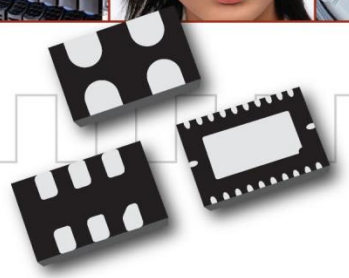
SiTime™

15 min SiTime Turbo Webinars

# SiTime University Turbo Seminar Series

January 14 - 15
Silicon MEMS vs. Quartz

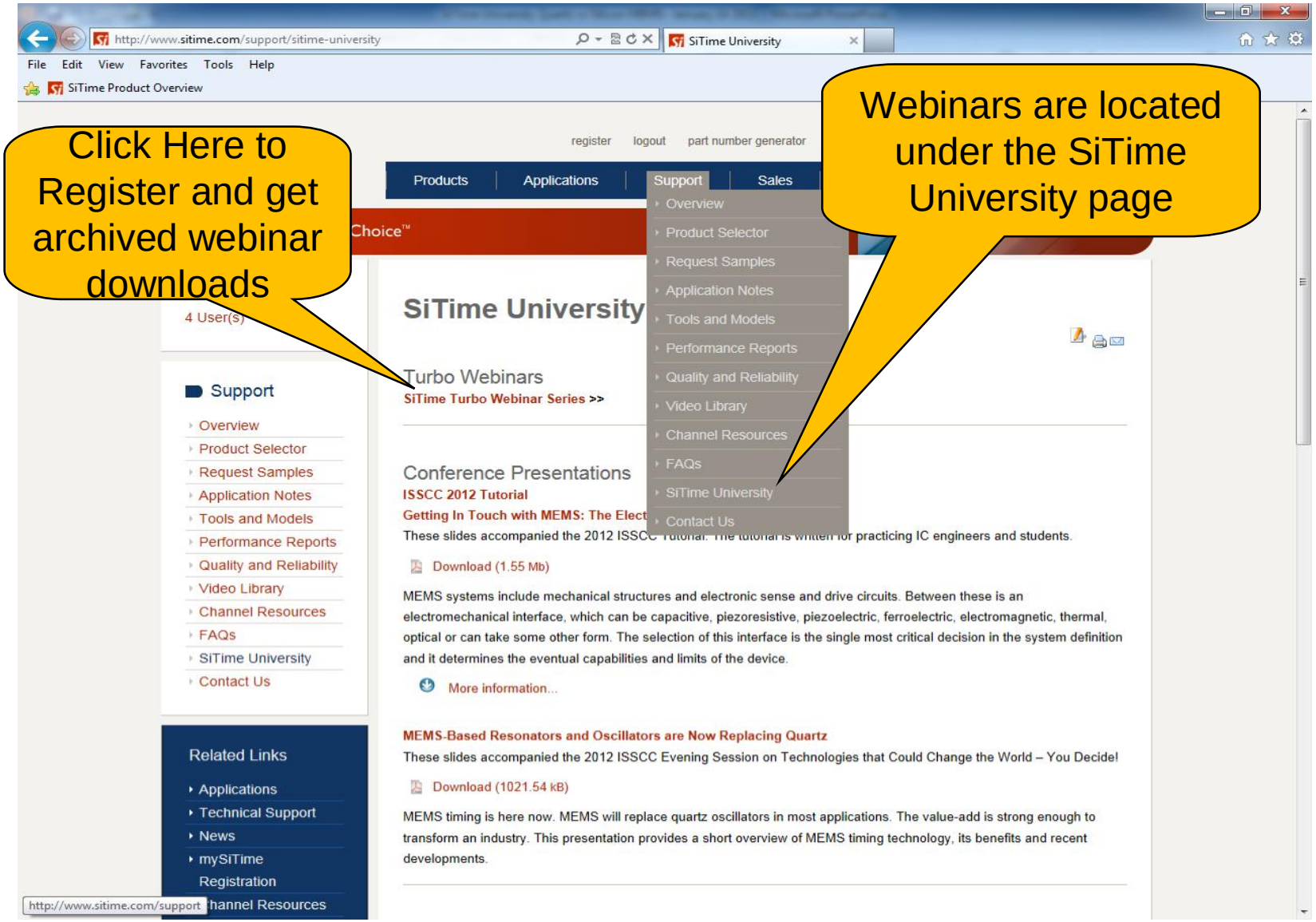



The Smart Timing Choice™

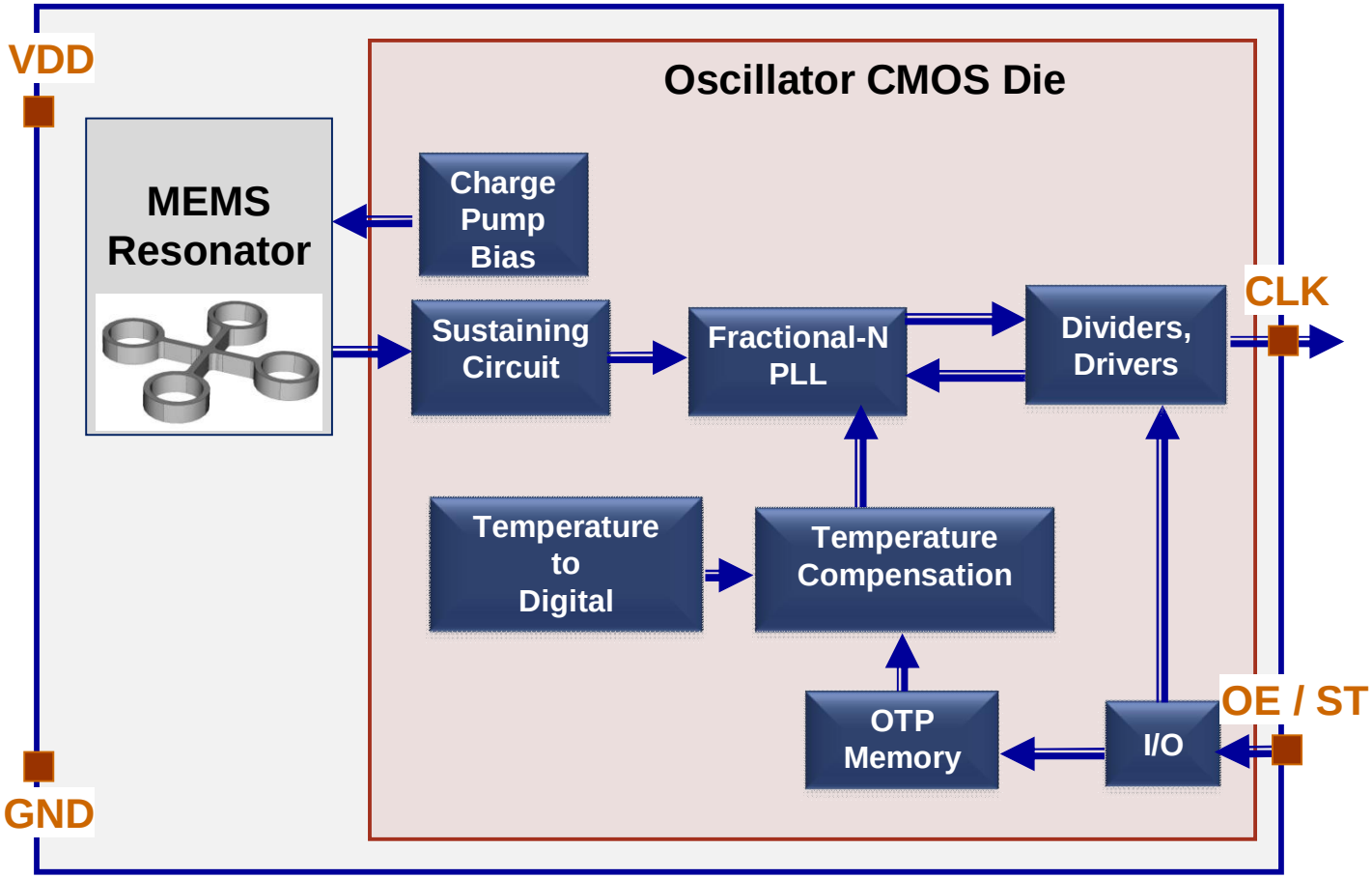
# Agenda

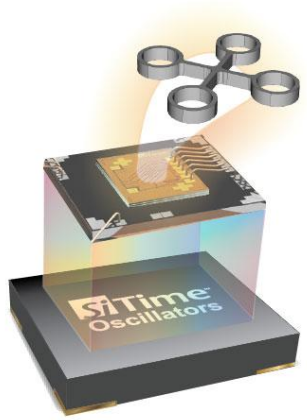
- Silicon MEMS Introduction
- Phase Noise
- Frequency Stability
- Aging—Frequency Shift Over Time
- Current Consumption
- Start-up Time
- Reliability & Resilience (covered in Dec webinar)

