TEST REPORT

of

FCC Part 15 Subpart B&C §15.247
FCC ID : WWTSCP860

Equipment Under Test	:	Bluetooth Speaker Mic
Model Name	:	SCP860
Serial No.	:	N/A
Applicant	:	SEHWA Electronics Co., Ltd.
Manufacturer	:	SEHWA Electronics Co., Ltd.
Date of Test(s)	:	2008.10.13 ~ 2008.11.06
Date of Issue	:	2008.11.07

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

Tested By:  **Date** **2008.11.07**

Duke Ko

Approved By  **Date** **2008.11.07**

Jim Kim

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1. General information

1.1 Testing laboratory

SGS Testing Korea Co., Ltd.
Wireless Div. 2FL, 18-34, Sanbon-dong, Gunpo-si, Gyeonggi-do, Korea 435-040
www.electrolab.kr.sgs.com
Telephone : +82 +31 428 5700
FAX : +82 +31 427 2371

1.2 Details of applicant

Applicant : SEHWA Electronics Co., Ltd.
Address : 378-1, Maetan-dong, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea
Contact Person : Moon, Hoseong
Phone No. : +82 +31 241 1100

1.3 Description of EUT

Kind of Product	Bluetooth Speaker Mic
Model Name	SCP860
Serial Number	N/A
Power Supply	DC 3.7 V(Li-ion Polymer Battery), DC 12 V(for recharge from Car battery), AC 100~240 V(for recharge from AC Adaptor)
Frequency Range	2402 ~ 2480 MHz
Modulation Technique	GFSK
Number of Channels	79
Operating Conditions	-10 ~ 60 ℃
Antenna Type	Integral Type (Chip Antenna)
Antenna Gain	0.62 dBi

1.4. Details of Manufacturers

- N/A

1.5. Information about the FHSS characteristics:

1.5.1. 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 1600 hops/s.

1.5.2. Medium access protocol

The manufacturer declares that the device uses Bluetooth protocol.

1.5.3. System Receiver Input Bandwidth

Each channel bandwidth is 1MHz

1.6 Test equipment list

Equipment	Manufacturer	Model	Cal Due.
Signal Generator	Agilent	E4438C	May 09, 2009
Spectrum Analyzer	Agilent	E4440A	May 09, 2009
Bluetooth Tester	TESOM	TC-3000B	Oct. 10, 2009
Directional Coupler	Narda	4226-20	Feb. 04, 2009
High Pass Filter	Wainwright Instrument GmbH	WHK3.0/18 G-11SS	Oct. 02, 2009
DC Power Supply	Agilent	E3631A	May 09, 2009
Two-Line V-Network	R & S	ENV216	Jan. 17, 2009
Test Receiver	R & S	ESVS10	Mar. 21, 2009
Test Receiver	R & S	ESHS10	Jun. 21, 2009
Preamplifier	HP	8447F	Jul. 03, 2009
Preamplifier	R & S	SCU_F0118_G35 _AFS42_CSS(F)	Aug. 25, 2009
Ultra-Broadband Antenna	R & S	HL562	Oct. 11, 2009
Horn Antenna	Electro-Metrics	HF906	Nov. 13, 2009
Anechoic Chamber	SY Corporation	L x W x H (6.5 m x 3.5 m x 3.5 m)	Feb. 15, 2009

1.7. Summary of test results

The EUT has been tested according to the following specifications:

Applied standard : FCC Part15 subpart B&C		
Standard section	**Test item**	**Result**
15.207	Transmitter AC Power Line Conducted Emission	Complied
15.205(a) 15.209 15.247(d)	Transmitter radiated spurious emissions and Conducted spurious emission	Complied
15.247(a)(1)	20 dB bandwidth	Complied
15.247(b)(1)	Maximum peak output power	Complied
15.247(a)(1)	Frequency separation	Complied
15.247(a)(1)(iii)	Number of hopping frequency	Complied
15.247(a)(1)(iii)	Time of occupancy (Dwell time)	Complied
15.247(f)	Power spectral density	Complied
15.247(i) 1.1307(b)(1)	RF exposure evaluation	Complied

1.8. Conclusion of worst-case

The EUT has three type of conditions (DC 3.7 V, DC 12.0 V-charging, AC 100-240 V-charging). Each maximum output power as following:

Modulation Type	Ouput power(dBm)	Output power(mW)
DC 3.7 V (2402 MHz)	12.16	16.44
DC 12.0 V (2402 MHz)	12.13	16.33
AC 100-240 V (2402 MHz)	12.09	16.18

Therefore conducted test items were tested a condition of DC 3.7 V.

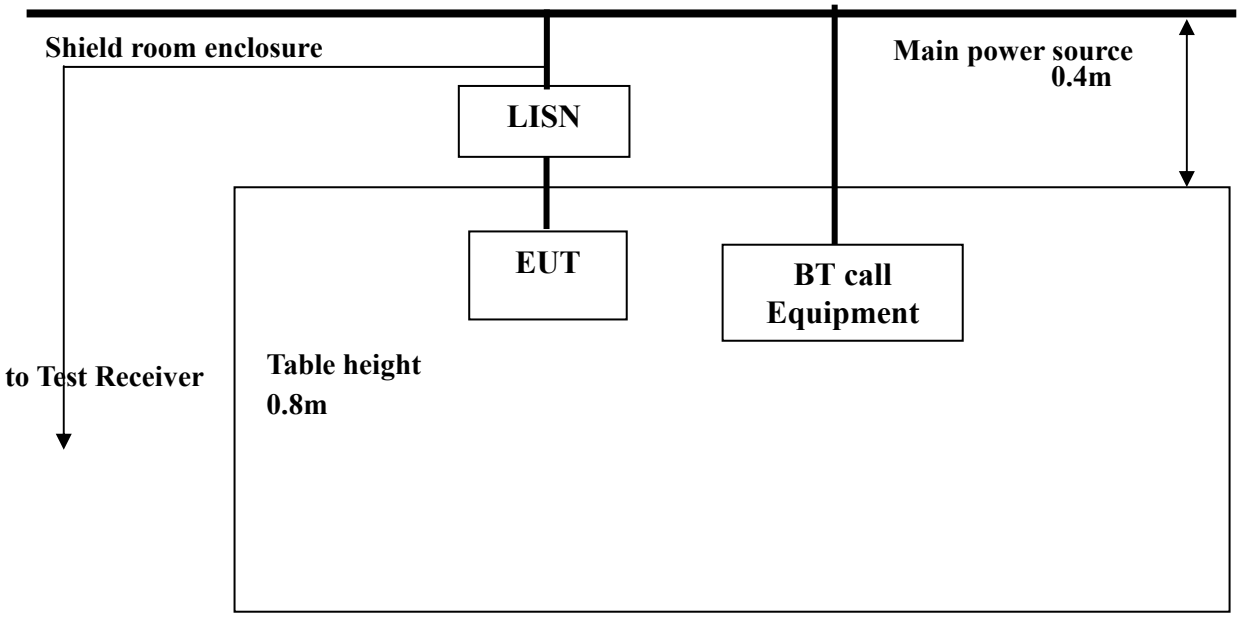
The field strength of spurious emission was measured in three orthogonal EUT positions(X-axis, Y-axis and Z-axis). Worst case is Z-axis.

1.9. Test report revision

Revision	Report number	Description
0	F690501/RF-RTL002745	Initial

2. Transmitter AC Power Line Conducted Emission

2.1. Test Setup



2.2. 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 kHz to 30 MHz, 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 (MHz)	Conducted limit (dBμV)	
	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.

2.3. 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 1.0m(W)× 1.5m(L) and 0.8m 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.

2.4. Test Results

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

Ambient temperature : 27 ℃ Relative humidity : 47 % R.H.

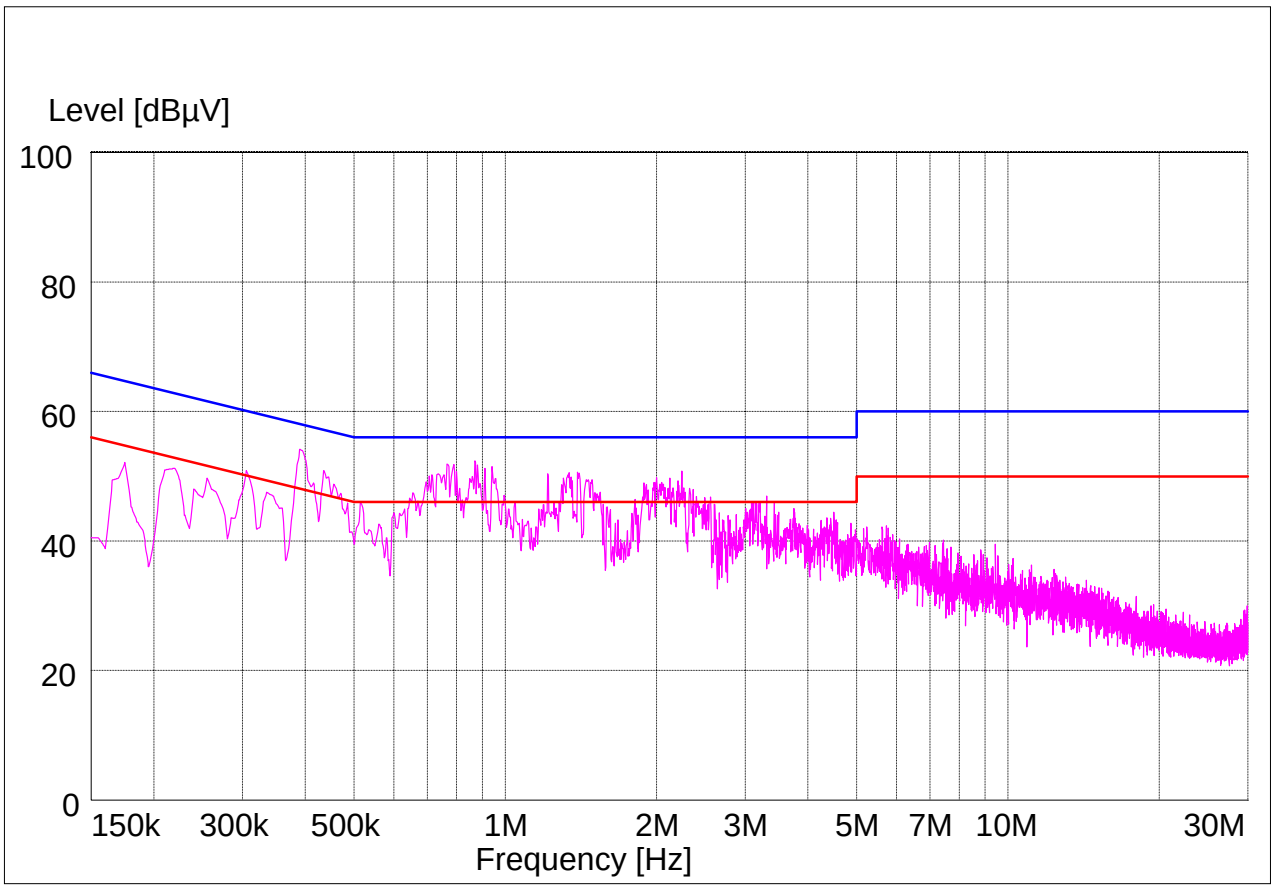
Frequency range : 0.15 MHz – 30 MHz
Measured Bandwidth : 9 kHz

