A Holdover Clock achieving

+/-1.5uS over 3 days

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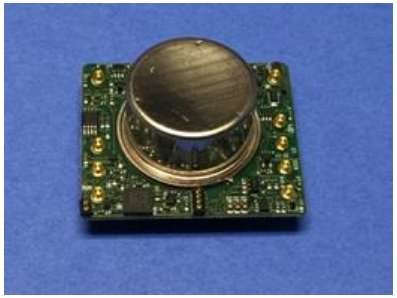
TAITIEN

PLETRONICS
Innovations in Frequency Control

Agenda



- Introduction
- The Problem
- The Solution

Summary

Introduction

Quartz **Bar**, **Wafer**, **Blank**

Thickness/Pressure/
Temperature **Sensor** Crystal

Metal Can **Crystal**

SMD **Crystal**

General Purpose &
Precision SMD **Clock Oscillator**

Voltage Controlled
Crystal Oscillator (**VCXO**)

Fast Delivery Products
(**XO/VCXO/TCXO**)

Voltage Controlled
Temperature Compensated
Crystal Oscillator (**VCTCXO**)

Oven Controlled
Crystal Oscillator (**OCXO**)

Timing Module

The Problem

- Today's Communications systems require more precise network synchronization & holdover capability

- The transition to next generation, packet-based, networks makes sync technology more challenging, because packet-based networks do not naturally deliver synchronization.

- This means synchronization and holdover must be engineered into the system

The Problem, cont.

- If the Networks timing or synchronization reference is lost
  The network's ability to maintain time or “holdover” is critical

- Selecting a well thought out Sync / Holdover strategy is the first step.
  GPS is not always the solution.
  Loss of GPS, GPS denial or GPS spoofing could be issues

- Holdover capability is not the only need.
  Today’s systems need to consider
  cost, performance, size and power

Available Solutions for Holdover

- Cesium Beam clock
  The primary standard <<1us for 3 days.
  bulky, power hungry and cost $$$$.
- Rubidium clock.
  cost, size and power are more practical
  has difficulty meeting <1.5us holdover for 3 days
  under all conditions
- Quartz OCXO
  Best cost, size, power and life.
  Typical units not able to meet performance
  But significant progress has been made.

