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Test Report

Prepared for:	**Garmin International Inc.**
Address:	**1200 E. 151st Street** **Olathe, Kansas, 66062, USA**
Product:	**A03992**
Test Report No:	**R20200220-21-E3A**
Approved By:	**Nic S. Johnson, NCE** **Technical Manager** **iNARTE Certified EMC Engineer #EMC-003337-NE**
DATE:	**4 January 2021**
Total Pages:	**23**

ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

Revision Page

Rev. No.	Date	Description
Original	24 March 2020	Original – Prepared by KVepuri Approved by NJohnson
A	4 January 2021	Corrected Figure 4 -NJ

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FIGURES

1 Summary of Test Results

The EUT was tested for compliance to the following standards and/or regulations;

1.1 Emissions Test Results

The EUT was tested for compliance to:

US CFR Title 47 FCC Part 15.225
RSS-210 Issue 10

Below is a summary of the test results. Complete results of testing can be found in Section 3.

Table 1 – Emissions Test Results

Emissions Tests	Test Method and Limits	Result
Radiated Emissions	FCC Part 15.225 (a), (b), (c), (d) RSS-210, Sec 4.3	Complies
Frequency Error	FCC Part 15.225 (e) RSS-210, Annex D	Complies
Conducted Emissions	FCC Part 15.207 RSS-Gen, Sec 8.8	Complies

2 EUT Description

The Equipment Under Test (EUT) was a portable transceiver from Garmin.

2.1 Equipment under Test (EUT)

Table 2 – Equipment under Test (EUT)

Model	03992
EUT Received	13 January 2020
EUT Tested	20 March 2020
Serial No.	3319808343 (radiated measurements)
Operating Band	13.56 MHz
Device Type	Low-power
Antenna	Trace Antenna
Power Supply	Internal Battery/ 5VDC Charger: Garmin (Phi Hong) MN: PSAF10R-050Q (Representative Power Supply)

2.2 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 28 ± 4%
Temperature of 22 ± 3° C

2.3 EUT Setup

The EUT was powered by 120 VAC / 60Hz (5 VDC Output) for all tests.

3 Test Results

3.1 Radiated Emissions, Band Width, Output Power and Band edge

Test:	FCC Part 15.225 (a), (b), (c), (d)		
Test Specifications:	Class A		
Test Result:	Complies	**Date:**	3/20/2020

3.1.1 Test Description

Radiated emissions measurements were made from 30MHz to 1GHz at a distance of 3m (Radiated Emissions) and 0.5 m (Band width, Output Power and Band edges) inside a semi-anechoic chamber. The EUT was rotated 360°, the antenna height varied from 1-4 meters and both the vertical and horizontal antenna polarizations examined. For measurements below 30 MHz, the loop antenna was used to measure in all 3 axis. The results were compared against the limits. Measurements were made by first using a spectrum analyzer to acquire the signal spectrum; individual frequencies were then measured using a CISPR 16.1 compliant receiver with the following bandwidth setting:

30MHz – 1GHz:120kHz IF bandwidth, 60kHz steps
10 – 30MHz, 9kHz RBW, 5 kHz steps

Intermodulation products were investigated by measuring spurious emissions with each of the two 2.4 GHz radios running in parallel with the NFC radio. No intermodulation products were found above the labs system sensitivity.

3.1.2 Test Results

No radiated emissions measurements were found in excess of the limits. Test result data can be seen below.

3.1.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility in the 10m semi-anechoic chamber. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of 30 ± 5%
Temperature of 23 ±2° C

3.1.4 Test Setup

See Section 2.3 for further details.

3.1.5 Test Equipment Used

Serial No.	Manufacturer	Model	Description	Last Cal.
A082918-1	SunAR RF Motion	JB1	Bicon Antenna	15 Oct 2018*
00024936	EMCO	6512	Loop Antenna	11 Feb 2019*
MY59050109	Keysight	N9038A	MXE Signal Analyzer	23 Apr 2019
700307	TDK	TDK Emissions lab	Software V.11.25	Not Required

