PRINCIPLES OF COMMUNICATION (BEC-28)

UNIT-3
NOISE

Dr. Dharmendra Kumar
Assistant Professor
Department of Electronics and Communication Engineering
MMM University of Technology, Gorakhpur–273010.

Content of Unit-3

- **Noise:** Source of Noise, Frequency domain, Representation of noise, Linear Filtering of noise, Noise in Amplitude modulation system, Noise in DSBSC, SSB-SC and DSB-C, Noise Ratio, Noise Comparison of FM and AM, Pre-emphasis and De-emphasis, Figure of Merit.

Noise in SSB

Assuming that LSB has been transmitted, we can write *s (t) as follows:*

$$s(t) = \frac{A_c}{2} m(t)\cos(\omega_c t) + \frac{A_c}{2}\widehat{m}(t)\sin(\omega_c t)$$

where *m (t) is the Hilbert transform of m(t) . Generalizing,*

$$S(t) = \frac{A_c}{2} M(t)\cos(\omega_c t) + \frac{A_c}{2}\widehat{M}(t)\sin(\omega_c t).$$

We can show that the autocorrelation function of *S(t), Rs (τ) is given by*

$$R_s(\tau) = \frac{A_c^2}{4}\left[R_M(\tau)\cos(\omega_c \tau) + \hat{R}_M(\tau)\sin(\omega_c \tau)\right]$$

where *R M (t) is the Hilbert transform of RM (t) . Hence the average signal* power, $R_S(0) = (A_C)^2/4 * P_M$

and

$$(SNR)_r = \frac{A_c^2 P_M}{4 W N_0}$$

Noise in SSB Cont..

$$\text{Let } n(t) = n_c(t)\cos(\omega_c t) - n_s(t)\sin(\omega_c t)$$

(Note that with respect to *fc , n(t) does not have a locally symmetric spectrum).*

$$y(t) = \frac{1}{4} A_c\, m(t) + \frac{1}{2} n_c(t)$$

Hence, the output signal power is $(A_C)^2 * P_M / 16$ and the output noise power as $(W * N_0)/4$.

Thus, we obtain,

$$(SNR)_{0,SSB} = \frac{A_c^2 P_M}{16} \times \frac{4}{W N_0} = \frac{A_c^2 P_M}{4 W N_0}$$

So,

$$(FOM)_{SSB} = 1$$

Noise in DSB-C or AM

DSB-LC or AM signals are normally envelope detected, though coherent detection can also be used for message recovery. This is mainly because envelope detection is simpler to implement as compared to coherent detection.

The transmitted signal *s (t) is given by*

$$s(t) = A_c\left[1 + g_m m(t)\right]\cos(\omega_c t)$$

Then the average signal power in

$$s(t) = \frac{A_c^2\left[1 + g_m^2 P_M\right]}{2}.$$

Hence

$$(SNR)_{r,\,DSB-LC} = \frac{A_c^2\left(1 + g_m^2 P_M\right)}{2W N_0}$$

Using the in-phase and quadrature component description of the narrowband noise, the quantity at the envelope detector input, *x (t) , can be written as*

$$\begin{aligned} x(t) &= s(t) + n_c(t)\cos(\omega_c t) - n_s(t)\sin(\omega_c t) \\ &= \left[A_c + A_c\, g_m\, m(t) + n_c(t)\right]\cos(\omega_c t) - n_s(t)\sin(\omega_c t) \end{aligned}$$

Cont…

The receiver output *y (t) is the envelope of the input quantity x (t) . That is,*

$$y(t) = \left\{\left[A_c + A_c g_m m(t) + n_c(t)\right]^2 + n_s^2(t)\right\}^{\frac{1}{2}}$$

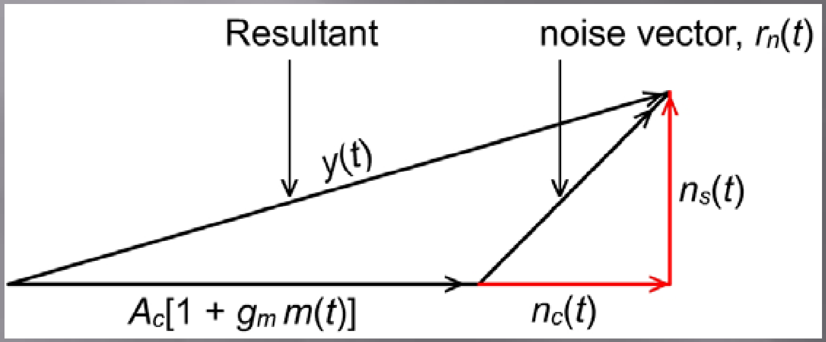

Fig. 7.5: Phasor diagram to analyze the envelope detector

The output noise power being equal to $2W*N_0$ *we have,*

$$\left[(SNR)_0\right]_{AM} \approx \frac{A_c^2 g_m^2 P_M}{2W N_0}$$

It is to be noted that the signal and noise are additive at the detector output and power spectral density of the output noise is flat over the message bandwidth.

$$(FOM)_{AM} = \frac{g_m^2 P_M}{1 + g_m^2 P_m}$$

Thank you