

Differential BPSK: DPSK

EE161: Digital Communication Systems

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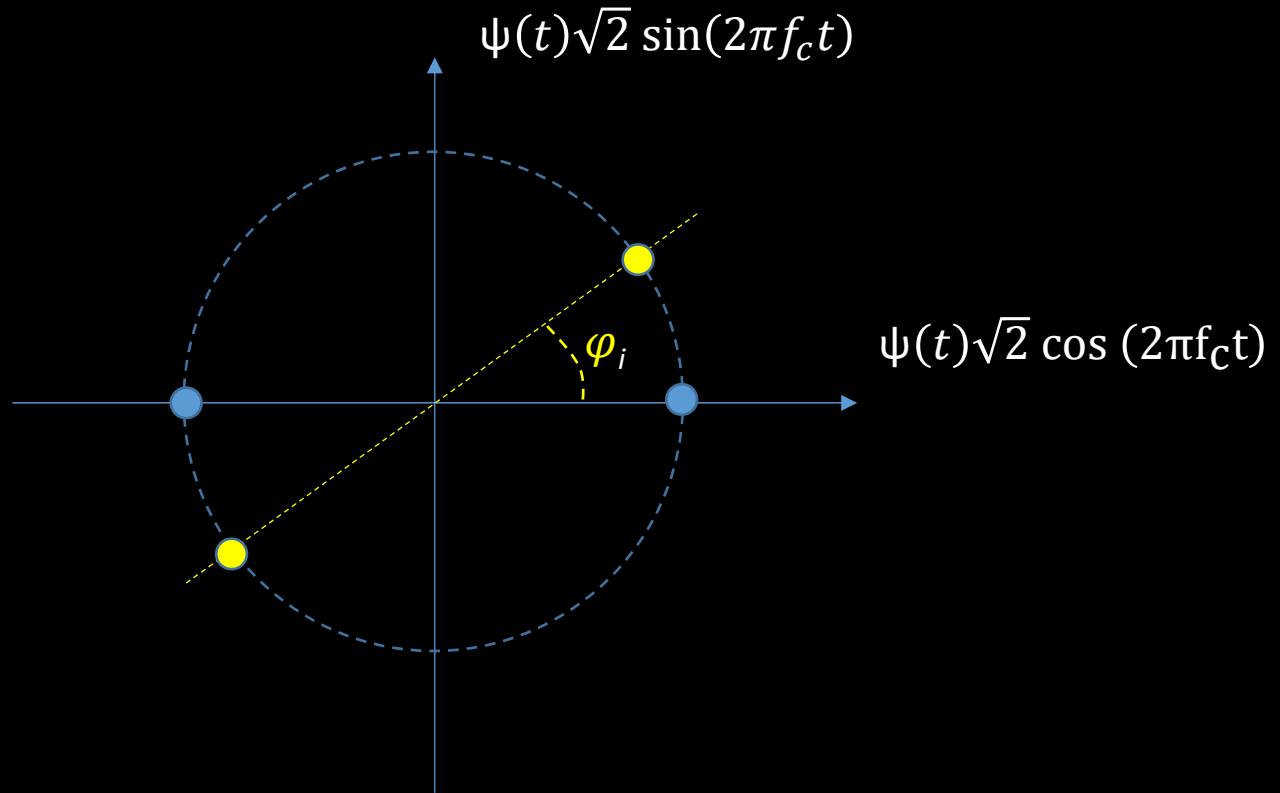
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Random phase in wireless communications

