SPACE PASSIVE COMPONENT DAYS

2nd SPCD Edition

10150 JEFFERSON BLVD,
CULVER CITY, CA 90232 USA

2nd INTERNATIONAL SYMPOSIUM
SPACE PASSIVE COMPONENT DAYS

ULTRA^3
ULTRA MINIATURE, ULTRA RUGGED, ULTRA STABLE
HIGH PERFORMANCE
SPACE GRADE OVEN CONTROLLED CRYSTAL OSCILLATORS
&
HIGH RELIABILITY 5x7mm SMT, SPACE GRADE
CRYSTAL OSCILLATORS

Richard Duong[1], Sergei Gulin[2]

CONTENTS

PART I
Company Profile

- Q-Tech Corporation founded in 1972
- Focused exclusively on providing high reliability crystal oscillators
- Contributed to the first government specifications for hybrid oscillators: MIL-O-55310
- Qualified to QPL on MIL-PRF-55310/S Space Level
- More products QPL qualified to MIL-PRF-55310 than any other supplier
- Providing oscillators for space since 1985
- M55310 / ISO 9001 / AS 9100 Registered

MICROMINIATURE CRYSTAL OSCILLATORS
TYPE MCO-F

DESCRIPTION

The MCO-F is a crystal controlled oscillator totally contained within a TO-5 package. The unit has been designed with an AT cut quartz crystal and thin film circuitry for high stability and reliability. A three point mounting arrangement is used in mounting the quartz crystal blank, resulting in a unit able to withstand the most extreme environmental conditions without failure.

FREQUENCY RANGE

Frequency Range - 7 MHz to 25MHz

NOMINAL FREQUENCY TOLERANCE AVAILABLE

Standard:	± 0.005 %	-55°C to +105°C
Special:	± 0.0035%	-55°C to +105°C
	± 0.0025%	-55°C to +105°C
	± 0.002 %	-40°C to + 90°C

Frequency Stability - Long term aging 5 parts in 10^{-6}/30 days to 5 parts in 10^{-7}/30 days.*

Stability vs Input - 1 X 10^{-6} for 10% change

Stability vs Load - 1 X 10^{-7} for 20% change

Wave Form - Sinusoildal

Output Voltage - .35 volts RMS (min.) into 5K load (5.0 V.D.C. Input)

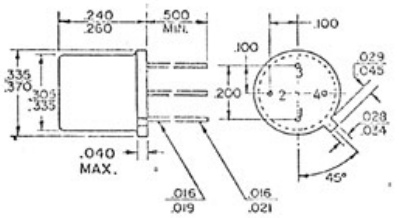
Input Voltage - 2.0 to 10.0 volts

STATE-OF-THE-ART DEVELOPMENT

MCO-F OSCILLATOR CONNECTIONS

1. Crystal T.P.
2. Vcc
3. Common
4. Output

TO-5 Case Outline
(TO-77)



*Dependent on package, frequency, temperature and operating levels. Improved stability available on special orders.

Note: Consult TRW Crystal Plant application engineering for special applications.

Workmanship and Quality Standards - TRW standard crystal products are manufactured to comply with the latest military specifications. Special products may be ordered with additional specifications or special applications.

Space Products History

- **1985** – Entered the Space Applications Market and received our first order for the MILSTAR program.
- **1986 & 1987** – Received the TRW "Supplier of the Year Award".
- **1994** – Became the major supplier of hybrid crystal oscillators to virtually every satellite manufacturer in the USA.
- **1999** – Received the JPL award for our contribution to Cassini program.
- **2002** – Produced our first Space level TCXO.
- **2004** – Received our first NGST “Gold Supplier Award”.
- **2006** – Received our second NGST “Gold Supplier Award”.
- **2007** – Released “catalogue” part numbers for “standard” Space level product.
- **2007** – Received our third NGST “Gold Supplier Award”
- **2008** – Launched QT800 Series TCXOs to 350MHz
- **2009** – Launched Class B+ small, 7 x 9 mm space clocks up to 360MHz.
- **2010** – Launched QT700 Series VCXOs to 350MHz
- **2010** – Launched Low Phase Noise Space OCXO
- **2011 –** Launched Ultra Low Phase Noise 100 MHz PLL OCXO series
- **2012 –** Launched Miniature Space OCXO
- **2014 – Launched QT4200, the world’s smallest full performance space OCXO**
- **2014 –** Launched SAW space clocks and VCSOs
- **2016 – Launched Class B+ small, 5 x 7 mm space clocks up to 162.5MHz**.

2nd INTERNATIONAL SYMPOSIUM
SPACE PASSIVE COMPONENT DAYS

PART II

ULTRA^3

ULTRA MINIATURE, ULTRA RUGGED, ULTRA STABLE HIGH PERFORMANCE SPACE GRADE OCXO

SPACE OCXO PRODUCT EVOLUTION

- **QT4100 SPACE OCXO**
  - *LAUNCHED IN 2012*
  - *LIGHT WEIGHT 165grams*
  - *65 x 57 x 40mm IN SIZE*
  - *1MHz to 125MHz*
  - *5V to 15Vdc SUPPLY*

- **QT4200 SPACE OCXO**
  - *LAUNCHED IN 2014*
  - *LIGHTER WEIGHT 100grams*
  - *SMALLER 50 x 25 x 19mm*
  - *HERMETICALLY SEALED*
  - *IMPROVED PHASE NOISE*
  - *BETTER PERFORMANCE*

ULTRA³ HIGH RELIABILITY SPACE OCXO

Standard offerings

Ordering Information

(Sample part number)

QT4207SNM-60.000MHz

Q	T	4	2	0	7	S	N	M	-	60.000MHz

Output Power:

0 (**)	=	+0 dBm
1	=	+1 dBm
2	=	+2 dBm
3	=	+3 dBm
4	=	+4 dBm
5	=	+5 dBm
6	=	+6 dBm
7	=	+7 dBm
8	=	+8 dBm
9	=	+9 dBm

Supply Voltage:

5	=	+5.0V
6	=	+12.0V
7	=	+15.0V

Logic:

C = HCMOS (**)
S = Sine Wave

Output Frequency

Screening Option:

Blank = EM
M = Per MIL-PRF-55310, Level S

Frequency vs. Temperature Code:

G	=	± 100PPB	at	-20°C	to	+70°C
H	=	± 10PPB	at	-20°C	to	+70°C
L	=	± 200PPB	at	-40°C	to	+75°C
N	=	± 20PPB	at	-40°C	to	+75°C

ULTRA³ HIGH RELIABILITY SPACE OCXO

- ✓ Made in USA
- ✓ Small **50 x 25 x 19mm, light weight 100grams**
- ✓ Supply voltages **5.0Vdc to 15Vdc**
- ✓ Frequency **1MHz to 125MHz**
- ✓ Sine output or CMOS output
- ✓ Wide operating temperature **-40° C to +75° C**
- ✓ Radiation hardened **100kRad(Si) to 300kRad(Si)**
- ✓ Low g-sensitivity **1ppb/g max.**
- ✓ Initial tolerance at 25° C: **±0.2ppm max.**
- ✓ Steady state power at 25° C: **2.7Watts max.**
- ✓ Best frequency stability @ -20° C to + 70° C : **±10ppb**
- ✓ Aging : **±1ppb/day & ±1.5ppm max. over 15 years**

ULTRA³ HIGH RELIABILITY SPACE OCXO

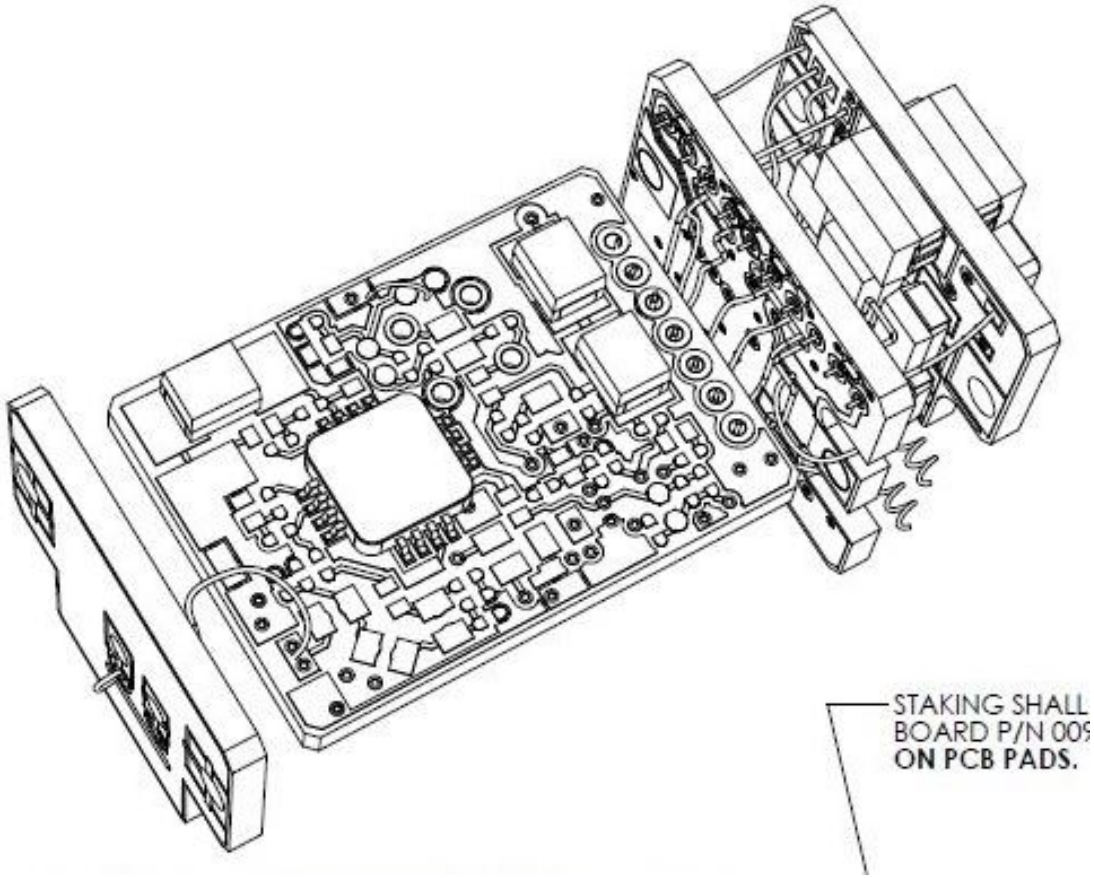
- ✓ Allan Variance 1.8 x 10^{-11} in 1s
- ✓ QT4200 has extremely ruggedized construction to withstand high levels of shock and vibration fully qualified and tested.
- ✓ Very low phase noise -160dBc/Hz at 10kHz
- ✓ Passive components per MIL-PRF-38534, Class K, and MIL-PRF-55310, Level S.
- ✓ Active components per MIL-PRF-38534, Class K, or MIL-PRF-38535, Class V.
- ✓ Meet Derating and Worst-Case Analyses over extreme worst-conditions in orbit and the life of applications 15 to 20 years.
- ✓ Standard screening and QCI per MIL-PRF-55310, Level S or other options per Specification Control Drawing.

