Specification	AXLE7050S	Rev.: 3	Date: 2025-01-21

Oscillator type: **Low Phase Noise TCXO in 7x5 mm ceramic package for Space Application (Space COTS version)**

Features:

- **Lower cost Commercial Off-The-Shelf version (COTS)**
- **Dedicated for LEO~MEO 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 7x5 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. 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]
AXLE7050S	EM FM	See table 1	Rev.3	10.000 ~ 50.000

Example: AXLE7050S-FM-V-C_Rev.3 – 40.000 MHz

0. Contents:

1. Electrical specification

Parameter	min.	typ.	max.	Unit	Condition
Frequency range	10		50	MHz	
Standard frequencies (Note 3)	20.000 / 40.000 / 50.000			MHz	
Frequency stability					
Initial tolerance @ +25°C		±0.3	±1	ppm	V_C = 1.5 V
vs. operating temperature range		±0.3	±1	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" (Note 5, 6)
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 – Option 2 = "C" (CSW)					
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 See table 1A				
RF output – Option 2 = "H" (HCMOS)					
Signal waveform	LVCMOS				
Load R_L	10 pF				±10%
Symmetry (duty cycle)	45		55	%	@ V_S/2
Rise & fall time			5	ns	@ 10% ~ 90% V_S
Phase noise	Please consult factory See table 1B				
Supply voltage V_S	3.15	3.3	3.45	V	
Current consumption			6 8	mA mA	Option 2 = "C" Option 2 = "H"
Operating temperature range	-40		+85	°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 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 TCXO series was performed up to 50 krad. Please consult factory for radiation report.
5. For option 1 = "N" (No EFC) pin 1 can be left open.
6. Tuning range is sufficient to compensate for initial tolerance, temperature stability, pushing, pulling, min. of 5 years aging & radiation of 40 krad(Si)

Ordering Code

Model	Product category	Option 1 [EFC]	Option 2 [Output]	Revision	Frequency [MHz]
AXLE7050S	EM FM	"N" = No EFC "V" = EFC	"C" = Clipped Sine Wave (CSW) "H" = HCMOS (LVCMOS)	Rev.3	10.000 ~ 50.000

Examples:

(1) **AXLE7050S-FM-V-C_Rev.3 – 40.000 MHz** (with EFC and CSW output)

(2) **AXLE7050S-FM-N-H_Rev.3 – 40.000 MHz** (without EFC and HCMOS output)

Typical phase noise performance

Offset	Frequency		Unit
	20 MHz	50 MHz	
1 Hz	-67	-60	**dBc/Hz**
10 Hz	-98	-90	**dBc/Hz**
100 Hz	-127	-115	**dBc/Hz**
1 kHz	-148	-135	**dBc/Hz**
10 kHz	-155	-154	**dBc/Hz**
≥100 kHz	-157	-160	**dBc/Hz**

Table 1A – Clipped Sine Wave Output (CSW)

Offset	Frequency		Unit
	20 MHz	50 MHz	
1 Hz	-65	-58	**dBc/Hz**
10 Hz	-96	-88	**dBc/Hz**
100 Hz	-125	-113	**dBc/Hz**
1 kHz	-146	-133	**dBc/Hz**
10 kHz	-153	-152	**dBc/Hz**
≥100 kHz	-155	-158	**dBc/Hz**

Table 1B – HCMOS Output (LVCMOS)

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 – CSW Output	500	∞	Ω	Must not cause any damage
Load R_L – HCMOS Output	0	15	pF	
Operable temperature range	-50	+95	°C	Operation of unit without any damage
Storage temperature range	-55	+105	°C	-

