Impact of Oscillator Noise on PTP Time Error – Part 2

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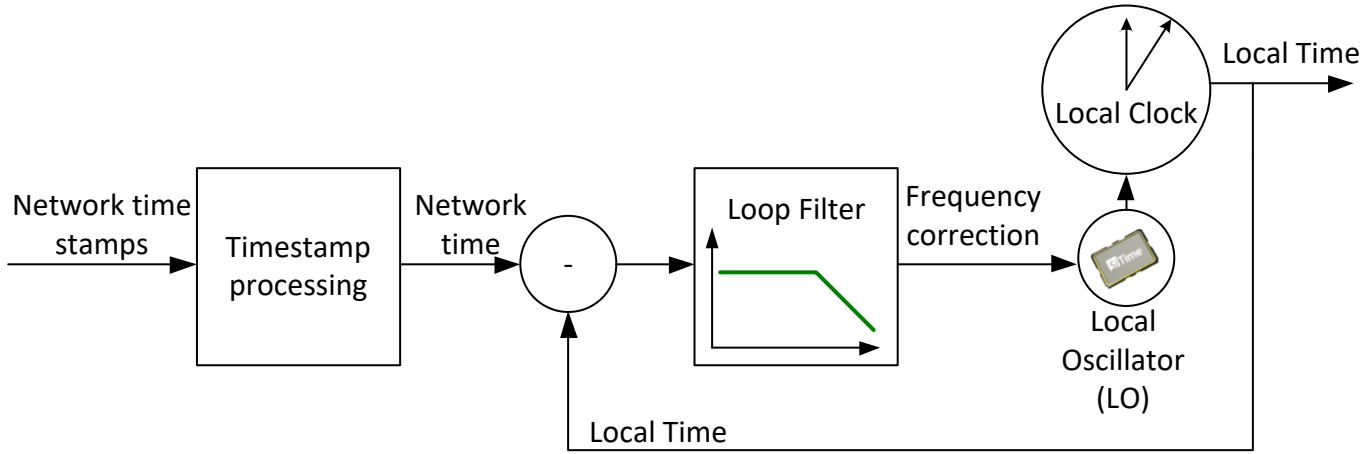
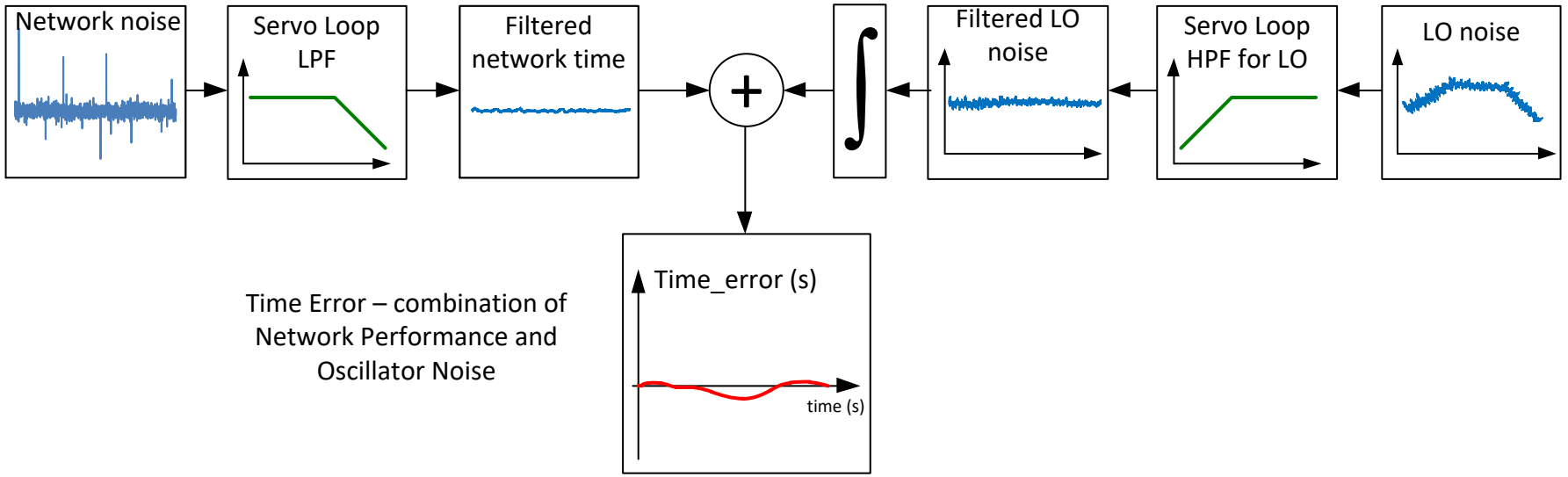
SiTime

