FCC CFR47 PART 15 SUBPART C

NFC

CERTIFICATION TEST REPORT

FOR

RMCU-FMS

MODEL NUMBER : FMS-HF1

FCC ID: ZE8-FMS-HF1

REPORT NUMBER: 4788243069-E3V3

ISSUE DATE: FEB 20, 2018

Prepared for
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Prepared by
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ACCREDITED
Testing Laboratory

TL-637

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	01/31/18	Initial issue	Hyunsik Yun
V2	02/07/18	Reviced typo and description	Hyunsik Yun
V3	02/20/18	Reviced description and remove test setup	Hyunsik Yun

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: KYUNGWOO SYSTECH INC.

EUT DESCRIPTION: RMCU-FMS

MODEL NUMBER: FMS-HF1

SERIAL NUMBER: Prototype

DATE TESTED: DEC 28, 2017 - JAN 09, 2018

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Pass

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.

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SungGil Park
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Tested By:

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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.

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
☐ Chamber 1
☒ Chamber 2

UL Korea, Ltd. is accredited by IAS, Laboratory Code TL-637. The full scope of accreditation can be viewed at http://www.iasonline.org/PDF/TL/TL-637.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:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)
36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

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	2.32 dB
Radiated Disturbance, Below 1GHz	3.86 dB

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

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT has GSM/WCDMA, DTS b/g/n and RFID functions.
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 21.97 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. 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.

All test was performed in the ISO 14443 Type A.

5.4. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
N/A	N/A	N/A	N/A	N/A

I/O CABLES

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	DC Power	1	Fixed	Non-shielded	0.8m	N/A

TEST SETUP

The EUT is a stand-alone unit during the tests.

All test item has been tested with DC 12V, 24V to determine the worst-case condition. The test results in condition of DC 24 V (Worst-case) is only described in this report.

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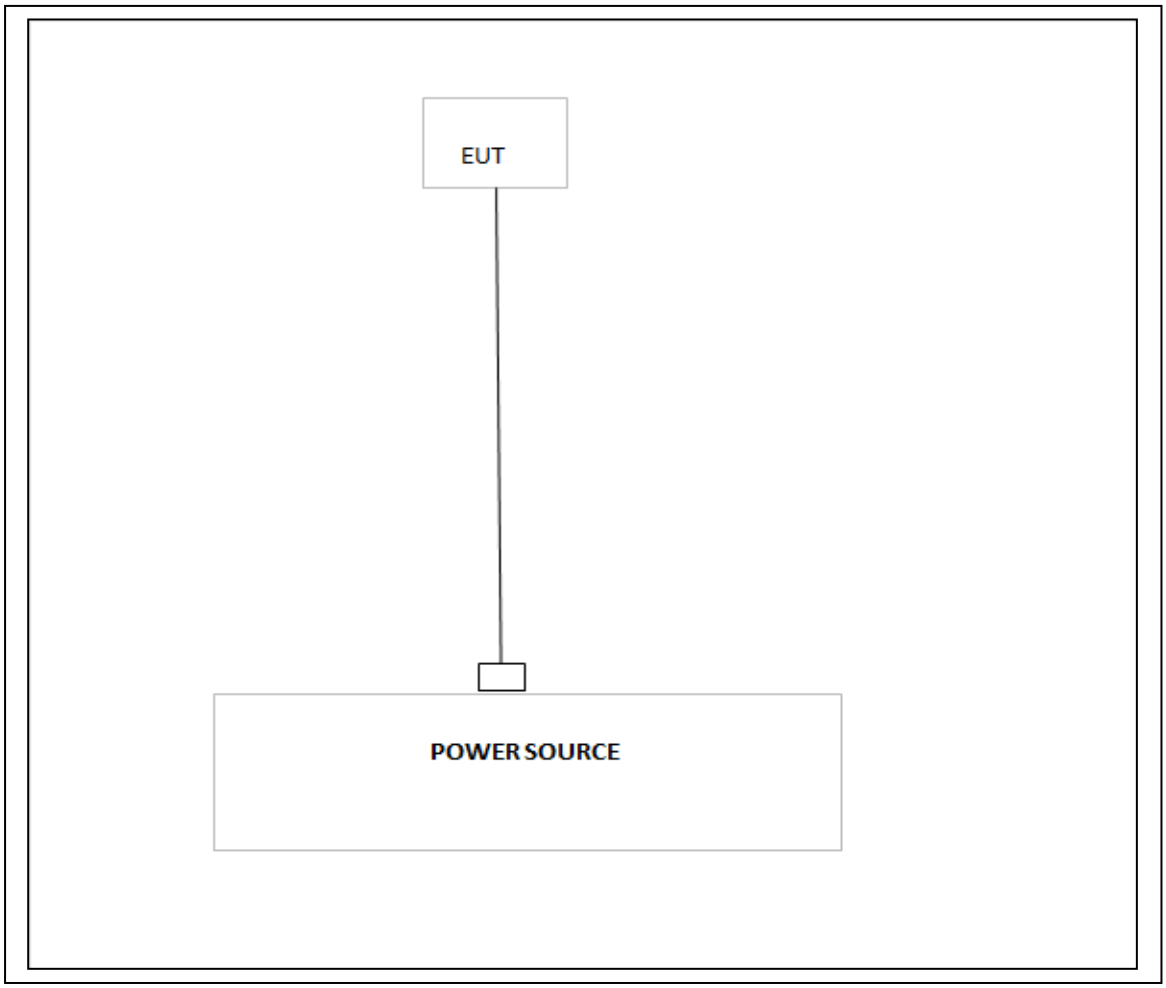
SETUP DIAGRAM FOR TESTS

