

# ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR LOW-POWER, NON-LICENSED TRANSMITTER

**Test Report No.** : E147R-021  
**AGR No.** : A145A-169  
**Applicant** : Remote Solution Co., Ltd.  
**Address** : 92, Chogokri, Nammyun, Kimchon city, Kyungbuk, Korea, 740-871  
**Manufacturer** : Remote Solution Co., Ltd.  
**Address** : 92, Chogokri, Nammyun, Kimchon city, Kyungbuk, Korea, 740-871  
**Type of Equipment** : Smart Home Sensor  
**FCC ID.** : TX4ES60A  
**Model Name** : ES60A  
**Multiple Model Name** : ES60B, ES60C, ES60D, ES60E, ES60F, ES60G, ES60H  
**Serial number** : N/A  
**Total page of Report** : 34 pages (including this page)  
**Date of Incoming** : June 04, 2014  
**Date of issue** : July 03, 2014

## SUMMARY

The equipment complies with the regulation; *FCC PART 15 SUBPART C Section 15.247*  
 This test report only contains the result of a single test of the sample supplied for the examination.  
 It is not a generally valid assessment of the features of the respective products of the mass-production.

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### Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
E147R-021	July 03, 2014	Initial Issue	All

## 1. VERIFICATION OF COMPLIANCE

Applicant : Remote Solution Co., Ltd.  
 Address : 92, Chogokri, Nammyun, Kimchon city, Kyungbuk, Korea, 740-871  
 Contact Person : Ku Yeong Hwa / Assistant Research Engineer  
 Telephone No. : +82-54-420-4500  
 FCC ID : TX4ES60A  
 Model Name : ES60A  
 Serial Number : N/A  
 Date : July 03, 2014

EQUIPMENT CLASS	<i><b>DTS – DIGITAL TRNSMISSION SYSTEM</b></i>
E.U.T. DESCRIPTION	Smart Home Sensor
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2009 and FCC KDB D01 DTS Meas Guidance v03r02
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247
MODIFICATIONS ON THE EQUIPMENT TO ACHIEVE COMPLIANCE	None
FINAL TEST WAS CONDUCTED ON	3 m semi anechoic chamber.

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

## 2. TEST SUMMARY

### 2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.247 (a) (2)	Minimum 6 dB Bandwidth	Met the Limit / PASS
15.247 (b) (3)	Maximum Peak Conducted Output Power	Met the Limit / PASS
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.247 (e)	Peak Power Spectral Density	Met the Limit / PASS
15.209	Radiated Emission Limits	Met the Limit / PASS
15.207	Conducted Limits	N/A (See Note)
15.203	Antenna Requirement	Met requirement / PASS

Note: This test is not performed because the EUT is operated by DC battery.

### 2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

### 2.3 Related Submittal(s) / Grant(s)

Original submittal only

### 2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in section 2.1.

### 2.5 Test Methodology

Radiated testing was performed according to the procedures in ANSI C63.10: 2009 at a distance of 3 m from EUT to the antenna.

### 2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 301-14, Daessangnyeong-ri, Chowol-eup, Gwangju-si, Gyeonggi-do, 464-862 Korea.

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-4112/ C-4617/ G-666/ T-1842 IC (Industry Canada) – Registration No. Site# 3736-3

-. Site Accreditation:

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation No. 85

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

### 3. GENERAL INFORMATION

#### 3.1 Product Description

The Remote Solution Co., Ltd., Model ES60A (referred to as the EUT in this report) is a Smart Home Sensor. Product specification information described herein was obtained from product data sheet or user’s manual.

DEVICE TYPE	Portable Device
FREQUENCY RANGE	2 405 MHz ~ 2 475 MHz
Channel Number	15
MAX. RF OUTPUT POWER:	17.14 dBm
NUMBER OF LAYER	4 Layers
ANTENNA TYPE	F-Antenna
ANTENNA GAIN	0.27 dBi
MODULATION METHOD	GFSK
USED RF CHIP	Marker: GreenPeak Technologies Model Name: GP490C40GP
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	16 MHz
POWER REQUIREMENT	DC 3.0 V
EXTERNAL CONNECTOR	-

#### 3.2 Alternative type(s)/model(s); also covered by this test report.

-. The following lists consist of the added model and their differences.

Model Name	Differences	Tested
ES60A	Basic Model	<input checked="" type="checkbox"/>
ES60B	This models are Temperature Sensor there is no difference on RF.	<input type="checkbox"/>
ES60C	This models are Humidity Sensor there is no difference on RF.	<input type="checkbox"/>
ES60D	This models are Humidity ST Sensor there is no difference on RF.	<input type="checkbox"/>
ES60E, ES60F, ES60G, ES60H	Buyers Request Model Name.	<input type="checkbox"/>

Note: 1. Applicant consigns only basic model to test. Therefore this test report just guarantees the units, which have been tested.

2. The Applicant/manufacturer is responsible for the compliance of all variants.

### 4. EUT MODIFICATIONS

-. None

## 5. SYSTEM TEST CONFIGURATION

### 5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
Main Board	Remote Solution Co., Ltd.	SC10-V-0	N/A

### 5.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

Model	Manufacturer	Description	Connected to
ES60A	Remote Solution Co., Ltd.	Smart Home Sensor (EUT)	-

### 5.3 Mode of operation during the test

For the testing, software used to control the EUT for staying in continuous transmitting mode is programmed.

-. The EUT was set at Low Channel (2 405 MHz), Middle Channel (2 440 MHz), and High Channel (2 475 MHz).

To get a maximum radiated emission levels from the EUT

### 5.4 Configuration of Test System

**Line Conducted Test:** It is not need to test this requirement, because the EUT shall be operated by DC battery.

**Radiated Emission Test:** Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2009 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 m open area test site.

The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

### 5.5 Antenna Requirement

For intentional device, according to section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

#### Antenna Construction:

The antenna of the EUT is a PCB Antenna on the main board in the EUT, so no consideration of replacement by the user.



## 6. PRELIMINARY TEST

### 6.1 AC Power line Conducted Emissions Tests

During Preliminary Tests, the following operating mode was investigated

Operation Mode	The Worse operating condition (Please check one only)
Charging and Transmitter Mode	X

### 6.2 General Radiated Emissions Tests

During Preliminary Tests, the following operating modes were investigated

Operation Mode	The Worse operating condition (Please check one only)
Transmitter Mode	X

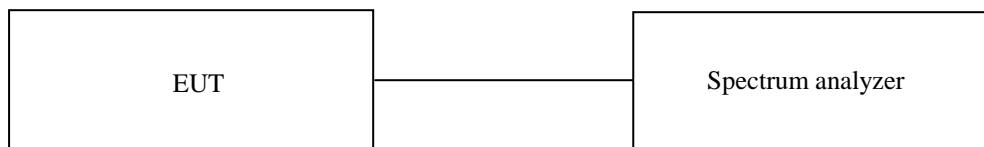
## 7. MIMIMUM 6 dB BANDWIDTH

### 7.1 Operating environment

Temperature : 25 °C  
Relative humidity : 44 % R.H.

### 7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, and peak detection was used. The 6 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 6 dB.



### 7.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV30	R/S	Spectrum Analyzer	101372	Apr. 28, 2014(1Y)

All test equipment used is calibrated on a regular basis.

**7.4 Test data**

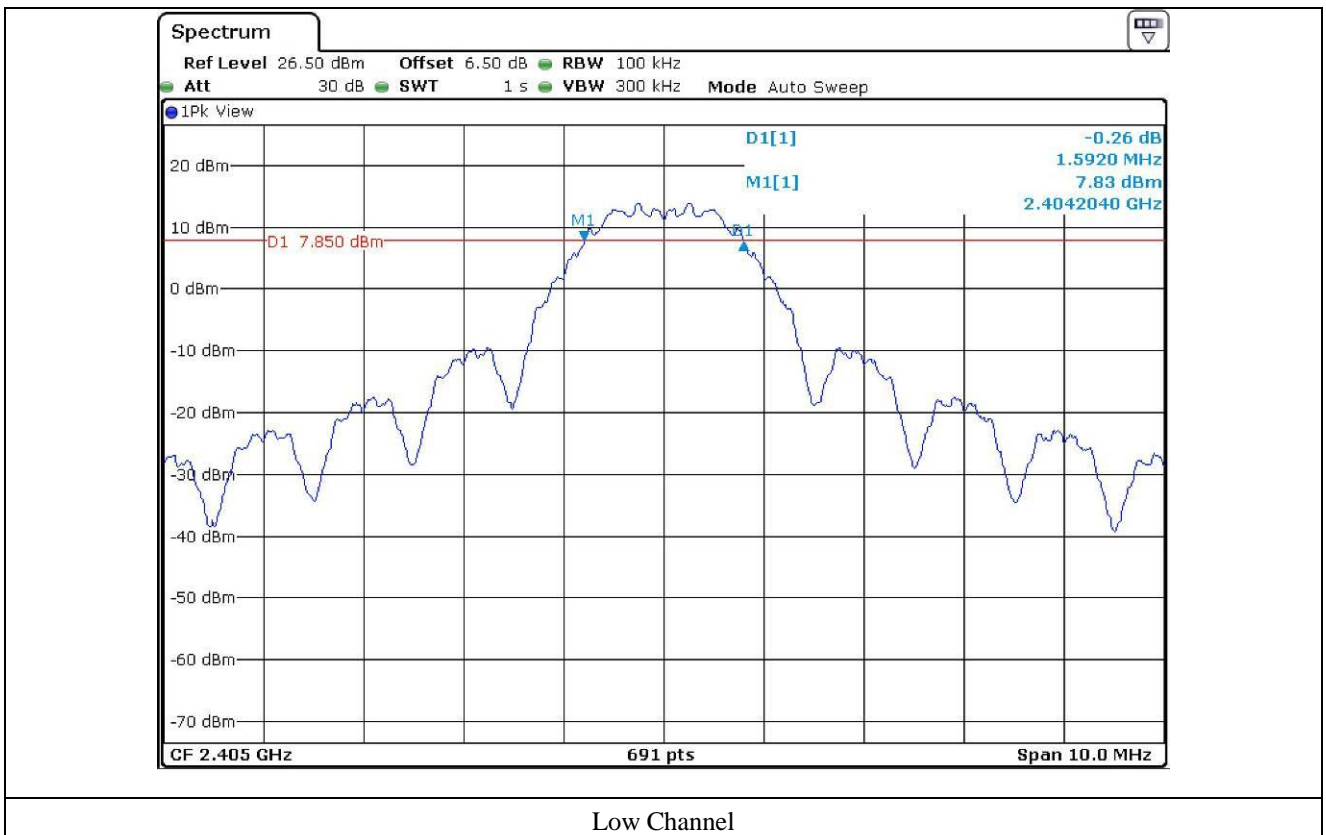
-. Test Date : June 27, 2014  
-. Test Result : Pass

