

Amended
FCC/ISED DXX Part 15.225
Test Report

Prepared for: Labstrong International Inc.

Address: 7709 Commerce Park
Dubuque, IA 52002-9699
United States

Product: EA00351 NFC Controller

Test Report No: R20190211-23-01A

Approved By:




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Revision Page

Rev. No.	Date	Description
Original	17 July 2019	Original – Prepared by KVepuri/CFarrington Approved by NJohnson
A	14 August 2019	Updated product name



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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 9

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 Issue 5, Sec 4.3	Complies
Frequency Error	FCC Part 15.225 (e) RSS-210 Issue 5, Annex D	Complies
Conducted Emissions	FCC Part 15.207 RSS-Gen Issue 5, Sec 8.8	Complies

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2 EUT Description

The Equipment Under Test (EUT) was an NFC transceiver from Labstrong.

2.1 Equipment under Test (EUT)

Table 2 – Equipment under Test (EUT)

Model	EA00351 NFC Controller
EUT Received	8 April 2019
EUT Tested	8 April 2019
Serial No.	NCEETEST1 (assigned by Lab)
Operating Band	13.56 MHz
Device Type	Low-power
Antenna	Trace Antenna

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 $28 \pm 4\%$
 Temperature of $22 \pm 3^{\circ}\text{C}$

2.3 EUT Setup

The EUT was powered by 5 VDC for all tests. The 5 VDC was supplied from a typical host device that was placed on the floor during testing with a long extension cable leading to the module.

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3 Test Results

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

Test:	FCC Part 15.225 (a), (b), (c), (d) using ANSI C63.10, Sections 6.4, 6.5, and 6.9		
Test Specifications:	Class A		
Test Result:	Complies	Date:	4/8/2019

3.1.1 Test Description

Radiated emissions measurements were made from 30MHz to 1GHz at a distance of 3m (Radiated Emissions and Band edges) and 1m (Band width and Output Power) 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. 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

10MHz – 30MHz, 9kHz RBW, 5 kHz steps

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 $30 \pm 5\%$

Temperature of $23 \pm 2^\circ \text{C}$


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.
1647	EMCO	3142B	Bicon Antenna	02 Aug 2017*
00024936	EMCO	6512	Loop Antenna	11 Feb 2019*
100037	Rohde & Schwarz	ES126	EMI Test Receiver	30 Jan 2018*
2575	Rohde & Schwarz	ES-K1	Software v.1.60	N/A

*Two Year Calibration Cycle

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3.1.6 Test Pictures and/or Figures

