

**PCB Carolina Event Nov 8th, 2023
3:30 PM Room 5**

**Technical session title: "High-end
Crystal Oscillator considerations and
benefit for a smaller oscillator"**

**Speaker: David Kenny – Pletroincs
<https://www.pletronics.com/>**

AUROMA

GROUP

Electronic Components
Mechanical Components
Contract Manufacturing
Test Services

*Experience,
Support &
Beyond*

The Aurora Group is a premier manufacturers' representative firm with over 30 years experience providing exceptional service and support to our manufacturers and customers on the East Coast.

<https://www.auroragroup.net/>

ple
PLETRONICS
Innovations in
Frequency Control

The Aurora Technical Group – what we do

The Aurora Group is committed to facilitating electronic/mechanical component solutions **for OEMs/CMs/Engineers and Manufacturers.**

We accomplish this by:

- Providing technical information/advice and support of quality manufacturers
- Guiding through technical challenges with new and existing products
- Offering component supply liaison/quotes/orders/samples/expediting



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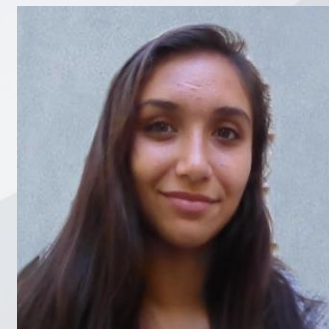
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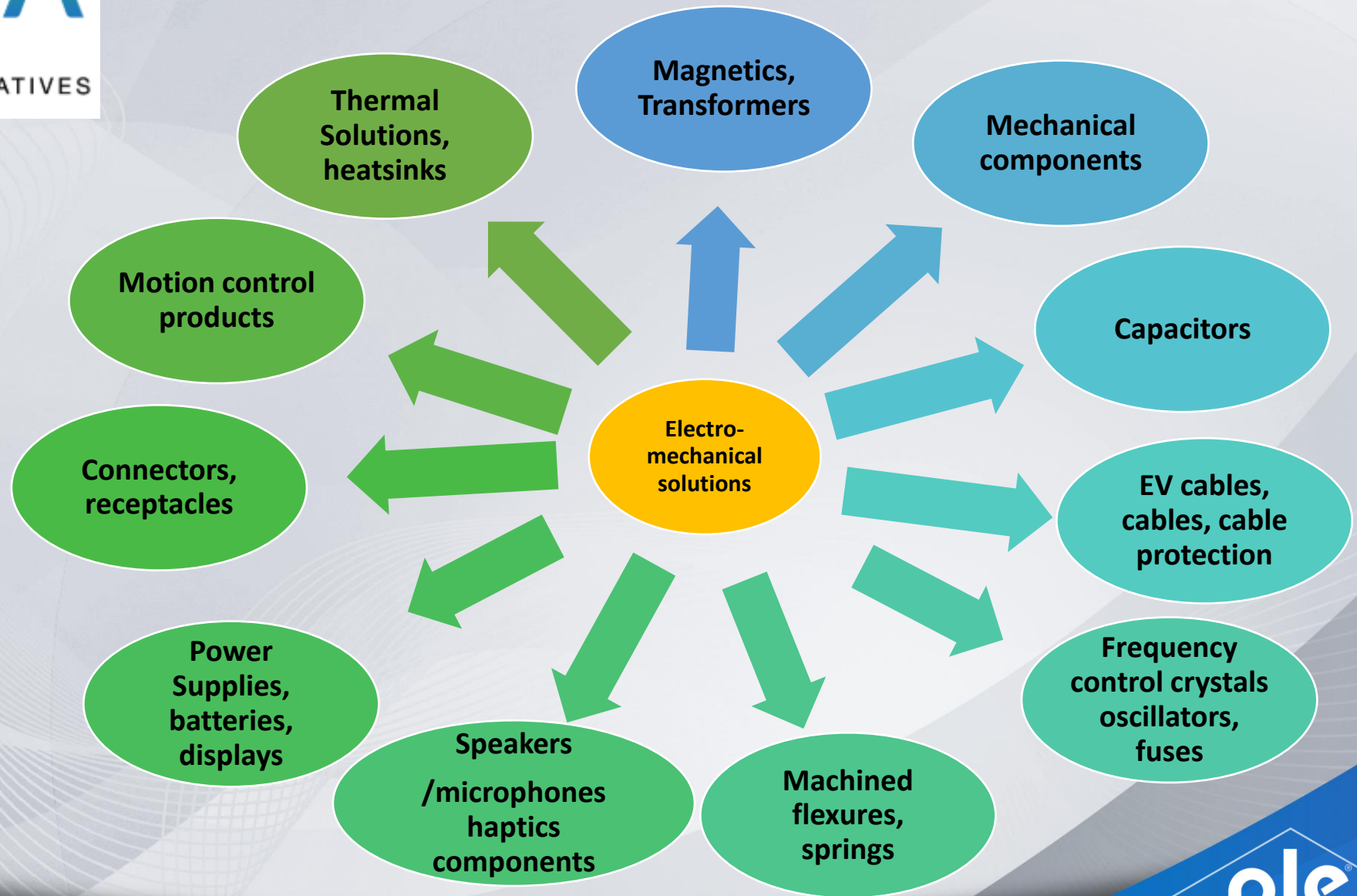


Nelysa Rosario
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Thank you for your time!

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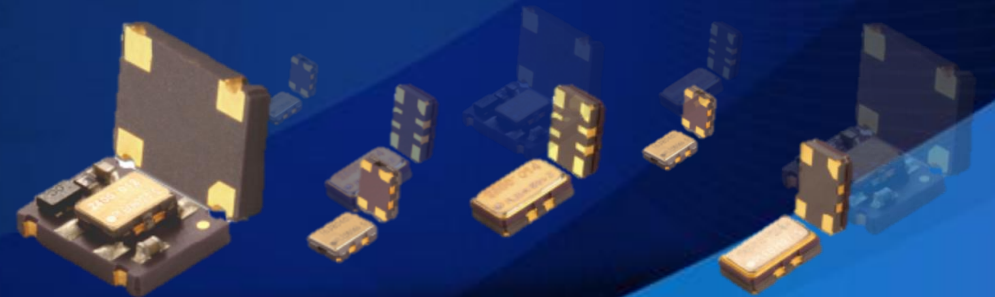




High-end Crystal Oscillator (TCXO/OCXO) design-in considerations and benefits for a smaller OCXO oscillator

David Kenny, VP R&D

11/8/2023



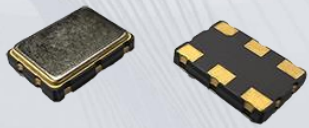
Introduction to Pletronics

- Established in 1979, Pletronics boasts over four decades of engineering and manufacturing expertise.
- Pletronics offers a comprehensive range of precision frequency control devices, including OCXO, TCXO, VCXO, Clocks and Crystals.
- Our in-house capabilities encompass temperature testing, phase noise analysis and more, ensuring the highest quality standards.
- Pletronics has cultivated long term relationships with manufacturing partners in Japan, Korea and Taiwan, fostering a global network of excellence.
- In 2019, Pletronics was acquired by Taitien, a testament to our company's growth and potential.
- Even after the acquisition, Pletronics has maintained strong, ongoing partnerships with factories in Japan and Korea.
- Strategically located near Seattle, Washington, Pletronics is positioned to provide comprehensive support and technical assistance.

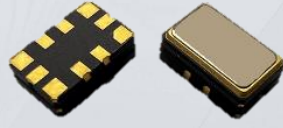


Pletronics Production Offerings

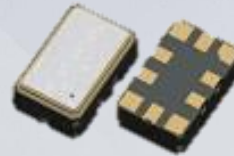
OeXO



Voltage Controlled
Crystal Oscillator (VCXO)



(Voltage Controlled)
Temperature Compensated
Crystal Oscillator (VC-TCXO)



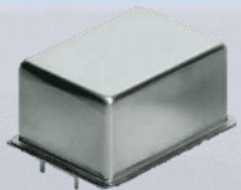
High Precision TCXO
OCXO equivalent
Crystal Oscillators



Oven Controlled
Crystal Oscillator (OCXO)



