

# A/D, Quantization

Word Length	Number of Quantizer Levels	Bandwidth	Dynamic Range
n-bits	$M=2^n$	n2B	$20 \cdot \log(M)$ (ave S/N) dB
1	2	2	6.02
2	4	4	12.04
3	8	6	18.06
4	16	8	24.08
5	32	10	30.10
6	64	12	36.12
7	128	14	42.14
8	256	16	48.16
9	512	18	54.19
10	1024	20	60.21
11	2048	22	66.23
12	4096	24	72.25
13	8192	26	78.27
14	16384	28	84.29
15	32768	30	90.31
16	65536	32	96.33

# Line Codes

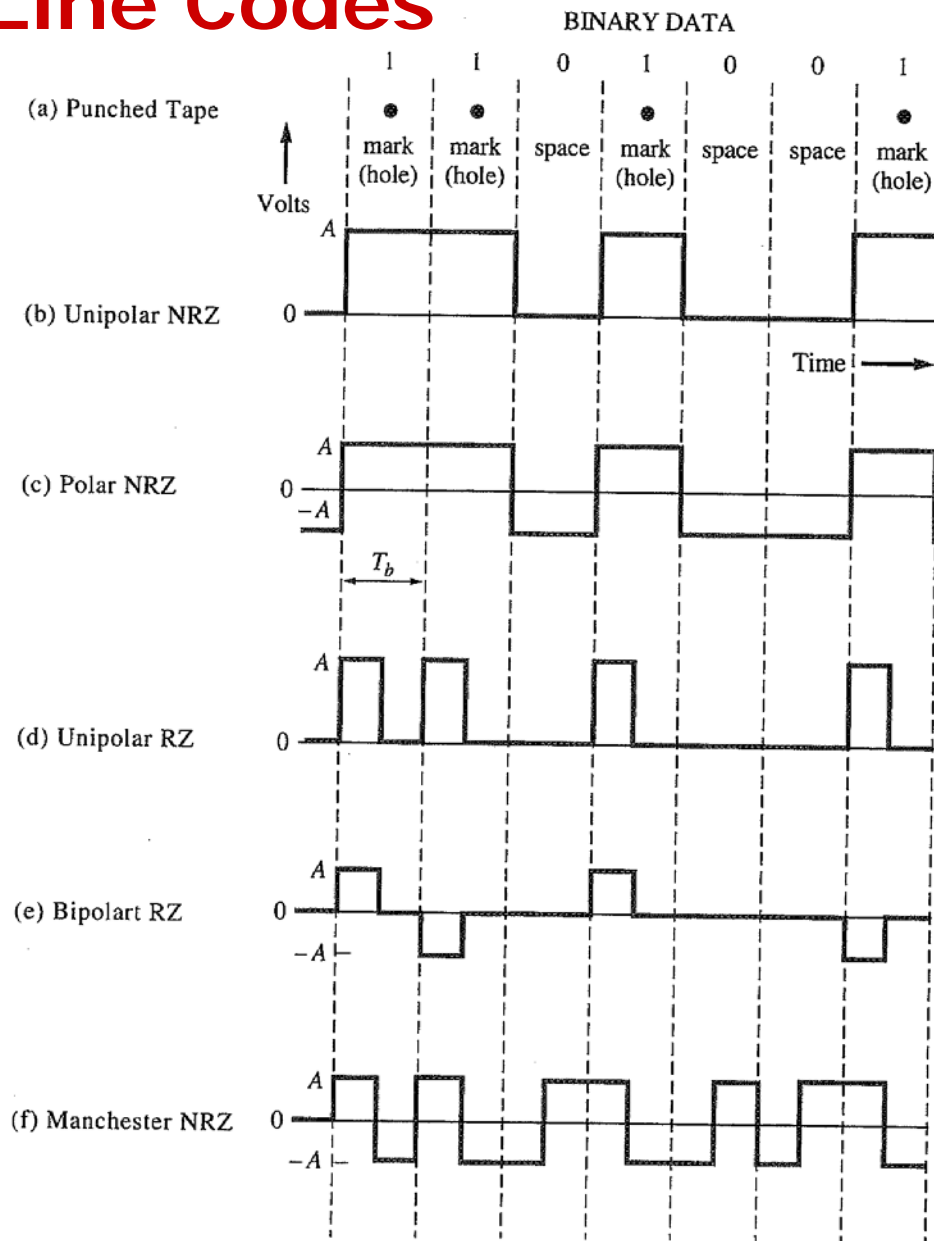


Figure 3-15 Binary signaling formats.

