



Company Presentation

AXTAL GmbH & Co. KG

About AXTAL



- **AXTAL GmbH & Co. KG is a privately owned company, founded in November 2003 by Bernd Neubig. It is dedicated to the Development, Prototyping, Testing, and Manufacturing of Frequency Control Products, namely oscillators. Facility location: Mosbach/Baden in Germany.**
- **Establishment of AXTAL CONSULTING in April 2002 as a Company for Design and Consulting Services in the Field of Frequency Control Products and Piezoelectric Sensors**
- **Prior to founding AXTAL, Bernd Neubig was Vice President of Tele Quarz (TQ) (later Corning Frequency Control, now Vectron) since 1983. He established the oscillator and filter product line at Tele Quarz, with full responsibility including R&D, operations and engineering.**
- **Prior to joining TQ, Bernd Neubig was 7 years with KVG (Kristallverarbeitung Neckarbischofsheim), a manufacturer of frequency controlled products. He held positions as crystal design engineer and later R&D manager for oscillators and filters.**



Personal Profile

Bernd Neubig



- **1969 Graduation as Diplom Engineer (Dipl.-Ing.) for Telecommunications at the University of Applied Sciences in Berlin. Study of Physics at the Technical University in Berlin, graduation as Diplom Physicist (Dipl.-Phys.) in 1975.**
- **Chairman of the German Section of IEC TC 49 Standardization Committee, Member of the Scientific Committee of the European Time and Frequency Forum (EFTF). Member of the Technical Program Committee of the IEEE Frequency Control Symposium (FCS)**
- **More than 30 scientific and technical publications, Co-author of a book on Frequency Control components („Das Grosse Quarzkochbuch“, 1997)**
- **Lecturer of seminars on quartz crystals, oscillators, filters and related frequency control components**
- **November 2004: Recipient of the IEC 1906 Award from the International Electrotechnical Commission (IEC)**
- **June 2006: Recipient of the David P. Larsen Award of the Piezoelectric Devices Association (PDA) USA**
- **April 2010: Recipient of the DKE Needle Award for long-term voluntary engagement and for the contributions to the standardization in the field of Frequency Control.**

Location



AXTAL GmbH & Co. KG **AXTAL CONSULTING**

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Company Profile



- **AXTAL GmbH & Co. KG** focuses on the Design, Manufacturing and Sales of advanced Frequency Control Products (FCP), i.e. mainly crystal oscillators, crystal filters, frequency & time modules, and products for piezoelectric sensors
- **AXTAL GmbH & Co. KG** possesses an assured crystal supply through a close cooperation with ISO 9001 certified companies in Europe, USA/Canada and in Asia.
- **AXTAL GmbH & Co. KG** manufactures prototypes, samples and production quantities completely in-house. All processes of AXTAL's core competence like adjustment, testing, qualification etc. are strictly kept in-house
- **AXTAL GmbH & Co. KG** is the exclusive representative of FOMOS, the leading manufacturer of Langasite (LGS) and Langatate (LGT) crystals, and SCTB ELPA for piezoelectric crystal sensors. AXTAL cooperates with Piezocryst/Graz, Austria (ex AVL) for Gallium phosphate (GaPO_4) crystals.

Company Profile: Consulting



- **AXTAL Consulting** is an independent Consulting Company and Test House
- **AXTAL Consulting** offers Consulting Services for application and design of Frequency Control Products (FCP), i.e. quartz crystal units, LGS and GaPO₄ crystal resonators, crystal oscillators, filters, and piezoelectric sensors
- **AXTAL Consulting** helps suppliers and users to optimise the match between product and application, and thus reduces the risk of failures in the volume application and in the field in an early stage.
- **AXTAL Consulting** provides failure analyses, suggests corrective actions, and assists its customers in process audits of manufacturing lines
- **AXTAL Consulting** offers testing, screening and characterization of FCP according to acknowledged IEC-, MIL- and Automotive Standards, e.g.
 - measurement of linear and non-linear electrical parameters,
 - temperature tests,
 - phase noise and short-term stability tests
 - aging tests
 - mechanical and environmental tests

