SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution

Coimbatore-35

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB301-ANALOG AND DIGITAL COMMUNICATION

III YEAR/ V SEMESTER

UNIT 3 – DIGITAL COMMUNICATION

TOPIC – EYE PATTERN

UNIT III –Digital Communication

UNIT III DIGITAL COMMUNICATION 9+6

THEORY

Block diagram of Digital communication, Low pass Sampling, Quantization- Types.

Baseband Transmission: Properties of Line codes- Power Spectral Density of Line codes –ISI- Nyquist criterion for distortion less transmission – Correlative coding – Eye pattern – Equalization- Linear equalization, Decision -feedback equalization, Adaptive linear equalizer.

Eye pattern

- The quality of digital transmission systems are evaluated using the bit error rate. Degradation of quality occurs in each process modulation, transmission, and detection.

- The eye pattern is experimental method that contains all the information concerning the degradation of quality. Therefore, careful analysis of the eye pattern is important in analyzing the degradation mechanism.

- Eye patterns can be observed using an oscilloscope. The received wave is applied to the vertical deflection plates of an oscilloscope and the saw tooth wave at a rate equal to transmitted symbol rate is applied to the horizontal deflection plates, resulting display is eye pattern as it resembles human eye.

Eye pattern

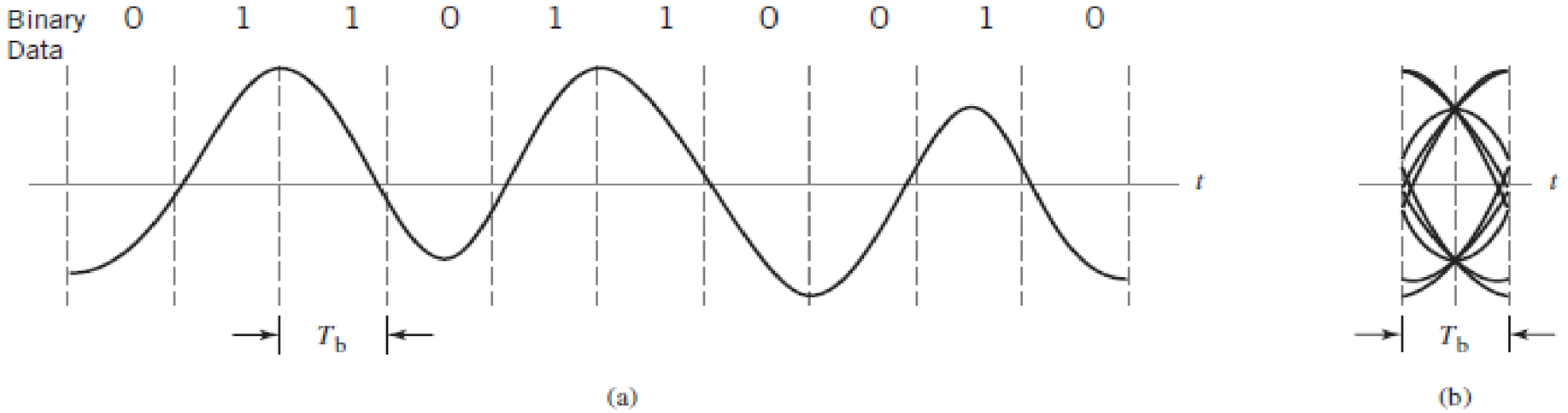

Figure 8.12 (a) Binary data sequence and its waveform. (b) Corresponding eye pattern.

EYE PATTERN

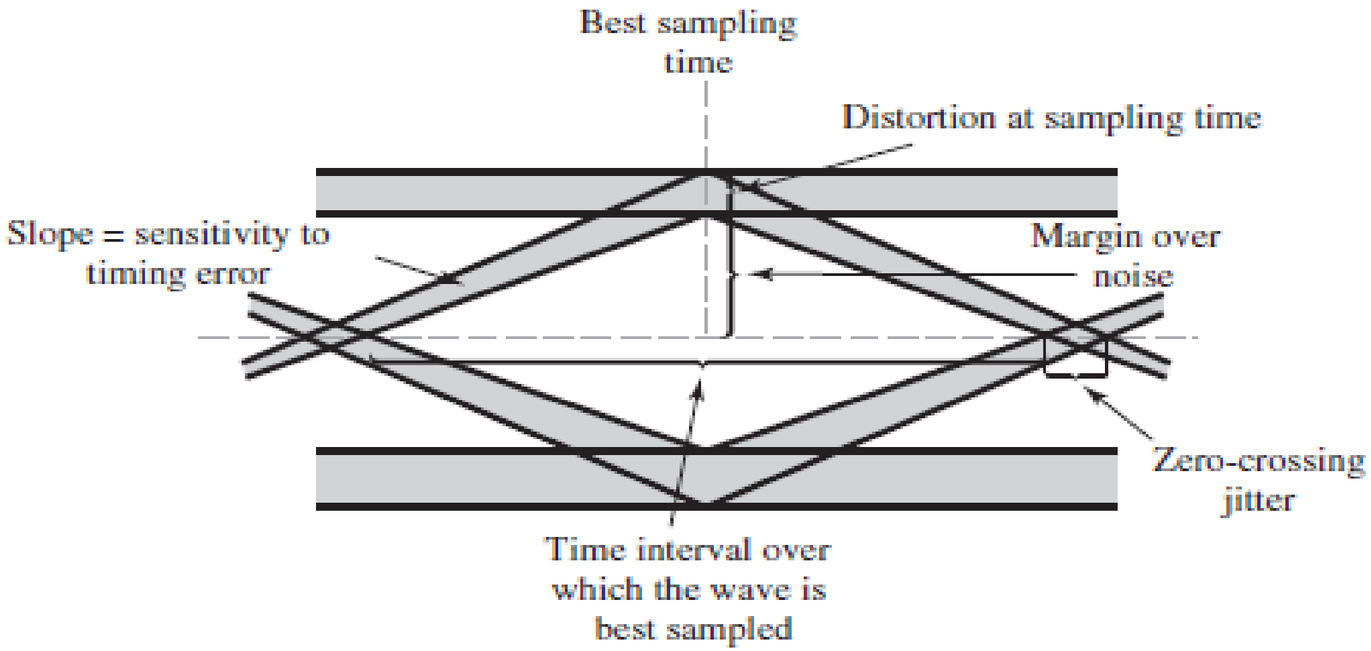

Figure 8.13 Interpretation of the eye pattern for a baseband binary data transmission system.

