±1ppb MEMS OCXO Technology for Extended Holdover

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WSTS – May 9, 2024, San Diego, CA USA

SiTime

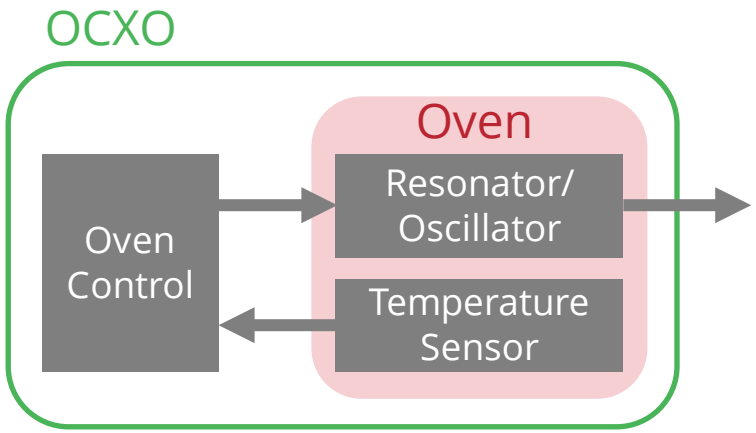
Agenda

1. Motivation
2. Construction
3. Performance
4. Summary

Traditional (Quartz) OCXOs

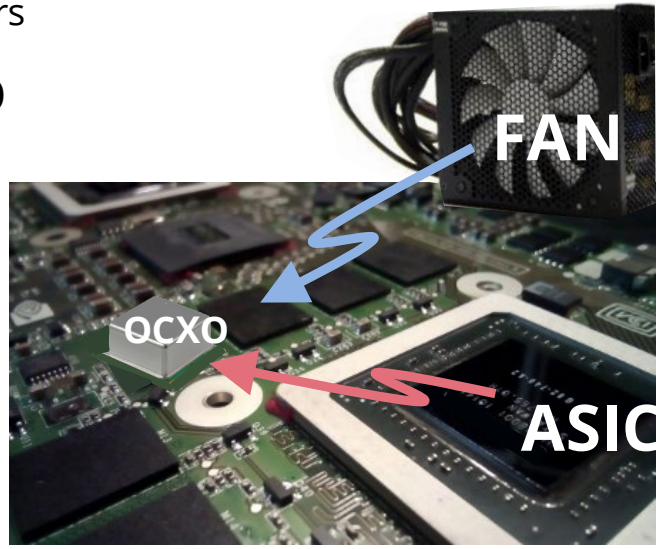
Construction

To minimize influence of ambient operating temperature, set oven temperature higher.

