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TEST REPORT

Part 15 Subpart C 15.231

Equipment under test Auxiliary repeater

Model name SOLTREPEATER

FCC ID 2ABE3SOLTREPEATER

Applicant SOLT Co., Ltd.

Manufacturer SOLT Co., Ltd.

Date of test(s) 2013.11.25 ~ 2013.12.02

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Issued to

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Revision history

Revision	Date of issue	Test report No.	Description
-	2013.12.03	KES-RF-13T0030	Initial



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1. General information

1.1. EUT description

Equipment under test	Auxiliary repeater
Model name	SOLTREPEATER
Serial number	N/A
Frequency Range	433.05 MHz ~ 434.79 MHz
Modulation technique	FSK
Number of channels	11
Antenna type	Monopole antenna
Power source	DC 12 V

1.2. Test frequency

	Low channel	Middle channel	High channel
Frequency (MHz)	433.05	433.95	434.79

1.3. Information about variant model

N/A

1.4. Device modifications

N/A



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1.5. Test facility

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

1.6. 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



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2. Summary of tests

Reference	Parameter	Status
15.209(a) 15.231(b)	The field strength of fundamental and the field strength of spurious emission	C
15.231(c)	20 dB bandwidth	C
15.231(a)(1)	Transmission time	C
15.207(a)	AC conducted emissions	C

Note: C=Complies NC=Not complies NT=Not tested NA=Not applicable

3. Test results

3.1. The field strength of fundamental and the field strength of spurious emission

Test location

Testing was performed at a test distance of 3 meter Open Area Test Site

Test procedures

[9 kHz to 30 MHz]

The EUT was placed on the top of a rotating table 0.8 meter 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. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading. The test-receiver system was set to Quasi-peak function and specified bandwidth with maximum hold mode.

The spectrum analyzer is set to:

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 above 1 GHz]

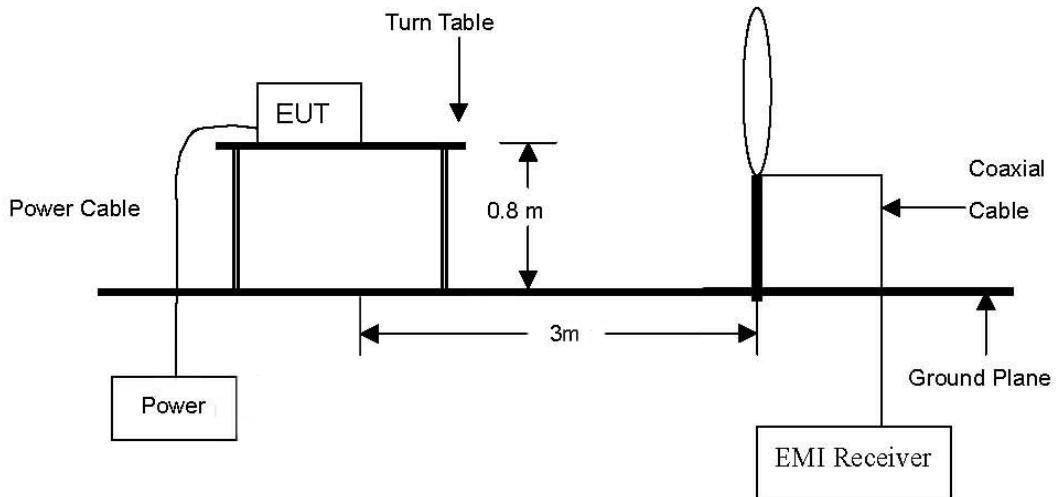
The height of the measuring antenna was varied between 1 to 4 m and the table was rotated a full revolution in order to obtain maximum values of the electric field intensity.

The measurement was made in both the vertical and horizontal polarization, and the maximum value is presented in the report.

