



CERTIFICATION TEST REPORT

Report Number. : 4789765080-FR1V3

Applicant : XCATH, Inc
42 Changeop-ro, Sujeong-gu, Seongnam-si, Gyeonggi-do, 13449,
Korea

Model : IS-4500-C1

FCC ID : 2AYHQ-IS-4500-C1

EUT Description : RFID Reader

Test Standard(s) : FCC 47 CFR PART 15 SUBPART C

Date Of Issue:
December 24, 2020

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Testing Laboratory

TL-637

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	12/23/20	Initial issue	Jaehyong Lee
V2	12/24/20	Update the section 5.2	Jaehyong Lee
V3	12/24/20	Update the section 5.3	Jaehyong Lee

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: XCATH, Inc
EUT DESCRIPTION: RFID Reader
MODEL NUMBER: IS-4500-C1
SERIAL NUMBER: Prototype (RADIATED)
DATE TESTED: DEC 17, 2020 – DEC 22, 2020;

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Complies

UL Korea, Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Korea, Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Korea, Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Korea, Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by IAS, any agency of the Federal Government, or any agency of any government.

Approved & Released For
UL Korea, Ltd. By:



CY Choi
Suwon Lab Engineer
UL Korea, Ltd.

Tested By:



Jaehyong Lee
Suwon Lab Engineer
UL Korea, Ltd.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with following methods.

1. FCC CFR 47 Part 2.
2. FCC CFR 47 Part 15.
3. ANSI C63.10-2013.
4. 414788 D01 Radiated Test Site v01r01

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 218 Maeyeong-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16675, Korea. Line conducted emissions are measured only at the 218 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

218 Maeyeong-ro
<input checked="" type="checkbox"/> 10m Chamber

UL Korea, Ltd. is accredited by IAS, Laboratory Code TL-637. The full scope of accreditation can be viewed at <https://www.iasonline.org/wp-content/uploads/2017/05/TL-637-cert-New.pdf>.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \\ &\text{Cable Loss (dB)} - \text{Preamp Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m} \end{aligned}$$

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	2.87 dB
Radiated Disturbance, 9 kHz to 30 MHz	4.60 dB
Radiated Disturbance, 30 MHz to 1 GHz	4.40 dB

Uncertainty figures are valid to a confidence level of 95%.

4.4. DECISION RULE

Decision rule for statement(s) of conformity is based on Procedure 1, Clause 4.4.2 in IEC Guide 115:2007.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is RFID reader. This test report addresses the DXX (NFC) operational mode.

5.2. MAXIMUM E-FIELD STRENGTH

The testing was performed at 3 meter. The transmitter maximum E-field at 30m distance is 16.34 dBuV/m which convert from 3 meter data.

5.3. WORST-CASE CONFIGURATION AND MODE

The NFC function was tested at its' fundamental and only operational frequency of 13.56 MHz.

RF protocol : ISO 14443-A type

The field strength of fundamental was investigated in both without reading a passive tag condition[test mode] and with reading a passive tag condition. It was determined that the condition without reading a passive tag condition[test mode] was the worst-case. therefore all final radiated testing was performed in the condition without reading a passive tag condition[test mode].

The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z. It was determined that the Y orientation was the worst-case orientation; therefore all final radiated testing was performed with the EUT in the Y orientation while generating continuous emissions.