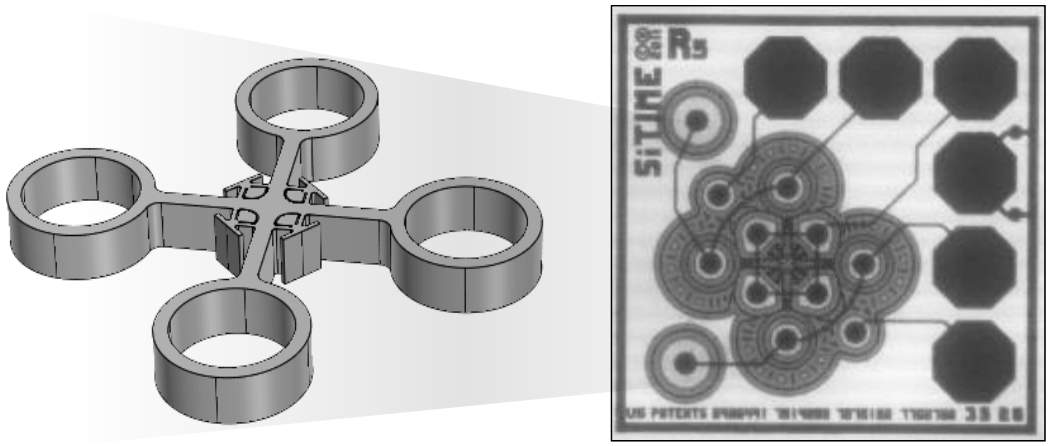


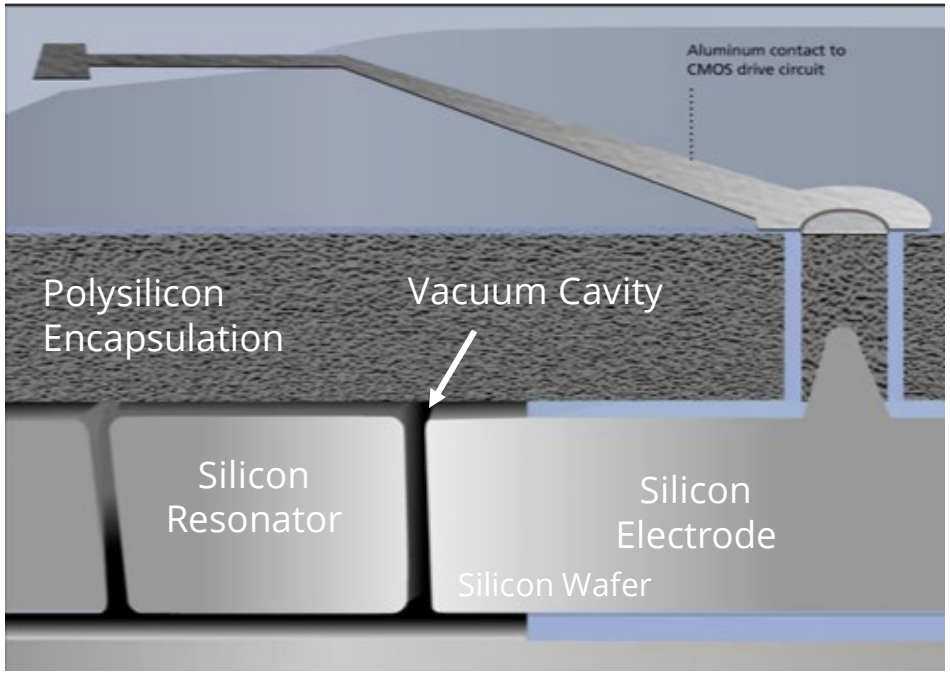
Limitations

- Limitations of traditional quartz OCXOs
  - Don't meet holdover targets in real world environments
  - Airflow, temperature changes impact performance
- Application
  - 5G equipment in densified deployment
  - DU in edge datacenters
- Solution – MEMS OCXO



Silicon MEMS Resonator Construction

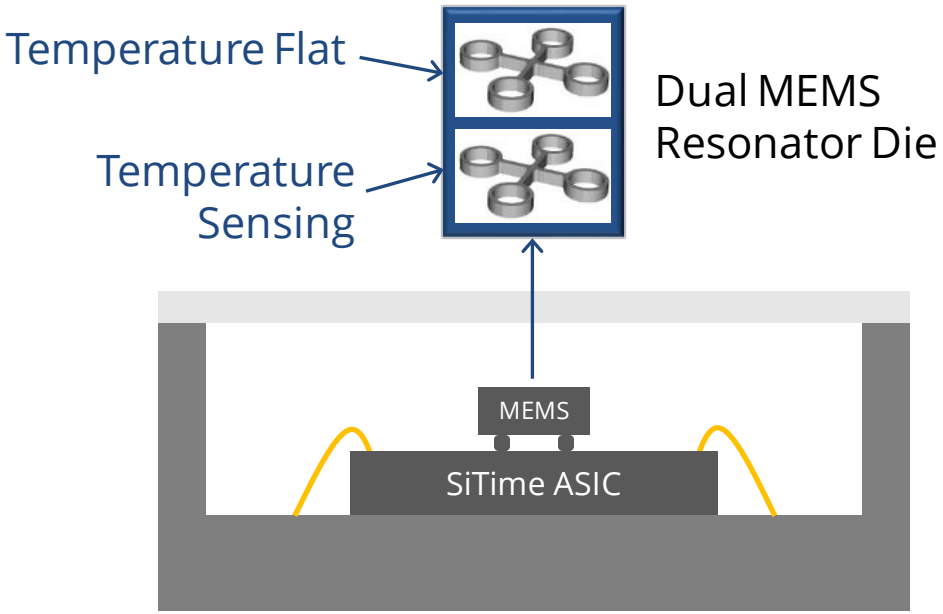




- 500 µm x 500 µm vacuum sealed resonator die
- Low weight, high tensile strength → high shock and vibration resistance
- 200k Q-factor → low noise, excellent stability
- Encapsulate resonator vacuum → high stability, low aging
- -55°C to 125°C operating temperature
- High volume scalable process

