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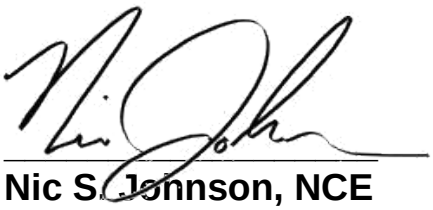
FCC/ISED Test Report

Prepared for:	**Kipit Engineering Services**
Address:	**53 East 82nd Street** **New York, New York 10028**
Product:	**Kipit Tote Liner**
Test Report No:	**R20191022-21-E1D**
Approved By:	 **Nic S. Johnson, NCE** **Technical Manager** **iNARTE Certified EMC Engineer #EMC-003337-NE**
DATE:	**11 January 2021**
Total Pages:	**25**

ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

Revision Page

Rev. No.	Date	Description
Original	7 July 2020	Original – Prepared by CFarrington Approved by NJohnson
A	31 August 2020	Re-calculated limits, field strength at fundamental frequency and second harmonic.
B	1 October 2020	Corrected specified distanced and output power calculation.
C	19 October 2020	Correct all test distances to 3m.
D	11 January 2021	Added frequency error test results

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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 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
Conducted Emissions	FCC Part 15.207 RSS-Gen, Sec 8.8	Complies

2 EUT Description

2.1 Equipment under Test (EUT)

Table 2 – Equipment under Test (EUT)

Model	Kipit Tote Liner
EUT Received	23 April 2020
EUT Tested	27 April 2020 - 27 May 2020
Serial No.	00091 (Assigned by test lab)
Operating Band	13.56 MHz
Device Type	NFC
Antenna	Trace Antenna
Power Supply	Internal Battery/ 5VDC Charger: 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 power supply mentioned in section 2.1 for conducted emissions. All other tests were run on internal battery.

3 Test Results

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

Test:	FCC Part 15.225 (a), (b), (c), (d)
Test Result:	Complies

3.1.1 Test Description

Radiated emissions measurements were made from 30MHz to 1GHz at a distance of 3m 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

The device contains a pre-certified 2.4GHz radio. The manufacturer has declared that it is not possible for the 2.4GHz radio and the 13.56MHz radio to operate simultaneously, thus intermodulation products were not investigated.

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.
A091418	SunAR RF Motion	JB1	Bicon Antenna	06 Mar 2020
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

