TEST REPORT

of

FCC Part 15 Subpart C §15.247

FCC ID : A3L-HEG-110

Equipment Under Test	:	DR Gateway
Model Name	:	HEG-110
Serial No.	:	N/A
Applicant	:	Samsung Electronics Co., Ltd.
Manufacturer	:	Samsung Electronics Co., Ltd.
Date of Test(s)	:	2011.05.17 ~ 2011.06.20
Date of Issue	:	2011.06.20

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

Tested By: **Date** **2011.06.20**

Wonsuk Kim

Approved By: **Date** **2011.06.20**

Feel Jeong

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1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)
- 705, Dongchun-Dong Sooji-Gu, Yongin-Shi, Kyungki-Do, South Korea.
- Wireless Div. 2FL, 18-34, Sanbon-dong, Gunpo-si, Gyeonggi-do, Korea 435-040

www.kr.sgs.com/ee
Telephone : +82 +31 428 5700
FAX : +82 +31 427 2371

1.2. Details of Applicant

Applicant : Samsung Electronics Co., Ltd.
Address : 416, Maetan3-dong, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea
Contact Person : Dong-Seok Kim
Phone No. : +82 +31 279 7481

1.3. Description of EUT

Kind of Product	DR Gateway
Model Name	HEG-110
Serial Number	N / A
Power Supply	AC 100 ~240 V
Frequency Range	2 412 ㎒ ~ 2 462 ㎒ (80 2.11b/g/n-HT20, 2X2 MIMO) 2 422 ㎒ ~ 2 452 ㎒ (8 02.11n-HT40, 2X2 MIMO) 2 405 ㎒ ~ 2 475 ㎒ (Zig bee)
Modulation Technique	DSSS, OFDM
Number of Channels	11 Ch (b/g/n-HT20), 7 Ch (HT40), 15 Ch (Zigbee)
Antenna Type	Integral Type
Antenna Gain	7.006 ㏈i(Combined), 4.887 ㏈i(Ant 1), 2.873 ㏈i(Ant 2), 0.477 ㏈i(Zigbee)

1.4. Declaration by the manufacturer

- This device include 2 same zigbee module which has 2 antenna each.(MISO)
  Those zigbee modules can transmit at the same time but only transmit in different frequency.

1.5. Test Equipment List

EQUIPMENT	MANUFACTURER	MODEL	CAL DUE.
Signal Generator	Agilent	E4438C	Mar. 31, 2012
Signal Generator	Rohde & Schwarz	SMR40	Jul. 15, 2011
Spectrum Analyzer	R & S	FSV30	Apr. 01, 2012
Power sensor	R & S	NRP-Z81	Aug. 14, 2011
Preamplifier	H.P	8447F	Jul. 05, 2011
Preamplifier	Agilent	8449B	Mar. 31, 2012
High Pass Filter	Wainwright	WHK3.0/18G-10SS	Sep. 29, 2011
Test Receiver	R & S	ESU26	Feb. 21, 2012
Bilog Antenna	SCHWARZBECK MESSELEKTRONIK	396	Jul. 22, 2011
Horn Antenna	R & S	HF 906	Oct. 08, 2011
Horn Antenna	SCHWARZBECK MESSELEKTRONIK	BBHA9170	Mar. 17, 2012
Anechoic Chamber	SY Corporation	L × W × H (9.6 m×6.4 m×6.6 m)	N.C.R.
Two-Line V-Network	R & S	ENV216	Jan. 04, 2012
Test Receiver	R & S	ESHS10	Jul. 13, 2011
Anechoic Chamber	SY Corporation	L × W × H (6.5 m×3.5 m×3.5 m)	N.C.R.

1.6. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD:FCC Part15 subpart C		
Standard section	**Test Item**	**Result**
15.205(a) 15.209 15.247(d)	Transmitter Radiated Spurious Emissions Conducted Spurious Emission	Complied
15.247(a)(2)	6 dB Bandwidth	Complied
15.247(b)(3)	Maximum Peak Output Power	Complied
15.247(e)	Power Spectral Density	Complied
15.207	Transmitter AC Power Line Conducted Emission	Complied
15.247(i) 1.1307(b)(1)	Maximum Permissible Exposure (Exposure of Humans to RF Fields)	Complied

1.7. Test report revision

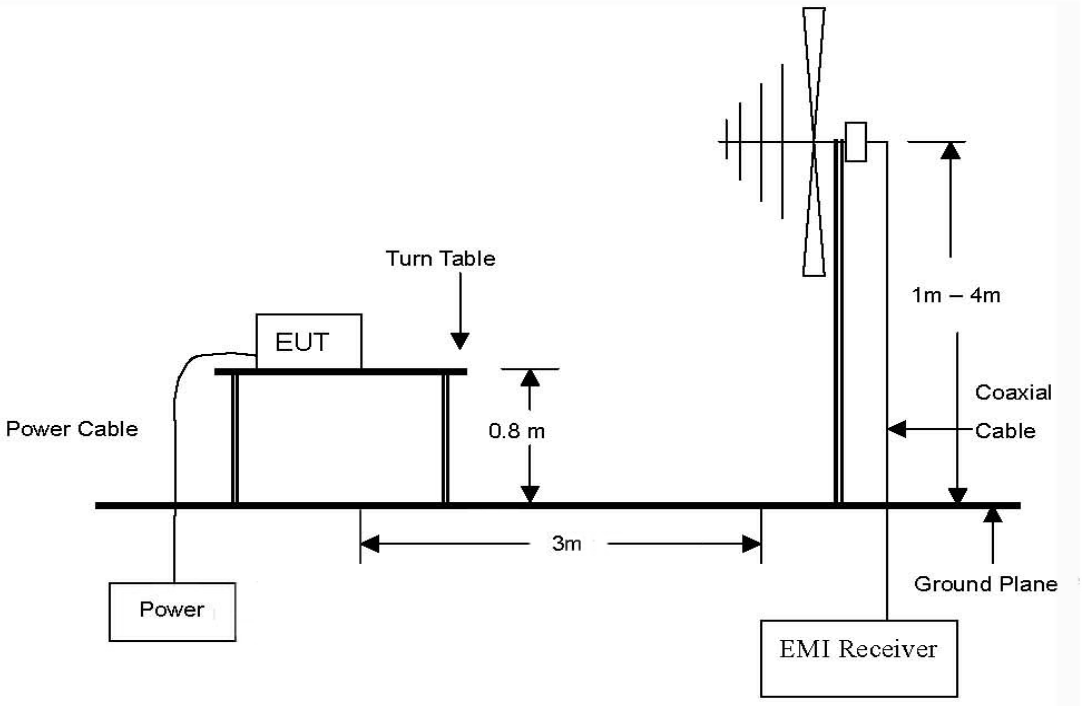
Revision	Report number	Description
0 F690	501/RF-RTL004758	Initial

2. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

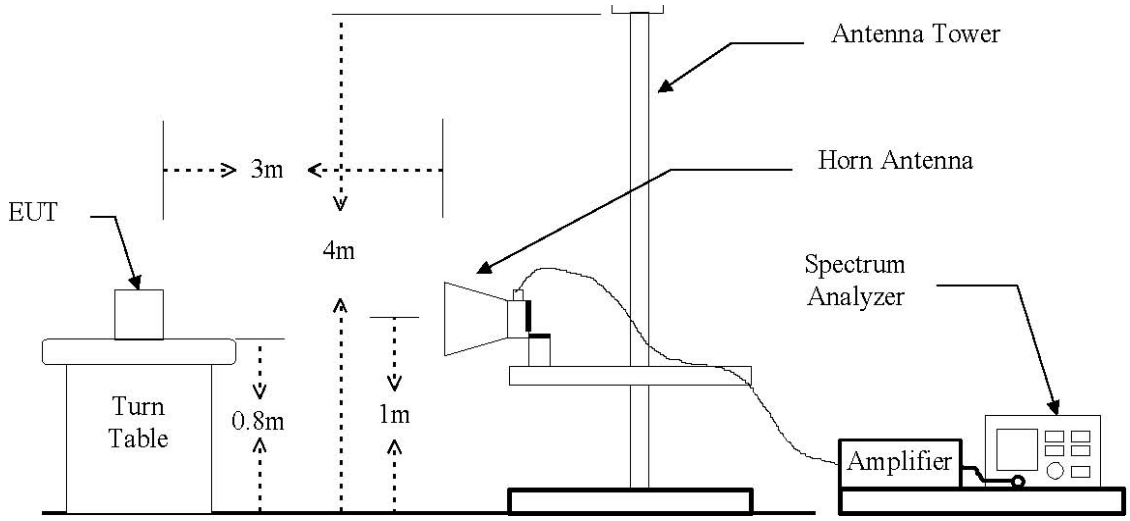
2.1. Test Setup

2.1.1. Transmitter Radiated Spurious Emissions

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



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



2.1.2. Conducted Spurious Emission

2.2. 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 § 15.209(a), 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 (㎒)	Distance (Meters)	Field Strength (㏈㎶/m)	Field Strength (㎶/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

2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2003

2.3.1. Test Procedures for Radiated Spurious Emissions

1. The EUT was placed on the top of a rotating table 0.8 meters 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.
2. During performing radiated emission below 1 ㎓, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 ㎓, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10 ㏈ lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 ㏈ margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

NOTE ;

1. 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 ㎓.
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 ㎓.

2.3.2. Test Procedures for Conducted Spurious Emissions

1. The transmitter output was connected to the spectrum analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 100 ㎑, VBW = 100 ㎑.

2.4. Test Results

Ambient temperature : (24 ± 2) ℃
Relative humidity : 47 % R.H.

2.4.1. Spurious Radiated Emission (Worst case configuration_module 1 mode)

The frequency spectrum from 30 ㎒ to 1 000 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 30 ㏈. All reading values are peak values.