*Two Year Calibration Cycle

3.1.6 Test Pictures and/or Figures

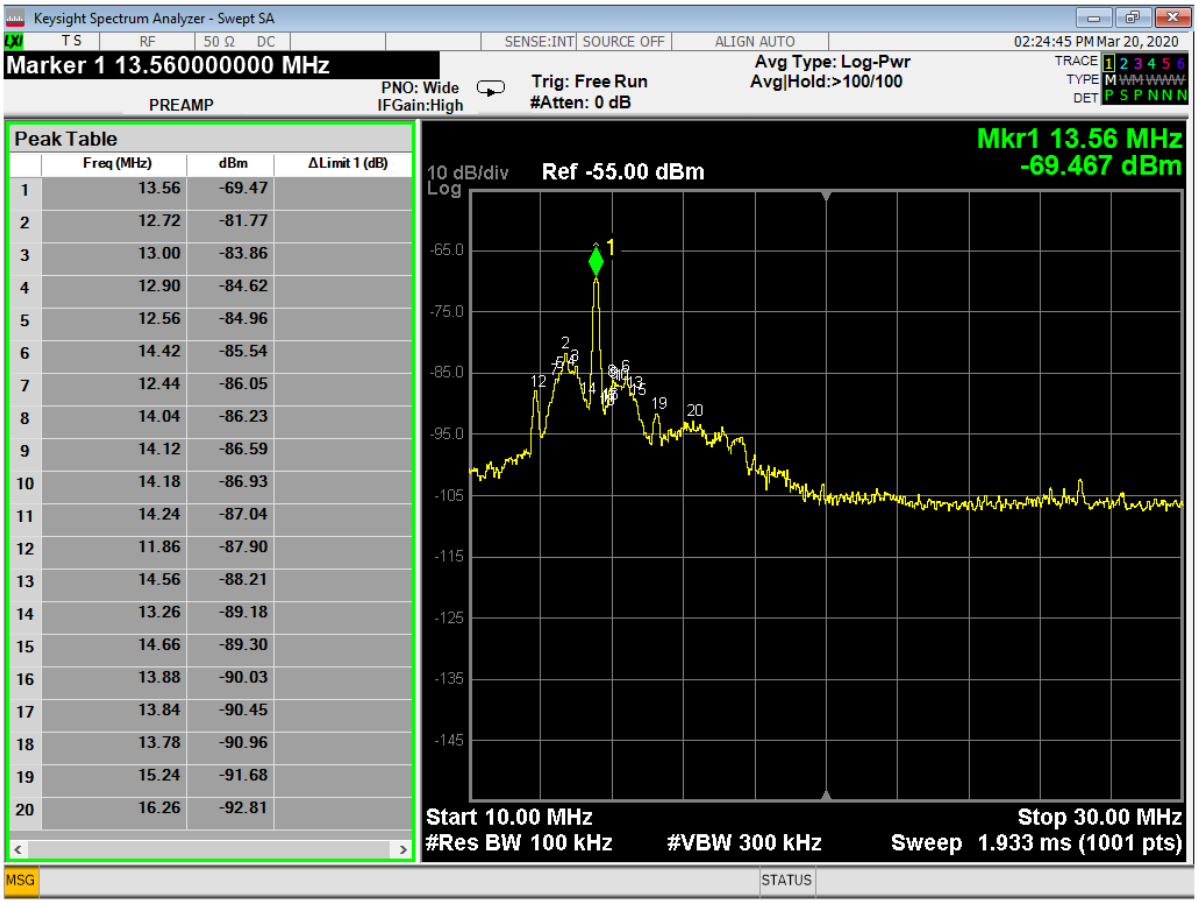


Figure 1 – Radiated Emissions Peak Plot, Horizontal Polarization, 10 MHz- 30 MHz

Limit: 30 µV/m at 30m = 29.54 dBµV/m = 65.10 dBµV/m at 0.5 m

Maximum Spurious = 107 – FS(dBm) + CL + AF = 107 – 81.77 + 0.9 + 34.40 = 60.53 dBuV/m @ 0.5m

CL = cable loss = 0.90 dB
AF = antenna factor = 34.40 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system

Loop antenna was used in all three axis, worst axis is reported.

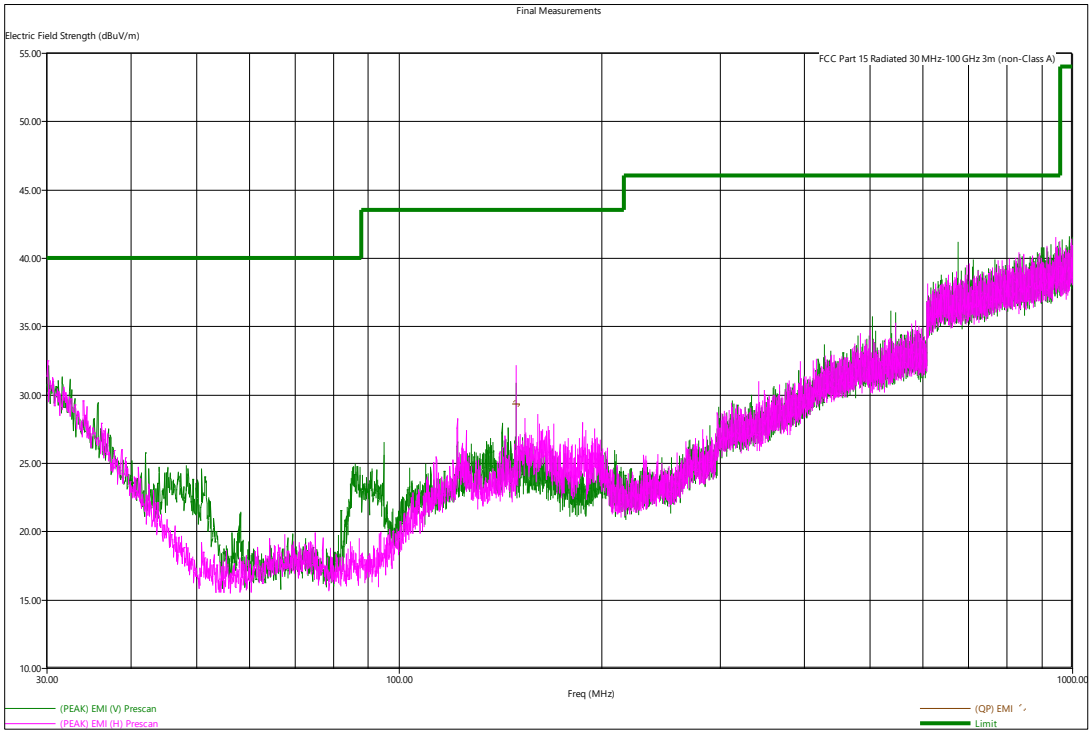


Figure 2 – Radiated Emissions Peak Plot, 30 MHz- 1 GHz

Table 3 – Radiated Emissions QP Data

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg	
149.13	29.28	43.52	14.24	213.00	184.00	H

