



# FCC RADIO TEST REPORT

**FCC ID** : Z64-LPSTKCC1352R  
**Equipment** : CC1352R LaunchPad SensorTag Kit  
**Brand Name** : Texas Instruments Incorporated  
**Model Name** : LPSTK-CC1352R  
**Marketing Name** : SimpleLink™ multiprotocol CC1352R  
wireless MCU LaunchPad™ SensorTag  
development kit  
**Applicant** : Texas Instruments Incorporated  
12500 TI BLVD., Dallas Texas, 75243  
**Manufacturer** : Texas Instruments Incorporated  
12500 TI BLVD., Dallas Texas, 75243  
**Standard** : FCC Part 15 Subpart C §15.247

The product was received on Sep. 10, 2019 and testing was started from Sep. 27, 2019 and completed on Oct. 15, 2019. We, SPORTON INTERNATIONAL INC., EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

*Louis Wu*

Approved by: Louis Wu

**SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory**  
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)



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## History of this test report

Report No.	Version	Description	Issued Date
FR991024A	01	Initial issue of report	Oct. 30, 2019

## Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.247(a)(2)	6dB Bandwidth	Pass	-
3.1	2.1049	99% Occupied Bandwidth	Reporting only	-
3.2	15.247(b)(3)	Peak Output Power	Pass	-
3.3	15.247(e)	Power Spectral Density	Pass	-
3.4	15.247(d)	Conducted Band Edges and Spurious Emission	Pass	-
3.5	15.247(d)	Radiated Band Edges and Spurious Emission	Pass	Under limit 7.21 dB at 30.000 MHz
-	15.207	AC Conducted Emission	Not Required	-
3.6	15.203 & 15.247(b)	Antenna Requirement	Pass	-

**Remark:** Not required means after assessing, test items are not necessary to carry out.

**Declaration of Conformity:**

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

**Comments and Explanations:**

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

**Reviewed by: Wii Chang**

**Report Producer: Vivian Hsu**

# 1 General Description

## 1.1 Product Feature of Equipment Under Test

Bluetooth Low Energy, and Sub-1GHz

Product Specification subjective to this standard	
Antenna Type	Bluetooth Low Energy: PCB Trace Antenna Sub-1GHz: Whip Antenna

## 1.2 Modification of EUT

No modifications are made to the EUT during all test items.

## 1.3 Testing Location

Test Site	SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory	
Test Site Location	No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978	
Test Site No.	Sporton Site No.	
	TH05-HY	03CH07-HY

**Note:** The test site complies with ANSI C63.4 2014 requirement.

FCC designation No.: TW1190

## 1.4 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02
- ♦ FCC KDB 414788 D01 Radiated Test Site v01r01
- ♦ ANSI C63.10-2013

### Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

## 2 Test Configuration of Equipment Under Test

### 2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	0	2402	21	2444
	1	2404	22	2446
	2	2406	23	2448
	3	2408	24	2450
	4	2410	25	2452
	5	2412	26	2454
	6	2414	27	2456
	7	2416	28	2458
	8	2418	29	2460
	9	2420	30	2462
	10	2422	31	2464
	11	2424	32	2466
	12	2426	33	2468
	13	2428	34	2470
	14	2430	35	2472
	15	2432	36	2474
	16	2434	37	2476
	17	2436	38	2478
	18	2438	39	2480
	19	2440	-	-
	20	2442	-	-

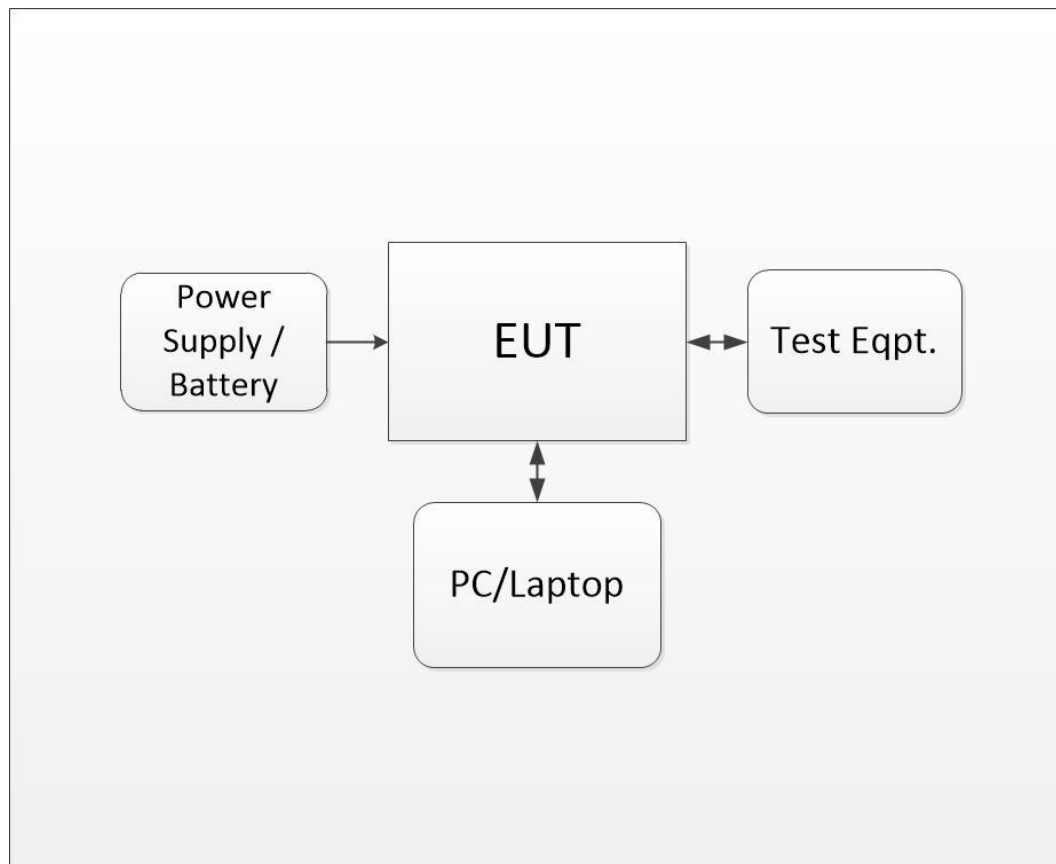
## 2.2 Test Mode

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (X plane) were recorded in this report.

The following summary table is showing all test modes to demonstrate in compliance with the standard.

Summary table of Test Cases	
Test Item	Data Rate / Modulation
	Bluetooth – LE / GFSK
Conducted Test Cases	Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps
	Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps
	Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps
Radiated Test Cases	Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps
	Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps
	Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps

## 2.3 Connection Diagram of Test System



## 2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Battery	TOSHIBA	R03 SIZE AAA 1.5V	N/A	N/A	N/A

## 2.5 EUT Operation Test Setup

The RF test items, utility “SmartRF Studio 7 Tool” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

Maximum TX power Setting of +5 dBm from SmartRF Studio 7 is used in all the tests.

Bluetooth5, LE 1M PHY (1 MSym/Sec GFSK, 1MBPS data rate) from SmartRF Studio is used in all the tests.





## 2.6 Measurement 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.

Example :

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

*Offset = RF cable loss + attenuator factor.*

Following shows an offset computation example with cable loss 15.6 dB and 10dB attenuator.

$$\begin{aligned}\text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)} \\ &= 15.6 + 10 = 25.6 \text{ (dB)}\end{aligned}$$

### 3 Test Result

#### 3.1 6dB and 99% Bandwidth Measurement

##### 3.1.1 Limit of 6dB and 99% Bandwidth

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

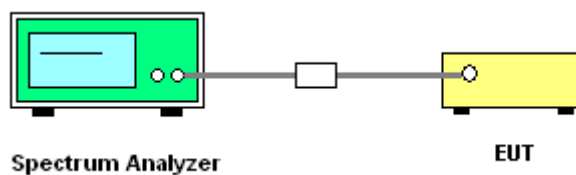
##### 3.1.2 Measuring Instruments

See list of measuring equipment of this test report.

##### 3.1.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 6.9.3 (OBW) and 11.8.1 (6dB BW).
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 1-5% of the emission bandwidth and set the Video bandwidth (VBW)  $\geq 3 * RBW$ .
6. Measure and record the results in the test report.

##### 3.1.4 Test Setup

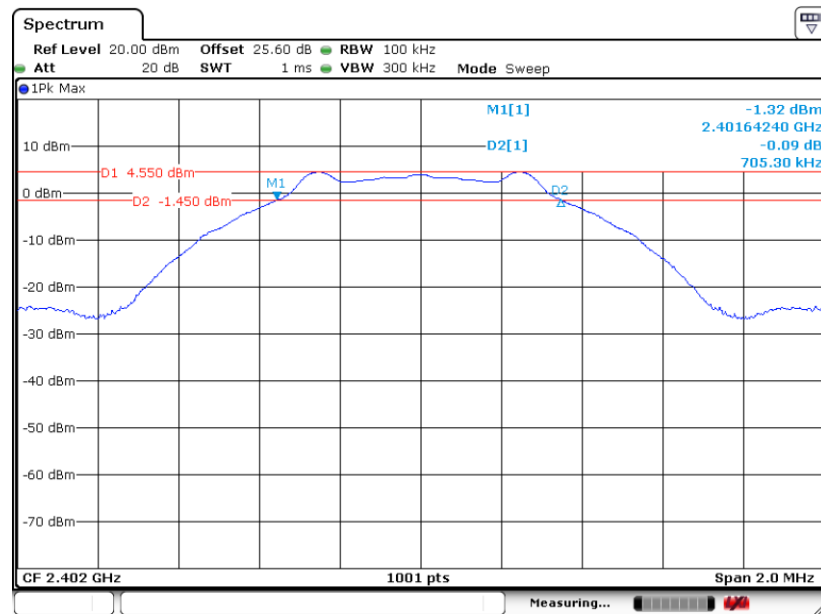




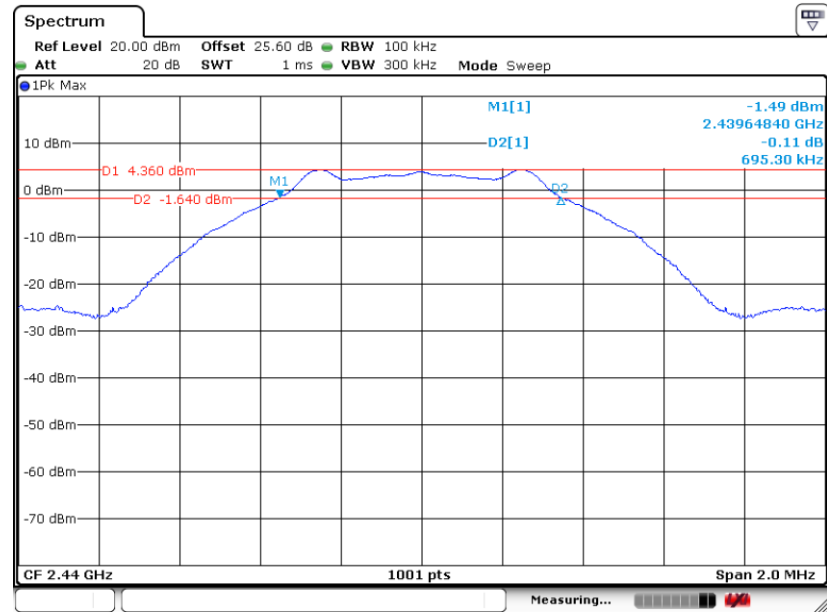
### 3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

