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Report No.: 13CA02038-1-FCC
Date: January 31, 2013
Model No.: WNI20NC0302
FCC ID.: E2XWNI20NC0302
IC ID.: 3269B-WNI20NC0302

FCC Test Report
in accordance with
FCC Part 15 Subpart C Section 15.215 & 15.225
for
NFC Module

Samsung Electro-Mechanics Co., Ltd.

**150, Maeyoung-ro (Maetan-dong), Yeongtong-gu, Suwon-si,
Gyeonggi-do, 442-743, KOREA**

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Summary of Test Results:

The following tests were performed on a sample submitted for evaluation of compliance with FCC Part 15 Subpart C Section 15.215 & 15.225 and RSS-210 & RSS-Gen

No	Reference Clause No.	FCC Part15 Subpart C Conformance Requirements	Verdict	Remark
1	15.215(c) RSS-210 A8.2(a)	20 dB Bandwidth & 99 % Bandwidth	Complied	
2	15.225(a),(b),(c) RSS-210 A2.6	The field strength of any emission within the band 13.110-14.010 MHz	Complied	
3	15.225(d) RSS-210 A2.6	The field strength of any emission appearing outside of the 13.110-14.010 MHz band	Complied	
4	15.225(e) RSS-210 A2.6	The frequency tolerance of the carrier signal	Complied	
5	15.209(a) RSS-Gen 7.2.5	Transmitter radiated spurious emissions	Complied	
6	15.109(a) RSS-Gen 6.1	Receiver radiated spurious emissions	Complied	
7	15.207(a) RSS-Gen 7.2.4	Transmitter AC power line conducted emission	Complied	
8	15.107(a) RSS-Gen 7.2.4	Receiver AC power line conducted emission	Complied	

Conclusion:

The tests listed in the Summary of Testing section of this report have been performed and the results recorded by UL Korea Ltd. in accordance with the procedures stated in each test requirement and specification. The test list was determined by the Applicant as being applicable to the Equipment Under Test. As a result, the subject product has been verified to comply or not comply as noted in the Summary of Testing with each test specification. The test results relate only to the items tested.



Tested by
Kyung Duk Ko, WiSE Project Engineer
UL Verification Services- 3014ASEO
UL Korea Ltd.
January 31, 2013



Reviewed by
Jeawoon, Choi, WiSE Engineering Leader
UL Verification Services- 3014ASEO
UL Korea Ltd.
January 31, 2013

Test Report Details

Witnessed By: UL Korea Ltd.
33rd FL. GFC Center, 737 Yeoksam-dong, Gangnam-gu, Seoul, 135-984, Korea

Test Site: EMC Compliance Ltd.
480-5 Sin-dong, Yeongtong-gu, Suwon-city, Gyeonggi-do, 443-390, Korea
The test facility was deemed to have the environment and capabilities necessary to perform the tests included in the test package.

Applicant: Samsung Electro-Mechanics Co., Ltd.
150, Maeyoung-ro (Maetan-dong), Yeongtong-gu, Suwon-si, Gyeonggi-do, 442-743, KOREA

Applicant Contact: Myunglim Ryu
Title: Senior Engineer
Phone: 82-31-210-5047
E-mail: aprilryu@samsung.com

Product Type: NFC Module

Model Number: WNI20NC0302

Trademark: SAMSUNG

Sample Serial Number: N/A

Test standards: FCC Part 15 Subpart C Section 15.215
Additional provisions to the general radiated emission limitations
FCC Part 15 Subpart C Section 15.225
Operation within the band 13.110–14.010 MHz.

RSS-Gen Issue 3
General Requirements and Information for the Certification of Radio Apparatus
RSS-210 Issue 8
Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

Sample Receive Date: December 05, 2012

Testing Start Date: January 24, 2013

Date Testing Complete: January 31, 2013

Overall Results: **Pass**

UL Korea Ltd. reports apply only to the specific test samples and test results submitted for UL's review. All samples tested were in good operating condition throughout the entire test program. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. UL Korea Ltd. shall have no liability for any deductions, inferences or generalizations drawn by the client or others from UL Korea Ltd. issued reports. This report shall not be used to claim, constitute or imply product certification, approval, or any agency of the National Authorities. This report may contain test results that are not covered by the NVLAP or KOLAS accreditation.

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1. General Product Information

1.1. Equipment Description

WNI20NC0302 is the module that integrates NFC (13.56 MHz). This embedded module is optimized for NFC enabled Portable device.

1.2. Details of Test Equipment (EUT)

- Equipment Type : NFC Module
- Model No. : WNI20NC0302
- Trade name : SAMSUNG
- Type of test Equipment : module type
- Operating characteristic : Operation within the band 13.110–14.010 MHz.
- Manufacturer : Samsung Electro-Mechanics Co., Ltd.
150, Maeyoung-ro (Maetan-dong), Yeongtong-gu, Suwon-si, Gyeonggi-do, 442-743,
KOREA

1.3. Equipment Configuration

The EUT is consisted of the following component provided by the manufacturer.

Use*	Product Type	Manufacturer	Model	Comments
EUT	NFC Module	Samsung Electro-Mechanics Co., Ltd.	WNI20NC0302	-
Note: Use = EUT - Equipment Under Test, AE - Auxiliary/Associated Equipment. SIM - Simulator (Not Subjected to Test)				

1.4. Technical Data

Item	Type of NFC Module
Operating Frequency Ranges	13.56 MHz
Emission Designator	A1D
Kind of modulation (s)	ASK
Antenna information	Integral antenna (Loop Antenna)
Receiver class	Receiver class 3
Duty cycle class	Class 2
Working temperature	-20 ~ 85 °C
Supply Voltage	DC 3.8 V

Note ;

1. All the technical data described above were provided by the manufacturer.

1.5. Antenna Information

Antenna Model Name : WPR14NRC4000
Antenna Type : Loop Antenna
Manufacturer : Samsung Electro-Mechanics Co., Ltd.

1.6. Equipment Type :

- ☒ Radio and ancillary equipment for fixed or semi-fixed use
☐ Radio and ancillary equipment for vehicular mounted use
☒ Radio and ancillary equipment for portable or handheld use
- ☒ Stand alone ☐ Host connected ☐ Host connected
- ☐ Self contained single unit ☒ Module with associated connection or interface

1.7. Technical descriptions and documents

The following documents was provided by the manufacturer.

No.	Document Title and Description
1	User Manual
2	Technical Document for supporting SONY_GD (WNI20NC0302) / Samsung Electro-Mechanics Co., Ltd.

1.8. Description of additional model name

Model name	Model name Designation	Description of design
WNI20NC0302	Basic model	-

2. Test Specification

The following test specifications and standards have been applied and used for testing.

