Report on the Testing of the

iKeyless LLC
HNSSL-G070

FCC ID: X32-HNSSLG070
IC: 8797A-HNSSLG070

America

Add value.
Inspire trust.

In accordance with:
FCC 47 CFR Part 15.231
FCC 47 CFR Part 15.109
ISED RSS-210 Issue 10, December 2019
ISED RSS-GEN Issue 5, April 2018

Prepared for: iKeyless LLC
12101 Sycamore Station Pl. Ste 140
Louisville, Kentucky, 40299

COMMERCIAL-IN-CONFIDENCE

Document Number: NC72180763.1 | Issue: 1

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Sean Sellergren	Sr. EMC Engineer	**Authorized Signatory**	09 August 2022

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.

TÜV SÜD America Inc
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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	09 August 2022
2	Add peak data to above 1GHz spurious emissions	12 December 2022

1.2 Introduction

Applicant	iKeyless LLC
Manufacturer	iKeyless LLC
Applicant's Email Address	pdeokar@ikeyless.com
Model Number(s)	HNSSL-G070
Serial Number(s)	01, 02, 03, 04, 05, 06, 07, 08
Number of Samples Tested	8
ISED PMN	HNSSL-G070
ISED HVIN	HNSSL-G070
ISED FVIN	HNSSL-F010
ISED HMN	n/a
Test Specification/Issue/Date	FCC 47 CFR Part 15.231 FCC 47 CFR Part 15.109 ISED RSS-210 Issue 10, December 2019 ISED RSS-GEN Issue 5, April 2018
Order Number	72180763
Date of Receipt of EUT	19 JUL 2022
Start of Test	20 JUL 2022
Finish of Test	01 AUG 2022
Related Document(s)	ANSI C63.10 2013 HNSSL - FCC Testing.pdf

1.3 Scope of Testing

To perform certification testing to confirm that the wireless device(s) meet the requirements of the applicable standards and guidance documents.

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

Report Section	Specification Clause		Test Description	Accredit -ation	Base Standard
2.1	15.203	RSS-GEN	Antenna Requirements	A2LA	FCC Part 15.203
2.2	15.231(a)(1), (2)	RSS-210 A.1.1 a, b	Deactivation Period	A2LA	ANSI C63.10:2013
2.3	15.231(a)(3)	RSS-210 A.1.1 c	Pulse Characteristics & Duty Cycle of Transmitter	A2LA	ANSI C63.10:2013
2.4	15.231(b)(1), (e)	RSS-210 A.1.2; A.1.4	Field Strength of Fundamental	A2LA	ANSI C63.10:2013
2.4	15.231(b)(1), (e)	RSS-210 A.1.2; A.1.4	Field Strength of Emissions	A2LA	ANSI C63.10:2013
2.5	15.231(c)	RSS-210 A.1.3	Occupied Bandwidth	A2LA	ANSI C63.10:2013
2.6	15.231(d)	RSS-GEN 6.11	Frequency Stability (40 MHz TX only)	A2LA	ANSI C63.10:2013

Table 1.4-2 – Test Accreditation

Test Name	Name of Tester(s)	Results / Comments
Antenna Requirements	Franklin Rose	Pass
Deactivation Period	Franklin Rose	Pass
Pulse Characteristics &	Franklin Rose	Pass
Duty Cycle of Transmitter	Franklin Rose	Pass
Field Strength of Fundamental	Franklin Rose	Pass
Field Strength of Emissions	Franklin Rose	Pass
Occupied Bandwidth	Franklin Rose	Pass
Frequency Stability (40 MHz TX only)	Franklin Rose	n/a

Note: Tests marked with N/A were not tested due to EUT not meeting the full requirements for test applicability and therefore are not required.

1.5 Product Information

1.5.1 Technical Description

The Equipment Under Test (EUT): HNSSL-G070 keyfob device.

Table 1.5-1 – Wireless Module Technical Information

Detail	Description
FCC ID	X32-HNSSLG070
IC	8797A-HNSSLG070
Transceiver Model #	HNSSL-G070
Operating Frequency	313.55 – 314.15 MHz; 433.66 – 434.18 MHz
Modulation Format	FSK
Antenna Type	PCB Loop
Antenna Gain	313.55 – 314.15 MHz: -13.90 dBi; 433.66 – 434.18 MHz: -10.22 dBi

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

Table 1.5-2 – Cable Descriptions

Cable/Port	Description
SMA Connector	SMA Lead (conducted samples only)

Table 1.5-3 – Support Equipment Descriptions

Make/Model	Description
N/A	N/A

1.5.2 Modes of Operation

Table 1.5-4 – Test Frequencies & Modes of Operation

Channel	Frequency (MHz)
Low	313.55 MHz
High	314.15 MHz
Low	433.66 MHz
High	434.18 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 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

Frequency	Antenna Type	Connection Type	Antenna Gain
313.55 – 314.15 MHz	PCB Loop	Integral	-13.90 dBi
433.66 – 434.18 MHz	PCB Loop	Integral	-10.22 dBi

Note: The antenna and antenna connector are fully contained within the EUT and are inaccessible to the end user.

2.2 Deactivation Period

2.2.1 Specification Reference

FCC 47 CFR Part 15.231(a)(1), (2)
ISED RSS-210 A.1.1 a, b

2.2.2 Equipment Under Test and Modification State

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

2.2.3 Date of Test

2022-July-20

2.2.4 Test Method

The spectrum analyzer was triggered to sweep on the TX of the device. Sweep time was set equal to or greater than the specified time for periodic operation. The device was manually activated and to confirm that it ceases transmission within the specified time of deactivation. Periodic transmissions at regular predetermined intervals were verified to not exist, except where regulatory requirements allow polling or supervision transmissions, including data, to determine system integrity. In addition to this test data, compliance is addressed by an attestation supported by the equipment theory of operation.

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 Test Results

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

Test Result: Pass

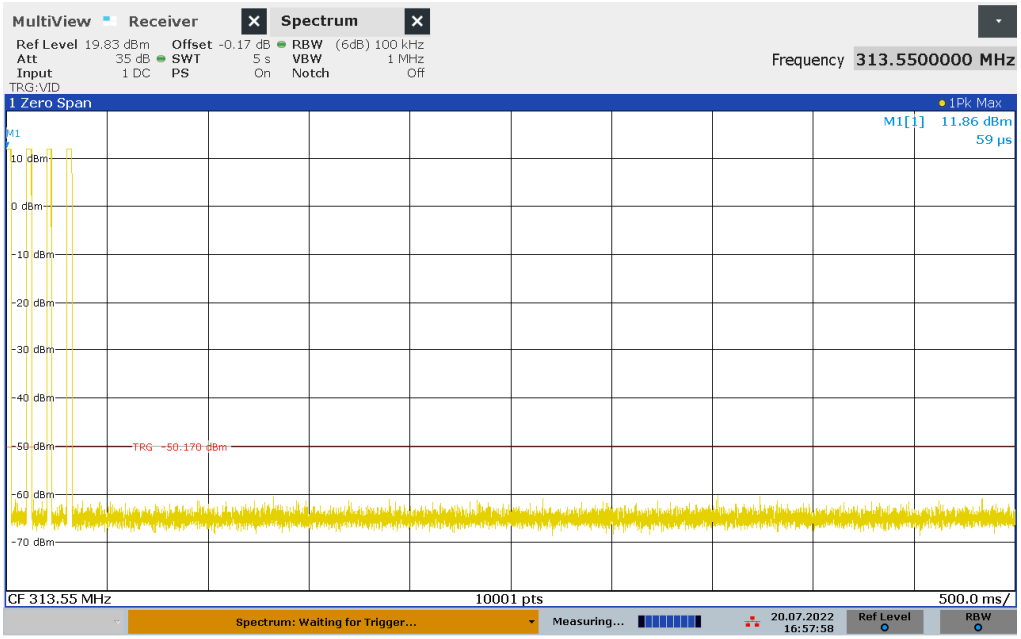


Figure 2-1 – Deactivation Period (313.55 MHz)

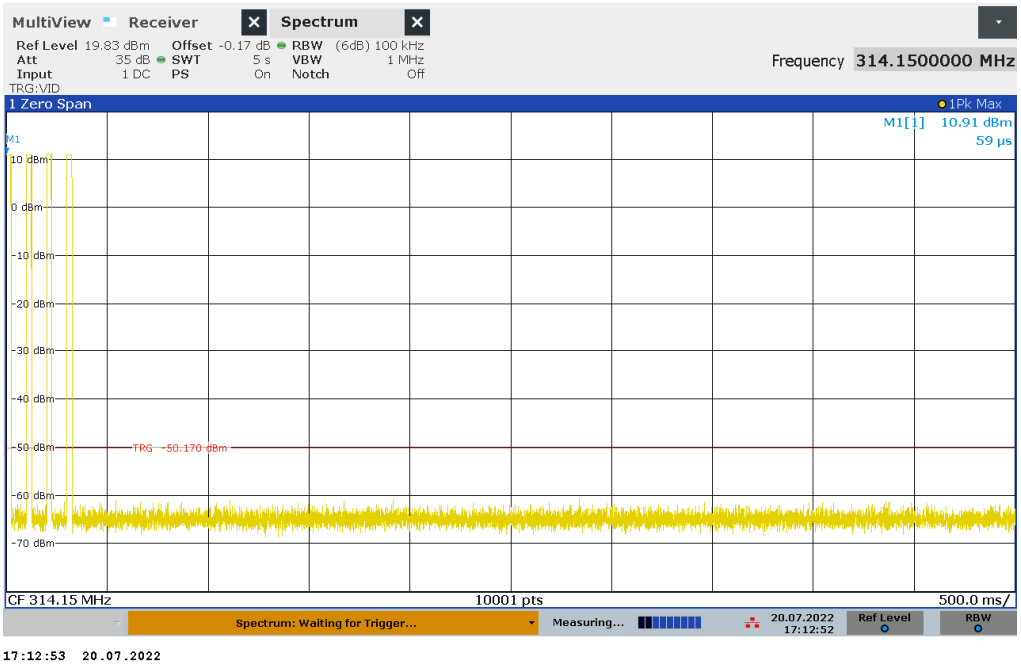


Figure 2-2 – Deactivation Period (314.15 MHz)

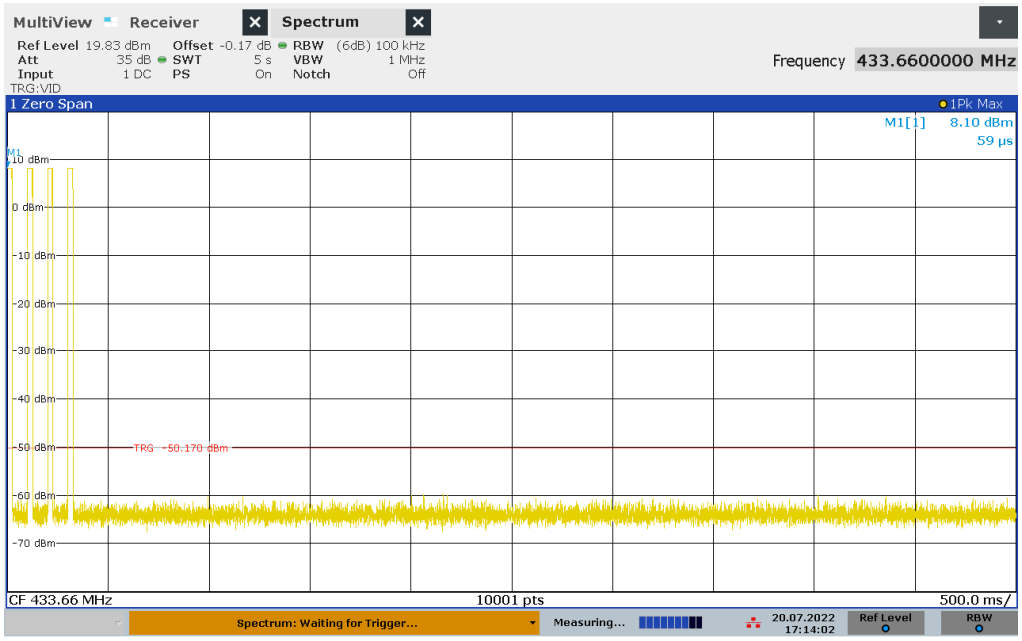


Figure 2-3 – Deactivation Period (433.66 MHz)

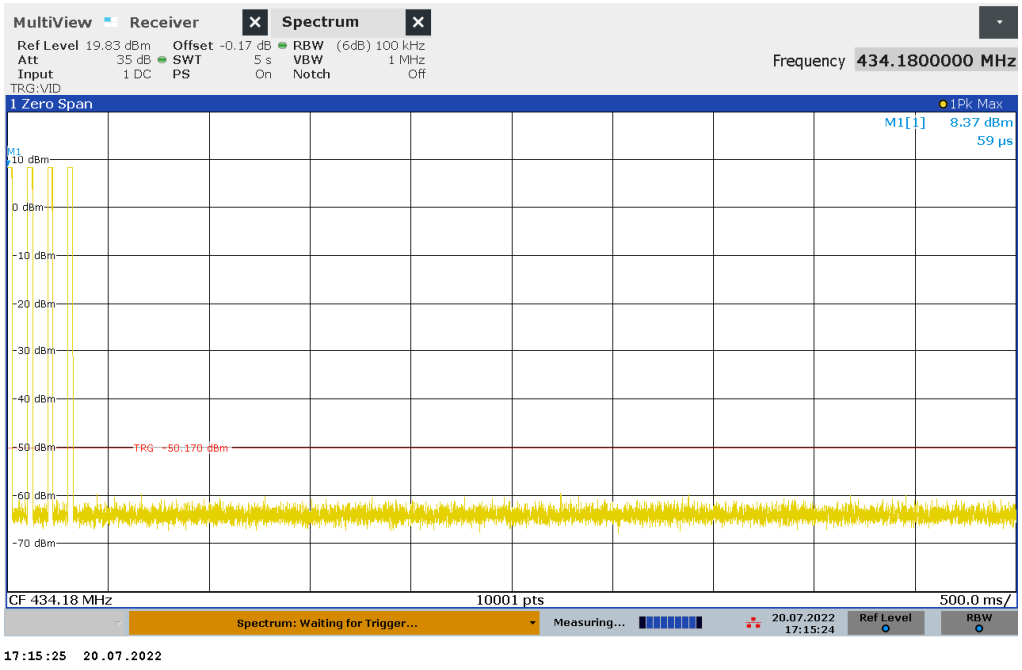


Figure 2-4 – Deactivation Period (434.18 MHz)

2.2.7 Test Location and Test Equipment Used

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

Table 2.2-1 – Conducted Emissions Test Equipment List

Device #	Manufacturer	Description	Model	Serial #	Cal Code	Cal Date	Cal Due
NBLE03517	Florida RF Labs	Cable, SMA	FL200	3ft-12	B	12/22/2021	12/22/2022
WRLE11324	Mini-Circuits Lab	Attenuator, 10 dB	BW-N10W5	1324	B	12/02/2021	12/02/2022
NBLE11754	Rohde & Schwarz	Receiver, 1 Hz-44 GHz	ESW44	103037	G	09/10/2021	09/10/2022

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 Pulse Characteristics / Duty Cycle

2.3.1 Specification Reference

FCC 47 CFR Part 15.231(a)(3)
ISED RSS-210 A.1.1 c

2.3.2 Equipment Under Test and Modification State

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

2.3.3 Date of Test

2022-July-20

2.3.4 Test Method

The EUT switches, controls, or input data streams were adjusted to ensure that the EUT is transmitting or encoded to obtain the “worst-case” pulse ON time. A radiated, direct connection (i.e., conducted) or a “near-field” coupling method was used to assess the EUT. The RBW was adjusted to be equal or larger than the occupied bandwidth of the signal; the center frequency of the spectrum analyzer was set to the center of the RF signal, and the spectrum analyzer was put into Time Domain analysis (Zero Hz Span). The Sweep Time was adjusted to obtain at least a 100 ms period of time on the horizontal display axis of the spectrum analyzer.

The EUT pulse train is **periodic** (i.e., consists of a series of pulses that repeat in a characteristic pattern over a constant time period), and the period (T) is less than or equal to 100 ms. The Trigger was set to capture at least one period of the pulse train, including any blanking intervals. Total maximum pulse “On time” (tON) over one period of the pulse train was determined by summing the duration of all of the pulses within the pulse train [i.e., tON = Σ(t1 + t2 + …tn), and the duty cycle was then determined by dividing the total maximum “On time” by the period of the pulse train (tON/T).

The duty cycle correction factor was then determined by applying the following equation to the duty cycle determined in the preceding steps:

*20 * Log(numeric duty cycle) = Duty Correction (dB)*

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 Test Results

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

Test Result: Pass

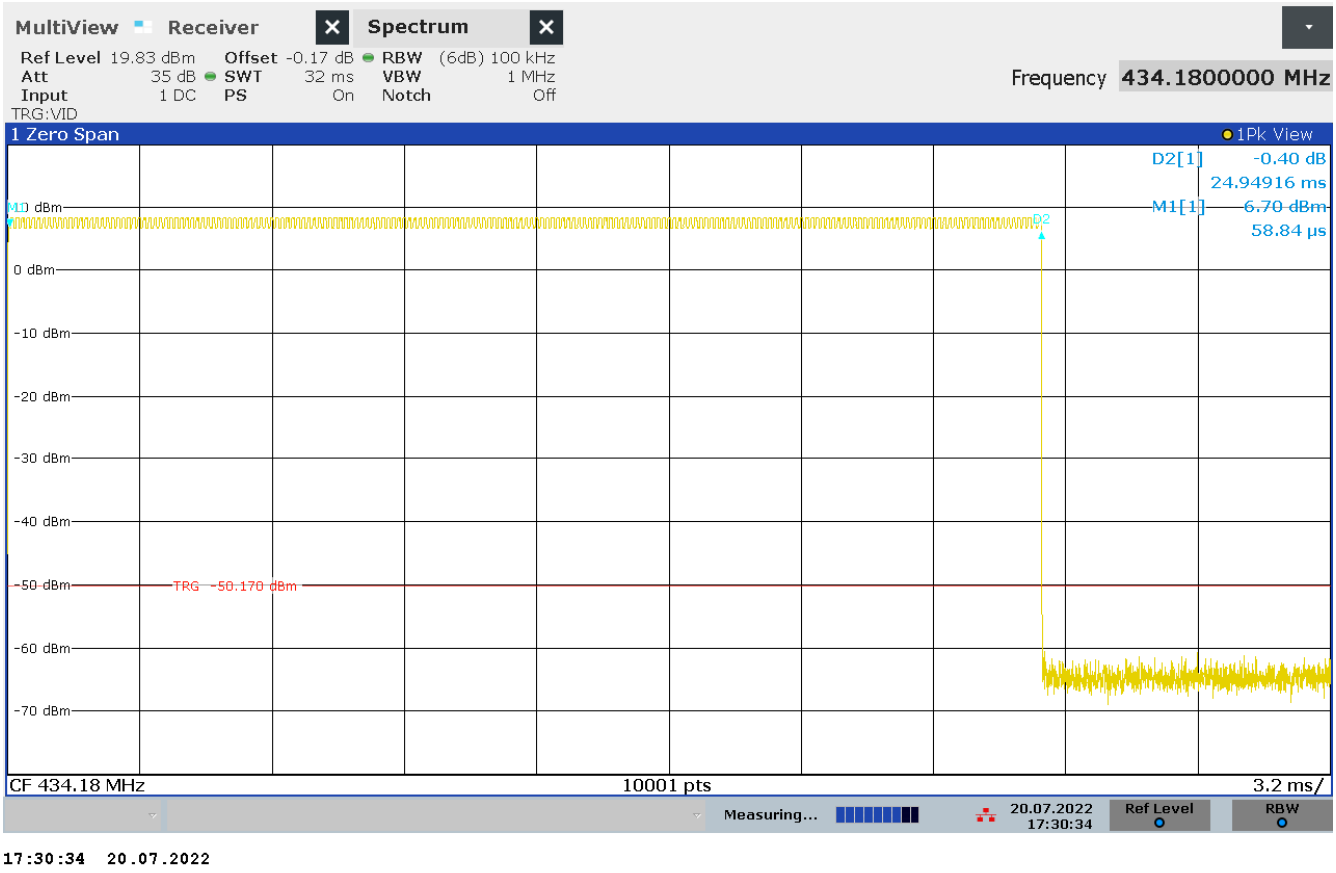


Figure 2-5 – FSK Burst 1, 25.0 ms

TX On-time per Burst = 25.0 / Burst

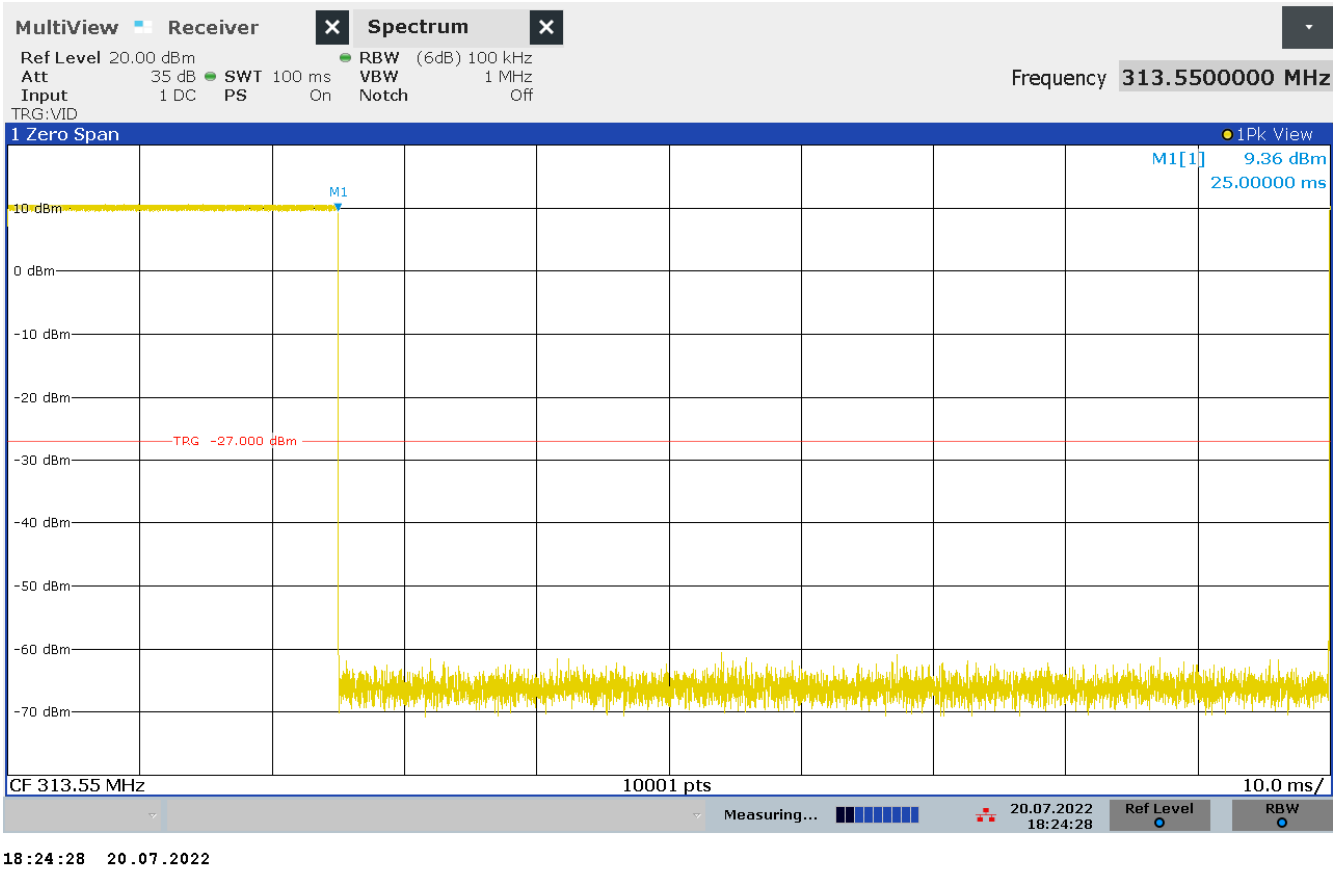


Figure 2-6 – FSK Bursts in 100ms, 1.0 Bursts

EUT Duty Cycle (per 100ms) = (on time 25 ms) /100 ms = **25%**

Duty Cycle Correction Factor = 20 * Log(0.25) = **-12.04 dB**

NOTE: Duty Cycle was evaluated at each test frequency and found to be identical.

2.3.7 Test Location and Test Equipment Used

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

Table 2.3-1 – Conducted Emissions Test Equipment List

Device #	Manufacturer	Description	Model	Serial #	Cal Code	Cal Date	Cal Due
NBLE03517	Florida RF Labs	Cable, SMA	FL200	3ft-12	B	12/22/2021	12/22/2022
WRLE11324	Mini-Circuits Lab	Attenuator, 10 dB	BW-N10W5	1324	B	12/02/2021	12/02/2022
NBLE11754	Rohde & Schwarz	Receiver, 1 Hz-44 GHz	ESW44	103037	G	09/10/2021	09/10/2022

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 Radiated Fundamental Field Strength

2.4.1 Specification Reference

FCC 47 CFR Part 15.231(b)(1), (e)
ISED RSS-210 A.1.2; A.1.4

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

2022-July-21 to 2022-August-03

2.4.4 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 30-1000 MHz and 1.5m above the ground plane for above 1 GHz.

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.

For above 1 GHz a pre-scan of the EUT emissions profile was made while varying the antenna-to-EUT azimuth and antenna-to-EUT polarization using peak and average detectors; measurements were taken at a 3m distance.

For all frequency ranges the final readings were maximized by adjusting the antenna height, polarization and turntable azimuth, in accordance with the specification. For final measurements below 1 GHz a quasi-peak detector was used and above 1 GHz final measurements were re-measured with peak and average detectors.

2.4.5 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.

2.4.6 Additional Observations

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

Automated measurements used BAT-EMC (v3.18) software. 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.

2.4.7 Sample Computation (Radiated Emissions)

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

2.4.8 Test Results

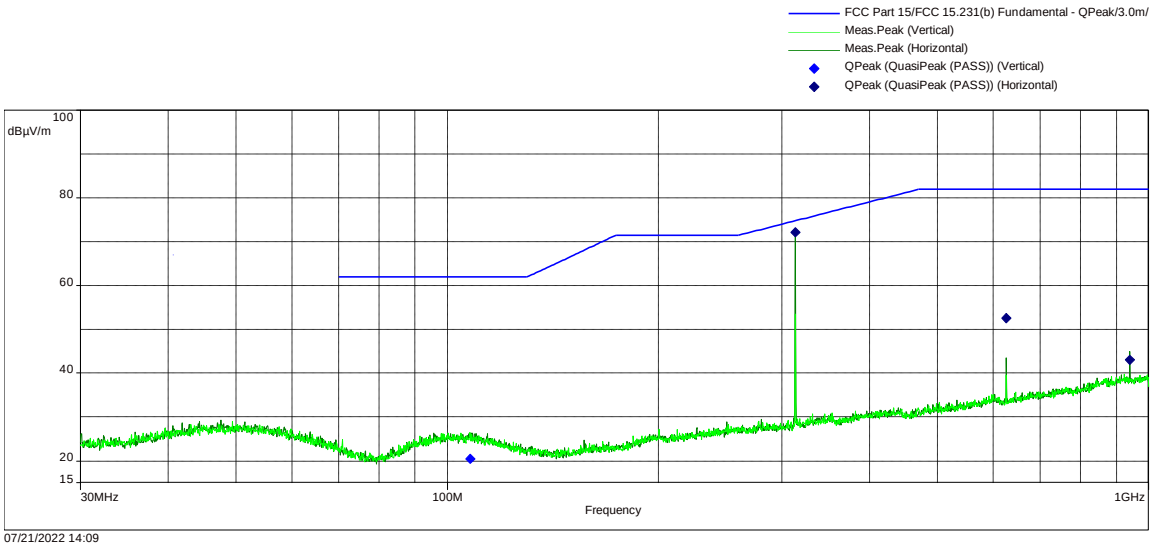
Test Summary: EUT operated as intended before, during, and after testing.

Test Result: Pass

See data below for detailed results.

RE 30M-1GHz (TX 313.55 MHz)

Frequency Range	Polarity	Antenna Distance	RBW	Step Size	Sweep Time
30MHz- 1GHz	Vertical	3m	100kHz	18001Pts	Auto
30MHz- 1GHz	Horizontal	3m	100kHz	18001Pts	Auto



Limit:
FCC 15.231(b) fundamental limit

Test Results:
Pass

Figure 2-7 – RE Spurious Emissions 30-1000 MHz – Low Channel 1

Table 2.4-1 – RE Fundamental Emission 30-1000 MHz – Low Channel 1

Frequency	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)	Azimuth (º)	Height (m)	Polarity	QP Result
313.55827MHz	72.19	74.79	-2.60	145.00	1.00	Horizontal	PASS

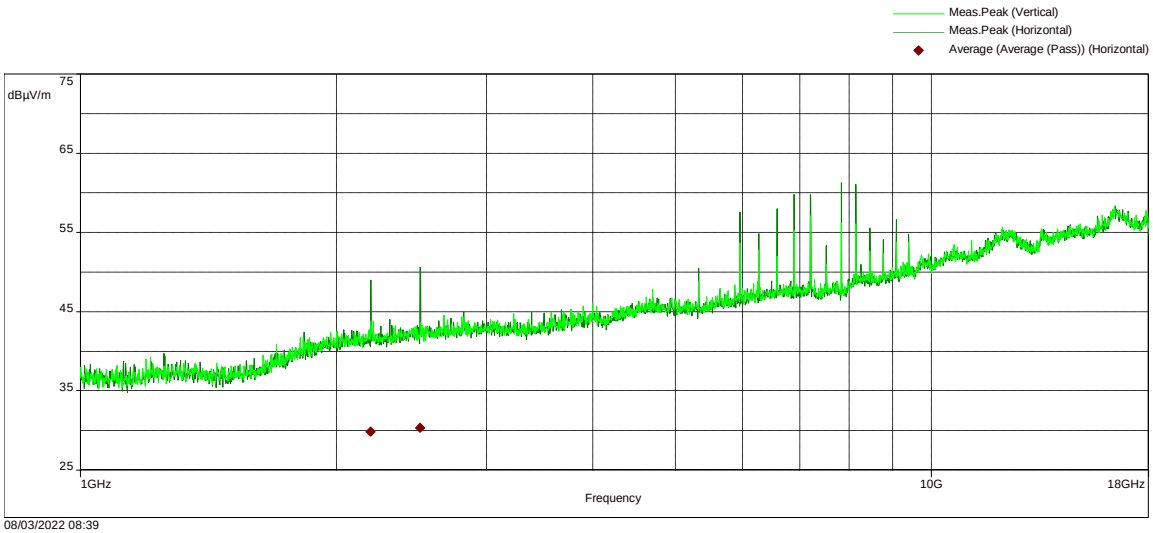
Table 2.4-2 – RE Spurious Emissions 30-1000 MHz – Low Channel 1

Frequency	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)	Azimuth (º)	Height (m)	Polarity	QP Result
107.79817MHz	20.49	54.79	-34.30	64.00	1.98	Vertical	PASS
627.05417MHz	52.54	54.79	-2.25	350.00	1.62	Horizontal	PASS
940.58131MHz	43.02	54.79	-11.77	17.00	1.06	Horizontal	PASS

Note: Spurious Emissions limits are 20 dB below the limit indicated by the fundamental frequency.