FREQ.	LEVEL(dBuV)		LINE	LIMIT(dBuV)		MARGIN(dB)	
(MHz)	Q-Peak	Average		Q-Peak	Average	Q-Peak	Average
0.18	40.50	25.20	H	64.49	54.49	23.99	29.29
0.30	44.80	28.70	H	60.38	50.38	15.58	21.68
0.43	37.20	22.20	H	57.35	47.35	20.15	25.15
0.78	44.50	27.80	H	56.00	46.00	11.50	18.20
0.96	42.70	26.10	H	56.00	46.00	13.30	19.90
2.22	40.90	24.50	H	56.00	46.00	15.10	21.50
0.18	39.60	21.50	N	64.49	54.49	24.89	32.99
0.30	40.90	24.10	N	60.38	50.38	19.48	26.28
0.35	37.20	20.60	N	58.96	48.96	21.76	28.36
0.78	43.20	26.10	N	56.00	46.00	12.80	19.90
0.84	40.90	23.30	N	56.00	46.00	15.10	22.70
2.28	40.30	22.80	N	56.00	46.00	15.70	23.20

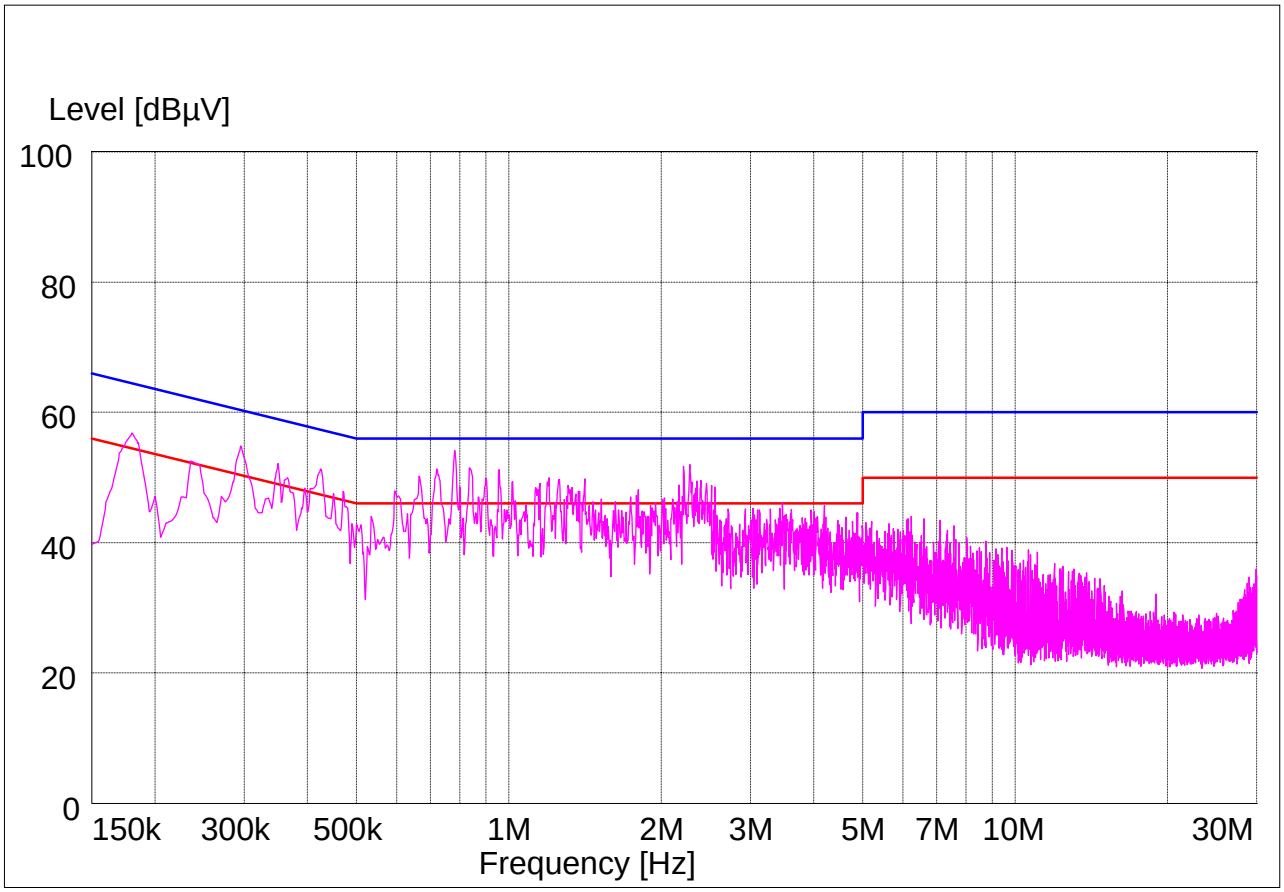
Note ;
Line (H) : Hot
Line (N) : Neutral

Plot of Conducted Power line

Test mode : (Hot)



Test mode : (Neutral)

