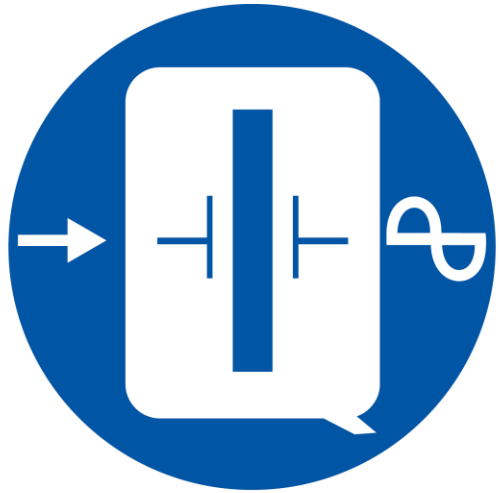


CMSE CONFERENCE 2023



Q-TECH
CORPORATION

**NEW PRODUCTS OFFERINGS FOR MILITARY
AND SPACECRAFT ELECTRONICS**

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Introduction

- Q-Tech Corporation founded in 1972
- Focused exclusively on providing high reliability crystal oscillators
- Providing oscillators for space since 1985
- ISO 9001 / AS 9100 Certified / MIL-STD-790 (MIL-PRF-55310)
 - QPL listed to Class “B” & “S”
- More MIL-PRF-55310 slash sheets than any other supplier at 28
- Acquired Axtal, German-based oscillator manufacturer, end of 2022



Space and Military Markets

- **Spacecraft Electronics**
 - LEO, MEO, GEO Satellites
 - Launch Vehicles
 - Manned and Unmanned Space Vehicles
 - Space Stations

- **Military**
 - Missile Systems (Conventional and Nuclear)
 - Aircraft
 - Radar



Available Products

- XO, TCXO, VCXO, OCXO, MCXO, SO, VCSO, PLL including standard and custom specifications
- Various packages and output types, including:
 - Multiple Output options in LVDS or CMOS
 - Standard CMOS, TTL, LVDS, and LVPECL in various voltage options
 - Sine wave or CMOS output TCXOs and OCXOs
 - Sine wave SAW oscillators
- 2, 3 or 4-point crystal mount dependent on package type
- Package sizes range from as large as DIP and Flat Packs down to as small as ultra-miniature SMT packages available, including a TCXO as small as 2 x 2.5mm
- Radiation Tolerant products for LEO, MEO, GEO, and Deep Space as well Nuclear Missile Applications

Q-TECH & AXTAL



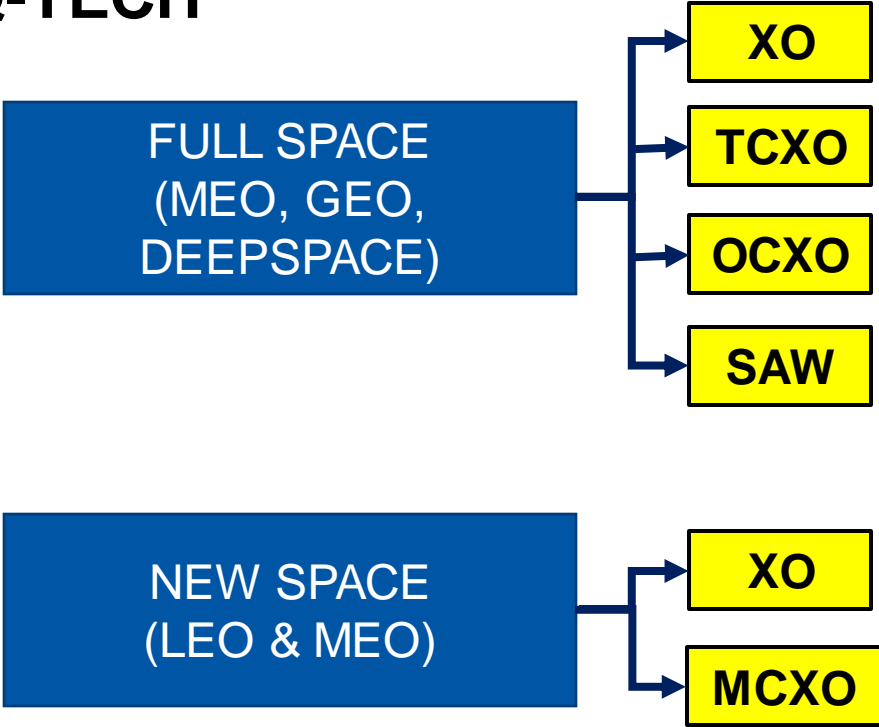
- Q-Tech and Axtal product portfolios combined offer full range of crystal oscillators: from basic clocks (XO) and temperature-compensated (TCXO), to microprocessor-controlled (MCXO) and oven-controlled (OCXO) quartz oscillators.
- The acquisition of Axtal GmbH & Co. KG in end of 2022 significantly expands the Q-Tech family of precision clocking devices for mission-critical global applications.





