Low-power radio design for the IoT
Exercise 6 (31.03.2022)

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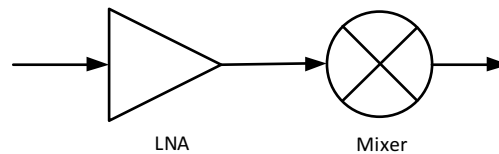## Problem 1   Receiver Front-End

Figure 1: Block diagram of a receiver front-end

The system shown in Fig. 1 consists of a cascade of an LNA followed by a mixer. The system has the following specifications:

- Total Gain, $G_{tot} \geq 20 \, \text{dB}$

- Total Noise Figure, $NF_{tot} = 4 \, \text{dB}$

- Total $IIP3$, $IIP3_{tot} = 5 \, \text{dBm}$

1.1   LNA Design

- Design the LNA (calculate the gain) such that its noise figure $NF_{LNA} < 1 \, \text{dB}$. Calculate its $IIP3$ if $IIP3_{mixer} = 20 \, \text{dBm}$. Assume the noise figure of the mixer $NF_{mixer} = 10 \, \text{dB}$.

- Design the LNA such that its noise figure $NF_{LNA} = 3 \, \text{dB}$. Calculate the $IIP3$ assuming $IIP3_{mixer} = 20 \, \text{dBm}$. Assume the noise figure of the mixer $NF_{mixer} = 10 \, \text{dB}$.

- Comment on the results.

1.2   Mixer Design

- Assuming that the mixer stage contributes half of the total gain, compute the Noise Figure of the mixer such that the Noise Figure of the LNA is less than $1 \, \text{dB}$.

- Assuming that the mixer stage contributes one-fourth of the total gain, compute the Noise Figure of the mixer such that the Noise Figure of the LNA is less than $1 \, \text{dB}$.

- Comment on the results.