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (㏈㎶)	Detect Mode	Pol.	AF (㏈/m)	AMP + CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
874.991	41.22	Peak	H	23.35	-24.3 7	40.20	46.00	5.8
Above 900.000	Not Detected	- -		-	-	-	-	-

Remark:

1. All spuri ous emissio n at cha nnels a re almost the same belo w 1 ㎓, so that the chan nel was chosen a t r epresentative in final tes t.
2. Actual = Reading + AF + AMP + CL

2.4.2. Spurious Radiated Emission

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

Zigbee : Module 1

Low Channel (2 405 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (㏈㎶)	Detect Mode	Pol.	AF (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
*2 390.00	26.13	Peak	H	28.09	6.23	60.45	74.00	13.55
*2 390.00	12.13	Average	H	28.09	6.23	46.45	54.00	7.55

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (㏈㎶)	Detect Mode	Pol.	AF (㏈/m)	AMP+CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
4 809.28	46.41	Peak	H	32.61	-25.07	53.95	74.00	20.05
Above 4 900.00	Not Detected	- -		-	-	-	-	-

Middle Channel (2 445 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (㏈㎶)	Detect Mode	Pol.	AF (㏈/m)	AMP+CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
4 889.14	47.23	Peak	H	32.94	-25.24	54.93	74.00	19.07
4 889.14	32.12	Average	H	32.94	-25.24	39.82	54.00	14.18
Above 4 900.00	Not Detected	- -		-	-	-	-	-

High Channel (2 475 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 483.50	29.24	Peak	H	28.09	6.36	63.69	74.00	10.31
*2 483.50	17.04	Average	H	28.09	6.36	51.49	54.00	2.51

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
4 948.86	47.53	Peak	H	33.20	-24.5 0	56.23	74.00	17.77
4 948.86	33.54	Average	H	33.20	-24.50	42.24	54.00	11.76
Above 5 000.00	Not Detected	- -		-	-	-	-	-

Zigbee : Module 2

Low Channel (2 405 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 390.00	28.30	Peak	H	28.09	6.23	62.62	74.00	11.38
*2 390.00	12.62	Average	H	28.09	6.23	46.94	54.00	7.06

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
4 809.97	46.37	Peak	H	32.61	-25.0 7	53.91	74.00	20.09
Above 4 900.00	Not Detected	- -		-	-	-	-	-

Middle Channel (2 445 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
4 890.88	46.70	Peak	H	32.95	-25.24	54.41	74.00	19.59
4 890.88	33.99	Average	H	32.95	-25.24	41.70	54.00	12.30
Above 4 900.00	Not Detected	- -		-	-	-	-	-

High Channel (2 475 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 483.50	30.17	Peak	H	28.09	6.36	64.62	74.00	9.38
*2 483.50	16.42	Average	H	28.09	6.36	50.87	54.00	3.13

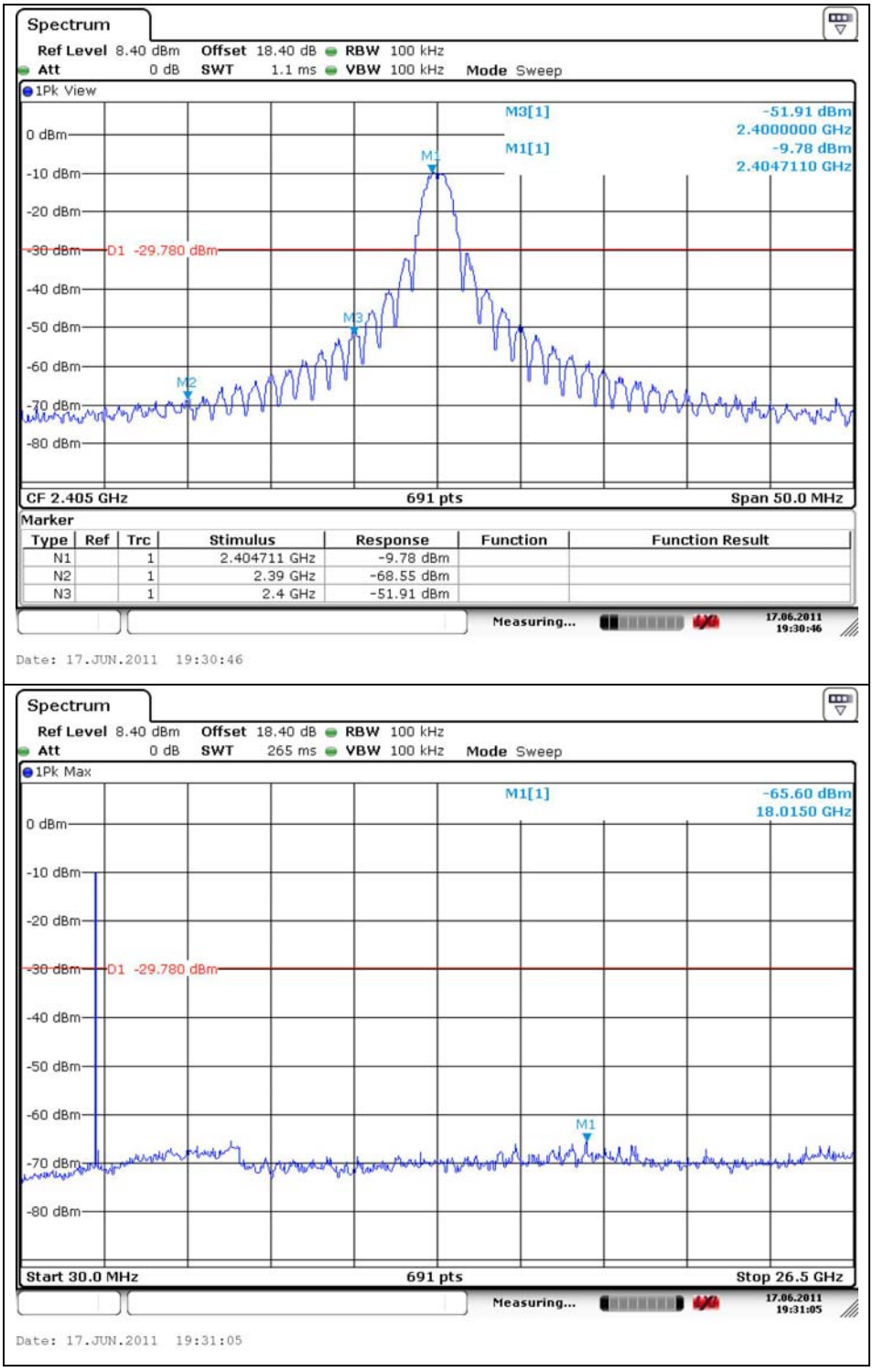
Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
4 951.11	47.82	Peak	H	33.21	-24.5 0	56.53	74.00	17.47
4 951.11	33.72	Average	H	33.21	-24.50	42.43	54.00	11.57
Above 5 000.00	Not Detected	- -		-	-	-	-	-

Remarks ;

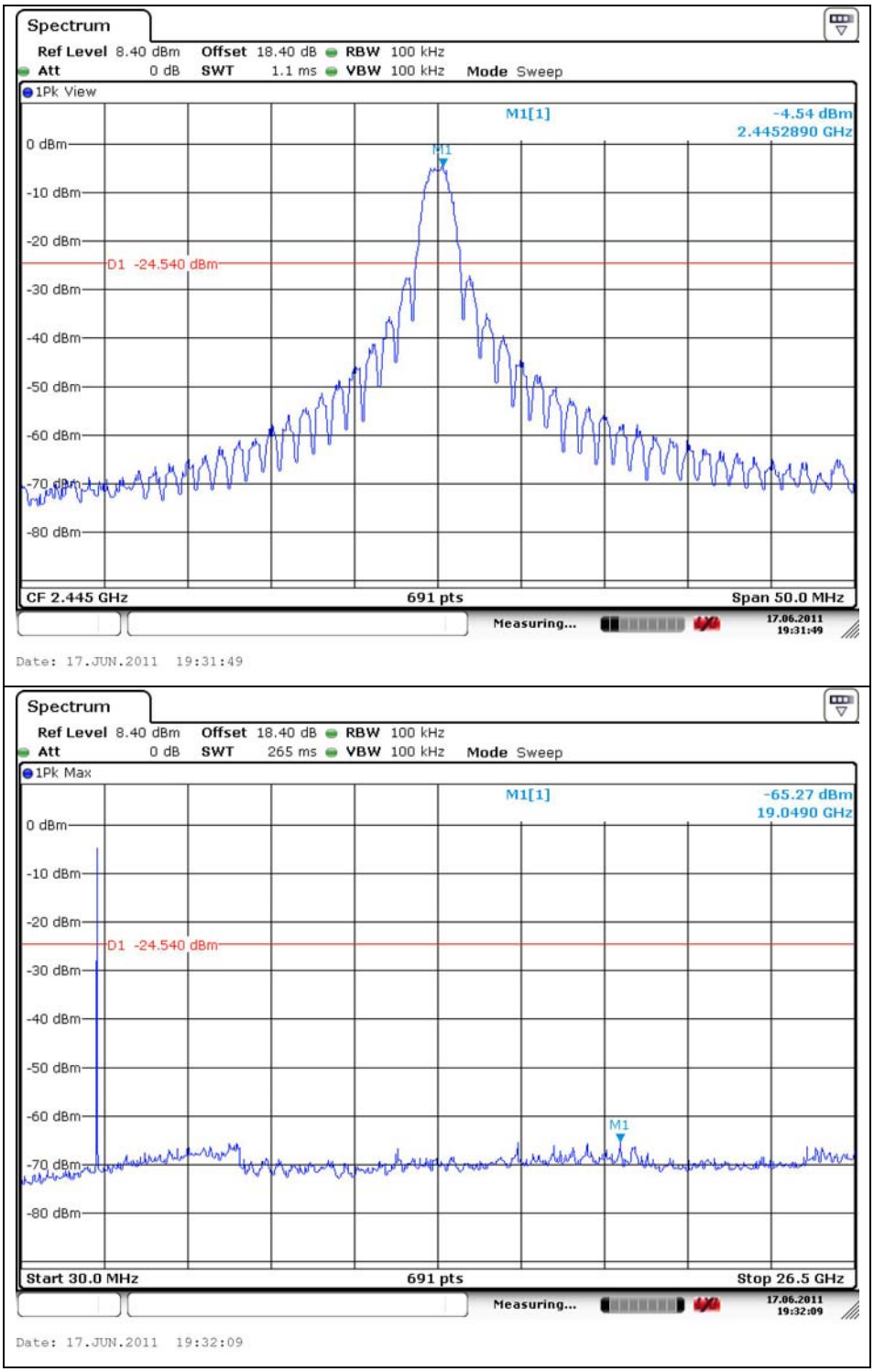
1. “*” me ans the re stricted band.
2. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental Frequency.
3. Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument using peak/average detector mode.
4. Average test would be performed if the peak result were greater than the average limit.
5. Actual = Reading + AF + AMP + CL