Q-TECH & AXTAL SPACE PRODUCTS

- Q-TECH



- AXTAL



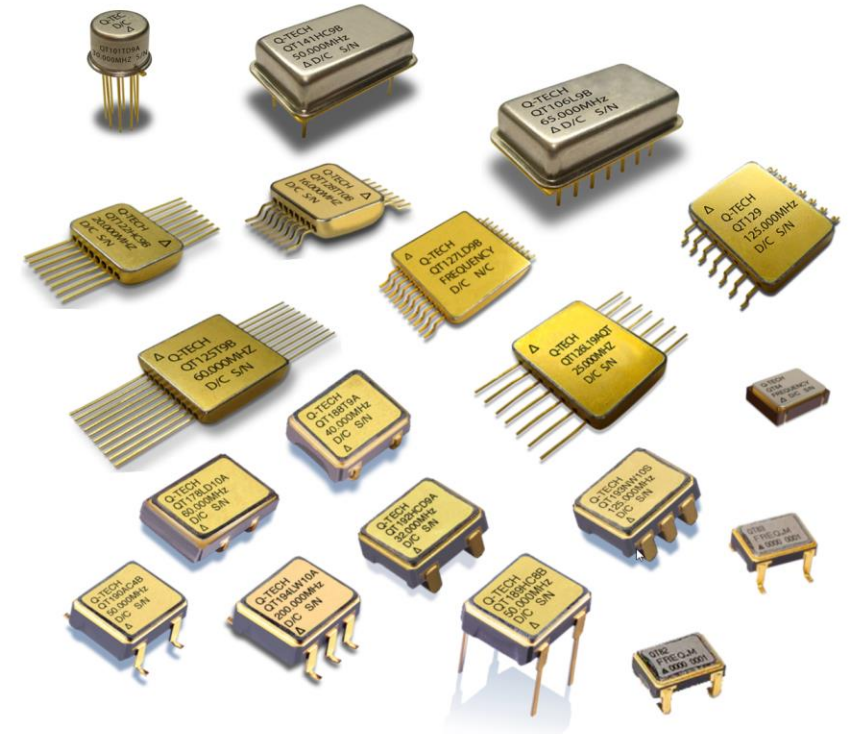


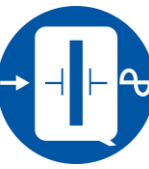
Full Space Products



Hybrid Products: B+ Space Oscillators

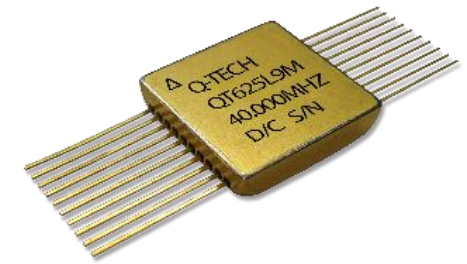
- Various output types: CMOS, TTL, LVDS, LVPECL
- Stability as low as $\pm 50\text{ppm}$ from -55°C to $+125^\circ\text{C}$
- Wide range of available packages
 - As small as 5x7mm SMT
- Swept Quartz, 3 or 4-point mount (package dependent)
- Standard 100kRad(Si) TID
- SEL immune tested up to $109\text{ MeV}\cdot\text{cm}^2/\text{mg}$
- Low Jitter
 - Integrated phase jitter (12kHz to 20MHz) of 1ps maximum
 - Peak-to-peak jitter of 40ps maximum
- Space Screening and QCI Available
 - MIL-PRF-55310, Level S
 - MIL-PRF-38534, Class K

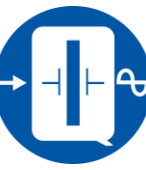




Hybrid Products: Multiple Output Oscillators

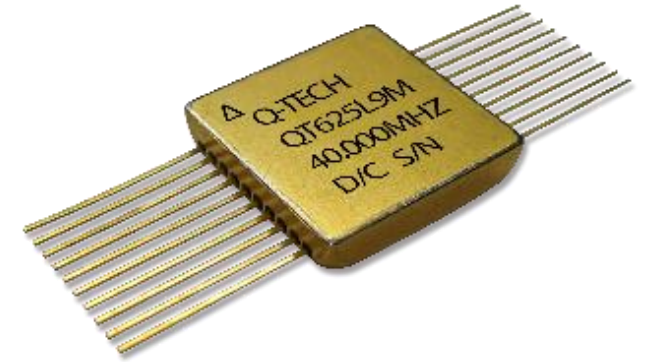
- QT625/QT697 Multiple Output LVDS and CMOS Clocks
 - LVDS: up to 12 differential output pairs
 - CMOS: up to 4 outputs
- Typical phase noise floor of -157 dBc/Hz
- Jitter
 - Integrated phase jitter (12kHz to 20MHz) of 1ps maximum
 - Peak-to-peak jitter of 40ps maximum
- Standard 100kRad(Si) TID
- SEL immune tested up to 117 MeV-cm²/mg
- Advantages of the all-in-one multiple output design:
 - Low skew between outputs (< 0.4ns)
 - All-in-one multiple output design saves on board real estate
 - Single clock integration saves on engineering costs
- In Development:
 - Multiple Output Space TCXO





Hybrid Products: SAW Oscillators

- QT625S/QT725S SAW Oscillators (SO and VCSSO)
- Standard temperature range: -40°C to +85°C
- 3.3V, 5.0V, and 12.0V options
- Typical phase noise floor of -170 dBc/Hz
- Absolute Pull range (APR) ± 10 ppm min., ± 20 ppm typical
- 100kRad (Si) TID Radiation Tolerance
- In Development:
 - Improved stability Non-Space Lamb-Wave SAW (LSAW) oscillator: ± 50 ppm over -40°C to +125°C (vs. +50 to -200ppm from -40°C to +85°C)
 - Second phase: New Space (LEO)

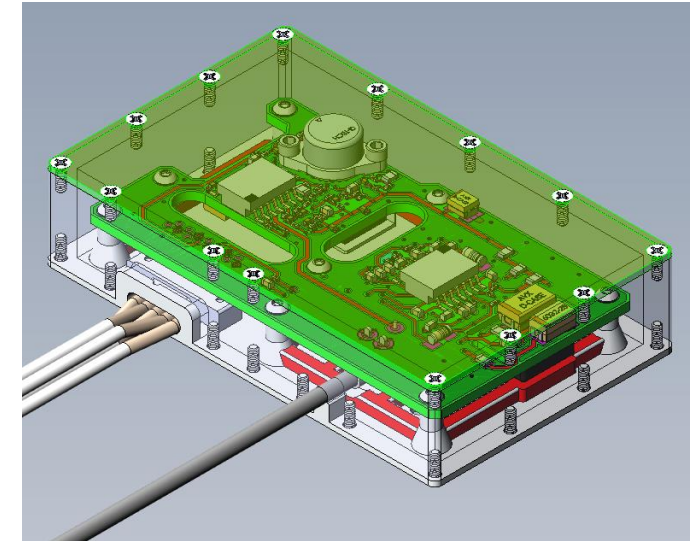


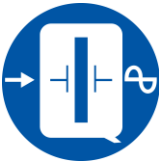


Single Board OCXO

QT4800 Single-board OCXO (In Development)