- In wireless communications, the phase of the carrier signal is affected by several factors:
 - Propagation delay, τ
 - Independent oscillators in each device
- Assuming that fading is slow, the received signal over each propagation path is

$$r_i(t) = \alpha_i s(t - \tau_i) \cos(2\pi f_c t + \varphi_i)$$

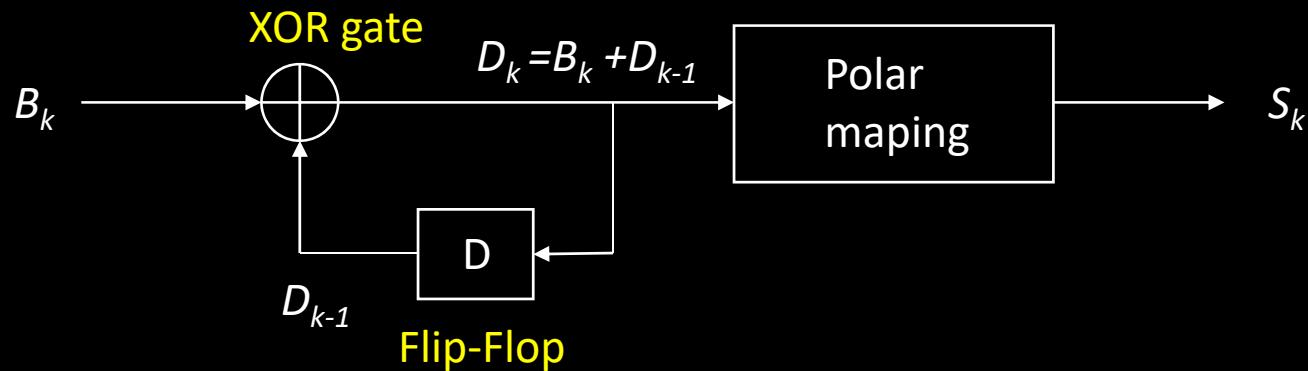
Phase effect on BPSK constellation



Idea: Encode phase difference, not absolute phase

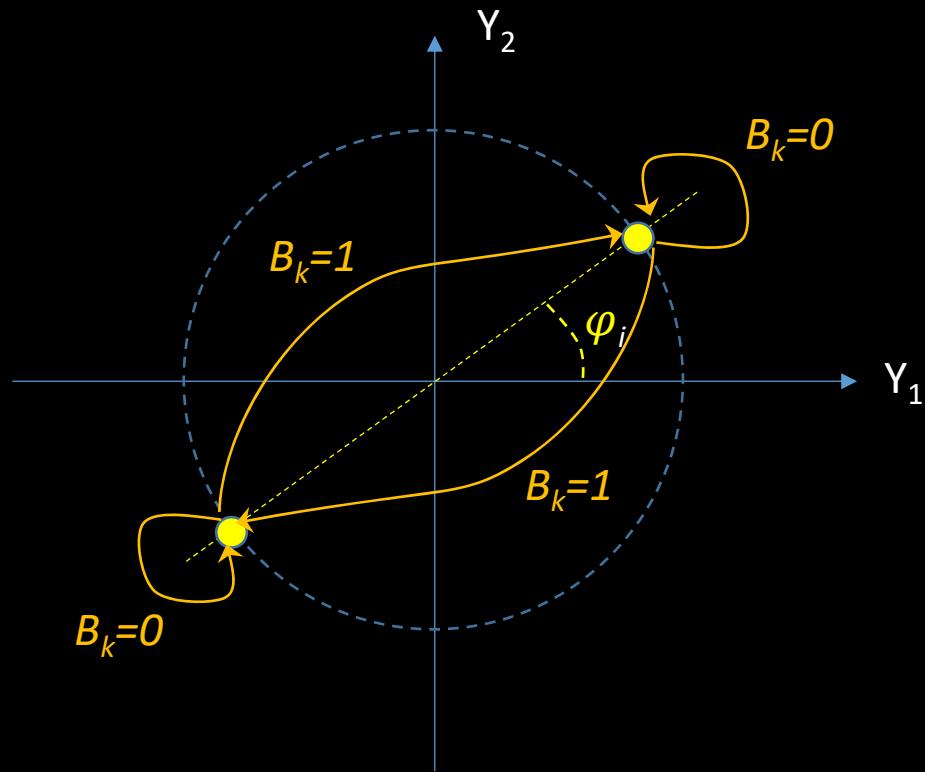
Differential encoder and mapper

Read “Differential Phase Encoding and Differential Phase Modulation and Demodulation” (sec. 8.6.4 of textbook, 2nd ed.)