2.4.3. Spurious RF Conducted Emissions: Plot of Spurious RF Conducted Emission

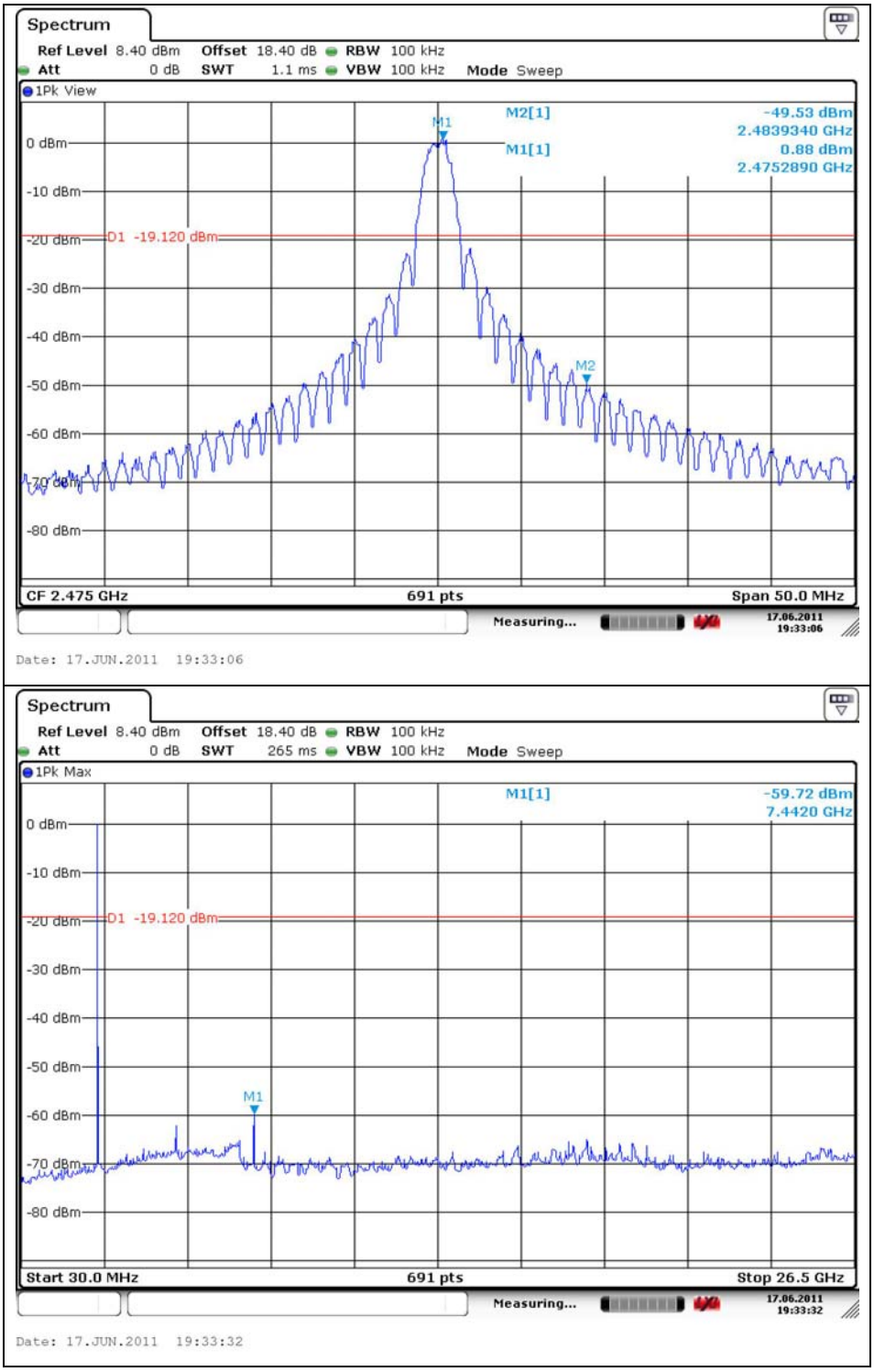
Zigbee : Module 1
Low Channel



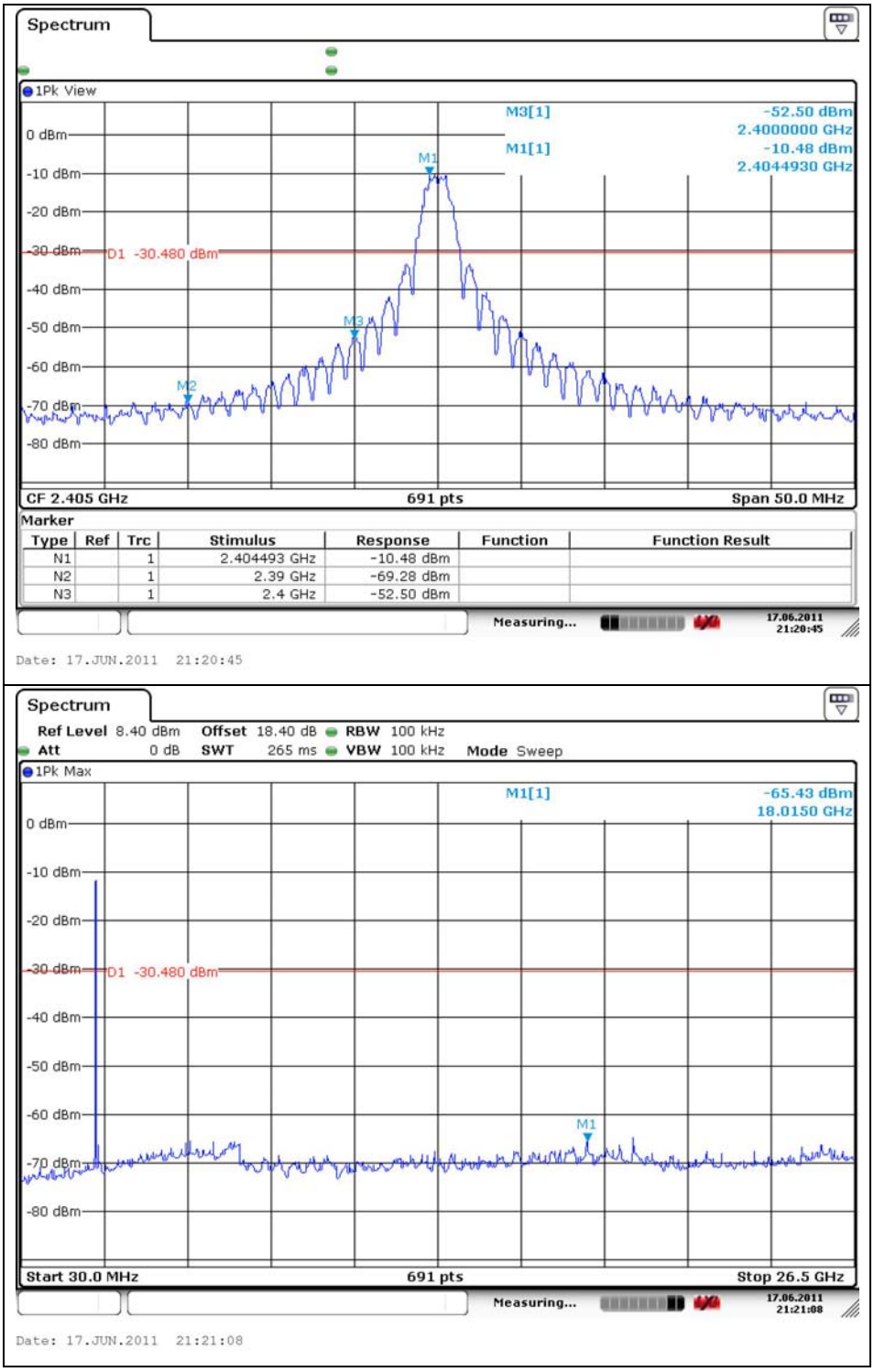
Middle Channel



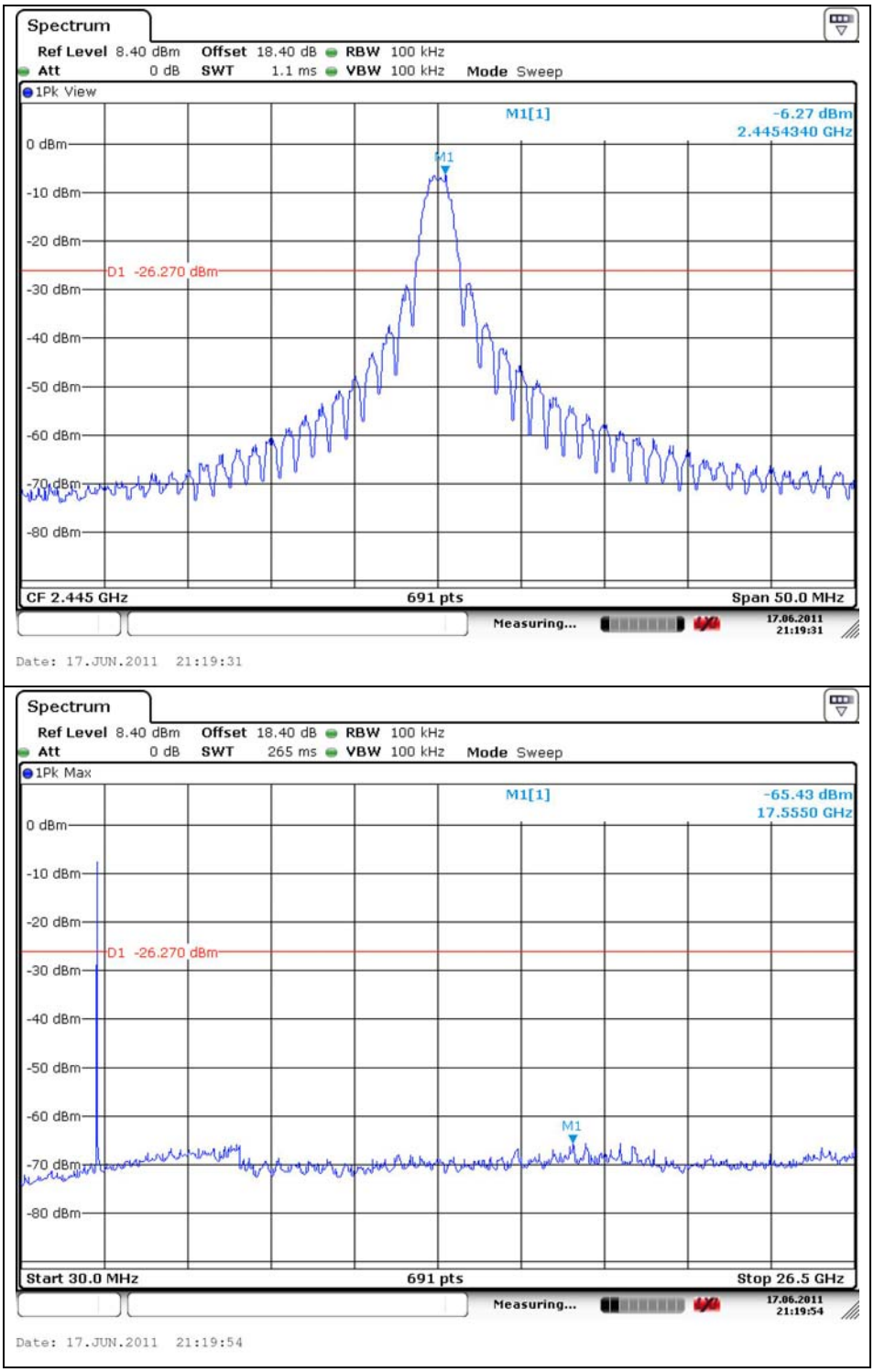
High Channel



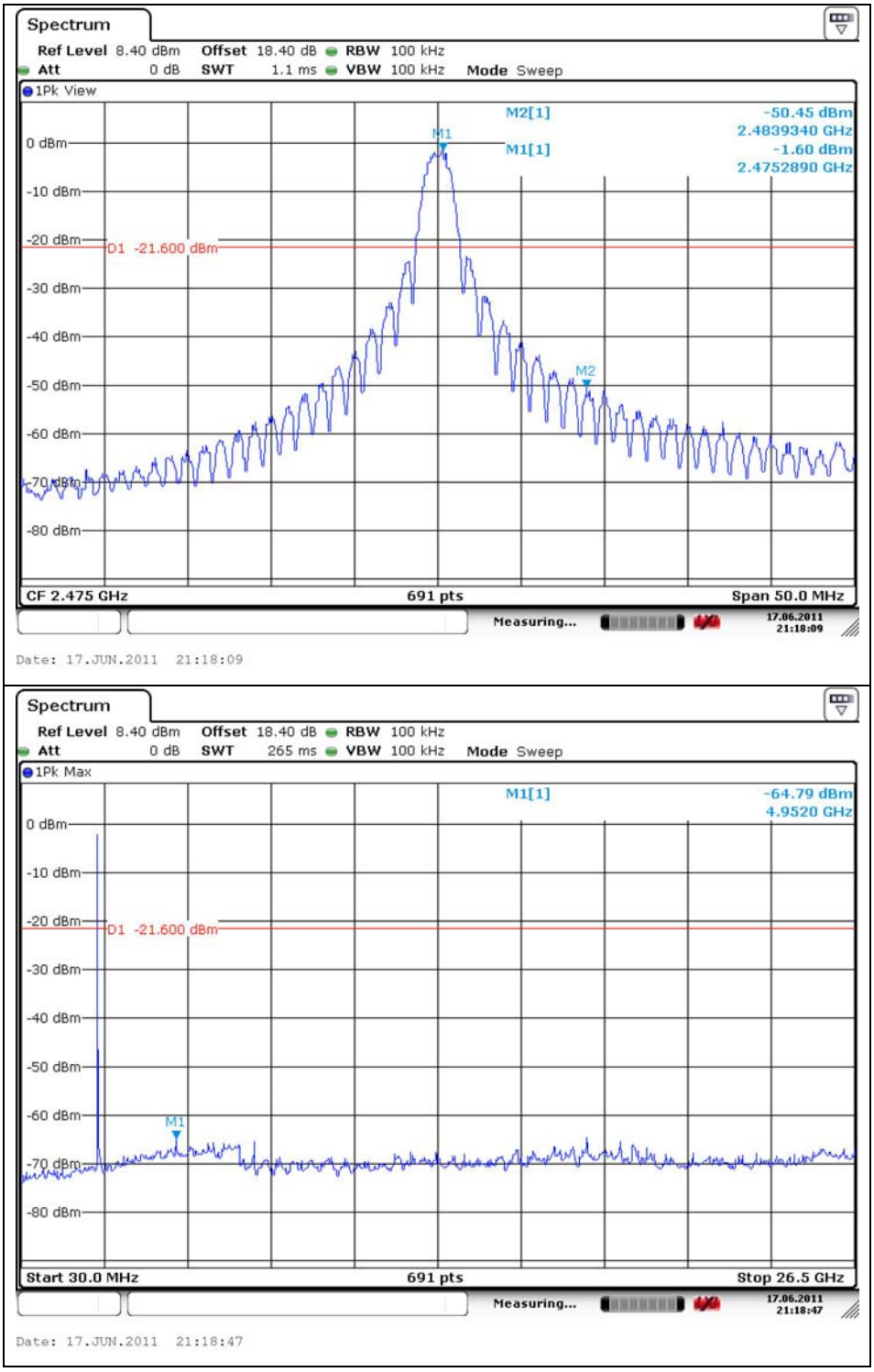
Zigbee : Module 2
Low Channel



Middle Channel



High Channel



3. 6 dB Bandwidth Measurement

3.1. Test Setup

3.2. 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 dB Bandwidth shall be at least 500 ㎑

3.3. Test Procedure

1. The 6 dB band width was measured with a spectrum analyzer connected to RF antenna connector(conducted measurement) while EUT wa s op erating in tran smit