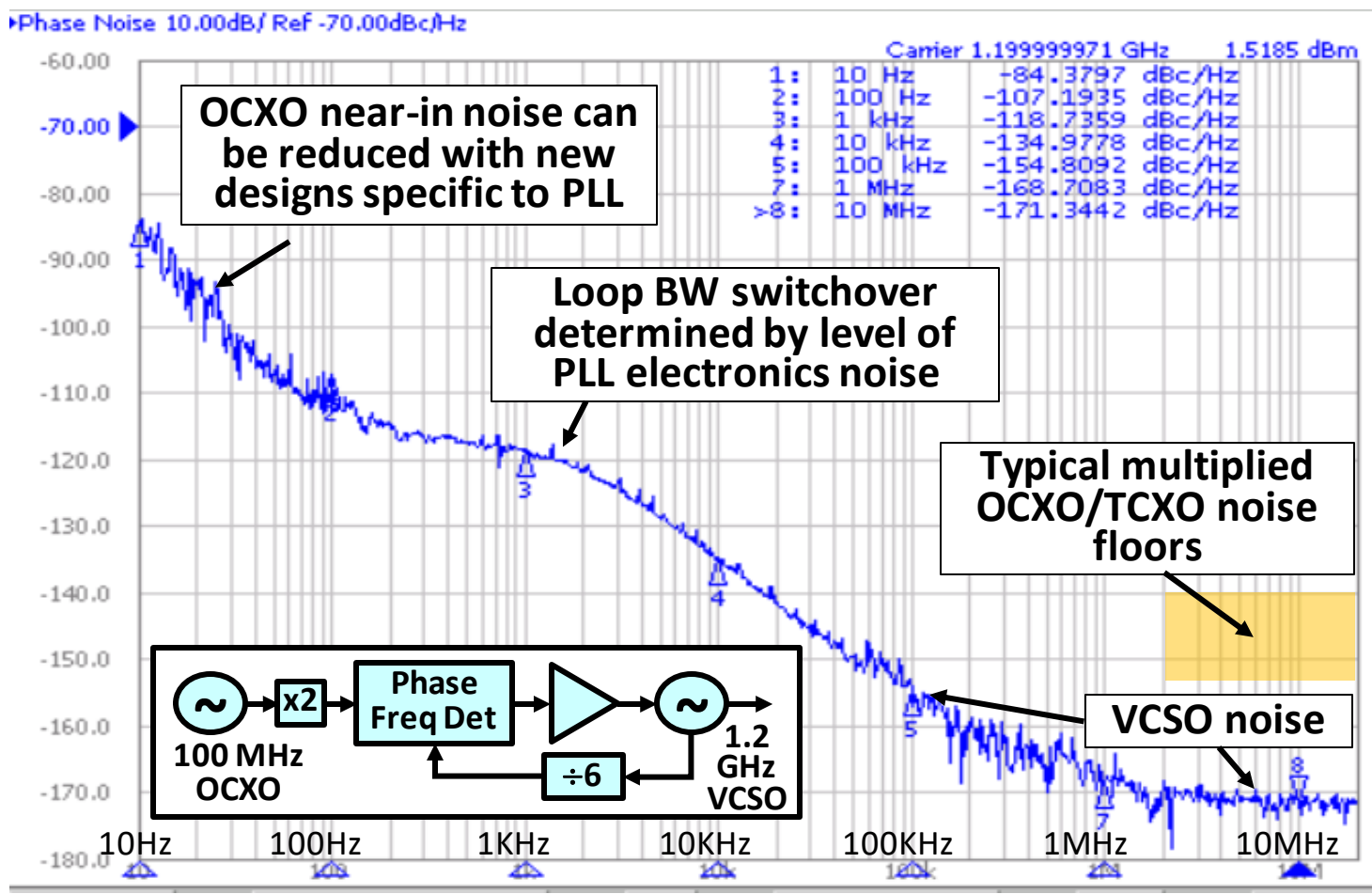
- Approximate dimensions of 1" x 2" x 3.75" with customizable external hardware to fit various mounting configurations
- Efficient assembly for high-volumes due to single-board design requiring no internal wires (and potentially no foam depending on performance requirements)
- Will be Q-Tech's first OCXO available with pre-soldered cables for RF and power/ground/telemetry
- Outstanding OCXO performance for frequency stability and phase noise and is voltage tunable for even better long-term performance
- For Space and Military applications
 - Radiation Hardened components available





PLL Products

- Custom OCXO/TCXO + VCSO PLL solutions for the best performance of both products:
 - Near in phase noise performance of the OCXO or TCXO
 - Far out phase noise floor performance of the VCSO
- Vibration isolated options are available with ultra low phase noise and vibration sensitivity



1.2GHz VCSO phase locked at 100MHz OCXO Phase Noise

Custom Frequency Control Module Subsystems





- Q-Tech is staffed and prepared to handle these complex subsystems having worked closely with a U.S. Prime to development cutting edge technology
- We can combine OCXO, MCXO, TCXO, SO, VCXO, PLL and crystal filters into modules with multiple outputs and ultra low phase noise
- We are experienced with various analyses:
 - Worst Case Circuit Analysis (WCCA)
 - Critical Design Review (CDR)
 - Manufacturing Readiness Review (MRR)
 - Test Readiness Review (TRR)
 - Various mechanical and electrical analyses
 - Many other Supplier Document Requirements (SDRLs)



New Space (LEO) Products

New Space Oscillators



 Q-TECH CORPORATION		New Space Components						
	XO			TCXO	OCXO			MCXO
Product Line	QT723 Series	QT735 Series	QT780 Series	AXLE7050S Series	AXIOM70SL	AXIOM75SL	AXIOM75SH	QT2020
Frequency Range	1.5MHz - 133MHz	1MHz to 250MHz	225kHz to 250MHz	10 to 50MHz (CSW)	10MHz (HCMOS)	10MHz (Sine)	80 - 125MHz (Sine)	5 - 100MHz
Stability Range	±25ppm (limited) ±50ppm	±25ppm (limited) ±50ppm	±25ppm (limited) ±50ppm	±1 ~ ±2 ppm	±10ppb	±10ppb	±50ppb	±10ppb to ±30ppb
Voltage	1.8V - 3.3V	1.8V - 5.0V	1.8V - 5.0V	3.3 V	5V	12V	12V	3.3V
Temperature Range	-55°C to +125°C	-55°C to +125°C	-55°C to +125°C	-40°C ~ +85°C	-20°C to +70°C	-20°C to +70°C	-20°C to +70°C	0°C to +70°C -40°C to +85°C
Radiation Hardness (TID)	50kRad TID	50kRad TID	50kRad TID	40kRad TID (50kRad tested)	10kRad TID	40kRad TID (50kRad tested)	40kRad TID (50kRad tested)	50kRad TID
Radiation Hardness (SEE)	Contact Factory	Contact Factory	Contact Factory	Contact Factory	Contact Factory			N/A
Crystal	Non-Swept	Non-Swept	Non-Swept	Non-Swept	Non-Swept	Swept on request	Swept on request	Swept
Crystal Mount	2-pt mount	2-pt mount	2-pt or 4-pt mount (package dependent)	2-pt mount	2-pt mount	2-pt mount	4-pt mount	4-pt mount
Size/Package	2.5 x 3.2mm	3.2 x 5mm	5 x 7mm - 7 x 9mm	5 x 7mm	25 x 25 x 13mm	25 x 25 x 13mm	25 x 25 x 13mm	1" x 2" x 0.33"
Standard Screening	MIL-PRF-55310, Level B + PIND	MIL-PRF-55310, Level B + PIND	MIL-PRF-55310, Level B + PIND	MIL-PRF-55310, Level S Modified	MIL-PRF-55310, Level S Modified	MIL-PRF-55310, Level S Modified	MIL-PRF-55310, Level S Modified	MIL-PRF-55310, Level B Modified

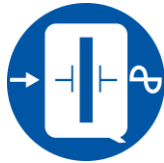
Q-Tech and Axtal New Space Oscillators



Ultra Miniature Products – New Space

- XOs for New Space (LEO) applications
- QT780 Series – 5x7mm and 7x9mm, SMT and various lead options (LVDS, LVPECL, CMOS)
- QT735 - 3.2 x 5mm (LVDS, LVPECL, CMOS)
- QT723 - 2.5 x 3.2mm (CMOS)
- Standard XO stabilities
 - Down to ± 50 ppm from -55°C to $+125^{\circ}\text{C}$
 - Down to ± 25 ppm from -40°C to $+85^{\circ}\text{C}$





Axtal New Space OCXO

AXIOM75SH 100.000MHz OCXO

- 25x25mm thru-hole package
- Ultra-Low Phase Noise
- Built and tested to MIL-PRF-55310, S
- Suitable for LEO and MEO applications
- Technology: Bipolar, non-swept High-Q quartz (SC cut 5th OT)
- 50krad(Si) TID with monitored parameters:
 - Frequency
 - Output of the internal voltage regulator
 - Output level
 - Current consumption