Need High Performance but Low Cost Solution

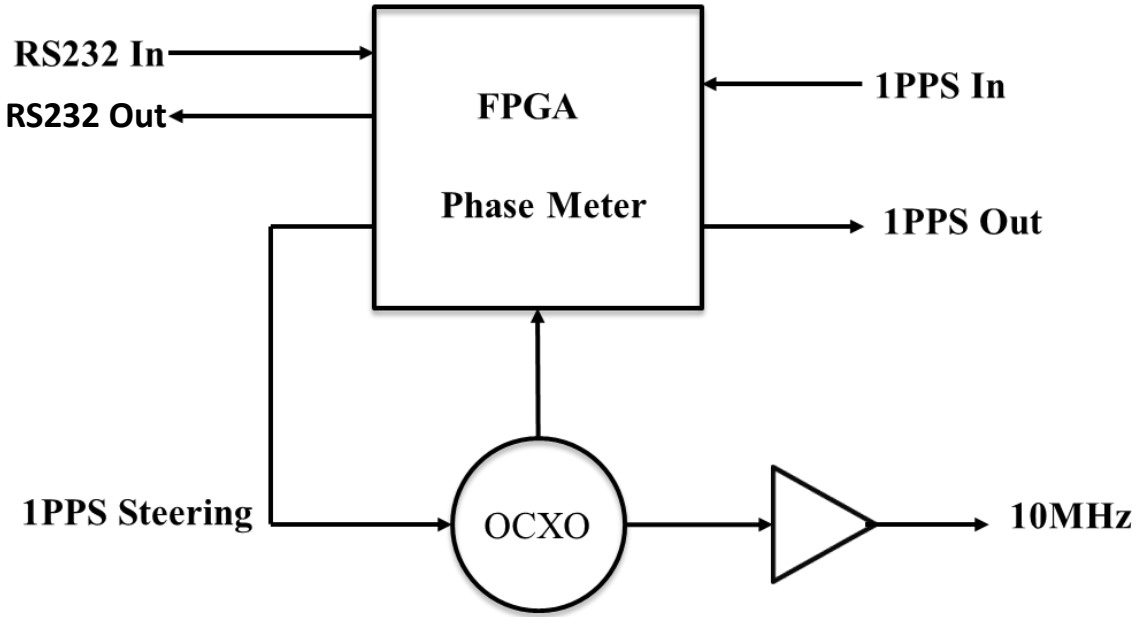
Full Performance Timing Module

- Low End Rubidium grade performance
  +/-1.5 uS / 3 days
- 1PPS disciplined
- Adaptive Algorithm
- Quartz Technology

Advantages for Quartz Technology

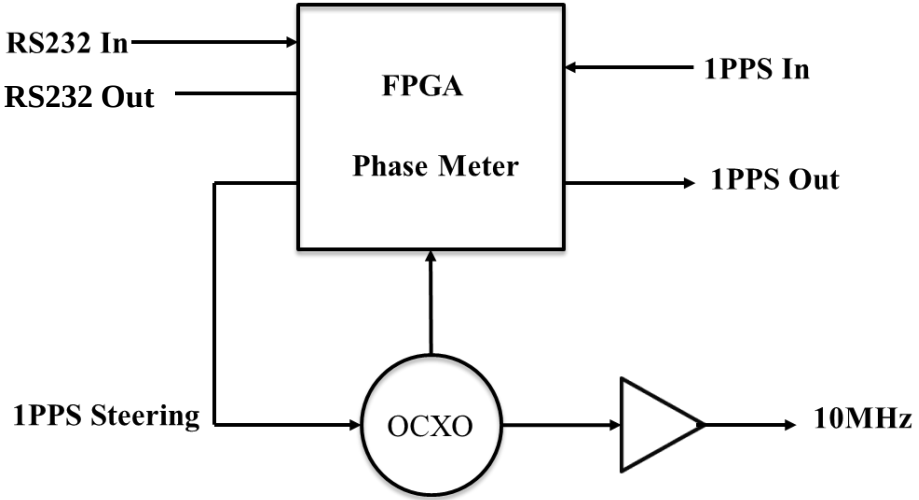
- Low Cost
- Low Power
- Small size and less weight
- High Reliability for long life
- High Performance, achieving +/-1.5 uS / 3 days

Holdover Clock – Block Diagram



Industry Partnerships for Key technologies

- High end Holdover Clock products
  - low power technology
  - high performance holdover clock Technology
- GPS Sync products
  - GPS Discipline Technology
- High end OCXO
  - Ultra-Low drift crystal
  - High Stability Oven Design



Continuous Improvement

Crystal Manufacturing and Oscillator Design

- Ultra-Low drift crystal Technology
  - High Q quartz processing
  - Enhanced Crystal finishing technology
  - Repeatable Aging performance
- High stability oscillator design methodology
  - Low Power circuit design enhancements
  - High stability temperature controllers
  - Low drift oscillator circuit design

Continuous Improvement

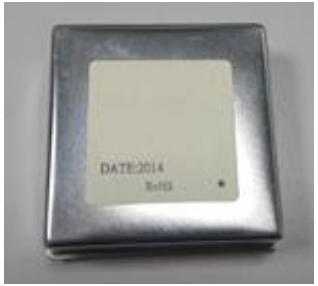
Improved Characterization and Modeling

- Proprietary GPS disciplining
  - High resolution phase measurement
  - 1pps jitter filtering
- Improved Thermal modeling
  - Reductions in thermal transit disturbance
  - Improved retrace characteristics
- Improved algorithm on timing error prediction and correction

