FCC C2PC Test Report

FCC ID	:	**SQGBL652**
Equipment	:	**Bluetooth 4.2 module (BLE only)**
Model No.	:	**BL652-SA, BL652-SC** **(Refer to item 1.1.1 for more details)**
Brand Name	:	**Laird**
Applicant	:	**Laird Technologies**
Address	:	**W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA**
Standard	:	**47 CFR FCC Part 15.247**
Received Date	:	**May 14, 2018**
Tested Date	:	**May 25 ~ May 28, 2018**

We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by: **Approved by:**

Along Chen / Assistant Manager **Gary Chang / Manager**

Testing Laboratory
2732

Table of Contents

Release Record

Report No.	Version	Description	Issued Date
FR662202-06-1AE	Rev. 01	Initial issue	Jul. 27, 2018

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	AC Power Line Conducted Emissions	[dBuV]: 0.387MHz 36.84 (Margin -11.28dB) - AV	Pass
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]: 64.92MHz 36.38 (Margin -3.62dB) - PK	Pass
15.247(b)(3)	Maximum Output Power	Power [dBm]: 4.42	Pass
15.247(a)(2)	6dB Bandwidth	Meet the requirement of limit	Pass
15.247(e)	Power Spectral Density	Meet the requirement of limit	Pass
15.203	Antenna Requirement	Meet the requirement of limit	Pass

1 General Description

1.1 Information

This report is issued as a FCC Class II Permissive Change.
This report is issued as a supplementary report to original ICC report no. FR662202AE. The modification is concerned with adding 4 antennas and 2 Mbps data rate by software setting.

1.1.1 Product Details

The following models are provided to this EUT.

Brand Name	Model Name	Product Name	Description
Laird	BL652-SA	Bluetooth 4.2 module (BLE only)	with chip antenna
	BL652-SC		with MHF4 & IPEX connector type antenna
✦ The above models, model **BL652-SC** was selected as a representative one for the final test and only its data was recorded in this report.			

1.1.2 Specification of the Equipment under Test (EUT)

RF General Information				
Frequency Range (MHz)	**Bluetooth Mode**	**Ch. Freq. (MHz)**	**Channel Number**	**Data Rate**
2400-2483.5	V4.2 LE	2402-2480	0-39 [40]	2 Mbps
Note 1: Bluetooth LE (Low energy) uses GFSK modulation.				

1.1.3 Antenna Details(The additional antennas are marked in boldface)

Ant. No.	Brand	Model	Type	Connector	Gain (dBi)	Remarks
1	ACX	AT3216-B2R7HAA	Chip	N/A	0.5	For BL652-SA
2	LSR	FlexPIFA 001-0022	FlexPIFA	MHF4	2	For BL652-SC
3	LSR	FlexNotch 001-0023	Flexible Notch	MHF4	2	
4	MAG. LAYERS	EDA-8709-2G4C1-B27	Dipole	MHF4	2	
5	Walsin	RFDPA870910EMAB302	Dipole	MHF4	2	
6	**Walsin**	**RFDPA870900SBAB8G1**	**Dipole**	**MHF4**	**2**	
7	**YAMAMOTO METAL**	**YAN-02-C-MHF4P-050**	**Chip**	**MHF4**	**-1.76**	
8	**Laird**	**PCA-4606-2G4C1-A33-CY Laird # 0600-00056**	**PCB Dipole**	**IPEX**	**2.21**	
9	**Laird**	**EFA2400A3S-10MH4L**	**mFlexPIFA**	**MHF4**	**2**	

Note: The antenna with highest gain was selected for final testing in this test report

