

Interactive comment on “A radiation hardened digital fluxgate magnetometer for space applications” by D. M. Miles et al.

Anonymous Referee #1

Received and published: 28 February 2013

1. The analysis of the modern state of the space borne, radiation tolerant fluxgate magnetometers would be very useful. It is particularly advised to compare the proposed magnetometer design with those reported in the following papers:

Highly integrated front-end electronics for spaceborne fluxgate sensors, by W. Magnes et al 2008 Meas. Sci. Technol. 19 115801 doi:10.1088/0957-0233/19/11/115801
The THEMIS Fluxgate Magnetometer, by H.U. Auster Space Sci. Rev. DOI 10.1007/s11214-008-9365-9

Miniaturized digital fluxgate magnetometer for small spacecraft applications, by Åke Forslund et al 2008 Meas. Sci. Technol. 19 015202 doi:10.1088/0957-0233/19/1/015202

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



All these instruments have the digital structure and the first two are radiation tolerant. Some data, e.g., correlation analysis principles, are already discussed there with better output. Necessary to compare also the advantages of principal solutions proposed in the paper.

2. Page 6, row 15. Eq. 2 is given without reference and probably is true only for the special case when the induction of the sense winding is much less than its active resistance $R_{winding}$. For ordinal fluxgate sensor in short-circuit configuration shown in Fig.4 the amplifier output voltage V_{out} should be proportional to the relative permeability $\mu_r(t)$, but not to its derivative ($d\mu_r(t)/dt$) as it follows from Eq. 2.

3. Page 6, rows 21 – 25. The V_{out} could contain a number of the even harmonics ($2f$, $4f$, $6f$, etc.) of the excitation frequency f , but not only $2f$ as it is claimed.

4. Page 7, rows 1-5 and Fig. 5. It seems that responses at the large fields (+24820 nT and -24430 nT) go into saturation and the shape of the signal is distorted. So, these plots hardly indicate the true shape of the signal at large fields.

5. Page 7, rows 6-8. If I correctly understand the ADC samples the preamplifier output two times per excitation period and then the average value for even number of samples is calculated. Using such detection technique all low frequency fluctuations of the preamplifier and the ADC itself will be added to the useful signal. It is necessary to mention how much this contribution could increase the pure fluxgate sensor noise and zero offset temperature dependence.

6. Page 8, rows 15-22. For feedback field temperature compensation Acuna et al. (1978) used the temperature variations of the feedback coil resistance rather than its impedance. The inductivity of the feedback coil could also be temperature dependent. From this point of view the sentences *“However, it is intentionally unbalanced so that the voltage to current conversion factor depends on the coil impedance. This dependence on coil impedance is then tuned until the temperature effects of the coil impedance and the coil geometry are equal and opposite.”* is not clear enough to un-

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



derstand what parameter of the coil is used for temperature compensation.

7. Page 9, rows 13-14. It is not clear what were the criteria for the selection of the instrument resolution 8 pT. The spectral density of the quantization noise at such resolution and frequency band is only 0.11 pT/rtHz ($8 \text{ pT}/\sqrt{12 \cdot 450 \text{ Hz}}$). Is it really needed to keep such small value (only 1 % of the sensor noise)? As the main parts of the magnetometer (Analog-to-digital and digital-to analog converters) strongly depend on resolution, its value should be properly selected.

8. Page 9, rows 18-20. There is no proof of the 24 noise-free bits of digital-to-analog converter. Please, see the previous comment for the quantization noise estimation.

9. Page 10, rows 3-6. It is not clear why sharing 2 bits from two 10-bit converters the 16-bit converter instead of 18-bit one is obtained.

10. Page 10, rows 7-9. Combining of two digital-to-analog converters may potentially produce a non-linear output. The results of the linearity tests are not presented in the paper.

11. Page 11, rows 15-17; Fig. 7. In the text it is declared that "...the amplitude of the sideband carriers is constant up to 1500 Hz ...", but in Fig. 7 these sideband amplitudes vary in the range

– (24 ... 44) dB.

12. Page 12, rows 21-24. The tests justifying the effective ADC resolution are not clear. As it is parameter of the ADC it has to be measured without influence of the sensor noise, but tests were performed with sensor. It is unclear also why the effective resolution is checked in the frequency domain, but not in the time domain.

13. There is no the frequency response analysis of the magnetometer. Particularly, it is interesting how the 3-pole low-pass filter in the feedback loop (page 9, rows 5-6) influences on the frequency response. As this filter introduces a considerable phase shift, the magnetometer could become a self-oscillating system at some conditions.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



What measures were taken to avoid this? Maybe the irregularities of the noise spectra in the band 100-300 Hz (Fig. 8 - 10) are caused by this reason.

Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss., 3, 31, 2013.

GID

3, C1–C4, 2013

Interactive
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

