第16讲 QPSK

1 QPSK信号的产生

2 QPSK信号的平均功率谱密度

3 QPSK信号的接收及其平均误比特率

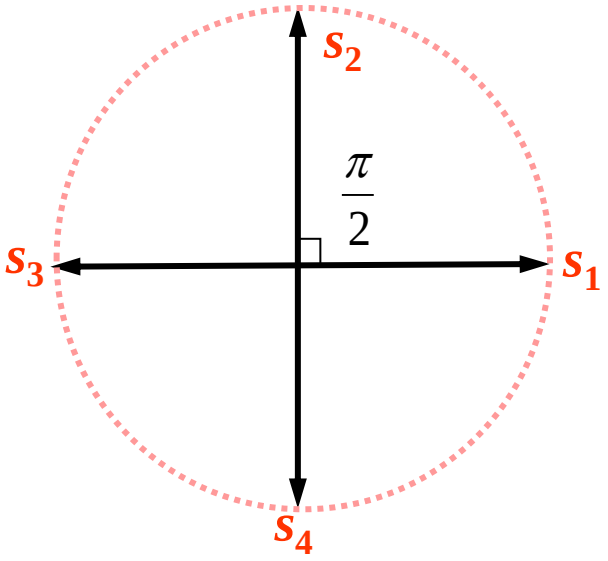
4 差分四相移相键控

Quadrature phase-shift keying (QPSK)

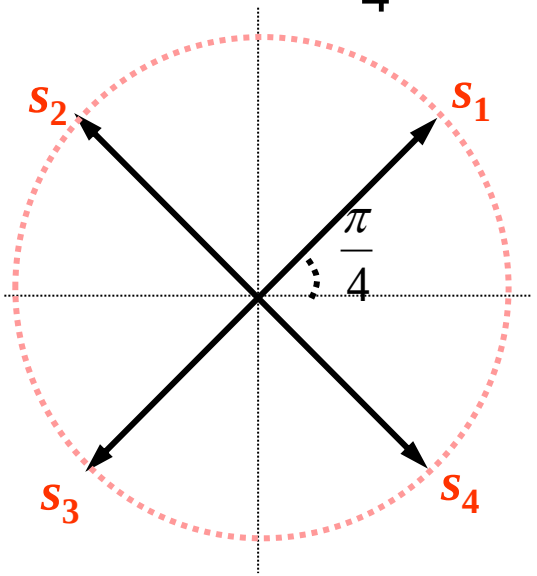
1 QPSK信号的产生

$$s_i(t) = A\cos(2\pi f_c t + \theta_i), \qquad i = 1,2,3,4 \qquad 0 \le t \le T_s$$

$$\theta_i = (i-1)\cdot\frac{\pi}{2}$$



$$\theta_i = (2i-1)\cdot\frac{\pi}{4}$$



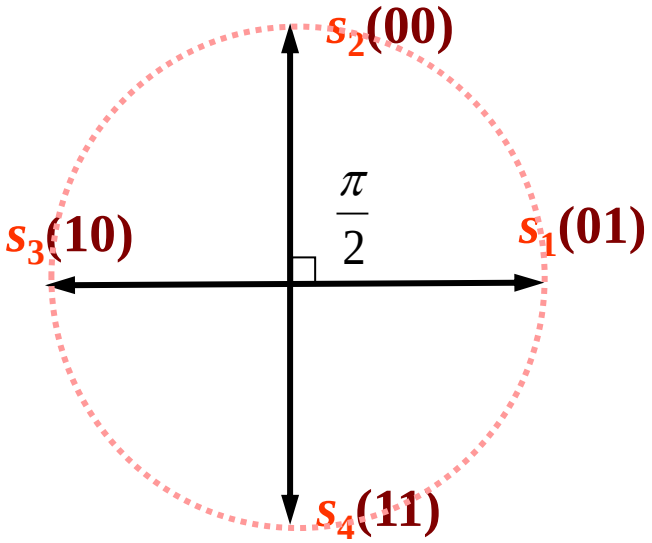
1 QPSK信号的产生

$$s_i(t) = A\cos(\omega_c t + \theta_i) = A\left(\cos\theta_i \cos\omega_c t - \sin\theta_i \sin\omega_c t\right)$$

