AXTAL ADVANCED XTAL PRODUCTS
a Q-TECH Company

Designed and Manufactured in Germany

| Specification | AXIS45SH | Rev.: 1 | Date: 2025-02-10 |
|---|---|---|---|

**Oscillator type:** **Low Phase Noise 10~200 MHz VCXO for Space Application (Space COTS version)**

## Features:

- **Lower cost New Space version (COTS)**
- **Manufactured according to MIL-PRF-55310 Level "S"**
- **Radiation hardened – 40 krad(Si) total dose (TID)**
- **Radiation hardened – SEL immunity / SET insensitive**
- **VCXO Characteristic can be tailored to customer requirements**
- **ITAR Free – Manufactured in Germany**
- **Low Phase Noise**
- **Hermetical sealed THD package**


## Models:

| Item | Engineering Model (EM) | Flight Model (FM) | Note |
|---|---|---|---|
| **Quartz Crystal** | Synthetic HiQ Quartz, AT-cut, HC-52/U | Synthetic HiQ Quartz, AT-cut, HC-45/U | 1 |
| **Electrical Components** | COTS parts | COTS parts Automotive Grade and/or HighRel Heritage | 2 |
| **Mechanical Components** | Stainless steel package with Ni finish | Stainless steel package with Ni finish | - |
| **Workmanship (Soldering)** | IPC610 Class 3 | IPC610 Class 3 | - |
| **Rad Hardness** | - | 40 krad(Si) TID | 3 |
| **Acceptance Testing** | | | |
| **Screening** | Test procedure as commercial models | X | 4 |
| **Group-B** | | X | - |
| **Group-C** | - | On request | 5 |

**Notes:**

1. Swept Quartz material available on request.
2. Higher product levels of add-on components on request. For tin whisker mitigation components with SnPb finish can be used on request.
3. Semiconductors tested up to 50 krad and SEE tested up to 60 MeV·cm²/mg
4. Screening procedure can be modified IAW customer requirements.
5. Group-C (LAT) can be performed based on customer requirements.

## Ordering Code:

| Model | Product category | Option 1 | Revision | Frequency [MHz] |
|---|---|---|---|---|
| AXIS45SH | EM<br>FM | "33" – 3.3 V Supply<br>"50" – 5.0 V Supply | Rev.1 | 100.000 |