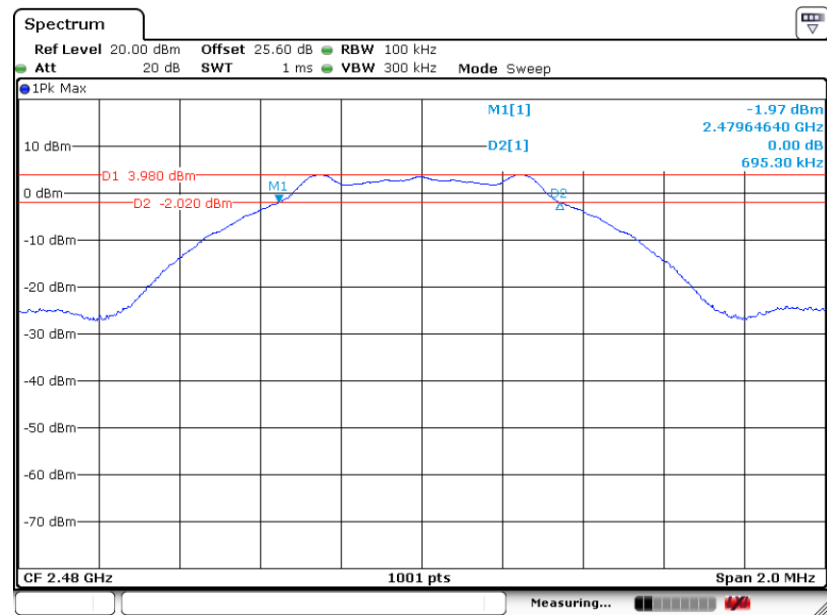
6 dB Bandwidth Plot on Channel 00



Date: 28.SEP.2019 17:11:43

**6 dB Bandwidth Plot on Channel 19**

Date: 28.SEP.2019 17:16:19

**6 dB Bandwidth Plot on Channel 39**

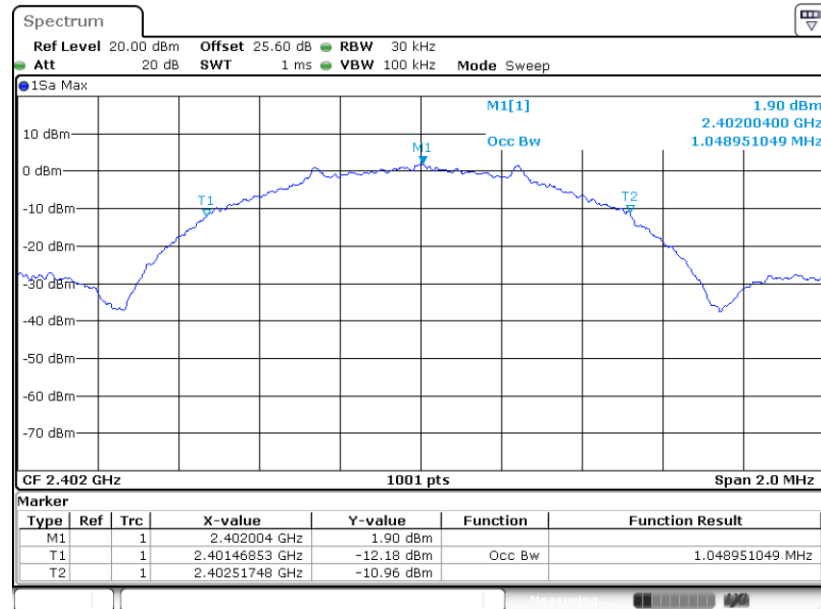
Date: 28.SEP.2019 17:20:55



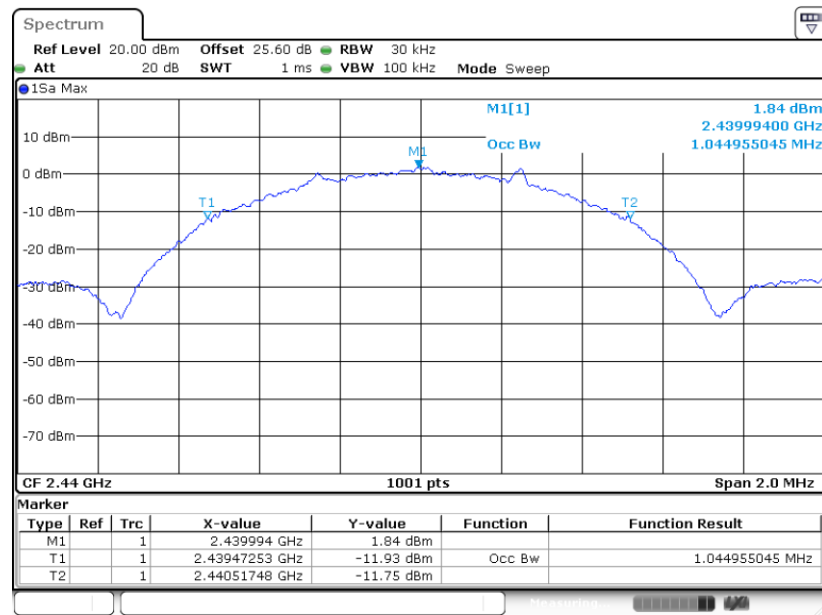
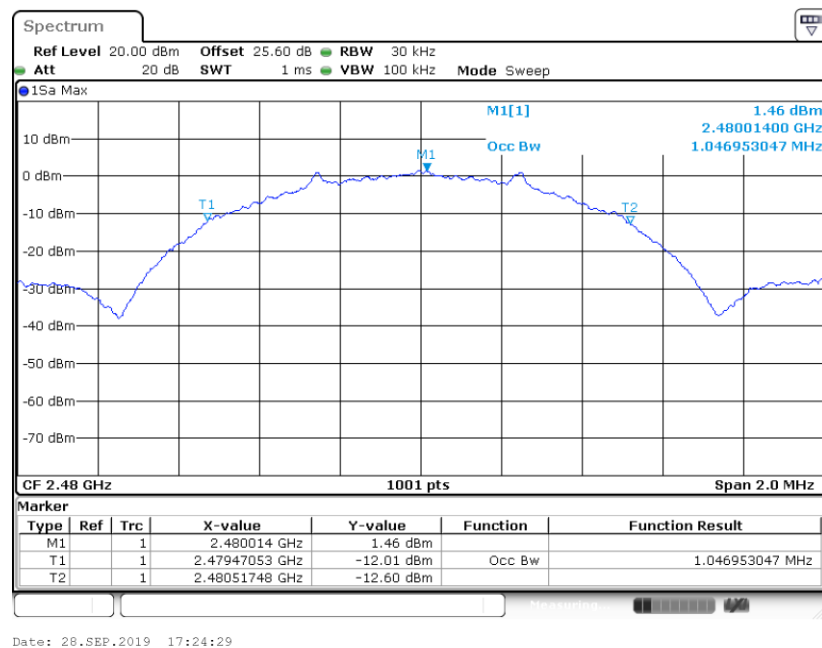
### 3.1.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

#### 99% Bandwidth Plot on Channel 00



Date: 28.SEP.2019 17:14:08

**99% Occupied Bandwidth Plot on Channel 19****99% Occupied Bandwidth Plot on Channel 39**

Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

## 3.2 Output Power Measurement

### 3.2.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5MHz, the limit for peak output power is 30dBm. If transmitting antenna of directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

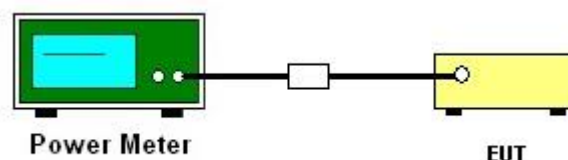
### 3.2.2 Measuring Instruments

See list of measuring equipment of this test report.

### 3.2.3 Test Procedures

1. For Peak Power, the testing follows ANSI C63.10 Section 11.9.1.3 PKPM1.
2. For Average Power, the testing follows ANSI C63.10 Section 11.9.2.3.2 Method AVGPM-G
3. The RF output of EUT was connected to the power meter by RF cable and attenuator.
4. The path loss was compensated to the results for each measurement.
5. Set to the maximum power setting and enable the EUT transmit continuously.
6. Measure the conducted output power and record the results in the test report.

### 3.2.4 Test Setup



### 3.2.5 Test Result of Peak Output Power

Please refer to Appendix A.

### 3.2.6 Test Result of Average Output Power (Reporting Only)

Please refer to Appendix A.

### 3.3 Power Spectral Density Measurement

#### 3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

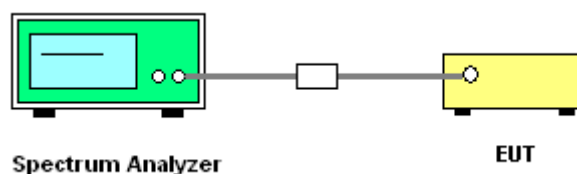
#### 3.3.2 Measuring Instruments

See list of measuring equipment of this test report.

