Digital Communications 1

Fundamentals and Techniques

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Dominique Barba

Color Section

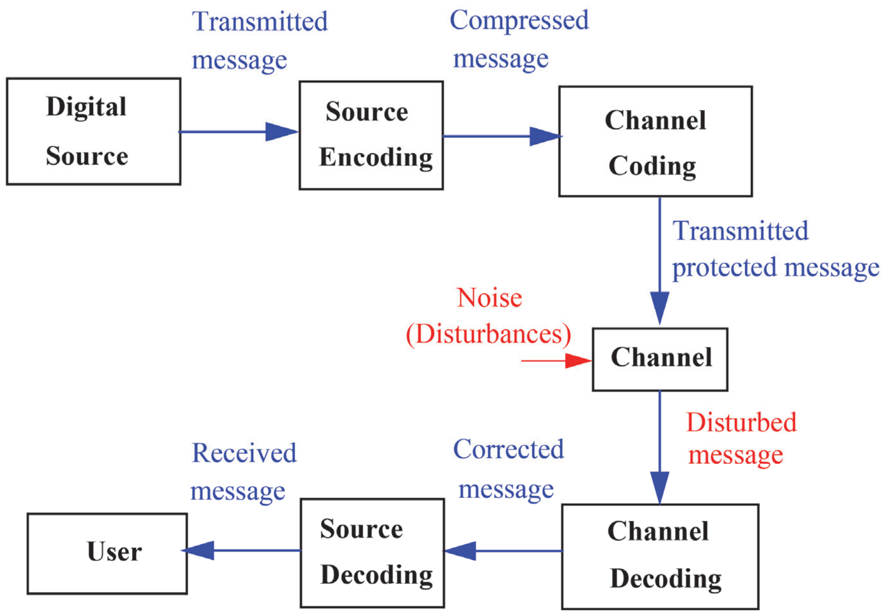


Figure I1.1. *General structure of a digital communications system and its problems*

Figure 1.1. *Simple communication system*

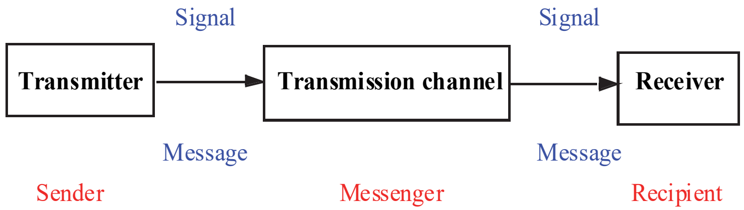


Figure 1.4. *Principle of communication*

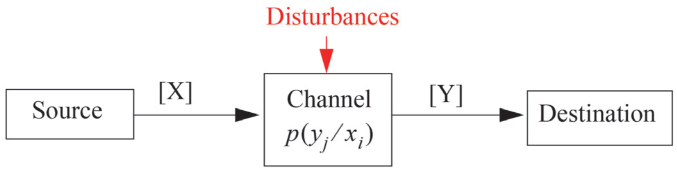


Figure 2.2. *Basic transmission system based on a discrete channel.*

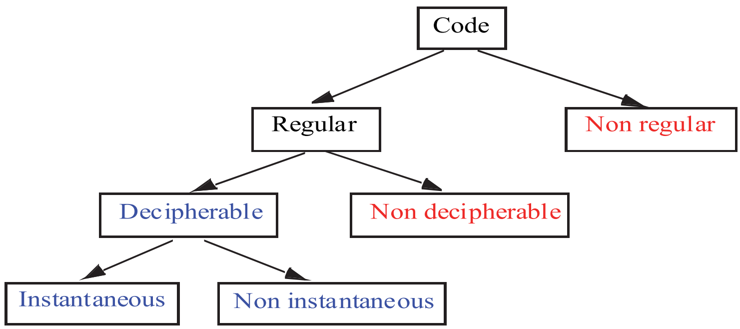


Figure 3.1. *Classification of codes*

Let:

$$u(x) = i(x) \times g(x)$$

$$u(x) = [x^3 + x^2 + x] \times [x^3 + x + 1] = x^6 + x^5 + x$$

$$[1 \quad 1 \quad 1 \quad 0] \times [1 \quad 0 \quad 1 \quad 1] = [1 \quad 1 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0]$$

