



**KES Co., Ltd.**  
C-3701 Dongil Techno Town, 889-1, Gwanyang 2-dong,  
Dongan-gu, Anyang-si, Gyeonggi-do, 431-716, Korea  
Tel: +82-31-425-6200 / Fax: +82-31-424-0450  
www.kes.co.kr

# TEST REPORT

## Part 15 Subpart C 15.231

**Equipment under test** Main Transceiver

**Model name** SOLTMAIN

**FCC ID** 2ABE3SOLTMAIN

**Applicant** SOLT Co., Ltd.

**Manufacturer** SOLT Co., Ltd.

**Date of test(s)** 2013.11.25 ~ 2013.12.02

**Date of issue** 2012.12.03

**Issued to**

**SOLT Co., Ltd.**

(Gumi-dong, 4F Hansol Bidg.) Migeumil-ro 85, Bundang-gu,  
Seongnam-si, Gyeonggi-do, Korea

**Issued by**

**KES Co., Ltd.**

C3701 Dongil Techno Town, 889-1, Gwanyang 2-dong, Dongan-gu, Anyang-si,  
Gyeonggi-do, 431-716, Korea  
477-6, Hageo-ri, Yeoju-eup, Yeoju-gun, Gyeonggi-do, 469-803, Korea  
Tel: +82-31-425-6200 / Fax: +82-31-424-0450

<b>Test and report completed by :</b>	<b>Report approval by :</b>
Kwang-Yeol Choo Test engineer	Jeff Do Technical manager



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C-3701 Dongil Techno Town, 889-1, Gwanyang 2-dong,  
Dongan-gu, Anyang-si, Gyeonggi-do, 431-716, Korea  
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### Revision history

Revision	Date of issue	Test report No.	Description
-	2013.12.03	KES-RF-13T0029	Initial



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Dongan-gu, Anyang-si, Gyeonggi-do, 431-716, Korea  
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### 1. General information

#### 1.1. EUT description

<b>Equipment under test</b>	Main Transceiver
<b>Model name</b>	SOLTM MAIN
<b>Serial number</b>	N/A
<b>Frequency Range</b>	433.05 MHz ~ 434.79 MHz
<b>Modulation technique</b>	FSK
<b>Number of channels</b>	11
<b>Antenna type</b>	Monopole antenna
<b>Power source</b>	DC 12 V

#### 1.2. Test frequency

	<b>Low channel</b>	<b>Middle channel</b>	<b>High channel</b>
<b>Frequency (MHz)</b>	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

C3701 Dongil Techno Town, 889-1, Gwanyang 2-dong, Dongan-gu, Anyang-si, Gyeonggi-do, 431-716, Korea 477-6,  
Hageo-ri, Yeoju-eup, Yeoju-gun, Gyeonggi-do, 469-803, Korea

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]

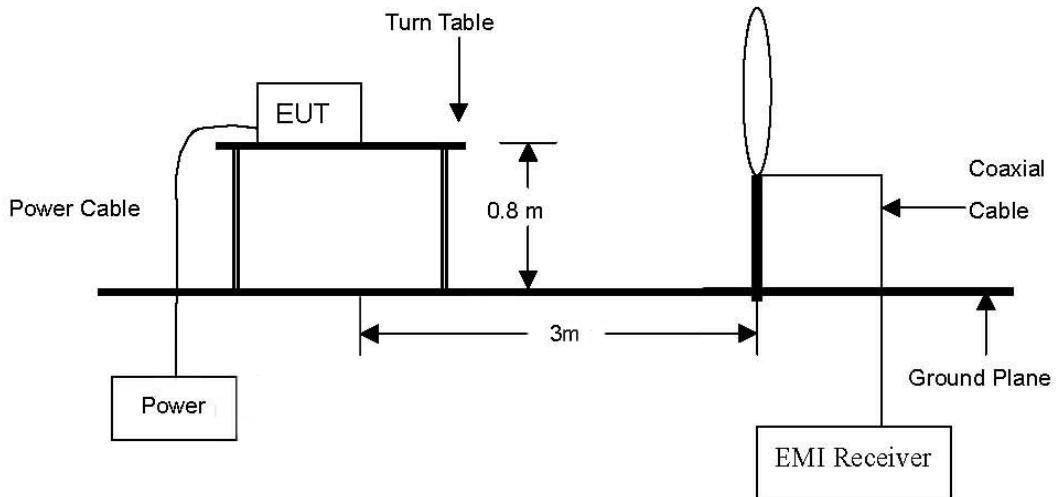
The height of the measuring antenna was varied between 1 to 4 m and the table was rotated a full revolution in order to obtain maximum values of the electric field intensity.

