

Test Report of FCC CFR 47 Part 15 Subpart C and Industry Canada RSS-247 Issue 1

On Behalf of

DEFA AS

FCC ID: 2AFR4BLUETOOTHHUB
Product Description: Bluetooth Hub
Model No.: Bluetooth Hub
Brand Name: DEFA

Prepared for: DEFA AS
Blingsmoveien 30, 3540 Nesbyen, Norway
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Report No.: HCT15HR047E
Issue Date: August 24, 2015
Test Date: August 4~ 24, 2015

Tested by:



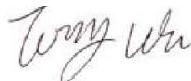
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1. GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

Client Information

Applicant:	DEFA AS
Address of Applicant:	Blingsmoveien 30, 3540 Nesbyen, Norway
Manufacturer:	DEFA TECHNOLOGY(WUXI) CO., LTD.
Address of Manufacturer:	No. 1 standard building , Xikun road 11#,xu feng industry park, No. 83-C block, Wuxi national hi-tech development Zone, Wuxi, Jiangsu Province

General Description of E.U.T

Items	Description
EUT Description:	Bluetooth Hub
Model No.:	Bluetooth Hub
Trade Name:	DEFA
BT Module	Bluetooth 4.0
Frequency Band:	2402~2480MHz
Number of Channels:	40
Type of Modulation:	Only GFSK Modulation technology
Antenna Gain	0 dBi
Antenna Type:	Integral Antenna
Rated Voltage:	DC 12-24 V, 150mA

Remark: * The test data gathered are from the production sample provided by the manufacturer.

1.2 Test standards

The tests were performed based on the Electromagnetic Interference (EMI) tests performed on the EUT. Both conducted and radiated testing were performed according to the procedures in ANSI C63.4 – 2003 and clause 4 of RSS-GEN Issue 2. Radiated testing was performed at an antenna to EUT distance 3 meters

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.207, 15.209 and 15.247 rules and the FCC publication KDB558074 of Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247) and RSS-GEN Issue 2 and RSS-210 Issue 8 and RSS 247 Issue 1

1.3 Test Facility

All measurement required was performed at laboratory of Shenzhen CTL Testing Technology Co., Ltd. at Floor 1-A, Baisha Technology Park, No.3011, Shahexi Road, Nanshan District, Shenzhen, China 518055.

The test facility is recognized, certified, or accredited by the following organizations:

FCC – Registration No.: 970318

Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 970318, December, 2013.

IC Registration No.: 9618B

The 3m alternate test site of Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered by Certification and Engineering Bureau of Industry Canada for the performance of with Registration NO.: 9618B on November 13, 2013.

The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2003.

2. SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

The calibrated antennas used to sample the radiated field strength are mounted on a non-conductive, motorized antenna mast 3 or 10 meters from the leading edge of the turntable.

2.3 General Test Procedures

Conducted Emissions: The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 7.1 of ANSI C63.4–2003 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-Peak detector mode.

Radiated Emissions: The EUT is placed on as turntable, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 13.1.4.1 of ANSI C63.4–2003.

2.4 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Parameter	Uncertainty
Power Line Conducted Emission	+/- 2.3 dB
Radiated Emission	+/- 3.4 dB

Uncertainty figures are valid to a confidence level of 95%.

2.5 List of Measuring Equipments Used

No.	Instrument no.	Equipment	Manufacturer	Model No.	S/N	Last Calculator	Due Calculator
1	BCT-EMC001	EMI Test Receiver	R&S	ESCI	100687	2015-4-25	2016-4-24
2	BCT-EMC002	EMI Test Receiver	R&S	ESPI	100097	2014-11-1	2015-10-31
3	BCT-EMC003	Amplifier	HP	8447D	1937A02492	2015-4-25	2016-4-24
4	BCT-EMC018	TRILOG Broadband Test- Antenna	SCHWARZBECK	VULB9163	9163-324	2015-4-25	2016-4-24
5	BCT-EMC021	Triple-Loop Antenna	EVERFINE	LLA-2	711002	2014-11-1	2015-10-31
6	BCT-EMC026	RF POWER AMPLIFIER	FRANKONIA	FLL-75	1020A1109	2015-4-25	2016-4-24
7	BCT-EMC029	6dB Attenuator	FRANKONIA	N/A	1001698	2015-4-25	2016-4-24
8	BCT-EMC032	10dB attenuator	ELECTRO- METRICS	EM-7600	836	2015-4-25	2016-4-24
9	BCT-EMC036	Spectrum Analyzer	R&S	FSP	100397	2014-11-1	2015-10-31
10	BCT-EMC037	Broadband preamplifier	SCH WARZBECK	BBV9718	9718-182	2015-4-25	2016-4-24
11	BCT-EMC039	Horn Antenna	SCHWARZBECK	BBHA 9120D	0437	2015-4-25	2016-4-24
12	BCT-EMC038	Horn Antenna	SCHWARZBECK	BBHA9170	0483	2015-4-5	2016-4-4

3. SUMMARY OF Test RESULTS

FCC/IC Rules	Description of Test	Result
FCC §15.207 IC RSS-GEN Clause 7.2.2	AC Power Line Conducted Emission	Pass
FCC §15.247(b) IC RSS-247 Issue1 Clause 5.4 (4)	Maximum Peak Output Power	Pass
FCC §15.247(e) IC RSS-247 Issue1 Clause 5.2 (2)	Power Spectral Density	Pass
FCC §15.247(a) IC RSS-247 Issue1 Clause 5.2 (1)	6dB Bandwidth 99% Occupied Bandwidth	Pass
FCC §15.247 (d) IC RSS-247 Issue1 Clause 5.5	Conducted Spurious Emission	Pass
FCC §15.205 and §15.209 IC RSS-210 Clause 2.6 (Transmitter) IC RSS-GEN Clause 6 (Receiver)	Radiated Spurious Emission	Pass
FCC §15.247 (d) and §15.205 and §15.209 IC RSS-247 Issue1 Clause 5.5	Unwanted Emissions	Pass
FCC §15.203/15.247(b)/(c) IC RSS-GEN Clause 7.1.4	Antenna Requirement	Pass

4. Test OF AC POWER LINE CONDUCTED EMISSION

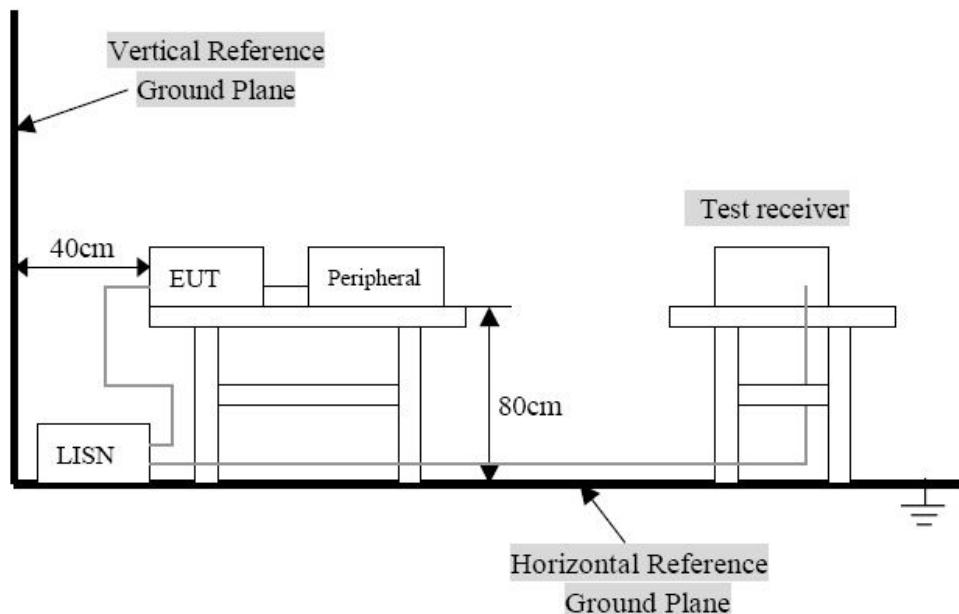
4.1 Applicable standard

Refer to FCC §15.207 and IC RSS-GEN Clause 7.2.2

For a Low-power Radio-frequency Device is designed to be connected to the 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 below limits table.

Frequency Range (MHz)	Limits (dBuV)	
	Quasi-Peak	Average
0.150~0.500	66~56	56~46
0.500~5.000	56	46
5.000~30.00	60	50

4.2 Test Setup Diagram



Remark: The EUT was connected to a 120 VAC/ 60Hz power source.

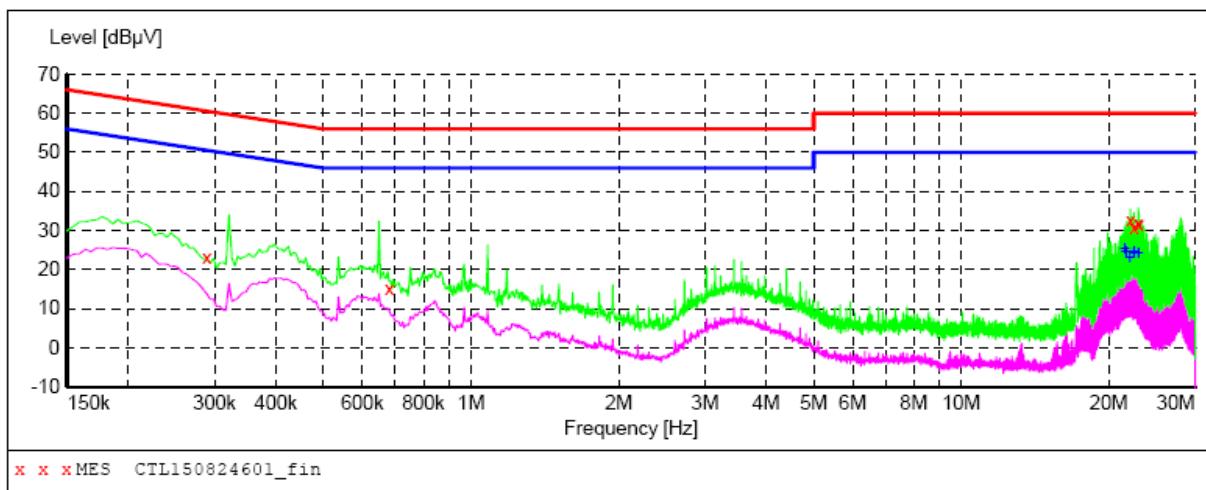
4.3 Test Result

Temperature (°C) : 23~25	EUT: Bluetooth Hub
Humidity (%RH) : 45~58	M/N: Bluetooth Hub
Barometric Pressure (mbar) : 950~1000	Operation Condition: Tx Mode