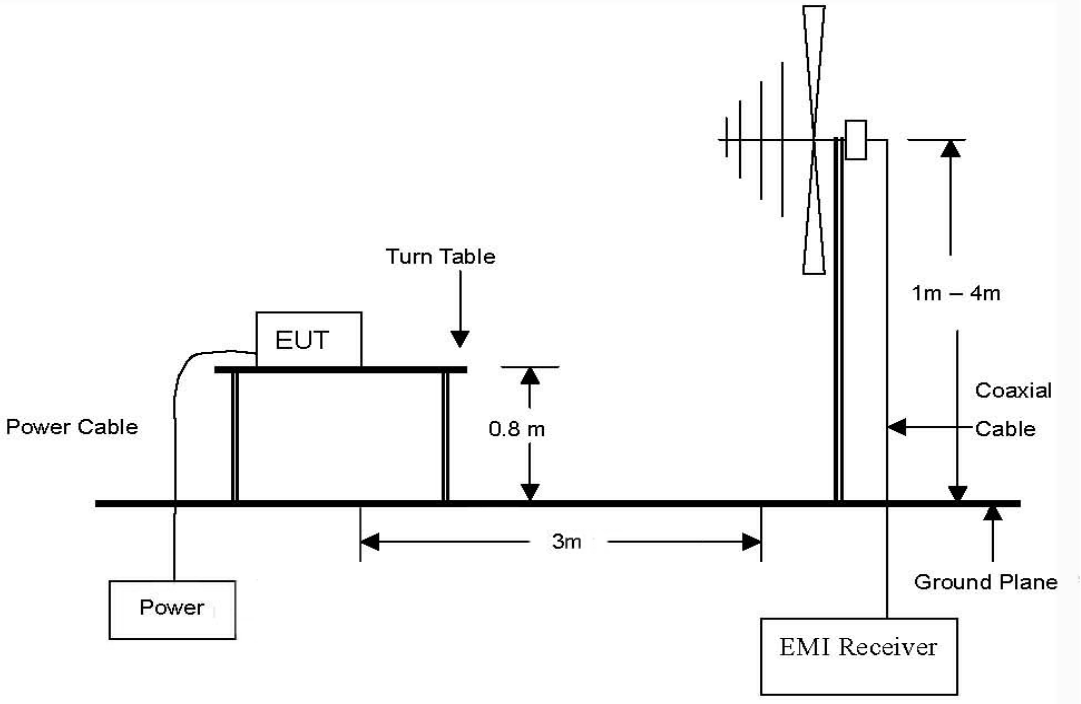


3. Transmitter radiated spurious emissions and conducted spurious emission

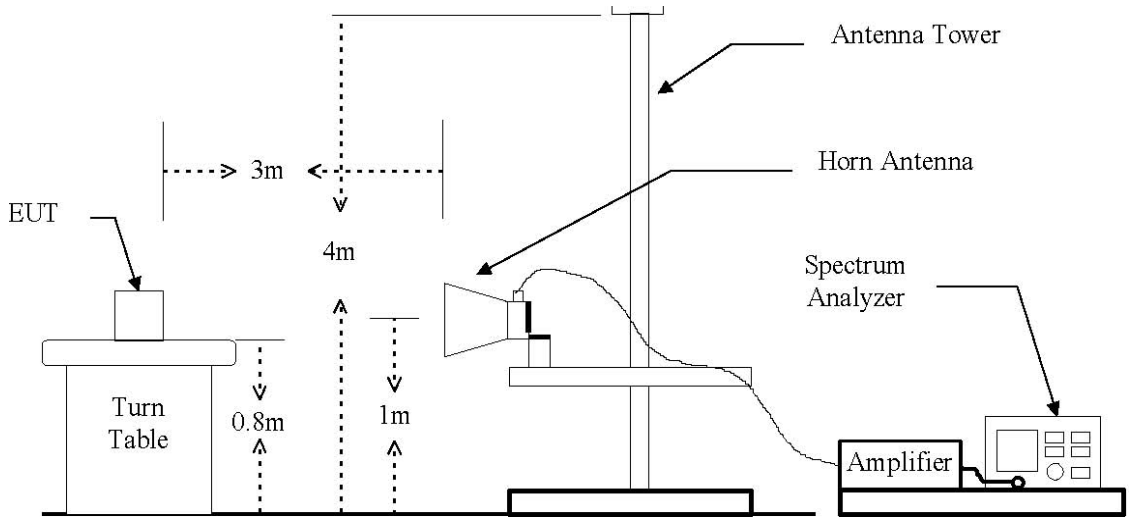
3.1. Test setup

3.1.1. Transmitter radiated spurious emissions

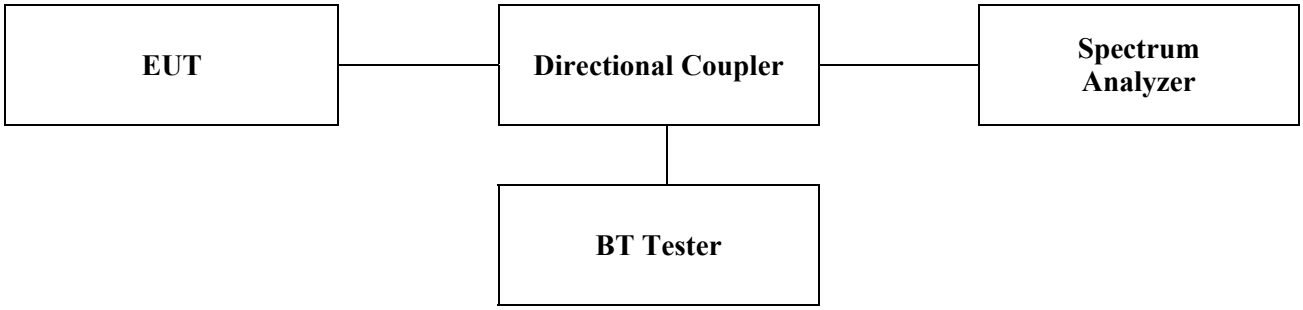
The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz Emissions.



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



3.1.2. Conducted spurious emissions



3.2. Limit

According to §15.247(d), in any 100 kHz 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 dB below that in the 100 kHz 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 dB instead of 20 dB. 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 (MHz)	Distance (Meters)	Radiated (dBμV/m)	Radiated (μV/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

3.3. Test procedures

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

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

2.3.2. 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 kHz, VBW=100 kHz.

3.4. Test result

Ambient temperature : 24 ℃
Relative humidity : 47 % R.H.

3.4.1. Spurious radiated emission

The frequency spectrum from 30 MHz to 1000 MHz was investigated. Emission levels are not reported much lower than the limits by over 30 dB. All reading values are quasi-peak values.

DC 3.7 V (internal rechargeable battery)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
30.000	30.50	Q.P.	H	19.83	-27.62	22.71	40.00	17.29
61.525	36.60	Q.P.	V	4.70	-27.21	14.08	40.00	25.92
187.625	34.80	Q.P.	V	7.73	-25.99	16.54	43.50	26.96
219.150	33.20	Q.P.	V	8.22	-25.70	15.72	46.00	30.28
Above 300.000	Not detected	-	-	-	-	-	-	-

DC 12 V (for recharge from Car battery)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
30.000	30.10	Q.P.	V	19.83	-27.62	22.31	40.00	17.69
34.850	31.20	Q.P.	H	17.18	-27.55	20.83	40.00	19.17
46.975	34.00	Q.P.	V	9.83	-27.41	16.42	40.00	23.58
182.775	34.10	Q.P.	V	7.86	-26.04	15.92	43.50	27.58
248.250	33.90	Q.P.	V	9.46	-25.45	17.91	46.00	28.09
345.250	35.00	Q.P.	H	12.24	-25.26	21.98	46.00	24.02
Above 400.000	Not detected	-	-	-	-	-	-	-

AC 110 V (for recharge from AC Adaptor)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
51.825	45.60	Q.P.	V	7.27	-27.35	25.52	40.00	14.48
187.625	41.20	Q.P.	H	7.73	-25.99	22.94	43.50	20.56
345.250	36.60	Q.P.	H	12.24	-25.26	23.58	46.00	22.42
539.250	34.30	Q.P.	V	16.06	-25.85	24.51	46.00	21.49
Above 600.000	Not detected	-	-	-	-	-	-	-

▣ Remark:

1. All spurious emission at low, middle and high channel are almost the same below 1 GHz, so the spurious emission test result of the high channel was chosen as representative in finial test.
2. "*" means the restricted band.
3. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes
4. The emission levels above 600 MHz are very lower than the limit by over 30 dB.

3.4.2. Spurious radiated emission

The frequency spectrum above 1000 MHz was investigated. All emissions are not reported much lower than the prescribed limits.

DC 3.7 V (internal rechargeable battery)

A. Low Channel (2402 MHz)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2390.00*	57.90	Peak	V	28.05	-34.80	51.15	74.00	22.85
4803.75	56.71	Peak	V	32.95	-31.70	57.96	74.00	16.04
4803.75	42.49	Average	V	32.95	-31.70	43.74	54.00	10.26
Above 4900.00	Not detected	-	-	-	-	-	-	-

B. Middle Channel (2441 MHz)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4882.15	55.97	Peak	V	33.17	-31.90	57.24	74.00	16.76
4882.15	42.95	Average	V	33.17	-31.90	44.22	54.00	9.78
Above 4900.00	Not detected	-	-	-	-	-	-	-

C. High Channel (2480 MHz)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.50*	68.83	Peak	V	28.18	-34.67	62.34	74.00	11.66
2483.50*	51.37	Average	V	28.18	-34.67	44.88	54.00	9.12
4960.00	56.38	Peak	V	33.39	-31.68	58.09	74.00	15.91
4960.00	42.55	Average	V	33.39	-31.68	44.26	54.00	9.74
Above 5000.00	Not detected	-	-	-	-	-	-	-

DC 12 V (for recharge from Car battery)

D. Low Channel (2402 MHz)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2390.00*	57.71	Peak	V	28.05	-34.80	50.96	74.00	23.04
4804.45	56.13	Peak	V	32.95	-31.70	57.38	74.00	16.62
4804.45	42.42	Average	V	32.95	-31.70	43.67	54.00	10.33
Above 4900.00	Not detected	-	-	-	-	-	-	-

E. Middle Channel (2441 MHz)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4882.05	56.30	Peak	V	33.17	-31.90	57.57	74.00	16.43
4882.05	43.02	Average	V	33.17	-31.90	44.29	54.00	9.71
Above 4900.00	Not detected	-	-	-	-	-	-	-

F. High Channel (2480 MHz)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.50*	69.27	Peak	V	28.18	-34.67	62.78	74.00	11.22
2483.50*	52.54	Average	V	28.18	-34.67	46.05	54.00	7.95
4959.85	56.36	Peak	V	33.39	-31.68	58.06	74.00	15.94
4959.85	42.82	Average	V	33.39	-31.68	44.52	54.00	9.48
Above 5000.00	Not detected	-	-	-	-	-	-	-

AC 110 V (for recharge from AC Adaptor)

G. Low Channel (2402 MHz)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2390.00*	56.05	Peak	V	28.05	-34.80	49.30	74.00	24.70
4803.85	57.15	Peak	V	32.95	-31.70	58.40	74.00	15.60
4803.85	42.60	Average	V	32.95	-31.70	43.85	54.00	10.15
Above 4900.00	Not detected	-	-	-	-	-	-	-

H. Middle Channel (2441 MHz)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4882.00	55.04	Peak	V	33.17	-31.90	56.31	74.00	17.69
4882.00	42.97	Average	V	33.17	-31.90	44.24	54.00	9.76
Above 4900.00	Not detected	-	-	-	-	-	-	-

I. High Channel (2480 MHz)

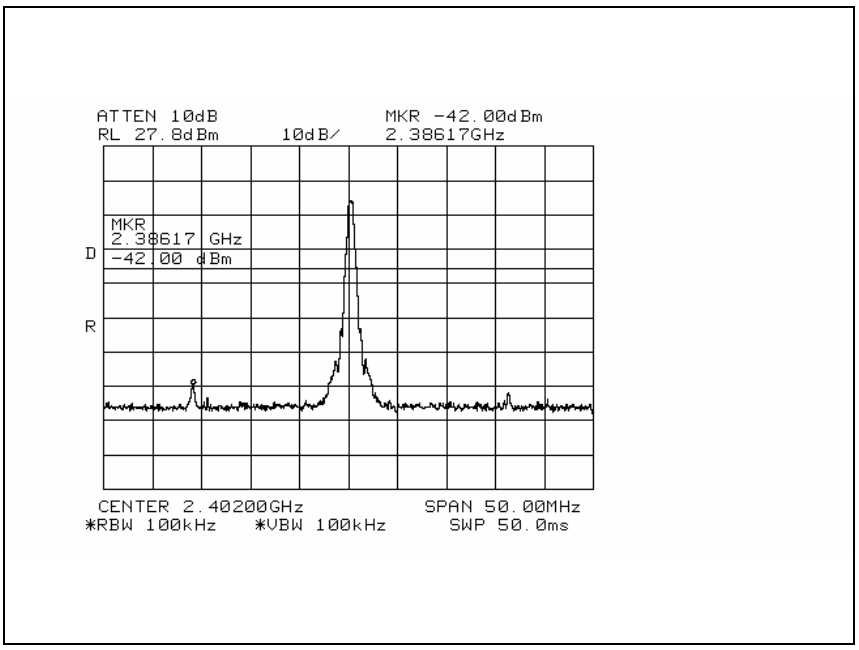
Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBuV)	Detect Mode	Pol.	AF (dB/m)	Amp Gain+CL (dB)	Actual (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.50*	68.21	Peak	V	28.18	-34.67	61.72	74.00	12.28
2483.50*	51.07	Average	V	28.18	-34.67	44.58	54.00	9.42
4960.73	55.39	Peak	V	33.39	-31.68	57.10	74.00	16.90
4960.73	41.86	Average	V	33.39	-31.68	43.57	54.00	10.43
Above 5000.00	Not detected	-	-	-	-	-	-	-