EYE PATTERN

- **The interior region** of eye pattern is called **eye opening.**
- **The width of the eye opening** defines the time interval over which the received wave can be sampled without error from ISI.
- The optimum sampling time corresponds to the **maximum eye opening**
- **The height of the eye opening** at a specified sampling time is a measure of the margin over channel noise.
- **The sensitivity of the system** to timing error is determined by the rate of closure of the eye as the sampling time is varied.

EYE PATTERN

- Any non linear transmission distortion would reveal itself in an asymmetric or squinted eye.
- When the effect of ISI is excessive, traces from the upper portion of the eye pattern cross traces from lower portion with the result that the eye is completely closed.

Three Timing Features of Eye Pattern

1. ***Optimum sampling time.*** The width of the eye opening defines the time interval over which the distorted binary waveform appearing at the output of the receive filter in the PAM system can be uniformly sampled without decision errors. Clearly, the *optimum sampling time* is the time at which the eye opening is at its widest.

2. Zero-crossing jitter. In practice, the timing signal (for synchronizing the receiver to the transmitter) is extracted from the *zero-crossings* of the waveform that appears at the receive-filter output. In such a form of synchronization, there will always be irregularities in the zero-crossings, which, in turn, give rise to *jitter* and, therefore, Non optimum sampling times.

3. Timing sensitivity. Another timing-related feature is the sensitivity of the PAM system to timing errors. This sensitivity is determined by the rate at which the eye pattern is closed as the sampling time is varied.

The Peak Distortion for Intersymbol Interference

Hereafter, we assume that the ideal signal amplitude is scaled to occupy the range from –1 to +1. We then find that, in the absence of channel noise, the eye opening assumes two extreme values:

1. *An eye opening of unity*,[4] which corresponds to zero ISI.
2. *An eye opening of zero*, which corresponds to a completely closed eye pattern; this second extreme case occurs when the effect of intersymbol interference is severe enough for some upper traces in the eye pattern to cross with its lower traces.

It is indeed possible for the receiver to make decision errors even when the channel is noise free. Typically, *an eye opening of 0.5 or better is considered to yield reliable data transmission*.

Eye opening

In a noisy environment, the extent of eye opening at the optimum sampling time provides a measure of the operating margin over additive channel noise. This measure, as illustrated in Figure 8.13, is referred to as the *noise margin*.

From this discussion, it is apparent that the eye opening plays an important role in assessing system performance; hence the need for a formal definition of the eye opening. To this end, we offer the following definition:

$$\text{Eye opening} = 1 - D_{\text{peak}} \tag{8.37}$$

where D_{peak} denotes a new criterion called the *peak distortion*. The point to note here is that peak distortion is a *worst-case* criterion for assessing the effect of ISI on the performance (i.e., error rate) of a data transmission system. The relationship between the

Two extreme values of the eye opening

To emphasize this statement, the two extreme values of the eye opening translate as follows:

1. ***Zero peak distortion,*** which occurs when the eye opening is unity.
2. ***Unity peak distortion,*** which occurs when the eye pattern is completely closed.

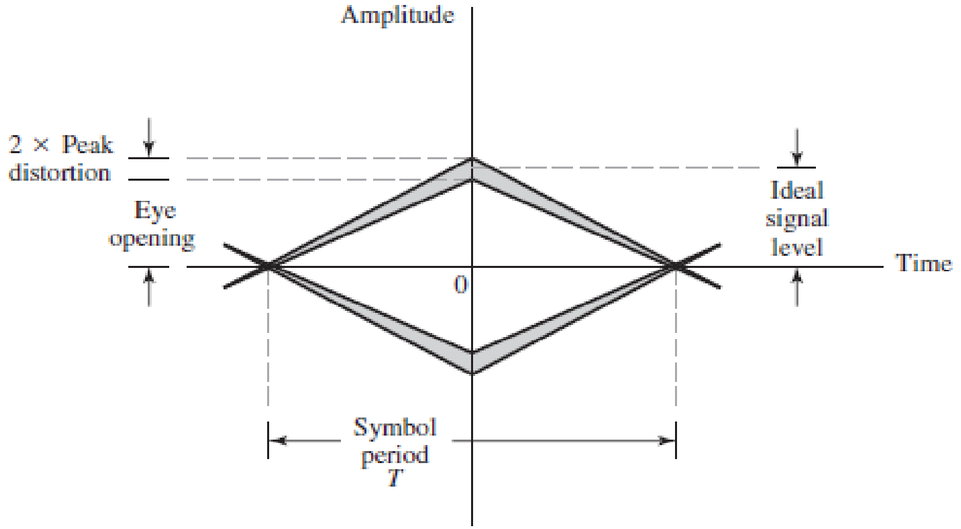

Figure 8.14 Illustrating the relationship between peak distortion and eye opening.
Note: the ideal signal level is scaled to lie inside the range –1 to +1.

Thank You