FCC RF TEST REPORT

ISSUED BY
Shenzhen BALUN Technology Co., Ltd.

FOR

LED battery light

ISSUED TO
INTERNATIONAL DEVELOPMENT COMPANY

899 Henrietta Creek Road, Roanoke, Texas 76262 USA.

Tested by: Heng Aiping
(Engineer)
Date Aug. 05, 2019

Approved by: Wei Yanquan
(Chief Engineer)
Date Aug. 05, 2019

Report No.:	BL-SZ1970161-601
EUT Name:	LED battery light
Model Name:	A04HF013H-06 (refer section 2.4)
Brand Name:	N/A
Test Standard:	47 CFR Part 15 Subpart C
FCC ID:	2AP35-A04HF013H
Test Conclusion:	Pass
Test Date:	Jul. 17, 2019 ~ Jul. 21, 2019
Date of Issue:	Aug. 05, 2019

NOTE: This test report of test results only related to testing samples, which can be duplicated completely for the legal use with the approval of the applicant; it shall not be reproduced except in full, without the written approval of Shenzhen BALUN Technology Co., Ltd. Any objections should be raised within thirty days from the date of issue. To validate the report, please contact us.

Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong, P. R. China 518055
TEL: +86-755-66850100, FAX: +86-755-61824271
Email: qc@baluntek.com
www.baluntek.com

Revision History

Version	Issue Date	Revisions
Rev. 01	Aug. 05, 2019	Initial Issue

TABLE OF CONTENTS

1 ADMINISTRATIVE DATA (GENERAL INFORMATION) 6
1.1 Identification of the Testing Laboratory 6
1.2 Identification of the Responsible Testing Location 6
1.3 Laboratory Condition 6
1.4 Announce 6
2 PRODUCT INFORMATION 7
2.1 Applicant Information 7
2.2 Manufacturer Information 7
2.3 Factory Information 7
2.4 General Description for Equipment under Test (EUT) 7
2.5 Technical Information 8
3 SUMMARY OF TEST RESULTS 9
3.1 Test Standards 9
3.2 Verdict 10
4 GENERAL TEST CONFIGURATIONS 11
4.1 Test Environments 11
4.2 Test Equipment List 11
4.3 Description of Test Setup 13
4.3.1 For Antenna Port Test 13
4.3.2 For AC Power Supply Port Test 13
4.3.3 For Radiated Test (Below 30 MHz) 14
4.3.4 For Radiated Test (30 MHz-1 GHz) 14
4.3.5 For Radiated Test (Above 1 GHz) 15
4.4 Measurement Results Explanation Example 16
4.4.1 For conducted test items: 16
4.4.2 For radiated band edges and spurious emission test: 16

5 TEST ITEMS 17
5.1 Antenna Requirements 17
5.1.1 Relevant Standards 17
5.1.2 Antenna Anti-Replacement Construction 17
5.1.3 Antenna Gain 18
5.2 Number of Hopping Frequency 18
5.2.1 Limit 18
5.2.2 Test Setup 18
5.2.3 Test Procedure 18
5.2.4 Test Result 18
5.3 Peak Output Power 19
5.3.1 Test Limit 19
5.3.2 Test Setup 19
5.3.3 Test Procedure 19
5.3.4 Test Result 19
5.4 Occupied Bandwidth 20
5.4.1 Limit 20
5.4.2 Test Setup 20
5.4.3 Test Procedure 20
5.4.4 Test Result 20
5.5 Carrier Frequency Separation 21
5.5.1 Limit 21
5.5.2 Test Setup 21
5.5.3 Test Procedure 21
5.5.4 Test Result 21
5.6 Time of Occupancy (Dwell time) 22
5.6.1 Limit 22
5.6.2 Test Setup 22
5.6.3 Test Procedure 22
5.6.4 Test Result 22
5.7 Conducted Spurious Emission & Authorized-band band-edge 23
5.7.1 Limit 23

5.7.2 Test Setup 23
5.7.3 Test Procedure 23
5.7.4 Test Result 23
5.8 Conducted Emission 24
5.8.1 Limit 24
5.8.2 Test Setup 24
5.8.3 Test Procedure 24
5.8.4 Test Result 24
5.9 Radiated Spurious Emission 25
5.9.1 Limit 25
5.9.2 Test Setup 25
5.9.3 Test Procedure 25
5.9.4 Test Result 26
5.10 Band Edge (Restricted-band band-edge) 27
5.10.1 Limit 27
5.10.2 Test Setup 27
5.10.3 Test Procedure 27
5.10.4 Test Result 27
5.11 Power Spectral density (PSD) 28
5.11.1 Limit 28
5.11.2 Test Setup 28
5.11.3 Test Procedure 28
5.11.4 Test Result 28
ANNEX A TEST RESULT 29
A.1 Number of Hopping Frequency 29
A.2 Peak Output Power and E.I.R.P 29
A.3 6 dB and 99% bandwidth 30
A.4 Hopping Frequency Separation 31
A.5 Average Time of Occupancy 31
A.6 Conducted Spurious Emissions & Authorized-band band-edge 32
A.7 Conducted Emissions 36
A.8 Radiated Emission 37

A.9 Band Edge (Restricted-band band-edge) 42
A.10 Power Spectral Density (PSD) 44
ANNEX B TEST SETUP PHOTOS 45
ANNEX C EUT EXTERNAL PHOTOS 45
ANNEX D EUT INTERNAL PHOTOS 45

1 ADMINISTRATIVE DATA (GENERAL INFORMATION)

1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100

1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1. The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196. The laboratory is a testing organization accredited by American Association for Laboratory Accreditation(A2LA) according to ISO/IEC 17025.The accreditation certificate is 4344.01. The laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L6791.
Description	All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055

1.3 Laboratory Condition

Ambient Temperature	20℃ to 25℃
Ambient Relative Humidity	45% to 55%
Ambient Pressure	100 kPa to 102 kPa

1.4 Announce

(1) The test report reference to the report template version v2.2.

(2) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.

(3) The test report is invalid if there is any evidence and/or falsification.

(4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.

(5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.

(6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	INTERNATIONAL DEVELOPMENT COMPANY
Address	899 Henrietta Creek Road, Roanoke, Texas 76262 USA.

2.2 Manufacturer Information

Manufacturer	Zhongshan Quanxin Lighting Electrical Co., Ltd.
Address	Hong Ji Street, Shalang, Long Ping Cun, West District, Zhongshan Guangdong 528411 China

2.3 Factory Information

Factory	Zhongshan Quanxin Lighting Electrical Co., Ltd.
Address	Hong Ji Street, Shalang, Long Ping Cun, West District, Zhongshan Guangdong 528411 China

2.4 General Description for Equipment under Test (EUT)

EUT Type	LED battery light
Model Name Under Test	A04HF013H-06
Series Model Name	A04HF01#*-##
Description of Model name differentiation	Where "#" is used to denote numbers or blank for commercial purpose; Where “*” is used to denote letters or blank for commercial purpose.
Hardware Version	N/A
Software Version	N/A
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.5 Technical Information

Network and Wireless connectivity	2.4G ISM Band(GFSK modulation)

The requirement for the following technical information of the EUT was tested in this report:

Modulation Technology	DTS
Modulation Type	GFSK
Product Type	☒ Mobile ☐ Portable ☐ Fix Location
Transfer Rate	1 Mbps
Frequency Range	The frequency range used is 2438 MHz;
Number of channel	1
Tested Channel	Middle channel(2438 MHz)
Antenna Type	PCB Antenna
Antenna Gain	1 dBi (In test items related to antenna gain, the final results reflect this figure.)
Adaptive or non-adaptive	non-adaptive
The Max RF Output power	6.41 dBm

Test Case	Test Conditions			
	Modulation Technology	Modulation Type	Date rate	Channel
Number of Hopping Frequency	DTS	GFSK	1 Mbps	N/A
Peak Output Power	DTS	GFSK	1 Mbps	Middle
Occupied Bandwidth	DTS	GFSK	1 Mbps	Middle
Carrier Frequency Separation	DTS	GFSK	1 Mbps	N/A
Time of Occupancy (Dwell time)	DTS	GFSK	1 Mbps	N/A
Conducted Spurious Emission	DTS	GFSK	1 Mbps	Middle
Conducted Emission	DTS	GFSK	1 Mbps	N/A
Radiated Emission	DTS	GFSK	1 Mbps	Middle
Band Edge	DTS	GFSK	1 Mbps	Middle
Power spectral density (PSD)	DTS	GFSK	1 Mbps	Middle

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15, Subpart C	Miscellaneous Wireless Communications Services
2	KDB Publication 558074 D01v05r02	GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES
3	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

3.2 Verdict

No.	Description	FCC Part No.	Test Result	Verdict
1	Antenna Requirement	15.203	--	Pass Note 1
2	Number of Hopping Frequency	15.247(a)	ANNEX A.1	N/A
3	Peak Output Power	15.247(b)	ANNEX A.2	Pass
4	Occupied Bandwidth	15.247(a)	ANNEX A.3	Pass
5	Carrier Frequency Separation	15.247(a)	ANNEX A.4	N/A
6	Time of Occupancy (Dwell time)	15.247(a)	ANNEX A.5	N/A
7	Conducted Spurious Emission& Authorized-band band-edge	15.247(d)	ANNEX A.6	Pass
8	Conducted Emission	15.207	ANNEX A.7	N/A
9	Radiated Spurious Emission	15.209 15.247(d)	ANNEX A.8	Pass
10	Band Edge (Restricted-band band-edge)	15.209 15.247(d)	ANNEX A.9	Pass
11	Receiver Spurious Emissions	--	--	N/A Note 2
12	Power spectral density (PSD)	15.247(e)	ANNEX A.10	Pass

Note 1: The EUT has a permanently and irreplaceable attached antenna, which complies with the requirement FCC 15.203.

