**Noise Figure & Level**

**Noise figure** is defined as:

\[
NF = \frac{(So/No) \text{ Signal To Noise At Output}}{(Si/Ni) \text{ Signal To Noise At Input (Source)}}
\]

**Background**

\[N = \text{Noise Power} = kTB\]

Where \( K = \text{Boltzman's Constant} = 1.38 \times 10^{-23} \text{ Joules/Kelvin} \)

\( T = \text{Absolute Temperature, } K(0^\circ \text{C} = 273K) \)

\( B = 3 \text{ dB Noise Bandwidth, Hz} \)

**Example:** What is the noise level, in dBm, of a resistor (black body) at 17°C (room temperature) over a 1 MHz bandwidth?

\[N = kTB = (1.38 \times 10^{-23}) \times (273 + 17) \times (1 \times 10^6) = 1.37 \times 10^{-17} \times 290 = 4.0 \times 10^{-15} \text{ Joules/Second}\]

\[\text{Or} = 4 \times 10^{-15} \text{ Joules/Second} = 4 \times 10^{-15} \text{ Watts}\]

In dBm

\[1 \times 10^{-15} \text{ Watts} = 1 \times 10^{-12} \text{ mW} = -120 \text{ dBm}\]

Power ratio of 4 = +6 dB

\[\text{Noise level} = -120 \text{ dBm} + 6 = -114 \text{ dBm} \text{ (Plot A on nomograph)}\]

**Note:** NF of transistors are 2 dB to 30 dB due to bias currents, materials, etc.

**Noise Level** in dBm at the input of an amplifier assuming NF = 10 dB is -104 dBm (Plot B):

**Noise Level** at the output, assuming the gain of the amplifier is 50 dB is:

\[No = kTB + \text{NF} + \text{Gain} = -114 \text{ dBm} + 10 dB + 50 dB = -54 \text{ dBm}\]

**Example:** If you add the gain of the amplifier to its NF (e.g., 50 dB + 10 dB = 60 dB), plot C indicates -54 dBm output noise level.

**Noise Figure Nomograph**

![Noise Figure Nomograph Image](image-url)