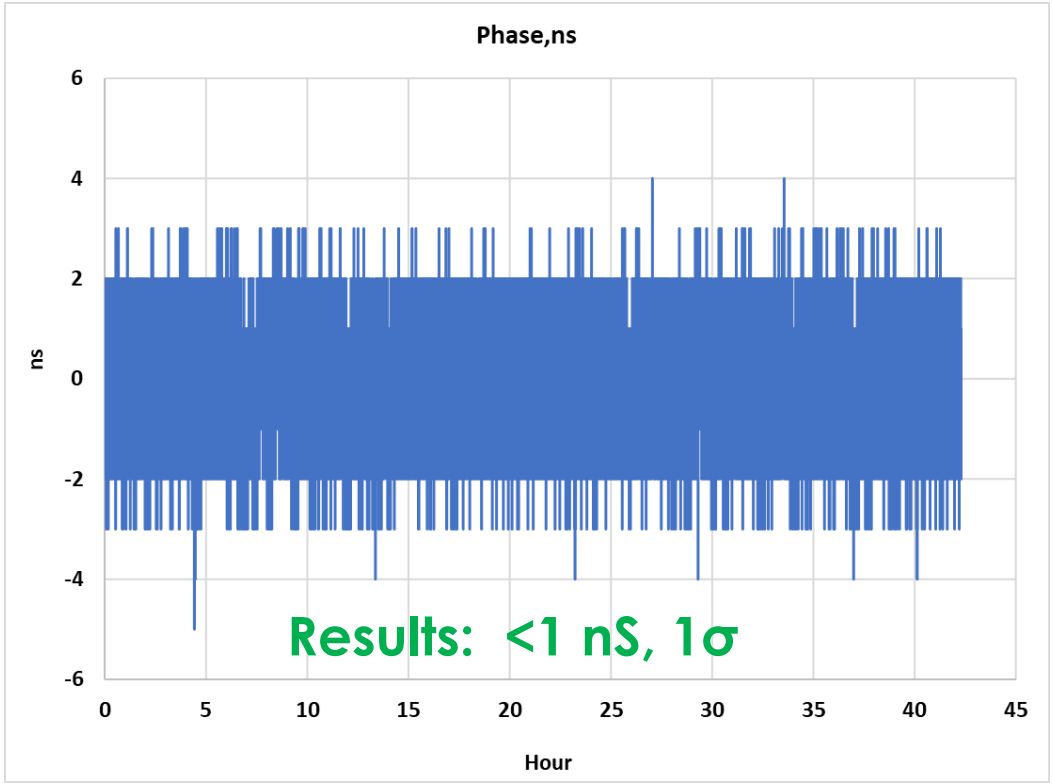
Full Performance Holdover Clock

A Quartz based 1PPS Disciplined Timing Module

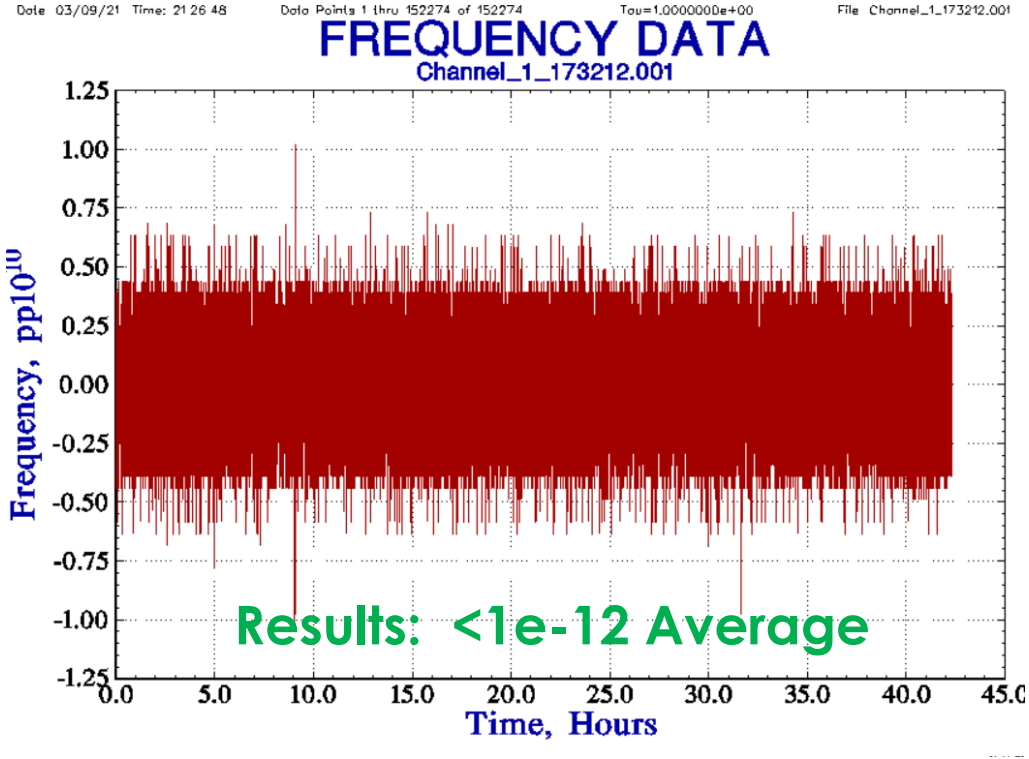
- Standard Frequency: 10MHz
- Disciplined 1pps Output: <1ns RMS in Phase,
  <10-12 in Frequency
- Holdover: <+/-1.5uSec. for 24 hours, △T=+/-10°C
  <+/-1.5uSec. for 3 days, △T=+/-3°C
  <+/-100uSec. for 7 days, △T=+/-5°C
- Power, 5V: 1.5W (Steady State at 25°C)
  125mW Low Power option
- Size: < 43 cc
- Operating Temperature Range: -20 to +70C



