FCC Part 15 Subpart B&C §15.247

Test Report

Equipment Under Test	**Bluetooth Stereo Speaker**
Model Name	**ONYX**
Applicant	**MOVON CORPORATION**
FCC ID	**TDU-ONYX**
Manufacturer	**QINGDAO MOVON ELECTRONIC CORPORATION**
Date of Test(s)	**2013. 03. 15 ~ 2013. 03. 25**
Date of Issue	**2013. 04. 03**

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

Issue to	Issue by
MOVON CORPORATION 140-28 SAMSUNG DONG, GANGNAM GU, SEOUL, KOREA Tel.: +82-2-2050-4632 Fax: +82-2-2050-4666	MOVON CORPORATION 194-1, Geumeo-ri, 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
--	Mar 29, 2013	Initial	--
1	Apr 2, 2013	Add Photo of Conducted emission	Raymond Kim
2	Apr 3, 2013	Add Band-edge comment for page 17,19	Raymond Kim

Table of contents

1. Attestation of test results

1.1. Details of applicant

Applicant	:	MOVON CORPORATION
Address	:	140-28 SAMSUNG DONG, GANGNAM GU, SEOUL, KOREA
Contact Person	:	MR. DOMINIC SO
Telephone	:	+82-2-2050-4632
Fax	:	+82-2-2050-4666

1.2. Summary of test results

The EUT has been tested according to the following specifications;

Section in FCC part 15	Description	Result
§15.205(a) §15.209 §15.247(d)	Transmitter radiated spurious emissions, Conducted spurious emission	C
§15.247(a)(1)	20 dB bandwidth	C
§15.247(b)(1)	Maximum peak output power	C
§15.247(a)(1)	Frequency separation	C
§15.247(a)(1)(iii)	Number of hopping frequency	C
§15.247(a)(1)(iii)	Time of occupancy(Dwell time)	C
§15.247(i) §1.1307(b)(1)	RF exposure evaluation	C

The sample was tested according to the following specification:
FCC Parts 15.247; ANSI C-63.4-2003
FCC Public Notice DA 00-705
TEST SITE REGISTRATION NUMBER:
FCC(670686)

※ Abbreviation

C Complied
N/A Not applicable
F Fail

Approval Signatories

Test and Report Completed by :	Report Approval by :
	
Raymond Kim Test Engineer MOVON CORPORATION	Issac Jin Technical Manager MOVON CORPORATION

2. EUT Description

Kind of product	Bluetooth Stereo Speaker
Model Name	ONYX
Serial Number	N/A
Power supply	DC 3.70 V
Frequency range	2 402 ㎒ ~ 2 480 ㎒
Modulation technique	GFSK(1Mbps)
Number of channels	79
Antenna gain	3.847 ㏈i (Max.)
TEST SITE REGISTRATION NUMBER	FCC(670686)

2.1. Declarations by the manufacturer

The EUT is does not do anything at charging mode (Power is turned off when it is charging)

2.2. Details of modification

None

3. Information about the FHSS characteristics

3.1. Pseudorandom frequency hopping sequence

The channel is represented by a pseudo-random hopping sequence hopping through the 79 RF channels. The hopping sequence is unique for the piconet and is determined by the Bluetooth device address of the master; the phase in the hopping sequence is determined by the Bluetooth clock of the master. The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies. The nominal hop rate is 1 600 hops/s.

Example of a 79 hopping sequence in data mode: 40,21,44,23,42,53,46,55,48,33,52,35,50,65,54…

3.2 Equal Hopping Frequency Use

All Bluetooth units participating in the piconet are time and hop-synchronized to the channel.

3.3 System Receiver Input Bandwidth

The input bandwidth of the receiver is 1 ㎒. In every connection one Bluetooth device is the master and the other one is slave. The master determines the hopping sequence. The slave follows this sequence. Both devices shift between RX and TX time slot according to the clock of the master. Additionally the type of connection (e.g. single of multisport (packet) is set up at the beginning of the connection. The master adapts its hopping frequency and its TX/RX timing according to the packet type of the connection. Also the slave of the connection will use these settings. Repeating of a packet has no influence on the hopping sequence. The hopping sequence generated by the master of the connection will be followed in any case. That means, a repeated packet will not be send on the same frequency, it is send on the next frequency of the hopping sequence.

3.4 Equipment Description

15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of The regulations in Section15.247 when the transmitter is presented with a continuous data (or information) system.

15.247(h):In accordance with the Bluetooth Industry Standard, the system does not coordinate it channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

4. Measurement equipment

Equipment	Manufacturer	Model	Calibration due.
EMI Test Receiver	R&S	ESIB26	2013-12-14
Signal Generator	R&S	SMR27	2013-12-13
Spectrum Analyzer	R&S	FSV-40	2013-10-04
Power Meter	Agilent	E4416A	2013-10-04
Power Sensor	Agilent	9327A	2013-10-04
Double Redge Horn Antenna	ETS	3115	2013-03-22
Horn Antenna	A.H.SYSTEMS	SAS-572	2013-09-07
Ultra Broadband Antenna	R&S	HL562	2013-12-13
Power Amplifier	MITEQ	AM-1431	2013-10-04
Power Amplifier	MITEQ	AFS43-01002600	2013-10-04
High Pass Filter	Wainwright	WHK3.0/18G-10SS	2013-10-04
DC Power Supply	HP	6674A	2013-10-04
Controller	INNCO	CO2000	N/A
Antenna Master	INNCO	MA4000	N/A
Loop Antenna	ETS LINDGREN	6502	2013-10-10

※ Remark;
Support equipment

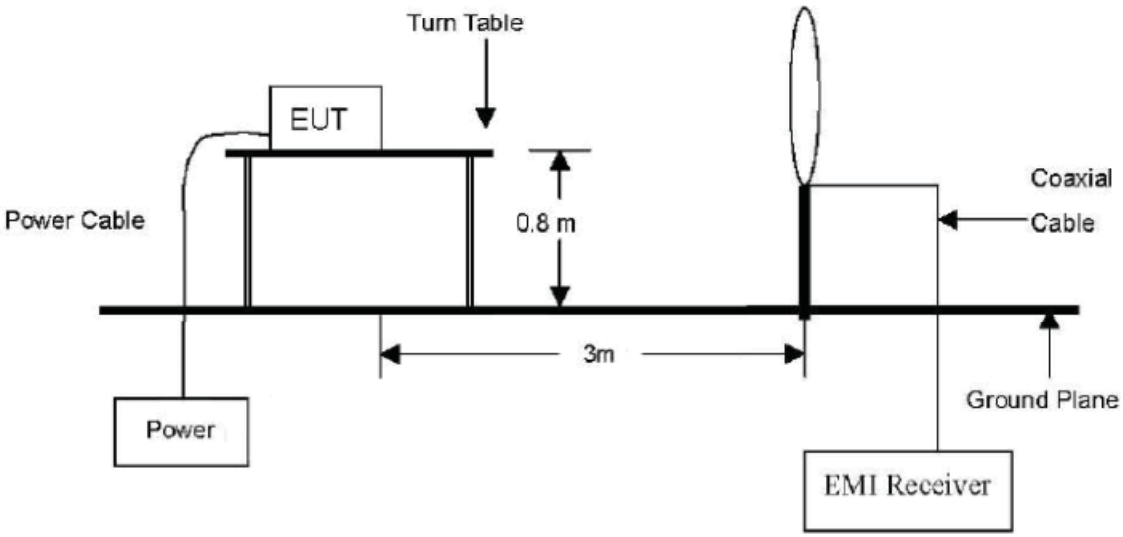
Description	Manufacturer	Model	Serial number
Notebook computer	Samsung Electronics.	SENS P30	W3179RFX300144N

