Chapter 07

Passband Digital Transmission

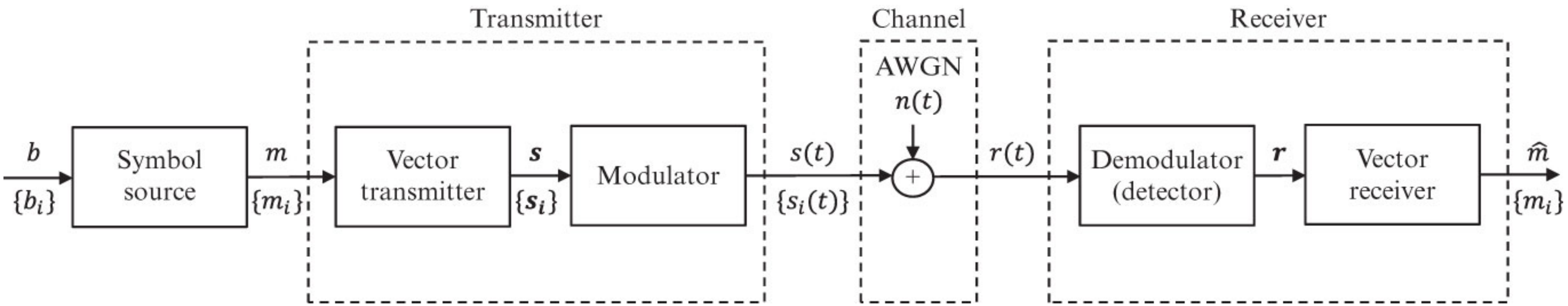


Figure 7.1 A model of passband digital communication system.

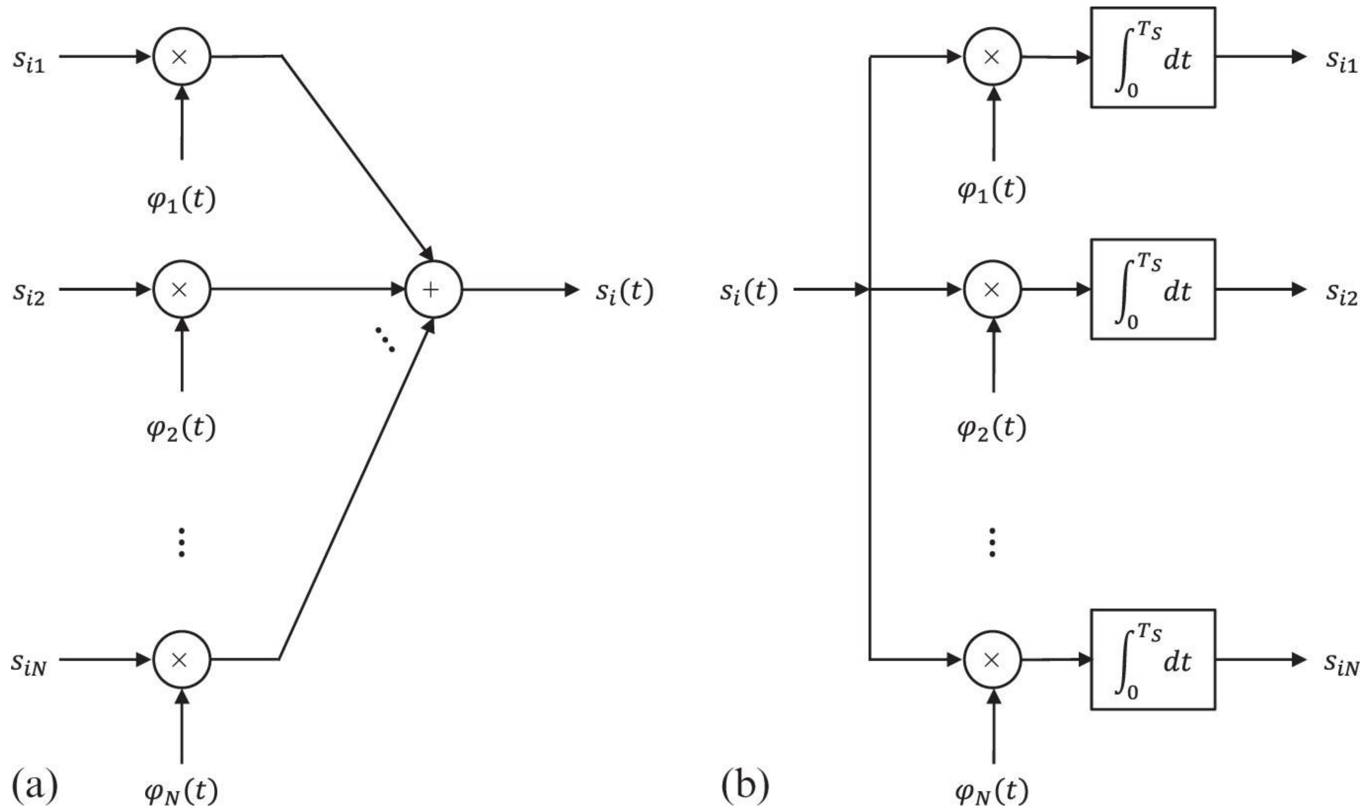


Figure 7.2 The Gram-Schmidt orthogonalization procedure: (a) generation of signal from coefficients and (b) extraction of coefficients from signal.

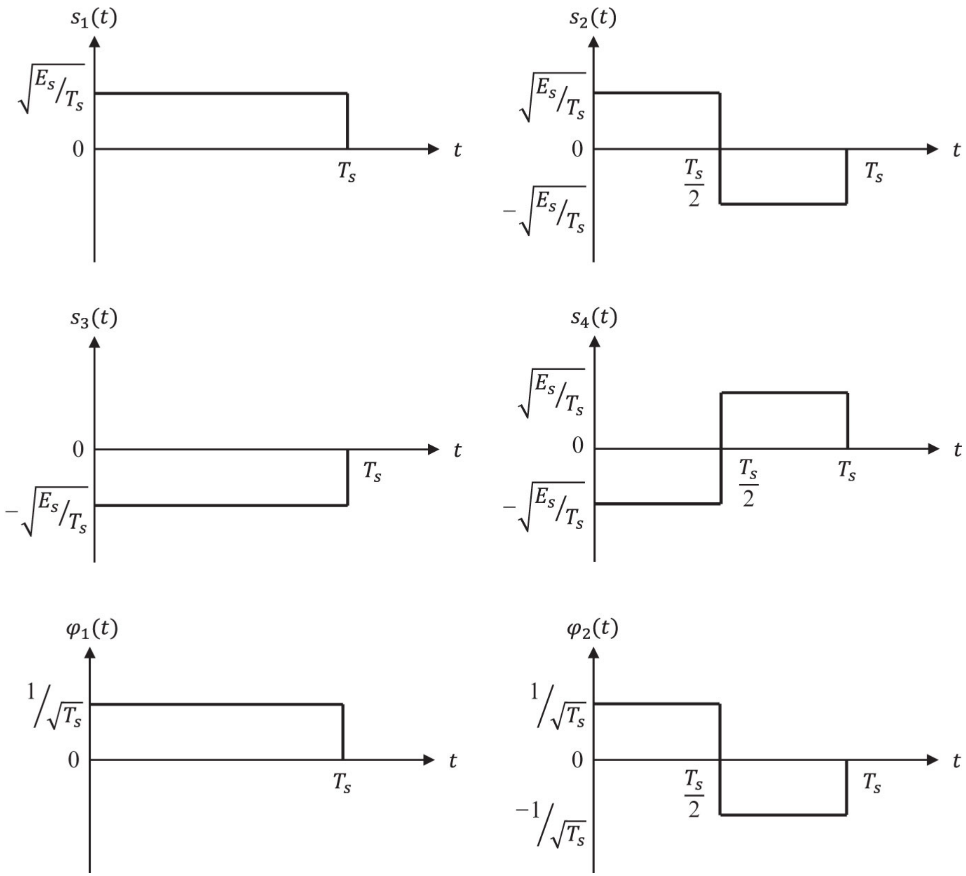


Figure 7.3 Set of signals and orthonormal functions for Example 7.1.

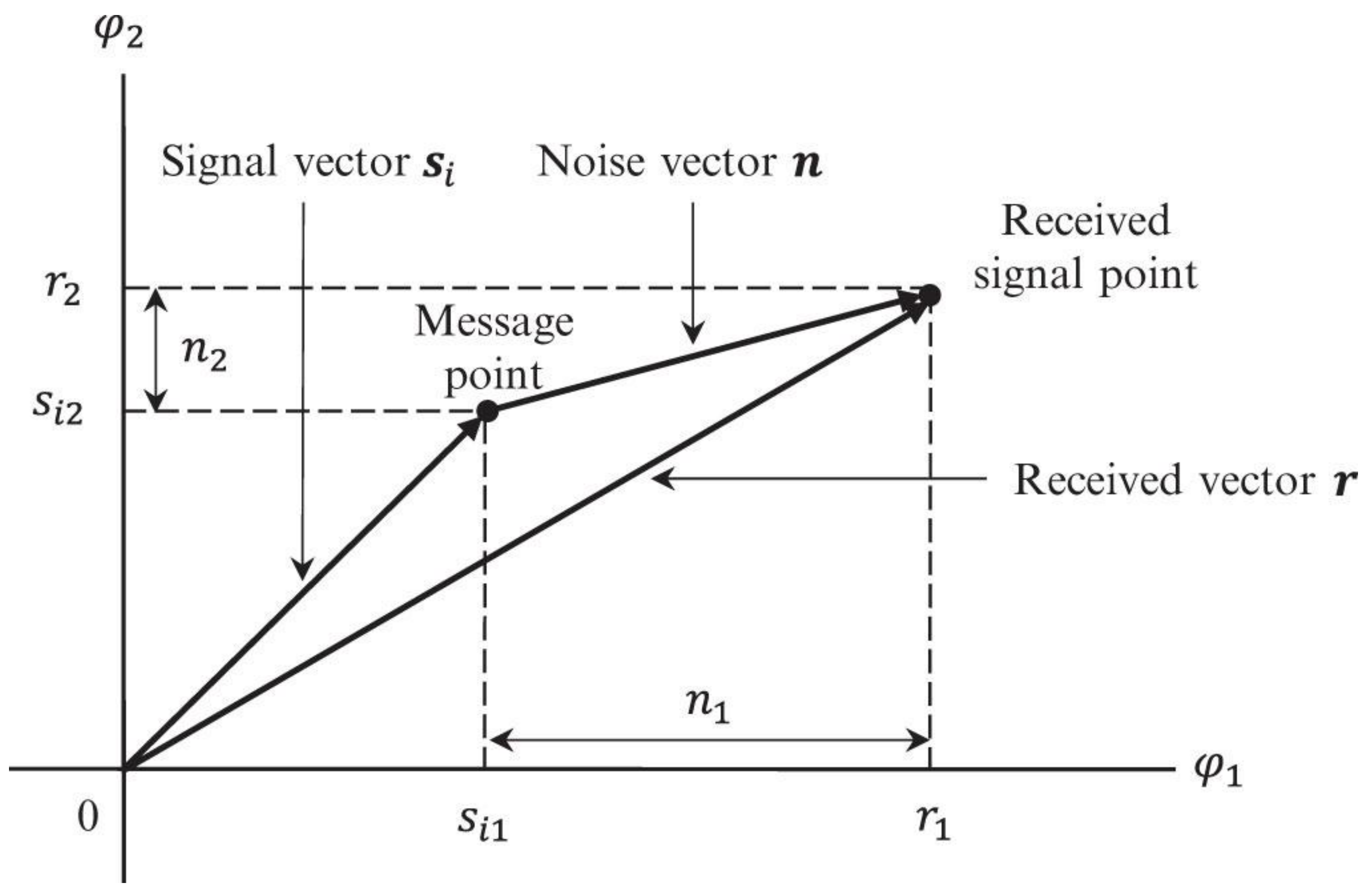


Figure 7.4 A geometric representation of transmitted vector, noise vector, and received vector.

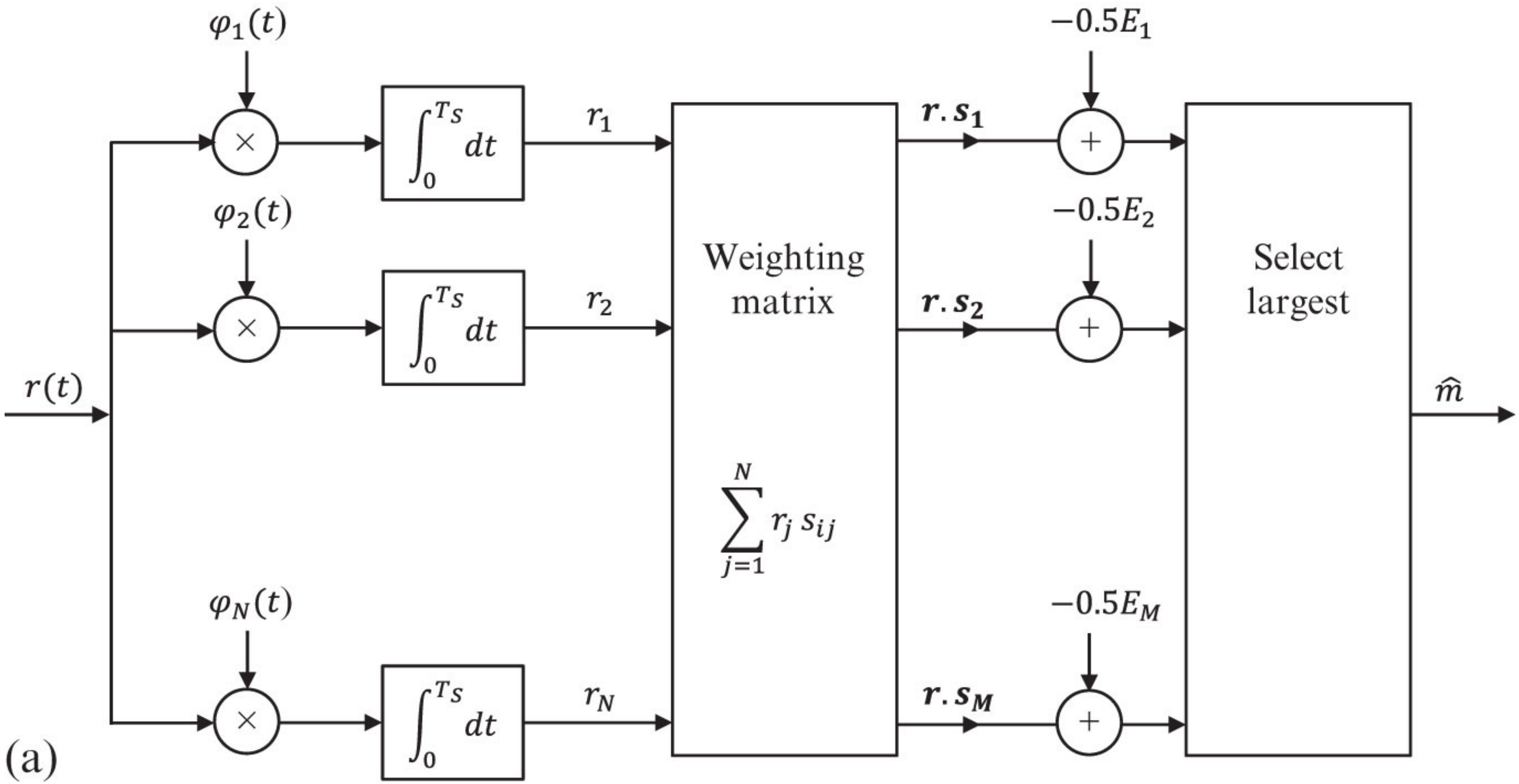


Figure 7.5a Optimum receivers: (a) correlation receiver and (b) matched-filter receiver.

