AXTAL ADVANCED XTAL PRODUCTS
a Q-TECH Company

Designed and Manufactured in Germany

Specification	AXIOM6060	Rev.: 6	Date: 2023-04-13

Oscillator type: Ultra-Low Phase Noise OCXO for Space Application (Class 1)

Features:

- **Manufactured according to MIL-PRF-55310 Level "S"**
- **Frequency range 80 to 125 MHz**
- **Radiation hardened – 100 krad(Si) total dose (TID)**
- **Radiation hardened – SEL immunity / SET insensitive**
- **ITAR Free – Manufactured in Germany**
- **Ultra-Low Phase Noise**
- **High Frequency Stability and Very Low Aging**
- **Entry in the European Preferred Parts List (EPPL)**
- **Heritage: GEO and LEO missions**

Models:

Item	Engineering Model (EM)	Flight Model (FM)	Lot Acceptance Test Model 1 (LAT1)	Lot Acceptance Test Model 2 (LAT2)
Quartz Crystal	Synthetic HiQ Quartz, SC-cut, HC-35/U 4-point	Synthetic HiQ Swept Quartz IAW ESCC3501, SC cut, HC-35/U 4-point	Synthetic HiQ Swept Quartz IAW ESCC3501, SC cut, HC-35/U 4-point	Synthetic HiQ Swept Quartz IAW ESCC3501, SC cut, HC-35/U 4-point
Electrical Components	Passives: COTS Actives: EM parts from same manufacturer as the HiRel parts	HiRel Parts ECSS-Q-ST-60C class 1	HiRel Parts ECSS-Q-ST-60C class 1	HiRel Parts ECSS-Q-ST-60C class 1
Mechanical Components	Form Fit Function, Al body with Ni finish	Al body with NiAu finish	Al body with NiAu finish	Al body with NiAu finish
Workmanship (Soldering)	IPC610 Class 3	ECSS-Q-ST-70-08C and ECSS-Q-ST-70-38C	ECSS-Q-ST-70-08C and ECSS-Q-ST-70-38C	ECSS-Q-ST-70-08C and ECSS-Q-ST-70-38C
Rad Hard	typ. 10 krad(Si) TID	100 krad(Si) TID	100 krad(Si) TID	100 krad(Si) TID
Acceptance Testing				
Screening	X	X	X	X
Group-A	X	X	X	X
Group-B	On request	X	X	X
Group-C	-	-	X	X
DPA	-	-	-	X

Ordering Code:

Model	Package Option	Product category	Revision	Frequency [MHz]
AXIOM6060	"MD" – Micro-D "FT" – Feedthrough	EM FM LAT1 LAT2	Rev.6	100.000

Example: AXIOM6060-MD-FM_Rev.6 – 100.000 MHz

0. Contents:

1. Electrical specification

Parameter	min.	typ.	max.	Unit	Condition
Frequency range	80		125	MHz	
Standard frequencies	100.000 / 120.000			MHz	
Frequency stability					
Initial tolerance at delivery		±200	±500	ppb	@ +25°C
vs. operating temperature range			±50	ppb	
vs. supply voltage variation			±5	ppb	V_S ±5%
vs. load change			±5	ppb	R_L ±10%
Long term (aging) per day			±2	ppb	after 30 days operation
Long term (aging) 1st year			±50	ppb	after 30 days operation
Long term (aging) following 9 years			±200	ppb	after 30 days operation
Frequency adjustment range					
Electronic Frequency Control (EFC)	On request			ppm	
RF output					
Signal waveform	Sine wave				
Load R_L	50			Ω	±10%
Output level	+12	+13	+14	dBm	
Harmonics			-30	dBc	
Spurious			-80	dBc	
Warm-up time vs. temp. range			20	min	$\Delta f/f_0 < \pm 20$ ppb
Phase noise @ 100 MHz (Note 3)		-73	-70	dBc/Hz	@ 1 Hz
		-105	-100	dBc/Hz	@ 10 Hz
		-135	-130	dBc/Hz	@ 100 Hz
		-156	-153	dBc/Hz	@ 1 kHz
		-165	-160	dBc/Hz	@ 10 kHz
		-170	-165	dBc/Hz	@ ≥100 kHz
Short term stability (Allan deviation)		$5 \cdot 10^{-12}$	$5 \cdot 10^{-11}$		@ τ = 1 sec
G-Sensitivity		0.5	1.0	ppb/g	per axis
Supply voltage V_S	11.4	12.0	12.6	V	
Current consumption (steady state)		200	350	mA	@ +25°C
		350	450	mA	@ -30°C
Current consumption (warm-up)		450	600	mA	
Operating temperature range	-30		+70	°C	