- 1) FCC Part 15 Subpart C Section 15.215 Additional provisions to the general radiated emission limitations
- 2) FCC Part 15 Subpart C Section 15.225 Operation within the band 13.110–14.010 MHz
- 3) ANSI C63.4:2009 : American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
- 4) ANSI C63.10:2009 : American National Standard for Testing Unlicensed Wireless Devices

3. Test Conditions

3.1. Equipment Used During Test

Use*	Product Type	Manufacturer	Model	Comments
EUT	NFC Module	Samsung Electro-Mechanics Co., Ltd.	WNI20NC0302	-
AE	Note PC	TOSHIBA	PSLQ0K-02N005	-
Note: Use = EUT - Equipment Under Test, AE - Auxiliary/Associated Equipment. SIM - Simulator (Not Subjected to Test)				

3.2. Input/Output Ports

No	Port Name	Type*	Cable Max. >3m (Y/N)	Cable Shielded (Y/N)	Comments
1	Power Input	DC	N	N	Connected to DC Power supply
2	Radio Antenna	I/O	N	Y	-
Note: *AC = AC Power Port DC = DC Power Port N/E = Non-Electrical I/O = Signal Input or Output Port (Not Involved in Process Control) TP = Telecommunication Ports					

3.3. Power Interface

Mode #	Voltage (V)	Current (A)	Power (W)	Frequency (DC/AC-Hz)	Phases (#)	Comments
Rated	3.8 Vdc	-	-	DC	-	Normal operating voltage
Rated	Input : 100~250 Vac Output : 5 Vdc	Input : 0.5 Output : 0.8	-	50/60 Hz		Rated of AC to DC Adapter of Note PC
1	3.8 Vdc	-	-	DC	-	V _{Nom}
2	120 Vac	-	-	60 Hz	-	Normal operating voltage
3	3.42 Vdc	-	-	DC	-	V _{Min}
4	4.18 Vdc	-	-	DC	-	V _{Max}

3.4. Operating Frequencies

Mode #	Frequency tested
1	Operating frequency range : 13.56 MHz

3.5. Operation Modes

Mode #	Description
1	Carrier on mode with modulation : Signal from the RF module was generated continuously by the test program incorporated
2	Carrier on mode with un-modulation : Signal from the RF module was generated continuously by the test program incorporated
3	Carrier off mode

3.6. Environment Conditions

Parameters	Normal condition
Temperature	+ 15°C ~ +35°C
Humidity	20% ~ 75%
Supply voltage	3.8 Vdc (Rated nominal voltage)
Note ; - The extreme condition is applied to the boundary limits of the declared operational environmental condition by the manufacturer. - The operating condition for humidity requirement has not been declared in the manufacturer's specification. - Test has been carried out for three frequencies specified above under the normal condition and for the extreme condition, minimum and maximum frequencies has been tested.	

3.7. Test Configurations

Mode #	Description
1	Shield room enclosure LISN AC/DC Adaptor EUT Table height 0.8m to Test Receiver Power Line 0.4m
2	AC/DC Adapter EUT Test Receiver Power Line
3	DC Power Supply EUT Attenuator Spectrum Analyzer

3.8. List of Test Equipment

	Description	Manufacturer	Model	Identifier	Next Cal Date.
☒	Temp & humidity chamber	taekwang	TK-04	TK001	13.12.07
☐	Temp & humidity chamber	taekwang	TK-500	TK002	13.09.05
☐	Frequency Counter	HP	53150A	US39250565	13.09.04
☒	Spectrum Analyzer	Agilent	E4440A	MY46186407	14.01.20
☒	Spectrum Analyzer	R & S	FSP40	100209	13.10.23
☒	Signal Generator	R & S	SMR40	100007	13.06.27
☐	Modulation Analyzer	HP	8901B	3538A05527	13.11.06
☐	Audio Analyzer	HP	8903B	3729A19213	14.01.07
☐	AC Power Supply	KIKUSUI	PCR2000W	GB001619	13.10.23
☐	DC Power Supply	Tektronix	PS2520G	TW50517	13.02.06
☒	DC Power Supply	Tektronix	PS2521G	TW53135	13.10.23
☐	Dummy Load	BIRD	8141	7560	13.09.09
☐	Dummy Load	BIRD	8401-025	799	13.09.09
☒	EMI Test Receiver	R&S	ESCI	100001	13.07.10
☐	Attenuator	HP	8494A	2631A09825	13.10.24
☐	Attenuator	HP	8496A	3308A16640	13.10.24
☐	Attenuator	R & S	RBS1000	D67079	13.10.24
☐	Power sensor	R & S	NRP-Z81	100677	13.05.04
☒	LOOP Antenna	EMCO	EMCO6502	9205-2745	13.05.23
☒	BILOG Antenna	Schwarzbeck	VULB 9168	375	13.09.21
☐	HORN Antenna	ETS	3115	00062589	13.09.06
☐	HORN Antenna	ETS	3116	00086632	13.11.15
☐	Power Divider	Weinschel	1580-1	NX375	13.10.23
☐	Power Divider	Weinschel	1580-1	NX380	13.09.09
☐	Power Divider	Weinschel	1594	671	13.09.10
☒	Test Receiver	R&S	ESHS30	828765/009	13.08.06
☒	LISN	R&S	ENV216	101358	14.01.07
☒	LISN	PMM	L2-16A	0000J10705	-

4. Overview of Technical requirements

The following essential requirements and test specifications are relevant to the presumption of conformity FCC Part 15 Subpart C Section 15.215 & 15.225 RSS-210 & RSS-Gen			Reported
Reference Clause No.	Essential technical requirements	Test method	
15.215(c) RSS-210 A8.2(a)	20 dB Bandwidth & 99 % Bandwidth	ANSI C63.10-2009	[X]
15.225(a),(b),(c) RSS-210 A2.6	The field strength of any emission within the band 13.110-14.010 MHz	ANSI C63.10-2009	[X]
15.225(d) RSS-210 A2.6	The field strength of any emission appearing outside of the 13.110-14.010 MHz band	ANSI C63.10-2009	[X]
15.225(e) RSS-210 A2.6	The frequency tolerance of the carrier signal	ANSI C63.10-2009	[X]
15.209(a) RSS-Gen 7.2.5	Transmitter radiated spurious emissions	ANSI C63.4-2009	[X]
15.109(a) RSS-Gen 6.1	Receiver radiated spurious emissions	ANSI C63.4-2009	[X]
15.207(a) RSS-Gen 7.2.4	Transmitter AC power line conducted emission	ANSI C63.4-2009	[X]
15.107(a) RSS-Gen 7.2.4	Receiver AC power line conducted emission	ANSI C63.4-2009	[X]

5. Test Results

5.1. 20 dB Bandwidth & 99 % Bandwidth

TEST: 20 dB Bandwidth & 99 % Bandwidth		
Method	The transmitter output is connected to the Spectrum analyzer. 20 dB Bandwidth from the EUT was measured under the below setting condition. 1. Set resolution bandwidth (RBW) = 1-5 % of the emission bandwidth (EBW). 2. Set the video bandwidth (VBW) $\geq 3 \times$ RBW. 3. Detector = Peak. 4. Trace mode = max hold. 5. Sweep = auto couple. 7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission. Compare the resultant bandwidth with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is 1-5 %.	
Reference Clause	Part15 Subpart C Section 15.215 (c) RSS-210 A8.2(a)	
Parameters recorded during the test	Laboratory Ambient Temperature	22 °C
	Relative Humidity	36 %
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	13.56 MHz	Antenna port

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
1	1	3
Supplementary information: None		

Limits

According to §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. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of band operation.