KEY CHALLENGES OF MINIATURIZATION

- **SELECT COMPONENTS SIZE AND QUALITY LEVEL TO MEET THE LIFE OF SPACE APPLICATIONS**
  - MITIGATION WITH CLASS 3, TYPE 4 CONSTRUCTION (DISCRETE & HYBRID TECHNOLOGY) WITH MIL-PRF-38534, CLASS K COMPONENTS
  - USE OF 0603 COMPONENTS
- **SIZE RELEVANT TO PARAMETRIC LIMITS**
  - MUST MEET DERATING AND WCCA CRITERIA BOL AND EOL
  - MUST MEET FULL DPA SPACE CRITERIA
- **ASSEMBLY COMPACT**
  - MUST USE BEST METHOD OF PCB LAYOUT & BOTH SIDES ASSEMBLYING WHILE PRESERVING HEAT & POWER SUPPLY MANAGEMENT
  - COMBINATION OF DISCRETE AND HYBRID TECHNOLOGY
  - USE OF RUBBER FOAM FOR MAXIMUM HEAT INSULATION
  - USE TANTALUM CAPACITORS FOR SMALL SIZE WITH LARGE VALUES FOR BEST DECOUPLING AND BYPASSING.
  - HEAT SINK ON CRYSTAL AND HEAT SOURCE MOSFET

ULTRA³ HIGH RELIABILITY SPACE OCXO

HIGH PERFORMANCE OPTIMUM CONSTRUCTION



ULTRA³ HIGH RELIABILITY SPACE OCXO

CONSTRUCTION

- There are four separate sections optimized for power supply management with good decoupling and bypassing capacitors and ground plane, along with thermal management controlling the air flow and heat transfer to reach and sustain thermal equilibrium.
- Section 1: **REGULATOR BOARD**
  - QML V RHA Level F Adjustable Positive Voltage Regulator
  - Space level solid tantalum capacitors for decoupling and bypassing
  - Space level high-precision fixed chip resistors for voltages Vreg1 and Vreg2 adjust
- Section 2: **HEATER CONTROL BOARD**
  - Radiation Hardened Precision Operational Amplifier
  - Space level solid tantalum capacitors for decoupling and bypassing and resistors
  - The oven heater control circuit is a proportional controller with an electronic system that continuously supplies power to the oven. The thermistor is heat sunk to the oven's case to sense temperature. The oven control varies the oven power constantly to continuously compensate the ambient temperature changes with worst at cold start temperature.
  - Heater control is very low gain guaranteeing control response will never oscillate.

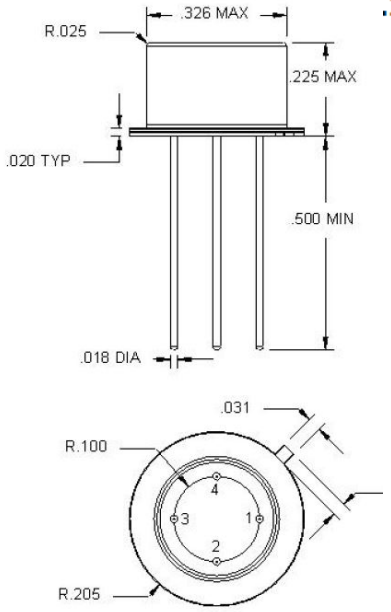
CONSTRUCTION

- Section 3: **MAIN BOARD**
  - The main board consists of:
    - The oscillator sustaining stage providing gain and phase characteristics to sustain oscillation.
    - The output stage which the signal is buffered with a QML V microcircuit.
    - The output microcircuit is fed to a band pass filtering RLC network to generate a sine wave output.
    - The heater source MOSFET is directly mounted close to the TO crystal with heat sink. Discrete heater design makes power consumption manageable and keep OCXO at its highest stability within ppb.

- Section 4: **OUTPUT BOARD**
  - To provide connections to the RF SMA output.

All four boards are assembled with wiring interface and staking adhesive and thermally insulated with foam. The unit is finally hermetically sealed to avoid issues with outgassing of internal materials and problems related to rapid pressure change.

CRYSTAL DESIGN FLOW DOWN FROM REQUIREMENTS



DEVELOPPED FREQUENCIES

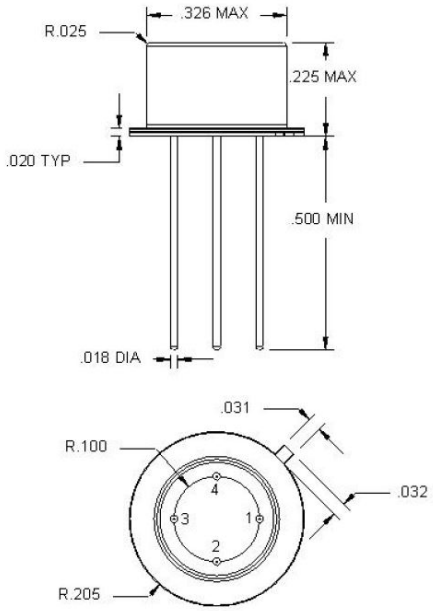
37.5MHz, 40MHz, 49.94186MHz 50MHz, 80MHz, 100MHz

.2 **Electrical Characteristics**

PARAMETER	SPECIFICATION	UNIT
Crystal Type	SC-cut, Swept, Space Level	
Mode	5th Overtone	
Turning Point	78 to 88	°C
Turning Point Flatness (max)	10	PPB/C
Nominal Tolerance (@82°C)	±5	PPM
Load Capacitance	18	pF
Drive Level	500 TYP	µW
Motional Capacitance (C1)	0.17±20%	fF
Shunt Capacitance (max) (C0)	5.0	pF
Motional Resistance (max) (R1)	90	Ω
Q (min)	130	K
Aging per Day	±1	PPB
Aging First Year	±200	PPB
Aging 15 Years	±1.5	PPM
Internal	High Vacuum	
Package Type	TO5, Height – 0.22", 4-point mount	
Phase Noise: 10 Hz 100 Hz 1 KHz 10KHz ≥100 KHz	-96 Max -124 -138 -147 -160	dBc/Hz

ULTRA³ HIGH RELIABILITY SPACE OCXO

CRYSTAL SCREENING & GROUP A TESTS

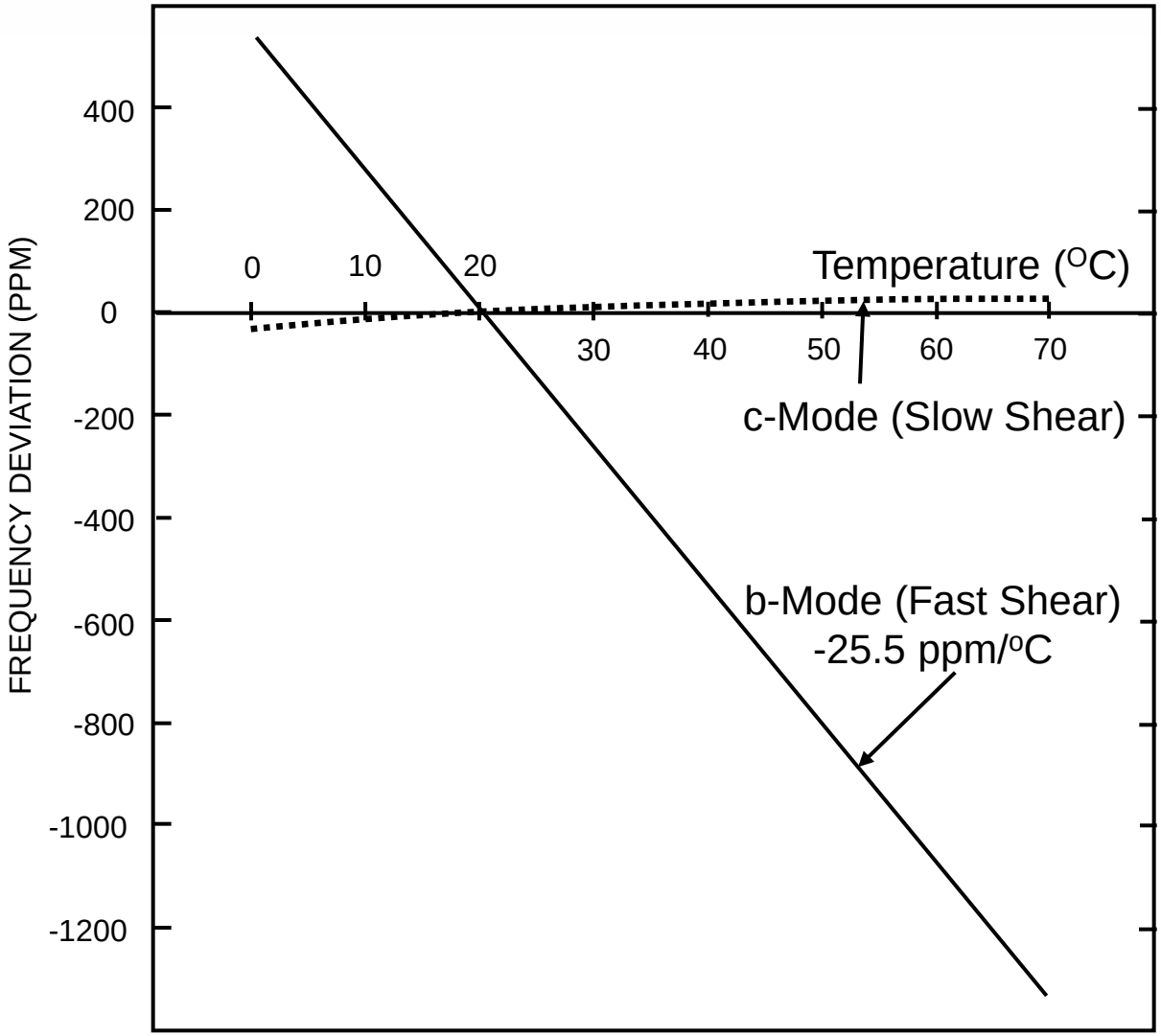


Screening, Group A / Quality Conformance Inspection (100%)