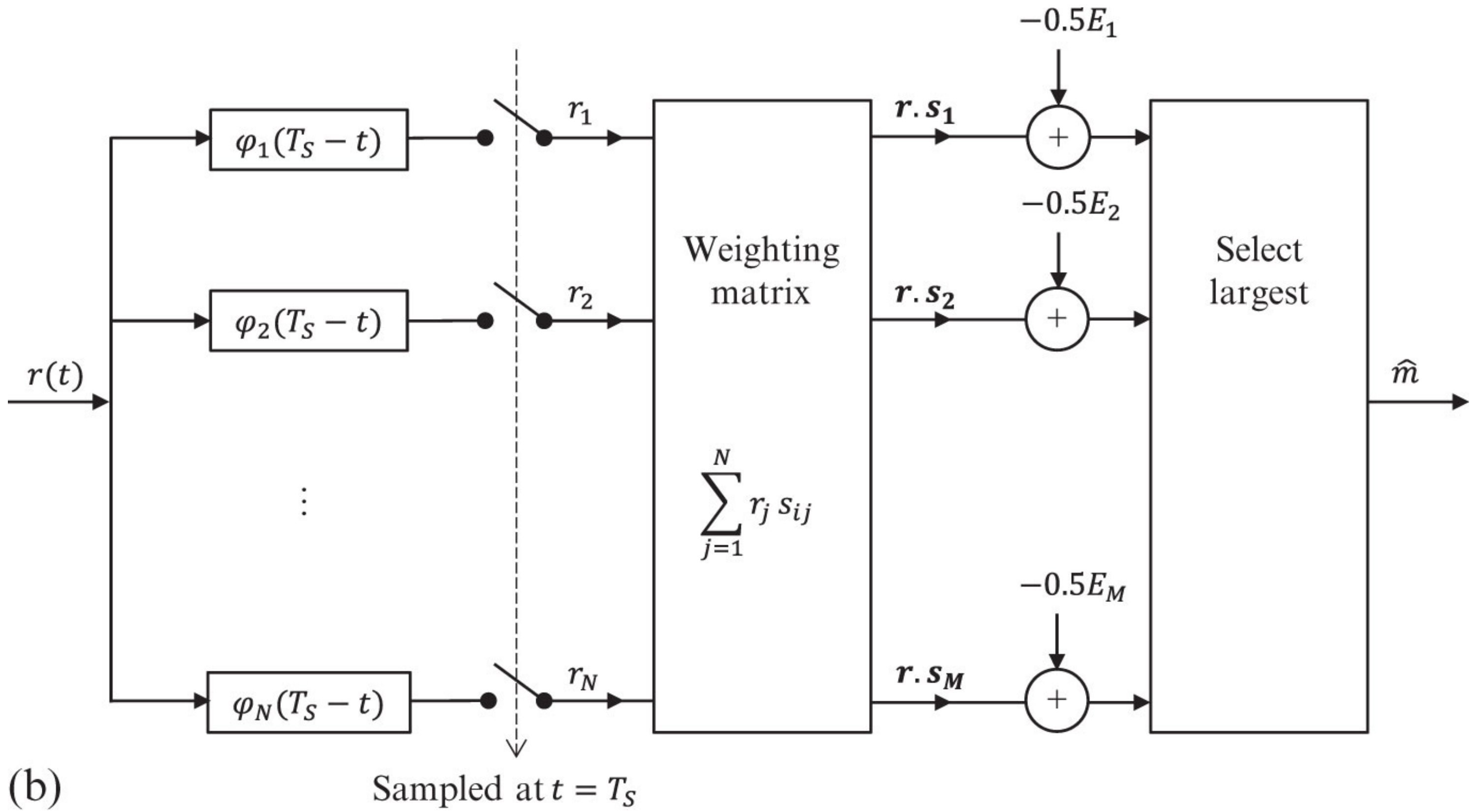


Figure 7.5b Optimum receivers: (a) correlation receiver and (b) matched-filter receiver.

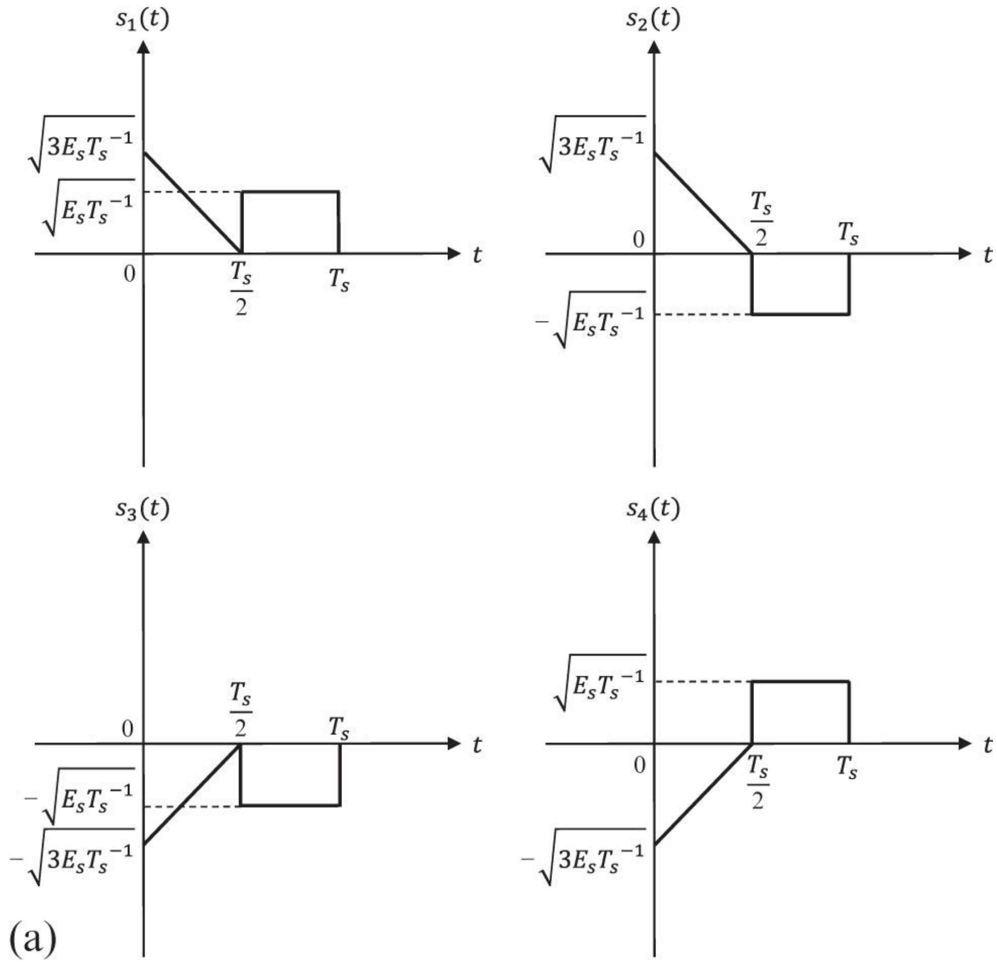


Figure 7.6a Example 7.3: (a) signal set, (b) orthonormal functions, (c) matched filters, and (d) optimum decision regions.

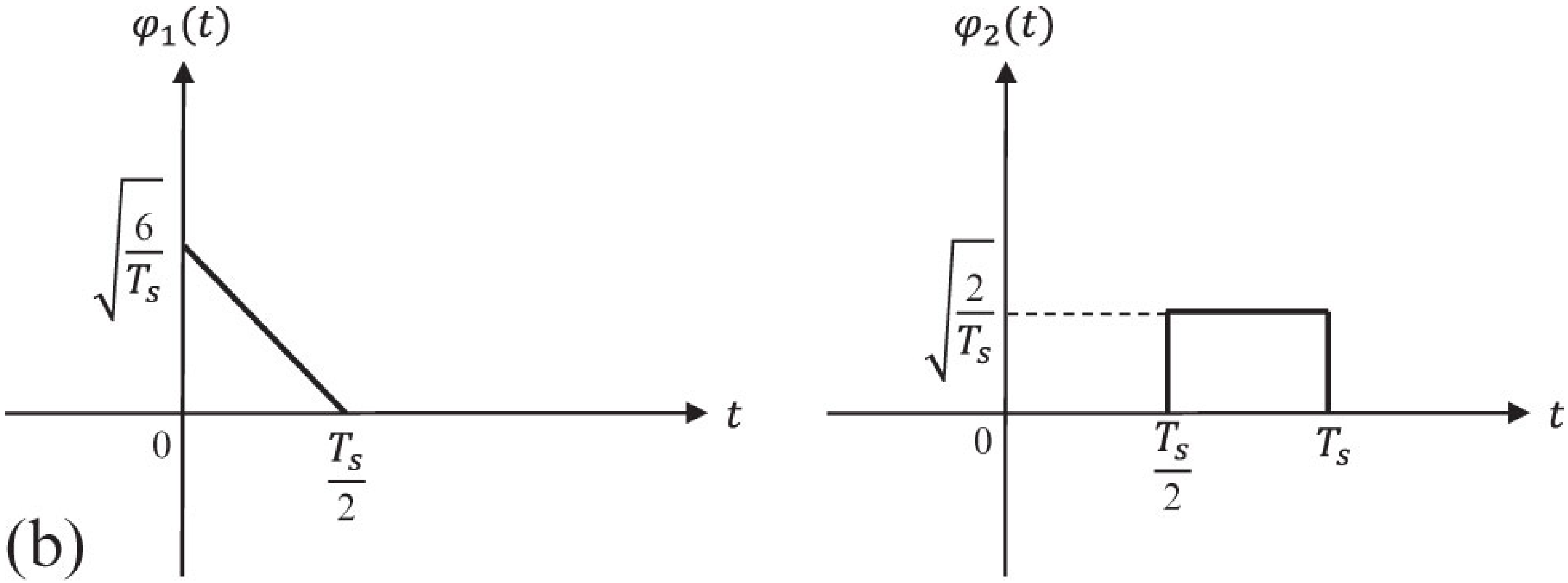


Figure 7.6b Example 7.3: (a) signal set, (b) orthonormal functions, (c) matched filters, and (d) optimum decision regions.

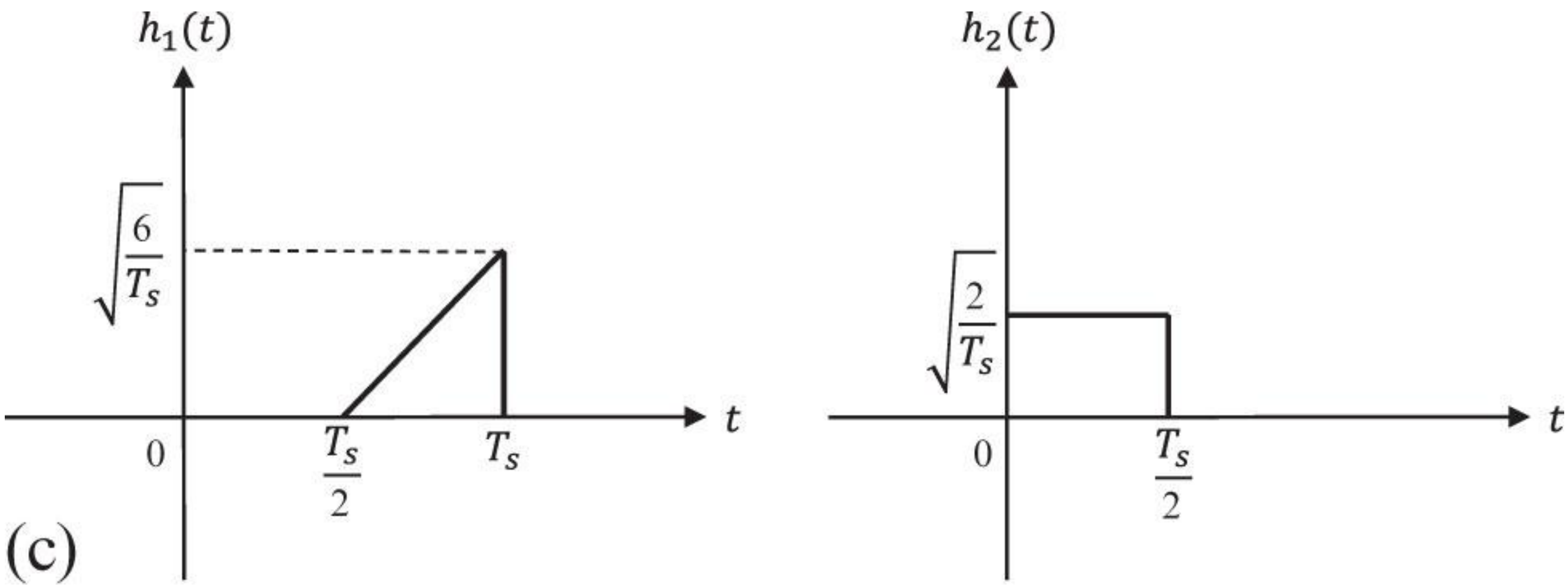


Figure 7.6c Example 7.3: (a) signal set, (b) orthonormal functions, (c) matched filters, and (d) optimum decision regions.

