EE 354
Modern Communication Systems

FSK

Spring 2014

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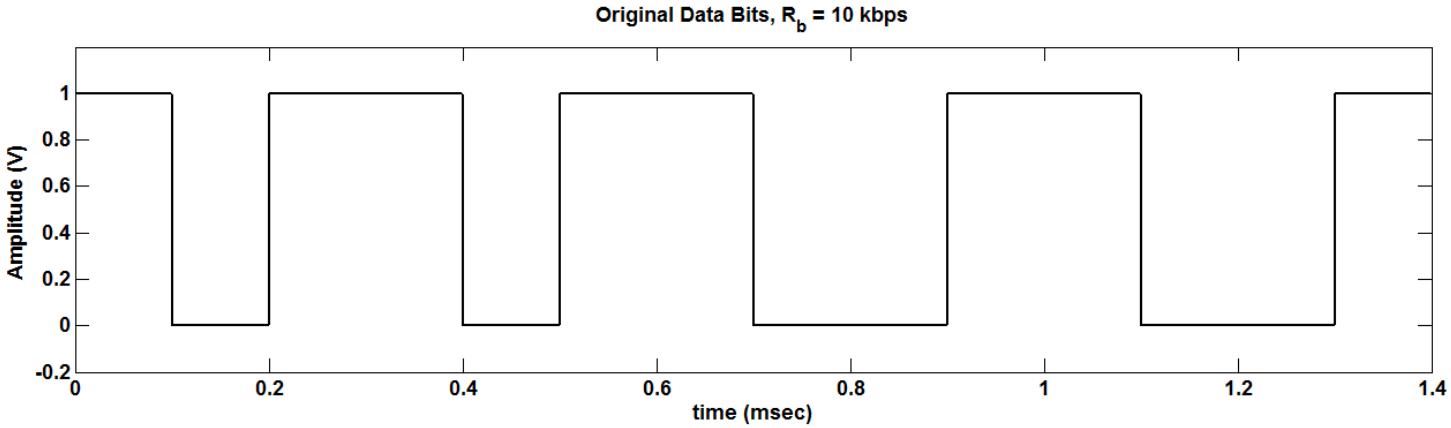
UNITED STATES NAVAL ACADEMY 1845

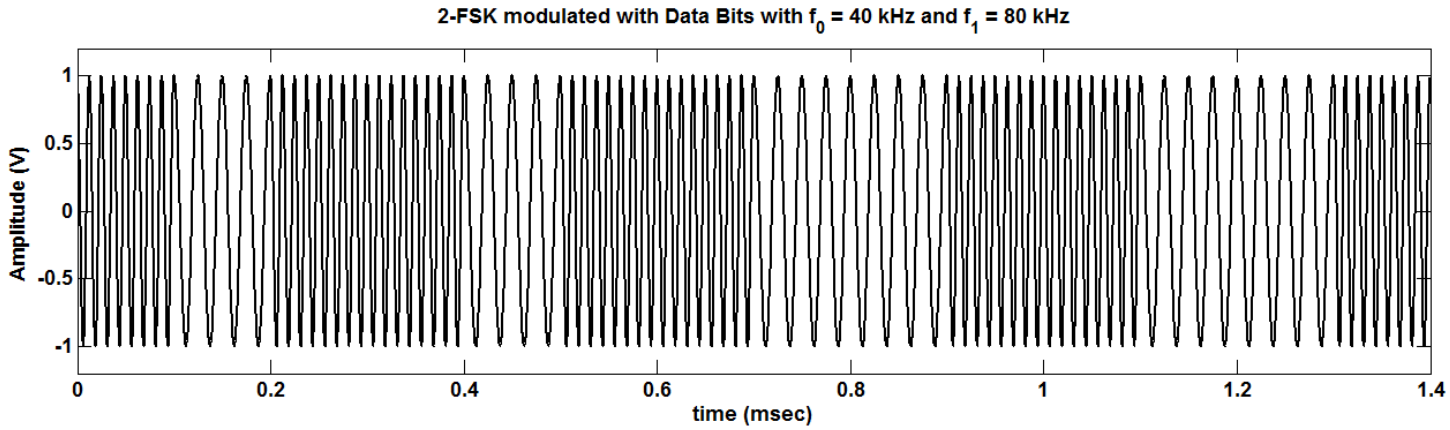
Frequency Shift Keying

1 0 1 1 0 1 1 0 0 1 1 0 0 1

Unipolar NRZ Data



FSK Waveform



FSK Power Spectral Density

Recall: Frequency Shift Property of the Fourier Transform:

$$\Im\left[s(t)\cos(2\pi f_c t)\right] = \frac{1}{2}S(f-f_c)+\frac{1}{2}S(f+f_c)$$