#### 3.3.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 11.10.2 Method PKPSD.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. The Measured power density (dBm)/ 100kHz is a reference level and used as 20dBc down limit line for Conducted Band Edges and Conducted Spurious Emission.

#### 3.3.4 Test Setup



#### 3.3.5 Test Result of Power Spectral Density

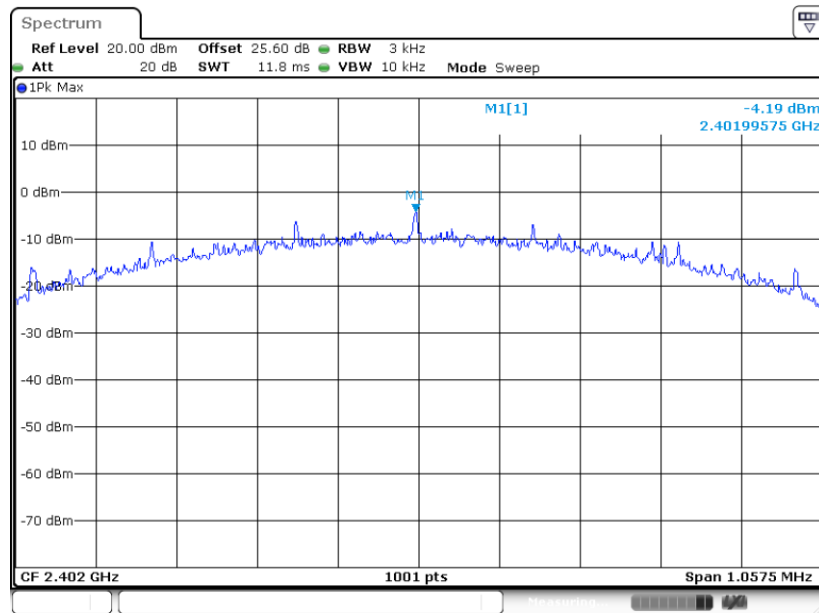
Please refer to Appendix A.





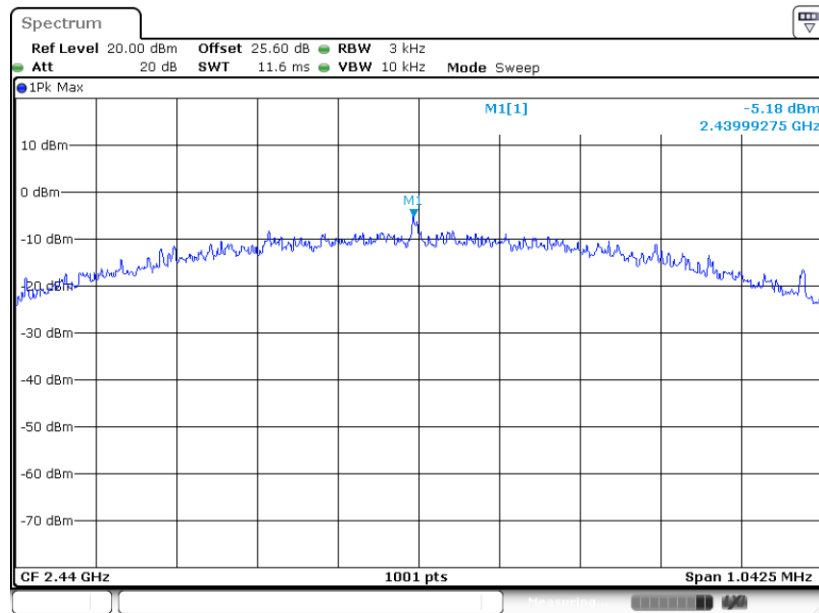
### 3.3.6 Test Result of Power Spectral Density Plots (3kHz)

PSD 3kHz Plot on Channel 00



Date: 28.SEP.2019 17:12:07

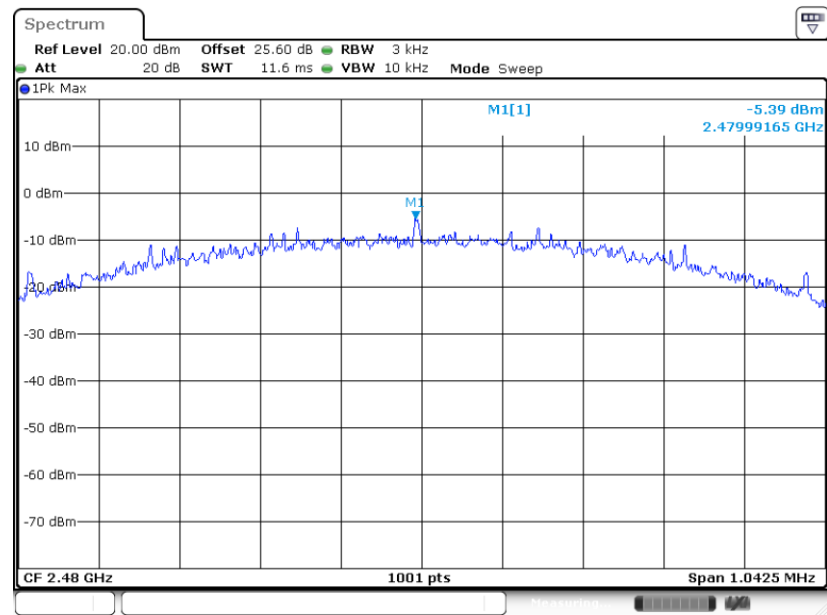
PSD 3kHz Plot on Channel 19



Date: 28.SEP.2019 17:17:04



PSD 3kHz Plot on Channel 39

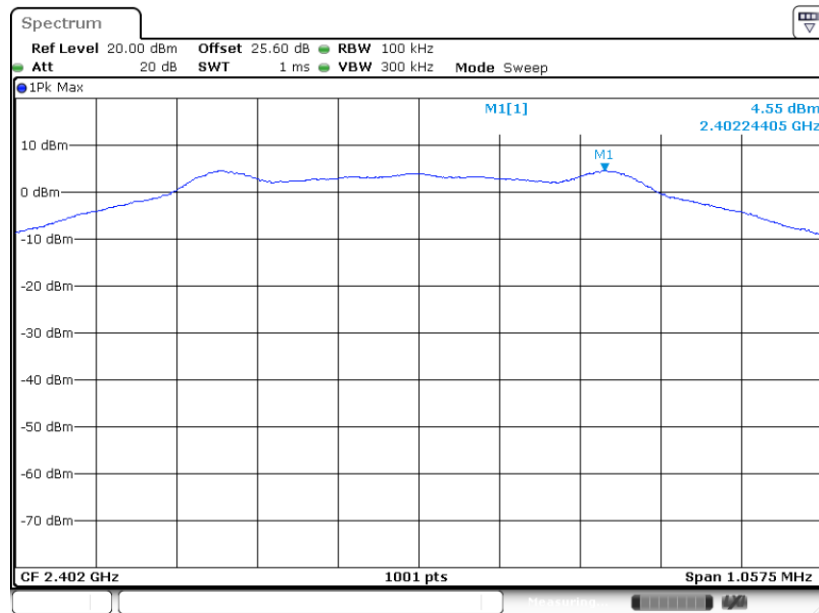


Date: 28.SEP.2019 17:22:06



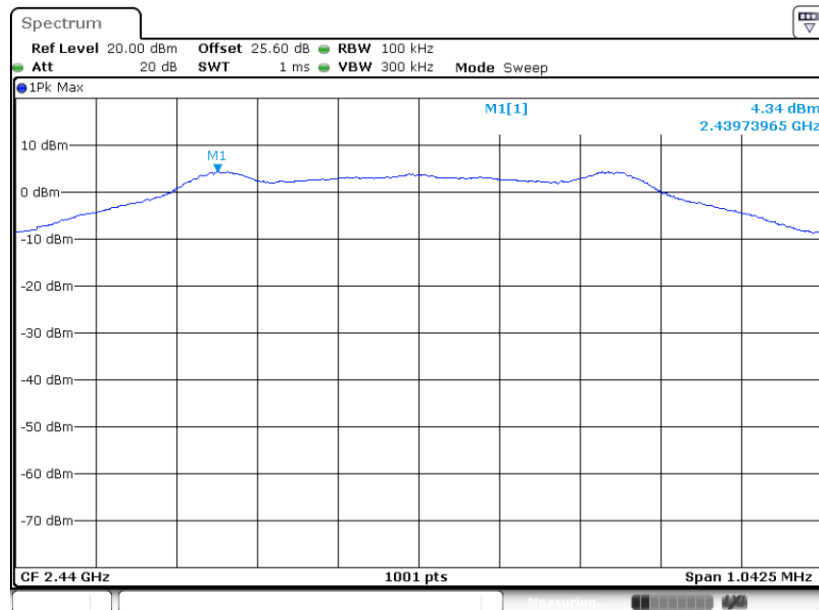
### 3.3.7 Test Result of Power Spectral Density Plots (100kHz)

**PSD 100kHz Plot on Channel 00**



Date: 28.SEP.2019 17:12:21

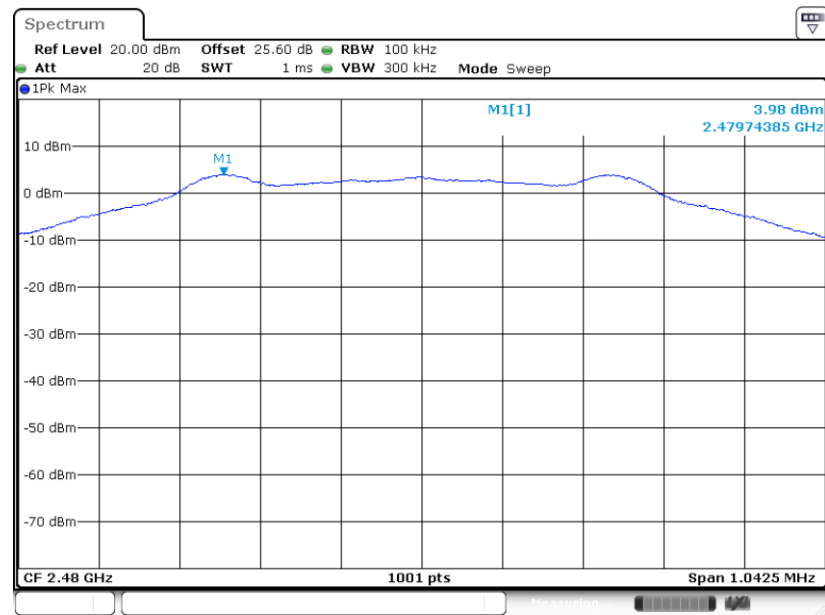
**PSD 100kHz Plot on Channel 19**



Date: 28.SEP.2019 17:17:32



PSD 100kHz Plot on Channel 39



Date: 28.SEP.2019 17:22:23

### 3.4 Conducted Band Edges and Spurious Emission Measurement

#### 3.4.1 Limit of Conducted Band Edges and Spurious Emission

All harmonics/spurious must be at least 20 dB down from the highest emission level within the authorized band.