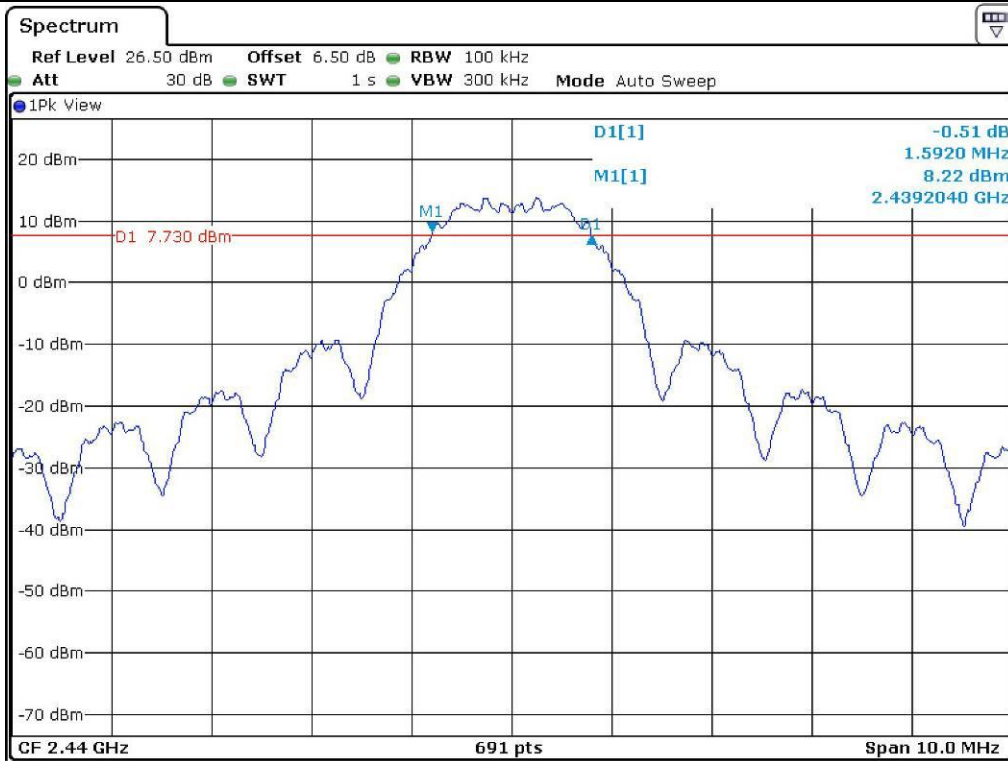
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (MHz)	LIMIT (MHz)	MARGIN (MHz)
Low	2 405	1.59	0.5	1.09
Middle	2 440	1.59	0.5	1.09
High	2 475	1.56	0.5	1.06

Remark. Margin = Measured Value - Limit

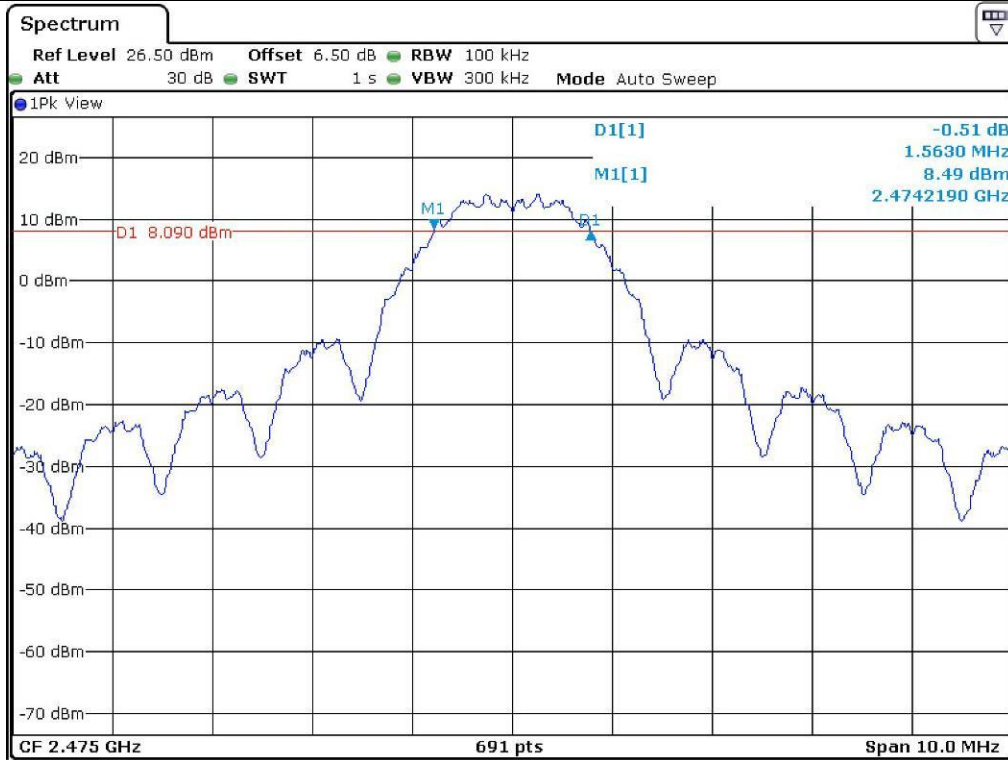


**Tested by: Tae-Ho, Kim / Project Engineer**





Middle Channel



High Channel

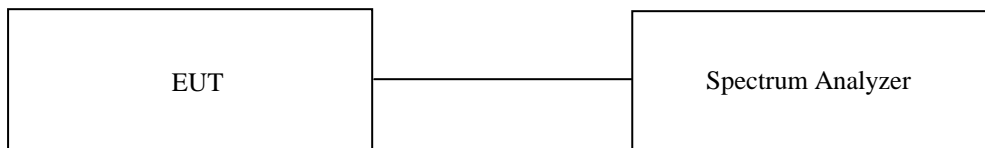
## 8. MAXIMUM PEAK OUTPUT POWER

### 8.1 Operating environment

Temperature : 25 °C  
Relative humidity : 44 % R.H.

### 8.2 Test set-up

The maximum peak output power was measured with the spectrum analyzer connected to the antenna output of the EUT. The EUT was operating in transmit mode at the appropriate center frequency.



### 8.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV30	R/S	Spectrum Analyzer	101372	Apr. 28, 2014(1Y)

All test equipment used is calibrated on a regular basis.

**8.4 Test data**

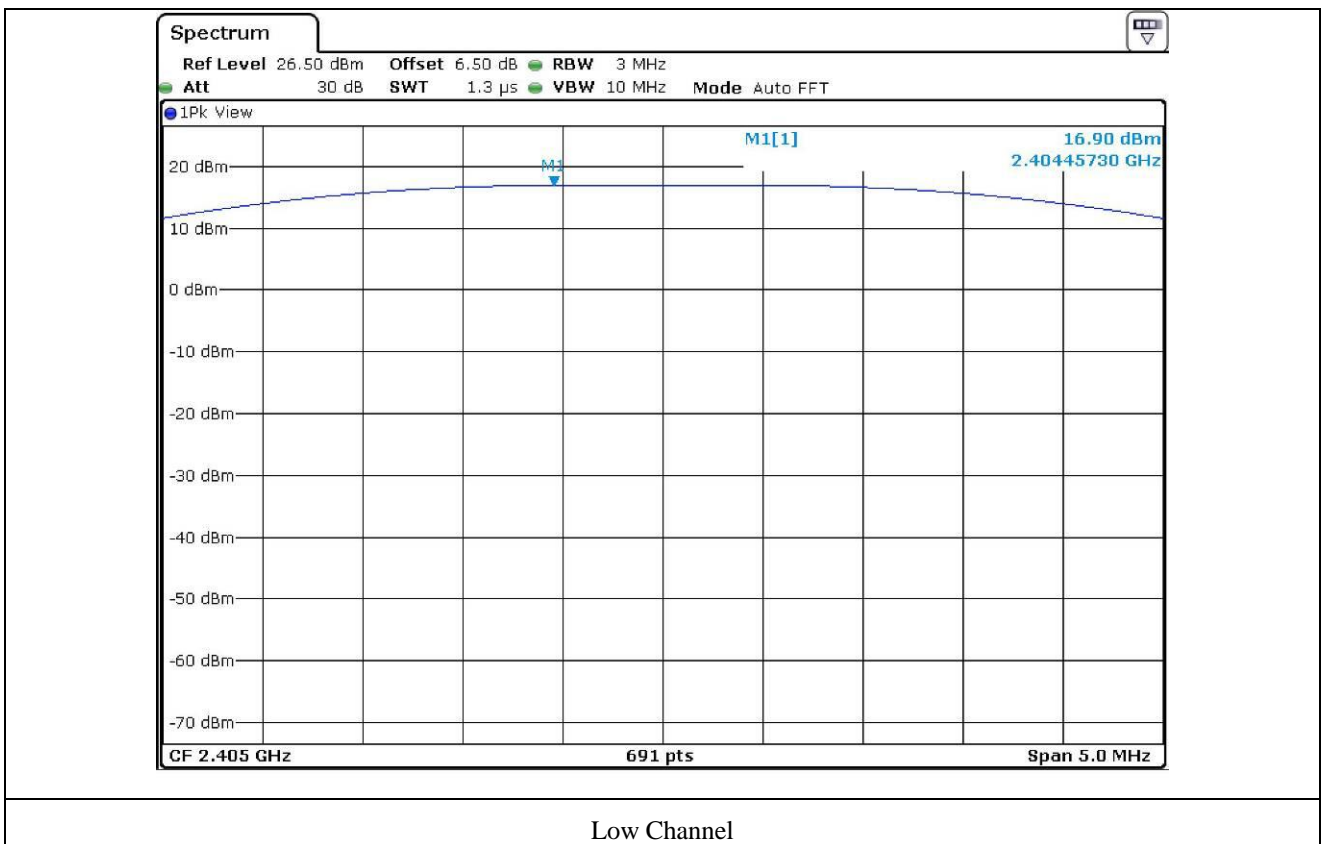
- Test Date : June 27, 2014
- Test Result : Pass