Which means that the PSD will be:

$$S_\phi(f) = \left|\frac{1}{2}S(f-f_c)\right|^2 + \left|\frac{1}{2}S(f+f_c)\right|^2$$

$$S_\phi(f) = \frac{1}{4}M_\phi(f-f_c)+\frac{1}{4}M_\phi(f+f_c)$$

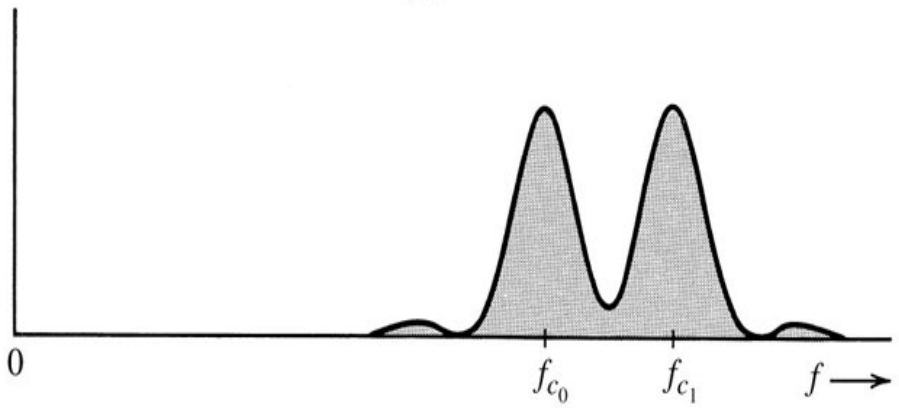
M_ϕ is the baseband PSD of the NRZ bitstream.

Note: $M_\phi(f) \propto \text{sinc}^2(f)$

Note: For FSK we have **two different** carrier frequencies f_{c_0} & f_{c_1}!

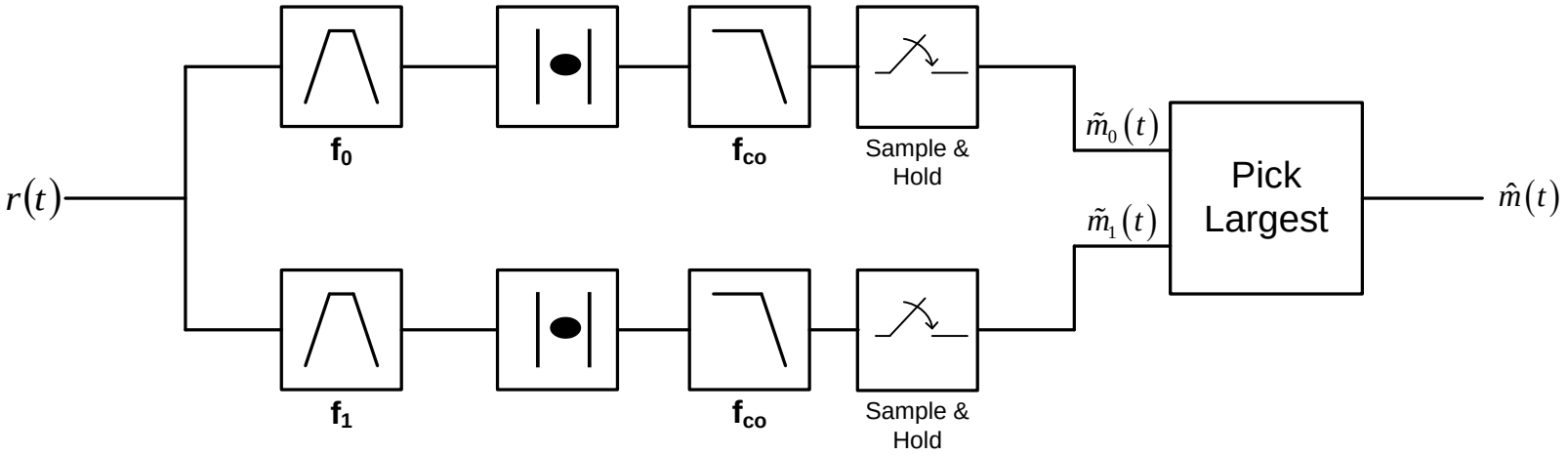
The Result:

For FSK: Effectively creating **two ASK** signals at two different carrier frequencies.