Radiated Emissions Below 30 MHz:



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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**
Antenna, Bilog, 30MHz-1GHz	SCHWARZBECK	VULB9163	750	08-31-19
Antenna, Bilog, 30MHz-1GHz	SCHWARZBECK	VULB9163	749	04-14-19
Antenna, Loop, 9kHz-30MHz	R&S	HFH2-Z2	100418	10-26-19
Preamplifier, 1000 MHz	Sonoma	310N	341282	08-09-18
Preamplifier, 1000 MHz	Sonoma	310N	251741	08-07-18
Spectrum Analyzer, 40 GHz	R&S	FSV40	101237	08-11-18
Spectrum Analyzer, 44 GHz	Agilent / HP	N9030A	MY54170614	08-08-18
Spectrum Analyzer, 44 GHz	Agilent / HP	N9030A	MY54490312	08-08-18
EMI Test Receive, 40 GHz	R&S	ESU40	100439	08-08-18
EMI Test Receive, 40 GHz	R&S	ESU40	100457	08-08-18
EMI Test Receive, 3 GHz	R&S	ESR3	101832	08-07-18
DC Power Supply	Agilent / HP	E3640A	MY54226395	08-07-18
Temperature Chamber	ESPEC	SH-642	93001109	08-08-18
UL Software				
Description	**Manufacturer**	**Model**	**Version**	
Radiated software	UL	UL EMC	Ver 9.5	

