# Autonomous Frequency Jump Detection and Correction for On-board Navigation Payload

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Objective and Requirement

- [ ] Frequency jumps are common in rubidium frequency sources caused by either environmental disturbances or internal malfunctions.

- [ ] Affects the estimation of user position in navigational satellite systems

- [ ] Frequency errors accumulated over time will result in a significantly large user ranging error varying up to several meters

- [ ] The response time for jump correction from ground station is around several minutes, which is insufficient for critical applications.

- [ ] The best way to reduce the time for jump correction is by onboard detection and onboard correction

- [ ] Onboard jump correction reduces the time from several minutes to few seconds.
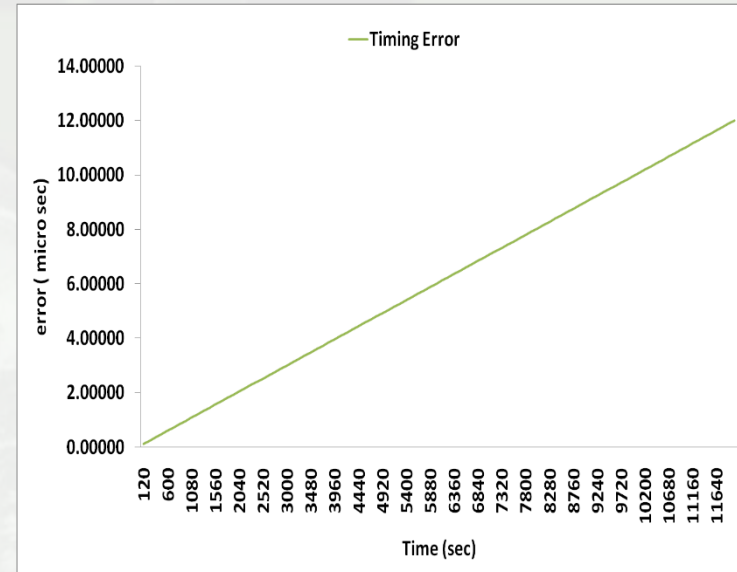
Because of initial accuracy of RAFS of the order of 1e-9

THE POSITION ERROR WITHOUT RE SYNCHRONIZATION IN 2 HOURS WILL BE:
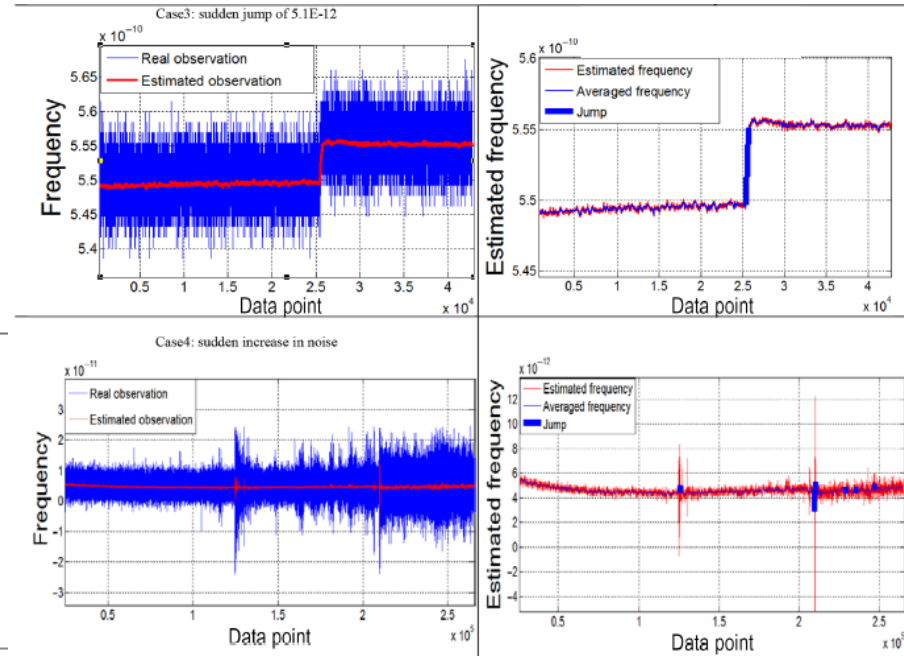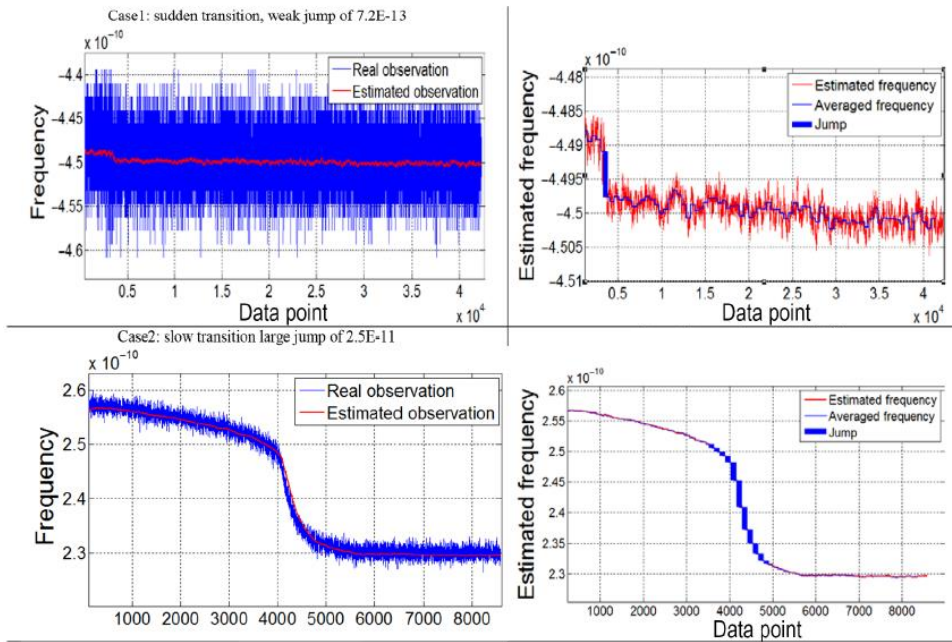
5.4 KM!!!