5.4. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

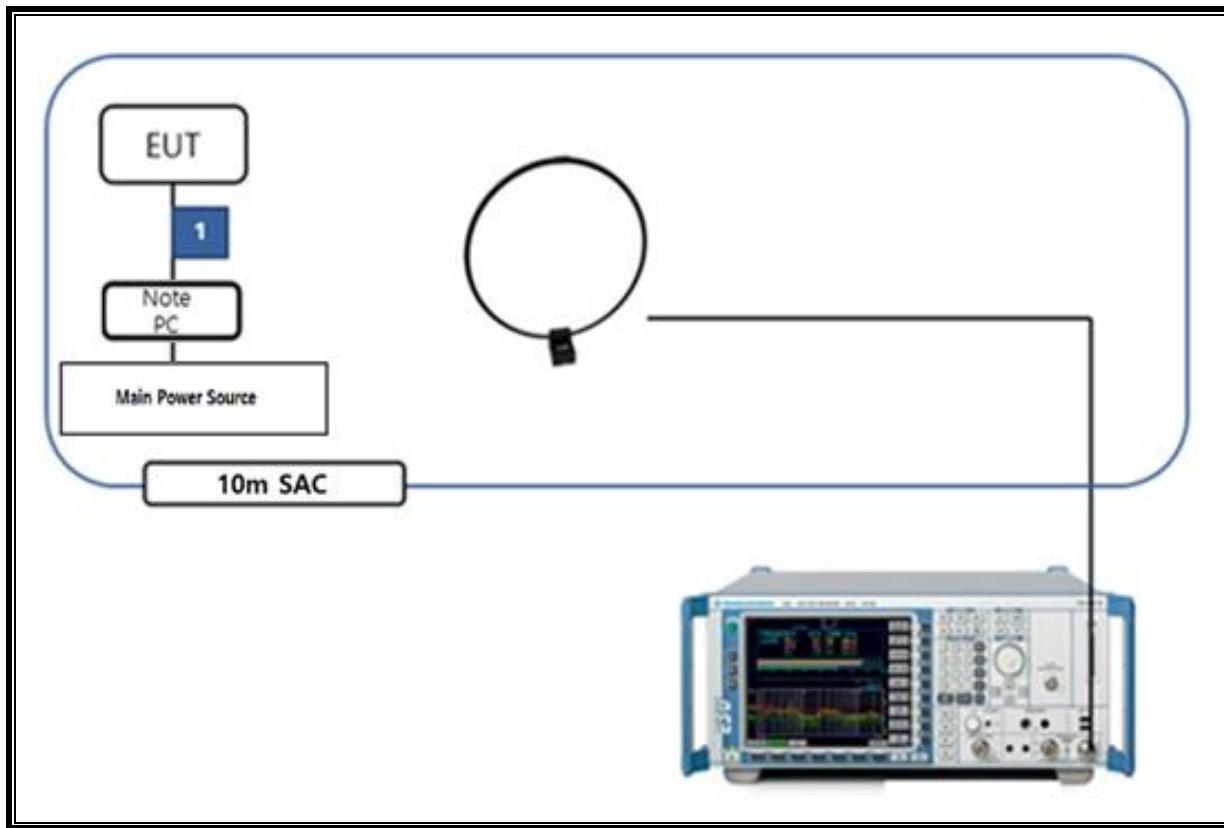
Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Notebook PC	HP	HP ProBook 440 G3	5CD7182ZLC	N/A
AC ADAPTER	HP	PPP019L-S	N/A	N/A

I/O CABLE

I/O Cable List						
Cable No.	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	DC Power	1	4 Pin Type	Shielded	1.2 m	N/A

The EUT is a stand-alone device configured and tested in a worst-case setup.

SETUP DIAGRAM FOR TESTS (RADIATED TEST SETUP)



6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment List				
Description	Manufacturer	Model	S/N	Cal Due
Test Receiver	R&S	ESW44	101848	08-03-21
Active Loop Antenna	R&S	HFH2-Z2E	100900	09-30-21
Bias Unit	R&S	IN600	100974	09-30-21
BiLog Antenna	Schwarzbeck	VULB 9163	1241	09-30-21
Preamplifier, 1000 MHz	R&S	SCU08F2	100725	08-03-21
Open Switch and Control Unit	R&S	OSP220	101456	N/A
Attenuator	WEINSCHEL	54A-10	74560	08-08-21
Spectrum Analyzer	AGILENT	N9030B	MY57143652	01-20-21
DC power supply	KEYSIGHT	N5747A	MY57300040	08-06-21
Signal Generator	R&S	SMB100A	180032	08-06-21
Temperature & Humidity Chamber	ESPEC	PL-3J	15011850	08-04-21
EMI Test Receive, 3 GHz	R&S	ESR3	102592	08-06-21
Two-Line V-Network	R&S	ENV216	102478	11-16-21
Software				
Description	Manufacturer	Model	Version	
AC Line Conducted software	R&S	EMC32	10.60.10	
Radiated software	R&S	EMC32	10.60.10	

7. 20dB BANDWIDTH

LIMITS

§15.215

(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated

§15.225

Operation within the band 13.110 – 14.010MHz

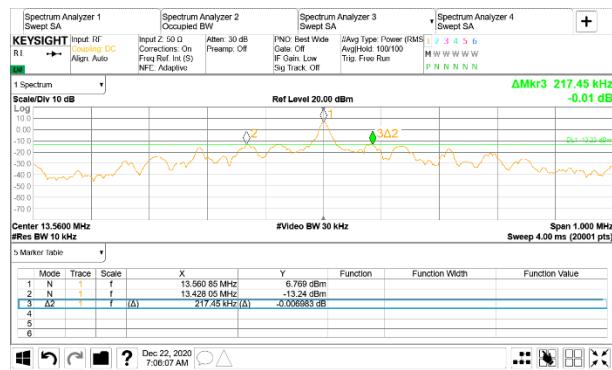
TEST PROCEDURE

The spectrum analyzer connected receive antenna and the EUT placed on near the receive antenna. The RBW is set to 10KHz. The VBW is set to 3 times the RBW. The sweep time is coupled.

