RF Test Report

Test Report No.	:	TK-FR11041
Standards	:	Part 15 Subpart C 15.247
FCC ID	:	X4ORPH-1000
Description of Product	:	VoIP System
Applicant	:	RF WINDOW Co., Ltd.
Manufacturer	:	RF WINDOW Co., Ltd.
Model Name	:	RPH-1000
Date of test(s)	:	2011.06.13 ~ 2011.06.17
Date of issue	:	2011.06.20

The test results relate only to the items tested.

Test and Report Completed by :	**Report Approval by :**
	
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Revision history

Revision	Date of issue	Test report No.	Description
-	2011.06.20	TK-FR11041	Initial

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1. General product description

Equipment model name	:	RPH-1000
Serial number	:	Prototype
EUT condition	:	Pre-production, not damaged
Antenna type & gain	:	Chip Antenna(Max. 3.7 ㏈i)
Frequency Range	:	2402 ㎒ ~ 2480 ㎒
Number of channels	:	79
Type of Modulation	:	GFSK
Power Source	:	DC 3.7 V

1.1 Test frequency

	Low channel	Middle channel	High channel
Frequency (㎒)	2402	2440	2480

1.2 Test mode

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

1.3 Model differences

Not applicable

1.4 Device modifications

The following modifications were necessary for compliance: Not applicable manufacturer

1.5 Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Netbook	Lenovo	S10-2	2957N5K

1.6 Test facility

The measurement facility is located at 477-6, Hageo-ri, Yeoju-eup, Yeoju-gun, Gyeonggi-do, 469-803, Korea.
Tel: +82-31-883-5092/Fax: +82-31-883-5169.
The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 and CISPR Publication 22.

1.7 Laboratory accreditations and listings

Country	Agency	Scope of accreditation	Logo
USA	FCC	3 & 10 meter Open Area Test Sites and one conducted site to perform FCC Part 15/18 measurements.	343818
KOREA	KCC	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

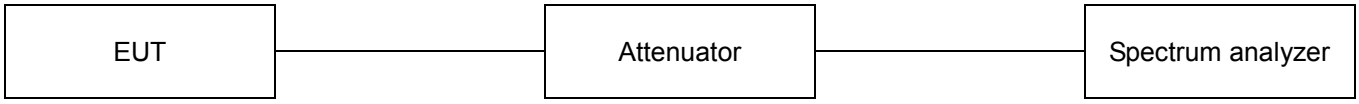
1.8 Summary of tests

Section in FCC Part 15	Parameter	Status
15.247(a)(2)	6 dB Bandwidth	C
15.247(b)(3)	Maximum peak output power	C
15.247(e)	Power spectral density	C
15.247(d)	Conducted spurious emission & band edge	C
15.247(d)	Radiated spurious emission & band edge	C
15.247(i) 1.1307(b)(1)	RF exposure evaluation	C
Note 1: C=Complies NC=Not complies NT=Not tested NA=Not applicable		
Note 2: The data in this test report are traceable to the national or international standards.		
Note 3: The sample was tested according to the following specification: FCC Part 15.247, ANSI C63.4-2003		

2.1 Technical characteristic test

2.1.1 6 dB Bandwidth

Test setup



Test procedure

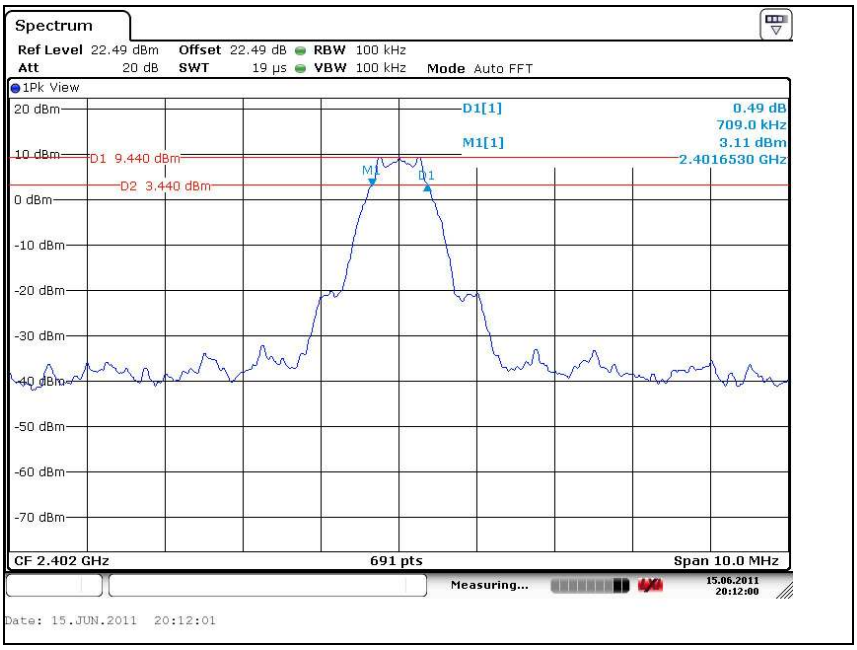
1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer
3. Set the spectrum analyzer as RBW = 100 ㎑, VBW = RBW, Span = 20 ㎒, Sweep = auto.
4. Mark the peak frequency and -6 dB (upper and lower) frequency.
5. Repeat until all the rest channels are investigated.

