

Test Report

Prepared for: North Pole Engineering

Address: 221 N. 1st Street
Minneapolis, MN 55401

Product: GEMSRB02

Test Report No: R20200622-22-E1B

Approved by:



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iNARTE Certified EMC Engineer #EMC-003337-NE

DATE: 15 September 2020

Total Pages: 23

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REVISION PAGE

Rev. No.	Date	Description
0	18 August 2020	Original – NJohnson Prepared by FLane
A	14 September 2020	Added FCC ID and IC number
B	15 September 2020	Corrected IC number



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1.0 SUMMARY OF TEST RESULTS

Report Purpose: Class II permissive change. FCC ID: XRH-NPE103 ISED ID: 11922A - NPE103

The worst-case measurements were reported in this report.

Summary of test results presented in this report correspond to the following section

Emissions Test Results:

The EUT has been tested according to the following specifications:

US Code of Federal Regulations, Title 47, Part 15.225

RSS-210, Issue 10

APPLIED STANDARDS AND REGULATIONS		
Standard Section	Test Type	Result
FCC Part 15.225 (a) RSS-210, Sec 4.3	Fundamental Field Strength	Pass
NA	Bandwidth	Pass
FCC Part 15.209	Radiated Emissions	Pass
FCC Part 15.225 (a) (b) (c) (d) RSS-210, Sec 4.3	Band edges	PASS

See Section 4 for details on the test methods used for each test.



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2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	GEMSRB02
EUT Received	7 July 2020
EUT Tested	3 August 2020- 13 August 2020
Serial No.	0A012102510310
Operating Band	13.553MHz - 13.567MHz*
Device Type	NFC and BT radio
Power Supply / Voltage	5VDC USB

*Though this device is capable of BT transmission; this report is strictly for NFC radio.

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.



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2.2 DESCRIPTION OF TEST MODES

The operating range of the EUT is dependent on the device type found in section 2.1:

For NFC Transmissions:

Channel	Frequency
Normal	13.56 MHz

These are the only representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

2.3 DESCRIPTION OF SUPPORT UNITS

None

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3.0 LABORATORY AND GENERAL TEST DESCRIPTION

3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
 4740 Discovery Drive
 Lincoln, NE 68521

A2LA Certificate Number:	1953.01
FCC Accredited Test Site Designation No:	US1060
Industry Canada Test Site Registration No:	4294A-1
NCC CAB Identification No:	US0177

Environmental conditions varied slightly throughout the tests:

Relative humidity of $35 \pm 4\%$
 Temperature of $22 \pm 3^{\circ}$ Celsius



3.2 TEST PERSONNEL

No.	PERSONNEL	TITLE	ROLE
1	Nic Johnson	Technical Manager	Review/editing
2	Fox Lane	Test Engineer	Testing and report

Notes:

All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.

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3.3 TEST EQUIPMENT

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer**	N9038A	MY59050109	April 23, 2019	April 23, 2021
SunAR RF Motion	JB1	A091418	March 6, 2020	March 6, 2021
Agilent Preamplifier*	87405A	3950M00669	April 14, 2020	April 14, 2022
EMCO Loop Antenna**	6512	00024936	February 11, 2019	February 11, 2021
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	April 14, 2020	April 14, 2022
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	April 14, 2020	April 14, 2022
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3874	April 14, 2020	April 14, 2022
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	April 14, 2020	April 14, 2022
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	April 14, 2020	April 14, 2022
N connector bulkhead (control room)*	PE9128	NCEEBH2	April 14, 2020	April 14, 2022

*Internal Characterization

**2 year calibration cycle

Notes:

All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.

3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMENTS

Radiated ☒

All the radiated measurements were taken at a distance of 3m from the EUT. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10.