RESULTS

Frequency [MHz]	20 dB Bandwidth [kHz]
13.56	217.45

20dB Bandwidth Plot



8. RADIATED EMISSION TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMIT

§15.225

(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.

(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.

(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.

(d) The field strength of any emissions appearing outside of the 13.110–14.010 MHz and shall not exceed the general radiated emission limits in § 15.209 as follows:

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Limits for radiated disturbance of an intentional radiator		
Frequency range (MHz)	Limits (μ V/m)	Measurement Distance (m)
0.009 – 0.490	2400 / F (kHz)	300
0.490 – 1.705	24000 / F (kHz)	30
1.705 – 30.0	30	30
30 – 88	100**	3
88 - 216	150**	3
216 – 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g. §§ 15.231 and 15.241.

§15.209 (b) In the emission table above, the tighter limit applies at the band edges.

Formula for converting the field strength from μ V/m to dB μ V/m is:

Limit (dB μ V/m) = 20 log limit (μ V/m)

In addition:

§15.209 (d) The emission limits shown the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector.

§15.209 (d) The provisions in §§ 15.225, measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

TEST PROCEDURE

ANSI C63.10-2013

The EUT is an intentional radiator that incorporates a digital device. The highest fundamental frequency generated or used in the device is 13.56 MHz. The frequency range was investigated from 0.15 MHz to the 10th harmonic of the highest fundamental frequency, or 1000 MHz, whichever is greater (1000MHz)

Test result (dB_{UV}/m) = Reading Value (dB_{UV}) + Correction Factor (dB/m)

Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss + Distance Correction Factor (dB)

Distance Correction Factor:

3m vs 300m conversion factor = $40\log(300/3) = -80$ dB

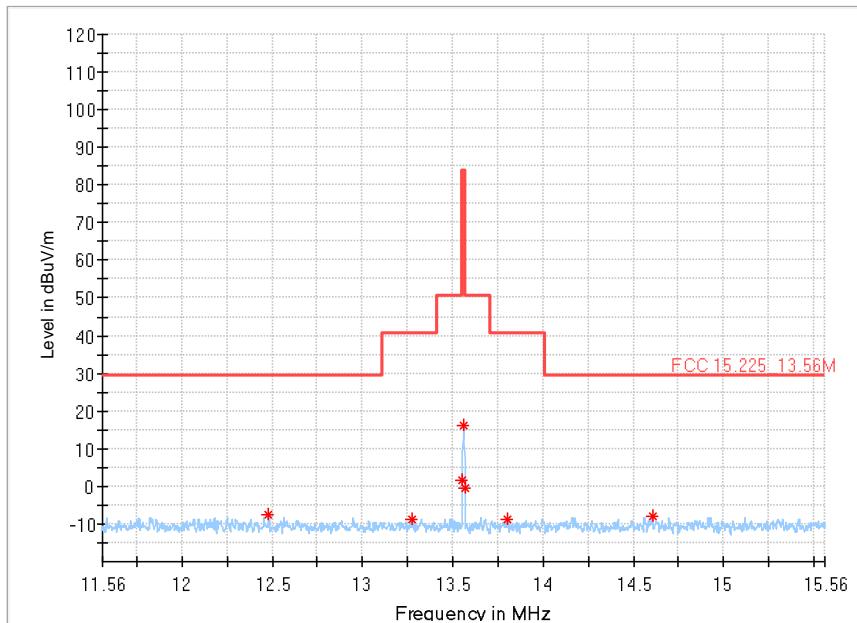
3m vs 30m conversion factor = $40\log(30/3) = -40$ dB

RESULTS

No non-compliance noted:

8.1.1. FUNDAMENTAL AND SPURIOUS EMISSIONS (0.15 – 30 MHz)

[Face On]

