

EE206 2020 Spring

通信原理 习题课

Homework #D7 D7.1, D7.2

2020/6/2



- D7.1

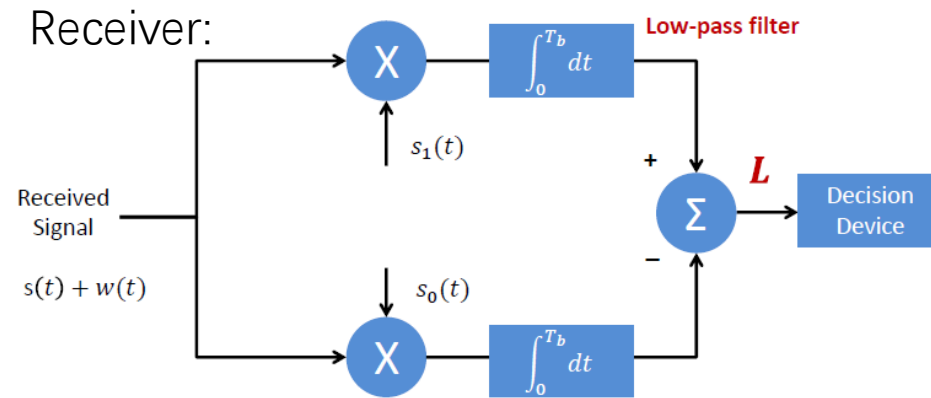
Please design a receiver of the following band-pass modulation for AWGN channel. What is the BER?

$$\begin{aligned} \text{Bit 1: } s(t) = s_1(t) &= A_c \cos(2\pi f_c t) & 0 \leq t \leq T_b \\ \text{Bit 0: } s(t) = s_0(t) &= A_c \cos(2\pi f_c t + \phi) & 0 \leq t \leq T_b \end{aligned}$$

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Solution

Assume AWGN channel with white noise of *zero-mean* and *spectral density* $N_0/2$



The receiver output L is given by

$$L = \int_0^{T_b} x(t)[s_1(t) - s_0(t)]dt$$

BER is given by

$$P_e = Q\left(\sqrt{\frac{E_b(1-\rho)}{N_0}}\right)$$

Signal Energy

$$E_b = \int_0^{T_b} s_1^2(t)dt = \int_0^{T_b} s_0^2(t)dt = \frac{A_c^2 T_b}{2}$$

Correlation coefficient

$$\begin{aligned} \rho &= \frac{\int_0^{T_b} s_0(t)s_1(t)dt}{E_b} \in [-1,1] \\ &= \cos\phi \end{aligned}$$

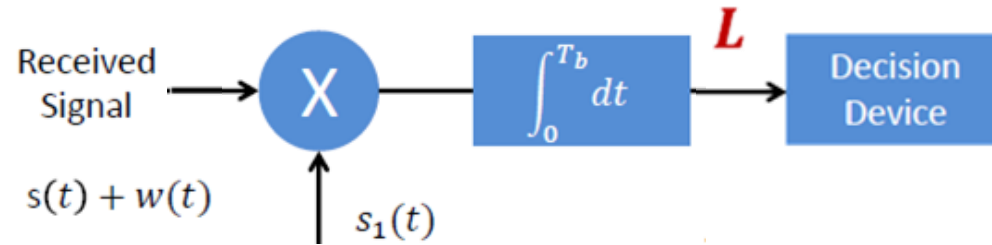
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Discuss

Assume $\phi = \pi$, BPSK

Due to $s_0(t)$ is the negative of $s_1(t)$, the receiver reduces to a single path

Receiver:



The receiver output L is given by

$$L = \int_0^{T_b} x(t) [s_1(t) - s_0(t)] dt = \int_0^{T_b} x(t) 2s_1(t) dt$$

Signal Energy

$$E_b = \int_0^{T_b} s_1^2(t) dt = \int_0^{T_b} s_0^2(t) dt = \frac{A_c^2 T_b}{2}$$

Correlation coefficient

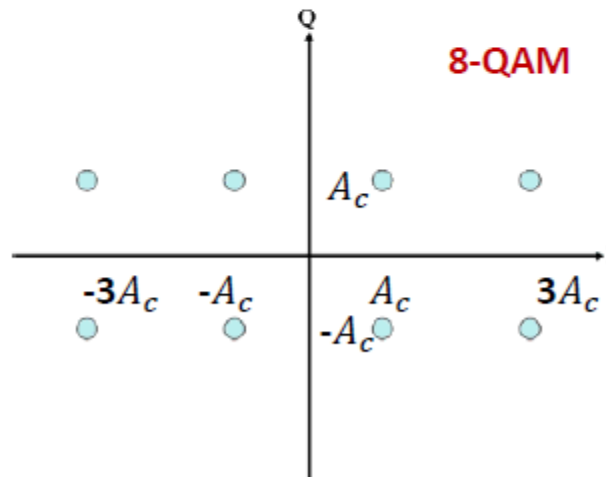
$$\begin{aligned} \rho &= \frac{\int_0^{T_b} s_0(t) s_1(t) dt}{E_b} \in [-1, 1] \\ &= -1 \end{aligned}$$

BER is given by

$$P_e = Q\left(\sqrt{\frac{E_b(1-\rho)}{N_0}}\right) = Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$$

- D7.2

What is the average transmission power of the following 8-QAM modulation scheme? Suppose each symbol is transmitted with equal probability, and the symbol duration is T .



Solution

8 symbols total power

$$P_{total} = 4 \times \left(\frac{1}{2} (\sqrt{2}A_c)^2 \right) + 4 \times \left(\frac{1}{2} (\sqrt{10}A_c)^2 \right) = 24A_c^2$$

average transmission power with equal probability

$$P_{symbol} = \frac{E_{total}}{8} = 3A_c^2$$