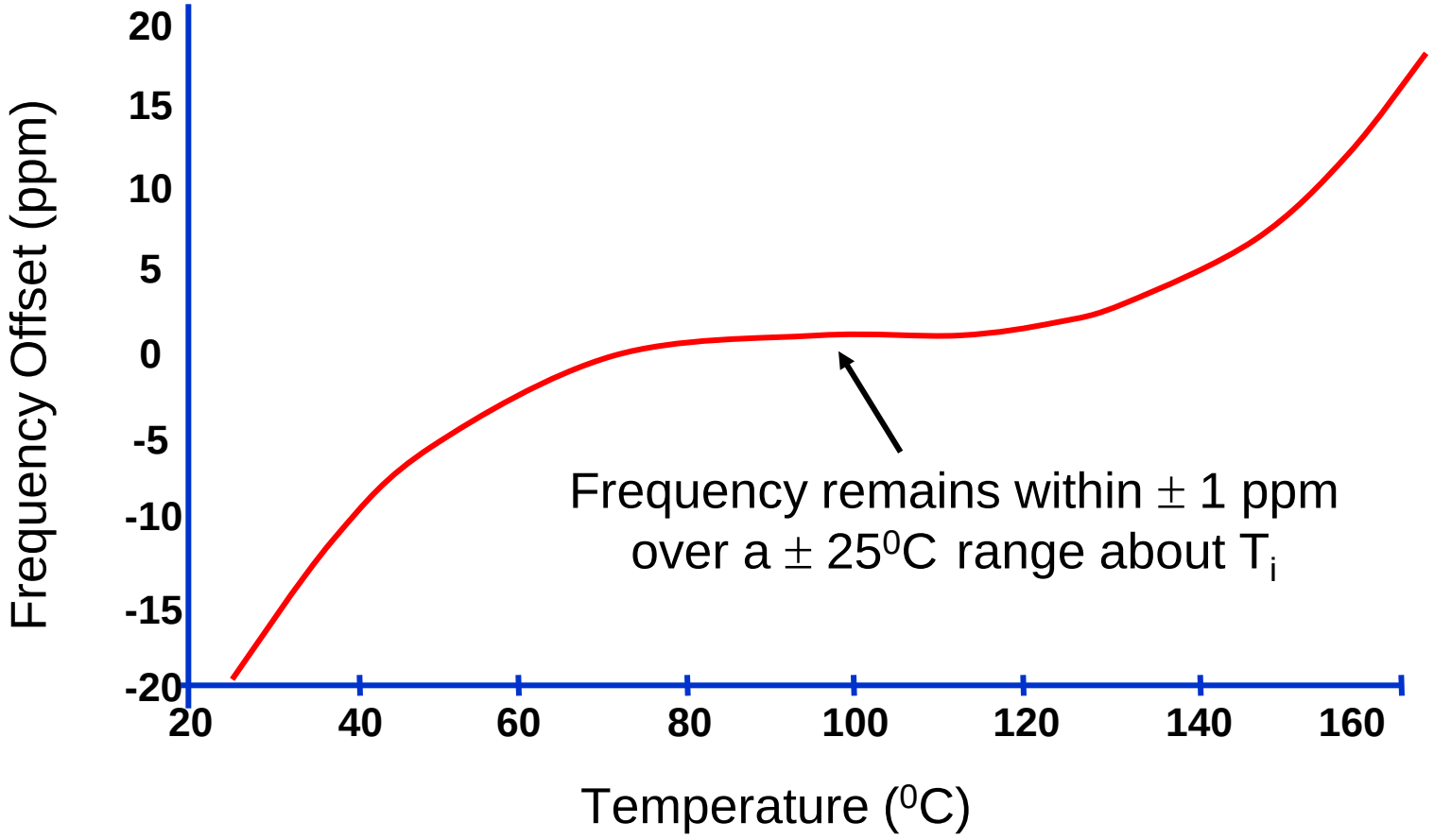
Test Number	Inspection	Requirements	Method Paragraph
1	Pre-Seal Internal Visual Inspection	MIL-PRF-3098 or Manufacturer procedure	4.4
2	Marking & Serialization		5.2
3	Initial Electrical Test	C0, C1, R, Fl, Q @83°C	4.5
4	Thermal Shock (Pre/Post Electrical Test)	MIL-STD-202, Method 107, Condition A2 Delta ($F \leq 5x10^{-7}$, R≤10%)	4.9.2
5	Random Vibration (Pre/Post Electrical Test)	MIL-STD-202, Method 214, Cond-I-G (23.91Grms) Delta ($F \leq 5x10^{-7}$, R≤10%)	4.9.4
6	PIND	MIL-STD-883, Method 2020.9	4.9.11
7	Leak Test	MIL-STD-202, Method 112, Cond C Fine Leak MIL-STD-202, Method 112, Cond B Gross Leak	4.9.6
8	Final Electrical Test over temperature	C0, C1, R, Fl, Q, @Turning Point Temp R over operating temperature range	4.7 4.9.5.1
9	Spurious Test		4.9.10
10	Radiographic Inspection	MIL-STD-202, Method 209	4.9.9
11	Aging	30 days +85°C	4.9.8

Table 3.

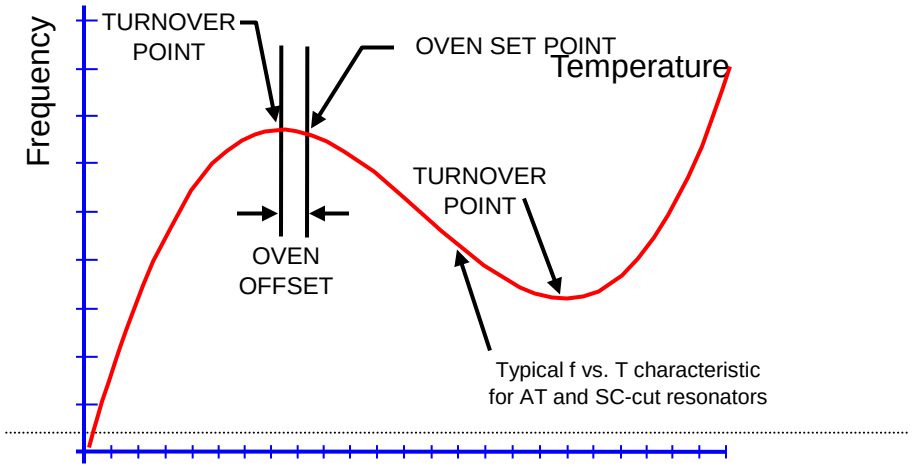
B VERSUS C MODE OF SC CRYSTAL (~ 10% higher in F of C mode)



SELECT TURN OVER POINT



SET OVEN TEMPERATURE



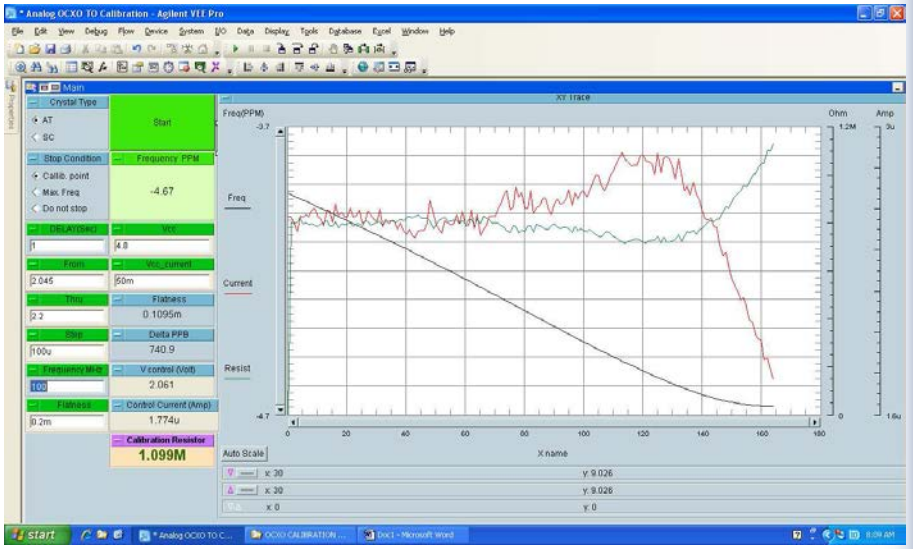
ULTRA³ HIGH RELIABILITY SPACE OCXO

SEVERAL STEPS BETWEEN ASSEMBLIES… FEW SHOWN below

- FIND TURN OVER POINT
- FUNCTIONAL TEST
- ENVIRONMENTAL TEST UNDER VACUUM
- INSTALL CALCULATED RESISTORS
- NORMAL CALIBRATION
- INSTALL TUNING COMPONENTS
- AGING AT +25C
- ELECTRICAL TEST TO SET CENTER FO
- INSTALL “SIT” (SELECT IN TEST) COMPONENTS
- TEMPERATURE TEST UNDER VACUUM
- INTERNAL PHOTOGRAPHY
- FUNCTIONAL TEST
- PRE CAP SOURCE INSPECTION
- PRE SEAL TEST
- FINAL FOAM INSTALLATION
- SEAL

PRE SEAL ELECTRICAL TESTS AND VERIFICATION

- **CALIBRATION AND SET THE OVEN TEMPERATURE**
- **VERIFICATION TEST FOR OVEN TEMPERATURE**
- **FUNCTIONAL TEST (25° C, 12V)**
  - Warm-up current (mA)
  - Steady-state input current (mA)
  - Output power (dBm)
- **INTERMEDIATE TEST (25° C, 12V)**
  - Warm-up current (mA)
  - Steady-state input current (mA)
  - Output power (dBm)
  - Cold start (ms)
  - Output frequency (ppm from nominal)
  - Harmonics (dBc)
  - Phase noise (dBc/Hz)
  - Spurious(dBc)
  - Return loss (dB)



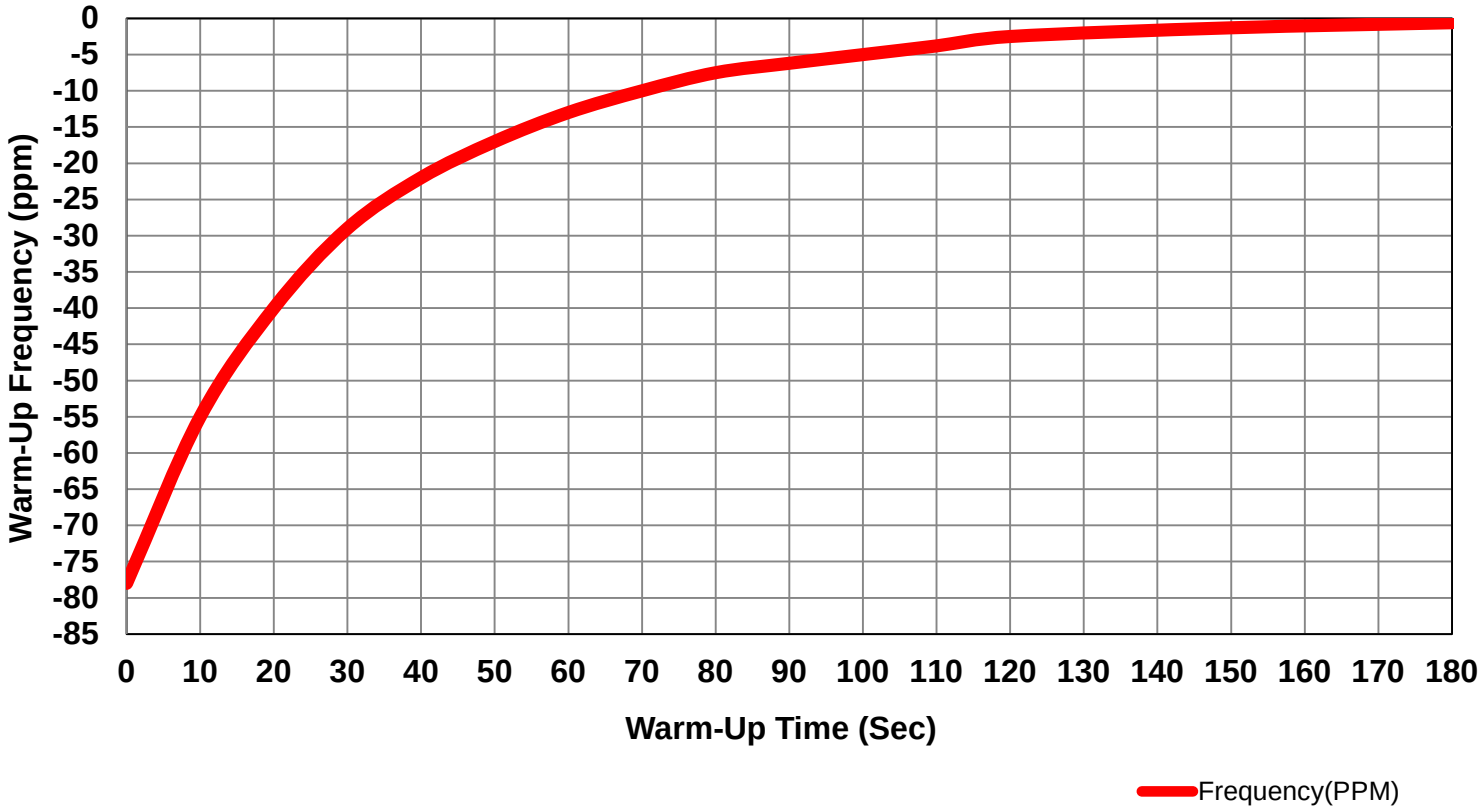
PRE SEAL ELECTRICAL TESTS AND VERIFICATION

- **ENVIRONMENTAL TESTING IN VACUUM 78 to 103kPa**
  - Output frequency in vacuum at 12V, 25° C
  - Record vacuum level
  - Aging at 25° C
  - Aging prediction for 15 years
- **PRE-SEAL TEST (25° C & 76° C, 12V) UNDER VACUUM**
  - Warm-up current (mA)
  - Steady-state input current (mA)
  - Output power (dBm)
  - Supply sensitivity (ppm)
  - Harmonics (dBc)
  - Phase noise (dBc/Hz)
  - Spurious(dBc)
  - Return loss (dB)