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

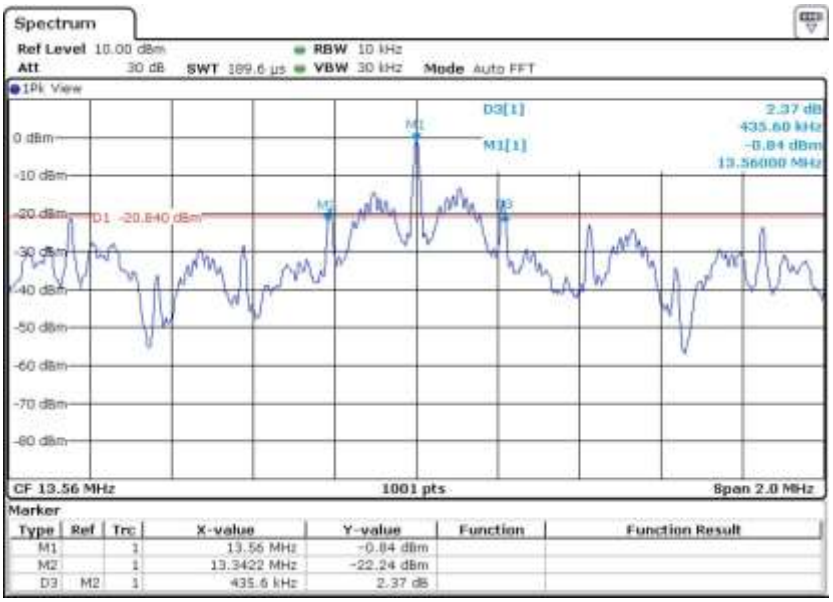
TEST PROCEDURE

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

RESULTS

Frequency [MHz]	20dB Bandwidth [KHz]
13.56	435.60

20dB Bandwidth Plot



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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 (µV/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 filed strength from uV/m to dBuV/m is:
Limit (dBuV/m) = 20 log limit (uV/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

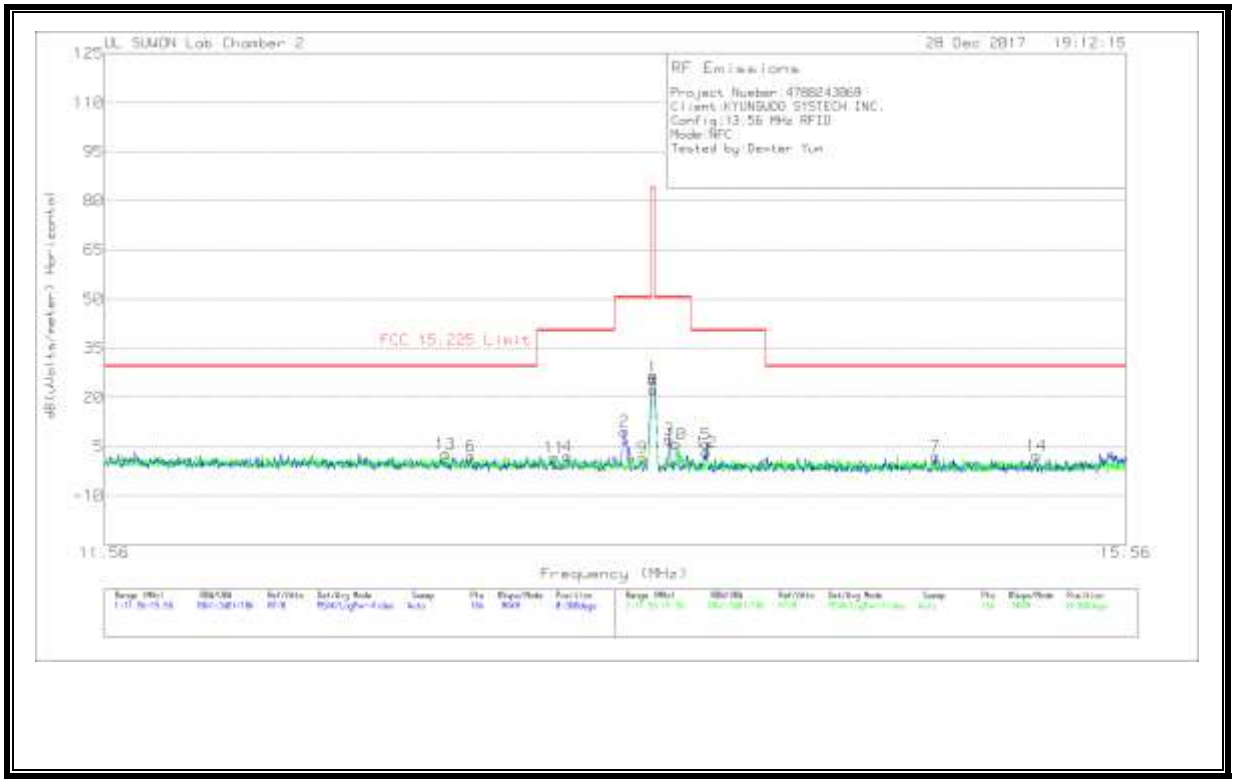
ANSI C63.10-2013

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)

RESULTS

No non-compliance noted:

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



Trace Markers

Range 1: Face On 11.56 - 15.56MHz										
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna	Dist Corr 40Log	Cable Loss	Corrected Reading dB(uVolts/meter)	FCC 15.225 Limit	PK Margin (dB)	Azimuth (Degs)
1	13.56	45.56	Pk	19.9	-40	.5	25.96	84	-58.04	0-360
2	13.44713	29.31	Pk	19.9	-40	.5	9.71	50.5	-40.79	0-360
3	13.62463	26.77	Pk	19.9	-40	.6	7.27	50.5	-43.23	0-360
4	13.22638	21.58	Pk	19.9	-40	.5	1.98	40.51	-38.53	0-360
5	13.77375	25.41	Pk	19.8	-40	.6	5.81	40.51	-34.7	0-360
6	12.85988	21.7	Pk	19.9	-40	.5	2.1	29.54	-27.44	0-360
7	14.72138	21.61	Pk	19.8	-40	.6	2.01	29.54	-27.53	0-360

Pk - Peak detector

Range 2: Face Off 11.56 - 15.56MHz										
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna	Dist Corr 40Log	Cable Loss	Corrected Reading dB(uVolts/meter)	FCC 15.225 Limit	PK Margin (dB)	Azimuth (Degs)
8	13.56063	41.82	Pk	19.9	-40	.5	22.22	84	-61.78	0-360
9	13.51888	21.35	Pk	19.9	-40	.5	1.75	50.5	-48.75	0-360
10	13.65138	25.21	Pk	19.9	-40	.6	5.71	50.5	-44.79	0-360
11	13.17688	21.26	Pk	19.9	-40	.5	1.66	40.51	-38.85	0-360
12	13.77363	22.96	Pk	19.8	-40	.6	3.36	40.51	-37.15	0-360
13	12.76563	22.39	Pk	19.9	-40	.5	2.79	29.54	-26.75	0-360
14	15.16088	21.81	Pk	19.8	-40	.6	2.21	29.54	-27.33	0-360

Pk - Peak detector

Note : Although these tests were performed other than open area 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.

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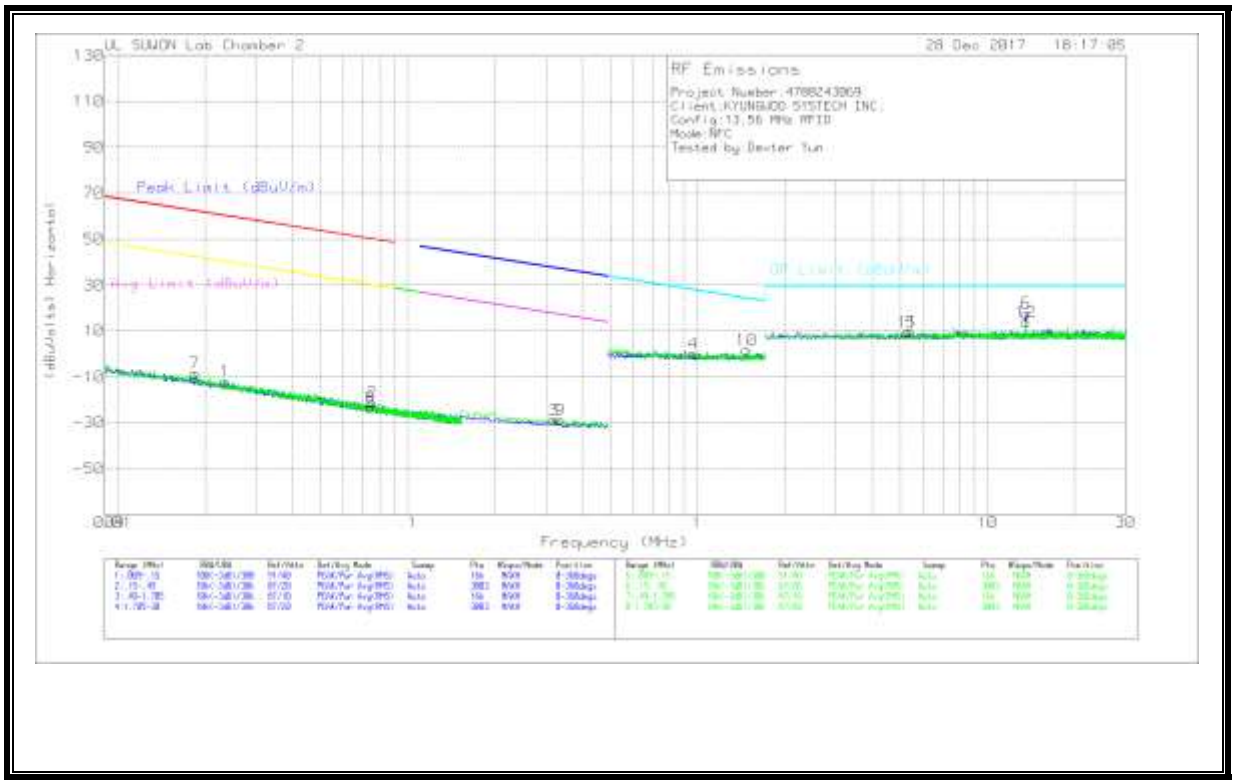
8.1.2. SPURIOUS EMISSION 0.09 TO 30 MHz