Markets served



- RF & Microwave Industry
- Military
- Avionics
- Airborne
- Marine
- Satellite Search & Rescue (SAR)
- Satellite Communication
- Space (in preparation)
- RF Test & Measurement equipment
- Research Institutes
- Industrial Electronics
- AV Studio equipment

Quality Management



- Quality management system in accordance with ISO 9001:2008, certified by TÜEV SÜED
- 100 % Incoming inspection of quality-critical components (crystals, PCB, etc.)
- Pre-aging of quartz crystals
- Thorough intermediate testing (production line)
- Computer-controlled test equipment
- 100 % final test of key & critical parameters
- Optional screening to MIL-PRF55310
- Traceability of test and measurement results
- Product marking with serial no. and date code
- Traceable instrument calibration



Customer Audits



- EADS Defence (now: Cassidian) Ulm/Germany



- Selex Galileo Luton/UK



- Diehl Aerospace Frankfurt Ulm/Germany



- Facility survey by TESAT Backnang /Germany

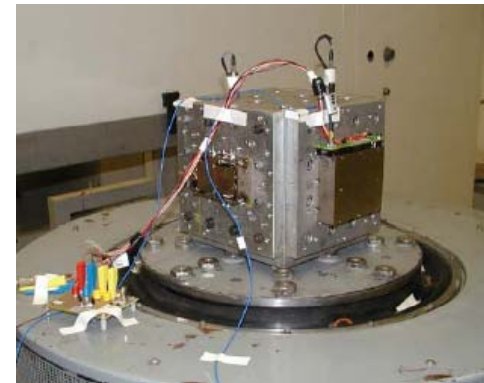


Oscillator Qualification



➤ Qualification testing based on IEC 60679-4 and MIL-PRF-55310

- Frequency stability over various parameters
- Output waveform & spectrum
- Frequency control, linearity, modulation response
- Start-up behaviour, start-up time
- Stabilization time, re-trace, time-domain
- Phase noise, short term stability (Allan deviation)
- Temperature tests $-55^{\circ}\text{C} \sim +125^{\circ}\text{C}$, activity dips.
- Aging tests - passive and active
- Leak test
- In-house environmental tests: shock, vibration (sine and random), temperature shock, High temperature storage etc.



AXTAL Products



➤ Oscillators

- PXO (Fixed-frequency Oscillators, clocks)
- VCXO (Voltage Controlled Oscillators)
- TCXO (Temperature Compensated Oscillators), including VC-TCXO
- OCXO (Oven Controlled Crystal Oscillators), including VC-OCXO and DOCXO
- SAW Oscillators (PSO, VCSO, OCSO)
- Special Frequency Control Modules:
 - FCXO / PLXO (Phase-Locked Crystal Oscillators)
 - Crystal-Controlled Microwave Oscillators
 - Gated Crystal Oscillators (Transponder applications)



Clock Oscillators (PXO)



Packaged **AXTAL** Oscillators (PXO)

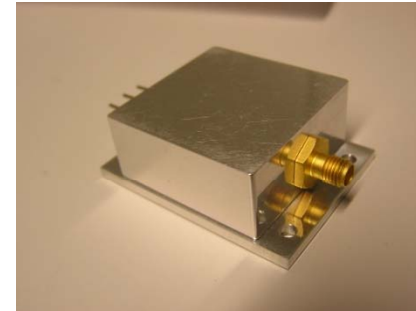
- Enclosures:
 - Hermetically sealed metal packages
 - Hybrid SMD enclosures
 - Customized packages (machined, connectorized)
- Low phase noise, low jitter
- High stability through hermetically sealed resonators
- High Output Frequencies (up to >2 GHz) by using
 - Low Noise Frequency Multiplication,
 - Phase-Locked Loop (PLL),
 - SAW resonators
- Microwave Oscillators for MIL, Satcom & Airborne

Clock Oscillators (PXO)

Packaged **AXTAL** Oscillators (PXO)

➤ Examples:

- AXE55310- and AXM55310-Series
in 14-pin DIL14 package
compliant to MIL-PRF55310/16 etc.
- AXE 1000 & AXE 1200 Series
Low phase noise crystal oscillators
at 1000 MHz and 1200 MHz in
connectorized package
- SAW oscillators in customized packages



VCXO



Voltage Controlled **AXTAL** Oscillators (VCXO)

- Enclosures:
 - Hermetical sealed metal packages
 - Hybrid SMD enclosures
 - Customized packages (machined, connectorized)
- Low phase noise, low jitter
- High Frequency VCXO by using
 - Low Noise Frequency multiplication
 - Phase-locked loop
 - SAW resonators
- Wide pulling up to ± 5000 ppm using LGS crystals
- Microwave VCXO for MIL, Satcom & Airborne

VCXO



Voltage Controlled **AXTAL** Oscillators (VCXO)

➤ Examples:

- **AXIS30 and AXIS45 series** 10 ~ 70 MHz, EFC up to ± 5000 ppm
Wide-pull low-jitter VCXO in 9x14 mm or DIL14 package
Applications: Audio/Video Studio equipment, IR camera (drones)
- **AXIS10LN:** 50 ~ 165 MHz
VCXO with very low phase noise in 9x14 mm package (CO27)
- **AXIS50-11S/L :** 60 / 186.67 / 213.3 / 390 / 400 / 400.7868 MHz
VCXO in 20x20 mm package (CO15) with sine wave or LVPECL output

TCXO



Temperature Compensated **AXTAL** Oscillators (TCXO)

- Hybrid SMD enclosures and sealed metal enclosures
- Low aging through hermetically sealed resonators
- Low phase noise & jitter
- High frequency up to >160 MHz
- Wide operating temperature range -55°C to 90°C

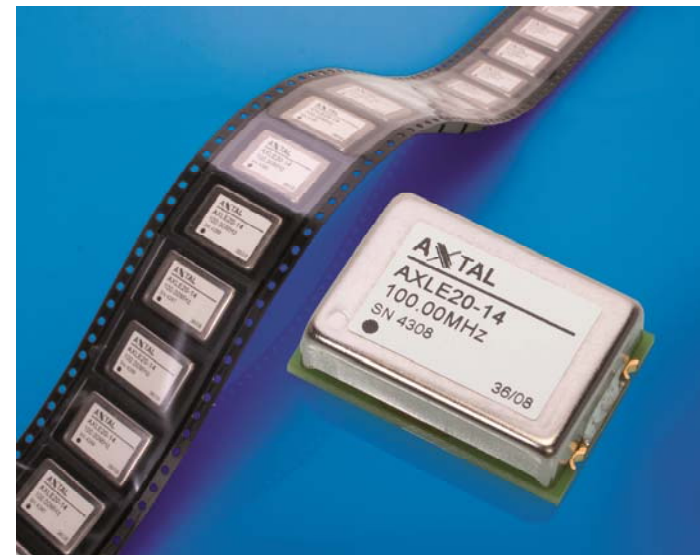
TCXO



Temperature Compensated **AXTAL** Oscillators (TCXO)

➤ Examples:

- AXLE20-14 : 100 MHz
Low phase noise TCXO
in SMD package CO30
- AXLE20-15, -16 : 19.2 / 32.0 MHz
VC-TCXO ± 100 ppm pull range,
with ± 5 ppm/ $-40^{\circ}\text{C} \sim +85^{\circ}\text{C}$



OCXO



Oven Controlled **AXTAL** Oscillators (OCXO)

- Hybrid SMD enclosures, sealed metal enclosures and customized packages
- Usage of AT- and SC-cut resonators in Cold-weld packages for very low aging / low phase noise down to -180 dBc/Hz
- Frequency range up to >200 MHz
- High-Performance OCXO (± 2 ppb stability) in 20x20 mm package
- Double Oven Oscillators (DOCXO) for ultimate stability
- Fast warm-up OCXO in DIL14 (CO 02) package
- Connectorized OCXO for Microwave applications
- OCXO with low G-sensitivity
- OCXO with low phase noise, also under random vibration
- OCXO in ruggedized vibration isolated packages