Table 1 – Electrical Performance and Characteristics

Notes:

1. Terminology and test conditions are according to IEC60679-1, MIL-PRF-55310 and ESCC21300, unless otherwise stated
2. Classification (MIL-PRF-55310): Type 4 (OCXO), Class 1 (Discrete Technology), Product Level "S"
3. Please consult factory for phase noise of other frequencies

Absolute Maximum Ratings

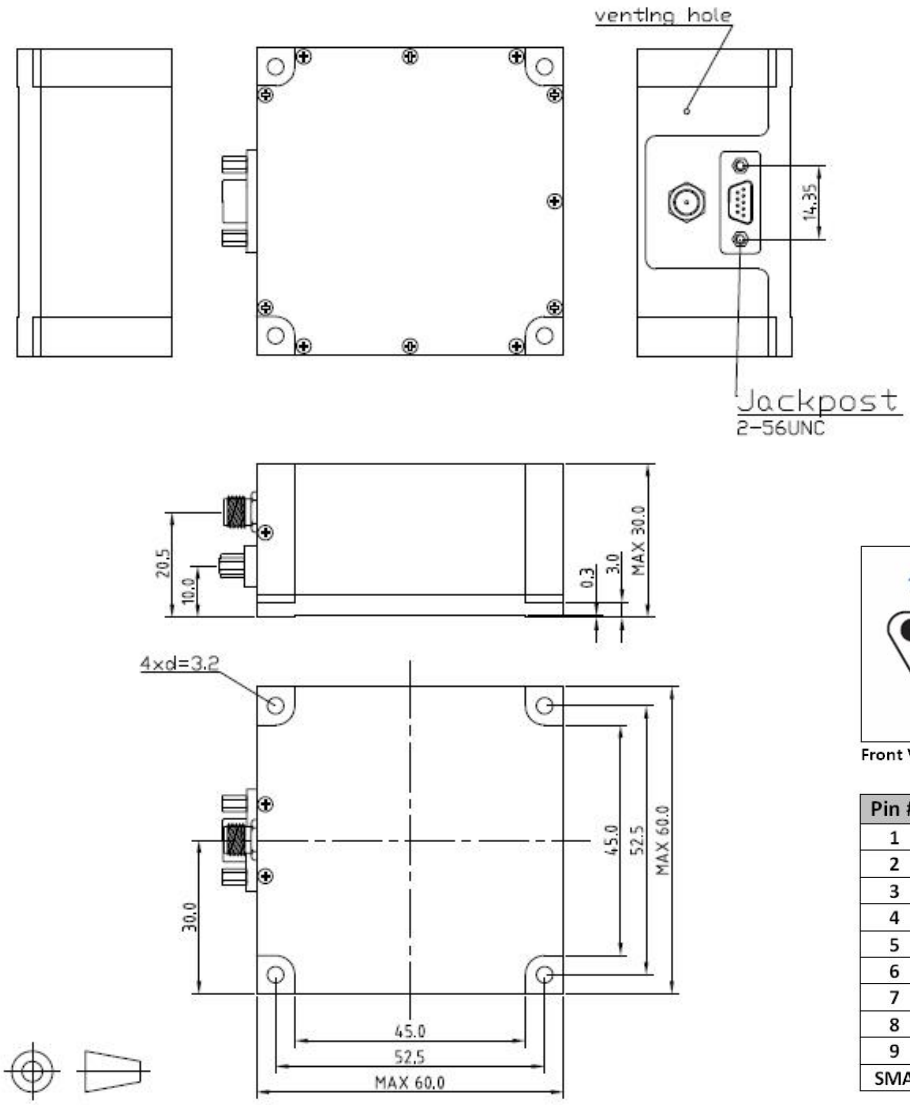
Parameter	Min.	Max.	Unit	Condition	Remark
Supply Voltage V_S	0	12.6	V	V_S to GND	Overshoot survivability in acc. with generic specification
Load R_L	0	∞	Ω	-	Must not cause any damage
Operable temperature range	-35	+75	°C	-	Operation of unit without any harm or damage
Storage temperature range	-40	+80	°C	-	

