FCC Part 15 Subpart C §15.247
RSS-210 ISSUE No. :9

Test Report

Equipment Under Test	**Pico Projector**
Model Name	**PicoBit**
Variant Model Name	**PicoBit-S**
Applicant	**CELLUON, INC.**
FCC ID	**TCLPICOBIT**
IC Number	**10211A-PICOBIT**
Manufacturer	**CELLUON, INC.**
Date of Test(s)	**2017. 01.03 ~ 2017. 01. 18**
Date of Issue	**2017. 01. 18**

In the configuration tested, the EUT complied with the standards specified above.

Issue to	Issue by
CELLUON, INC. Ace High-End Tower 1101 235-2, Guro-Dong, Guro-Gu, Seoul, Korea, 152-740 Tel.: +82-2-6220-3886 Fax: +82-2-6220-3899	**MOVON CORPORATION** 498-2, Geumeo-ro, Pogok-eup, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 449-812 Tel.: +82-31-338-8837 Fax: +82-31-338-8847

Revision history

Revision	Date of issue	Description	Revised by
--	Jan 18, 2017	Initial	--

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1. Attestation of test result

1.1. Details of applicant and Manufacturer

Applicant	:	CELLUON, INC.
Address	:	Ace High-End Tower 1101 235-2, Guro-Dong, Guro-Gu, Seoul, Korea, 152-742
Contact Person	:	Chun Bae, Park
Telephone	:	+82-2-6220-3886
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1.3. Summary of test results

The EUT has been tested according to the following specifications;

Section in FCC part 15	Section in RSS-GEN, RSS-210	Description	Result
§15.205 §15.209 §15.247(d)	5.5	Transmitter radiated spurious emissions, Conducted spurious emission	C
§15.109(a)	RSS-Gen 6	Receiver radiated spurious emission	C
§15.247(a)(2)	A8.2(a)	6 dB Bandwidth and 99 % bandwidth	C
§15.247(b)(e)	A8.4(4)	Maximum Conducted Output Power	C
§15.247(e)	A8.2(b)	Transmitter Power Spectral Density	C
§1.1307(b)(1)	RSS-Gen 5.5 RSS-102	RF exposure evaluation	C
§15.207(a)	7.2.2	Conducted power line test	C

The sample was tested according to the following specification:
FCC Parts 15.247; ANSI C63.4:2014, ANSI C63.10:2013
FCC Public Notice KDB 558074 D01 v03r05
TEST SITE REGISTRATION NUMBER: ***FCC(KR0151), IC(6432B-3), IC(21313-1)***

※ Abbreviation

C Complied
N/A Not applicable
F Fail

※ NOTE

Note 1 : No operate during charging.

Approval Signatories

Test and Report Completed by :	Report Approval by :
Kin Son Test Engineer MOVON CORPORATION	Issac Jin Technical Manager MOVON CORPORATION

2. EUT Description

Kind of product	Pico projector
Model Name	PicoBit
Variant Model Name	PicoBit-S
FCC ID	TCLPICOBIT
IC Number	10211A-PICOBIT
Serial Number	N/A
Power supply	DC 3.8V
Frequency range	2 402 ㎒ ~ 2 480 ㎒
Modulation technique	GFSK
Number of channels	40
Antenna gain	-13.68 ㏈i (Max.)
Test Site Registration Number	FCC(KR0151), IC(6432B-3), IC(21313-1)

2.1. Declarations by the manufacturer
None

2.2. Details of modification
None

3. Measurement equipment.

Equipment	Manufacturer	Model	Serial number	Calibration Interval	Calibration due.
Test Receiver	R&S	ESVS30	829673/015	1 year	2017-12-09
Signal Generator	R&S	SMA100A	102188	1 year	2017-12-09
Spectrum Analyzer	R&S	FSV-40	100832	1 year	2017-11-09
Power Meter	Agilent	E4416A	GB41290645	1 year	2017-06-28
Power Sensor	Agilent	9327A	US40441490	1 year	2017-06-28
Horn Antenna	R&S	HF906	100236	2 year	2017-07-24
Horn Antenna	R&S	HF906	100235	2 year	2017-04-23
Horn Antenna	AH Systems	SAS-573	164	2 year	2018-05-03
TRILOG Supper Broadband test Antenna	SCHWARZBECK	SAS-521-7	9161-4159	2 year	2018-06-14
Power Amplifier	MITEQ	AM-1431	1497315	1 year	2017-06-28
Power Amplifier	MITEQ	AFS43-01002600	1374382	1 year	2017-11-03
High Pass Filter	Wainwright	WHK3.0/18G-10SS	508	1 year	2017-06-29
Controller	INNCO	CO2000	co200/064/6961003/L	N/A	N/A
Antenna Master	INNCO	MA4000	MA4000/038/6961003/L	N/A	N/A
Loop Antenna	ETS LINDGREN	6502	00118166	2 year	2018-02-23
TWO LINE-V-NETWORK	R&S	ESH3-Z5	100296	1 year	2017-12-09
Power Amplifier	TESTEK	TK-PA6S	140009	1 year	2017-12-08

※ Remark;
Support equipment

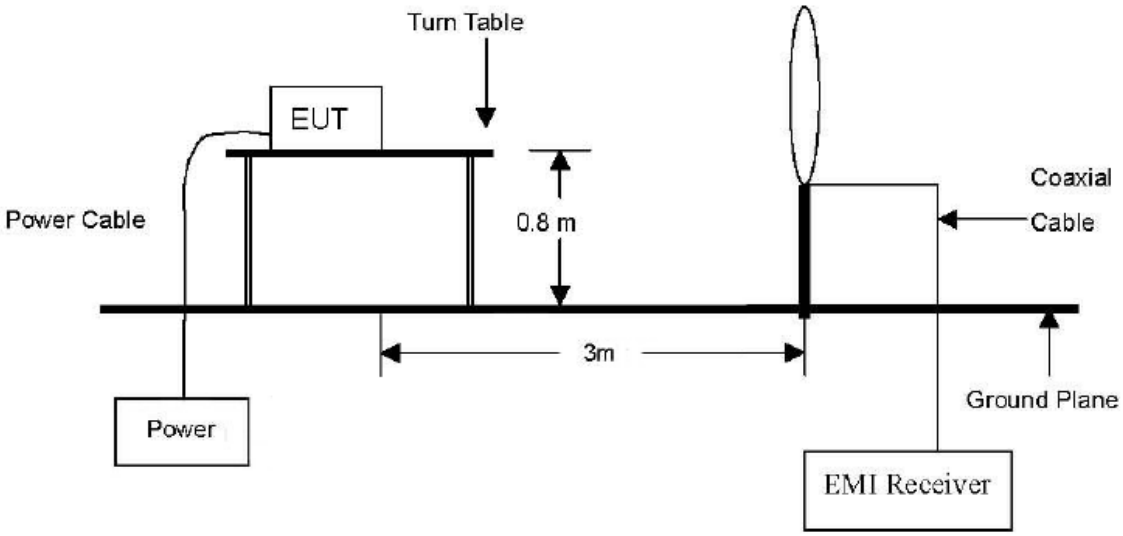
Description	Manufacturer	Model	Serial number
Notebook computer	DELL	Lattitude D510	-