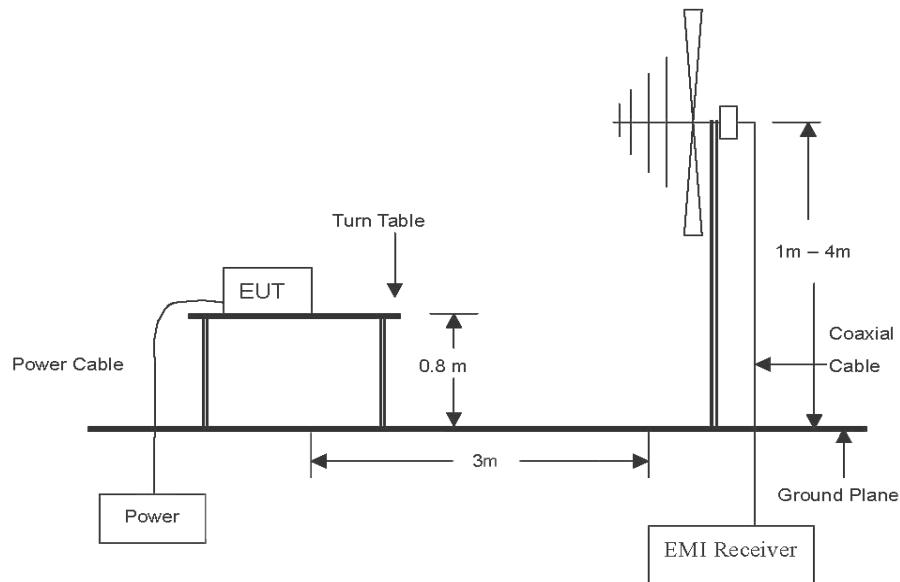
The spectrum analyzer is set to:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 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 for Peak detection at frequency above 1 GHz.

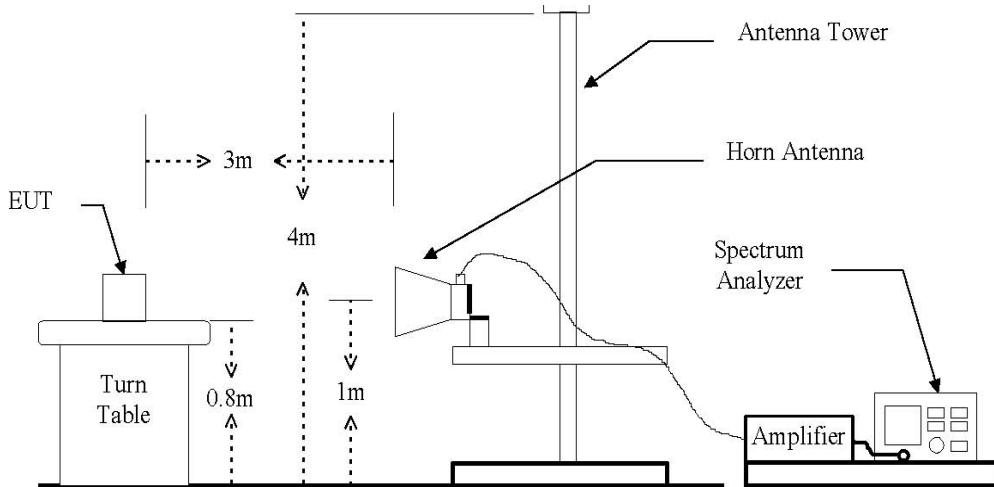
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



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 5 GHz emissions.



Limit

In the section 15.209:

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:

Frequency (MHz)	Distance (Meters)	Radiated (μ V/m)
0.009 ~ 0.490	300	2400 / F(kHz)
0.490 ~ 1.705	30	24000 / 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.



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In the section 15.231(b):

In addition to the provisions of section 15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Fundamental frequency (MHz)	Field strength of fundamental (microvolts / meter)	Field strength of spurious emission (microvolts / meter)
40.66 ~ 40.70	2,250	225
70 ~ 130	1,250	125
130 ~ 174	1,250 to 3,750**	125 to 375**
174 ~ 260	3,750	375
260 ~ 470	3,750 to 12,500**	375 to 1,250**
Above 470	12,500	1,250

Where F is the frequency in MHz, the formulas for calculating the maximum permitted fundamental field strengths are as follows: for the band 130 ~ 174 MHz, $\mu V/m$ at 3 meters = $56.81818(F) - 6136.3636$; for the band 260 ~ 470 MHz, $\mu V/m$ at 3 meters = $41.6667(F) - 7083.333$. The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.



