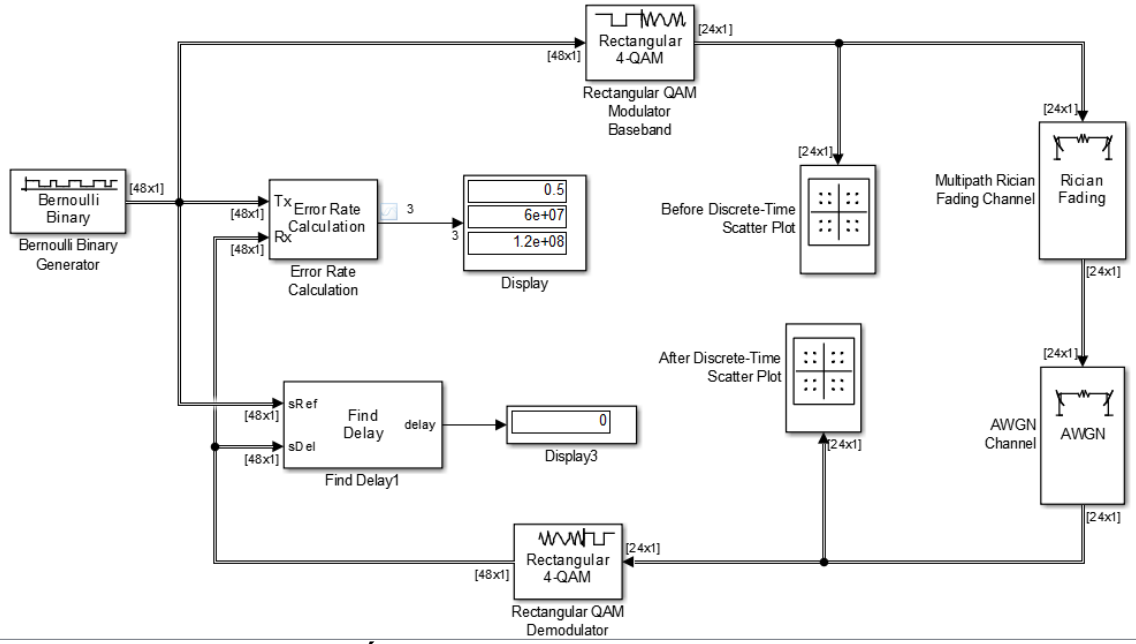
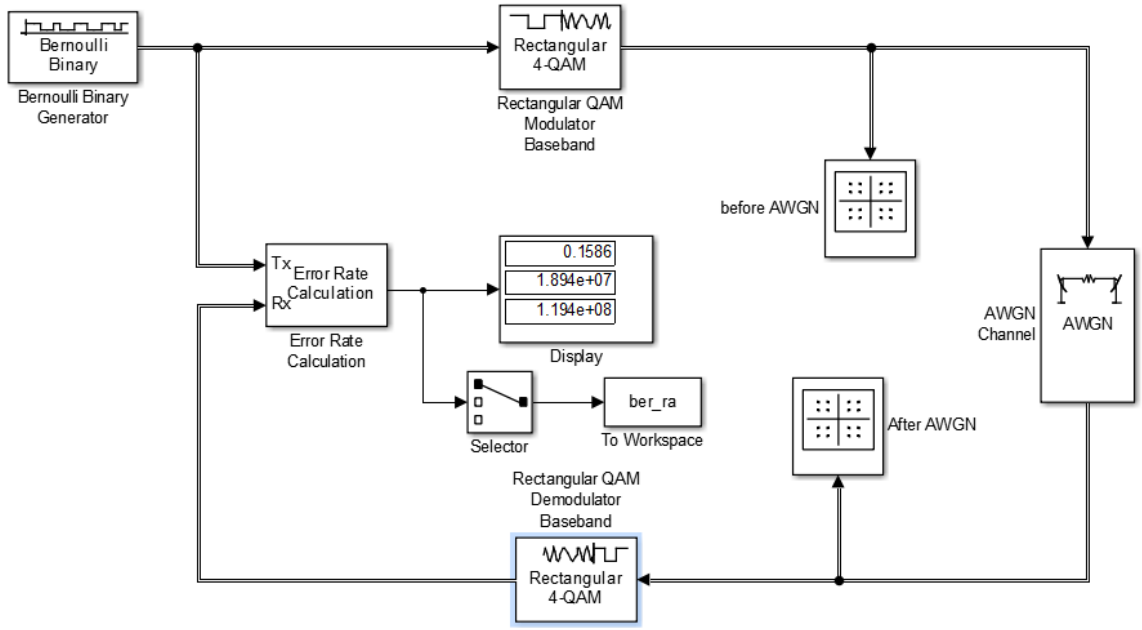
BÀI 6: Xây dựng sơ đồ hệ thống điều chế đa mức và khảo sát đánh giá BER

