Communications Project for 4th year students

Due Wednesday, 25 December 2021

The purpose of the project is to introduce the students to the simulation of the single and multicarrier communication systems. The requirements of the project are described in the following sections.

1. Single Carrier System

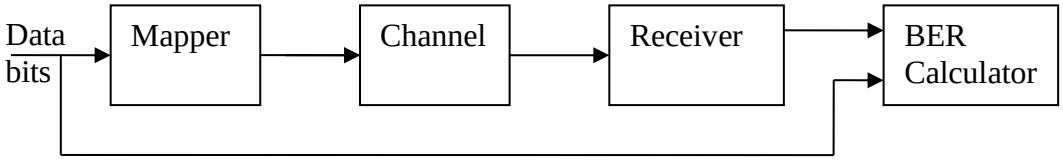


Figure 1 Single carrier communication system.

1.1 The Mapper

The first block in the communication system under consideration is the mapper. The mapper takes the I/P data bits and produces the symbols to be transmitted on the channel. The modulation schemes under consideration are the QPSK and the 16QAM systems. Figure 2 shows the constellations.

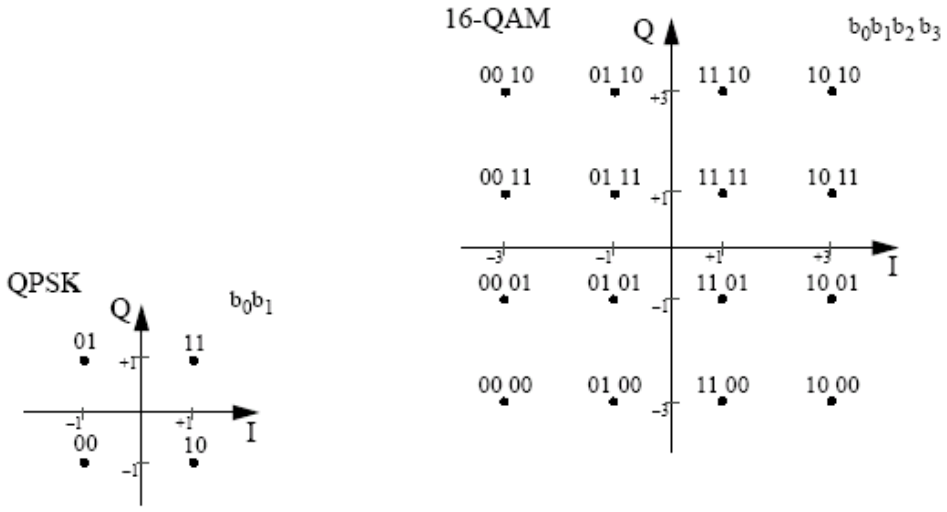


Figure 2 QPSK and 16-QAM constellations

1.2 The channel

The channel that will be simulated is the flat Rayleigh fading channel. For this channel model, the received signals *y(n)* is given by

$$y(n)=R(n)x(n)+v(n)$$

where *x(n)* is the transmitted signal, *v(n)* is the AWGN, and *R(n)* is the Rayleigh fading envelope. R(n) can be generated using the equation

$$R(n) = \left(\sqrt{v_1^2(n) + v_2^2(n)}\right)/\sqrt{2}$$

Where *v(n)* is AWGN. Note that *R(n)* in this case has power=1.

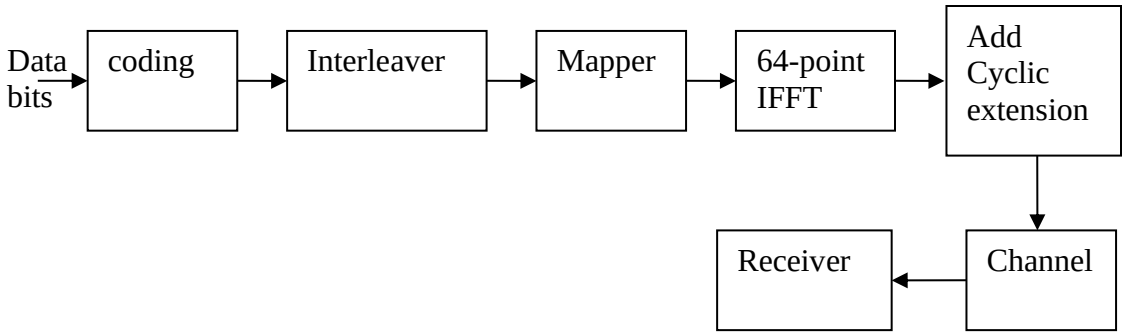
1.3 The receiver

The simple receiver in the model under consideration will take the output of the channel and decide on the symbol transmitted. The output bit stream of the receiver is compared to the input bit stream and the BER is calculated. Assume perfect channel knowledge at receiver .

1.4 Mandatory Tasks

It is required to plot curves for the BER Vs Eb/No. Note that for the fading channel, Eb/No will be average Eb/No, as the fading magnitude will vary from one sample to the other.
The other requirement is to evaluate the performance of a repetition code. This is done by transmitting every "1" as three "1's" and every "0" as three "0's". Note that in this case Eb is the energy of information bit then the energy of each coded bit will be Eb/3 to maintain same average power .Draw BER curves in case of coded system Vs Eb/No.

2 OFDM system simulation



2.1 Coding

Either no coding or rate 1/3 repetition code are used. Note that you have to adjust the number of input bits per OFDM symbol when using repetition code. For example if you use QPSK, only 42 data bits will be used per OFDM symbol, a zero is added to the encoded data to have 64 symbols at the input of the mapper before the IFFT block.

2.2 Interleaver

For QPSK, The size of the interleaver is 8 by 16.
For 16QAM, the interleaver size is 16 by 16.

2.3 Mapper

The mappers used are the same as those used in the single carrier system in section 1.1

2.4 IFFT

Use a size 64 IFFT block. In Matlab use the command "IFFT"

2.5 Channel

Two channel models should be considered
a- Flat fading time invariant AWGN channel .
b- Frequency selective Fading channel: assume a 2-path fading channel h=[0.8 0 0 0 0 0 0 0 0 0 0 0.6] . For simplicity, power will be distributed equally across all subcarriers although the optimum allocation is given by the water-filling algorithm.

2.6 Receiver

Design a receiver to receive the signal described above in two cases of AWGN and fading channels. Assume perfect channel knowledge at receiver.

2.7 Requirements

Same as in the single carrier system for the two channel models and for the coding/no-coding scenarios.

3 Regulations

1. This is an individual task.
2. Cheating will be met with zero tolerance. In case of cheating the two reports will get zero marks even if the cheating occurred in one part only of the report.
3. Late submission is not accepted and will be discarded.