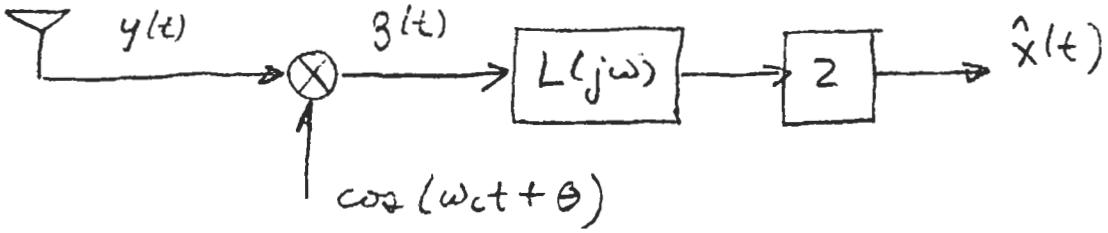
LECTURE S23

Incoherent Demodulation of AM-DSB/SC

In practice we know the frequency, but not the phase, of the carrier. So we really have



Then $$z(t) = \cos(\omega_c t + \theta)\, y(t)$$
$$= \cos(\omega_c t)\cos(\omega_c t + \theta)\, x(t)$$
$$= \left[\frac{1}{2}\cos\theta + \frac{1}{2}\cos(2\omega_c t + \theta)\right] x(t)$$

($\frac{1}{2}\cos\theta$: low frequency; $\frac{1}{2}\cos(2\omega_c t + \theta)$: high frequency)

Therefore, after filtering,

$$\hat{x}(t) = (\cos\theta)\, x(t)$$

In practice, phase varies with time:

$$\hat{x}(t) = \cos\theta(t) \cdot x(t)$$

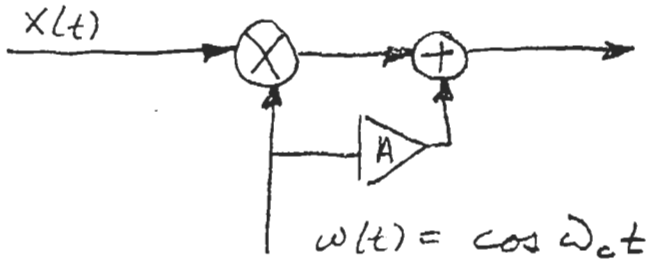
Signal fades in and out with time!

Without some means to estimate the phase of the carrier, AM-DSB/<u>sc</u> is not very practical.

$\Rightarrow$ We need to transmit information about the phase.

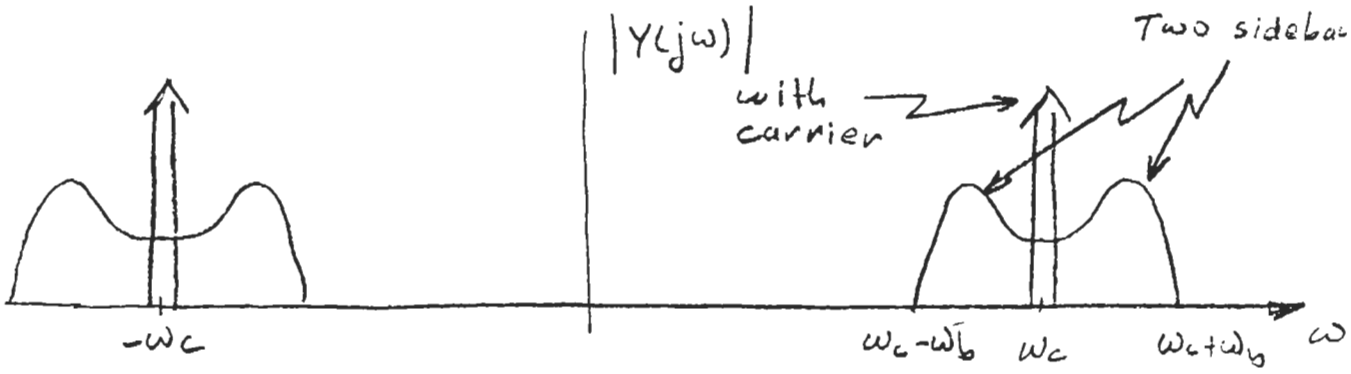
AM Double Sideband with Carrier (AM-DSB/wc)

To allow the receiver to determine the phase, add some carrier to the signal:



The Fourier Transform of $y(t)$ is

$$Y(j\omega) = \frac{1}{2} X(j(\omega-\omega_c)) + \frac{1}{2} X(j(\omega+\omega_c)) + \pi A(\delta(\omega-\omega_c) + \delta(\omega+\omega_c))$$



This is the type of AM used on commercial AM stations.

There are two ways to demodulate this signal:

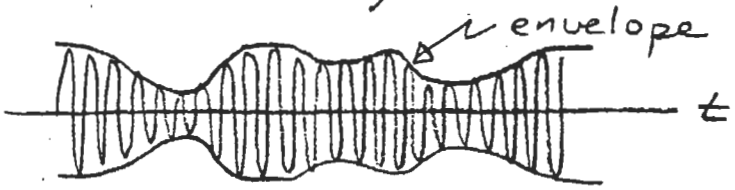
1. Use transmitted carrier to reconstruct phase
2. Envelope detection

