# Can I use the THM1176-HF as a thermometer?

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## The question

In order to compensate for temperature drift, the THM1176-HF sensor includes a temperature sensor. The THM1176 command set allows reading its value. Does this mean that I can use the THM1176 as a thermometer?

## The short answer

No.

## The slightly longer answer

The THM1176-HF makes a very poor thermometer, for a number of reasons:

- The reading reflects the temperature of the Hall sensor, which, thermally speaking, is poorly coupled to the outside world. In other words, temperature readings significantly lag behind changes in the outside temperature.
- The Hall sensor contains electronic circuitry that generates a significant amount of heat. In other words, temperature readings drift some time after powering up the Hall sensor, or, to a lesser extent, when switching measurement ranges.
- The temperature sensor output is quite sensitive, but also very noisy.
- The output is a raw ADC count, rather than something physically meaningful like °C. In principle, Metrolab could calibrate the output, especially since we use a thermometer during calibration anyway. But:
    - The effects enumerated above make the calibration inaccurate.
    - The thermometer we use for calibration is itself not calibrated, thus the temperature calibration would not be traceable to (inter)national standards.

## The incredibly long and boring answer

Here are the results of a quick and dirty experiment using our THM1176-HF calibration setup, shown below. The sensor is mounted in a small carriage, which in turn slides into one of the slots of the calibration fixture (blue string to pull the carriage back out of the slot). A heater is mounted on the bottom of the calibration fixture (white wires), and a thermocouple thermometer slides into a hole just below the sensor (blue wire).