4. Transmitter radiated spurious emissions and conducted spurious emissions

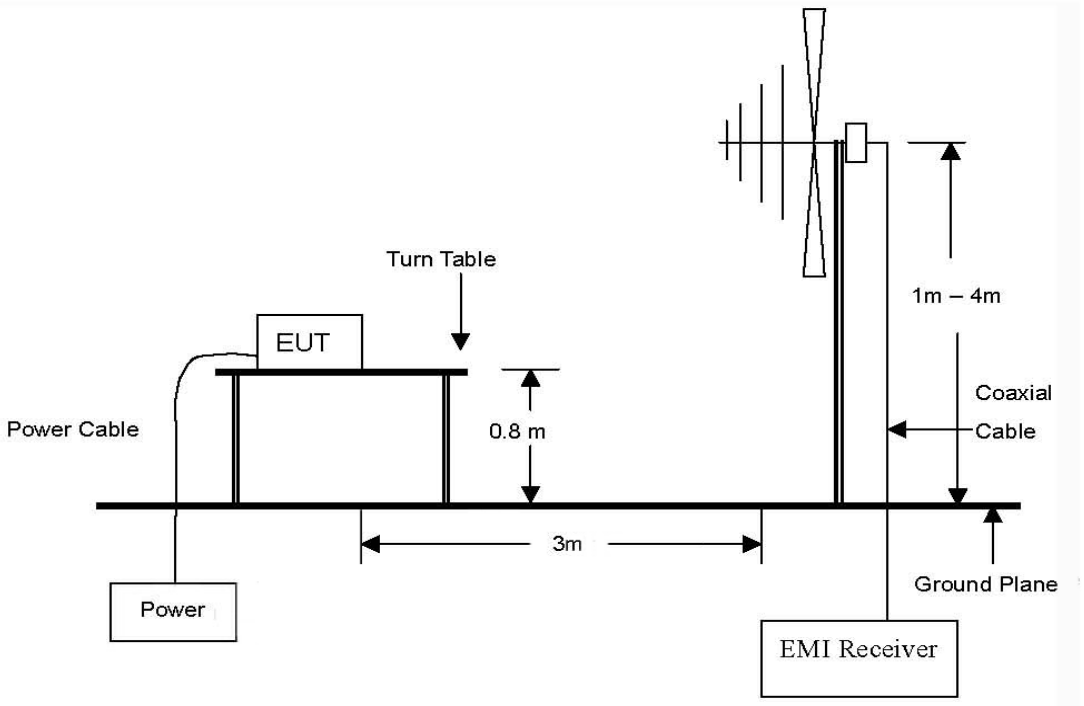
4.1. Test setup

4.1.1. Transmitter radiated spurious emissions

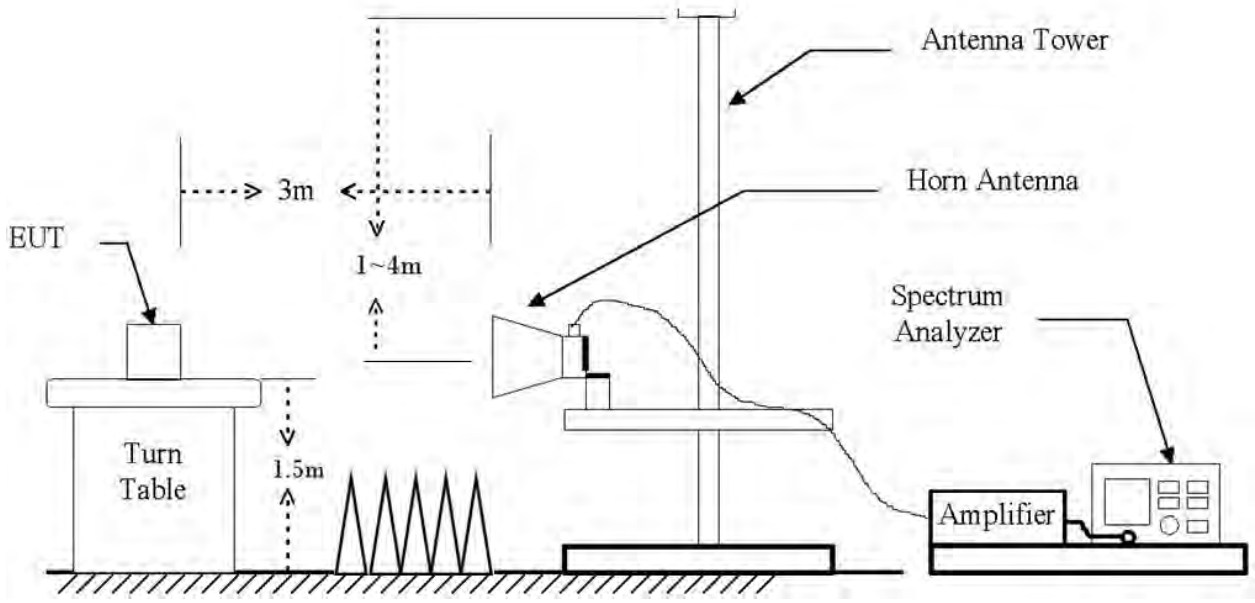
The diagram below shows the test setup that is utilized to make the measurements for emission from 9kHz to 30MHz Emissions.



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 40 ㎓ emissions.



4.2. 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))

According to § 15.109(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 at 3M (㏈㎶/m)	Radiated (㎶/m)
0.009–0.490	300	See the remark	2400/F(㎑)
0.490–1.705	30		24000/F(㎑)
1.705–30.0	30		30
30 - 88	3	40.0	100
88 – 216	3	43.5	150
216 – 960	3	46.0	200
Above 960	3	54.0	500

*Remark

1. Emission level in ㏈uV/m = 20 log (uV/m)
2. Measurement was performed at an antenna to the closed point of EUT distance of meters.
3. Distance extrapolation factor = 40log(Specific distance/ test distance) (㏈)
   Limit line=Specific limits(㏈uV) + distance extrapolation factor.

4.3. Test procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.10:2013
In case of the air temperature of the test site is out of the range is 10 to 40°C before the testing proceeds the warm-up time of EUT maintain adequately

4.3.1. Test procedures for radiated spurious emissions

1. The EUT is placed on a turntable, which is 0.8 m (Below 1 ㎓.) **/** 1.5 m (Above 1 ㎓) above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.

※ Remark;

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 10 ㎑ for Peak detection (PK) at frequency below 30 ㎒
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 ㎑ for Peak detection (PK) or Quasi-peak detection (QP) at frequency below 1 ㎓.
3. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection and frequency above 1 ㎓.
4. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒z and the video bandwidth is 10 ㎐ for Average detection (AV) at frequency above 1 ㎓.

4.3.2. Test procedures for conducted spurious emissions

All data rates and modes were investigated for conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.

Per the guidance of KDB 558074, section 5.4.1.1, the reference level for out of band emissions is established from the plots of this section since the band edge emissions are measured with a RBW of 100 ㎑. This reference level is then used as the limit in subsequent plots for out of band spurious emissions shown in section 4.4.4. The limit for out of band spurious emission at the band edge is 30 ㏈ below the fundamental emission level measured in a 100 ㎑ bandwidth.

4.4. Test result

Ambient temperature: 20 ℃
Relative humidity: 45 % R.H.

4.4.1. Spurious radiated emission

The frequency spectrum from 9㎑ to 30 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈. All reading values are peak values.
To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes.

A. Low channel (2 402 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

B. Middle channel (2 440 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

C. High channel (2 480 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

※ Remark
1. Actual = Reading + Ant. factor + CL (Cable loss)
2. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
3. Limit line = specific Limits (dBuV) + Distance extrapolation factor
4. 15.31 Measurement standards.
The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

4.4.2. Spurious radiated emission

The frequency spectrum from 30 ㎒ to 1 000 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈. All reading values are peak values.
To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes.

A. Low channel (2 402 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (dB)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
188.84	13.1	PK	H	13.8	2.9	29.8	43.5	13.7
354.19	17.5	PK	V	14.7	4.0	36.2	46.0	9.8
539.68	13.7	PK	V	18.6	5.0	37.3	46.0	8.7
643.17	8.3	PK	H	20.5	5.5	34.3	46.0	11.7
Above 900.00	Not detected	-	-	-	-	-	-	-

B. Middle channel (2 440 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (dB)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
166.27	14.2	PK	V	18.7	2.7	35.6	43.5	7.9
297.39	13.8	PK	V	13.3	3.7	30.7	46.0	15.3
369.47	18.0	PK	V	15.0	4.1	37.1	46.0	8.9
437.19	12.2	PK	H	16.6	4.5	33.2	46.0	12.8
564.86	15.7	PK	V	19.1	5.1	39.9	46.0	6.1
687.72	7.6	PK	H	21.2	5.7	34.5	46.0	11.5
Above 900.00	Not detected	-	-	-	-	-	-	-

C. High channel (2 480 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
149.27	14.1	PK	V	19.3	2.6	36.0	43.5	7.5
253.53	12.5	PK	H	11.9	3.4	27.8	46.0	18.2
468.81	11.2	PK	H	17.3	4.6	33.1	46.0	12.9
519.35	13.8	PK	V	18.3	4.9	37.0	46.0	9.0
633.41	8.3	PK	V	20.3	5.4	34.0	46.0	12.0
Above 900.00	Not detected	-	-	-	-	-	-	-

※ Remark

1. Actual = Reading + Ant. factor + CL (Cable loss)
2. 15.31 Measurement standards.

The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

4.4.3. Spurious radiated emission

The frequency spectrum above 1 000 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈.
To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes.