- Firmware uses three RAFS clocks, two test and one main to monitor and confirm jumps in master clock

- Two continuously running phase meters provide phase difference data of master clock w.r.t. test clocks

- Novel Kalman filter based Jump detector detects and calculates the jump value

- Jump correction algorithm calculates the frequency tuning word and gives to digital synthesizer

- Digital waveform is converted to analog and given to hybrid PLL for correction in payload clock
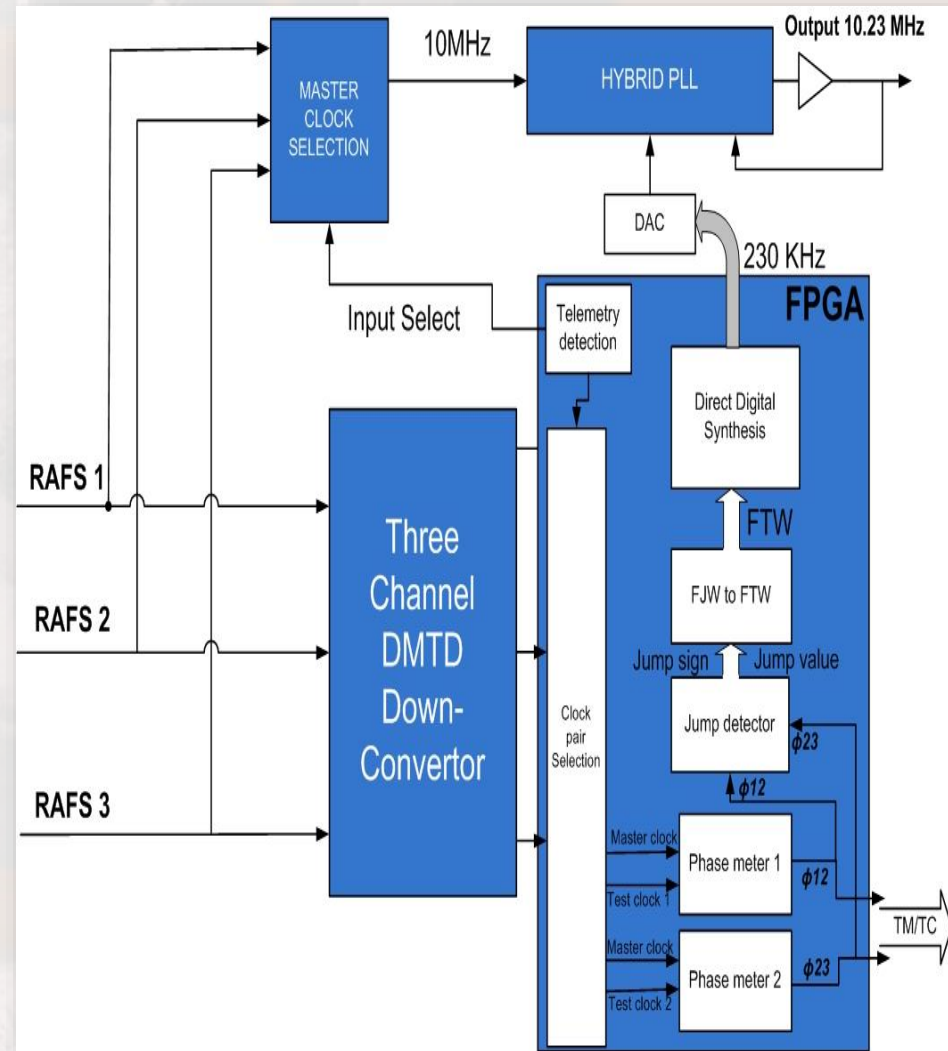
- ➢ Two jump detector are used to monitor and confirm frequency jump in master clock