mode at t he ap propriate cente r fre quency. Th e analyzer cent er freq uency was set to the EUT ca rrier freq uency, using the a nalyzer. Di splay Line and Marker Delta functions, the 6 dB band width of the emission was determined.

2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 100 ㎑, VBW = 100 ㎑, Span = 10 ㎒.

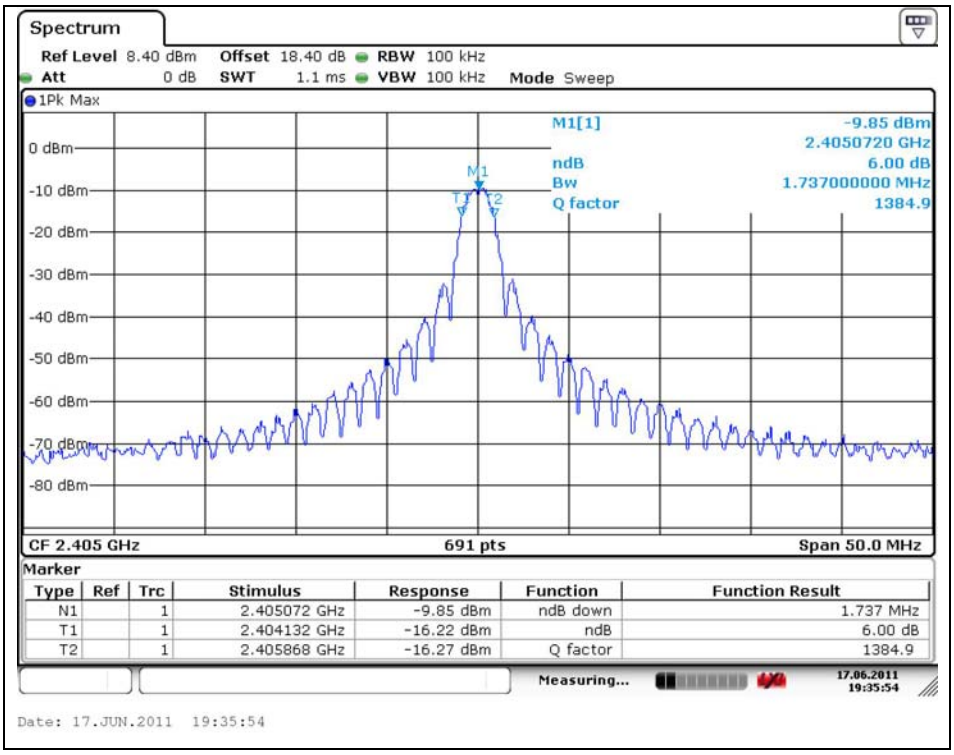
3.4. Test Results

Ambient temperature : (24 ± 2) ℃
Relative humidity : 47 % R.H.

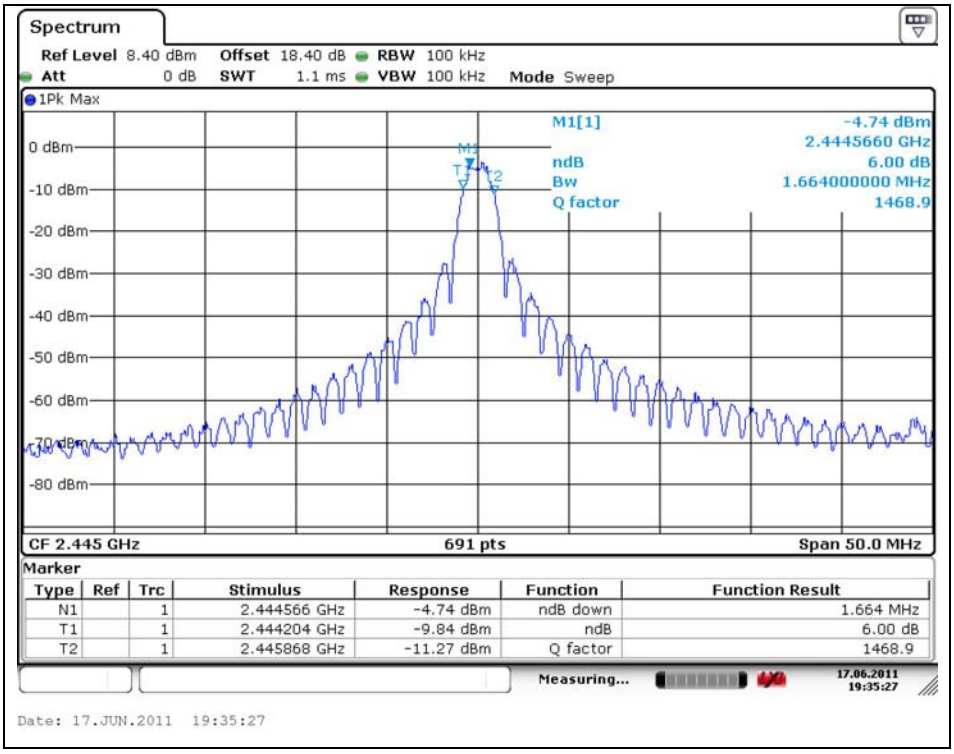
Operation Mode	Channel	Channel Frequency (㎒)	6 ㏈ Bandwidth (㎒)	Minimun Limit (㎒)
Module 1	Low 2	405	1.74	0.5
	Middle 2	445	1.66	
	High 2	475	1.74	
Module 2	Low 2	405	1.59	
	Middle 2	445	1.59	
	High 2	475	1.66	