Conducted Emission Test Data

EUT: Bluetooth Hub
 M/N: Bluetooth Hub
 Operating Condition: Tx Mode
 Test Site: Shielded Room
 Operator: Li
 Test Specification: DC 12V
 Comment: Live Line
 Start of Test: 8/24/2015 Tem:25°C Hum:50%

SCAN TABLE: "Voltage (9K-30M) FIN"
Short Description: 150K-30M Voltage



MEASUREMENT RESULT: "CTL150824601_fin"

8/24/2015 10:52AM	Frequency	Level	Transd	Limit	Margin	Detector	Line	PE
	MHz	dB μ V	dB	dB μ V	dB			
	0.289501	23.00	10.2	61	37.5	QP	L1	GND
	0.681001	15.00	10.2	56	41.0	QP	L1	GND
	22.141501	32.50	11.0	60	27.5	QP	L1	GND
	22.501501	30.70	11.0	60	29.3	QP	L1	GND
	22.983001	32.00	11.1	60	28.0	QP	L1	GND
	23.041501	31.40	11.1	60	28.6	QP	L1	GND

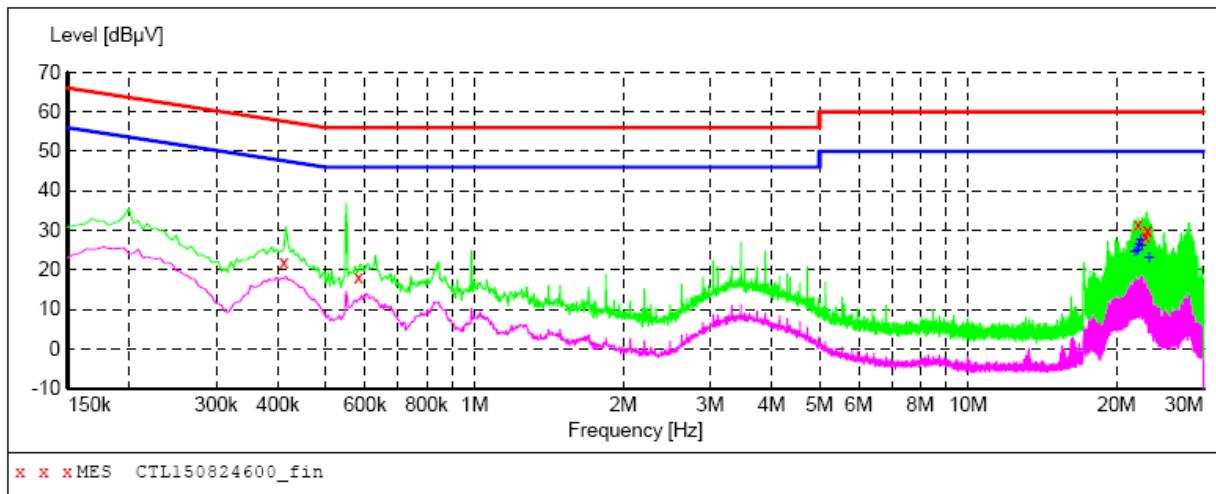
MEASUREMENT RESULT: "CTL150824601_fin2"

8/24/2015 10:52AM	Frequency	Level	Transd	Limit	Margin	Detector	Line	PE
	MHz	dB μ V	dB	dB μ V	dB			
	21.538501	25.60	11.0	50	24.4	AV	L1	GND
	21.660001	24.60	11.0	50	25.4	AV	L1	GND
	22.078501	23.20	11.0	50	26.8	AV	L1	GND
	22.443001	24.30	11.0	50	25.7	AV	L1	GND
	22.501501	24.60	11.0	50	25.4	AV	L1	GND
	22.983001	24.30	11.1	50	25.7	AV	L1	GND

Conducted Emission Test Data

EUT: Bluetooth Hub
 M/N: Bluetooth Hub
 Operating Condition: Tx Mode
 Test Site: Shielded Room
 Operator: Li
 Test Specification: DC 12V
 Comment: Neutral Line
 Start of Test: 8/24/2015 Tem:25°C Hum:50%

SCAN TABLE: "Voltage (9K-30M) FIN"
Short Description: 150K-30M Voltage



MEASUREMENT RESULT: "CTL150824600_fin"

8/24/2015 10:48AM	Frequency	Level	Transd	Limit	Margin	Detector	Line	PE
	MHz	dB μ V	dB	dB μ V	dB			
	0.411001	22.10	10.2	58	35.5	QP	N	GND
	0.582001	18.10	10.2	56	37.9	QP	N	GND
	22.078501	31.40	11.0	60	28.6	QP	N	GND
	22.920001	28.50	11.1	60	31.5	QP	N	GND
	23.046001	29.90	11.1	60	30.1	QP	N	GND
	23.104501	29.90	11.1	60	30.1	QP	N	GND

MEASUREMENT RESULT: "CTL150824600_fin2"

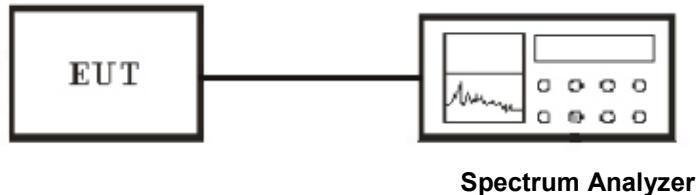
8/24/2015 10:48AM	Frequency	Level	Transd	Limit	Margin	Detector	Line	PE
	MHz	dB μ V	dB	dB μ V	dB			
	21.781501	24.70	11.0	50	25.3	AV	N	GND
	22.078501	25.20	11.0	50	24.8	AV	N	GND
	22.141501	26.60	11.0	50	23.4	AV	N	GND
	22.380001	27.80	11.0	50	22.2	AV	N	GND
	22.443001	26.20	11.0	50	23.8	AV	N	GND
	23.284501	23.00	11.1	50	27.0	AV	N	GND

5. Test of Maximum Peak Output Power

5.1 Applicable standard

Refer to FCC §15.247 (b) and IC RSS-247 Issue1 Clause 5.4 (4).

5.2 EUT Setup



5.3 Test Equipment List and Details

See section 2.5.

5.4 Test Procedure

This procedure should only be used when the maximum available RBW of the spectrum/signal analyzer is less than the DTS bandwidth. The transmitter output was connected to a spectrum analyzer and the parameter was set as below:

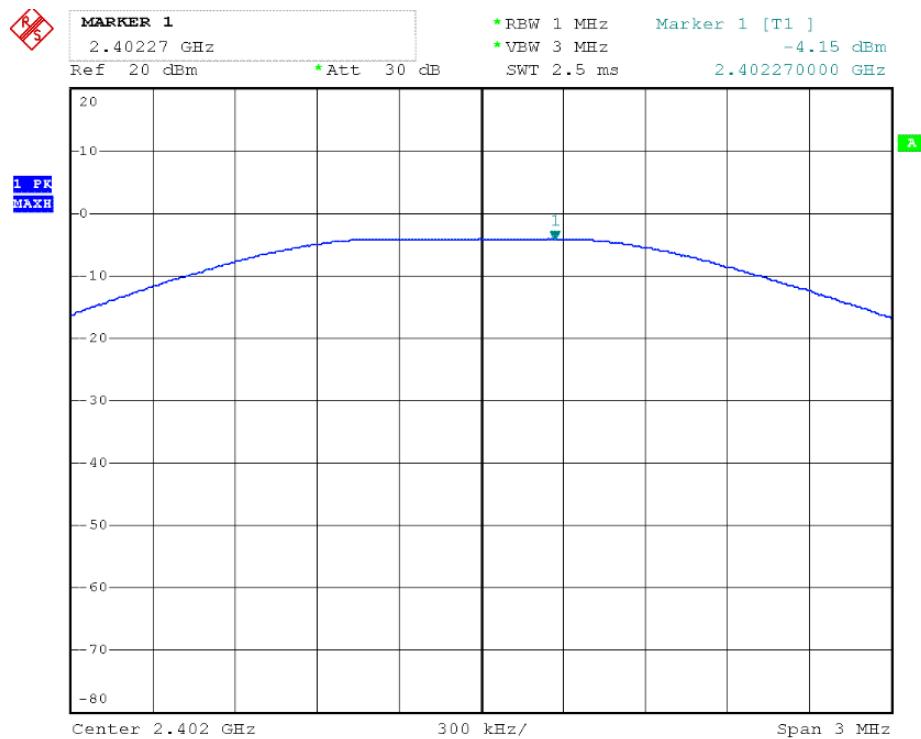
1. Set the RBW = maximum available (at least 1 MHz).
2. Set the VBW = $3 \times$ RBW or maximum available setting (must be \geq RBW).
3. Set the span to fully encompass the DTS bandwidth.
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the spectrum analyzer's band/channel power measurement function with the band limits set equal to the DTS bandwidth edges (for some analyzers, this may require a manual override to ensure use of peak detector). If the spectrum analyzer does not have a band power function, sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the DTS channel bandwidth.

5.5 Test Result

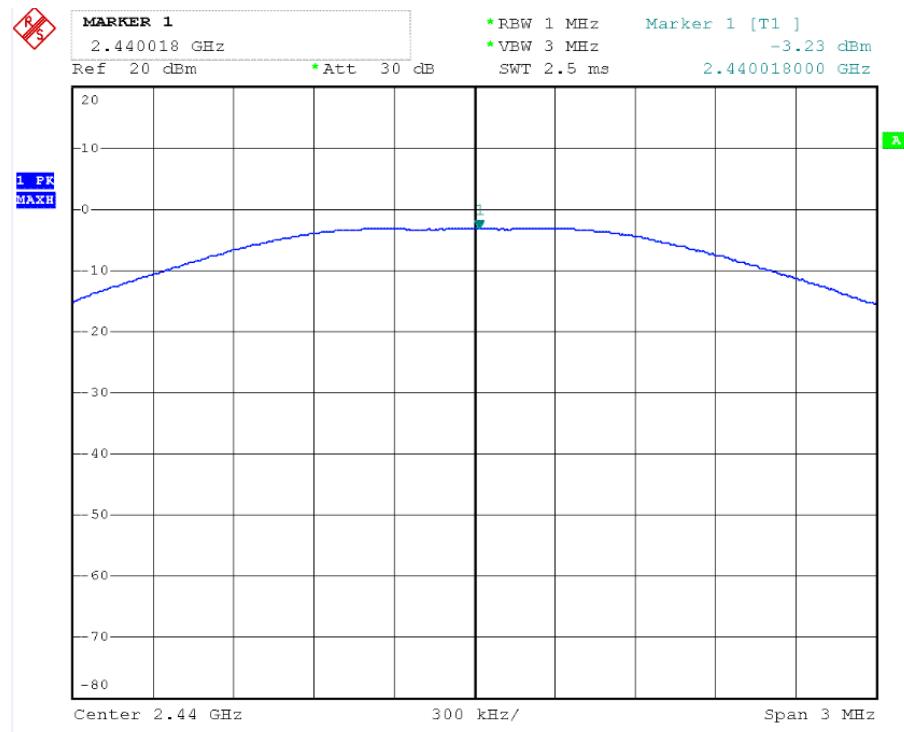
Temperature (°C) : 22~23	EUT: Bluetooth Hub
Humidity (%RH) : 50~54	M/N: Bluetooth Hub
Barometric Pressure (mbar) : 950~1000	Operation Condition: Tx Mode