5.1.1. Measurement Results

Table 1. Data Table of 20 dB Bandwidth

Environmental condition				Measured Frequency (MHz)	Lower Frequency (MHz)	Upper Frequency (MHz)	20 dB Bandwidth (kHz)	99 % Bandwidth (kHz)
T _{Nom.}	22 °C	V _{NOM}	3.8 Vdc	13.55952	13.55883	13.5603	1.47	1.74

Figure 1. Plots of 20 dB Bandwidth

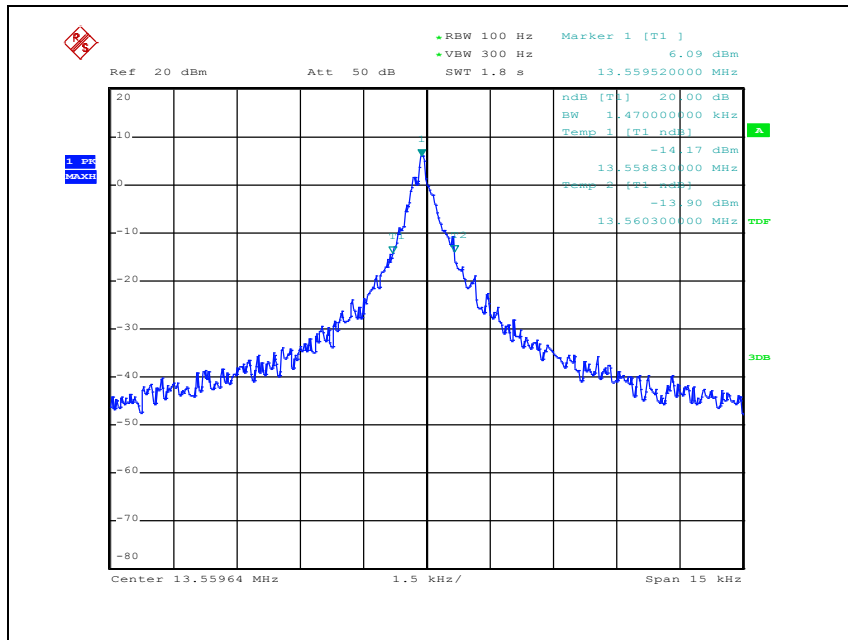
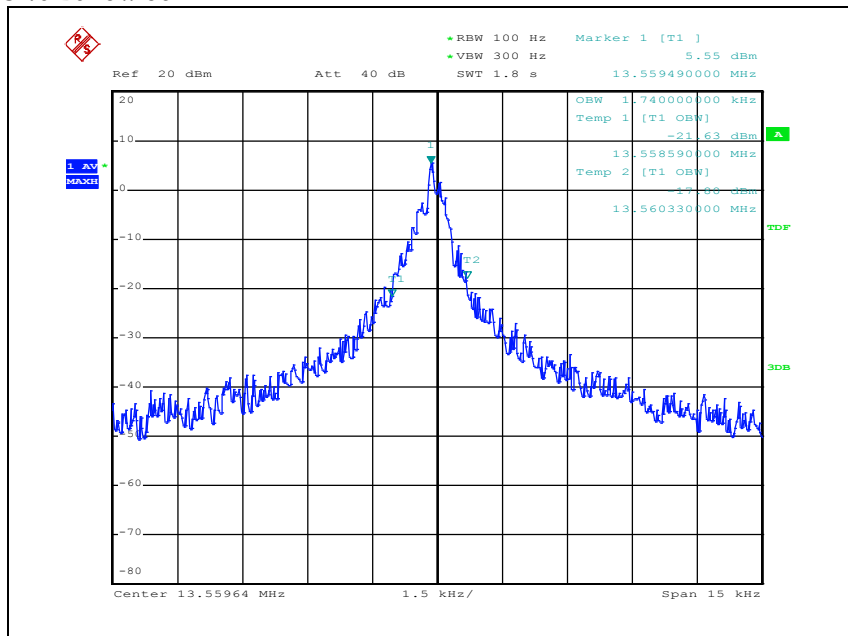


Figure 2. Plots of 99 % Bandwidth



5.2. The field strength of any emission within the band 13.110-14.010 MHz

TEST: The field strength of any emission within the band 13.110-14.010 MHz														
Method	The E-field produced by the equipment shall be measured at standard distance of 10 m. Where this is not practical, e.g. due to physical size of the equipment including the antenna or with use of special field cancelling antenna, then other distances may be used. When another distance is used, the distance used and the field strength value measured shall be stated in the test report. In this case, the measured value at actual test distance shall be extrapolated to 10 m and stated in the test report. The E-field is measured with a shielded loop antenna connected to a measurement receiver. The measuring bandwidth and detector type of the measurement receiver shall be in accordance with the table as below; <table border="1"> <thead> <tr> <th>Frequency (f)</th><th>Detector type</th><th>Bandwidth</th></tr> </thead> <tbody> <tr> <td>$9 \text{ kHz} \leq f < 150 \text{ kHz}$</td><td>Quasi Peak</td><td>200 Hz to 300 Hz</td></tr> <tr> <td>$150 \text{ kHz} \leq f < 30 \text{ MHz}$</td><td>Quasi Peak</td><td>9 kHz to 10 kHz</td></tr> <tr> <td>$30 \text{ MHz} \leq f \leq 1\,000 \text{ MHz}$</td><td>Quasi Peak</td><td>100 kHz to 120 kHz</td></tr> </tbody> </table>		Frequency (f)	Detector type	Bandwidth	$9 \text{ kHz} \leq f < 150 \text{ kHz}$	Quasi Peak	200 Hz to 300 Hz	$150 \text{ kHz} \leq f < 30 \text{ MHz}$	Quasi Peak	9 kHz to 10 kHz	$30 \text{ MHz} \leq f \leq 1\,000 \text{ MHz}$	Quasi Peak	100 kHz to 120 kHz
Frequency (f)	Detector type	Bandwidth												
$9 \text{ kHz} \leq f < 150 \text{ kHz}$	Quasi Peak	200 Hz to 300 Hz												
$150 \text{ kHz} \leq f < 30 \text{ MHz}$	Quasi Peak	9 kHz to 10 kHz												
$30 \text{ MHz} \leq f \leq 1\,000 \text{ MHz}$	Quasi Peak	100 kHz to 120 kHz												
Reference Clause	Part15 Subpart C Section 15.225(a),(b),(c) RSS-210 A2.6													
Parameters recorded during the test	Laboratory Ambient Temperature	22 °C												
	Relative Humidity	36 %												
	Frequency range	Measurement Point												
Fully configured sample scanned over the following frequency range	13.110 – 14.010 MHz	Antenna port												

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
2	1	2
Supplementary information: None		

Limits

According to the Section 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.

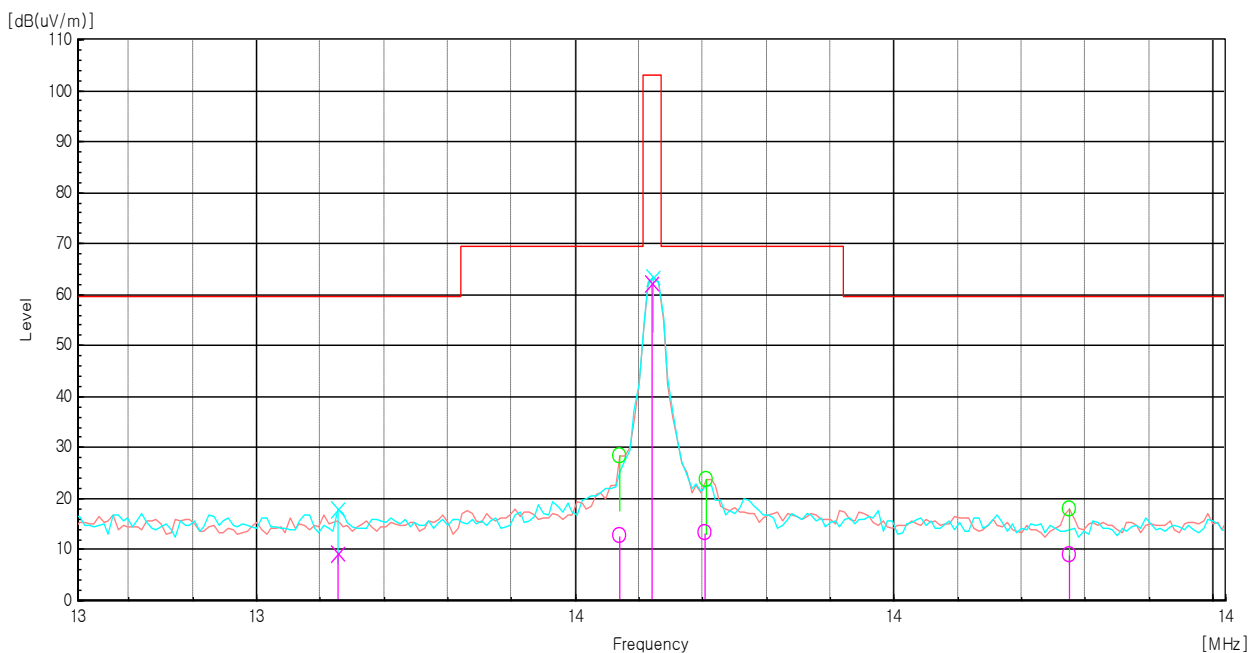
Frequency range (MHz)	E-field strength limit (Ef) dBµV/m at 30 m	E-field strength limit (Ef) dBµV/m at 10 m
13.553–13.567	84.0	103.1 (Note)
13.410 to 13.553 13.567 to 13.710	50.5	69.6 (Note)
13.110 to 13.410 13.710 to 14.010	40.5	59.6 (Note)