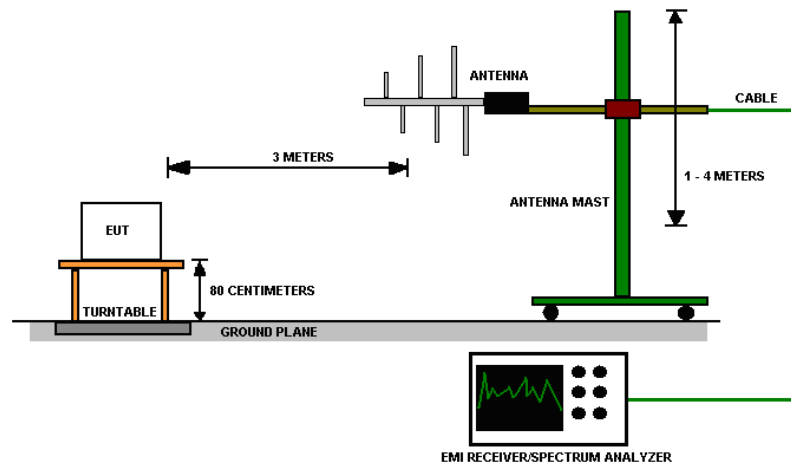


Figure 1 - Radiated Emissions Test Setup

*Note that a Loop Antenna was used for the measurements under 30 MHz



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4.0 RESULTS

NFC Radio Measurements

Transmitter	Field Strength (dBuV)	Occupied Bandwidth(kHz)	20dB Bandwidth(kHz)	RESULT
NFC	65.844	8.522	8.475	PASS
Occupied Bandwidth = N/A; 20 dB Bandwidth Limit = N/A			Field Strength Limit = 104 dBuV/m @ 3m;	

Band Edge Measurements

Freq (MHz)	(PEAK) EMI (H) (dBuV/m)	Limit (dBuV/m)	(PEAK) Margin (H) (dB)
13.340000	43.68	60.51	16.83
13.450000	49.22	70.47	21.25
13.670000	48.81	70.47	21.66
13.780000	43.17	60.51	17.34



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4.1 FUNDAMENTAL FIELD STRENGTH

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, section 11.9.1.1.

Limits of field strength measurements:

For FCC Part 15.225 Device:

(a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

Test procedures:

Details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. Fundamental field strength plots can be found in the Appendix C and tables can be found in the Results section.
2. All the measurements were found to be compliant.



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4.2 BANDWIDTH

Test Method: The method was similar to the measurement method used in the original grant.

Limits of bandwidth measurements:

For FCC Part 15.247 Device:

The 99% occupied bandwidth and 20 dB bandwidth is for informational purpose only.

Test procedures:

Details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Test setup details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the Bandwidth plots can be found in the Appendix C and tables can be found in the Results section.
2. All the measurements were found to be compliant.

4.3 RADIATED EMISSIONS

Test Method: ANSI C63.10-2013, Section 6.5

Limits for radiated emissions measurements:

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH ($\mu\text{V/m}$)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = $20 * \log * \text{Emission level } (\mu\text{V/m})$.
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.
4. The EUT was tested for spurious emissions while running off 5V DC USB power. Results from this mode are presented. The worst-case orientation can be found in the figure below.



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Test procedures:

- a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements from 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.
- d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.
- e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.
- f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- g. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions. See Figure 2 for worst-case orientation.

Test setup:

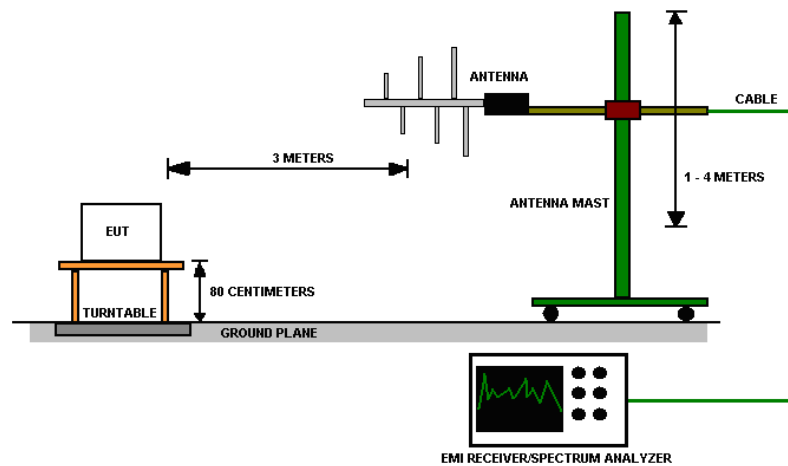


Figure 2 - Radiated Emissions Test Setup

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

Deviations from test standard:

No deviation.

