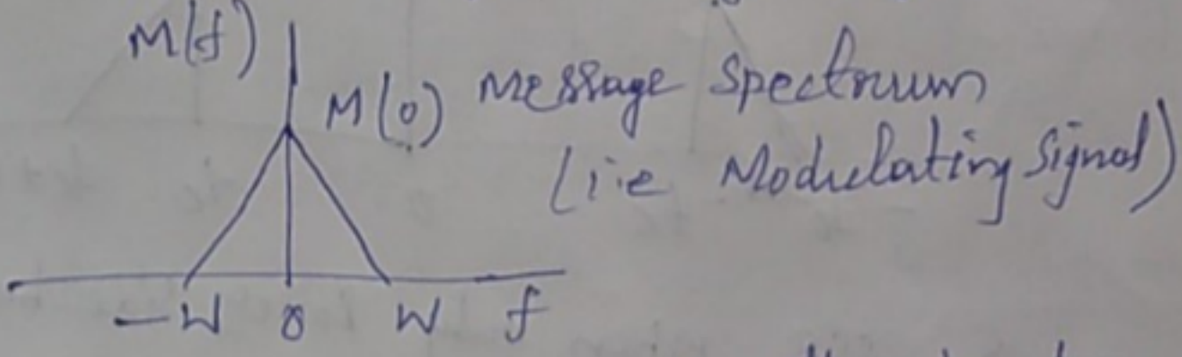
SSB (Single Side Band) Modulation

There are different Methods for generating SSB Modulation.

1) Frequency Domain Description

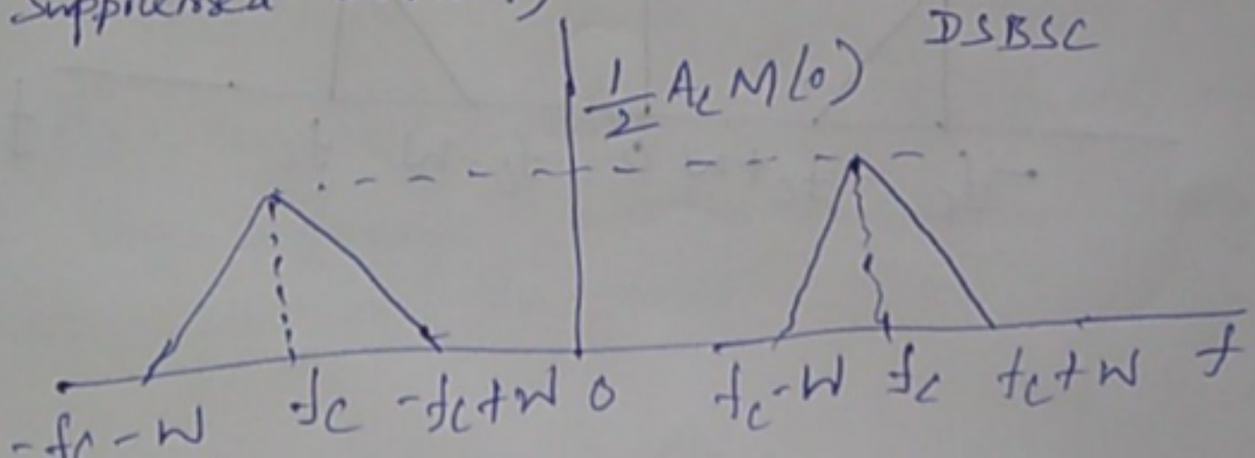
⇒ It depends on which Side band is transmitted

