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HEADQUARTERS: 914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230 • PHONE (410) 354-3300 • FAX (410) 354-3313

January 10, 2021

Nexxiot Inc
7290 Virginia Parkway Suite 3000
McKinney, TX 75071
USA

Dear Kenneth Mannka,

Enclosed is the EMC Wireless test report for compliance testing of the Nexxiot Inc, Globehopper Crossmodal 3.0 as tested to the requirements of the FCC Certification rules under Title 47 of the CFR Part 1 1.1310 RF Exposure.

Thank you for using the services of Eurofins E&E North America. If you have any questions regarding these results or if MET can be of further service to you, please contact me.

Sincerely yours,
EUROFINS E&E NORTH AMERICA

Arsalan Hasan
Wireless Laboratory

Reference: (\Nexxiot Inc\WIRS109627-FCC-MPE Rev 0)

ACCREDITED
TESTING CERT #0591.02

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Electromagnetic Compatibility Criteria Test Report

for the

Nexxiot Inc
Globehopper Crossmodal 3.0

Tested under
FCC Certification Rules
Title 47 of the CFR, Part 1 1.1310

Report: WIRS109627-FCC-MPE Rev 0

January 10, 2021

Prepared For:

Nexxiot Inc
7290 Virginia Parkway Suite 3000
McKinney, TX 75071
USA

Prepared By:
Eurofins E&E North America
3162 Belick Street
Santa Clara, CA 95054

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Title 47 of the CFR, Part 1 1.1310

Felix Huang
Engineer, Wireless Laboratory

Arsalan Hasan
Manager, Wireless Laboratory

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 1 of the FCC Rules under normal use and maintenance.

Eleazar Zuniga, PhD.
Director, Wireless Technologies

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	January 10, 2021	Initial Issue.

Table of Contents

List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**ert**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**ert**z**
kPa	**k**ilo**pa**scal
kV	**k**ilovolt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**micro**henry
µ	**micro**farad
µs	**micro**seconds
NEBS	**N**etwork **E**quipment-**B**uilding **S**ystem
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

I. Executive Summary

1.1 Purpose of Test

An EMC evaluation was performed to determine compliance of the Nexxiot Inc Globehopper Crossmodal 3.0, with the requirements of Part 1. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Globehopper Crossmodal 3.0. Nexxiot Inc should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Globehopper Crossmodal 3.0, has been **permanently** discontinued.

1.2 Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 1, in accordance with Nexxiot Inc, purchase order number PO00435.

Reference	Description	Compliance
§1.1310	RF Exposure	Compliant

Table 1. Executive Summary of EMC ComplianceTesting

II. Equipment Configuration

2.1 Overview

Eurofins E&E North America was contracted by Nexxiot Inc to perform testing on the Globehopper Crossmodal 3.0, under Nexxiot Inc's purchase order number PO00435

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Nexxiot Inc, Globehopper Crossmodal 3.0.

Model(s) Tested:	Globehopper Crossmodal 3.0	
Filing Status:	Original	
EUT Specifications:	Primary Power: 2.4VDC (Battery Operated)	
	FCC ID: 2AXRX-AX3A	
	Module Original Report Number(s): Report: EMC_CTSMC-003-18001_FCC_ISED_MPE_Rev_1	
	Type of Modulations:	GFSK, GMSK, 8PSK, QPSK, 16QAM
	Equipment Code:	DTS, PCB
	Technology	TX Frequency Range
	GSM 850	824 – 849 MHz
	GSM 1900	1850 – 1910 MHz
	LTE CAT-M1 Band 2	1850 – 1910 MHz
	LTE CAT-M1 Band 4	1710 – 1755 MHz
	LTE CAT-M1 Band 5	824 – 849 MHz
	LTE CAT-M1 Band 12	699 – 716 MHz
	LTE CAT-M1 Band 13	777 – 787 MHz
	BLE	2402 – 2480 MHz
	ZigBee	2405 – 2480 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35° C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Arsalan Hasan	
Date(s):	January 10, 2021	

Table 2. EUT Summary Table

2.2 References

CFR 47, Part 22, Subpart H	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 22: Rules and Regulations for Cellular Devices.
CFR 47, Part 24, Subpart E	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 24: Rules and Regulations for Personal Communications Services
CFR 47, Part 27	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 27: Rules and Regulations for Advanced Wireless Services
KDB 996369 D04	Modular Transmitter Integration Guide – Guidance For Host Product Manufacturers
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.26: 2015	Compliance Testing of Transmitters Used in Licensed Radio Services
ISO/IEC 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories
EIA/TIA-603-A-2001	Land Mobile FM or PM Communication Equipment Measurement and Performance Standards
KDB 971168 v02r02	Measurement Guidance For Certification Of Licensed Digital Transmitters

Table 3. Standard References

2.3 Test Site

All testing was performed at Eurofins MET Labs, 3162 Belick St., Santa Clara, CA 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Eurofins MET Labs is a ISO/IEC 17025 accredited site by A2LA, California #0591.02.