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Test results (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 (dB μ N)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Fd (dB)	Actual (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
Below 30	Not detected							

* Remark

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 + Fd
3. $Fd = 40\log(Dm / Ds)$

Where:

Fd = Distance factor in dB
 Dm = Measurement distance in meters
 Ds = Specification distance in meters

Low Channel

Fundamental

Radiated emissions		Ant.	Ant. factor (dB/m)	Correction factor (dB)	Total	Limit	
Frequency (MHz)	Reading (dB μ N)	Pol.			Actual (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
433.05	46.66	H	16.300	5.710	68.670	100.79	32.120
433.05	53.29	V	16.300	5.710	75.300	100.79	25.490

Spurious emission

Radiated emissions		Ant.	Ant. factor (dB/m)	Correction factor (dB)	Total	Limit	
Frequency (MHz)	Reading (dB μ N)	Pol.			Actual (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
866.1	8.22	H	22.930	8.710	39.860	80.79	40.930
866.1	7.34	V	22.930	8.710	38.980	80.79	41.810

* Remark

1. Actual = Reading + Ant. factor + Correction factor(Cable loss or Amp. Gain + 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



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Middle Channel

Fundamental

Radiated emissions		Ant.	Ant. factor (dB/m)	Correction factor (dB)	Total	Limit	
Frequency (MHz)	Reading (dB μ N)	Pol.			Actual (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
433.95	39.33	H	16.320	5.710	61.360	100.82	39.460
433.95	51.76	V	16.320	5.710	73.790	100.82	27.030

Spurious emission

Radiated emissions		Ant.	Ant. factor (dB/m)	Correction factor (dB)	Total	Limit	
Frequency (MHz)	Reading (dB μ N)	Pol.			Actual (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
867.9	8.44	H	22.940	8.720	40.100	80.82	40.720
867.9	6.30	V	22.940	8.720	37.960	80.82	42.860

* Remark

1. Actual = Reading + Ant. factor + Correction factor(Cable loss or Amp. Gain + 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

High Channel

Fundamental

Radiated emissions		Ant.	Ant. factor (dB/m)	Correction factor (dB)	Total	Limit	
Frequency (MHz)	Reading (dB μ N)	Pol.			Actual (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
434.79	46.12	H	16.330	5.720	68.170	100.85	32.680
434.79	53.68	V	16.330	5.720	75.730	100.85	25.120

Spurious emission

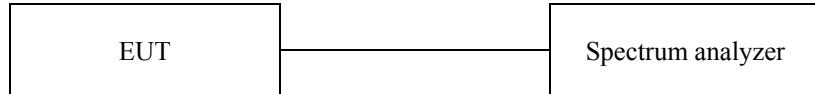
Radiated emissions		Ant.	Ant. factor (dB/m)	Correction factor (dB)	Total	Limit	
Frequency (MHz)	Reading (dB μ N)	Pol.			Actual (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
869.58	7.12	H	22.950	8.730	38.800	80.85	42.050
869.58	5.64	V	22.950	8.730	37.320	80.85	43.530

* Remark

1. Actual = Reading + Ant. factor + Correction factor(Cable loss or Amp. Gain + 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

3.2. 20 dB bandwidth

Test setup



Test procedure

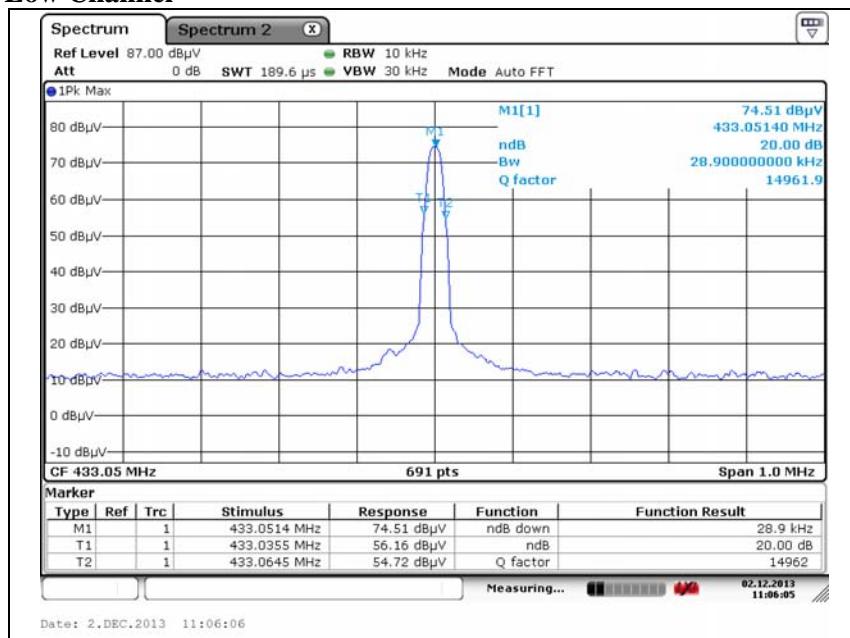
1. Use the following spectrum analyzer setting
2. RBW = 10 kHz
3. VBW = 30 kHz (\geq RBW)
4. Span = 1 MHz
5. Detector function = peak
6. Trace = max hold