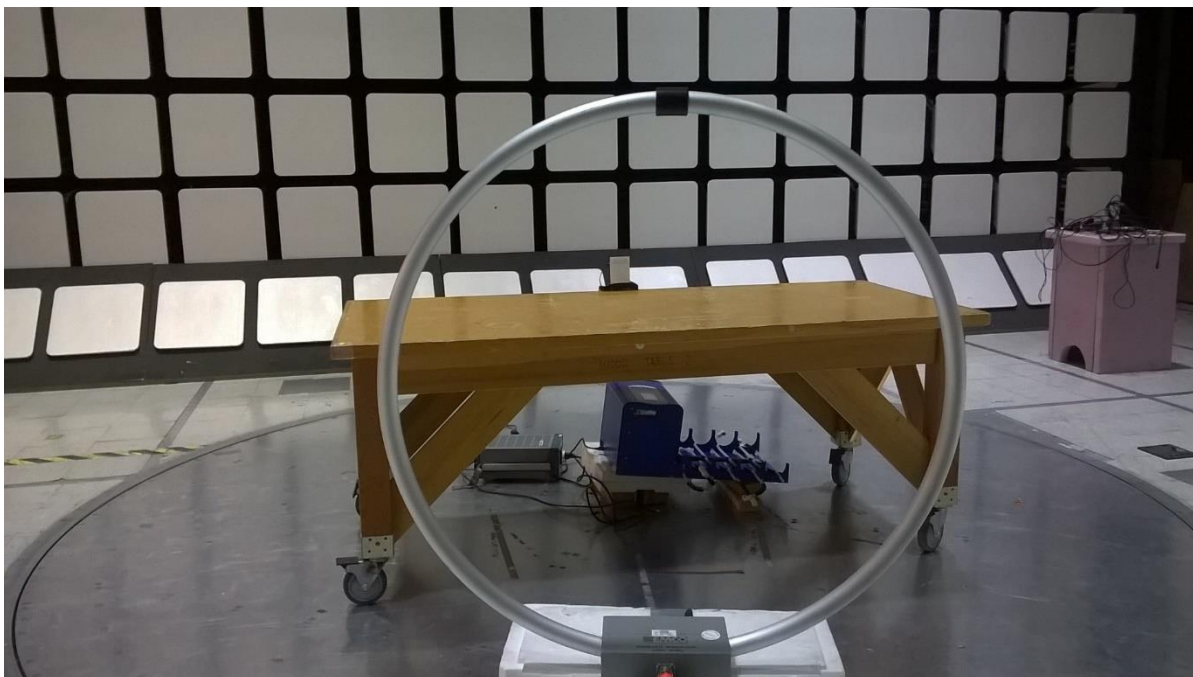


Figure 1 – Radiated Emissions Setup

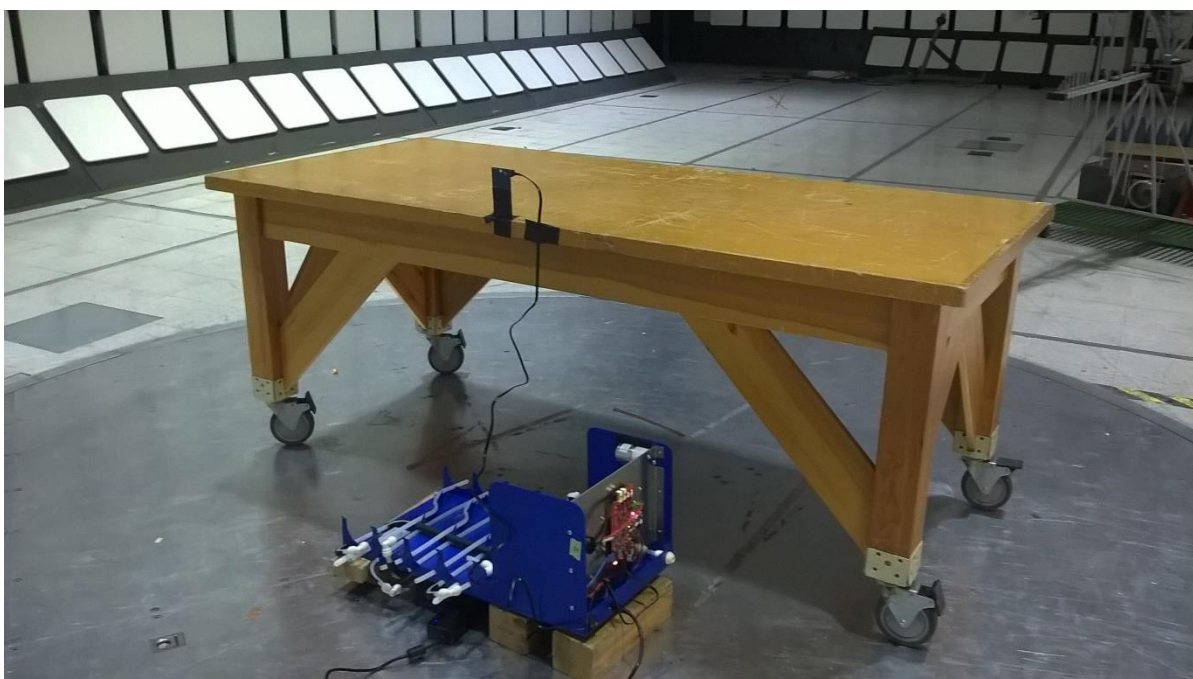


Figure 2 – Radiated Emissions Setup

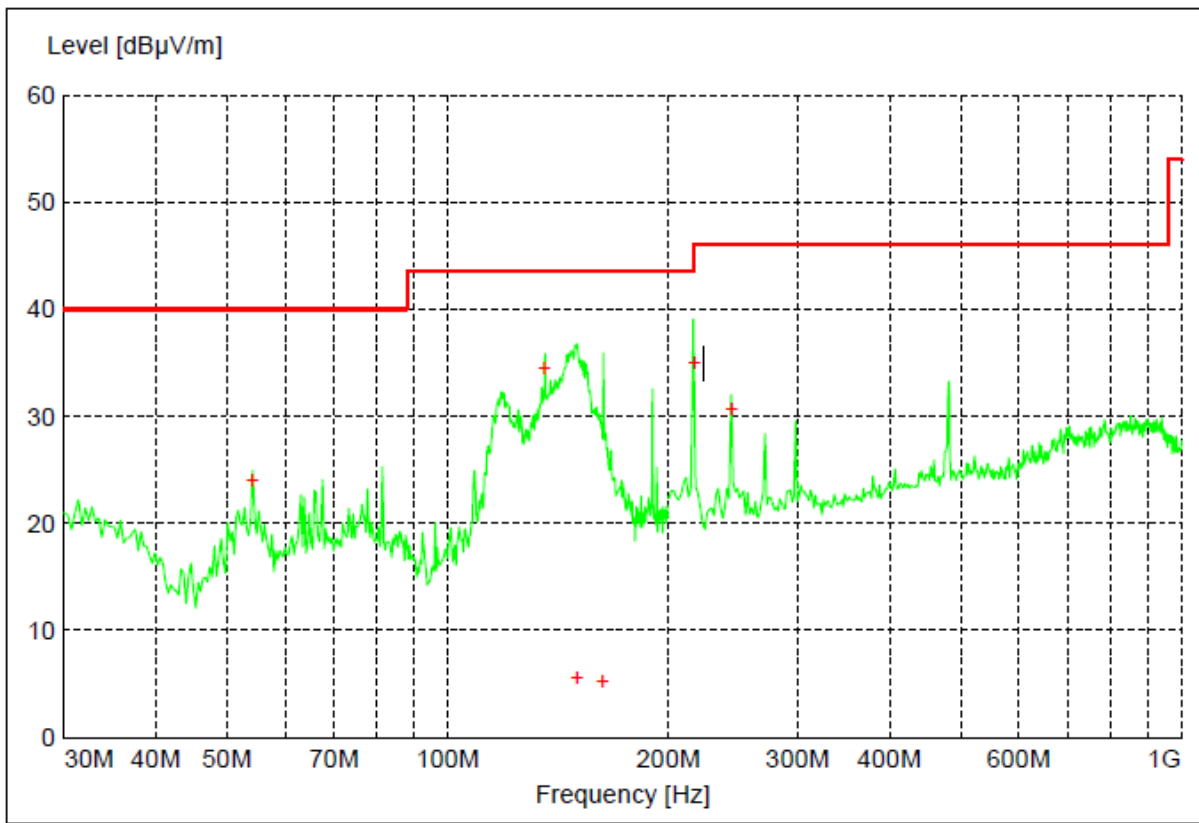

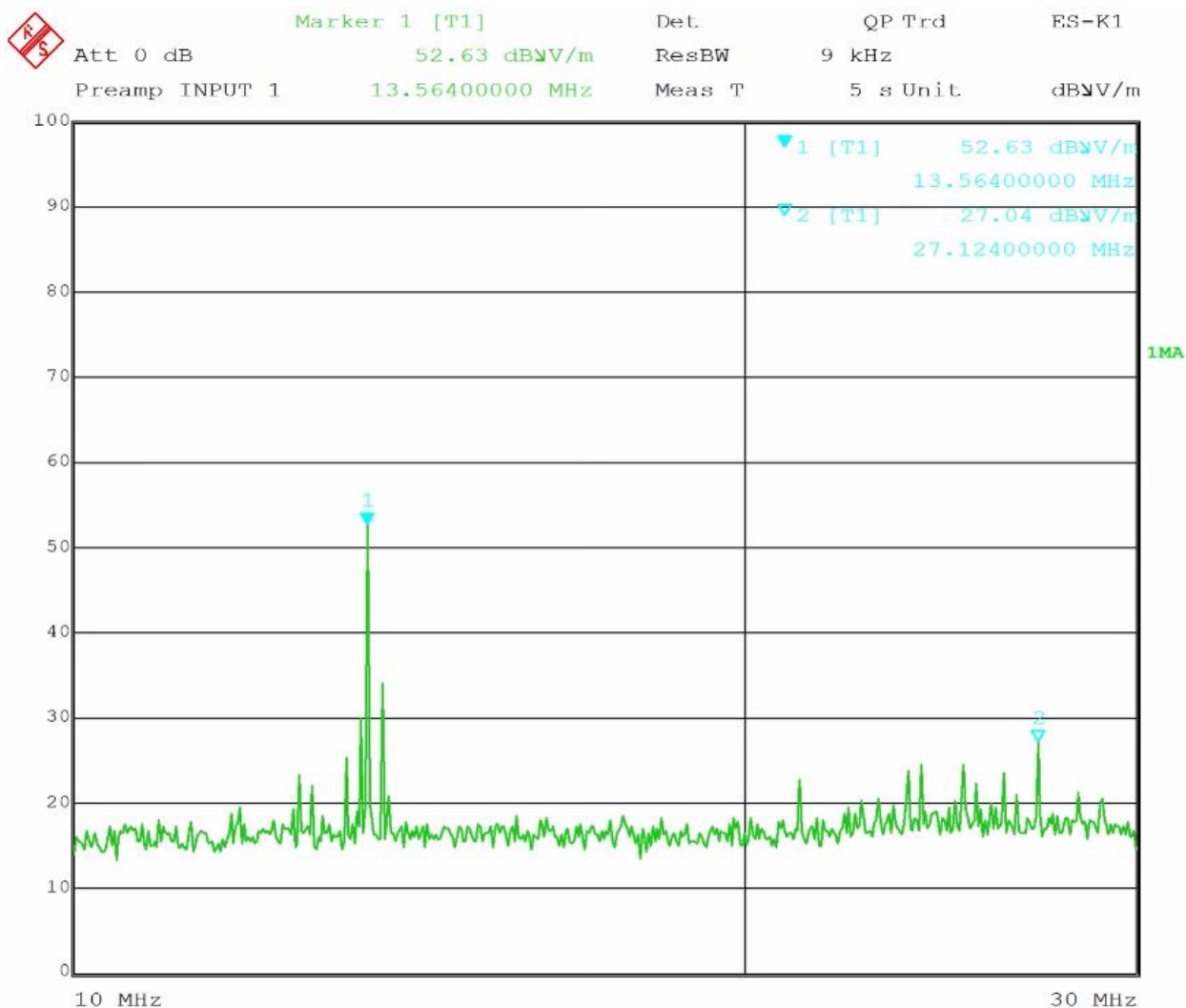


Figure 3 – Radiated Emissions Plot, 30 MHz- 1 GHz

Table 3 – Radiated Emissions QP Data

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg	
54.240000	24.12	40.00	15.90	100.00	353.00	VERT
135.600000	34.66	43.50	8.90	100.00	261.00	VERT
150.120000	5.57	43.50	37.90	280.00	187.00	VERT
162.660000	5.32	43.50	38.20	384.00	167.00	VERT
217.020000	35.10	46.00	10.90	100.00	83.00	VERT