PRE SEAL ELECTRICAL TESTS AND VERIFCATION

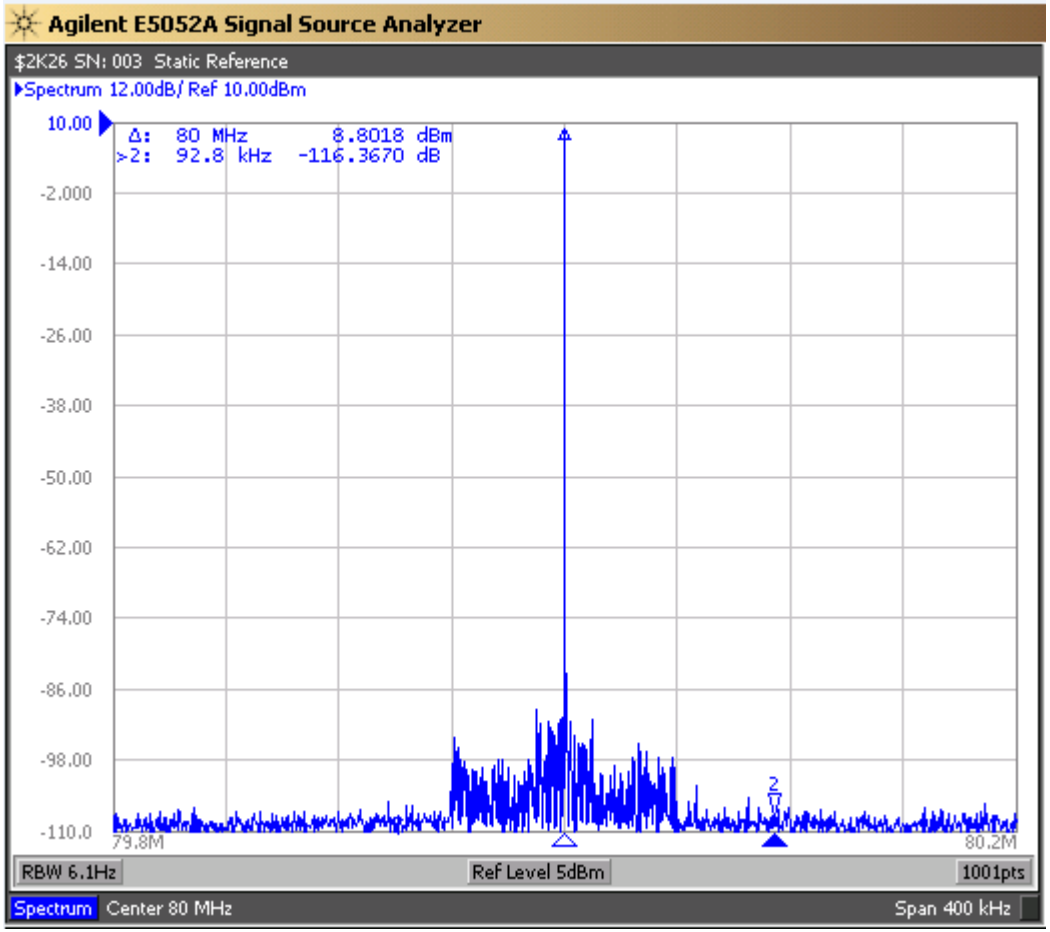
- **PRE-SEAL TEST (-18° C, 12V) UNDER VACUUM**
  - Warm-up current (mA)
  - Steady-state input current (mA)
  - Output power (dBm)
  - Warm-up time (minutes) when frequency to within ±1ppm
  - Supply sensitivity (ppm)
  - Harmonics (dBc)
  - Phase noise (dBc/Hz)
  - Spurious(dBc)
  - Return loss (dB)
- **PRE-SEAL TEST FREQUENCY (-18° C to +76° C, 12V) UNDER VACUUM**
  - Frequency
- **POST-SEAL TEST FREQUENCY (-18° C to +76° C, 12V) UNDER VACUUM**
  - Frequency

PERFORMANCE TESTING



ULTRA³ HIGH RELIABILITY SPACE OCXO

PERFORMANCE TESTING OUTPUT POWER & SPURIOUS



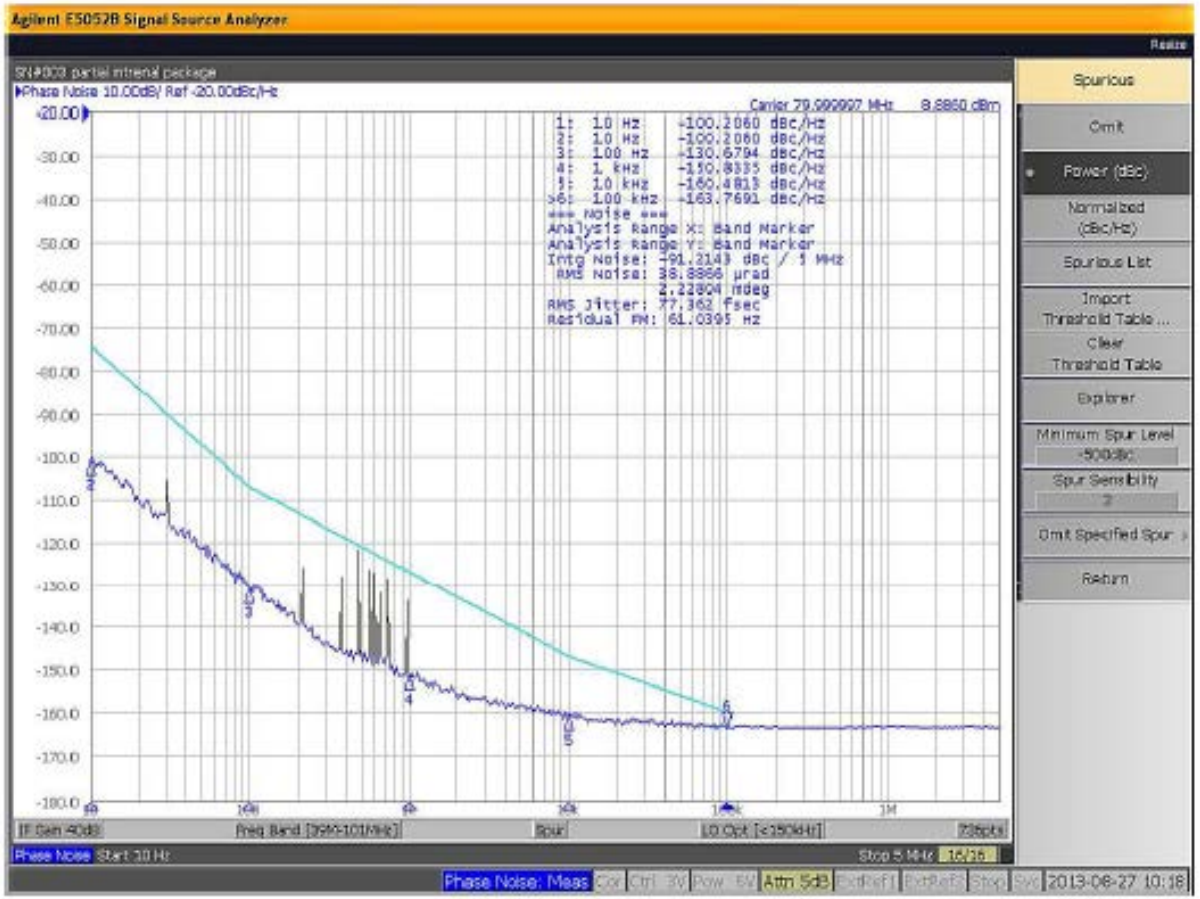
ULTRA³ HIGH RELIABILITY SPACE OCXO

PERFORMANCE TESTING

Parameter	Requirement	Sn#003 Before Temp Cycle	Sn#003 After Temp Cycle
Nominal Frequency	80.000 000 0MHz	P	P
Frequency			
Shipping at +25C	± 1 ppm (1)	0.12	0.14
After 15 years at -13 to +65 C	± 6 ppm (1)	-	
Input current (all conditions)	400 mA maximum	337	334
Output Waveform	Sine wave	P	P
Output power level			
Shipping at +25C	7.0 dBm min, 9.0 dBm max	8.45	8.48
Shipping at -13 to +65 C (includes supply variation)	Initial value at +25C ±0.5 dB		
After 15 years			
Initial value at shipping	± 1.0 dB		
Harmonics	-30 dBc maximum	-51.33	-51.9
Spurious responses(non-harmonics)	< -105 dBc over the band ±100KHz from carrier	P	P
	< -90 dBc outside the band ± 100KHz from carrier.	P	P
Single Side Band Phase noise			
Frequency offset from carrier	Maximum Phase Noise Level		
10 Hz	-74 dBc/Hz	-100.2	-97.1
100 Hz	-107 dBc/Hz	-130.7	-128.3
1 KHz	-127 dBc/Hz	-150.8	-152.2
10 KHz	-147 dBc/Hz	-160.5	-160.1
≥ 100 KHz	-160 dBc/Hz	-163.7	-162.7
Warm-up time	Oscillator frequency shall stabilize at a value within the minimum and maximum limits specified herein for frequency at shipment within 20 minutes after supply voltage is applied.	-	-
Table Notes:			
(1) Relative to the specified nominal frequency			

PERFORMANCE TESTING

PHASE NOISE 80MHz OCXO QT4200



PERFORMANCE TESTING

G SENSITIVITY

Frequency[MHz]	80	G-Sensitivity[PPB/G]													
Oscillator	Offset Freq[Hz]	20	50	80	110	140	170	200	500	800	1100	1400	1700	2000	Max	Total PPB/G
Y	Qual#1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.4	0.2	0.1	0.0	0.5	
X	Qual#1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.5	0.1	0.3	0.1	0.1	0.1	0.5	
Z	Qual#1	0.1	0.0	0.0	0.0	0.3	0.1	0.1	0.2	0.4	0.6	0.1	0.1	0.7	0.7	0.98