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Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna	Cable Loss	Dist Corr 300m	Corrected Reading (dBuVolts)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	QP Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
1	.02337	48.18	Pk	19.9	.1	-80	-11.82	60.21	-72.03	40.21	-52.03	-	-	-	-	-	-	0-360
2	.07545	39.21	Pk	19.7	.1	-80	-20.99	50.03	-71.02	30.03	-51.02	-	-	-	-	-	-	0-360
3	.31894	31.62	Pk	19.5	.1	-80	-28.78	-	-	-	-	-	-	37.54	-66.32	17.54	-46.32	0-360
7	.01842	51.62	Pk	20	.1	-80	-8.28	62.28	-70.56	42.28	-50.56	-	-	-	-	-	-	0-360
8	.07451	36.97	Pk	19.8	.1	-80	-23.13	50.14	-73.27	30.14	-53.27	-	-	-	-	-	-	0-360
9	.33498	31.69	Pk	19.5	.1	-80	-28.71	-	-	-	-	-	-	37.11	-65.82	17.11	-45.82	0-360

Pk - Peak detector

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	Loop Antenna	Cable Loss	Dist Corr 30m	Corrected Reading (dBuVolts)	Peak Limit (dBuV/m)	Margin (dB)	Avg Limit (dBuV/m)	Margin (dB)	QP Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)
4	.96606	20.23	Pk	19.7	.2	-40	.13	-	-	-	-	27.92	-27.79	0-360
5	5.44673	29	Pk	19.9	.4	-40	9.3	-	-	-	-	29.5	-20.2	0-360
6	13.56165	37.31	Pk	19.9	.5	-40	17.71	-	-	-	-	29.5	-11.79	0-360
10	1.47621	21.76	Pk	19.7	.2	-40	1.66	-	-	-	-	24.25	-22.59	0-360
11	5.29593	29.46	Pk	19.9	.4	-40	9.76	-	-	-	-	29.5	-19.74	0-360
12	13.56165	33.36	Pk	19.9	.5	-40	13.76	-	-	-	-	29.5	-15.74	0-360

