66th International Astronautical Congress 2015

SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advanced Technologies for Space Communications and Navigation (5)

Author: Mrs. Marina Gioia
Selex ES S.p.A, Italy, marina.gioia@selex-es.com

Mr. Alessandro Piana
Selex ES S.p.A., Italy, alessandro.piana@selex-es.com
Dr. Marco MOLINA
Selex ES, Italy, marco.molina@selex-es.com
Mr. Davide Hazan
Selex ES, Italy, davide.hazan@selex-es.com
Dr. Salvatore Micalizio
INRIM, Italy, s.micalizio@inrim.it
Dr. Aldo Godone
INRIM, Italy, a.godone@inrim.it
Dr. Filippo Levi
INRIM, Italy, f.levi@inrim.it
Dr. Claudio Calosso
INRIM, Italy, c.calosso@inrim.it

INDUSTRIALISATION APPROACH OF THE POP ATOMIC CLOCK FOR APPLICATION TO GNSS

Abstract

Since 2007 Selex ES, in collaboration with INRIM, has been studying the possibility to develop a Pulsed Optically Pumped (POP) clock suitable for the needs of future Navigation Systems, such as high frequency stability, low failure rate for more than 10 years mission time, ability to withstand space radiation, low sensitivity to environmental perturbations, reduced mass and power consumption. The POP clock is a vapour cell frequency standard operating in pulsed regime at the Rb ground-state hyperfine frequency (6834 MHz). Selex ES interest in this technology relies on the possibility to implement a compact device, with improvement in terms of mass, size and power consumption compared to a passive hydrogen maser (PHM), but with a similar frequency stability and less operation constraints. A first feasibility study [1] (under an ASI contract) based on the maser approach was concluded in 2009 leading to a preliminary design for space use (mass 10.8 kg max, power consumption 45 W max). Further studies, carried out at INRIM under an ESA contract , with the partnership of Selex-ES, demonstrated that the optical detection improves the frequency stability performances, while reducing the complexity of the clock design. Specifically, a frequency stability of 1.7x10-13 at 1s and 5x10-15 until 50000 s has been demonstrated [2] (drift ¡10-14/day), a result fully compliant to the GALILEO PHM specifications. Moreover, the design simplification leads to further reduction in terms of mass (¡ 9 kg), size and power consumption (¡ 40 W). This paper presents the Selex ES industrialization approach required to pass from a laboratory successful prototype to a POP engineering model designed for space environment and offering clock performances at the state of the art in terms of frequency stability, mass, power consumption and cost. This work was supported by the European Metrology EM Model Unit Layout Research Program (EMRP project IND55-Mclocks). The EMRP is jointly funded by the EMRP participating countries within EURAMET

and the European Union. [1] M. Belloni et al., A space rubidium pulsed optical pumped clock – Current Status and future activities, PTTI 2009 [2] S. Micalizio et al., Metrological characterisation of the pulsed Rb clock with optical detection, Metrologia vol. 49, pp.425-436, 2012