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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:	**R20190211-23-03A**
Approved By:	

Nic S. Johnson, NCE
Technical Manager
iNARTE Certified EMC Engineer #EMC-003337-NE

DATE:	**11/3/2022**
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ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

Revision Page

Rev. No.	Date	Description
Original	25 August 2022	Original – Prepared by KVepuri Approved by NJohnson
A	3 September 2022	Added additional clarification to Sections 3.1.1 and 2.3. -NJ

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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
RSS-Gen Issue 5

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 10, B.6	Complies
Frequency Error	FCC Part 15.225 (e) RSS-210 Issue 10, B.6 (b)	Complies
Conducted Emissions	FCC Part 15.207 RSS-Gen Issue 5, Sec 8.8	Complies

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	20 January 2022
EUT Tested	20 January 2022
Serial No.	010106 (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 35 ± 4%
Temperature of 22 ± 3° C

2.3 EUT Setup

The EUT was powered by 12 VDC for all tests. The 12 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. The EUT was tested with production firmware and a tag was used to initiate transmit

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 Result:	Complies

3.1.1 Test Description

All radiated emissions and fundamental emission 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 ± 5%
Temperature of 23 ±2° C

3.1.4 Test Setup

See Section 2.3 for further details. Power supply used was AC/DC M/N:TR30RAM120.

3.1.5 Test Equipment Used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	July 19, 2022	July 19, 2024
SunAR RF Motion	JB1	A091418	July 27, 2021	July 27, 2022***
Com-Power	AI-130R	10160084	2022 Apr 12	2023 Apr 12
TDK Emissions Lab Software	V11.25	700307	NA	NA

*Two Year Calibration Cycle

3.1.6 Test Pictures and/or Figures

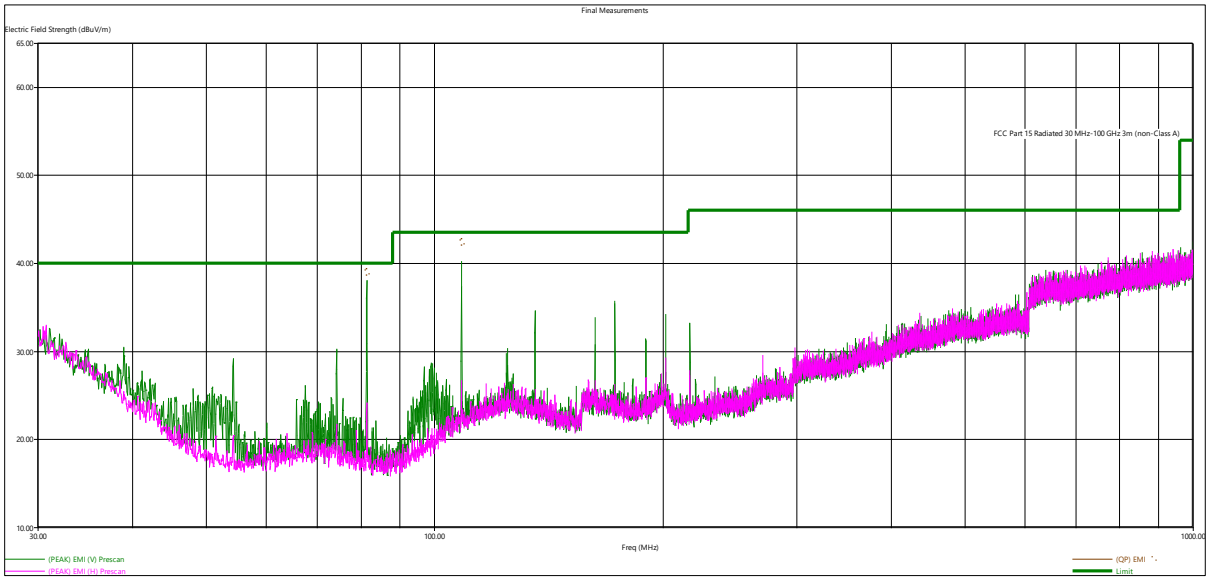


Figure 1 – Radiated Emissions Plot, 30 MHz- 1 GHz

Table 3 – Radiated Emissions QP Data

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg	
81.389040	38.96	40.00	1.04	104.00	310.00	V
108.492240	42.37	43.52	1.15	112.00	71.00	V

