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NANOCOM AM2150-O MK2
QUALIFICATION CERTIFICATE

Reference: 1068601
Revision: 1.0
Date: 2026-01-05

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Document Title:	NanoCom AM2150-O MK2 qualification certificate		
Reference:	1068601	**Document Class**	QTCT
Revision number:	1.0	**Date:**	2026-01-05

Release Table:

Action	Name	Function	Signature	Date
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Document Change Log (Not mandatory)

Revision	Date	Name	Description
1.0	2026-01-05	ROBB	Creation

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1. Introduction

1.1 Purpose

This document describes the environmental qualification tests carried out on the NanoCom AM2150-O MK2 antenna, a S-band antenna designed for low data rate communication between earth and a LEO satellite.

1.2 References

Ref.	Document title	Document no.	Revision
[1]	NanoCom AM2150-O TID Qualification Test Report	1033124	1.0
[2]	NanoCom AM2150-O MK2 Vibration Test Report	1068630	1.0
[3]	NanoCom AM2150-O MK2 Mechanical Shock Test Report	1076567	1.0
[4]	NanoCom AM2150-O MK2 Thermal Cycling Test Report	1068632	1.0
[5]	NanoCom AM2150-O MK2 Thermal Vacuum Test Report	1068629	1.0
[6]	NanoCom AM2150-O MK2 Check out form	1068634	1.0

2. Total Ionizing Dose Qualification

Test Facility: DTU, Risø, Denmark (irradiation) and GomSpace office Denmark (annealing)

Product ID: NanoCom AM2150-O

Serial No (Part-Item No): 108927-4

Test Condition: NanoCom AM2150-O is oriented with the topside facing the irradiation source. After irradiation, the board is stored unbiased in dry ice while transported from DTU to GomSpace premises for post checkout (within 72hours). The checkout is followed by 24hours of annealing at +25C, a checkout, and then 168hours of annealing at +85C followed by a checkout. Throughout the irradiation and annealing process, the board is biased while current consumption and GSRB related parameters are monitored at regular intervals.

Condition	Test levels
Low-rate ionizing radiation exposure, Board is biased and GSRB related parameters are monitored during the test.	Radiation dose: 20 kRad Radiation rate: 280 Rad/Hour Irradiation time: 70.33 hours
Annealing	24hours at +25C and 168hours at +85C

References: NanoCom AM2150-O TID Qualification Test Report [1].

Remarks: NanoCom AM2150-O MK2 (IFS 112223) reuses the TID test result from AM2150-O (IFS 108927), as all active circuitry remains unchanged on the MK2 compared to the former version of the product.

NanoCom AM2150-O MK2 is hereby qualified with respect to a total ionizing dose of 20 kRad. After completion of the test, the board was fully functional and performed as expected. This document certifies that performance, test conditions and test equipment are according to GomSpace quality.

3. Vibration Test Qualification

Test Facility: Hytec, Aalborg, Denmark

Product ID: NanoCom AM2150-O MK2

Serial No (Part-Item No): 112223-6

Test Condition: NanoCom AM2150-O MK2 is mounted onto a stand which interfaces to a GomSpace 3U interface plate. The interface plate is fixated to a vibration table, and the assembly is exposed to the vibration profiles listed below in the XYZ axis.

Condition	Vibration profile
Random vibration (*Duration: 120 seconds on each axis)*	20Hz, 0.052 g^2/Hz 20-50Hz, +6 dB/Oct 50-800Hz, 0.32 g^2/Hz 800-2000Hz, -6 dB/Oct 2000Hz, 0.052 g^2/Hz Overall, 20.1 g RMS (+/-10%)
Sine vibration (*Sweep rate: 2 octaves / minute on each axis)*	5-8Hz, 10mm (0-p) 8-100Hz, 4.5g (+/-10%)

References: NanoCom AM2150-O MK2 Vibration Test Report [2].

Remarks: None

NanoCom AM2150-O MK2 is hereby tested with respect to vibration. After completion of the test, the board was fully functional and performed as expected. Visual inspection didn't reveal any damage such as cracks, loose screws, delamination etc. This document certifies that performance, test conditions and test equipment are according to GomSpace quality.