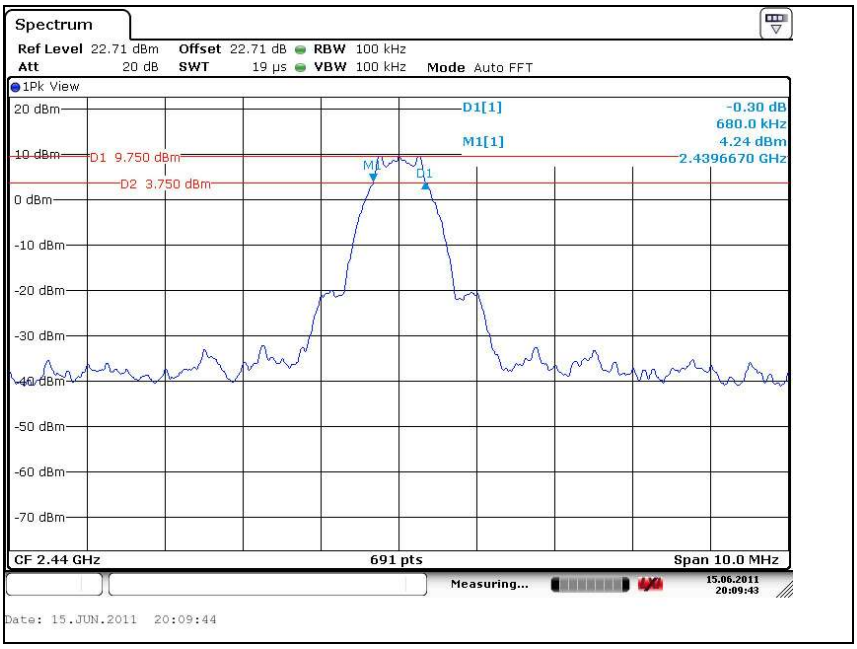
Limit

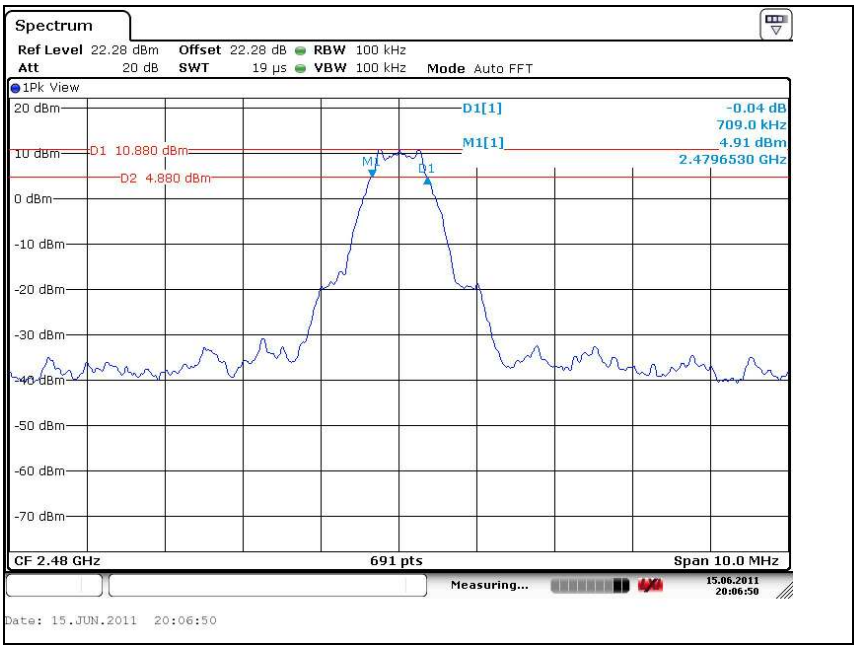
According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902 ~928 ㎒, 2400 ~ 2483.5 ㎒, and 5725 ~ 5825 ㎒ bands. The minimum of 6 dB Bandwidth shall be at least 500 ㎑

Test results

Frequency (㎒)	6 dB Bandwidth (㎑)	26 dB Bandwidth (㎒)
2402	709	1.360
2440	680	1.360
2480	709	1.375

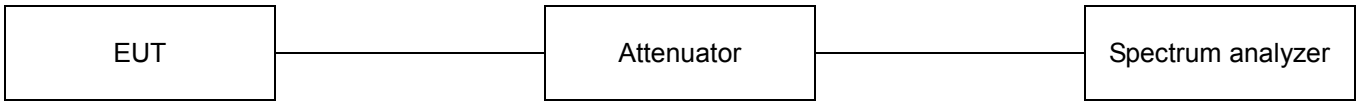






2.1.2 Maximum peak output power

Test setup



Test procedure

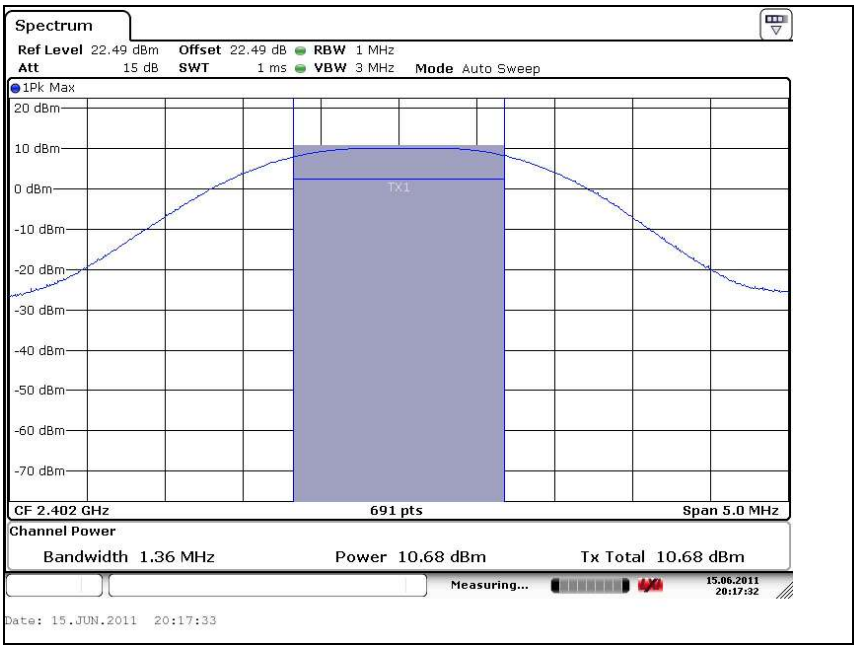
1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the Spectrum analyzer as RBW = 1 ㎒, VBW = 3 ㎒, Span = Auto, Channel BW = 26 ㏈ Bandwidth.

