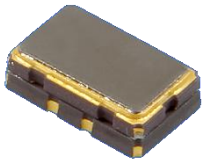
| Specification | AXLE5032S | Rev.: 1 | Date: 2023-04-14 |
|---|---|---|---|

**Oscillator type:** **Low Phase Noise TCXO in 5x3.2 mm ceramic package for Space Application (Space COTS version)**

## Features:

- **Lower cost Commercial Off-The-Shelf version (COTS)**
- **Dedicated for LEO applications**
- **Manufactured according to MIL-PRF-55310 Level "S"**
- **Radiation hardened – 40 krad(Si) total dose (TID)**
- **Radiation hardened – SEL immune > 90 MeV**
- **ITAR Free – Manufactured in Europe**
- **Low Phase Noise**
- **High Frequency Stability**
- **Hermetical sealed 5x3.2 mm ceramic package**
- **Short lead time**



## Models:

| Item | Engineering Model (EM) | Flight Model (FM) | Note |
|---|---|---|---|
| **Quartz Crystal** | Synthetic HiQ Quartz, AT-cut | Synthetic HiQ Quartz, AT-cut | 1 |
| **Electrical Components** | COTS parts | COTS parts Automotive Grade and/or HighRel Heritage | - |
| **Mechanical Components** | Ceramic package with metal cover | Ceramic package with metal cover | - |
| **Workmanship** | Hybrid manufacturing | Hybrid manufacturing | - |
| **Rad Hard** | - | 40 krad(Si) TID | 2 |
| **Acceptance Testing** | | | |
| **Screening** | Test procedure as commercial models | X | 3 |
| **Group-B** | | X | - |
| **Group-C** | - | On request | 4 |

**Notes:**

1. Swept Quartz material available on request.
2. TCXO series tested up to 50 krad and SEE tested up to 125 MeV·cm²/mg
3. Screening procedure can be modified IAW customer requirements.
4. Group-C (LAT) can be performed based on customer requirements.

## Ordering Code:

| Model | Product category | Options | Revision | Frequency [MHz] |
|---|---|---|---|---|
| AXLE5032S | EM<br>FM | 1 to 3* | Rev.1 | 20.000 |

**Example: AXLE5032S-FM-V-10-2C_Rev.1 – 20.000 MHz**

** Please see full order code with options below*

## 0. Contents:

1. Electrical specification

2. Mechanical specification

3. Applicable documents

4. General flow of manufacturing

5. Acceptance Testing

    5.1 Screening

    5.2 Group B inspection

    5.3 Electrical measurements

6. Radiation

7. Components, Materials and Processes

8. Marking

9. Data Documentation

10. Handling, Packaging and Delivery

11. Specification History

## 1. Electrical specification

| Parameter | min. | typ. | max. | Unit | Condition |
|---|---|---|---|---|---|
| **Frequency range** | 10 | | 50 | MHz | |
| **Standard frequencies** (Note 3) | 20.000 / 50.000 | | | MHz | |
| **Frequency stability** | | | | | |
| Initial tolerance @ +25°C | | | ±1 | ppm | $V_C$ = 1.5 V |
| vs. operating temperature range | Options 2 & 3<br>See tables 1A & 1B | | | ppm | |
| vs. supply voltage variation (pushing) | | | ±0.2 | ppm | $V_S$ ±5% |
| vs. load change (pulling) | | | ±0.2 | ppm | $R_L$ ±5% |
| Long term (aging) 1st year | | | ±1 | ppm | @ +40°C |
| Long term (aging) 5 years | | | ±3 | ppm | @ +40°C |
| vs. radiation | | | ±1.5 | ppm | (Note 4) |
| **Frequency adjustment range** | | | | | |
| Electronic Frequency Control (EFC) | ±5 | ±10 | | ppm | Option 1 = "V" |
| EFC voltage $V_C$ | 0.5 | 1.5 | 2.5 | V | |
| EFC slope ($\Delta f / \Delta V_C$) | Positive | | | | |
| EFC input impedance | 100 | | | kΩ | |
| **RF output** | | | | | |
| Signal waveform | Clipped sine wave | | | | |
| Load $R_L$ | 10 kΩ // 10 pF | | | | ±5% |
| Output voltage | 0.8 | 1.2 | | Vpp | |
| Phase noise | Please consult factory<br>See table 1C | | | | |
| **Supply voltage $V_S$** | 3.15 | 3.3 | 3.45 | V | |
| **Current consumption** | | 2 | 6 | mA | |

**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 5 (TCXO), Class 2 (Hybrid Technology), Product Level "S"
3. Arbitrary frequency within specified frequency range on request
4. Radiation of 40 krad(Si) total dose (TID). Radiation low dose test of similar TCXO series AXLE7050S was performed up to 50 krad. Please consult factory for radiation report.