4. Mechanical Shock Qualification

Test Facility: GomSpace, Aalborg, Denmark

Product ID: NanoCom AM2150-O MK2

Serial No (Part-Item No): 112223-6

Test Condition: NanoCom AM2150-O MK2 is equipped with a type C backplate to interface with the GomSpace shock bench. The assembly is exposed to three hammer impact generated shocks in the XYZ axis, following a target shock response spectrum profile (SRS) of:

Frequency [Hz]	SRS nominal (+6/-3dB tolerance)
100	50G
1000	1500G
2000	2000G
10000	2000G

References: NanoCom AM2150-O M2 Mechanical Shock Test Report [3].

Remarks: None

NanoCom AM2150-O MK2 is hereby tested with respect to mechanical shock. After completion of the test, the board was fully functional and performed as expected. Visual inspection didn't reveal any damage such as cracks, loose screws, delamination etc. This document certifies that performance, test conditions and test equipment are according to GomSpace quality.

5. Thermal Cycling Qualification

Test Facility: GomSpace, Aalborg, Denmark

Product ID: NanoCom AM2150-O MK2

Serial No (Part-Item No): 112223-1

Test Condition: NanoCom AM2150-O MK2 is placed inside a thermal stress temperature chamber.

Test description	Test levels
Temperature cycling	Low temp: -55°C for 15 minutes High temp: 100°C for 15 minutes 150 cycles of Low / High temp.

References: NanoCom AM2150-O MK2 Thermal Cycling Test Report [4].

Remarks: None

NanoCom AM2150-O MK2 is hereby tested with respect to thermal cycling. After completion of the test, the board was fully functional and performed as expected. This document certifies that performance, test conditions and test equipment are according to GomSpace quality.

6. Thermal Vacuum Qualification

Test Facility: GomSpace, Aalborg, Denmark

Product ID: NanoCom AM2150-O MK2

Serial No (Part-Item No): 112223-1

Test Condition: NanoCom AM2150-O MK2 is mounted onto a GomSpace 6U structure.

The TVAC test expose AM2150-O MK2 to eight temperature cycles under vacuum. Cycle 1 represent non-operational temperature conditions, under which GSRB interface is powered off. Cycles 2 to 8 represents operational temperature conditions. A 10deg margin is added to both non-operational and operational temperature conditions compared to the specified temperature range of the antenna.

The antenna element is stowed when entering Cycle 1 (non-operational) and the release bus interface is unpowered. At the end of the +95°C condition in Cycle 2 (operational), the release bus is powered, and a functional test was conducted whereafter the bus is turned off again.

At the end of the -40°C condition in Cycle 2, the release bus is powered and the antenna was released. From this point onwards the release bus is kept powered. Current consumption and GSRB related parameters are monitored at regular intervals as well as the return loss of the deployed antenna until the end of Cycle 8.

All Cycles has a minimum Dwell time of 120min, except for the last Cycle 8 which has an extended Dwell time of 240minutes. The extended Dwell time is used to monitor and refine thermal model related parameters.

TVAC test settings:

Condition	Test levels
Temperature	95°C +/-3°C and -50°C +/-3°C
Thermal interface temperature	Stabilized to 95°C / -50°C ±3°C
Max rate, temperature cycle	> 2.5 C/min
Temperature cycles	8
Dwell time Cycle 1 to 7	≥120minutes
Dwell time Cycle 8	≥240minutes
Pressure level	<1.0x 10^{-5} mbar

References: NanoCom AM2150-O MK2 Thermal Vacuum Test Report [5].

Remarks: None

NanoCom AM2150-O MK2 is hereby tested with respect to thermal vacuum. After completion of the test, the board was fully functional and performed as expected.

7. Flight Heritage

The NanoCom AM2150-O MK2 is considered to have reached TRL 8, as it has successfully completed qualification testing at unit level in a representative flight configuration.

The MK2 is an incremental update of the AM2150-O, which is at TRL 9 with demonstrated flight heritage since 2022 on multiple missions. The AM2150-O MK2 maintains the same AR6 software version and overall hardware configuration as the heritage unit. The only design change concerns the burn resistors, which are implemented as leaded-type devices instead of SMD-based components.

This limited and well-controlled modification has been fully verified through qualification testing, thereby justifying the assigned TRL.