5. Transmitter radiated spurious emissions and conducted spurious emissions

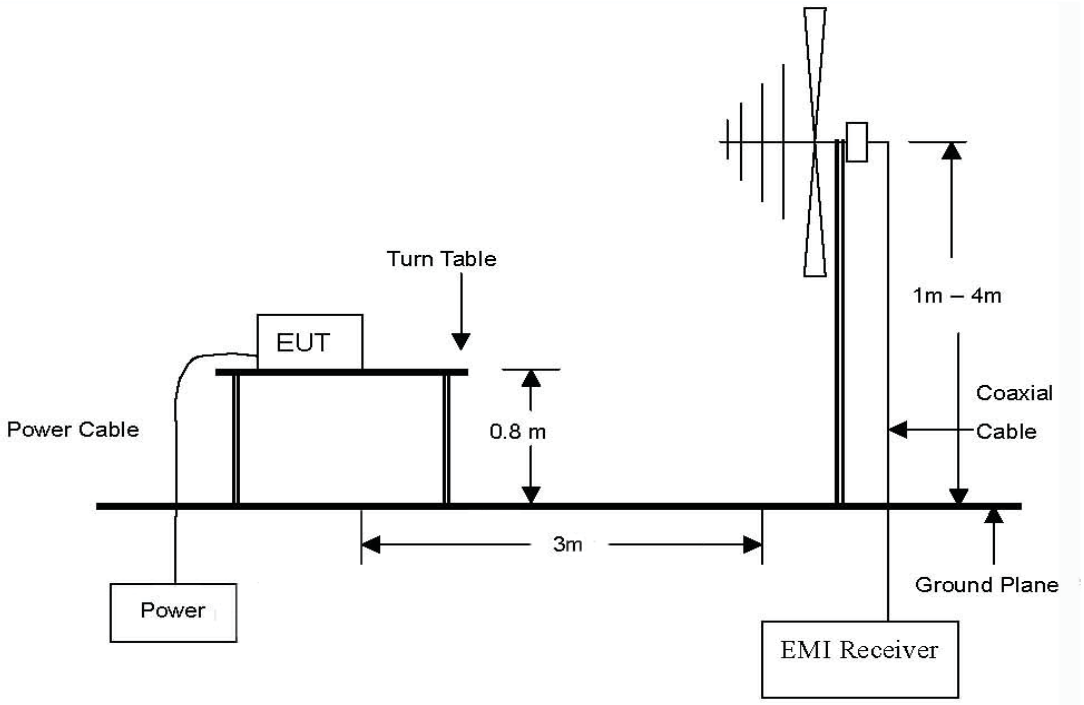
5.1. Test setup

5.1.1. Transmitter radiated spurious emissions

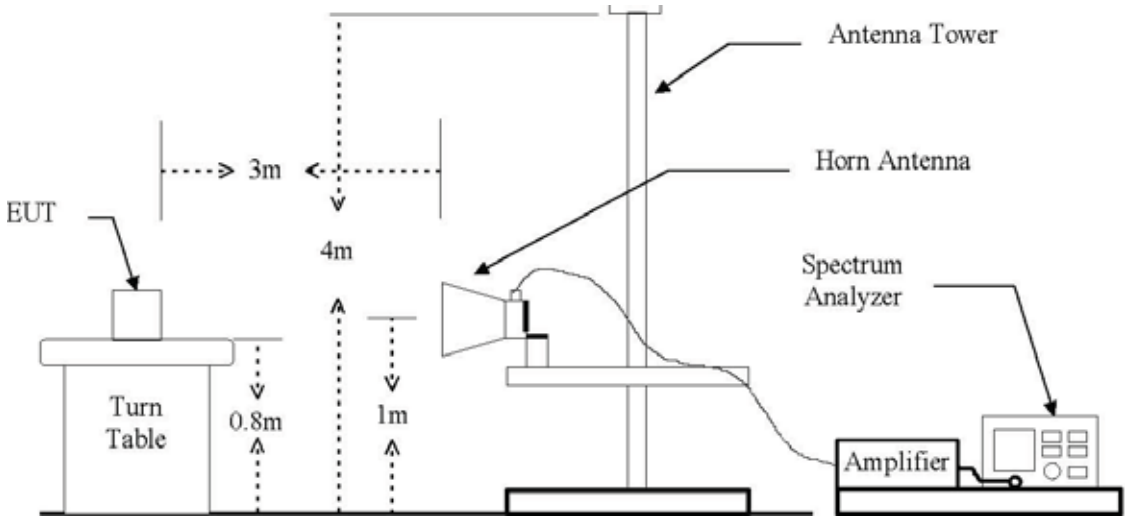
The diagram below shows the test setup that is utilized to make the measurements for emission from 9kHz to 30MHz Emissions.



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 24 ㎓ emissions.



5.2. 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.

5.3. Test procedures

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

1. The EUT is placed on a turntable, which is 0.8 m 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 ㎓.

5.3.2. Test procedures for conducted spurious emissions

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

5.4. Test result

Ambient temperature: 5 ℃
Relative humidity: 45 % R.H.

5.4.1. 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.

Operation mode
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 (2 441 ㎒)

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.

5.4.2. 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.

Operation mode: Basic mode
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 (㏈)
31.94	16.68	Peak	V	16.55	1.64	34.87	40.00	5.13
53.33	16.21	Peak	H	6.85	2.05	25.11	40.00	14.89
191.34	10.41	Peak	V	11.23	3.93	25.57	43.50	17.93
224.39	9.24	Peak	V	12.85	4.28	26.37	46.00	19.63
280.76	7.49	Peak	H	14.18	4.81	26.48	46.00	19.52
Above 400.00	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.

B. Middle channel (2 441 ㎒)

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)
31.94	16.37	Peak	V	16.55	1.64	34.56	40.00	5.44
53.33	16.67	Peak	H	6.85	2.05	25.57	40.00	14.43
191.34	9.84	Peak	V	11.23	3.93	25.00	43.50	18.50
224.39	8.87	Peak	V	12.85	4.28	26.00	46.00	20.00
280.76	8.26	Peak	H	14.18	4.81	27.25	46.00	18.75
Above 300.00	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)
31.94	15.06	Peak	V	16.55	1.64	33.25	40.00	6.75
53.33	17.04	Peak	H	6.85	2.05	25.94	40.00	14.06
191.34	10.09	Peak	V	11.23	3.93	25.25	43.50	18.25
224.39	9.74	Peak	V	12.85	4.28	26.87	46.00	19.13
280.76	8.12	Peak	H	14.18	4.81	27.11	46.00	18.89
Above 300.00	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.

5.4.3. 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.

Operation mode: Basic mode

A. Low channel (2 402 ㎒)

Radiated emissions			Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	Amp + CL (㏈)	D.C.F (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
2 376.00*	58.25	Peak	H	28.84	43.87	0.00	43.22	74.00	30.78
2 376.00*	47.21	Average	H	28.84	43.87	0.00	32.18	54.00	21.82
2 376.00*	59.59	Peak	V	28.84	43.87	0.00	44.56	74.00	29.44
2 376.00*	48.70	Average	V	28.84	43.87	0.00	33.67	54.00	20.33
1 602.00	60.25	Peak	H	27.49	43.79	0.00	43.95	74.00	30.05
1 602.00	45.25	Average	H	27.49	43.79	0.00	28.95	54.00	25.05
1 602.00	60.32	Peak	V	27.49	43.79	0.00	44.02	74.00	29.98
1 602.00	50.59	Average	V	27.49	43.79	0.00	34.29	54.00	19.71
4 804.00	60.25	Peak	H	33.61	42.74	-30.35	20.77	74.00	53.23
4 804.00	51.31	Average	H	33.61	42.74	-30.35	11.83	54.00	42.17
4 804.00	71.32	Peak	V	33.61	42.74	-30.35	31.84	74.00	42.16
4 804.00	63.84	Average	V	33.61	42.74	-30.35	24.36	54.00	29.64
7 206.00	68.50	Peak	V	36.43	40.45	-30.35	34.13	74.00	39.87
7 206.00	60.38	Average	V	36.43	40.45	-30.35	26.01	54.00	27.99
Above 8 000.00	Not detected								

※D.C.F

D.C.F (Duty Cycle Correction Factor) = 20log(The worst Case DWELL Time/100ms)
= 20log(3.036ms/100ms) = -30.35

B. Middle channel (2 441 ㎒)

Radiated emissions			Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	D.C.F (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1 627.00	61.34	Peak	H	27.49	43.79	0.00	45.04	74.00	28.96
1 627.00	50.34	Average	H	27.49	43.79	0.00	34.04	54.00	19.96
1 627.00	60.95	Peak	V	27.49	43.79	0.00	44.65	74.00	29.35
1 627.00	54.70	Average	V	27.49	43.79	0.00	38.40	54.00	15.60
4 882.00	58.25	Peak	H	33.61	42.74	-30.35	18.77	74.00	55.23
4 882.00	52.34	Average	H	33.61	42.74	-30.35	12.86	54.00	41.14
4 882.00	70.44	Peak	V	33.61	42.74	-30.35	30.96	74.00	43.04
4 882.00	63.18	Average	V	33.61	42.74	-30.35	23.70	54.00	30.30
7 323.00	67.64	Peak	V	36.43	40.45	-30.35	33.27	74.00	40.73
7 323.00	58.97	Average	V	36.43	40.45	-30.35	24.60	54.00	29.40
Above 8 000.00	Not detected								

※D.C.F

D.C.F (Duty Cycle Correction Factor) = 20log(The worst Case DWELL Time/100ms)
= 20log(3.036ms/100ms) = -30.35