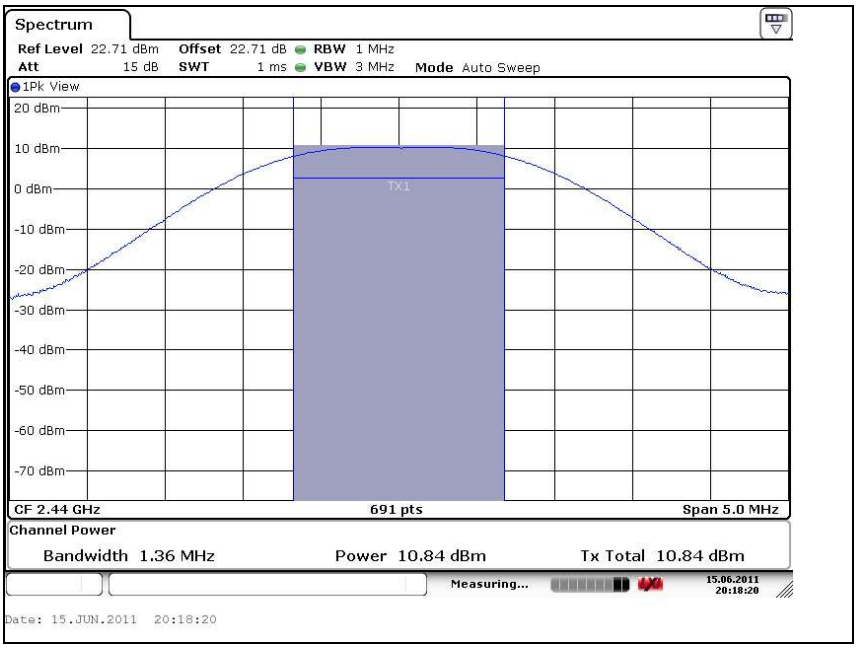
Limit

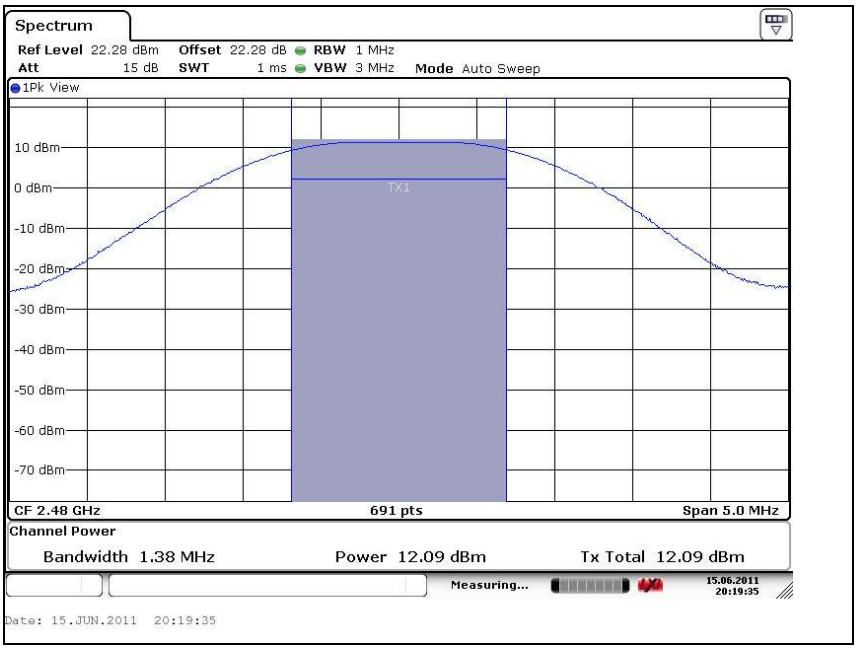
According to §15.247(b)(3), for systems using digital modulation in the 902 ~ 928 ㎒, 2400 ~2483.5 ㎒, and 5725 ~ 5850 ㎒ band: 1 Watt.
As an alternative to a peak power measurement, compliance with the one watt limit can be based on a measurement of the maximum conducted output power.
Maximum Conducted output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antenna elements.
The average must not include any intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