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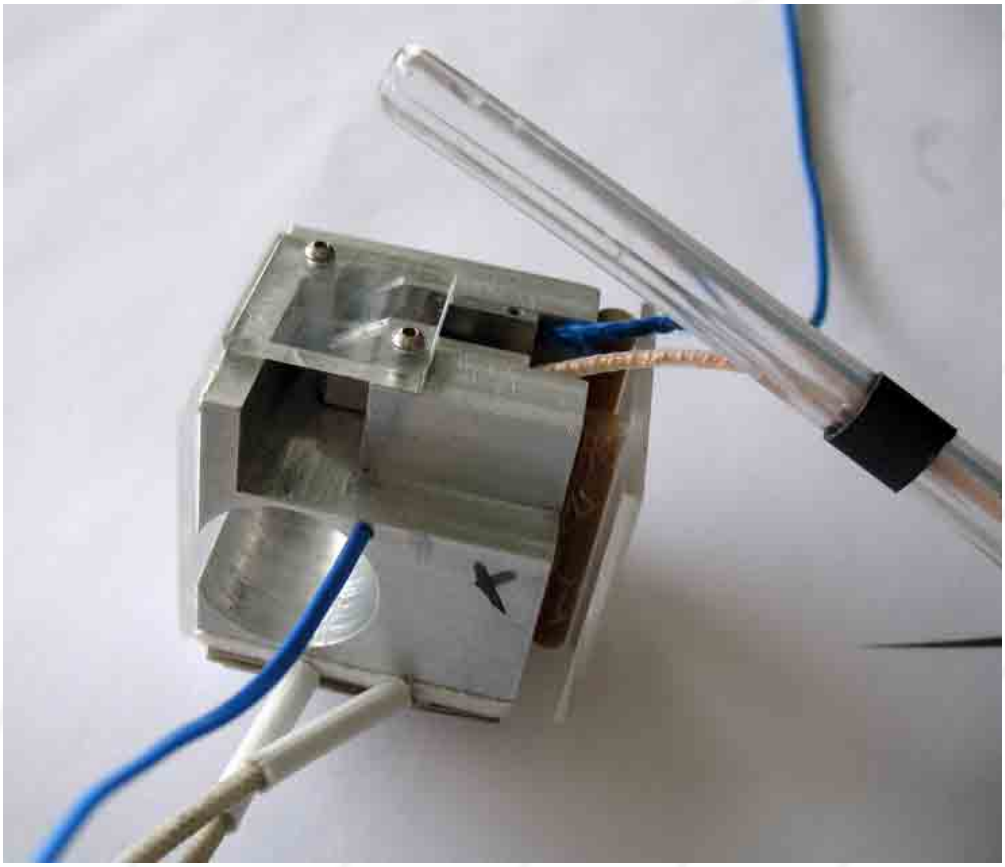
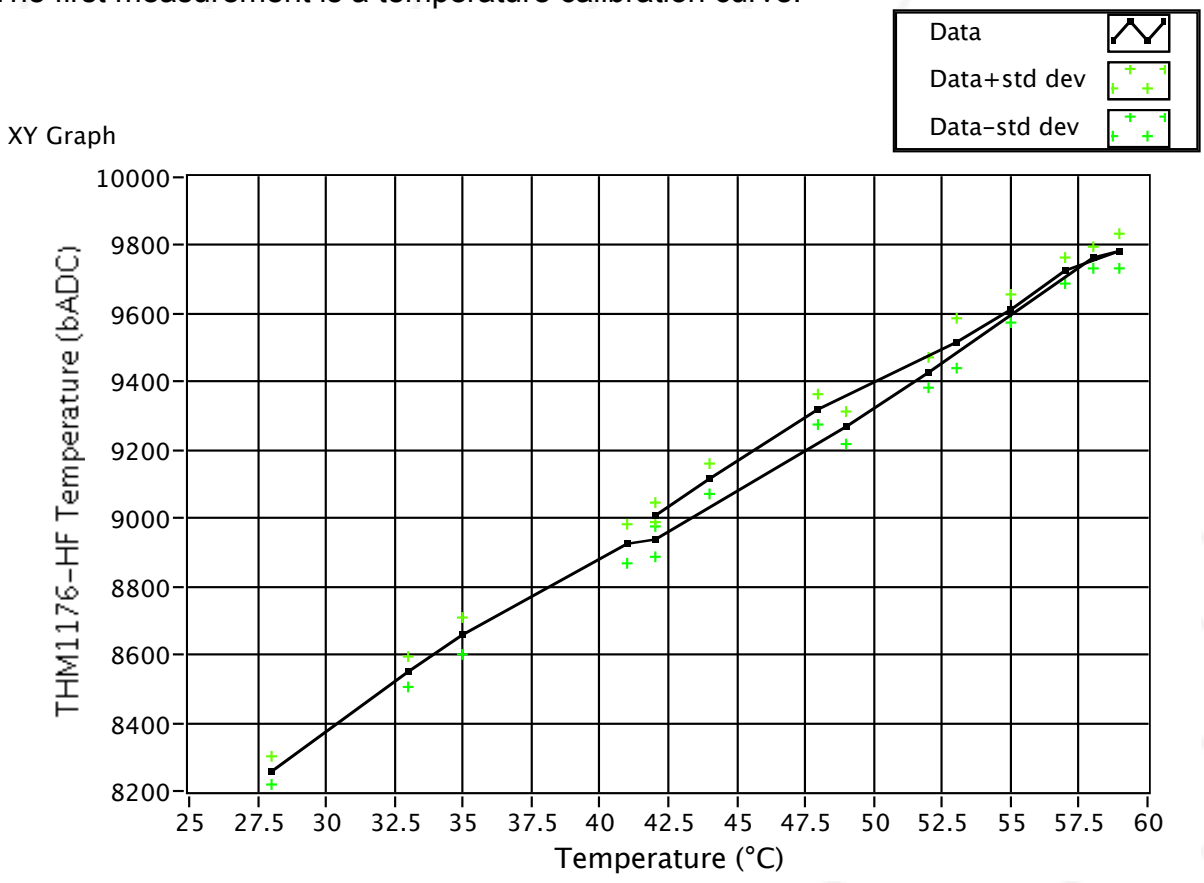


The first measurement is a temperature calibration curve:

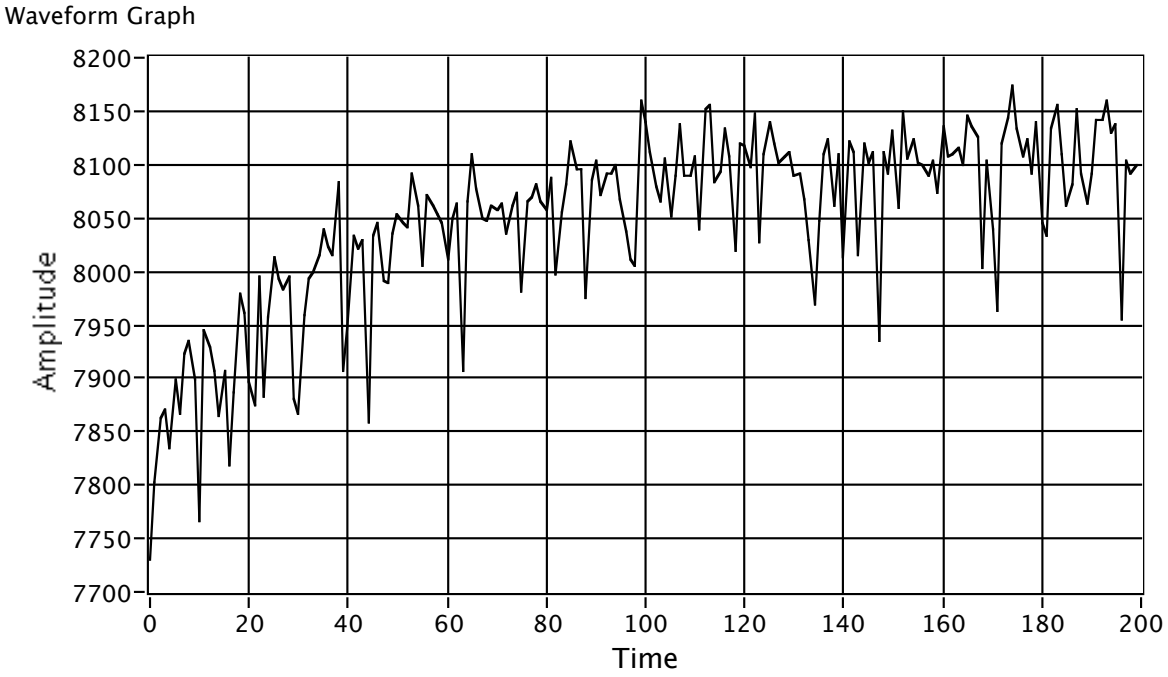


Some observations:

- The THM1176-HF temperature output is more or less linear over this range, with a gain of approximately 50 bADC/°C.
- The flattening of the curve, once at 42° and once at 59°, is where the calibration jig started to attain equilibrium temperature. At 42°, we decided to give the heater another kick.
- The readings are noisy. We took ten readings at every point, and plotted the average as the data point with the standard deviation as error bars. The standard deviation fluctuates around 50 bADC, or roughly 1°C. We used revision B of the THM1176 electronics; later revisions are slightly less noisy. Also, if one made multiple field measurements per block, the temperature measurements would be averaged, which would reduce the variance.
- We took some readings while the system was cooling down, to explore the temperature hysteresis due to the thermal resistance in the calibration setup. Generally, the thermal resistance is mostly due to air gaps: between the block and the carriage, between the carriage and the sensor's ceramic plate, and between the ceramic plate and the IC. The width of the hysteresis loop is about 100 bADC, or 2°C.

Next, to explore the self-heating phenomena we mentioned, we took some measurements as follows (see below):

- Turn off the analog electronics and wait 100 seconds to let the sensor cool to room temperature.
- Select the 3T range and take 100 temperature measurements.
- Select the 100mT range and take another 100 temperature measurements.




We see that the initial warm-up is dramatic, rising approximately 350 bADC, or roughly 7°C, The temperature change due to the range switch is barely perceptible here, lost in the measurement noise, probably on the order of 10-20 bADC.