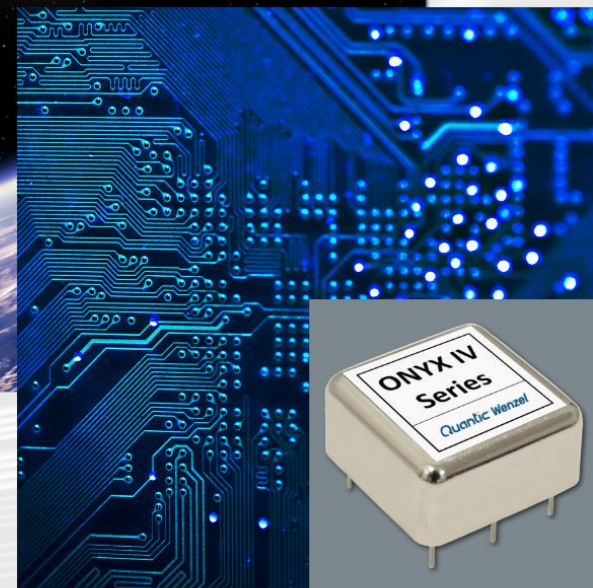


Crystal Oscillators for Low Earth Orbit Applications

What You Need to Know

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IMS 2023 San Diego
MicroApps Seminar: THMA22
Booth 1947



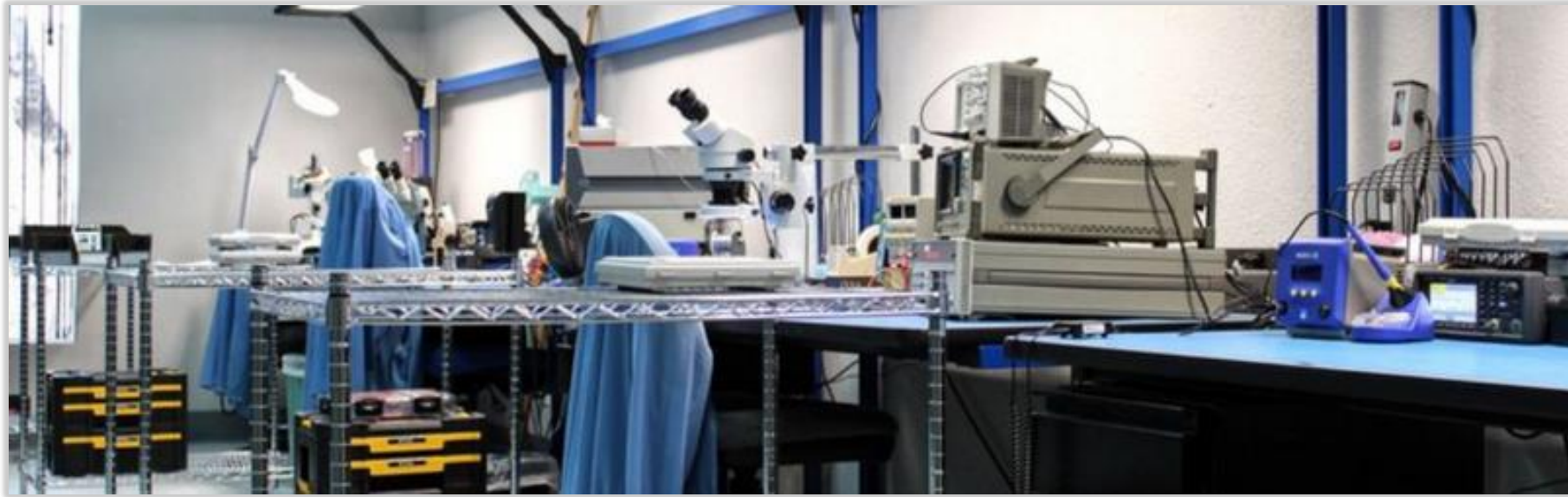
- As access to and utilization of the low Earth orbit (LEO) region has expanded, so too has demand increased for affordable, mass producible space-worthy timing devices.
- By the end of this presentation, you will have learned a proved approach, process, and the end results of adapting and qualifying crystal oscillators to production for commercial LEO applications.



