AMPLIFIER NOISE TEMPERATURES

Thermal noise: A body at absolute temperature T (in degrees Kelvin) will emit electromagnetic waves at a power level that is for practical matters constant over all radio frequencies, namely at kT Watts/Hz where k is Boltzmann's constant : $k = 1.38 \times 10^{-23}$ J/K.

Amplifier noise: Let us think of applying wide-band noise-power P at kT Watts per Hz to an ideal amplifier of gain G:

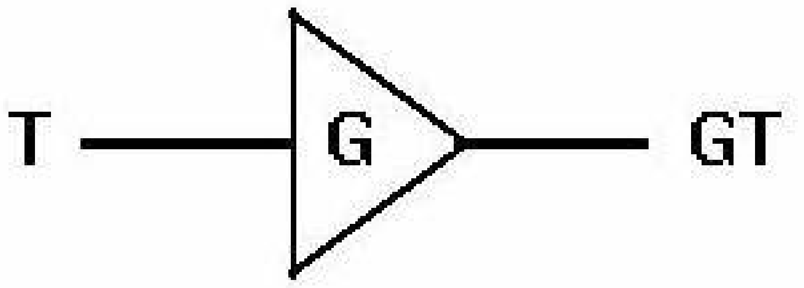

Figure 1. An ideal noiseless amplifier.

We agree that the above diagram means that when we apply a 1 Hz wide input signal of power P = kT to the amplifier, we obtain a 1 Hz wide output power of Po = GkT.

But a realworld amplifier has internal sources of noise generation---see 1997 ARRL Handbook, p.17-4. Thus the actual situation is that the output power is increased by the internal noise:

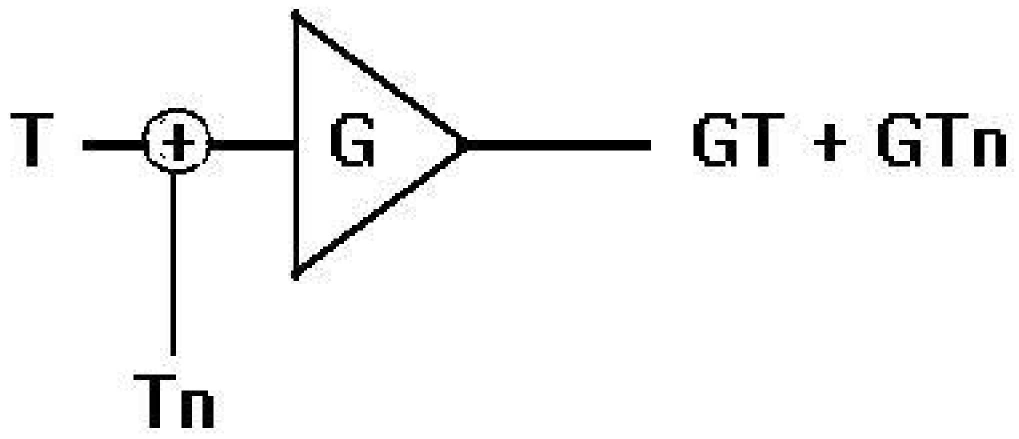

Figure 2. An amplifier with noise temperature Tn.

Tn is called the **noise temperature** of the amplifier. This noise temperature Tn is found by toggling a source with known on and off temperatures T, and measuring the two resulting levels of output power.

Source: http://www.mth.msu.edu/~maccluer/Lna/noisetemp.html

In cascade: Suppose we cascade two real-world amplifiers of gain G1, G2 and noise temperatures T1 and T2:

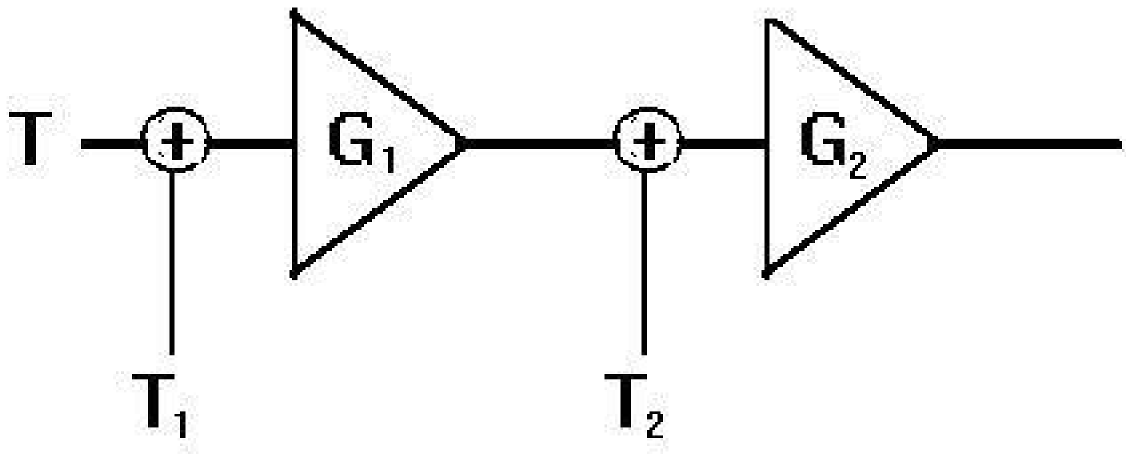

Figure 3. Two cascaded amplifiers.

The power at the output of the first amplifier G1(T1+T) is added to the noise power of the second, and then amplified, to yield

G2(T2 + G1(T1+T)) = G2G1(T1 + T2/G1 + T).

That is, the two amplifiers cascaded are equivalent to a single amplifier of gain G1G2:

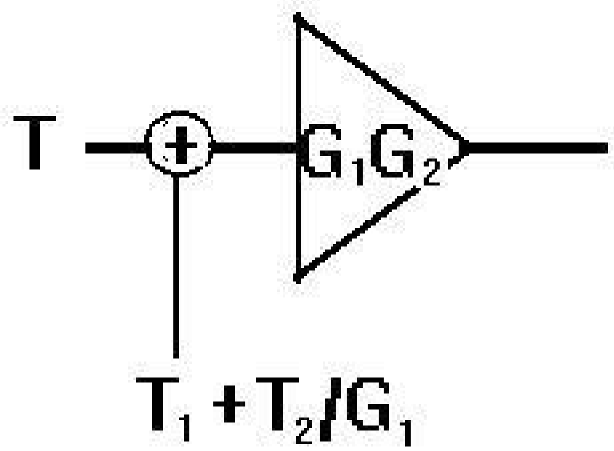

Figure 4. An amplifier equivalent to the cascade of Figure 3.

of noise temperature Tn = T1 + T2/G1.

Summary: The noise temperature Tn of the two amplifiers in cascade is the noise temperature of the first plus the noise temperature of the second divided by the gain of the first:

Tn = T1 + T2/G1.

Thus the gain of the first amplifier `washes out' the noise of second stage.