RE 1 - 18GHz (TX 313.55 MHz)

Frequency Range	Polarity	Antenna Distance	RBW	Step Size	Sweep Time
1GHz- 18GHz	Vertical	3m	1MHz	18001Pts	Auto
1GHz- 18GHz	Horizontal	3m	1MHz	18001Pts	Auto



Limit:
FCC 15.231(b)

Test Results:
Pass

Figure 2-8 – RE Spurious Emissions 1-18 GHz – Low Channel 1

Table 2.4-3 – RE Spurious Emissions 1-18 GHz – Low Channel 1

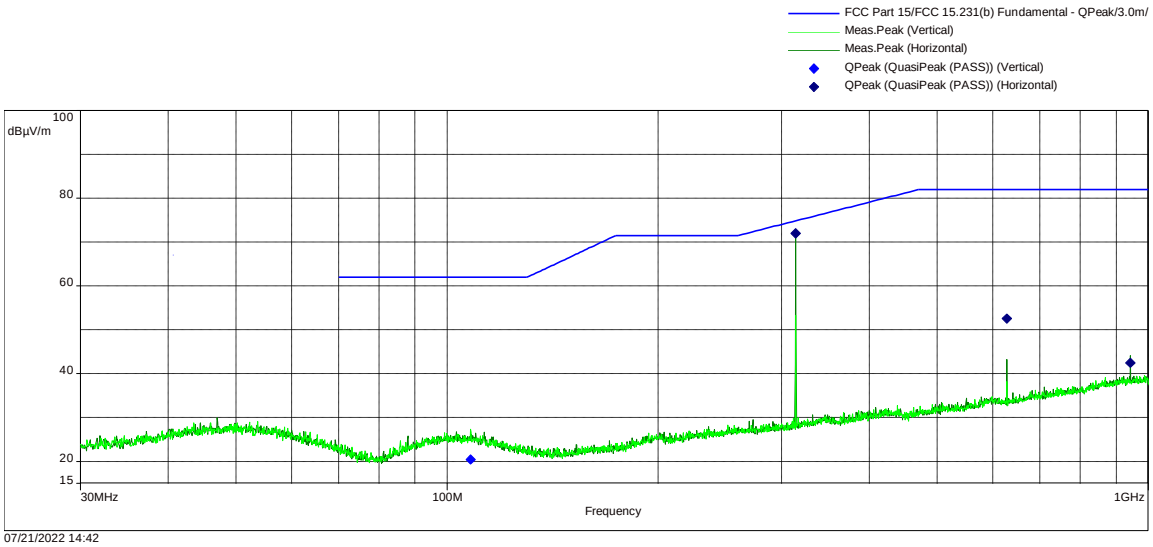
Frequency	Average Level (dBuV/m)	Peak Level (dBuV/m)	Average Limit (dBuV/m)	Peak Limit (dBuV/m)	Average Margin (dB)	Peak Margin (dB)	Azimuth (°)	Height (m)	Polarity	Average Result
2.1937778GHz	29.86	48.78	54.79	74.79	-24.93	-26.01	138.00	2.99	Horizontal	PASS
2.5073333GHz	30.31	50.62	54.79	70.79	-24.48	-20.17	263.00	1.00	Horizontal	PASS

Note: Spurious Emissions limits are 20 dB below the limit indicated by the fundamental frequency.

Note: Spurious Emissions limits only apply to emissions < 10th Harmonic of the fundamental.

RE 30M-1GHz (TX 314.15 MHz)

Frequency Range	Polarity	Antenna Distance	RBW	Step Size	Sweep Time
30MHz- 1GHz	Vertical	3m	100kHz	18001Pts	Auto
30MHz- 1GHz	Horizontal	3m	100kHz	18001Pts	Auto



Limit:
FCC 15.231(b) fundamental limit

Test Results:
Pass

Figure 2-9 – RE Spurious Emissions 30-1000 MHz – Low Channel 2

Table 2.4-4 – RE Fundamental Emission 30-1000 MHz – Low Channel 2

Frequency	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)	Azimuth (º)	Height (m)	Polarity	QP Result
314.12468MHz	71.99	74.82	-2.83	152.00	1.00	Horizontal	PASS

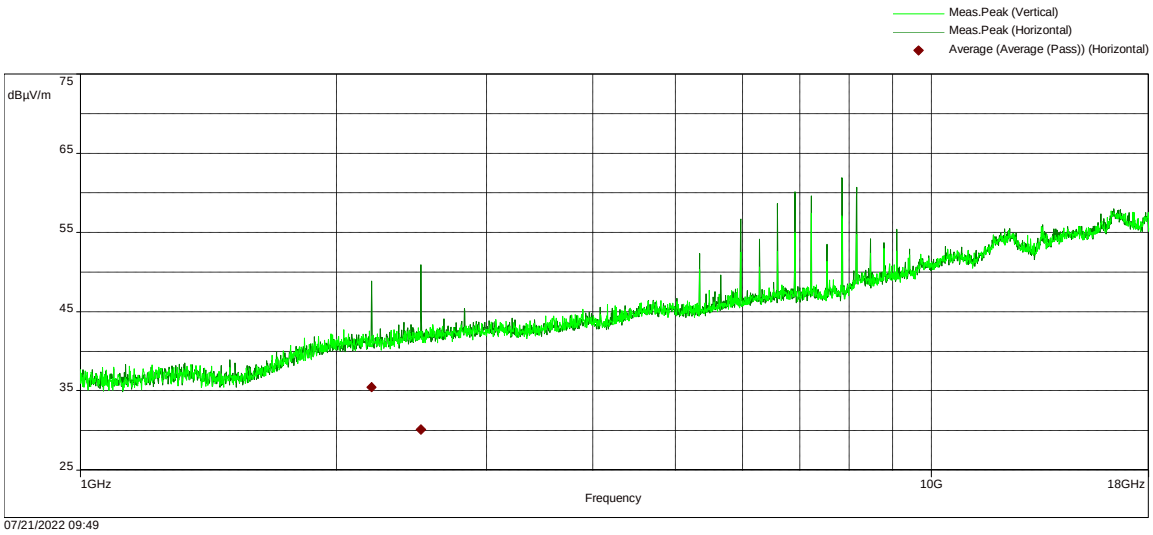
Table 2.4-5 – RE Spurious Emissions 30-1000 MHz – Low Channel 2

Frequency	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)	Azimuth (º)	Height (m)	Polarity	QP Result
108.0745MHz	20.49	54.82	-34.33	145.00	2.33	Vertical	PASS
628.24937MHz	52.54	54.82	-2.28	328.00	1.62	Horizontal	PASS
942.37423MHz	42.45	54.82	-12.37	17.00	1.02	Horizontal	PASS

Note: Spurious Emissions limits are 20 dB below the limit indicated by the fundamental frequency.

RE 1 - 18GHz (TX 314.15 MHz)

Frequency Range	Polarity	Antenna Distance	RBW	Step Size	Sweep Time
1GHz- 18GHz	Vertical	3m	1MHz	18001Pts	Auto
1GHz- 18GHz	Horizontal	3m	1MHz	18001Pts	Auto



Limit:
FCC 15.231(b)

Test Results:
Pass

Figure 2-10 – RE Spurious Emissions 1-18 GHz – Low Channel 2

Table 2.4-6 – RE Spurious Emissions 1-18 GHz – Low Channel 2

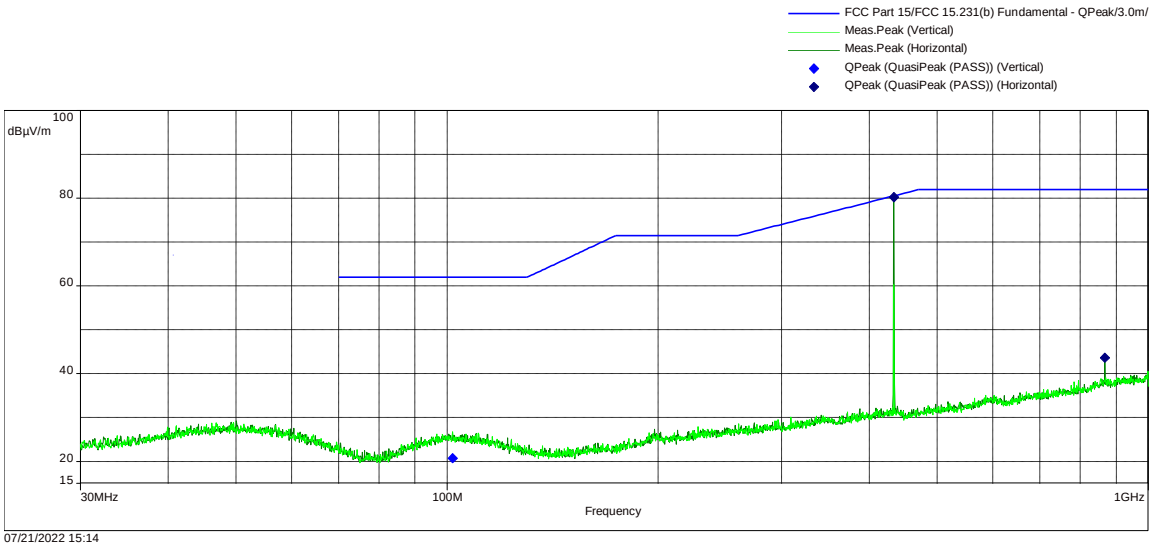
Frequency	Average Level (dBuV/m)	Peak Level (dBuV/m)	Average Limit (dBuV/m)	Peak Limit (dBuV/m)	Average Margin (dB)	Peak Margin (dB)	Azimuth (º)	Height (m)	Polarity	Average Result
2.1985GHz	35.46	48.88	54.82	74.82	-19.36	-25.94	351.00	1.11	Horizontal	PASS
2.5120556GHz	30.10	50.90	54.82	74.82	-24.72	-23.92	354.00	1.21	Horizontal	PASS

Note: Spurious Emissions limits are 20 dB below the limit indicated by the fundamental frequency.