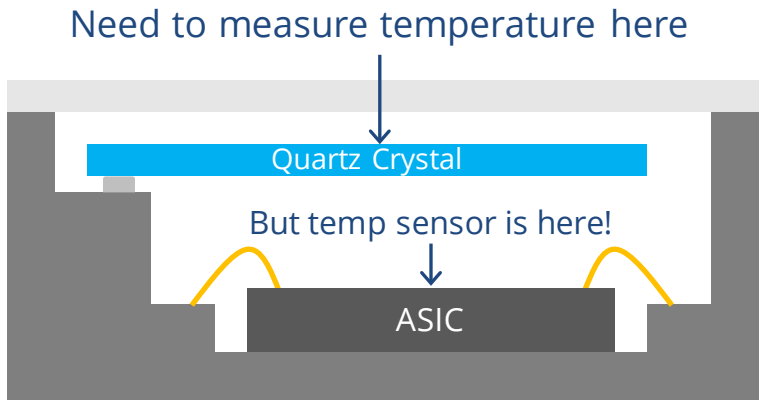
Dual-MEMS Resonator Designed for Improved Temperature Tracking

MEMS Temperature Sensor



- MEMS resonator and sensor are both silicon technologies, enables easy integration
- Excellent thermal coupling between two MEMS resonators in same die
- Enables compensation of fast temp changes

Quartz Temperature Sensor



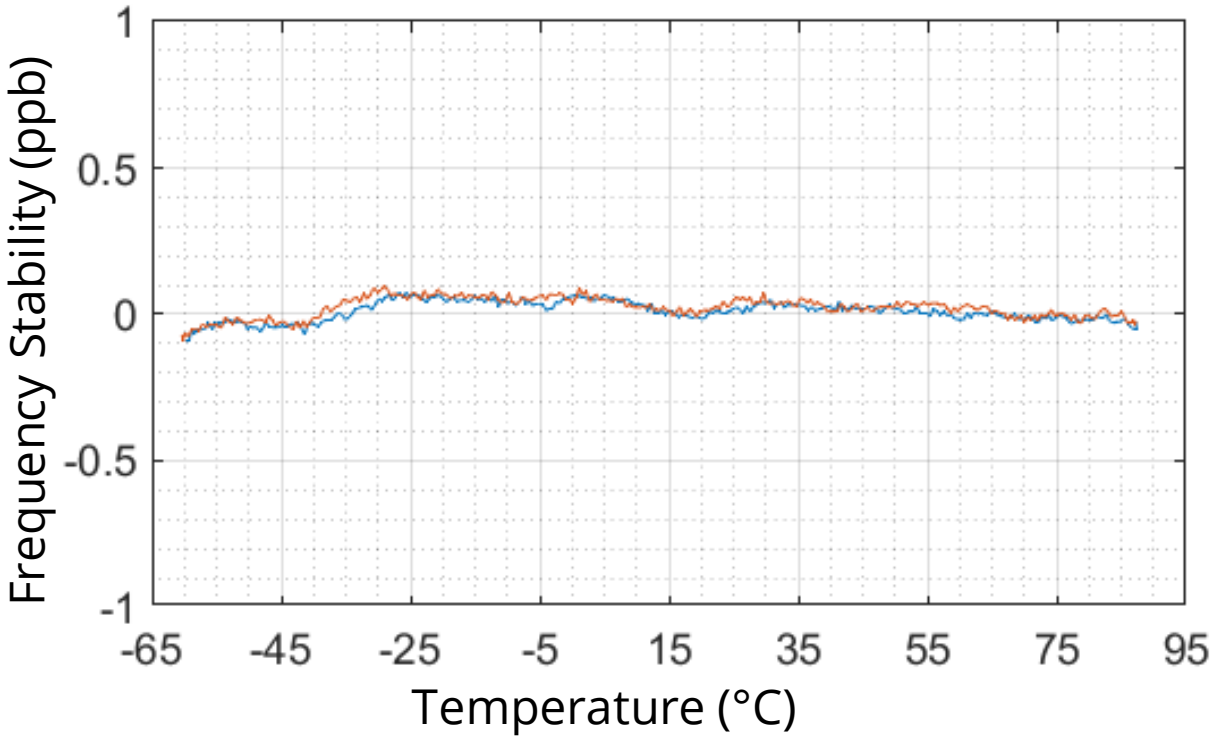
- Quartz resonator and silicon sensor are different technologies, limits how close can place together
- Physical separation limits thermal coupling, and thus response time to thermal gradients

