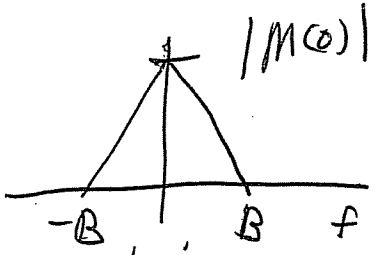
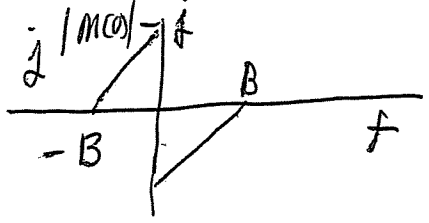
EE511: Lecture 17: Vertical Side Band Modulation and Hilbert Transform

Recall Hilbert Transform: $\hat{m}(t) = m(t) * h(t)$

where $h(t) = \frac{1}{\pi t} \longleftrightarrow H(f) = \begin{cases} -j & \text{for } f > 0 \\ j & \text{for } f < 0 \end{cases}$

$= -j\,\text{sgn}(f)$

let $M(f) =$ 

then $\hat{M}(f) =$ 

Let $G_1(f) = A_c\, M(f) \left[1 \pm j\, H(f)\right]$ ← upper or lower sideband

given $V(f) = \frac{1}{2}\left\{ G_1(f - f_c) + G_1^*(-(f + f_c)) \right\}$

$$S(f) = \frac{A_c}{2}\left[M(f - f_c) + j\,\hat{M}(f - f_c) + M^*(-f - f_c) - j\,\hat{M}(-f - f_c) \right]$$

We will look at some examples later

Vestigal Sidebands Modulation

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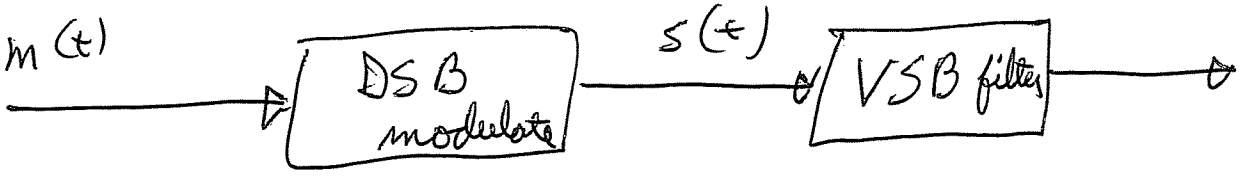
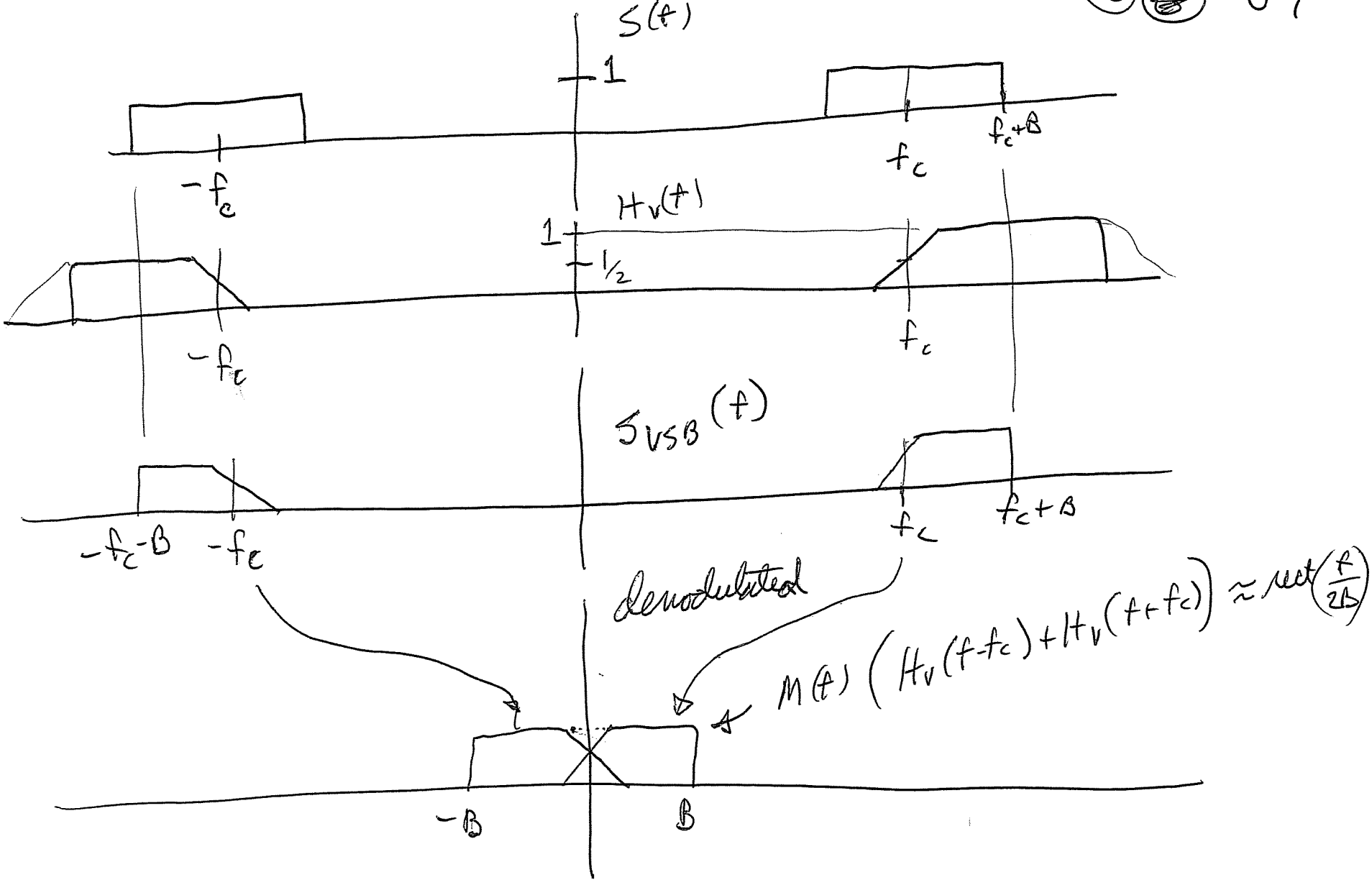
Assume we don't have ideal filters to "cut" our lower and upper sidebands apart. We can use the concept of Vestigal Side Band (VSB) in our design. Let $h_v(t)$ be our VSB filter