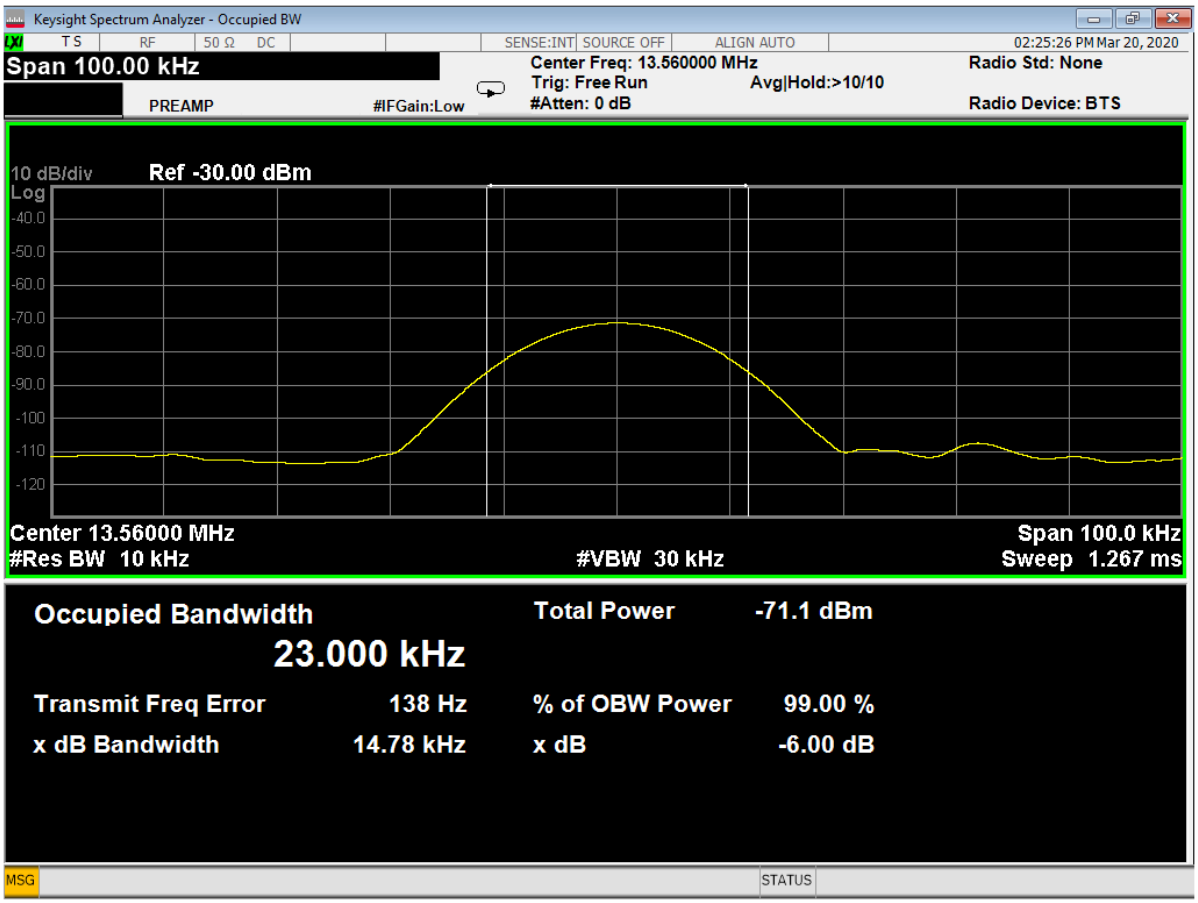


Figure 3 - 99% Occupied Bandwidth, NFC

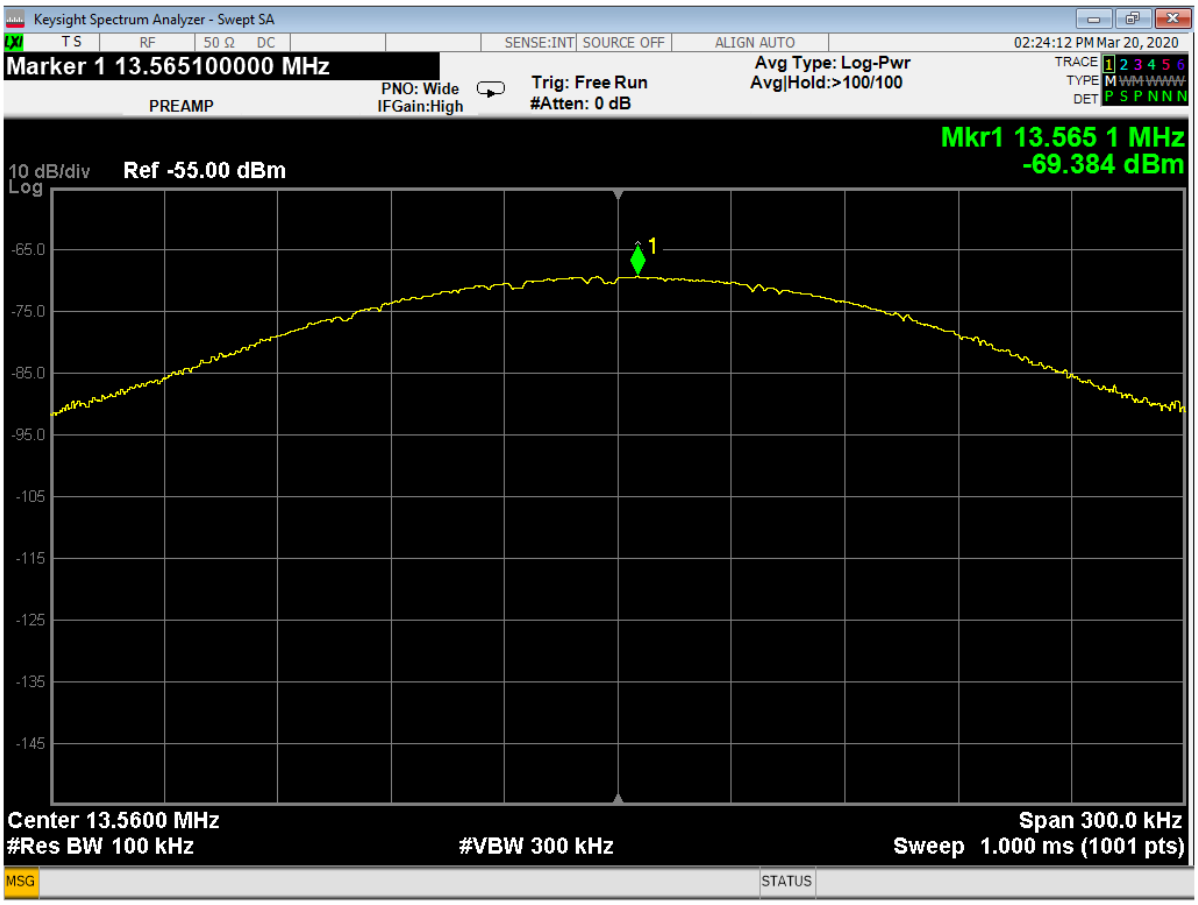


Figure 4 – Fundamental Field Strength

Raw band level dBm	Corrected band level dBµV/m	Limit @ 0.5 m	Margin	Result
-69.384	72.916	119.56*	40.024	PASS

Maximum power = 107 – 69.384 + 0.9 + 34.4 = 72.916dBuV/m @ 0.5m
CL = cable loss = 0.90 dB
AF = antenna factor = 34.40 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system

* Extrapolated limit from 30 m to 0.5 m

Measurement performed at 1m distance.