Performance Benchmarks

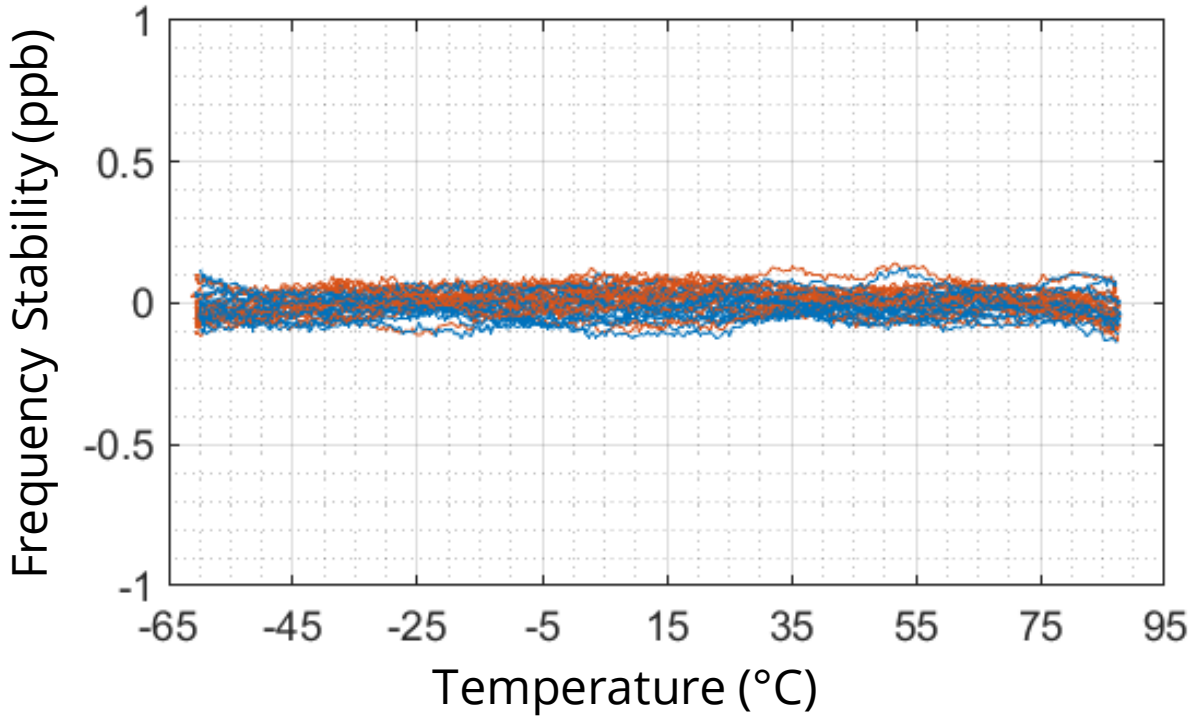
- ±1 ppb OCXOs
- Customers often select an OCXO based on its frequency stability
- Benchmarks use popular quartz device that customers compare it against