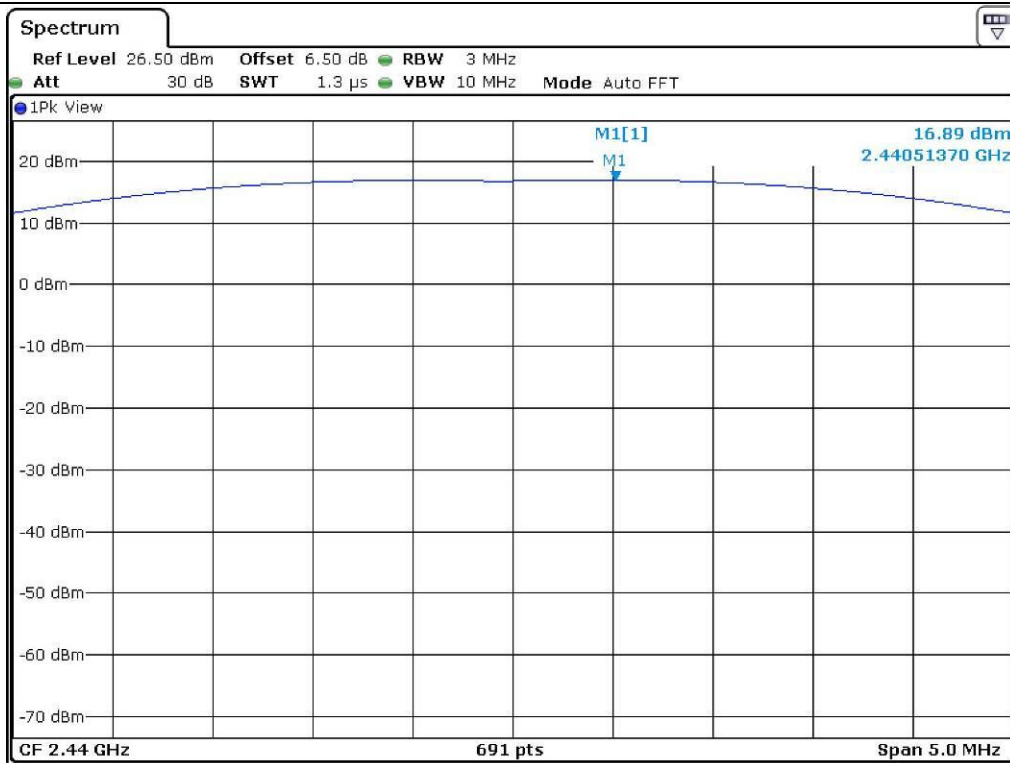
CHANNEL	FREQUENCY (MHz)	DTS (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 405	1.59	16.90	30	13.10
MIDDLE	2 440	1.59	16.89	30	13.11
HIGH	2 475	1.56	17.14	30	12.86

Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

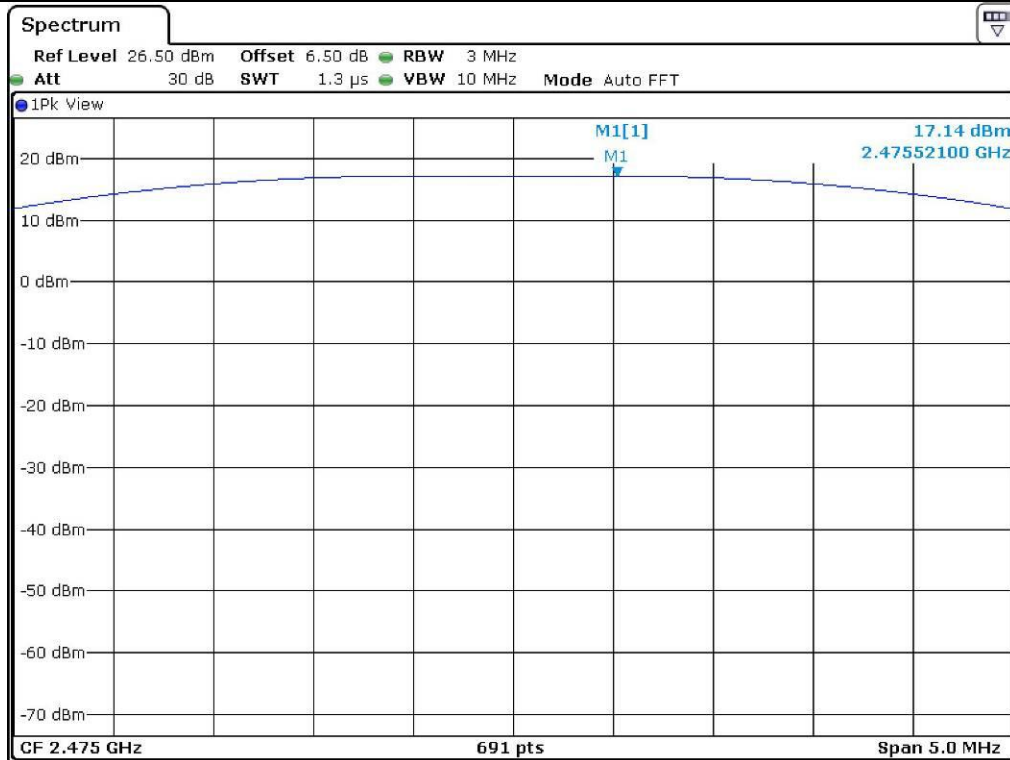


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Middle Channel



High Channel

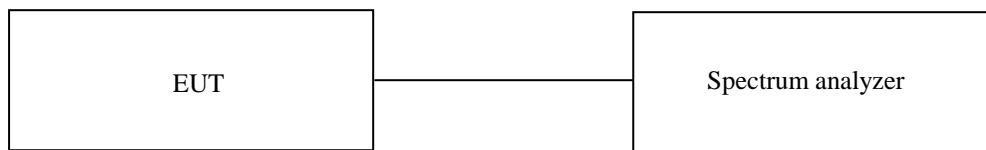
## 9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

### 9.1 Operating environment

Temperature : 25 °C  
Relative humidity : 45 % R.H.

### 9.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution and video bandwidth is set to 100 kHz, and peak detection was used.



### 9.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m, open-field test site. The EUT was placed on a non-conductive turntable approximately 0.8 m above the ground plane.

The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

### 9.4 Test equipment used

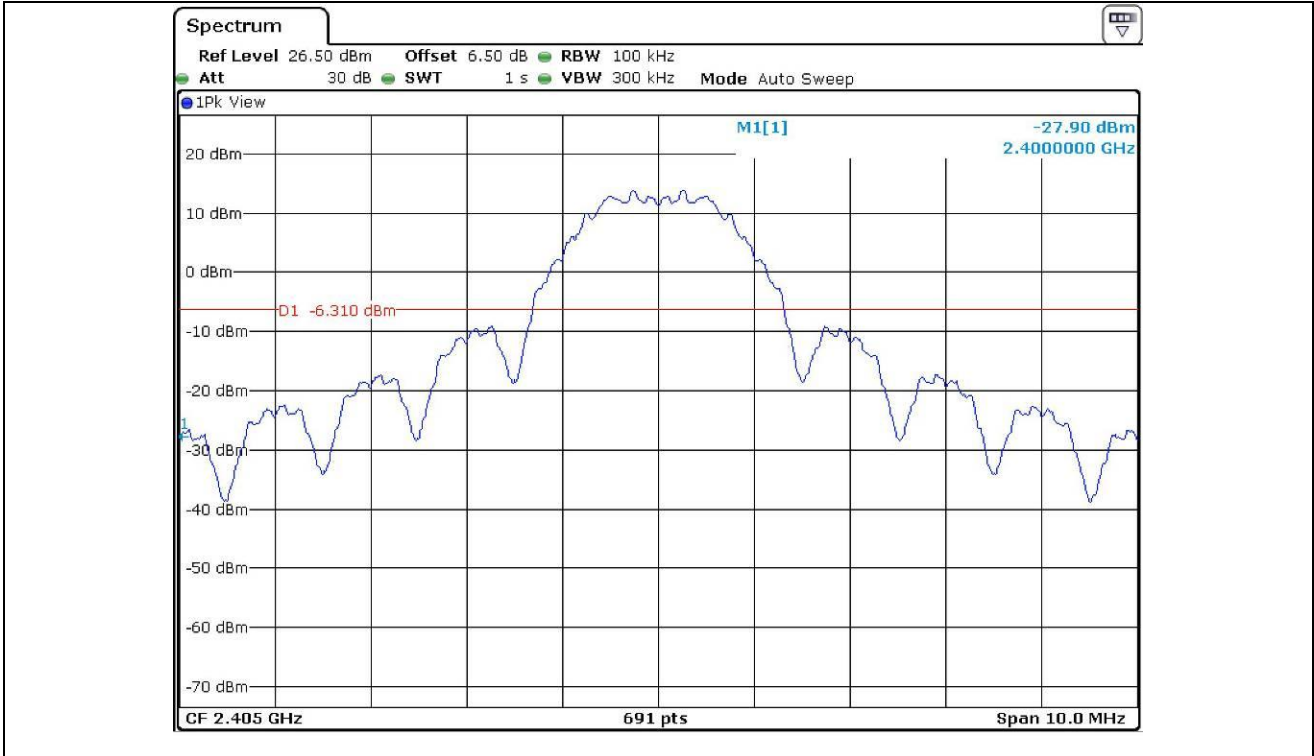
	Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
■ -	8564E	HP	Spectrum Analyzer	3650A00756	Apr. 28, 2014(1Y)
■ -	ESU	Rohde & Schwarz	EMI Test Receiver	100261	Apr. 29, 2014(1Y)
■ -	310N	Sonoma Instrument	AMPLIFIER	312544	Apr. 28, 2014(1Y)
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101372	Apr. 28, 2014(1Y)
■ -	SCU-18	Rohde & Schwarz	PRE-AMPLIFIER	10041	Jan. 20, 2014(1Y)
■ -	MA220	HD	Turn Table	N/A	N/A
■ -	HD240	HD	Antenna Mast	N/A	N/A
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-255	May 05, 2014(2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Sep. 05, 2013 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	N/A

All test equipment used is calibrated on a regular basis.