1.1.4 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	3.3Vdc from host

1.1.5 Accessories

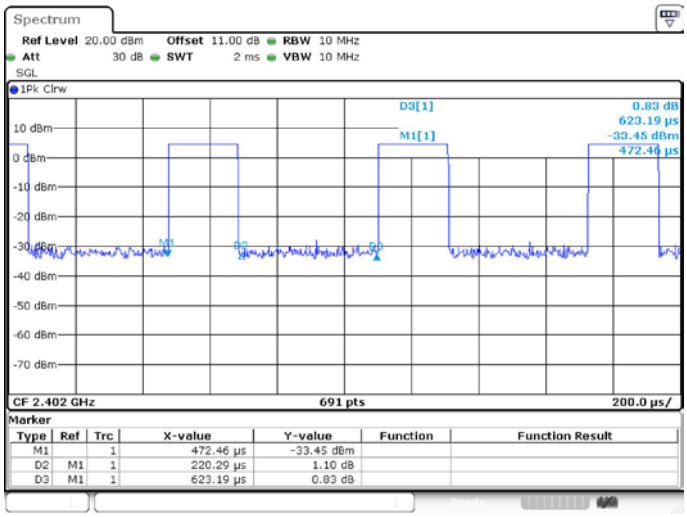
N/A

1.1.6 Channel List

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

1.1.7 Test Tool and Duty Cycle

Test tool	UwTerminal, Version: v7_94
Duty cycle of test signal (%)	35.35%
Duty Factor (dB)	4.52

Duty cycle plot


1.1.8 Power Setting

Modulation Mode	**Test Frequency (MHz)**		
	2402	**2440**	**2480**
GFSK/2Mbps	Default	Default	Default

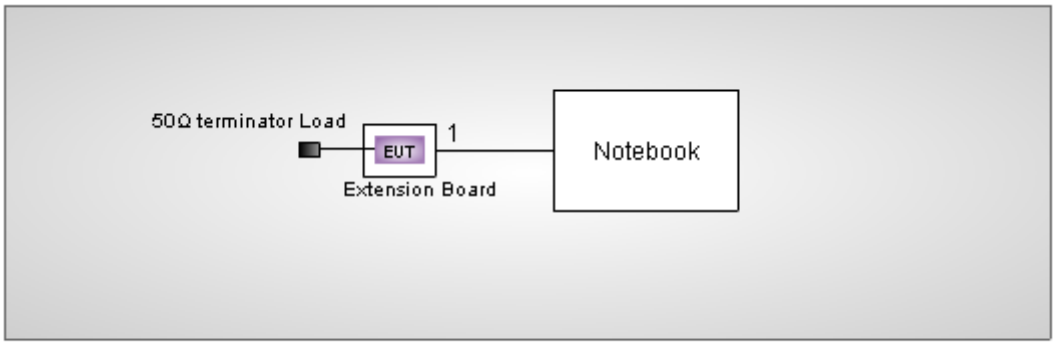
1.2 Local Support Equipment List

Support Equipment List					
No.	**Equipment**	**Brand**	**Model**	**FCC ID**	**Signal cable / Length (m)**
1	Notebook	DELL	Latitude E6440	DoC	---
2	Extension Board	Laird	DVK-BL652-A1	---	USB, 1m shielded without core

Note: Extension Board and USB cable were supplied by applicant.