Note: Spurious Emissions limits only apply to emissions < 10th Harmonic of the fundamental.

RE 30M-1GHz (TX 433.66 MHz)

Frequency Range	Polarity	Antenna Distance	RBW	Step Size	Sweep Time
30MHz- 1GHz	Vertical	3m	100kHz	18001Pts	Auto
30MHz- 1GHz	Horizontal	3m	100kHz	18001Pts	Auto



Limit:
FCC 15.231(b) fundamental limit

Test Results:
Pass

Figure 2-11 – RE Spurious Emissions 30-1000 MHz – High Channel 1

Table 2.4-7 – RE Fundamental Emission 30-1000 MHz – High Channel 1

Frequency	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)	Azimuth (º)	Height (m)	Polarity	QP Result
433.63327MHz	80.20	80.52	-0.32	153.00	1.00	Horizontal	PASS

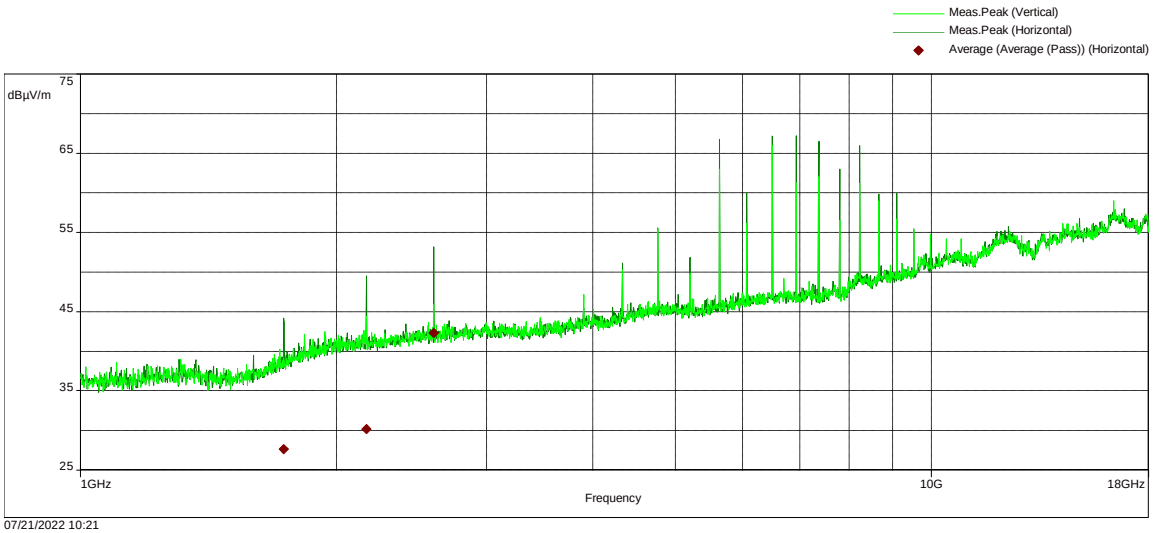
Table 2.4-8 – RE Spurious Emissions 30-1000 MHz – High Channel 1

Frequency	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)	Azimuth (º)	Height (m)	Polarity	QP Result
101.93575MHz	20.75	60.52	-39.77	94.00	1.00	Vertical	PASS
867.32886MHz	43.62	60.52	-16.90	226.00	1.06	Horizontal	PASS

Note: Spurious Emissions limits are 20 dB below the limit indicated by the fundamental frequency.

RE 1 - 18GHz (TX 433.66 MHz)

Frequency Range	Polarity	Antenna Distance	RBW	Step Size	Sweep Time
1GHz- 18GHz	Vertical	3m	1MHz	18001Pts	Auto
1GHz- 18GHz	Horizontal	3m	1MHz	18001Pts	Auto



Limit:
FCC 15.231(b)

Test Results:
Pass

Figure 2-12 – RE Spurious Emissions 1-18 GHz – High Channel 1

Table 2.4-9 – RE Spurious Emissions 1-18 GHz – High Channel 1

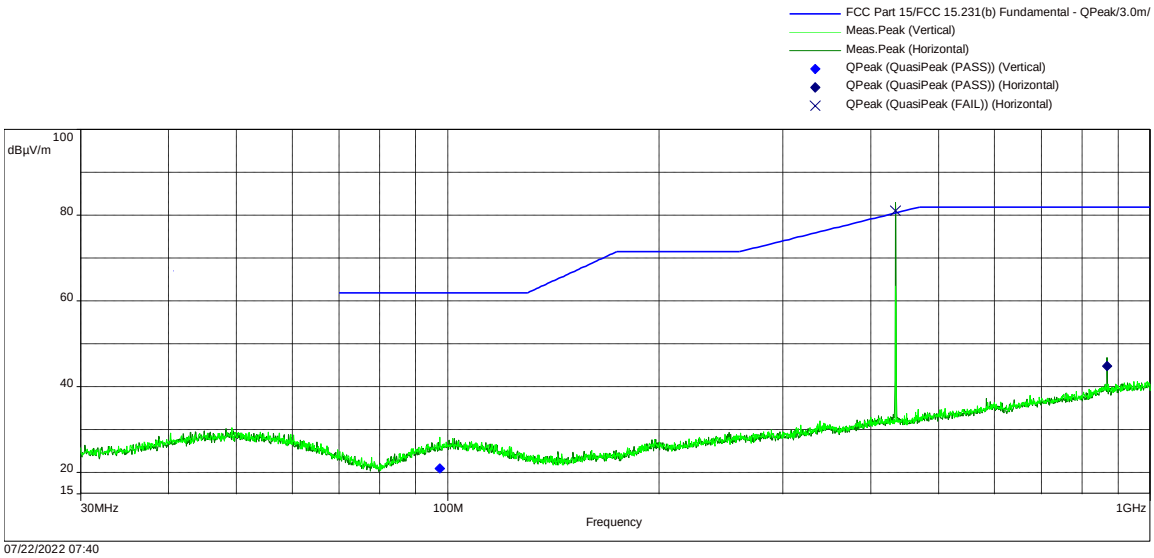
Frequency	Average Level (dBuV/m)	Peak Level (dBuV/m)	Average Limit (dBuV/m)	Peak Limit (dBuV/m)	Average Margin (dB)	Peak Margin (dB)	Azimuth (º)	Height (m)	Polarity	Average Result
1.7338333GHz	27.64	44.17	60.52	80.52	-32.88	-36.35	350.00	1.52	Horizontal	PASS
2.1673333GHz	30.19	49.49	60.52	80.52	-30.33	-31.03	325.00	1.62	Horizontal	PASS
2.6017778GHz	42.28	53.18	60.52	80.52	-18.04	-27.34	332.00	1.06	Horizontal	PASS

Note: Spurious Emissions limits are 20 dB below the limit indicated by the fundamental frequency.

Note: Spurious Emissions limits only apply to emissions < 10th Harmonic of the fundamental.

RE 30M-1GHz (TX 434.18 MHz)

Frequency Range	Polarity	Antenna Distance	RBW	Step Size	Sweep Time
30MHz- 1GHz	Vertical	3m	100kHz	18001Pts	Auto
30MHz- 1GHz	Horizontal	3m	100kHz	18001Pts	Auto



Limit:
FCC 15.231(b) fundamental limit

Test Results:
Pass

Figure 2-13 – RE Spurious Emissions 30-1000 MHz – High Channel 2

Table 2.4-10 – RE Fundamental Emission 30-1000 MHz – High Channel 2

Frequency	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)	Azimuth (º)	Height (m)	Polarity	QP Result
434.15319MHz	80.98	80.54	0.44	358.00	1.00	Horizontal	**See AVG**

Frequency	AVG Level (dBuV/m)	AVG Limit (dBuV/m)	AVG Margin (dB)	Azimuth (º)	Height (m)	Polarity	Average Result
434.15319MHz	75.68	80.54	-4.86	358.00	1.00	Horizontal	PASS

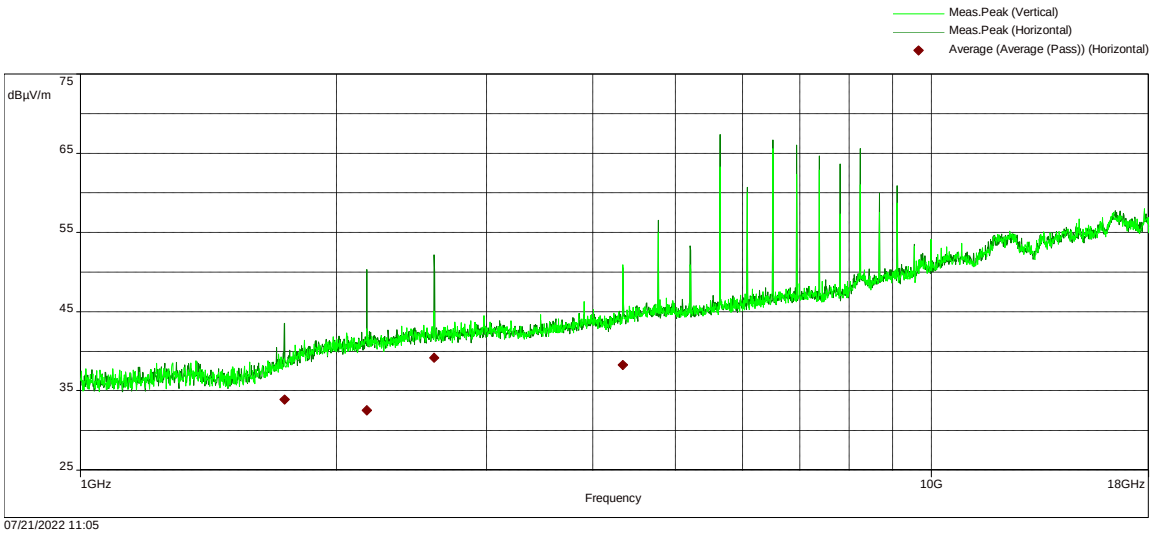
Table 2.4-11 – RE Spurious Emissions 30-1000 MHz – High Channel 2

Frequency	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)	Azimuth (º)	Height (m)	Polarity	Average Result
97.435874MHz	20.88	60.54	-39.66	360.00	1.67	Vertical	PASS
868.36873MHz	44.81	60.54	-15.73	9.00	1.11	Horizontal	PASS

Note: Spurious Emissions limits are 20 dB below the limit indicated by the fundamental frequency.