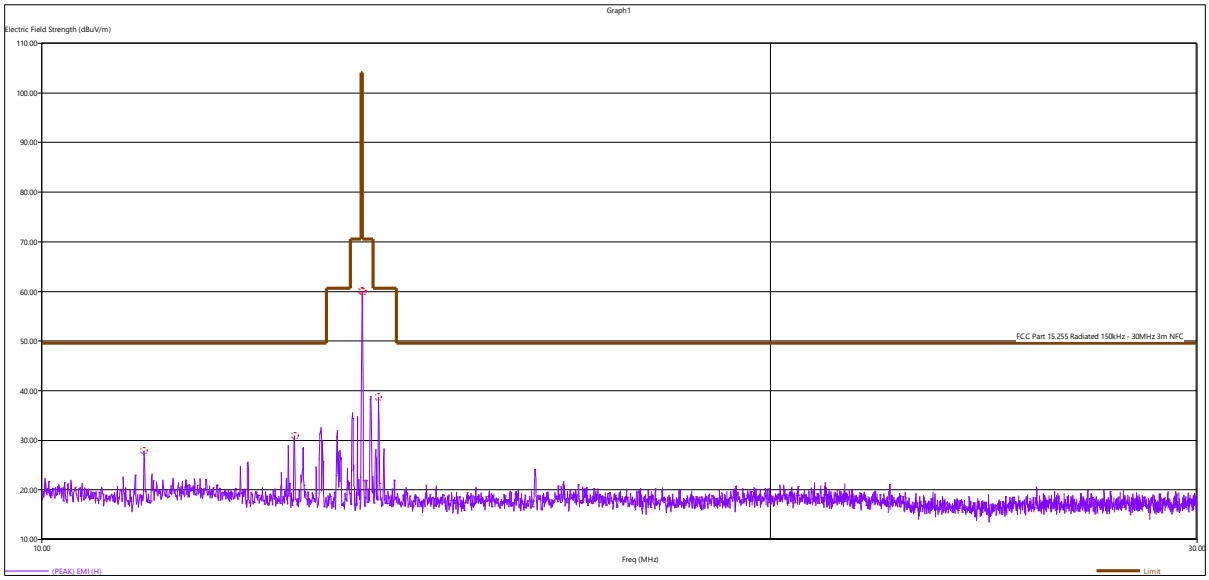


Figure 2 – Radiated Emissions Peak Plot, Vertical Polarization, 10 MHz- 30 MHz

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.

Frequency	Level	Limit	Margin
MHz	dBµV/m	dBµV/m	dB
11.022000	27.82	49.54	21.72
12.714000	30.88	49.54	18.66
13.560000	59.98	104.00	44.02
13.564500	59.85	104.00	44.15
13.776000	38.55	60.51	21.96