**Example: AXIS45SH-FM-50_Rev.1 – 100.000 MHz**

## 0. Contents:

## 1. Electrical specification

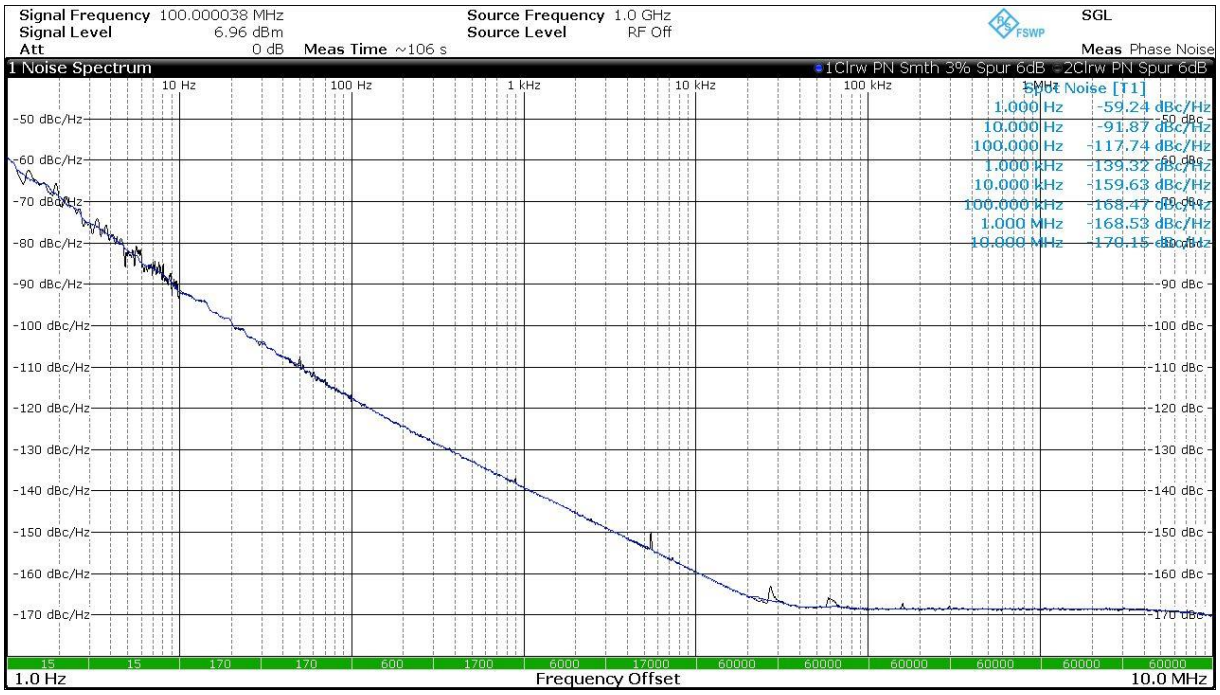
| Parameter | min. | typ. | max. | Unit | Condition |
|---|---|---|---|---|---|
| **Frequency range 1** (Note 4) | 10 | | 100 | MHz | Crystal frequency |
| **Frequency range 2** (Note 4) | >100 | | 200 | MHz | Multiplication |
| **Frequency stability** | | | | | |
| vs. operating temperature range | | ±10 | ±15 | ppm | ref. to $f_{nominal}$ |
| vs. supply voltage variation (pushing) | | | ±0.5 | ppm | $V_S$ ±5% |
| vs. load change (pulling) | | | ±0.5 | ppm | $R_L$ ±5% |
| Long term (aging) 1st year | | | ±1 | ppm | after 30 days operation |
| Long term (aging) over 10 years | | | ±4 | ppm | after 30 days operation |
| **Frequency adjustment range** | | | | | |
| Electronic Frequency Control (EFC) | ±20 | ±30 | | ppm | (Note 3) |
| EFC voltage $V_C$ | 0<br>0 | 2.5<br>1.5 | 5.0<br>3.3 | V<br>V | Option 1 = "33"<br>Option 1 = "50" |
| EFC slope ($\Delta f / \Delta V_C$) | | Positive | | | |
| EFC input impedance | 100 | | | kΩ | |
| EFC non-linearity | | 5 | 10 | % | |
| **RF output** | | | | | |
| Signal waveform | | Sine wave | | | |
| Load $R_L$ | | 50 | | Ω | ±5% |
| Output level | +4<br>+7 | +7<br>+9 | +10<br>+12 | dBm<br>dBm | Frequency range 1<br>Frequency range 2 |
| Harmonics | | -40 | -30 | dBc | |
| Sub-harmonics | | -50 | -40 | dBc | Frequency range 2 only |
| Spurious | | | -90 | dBc | |
| Phase noise | | Consult factory<br>See performance examples | | | |
| **Supply voltage $V_S$** | 3.15<br>4.75 | 3.3<br>5.0 | 3.45<br>5.25 | V<br>V | Option 1 = "33"<br>Option 1 = "50" |
| **Current consumption** | | | 20<br>40 | mA<br>mA | Frequency range 1<br>Frequency range 2 |
| **Operating temperature range** | -30 | | +70 | °C | |