Let us make the discrete convolution product degree by degree according to:

$$u_l = \left[\sum_{s=0}^{m-1} i_s g_{l-s} \right]$$

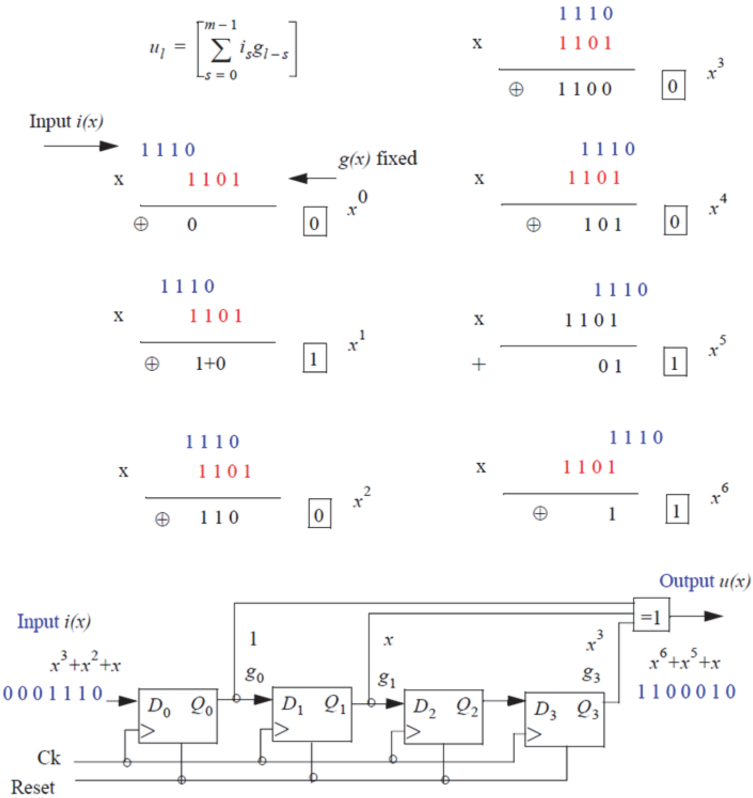
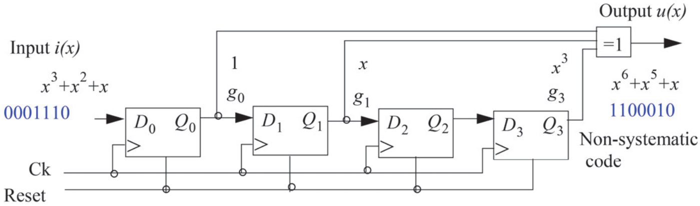


Figure 4.21. *Coding by multiplication*

$$u(x) = i(x) \times g(x)$$

$$u(x) = (x^3+x^2+x) \times (x^3+x+1) = x^6+x^5+x$$

$$(1\ 1\ 1\ 0)\ \mathrm{x}\ (1\ 0\ 1\ 1) = (1\ 1\ 0\ 0\ 0\ 1\ 0)$$



Ck	$i(x)$	D_0	Q_0	D_1	Q_1	D_2	Q_2	D_3	Q_3	u
	0 x^0	0	**0**	0	**0**	0	**0**	0	**0**	
1			0		0		0		0	0
	1 x^1	1		0		0		0		
2			1		0		0		0	1
	1 x^2	1		1		0		0		
3			1		1		0		0	0
	1 x^3	1		1		1		0		
4			1		1		1		0	0
	0 x^4	0		1		1		1		
5			0		1		1		1	0
	0 x^5	0		0		1		1		
6			0		0		1		1	1
	0 x^6	0		0		0		1		
7			0		0		0		1	1
Reset			**0**		**0**		**0**		**0**	u_{n-1}

Figure 4.22. *State of the register at each clock cycle.*

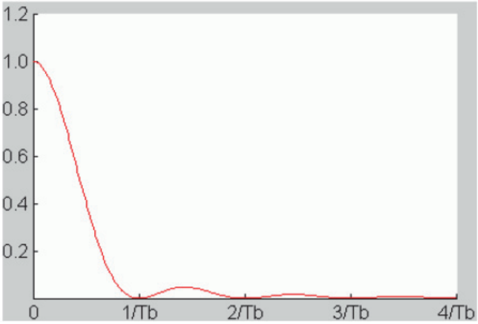


Figure 5.4. *Power spectral density of the symmetrical NRZ-L on-line code*

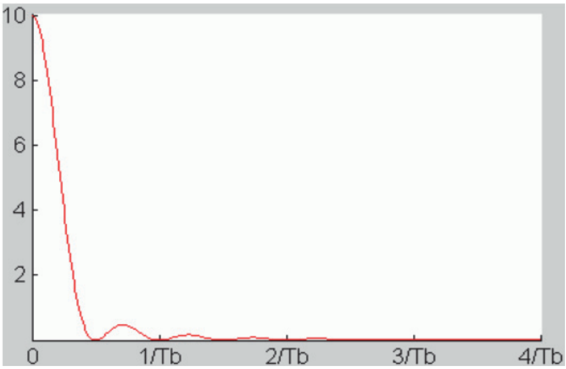


Figure 5.8. *Power spectral density of the symmetrical NRZ 4-ary code*

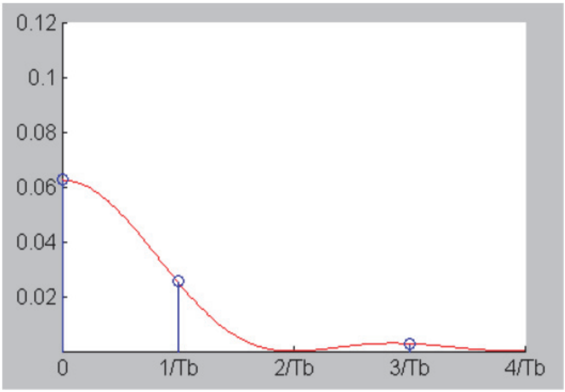


Figure 5.11. *Power spectral density of the binary RZ on-line code (for $\theta = 1/2$).*