Zigbee : Module 1

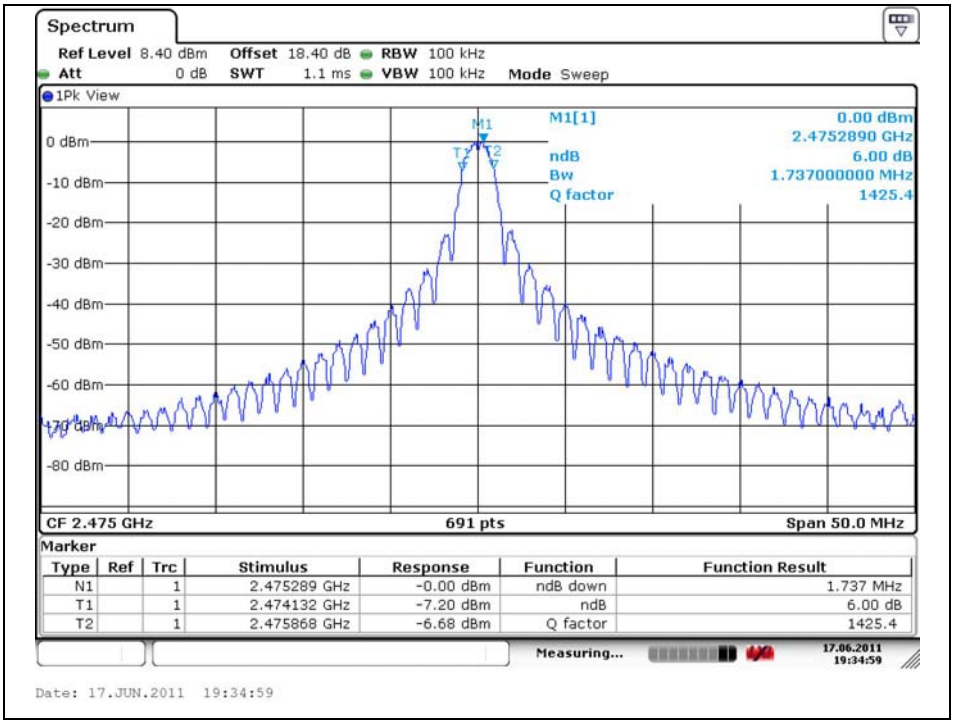
Low Channel



Middle Channel

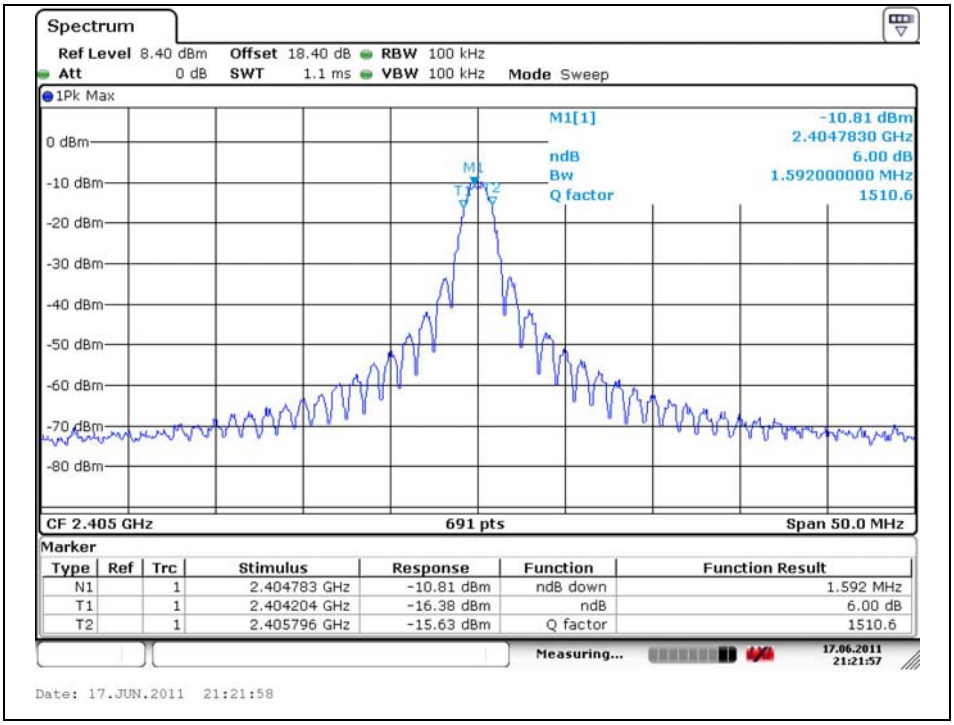


High Channel

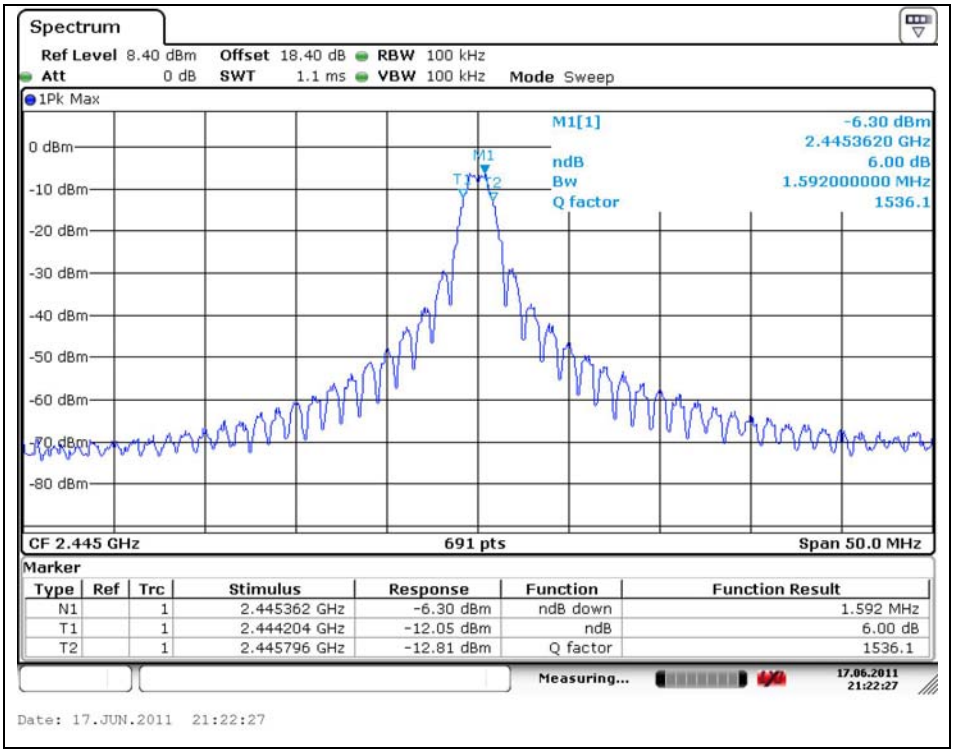


Zigbee : Module 2

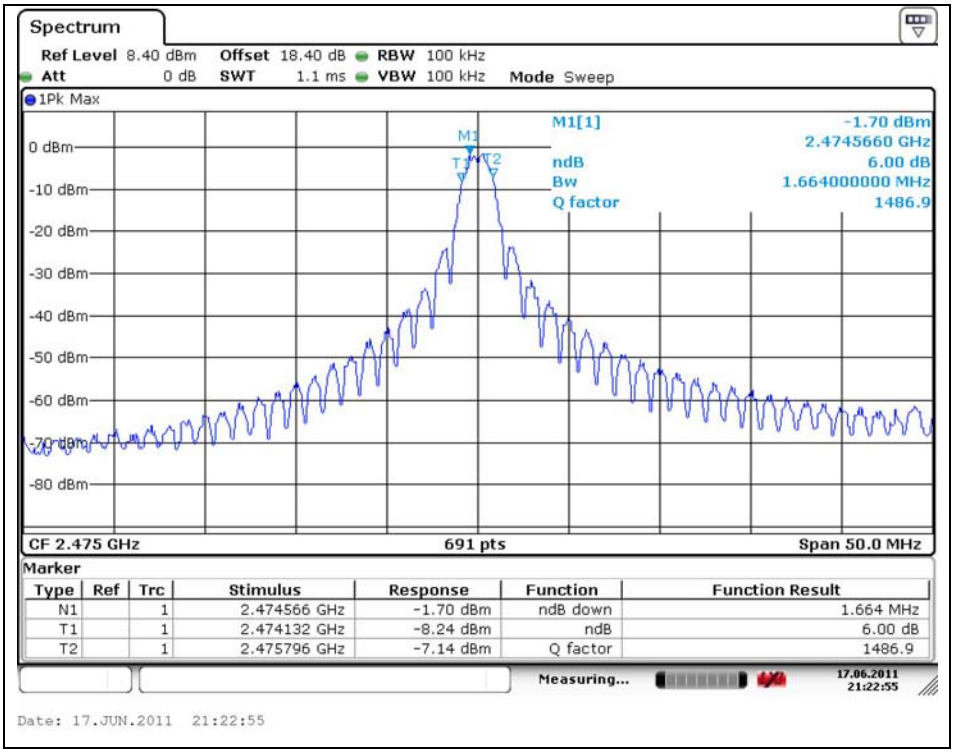
Low Channel



Middle Channel

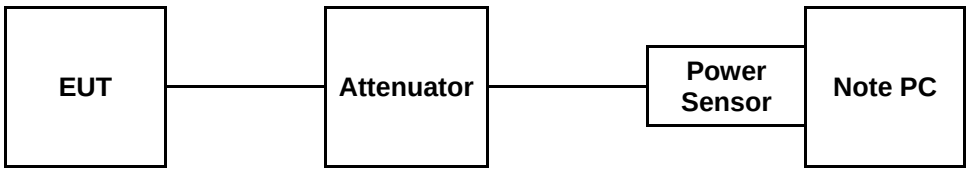


High Channel



4. Maximum Peak Output Power Measurement

4.1. Test Setup



4.2. Limit

According to §15.247(b)(3), for systems using digital modulation in the 902 ~ 928 ㎒, 2 400 ~2 483.5 ㎒, and 5 725 ~ 5 850 ㎒ 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 defi ned a s the total tran smit power d elivered to all ant ennas an d a ntenna el ements ave raged across all symbol s in the signaling alphabet when the transmitter is operat ing at its maximum powe r control level. Power must be su mmed acro ss all antenna e lements. The average mu st not includ e any intervals during which the tran smitter is off or i s transmitting at a reduced power level. If multiple modes of op eration are po ssible (e.g., alternat ive modulatio n methods), the maximum condu cted output powe r is the highest total transmit power occurring in any mode.
According to §15.247 (b)(4), the con ducted o utput powe r limit specified in paragraph(b) of this section is based on th e use of an tenna with d irectional gai ns that do not excee d 6 ㏈i. Except as sho wn in paragraph(c) of this se ction, if transm itting antenn a of dire ctional gain greater than 6 ㏈i a re us ed, the conducted output power from the in tentional radiator shall be redu ced below the stated values in paragra ph (b)(1), (b)(2), and (b)(3) of this se ction , as appropriate, by the amount in ㏈ that the directio nal gain of the antenna exceeds 6㏈i.

