VESTIGIAL SIDEBAND (VSB) MODULATION

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IIT Bombay

AM → carrier power + 2 × (BW)

DSB-SC → 2 × (BW)

SSB → BW

(BW: Bandwidth of the message signal)

complexity of implementation INCREASES

VSB MODULATION

- A VSB system is a compromise between DSB and SSB

- In VSB, instead of rejecting one sideband completely as in SSB, a gradual cutoff of the sideband is accepted. ALMOST ALL of the one sideband is transmitted and a small amount (VESTIGE) of the other sideband

- The sideband suppression filter is allowed to have a nonzero transition band
- The roll-off characteristic of the filter is such that the partial suppression of the Xmitted sideband in the neighborhood of the carrier frequency is exactly compensated for by the partial transmission of the corresponding part of the suppressed sideband

VSB filter (sideband shaping filter)

(only the positive-frequency portion is shown)

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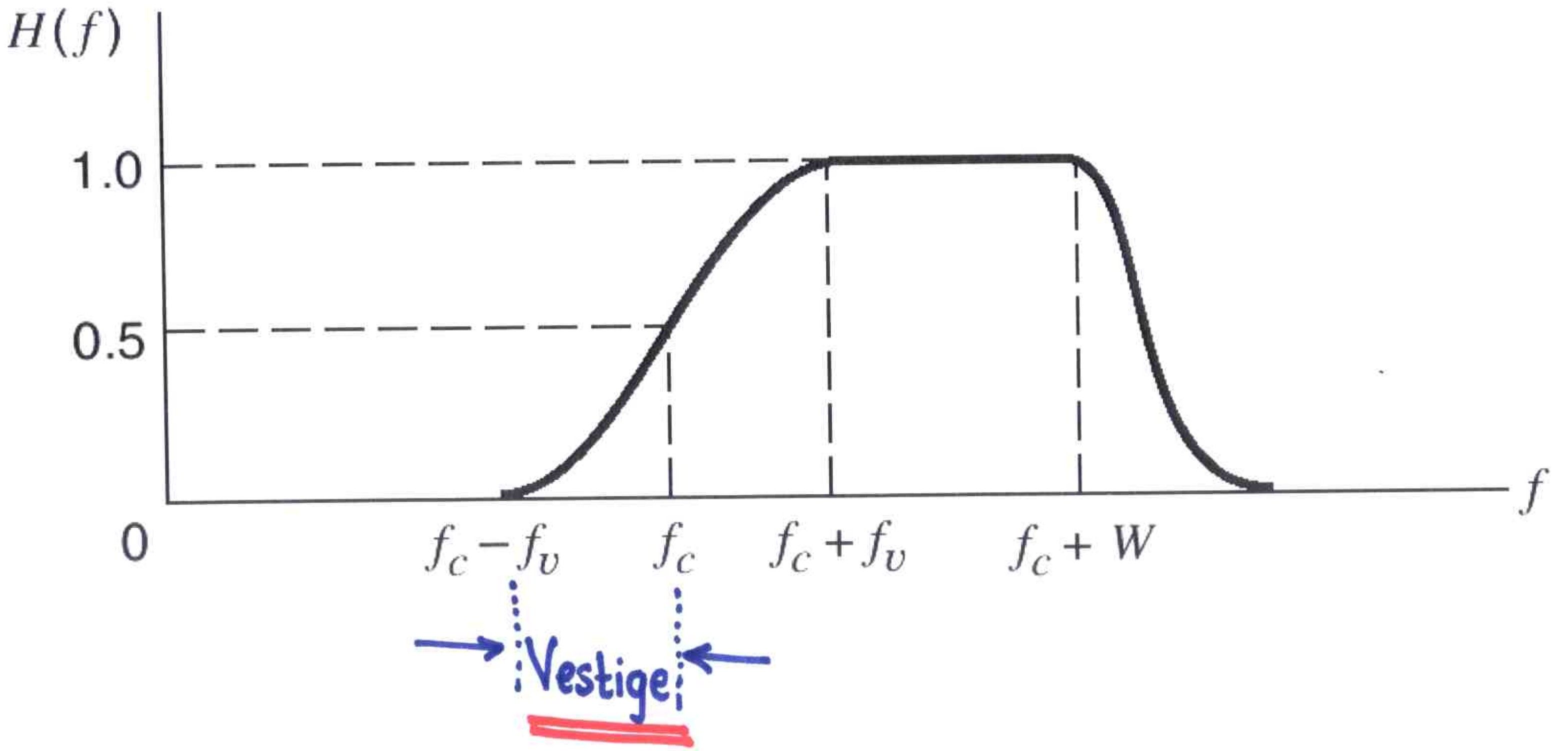
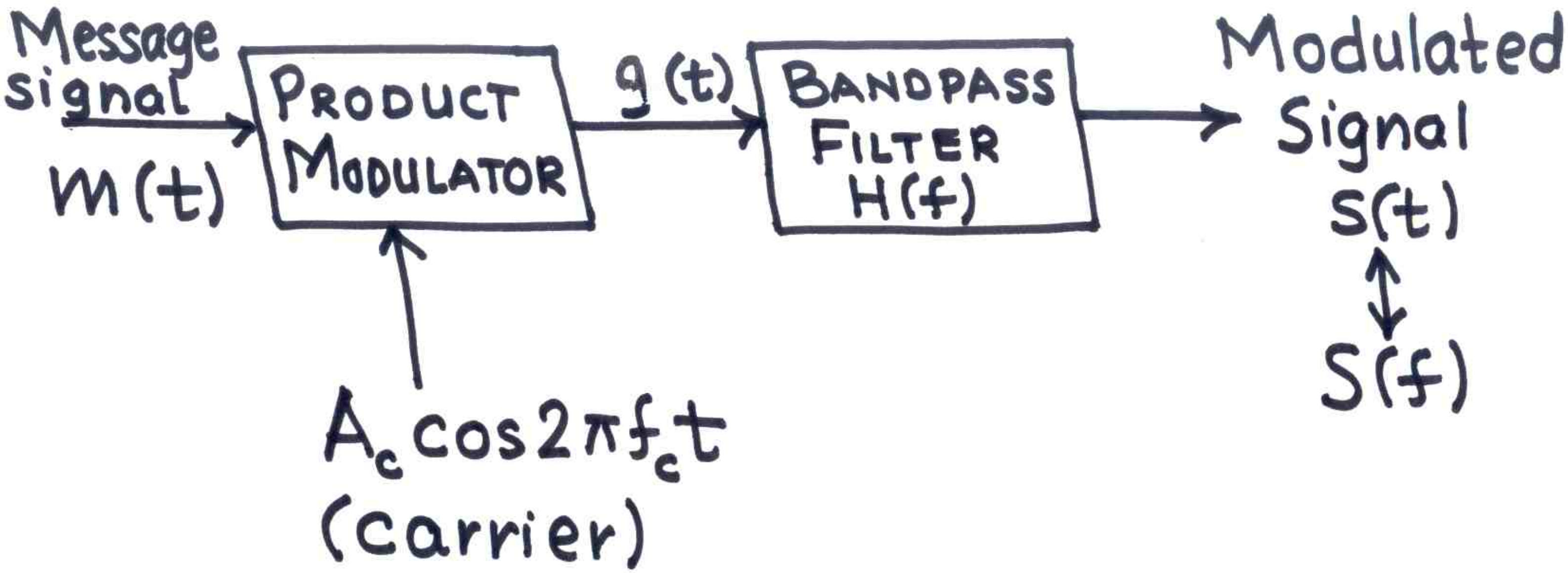


