Report on the Testing of the

Marquardt GmbH
NH1
In accordance with:
FCC Part 15 Subpart C §15.225
ISED RSS-210 Issue 10, December 2019, Amendment 2020

America

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Prepared for: Marquardt GmbH
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Document Number: NC72193137.2 | Issue: 1

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Brad Reasoner	EMC Technical Lead	**Authorized Signatory**	16 October 2023

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD America, Inc. document control rules.

FCC Accreditation Designation Number US1148 New Brighton, MN Test Laboratory	Innovation, Science, and Economic Development Canada Accreditation Site Number 4512A New Brighton, MN Test Laboratory

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with the standards listed above and the tests shown in Table 1.3.1 of this report.

A2LA Cert. No. 2955.11

ACCREDITATION
Our A2LA Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our A2LA Accreditation.

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Contents

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Table 1.1-1 – Modification Record

Issue	Description of Change	Date of Issue
1	First Issue	16 October 2023

1.2 Introduction

Applicant	Marquardt GmnH
Manufacturer	Marquardt GmnH
Applicant's Email Address	Agnetta.Rebello@marquardt.com
Model Number(s)	NH1
Serial Number(s)	N/A
Number of Samples Tested	1
Test Specification/Issue/Date	FCC Part 15 Subpart C §15.225 ISED RSS-210 Issue 10, December 2019, Amendment 2020
Order Number	72193137
Start of Test	05 October 2023
Finish of Test	05 October 2023
Related Document(s)	ANSI C63.10 & RSS-GEN

1.3 Scope of Testing

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and ISED Canada's Radio Standard Specification RSS-210 Certification.

1.4 Summary of Results

A summary of the tests carried out in accordance with the specifications shown below.

Table 1.4-1 – Summary of Results

Section	Specification Clause		Test Description	Accreditation	Base Standard
2.1	15.203	RSS-GEN	Antenna Requirements	A2LA	FCC Sub Part C 15.203
2.2	15.225(a-c)	RSS-210	Fields Strength within the bands 13.110 MHz – 14.010 MHz	A2LA	ANSI C63.10:2013
2.3	15.225(d)	RSS-210	Fields Strength outside the bands 13.110 MHz – 14.010 MHz	A2LA	ANSI C63.10:2013
2.4	15.225(e)	RSS-210	Frequency Tolerance	A2LA	ANSI C63.10:2013

Table 1.4-2 – Test Accreditation

Test Name	Name of Tester(s)	Results / Comments
Antenna Requirements	Sean Sellergren	Pass
Fields Strength within the bands 13.110 MHz – 14.010 MHz	Sean Sellergren	Pass
Fields Strength outside the bands 13.110 MHz – 14.010 MHz	Sean Sellergren	Pass
Frequency Tolerance	Sean Sellergren	Pass

1.5 Product Information

1.5.1 Technical Description

The Equipment Under Test (EUT): The NH1 is a door handle for a car with capacitive touch sensors and NFC transmitting at 13.56 MHz.

Table 1.5-1 – Wireless Module Technical Information

Detail	Description
FCC ID	IYZNH1
IC	2701A-NH1
Firmware Version	23.38
Transceiver Model #	NH1
Operating Frequency	13.56
Modulation Format	RFID
Antenna Type / Gain:	Coil

A full description and detailed product specification details are available from the manufacturer.

Table 1.5-2 – Cable Descriptions

Cable/Port	Description
Cable Harness	Harness with DC input power and CAN lines

Table 1.5-3 – Support Equipment Descriptions

Make/Model	Description
N/A	N/A

1.5.2 Modes of Operation

The tested mode of operation was: EUT loaded with test firmware to put RFID into 100% transmit mode.

The EUT was placed in transmit mode 100% duty cycle.

Frequency	13.56 MHz

1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test program. The modifications incorporated during each test are recorded on the appropriate test pages.

Table 1.7-1 – Modification Record

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
0	Initial State		

1.8 Test Location

TÜV SÜD conducted the following tests at our New Brighton, MN Test Laboratory.

Office address:

TÜV SÜD America
141 14th Street NW
New Brighton, MN 55112 USA

2 Test Details

2.1 Antenna Requirements

2.1.1 Specification Reference

FCC 47 CFR Part 15 Subpart C, 15.203
RSS-GEN Issue 5

2.1.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state “0”, as noted in §1.6.

2.1.3 Antenna Requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

Note: Above statement is taken from FCC Part 15 Subpart C §15.203

Table 2.1-1 – Antenna Used In EUT

Antenna Type	Connection Type
Coil	On board

2.2 Fields Strength within the bands 13.110 MHz – 14.010 MHz

2.2.1 Specification Reference

FCC 47 CFR Part 15 Subpart C, §15.225(a)(b)(c)
ISED RSS-210 B.6(a)(b)(c)

2.2.2 Equipment Under Test and Modification State

As shown in §1.2 with modifications if any as shown in §1.6.

