Ultra-Low Noise 100 MHz OCXO for Space Applications

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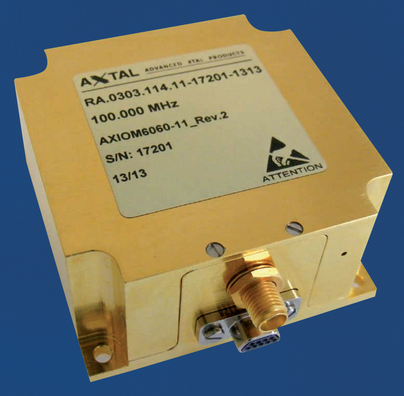


Ultra-Low Noise OCXO in the 100 MHz range are a key component in many satellite-born applications for microwave links, radar and navigation. The paper reports details about realisation of the fully space qualified AXTAL USO AXIOM6060, which is listed on the ESA EPPL since 2015. The whole project including design, manufacturing and testing of EM, FM and LAT was realised by AXTAL without any funding.

Target specification (AXIOM6060)

- Radiation hardened: min. 100 krad(Si) TID for GEO application
- Ultra-Low Phase Noise:
  < –70 dBc/Hz at 1 Hz
  < –100 dBc/Hz at 10 Hz
  < –130 dBc/Hz at 100 Hz
  < –160 dBc/Hz noise floor
- Very low frequency aging: < ±50 ppb/year
- Very tight calibration tolerance: ±10 ppb typical before screening
- Very high frequency stability: < ±50 ppb vs. -30°C to +70°C
- Screening according to MIL-PRF-55310 Level "S"
- Random Vibration with G_{rms} = 38.1 g, Shock of 1500 g / 0.5 ms
- 100 % ITAR free component selection

Electrical design

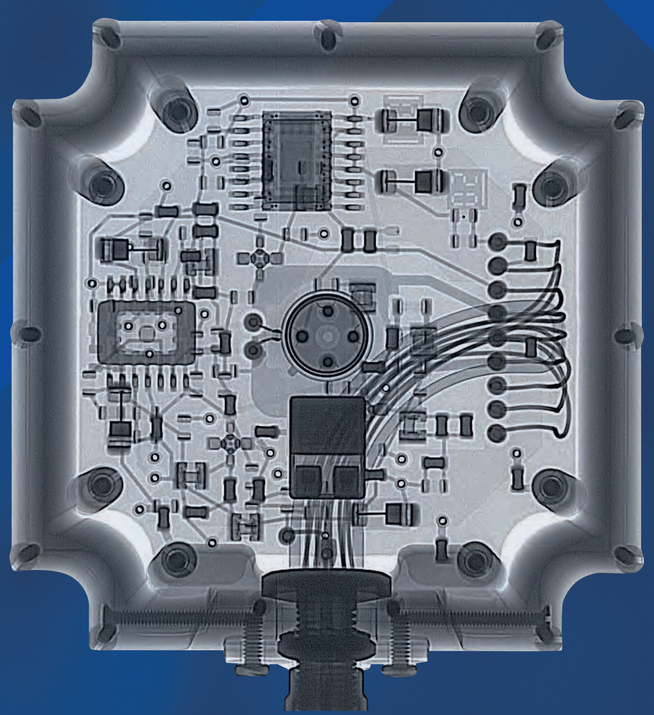
- All add-on components according to ESCC-Q-ST-60C Class 1
- Radiation hardened active components > 100 krad(Si) TID
- No Latch-up sensitive (SEL) components
- Strong focus on European manufacturers (ITAR free requirement)
- Only surface mount (SMD) add-ons except the quartz crystal

Core add-on components:

- Low Noise RF transistor (TID up to 1000 krad)
- Power Transistor (TID >100 krad)
- Low Noise Voltage Regulator (TID 300 krad, SEL immune)
- Operational Amplifier (TID >100 krad, SEE > 90 MeV)
- High-Q Swept Quartz Crystal Unit, SC-Cut 5th overtone
- Qualification derived from ESCC3501/018 (type T807)

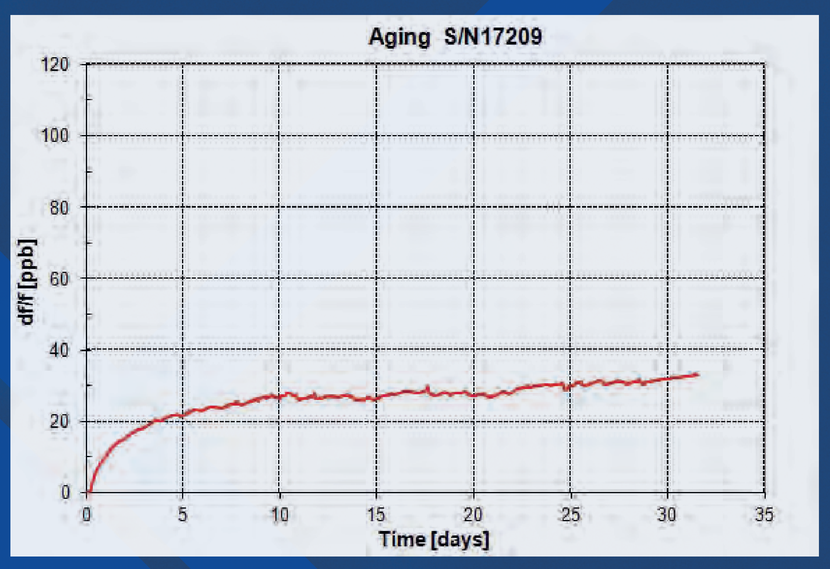
Mechanical design

- Robust flange mount package with SMA and
- Micro-D connectors.
- Hermetically sealed add-ons.
- Multilayer PCB manufactured by ESA qualified vendor.
- Ruggedized internal construction, withstanding very high vibration levels and strong mechanical shock.



Manufacturing and Screening

- Soldering according to ECSS-Q-ST-70-08C and ECSS-Q-ST-70-38C.
- Assembly, In-Process Testing and Soldering in Clean-room.
- Phase noise measurement in Electromagnetic shielded room.
- Screening, Group-A, Group-B and Group-C inspection according to MIL-PRF-55310 Level "S".
- On-site Precap and Final Source Inspection by end customer.



Test results and features.

- Aging:
  ±30 ppb
  for 1st year
  (specification
  < ±50 ppb)
- Stability:
  ±15 ppb
  -30°C ~ +70°C
  (specification
  < ±50 ppb)
- Phase noise:
  see chart left
- Short-term stability (ADEV):
  $5 \cdot 10^{-12}$ @ 1 sec
  (specification
  < $1 \cdot 10^{-10}$)

COTS Versions (AXIOM75S)

- Hermetically sealed 25x25 mm THD package (CO 43).
- Small size with only 8% volume of AXIOM6060.
- Radiation hard up to 20 krad(Si) TID, for LEO and MEO missions.
- Ultimate electrical performance possible due to the use of state-of-the-art add-ons.
- Screening and inspections according to MIL-PRF55310 Level "S".

Conclusions and Future Work

The qualification was performed by CAST (China) in close cooperation with TESAT (Germany). Several flight models were successfully launched on the Chinese GEO weather satellite Feng Yun FY-2G and are operating without any issue since December 2014. Other models were qualified by Astrium/Airbus D&S for an experiment on ISS and by DSO (Singapore). Any frequency between 5 MHz and 125 MHz can be realised with basically the same design. The realization of the same performance as AXIOM6060 in a compact 25x25 mm flat-pack package is currently in progress.

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