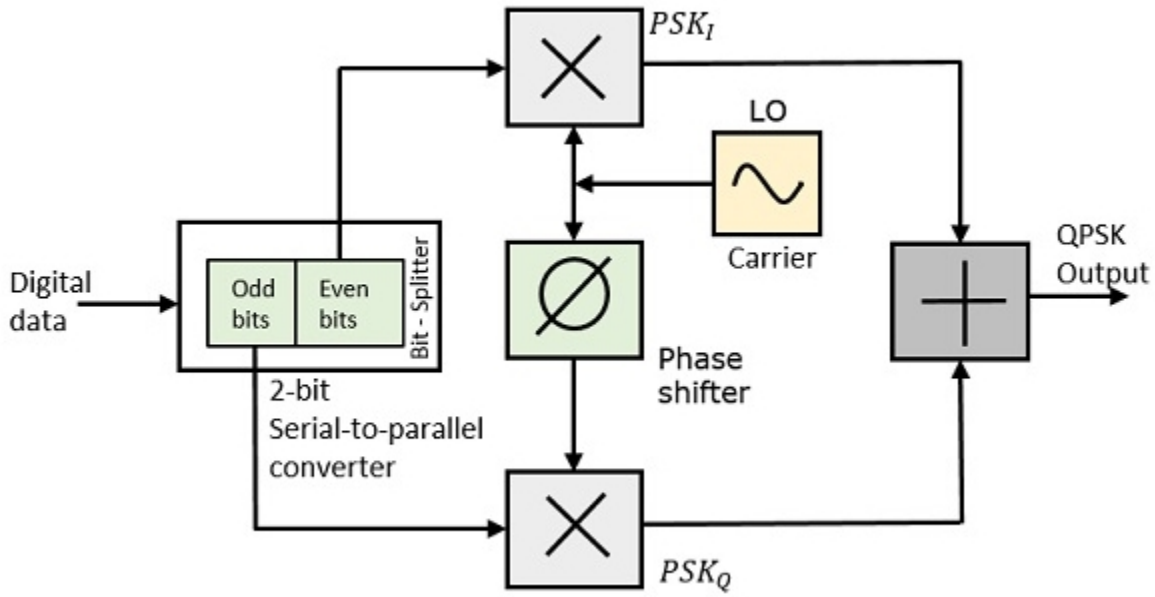
QPSK constellation and Comparison of different BER of various Modulation Schemes

QPSK Modulator:

- The QPSK Modulator uses a bit-splitter, two multipliers with local oscillator, a 2-bit serial to parallel converter, and a summer circuit. Following is the block diagram for the same.

QPSK Modulator:

