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Author: Dr. Stephan Busch
Fraunhofer EMI, Germany, stephan.busch@emi.fraunhofer.de

Dr. Peter Koss
Fraunhofer IPM, Germany, peter.koss@ipm.fraunhofer.de
Mr. Clemens Horch
Fraunhofer EMI, Germany, clemens.horch@emi.fraunhofer.de
Mr. Konstantin Schaefer
Fraunhofer - Institut für Kurzzeitdynamik, Ernst-Mach-Institut (EMI), Germany, konstantin.schaefer@emi.fraunhofer.de
Dr. Martin Schimmerohn
Fraunhofer - Institute for High-Speed Dynamics, Germany, martin.schimmerohn@emi.fraunhofer.de
Dr. Frank Schäfer
Fraunhofer EMI, Germany, frank.schaefer@emi.fraunhofer.de
Dr. Frank Kühnemann
Fraunhofer IPM, Germany, frank.kuehnemann@ipm.fraunhofer.de

MAGNETIC CLEANLINESS VERIFICATION OF MINIATURE SATELLITES FOR HIGH PRECISION POINTING

Abstract

The increasing utilization of miniature satellites in more and more demanding scientific and commercial applications gives rise to tough pointing requirements for the small platforms. Apparently, the residual magnetic dipole becomes the dominant source of disturbances for the compact and often resource-limited systems operating in LEO. In the past years, magnetic cleanliness issues led to significant performance degradation in several CubeSat missions.

Unfortunately, the utilization of permeable materials cannot always be avoided when relying on efficient state-of-the-art COTS technology such as a high-performance miniaturized cryogenic cooler. Hence, the precise identification of the residual magnetic dipole becomes evident in order to enable compensation of disturbance torques by the attitude control systems which are typically selected with low performance margins.

While the residual dipole moment can be easily estimated in orbit, the verification of magnetic cleanliness requirements in the laboratory becomes challenging for small satellite systems. On the one hand, the requirements itself tend to be proportional to the satellite's moment of inertia, thus scaling approximately with the fifth power of the satellites cubic side length. On the other hand, the measured magnetic field strength drops with the third power of the distance to the magnetic dipole source. Thus, the robust identification of a multi-dipole model for a small satellite becomes unfeasible in standard laboratory environments as the signal-to-noise ratio of necessary magnetic field measurements in the satellite's far field decreases with decreasing satellite size.

In order to qualify a nano-satellite carrying a capable commercial infrared telescope for Earth observation, Fraunhofer EMI and IPM developed a test setup for precise characterization of small residual dipole moments. The procedure bases on the automated collection of comprehensive rotational field scans in three individual axes. The scans are then used to optimize a multi dipole-model describing the magnetic

characteristics of the satellite. The setup allows to determine orientation and dipole strength for individual small components even within laboratory environment. However, as the qualification of the integrated satellite requires enhanced SNR to identify small moments from larger distances, a magnetically shielded room is required.

This contribution describes procedure, facilities, and test results obtained during qualification of our first nano-satellite. While preliminary tests at the magnetically super-shielded room (BMSR-2) at PTB have already been conducted, a dedicated magnetically shielded room is currently set up at IPM. It is anticipated that the test facility can offer cost-efficient access to an automated test procedure for magnetic cleanliness qualification for miniature satellite systems of the NewSpace domain.