SINGLE SIDEBAND SUPPRESSED CARRIER (SS-SB) & VESTIGIAL SIDEBAND MODULATION (VSB)

ECE 328

Principles of Communication Systems

Monday, 04 September 2017

HISTORY OF SSB

- **1915:** First patent for SSB by John Carson.
- **1927:** SSB used on long wave transatlantic public radiotelephone circuit between New York and London.
- **1930:** SSB used on long distance telephone communication as frequency-division multiplexing (FDM).

ADVANTAGES OF SINGLE SIDE-BAND SUPPRESSED CARRIER (SSB-SC)

1. **Less bandwidth required:** Half that of DBSB

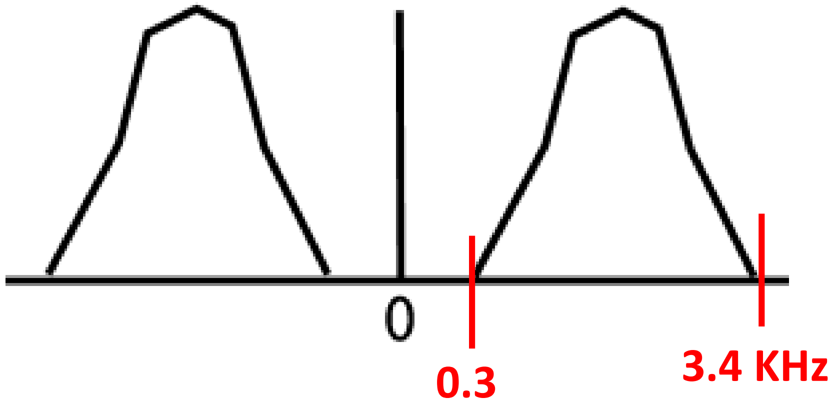
2. **Less transmitter power:** Quarter that of AM and half that of DSB-SC

3. **Reduced noise interference** due to less bandwidth

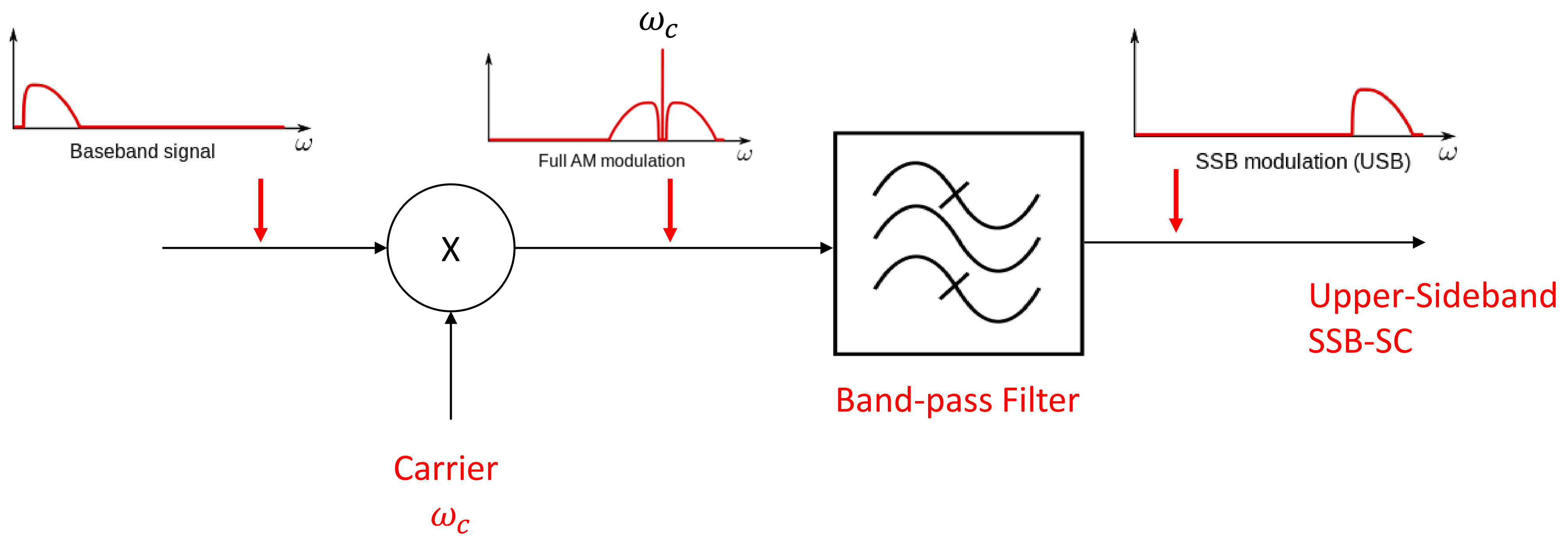
DISADVANTAGES OF SINGLE SIDE-BAND SUPPRESSED CARRIER (SSB-SC)