Impact of Precision Oscillator Noise on PTP Time Error – Part 2

- Part 1 – Key Points
- Demo of PTP Time Error
- TCXO Architecture Optimized for Sync Applications

Connecting Oscillator Performance to IEEE 1588 Time Error

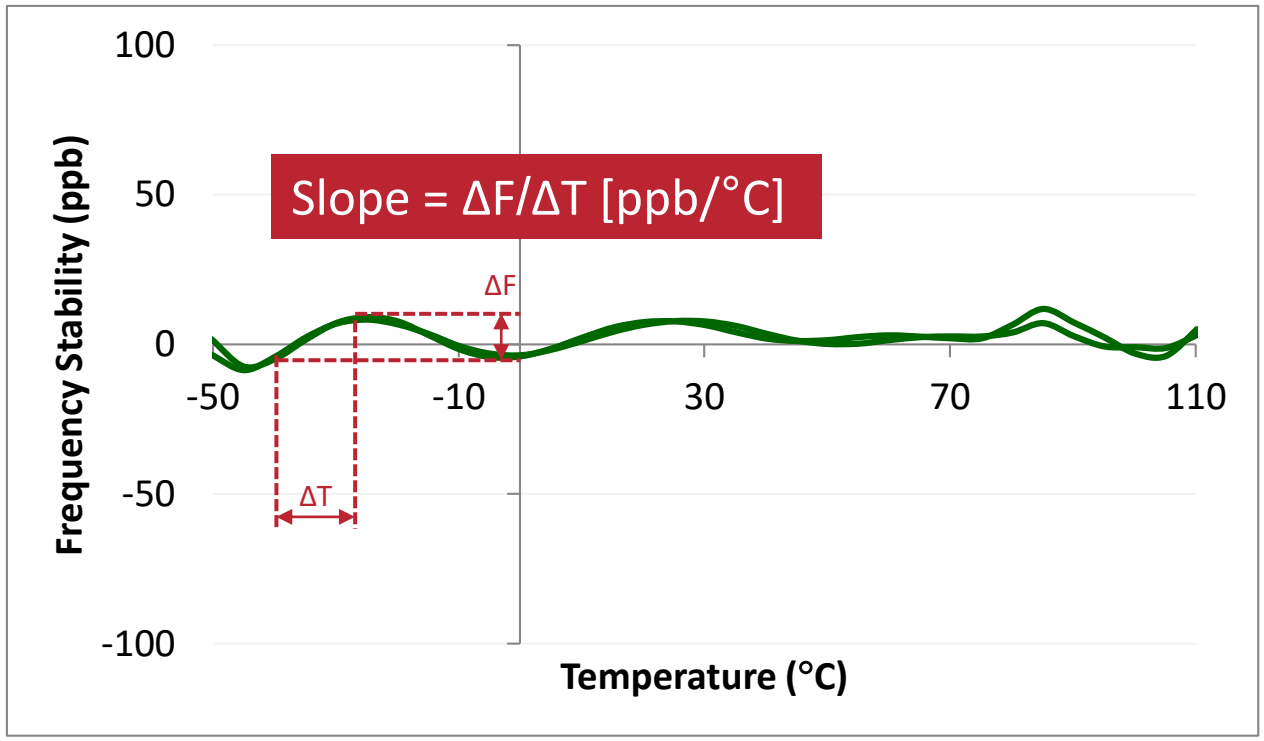