Note 2: Only radio communication receivers operating in stand-alone mode within the band 30-960 MHz, as well as scanner receivers, are subject to Industry Canada requirements, so this test is not applicable.

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

During the measurement, the normal environmental conditions were within the listed ranges:

Relative Humidity	45% to 55%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	20℃ to +25℃
Working Voltage of the EUT	NV (Normal Voltage)	4.5 V

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	ROHDE&SCHWARZ	FSV-30	103118	2019.06.13	2020.06.12
Vector Signal Generator	ROHDE&SCHWARZ	SMBV100A	260592	2019.06.13	2020.06.12
Signal Generator	ROHDE&SCHWARZ	SMB100A	177746	2019.06.13	2020.06.12
Switch Unit with OSP-B157	ROHDE&SCHWARZ	OSP120	101270	2019.06.13	2020.06.12
Spectrum Analyzer	AGILENT	E4440A	MY45304434	2018.11.08	2019.11.07
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2019.06.13	2020.06.12
LISN	SCHWARZBECK	NSLK 8127	8127-687	2019.06.13	2020.06.12
Bluetooth Tester	ROHDE&SCHWARZ	CBT	101005	2019.06.15	2020.06.14
Power Splitter	KMW	DCPD-LDC	1305003215	--	--
Power Sensor	ROHDE&SCHWARZ	NRP-Z21	103971	2019.06.15	2020.06.14
Attenuator (20 dB)	KMW	ZA-S1-201	110617091	--	--
Attenuator (6 dB)	KMW	ZA-S1-61	1305003189	--	--
DC Power Supply	ROHDE&SCHWARZ	HMP2020	18141664	2019.06.18	2020.06.16
Temperature Chamber	ANGELANTIONI SCIENCE	NTH64-40A	1310	2019.07.02	2020.07.01
Test Antenna-Loop(9 kHz-30 MHz)	SCHWARZBECK	FMZB 1519	1519-037	2017.11.09	2019.11.08
Test Antenna-Bi-Log(30 MHz-3 GHz)	SCHWARZBECK	VULB 9163	9163-624	2018.08.22	2020.08.21
Test Antenna-Horn(1-18 GHz)	SCHWARZBECK	BBHA 9120D	9120D-1148	2018.07.22	2020.07.21
Test Antenna-Horn(15-26.5 GHz)	SCHWARZBECK	BBHA 9170	9170-305	2019.06.21	2020.06.20
Test Antenna-Horn (18-40 GHz)	A-INFO	LB-180400KF	J211060273	2019.01.06	2021.01.05
Anechoic Chamber	RAINFORD	9m*6m*6m	N/A	2019.02.21	2021.02.20
Anechoic Chamber	EMC TECHNOLOGY LTD	21.1m*11.6m*7.35m	N/A	2018.07.19	2020.07.18
Shielded Enclosure	ChangNing	CN-130701	130703	--	--
Signal Generator	ROHDE&SCHWARZ	SMB100A	177746	2019.06.13	2020.06.12
Power Amplifier	OPHIR RF	5225F	1037	2019.02.17	2020.02.16

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Power Amplifier	OPHIR RF	5273F	1016	2019.02.17	2020.02.16
Directional Coupler	Werlantone	C5982-10	109275	N/A	N/A
Directional Coupler	Werlantone	CHP-273E	S00801z-01	N/A	N/A
Feld Strength Meter	Narda	EP601	511WX51129	2019.02.23	2020.02.22
Mouth Simulator	B&K	4227	2423931	2018.11.15	2019.11.14
Sound Calibrator	B&K	4231	2430337	2018.11.09	2019.11.08
Sound Level Meter	B&K	NL-20	00844023	2018.11.11	2019.11.10
Ear Simulator	B&K	4185	2409449	2018.11.15	2019.11.14
Ear Simulator	B&K	4195	2418189	2018.11.15	2019.11.14
Audio analyzer	B&K	UPL 16	100129	2018.11.08	2019.11.07

4.3 Description of Test Setup

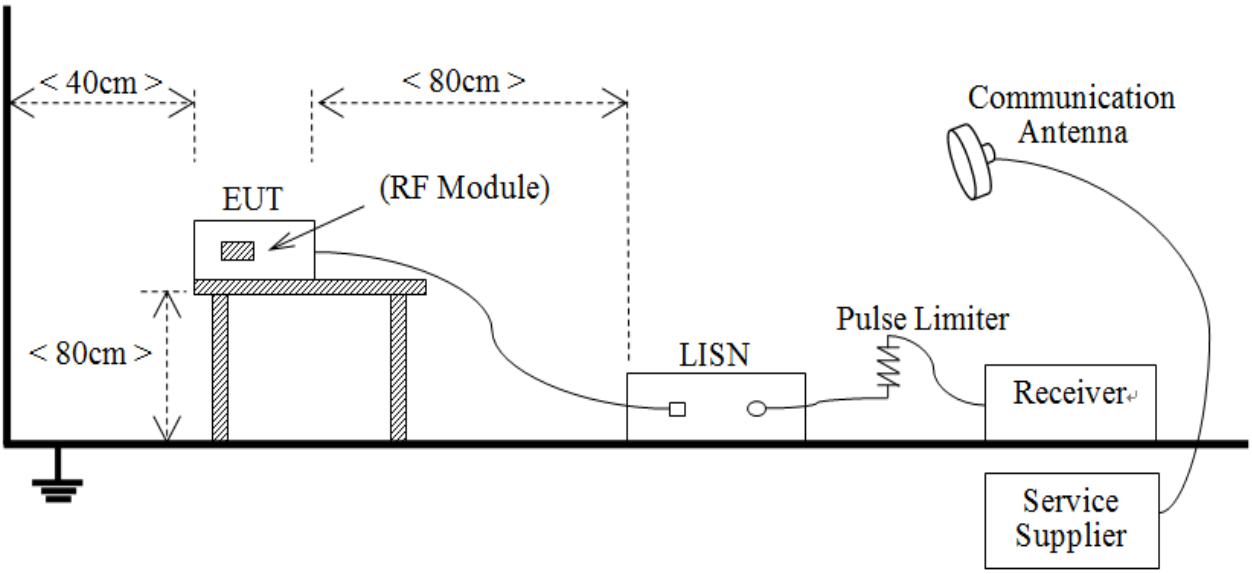
4.3.1 For Antenna Port Test

Conducted value (dBm) = Measurement value (dBm) + cable loss (dB)

For example: the measurement value is 10 dBm and the cable 0.5dBm used, then the final result of EUT:
Conducted value (dBm) = 10 dBm + 0.5 dB = 10.5 dBm

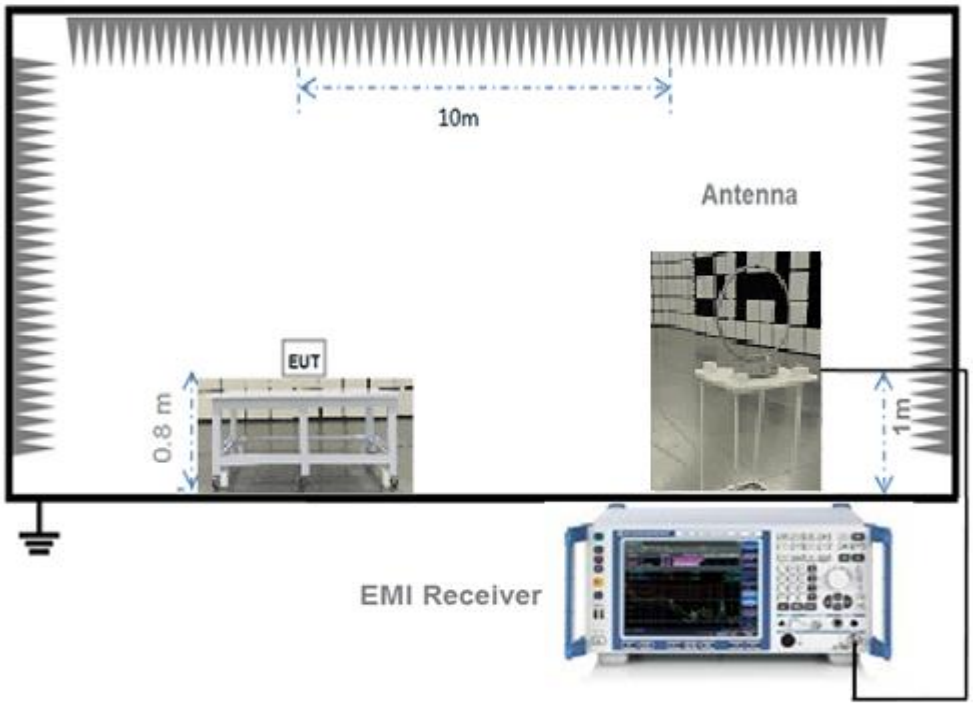
(Diagram 1)