2.4 Measurement Uncertainty

Test Method	Typical Expanded Uncertainty	K	Confidence Level
RF Frequencies	±4.52 Hz	2	95%
RF Power Conducted Emissions	±2.32 dB	2	95%
RF Power Conducted Spurious Emissions	±2.25 dB	2	95%
RF Power Radiated Emissions	±3.01 dB	2	95%

Table 4. Measurement Uncertainty

2.5 Description of Test Sample

The Nexxiot Inc Globehopper Crossmodal 3.0 is a zero-maintenance hardware unit for enabling real-time monitoring of non-powered rail cars. Device installation can be done in under 2 minutes ensuring quick and effortless onboarding. Once set up, the Crossmodal device provides real-time updates of location, utilization and sensor readings as often as every 5 minutes. Intelligent energy harvesting, and energy management techniques ensures a hassle-free operation for a guaranteed time of 6 years.

2.6 Equipment Configuration

The EUT was set up as outlined in **Error! Reference source not found.**, Block Diagram of Test Setup. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Revision
	NA	Telemetrics Device	Globehopper Crossmodal 3.0	NA	NA	NA

Table 5: Equipment Configuration

2.7 Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
	Laptop with Windows 10	HP	NA	N/A

Table 6: Support Equipment

2.8 Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (m)	Max Length (m)	Shielded? (Y/N)	Termination Box ID & Port Name
	NA	NA	NA	NA	NA	NA	NA

Table 7: Ports and Cabling Information

2.9 Mode of Operation During Testing

Standard test mode was used. Allows independent activation of all radios in their various test modes, as well as methods to generate traffic similar to normal operation on all digital busses.

2.10 Method of Monitoring EUT Operation

The signal will be displayed on a spectrum analyzer.

2.11 Modifications

2.11.1 Modifications to EUT

No modifications were made to the EUT.

2.11.2 Modifications to Test Standard

No modifications were made to the test standard.

2.12 Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Nexxiot Inc upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Maximum Permissible Exposure

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*(100)	≤6
3.0-30	1842/f	4.89/f	*(900/f^2)	<6
30-300	61.4	0.163	1.0	<6
300-1,500			f/300	<6
1,500-100,000			5	<6
(ii) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	<30
1.34-30	824/f	2.19/f	*(180/f^2)	<30
30-300	27.5	0.073	0.2	<30
300-1,500			f/1500	<30
1,500-100,000			1.0	<30

Table 8. RF Exposure Limits

$$S = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{(PG / 4\pi S)}$$

where, S = Power Density (mW/cm^2)
P = Power Input to antenna (mW)
G = Antenna Gain (numeric value)
R = Distance (cm)

For Antenna Gain → **dBi = 10log(Numeric)**

Technology	TX Frequency Range (MHz)	Peak Gain (dBi)	Type
GSM 850	824 – 849	3.0	External Tape Antenna
GSM 1900	1850 – 1910	3.0	External Tape Antenna
LTE CAT-M1 Band 2	1850 – 1910	3.0	External Tape Antenna
LTE CAT-M1 Band 4	1710 – 1755	3.0	External Tape Antenna
LTE CAT-M1 Band 5	824 – 849	3.0	External Tape Antenna
LTE CAT-M1 Band 12	699 – 716	3.0	External Tape Antenna
LTE CAT-M1 Band 13	777 – 787	3.0	External Tape Antenna
BLE	2402 – 2480	3.5	Ceramic
ZigBee	2405 – 2480	3.5	Ceramic

Table 9. EUT Antenna Gain Specification

Technology	TX Frequency Range (MHz)	Time-average maximum tune-up procedure (dBm)	Division Factor (dB)	Frame-Average Power (dBm)
GSM 850	824 – 849	33 (-3 ~ +1dB)	-9.03	24.97
GSM 1900	1850 – 1910	30 (-3 ~ +1dB)	-9.03	21.97

Table 10. Tune up Power

Technology	TX Frequency Range (MHz)	Maximum Conducted Output Power (dBm)
GSM 850	824 – 849	24.97
GSM 1900	1850 – 1910	21.97
LTE CAT-M1 Band 2	1850 – 1910	25 (-3 ~ +1dB) = 26
LTE CAT-M1 Band 4	1710 – 1755	25 (-3 ~ +1dB) = 26
LTE CAT-M1 Band 5	824 – 849	25 (-3 ~ +1dB) = 26
LTE CAT-M1 Band 12	699 – 716	25 (-3 ~ +1dB) = 26
LTE CAT-M1 Band 13	777 – 787	25 (-3 ~ +1dB) = 26
BLE	2402 – 2480	4 (-1 ~ +1dB) = 5
ZigBee	2405 – 2480	4 (-1 ~ +1dB) = 5

