FCC Part 15.247

TEST REPORT

For

InnoComm Mobile Technology Corporation

3F, No. 6, Hsin Ann Rd., Hsinchu Science Park, Hsinchu 30078, Taiwan

FCC ID: YAIBM20

Report Type Original Report	**Product Type:** Wireless Module
Report Producer :	**Himiko Chen**
Report Number :	**RLK1806001-00A**
Report Date :	**2018/10/30**
Reviewed By:	**Jerry Chang**
Prepared By: **Bay Area Compliance Laboratories Corp.(Taiwan)** **70, Lane 169, Sec. 2, Datong Road, Xizhi Dist.,** **New Taipei City 22183, Taiwan, R.O.C.** **Tel: +886 (2)2647 6898** **Fax: +886 (2) 2647 6895** **www.bacl.com.tw**	

***Note**: This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (Taiwan)*

Revision History

Revision	Report Number	Issue Date	Description	Author/Revised by
1.0	RLK1806001-00A	2018/10/30	Original Report	Himiko Chen

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	**InnoComm Mobile Technology Corporation** 3F, No. 6, Hsin Ann Rd., Hsinchu Science Park, Hsinchu 30078, Taiwan
Manufacturer	**InnoComm Mobile Technology Corporation** 3F, No. 6, Hsin Ann Rd., Hsinchu Science Park, Hsinchu 30078, Taiwan
Brand(Trade) Name	innocomm
Product (Equipment)	**Wireless Module**
Model Name	**BM20**
EUT Function	BT4.0 + BT5.0
Frequency Range	BLE mode : 2402 ~ 2480 MHz
Number of Channels	BLE mode : 40 Channels
Output Power	BLE 1Mbps: 4.67 dBm (0.0029 W) BLE 2Mbps: 4.89 dBm (0.0031 W)
Received Date	Jun. 07, 2018
Date of Test	Sep. 19, 2018 ~ Oct. 30, 2018
Related Submittal(s)/Grant(s)	N/A
Modulation Type	GFSK

**All measurement and test data in this report was gathered from production sample serial number: 1806001 (Assigned by BACL, Taiwan).*

1.2 Operation Condition of EUT

Power Operation (Voltage Range)	☐ AC 120V/60Hz ☐ Adapter ☐ By Power Core
	☐ DC Type ☒ DC Power Supply 3.3V ☐ Battery ☐ External from USB Cable ☐ External DC Adapter
	☐ Host System

1.3 Objective and Test Methodology

The Objective and Test Methodology of this Test Report was to document the compliance of the InnoComm Mobile Technology Corporation Appliance (Model: BM20) to the requirements of the following Standards:

-Part 2, Subpart J, Part 15, Subparts A and C, section 15.247 of the Federal Communication Commission's rules.

- ANSI C63.10-2013 of t American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

1.4 Measurement Uncertainty

Parameter	Expanded Measurement uncertainty
RF output power with Power Meter	± 0.55 dB
Occupied Channel Bandwidth	± 4.45 %
RF Conducted test with Spectrum	± 1.45 dB
AC Power Line Conducted Emission	± 4.64 dB
Radiated Below 1G	± 5.83 dB
Radiated Above 1G-18G	± 5.35 dB
Radiated Above 18G-40G	± 4.49 dB

1.5 Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Taiwan) to collect test data is located on

☒ 70, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.

☒ 68-3, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.

2 System Test Configuration

2.1 Description of Test Configuration

The system was configured for testing in testing mode which was provided by manufacturer.

No special accessory, No modification was made to the EUT and No special equipment used during test.

For BLE mode, there are totally 40 channels.

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	**2402**	20	2442
1	2404	--	--
2	2406	--	--
3	2408	37	2476
--	--	38	2478
19	**2440**	**39**	**2480**

**For BLE mode: Channel 0, 19 and 39 were tested.*

The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the Peak power and PSD across all data rates and modulations of all bandwidth.

Radiated below 1G were tested worst output power mode.

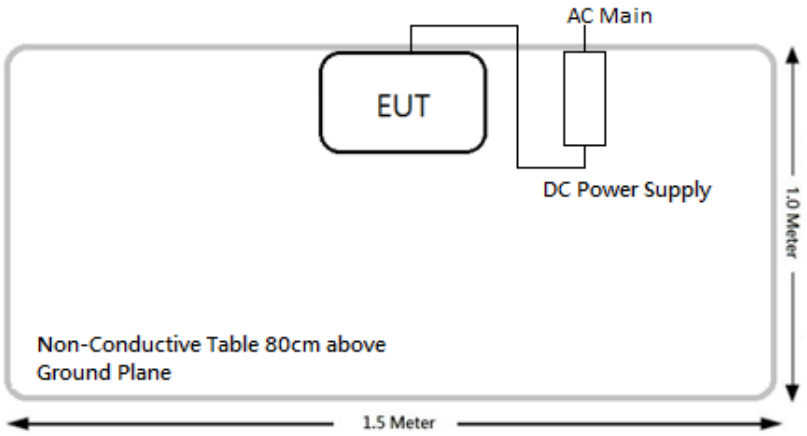
2.2 Description of Worst Test Configuration

Modulation Used for Conformance Test			
Configuration	**N_{TX}**	**Data Rate**	**Worst Data Rate**
BLE 1Mbps	1	125 kbps – 1 Mbps	1 Mbps
BLE 2Mbps	1	125 kbps – 2 Mbps	2 Mbps

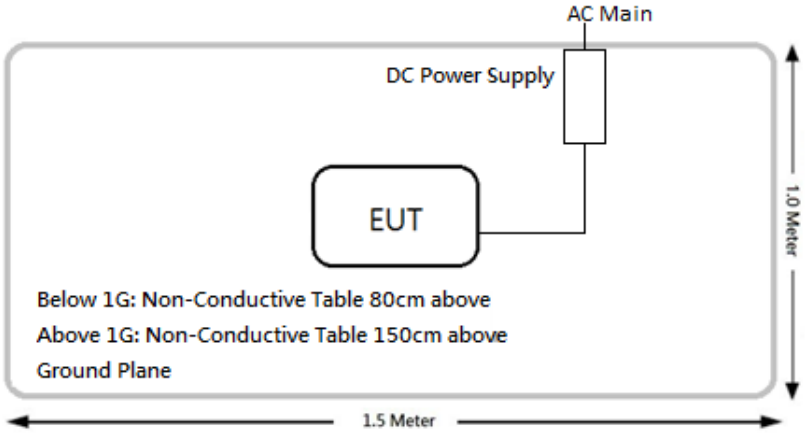
Worst Case of BLE Power Setting				
EUT Exercise Software		nRFgo Test Tool		
Configuration	**N_{TX}**	**2402**	**2440**	**2480**
BLE 1Mbps	1	Default	Default	Default
BLE 2Mbps	1	Default	Default	Default

2.3 Block Diagram of Test Setup

Conduction



Radiation

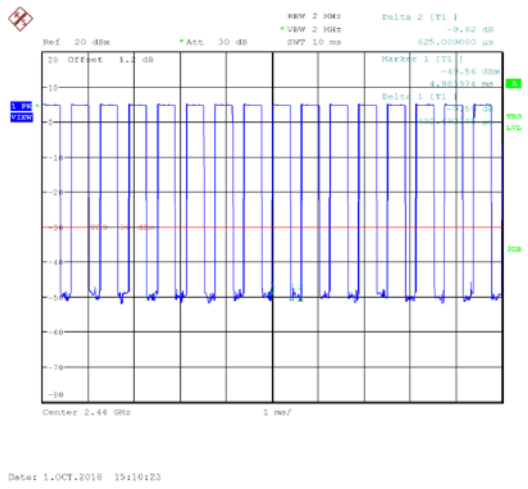
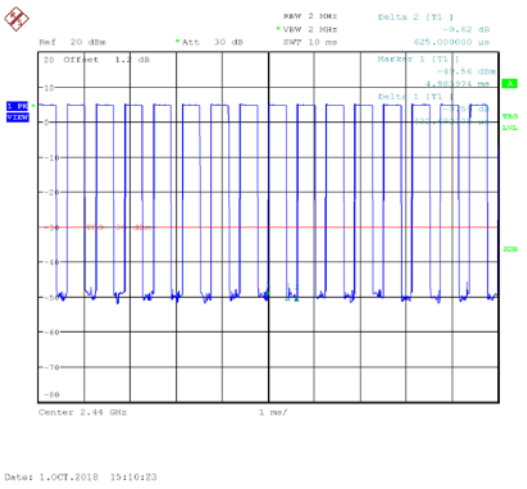


2.4 Duty Cycle

According to KDB 558074 D01 15.247 Meas Guidance v05:

All measurements are to be performed with the EUT transmitting at 100% duty cycle at its maximum power control level; however, if 100% duty cycle cannot be achieved, measurements of duty cycle, x, and maximum power transmission duration, T, are required for each tested mode of operation. (*Duty Factor = 10*log (1/Duty cycle))*

Configuration	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Factor (dB)
BLE 1Mbps mode	0.43	0.62	69.35	1.59
BLE 2Mbps mode	0.21	0.62	33.87	4.70

BLE 1Mbps mode	BLE 2Mbps mode
	

3 Summary of Test Results

FCC Rules	Description of Test	Result
§15.247(i), § 2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247(a)(2)	6 dB Emission Bandwidth	Compliance
§15.247(b)(3)	Maximum Peak Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

4 FCC §15.247(i), § 2.1093 – RF Exposure

4.1 Applicable Standard

According to FCC §2.1093 and §1.1307(b) (1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance v06

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] ·

[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum *test separation distance* is ≤ 50 mm, and for transmission frequencies between 100 MHz and 6 GHz. When the minimum *test separation distance* is < 5 mm, a distance of 5 mm according to 4.1 f) is applied to determine SAR test exclusion.

