Manual for Communication Systems Laboratory (EEE/ECE F311)

Prepared by
Faculty & Laboratory Staff
Dept. EEE

BITS Pilani, Hyderabad

Date: October 2025

Experiment 9: Designing a simple Baseband Communication System using Simulink on MATLAB

Aim : The objective of this experiment is to build a baseband communication system by doing Pulse Shaping and finding BER in MATLAB Simulink.

Essential Blocks Required :

- Random Integer Generator
- Root Raised Cosine Filter at Transmitter and Receiver
- AWGN Channel
- Relay
- Error Rate Measurement
- Eye Diagram Scope
- Delay

Running Simulink

Open MATLAB 2015a and type *simulink* in the command window. This will open the Simulink Library which consists of all the Simulink Blocks.

Then click  option for creating a new model.

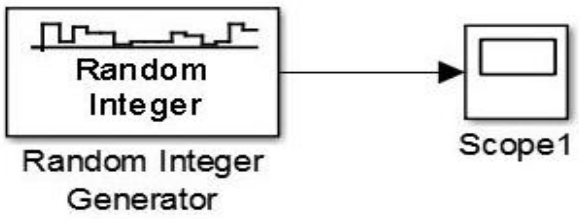
Please save all the scope results (waveforms) in a word file in your system or in your google drive named as Expt 9. The print out of scope results should be staple to your observation book before final submission of the book.

***Important**

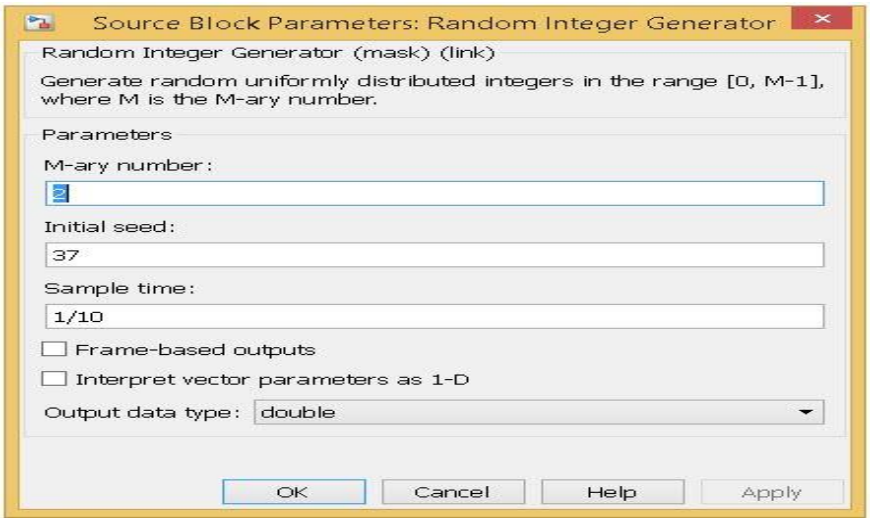
The properties for each block are mentioned in the manual after the run.
You will have to periodically save the model from time to time.
(Don't forget, else you might lose some data)

Run 1 : Generate Random Integers

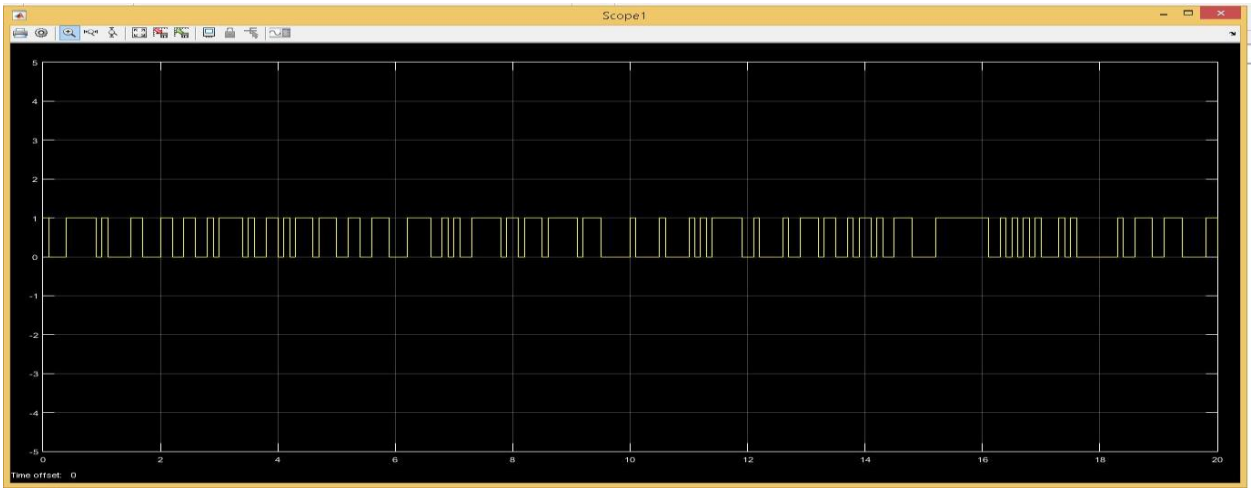
In this run we will be generating a set of random integers.
Connect the blocks as shown in figure by dragging and dropping them from Simulink Library.
(You can browse for each block in Simulink using the search option)
Double click on the blocks to change their properties.
After changing properties, observe the output on the scope.
Use a simulation time of 20 for all the runs.