# Where to Locate Archived Webinars and Register for Upcoming Webinars



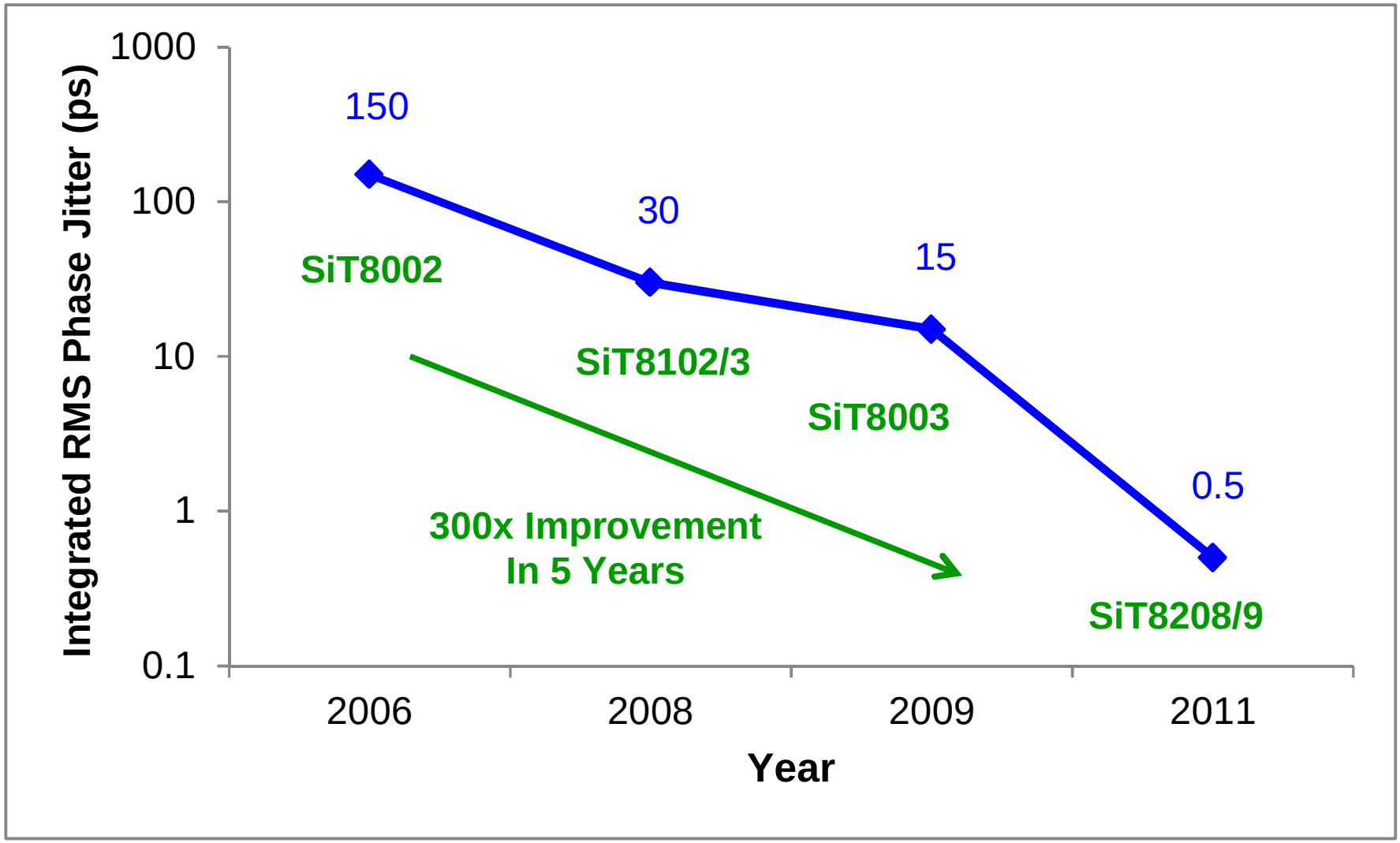
# SiTime's MEMS Oscillator has the Most Flexible System Architecture



