RF Design - Noise

Exercise 1: What are the minimum possible values of T_e and F?

$kT_eB = 0$

if amplifier adds no noise

minimum $T_e = 0$

Then $F = \frac{T + T_e}{T} = 1$

if $T_e > 0$ $F > 1$ (0 dB)

Exercise 2: The datasheet for a low-noise amplifier (LNA) specifies a noise figure of 2 dB. What is the noise temperature T_e?

$2\,dB = 10^{\frac{2}{10}} = 1.6$

$F = \frac{T_0 + T_e}{T_0} = \frac{290 + T_e}{290} = 1.6$

$T_e = (1.6 \cdot 290) - 290$

$\approx 169.6\,K$

Exercise 3: An LNA with a noise figure of 0.3 dB receives a signal with an SNR of 6 dB. What is the output SNR?

$0.3\,dB = 10^{\frac{0.3}{10}}$

$6\,dB = 4$

$F = \frac{S_i/N_i}{S_o/N_o} = 1.07 = \frac{4}{S_o/N_o}$

$S_o/N_o = \frac{4}{1.07} = 3.73 = 5.7\ dB$

Exercise 4: A What is the system noise figure of a receiver that consists of a 10 dB amplifier with 3 dB noise figure followed by a mixer with a 6 dB loss and an IF amplifier with a 20dB gain and a noise figure of 10 dB?

$G_1 = 10\ dB = 10$

$F_1 = 3\ dB = 2$

$G_2 = -6 = \frac{1}{4}$

$F_2 = 6 = 4$

$G_3 = 20 = 100$

$F_3 = 10 = 10$

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2}$$

$$= 2 + \frac{4-1}{10} + \frac{10-1}{10 \cdot \frac{1}{4}}$$

$$= 2 + 0.3 + 3.6$$

$$= 5.9 \simeq 8\ dB$$