C. High channel (2 480 ㎒)

Radiated emissions			Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	D.C.F (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2 483.50*	58.34	Peak	H	28.84	43.87	0.00	43.31	74.00	30.69
2 483.50*	46.25	Average	H	28.84	43.87	0.00	31.22	54.00	22.78
2 483.50*	60.96	Peak	V	28.84	43.87	0.00	45.93	74.00	28.07
2 483.50*	48.44	Average	V	28.84	43.87	0.00	33.41	54.00	20.59
1 653.00	60.55	Peak	H	27.49	43.79	0.00	44.25	74.00	60.55
1 653.00	48.75	Average	H	27.49	43.79	0.00	32.45	54.00	48.75
1 653.00	60.57	Peak	V	27.49	43.79	0.00	44.27	74.00	60.57
1 653.00	54.25	Average	V	27.49	43.79	0.00	37.95	54.00	54.25
4 960.00	55.25	Peak	H	33.61	42.74	-30.35	15.77	74.00	58.23
4 960.00	43.24	Average	H	33.61	42.74	-30.35	3.76	54.00	50.24
4 960.00	65.68	Peak	V	33.61	42.74	-30.35	26.20	74.00	47.80
4 960.00	56.53	Average	V	33.61	42.74	-30.35	17.05	54.00	36.95
7 440.00	65.62	Peak	V	36.43	40.45	-30.35	31.25	74.00	42.75
7 440.00	57.12	Average	V	36.43	40.45	-30.35	22.75	54.00	31.25
Above 5 000.00	Not detected								

※ Remark

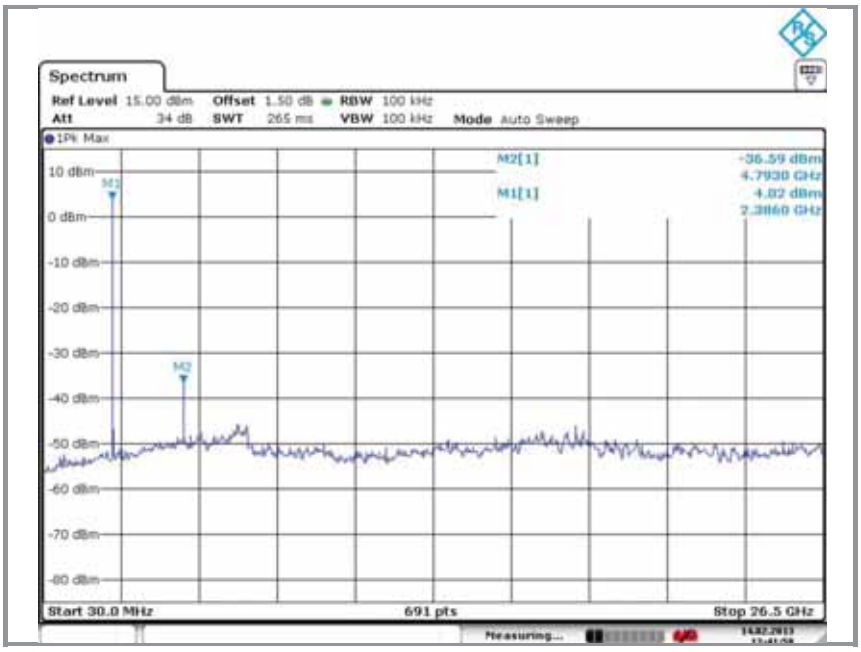
1. "*" means the restricted band.
2. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental Frequency.
3. Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument using peak/average detector mode.
4. Average test would be performed if the peak result were greater than the average limit.
5. Actual = Reading + Ant. factor + Amp + CL (Cable loss)
6. D.C.F (Duty Cycle Correction Factor) = 20log(The worst Case DWELL Time/100ms)
   = 20log(3.036ms/100ms) = -30.35
7. 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.

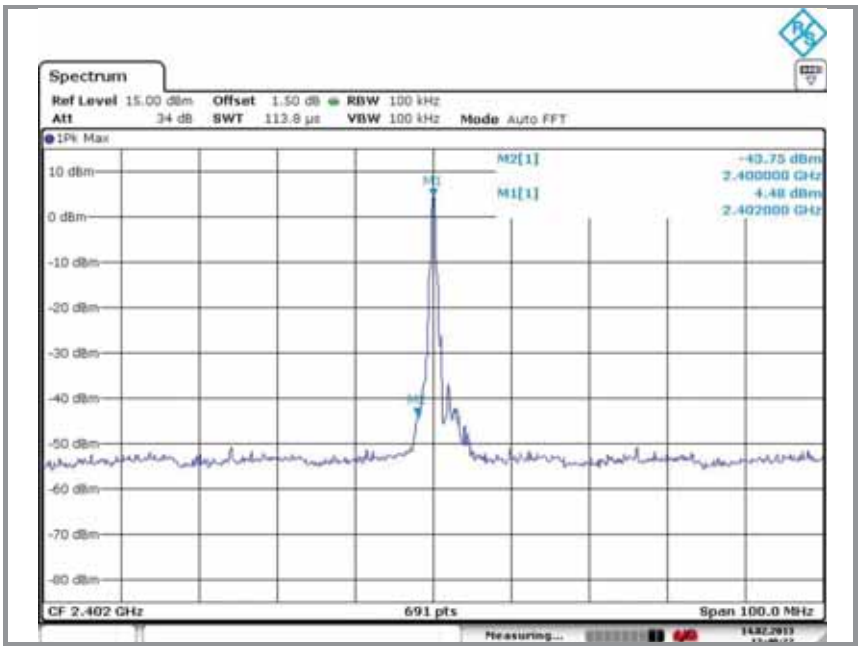
5.4.4. Spurious RF conducted emissions: Plot of spurious RF conducted emission
Operation mode: Basic mode

A. Low channel (2 402 ㎒)

Unwanted Emission data

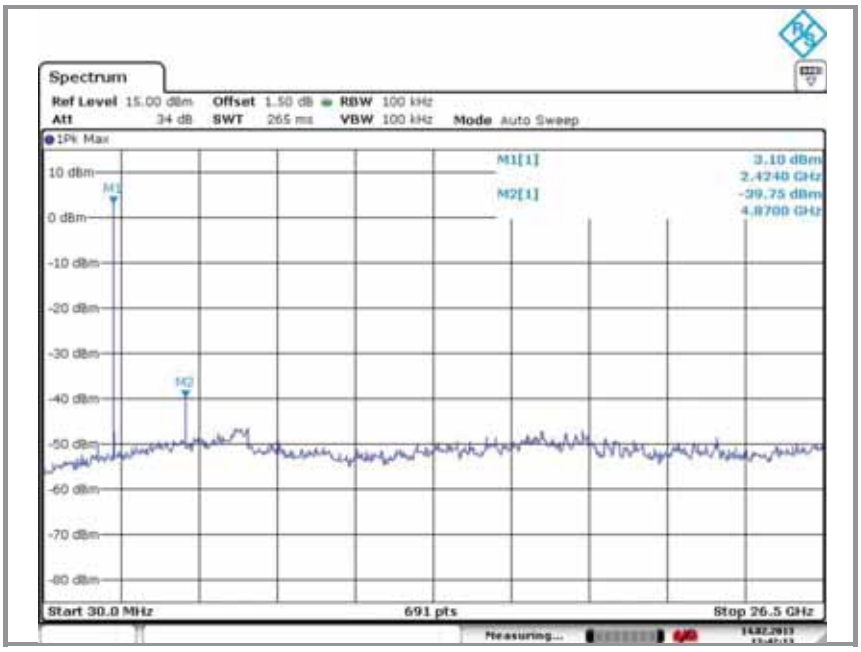


Band-edge data



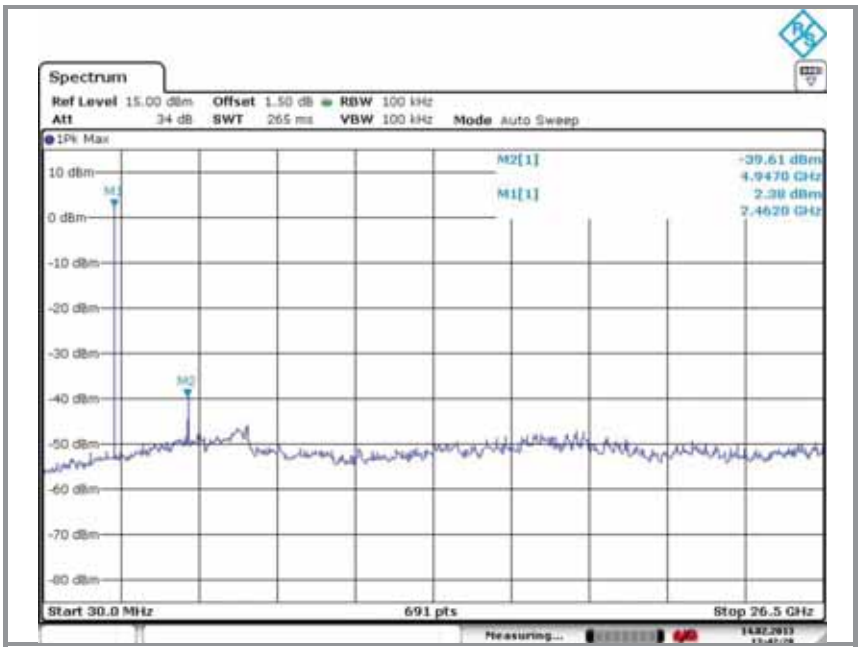
B. Middle channel (2 441 ㎒)