6.1. Xây dựng hệ thống M-QAM

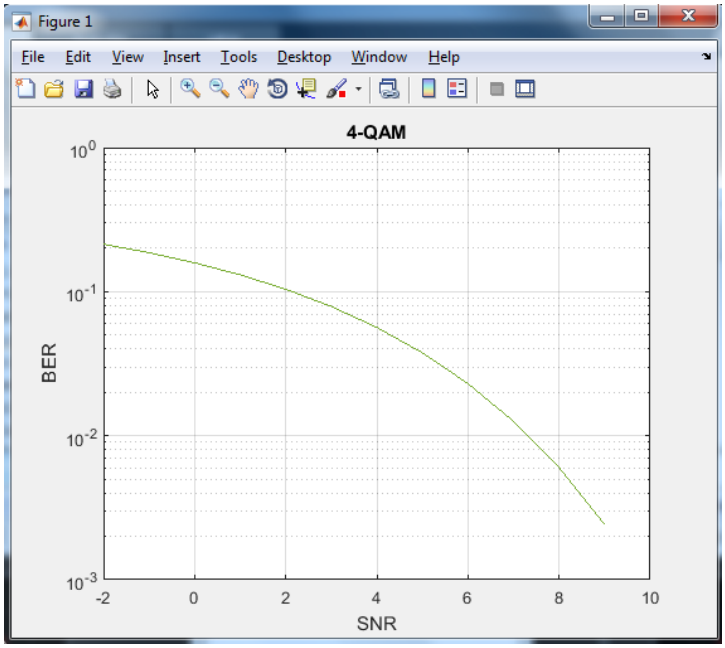


6.2. Đánh giá BER của hệ thống 4-QAM theo SNR trên kênh AWGN dùng m file



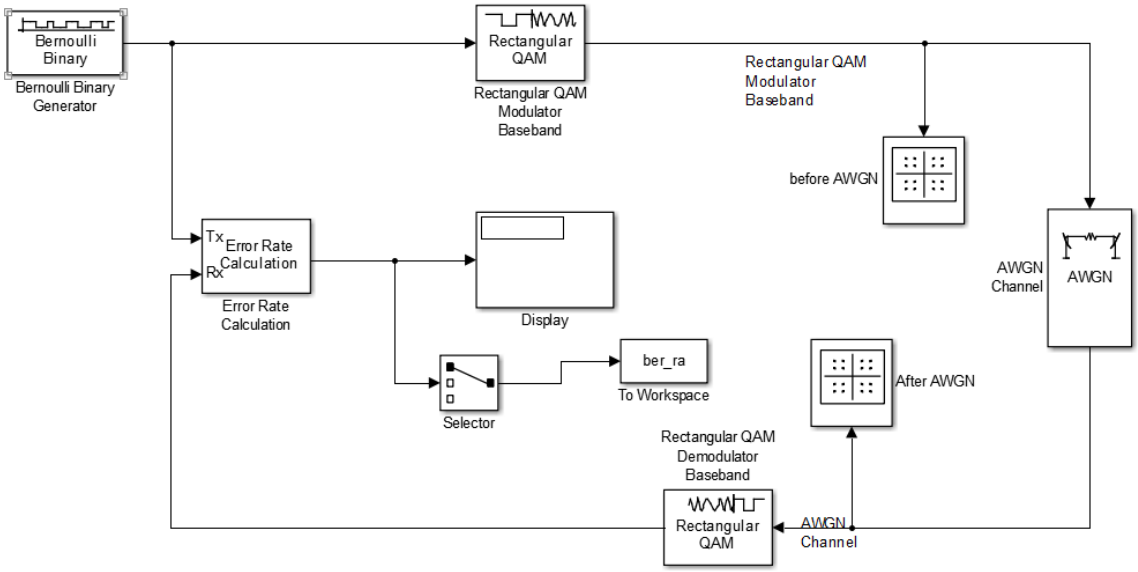

```
snrdB=-2:1:10; % khoi AWGN
    for n=1:length(snrdB)
       simOut=sim('Cau1.slx') % Duong dan den file chay mo phong - cung thu muc
        LoiBit(n)=ber_ra;
        grid on;
        semilogy(snrdB(1:n), LoiBit(1:n));
        hold on;
        xlabel('SNR');
        ylabel('BER');
        title('4-QAM');
    end
```