244.080000	30.74	46.00	15.30	233.00	177.00	VERT

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Figure 4 – Radiated Emissions Peak Plot, Vertical Polarization, 10 MHz- 30 MHz

Value VS Limit @ 30m: Level=32.63; Limit= 83.99; Margin=51.36; 13.553-13.567 and outside the band Level= 7.04; Limit= 29.54; Margin =22.50

Limit Extrapolation: 103.99 within the band 13.553-13.567 and 49.54 outside the band (Extrapolated from 30 m to 3 m)

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

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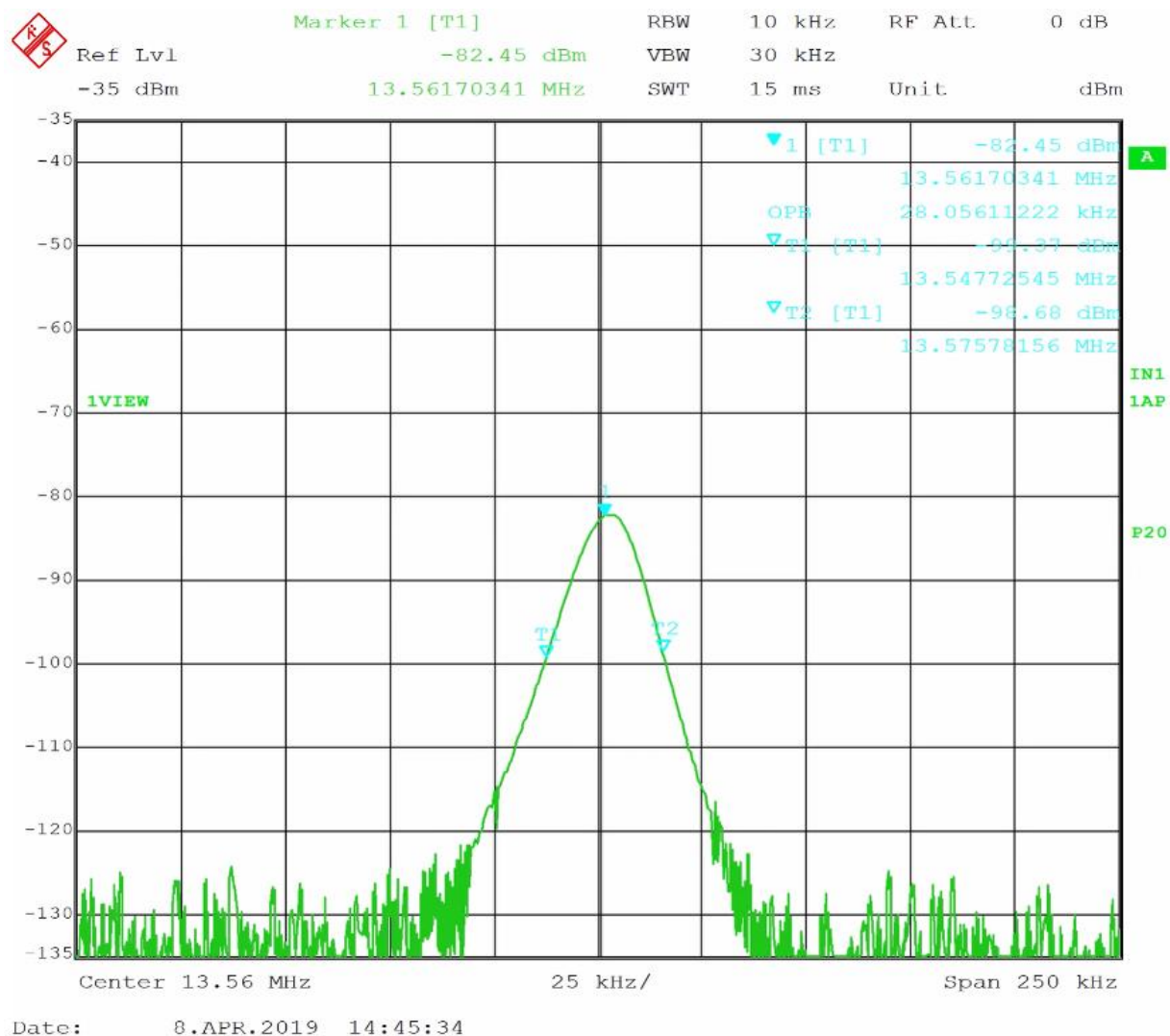