Band Edge Measurements:

Band edge /Measurement Frequency (MHz)	Uncorrected band level dBµV	Corrected band level dBµV/m @0.5 m	Limit dBµV	Margin	Result
13.11-13.41	-96.232	52.6886	76.5306	23.842	PASS
13.41-13.553	-75.801	73.1196	86.0406	12.921	PASS
13.71-14.01	-97.472	51.4486	76.5306	25.082	PASS
13.567-13.71	-71.035	77.8856	86.0406	8.155	PASS

* Extrapolated limit from 30 m to 0.5 m. Corrected band level = uncorrected band level + cable loss + antenna factor

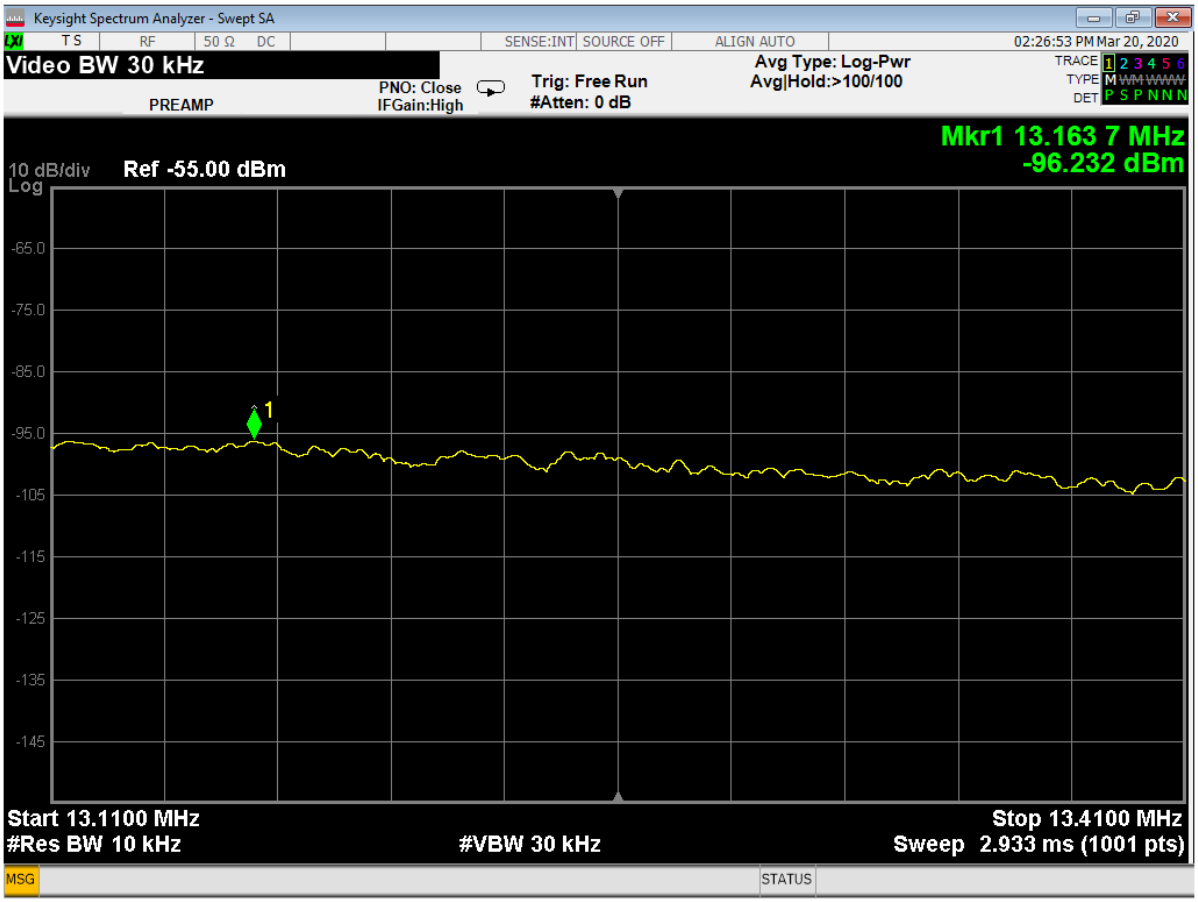


Figure 5 – Lower Band-edge

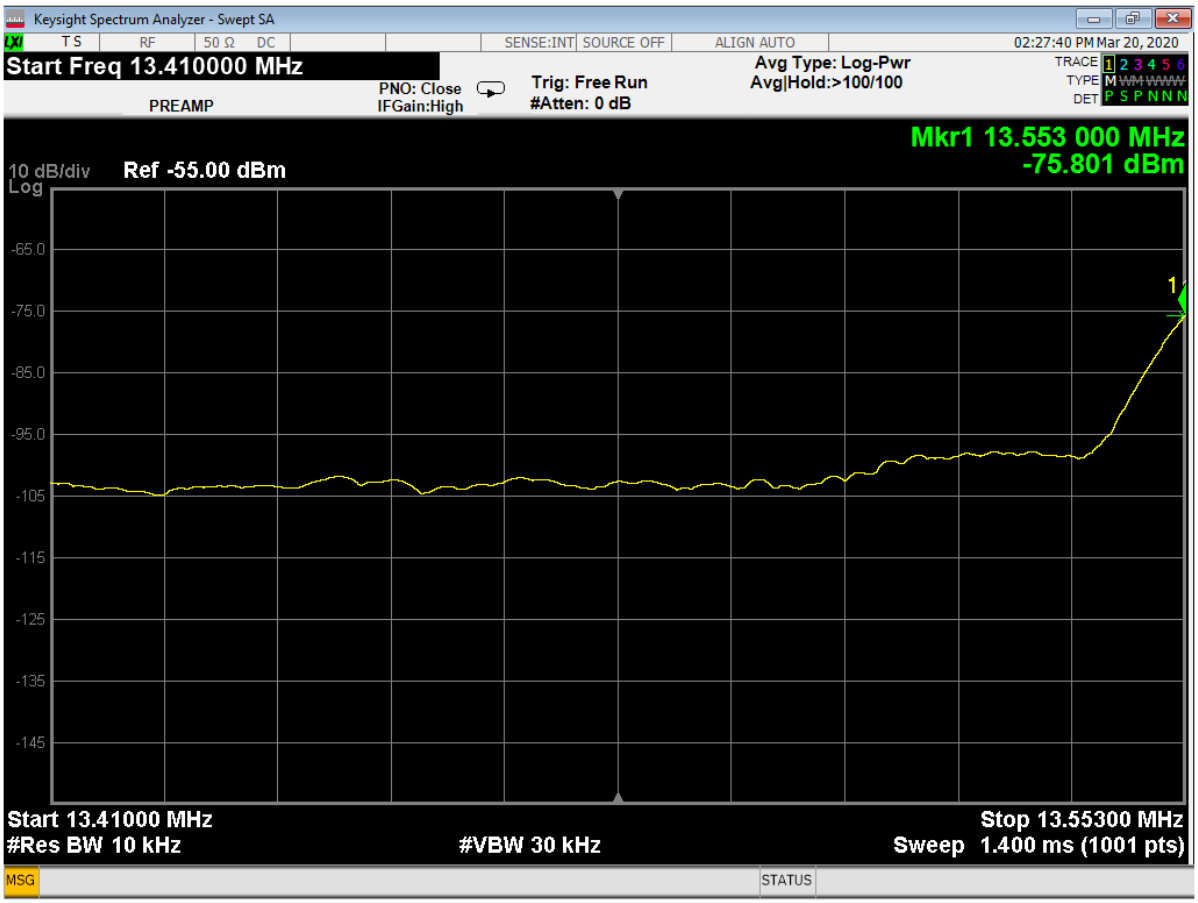


Figure 6 – Lower Band-edge

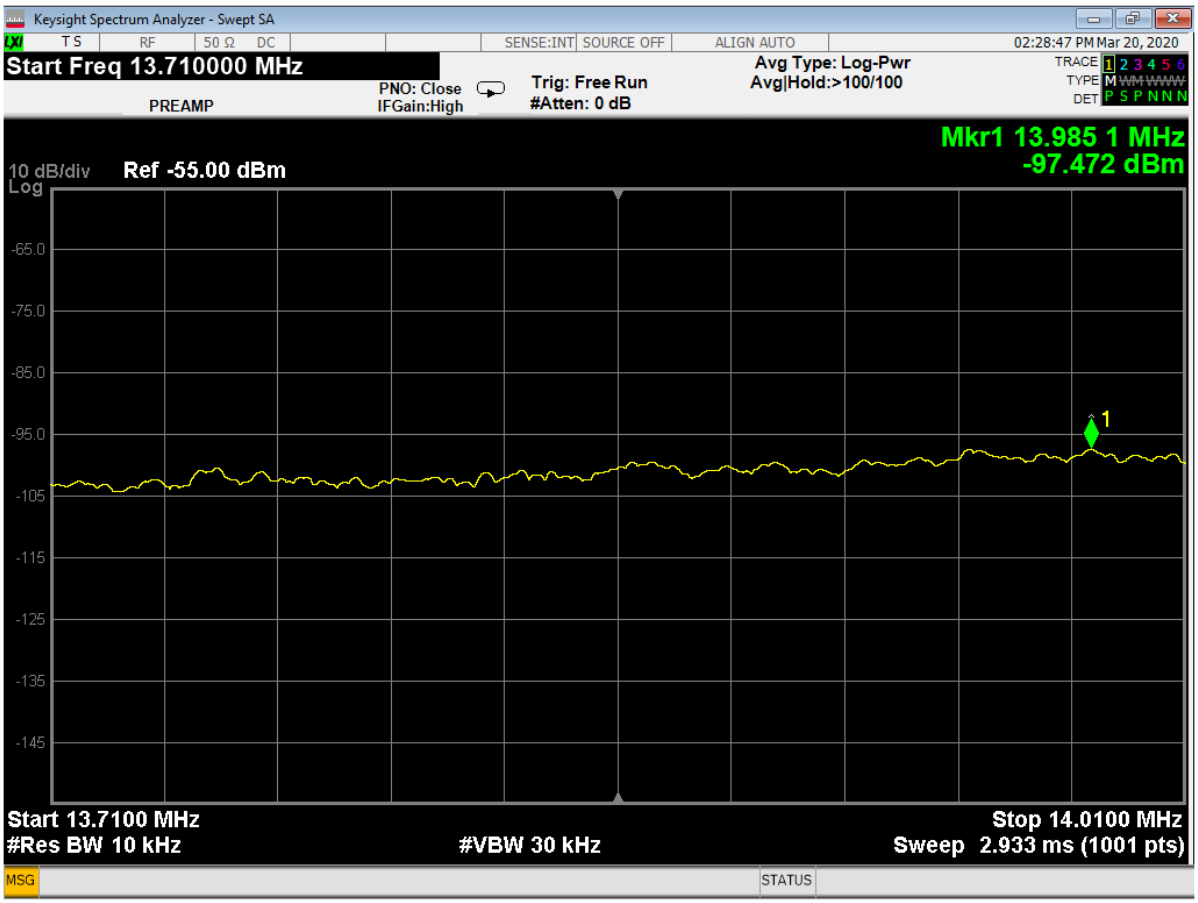


Figure 7 – Higher Band-edge

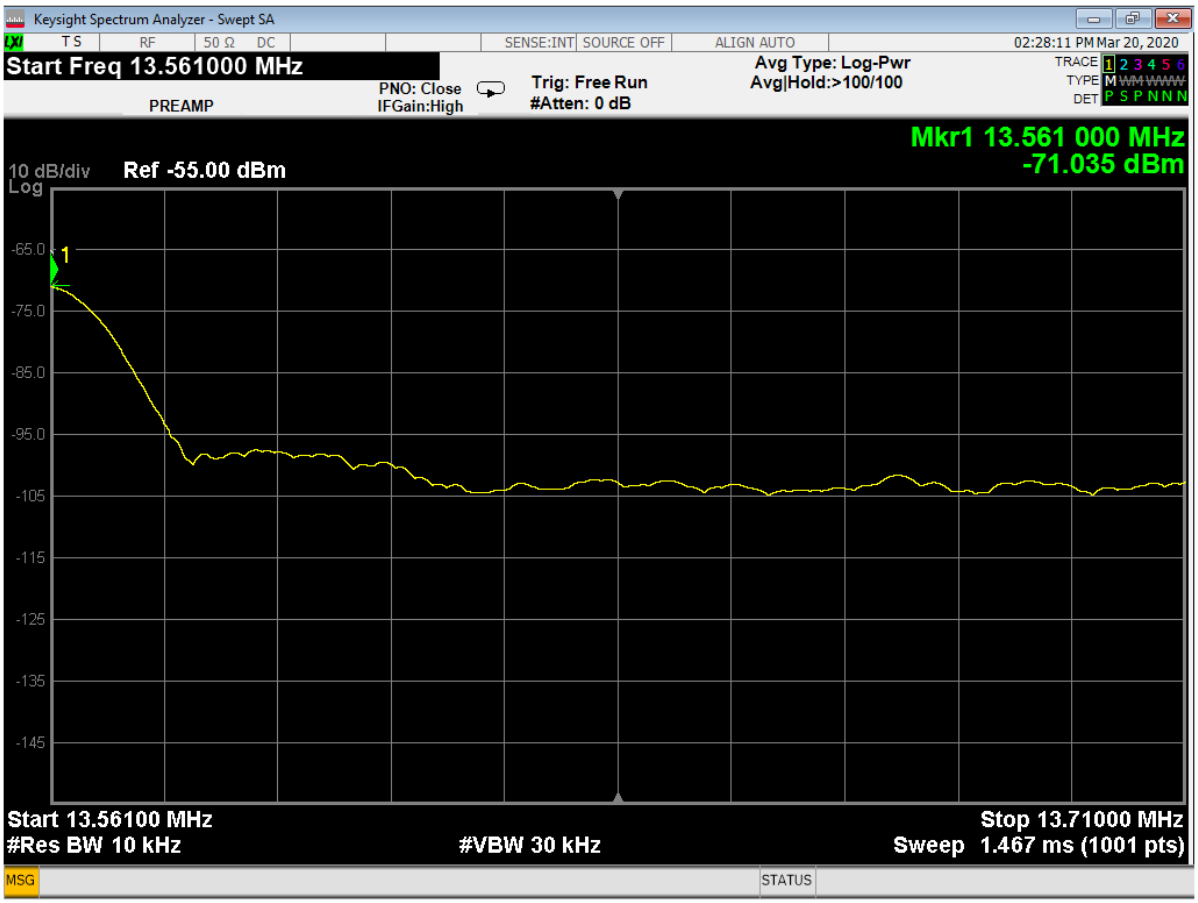


Figure 8 – Higher Band-edge

3.2 Frequency Error

Test:	FCC Part 15.225 (e)		
Test Result:	Complies	**Date:**	3/20/2020

3.2.1 Test Description