$$\theta_i = (i-1)\cdot\frac{\pi}{2}$$

$$s_i(t) = A\left[I(t)\cos\omega_c t - Q(t)\sin\omega_c t\right]$$

$$I(t) = \cos\theta_i; Q(t) = \sin\theta_i \qquad 0 \le t \le T_s$$



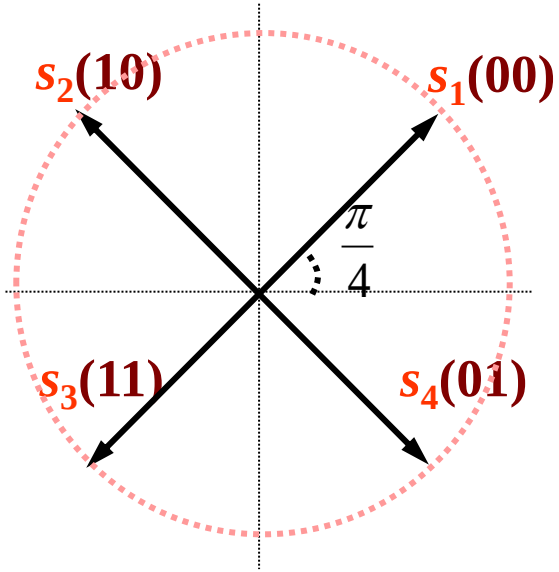
Data bits		phase
d_{2i+1}	d_{2i}	θ_i
0	0	90°
0	1	0°
1	0	180°
1	1	270°

1 QPSK信号的产生

$$s_i(t) = A\cos(\omega_c t + \theta_i) = A\left(\cos\theta_i \cos\omega_c t - \sin\theta_i \sin\omega_c t\right)$$

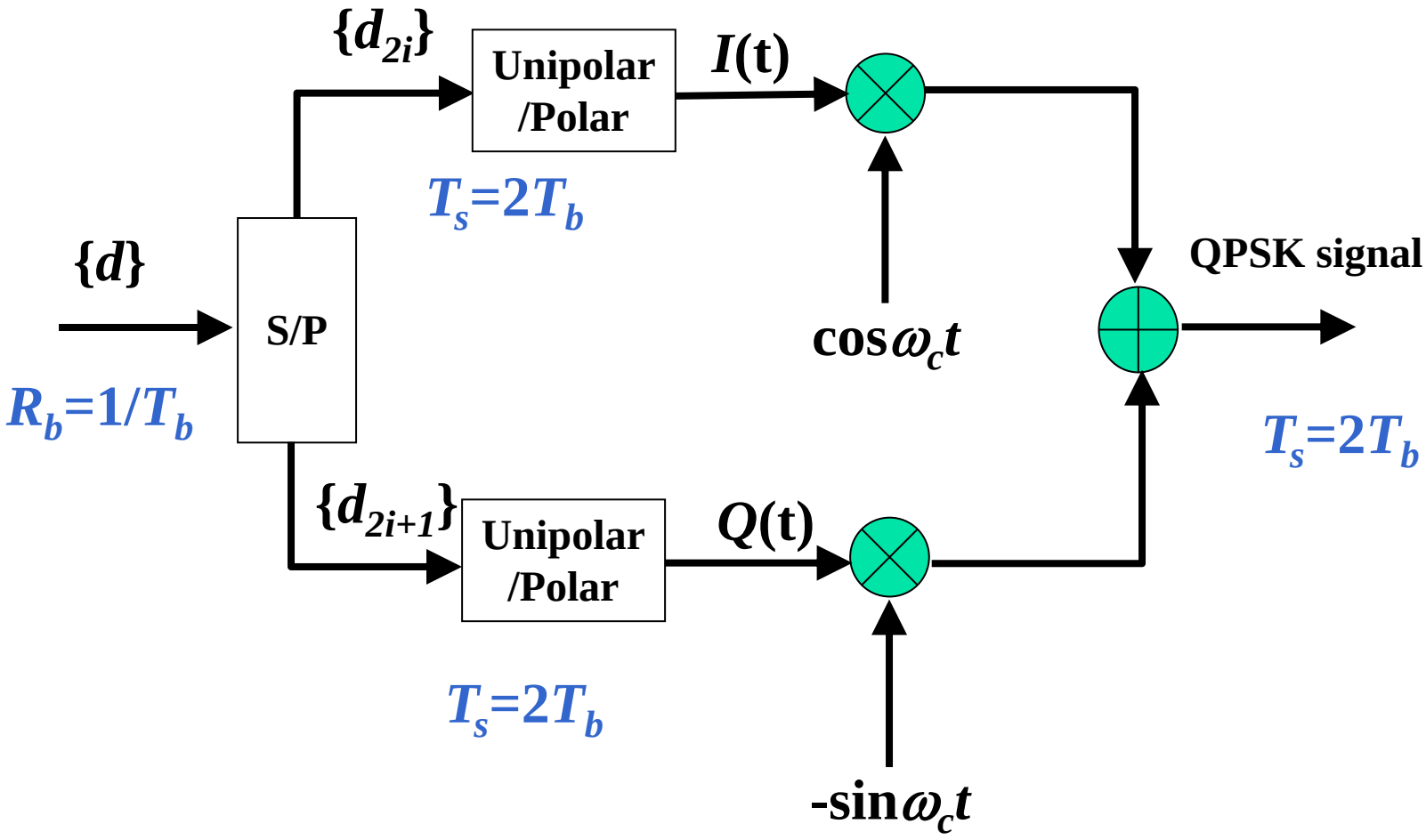
$$\theta_i = (2i-1)\cdot\frac{\pi}{4} \qquad s_i(t) = \frac{A}{\sqrt{2}}\left[I(t)\cos\omega_c t - Q(t)\sin\omega_c t\right]$$