		Side Band Amplitude[dBc]											
Offset Freq		20Hz	50Hz	80Hz	110Hz	140Hz	170Hz	200Hz	500Hz	800Hz	1100Hz	1400Hz	1700Hz	2000Hz
Y	Qual#1	-91.34	-94.50	-94.30	-94.70	-100.70	-97.90	-92.80	-64.80	-72.70	-71.80	-82.60	-86.90	-99.22
X	Qual#1	-56.60	-62.70	-65.30	-66.79	-66.20	-66.27	-66.00	-64.98	-88.20	-74.09	-83.30	-87.00	-87.80
Z	Qual#1	-60.90	-79.16	-82.10	-77.40	-60.73	-71.45	-78.05	-74.21	-70.44	-68.35	-85.43	-89.00	-71.66
Vibe Level (G)		5.00	6.25	7.50	8.75	10.00	11.25	12.50	13.75	15.00	16.25	17.00	18.75	20.00

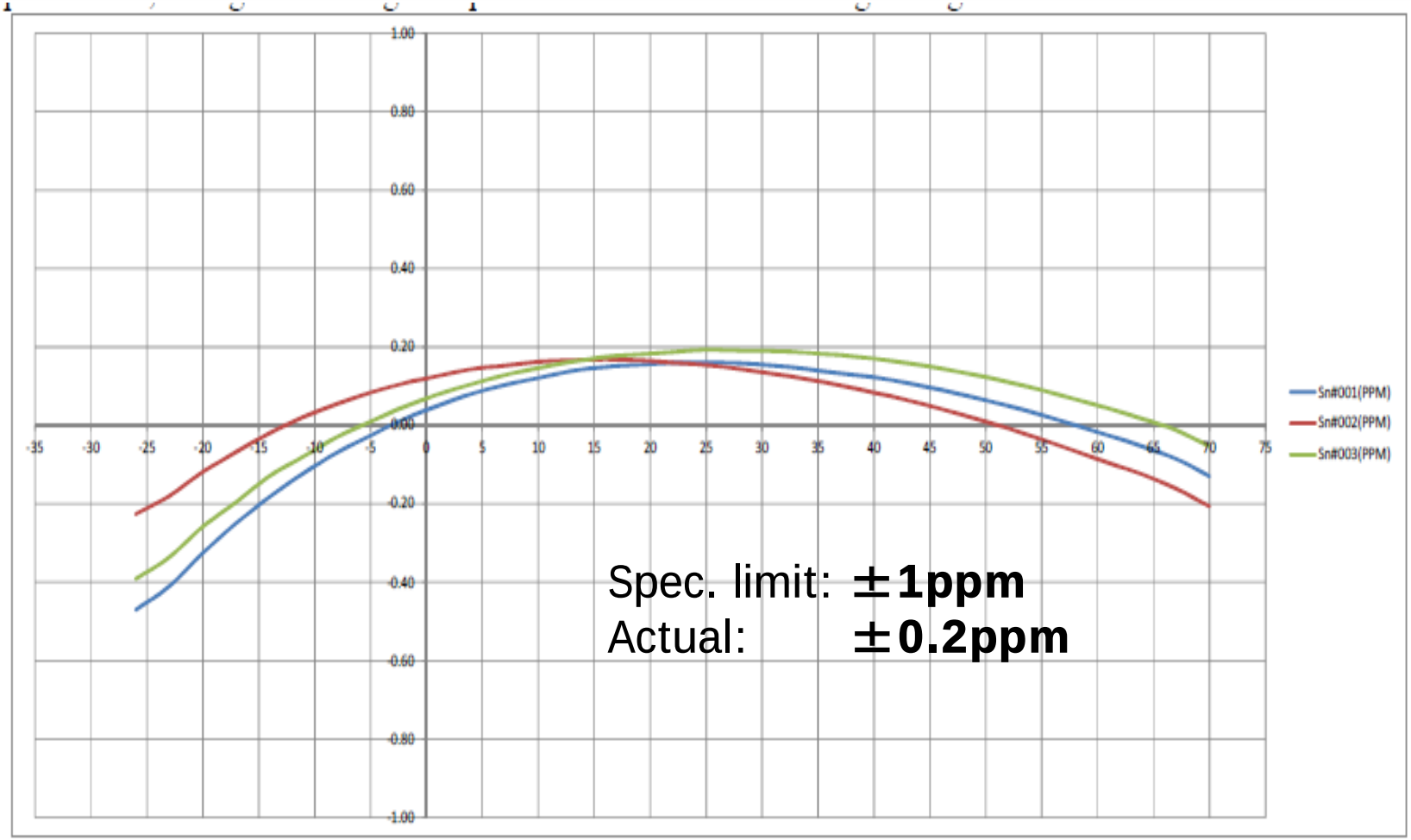
Allan Deviation $\sigma_y(\tau)$

Avg. Time (s)	Allan Deviation $\sigma_y(\tau)$	Noise Floor
0.01	1.580×10^{-11}	9.64883×10^{-12}
0.02	1.377×10^{-11}	2.85830×10^{-12}
0.04	1.029×10^{-11}	2.90568×10^{-12}
0.1	1.113×10^{-11}	8.33054×10^{-13}
0.2	1.235×10^{-11}	7.34410×10^{-13}
0.4	1.399×10^{-11}	4.34043×10^{-13}
1	1.80×10^{-11}	2.81508×10^{-13}
2	2.47×10^{-11}	2.24946×10^{-13}
4	3.75×10^{-11}	1.99374×10^{-13}
10	7.9×10^{-11}	1.80932×10^{-13}
20	1.49×10^{-10}	1.45978×10^{-13}
40	2.8×10^{-10}	
100	5.2×10^{-10}	
200	1.0×10^{-9}	

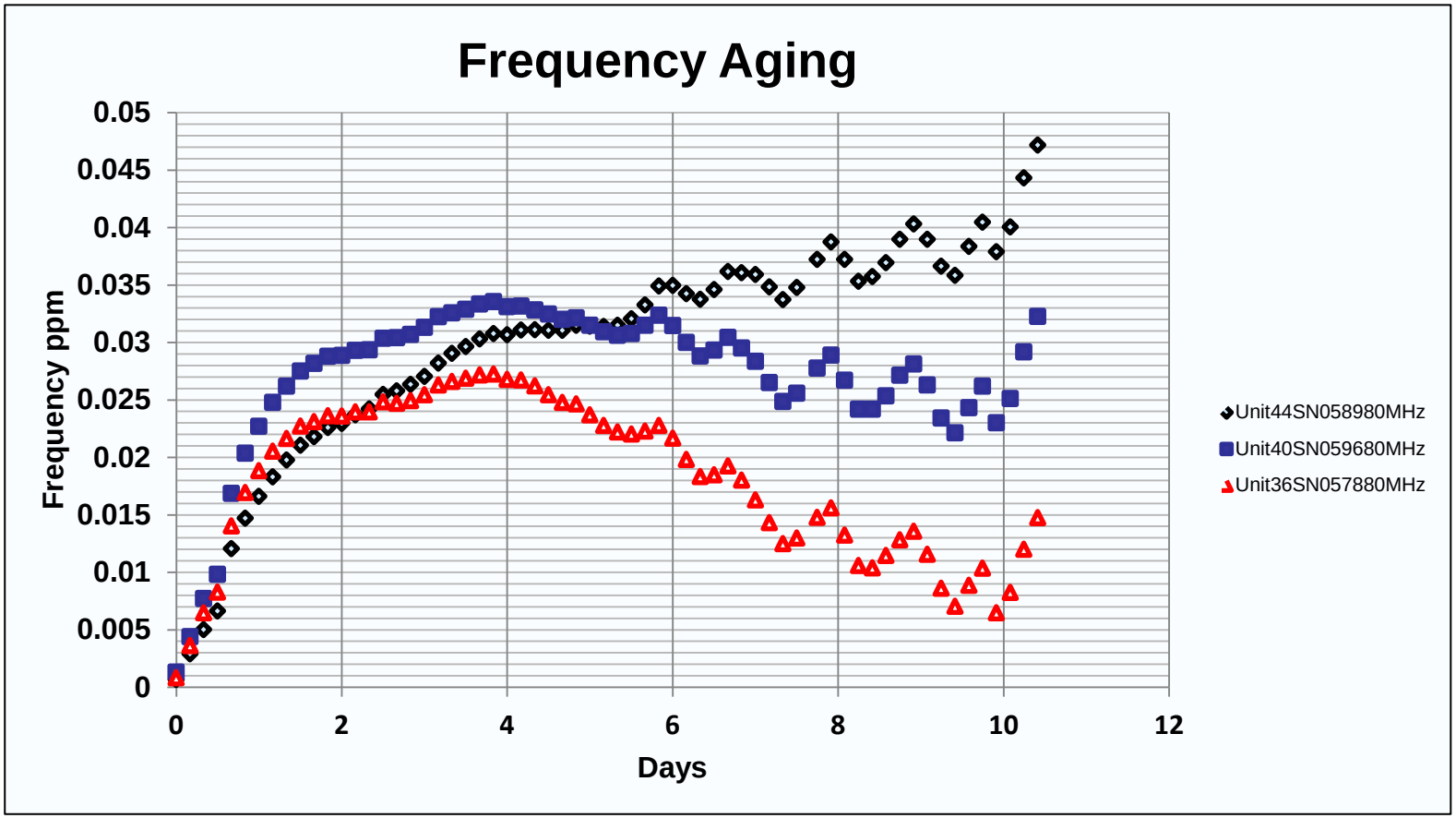
τ_0 = 10 ms NEQ BW = 50 Hz

ULTRA³ HIGH RELIABILITY SPACE OCXO

FVT TEST BETWEEN -15ºC and +65ºC OF A 80MHz OCXO



PERFORMANCE TESTING



WORST CASE ANALYSIS

❑ WORST-CASE ANALYSIS INCLUDE:

- Beginning of Life (BOL) and End of Life (EOL)
- Changes due to temperature
- Changes due to Total Dose Ionization Radiation 100kRad(Si)
- Changes due to an accumulated neutron fluence of $2x10^{-12}$ N/cm^2
- Effects of voltage variations
- End of Life component parametric drift for aging and environmental exposure defined for the life of applications.