Properties of Random Generator Block

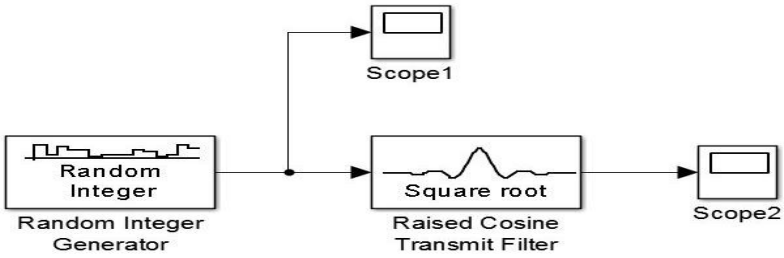


Output on Scope1outp

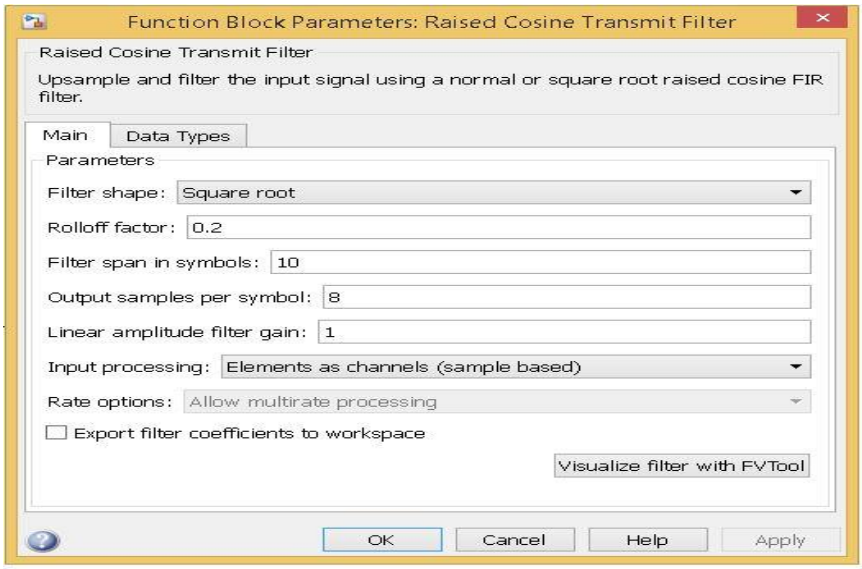


Run 2 : Building Baseband Transmitter

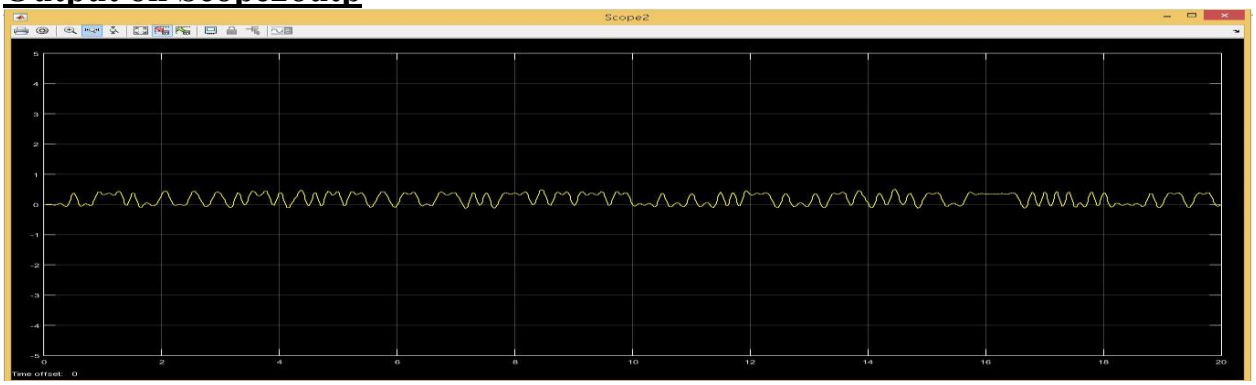
In this run, we will be doing Nyquist pulse shaping on the transmitter side using Root Raised Cosine Filter.
Connect the blocks as shown.
After setting the respective properties observe the output on scope.



Properties of Raised Cosine Transmit Filter



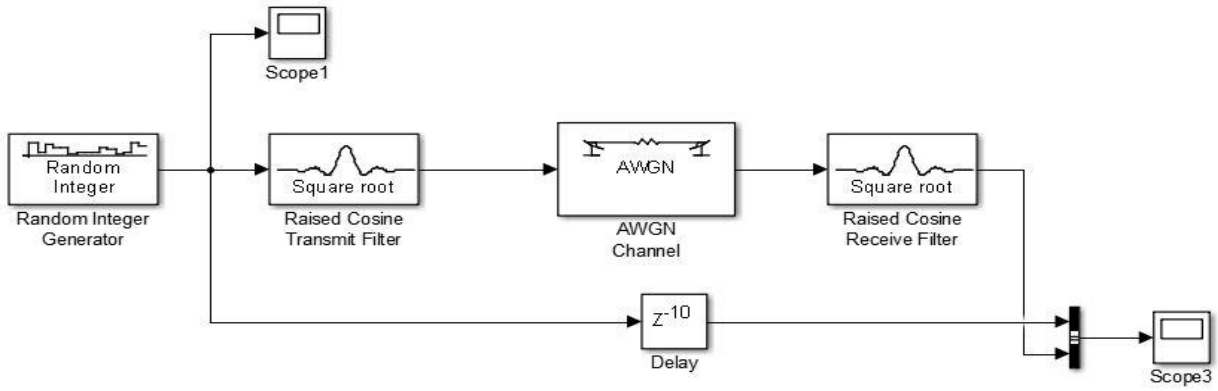
Output on Scope2outp



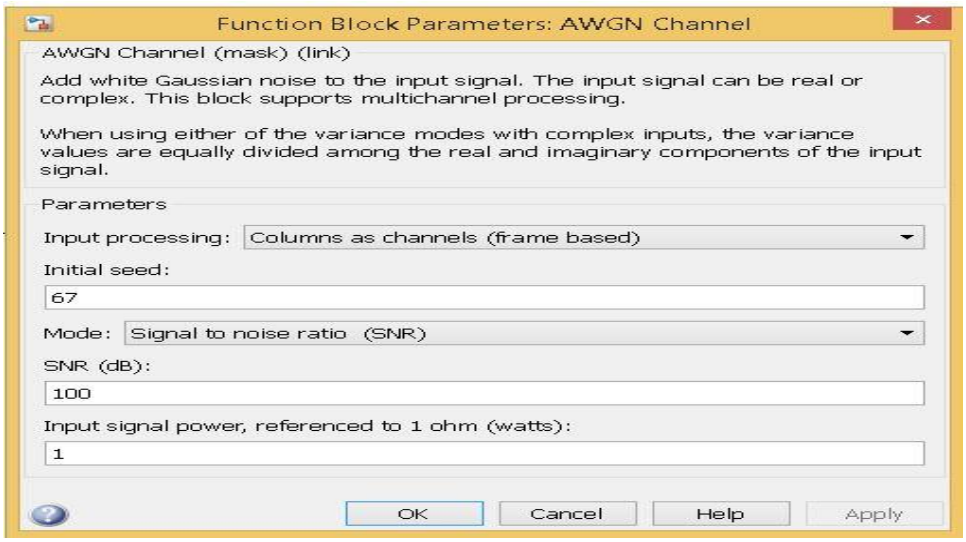
Run 3 : AWGN Channel and Matched Filter

Place the AWGN channel block and the Root raised cosine filter at the receiver (which is the matched filter).
AWGN block is used to add noise to the channel by specifying SNR.

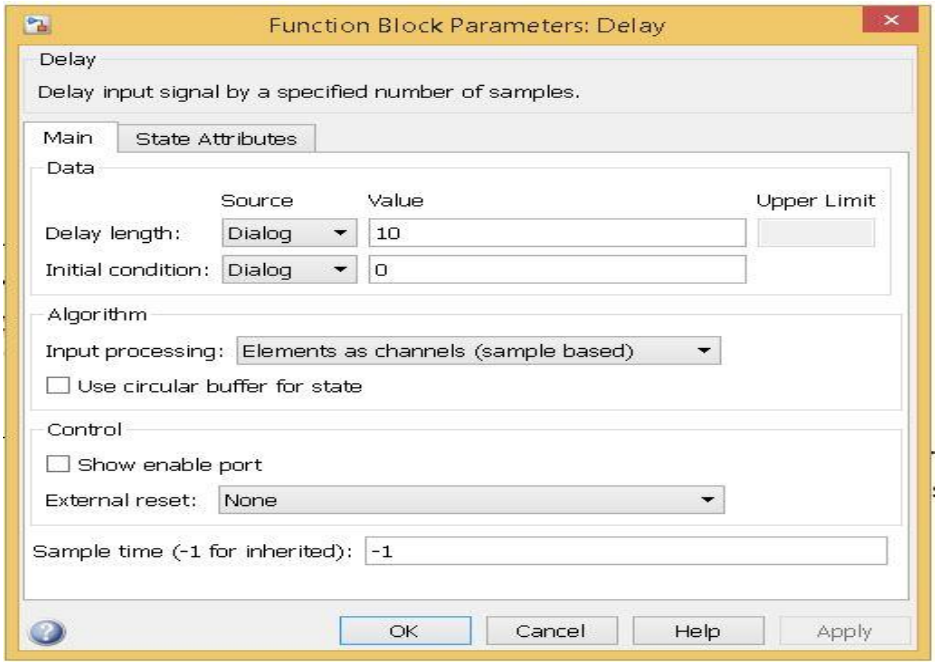
The  block is the bus creator block used for transmitting two signals simultaneously.
After setting the respective properties observe the output on scope.