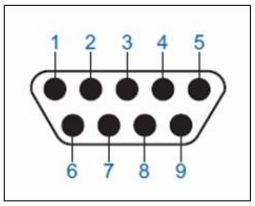
2. Mechanical specification

Parameter		Min.	Typ.	Max.	Unit	Condition
Enclosure (LxWxH)		60x60x30 max.			mm	See drawings
Weight			130	200	g	
Case material		Aluminum alloy AlMgSi1			-	
Case finish (FM & LAT models only)		1.78 < Ni < 5.71 1.27 < Au < 5.71			µm µm	MIL-PRF-55310, Clause 6.5.3 & 6.5.4
RF output connector		SMA Female			-	
DC connector	**Option "MD"** **Option "FT"**	Micro-D (M83513/03) Feed through			- -	With jack posts NiAu plated

Table 3 – Mechanical specification

Enclosure drawing – Option "MD" = Micro-D Connector



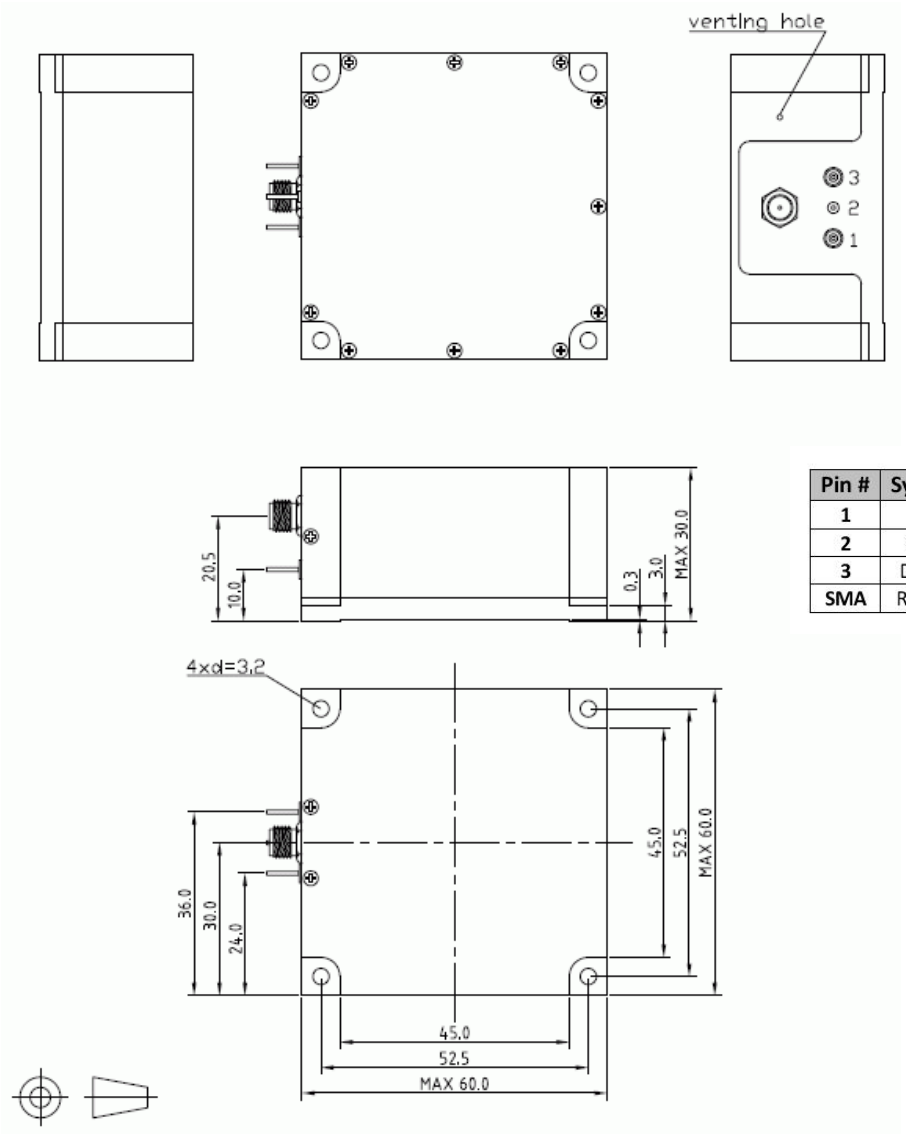


Front View Micro-D connector

Pin #	Symbol	Assignment
1	V_S	Supply Voltage Oven
2	V_S	Supply Voltage Oven
3	GND	Ground Oven
4	GND	Ground Oven
5	D.N.C.	Do Not Connect
6	V_S	Supply Voltage Oscillator
7	GND	Ground Oscillator
8	D.N.C.	Do Not Connect
9	D.N.C.	Do Not Connect
SMA	RF Out	RF Output

[Tolerances ±100 µm]

Enclosure drawing – Option "FT" = Feedthrough



Pin #	Symbol	Assignment
1	V_S	Supply Voltage
2	GND	Ground, Case
3	D.N.C.	Do Not Connect
SMA	RF Out	RF Output

[Tolerances ±100 µm]

3. Applicable documents

The following specifications and standards are part of this specification:

ECSS-Q-ST-60C	Electrical, Electronic and Electromechanical (EEE) Components
ECSS-Q-ST-70-08C	The manual soldering of high-reliability electrical connections
ECSS-Q-ST-70-38C	High-reliability soldering for surface-mount and mixed technology
ECSS-Q-ST-70-11C	Procurement of printed circuit boards
ECSS-Q-70-71A	Data for selection of space materials and processes
ESCC21300	Terms, Definitions, Abbreviations, Symbols and Units
ESCC21700	General Requirements for the marking of ESCC components
ESCC23500	Requirements for Lead Materials and Finishes for components for space application
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