4.3.2 For AC Power Supply Port Test



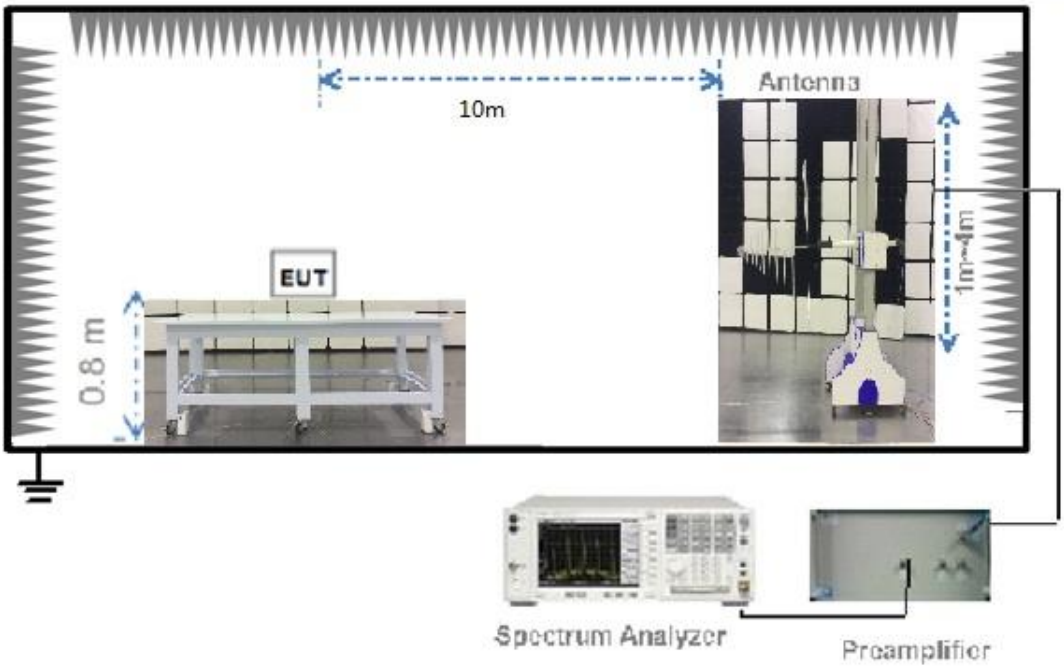
(Diagram 2)

4.3.3 For Radiated Test (Below 30 MHz)



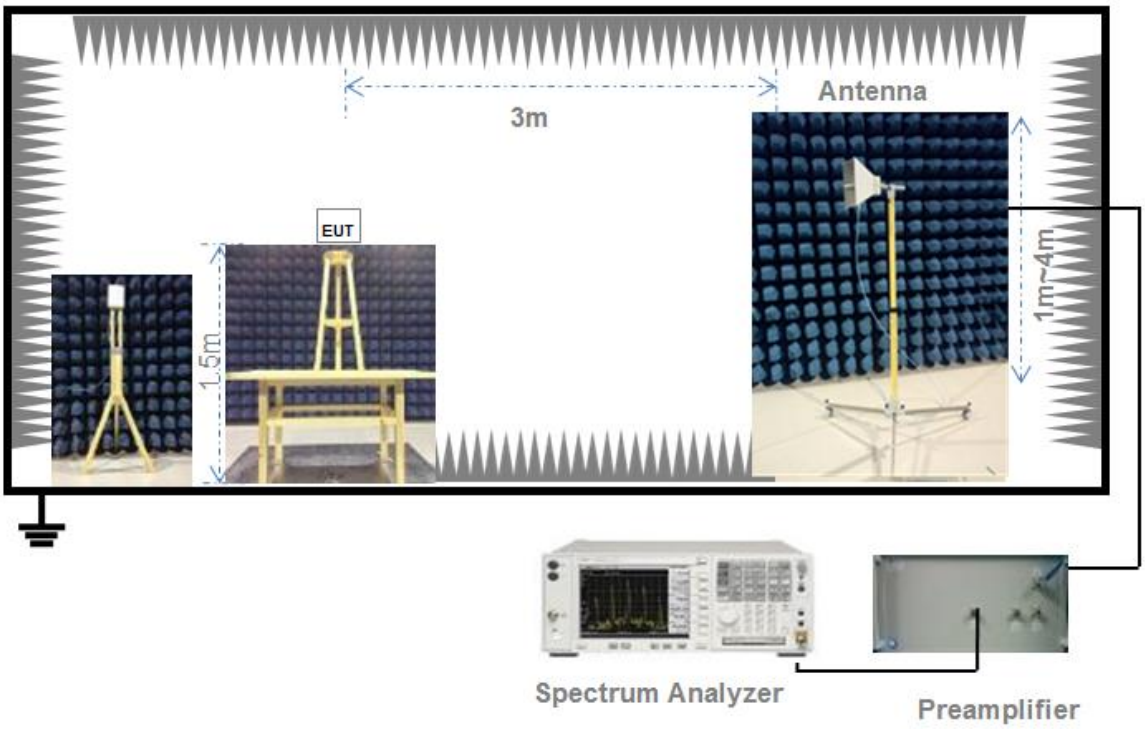
(Diagram 3)

4.3.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.3.5 For Radiated Test (Above 1 GHz)



(Diagram 5)

4.4 Measurement Results Explanation Example

4.4.1 For conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator 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 loss and attenuator factor.
Offset = RF cable loss + attenuator factor.

4.4.2 For radiated band edges and spurious emission test:

Per part 15.35(c), the EUT Bluetooth average emission level could be determined by the peak emission level applying duty cycle correction factor, to represent averaging over the whole pulse train.
The average level is derived from the peak level corrected with “Duty cycle correction factor”.
Average Emission Level (dBuV/m) = Peak Emission Level (dBuV/m) + Duty cycle correction factor (dB)
Duty cycle correction factor (dB) = 20 * log (Duty cycle).
Duty cycle = on time / 100 milliseconds
On time = dwell time * hopping number in 100 ms
For example: bluetooth with dwell time 2.9 ms and 3 hops in 100 ms, then
Duty cycle correction factor (dB) = 20 * log ((2.9 * 3) / 100) = -21.21 dB
Following shows an average computation example with duty cycle correction factor = -21.21 dB, and the peak emission level is 45.61 dBuV/m.
Example:
Average Emission Level (dBuV/m) = Peak Emission Level (dBuV/m) + duty cycle correction factor (dB)
= 45.61 + (-21.21) = 24.4 (dBuV/m)

5 TEST ITEMS

5.1 Antenna Requirements

5.1.1 Relevant Standards

FCC §15.203 & 15.247(b); RSS-247, 5.4 (6)

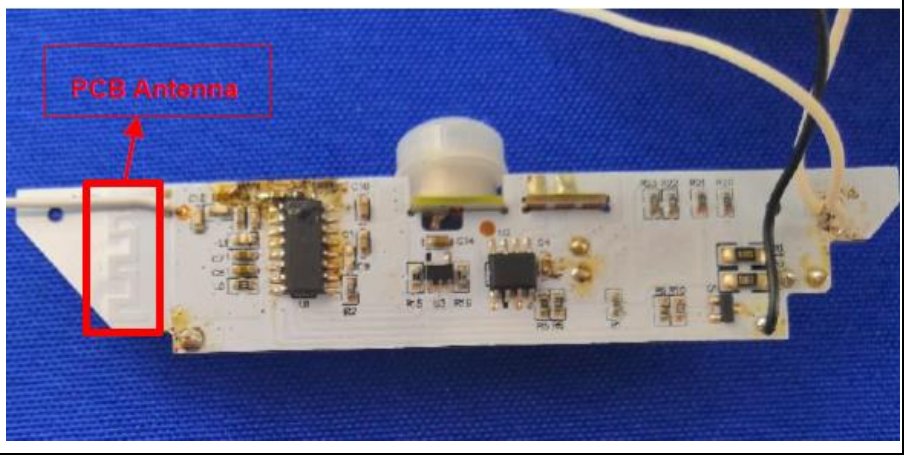
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, § 15.213, § 15.217, § 15.219, or § 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. 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 FCC rule.

5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

Protected Method	Description
The antenna is embedded in the product.	The antenna is welded on the mainboard, can't be replaced by the consumer

Reference Documents	Item
Photo	

5.1.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

5.2 Number of Hopping Frequency

5.2.1 Limit

FCC §15.247(a) (1) (iii); RSS-247, 5.1 (4)

Frequency hopping systems operating in the 2400 MHz to 2483.5 MHz bands shall use at least 15 hopping frequencies.

5.2.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.2.3 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = the frequency band of operation

RBW ≥ 1% of the span

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

5.2.4 Test Result

Please refer to ANNEX A.1.

5.3 Peak Output Power

5.3.1 Test Limit

FCC § 15.247(b)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

RSS-247, 5.4 (2)

For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W and the e.i.r.p. shall not exceed 4 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W and the e.i.r.p. shall not exceed 0.5 W if the hopset uses less than 75 hopping channels (see Section 5.4(5) for exceptions).

5.3.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.3.3 Test Procedure

The Bluetooth Module operates at hopping-off test mode. The lowest, middle and highest channels are selected to perform testing to verify the conducted RF output peak power of the Module.

Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

RBW > the 20 dB bandwidth of the emission being measured

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize.

5.3.4 Test Result

Please refer to ANNEX A.2.

5.4 Occupied Bandwidth

5.4.1 Limit

FCC §15.247(a); RSS-247, 5.1 (1)

Measurement of the 20dB bandwidth of the modulated signal.

5.4.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.4.3 Test Procedure

Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel

RBW ≥ 1% of the 20 dB bandwidth

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

The EUT should be transmitting at its maximum data rate, Allow the trace to stabilize.