fig:- Spectrum of Message Signal



⇒ The spectrum is limited to the band $-W \leq f \leq W$

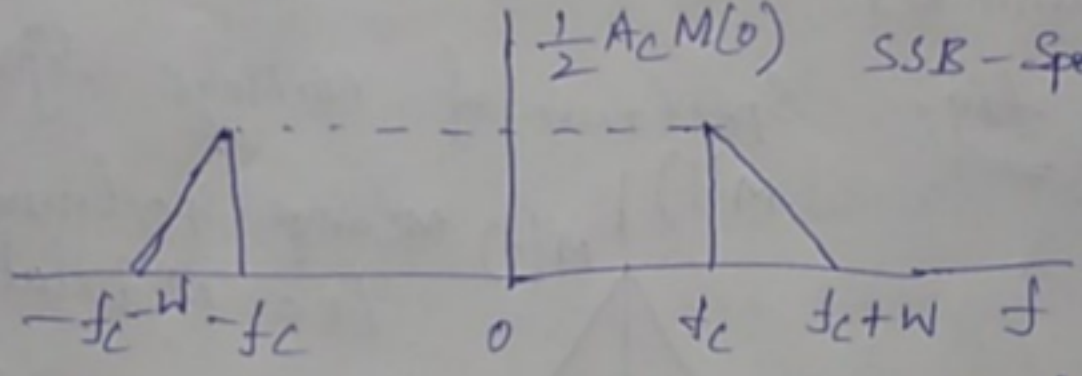
fig:- Spectrum of DSBSC (Double Side Band Suppressed carrier)



→ We know that, the spectrum of the DSBSC Modulated wave, can be obtained by Multiplying $m(t)$ by the carrier wave $A_c \cos(2\pi f_c t)$.

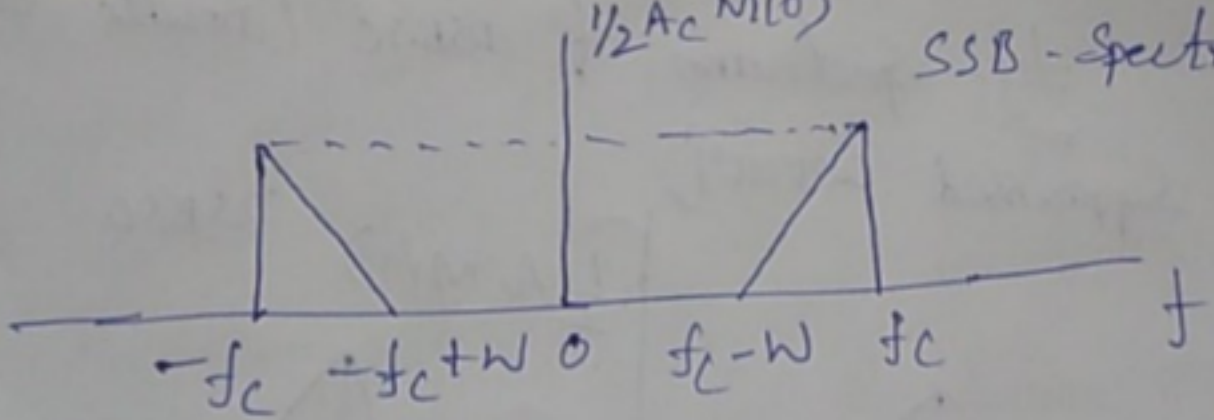
→ In SSB, when only upper sideband is transmitted

fig: Spectrum of SSB Modulated wave with the Upper Sideband (USB) transmitted.



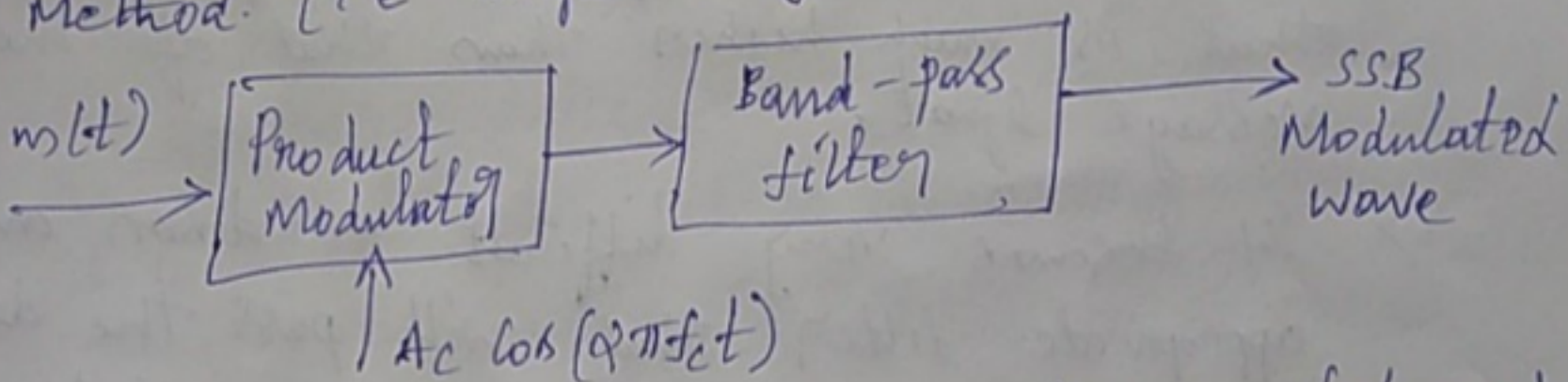
→ In SSB, when only lower sideband is transmitted