*From Couch, Digital and Analog Comm. Sys.*

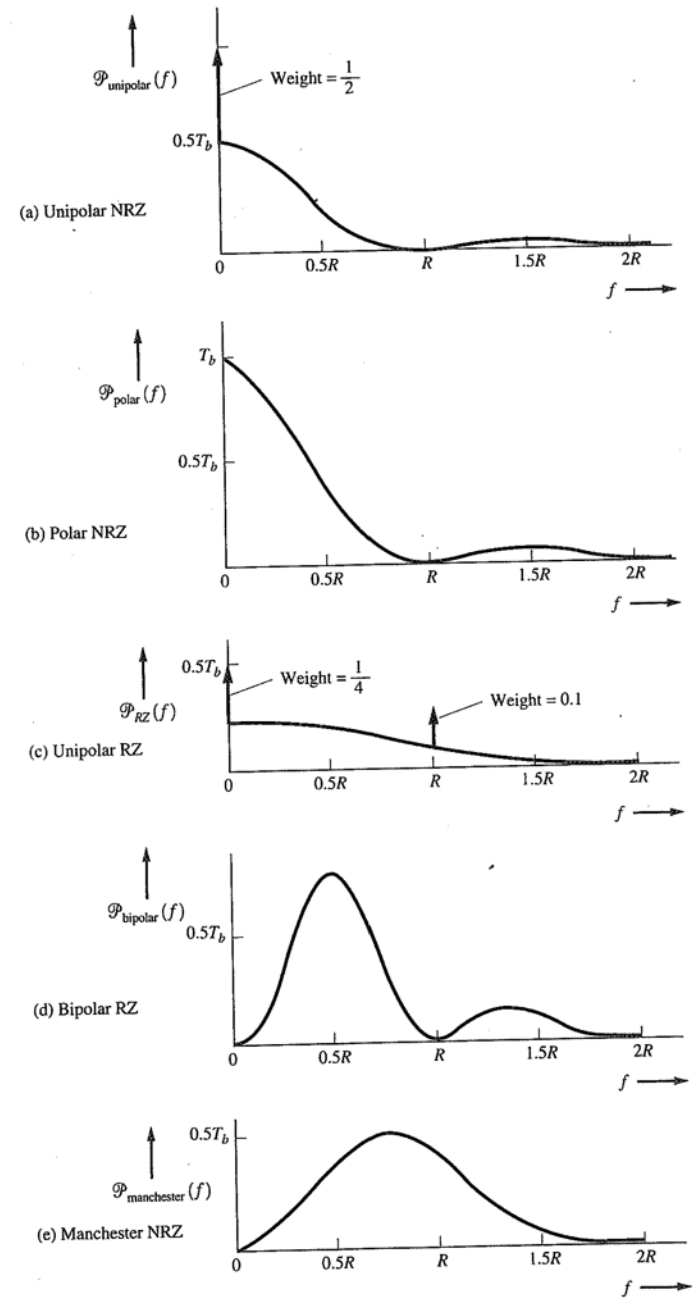