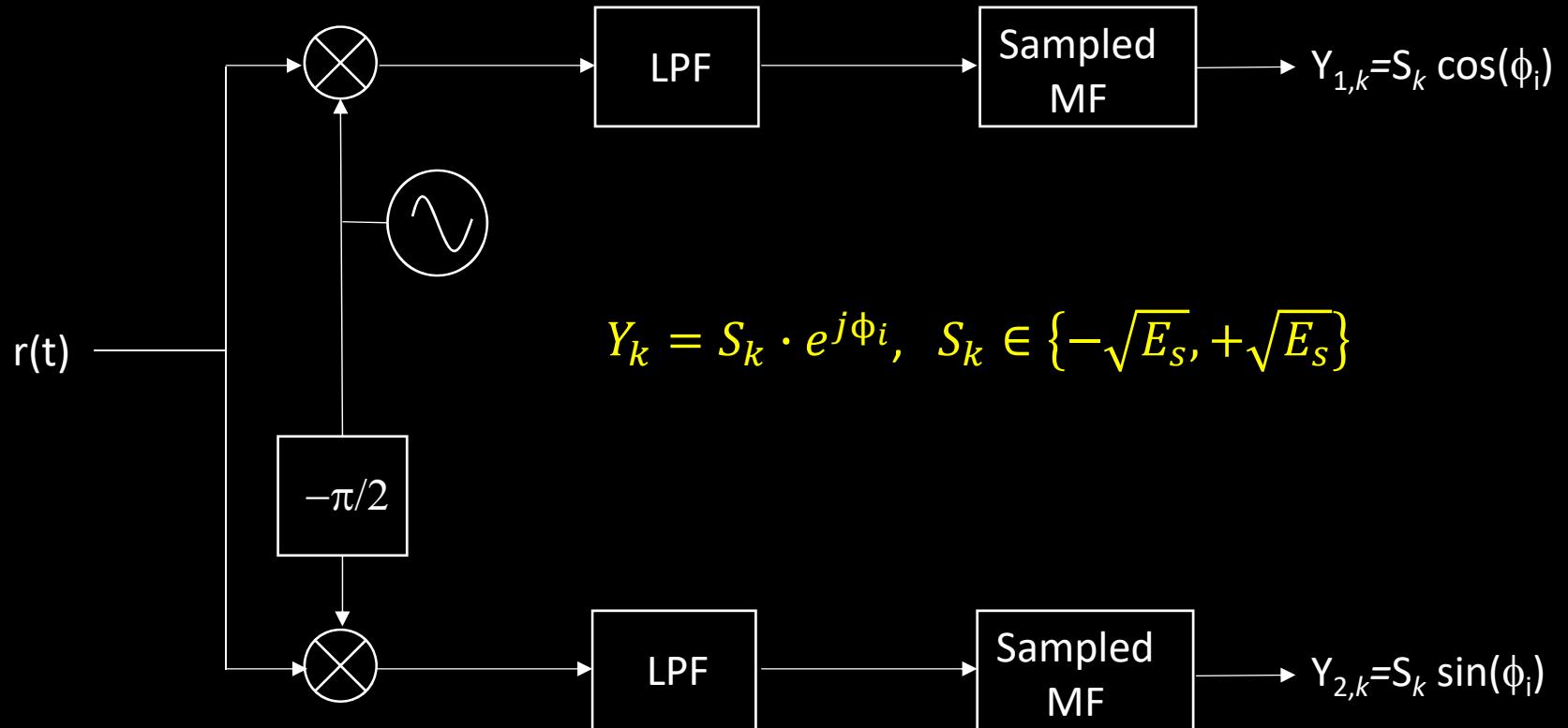
B_k	D_k	S_k	
0	D_{k-1}	S_{k-1}	No change
1	\overline{D}_{k-1}	$-S_{k-1}$	Phase change