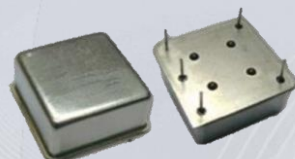
GPS Timing Module



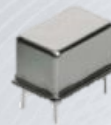
OSI5 Series
36.3 x 27.2 mm



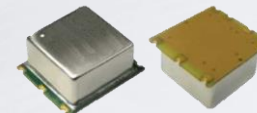
OLA5/OSA5
Series
25.4 x 25.4 mm



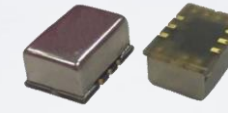
OSP5 Series
20.6 x 20.6 mm



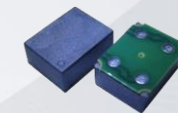
OSF4 Series
20.3 x 12.7 mm



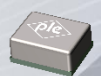
OSJ7 Series
25.4 x 22.1 mm



OSK6 Series
14.3 x 9.3 mm



OSN4 Series
9.7 x 7.5 mm

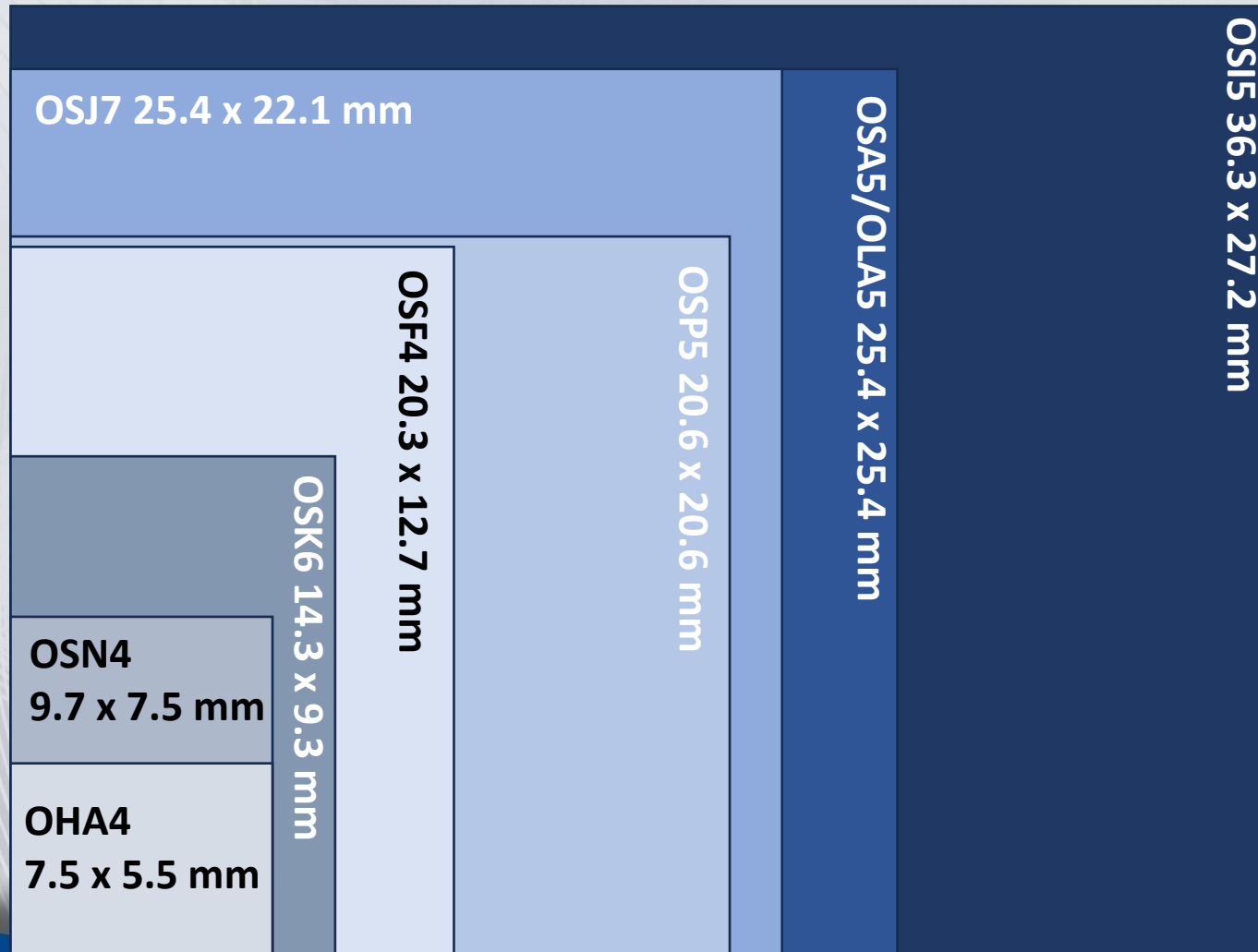


OHA4 Series
7.5 x 5.5 mm

Through hole type

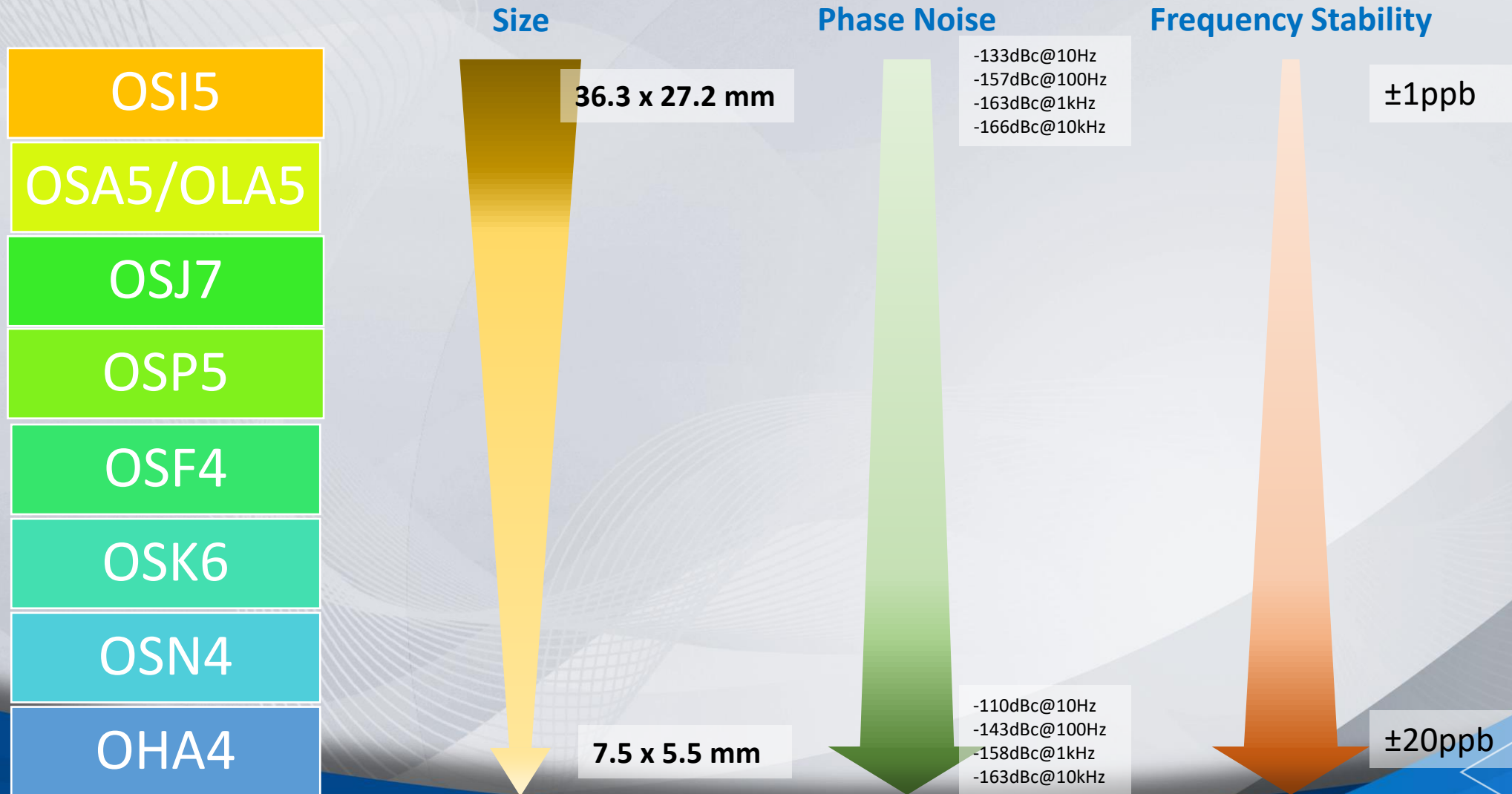
Surface mount type

Package Size trends



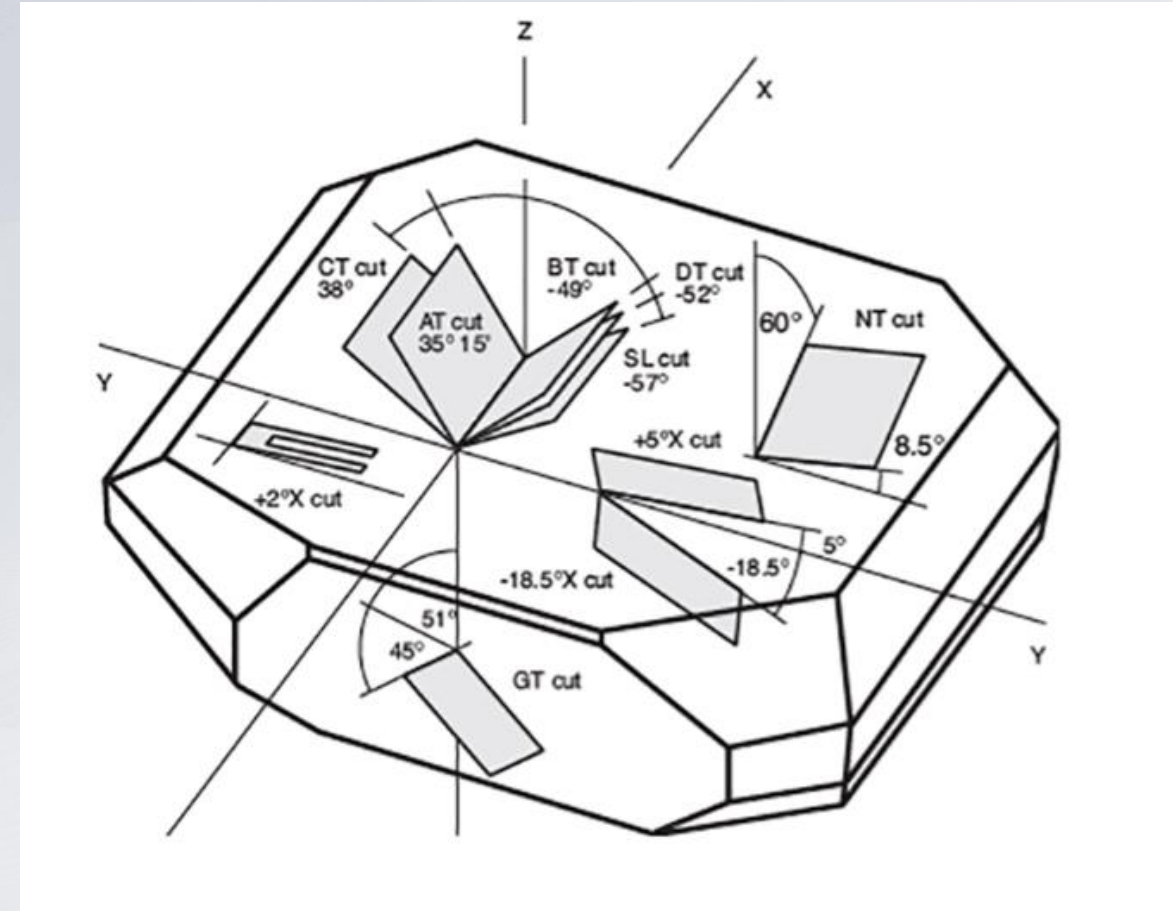
Size Comparison:
OSI5 $\approx$ 24 x OHA4