Dual-MEMS Technology – Frequency versus Temperature

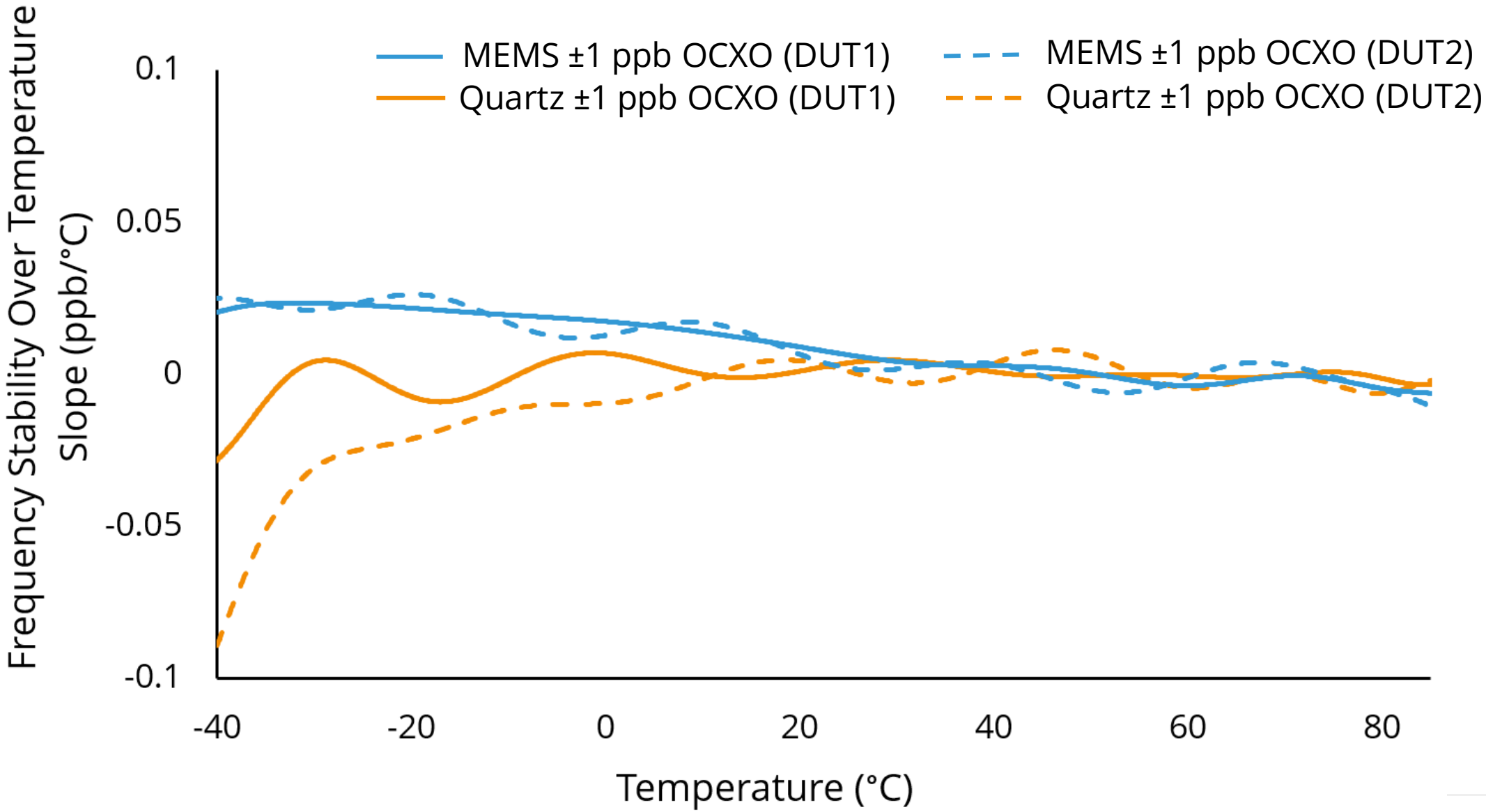
Single Device – Minimal Hysteresis