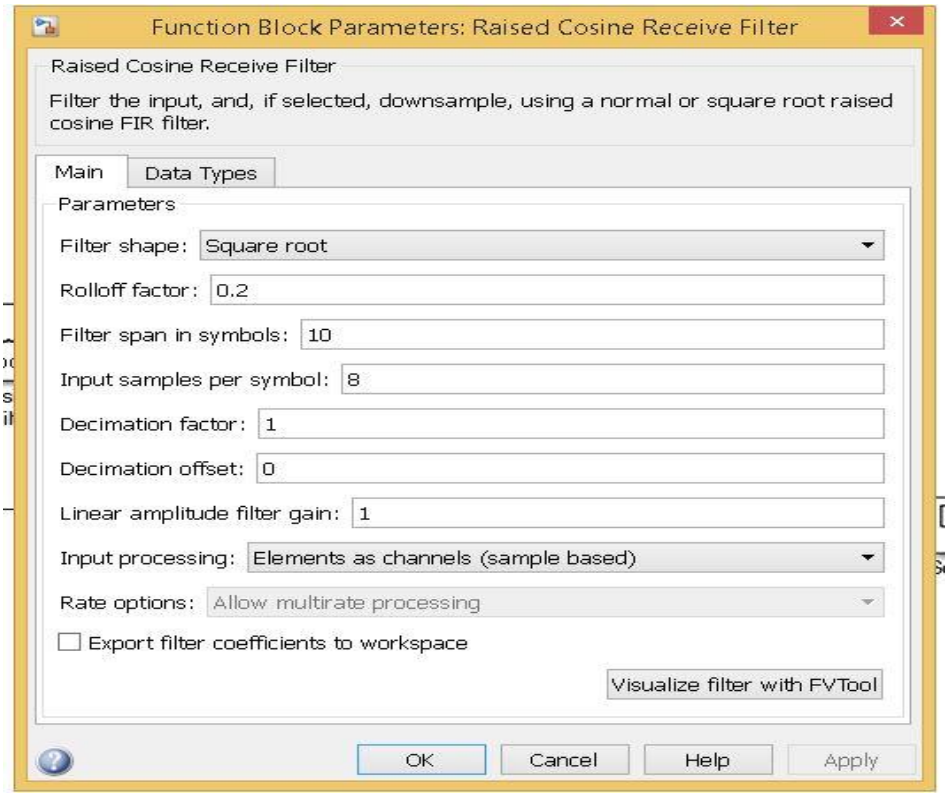
Properties of AWGN Block



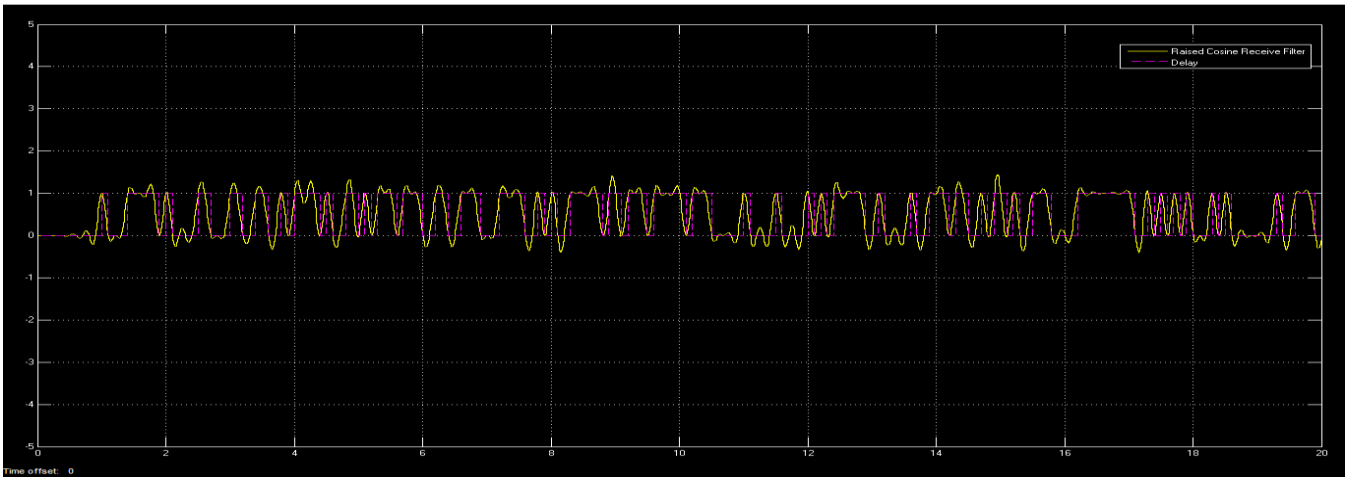
Properties of Delay Block



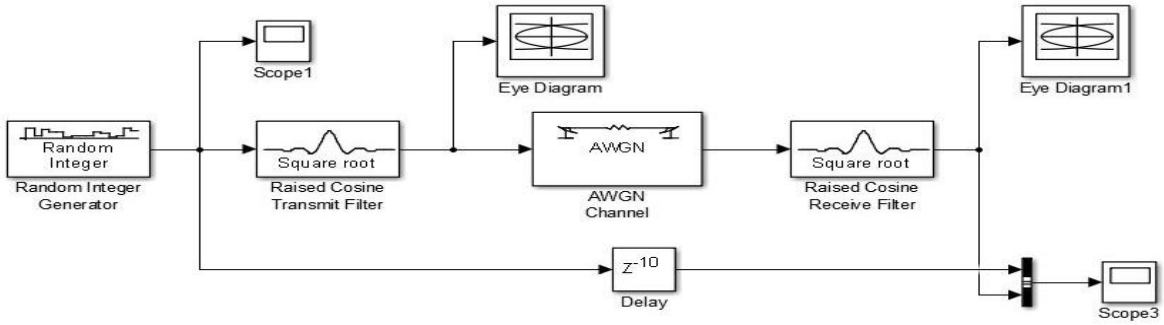
Properties of Root Raised Cosine Receive Filter