RE 1 - 18GHz (TX 434.18 MHz)

Frequency Range	Polarity	Antenna Distance	RBW	Step Size	Sweep Time
1GHz- 18GHz	Vertical	3m	1MHz	18001Pts	Auto
1GHz- 18GHz	Horizontal	3m	1MHz	18001Pts	Auto



Limit:
FCC 15.231(b)

Test Results:
Pass

Figure 2-14 – RE Spurious Emissions 1-18 GHz – High Channel 2

Table 2.4-12 – RE Spurious Emissions 1-18 GHz – High Channel 2

Frequency	Average Level (dBuV/m)	Peak Level (dBuV/m)	Average Limit (dBuV/m)	Peak Limit (dBuV/m)	Average Margin (dB)	Peak Margin (dB)	Azimuth (º)	Height (m)	Polarity	Average Result
1.7366667GHz	33.88	43.54	60.54	80.54	-26.66	-37.00	351.00	1.31	Horizontal	PASS
2.1701667GHz	32.55	50.34	60.54	80.54	-27.99	-30.20	354.00	1.00	Horizontal	PASS
2.6046111GHz	39.18	52.17	60.54	80.54	-21.36	-28.37	360.00	1.72	Horizontal	PASS
4.3414444GHz	38.25	50.53	60.54	80.54	-22.29	-30.01	16.00	1.77	Horizontal	PASS

Note: Spurious Emissions limits are 20 dB below the limit indicated by the fundamental frequency.

Note: Spurious Emissions limits only apply to emissions < 10th Harmonic of the fundamental.

2.4.9 Test Location and Test Equipment Used

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

Table 2.4-13 – 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	07/26/2022	07/26/2023
WRLE11324	Mini-Circuits Lab	Attenuator, 10 dB	BW-N10W5	1324	B	12/02/2021	12/02/2022
WRLE11519	Com-Power Corp.	Preamplifier, 500 MHz-18 GHz	PAM-118A	18040002	B	01/19/2022	01/19/2023
NBLE11630	ETS-Lindgren	Antenna, 1-18 GHz	3117	00218816	G	09/04/2020	09/04/2022
NBLE11645	Schwarzbeck	Antenna, Trilog Broadband, 30-7000 MHz	VULB 9162	0254	G	04/09/2021	04/09/2023
NBLE11754	Rohde & Schwarz	Receiver, 1 Hz-44 GHz	ESW44	103037	G	09/10/2021	09/10/2022

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.

2.5 Occupied Bandwidth

2.5.1 Specification Reference

FCC 47 CFR Part 15.231(c)
ISED RSS-210 A.1.3

2.5.2 Equipment Under Test and Modification State

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

2.5.3 Date of Test

2022-July-20

2.5.4 Test Method

A signal source was connected to the input of the EUT and configured to transmit the appropriate test signal as specified by the standard(s). The center frequency of the Spectrum Analyzer was set to the nominal EUT channel center frequency. The span range for the spectrum analyzer was set between 2 × to 5 × the EBW (or OBW). The RBW was set to 1% to 5% of the anticipated OBW, and the VBW shall be set ≥ 3 × RBW. The reference level of the spectrum analyzer was set to accommodate the maximum input amplitude level, with the detection mode set to peak, and trace mode set to max hold. The OBW automatic measurement function in the spectrum analyzer was utilized to produce either the Power Bandwidth or XdB down Bandwidth.

2.5.5 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.

2.5.6 Test Results

Table 2.5-1 – Occupied Bandwidth

Frequency (MHz)	Occupied Bandwidth Type	Occupied Bandwidth (kHz)	Limit (kHz)	Margin (kHz)
313.55 MHz	99% OBW	77.47 kHz	783.88 kHz	706.41 kHz
314.15 MHz	99% OBW	77.68 kHz	785.38 kHz	707.70 kHz
433.66 MHz	99% OBW	77.90 kHz	1084.15 kHz	1006.25 kHz
434.18 MHz	99% OBW	77.92 kHz	1085.45 kHz	1007.53 kHz