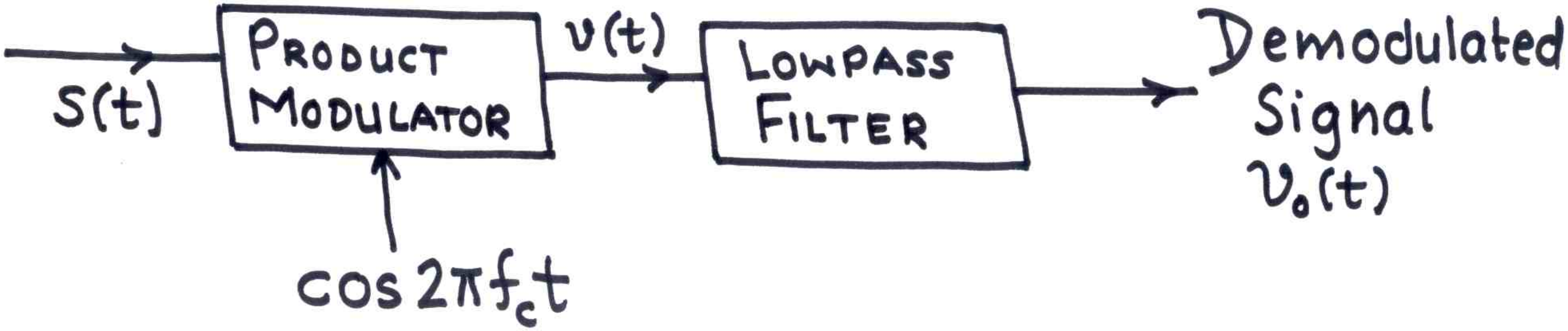
* OUR GOAL is to determine the particular '$H(f)$' required to produce a modulated signal $s(t)$ with desired spectral characteristics, such that the original baseband signal $m(t)$ may be recovered from $s(t)$ by coherent detection

message signal : $m(t)$

carrier : $c(t) = A_c \cos 2\pi f_c t$

modulated VSB signal : $s(t)$


Message signal
$m(t)$
PRODUCT MODULATOR
$g(t)$
BANDPASS FILTER $H(f)$
Modulated Signal
$s(t)$
$S(f)$
$A_c \cos 2\pi f_c t$
(carrier)


$s(t)$
PRODUCT MODULATOR
$v(t)$
LOWPASS FILTER
Demodulated Signal
$v_o(t)$
$\cos 2\pi f_c t$

$$v(t) = \cos 2\pi f_c t \cdot s(t)$$

$$V(f) = \frac{1}{2}\left[S(f-f_c) + S(f+f_c)\right]$$

$$= \frac{A_c}{2} M(f)\left[H(f-f_c) + H(f+f_c)\right]$$

$$+ \frac{A_c}{2}\left[M(f-2f_c)H(f-f_c) + M(f+2f_c)H(f+f_c)\right]$$

$\Downarrow$ LOWPASS FILTER

{VSB wave modulated onto $2f_c$}

$$V_0(f) = \frac{A_c}{2} M(f)\left[H(f-f_c) + H(f+f_c)\right]$$

Requirement: $V_0(f) \propto M(f)$

$$\Rightarrow \boxed{H(f-f_c) + H(f+f_c) = 1, \quad -W \leq f \leq W}$$

$$v_0(t) = A_c/2 \cdot m(t)$$

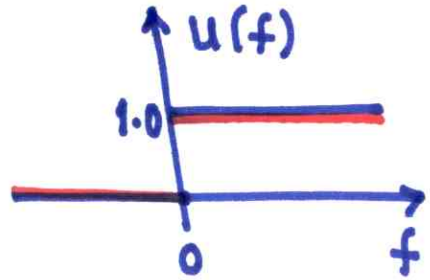
Two properties of the sideband shaping filter:

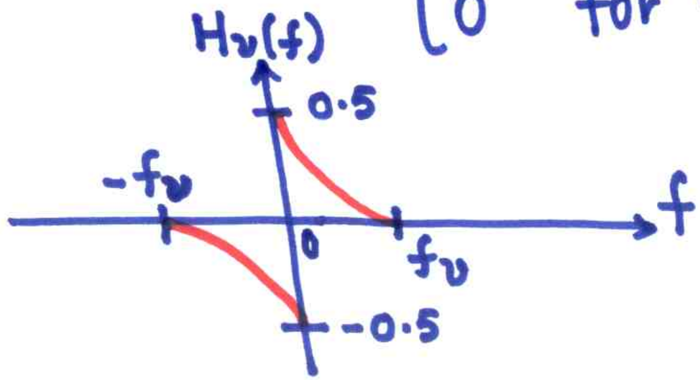
(1) Transfer function:

exhibits ODD SYMMETRY about f_c

$$H(f) = u(f-f_c) - H_v(f-f_c) \quad \text{for } f_c - f_v < |f| < f_c + W$$

$$u(f) = \begin{cases} 1 & \text{for } f > 0 \\ 0 & \text{for } f < 0 \end{cases}$$





(2)

VSB filter (sideband shaping filter)

(only the positive-frequency portion is shown)

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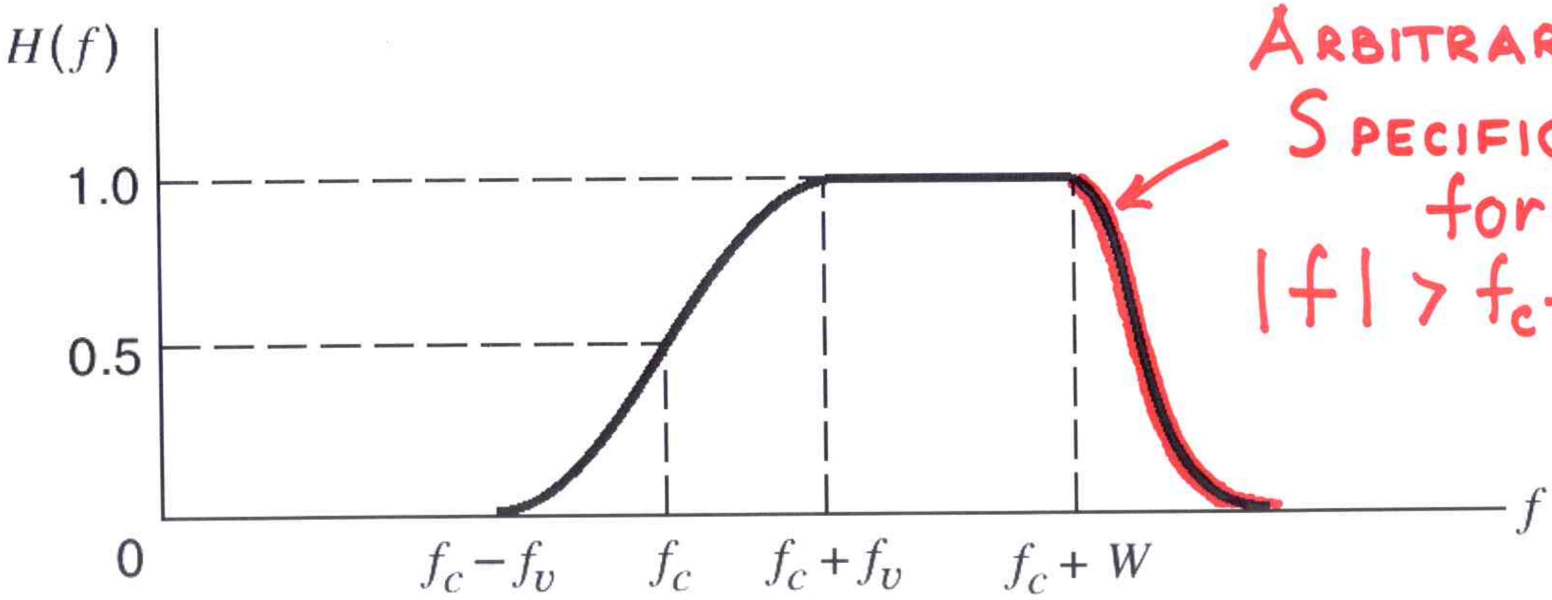

ARBITRARY SPECIFICATION for $|f| > f_c + W$

MODULE

END