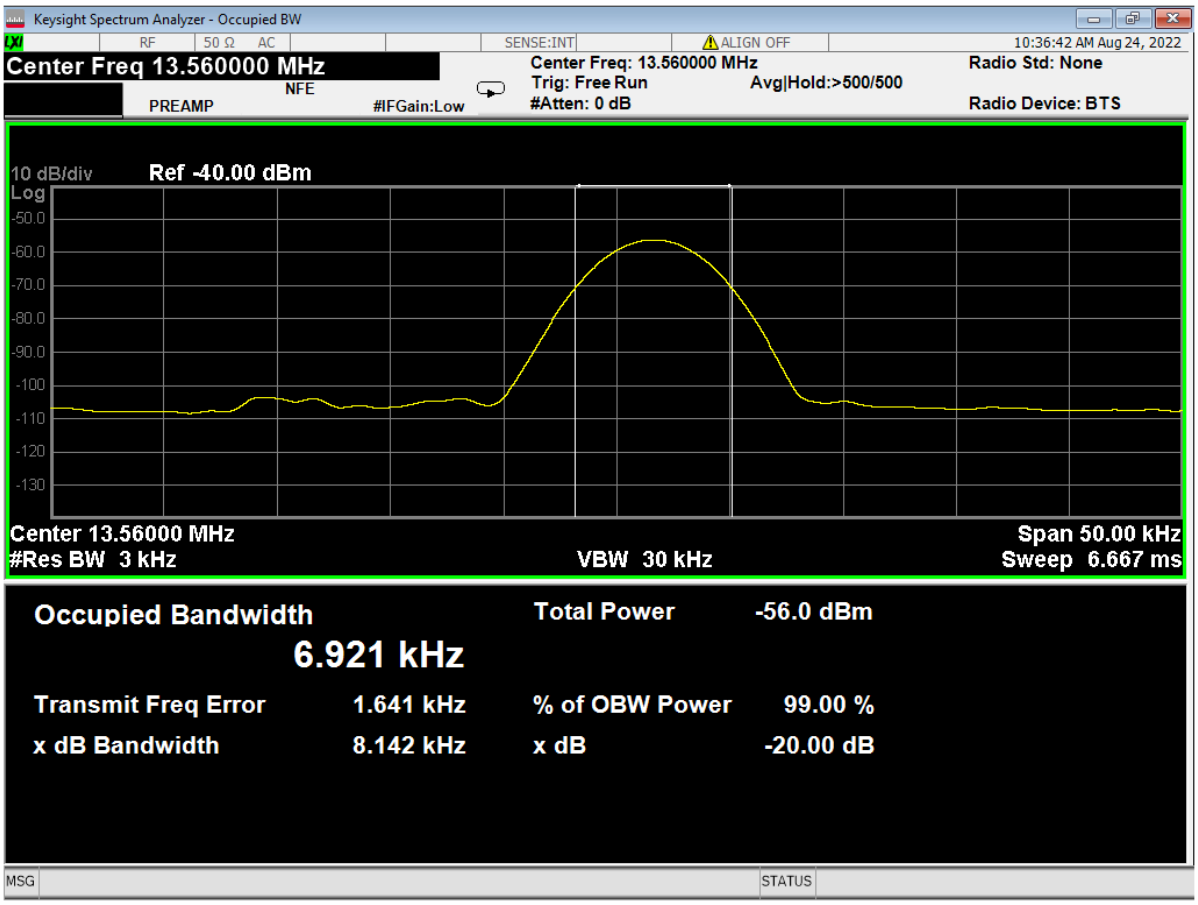


Figure 3 - 99% Occupied Bandwidth

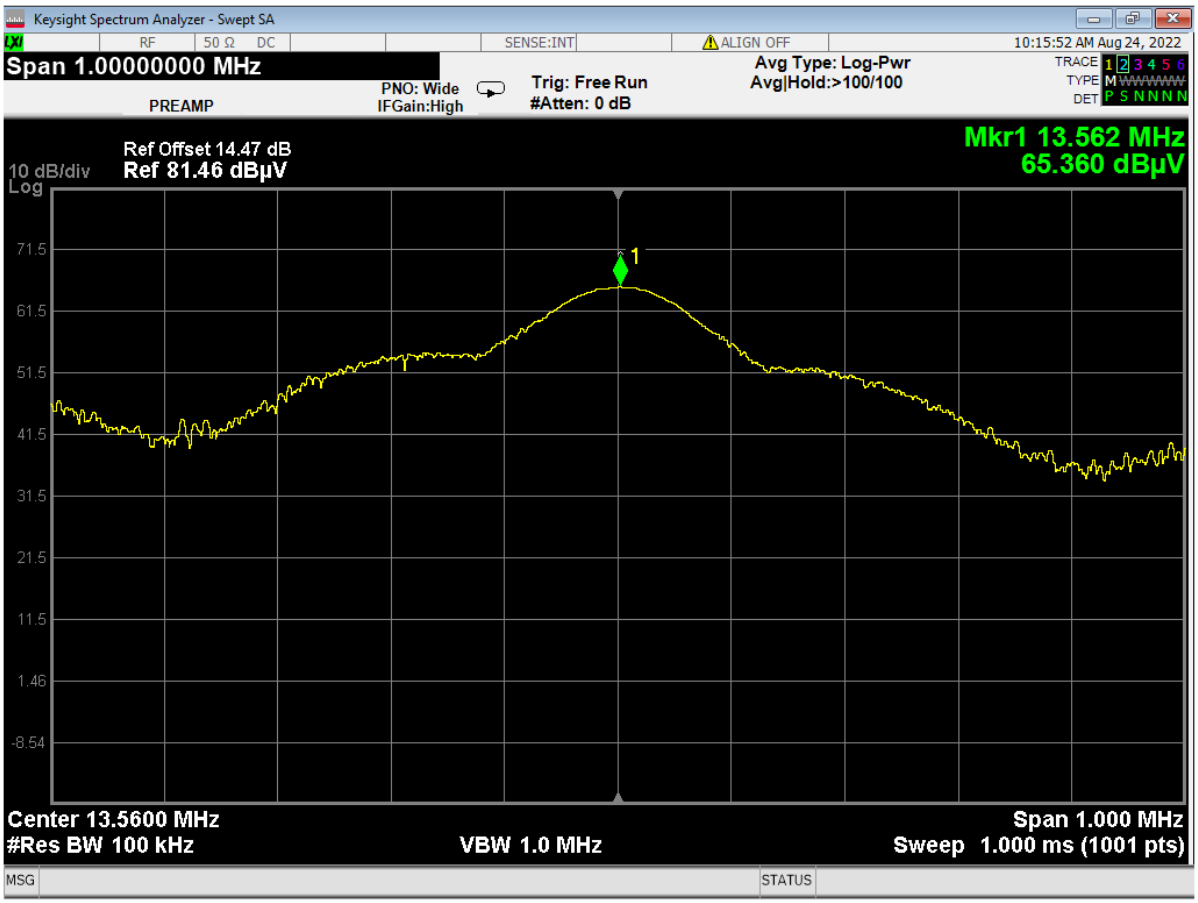


Figure 4 – Output Power, NFC

Figure 5 – Field Strength

Corrected level dBµV/m@ 3m	Corrected level dBµV/m@ 30m	Limit @30m	Margin	Result
65.360	45.360	83.99	38.63	PASS

Band Edge Measurements:

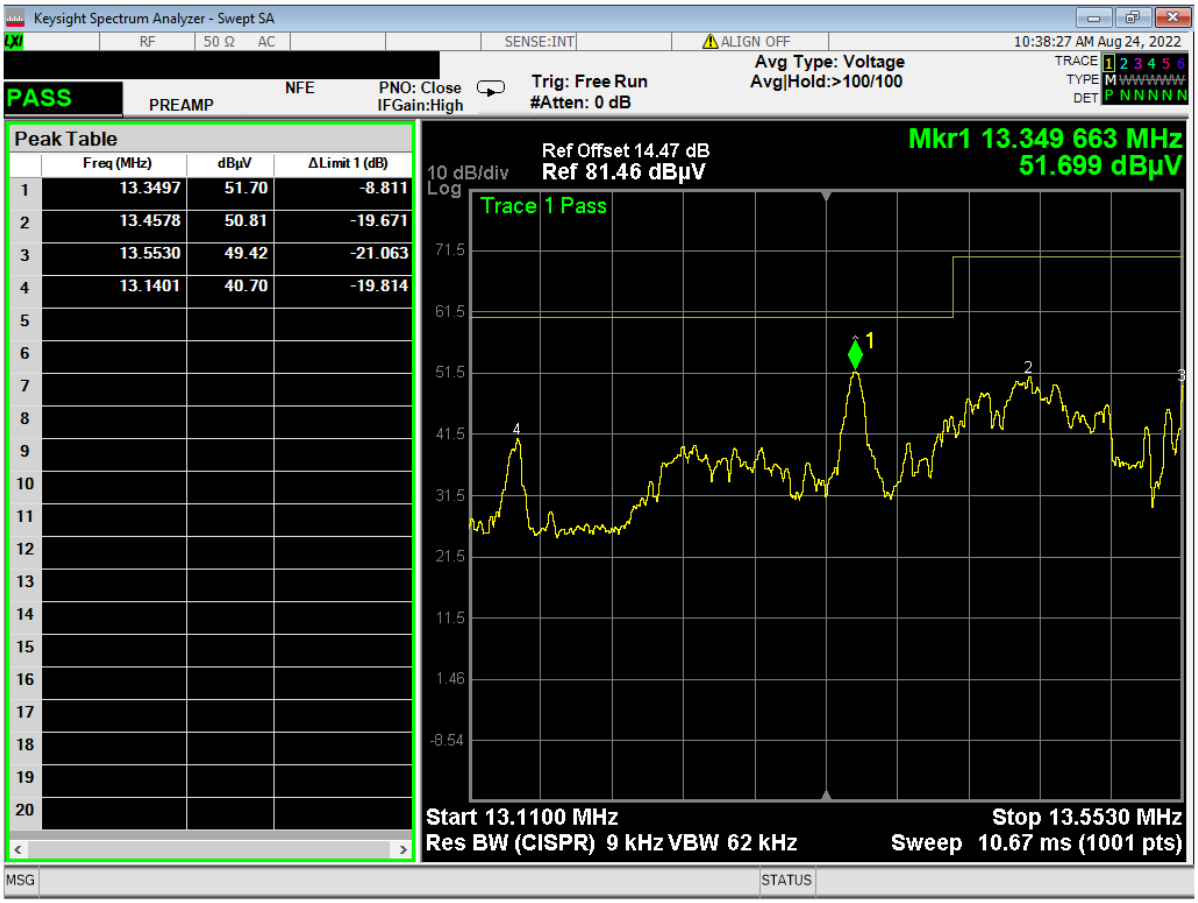


Figure 6 – Lower Band-edge

Figure 7 – Higher Band-edge

3.2 Frequency Error

Test:	FCC Part 15.225 (e)
Test Result:	Complies

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 halfway 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 ± 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
MY56070862	Keysight	N9010A*	EXA Signal Analyzer	July 20, 2021
10160084	Com-power	AI-130R	Active Loop Antenna	2022 Apr 12
18020052	Omega	iTHX-SD*	3m Temp. Humidity Meter	2021 Apr 28

*Two Year Calibration Cycle

3.2.6 Test results

Table 4 - Frequency Range Measurements

