

TEST REPORT

Part 15 Subpart C 15.249

Equipment under test Wall Controller

Model name WCRF-SKUS

FCC ID TSW-WCRFSKUS

Applicant Samjin LND

Manufacturer Samjin LND

Date of test(s) 2014.03.07 ~2014.03.20

Date of issue 2014.04.04

Issued to



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Revision history

Revision	Date of issue	Test report No.	Description
-	2014.04.04	KES-RF-14T0017	Initial



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1. General information

1.1. EUT description

Equipment under test	Wall Controller
Model name	WCRF-SKUS
Serial number	N/A
Frequency range	917.1 MHz ~ 923.3 MHz
Modulation technique	FSK
Number of channels	32
Antenna type & gain	Fixed type(Monopole antenna) // 0.5 dBi
Power source	Power Adapter (AC 100-240 V 50/60 Hz // DC 24 V)

1.2. Test frequency

- 802.11b/g/n HT20

	Low channel	Middle channel	High channel
Frequency (MHz)	917.1	920.3	923.3

1.3. Information about derivative model

N/A

1.4. Device modifications

N/A

1.5. Device information

- The device duty cycle \geq 98 percent

1.6. Test facility

C-3701, Simin-daero 365-40, Dongan-gu, Anyang-si, Gyeonggi-do, 431-716, Korea
473-29, Gayeo-ro, Yeosu-si, Gyeonggi-do, Korea

The open area test site is constructed in conformance with the requirements ANSI C63.4-2003/2009.

1.7. Laboratory accreditations and listings

Country	Agency	Scope of accreditation	Certificate No.
USA	FCC	3 & 10 meter Open Area Test Sites and one conducted site to perform FCC Part 15/18 measurements.	343818
KOREA	KC	EMI (10 meter Open Area Test Site and two conducted sites) Radio (3 & 10 meter Open Area Test Sites and one conducted site)	KR0100
CANADA	IC	3 & 10 meter Open Area Test Sites and one conducted site	4769B-1

2. Summary of tests

Reference	Parameter	Test results
15.249(a)	Field strength of fundamental	Pass
15.205 15.209 15.249(d)	Radiated spurious emission, Out-of-band emission	Pass
15.215(c)	20 dB bandwidth	Pass
15.207	AC conducted emissions	Pass

Test procedures;

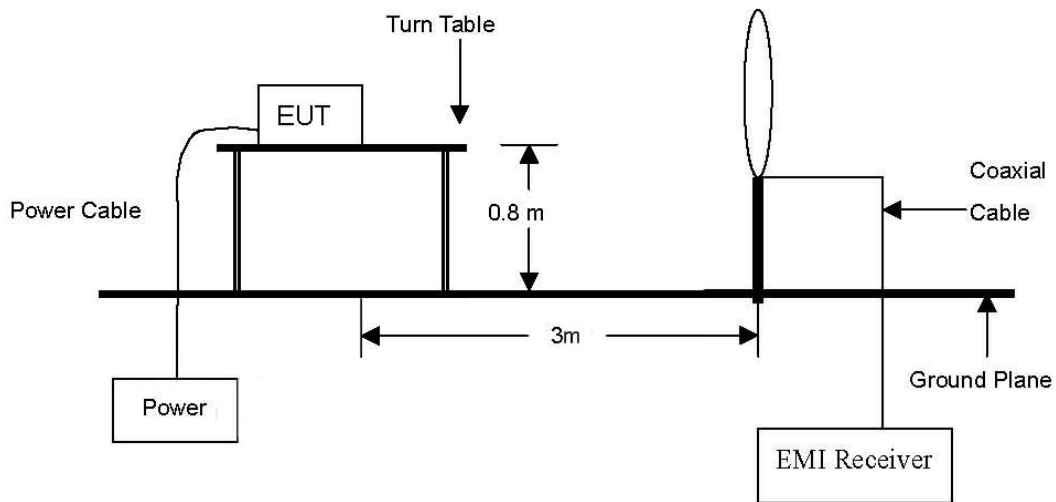
The measurement procedures described in the American National Standard for Methods of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2003/2009) were used in the measurement of the EUT.