Pk - Peak detector

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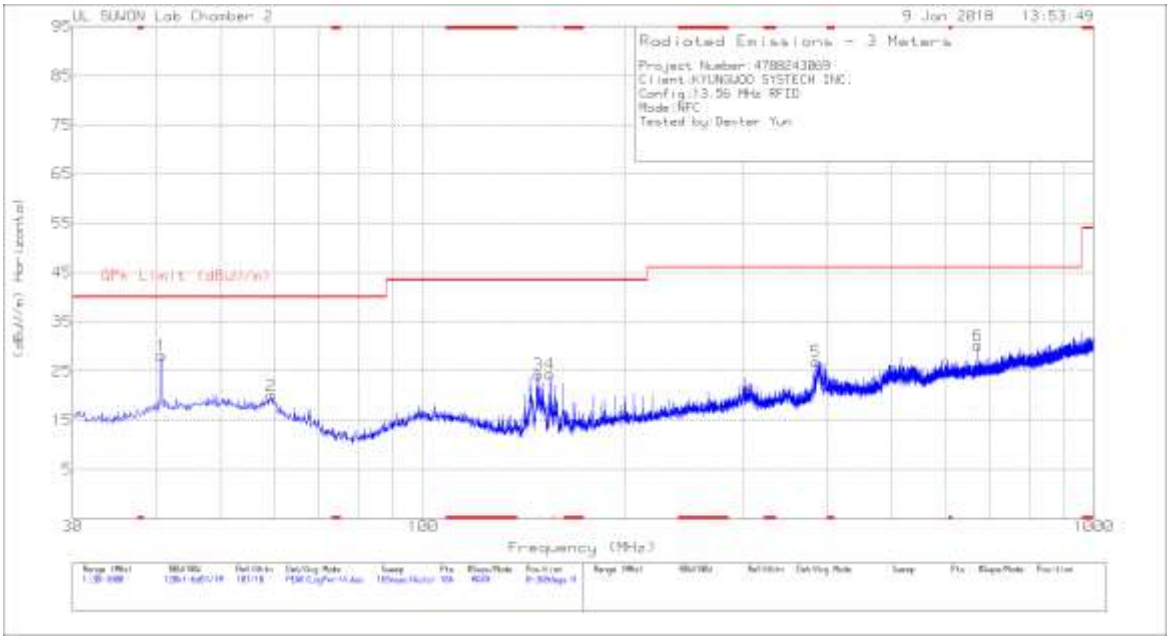
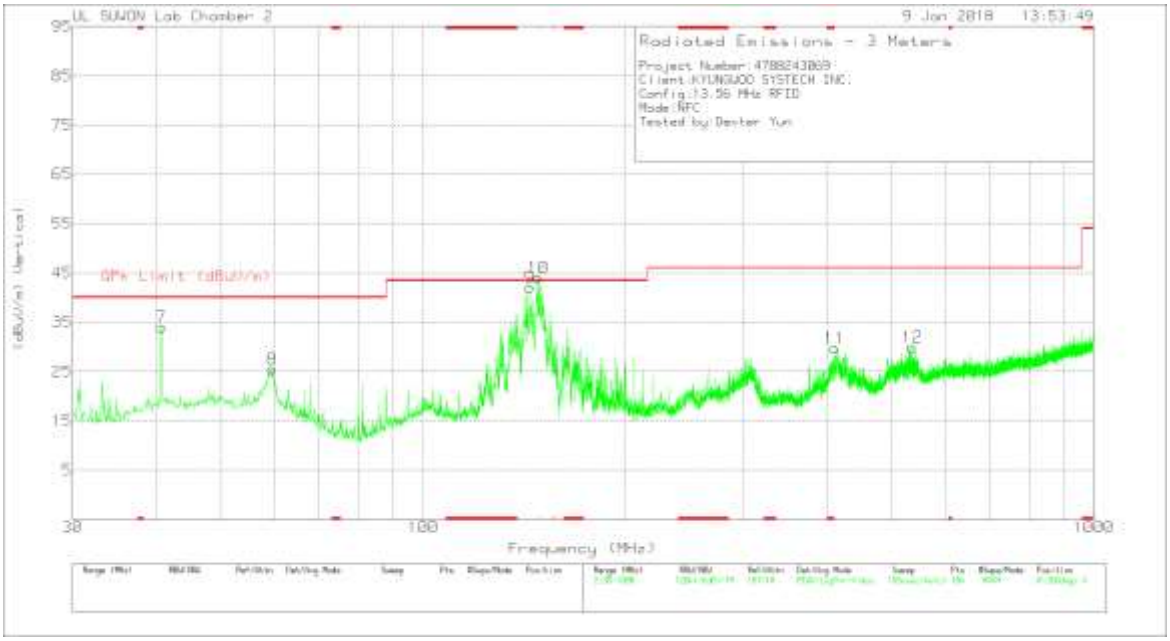
8.1.3. TX SPURIOUS EMISSION 30 TO 1000 MHz