2.2.3 Date of Test

10 October 2023

2.2.4 Test Method

Measurements were performed in a semi anechoic chamber. The fundamental emission was measured at 3m with the limit adjusted using the formulas provided in ANSI C63.10. The EUT was rotated 360° and the magnetic loop antenna used to maximize emissions. Final emissions were performed using a quasi-peak detector.

2.2.5 Environmental Conditions

The EUT was evaluated within the climatic range of the EUT as specified by the manufacturer. When the manufacturer does not specify climatic parameters for the EUT, all tests are performed within the ambient climatic conditions of the laboratory.

2.2.6 Additional Observations

Measurements were performed using BAT-EMC (v2022.0.27.0) automated software. The reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only.

2.2.7 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dBµV) @ 150 kHz			30.0
Correction Factor (dB/m)	TEMC00002 - LISN	0.03	10.53
	Cable 1	10.50	
Reported Quasi-peak Final Measurement (dBµV) @ 150 kHz			40.53

2.2.8 Test Results

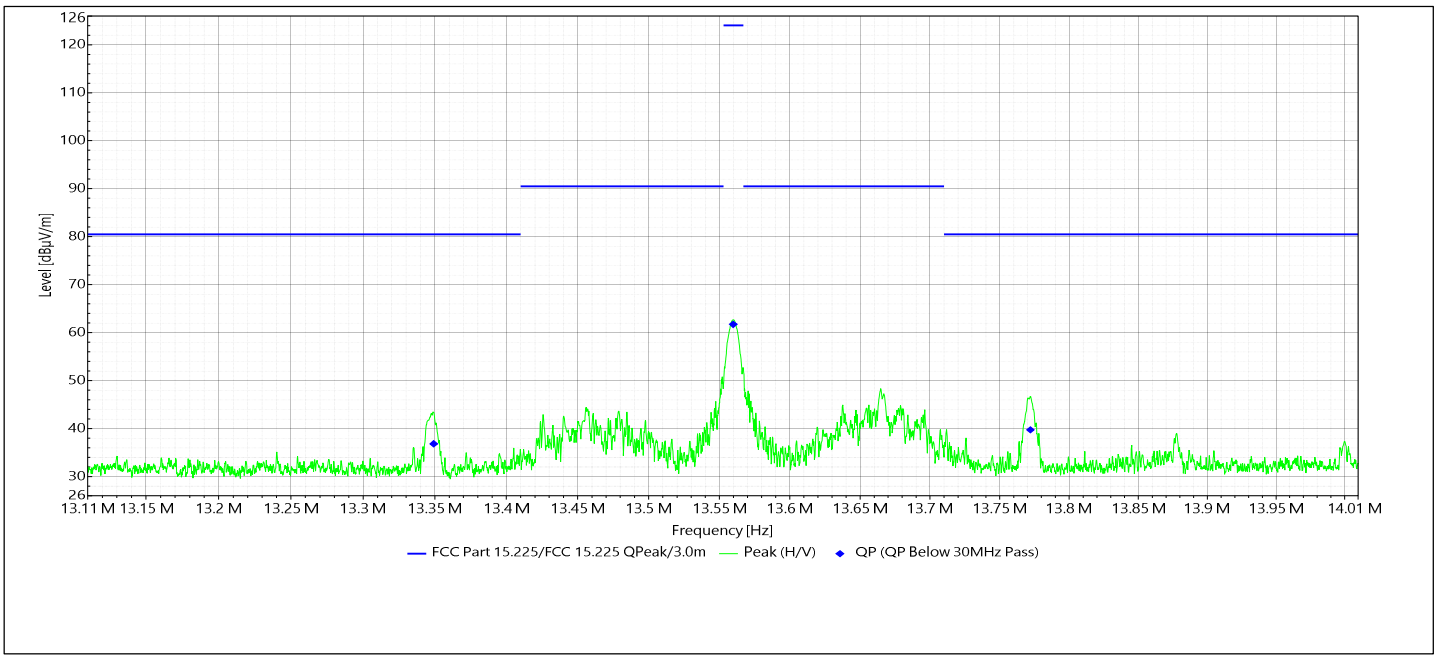
Test Summary: EUT operated as intended before, during, and after testing.

Test Result: Pass

See data below for detailed results.