Figure 5 - 99% Occupied Bandwidth, Horizontal polarity, NFC

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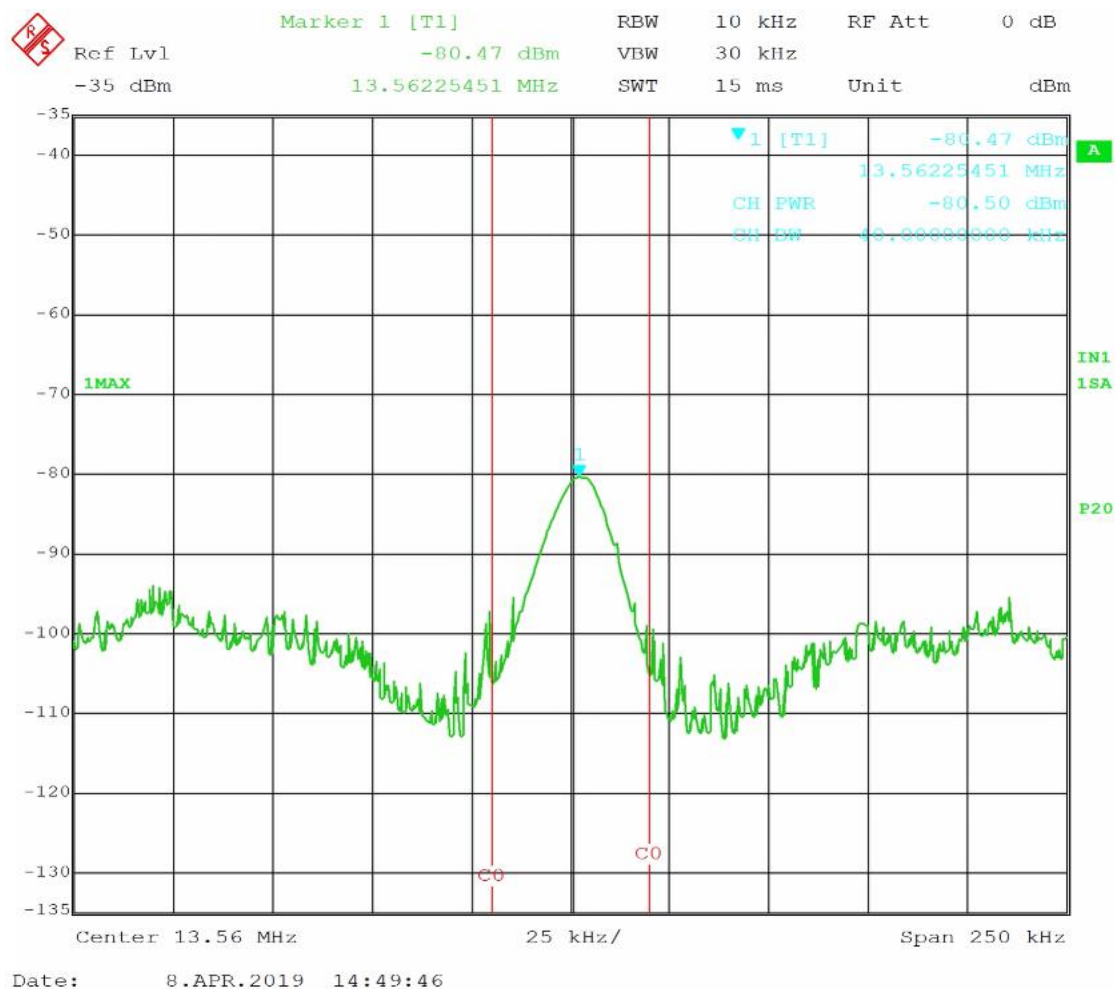


Figure 6 – Output Power, NFC

Figure 7 – Output Power

Raw band level dBm	Corrected band level dBμV/m	Limit	Margin	Result
-80.50	30.85*	83.99	53.14	PASS