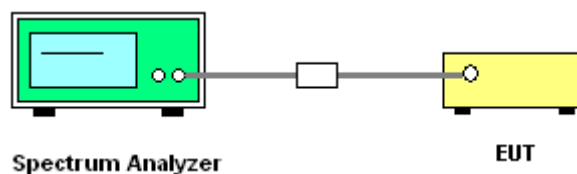
#### 3.4.2 Measuring Instruments

See list of measuring equipment of this test report.

#### 3.4.3 Test Procedure

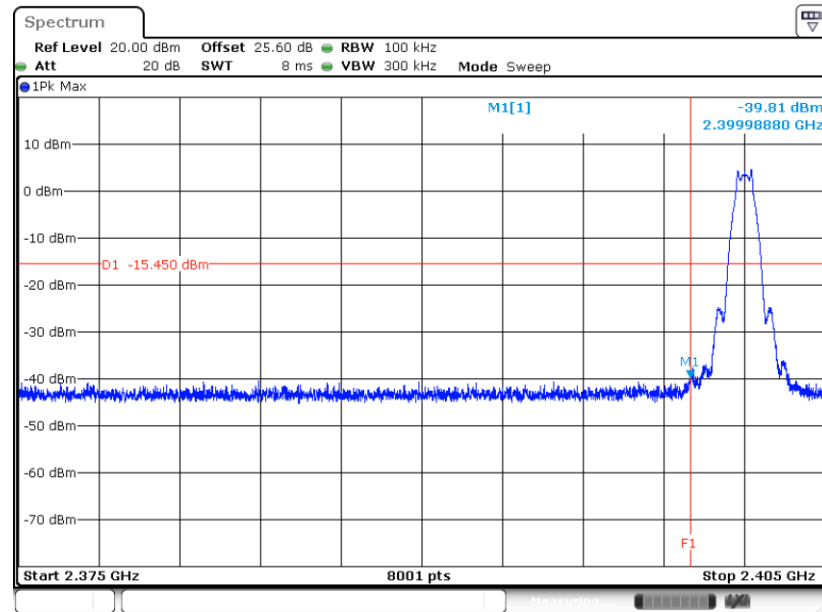
1. The testing follows the ANSI C63.10 Section 11.11.3 Emission level measurement.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

#### 3.4.4 Test Setup

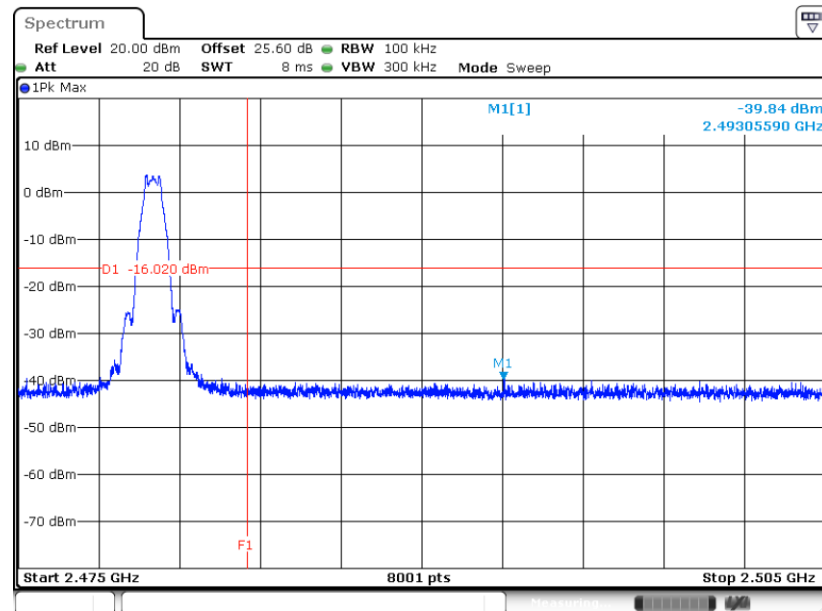




### 3.4.5 Test Result of Conducted Band Edges Plots

**Low Band Edge Plot on Channel 00**

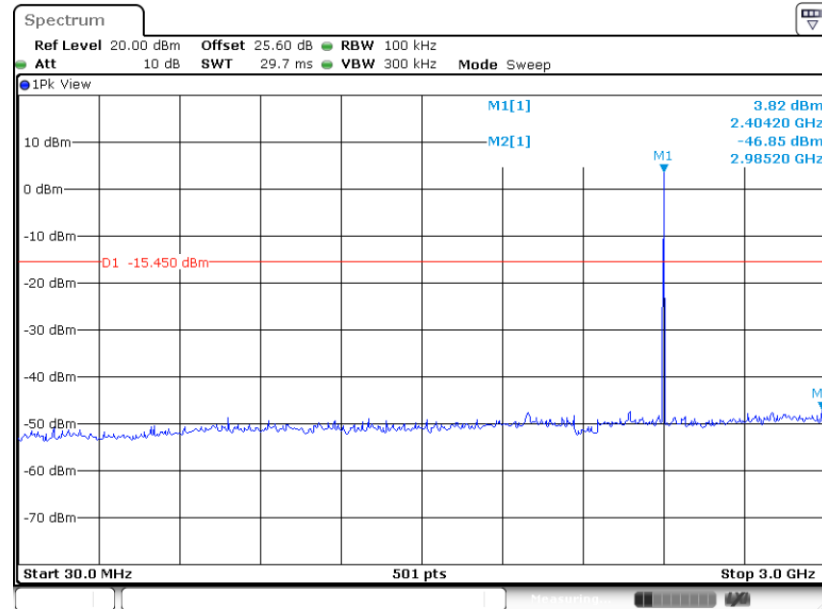
Date: 28.SEP.2019 10:21:54

**High Band Edge Plot on Channel 39**

Date: 28.SEP.2019 10:30:05

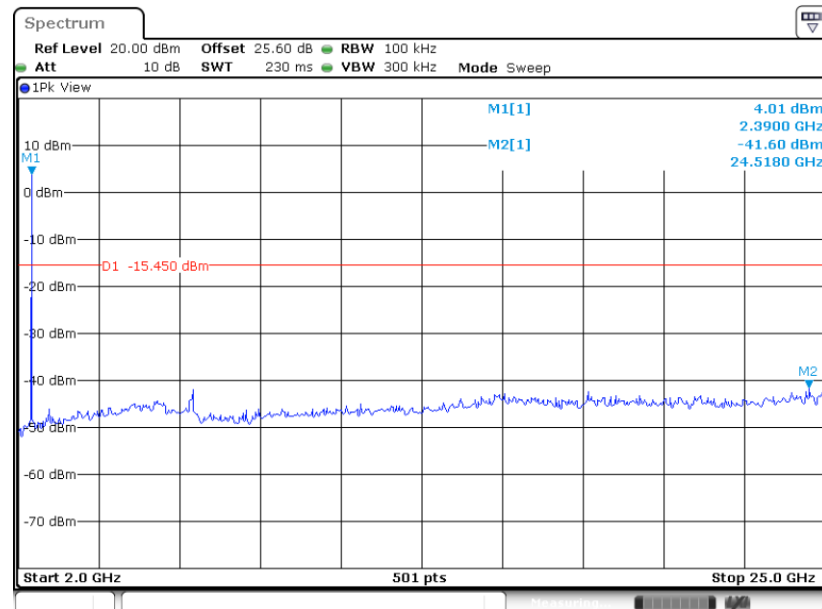
### 3.4.6 Test Result of Conducted Spurious Emission Plots

#### Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 00

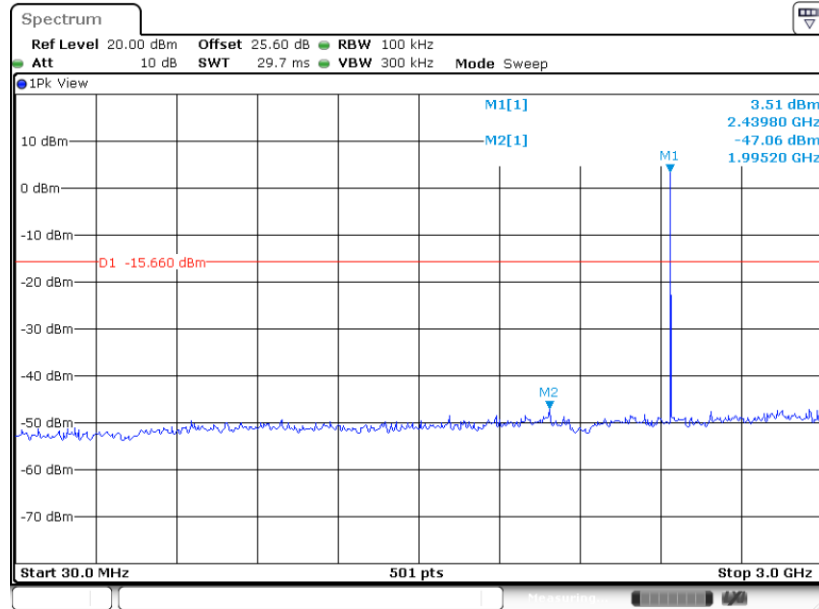


Date: 28.SEP.2019 10:23:14

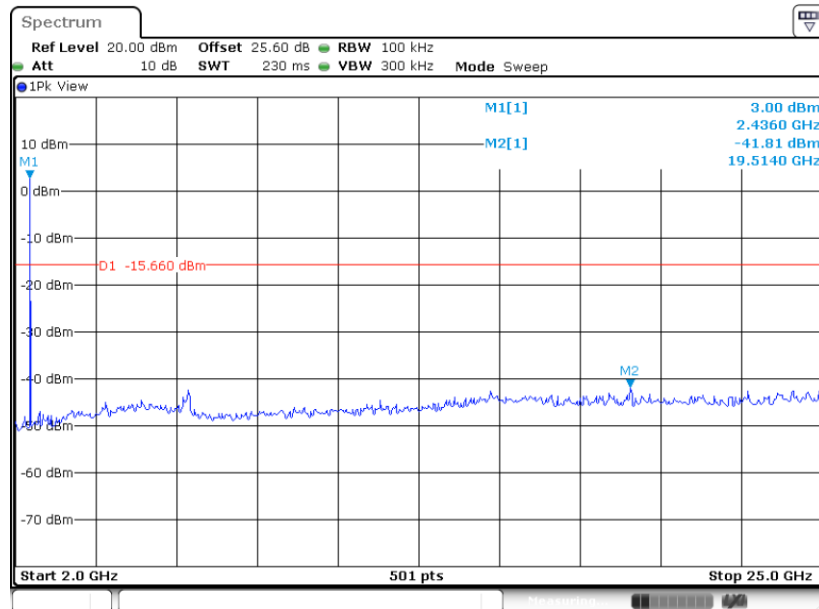
#### Conducted Spurious Emission Plot on Bluetooth LE 1Mbps GFSK Channel 00