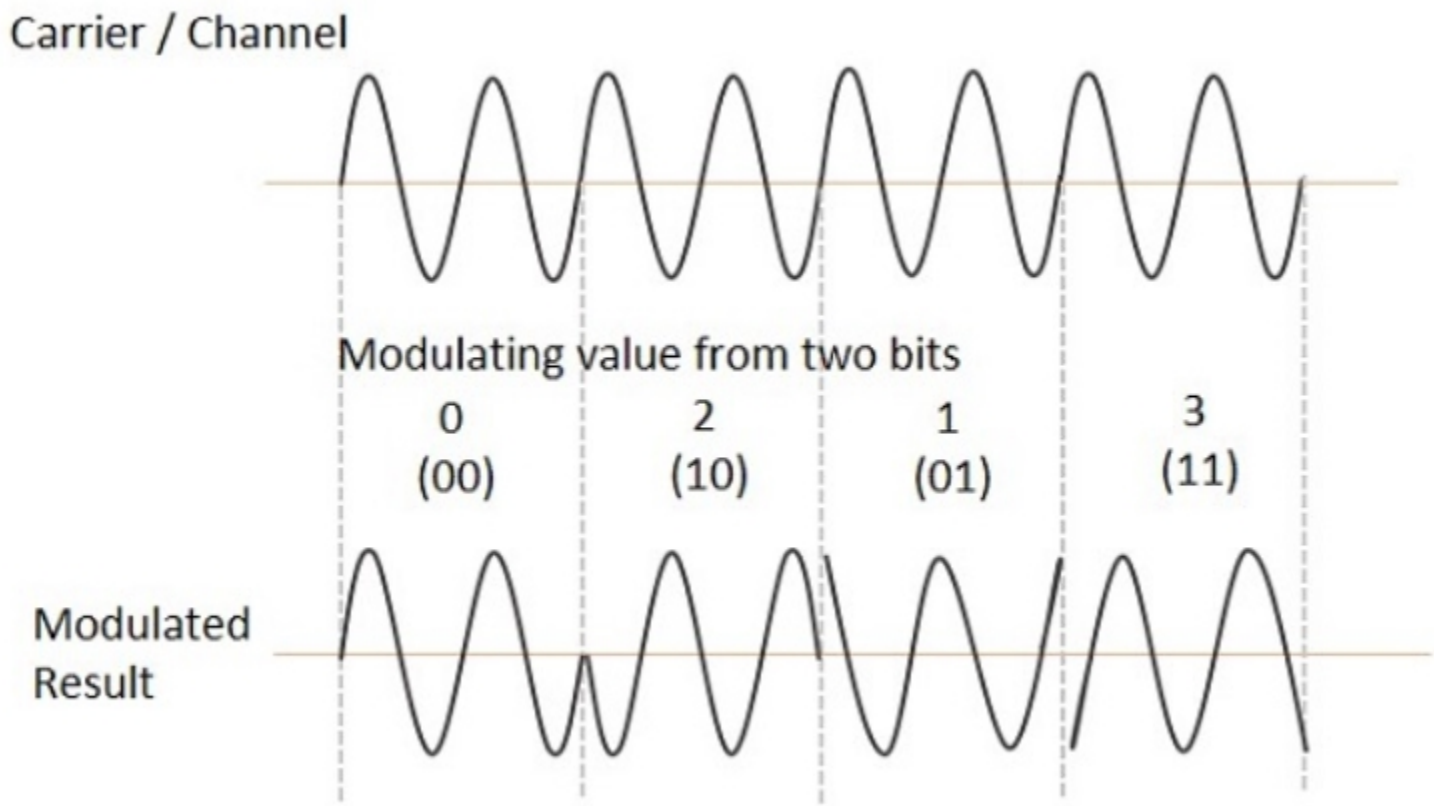


QPSK Modulator:

- At the modulator's input, the message signal's even bits (i.e., 2nd bit, 4th bit, 6th bit, etc.) and odd bits (i.e., 1st bit, 3rd bit, 5th bit, etc.) are separated by the bits splitter and are multiplied with the same carrier to generate odd BPSK (called as PSKI) and even BPSK (called as PSKQ). The PSKQ signal is anyhow phase shifted by 90° before being modulated.

- The QPSK waveform for two-bits input is as follows, which shows the modulated result for different instances of binary inputs.

QPSK Modulator:

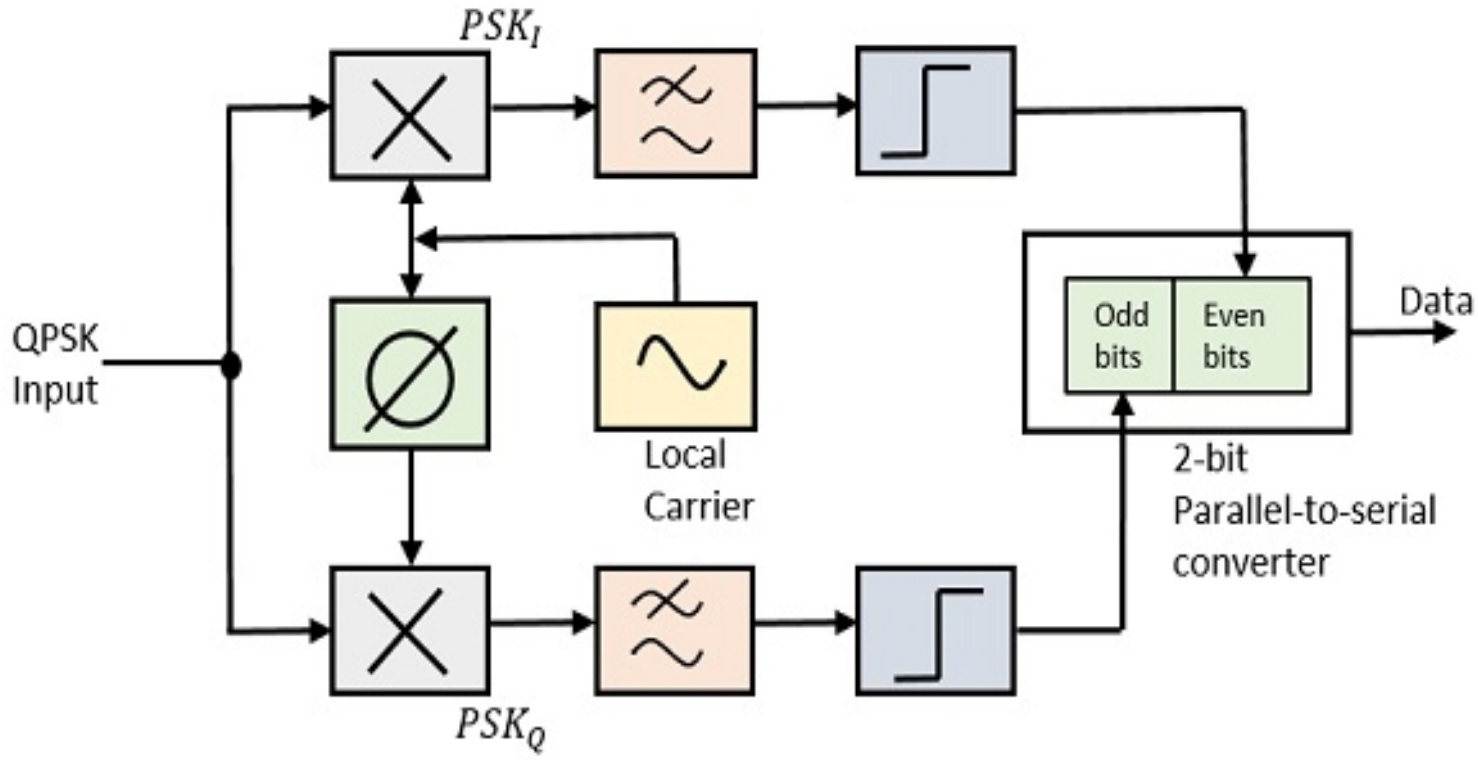


QPSK Demodulator:

- The QPSK Demodulator uses two product demodulator circuits with local oscillator, two band pass filters, two integrator circuits, and a 2-bit parallel to serial converter. Following is the diagram for the same.

- The two product detectors at the input of demodulator simultaneously demodulate the two BPSK signals. The pair of bits are recovered here from the original data. These signals after processing, are passed to the parallel to serial converter.

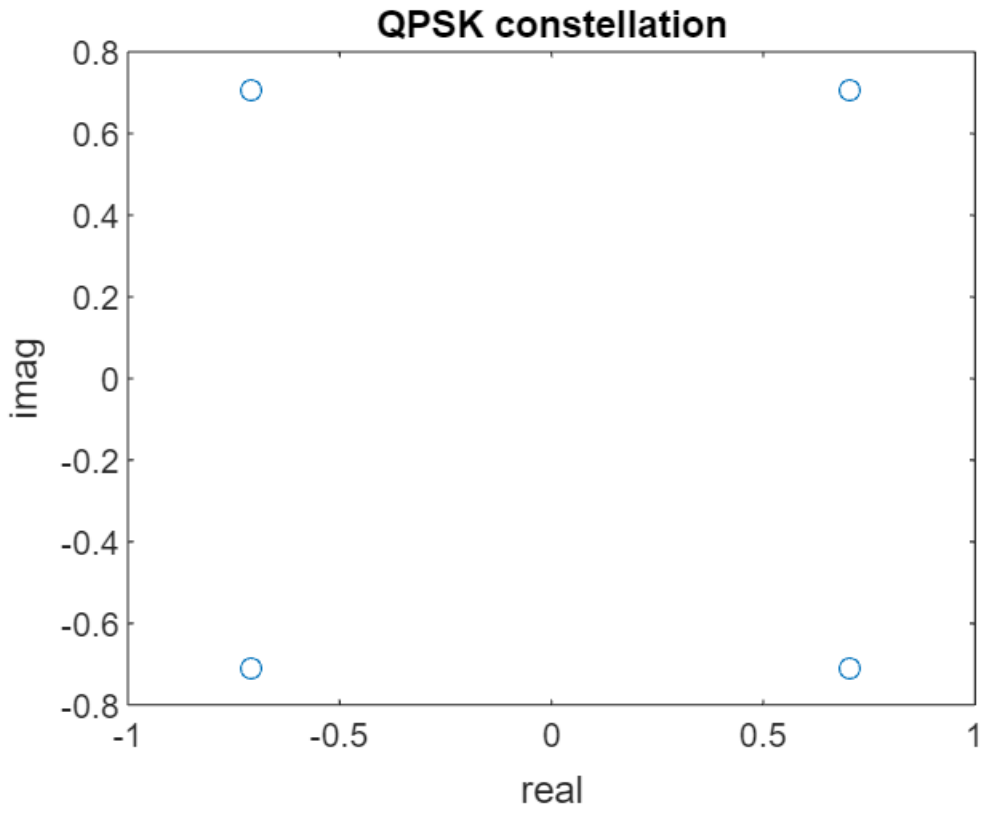
QPSK Demodulator:



QPSK constellation MATLAB code:

```
clear;
b=[1,0,0,0,1,1,0,1]        % Assign binary data bits
for n=1:length(b)/2
p=b(2*n);
q=b(2*n-1);
if(q==0)&(p==0)
d(n)=exp(j*pi/4);%45
end
if(q==1)&(p==0)
d(n)=exp(j*3*pi/4);%135
end
if(q==1)&(p==1)
d(n)=exp(j*5*pi/4);%225
end
if(q==0)&(p==1)
d(n)=exp(j*7*pi/4);%315
end
end
qpsk=d;
plot(d,'o');
xlabel('real');
ylabel('imag');
title('QPSK constellation');
```