## Ordering Code

| Model | Product category | Option 1 [EFC] | Option 2 [Stability] | Option 3 [Temp. range] | Revision | Frequency [MHz] |
|---|---|---|---|---|---|---|
| AXLE5032S | EM<br>FM | "_" = No EFC<br>"V" = EFC | Table 1A | Table 1B | Rev.1 | 20.000 |

**Examples:**

(1) **AXLE5032S-FM-V-10-2C_Rev.1 – 20.000 MHz** (with EFC)
(2) **AXLE5032S-FM_10-2C_Rev.1 – 20.000 MHz** (without EFC)

## Frequency stability vs. temperature

| Option 2 | Stability* [ppm] |
|---|---|
| 10 | ±1.0 |
| 15 | ±1.5 |
| 20 | ±2.0 |
| 25 | ±2.5 |
| 30 | ±3.0 |
| | |

**Table 1A**

| Lower Temperature | | | Upper Temperature | |
|---|---|---|---|---|
| Option 3 | T [°C] | | Option 3 | T [°C] |
| 0 | 0 | | A | +50 |
| 1 | -10 | | B | +60 |
| 2 | -20 | | C | +70 |
| 3 | -30 | | D | +75 |
| 4 | -40 | | E | +80 |
| | | | F | +85 |

**Table 1B**

*Stability referred to $(f_{max} + f_{min})/2$

## Typical phase noise performance

| Offset | Frequency | | Unit |
|---|---|---|---|
| | 20 MHz | 50 MHz | |
| **1 Hz** | -65 | -60 | **dBc/Hz** |
| **10 Hz** | -95 | -90 | **dBc/Hz** |
| **100 Hz** | -124 | -115 | **dBc/Hz** |
| **1 kHz** | -146 | -135 | **dBc/Hz** |
| **10 kHz** | -158 | -154 | **dBc/Hz** |
| **≥100 kHz** | -160 | -160 | **dBc/Hz** |

**Table 1C**

## Absolute Maximum Ratings

| Parameter | Min. | Max. | Unit | Condition / Remark |
|---|---|---|---|---|
| **Supply Voltage $V_S$** | -0.5 | 4.5 | V | $V_S$ to GND |
| **Control Voltage $V_C$** | -0.5 | 4.5 | V | $V_S$ to GND |
| **Load $R_L$** | 500 | ∞ | Ω | Must not cause any damage |
| **Operable temperature range** | -40 | +85 | °C | Operation of unit without any damage |
| **Storage temperature range** | -55 | +105 | °C | - |

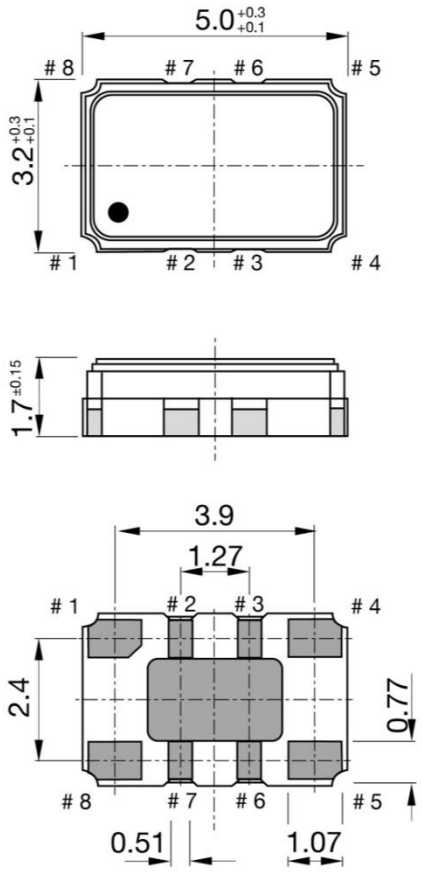
**Table 2 – Maximum Ratings**

## 2. Mechanical specification

| Parameter | Min. | Typ. | Max. | Unit | Condition |
|---|---|---|---|---|---|
| **Enclosure (see drawing) (LxWxH)** | | 5.0 x 3.2 x 1.7 | | mm | Hermetically sealed |
| **Weight** | | | 1 | g | |
| **Case** | | Ceramic package with metal cover | | - | |
| **Pins** | | NiAu plated | | - | |
| **Moisture Sensitivity Level** | | MSL 1 | | | J-STD-020 |