Test results

Frequency (㎒)	Maximum peak output power (㏈m)
2402	10.68
2440	10.84
2480	12.09

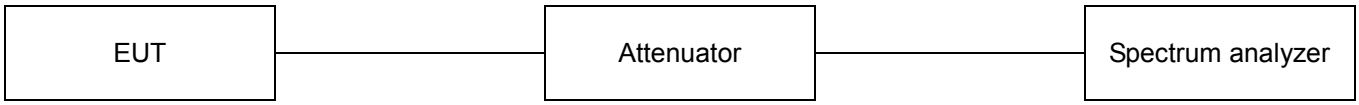






2.1.3 Power spectral density

Test setup



Test procedure

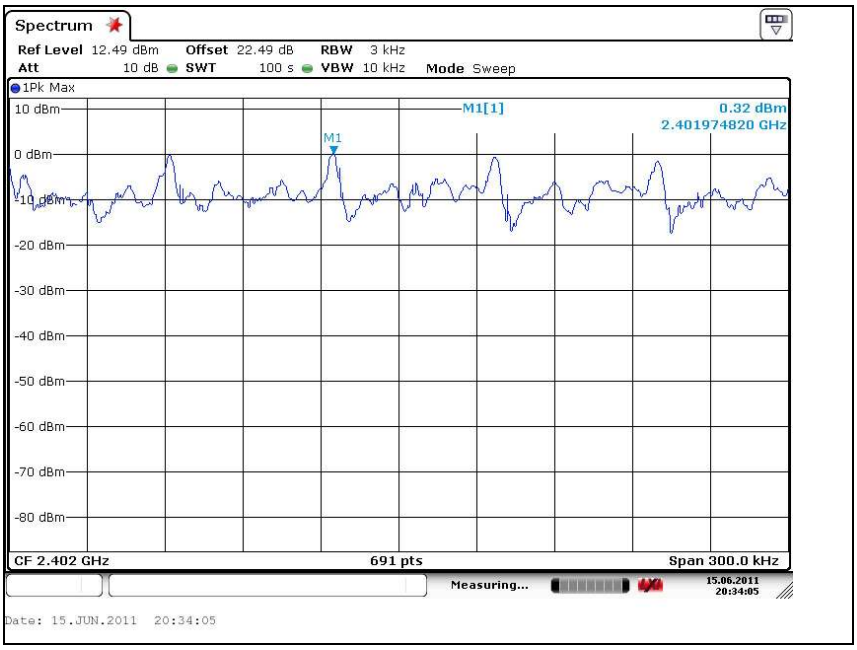
1. Place the EUT on the table and set it in transmitting mode
   Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
2. Set the spectrum analyzer as RBW = 3 ㎑, VBW = 10 ㎑, Span = 300 ㎑, Sweep = 100 s
3. Record the max reading.
4. Repeat the above procedure until the measurements for all frequencies are completed.

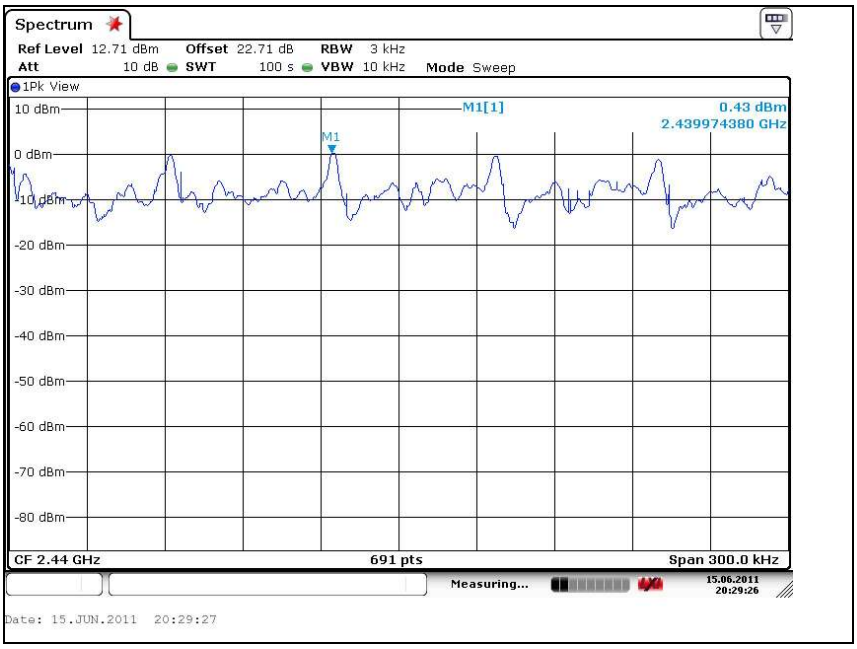
Limit

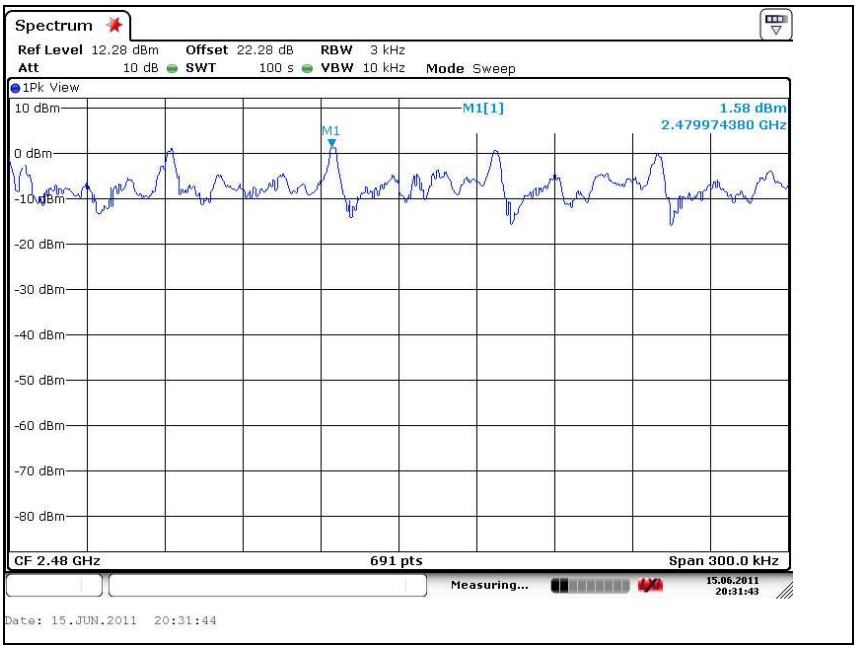
According to §15.247(e), For digitally modulated system, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 ㏈m in any 3 ㎑ band any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph(b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density