5.4.4 Test Result

Please refer to ANNEX A.3.

5.5 Carrier Frequency Separation

5.5.1 Limit

FCC §15.247(a); RSS-247, 5.1 (2)

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 shall have hopping channel carrier frequencies separated by a minimum of 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.

5.5.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.5.3 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels

Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span

Video (or Average) Bandwidth (VBW) ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

5.5.4 Test Result

Please refer to ANNEX A.4.

5.6 Time of Occupancy (Dwell time)

5.6.1 Limit

FCC §15.247(a); RSS-247, 5.1 (4)

Frequency hopping systems in the 2400 MHz - 2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

5.6.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.6.3 Test Procedure

The lowest, middle and highest channels are selected to perform testing to record the dwell time of each occupation measured in this channel, which is called Pulse Time here.

5.6.4 Test Result

Please refer to ANNEX A.5

5.7 Conducted Spurious Emission & Authorized-band band-edge

5.7.1 Limit

FCC §15.247(d); RSS-247, 5.5

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.

5.7.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.7.3 Test Procedure

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Allow the trace to stabilize

5.7.4 Test Result

Please refer to ANNEX A.6.

5.8 Conducted Emission

5.8.1 Limit

FCC §15.207; RSS-GEN, 8.8

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 within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50μH/50Ω line impedance stabilization network (LISN).

Frequency range (MHz)	Conducted Limit (dBμV)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
0.50 - 30	60	50

5.8.2 Test Setup

See section 4.4.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX B.

5.8.3 Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.

5.8.4 Test Result

Please refer to ANNEX A.7.

5.9 Radiated Spurious Emission

5.9.1 Limit

FCC §15.209&15.247(d); RSS-247, 5.5

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

According to FCC section 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 (µV/m)	Measurement Distance (m)
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

Note:

1. Field Strength (dBµV/m) = 20*log[Field Strength (µV/m)].
2. In the emission tables above, the tighter limit applies at the band edges.
3. For Above 1000 MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
4. For above 1000 MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK).

5.9.2 Test Setup

See section 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.9.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW

Sweep = auto
Detector function = peak
Trace = max hold
For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

5.9.4 Test Result

Please refer to ANNEX A.8.

5.10 Band Edge (Restricted-band band-edge)

5.10.1 Limit

FCC §15.209&15.247(d); RSS-247, 5.5

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

5.10.2 Test Setup

See section 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.10.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

5.10.4 Test Result

Please refer to ANNEX A.9.

5.11 Power Spectral density (PSD)

5.11.1 Limit

FCC §15.247(e); RSS-247, 5.2 (2)

The same method of determining the conducted output power shall be used to determine the power spectral density. If a peak output power is measured, then a peak power spectral density measurement is required. If an average output power is measured, then an average power spectral density measurement should be used.

The transmitter 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. This power spectral density shall be determined in accordance with the provisions of Section 5.4(4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

5.11.2 Test Setup

See section 4.4.1 (Diagram 1) for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.11.3 Test Procedure

Set analyzer center frequency to DTS channel center frequency.

Set the span to 1.5 times the DTS bandwidth.

Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.

Set the VBW ≥ 3 RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level within the RBW.

If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

5.11.4 Test Result

Please refer to ANNEX A.10.

ANNEX A TEST RESULT

A.1 Number of Hopping Frequency

Note: not application.

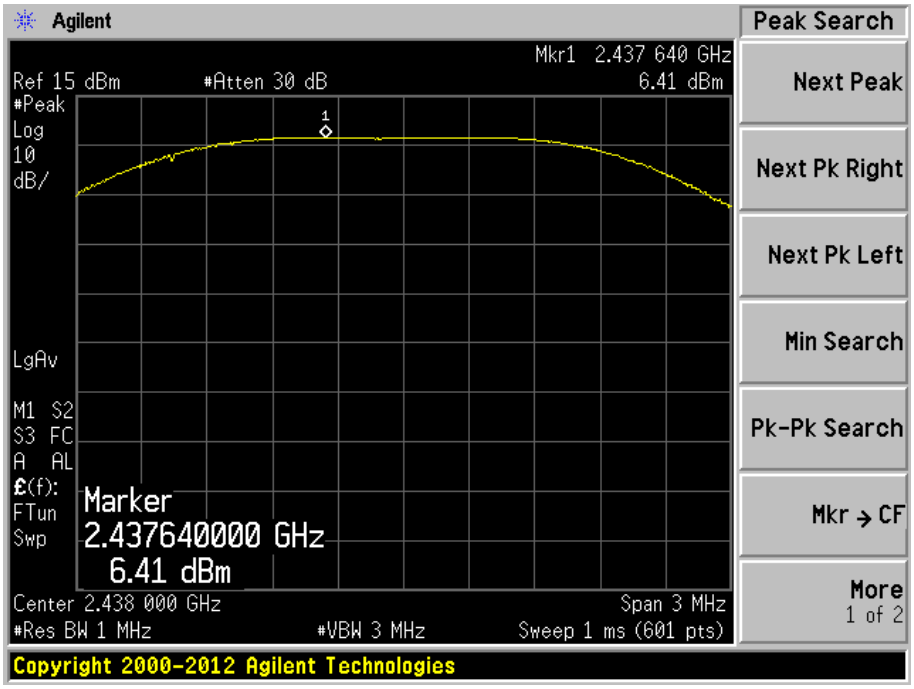
A.2 Peak Output Power and E.I.R.P

Peak Power Test Data

Channel	Measured Output Peak Power		Limit		Verdict
	dBm	mW	dBm	mW	
2438MHz	6.41	4.38	30	1000	Pass

Test plots

GFSK CHANNEL 2438



A.3 6 dB and 99% bandwidth

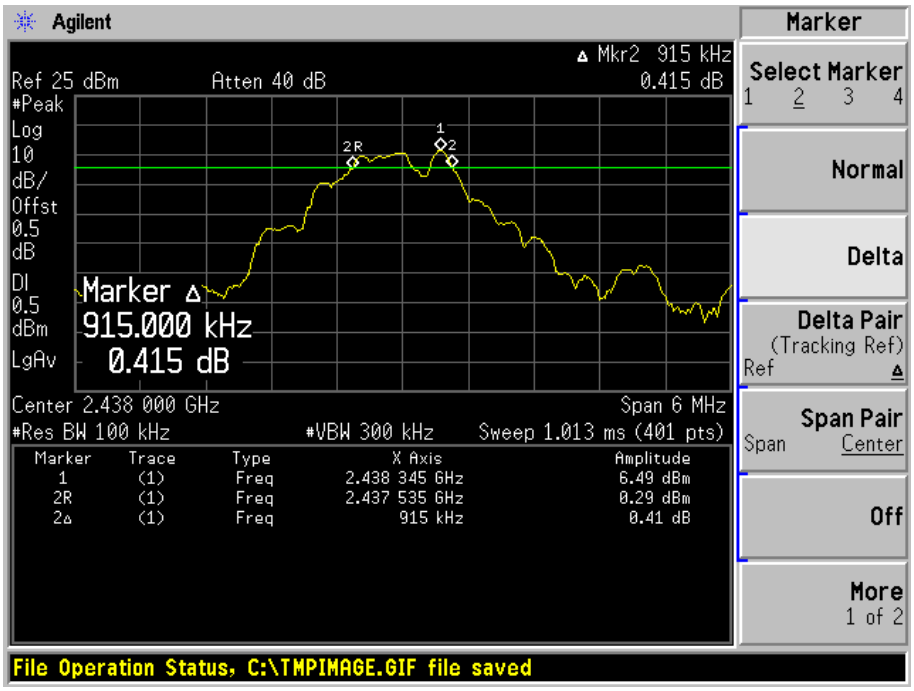
Test Data

GFSK Mode:

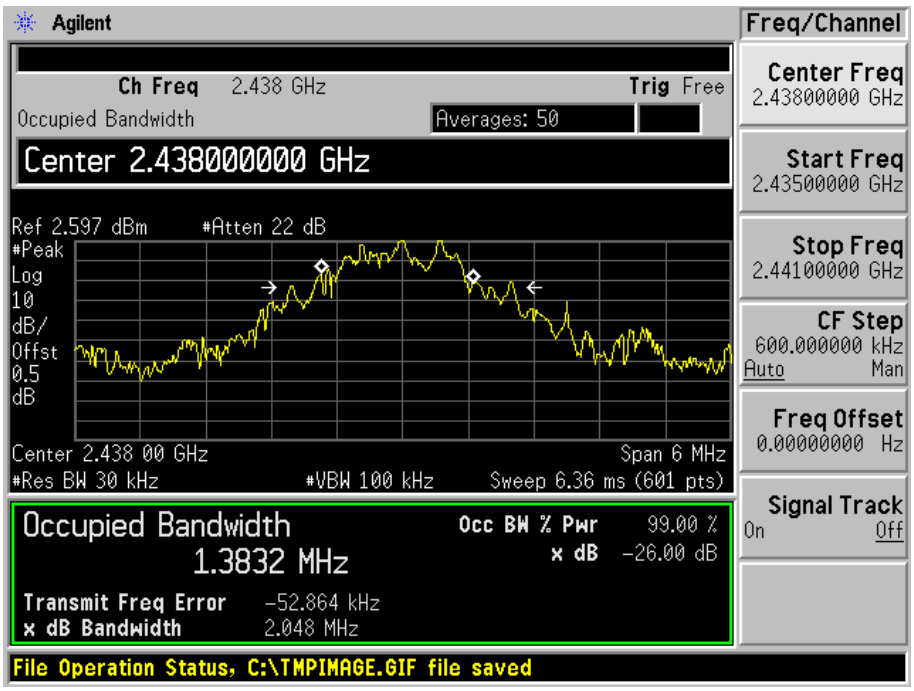
Channel	6 dB Bandwidth (kHz)	99% Bandwidth (kHz)
2438MHz	915.000	1383.200

Test plots

GFSK 6dB Bandwidth



GFSK 99% Bandwidth



A.4 Hopping Frequency Separation

Note: not application.

