AXTAL

ADVANCED XTAL PRODUCTS

a Q-TECH Company

AXTAL Oscillators & Filters for Space Applications

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- **AXTAL GmbH** was founded in November 2003 by Bernd and Brigitte Neubig. Since 2023 it is an independent subsidiary of **Q-Tech Corporation**. It is dedicated to the Development, Testing, and Manufacturing of Frequency Control Products, namely High Performance Oscillators, Frequency Control Modules and Units.

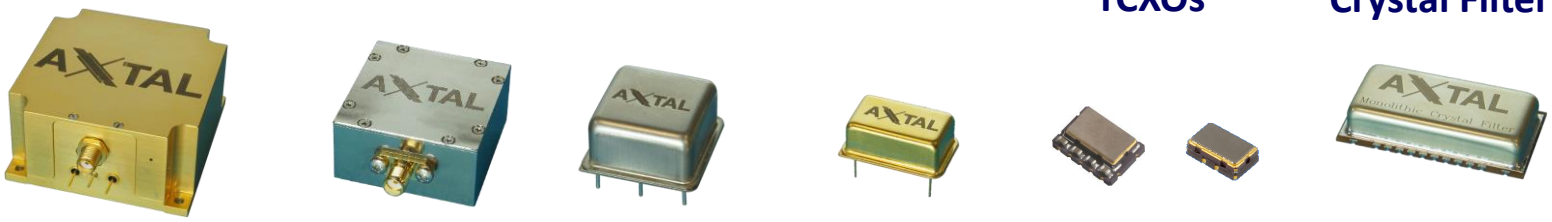
- **Main markets:**
  - Customer Specific High Stability Low Noise Oscillators with Quartz BAW and SAW resonators and Frequency Control Modules/Units (Masterclocks, Synthesizers etc.)
  - High Precision RF Test Equipment
  - Military (Ground, Mobile, Marine, Aerospace)
  - Space and Aerospace
  - Navigation, Surveillance
  - Satellite Communication

- **Facility location: Mosbach/Baden in Southern Germany**
  - Comprises full manufacturing line, extensive test equipment, Quality Management, R&D
  - Quartz crystals sourced from qualified manufacturers, ITAR free

Oscillators & Filters for Space

- **AXTAL** manufactures oscillators for space since 2011 and is listed on the ESA EPPL since 2014 (OCXO AXIOM6060 series).
- **AXTALs** space portfolio comprises of Ultra-low Noise High Stability OCXO, Space-COTS OCXO, VCXO, TCXO and Crystal Filters.
- **AXTALs** products are part of many space missions:
  Feng Yun (GEO weather satellite), ISS/ACES (Scientific Timing System),
  NCLE Project (Earth-Moon L2 orbit), LARA/ExoMars Mission and many others.

USO OCXO | **New Space OCXOs** | **VCXOs** | **New Space TCXOs** | **Monolithic Crystal Filter**



No subject to US export control

Space Product Categories

"Classical" Space Category:

- Highest grade products in regards of component selection, design, manufacturing and radiation hardness (typically 100 krad TID and SEE > 60 MeV, SEL immunity).
- Conventual approach to assure very high reliability and with focus on long GEO and extraplanetary missions.
- This highest quality grade results in high cost and very long lead times. But it is a must, where no compromise on reliability can be made.

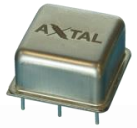
"New" Space Category:

- Space COTS (commercial-off-the-shelf) product class, where the design is based on specially selected commercial components and suitable semiconductor technology.
- New approach focuses on LEO and shorter missions with lower requirements for radiation hardness (typically <30 krad TID and SEE ≤60 MeV).
- This COTS grade allows much lower cost and lead times, while still maintaining a high level of reliability. Typical applications are Small and Cube SATs, mega constellations etc.

Space Product Categories

Item	High Grade Products „Classical Space“	COTS Grade Products „New Space“
Standard	MIL-PRF-55310 „S“ / ESCC3503	MIL-PRF-55310 Level „B“ or „S“
Component/ Material Selection	ECSS-Q-ST-60C class 1 (Components) ECSS-Q-ST-70C / ECSS-Q-70-71 (Material) ECSS-Q-ST-70-11C (PCB) 100% Traceable components (PADs)	Specially selected and up-screened COTS parts (AEC-Q100/200 qualified parts or parts with proven reliability level/heritage) Traceability of critical components
Quartz crystal	Synthetic HighQ Swept Quartz IAW ESCC3501 Precap Inspection (on request)	Synthetic HighQ Quartz (swept material on request) Screening IAW MIL-PRF-3098 (optional)
Radiation hardness	Total dose (TID) up to 100 krad SEE up to 90 MeV, SEL immunity	Total dose (TID) up to 40 krad SEL immunity per design
Workmanship	ECSS-Q-ST-70-08C / ECSS-Q-ST-70-38C	ECSS-Q-ST-70-08C / ECSS-Q-ST-70-38C

„Classical Space“



„New Space“

Quartz Crystals

- **Key component, which mainly determines frequency stability.**
- **Assurance of radiation hardness of the crystal is critical.**
- **There are <u>two</u> approaches for the crystal quality & material selection:**
  - **<u>Conventual „Classical Space“ approach:</u>**
    Use of “swept” Quartz material for resonators for high radiation levels
    “Sweeping is a purification process that removes certain impurities and thereby improves the radiation sensitivity of quartz crystals.”
    Manufacturing IAW ESCC3501, Screening & PreCap Inspection (on request)
    →High radiation hardness & reliability, but high cost and very long lead time