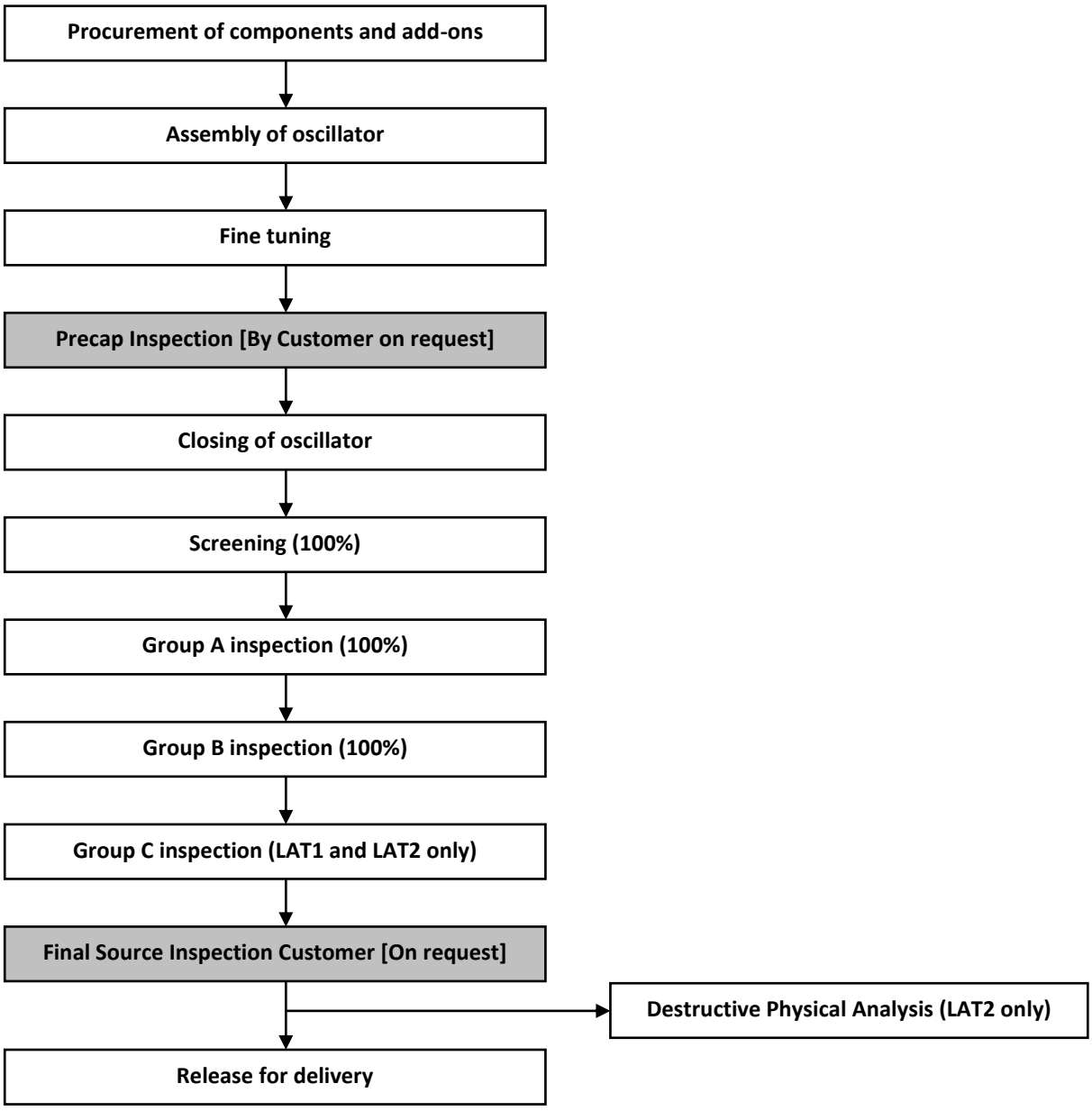
(2) Oscillator detail specification AXIOM6060

(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	Random Vibration	MIL-STD-202, Method 214, Condition 1-B
3	Thermal Shock	MIL-STD-202, Method 107, Condition A-1
4	Electrical measurements at room temperature (Interim)	IEC 60679-1 (see Table 1)
5	Burn-in (load)	MIL-PRF-55310
6	Electrical measurements at room temperature (Final)	IEC 60679-1 (see Table 1)
7	Electrical measurements at high and low temperature	IEC 60679-1 (see Table 1)
8	Seal Test – Gross Leak (Note 1)	Not applicable
9	Radiographic Inspection (Note 2)	MIL-STD-202, Method 209
10	External Visual Inspection	ESCC20500 / MIL-STD-883 Method 2009

Table 4 – Screening procedure

Notes:

1. Not required. All add-on components are hermetically sealed.
2. May be performed at any point during the test sequence

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 11
