Noise Figure & Level

Noise figure is defined as:

NF = ((So/No) Signal To Noise At Output) / ((Si/Ni) Signal To Noise At Input (Source))

Background

N = Noise Power = kTB
Where K = Boltzman's Constant = 1.38 *10-23 Joules/Kelvin
T = Absolute Temperature, K(0°C = 273K)
B = 3 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 *10^{-23}) * (273 + 17) * (1 *10^{6}) = 1.37 *10^{-17} *290 = 4.0 *10^{-15} Joules/Second
Or = 4 *10^{-15} Joules/Second = 4 *10^{-15} Watts

In dBm 1 *10^{-15} Watts = 1 *10^{-12} mW = -120 dBm
Power Ratio of 4 = +6 dB
Noise level = -120 dBm + 6 dB = -114 dBm (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 + NF + Gain = -114 dBm + 10 dB + 50 dB = -54 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 Momograph