Frequency error was determined using the build in frequency error function of the a spectrum analyzer. The analyzer finds the occupied bandwidth, calculates the center of the given band then returns the deviation with respect to the given transmit frequency. The temperature was varied from -20°C to -50°C. Limit: 100 PPM

3.2.2 Test Results

No results were found to be in excess of the limits. A plot of the results can be seen below.

3.2.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility on the 10-meter chamber ground plane. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of 30 ± 5%
Temperature of 23 ±2° C

3.2.4 Test Setup

See Section 2.3 for further details.

3.2.5 Test Equipment Used

Serial No.	Manufacturer	Model	Description	Last Cal.
31373	Thermotron	SE1000-5-5	Temp chamber	NA
MY59050109	Keysight	N9038A	MXE Signal Analyzer	23 Apr 2019
00024936	EMCO	6512	Loop Antenna	11 Feb 2019*
ID # 2130155	Omega	iTHX-SD	3m Temp. Humidity Meter	2018 Jan 31

3.2.6 Test results

Table 4 - Frequency Range Measurements

Temperature (°C)	Channel (MHz)
	13.56000 Nom.
-20°C	13.56081
-10°C	13.56096
0°C	13.56058
10°C	13.56023
20°C	13.56091
30°C	13.56075
40°C	13.56089
50°C	13.56075

Limit: 100 PPM

Table 5 - Voltage Range Measurements

Temperature (°C)	Voltage (VDC)	Channel (MHz)
		13.56000
20°C	3.20	13.560800
20°C	3.90	13.560910
20°C	4.75	13.560310

Voltage ranges provided by the manufacturer, Limit: 100 PPM

3.3 Conducted Emissions

Test Method:	ANSI C63.10-2013, Section(s) 6.2		
Test Result:	Complies	**Date:**	5/20/2019

3.3.1 Test Description

Conducted emissions measurements were made from 150kHz to 30MHz via a 50µH Line Impedance Stabilization Network (LISN). The results were compared against the limits. Measurements were made on both the line and neutral conductors by first using a spectrum analyzer to acquire the signal spectrum; individual frequencies were then measured using a CISPR 16.1 compliant receiver with the following bandwidth setting:

150kHz – 30MHz: 9kHz IF bandwidth, 5kHz steps

3.3.2 Test Results

No results were found to be in excess of the limits. A plot of the results can be seen below.