Unwanted Emission data

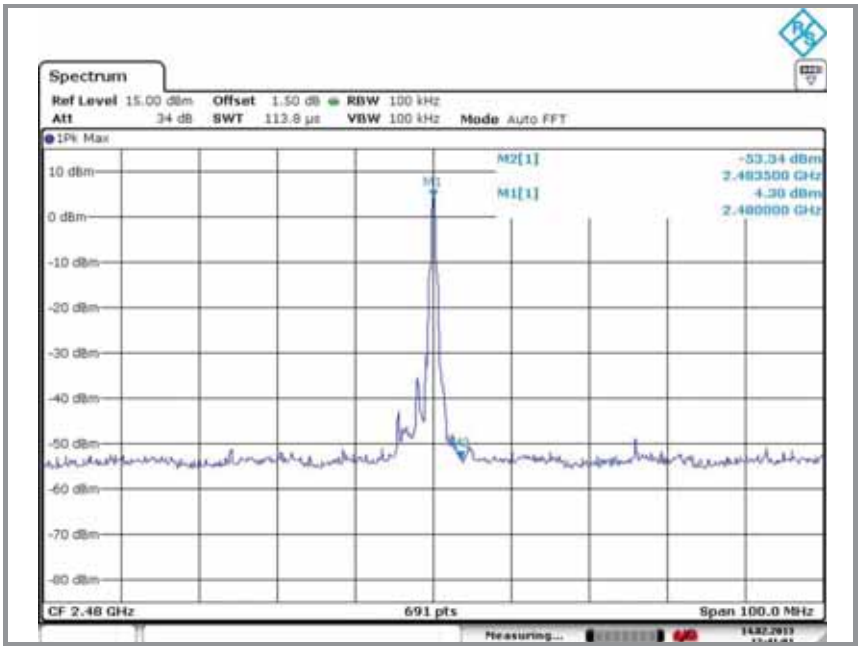


C. High channel (2 480 ㎒)

Unwanted Emission data

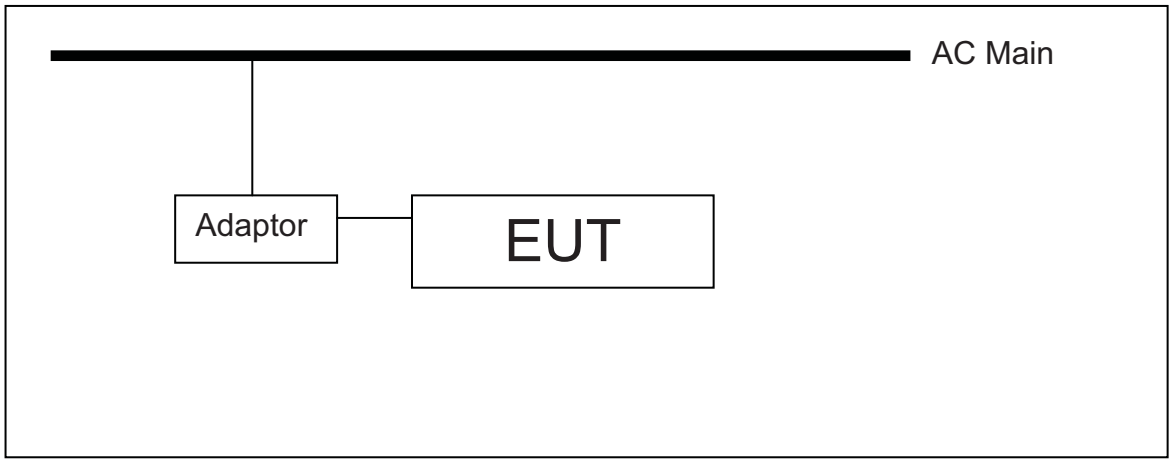


Band-edge data



6. Conducted power line test

6.1. Test setup



6.2. 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.

6.3. 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.

6.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 45 % R.H.

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

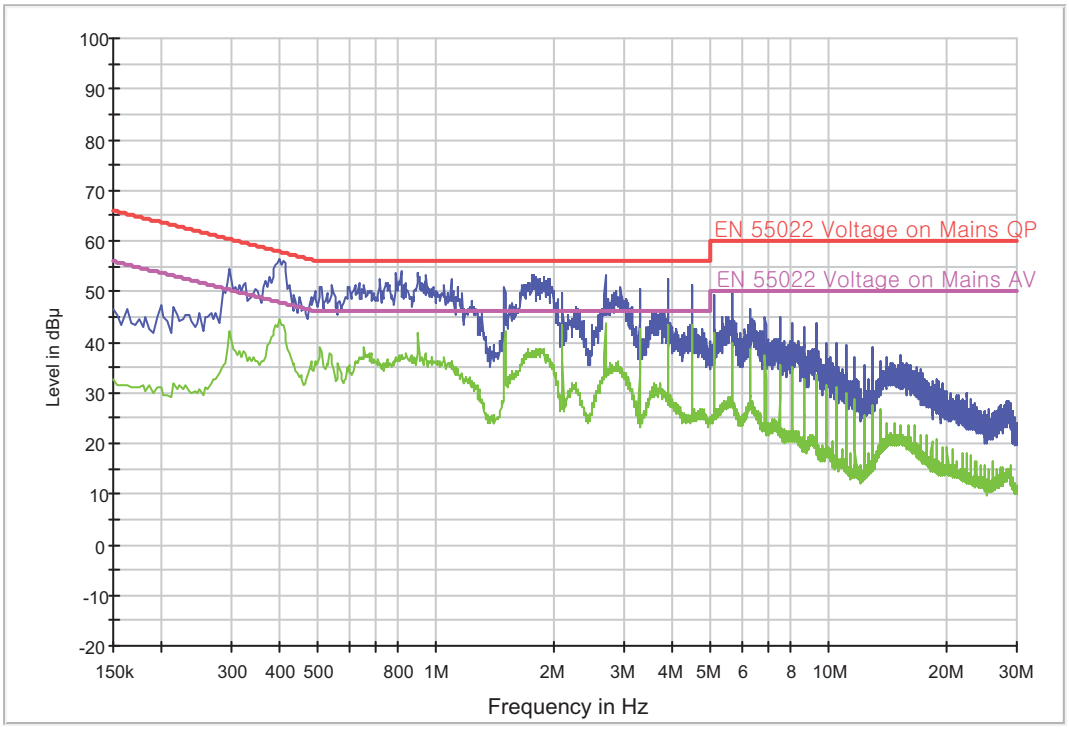
Freq. (㎒)	Line	Q-Peak		
		Level(dB㎶/m)	Limit(dB㎶/m)	Margin(dB)
0.30	L	49.19	60.30	11.11
0.40	L	51.69	57.81	6.12
2.69	N	50.22	56.00	5.78
3.28	N	48.91	56.00	7.09
5.07	N	46.80	60.00	13.20
5.64	L	45.92	60.00	14.08

Freq. (㎒)	Line	Average		
		Level(dB㎶/m)	Limit(dB㎶/m)	Margin(dB)
0.40	L	44.38	47.81	3.43
2.69	N	44.44	46.00	1.56
3.28	N	44.41	46.00	1.59

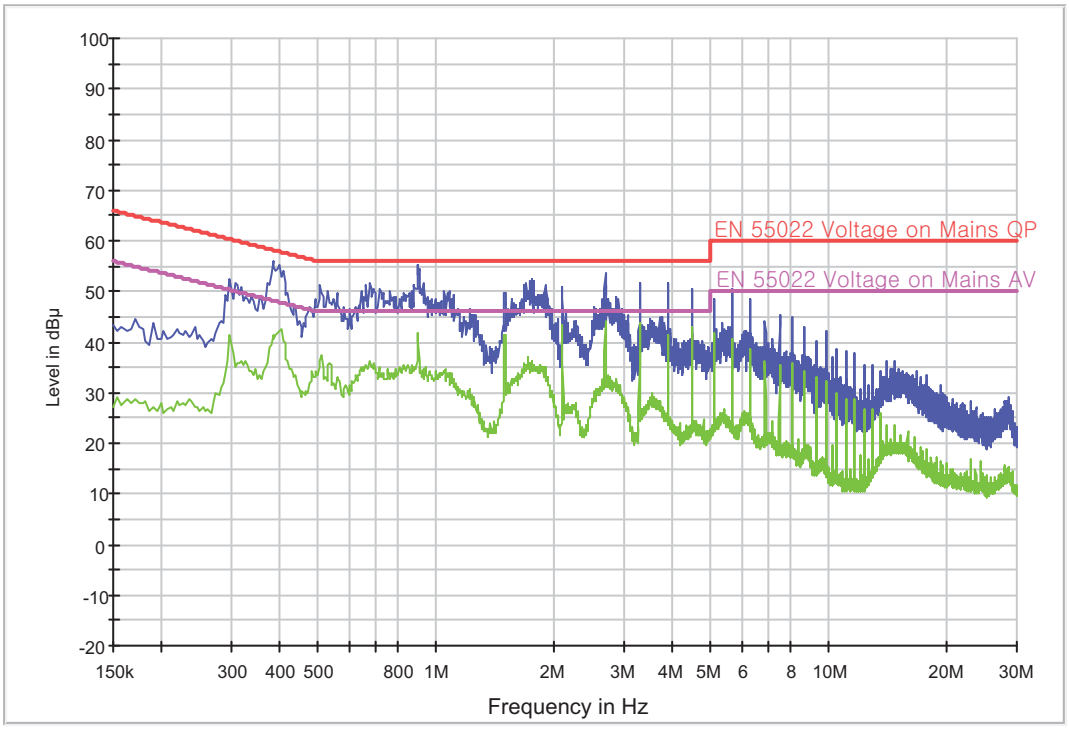
※ Remark
Line(H): Hot
Line(N): Neutral

Plot of conducted power line

Test mode: Hot

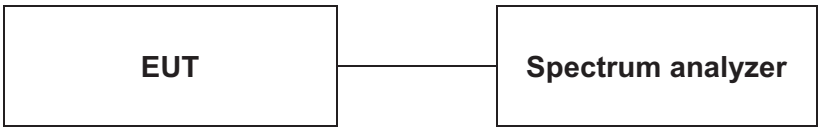


Test mode: Neutral



7. 20 dB bandwidth measurement

7.1. Test setup



7.2. Limit
Not applicable

7.3. Test procedure
1. The 20 dB 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 20 dB band width of the emission was determined.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 10 ㎑, VBW = 10 ㎑, Span = 5 ㎒.