$$s_{VSB}(t) = s(t) * h_v(t) \longleftrightarrow S_{VSB}(f) H_v(f)$$



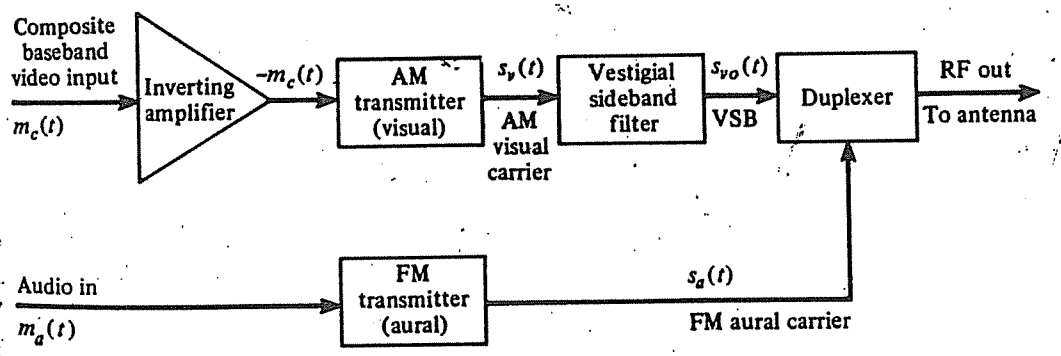

S(f)
1
f_c
f_c+B
$-f_c$
$H_v(f)$
1
1/2
f_c
$-f_c$
$S_{VSB}(f)$
f_c
f_c+B
$-f_c-B$
$-f_c$
demodulated
$M(f)\left(H_v(f-f_c)+H_v(f+f_c)\right)\approx \mathrm{rect}\left(\frac{f}{2B}\right)$
$-B$
B

HDTV standard that is compatible with the present system so that standard TV sets may be used to view a HDTV signal, (2) the FCC requirement that HDTV must operate within the present bands allocated for broadcast TV, and (3) the cost, which must be reasonable. More than 20 HDTV standards have been proposed [Jurgen, 1988], but it is not clear which one, if any, will be universally accepted. Moreover, it is argued that any new HDTV standard should use digital instead of analog transmission [Jurgen, 1991]. Several digital standards are proposed [Zou, 1991].

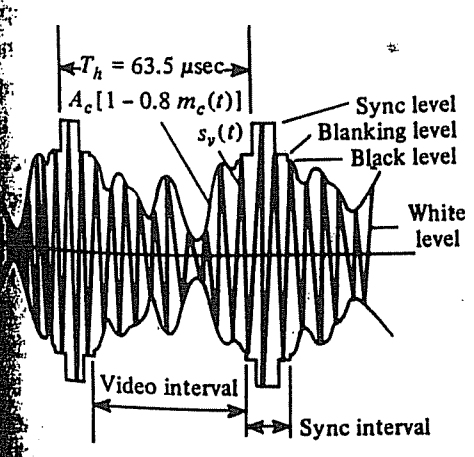
For broadcast TV transmission (U.S. standard), the composite video signal of (5-108) is inverted and amplitude modulated onto an RF carrier so that the AM signal is

$$s_v(t) = A_c[1 - 0.875m_c(t)] \cos \omega_c t \tag{5-110}$$

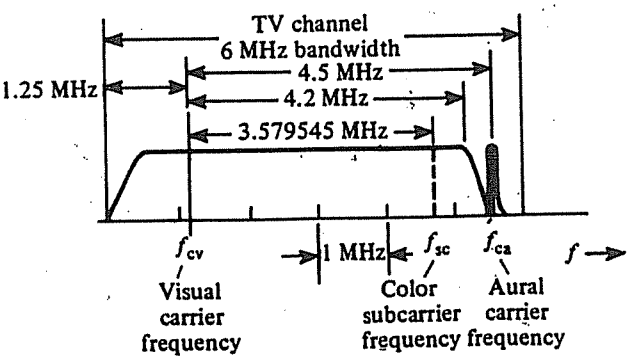
This is shown in Fig. 5-52. The lower sideband of this signal is attenuated so that the spectrum will fit into the 6-MHz TV channel bandwidth. This attenuation can be achieved by using a vestigial sideband filter, which is a bandpass filter that attenuates most of the lower sideband. The resulting filtered signal is called a



(a) Equipment Block Diagram



(b) AM Visual Carrier Waveform, $s_v(t)$ (Typical Video Modulation Illustrated)



(c) Magnitude Spectrum of RF Output (Frequency Response Characteristic)

FIGURE 5-52 TV transmission system.