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PERFORMANCES OF A LOW-COST COMMERCIAL GNSS RECEIVER IN LEO

Abstract

Small-Satellite missions are slowly closing the gap with bigger space missions in terms of performances and value-added data. A greater number of companies are basing their analyses on data sourced from CubeSat constellations, which in turn require an adequate level of navigation precision for data geotagging and for constellation housekeeping maneuvers, to maintain the required relative geometry. Miniaturization and the advancement of consumer electronics are also increasing performances of commercial components, with navigation Systems-on-a-Chip now able to receive and process data from most navigation constellations simultaneously, thus increasing the overall fixing precision. GAUSS has been developing, manufacturing, and launching micro-satellites since 2000. One of the company's objectives is the use of commercial-off-the-shelf (COTS) components, instead of space-grade elements, to lower mission costs, as well as gaining valuable insights on the space effectiveness of such items. GAUSS' latest satellite, launched on March 22nd, 2021, included several original subsystems developed specifically for this and future missions. A GPS navigation subsystem based on a low-cost, COTS element was designed and employed in UNISAT-7 mission. It was conceived using lean-satellite philosophy, with a swift development, assembly, and testing phase. The first prototype's 3D fix in LEO orbital conditions was accomplished in GAUSS' RF laboratory, using a multi-satellite GPS signal simulator developed using software-defined-radios and open-source software. An increment in reliability of the flight subsystem was assured by a selective, manual revision and strengthening of critical elements on the electronic board, to mechanically secure key components and guarantee an endurance level suitable for space conditions. The system was then verified in TVAC and during environmental test sessions at flight qualification levels. The GNSS receiver was coupled with a COTS L1 active microstrip antenna, typically employed on civilian aviation leisure aircraft, and low-loss RF cables. The system was activated days after the release in orbit of UNISAT-7 and first 3D fix occurred shortly after its cold start in space. System performances were verified against 3D positions calculated using NORAD two-line-elements (TLE) and SGP4 propagators. An algorithm was implemented at ground to recreate a TLE based on several fix data obtained by the system in space, to pose the grounds for an automated computation of TLEs directly in space, on next GAUSS' small-satellite missions. This work will delve into ground testing, customized board preparation for flight, IOD mission and comparative results between the data sourced from the boarded GNSS solution and NORAD TLE orbital data.