University of Moratuwa
Department of Electronic and Telecommunication Engineering

EN1055 - Introduction to Telecommunications

Semester 2, 2022

Assignment 1

Introduction

The primary goal of this assignment is to understand the theory of digital modulation and demodulation and, simulate a working digital communication system in MATLAB Simulink. There will be 100 marks available for this assignment. This assignment contributes 20% to your overall marks of this module.

Simulation Setup

First load *modulation_assignment.slx* in MATLAB.

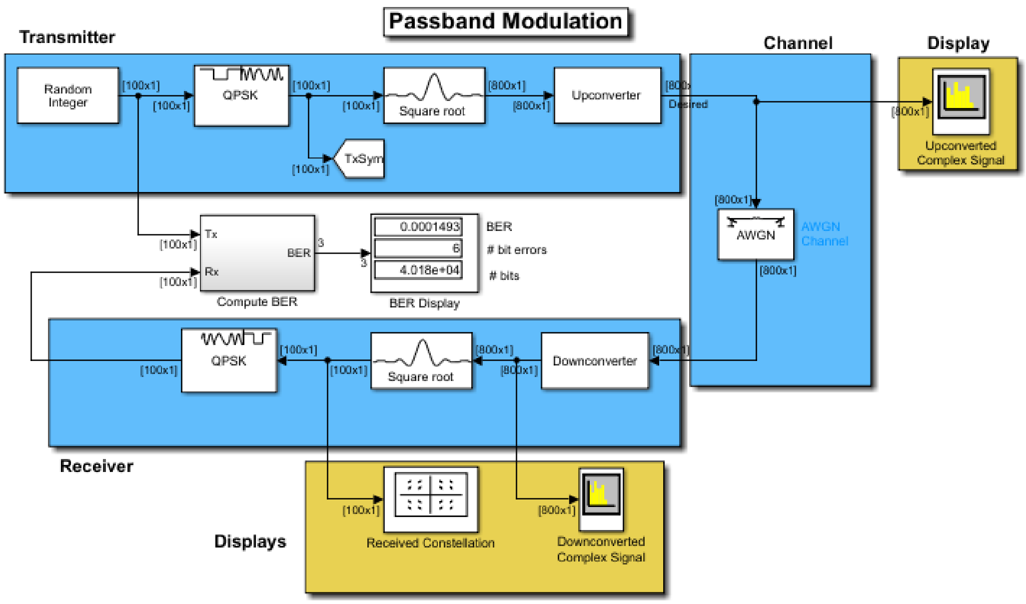

Figure 1: The communication link.

This model shows a straightforward way to perform passband modulation, by multiplying a modulated complex signal with a complex sine wave to perform frequency upconversion. In general, it is preferable to model a system at complex baseband. However, there are some circumstances where it is necessary to model the system at real passband. The communications link in this model includes these components:

- A Random Integer Generator block used as source of random data.
- A modulator and a pulse shaping filter that perform QPSK modulation and root raised cosine pulse shaping.
- An Upconverter block that multiplies the modulated signal by a carrier frequency.
- An AWGN Channel block, set to Eb/No mode. It specifies two bits per symbol because the modulation format is QPSK. The signal power is $1/(2{\times}8)$ watts. This is because the original signal power at the modulator is 1 watt. The root-raised cosine filter upsamples the signal by a factor of 8, which reduces the power by that factor. The

frequency upconversion block output takes only the real part of the signal, thereby reducing the power again, this time by a factor of 2. Finally, the symbol period is 1×10^{-6} seconds, to match the original sample time on the Random Integer Generator source.

- A Downconverter block that converts the signal from real passband to complex baseband.
- A root raised cosine pulse shaping filter that decimates back to one sample per symbol, and a QPSK demodulator block.
- Bit Error Rate (BER) calculation block.

Tasks

1. Simulate the communication link given in *modulation_assignment.slx* and explain the functionality of it in detail. To demonstrate the correctness of your implementation, you should provide at least the following plots as evidence. You are encouraged to include any other plots that are inline with your arguments.
   - Input and output sequences
   - Signals before and after modulation / demodulation
   - Input and output constellation diagrams
   - Signals before and after up/down converters

   [20 marks]

2. Now change the carrier frequency of modulation to 2.5 MHz and re-do the simulation. To verify the results, plot the signals after up/down converters.

   [20 marks]

3. Plot the BER while changing the Eb/No from 0 to 10 dB in AWGN block. Briefly discuss your results.

   [20 marks]

4. While keeping the other setting as in part (2), change the modulation to 8-PSK and re-do the simulation. To demonstrate the correctness of your implementation, you should provide at least the following plots as evidence. You are encouraged to include any other plots that are in line with your arguments.
   - Input and output sequences
   - Signals before and after modulation / demodulation
   - Input and output constellation diagrams
   - Signals before and after up/down converters

   [20 marks]

5. Repeat part (3) with 8-PSK modulation and compare the BER for the two modulation schemes. Briefly discuss your observations.

   [20 marks]

References

- `https://www.mathworks.com/help/comm/ug/passband-modulation.html`

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