Test RE 13.110MHz - 14.01MHz - Test Sample 3

Frequency Range	Antenna Distance	Antenna Polarization	RBW	Step Size	Sweep Time
13.11 MHz - 14.01 MHz	3m	*H/V*	9 kHz	*18001 Pts*	*1 ms/MHz*



Limit:	Test Date:	Test Results:
FCC Part 15.225/FCC 15.225	10/4/2023	Pass

Test Notes: Test Sample 3 with Homologation SW loaded.

Figure 2.2-1 – Graphical Results – 13.110MHz – 14.01MHz In Band Measurement – Transmitter Operational

Table 2.2-1 – 13.110MHz – 14.01MHz In Band Measurement – Transmitter Operational

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (º)	Result
13.349	36.85	80.50	-43.65	0.00	Pass
13.560	61.73	124.01	-62.28	173.00	Pass
13.772	39.75	80.5	-40.75	43.00	Pass

2.2.9 Test Location and Test Equipment Used

The tests were carried out in New Brighton, MN.
Test Area: 3mSAC

Table 2.2-2 – Conducted Emissions Test Equipment List

Device #	Manufacturer	Description	Model	Serial #	Cal Code	Cal Date	Cal Due
WRLE02418	EMCO/EMC Test	Antenna, Loop	6502	2215	G	01/23/2023	01/23/2025
WRLE10998	Rohde & Schwarz	Receiver, 20 Hz-26.5 GHz	ESU 26 (SAP 21003498)	100379	G	08/22/2023	08/22/2024

Cal Code G = Calibration performed by an accredited outside source.
Cal Code B = Calibration verification performed internally.
Cal Code Y = Passive Device, or Calibration not required when used with other calibrated equipment.

2.3 Fields Strength outside the bands 13.110 MHz – 14.010 MHz

2.3.1 Specification Reference

FCC 47 CFR Part 15 Subpart C, §15.225(d)
ISED RSS-210 B.6(d)

2.3.2 Equipment Under Test and Modification State

As shown in §1.2 with modifications if any as shown in §1.6.

2.3.3 Date of Test

05 October 2023

2.3.4 Test Method

The EUT was set up in a semi-anechoic chamber on a remotely controlled turntable and placed on a non-conductive table 0.8 m above a reference ground plane.

For 9kHz – 30MHz a pre-scan of the EUT emissions profile was made with the EUT rotated 360° and the magnetic loop antenna used to maximize emissions at a 3m distance. Final measurements were then taken using a quasi-peak detector.

For 30-1000 MHz a pre-scan of the EUT emissions profile was made while varying the antenna-to-EUT azimuth and antenna-to-EUT polarization using a peak detector; measurements were taken at a 3m distance.

Final readings were maximized by adjusting the antenna height, polarization and turntable azimuth, in accordance with the specification. For below 1 GHz final measurements were taken with a quasi-peak detector.

The EUT was assessed against the limits specified in FCC 47 CFR Part 15C §15.209.

2.3.5 Environmental Conditions

The EUT was evaluated within the climatic range of the EUT as specified by the manufacturer. When the manufacturer does not specify climatic parameters for the EUT, all tests are performed within the ambient climatic conditions of the laboratory.

2.3.6 Additional Observations

The highest frequency to which the DUT was measured was determined in accordance with §15.33(a)(1).

Automated measurements used BAT-EMC (v2022.0.27.0) software. All measurements were done at a 3m distance. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only.

2.3.7 Sample Computation (Radiated Emissions)

Measuring equipment raw measurement (dBµV) @ 30 MHz			20.0
Correction Factor (dB/m)	Cable 2	0.24	18.94
	TEMC00011 (antenna)	18.70	
Reported Quasi-peak Final Measurement (dBµV/m) @ 30 MHz			38.94

