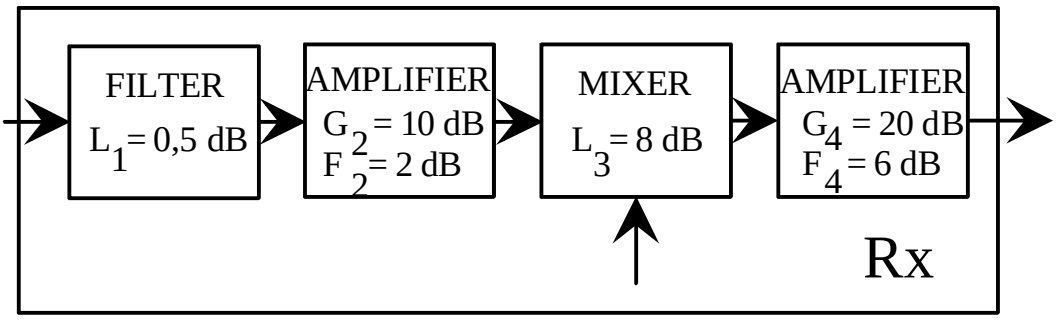
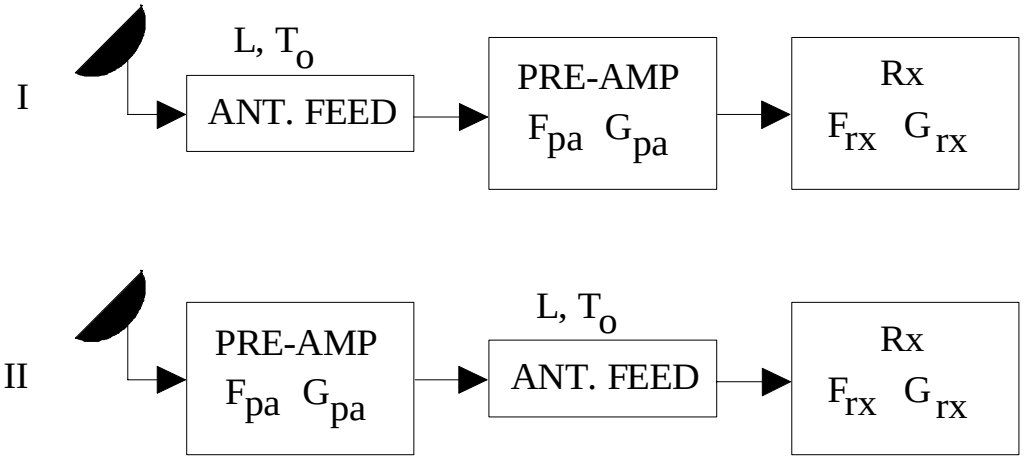
1.



The figure shows the block diagram of a radio receiver and the noise figures and gains of the different blocks. The filter and mixer temperatures are 290 K.

a) Calculate the receiver noise temperature in the input.
b) Increasing the gain G_2 to 13 dB or decreasing tne noise figure F_4 to 4 dB causes the same cost, when the other parameters are unchan. Choose the improvement giving better noise characteristics.

2.



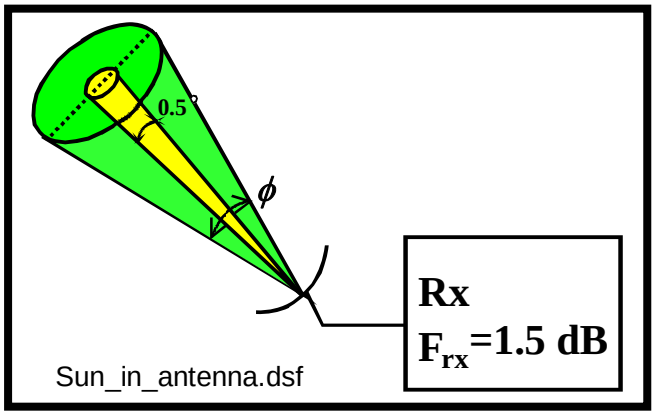
a) Show that configuration II performs better in terms of noise.
b) Determine the performance difference in dB in a Earth station - satellite transponder link with the following system parameters:

	Satellite transponder	Earth station
T_a	290 K	50 K
L	4 dB	2 dB
T_o	290 K	290 K

F_{pa} , T_{pa}	1,5 dB	100 K
G_{pa}	20 dB	20 dB
F_{rx}, T_{rx}	8 dB	700 K

c) would it be better to omit the Earth station pre-amplifier and instead cool the receiver front end to 70 K?

3. In a radio communication system on 1500 MHz the sun noise temperature is 100000 K, and the temperature of the surrounding heaven is 10 K. The receiver noise figure measured at 290 K is 1.5 dB.



a) Calculate the receiver noise temperature.

b) Which ideal lobe angle ϕ will give the same antenna noise temperature as the receiver noise temperature? (Calculate the average noise temperature over the ideal lobe and observe that the plane angles are given.)

c) How many dB will the the signal to noise ratio degrade when the sun comes into the antenna lobe determined in (b)?

d) How many dB is the receiver output SNR degraded when the sun comes inside a 3° antenna lobe?

4. The noise figure of a radio receiver tells the SNR degradation caused by the receiver, when the source temperature is the same as that used in the noise figure measurement.

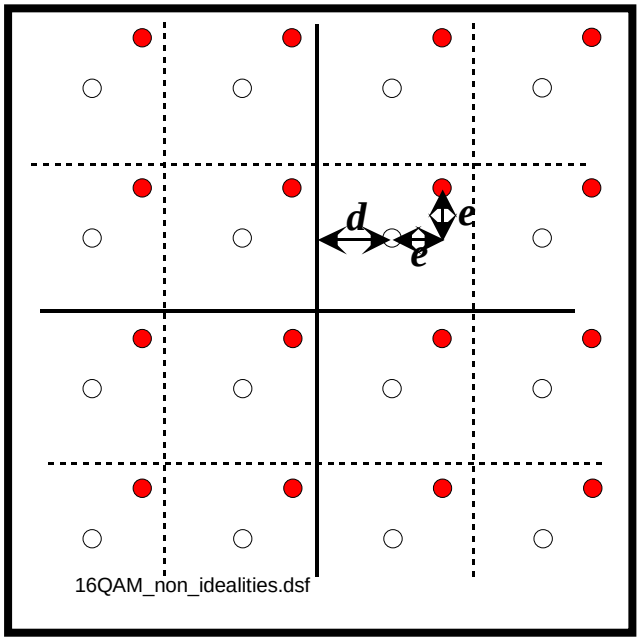
a) The receiver noise figure measured with 290 K source temperature is 5.0 dB. The receiver is used with a 50 K source noise temperature. How many dB is the SNR degradation?

b) In a radio communication system the receive antenna sees a noise temperature of 2900 K. How large may the receiver noise figure measured at a temperature of 290K be, that the signal to noise ratio degradation in the receiver would not be more than 1 dB?

5. Due to mixer LO leakage a 16QAM constellation is shifted as depicted in the figure. The data decision procedure assumes an ideal constellation.

a) Derive an expression of the symbol error probability as function of d, e, and the r.m.s. noise σ.

b) How large is the performance degradation in dB at the symbol error probability 0.001 when d/e gets the values 0.1 and 0.5?



Home work 1 Submit your solution before March 2, 2006

The noise figure of a radio receiver is 1.5 dB (T_s = 290 K).

a) What is the SNR degradation (dB) in the receiver when the source noise temperature is i) 290 K, ii) 50 K, iii) 8 K and the source is directly connected to the receiver?

b) Repeat the degradation calculation when the source is connected to the receiver with a lossy cable, the loss being L = 1.2 dB.