Test Report of FCC CFR 47 Part 15 Subpart C

On Behalf of

Zhuhai Topland Technologies, Ltd.

Ha Gong Da Rd-1., Industrial Park, R&D Bldg, Tang Jia Wan,
Zhuhai, PRC 519085.

Product Name:	**Bluetooth module**
Model/Type No.:	**TL-2.3**
Trade Name:	**N/A**
FCC ID:	**2AIO3-TL2**
Prepared By:	**Shenzhen Hongcai Testing Technology Co., Ltd.** 1st-3rd Floor, Building C, Shuanghuan Xin Yi Dai Hi-Tech Industrial Park, No.8 Baoqing Road, Baolong Industrial Zone, Longgang District, Shenzhen, Guangdong, China Tel: +86-755-86337020 Fax:+86-755-86337028
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1. GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

Client Information

Applicant:	Zhuhai Topland Technologies, Ltd.
Address of Applicant:	Ha Gong Da Rd-1., Industrial Park, R&D Bldg, Tang Jia Wan, Zhuhai, PRC 519085.
Manufacturer:	Zhuhai Topland Technologies, Ltd.
Address of Manufacturer:	Ha Gong Da Rd-1, Industrial Park, R&D Bldg, Tang Jia Wan, Zhuhai, PRC 519085.

General Description of E.U.T

Items	Description
EUT Description:	Bluetooth module
Trade Name:	N/A
Model No.:	TL-2.3
BT Version	BT4.0 BLE
Frequency Band:	2402MHz～2480MHz,
Channel Spacing:	2MHz
Number of Channels:	40 Channels
Type of Modulation:	GFSK
Antenna Type:	PCB Antenna
Antenna Gain	0.5dBi
Power Supply:	DC 2.5-3.6V
Adapter Information:	N/A

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

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1.2 Test standards

FCC Rules Part 15.247: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz

ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices

KDB558074 D01 V03r03: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

RSS-GEN Issue 4: General Requirements for Compliance of Radio Apparatus

RSS-210 Issue 8: Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

RSS 247 Issue 1: Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.3 Test Facility

All measurement required was performed at laboratory of Shenzhen CTL Testing Technology Co., Ltd.

Floor 1-A, Baisha Technology Park, No. 3011, Shahexi Road, Nanshan, Shenzhen 518055 China

There is one 3m semi-anechoic chamber and two line conducted labs for final test. The Test Sites meet the requirements in documents ANSI C63.4 and CISPR 22/EN 55022 requirements.

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 Engineer Bureau of Industry Canada for the performance of with Registration No.: 9618B on November 13, 2013.

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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 ANSI C63.10-2013 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 a 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 ANSI C63.10-2013.

2.4 Measurement Uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16 - 4 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements“ and is documented in the Shenzhen CTL Testing Technology Co., Ltd. quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

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

Parameter	Uncertainty
Transmitter power conducted	+/- 0.57 dB
Transmitter power Radiated	+/- 2.20 dB
Conducted spurious emission 9KHz-40 GHz	+/- 2.20 dB
Occupied Bandwidth	+/- 0.01 dB
Power Line Conducted Emission	+/- 3.20 dB
Radiated Emission	+/- 4.32 dB

Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

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2.5 Measure Results Explanation Example

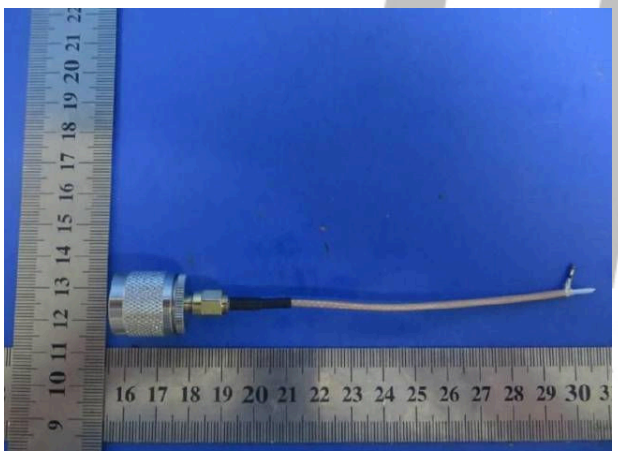
For all conducted test items:

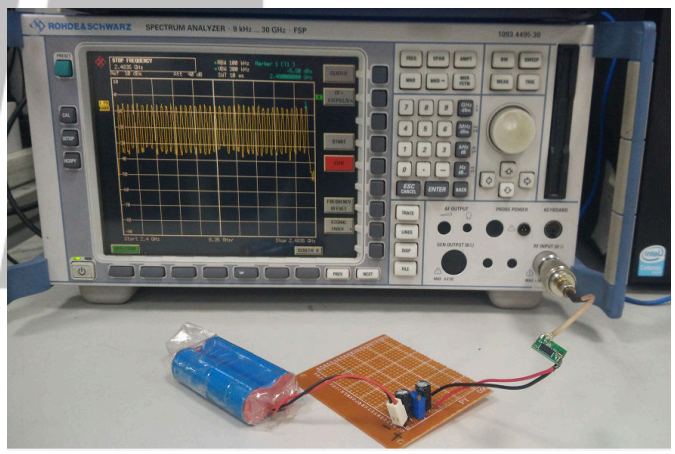
The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

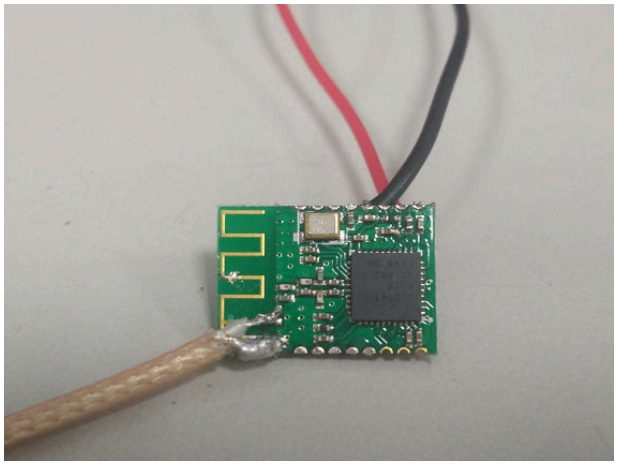
The spectrum analyzer offset is derived from RF cable less and attenuator factor.
Offset= RF cable less+ attenuator factor.

Note: Using a temporary antenna connector for the EUT when the conducted measurements are performed.