- Designing and implementing the sharp Low-pass (or High-pass/pass-band) filter is not easy for circuit designer.

- SSB is difficult to implement for the message signal which contains the significant energy around zero frequency such as video signal, computer data, and etc.



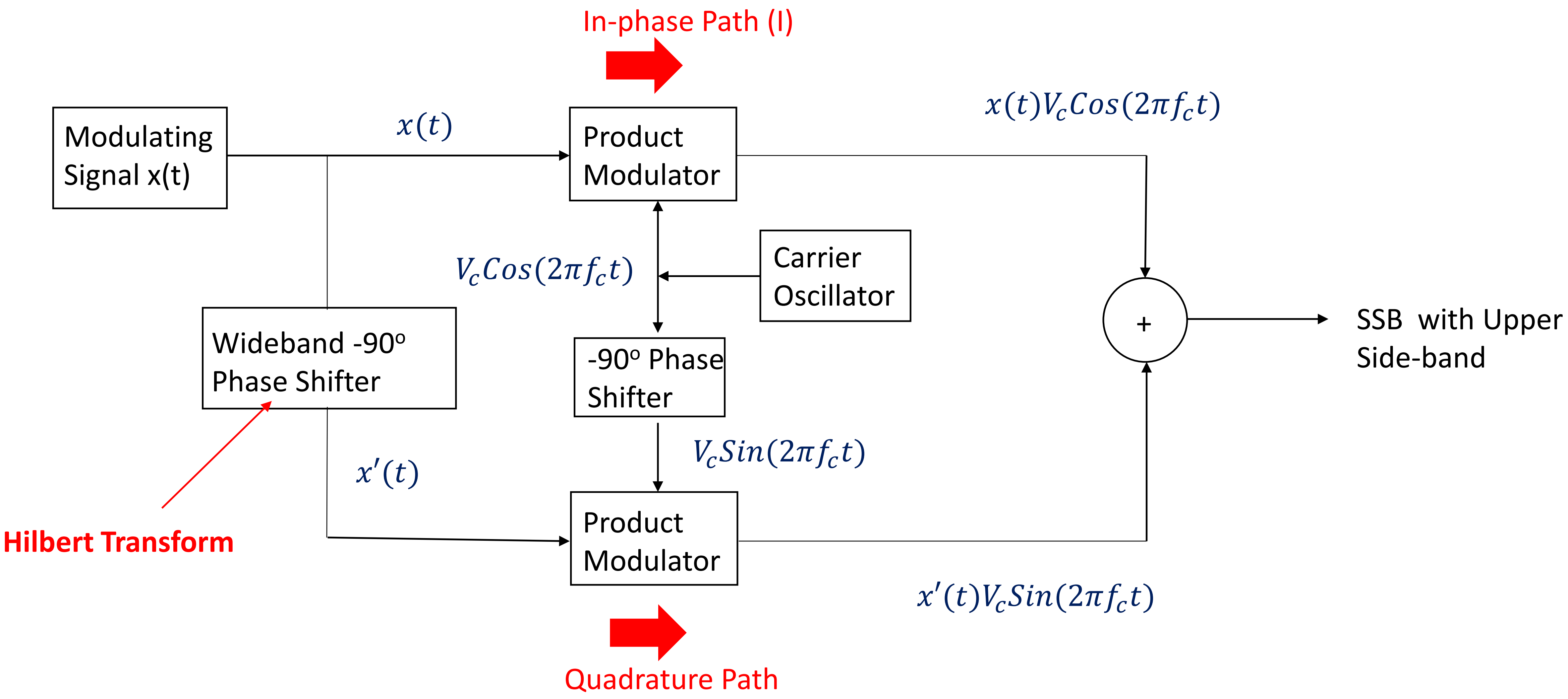
GENERATING SSB-SC USING FREQUENCY DISCRIMINATION METHOD



Limitations:

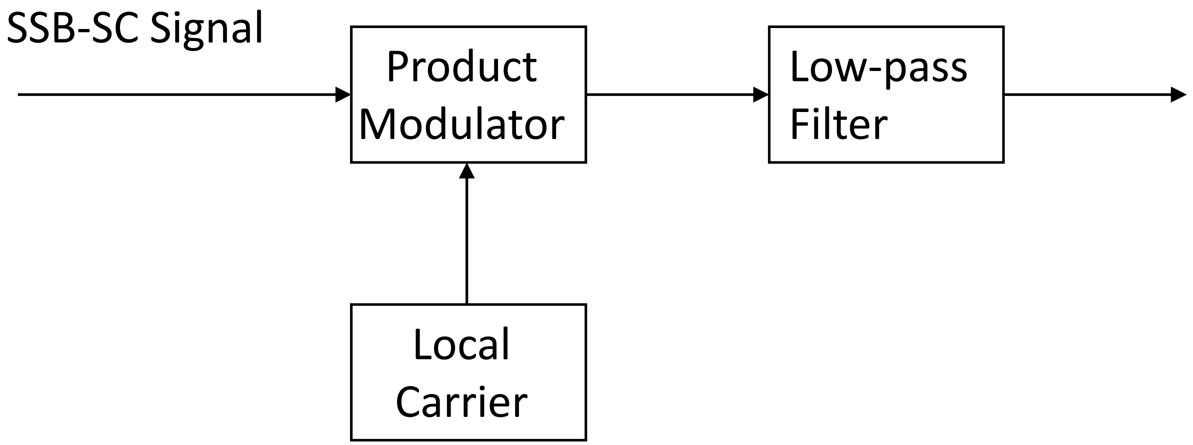
1. The baseband signal must have a guardband. This is easy to provide for voice but difficult for certain signals, e.g. video
2. The baseband signal must be appropriately related to the carrier.

GENERATING SSB-SC USING PHASE SHIFT METHOD



DEMODULATING SSB-SC SIGNALS

- SSB demodulation employs a locally generated coherent carrier as shown.