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

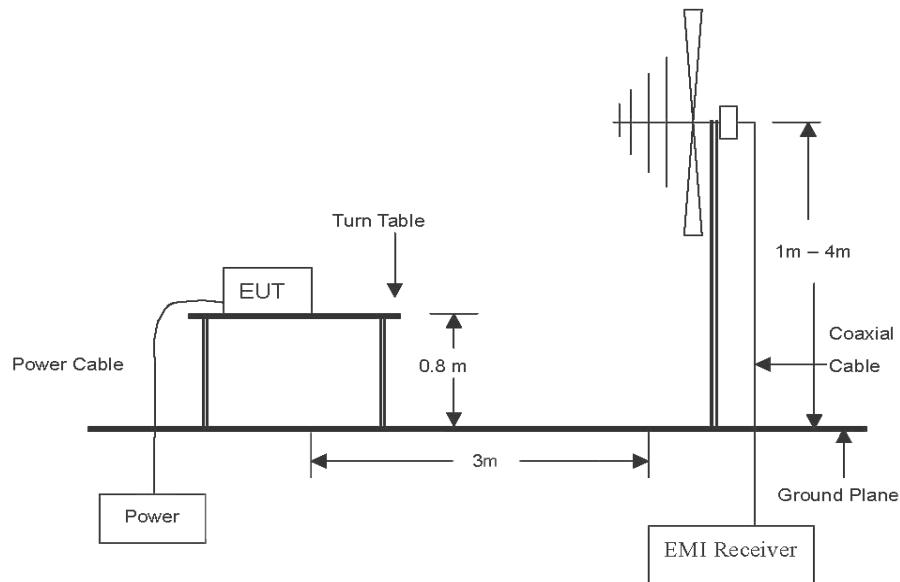
The spectrum analyzer is set to:

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.

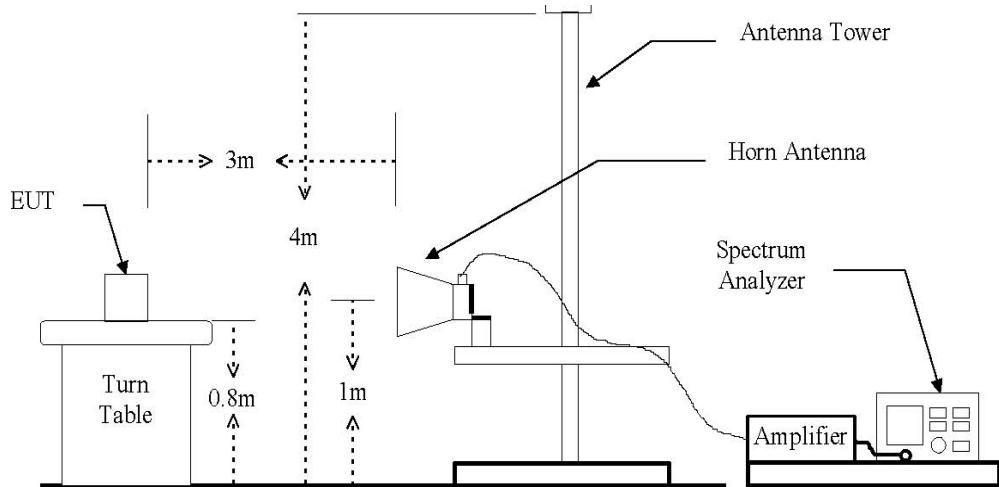
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



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 ( $\mu$ N/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 30MHz)