Comparison for OCXO



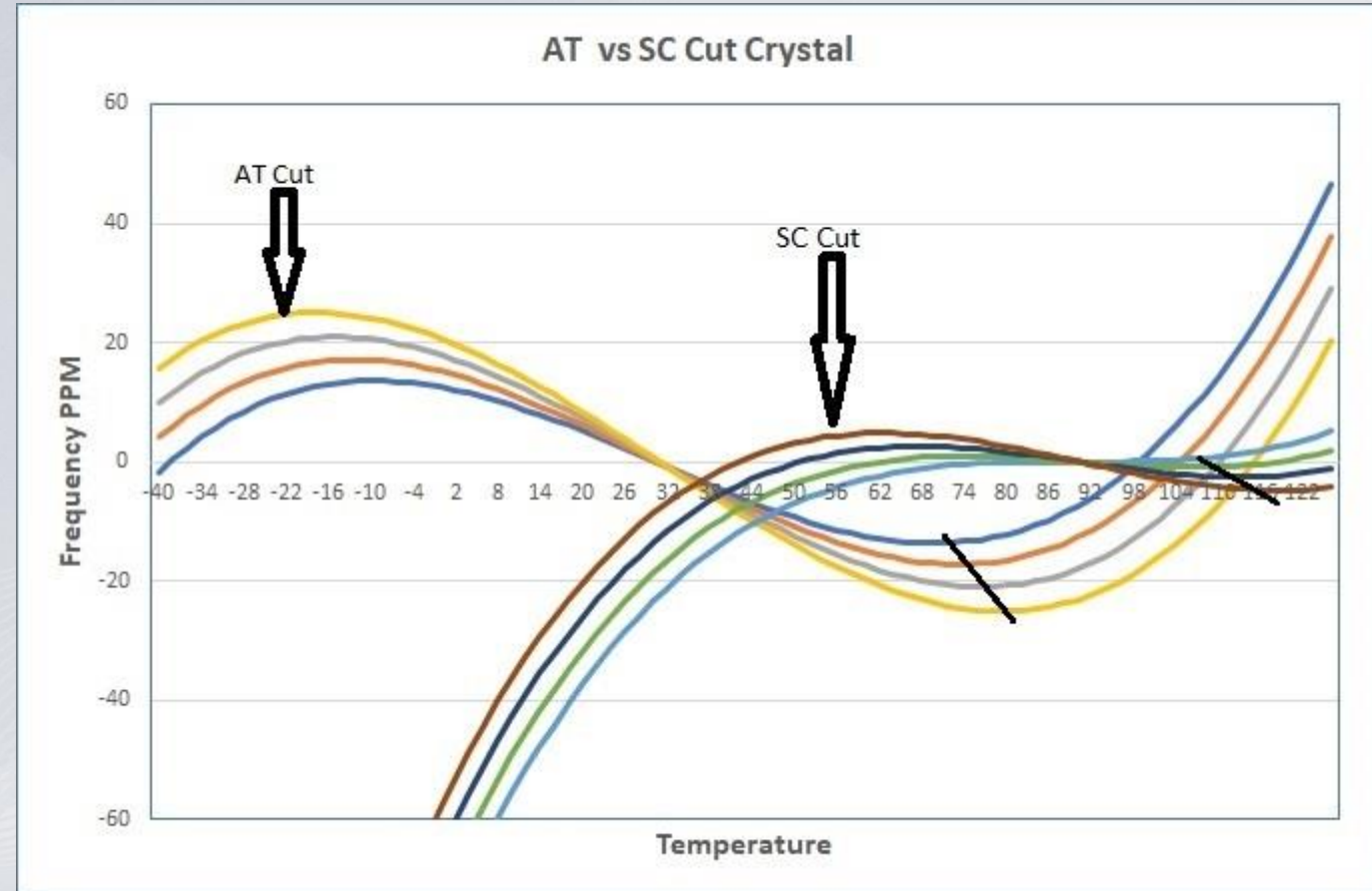
Understanding Quartz and Crystals

- Many different cuts of crystals
- The type of crystal is determined by the orientation of the cut
- The most common is AT and SC



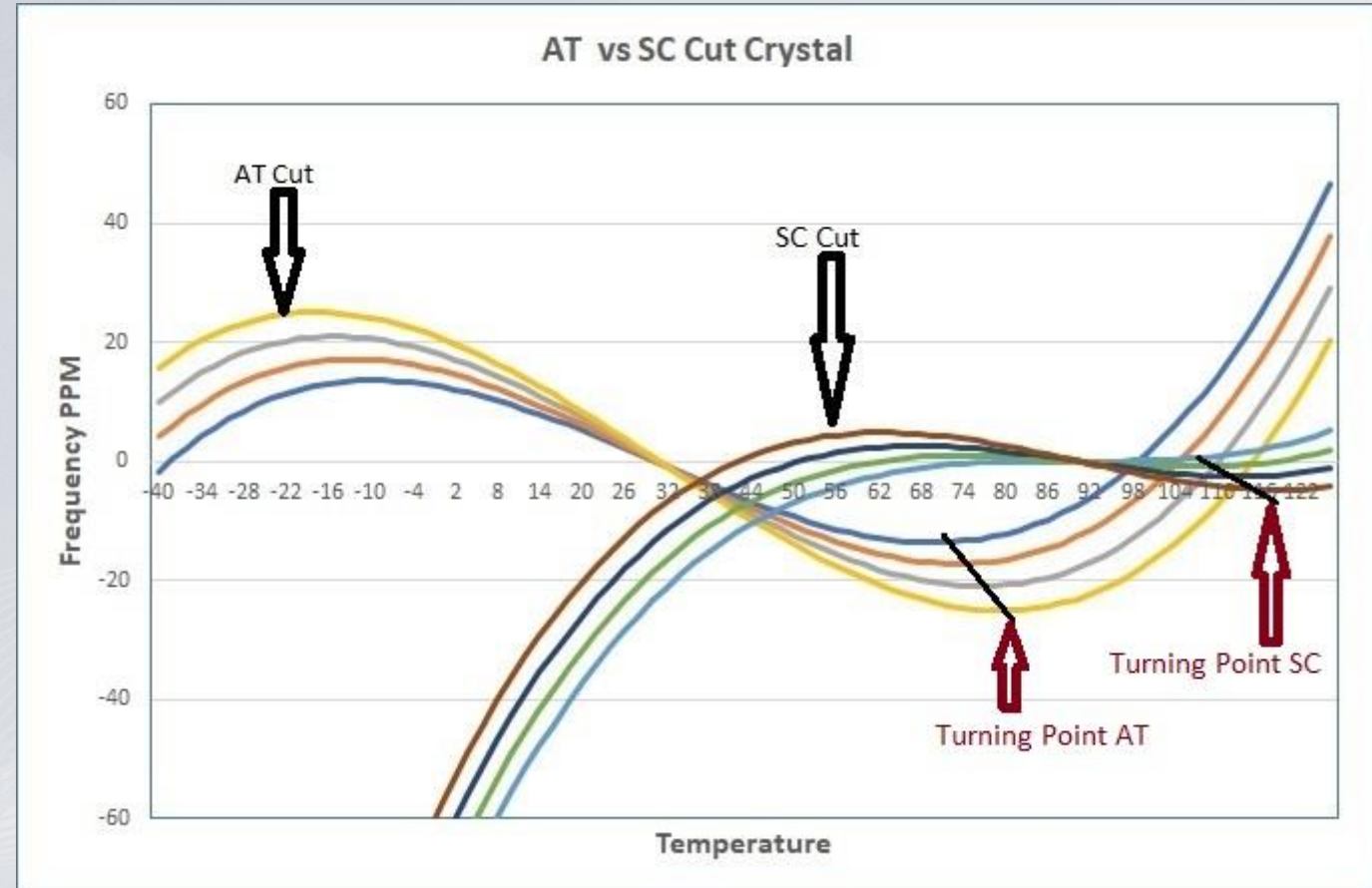
Key elements of OCXO Design

- Temperature sense and control circuitry
- Heater is typically a minimum of 10° above maximum operating temperature
- Best stability is lowest PPB / °C
- Layout to thermally stabilize the crystal and associated circuitry at a given temperature and minimize thermal losses



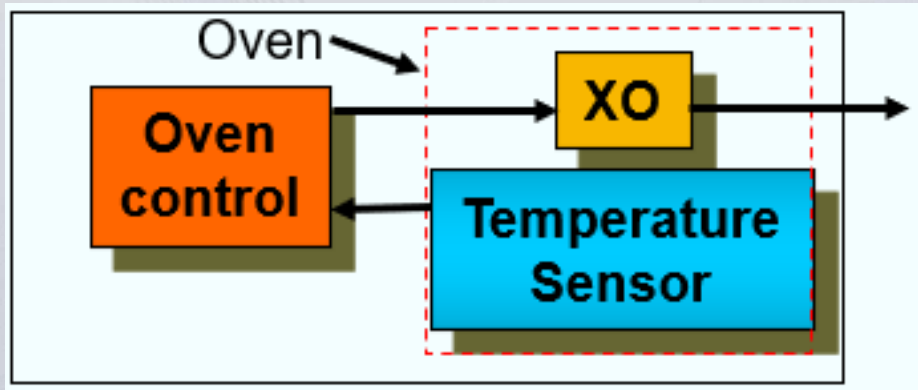
Key elements of OCXO Design

- Set the Temperature of the heater control circuitry to the flatness portion of the crystal turning point, Lowest PPB / °C
- The narrower the temperature swing, the greater the stability of the OCXO
- Layout to stabilize the crystal and associated circuitry while minimize thermal losses