- LEO satellites present an increasingly attractive option across a range of industries. This is due in part to:
 - Low energy threshold for placement
 - Ease of accessibility
 - Superior bandwidth & latency characteristics
 - Flexibility in orbital path and speed

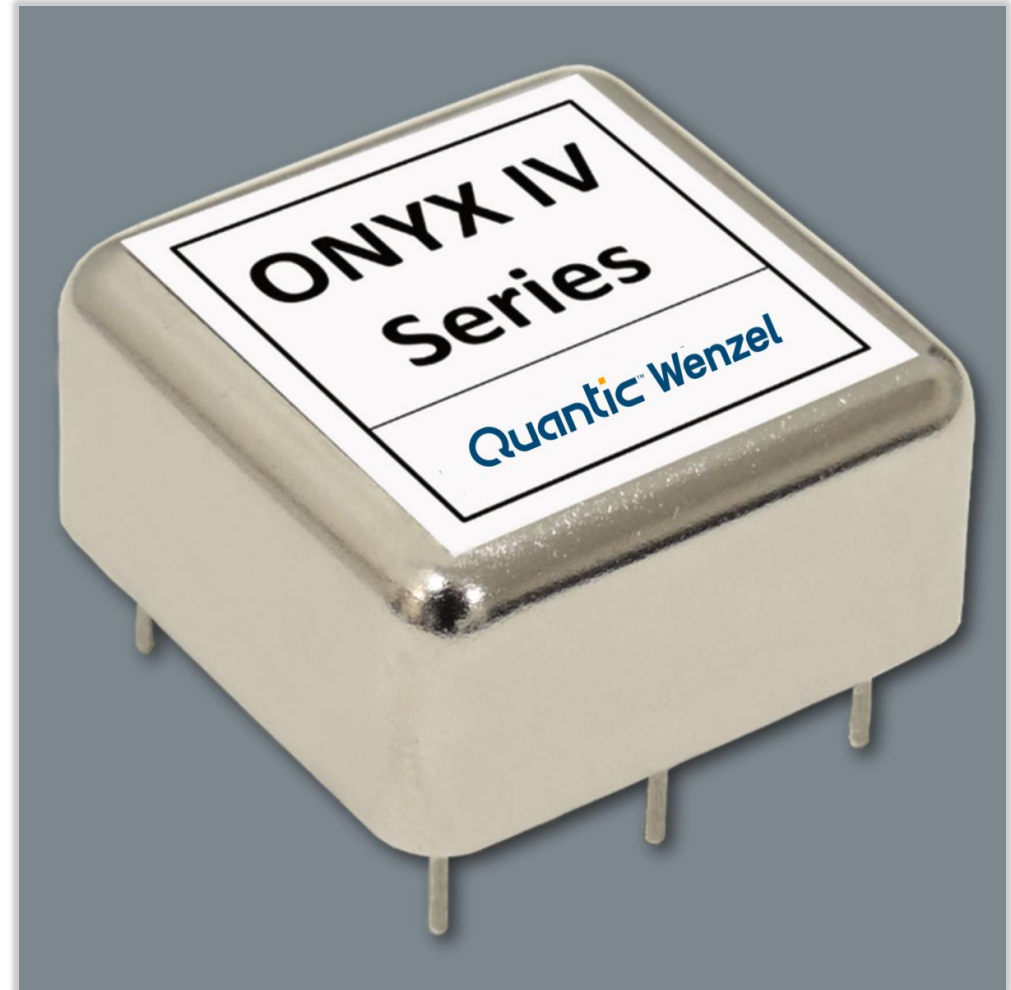


- Shift from traditional lot based, component level qualification to design qualification at the final assembly level.
- By subjecting proven designs to iterative cycles of careful review, followed by select qualification testing, designs can be optimized and validated for reliable performance.



- **ONYX IV OCXO**

- Frequencies from 10 MHz to 160 MHz, fixed
- Rugged/Low Cost/High Performance
- Low Phase Noise to -176 dBc/Hz
- Low-G Sensitivity to 1E-10/g per axis
- Output: Sine, +10 dBm, Standard; TTL, Optional
- Small Package; Low Profile (0.5" ht)
- Solder Sealed Steel Can
- Thru Hole (PCB) Mount



Testing Overview

- Validating static phase noise performance in ambient atmosphere, frequency stability, and output power under vacuum across an operating temperature range of -40°C to $+85^{\circ}\text{C}$, and radiation sensitivity.
- Except for radiation, all tests were performed at our 26,000 sq. ft facility in Austin, TX.