4.2 RF Exposure Evaluation Result

MPE evaluation:

Frequency (MHz)	Tunp-up Power		Evaluation Distrance (mm)	SAR Excluion Result	Extremity SAR Exclusion Limit
	(dBm)	(mW)			(1g SAR)
2402-2480	5	3.162	5	1.0066	3

Result: T**he stand-alone SAR evaluation for BLE is not necessary.**

5 FCC §15.203 – Antenna Requirements

5.1 Applicable Standard

According to § 15.203,

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

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 user of a standard antenna jack or electrical connector is prohibited.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna does not exceed 6 dBi

5.2 Antenna List and Details

Manufacturer	Model	Antenna Type	Antenna Gain	Result
InnoComm	BM20-BLE	PCB Antenna	2.14 dBi	Compliance

The EUT has an antenna permanently attached arrangement, fulfill the requirement of this section.

6 FCC §15.207 – AC Line Conducted Emissions

6.1 Applicable Standard

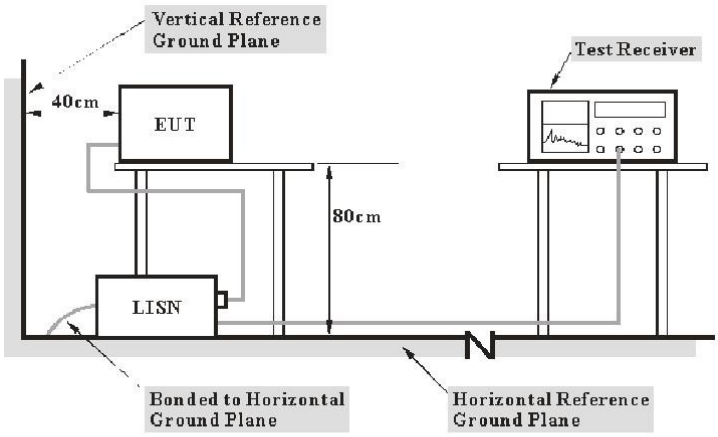
According to FCC §15.207

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 Note 1	56 to 46 Note 2
0.5-5	56	46
5-30	60	50

Note 1: Decreases with the logarithm of the frequency.
Note 2: A linear average detector is required

6.2 EUT Setup and Test Procedure



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz. During the conducted emission test, the EMI test receiver was set with the following configurations

Frequency Range	Receiver RBW
150 kHz - 30 MHz	9 kHz

During the conducted emission test, the adapter was connected to the outlet of the LISN. Maximizing procedure was performed on the six (6) highest emissions of the EUT. All data was recorded in the Quasi-peak and average detection mode.

6.3 Test Equipment List and Details

Manufacturers	Descriptions	Models	Serial Numbers	Calibration Date	Calibration Due Date
LISN	Rohde & Schwarz	ENV216	101612	2018/02/22	2019/02/21
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2017/11/06	2018/11/05
Pulse Limiter	Rohde & Schwarz	ESH3Z2	TXZEM104	2018/08/03	2019/08/02
RF Cable	EMEC	EM-CB5D	001	2018/07/02	2019/07/01
Software	AUDIX	E3	V9.150826k	N.C.R	N.C.R

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).*

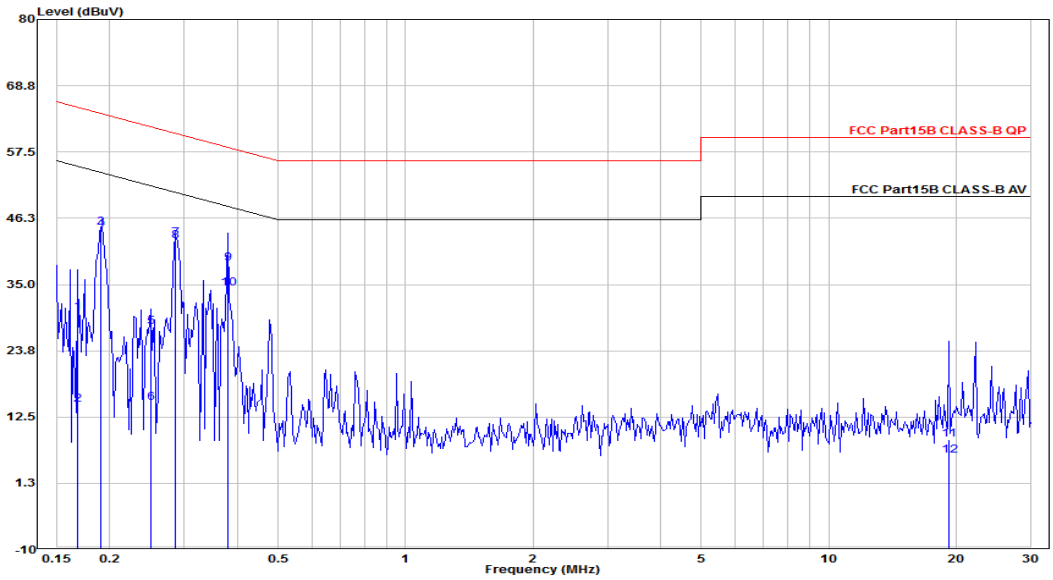
6.4 Test Environmental Conditions

Temperature:	22.1 ℃
Relative Humidity:	61.0 %
ATM Pressure:	1015 hPa

The testing was performed by Eric Lee from 2018-10-30.

6.5 AC Line Conducted Emission Test Plot and Data

Mode: AC 120V/60 Hz, Line



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBuV)	Factor(dB)	(dBuV)	(dBuV)	(dB)	
1	0.168	10.39	19.87	30.26	65.07	-34.81	QP
2	0.168	-5.23	19.87	14.63	55.07	-40.44	Average
3	0.191	24.73	19.86	44.59	64.01	-19.42	QP
4	0.191	24.46	19.86	44.32	54.01	-9.70	Average
5	0.250	7.86	19.87	27.73	61.76	-34.04	QP
6	0.250	-5.01	19.87	14.86	51.76	-36.91	Average
7	0.286	22.94	19.87	42.81	60.64	-17.83	QP
8	0.286	22.50	19.87	42.37	50.64	-8.27	Average
9	0.381	18.68	19.87	38.55	58.26	-19.71	QP
10	0.381	14.37	19.87	34.24	48.26	-14.01	Average
11	19.202	-11.50	20.17	8.67	60.00	-51.33	QP
12	19.202	-14.17	20.17	6.00	50.00	-44.00	Average

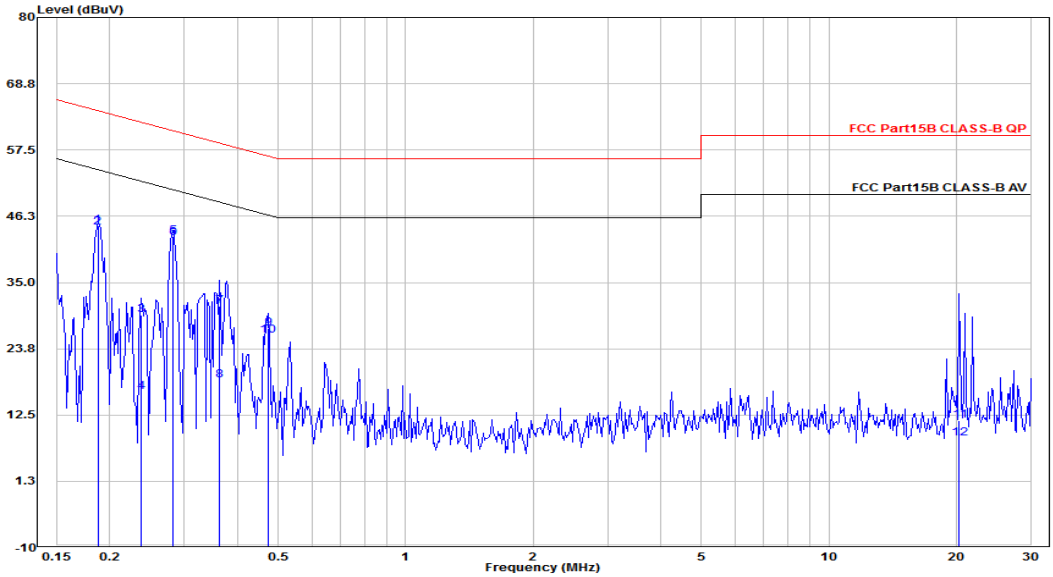
Note:

Level = Read Level + Factor

Over Limit (Margin) = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

Mode: AC 120V/60 Hz, Neutral



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBuV)	Factor(dB)	(dBuV)	(dBuV)	(dB)	
1	0.187	24.83	19.86	44.69	64.15	-19.46	QP
2	0.187	24.52	19.86	44.38	54.15	-9.76	Average
3	0.238	9.53	19.86	29.39	62.16	-32.77	QP
4	0.238	-3.51	19.86	16.36	52.16	-35.81	Average
5	0.281	22.92	19.86	42.78	60.77	-17.99	QP
6	0.281	22.72	19.86	42.58	50.77	-8.19	Average
7	0.363	11.16	19.86	31.02	58.65	-27.64	QP
8	0.363	-1.48	19.86	18.38	48.65	-30.28	Average
9	0.472	7.35	19.87	27.22	56.47	-29.25	QP
10	0.472	6.14	19.87	26.01	46.47	-20.46	Average
11	20.304	-8.64	20.22	11.58	60.00	-48.42	QP
12	20.304	-11.70	20.22	8.52	50.00	-41.48	Average

Note:

Level = Read Level + Factor

Over Limit (Margin) = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

7 FCC §15.209, §15.205, §15.247(d) – Spurious Emissions

7.1 Applicable Standard

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

As Per FCC §15.205(a) except as show 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 0.495 – 0.505 2.1735 – 2.1905 4.125 – 4.128 4.17725 – 4.17775 4.20725 – 4.20775 6.215 – 6.218 6.26775 – 6.26825 6.31175 – 6.31225 8.291 – 8.294 8.362 – 8.366 8.37625 – 8.38675 8.41425 – 8.41475 12.29 – 12.293 12.51975 – 12.52025 12.57675 – 12.57725 13.36 – 13.41	16.42 – 16.423 16.69475 – 16.69525 25.5 – 25.67 37.5 – 38.25 73 – 74.6 74.8 – 75.2 108 – 121.94 123 – 138 149.9 – 150.05 156.52475 – 156.52525 156.7 – 156.9 162.0125 –167.17 167.72 – 173.2 240 – 285 322 – 335.4 399.9 – 410	608 – 614 960 – 1240 1300 – 1427 1435 – 1626.5 1645.5 – 1646.5 1660 – 1710 1718.8 – 1722.2 2200 – 2300 2310 – 2390 2483.5 – 2500 2690 – 2900 3260 – 3267 3.332 – 3.339 3 3458 – 3 358 3.600 – 4.400	4. 5 – 5. 15 5. 35 – 5. 46 7.25 – 7.75 8.025 – 8.5 9.0 – 9.2 9.3 – 9.5 10.6 – 12.7 13.25 – 13.4 14.47 – 14.5 15.35 – 16.2 17.7 – 21.4 22.01 – 23.12 23.6 – 24.0 31.2 – 31.8 36.43 – 36.5 Above 38.6

As per FCC §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:

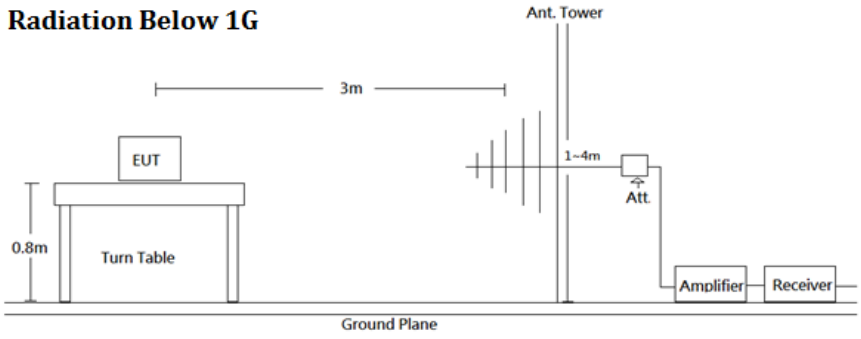
Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** 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.

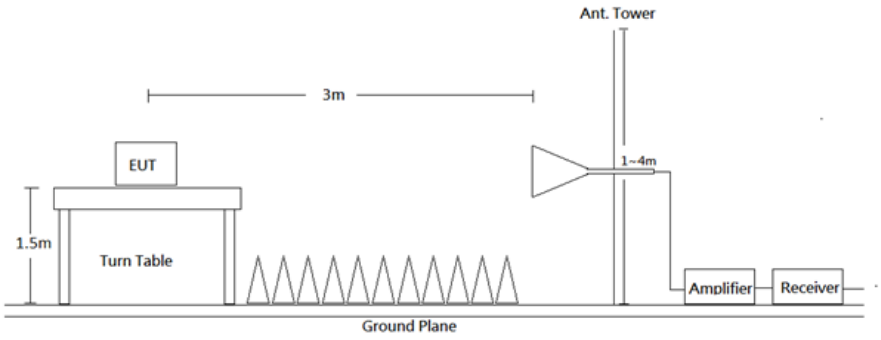
As per FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

7.2 EUT Setup and Test Procedure

Radiation Below 1G



Radiation Above 1G



Radiated emission tests were performed in the 3 meters chamber test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC Part 15.209 and FCC 15.247 Limits.

The system was investigated from 30 MHz to 26.5 GHz. During the radiated emission test, the EMI test receiver was set with the following configurations measurement method 6.3 in ANSI C63.10.

Frequency Range	RBW	VBW	Detector	Duty cycle	Measurement method
30-1000 MHz	120 kHz	/	QP		QP
Above 1 GHz	1 MHz	3 MHz	PK		PK
	1 MHz	3 MHz	RMS	>98%	Ave
	1 MHz	1/T	PK	<98%	Ave

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All data was recorded in the Quasi-peak detector mode from 30 MHz to 1 GHz and PK and average detector modes for frequencies above 1 GHz.

7.3 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
966A Room					
Bilog Antenna with 6 dB Attenuator	SUNOL SCIENCES & MINI-CIRCUITS	JB6/UNAT-6+	A050115/15542_01	2017/12/20	2018/12/19
Horn Antenna	EMCO	3115	9311-4158	2018/04/20	2019/04/19
Horn Antenna	ETS-Lindgren	3116	62638	2018/08/29	2019/08/28
Preamplifier	Sonoma	310N	130602	2018/07/04	2019/07/03
Preamplifier	EM Electronics Corp.	EM01G18G	060657	2017/12/14	2018/12/13
Microware Preamplifier	EM Electronics Corporation	EM18G40G	060656	2018/01/15	2019/01/14
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2017/11/06	2018/11/05
Spectrum Analyzer	Rohde & Schwarz	FSV40	101435	2018/02/12	2019/02/13
Micro flex Cable	UTIFLEX	FSCM 64639 / (2M)	93D0127	2018/07/31	2019/07/30
Micro flex Cable	UTIFLEX	UFA210A-1-3149-300300	MFR64639 226389-001	2017/11/10	2018/11/09
Micro flex Cable	ROSNOL	K1K50-UP0264-K1K50-450CM	160309-1	2018/03/05	2019/03/04
Micro flex Cable	ROSNOL	K1K50-UP0264-K1K50-80CM	160309-2	2018/01/17	2019/01/16
20 dB Attenuator	NCL	BW-S20W5+	NA	Each Use	/
Turn Table	Champro	TT-2000	060772-T	N.C.R	N.C.R
Antenna Tower	Champro	AM-BS-4500-B	060772-A	N.C.R	N.C.R
Controller	Champro	EM1000	060772	N.C.R	N.C.R
Software	Farad	EZ_EMC	BACL-03A1	N.C.R	N.C.R

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).*

Description	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Room					
Spectrum Analyzer	Rohde & Schwarz	FSU26	200268	2018/05/04	2019/05/03
Cable	WOKEN	SFL402	S02-160323-07	2018/02/12	2019/02/11

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).*

7.4 Test Environmental Conditions

Temperature:	22.1 ℃
Relative Humidity:	61.0 %
ATM Pressure:	1015 hPa

The testing was performed by Eric Lee from 2018-10-01 to 2018-10-12.