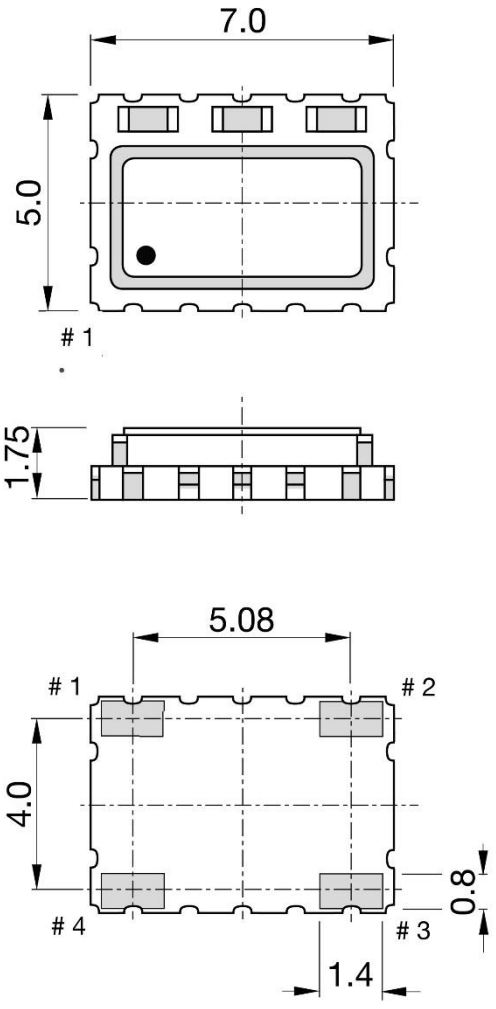
Table 2 – Maximum Ratings

2. Mechanical specification & Handling

Parameter	Min.	Typ.	Max.	Unit	Condition
Enclosure (see drawing) (LxWxH)		7.0 x 5.0 x 1.8		mm	Hermetically sealed
Weight			1	g	
Case		Ceramic package with metal cover		-	
Pins		NiAu plated		-	
Passive Components (top side)		Matte tin finish SAC3 soldered		-	
Moisture Sensitivity Level		MSL 1		-	IPC/JEDEC J-STD-020C
Cleaning		Washable		-	
Electrostatic Discharge (ESD)		MM Class M2: < 200 V		-	
Reflow Profile		max. +260°C for 10 seconds		-	IPC/JEDEC J-STD-020C

Table 3 – Mechanical specification & Handling

Enclosure drawing



Pin connections

Pin #	Symbol	Function
1	V_C	Control Voltage (EFC) *
2	GND	Ground
3	RF OUT	RF Output
4	V_S	Supply Voltage

* For option 1 = “N” (no EFC) pin 1 can be left open

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 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

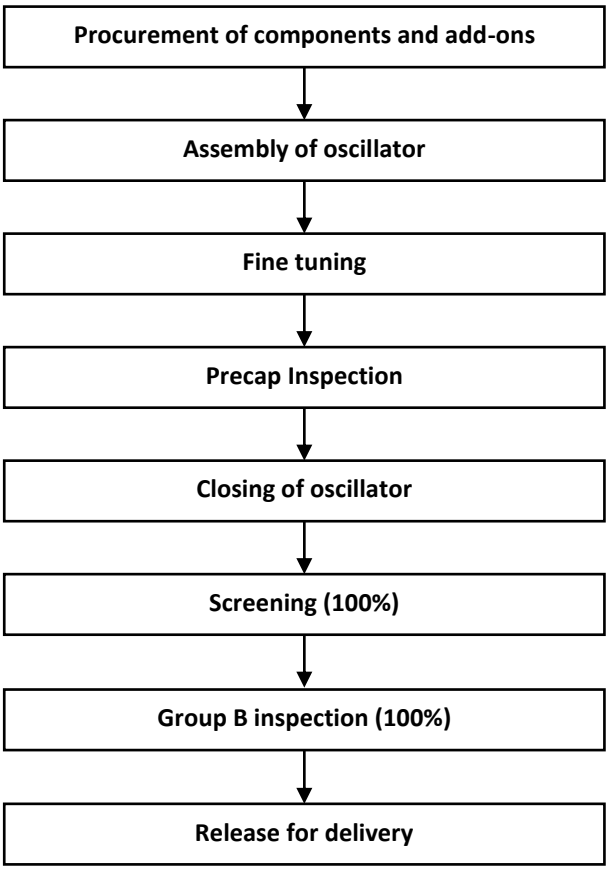
(2) Oscillator detail specification AXLE7050S

(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) Table 8
2	Thermal Shock	-40 to +80°C, 25 cycles, max. 5 minutes transfer time, 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 Limits: See Table 1
6	Electrical measurements at room temperature (Final)	@ T_{amb} = 25°C±3°C (unless otherwise stated) 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 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) Frequency measurement every hour Limits Aging: See Table 1
2	Electrical measurements at room temperature (Final)	@ T_{amb} = 25°C±3°C (unless otherwise stated) 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. 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 with discrete capacitors at the top side of the package.
- No pure tin is used inside the oscillator, as package or lead finish. The capacitors on top of the package are COTS parts with matte tin finish and SAC3 solder. SnPb finish and solder is available with our AXLE7050S-PB series, that guarantees full tin whisker mitigation.
- 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	02.02.2022	First issue	HH	BN/ME
1	D1	03.02.2022	Minor update leak test	HH	HH
1	D2	08.06.2022	Typo of order code examples corrected	HH	HH
1	D3	15.03.2023	Editorial update – Additional information added	HH	HH
2	D0	14.04.2023	Additional information and SEE data added. Typical phase noise performance updated	HH	HH
2	D1	14.03.2024	Solder type information for capacitors added	HH	HH
3	D0	20.01.2025	AXLE7050S (CSW) and AXLE7050S-H (HCMOS) series combined to one model with updated order options, various additional information added	HH	HH
3	D1	21.01.2025	Package drawing updated	HH	HH