Maximum power = $107 - 80.50 + 0.9 + 35 = 62.40$ dBuV/m @ 1m=30.85 dBuV/m @ 30m

CL = cable loss = 0.90 dB

AF = antenna factor = 35.00 dB

107 = conversion from dBm to dBμV on a 50Ω measurement system

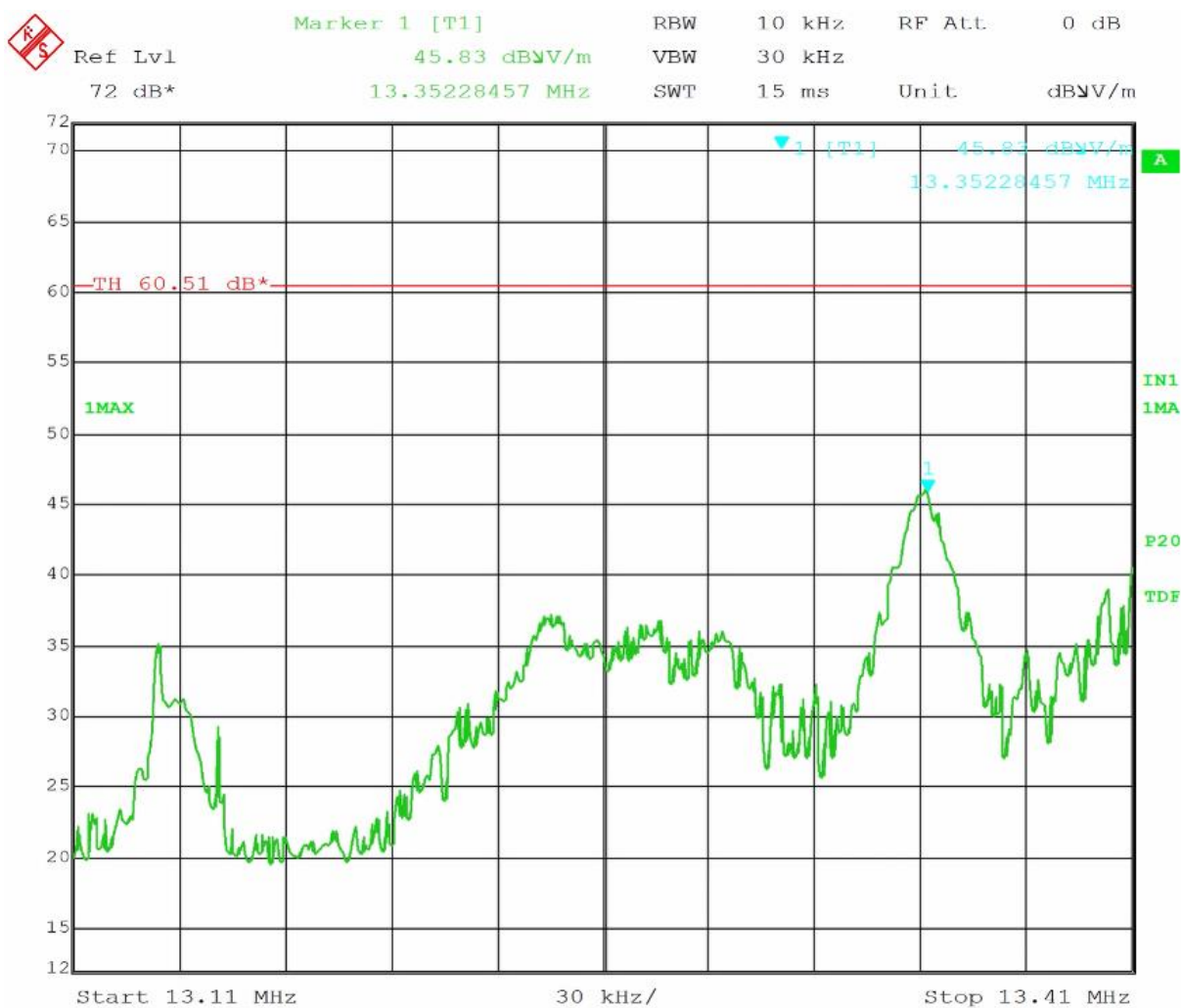
* Extrapolated limit from 1 m to 30 m; Measurement performed at 1m distance.

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Band Edge Measurements:


Band edge /Measurement Frequency (MHz)	Corrected band level dBμV	Extrapolated band level from 3m to 30m	Limit	Margin	Result
13.11-13.41	45.83	25.83*	40.51	14.68	PASS
13.41-13.553	52.14	32.14*	50.47	18.33	PASS
13.71-14.01	42.39	22.39*	40.51	18.12	PASS
13.567-13.71	56.91	36.91*	50.47	13.56	PASS

* Extrapolated limit from 3 m to 30 m. Corrected band level = uncorrected band level + cable loss + antenna factor (Note that the values shown in the plots are corrected values)



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Figure 8 – Lower Band-edge, 13.11 MHz – 13.41 MHz

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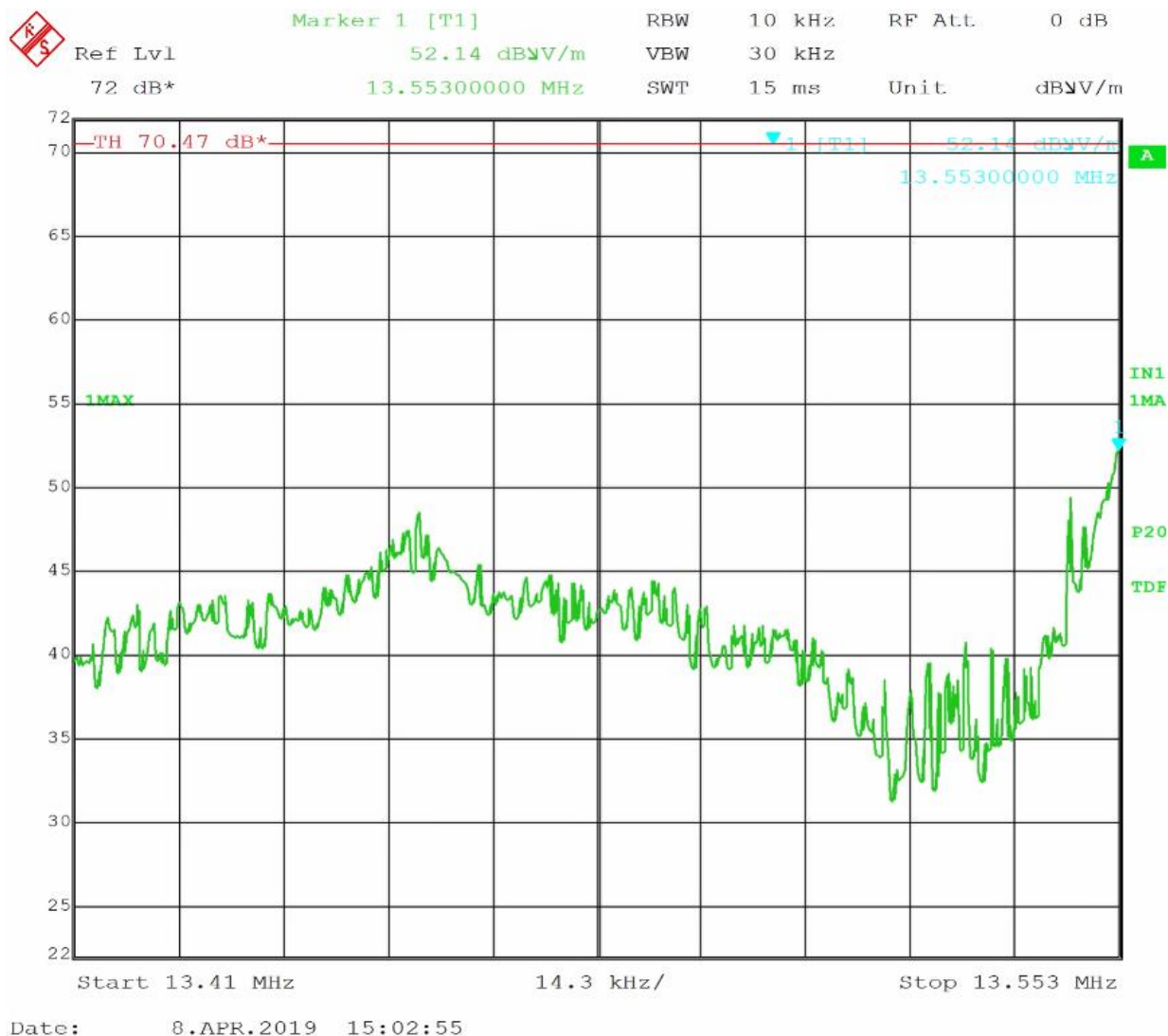