Note : According to section 15.31(f)(2), 40 dB/decade is used for the inverse linear distance below 30 MHz.
Limit at 10 m (dBµV/m) = Limit at 30 m (dBµV/m) + 40 log(30/10) (dB)

Measurement Results

Table 2. Data Table of within the band 13.110-14.010 MHz

Radiated emissions				Ant	Correction factors	Limit (dBuV/m)	Total	
Frequency range (MHz)	Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)+ Amp gain+CL (dB)		Actual (dBuV/m)	Margin (dB)
13.110 ~ 13.410	13.314	31.1	Q.P.	V	-21.9	59.6	9.2	50.4
13.410 ~ 13.553	13.535	34.5	Q.P.	H	-21.9	69.6	12.6	57.0
13.553 ~ 13.567	13.560	84.2	Q.P.	V	-21.9	103.1	62.3	40.8
13.567 ~ 13.710	13.602	35.3	Q.P.	H	-21.9	69.6	13.4	56.2
13.710 ~ 14.010	13.887	30.8	Q.P.	H	-21.9	59.6	8.9	50.7



5.3. The field strength of any emission appearing outside of the 13.110-14.010 MHz band

TEST: The field strength of any emission appearing outside of the 13.110-14.010 MHz band														
Method	The E-field produced by the equipment shall be measured at standard distance of 10 m. Where this is not practical, e.g. due to physical size of the equipment including the antenna or with use of special field cancelling antenna, then other distances may be used. When another distance is used, the distance used and the field strength value measured shall be stated in the test report. In this case, the measured value at actual test distance shall be extrapolated to 10 m and stated in the test report. The E-field is measured with a shielded loop antenna connected to a measurement receiver. The measuring bandwidth and detector type of the measurement receiver shall be in accordance with the table as below; <table border="1"> <thead> <tr> <th>Frequency (f)</th><th>Detector type</th><th>Bandwidth</th></tr> </thead> <tbody> <tr> <td>$9 \text{ kHz} \leq f < 150 \text{ kHz}$</td><td>Quasi Peak</td><td>200 Hz to 300 Hz</td></tr> <tr> <td>$150 \text{ kHz} \leq f < 30 \text{ MHz}$</td><td>Quasi Peak</td><td>9 kHz to 10 kHz</td></tr> <tr> <td>$30 \text{ MHz} \leq f \leq 1\,000 \text{ MHz}$</td><td>Quasi Peak</td><td>100 kHz to 120 kHz</td></tr> </tbody> </table>		Frequency (f)	Detector type	Bandwidth	$9 \text{ kHz} \leq f < 150 \text{ kHz}$	Quasi Peak	200 Hz to 300 Hz	$150 \text{ kHz} \leq f < 30 \text{ MHz}$	Quasi Peak	9 kHz to 10 kHz	$30 \text{ MHz} \leq f \leq 1\,000 \text{ MHz}$	Quasi Peak	100 kHz to 120 kHz
Frequency (f)	Detector type	Bandwidth												
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$30 \text{ MHz} \leq f \leq 1\,000 \text{ MHz}$	Quasi Peak	100 kHz to 120 kHz												
Reference Clause	Part15 Subpart C Section 15.225(d) RSS-210 A2.6													
Parameters recorded during the test	Laboratory Ambient Temperature	22 °C												
	Relative Humidity	36 %												
	Frequency range	Measurement Point												
Fully configured sample scanned over the following frequency range	9 kHz ~ 30 MHz	Antenna port												

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
2	1	2
Supplementary information: None		

Limits

According to the Section 15.225,

(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..

Frequency range (MHz)	E-field strength limit (Ef) $\mu\text{V/m}$	E-field strength limit (Ef) $\text{dB}\mu\text{V/m}$ at 10 m
0.009 to 0.150	$2400/F(\text{kHz})$ at 300 m	107.6 to 83.2
0.150 to 0.490	$2400/F(\text{kHz})$ at 300 m	83.2 to 72.9
0.490 to 1.705	$24000/F(\text{kHz})$ at 30 m	92.9 to 82.1
1.705 to 30	30 at 30 m	88.6

Note : According to section 15.31(f)(2), 40 dB/decade is used for the inverse linear distance below 30 MHz.

Limit at 10 m (dB $\mu\text{V/m}$) = Limit at 300 m (dB $\mu\text{V/m}$) + 40 log(300/10) (dB)

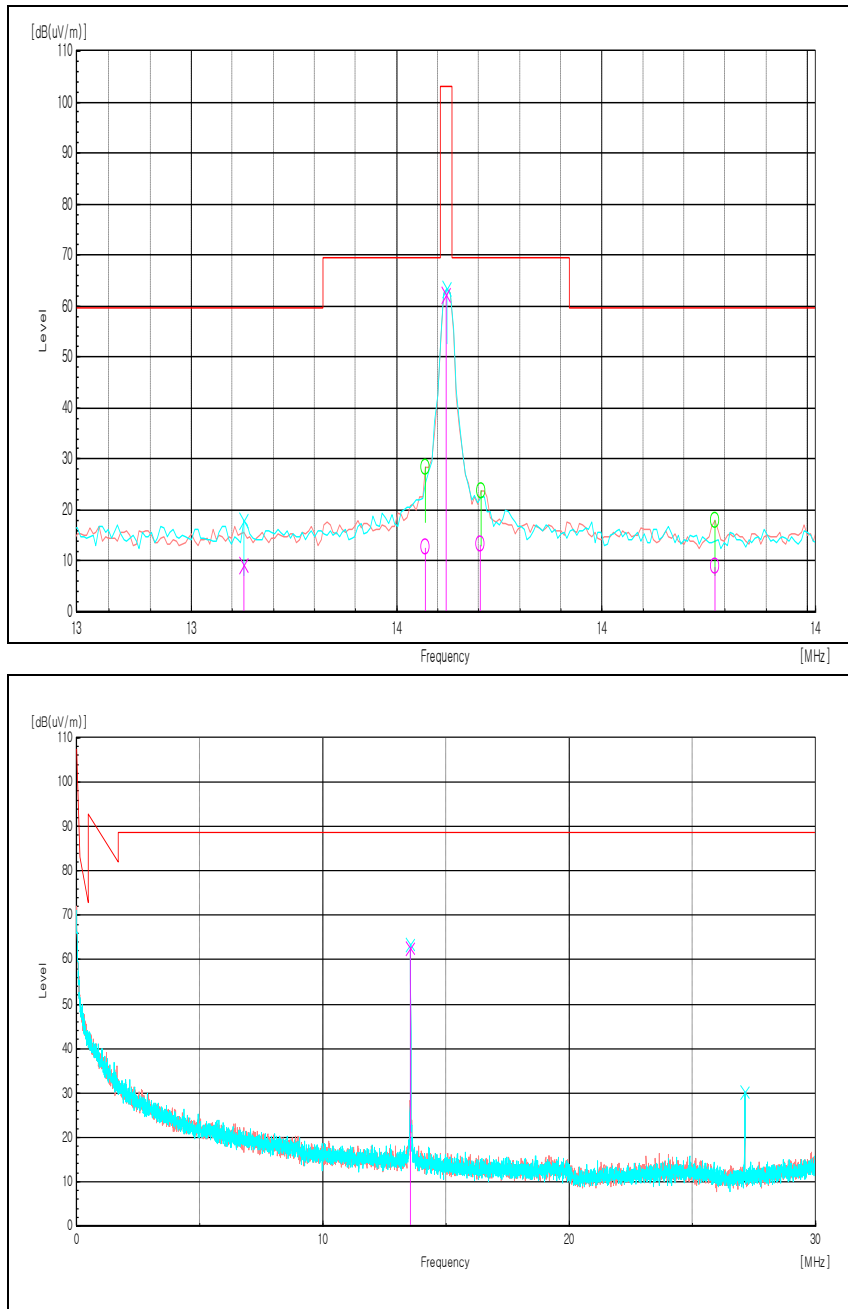
Limit at 10 m (dB $\mu\text{V/m}$) = Limit at 30 m (dB $\mu\text{V/m}$) + 40 log(30/10) (dB)