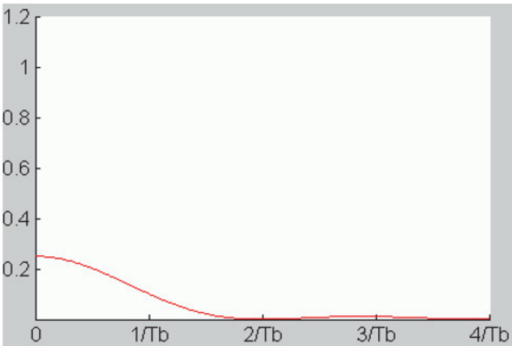


Figure 5.14. *Power spectral density of the polar RZ code (for $\theta = 1/2$).*

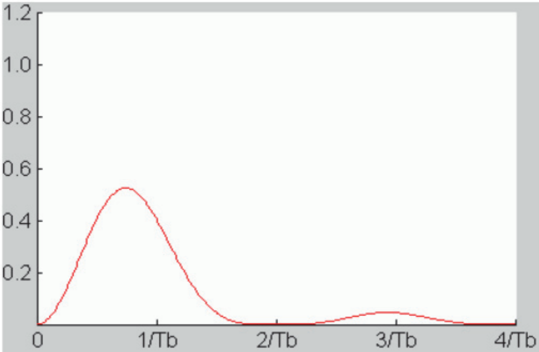


Figure 5.17. *Power spectral density of a biphase code (Manchester code)*

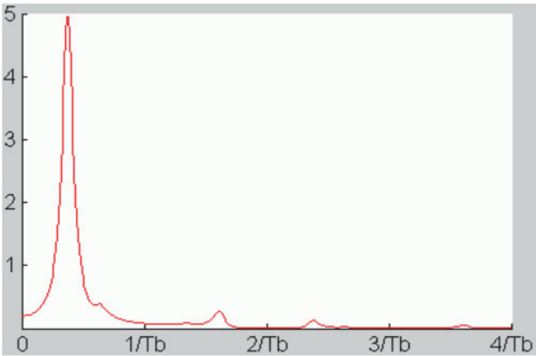


Figure 5.22. *Power spectral density of the Miller on-line code*

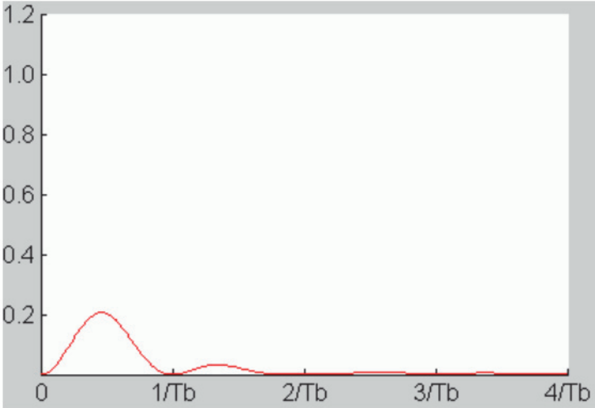


Figure 5.25. *Power spectral density of the bipolar RZ code (or AMI)*

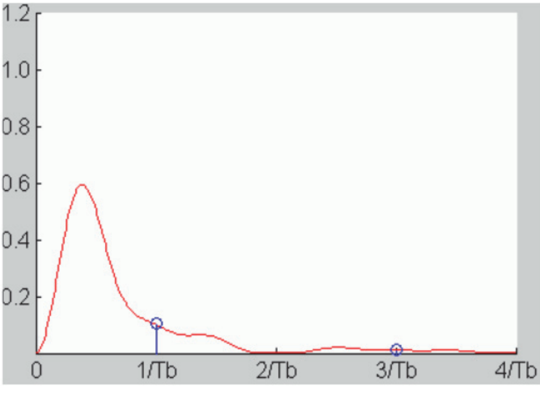


Figure 5.27. *Power spectral density of the CMI on-line code*