Test results

Frequency (㎒)	Power spectral density (㏈m)
2402	0.32
2440	0.43
2480	1.58

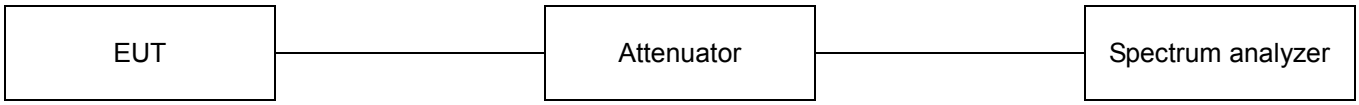






2.1.4 Conducted spurious emission & band edge

Test setup



Test procedure for band edge

1. Use the following spectrum analyzer setting
   Center frequency: Lowest, middle and highest channels
   Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.
   RBW = 100 ㎑
   VBW = 100 ㎑ (≥ RBW)
   Sweep = auto
   Detector function = peak
   Trace = max hold
2. Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge.
   Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission

Test procedure for spurious emission

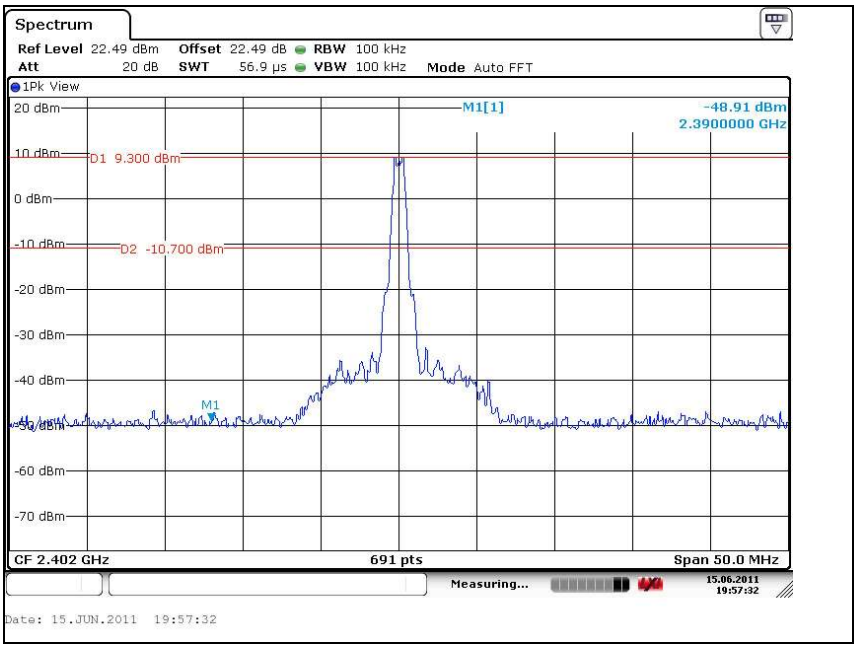
1. Use the following spectrum analyzer setting
   Center frequency: Lowest, middle and highest channels
   Span = wide enough to capture the peak level of the in-band emission and all spurious emissions from the lowest frequency generated in the EUT up through the 10th harmonics.
   RBW = 100 ㎑
   VBW = 100 ㎑ (≥ RBW)
   Sweep = auto
   Detector function = peak
   Trace = max hold
2. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.

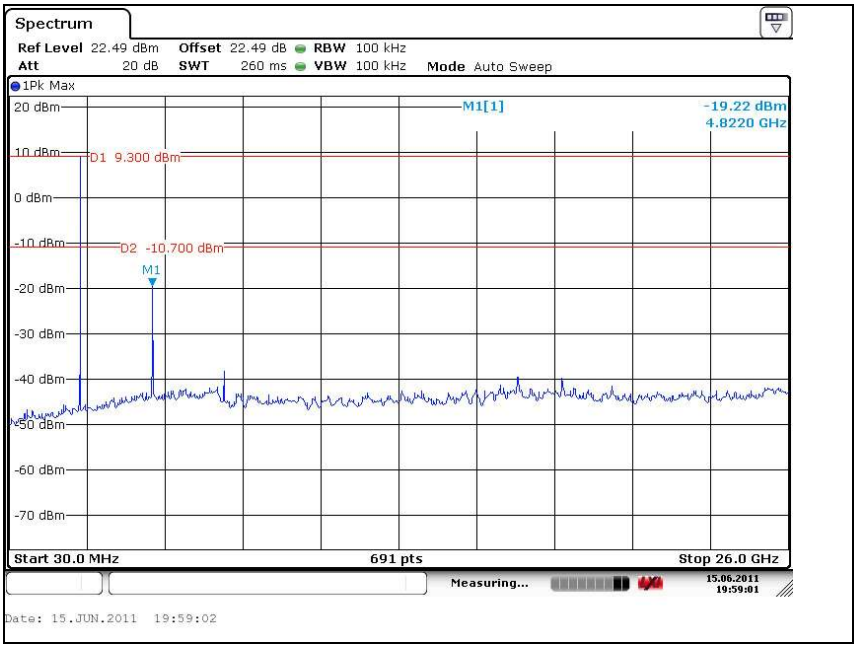
Limit

According to 15.247(d), in any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 ㏈ below that in the 100 ㎑ bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement , provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval , as permitted under paragraph(b)(3) of this section , the attenuation required under this paragraph shall be 30 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in section 15.209(a) is not required.
In addition, radiated emission which in the restricted band, as define in section 15.205(a), must also comply the radiated emission limits specified in section 15.209(a) (see section 15.205(c))