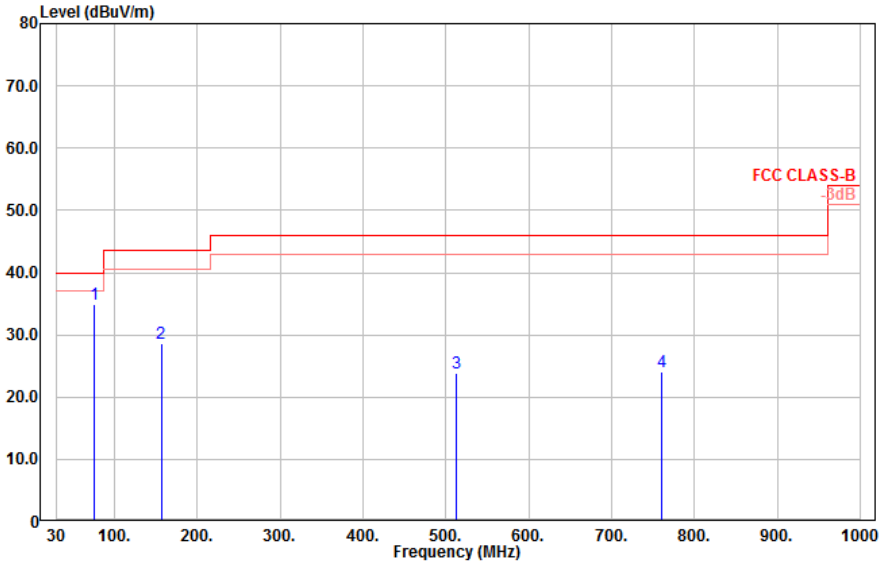
7.5 Radiated Emission Test Plot and Data

BLE Mode: Transmitting Mode *(Pre-scan with three orthogonal axis, and worse case as X axis)*

Below 1G (30 MHz-1 GHz) test the output power worst mode:

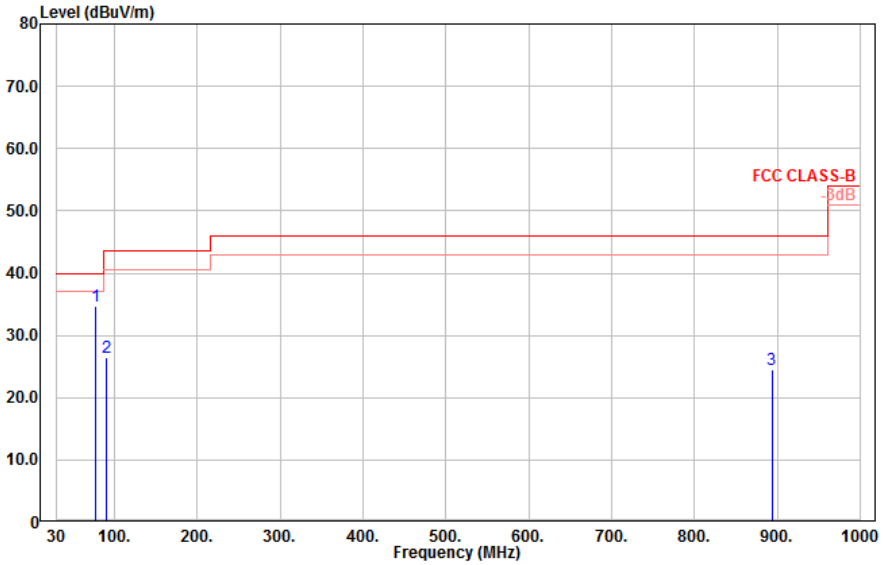
Wi-Fi mode: Worst case is BLE 1 Mbps Low Channel.

Horizontal



	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m		
1	76.391	34.88	40.00	-5.12	57.30	-22.42	Peak	horizontal
2	156.522	28.52	43.50	-14.98	47.13	-18.61	Peak	horizontal
3	512.188	23.89	46.00	-22.11	37.91	-14.02	Peak	horizontal
4	759.609	24.01	46.00	-21.99	34.45	-10.44	Peak	horizontal

Vertical



	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m		
1	77.797	34.79	40.00	-5.21	57.29	-22.50	Peak	vertical
2	90.449	26.51	43.50	-16.99	49.44	-22.93	Peak	vertical
3	893.159	24.47	46.00	-21.53	33.42	-8.95	Peak	vertical

BLE 1 Mbps mode

Fundamental and Band Edge:

Pre-scan with Horizontal and Vertical, the worst case was Horizontal.

Low CH Horizontal Peak

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2337.681	49.45	74.00	-24.55	58.01	-8.56	Peak
2402.319	[illegible]	[illegible]	22.56	105.04	-8.48	Peak

Low CH Horizontal Average

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2337.971	37.87	54.00	-16.13	46.43	-8.56	Average
2402.174	77.36			85.84	-8.48	Average

Mid CH Horizontal Peak

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2311.652	50.95	74.00	-23.05	59.57	-8.62	Peak
2440.522	97.83	[illegible]	[illegible]	106.20	-8.37	Peak
2489.812	46.81	74.00	-27.19	55.04	-8.23	Peak

Mid CH Horizontal Average

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2311.927	38.72	54.00	-15.28	47.33	-8.61	Average
2439.971	72.21			80.58	-8.37	Average
2486.783	35.54	54.00	-18.46	43.78	-8.24	Average

High CH Horizontal Peak

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2480.326	97.13		[illegible]	105.38	-8.25	Peak
2483.500	55.87	74.00	-18.13	64.11	-8.24	Peak

High CH Horizontal Average

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2479.964	74.71			82.96	-8.25	Average
2483.500	31.19	54.00	-22.81	39.43	-8.24	Average

Result = Reading + Correct Factor

Margin = Result – Limit

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

Spurious emissions more than 20 dB below the limit were not reported

Spurious Emission: 1 GHz to 26.5 GHz:

Low CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
4804.000	43.08	54.00	-10.92	44.08	-1.00	Average
4804.000	53.65	74.00	-20.35	54.65	-1.00	Peak
7206.000	33.44	54.00	-20.56	31.65	1.79	Average
7206.000	46.64	74.00	-27.36	44.85	1.79	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
4804.000	39.66	54.00	-14.34	40.66	-1.00	Average
4804.000	50.53	74.00	-23.47	51.53	-1.00	Peak
7206.000	36.74	54.00	-17.26	34.95	1.79	Average
7206.000	50.45	74.00	-23.55	48.66	1.79	Peak

Mid CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
4880.000	43.47	54.00	-10.53	44.35	-0.88	Average
4880.000	52.83	74.00	-21.17	53.68	-0.85	Peak
7320.000	35.00	54.00	-19.00	32.56	2.44	Average
7320.000	47.95	74.00	-26.05	45.79	2.16	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
4880.000	42.69	54.00	-11.31	43.57	-0.88	Average
4880.000	51.14	74.00	-22.86	52.02	-0.88	Peak
7320.000	36.58	54.00	-17.42	34.46	2.12	Average
7320.000	50.02	74.00	-23.98	47.90	2.12	Peak

High CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
4960.000	41.95	54.00	-12.05	42.74	-0.79	Average
4960.000	51.90	74.00	-22.10	52.70	-0.80	Peak
7440.000	33.28	54.00	-20.72	30.63	2.65	Average
7440.000	45.51	74.00	-28.49	42.86	2.65	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
4960.000	41.01	54.00	-12.99	41.81	-0.80	Average
4960.000	51.06	74.00	-22.94	51.86	-0.80	Peak
7440.000	35.61	54.00	-18.39	32.96	2.65	Average
7440.000	48.16	74.00	-25.84	45.51	2.65	Peak

Result = Reading + Correct Factor

Margin = Result – Limit

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

Spurious emissions more than 20 dB below the limit were not reported

BLE 2 Mbps mode

Fundamental and Band Edge:

Pre-scan with Horizontal and Vertical, the worst case was Horizontal.

Low CH Horizontal Peak

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2311.594	50.38	74.00	-23.62	59.00	-8.62	Peak
2401.594	99.93			108.41	-8.48	Peak

Low CH Horizontal Average

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2356.812	43.84	54.00	-10.16	52.38	-8.54	Average
2402.029	97.22			105.70	-8.48	Average

Mid CH Horizontal Peak

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2311.927	53.01	74.00	-20.99	61.62	-8.61	Peak
2440.246	100.40			108.77	-8.37	Peak
2486.783	49.45	74.00	-24.55	57.69	-8.24	Peak

Mid CH Horizontal Average

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2311.927	46.04	54.00	-7.96	54.65	-8.61	Average
2439.971	97.68			106.05	-8.37	Average
2485.406	42.49	54.00	-11.51	50.73	-8.24	Average

High CH Horizontal Peak

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2479.529	99.33			107.58	-8.25	Peak
2483.500	58.39	74.00	-15.61	66.63	-8.24	Peak

High CH Horizontal Average

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2480.036	96.58			104.83	-8.25	Average
2483.500	41.42	54.00	-12.58	49.66	-8.24	Average

Result = Reading + Correct Factor

Margin = Result – Limit

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

Spurious emissions more than 20 dB below the limit were not reported

Spurious Emission: 1 GHz to 26.5 GHz:

Low CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
4804.000	35.61	54.00	-18.39	36.64	-1.03	Average
4804.000	52.90	74.00	-21.10	53.93	-1.03	Peak
7206.000	32.44	54.00	-21.56	29.71	2.73	Average
7206.000	47.65	74.00	-26.35	44.92	2.73	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
4804.000	33.80	54.00	-20.20	35.06	-1.26	Average
4804.000	48.52	74.00	-25.48	49.78	-1.26	Peak
7206.000	34.20	54.00	-19.80	30.70	3.50	Average
7206.000	49.34	74.00	-24.66	45.84	3.50	Peak

Mid CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
4880.000	35.37	54.00	-18.63	36.25	-0.88	Average
4880.000	49.80	74.00	-24.20	50.68	-0.88	Peak
7320.000	31.80	54.00	-22.20	29.45	2.35	Average
7320.000	46.04	74.00	-27.96	43.69	2.35	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
4880.000	34.80	54.00	-19.20	35.68	-0.88	Average
4880.000	48.81	74.00	-25.19	49.69	-0.88	Peak
7320.000	32.70	54.00	-21.30	30.35	2.35	Average
7320.000	47.81	74.00	-26.19	45.46	2.35	Peak

High CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
4960.000	35.90	54.00	-18.10	36.93	-1.03	Average
4960.000	51.65	74.00	-22.35	52.68	-1.03	Peak
7440.000	31.55	54.00	-22.45	29.43	2.12	Average
7440.000	46.77	74.00	-27.23	44.65	2.12	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
4960.000	35.74	54.00	-18.26	36.77	-1.03	Average
4960.000	48.79	74.00	-25.21	49.82	-1.03	Peak
7440.000	33.90	54.00	-20.10	31.46	2.44	Average
7440.000	47.32	74.00	-26.68	44.88	2.44	Peak

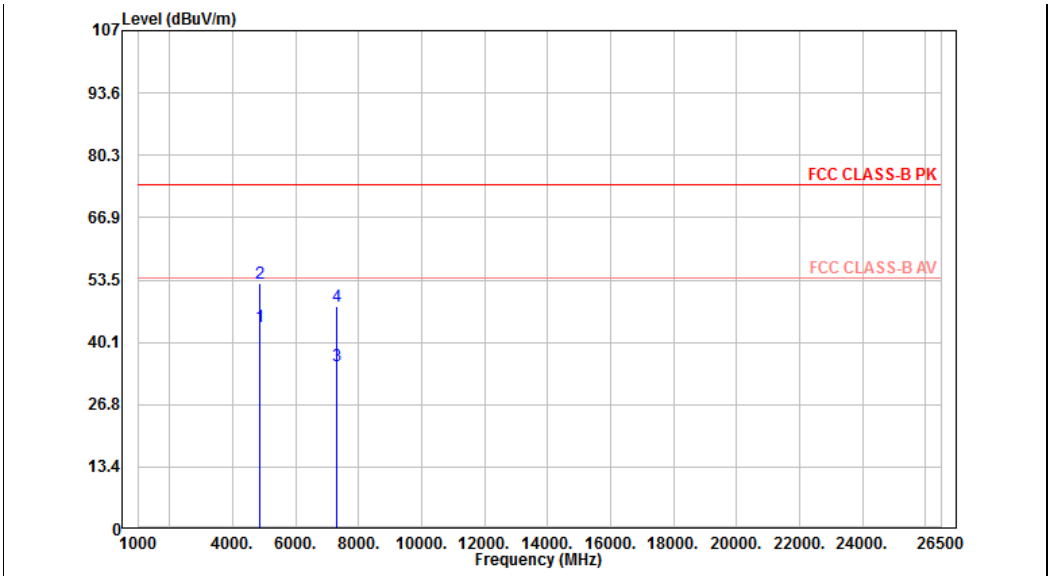
Result = Reading + Correct Factor

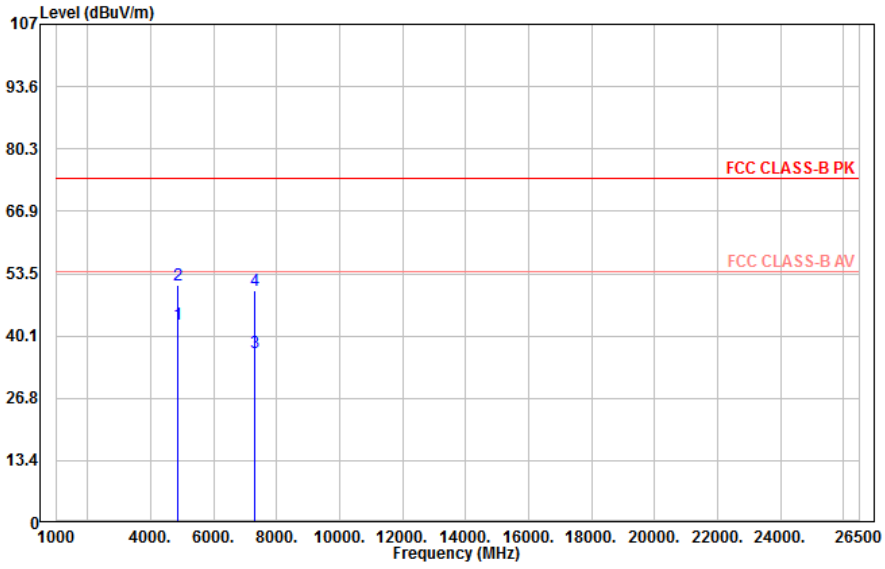
Margin = Result – Limit

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

Spurious emissions more than 20 dB below the limit were not reported

Spurious Emission: 1 GHz to 26.5 GHz: the output power worst case is BLE 1 Mbps mode Low channel

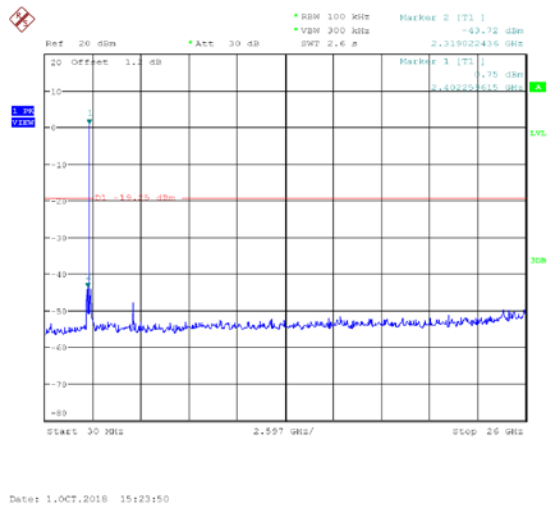
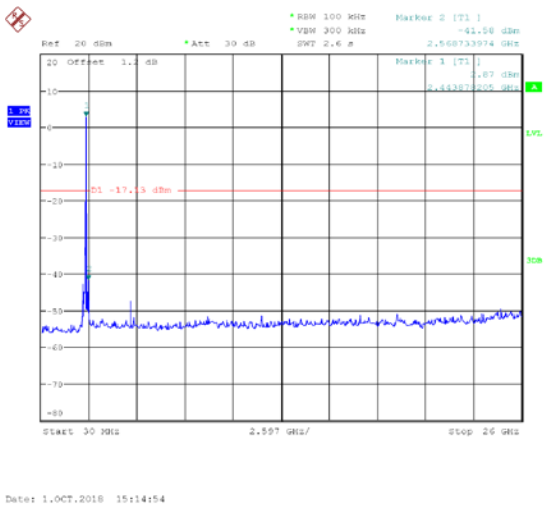
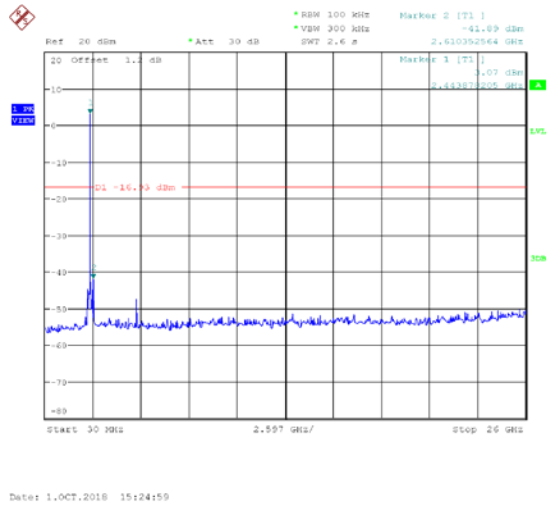
Horizontal