Channel	Channel Frequency (MHz)	Peak Power (dBm)	Peak Power Limit (dBm)	Pass / Fail
Low	2402	-4.15	30	PASS
Middle	2440	-3.23	30	PASS
High	2480	-2.11	30	PASS

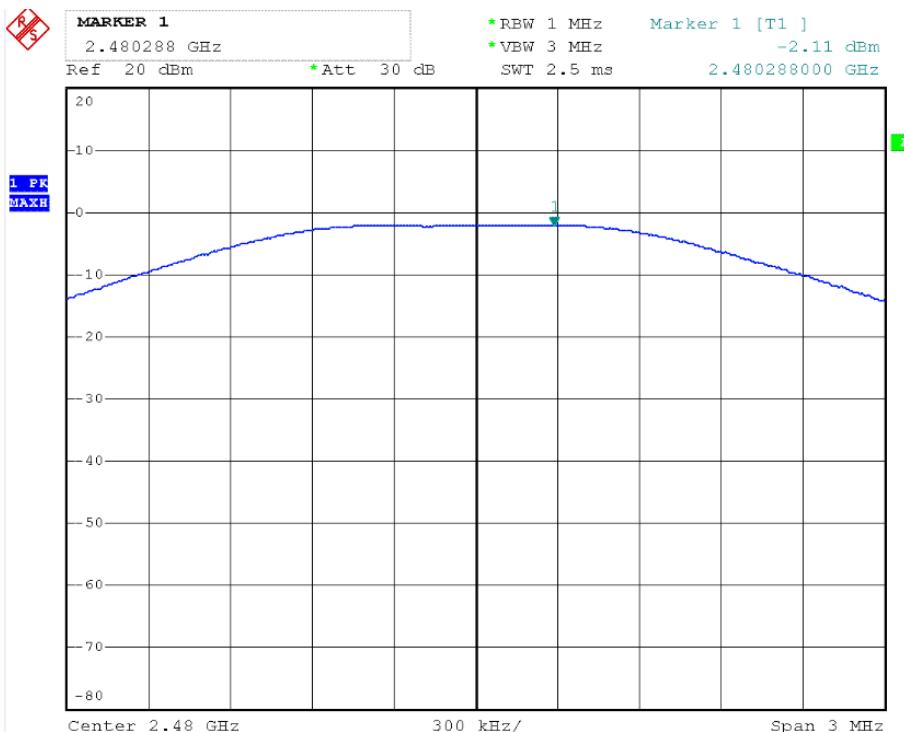
MAXIMUM PEAK OUTPUT POWER (MODE CH Low)



MAXIMUM PEAK OUTPUT POWER (MODE CH Mid)



MAXIMUM PEAK OUTPUT POWER (MODE CH High)



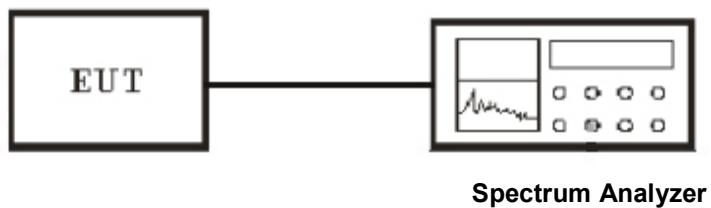
6. Test of Peak Power Spectral Density

6.1 Applicable standard

Refer to FCC §15.247 (e) and IC RSS-247 Issue1 Clause 5.2 (2).

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

6.2 EUT Setup



6.3 Test Equipment List and Details

See section 2.5.

6.4 Test Procedure

The transmitter output was connected to the spectrum analyzer and the parameter was set as below:

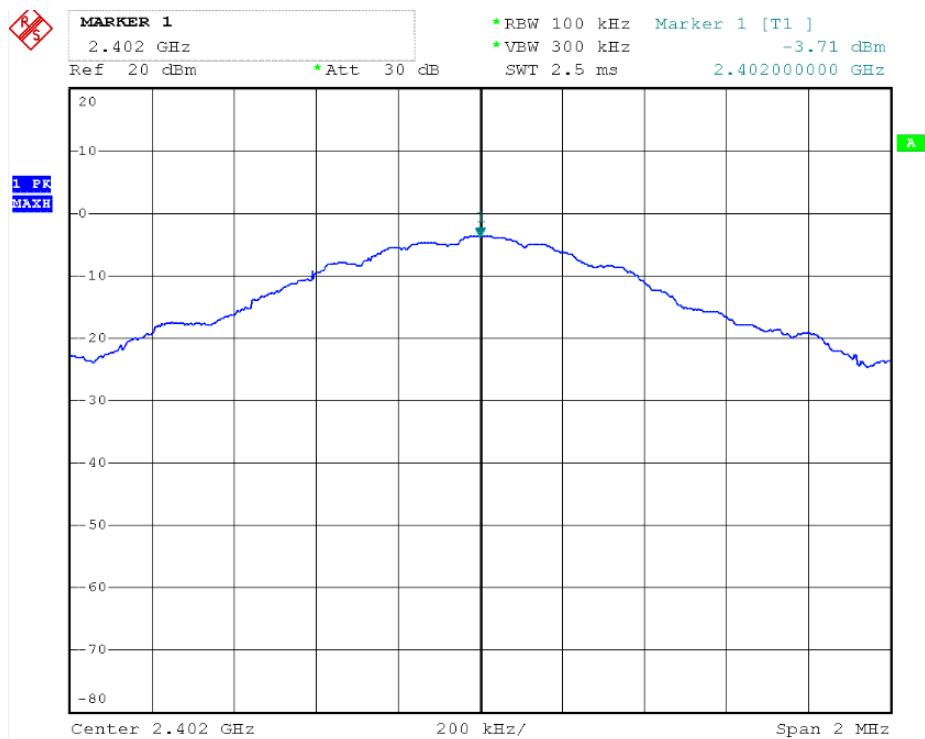
1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS channel bandwidth.
3. Set the RBW ≥ 3 kHz.
4. Set the VBW $\geq 3 \times$ RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

6.5 Test Result

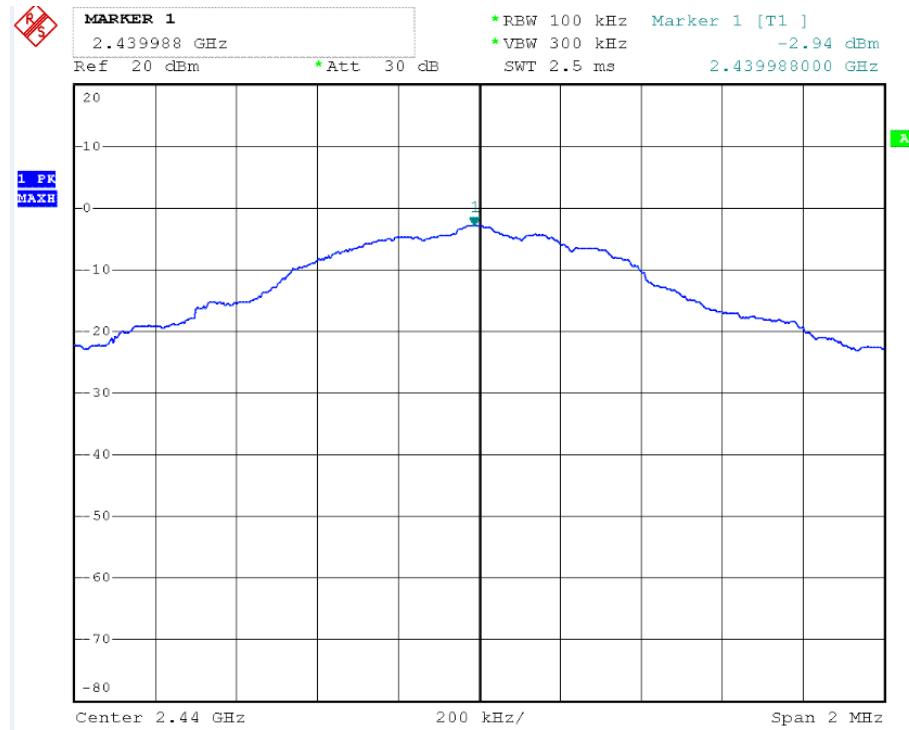
Temperature (°C) : 22~23	EUT: Bluetooth Hub
Humidity (%RH) : 50~54	M/N: Bluetooth Hub
Barometric Pressure (mbar) : 950~1000	Operation Condition: Tx Mode

Channel	Channel Frequency (MHz)	RF Power Level in 100KHz RBW (dBm)	Correct Factor 100KHz to 3KHz (dB)	Final RF Power Level in 3KHz RBW (dBm)	Maximum Limit (dBm)	Pass / Fail
Low	2402	-3.71	-15.22	-18.73	8	PASS
Middle	2440	-2.94	-15.22	-18.16	8	PASS
High	2480	-1.80	-15.22	-17.02	8	PASS

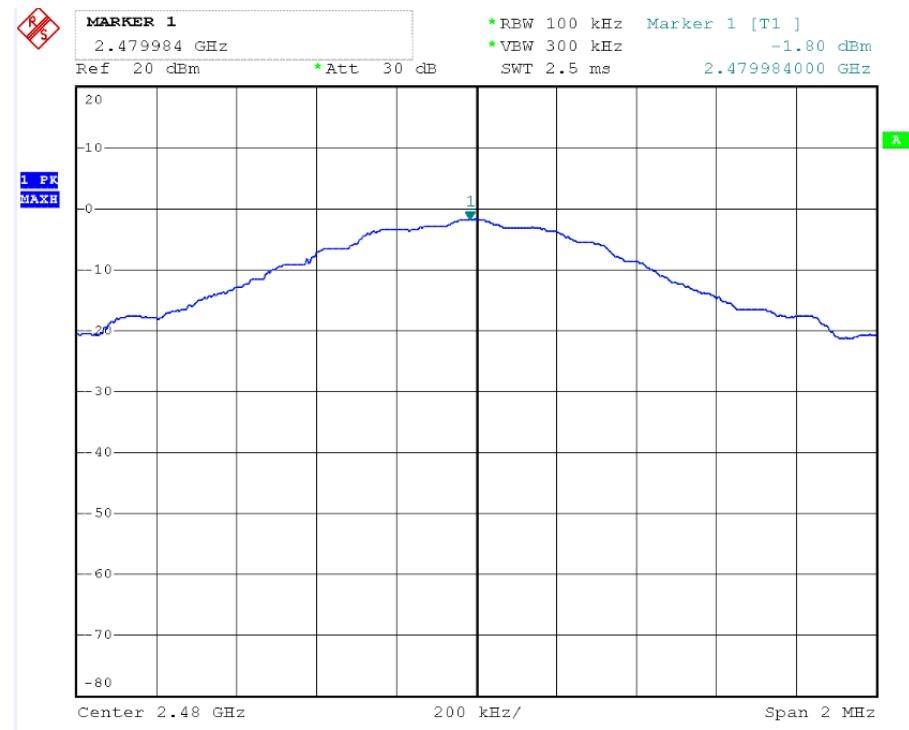
POWER SPECTRAL DENSITY (MODE CH Low)