Table 11. Tune up Power

Bands covered under FCC Part 22 / FCC Part 24

Test Results:

Band	Frequency (MHz)	Maximum Conducted Power (dBm)	Conducted Power (mW)	Antenna Gain (dBi)	Antenna Gain (Numeric)	Power Density (mW/cm2)	Limit (mW/cm2)	Margin	Distance (cm)	Result
GSM 850	836.6	24.97	314.05	3.0	1.995	0.124	0.557	-0.432	20	Pass
GSM 1900	1850.2	21.97	157.39	3.0	1.995	0.062	1	-0.937	20	Pass
LTE Band 2	1850.7	26	398.10	3.0	1.995	0.158	1	-0.841	20	Pass
LTE Band 5	824.7	26	398.10	3.0	1.995	0.158	0.549	-0.533	20	Pass

Table 12. MPE Calculation for Bands under Part 22 and Part 24

The safe distance where Power Density is less than the MPE limit listed above was found to be 20 cm.

Bands covered under FCC Part 27

Test Results:

Band	Frequency (MHz)	Maximum Conducted Power (dBm)	Conducted Power (mW)	Antenna Gain (dBi)	Antenna Gain (Numeric)	Power Density (mW/cm2)	Limit (mW/cm2)	Margin	Distance (cm)	Result
LTE Band 4	1710.7	26	398.10	3.0	1.995	0.158	1	-0.841	20	Pass
LTE Band 12	699.7	26	398.10	3.0	1.995	0.158	0.466	-0.308	20	Pass
LTE Band 13	782.5	26	398.10	3.0	1.995	0.158	0.521	-0.363	20	Pass

Table 13 MPE Calculation for Bands under Part 27

The safe distance where Power Density is less than the MPE limit listed above was found to be 20 cm.

Bands covered under FCC Part 15.247 / 15.407

Test Results:

Band	Frequency (MHz)	Maximum Conducted Power (dBm)	Conducted Power (mW)	Antenna Gain (dBi)	Antenna Gain (Numeric)	Power Density (mW/cm2)	Limit (mW/cm2)	Margin	Distance (cm)	Result
BLE	2402	5	3.16	3.5	2.238	0.0014	1	-0.998	20	Pass
ZigBee	2405	5	3.16	3.5	2.238	0.0014	1	-0.998	20	Pass

Table 14. MPE Calculation for Bands under Part 15.247 / 15.407

The safe distance where Power Density is less than the MPE limit listed above was found to be 20 cm.

Note: Results are based on KDB 447498 D01 (Section 7.2) Transmitters used in mobile devices exposure conditions for simultaneous transmission operations.

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0, according to calculated/estimated, numerically modeled, or measured field strengths or power density. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to the MPE limit at the test frequency.

BLE & Cellular or ZigBee & Cellular can transmit simultaneously, the formula for calculating the simultaneous MPE is

CPD1/LPD1 + CPD2/LPD2 + „„ CPDn/LPDn < 1

CPD: Calculated Power Density
LPD: Limit of Power Density

CASE 1:

Simultaneous MPE =	**Cellular**	**+**	**BLE**
=	0.158/0.466	+	0.0014/1
=	0.399	+	0.0014
=	0.4004		

Result: 0.4004 < 1 (Pass)

CASE 2:

Simultaneous MPE =	**Cellular**	**+**	**ZigBee**
=	0.158/0.466	+	0.0014/1
=	0.399	+	0.0014
=	0.4004		

Result: 0.4004 < 1 (Pass)

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2017.

Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1S4075	RADIO COMMUNICATION TESTER	ROHDE & SCHWARZ	CMW500	09/20/2020	09/20/2022
1S2399	TURNTABLE/MAST CONTROLLER	SUNOL SCIENCES	SC99V	SEE NOTE 1	
1S2600	BILOG ANTENNA	TESEQ	CBL6112D	03/19/2019	03/19/2021
1S2733	BILOG ANTENNA	TESEQ	CBL6112D	06/05/2019	06/05/2021
1S3826	DRG HORN ANTENNA	ETS-LINDGREN	3117	12/03/2020	12/03/2022
1S2198	DRG HORN ANTENNA	ETS-LINDGREN	3117	10/07/2019	10/07/2021
1S2000	SPECTRUM ANALYZER	AGILENT	E4448A	11/06/2020	11/06/2022
1S2587	PRE AMPLIFIER	AML COMMUNICATIONS	AML0126L3801	SEE NOTE 1	
1S2653	AMPLIFIER	SONOMA INSTRUMENT	310 N	SEE NOTE 1	
1S2486	5 METER CHAMBER	PANASHIELD - ETS	5M	SEE NOTE 2	
1S3824	SIGNAL GENERATOR	ROHDE & SCHWARZ	SMA100B	11/06/2019	05/06/2021

Table 15. Test Equipment List

Note 1: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.
Note 2: Latest NSA and VSWR data available upon request.

End of Report