2.3.8 Test Results

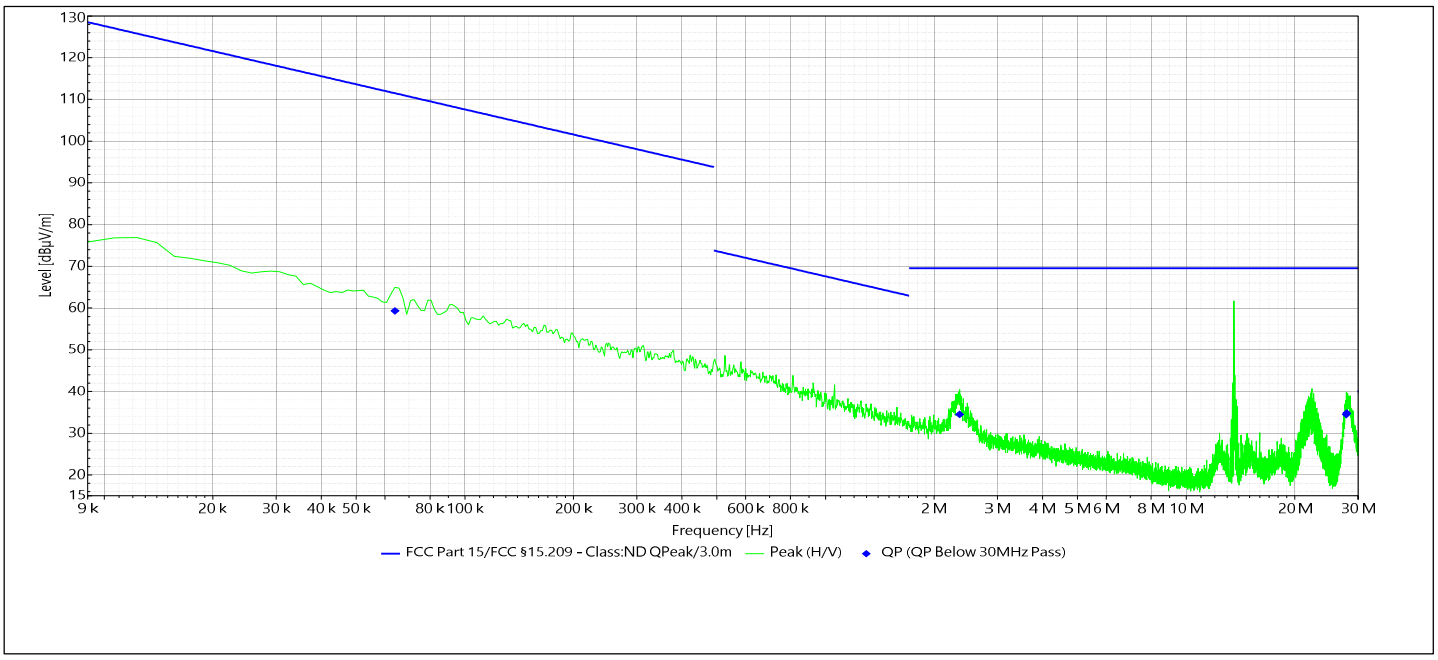
Test Summary: The EUT was set to transmit constant transmit mode using special test software loaded in the EUT.

Test Result: Pass

See data below for detailed results.

Spurious Emissions RE 9kHz - 30MHz - Test Sample 3 - FCC Sample

Frequency Range	Antenna Distance	Antenna Polarization	RBW	Step Size	Sweep Time
9 kHz - 30 MHz	3m	*H/V*	9 kHz	*18001 Pts*	*1 ms/MHz*



Limit:	Test Date:	Test Results:
FCC Part 15/FCC §15.209	10/5/2023	Pass

Test Notes: Test Sample 3 with Homologation SW loaded.

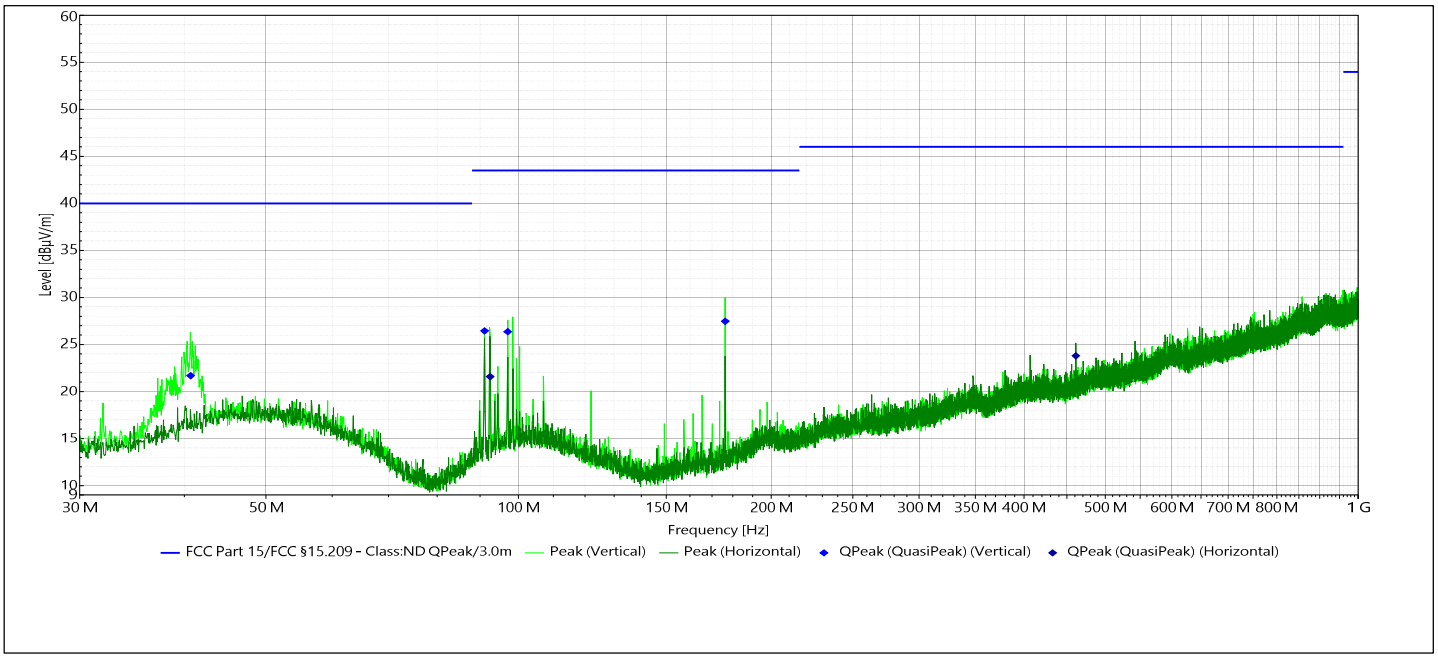
Figure 2.3-1 – RE Spurious Emissions 9 kHz- 30 MHz – Transmitter Operational