Discipline - Phase, typical

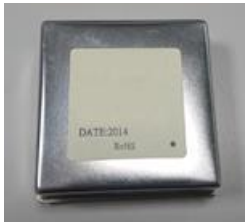


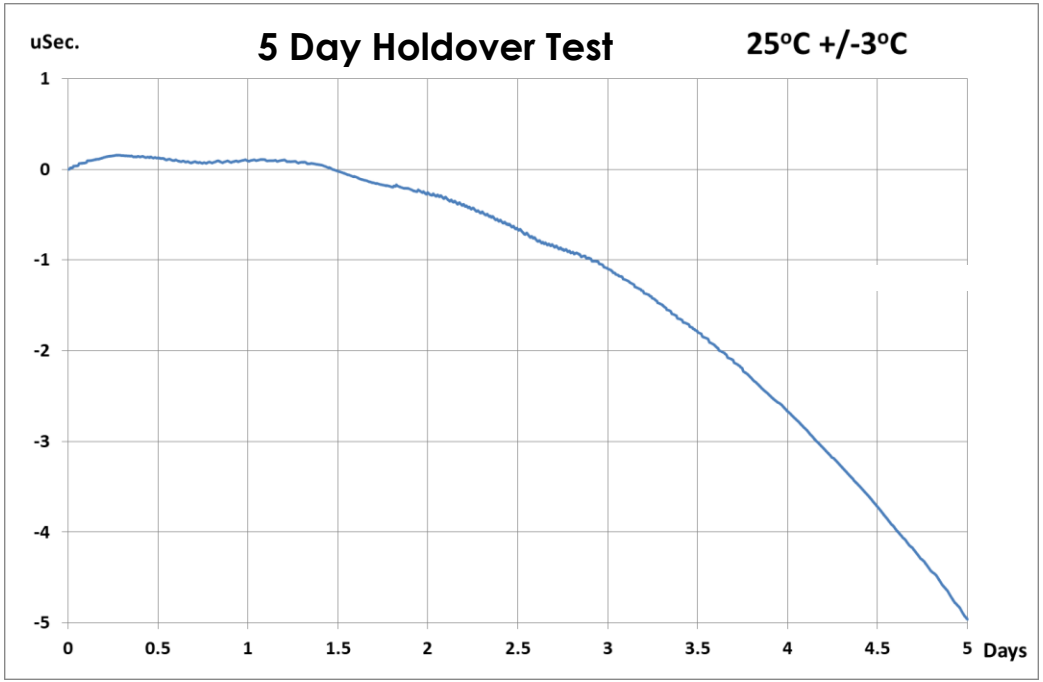
Discipline - Frequency Accuracy



Holdover - Constant Temp

Power on: 7 days
Discipline: 1 day
Holdover: 5 days, 25C
Results: 1.1 uS - 3 days
5.0 uS – 5 days