A. Low channel (2 402 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

B. Middle channel (2 440 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

C. High channel (2 480 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

※ Remark

1. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental Frequency.
2. Radiated emissions measured in frequency above 1 000 ㎒ 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 + Ant. factor - Amp + CL (Cable loss)
5. 15.31 Measurement standards.

THE AMPLITUDE OF SPURIOUS EMISSIONS FROM INTENTIONAL RADIATORS AND EMISSIONS FROM UNINTENTIONAL RADIATORS WHICH ARE ATTENUATED MORE THAN 20 DB BELOW THE PERMISSIBLE VALUE NEED NOT BE REPORTED UNLESS SPECIFICALLY REQUIRED ELSEWHERE IN THIS PART.

4.5 Radiated Band Edge

4.5.1 Limit of Radiated Band Edges

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30dB instead of 20dB. In addition, radiated emissions which fall in test restricted bands must also comply with the FCC section 15.209 limits as below.

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

4.5.2 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r05.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
7. Use the following spectrum analyzer settings:
(1) Span shall wide enough to fully capture the emission being measured;
(2) Set RBW=100 kHz for f < 1 GHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
(3) Set RBW = 1 MHz, VBW= 3MHz for f ≥ 1 GHz for peak measurement. For average measurement:
• VBW = 10 Hz, when duty cycle is no less than 98 percent.

4.5.3. Test Result

A. 2 310 - 2 390 ㎒ measurement (2 402MHz)

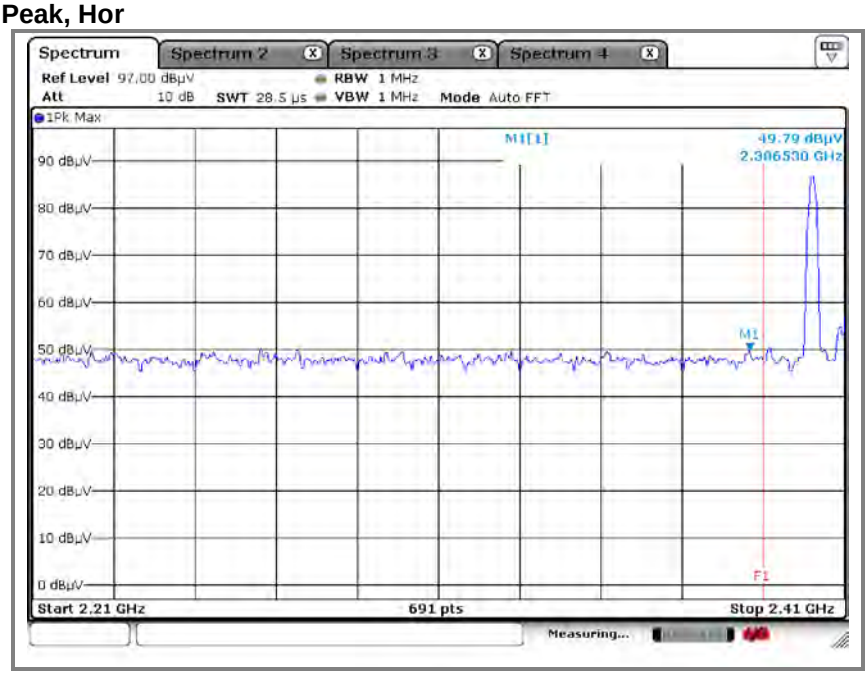
Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2 381.90	49.99	Peak	V	28.21	36.16	42.04	74.00	31.96
2 389.42	36.55	Average	V	28.21	36.16	28.60	54.00	25.40
2 386.53	49.79	Peak	H	28.21	36.16	41.84	74.00	32.16
2 389.42	36.45	Average	H	28.21	36.16	28.50	54.00	25.50

B. 2 483.5 – 2 500 ㎒ measurement (2 480MHz)

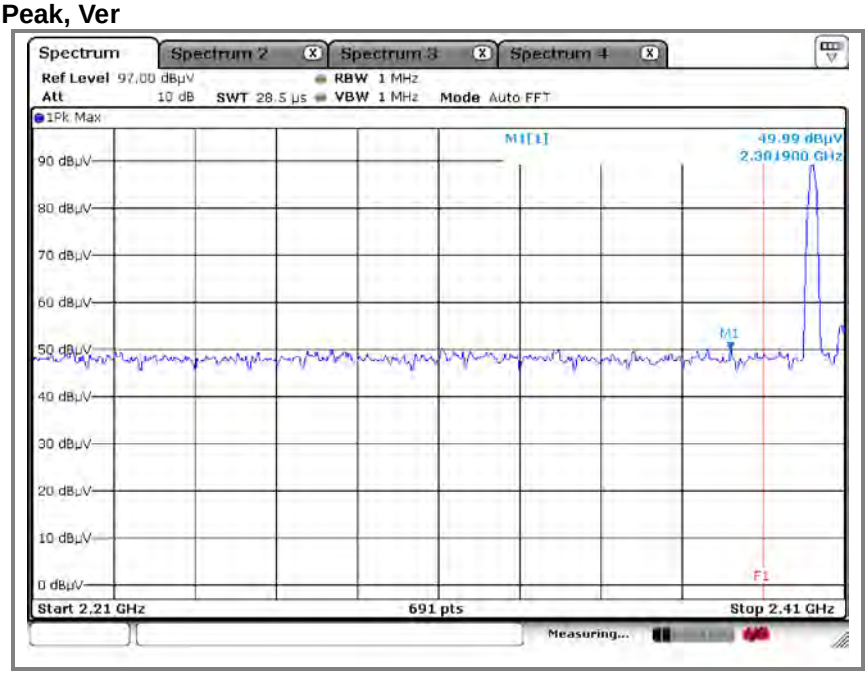
Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2494.40	49.93	Peak	V	28.21	36.16	41.98	74.00	32.02
2494.62	34.60	Average	V	28.21	36.16	26.65	54.00	27.35
2494.31	48.57	Peak	H	28.21	36.16	40.62	74.00	33.38
2497.60	34.54	Average	H	28.21	36.16	26.59	54.00	27.41