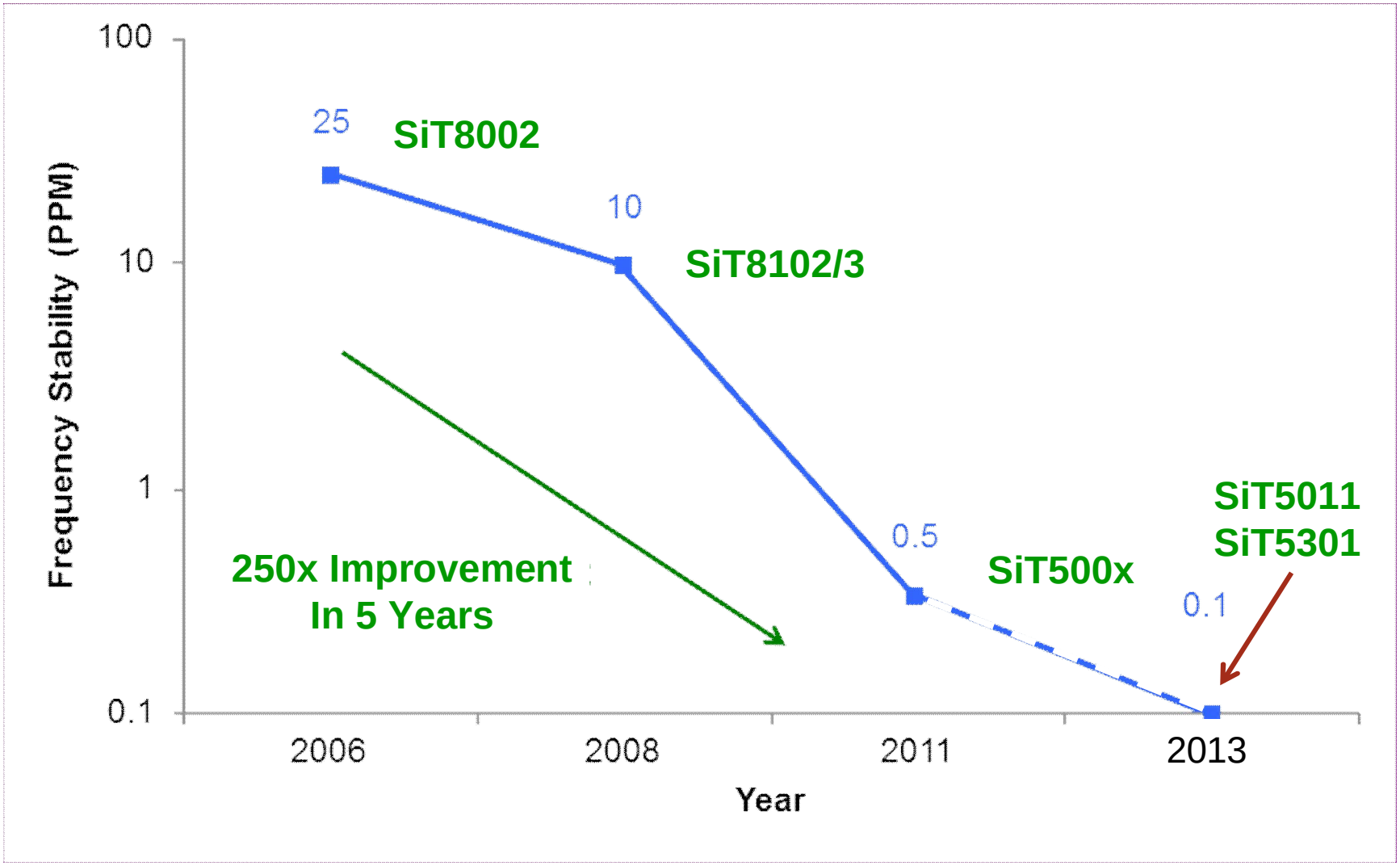




**Stacked Die Plastic Package**

# Semiconductor Expertise Drove 300x Jitter Improvement in 5 Years



# Semiconductor Expertise Driving 250x Stability Improvement in 6 Years

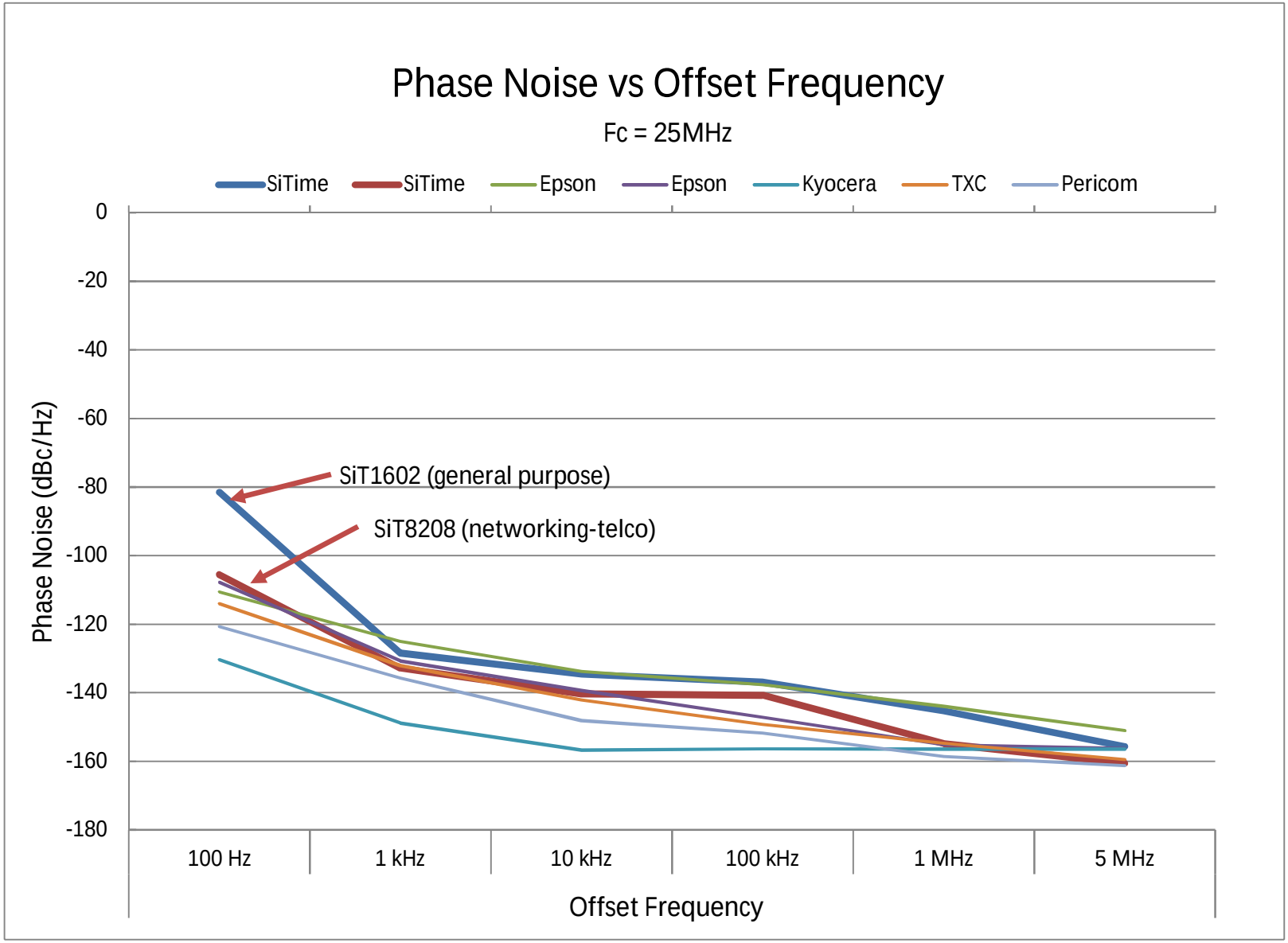


# Silicon MEMS vs Quartz Oscillator Phase Noise Performance Comparison

# SiTime MEMS 70dB Phase Noise Improvement in 3-Years

- SiTime has improved integrated phase jitter 300x over the last 5 years
- SiTime's more recent oscillators (SiT810x, 820x, 380x, 500x) have MEMS resonators with a Q of 150k.
- SiTime's resonators today have a Q-factor similar to quartz, which translates to phase noise and integrated phase jitter that rivals quartz.