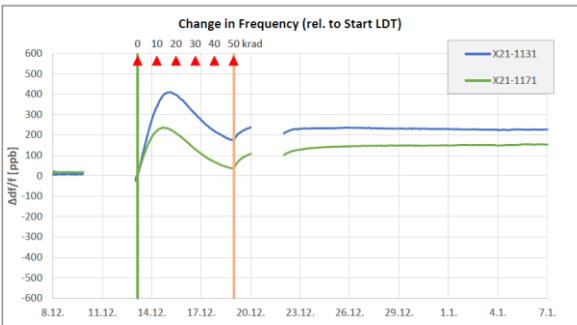
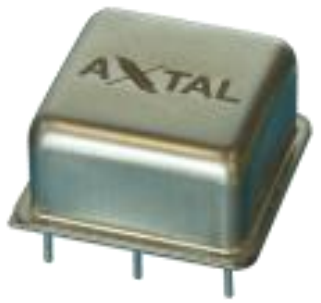


Figure 5 - Change in Frequency during irradiation and subsequent annealing

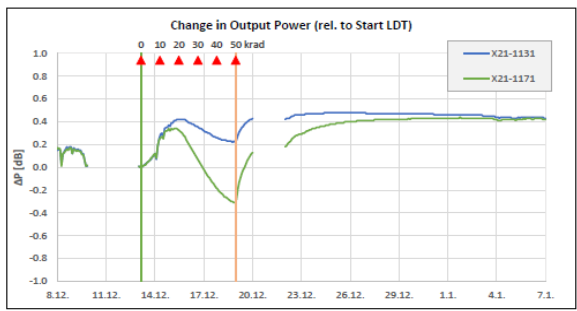


Figure 6 - Change in Output Power during irradiation and subsequent annealing

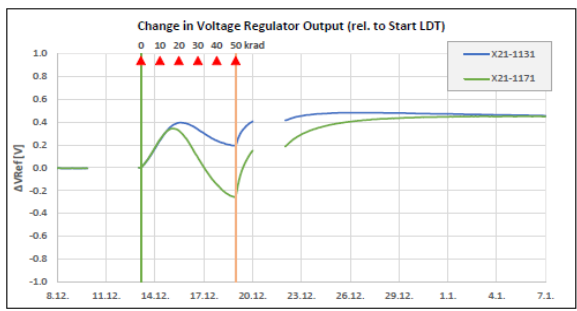
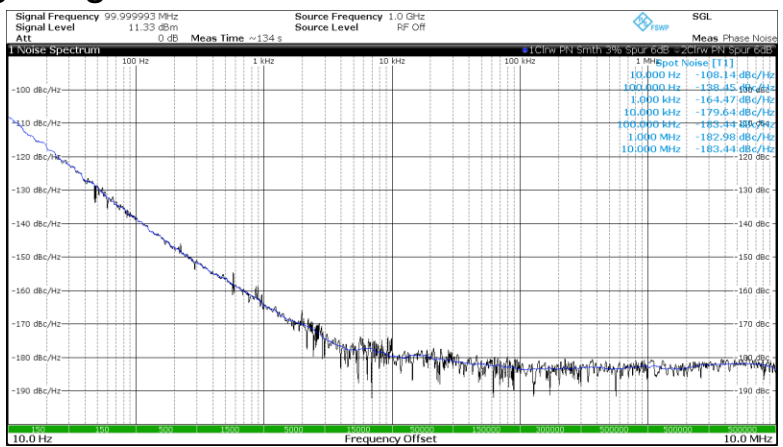
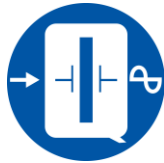


Figure 7 - Change in Voltage Regulator Output during irradiation and subsequent annealing

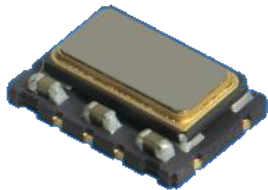




Axtal New Space TCXO

AXLE7050S Series TCXO

- 10MHz to 50MHz
- 5x7mm SMD low profile package
- Low Phase Noise TCXO for Space application
- Built per MIL-PRF-55310, S
- Suitable for demanding LEO and MEO applications
- Technology: Mixed, non-swept High-Q quartz (AT cut)
- Tested to 50krad(Si) TID
- Monitored parameters are:



- Frequency
- Output level
- Current consumption

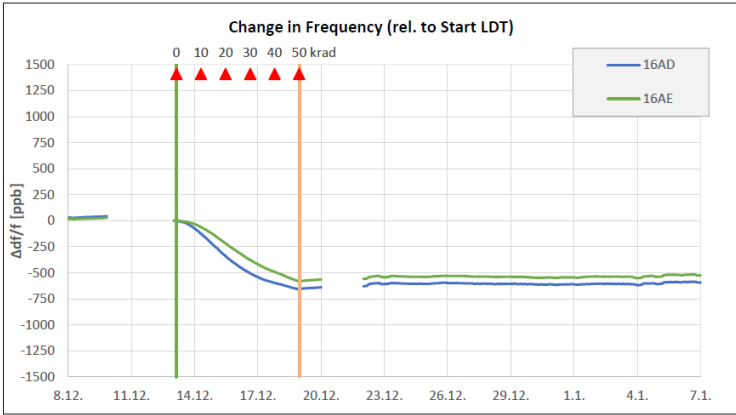
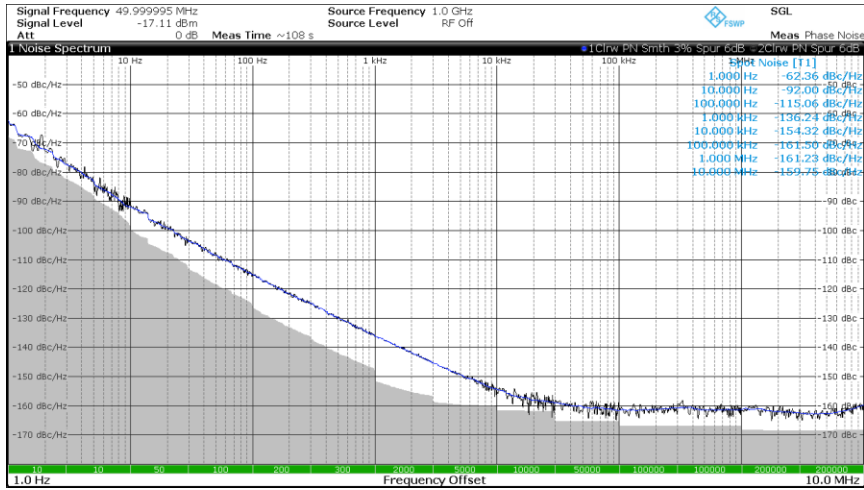


Figure 5 - Change in Frequency during irradiation and subsequent annealing

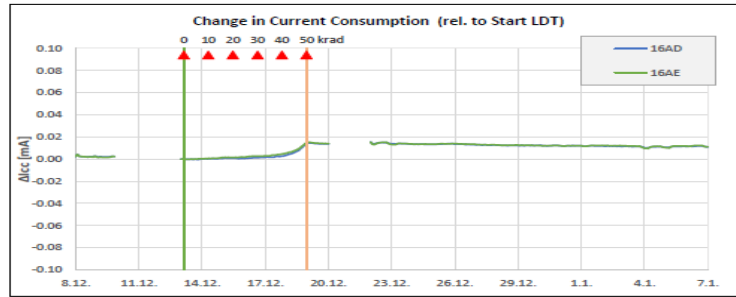


Figure 6 - Change in Current Consumption during irradiation and subsequent annealing