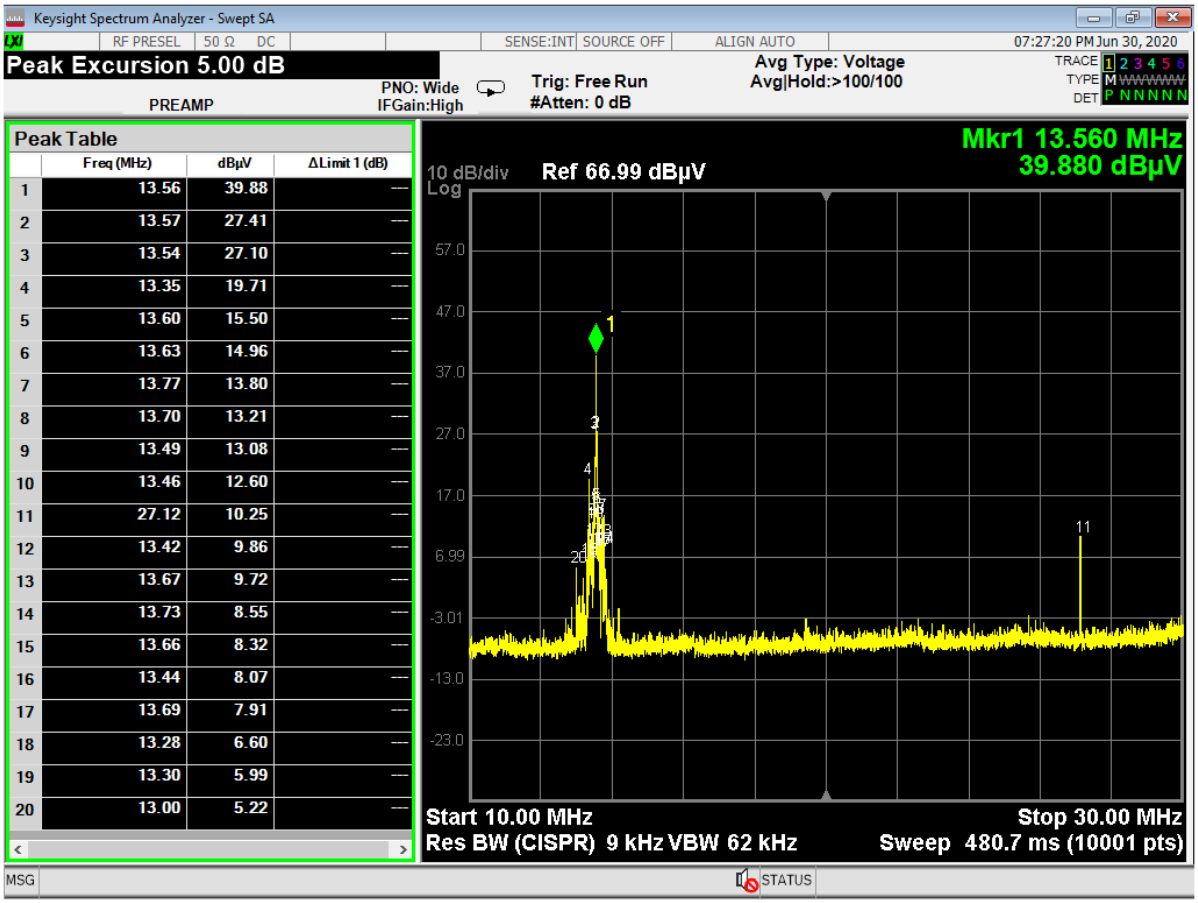


Figure 1 – Radiated Emissions Peak Plot, Horizontal Polarization, 10 MHz- 30 MHz

*The below calculations detail measurements outside the band of operation. For measurements detailing the band of operation and those bands surrounding the band of operation, please see the band-edge and output power sections later in this report.

(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.

Limit = 20*log(15848) + 20log(30/3) = 104.0 dBuV/m at 3m

(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.

Limit = 20*log(334) + 20log(30/3) = 70.5 dBuV/m at 3m

(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.

Limit = 20*log(106) + 20log(30/3) = 60.5 dBuV/m at 3m

(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.

Limit = 20*log(30) + 20log(30/3) = 49.54 dBuV/m at 3m

Spurious Emissions Level = FS + CL + AF

CL = cable loss = 0.60 dB
AF = antenna factor = 34.7 dB

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

Frequency	Level	Limit	Margin
MHz	dBuV/m	dBuV/m	dB
13.56	75.18	104.00	28.82
13.57	62.71	70.50	7.79
13.54	62.40	70.50	8.10
13.35	55.01	70.50	15.49
13.60	50.80	70.50	19.70
13.63	50.26	70.50	20.24
13.77	49.10	60.50	11.40
13.70	48.51	70.50	21.99
13.49	48.38	70.50	22.12
13.46	47.90	70.50	22.60
27.12	45.55	49.54	3.99
13.42	45.13	70.50	25.37
13.67	45.02	70.50	25.48
13.73	43.85	60.50	16.65
13.66	43.62	70.50	26.88
13.44	43.37	70.50	27.13
13.69	43.21	70.50	27.29
13.28	41.90	70.50	28.60
13.30	41.29	70.50	29.21
13.00	40.52	70.50	29.98

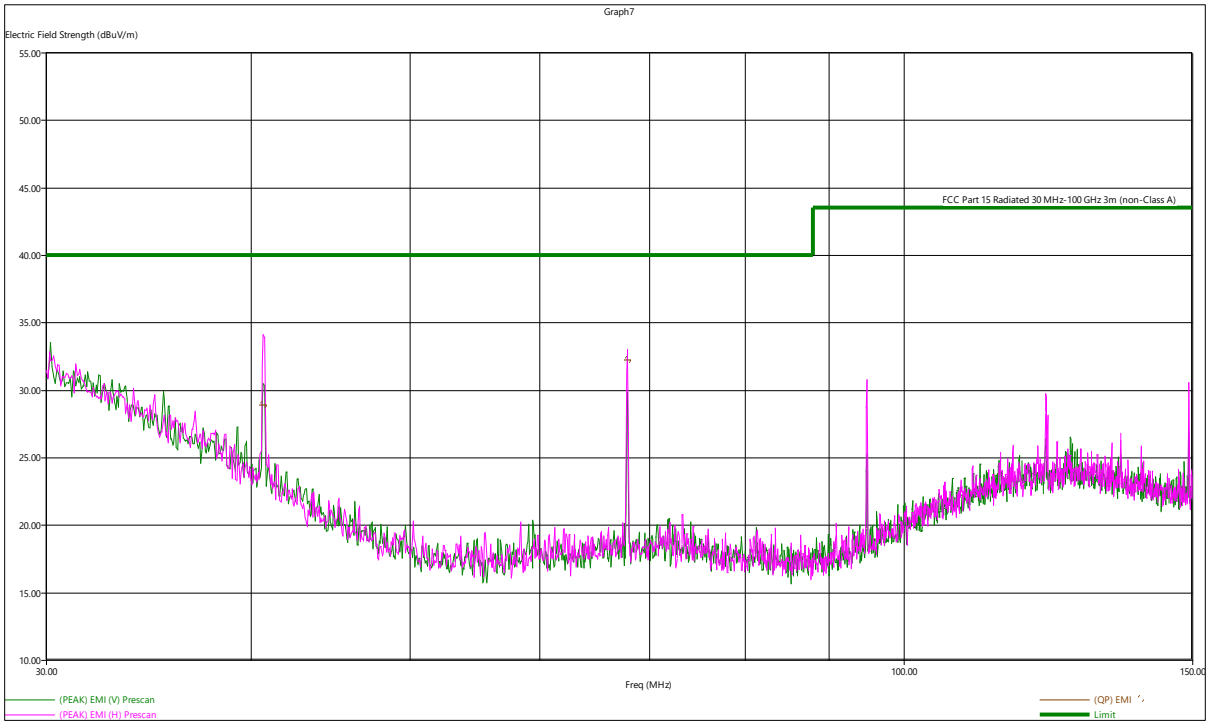


Figure 2 – Radiated Emissions Peak Plot, 30 MHz- 1 GHz

All other emissions were found to be at least 10dB below the limit.

