Figure 13-1. Block diagram illustrating parameters used in analog receiving system analysis.

\[ P_R \]

\[ N_a = kT_a B \]

\[ N_{sys} = N_a + N_e \]

\[ = k(T_a + T_e)B \]

\[ = kT_{sys} B \]

\[ N_e = kT_e B \]
Figure 13-2. Baseband Comparison Gains for FM and PM

Deviation Ratio or Maximum Phase Deviation

Gain in dB

FM

PM
Figure 13-3. Receiver Processing Gains for FM and PM

Gain in dB vs. Deviation Ratio or Maximum Phase Deviation.
Figure 13-4. Threshold effect in the receiver processing gain for an FM detector.
$\frac{S}{N}_{out} = \text{Detected output signal-to-noise ratio}$

$\frac{S}{N}_T \quad \frac{S}{N}_{op}$ = Receiver operating input signal-to-noise ratio

Figure 13-5. Threshold effect in a digital PCM system.
Figure 13-6. Probability of Error Curves for Several Binary Modulation Systems

Probability of Error

Bit Energy to One-Sided Noise Density Ratio in dB
Figure 13-7. Comparison of Error Probabilities for Coherent BPSK and QPSK

Probability of Error

Bit Energy to One-Sided Noise Density in dB

BPSK

QPSK

$10^{-6}$ $10^{-5}$ $10^{-4}$ $10^{-3}$ $10^{-2}$ $10^{-1}$ $10^{0}$
Figure 13-8. Performance of PM for Three Different Maximum Phase Deviation Values

Baseband Signal-to-Noise Ratio in dB
Detector Output Signal-to-Noise Ratio in dB

Maximum Phase

Deviation =

- 10
- 5
- 2.5
Figure 13-9. Performance of FM for Three Different Deviation Ratios

Deviation Ratio = 2.5, 5, 10
Figure 13-10. Comparison of Different Analog Modulation Systems

Detected Output Signal-to-Noise Ratio in dB

Baseband Reference Signal-to-Noise Ratio in dB

- FM with preemphasis
- FM
- PM
- DSB or SSB
- AM (m=1)
Figure 13-11. Performance of PCM for Different Word Lengths

Baseband Reference Signal-to-Noise Ratio in dB

Detected Output Signal-to-Noise Ratio in dB

4 bits

8 bits

12 bits

16 bits

Baseband Reference Signal-to-Noise Ratio in dB
Figure 13-12. Comparison of FM and PCM for Different Bandwidth Expansion Ratios

- **FM**
  - $K=20$
  - $K=10$

- **PCM**
  - $K=20$
  - $K=10$

Baseband Reference Signal-to-Noise Ratio in dB

Detected Output Signal-to-Noise Ratio in dB