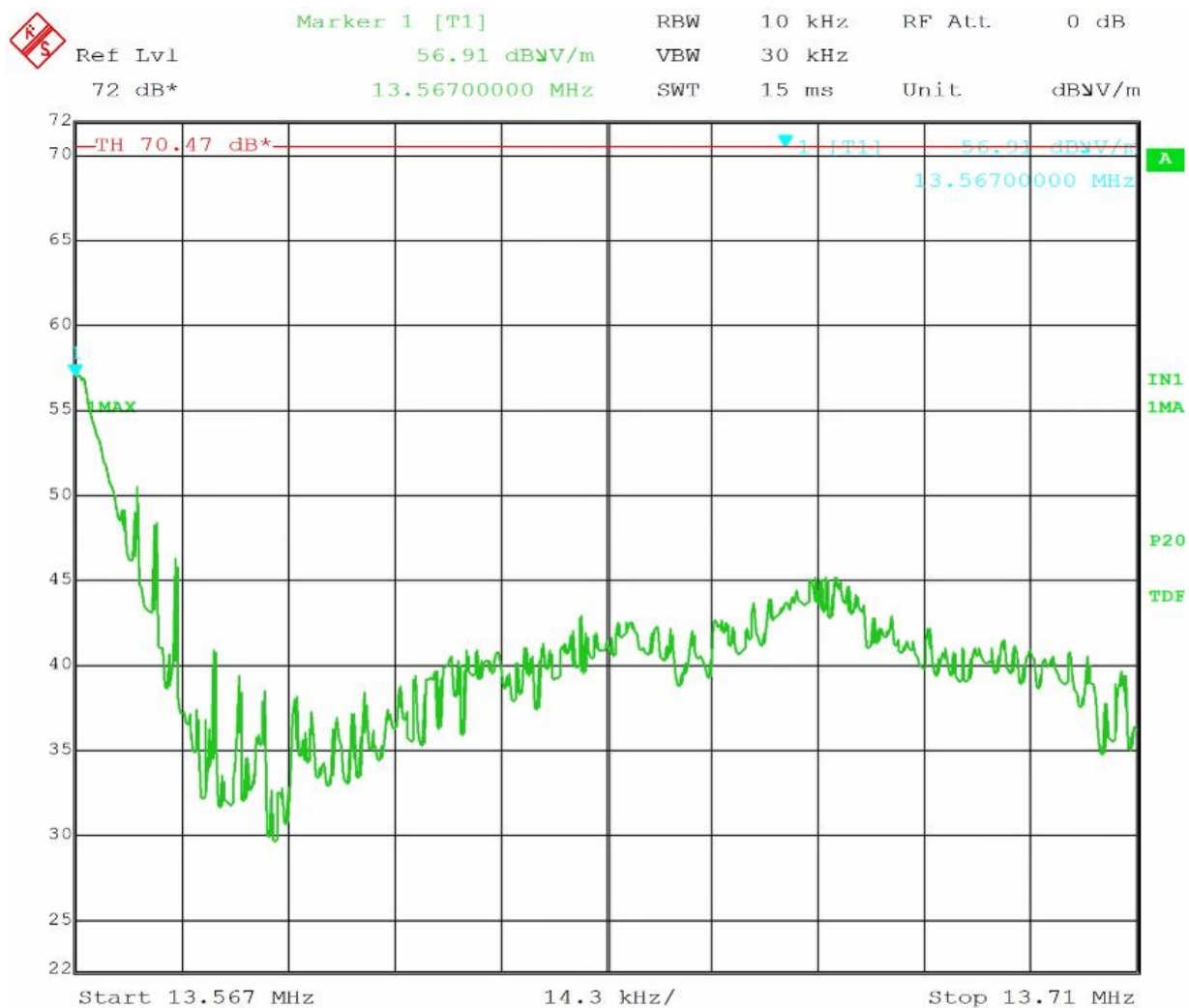



Figure 9 – Lower Band-edge, 13.41 MHz – 13.553 MHz

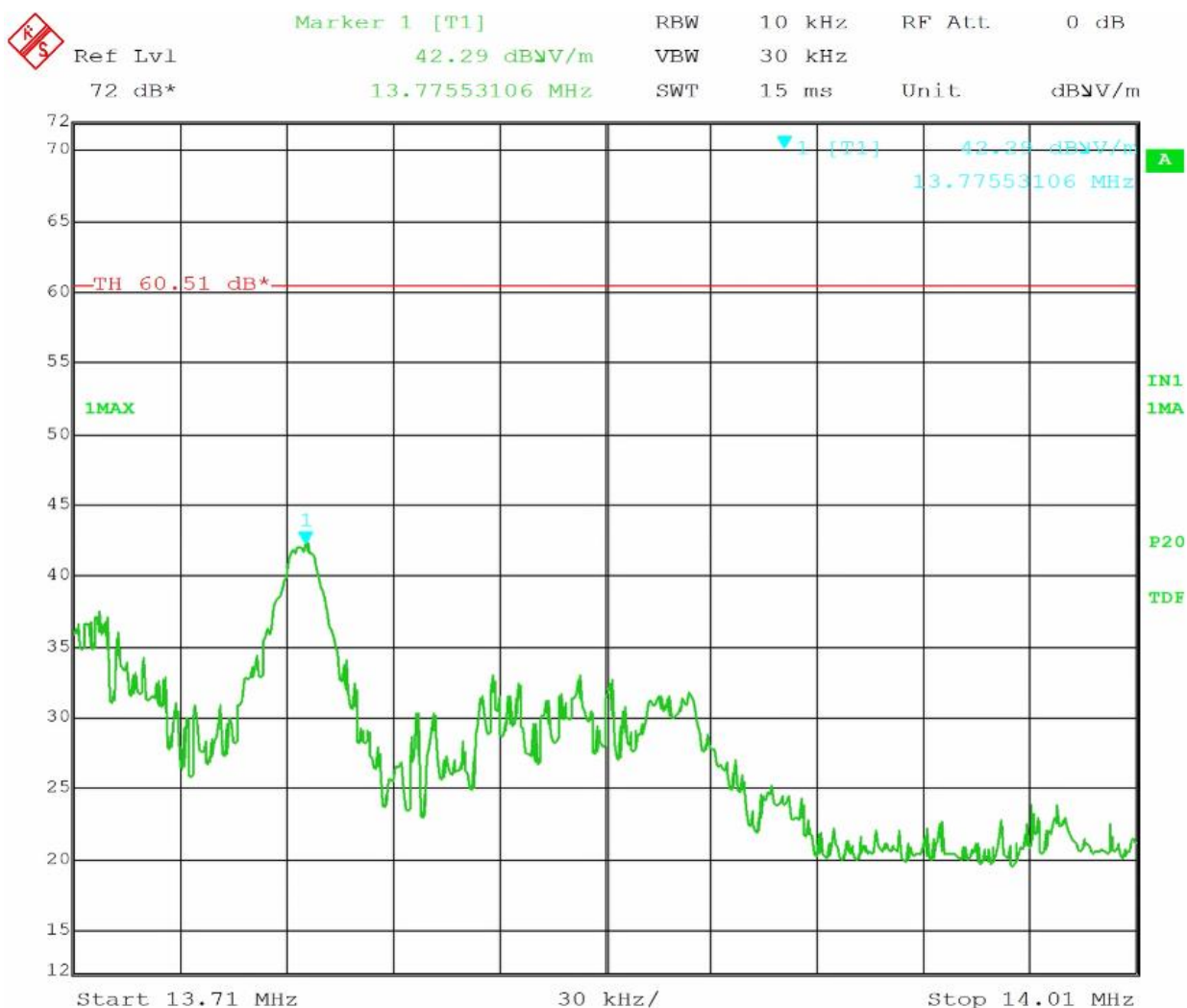
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Figure 10 – Higher Band-edge, 13.567 MHz – 13.71 MHz