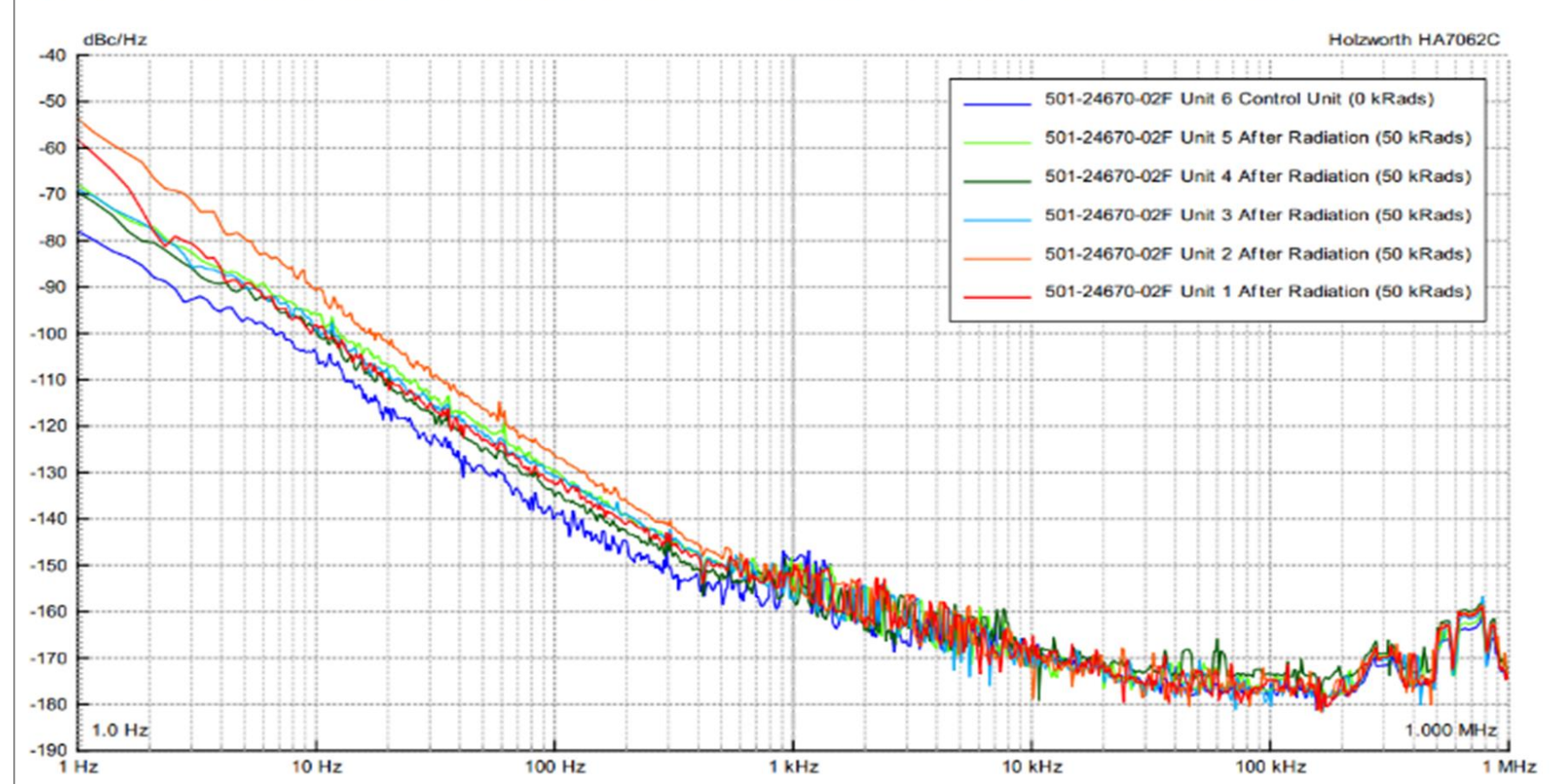


- Performed on 100 MHz, 10 MHz, and 10 MHz ONYX Series OCXOs.
- Sample units tested to MIL STD-202 and showed no significant parametric degradation post-irradiation.
- Heavy ion and high-energy proton testing.