Time Error – combination of Network Performance and Oscillator Noise

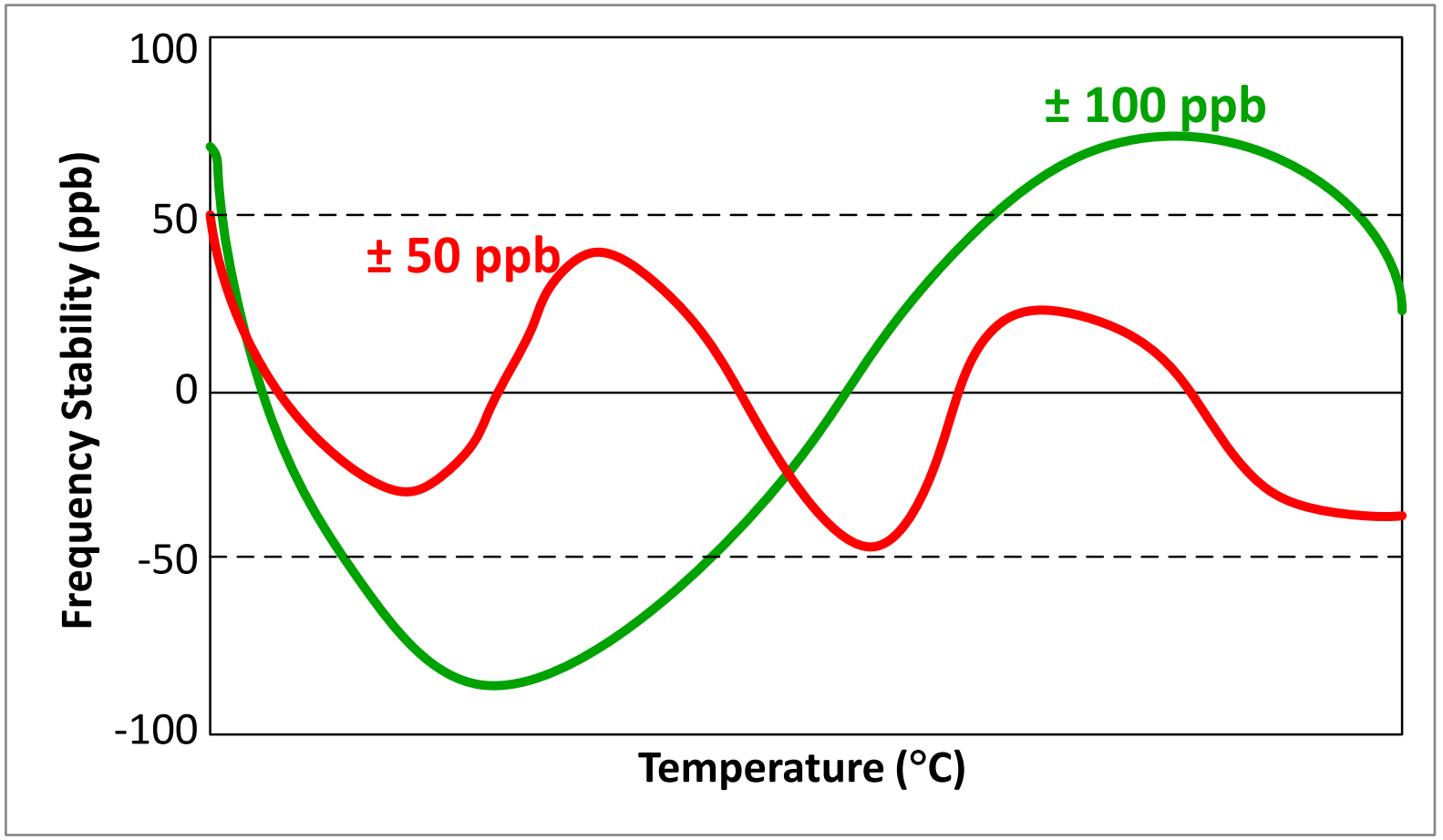
Frequency-over-Temperature Slope, dF/dT

- Frequency-over-temperature slope quantifies frequency change per change in temperature, in units of ppb/°C