Quasi-Peak Measurements						
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
40.730000	28.85	40.00	11.15	266	98	H
67.800000	32.18	40.00	7.82	361	73	H
189.810000	36.28	43.52	7.24	200	73	H

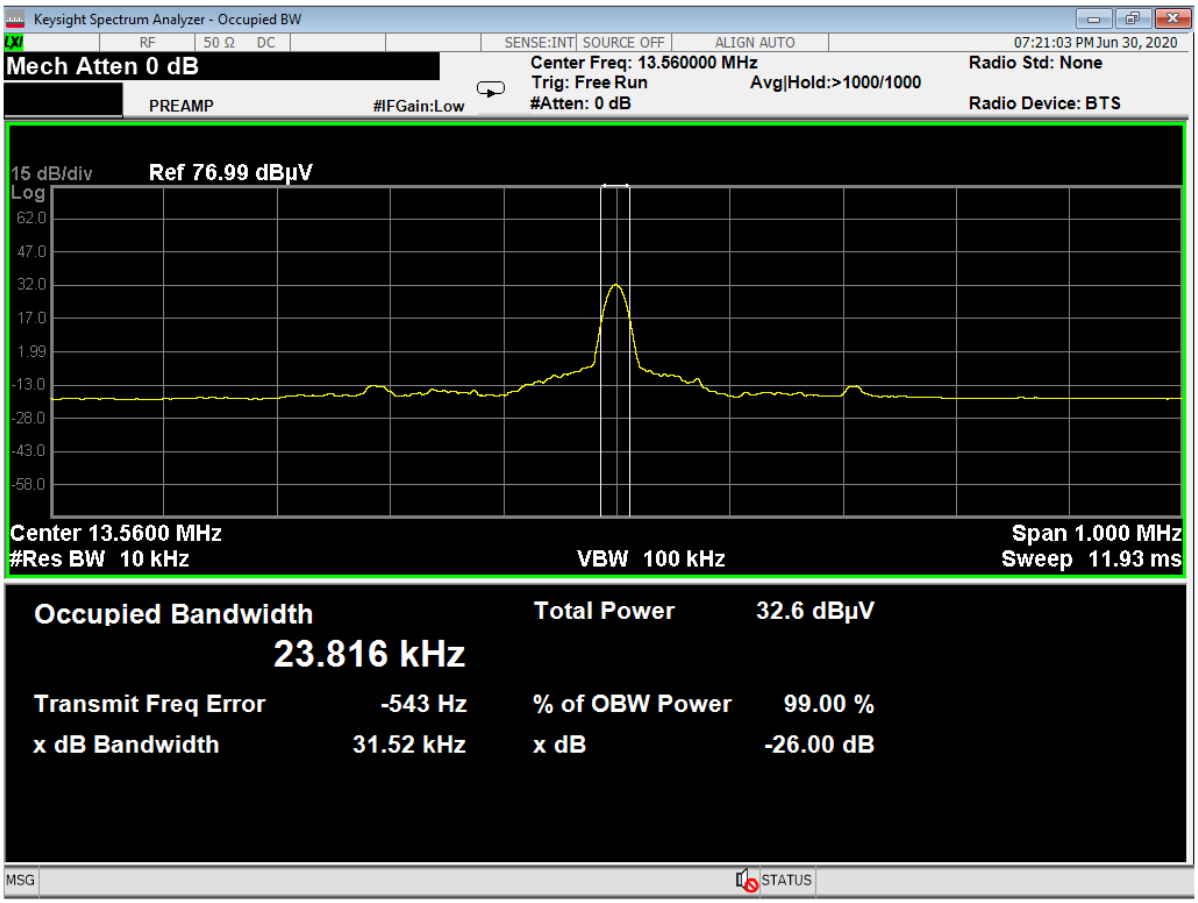


Figure 3 - 99% Occupied Bandwidth, NFC

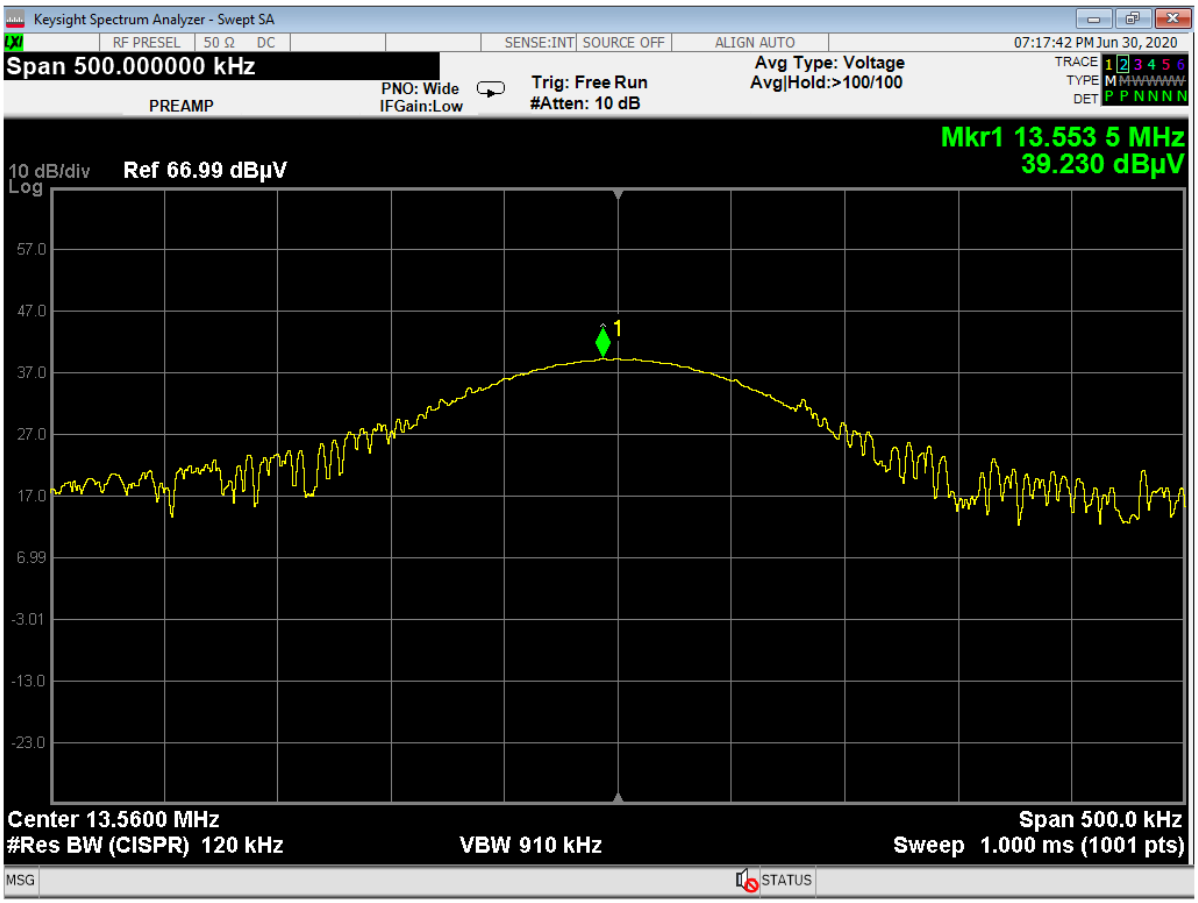


Figure 4 – Output Power

Raw band level dBm	Corrected band level dBµV/m	Limit*	Margin	Result
39.23	74.53	104.00	29.47	Pass

Maximum power = 39.230 + 0.60 + 34.70 = 74.53 dBuV/m @ 3m
CL = cable loss = 0.60 dB
AF = antenna factor = 34.7 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system

* Extrapolated limit from 30 m to 3 m. Limit found in FCC Part 15.225(a)

Measurement performed at 3m distance.

Band Edge Measurements:

Band edge /Measurement Frequency (MHz)	Uncorrected band level (dBm)	Corrected band level (dBµV/m @ 3m)	Limit* dBµV	Margin	Result
13.11-13.41	19.416	54.716	60.506	5.790	PASS
13.41-13.553	31.690	66.990	70.475	3.485	PASS
13.71-14.01	17.257	52.557	60.506	7.949	PASS
13.567-13.71	34.055	69.355	70.475	1.120	PASS

* Extrapolated limit from 30 m to 3 m. Limit taken from FCC Part 15.225(b),(c)
Corrected band level = uncorrected band level + cable loss + antenna factor