**Table 1 – Electrical Performance and Characteristics**

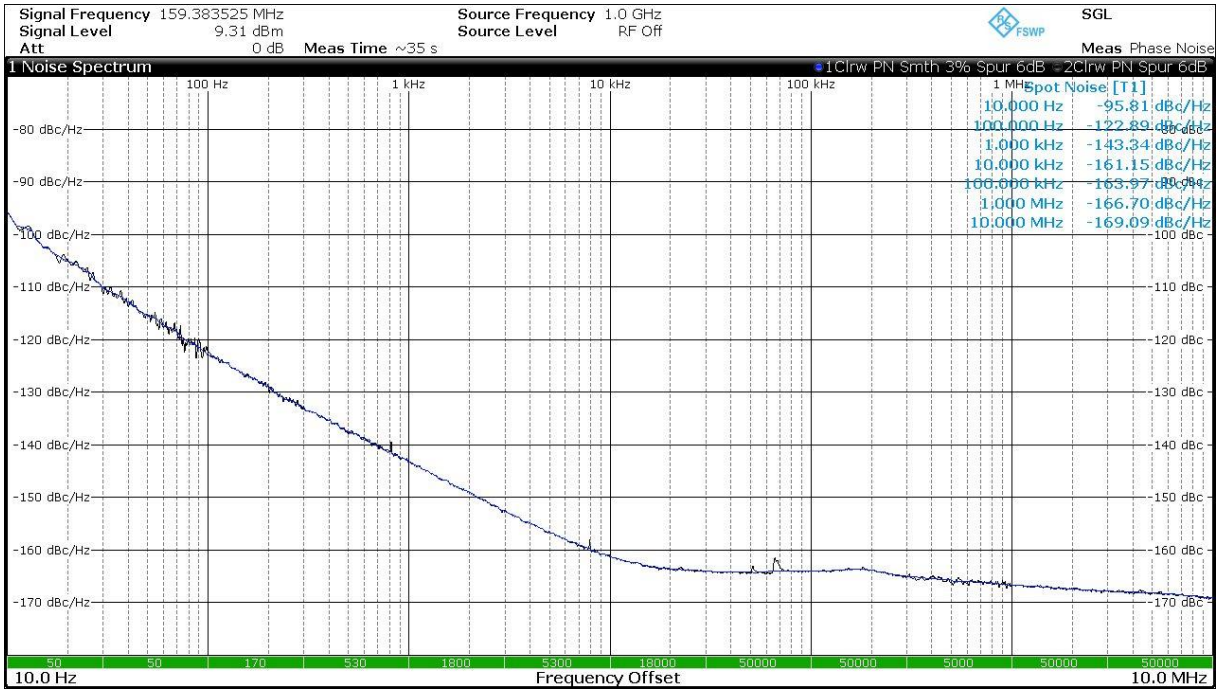
**Notes:**

1. Terminology and test conditions are according to IEC60679-1 and MIL-PRF-55310 unless otherwise stated
2. Classification (MIL-PRF-55310): Type 2 (VCXO), Class 1 (Discrete Technology), Product Level "S"
3. Tuning range is sufficient to compensate temperature stability, pushing, pulling, aging over 10 years and change due to radiation.
4. The entire VCXO characteristic including frequency, supply voltage and tuning characteristic can be tailored to customer requirements. Multiplication of frequencies < 100 MHz can be used to increase tuning range and to improve close-in phase noise. Please consult factory.

## Phase noise – Performance examples




**100 MHz**




**160 MHz**

## Absolute Maximum Ratings

| Parameter | Min. | Max. | Unit | Condition / Remark |
|---|---|---|---|---|
| **Supply Voltage $V_S$** | -0.5 | $V_S$ + 10% | V | $V_S$ to GND |
| **Control Voltage $V_C$** | -0.5 | 15 | V | $V_S$ to GND |
| **Load $R_L$** | 0 | ∞ | Ω | Must not cause any damage |
| **Operable temperature range** | -40 | +85 | °C | Operation of unit without any damage |
| **Storage temperature range** | -55 | +105 | °C | - |

