Assignment on class note compilation (DSB-WC)

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1 Limitation of DSB-SC

When demodulating a DSB-SC signal, the DSB-SC signal is multiplied by carrier frequency $\cos(\omega_c t)$. For demodulation, the receiver must generate a carrier in phase and frequency that was used during modulation. This perfect match is not always possible.

2 The DSB-WC modulator

We can solve this problem by sending carrier signal ($A\cos(\omega_c t)$) along with the modulated $m(t)\,cos(\omega_c t)$ signal. This type of modulator is called Double Side Band modulator - With Carrier (DSB-WC). So transmitted signal is:

$$\begin{aligned} T(t) &= m(t)\cos(\omega_c t) + A\cos(\omega_c t) \\ &= (m(t) + A)\cos(\omega_c t) \end{aligned} \tag{1}$$

3 Trade-off between DSB-SC and DSB-WC

DSB-WC modulator needs to transfer carrier signal with the modulated signal. So DSB-WC requires more power to transmit.

DSB-SC demodulator needs to multiply signals which is costly

In point-to-point (unicast) communication, there are a single sender and a single receiver. So using the DSB-SC modulator is not a problem. But for communication with multiple points (broadcast), there are many receivers. So using the DSB-WC modulator in this case, we can reduce the costs of receivers.

Ex. 1 — For Broadcast communication which modulator should you use?

4 Tone modulation

Definition (Tone Signal)**.** *If the baseband signal is a sinusoid, it is called tone.*

Modulation done to a tone is known as tone modulation

5 DSB-WC : Modulation

From Equation 1 modulated signal is:

$$T(t) = m(t)\cos(\omega_c t) + A\cos(\omega_c t)$$

In frequency domain, DSB-WC the modulated signal is:

$$T(\omega) = \frac{1}{2}M(\omega + \omega_c) + \frac{1}{2}M(\omega - \omega_c) + \frac{A}{2}\delta(\omega + \omega_c) + \frac{A}{2}\delta(\omega - \omega_c)$$

Again from DSB-SC modulated signal in frequency domain is:

$$T(\omega) = \frac{1}{2}M(\omega + \omega_c) + \frac{1}{2}M(\omega - \omega_c)$$

So modulated signal of DSB-WC in frequency domain is almost equal except two impulses at $\pm\omega$.

6 DSB-WC : Demodulation

6.1 Envelope

Envelope of a signal is found by joining peaks of that signal.

Figure 1: Here Red signal is the envelope of the black signal

6.2 Envelope Detection

If $m(t) + A$ is greater than 0 for all t, then the envelope of the modulated signal is the modulated signal itself. So we can detect the modulated signal by using envelope detection. On the other hand if $m(t) + A$ is less than 0 for any t, then envelope signal does not represent $m(t)$.

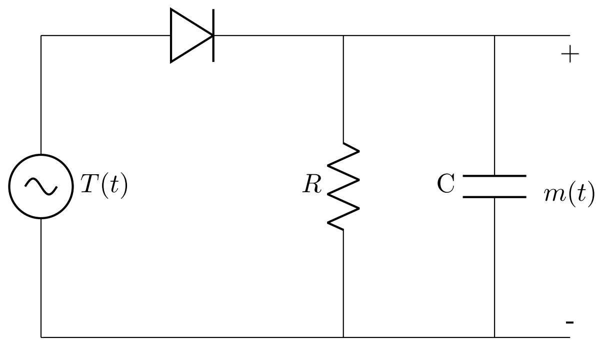

Figure 2: Envelope Detection Circuit

6.3 Configuration of Circuit

In envelope detection circuit, value of R, C needs to be balanced for perfect demodulation. If RC value is vaery high, there will be slow discharge from capacitor and signal will be distored. If RC value is very low, there will be fast discharge and due to ripple effect intended $m(t)$ could not be recovered. There are two options to balance RC value.

- Using current value of RC to generate more accurate values of R and C
- Changing value of C such that following equation holds:

$$\frac{1}{\omega_c} << RC < \frac{1}{2\pi B}$$