Smart Sensors for IoT
Exercise 6 (30.11.2022)

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Problem 1 Autozero SC Amplifiers

Referring to Fig. 1 and Fig. 2, and considering both OpAmps having infinite gain and an off-set voltage of 0.1 mV, what is the output residual off-set voltage in the two cases if:

- $C_1 = 10\,\text{pF}$ and $C_2 = 1\,\text{pF}$;
- $C_1 = 1\,\text{pF}$ and $C_2 = 1\,\text{pF}$.

Now, referring to Fig. 2, consider the OpAmp to have the same offset but limited gain A.

- Calculate the minimum A in order to have a 99.9% offset reduction for the two values of C_1 and C_2 above. Comment the results, focusing also on the impact of the offset on the A_v gain.

Optional problem [difficult]

Referring to Fig. 2 and Slide 20 in the lecture notes, derive the results for:

- V_{neq}
- $V_{os\text{-}res}$.

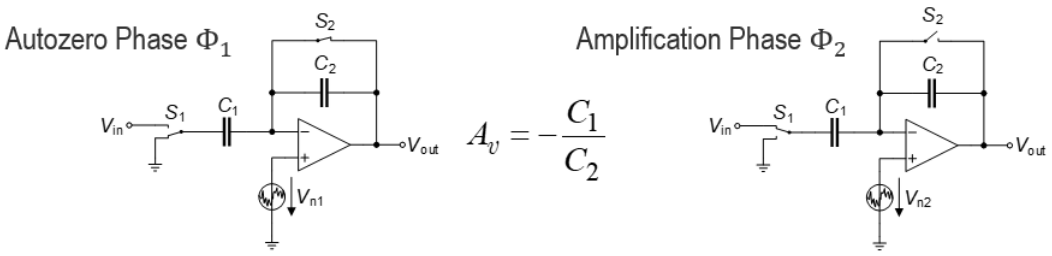

Figure 1: Autozero SC Amplifiers, first implementation.

Problem 2 The Chopper Stabilization (CS) technique

Consider the Chopper Stabilization (CHS) Principle chain shown in Fig. 3 and consider the amplifier DC gain $A_{dc} = 80\,\text{dB}$, the input signal amplitude $A_{in} = 10\,\text{mV}$0-P, the flicker corner frequency $f_k = 10\,\text{kHz}$, the amplifier off-set voltage $V_{os} = 0.1\,\text{mV}$, $S_0 = 50\,\text{nV}/\sqrt{\text{Hz}}$

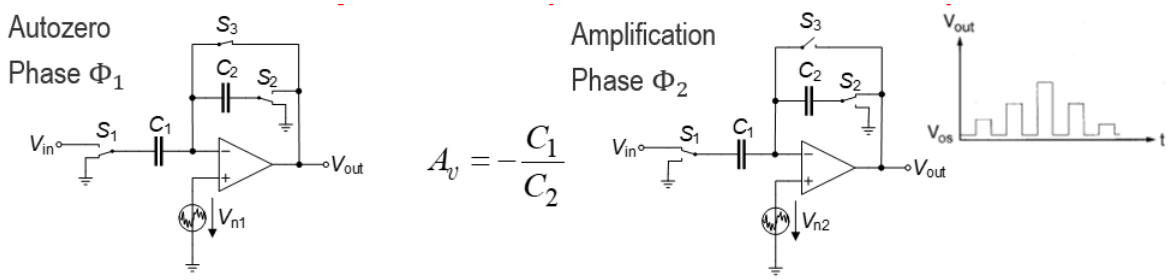

Figure 2: Autozero SC Amplifiers, second implementation.

- Calculate the equivalent DC gain.
- Chose a proper chopping period T so to have the total residual noise in the baseband around $92.5\,\mathrm{nV}/\sqrt{\mathrm{Hz}}$.
- Consider the residual input-referred offset due to the injection of the modulator switches. The input equivalent capacitance of the OpAmp is 500 fF, the relative tuning error between the selective amplifier center frequency and the chopper frequency is negligible and the worst case error charge Δq is 25 µC. Calculate the maximum switches on-resistance R_{on} resistance in order to have a residual input-referred offset smaller than 10 µV.

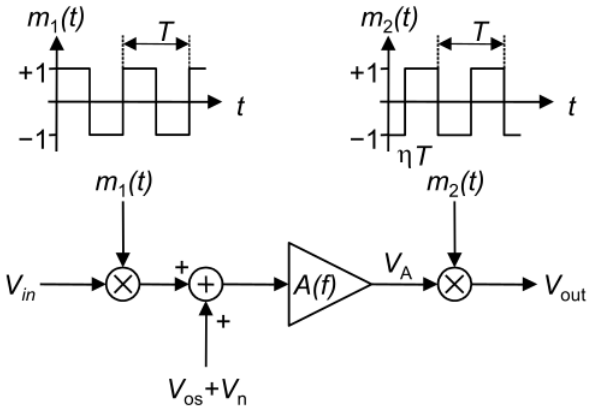

Figure 3: Chopper Stabilization (CHS) Principle chain.