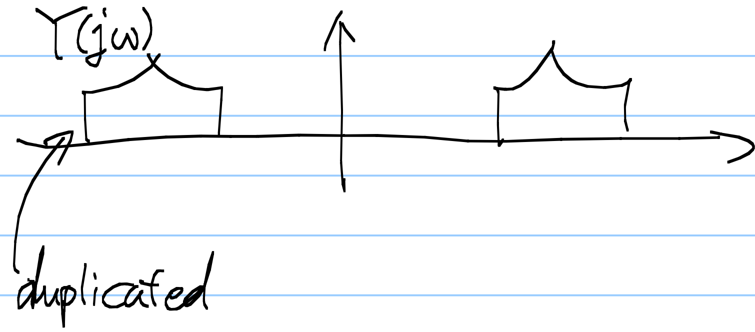
Watch Video 5.1

8.4 Single Side-Band Amplitude Modulation (AM-SSB)

Observation: any real signal is (conjugate) symmetric. It seems that when we use the AM to transmit, we waste double the frequency to transmit the same data.

Motivation: Can we squeeze in more radio stations by taking advantages of the above observation? (Bandwidth is very expensive.)

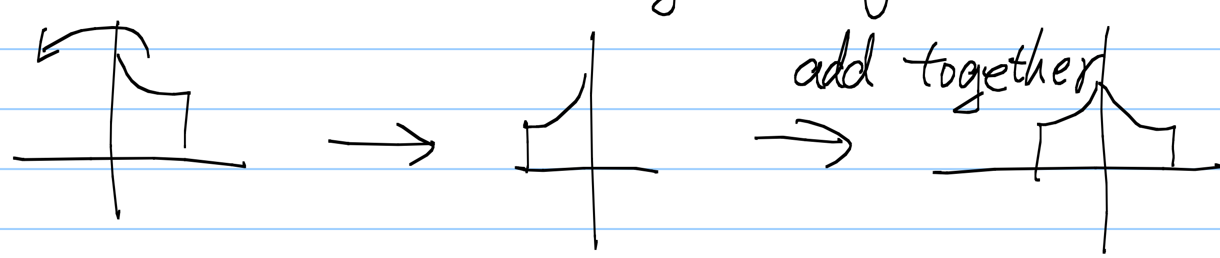


Solution #1:

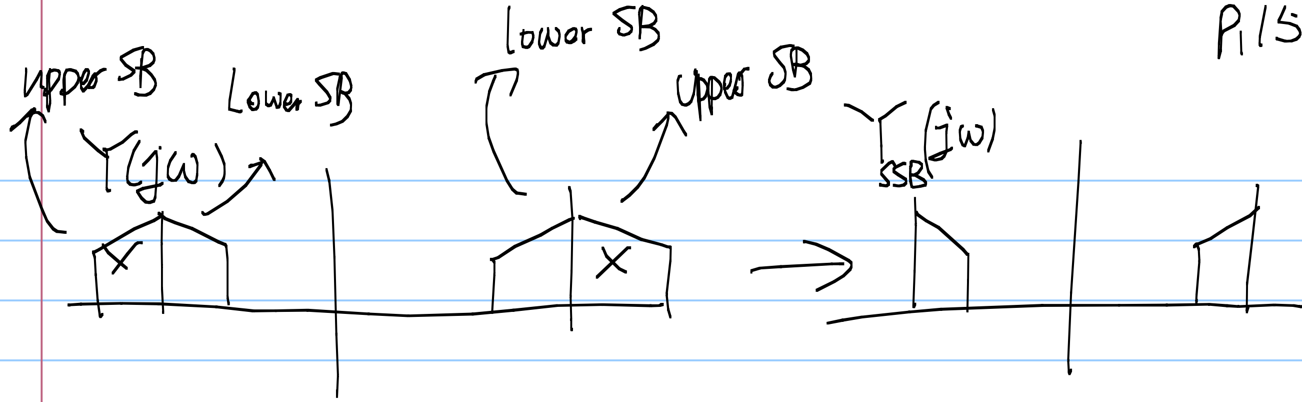
Send 6 different signals using the original bandwidth.

