GomSpace A/S
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NANOCOM AX2150
QUALIFICATION CERTIFICATE

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1.0	2021-07-30	MOV	Issued
2.0	2021-11-30	MOV	Thermal stress updated with reference to PCB substrate change.

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1. Introduction

1.1 Purpose

This document describes the environmental qualification tests carried out on the Nanocom AX2150, a S-band TMTC transceiver designed for low data rate communication between earth and a LEO satellite. The test plan and the definition of the Gomspace qualification is described [12]

1.2 References

Ref.	Document title	Document no.	Revision
[1]	Total Ionizing Dose Test Procedure	1028955	1.0
[2]	Total Ionizing Dose Test Report	1028962	2.0
[3]	Vibration Test Procedure	1028958	1.1
[4]	Vibration Test Report	1028961	2.0
[5]	Thermal Vacuum Test Procedure	1028959	1.0
[6]	Thermal Vacuum Test Report	1030284	2.0
[7]	Thermal Stress Test Procedure	1028957	1.0
[8.1]	Thermal Stress Test Report	1028960	1.1
[8.2]	Thermal Stress Test Report	1028960	2.0
[9]	Mechanical Shock Test Procedure	1027297	1.1
[10]	Mechanical Shock Test Report	1033087	2.0
[11]	Check out form	1028574	1.1
[12]	GomSpace Qualification Program	1012670	2.1

2. Total Ionizing Dose Qualification

Test Facility: DTU, Risø, Denmark

Product ID: Nanocom AX2150. S-band TMTC transceiver (108455)

Part no: 108455 rev. 2.0. Serial no. 7

Test Condition: Nanocom AX2150 mounted on a Nanodock DMC-3 (200232). Aluminium shield is not mounted, so all components are directly exposed to radiation. Biased with external 5 Volt power supply.

Condition	Test levels
Low rate ionizing Receiver operating during test	Radiation 200Gy Radiation rate: 3.3Gy/Hour Irradiation time: 60.42 hours

References: Gomspace Qualification Total Dose Ionizing test procedure and report [1,2].

Remarks: Onboard 5 V to 3.3 V DC-DC converter became unfunctional after approximately 150Gy. The product is qualified to 120Gy (equal 12 kRad) until an alternative DC-DC converter is introduced and qualified for the product.

The replacement DC-DC converter is inherited from GomSpace Product Nanomind Z7000-MK3 that is TID tested to 200Gy without any issues. Introduced into PCB 109201.
Production with updated AX2150 design will be in production from end of year 2021 and the product is from then qualified to 20 kRad.

Distinguish between 12 kRad qualified modules and 20 kRad qualified modules is done the PCB marking. The PCB is marked on the backside

20 kRad marking	12 kRad marking
109201-x	108376-1
	

The Nanocom AX2150 is hereby verified with respect to the total ionizing dose of 20 kRad and is fully functional with the expected performance. This certificate ensures that performance, test conditions and test equipment are according to Gomspace quality.

3. Vibration Test Qualification

Test Facility: Hytec, Aalborg, Denmark

Product ID: Nanocom AX2150. S-band TMTC transceiver (108455)

Part no: 108455 rev. 2.0. Serial no. 1

Test Condition: Nanocom AX2150 mounted on a Nanodock DMC-3 (200232) inside a 6U satellite structure which is mounted inside a POD. The DUT is unbiased. This configuration is tested with respect to

Condition	Test levels
Random vibration	20Hz, 0.026g^2/Hz 50Hz, 0.16g^2/Hz 800Hz, 0.16g^2/Hz 2000Hz, 0.026g^2/Hz Overall, 14.1Grms
Sine vibration	Frequency, level [g] 5-11.5Hz, 17-20mm pp 11.5-100, 4.5G*
Sine burst	30Hz,19cyles/7 loaded cycles,15G

References: Gomspace Qualification vibration test procedure and report [3,4].

Remarks: *) sine vibration is not tested in 8-100Hz as specified in [12] but in 11.5-100Hz due to technical issues at test facility. This does not cause any strength issues since no fundamental eigenfrequencies are present at these frequencies. Therefore, the load is more than covered by the 15 G at the quasi-static test.

The Nanocom AX2150 is hereby tested with respect to vibration and is fully functional with the expected performance. This certificate ensures that performance, test conditions and test equipment are according to Gomspace quality.