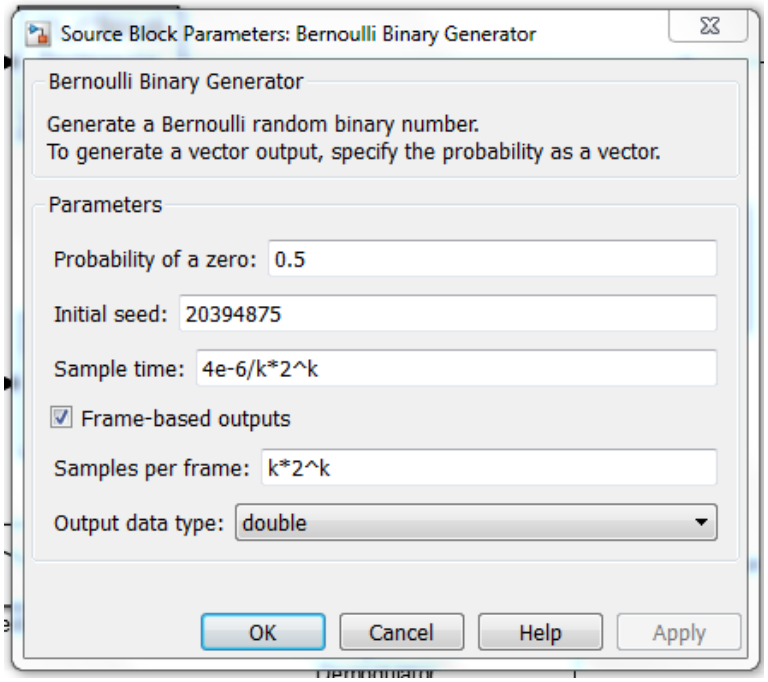
Kết quả

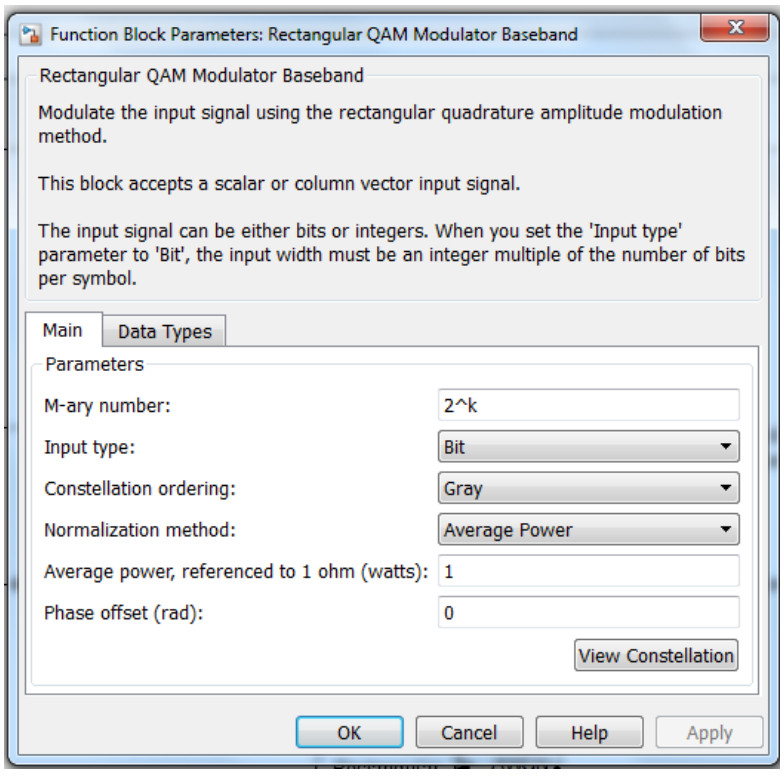


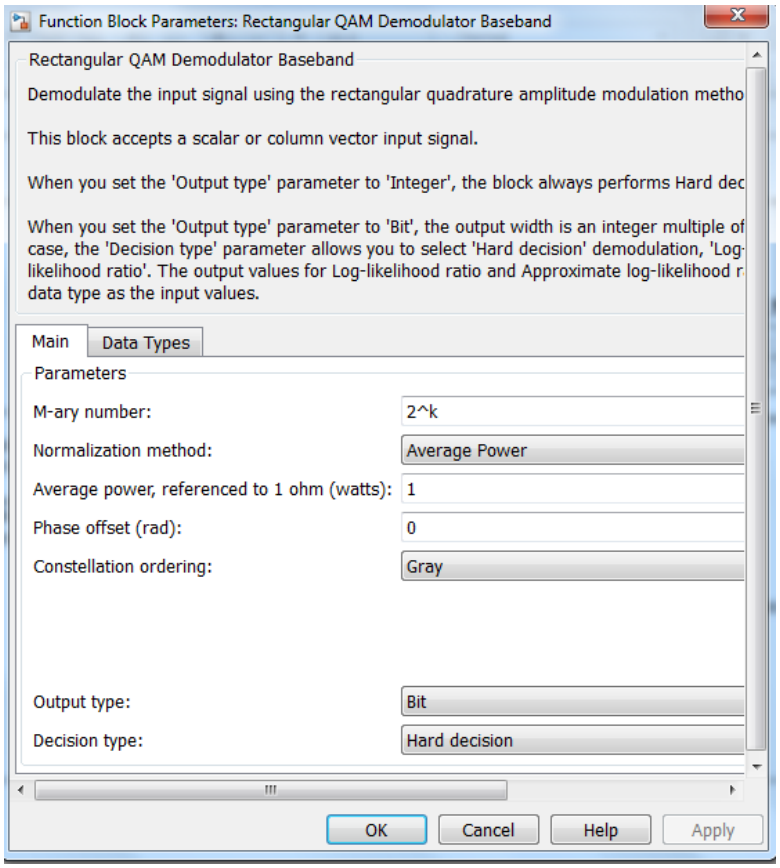
6.3. Đánh giá BER của hệ thống M-QAM theo SNR trên kênh AWGN dùng m file

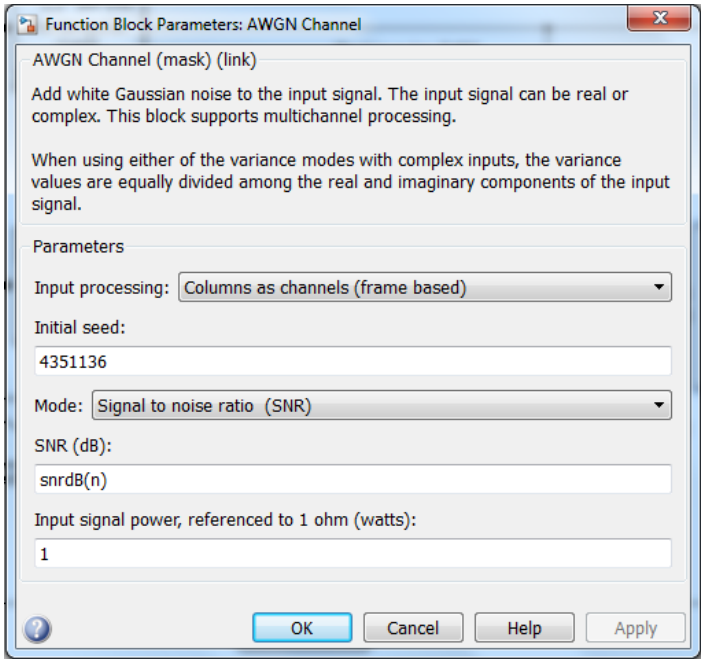
- Điều chế M-QAM với M-aray number = 2^k (k – số bit vào)
- Kênh AWGN có chỉ số SNR thay đổi

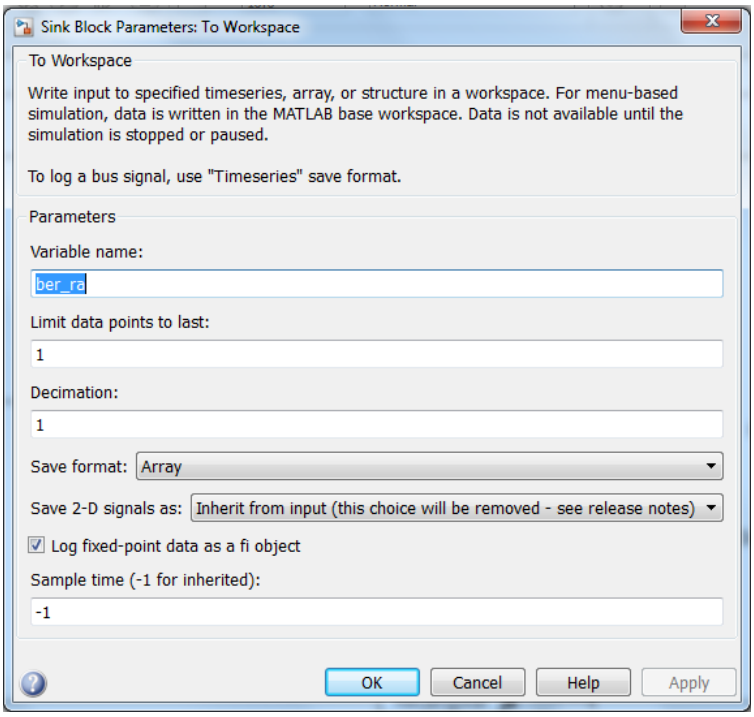



Source Block Parameters: Bernoulli Binary Generator
Bernoulli Binary Generator
Generate a Bernoulli random binary number.
To generate a vector output, specify the probability as a vector.
Parameters
Probability of a zero: 0.5
Initial seed: 20394875
Sample time: 4e-6/k*2^k
Frame-based outputs
Samples per frame: k*2^k
Output data type: double
OK
Cancel
Help
Apply


Function Block Parameters: Rectangular QAM Modulator Baseband
Rectangular QAM Modulator Baseband
Modulate the input signal using the rectangular quadrature amplitude modulation method.
This block accepts a scalar or column vector input signal.
The input signal can be either bits or integers. When you set the 'Input type' parameter to 'Bit', the input width must be an integer multiple of the number of bits per symbol.
Main
Data Types
Parameters
M-ary number: 2^k
Input type: Bit
Constellation ordering: Gray
Normalization method: Average Power
Average power, referenced to 1 ohm (watts): 1
Phase offset (rad): 0
View Constellation
OK
Cancel
Help
Apply


Function Block Parameters: Rectangular QAM Demodulator Baseband
Rectangular QAM Demodulator Baseband
Demodulate the input signal using the rectangular quadrature amplitude modulation metho
This block accepts a scalar or column vector input signal.
When you set the 'Output type' parameter to 'Integer', the block always performs Hard dec
When you set the 'Output type' parameter to 'Bit', the output width is an integer multiple of
case, the 'Decision type' parameter allows you to select 'Hard decision' demodulation, 'Log
likelihood ratio'. The output values for Log-likelihood ratio and Approximate log-likelihood r
data type as the input values.
Main
Data Types
Parameters
M-ary number:
2^k
Normalization method:
Average Power
Average power, referenced to 1 ohm (watts):
1
Phase offset (rad):
0
Constellation ordering:
Gray
Output type:
Bit
Decision type:
Hard decision
OK
Cancel
Help
Apply