4.3. Test Procedure

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenn a from the EUT and then co nnect a low loss RF cable fro m the antenn a port to powe r sensor.

4.4. Test Results

Ambient temperature : (24 ± 2) ℃
Relative humidity : 47 % R.H.

Operation Mode	Channel	Channel Frequency (㎒)	Attenuator + Cable offset (dB)	Peak Power Result (dB m)	Peak Power Limit (dB m)
Module 1	Low 2	405	17.31	-3.08	30
	Middle 2	445	17.31	0.58	
	High 2	475	17.31	4.87	
Module 2	Low 2	405	17.31	-3.63	
	Middle 2	445	17.31	-0.95	
	High 2	475	17.31	3.13	

5. POWER SPECTRAL DENSITY MEASUREMENT

5.1. Test Setup

5.2. Limit

§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 dBm 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.

5.3. Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
3. By using the Max Hold function record the separation of adjacent channels.
4. Repeat above procedures until all frequencies measured were complete.
5. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using ; RBW = 3 ㎑, VBW = 10 ㎑, Span = 300 ㎑ and Sweep = 100 s.

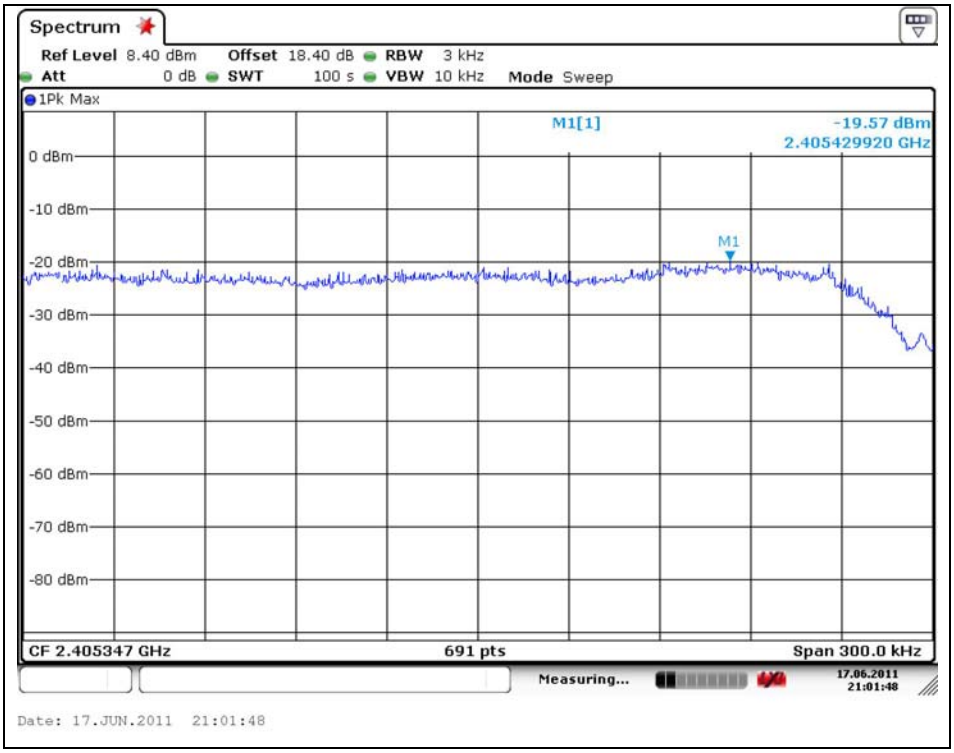
5.4. Test Results

Ambient temperature : (24 ± 2) ℃
Relative humidity : 47 % R.H.

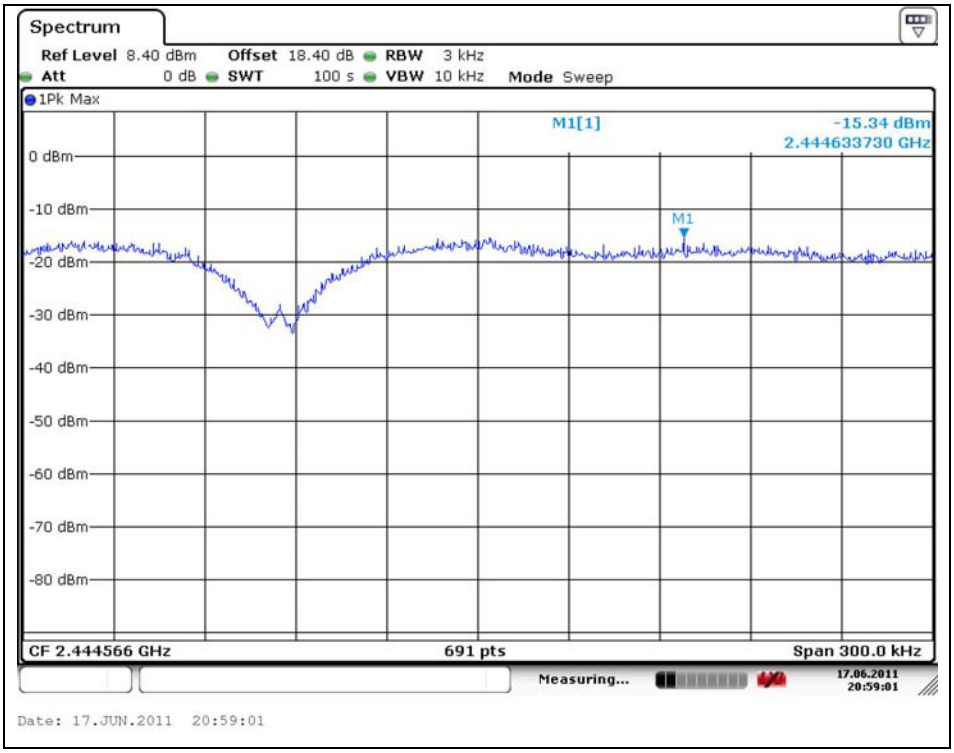
Operation Mode	Frequency	Final RF Power Level in 3 ㎑ BW (㏈m)	Maximum Limit (㏈m)
Module 1	2 405 ㎒	-19.57	8
	2 445 ㎒ -15.3	4	
	2 475 ㎒	-10.15	
Module 2	2 405 ㎒	-21.08	
	2 445 ㎒ -17.0	8	
	2 475 ㎒	-12.21	