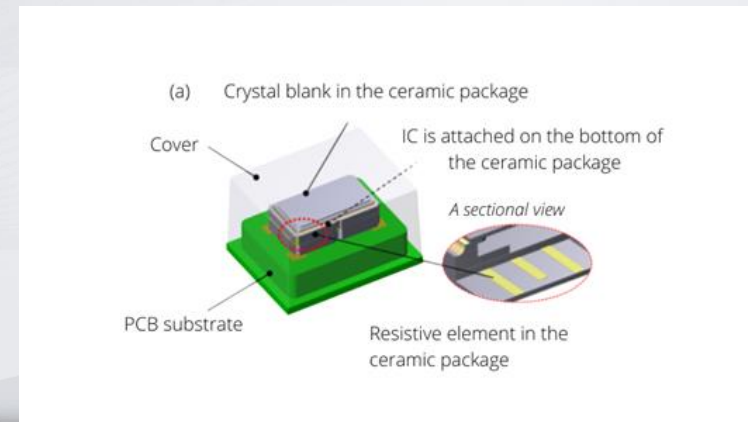
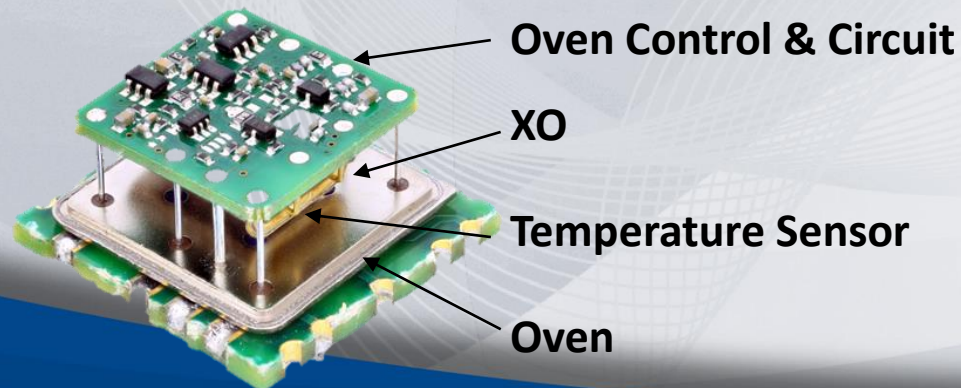
OCXO – Oven Controlled Crystal Oscillator

Block Diagram of OCXO



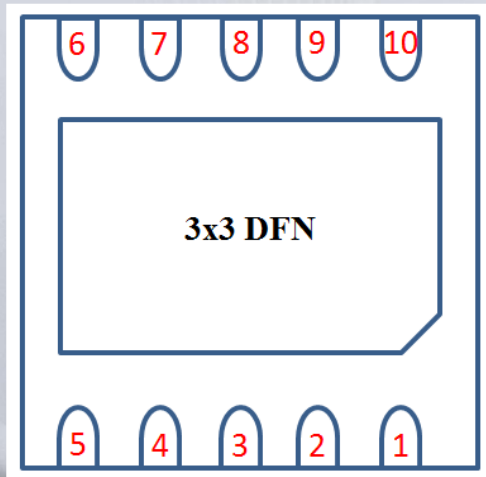
Considerations for Design

- AT Crystal
- SC Crystal
- Fundamental versus Overtone
- Controller Circuit
- Layout considerations to optimize thermal performance

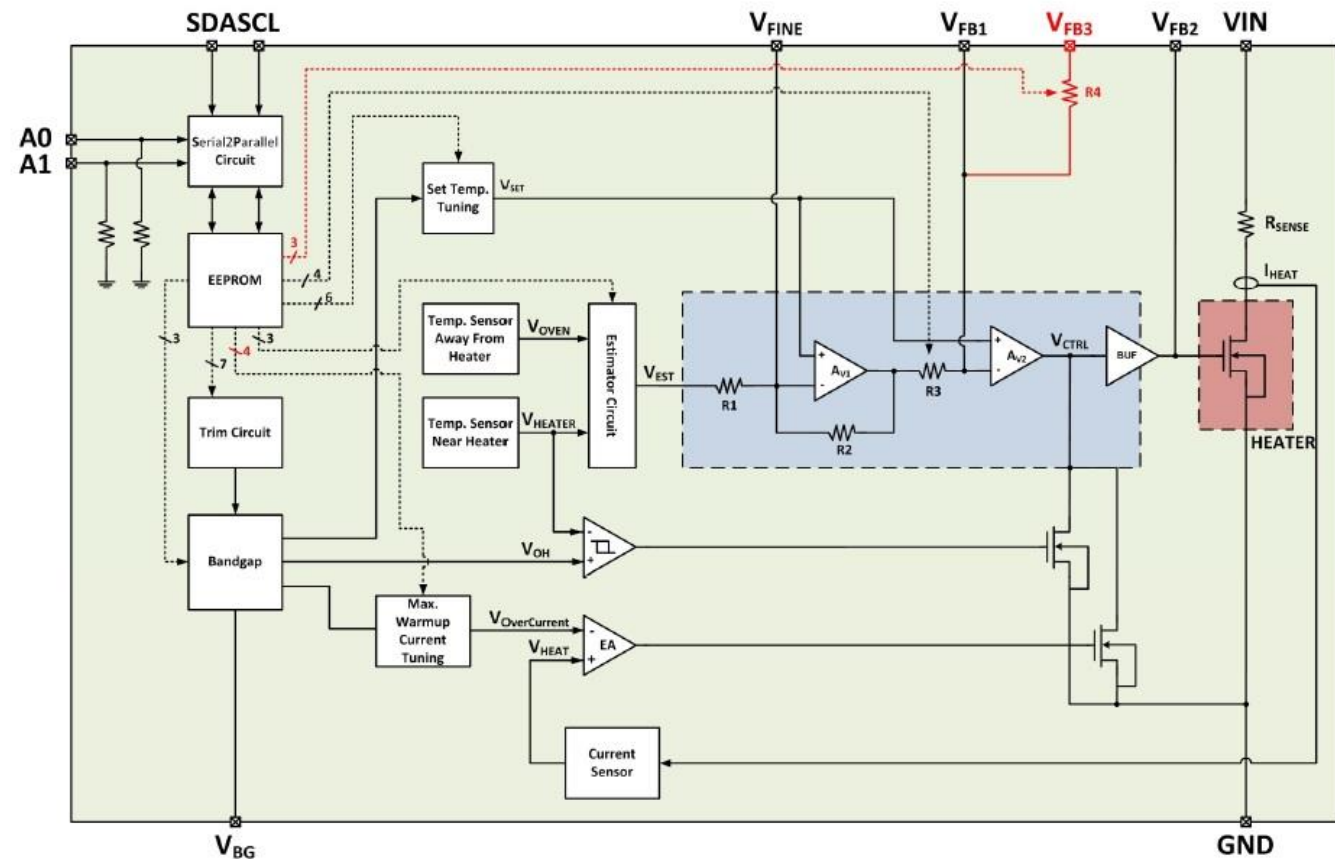


Key elements of OCXO Design

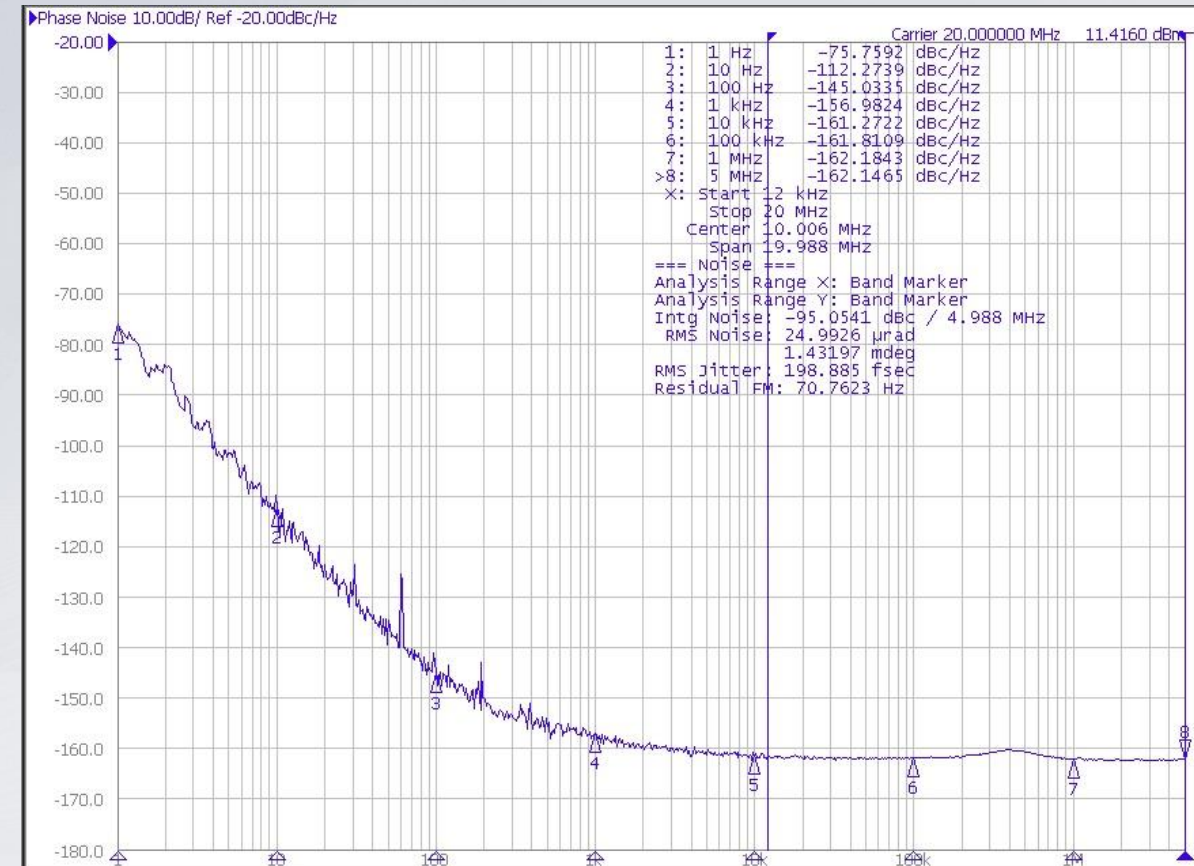
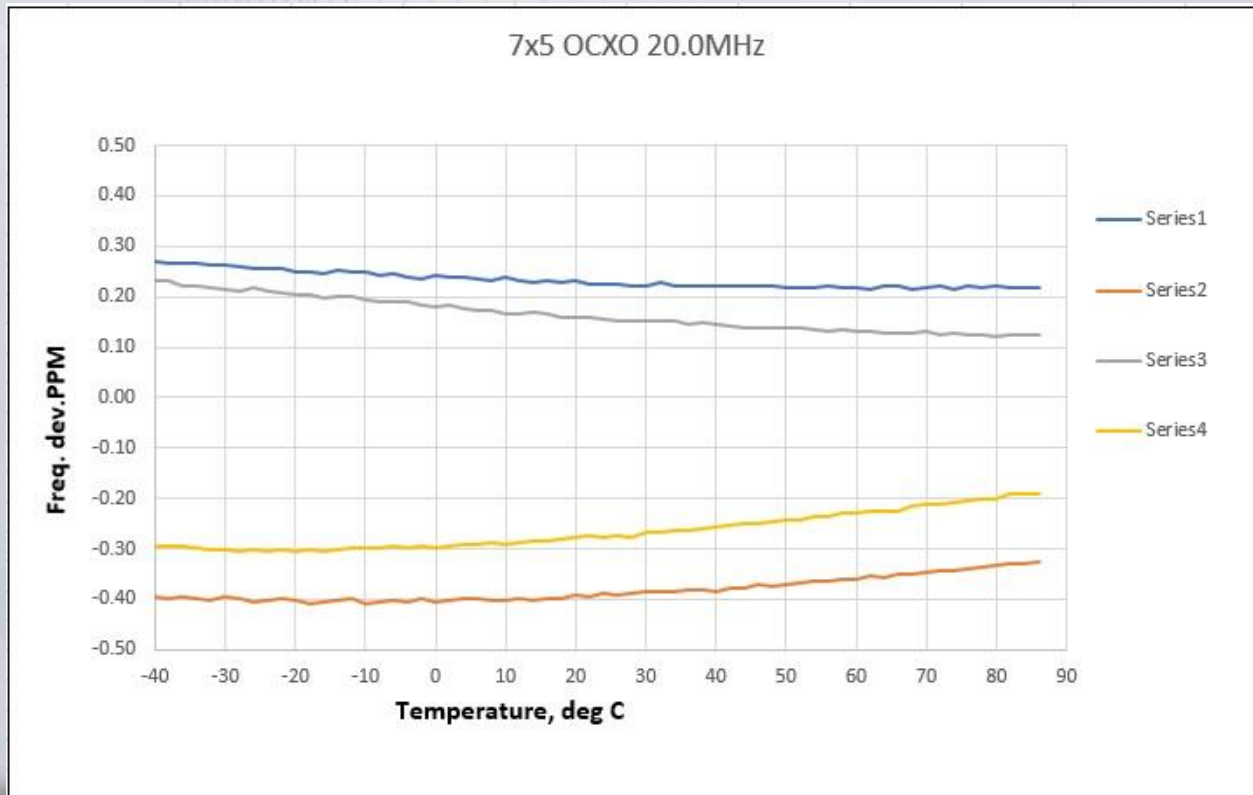
- Heater Controller
- Digital Control
- Smaller package