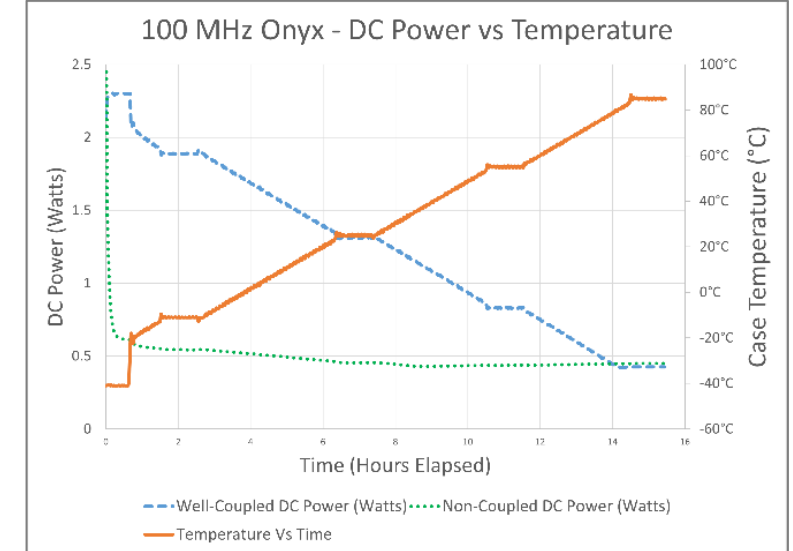
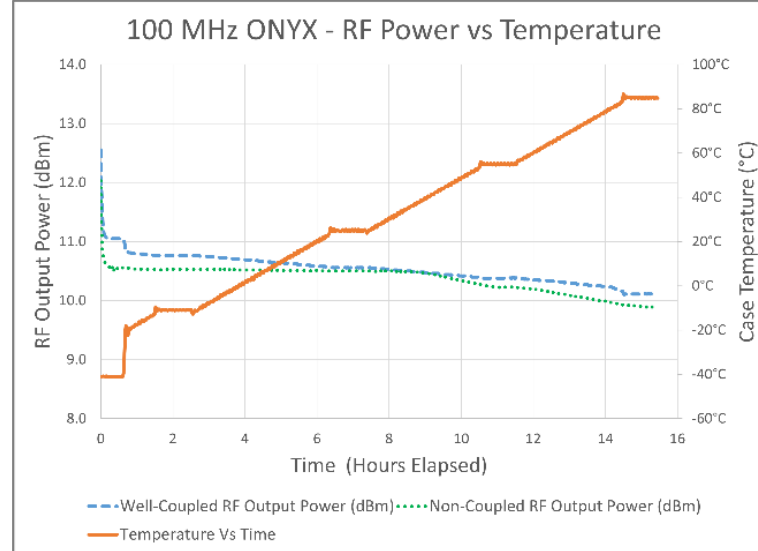
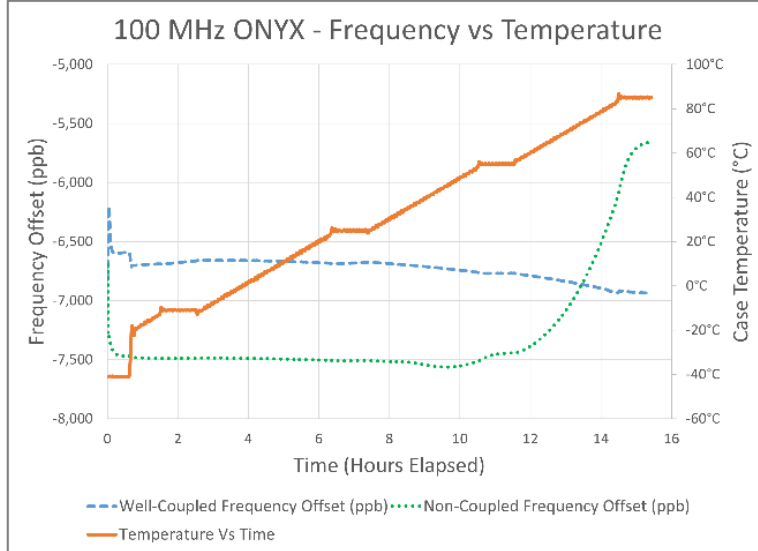


- Static phase noise testing was performed on all irradiated units and compared to baseline phase noise performance.

Figure 1: Post-Irradiation Static Phase Noise, 100 MHz Onyx, Control Unit vs. Irradiated Units



- Solder sealed, leak tested, then mounted to a fixture on the thermal control platform of the vacuum chamber (TVAC).
- Analysis of the test data indicated that both oscillator configurations performed well when mounted to the thermally controlled surface.



- COTS-based devices are viable, reliable, and cost-effective solutions for LEO space applications.
- Future goals for this design effort include:
 - Expanding the capabilities of the multiplier board option
 - Supplementary environmental and radiation testing
 - Synchronization with the 1 PPS for space design efforts



Crystal Oscillators, Fixed-Frequency Systems, IMAs & Synthesizers for Mission-Critical Applications

Advantages

- Products distinguished by unmatched precision, low-g sensitivity, and very low phase noise
- Oscillators and synthesizers are designed into mission-critical military, space, and commercial applications
- Vertically integrated to offer the most secure supply chain of crystals for mission-critical applications

Key Platforms

Next-Gen Radar



EW Simulator



Space 2.0



- Design Focus: Active
- Core Products: IMAs, Crystal Oscillators, Frequency Sources, Synthesizers
- Core Market Segments: Mil-Aero, Space, Commercial
- Frequency Range: 1 MHz – 35 GHz
- Power Level: CW – .05W