A. Low channel (2 402 ㎒)

Detected Mode : Peak, Hor

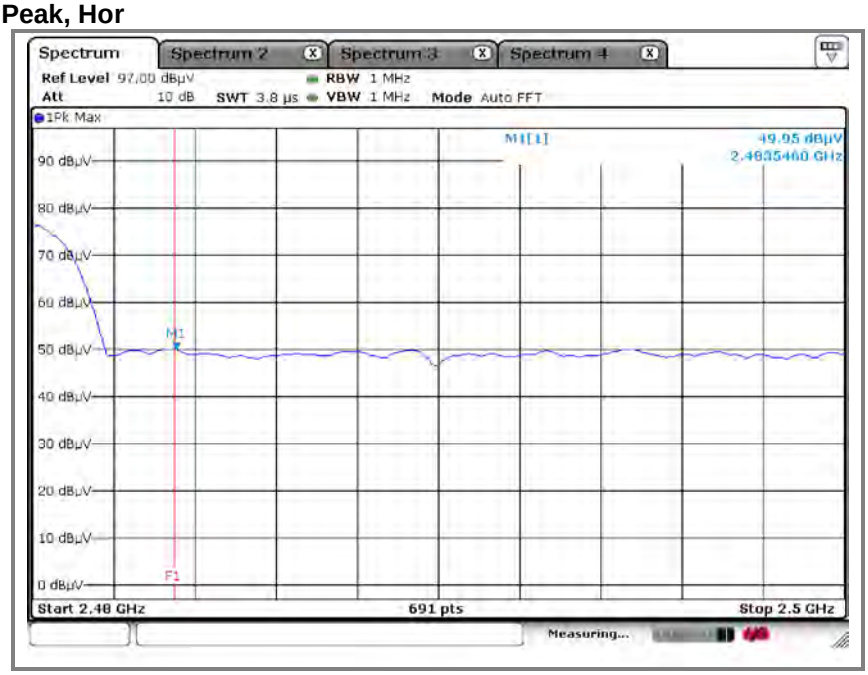


Detected Mode : Peak, Ver

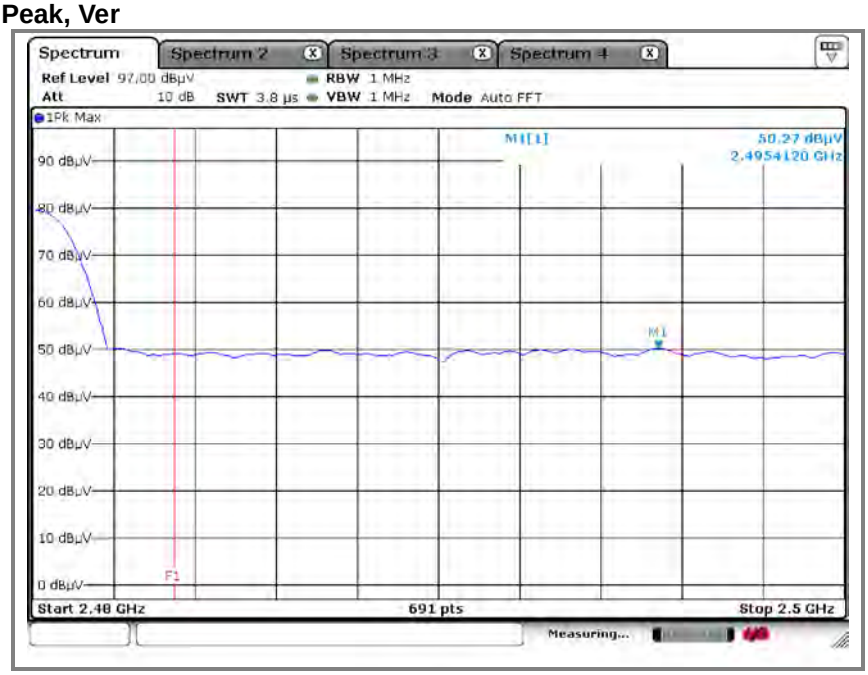


B. High channel (2 480 ㎒)

Detected Mode : Peak, Hor



Detected Mode : Peak, Ver



5. Receiver radiated spurious emissions

5.1. Test setup
Same as clause 5.1.

5.1.1. Receiver radiated spurious emissions
Same as clause 5.1.1

5.2. Limit
According to §15.109(a), Except for Class A digital devices, the field strength of radiated emission from unintentional radiator at a distance of 3 m shall not exceed the following values:

Frequency (㎒)	Distance (Meters)	Radiated (dB㎶/m)	Radiated (㎶/m)
0.009–0.490	300	See the remark	2400/F(㎑)
0.490–1.705	30		24000/F(㎑)
1.705–30.0	30		30
30 - 88	3	40.0	100
88 – 216	3	43.5	150
216 – 960	3	46.0	200
Above 960	3	54.0	500

5.3. Test procedures
Same as clause 5.3.
Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2003
In case of the air temperature of the test site is out of the range is 10 to 40°C before the testing proceeds the warm-up time of EUT maintain adequately

5.3.1. Test procedures for radiated spurious emissions
Same as Clause 5.3.1.

5.4. Test results

Ambient temperature: 20 ℃
Relative humidity: 45 % R.H.

5.4.1. Spurious radiated emission.

The frequency spectrum from 30 ㎒ to 26 ㎓ was investigated. Emission levels are not reported much lower than the limits by over 30 ㏈. All reading values are peak values.

A. Low channel (2 402 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

B. Middle channel (2 440 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

C. High channel (2 480 ㎒)

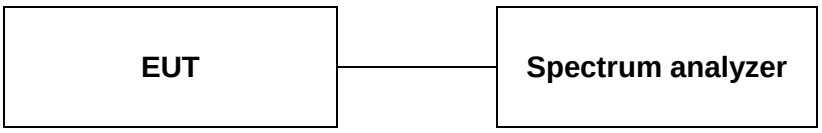
Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

※ Remark

1. Actual = Reading + Ant. factor + CL (Cable loss)
2. 15.31 Measurement standards.
   The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

6. 6 ㏈ bandwidth & 99 % bandwidth measurement

6.1. Test setup



6.2. Limit

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902~928 ㎒, 2 400~2 483.5 ㎒, and 5 725~5 825 ㎒ bands. The minimum of 6 ㏈ Bandwidth shall be at least 500 ㎑

6.3. Test procedure

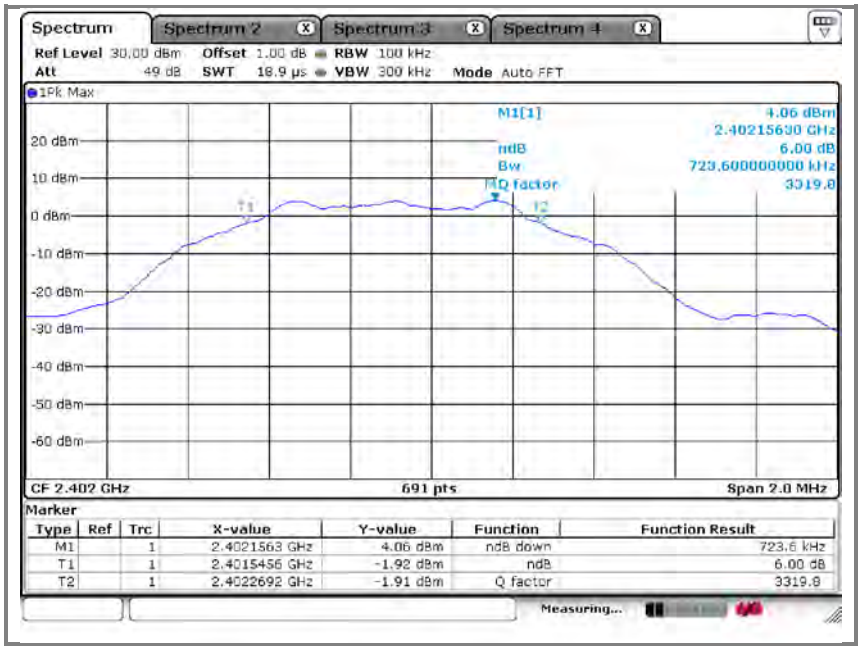
1. The 6 ㏈ band width was measured with a spectrum analyzer connected to RF antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer. Display Line and Marker Delta functions, the 6 ㏈ band width of the emission was determined.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 100㎑, VBW ≥ 3 x RBW, Span= 2 times the DTS bandwidth
   Detector = peak, Trace = max hold, Sweep=auto couple