Vertical


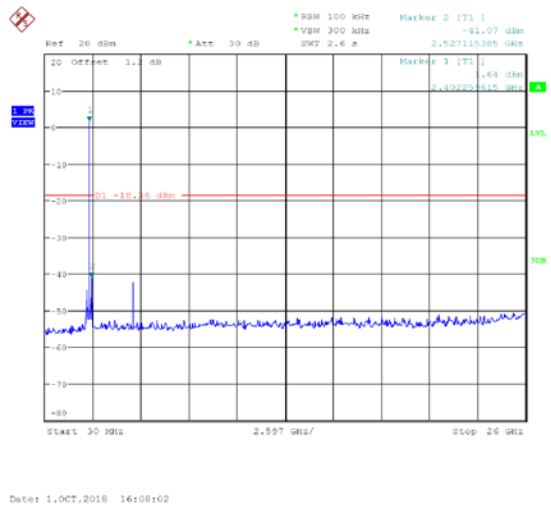
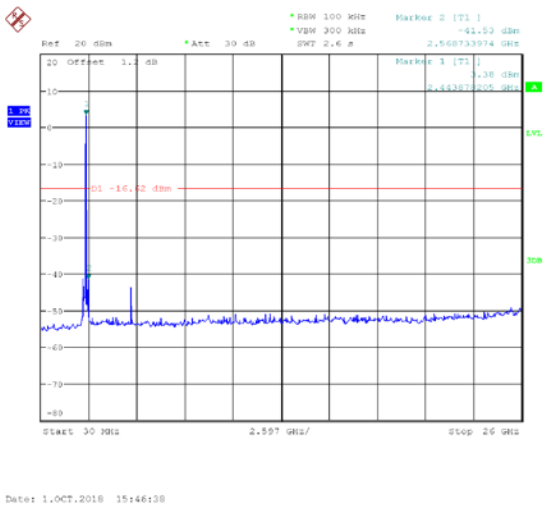
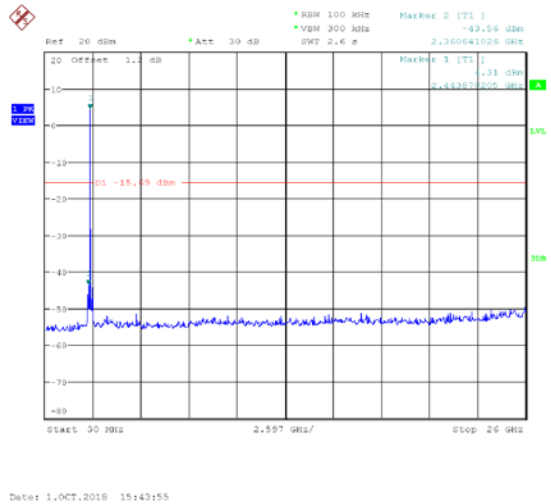
Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE 1 Mbps mode				
Low	2402	44.47	≥ 20	Compliance
Mid	2440	44.45	≥ 20	Compliance
High	2480	44.96	≥ 20	Compliance
BLE 2 Mbps mode				
Low	2402	42.71	≥ 20	Compliance
Mid	2440	44.91	≥ 20	Compliance
High	2480	47.87	≥ 20	Compliance

BLE 1 Mbps mode:

Low Channel	Middle Channel
	
High Channel	
	

BLE 2 Mbps mode:

Low Channel	Middle Channel
	
High Channel	
	

8 FCC §15.247(a)(2) – 6 dB Emission Bandwidth

8.1 Applicable Standard

According to FCC §15.247(a) (2).

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.2 Test Procedure

According to ANSI C63.10-2013

6 dB Emission Bandwidth

The steps for the first option are as follows:

a) Set RBW = 100 kHz. b) Set the VBW ≥ [3 × RBW]. c) Detector = peak. d) Trace mode = max hold.

e) Sweep = auto couple. f) Allow the trace to stabilize. g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

8.3 Test Equipment List and Details

Descriptions	Manufacturers	Models	Serial Numbers	Calibration Date	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSU26	101140	2017/11/15	2018/11/14
Cable	WOKEN	SFL402	S02-160323-07	2018/02/12	2019/02/11

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).*

8.4 Test Environmental Conditions

Temperature:	22.1 ℃
Relative Humidity:	61.0 %
ATM Pressure:	1015 hPa

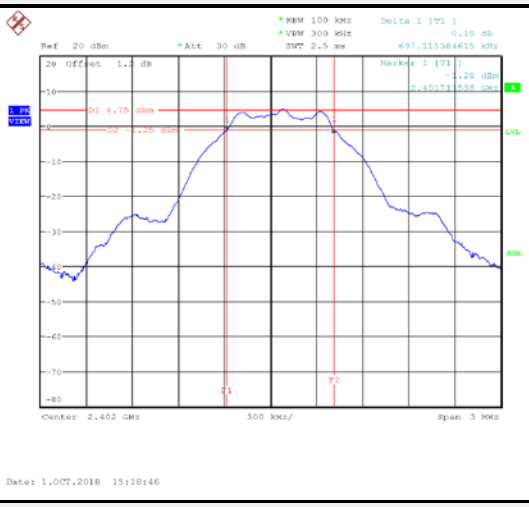
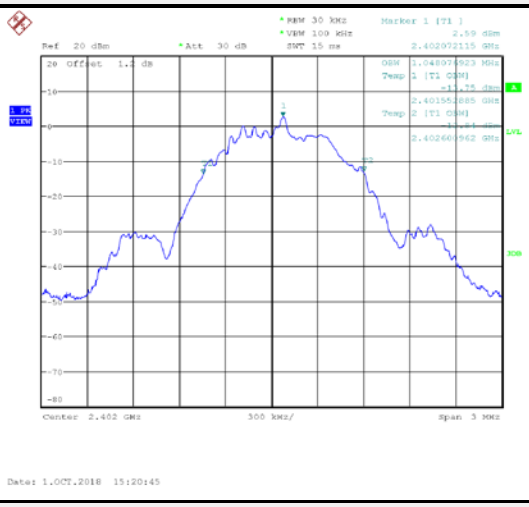
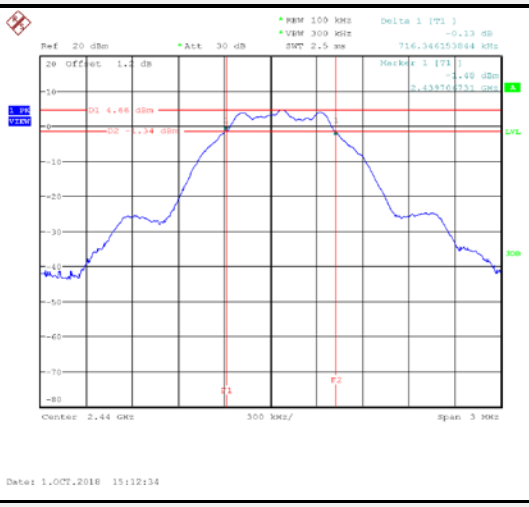
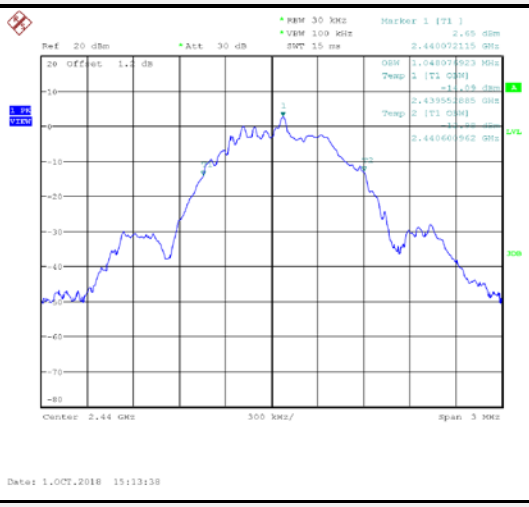
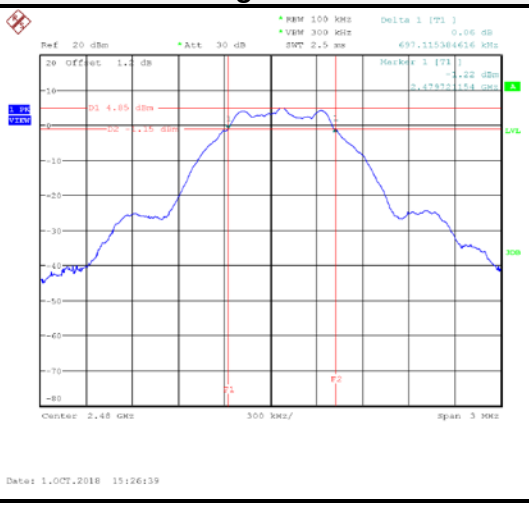
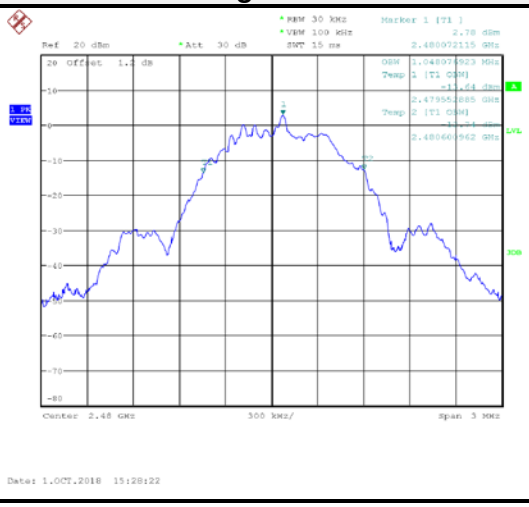
The testing was performed by Eric Lee on 2018-10-01.

