

# AXTAL CONSULTING Company Presentation





# Personal Profile

## Bernd Neubig



- ✘ Founder and Owner of **AXTAL CONSULTING** – the Independent FCP Test House - in April 2002
- ✘ 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)

# Location



## AXTAL CONSULTING

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# 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 GaPO<sub>4</sub> 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



- **AXTAL Consulting** executes qualification approvals of Frequency Control Products based on
  - IEC 60122 and IEC 61178-2 and -3 (crystals)
  - AEC-Q200 (automotive crystals)
  - MIL-PRF-3098 (crystals)
  - ESA ESCC3501 (crystals)
  - IEC 60679-4 (oscillators),
  - MIL-PRF-55310 (oscillators)
  - IEC 60368-4 (filters)
  
- **AXTAL Consulting** organises training courses, seminars and workshops on Frequency Control Products, its measurement and application

# Markets served



## ➤ **AXTAL CONSULTING:**

- Users of Frequency Control Products, mainly suppliers of
  - Automotive
  - high reliability, e.g. downhole, off-shore
  - Telecommunication, telemetry
  - industrial electronics (metering, test instruments)
  - Defence, aerospace and space
- Electronic Manufacturing Services
- Distributors and Re-sellers of Frequency Control Products
- Manufacturers of Frequency Control Products
- Sensor Applications

# Consulting: 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
  
- Qualification 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



# 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 (MTBF, MTTF, fit rate)
- Application of novel piezoelectric material & resonators (Langasite (LGS), Langatate (LGT), CTGS, CNGS, GaPO<sub>4</sub> etc.)

# Failure Analysis I



The most frequent causes of crystal failures are

- ▶ Insufficient safety margin ("oscillation allowance") of the oscillator stage for oscillation start-up
- ▶ Strong Drive Level Dependence ("DLD") of the crystals's resonance resistance
- ▶ Too low or excessive crystal drive level (crystal current or power)

# Failure Analysis II



Further causes of crystal failures are

- ▶ Frequency jumps (discontinuities) or stopping of oscillation in a certain temperature range due to so-called "Activity Dips" of "Frequency Dips" of the crystal
- ▶ Mismatch between the specified crystal load capacitance and the effective load conditions given by the oscillator circuit

# Oscillator Characterization



- ▶ Worst-Case Analysis of the safety factor of oscillation start-up
- ▶ Testing of the crystals for Drive Level Dependency (DLD) and Activity Dips
- ▶ Measurement of crystal drive level in the circuit
- ▶ Determination of the working frequency and the equivalent load capacitance of the oscillator circuit
- ▶ Proposal for modification of the oscillator circuit in case of issue shown in above points
- ▶ Support in modification or setting up an appropriate crystal specification

# Consulting: Oscillators



- Qualification 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)

# Consulting: Filters



## ➤ Qualification testing based on IEC 60368-4

- Frequency response of attenuation, phase, group delay
- Bandwidth, ripple, insertion attenuation, selectivity, shape factor, ultimate attenuation, spurious attenuation
- Reflection attenuation, VSWR
- Intermodulation
- Temperature tests  $-55^{\circ}\text{C} \sim +125^{\circ}\text{C}$
- Temperature cycling
- Leak test
- Environmental tests (on request)

# Consulting: Piezo Sensors



- Bulk Acoustic Wave (BAW) Piezoelectric Sensors and Substrates
- Surface Acoustic Wave (SAW) Sensors
- Sensors for High Temperature environment based on Langasite (LGS), Langatate (LGT), CTGS; CNGS, and Gallium Phosphate ( $\text{GaPO}_4$ )
- Piezo transducers and modules

# AXTAL Test Equipment



## OSCILLATORS:

- Automatic Temperature Test System for SPXO, VCXO and TCXO, and 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, HP8753D)
- 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 (Proprietary)

## GENERAL:

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



# AXTAL Laboratory



Phase noise test in shielded cabinet



Rework under Laminar Flow

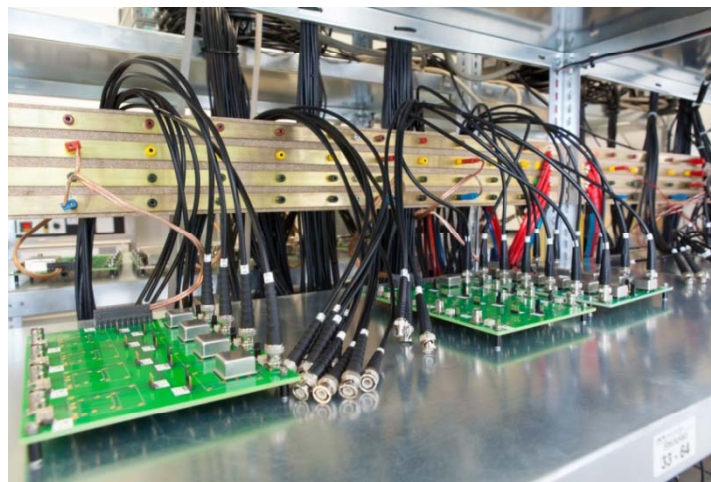


Electrical tests

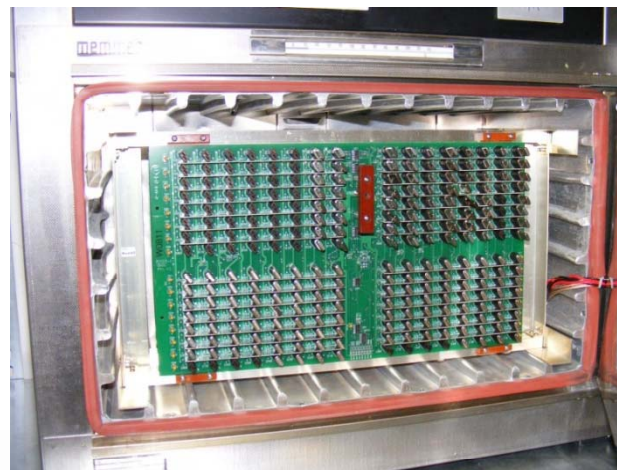


Functional Vibration test

# AXTAL Laboratory



Temperature test & thermal shock test

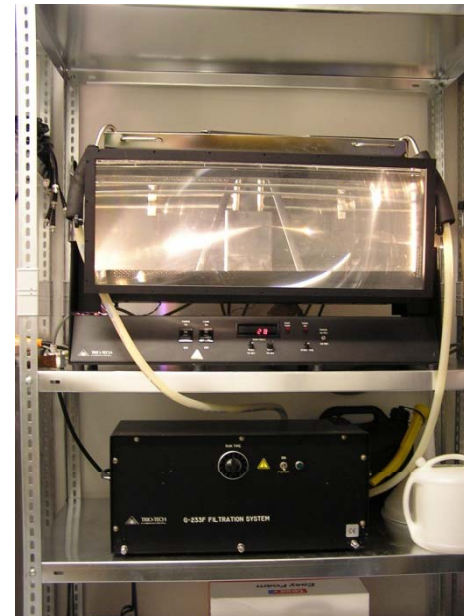


Active aging test of crystals & oscillators

# AXTAL Laboratory



Burn-in test under vacuum



Gross-leak test