Block Diagram

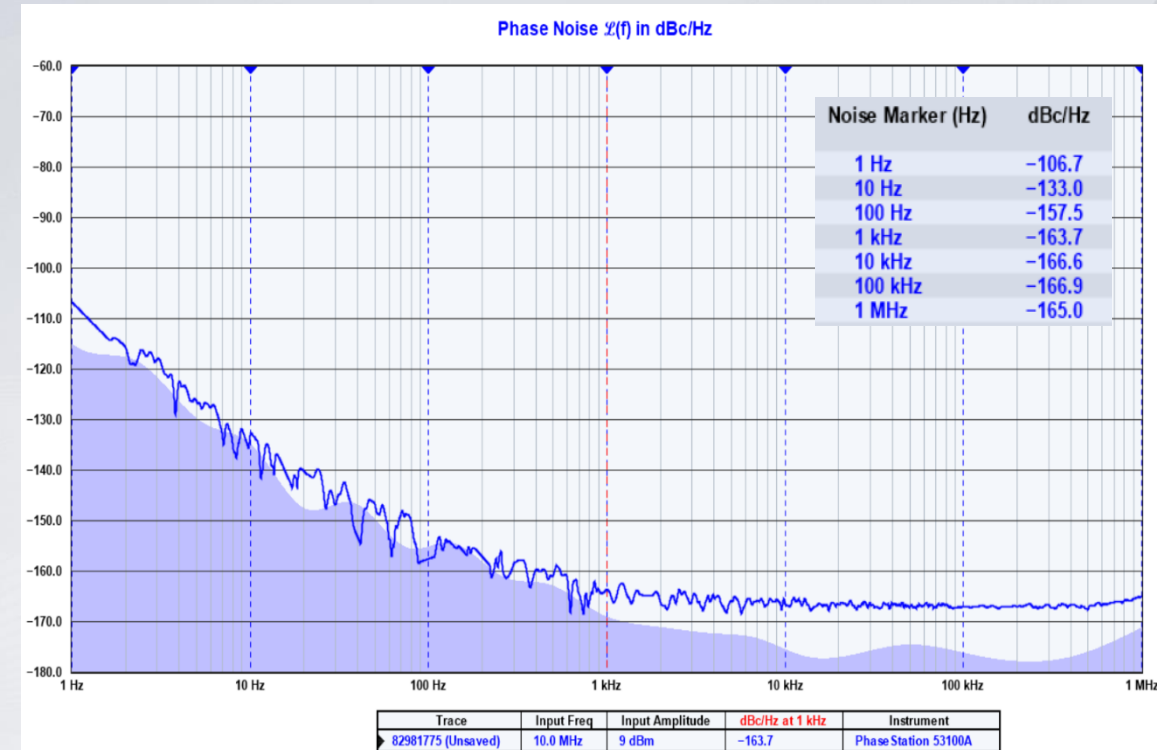
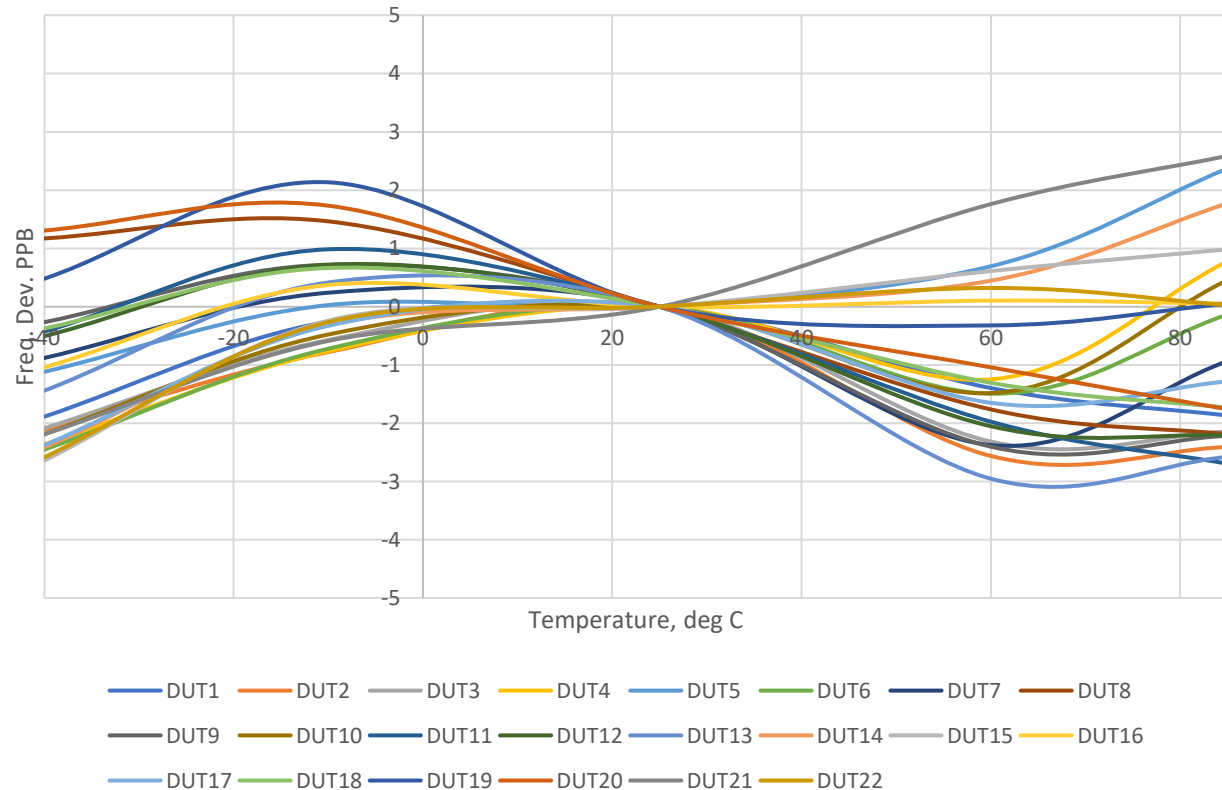


Performance 7.5x5.5 OCXO



Performance Large OCXO

36 x 27mm OCXO 10MHz



OCXO Considerations

- Form Factor
- Power
- Stability
- Warm up time
- Frequency
- Phase Noise
- Allan Deviation
- Aging
- G sensitivity