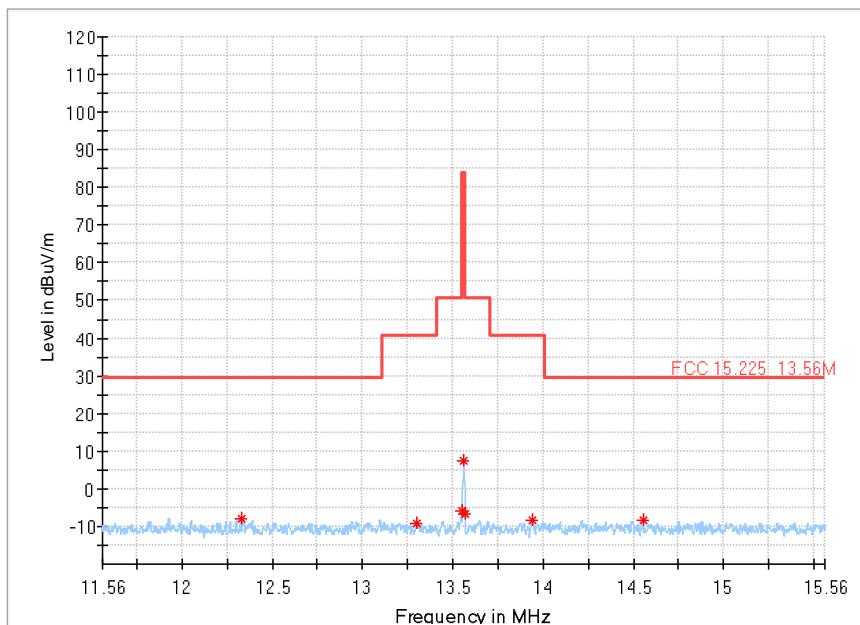


Trace Markers

Frequency (MHz)	MaxPeak (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pol	Azimuth (deg)	Corr. (dB/m)
12.482000	-7.64	29.52	37.16	H	50.0	-19.2
13.278000	-8.62	40.50	49.12	H	230.0	-19.2
13.552000	1.75	50.50	48.75	H	346.0	-19.2
**13.560000	16.34	84.00	67.66	H	346.0	-19.2
13.568000	-0.58	50.50	51.08	H	359.0	-19.2
13.806000	-8.86	40.50	49.36	H	225.0	-19.1
14.604000	-7.91	29.50	37.41	H	296.0	-19.1

**Fundamental

[Face Off]



Trace Markers

Frequency (MHz)	MaxPeak (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pol	Azimuth (deg)	Corr. (dB/m)
12.328000	-8.00	29.52	37.52	H	106.0	-19.2
13.296000	-9.15	40.50	49.66	H	292.0	-19.2
13.552000	-6.06	50.50	56.56	H	109.0	-19.2
**13.560000	7.60	84.00	76.40	H	283.0	-19.2
13.568000	-6.85	50.50	57.35	H	283.0	-19.2
13.942000	-8.55	40.50	49.05	H	296.0	-19.1
14.552000	-8.18	29.50	37.68	H	301.0	-19.1

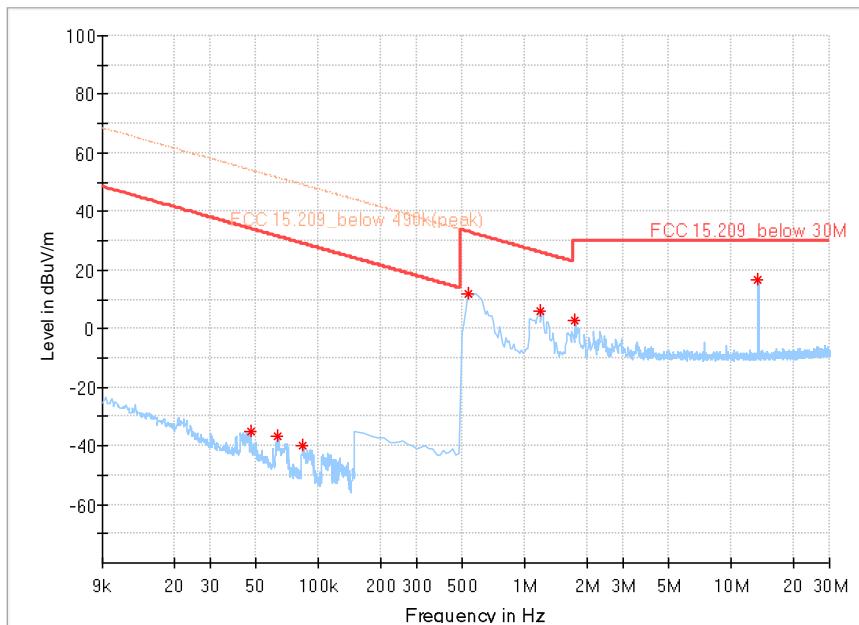
**Fundamental

Note 1 : Although these tests were performed other than open filed test site, adequate comparison measurements were confirmed against 30 m open are test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

Note 2: Radiated test were investigated with three receiving antenna axes: Face-on, Face-off and horizontal (parallel to the ground plane) and the worse orientations of Face-on and Face-off were set for final test.