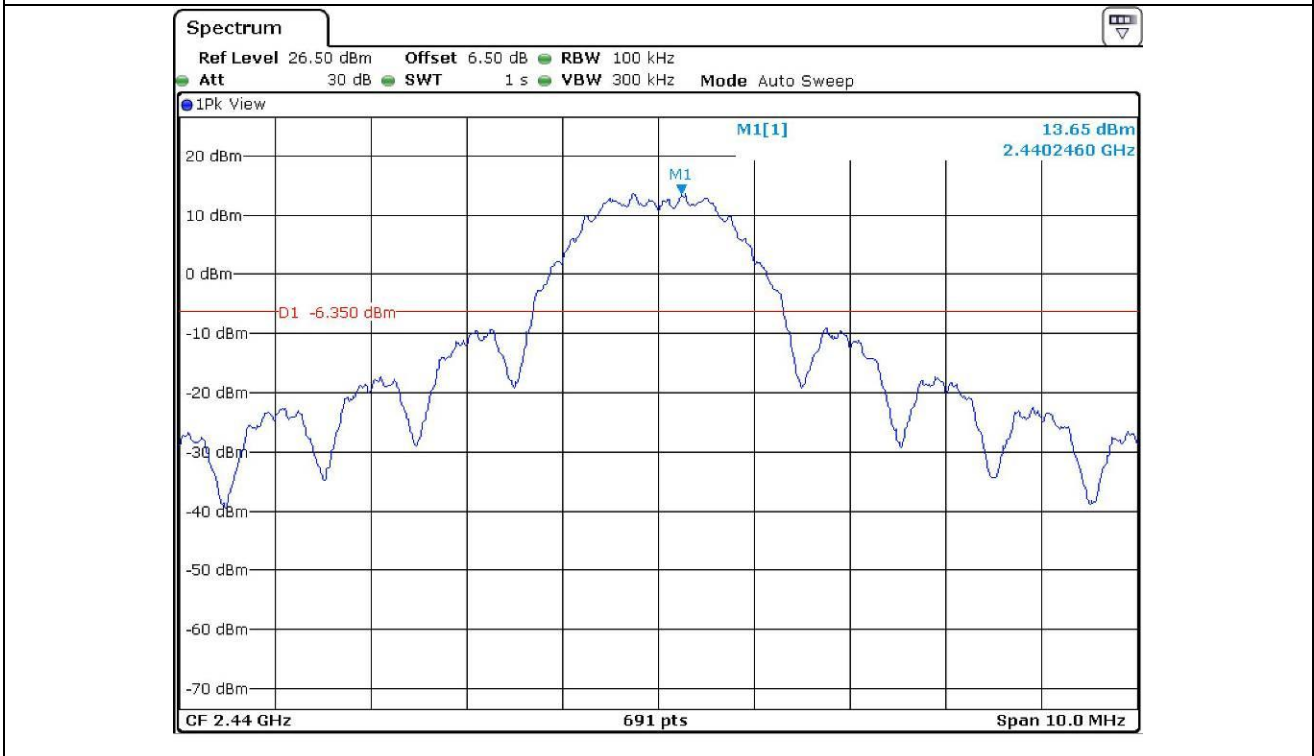


9.5 Test data for conducted emission

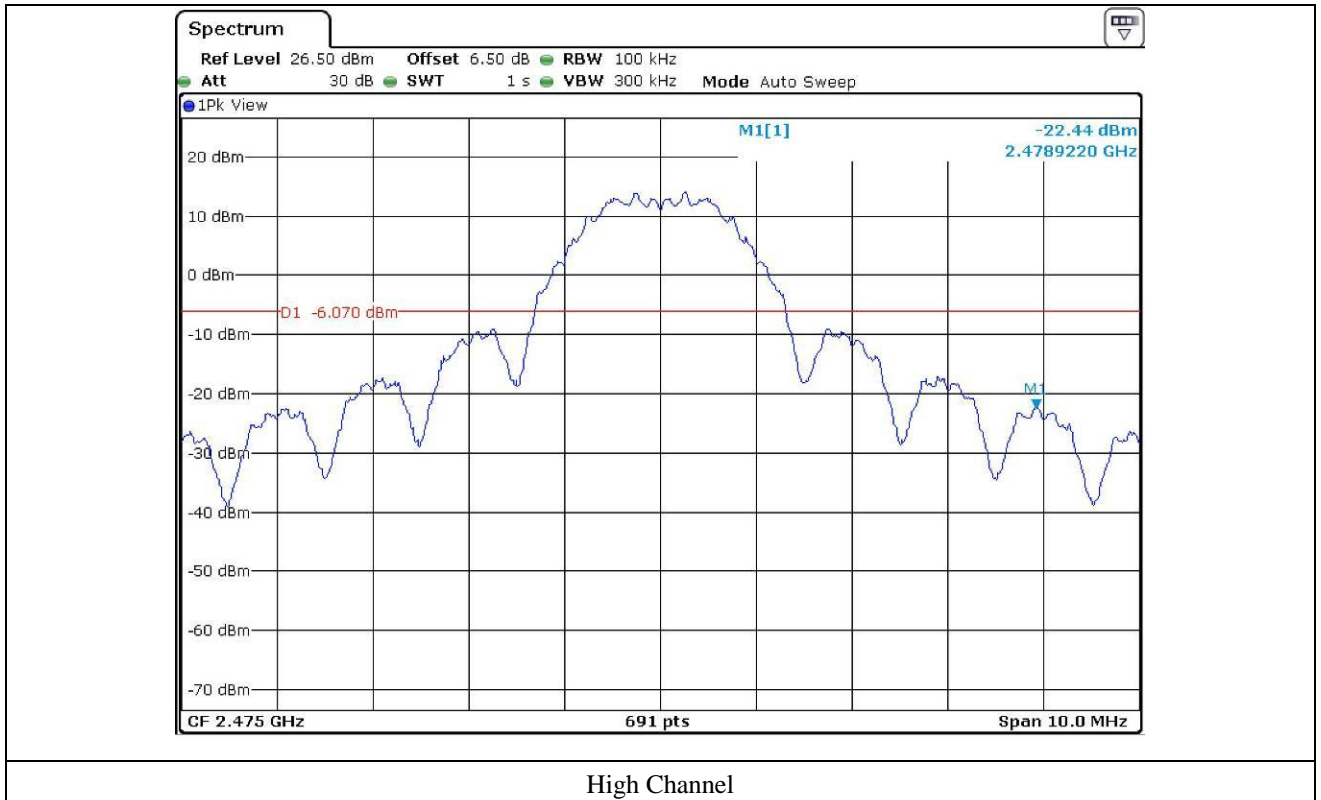
9.5.1 Test data

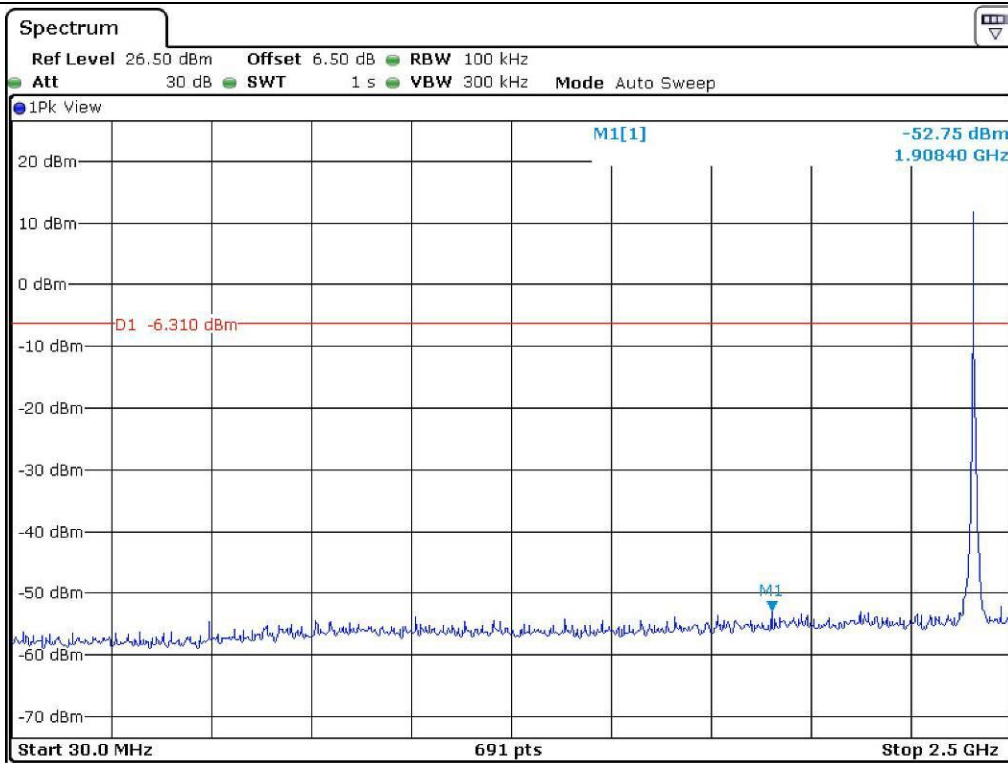


Low Channel

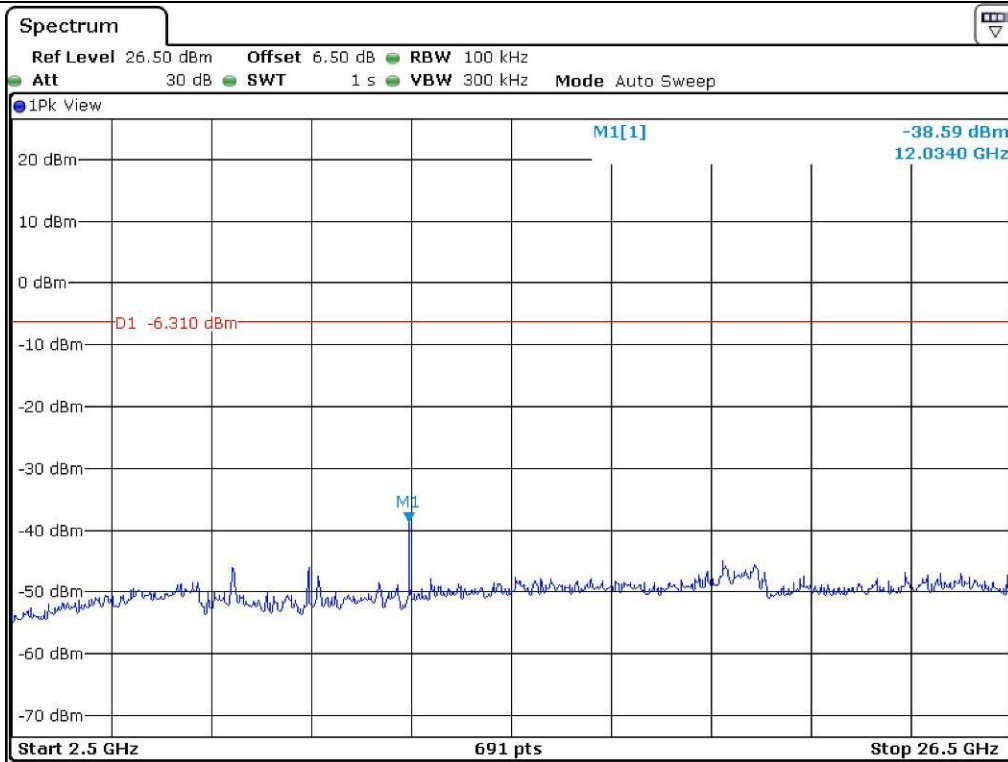


Middle Channel

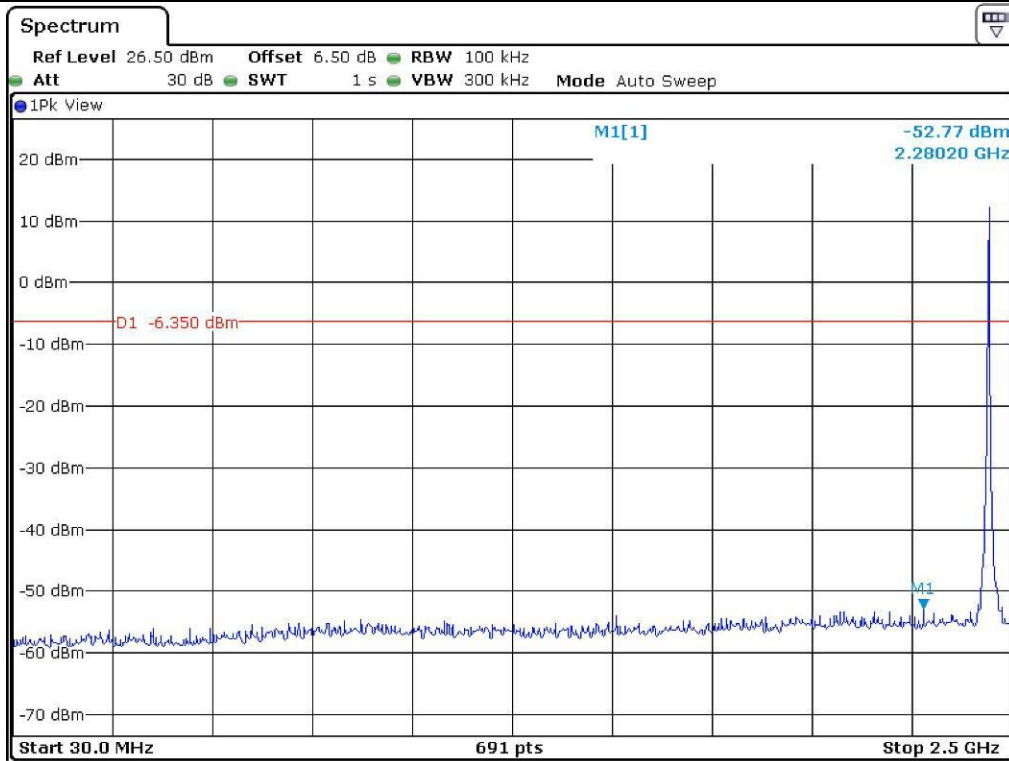




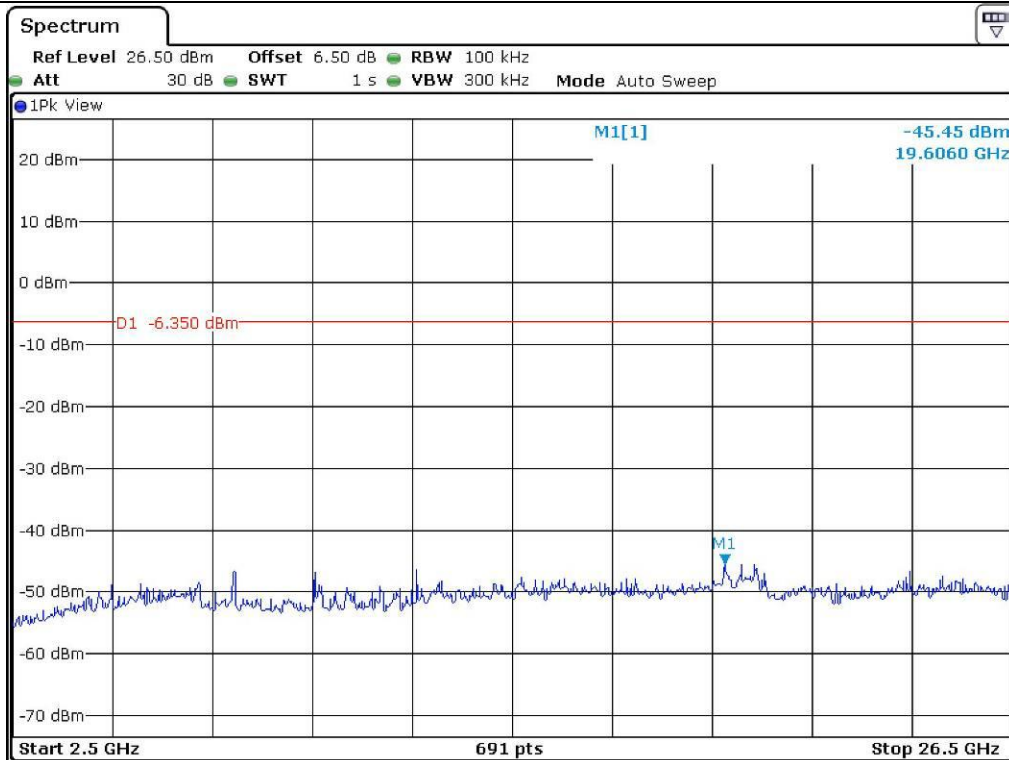
Low Channel



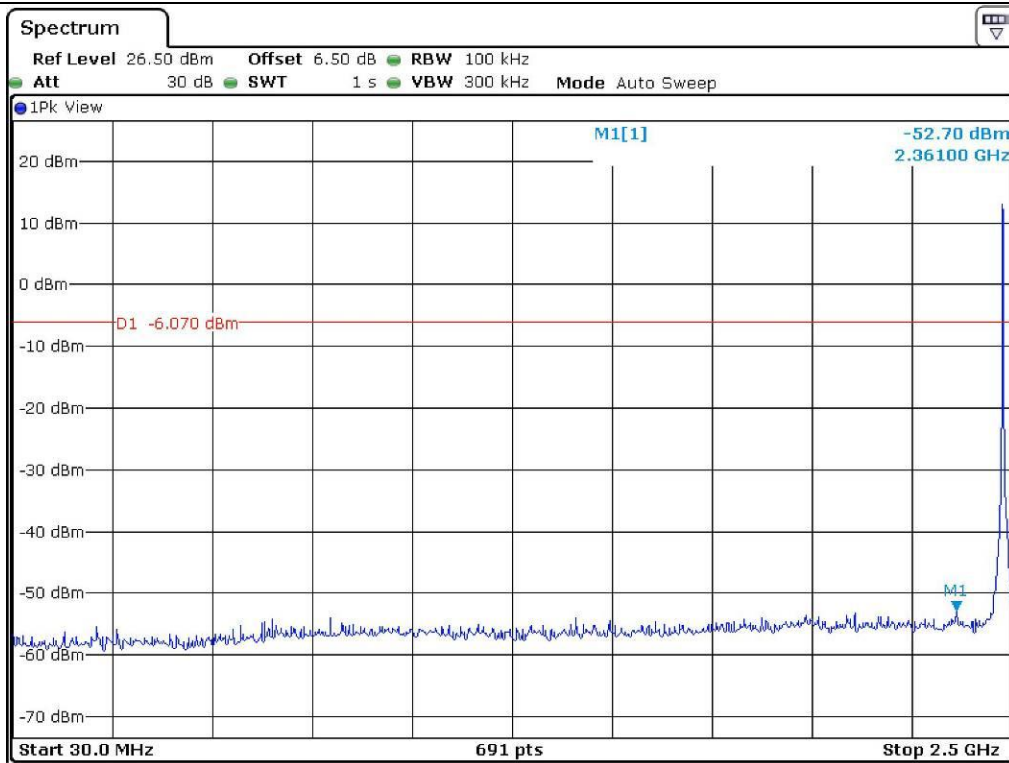
Low Channel



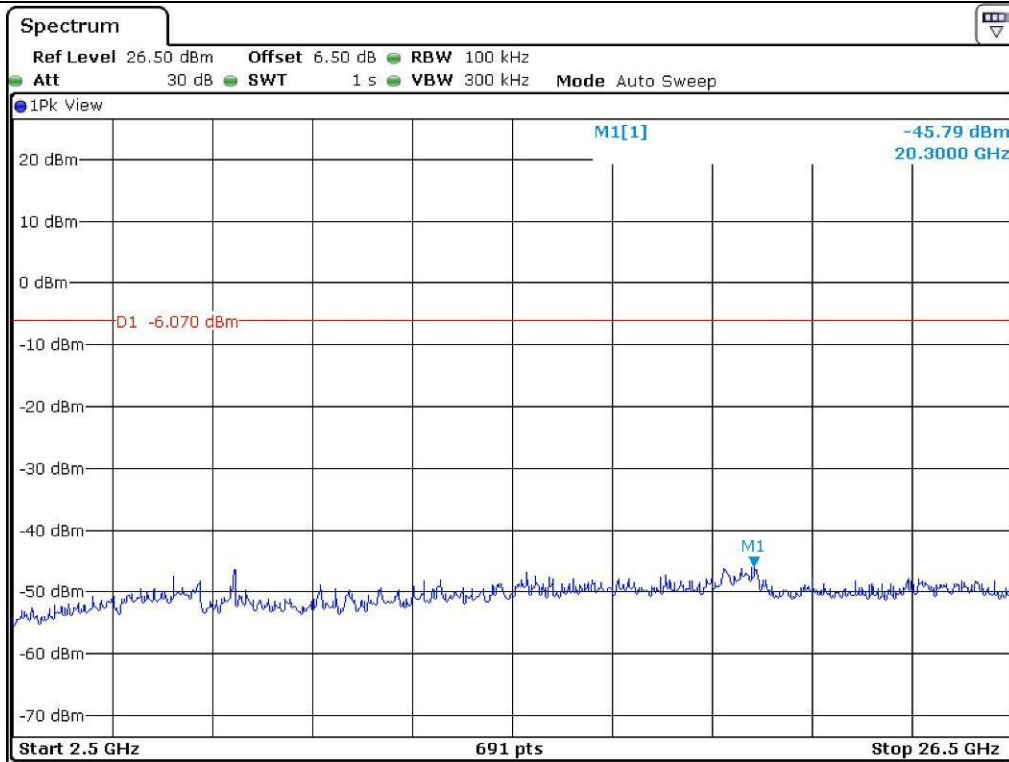
Middle Channel



Middle Channel



High Channel



High Channel

**9.6 Test data for radiated emission**

**9.6.1 Radiated Emission which fall in the Restricted Band**

- . Test Date : June 26, 2014
- . Resolution bandwidth : 100 kHz for Peak and Average Mode at 30 MHz ~ 1 GHz  
1 MHz for Peak and Average Mode at above 1 GHz
- . Video bandwidth : 100 kHz for Peak and Average Mode at 30 MHz ~ 1 GHz  
1 MHz for Peak and 10 Hz for Average Mode at above 1 GHz
- . Frequency range : 30 MHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
<b>Test Data for Low Channel</b>									
2 398.80	57.20	Peak	H	27.20	7.10	43.10	48.40	74.00	25.60
	44.90	Average	H				36.10	54.00	17.90
2 400.00	47.20	Peak	V				38.40	74.00	35.60
	30.74	Average	V				21.94	54.00	32.06
<b>Test Data for High Channel</b>									
2 483.56	44.87	Peak	H	27.40	7.10	43.10	36.27	74.00	37.73