Measurement Result

Table 3. Data Table of The field strength of any emission appearing outside of the 13.110-14.010 MHz band

Radiated emissions				Ant	Correction factors	Limit (dBuV/m)	Total	
Frequency range (MHz)	Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)+ Amp gain+CL (dB)		Actual (dBuV/m)	Margin (dB)
0.009 ~ 0.150	-	-	Q.P.	-	-	-	-	-
0.150 ~ 0.490	-	-	Q.P.	-	-	-	-	-
0.490 ~ 1.705	-	-	Q.P.	-	-	-	-	-
1.705 ~ 13.110	-	-	Q.P.	-	-	-	-	-
14.010 ~ 30	27.121	53.8	Q.P.	V	-23.9	88.6	29.9	58.7

Figure 3. The field strength of any emission appearing outside of the 13.110-14.010 MHz band



5.4. The frequency tolerance of the carrier signal

TEST: The frequency tolerance of the carrier signal		
Method	1. The RF signal from the signal generator(s) was injected to the EUT and the amplified RF signal at the output of the EUT was connected to the CW Microwave Frequency Counter. The test was performed at frequency using all applicable un-modulation. 2. The EUT was placed inside the temperature chamber. 3. After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the counter.	
Reference Clause	Part15 Subpart C Section 15.225(e) RSS-210 A2.6	
Parameters recorded during the test	Laboratory Ambient Temperature	22 °C
	Relative Humidity	36 %
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	13.56 MHz	Antenna port

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
1, 3, 4	2	3
Supplementary information: None		

Limits

According to the Section 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.

Measurement Results

Table 4. Test Result

Frequency Stability versus Temperature				
Environment Temperature (°C)	Power Supplied (Vdc)	Frequency Measure with Time Elapse		
		Measured Frequency (MHz)	Frequency Error (Hz)	%
50	3.8	13.559810	0.0002	-0.001
40		13.559890	0.0001	-0.001
30		13.559887	0.0001	-0.001
20		13.559847	0.0002	-0.001
10		13.559824	0.0002	-0.001
0		13.559815	0.0002	-0.001
-10		13.559889	0.0001	-0.001
-20		13.559848	0.0002	-0.001
Frequency Stability versus power Supply				
Environment Temperature (°C)	Power Supplied (Vdc)	Frequency Measure with Time Elapse		
		Measured Frequency (MHz)	Frequency Error (Hz)	%
24	4.3	13.559878	0.0001	-0.001
	3.8	13.559850	0.0001	-0.001
	3.2	13.559862	0.0001	-0.001

Supplementary information:

The percent of the reference frequency (%) = (Measured frequency – Reference frequency) / Reference frequency

5.5. Radiated Spurious Emissions Measurement

TEST: Radiated spurious emissions measurement		
Method	Radiated emissions from the EUT were measured according to ANSI C63.4 procedure. 1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation. The antenna is varied from 1 to 4 meters above the ground to find the maximum field strength. Measurement are made with both horizontal and vertical polarizations For fundamental investigation, the EUT was positioned for 3 orthogonal orientations. 2. For measurement below 1GHz, the resolution bandwidth is set to 100 kHz for peak detection or 120kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.	
Reference Clause	Part15 Subpart C Section 15.209(a) RSS-Gen 7.2.5	
Parameters recorded during the test	Laboratory Ambient Temperature	22 °C
	Relative Humidity	36 %
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30 MHz – 1 GHz	3 meter chamber

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
2	1	2
Supplementary information: None		

Limits

According to § 15.209(a), the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Distance (meters)	Field Strength (dBuV/m)	Field Strength (uV/m)
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

Measurement Results

Table 5. Test Result

Radiated emissions			Ant	Correction factors	Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)+ Amp gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
67.830	42.3	QP	V	-15.3	27.0	40.0	13.0
92.908	38.1	QP	V	-19.2	18.9	43.5	24.6
325.365	43.1	QP	H	-11.3	31.8	46.0	14.2
433.924	41.4	QP	H	-8.5	32.9	46.0	13.1

Supplementary information:

- The frequency spectrum from 30 MHz to 1 000 MHz was investigated. Emission levels of 30 dB below than the limit is not reported.
- The worst case is x-axis and reported.
- Actual = Reading + AF + CL (AF : Antenna factor, CL : Cable loss)
- Distance factor = $20\log(\text{Measurement distance} / \text{The measured distance})$
- Margin = Limit (dBuV/m) - Actual (dBuV/m)

5.6. Receiver radiated spurious emissions

TEST: Receiver radiated spurious emissions		
Method	Radiated emissions from the EUT were measured according to ANSI C63.4 procedure. 1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation. The antenna is varied from 1 to 4 meters above the ground to find the maximum field strength. Measurement are made with both horizontal and vertical polarizations For fundamental investigation, the EUT was positioned for 3 orthogonal orientations. 2. For measurement below 1GHz, the resolution bandwidth is set to 100 kHz for peak detection or 120kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.	
Reference Clause	Part15 Subpart B Section 15.109(a) RSS-Gen 6.1	
Parameters recorded during the test	Laboratory Ambient Temperature	22 °C
	Relative Humidity	36 %
	Frequency range	Measurement Point
Fully configured sample scanned over the following frequency range	30 MHz – 1 GHz	3 meter chamber

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
2	3	2
Supplementary information: None		

Limits

According to § 15.109(a), Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency (MHz)	Distance (meters)	Field Strength (dBuV/m)	Field Strength (uV/m)
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

Measurement Results

Table 6. Test Result

Radiated emissions			Ant	Correction factors	Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)+ Amp gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
85.959	21.2	QP	V	-19.0	2.2	40.0	37.8

Supplementary information:

- The frequency spectrum from 30 MHz to 1 000 MHz was investigated. Emission levels of 30 dB below than the limit is not reported.
- The worst case is x-axis and reported.
- Actual = Reading + AF + CL (AF : Antenna factor, CL : Cable loss)
- Distance factor = $20\log(\text{Measurement distance} / \text{The measured distance})$
- Margin = Limit (dBuV/m) - Actual (dBuV/m)

5.7. Transmitter AC Power Line Conducted Emission

TEST: Transmitter AC Power Line Conducted Emission		
Method	AC line conducted emissions from the EUT were measured according to the dictates of ANSI C63.4-2003. 1. The test procedure is performed in a 5.05m × 4.0m× 3.0m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m(W)× 1.5 m(L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane. 2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room. 3. The excess power cable between the EUT and the LISN was bundled. All connecting cables of EUT were moved to find the maximum emission.	
Basic Standard	Part15 Subpart C Section 15.207(a) RSS-Gen 7.2.4	
Parameters recorded during the test	Laboratory Ambient Temperature	22°C
	Relative Humidity	46%
-	Frequency range on each side of line	Measurement Point
Fully configured sample scanned over the following frequency range	150 kHz to 30 MHz	A.C. Input port of A.C. to D.C. adapter.