  - **<u>Space COTS “New Space” approach:</u>**
    Use of Hi-Q (> 2.4 million) “pure z” Quartz material with low etch channel density for low and medium radiation levels – HighQ material can achieve very similar radiation hardness like swept material (ongoing research projects)
    Screening to MIL-PRF-3098 Level “S” or custom specifications
    →Good radiation hardness & reliability, significantly lower cost and lead time

Manufacturing

Manufacturing

- Soldering and assembly by ESA certified personnel in clean room
- Pre-cap inspection of oscillator assembly prior to sealing
- Complete traceability of all materials and manufacturing steps

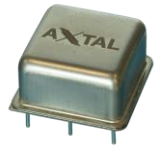
Space Products

OCXO (USO) for GEO and interplanetary applications

- AXIOM6060 Series 100 & 120 MHz (50~150 MHz available)
- High radiation hardness (TID 100 krad, SEE>90 MeV)
- Ultra-low noise and highest frequency stability
- Listed in ESA European Preferred Products List (EPPL)

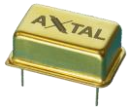
OCXO in Space-COTS Technology for New Space applications

- AXIOM75SL/SH/SHM – 10~400 MHz available
- Ultra-low noise and highest frequency stability
- Small hermetically sealed THD 25x25 mm package



VCXO for GEO and interplanetary applications

- AXIS45S – 10~100 MHz
- High radiation hardness (TID >100 krad, SEE immune)
- Small hermetically sealed THD 21x13 mm package



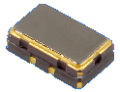
Space Products

Crystal Filter for GEO and interplanetary applications

- MQF4021 – 50 MHz (other frequencies on request)
- High filter slope and out-of-band attenuation
- High radiation hardness (TID >100 krad, SEE immune)
- Small hermetically sealed SMD 40x21 mm package

TCXO in Space-COTS Technology for New Space applications

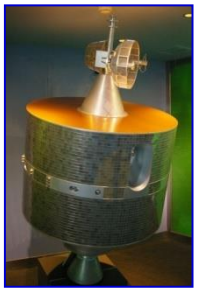
- AXLE7050S – 10~50 MHz, High Stability & Low Noise
- AXLE5032S – 10~50 MHz, High Stability & Low Noise
- Small 7x5 mm or 5x3.2 mm ceramic package
- TID tested up to 50 krad
- SEE tested up to 125 MeV – SEL immune



Space Heritage

Feng Yun 2G – Geostationary Weather Satellite

- Customer: Tesat-Spacecom/CAST
- AXIOM6060-FM – 100 MHz
- ULN Reference OCXO (USO), TID 100 krad, SEE 90 MeV
- Launched 31 December 2014



Feng Yun 2G

ACES (Atomic Clock Ensemble in Space) – International Space Station (ISS)

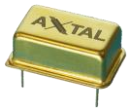
- Customer: Airbus D&S
- AXIOM6060-FM – 100 MHz
- ULN Reference OCXO (USO), TID 100 krad, SEE 90 MeV
- Planned launch date 2018

NCLE (NL-China Low Frequency Explorer) – Earth-Moon L2 Orbit

- Customer: ESA/Radboud University
- AXIOM6060-FM – 120 MHz
- ULN Reference OCXO (USO), TID 100 krad, SEE 90 MeV
- Launched 21 May 2018

Space Heritage

LARA/ExoMars Mission (ESA) – Mars Lander and Rover



- VCXO AXIS45S – 50 MHz
- Crystal filter MCF4021 – 50 MHz
- Used in communication link for Earth-Mars
- TID 100 krad, SEE immune
- VCXO & filters shipped October 2018. Planned launch date 2021

PLATiNO Platform (Thales Alenia Space Italy) – Small satellites

- OCXO AXIOM3838S – 10 MHz
- Used as high stability ultra-low noise frequency reference
- Planned launch 2022/2023

DSO Singapore – LEO and GEO missions

- Space-COTS OCXO AXIOM75-35 – 100 MHz for LEO application (10 krad)
- OCXO AXIOM6060-12 – 120 MHz for GEO application(s)
- OCXO AXIOM6060-13 – 100 MHz for GEO application(s)
- Different EM models delivered – FM models pending

Thank you!

AXTAL GmbH

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(Billing & shipping address)
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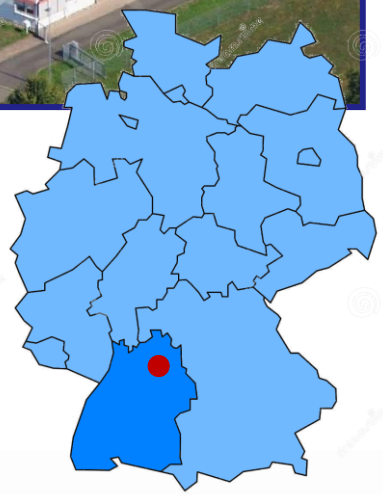
Germany



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