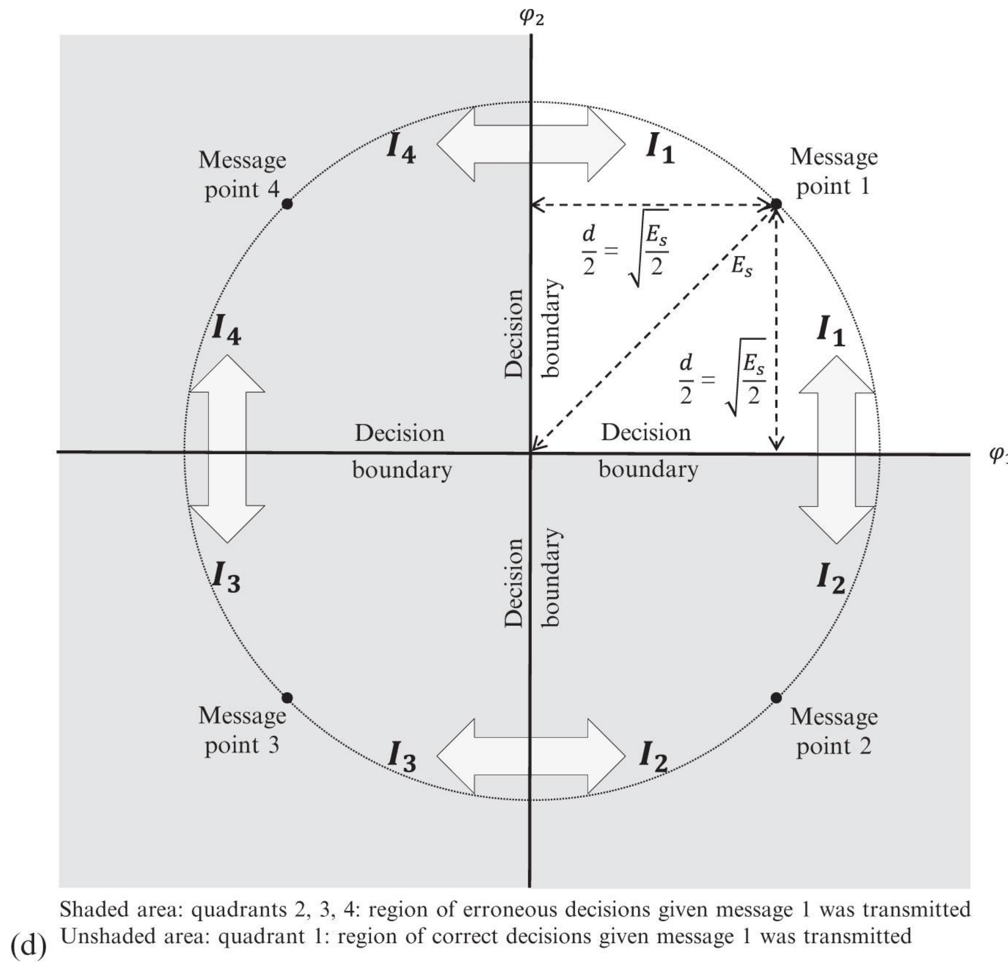


Figure 7.6d Example 7.3: (a) signal set, (b) orthonormal functions, (c) matched filters, and (d) optimum decision regions.

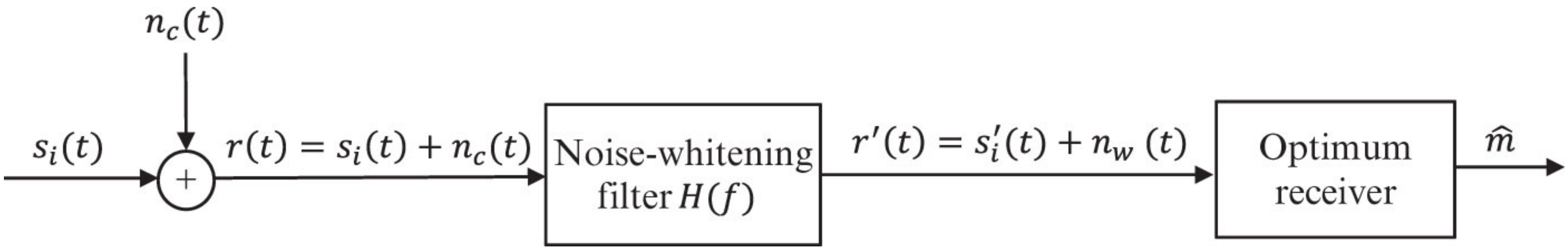


Figure 7.7 Optimum receiver for nonwhite noise.

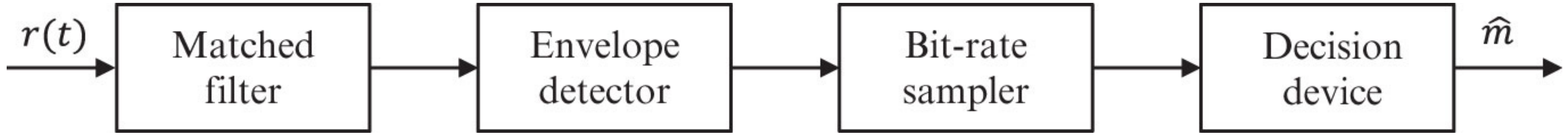


Figure 7.8 Noncoherent detection.

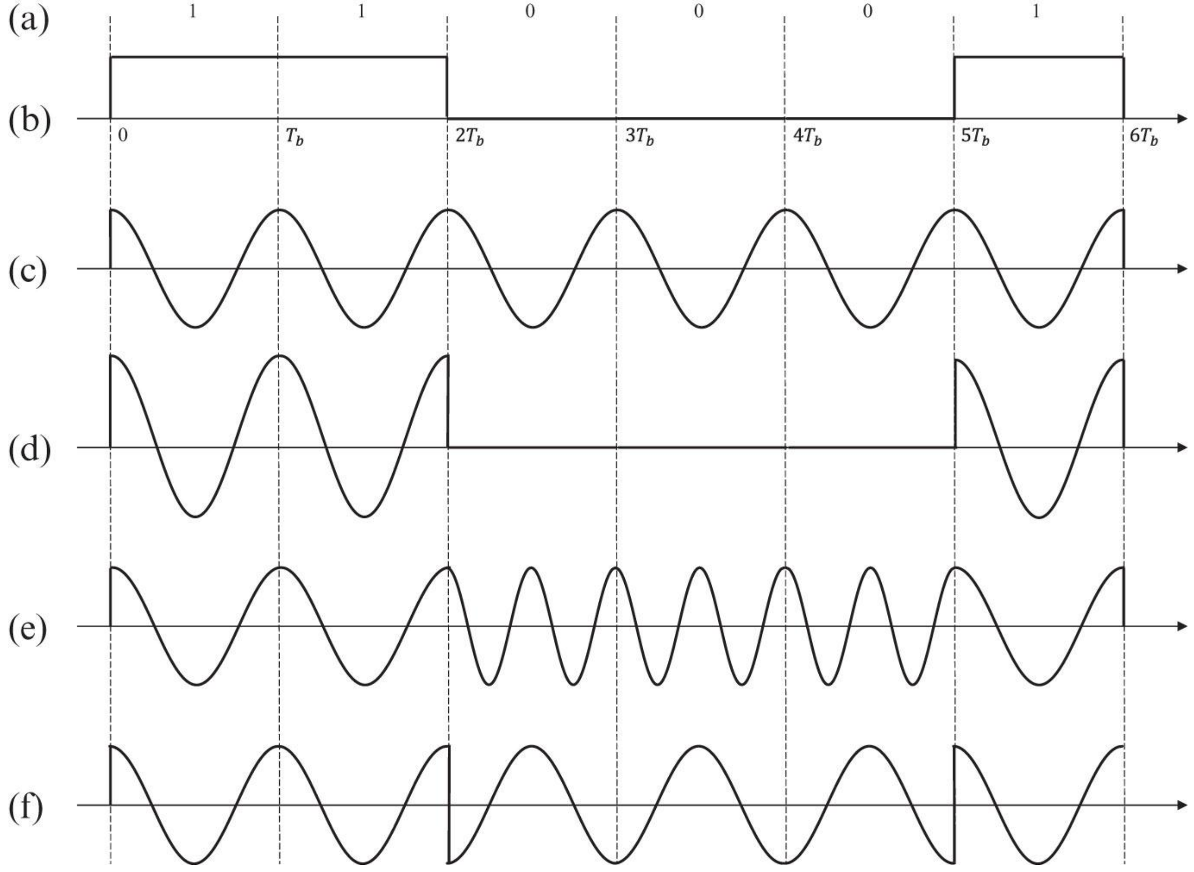


Figure 7.9 Binary digital modulation schemes: (a) binary data, (b) modulating signal, (c) carrier wave, (d) BASK signal, (e) BFSK signal, and (f) BPSK signal.

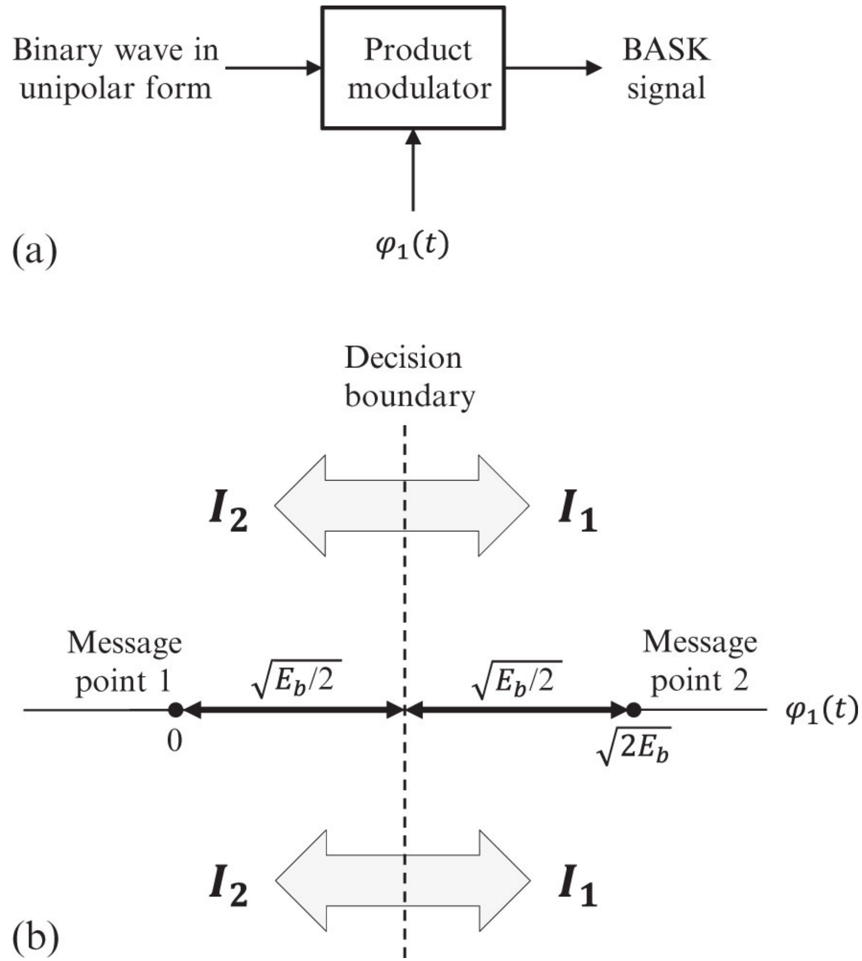


Figure 7.10ab BASK modulation: (a) transmitter, (b) signal space and optimum decision regions, (c) coherent detection, and (d) noncoherent detection.

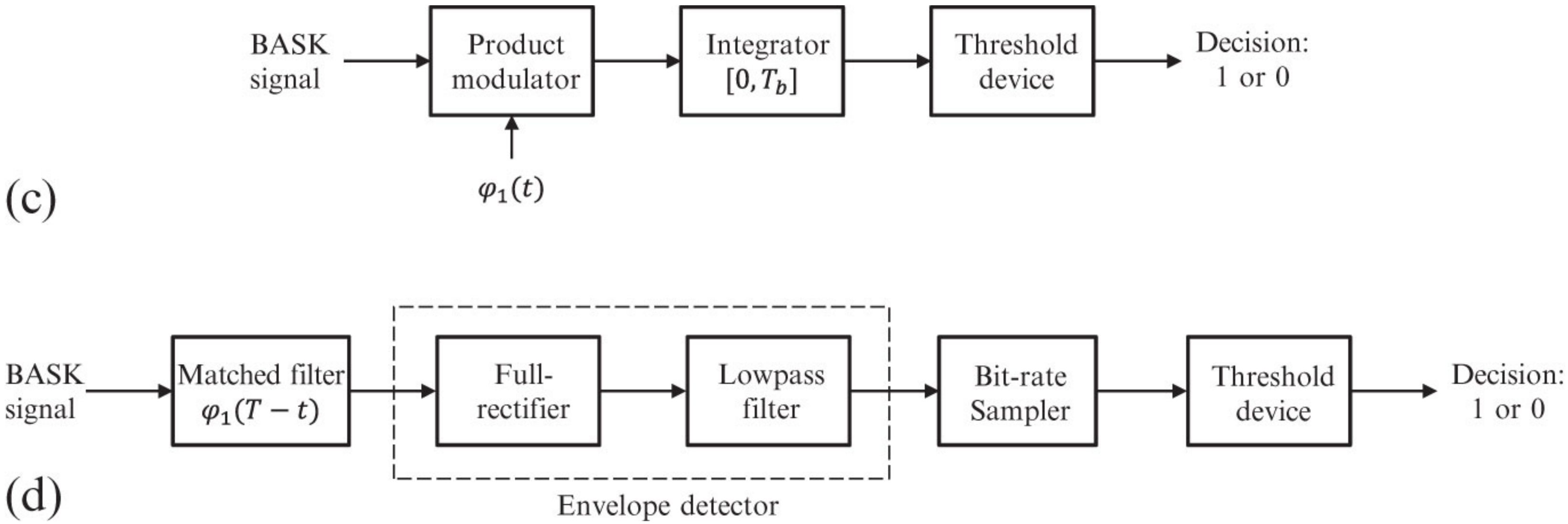


Figure 7.10cd BASK modulation: (a) transmitter, (b) signal space and optimum decision regions, (c) coherent detection, and (d) noncoherent detection.