1.3 Test Setup Chart

Test Setup Diagram



1. USB, 1m shielded

1.4 Test Equipment List and Calibration Data

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Receiver	R&S	ESR3	101657	Jan. 05, 2018	Jan. 04, 2019
LISN	SCHWARZBECK	Schwarzbeck 8127	8127-667	Nov. 13, 2017	Nov. 12, 2018
RF Cable-CON	EMC	EMCCFD300-BM-BM-6000	50821	Dec. 18, 2017	Dec. 17, 2018
Measurement Software	AUDIX	e3	6.120210k	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emission				
Test Site	966 chamber 3 / (03CH03-WS)				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101499	Jan. 03, 2018	Jan. 02, 2019
Receiver	R&S	ESR3	101658	Nov. 20, 2017	Nov. 19, 2018
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-685	Apr. 19, 2018	Apr. 18, 2019
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1206	Jan. 18, 2018	Jan. 17, 2019
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 23, 2017	Nov. 22, 2018
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 13, 2017	Nov. 12, 2018
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Dec. 07, 2017	Dec. 06, 2018
Preamplifier	EMC	EMC02325	980187	Sep. 04, 2017	Sep. 03, 2018
Preamplifier	Agilent	83017A	MY53270014	Aug. 21, 2017	Aug. 20, 2018
Preamplifier	EMC	EMC184045B	980192	Aug. 22, 2017	Aug. 21, 2018
RF cable-3M	HUBER+SUHNER	SUCOFLEX104	MY22620/4	Nov. 27, 2017	Nov. 26, 2018
RF cable-8M	HUBER+SUHNER	SUCOFLEX104	MY32487/4	Nov. 27, 2017	Nov. 26, 2018
RF cable-1M	HUBER+SUHNER	SUCOFLEX104	MY22624/4	Nov. 27, 2017	Nov. 26, 2018
LF cable-0.8M	EMC	EMC8D-NM-NM-800	EMC8D-NM-NM-800-001	Nov. 27, 2017	Nov. 26, 2018
LF cable-3M	EMC	EMC8D-NM-NM-3000	131103	Nov. 27, 2017	Nov. 26, 2018
LF cable-13M	EMC	EMC8D-NM-NM-13000	131104	Nov. 27, 2017	Nov. 26, 2018
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101499	Jan. 03, 2018	Jan. 02, 2019
Power Meter	Anritsu	ML2495A	1241002	Oct. 16, 2017	Oct. 15, 2018
Power Sensor	Anritsu	MA2411B	1207366	Oct. 16, 2017	Oct. 15, 2018
DC POWER SOURCE	GW INSTEK	GPC-6030D	EM892433	Oct. 26, 2017	Oct. 25, 2018
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.5 Test Standards

According to the specification of EUT, the EUT must comply with following standards and KDB documents.

47 CFR FCC Part 15.247
ANSI C63.10-2013
FCC KDB 558074 D01 DTS Meas Guidance v04

1.6 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)

Measurement Uncertainty	
Parameters	**Uncertainty**
Bandwidth	±34.134 Hz
Conducted power	±0.808 dB
Power density	±0.463 dB
Conducted emission	±2.670 dB
AC conducted emission	±2.90 dB
Radiated emission ≤ 1GHz	±3.66 dB
Radiated emission > 1GHz	±5.37 dB

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	22°C / 58%	Alex Tsai
Radiated Emissions	03CH03-WS	23°C / 63%	Akun Chung
RF Conducted	TH01-WS	23°C / 65%	Brad Wu

- FCC Designation No.: TW0009
- FCC site registration No.: 207696
- IC site registration No.: 10807C-1

2.2 The Worst Test Modes and Channel Details

Test item	Mode	Test Frequency (MHz)	Data Rate	Test Configuration
AC Power Line Conducted Emissions	BT LE	2440	2Mbps	---
Radiated Emissions ≤ 1GHz	BT LE	2440	2Mbps	---
Maximum Output Power 6dB bandwidth Power spectral density	BT LE	2402, 2440, 2480	2Mbps	---
Radiated Emissions > 1GHz	BT LE	2402, 2440, 2480	2Mbps	---

NOTE:
1. The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z axis. The X axis results were found as the worst case and were shown in this report.
2. 50Ω terminator is connected to antenna port of EUT for radiated emission measurement.