	30.20	Average	H				21.60	54.00	32.40
2 483.50	42.78	Peak	V				34.18	74.00	39.82
	30.47	Average	V				21.87	54.00	32.13

Tabulated test data for Restricted Band

Remark: “H”: Horizontal, “V”: Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Pre-Amplifier Gain}$$



**Tested by: Tae-Ho, Kim / Project Engineer**

### 9.6.2 Spurious & Harmonic Radiated Emission

- Test Date : June 26, 2014
- Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,  
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Result : PASSED

Frequency (GHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
<b>Test Data for Low Channel</b>									
2 405.00	112.33	Peak	H	27.20	7.10	43.10	103.53	113.98	10.45
	87.94	Average	H				79.14	93.98	14.84
	110.57	Peak	V				101.77	113.98	12.21
	88.35	Average	V				79.55	93.98	14.43
4 810.00	48.91	Peak	H	31.10	9.60	42.40	47.21	73.98	26.77
	39.70	Average	H				38.00	53.98	15.98
	47.55	Peak	V				45.85	73.98	28.13
	39.50	Average	V				37.80	53.98	16.18
<b>Test Data for Middle Channel</b>									
2 440.00	113.23	Peak	H	27.30	7.10	43.10	104.53	113.98	9.45
	88.30	Average	H				79.60	93.98	14.38
	11.98	Peak	V				3.28	113.98	110.70
	87.57	Average	V				78.87	93.98	15.11
4 880.00	49.20	Peak	H	31.30	9.80	42.40	47.90	73.98	26.08
	39.75	Average	H				38.45	53.98	15.53
	48.74	Peak	V				47.44	73.98	26.54