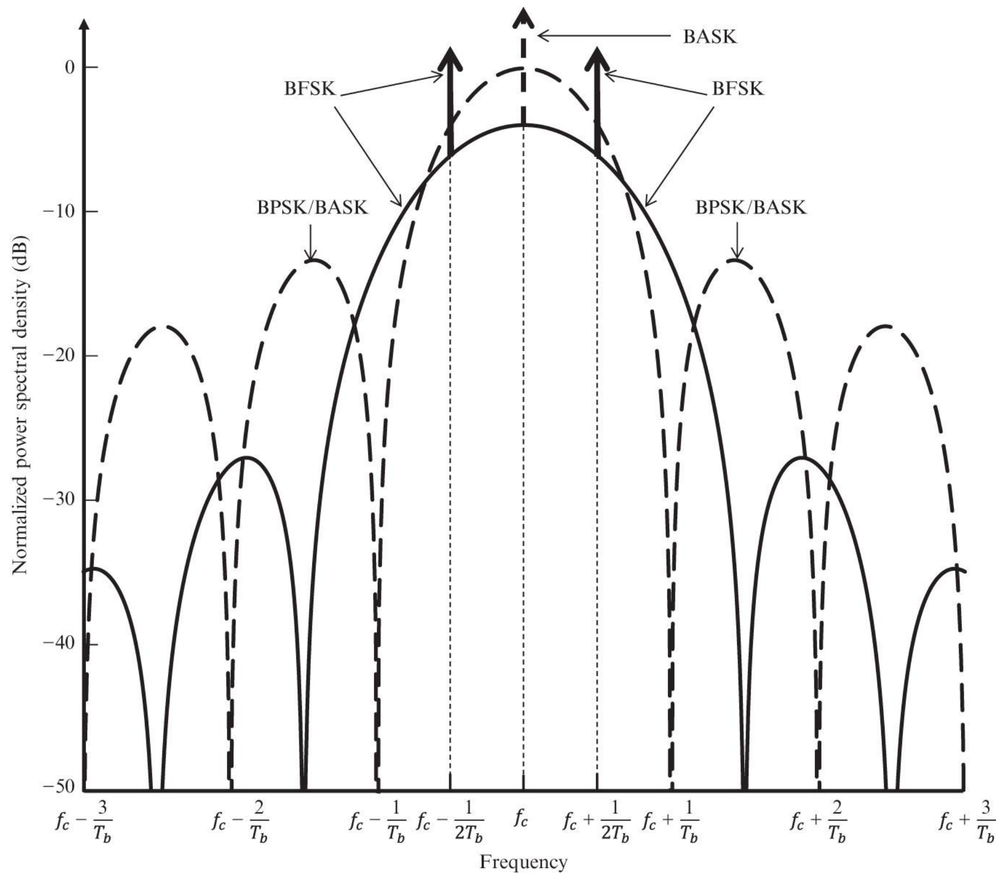


Figure 7.11 Power spectral density functions for BASK, BFSK, and BPSK modulation schemes.

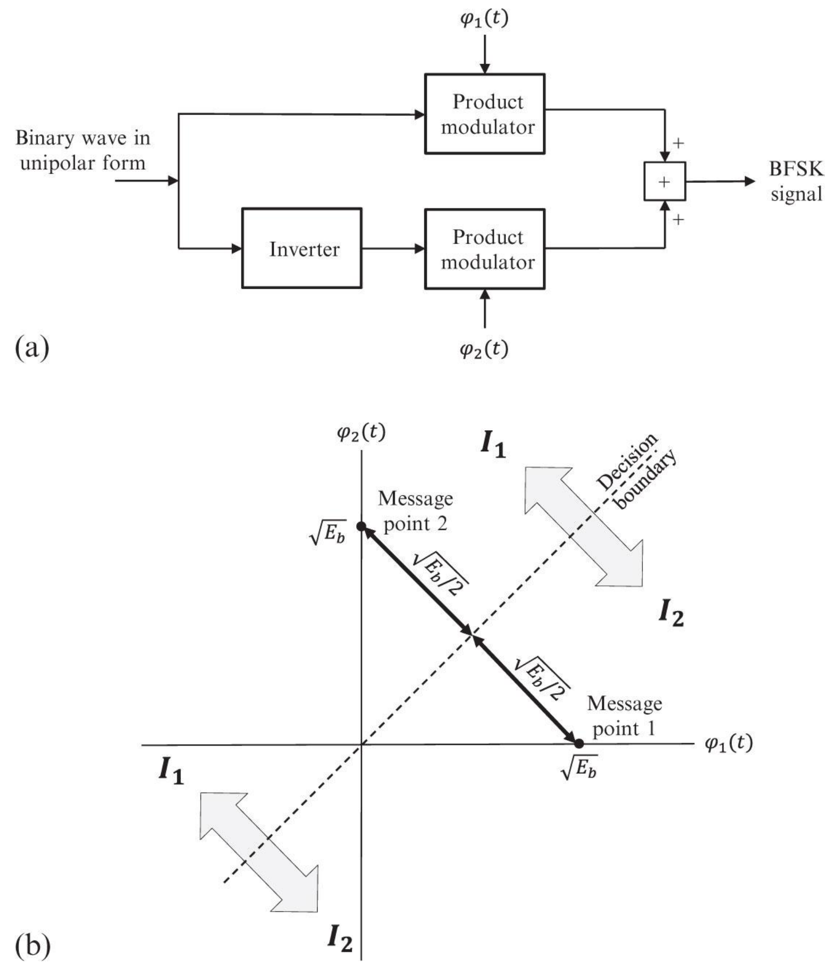


Figure 7.12ab BFSK modulation: (a) transmitter, (b) signal space and optimum decision regions, (c) coherent detection, and (d) noncoherent detection.

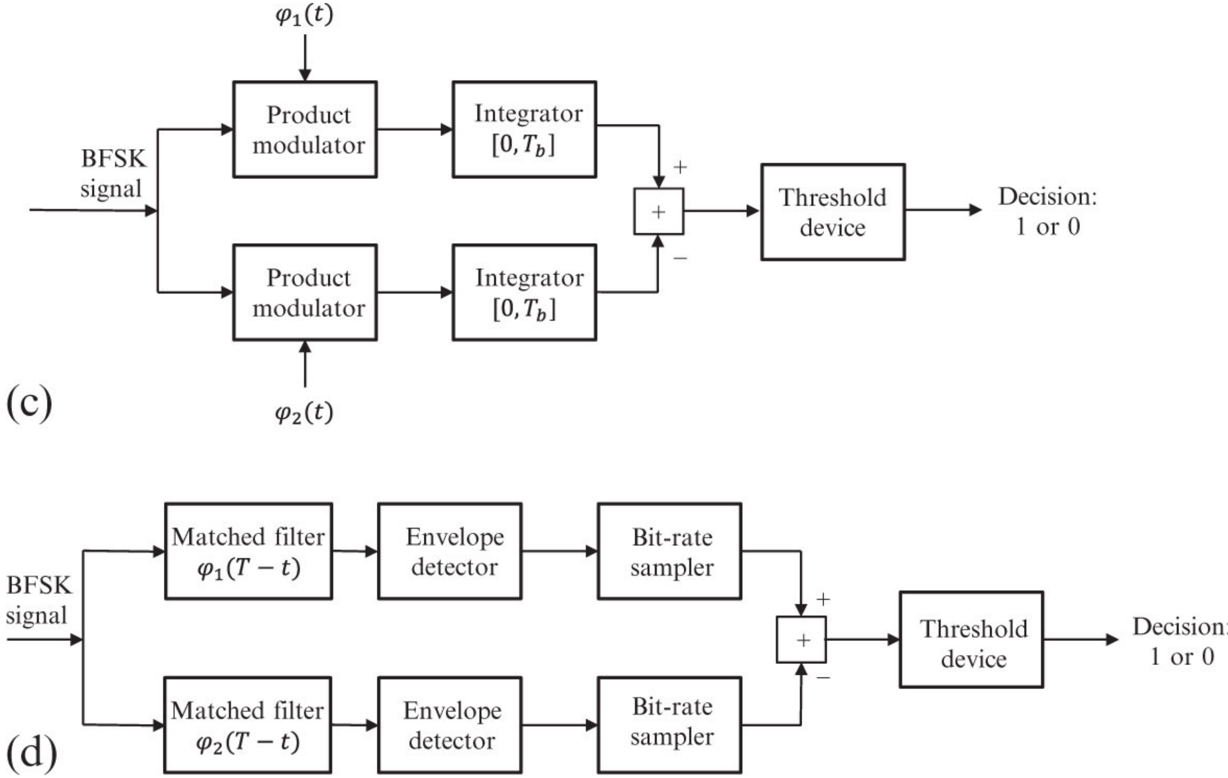


Figure 7.12cd BFSK modulation: (a) transmitter, (b) signal space and optimum decision regions, (c) coherent detection, and (d) noncoherent detection.

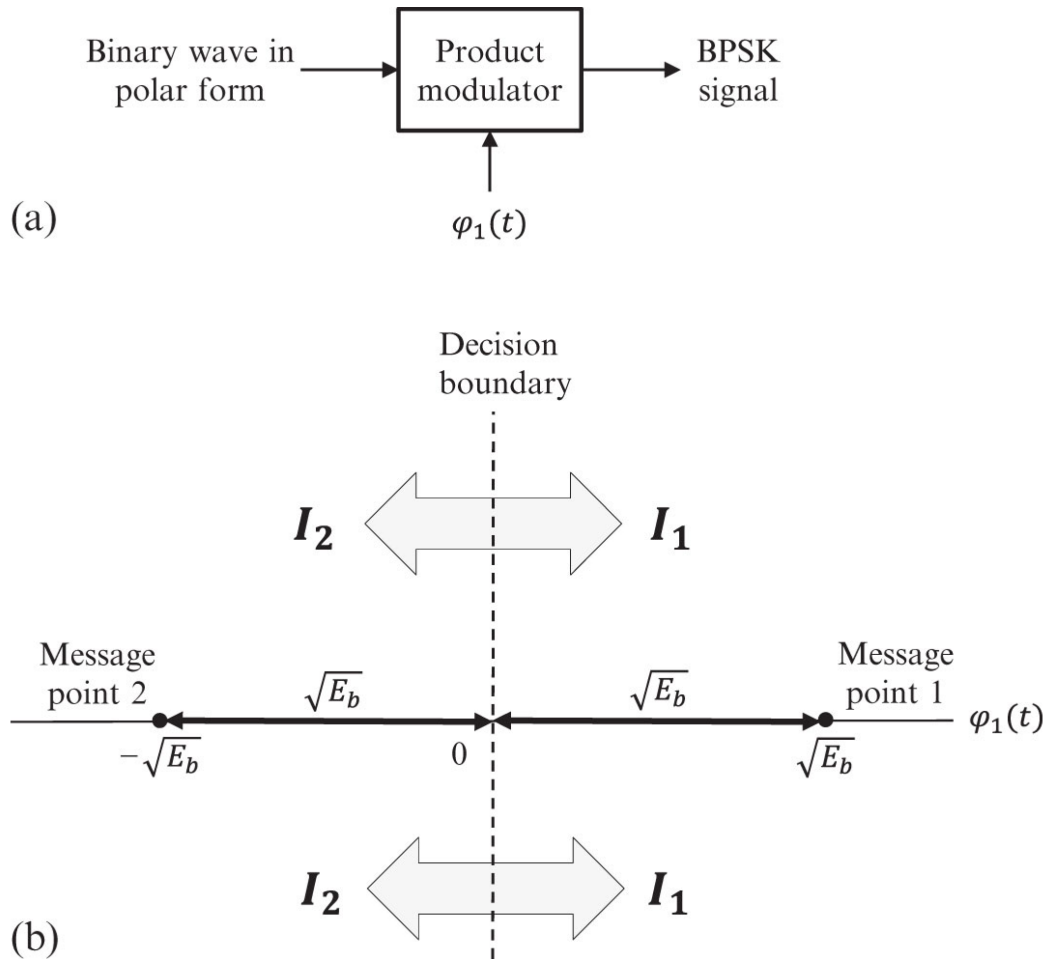


Figure 7.13ab BPSK modulation: (a) transmitter, (b) signal space and optimum decision regions, (c) coherent detection, and (d) differential detection.

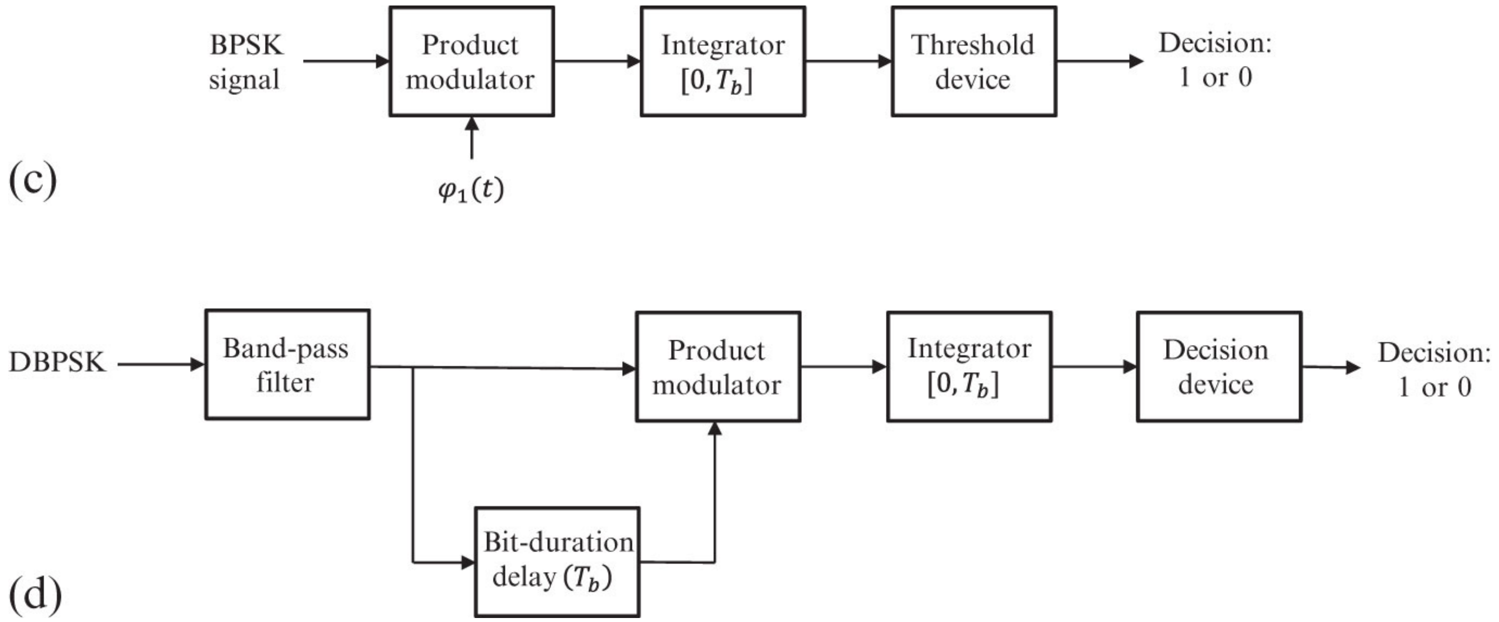


Figure 7.13cd BPSK modulation: (a) transmitter, (b) signal space and optimum decision regions, (c) coherent detection, and (d) differential detection.