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
2	1	1
Supplementary information: None		

Limits

According to §15.207(a) 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 uH/50 ohm line impedance stabilization network (LISN).

Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted limit (dB µV)	
	Quasi-peak	Average
0.15 – 0.5	66 - 56*	56 - 46*
0.5 – 5	56	46
5 – 30	60	50

* Decreases with the logarithm of the frequency.

Measurement Results

5.7.1. Test data for conducted emission_with Antenna

Frequency [MHz]	Correction		Line	Quasi-peak				Average			
	Factor			Limit [dBuV]	Reading [dBuV]	Result [dBuV]	Margin [dB]	Limit [dBuV]	Reading [dBuV]	Result [dBuV]	Margin [dB]
	LISN	Cable									
0.189	9.85	0.04	N	64.08	45.25	55.14	8.94	54.08	30.57	40.46	13.62
0.195	9.85	0.04	H	63.82	45.14	55.03	8.79	53.82	32.36	42.25	11.57
0.273	9.85	0.04	N	61.03	38.39	48.28	12.75	51.03	26.20	36.09	14.94
0.276	9.90	0.04	H	60.94	39.15	49.09	11.85	50.94	22.59	32.53	18.41
0.339	9.90	0.04	N	59.23	36.48	46.42	12.81	49.23	22.93	32.87	16.36
0.453	9.96	0.05	H	56.82	33.14	43.15	13.67	46.82	18.82	28.83	17.99
2.391	9.67	0.05	H	56.00	24.19	33.91	22.09	46.00	8.92	18.64	27.36
2.793	9.66	0.06	N		25.30	35.02	20.98		9.82	19.54	26.46
4.630	9.64	0.08	H		23.07	32.79	23.21		9.59	19.31	26.69
21.980	9.74	0.14	N	60.00	29.43	39.31	20.69	50.00	22.38	32.26	17.74
27.120	9.73	0.15	N		33.51	43.39	16.61		30.90	40.78	9.22

<Note>

1. Margin(dB) = Limit(dBuV) - Level(dBuV)

5.7.2. Test data for conducted emission_with dummy load

Frequency [MHz]	Correction Factor		Line	Quasi-peak				Average			
				Limit	Reading	Result	Margin	Limit	Reading	Result	Margin
	LISN	Cable		[dBuV]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dB]
0.189	9.90	0.07	N	64.08	47.97	57.94	6.14	54.08	32.64	42.61	11.47
0.192	9.91	0.07	H	63.95	50.69	60.67	3.28	53.95	35.96	45.94	8.01
0.252	9.90	0.07	N	61.69	39.38	49.35	12.34	51.69	25.34	35.31	16.38
0.258	9.91	0.07	H	61.50	41.21	51.19	10.31	51.50	28.74	38.72	12.78
0.402	10.02	0.07	N	57.81	32.58	42.67	15.14	47.81	18.70	28.79	19.02
0.507	9.94	0.07	N	56.00	28.99	39.00	17.00	46.00	9.76	19.77	26.23
0.618	9.94	0.07	N		24.69	34.70	21.30		6.45	16.46	29.54
1.023	9.96	0.07	H		24.01	34.04	21.96		8.70	18.73	27.27
2.685	9.95	0.10	N		25.83	35.88	20.12		10.42	20.47	25.53
2.757	9.96	0.10	H		23.99	34.05	21.95		10.31	20.37	25.63
5.390	9.98	0.11	N	60.00	21.97	32.06	27.94	50.00	8.55	18.64	31.36
7.270	10.08	0.14	N		20.56	30.78	29.22		9.24	19.46	30.54
13.530	10.51	0.18	H		26.05	36.74	23.26		22.90	33.59	16.41
13.560	10.41	0.18	N		26.83	37.42	22.58		23.20	33.79	16.21