POWER SPECTRAL DENSITY (MODE CH Mid)



POWER SPECTRAL DENSITY (MODE CH High)



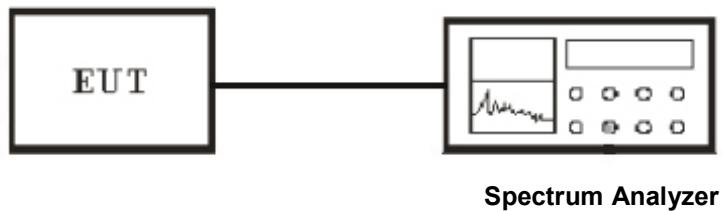
7. Test of 6dB Bandwidth

7.1 Applicable standard

Refer to FCC §15.247 (a) (2) and IC RSS-247 Issue1 Clause 5.2 (1).

The minimum 6 dB bandwidth shall be at least 500 kHz.

7.2 EUT Setup



7.3 Test Equipment List and Details

See section 2.5.

7.4 Test Procedure

The 6dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 6dB. The transmitter output was connected to a spectrum analyzer and the parameter was set as below:

1. Set resolution bandwidth (RBW) = 1-5% or DTS BW, not to exceed 100 kHz.
2. Set the video bandwidth (VBW) $\geq 3 \times \text{RBW}$.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

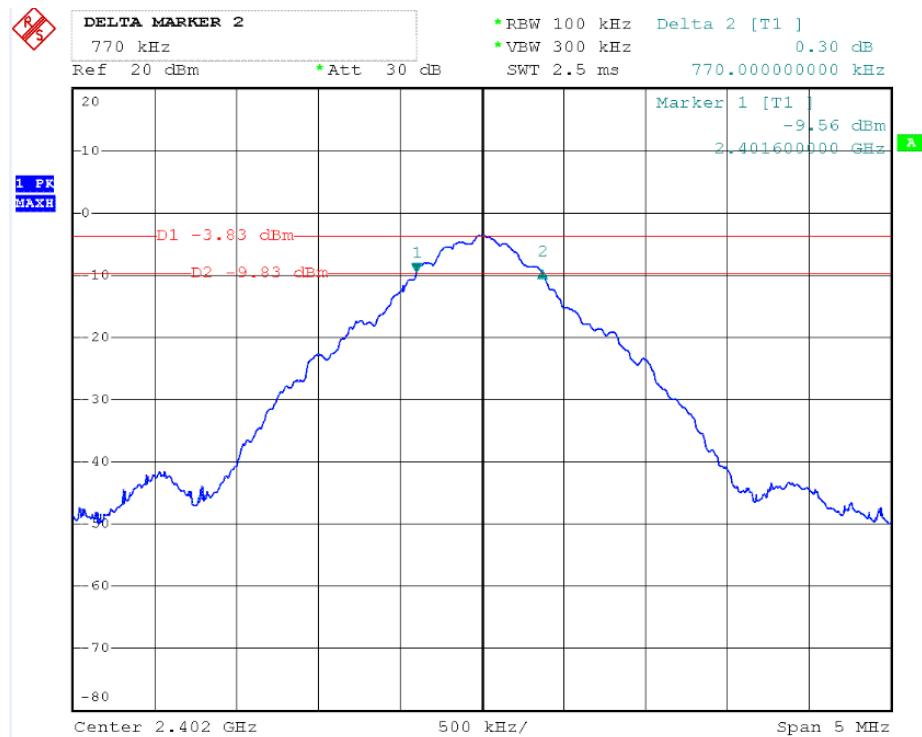
7.5 Test Result

Temperature (°C) : 22~23	EUT: Bluetooth Hub
Humidity (%RH) : 50~54	M/N: Bluetooth Hub
Barometric Pressure (mbar) : 950~1000	Operation Condition: Tx Mode

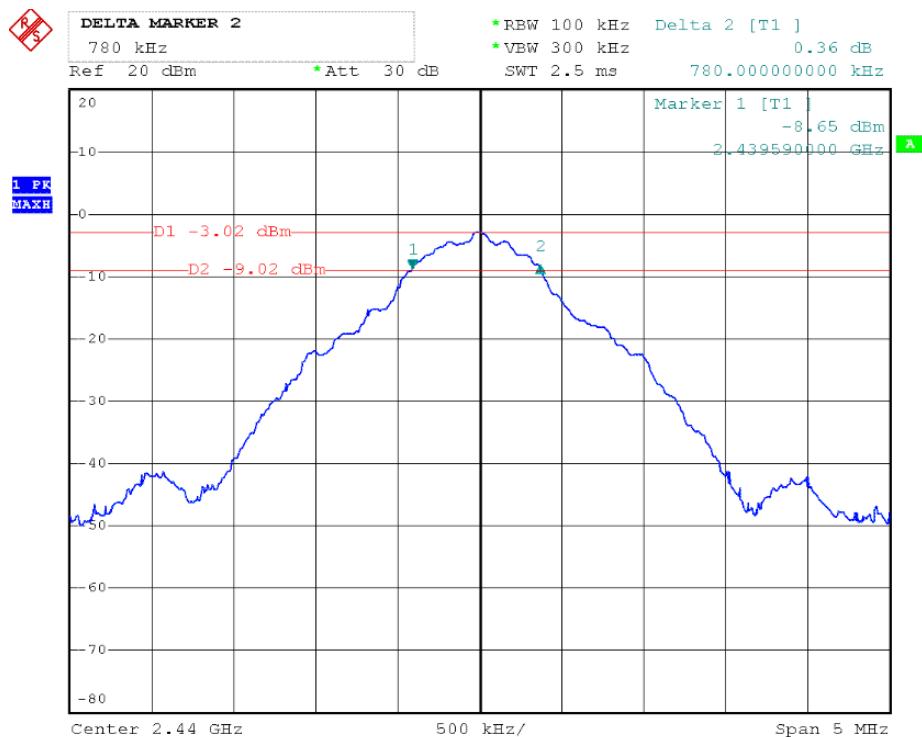
Channel	Channel Frequency (MHz)	6dB Bandwidth (KHz)	Minimum Limit (kHz)	Pass / Fail
Low	2402	770	500	PASS
Middle	2440	780	500	PASS
High	2480	740	500	PASS

Channel	Channel Frequency (MHz)	99% Occupy Bandwidth (KHz)	Minimum Limit (kHz)	Pass / Fail
Low	2402	1770	N/A	N/A
Middle	2440	1790	N/A	N/A
High	2480	1790	N/A	N/A

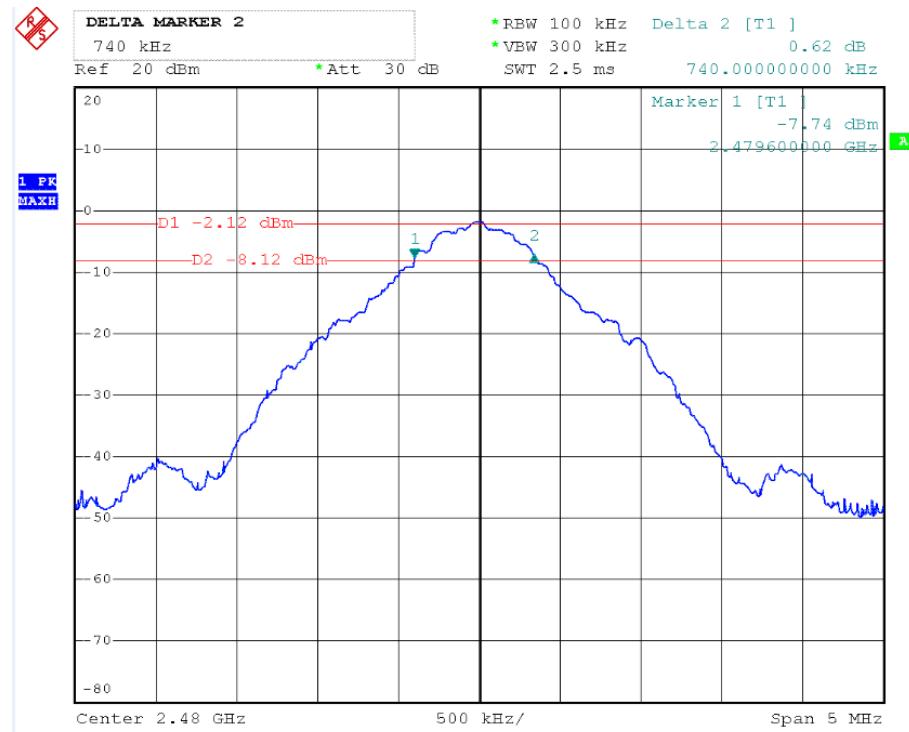
6dB BANDWIDTH (MODE CH Low)