	40.11	Average	V				38.81	53.98	15.17

Test Data for High Channel									
2 475.00	110.95	Peak	H	27.30	7.10	43.10	102.25	113.98	11.73
	86.14	Average	H				77.44	93.98	16.54
	109.77	Peak	V				101.07	113.98	12.91
	85.50	Average	V				76.80	93.98	17.18
4 950.00	47.80	Peak	H	31.30	9.90	42.30	46.70	73.98	27.28
	38.32	Average	H				37.22	53.98	16.76
	47.23	Peak	V				46.13	73.98	27.85
	38.77	Average	V				37.67	53.98	16.31

Tabulated test data for Restricted Band

Remark: “H”: Horizontal, “V”: Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Pre-Amplifier Gain}$$



**Tested by: Tae-Ho, Kim / Project Engineer**



## 10 PEAK POWER SPECTRUL DENSITY

### 10.1 Operating environment

Temperature : 25 °C  
Relative humidity : 44 % R.H.

### 10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 3 kHz, the video bandwidth is set to 3 times the resolution bandwidth. The maximum level form the EUT in 3 kHz bandwidth was measured with above condition.



### 10.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV30	R/S	Spectrum Analyzer	101372	Apr. 28, 2014(1Y)

All test equipment used is calibrated on a regular basis.

**10.4 Test data**

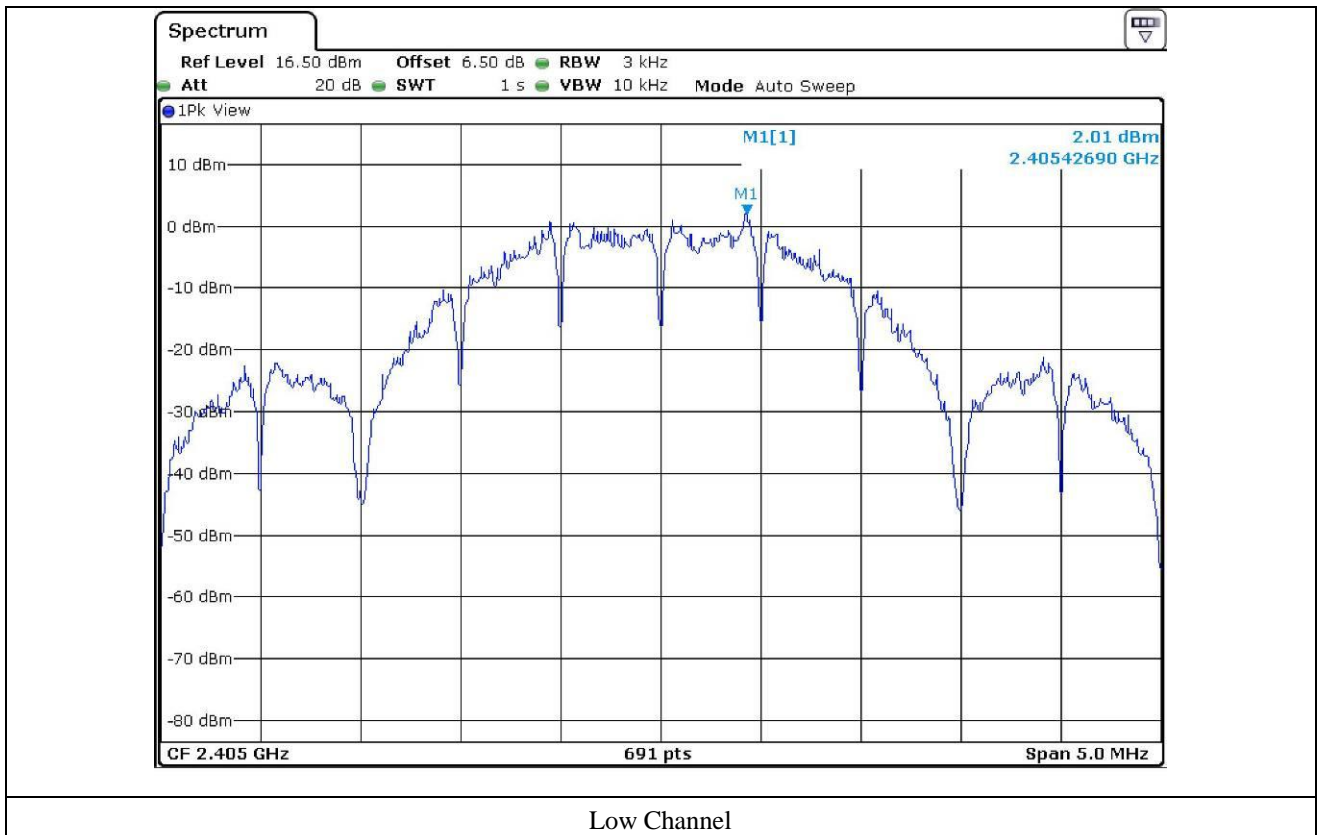
- Test Date : June 27, 2014
- Test Result : Pass
- Operating Condition : Continuous transmitting mode