<Note>

1. Margin(dB) = Limit(dBuV) - Level(dBuV)

Figure 4. Graphical representation of Conducted Emission_with Antenna

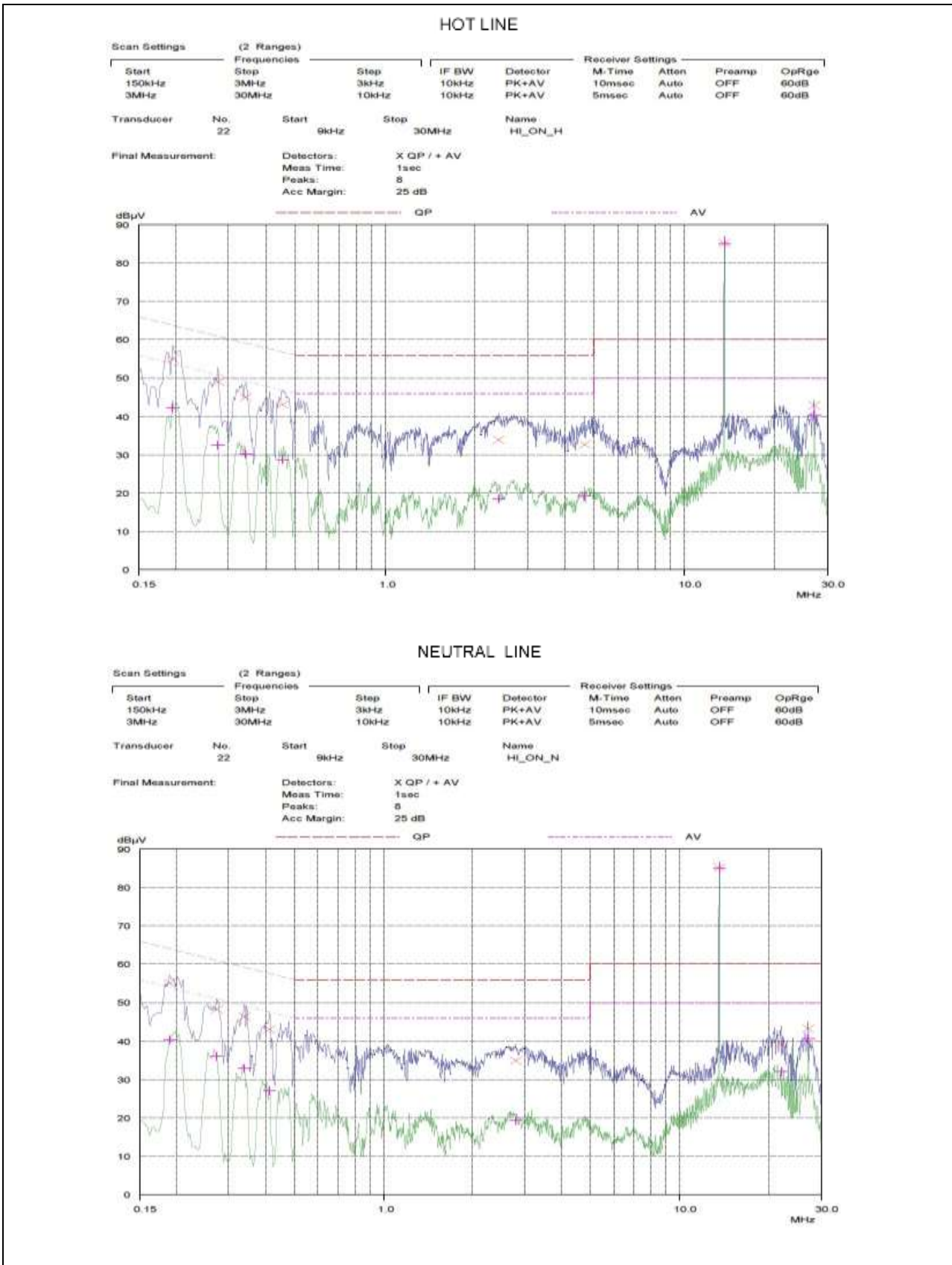
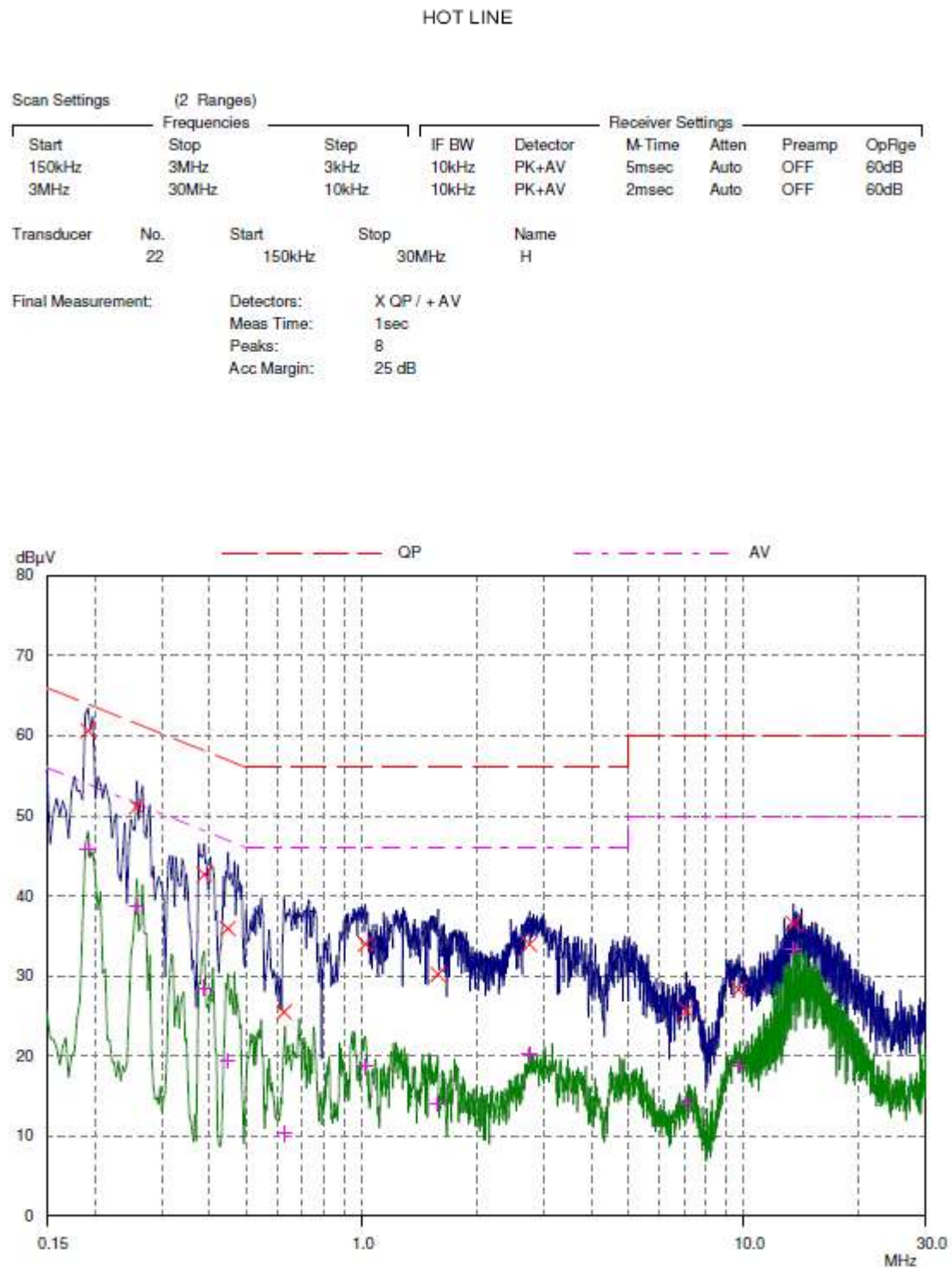
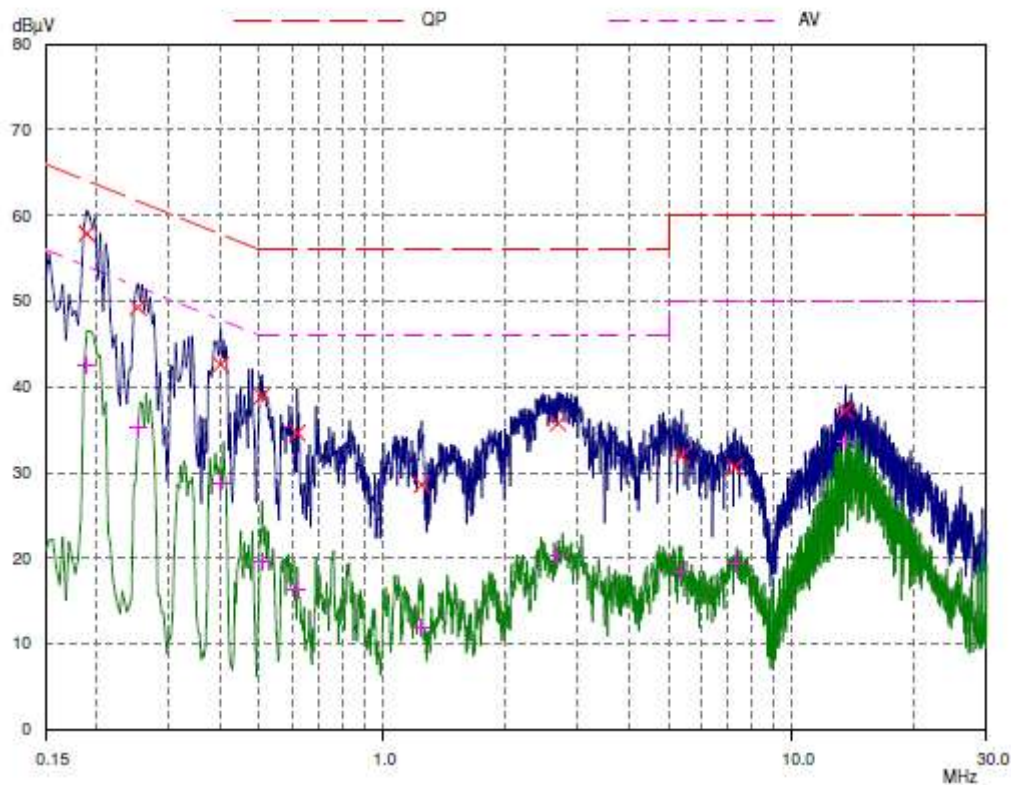