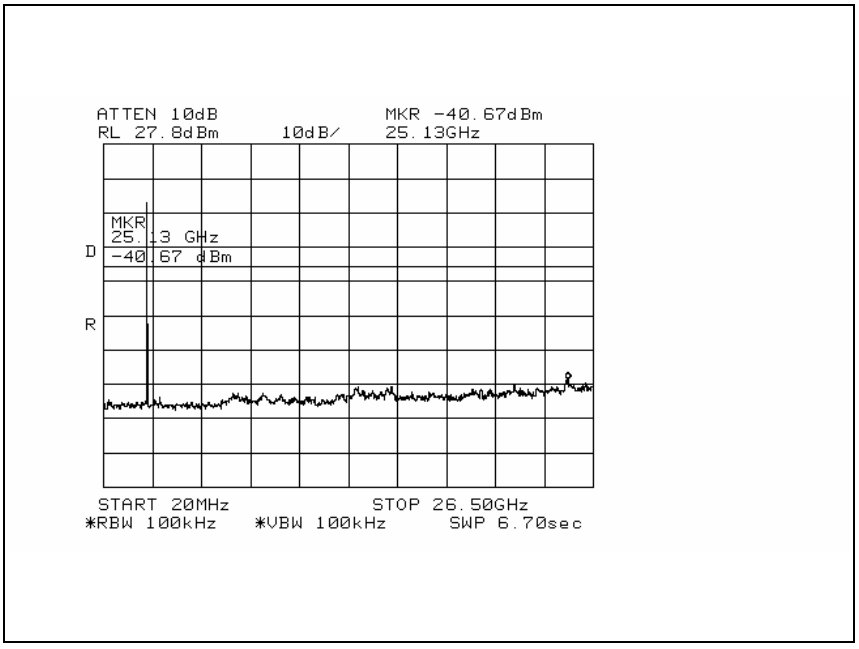
▣ Remarks

1. "*" means the restricted band.
2. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental Frequency.
3. Radiated emissions measured in frequency above 1000 MHz 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. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes

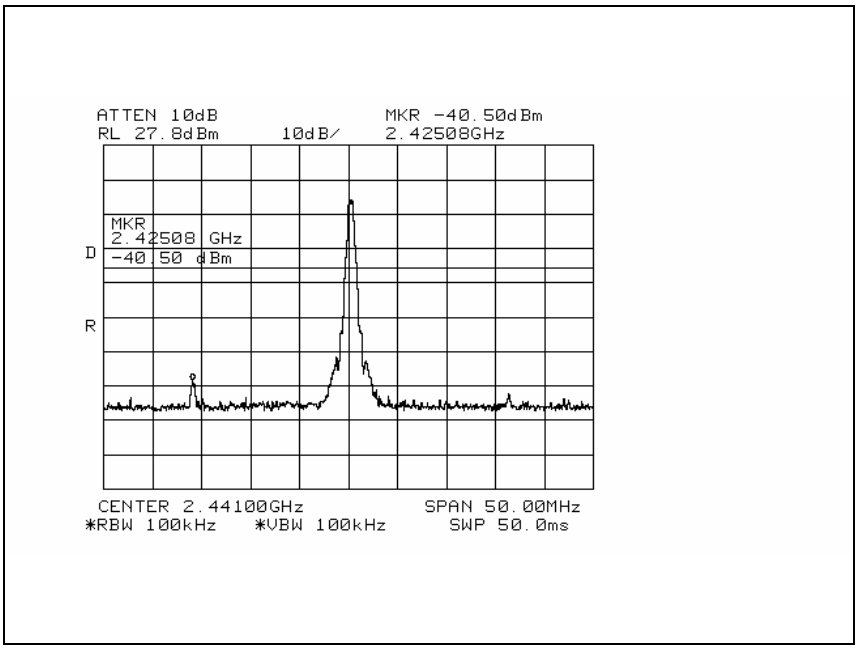
3.4.3. Spurious RF conducted emissions: Plot of spurious RF conducted emission

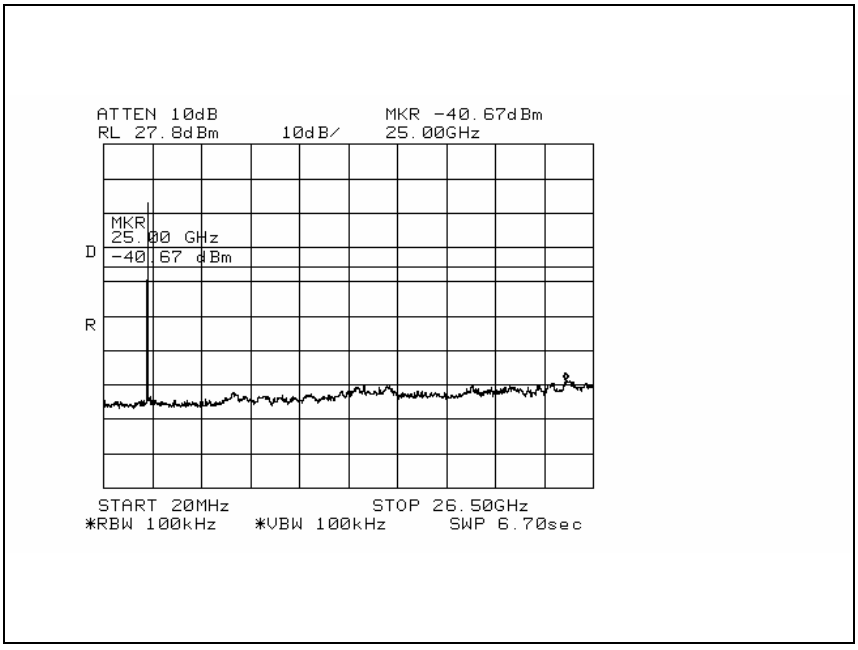
Low Channel



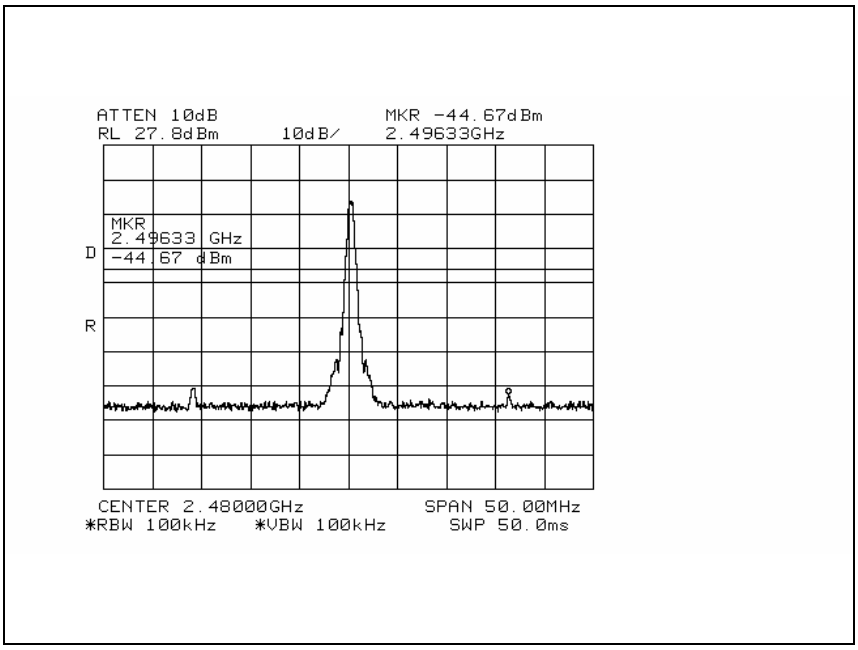


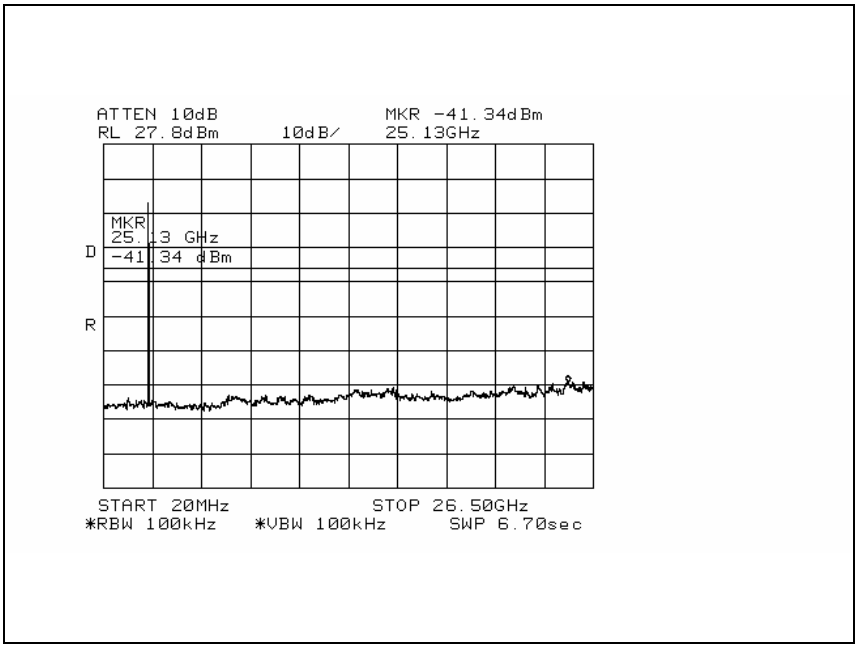
Middle Channel





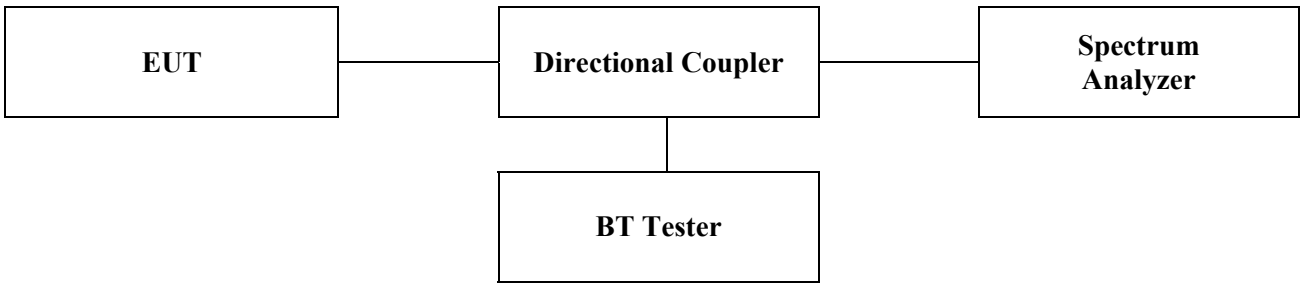
High Channel





4. 20 dB bandwidth

4.1. Test setup



4.2. Limit

Limit: Not Applicable

4.3. Test procedure

1. The 20dB 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 20dB band width of the emission was determined.

2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW=10 kHz, VBW=10 kHz, Span=3 MHz.