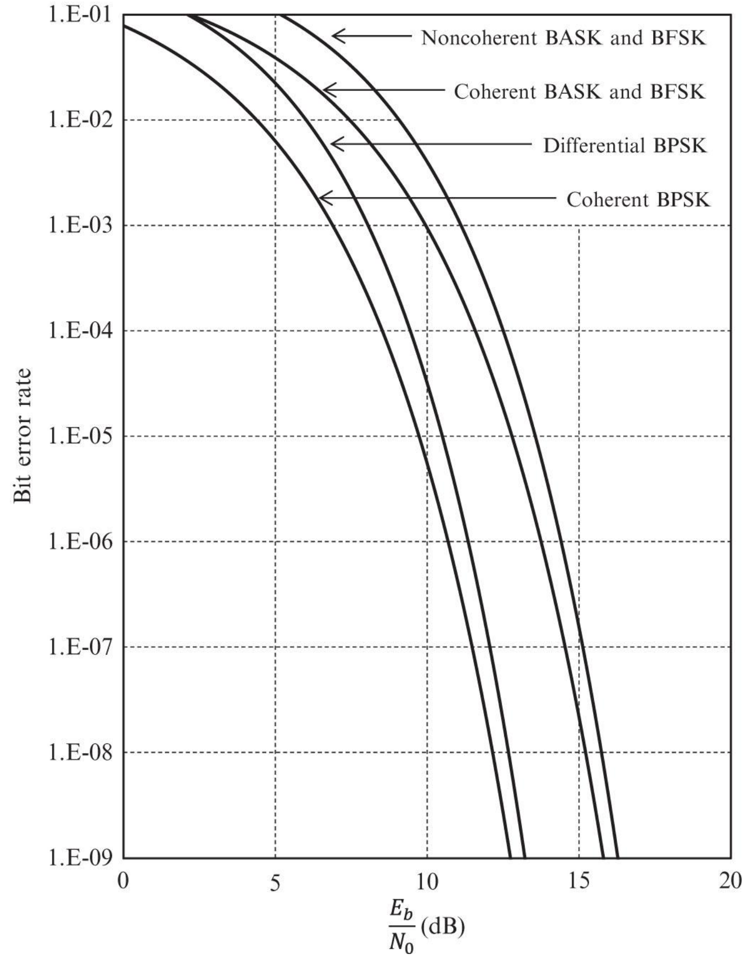


Figure 7.14 Bit error rate performances of binary digital modulation schemes.

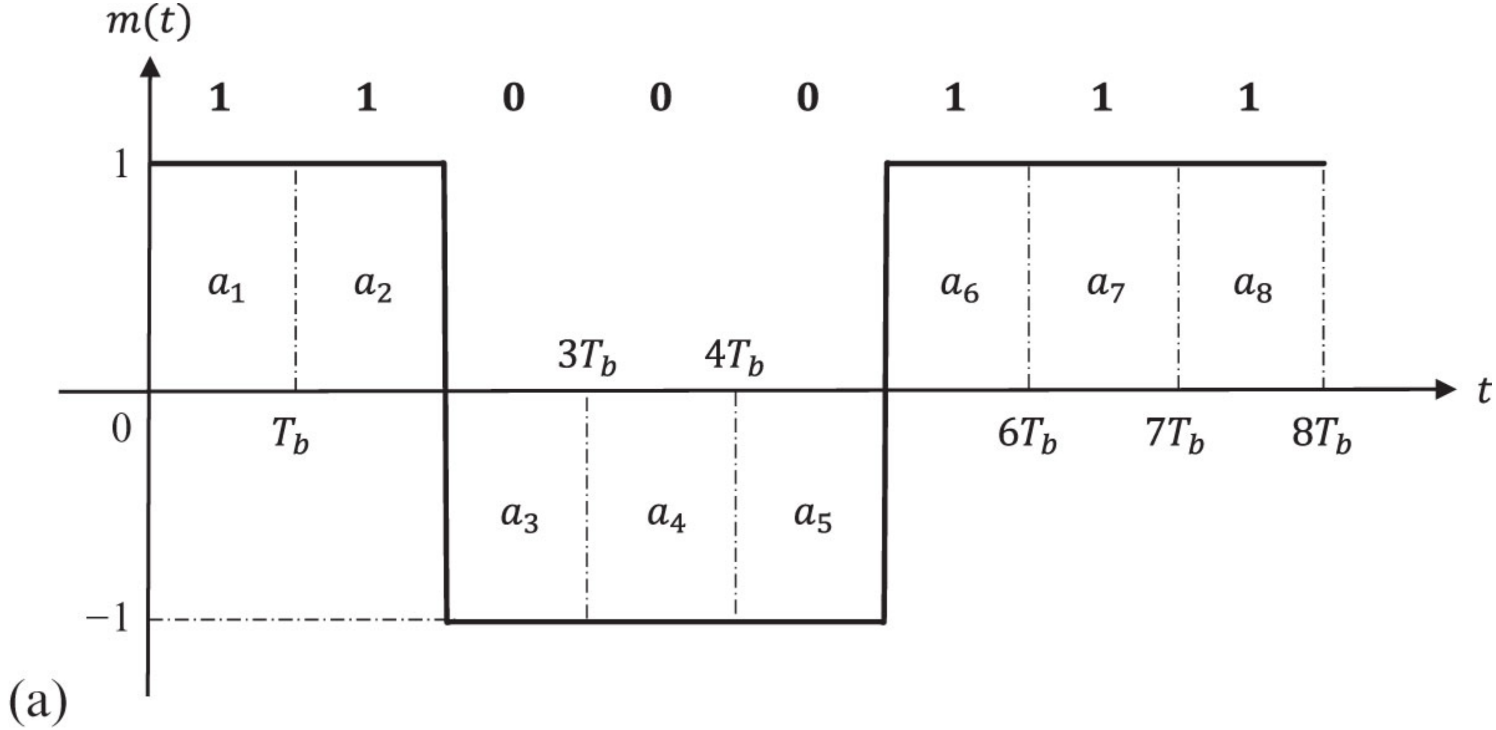


Figure 7.15a QPSK modulation: (a) input binary signal in polar form, (b) signal decomposition into two independent signals, (c) transmitted signal, (d) transmitter, (e) receiver, and (f) signal space and optimum decision regions.

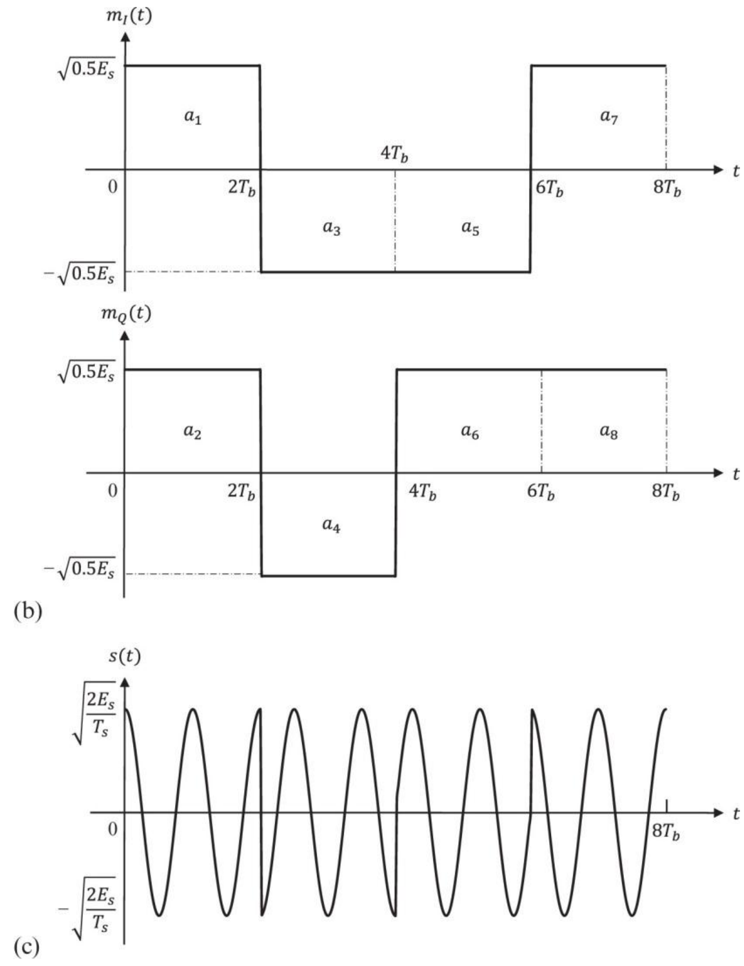
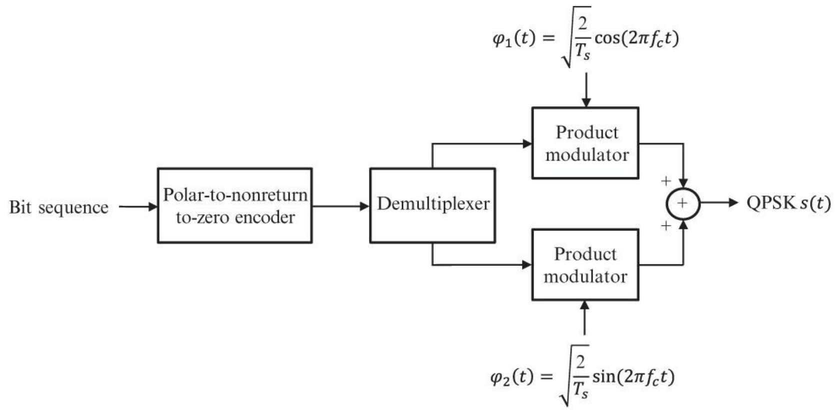
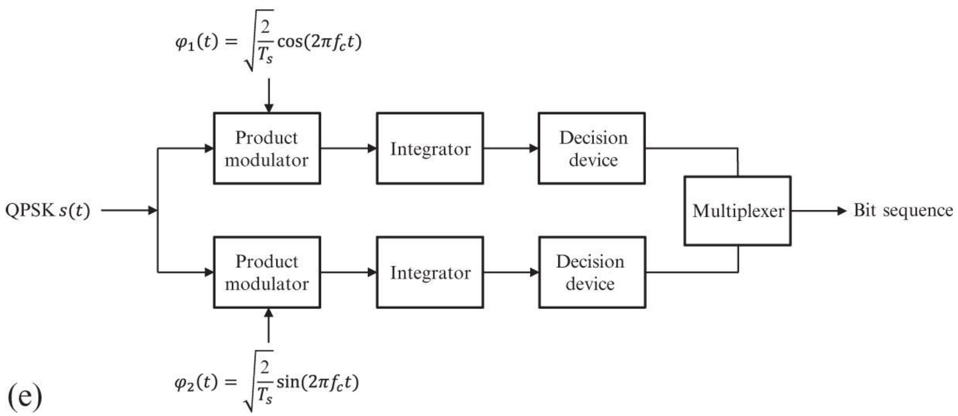


Figure 7.15bc QPSK modulation: (a) input binary signal in polar form, (b) signal decomposition into two independent signals, (c) transmitted signal, (d) transmitter, (e) receiver, and (f) signal space and optimum decision regions.



(d)



(e)

Figure 7.15de QPSK modulation: (a) input binary signal in polar form, (b) signal decomposition into two independent signals, (c) transmitted signal, (d) transmitter, (e) receiver, and (f) signal space and optimum decision regions.

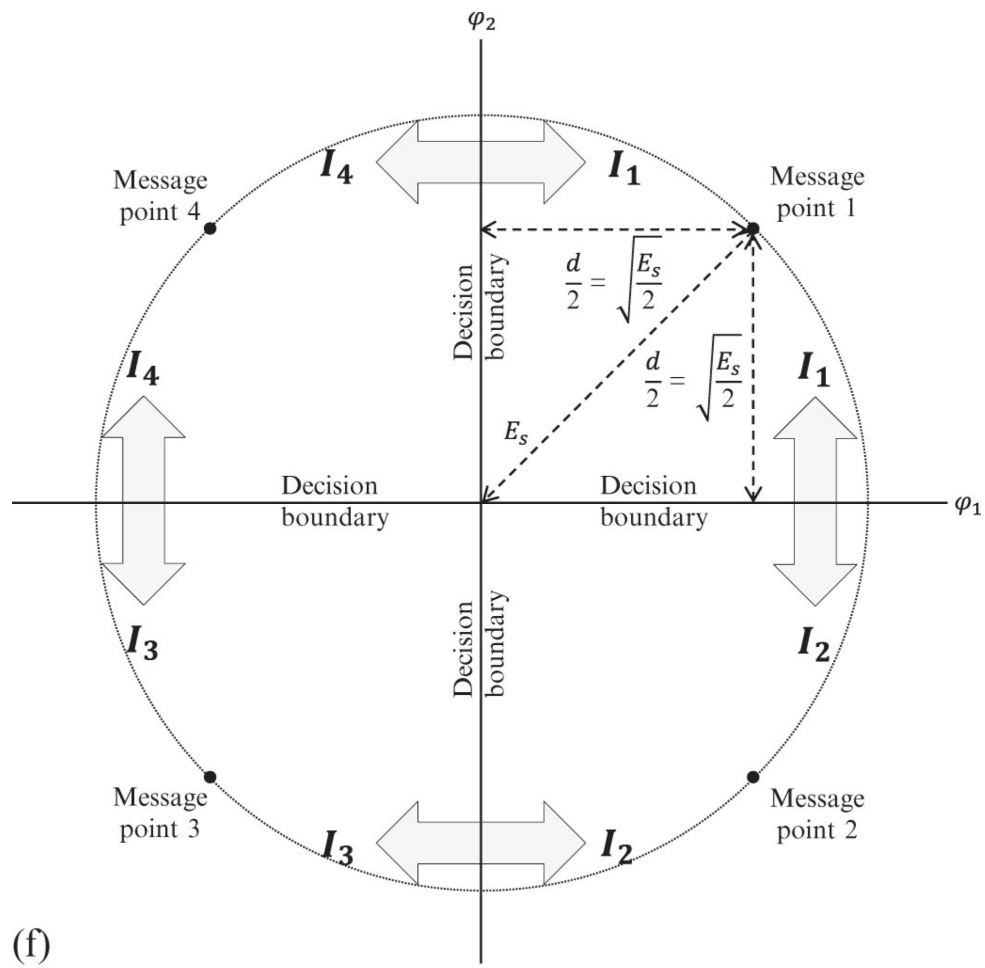


Figure 7.15f QPSK modulation: (a) input binary signal in polar form, (b) signal decomposition into two independent signals, (c) transmitted signal, (d) transmitter, (e) receiver, and (f) signal space and optimum decision regions.