A.5 Average Time of Occupancy

Note: not application.

A.6 Conducted Spurious Emissions & Authorized-band band-edge

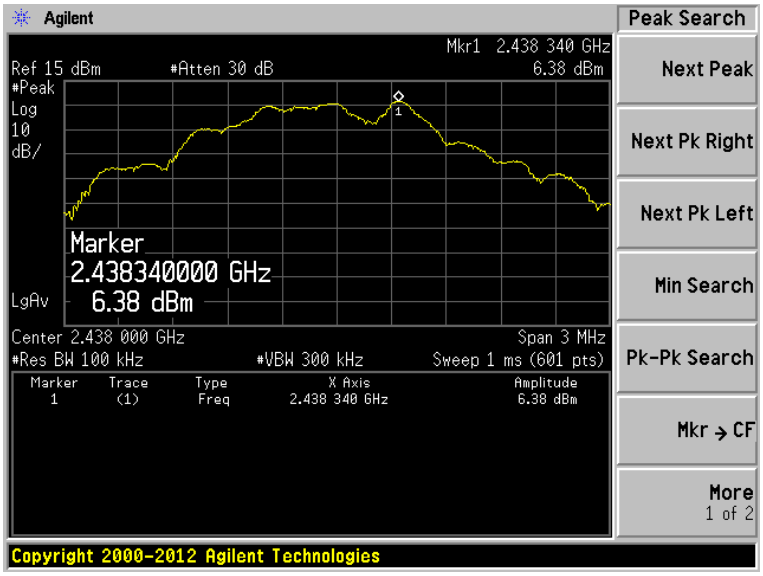
Test Data

GFSK Mode:

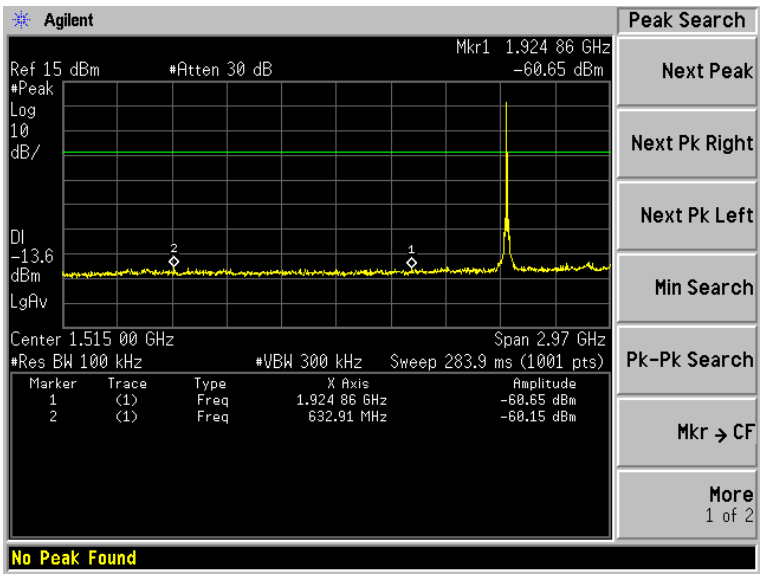
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
2438MHz	-50.07	6.38	-13.62	Pass

Test Plots

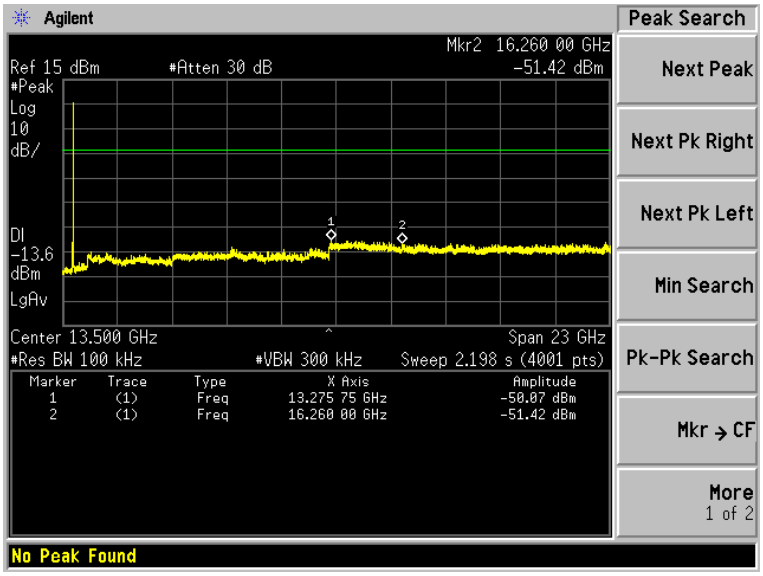
GFSK, CARRIER LEVEL



GFSK, SPURIOUS 30 MHz ~ 3 GHz



GFSK , SPURIOUS 3 GHz ~ 25 GHz

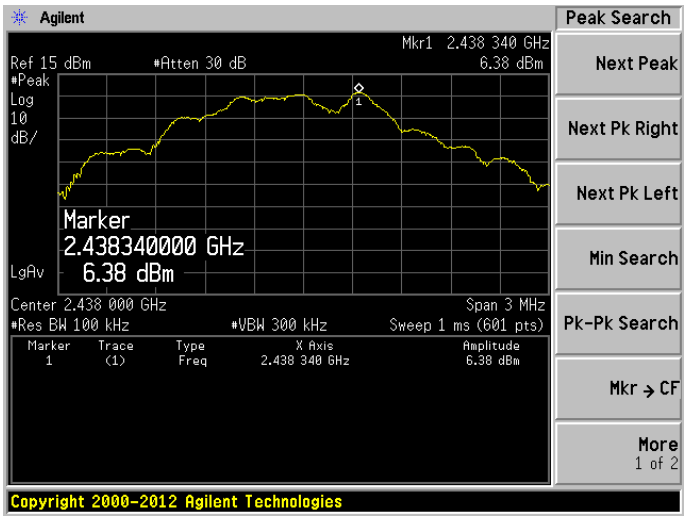


Test Data

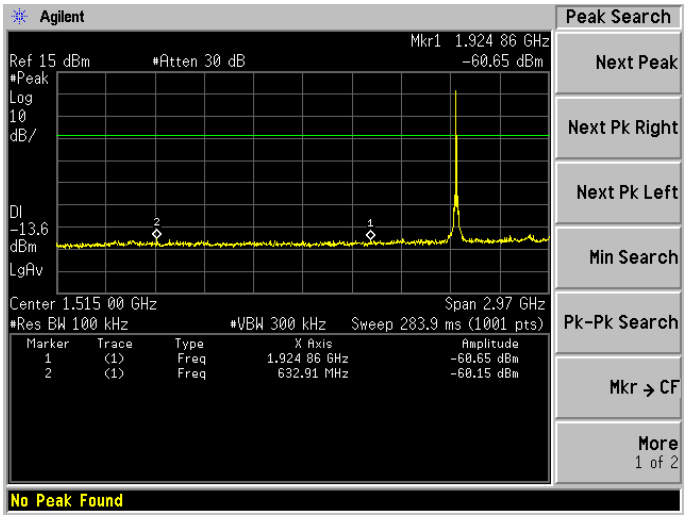
GFSK Mode:

Channel	Measured Max. Band Edge Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Middle Channel (left)	-58.51	6.38	-13.62	Pass
Middle Channel (right)	-62.64	6.38	-13.62	Pass

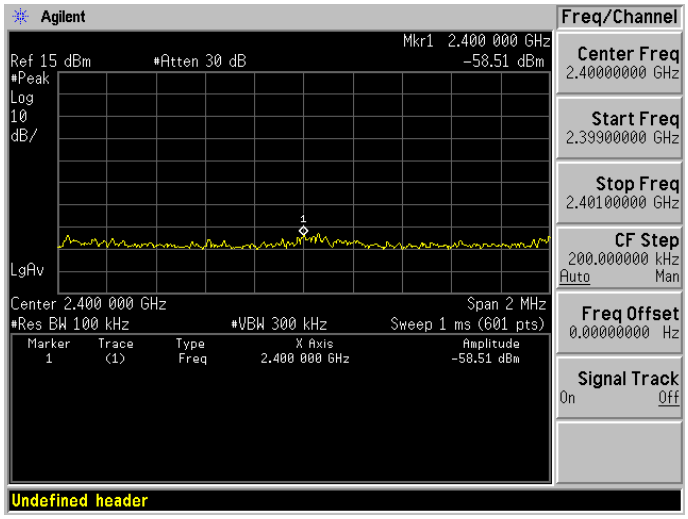
802.11b Middle Channel (left), Carrier level