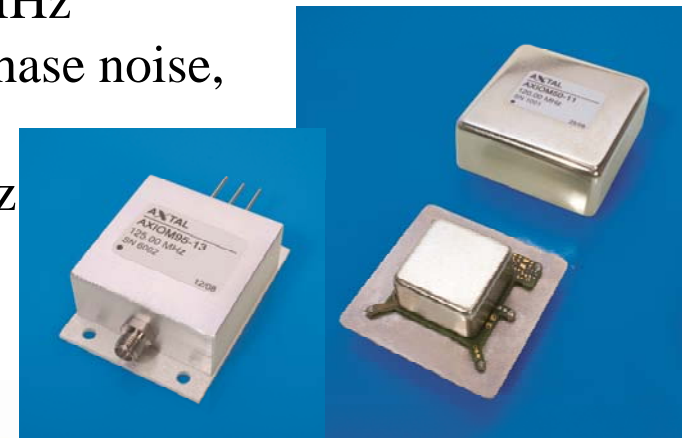
OCXO



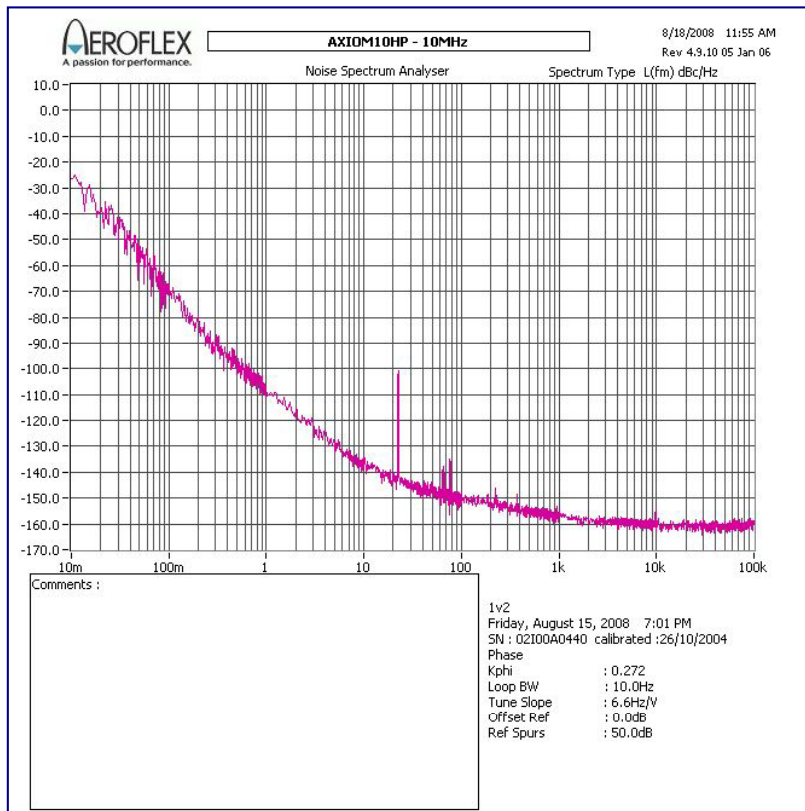
Oven Controlled **AXTAL** Oscillators (OCXO)

► Examples:

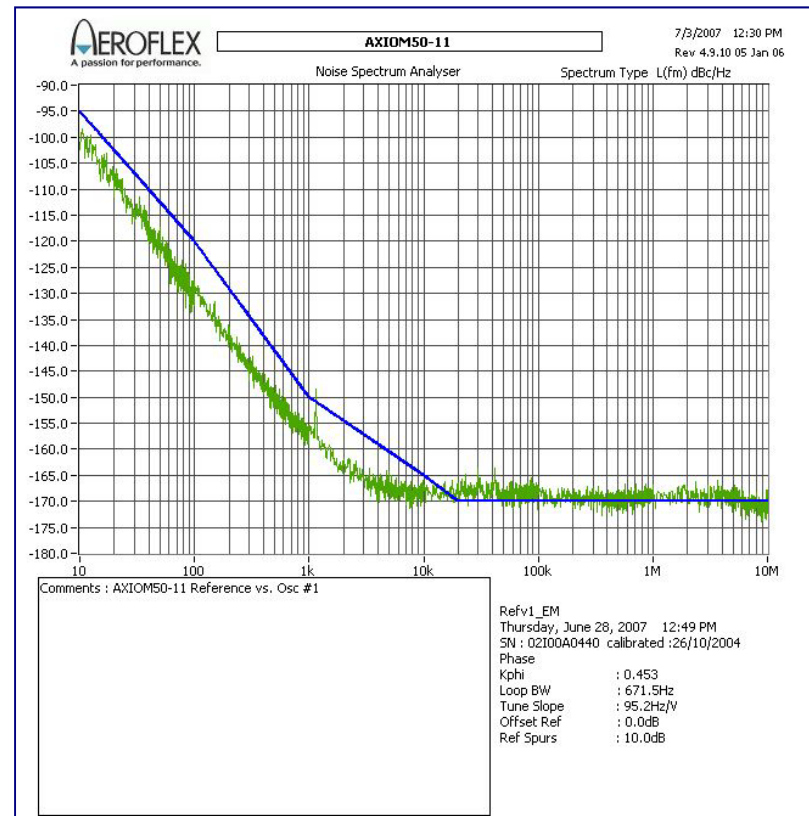
- AXIOM20-14 : 130 MHz
OCXO in DIL14/4 package (CO02) with sine wave output
- AXIOM20-16 : 21.4 MHz
VC-OCXO in DIL14/4 package with wide pull range of ± 500 ppm
- AXIOM90/95 series : 10/100/120/125 MHz
OCXO. Connectorized, with very low phase noise, low g-sensitivity
- AXIOM50/55 series: 96 / 100 / 120 MHz
low-noise OCXO in 50x50 mm package
- AXIOM5151(120 MHz):
lowest noise floor of < -180 dBc/Hz