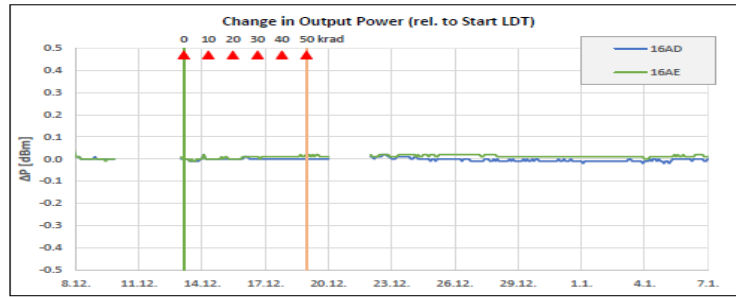
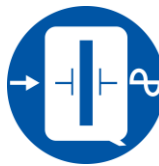


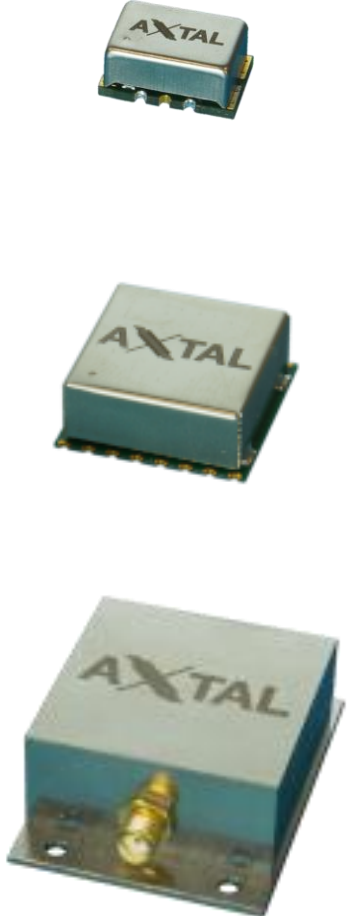
Figure 7 - Change in Output Power during irradiation and subsequent annealing



Axtal AXLE TCXO Products

- AXLE145HF
 - 60MHz to 150MHz
 - 9x14mm SMT package
 - High Stability, Low Jitter, Low G-Sensitivity
 - As low as ± 0.5 ppm stability over -40°C to $+85^{\circ}\text{C}$

- UHF AXLE130, AXLE175, AXLE1000 and AXLE2000
 - Ranging from 500MHz up to 2.5GHz (20x20mm and 25x25mm SMT package)
 - Ranging from 300MHz to 8GHz (connectorized)
 - As low as ± 0.5 ppm stability over -40°C to $+85^{\circ}\text{C}$



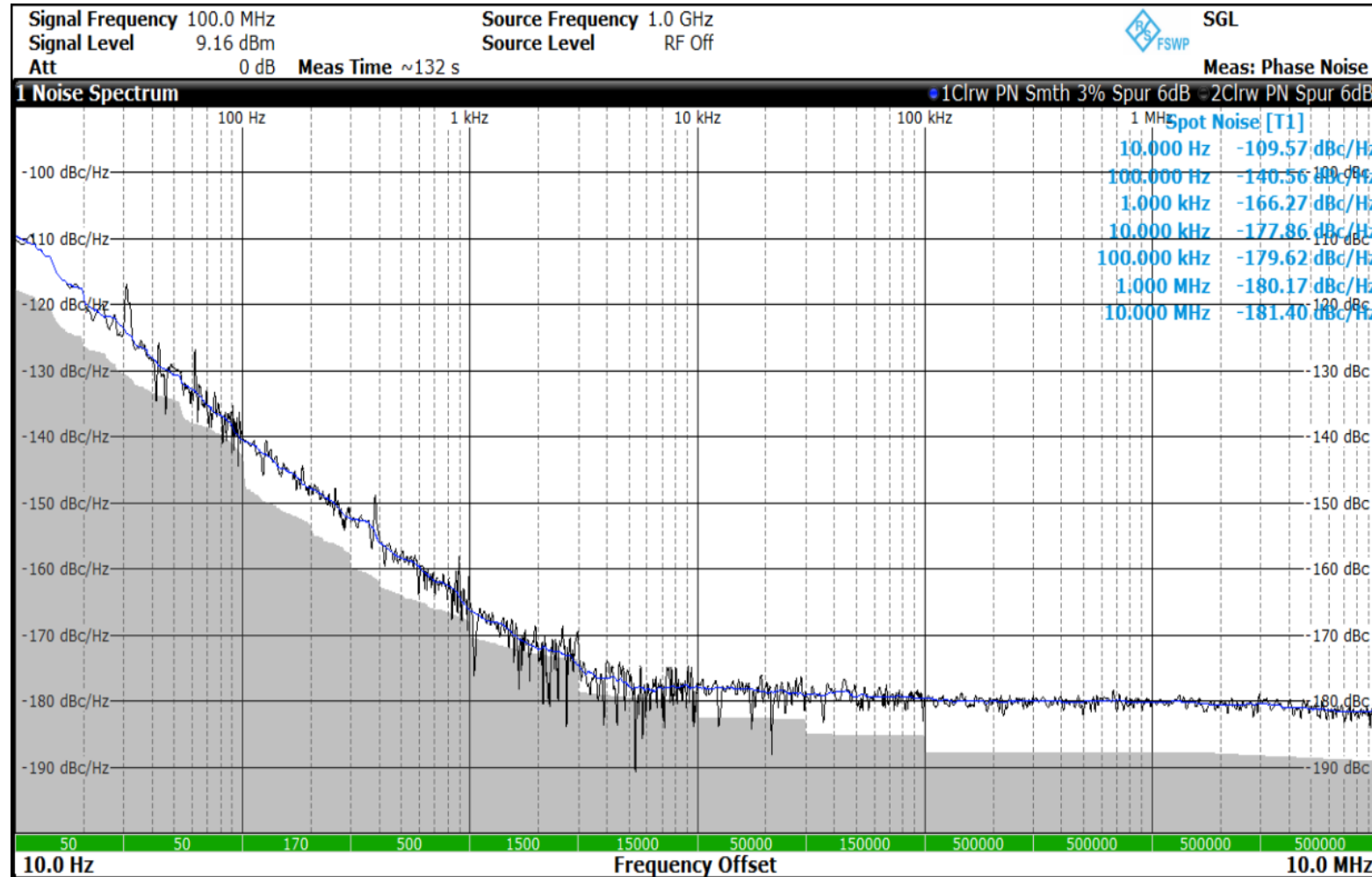
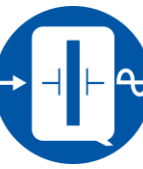