3 Transmitter Test Results

3.1 Conducted Emissions

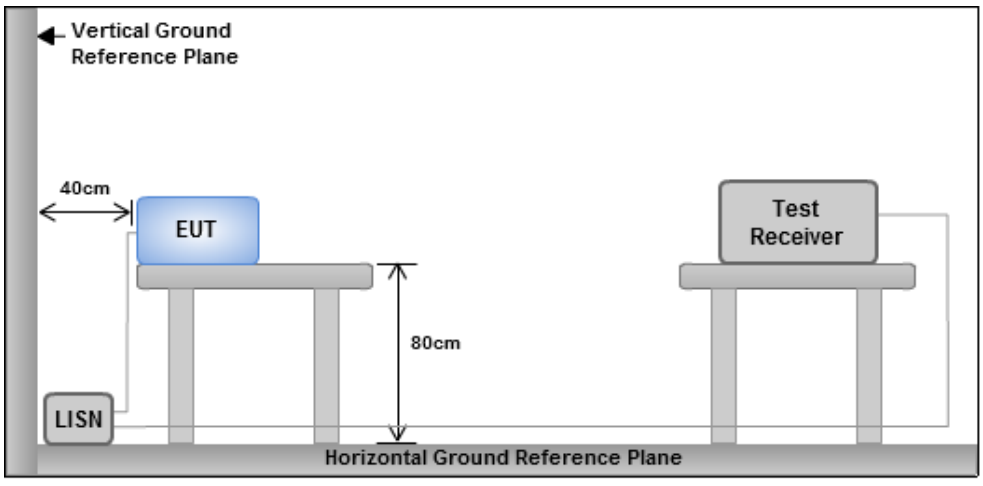
3.1.1 Limit of Conducted Emissions

Conducted Emissions Limit		
Frequency Emission (MHz)	**Quasi-Peak**	**Average**
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50
Note 1: * Decreases with the logarithm of the frequency.		

3.1.2 Test Procedures

1. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
2. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
3. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.
4. This measurement was performed with AC 120V/60Hz

3.1.3 Test Setup

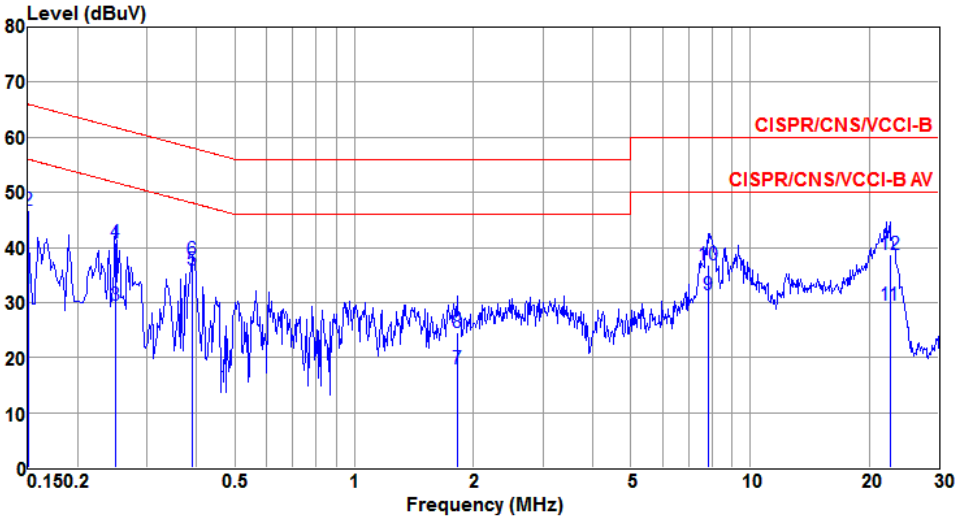


Note: 1. Support units were connected to second LISN.

2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

3.1.4 Test Result of Conducted Emissions

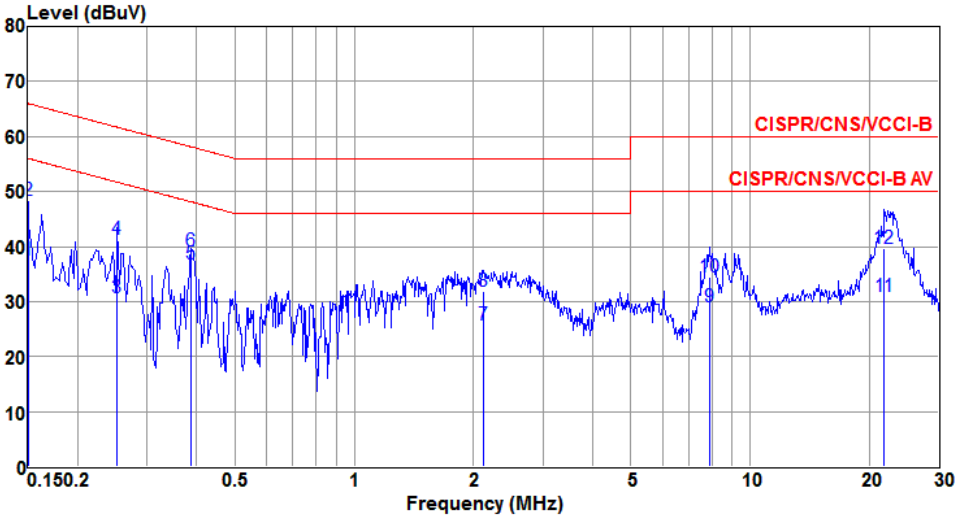
Modulation Mode	GFSK	Test Freq. (MHz)	2440
Power Phase	Line		