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 $\mu$ N)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Fd (dB)	Actual (dB $\mu$ N/m)	Limit (dB $\mu$ 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 $\mu$ N)	Pol.			Actual (dB $\mu$ N/m)	Limit (dB $\mu$ N/m)	Margin (dB)
433.05	45.83	H	16.300	5.710	67.840	100.79	32.950
433.05	53.26	V	16.300	5.710	75.270	100.79	25.520

#### Spurious emission

Radiated emissions		Ant.	Ant. factor (dB/m)	Correction factor (dB)	Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ N)	Pol.			Actual (dB $\mu$ N/m)	Limit (dB $\mu$ N/m)	Margin (dB)
866.1	5.20	H	22.930	8.710	36.840	80.79	43.950
866.1	4.36	V	22.930	8.710	36.000	80.79	44.790

#### \* 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 $\mu$ N)	Pol.			Actual (dB $\mu$ N/m)	Limit (dB $\mu$ N/m)	Margin (dB)
433.95	48.20	H	16.320	5.710	70.230	100.82	30.590
433.95	52.50	V	16.320	5.710	74.530	100.82	26.290

#### Spurious emission

Radiated emissions		Ant.	Ant. factor (dB/m)	Correction factor (dB)	Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ N)	Pol.			Actual (dB $\mu$ N/m)	Limit (dB $\mu$ N/m)	Margin (dB)
867.9	5.28	H	22.940	8.720	36.940	80.82	43.880
867.9	5.37	V	22.940	8.720	37.030	80.82	43.790

#### \* 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 $\mu$ N)	Pol.			Actual (dB $\mu$ N/m)	Limit (dB $\mu$ N/m)	Margin (dB)
434.79	49.15	H	16.330	5.720	71.200	100.85	29.650
434.79	52.47	V	16.330	5.720	74.520	100.85	26.330

#### Spurious emission

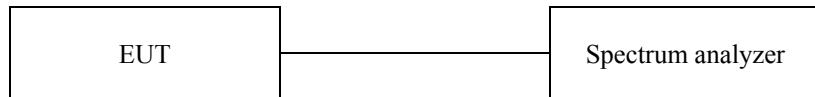
Radiated emissions		Ant.	Ant. factor (dB/m)	Correction factor (dB)	Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ N)	Pol.			Actual (dB $\mu$ N/m)	Limit (dB $\mu$ N/m)	Margin (dB)
869.58	5.72	H	22.950	8.730	37.400	80.85	43.450
869.58	4.98	V	22.950	8.730	36.660	80.85	44.190