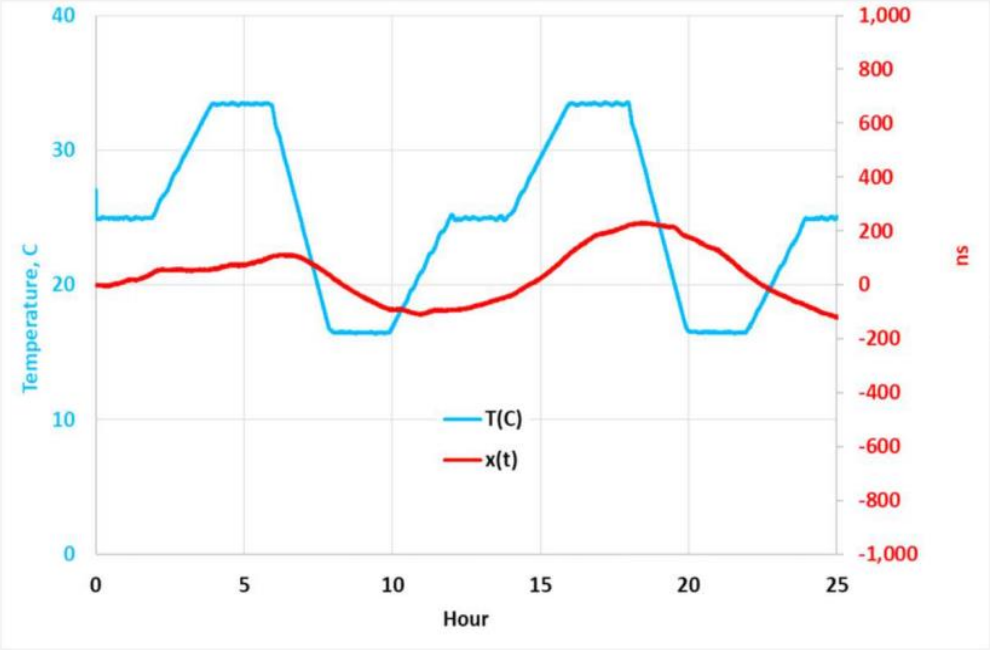




Holdover - Temp Variation, +/-10C

Power on: 7 days
Discipline: 1 day
Holdover: 1 day, +/- 10 C

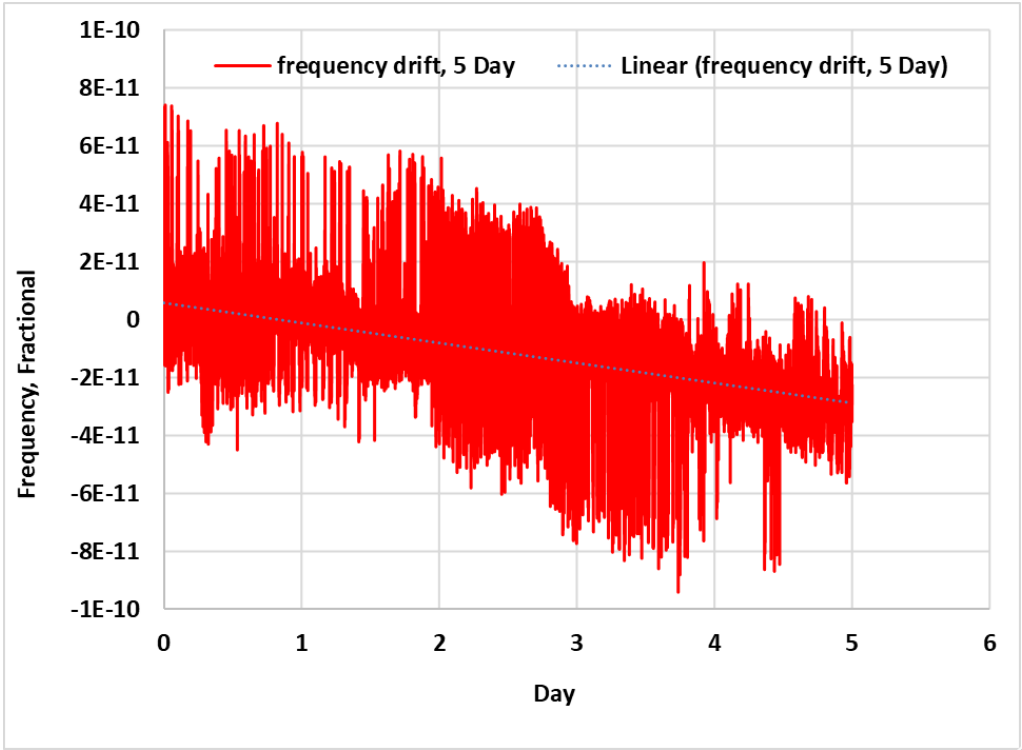
Results: +/- 200 ns



Holdover - Frequency Drift, 5 Day

