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THE GPS NAVIGATION AND OCCULTATION EXPERIMENT (NOX) ONBOARD TET-1 – RESULTS AND EXPERIENCE AFTER ONE YEAR IN SPACE

Abstract

The German TET-1 (Technologieerprobungsträger) satellite is a small-scale spacecraft developed within the national On-Orbit-Verification program, primarily intended to provide research institutions and companies with flight opportunities for new technologies. TET-1 has been successfully launched on July 22nd, 2012, from Baikonur onboard a Soyuz-FG. In total, TET-1 accommodates eleven technology payloads, including the Navigation and Occultation Experiment (NOX).

NOX is composed of a main unit, containing a commercial off-the-shelf (COTS) dual-frequency PolaRx2 GPS receiver by Septentrio and an electrical interface board, two GPS antennas, one pointing to the zenith and the other in anti-flight direction and a relay for switching between these antennas. The PolaRx2 is a geodetic-grade GPS sensor designed for terrestrial applications and provides measurements for up to 16 satellites.

Primarily goal of the experiment was to demonstrate the suitability of a COTS based GPS sensor for LEO applications and to characterize its space performance. A secondary objective was to assess the capability of a GPS receiver to gather space data for scientific applications such as Precise Orbit Determination (POD) or GNSS radio occultation measurements.

Due to technical constraints the GPS payload was operated in an intermittent mode, with activation slots of typically 12-24 hours once per week. Neither a single-event-effect nor any other malfunction has been observed during the mission. The time-to-first-fix has been measured to range between 1.5 and 3 minutes. And up to 15 GPS satellites were tracked simultaneously . A comparison of onboard navigation fixes with a ground-computed POD solution revealed an average precision of about 1.5m RMS. The radio occultation experiment has shown that dual-frequency carrier-phase signals can be tracked through the Earth's troposphere with an update rate of 5 Hz. A bending angle profile for L1 and L2 carrier-phase measurements has been successfully derived in the troposphere down to an impact height of 10 km.

Following a description of the TET-1 satellite and an outline of the NOX payload, the paper provides a summary of the performed qualification tests. The main part of the paper is then devoted to the analysis of the acquisition and tracking behavior and performance of the receiver. The results are illustrated and discussed and the applied methodology is explained. Moreover, the tracking results obtained with the

occultation antenna are summarized. Finally, the suitability of COTS receiver technology for "simple" navigation tasks onboard a satellite as well as for scientific high-end POD and radio occultation applications is assessed.