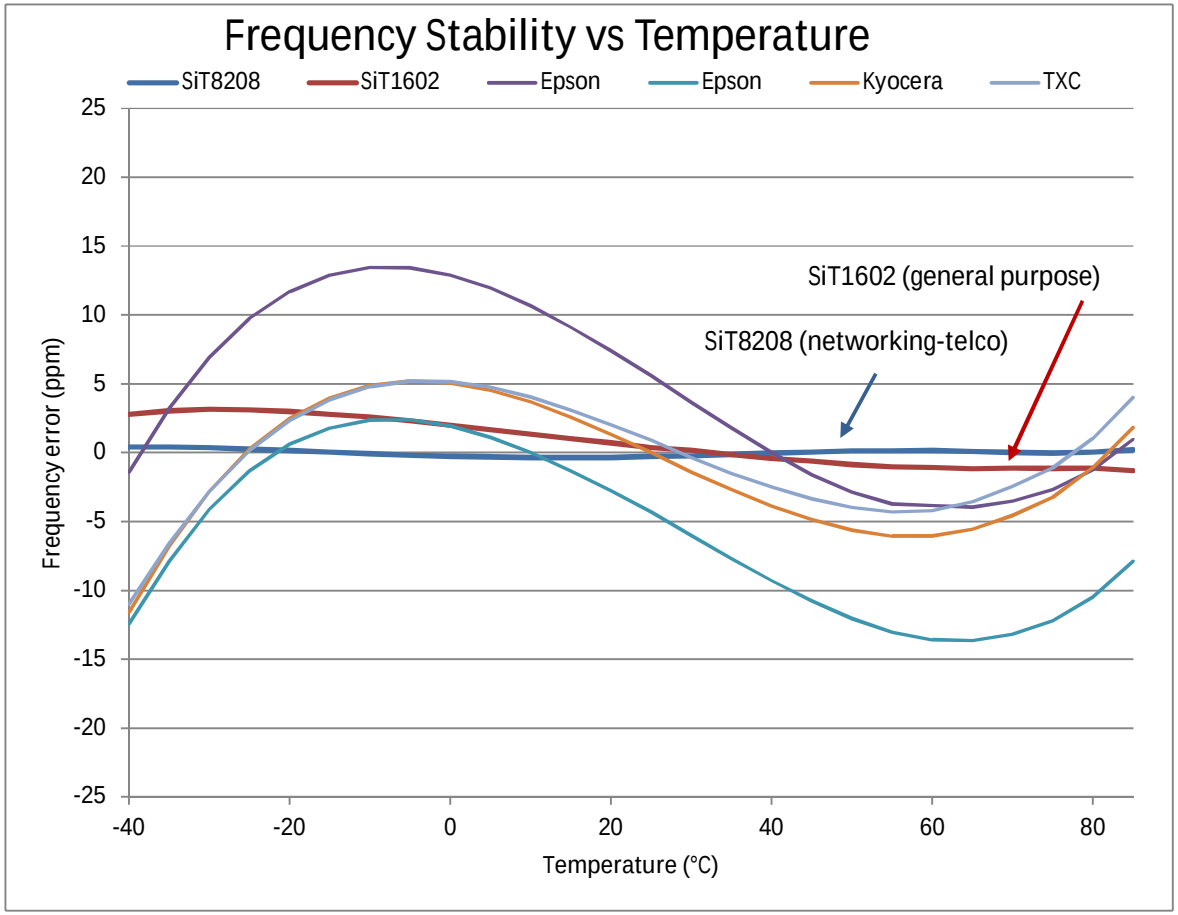
# SiTime MEMS vs Quartz XO Phase Noise



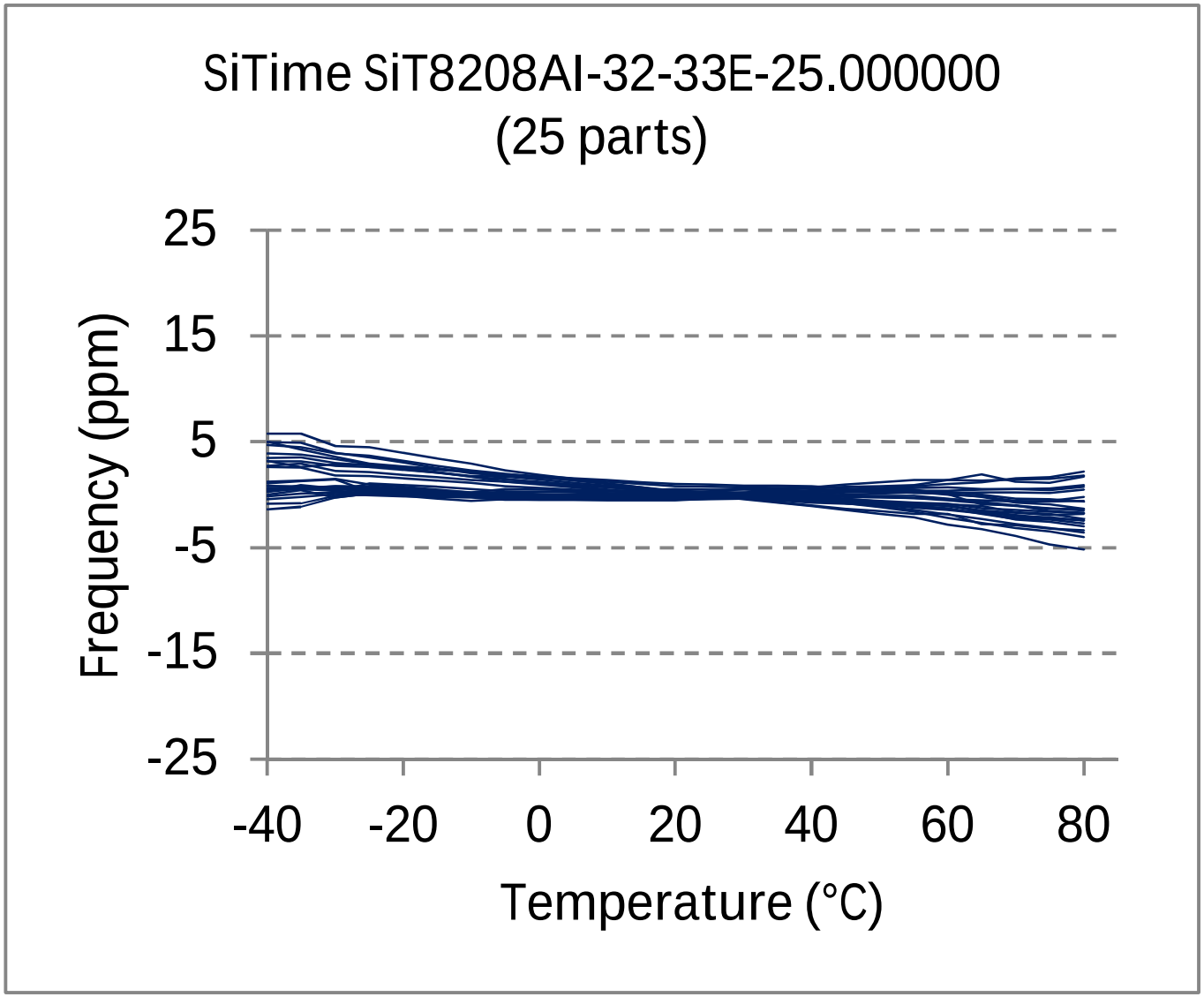
# Silicon MEMS vs Quartz Oscillator Frequency Stability Performance Comparison

# SiTime MEMS has 25x Less Variability Than Quartz

- SiTime guarantees 10ppm stability over temp vs quartz 20ppm
- SiTime XO frequency variability is 25x better than quartz