Date: 28.SEP.2019 10:23:42

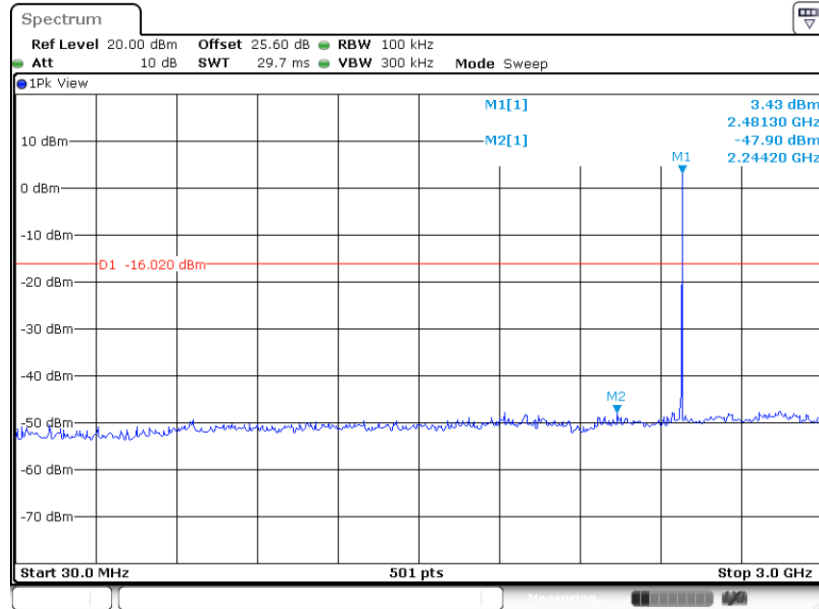
**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps  
GFSK Channel 19**

Date: 28.SEP.2019 10:25:10

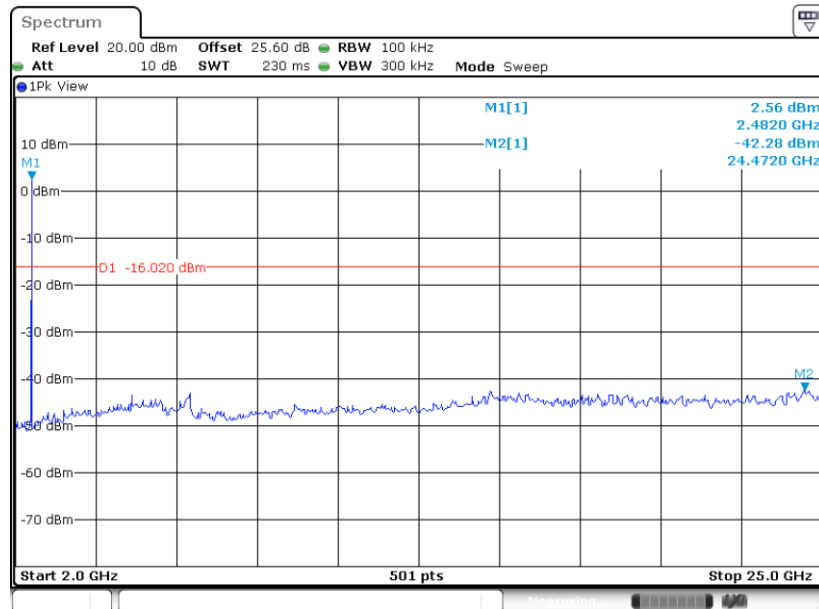
**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps  
GFSK Channel 19**

Date: 28.SEP.2019 10:28:19



**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps  
GFSK Channel 39**

Date: 28.SEP.2019 10:31:07

**Conducted Spurious Emission Plot on Bluetooth LE 1Mbps  
GFSK Channel 39**

Date: 28.SEP.2019 10:32:00

### **3.5 Radiated Band Edges and Spurious Emission Measurement**

#### **3.5.1 Limit of Radiated Band Edges and Spurious Emission**

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

<b>Frequency (MHz)</b>	<b>Field Strength (microvolts/meter)</b>	<b>Measurement Distance (meters)</b>
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

#### **3.5.2 Measuring Instruments**

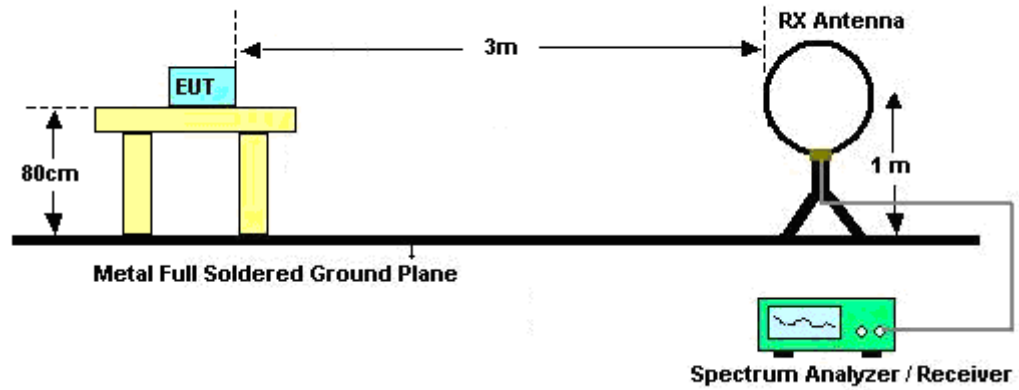
See list of measuring equipment of this test report.

### 3.5.3 Test Procedures

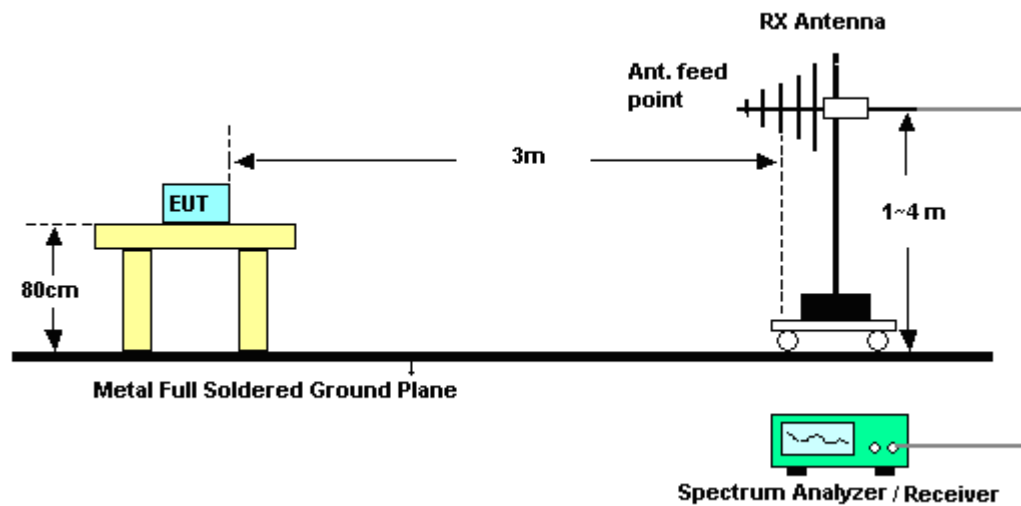
1. The testing follows the ANSI C63.10 Section 11.12.1 Radiated emission measurements.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
8. Use the following spectrum analyzer settings:
  - (1) Span shall wide enough to fully capture the emission being measured;
  - (2) Set RBW=100 kHz for  $f < 1$  GHz;  $VBW \geq RBW$ ; Sweep = auto; Detector function = peak; Trace = max hold;
  - (3) Set RBW = 1 MHz, VBW= 3MHz for  $f \geq 1$  GHz for peak measurement.  
For average measurement:
    - $VBW = 10$  Hz, when duty cycle is no less than 98 percent.
    - $VBW \geq 1/T$ , when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

### 3.5.4 Test Setup

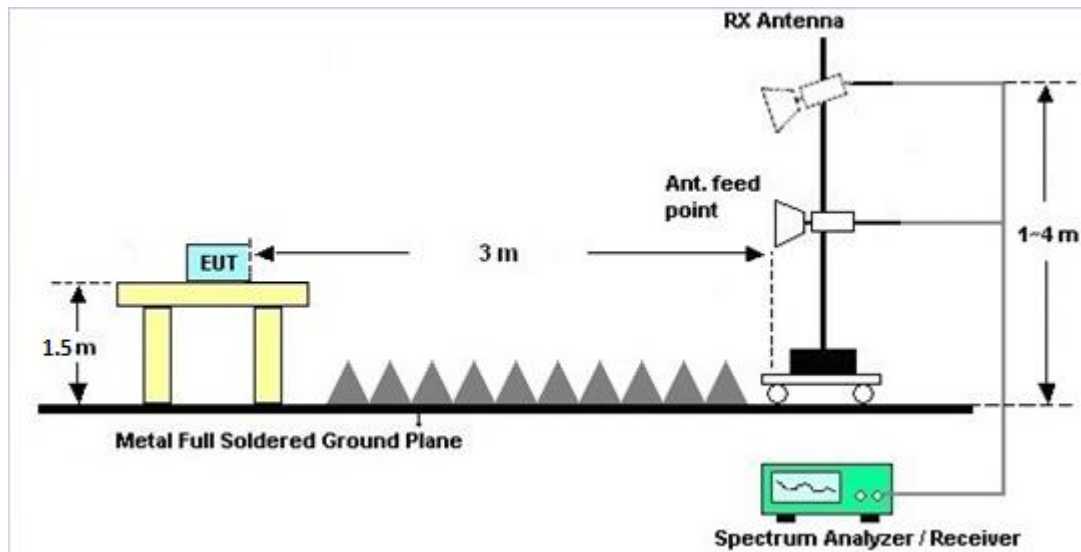
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



### 3.5.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

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

There is a comparison data of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result came out very similar.