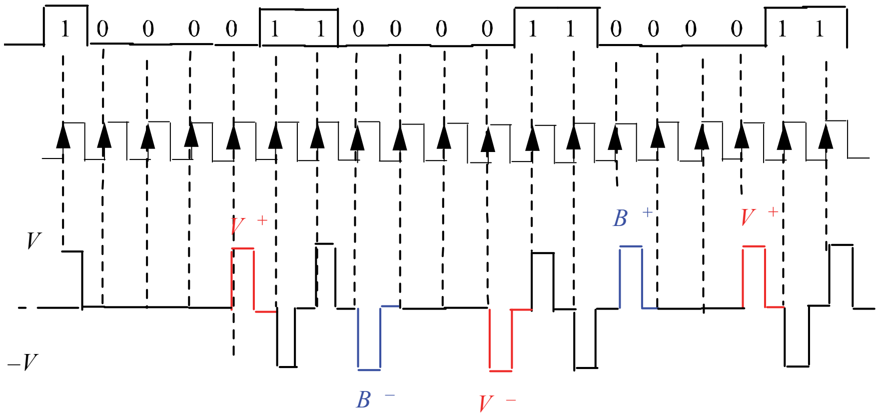


Figure 5.28. *Example of a chronogram of the HDB-3 code*

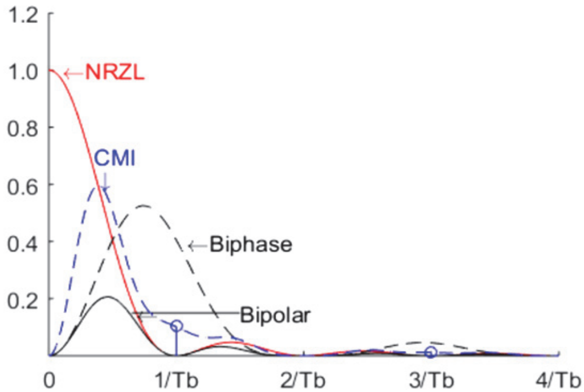


Figure 5.30. *Power spectral density of the main on-line codes presented*

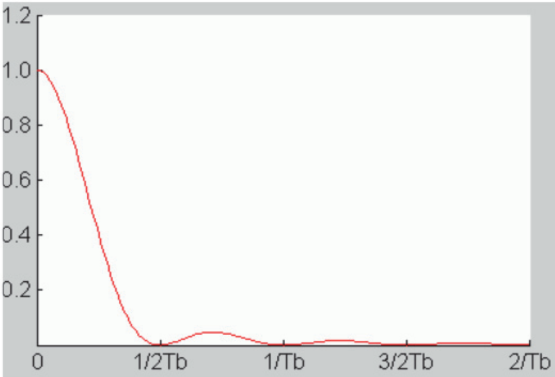


Figure 5.41. *Power spectral density of duobinary on-line code*

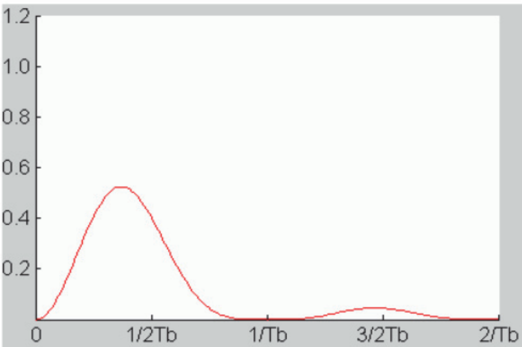


Figure 5.45. *Power spectral density of the NRZ bipolar on-line code.*

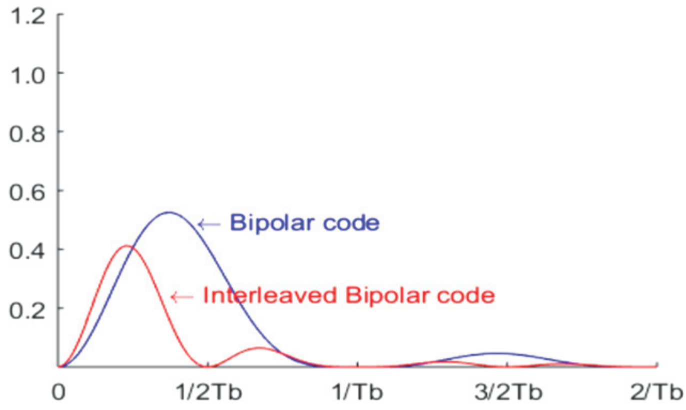


Figure 5.51. *Power spectral density of the 2nd order interleaved bipolar codes and the simple bipolar code*