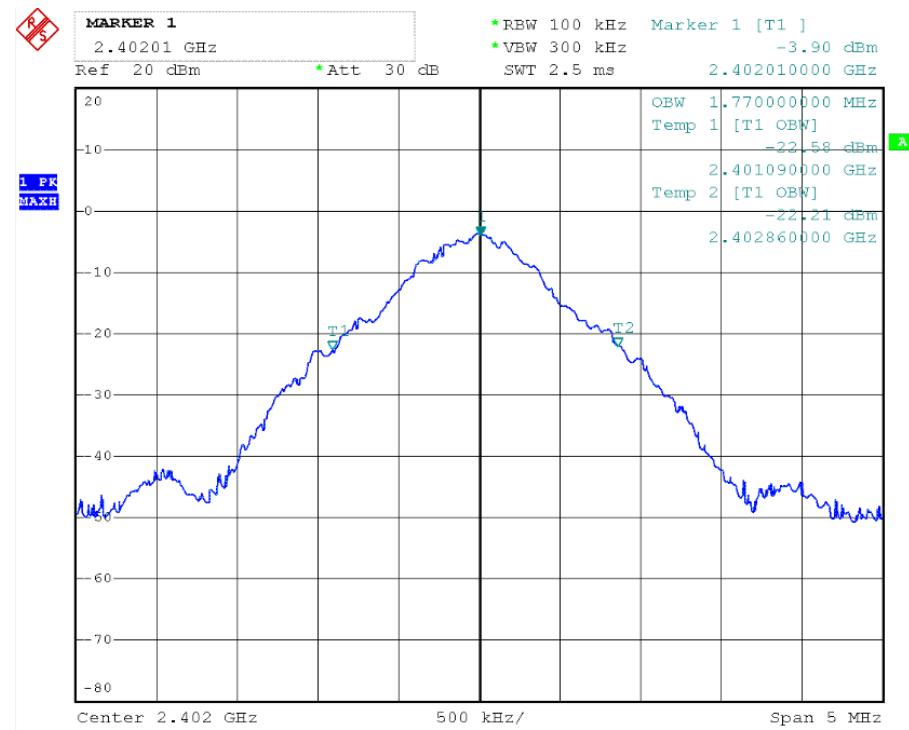
6dB BANDWIDTH (MODE CH Mid)



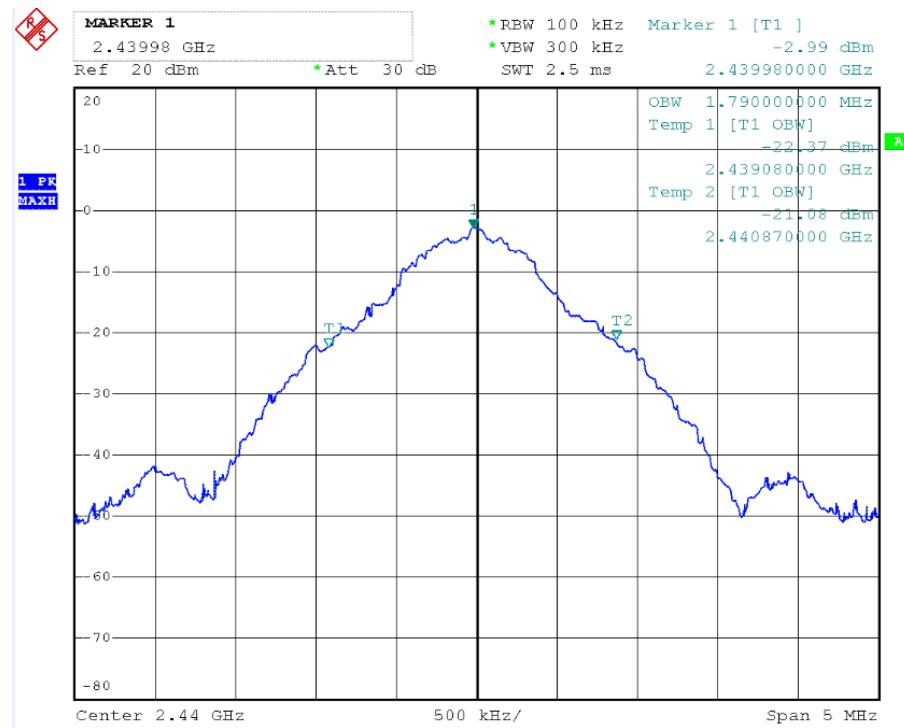
6dB BANDWIDTH (MODE CH High)



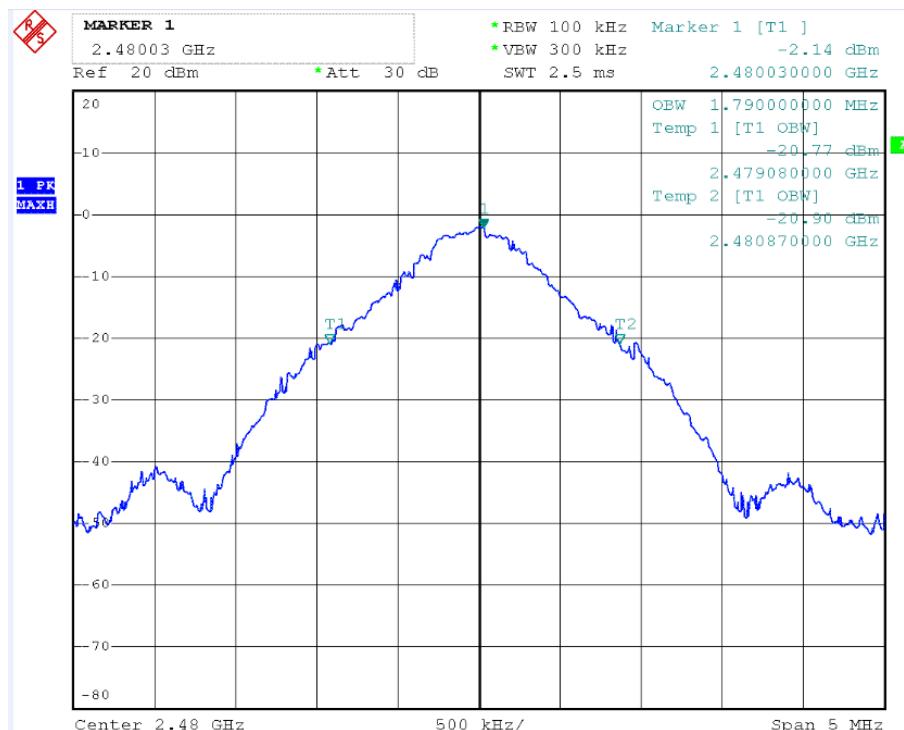
99% Occupy BANDWIDTH (MODE CH Low)



99% Occupy BANDWIDTH (MODE CH Mid)



99% Occupy BANDWIDTH (MODE CH High)



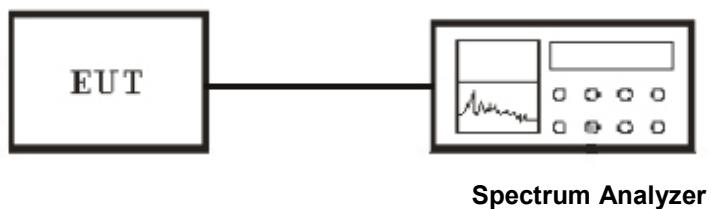
8. Test of Conducted Spurious Emission

8.1 Applicable standard

Refer to FCC §15.247 (d) and IC RSS-247 Issue1 Clause 5.5.

Output power was measured based on the use of RMS averaging over a time interval, therefore the required attenuation is 30 dB.

8.2 EUT Setup



8.3 Test Equipment List and Details

See section 2.5.

8.4 Test Procedure

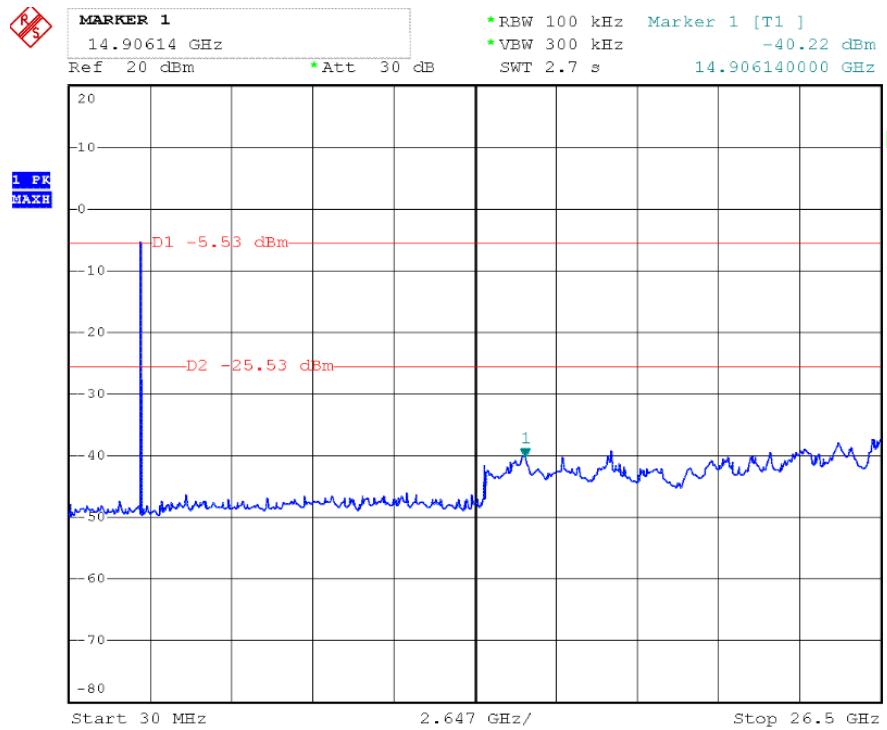
The transmitter output was connected to a spectrum analyzer. The spectrum from 30 MHz to 26.5 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band. The parameter of the spectrum analyzer was set as below:

1. Set start frequency to DTS channel edge frequency.
2. Set stop frequency so as to encompass the spectrum to be examined.
3. Set RBW = 100 kHz.
4. Set VBW ≥ 300 kHz.
5. Detector = peak.
6. Trace Mode = max hold.
7. Sweep = auto couple.
8. Allow the trace to stabilize (this may take some time, depending on the extent of the span).
9. Use peak marker function to determine maximum amplitude of all unwanted emissions within any 100 kHz bandwidth.