$$I(t) = \sqrt{2}\cos\theta_i = \pm 1; Q(t) = \sqrt{2}\sin\theta_i = \pm 1 \qquad 0 \le t \le T_s$$



Data bits		phase	In-phase component	Quadrature component
d_{2i+1}	d_{2i}	θ_i	$I(t)$	$Q(t)$
0	0	45°	1	1
1	0	135°	-1	1
1	1	225°	-1	-1
0	1	315°	1	-1

π/4 QPSK modulator



2 QPSK信号功率谱密度

- 2PSK信号功率谱密度

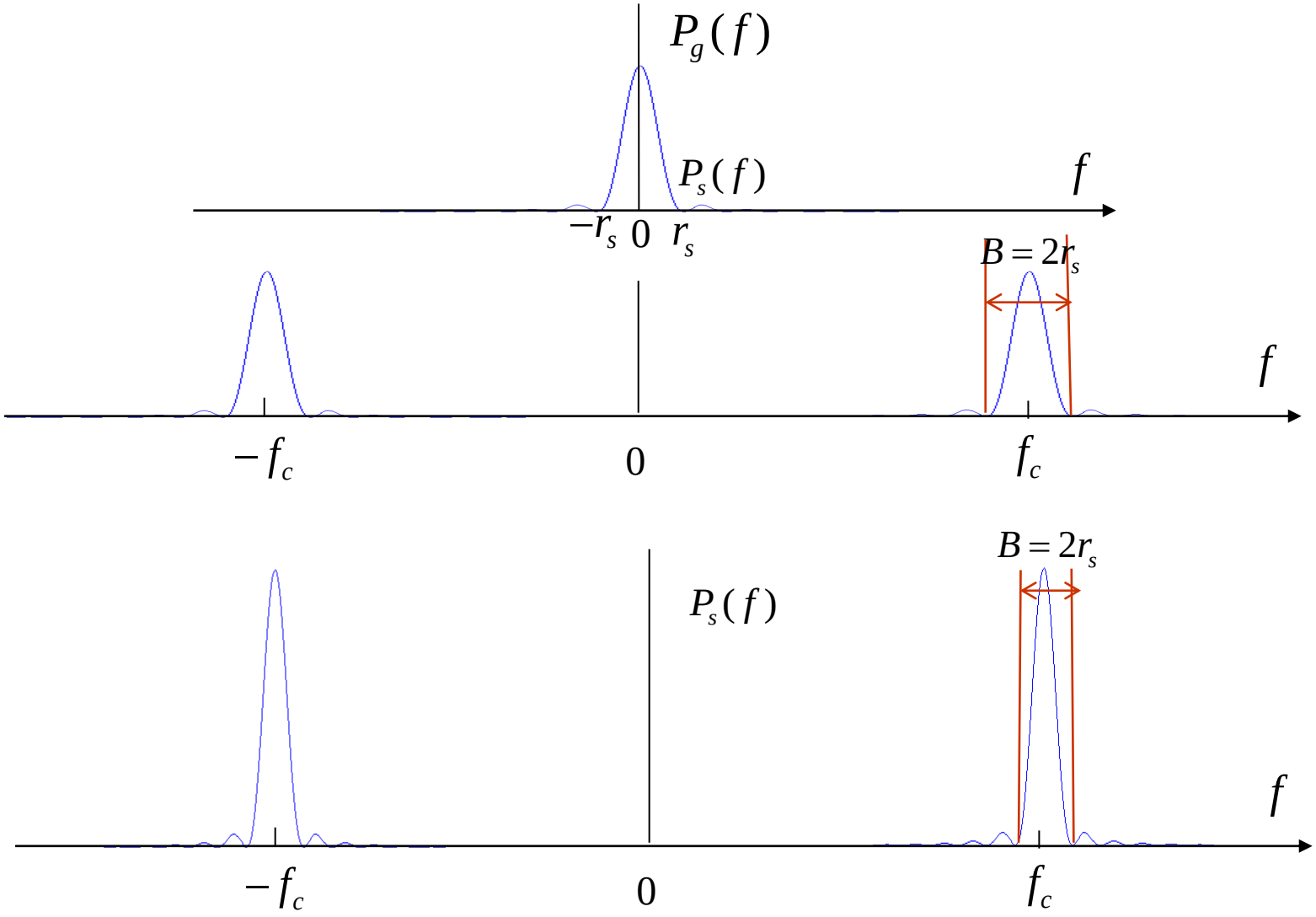
$$P_{2PSK}(f)=\frac{A^2T_b}{4}\left\{\mathrm{Sa}^2[\pi(f-f_c)T_b]+\mathrm{Sa}^2[\pi(f+f_c)T_b]\right\}$$

- QPSK信号功率谱密度

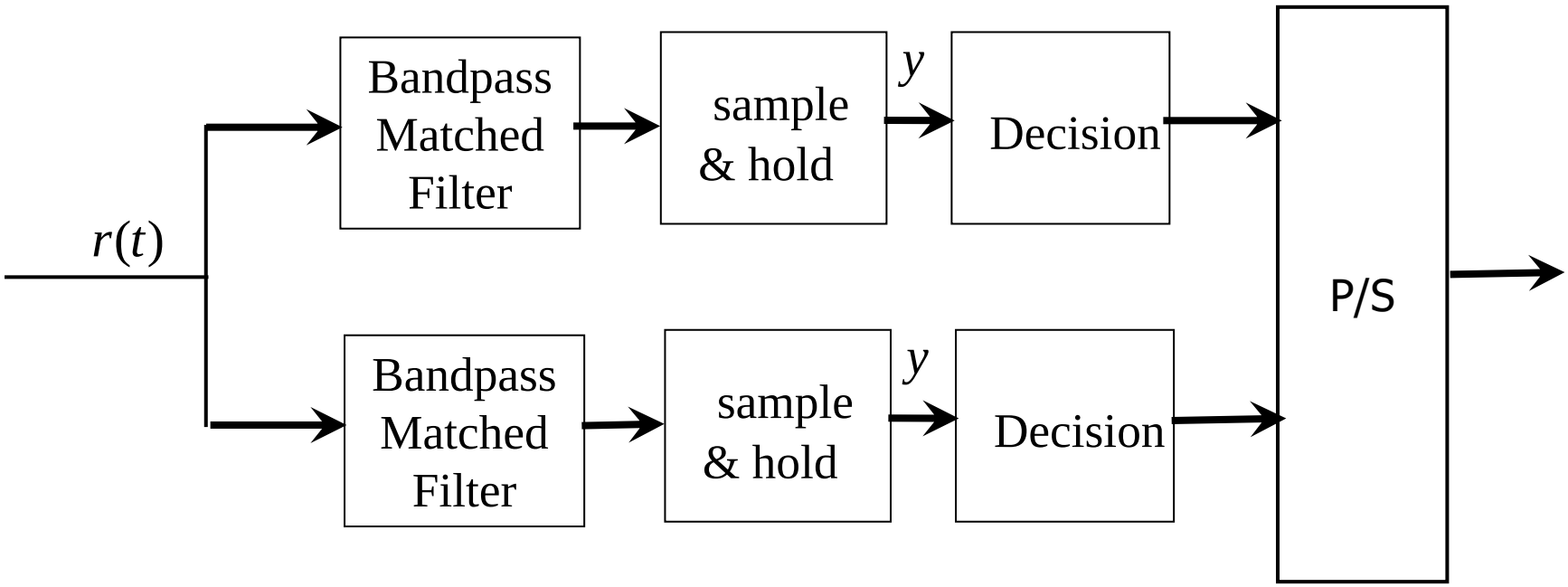
$$P_{QPSK}(f)=2\{\frac{(A/\sqrt{2})^2T_s}{4}\left\{\mathrm{Sa}^2[\pi(f-f_c)T_s]+\mathrm{Sa}^2[\pi(f+f_c)T_s]\right\}$$