Equipment	Manufacturer	Model No.	Frequency range(GHz)	Attenuation values(dBm)
Line	Zhenjiang south electronic	RG316	1-12	0.08
Connector	Zhenjiang south electronic	SMA-K/N-J	1-12	0.01







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2.6 List of Measuring Equipments Used

No.	Instrument no.	Equipment	Manufacturer	Model No.	S/N	Last Calibration	Due Calibration
1	BCT-EMC001	EMI Test Receiver	R&S	ESCI	100687	2015-8-25	2016-8-24
2	BCT-EMC002	EMI Test Receiver	R&S	ES PI	100097	2015-11-1	2016-10-31
3	BCT-EMC003	Amplifier	HP	8447D	1937A02492	2015-8-25	2016-8-24
4	BCT-EMC018	TRILOG Broadband Test-Antenna	SCHWARZBECK	VULB9163	9163-324	2015-8-25	2016-8-24
5	BCT-EMC021	Triple-Loop Antenna	EVERFINE	LLA-2	711002	2015-11-1	2016-10-31
6	BCT-EMC026	RF POWER AMPLIFIER	FRANKONIA	FLL-75	1020A1109	2015-8-25	2016-8-24
7	BCT-EMC029	6DB Attenuator	FRANKONIA	N/A	1001698	2015-8-25	2016-8-24
8	BCT-EMC032	10dB attenuator	ELECTRO-METRICS	EM-7600	836	2015-8-25	2016-8-24
9	BCT-EMC036	Spectrum Analyzer	R&S	FSP	100397	2015-11-1	2016-10-31
10	BCT-EMC037	Broadband preamplifier	SCH WARZBECK	BBV9718	9718-182	2015-8-25	2016-8-24
11	BCT-EMC039	Horn Antenna	SCHWARZBECK	BBHA 9120D	0437	2015-8-25	2016-8-24
12	BCT-EMC038	Horn Antenna	SCHWARZBECK	BBHA9170	0483	2015-8-5	2016-8-4
13	BCT-EMC050	Pulse power sensor	Anritsu	MA2411B	110553	2015-11-1	2016-10-31
14	BCT-EMC050	Power Meter	Anritsu	ML2487B	100345	2015-11-1	2016-10-31

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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	N/A
FCC §15.247(b) IC RSS-247 Issue1 Clause 5.4 (4)	Output Power Measurement	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)	6dBBandwidth 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

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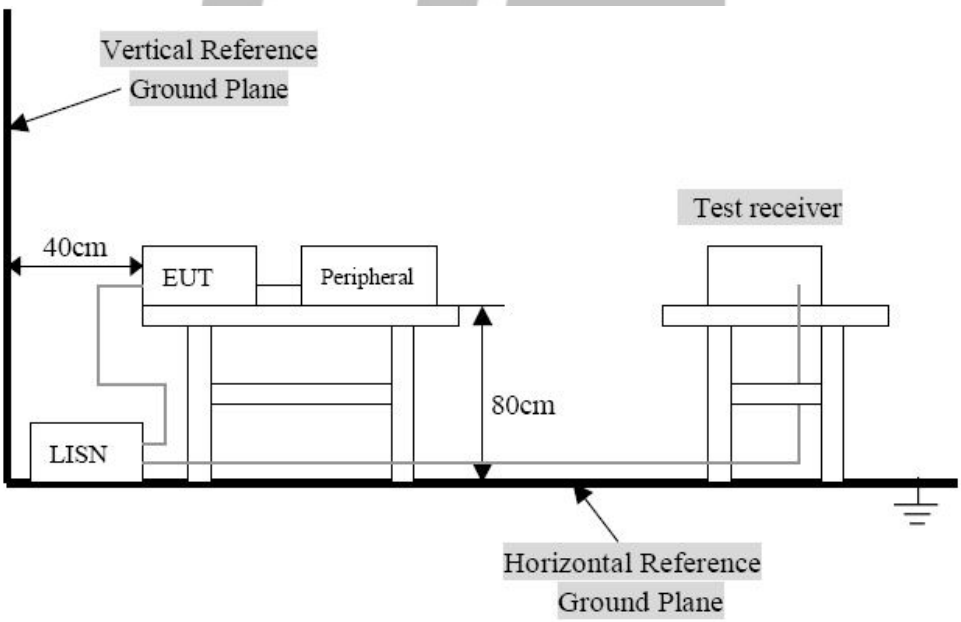
4. Test OF AC POWER LINE CONDUCTED EMISSION

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: EUT is powered by battery.

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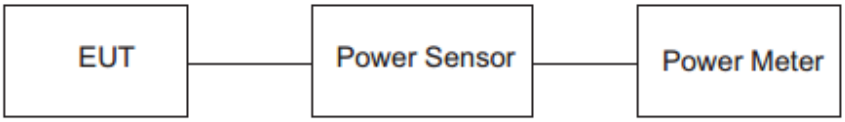
5. Output Power Measurement

5.1 Applicable standard

Refer to FCC §15.247 (b) and IC RSS-247 Issue1 Clause 5.4 (4).
KDB 558074 v03r03 – Section 9.1.2 PKPM1 Peak Power, Method
KDB 558074 v03r03 – Section 9.2.3.2 Method AVGPM-G

The maximum permissible conducted output power is 1Watt.

5.2 EUT Setup



5.3 Test Equipment List and Details

See section 2.5.

5.4 Test Procedure

Method PKPM1 (Peak Power Measurement)

Peak power measurement were performed only when the EUT was transmitting at its maximum power control level using a broadband power meter with a pulse sensor, The pulse senor employs a VBW = 50MHz so this method was only used for signals whose DTS bandwidth was than or equal to 50MHz.

Method AVGPM-G (Average Power Measurement)

Average power measurement were performed only when the EUT was transmitting at its maximum power control level using a broadband power meter with a pulse sensor, The pulse mater implemented triggering and fating capabilities which were set up such that power measurements were recorded only during the ON time of the transmitter, The trace was averaged over 100 traces to obtain the final measured average power.

5.5 Test Result

Temperature (℃) : 22~23	EUT: Bluetooth module
Humidity (%RH): 50~54	M/N: TL-2.3
Barometric Pressure (mbar): 950~1000	Operation Condition: Tx Mode

GFSK mode

Channel	Channel Frequency (MHz)	Average Power (dBm)	Peak Power (dBm)	Peak Power Limit (dBm)	Pass / Fail
Low	2402	-5.42	-0.51	30	PASS
Middle	2440	-5.61	-0.52	30	PASS
High	2480	-5.22	-0.37	30	PASS

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6. Test of Peak Power Spectral Density

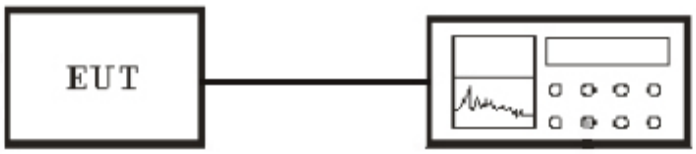
6.1 Applicable standard

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

KDB 558074v03r03 – Section 10.2 Method PKPSD

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



Spectrum Analyzer

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 ⩾ 3 x 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.