8.5 Test Results

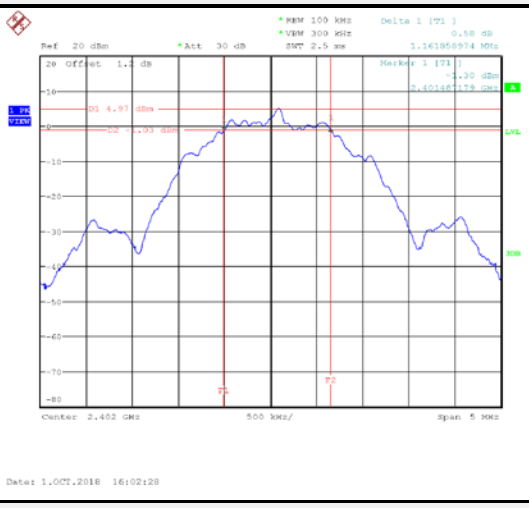
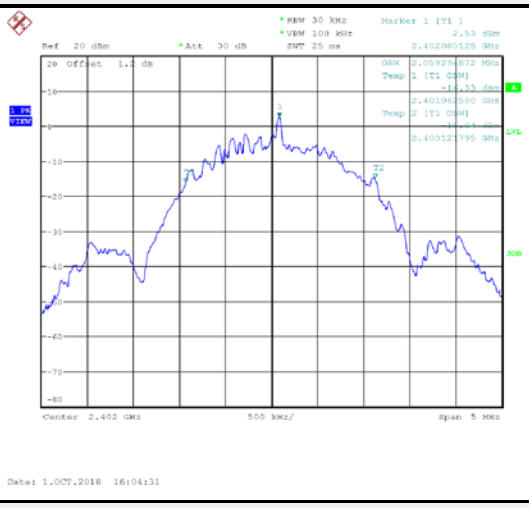
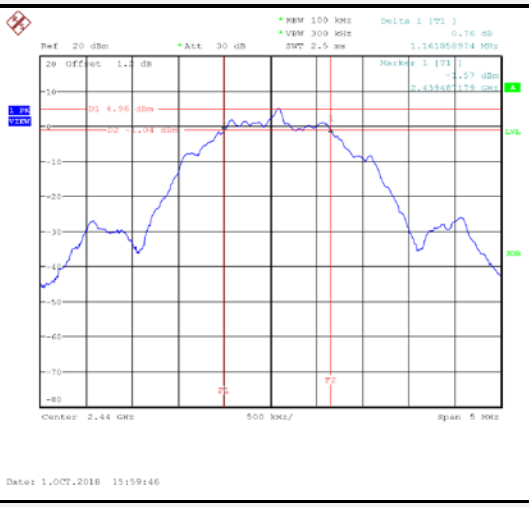
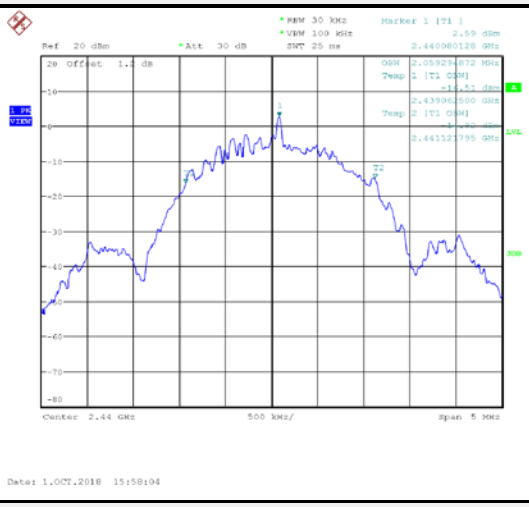
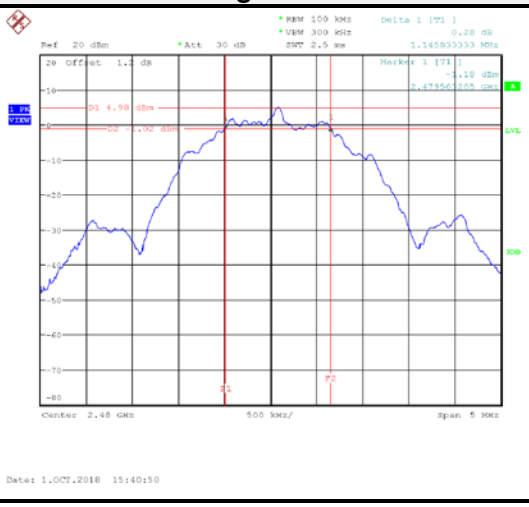
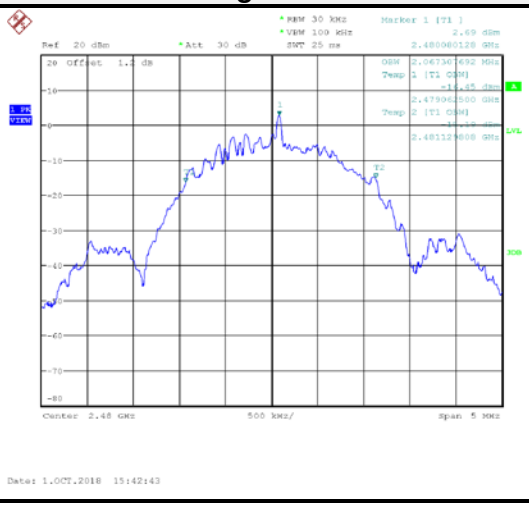
Channel	Frequency (MHz)	6 dB OBW (MHz)	99% Bandwidth (MHz)	6dB Limit (MHz)	Result
BLE 1Mbps mode					
Low	2402	0.6971	1.0481	> 0.5	Compliance
Middle	2440	0.7163	1.0481	> 0.5	Compliance
High	2480	0.6971	1.0481	> 0.5	Compliance
BLE 2Mbps mode					
Low	2402	1.1619	2.0593	> 0.5	Compliance
Middle	2440	1.1619	2.0593	> 0.5	Compliance
High	2480	1.1458	2.0673	> 0.5	Compliance

Please refer to the following plots

BLE 1 Mbps mode:

6 dB Emission Bandwidth	Occupied Bandwidth (99%)
Low Channel	**Low Channel**
	
Middle Channel	**Middle Channel**
	
High Channel	**High Channel**
	

BLE 2 Mbps mode:

6 dB Emission Bandwidth	Occupied Bandwidth (99%)
Low Channel	**Low Channel**
	
Middle Channel	**Middle Channel**
	
High Channel	**High Channel**
	

9 FCC §15.247(b)(3) – Maximum Output Power

9.1 Applicable Standard

According to FCC §15.247(b) (3).

Systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

9.2 Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to measuring equipment.
3. Add a correction factor to the display.

9.3 Test Equipment List and Details

Descriptions	Manufacturers	Models	Serial Numbers	Calibration Date	Calibration Due Date
Power Sensor	KEYSIGHT	U2021XA	MY54080018	2018/03/07	2019/03/06
Cable	WOKEN	SFL402	S02-160323-07	2018/02/12	2019/02/11

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).*

9.4 Test Environmental Conditions

Temperature:	22.1 ℃
Relative Humidity:	61.0 %
ATM Pressure:	1015 hPa

The testing was performed by Eric Lee on 2018-10-01.

9.5 Test Results

Channel	Frequency (MHz)	Maximum peak Conducted Output Power (dBm)	Limit (dBm)	Result
BLE 1 Mbps mode				
Low	2402	4.67	30	Compliance
Middle	2440	4.59	30	Compliance
High	2480	4.44	30	Compliance
BLE 2 Mbps mode				
Low	2402	4.89	30	Compliance
Middle	2440	4.84	30	Compliance
High	2480	4.72	30	Compliance

10 FCC §15.247(d) – 100 kHz Bandwidth of Frequency Band Edge

10.1 Applicable Standard

According to FCC §15.247(d).

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

10.2 Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

10.3 Test Equipment List and Details

Descriptions	Manufacturers	Models	Serial Numbers	Calibration Date	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSU26	101140	2017/11/15	2018/11/14
Cable	WOKEN	SFL402	S02-160323-07	2018/02/12	2019/02/11

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).*

10.4 Test Environmental Conditions

Temperature:	22.1 ℃
Relative Humidity:	61.0 %
ATM Pressure:	1015 hPa

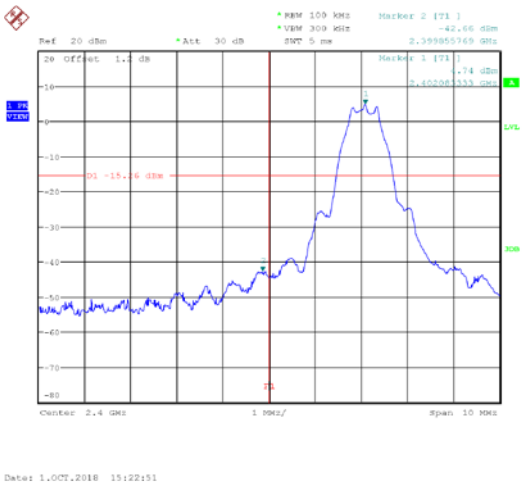
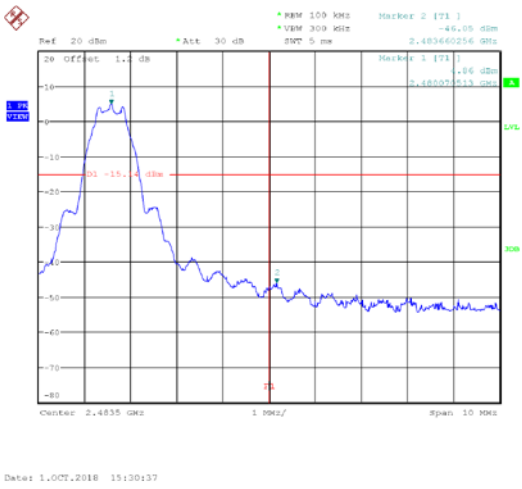
The testing was performed by Eric Lee on 2018-10-01.

