# Correction of the offset drift of an orthogonal fluxgate by measurement of its core temperature

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In this paper we present a simple method to correct the dependence of the offset of an orthogonal fluxgate on the temperature of its core. The method consists in measuring the temperature of the core by measuring either the DC or AC component of the voltage on the terminations of the ferromagnetic wires which compose its core. Since the resistance of the wire linearly depends on the temperature when well below its Curie temperature, once the sensor is excited by a current source the voltage on its core becomes an indicator of its temperature. We show how this method can help to suppress the dependence of the offset on the temperature.

*Keywords: fluxgate, offset drift, temperature, correction, temperature coefficient*

## 1. Introduction

One of the drawbacks of orthogonal fluxgates based on amorphous CoFeSiB [1] is that they show a rather large dependence of the offset on the temperature. This problem has been solved in the past by periodical switching of the excitation current. This solution, however, increases the noise and the complexity the excitation and demodulation circuits [2]. Another solution is to embed the fluxgate core in silicone to provide thermal inertia to the core and damp the fast variations of temperature. In this work we propose a different approach: we measure the resistance of the wire composing the magnetic core of the fluxgate and we use this value to derive the temperature changes of the core. The advantage, compared to using an external sensor of temperature is that we can measure the actual temperature fluctuations on the sensing element of the fluxgate without any hysteresis due to the heat propagation between the temperature sensor and core.

## 2. Results and discussion

First, we measured the DC resistance of the magnetic core of the fluxgates using a differential RC low-pass filter composed of R=830 kΩ and C=100 nF, which is enough to effectively suppress the 52 kHz excitation frequency. For acquisition, we used a 7 ½ digit multimeter (Keithley DMM7510). We then used a resistive heating element to change the temperature in the proximity of the sensor emitting 2.5W for 24 minutes first and 10 W for 12 minutes later.

In Fig. 1 we can see how the output of the magnetometer is closely correlated to the DC voltage on the core, which is proportional to its resistance (the core is excited by a current source making the current independent on temperature-induced changes of the load). By knowing the temperature coefficient of the core resistance (0.02%/K) we could correct the output of the magnetometer using the measurement of the DC voltage across the core as an indicator of its temperature. In Fig. 1 we can see that the output, after this correction, is not showing the large variations due to the change of temperature.

We tested the same method by measuring the AC resistance demodulating the AC component of the excitation current on the core using the same type of demodulator used to demodulate the fluxgate output. We obtained similar results, highlighting that the observed phenomenon is in fact caused by the change of resistance of the wire and not by thermoelectric voltages.

We also measured the noise with and without the circuits for measurement of the resistance connected and we verified that the noise of the fluxgate is not affected by this measurement, namely we obtained in both cases 550 fT/√Hz, while the noise at 1 Hz is 0.85 pT/√Hz.

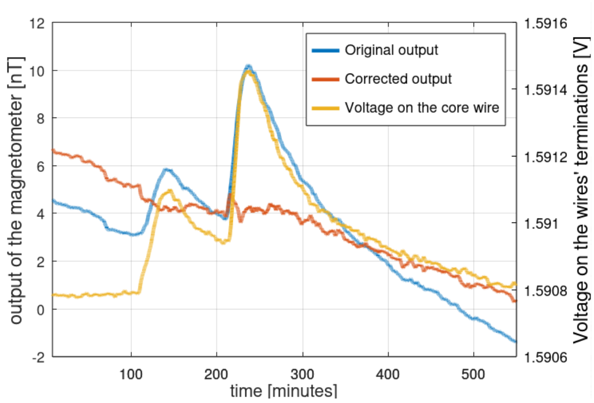


Fig. 1. Original output of the magnetometer (blue) and output corrected (red) using the voltage on the ferromagnetic core of the sensor (yellow).

Another important advantage of this method is that we can use it to correct the output drift caused by self heating of the magnetic wires caused by the excitation current in the transient after turing the magnetometer on.

Finally we will show how the proposed method performs better than using an external thermistor due to the fact that there is no delay in measuring directly the temperature and no additional disturbing DC currents.

## References

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