Output on Scope3outp

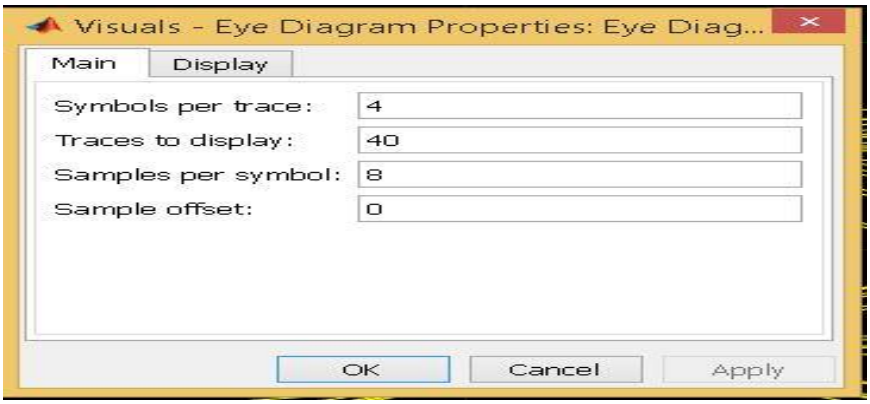


Run 4 : Observe Eye Diagram

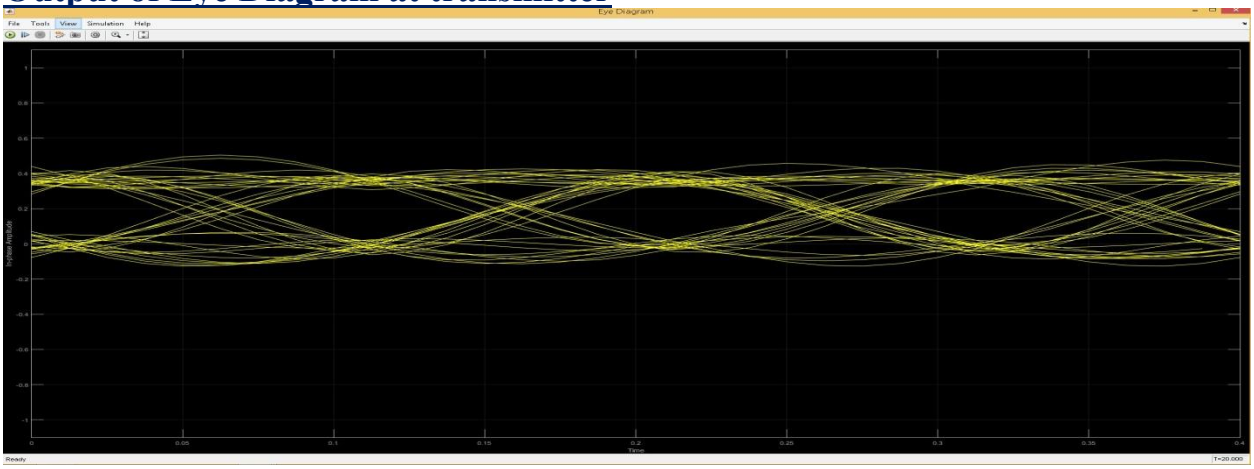


In this run, we use the Eye diagram block to observe eye patterns.
Before simulating change the properties of the eye diagram by double clicking on the block and clicking on  option.
After changing the properties run the model.