EUT operating conditions

Details can be found in section 2.1 of this report.

Test results:

Freq	Freq (Max)	(QP) EMI	Limit	(QP) Margin	Twr Ht	Ttbl Ang	Pol
(MHz)	(MHz)	(dBuV/m)	(dBuV/m)	(dB)	(cm)	(deg)	
176.280000	176.396160	28.52	43.52	15.00	214.00	9.00	H
40.680000	40.673520	31.84	40.00	8.16	134.00	96.00	V
54.240000	54.172800	25.32	40.00	14.68	279.00	53.00	V
67.800000	67.581600	38.70	40.00	1.30	129.00	322.00	V

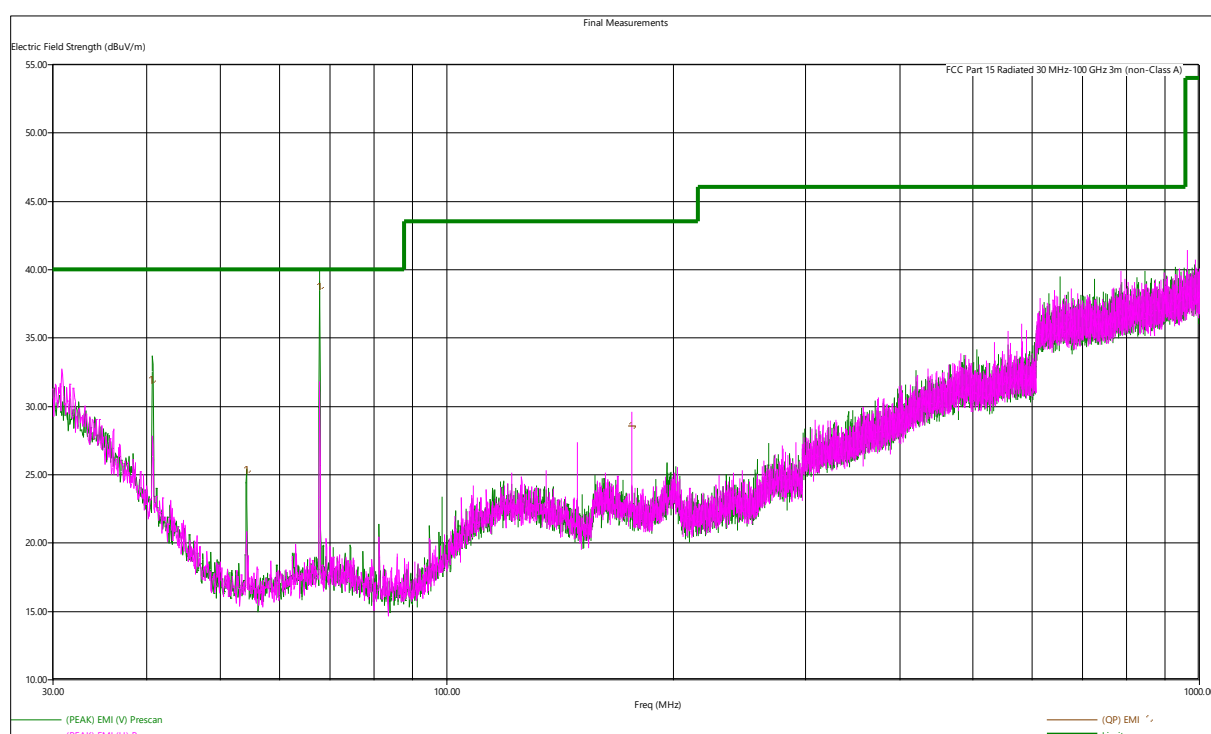


Figure 3 - Radiated Emissions Plot, 30MHz – 1GHz

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value



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4.4 BAND EDGES

Test Method: All the radio measurements were performed using the sections from ANSI C63.10 Section 6.4

Limits of band-edge measurements:

(a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

(b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

(c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

(d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

Test procedures:

The highest emissions level beyond the band-edge was measured and recorded. All band edge measurements were evaluated to the limits in Part 15.225. More details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Test setup details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the band edge plots can be found in the Appendix C and tables can be found in the Results section.
2. The restricted band edge compliance is shown by comparing to the general limit defined in Part 15.209 and 15.225(a)(b)(c)(d). The limit shown in the graph accounts for the antenna gain of the device.