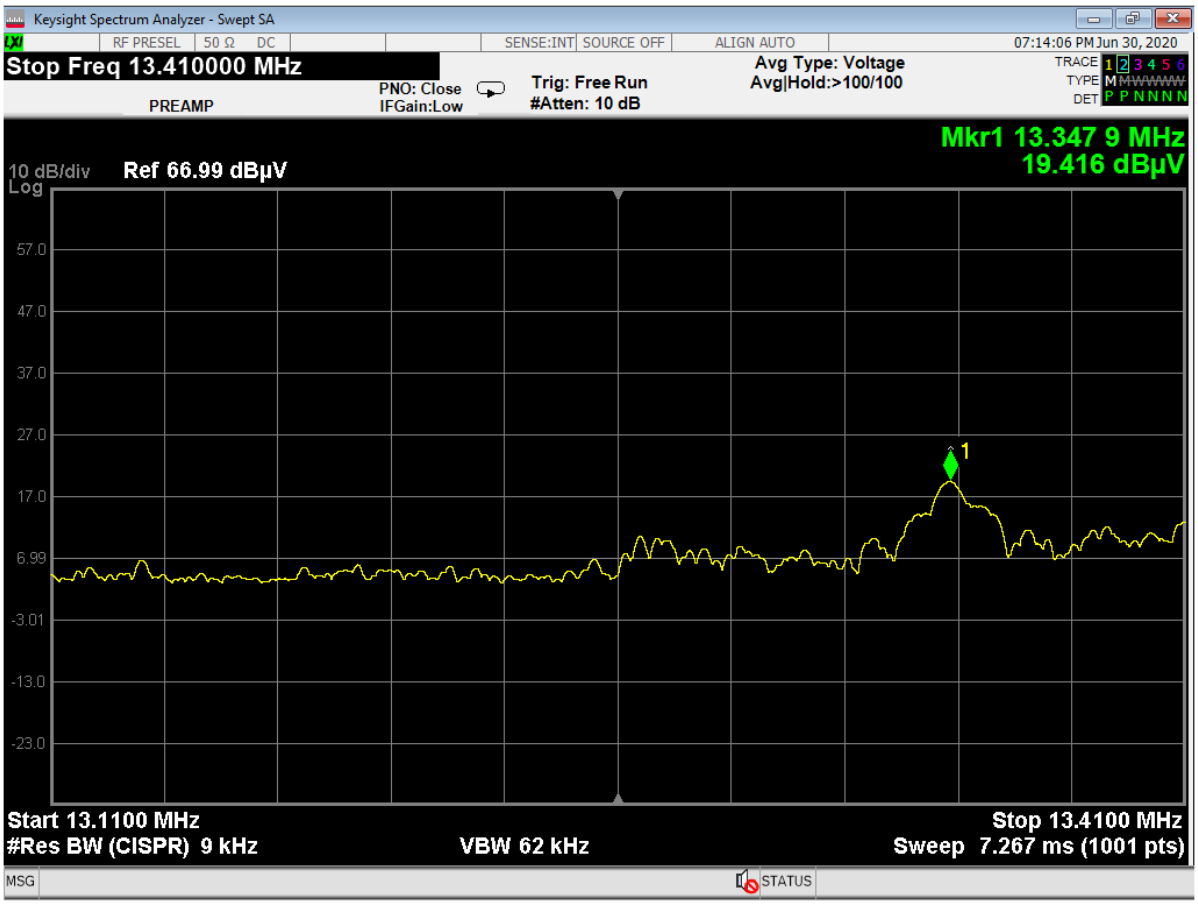


Figure 5 – Lower Band-edge

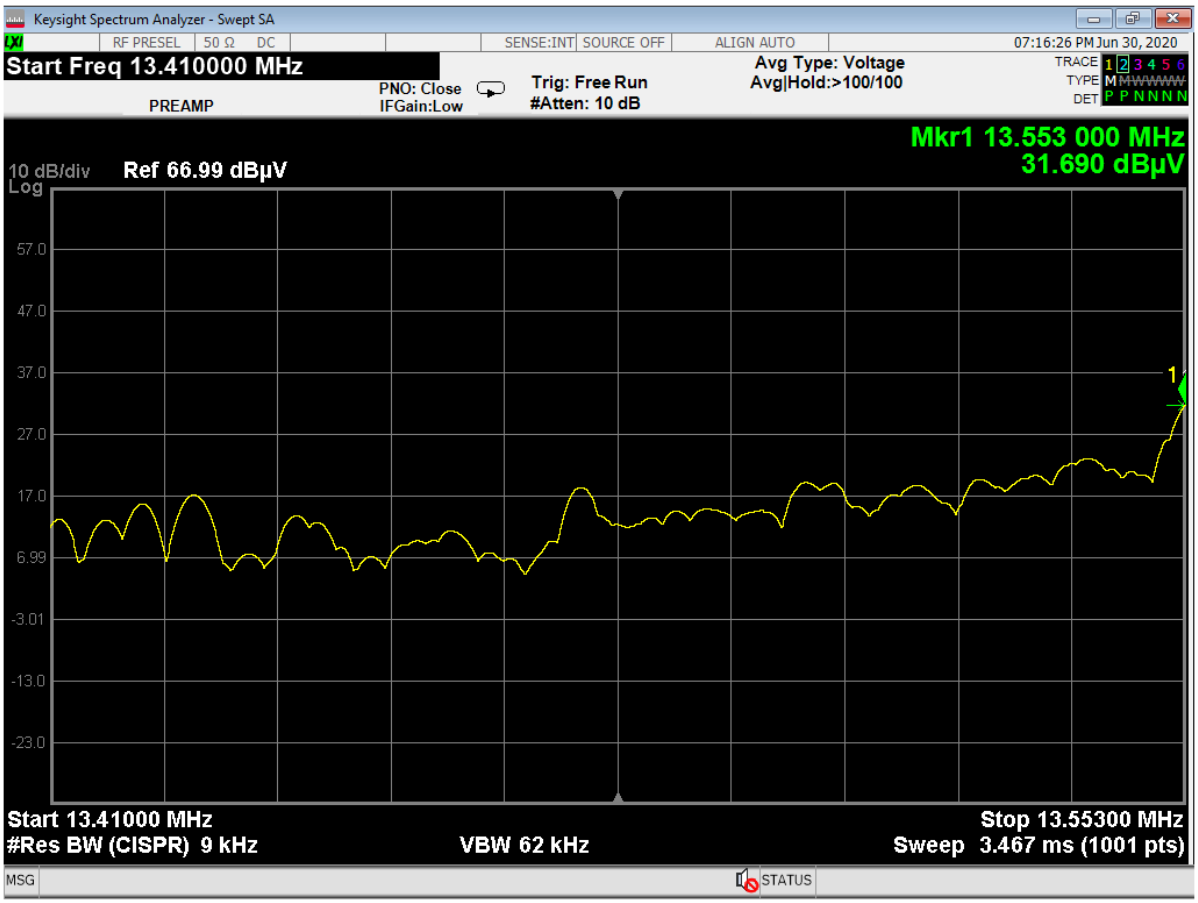


Figure 6 – Lower Band-edge

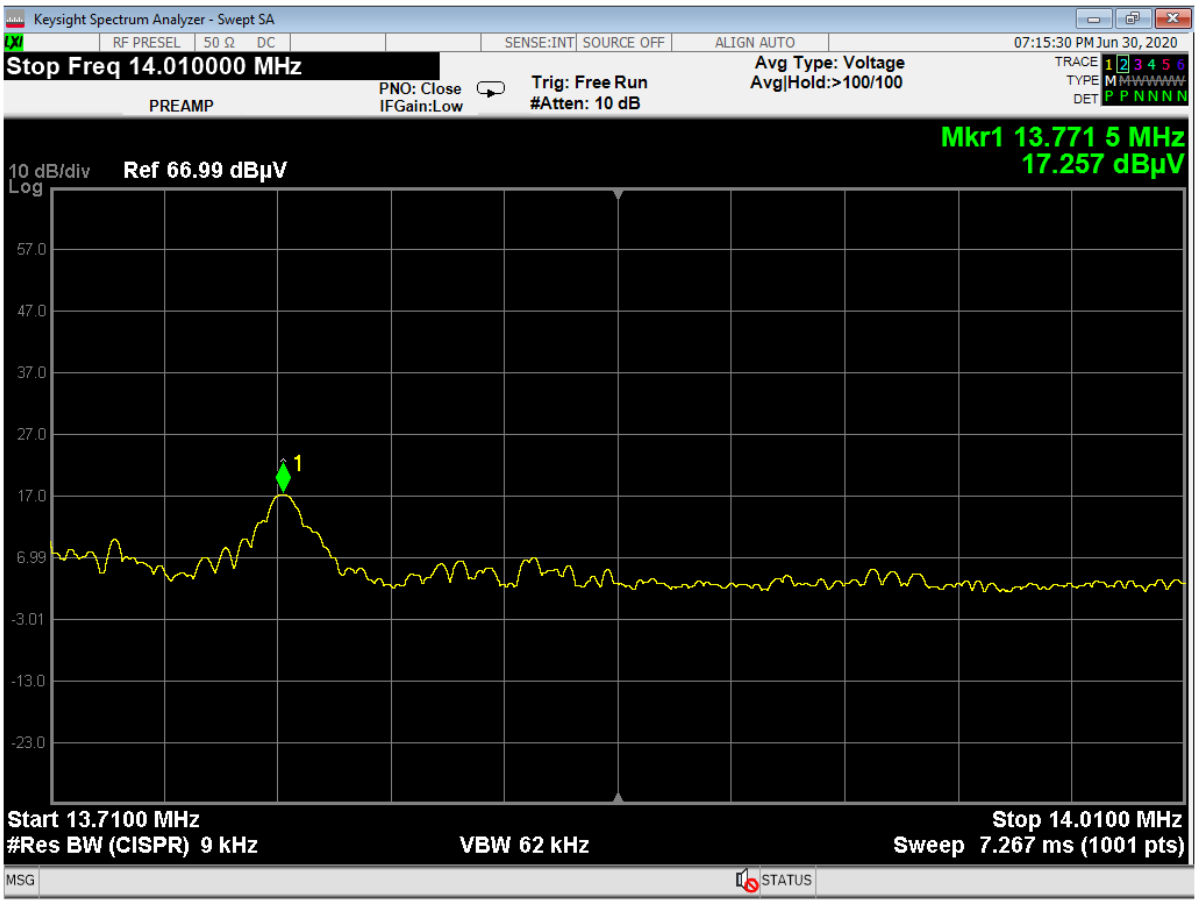


Figure 7 – Higher Band-edge