OCXO Phase Noise examples

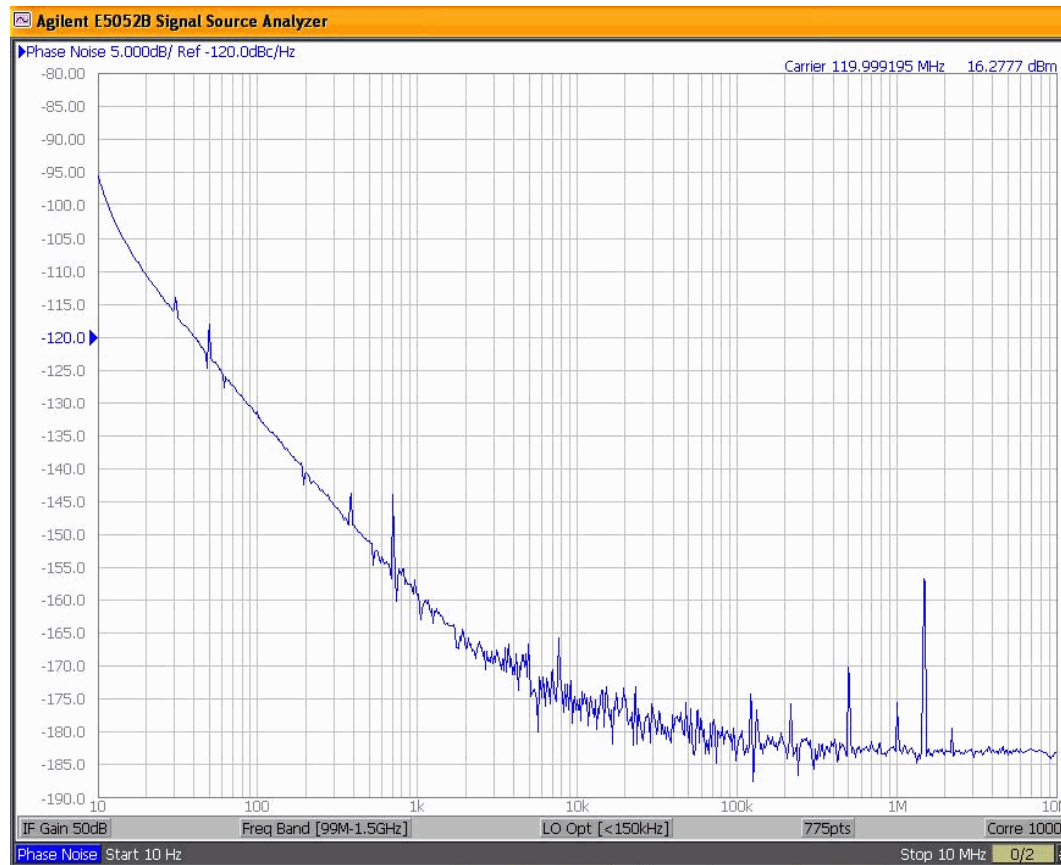


10 MHz (SC): AXIOM10HP



120 MHz (SC): AXIOM50

Phase Noise examples



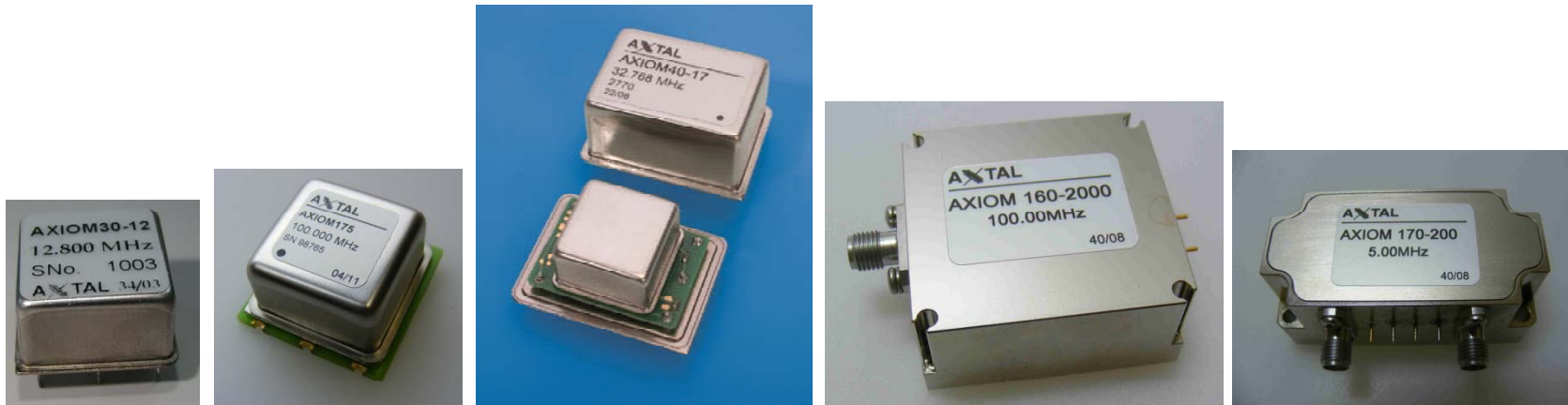
120 MHz Ultra-Low Phase Noise OCXO <-180 dBc/Hz : AXIOM5151

OCXO



Oven Controlled **AXTAL** Oscillators (OCXO)

- Examples (cont'd) with HCMOS or sine wave output:
 - AXIOM30/35 series: OCXO in CO15 package (20x20mm)
 - AXIOM10/15 series: OCXO in CO28 SMD package (25x22mm)
 - AXIOM70/75: OCXO in 25x25mm package
 - AXIOM40/45 series: OCXO in CO08 package (36x27mm)