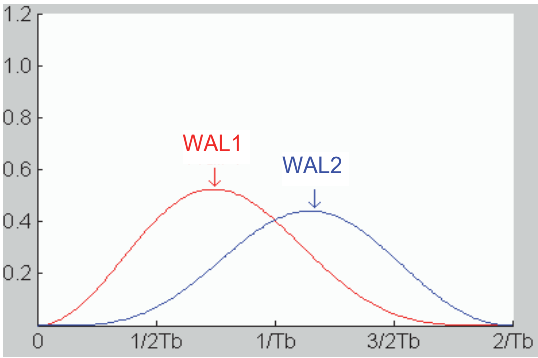


Figure 5.53. *Power spectral densities of the two-phase codes WAL1 and WAL2*

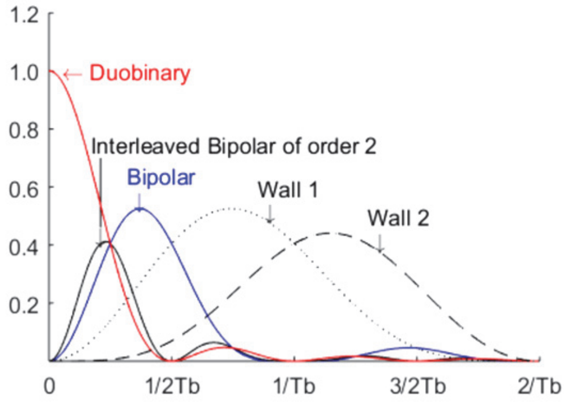


Figure 5.54. *Power spectral density of on-line codes presented*

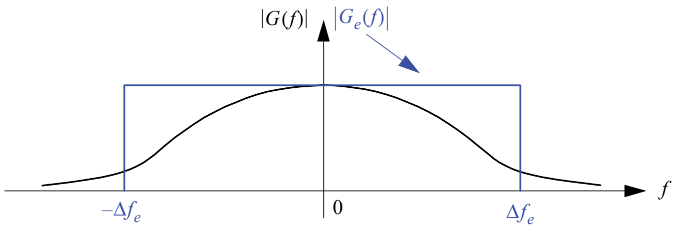


Figure 6.2. *Equivalent energy bandwidth Δf_e of a low-pass filter*

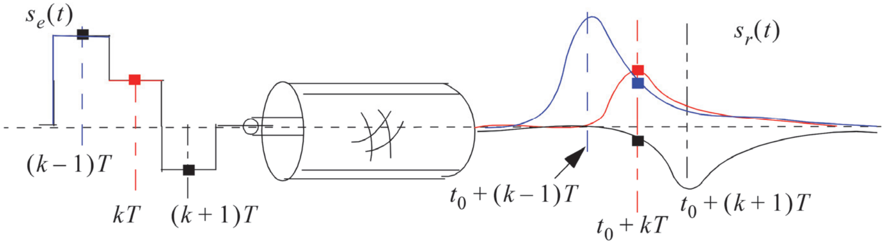


Figure 6.3. *Illustration of the intersymbol interference phenomenon*

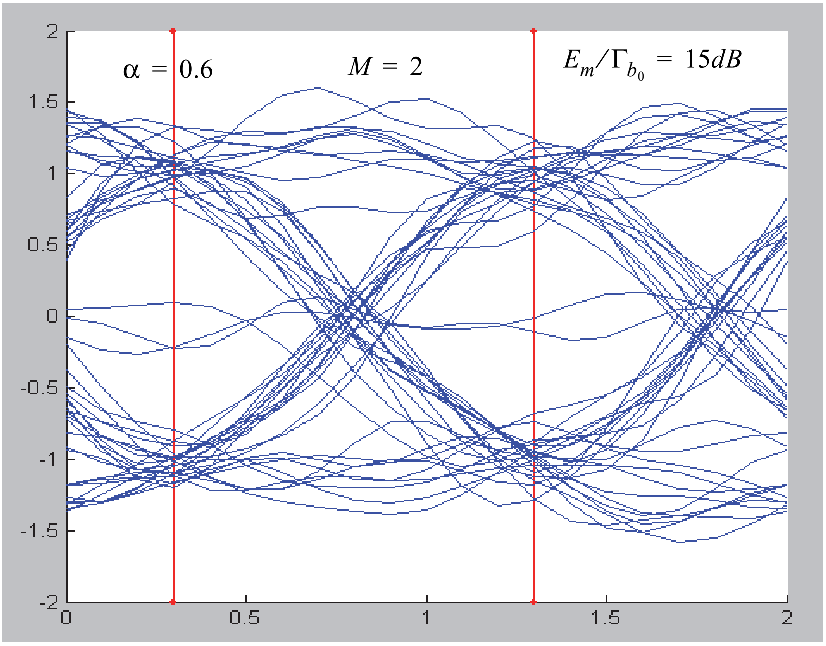


Figure 6.5(a). *Examples of an eye pattern*

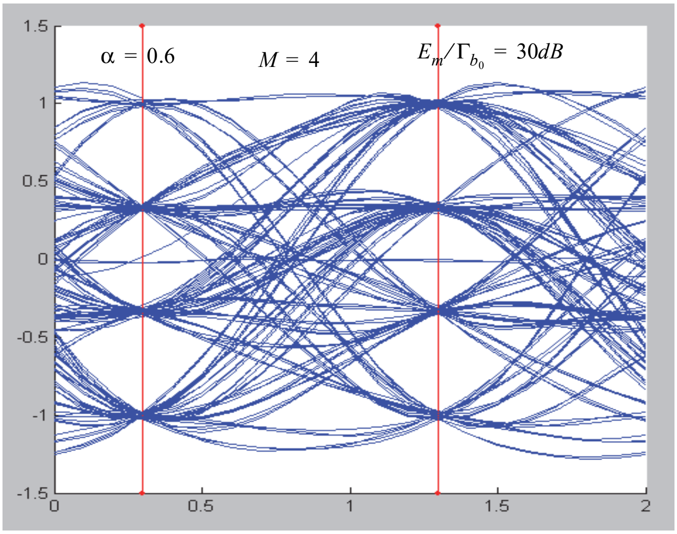


