Atomic Clocks and Timing Systems in Global Navigation Satellite Systems

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Accurate and ultra-stable atomic clocks have been recognized as the critical equipment for the precision Global Navigation Satellite Systems (GNSS). SpectraTime (SpT) and T4Science (T4S) are space and ground clocks manufacturers of Rubidium Atomic Frequency Standard (RAFS) and Active & Passive Hydrogen Maser (HM) for various navigation systems (European, Chinese and Indian) and other programs.
More than 100 SpT RAFS more than 50 Passive HM units are flying around the globe. As for ground application, more than 24 T4S Active HMs are involved in different GNSS ground segment worldwide, and one passive HM is in progress in the frame of a ground development program.

Key words: Global Satellite Navigation System.

This paper describes for space RAFS and HM performances and life-time tests, as well as onboard clock performances.
 A short overview of the ground GNSS timing reference segment with its active Masers and associated disciplining algorithms will be given. Even these standard Rubidium and maser technologies have been proven to be highly reliable and robust those could be subject to perturbations and could exhibit some anomalies , especially when exposed to single event radiations , magnetic field perturbations etc.… With those elements in hands, a presentation of novel onboard techniques to generate highly robust timing signal directly from the satellite onboard One CLock Ensemble (ONCLE) is presented. Performances achievements in presence of perturbations, and frequency jumps are also shown allowing a continuous and uninterrupted operation of the satellite navigation signals.
Futher developpement of the next generation of Galileo Clock like mini-Maser, RAFS II & Mercury Ions trap clocks will be described as well of possible new techniques using LEO satellites combining booth navigation & communication ,taking benefits of mini-Rubidium recently designed and already tested under radiations .

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