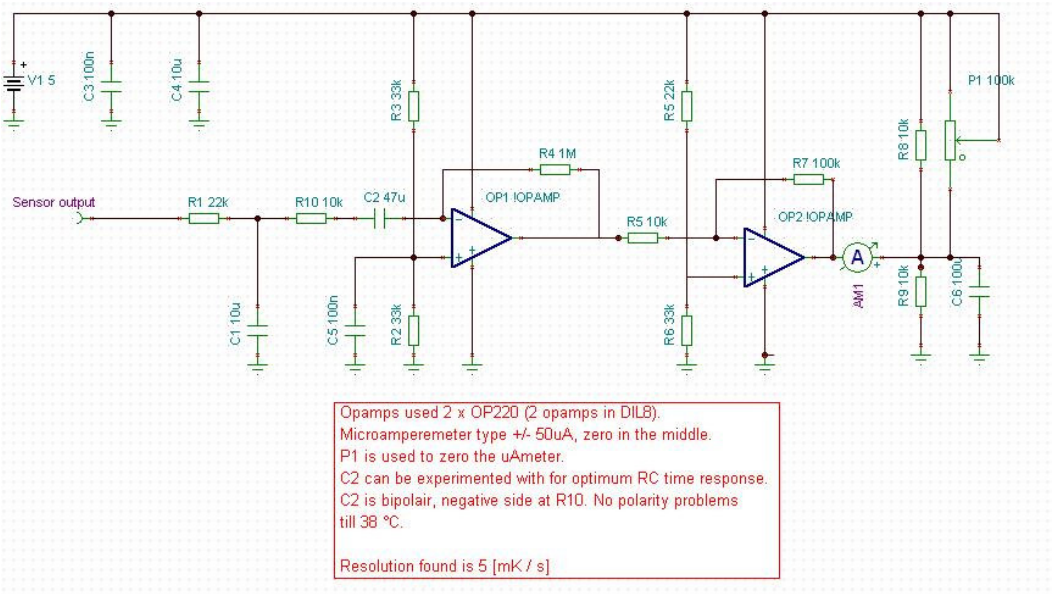
Low temperature gradient detection

While most users of the SMT160-30 temperature sensor treat this sensor as a digital device (because it can be hooked up directly to a µ-controller input), the actual information of the chip temperature is coded in the duty-cycle value of the output signal in a 100% analogue way. Since the thermal noise in the internal components of the sensor is about 0,005 [K], with the proper analogue electronics connected, it is possible to detect temperature differences with a resolution close to 0,005 [K].

The design below shows a very simple circuit, with which this can be achieved. This setup has been tested in a controlled environment, where the sensor was in contact with a volume of water, that was linearly heated up at a speed of 20 [K] per hour, or 5,5 [mK/s]. This warming-up speed was detected by the circuit shown. The reading showed a noisy behaviour, as was to be expected.

This application resulted from a customer inquiry, who needed to detect underwater temperature gradients, as part of a larger collection of physical variables, the most important one being magnetism. Underwater pipelines, transporting oil at temperatures well above the surrounding seawater temperature create temperature gradients and their mere presence also causes a magnetic gradient to appear. When divers are informed about changes in these physical variables, this gives valuable information about the location of these pipelines, often hidden under the sediment.

Divers that swim at a speed of 1 [m/s] will theoretically be capable to detect a temperature gradient of 5 [mK/m], or 1 [°C] per 200 [m]. First tests suggest that the sensitivity of the device is better than needed and therefore subject to revision. Logarithmic readings will probably a logic next step. In case gradients have to be measured in air the selfheating of the temperature sensor has to be taken in account.



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