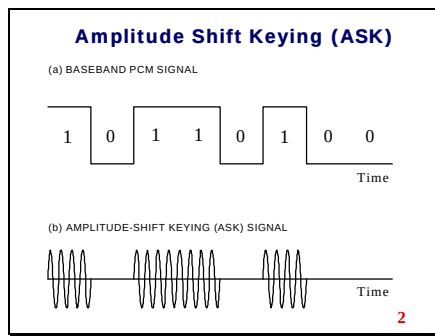


Slide 1

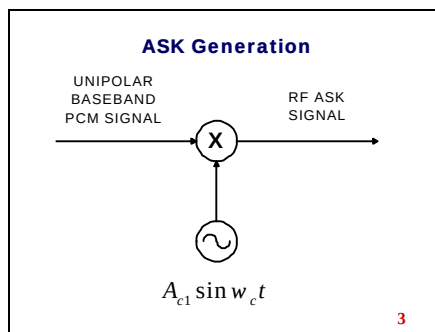
Digital Modulation Forms

Within a limited environment, digital data can be transmitted directly as baseband pulses. However, for transmission at RF frequencies or as transmission over cables with transformer coupling, it is necessary to encode the signals in forms in which the spectra are shifted to higher frequencies. Some of the most basic methods for binary transmission will be studied in this module. This will include *amplitude-shift keying (ASK)*, *frequency-shift keying (FSK)*, and *binary phase-shift keying (BPSK)*.

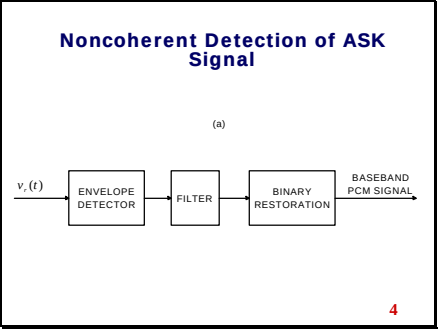
Slide 2



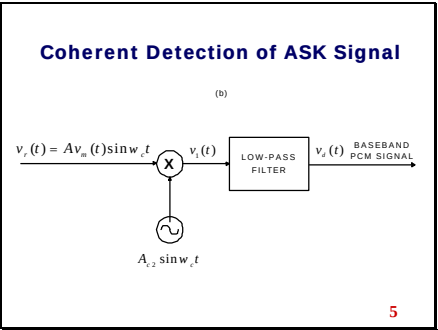
Slide 3



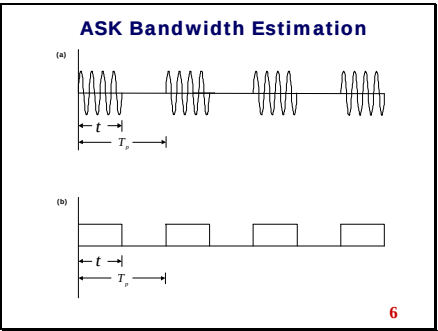
Slide 4



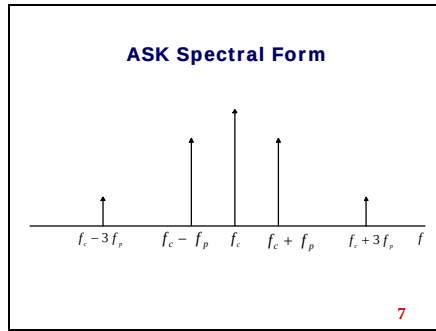
Slide 5



Slide 6



Slide 7



Slide 8

ASK Bandwidth Estimation Results

$T_p = \text{period} = 2t$

$f_p = \text{fundamental frequency} = \frac{1}{T_p} = \frac{0.5}{t}$

$R = \text{data rate in bits/s} = \frac{1}{t} = \frac{1}{T_p/2} = 2f_p$

$B_T = 2f_p = R$

8

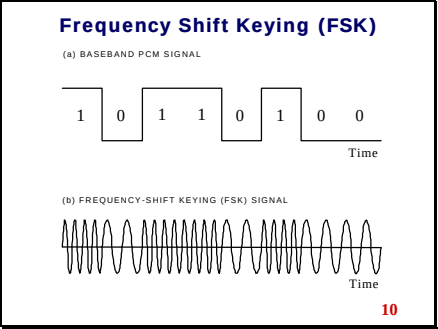
Slide 9

Example 1. A binary NRZ-L signal having a data rate of 200 kbits/s modulates an RF carrier in ASK. Determine the bandwidth.