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

Test Result: Pass

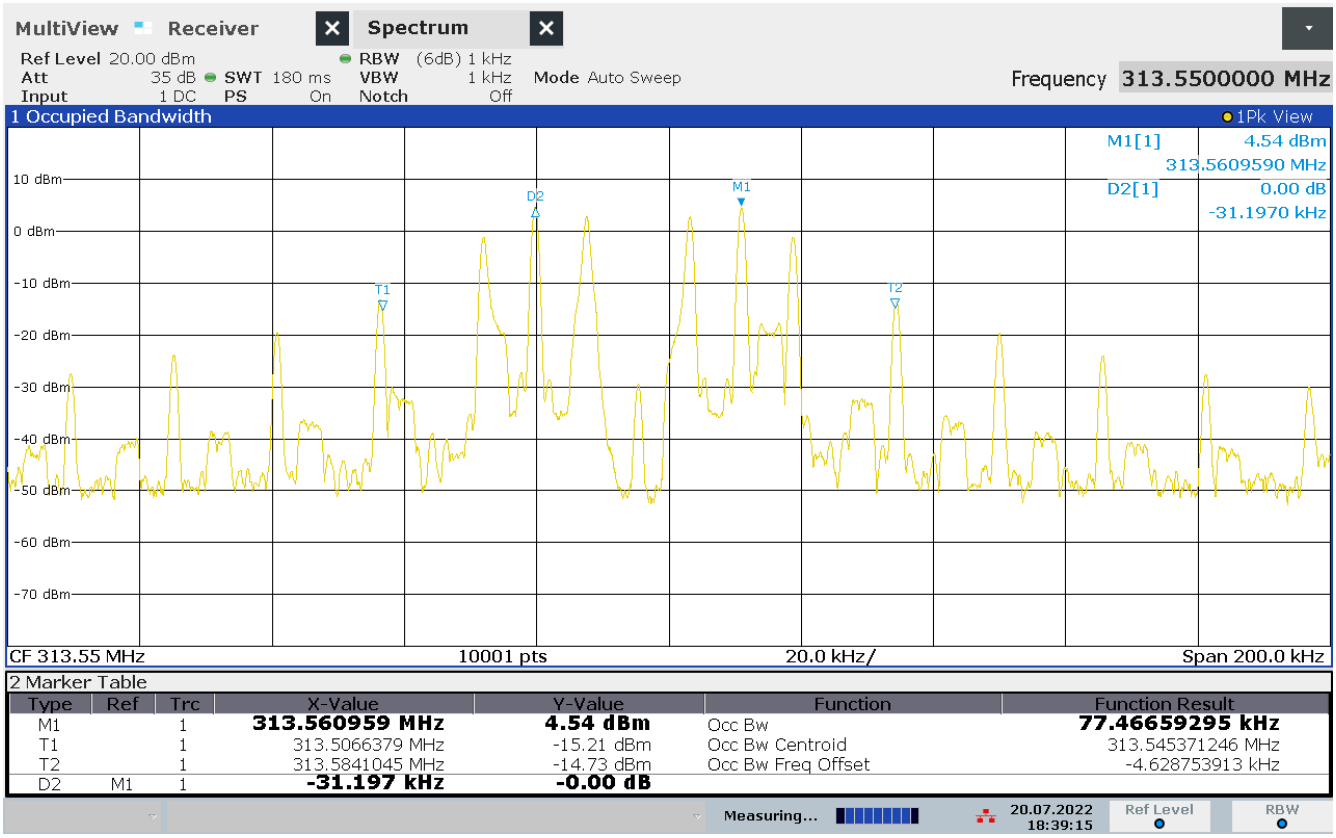


Figure 2-15 – Occupied Bandwidth – 313.55 MHz

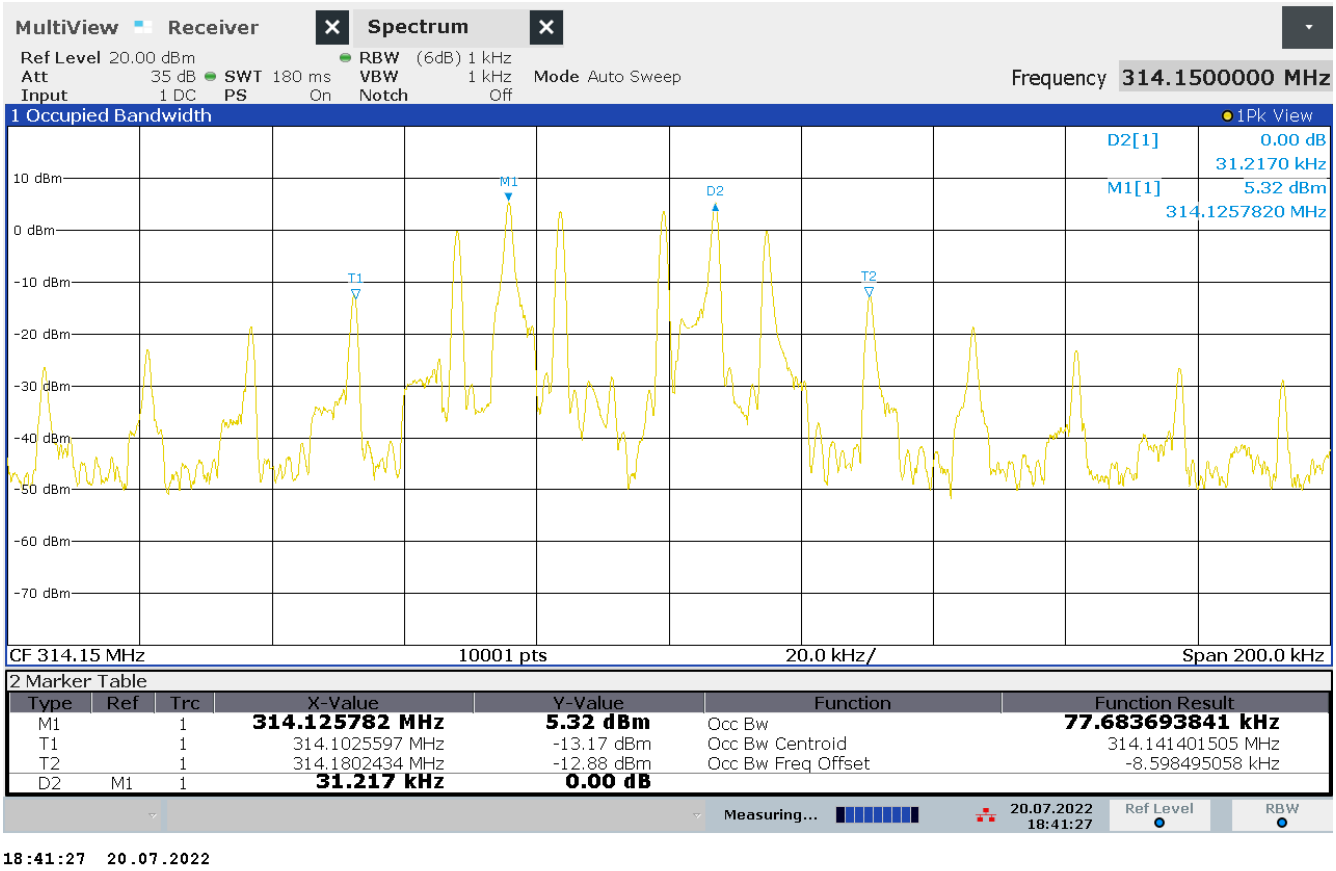


Figure 2-16 – Occupied Bandwidth – 314.15 MHz

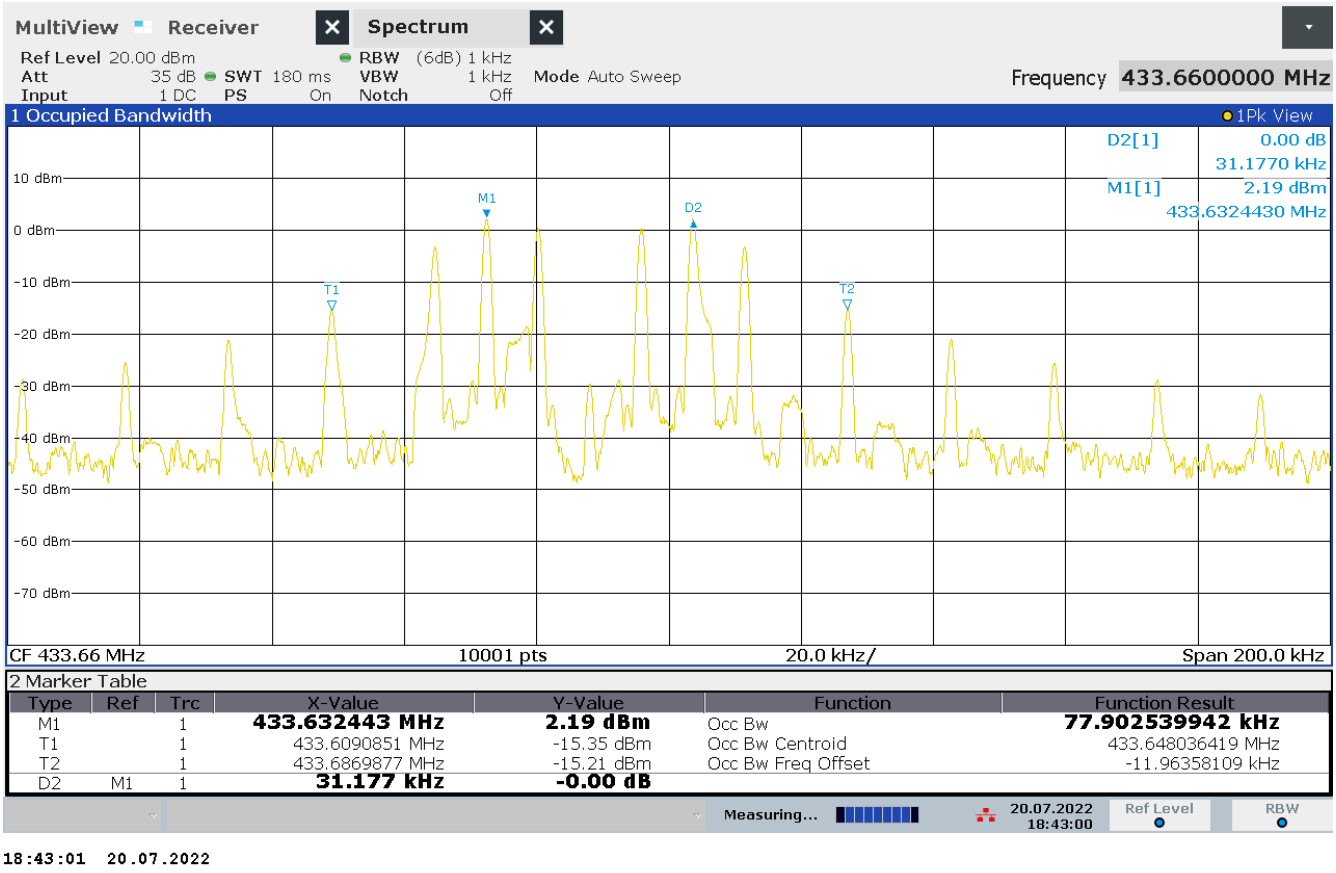


Figure 2-17 – Occupied Bandwidth – 433.66 MHz

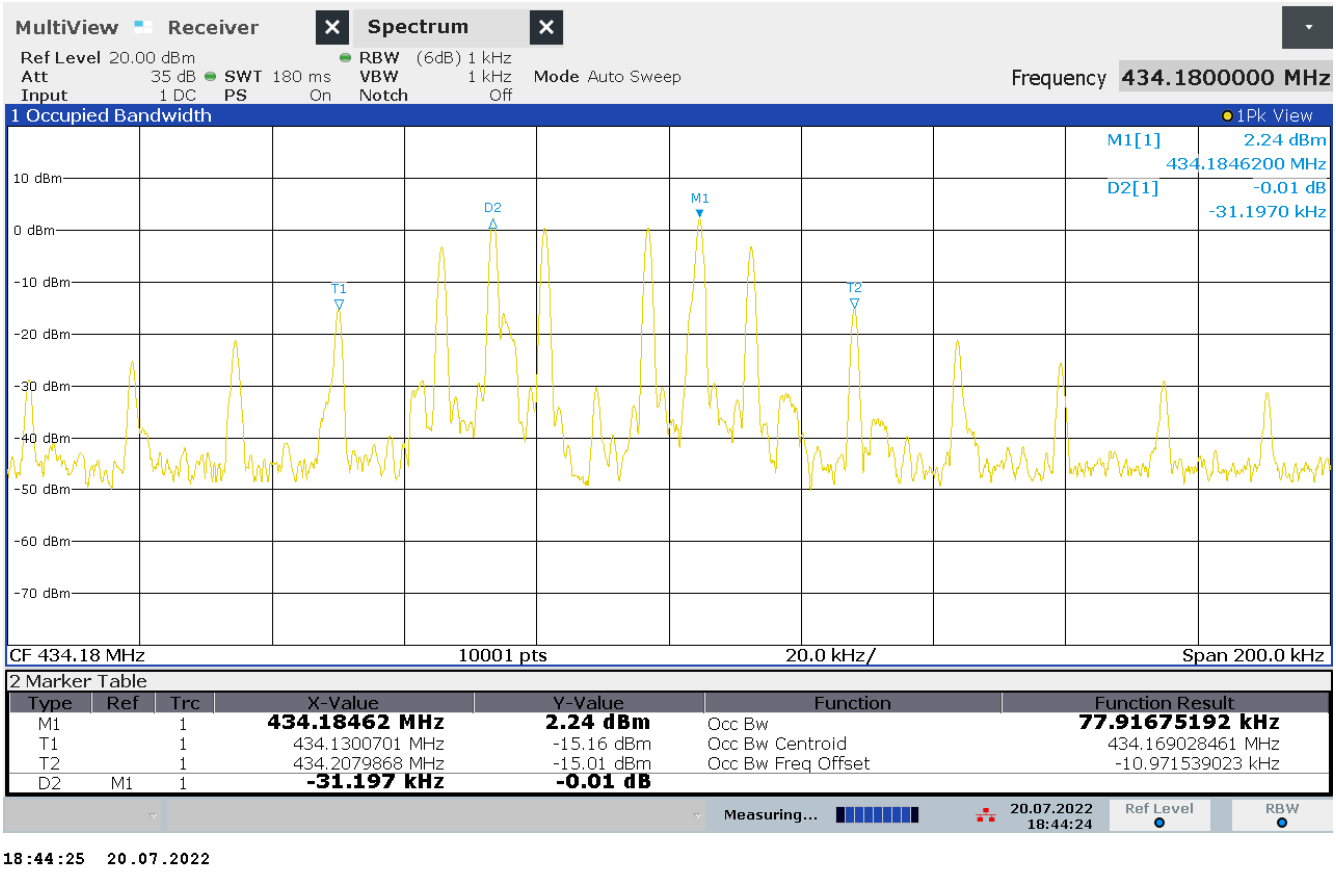


Figure 2-18 – Occupied Bandwidth – 434.18 MHz

2.5.7 Test Location and Test Equipment Used

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

Table 2.5-2 – Conducted Emissions Test Equipment List

Device #	Manufacturer	Description	Model	Serial #	Cal Code	Cal Date	Cal Due
NBLE03517	Florida RF Labs	Cable, SMA	FL200	3ft-12	B	12/22/2021	12/22/2022
WRLE11324	Mini-Circuits Lab	Attenuator, 10 dB	BW-N10W5	1324	B	12/02/2021	12/02/2022
NBLE11754	Rohde & Schwarz	Receiver, 1 Hz-44 GHz	ESW44	103037	G	09/10/2021	09/10/2022

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.

2.6 Frequency Stability

2.6.1 Specification Reference

FCC 47 CFR Part 15.231(d)
ISED RSS-GEN 6.11

2.6.2 Equipment Under Test and Modification State

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

2.6.3 Date of Test

N/A

2.6.4 Test Method

The equipment under test is placed inside an environmental chamber. The RF output is directly coupled to the input of the measurement equipment and a power supply is attached to the primary supply voltage.

Frequency measurements were made at the extremes of the of temperature range -30º C to +50º C and at intervals of 10º C at normal supply voltage. Sufficient time to stabilize all components of the equipment was allowed at each frequency measurement. At a temperature 20º C the supply voltage was reduced to the battery operating endpoint. The maximum variation of frequency was recorded.

2.6.5 Test Results

Test Summary: The EUT operates above 40 MHz and does not require Frequency Stability testing.