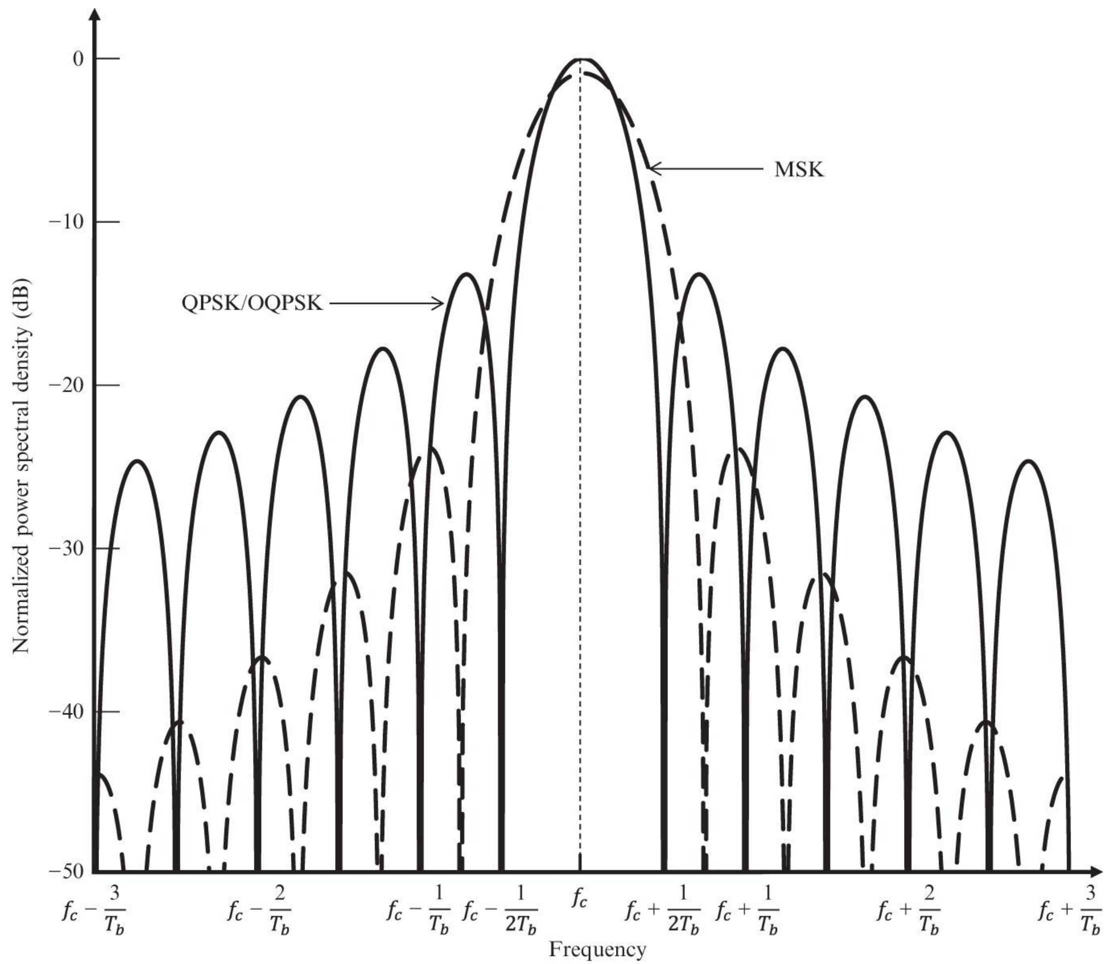


Figure 7.16 Power spectral density functions for QPSK, OQPSK, and MSK.

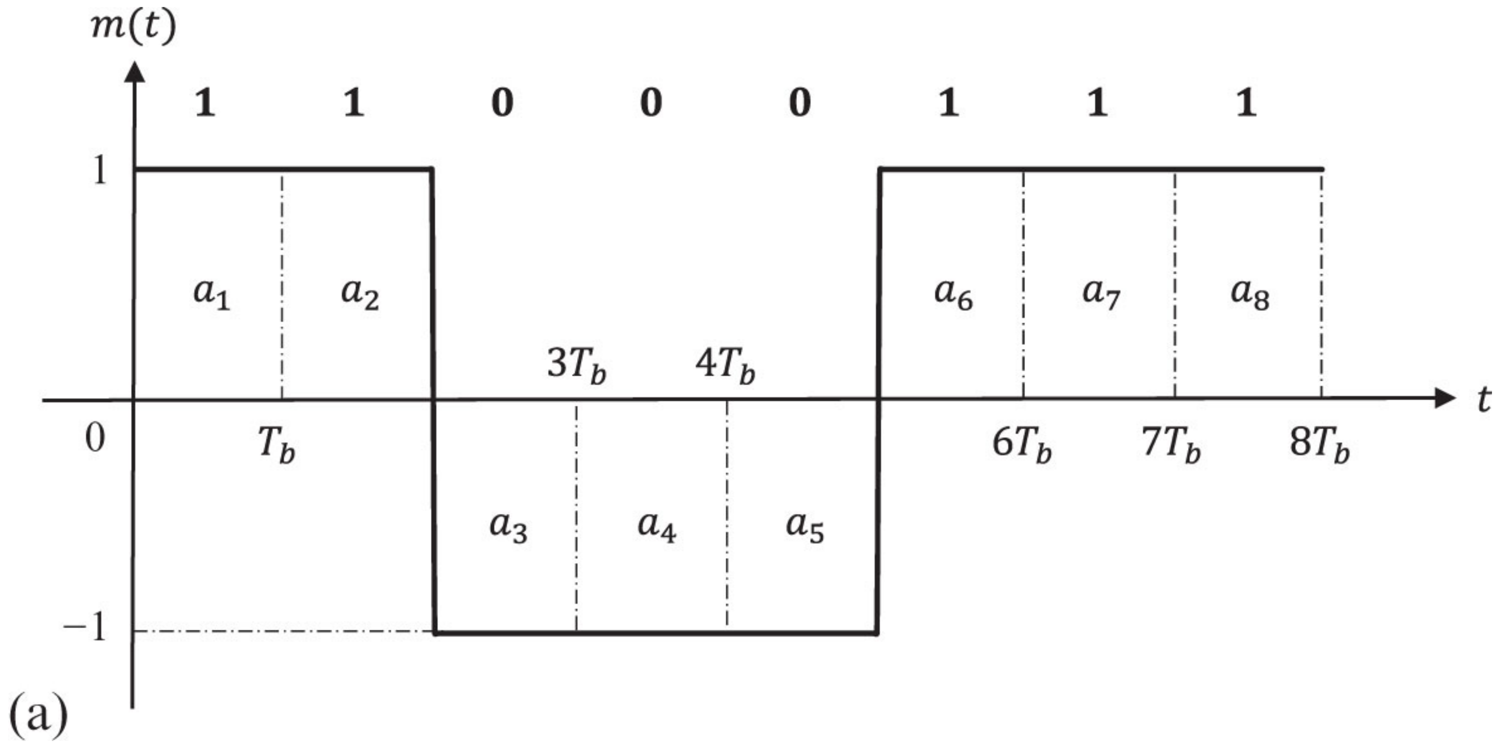


Figure 7.17a OQPSK modulation: (a) input binary signal in polar form, (b) signal decomposition into two independent signals, and (c) transmitted signal.

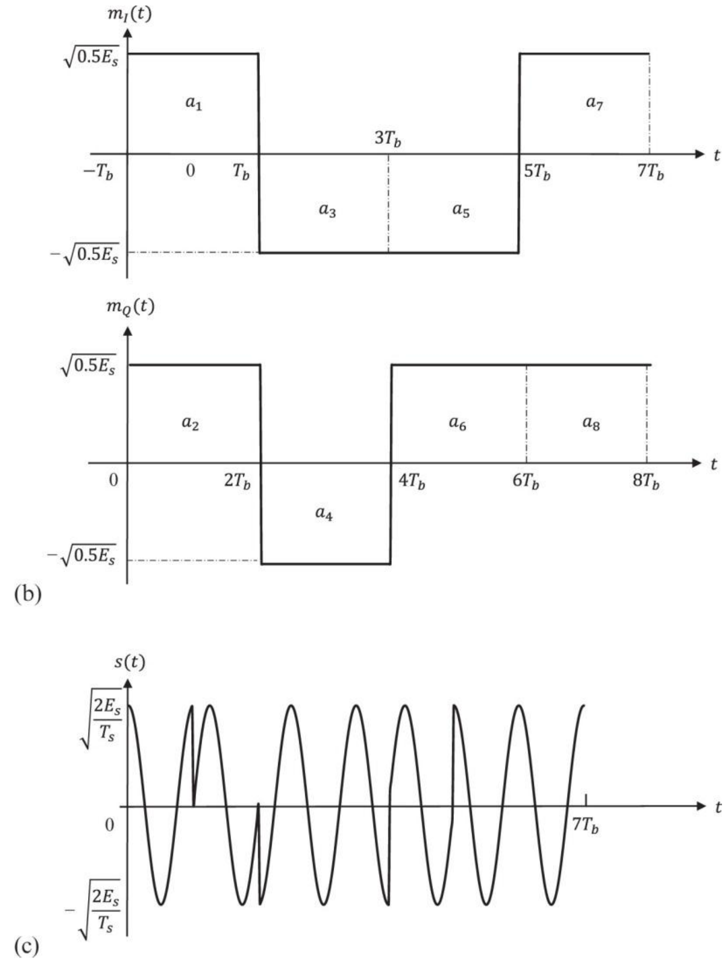


Figure 7.17bc OQPSK modulation: (a) input binary signal in polar form, (b) signal decomposition into two independent signals, and (c) transmitted signal.

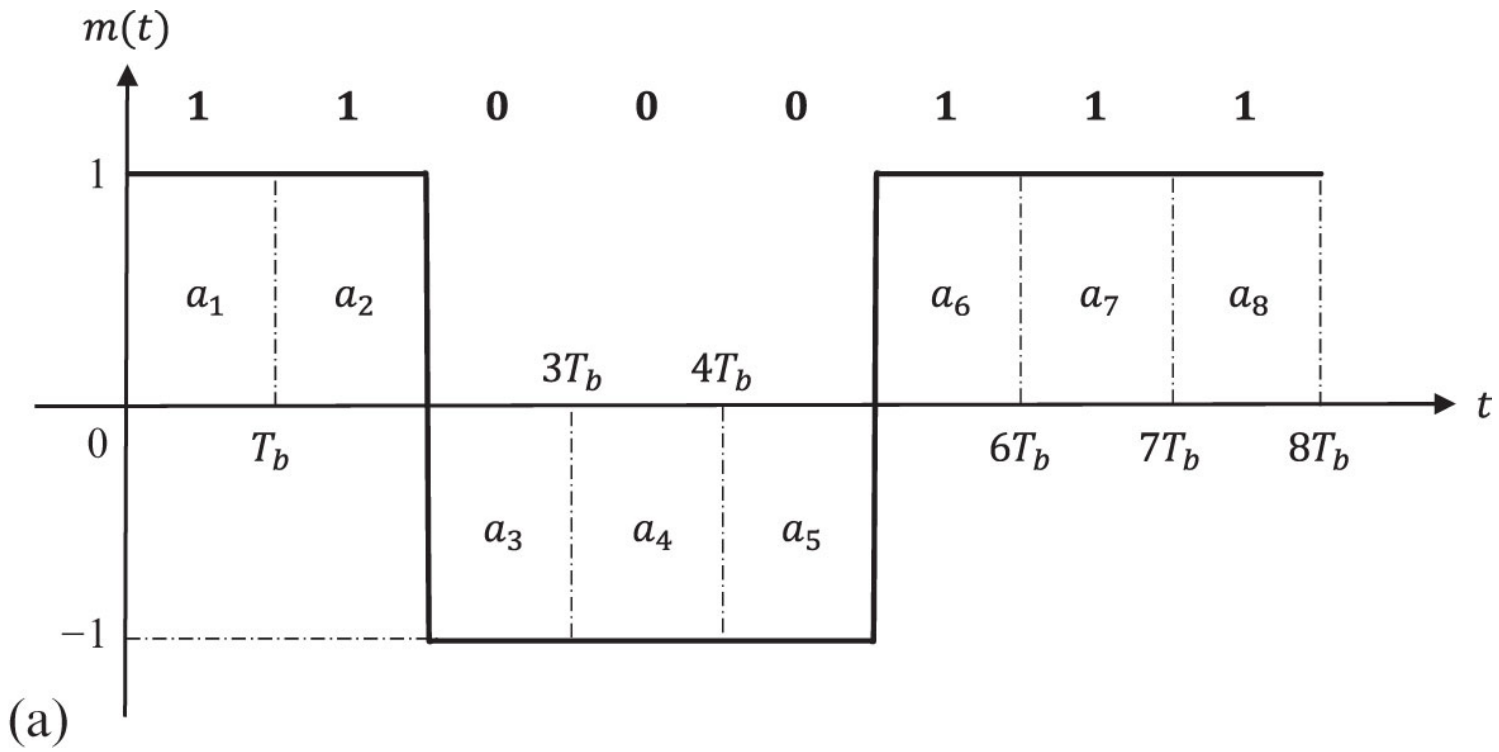


Figure 7.18a MSK modulation: (a) input binary signal in polar form, (b) signal decomposition into two independent signals, and (c) transmitted signal.