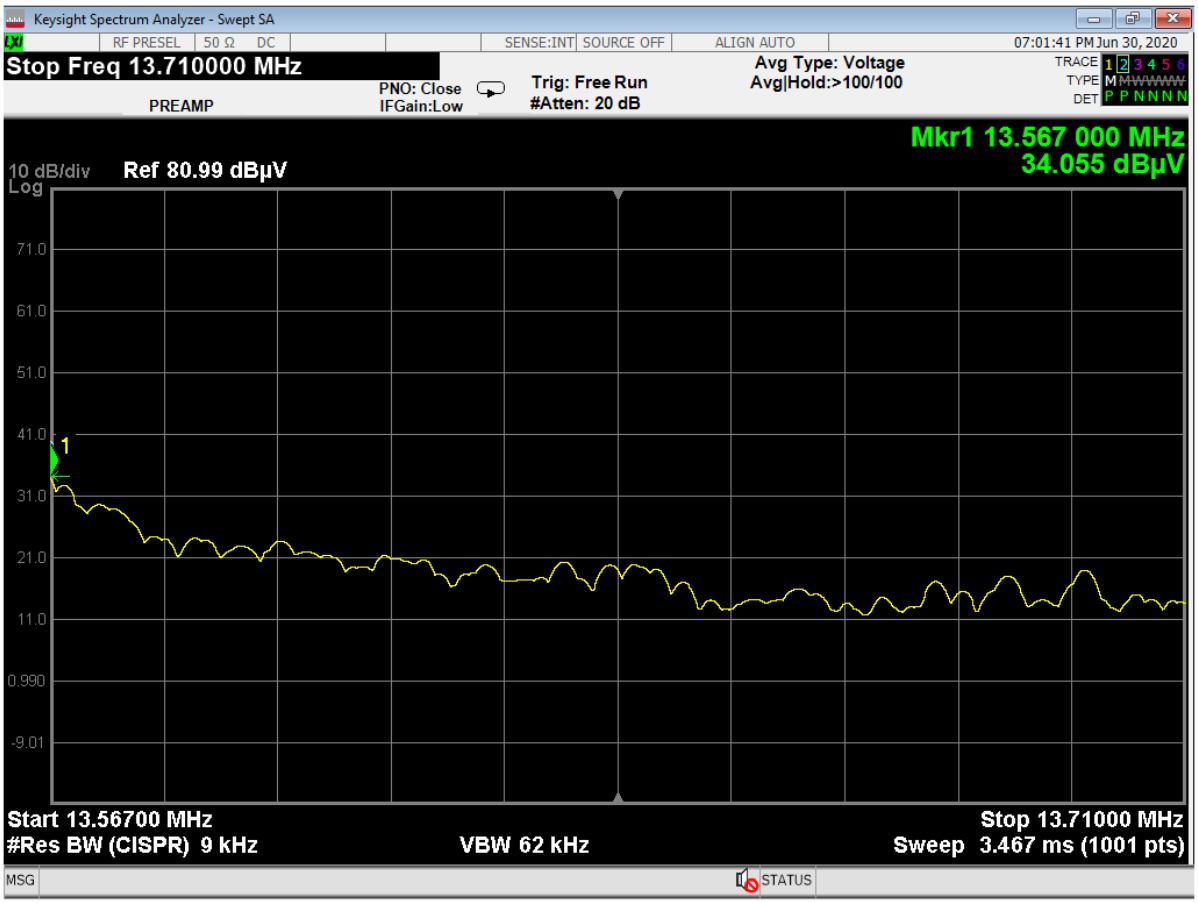


Figure 8 – Higher Band-edge

3.2 Conducted Emissions

Test Method:	ANSI C63.10-2013, Section(s) 6.2
Test Result:	Complies

3.2.1 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