**Table 3 – Mechanical specification**

## Enclosure drawing




**Pin connections**

| Pin # | Symbol | Function |
|---|---|---|
| **1** | $V_C$ | Control Voltage (EFC) |
| **2** | D.N.C. | Do Not Connect |
| **3** | D.N.C. | Do Not Connect |
| **4** | GND | Ground |
| **5** | RF OUT | RF Output |
| **6** | D.N.C. | Do Not Connect |
| **7** | D.N.C. | Do Not Connect |
| **8** | $V_S$ | Supply Voltage |

## 3. Applicable documents

The following specifications and standards are part of this specification:

| | |
|---|---|
| ESCC21300 | Terms, Definitions, Abbreviations, Symbols and Units |
| 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

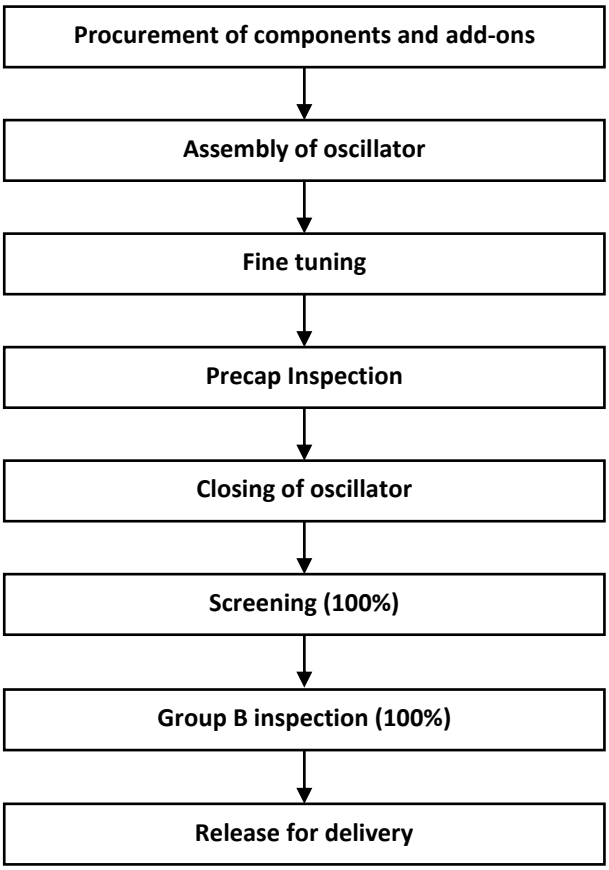
(2) Oscillator detail specification AXLE5032S

(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 – Fine Leak *2 | 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
2. Fine leak test is performed for the crystal, which is a 100% test during crystal manufacturing

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 – Fine Leak | MIL-STD-202, Method 112, Condition D |
| 5 | Electrical measurements vs. temperature | @ T = $T_{MIN}$ to $T_{MAX}$, 5°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 10 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, $R_L$ = 10 kΩ // 10 pF | X | X | Table 1 |
| 2 | Output level | IEC 60679-1 | $V_S$ = 3.3 V, $R_L$ = 10 kΩ // 10 pF | X | X | Table 1 |
| 3 | Current consumption | IEC 60679-1 | $V_S$ = 3.3 V, $R_L$ = 10 kΩ // 10 pF | X | X | Table 1 |
| 4 | Tuning range | IEC 60679-1 | $V_S$ = 3.3 V, $R_L$ = 10 kΩ // 10 pF | - | X | Table 1 |
| 5 | Phase noise | IEC 60679-1 | $V_S$ = 3.3 V, $R_L$ = 10 kΩ // 10 pF | - | 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 oscillator is based on a Space COTS approach and the radiation performance has been verified by a radiation test (Co 60) up to 50 krad(Si) and a SEE test up to 125 MeV·cm²/mg with the very similar TCXO series AXLE7050S. The oscillator is SEL immune and didn't show any other destructive events during the radiation tests. Radiation reports are available on request.

## 7. Components, Materials and Processes

The oscillators 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) versions.
- The crystal is made of synthetic high Q quartz material with low inclusion density and low etch channel density (according to IEC 60758).
- The oscillator and crystal unit are in hermetically sealed packages.
- The manufacturing is done in hybrid technology.
- No pure tin is used inside the oscillator, as package or lead finish.

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) First line: Frequency & Lot number

(2) Second line: Serial number

## 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)
- 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 | 14.04.2023 | First issue | HH | HH |