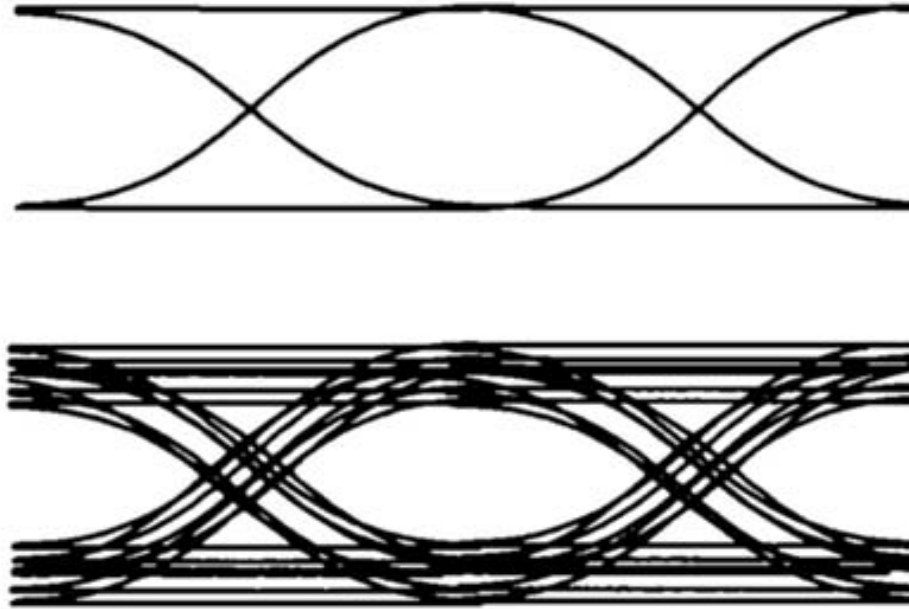
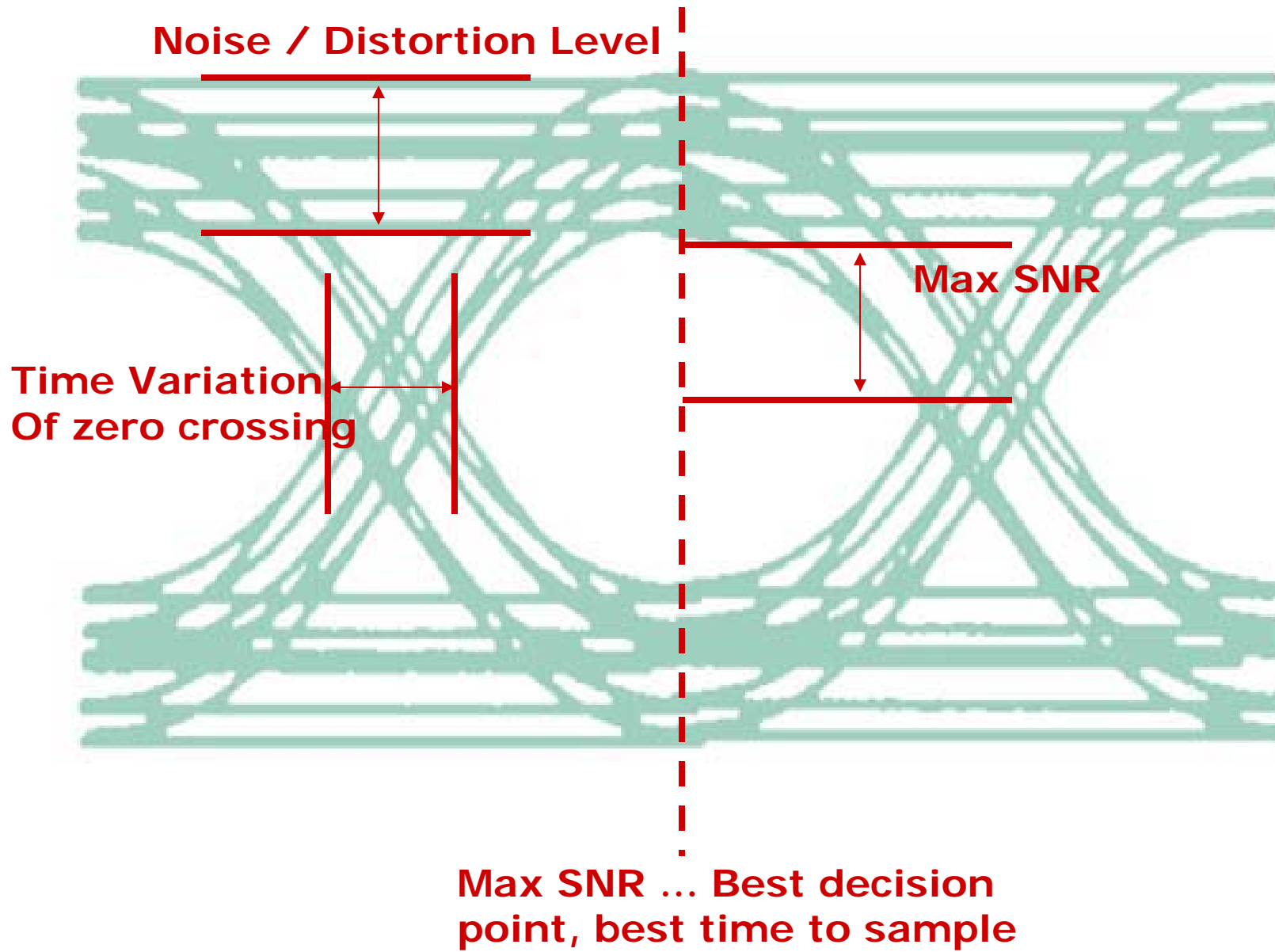