Constellation diagram:



To plot Various BER vs Eb/N0 (dB) for different digital Modulation schemes

BER:

- The **bit error rate** (**BER**) is the number of bit errors per unit time. The **bit error ratio** (also **BER**) is the number of bit errors divided by the total number of transferred bits during a studied time interval. Bit error ratio is a unitless performance measure, often expressed as a percentage.
- The **bit error probability** p_e is the expected value of the bit error ratio. The bit error ratio can be considered as an approximate estimate of the bit error probability. This estimate is accurate for a long time interval and a high number of bit errors.

Matlab code:

- clc;
- close all;
- EbN0dB = 0:20
- EbN0=10.^(EbN0dB/10);
- pe_bpsk=0.5*erfc(sqrt(EbN0));
- pe_bfsk=0.5*erfc(sqrt(EbN0/2));
- pe_bask=0.5*erfc(sqrt(EbN0/4));

- `semilogy(EbN0dB,pe_bpsk,'r',EbN0dB,pe_bfsk,'b',EbN0dB,pe_bask,'k')`
- `xlabel('Eb/N0(db)')`
- `ylabel('BER')`

Plot

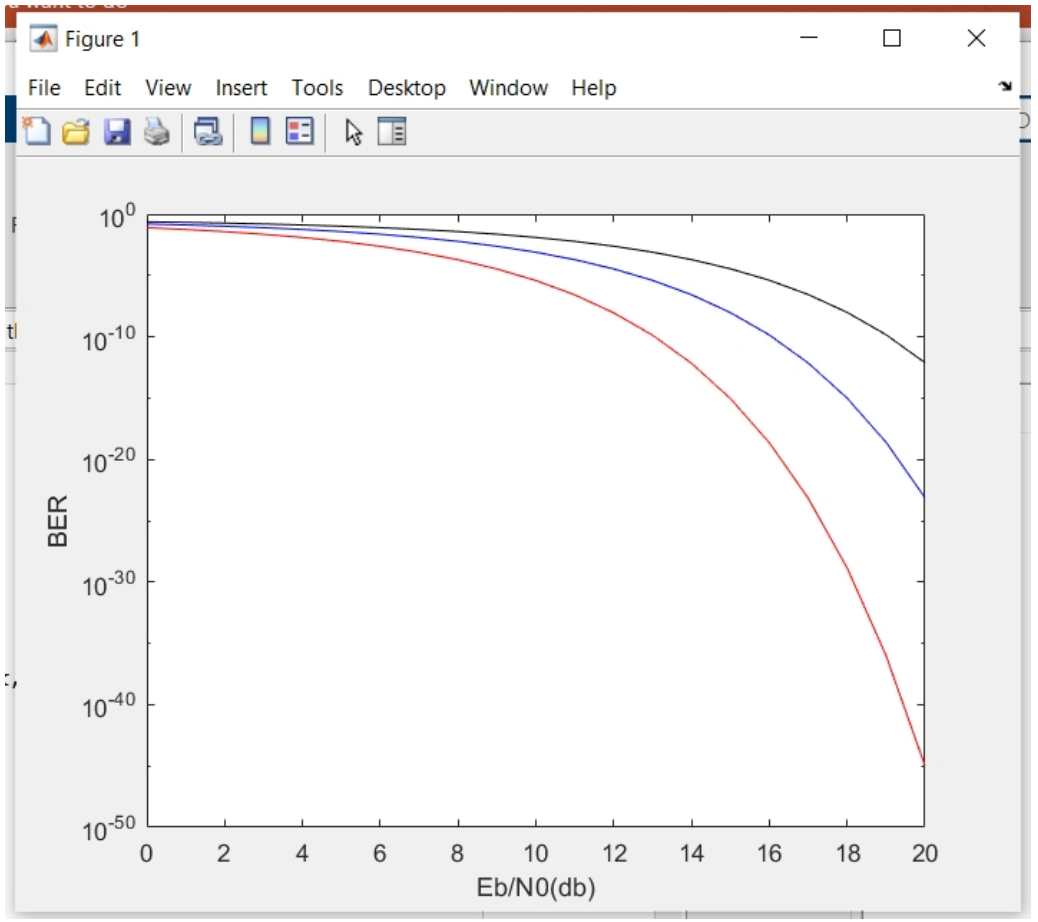


Figure 1
File Edit View Insert Tools Desktop Window Help
BER
Eb/N0(db)
10^0
10^-10
10^-20
10^-30
10^-40
10^-50
0 2 4 6 8 10 12 14 16 18 20

References:

[1]https://www.tutorialspoint.com

[2] www.youtube.com

Thank you