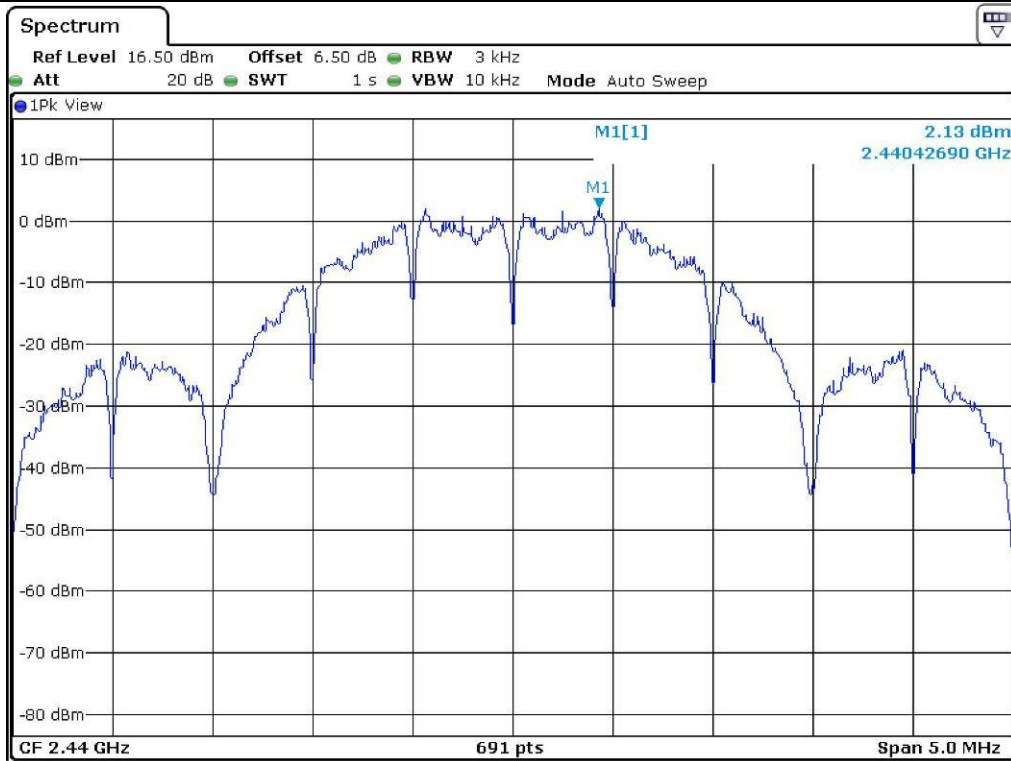
CHANNEL	FREQUENCY(MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 405	2.01	8.00	5.99
Middle	2 440	2.13	8.00	5.87
High	2 475	2.30	8.00	5.70

Remark. Margin = Limit – Measured value

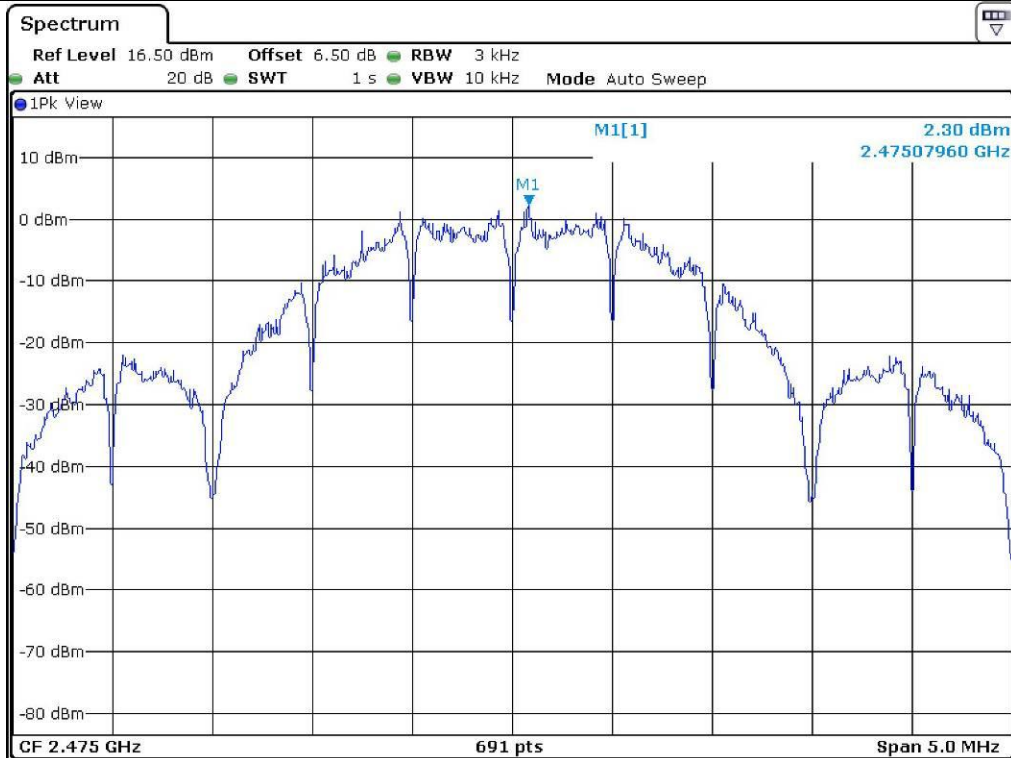


**Tested by: Tae-Ho, Kim / Project Engineer**





Middle Channel



High Channel

## 11. RADIATED EMISSION TEST

### 11.1 Operating environment

Temperature : 22 °C  
Relative humidity : 41 % R.H.

### 11.2 Test set-up

The radiated emissions measurements were on the 3 meters, open-field test site. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

The frequency spectrum from 9 kHz to 26.5 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 and 4.0 meters in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

### 11.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
□ -	ESCI	Rohde & Schwarz	EMI Test Receiver	101012	Nov. 18, 2013(1Y)
■ -	ESU	Rohde & Schwarz	EMI Test Receiver	100261	Apr. 29, 2014(1Y)
■ -	310N	Sonoma Instrument	AMPLIFIER	312544	Apr. 28, 2014(1Y)
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101372	Apr. 28, 2014(1Y)
■ -	SCU-18	Rohde & Schwarz	PRE-AMPLIFIER	10041	Jan. 20, 2014(1Y)
■ -	MA220	HD	Turn Table	N/A	N/A
■ -	HD240	HD	Antenna Mast	N/A	N/A
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	VULB9163-255	May 05, 2014(2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Sep. 05, 2013 (2Y)
■ -	83051A	Agilent	Microwave System Preamplifier	3950M00201	Apr. 30, 2014(1Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	N/A
■ -	HFH2-Z2	Rohde & Schwarz	Loop Antenna	889 285 / 26	Dec. 11, 2012 (2Y)

All test equipment used is calibrated on a regular basis.

**11.4 Test data**

**11.4.1 Test data for Below 30 MHz**

- Test Date : June 30, 2014
- Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)
- Frequency range : 9 kHz ~ 30 MHz
- Measurement distance : 3 m
- Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
It was not observed any emissions from the EUT.									

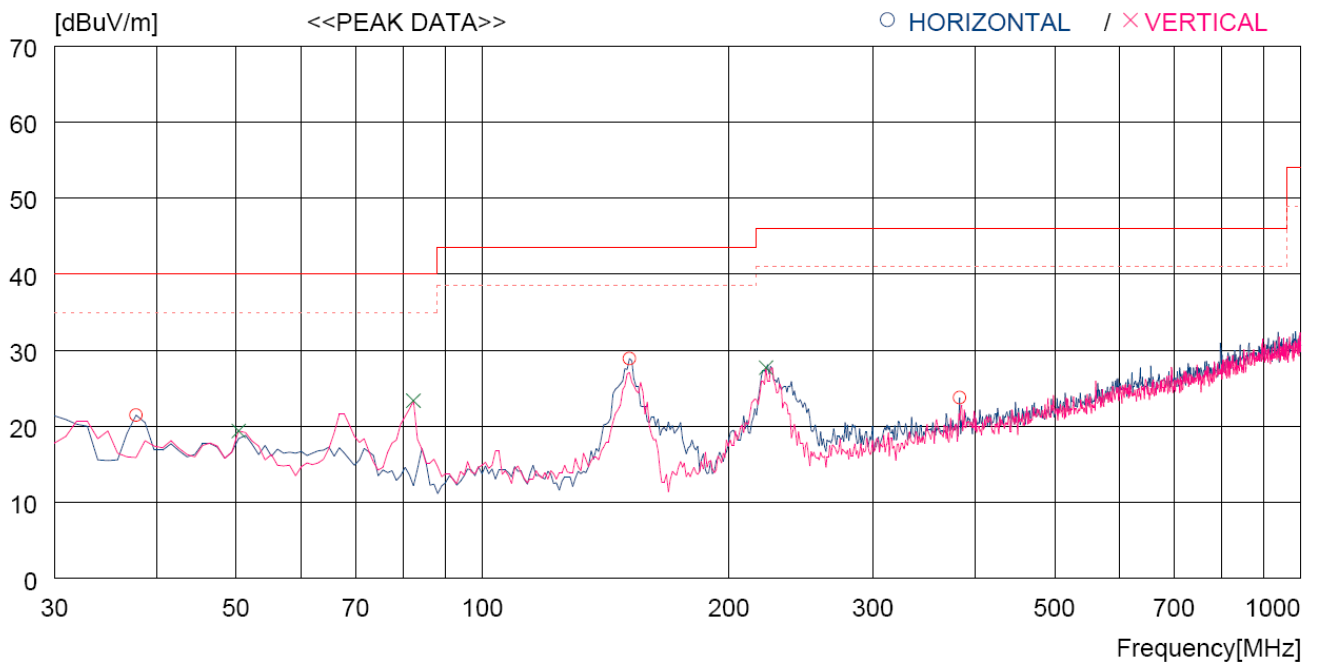


**Tested by: Tae-Ho, Kim / Project Engineer**

**11.4.2 Test data for 30 MHz ~ 1 000 MHz**

- Test Date : June 30, 2014
- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m
- Operating mode : Transmitting mode