3. Test results

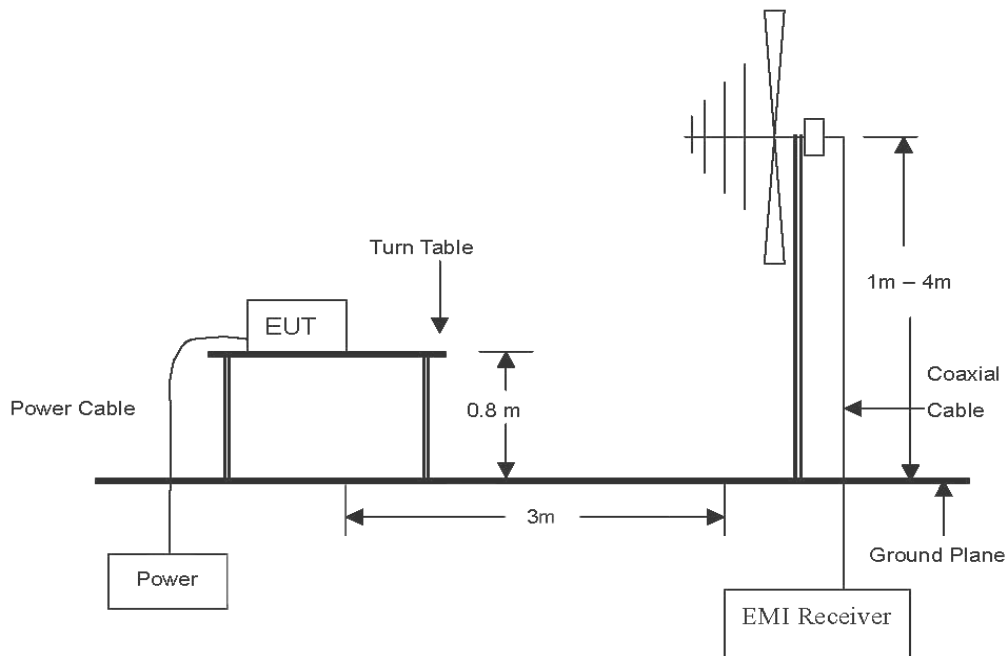
3.1 Field strength of fundamental & Radiated spurious emission & Out-of-band emission

Test setup

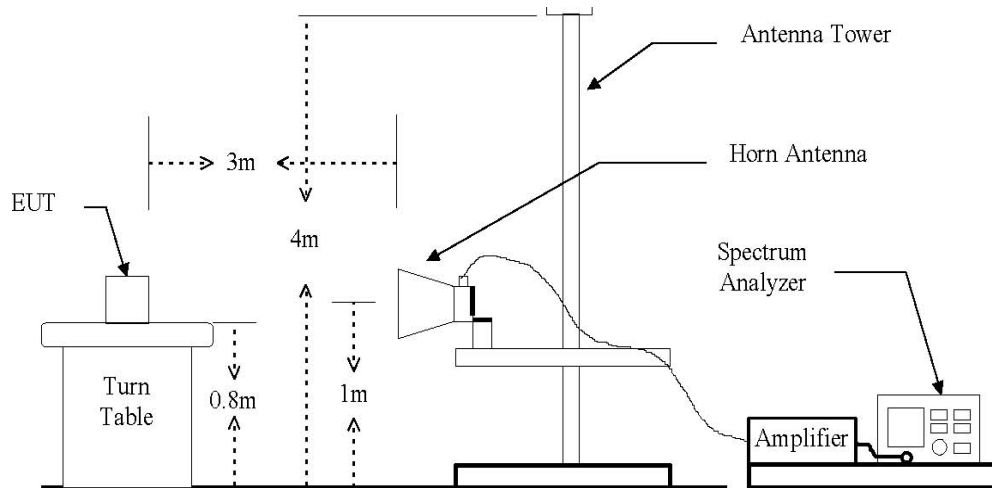
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 GHz to 40 GHz emissions.



Test procedure

Radiated emissions from the EUT were measured according to the dictates in section 8 & 13 of ANSI C63.4-2009

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 or open area test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 3 meter away from the interference receiving antenna.
3. The antenna is a broadband antenna, and its height is varied from 1 meter to 4 meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test receiver system was set to peak detect function and specified bandwidth with maximum hold mode.
6. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be retested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet

Note.

The spectrum analyzer is set to:

[9 kHz to 30 MHz]

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 200 Hz for Quasi-peak detection (QP) at frequency below 9 kHz~ 150 kHz.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 9 kHz for Quasi-peak detection (QP) at frequency below 150 kHz~ 30 MHz.