Envelope detection

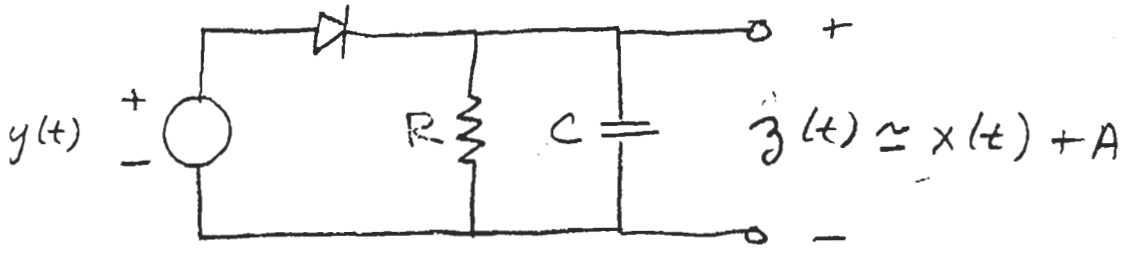
Define the modulation index as

$$m = \frac{\max |x(t)|}{A}$$

If $m < 100\%$, signal looks like

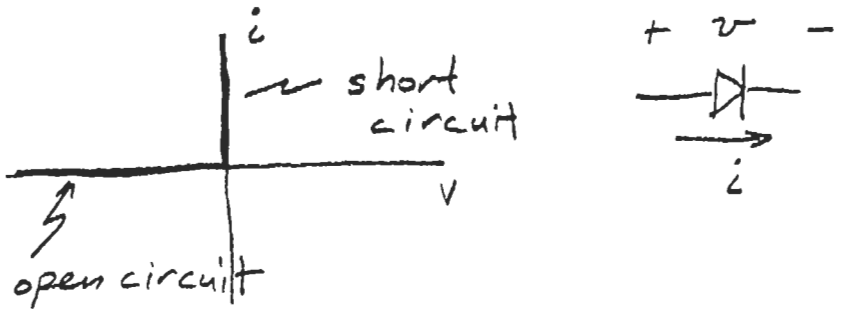


The shape of the envelope is $x(t) + A$.
To detect, use the circuit



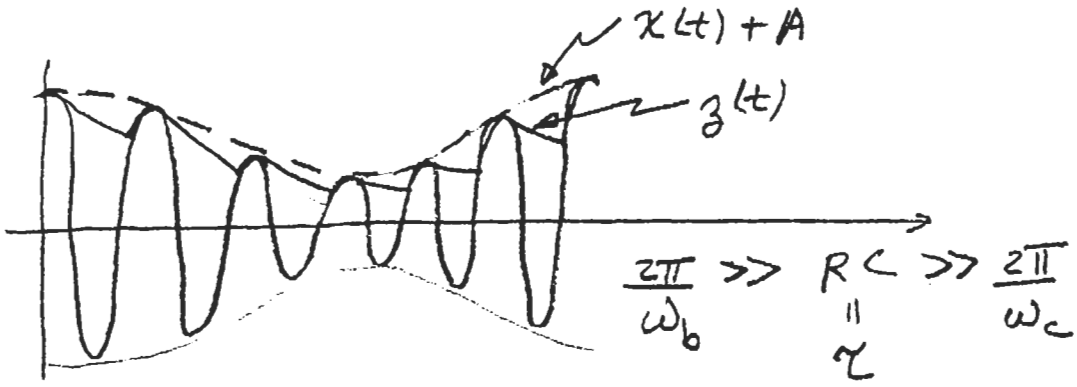
How does this work?

Model of diode:



So if $y(t) > z(t)$, current is infinite until enough charge is on capacitor to make $y(t) = z(t)$.

When $y(t) < z(t)$, we have homogeneous RC network. $z(t)$ decays slowly, until next peak



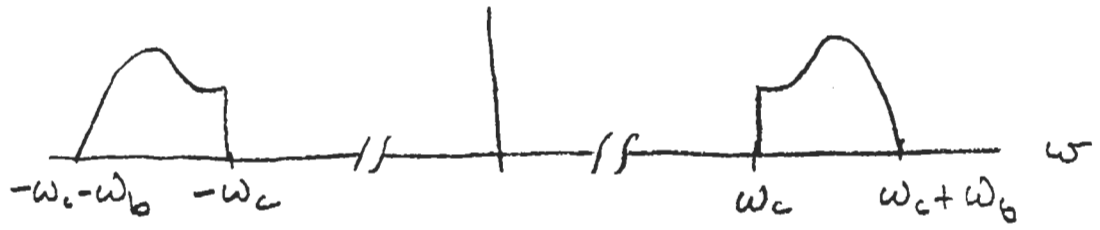
Can clean up signal by passing $z(t)$ through LPF.

Advantages of AM-DSB/WC
- Much easier demodulation
- Cheaper receivers
- Better quality of reproduced signal

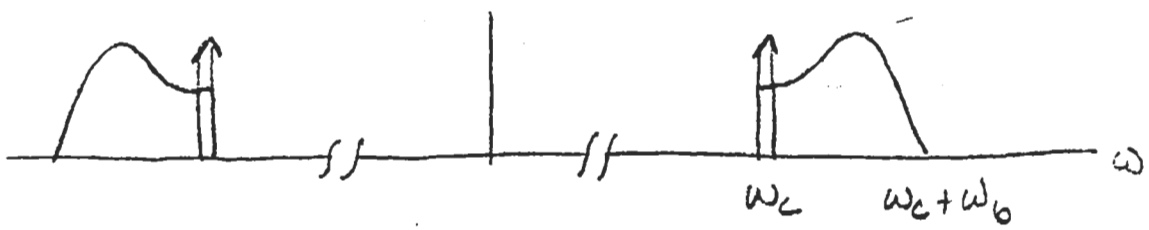
Disadvantages of AM-DSB/WC
- Transmitted carrier takes power, but carries no real information.
- Double sideband uses up spectrum

Other AM modulation techniques

AM-SSB/SC (single sideband, suppressed carrier)



AM-SSB/WC (single sideband, with carrier)



SSB:
- uses half the spectrum of DSB
- harder to demodulate
- quality of demodulated signal may be poor.