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A low-cost commercial off-the-shelf GNSS receiver for space

Gregor Moeller[1], Alexander Wolf[2], Flavio Sonnenberg[2,3], Gerald Bauer[1], Benedikt Soja[2], and Markus Rothacher[2]

[1]Department of Geodesy and Geoinformation, TU Wien, Vienna, Austria (gregor.moeller@geo.tuwien.ac.at)
[2]Institute of Geodesy and Photogrammetry, ETH Zurich, Zurich, Switzerland
[3]Now at: ERNI, Bern, Switzerland

The era of tracking artificial Earth satellites using Global Navigation Satellite Systems (GNSS) began in the early 1980s when a GPS receiver was launched onboard the Landsat-4 mission. Since then, a large number of Low Earth Orbiters has utilized constantly improved GPS receivers for timing and positioning. GNSS has become a key technique not only for satellite orbit determination but also for atmosphere sounding. With the increasing popularity of miniaturized satellites in recent years, the need for an adapted GNSS payload for nanosatellites arose. Therefore, we developed a small-size, versatile payload board using commercial-off-the-shelf (COTS) low-cost multi-GNSS receivers with extremely small weight, size, and power consumption.

The receiver firmware enables multi-constellation navigation solutions and GNSS raw data output in space with a sampling rate of up to 20 Hz. With this configuration, we can retrieve the required GNSS code and carrier phase measurements, e.g. for precise orbit and attitude determination, to monitor the total air density from drag, the distribution of the electron content, or scintillation effects. The high demands on GNSS receiver performance lead to particular requirements for hardware, payload software, onboard computing, data downlink, and remote control, which will be briefly discussed in the presentation. The resulting low-cost GNSS board fits into a 0.25U form factor, and the modular design makes it a scalable and adaptable payload for CubeSat missions.

In this presentation, we will provide insight into the performance of the GNSS payload under simulated orbit conditions and highlight the necessary modifications that allow us to transform a COTS GNSS receiver into a scientific instrument for space applications.