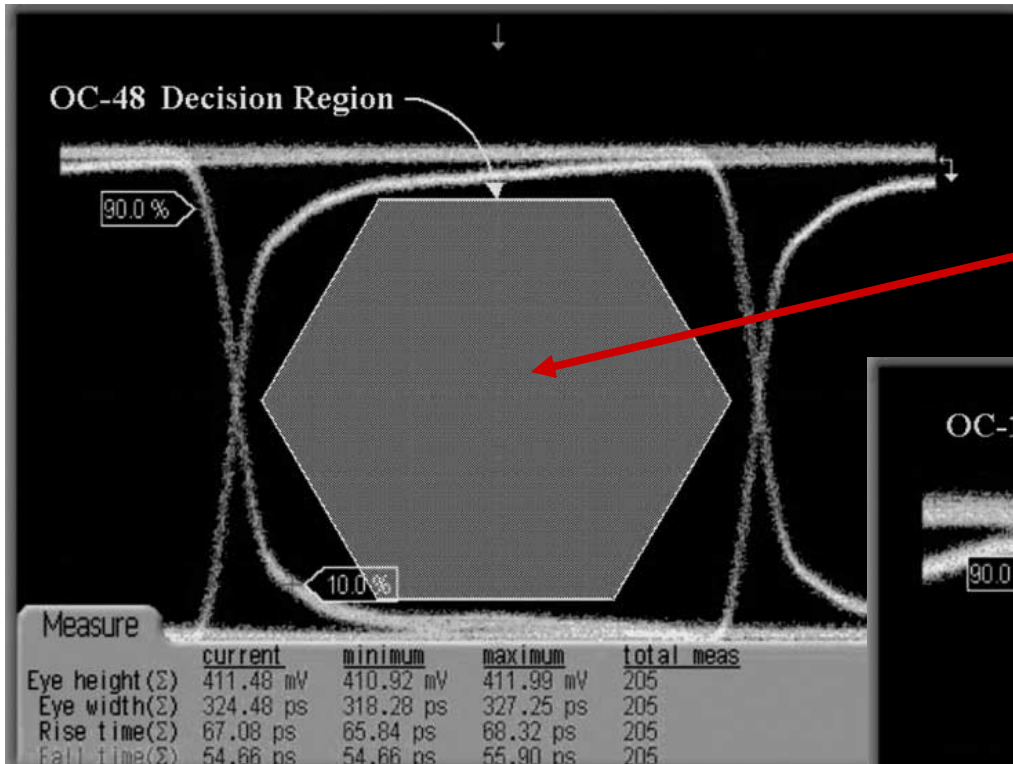
Figure 3-16 PSD for line codes (positive frequencies shown).