Function Block Parameters: AWGN Channel
AWGN Channel (mask) (link)
Add white Gaussian noise to the input signal. The input signal can be real or
complex. This block supports multichannel processing.
When using either of the variance modes with complex inputs, the variance
values are equally divided among the real and imaginary components of the input
signal.
Parameters
Input processing:
Columns as channels (frame based)
Initial seed:
4351136
Mode:
Signal to noise ratio (SNR)
SNR (dB):
snrdB(n)
Input signal power, referenced to 1 ohm (watts):
1
OK
Cancel
Help
Apply



m.file

Chương trình chính

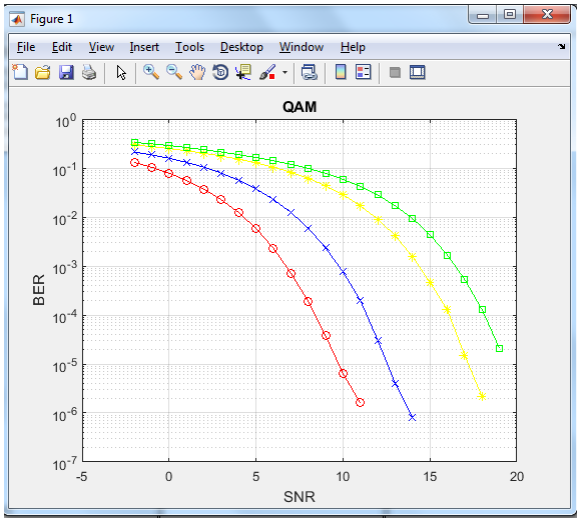
```
snrdB=-2:1:22; % khoi AWGN - SNR nhận giá trị từ -2 đến 22 dB
i=2:1:6; % Bien chay tao he so k bit - tương ứng các loại điều chế 4-QAM,
          8-QAM, 16-QAM, 32-QAM, 64-QAM

for k=1:length(i)
    for n=1:length(snrdB)
       simOut=sim('Cau1.slx')
             % Duong dan den file chay mo phong - cung thu muc
        %simOut=sim('C:\Users\Administrator\Desktop\MophongQAM\Cau1.slx')
             % Duong dan den file chay mo phong
        LoiBit(n)=ber_ra; % Khối To Workspace
        grid on;
        semilogy(snrdB(1:n), LoiBit(1:n), chonmau2(k));
                % chon mau(k) cho cac mau chay
        hold on;
        xlabel('SNR');
        ylabel('BER');
        title('QAM');
    end
end
```

Chọn màu:

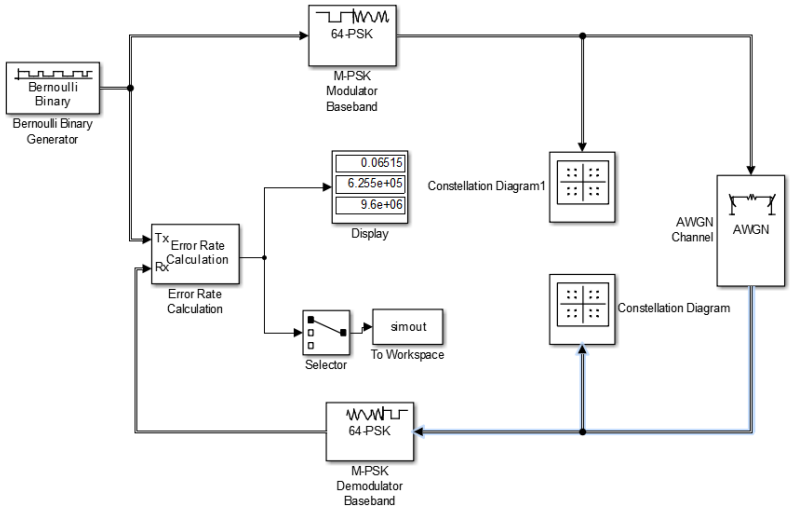
```
function mau=chonmau2(k)
switch k
         case 1
           mau = 'red o-';
         case 2
           mau = 'blue x-';
         case 3
           mau = 'yellow *-';
         case 4
           mau = 'green sq-';
         case 5
           mau = 'black tri-';
         otherwise
           mau = 'cyan -';
  end
```