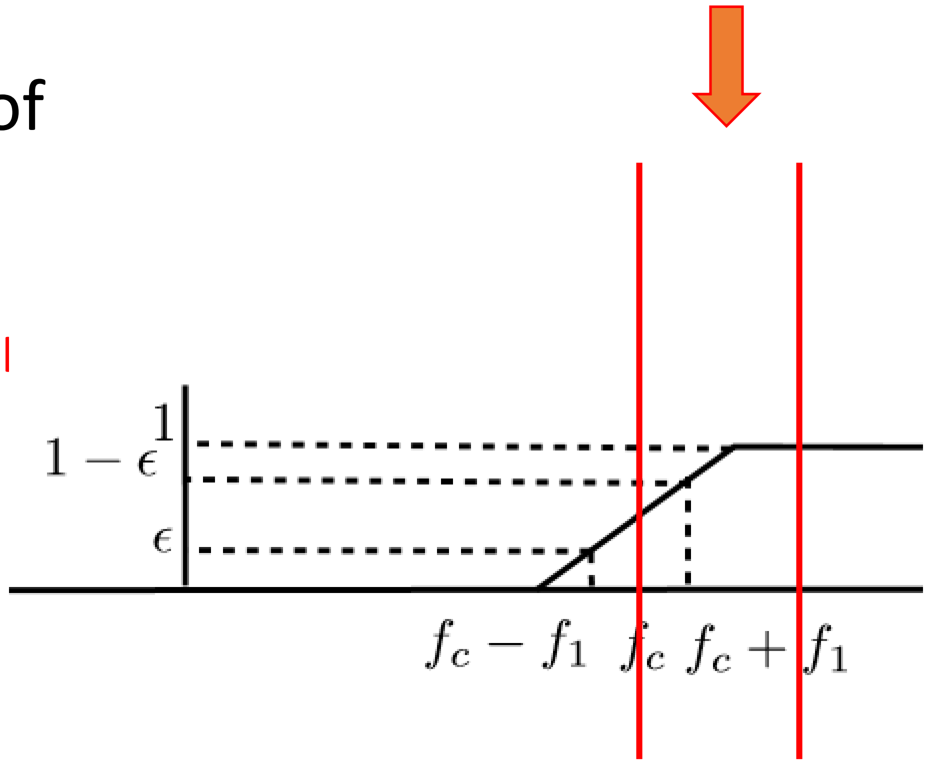
VESTIGIAL SIDEBAND MODULATION

ECE 328 – PRINCIPLES OF COMMUNICATION SYSYEMS

INTRODUCTION

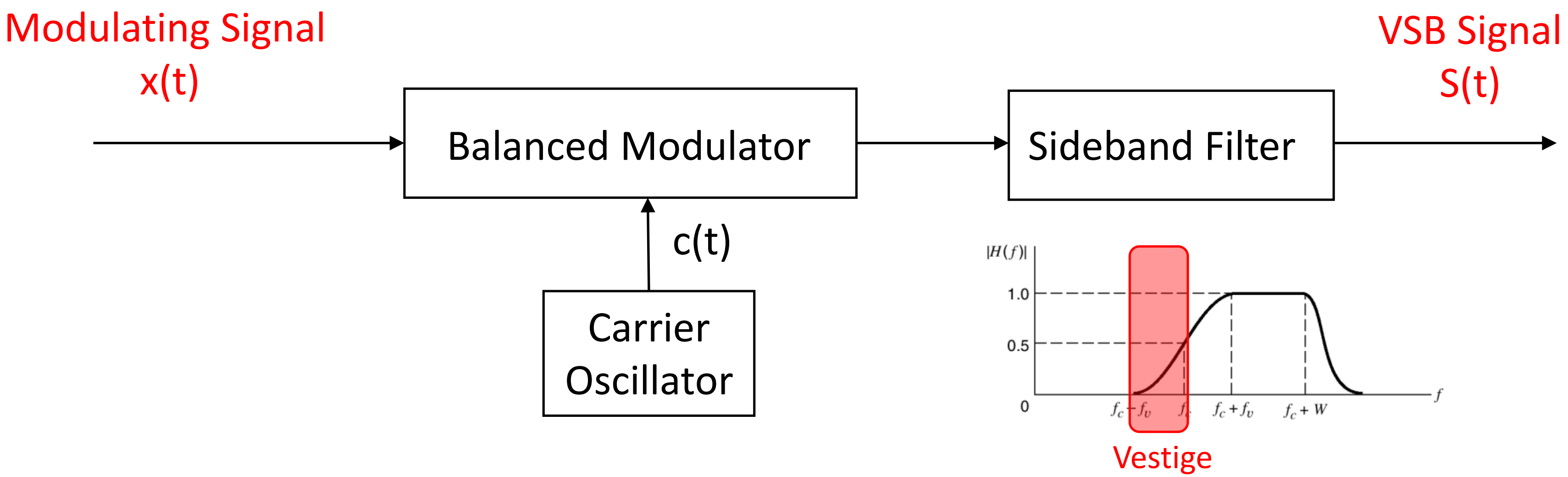
1. **Vestigial Sideband (VSB)** Modulation was introduced to overcome the two difficulties of the SSB modulations.
2. **VSB** allows a small amount, or vestige, of the unwanted sideband to appear at the output of an SSB modulator
3. The design of the sideband filter is therefore simpler compared with SSB since the need for sharp cut-off at the carrier frequency is eliminated.
4. In addition, a VSB system has improved low-frequency response and can even have dc response.