6.4. Test results

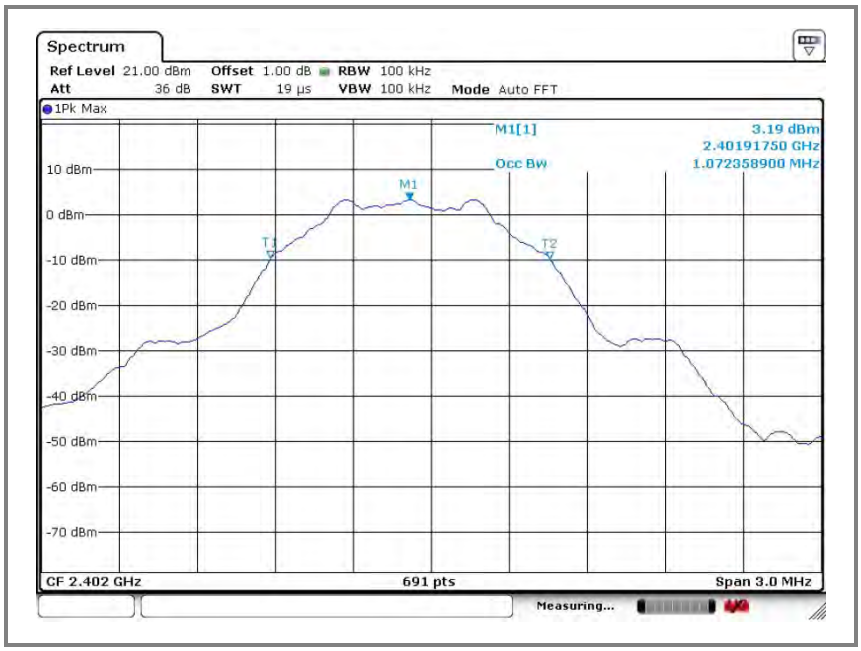
Ambient temperature: 22 ℃
Relative humidity: 45 % R.H.

Frequency(㎒)	6 ㏈ bandwidth(㎒)	99% bandwidth(㎒)
2 402	0.723	1.072
2 440	0.727	1.072
2 480	0.732	1.068

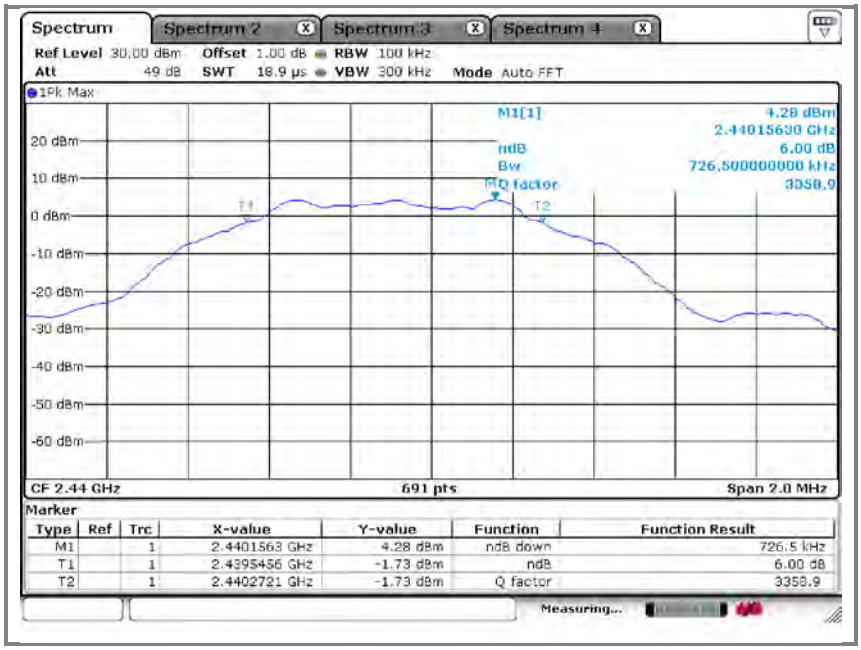
A. Low channel (2 402 ㎒) - 6 ㏈ bandwidth



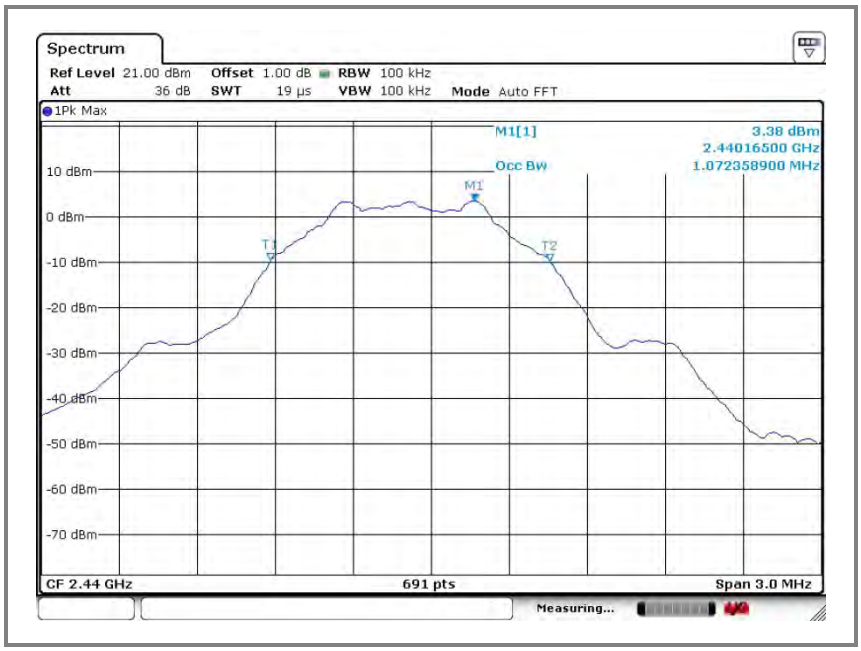
A. Low channel (2 402 ㎒) – 99 % bandwidth



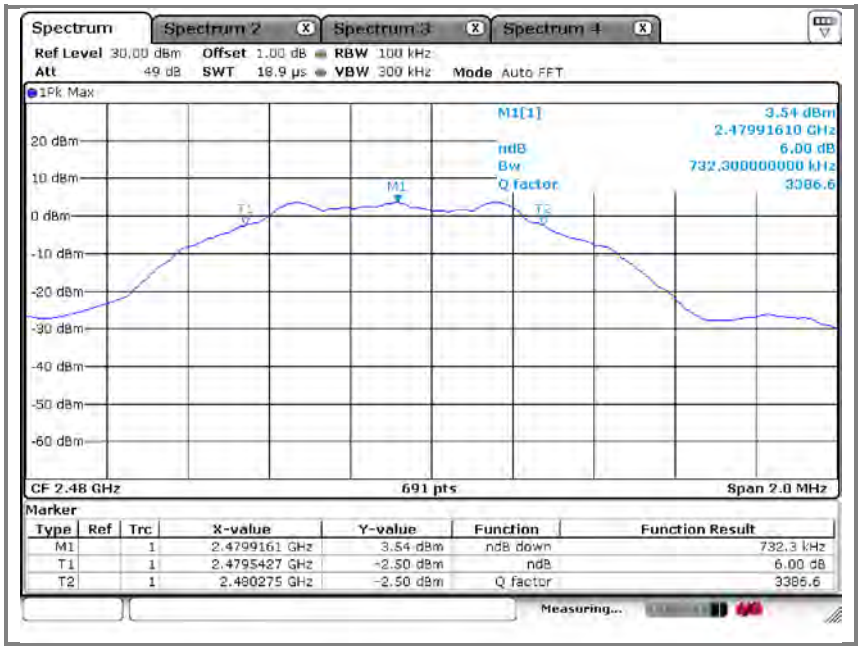
B. Middle channel (2 440 ㎒) - 6 ㏈ bandwidth