[30 MHz to 1 GHz and 1 GHz to 10 GHz]

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 120 kHz for Peak detection (PK) or Quasi-peak detection (QP) at frequency below 1 GHz.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz and video bandwidth is 1 MHz for Peak detection at frequency above 1 GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 10 Hz for Average detection (AV) at frequency above 1 GHz.

To get a maximum emission level from the EUT, the EUT is manipulated through three orthogonal planes.

Limit

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values :

Frequency (MHz)	Distance (Meters)	Radiated ($\mu\text{V/m}$)
0.009 ~ 0.490	300	2 400 / F(kHz)
0.490 ~ 1.705	30	24 000 / F(kHz)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**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., Sections 15.231 and 15.241.

According to 15.249(a)

Fundamental frequency	Field strength of fundamental		Field strength of harmonics	
	mV/m	dBuV/m	uV/m	dBuV/m
902-928 MHz	50	94	500	54
2400-2483.5 MHz	50	94	500	54
5725-5875 MHz	50	94	500	54
24.0-24.25 GHz	250	108	2500	68

According to 15.249(d)

Emission radiated outside of the specified frequency bands, except harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated limit in FCC part 15C, Section 15.209, whichever is the lesser attenuation.

Test result (Fundamental)

Low Channel

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (MHz)	Reading (dB μ V)	Detect	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
917.08	60.82	QP	H	23.57	8.42	92.81	94	1.19
917.08	52.07	QP	V	23.57	8.42	84.06	94	9.94

Middle Channel

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (MHz)	Reading (dB μ V)	Detect	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
920.29	60.60	QP	H	23.65	8.43	92.68	94	1.32
920.28	52.10	QP	V	23.65	8.43	84.18	94	9.82

High Channel

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (MHz)	Reading (dB μ V)	Detect	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
923.32	60.17	QP	H	23.73	8.45	92.35	94	1.65
923.31	51.94	QP	V	23.73	8.45	84.12	94	9.88

1. Radiated emissions measured in fundamental frequency were made with an instrument using Quasi peak detector mode.
2. Actual = Reading + Ant. factor + Cable loss
3. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

Test results (Spurious emission Below 30 MHz)

The frequency spectrum from 9 kHz to 30 MHz was investigated. Emission levels are not reported much lower than the limits by over 20 dB.

Radiated emissions		Ant.	Correction factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	F _d (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Not detected for above 30 MHz								

Note.

1. All spurious emission at channels are almost the same below 30 MHz, so that high channel was chosen at representative in final test.
2. Actual = Reading + Ant. factor + Cable loss + F_d
3. $F_d = 40 \log(D_m / D_s)$

Where:

- F_d = Distance factor in dB
D_m = Measurement distance in meters
D_s = Specification distance in meters

Test results (Spurious emission Below 1 000 MHz)

The frequency spectrum from 30 MHz to 1 000 MHz was investigated.

Low Channel

Radiated emissions		Ant.	Correction factors		Total	Limit	
Frequency (MHz)	Reading (dBμV)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
59.1	19.99	V	13.18	1.39	34.56	40.0	5.44
76.1	21.67	V	10.10	1.62	33.39	40.0	6.61
219.2	17.02	H	10.60	3.23	30.85	46.0	15.15
495.8	18.97	H	17.66	5.57	42.20	46.0	3.80
505.3	17.43	H	17.85	5.63	40.91	46.0	5.09

Middle Channel

Radiated emissions		Ant.	Correction factors		Total	Limit	
Frequency (MHz)	Reading (dBμV)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
59.1	19.85	V	13.18	1.39	34.42	40.0	5.58
76.1	23.29	V	10.10	1.62	35.01	40.0	4.99
219.2	17.70	H	10.60	3.23	31.53	46.0	14.47
495.6	18.83	H	17.65	5.57	42.05	46.0	3.95
512.6	17.21	H	17.98	5.66	40.85	46.0	5.15

High Channel

Radiated emissions		Ant.	Correction factors		Total	Limit	
Frequency (MHz)	Reading (dBμV)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
59.1	19.50	V	13.18	1.39	34.07	40.0	5.93
68.8	21.58	V	11.81	1.54	34.93	40.0	5.07
216.7	18.33	H	10.50	3.21	32.04	46.0	13.96
495.6	18.43	H	17.65	5.57	41.65	46.0	4.53
505.3	15.89	H	17.85	5.63	39.37	46.0	6.63

※ Remark

1. Actual = Reading + Ant. factor + Cable loss
2. Detector mode: Quasi peak
3. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

Test results (Spurious emission Above 1 000 MHz)

The frequency spectrum from 1 GHz to 10 GHz was investigated.