# SiTime MEMS is 25x More Stable Than Quartz



# Silicon MEMS vs Quartz Oscillator Aging Performance Comparison

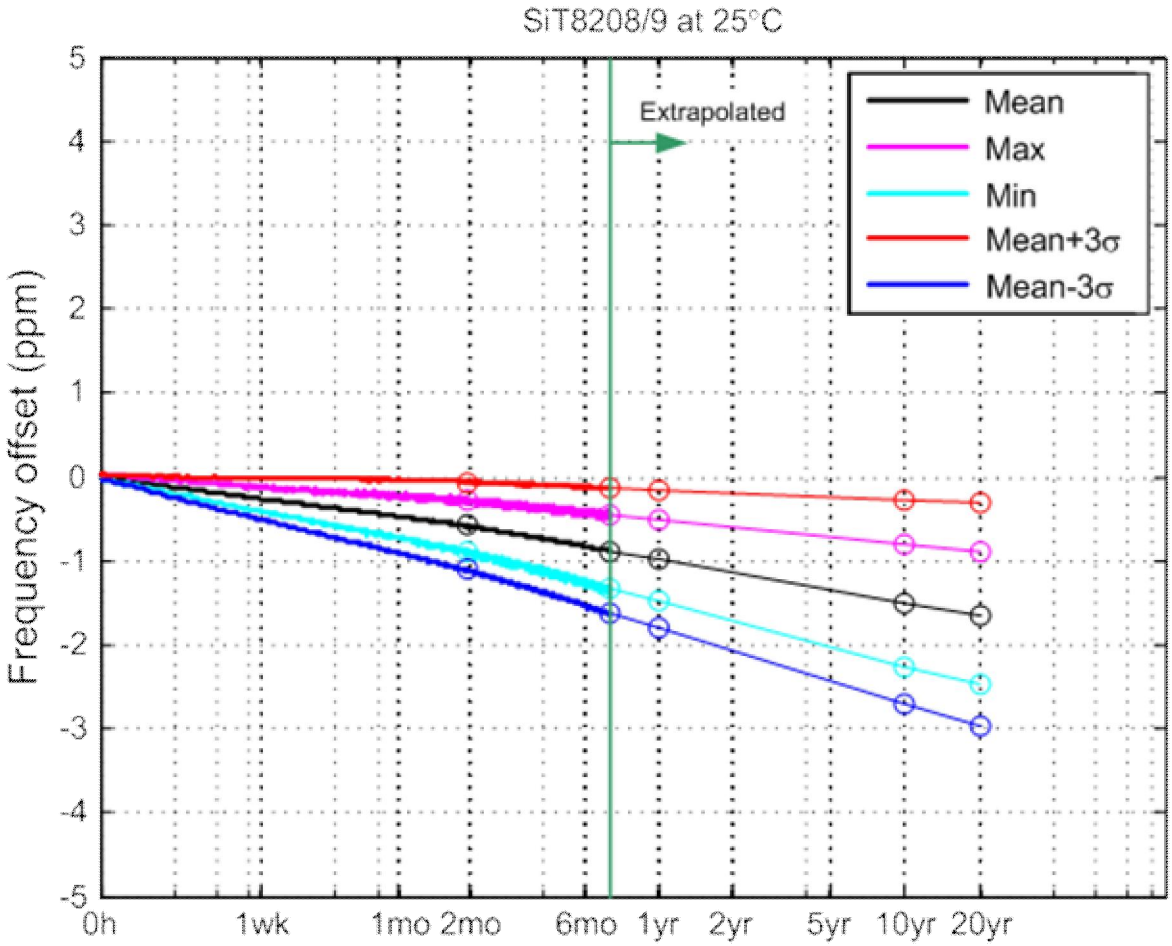
# Aging Methodology and Sample Results

- MIL-PRF-55310E Compliant
- 2 Aging Systems
  - 1 with oven set at 25 C
  - 1 with oven set at 85 C
  - 480 DUT capacity in each system
  - Package size and vendor diversity
  - Continuous frequency measurement
  - GPS disciplined frequency reference
  - Continuous $V_{DD}$ and temperature monitoring
  - UPS power backup
- Results
  - At 5,100 hours (6+ months), and continuing
  - Aging up to 6-months explicitly measured
  - 1 year and 20 year aging extrapolated

| Sample Population | Sample Size | Nominal Frequency |
|---|---|---|
| SiT 8208/9 | | |
| Main population | 128 | 19.2 MHz |
| PCB assembly variations | 30 | 19.2 MHz |
| Package variations | 48 | 19.2 MHz |
| Prior Silicon versions | 29 | 19.2 MHz |
| SiT 9120/1/2 | | |
| Main population | 96 | 100 MHz |
| SIT8103 | 24 | 19.2 MHz |
| Other SiTime devices | 99 | 10-20 MHz |
| Competitors' oscillators | 14 | 25 MHz |
| Quartz-based TCXOs (controls) | 12 | 10-25 MHz |

| | SiT8208/9 | | SiT9120/1/2 | |
|---|---|---|---|---|
| | 25C | 85C | 25C | 85C |
| 6-month aging (ppm) | ± 1.3 | ± 2.4 | ± 1.3 | ± 2.4 |
| 1 year aging (ppm)* | ± 1.5 | ± 3 | ± 2 | ± 3 |
| 20 year aging (ppm)* | ± 3 | ± 6 | ± 3 | ± 6 |

# SiT8208/9 Aging Data



# Best Aging Performance

- For applications that require aging performance, use the SiT8208/9 LVCMOS XO and the SiT9120/1 LVDS/LVPECL
- SiTime breaks out and guarantees aging for 1-yr and 10-yr

| | | | | | | |
|---|---|---|---|---|---|---|
| First year Aging | F_aging | -1.5 | – | +1.5 | PPM | 25°C |
| 10-year Aging | | -5 | – | +5 | PPM | 25°C |

| Mfr | Part Number | Osc Type | Freq | Output | 1st yr Aging | 10-yr Aging |
|---|---|---|---|---|---|---|
| SiTime | SiT8208AC-22-33E-26.000000 | MEMS, XO | 26 | LVCMOS | 1.5 ppm | 5 ppm |
| SiTime | SiT9120AC-1D2-33E156.250000 | MEMS, XO | 156.25 | LVPECL | 2 ppm | 5 ppm |
| TXC | 7Q-26.000MBG-T | Quartz, TCXO | 26 | Clipped Sine | 1 ppm | NA |
| Kyocera | KT3225R26000ZAW28TMA | Quartz, TCXO | 26 | Clipped Sine | 1 ppm | NA |
| NDK | NT3225SA-26.000000MHZ-G8 | Quartz, TCXO | 26 | Clipped Sine | 1 ppm | NA |
| Epson | EG-2102CA 156.2500M-PHPAL3 | Quartz, SAW | 156.25 | LVPECL | 10 ppm | NA |
| TXC | BB-156.250MBE-T | uartz,3rd Overtor | 156.25 | LVPECL | NA | NA |
| AVX/Kyocera | KC7050T156.250P30E00 | Quartz, SAW | 156.25 | LVPECL | Inclusive 50 ppm | Inclusive 50 ppm |
| SiLabs | 590AB-BDG | rtz,3rd Overtone | 156.25 | LVPECL | Inclusive 50 ppm | Inclusive 50 ppm |
| Discera | ASFLMPLP-156.250MHZ-LR-T | MEMS, XO | 156.25 | LVPECL | 5 ppm | NA |

# Silicon MEMS vs Quartz Oscillator Power Consumption

# LVCMOS Power Consumption

- SiTime XOs are targeting wireline and battery-powered applications
- SiTime consumes approx 2.5 to 3x more supply current than low current quartz alternatives.