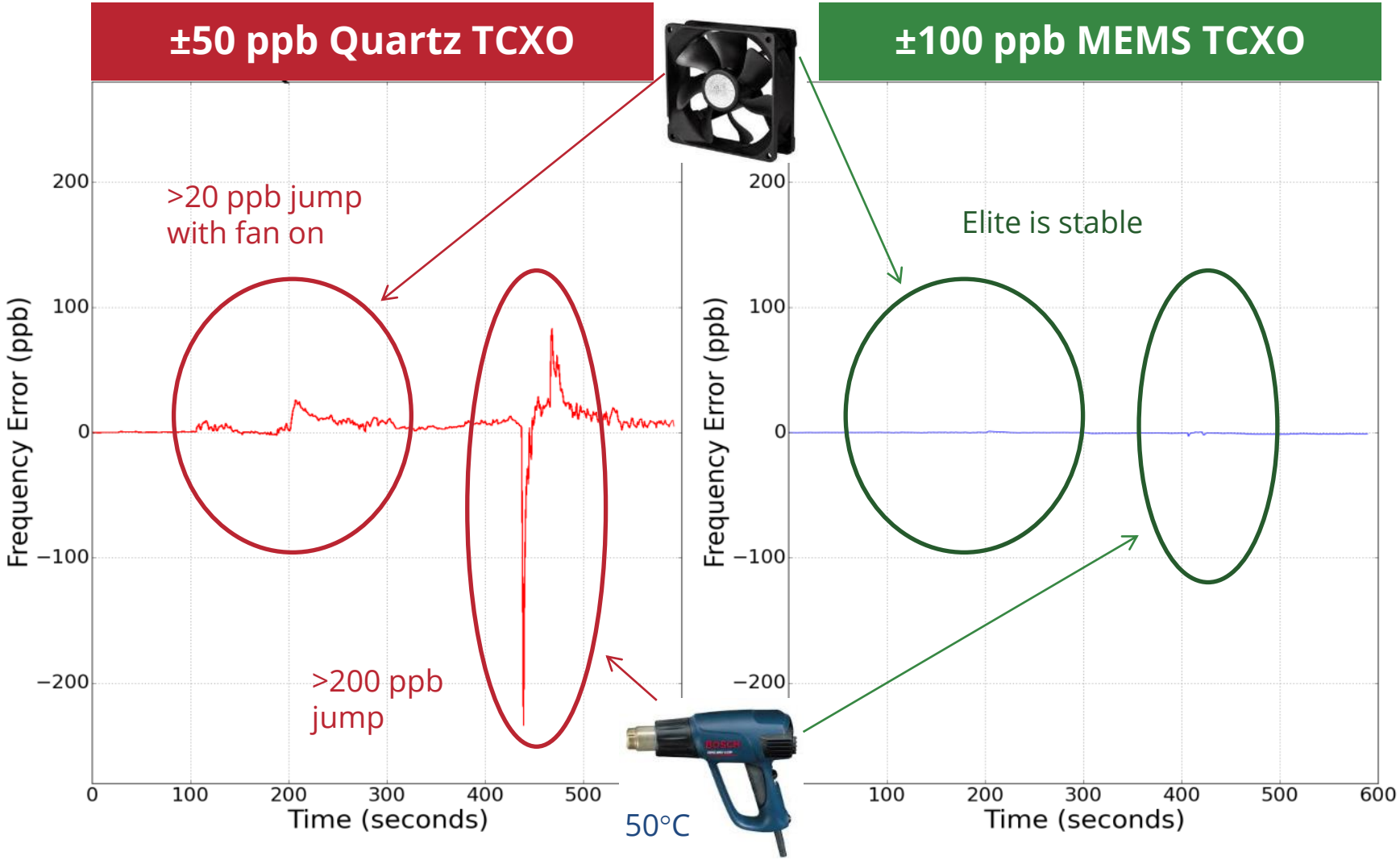
Measured MEMS TCXO Frequency Stability

Which Part is Better for PTP Applications: 50 or 100 ppb?