No need for Sharp cut-off filter



NEED FOR A VESTIGE

1. **Vestigial Sideband (VSB) Modulation** relaxes the stringent requirement on the frequency response of the sideband filter by allowing part of the unwanted sideband (called vestige) to appear in the output.
2. VSB signals are easier to generate because some roll-off in filter edges is allowed.
3. VSB therefore results in system simplification and is therefore a compromise between DB-SC and SSB-SC.

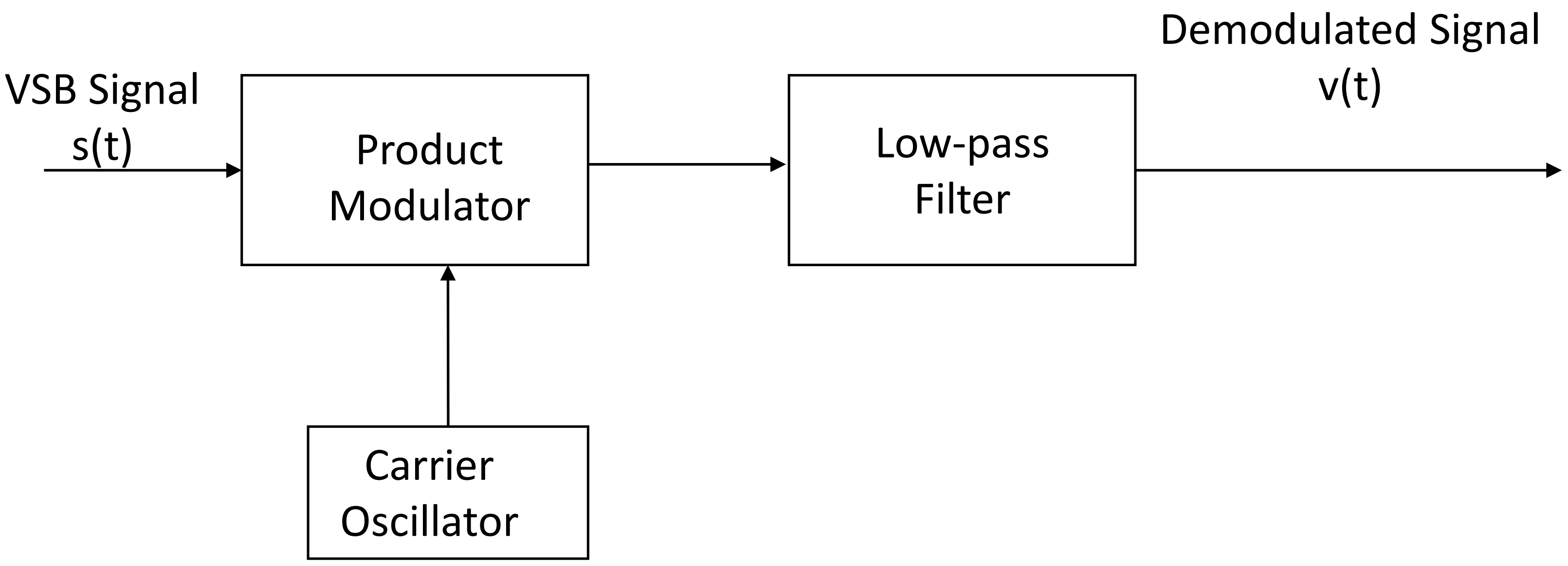


ADVANTAGES OF VSB (SUMMARY)

1. Efficient use of bandwidth, i.e better than DS-AM but not as good as SSB-AM;
2. Less constraints on filter thus making it easier to design filters;
3. Easier to transmit low frequency components especially those arising from data communications or video signals.