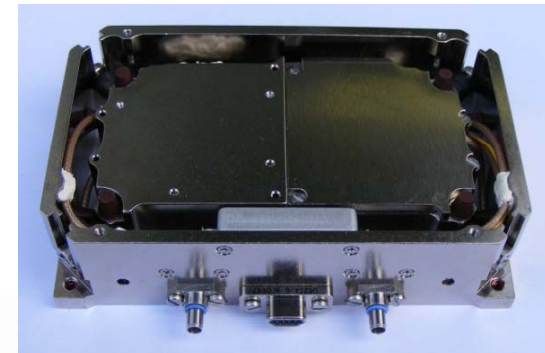
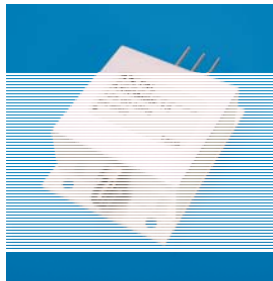
Special Oscillators



- FCXO / PLO (Phase Locked Crystal Oscillators)
 - Output frequency = $M/N \cdot$ Input frequency (PLL)
 - Internal VC(X)O or OCXO at output frequency
 - Low phase noise, low transfer jitter



- Microwave Oscillators
 - Gated Crystal Oscillators AXMW- series @ 1030 MHz & 1090 MHz
 - SAW Oscillators (PSO and VCXO) 500 MHz ~1500 MHz
 - Multi-Channel Switchable crystal oscillators
- Special Oscillator Modules for MIL applications



Near Future Activities



- Oscillators (PXO, VCXO, TCXO and OCXO) for Space Applications
 - Usage of radiation resistant components from ESA or NASA (or equivalent) QPL or QML lists or other approved sources
 - Material selection based on ECSS-Q-ST-70C and ECSS-Q-70-71
 - Usage of quartz crystal resonators manufactured from swept quartz material for high radiation resistance IAW with ESCC 3501
 - Oscillator manufacturing in ESA certified Clean-Room environment in accordance with ECSS-Q-ST-70-08C and ECSS-Q-ST-70-38C
 - Pre-cap inspection of quartz crystal prior to sealing
 - Pre-cap inspection of oscillator assembly prior to sealing
 - Screening and testing to ESA, NASA and customer specifications
 - Complete traceability of all manufacturing steps
 - Breadboards, Engineering Models, Qualification Models, Flight Models

AXTAL Products



➤ Crystal Sensors

■ Quartz Crystal Microbalances (QCM)

- Metallization: silver (Cr-Ag), Gold (Cr-Au), or Titanium (Ti)
- 5 MHz and 6 MHz
- “Balzers”- or “Maxtek”-style
- High Temperature QCM elements on Langasite (LGS) and Langatate (LGT) $> 500^{\circ}\text{C}$



■ Crystal Temperature Sensors

- 32 kHz tuning fork sensors RKTV206 series
 - for temperatures up to 300°C (with quartz)
 - for up to $>400^{\circ}\text{C}$ with Langasite (LGS)
- Thickness-shear sensors with $90 \sim 100$ ppm/K sensitivity