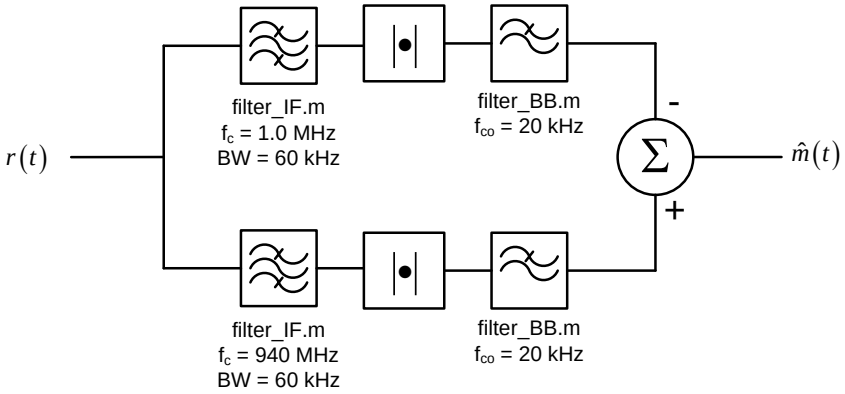


Incoherent Demodulation of FSK

Block Diagram of incoherent FSK Demodulator:



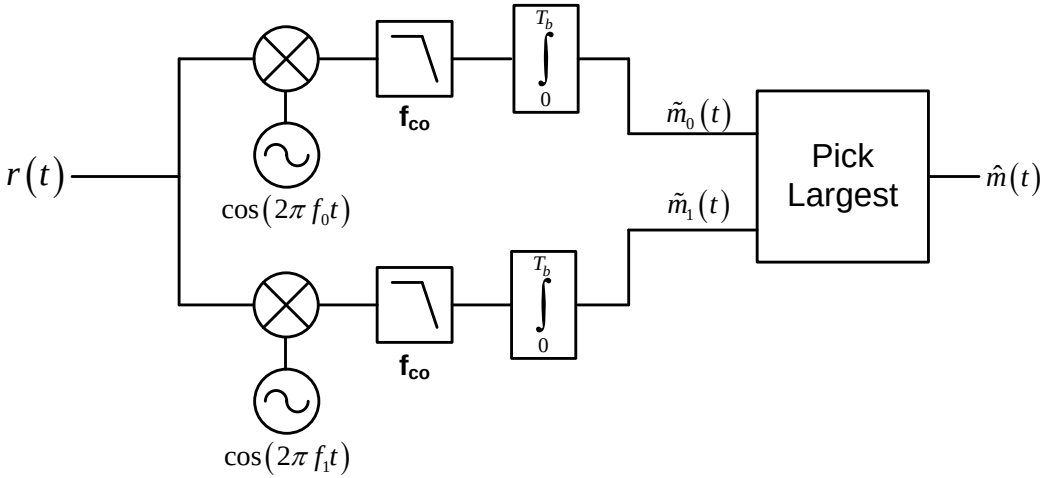
Incoherent FSK Demod in Software (example from lab):



Note: We have the same analysis as ASK: the noise will be transformed to have a Rayleigh and Rician PDF.

Coherent Demodulation of FSK

Block Diagram of coherent FSK Demodulator:



Coherent FSK Demod in Software (example from lab):

Note: The coherent receiver is a Matched Filter (MAP) Receiver.
The performance will be equal to the **orthogonal** MAP Receiver performance.

Example

Given: A 2.5 Mbps coherent BFSK system suffers AWGN with $\frac{N_0}{2} = 10^{-20}$ watts/Hz.

With no noise, the amplitude of the received signal is across an input impedance of 50Ω.

Find: What is the probability of bit error for an Incoherent and Coherent Receiver?