Exam presentation

Assignment 2.1 and 3

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Overview

- Assignment 2
    - Eye diagrams
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- Assignment 3
    - Link budget model
    - SNR and P_E
    - Alternative modulations

Eye diagram

- Plot composed by overlaying segments of different bit sequences
- Can be generated with an oscilloscope
- Shows effects of *inter-symbol interference*
- Provides a qualitative measure of the system performance
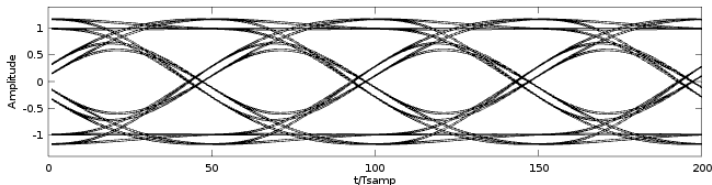
Eye diagram characteristics

Figure: *Eye diagram of BPSK signal*

- A Difference between high and low levels
- A_j Difference between A and the eye opening
- T_j Deviations from ideal timing
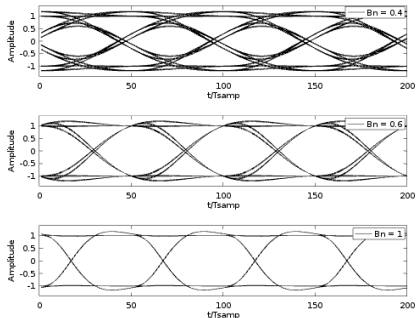- T_b Bit time period

Eye diagram at different bandwidths

Figure: *Eye diagram for normalized bandwidths 0.3, 0.7, 1.2*

- Low BW: high amplitude and timing jitter
- High BW: no ISI, chances of higher noise

Link budget model

- A way of estimating the power of a received signal
- Takes into account all the gains and losses of transmitter, channel, and receiver

$$P_R = \left(\frac{\lambda}{4\pi d}\right)^2 \frac{P_T G_T G_R}{L_0}; \tag{1}$$

- In decibels:

$$P_{R,dB} = 20\log_{10}\left(\frac{4\pi d}{\lambda}\right) + ERP_{dB} + G_{R,dB} - L_{0,dB}; \tag{2}$$

$(\frac{4\pi d}{\lambda})^2$ Free-space loss

$ERP = P_T G_T$ Effective radiated power

G_R Gain of receiver antenna

L_0 Other losses, link budget margin

SNR calculation

■ Signal-to-noise ratio in decibels:

$$SNR_{dB} = P_{R,dB} - P_{int,dB} \tag{3}$$

P_R Calculated using link budget model

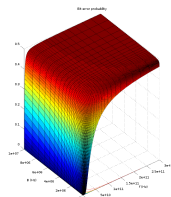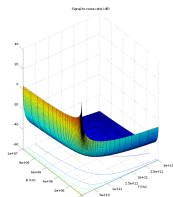P_{int} Noise power, proportional to the receiver noise temperature and the transmission bandwidth
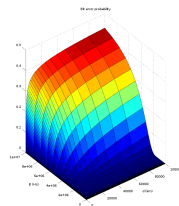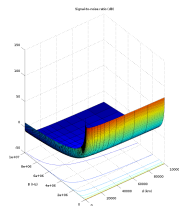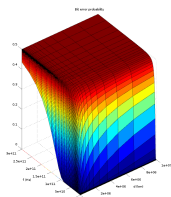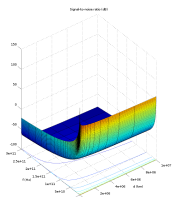
P_E calculation

- Bit error probability for BSFK transmissions:

$$P_E = Q\left(\sqrt{\frac{2E_b}{N_0}}\right) \qquad (4)$$

1. ratio E_b/N_0 derived from $SNR =\to \frac{E_b}{N_0 B T_b}$
2. For binary BPSK, $B = 2/T_b$
3. Factor BT_b is 2, or 3 dB

Impact of d, λ, B

Impact of P_T

- P_E for P_T at 50 W, 5 W, and 500 mW:

$$1.4062\text{e}{-}05 \quad 9.2684\text{e}{-}02 \quad 3.3768\text{e}{-}01 \tag{5}$$

Figure: P_E over values of P_T

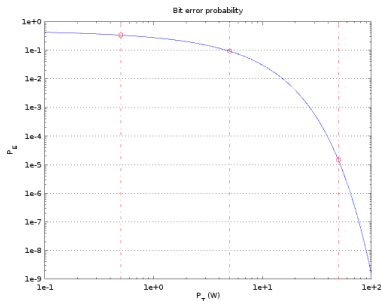# Alternative modulation: ASK

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Alternative modulation: FSK

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