Power on: 7 days
Discipline: 1 day
Holdover: 5 day, 25C

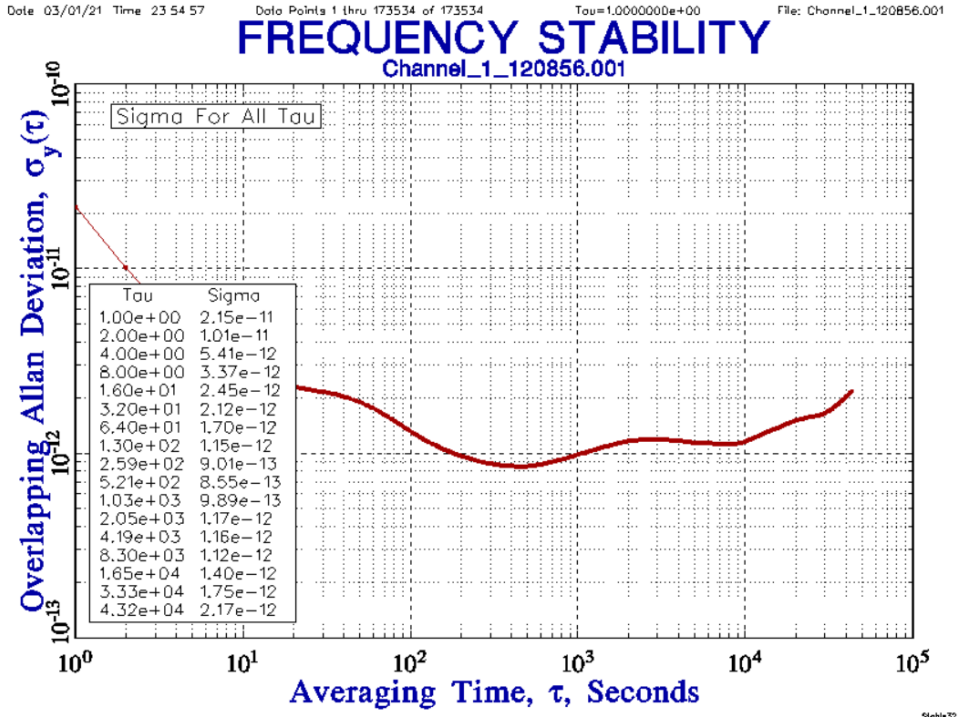
Results: <3 e-11/5 days
<6 e-12/ day



Holdover – Allan Deviation

Power on: 7 days
Discipline: 1 day