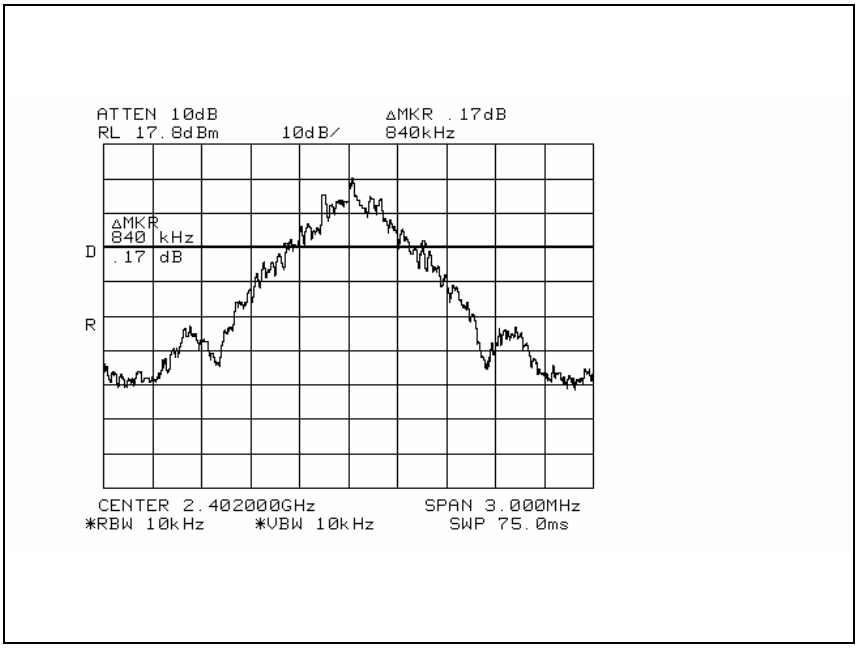
4.4. Test result

Ambient temperature : 24 ℃
Relative humidity : 47 %

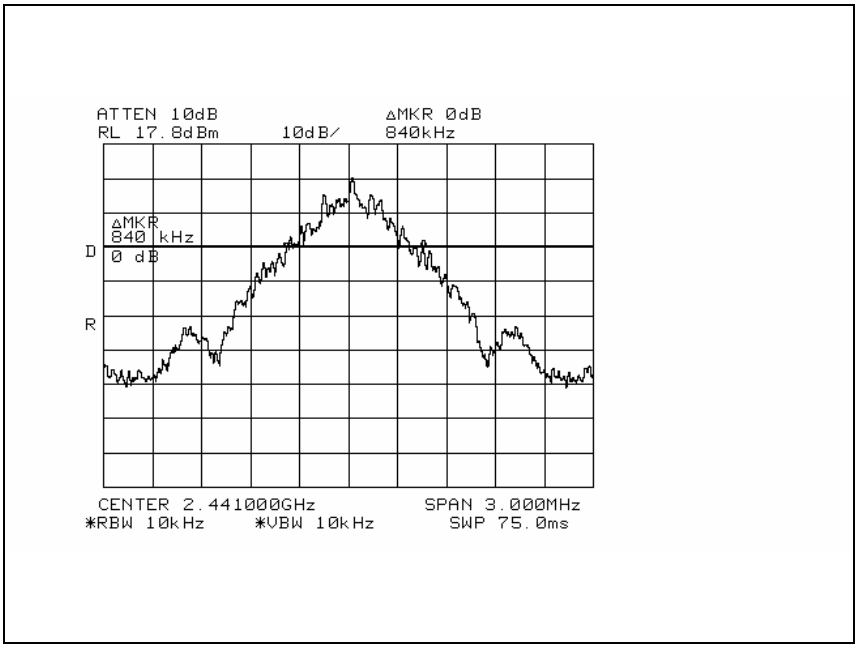
Operation Mode	Channel frequency (MHz)	20 dB bandwidth (MHz)
GFSK	2402	0.84
	2441	0.84
	2480	0.84

20 dB Bandwidth

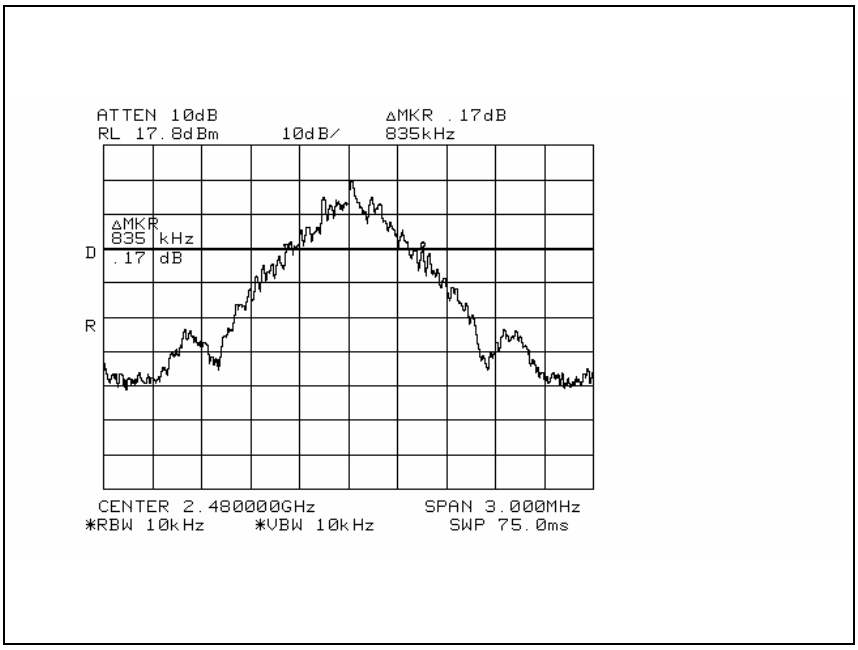
Low channel



Middle channel

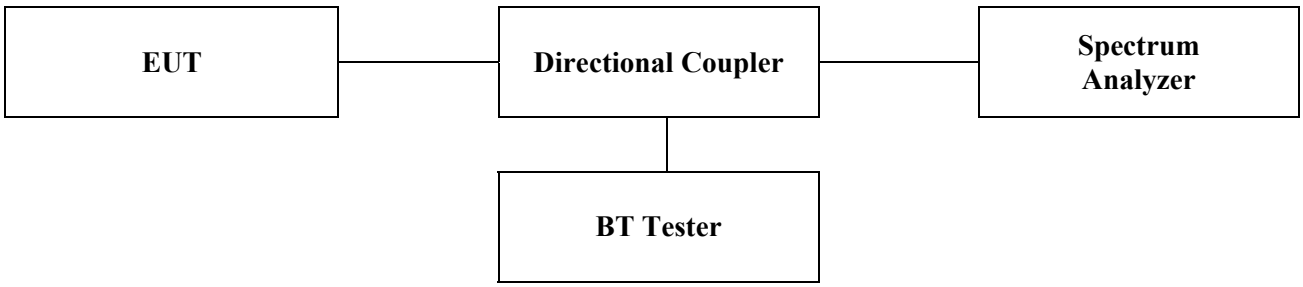


High channel



5. Maximum peak output power

5.1. Test setup



5.2. 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 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.
   Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
2. §15.247(b)(3), for systems using digital modulation in the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz: 1 Watt.

5.3. 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.

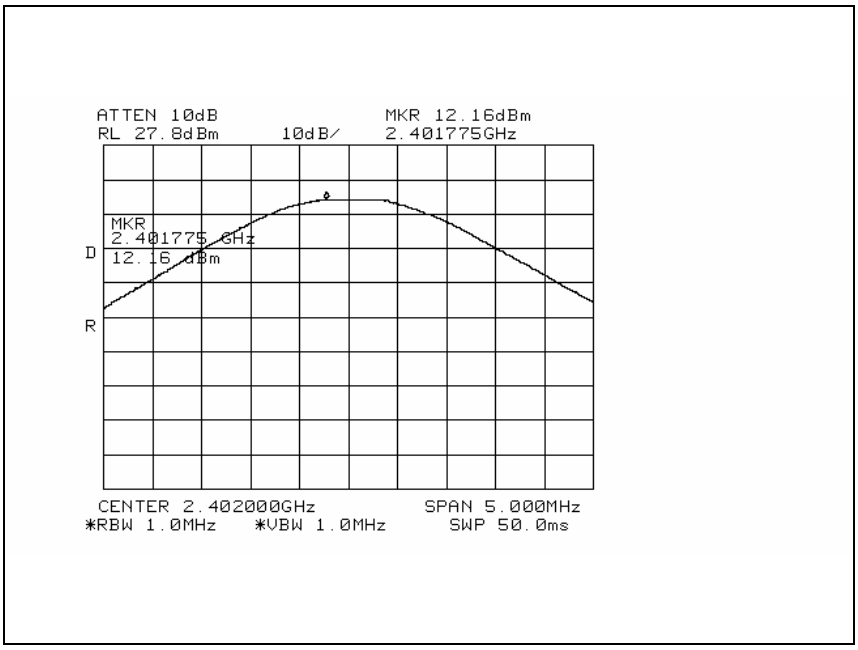
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using ;
   Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
   RBW ≥ 20dB BW
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold

5.4. Test result

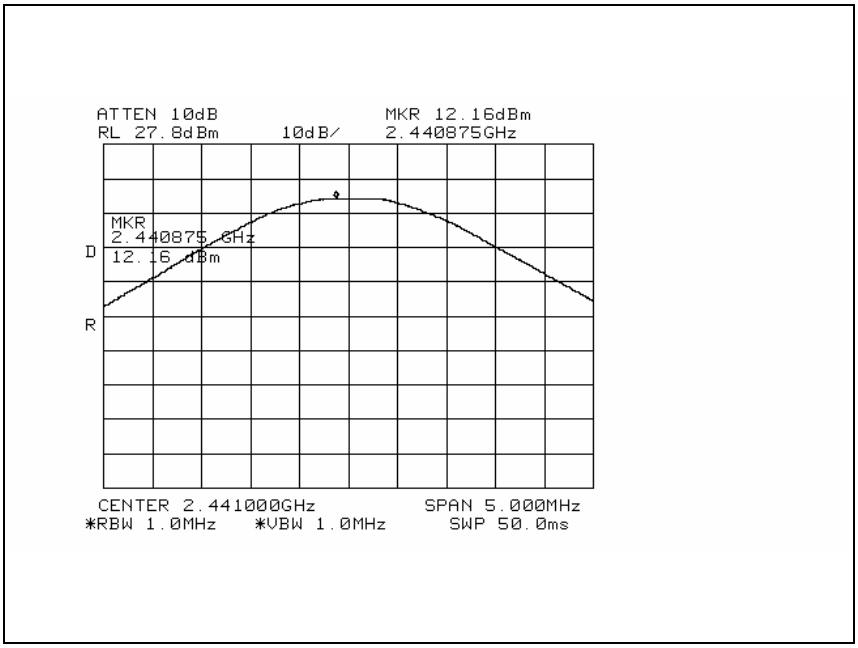
Ambient temperature : 24 ℃
Relative humidity : 47 %

Operation mode	Channel	Frequency (MHz)	Peak power (dBm)	Limit (dBm)
GFSK	Low	2402	12.16	20.97
	Middle	2441	12.16	20.97
	High	2480	11.83	20.97

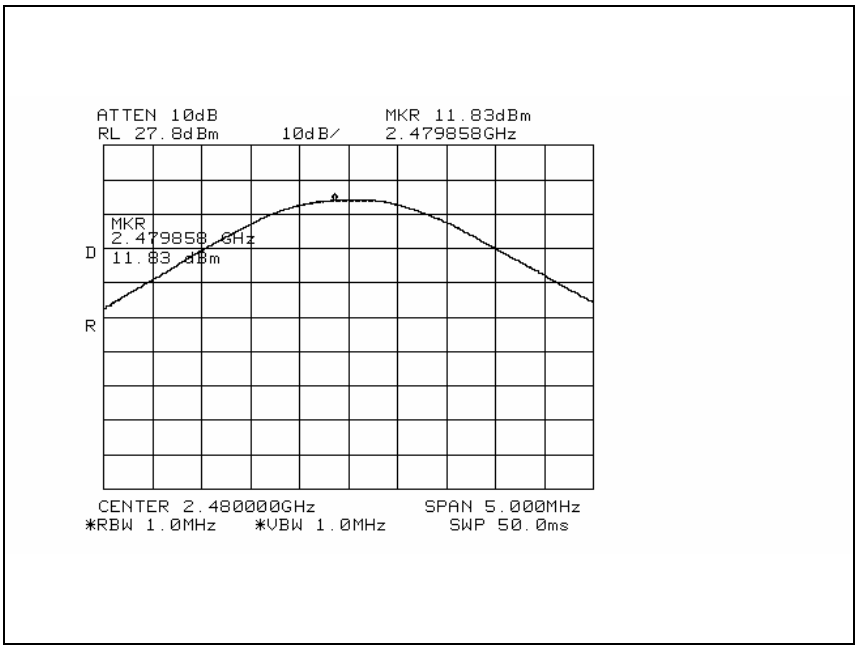
Low channel



Middle channel

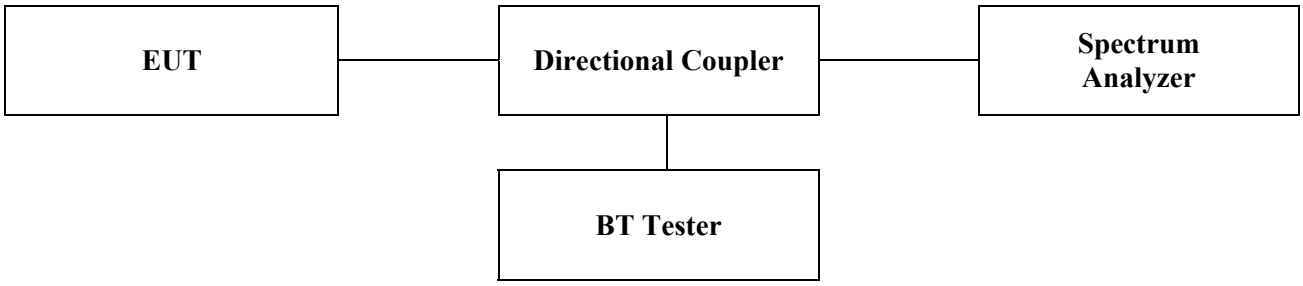


High channel



6. Hopping Channel Separation

6.1. Test setup



6.2. Limit

§15.247(a)(1) Frequency hopping system operating in 2400-2483.5MHz. Band may have hopping channel carrier frequencies that are separated by 25kHz or two-third of 20dB bandwidth of the hopping channel, whichever is is greater, provided the systems operate with an output power no greater than 125mW.

6.3. Test procedure

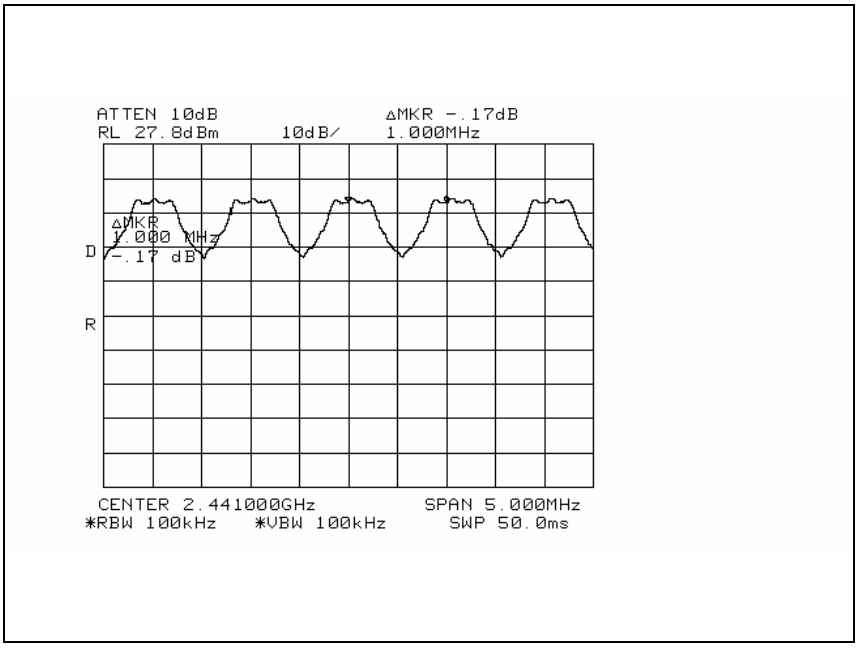
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
3. By using the MaxHold 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 kHz, VBW=100 kHz, Span=5 MHz and Sweep = auto.

6.4. Test result

Ambient temperature : 24 ℃
Relative humidity : 47 %

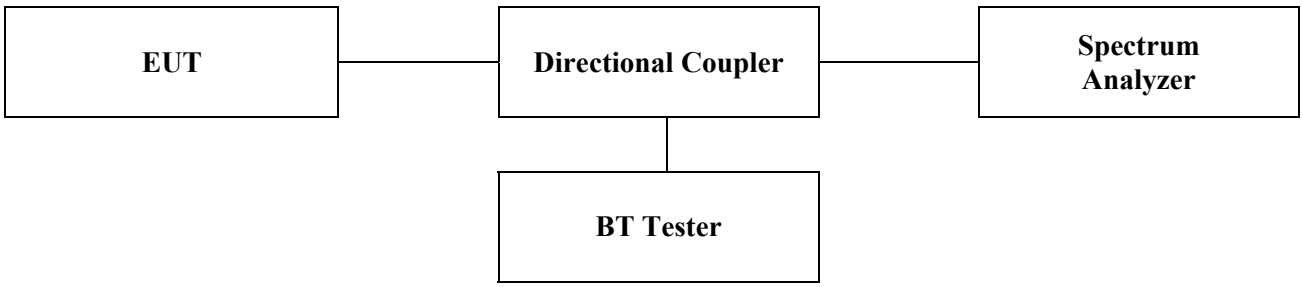
Operation Mode	Channel (Middle)	Adjacent Hopping Channel Separation (kHz)	Two-third of 20 dB Bandwidth (kHz)	Minimum Bandwidth (kHz)
GFSK	2441 MHz	1000	560	25

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



7. Number of hopping frequency

7.1. Test setup



7.2. Limit

§15.247(a)(1)(iii) For frequency hopping system operating in the 2400-2483.5 MHz bands shall use at least 15 hopping frequencies.