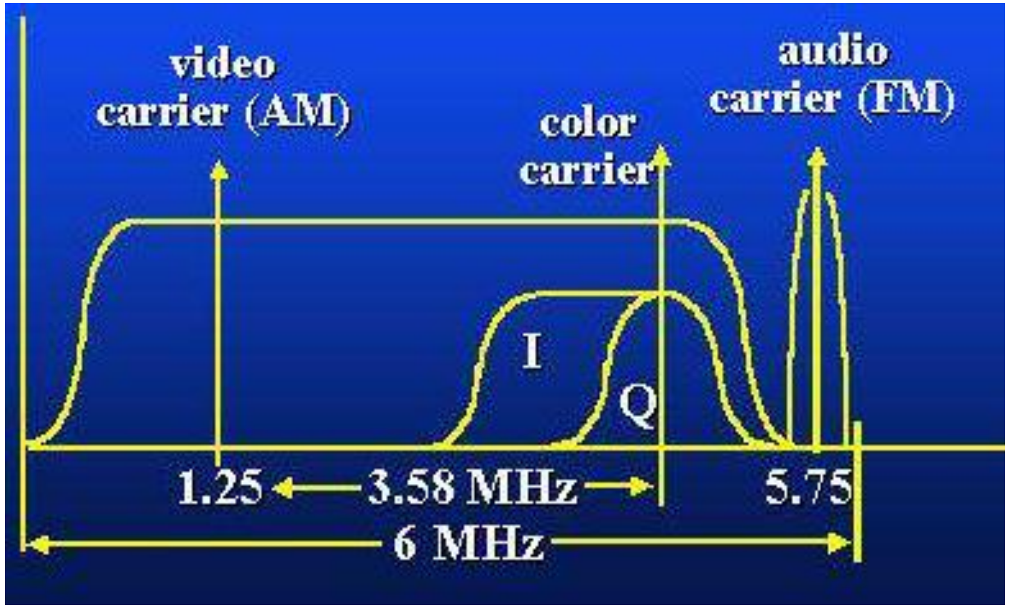
DEMODULATION OF VSB SIGNALS

VSB signals are demodulated by multiplying the VSB signal with a locally generated carrier



APPLICATION OF VSB

1. PAL Television picture signal has nominal bandwidth of 6 MHz
2. If DSB-SC modulation was used, it would have required at least 12 MHz for each TV channel.
3. VSB modulation is used to confine the signal to about 8MHz.