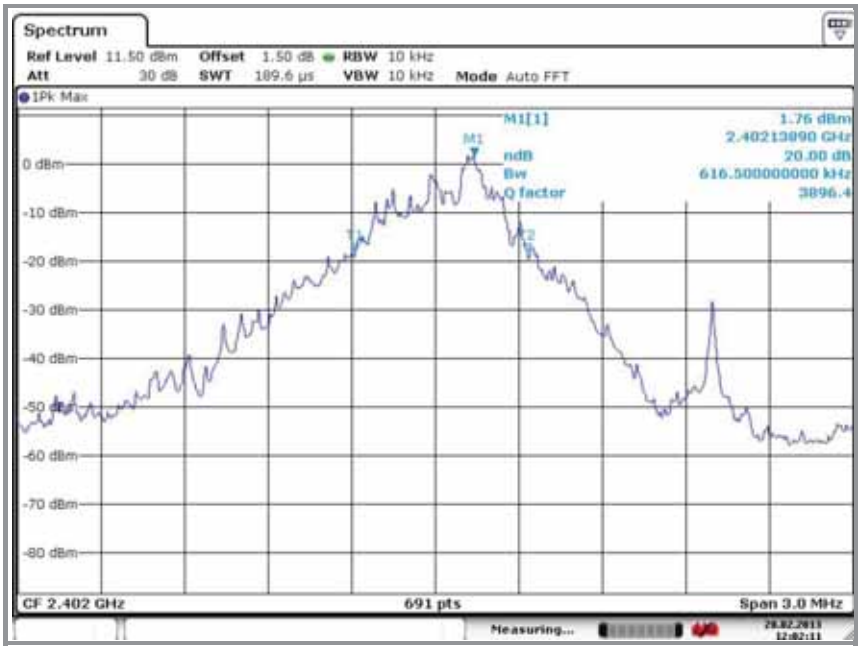
7.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 45 % R.H.

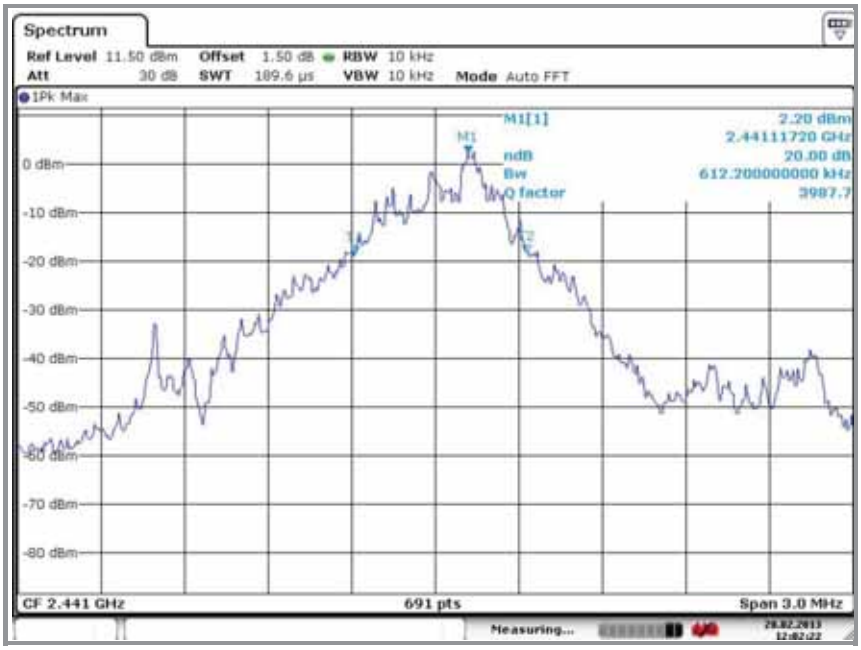
Operation mode	Frequency(㎒)	20 dB bandwidth(㎒)
Basic	2 402	0.62
	2 441	0.61
	2 480	0.62

Operation mode: Basic mode

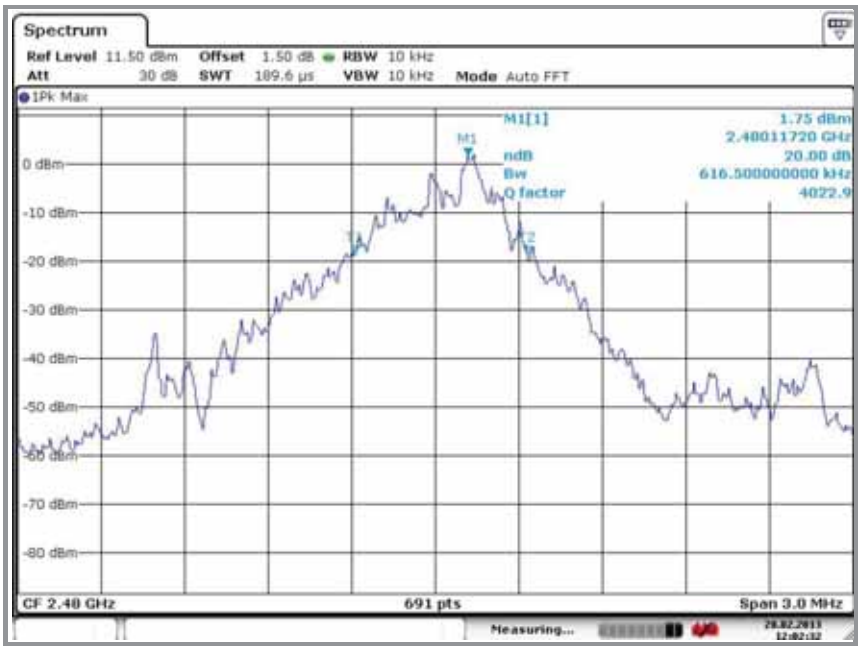
A. Low channel (2 402 ㎒) – 20 ㏈ bandwidth



B. Middle channel (2 441 ㎒) – 20 ㏈ bandwidth

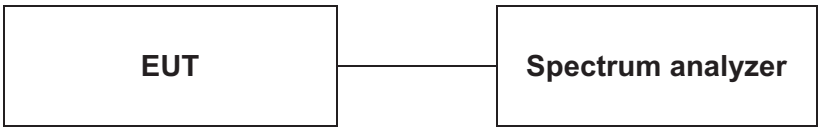


C. High channel (2 480 ㎒) – 20 ㏈ bandwidth



8. Maximum peak output power measurement

8.1. Test setup.



8.2. 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 20 ㏈ 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.

8.3. Test procedure

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 = approximately 5 times the 20 ㏈ bandwidth, centered on a hopping channel
   RBW ≥ 20 ㏈ BW, VBW ≥ RBW, Sweep = auto, Detector function = peak, Trace = max hold

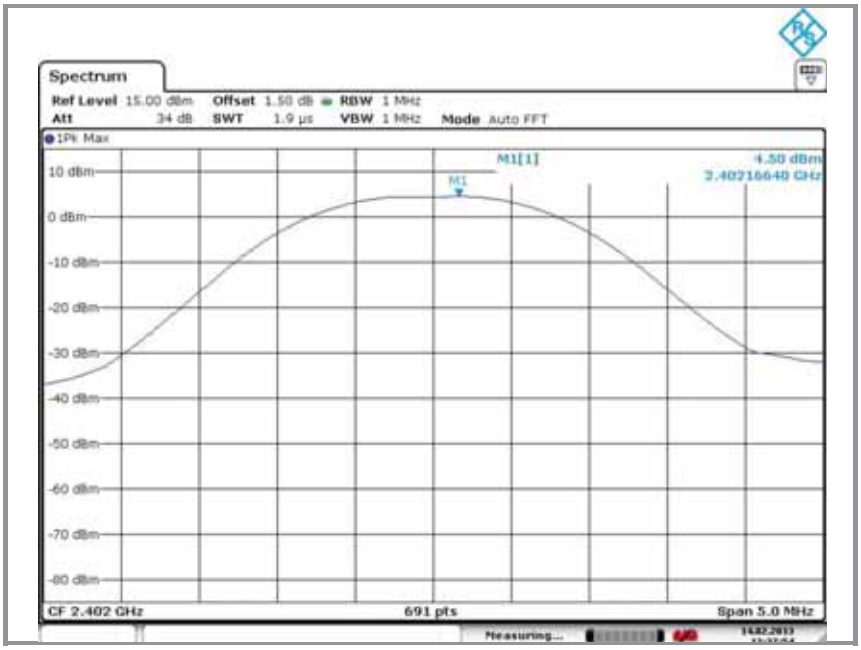
8.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 45 % R.H.