2	Random Vibration	50~100 Hz +6 dB/Oct, 100~1000 Hz 0.04 g^2/Hz, 1~2 kHz -6 dB/Oct RMS = 7.56 g, 5 minutes per axis
3	Thermal Shock	-40 to +80°C, 25 cycles, max. 5 minutes transfer time, 15 minutes dwell time
4	Electrical measurements at room temperature (Interim)	@ T_{amb} = 25°C±3°C (unless otherwise stated) Table 11
5	Burn-in (load)	@ T = +85°C for 10 days (nominal V_S and Load) Drift: $\Delta f/f$ < ±1 ppm and ±5 % current consumption (steady state)
6	Electrical measurements at room temperature (Final)	@ T_{amb} = 25°C±3°C (unless otherwise stated) Table 11
7	Electrical measurements at high and low temperature	@ T = -30°C, +25°C, +70°C with ±1°C tolerance Limits: See Table 1
8	Seal Test – Gross Leak	Not applicable
9	Radiographic Inspection	1 view Y-direction (perpendicular to largest surface) 1 view 90° to Y-direction
10	External Visual Inspection	ESCC20500 / MIL-STD-883 Method 2009

Table 5 – Detailed test conditions for screening procedure

5.2 Group A inspection

Table 6 shows the Group A inspection procedure.