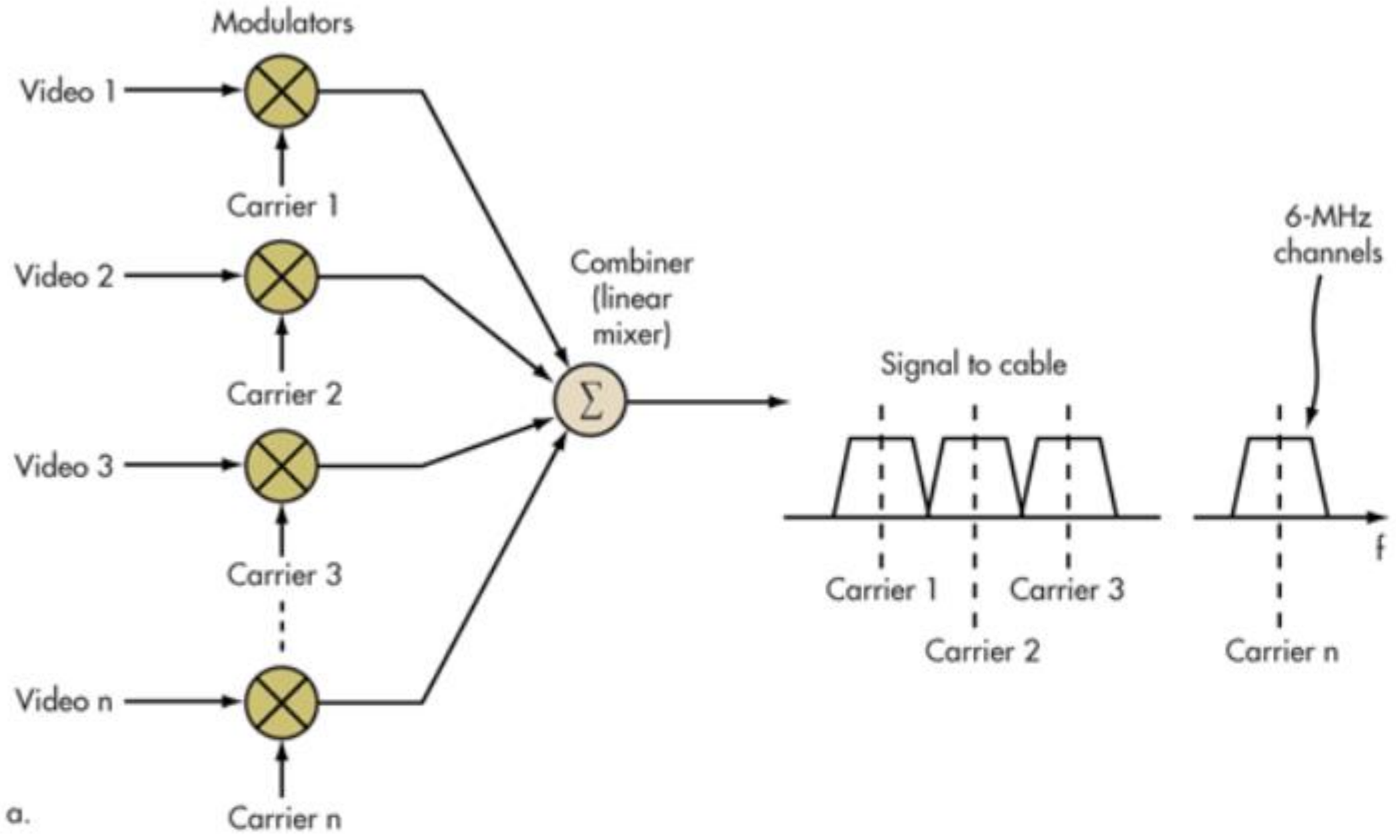


APPLICATION EXAMPLE – CABLE TV COMPANIES

1. All of the TV signals and Internet data are transmitted in a spectrum of 6-MHz wide channels. Since a coax cable has a bandwidth as wide as 850 MHz to slightly over 1 GHz, the system can accommodate from 140 to 170 downstream channels of 6 MHz each.
2. The TV signals or Internet data are modulated on to carriers in each channel.
3. There are also upstream channels that allow the consumer to transmit data back to the headend.
4. This communication takes places in 6-MHz channels as well that occupy the cable spectrum from 5 MHz to 40 MHz or in some systems up to 65 MHz.

MULTIPLEXING OF TV SIGNALS

In older systems, the video information is modulated on to the 6-MHz channel carriers and then all channels are combined or linearly mixed to form the composited cable signal.



DIGITAL SYSTEMS

In modern digital systems, the digitized video is sent to an application-specific integrated circuit (ASIC) or Filed Programmable Gate Array (FPGA) programmed to produce the desired quadrature amplitude modulation (QAM) for each channel.

The signals are then digitally upconverted to the final frequency and sent to a wideband digital-to-analogue converter (DAC) that produces the composite multi-channel signal to be sent to the cable.