### 3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix B and C.

### 3.5.7 Duty Cycle

Please refer to Appendix D.

### 3.5.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix B and C.



## **3.6 Antenna Requirements**

### **3.6.1 Standard Applicable**

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. 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 rule.

### **3.6.2 Antenna Anti-Replacement Construction**

Integrated PCB Trace Antenna is used

### **3.6.3 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.



## 4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	Jan. 11, 2019	Oct. 09, 2019~ Oct. 15, 2019	Jan. 10, 2020	Radiation (03CH07-HY)
Bilog Antenna	TESEQ	CBL 6111D & 00800N1D01 N-06	35419 & 03	30MHz~1GHz	Apr. 30, 2019	Oct. 09, 2019~ Oct. 15, 2019	Apr. 29, 2020	Radiation (03CH07-HY)
Double Ridge Horn Antenna	ESCO	3117	00075962	1GHz ~ 18GHz	Dec. 02, 2018	Oct. 09, 2019~ Oct. 15, 2019	Dec. 03, 2019	Radiation (03CH07-HY)
SHF-EHF Horn Antenna	SCHWARZBE CK	BBHA 9170	BBHA9170 251	18GHz~40GHz	Nov. 20, 2018	Oct. 09, 2019~ Oct. 15, 2019	Nov. 19, 2019	Radiation (03CH07-HY)
Preamplifier	COM-POWER	PA-103A	161241	10MHz~1GHz	May 20, 2019	Oct. 09, 2019~ Oct. 15, 2019	May 19, 2020	Radiation (03CH07-HY)
Preamplifier	MITEQ	AMF-7D-0010 1800-30-10P	1590075	1GHz~18GHz	Apr. 24, 2019	Oct. 09, 2019~ Oct. 15, 2019	Apr. 23, 2020	Radiation (03CH07-HY)
Preamplifier	Agilent	8449B	3008A023 62	1GHz~26.5GHz	Nov. 02, 2018	Oct. 09, 2019~ Oct. 15, 2019	Nov. 01, 2019	Radiation (03CH07-HY)
Preamplifier	MITEQ	TTA1840-35- HG	1871923	18GHz~40GHz, VSWR : 2.5:1 max	N/A	Oct. 09, 2019~ Oct. 15, 2019	N/A	Radiation (03CH07-HY)
EMI Test Receiver	Agilent	N9038A(MXE )	MY532900 53	20Hz~26.5GHz	Jan. 23, 2019	Oct. 09, 2019~ Oct. 15, 2019	Jan. 22, 2020	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY24971/ 4,MY2865 5/4	9kHz~30MHz	Feb. 26, 2019	Oct. 09, 2019~ Oct. 15, 2019	Feb. 25, 2020	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY28655/ 4,MY2497 1/4,MY156 82/4	30MHz~1GHz	Feb. 26, 2019	Oct. 09, 2019~ Oct. 15, 2019	Feb. 25, 2020	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY28655/ 4,MY2497 1/4,MY156 82/4	1GHz~18GHz	Feb. 26, 2019	Oct. 09, 2019~ Oct. 15, 2019	Feb. 25, 2020	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2858/2	18GHz~40GHz	Feb. 26, 2019	Oct. 09, 2019~ Oct. 15, 2019	Feb. 25, 2020	Radiation (03CH07-HY)
Software	Audix	E3 6.2009-8-24	805040046 56H	N/A	N/A	Oct. 09, 2019~ Oct. 15, 2019	N/A	Radiation (03CH07-HY)
Antenna Mast	Max-Full	MFA520BS	N/A	1m~4m	N/A	Oct. 09, 2019~ Oct. 15, 2019	N/A	Radiation (03CH07-HY)
Turn Table	ChainTek	Chaintek 3000	N/A	0~360 Degree	N/A	Oct. 09, 2019~ Oct. 15, 2019	N/A	Radiation (03CH07-HY)
Power Sensor	DARE	RPR3006W	16I00054S NO12	10MHz~6GHz	Dec. 27, 2018	Sep. 27, 2019~ Sep. 28, 2019	Dec. 26, 2019	Conducted (TH05-HY)
Spectrum Analyzer	Rohde & Schwarz	FSV30	101749	10Hz~30GHz	Jan. 21, 2019	Sep. 27, 2019~ Sep. 28, 2019	Jan. 20, 2020	Conducted (TH05-HY)
Programmable Power Supply	GW Instek	PSS-2005	GEO82176 7	N/A	Oct. 16, 2018	Sep. 27, 2019~ Sep. 28, 2019	Oct. 15, 2019	Conducted (TH05-HY)
Switch Box & RF Cable	Burgeon	ETF-058	EC120838 2	N/A	Mar. 27, 2019	Sep. 27, 2019~ Sep. 28, 2019	Mar. 26, 2020	Conducted (TH05-HY)



## 5 Uncertainty of Evaluation

### Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ( $U = 2Uc(y)$ )	3.4 dB
--	--------

### Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ( $U = 2Uc(y)$ )	5.7 dB
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### Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ( $U = 2Uc(y)$ )	5.5 dB
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**Appendix A. Test Result of Conducted Test Items**

Test Engineer:	Tommy Lee	Temperature:	21~25	°C
Test Date:	2019/9/27~2019/9/28	Relative Humidity:	51~54	%

**TEST RESULTS DATA**  
**6dB and 99% Occupied Bandwidth**

Mod.	Data Rate	NTx	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
BLE	1Mbps	1	0	2402	1.049	0.705	0.50	Pass
BLE	1Mbps	1	19	2440	1.045	0.695	0.50	Pass
BLE	1Mbps	1	39	2480	1.047	0.695	0.50	Pass

**TEST RESULTS DATA**  
**Peak Power Table**

Mod.	Data Rate	NTx	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail	TX Power Setting
BLE	1Mbps	1	0	2402	6.69	30.00	3.50	10.19	36.00	Pass	
BLE	1Mbps	1	19	2440	6.51	30.00	3.50	10.01	36.00	Pass	
BLE	1Mbps	1	39	2480	6.32	30.00	3.50	9.82	36.00	Pass	

**TEST RESULTS DATA**  
**Average Power Table**  
**(Reporting Only)**

Mod.	Data Rate	NTx	CH.	Freq. (MHz)	Average Conducted Power (dBm)
BLE	1Mbps	1	0	2402	5.00
BLE	1Mbps	1	19	2440	4.70
BLE	1Mbps	1	39	2480	4.40

**TEST RESULTS DATA**  
**Peak Power Density**

Mod.	Data Rate	NTx	CH.	Freq. (MHz)	Peak PSD (dBm /100kHz)	Peak PSD (dBm /3kHz)	DG (dBi)	Peak PSD Limit (dBm /3kHz)	Pass/Fail
BLE	1Mbps	1	0	2402	4.55	-4.19	3.50	8.00	Pass
BLE	1Mbps	1	19	2440	4.34	-5.18	3.50	8.00	Pass
BLE	1Mbps	1	39	2480	3.98	-5.39	3.50	8.00	Pass

Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 20dBc limit.



## Appendix B. Radiated Spurious Emission

Test Engineer :	Nick Yu, Stan Hsieh	Temperature :	24~26°C
		Relative Humidity :	58~60%

2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

BLE	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		( MHz )	( dBμV/m )	( dB )	( dBμV/m )	( dBμV )	( dB/m )	( dB )	( dB )	( cm )	( deg )	( P/A )	( H/V )
BLE CH 00 2402MHz	-	2371.95	55.14	-18.86	74	40.48	31.93	17.67	34.94	122	244	P	H
	-	2388.645	44.04	-9.96	54	29.24	32	17.74	34.94	122	244	A	H
	*	2402	100.94	-	-	86.15	32	17.74	34.95	122	244	P	H
	*	2402	100.38	-	-	85.59	32	17.74	34.95	122	244	A	H
													H
													H
	-	2324.28	55.67	-18.33	74	41.21	31.8	17.59	34.93	396	196	P	V
	-	2390	44.03	-9.97	54	29.24	32	17.74	34.95	396	196	A	V
	*	2402	97.56	-	-	82.77	32	17.74	34.95	396	196	P	V
	*	2402	97.13	-	-	82.34	32	17.74	34.95	396	196	A	V
													V
													V
BLE CH 19 2440MHz	-	2377.9	54.65	-19.35	74	39.99	31.93	17.67	34.94	120	248	P	H
	-	2389.38	44.07	-9.93	54	29.27	32	17.74	34.94	120	248	A	H
	*	2440	101.26	-	-	86.23	32.2	17.79	34.96	120	248	P	H
	*	2440	100.76	-	-	85.73	32.2	17.79	34.96	120	248	A	H
	-	2490.62	54.8	-19.2	74	39.73	32.2	17.84	34.97	120	248	P	H
	-	2487.96	44.55	-9.45	54	29.48	32.2	17.84	34.97	120	248	A	H
	-	2326.38	55.51	-18.49	74	41.05	31.8	17.59	34.93	335	192	P	V
	-	2387.14	44.01	-9.99	54	29.21	32	17.74	34.94	335	192	A	V
	*	2440	97.2	-	-	82.17	32.2	17.79	34.96	335	192	P	V
	*	2440	96.69	-	-	81.66	32.2	17.79	34.96	335	192	A	V
	-	2486.07	55.02	-18.98	74	39.95	32.2	17.84	34.97	335	192	P	V
	-	2488.03	44.2	-9.8	54	29.13	32.2	17.84	34.97	335	192	A	V



