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# GNSS RECEIVER FOR Q-SAT AND ITS ANALYSIS OF PRECISE ORBIT DETERMINATION


## Abstract

Q-Sat, a small satellite used for jointly detecting atmospheric density and gravity field in Leo, was designed by the School of Astronautics of Tsinghua University and launched on August 6, 2020. Q-Sat weighs 21.2kg and the mission orbit height is 499.3km, which is China's first satellite dedicated to the scientific measurement of gravity and atmosphere, as well as the world's first purely spherical satellite. The spherical configuration can ensure that the atmospheric resistance of the satellite has nothing to do with the attitude, meeting the needs of low-cost atmospheric density measurement. In order to achieve the mission requirements of high-precision atmospheric density and gravity field measurement, the precise orbit determination data must be at the centimeter level, which puts forward high requirements for the GNSS receiver. In order to reduce costs, the GNSS receiver for Q-Sat is based on commercial product, which had passed the filtering, space adaptability modification, firmware optimization and performance test and transformed into the THSS GNSS receiver. The modified receiver can not only receive GPS-L1\L2, BD1\BD2 and other multi-system multi-frequency navigation satellite signals, but also operate normally on a high dynamic platform with a speed of 8km/s and an acceleration of 8g. The data update rate of the receiver is up to 20HZ, the cycle slip rate is less than 0.9% and the frame loss rate is less than 3.0%. The receiver supports multiple functions such as navigation, precise positioning and orbit determination in -45 to 80 degrees Celsius. The THSS GNSS receiver has been verified in orbit on the Q-Sat, and the receiver is operating normally. Through precise orbit determination analysis of on-orbit flight data, and excluding low altitude and abnormal observation data, the average number of available satellites per epoch is 7.50. The precise orbit determination of the satellite is carried out by the reduced dynamics method, and the change of the coincidence residual within the phase of the ionospheric combination shows a trend of decreasing with the increase of the altitude angle. The RMS of the residual is 2.57cm, 3.09cm, 2.91cm in the radial, tangential and normal directions, respectively, and the RMS of the three-dimensional residual is 4.96cm. The positioning accuracy of the THSS GNSS receiver meets the mission requirements of high-precision atmospheric density and gravity field measurement, laying the foundation for the earth's gravity field and atmospheric density inversion in the future.