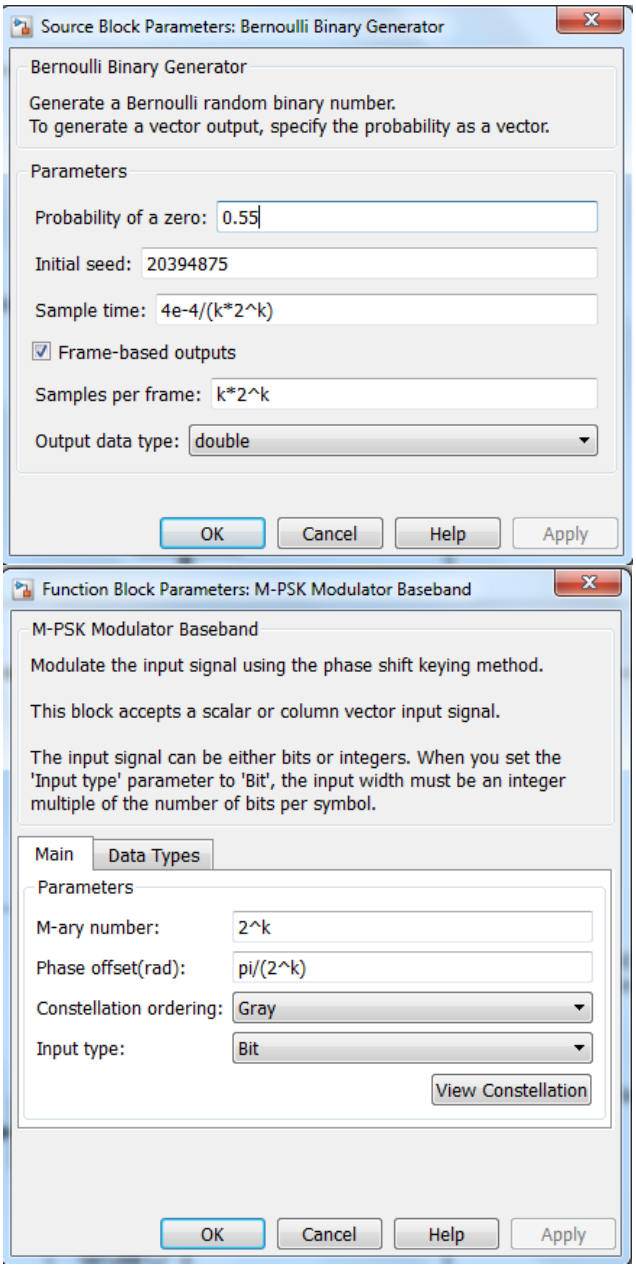
Kết quả

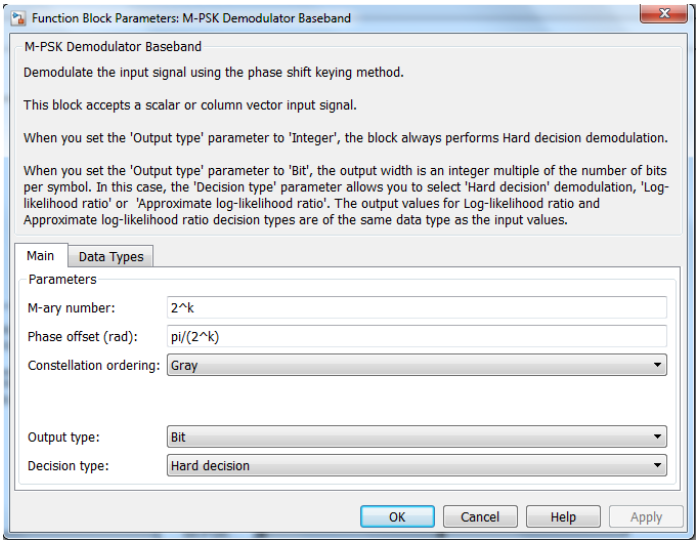


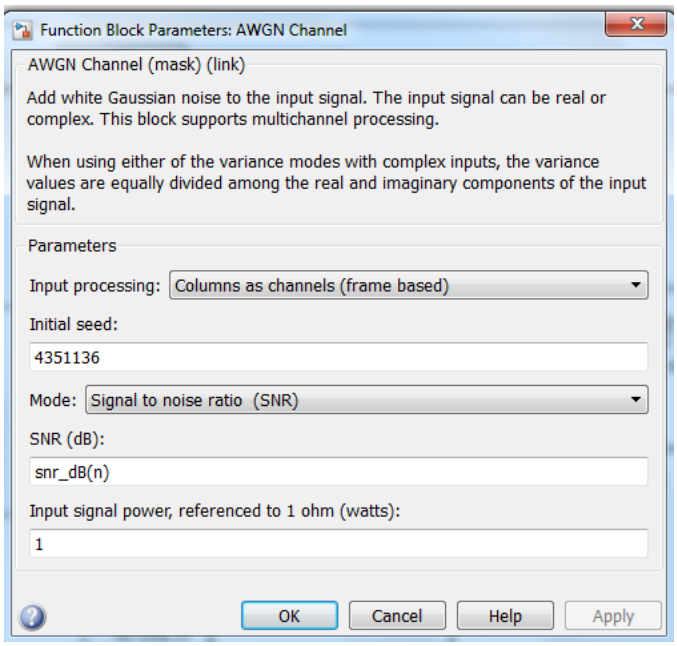
6.4. Đánh giá BER của hệ thống M-PSK theo SNR trên kênh AWGN dùng m file

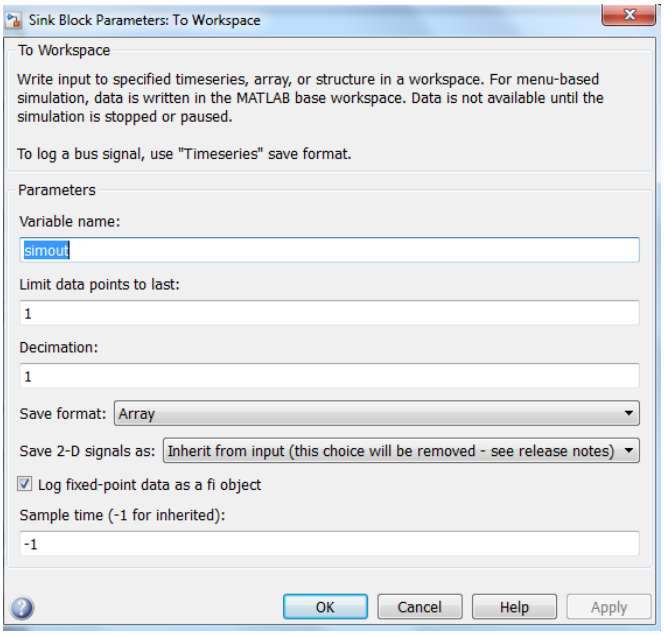
- Điều chế M-PSK với M-aray number = 2^k (k – số bit vào)
- Kênh AWGN có chỉ số SNR thay đổi




Source Block Parameters: Bernoulli Binary Generator
Bernoulli Binary Generator
Generate a Bernoulli random binary number.
To generate a vector output, specify the probability as a vector.
Parameters
Probability of a zero: 0.55
Initial seed: 20394875
Sample time: 4e-4/(k*2^k)
Frame-based outputs
Samples per frame: k*2^k
Output data type: double
OK
Cancel
Help
Apply
Function Block Parameters: M-PSK Modulator Baseband
M-PSK Modulator Baseband
Modulate the input signal using the phase shift keying method.
This block accepts a scalar or column vector input signal.
The input signal can be either bits or integers. When you set the 'Input type' parameter to 'Bit', the input width must be an integer multiple of the number of bits per symbol.
Main
Data Types
Parameters
M-ary number: 2^k
Phase offset(rad): pi/(2^k)
Constellation ordering: Gray
Input type: Bit
View Constellation
OK
Cancel
Help
Apply


Function Block Parameters: M-PSK Demodulator Baseband
M-PSK Demodulator Baseband
Demodulate the input signal using the phase shift keying method.
This block accepts a scalar or column vector input signal.
When you set the 'Output type' parameter to 'Integer', the block always performs Hard decision demodulation.
When you set the 'Output type' parameter to 'Bit', the output width is an integer multiple of the number of bits per symbol. In this case, the 'Decision type' parameter allows you to select 'Hard decision' demodulation, 'Log-likelihood ratio' or 'Approximate log-likelihood ratio'. The output values for Log-likelihood ratio and Approximate log-likelihood ratio decision types are of the same data type as the input values.
Main
Data Types
Parameters
M-ary number: 2^k
Phase offset (rad): pi/(2^k)
Constellation ordering: Gray
Output type: Bit
Decision type: Hard decision
OK
Cancel
Help
Apply