Differential phase changes (BPSK)

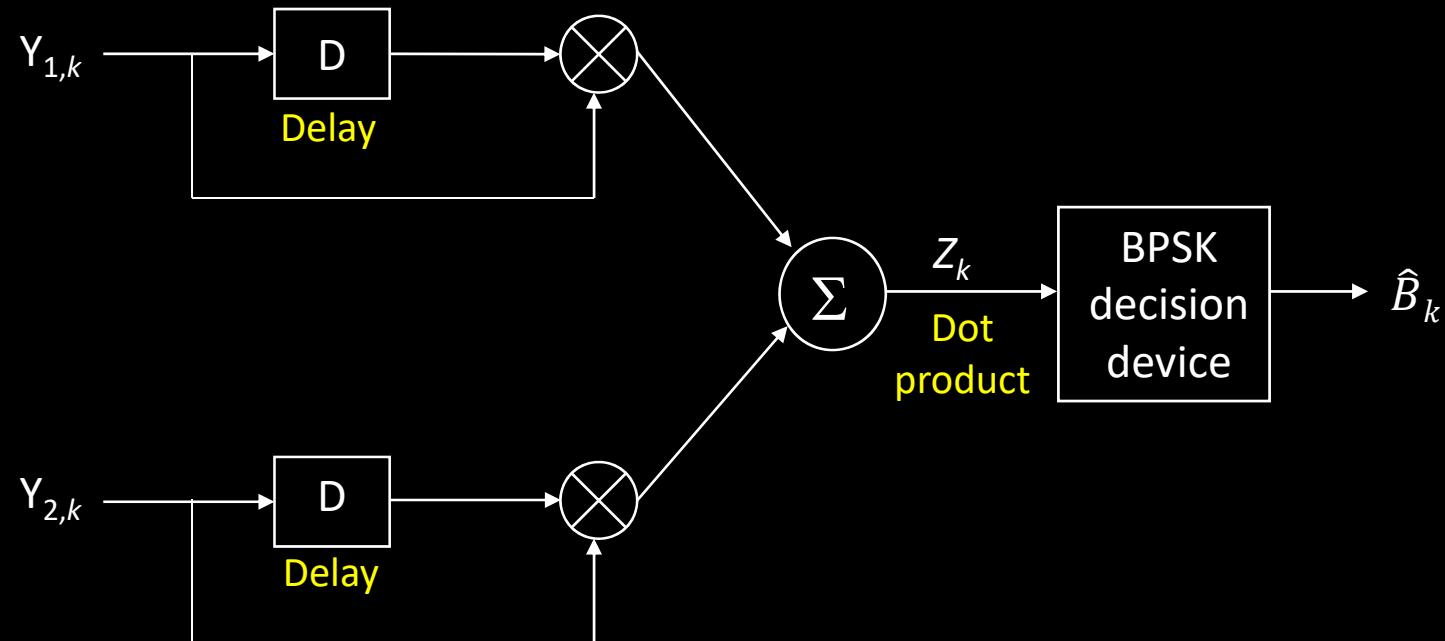


Idea: Compute the dot product Z_k between two consecutive matched filter output pairs $(Y_{t,k}, Y_{2,k})$ and $(Y_{t,k-1}, Y_{2,k-1})$ ---> Need **quadrature demodulator**.

Quadrature demodulator (DPSK)



DPSK decision device



$Z_k > 0$: Same direction ($B_k=0$)

$Z_k < 0$: Opposite direction ($B_k=1$)

