Department of Communications Engineering

Communication Systems

Third Year Class

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Lecture 4

Quadrture Carrier Modulation and Single Side Band Modulation

Quadrature-Amplitude Modulation (QAM)

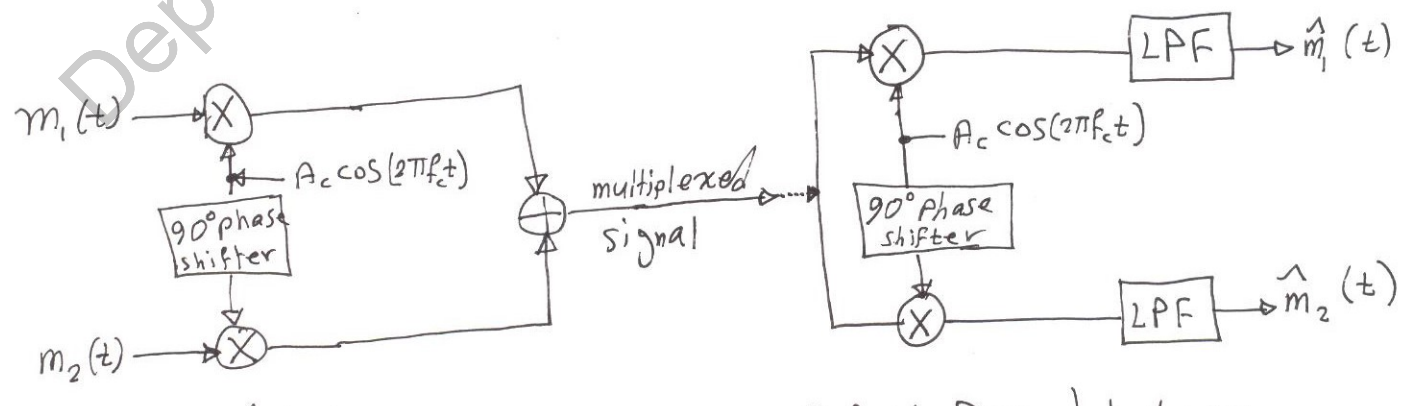
- Also called Quadrature Carrier Multiplexing
- In this modulation scheme, two DSB-SC can hold two different messages on the same carrier.
- Therefore, this scheme is bandwidth-conservation scheme.
- QAM is used for digital modulation of analoge carriers in data modems to convey data through the public telephone network. Also, QAM used for digital satellite communications systems.