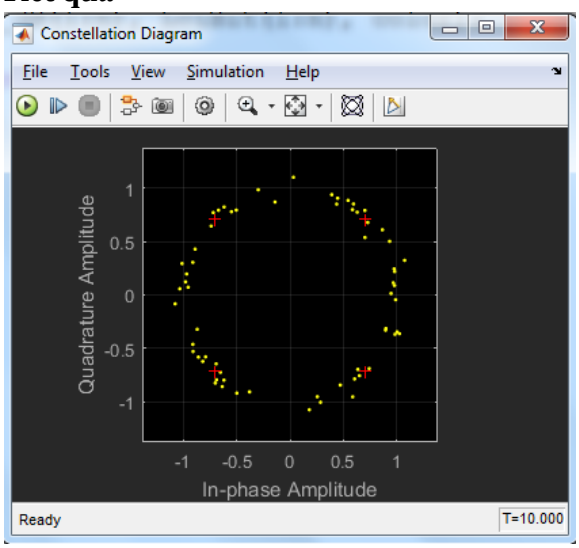

Function Block Parameters: AWGN Channel
AWGN Channel (mask) (link)
Add white Gaussian noise to the input signal. The input signal can be real or complex. This block supports multichannel processing.
When using either of the variance modes with complex inputs, the variance values are equally divided among the real and imaginary components of the input signal.
Parameters
Input processing: Columns as channels (frame based)
Initial seed:
4351136
Mode: Signal to noise ratio (SNR)
SNR (dB):
snr_dB(n)
Input signal power, referenced to 1 ohm (watts):
1
OK
Cancel
Help
Apply

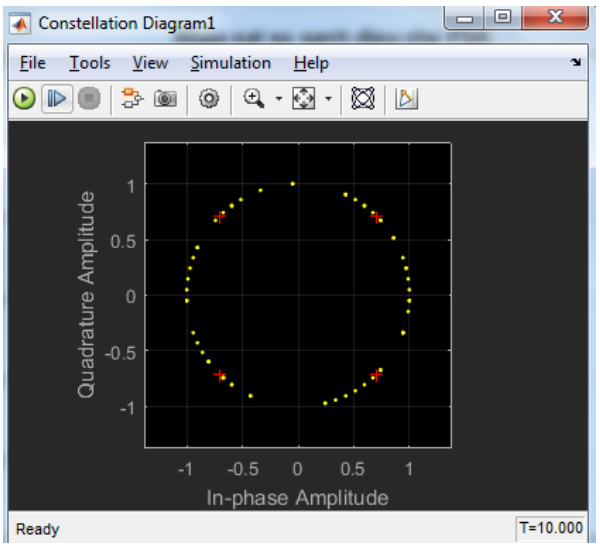

Sink Block Parameters: To Workspace
To Workspace
Write input to specified timeseries, array, or structure in a workspace. For menu-based simulation, data is written in the MATLAB base workspace. Data is not available until the simulation is stopped or paused.
To log a bus signal, use "Timeseries" save format.
Parameters
Variable name:
simout
Limit data points to last:
1
Decimation:
1
Save format: Array
Save 2-D signals as: Inherit from input (this choice will be removed - see release notes)
Log fixed-point data as a fi object
Sample time (-1 for inherited):
-1
OK
Cancel
Help
Apply

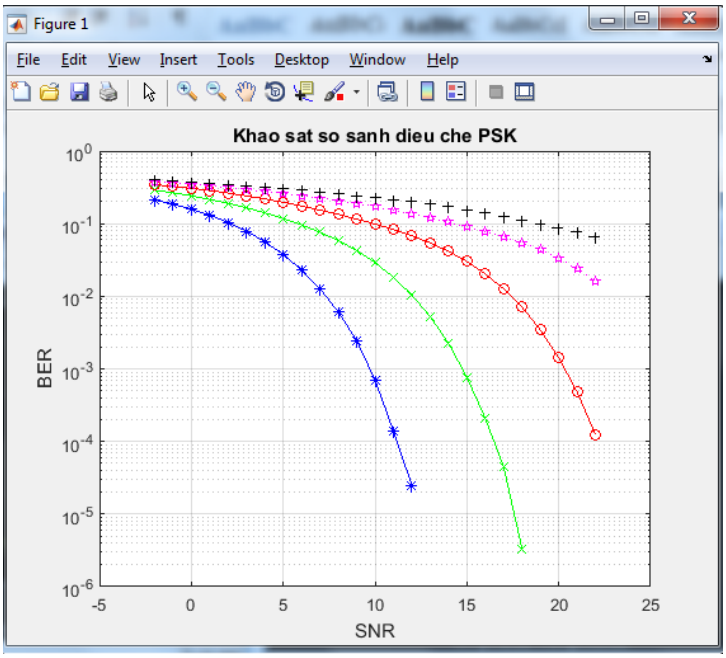
m file

```
snr_dB = -2:1:22;
i=2:1:6;
%Chon mau cho cac duong mo phong
color='';
for a=1:length(i) %so bit/symbol cua cac bac dieu che
    k = a+1;
    if k==2
        color='b *-';
    elseif k==3
        color='g x-';
    elseif k==4
        color='r o-';
    elseif k==5
        color='m :p';
    elseif k==6
        color='k +';
    end
    % ve hinh
    for n=1:length(snr_dB)
        simOut=sim('Cau2.slx')
        LoiBit(n) = simout;
        grid on;
        plot = semilogy(snr_dB(1:n), LoiBit(1:n), color);
        hold on;
        title('Khao sat so sanh dieu che PSK');
        xlabel('SNR');
        ylabel('BER');
   end
end
```