Axtal AXIOM OCXO Products

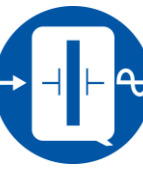
- Standard OCXO Line
 - 5MHz to 160MHz
 - Standard temperature range of -10°C to $+60^{\circ}\text{C}$ with temperature stability as low as $\pm 5\text{ppb}$
 - Extended temperature range of -55°C to $+85^{\circ}\text{C}$ with temperature stability as low as $\pm 100\text{ppb}$
 - Sine Wave and CMOS Output, 3.3V to 15V
- AXIOM75ULN Ultra-Low Noise Line OCXOs
 - 10MHz Standard
 - 50MHz to 160MHz available
 - Noise Floor: $-170\text{dBc}/\text{Hz}$
 - Temperature Range: -10°C to $+60^{\circ}\text{C}$, up to -55°C to $+95^{\circ}\text{C}$
 - Sine Wave, 5V ~ 12V
 - Warm-up Power $<4\text{W}$, Steady State Power $<1.3\text{W}$
 - As small as 20x20mm



Axtal OCXO Products

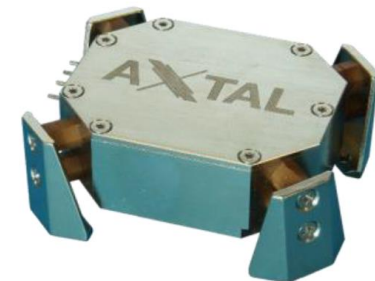


100.000MHz AXIOM75ULN-E Phase Noise

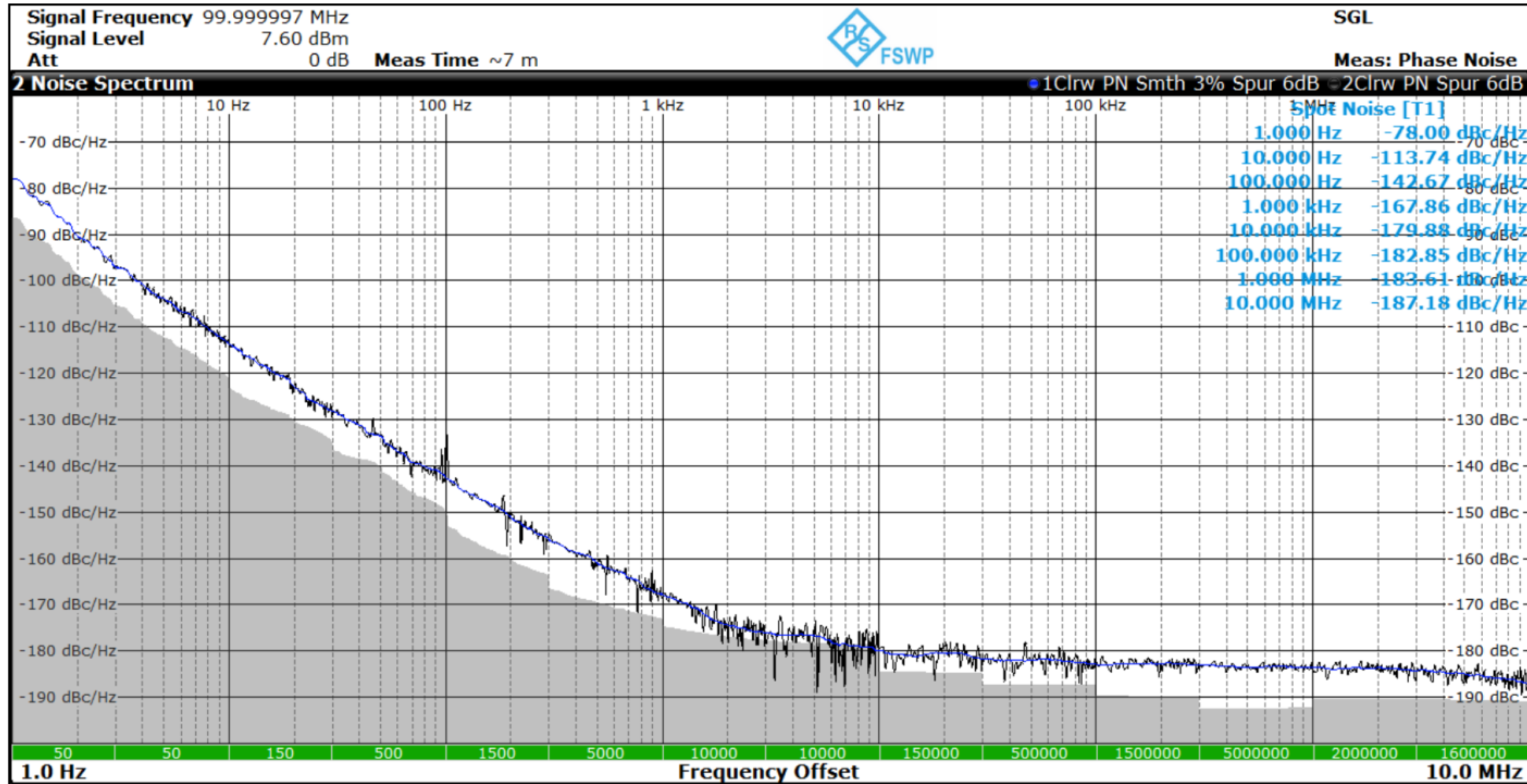
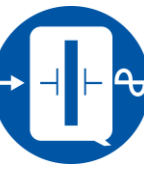


Axtal AXIOM Connectorized OCXO Products

- 5MHz to 160MHz
- Standard temperature range of -10°C to $+60^{\circ}\text{C}$ with temperature stability as low as $\pm 5\text{ppb}$
- Extended temperature range of -55°C to $+85^{\circ}\text{C}$ with temperature stability as low as $\pm 100\text{ppb}$
- Phase Noise Floor: $< -175\text{dBc/Hz}$
- Ultra Low Noise Floor (ULN): $< -180\text{dBc/Hz}$
- Warm-up Power $< 5.7\text{W}$, Steady State Power $< 3.2\text{W}$
- Available with multiple outputs (up to 6x)
- Vibration Isolated OCXO
 - G-Sensitivity down to $0.001\text{ g}^2/\text{Hz}$