fig: Spectrum of SSB Modulated wave with the lower Sideband (LSB) transmitted.



Frequency Discrimination Method for Generating SSB Modulated

fig:- Block diagram of frequency discrimination Method. (i.e Single-stage modulation)



⇒ Here after Product Modulator i.e balanced Modulator, the filter i.e band pass filter can be used to remove Unwanted Sideband

⇒ The filter has flat passband and extremely high attenuation outside the passband.

⇒ In order to have above response the Q i.e Quality factor of the tuned circuits must be very high.

⇒ The required value of Q factor increases as the difference between Modulation frequency and carrier frequency.

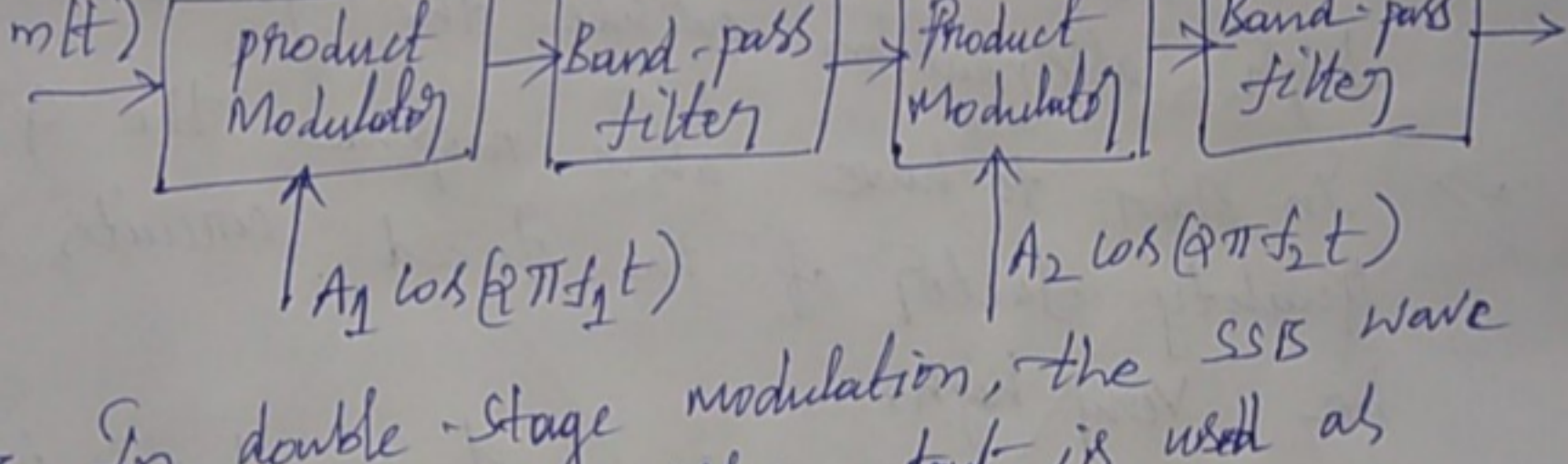
⇒ carrier frequency usually same as the transmitter frequency.

⇒ When it is necessary to generate an SSB-Modulated wave occupying a frequency band that is much higher than that of the message signal,

⇒ It becomes very difficult to design an appropriate filter that will pass the desired sideband and reject other using single stage Modulation.