■ Crystal pressure sensors

- High accuracy (0.025% FS) , e.g. for meteorological applications

■ Pressure transducer modules with temperature transducer

- For downhole and industrial applications

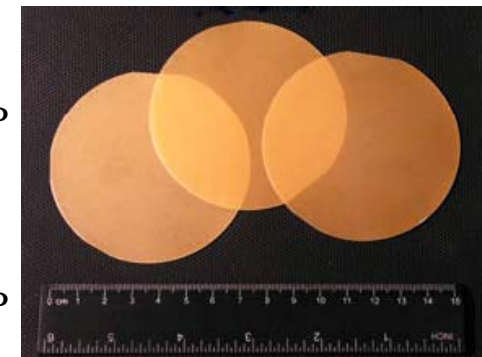


AXTAL Products

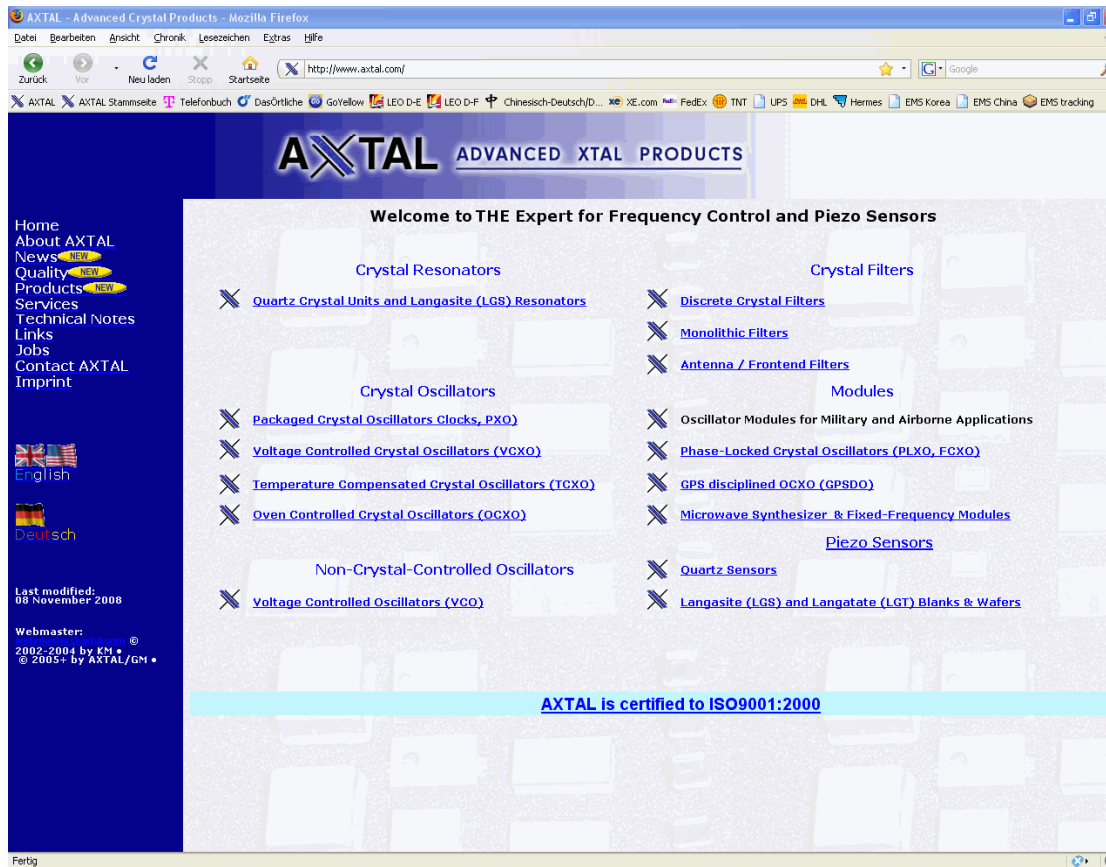


➤ Crystal Wafers and Blanks

- Langasite (LGS) Wafers
 - 3" (76.2 mm) diameter and 4" (100 mm) diameter, SSP or DSP
 - Thickness 0.35 mm or 0.5 mm, one-side or two sides polished
 - X- cut, Y- cut or special cuts like YXlt/48.5°/26.6°
- Langatate (LGT) Wafers
 - 3" (76.2 mm) diameter and 4" (100 mm) diameter, SSP or DSP
 - Thickness 0.35 mm or 0.5 mm, one-side or two sides polished
 - X- cut, Y- cut or special cuts like YXlt/48.5°/26.6°
- LGS and LGT blanks
 - various sizes, round, or rectangular or special
- LGT rings
 - 6 mm ~ 16 mm diameter, 3 mm ~ 6 mm bore
 - with double-sided Gold (Cr-Au) plating
- Other crystals from Langasite family
 - Wafers, blanks, or other shapes
- Quartz crystal wafers
 - 3" (76.2 mm) diameter and 4" (100 mm) diameter, AT-cut, ST- cut, X- cut, Y- cut etc.



AXTAL Website



For latest updates:
Visit our Website
www.axtal.com



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