Holdover: 1 day, 25C

ADEV: <3 e-12/sec

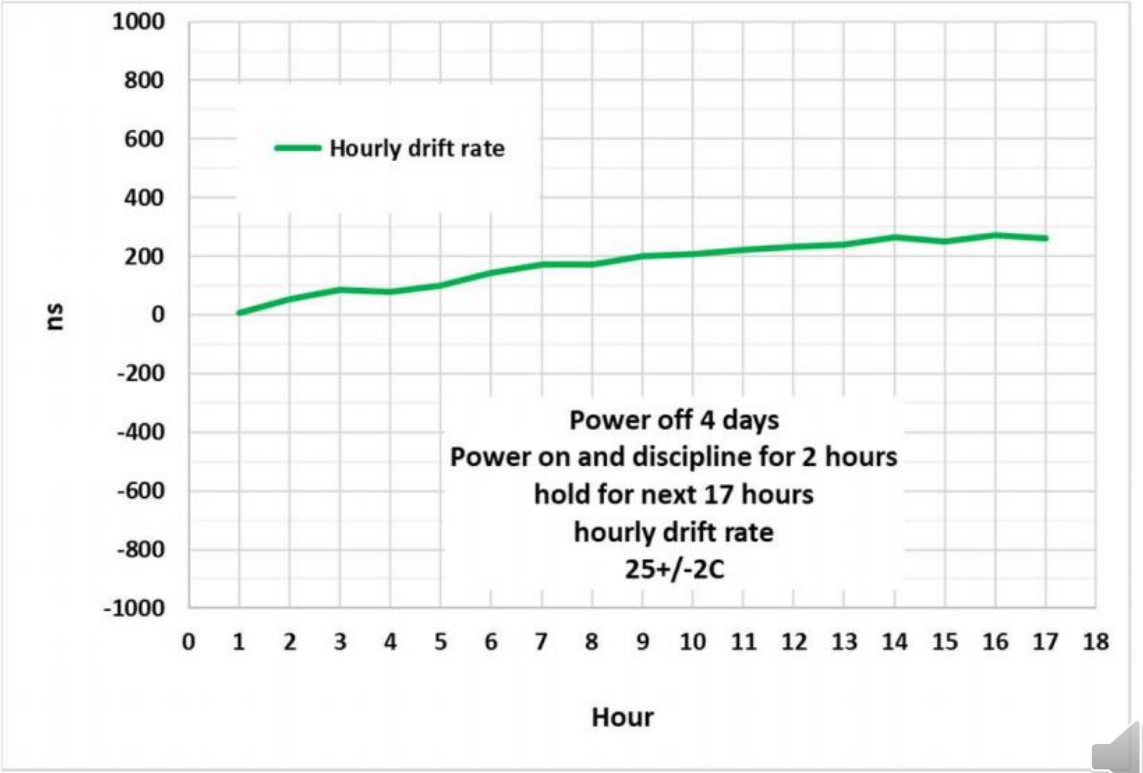


Holdover - Retrace

Power on: 7 days
Power off: 4 days
Power on & discipline: 2 Hrs.

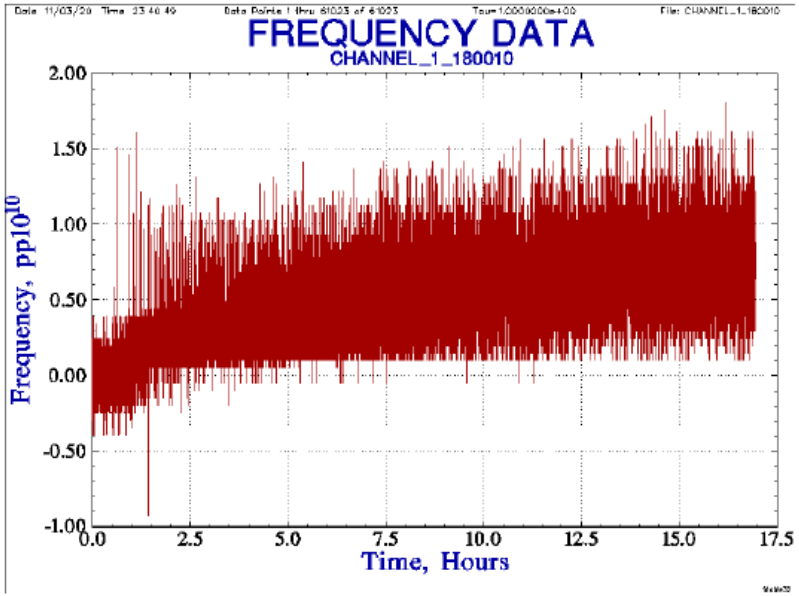
Holdover: 17 Hrs.

