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TOWARDS A GNSS-ASSISTED AUTONOMOUS HETEROGENEOUS CLOCK SYSTEM FOR VERY SMALL SATELLITES IN THE EARTH-MOON SYSTEM

Abstract

There is an increasing interest in science and exploration missions in the Earth-Moon system. These missions call for simple, efficient and accurate timing onboard of these spacecraft.

A heterogeneous onboard timing system is proposed, presented and characterized, which comprises an Oven-Controlled Crystal Oscillator (OCXO) and one or several Chip Scale Atomic Clocks (CSACs), providing nano-second timing accuracy on time scales of seconds to hours. To extend the stability of this system to days, weeks and months, it is assisted by a Global Navigation Satellite Systems (GNSS) timing receiver, which is operated in snapshot mode and activated only for very short time durations of a few seconds on a daily or weekly basis, based on the mission needs. This innovative GNSS assistance replaces the ground-based synchronisation and offers an autonomous operations of the onboard timing system. In this way, a highly accurate yet very low Size, Weight and Power (SWaP) system can be realized, which can be used on very small satellites down to nano-satellites.

The onboard architecture of this system is presented and characterised in terms of its achievable Allan deviations as well as its SWaP. It is found that the power consumption can be as low as 2.2 W, based on a daily GNSS synchronisation schedule, significantly reducing the power requirements over current state-of-the-art solutions. An even less complex variant of this innovative system can be employed for any deep space or planetary mission, replacing the onboard GNSS timing receiver by a traditional time synchronisation mechanism using a terrestrial ground station, or, in the further future, using a pulsar.