Drawback: Not symmetric in freq domain
$\Rightarrow$ Not real in time domain.

Solution #2: Since for any real signal, Knowing half of the freq spectrum is sufficient to reconstruct the original signal

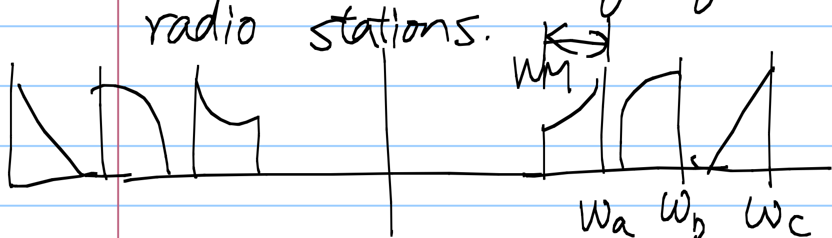


$\Rightarrow$ The main idea is "Discard half of the BW."



For example, we can keep the lower side band, and discard the upper side band. Therefore we use only half of the BW.

Now we can squeeze in twice as many radio stations.

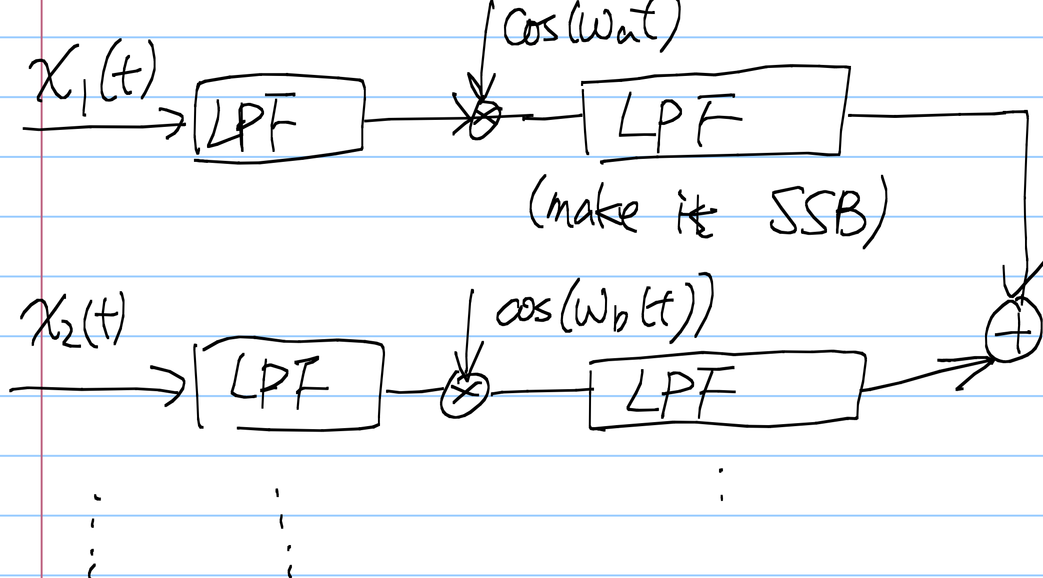


Need only $\omega_b - \omega_a > 1\,\omega_M$

Q: How to "discard the upper side-band?