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6.5 Test Result

Temperature (℃) : 22~23	EUT: Bluetooth module
Humidity (%RH): 50~54	M/N: TL-2.3
Barometric Pressure (mbar): 950~1000	Operation Condition: Tx Mode

GFSK mode

Channel	Channel Frequency (MHz)	Final RF Power Level in 3KHz RBW (dBm)	Maximum Limit (dBm)	Pass / Fail
Low	2402	-19.621	8	PASS
Middle	2440	-19.665	8	PASS
High	2480	-19.197	8	PASS

POWER SPECTRAL DENSITY (GFSK MODE CH Low)

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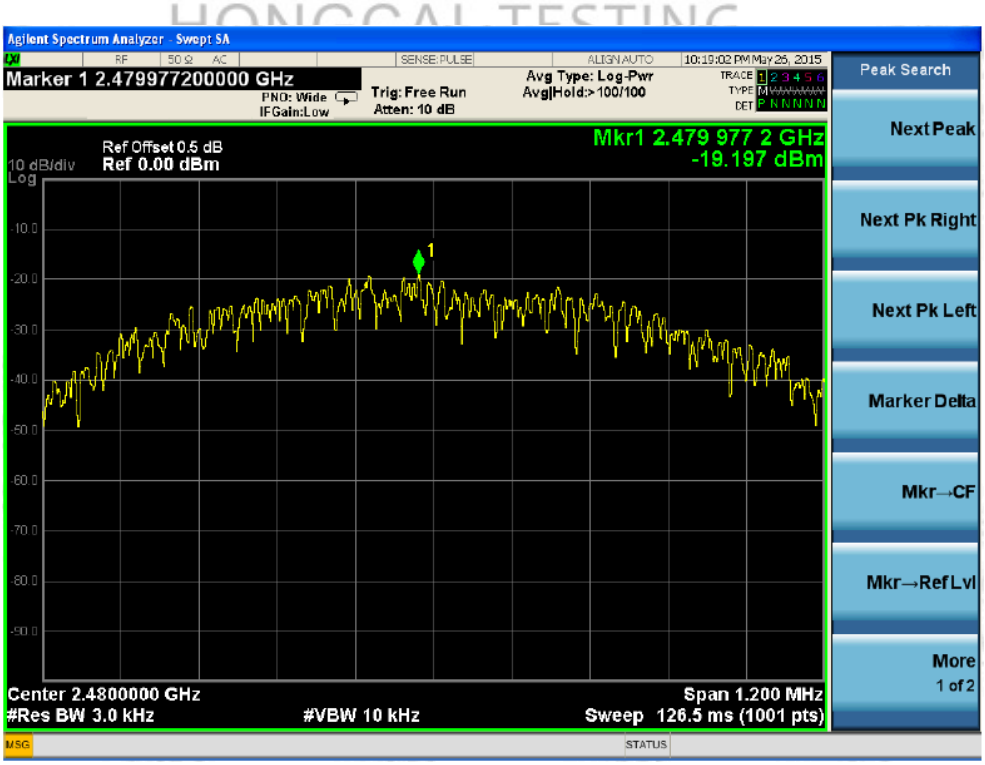
POWER SPECTRAL DENSITY (GFSK MODE CH Mid)

POWER SPECTRAL DENSITY (GFSK MODE CH High)



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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).

KDB558074 v03r03 – Section 8.2 Option 2

For digital modulation systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

7.2 EUT Setup

Spectrum Analyzer

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) ⩾ 3 x 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.

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7.5 Test Result

Temperature (℃) : 22~23	EUT: Bluetooth module
Humidity (%RH): 50~54	M/N: TL-2.3
Barometric Pressure (mbar): 950~1000	Operation Condition: Tx Mode

GFSK mode

Channel	Channel Frequency (MHz)	99%Occupied Bandwidth (MHz)	6dB Bandwidth (MHz)	Minimum Limit (kHz)	Pass / Fail
Low	2402	1.0289	690.6	500	PASS
Middle	2440	1.0309	690.9	500	PASS
High	2480	1.0316	694.6	500	PASS

6dB BANDWIDTH (GFSK MODE CH Low)