Table 2.3-1 – RE Spurious Emissions 9 kHz- 30 **MHz – Transmitter Operational**

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (º)	Result
0.064	59.32	111.47	-52.15	59.00	Pass
2.353	34.51	69.54	-35.03	11.00	Pass
27.799	34.48	69.54	-35.06	204.00	Pass
27.872	34.83	69.54	-34.71	84.00	Pass

Spurious Emissions RE 30M-1GHz Test Sample 3 - FCC Sample

Frequency Range	Antenna Distance	Antenna Polarization	RBW	Step Size	Sweep Time
30 MHz - 1 GHz	3m	*Vertical*	100 kHz	*18001 Pts*	*1 ms/MHz*
30 MHz - 1 GHz	3m	*Horizontal*	100 kHz	*18001 Pts*	*1 ms/MHz*



Limit:	Test Date:	Test Results:
FCC Part 15/FCC §15.209	10/5/2023	Pass

Test Notes: Test Sample 3 with Homologation SW loaded.

Figure 2.3-2 – RE Spurious Emissions 30-1000 MHz – Transmitter Operational

Table 2.3-2 – RE Spurious Emissions 30-1000 MHz – Transmitter Operational

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (°)	Height (m)	Polarity	Result
40.679	21.69	40.00	-18.31	180.00	1.01	Vertical	Pass
91.100	26.45	43.50	-17.05	217.00	1.36	Vertical	Pass
97.071	26.36	43.50	-27.14	316.00	1.75	Vertical	Pass
176.278	27.46	43.50	-16.04	336.00	1.06	Vertical	Pass
92.501	21.58	43.50	-21.92	265.00	3.17	Horizontal	Pass
461.033	23.79	46.00	-22.21	316.00	1.00	Horizontal	Pass

2.3.9 Radiated Emissions photos

2.3.10 Test Location and Test Equipment Used

The tests were carried out in New Brighton, MN.
Test Area: 3mSAC

Table 2.3-3 – Radiated Emissions Equipment List

Device #	Manufacturer	Description	Model	Serial #	Cal Code	Cal Date	Cal Due
NBLE11142	Hewlett-Packard	Preamplifier, 0.1 to 1300 MHz	8447D	2727A05370	B	10/19/2022	10/19/2023
WRLE10998	Rohde & Schwarz	Receiver, 20 Hz-26.5 GHz	ESU 26 (SAP 21003498)	100379	G	08/22/2023	08/22/2024
NBLE11645	Schwarzbeck	Antenna, Trilog Broadband, 30-7000 MHz	VULB 9162	0254	G	04/25/2023	04/25/2025
WRLE02418	EMCO/EMC Test	Antenna, Loop	6502	2215	G	01/23/2023	01/23/2025

Cal Code G = Calibration performed by an accredited outside source.
Cal Code B = Calibration verification performed internally.
Cal Code Y = Passive Device, or Calibration not required when used with other calibrated equipment.

2.4 Frequency Tolerance

2.4.1 Specification Reference

FCC 47 CFR Part 15 Subpart C, §15.225(e)
ISED RSS-210 B.6

2.4.2 Equipment Under Test and Modification State

As shown in §1.4 with modification state "0", as noted in §1.6.

2.4.3 Date of Test

05 October 2023

2.4.4 Test Method

A baseline measurement was taken with the EUT powered at nominal voltage / nominal temperature and was used for a reference to determine frequency stability at the various temperature and voltage conditions. The EUT was placed inside a temperature chamber with a near field probe placed near the EUT's antenna location for frequency measurement. The voltages and temperature was adjusted per the requirements of FCC 15.225(e) and the peak frequency was measured and recorded to ensure that the frequency remained within ±0.01% (±100ppm).