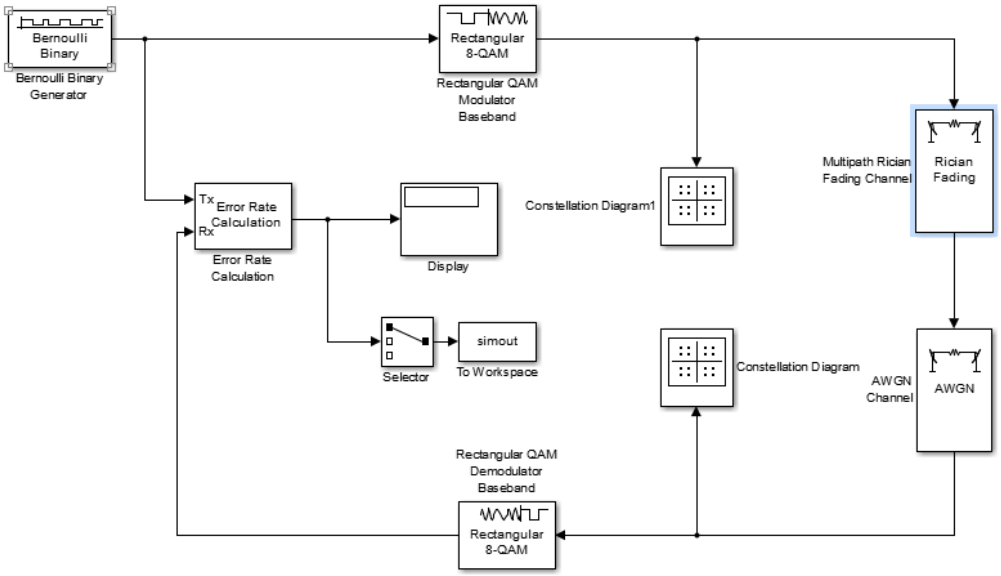
Kết quả

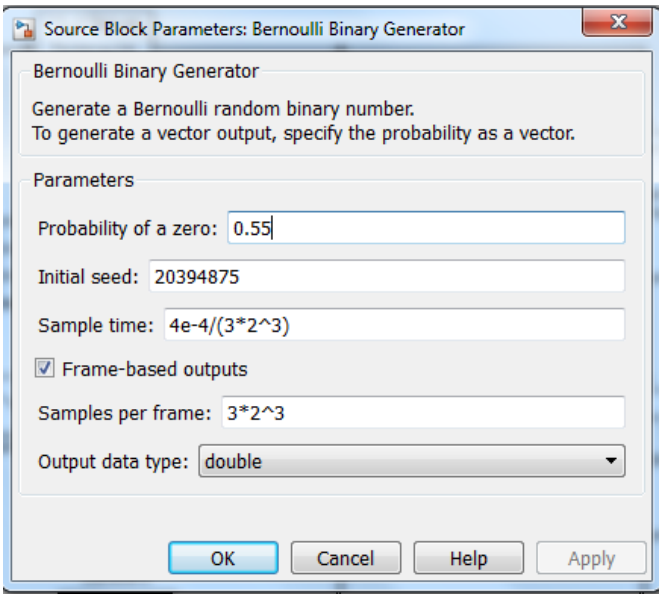


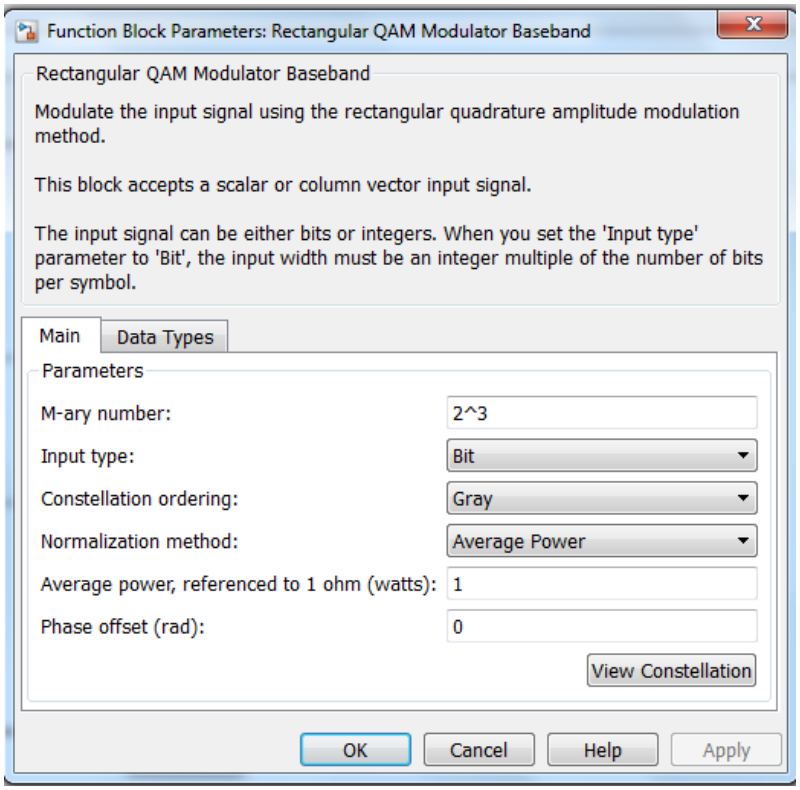


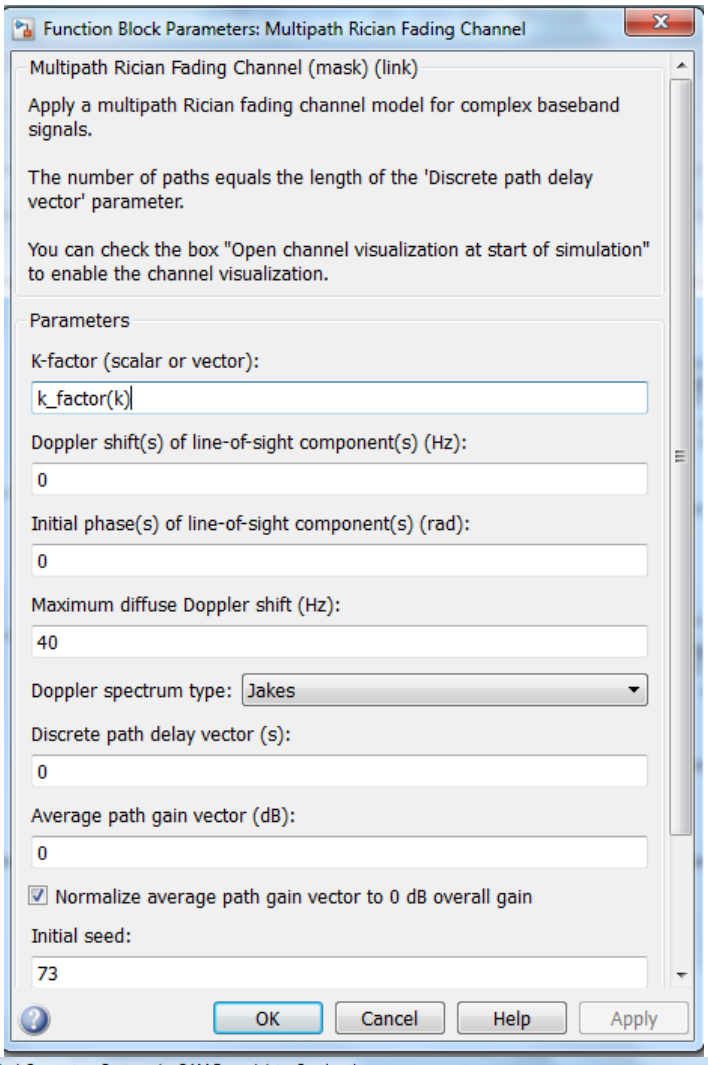


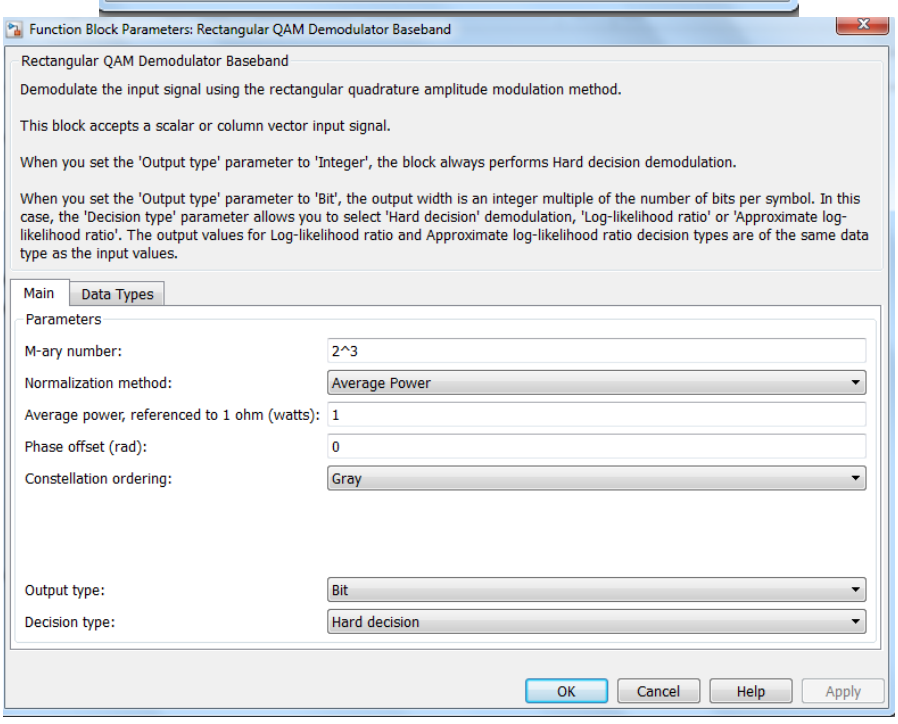
6.5. Đánh giá BER của hệ thống 8-QAM theo hệ số k trên kênh Rician Fading dùng m file

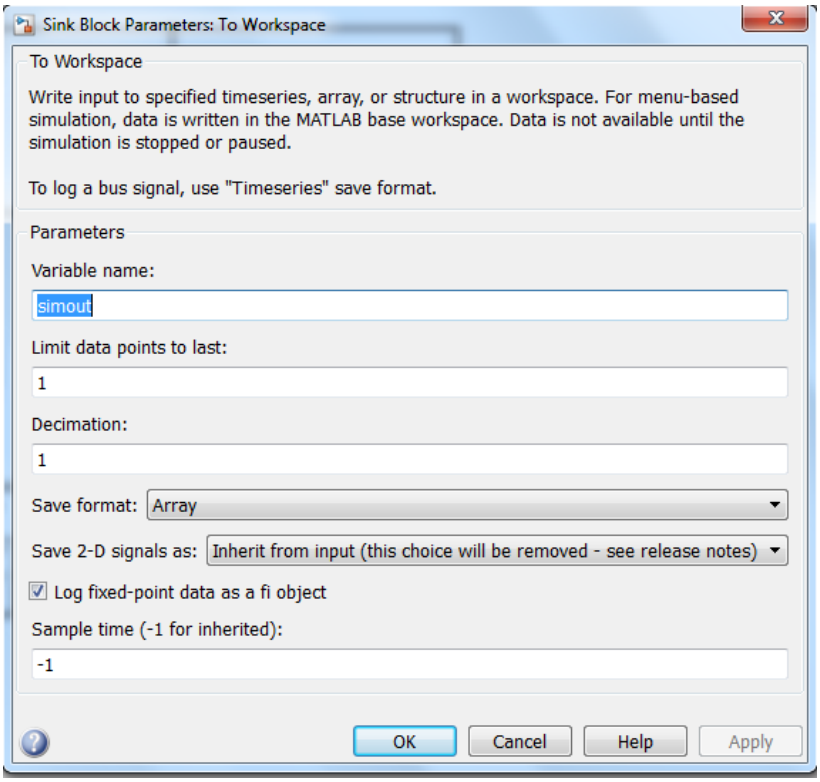



Source Block Parameters: Bernoulli Binary Generator
Bernoulli Binary Generator
Generate a Bernoulli random binary number.
To generate a vector output, specify the probability as a vector.
Parameters
Probability of a zero: 0.55
Initial seed: 20394875
Sample time: 4e-4/(3*2^3)
Frame-based outputs
Samples per frame: 3*2^3
Output data type: double
OK
Cancel
Help
Apply


Function Block Parameters: Rectangular QAM Modulator Baseband
Rectangular QAM Modulator Baseband
Modulate the input signal using the rectangular quadrature amplitude modulation method.
This block accepts a scalar or column vector input signal.
The input signal can be either bits or integers. When you set the 'Input type' parameter to 'Bit', the input width must be an integer multiple of the number of bits per symbol.
Main
Data Types
Parameters
M-ary number: 2^3
Input type: Bit
Constellation ordering: Gray
Normalization method: Average Power
Average power, referenced to 1 ohm (watts): 1
Phase offset (rad): 0
View Constellation
OK
Cancel
Help
Apply


Function Block Parameters: Multipath Rician Fading Channel
Multipath Rician Fading Channel (mask) (link)
Apply a multipath Rician fading channel model for complex baseband signals.
The number of paths equals the length of the 'Discrete path delay vector' parameter.
You can check the box "Open channel visualization at start of simulation" to enable the channel visualization.
