A Method of Satellite Autonomous On-board Clock Monitoring Using High-stability Crystal Oscillator

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Atomic clock anomaly is one of the main reasons for hazardous misleading information(HMI) generation in space. As an important aspect of satellite autonomous integrity monitoring(SAIM), satellite autonomous on-board clock monitoring can perform the observation and detection of on-board atomic clock anomalies without assistant of the ground segment. The benefit is that each satellite can independently monitor the status of atomic clock and generate the alarm flag in real-time, avoiding the influence such as limitation of location and number of ground monitoring stations, multipath, interference and so on. As a result the requirement of time-to-alert(TTA) could be relaxed to achieve and the results are more reliable. This paper presents a method of satellite autonomous on-board clock monitoring in SAIM receiver, which takes advantage of the short-term good characteristics of high-stability crystal oscillator. Using digital phase locked loop(DPLL) to keep the frequency of 10.23MHz generated by high-stability crystal oscillator synchronized with the on-board atomic frequency standard, while the loop is locked the clock phase error and frequency bias between the two frequencies are measured and processed, then the integrity flag of clock monitoring can be generated after comparing the measurements value to the preset threshold. Simulation results and experimental data show that using the method proposed in this paper the accuracy of clock phase and frequency monitoring can achieve 0.018ns and 0.26mHz respectively while the time to generate the clock integrity flag is no more than two seconds.