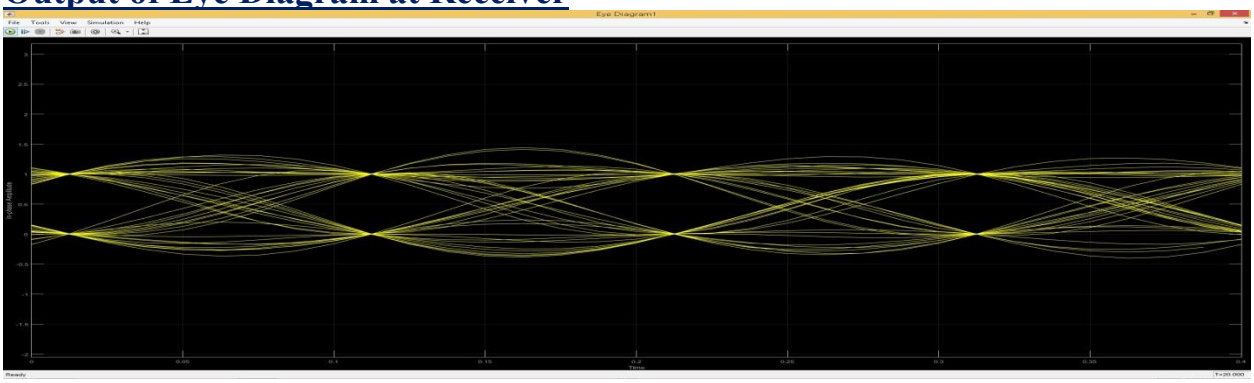
Properties of Eye diagram block



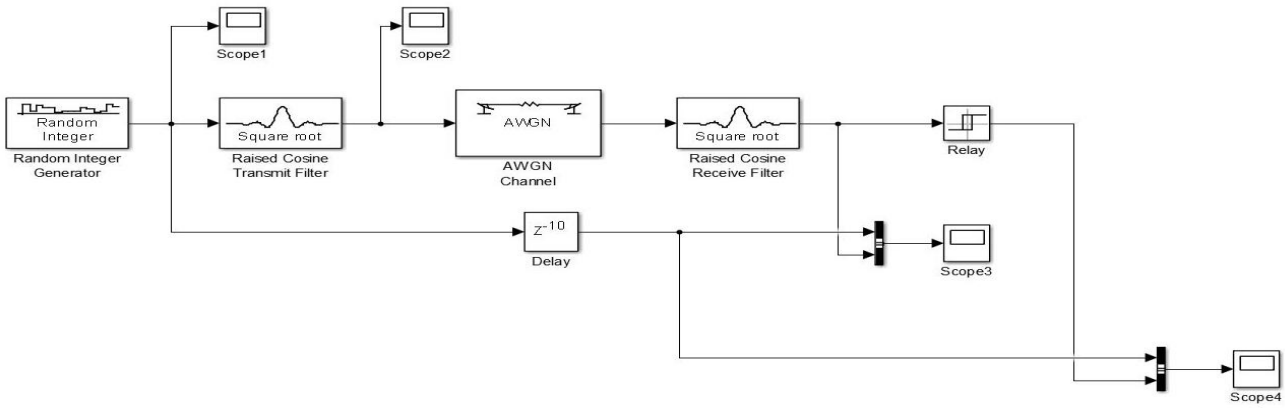
Output of Eye Diagram at transmitter



Output of Eye Diagram at Receiver



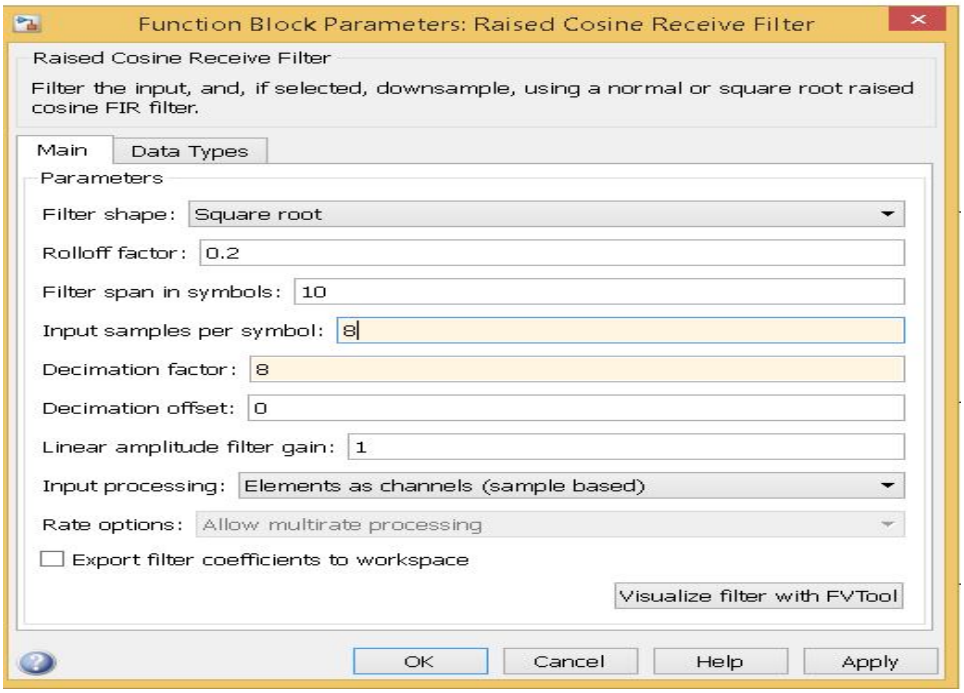
Run 5 : Thresholding at the Receiver



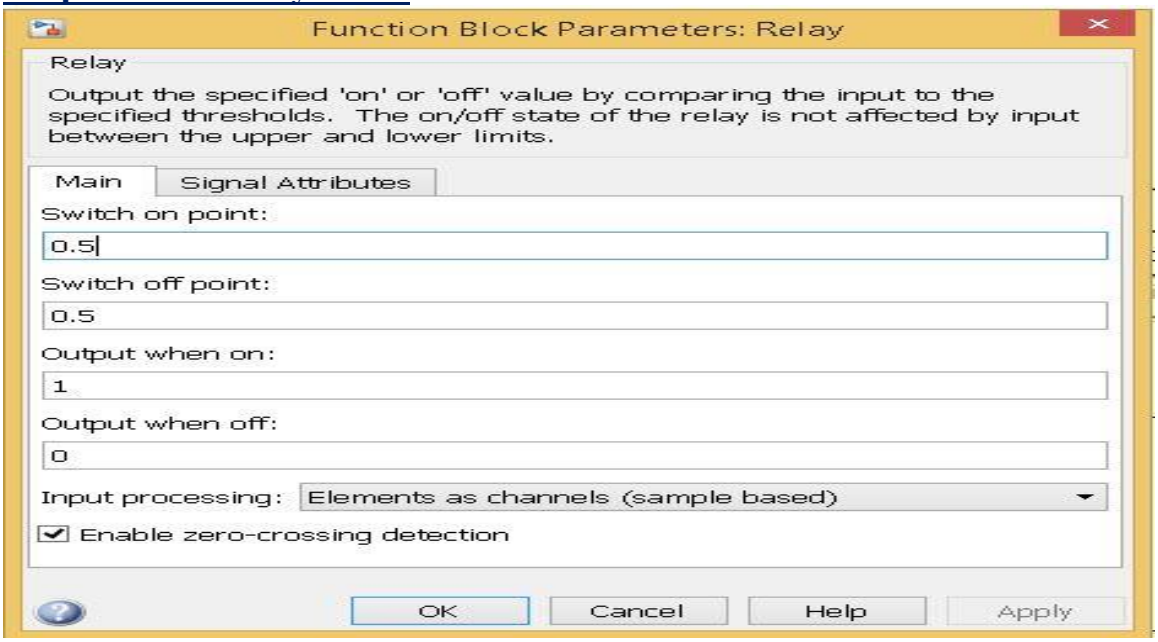
Connect the blocks as shown.(Remove the previous Eye diagram block)
Relay block is used for thresholding.
Compare the transmitted and Received bits on Scope4.

You will have to change the properties of root raised cosine receive filter.

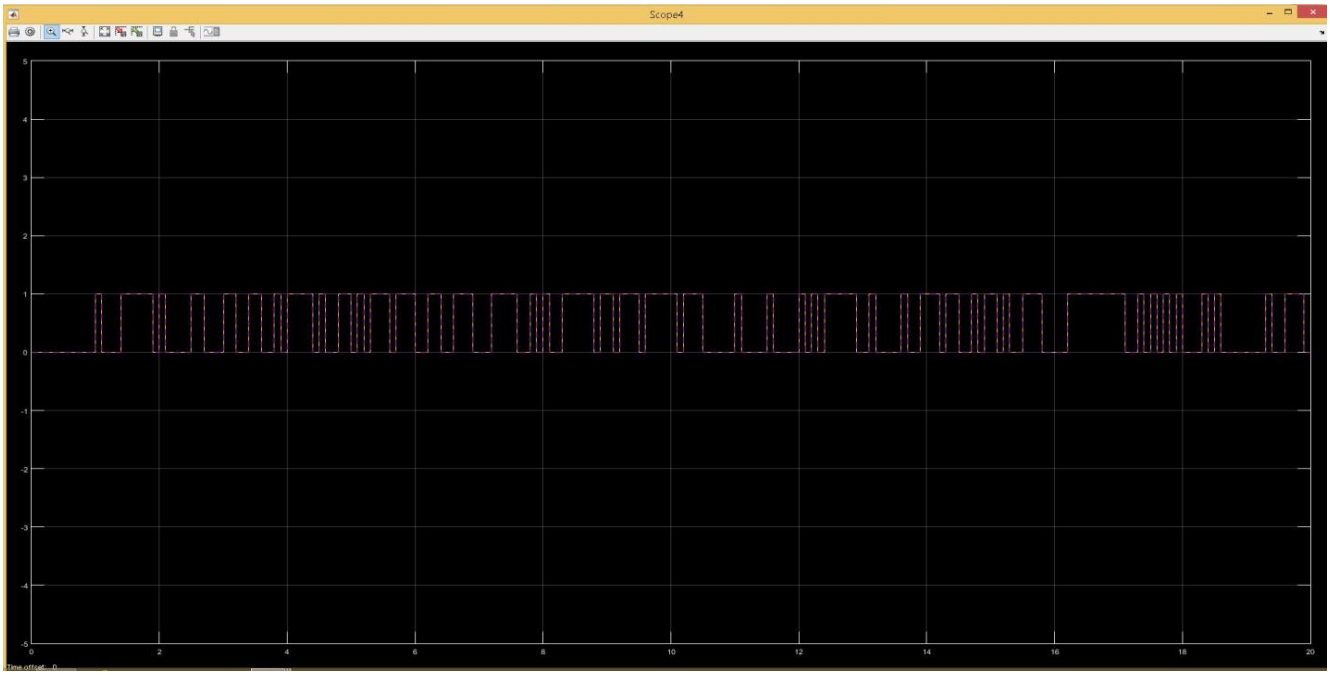
Properties of Root Raised Cosine Receive filter