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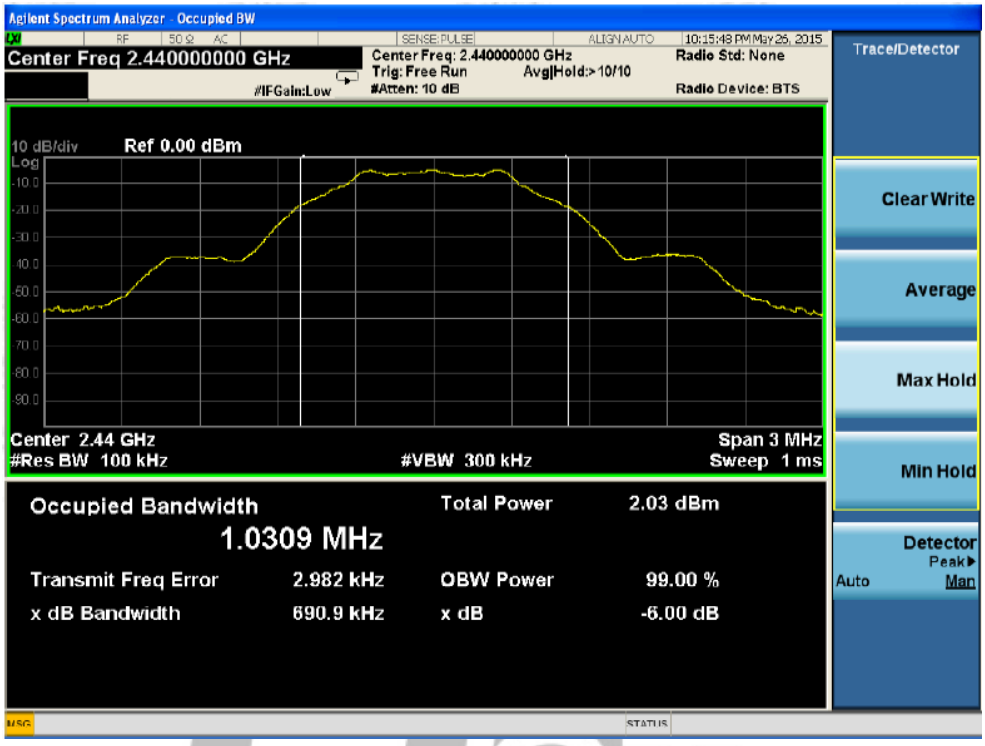
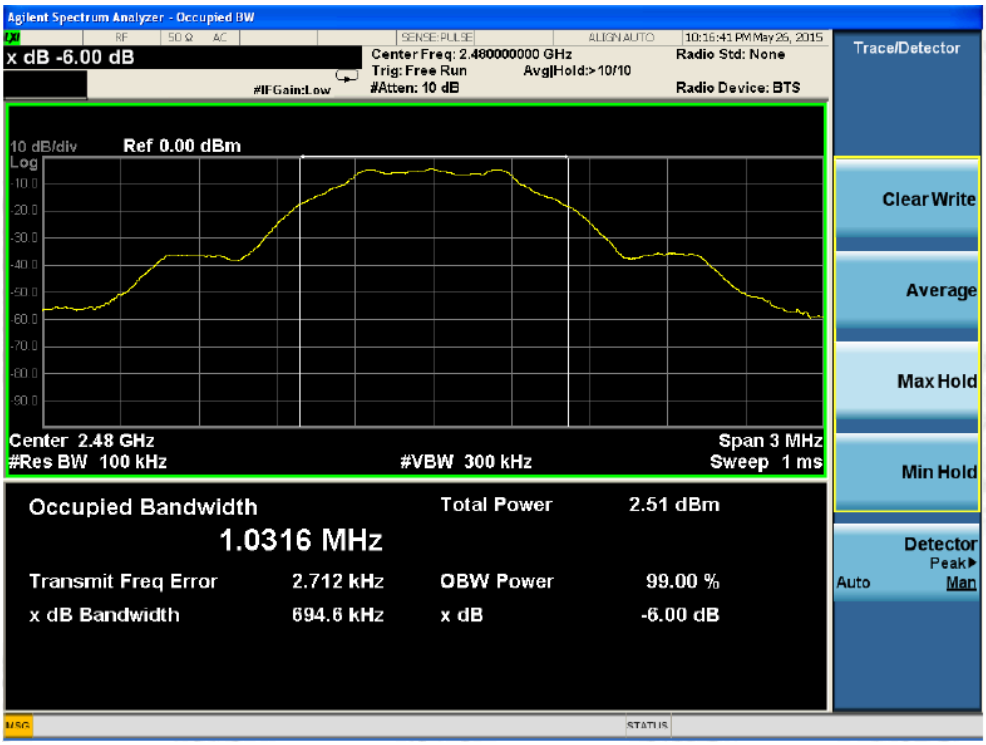
6dB BANDWIDTH (GFSK MODE CH Mid)



6dB BANDWIDTH (GFSK MODE CH High)



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8. Test of Conducted Spurious Emission

8.1 Applicable standard

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

KDB 558074 v03r03 – Section 11.3

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.

8.2 EUT Setup

Spectrum Analyzer

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.

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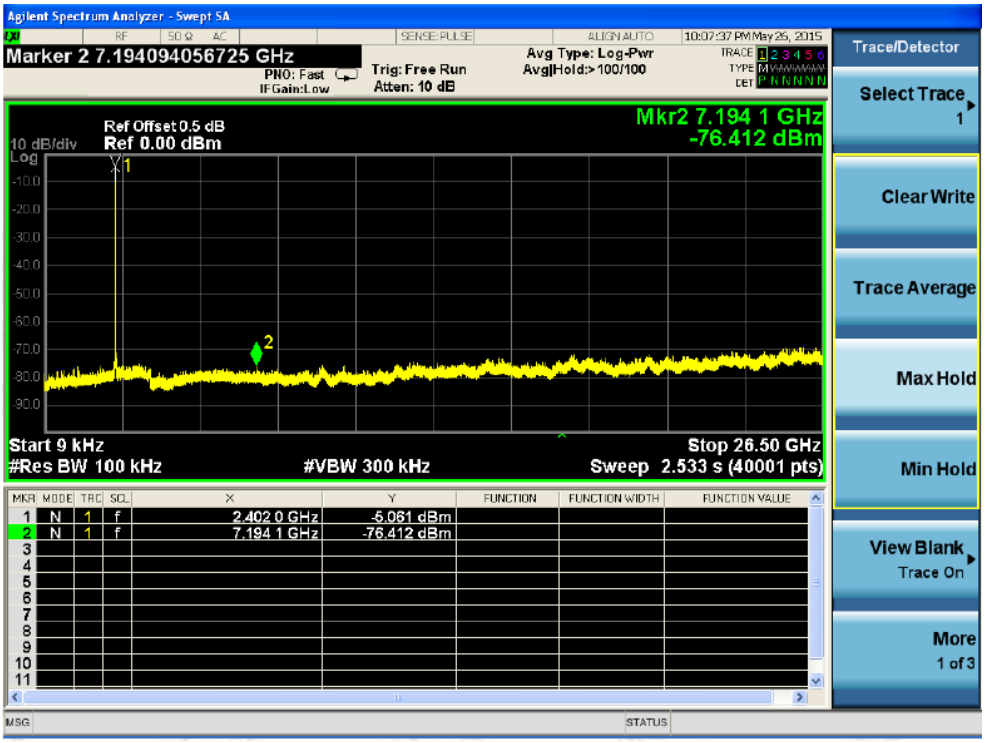
8.5 Test Result

Temperature (℃) : 22~23	EUT: Bluetooth module
Humidity (%RH): 50~54	M/N: TL-2.3
Barometric Pressure (mbar): 950~1000	Operation Condition: TX Mode