Figure 6.5(b). *Examples of an eye pattern (following)*

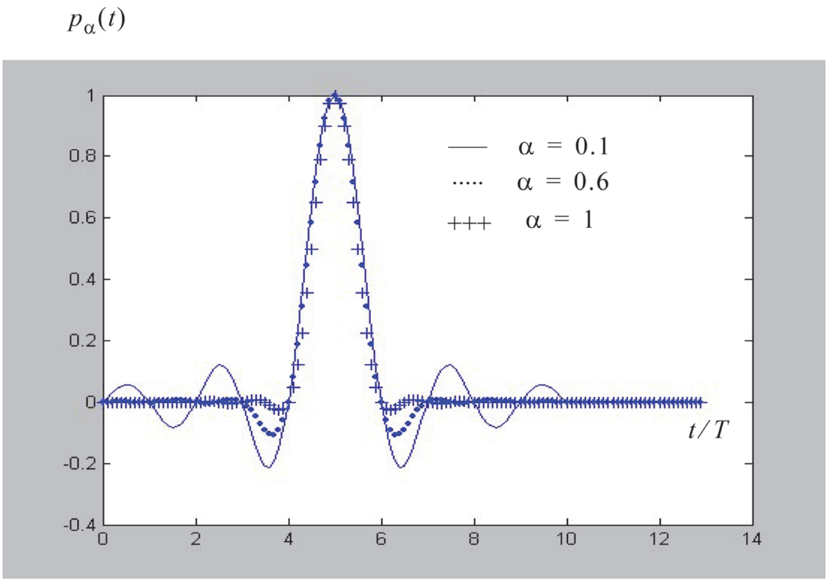


Figure 6.13. *Impulse response for different values of the parameter α*

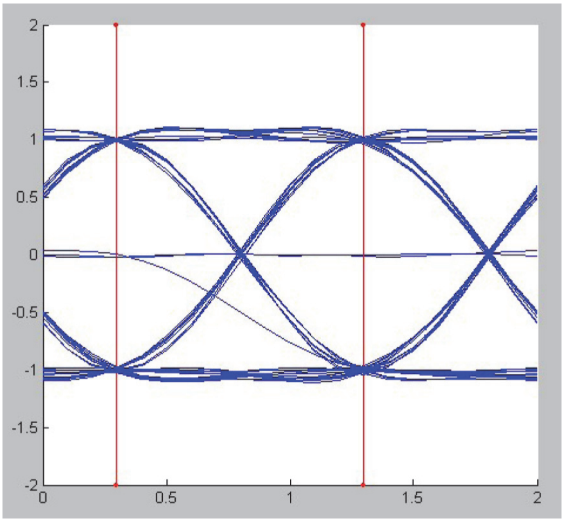


Figure 6.15. *Eye pattern (without noise), for α = 1;T = 1 s*

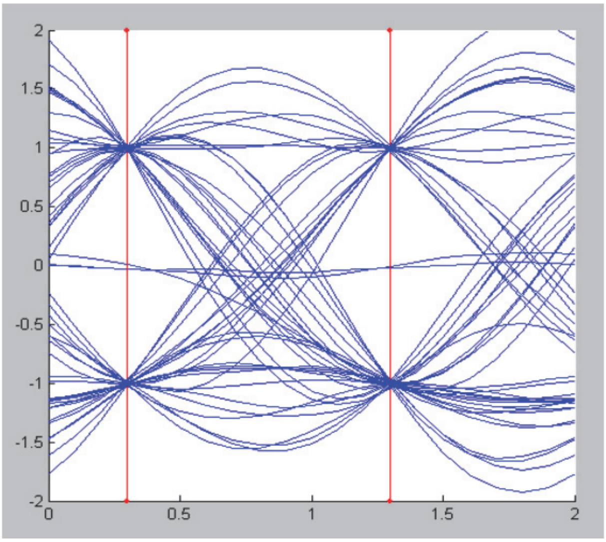


Figure 6.16. *Eye pattern (without noise), for α = 0.1; T = 1 s*

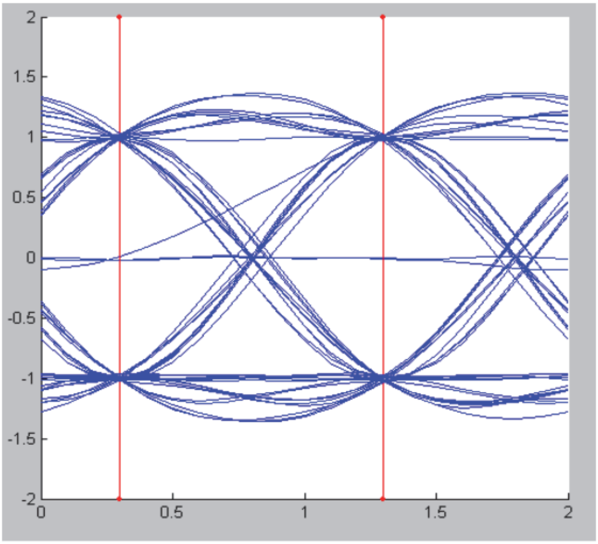


Figure 6.17. *Eye pattern (without noise), for α = 0.6; T = 1 s*

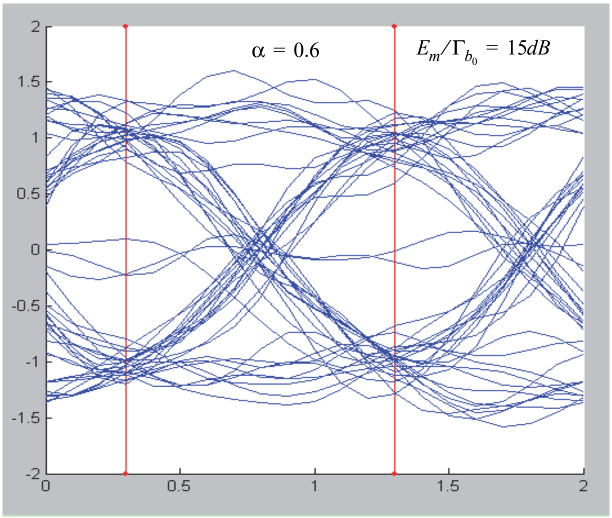


Figure 6.18. *Eye pattern (with noise), for α = 0.6 ; E_m/Γ_{b_0} = 15 dB; T = 1 s*