3.3.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of 30 ± 5%

Temperature of 23 ±2^{o} C

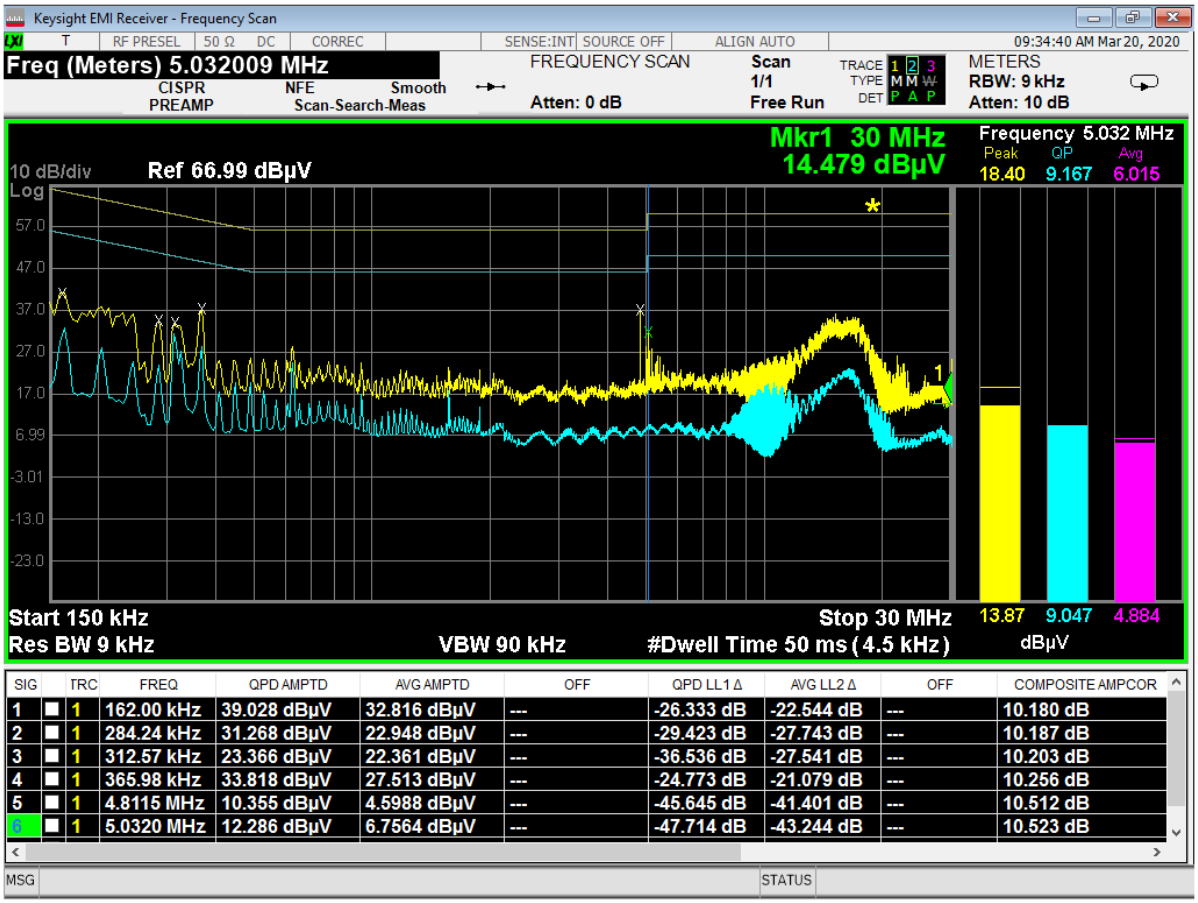
3.3.4 Test Setup

See Section 2.3 for further details.

3.3.5 Test Equipment Used

Serial No.	Manufacturer	Model	Description	Last Cal.
836679/010	Rohde & Schwarz	ESH3-Z5	Artificial Mains	25 Jul 2019
MY59050109	Keysight	N9038A	MXE Signal Analyzer	23 Apr 2019
700307	TDK	TDK Emissions lab	Software V.11.25	Not Required