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APPENDIX A - SAMPLE CALCULATION

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF - (-CF + AG) + AV$$

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dB μ V is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dB μ V/m.

$$FS = 55 + 12 - (-1.1 + 20) + 0 = 48.1 \text{ dB}\mu\text{V/m}$$

The 48.1 dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm} [(48.1 \text{ dB}\mu\text{V/m})/20] = 254.1 \mu\text{V/m}$$

AV is calculated by taking the $20 \cdot \log(T_{\text{on}}/100)$ where T_{on} is the maximum transmission time in any 100ms window.



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EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

$$EIRP \text{ (Watts)} = [Field \text{ Strength (V/m)} \times \text{antenna distance (m)}]^2 / 30$$

$$Power \text{ (watts)} = 10^{[Power \text{ (dBm)}/10]} / 1000$$

$$Voltage \text{ (dB}\mu\text{V)} = Power \text{ (dBm)} + 107 \text{ (for } 50\Omega \text{ measurement systems)}$$

$$Field \text{ Strength (V/m)} = 10^{[Field \text{ Strength (dB}\mu\text{V/m)} / 20]} / 10^6$$

$$Gain = 1 \text{ (numeric gain for isotropic radiator)}$$

Conversion from 3m field strength to EIRP (d=3):

$$EIRP = [FS(V/m) \times d^2]/30 = FS [0.3] \quad \text{for } d = 3$$

$$EIRP(dBm) = FS(dB\mu V/m) - 10(\log 10^9) + 10\log[0.3] = FS(dB\mu V/m) - 95.23$$

$10\log(10^9)$ is the conversion from micro to milli



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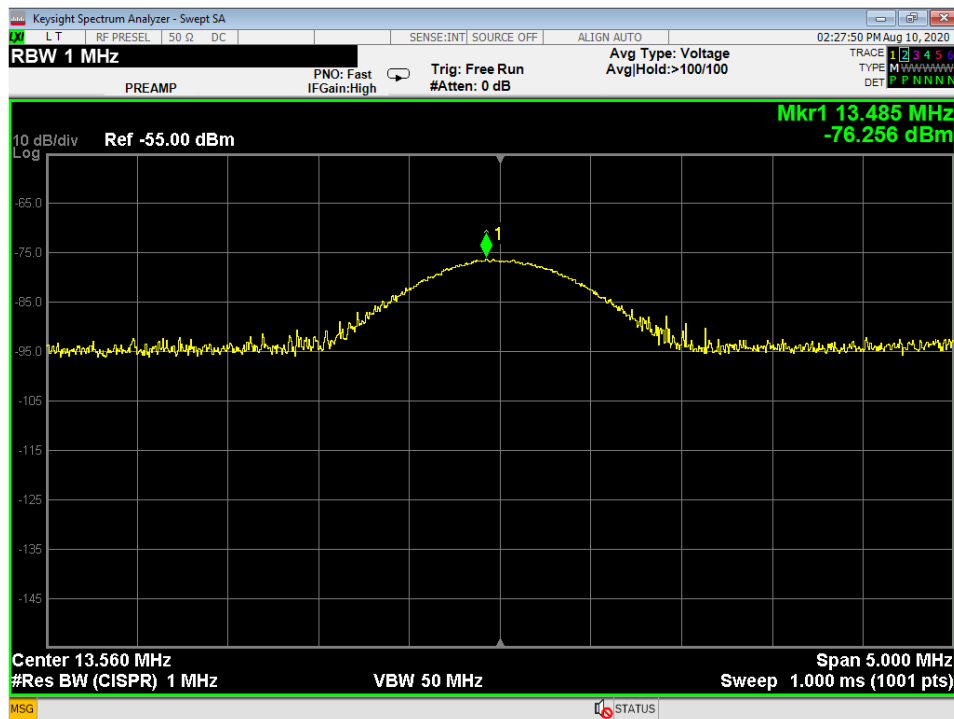
APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	3.82
Radiated Emissions, 3m	1GHz - 18GHz	4.44
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB

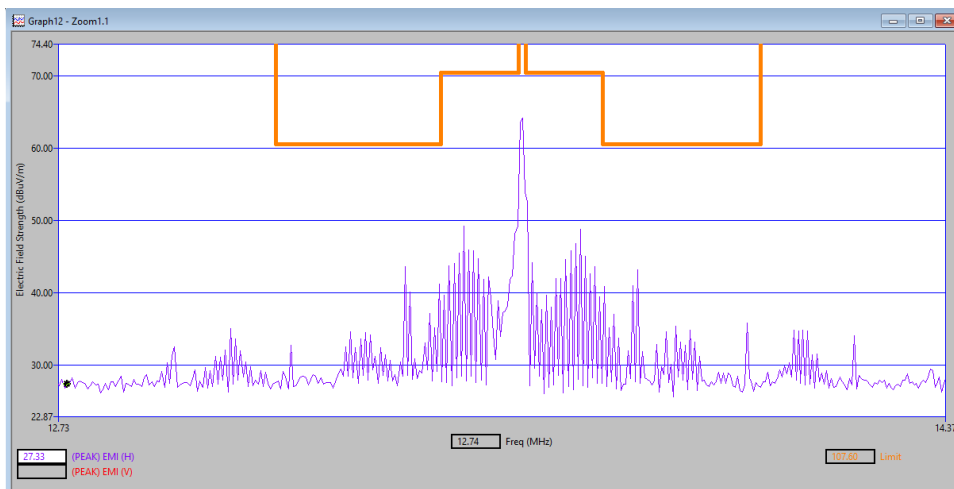
Expanded uncertainty values are calculated to a confidence level of 95%.

APPENDIX C – GRAPHS AND TABLES

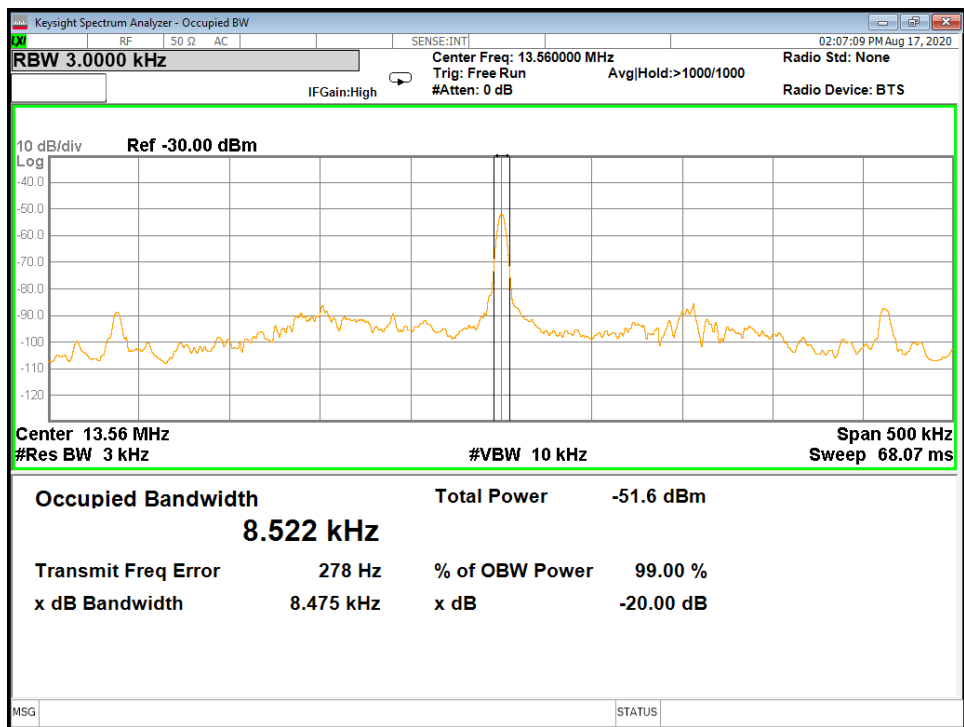


Uncorrected Field Strength, 1MHz RBW

*Refer to the Table in Results section for corrected value



Band Edges



Occupied Bandwidth



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