EDGES MEMO #009
RFI MEMO #024

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To: RFI Group
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Subject: Model of active antenna noise

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

$$T_a' = T_a\left(1-|\Gamma|^2\right)$$

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

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

$$E = Z_p/\left(Z_a + Z_p\right)$$

and the current is

$$I = 1/\left(Z_a + Z_p\right)$$

and the power is

$$\mathrm{Re}\, EI^* = \mathrm{Re}\, Z_p/\left|\left(Z_a + Z_p\right)\right|^2$$

while the power to a conjugate load is

$$\mathrm{Re}\, Z_a/\left|Z_a + Z_a^x\right|^2 = 1/4\,\mathrm{Re}\, Z_a$$

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

When the preamp is connected to a load the "effective" temperature is $T_{amb}' = T_{amb}\left(1-|\Gamma|^2\right)$

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

and T_{amb} = ambient temperature

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

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

where R_n = normalized noise resistance (50 ohms)

$\approx$ = 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.

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

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.

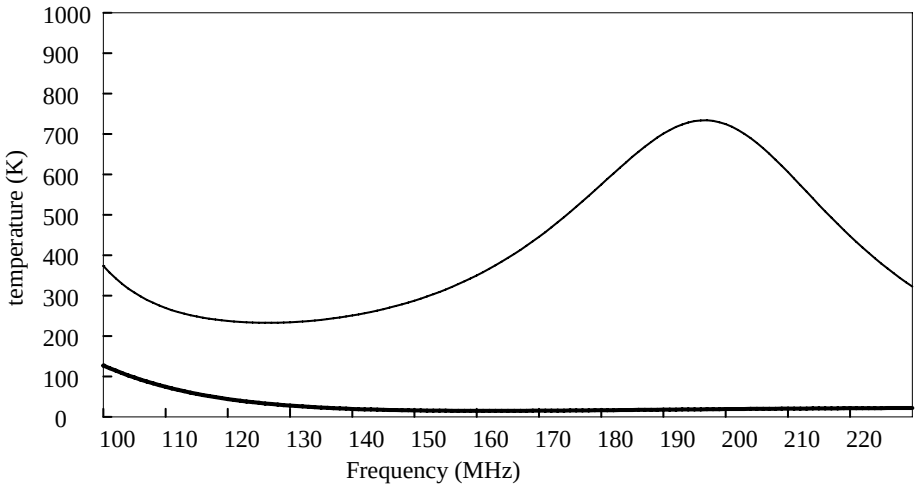

Figure 1. "Effective" antenna temperature. Lower curve is noise contribution from the amplifier.