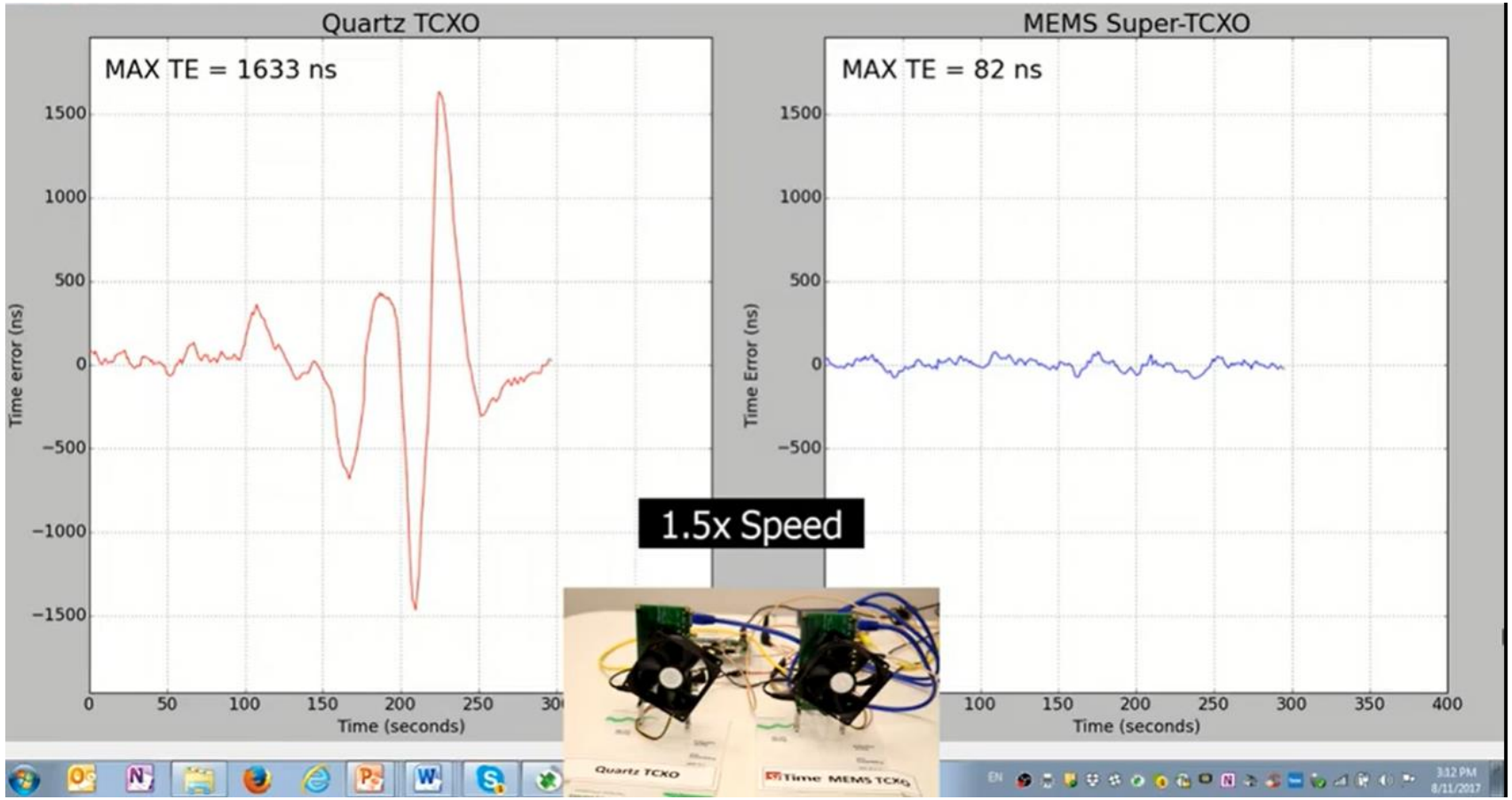
What matters is low sensitivity to temperature changes (dF/dT), not lifetime peak-peak stability