4. Thermal Vacuum Qualification

Test Facility: Gomspace, Aalborg, Denmark

Product ID: Nanocom AX2150. S-band TMTC transceiver (108455)

Part no: 108455 rev. 2.0. Serial no. 1

Test Condition: Nanocom AX2150 mounted on a Nanodock DMC-3 (200232) in a 6U satellite structure inserted into a thermal vacuum chamber.
Biased with external 5 Volt power supply.
During the test the transmitter power and receiver RSSI monitored during test. The transmitter is transmitting with maximum power in total active 9 minutes for each temperature cycle.

Test description	Test levels
RF power @50C	27.5 dBm +/- 1dB
RF power @-30C	30 dBm +/- 1dB
Thermal Vacuum	Temperature 50°C +/-3°C and -30°C +/-3°C Stabilized to 50°C Slope 2.5 °C/min cycles 8 Time 48hours Dwell time 120minutes Pressure < 1.0x 10e-5mBar

References: Gomspace Qualification Thermal vacuum test procedure and report [5,6].

Remarks: The temperature of 50°C is the base temperature of the satellite structure thermal interface. The test shows that the maximum board temperature below the PA is increased by up to 15C during a transmit cycle.
During the test some TX power monitoring issues occurred for the external equipment, so the module was thermal cycled 12 times instead of the specified 8 cycles to have data for the required full 8 cycles.

The Nanocom AX2150 is hereby tested with respect to thermal vacuum and is fully functional with the expected performance. This certificate ensures that performance, test conditions and test equipment are according to Gomspace quality.

5. Temperature Cycling / Thermal Stress Qualification

Test Facility: Gomspace, Aalborg, Denmark

Product ID: Nanocom AX2150. S-band TMTC transceiver (108455)

Part no: 108455 rev. 2.0. Serial no. 1. PCB marking 108376-1

Test Condition: The module is placed inside the thermal stress temperature chamber.

Test description	Test levels
Temperature cycling	-55°C for 15 minutes 100°C for 15minutes 500 cycles Switch time < 15minutes

References: Gomspace Qualification Thermal cycling test procedure and report [7,8.1].

Remarks: The module ended up in having 546 thermal cycles 46 cycles more than anticipated. The solder joints to a SAW filter did show a minor fracture. The fracture did not affect any performance of the unit.

Updated PCB substrate:
As the PCB substrate will be changed in production from end of 2021 the Thermal stress test is repeated with the updated substrate prior to introduction in the AX2150 product.

Test Facility: Gomspace, Aalborg, Denmark

Product ID: Nanocom AX2150. S-band TMTC transceiver.

Part no: 109212 rev. 1.0. Serial no. 5. PCB marking 109201-1

Test Condition: The module is placed inside the thermal stress temperature chamber.

Test description	Test levels
Temperature cycling	-55°C for 15 minutes 100°C for 15minutes 500 cycles Switch time < 15minutes

References: Gomspace Qualification Thermal cycling test procedure and report [7,8.2].

Remarks: The solder joints on two 47 µF capacitors showed minor fractures. The fractures did not affect any performance of the unit.

The Nanocom AX2150 is hereby tested with respect to thermal cycling / thermal stress and is fully functional with the expected performance. This certificate ensures that performance, test conditions and test equipment are according to Gomspace quality.

6. Mechanical Shock Qualification

Test Facility: Terma A/S, Lystrup, Denmark

Product ID: Nanocom AX2150. S-band TMTC transceiver (108455)

Part no: 108455 rev. 2.0. Serial no. 1 and Serial no. 6

Test Condition: Both modules are mounted on Nanodock DMC-3 (200232). One on each side of the Nanodock. Mounted inside a 6U satellite structure together with other modules subject to shock test. The 6U structure was mounted inside a POD. The DUT was unbiased.
Two Nanocom AX2150 modules are used. Serial no. 6 is new direct from production and Serial no. 1 is previously used for vibration, thermal vacuum and thermal stress qualification.

The POD was subject to pyro shocks with the following target SRS profile

Frequency	SRS nominal (± 6 dB tolerance)
[Hz]	[g]
100	40
1000	1000
2000	1500
10000	1500

Number of shocks per axis: two

References: Gomspace Qualification Mechanical shock test procedure and report [9,10].

Remarks: Two additional shocks were applied in the X-axis because the first two had less than 50% above target as specified [12].

The Nanocom AX2150 is hereby tested with respect to mechanical shock test and is fully functional with the expected performance. This certificate ensures that performance, test conditions and test equipment are according to Gomspace quality.

7. Summary

The Nanocom AX2150 is tested according to the above-mentioned conditions and is fully functional and have the expected performance.

This certificate ensures that performance, test condition and test equipment are according to GomSpace quality.