Ans: By a LPF with cut-off freq $-\omega_a, \omega_a$

In sum, for the Tx of AM-SSB, we have

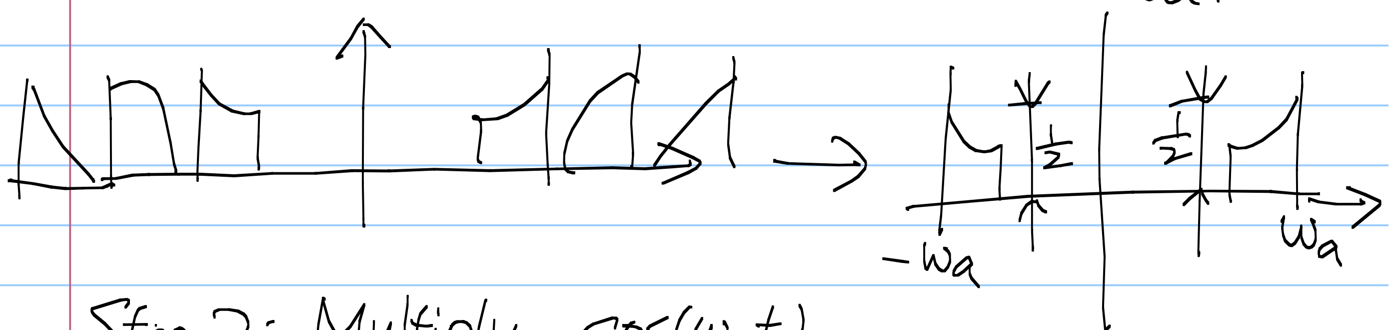


Doable but too complicated.

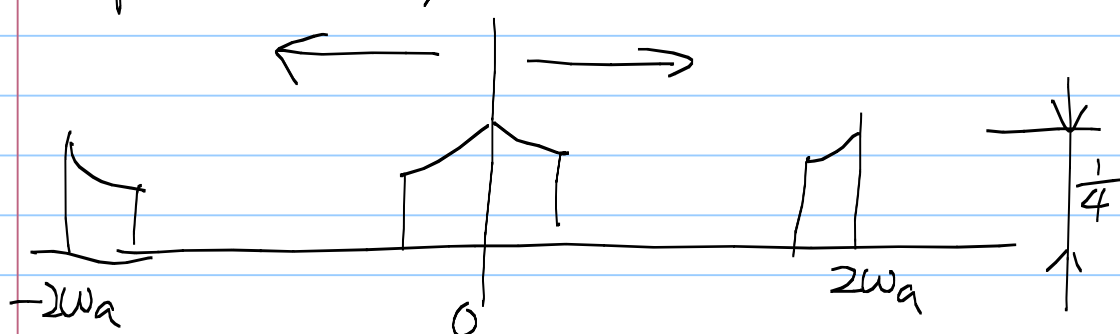
A more efficient method:

Step 1: BPF to obtain the desired signal

(Assuming we are interested in Station A.)



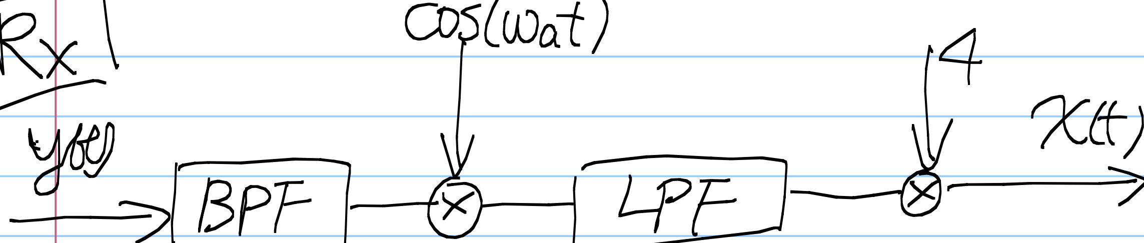
Step 2: Multiply $\cos(\omega_a t)$



Step 3: Apply LPF with cut-off freq W_m

Step 4: Multiply it by 4.

Rx



* The Rx design is almost identical to that of Double-Side Band AM receiver.

The only changes are ① BPF has different freqs.
② ×4 instead of ×2

* BPF freq for DSB: $\omega_a - W_m \sim \omega_a + W_m$

for SSB using lower side band

$W_a - W_m \sim \omega_a$

Exercise: Discuss the Tx & Rx designs for SSB using upper-side-band.

Watch Video 5.1