MICRO-428: Metrology

Week Three: Optical Image Sensors

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Exercise 1: Dynamic Range

- For a project experiment, we need a very high dynamic range camera. The camera we are designing has a noise floor of $4.8\ e^-$. The required dynamic range is 100 dB, while the maximum operating voltage is 1 V.

- What is the minimum capacitance we can have for our collector capacitor?

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- First of all, let us determine what needs to be our saturation level:

$$100\ \text{dB} = 20 \log \frac{Saturation\ level}{Noise\ level} \rightarrow$$

$$Saturation\ level = 10^{\frac{100}{20}} \times Noise\ level$$

$$Saturation\ level = 480'000\ e^-$$

Exercise 1: Dynamic Range

- For this saturation level, what should be the bit depth of our ADC?

$$\log_2 480'000 = 18.872$$

so we will need a 19-bit ADC.

- For this saturation value, we are going to have to design a collector capacitor of:

$$Voltage = \frac{Saturation\ level \times electron\ charge}{C} \rightarrow$$

$$C = \frac{4.8 \cdot 10^5 \times 1.6 \cdot 10^{-19}\ \text{C}}{1\ \text{V}} = 7.68 \cdot 10^{-14} = 76.8\ \text{fF}$$