Operating condition : Low Channel

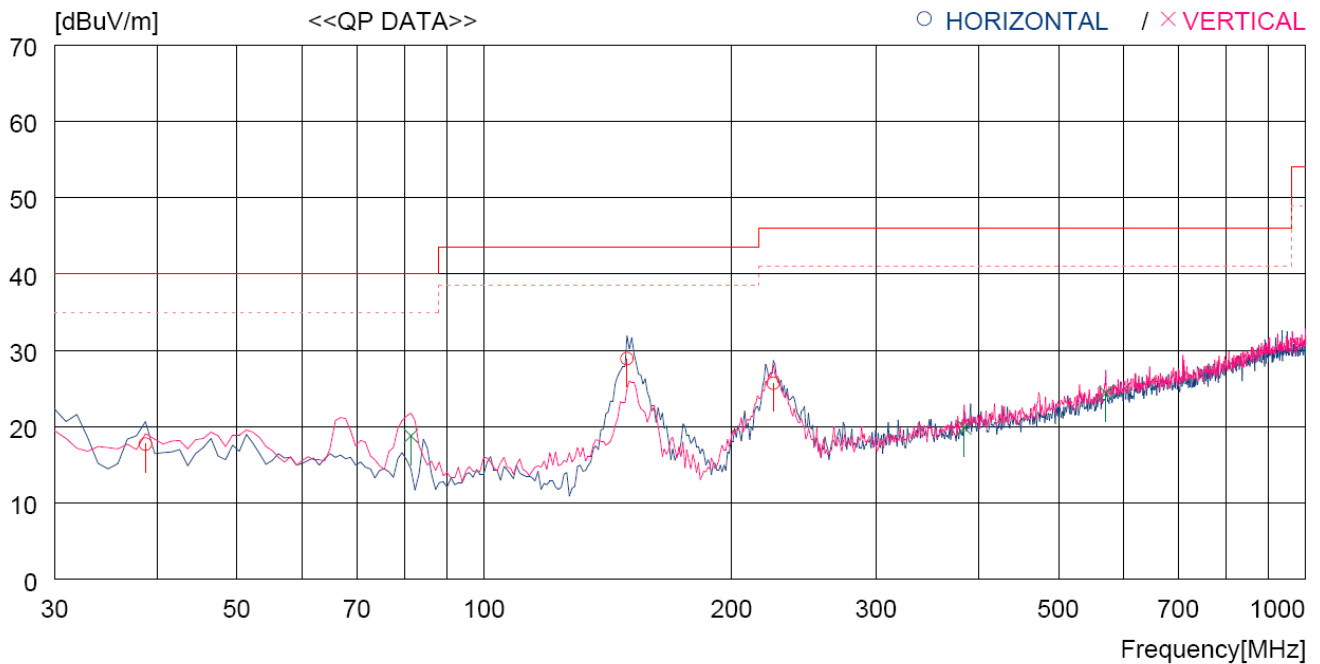


No.	FREQ [MHz]	READING PEAK [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	37.760	33.3	14.2	7.2	33.2	21.5	40.0	18.5	100	229
2	151.250	44.2	9.3	8.4	33.0	28.9	43.5	14.6	100	145
3	383.080	30.4	16.5	9.9	33.0	23.8	46.0	22.2	100	229
----- Vertical -----										
4	50.370	30.1	15.1	7.4	33.2	19.4	40.0	20.6	100	61
5	82.380	39.6	9.2	7.7	33.1	23.4	40.0	16.6	100	54
6	222.060	38.8	12.9	9.0	33.0	27.7	46.0	18.3	100	12

Remark: Margin (dB) = Limit – Result and Result = Reading Quasi- Peak + Antenna Factor + Loss – Gain

Loss and Gain in above table means Cable Loss and Pre-amplifier gain.

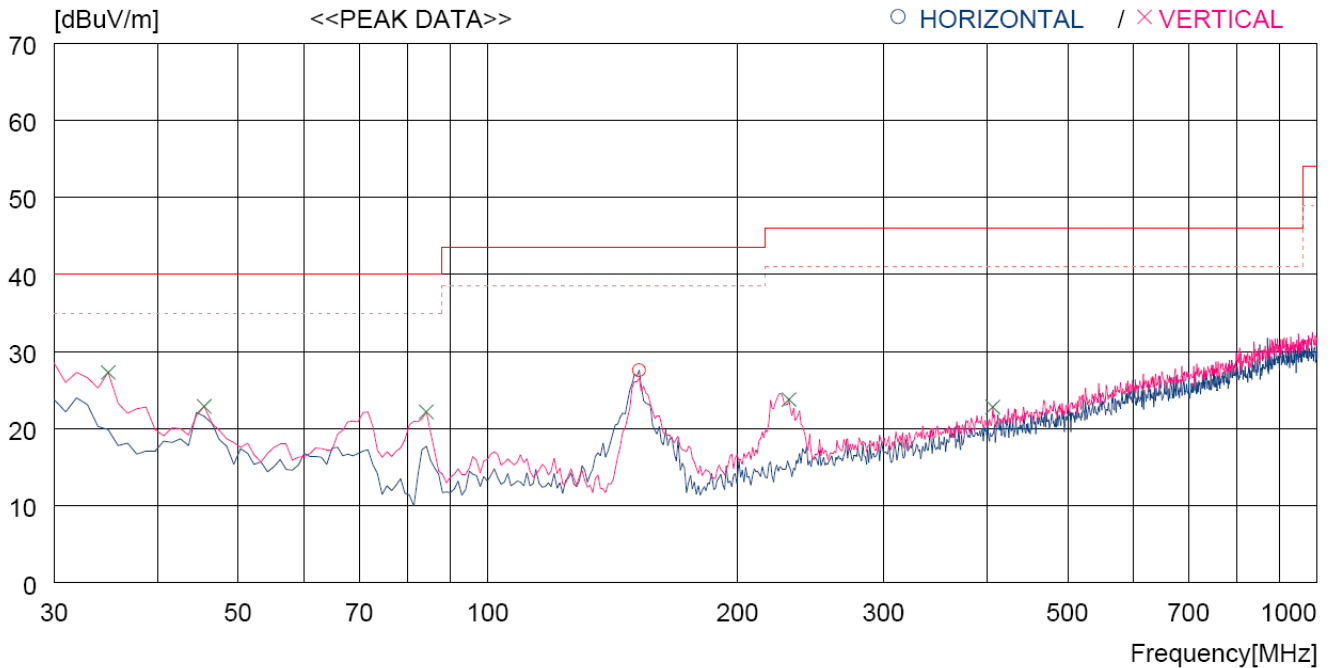
Operating condition : Middle Channel



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	38.730	30.5	13.0	7.2	33.0	17.7	40.0	22.3	100	249
2	149.310	45.2	8.3	8.4	33.0	28.9	43.5	14.6	100	334
3	224.970	38.0	11.6	9.0	32.9	25.7	46.0	20.3	100	249
----- Vertical -----										
4	81.410	36.4	7.8	7.7	33.1	18.8	40.0	21.2	111	0
5	384.050	27.5	15.5	9.9	33.0	19.9	46.0	26.1	111	0
6	571.259	28.1	18.6	11.0	33.3	24.4	46.0	21.6	100	0

Remark: Margin (dB) = Limit – Result and Result = Reading Quasi- Peak + Antenna Factor + Loss – Gain  
Loss and Gain in above table means Cable Loss and Pre-amplifier gain.

Operating condition : High Channel



No.	FREQ [MHz]	READING PEAK [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	152.220	43.8	8.4	8.4	33.0	27.6	43.5	15.9	400	328
----- Vertical -----										
2	34.850	41.1	12.1	7.1	33.0	27.3	40.0	12.7	289	359
3	45.520	34.7	13.9	7.3	33.0	22.9	40.0	17.1	400	0
4	84.320	38.9	8.6	7.8	33.1	22.2	40.0	17.8	400	0
5	230.790	35.8	11.8	9.1	32.9	23.8	46.0	22.2	289	359
6	406.360	29.7	16.0	10.1	33.0	22.8	46.0	23.2	400	166

Remark: Margin (dB) = Limit – Result and Result = Reading Quasi- Peak + Antenna Factor + Loss – Gain  
Loss and Gain in above table means Cable Loss and Pre-amplifier gain.

**Tested by: Tae-Ho, Kim / Project Engineer**



**11.4.3 Test data for above 1 GHz**

- . Test Date : June 30, 2014
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
It was not observed any emissions from the EUT.									



**Tested by: Tae-Ho, Kim / Project Engineer**

## 12. RADIO FREQUENCY EXPOSURE

### 12.1 RF Exposure Calculation

According to the FCC rule 1.1310 table 1B, the limit for the maximum permissible RF exposure for an uncontrolled environment are  $f/1500 \text{ mW/cm}^2$  for the frequency range between 300 MHz and 1 500 MHz and  $1.0 \text{ mW/cm}^2$  for the frequency range between 1 500 MHz and 100 000 MHz.

The electric field generated for a  $1 \text{ mW/cm}^2$  exposure is calculated as follows:

$$E = \sqrt{(30 * P * G) / d}, \text{ and } S = E^2 / Z = E^2 / 377, \text{ because } 1 \text{ mW/cm}^2 = 10 \text{ W/m}^2$$

Where

S = Power density in  $\text{mW/cm}^2$ , Z = Impedance of free space,  $377 \Omega$

E = Electric field strength in V/m, G = Numeric antenna gain, and d = distance in meter

Combining equations and rearranging the terms to express the distance as a function of the remaining variable

$$d = \sqrt{(30 * P * G) / (377 * 10 S)}$$

Changing to units of mW and cm, using  $P (\text{mW}) = P (\text{W}) / 1 000$ ,  $d (\text{cm}) = 0.01 * d (\text{m})$

$$d = 0.282 * \sqrt{(P * G) / S}$$

Where

d = distance in cm, P = Power in mW, G = Numeric antenna gain, and S = Power density in  $\text{mW/cm}^2$

### 12.2 Calculated MPE Safe Distance

According to above equation, the following result was obtained.

Operating Freq. Band (MHz)	Peak Output Power		Antenna Gain		Safe Distance (cm)	Power Density ( $\text{mW/cm}^2$ ) @ 20 cm Separation	Limit ( $\text{mW/cm}^2$ )
	(dBm)	(mW)	Log	Linear			
2 405 ~ 2 475	17.14	51.76	0.27	1.06	2.09	0.0109	1.00

$$D = 0.282 * \sqrt{(51.76 * 1.06) / 1.00} = 2.09 \text{ cm.}$$

For getting power density at 20 cm separation in above table, following formula was used.

$$S = P * G / (4\pi * R^2) = 51.76 * 1.06 / (4 * 3.14 * 20^2) = 0.0109$$

Where:

S = Power Density,

P = Power input to the external antenna (Output power from the EUT antenna port (dBm) – cable loss (dB)),

G = Gain of Transmit Antenna (linear gain), R = Distance from Transmitting Antenna