#### \* 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



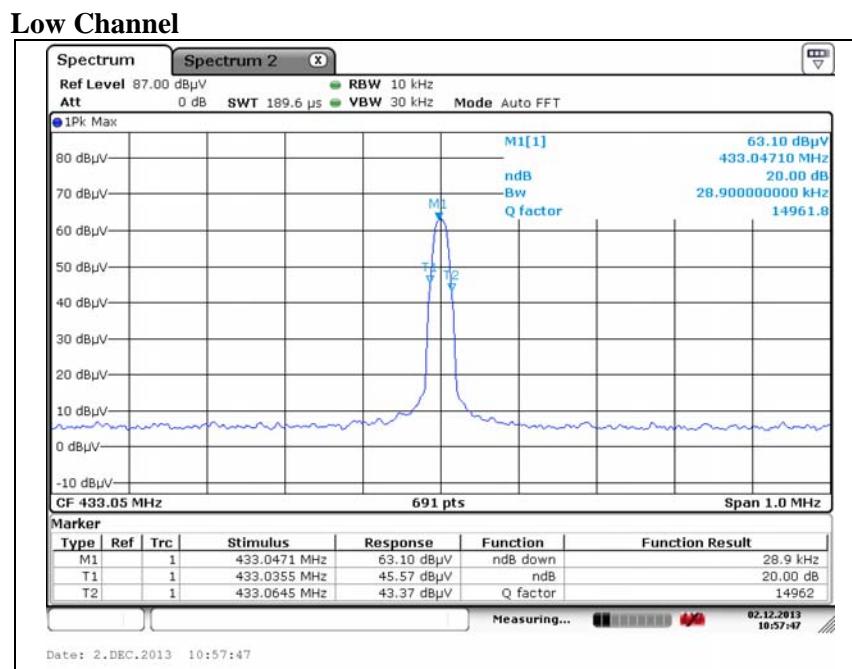
#### Test procedure

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

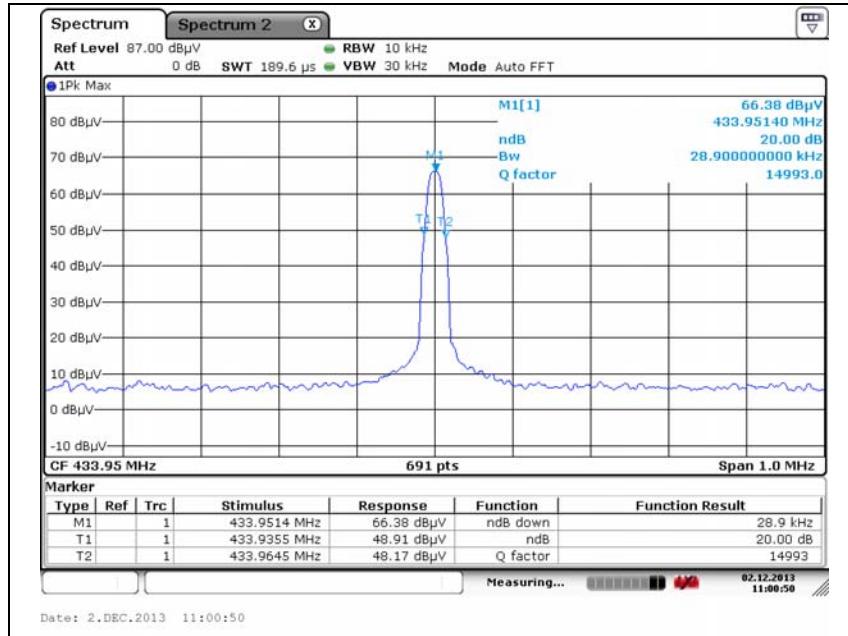
#### Limit

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.