PASS

GFSK mode

CH Low



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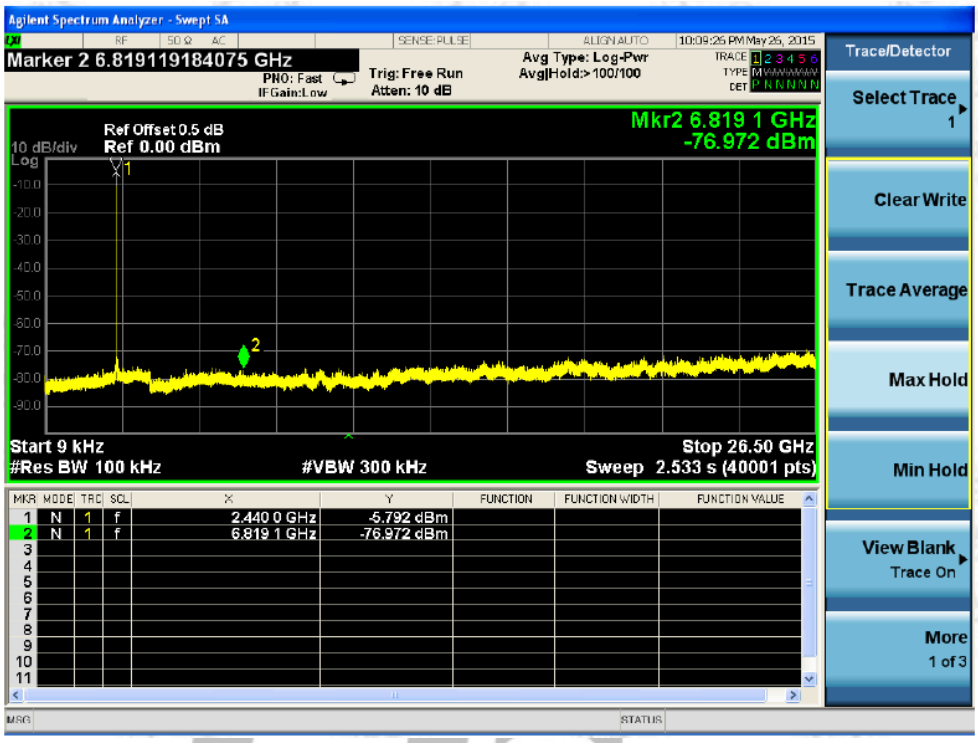
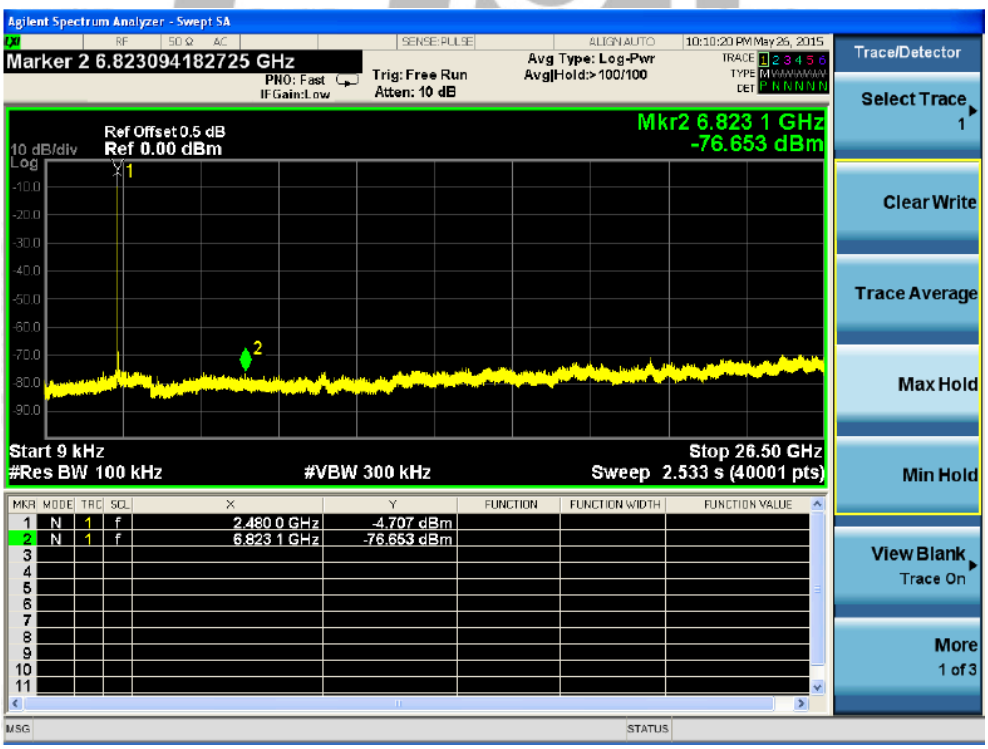
CH Mid



CH High



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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)

KDB 558074 v03r03 – Section 12.1, 12.2.7

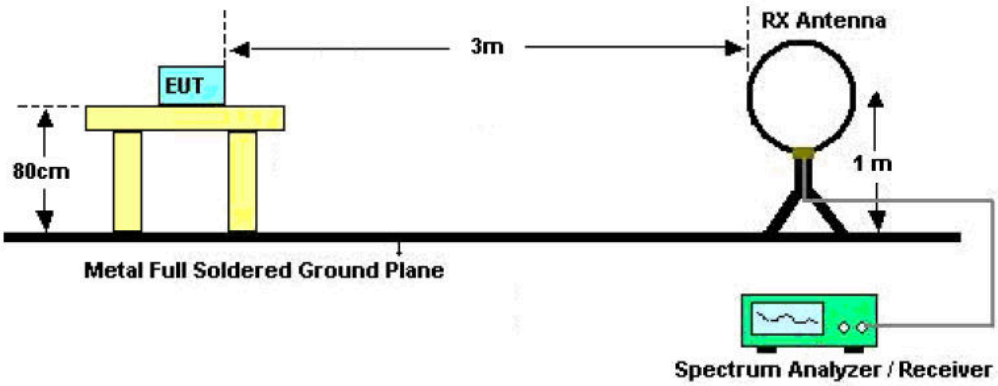
9.1.1 Limits

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table per Section 15.209.