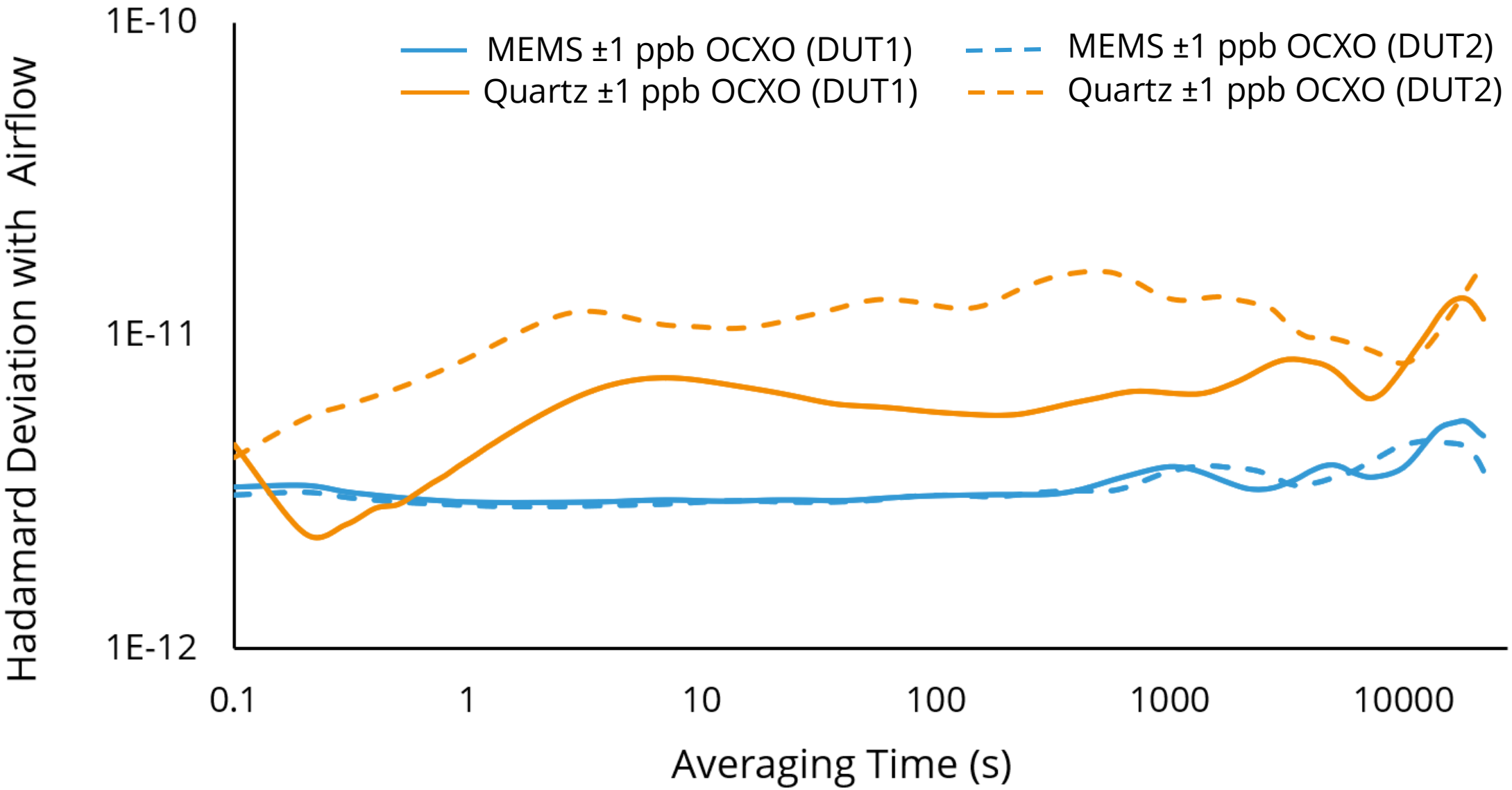
20 Devices – Low variation part-to-part



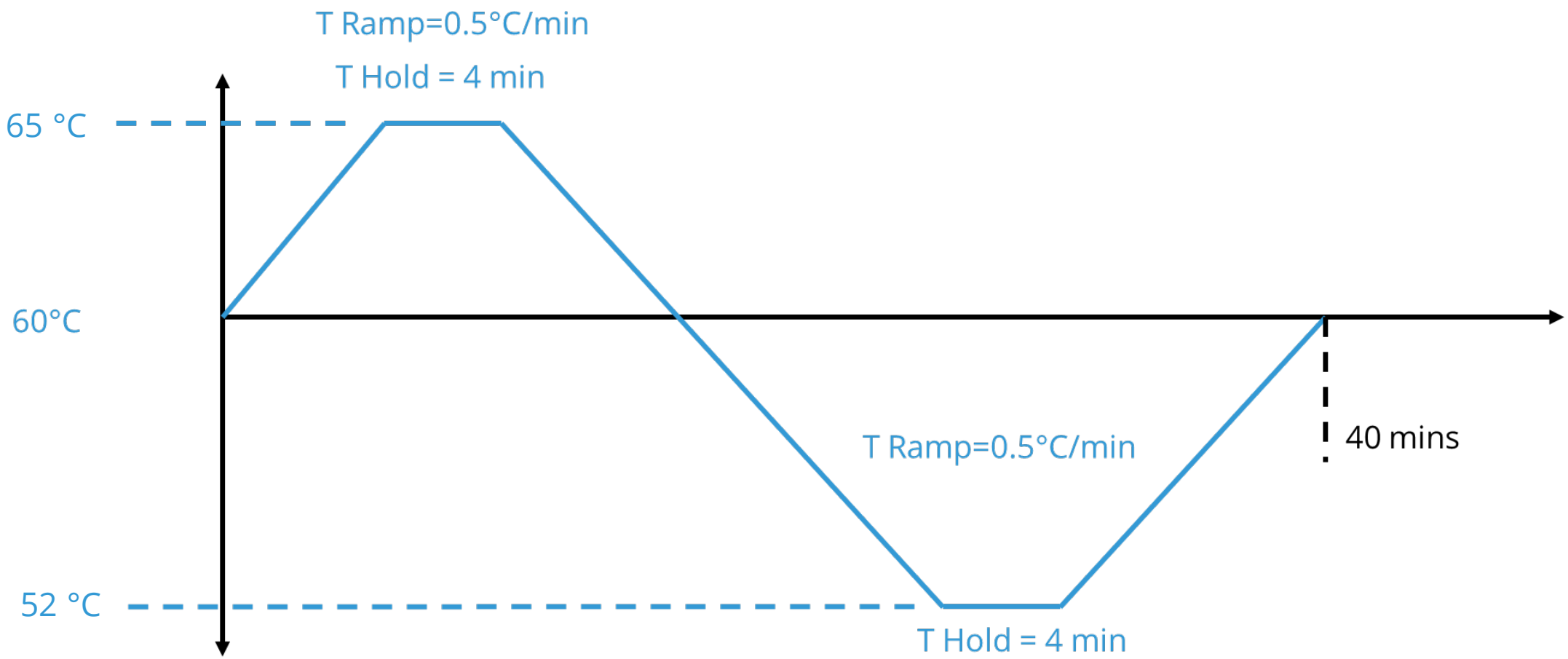