3.2.2 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. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of 30 ± 5%

Temperature of 23 ±2^{o} 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.
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

*2 Year Calibration

3.2.6 Test Pictures and/or Figures

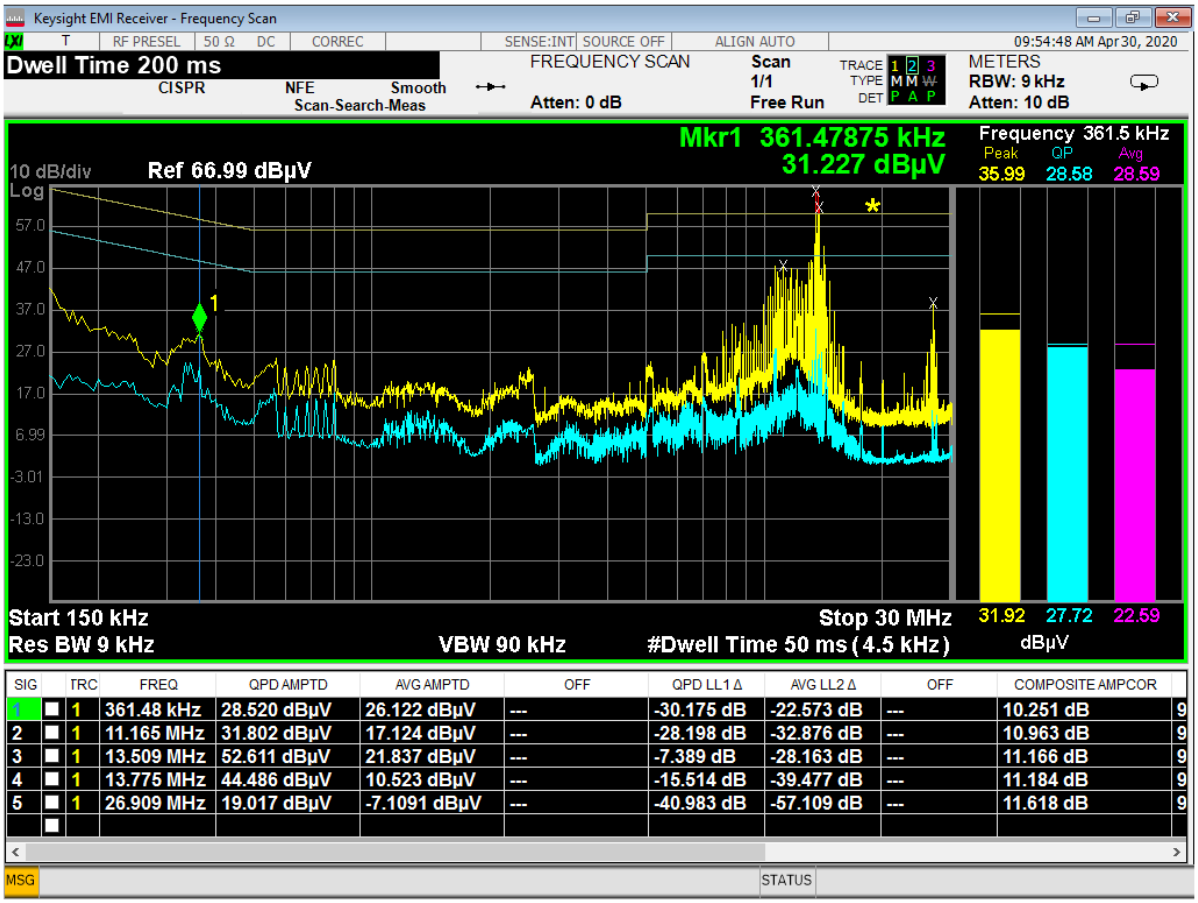
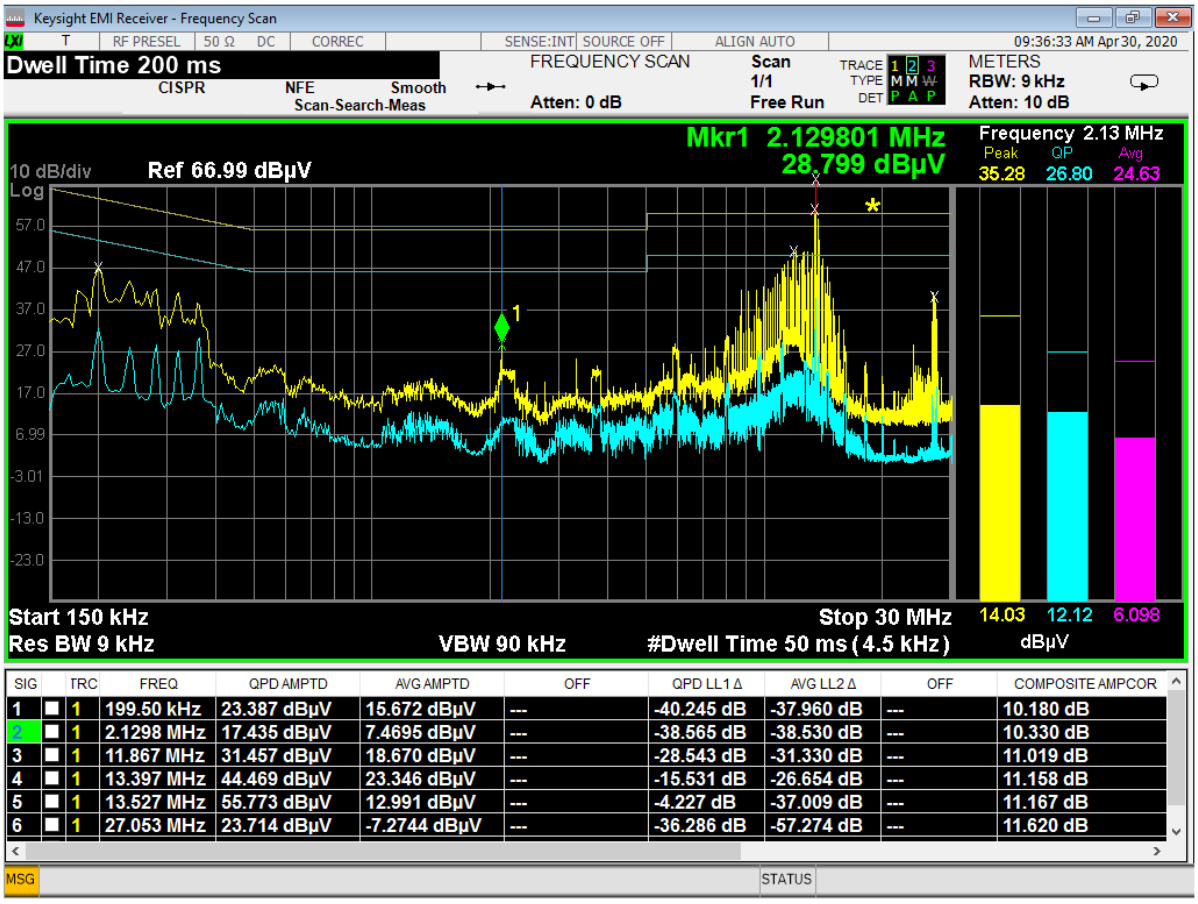