8.1.2. SPURIOUS EMISSION 0.009 TO 30 MHz

[Face On]

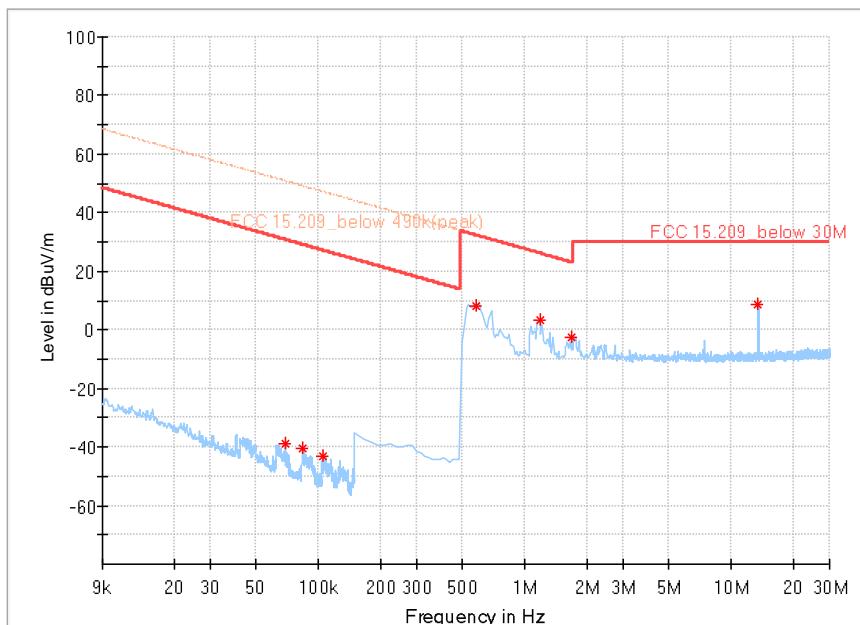


Trace Markers

Frequency (MHz)	MaxPeak (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pol	Azimuth (deg)	Corr. (dB/m)
0.047383	-35.17	34.08	69.25	H	227.0	-59.5
0.063050	-36.89	31.60	68.49	H	327.0	-59.5
0.084670	-40.10	29.04	69.14	H	317.0	-59.6
0.538050	11.88	32.99	21.11	H	329.0	-19.6
1.179825	6.23	26.19	19.96	H	314.0	-19.6
1.761900	2.61	30.00	27.39	H	332.0	-19.6
**13.553650	16.93	84.00	67.07	H	198.0	-19.2

** Fundamental

[Face Off]



Trace Markers

Frequency (MHz)	MaxPeak (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pol	Azimuth (deg)	Corr. (dB/m)
0.069317	-38.82	30.78	69.60	H	245.0	-59.5
0.084043	-40.25	29.11	69.35	H	276.0	-59.6
0.105037	-43.03	27.17	70.20	H	276.0	-59.6
0.582825	7.96	32.30	24.34	H	271.0	-19.6
1.179825	3.57	26.19	22.61	H	268.0	-19.6
1.687275	-2.35	23.09	25.44	H	274.0	-19.6
**13.553650	8.55	84.00	75.45	H	272.0	-19.2

