Experiment No.: **Date:**

Title: **Eye pattern**

Learning Objectives: At the end of this experiment, students will be able to:

- Generate eye pattern using oscilloscope for the given data.
- Predict change in the eye pattern according to variation in the channel condition.
- Interpret and link the changes in the observed eye pattern according to the variation in ISI.

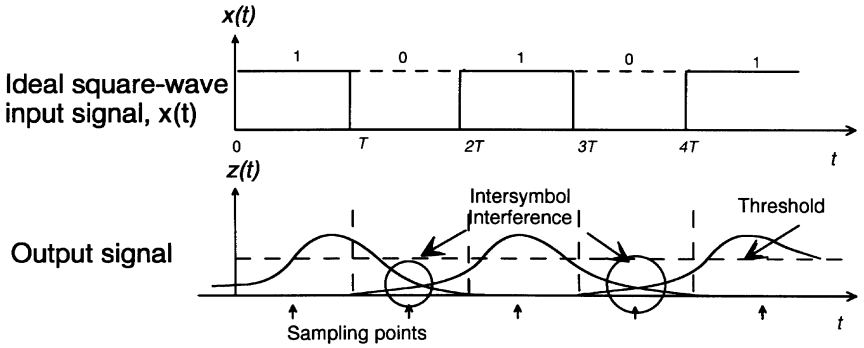
Pre-requisite: Inter symbol interference (ISI), channel imperfections

Apparatus: PRBS generator, Oscilloscope, connecting wires, CRO probes, Capacitor and Resistors for filter etc.

Theory:

There are various filters (and reactive circuit elements such as inductors and capacitors) throughout the system – in the transmitter, in the receiver, and in the channel. At the transmitter, the information symbols, characterized as impulse voltage levels, modulate pulses that are then filtered to comply with some bandwidth constraint. Some bandpass systems, such as wireless systems are characterized by fading channels that behave like undesirable filters manifesting signal distortion. When the receiving filter is configured to compensate for the distortion caused by both the transmitter and the channel, it is often referred to as an equalizing filter or receiving/equalizing filter.

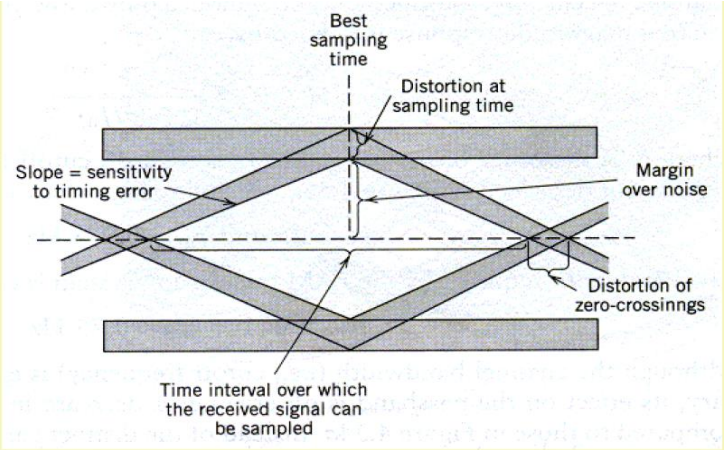
Due to the effects of system filtering, the received pulses can overlap one another as shown in the figure. The tail of a pulse can "smear" into adjacent symbol intervals, thereby interfering with the detection process; such interference is termed as Intersymbol Interference (ISI).



Eye Diagram:

The performance of baseband PAM systems depends on the amount of ISI and channel noise. The distribution of ISI and channel noise in the system can be readily observed by

displaying the received waveform Y(t) on an oscilloscope using a sweep rate that is a fraction of the symbol rate. The resulting shape resembles a human eye and is widely known as the eye pattern of the system.



Eye patterns are often used in the evaluation of channel and signal imperfections. If the signal-to-noise ratio is high, then the following observations can be made from the eye pattern:

1. The best time to sample the received waveform is when the eye opening is the largest.
2. The maximum distortion and ISI are indicated by the vertical width of the two branches at sampling time.
3. The noise margin or immunity to noise is proportional to the width of the eye opening.
4. The sensitivity of the system to timing errors is revealed by the rate of closing of the eye as the sampling time is varied.
5. The sampling time is midway between zero crossings; if the clock information is derived from zero crossings, then the amount of distortion of zero crossings indicates the amount of "jitter" or variations in clock rate and phase.
6. Asymmetries in the eye pattern indicate nonlinearities in the channel since in a strictly linear system with truly random data all the eye openings will be identical.

EXPERIMENTAL SETUP for generating Eye Diagram:

Eye diagrams may be obtained on oscilloscope if a signal such as $v_o(t)$ is fed to the vertical input "y" of an oscilloscope. The clock is fed to the external trigger of the oscilloscope. The front trigger-delay adjustment, conveniently available on most oscilloscopes, ensures that the displayed eye pattern is centered on the screen. The horizontal time base is set to be approximately equal to the symbol duration. The inherent persistence of the cathode-ray tube displays the superimposed segments of the $v_o(t)$

signal. Eye pattern of the pseudorandom binary sequence (PRBS) generator is displayed if the data output of this generator is directly connected to the vertical input of the oscilloscope.

Procedure:

1) Connect the set up as shown in the figure.

2) Observe the eye diagram for given PRBS sequence with and without a band-limiting filter.

3) Note down the eye opening for different cut-off frequencies of the filter.

Result and Discussion:

Conclusion: