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FCC/ISED DXX Part 15.225 Test Report

Prepared for:	**RFID, Inc.**
Address:	**14190 E Jewell Ave, Ste 4 Aurora, CO 80012**
Product:	**Model HF-3021 13.56 MHz Passive Tag Reader**
FCC ID:	**YVURFIDHF**
IC:	**27875-RFIDINC1356**
Test Report No:	**R20210616-20-E1B**
Approved By:	 **Nic S. Johnson, NCE** **Technical Manager** **iNARTE Certified EMC Engineer #EMC-003337-NE**
DATE:	**May 19, 2022**
Total Pages:	**19**

ilac-MRA A2LA ACCREDITED TESTING LABORATORY CERTIFICATE NO. 1953.01

Revision Page

Rev. No.	Date	Description
Original	29 September 2021	Original – Prepared by FLane Approved by NJohnson
A	18 May 2022	Approved by NJohnson
B	19 May 2022	Corrected model number Clarified test distances

TABLE OF CONTENTS

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 B.6	Complies
Frequency Error	FCC Part 15.225 (e) RSS-210 B.6	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	HF-3021
EUT Received	16 August 2021
EUT Tested	3 September 2021
Serial No.	00680 (assigned by lab)
Operating Band	13.56 MHz
Device Type	NFC
Antenna	External NFC Loop
Power Supply	Powered through 5VDC USB type A

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 a PC's USB type A port (5 VDC Output) for all tests. The PC was placed below the ground plane turntable for testing. The EUT does not have a USB-port and the USB cable is permanently attached on the side of the EUT. Production firmware was used for testing.

3 Test Results

3.1 Radiated Emissions

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

3.1.1 Test Description

Radiated emissions measurements were made from 10 MHz to 1GHz at a distance of 3m (Radiated Emissions) and 1m (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:

30 MHz – 1 GHz:120kHz IF bandwidth, 60kHz steps
10 MHz – 30 MHz, 9kHz RBW, 4.5 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.

3.1.5 Test Equipment Used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
SunAR RF Motion	JB1	A091418	July 27, 2021	July 27, 2022
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	May 5, 2020	May 5, 2022
Keysight EXA Signal Analyzer	N9010A	MY56070862	July 20, 2021	July 20, 2023
EMCO Loop Antenna	6512	00024936	Feb 11, 2019	Feb 11, 2023
TDK Emissions Lab Software	V11.25	700307	NA	NA

3.1.6 Test Pictures and/or Figures

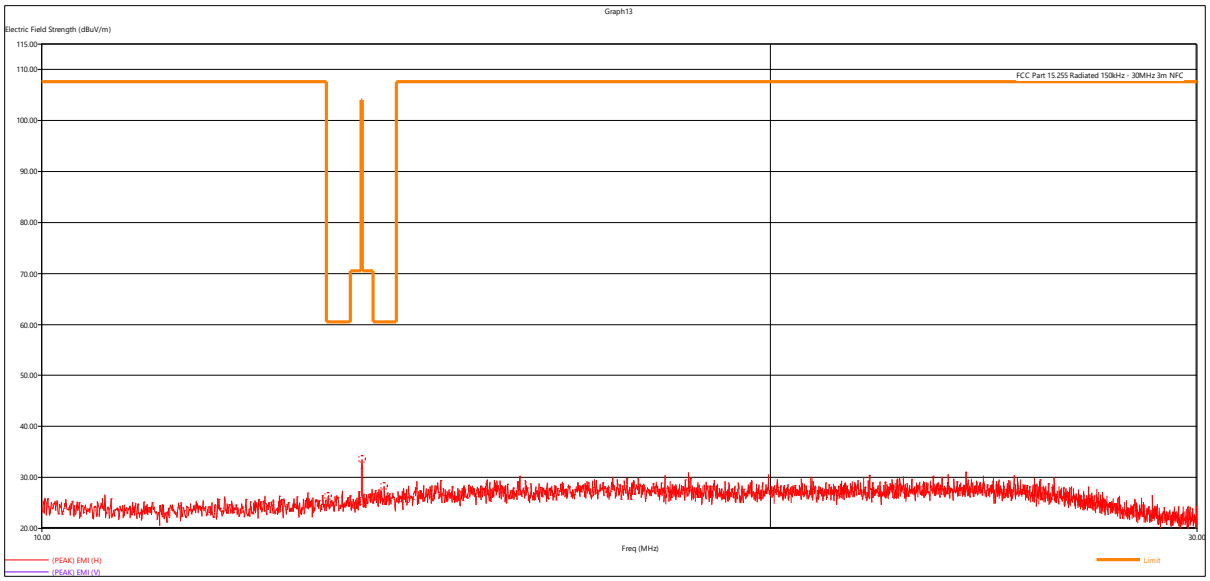


Figure 1 – Radiated Emissions Peak Plot, Horizontal Polarization, 10 MHz- 30 MHz

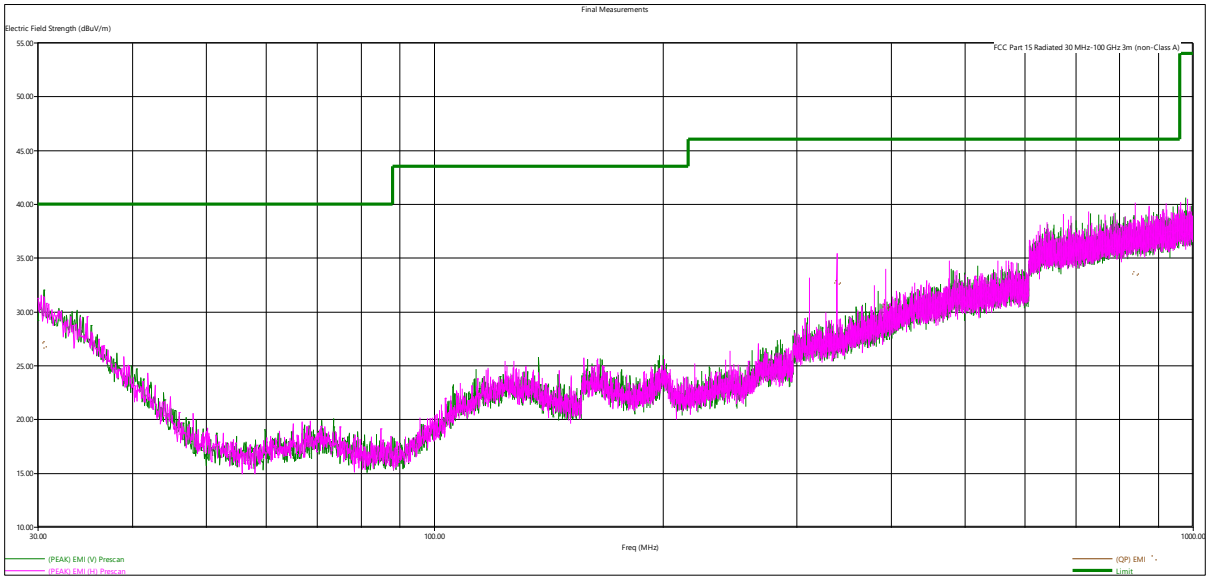


Figure 2 – Radiated Emissions Peak Plot, 30 MHz- 1 GHz

Table 3 - Radiated Emissions QP Data

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg	
338.976240	32.67	46.02	13.35	104.00	122.00	H
393.242640	30.44	46.02	15.58	232.00	135.00	H
839.000160	33.48	46.02	12.54	169.00	311.00	H
30.475920	26.87	40.00	13.13	202.00	232.00	V