Properties of Relay Block

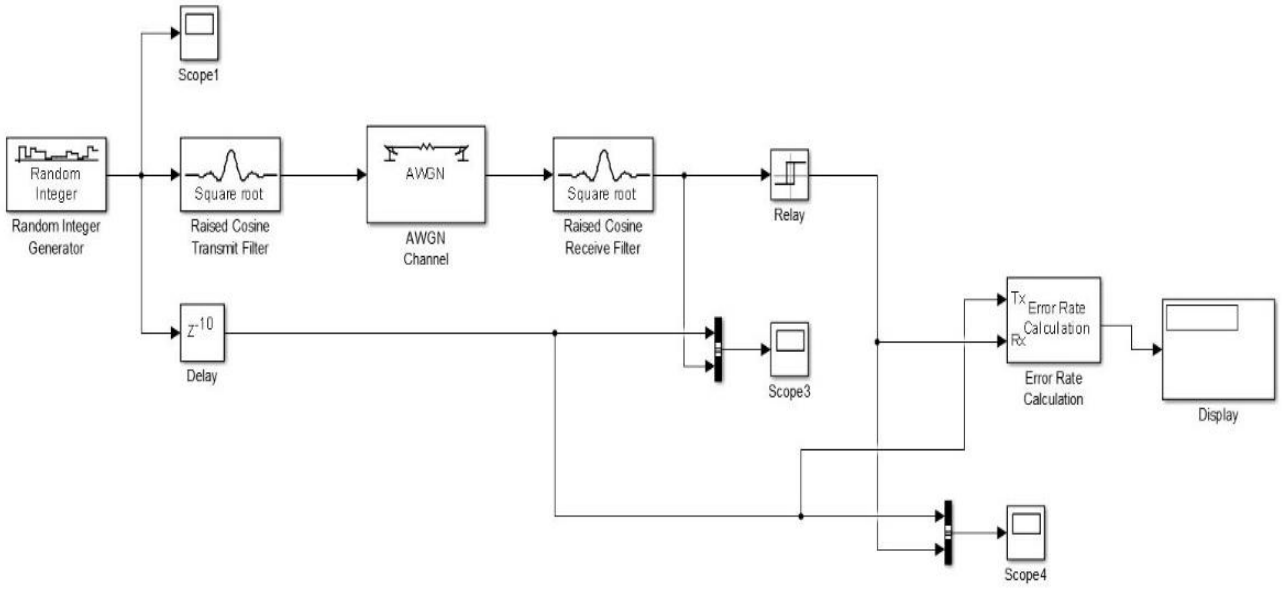


Output on Scope4tp

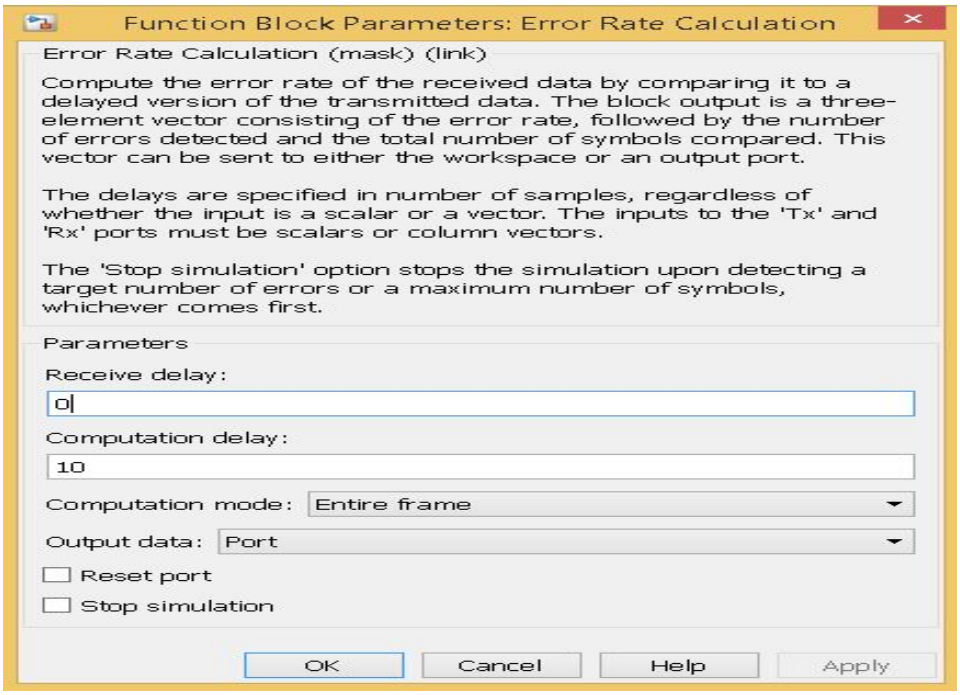


Run 6 : Evaluating the Bit Error Rate (BER)

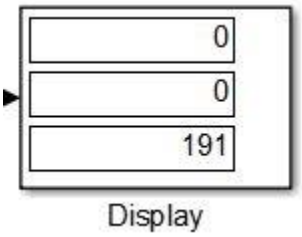
Use the Error Rate Calculation Block to evaluate the Bit Error Rate.(Bit Error Rate is displayed on Display Block)
Calculate the Bit Error Rate for different SNR values (1,3,5,7,10,50,100dB)
You can change the SNR in AWGN channel.
Note down the Bit error rate values in your note book.



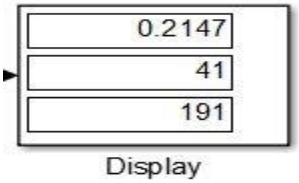
Properties of Error Rate Calculation Block



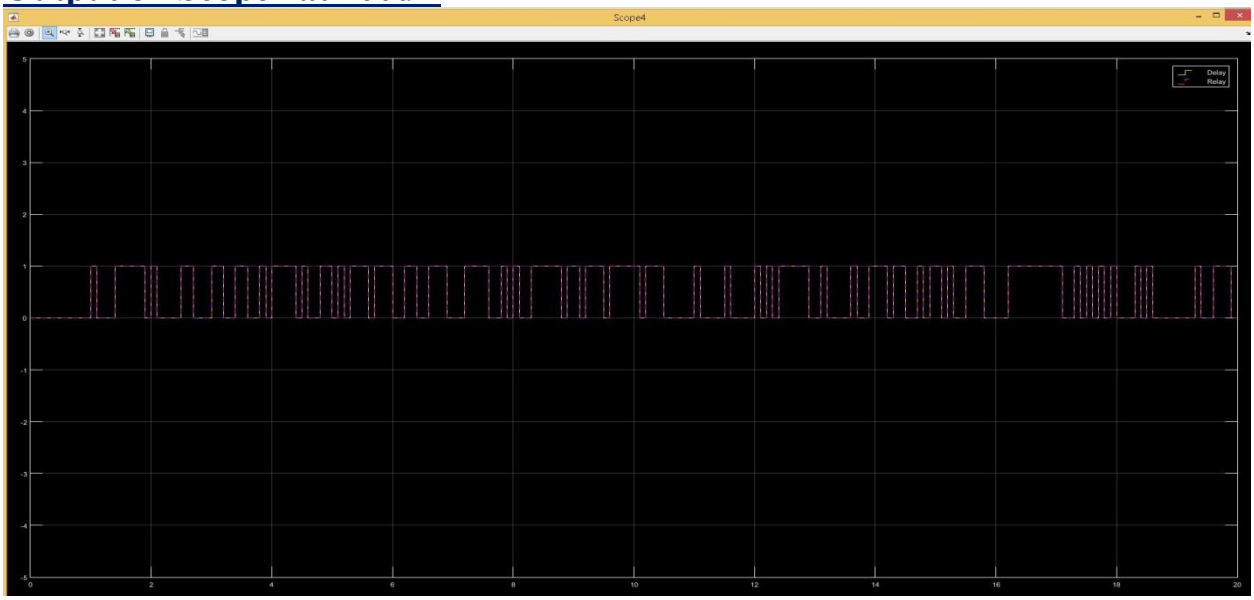
Output in Display Block for an SNR of 100dB