<b>BLE CH 39 2480MHz</b>	*	2480	100.68	-	-	85.61	32.2	17.84	34.97	105	243	P	H
	*	2480	100.15	-	-	85.08	32.2	17.84	34.97	105	243	A	H
	-	2483.6	54.98	-19.02	74	39.91	32.2	17.84	34.97	105	243	P	H
	-	2483.52	45.37	-8.63	54	30.3	32.2	17.84	34.97	105	243	A	H
													H
													H
	*	2480	96.6	-	-	81.53	32.2	17.84	34.97	366	187	P	V
	*	2480	96.07	-	-	81	32.2	17.84	34.97	366	187	A	V
	-	2488.32	55.67	-18.33	74	40.6	32.2	17.84	34.97	366	187	P	V
	-	2483.52	44.63	-9.37	54	29.56	32.2	17.84	34.97	366	187	A	V
													V
													V
<b>Remark</b>	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



## 2.4GHz 2400~2483.5MHz

## BLE (Harmonic @ 3m)

BLE	Note	Frequency ( MHz )	Level ( dBμV/m )	Over Limit ( dB )	Limit Line ( dBμV/m )	Read Level ( dBμV )	Antenna Factor ( dB/m )	Path Loss ( dB )	Preamp Factor ( dB )	Ant Pos ( cm )	Table Pos ( deg )	Peak Avg. ( P/A )	Pol. ( H/V )
BLE CH 00 2402MHz	-	4804	45.75	-28.25	74	59.45	34	11.36	59.06	100	0	P	H
													H
													H
													H
	-	4804	46.32	-27.68	74	60.02	34	11.36	59.06	100	0	P	V
													V
													V
													V
BLE CH 19 2440MHz	-	4880	45.66	-28.34	74	59.03	34.13	11.42	58.92	100	0	P	H
	-	7320	45.03	-28.97	74	53.74	35.63	13.97	58.31	100	0	P	H
													H
													H
	-	4880	44.6	-29.4	74	57.97	34.13	11.42	58.92	100	0	P	V
	-	7320	44.97	-29.03	74	53.68	35.63	13.97	58.31	100	0	P	V
													V
													V
BLE CH 39 2480MHz	-	4960	44.83	-29.17	74	57.96	34.13	11.48	58.74	100	0	P	H
	-	7440	43.98	-30.02	74	52.77	35.5	14.09	58.38	100	0	P	H
													H
													H
	-	4960	44.41	-29.59	74	57.54	34.13	11.48	58.74	100	0	P	V
	-	7440	44.68	-29.32	74	53.47	35.5	14.09	58.38	100	0	P	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

### Emission below 1GHz

## 2.4GHz BLE (LF)

[illegible]



**Note symbol**

*	<b>Fundamental Frequency</b> which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is <b>over limit</b> line.
P/A	<b>Peak</b> or <b>Average</b>
H/V	<b>Horizontal</b> or <b>Vertical</b>

**A calculation example for radiated spurious emission is shown as below:**

BLE	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		( MHz )	( dBμV/m )	( dB )	( dBμV/m )	( dBμV )	( dB/m )	( dB )	( dB )	( cm )	( deg )	( P/A )	( H/V )
BLE CH 00 2402MHz		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) =  
Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
3. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

**For Peak Limit @ 2390MHz:**

1. Level(dBμV/m)  
= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)  
= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)  
= 55.45 (dBμV/m)
2. Over Limit(dB)  
= Level(dBμV/m) – Limit Line(dBμV/m)  
= 55.45(dBμV/m) – 74(dBμV/m)  
= -18.55(dB)

**For Average Limit @ 2390MHz:**

1. Level(dBμV/m)  
= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)  
= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)  
= 43.54 (dBμV/m)
2. Over Limit(dB)  
= Level(dBμV/m) – Limit Line(dBμV/m)  
= 43.54(dBμV/m) – 54(dBμV/m)  
= -10.46(dB)

**Both peak and average measured complies with the limit line, so test result is “PASS”.**



## Appendix C. Radiated Spurious Emission Plots

Test Engineer :	Nick Yu, Stan Hsieh	Temperature :	24~26°C
		Relative Humidity :	58~60%

### Note symbol

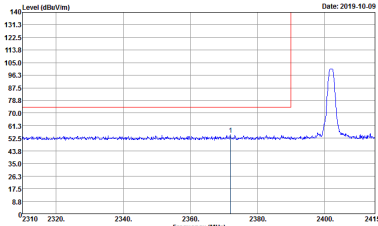
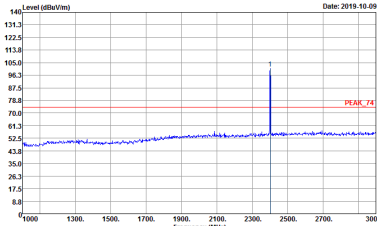
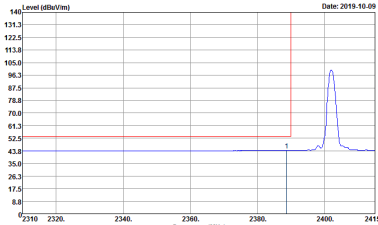
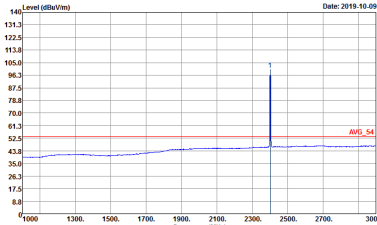
-L	Low channel location
-R	High channel location





2.4GHz 2400~2483.5MHz

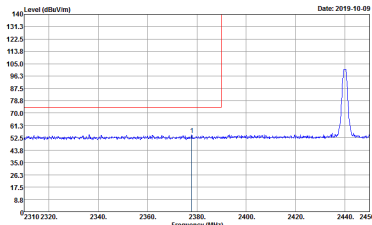
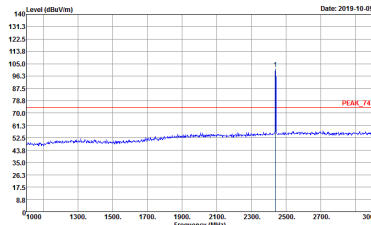
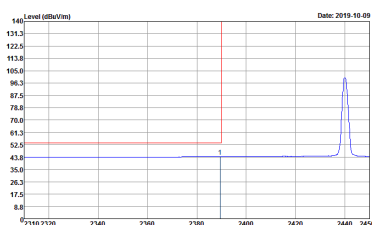
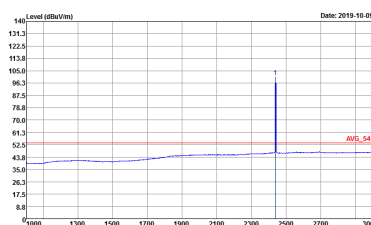
BLE (Band Edge @ 3m)

BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Fundamental
Peak	<div><p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 HORIZONTAL Detector : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto Project : Peak Mode : 1</p></div>	<div><p>Site : 03CH07-HY Condition : PEAK_74 3m HF_ANT_00075962 HORIZONTAL Detector : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto Project : Peak Mode : 1</p></div>
Avg.	<div><p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 HORIZONTAL Detector : RBW:1000.000kHz VBW:0.010kHz SWT:Auto Project : Peak Mode : 1</p></div>	<div><p>Site : 03CH07-HY Condition : AVG_54 3m HF_ANT_00075962 HORIZONTAL Detector : RBW:1000.000kHz VBW:0.010kHz SWT:Auto Project : Peak Mode : 1</p></div>

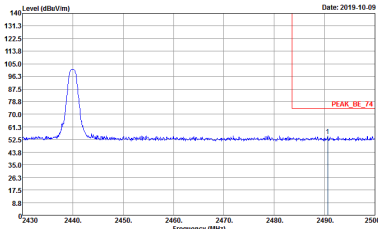
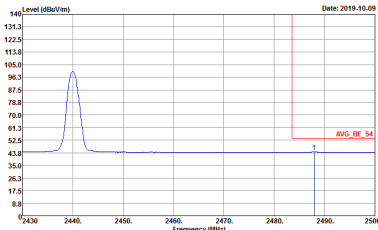


BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH00 2402MHz	
	Vertical	Fundamental
Peak	<p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 1</p>	<p>Site : 03CH07-HY Condition : PEAK_74 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 1</p>
Avg	<p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 1</p>	<p>Site : 03CH07-HY Condition : AVG_54 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 1</p>

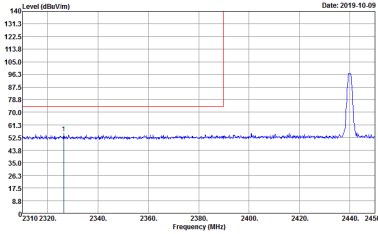
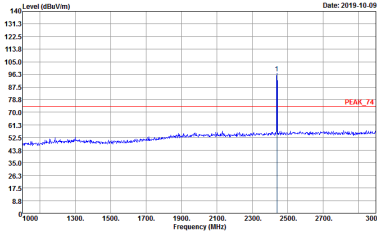
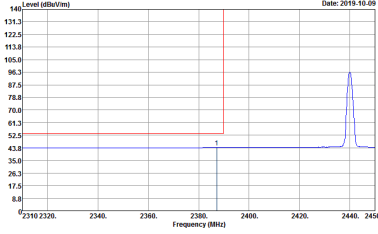
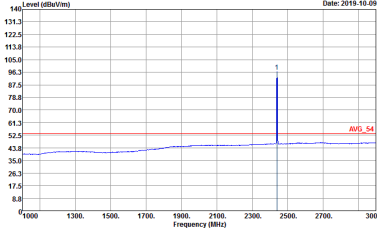


BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - L	
	Horizontal	Fundamental
Peak	<div><p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 HORIZONTAL Detector : Peak Project : 991024 Mode : 2</p></div>	<div><p>Site : 03CH07-HY Condition : PEAK_74 3m HF_ANT_00075962 HORIZONTAL Detector : Peak Project : 991024 Mode : 2</p></div>
Avg.	<div><p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 HORIZONTAL Detector : Peak Project : 991024 Mode : 2</p></div>	<div><p>Site : 03CH07-HY Condition : AVG_54 3m HF_ANT_00075962 HORIZONTAL Detector : Peak Project : 991024 Mode : 2</p></div>