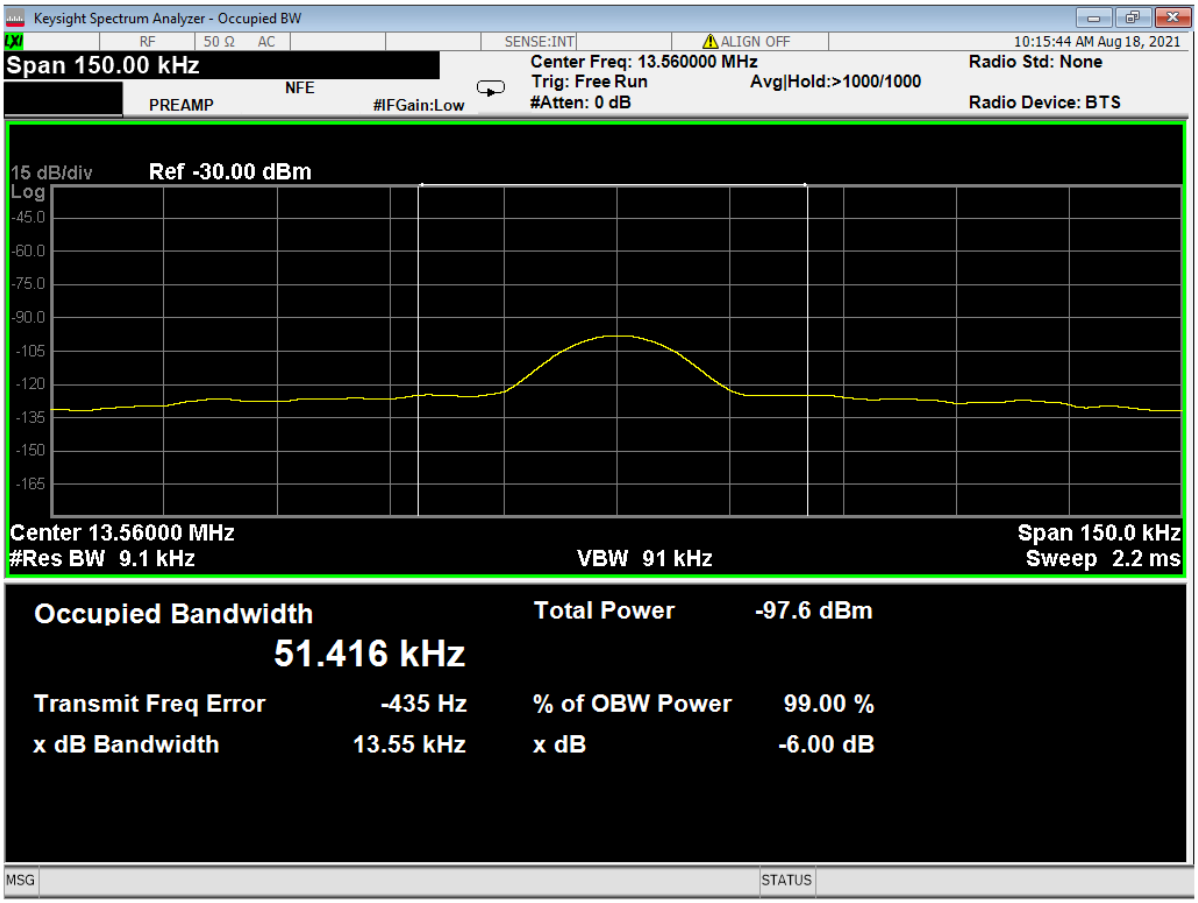


Figure 3 - 99% Occupied Bandwidth, NFC, 1m Test Distance
*For informational purposes only