# Eye Diagrams

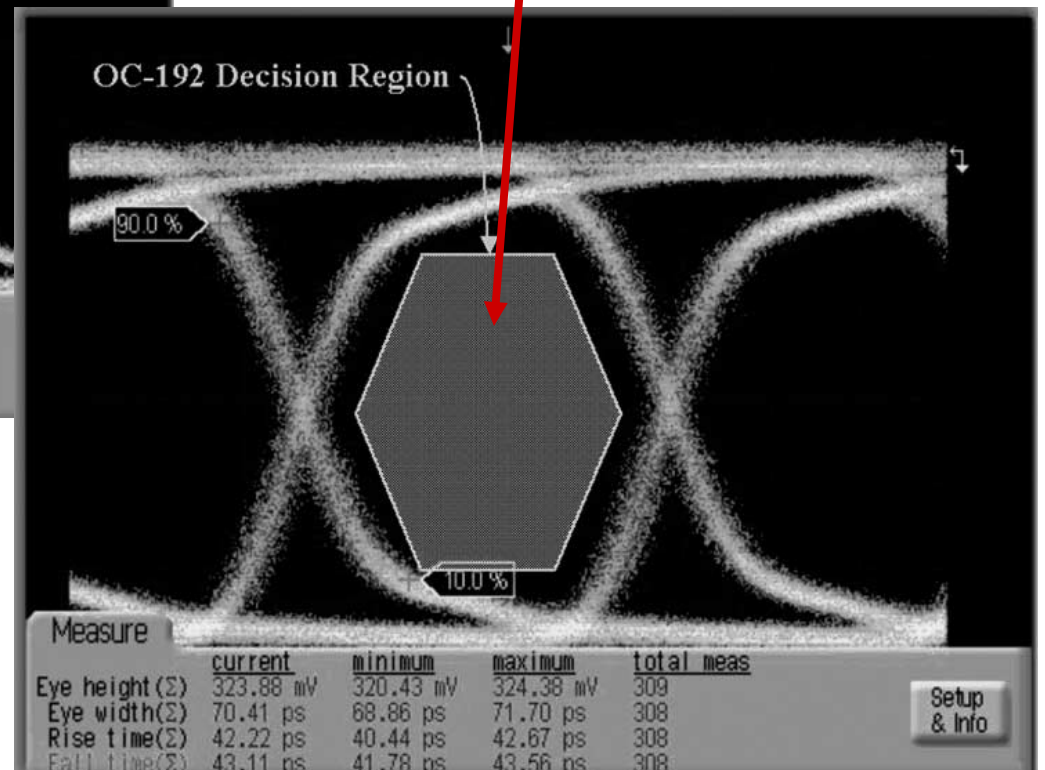


At top is an undistorted eye diagram of a band-limited digital signal. The bottom eye pattern includes amplitude (noise) and phase (timing) errors. The various transition points can provide insight into the nature of the impairments.

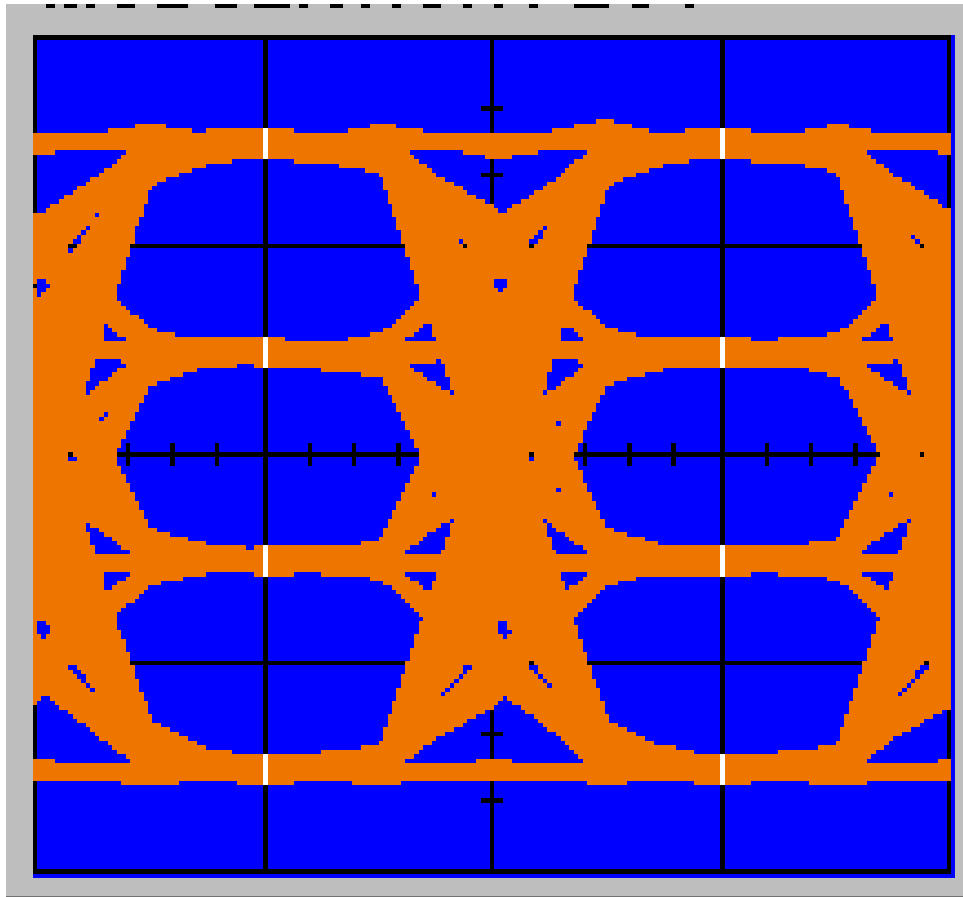




**2.5 GBPS**



**10 GBPS**



**Eye Diagram for a 4-level signal  
(wikipedia)**