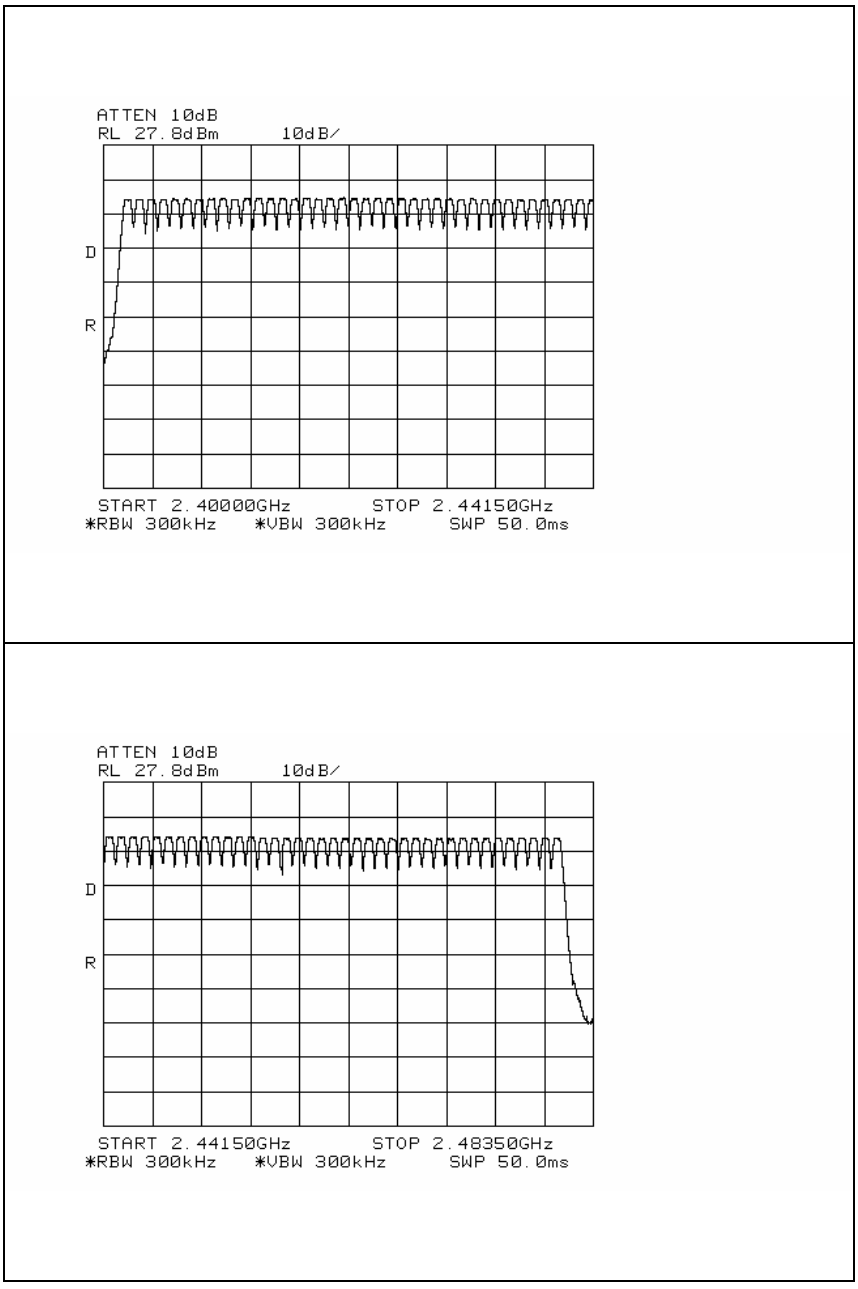
7.3. Test procedure

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=2400 MHz, Stop=2441.5 MHz, Sweep=auto and Start=2441.5 MHz, Stop= 2483.5 MHz, Sweep=auto.
4. Set the spectrum analyzer as RBW, VBW=300 kHz.
5. Max hold, view and count how many channel in the band.

7.4. Test result

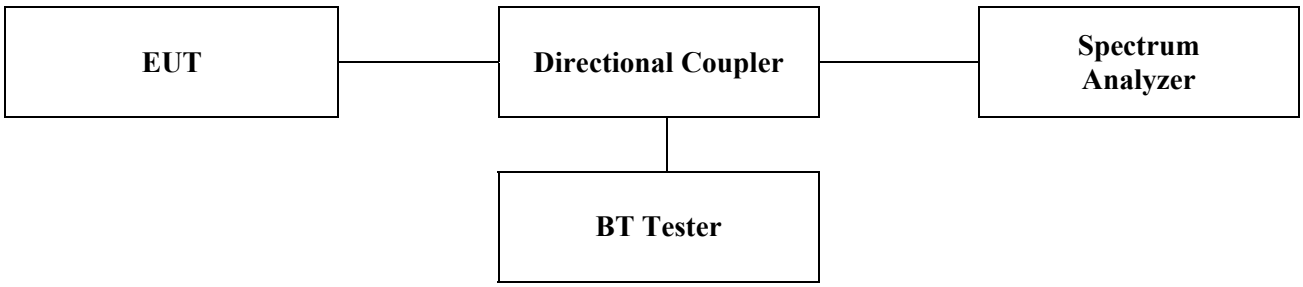
Ambient temperature : 24 ℃
Relative humidity : 47 %

Operation mode	Number of hopping frequency	Limit
GFSK	79	>= 15



8. Time of occupancy (Dwell time)

8.1. Test setup



8.2. Limit

§15.247(a)(1)(iii) For frequency hopping system operating in the 2400-2483.5MHz 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)

8.3. 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 3 type of payload, DH1, DH3, DH5.The hopping rate is 1600 per second.

8.4. Test result

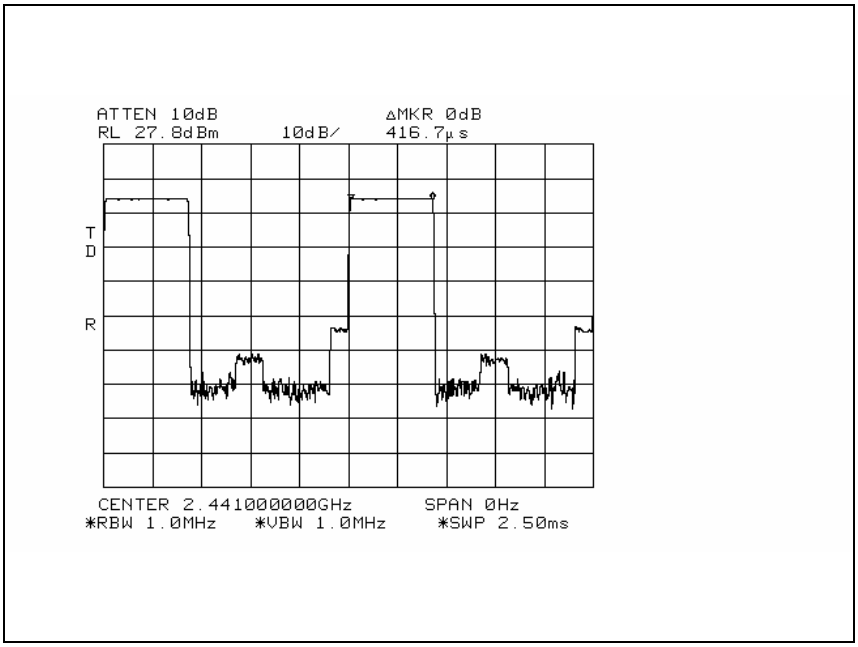
Ambient temperature : 24 ℃
Relative humidity : 47 %

Time of occupancy on the TX channel in 31.6sec
= time domain slot length × (hop rate ÷ number of hop per channel) × 31.6

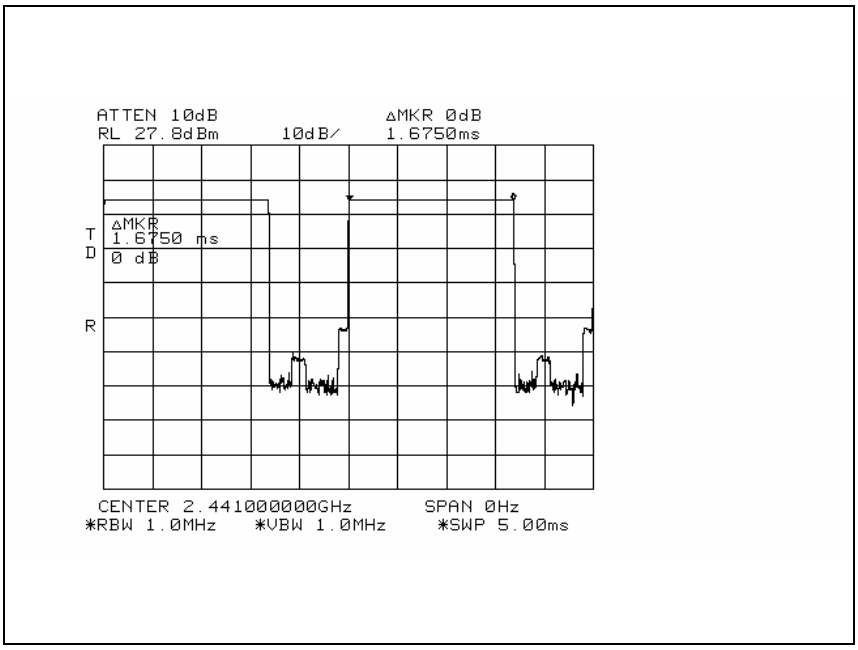
Frequency	Packet type	Dwell time (ms)	Time of occupancy on the Tx channel in 31.6 sec (ms)	Limit for time of occupancy on the Tx channel in 31.6 sec (ms)
2441 MHz	DH1	0.42	134.4	400
2441 MHz	DH3	1.68	268.8	400
2441 MHz	DH5	2.91	310.4	400

DH1 Dwell time : 0.42 (ms) × [(1600÷2) ÷79] ×31.6(s) = 134.4 (ms)
DH3 Dwell time : 1.68 (ms) × [(1600÷4) ÷79] ×31.6(s) = 268.8 (ms)
DH5 Dwell time : 2.91 (ms) × [(1600÷6) ÷79] ×31.6(s) = 310.4 (ms)