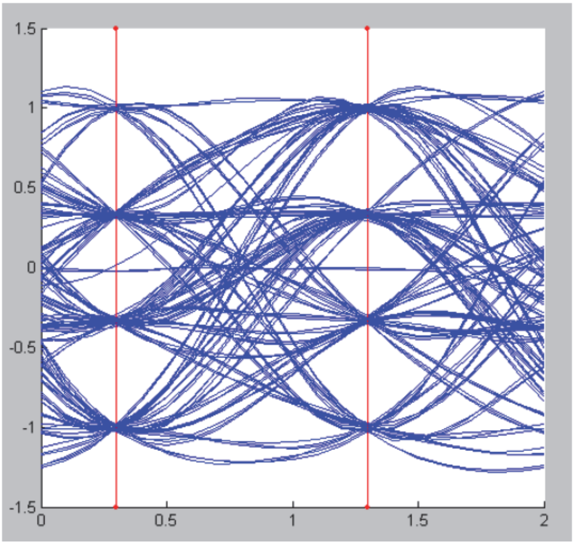


Figure 6.19. *Eye pattern 4-ary (without noise), for $\alpha = 0.6$; $T = 1$ s*

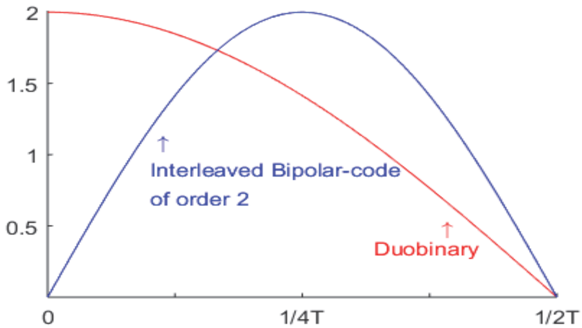


Figure 6.22. *Modulus normalized with respect to $T \times p(t_0)$ of the frequency response $|P(f)|$ of codes duobinary and bipolar interleaved of order 2*

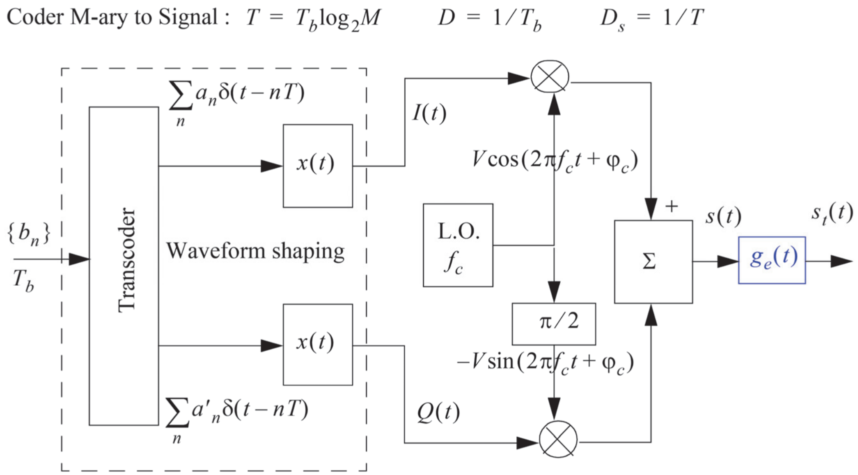


Figure 7.12. *General structure of the linear digital modulator*

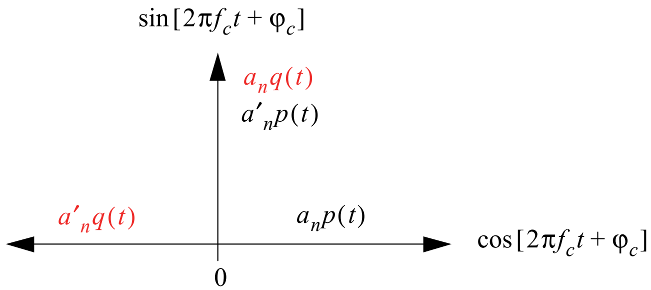


Figure 7.17. *Distribution of the signals on the carrier in-phase and on the carrier in-quadrature*