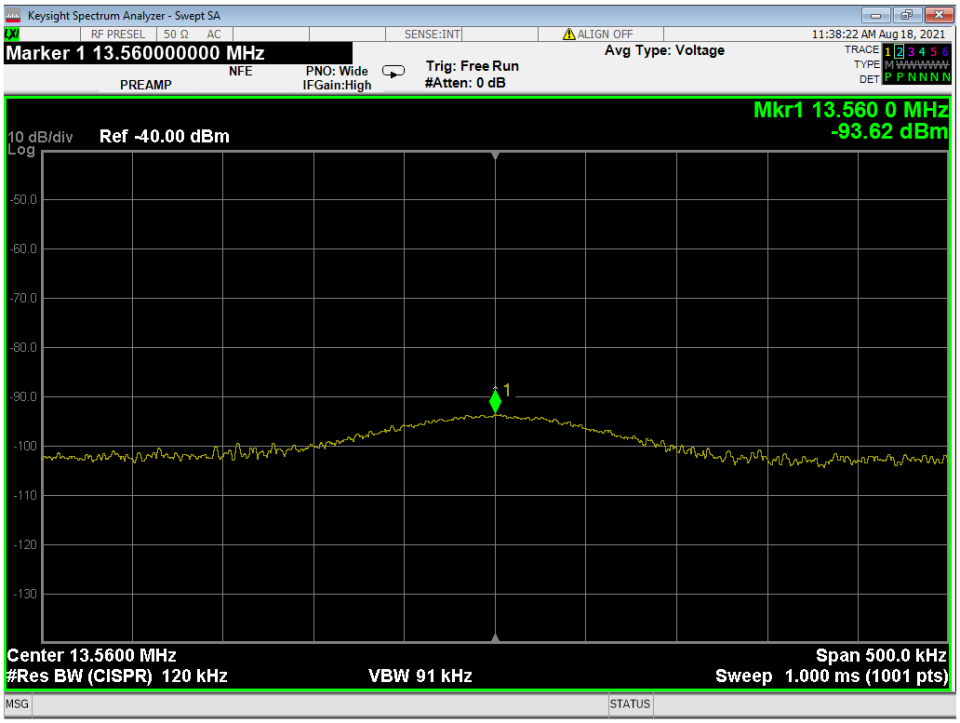


Figure 4 - 99% Field Strength, NFC, 1m Test Distance

Figure 5 – Field Strength

Raw Field Strength Level (dBm)	Corrected Field Strength Level (dBµV/m)	Limit* (dBuV/m)	Margin (dB)	Result
-93.62	48.38	113.54	65.16	Pass

Analyzer reading (dBm) + 107 + antenna factor = corrected value

Antenna factor at 13.56 MHz = 35 dB

Band Edge Measurements:

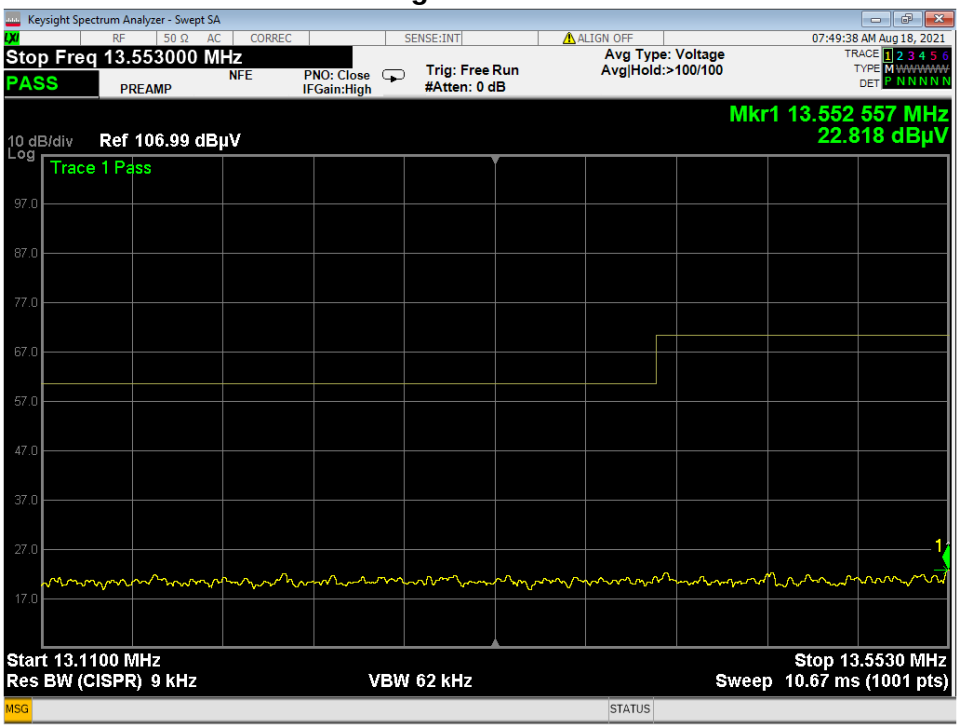


Figure 6 – Lower Band-edge

*Measurements showed level < 20dB below limit line tabular data not reported

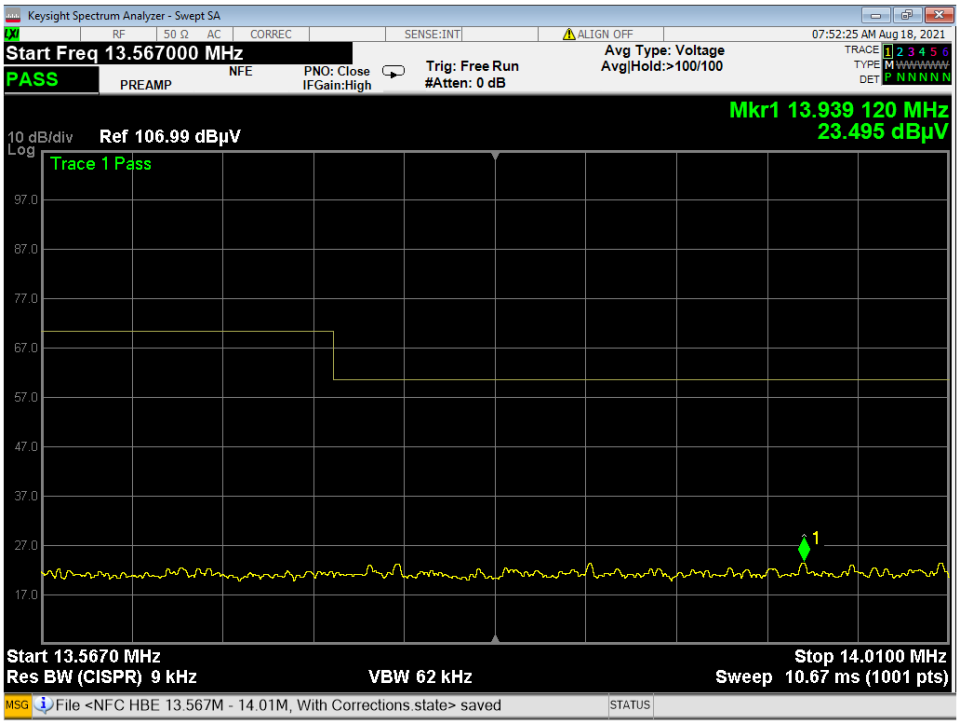


Figure 7 – Higher Band-edge

*Measurements showed level < 20dB below limit line tabular data not reported

3.2 Frequency Error

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

3.2.1 Test Description

Frequency error was determined using the build in frequency error function of the 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 ±2º 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	20 July 2023
00024936	EMCO	6512	Loop Antenna	11 Feb 2019*

3.2.6 Test results

Table 4 - Frequency Range Measurements

Temperature (°C)	Channel (MHz)
	13.56000 Nom.
-20°C	633
-10°C	656
0°C	656
10°C	635
20°C	581
30°C	264
40°C	218
50°C	307

Limit: 100 PPM

Table 5 - Voltage Range Measurements

Temperature (°C)	Voltage (VDC)	Channel (MHz)
		13.56000
20°C	3.20	382
20°C	3.90	532
20°C	4.75	316

Voltage ranges provided by the manufacturer, Limit: 100 PPM

3.2.7 Conducted AC Mains Emissions

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

Limits for conducted emissions measurements:

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

Notes:
1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

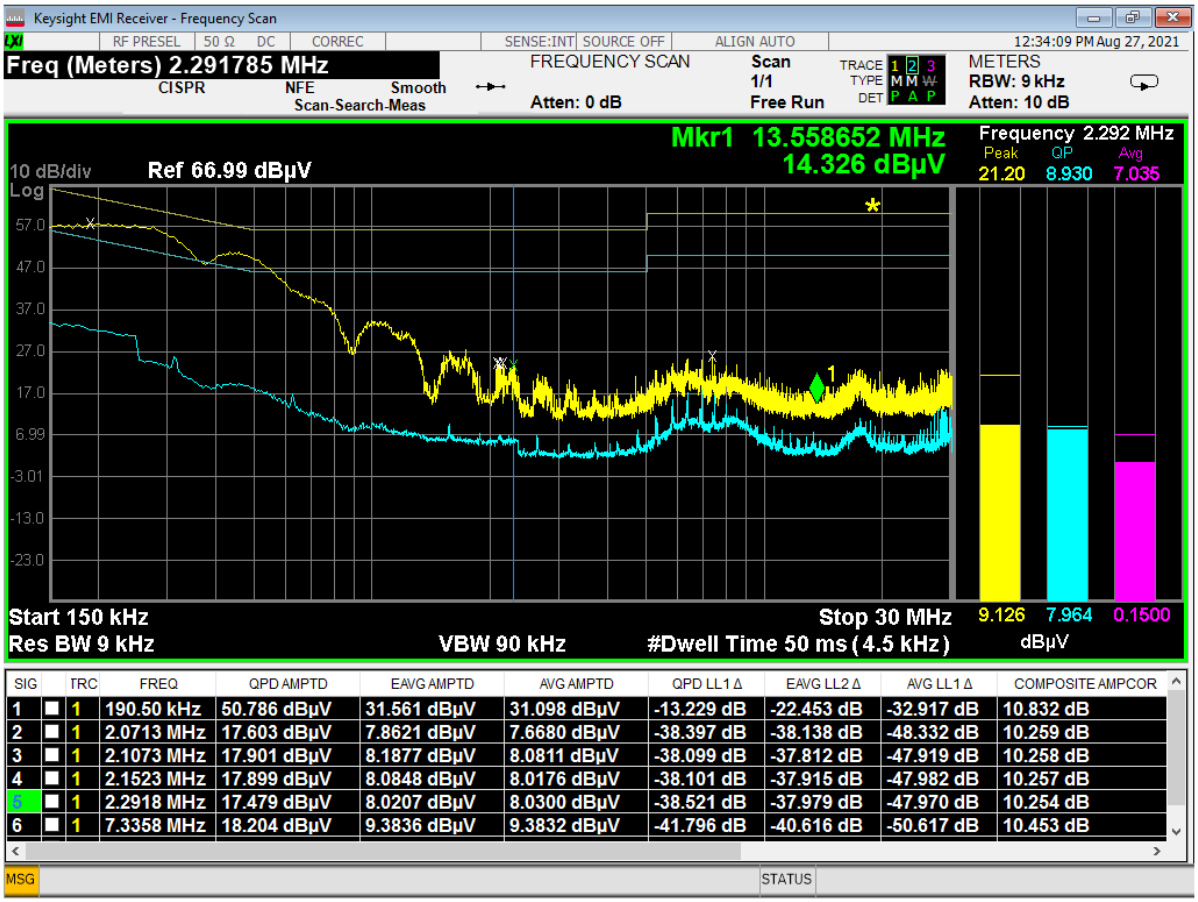
Test Procedures:

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits are not reported.
d. Results were compared to the 15.207 limits.
e. Measurements were performed on the AC input to an unmodified off-the shelf power supply.
f. EUT was tested in a plastic box to protect the board.

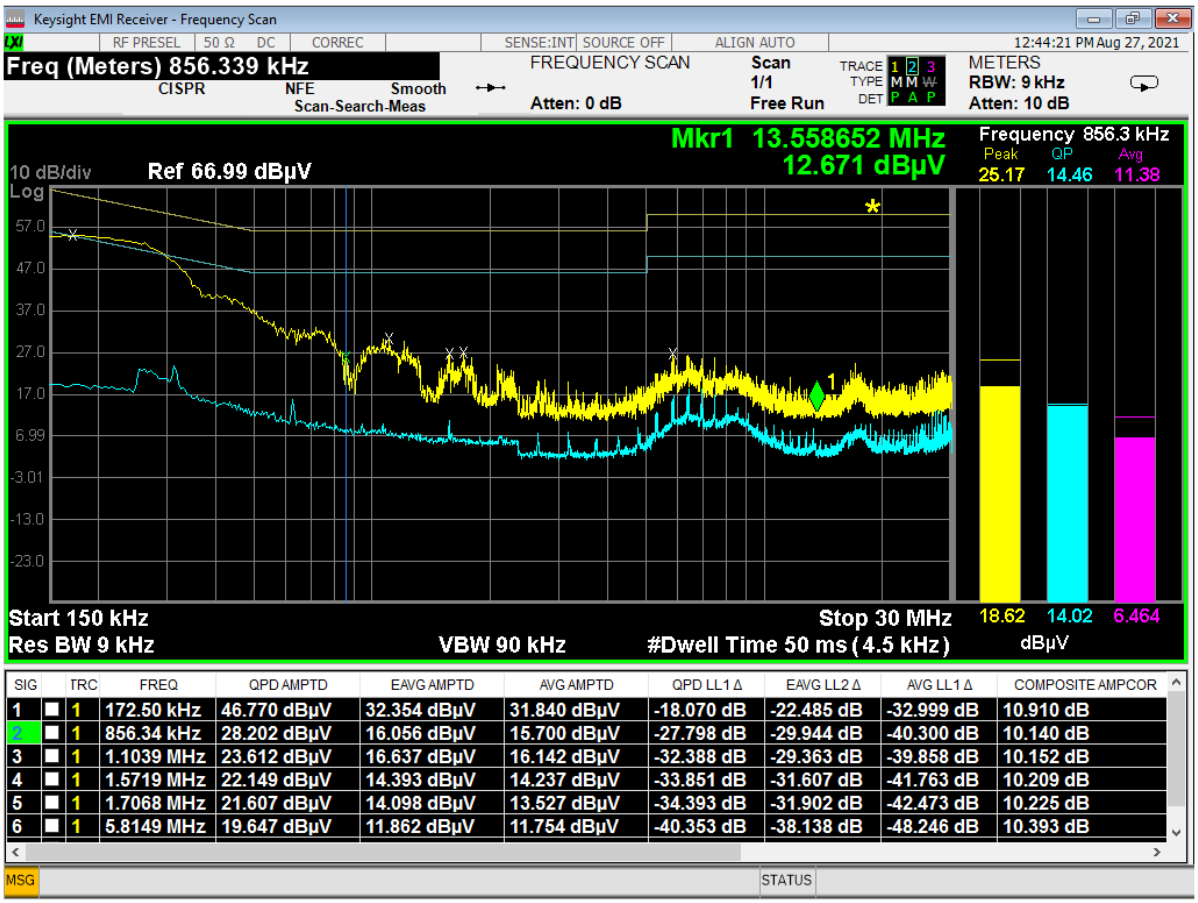
Deviation from the test standard:
No deviation