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

9.1.2 EUT Setup

For radiated emission below 30MHz



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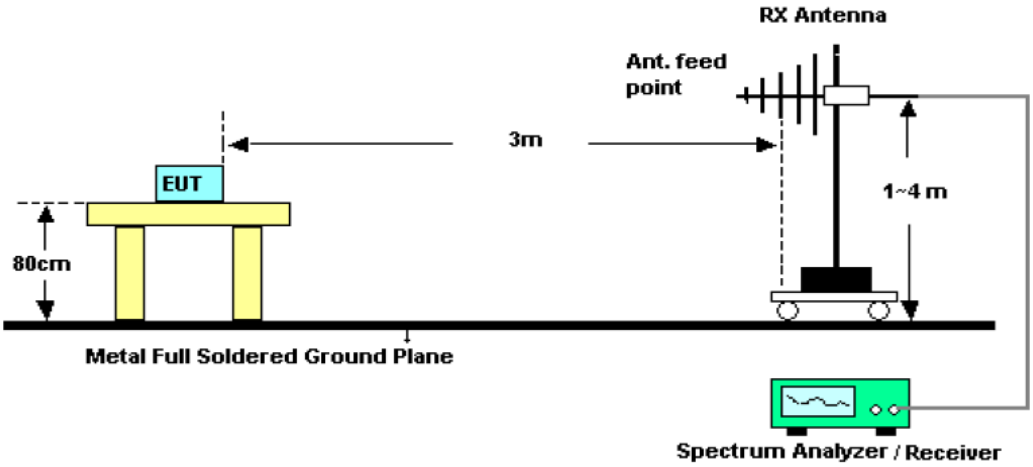
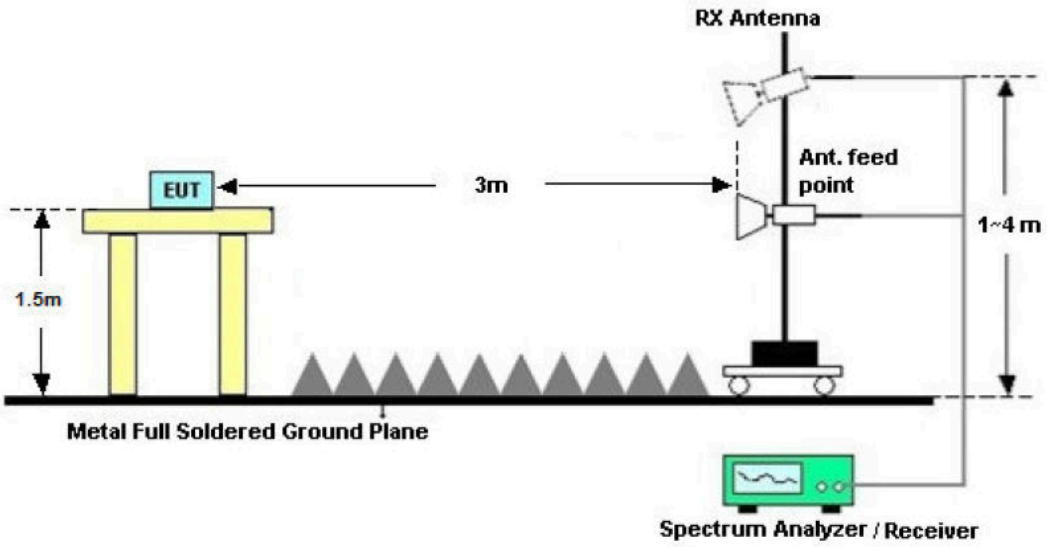
For radiated emission from 30MHz to1GHz



For radiated emission from above1GHz



9.1.3 Test Procedure

KDB 558074 v03r03 – Section 12.1, 12.2.7

Quasi-Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. Set RBW = 120kHz(for emissions from 30MHz-1GHz)
3. Detector = Quasi-Peak
4. Trace Mode = max hold.
5. Sweep = auto couple.
6. Trace was allowed to stabilize

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Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. Set RBW = 1MHz
3. Set VBW = 3MHz
4. Detector = Peak
5. Trace Mode = max hold.
6. Sweep = auto couple.
7. Trace was allowed to stabilize

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. Set RBW = 1MHz
3. Set VBW = 3MHz
4. Detector = power average (RMS)
5. Number of measurement points=1001 (>= 2 x span/RBW)
6. Sweep = auto couple.
7. Trace (RMS) averaging was performed over at least 100 traces

NOTE:

1. Configure the EUT according to ANSI C63.10-2013
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.

9.1.4 Test Result

Temperature (℃) : 22~23	EUT: Bluetooth module
Humidity (%RH): 50~54	M/N: TL-2.3
Barometric Pressure (mbar): 950~1000	Operation Condition: Normal operation & TX Mode

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WORST-CASE RADIATED EMISSION BELOW 30 MHz

Normal operating Mode:

Frequency	Meter Reading	Antenna Factor	Cable Loss	Emission Levels	Limits	Margin	Detector Mode
(MHz)	(dBμV)	(dB/M)	(dB)	(dBμV/M)	(dB μ V/M)	(dB)	PK/QP
5.87	22.56	8.23	1.03	29.76	67	-37.24	QP
14.78	21.38	9.07	1.19	29.26	49.5	-20.24	QP
21.56	21.59	9.25	1.08	29.76	49.5	-19.74	QP
24.69	21.45	8.43	1.66	28.22	49.5	-21.28	QP

WORST-CASE RADIATED EMISSION BELOW 1 GHz

Normal operating Mode:

Horizontal

Frequency	Meter Reading	Tansd	Limits	Margin	Detector Mode
(MHz)	(dBμV)	(dB)	(dB μ V/M)	(dB)	PK/QP
36.76	27.80	13.6	40	-12.2	QP
86.26	25.60	13.8	40	-14.4	QP
101.78	27.80	16.1	43.5	-15.7	QP
187.14	25.60	13.7	43.5	-17.9	QP
549.92	32.70	20.9	46	-13.3	QP
873.90	39.00	25.4	46	-7.0	QP
N/A	----	----	----	----	----

Vertical

Frequency	Meter Reading	Tansd	Limits	Margin	Detector Mode
(MHz)	(dBμV)	(dB)	(dB μ V/M)	(dB)	PK/QP
33.88	35.40	13.8	40	-4.6	QP
107.6	33.70	15.5	43.5	-9.8	QP
121.18	36.00	13.4	43.5	-7.5	QP
134.76	37.60	11.8	43.5	-5.9	QP
148.34	36.10	11.6	43.5	-7.4	QP
922.40	38.50	25.9	46	-7.5	QP
N/A	----	**----**	----	----	----

Note: 1. Transd.=Antenna Factor+Cable Loss-Pre-amplifier
Margin = Level-Limit

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WORST-CASE RADIATED EMISSION ABOVE 1 GHz

GFSK TX (CH Low)

Channel Low（2402MHz）								
Maximum Frequency (MHz)	Polarity and Level					Limit (dBμV/m)	Margin (dBμV/m)	Mark (P/Q/A)
	Polarity	Height (m)	Reading dBμV	Transd	Result dBμV/m			
1385.21	H	1	46.27	-7.97	38.30	74	-35.70	P
			33.36	-7.97	25.39	54	-28.61	A
1368.33	V	1	46.36	-7.97	38.39	74	-35.61	P
			32.74	-7.97	24.77	54	-29.23	A
2402	H	1	86.24	-6.47	79.77	----	----	P
			79.54	-6.47	73.07	----	----	A
2402	V	1	84.24	-6.47	77.77	----	----	P
			78.25	-6.47	71.78	----	----	A
4804	H	1	41.30	0.52	41.82	74	-32.18	P
			30.27	0.52	30.79	54	-23.21	A
4804	V	1	42.71	0.52	43.23	74	-30.77	P
			30.22	0.52	30.74	54	-23.26	A
7206	H	1	40.15	7.41	47.56	74	-26.44	P
			30.63	7.41	38.04	54	-15.96	A
7206	V	1	40.15	7.41	47.56	74	-26.44	P
			30.46	7.41	37.87	54	-16.13	A
11145.34	----	----	----	----	----	----	----	----
			----	----	----	----	----	----
16327.65	----	----	----	----	----	----	----	----
25376.32	----	----	----	----	----	----	----	----