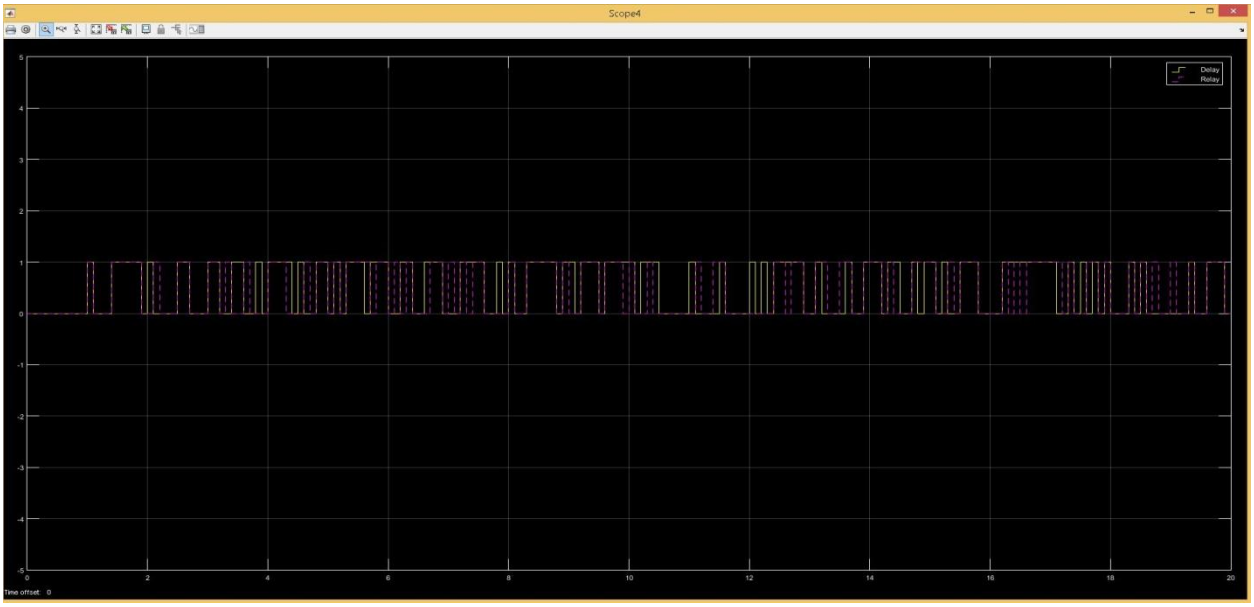
Output in Display Block for an SNR of 5dB



Output on Scope4 at 100dB

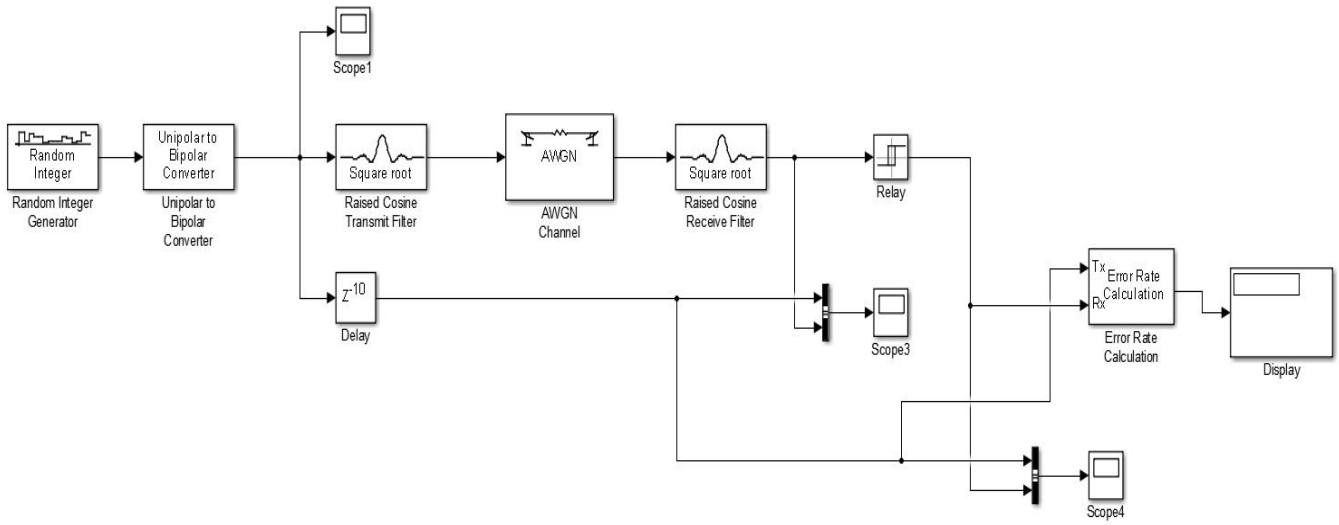


Output on Scope4 at 5dB



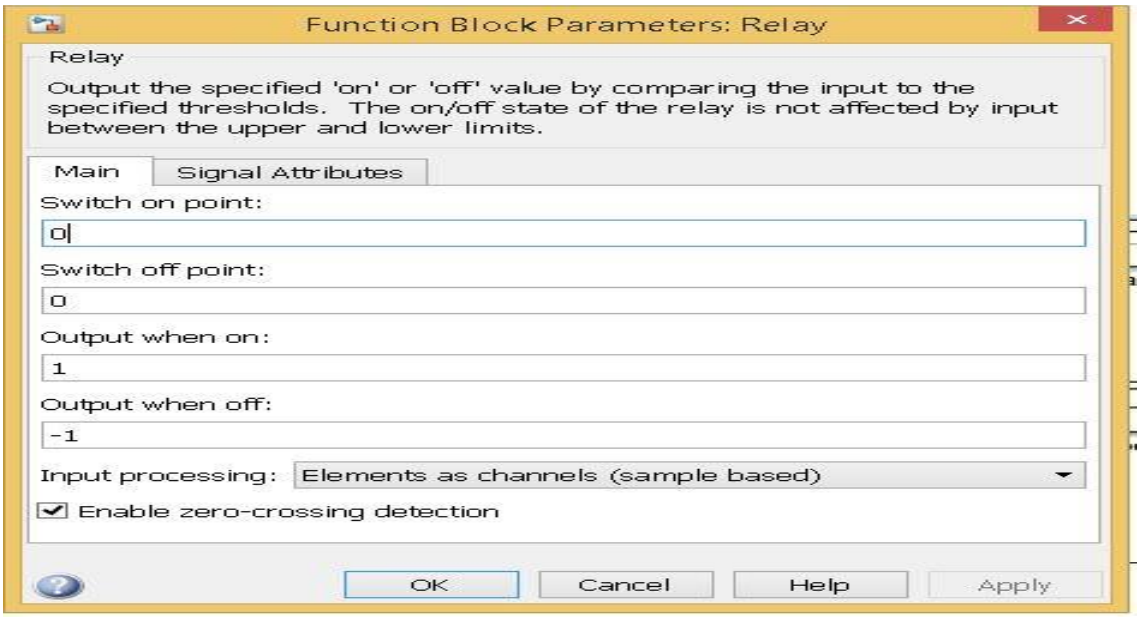
Run 7: Calculating BER for Bipolar Signal

The experiment till now was performed with a unipolar signal generated with Random number Generator block.
Now, we will use a Bipolar Signal at the transmitter.
Connect the block diagram as shown below.