Low channel

Radiated emissions			Ant.	Correction factors	Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detector mode	Pol.	AFCL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 192.8	42.89	PK	H	-5.58	37.31	74.00	36.69
1 121.3	42.08	PK	V	-6.33	35.75	74.00	38.25
1 834.2	39.37	PK	H	1.04	40.41	74.00	33.59
1 834.8	40.72	PK	V	1.05	41.77	74.00	32.23

Middle channel

Radiated emissions			Ant.	Correction factors	Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detector mode	Pol.	AFCL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 193.1	43.11	PK	H	-5.58	37.53	74.00	36.47
1 120.9	42.59	PK	V	-6.33	36.26	74.00	37.74
1 834.5	39.79	PK	H	1.04	40.83	74.00	33.17
1 834.7	40.30	PK	V	1.05	41.35	74.00	32.65

High channel

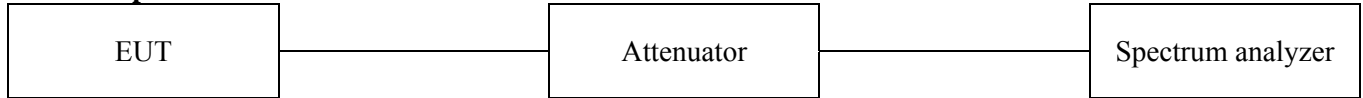
Radiated emissions			Ant.	Correction factors	Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detector mode	Pol.	AFCL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 192.6	42.87	PK	H	-5.58	37.29	74.00	36.71
1 121.1	42.72	PK	V	-6.33	36.39	74.00	37.61
1 833.8	40.15	PK	H	1.04	41.19	74.00	32.81
1 834.4	39.98	PK	V	1.05	41.03	74.00	32.97

※ Remark

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Radiated emissions measured in frequency above 1 000 MHz were made with an instrument using peak/average detector mode.
3. Average test would be performed if the peak result were greater than the average limit.
4. Actual = Reading + AFCL(Ant. factor – Amp. gain + Cable loss)
5. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

3.2 20 dB bandwidth

Test setup



Test procedure

1. Use the following spectrum analyzer setting
Center frequency: Lowest, middle and highest channels
RBW = 1 kHz
VBW = 3 kHz ($\geq 3 \times \text{RBW}$)
Sweep = auto
Detector function = peak
Trace = max hold
2. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