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=3MHz, A(Average): RBW=1MHz, VBW=3MHz.
4. The test limit distance is 3m limit

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GFSK TX (CH Middle)

Channel Middle（2440MHz）								
Maximum Frequency (MHz)	Polarity and Level					Limit (dBμV/m)	Margin (dBμV/m)	Mark (P/Q/A)
	Polarity	Height (m)	Reading dBμV	Transd	Result dBμV/m			
1311.67	H	1	45.43	-8.23	37.20	74	-36.80	P
			34.04	-8.23	25.81	54	-28.19	A
1311.67	V	1	46.01	-8.23	37.78	74	-36.22	P
			34.74	-8.23	26.51	54	-27.49	A
2440	H	1	86.21	-6.37	79.84	----	----	P
			78.12	-6.37	71.75	----	----	A
2440	V	1	85.23	-6.37	78.86	----	----	P
			77.27	-6.37	70.9	----	----	A
4880	H	1	40.77	0.75	41.52	74	-32.48	P
			30.64	0.75	31.39	54	-22.61	A
4880	V	1	42.25	0.75	43.00	74	-31.00	P
			31.64	0.75	32.39	54	-21.61	A
7320	H	1	39.41	7.48	46.89	74	-27.11	P
			30.84	7.48	38.32	54	-15.68	A
7320	V	1	40.08	7.48	47.56	74	-26.44	P
			30.73	7.48	38.21	54	-15.79	A
11238.52	----	----	----	----	----	----	----	----
			----	----	----	----	----	----
16327.71	----	----	----	----	----	----	----	----
25376.58	----	----	----	----	----	----	----	----

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=3MHz, A(Average): RBW=1MHz, VBW=3MHz.
4. The test limit distance is 3m limit

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GFSK TX (CH High)

Channel High（2480MHz）								
Maximum Frequency (MHz)	Polarity and Level					Limit (dBμV/m)	Margin (dBμV/m)	Mark (P/Q/A)
	Polarity	Height (m)	Reading dBμV	Transd	Result dBμV/m			
1321.44	H	1	45.77	-8.23	37.54	74	-36.46	P
			33.67	-8.23	25.44	54	-28.56	A
1321.44	V	1	46.27	-8.23	38.04	74	-35.96	P
			33.78	-8.23	25.55	54	-28.45	A
2480	H	1	85.74	-6.28	79.46	----	----	P
			76.74	-6.28	70.46	----	----	A
2480	V	1	84.27	-6.28	77.99	----	----	P
			72.48	-6.28	66.20	----	----	A
4960	H	1	41.07	0.97	42.04	74	-31.96	P
			30.74	0.97	31.71	54	-22.29	A
4960	V	1	44.59	0.97	45.56	74	-28.44	P
			31.73	0.97	32.70	54	-21.30	A
7440	H	1	40.48	7.56	48.04	74	-25.96	P
			30.24	7.56	37.80	54	-16.20	A
7440	V	1	39.84	7.56	47.40	74	-26.60	P
			29.75	7.56	37.31	54	-16.69	A
11243.58	----	----	----	----	----	----	----	----
			----	----	----	----	----	----
16327.45	----	----	----	----	----	----	----	----
25376.26	----	----	----	----	----	----	----	----

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=3MHz, A(Average): RBW=1MHz, VBW=3MHz.
4. The test limit distance is 3m limit

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10.Test of Band Edges Emission

10.1 Applicable standard

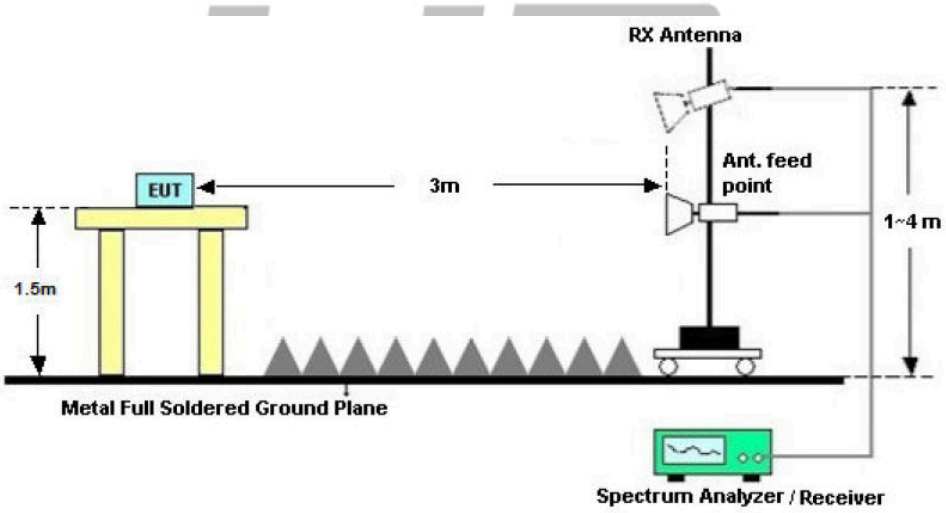
Refer to FCC §15.247 (d), IC RSS-247 Issue1 Clause 5.5

KDB558074 v03r03 – Section 11.3

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



Conducted Measurement Setup

Spectrum Analyzer

10.3 Test Equipment List and Details

See section 2.5.

10.4 Test Procedure

Conducted Measurement

KDB558074 v03r03 – Section 11.3

1.Set the center frequency and span to encompass frequency range to be measured.

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2.Set the RBW = 100 kHz.
3.Set the VBW ≥ 3 x RBW.
4.Detector = peak.
5.Sweep time = auto couple.
6.Trace mode = max hold.
7.Allow trace to fully stabilize.
8.Use the peak marker function to determine the maximum amplitude level.

