated signal varies around its 'original' level. The maximum allowed value of m is 1.0. If this is exceed the envelope of the output waveform is distorted. This is known as Over-modulation and should never occur in practice, because the distorted envelope will result in a distorted output sound signal in the radio receiver.

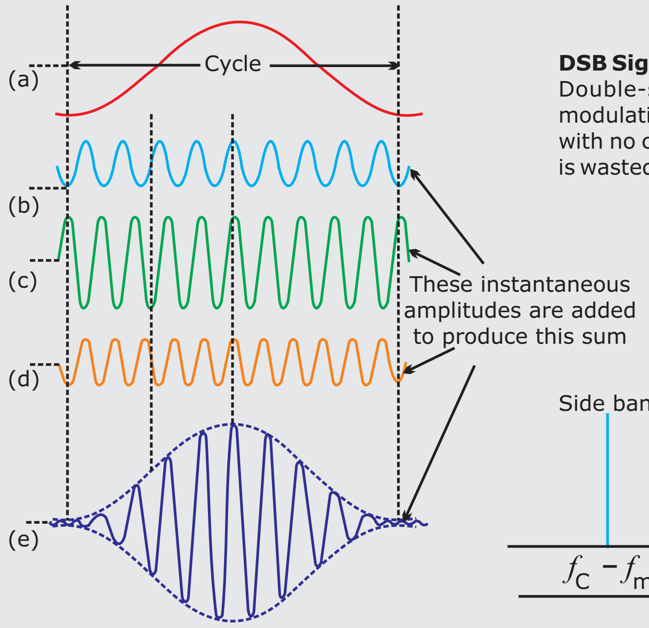
Over Modulation



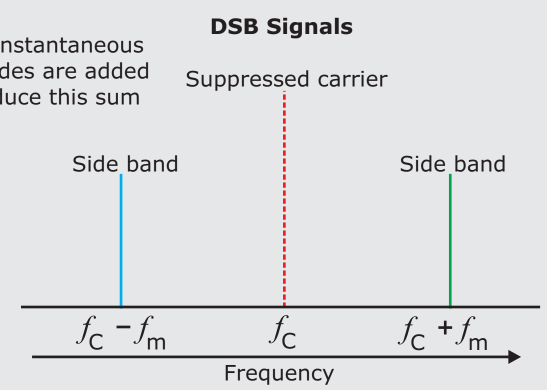
Sidebands and Frequency Domain
Whenever a carrier is modulated by an information signal, new signals at different frequencies are generated as part of the process. These new frequencies, which are called side frequencies, or sidebands, occur in the frequency spectrum directly above and directly below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



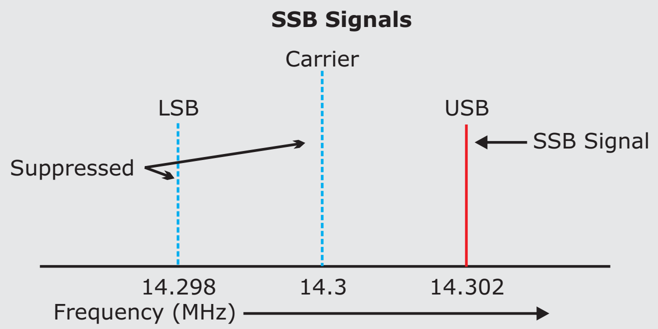
$$v_{AM} = V_c \sin 2\pi f_c t + \frac{V_m}{2}\cos 2\pi t(f_c - f_m) - \frac{V_m}{2}\cos 2\pi t(f_c + f_m)$$



DSB Signals
Double-sodednand suppressed carrier modulation is simply a special case of AM with no carrier. The benefit is that no power is wasted on the carrier.



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 (SSSC or SSB) signal. SSB signals offer four major benefits:

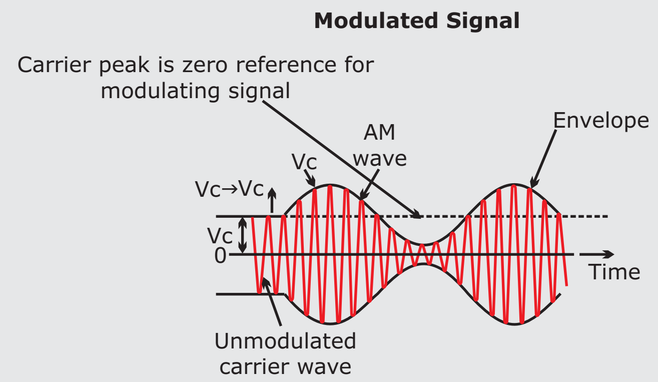


* Spectrum space it occupies is only one-half that of AM and DSB signals
* SSB transmitters can be made smaller and lighter
* SSB signals occupy a narrower bandwidth, the amount of noise in the signal is reduced
* Selective fading is not a problem with SSB

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.

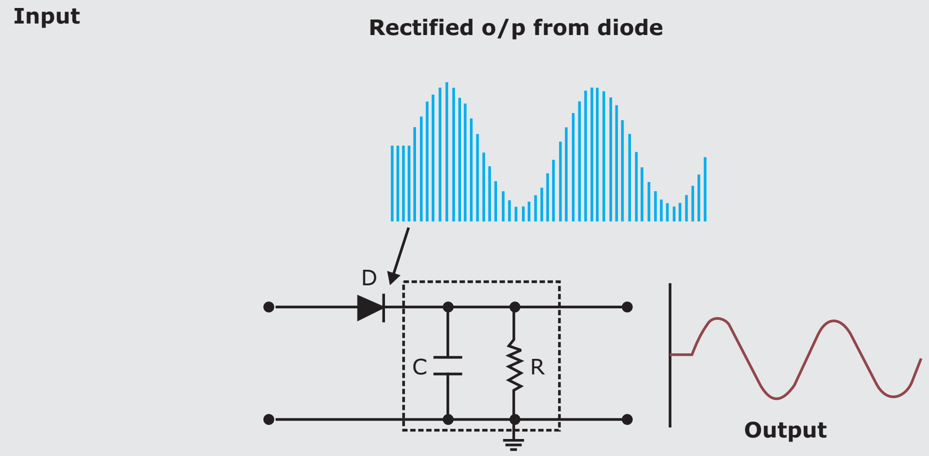
Applications of DSB and SSB
SSB signals are used for two-way radios, marine, military.
DSB signals are used in FM and TV broadcasting.

Concept of Amplitude Demodulation



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

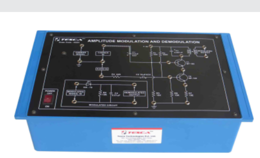
Note: Peck voltage of modulating signal should be lass then the peak value of the carrier



The process of detection provides a means of recovering the modulating Signal from modulating 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 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	$P_c = \frac{(V_{carrier(RMS)})^2}{R_L}$, where $V_{RMS} = \frac{V_{peak}}{\sqrt{2}}$
One sideband power	$P_{SB} = \frac{(\frac{1}{2} m V_{carrier(RMS)})^2}{R_L}$, where $V_{RMS} = \frac{V_{peak}}{\sqrt{2}}$
Total power to load	$P_{total} = P_c(1 + \frac{m^2}{2})$

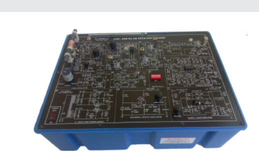

40501 Amplitude Modulation & Demodulation

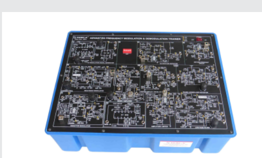

40502 Frequency Modulation & Demodulation


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

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