	Freq	Level	Limit Line	Over Limit	Read Level	LISN factor	cable loss	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	dB	
1	0.150	32.61	56.00	-23.39	32.53	0.07	0.01	Average
2	0.150	46.65	66.00	-19.35	46.57	0.07	0.01	QP
3	0.249	29.39	51.78	-22.39	29.28	0.08	0.03	Average
4	0.249	40.94	61.78	-20.84	40.83	0.08	0.03	QP
5@	0.389	35.81	48.08	-12.27	35.71	0.08	0.02	Average
6	0.389	37.74	58.08	-20.34	37.64	0.08	0.02	QP
7	1.819	17.85	46.00	-28.15	17.65	0.11	0.09	Average
8	1.819	24.49	56.00	-31.51	24.29	0.11	0.09	QP
9	7.852	31.31	50.00	-18.69	30.84	0.18	0.29	Average
10	7.852	36.89	60.00	-23.11	36.42	0.18	0.29	QP
11	22.535	29.55	50.00	-20.45	28.90	0.28	0.37	Average
12	22.535	38.79	60.00	-21.21	38.14	0.28	0.37	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

Modulation Mode	GFSK	Test Freq. (MHz)	2440
Power Phase	Neutral		



	Freq	Level	Limit Line	Over Limit	Read Level	LISN factor	cable loss	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	dB	
1	0.150	37.46	56.00	-18.54	37.41	0.04	0.01	Average
2	0.150	48.29	66.00	-17.71	48.24	0.04	0.01	QP
3	0.252	30.65	51.69	-21.04	30.58	0.04	0.03	Average
4	0.252	41.30	61.69	-20.39	41.23	0.04	0.03	QP
5@	0.387	36.84	48.12	-11.28	36.78	0.04	0.02	Average
6	0.387	39.13	58.12	-18.99	39.07	0.04	0.02	QP
7	2.121	25.78	46.00	-20.22	25.60	0.07	0.11	Average
8	2.121	31.92	56.00	-24.08	31.74	0.07	0.11	QP
9	7.893	28.96	50.00	-21.04	28.52	0.15	0.29	Average
10	7.893	34.57	60.00	-25.43	34.13	0.15	0.29	QP
11	21.830	30.90	50.00	-19.10	30.26	0.28	0.36	Average
12	21.830	39.55	60.00	-20.45	38.91	0.28	0.36	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

3.2 6dB and Occupied Bandwidth

3.2.1 Limit of 6dB Bandwidth

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

3.2.2 Test Procedures

6dB Bandwidth

1. Set resolution bandwidth (RBW) = 100 kHz, Video bandwidth = 300 kHz.
2. Detector = Peak, Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6dB relative to the maximum level measured in the fundamental emission.