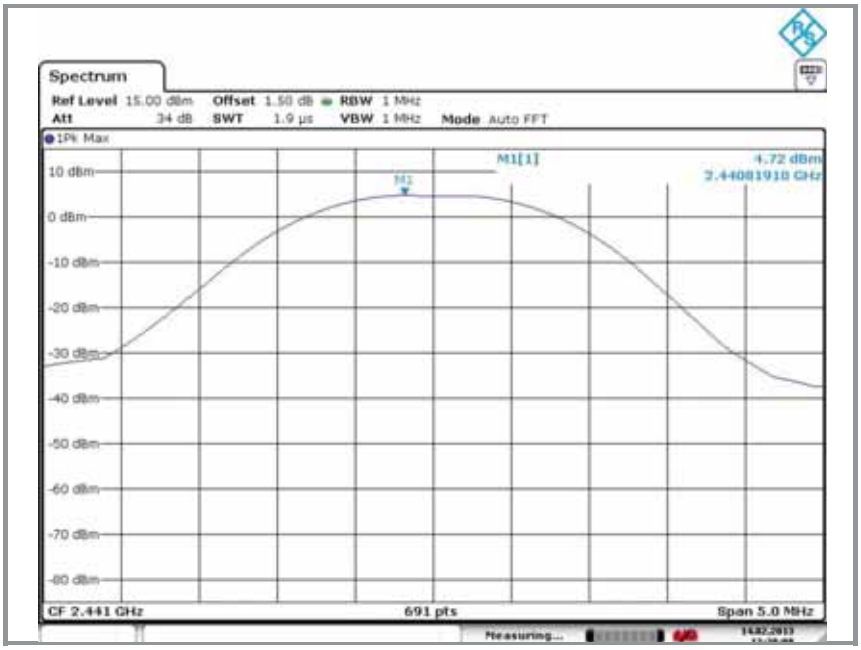
Operation mode	Frequency(㎒)	Peak output power(㏈m)	Limit(㏈m)
Basic	2 402	4.50	30
	2 441	4.72	30
	2 480	4.38	30

Operation mode: Basic mode

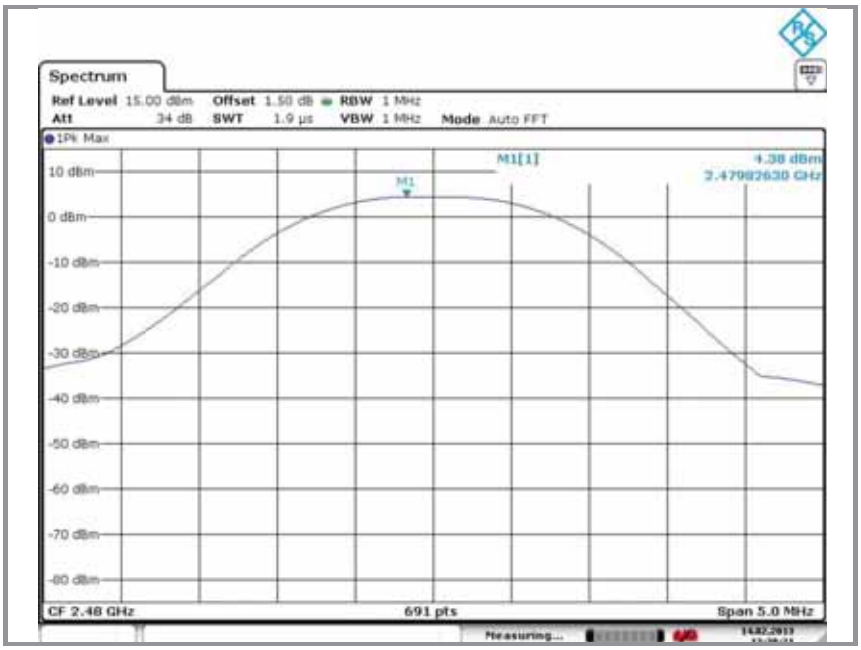
A. Low channel (2 402 ㎒)



B. Middle channel (2 441 ㎒)

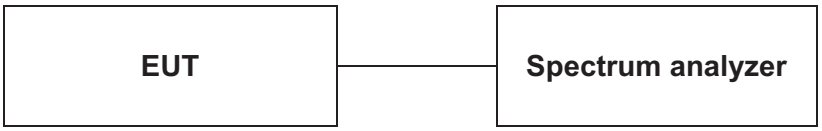


C. High channel (2 480 ㎒)



9. Hopping channel separation

9.1. Test setup



9.2. Limit

§15.247(a)(1) Frequency hopping system operating in 2 400 – 2 483.5 ㎒. Band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-third of 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

9.3. 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. Measure the frequency difference of these two adjacent channels by spectrum analyzer mark function. And then plot the result on spectrum analyzer screen.
5. Repeat above procedures until all frequencies measured were complete.
6. Set center frequency of spectrum analyzer = middle of hopping channel.
7. Set the spectrum analyzer as RBW = 100 ㎑, VBW = 100 ㎑, Span = 5 ㎒ and Sweep = auto.

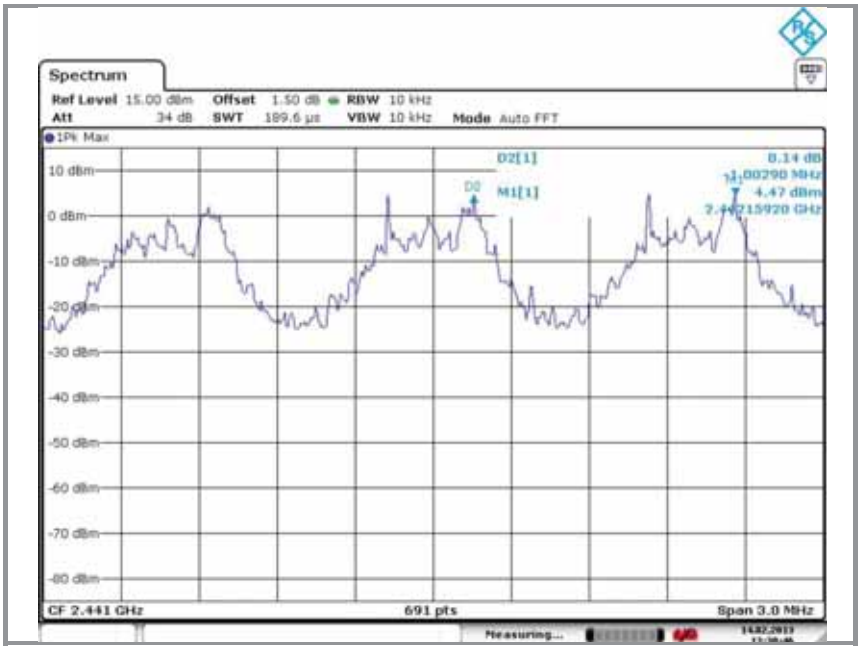
9.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 45 % R.H.

Operation mode	Frequency (㎒)	Adjacent hopping Channel separation (㎑)	Two-third of 20 ㏈ bandwidth (㎑)	Minimum bandwidth (㎑)
Basic	2 441.0	1 003	411	25

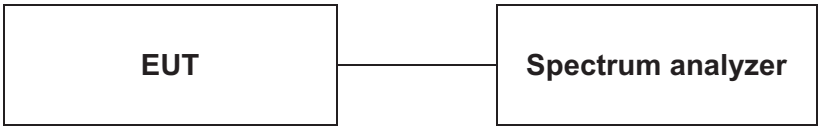
※ Remark:
20 ㏈ bandwidth measurement, the measured channel separation should be greater than two-third of 20 ㏈ bandwidth or Minimum bandwidth.

Operation mode : Basic mode



10. Number of hopping frequency

10.1. Test setup



10.2. Limit

§15.247(a)(1)(iii) For frequency hopping system operating in the 2 400 - 2 483.5 ㎒ bands shall use at least 15 hopping frequencies.