Center Frequency - 13.561 MHz	
Temperature (C)	Error (Hz)
-20	640
-10	667
0	653
10	634
20	626
30	566
40	536
50	542

Limit: 100 PPM=1.3561 kHz

Table 5 - Voltage Range Measurements

Temperature (C)	Voltage (VDC)	Error (Hz)
20	13.8	627
20	12	634
20	10.2	633

Voltage ranges provided by the manufacturer, Limit: 100 PPM=1.3561 kHz

3.3 Conducted Emissions

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

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° C

3.3.4 Test Setup

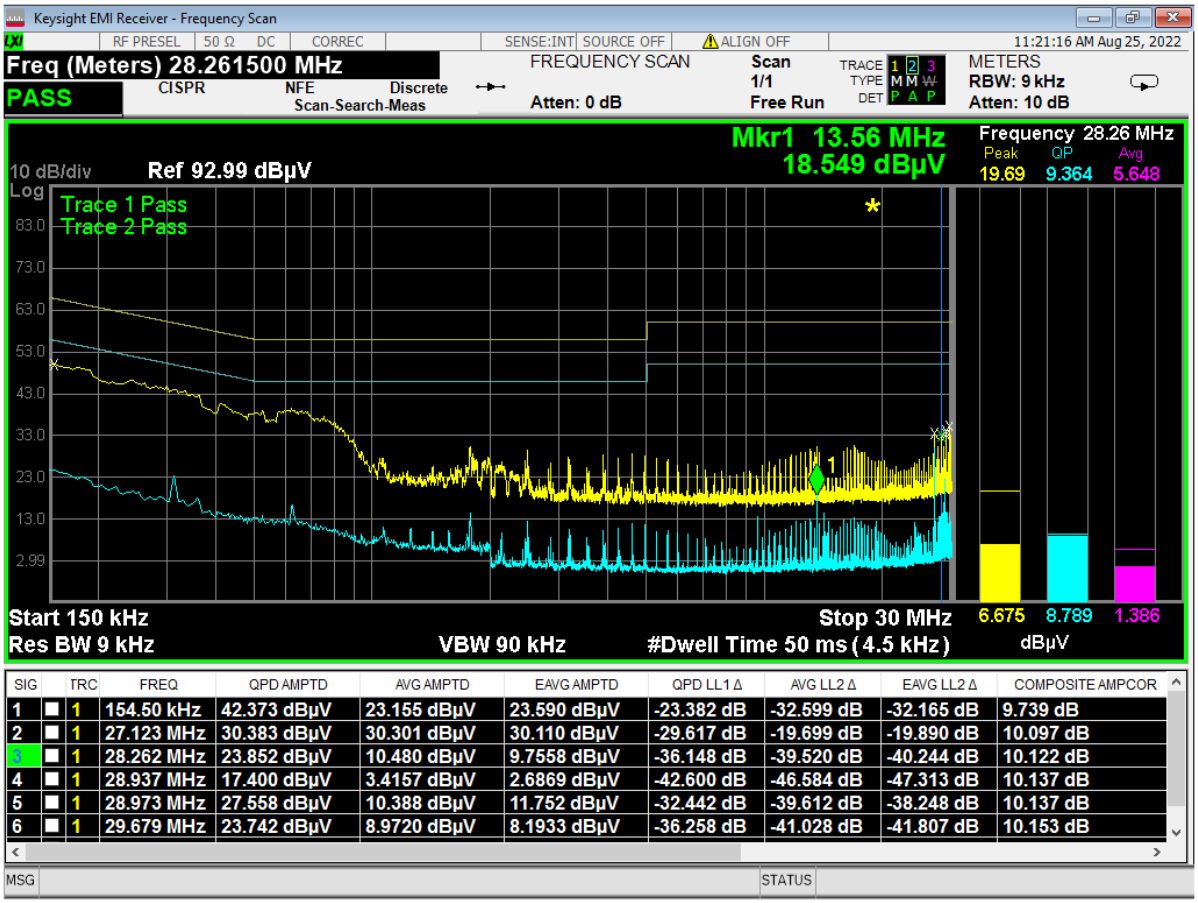
See Section 2.3 for further details. Power supply used was AC/DC M/N:PSD121A5-230.