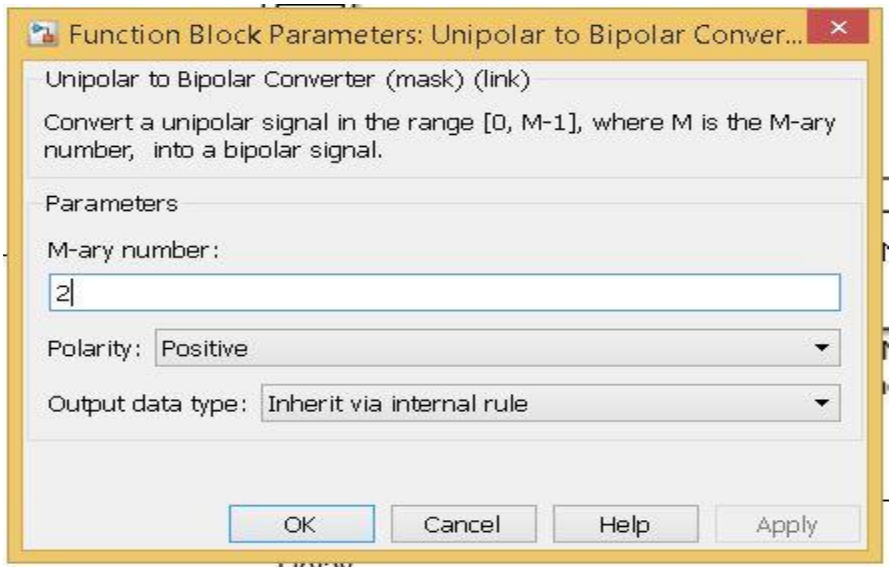


- A Bipolar Signal varies from -A to +A unlike a Unipolar signal (0 to +A). Verify this result by observing the signal in transmitted Scope1.
- Thresholding for Unipolar was done at 0.5, However the threshold for a Bipolar signal is at 0.Hence , you will have to change the properties of Relay block.
- Repeat Run 6 by placing the Unipolar to Bipolar converter and observe BER at SNR (1, 3, 5,7,10,20,50dB) values. Also observe the scope simultaneously. **Note down the Bit error rate values in your note book**.
- Compare the BER of Unipolar and Bipolar cases for the same SNR. Comment on your observations.

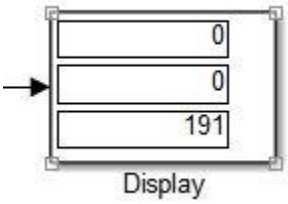
Properties of Relay Block



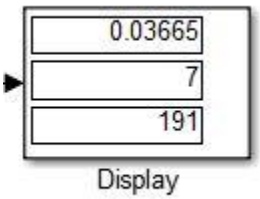
Properties of Unipolar to Bipolar Converter block.



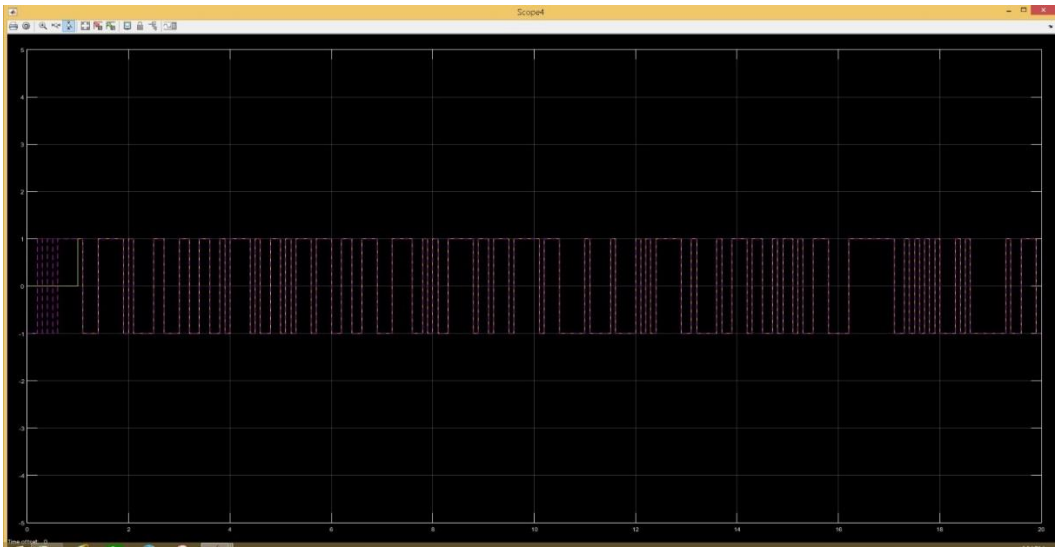
Output in Display Block for an SNR of 20dB

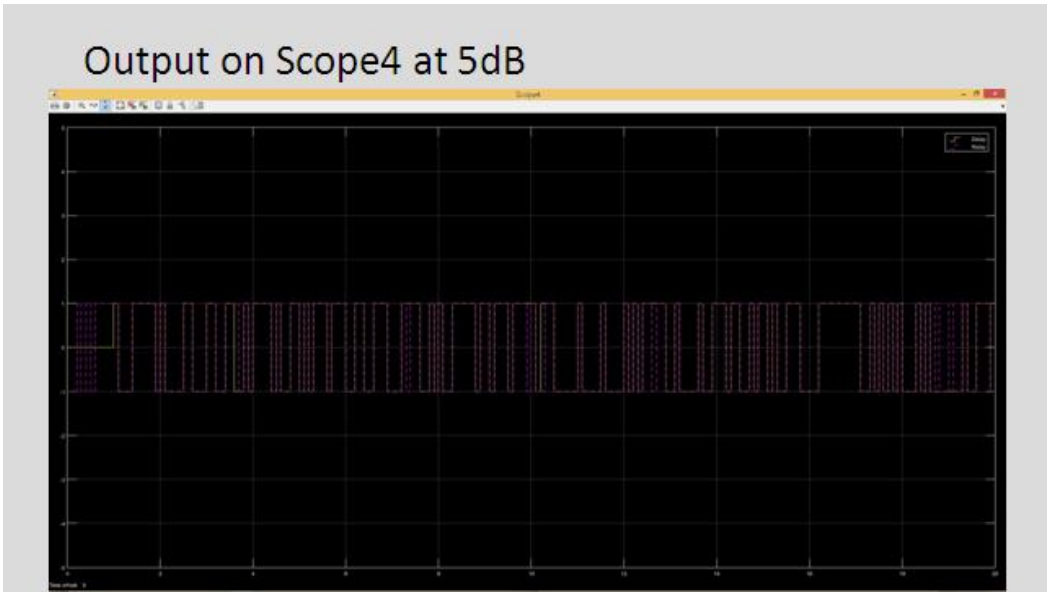


Output in Display Block for an SNR of 5dB



Output on Scope4 at 20dB





Conclusions:-

List out your learnings from the experiments
(observation of output for different values of SNR).