CASE STUDY

Mag649 Bartington's fluxgate adapted for Metrolab's THM1176 family

Like Bartington Instruments, Metrolab Technology SA builds magnetometers. The key difference is that Metrolab's magnetometers are designed for very strong fields. One of its product lines is a range of three-axis Hall effect magnetometers able to resolve up to 2μT, but even this is insufficient for some purposes. Metrolab has now been able to extend the resolution into the nT range, thanks to Bartington's Mag649 low-power three-axis fluxgate sensor.

Applications down to nT

Metrolab's THM1176 family of sensors is a range incorporating integrated drivers and amplifiers with highly integrated low-power electronic components and software control and display (see Figure 1). The result is a compact, portable instrument that Metrolab describes as essentially just 'a cable with some fat spots' (see Figure 2). While the range of products is ideally suited to measuring strong magnetic fields, its resolution is limited. The highest resolution product, the THM1176-LF ('Low Field'), has a range of 8mT and a resolution of 2μT. Even this is insufficient for (to take an example) measuring the small magnetic field fluctuations, perhaps due to elevators or ground currents, that could distort the images of an MRI scanner. In this example, even μT-level fluctuations, representing approximately 1 ppm (part per million) of an MRI system's main field, are relevant. It is important to assess these effects before installing the scanner, as this will influence the extent and type of magnetic shielding required, and to make periodic checks thereafter. A handheld, battery-operated system that could read at this resolution would allow the installer to perform such measurements easily, even on a construction site.

Integrating the Mag649

Measuring fluctuations at the μT-level calls for fluxgate rather than Hall technology. After evaluating several fluxgate magnetometers, Metrolab quickly settled on Bartington's Mag649. It was an ideal match for the THM1176 family, the key parameters being

Figure 1. Family portrait of Metrolab's 3-axis magnetometers. The line encompasses probes for fields up to 14T or, using a Bartington Mag649, down to nano-teslas.

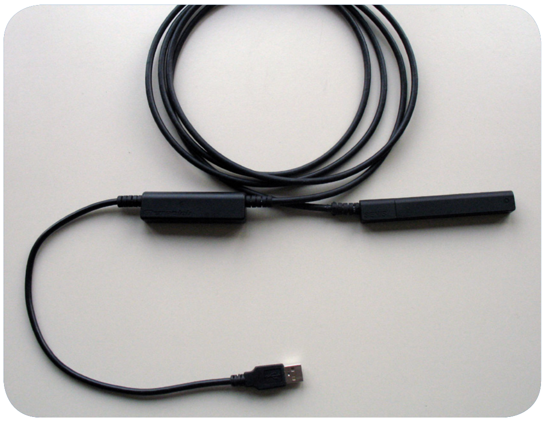

Figure 2. The complete magnetometer. The probe with the sensor is connected to a small dongle containing the instrument electronics, which in turn is powered and controlled via USB.

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three axes, low power, compact form, robustness, ±100 μT measurement range, and 1 kHz bandwidth. Metrolab also comments that it has "noise figures that render all self-respecting Hall sensors green with envy." A prototype (see Figure 3) proved the concept's promise and was quickly developed into the final product, the TFM1186 Three-axis Fluxgate Magnetometer (see Figure 4).

Metrolab reports: "We now look forward to discovering what problems our customers will be able to address with this combination of a high performance, low power fluxgate sensor and an ultra-portable instrument system."

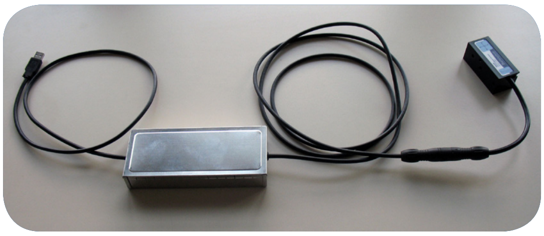

Figure 3. Prototype of the THM1176 electronics with a Bartington Mag649. The only required modification was the addition of differential receivers.

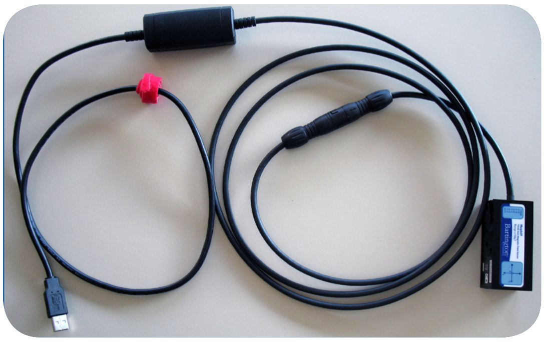

Figure 4. Metrolab's Three-axis Fluxgate Magnetometer, TFM1186. For simplicity, the differential receivers are on a second PCB, requiring a slightly larger housing than for the THM1176.

Magnetometer principles

Hall Effect

A continuous current is passed through a thin slab of semiconductor material. When the material is placed in a magnetic field, the electrons of the current are deflected to one side of the slab. This produces a potential difference between the two sides of the slab, creating a detectable voltage that is proportional to the magnetic field. Therefore measuring this voltage provides information about the magnetic field that produced it. Hall effect magnetometers are often used to regulate or provide information about moving machinery or strong magnetic fields.

Fluxgate

Two coils are wrapped around a magnetically susceptible core. An alternating current is passed through the first coil, which induces an alternating magnetic field in the core. This induces a current in the second coil. In a magnetically neutral environment, the currents in the two coils will be the same. If the core is exposed to a background field, it will be magnetised more easily when it is aligned with that field and less easily when it is not. Hence the magnetic field and the induced output current will be out of step with the input current. Thus, measuring the output current provides information about the external influences on the magnetic field produced by the core.