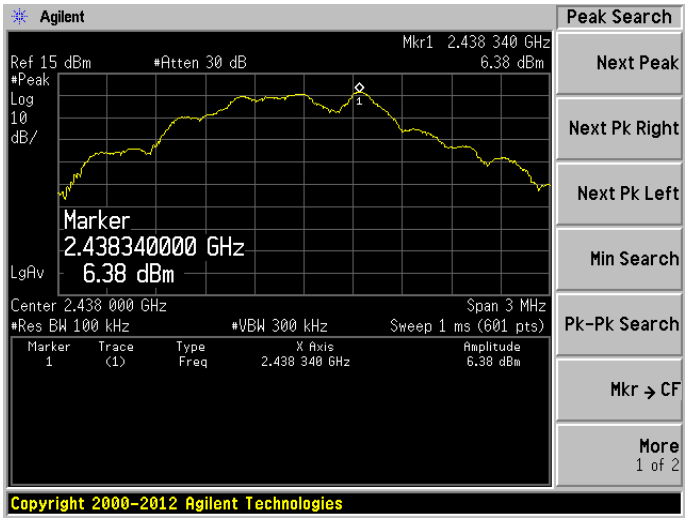
802.11b Middle Channel (left), Reference level



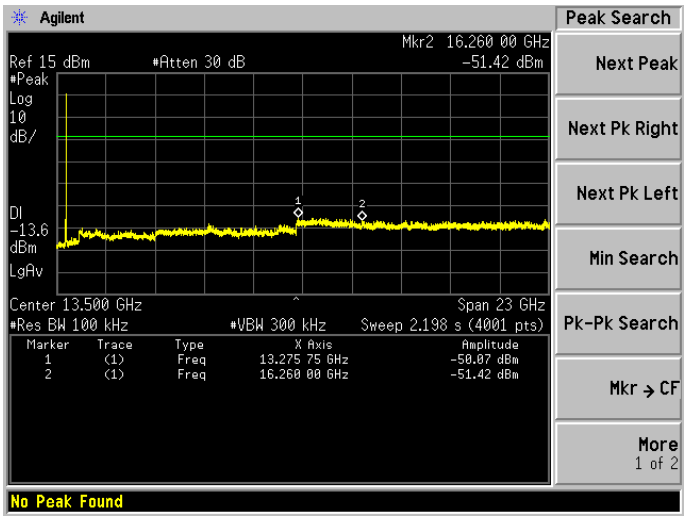
802.11b Middle Channel (left), Band Edge



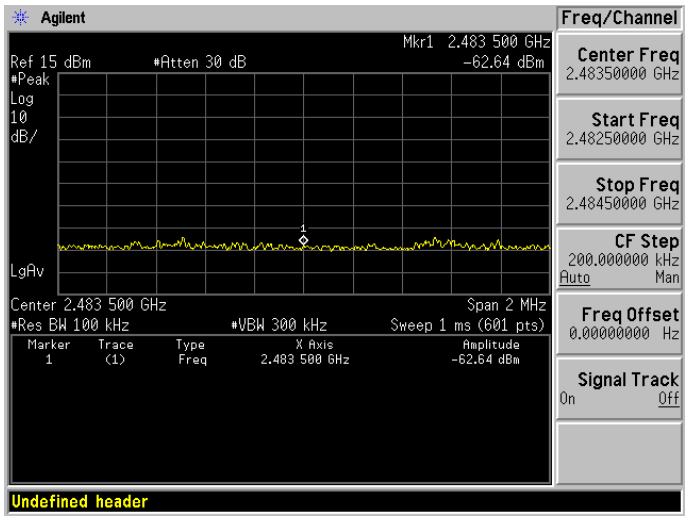
802.11b Middle Channel (right), Carrier level



802.11b Middle Channel (right), Reference level



802.11b Middle Channel (right), Band Edge



A.7 Conducted Emissions

Note: not application.

A.8 Radiated Emission

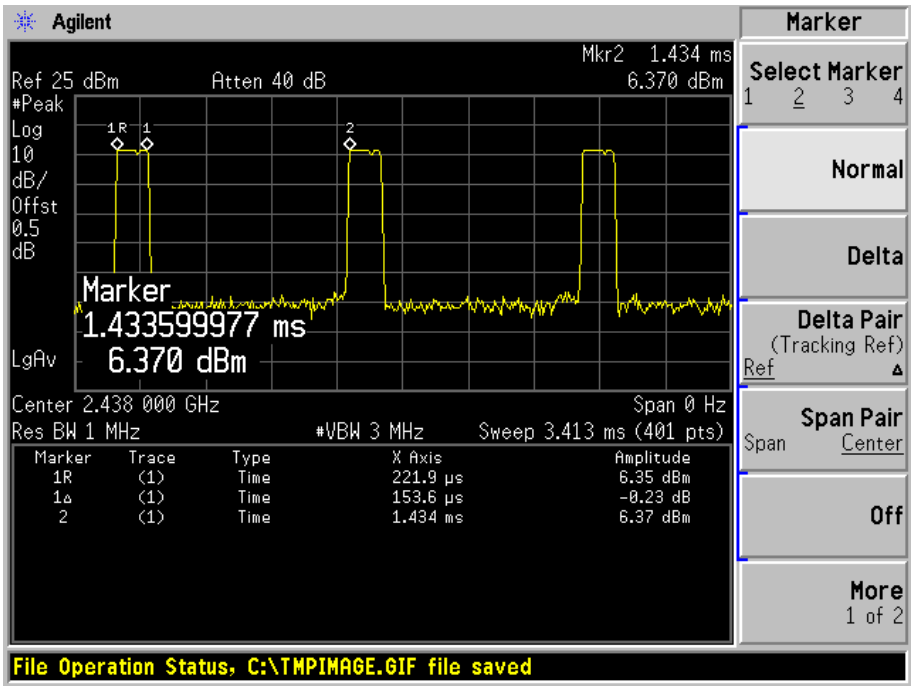
Duty cycle correction factor for average measurement.

Note:

1. Duty cycle = on time/100 milliseconds = 2* 1.434 / 100 =2.87 %
2. Duty cycle correction factor = 20*log (Duty cycle) = -30.85 dB
3. GFSK has the highest duty cycle and is reported.

Test Plots

GFSK on time/100 ms (One Pulse) Plot



Note [1]: The symbol of "--" in the table which means not application.

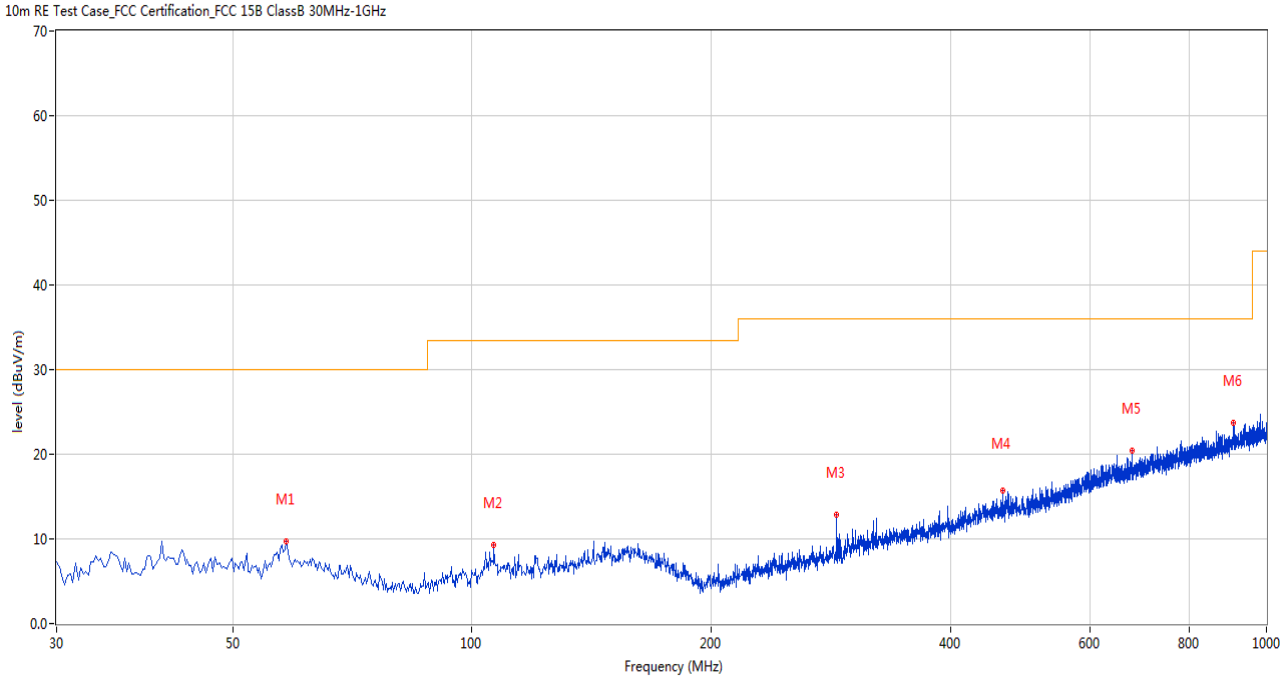
Note [2]: For the test data above 1 GHz, according the ANSI C63.4-2014, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

Note [3]: All configurations have been tested, only the worst configuration shown here.