SC Cut, Overtone



SC Cut, Fundamental



AT Cut, Overtone



AT Cut, Fundamental

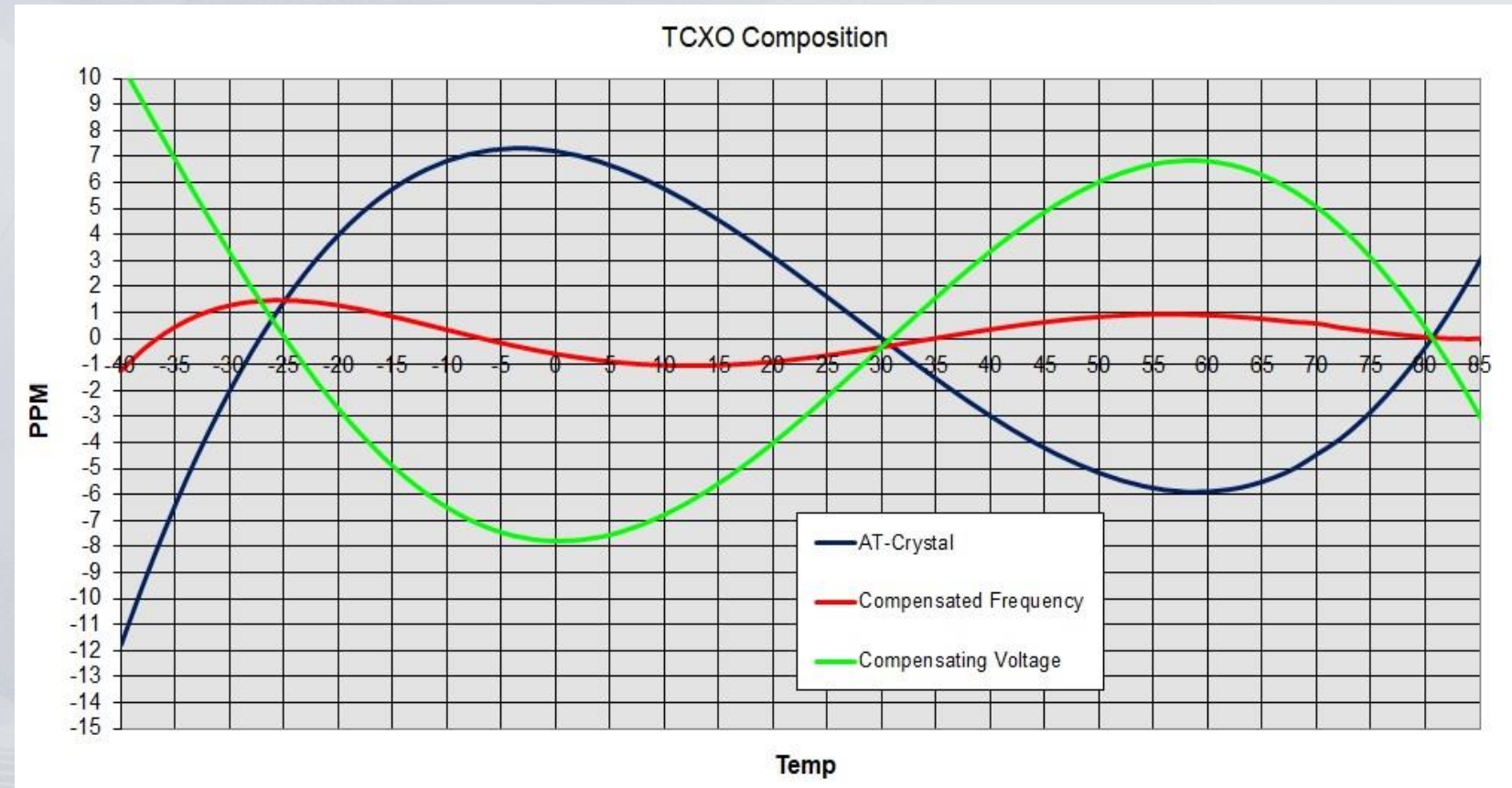
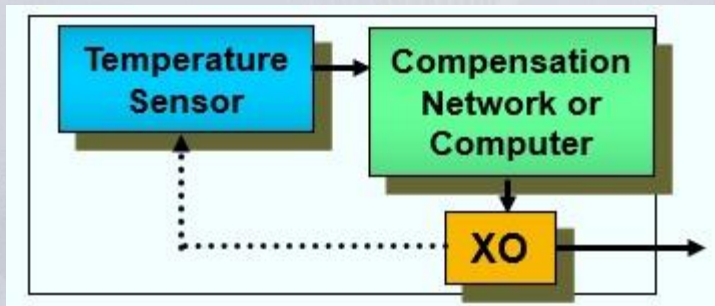


OCXO Specifications

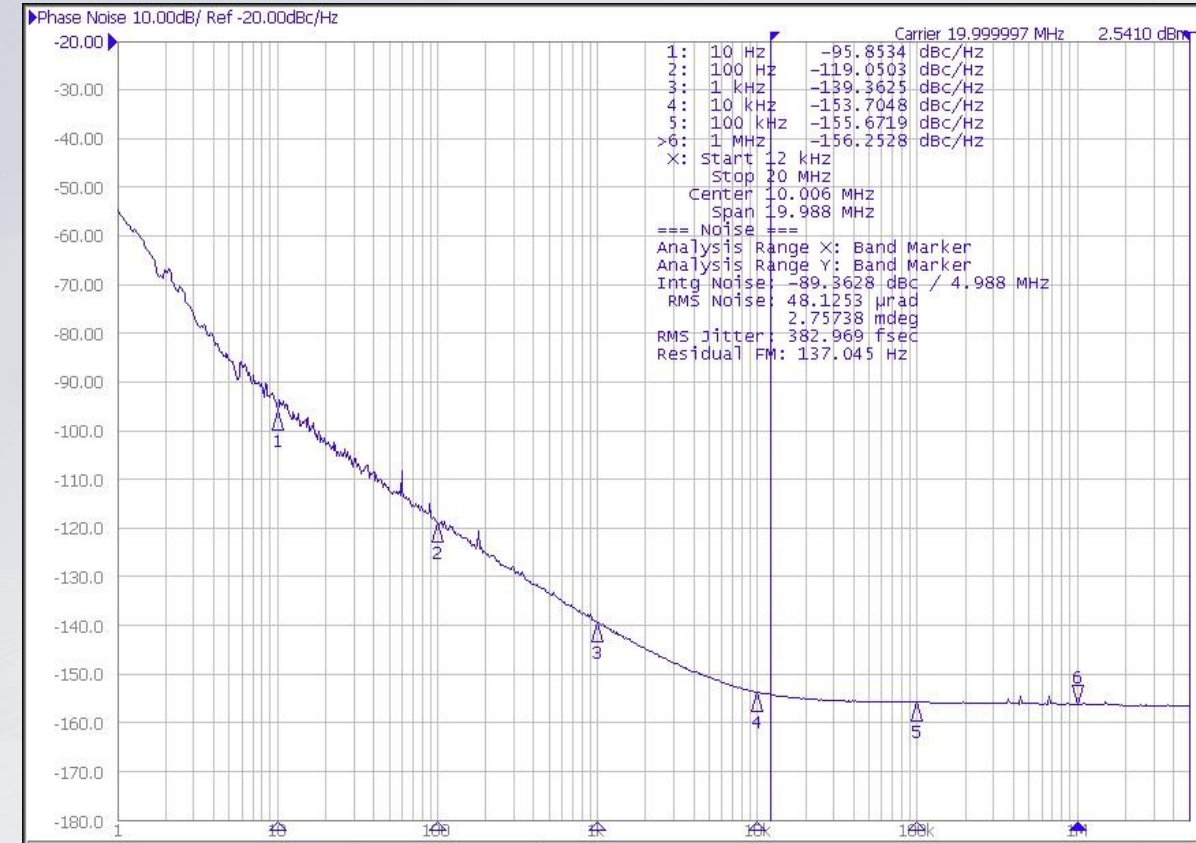
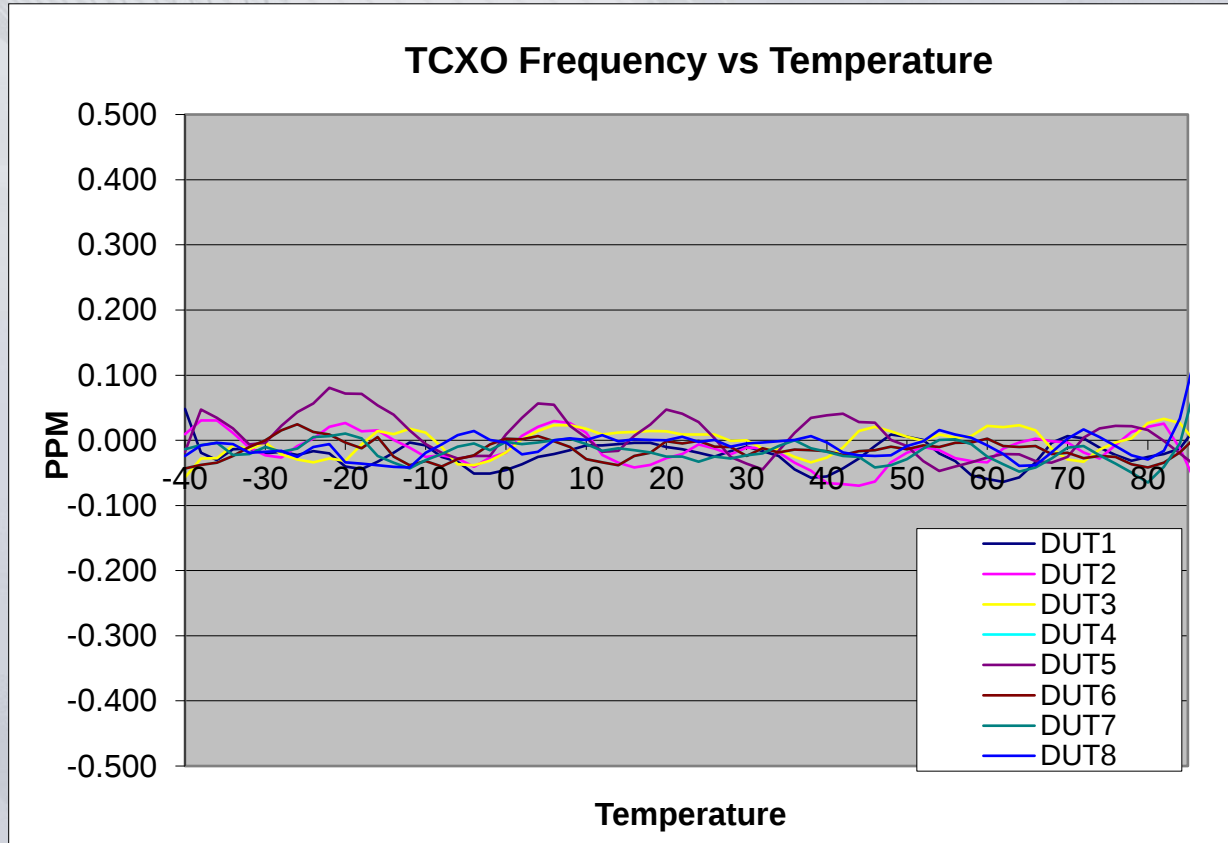
- Nominal Frequency/Stability - Limited
- Supply Voltage 3.3 – 12.0V
- Control Voltage/Pull range
- Aging
- Operating Temperature
- Output – Sinewave/CMOS
- Power Consumption/Warmup
- Phase Noise
- G Sensitivity