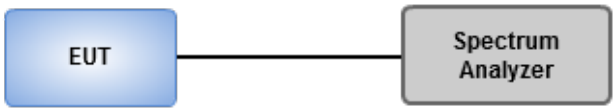
Occupied Bandwidth

1. Set resolution bandwidth (RBW) = 30 kHz, Video bandwidth = 100 kHz.
2. Detector = Sample, Trace mode = max hold.

3 Sweep = auto couple, Allow the trace to stabilize.

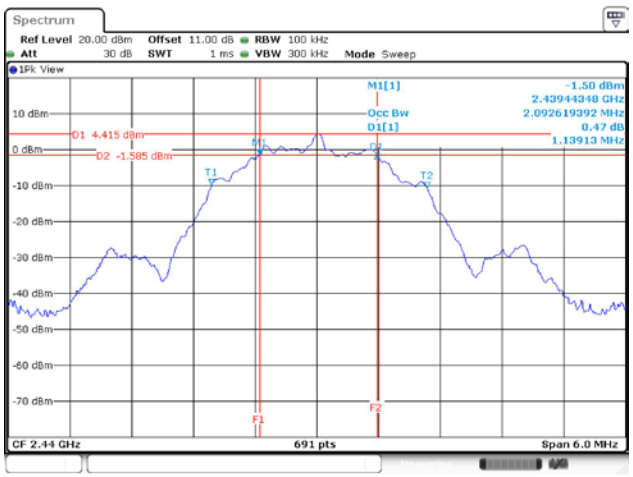
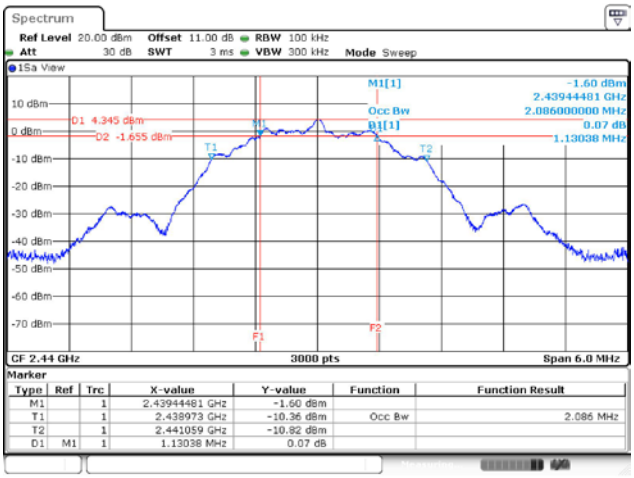
4. Use the OBW measurement function of spectrum analyzer to measure the occupied bandwidth.

3.2.3 Test Setup



3.2.4 Test Result of 6dB and Occupied Bandwidth

Mode	Freq. (MHz)	6dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	Limit of 6dB Bandwidth (kHz)
BT LE	2402	1.148	2.08	500
BT LE	2440	1.139	2.09	500
BT LE	2480	1.139	2.08	500

Worst Plots	
6dB Bandwidth	99% Occupied Bandwidth
	

3.3 RF Output Power

3.3.1 Limit of RF Output Power

Conducted power shall not exceed 1Watt.

Antenna gain <= 6dBi, no any corresponding reduction is in output power limit.

3.3.2 Test Procedures

A broadband RF power meter is used for output power measurement. The video bandwidth of power meter is greater than DTS bandwidth of EUT. If duty cycle of test signal is not 100 %, trigger and gating function of power meter will be enabled to capture transmission burst for measuring output power.

3.3.3 Test Setup

3.3.4 Test Result of Maximum Output Power

Mode	Freq. (MHz)	Peak Power			Antenna gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)
		Power (mW)	Power (dBm)	Limit (dBm)			
BT LE	2402	2.766942	**4.42**	30	2.21	6.63	36
BT LE	2440	2.747894	4.39	30	2.21	6.60	36
BT LE	2480	2.710192	4.33	30	2.21	6.54	36

Mode	Freq. (MHz)	AV Power (mW)	AV Power (dBm)	Limit (dBm)
BT LE	2402	2.747894	**4.39**	---
BT LE	2440	2.728978	4.36	---
BT LE	2480	2.691535	4.30	---

Note: Average power is for reference only

3.4 Power Spectral Density

3.4.1 Limit of Power Spectral Density

Power spectral density shall not be greater than 8 dBm in any 3 kHz band.

3.4.2 Test Procedures

Peak PSD

1. Set the RBW = 3 kHz, VBW = 10 kHz.
2. Detector = Peak, Sweep time = auto couple.
3. Trace mode = max hold, allow trace to fully stabilize.
4. Use the peak marker function to determine the maximum amplitude level.

Average PSD, duty cycle ≥ 98%

1. Set the RBW = 3 kHz, VBW = 10 kHz.
2. Detector = RMS, Sweep time = auto couple.
3. Sweep time = auto couple.
4. Employ trace averaging (RMS) mode over a minimum of 100 traces.
5. Use the peak marker function to determine the maximum amplitude level.

