

AXTAL CONSULTING

Upscreening Services for Frequency Control Products



Location



AXTAL CONSULTING

Administration, Headquarter:
Buchfinkenweg 8
D-74931 Lobbach

Laboratory Mosbach:
Roemerring 9
D-74821 Mosbach
Germany
Phone: +49(6261)939834
Fax: +49(6261)939936
E-Mail: consult@axtal.com
Web: www.axtal-consulting.com



AXTAL Consulting Business



Independent Test House and
Consulting Company for
Services in the field of
Quartz Crystal Products,
Ceramic Resonators, and Piezo Sensors

Company Profile



- **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** is an independent test house for FCP, offering testing, screening and characterization of FCP according to acknowledged IEC-, MIL-, Automotive and ESA 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

Company Profile



- **Qualification Testing** of Frequency Control Products (FCP) based on
 - IEC 60122 and IEC 61178-2 and -3 (crystals)
 - AEC-Q200 (automotive crystals)
 - MIL-PRF-3098 (crystals)
 - IEC 60679-4 (oscillators),
 - MIL-PRF-55310 (oscillators)
 - IEC 60368-4 (filters)
- **Screening and Upscreening** of FCP for Space Applications
 - ESA ESCC3501 (crystals)
 - MIL-PRF-3098 (crystals)
 - MIL-PRF-55310 (oscillators)

Testing: Crystal Units



- Test and measurement compliant to IEC 60444-x
 - Frequency, resistance, motional parameters, load resonance, pullability etc.
 - Start-up behaviour (Drive Level Dependence DLD)
 - Temperature tests -55°C ~ +125°C, Hysteresis
 - Frequency Dips and Activity Dips (band breaks) over load & over temperature
 - Spurious resonances
 - Aging tests, passive and active
- Testing based on IEC 61178-2 & -3, AEC-Q200, MIL-PRF-3098 and ESA ESCC 3501
 - Leak test
 - Isolation resistance
 - High temperature storage
 - Temperature cycling and temperature shock
 - Vibration (sine and random)
 - Mechanical Shock
 - Other environmental tests on request

Upscreening of Crystal Units



Screening (MIL-PRF3098K)

Test inspection	Level S	Level B	Level X*
Pre-seal visual examination	4.10.2.2	4.10.2.2	4.10.2.2
PIND	4.10.16	N/A	N/A
Thermal frequency repeatability	4.10.15, 10 cycles	N/A	N/A
Frequency and resistance	4.10.6 (@ T_{ref})	4.10.18	4.10.6 (@ T_{ref})
Unwanted Modes	4.9.10	N/A	4.9.10
Shunt capacitance	4.10.7.1	N/A	4.10.7.1
Motional capacitance	4.10.7.2	N/A	4.10.7.2
Quality factor	4.10.8	N/A	4.10.8
Aging	4.10.27.3, 30 days@85°C, $ \Delta f/f \leq 2$ ppm	N/A	N/A
Drive sensitivity (DLD)	4.10.11 $ \Delta f/f \leq 2$ ppm, $\Delta R_1/R_1 \leq \pm 10\%$ or $\leq \pm 3 \Omega$	N/A	4.10.11 $ \Delta f/f \leq 2$ ppm, $\Delta R_1/R_1 \leq \pm 10\%$ or $\leq \pm 3 \Omega$
Vibration	4.10.14, $ \Delta f/f \leq 1$ ppm	N/A	4.10.14, $ \Delta f/f \leq 1$ ppm
Thermal shock	4.10.19.2, $ \Delta f/f \leq 1$ ppm	N/A	4.10.19.2, $ \Delta f/f \leq 1$ ppm
Insulation resistance	4.10.10	N/A	4.10.10
Coupled modes (frequency dips)	4.10.6.2	N/A	4.10.6.2
Frequency and resistance @ T_{ref}	4.10.6 (@ T_{ref})	N/A	4.10.6 (@ T_{ref})
Frequency and resistance vs. temperature	4.10.6.1	N/A	4.10.6.1
Seal	4.10.26	4.10.26	4.10.26
Radiographic inspection (when specified)	MSFC-STD-355 Apdx. M	N/A	N/A
Visual (external) and mechanical inspection	4.10.2.1	4.10.2.1	4.10.2.1