Figure 5. Graphical representation of Conducted Emission_with dummy load



NEUTRAL LINE

Scan Settings		(2 Ranges)							
		Frequencies				Receiver Settings			
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge	
150kHz	3MHz	3kHz	10kHz	PK+AV	5msec	Auto	OFF	60dB	
3MHz	30MHz	10kHz	10kHz	PK+AV	2msec	Auto	OFF	60dB	
Transducer	No.	Start	Stop	Name					
	22	150kHz	30MHz	N					
Final Measurement:		Detectors:	X QP / + AV						
		Meas Time:	1sec						
		Peaks:	8						
		Acc Margin:	25 dB						



5.8. Receiver AC Power Line Conducted Emission

TEST: Receiver AC Power Line Conducted Emission		
Method	AC line conducted emissions from the EUT were measured according to the dictates of ANSI C63.4-2003. 1. The test procedure is performed in a 5.05m × 4.0m× 3.0m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m(W)× 1.5 m(L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane. 2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room. 3. The excess power cable between the EUT and the LISN was bundled. All connecting cables of EUT were moved to find the maximum emission.	
Basic Standard	Part15 Subpart C Section 15.107(a) RSS-Gen 7.2.4	
Parameters recorded during the test	Laboratory Ambient Temperature	22°C
	Relative Humidity	46%
-	Frequency range on each side of line	Measurement Point
Fully configured sample scanned over the following frequency range	150 kHz to 30 MHz	A.C. Input port of A.C. to D.C. adapter.

Configuration Settings

Power Interface Mode # (See Section 3.3)	EUT Operation Mode # (See Section 3.5)	Test Configurations Mode # (See Section 3.7)
2	3	1
Supplementary information: None		

Limits

According to §15.107, (a) Except for Class A digital devices, for equipment 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 of Emission (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15 – 0.5	66 - 56*	56 - 46*
0.5 – 5	56	46
5 – 30	60	50

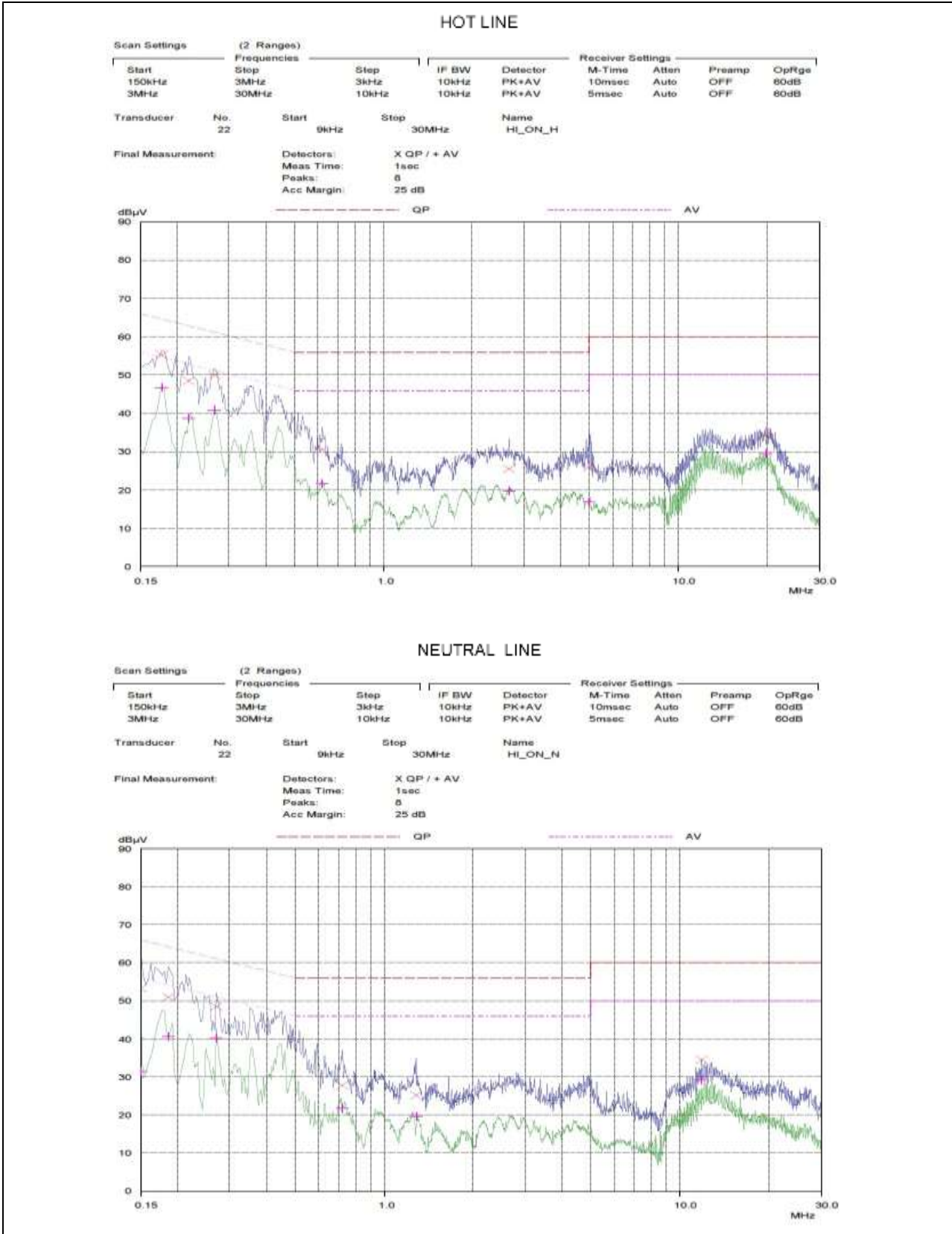
* Decreases with the logarithm of the frequency.

Measurement Results

5.8.1. Test data for conducted emission

Frequency [MHz]	Correction Factor		Line	Quasi-peak				Average			
				Limit	Reading	Result	Margin	Limit	Reading	Result	Margin
	LISN	Cable		[dBuV]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dB]
0.150	9.83	0.03	N	66.00	43.47	53.33	12.67	56.00	21.57	31.43	24.57
0.177	9.85	0.04	H	64.63	45.43	55.32	9.31	54.63	36.84	46.73	7.90
0.267	9.85	0.04	H	61.21	40.12	50.01	11.20	51.21	30.98	40.87	10.34
0.270	9.85	0.04	N	61.12	38.66	48.55	12.57	51.12	30.35	40.24	10.88
0.621	9.96	0.05	H	56.00	20.57	30.57	25.44	46.00	11.77	21.77	24.24
0.720	9.91	0.04	N		17.86	27.81	28.19	46.00	11.83	21.78	24.22
4.960	9.64	0.08	H		16.23	25.95	30.05	46.00	7.25	16.97	29.03
11.840	9.68	0.11	N	60.00	24.84	34.63	25.37	50.00	19.41	29.20	20.80
19.730	9.66	0.14	H		24.64	34.44	25.56	50.00	10.07	19.87	30.13

Figure 6. Graphical representation of Conducted Emission



APPENDIX A. Accreditations and Authorizations

EMC Compliance Ltd. has been accredited / filed / authorized by the agencies listed in the following table;

Certificate	Nation	Agency	Code	Mark
Accreditation	Korea	KOLAS	No. 231	ISO/IEC 17025
Site Filing	USA	FCC	508785	Test Facility list & NSA Data
	Japan	VCCI	C-1713 R-1606 T-258	Test Facility list & NSA Data
Certification	Korea	KC	KR0040	Test Facility list & NSA Data

Quality control in the testing laboratory is implemented as per ISO/IEC 17025 which is the “General requirements for the competent of calibration and testing laboratory”.