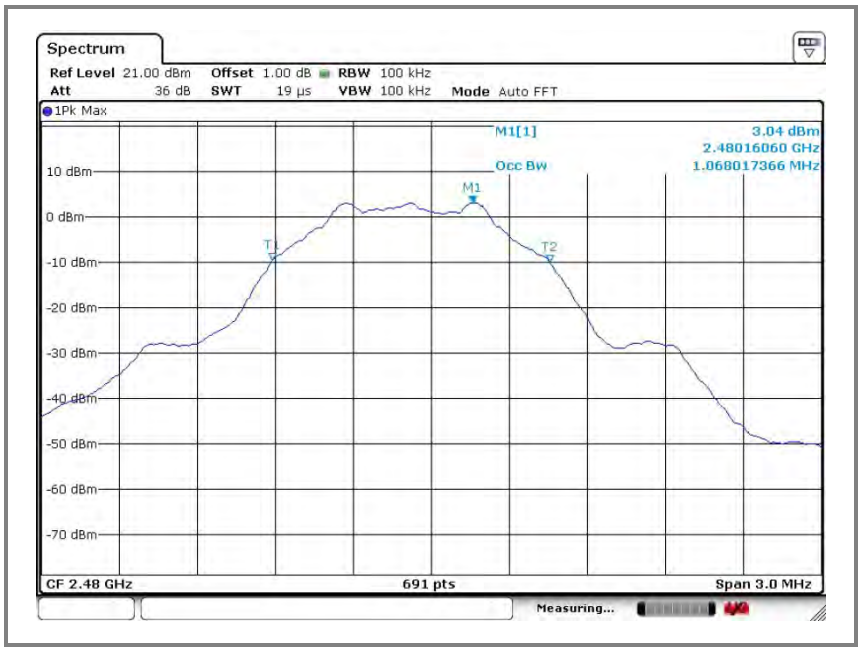
B. Middle channel (2 440 ㎒) – 99 % bandwidth



C. High channel (2 480 ㎒) - 6 ㏈ bandwidth

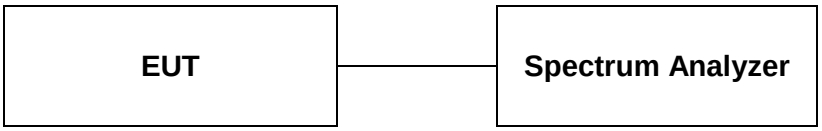


C. High channel (2 480 ㎒) – 99 % bandwidth



7. Maximum Output Power Measurement

7.1. Test setup.



7.2. Limit

The maximum peak output power of the intentional radiator shall not exceed the following:
1. §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 6 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽
2. §15.247(b)(1), For frequency hopping systems operating in the 2 400 – 2 483.5 ㎒ employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 805 ㎒ band: 1 Watt.

7.3 Test procedure

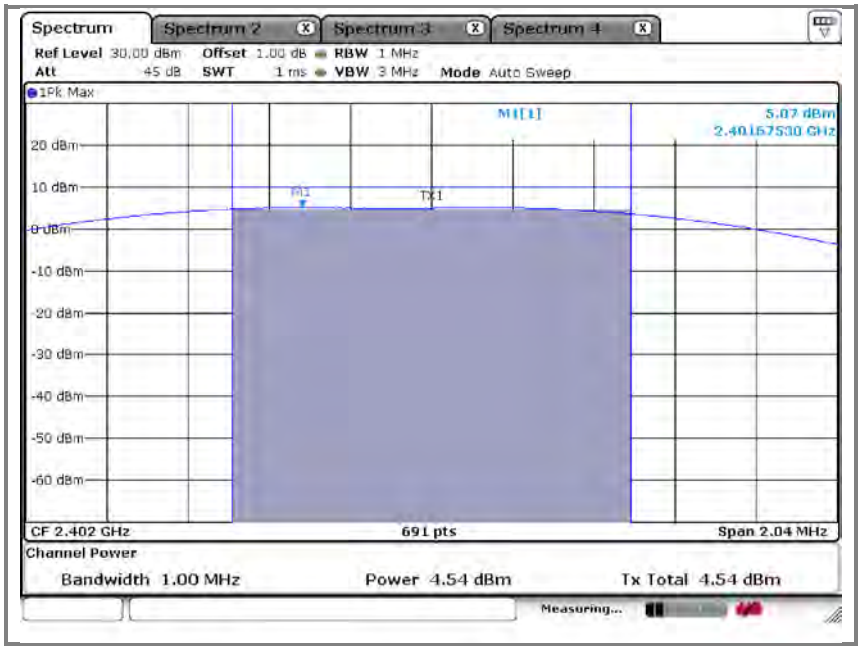
Maximum Peak Conducted Output Power is measured using the following procedure (RBW ≥ DTS bandwidth).
1. Set the RBW ≥ DTS bandwidth.
2. Set VBW ≥ 3 x RBW. / Set span ≥ 3 x RBW.
4. Sweep time = auto couple
5. Detector = peak
6. Trace mode = max hold
7. Allow trace to fully stabilize
8. Use peak marker function to determine the peak amplitude level.

7.4 Test results

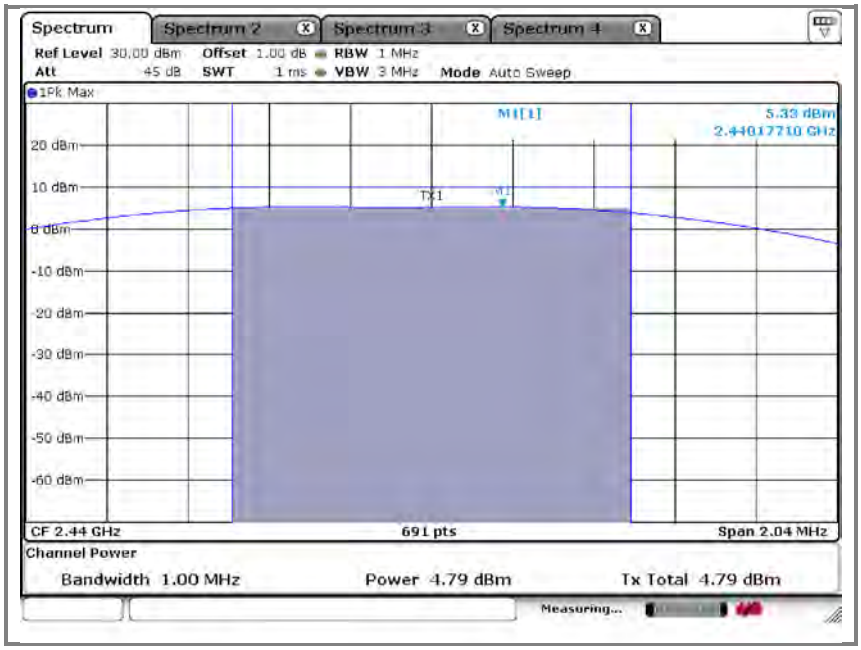
Ambient temperature: 22 ℃
Relative humidity: 45 % R.H.

Frequency (㎒)	Conducted power (㏈m)	Limit (㏈m)
2 402	4.54	30
2 440	4.79	
2 480	4.18	

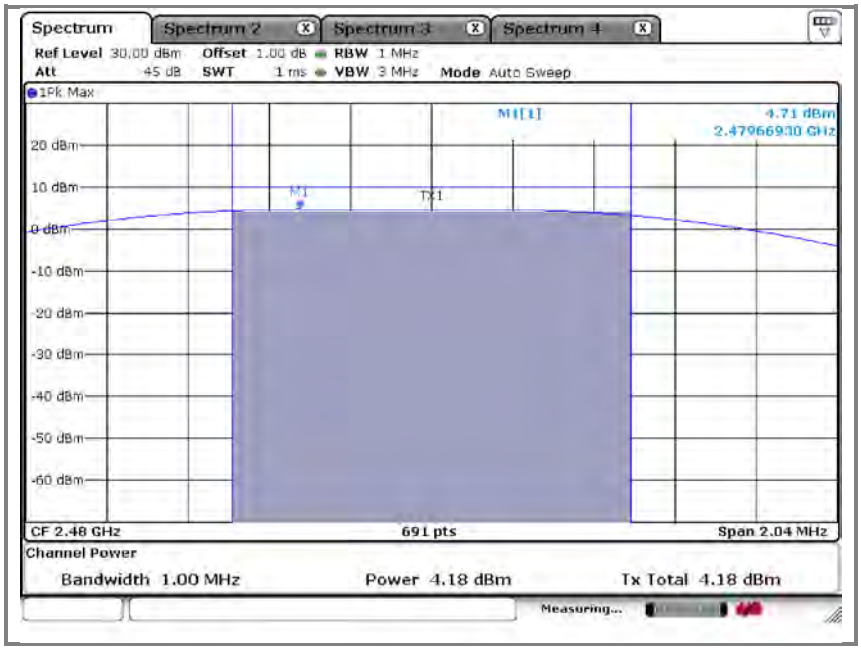
A. Low channel (2 402 ㎒)