Dual-MEMS Technology – dF/dT



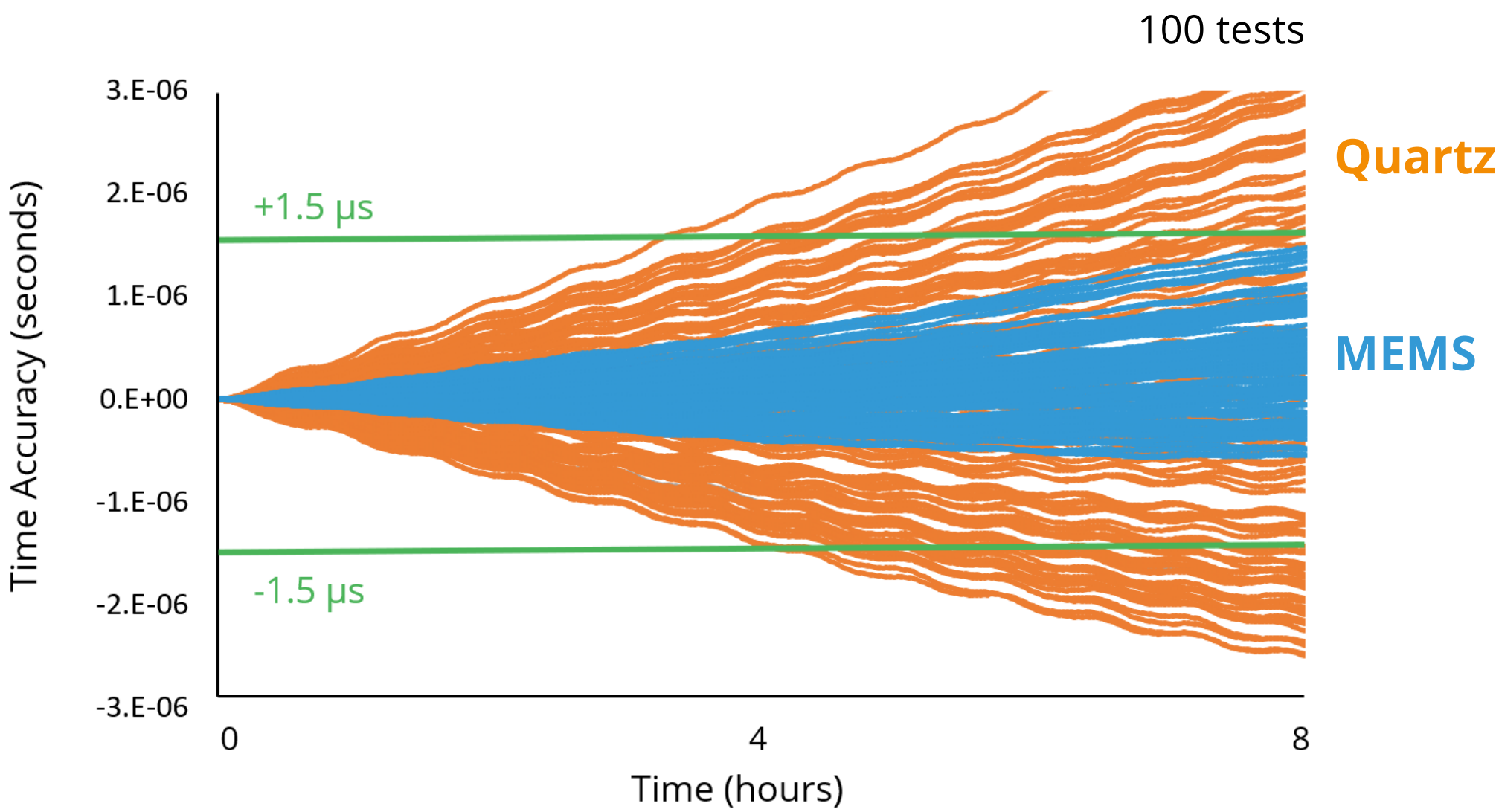
Dual-MEMS – Resistance to Breezy Airflow



