Advanced Radio Communication Engineering Report -Professor T. Kojima

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June 15 2016

[1]BER for equal energy binary transmission system based on ML criteria is given as

$$P_b = \frac{1}{2} erfc \sqrt{\frac{(1-\rho)E_b}{2N_0}}$$

where

$$\rho = \frac{1}{E_b} \int_{-\infty}^{\infty} s_0(t)s_1(t)dt$$

since the signals have equal energy

$$\int_{-\infty}^{\infty} s_0(t)^2 dt = \int_{-\infty}^{\infty} s_1(t)^2 dt = E_b$$

$s_0(t), s_1(t), s_0(t)s_1(t)$ are defined below

$$s_0(t) = \begin{cases} 1 & ,(0 \le t < T/2) \\ -1 & ,(T/2 \le t < T) \\ 0, & (otherwise) \end{cases}$$

$$s_1(t) = \begin{cases} -1 & ,(0 \le t < 7T/20) \\ 1 & ,(7T/20 \le t < T) \\ 0, & (otherwise) \end{cases}$$

$$s_0(t)s_1(t) = \begin{cases} -1 & ,(0 \le t < 7T/20) \\ 1 & ,(7T/20 \le t < T/2) \\ -1 & ,(T/2 \le t < T) \\ 0, & (otherwise) \end{cases}$$

therefore

$$E_b = \int_0^T s_0(t)^2 = T$$

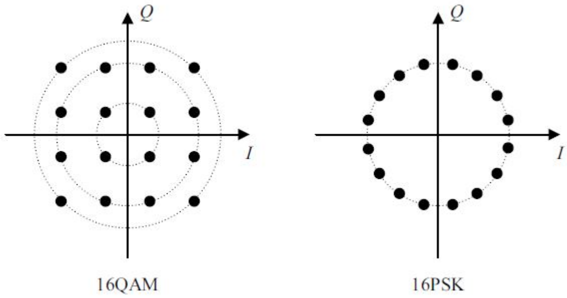
and

$$\rho = \frac{1}{T}\left[-\int_0^{7T/20} dt + \int_{7T/20}^{T/2} dt - \int_{T/2}^{T} dt \right] = \frac{-7}{10}$$

substituting the value of ρ and E_b into the BER equation gives

$$P_b = \frac{1}{2} erfc\sqrt{\frac{(1+7/10)T}{2N_0}} = \frac{1}{2} erfc\sqrt{\frac{17T}{20N_0}}$$

[2]The figure below shows the constellation diagrams for 16QAM and 16PSK.



Assuming minimum Euclidean distance is the same, it is denoted by d_{min}. the radius for the various circles in the 16QAM constellation are defined below

$$\begin{array}{ll} circle1 & \frac{\sqrt{2}}{2} d_{min} \\ circle\,2 & \frac{\sqrt{10}}{2} d_{min} \\ circle\,3 & \frac{3\sqrt{2}}{2} d_{min} \end{array}$$

therefore, the Energy per symbol for 16QAM, E_s is given below

$$E_s = \frac{1}{16}\left(4 \cdot \frac{\sqrt{2}}{2} d_{min}^2 + 8 \cdot \frac{\sqrt{10}}{2} d_{min}^2 + 4 \cdot \frac{3\sqrt{2}}{2} d_{min}^2 \right) = \frac{5}{2} d_{min}^2$$

For the case of 16PSK the radius of the circle is given by

$$\frac{d_{min}}{2\sin(\pi/16)}$$

therefore, the Energy per symbol for 16PSK, $E_s^{'}$ is given below

$$E_s^{'} = \frac{d_{min}^2}{4\sin^2(\pi/16)}$$

finally,

$$\frac{E_s^{'}}{E_s} = \frac{1}{10\sin^2(\pi/16)} = 2.6274$$