EE511 lecture 23: Binary Modulated Bandpass Signaling
The most common binary bandpass signaling techniques, illustrated in Fig. 5–19, are as follows:
OOK may be detected by using either an envelope detector (noncoherent detection) or a product detector (coherent detection), because it is a form of AM signaling. (In radio-frequency receiver applications in which the input RF signal is small, a superheterodyne receiver circuit of Fig. 4–29 is used, and one of the detector circuits is placed after the IF output stage.) These detectors are shown in Figs. 5–21a and 5–21b. For product detection, the carrier reference, cos(ω_c t), must be provided. This is usually obtained from a PLL circuit (studied in Sec. 4–14), where the PLL is locked onto a discrete carrier term (see Fig. 5–20a) of the OOK signal.

For optimum detection of OOK—that is, to obtain the lowest BER when the input OOK signal is corrupted by additive white Gaussian noise (AWGN)—product detection with matched filter processing is required. This is shown in Fig. 5–21c, where waveforms at various points of the circuit are illustrated for the case of receiving an OOK signal that corresponds to the binary data stream 1101. Details about the operation, the performance, and the realization of the matched filter are given in Sec. 6–8. Note that the matched filter also requires a clocking signal that is used to reset the integrator at the beginning of each bit interval. It is a simple held circuit at the end of each bit interval. This clock
Matched filter

Analog Matched filter

Correlation based
Discrete-time Matched filter

given a ref. \( s_r(t) \)

let \( h_{MF}(t) = s_r^*(-t) \)

\[
y(t) = s(t) * h_{MF}(t) = s(t) * s_r^*(-t)
\]

\[
y(f) = s(t) \iff s_r(f)^*
\]

in discrete-time (pseudo MATLAB) \( y = \text{ifft} \left( \text{fft}(s) \cdot \text{conj}(\text{fft}(s_r)) \right) \)
(a) Noncoherent Detection

(b) Coherent Detection with Low-Pass Filter Processing

(c) Coherent Detection with Matched Filter Processing

Figure 5–21 Detection of OOK.

The optimum coherent OOK detector of Fig. 5–21c is more costly to implement than the noncoherent OOK detector of Fig. 5–21a. If the input noise is small, the noncoherent receiver may be the best solution, considering both cost and noise performance. The trade-off in BER performance between optimum coherent detection and nonoptimum noncoherent detection is studied in Sec. 7–6.