2.4.5 Environmental Conditions

The EUT was evaluated within the climatic range of the EUT as specified by the test standard requirements inside a temperature chamber.

2.4.6 Test Results

Test Summary: The EUT was tested at 20ºC with the power supply to the EUT set to 85% and 115% of nominal voltage. The EUT was then powered by nominal voltage starting at a temperature of +50ºC and stepped down to -20ºC in 10ºC steps. At each temperature step the EUT was stabilized to the temperature and the maximum transmit frequency was recorded before moving to the next temperature value.

Test Result: Pass

See data below for detailed results.

Marquardt NH1

Degrees C	Frequency (MHz)	ppm	Percentage (%)	ppm upper limit	ppm lower limit	Percentage Limit (%)	Reference Frequency (MHz)
50	13.559757	-13.717	0.001372	100	-100	0.01	13.559943
40	13.559735	-15.339	0.001534	100	-100	0.01	13.559943
30	13.559735	-15.339	0.001534	100	-100	0.01	13.559943
20	13.559811	-9.735	0.000973	100	-100	0.01	13.559943
10	13.559908	-2.581	0.000258	100	-100	0.01	13.559943
0	13.559989	3.392	-0.000339	100	-100	0.01	13.559943
-10	13.560091	10.915	-0.001091	100	-100	0.01	13.559943
-20	13.560157	15.782	-0.001578	100	-100	0.01	13.559943

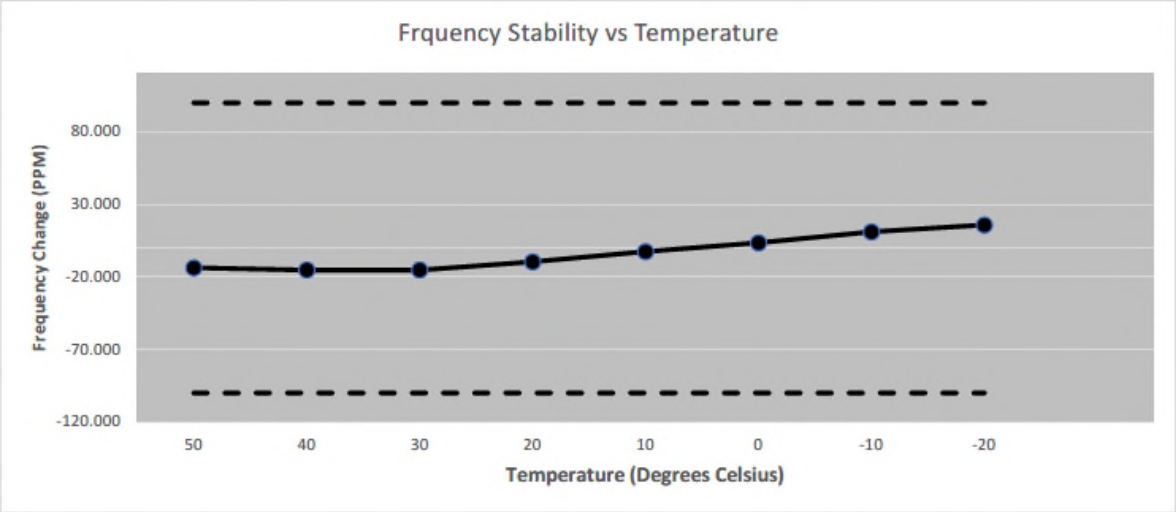


Figure 2.4-1 – Frequency Tolerance – Nominal Voltage – Variable Temperature

Table 2.4-1 – Frequency Stability

Temperature ºC	EUT Power Supply Setting (Vdc)	Measured Frequency	PPM	Measured Tolerance Percentage (%)	PPM Limit	Tolerance Percentage Limit (%)
20	12Vdc (Nominal)	13.559943	N/A	N/A	N/A	N/A
20	10.2 (85%)	13.559927	-1.180	0.000118	±100	±0.01
20	13.8 (115%)	13.559886	-4.204	0.000420	±100	±0.01

Note: Measurement taken at 20ºC nominal voltage is used as the reference frequency and not compared to any limits.