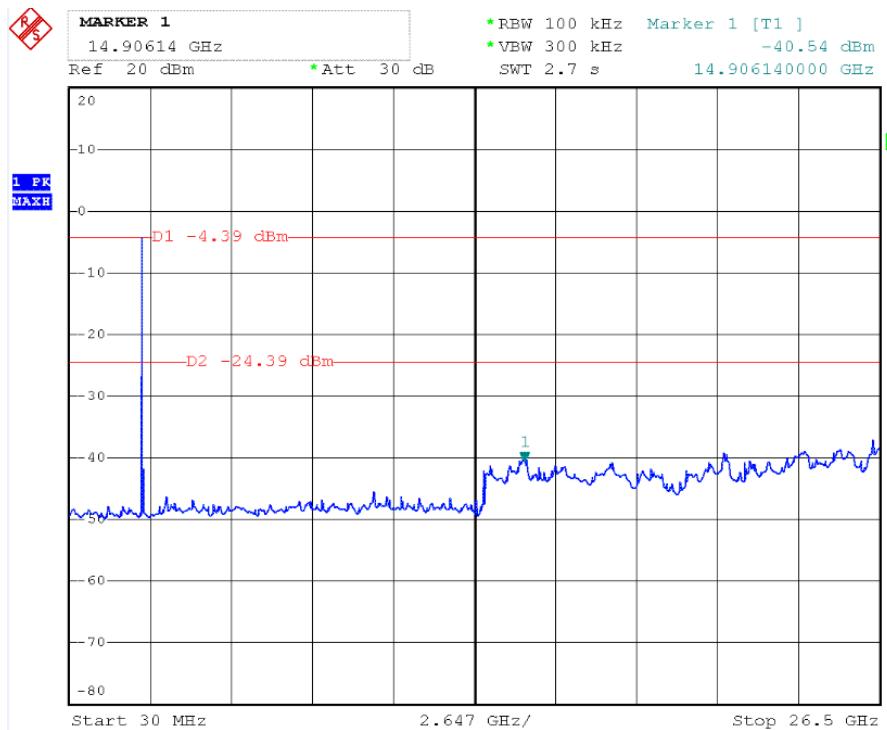
8.5 Test Result

Temperature (°C) : 22~23	EUT: Bluetooth Hub
Humidity (%RH) : 50~54	M/N: Bluetooth Hub
Barometric Pressure (mbar) : 950~1000	Operation Condition: TX Mode

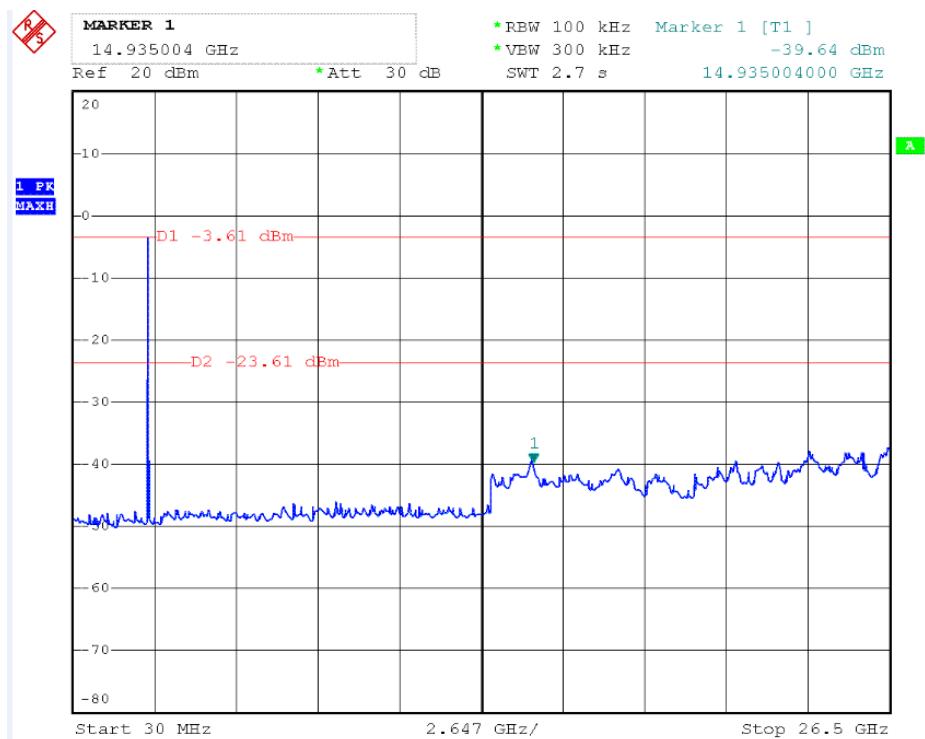
CH Low



CH Mid



CH High



9. Test of Radiated Spurious Emission

9.1 Radiated Spurious Emission

Refer to FCC §15.205 and §15.209 IC RSS-210 Clause 2.6 (Transmitter) &IC RSS-GEN Clause 6 (Receiver)

9.1.1 Limits

15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
¹ 0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3338	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	(²)
13.36 - 13.41			

15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

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 (MHz)	Field strength (microvolts/meter)	Measurement Distance (meters)
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

15.209 (b) In the emission table above, the tighter limit applies at the band edges.

9.1.2 EUT Setup

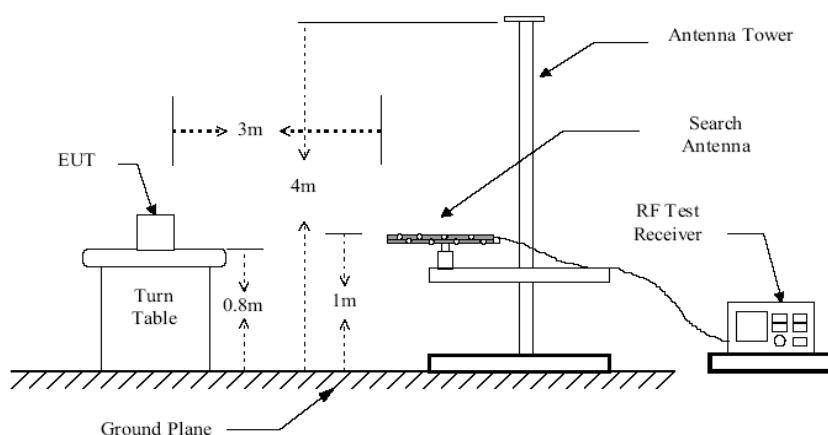
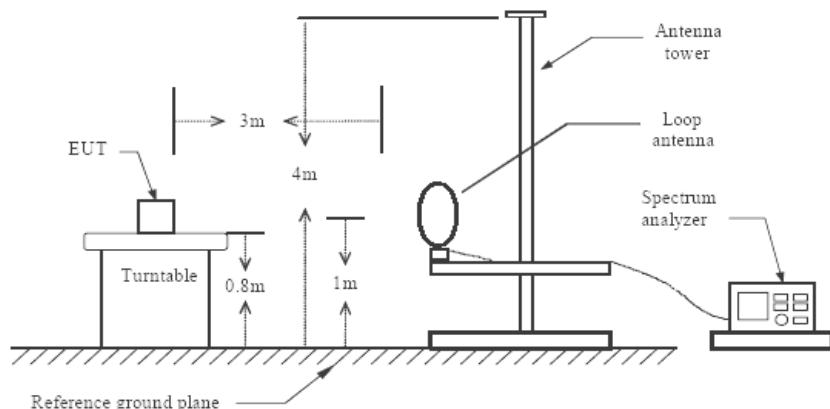


Figure 1 : Frequencies measured below 1 GHz configuration

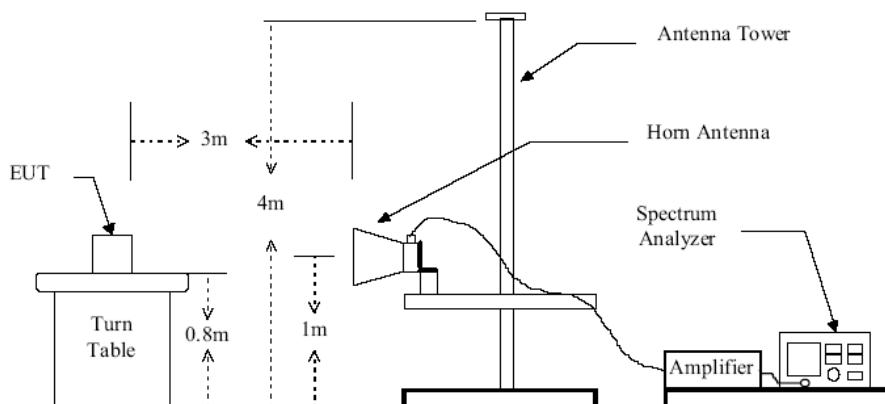


Figure 2 : Frequencies measured above 1 GHz configuration

9.1.3 Test Procedure

1. Configure the EUT according to ANSI C63.4–2003
2. The EUT was placed on the top of the turntable 0.8 meter above ground.
3. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
4. For each suspected emission, the antenna tower was scanned (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. According to the characteristic of the EUT crystals, the range of frequencies was investigated from 9KHz to 30MHz, 30MHz to 1GHz and 1GHz to 24.8GHz.
6. Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10: section 4.5, Table 1
7. In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
8. Measurements at 2400 & 2483.5 MHz were made to ensure band edge compliance.
9. Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
10. For Frequencies below 1 GHz, RBW= 100 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:
Peak RBW=VBW= 1MHz
Average RBW=VBW= 1MHz

These settings as per ANSI C63.10

9.1.4 Test Result

Temperature (°C) : 22~23	EUT: Bluetooth Hub
Humidity (%RH) : 50~54	M/N: Bluetooth Hub
Barometric Pressure (mbar) : 950~1000	Operation Condition: Normal operation & TX Mode

Note: In this testing, the EUT was respectively tested in three different orientations. That is:

1. EUT was lie vertically, and then its Antenna oriented upward
2. EUT was lie vertically, and then its Antenna oriented downward
3. EUT was lie flat wise, and then its Antenna oriented to the receiving antenna

The worst test data see following pages

When the EUT was lie flat wise, and its Antenna oriented to the receiving antenna, the worst test data was got as following table.