Limit

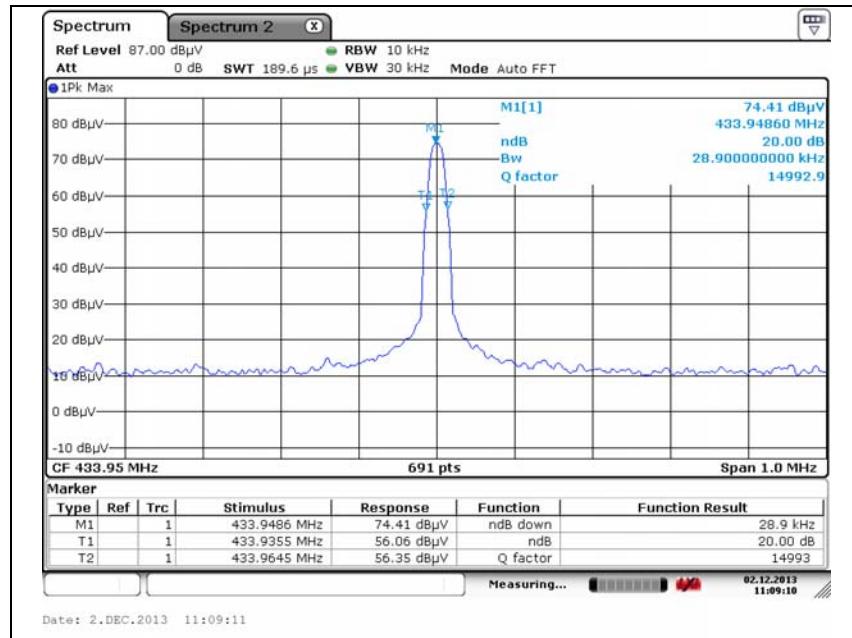
The bandwidth of the emissions shall be no wider than 0.25 % of the center frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