** Fundamental

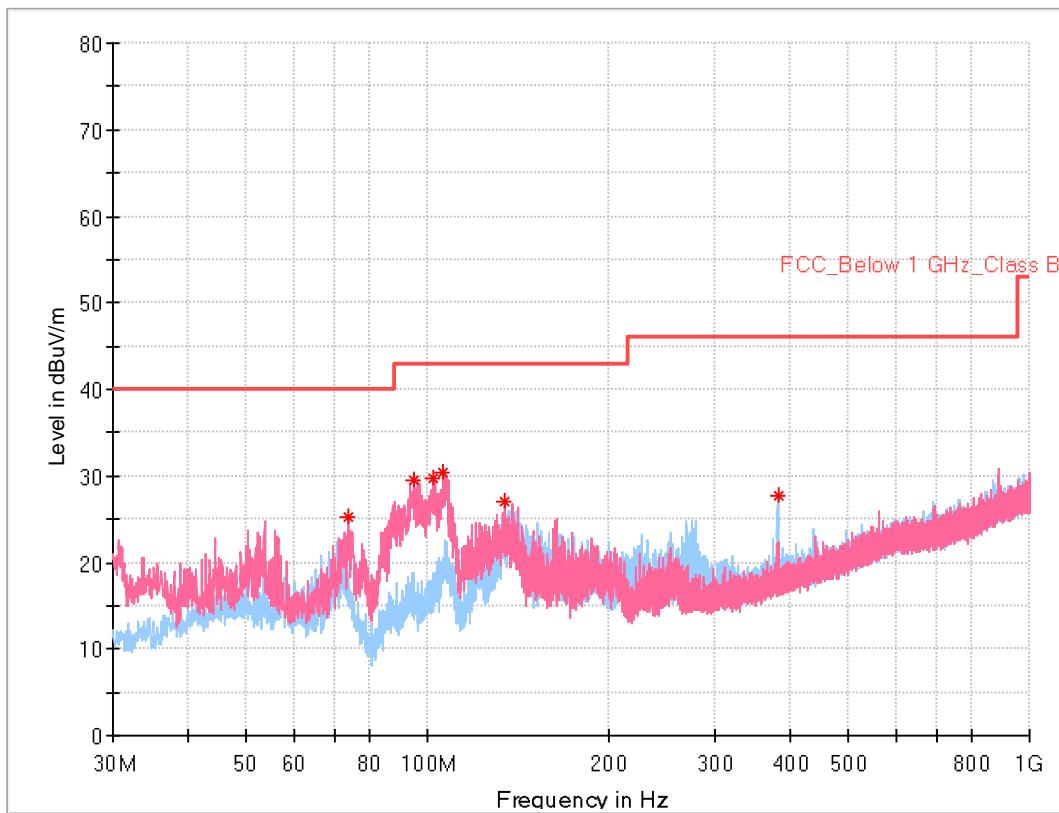
Note 1: The data for marker number 7 and 14 are the fundamental signal.

Please refer to section 8.1.1 about the fundamental level.

Frequency range 0.009MHz ~ 0.490MHz, only noise floor level and more than 20dB margin.

Note 2: Radiated test were investigated with three receiving antenna axes: Face-on, Face-off and horizontal (parallel to the ground plane) and the worse orientations of Face-on and Face-off were set for final test.

8.1.3. TX SPURIOUS EMISSION 30 TO 1000 MHz



Trace Markers

Frequency (MHz)	Raw Rec (dBuV)	Sig Path (dB)	Antenna (dB/m)	MaxPeak (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Azimuth (deg)	Pol
73.6985	51.2	-40.2	14.3	25.24	40.00	14.76	308.0	V
94.6505	52.9	-40.1	16.8	29.56	43.00	13.44	248.0	V
102.2165	52.2	-40.1	17.5	29.62	43.00	13.38	137.0	V
106.3875	53.4	-40.1	17.0	30.28	43.00	12.72	303.0	V
134.2750	52.8	-40.0	14.2	27.00	43.00	16.00	203.0	V
381.6250	45.0	-38.5	21.1	27.63	46.00	18.37	104.0	H

9. AC MAINS LINE CONDUCTED EMISSIONS

LIMITS

§15.207

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges.

Frequency range (MHz)	Limits (dB μ V)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Notes:

1. The lower limit shall apply at the transition frequencies
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.10.

The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

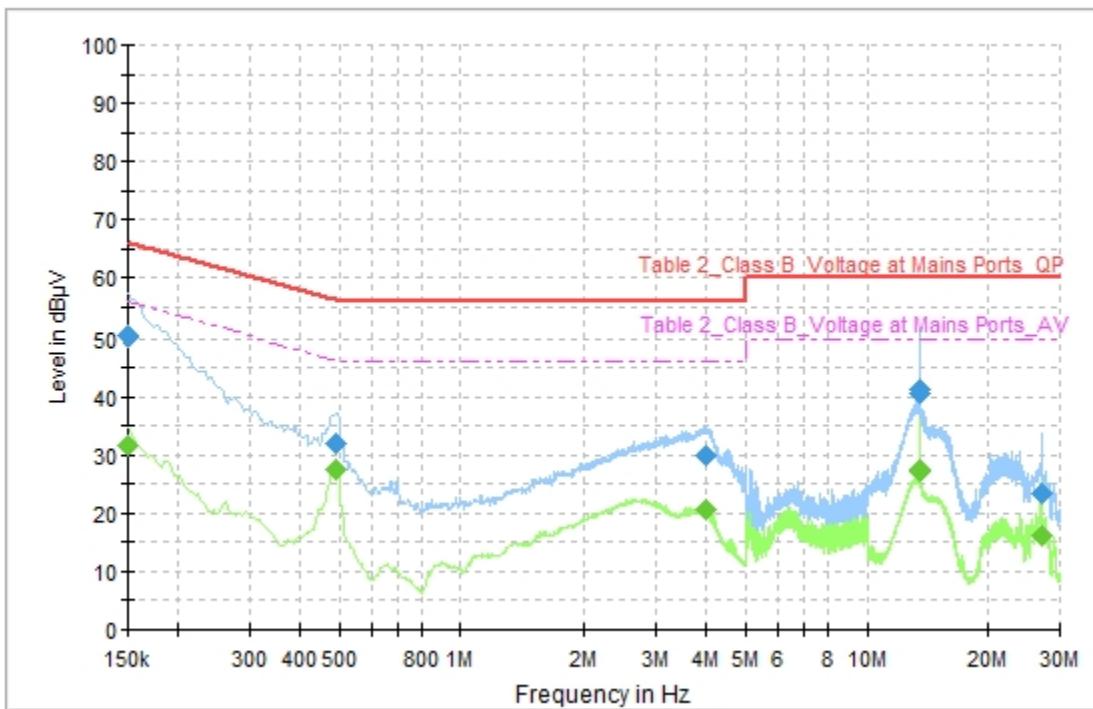
Line conducted data is recorded for both NEUTRAL and HOT lines.