Frequency Stability Video – Impact of dF/dT on Performance



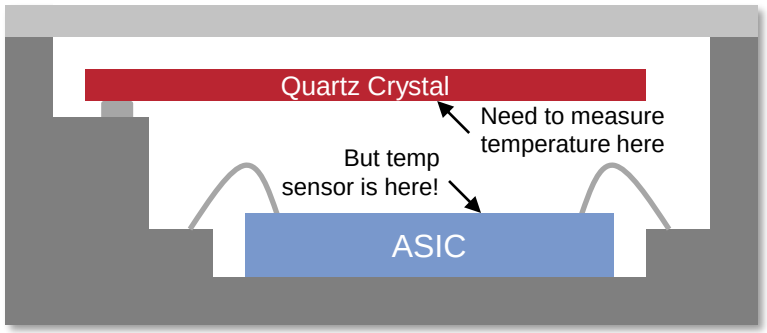
https://www.youtube.com/watch?v=Bttd1f1wo6g&feature=youtu.be

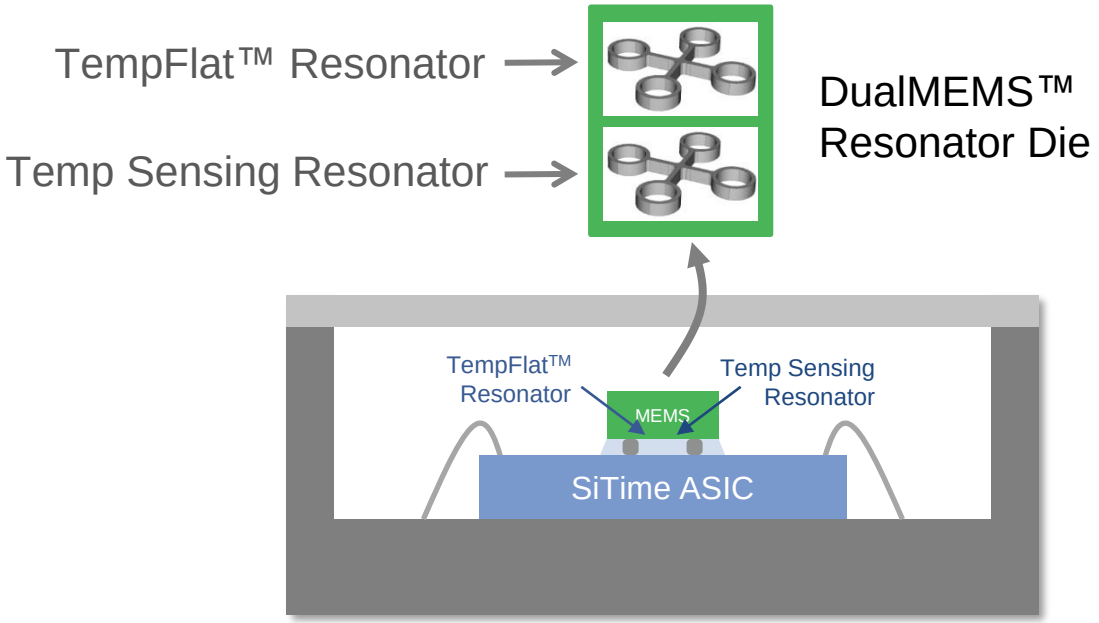
PTP Time Error Video – Impact of dF/dT on Performance



