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Tiny magnetic field measurement system onboard satellites by using an ASIC chip

MAGNES, Werner[1*], Hans Hauer[2], Aris Valavanoglou[1], Matthias Oberst[2], Harald Neubauer[2], Irmgard Jernej[1], Christian Hagen[1], Wolfgang Baumjohann[1]

[1]Space Research Institute, Austrian Academy of Sciences, [2]Fraunhofer Institute for Integrated Circuits

Scientific instruments for space applications are required to reduce their resource requirements, such as volume, mass and power while at the same time achieving at least the same performance as conventional instruments. So it is important that especially the instrument front ends and readout units undergo miniaturization.

A front-end ASIC (Application Specific Integrated Circuit) for magnetic field sensors based on the fluxgate principle (Magnetometer Front-end ASIC, MFA) has been developed that reduces the required power for the active readout electronics by a factor of 10 as well as the area needed on a printed circuit board by a factor of 3-4 compared to magnetic field instruments e.g. aboard Venus Express (ESA).

The concept of the MFA is based on a combination of the readout electronics of a conventional fluxgate magnetometer with the control loop of a delta-sigma modulator in order to get an optimized signal-to-noise ratio with a reasonable oversampling factor. The analog part of the MFA contains altogether four 2-2 cascaded sigma-delta modulators. Three of those modulators are having the fluxgate sensor in their control loops for a direct analog-to-digital conversion of the sensor output. The fourth modulator is unmodified and connected to the output of an eight-to-one multiplexer for housekeeping measurements (e.g. temperatures of MFA and fluxgate sensor). The single-bit outputs of the cascaded modulators are processed by a digital tuning logic for generating a fourth-order noise shaped and digitized output signal. The digital part includes primary (128Hz output) and secondary decimation filter stages (2, 4, 8, to 128Hz output) as well as a serial synchronous interface (data are transmitted with 24 bit resolution). The chip area (0.35um CMOS from austriamicrosystems) is about 20mmˆ2 and the total power consumption is 60mW (drive power for the fluxgate sensor is not included).

The achieved performance and radiation robustness can be summarized with THD $>$ 95dB, SNDR in field mode $>$ 85dB, offset stability $<$ 10pT/degC and $<$ 0.2nT/100h and TID $>$ 300krad. A first space magnetometer equipped with the MFA will fly aboard a 4-satellite NASA mission called Magnetospheric Multiscale (launch in 2014).

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