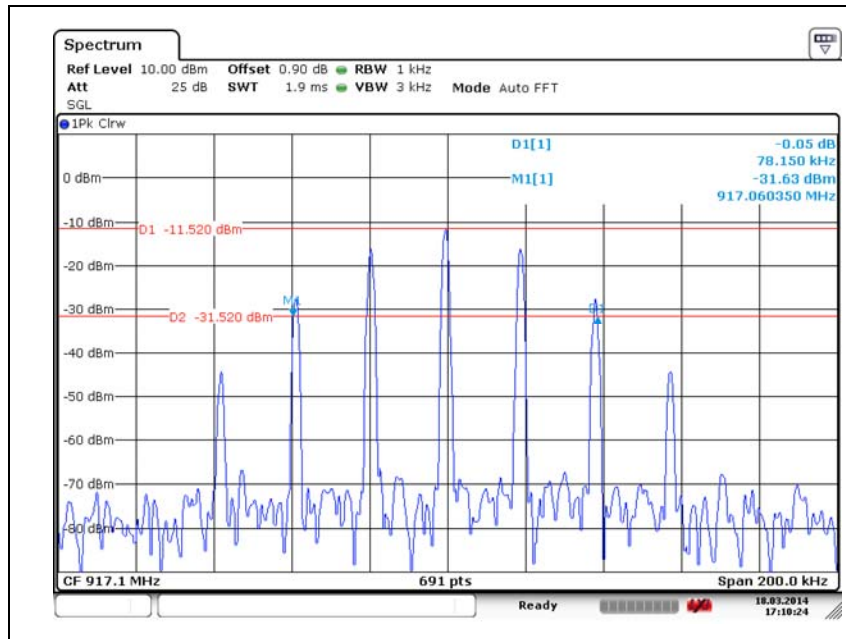
Limit

Not applicable

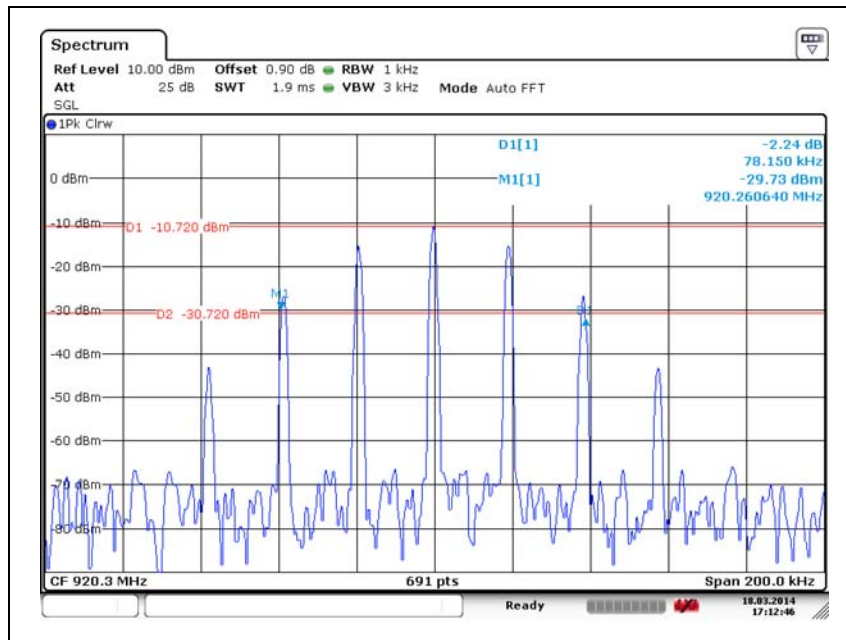
Test results

Operation mode	Frequency(MHz)	20 dB bandwidth(MHz)	Limit
Transmission	917.1	0.078	-
	920.3	0.078	-
	923.3	0.078	-

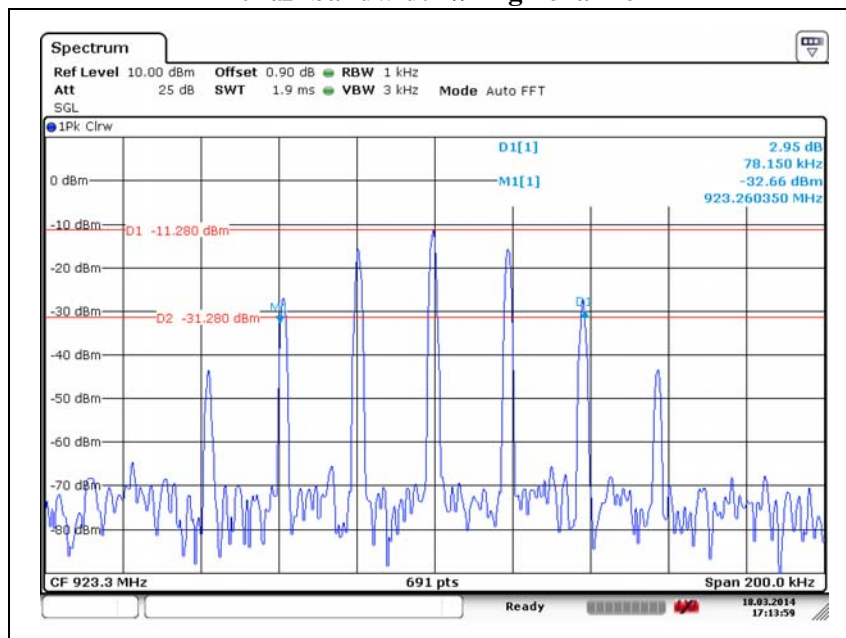
20 dB bandwidth // Low channel



20 dB bandwidth // Middle channel



20 dB bandwidth // High channel



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3.3. AC conducted emissions

Frequency range of measurement

150 kHz to 30 MHz

Instrument settings

IF Band Width: 9 kHz

Test procedures

The EUT was placed on a non-metallic table 0.8m above the metallic, grounded floor and 0.4m from the reference ground plane wall. The distance to other metallic surfaces was at least 0.8m. Amplitude measurements were performed with a quasi-peak detector and an average detector.