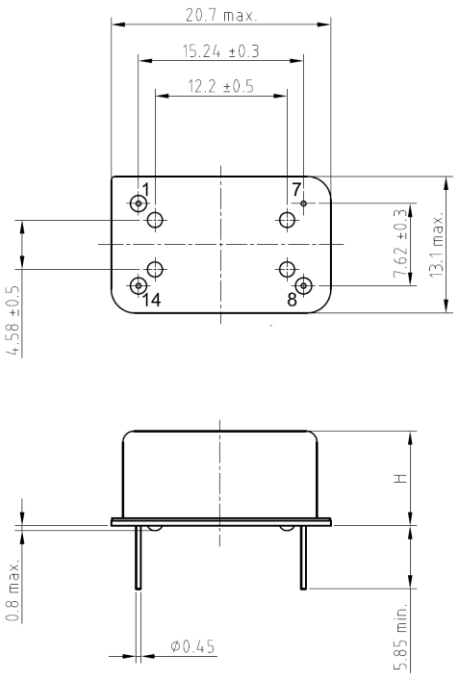
**Table 2 – Maximum Ratings**

## 2. Mechanical specification

| Parameter | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|
| **Enclosure (see drawing) (LxWxH)** | | 20.7x13.1x7.5 max. | | mm | IEC 60679-3 CO 02 |
| **Weight** | | | 5 | g | |
| **Case material** | | Stainless steel | | - | |
| **Case finish** | | Cover: Stainless steel blank<br>Header: Ni 8 µm | | - | |
| **Pins** | | Glass / Kovar<br>Solder dipped | | - | EM: RoHS<br>FM: Sn63Pb37 |

**Table 3 – Mechanical specification**

## Enclosure drawing




**Pin connections**

| Pin # | Symbol | Function |
|---|---|---|
| **1** | $V_C$ | Control Voltage (EFC) |
| **7** | GND | Ground |
| **8** | RF OUT | RF Output |
| **14** | $V_S$ | Supply Voltage |

## 3. Applicable documents

The following specifications and standards are part of this specification:

| | |
|---|---|
| IPC-A-610 | Acceptability of electronic assemblies |
| ESCC21300 | Terms, Definitions, Abbreviations, Symbols and Units |
| ESCC21700 | General Requirements for the marking of ESCC components |
| MIL-STD-55310 | General specification for crystal-controlled oscillators |
| MIL-STD-202 | Test Method Standard for electronic and electrical component parts |
| MIL-STD-883 | Test Method Standard for Microcircuits |
| IEC 60679-1 | Quartz crystal-controlled oscillators of assessed quality<br>Part 1: Generic specification |

## Order of precedence

In the event of a conflict between the text of this specification and the references cited herein, the order of precedence shall be as follows:

(1) Purchase order

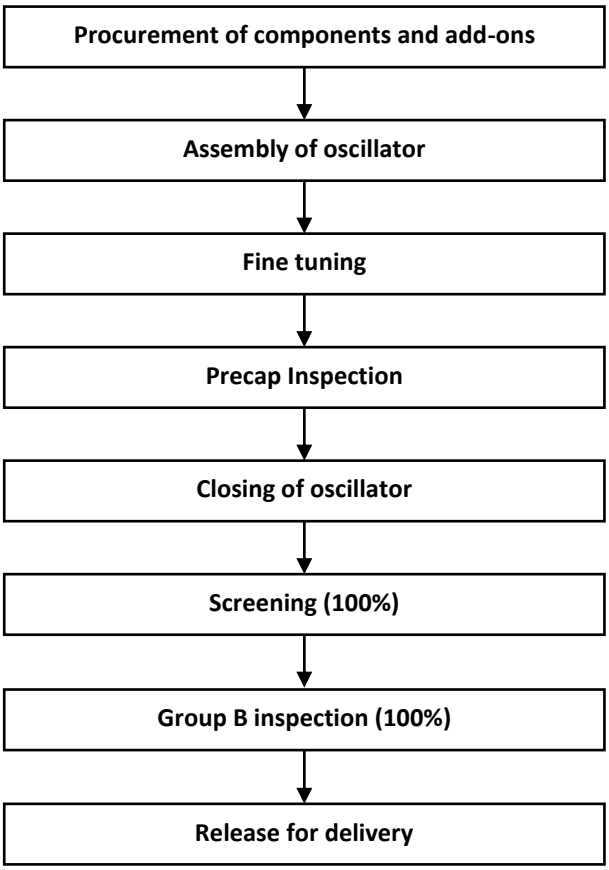
(2) Oscillator detail specification AXIS45SH