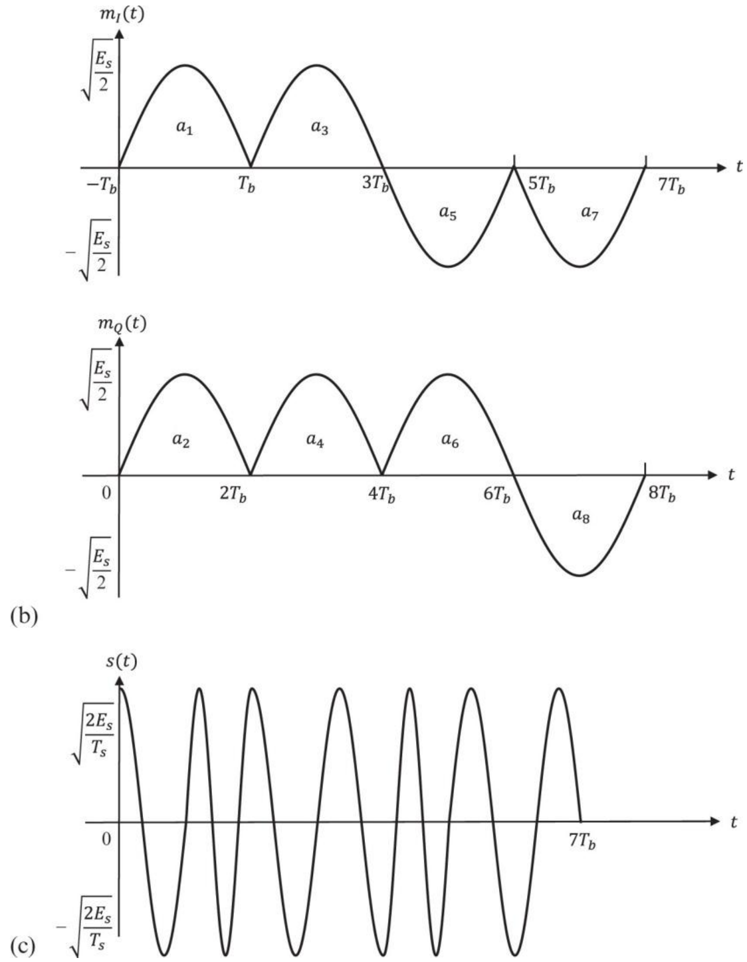
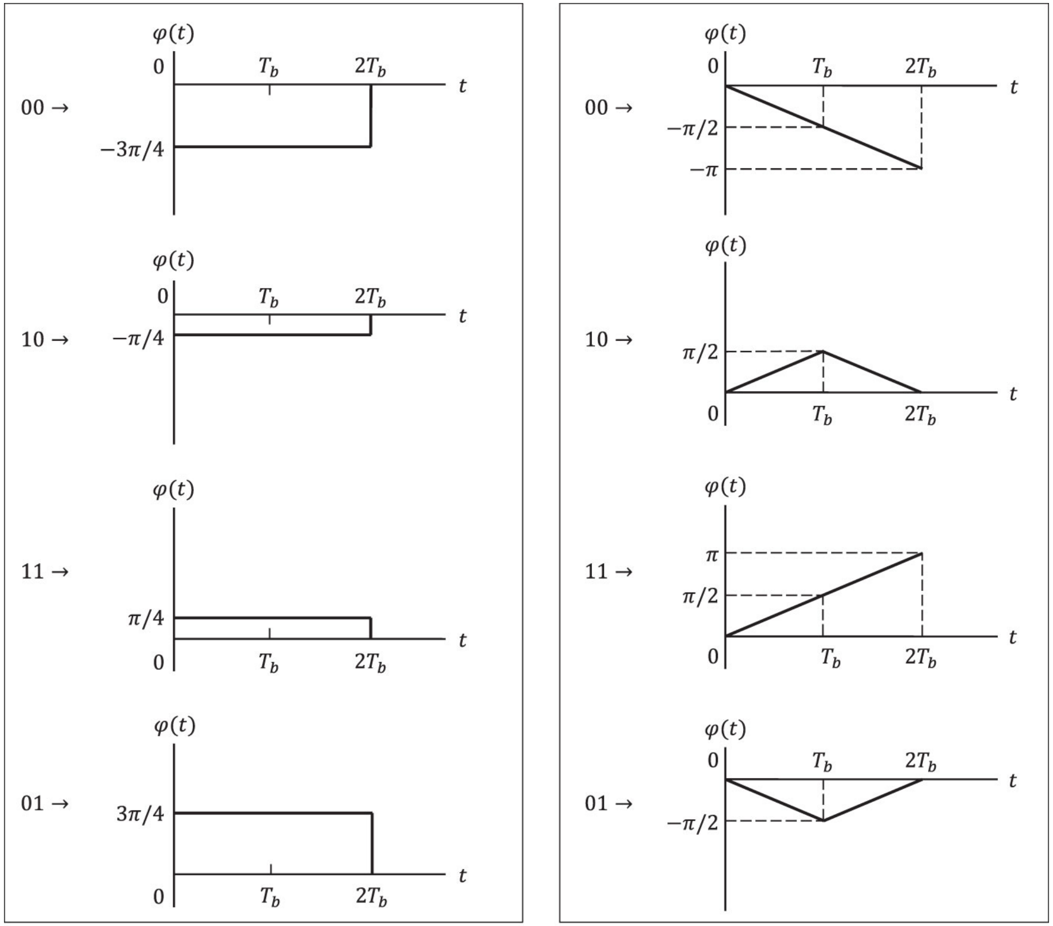


Figure 7.18bc MSK modulation: (a) input binary signal in polar form, (b) signal decomposition into two independent signals, and (c) transmitted signal.



Carrier phase for QPSK

Carrier phase for MSK

Figure 7.19 Carrier phases for QPSK and MSK schemes.

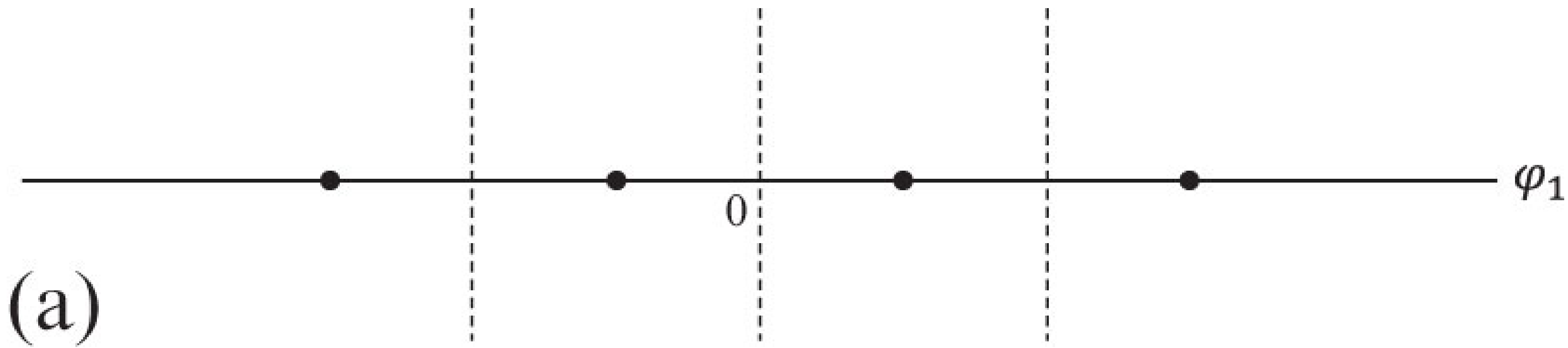
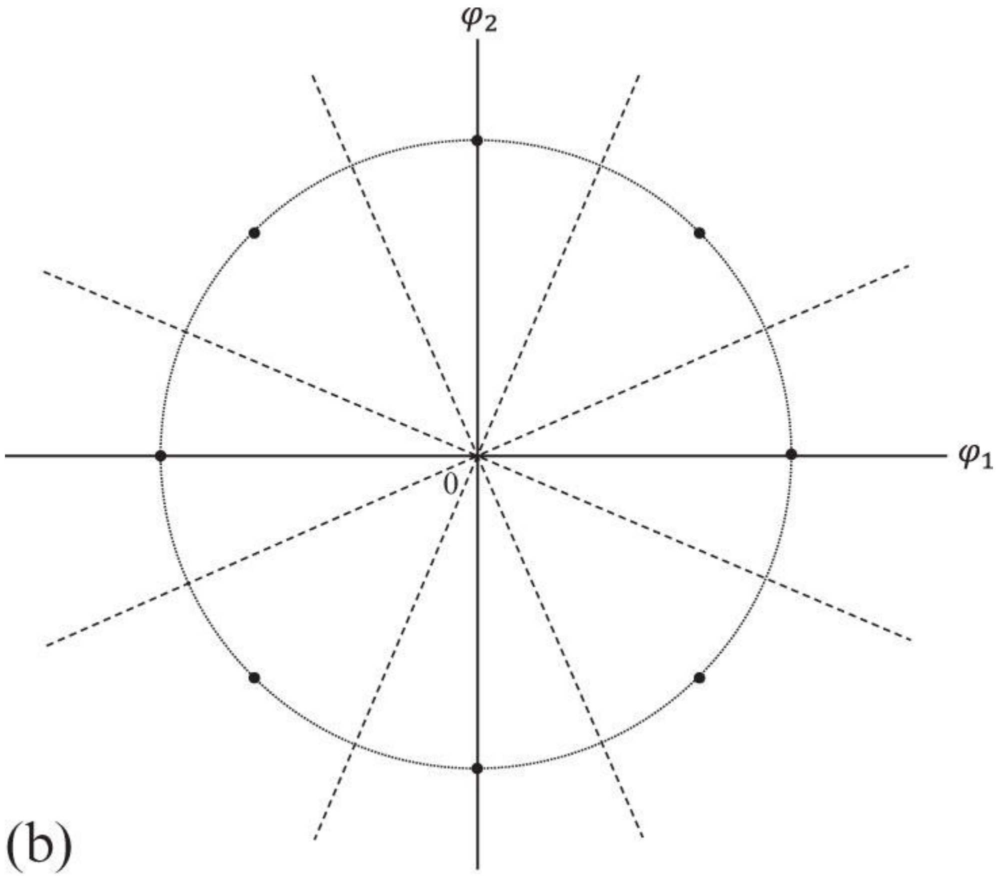


Figure 7.20a Signal space and optimum decision regions for *M*-ary modulation schemes: (a) MASK (*M*=4), (b) MPSK (*M*=8), (c) QAM (*M*=16), and (d) MFSK (*M*=3).



(b)

Figure 7.20b Signal space and optimum decision regions for *M*-ary modulation schemes: (a) MASK (*M*=4), (b) MPSK (*M*=8), (c) QAM (*M*=16), and (d) MFSK (*M*=3).

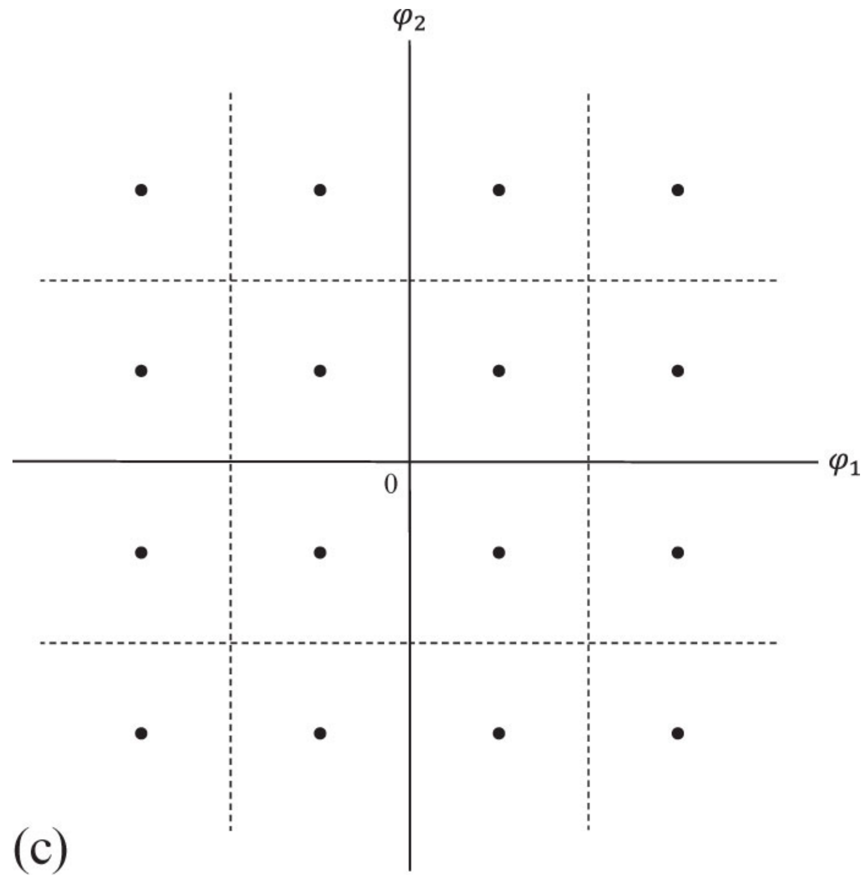
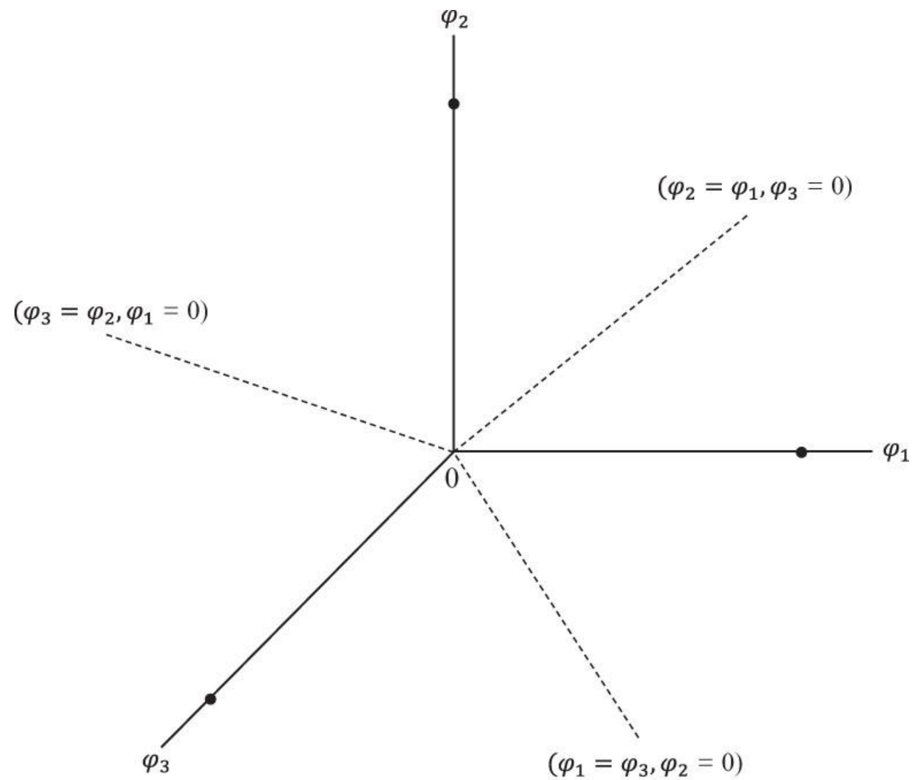


Figure 7.20c Signal space and optimum decision regions for *M*-ary modulation schemes: (a) MASK (*M*=4), (b) MPSK (*M*=8), (c) QAM (*M*=16), and (d) MFSK (*M*=3).