2.4.7 Test Location and Test Equipment Used

The tests were carried out in New Brighton, MN.
Test Area: TRN1

Table 2.4-2 – Restricted Band Edge Equipment List

Device #	Manufacturer	Description	Model	Serial #	Cal Code	Cal Date	Cal Due
NBLE11105	Sorensen	Power Supply, DC 33V-33A	XHR33-33-MGA (SAP 21003730)	1215A01757	Y	N/A	N/A
NBLE11522	Espec	Environmental Chamber	SU-241 (TUV)	92010168	G	08/01/2023	08/01/2024
WRLE10998	Rohde & Schwarz	Receiver, 20 Hz-26.5 GHz	ESU 26 (SAP 21003498)	100379	G	08/22/2023	08/22/2024

Cal Code G = Calibration performed by an accredited outside source.
Cal Code B = Calibration verification performed internally.
Cal Code Y = Passive Device, or Calibration not required when used with other calibrated equipment.

3 Diagram of Test Setups

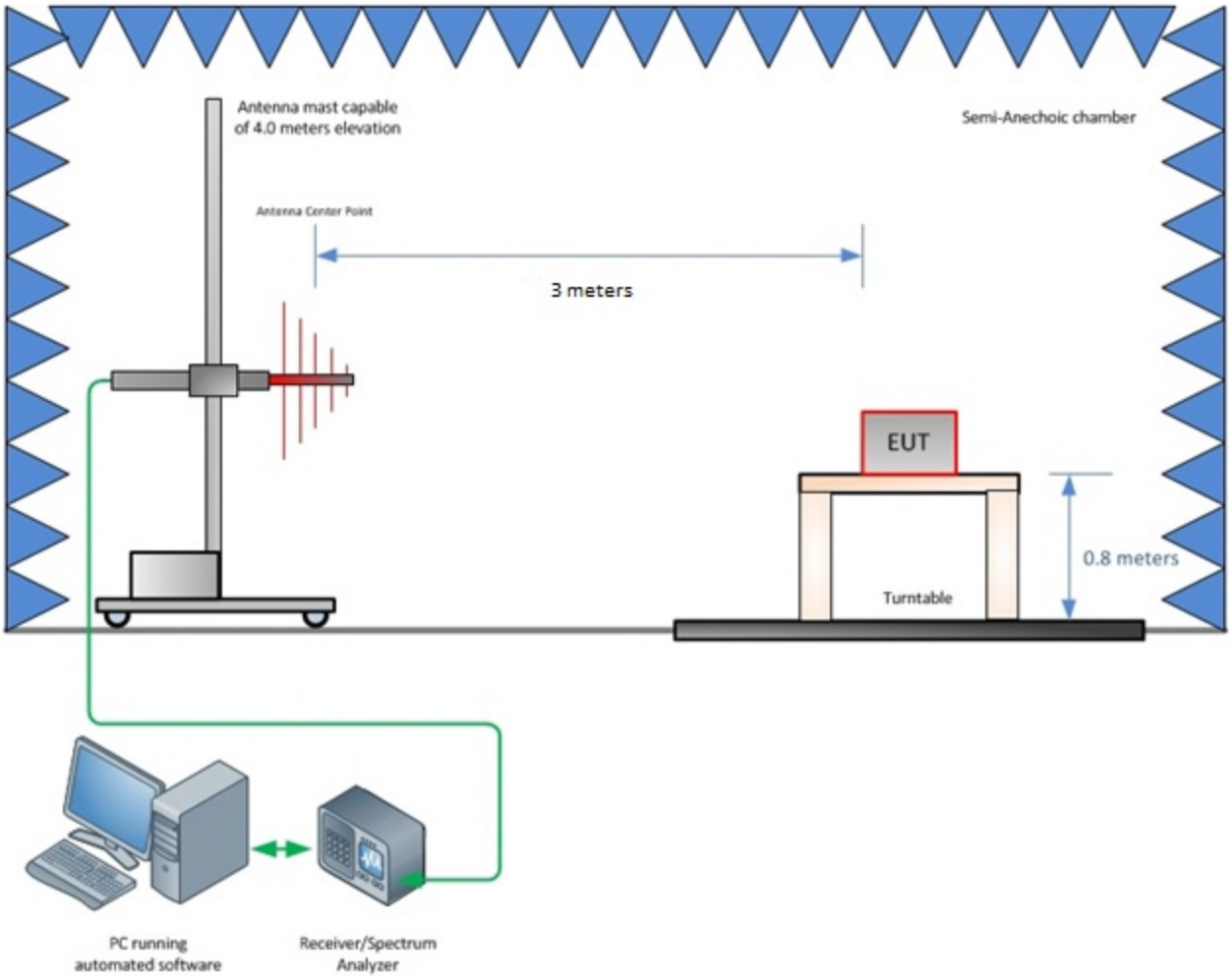


Figure 3-1 – Radiated Emissions Test Setup up to 1 GHz

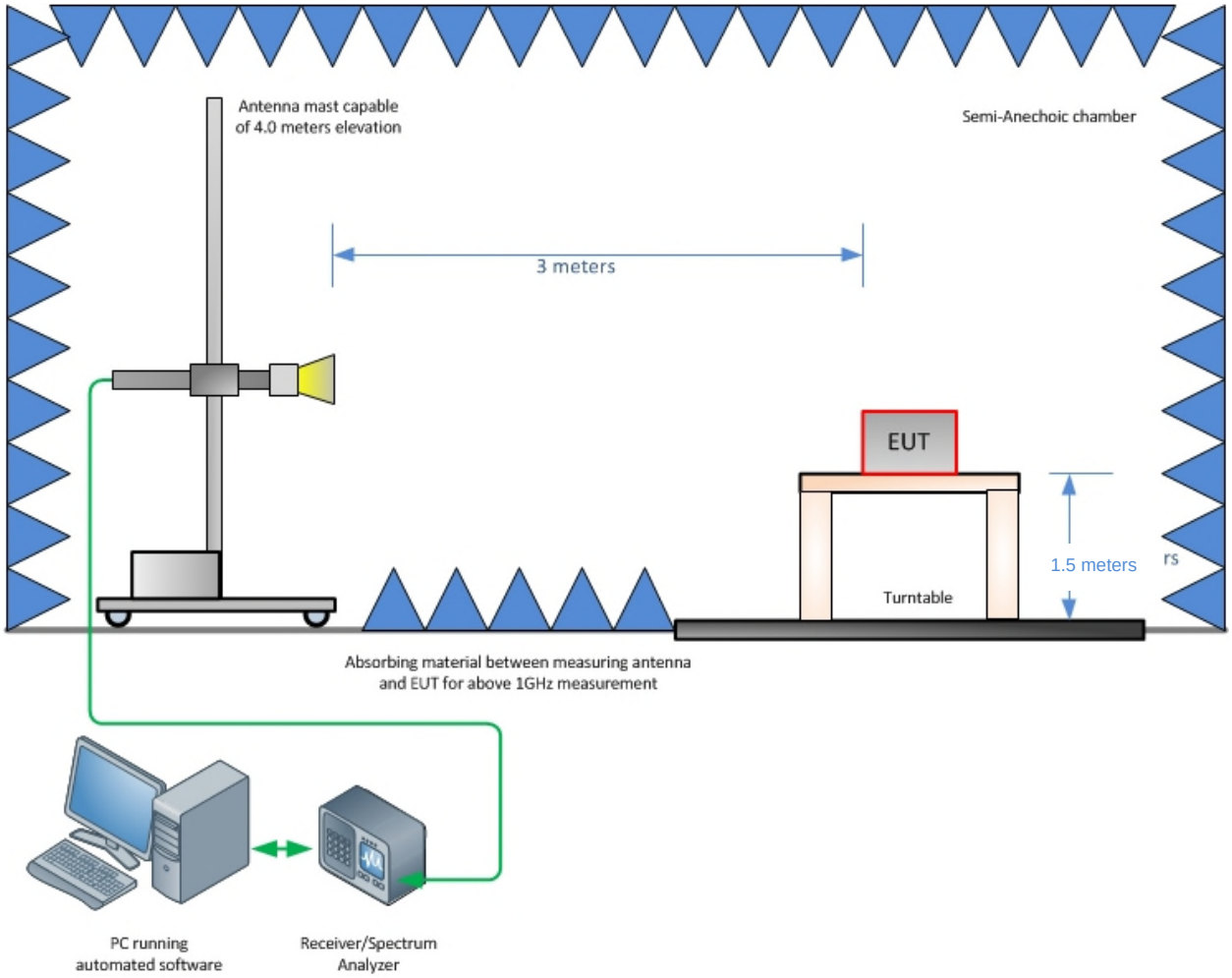


Figure 3-2 – Radiated Emissions Test Setup above 1 GHz

4 Accreditation, Disclaimers and Copyright

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This report must not be used to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the federal government.

STATEMENT OF MEASUREMENT UNCERTAINTY – Emissions

The test system for conducted emissions is defined as the LISN, tuned receiver or spectrum analyzer, and coaxial cable. This test system has a measurement uncertainty of ±3.30 dB. The test system for radiated emissions is defined as the antenna, the pre-amplifier, the spectrum analyzer and the coaxial cable. This test system for 30 MHz-1000 MHz has a measurement uncertainty of ±5.88 dB and above 1 GHz a measurement uncertainty of ±4.47 dB. The measurement uncertainty values for conducted and radiated emissions meet the requirements as expressed in CISPR 16-4-2. The equipment comprising the test systems is calibrated on an annual basis.

TEST EQUIPMENT

All measurement instrumentation is traceable to the National Institute of Standards and Technology and is calibrated to meet test method standard requirements and/or manufacturer's specifications