Thermal Profile for Holdover Testing



Dual-MEMS Holdover – Real World Conditions, 1 ppb OCXOs

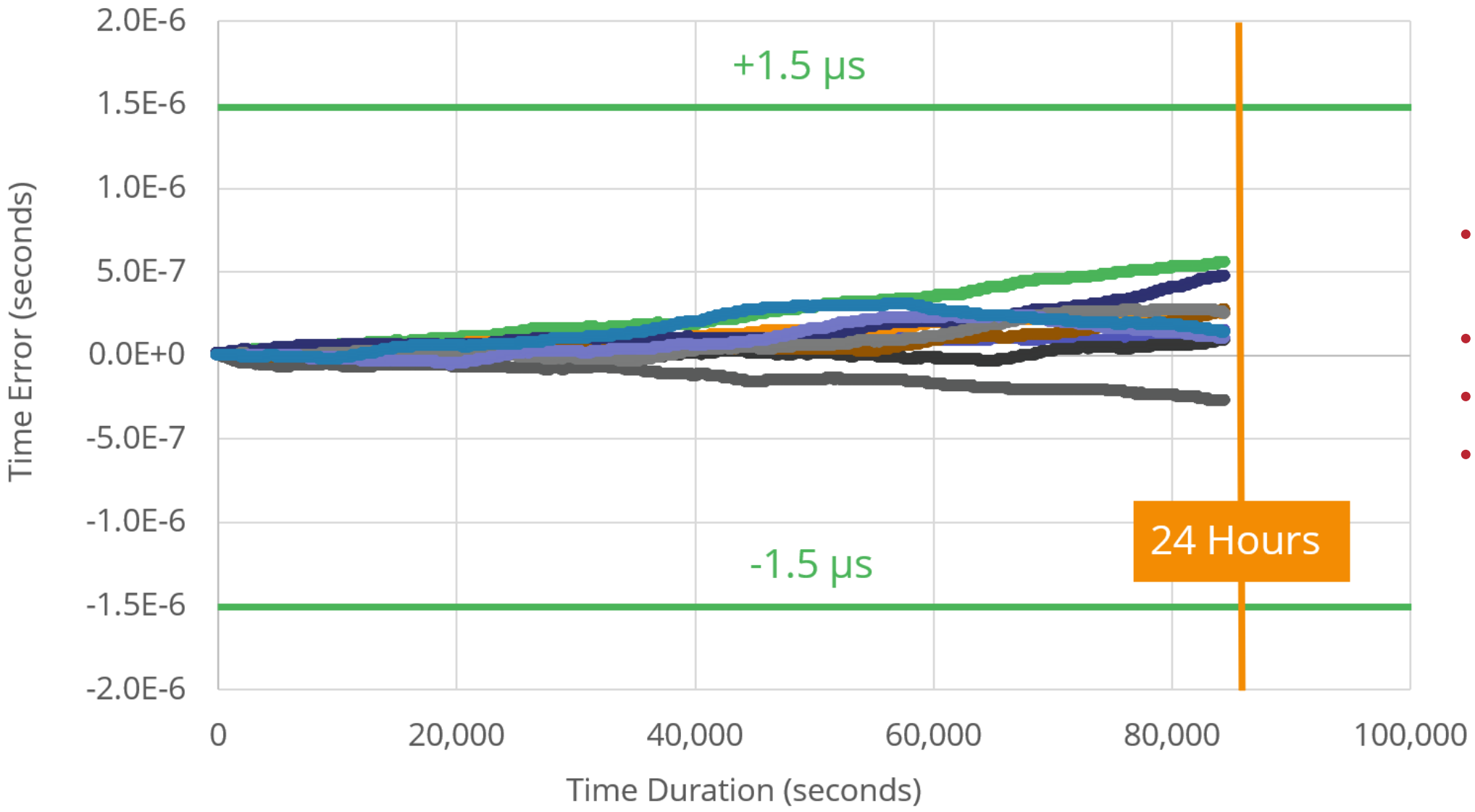


Dual-MEMS OCXO Technology Enables Real-world Synchronization

Application	Environment	Technology Benefit
Pole mounted DU/RU	Thermal change, vibration	**Extends service continuity**
SmartNIC	Space-constrained	**1/2 size PCIe card with 8-hour holdover**
Fan-cooled routers, switches	Complex design (thermal moat, simulation, cover, etc.)	**Environmental resilience simplifies designs**
Remote equipment	Limited access for maintenance	**Highly reliability**

Thank You!

Dual-MEMS – 24 Hour Holdover with Aging Compensation



- Constant temperature
- 10 tests
- 25°C
- Aging compensation