Zigbee : Module 1

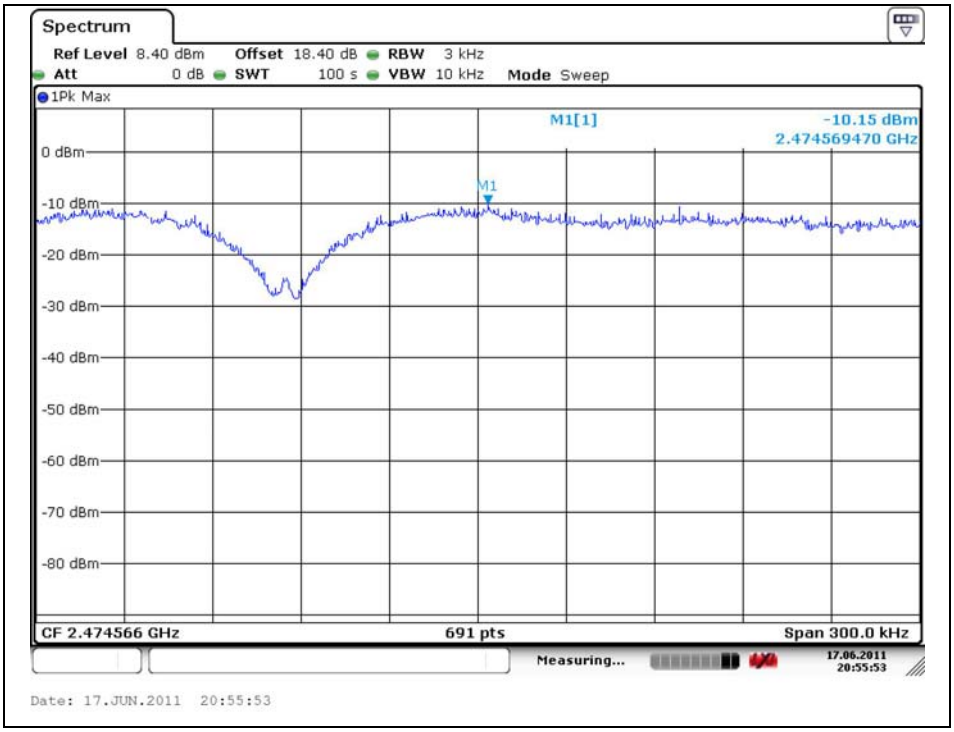
Low Channel



Middle Channel

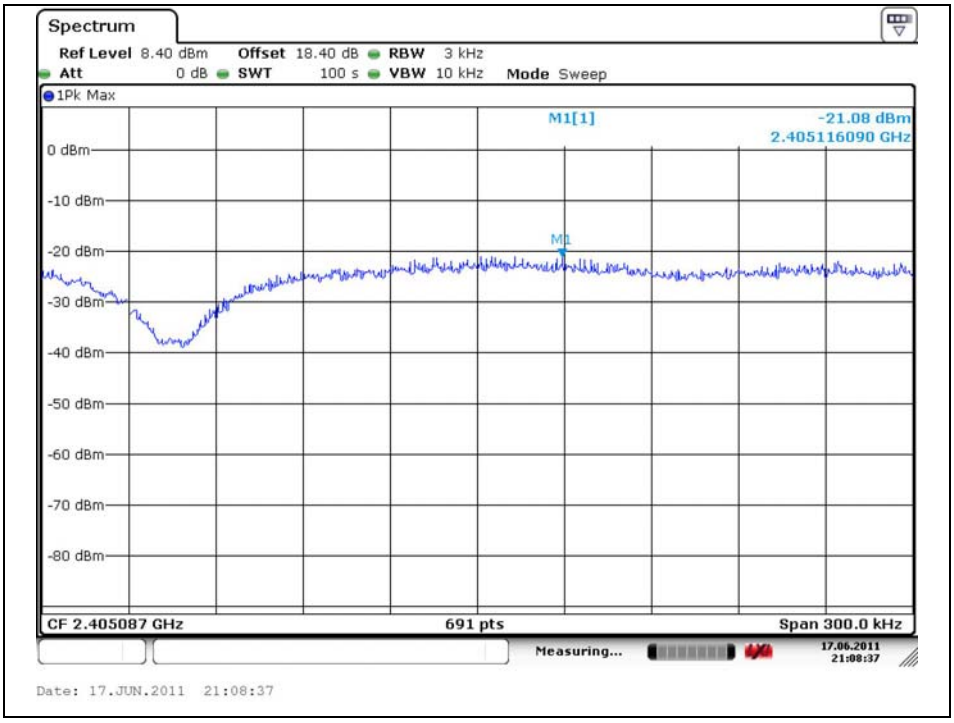


High Channel

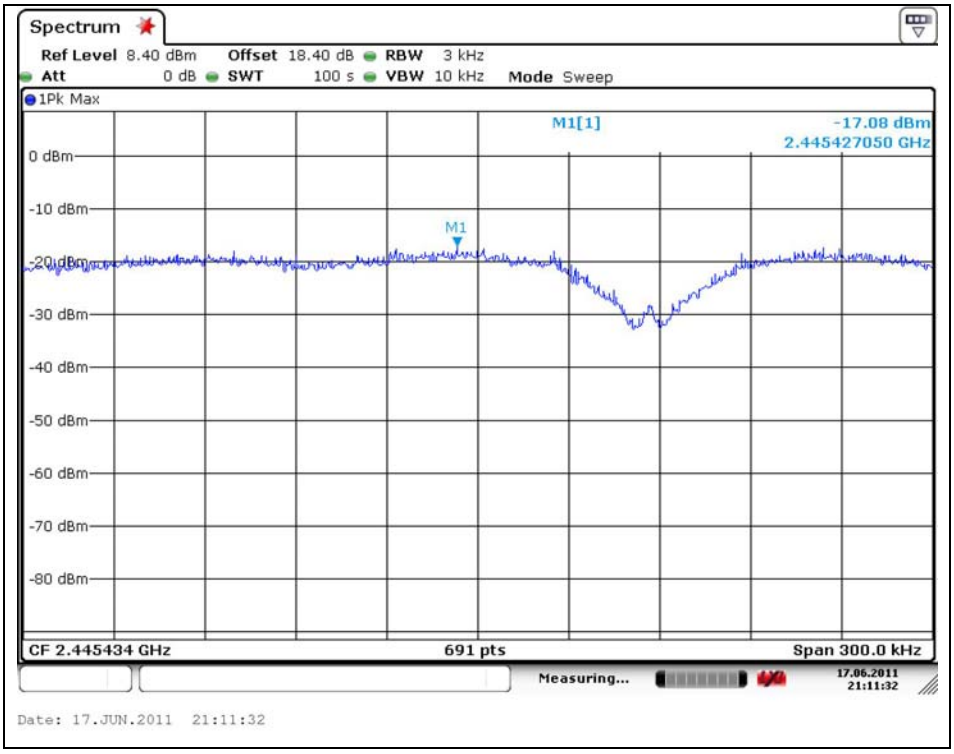


Zigbee : Module 2

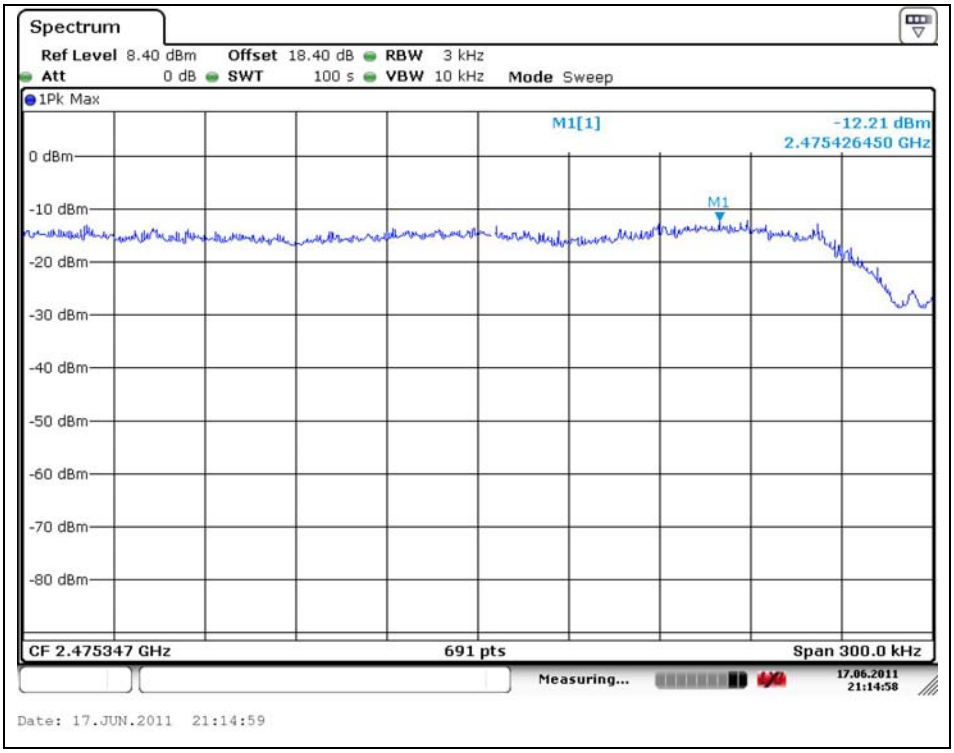
Low Channel



Middle Channel

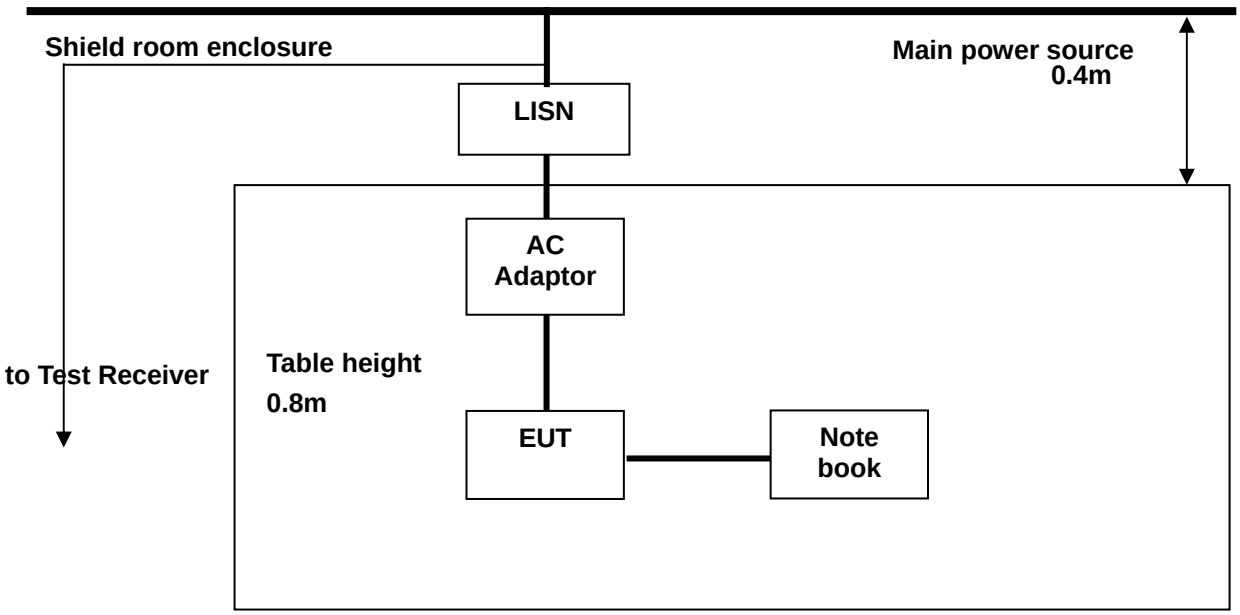


High Channel



6. Transmitter AC Power Line Conducted Emission

6.1. Test Setup



6.2. 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 ㎑ 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 frequency ranges.

Frequency of Emission (㎒)	Conducted limit (dB㎶)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

* Decreases with the logarithm of the frequency.

6.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2003

1. The test procedure is performed in a 6.5m × 3.6m× 3.6m (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.
2. 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.
3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
4. 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.

6.4. Test Results (Worst case configuration_module1 mode)

The following table shows the highest levels of conducted emissions on both phase of Hot and Neutral line.

Ambient temperature : (24 ± 2) ℃
Relative humidity : 47 % R.H.