WORST-CASE RADIATED EMISSION BELOW 30 MHz

Tx operating Mode:

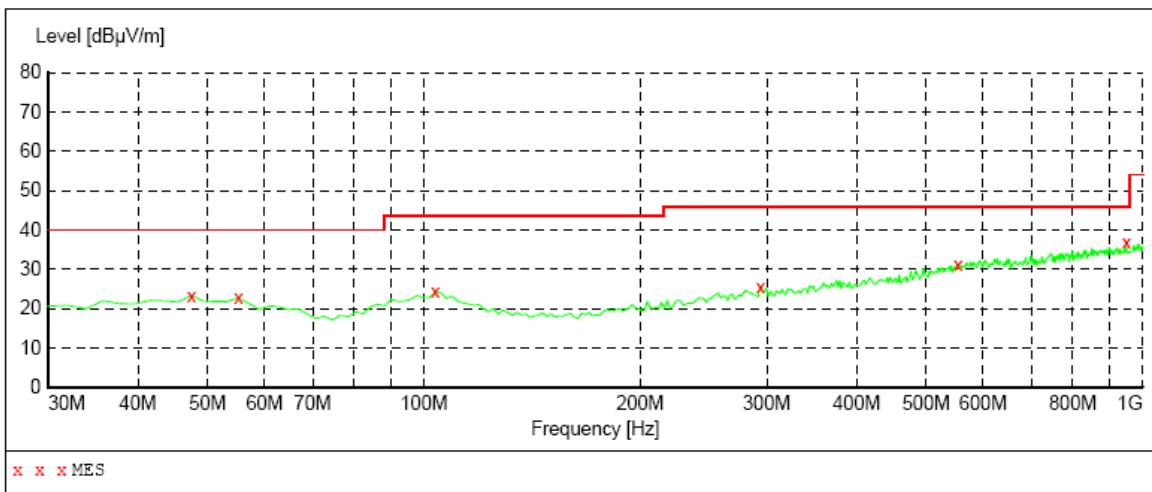
Frequency (MHz)	Meter Reading (dB μ V)	Antenna Factor (dB/M)	Cable Loss (dB)	Emission Levels (dB μ V/M)	Limits (dB μ V/M)	Margin (dB)	Detector Mode PK/QP
5.43	21.54	8.23	1.03	28.74	67	-38.26	QP
14.84	21.25	9.07	1.19	29.13	49.5	-20.37	QP
22.36	22.57	9.25	1.08	30.74	49.5	-18.76	QP
23.33	22.67	8.43	1.66	29.44	49.5	-20.06	QP

Spurious Emission Below 1GHz :

EUT: Bluetooth Sunglasses
 M/N: Bluetooth Hub
 Operating Condition: TX Mode
 Test Site: 3m CHAMBER
 Operator: Chen
 Test Specification: DC 12V from battery
 Comment: Polarization: Horizontal

SWEEP TABLE: "test (30M-1G)"

Short Description:		Field Strength			
Start Frequency	Stop Frequency	Detector	Meas.	IF	Transducer
30.0 MHz	1.0 GHz	MaxPeak	Coupled	100 kHz	VULB9163 NEW



MEASUREMENT RESULT:

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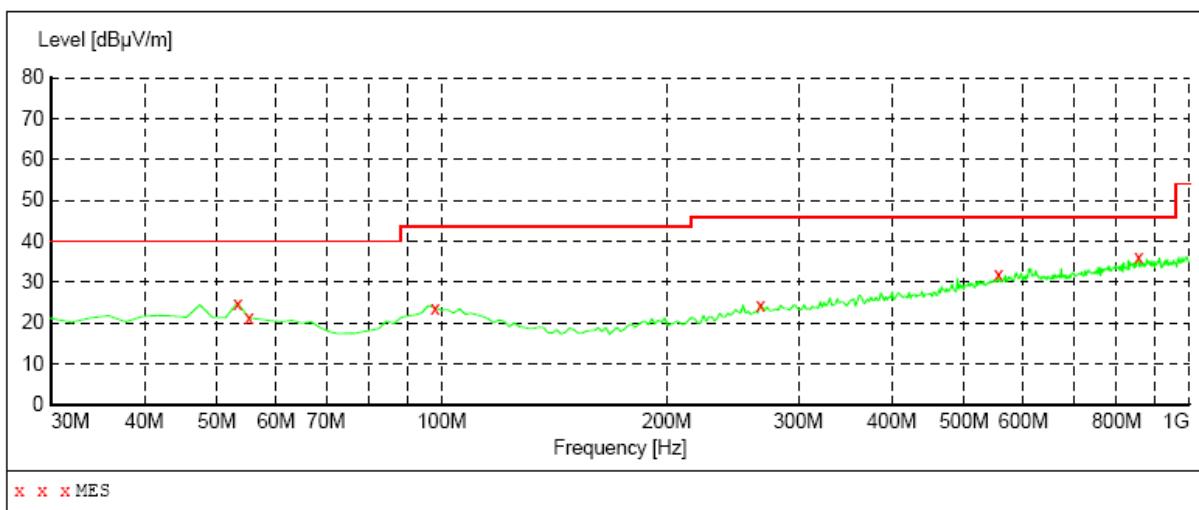
Frequency MHz	Level dB μ V/m	Transd dB	Limit dB μ V/m	Margin dB	Det. QP	Height cm	Azimuth deg	Polarization
47.460000	23.30	15.8	40.0	16.7	QP	100.0	0.00	HORIZONTAL
55.220000	22.70	15.6	40.0	17.3	QP	100.0	0.00	HORIZONTAL
103.720000	24.20	17.1	43.5	19.3	QP	100.0	0.00	HORIZONTAL
293.840000	25.40	18.6	46.0	20.6	QP	100.0	0.00	HORIZONTAL
553.800000	31.30	25.1	46.0	14.7	QP	100.0	0.00	HORIZONTAL
949.560000	36.70	29.6	46.0	9.3	QP	100.0	0.00	HORIZONTAL

Spurious Emission Below 1GHz :

EUT: Bluetooth Sunglasses
 M/N: Bluetooth Hub
 Operating Condition: TX Mode
 Test Site: 3m CHAMBER
 Operator: Chen
 Test Specification: DC 12V from battery
 Comment: Polarization: Vertical

SWEET TABLE: "test (30M-1G)"

Short Description:		Field Strength			
Start Frequency	Stop Frequency	Detector	Meas.	IF	Transducer
30.0 MHz	1.0 GHz	MaxPeak	Coupled	100 kHz	VULB9163 NEW



MEASUREMENT RESULT:

8/20/2015 09:52

Frequency MHz	Level dB μ V/m	Transd dB	Limit dB μ V/m	Margin dB	Det. QP	Height cm	Azimuth deg	Polarization
53.280000	24.90	15.7	40.0	15.1	QP	100.0	0.00	VERTICAL
55.220000	21.20	15.6	40.0	18.8	QP	100.0	0.00	VERTICAL
97.900000	23.70	17.4	43.5	19.8	QP	100.0	0.00	VERTICAL
266.680000	24.40	17.6	46.0	21.6	QP	100.0	0.00	VERTICAL
555.740000	31.80	25.1	46.0	14.2	QP	100.0	0.00	VERTICAL
856.440000	36.10	28.7	46.0	9.9	QP	100.0	0.00	VERTICAL

RADIATED EMISSION ABOVE 1 GHz

Channel Low (2402MHz)								
Maximum Frequency (MHz)	Polarity and Level					Limit (dB μ V/m)	Margin (dB μ V/m)	Mark (P/Q/A)
	Polarity	Height (m)	Reading dB μ V	Transd	Result dB μ V/m			
2402	H	1	88.52	-7.15	81.37	N/A	N/A	P
			79.37	-7.15	72.22	N/A	N/A	A
2402	V	1	87.19	-7.15	80.04	N/A	N/A	P
			83.35	-7.15	76.20	N/A	N/A	A
4804	H	1	38.92	1.07	39.99	74	-34.01	P
			30.56	1.07	31.63	54	-22.37	A
4804	V	1	41.43	1.07	42.50	74	-31.50	P
			31.01	1.07	32.08	54	-21.92	A
7206	H	1	39.26	7.38	46.64	74	-27.36	P
			29.36	7.38	36.74	54	-17.26	A
7206	V	1	42.03	7.38	49.41	74	-24.59	P
			29.88	7.38	37.26	54	-16.74	A
9611.37	H	1	40.05	10.29	50.34	74	-23.66	P
			29.21	10.29	39.50	54	-14.50	A
9611.37	V	1	41.06	7.38	48.44	74	-25.56	P
			29.85	7.38	37.23	54	-16.77	A
12022.89	H	1	40.03	14.01	54.04	74	-19.96	P
			30.67	14.01	44.68	54	-9.32	A
12023.33	V	1	42.36	14.01	56.37	74	-17.63	P
			30.85	14.01	44.86	54	-9.14	A
25220.89	---	---	---	---	---	---	---	---

Remark: 1. Transd.=Antenna Factor+Cable Loss+Pre-amplifier
Margin = Level-Limit
Mark: P means Peak Value, Q means Quasi Peak Value, A means Average Value
2. Data of measurement within this frequency range shown “ - ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
3. Spectrum analyzer setting P(Peak): RBW=1MHz, VBW=1MHz, A(Average): RBW=1MHz, VBW=10Hz.
4. The test limit distance is 3m limit

Channel Middle (2440MHz)								
Maximum Frequency (MHz)	Polarity and Level					Limit (dB μ V/m)	Margin (dB μ V/m)	Mark (P/Q/A)
	Polarity	Height (m)	Reading dB μ V	Transd	Result dB μ V/m			
2440	H	1	87.46	-6.37	81.09	N/A	N/A	P
			79.23	-6.37	72.86	N/A	N/A	A
2440	V	1	87.00	-6.37	80.63	N/A	N/A	P
			84.46	-6.37	78.09	N/A	N/A	A
4880	H	1	38.99	1.07	40.06	74	-33.94	P
			28.92	1.07	29.99	54	-24.01	A
4880	V	1	41.48	1.07	42.55	74	-31.45	P
			29.92	1.07	30.99	54	-23.01	A
7320	H	1	39.51	7.49	47.00	74	-27.00	P
			28.9	7.49	36.39	54	-17.61	A
7320	V	1	41.03	7.49	48.52	74	-25.48	P
			30.49	7.49	37.98	54	-16.02	A
9760	H	1	39.92	10.47	50.39	74	-23.61	P
			29.56	10.47	40.03	54	-13.97	A
9760	V	1	42.19	10.47	52.66	74	-21.34	P
			31.00	10.47	41.47	54	-12.53	A
12168.22	H	1	40.52	14.1	54.62	74	-19.38	P
			29.86	14.1	43.96	54	-10.04	A
12168.22	V	1	42.20	14.1	56.30	74	-17.70	P
			30.48	14.1	44.58	54	-9.42	A
25380.37	---	---	---	---	---	---	---	---

Remark: 1. Transd.=Antenna Factor+Cable Loss+Pre-amplifier
Margin = Level-Limit
Mark: P means Peak Value, Q means Quasi Peak Value, A means Average Value
2. Data of measurement within this frequency range shown “ - ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
3. Spectrum analyzer setting P(Peak): RBW=1MHz, VBW=1MHz, A(Average): RBW=1MHz, VBW=10Hz.
4. The test limit distance is 3m limit

Channel High (2480MHz)								
Maximum Frequency (MHz)	Polarity and Level					Limit (dB μ V/m)	Margin (dB μ V/m)	Mark (P/Q/A)
	Polarity	Height (m)	Reading dB μ V	Transd	Result dB μ V/m			
2480	H	1	88.02	-6.05	81.97	N/A	N/A	P
			80.05	-6.05	74.00	N/A	N/A	A
2480	V	1	88.26	-6.05	82.21	N/A	N/A	P
			83.03	-6.05	76.98	N/A	N/A	A
4960	H	1	39.25	1.07	40.32	74	-33.68	P
			29.69	1.07	30.76	54	-23.24	A
4960	V	1	41.02	1.07	42.09	74	-31.91	P
			31.00	1.07	32.07	54	-21.93	A
7440	H	1	39.56	7.61	47.17	74	-26.83	P
			30.03	7.61	37.64	54	-16.36	A
7440	V	1	41.26	7.61	48.87	74	-25.13	P
			31.00	7.61	38.61	54	-15.39	A
9920	H	1	39.56	10.65	50.21	74	-23.79	P
			30.01	10.65	40.66	54	-13.34	A
9920	V	1	41.92	10.65	52.57	74	-21.43	P
			31.26	10.65	41.91	54	-12.09	A
12362.56	H	1	40.35	14.19	54.54	74	-19.46	P
			31.36	14.19	45.55	54	-8.45	A
12362.56	V	1	41.87	14.19	56.06	74	-17.94	P
			31.80	14.19	45.99	54	-8.01	A
25380.89	----	----	----	----	----	----	----	----

Remark: 1. Transd.=Antenna Factor+Cable Loss+Pre-amplifier
Margin = Level-Limit
Mark: P means Peak Value, Q means Quasi Peak Value, A means Average Value
2. Data of measurement within this frequency range shown “-” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
3. Spectrum analyzer setting P(Peak): RBW=1MHz, VBW=1MHz, A(Average): RBW=1MHz, VBW=10Hz.
4. The test limit distance is 3m limit

10. Test of Band Edges Emission

10.1 Applicable standard

Section 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. In addition, radiated emissions that fall in the restricted bands, as defined in Section 15.205, must also comply with the radiated emission limits specified in Section 15.209.