10.3. Test procedure

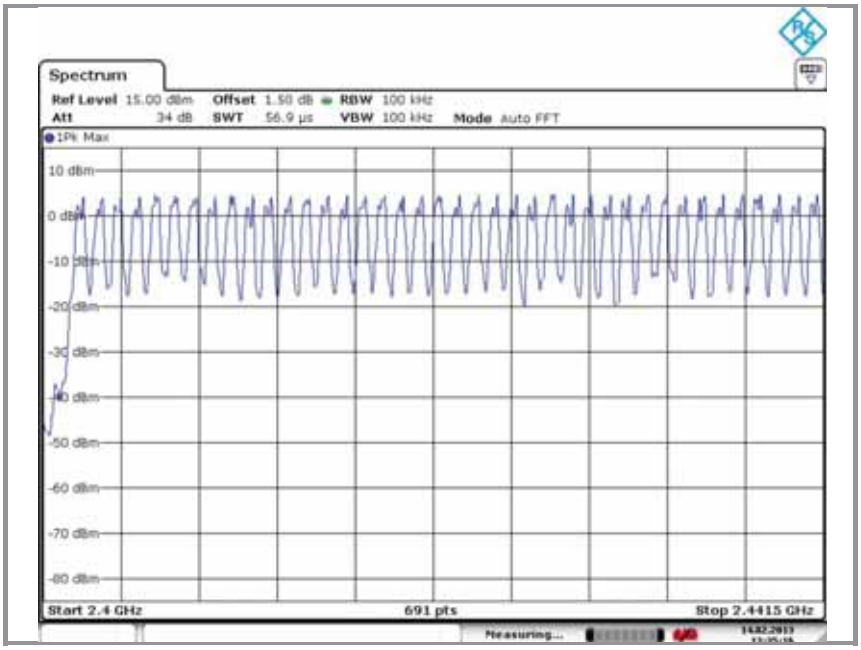
1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna the port to the Spectrum analyzer
3. Set spectrum analyzer Start = 2 400 ㎒, Stop = 2 441.5 ㎒, Sweep = auto and Start = 2 441.5 ㎒, Stop = 2 483.5 ㎒, Sweep = auto.
4. Set the spectrum analyzer as RBW, VBW = 300 ㎑.
5. Max hold, view and count how many channel in the band.

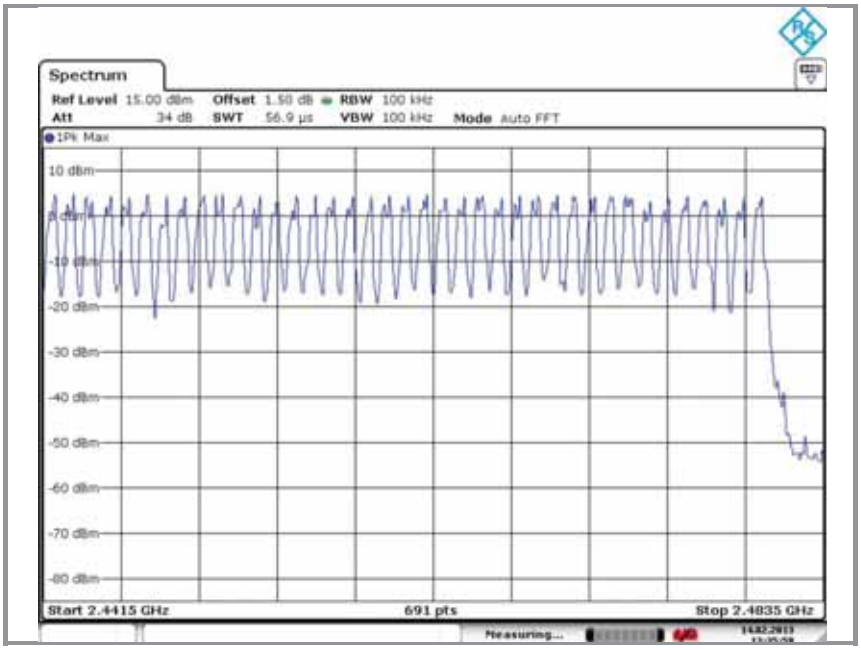
10.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 45 % R.H.

Number of Hopping Frequency	Limit
79	≥ 15

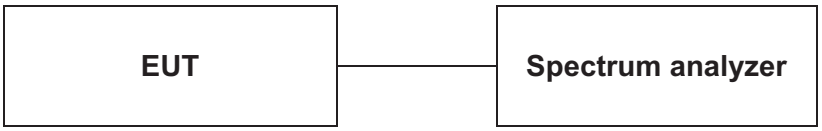
Operation mode: Basic mode





11. Time of occupancy(Dwell time)

11.1. Test setup



11.2. Limit

§15.247(a)(1)(iii) For frequency hopping system operating in the 2 400 – 2 483.5 ㎒ band, the average time of occupancy on any frequency shall not be greater than 0.4 second within a 31.6 second period.

A period time = 0.4(s) * 79 = 31.6(s)

11.3. 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 its antenna terminal to measurement instrument via a low loss cable.
3. Adjust the center frequency of spectrum analyzer on any frequency be measured and set spectrum analyzer to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
4. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
5. Repeat above procedures until all frequencies measured were complete.
6. The Bluetooth has 6 type of payload, DH1, DH3, DH5. The hopping rate is 1 600 per second.

11.4. Test results

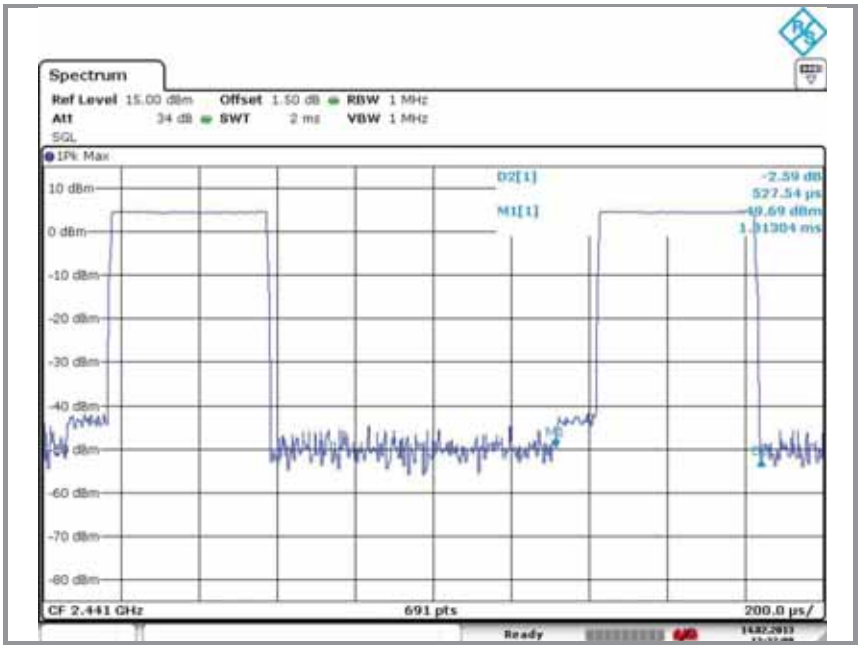
Ambient temperature: 23 ℃
Relative humidity: 45 % R.H.

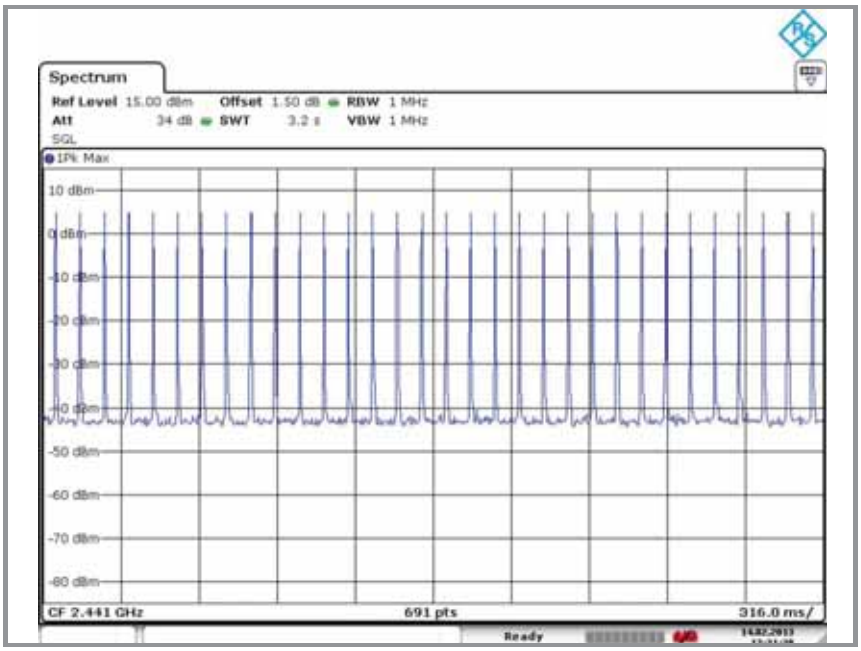
0.4 seconds within a 30 second period per any frequency