$$=\frac{A^2T_b}{2}\left\{\mathrm{Sa}^2[2\pi(f-f_c)T_b]+\mathrm{Sa}^2[2\pi(f+f_c)T_b]\right\}$$

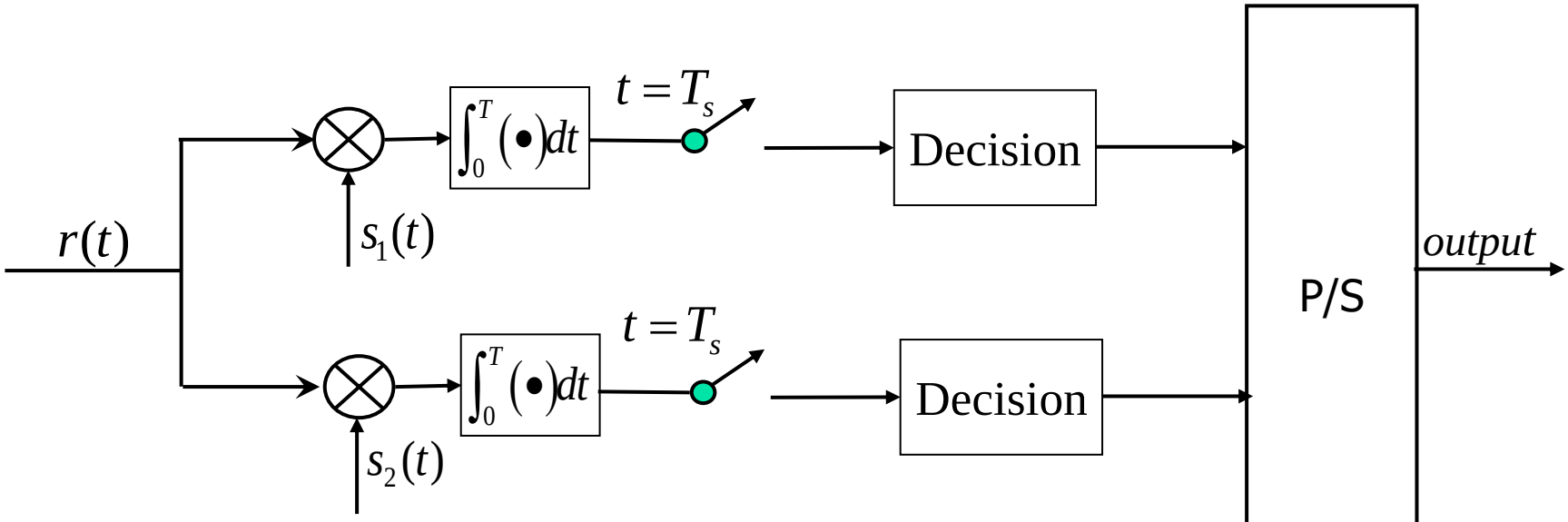
2 QPSK信号功率谱密度



3 QPSK信号接收


r(t)
Bandpass Matched Filter
sample & hold
y
Decision
Bandpass Matched Filter
sample & hold
y
Decision
P/S