Error performance of DPSK

- AWGN channel

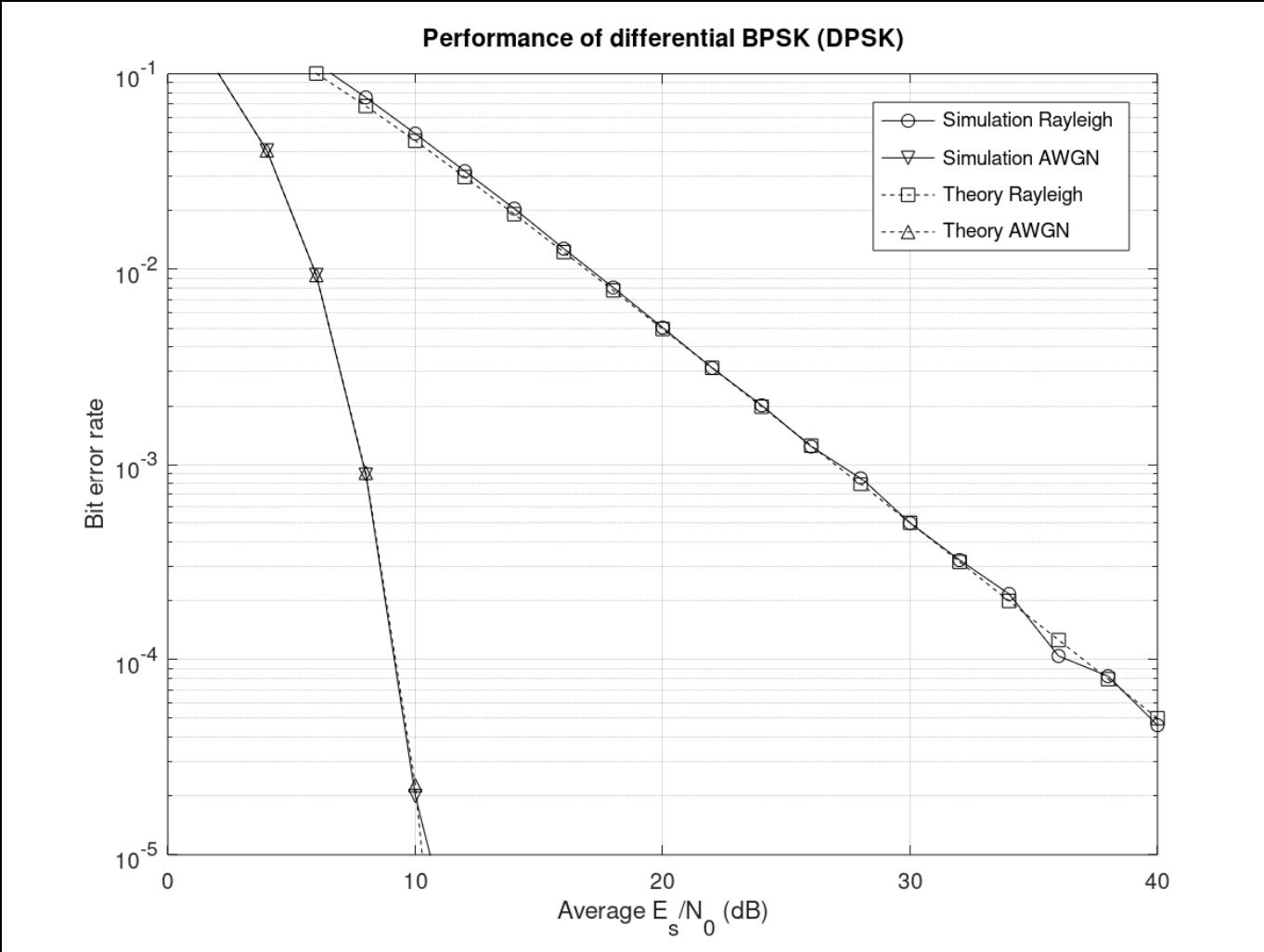
$$P_b = \frac{1}{2} e^{-E_s/N_0}$$

- Rayleigh fading channel, $\rho_0 = \frac{E_s}{N_0} E\{A^2\}$

$$P_b = \frac{1}{2(1 + \rho_0)}$$

See MATLAB script “dpsk_AWGN_rayleigh.m” and results shown next.

DPSK simulation results



Differential modulation

- The same ideas used in DPSK (differential encoding) can be extended to other linear modulation, such as M -PAM, M -PSK and M -QAM