(3) Generic specification MIL-PRF-55310

(4) Other documents

## 4. General flow of manufacturing

The figure below shows the overall flow for manufacturing:



## 5. Acceptance Testing

### 5.1 Screening

Table 4 shows the screening procedure according to MIL-PRF-55310 Product level "S".

| # | Test | Reference |
|---|---|---|
| 1 | Electrical measurements at room temperature (Initial) | IEC 60679-1 (see Table 1) |
| 2 | Thermal Shock | MIL-STD-202, Method 107, Condition A-1 |
| 3 | Burn-in (load) *1 | MIL-PRF-55310 |
| 4 | Seal Test – Gross Leak | MIL-STD-202, Method 112, Condition D |
| 5 | Electrical measurements vs. temperature | IEC 60679-1 (see Table 1) |
| 6 | Electrical measurements at room temperature (Final) | IEC 60679-1 (see Table 1) |
| 7 | External Visual Inspection | ESCC20500 / MIL-STD-883 Method 2009 |

**Table 4 – Screening procedure**

**Notes:**

1. Burn-in can be performed at any step after assembly and is usually performed as pre-aging procedure

Table 5 shows the detailed test conditions for each step in table 4.

| # | Test | Test Condition |
|---|---|---|
| 1 | Electrical measurements at room temperature (Initial) | @ $T_{amb}$ = 25°C±3°C (unless otherwise stated)<br>Table 8 |
| 2 | Thermal Shock | -40 to +80°C, 25 cycles, max. 5 minutes transfer time,<br>15 minutes dwell time |
| 3 | Burn-in (load) | @ T = +85°C for 10 days (nominal $V_S$ and Load) |
| 4 | Seal Test – Gross Leak | No bubbles allowed |
| 5 | Electrical measurements vs. temperature | @ T = -30 to +70°C, 10°C steps with ±1°C tolerance<br>Limits: See Table 1 |
| 6 | Electrical measurements at room temperature (Final) | @ $T_{amb}$ = 25°C±3°C (unless otherwise stated)<br>Table 8 |
| 7 | External Visual Inspection | ESCC20500 / MIL-STD-883 Method 2009 |

**Table 5 – Detailed test conditions for screening procedure**

## 5.2 Group B inspection (Aging)

Table 6 shows the Group B inspection procedure.

| # | Test | Reference |
|---|---|---|
| 1 | Aging test | MIL-PRF-55310, Clause 4.7.1.5<br>Product level "S" |
| 2 | Electrical measurements at room temperature (Final) | IEC 60679-1 (see Table 1) |

**Table 6 – Group B inspection procedure**

**Notes:**

1. Group B inspection may be performed before or after screening procedure. Final electrical measurements are only performed once after completion of screening and Group B inspection.

Table 7 shows the detailed test conditions for each step in table 6.

| # | Test | Test Condition |
|---|---|---|
| 1 | Aging test | @ $T_{amb}$ = 30°C±3°C for 30 days (nominal $V_S$ and Load)<br>Frequency measurement every hour<br>Limits Aging: See Table 1 |
| 2 | Electrical measurements at room temperature (Final) | @ $T_{amb}$ = 25°C±3°C (unless otherwise stated)<br>Table 8 |

**Table 7 – Detailed test conditions for Group B inspection procedure**

## 5.3 Electrical measurements

Table 8 shows all electrical measurements with its respective conditions and limits, which are performed for all models. If not otherwise stated all measurements are performed at $T_{amb}$ = 25°C ± 3°C and after a sufficient stabilization time.