(Stages)

fig:- Block diagram of a two-~~Stages~~ SSB Modulator

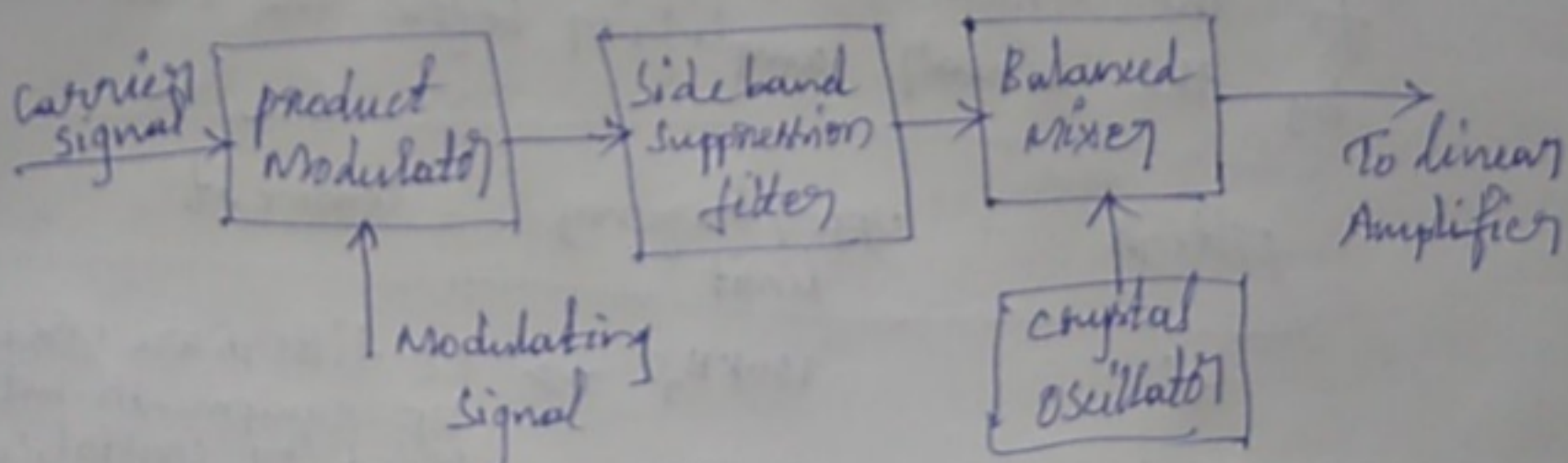


⇒ In double-stage modulation, the SSB wave at the first filter output is used as Modulating wave for the second Modulator.

→ The second modulator produces DSBSC wave with a spectrum i.e symmetrically spaced about the second carrier frequency f_2.

→ The frequency separation between the side bands of this DSBSC modulated wave is effectively twice the first carrier frequency f_1. Therefore, it is easier to remove unwanted sideband by second filter.

fig:- Filter Method of Sideband Suppression



→ For higher transmitting frequencies the required value of Q is so high that there is no practical way of achieving it.

→ In such a situation initial modulation is carried out at low frequency carrier say

⇒ The balanced modulator is used to suppress the carrier. Then filter suppresses one-side band signal.

⇒ The frequency of the SSB signal is very low as compared to the transmitter frequency.

⇒ This frequency is boosted up to the transmitter frequency by the balanced mixer and crystal oscillator. The process of boosting up the frequency is called Up-Conversion.

⇒ The sideband signal having frequency equal to the transmitter frequency is then amplified by the linear amplifier before the transmission.

Filters	Upper Frequency limit	Comment
LC	100KHz	⇒ LC filters are used in HF equipments, but superseded by crystal, ceramic and Mechanical filters.
Mechanical	500KHz	⇒ Mechanical filters have small size, good bandpass, very good attenuation characteristics and an adequate upper frequency limit
Ceramic and Crystal	20MHz	⇒ Ceramic and crystal filters are cheaper but are preferenable only at frequencies above 1MHz.

Advantages of filter Method

* It gives Sideband Suppression upto 50dB.
* It can be helps to attenuate carriers if present in the output of balanced Modulator.
* Bandwidth is sufficiently flat and wide

Disadvantages of filter Method

* They are bulky.
* As modulation takes place at lower carrier frequency repeated mixing is required in conjunction with extremly stable oscillators to generate SSB at high radio frequencys.
* At lower audio frequencies expensive filters are required.