Department of Electronic and Telecommunication Engineering

University of Moratuwa, Sri Lanka

EN3053 - Digital Communications - I

Lab Assignment

Eye diagrams and Equalization

Submitted by

Thalagala B.P. 180631J

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Note: `MATLAB R2018a` *of the MathWorks Inc. is used for the implementation.*

1 Task 1

Please note that for the MATLAB implementation bit rate(bits/second) of the generator was assumed to be 10. As we consider BPSK for the Task 1 and 2, the symbol rate(symbols/second) is remain the same as the bit rate of the generator.

1.1 Generation of an Impulse Train Representing BPSK Symbols

Binary data of the generator $D \in \{0, 1\}$ is mapped in to an impulse train according to the following function where $A(Amplitude)$ of the impulse was taken as 1 in the MATLAB implementation.

$$amplitude\ of\ the\ k^{th}\ impulse = \begin{cases} +A & if\ D = 1 \\ -A & if\ D = 0 \end{cases}$$

1.2 Transmit Signal

1.3 Sinc function as the Impulse response

Function `sinc(t)` in MATLAB is defined as follows.

$$\texttt{sinc(t)} = \begin{cases} \frac{sin(\pi.t)}{\pi.t} & if\ t \neq 0 \\ 1 & if\ t = 1 \end{cases}$$

In order to generate a sinc pulse that aligns with our time scale the function argument should be given as mentioned below. Where T_b is the separation between successive transmitted pulses.

$$sinc\ pulse = \texttt{sinc}(\frac{\texttt{t}}{\texttt{T}_\texttt{b}})$$

1.4 Eye Diagram

2 Task 2

Task 2 is a repetition of the Task 1, but in the presence of additive white Gaussian noise (AWGN). Variance of the noise $N_0/2$ was set such that the Power efficiency $\gamma = E_b/N_0 = 10\ dB$. Where E_b is the average bit energy and N_0 is the noise power spectral density.

$$\begin{aligned} \gamma\ in\ dB &= 10. \log_{10}(E_b/N_0) \\ \gamma/10 &= \log_{10}(E_b/N_0) \\ 10^{\gamma/10} &= E_b/N_0 \\ N_0 &= \frac{E_b}{10^{\gamma/10}} \end{aligned}$$

$$\therefore\ \sigma^2_{noise} = N_0/2 = \frac{E_b}{2 \times 10^{\gamma/10}}$$

Assuming the $P(D = 0) = P(D = 1) = 1/2$ as we consider sufficient large amount of bits in the initial bit stream,

$$E_b = \frac{1}{2} \times \left[(+A)^2 + (-A)^2\right] = \frac{1}{2} \times \left[(+1)^2 + (-1)^2\right] = 1$$