Figure 9 - Conducted Emissions, Line

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	199.50 kHz	23.387 dBµV	15.672 dBµV	---	-40.245 dB	-37.960 dB	---	10.180 dB
2	1	2.1298 MHz	17.435 dBµV	7.4695 dBµV	---	-38.565 dB	-38.530 dB	---	10.330 dB
3	1	11.867 MHz	31.457 dBµV	18.670 dBµV	---	-28.543 dB	-31.330 dB	---	11.019 dB
4	1	13.397 MHz	44.469 dBµV	23.346 dBµV	---	-15.531 dB	-26.654 dB	---	11.158 dB
5	1	13.527 MHz	55.773 dBµV	12.991 dBµV	---	-4.227 dB	-37.009 dB	---	11.167 dB
6	1	27.053 MHz	23.714 dBµV	-7.2744 dBµV	---	-36.286 dB	-57.274 dB	---	11.620 dB

Figure 10 - Conducted Emissions, Neutral

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

3.3 Frequency Error

Test:	FCC Part 15.225 (e)		
Test Result:	Complies	**Date:**	1/11/2021

3.3.1 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 (1356 Hz)

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 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

3.3.4 Test Setup

See Section 2.3 for further details.

3.3.5 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*
ID # 2130155	Omega	iTHX-SD	3m Temp. Humidity Meter	2018 Jan 31*

*2-year calibration cycle

3.3.6 Test results

Table 3 - Frequency Range Measurements

Temperature (°C)	Deviation (Hz) Limit = 1356
-20°C	505
-10°C	301
0°C	424
10°C	581
20°C	730
30°C	700
40°C	560
50°C	570

Table 4 - Voltage Range Measurements

Temperature (°C)	Voltage (VDC)	Deviation (Hz) Limit = 1356
20°C	3.20	443
20°C	3.90	030
20°C	4.75	521

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