Limit

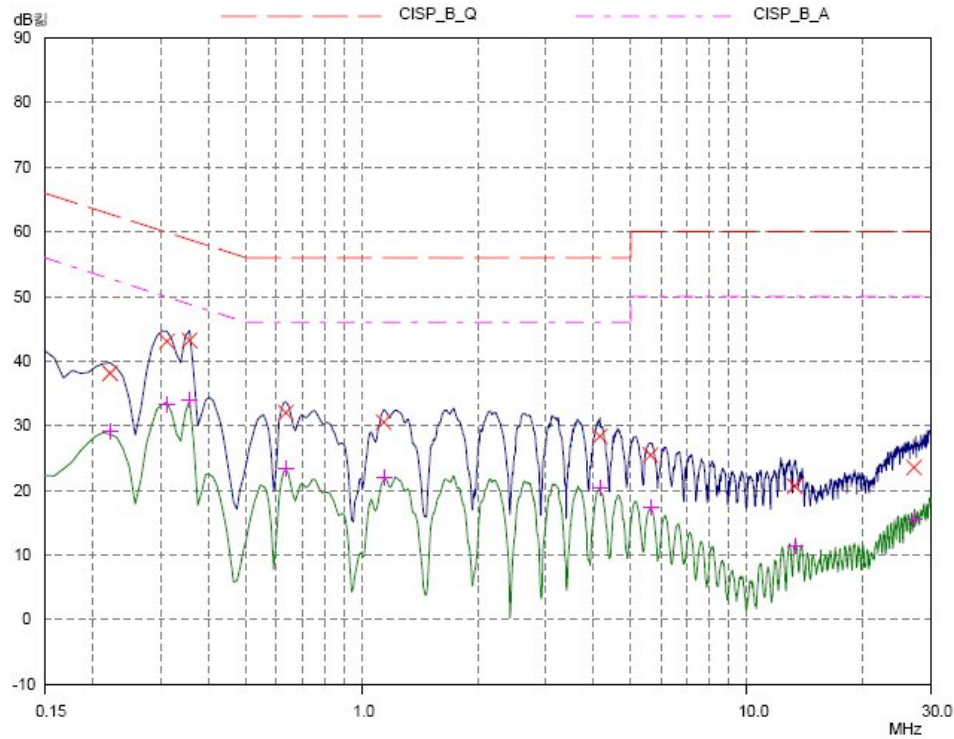
According to 15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50uH/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 frequencies ranges.

Frequency of Emission (MHz)	Conducted limit (dBμV/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

Note.

- Decreases with the logarithm of the frequency.
- Worst case configuration: 802.11 g
- All AC Conducted emission at channels are almost the same, so that high channel was chosen at representative in final test.