B. Middle channel (2 440 ㎒)

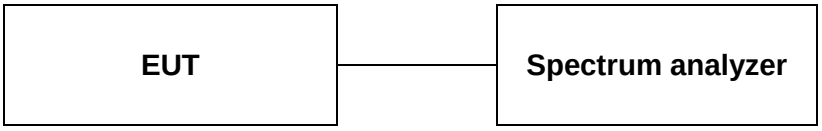


C. High channel (2 480 ㎒)



8. Power Spectral Density Measurement

8.1. Test setup



8.2. Limit

< 8dBm @ 3kHz BW

8.3. Test procedure (PKPSD)

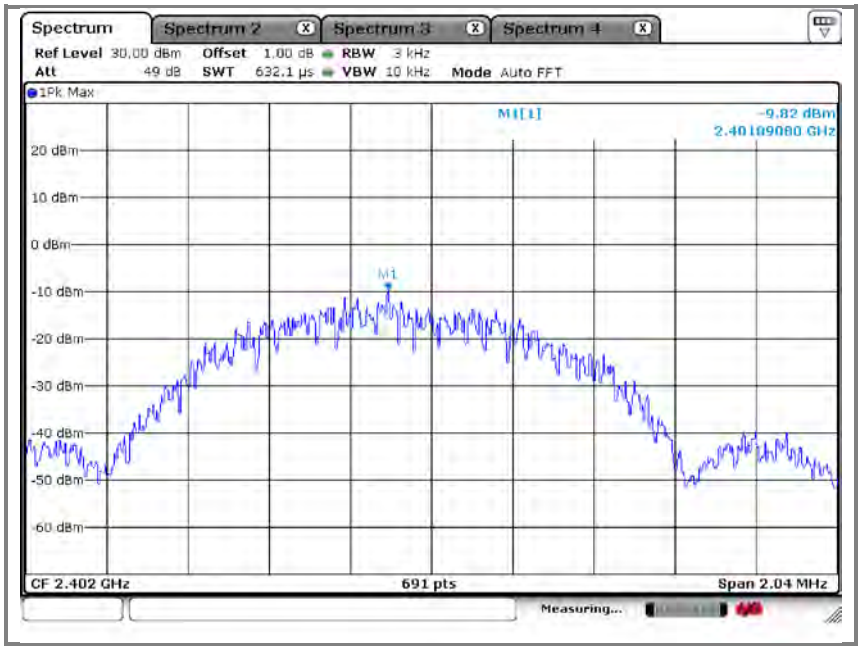
1. The RF power output was measured with a Spectrum analyzer connected to the RF Antenna connector(conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, A spectrum analyzer was used to record the shape of the transmit signal.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using;
   Span = 1.5 times the DTS bandwidth
   RBW = 3㎑ ≤ RBW ≤ 100㎑
   VBW ≥ 3 x RBW, Sweep = Auto couple
   Detector function = peak, Trace = max hold

8.4. Test results

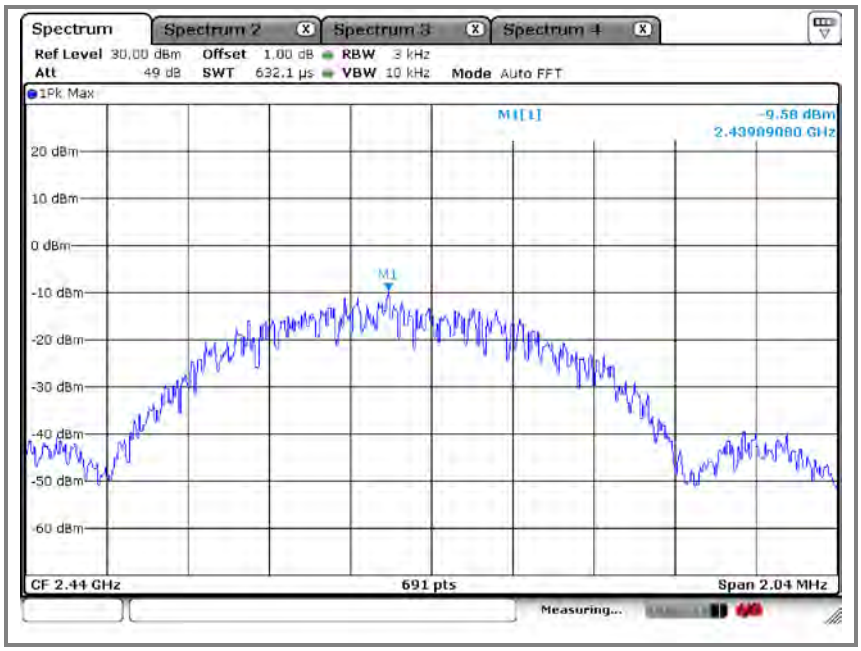
Ambient temperature: 22 ℃
Relative humidity: 45 % R.H.

Frequency (㎒)	Peak output power(dBm)	Limit (dBm)
2 402	-9.82	8
2 440	-9.58	
2 480	-10.21	

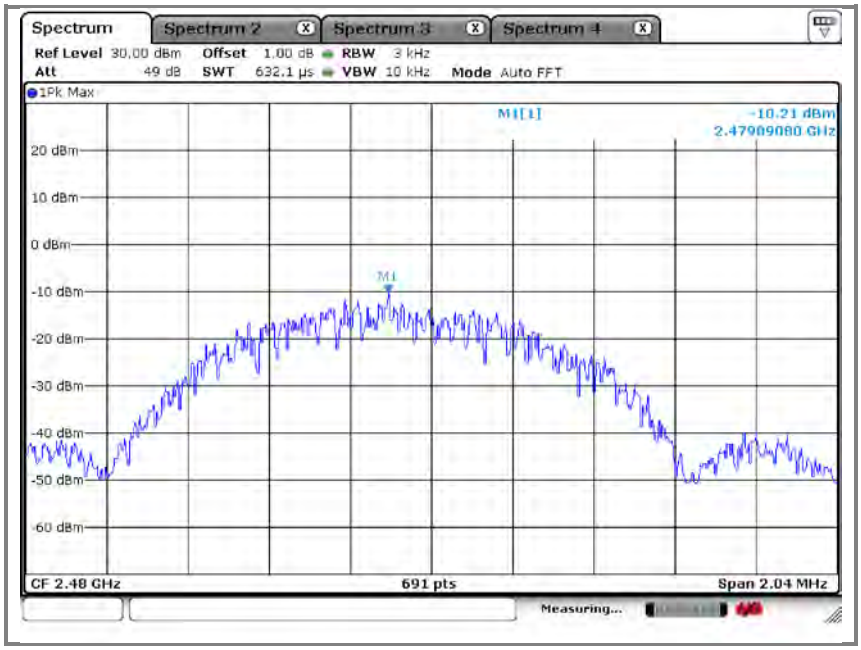
A. Low channel (2 402 ㎒)