- ➢ Frequency Jump Word (FJW) is converted to Frequency Tuning Word for Direct Digital Synthesis (DDS)

- ➢ This correction algorithm is suitable for DDS and hybrid PLL based design for 10.23MHz payload clock generation.

Evaluation and Result
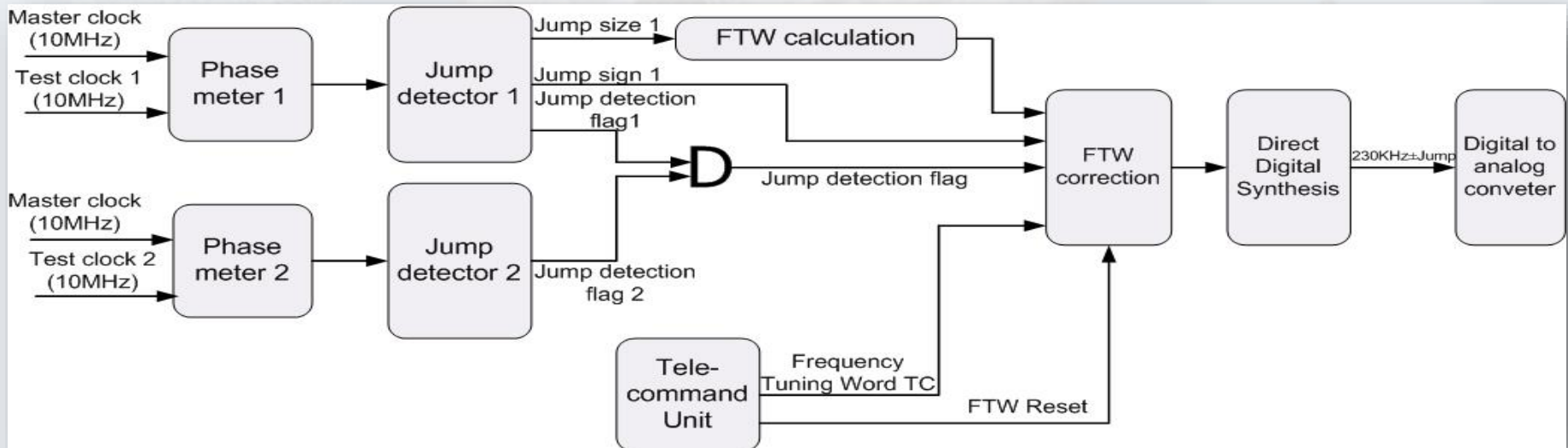
- Simulation analysis on in-orbit RAFS phase telemetry data of navigation satellite is performed

- Data for different jump type i.e. sudden jump, weak jumps, sudden arbitrarily noise is used and their results are verified

- Hardware testing carried out for this algorithm using DMTD based phase meter hardware.

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Thank You