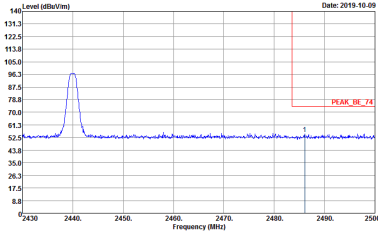
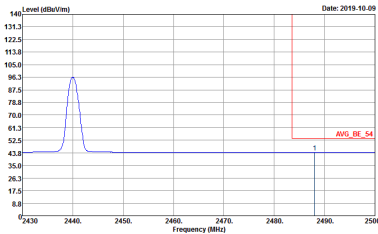


BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - R	
	Horizontal	Fundamental
Peak	<div><p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 HORIZONTAL Detector : Peak Project : 991024 Mode : 2</p></div>	Left blank
Avg.	<div><p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 HORIZONTAL Detector : Peak Project : 991024 Mode : 2</p></div>	Left blank

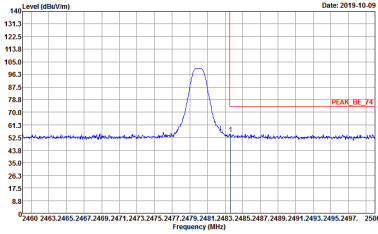
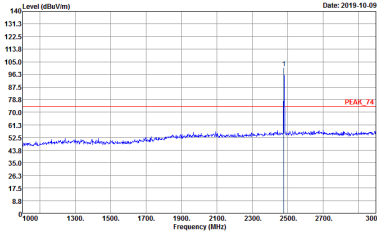
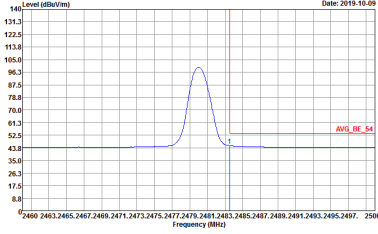
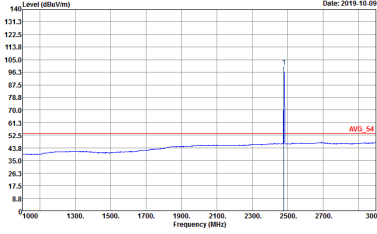


BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - L	
	Vertical	Fundamental
Peak	<div><p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 2</p></div>	<div><p>Site : 03CH07-HY Condition : PEAK_74 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 2</p></div>
Avg.	<div><p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 2</p></div>	<div><p>Site : 03CH07-HY Condition : AVG_54 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 2</p></div>

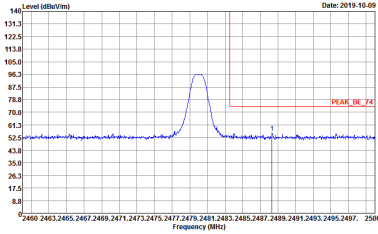
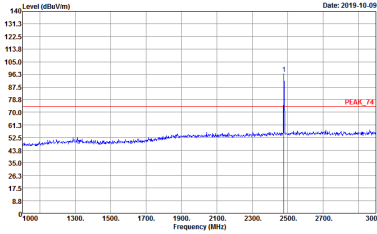
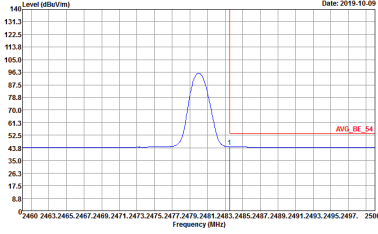
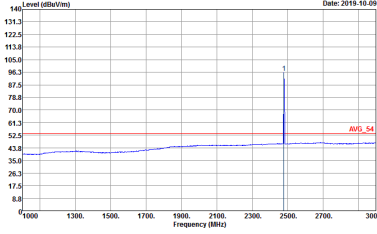


BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH19 2440MHz - R	
	Vertical	Fundamental
Peak	<div><p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 2</p></div>	Left blank
Avg.	<div><p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 2</p></div>	Left blank



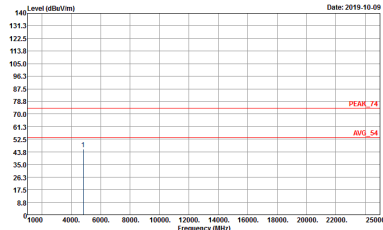
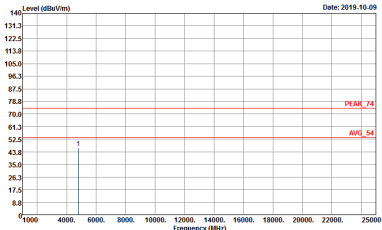
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Horizontal	Fundamental
Peak	 <p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 HORIZONTAL Detector : Peak Project : 991024 Mode : 3</p>	 <p>Site : 03CH07-HY Condition : PEAK_74 3m HF_ANT_00075962 HORIZONTAL Detector : Peak Project : 991024 Mode : 3</p>
Avg.	 <p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 HORIZONTAL Detector : Peak Project : 991024 Mode : 3</p>	 <p>Site : 03CH07-HY Condition : AVG_54 3m HF_ANT_00075962 HORIZONTAL Detector : Peak Project : 991024 Mode : 3</p>



BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BLE CH39 2480MHz	
	Vertical	Fundamental
Peak	<div><p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 3</p></div>	<div><p>Site : 03CH07-HY Condition : PEAK_74 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 3</p></div>
Avg.	<div><p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 3</p></div>	<div><p>Site : 03CH07-HY Condition : AVG_54 3m HF_ANT_00075962 VERTICAL Detector : Peak Project : 991024 Mode : 3</p></div>



**2.4GHz 2400~2483.5MHz**
**BLE (Harmonic @ 3m)**

BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH00 2402MHz	
	Horizontal	Vertical
<b>Peak</b>  <b>Avg.</b>	 <p>Site : 03CH07-HY  Condition : PEAK_74 3m SHF-EHF_131029 HORIZONTAL  Detector : Peak  Project : 991024  Mode : 1</p>	 <p>Site : 03CH07-HY  Condition : PEAK_74 3m SHF-EHF_131029 VERTICAL  Detector : Peak  Project : 991024  Mode : 1</p>

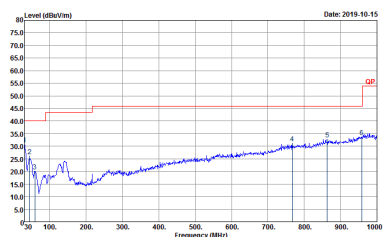
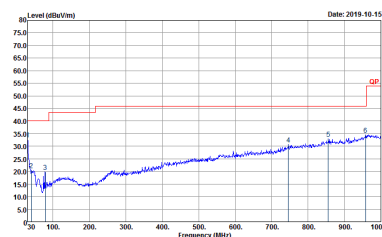


BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH19 2440MHz	
	Horizontal	Vertical
Peak Avg.	<div><p>Level (dBuV/m)</p><p>Date: 2019-10-09</p><p>Frequency (Hz)</p><p>Site : 03CH07-HY Condition : PEAK_74 3m SHF-EHF_131029 HORIZONTAL Detector : Peak Project : 991024 Mode : 2</p></div>	<div><p>Level (dBuV/m)</p><p>Date: 2019-10-09</p><p>Frequency (Hz)</p><p>Site : 03CH07-HY Condition : PEAK_74 3m SHF-EHF_131029 VERTICAL Detector : Peak Project : 991024 Mode : 2</p></div>



BLE	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BLE CH39 2480MHz	
	Horizontal	Vertical
Peak	<div><p>Level (dBuV/m)</p><p>Date: 2019-10-09</p><p>Frequency (Hz)</p><p>Site : 03CH07-HY Condition : PEAK_74 3m SHF-EHF_131029 HORIZONTAL Detector : Peak Project : 991024 Mode : 3</p></div>	<div><p>Level (dBuV/m)</p><p>Date: 2019-10-09</p><p>Frequency (Hz)</p><p>Site : 03CH07-HY Condition : PEAK_74 3m SHF-EHF_131029 VERTICAL Detector : Peak Project : 991024 Mode : 3</p></div>

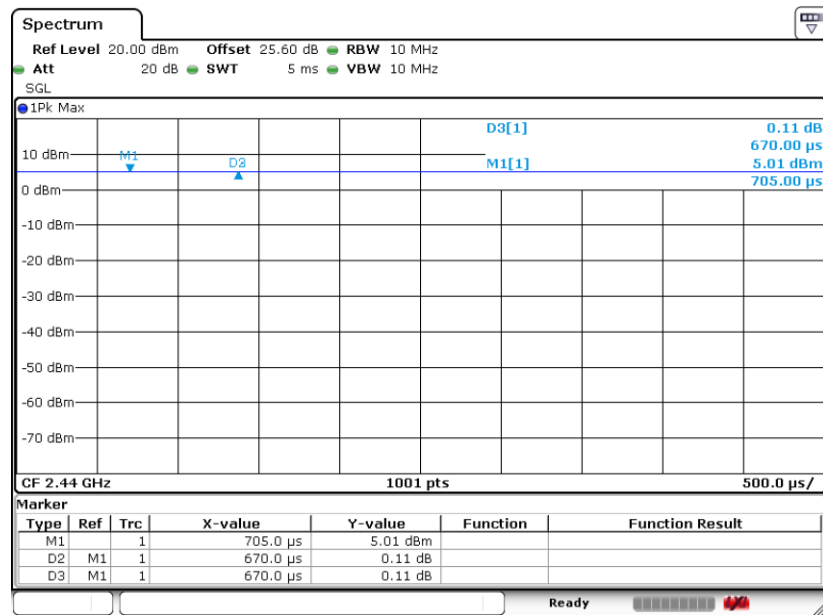
**Emission below 1GHz**
**2.4GHz BLE (LF)**

BLE	2.4GHz 2400~2483.5MHz	
	BLE LF	
	Horizontal	Vertical
QP / Peak	 <p>           Site : 03CH07-HY            Condition : QP 3m LF-ANT-35419(6) HORIZONTAL            Detector : Peak            Project : 991024            Mode : 4         </p>	 <p>           Site : 03CH07-HY            Condition : QP 3m LF-ANT-35419(6) VERTICAL            Detector : Peak            Project : 991024            Mode : 4         </p>

## Appendix D. Duty Cycle Plots

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting	Duty Factor(dB)
Bluetooth -LE	100	-	-	10Hz	0.00

### Bluetooth - LE



Date: 27.SEP.2019 16:39:39