Parameters
K-factor (scalar or vector):
k_factor(k)
Doppler shift(s) of line-of-sight component(s) (Hz):
0
Initial phase(s) of line-of-sight component(s) (rad):
0
Maximum diffuse Doppler shift (Hz):
40
Doppler spectrum type: Jakes
Discrete path delay vector (s):
0
Average path gain vector (dB):
0
Normalize average path gain vector to 0 dB overall gain
Initial seed:
73
OK
Cancel
Help
Apply


Function Block Parameters: Rectangular QAM Demodulator Baseband
Rectangular QAM Demodulator Baseband
Demodulate the input signal using the rectangular quadrature amplitude modulation method.
This block accepts a scalar or column vector input signal.
When you set the 'Output type' parameter to 'Integer', the block always performs Hard decision demodulation.
When you set the 'Output type' parameter to 'Bit', the output width is an integer multiple of the number of bits per symbol. In this case, the 'Decision type' parameter allows you to select 'Hard decision' demodulation, 'Log-likelihood ratio' or 'Approximate log-likelihood ratio'. The output values for Log-likelihood ratio and Approximate log-likelihood ratio decision types are of the same data type as the input values.
Main
Data Types
Parameters
M-ary number: 2^3
Normalization method: Average Power
Average power, referenced to 1 ohm (watts): 1
Phase offset (rad): 0
Constellation ordering: Gray
Output type: Bit
Decision type: Hard decision
OK
Cancel
Help
Apply



M file

```
k_factor = 1:1:10;
for k=1:length(k_factor)
    simOut=sim('Cau3.slx') % flie can danh gia
    LoiBit(k) = simout;% dau ra khoi To Workspace
    grid on;
    plot = semilogy(k_factor(1:k), LoiBit(1:k), 'blue *-');
    hold on;
    title('Fading Rician');
    xlabel('K FACTOR');
    ylabel('BER');
end
```

Kết quả