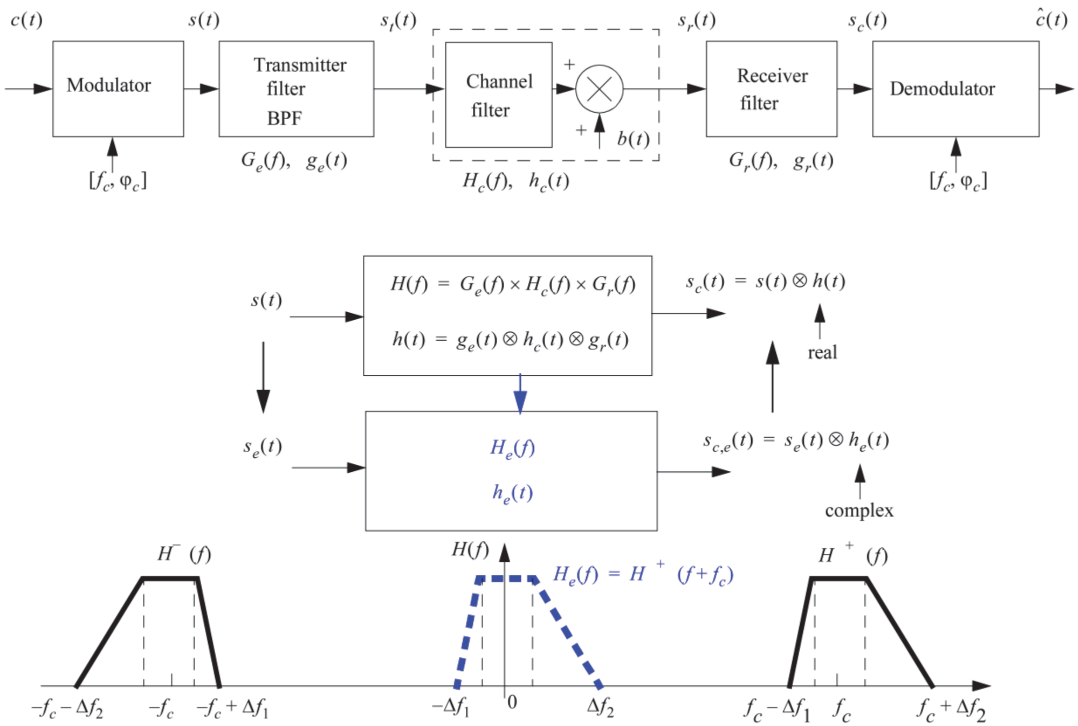
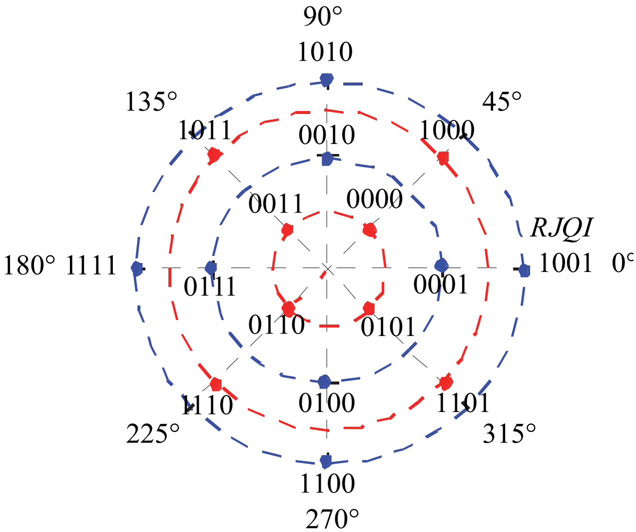


Figure 7.19. *Transition from a digital transmission with carrier modulation to an equivalent baseband digital transmission. For a color version of this figure, see www.iste.co.uk/assad/digital1.zip*

ψ_n	R	ρ_n
0°, 90°, 180°, 270°	0	3
	1	5
45°, 135°, 225°, 315°	0	$\sqrt{2}$
	1	$3\sqrt{2}$



$J\,Q\,I$	001	000	010	011	111	110	100	101
$\Delta\psi_n$	0°	45°	90°	135°	180°	225°	270°	315°

Figure 7.39. *CIR (4, 4, 4, 4) modulation*