Test results

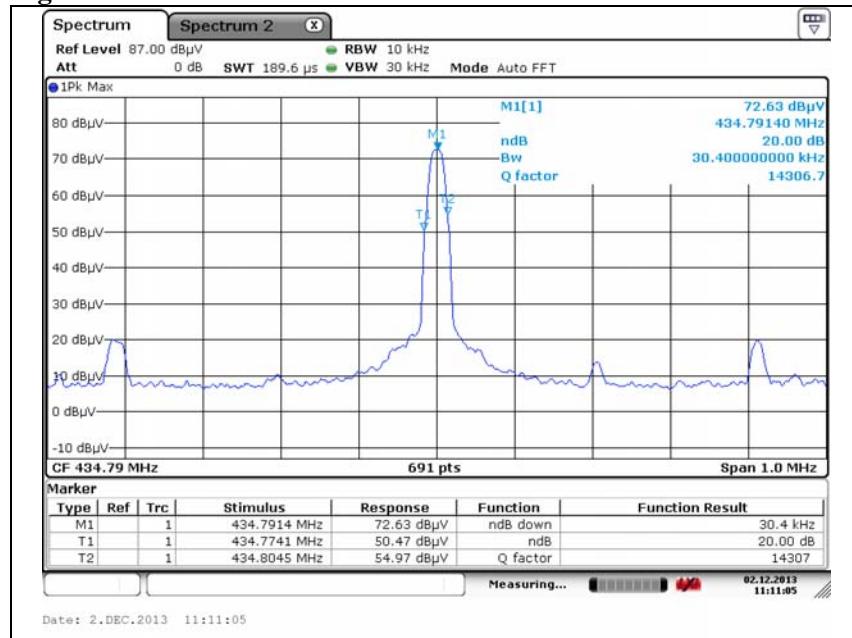
Low Channel



Middle Channel

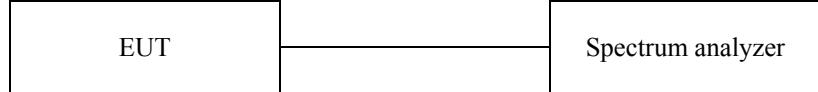


High Channel



3.3. Transmission time

Test setup



Test procedure

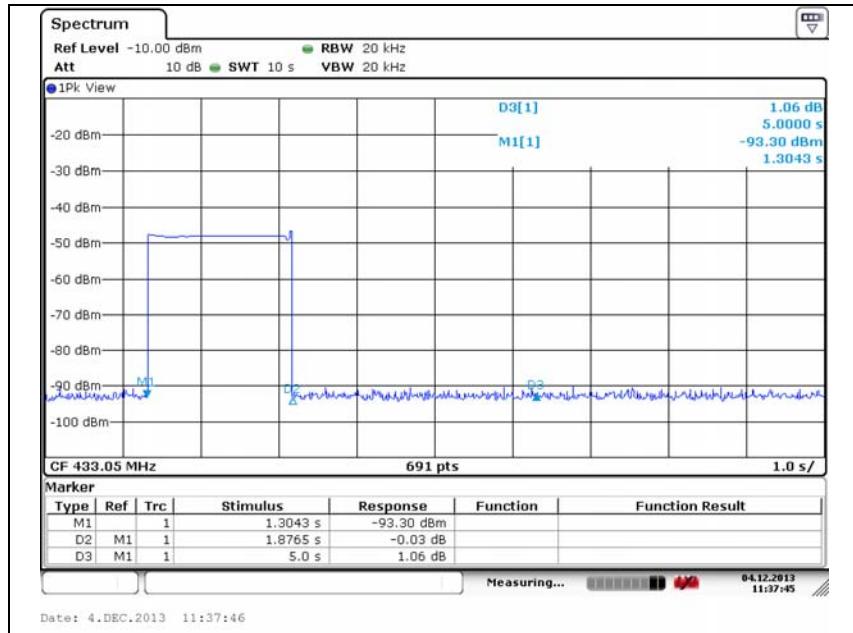
1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW=20 kHz, VBW=20 kHz, Span=0 Hz and Sweep time=10 sec.

Limit

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

Test results

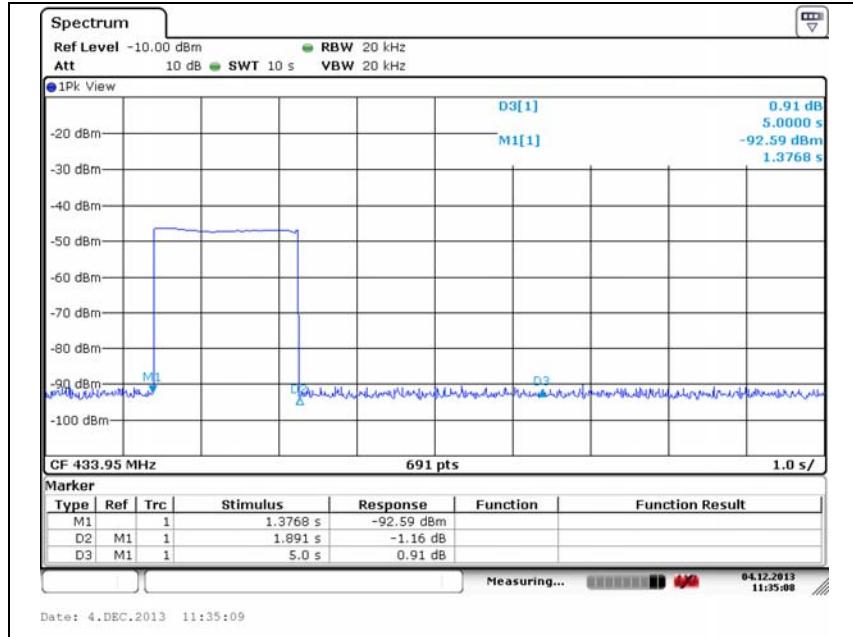
Low Channel



Transmission time

Frequency(MHz)	Transmission time (sec)	Limit (s)
433.05	1.876 5	Same or less than 5