Test Data and Plots

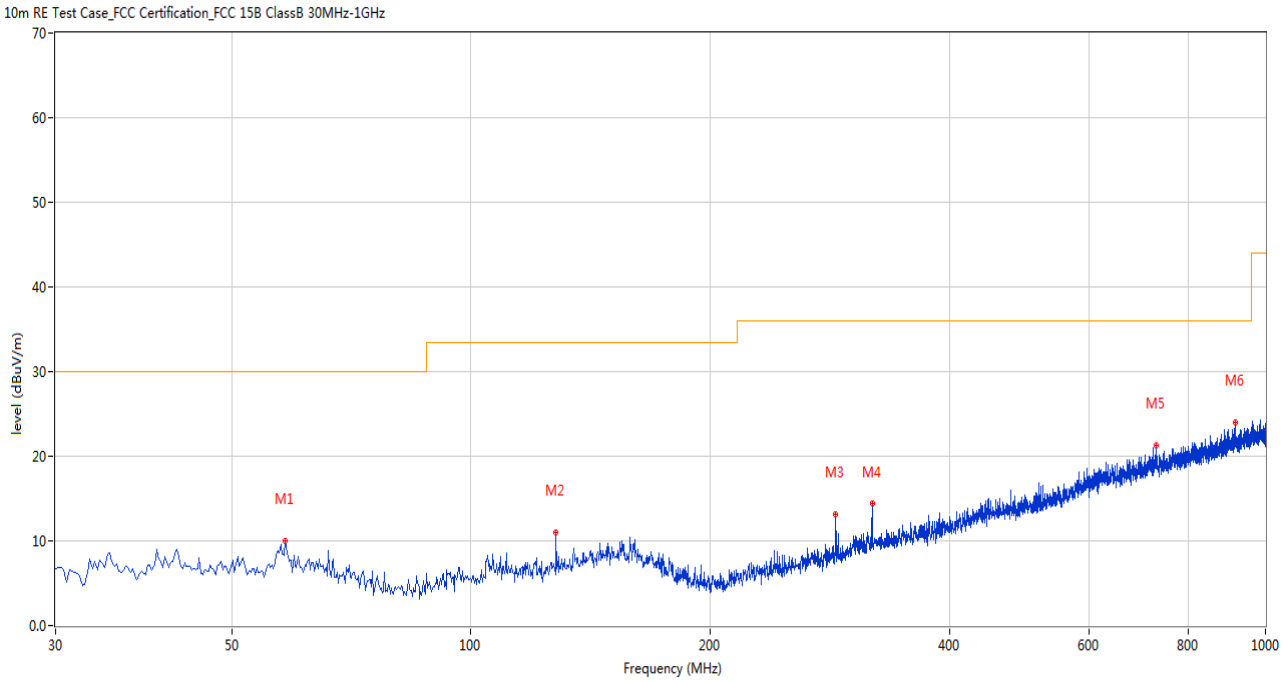
The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

30 MHz to 1 GHz, ANT V



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	58.365	9.72	-27.78	30.0	-20.28	Peak	0.00	200	Vertical	Pass
2	106.611	9.33	-29.33	33.5	-24.17	Peak	239.00	200	Vertical	Pass
3	287.956	12.80	-26.09	36.0	-23.20	Peak	306.00	100	Vertical	Pass
4	465.421	15.71	-21.24	36.0	-20.29	Peak	180.00	100	Vertical	Pass
5	676.828	20.50	-16.49	36.0	-15.50	Peak	160.00	200	Vertical	Pass
6	908.600	23.73	-12.24	36.0	-12.27	Peak	360.00	200	Vertical	Pass

30 MHz to 1 GHz, ANT H



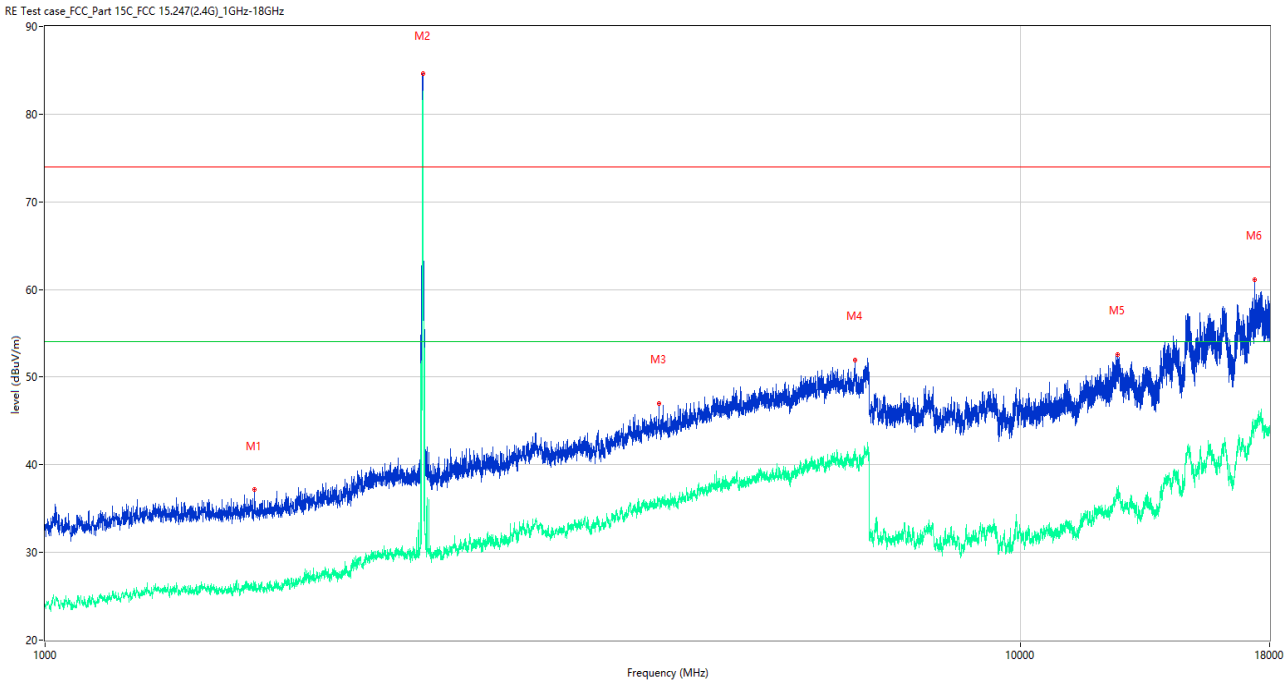
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	58.365	9.95	-27.78	30.0	-20.05	Peak	54.00	100	Horizontal	Pass
2	127.946	11.01	-27.34	33.5	-22.49	Peak	23.00	100	Horizontal	Pass
3	287.956	13.08	-26.09	36.0	-22.92	Peak	0.00	200	Horizontal	Pass
4	319.958	14.41	-25.31	36.0	-21.59	Peak	205.00	100	Horizontal	Pass
5	727.741	21.26	-15.36	36.0	-14.74	Peak	111.00	100	Horizontal	Pass
6	915.631	23.97	-12.07	36.0	-12.03	Peak	0.00	200	Horizontal	Pass

Note 1: The marked spikes near 2400 MHz with circle should be ignored because they are Fundamental signal.

Note 2: The spurious from 18GHz-25GHz is noise only, do not show on the report.

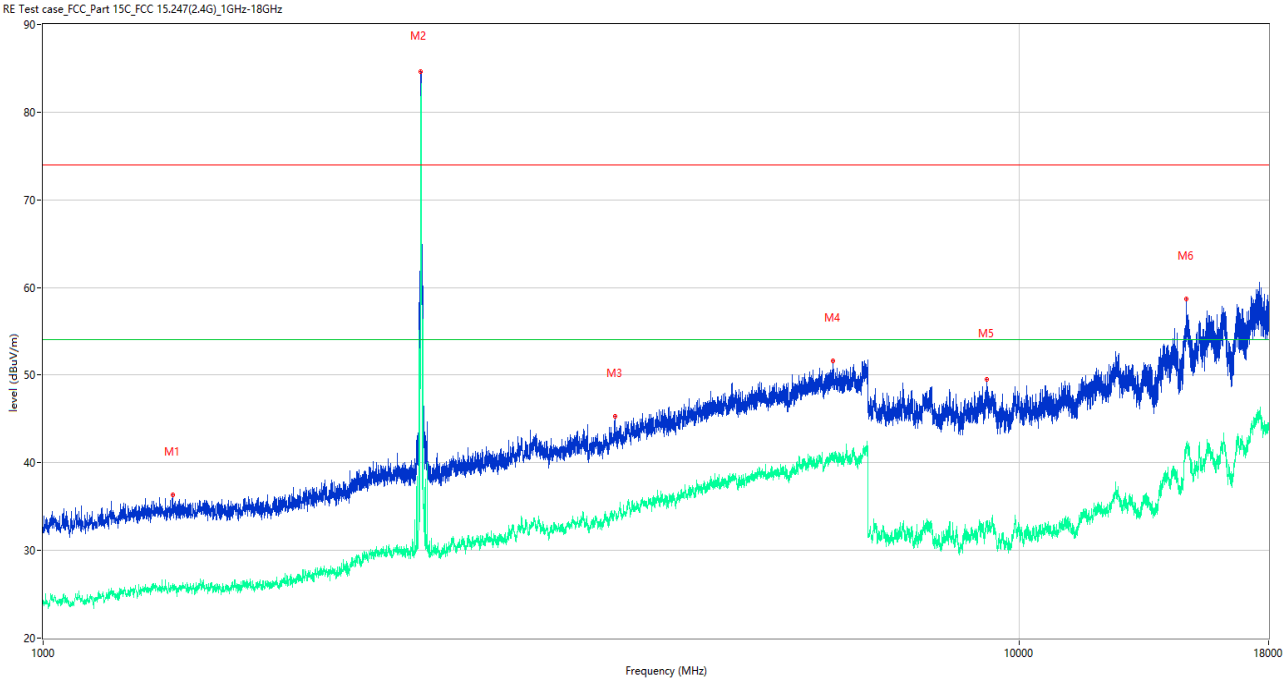
Test Data and Plots (1 GHz ~ 10th Harmonic)