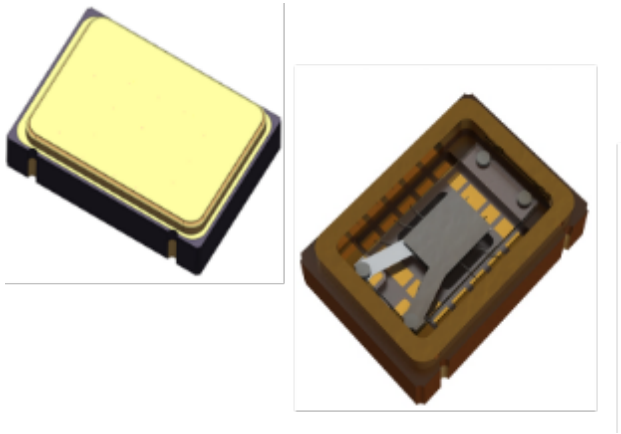
RELIABILITY TESTS

❑ GROUP C & QUALIFICATION TESTS

- ➢ Completed Group C per MIL-PRF-55310 on two units
- ➢ Qualification with 46.3gRMS Random Vibration

PART III

HIGH RELIABILITY 5x7mm SMT, SPACE QUALIFIED FOR SPACE APPLICATIONS

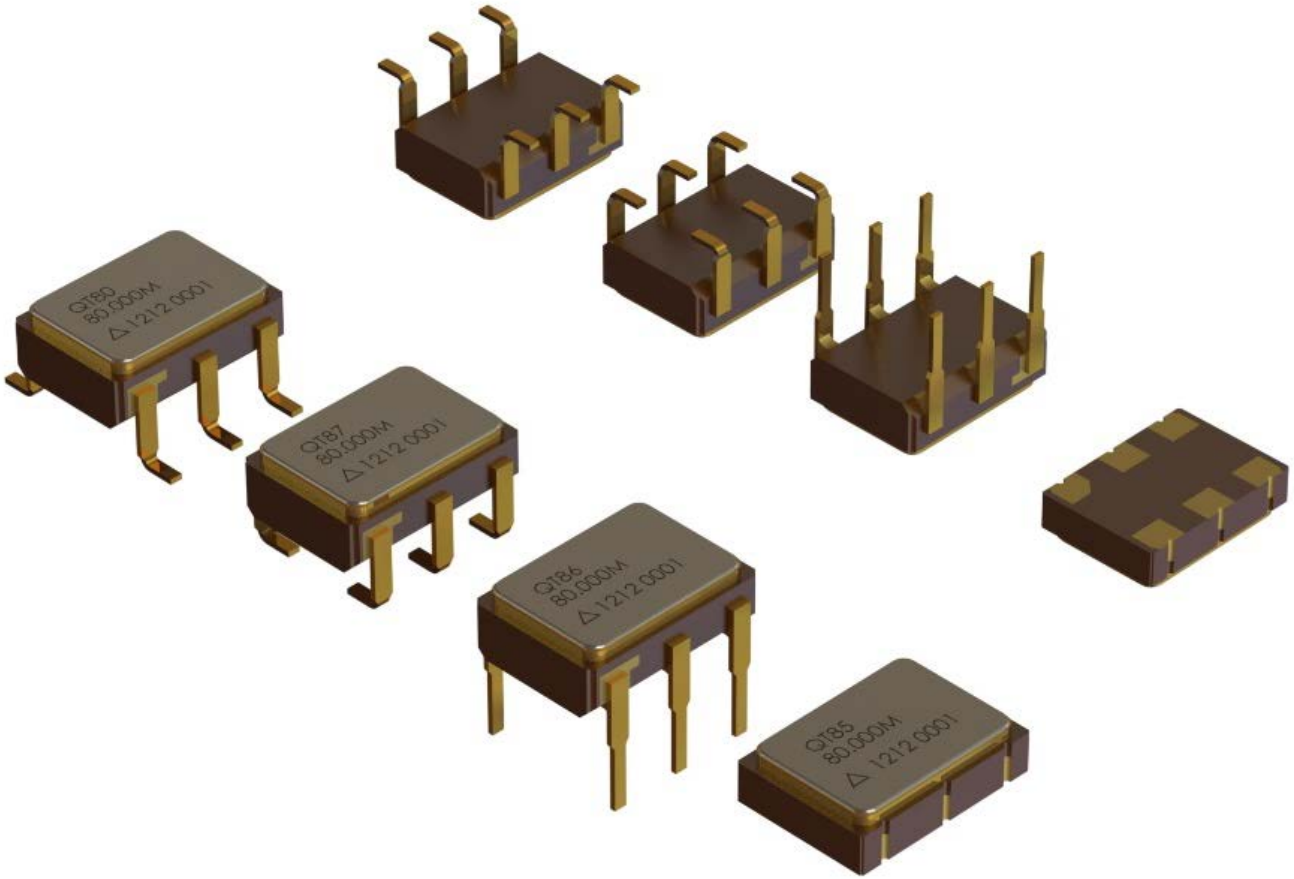


5x7mm HIGH RELIABILITY SPACE OSCILLATORS

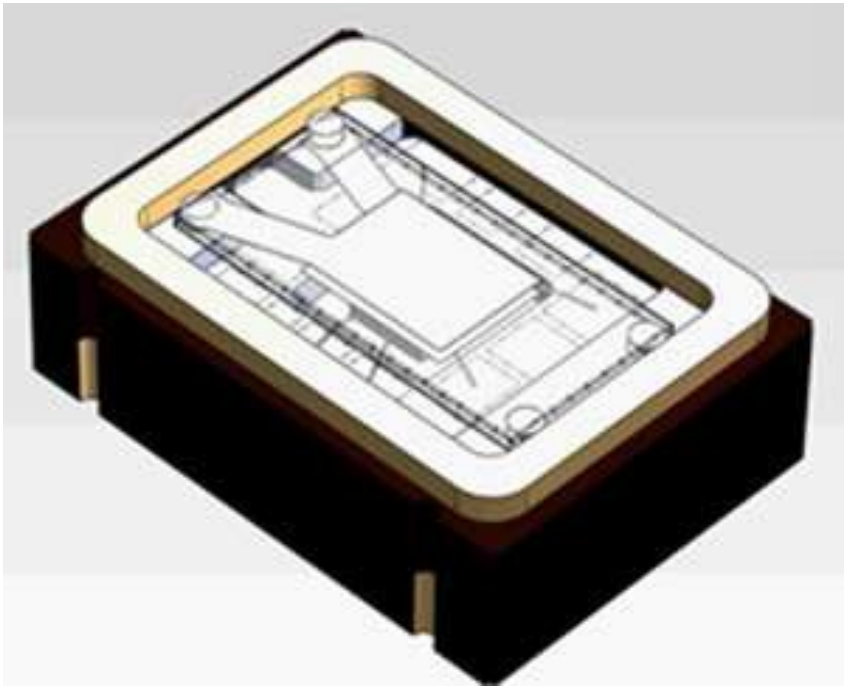
- Made in **USA**
- Small **5mm x 7mm x 2.1mm** SMT 4 or 6 pads, through hole 4 or 6 leads
- Supply voltages **2.5Vdc to 5Vdc**
- Frequency **1MHz to 162.5MHz**
- Logic **CMOS, LVDS, LVPECL output**
- Four-point mount **swept quartz**, high shock resistant
- Wide operating temperature **-55° C to +125° C**
- Radiation hardened **100kRad(Si) to 300kRad(Si)**
- Element Evaluation per **MIL-PRF-38534, Class K**
- 100% screened per **MIL-PRF-55310, Level S or MIL-PRF-38534, Class K with Aging at +70° C**
- QCI per MIL-PRF-55310, Level S or MIL-PRF-38534, Class K

5x7mm SPACE QUALIFIED HYBRID CRYSTAL OSCILLATORS

CASE OUTLINE



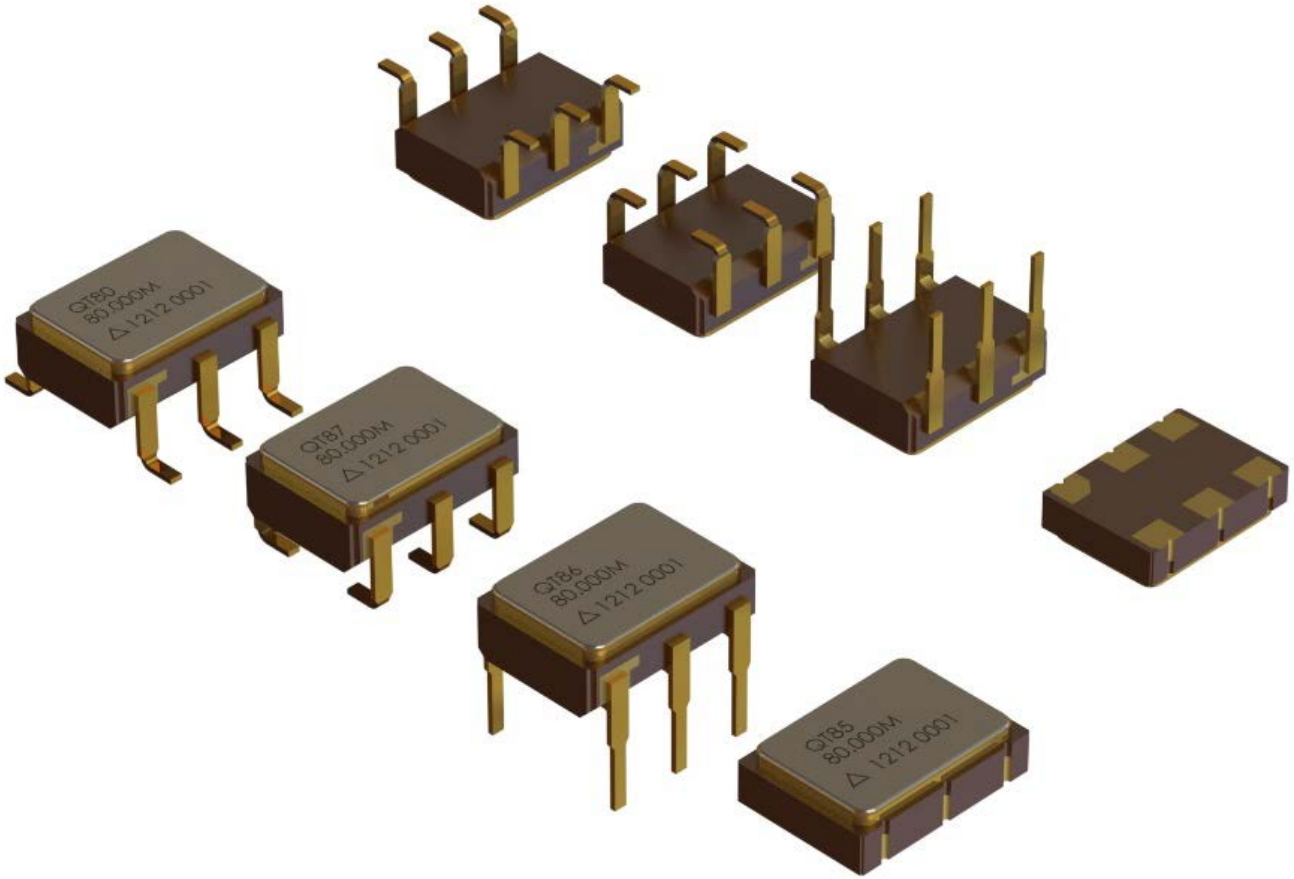
5x7mm SPACE QUALIFIED HYBRID CRYSTAL OSCILLATORS CONSTRUCTION



- Multilayer high-temperature co-fired ceramic (HTCC) package with bottom SMT pads or brazed lead frame.
- Single microcircuit Radiation tolerant 100kRad(Si) and SEL ≥ 75MeV-cm^2/mg.
- Swept strip quartz.
- Does not include decoupling capacitor. A 0.01µF or 0.1µF capacitor must be added on board for decoupling and bypassing purpose.
- Four-point mount quartz with compliant low outgassing epoxy.