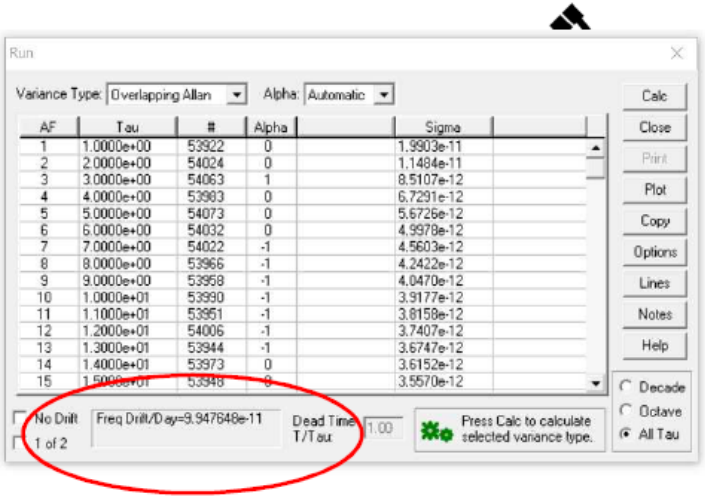
Hourly drift: < 270 nS



Holdover - Retrace

Power off 4 days, power on and discipline for 2 hours, holdover data in next 17 hours

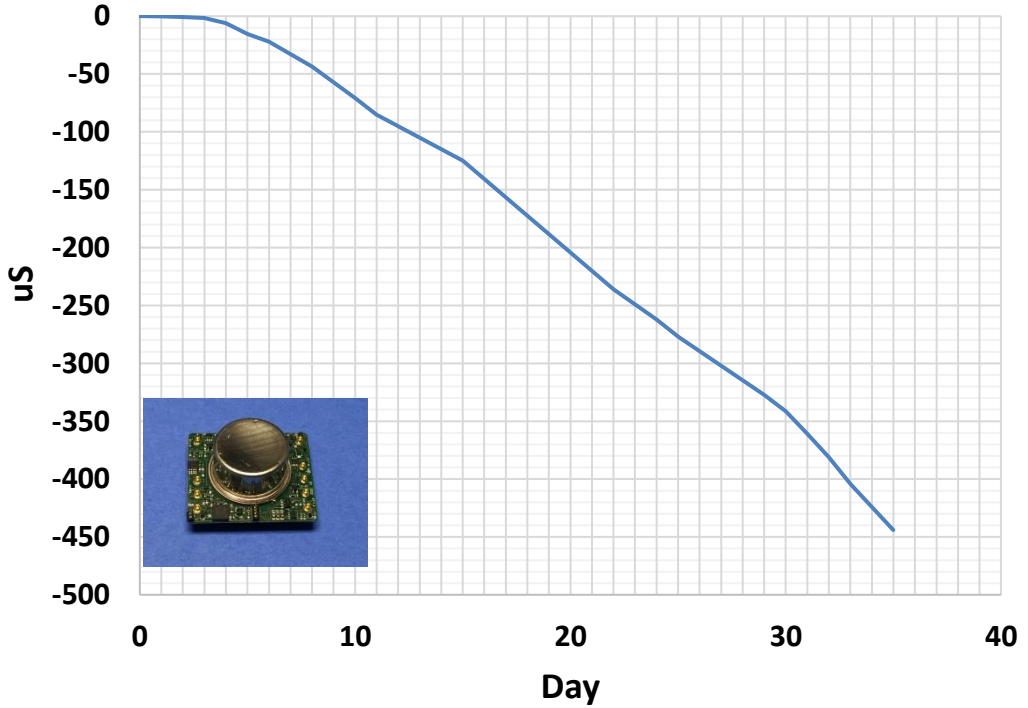




Holdover - Ultra-low power option,125mW*

Power on: 7 days
Discipline: 1 day
Holdover: 35 days,
25C+/-3C

Results: -1.5 uS - 3 days
-444 uS - 35 days



* 43 x 37 x 13 mm, -40C to +85C

Summary

Full Performance Holdover Clocks based on Quartz Technology are achieving

- High Performance, +/-1.5 uS / 3 days
- Low Power, 1.5W or 125mW
- Small Size
- High Reliability
- Low Cost
- Suitable for All Applications Requiring Exceptional Holdover Capability
- In active production

Thank you!

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