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The SMILE fluxgate sensor: performance and possibilities of improvement.

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The Small Magnetometer in Low-Mass Experiment (SMILE) is a miniaturized triaxial fluxgate magnetometer with volume compensation incorporating efficient signal processing algorithms within a field programmable gate array (FPGA). SMILE was designed in collaboration between the Lviv Centre of Institute for Space Research (LC ISR) in Ukraine where the sensor was developed and the Royal Institute of Technology (KTH) in Stockholm, Sweden where the electronics used to operate the instrument were designed and programmed.
The SMILE magnetometer compares well with modern digital FGMs in resolution (20 bit, corresponding to 0.1 nT per bit) and sample rate (up to 250 sample per second), but has significantly lower consumption (about 260 mW), smaller size (the sensor - 20x20x20 cubic millimeters, the first prototype of the electronic board – 120x80 square millimeters) and lower weight (the sensor - 21 g and the board - 80 g).
Using the cubic coils for volume compensation, optimizing the sensor design and using Macor for main sensor parts resulted in achieving uniquely stable geometric parameters for such a small sensor. A calibration of the SMILE instrument was carried out at the Nurmijarvi Geophysical Observatory, showing high linearity (deviation no more than 6 nT along total ± 50 μT scale) and low orthogonality error (<22 arcmin). The temperature coefficients of the scale factors were below 11 ppm/C and the deviation of the magnetic axes was about 3 arcsec per C in the range of -30 to +45 centidegrees.
The bar-core fluxgate sensors are based on the two strips of amorphous Co–Fe–Si–B alloy of the dimensions 16x1x0.02 cubic millimeters. The sensors noise level is less than 30 pT/sqrt(Hz)at 1 Hz that it is rather good for such modest magnetic core volume.
In the recent publications [1-3] the peculiarities of the electronic unit design, the signal detection algorithm and the results of the numerical simulation of the sensor magnetic core behavior during its excitation were described.
In this report the possibilities to reduce total power consumption and noise level of the SMILE instrument will be considered.
First of all we will present a new approach to the synthesis of the compensation coil system that allows considerably enlarge the sensor length relatively to the coil system dimensions simultaneously keeping the errors caused by compensation field non-uniformity as small as possible. The novel approach is based on the fitting of the spatial distribution of the compensation field to the sensor core dimensions. Another advantage of the proposed technique is rather simple construction of coil windings. The experimental test bench and the results, which prove the effectiveness of the proposed solution, will be described too.
Secondly, the analysis of the consumed power of the magnetometer components will be made. Basing on the improved design of the super low power analogue magnetometer LEMI-031 recently developed in LC ISR, the applicability of the novel engineering solutions for decreasing power consumption of both the sensor and some electronic blocks of the SMILE instrument will be considered.
And finally the possibilities of the noise level decreasing of the sensor will be studied. The last issue is very important for successful using of the modified version of the SMILE instrument in the Global Electromagnetic Moon Surveyor (GEMS) payload for the Indian spacecraft Chandrayaan-II.

Reference:

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