| Vendor | Part number | Measured Current Consumption (mA, No Load) |
|---|---|---|
| SiTime | SiT8208AI-32-33E-25.000000 | 32.11 |
| SiTime | SiT8002AI-13-33E-25.00000 | 13.22 |
| SiTime | SiT1602AI-12-33E-25.000000 | 3.71 |
| Epson | SG-210SCB 25.0000ML3 | 0.99 |
| Epson | SG-310SCF 25.0000MB3 | 1.22 |
| Kyocera | KC2520B25.0000C1GE00 | 1.32 |
| TXC | AU-25.000MBE-T | 1.02 |
| Pericom | FNETHE025 | 1.42 |

# LVPECL/LVDS Power Consumption

| Vendor | Part Number | Signal type | Frequency range (MHz) | Idd (mA) |
|---|---|---|---|---|
| SITime | SiT9120/1/2 | LVPECL | 1 - 625 | 69 |
| | SiT9120/1/2 | LVDS | 1- 625 | 55 |
| Epson | EG2102 | LVPECL | 100 - 700 | 100 |
| | | LVDS | 53.125 - 700 | 45 |
| | XG2121 | LVPECL | 100 - 700 | 60 |
| | | LVDS | 100 - 700 | 30 |
| | XG2102 | LVPECL | 100 - 700 | 60 |
| | | LVDS | 100 - 700 | 30 |
| KDS | DSO323S | LVPECL | 13.5 - 212.5 | 50 |
| | | LVDS | 13.5 - 212.5 | 20 |
| | DSO753H | LVPECL | 170- 230 | 80 |
| | | LVDS | 170- 230 | 60 |
| Kyocera | KC7050R-P3 | LVPECL | 10 - 800 | 100 |
| | KC7050Y-P3 | LVPECL | 75 - 700 | 100 |
| | KC7050Y-L2 | LVDS | 75 - 700 | 70 |
| | KC7050Y-L3 | LVDS | 75 - 700 | 70 |
| NDK | 7311S-GF | LVPECL | 62.5 - 313 | 88 |
| | 7311S-DF | LVPECL | 62.5 - 313 | 90 |
| TXC | BS Series<br>BT Series<br>CS Series<br>CT Series<br>SAW based | LVPECL<br>LVDS | 150 to 700 | 80 |

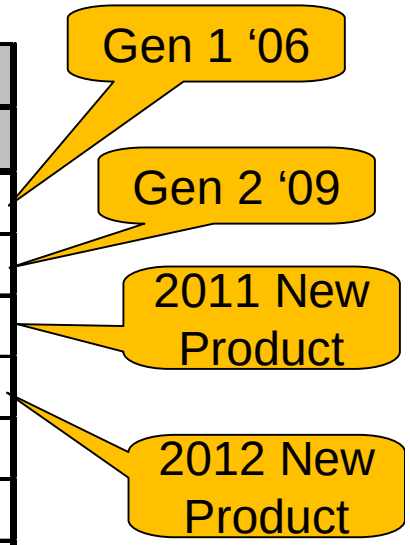
- LVPECL always consumes more power (Swing-Load)
- SiTime's LVPECL/LVDS Oscillators have competitive power

# Silicon MEMS vs Quartz Oscillator Start-up Time

# Start-up Time up 2x Faster Than Quartz

- 10ms start-up time is the accept standard
- SiTime's start-up time has improved 10x since gen 1 silicon
- Since 2009, SiTime has XOs with competitive start-up times

| Vendor | Part number | StartUp (ms) | |
|---|---|---|---|
| | | Measured | Datasheet MAX |
| SiTime | SiT8002AI-13-33E-25.00000 | 9.73 | 50 |
| SiTime | SiT8103AI-32-33E-25.000000 | 7.00 | 10 |
| SiTime | SiT8208AI-32-33E-25.000000 | 6.93 | 10 |
| SiTime | SiT1602AI-12-33E-25.000000 | 3.92 | 5 |
| Epson | SG-210SCB 25.0000ML3 | 0.48 | 3 |
| Epson | SG-310SCF 25.0000MB3 | 1.35 | 10 |
| Kyocera | KC2520B25.0000C1GE00 | 0.60 | 10 |
| TXC | AU-25.000MBE-T | 0.41 | 10 |
| Pericom | FNETHE025 | 0.40 | NA |



# Summary

- SiTime Oscillators Have Improved Phase Jitter 300x Since 2006
  - SiTime has low phase jitter solutions for wireline networking applications
  - Competitive Phase Noise and Phase Jitter Performance since 2011
  - Wireless Phase noise performance coming in Q3 2013!

- Best Oscillator Frequency Stability Over Temp
  - 25x better frequency variation than quartz
  - 2x better XO stability over temp than quartz

# Summary

- SiTime's Start-up Time is up to 2x Faster than Quartz
  - <10ms start-up time since 2009 (similar to quartz)
  - Latest Oscillator starts up within 5ms (SiT1602)
- SiTime Power Consumption is Optimized for Wireline Applications and Select Battery-Powered Apps
  - SiTime offers a 4mA MHz XO.  Acceptable for most apps
  - LVDS/LVPECL power consumption similar to quartz

# Contact Information

- **For Questions, contact SiTime Technical Support**
  Technicalsupport@sitime.com

- **For *Turbo Webinar* pdf Downloads on SiTime's Web Site**
  www.sitime.com/support/sitime-u/turbo-webinars

  •All new webinars will be posted within 1-week

  •For a list of part numbers used for each test, contact SiTime Technical Support at the email address listed above.