(d) Note: The dashed lines are the intersections of the decision boundaries with the planes $\varphi_1 = 0, \varphi_2 = 0$ and $\varphi_3 = 0$.

Figure 7.20d Signal space and optimum decision regions for *M*-ary modulation schemes: (a) MASK (*M*=4), (b) MPSK (*M*=8), (c) QAM (*M*=16), and (d) MFSK (*M*=3).

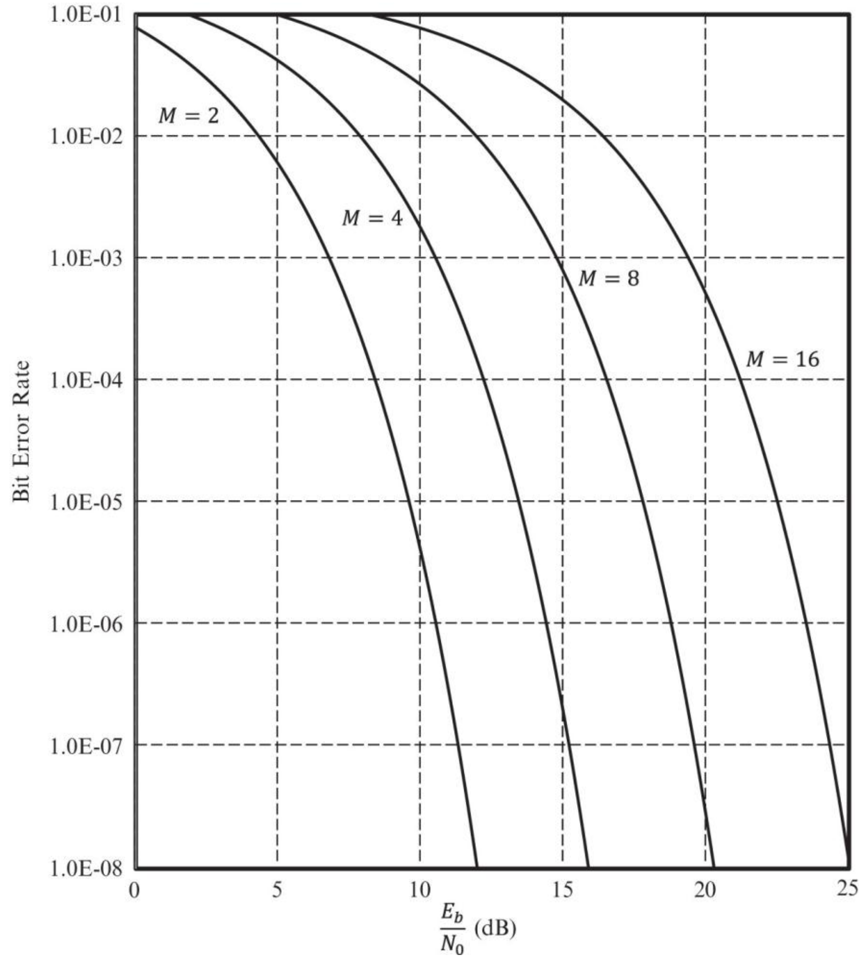


Figure 7.21 MASK bit error rate performance.

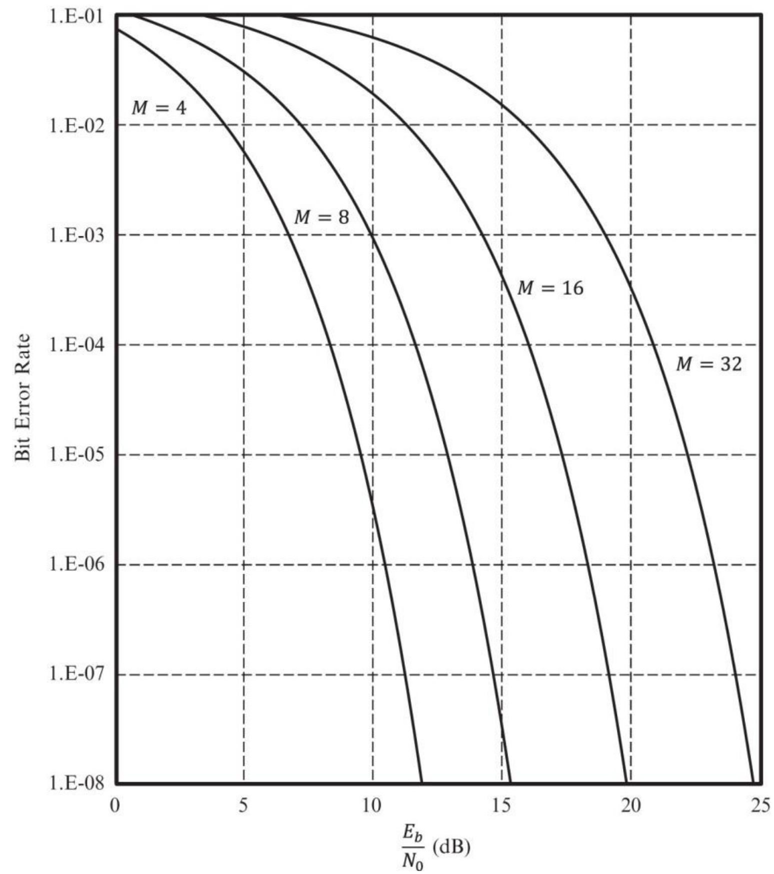


Figure 7.22 MPSK bit error rate performance.

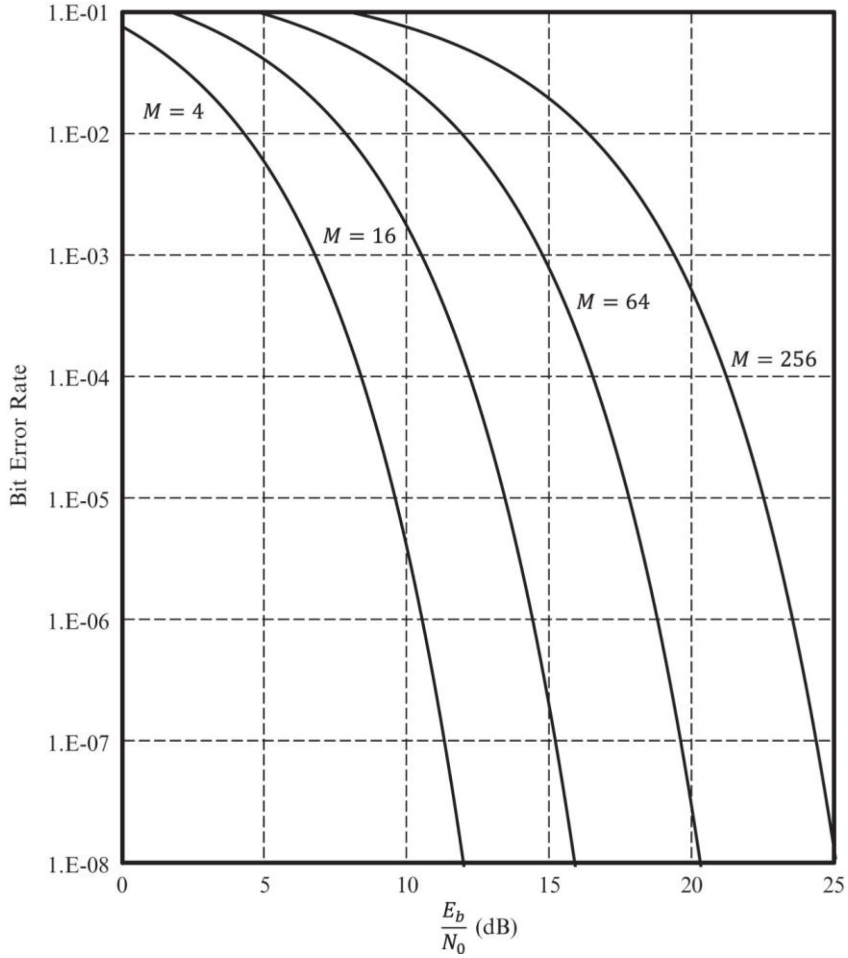


Figure 7.23 QAM bit error rate performance.

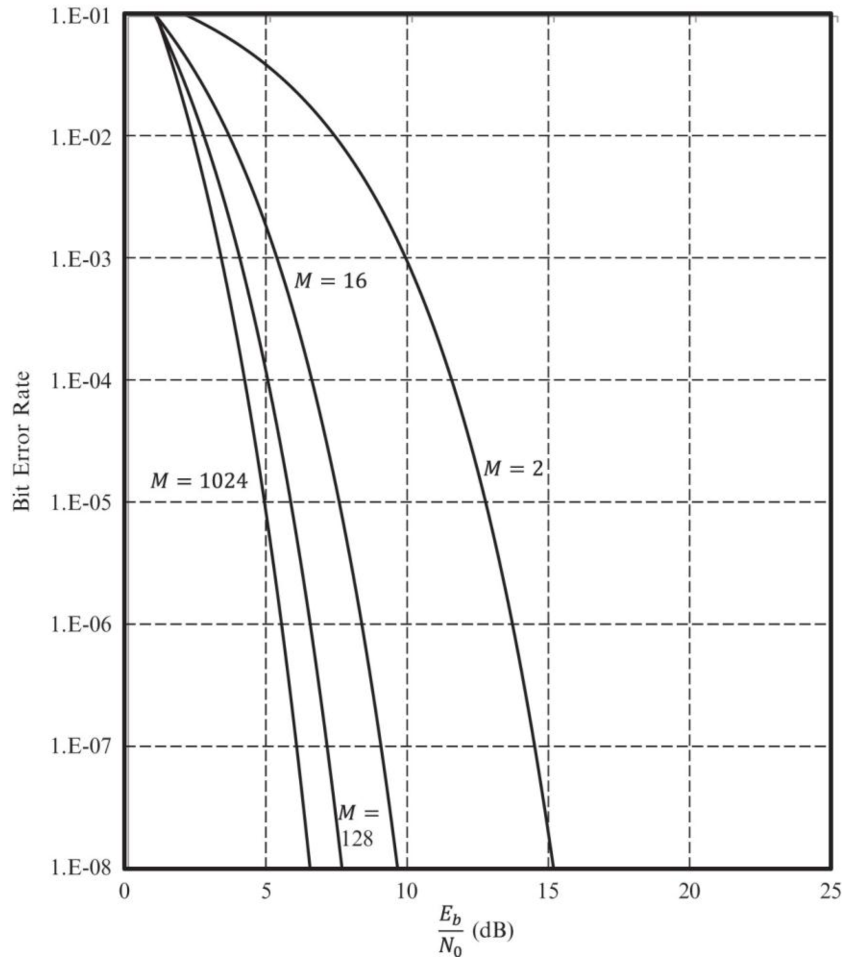


Figure 7.24 MFSK bit error rate performance.

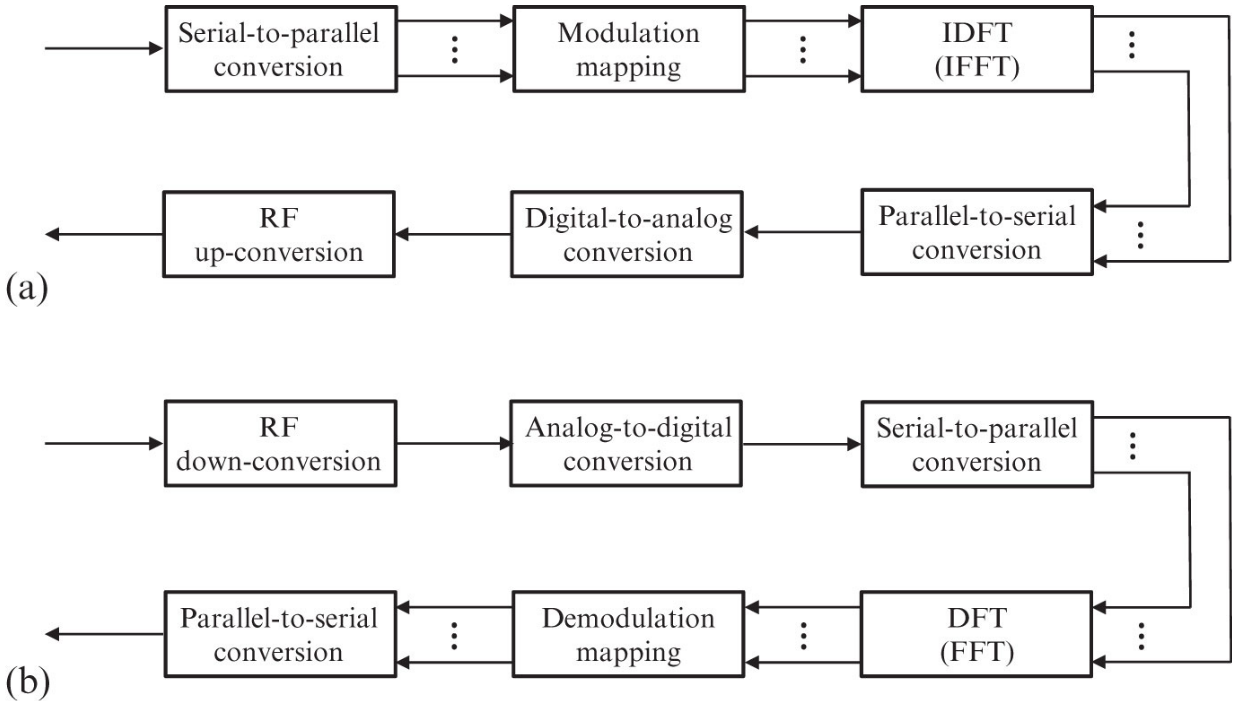


Figure 7.25 Block diagram of an orthogonal frequency-division multiplexing: (a) transmitter and (b) receiver.