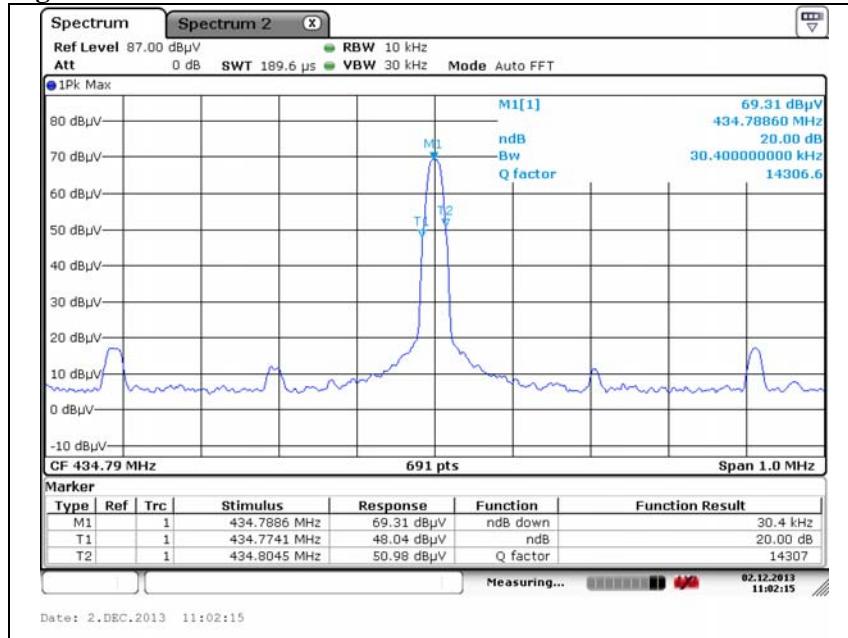
#### Test results



### Middle Channel

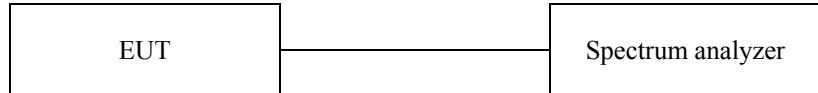


### High Channel



### 3.3. Transmission time

#### Test setup



#### Test procedure

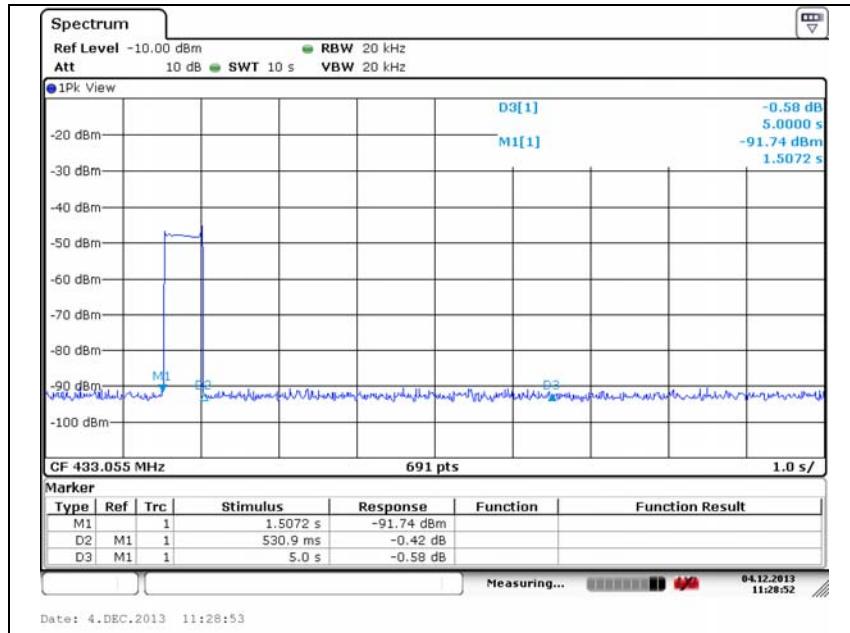
1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW=20 kHz, VBW=20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

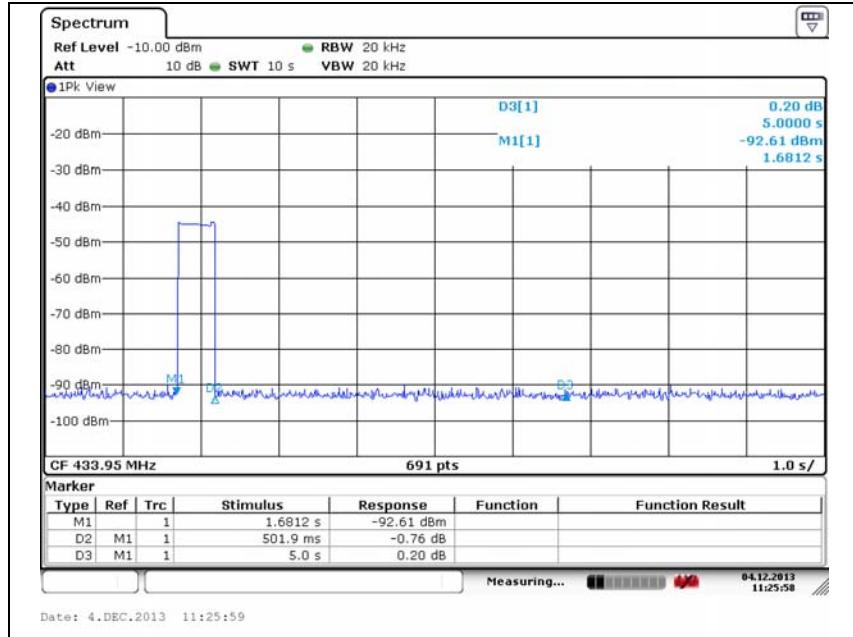
##### Low Channel



##### Transmission time

Frequency(MHz)	Transmission time (sec)	Limit (s)
433.05	0.530 9	Same or less than 5