https://www.youtube.com/watch?v=PRlxIJPrfhU

MEMS Architecture – Optimized for Low PTP Time Error





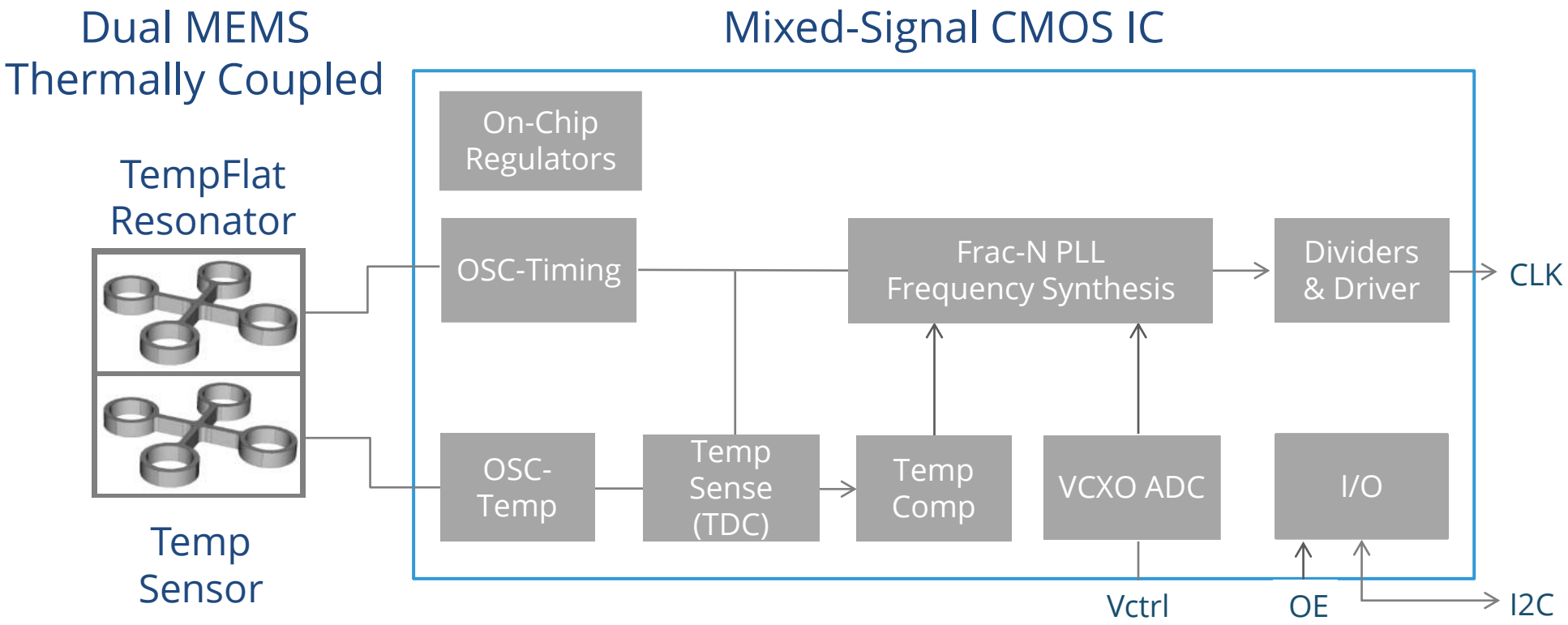
Quartz TCXO

- Limited thermal coupling between Quartz and ASIC
- Analog noisy temp sensor
- Limited compensation of slow temperature changes only
- Higher-order large dF/dT residues

SiTime DualMEMS™ Temperature Sensor

- Excellent thermal coupling between 2 MEMS resonators in same die
- Digital low-noise, high-bandwidth TDC
- Enables compensation of fast temperature changes
- Higher-order compensation enables smallest dF/dT residue

Elite-platform TCXO Architecture – Optimized for PTP Applications



TempFlat™ MEMS Resonator

- No aging
- No activity dips
- 30x better vibration immunity

DualMEMS™ Temp Sensing 100% Thermal Coupling

- 30 µK, 10x more accurate
- 350 Hz tracking, 40x faster
- Airflow, temp ramp resistant

Low Noise CMOS Enabling Frequency Agility

- 1 to 220 MHz, steps in mHz
- 0.2 ps/mv PSNR, 5x better
- In-system programmability

Conclusions

- Can’t judge PTP performance by frequency-over-temperature number alone
- Frequency-slope over temperature (dF/dT, ppb/°C) and temperature profile influence max time error
- TCXO’s with same frequency-over-temperature stability can have significantly different dF/dT performance, and thus PTP time error
- Dual-MEMS TCXO architecture is optimized for synchronization applications such as PTP
- DC-TCXOs enable tuning servo loops with ±5 ppt resolution