10.2 EUT Setup

Radiated Measurement Setup

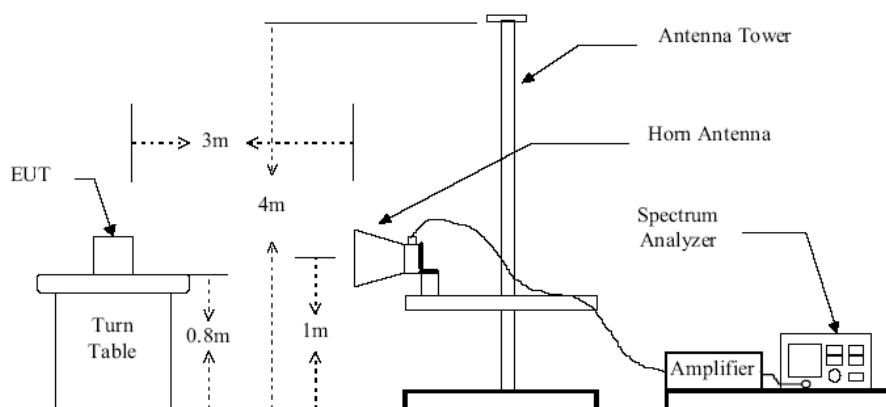
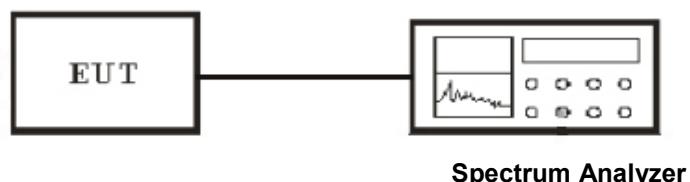


Figure 2 : Frequencies measured above 1 GHz configuration

Conducted Measurement Setup



10.3 Test Equipment List and Details

See section 2.5.

10.4 Test Procedure

Conducted Measurement

1. The transmitter is set to the lowest channel.
2. The transmitter output was connected to the spectrum analyzer via a cable and cable loss is used as the offset of the spectrum analyzer.

3. Set both RBW and VBW of spectrum analyzer to 100KHz with convenient frequency span including 100MHz bandwidth from lower band edge. Then detector set to peak and max hold this trace.
4. The lowest band edges emission was measured and recorded.
5. The transmitter set to the highest channel and repeated 2~4.

Radiated Measurement

1. Configure the EUT according to ANSI C63.4–2003
2. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emission field strength of both horizontal and vertical polarization.
4. For band edge emission, the antenna tower was scan (from 1 M to 4 M) and then the turn table was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. For band edge emission, use 1MHz VBW and 1MHz RBW for reading under AV and use 1MHz VBW and 1MHz RBW for reading under PK.

10.5 Test Result

Temperature (°C) : 22~23	EUT: Bluetooth Hub
Humidity (%RH) : 50~54	M/N: Bluetooth Hub
Barometric Pressure (mbar) : 950~1000	Operation Condition: Tx Mode

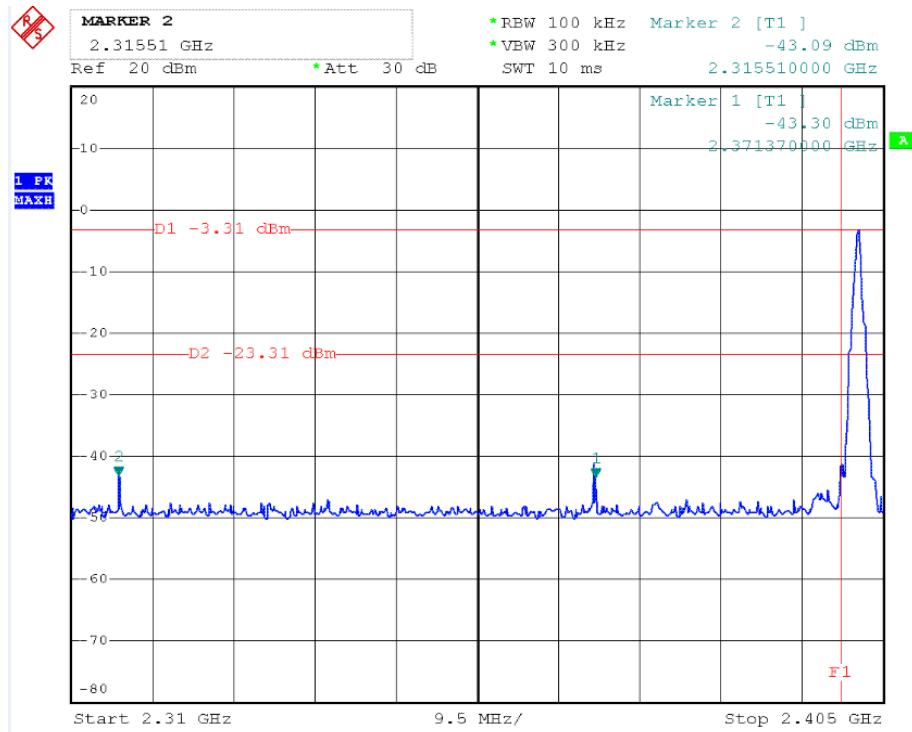
Radiated Test Result

GFSK mode

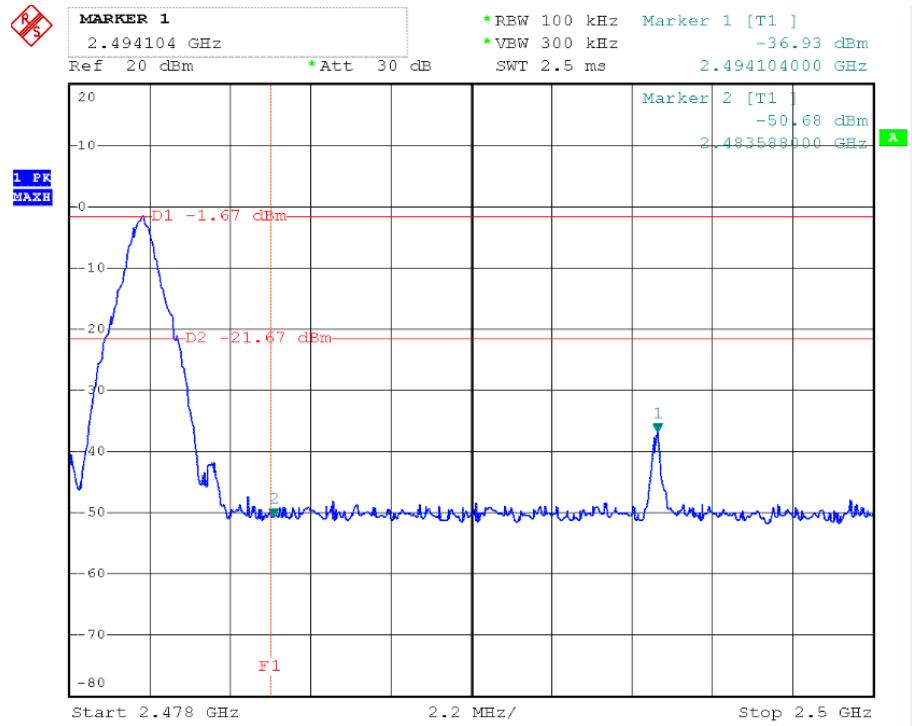
Channel	Freq.(MHz)	Polarity	Level(dBuV/m)	Limit(dBuV)	Margin(dB)	Detector
LOW	2390	H	42.58	74	-31.42	Peak
	2390	H	33.47	54	-20.53	Average
	2390	V	44.47	74	-29.53	Peak
	2390	V	34.55	54	-19.45	Average
HIGH	2483.52	H	43.57	74	-30.43	Peak
	2483.52	H	33.81	54	-20.19	Average
	2483.52	V	45.01	74	-28.99	Peak
	2483.52	V	34.37	54	-19.63	Average

Test of Conducted band edges

CH Low



CH High



11. ANTENNA REQUIREMENT

11.1 standard Applicable

Section 15.203 & IC RSS-GEN Clause 7.1.4

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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Section 15.247(b)/(c) & IC RSS-GEN Clause 7.1.4

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

If the intentional radiator is used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

11.2 Antenna Connected Construction

The antenna is designed with permanent attachment and no consideration of replacement. The antenna used in this product is complied with standard. The maximum Gain of the antenna lower than 6.0dBi and have the definite antenna Specification.

12 .Radio Frequency Exposure

According to FCC Part 1.1310: The criteria listed in the following table shall be used to evaluate the environmental 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)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f ²)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f ²)	30
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

Test Procedure

Equation from page 18 of OET Bulletin 65, Edition 97-01:

Where:

S = power density

$$S = \frac{P \times G}{4 \times \pi \times R^2}$$

P = power input to the antenna

G = numeric gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the centre of radiation of the antenna

Measurement Result:

Channel	Channel Freq. (MHz)	Measured Power (dBm)	Measured Power (mW)	Antenna Gain Numeric	Evaluation Result (mW/cm ²)	Power density Limits (mW/cm ²)
1	2402	-4.15	0.385	1.12	0.0000857	1
20	2440	-3.23	0.475	1.12	0.0001058	1
40	2480	-2.11	0.615	1.12	0.0001370	1

Note: For mobile or fixed location transmitters, no SAR consideration applied. The minimum separation generally be used is at least 20 cm, even if the calculations indicate that the MPE distance would be lesser.