HORIZONTAL



VERTICAL



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Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	VULB9163-749	30-1000MHz[dB]	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	40.67	40.55	Pk	19.1	-31.5	28.15	40	-11.85	0-360	300	H
2	59.294	32.74	Pk	18.5	-31.3	19.94	40	-20.06	0-360	400	H
3	148.437	41.48	Pk	13.6	-30.8	24.28	43.52	-19.24	0-360	300	H
4	154.354	41.16	Pk	13.9	-30.7	24.36	43.52	-19.16	0-360	200	H
5	385.117	35.74	Pk	21	-29.8	26.94	46.02	-19.08	0-360	100	H
6	672.043	34.21	Pk	25.2	-29.2	30.21	46.02	-15.81	0-360	100	H
7	40.67	46.49	Pk	19.1	-31.5	34.09	40	-5.91	0-360	100	V
8	59.488	38.43	Pk	18.4	-31.3	25.53	40	-14.47	0-360	100	V
9	144.169	59.41	Pk	13.5	-30.8	42.11	43.52	-1.41	0-360	100	V
10	148.437	61.25	Pk	13.6	-30.8	44.05	**43.52**	**.53**	0-360	100	V
11	411.21	37.68	Pk	21.7	-29.7	29.68	46.02	-16.34	0-360	100	V
12	535.661	36.09	Pk	23.4	-29.5	29.99	46.02	-16.03	0-360	100	V

Pk - Peak detector

Radiated Emissions

Frequency (MHz)	Meter Reading (dBuV)	Det	VULB9163-749	30-1000MHz[dB]	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
40.67	45.74	Qp	19.1	-31.5	33.34	40	-6.66	92	100	V
144.169	55.61	Qp	13.5	-30.8	38.31	43.52	-5.21	205	100	V
148.437	58.15	Qp	13.6	-30.8	40.95	43.52	-2.57	211	100	V

Qp - Quasi-Peak detector

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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 50µH/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 (dBµV)	
	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

NA

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10. FREQUENCY STABILITY

LIMIT

§15.225 (e) The frequency tolerance of the carrier signal shall be maintained within ±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	Envir.	Frequency Deviation Measureed with Time Elapse								
(Vdc)	Temp (°C)	Start up (MHz)	Delta (ppm)	@ 2mins (MHz)	Delta (ppm)	@ 5mins (MHz)	Delta (ppm)	@ 10 mins (MHz)	Delta (ppm)	Limit (ppm)
24.00	50	13.560002600	0.981	13.560002400	0.996	13.560002200	1.010	13.560002000	1.025	100
24.00	40	13.560007300	0.634	13.560006300	0.708	13.560006100	0.723	13.560004500	0.841	100
24.00	30	13.560011400	0.332	13.560010300	0.413	13.560013600	0.170	13.560007400	0.627	100
24.00	***20***	***13.560015900***	***0***	***13.560014200***	0.125	***13.560014000***	0.140	***13.560009500***	0.472	***100***
24.00	10	13.560020900	-0.369	13.560019800	-0.288	13.560019400	-0.258	13.560015800	0.007	100
24.00	0	13.560026100	-0.752	13.560024500	-0.634	13.560024700	-0.649	13.560021600	-0.420	100
24.00	-10	13.560031300	-1.136	13.560030300	-1.062	13.560031000	-1.114	13.560028200	-0.907	100
24.00	-20	13.560036300	-1.504	13.560035700	-1.460	13.560035500	-1.445	13.560034900	-1.401	100
24.00	-30	13.560042400	-1.954	13.560041400	-1.881	13.560040800	-1.836	13.560040750	-1.833	100

Reference Frequency: EUT Channel 13.56 MHz @ 20°C Limit: ± 100 ppm = 1.356 kHz										
Power Supply	Envir.	Frequency Deviation Measureed with Time Elapse								
(Vdc)	Temp (°C)	Start up (MHz)	Delta (ppm)	@ 2mins (MHz)	Delta (ppm)	@ 5mins (MHz)	Delta (ppm)	@ 10 mins (MHz)	Delta (ppm)	Limit (ppm)
24.00	***20***	***13.560015900***	***0***	***13.560014200***	0.125	***13.560014000***	0.140	***13.560009500***	0.472	***100***
27.60	20	13.560007700	0.605	***13.560005600***	0.760	***13.560005500***	0.767	***13.560000800***	1.114	100
20.40	20	13.560007200	0.642	***13.560005300***	0.782	***13.560005000***	0.804	***13.560000300***	1.150	100

No non-compliance noted.

END OF REPORT

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