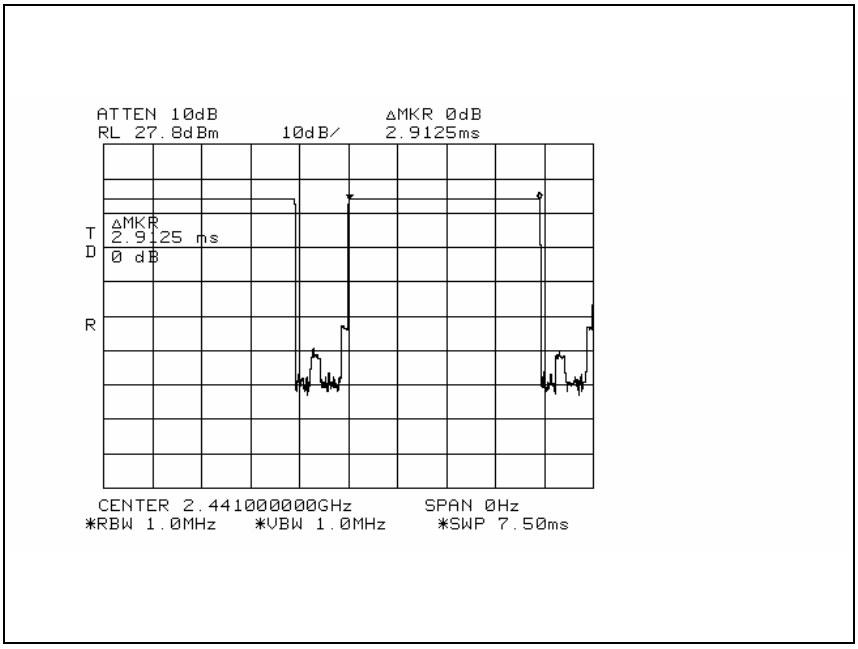
DH1



DH3

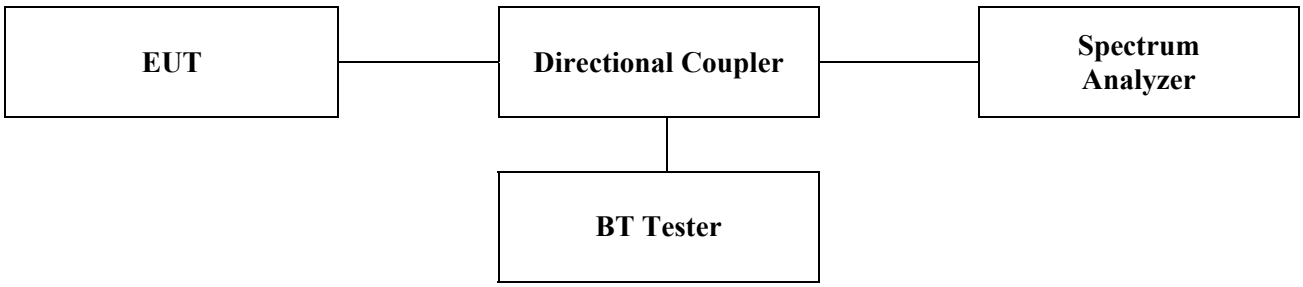


DH5



9. Power spectral density

9.1. Test setup



9.2. 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 kHz 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.

9.3. Test procedure

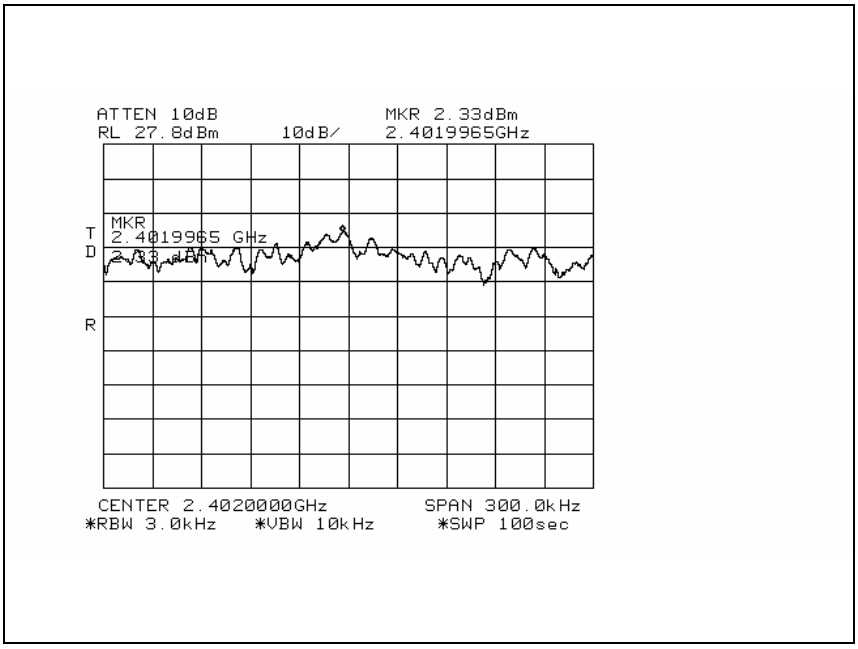
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
3. By using the Max Hold function record the separation of adjacent channels.
4. 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 kHz, VBW=10 kHz, Span=300 kHz and Sweep=100 s.

9.4. Test result

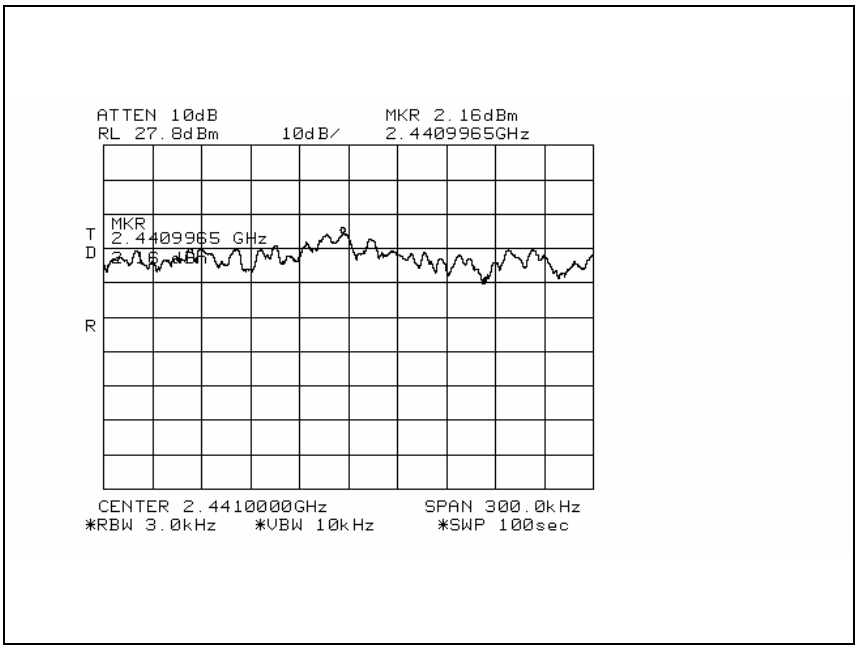
Ambient temperature : 24 ℃
Relative humidity : 47 %

Operation mode	Frequency	Final RF power level in 3 kHz BW (dBm)	Maximum limit (dBm)
GFSK	2402 MHz	2.33	8
	2441 MHz	2.16	8
	2480 MHz	1.83	8

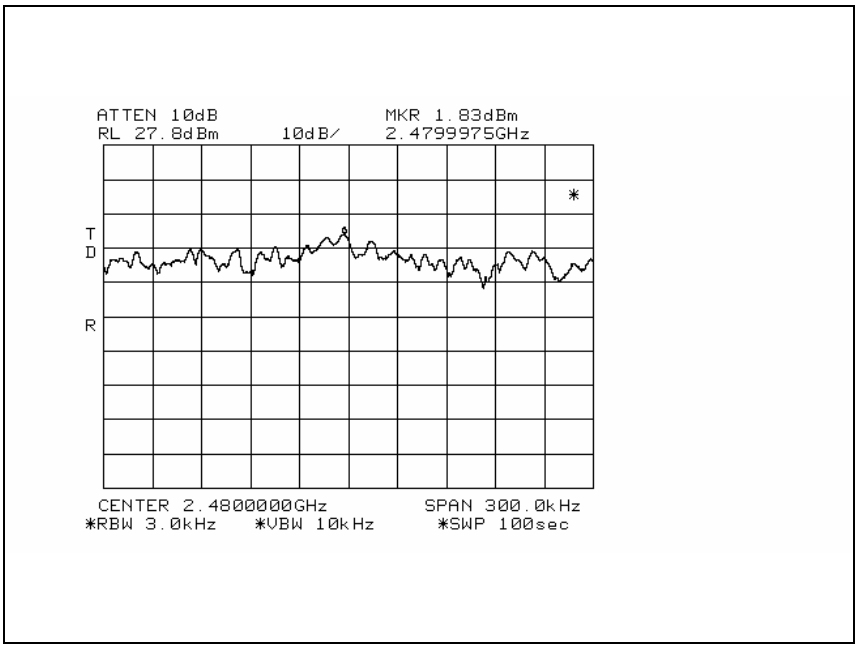
Low channel



Middle channel



High channel



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

10.2. Antenna connected construction

The antenna used of this product is Chip antenna.
The peak max gain of this antenna is 0.62 dBi

11. RF exposure evaluation

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

Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength(V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Average time
(A) Limits for Occupational /Control Exposures				
300 – 1500	--	--	F/300	6
1500 - 100000	--	--	5	6
(B) Limits for General Population/Uncontrol Exposures				
300 – 1500	--	--	F/1500	6
1500 - 100000	--	--	1	30

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

Where
Pd = power density in mW/cm^2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
Pi = 3.1416
R = distance between observation point and center of the radiator in cm
Pd the limit of MPE, 1 mW/cm^2. 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.

11.1 Test result of RF exposure evaluation

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

11.1.1 Output power into antenna & RF exposure evaluation distance

Operating mode	Channel	Frequency (MHz)	Peak output power (dBm)	Antenna gain (dBi)	Power density at 20cm (mW/cm^2)	Limit (mW/cm^2)
GFSK	Low	2402	12.16	0.62	0.00377	1
	Middle	2441	12.16	0.62	0.00377	
	High	2480	11.83	0.62	0.00350	

▣Note
The power density Pd (4th column) at a distance of 20cm calculated from the friis transmission formula is far below the limit of 1 mW/ cm^2.