

1. An unmodulated carrier of amplitude A_c and frequency f_c and band-limited white noise are summed and then passed through an ideal envelope detector. Assume the noise spectral density to be of height $N_0 / 2$ and bandwidth $2W$, centered about the carrier frequency f_c . Determine the output signal-to-noise ratio for the case when the carrier-to-noise ratio is high.
2. Suppose that the received signal in FM system contains some residual amplitude modulation of positive amplitude $a(t)$, as shown by

$$s(t) = a(t) \cos[2\pi f_c t + \phi(t)]$$

Where f_c is the carrier frequency. The phase $\phi(t)$ is related to the modulating signal $m(t)$ by

$$\phi(t) = 2\pi k_f \int_0^t m(\tau) d\tau$$

Where k_f is a constant. Assume that the signal $s(t)$ is restricted to a frequency band of width B_T , centered at f_c , where B_T is the transmission bandwidth of the FM signal in the absence of amplitude modulation, and that the amplitude modulation is slowly varying compared with $\phi(t)$. Show that the output of an ideal frequency discriminator produced by $s(t)$ is proportional to $a(t)m(t)$. Hint: Use the complex notation described in Appendix 2 to represent the modulated wave $s(t)$.

3. What are the definitions of SNR_i , SNR_o , SNR_c and figure of merit?
4. In a full AM signal, both sidebands and the carrier wave are transmitted, as shown by

$$s(t) = A_c[1 + k_a m(t)] \cos(2\pi f_c t)$$

where $A_c \cos(2\pi f_c t)$ is the carrier wave, $m(t)$ is the message signal, and k_a is a constant that determines the percentage modulation. Please compute the SNR_c for this AM signal $s(t)$. (Note: assume $m(t)$ zero mean.)