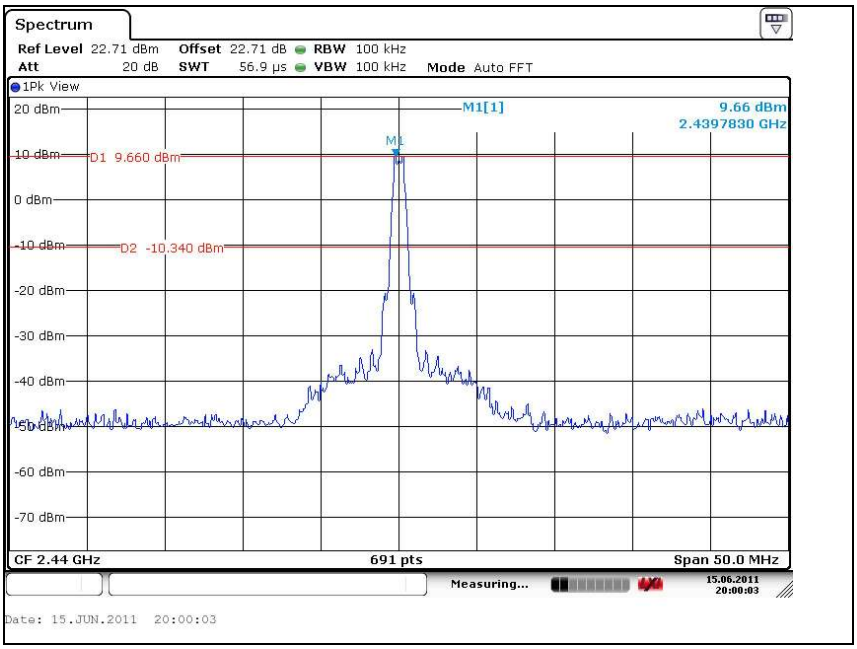
Test results

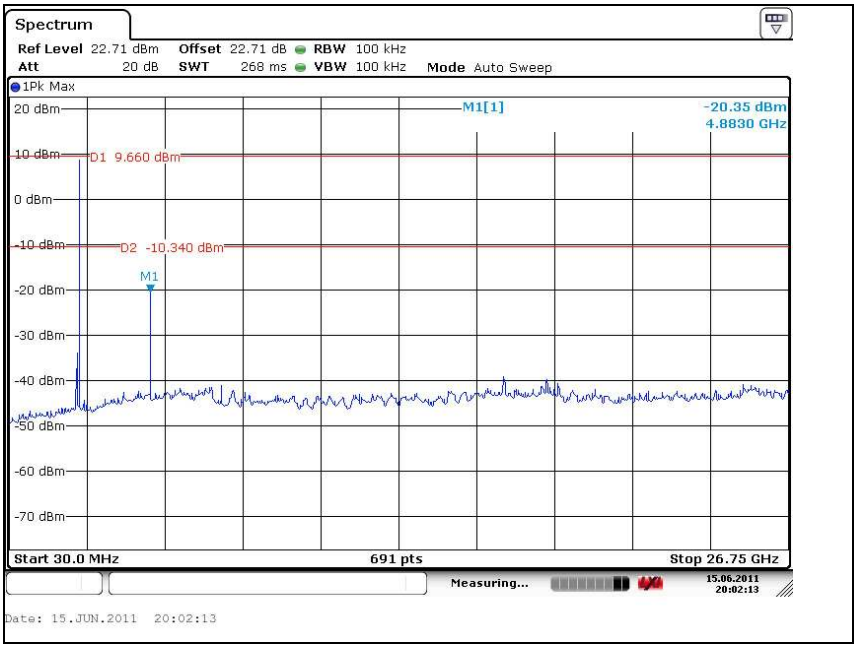
Low channel



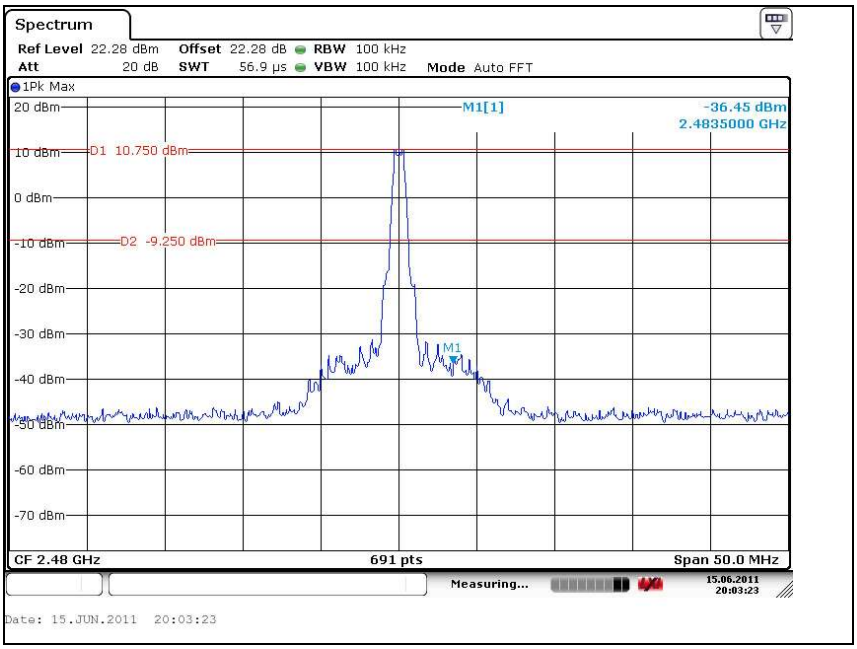


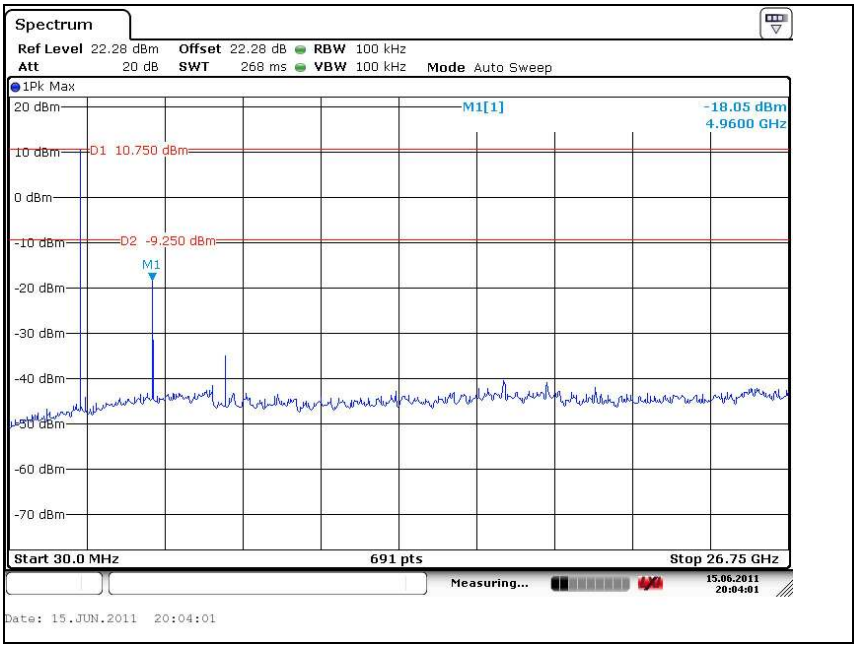
Middle channel





High channel





2.1.5 Radiated spurious emission & band edge