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Figure 11 – Higher Band-edge, 13.71 MHz – 14.01 MHz

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3.2 Frequency Error

Test:	FCC Part 15.225 (e) Using ANSI C63.10, Section 6.8.1		
Test Result:	Complies	Date:	4/8/2019

3.2.1 Test Description

Radiated power was measured on a spectrum analyzer with resolution bandwidth and video bandwidth set to 3 kHz and 10 kHz respectively. The center frequency was found by measuring the frequency of the signal 10dB below the peak on the high and low end of the signal. The frequency half way in between these frequencies was recorded as the center 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 $30 \pm 5\%$

Temperature of $23 \pm 2^\circ \text{C}$


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
100007	Rohde & Schwarz	ESIB7	EMI Test Receiver	2018 Jul 31
00024936	EMCO	6512	Loop Antenna	2019 Feb 11
ID # 2130155	Omega	iTHX-SD	3m Temp. Humidity Meter	2018 Jan 31

*Two Year Calibration Cycle

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3.2.6 Test results

Table 4 - Frequency Range Measurements


Temperature (°C)	Channel (MHz)
	13.56000 Nom.
-20°C	13.561600
-10°C	13.561640
0°C	13.561640
10°C	13.561600
20°C	13.561600
30°C	13.561600
40°C	13.561560
50°C	13.561560

Limit: 100 PPM

Table 5 - Voltage Range Measurements

Temperature (°C)	Voltage (VDC)	Channel (MHz)
		13.56000
20°C	3.20	13.561600
20°C	3.90	13.561600
20°C	4.75	13.561600

Voltage ranges provided by the manufacturer, Limit: 100 PPM

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3.3 Conducted Emissions

Test Method:	ANSI C63.10-2013, Section(s) 6.2			
Test Result:	Complies	Date:	4/8/2019	

3.3.1 Test Description

Conducted emissions measurements were made from 150kHz to 30MHz via a 50 μ H 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 \pm 5%

Temperature of 23 \pm 2° C


3.3.4 Test Setup

See Section 2.3 for further details.