| # | Parameter | Test Method | Conditions | Initial | Final | Limits |
|---|---|---|---|---|---|---|
| 1 | Initial frequency | IEC 60679-1 | $V_S$ = 3.3 V, $R_L$ = 50 Ω | X | X | Table 1 |
| 2 | Tuning range | IEC 60679-1 | $V_S$ = 3.3 V, $R_L$ = 50 Ω | X | X | Table 1 |
| 3 | Output level & spectrum | IEC 60679-1 | $V_S$ = 3.3 V, $R_L$ = 50 Ω | X | X | Table 1 |
| 4 | Current consumption | IEC 60679-1 | $V_S$ = 3.3 V, $R_L$ = 50 Ω | X | X | Table 1 |
| 5 | Phase noise | IEC 60679-1 | $V_S$ = 3.3 V, $R_L$ = 50 Ω | - | X | Table 1 |

**Table 8 – Electrical measurements**

## 6. Radiation

The oscillator is capable of meeting all electrical performance requirements after exposure to a total ionizing dose (TID) of 40 krad(Si). The OCXO is based on a Space COTS approach, where the OCXO design incorporates only bipolar technology for the active components, making the OCXO SEL immune.

## 7. Components, Materials and Processes

The FM models are built on the basis of the following requirements for components, materials and processes:

- All add-on components are specially-selected commercial off-the-shelf (COTS) or higher-grade types. The used active components are automotive qualified in accordance with AEC-Q100/200 and/or have a long HighRel heritage (>10 years, several thousand pieces, no failure) in many products with MIL-PRF-55310 Product Level “B” or “S”.
- The active components are radiation hardened based on TID radiation tests made on oscillator level.
- The crystal is made of synthetic high Q quartz material with low inclusion density and low etch channel density (according to IEC 60758). The quartz crystal has a hermetically sealed package.
- Soldering is done in accordance with IPC-A-610 Class 3
- No pure tin is used for the package leads. Soldering of the COTS components is done with Sn63Pb37 solder.
- The printed circuit board (PCB) is commercially procured.
- The marking is resistant to Zestron VD, Isopropyl alcohol (99% pure) and Ethyl alcohol (99.5% pure), tested in accordance with ESCC24800.

## 8. Marking

The marking of the parts is accordance with ESCC21700. The content is as follows:

(1) Company Logo AXTAL

(2) Part number AXTAL (according to order code)

(3) Part number Customer (on request)

(4) Nominal frequency

(5) Serial number

(6) Date Code

## 9. Data Documentation

### General

With each delivery the following data documentation package is supplied:

(1) Certificate of Conformity (CoC)

(2) Test data (full report of all inspections)

The following additional documents can be delivered on request:

- Declared Component List
- Equipment list (Testing & Measuring)
- Product Reliability Analysis (MTBF calculation)
- Radiation Report

### Certificate of Conformity

The certificate includes the following content:

- Full company information (Logo, Name, Address)
- Type and specification (part number and revision)
- Nominal frequency
- Number of purchase order
- Lot identification
- Range of serial numbers
- Number of delivered parts
- Authorized signature in behalf of manufacturer (including stamp and date)

## 10. Handling, Packaging and Delivery

- Some add-ons are susceptible to damage by electrostatic discharge. Therefore, suitable ESD precautions for handling during use and manufacturing must be employed.
- In order to minimize the risk of damage, all kinds of shock during handling and manufacturing must be avoided.
- The parts are packaged in a way to ensure adequately safeguarding against mechanical and electrical injury and deterioration due to humidity.
- The primary package is labeled as ESD sensitive component.

## 11. Specification History

| Rev. | Drawing | Date [dd.mm.yyyy] | Remarks | Author | Checked |
|---|---|---|---|---|---|
| **1** | D0 | 10.02.2025 | First issue | HH | HH |