Key elements of TCXO Design

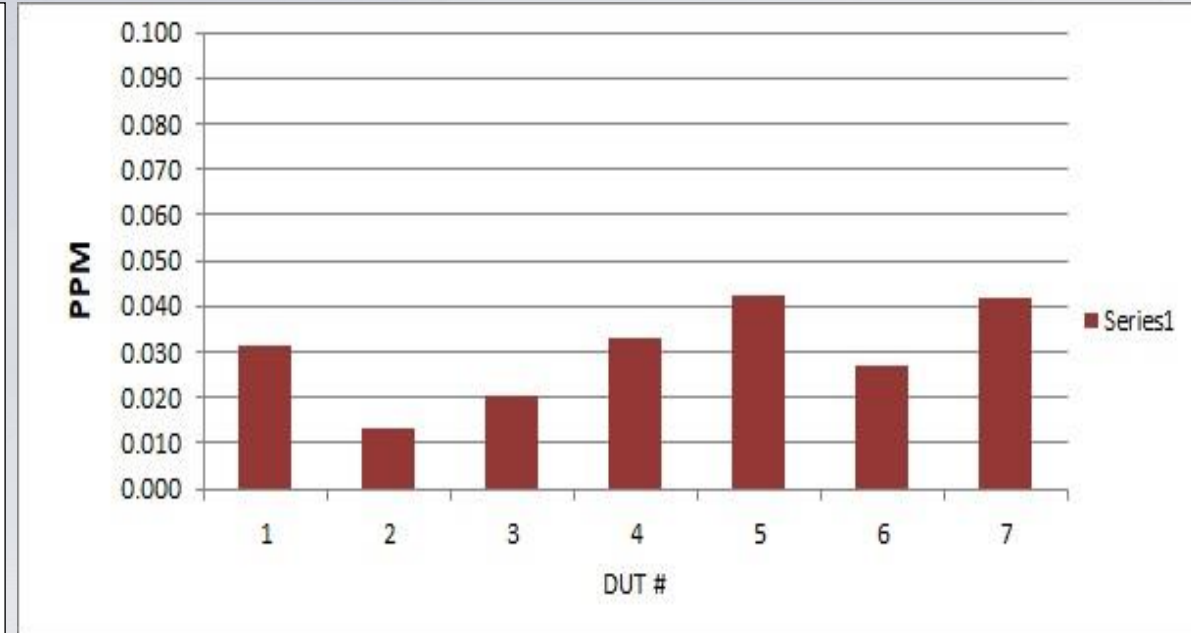
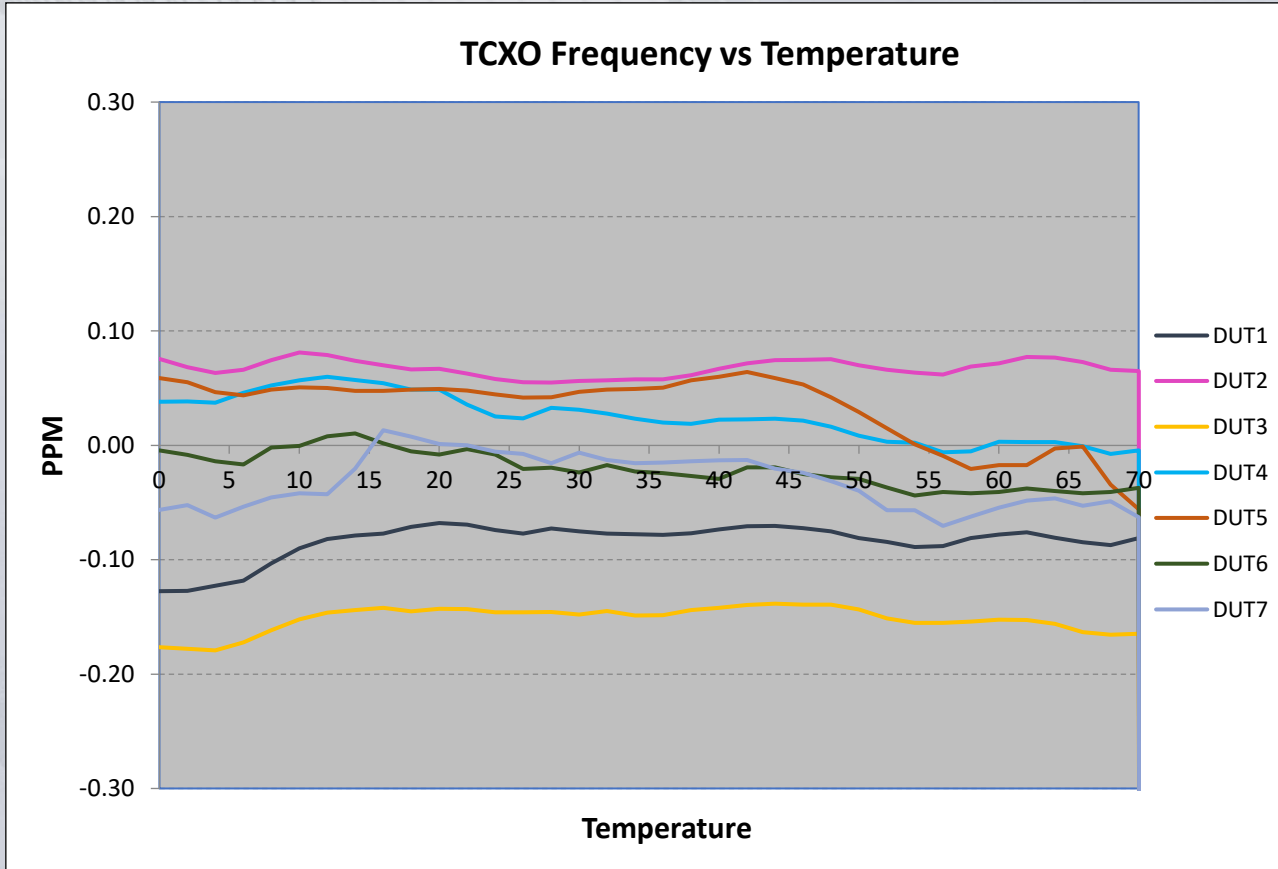
- AT Fundamental
- Temperature Sensor
- Compensation Network



High End TCXO Performance



High End TCXO Performance



TCXO Considerations

- Form Factor 2.0x1.6, 2.5x2.0, 3.2x2.5,
5.0x3.2, 7.0x5.0, 20x12
- Supply Voltage 1.8 – 3.3V
- Aging
- Stability 50 PPB - 2 PPM
- Start Time
- Frequency
- Phase Noise



AT Cut, Fundamental



TCXO Specifications

- Nominal Frequency/Stability
- Supply Voltage 1.8 ~ 3.3V
- Control Voltage/Pull range (VC Options)
- Aging
- Operating Temperature (Available up to 105°C)
- Output – Clipped Sine/CMOS
- Power Consumption
- Phase Noise

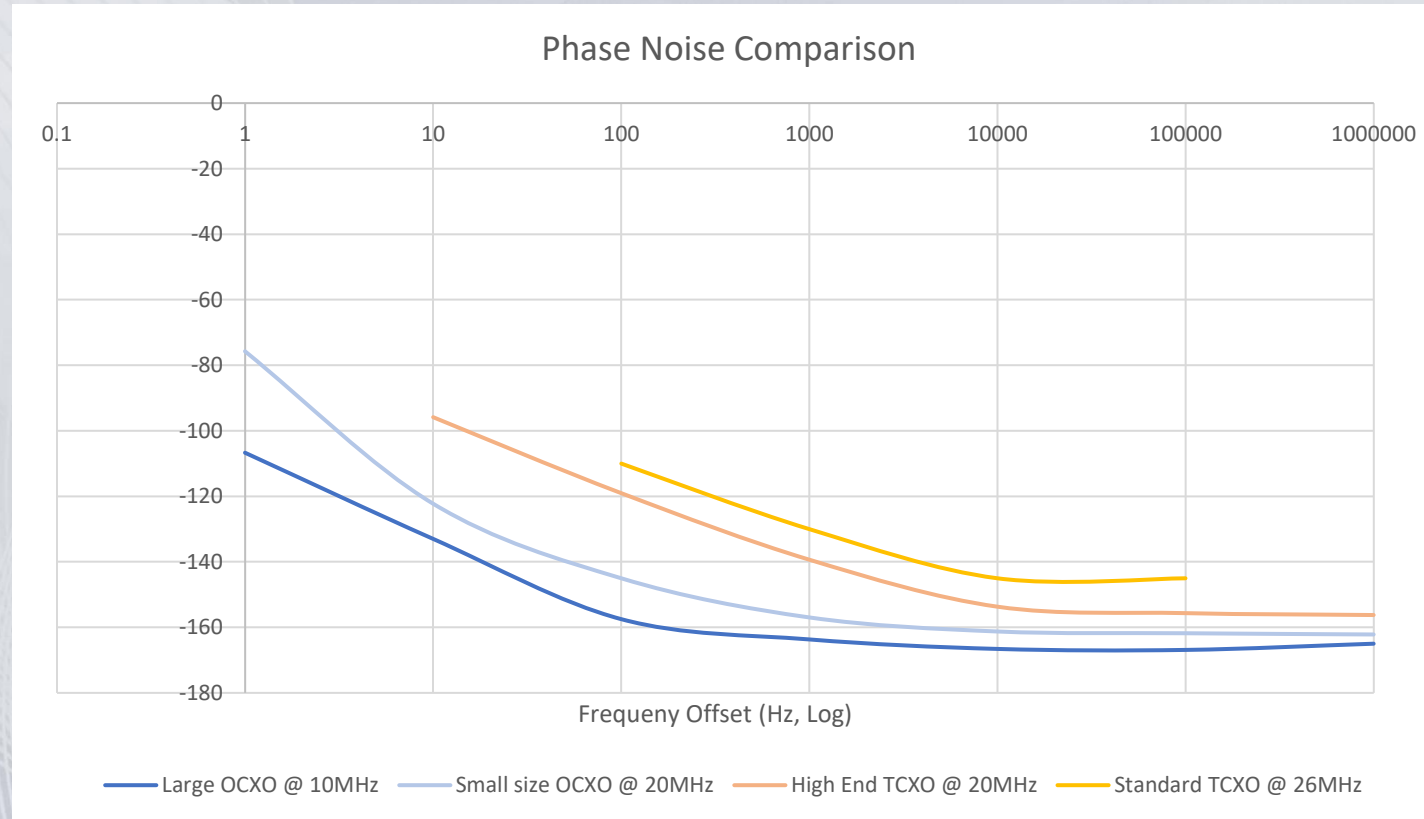
Application Considerations

- Remote Locations (Power Consumption, Temperature)
- Environmental (Power Consumption, Temperature, G sensitivity)
- Phase Noise (Application Specific, System requirement)
- Power (Battery operated?)
- Lifetime (Aging)