10.5 Test Results

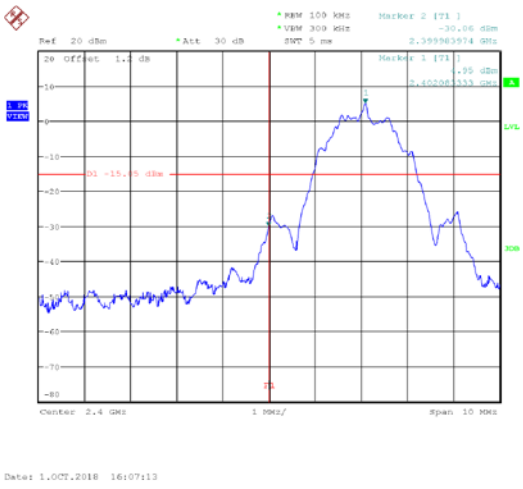
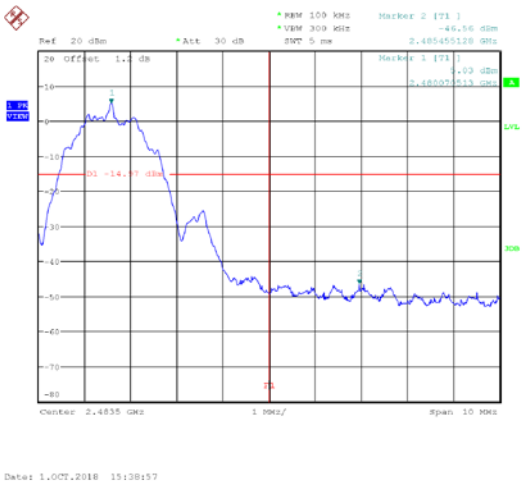
Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	RESULT
BLE 1 Mbps mode				
Low	2402	47.40	≥ 20	PASS
High	2480	50.91	≥ 20	PASS
BLE 2 Mbps mode				
Low	2402	35.51	≥ 20	PASS
High	2480	51.59	≥ 20	PASS

Please refer to the following plots

BLE 1 Mbps mode:

Band Edge, Left Side	Band Edge, Right Side
	

BLE 2 Mbps mode:

Band Edge, Left Side	Band Edge, Right Side
	

11 FCC §15.247(e) – Power Spectral Density

11.1 Applicable Standard

According to FCC §15.247(e).

For digitally modulated systems, the power spectral density conducted from the intentional radiator 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 paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

11.2 Test Procedure

According to ANSI C63.10-2013

a) Set analyzer center frequency to DTS channel center frequency.

b) Set the span to 1.5 times the DTS bandwidth. c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.

d) Set the VBW ≥ [3 × RBW]. e) Detector = peak. f) Sweep time = auto couple.

g) Trace mode = max hold. h) Allow trace to fully stabilize.

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

j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat

11.3 Test Equipment List and Details

Descriptions	Manufacturers	Models	Serial Numbers	Calibration Date	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSU26	101140	2017/11/15	2018/11/14
Cable	WOKEN	SFL402	S02-160323-07	2018/02/12	2019/02/11

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI)*.

11.4 Test Environmental Conditions

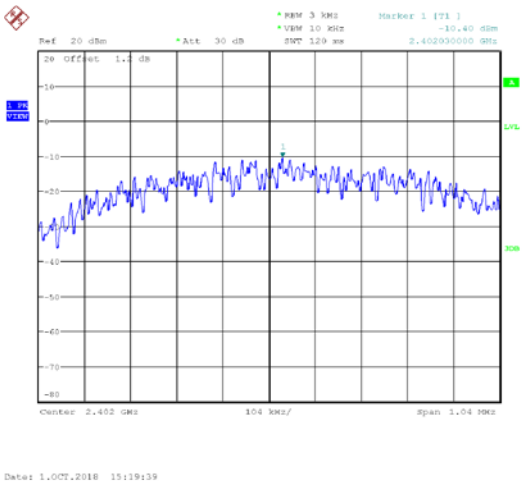
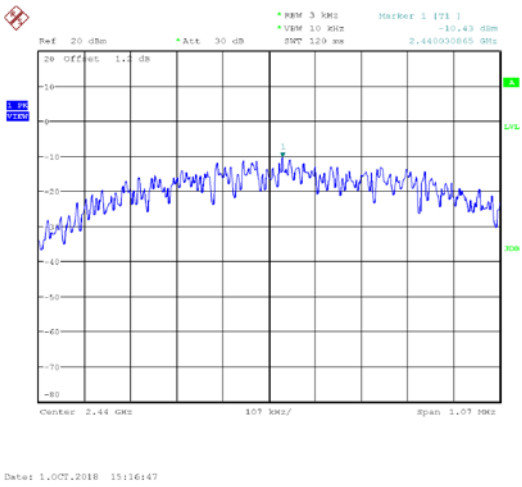
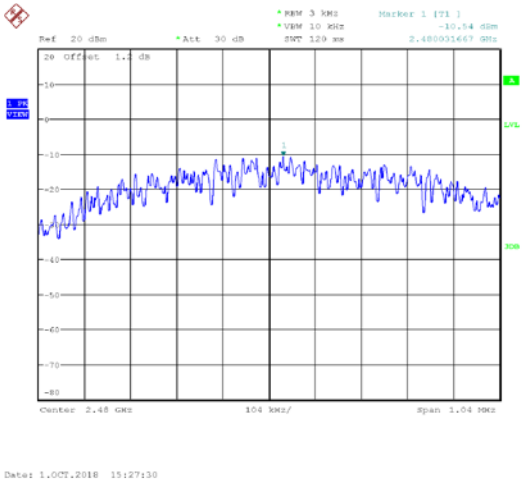
Temperature:	22.1 ℃
Relative Humidity:	61.0 %
ATM Pressure:	1015 hPa

The testing was performed by Eric Lee from 2018-10-01

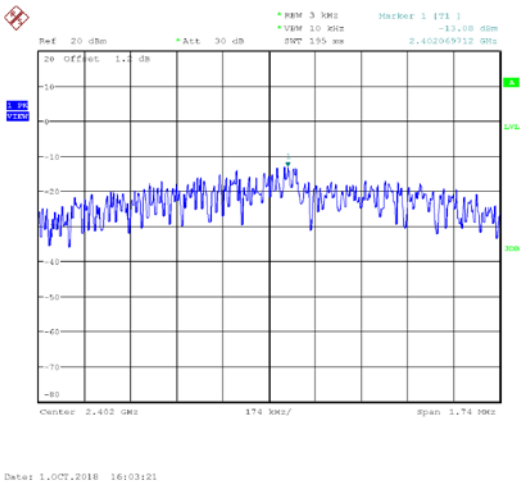
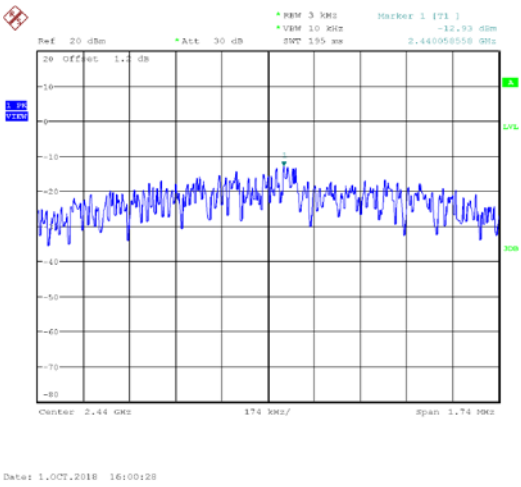
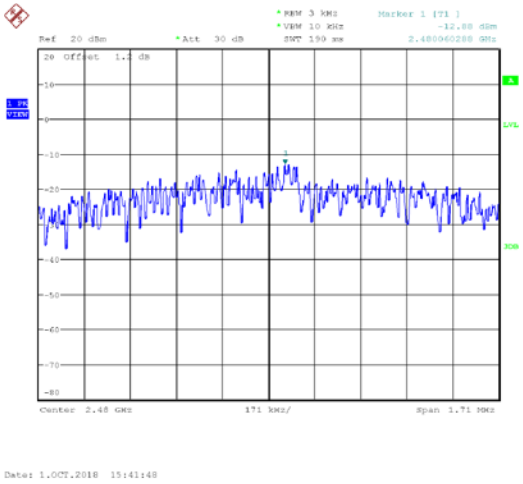
11.5 Test Results

Channel	Frequency (MHz)	PSD (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
BLE 1 Mbps mode				
Low	2402	-10.40	8	Compliance
Middle	2440	-10.43	8	Compliance
High	2480	-10.54	8	Compliance
BLE 2 Mbps mode				
Low	2402	-13.08	8	Compliance
Middle	2440	-12.93	8	Compliance
High	2480	-12.88	8	Compliance

BLE 1 Mbps mode:

Low Channel	Middle Channel
	
High Channel	**-**
	

BLE 2 Mbps mode:

Low Channel	Middle Channel
	
High Channel	**-**
	

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