RESULTS

No non-compliance noted:

WORST EMISSIONS

LINE 1 PLOT



Final_Result_QPK

Frequency (MHz)	QuasiPeak (dB μ V)	Limit (dB μ V)	Margin (dB)	Line	Filter	Corr. (dB)
0.150000	50.01	66.00	15.99	L1	ON	9.8
0.489500	31.87	56.18	24.30	L1	ON	10.0
4.002500	29.85	56.00	26.15	L1	ON	9.9
13.558333	40.43	60.00	19.57	L1	ON	10.0
13.562500	41.08	60.00	18.92	L1	ON	10.0
27.125000	23.44	60.00	36.56	L1	ON	10.1

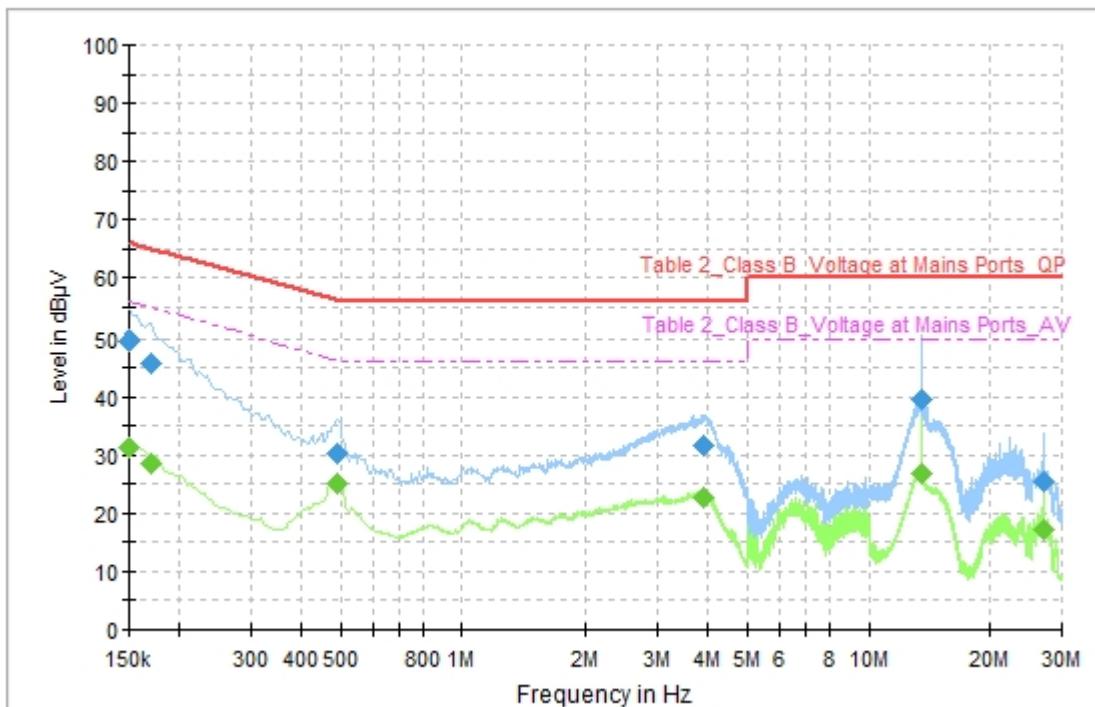
QPK - Quasi-Peak detector

Final_Result_CAV

Frequency (MHz)	CAverage (dB μ V)	Limit (dB μ V)	Margin (dB)	Line	Filter	Corr. (dB)
0.150000	31.53	56.00	24.47	L1	ON	9.8
0.489500	27.39	46.18	18.79	L1	ON	10.0
4.002500	20.49	46.00	25.51	L1	ON	9.9
13.558333	27.58	50.00	22.42	L1	ON	10.0
13.562500	27.04	50.00	22.96	L1	ON	10.0
27.125000	16.07	50.00	33.93	L1	ON	10.1