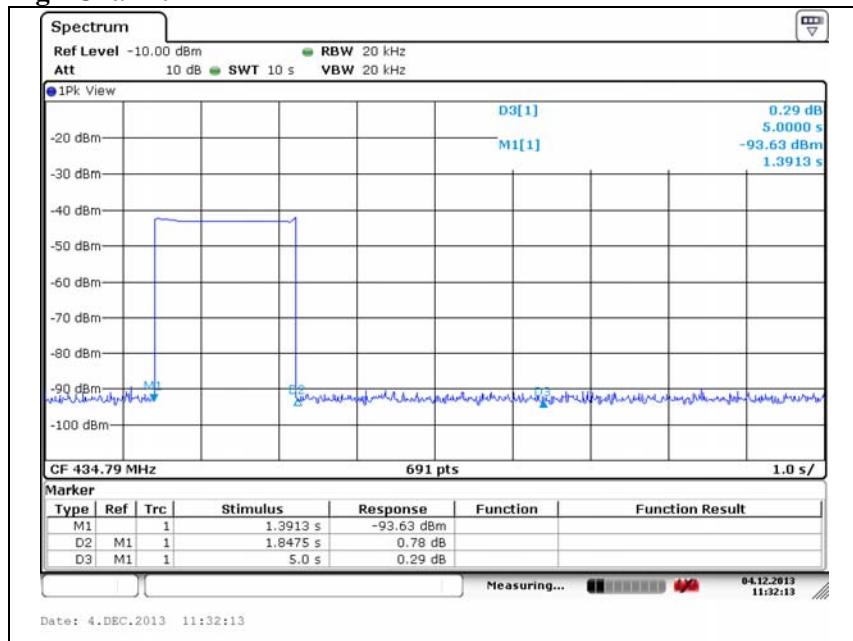
Middle Channel



Transmission time

Frequency(MHz)	Transmission time (sec)	Limit (s)
433.95	1.891	Same or less than 5

High Channel



Transmission time

Frequency(MHz)	Transmission time (sec)	Limit (s)
434.79	1.8475	Same or less than 5

3.4. AC conducted emissions

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 (dB μ V/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

* Remark

Decreases with the logarithm of the frequency.