5x7mm SPACE QUALIFIED HYBRID CRYSTAL OSCILLATORS

CASE OUTLINE



5x7mm HIGH RELIABILITY SPACE OSCILLATORS

- ✓ Case study: **QT381FLD10A-24.000MHz** (FO#216979-7AA)

VOH	VOL	DC	Tr	Tf	Icc	St-Up
3.3	0	52/48	3.1	3.1	4.9	1.0

S/N	2240	2241	2242	2243	2244	2245	2246	2247
Aging at 70°C, 30 days	-0.39	-0.45	-0.65	-0.46	-0.71	-0.43	-0.89	-0.58

5x7mm HIGH RELIABILITY SPACE OSCILLATORS

- ✓ Case study: **QT181FACD10S-20.000MHz** (FO#216979-7AA)

VOH	VOL	DC	Tr	Tf	Icc	St-Up
4.9	0	52/48	2.4	2.6	7.1	0.8

S/N	0429	0430	0431	0432	0433	0434	0435	0436
Aging at 70°C, 30 days	-0.26	-0.27	-0.29	-0.38	-0.41	-0.41	-0.37	-0.52

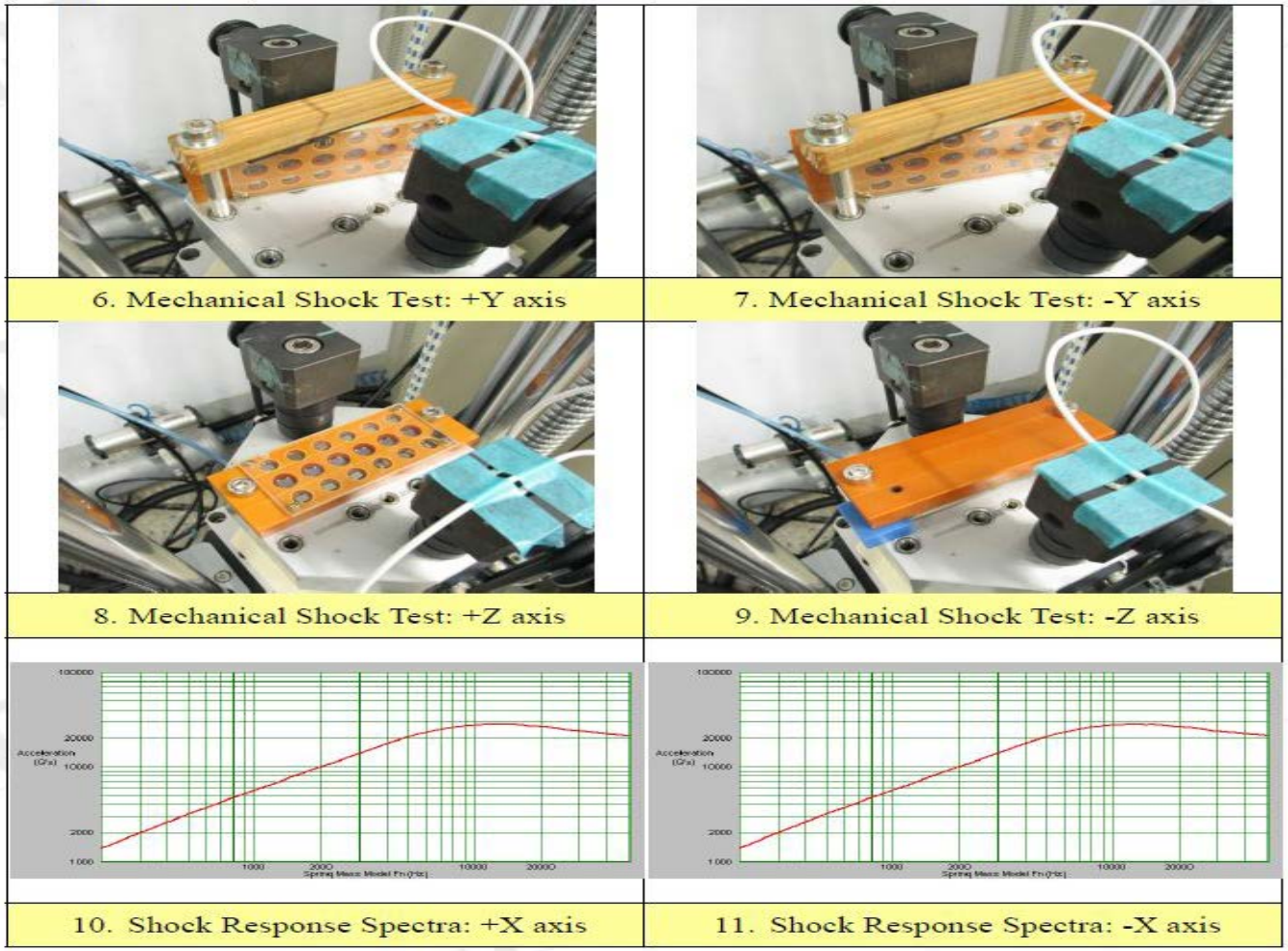
5x7mm HIGH RELIABILITY SPACE OSCILLATORS

- ✓ Case study: **QT181FLD10S-125.000MHz** (FO#216979-5AA)

VOH	VOL	DC	Tr	Tf	Icc	St-Up
3.3	0	51/49	0.6	0.6	28.5	0.2

S/N	0470	0471	0472	0473	0474	0475	0476	0477
Aging at 70°C, 30 days	-0.88	-1.4	-0.9	-0.7	-1.3	-1.1	-1.4	-1.4

SHOCK AND VIBRATION PERFORMANCE



6. Mechanical Shock Test: +Y axis

7. Mechanical Shock Test: -Y axis

8. Mechanical Shock Test: +Z axis

9. Mechanical Shock Test: -Z axis

10. Shock Response Spectra: +X axis

11. Shock Response Spectra: -X axis

5x7mm SPACE QUALIFIED HYBRID CRYSTAL OSCILLATORS SHOCK AND VIBRATION PERFORMANCE

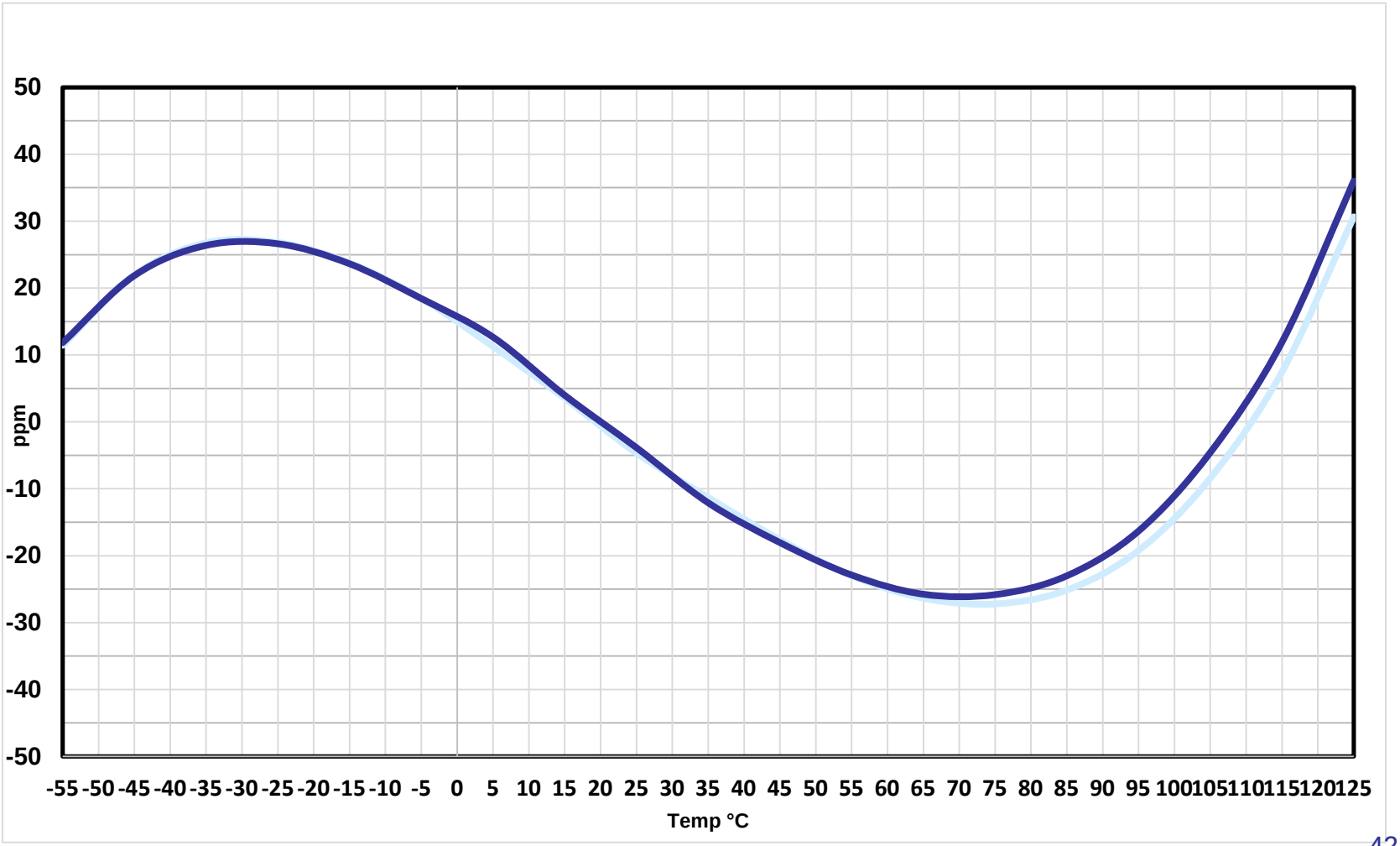
- Successfully passed standard Vibration and Mechanical shock per Group C tests of MIL-PRF-55310, i.e. MIL-STD-202, method 204 and method 213.
- Additional Random Vibration test per MIL-STD-202, method 214, condition I-K, 46.30grms, all axes.
- Additional Mechanical shock test per MIL-STD-202, method 213, condition 10,000g and 20,000g, half-sine, all axes.

Delta frequency Pre and Post 20,000g shock, 0.1ms, half-sine

Serial #	Pre-shock ppm	Post-shock ppm	Delta ppm
8437	-52.0	-54.8	**-2.8**
8438	-45.0	-46.1	**-1.1**
8439	-51.6	-52.0	**-0.4**
8440	-25.2	-25.0	**0.2**
8441	-28.8	-27.6	**1.2**
8442	-63.4	-63.3	**0.1**
Max. Delta ppm			**-2.8**