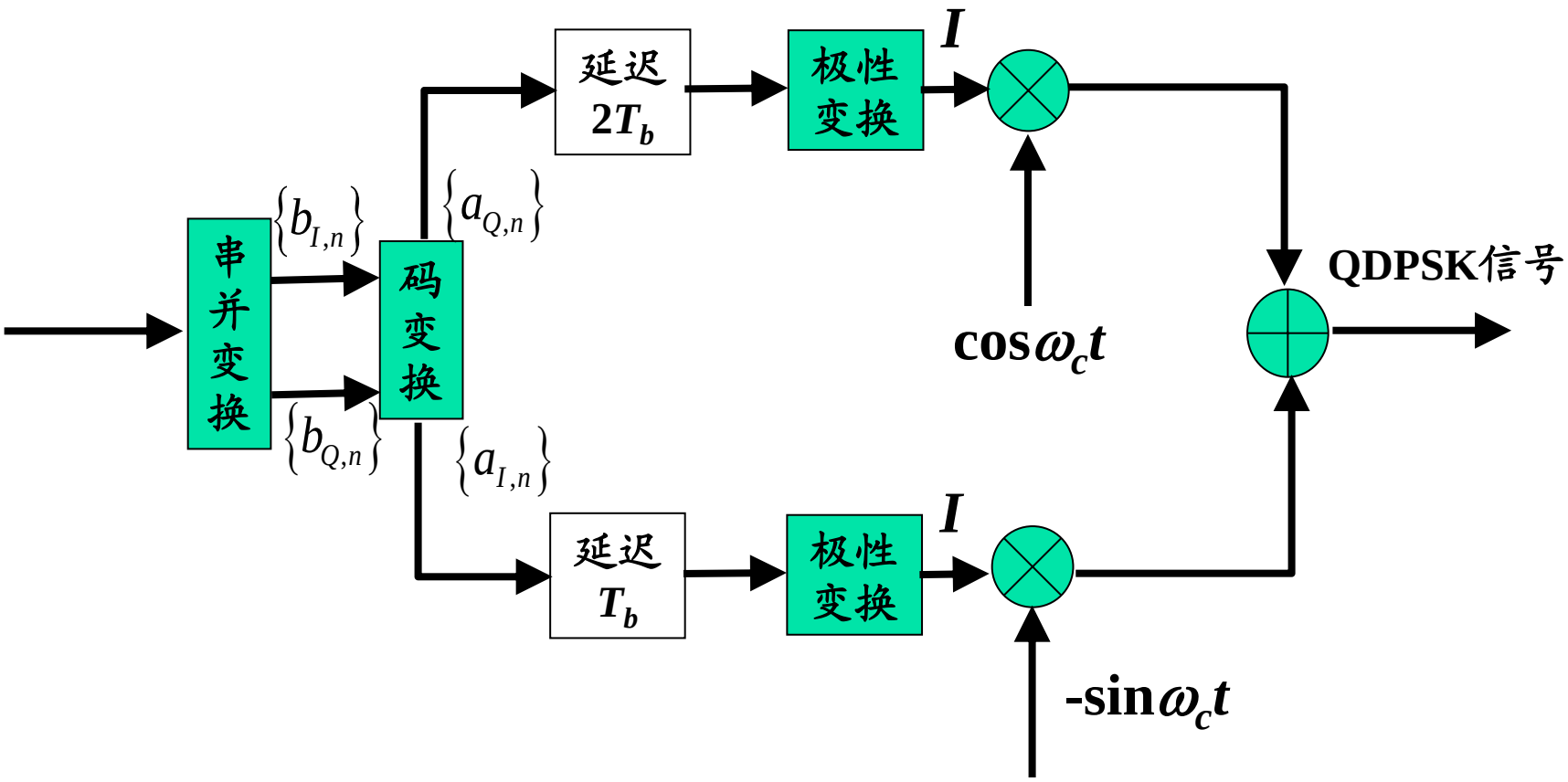
3 QPSK信号接收



$$P_e = Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$$

4 差分QPSK

- DQPSK利用前后码元的相对相位变化来表示数字信息



4 差分QPSK

$\{b_{I,n}\}$	$\{b_{Q,n}\}$	$\Delta\varphi_n$	$\{a_{I,n-1}\}$	$\{a_{Q,n-1}\}$	θ_{n-1}	$\{a_{I,n}\}$	$\{a_{Q,n}\}$	θ_n
0	0	0°	0	0	$3\pi/4$	0	0	$3\pi/4$
			0	1	$5\pi/4$	0	1	$5\pi/4$
			1	1	$7\pi/4$	1	1	$7\pi/4$
			1	0	$\pi/4$	1	0	$\pi/4$
0	1	90°	0	0	$3\pi/4$	0	1	$5\pi/4$
			0	1	$5\pi/4$	1	1	$7\pi/4$
			1	1	$7\pi/4$	1	0	$\pi/4$
			1	0	$\pi/4$	0	0	$3\pi/4$
1	1	180°	0	0	$3\pi/4$	1	1	$7\pi/4$
			0	1	$5\pi/4$	1	0	$\pi/4$
			1	1	$7\pi/4$	0	0	$3\pi/4$
			1	0	$\pi/4$	0	1	$5\pi/4$
1	0	270°	0	0	$3\pi/4$	1	0	$\pi/4$
			0	1	$5\pi/4$	0	0	$3\pi/4$
			1	1	$7\pi/4$	0	1	$5\pi/4$
			1	0	$\pi/4$	1	1	$7\pi/4$

4 差分QPSK

a_n b_n	$\Delta\varphi_n$	c_{n-1} d_{n-1}	θ_{n-1}	c_n d_n	θ_n