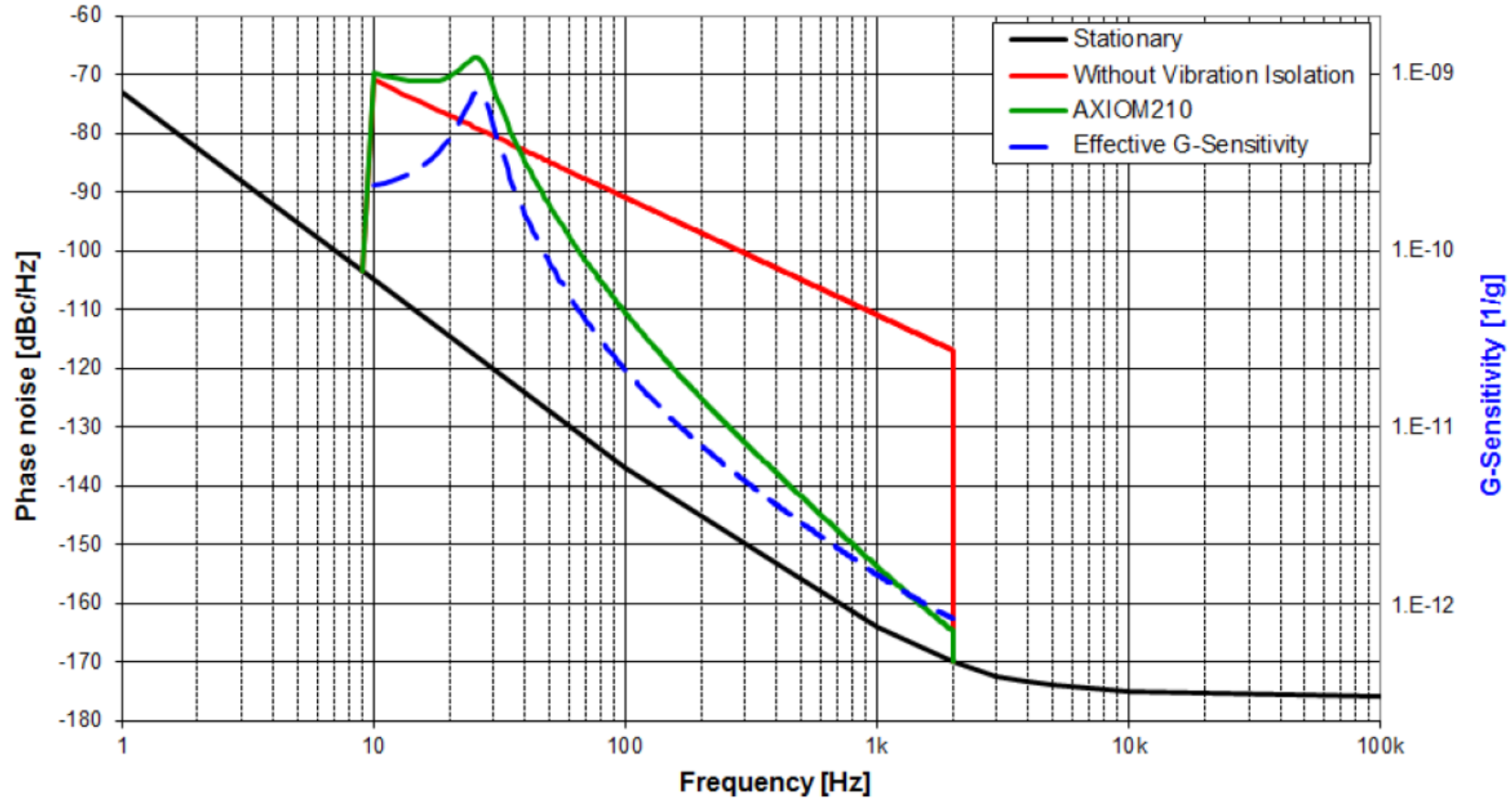
Axtal OCXO Products



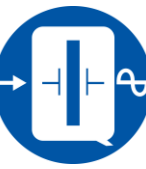
100.000MHz AXIOM5050ULN Phase Noise



AXIOM210 / 100 MHz - Phase noise under vibration
for flat random profile 0.04 g²/Hz, 10~2000 Hz

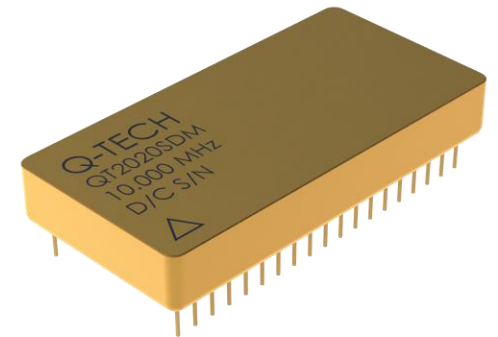


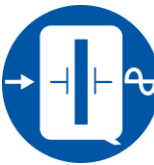
100.000MHz AXIOM210 Phase Noise under Vibration



QT2020 MCXO

- OCXO performance with less than 90mW power consumption
- Standard frequencies of 10, 30, 40, 50, 60, and 80MHz with CMOS or Sine Wave logic outputs
 - Custom frequencies available
- As low as ± 10 ppb frequency stability performance
- Startup time: 20ms to ± 50 ppm
- Initialization time: 30 seconds from power on to full ppb performance
 - Versus OCXO typical warm up time of 10 minutes plus
- Size: 2" x 1" x 0.33" (lower profile vs. space OCXO)
- 50kRad (Si) TID (New Space / LEO)