B. Middle channel (2 440 ㎒)

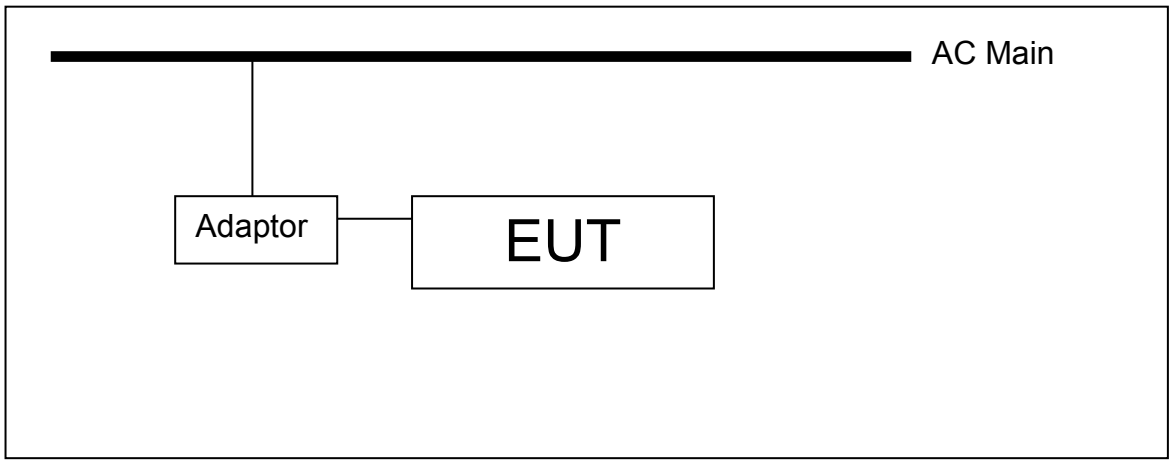


C. High channel (2 480 ㎒)



9. *Conducted power line test*

9.1 Test setup



9.2 Limit

According to §15.107(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 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50 uH/ 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 (㎒)	Conducted limit (dB㎶/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.

9.3 Test procedures

The test procedure is performed in a 6.5 m × 3.6 m × 3.6 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m(W) × 1.5 m(L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

9.4 Test results

Ambient temperature: 23 ℃
Relative humidity: 42 % R.H.

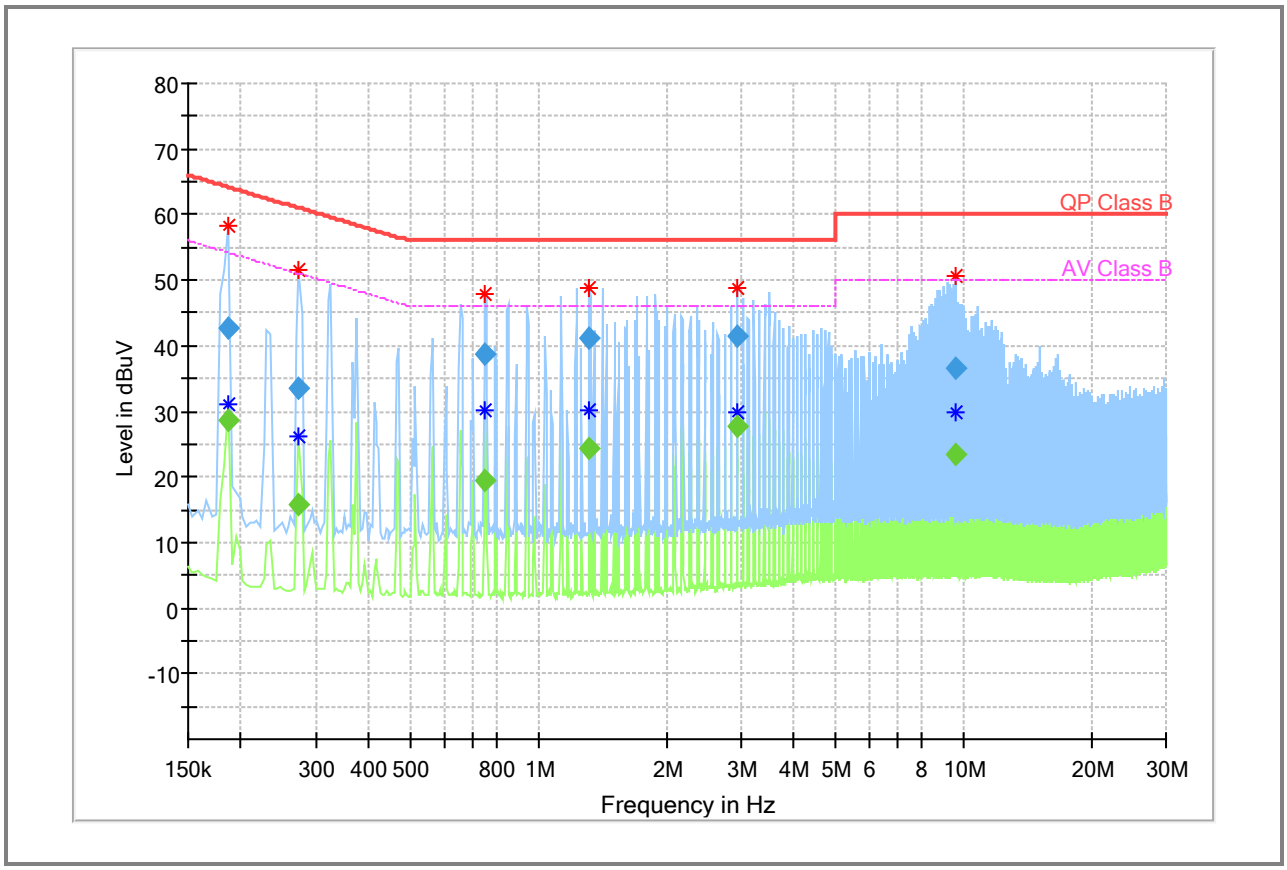
Frequency range: 0.15 ㎒ ~ 30 ㎒
Measured bandwidth: 9 ㎑

Freq. (㎒)	Line	Q-Peak		
		Level(dB㎶/m)	Limit(dB㎶/m)	Margin(dB)
0.19	H	42.77	64.21	21.44
0.75	H	38.83	56.00	17.17
1.32	H	41.24	56.00	14.76
2.93	H	41.32	56.00	14.68
-	-	-	-	-

Freq. (㎒)	Line	Average		
		Level(dB㎶/m)	Limit(dB㎶/m)	Margin(dB)
1.32	H	24.28	46.00	21.72
2.93	H	27.59	46.00	18.41
-	-	-	-	-
-	-	-	-	-

※ Remark
Line(H): Hot
Line(N): Neutral

Plot of conducted power line



10. Antenna requirement

10.1. Standard Applicable

For intentional device, according to FCC 47 CFR 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. And according to FCC 47 CFR Section §15.247 (b) if transmitting antennas of directional gain greater than 6 dBi are used.

10.2. Antenna Connected Construction

Antenna used in this product is Chip antenna,
Antenna gain is -13.68 dBi.

11. RF exposure evaluation

11.1. 10.1 Environmental evaluation and exposure limit according to FCC CFR 47 part 1, 1.1307(b), 1.1310

According to §15.247(e)(i) and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines. According to KDB 447498 (2)(a)(i)

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 – 1 500	--	--	F/300	6
1 500 – 100 000	--	--	5	6
(B) Limits for General Population / Uncontrol Exposures				
300 – 1 500	--	--	F/1 500	6
1 500 – 100 000	--	--	1	30

11.2. Friis transmission formula : Pd=(Pout*G)\(4*pi*R2)

Where
Pd= Power density in ㎽/㎠
Pout=output power to antenna in ㎽
G= Numeric gain of the antenna relative to isotropic antenna
Pi=3.1416
R= distance between observation point and center of the radiator in cm
Pd the limit of MPE, 1 ㎽/㎠. If we know the maximum gain of the antenna and total power input to the antenna, through the calculation, we will know the distance where the MPE limit is reached.

11.3. Test result of RF exposure evaluation

Test Item : RF Exposure evaluation data
Test Mode : Normal operation

11.4. Output power into antenna & RF exposure evaluation distance

Antenna gain: -13.68 dBi (BLE)

Frequency (㎒)	Output Peak power to antenna (dBm)	Antenna gain (dBi)	Antenna Gain (dBi) Numeric	Power density at 20 ㎝ (㎽/㎠)	Power density Limits (㎽/㎠)
2 402	-9.82	-13.68	0.043	0.000 001	1
2 440	-9.58			0.000 001	
2 480	-10.21			0.000 001	

※ Remark
The power density Pd (5th column) at a distance of 20 ㎝ calculated from the friis transmission formula is far below the limit of 1 ㎽/㎠ .