Comparison between OCXO & TCXO

	High End OCXO	Small Size OCXO	High End TCXO	Standard TCXO
Size	36.3 x 27.2 mm	7.5 x 5.5 mm	5.0 x 3.2 mm	2.0 x 1.6 mm
Stability	±1ppb	±20ppb	±50ppb 0-70°C	±2ppm
Power Consumption	2.1W (Steady State)	0.75W (Steady State)	~0.012W	~0.01W
Phase Noise	-130dBc@10Hz -153dBc@100Hz -158dBc@1kHz -160dBc@10kHz	-110dBc@10Hz -143dBc@100Hz -158dBc@1kHz -163dBc@10kHz	-104dBc@10Hz -130dBc@100Hz -148dBc@1kHz -156dBc@10kHz	-110dBc@100Hz -130dBc@1kHz -145dBc@10kHz
Aging				

Comparison between OCXO & TCXO



Frequency Offset (Hz)	1	10	100	1000	10000	100000	1000000
Large OCXO @ 10MHz	-106.7	-133	-157.5	-163.7	-166.6	-166.9	-165
Small size OCXO @ 20MHz	-75.7592	-122.274	-145.034	-156.982	-161.273	-161.811	-162.184
High End TCXO @ 20MHz		-95.8534	-119.05	-139.363	-153.705	-155.672	-156.253
Standard TCXO @ 26MHz			-110	-130	-145	-145	

Application



GNSS : TCXO, OCXO, Timing Module

- GPS / Beidou (BDS) / Galileo / GLONASS
- QZSS / IRNSS
- LEO/MEO/GEO
- Positioning and Tracking



Data Center : X'TAL, XO, TCXO

- Server
- Switch
- Storage
- PON



Networking :

X'TAL, XO, TCXO

- Gateway
- AP / Router
- HUB
- AIoT



Automotive : X'TAL, XO, TCXO

- Mobile data center
- GNSS
- Infotainment
- EV charger
- ADAS
- Connected Car



Consumer : X'TAL, XO

- Audio, Player, Speaker, Microphone, Web Camera, CCD
- Video, Display & TV(FPD/FTF LCD)
- Notebook
- DESKTOP
- All in One
- IPC
- Printer



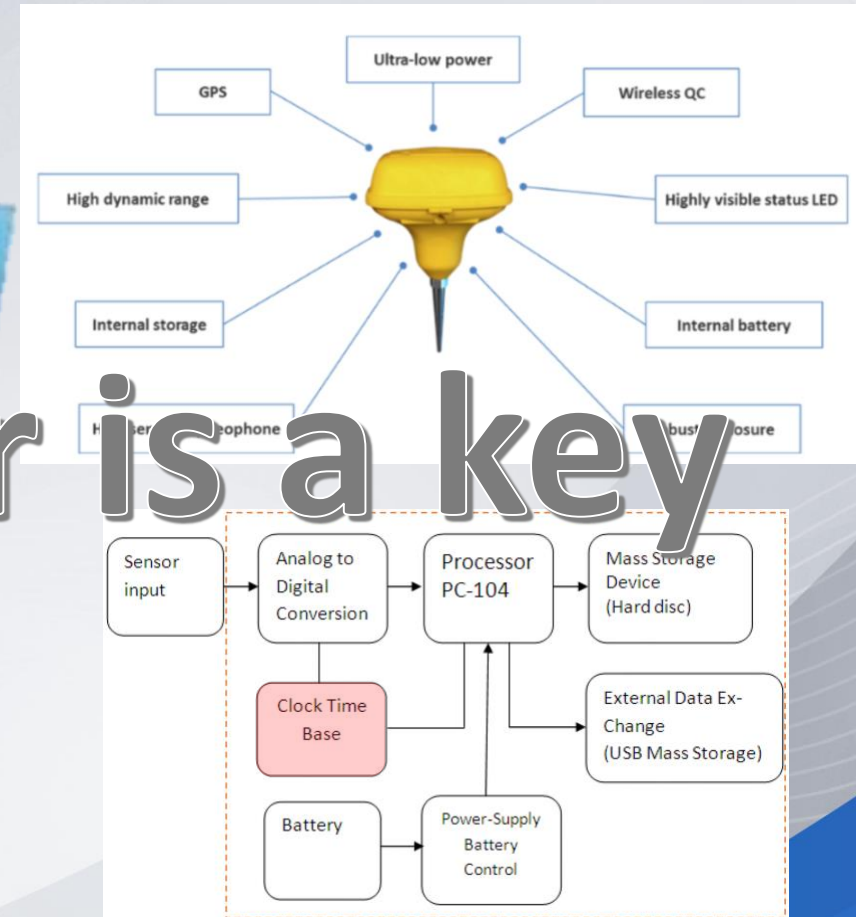
Telecom :

X'TAL, XO, TCXO,
OCXO, Timing Module

- CPE, Small cell
- RU / DU / CU
- Fronthaul machine
- Backhaul machine

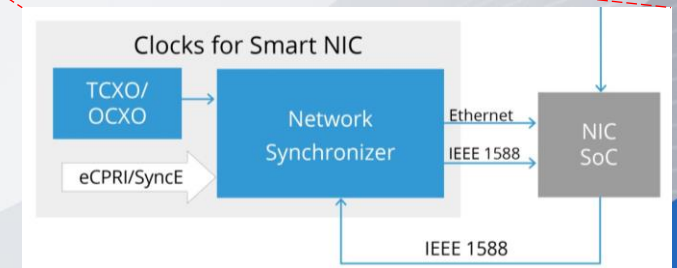
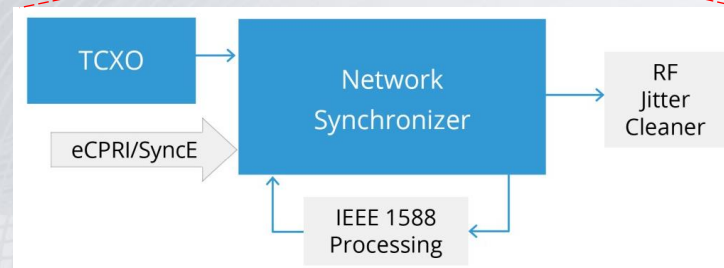
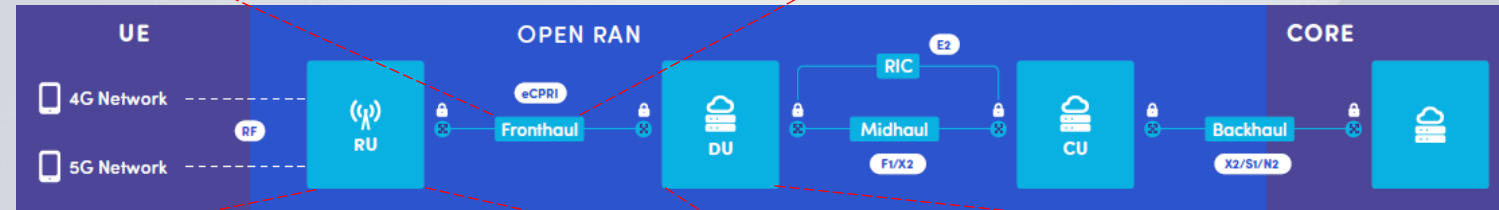
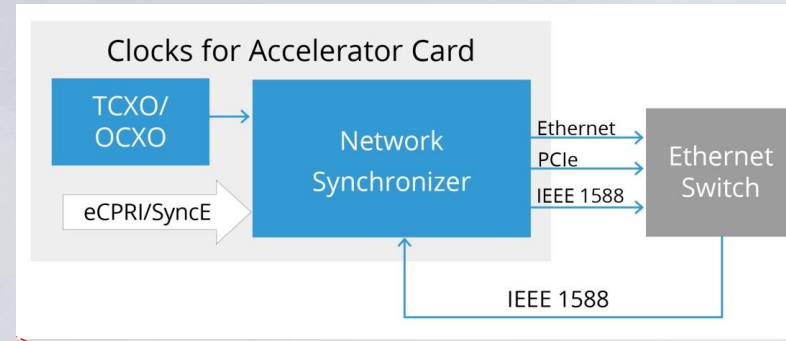
Seismic

Ultra-low-power is a key



Ocean-Bottom Seismic Data Acquisition with Nodes

Basestation (ORAN)



Automotive



Affiliate Brands

As an industry leader in frequency control products, we are pleased to announce the joining of Cardinal Components and Isotemp Research to its brand families.



Specialized in programmable products, Cardinal Components excelled in offering versatile frequency product solutions with fast deliveries. Cardinal offers both pre-programmed products and programming blanks and devices for those customers that require the utmost flexibility.

<https://www.cardinalxtal.com/>



Founded in 1968, Isotemp Research specialized in customized, high quality frequency control products for the communication and test equipment industries. Main product lines include Oven Controlled Crystal Oscillators (OCXOs), Temperature Compensated Crystal Oscillators (TCXOs), and Miniature Heater for Quartz Resonators (Mini-Ovens).

<https://www.isotemp.com/>



Source Reference

- OCXO Structure on slide 9
 - https://commons.wikimedia.org/wiki/File:RAKON_STP2734B_LF_OCXO_10MHZ_internal_view.jpg
 - <https://www.codico.com/en/current/news/txc-new-ocxo-oh-series-with-reduced-size>
- Semsmic Application on slide 24
 - <https://www.aogr.com/magazine/sneak-peek-preview/advances-scale-up-nodal-acquisition>
 - <https://www.inovageo.com/case-studies/field-performance-of-the-quantum-nodal-seismic-acquisition-system>
- Basestation on slide 25
 - <https://www.spirent.com/assets/ebook-open-ran-an-introduction>
 - <https://www.5gtechnologyworld.com/how-timing-sources-synchronize-open-ran-networks/>

Pletronics provides commitment to quality, collaboration and innovation



THANK YOU

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Question & Answer