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test Results:



SIG	TRC	FREQ	QPD AMPTD	EAVG AMPTD	AVG AMPTD	QPD LL1 Δ	EAVG LL2 Δ	AVG LL1 Δ	COMPOSITE AMPCOR
1	1	190.50 kHz	50.786 dBµV	31.561 dBµV	31.098 dBµV	-13.229 dB	-22.453 dB	-32.917 dB	10.832 dB
2	1	2.0713 MHz	17.603 dBµV	7.8621 dBµV	7.6680 dBµV	-38.397 dB	-38.138 dB	-48.332 dB	10.259 dB
3	1	2.1073 MHz	17.901 dBµV	8.1877 dBµV	8.0811 dBµV	-38.099 dB	-37.812 dB	-47.919 dB	10.258 dB
4	1	2.1523 MHz	17.899 dBµV	8.0848 dBµV	8.0176 dBµV	-38.101 dB	-37.915 dB	-47.982 dB	10.257 dB
5	1	2.2918 MHz	17.479 dBµV	8.0207 dBµV	8.0300 dBµV	-38.521 dB	-37.979 dB	-47.970 dB	10.254 dB
6	1	7.3358 MHz	18.204 dBµV	9.3836 dBµV	9.3832 dBµV	-41.796 dB	-40.616 dB	-50.617 dB	10.453 dB



SIG	TRC	FREQ	QPD AMPTD	EAVG AMPTD	AVG AMPTD	QPD LL1 Δ	EAVG LL2 Δ	AVG LL1 Δ	COMPOSITE AMPCOR
1	1	172.50 kHz	46.770 dBµV	32.354 dBµV	31.840 dBµV	-18.070 dB	-22.485 dB	-32.999 dB	10.910 dB
2	1	856.34 kHz	28.202 dBµV	16.056 dBµV	15.700 dBµV	-27.798 dB	-29.944 dB	-40.300 dB	10.140 dB
3	1	1.1039 MHz	23.612 dBµV	16.637 dBµV	16.142 dBµV	-32.388 dB	-29.363 dB	-39.858 dB	10.152 dB
4	1	1.5719 MHz	22.149 dBµV	14.393 dBµV	14.237 dBµV	-33.851 dB	-31.607 dB	-41.763 dB	10.209 dB
5	1	1.7068 MHz	21.607 dBµV	14.098 dBµV	13.527 dBµV	-34.393 dB	-31.902 dB	-42.473 dB	10.225 dB
6	1	5.8149 MHz	19.647 dBµV	11.862 dBµV	11.754 dBµV	-40.353 dB	-38.138 dB	-48.246 dB	10.393 dB

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

Margin is calculated by taking the limit and subtracting the Field

REPORT END