3.3.5 Test Equipment Used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Com-Power LISN 50µH / 250µH - 50Ω	LI-220C	20070017	July 18, 2022	July 18, 2024
Keysight MXE Signal Analyzer (44GHz)	N9038A	MY59050109	July 19, 2022	July 19, 2024

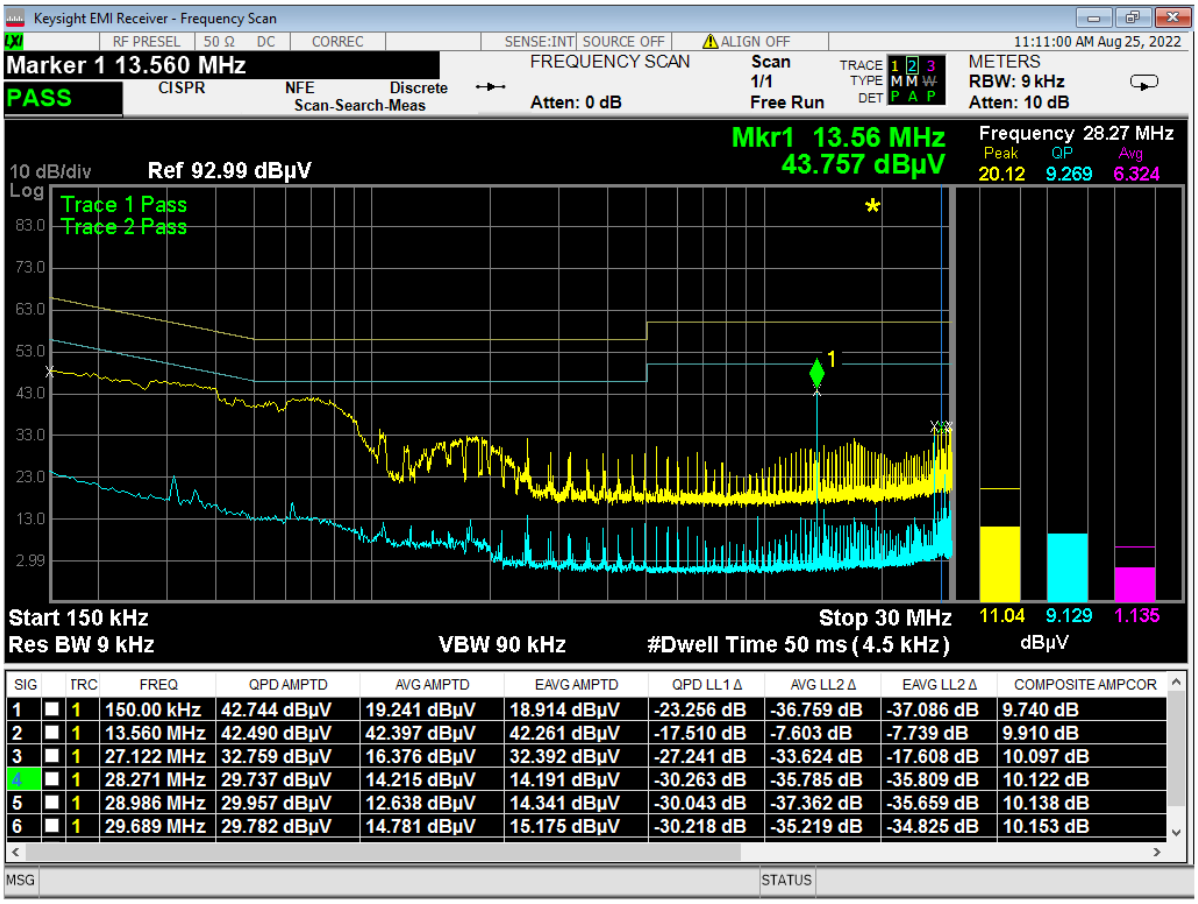
*Two Year Calibration Cycle

3.3.6 Test Pictures and/or Figures



SIG		TRC	FREQ	QPD AMPTD	AVG AMPTD	EAVG AMPTD	QPD LL1 Δ	AVG LL2 Δ	EAVG LL2 Δ	COMPOSITE AMPCOR
1	■	1	154.50 kHz	42.373 dBµV	23.155 dBµV	23.590 dBµV	-23.382 dB	-32.599 dB	-32.165 dB	9.739 dB
2	■	1	27.123 MHz	30.383 dBµV	30.301 dBµV	30.110 dBµV	-29.617 dB	-19.699 dB	-19.890 dB	10.097 dB
3	■	1	28.262 MHz	23.852 dBµV	10.480 dBµV	9.7558 dBµV	-36.148 dB	-39.520 dB	-40.244 dB	10.122 dB
4	■	1	28.937 MHz	17.400 dBµV	3.4157 dBµV	2.6869 dBµV	-42.600 dB	-46.584 dB	-47.313 dB	10.137 dB
5	■	1	28.973 MHz	27.558 dBµV	10.388 dBµV	11.752 dBµV	-32.442 dB	-39.612 dB	-38.248 dB	10.137 dB
6	■	1	29.679 MHz	23.742 dBµV	8.9720 dBµV	8.1933 dBµV	-36.258 dB	-41.028 dB	-41.807 dB	10.153 dB

Figure 8 - Conducted Emissions, Line, NFC



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	EAVG AMPTD	QPD LL1 Δ	AVG LL2 Δ	EAVG LL2 Δ	COMPOSITE AMPCOR
1	1	150.00 kHz	42.744 dBµV	19.241 dBµV	18.914 dBµV	-23.256 dB	-36.759 dB	-37.086 dB	9.740 dB
2	1	13.560 MHz	42.490 dBµV	42.397 dBµV	42.261 dBµV	-17.510 dB	-7.603 dB	-7.739 dB	9.910 dB
3	1	27.122 MHz	32.759 dBµV	16.376 dBµV	32.392 dBµV	-27.241 dB	-33.624 dB	-17.608 dB	10.097 dB
4	1	28.271 MHz	29.737 dBµV	14.215 dBµV	14.191 dBµV	-30.263 dB	-35.785 dB	-35.809 dB	10.122 dB
5	1	28.986 MHz	29.957 dBµV	12.638 dBµV	14.341 dBµV	-30.043 dB	-37.362 dB	-35.659 dB	10.138 dB
6	1	29.689 MHz	29.782 dBµV	14.781 dBµV	15.175 dBµV	-30.218 dB	-35.219 dB	-34.825 dB	10.153 dB

Figure 9 - Conducted Emissions, Neutral, NFC

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	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08
Emissions limits, conducted	30MHz – 18GHz	±3.03 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

Margin is calculated by taking the limit and subtracting the Field Level.

REPORT END