Test location

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

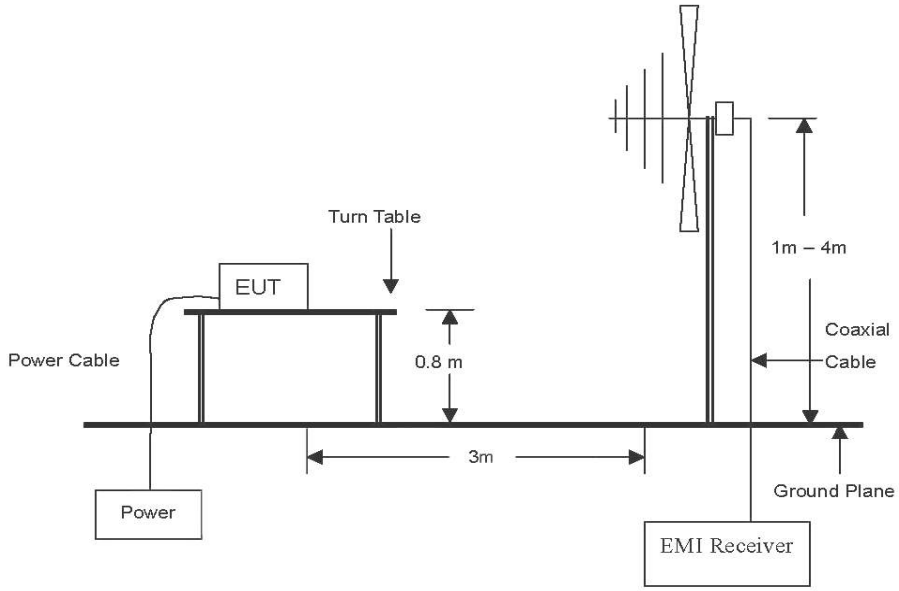
Test procedures

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.

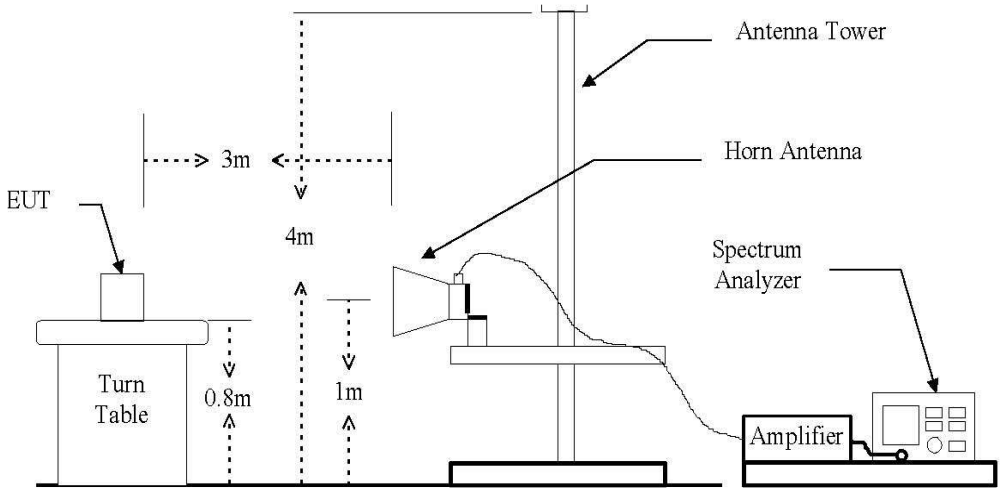
The spectrum analyzer is set to:

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

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



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to 24 ㎓ emissions.



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 (㎒)	Distance (Meters)	Radiated (dB㎶/m)	Radiated (㎶/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

Test results (Below 1000 ㎒)

The frequency spectrum from 30 ㎒ to 1000 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈.

Radiated emissions		Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Pol.	Ant. factor (㏈/m)	Cable loss (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
31.9	14.76	H	13.28	0.83	28.87	43.50	14.63
31.9	19.35	V	13.28	0.83	33.46	43.50	10.04
440.1	8.29	H	15.74	2.34	26.37	46.00	19.63

※ Remark

1. All spurious emission at channels are almost the same below 1 ㎓, so that high channel was chosen at representative in final test.
2. Actual = Reading + Ant. factor + Amp + Cable loss
3. Detector mode: Quasi peak
4. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

Test results (Above 1000 ㎒)

Low channel

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/ m)	Margin (dB)
2390.0*	43.29	Peak	H	28.31	-24.62	46.98	74.00	27.02
2390.0*	43.30	Peak	V	28.31	-24.62	46.99	74.00	27.01
4804.0*	34.75	Peak	H	33.91	-17.58	51.08	74.00	22.92
4804.0*	34.79	Peak	V	33.91	-17.58	51.12	74.00	22.88

Middle channel

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/ m)	Margin (dB)
4880.0*	33.55	Peak	H	34.16	-17.33	50.38	74.00	23.62
4880.0*	34.79	Peak	V	34.16	-17.33	51.62	74.00	22.38

High channel

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/ m)	Margin (dB)
2483.5*	54.37	Peak	H	28.50	-24.47	58.40	74.00	15.60
2483.5*	44.49	Average	H	28.50	-24.47	48.52	54.00	5.48
2483.5*	59.61	Peak	V	28.50	-24.47	63.64	74.00	10.36
2483.5*	48.10	Average	V	28.50	-24.47	52.13	54.00	1.87
4960.0*	34.37	Peak	H	34.42	-17.06	51.73	74.00	22.27
4960.0*	33.23	Peak	V	34.42	-17.06	50.59	74.00	23.41

※ Remark

1. "*" means the restricted band.
2. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental frequency.
3. Radiated emissions measured in frequency above 1000 ㎒ were made with an instrument using peak/average detector mode. Average test would be performed if the peak result were greater than the average limit.
4. Actual = Reading + Ant. factor + Amp + CL (Cable loss)
5. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

2.1.6 RF exposure evaluation

According to FCC 1.1310 : The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in §1.1307(b)

Limits for maximum permissible exposure (MPE)

Frequency range (㎒)	Electric field strength(V/m)	Magnetic field strength (A/m)	Power density (㎽/㎠)	Average time
(A) Limits for Occupational / Control exposures				
300 – 1500	--	--	F/300	6
1500 – 100000	--	--	5	6
(B) Limits for General Population / Uncontrol Exposures				
300 – 1500	--	--	F/1500	6
1500 – 100000	--	--	1	30

Friis transmission formula: $P_d = (P_{out} \times G)/(4 \times P_i \times R2)$

Where;

P_d = power density in ㎽/㎠

P_{out} = output power to antenna in ㎽

G = gain of antenna in linear scale

P_i = 3.141 6

R = distance between observation point and center of the radiator in ㎝

P_d the limit of MPE, 1 ㎽/㎠. If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance where the MPE limit is reached.

Output power into antenna & RF exposure evaluation distance

Frequency (㎒)	Average power (dBm)	Max. antenna gain (dBi)	Power density at 20 ㎝ (㎽/㎠)	Limit (㎽/㎠)
2402	9.50	3.70	0.00416	1
2440	9.80	3.70	0.00445	
2480	10.99	3.70	0.00586	

※ Remark

The power density P_d at a distance of 20 ㎝ calculated from the friis transmission formula is far below the limit of 1 ㎽/㎠ .

Appendix A – Test equipment used for test

Equipment	Manufacturer	Model	Calibration due.
Spectrum Analyzer	R&S	FSV30	2012-01-07
Vector Signal Generator	R&S	SMBV2100A	2012-01-07
Synthesized Signal Generator	HP	8673D	2011-06-25
Power Meter	Agilent	N1911A	2012-05-04
Power Sensor	Agilent	N1912A	2012-05-04
Attenuator	HP	8495B	2012-05-04
Attenuator	HP	8494B	2012-05-04
Trilog-BroadBand Antenna	Schwarzbeck	VULB 9168	2013-04-28
Horn Antenna	A.H.	SAS-571	2013-03-22
High Pass Filter	Wainwright Instrument	WHJS3000-10TT	2012-01-07
Preamplifier	HP	8449B	2011-07-27

Test setup photos

Radiated field emissions