



EE 617 Introduction to Wireless and Cellular Communications
July – December 2005

Computer Assignment #1 (Due date: August 22, 2005)

1. The task is to build a QPSK system and study the Bit Error Rate (BER) and Symbol Error Rate (SER) performance using Monte-Carlo simulations. Generate multiple bursts of about 512 (random) QPSK symbols and apply pulse shaping with a square-root raised cosine (RRC) pulse (roll off $\alpha = 0.35$). Use an over-sampling ratio of 8x symbol rate and a truncation length of 10 symbols for the RRC pulse. Use Gray Coding for the QPSK symbols

Bits	00	01	10	11
symbol	$e^{j\frac{\pi}{4}}$	$e^{j\frac{3\pi}{4}}$	$e^{-j\frac{\pi}{4}}$	$e^{-j\frac{3\pi}{4}}$

Assume that the symbol rate is 25 Ksymbols/sec.

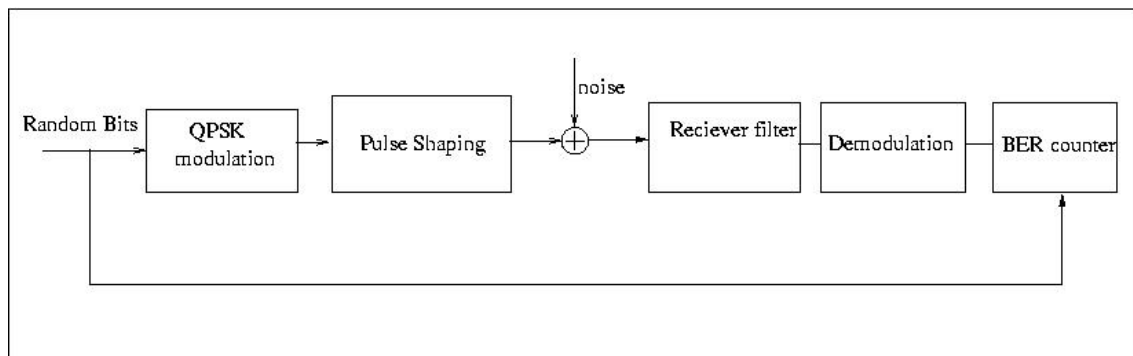
- (a) For one burst, plot the original constellation diagram for the transmitted symbols assuming no noise and with $\frac{E_b}{N_0} = 6$ dB.
- (b) Add AWGN with different variance values
- (c) Pass the signal and noise through a matched receive filter (same RRC filter as used in transmitter)
- (d) Use coherent detection and compute BER and SER for $\frac{E_b}{N_0}$ in [0, 10dB] in steps of 2 dB averaging over 200 bursts.
- (e) Plot BER versus $\frac{E_b}{N_0}$, and SER versus $\frac{E_b}{N_0}$. In the BER plot, include the analytical computation of BER for coherent QPSK given by $BER = Q\left(\sqrt{\frac{E_b}{N_0}}\right)$. Refer Rappaport Appendix F for definition of Q function).
Verify that BER plot (simulations) and the analytical computation of BER are in agreement.
- (f) Plot the normalized frequency response $|H(e^{j\omega})|$ (computed via DFT) of the sampled RRC pulse for $\alpha = 0.35, 0.7$ and 1.0.

Additional information

- Expression for SRRC filter impulse response



$$\bullet \quad h(t) = \begin{cases} 1 - \alpha + 4\frac{\alpha}{\pi}, & t = 0 \\ \frac{\alpha}{\sqrt{2}} \left[\left(1 + \frac{2}{\pi}\right) \sin\left(\frac{\pi}{4\alpha}\right) + \left(1 - \frac{2}{\pi}\right) \cos\left(\frac{\pi}{4\alpha}\right) \right], & t = \pm \frac{T}{4\alpha} \\ \frac{\sin\left[\pi(1-\alpha)\frac{t}{T}\right] + 4\alpha\frac{t}{T} \cos\left[\pi(1+\alpha)\frac{t}{T}\right]}{\pi\frac{t}{T} \left[1 - \left(4\alpha\frac{t}{T}\right)^2\right]}, & \text{for all other } t \end{cases}$$



Set-up for implementing the simulation