Test results



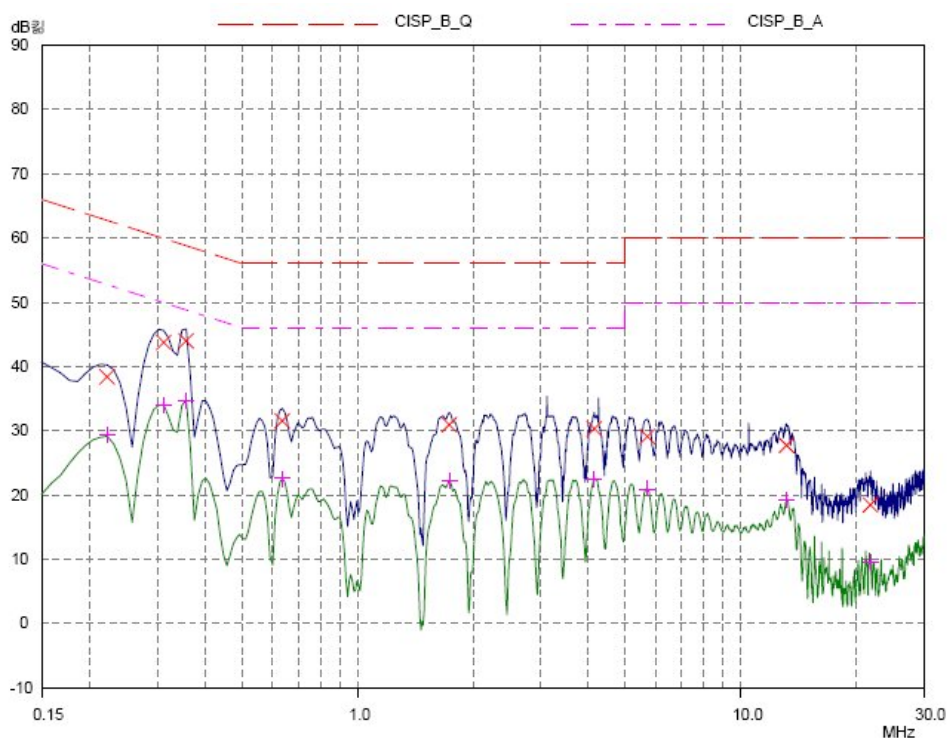
Final Measurement Results

Frequency MHz	QP Level dBμV	QP Limit dBμV	QP Delta dB
0.222	38.11	62.74	24.63
0.312	43.04	59.92	16.88
0.357	43.18	58.80	15.62
0.636	32.01	56.00	23.99
1.14	30.54	56.00	25.46
4.155	28.33	56.00	27.67
5.621	25.44	60.00	34.56
13.316	20.64	60.00	39.36
27.167	23.54	60.00	36.46

Frequency MHz	AV Level dBμV	AV Limit dBμV	AV Delta dB
0.222	29.12	52.74	23.62
0.312	33.28	49.92	16.64
0.357	33.91	48.80	14.89
0.636	23.39	46.00	22.61
1.14	21.87	46.00	24.13
4.155	20.28	46.00	25.72
5.621	17.43	50.00	32.57
13.316	11.39	50.00	38.61
27.167	15.52	50.00	34.48

Note; Hot Line
Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level).

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Final Measurement Results

Frequency MHz	QP Level dBμV	QP Limit dBμV	QP Delta dB
0.222	38.39	62.74	24.35
0.312	43.74	59.92	16.18
0.357	43.98	58.80	14.82
0.636	31.53	56.00	24.47
1.734	30.92	56.00	25.08
4.146	30.32	56.00	25.68
5.702	29.09	60.00	30.91
13.154	27.72	60.00	32.28
21.767	18.45	60.00	41.55

Frequency MHz	AV Level dBμV	AV Limit dBμV	AV Delta dB
0.222	29.30	52.74	23.44
0.312	33.91	49.92	16.01
0.357	34.59	48.80	14.21
0.636	22.55	46.00	23.45
1.734	22.26	46.00	23.74
4.146	22.36	46.00	23.64
5.702	20.94	50.00	29.06
13.154	19.21	50.00	30.79
21.767	9.49	50.00	40.51

Note; Neutral Line

Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level).

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Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum analyzer	R&S	FSV30	101389	1 year	2015.05.06
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2014.05.06
Broadband coaxial preamplifier	Schwarzbeck Mess-Elektronik	BB9718	9168-385	2 years	2014.09.23
Preamplifier	Schwarzbeck Mess-Elektronik	BBV-571	781	1 year	2014.09.23
Loop Antenna	R&S	HFH2- Z2.335.4711.52	826532	2 years	2015.04.25
Trilog-broadband antenna	Schwarzbeck	VULB 9168	9168-385	2 years	2015.05.09
Horn antenna	A.H.	SAS-571	414	2 years	2015.02.28
Horn antenna	A.H.	SAS-572	269	2 years	2015.09.07
EMI Test Receiver	LIG NEX1	ISA-80	L0912K014	1 year	2014.11.15
EMI Test Receiver	R & S	ESVS10	826008/014	1 year	2014.04.09
EMI Test Receiver	R & S	ESHS10	862970/018	1 year	2014.05.06
LISN	SCHWARZBECK	2823-568-1	8126157	1 year	2015.01.29
HIGH PASS FILTER	WEINSCHEL	WHKX1.2/15G-6TT	1	1 year	2014.08.05
BAND REJECT FILTER	K&L	3TNF-500/1000-N/N	399	1 year	2014.11.13

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
-	-	-	-

Appendix B. Test setup photo

Radiated Emission (30MHz~1GHz)



Radiated Emission (Above 1GHz)



AC conducted Emission



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