* Thus, two messages $m_1(t)$ & $m_2(t)$ using one f_c as follows

$$x_{QAM}(t) = m_1(t) A_c \cos(2\pi f_c t) + A_c m_2(t) \sin(2\pi f_c t)$$

OR

$$x_{QAM}(t) = m_1(t) A_c \sin(2\pi f_c t) + A_c m_2(t) \cos(2\pi f_c t)$$



QAM - Modulator   QAM - Demodulator which

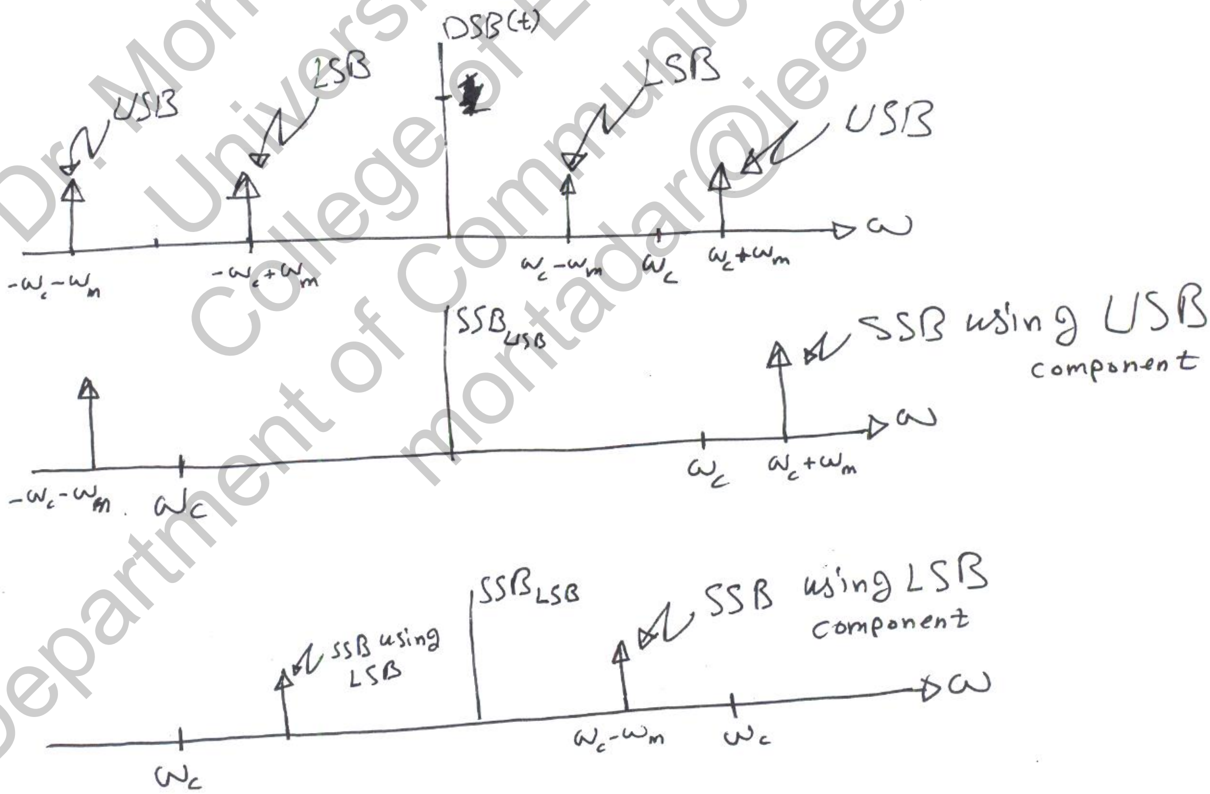
Single Side Band (SSB) Modulation

* We have seen that DSB transmits LSB & USB which they are holding the same information message. Thus, it is not necessary to transmit both sidebands.

* If one sideband (SSB) was transmitted, the occupied bandwidth of the DSB-SC will be halved.

$$\therefore BW_{SSB} = \frac{BW_{DSB}}{2} = \frac{2 f_m}{2} = f_m \text{ Hz.}$$

However, this bandwidth saving is accompanied by a considerable increase in complexity.



However, the SSB signal can be expressed as

$$x_{SSB}(t) = m(t)\cos\omega_c t \pm \tilde{m}(t)\sin\omega_c t$$

where $\tilde{m}(t)$ is the same as $m(t)$ but with its phase shifted by $-\frac{\pi}{2}$.

Hence,

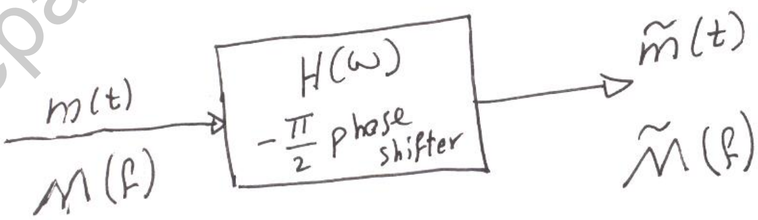
* For selecting the Lower sideband of the DSB-SC,

$$x_{LSSB}(t) = m(t)\cos\omega_c t + \tilde{m}(t)\sin\omega_c t$$

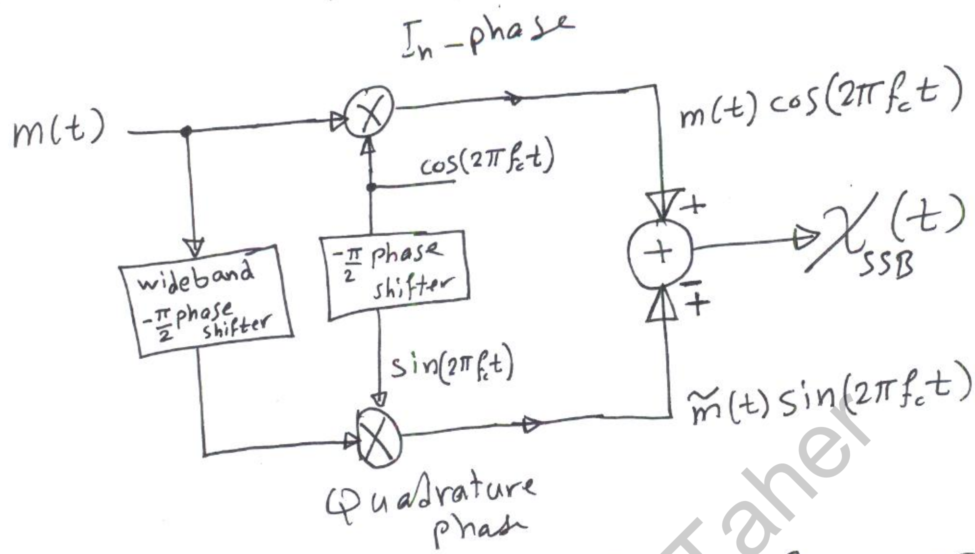
* For selecting the upper sideband of the DSB-SC

$$x_{USSB}(t) = m(t)\cos\omega_c t - \tilde{m}(t)\sin\omega_c t$$

* $\tilde{m}(t)$ can be obtained using Hilpert transform



* SSB finds applications in mobile radio communications, telemetry, military, navigation and amature radio. Many of these applications are point to point communication applications.



where (+) for LSB & (−) for USB