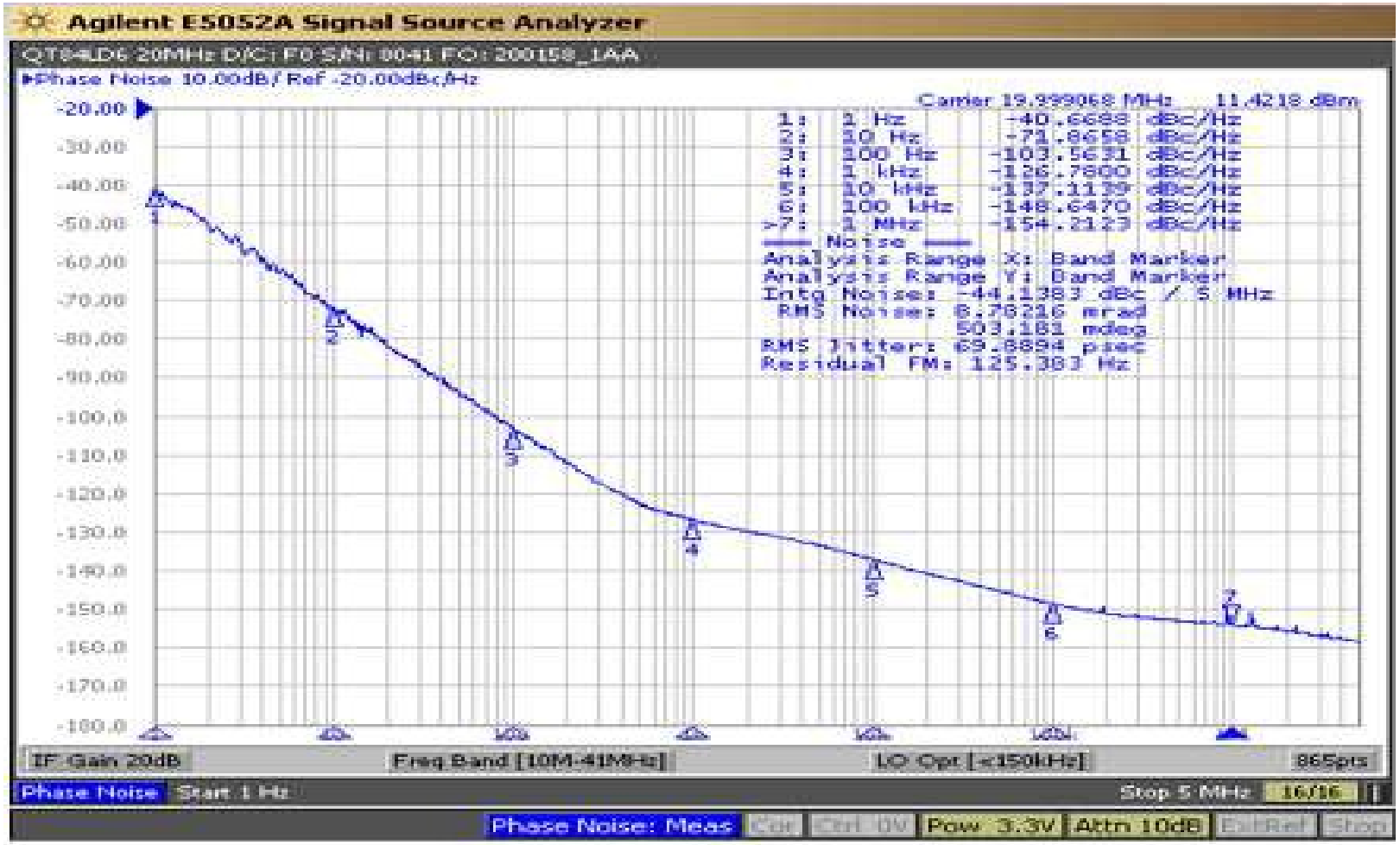
5x7mm SPACE QUALIFIED HYBRID CRYSTAL OSCILLATORS

PERFORMANCE TEST QT181LD10S-32.000MHz, 3.3Vdc



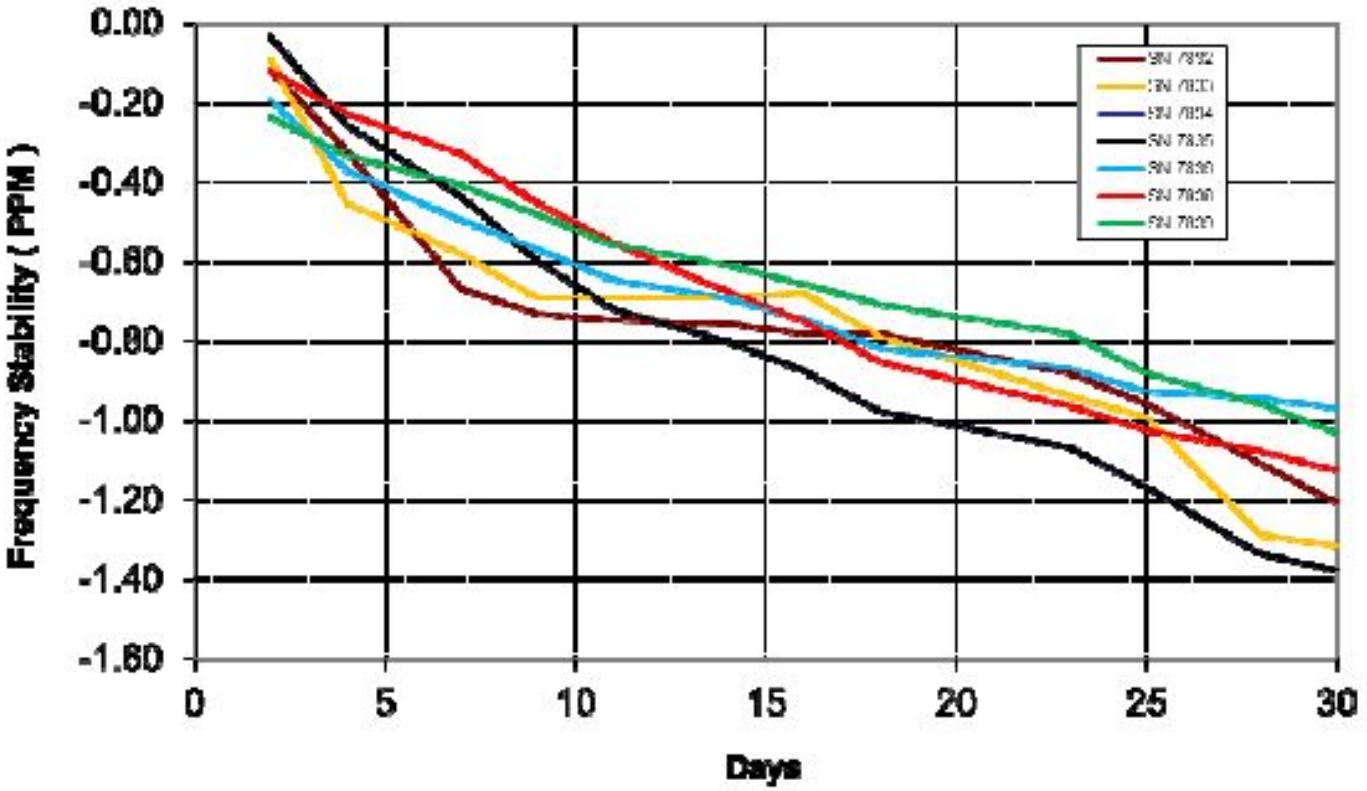
5x7mm SPACE QUALIFIED HYBRID CRYSTAL OSCILLATORS

PHASE NOISE TEST QT181LD10S-20.000MHz, 3.3Vdc



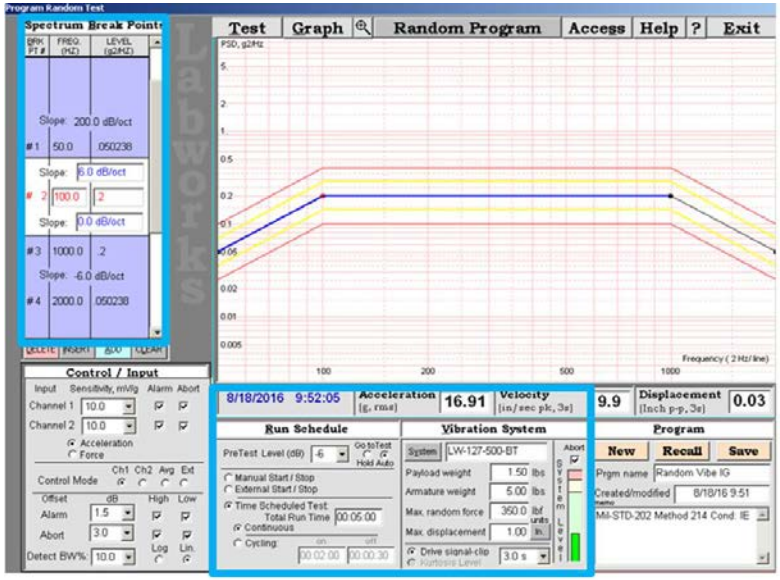
5x7mm SPACE QUALIFIED HYBRID CRYSTAL OSCILLATORS

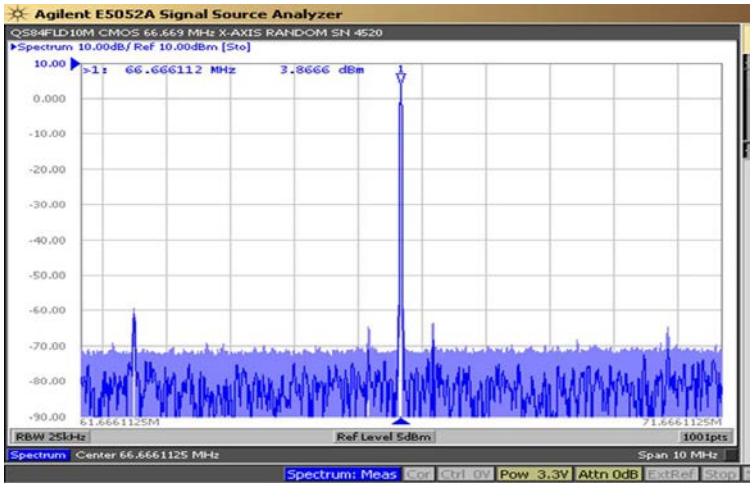
AGING 40MHz, 3.3Vdc, 30days at +70° C

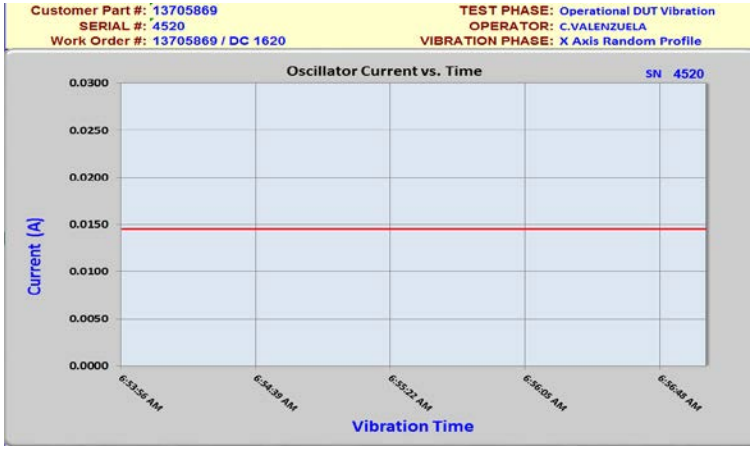


5x7mm SPACE QUALIFIED HYBRID CRYSTAL OSCILLATORS

RANDOM VIBRATION, OPERATING, 3.3Vdc
MIL-STD-202, Method 214A, I-E, 5 minutes per axis







TEST UNITS: 2
QS184FLD10M-66.666MHz,
SN4520 & 4525 DC 1620
Output monitoring during
Vibration

QUALIFICATION TESTS

- GROUPS A , B, AND C PER MIL-PRF-55310, Level S completed.
- GROUPS A, B, C, & D PER MIL-PRF-38534, Class K completed, except Life Test at +125ºC target finished by Mid November 2016.
- ELEMENT EVALUATION PER MIL-PRF-38534, CLASS K AND RADIATION TESTS (TID, ELDRS, SEL, SEU) COMPLETED ON ASICs USED IN THE DESIGN OF THE 5x7mm PARTS.

CONCLUSIONS

- **Q-TECH PRESENTED THE TWO LATEST SPACE QUALIFIED PRODUCTS FROM THE LARGEST TO SMALLEST FORM WITH FULL EVALUATION AND QUALIFICATION.**

- **PRODUCTS ARE NON ITAR CONTROLLED.**

- **PRODUCTS CAN BE PROCURED WITH STANDARD Q-TECH SPECIFICATIONS OR CUSTOMIZED CUSTOMER'S REQUIREMENTS.**

2nd INTERNATIONAL SYMPOSIUM
SPACE PASSIVE COMPONENT DAYS

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PART IV

THANK YOU FOR YOUR ATTENTION

QUESTIONS & ANSWERS