Mode	Number of transmission ina 31.6s (79Hopping*0.4)	Length of Transmission Time (msec)	Result (msec)	Limit (msec)
DH1	32(Times / 3.16sec) *10 = 320	0.528	168.96	400
DH3	16(Times / 3.16sec) *10= 160	1.788	286.08	400
DH5	11(Times / 3.16sec) *10= 110	3.036	333.96	400

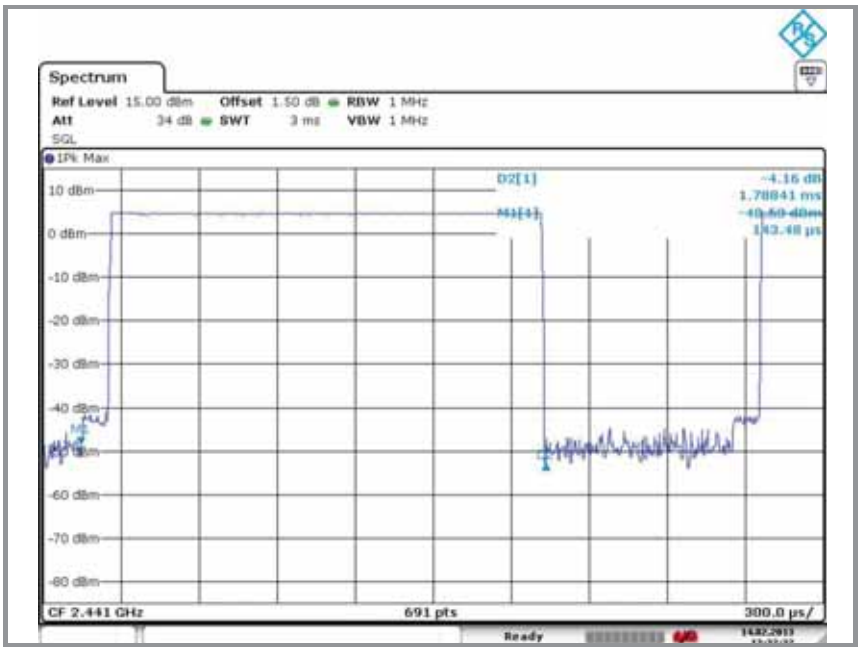
※ Remark:
dwell time = {(number of hopping per second / number of slot) x duration time per channel} x 0.4 ms

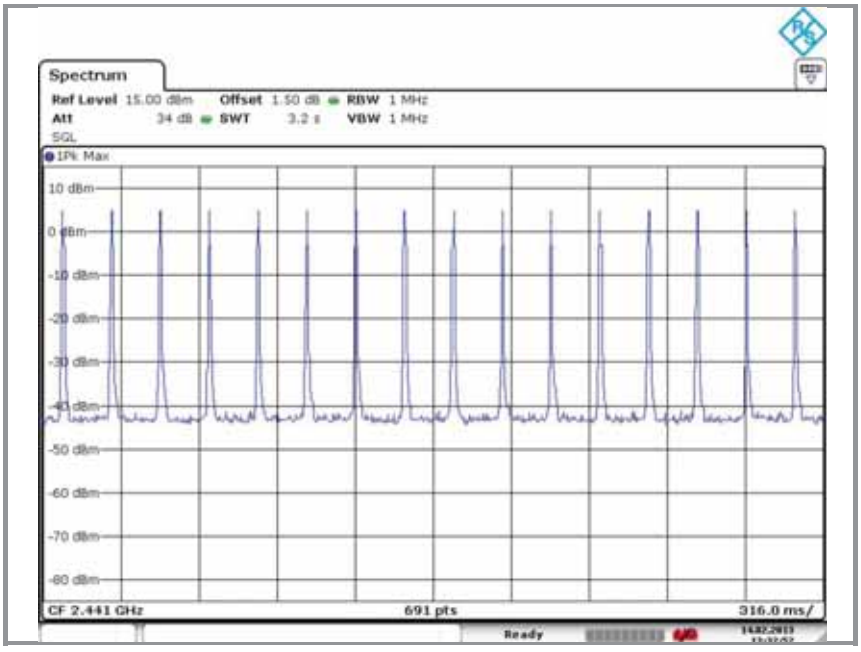
A. DH1



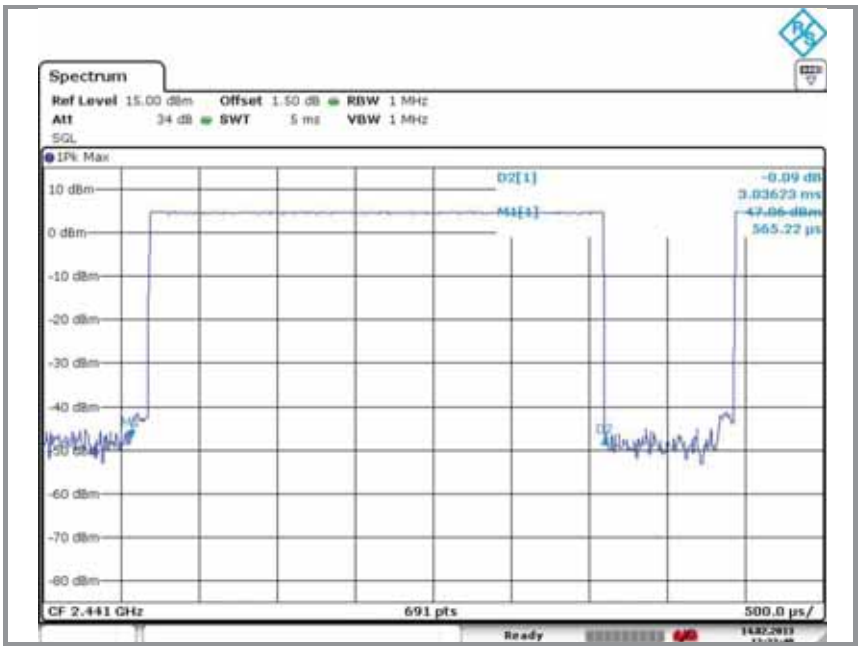


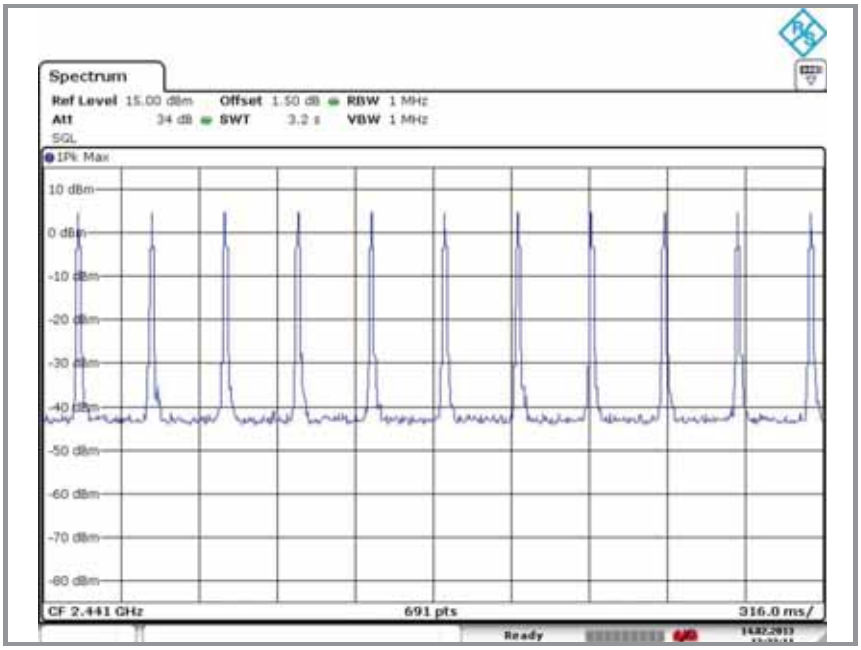
B. DH3





C. DH5





12. Antenna requirement

12.1. 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, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6 dBi.

12.2. Antenna Connected Construction

Antenna used in this product is Integral type (PCB Antenna) gain of 3.847 dBi.

13. RF exposure evaluation

13.1. 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

13.2. 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.

13.2. Test result of RF exposure evaluation

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

13.4. Output power into antenna & RF exposure evaluation distance

Antenna gain: 3.847 dBi

Frequency (㎒)	Output Peak power to antenna (dBm)	Antenna gain (dBi)	Antenna Gain (dBi) Numeric	Power density at 20 ㎝ (㎽/㎠)	Power density Limits (㎽/㎠)
2 402	4.50	3.568	2.27	0.001 3	1
2 441	4.72	3.744	2.37	0.001 4	
2 480	4.38	3.847	2.42	0.001 3	

※ 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 ㎽/㎠ .

14. Test setup photo of EUT

Photo of radiated spurious emission at below 30 ㎒

Photo of radiated spurious emission at 30 ㎒ ~ 1 000 ㎒

Photo of radiated spurious emission at above 1 000 ㎒

Photo of Conducted emission at below 30 ㎒