01UEF
Digital Communication Laboratory

Project #2

Build a numerical simulator to analyze M-PAM systems with antipodal symbols.

Consider three possible modulation formats:

- 2-PAM;
- 4-PAM;
- 8-PAM.

At transmitter consider three options for pulses:

- NRZ;
- RZ with 50% duty cycle (RZ);
- Square-Root Raised Cosine (SRRC, consider roll-off equal to 0.05, 0.5 and 1).

At the receiver consider two options for filters:

- matched;
- RC filter (with different -3 dB bandwidth, to be tested only with NRZ and RZ).

1. Plot and compare the transmitted spectra for the different cases, considering to operate all systems at same bit-rate.

2. Consider the transmission in an AWGN channel and operation with matched filter. Evaluate the performance in terms of BER as a function of E_b/N_0 when operating at the optimum sampling instant. Compare simulation results for the different modulation formats with theoretical formulas. BER must be evaluated through error counting.

3. Consider the transmission in an AWGN channel and operation with RC filter. The RC filter has a -3 dB bandwidth variable between $0.3*R_S$ and $2.0*R_S$. Evaluate the performance in terms of BER as a function of E_b/N_0 when operating at the optimum sampling instant. For NRZ and RZ measure the E_b/N_0 penalty at a target BER of 10^{-3} as a function of the RC filter -3 dB bandwidth.

4. For 2-PAM only and a RC filter with bandwidth equal to $0.75*R_S$, compare simulation results with approximated formulas based on the evaluation of eye opening achieved through noiseless simulations. Test both NRZ and RZ.

5. For 4-PAM and 8-PAM with NRZ pulses, considering transmission in an AWGN channel and matched filtering, evaluate the penalty due to a non-Gray coding. Assume a simple “binary ordered” labeling.