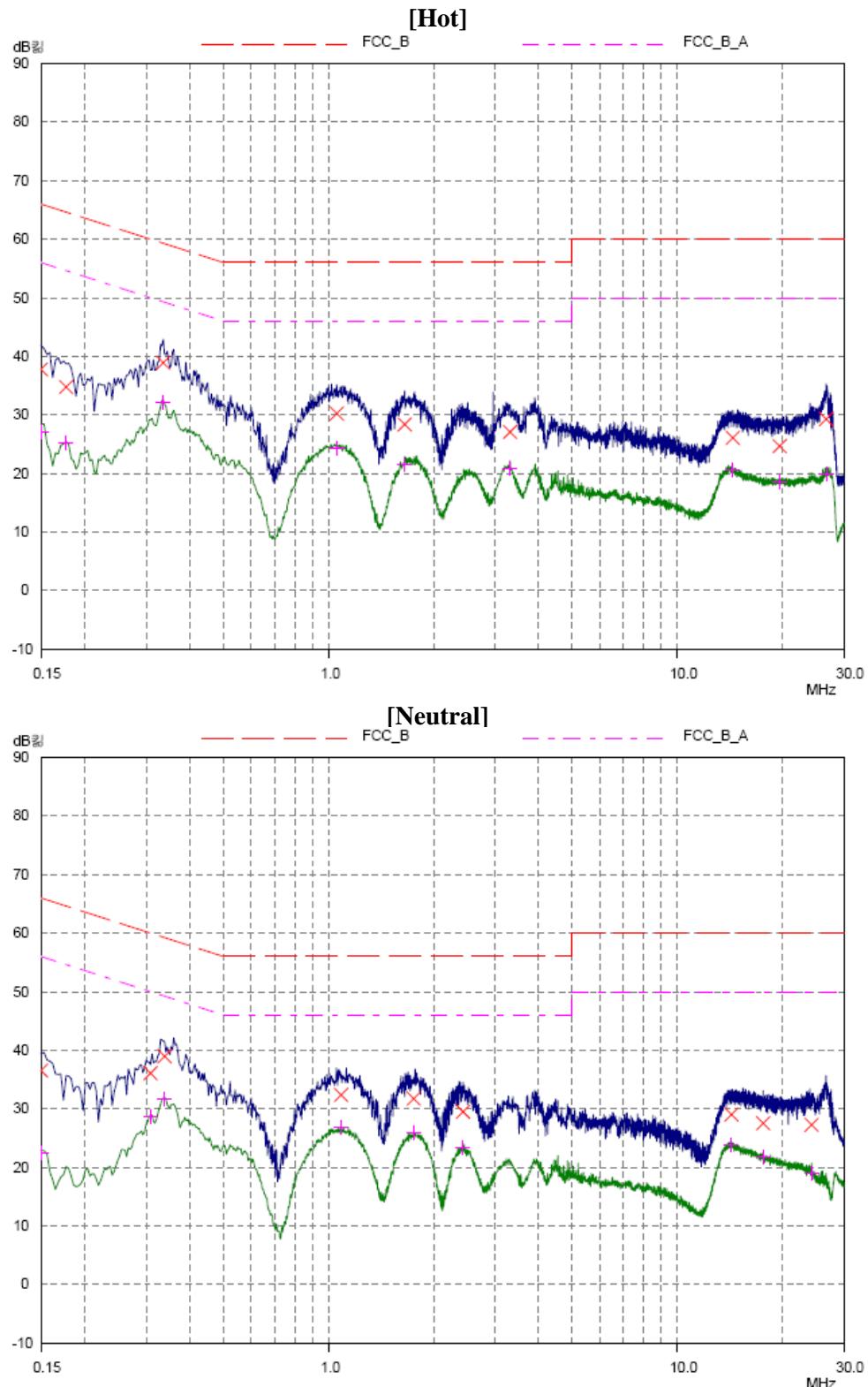


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Test results

Frequency (MHz)	Correction		Phase Hot/ Neutral	Quasi peak			Average		
	LISN	Cable Loss		Limit	Result	Reading	Limit	Result	Reading
0.150	9.580	0.025	H	66.000	37.770	37.770	56.000	27.110	27.110
0.150	9.580	0.025	N	66.000	36.530	36.530	56.000	22.480	22.480
0.177	9.580	0.022	H	64.625	34.750	34.750	54.625	25.150	25.150
0.309	9.570	0.002	N	59.997	36.070	36.070	49.997	28.630	28.630
0.336	9.570	0.002	H	59.302	38.900	38.900	49.302	32.040	32.040
0.339	9.570	0.002	N	59.228	38.960	38.960	49.228	31.590	31.590
1.056	9.570	0.062	H	56.000	30.230	30.230	46.000	24.390	24.390
1.086	9.580	0.062	N	56.000	32.360	32.360	46.000	26.750	26.750
1.653	9.570	0.071	H	56.000	28.350	28.350	46.000	21.490	21.490
1.755	9.580	0.074	N	56.000	31.730	31.730	46.000	25.820	25.820
2.430	9.590	0.087	N	56.000	29.490	29.490	46.000	23.340	23.340
3.315	9.600	0.107	H	56.000	27.070	27.070	46.000	20.910	20.910
14.277	9.710	0.218	N	60.000	29.000	29.000	50.000	23.860	23.860
14.394	9.666	0.205	H	60.000	26.070	26.070	50.000	20.490	20.490
17.598	9.772	0.242	N	60.000	27.530	27.530	50.000	21.840	21.840
19.632	10.014	0.255	H	60.000	24.650	24.650	50.000	18.620	18.620
24.213	9.834	0.267	N	60.000	27.250	27.250	50.000	19.010	19.010
26.670	9.878	0.277	H	60.000	29.260	29.260	50.000	19.950	19.950





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Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration Interval	Calibration due.
Spectrum Analyzer	R&S	FSV30	100736	1 year	2014.01.09
Vector Signal Generator	R&S	SMBV2100A	1407.6004K02	1 year	2014.01.10
Trilog-Broadband Antenna	Schwarzbeck	VULB 9168	385	2 years	2015.05.09
Horn Antenna	A.H.	SAS-571	414	2 years	2015.02.28
Broadband Preamplifier	Schwarzbeck	BBV9718	9718-245	1 year	2014.09.23
LISN	Schwarzbeck	NSLK8126	8126157	1 year	2014.01.02
EMI Test Receiver	R&S	ESHS10	862970/018	1 year	2014.05.06

Peripheral device

Device	Manufacturer	Model No.	Serial No.
N/A			

Appendix B. Test setup photos

