Smart Sensors for IoT
Exercise 7 (14.12.2022)

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Problem 1 The Transducer Bridge

Transducer resistances are expressed in the form $R + \Delta R$, where R is the resistance at some reference condition, such as 0 °C in the case of temperature transducers, or the absence of strain in the case of strain gauges, and ΔR represents the deviation from the reference value as a consequence of a change in the physical condition affecting the transducer. Transducer resistances are also expressed in the alternative form $R(1 + \delta)$, where $\delta = \Delta R/R$ represents the fractional deviation. Multiplying δ by 100 yields the percentage deviation.

Platinum resistance temperature detectors (Pt RTDs) have a temperature coefficient $\alpha = 0.003\,92\,^{\circ}\mathrm{C}^{-1}$. Usually, the Pt RTD reference value is given at 0 °C and it is 100 Ω. The expression for the resistance R as a function of the temperature T is:

$$R(T) = R(0\,^{\circ}\mathrm{C}) \cdot (1 + \alpha T) = 100 \cdot (1 + \alpha T) = 100 \cdot (1 + \delta).$$

An implementation of the Platinum resistance temperature detectors is shown in Fig. 1 and let $V_{\mathrm{REF}} = 15\,\mathrm{V}$.

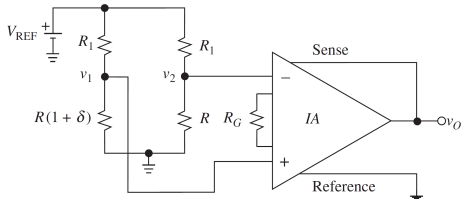

Figure 1: Transducer bridge and IA used as Pt RTD.

- Specify values for R_1 and A suitable for achieving an output sensitivity of 0.1 V/°C near 0 °C. To avoid self-heating in the RTD, limit its power dissipation to less than 0.2 mW.
- Compute $v_O(100\,^{\circ}\mathrm{C})$.

Problem 2 Wheatstone bridge linearization

The circuit in Figure Fig. 2 is a linearized bridge. Assume the op amps to be ideal:

- show that the output voltage is directly proportional to the measured quantity.

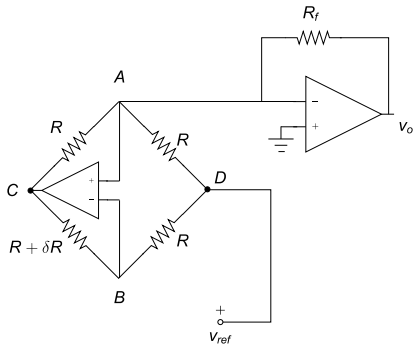

Figure 2: Wheatstone bridge linearization by two op amps.

Problem 3 Switched Capacitor circuit

Consider the Switched Capacitor circuit in Fig. 3, where the amplifier is ideal except it has a small offset voltage V_{os}.

- Evaluate the effect the offset voltage on the output.

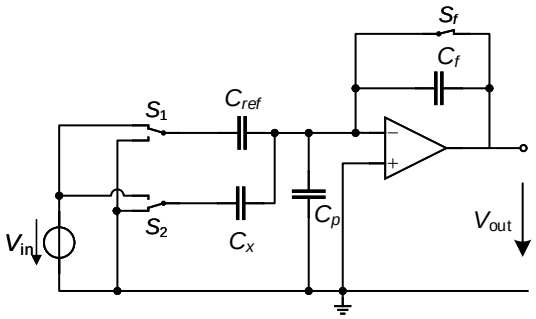

Figure 3: Switched Capacitor circuit.