CAV - Average detection

LINE 2 PLOT



Final_Result_QPK

Frequency (MHz)	QuasiPeak (dB μ V)	Limit (dB μ V)	Margin (dB)	Line	Filter	Corr. (dB)
0.150000	49.50	66.00	16.50	N	ON	9.7
0.171000	45.86	64.91	19.06	N	ON	10.0
0.493000	30.31	56.12	25.81	N	ON	9.9
3.920000	31.63	56.00	24.37	N	ON	9.8
13.558333	39.60	60.00	20.40	N	ON	10.0
27.120833	25.32	60.00	34.68	N	ON	10.3

QPK - Quasi-Peak detector

Final_Result_CAV

Frequency (MHz)	CAverage (dB μ V)	Limit (dB μ V)	Margin (dB)	Line	Filter	Corr. (dB)
0.150000	31.13	56.00	24.87	N	ON	9.7
0.171000	28.50	54.91	26.41	N	ON	10.0
0.493000	24.92	46.12	21.20	N	ON	9.9
3.920000	22.76	46.00	23.24	N	ON	9.8
13.558333	26.80	50.00	23.20	N	ON	10.0
27.120833	17.28	50.00	32.72	N	ON	10.3

CAV - Average detection

10. FREQUENCY STABILITY

LIMIT

§15.225 (e) The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency, over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

TEST PROCEDURE

ANSI C63.10 §6.8

RESULTS

Reference Frequency: EUT Channel 13.56 MHz @ 20°C Limit: ± 100 ppm = 1.356 kHz										
Power Supply (Vdc)	Envir. Temp (°C)	Frequency Deviation Measured with Time Elapse								
		Start up (MHz)	Delta (ppm)	@ 2mins (MHz)	Delta (ppm)	@ 5mins (MHz)	Delta (ppm)	@ 10 mins (MHz)	Delta (ppm)	Limit (ppm)
5.00	50	13.560779284	-4.505	13.560799318	-5.983	13.560795807	-5.724	13.560746188	-2.065	100
5.00	40	13.560764169	-3.391	13.560747965	-2.196	13.560749078	-2.278	13.560735801	-1.299	100
5.00	30	13.560742408	-1.786	13.560733354	-1.118	13.560711085	0.524	13.560724206	-0.444	100
5.00	20	13.560718190	0	13.560673655	3.284	13.560671426	3.448	13.560681096	2.735	100
5.00	10	13.560690915	2.011	13.560691414	1.975	13.560692231	1.914	13.560691021	2.004	100
5.00	0	13.560697759	1.507	13.560705562	0.931	13.560702929	1.125	13.560709300	0.656	100
5.00	-10	13.560706943	0.829	13.560711004	0.530	13.560708618	0.706	13.560711584	0.487	100
5.00	-20	13.560711875	0.466	13.560712853	0.394	13.560706433	0.867	13.560696157	1.625	100
5.00	-30	13.560708088	0.745	13.560691344	1.980	13.560685802	2.388	13.560685564	2.406	100

Reference Frequency: EUT Channel 13.56 MHz @ 20°C Limit: ± 100 ppm = 1.356 kHz										
Power Supply (Vdc)	Envir. Temp (°C)	Frequency Deviation Measured with Time Elapse								
		Start up (MHz)	Delta (ppm)	@ 2mins (MHz)	Delta (ppm)	@ 5mins (MHz)	Delta (ppm)	@ 10 mins (MHz)	Delta (ppm)	Limit (ppm)
5.00	20	13.560718190	0	13.560673655	3.284	13.560671426	3.448	13.560681096	2.735	100
5.75	20	13.560718875	-0.051	13.560682061	2.664	13.560673192	-0.130	13.560681705	2.690	100
4.25	20	13.560715875	0.171	13.560687619	2.254	13.560675746	-0.319	13.560676039	3.108	100

No non-compliance noted.

END OF TEST REPORT