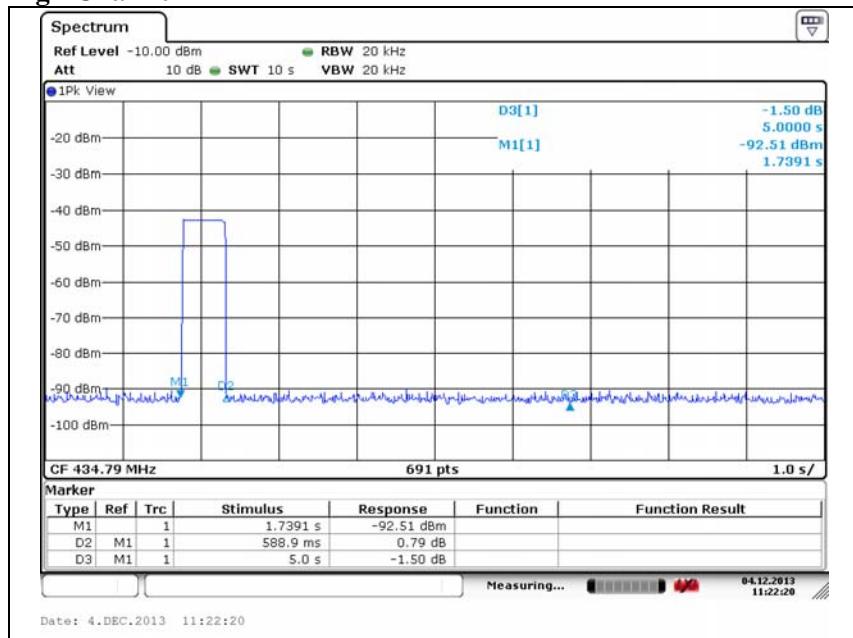
### Middle Channel



### Transmission time

Frequency(MHz)	Transmission time (sec)	Limit (s)
433.95	0.501 9	Same or less than 5

### High Channel



### Transmission time

Frequency(MHz)	Transmission time (sec)	Limit (s)
434.79	0.588 9	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 $\mu$ 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.