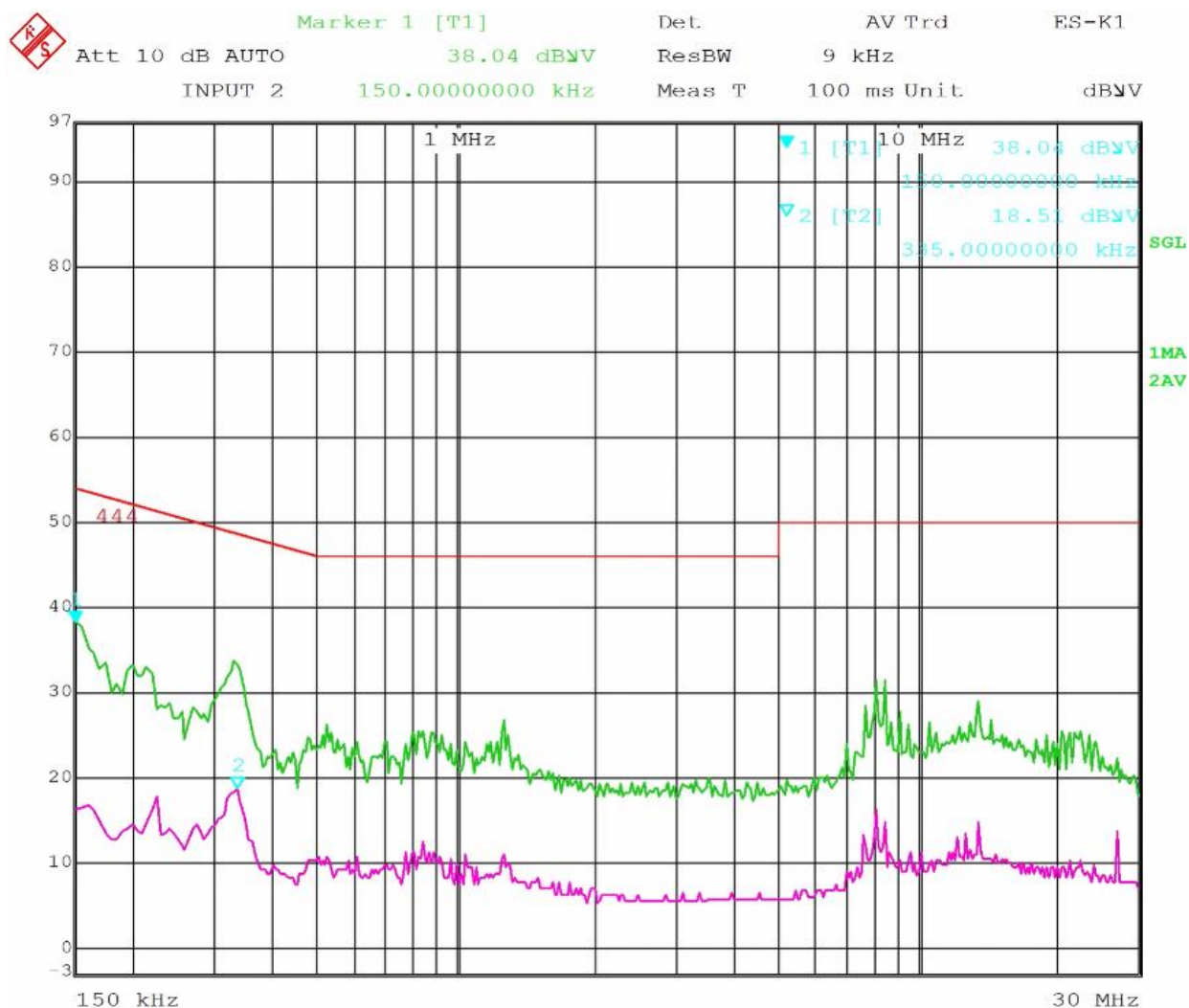
3.3.5 Test Equipment Used

Serial No.	Manufacturer	Model	Description	Last Cal.
836679/010	Rohde & Schwarz	ESH3-Z5	Artificial Mains	26 Jul 2018
100037	Rohde & Schwarz	ES126	EMI Test Receiver	30 Jan 2018*
2575	Rohde & Schwarz	ES-K1	Software v.1.60	N/A

*Two Year Calibration Cycle

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3.3.6 Test Pictures and/or Figures




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Figure 12 - Conducted Emissions, Line, NFC

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

Red line shown is average limit

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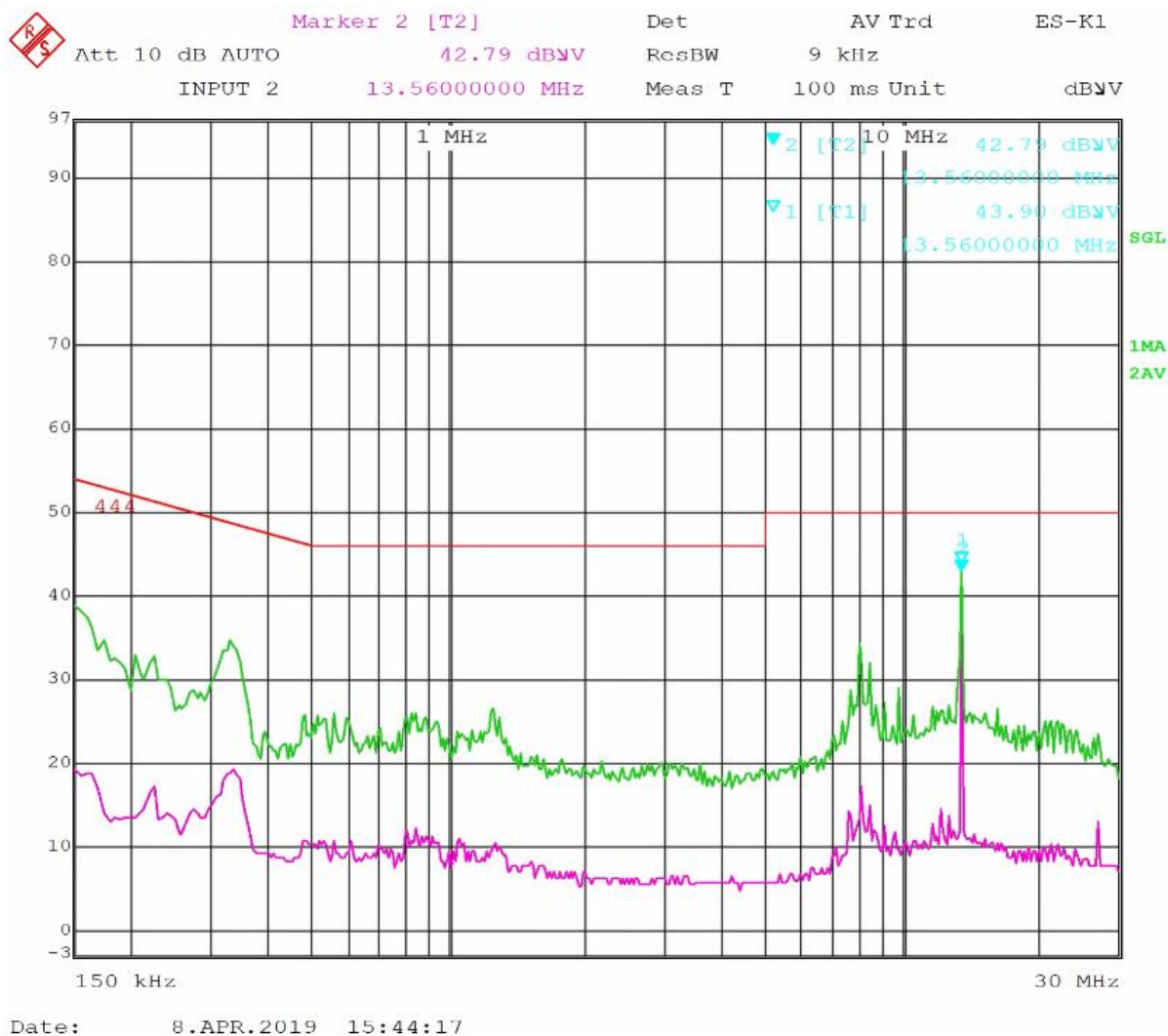



Figure 13 - Conducted Emissions, Neutral, NFC

All Measurements were found to be at least 10 dB below the limits.
 Red line shown is average limit

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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%.

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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 dB μ V

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Preamplifier Amplifier Gain

Assume a receiver reading of 55.00 dB μ V 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 dB μ V/m.

$$FS = 55.00 + 12.00 - (-1.10 + 20.00) = 48.1 \text{ dB}\mu\text{V/m}$$

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

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


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 dB μ V

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IL = LISN Insertion Loss

CF = Cable Attenuation Factor

Assume a receiver reading of 52.00 dB μ V 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 dB μ V/m.


$$V = 52.00 + 0.80 - (-1.10) = 53.90 \text{ dB}\mu\text{V/m}$$

The 53.90 dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(48.1 \text{ dB}\mu\text{V/m})/20] = 495.45 \mu\text{V/m}$$

*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

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