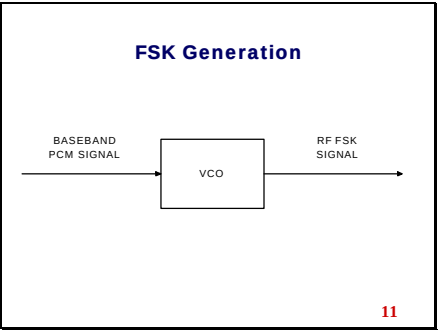
$B_T = R = 200 \text{ kHz}$

9

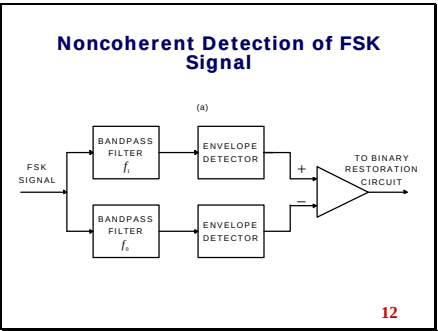
Slide 10



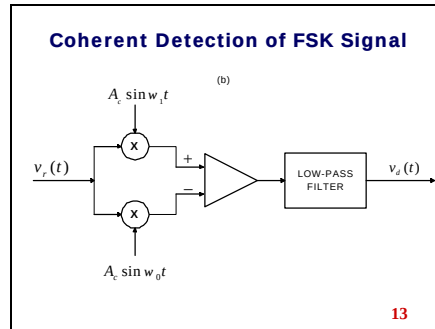
Slide 11



Slide 12



Slide 13



Slide 14

FSK Bandwidth Estimation Results

$$B_T = 2(\Delta f + f_m)$$

$$\Delta f = \frac{f_1 - f_0}{2}$$

$$f_m = f_p = 0.5R$$

$$B_T = f_1 - f_0 + R$$

14

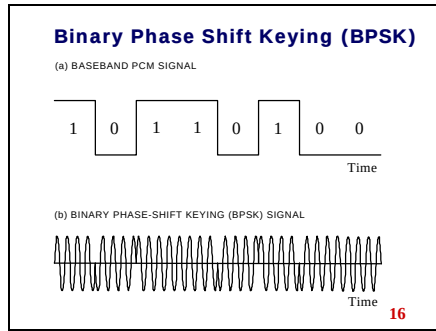
Slide 15

Example 2. A binary NRZ-L signal having a data rate of 200 kbits/s modulates an RF carrier in FSK. The two RF frequencies are 150 kHz apart. Determine the bandwidth.

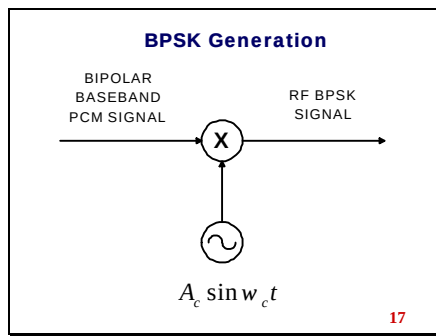
$$\begin{aligned}
 B_T &= f_1 - f_0 + R \\
 &= 150 + 200 \\
 &= 350 \text{ kHz}
 \end{aligned}$$

15

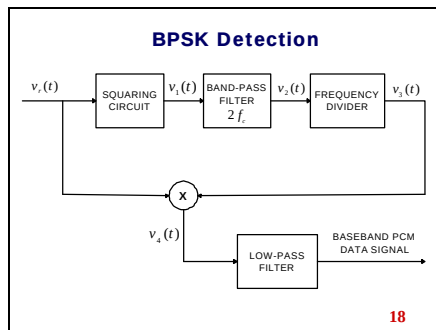
Slide 16



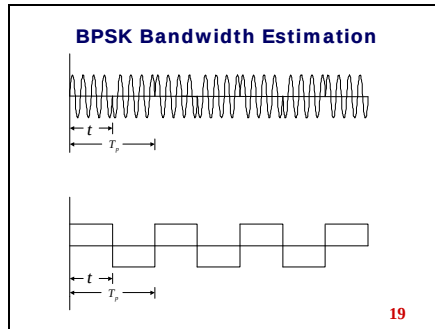
Slide 17



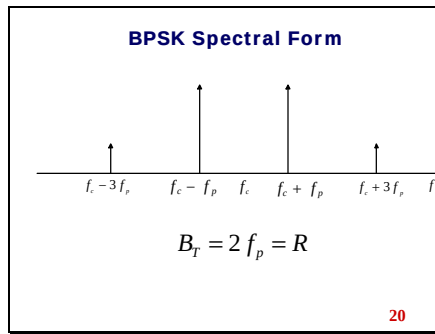
Slide 18



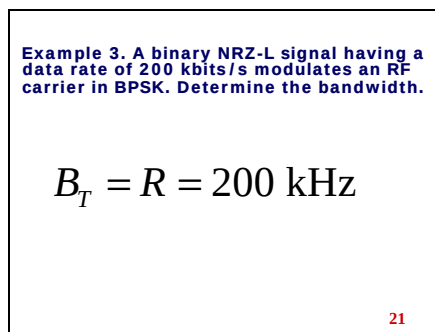
Slide 19



Slide 20



Slide 21



Summary

- Digital signals can be transmitted directly at baseband only under limited conditions.
- For either RF transmission or telephone line transmission, some form of modulation is required to shift the spectra.
- ASK involves turning a carrier on and off to represent the binary values.
- FSK involves switching between two frequencies that represent the binary values.
- PSK involves switching between two phases that represent the binary values.