Test	Reference	Test condition
Group A inspection	MIL-PRF-55310, Clause 4.7.1.4	Table V, Product level "S"

Table 6 – Group A inspection procedure

Notes:

1. Electrical measurements performed during screening are not repeated during Group A inspection

5.3 Group B inspection (Aging)

Table 7 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 7 – Group B inspection procedure

Table 8 shows the detailed test conditions for each step in table 7.

#	Test	Test Condition
1	Aging test	@ T_{amb} = 30°C±3°C for 30 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 11

Table 8 – Detailed test conditions for Group B inspection procedure

5.4 Group C inspection

Table 9 shows the Group C inspection procedure.

#	Test	Reference
1	Random Vibration	MIL-STD-202, Method 214, Condition 1-J
2	Mechanical Shock	MIL-STD-202, Method 213, Condition F
3	Thermal Shock	MIL-STD-202, Method 107, Condition B-1
4	High Temperature Storage	Detail specification
5	Electrical measurements at room temperature (Final)	IEC 60679-1 (see Table 1)
6	Seal Test – Gross Leak (Note 1)	Not applicable
7	External Visual Inspection	ESCC20500 / MIL-STD-883 Method 2009

Table 9 – Group C inspection procedure

Notes:

1. Not required. All add-on components are hermetically sealed.
2. Group C inspected LAT parts are end of life and shall not be used as flight models

Table 10 shows the detailed test conditions for each step in table 9.

#	Test	Test Condition
1	Random Vibration	50~100 Hz +6 dB/Oct, 100~1000 Hz 1.0 g^2/Hz, 1~2 kHz -6 dB/Oct RMS = 37.8 g, 3 minutes per axis
2	Mechanical Shock	1500 g, 0.5 ms, half sine, 3 shocks per axis
3	Thermal Shock	-65 to +125°C, 25 cycles, max. 5 minutes transfer time, 15 minutes dwell time
4	High Temperature Storage	24 hours at -35°C, 24 hours at +70°C, min. 2 hours at T_{amb}
5	Electrical measurements at room temperature (Final)	@ T_{amb} = 25°C±3°C (unless otherwise stated) Table 11
6	Seal Test – Gross Leak	Not applicable
7	External Visual Inspection	ESCC20500 / MIL-STD-883 Method 2009

Table 10 – Detailed test conditions for Group C inspection procedure

5.5 Electrical measurements

Table 11 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 / Interim	Final	Limits
1	Initial frequency	IEC 60679-1	V_S = 12 V, R_L = 50 Ω	X	X	Table 1
2	Output level	IEC 60679-1	V_S = 12 V, R_L = 50 Ω	X	X	Table 1
3	Current consumption (steady state)	IEC 60679-1	V_S = 12 V, R_L = 50 Ω	X	X	Table 1
4	Current consumption (warm-up)	IEC 60679-1	V_S = 12 V, R_L = 50 Ω	-	X	Table 1
5	Phase noise	IEC 60679-1	V_S = 12 V, R_L = 50 Ω	-	X	Table 1
6	Harmonics	IEC 60679-1	V_S = 12 V, R_L = 50 Ω	-	X	Table 1
7	Spurious	IEC 60679-1	V_S = 12 V, R_L = 50 Ω	-	X	Table 1
8	Frequency stability vs. supply change	IEC 60679-1	V_S = 12 V ±5%, R_L = 50 Ω	-	X	Table 1
9	Frequency stability vs. load change	IEC 60679-1	V_S = 12 V, R_L = 50 Ω ±10%	-	X	Table 1
10	Short term stability (ADEV)	IEC 60679-1	V_S = 12 V, R_L = 50 Ω	-	X	Table 1
11	Warm-up @ +25°C	IEC 60679-1	V_S = 12 V, R_L = 50 Ω	-	X	Table 1
12	Acceleration sensitivity	IEC 60679-1	V_S = 12 V, R_L = 50 Ω	-	-	Table 1