GFSK 1 GHz to 18 GHz, ANT V



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1**	1639.000	25.92	-15.07	54.0	-28.08	AV	339.00	150	Vertical	Pass
1	1639.000	37.17	-15.07	74.0	-36.83	Peak	339.00	150	Vertical	Pass
2**	2438.500	82.63	-10.76	54.0	28.63	AV	245.00	150	Vertical	N/A
2	2438.500	84.58	-10.76	74.0	10.58	Peak	245.00	150	Vertical	N/A
3**	4259.000	36.19	-3.52	54.0	-17.81	AV	202.00	150	Vertical	Pass
3	4259.000	47.03	-3.52	74.0	-26.97	Peak	202.00	150	Vertical	Pass
4**	6764.000	41.30	4.89	54.0	-12.70	AV	140.00	150	Vertical	Pass
4	6764.000	51.97	4.89	74.0	-22.03	Peak	140.00	150	Vertical	Pass
5**	12571.750	36.51	21.71	54.0	-17.49	AV	293.00	150	Vertical	Pass
5	12571.750	52.57	21.71	74.0	-21.43	Peak	293.00	150	Vertical	Pass
6**	17375.250	44.95	29.31	54.0	-9.05	AV	158.00	150	Vertical	Pass
6	17375.250	61.09	29.31	74.0	-12.91	Peak	158.00	150	Vertical	Pass

GFSK 1 GHz to 18 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1**	1359.000	26.24	-15.03	54.0	-27.76	AV	236.00	150	Horizontal	Pass
1	1359.000	36.30	-15.03	74.0	-37.70	Peak	236.00	150	Horizontal	Pass
2**	2437.500	75.04	-10.69	54.0	21.04	AV	316.00	150	Horizontal	N/A
2	2437.500	84.66	-10.69	74.0	10.66	Peak	316.00	150	Horizontal	N/A
3**	3853.000	34.26	-5.34	54.0	-19.74	AV	64.00	150	Horizontal	Pass
3	3853.000	45.30	-5.34	74.0	-28.70	Peak	64.00	150	Horizontal	Pass
4**	6443.000	41.13	3.12	54.0	-12.87	AV	282.00	150	Horizontal	Pass
4	6443.000	51.67	3.12	74.0	-22.33	Peak	282.00	150	Horizontal	Pass
5**	9258.313	33.13	18.18	54.0	-20.87	AV	142.00	150	Horizontal	Pass
5	9258.313	49.47	18.18	74.0	-24.53	Peak	142.00	150	Horizontal	Pass
6**	14822.438	41.66	26.82	54.0	-12.34	AV	146.00	150	Horizontal	Pass
6	14822.438	58.66	26.82	74.0	-15.34	Peak	146.00	150	Horizontal	Pass

A.9 Band Edge (Restricted-band band-edge)

Test Data

Note [1]: The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.

Note [2]: The test data all are tested in the vertical and horizontal antenna which the trace is max hold. So these plots have shown the worst case.

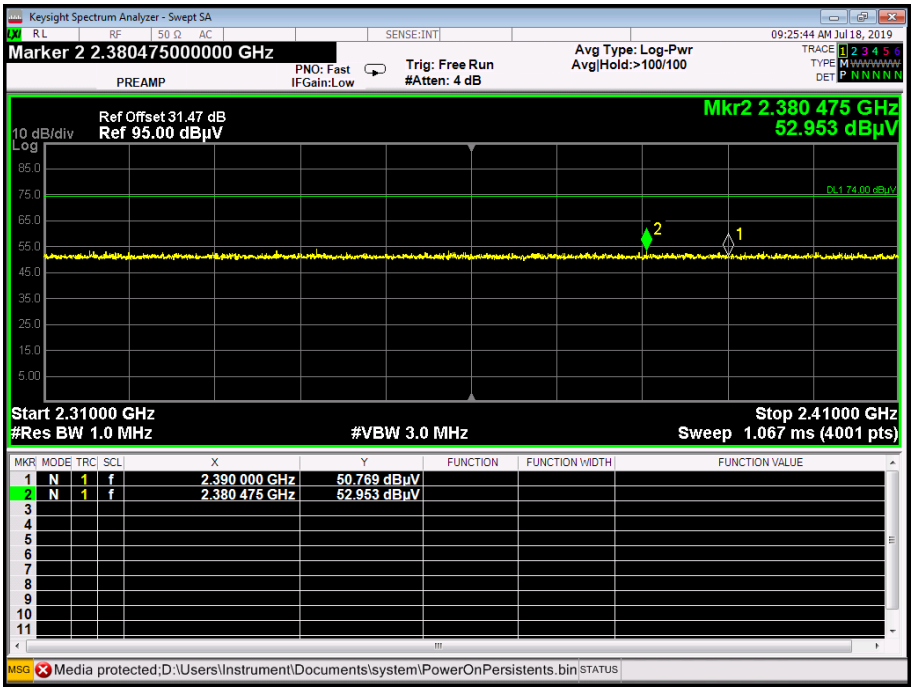
Note [3]: The average levels were calculated from the peak level corrected with duty cycle correction factor (-31.73 dB) derived from 20log (dwell time/100 ms).

For example: Average level = 62.29 dBuV/m – 31.73 (dB) = 30.56 dBuV/m.

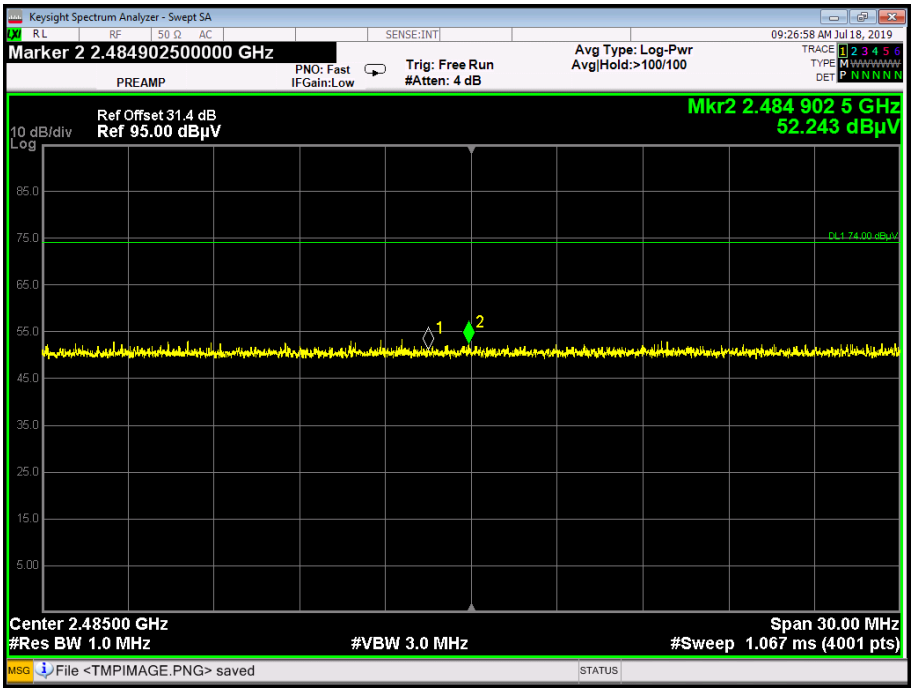
Test Plots

Test Mode	Test Channel	Frequency (MHz)	Level (dBuV/m)	Limit Line (dBuV/m)	Margin (dB)	Remark	Verdict
GFSK	Middle (left)	2390	52.953	74	21.047	PEAK	Pass
		2390	N/A	54	N/A	AVERAGE	Pass
GFSK	Middle (right)	2483.5	52.243	74	21.757	PEAK	Pass
		2483.5	N/A	54	N/A	AVERAGE	Pass

GFSK Middle Channel (left) , PEAK



GFSK Middle Channel (right) , PEAK



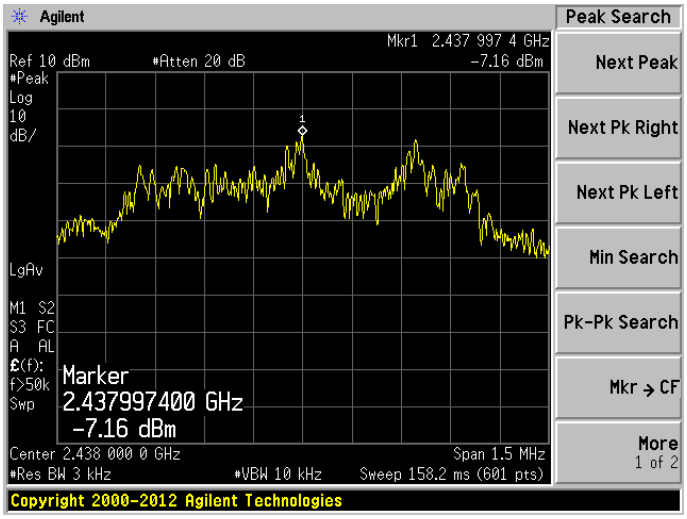
A.10 Power Spectral Density (PSD)

Test Data

Channel	Spectral power density (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
2438MHz	-7.16	8	Pass

Test plots

GFSK 2438MHz



ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SZ1970161-AR.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-SZ1970161-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-SZ1970161-AI.PDF”.

--END OF REPORT--