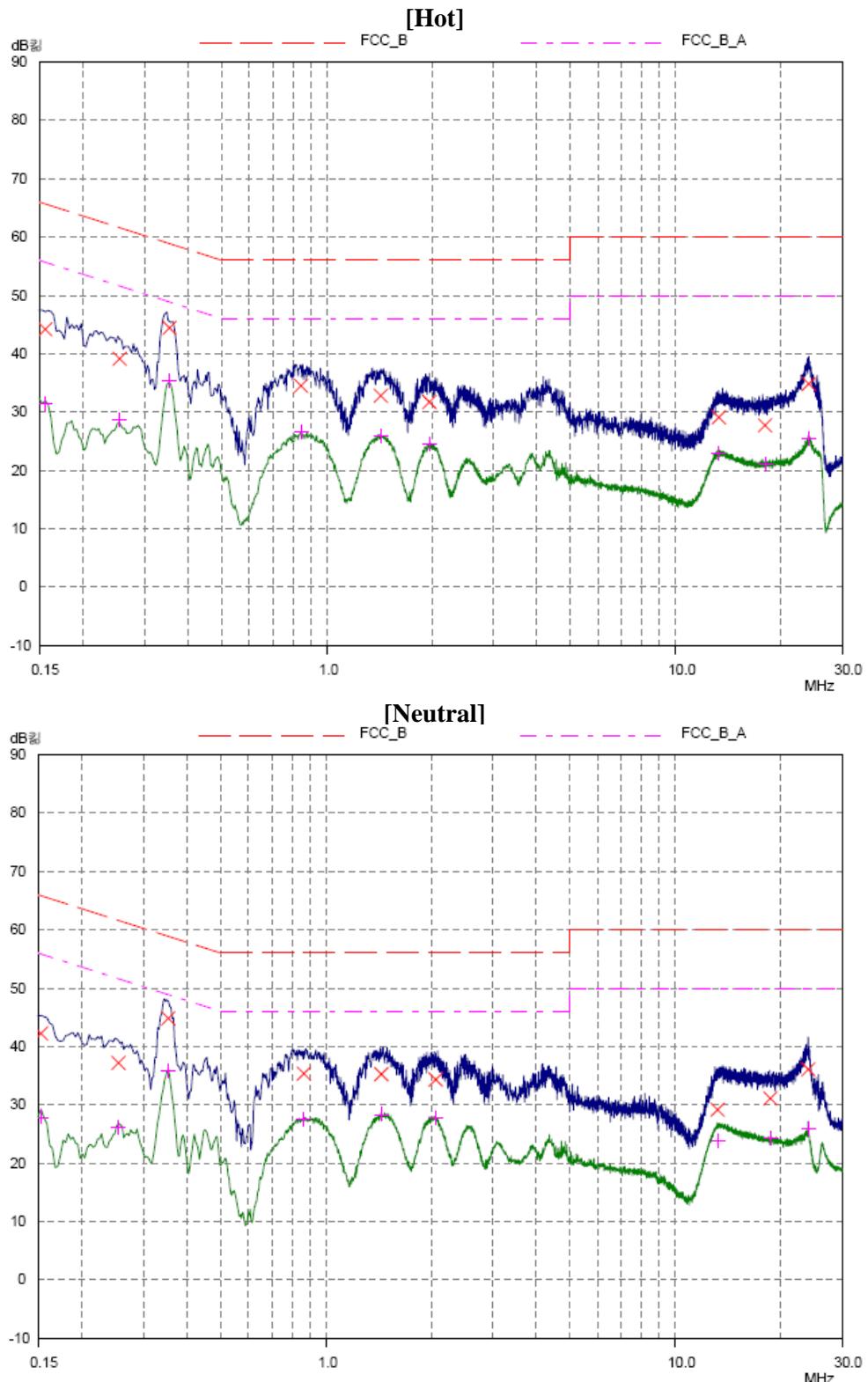


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### Test results

Frequency (MHz)	Correction		Phase Hot/ Neutral	Quasi peak			Average		
	LISN	Cable Loss		Limit	Result	Reading	Limit	Result	Reading
0.153	9.580	0.014	N	<b>65.836</b>	42.220	42.220	<b>55.836</b>	27.850	27.850
0.156	9.580	0.024	H	<b>65.674</b>	44.180	44.180	<b>55.674</b>	31.340	31.340
0.255	9.580	0.024	H	<b>61.593</b>	39.130	39.130	<b>51.593</b>	28.600	28.600
0.255	9.570	0.024	N	<b>61.593</b>	37.150	37.150	<b>51.593</b>	26.070	26.070
0.354	9.570	0.002	H	<b>58.868</b>	44.430	44.430	<b>48.868</b>	35.400	35.400
0.354	9.570	0.002	N	<b>58.868</b>	44.790	44.790	<b>48.868</b>	35.820	35.820
0.843	9.570	0.047	H	<b>56.000</b>	34.480	34.480	<b>46.000</b>	26.490	26.490
0.864	9.580	0.047	N	<b>56.000</b>	35.330	35.330	<b>46.000</b>	27.480	27.480
1.428	9.570	0.057	H	<b>56.000</b>	32.780	32.780	<b>46.000</b>	25.920	25.920
1.440	9.580	0.057	N	<b>56.000</b>	35.240	35.240	<b>46.000</b>	28.320	28.320
1.968	9.570	0.085	H	<b>56.000</b>	31.720	31.720	<b>46.000</b>	24.570	24.570
2.061	9.590	0.075	N	<b>56.000</b>	34.310	34.310	<b>46.000</b>	27.770	27.770
13.206	9.700	0.196	N	<b>60.000</b>	29.130	29.130	<b>50.000</b>	23.770	23.770
13.296	9.662	0.196	H	<b>60.000</b>	29.080	29.080	<b>50.000</b>	22.940	22.940
18.030	9.928	0.251	H	<b>60.000</b>	27.700	27.700	<b>50.000</b>	21.020	21.020
18.687	9.798	0.248	N	<b>60.000</b>	31.080	31.080	<b>50.000</b>	24.180	24.180
23.988	9.838	0.268	N	<b>60.000</b>	36.070	36.070	<b>50.000</b>	25.990	25.990
24.042	9.952	0.264	H	<b>60.000</b>	34.820	34.820	<b>50.000</b>	25.530	25.530





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www.kes.co.kr

### 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



