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To: RFI Group
From: Alan E.E. Rogers
Subject: Model of active antenna noise

The “effective” temperature delivered to the amplifier from the antenna is given by

$$T'_a = T_a (1 - |\Gamma|^2)$$

where $\Gamma = (Z_a - Z_p^*) / (Z_a + Z_p)$

and Z_a = impedance of the antenna

Z_p = input impedance of preamp

This result is obtained from the ratio of the power delivered to the preamp to the power delivered to a conjugate load as follows:

The voltage across the preamp is

$$E = Z_p / (Z_a + Z_p)$$

and the current is

$$I = 1 / (Z_a + Z_p)$$

and the power is

$$\text{Re } EI^* = \text{Re } Z_p / |(Z_a + Z_p)|^2$$

while the power to a conjugate load is

$$\text{Re } Z_a / |Z_a + Z_a^x|^2 = 1/4 \text{Re } Z_a$$

The ratio is $(\text{Re } Z_p / |Z_a + Z_p|^2) (4 \text{Re } Z_a) = 1 - |\Gamma|^2$

When the preamp is connected to a load the “effective” temperature is $T'_{amb} = T_{amb} (1 - |\Gamma|^2)$

Where $\Gamma^2 = (R_L - Z_p^*) / (R_L + Z_p)$

and T_{amb} = ambient temperature

The noise added by the preamp in each case is given by

$$T_{\text{Rec}} = T_{\text{min}} + 4R_n |\Gamma_s - \Gamma_{\text{opt}}|^2 / \left[(1 - |\Gamma_s|^2) |1 + \Gamma_{\text{opt}}|^2 \right]$$

where R_n = normalized noise resistance (50 ohms)

≈ 0.04 for ATF-54143

Γ_s = source reflection coefficient – referred to 50 ohms

Γ_{opt} = optimum source reflection coefficient referred to 50 ohms.

In practice it may be convenient to normalize the output by applying a gain factor.

$$g = T_{\text{amb}} / T'_{\text{amb}}$$

Figure 1 shows the effective antenna temperature normalized by the gain factor for a ATF-54143 preamp and the antenna described in memo 23. The input is shunted with 270 nH and the S parameters and noise parameters are interpolated from the data sheet. The sky noise with a perfect match is assumed to be 1000K at 100 MHz with spectral index of 2.6.

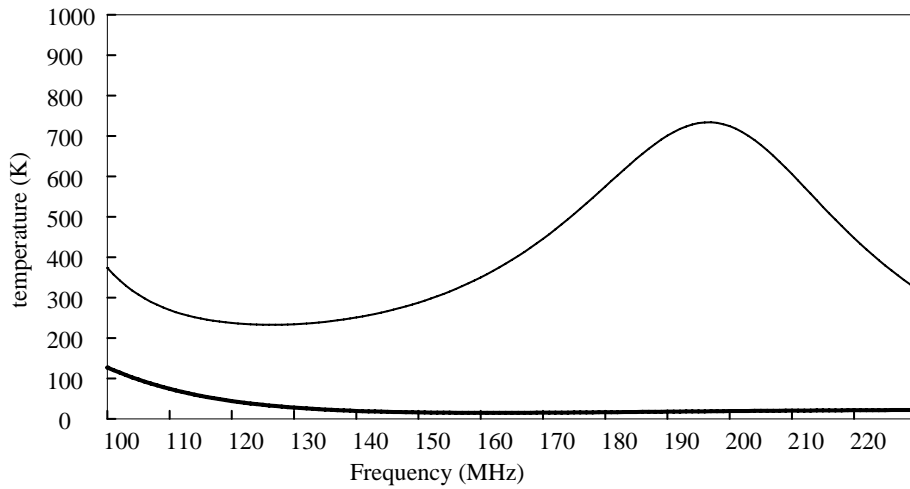


Figure 1. “Effective” antenna temperature. Lower curve is noise contribution from the amplifier.