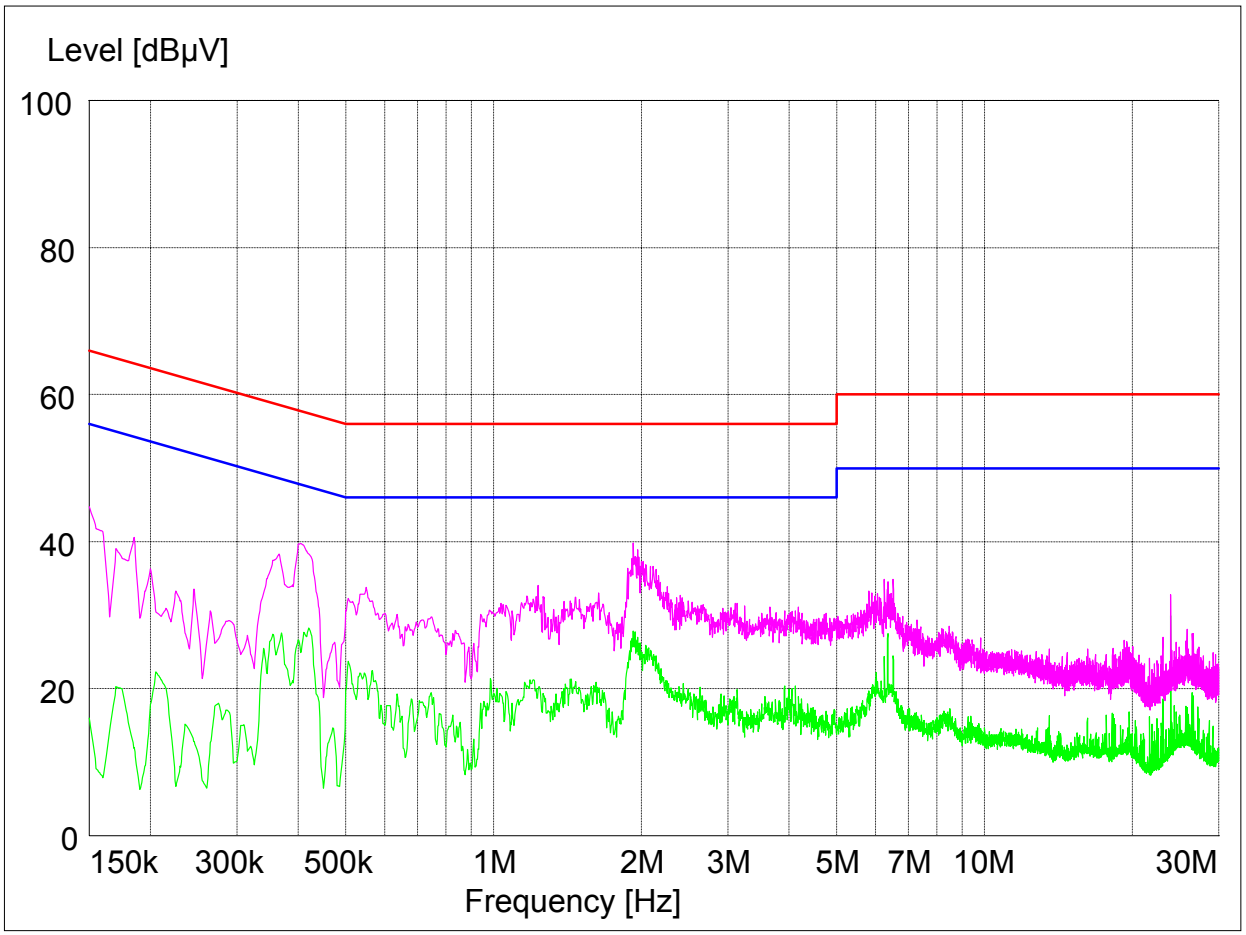
Frequency range : 0.15 ㎒ – 30 ㎒
Measured Bandwidth : 9 ㎑

FREQ.	LEVEL(dB㎶)		LINE	LIMIT(dB㎶)		MARGIN(dB)	
(㎒)	Q-Peak	Average		Q-Peak	Average	Q-Peak	Average
0.37	36.10	27.30	H	58.61	48.61	22.51	21.31
0.40	38.30	31.30	H	57.85	47.85	19.55	16.55
1.23	27.60	21.60	H	56.00	46.00	28.40	24.40
1.93	34.30	27.70	H	56.00	46.00	21.70	18.30
6.35	32.80	29.40	H	60.00	50.00	27.20	20.60
23.95	30.70	30.00	H	60.00	50.00	29.30	20.00
0.29	35.60	26.60	N	60.52	50.52	24.92	23.92
0.38	38.20	32.20	N	58.39	48.39	20.19	16.19
1.20	28.90	23.30	N	56.00	46.00	27.10	22.70
1.98	32.70	26.90	N	56.00	46.00	23.30	19.10
3.91	31.30	26.10	N	56.00	46.00	24.70	19.90
23.96	30.50	29.30	N	60.00	50.00	29.50	20.70

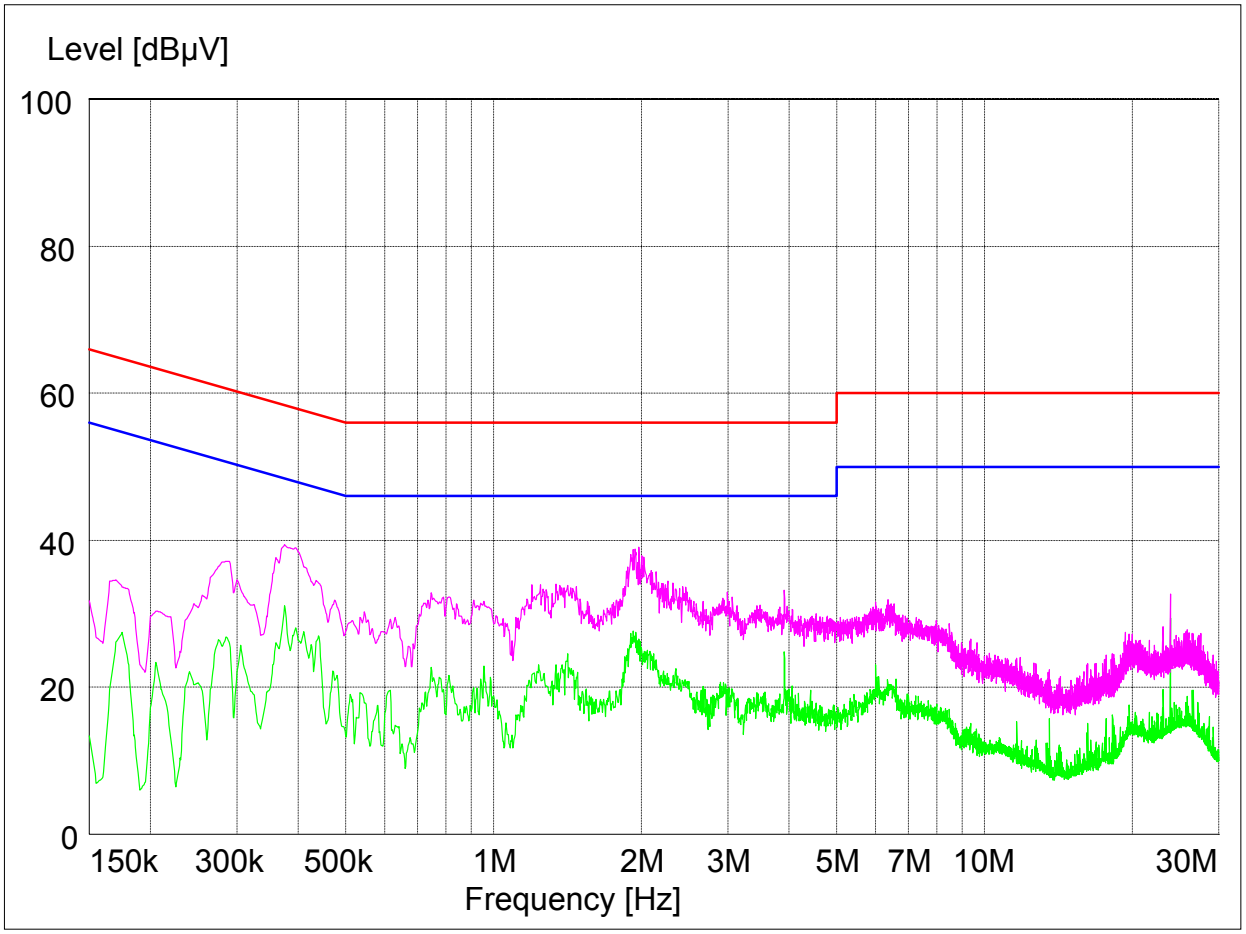
Note ;
Line (H) : Hot
Line (N) : Neutral

Plot of Conducted Power line

Test mode : (Hot)



Test mode : (Neutral)



7. Antenna Requirement

7.1. Standard Applicable

For intentional device, according to FCC 47 CFR Se ction §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, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6 dBi.

7.2. Antenna Connected Construction

Antenna used in this product is Connector type (Chip Antenna) gain of 0.477 dBi.

8. RF Exposure Evaluation

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

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 – 1 500	--	--	F/300	6
1 500 – 100 000	--	--	5	6
(B) Limits for General Population/Uncontrol Exposures				
300 – 1 500	--	--	F/1500	6
1 500 – 100 000	**--**	**--**	**1**	**30**

8.1.1. Friis transmission formula: Pd = (Pout*G)/(4*pi*R^2)

Where Pd = power density in ㎽/㎠

Pout = output power to antenna in ㎽

G = gain of antenna in linear scale

Pi = 3.1416

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

Pd 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.

8.1.2. Test Result of RF Exposure Evaluation

Test Item : RF Exposure Evaluation Data
Test Mode : Normal Operation

8.1.3. Output Power into Antenna & RF Exposure Evaluation Distance

Zigbee : Module 1

Channel	Channel Frequency (㎒)	Output Average Power to Antenna (dB m)	Antenna Gain (dB i)	Power Density at 20 ㎝ (㎽/㎠)	LIMITS (㎽/㎠)
Low	2 405	-6.29	0.477	0.000 05	1
Middle	2 445	-0.65	0.477	0.000 19	1
High	2 475	4.25	0.477	0.000 59	1

Zigbee : Module 2

Channel	Channel Frequency (㎒)	Output Average Power to Antenna (dB m)	Antenna Gain (dB i)	Power Density at 20 ㎝ (㎽/㎠)	LIMITS (㎽/㎠)
Low	2 405	-7.79	0.477	0.000 04	1
Middle	2 445	-2.71	0.477	0.000 12	1
High	2 475	2.32	0.477	0.000 38	1

Simultaneous Multiple band RF Exposure results

Band	Mode	Output Average Power to Antenna (dB m)	Antenna Gain (dB i)	Power Density at 20cm (㎽/㎠)	LIMITS (㎽/㎠)
2.4 GHz	WLAN	23.85	4.887	0.148 74	1
2.4 GHz	Zigbee module 1	4.25	0.477	0.000 59	1
2.4 GHz	Zigbee module 2	2.32	0.447	0.000 38	1
Combined				0.149 71	1

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