Test Result: N/A

3 Diagram of Test Setups

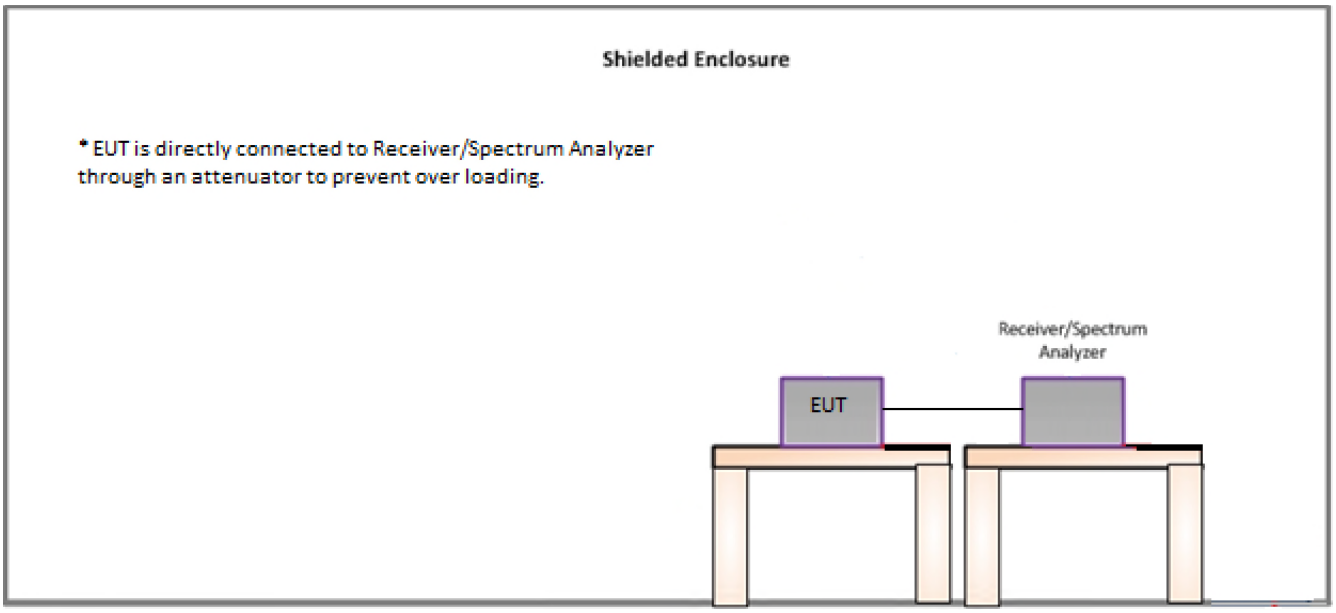


Figure 3-1 – Conducted Test Setup

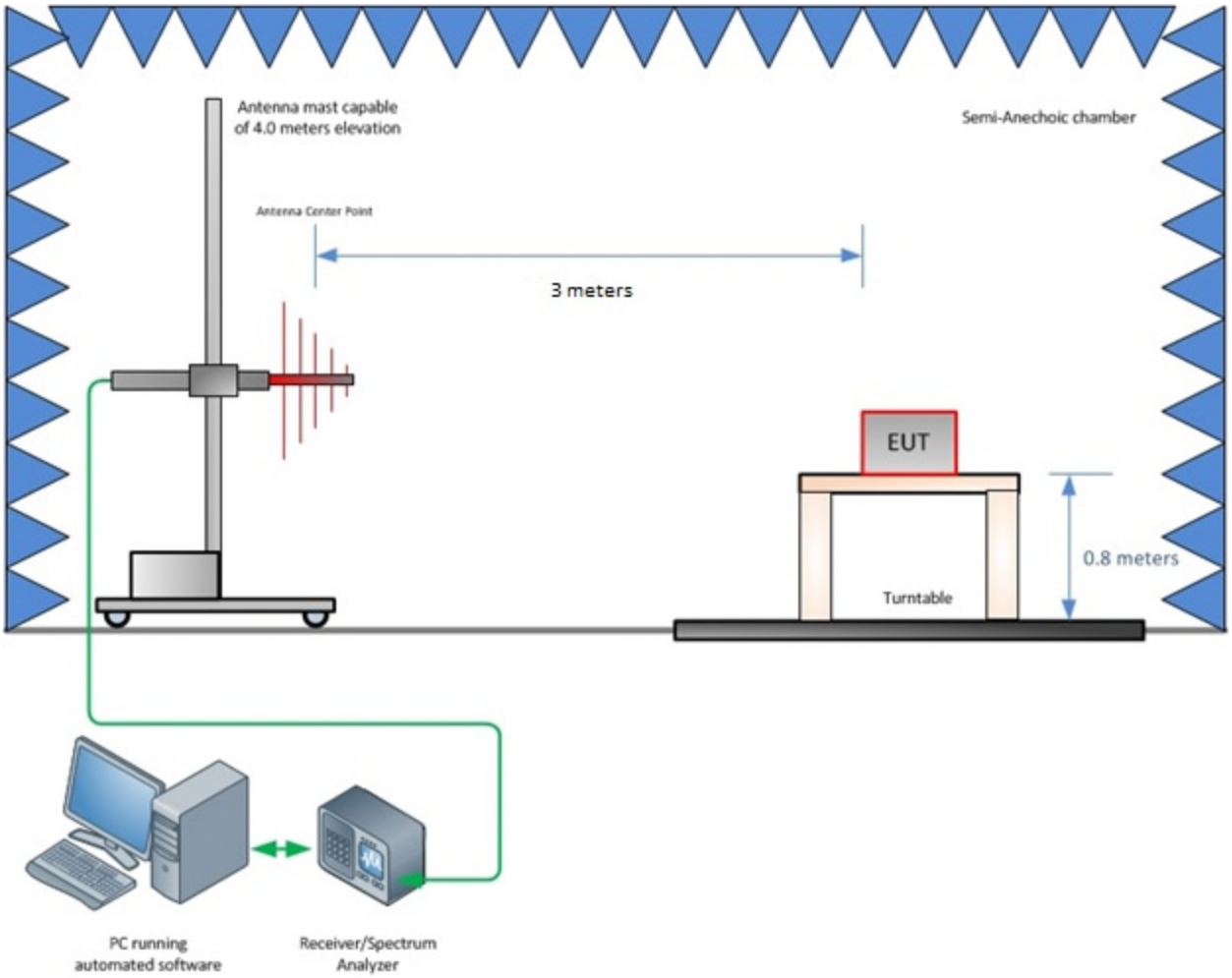


Figure 3-2 – Radiated Emissions Test Setup up to 1 GHz

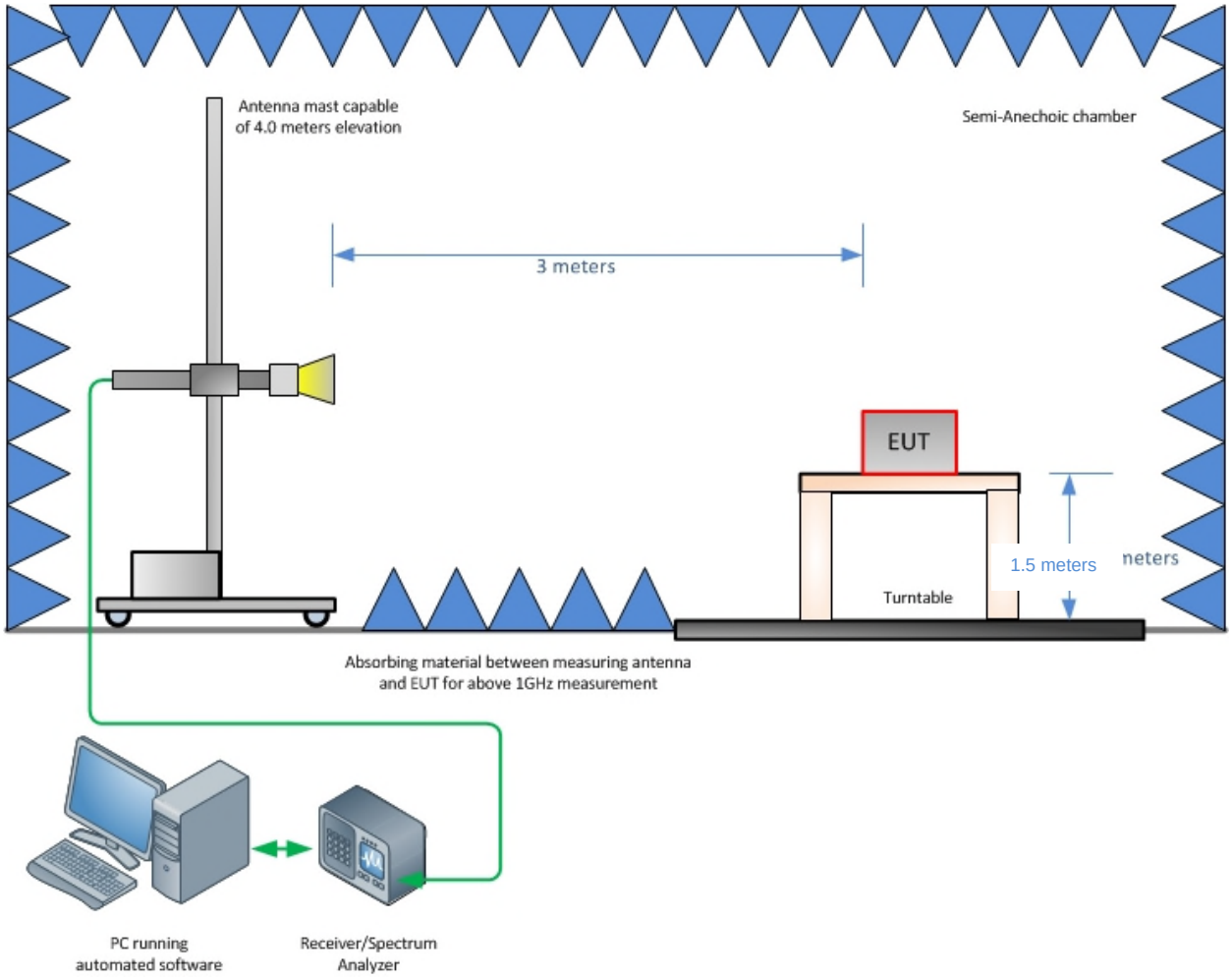


Figure 3-3 – Radiated Emissions Test Setup above 1 GHz

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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