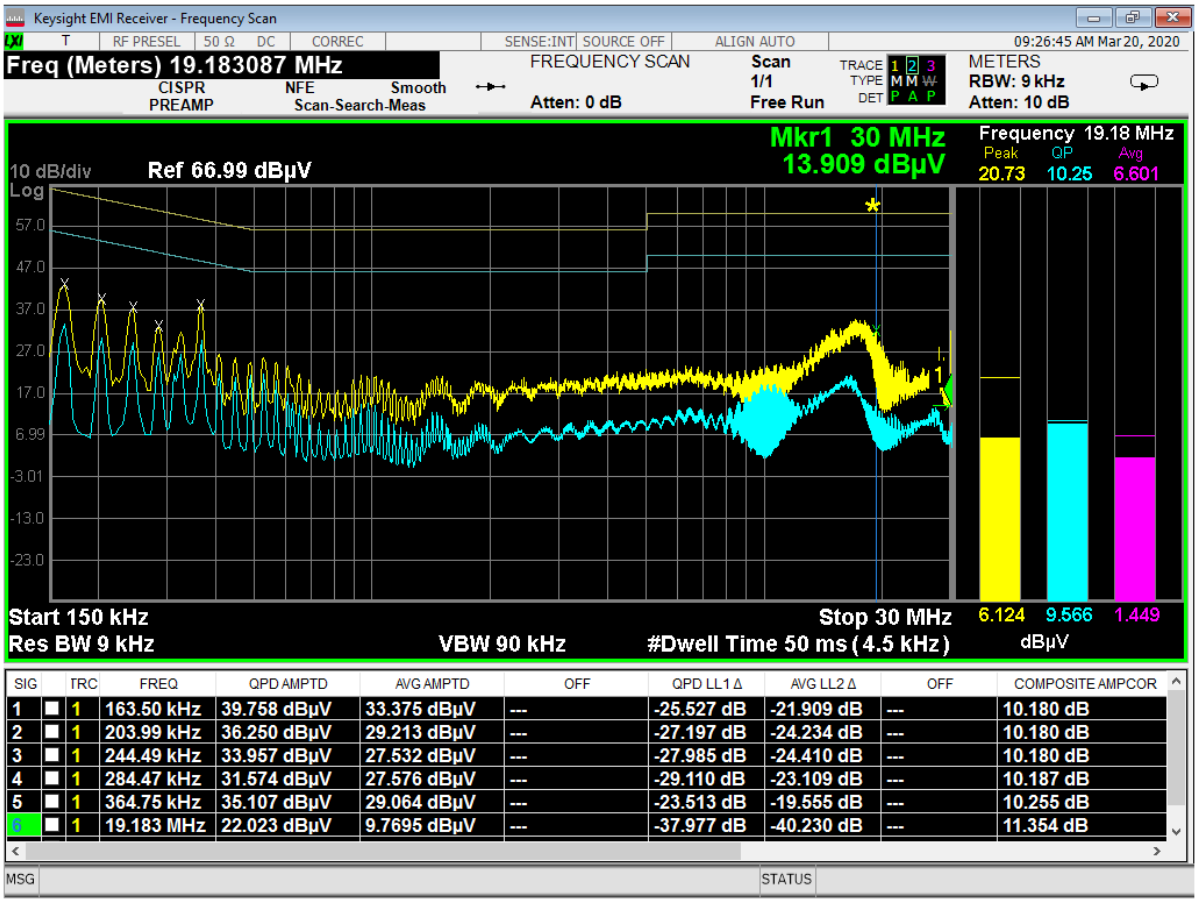
3.3.6 Test Pictures and/or Figures



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	OFF	QPD LL1 Δ	AVG LL2 Δ	OFF	COMPOSITE AMPCOR
1	1	162.00 kHz	39.028 dBµV	32.816 dBµV	---	-26.333 dB	-22.544 dB	---	10.180 dB
2	1	284.24 kHz	31.268 dBµV	22.948 dBµV	---	-29.423 dB	-27.743 dB	---	10.187 dB
3	1	312.57 kHz	23.366 dBµV	22.361 dBµV	---	-36.536 dB	-27.541 dB	---	10.203 dB
4	1	365.98 kHz	33.818 dBµV	27.513 dBµV	---	-24.773 dB	-21.079 dB	---	10.256 dB
5	1	4.8115 MHz	10.355 dBµV	4.5988 dBµV	---	-45.645 dB	-41.401 dB	---	10.512 dB
6	1	5.0320 MHz	12.286 dBµV	6.7564 dBµV	---	-47.714 dB	-43.244 dB	---	10.523 dB

Figure 9 - Conducted Emissions, Line

All Measurements were found to be at least 10 dB below the limits.



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	OFF	QPD LL1 Δ	AVG LL2 Δ	OFF	COMPOSITE AMPCOR
1	1	163.50 kHz	39.758 dBµV	33.375 dBµV	---	-25.527 dB	-21.909 dB	---	10.180 dB
2	1	203.99 kHz	36.250 dBµV	29.213 dBµV	---	-27.197 dB	-24.234 dB	---	10.180 dB
3	1	244.49 kHz	33.957 dBµV	27.532 dBµV	---	-27.985 dB	-24.410 dB	---	10.180 dB
4	1	284.47 kHz	31.574 dBµV	27.576 dBµV	---	-29.110 dB	-23.109 dB	---	10.187 dB
5	1	364.75 kHz	35.107 dBµV	29.064 dBµV	---	-23.513 dB	-19.555 dB	---	10.255 dB
6	1	19.183 MHz	22.023 dBµV	9.7695 dBµV	---	-37.977 dB	-40.230 dB	---	11.354 dB

Figure 10 - Conducted Emissions, Neutral

All Measurements were found to be at least 10 dB below the limits.

Annex A: 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 dB
Radiated Emissions, 3m	1GHz - 18GHz	±4.44 dB
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB
Antenna port conducted	9 kHz – 25 GHz	±0.50 dB

Values were calculated per CISPR 16-4-2:2011

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

Annex B: Sample Field Strength Calculation

Radiated Emissions

The field strength is calculated in decibels (dB) 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 = R + AF – (-CF + AG)

where FS = Field Strength

R = Receiver Amplitude Receiver reading in dBμV

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Preamplifier Amplifier Gain

Assume a receiver reading of 55.00 dBμV is obtained. The Antenna Factor of 12.00 and a Cable Factor of 1.10 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.10 dBμV/m.

FS = 55.00 + 12.00 – (-1.10 + 20.00) = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

Conducted Emissions

Receiver readings are compared directly to the conducted emissions limits in decibels (dB) by adding the cable loss and LISN insertion loss to the receiver reading. The basic equations with a sample calculation is as follows;

FS = R + IL – (-CF)

where V = Conducted Emissions Voltage Measurement

R = Receiver reading in dBμV

IL = LISN Insertion Loss

CF = Cable Attenuation Factor

Assume a receiver reading of 52.00 dBμV is obtained. The LISN insertion loss of 0.80 dB and a Cable Factor of 1.10 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

V = 52.00 + 0.80 – (-1.10) = 53.90 dBμV/m

The 53.90 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 495.45 μV/m

*Note: NCEE Labs uses the Rohde and Schwarz ES-K1 software package. In this software, all cable losses are listed as negative. This is why cable loss is subtracting in the preceding equations.

Margin is calculated by taking the limit and subtracting the Field

REPORT END