Table 11 – Electrical measurements

5.6 Destructive Physical Analysis (DPA)

The destructive physical analysis (DPA) inspects and verifies the internal design, materials, construction and workmanship of the part and extents the lot acceptance test (LAT). The part is disassembled and inspected with the procedure given in table 12.

#	Test	Reference / Condition
1	External Visual Inspection	MIL-STD-883, Method 2009
2	Radiographic Inspection	MIL-STD-202, Method 209
3	Marking Resistance Test	ESCC24800
4	Opening procedure / Disassembly	Decapsulation tools
5	Microsection of add-on components	Embedded in 2-component epoxy, evacuated, no plating
6	Internal Visual Inspection	MIL-STD-883, Method 2013
7	Passive Element Shear Test	MIL-STD-883, Method 2019
8	SEM Inspection add-on components	MIL-STD-883, Method 2018

Table 12 – DPA procedure

Notes:

1. Test order is not sequential
2. LAT part is fully destructed after analysis

6. Radiation

The oscillator is capable of meeting all electrical performance requirements after exposure to a total ionizing dose (TID) of 100 krad(Si). The oscillator is SEL immune and SET insensitive due to the use of qualified radiation hardened components and its circuitry. The radiation capability was verified by a radiation analysis in accordance with ECSS-Q-HB-30-01A.

7. Components, Materials and Processes

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

- All add-on components and materials are compliant with the requirements of ECSS-Q-ST-60C class 1.
- All active components and the quartz crystal have a hermetically sealed package.
- All active components are radiation tolerant. The crystal is made of synthetic swept quartz material.
- Soldering is done by ESA approved personal in accordance with ECSS-Q-ST-70-08C (manual soldering) and ECSS-Q-ST-70-38C (surface mount and mixed technology).
- All used materials are in accordance with ECSS-Q-ST-70-71A. The lead material and finishes are according to ESCC23500. No pure tin is used inside the oscillator, as package or lead finish.
- The printed circuit board (PCB) is procured in accordance with ECSS-Q-ST-70-11C.
- The case material is made of aluminum alloy AlMgSi1 with a plating of electrolytic NiAu in accordance with MIL-PRF-55310 clause 6.5.3 and 6.5.4 (see Table 3).
- 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

(7) Caution symbol for ESD

9. Data Documentation

General

With each delivery the following data documentation package is supplied:

(1) Cover sheet

(2) Certificate of Conformity (CoC)

(3) Equipment list (Testing & Measuring)

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

(5) Failed component list and failure analysis report (if applicable)

For the first delivery the following additional documents can be delivered on request:

- Product Technical Description
- Declared Material List
- Declared Process List
- Declared Component List
- Parts Stress Analysis
- Product Reliability Analysis
- Product Worst Case Analysis
- Radiation Analysis
- Part Approval Documents (PAD) for add-on components

Cover sheet

The cover sheet 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
- List of delivered documents

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	10.02.2012	First issue	BN	BN
2	D0	30.05.2012	New package drawing	BN	BN
3	D0	01.10.2012	Pushing and pulling changed, package drawing updated	BN	BN
4	D0	18.12.2012	Warm-up time changed	BN	BN
4	D1	23.04.2014	Phase noise marginally changed	BN	BN
5	D0	28.04.2014	Major editorial changes	HH	BN
5	D1	04.02.2014	EPPL Entry (Features) added	HH	HH
6	D0	13.04.2023	AXIOM6060 and AXIOM6060A integrated in one datasheet. Update of parameters. Editorial changes and information added.	HH	HH