Radiated Measurement

KDB 558074 v03r03 – Section 12.1, 12.2.7

Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. Set RBW = 1MHz
3. Set VBW = 3MHz
4. Detector = Peak
5. Trace Mode = max hold.
6. Sweep = auto couple.
7. Trace was allowed to stabilize

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. Set RBW = 1MHz
3. Set VBW = 3MHz
4. Detector = power average (RMS)
5. Sweep = auto couple.
6. Trace (RMS) averaging was performed over at least 100 traces

NOTE :

1. Configure the EUT according to ANSI C63.10-2013
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.

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10.5 Test Result

Temperature (℃) : 22~23	EUT: Bluetooth module
Humidity (%RH): 50~54	M/N: TL-2.3
Barometric Pressure (mbar): 950~1000	Operation Condition: Tx Mode

PASS
Test of Conducted band edges

CH Low (GFSK MODE)

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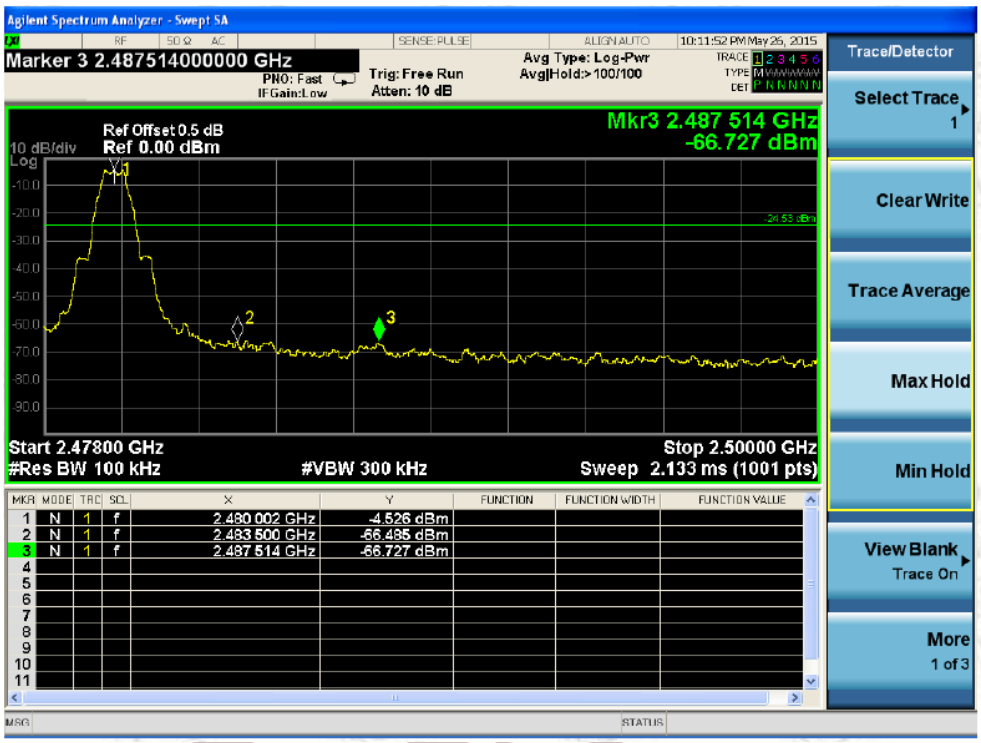
CH High (GFSK MODE)



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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.

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12 .Radio Frequency Exposure

12.1 Objective

The objective of the following report is used to demonstrate that EUT operated in a manner that ensures the public is not exposed to radio frequency energy levels in excess of the relative provisions of FCC 47CFR Part 1.1307

12.2 General Description of Test

Items	Description
EUT Frequency band	☒ FHSS: 2.400GHz ~ 2.483GHz ☐ WLAN: 2.400GHz ~ 2.483GHz ☐ WLAN: 5.18GHz ~ 5.32GHz / 5.50GHz ~ 5.70GHz ☐ WLAN: 5.745GHz ~ 5825GHz ☐Others:
Device category	☐Portable (<20cm separation) ☐Mobile (>20cm separation) ☒Others __Stationary type_ (>20cm separation)_____
Exposure classification	☐Occupational/Controlled exposure (S = 5mW/cm2) ☒General Population/Uncontrolled exposure (S=1mW/cm^2) ☐Others: _____
Antenna diversity	☒Single antenna ☐Multiple antennas: ☐Tx diversity ☐Rx diversity ☐Tx/Rx diversity
Max. output power	-0.37dBm (0.00092W)
Antenna gain (Max)	0.5 dBi (Numeric gain:1.12)
Evaluation applied	☒MPE Evaluation ☐SAR Evaluation

Note:

1. *The maximum output power is dBm -0.37dBm (0.00092W) at GFSK mode 2480MHz. (with 1.12 numeric antenna gain.)*
2. *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.*

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12.3 Human Exposure Assessment Results

Calculation

Given $E = \frac{\sqrt{30 \times P \times G}}{d}$ & $S = \frac{E^2}{3770}$

Where *E = Field Strength in Volts / meter*
P = Power in Watts
G=Numeric antenna gain
d=Distance in meters
S=Power Density in milliwatts / square centimeter

Combining equations and re-arranging the terms to express the distance as a function of the remaining variables yields:

$$S = \frac{30 \times P \times G}{3770 d^2}$$

Changing to units of mW and cm, using:

P (mW) = P (W) / 1000 and
*d (cm) =100 * d (m)*

Yields

$$S = \frac{30 \times (P/1000) \times G}{3770 \times (d/100)^2} = 0.0796 \times \frac{P \times G}{d^2}$$ ***Equation 1***

Where *d = distance in cm*
P = Power in mW
G = Numeric antenna gain
S = Power Density in mW/cm^2

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EUT parameter (data from the separate report)	
Given $E=\frac{\sqrt{30\times P\times G}}{d}$ & $S=\frac{E^2}{3770}$	Where G: numerical gain of transmitting antenna; TP: Transmitted power in watt; d: distance from the transmitting antenna in meter
Max average output power in Watt (TP)	-0.37dBm (0.00092W)
Antenna gain (G)	0.5 dBi (Numeric gain:1.12)
Exposure classification	S=1mW/cm^2
Minimum distance in meter (d) (from transmitting structure to the human body)	20cm (0.2m)
Yields $S=\frac{30xPxG}{3770d^2}$, P=0.00092W, G=1.12, d=0.2 S=0.00021mW/cm^2 Or $d=\sqrt{\frac{30xPxG}{3770S}}$, S=1, P=0.00092W, G=1.12 d=0.0028m	
Conclusion: S=0.00021mW/cm^2 is significant lower than the General Population Exposure Power Density Limit 1mW/cm2 or except the distance when human body proximity to the antenna is less than 0.34cm then will reach the General Population Exposure Power Density Limit. (For mobile or fixed location transmitters, the maximum power density is 1.0 mW / cm2 even if the calculation indicates that the power density would be larger.)	

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