Standard Screening Options

**Q-Tech Product Standard Screening and QCI Options
(Customer SCD Requirements Also Supported)**

Test Inspection	MIL-PRF-55310	MIL-PRF-55310	MIL-PRF-38534	0401-00298-0001	Engineering Model	Breadboard Model
	PRODUCT LEVEL B	PRODUCT LEVEL S	CLASS K, MODIFIED (B+)	Q-TECH SPACE LEVEL SPEC		
Nondestructive Bond Pull	N/A	MIL-STD-883, Method 2023	MIL-STD-883, Method 2023	MIL-STD-883, Method 2023	N/A	N/A
Internal Visual	MIL-STD-883, Method 2017 and Method 2032, Class H (Level B)	MIL-STD-883, Method 2017 and Method 2032, Class K (Level S)	MIL-STD-883, Method 2017, Class K	MIL-STD-883, Method 2017, Class K	MIL-STD-883, Method 2017 and Method 2032, Class H (Level B)	MIL-STD-883, Method 2017 and Method 2032, Class H (Level B)
Stabilization Bake	MIL-STD-883, Method 1008, Condition C (+150°C), 24 hours minimum	MIL-STD-883, Method 1008, Condition C (+150°C), 48 hours minimum	MIL-STD-883, Method 1008, Condition C (+150°C), 48 hours minimum	MIL-STD-883, Method 1008, Condition C (+150°C), 48 hours minimum	MIL-STD-883, Method 1008, Condition C (+150°C), 24 hours minimum	MIL-STD-883, Method 1008, Condition C (+150°C), 24 hours minimum
Random Vibration	N/A	MIL-STD-883, Method 2026, Condition I-B	N/A	N/A	N/A	N/A
Thermal Shock	N/A	MIL-STD-883, Method 1011, Condition A	N/A	N/A	N/A	N/A
Temperature Cycling	MIL-STD-883, Method 1010, Condition B	MIL-STD-883, Method 1010, Condition C	MIL-STD-883, Method 1010, Condition C	MIL-STD-883, Method 1010, Condition C	N/A	N/A
Constant Acceleration	MIL-STD-883, Method 2001, Condition A, Y1 only (5000 g's)	MIL-STD-883, Method 2001, Condition A, Y1 only (5000 g's)	MIL-STD-883, Method 2001, Condition A, Y1 only (5000 g's)	MIL-STD-883, Method 2001, Condition A, Y1 only (5000 g's)	N/A	N/A
Seal (Fine Leak)	MIL-STD-883, Method 1014, Condition A1, A2, or B1	MIL-STD-883, Method 1014, Condition A1, A2, or B1	MIL-STD-883, Method 1014, Condition A1 or B1	MIL-STD-883, Method 1014, Condition B1	MIL-STD-883, Method 1014, Condition A1	MIL-STD-883, Method 1014, Condition A1
Seal (Gross Leak)	MIL-STD-883, Method 1014, Condition C	MIL-STD-883, Method 1014, Condition B2 or B3	MIL-STD-883, Method 1014, Condition C, B2, or B3	MIL-STD-883, Method 1014, Condition B2 or B3	MIL-STD-883, Method 1014, Condition C	MIL-STD-883, Method 1014, Condition C
Particle Impact Noise Detection (PIND)	N/A	MIL-STD-883, Method 2020, Condition A	MIL-STD-883, Method 2020, Condition A	MIL-STD-883, Method 2020, Condition B	N/A	N/A
Pre Burn-in Electrical Test	Current, Waveform, Voltage (optional)	Current, Waveform, Voltage	Current, Waveform, Voltage	Current, Waveform, Voltage	N/A	N/A
Burn-in #1	MIL-STD-883, Method 1015, +125°C, nominal supply voltage and burn-in load, 160 hours minimum	MIL-STD-883, Method 1015, +125°C, nominal supply voltage and burn-in load, 240 hours minimum	MIL-STD-883, Method 1015, 125°C for 160 hours	MIL-STD-883, Method 1015, 125°C for 160 hours	N/A	N/A
Interim Electrical Test	N/A	N/A	Current, Waveform, Voltage	Current, Waveform, Voltage	N/A	N/A
Burn-in #2	N/A	N/A	MIL-STD-883, Method 1015, 125°C for 160 hours	MIL-STD-883, Method 1015, 125°C for 160 hours	N/A	N/A
Final Electrical Test	For Specified Parameters, Nominal and extreme supply voltages, specified load, +25°C and temperature extremes. PDA = 10% or 1 part	For Specified Parameters, Nominal and extreme supply voltages, specified load, +25°C and temperature extremes, record all test parameters by serial number. PDA = 2% or 1 part (Supply Current, VOH, VOL)	For Specified Parameters, Nominal and extreme supply voltages, specified load, +25°C and temperature extremes, record all test parameters by serial number. PDA = 2%, Supply Current Only	For Specified Parameters, Nominal and extreme supply voltages, specified load, +25°C and temperature extremes, record all test parameters by serial number. PDA = 2%, Supply Current Only	Frequency Tested over Temperature. Electrical Parameters tested at 25°C	Frequency and Electrical Parameters tested at 25°C.
Radiographic Inspection	N/A	MIL-STD-883, Method 2012	MIL-STD-883, Method 2012	MIL-STD-883, Method 2012	N/A	N/A
Frequency Aging	N/A During Screening (Optionally performed as Part of Group B QCI)	N/A During Screening (Performed as Part of Group B QCI)	Aging for 30 Days up to 90 days. May be ceased at 15 days if value is less than half the 30 day limit.	Aging for 30 Days. May be ceased at 15 days if value is less than half the 30 day limit.	N/A	N/A
External Visual	MIL-STD-883, Method 2009	MIL-STD-883, Method 2009	MIL-STD-883, Method 2009	MIL-STD-883, Method 2009	MIL-STD-883, Method 2009	MIL-STD-883, Method 2009
Additional Testing/QCI	100% Group A Per MIL-PRF-55310 Level B Optional Group B and C	100% Group A Per MIL-PRF-55310 Level S 100% Group B Aging for 30 Days. May be ceased at 15 days if value is less than half the 30 day limit. Optional Group C per MIL-PRF-55310	100% Group A Per MIL-PRF-38534 Optional Groups B, C, and D per MIL-PRF-38534	100% Group A Per MIL-PRF-38534 Optional Groups B, C, and D per MIL-PRF-38534	N/A	N/A

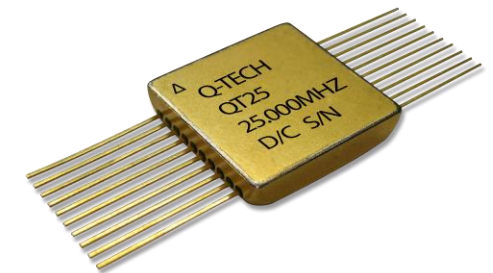
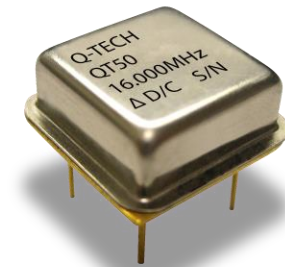
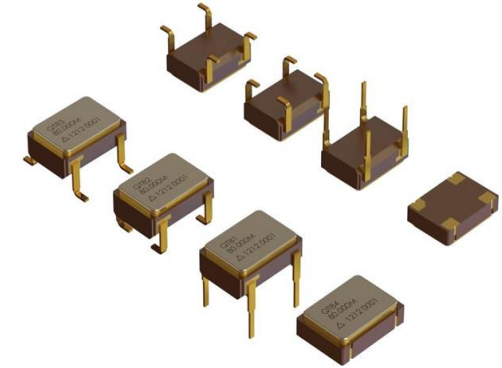


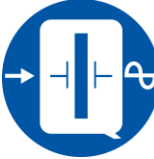
Military/Avionics Products



High Reliability and QPL Products

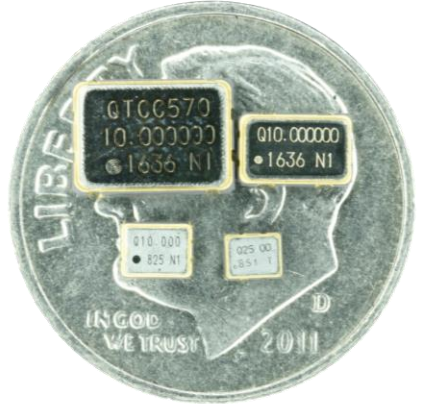
- Operating temperature range to -55°C to +125°C
- Frequency stability as low as ± 25 ppm dependent on operating temperature
- Frequencies up to 200 MHz including real time clocks at 32.768kHz
- 1.8V, 2.5V, 3.3V and 5.0V CMOS available
- Standard 2- and 3-point crystal mount
- 4-point mount crystal available dependent on package type
 - 4-point mount tested to 36,000g shock
- Surface mount and various leaded configurations and packages:
 - 5x7mm, 7x9mm, and 9x14mm Ceramic Packages
 - Dual Inline Packages
 - Flat Packages
 - Leaded Chip Carriers
- MIL-PRF-55310, Level B Screening available
- Available as MIL-PRF-55310 QPL Slash Sheets
 - Dependent on package type, as specified by the QPL

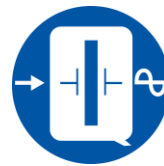




Ultra Miniature Products

- XOs, TCXOs, and VCXOs
- XOs for New Space (LEO) applications
- XO (LVDS) lower phase noise option available
- XO 3.2 x 5mm (LVDS, LVPECL, CMOS) 3-point option available
 - Shock tested to 28,000g
- XO stabilities
 - ± 50 ppm from -55°C to $+125^{\circ}\text{C}$
 - ± 12 ppm from -40°C to $+85^{\circ}\text{C}$
- TCXO stabilities as tight as ± 0.5 ppm from -40°C to $+85^{\circ}\text{C}$





Questions?