*AXTAL procedure

Consulting: Crystal Units



- Application & Design Support
 - Matching crystal vs. oscillator circuit. Specifications
- Oscillator circuit characterization
 - Oscillation allowance, crystal drive level, effective load capacitance, behaviour over temperature
- Failure Analysis
 - In-circuit, electrical, mechanical, x-ray and visual
 - Determination of corrective actions, support in process audits
- Reliability analysis

Testing: Oscillators



- Testing based on IEC 60679-4 and MIL-PRF-55310
 - Frequency, frequency/load- and frequency/voltage coefficient
 - Waveform & Output spectrum
 - Pulling range, AM and FM modulation response
 - Start-up behaviour, start-up time,
 - Stabilization time, re-trace, time-domain behaviour
 - Phase noise, short term stability (Allan variance)
 - Temperature tests $-55^{\circ}\text{C} \sim +125^{\circ}\text{C}$, hysteresis, activity dips (band breaks),
 - Aging tests
 - Temperature cycling, Leak test, environmental tests (on request)

Upscreening of Oscillators



TABLE II. Screening (100 percent) for class 1 and class 3 oscillators. MIL-PRF-55310

Test inspection	Product level S method-condition	Product level B method-condition
Random vibration	MIL-STD-202, method 214 , condition I-B, duration 5 minutes per axis	N/A
Thermal shock	MIL-STD-202, method 107 , condition A-1	MIL-STD-202, method 107 , condition A-1
Electrical test: Input current-power Output waveform Output voltage-power As specified	4.8.5 4.8.20 4.8.21 3.1	N/A N/A N/A 3.1
Burn-in (load)	Maximum specified operating temperature (see 3.1), nominal supply voltage and burn-in load, 240 hours minimum	Maximum specified operating temperature (see 3.1), nominal supply voltage and burn-in load, 160 hours minimum
Electrical test: Input current-power Output waveform Output voltage-power As specified	4.8.5 4.8.20 4.8.21 3.1	4.8.5 4.8.20 4.8.21 3.1
Seal test	MIL-STD-202, method 112 (see 4.8.2)	MIL-STD-202, method 112 (see 4.8.2)
Radiographic <u>1/</u>	MIL-STD-202, method 209	N/A

AXTAL Test Equipment



OSCILLATORS:

- Automatic Temperature Test System for VCXO and TCXO
- Automatic Temperature Test System for OCXO
- Automatic OCXO Test System
- Automatic Aging Test System
- Cyclic-Power oscillator Stress Test System
- Automatic Oscillator Final Test System
- Phase Noise Test system (Agilent & Noise XT)
- Frequency & Time Interval Analyser
- Short-Term Frequency Stability Test System
- Modulation Analyzer (R&S)
- Oscilloscopes (HP/Agilent & Tektronix)
- Spectrum Analyzers (R&S, Tektronix)
- Frequency Counters (HP/Agilent, Philips)
- Network Analyzers (HP5100A, HP3577A)
- Low-Noise Frequency Synthesizers (R&S)
- Rubidium and Caesium Frequency Standards, GPS-Disciplined Rubidium

CRYSTALS:

- Automatic Temperature Test system for crystals (THD and SMD) with NWA
- Automatic & Manual RT Test system for crystals (THD and SMD) with NWA
- Automatic Crystal Test System (Kolinker)
- Crystal Test System 8 kHz~200 MHz (Saunders)
- Active Crystal Aging System (PRA)

GENERAL:

- Leak test system (Trio-Tech)
- Burn-In System
- Vacuum Bake-Out (Heraeus)
- Vibration & Shock test System (TIRA)
- Temperature Shock Test System (Thermostream)
- Inspection systems (Vision Engineering),
- Stereo Microscopes, with camera

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Phase noise test in shielded cabinet



In-circuit test

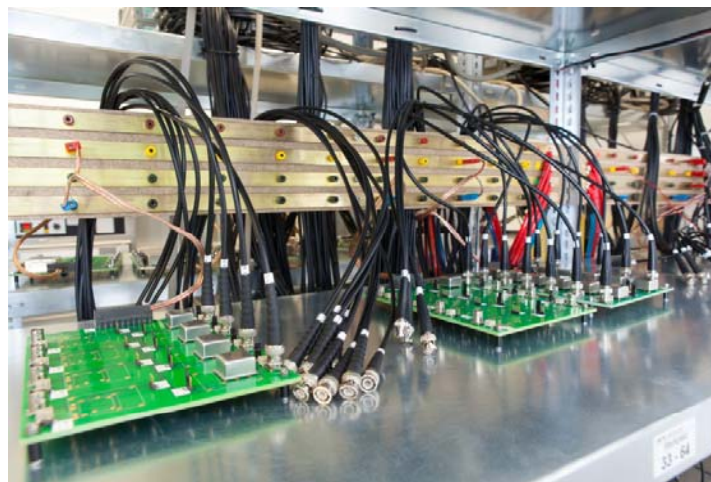


Electrical tests

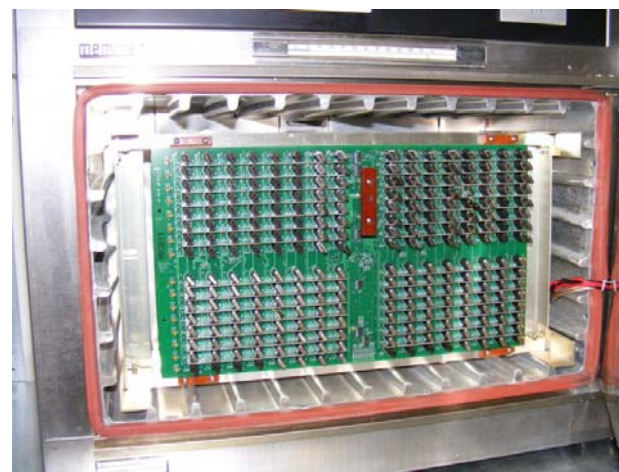


Functional Vibration test

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Temperature test & thermal shock test

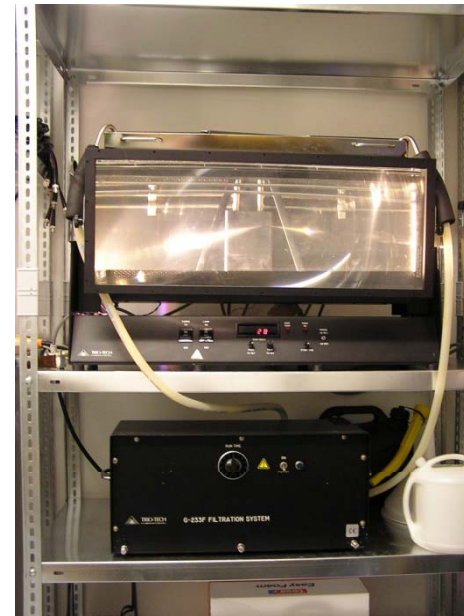


Active aging
test of crystals
& oscillators

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Burn-in test under vacuum



Gross-leak test



Personal Profile

Bernd Neubig



- ✘ 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.
- ✘ 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**, and Convenor of TC49 WG1 & WG7
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 Electro technical 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.
- ✘ April 2015: Recipient of the Marcel-Ecabert-Award issued by the European Time & Frequency Forum (EFTF)
- ✘ May 2016: Recipient of the W.G. Cady Award by the IEEE Frequency Control Symposium (IFCS)