0 0	0°	0 0 0 1 1 1 1 0	$3\pi/4$ $5\pi/4$ $7\pi/4$ $\pi/4$	0 0 0 1 1 1 1 0	$3\pi/4$ $5\pi/4$ $7\pi/4$ $\pi/4$
0 1	90°	0 0 0 1 1 1 1 0	$3\pi/4$ $5\pi/4$ $7\pi/4$ $\pi/4$	0 1 1 1 1 0 0 0	$5\pi/4$ $7\pi/4$ $\pi/4$ $3\pi/4$
1 1	180°	0 0 0 1 1 1 1 0	$3\pi/4$ $5\pi/4$ $7\pi/4$ $\pi/4$	1 1 1 0 0 0 0 1	$7\pi/4$ $\pi/4$ $3\pi/4$ $5\pi/4$
1 0	270°	0 0 0 1 1 1 1 0	$3\pi/4$ $5\pi/4$ $7\pi/4$ $\pi/4$	1 0 0 0 0 1 1 1	$\pi/4$ $3\pi/4$ $5\pi/4$ $7\pi/4$

单选题 1分

设置

此题未设答案

下列二进制频带传输系统中，误码性能最好的是

A 2ASK非相干解调

B 2PSK相干解调

C 2FSK相干解调

D 2DPSK非相干解调

提交

多选题 1分

设置

某2ASK传输系统，若符号传输速率为10kHz，则下列说法中正确的是

A 该2ASK信号的最小带宽为10kHz

B 该2ASK信号的最小带宽为20kHz

C 若基带信号采用不归零方波，则该2ASK信号第一过零点带宽为10kHz

D 若基带信号采用不归零方波，则该2ASK信号第一过零点带宽为20kHz

提交

单选题 1分

设置

若要求信息传输速率r_b=10kbps，分别采用BPSK和QPSK传输，所需要的最小带宽分别为：

A 5kHz，10kHz

B 10kHz，20kHz

C 10kHz，5kHz

D 20kHz，10kHz

提交