Average PSD, duty cycle < 98%

1 Set the RBW = 3 kHz, VBW = 10 kHz. Detector = RMS.

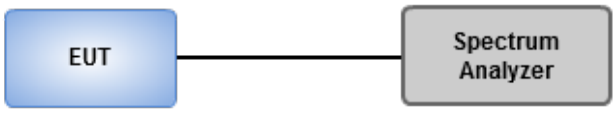
2 Set the sweep time to: ≥ 10 (number of measurement points in sweep) x (total on/off period of the transmitted signal).

3 Perform the measurement over a single sweep.

4 Use the peak marker function to determine the maximum amplitude level.

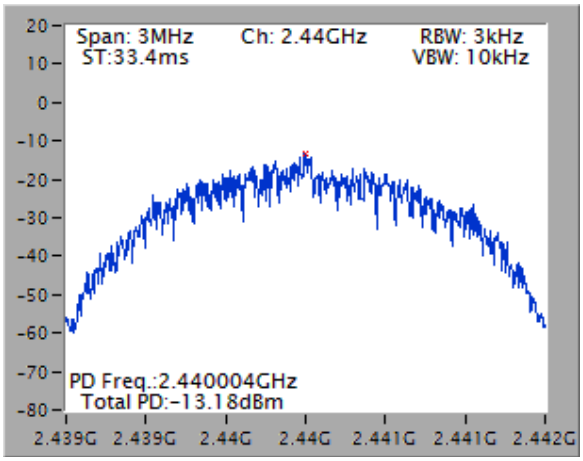
5 Add 10 log (1/x), where x is the duty cycle.

3.4.3 Test Setup



3.4.4 Test Result of Power Spectral Density

Mode	Freq. (MHz)	Total Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
BT LE	2402	-13.30	8
BT LE	2440	-13.18	8
BT LE	2480	-13.32	8

Worst Plot


3.5 Emissions in Restricted Frequency Bands

3.5.1 Limit of Emissions in Restricted Frequency Bands

Restricted Band Emissions Limit			
Frequency Range (MHz)	**Field Strength (uV/m)**	**Field Strength (dBuV/m)**	**Measure Distance (m)**
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1:
Qusai-Peak value is measured for frequency below 1GHz except for 9–90 kHz, 110–490 kHz frequency band. Peak and average value are measured for frequency above 1GHz. The limit on average radio frequency emission is as above table. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit
Note 2:
Measurements may be performed at a distance other than what is specified provided. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor as below, Frequency at or above 30 MHz: 20 dB/decade Frequency below 30 MHz: 40 dB/decade.

3.5.2 Test Procedures

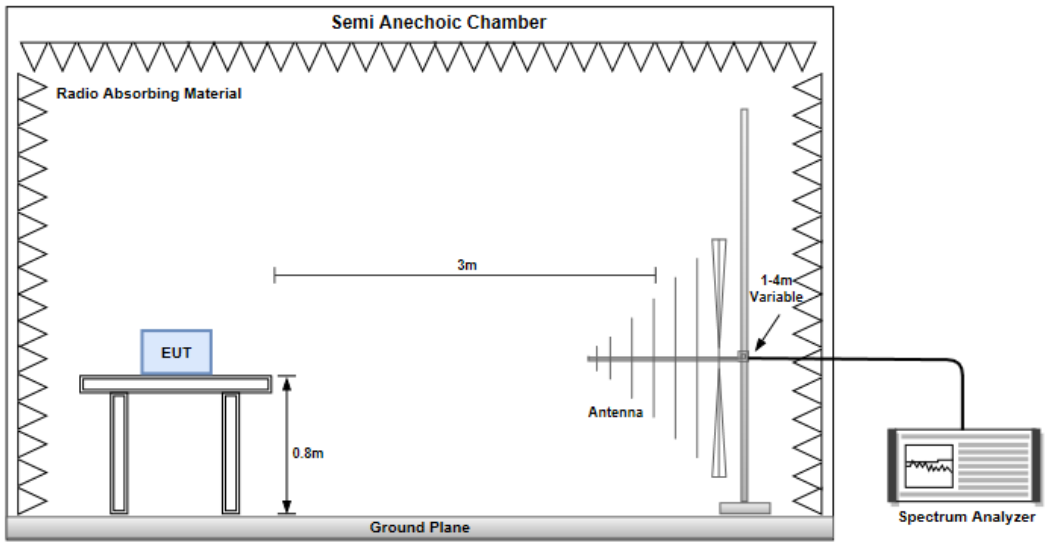
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at test table. For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height is 1.5 m
2. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
3. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Note:

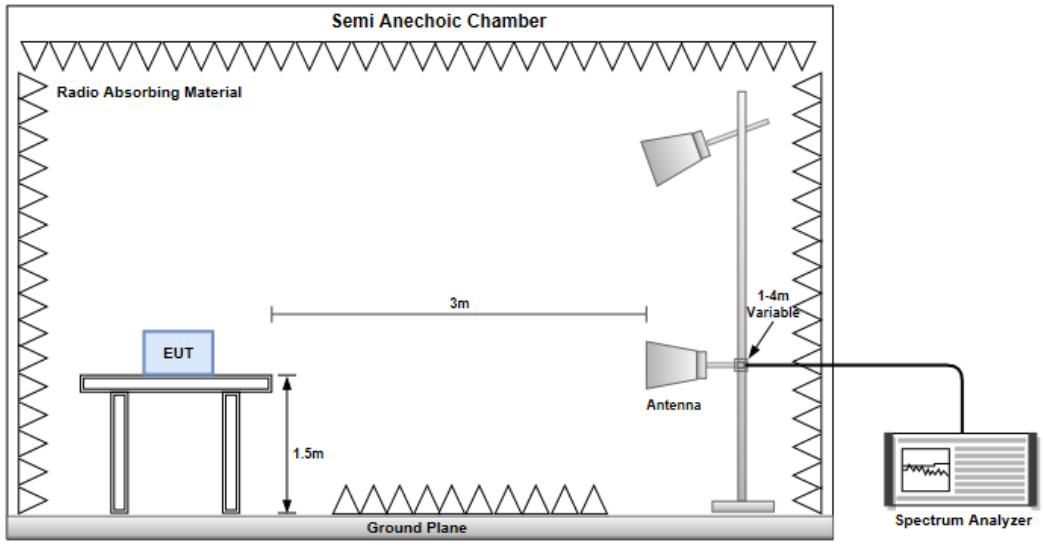
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above 1GHz.

3.5.3 Test Setup

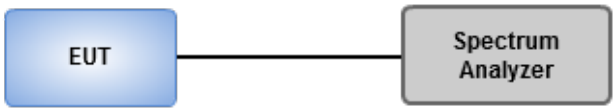
Radiated Emissions below 1 GHz



Radiated Emissions above 1 GHz

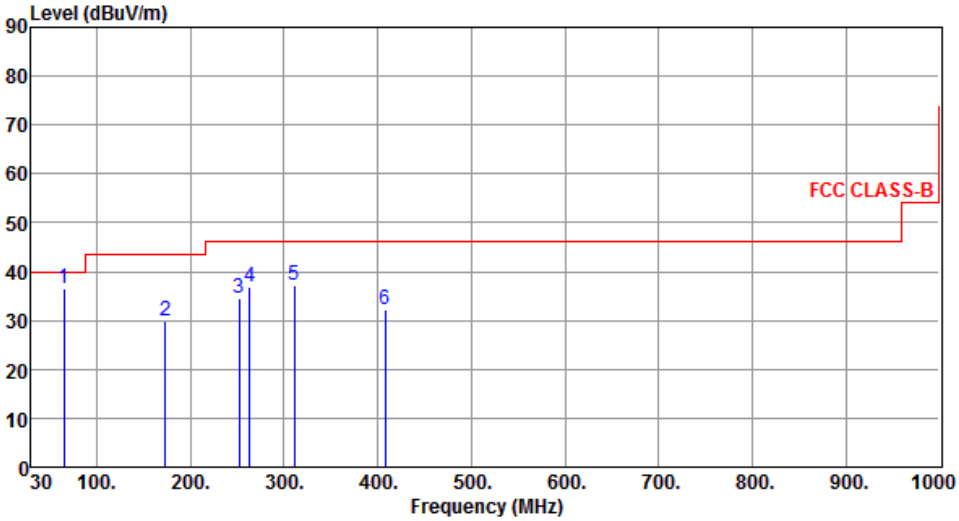


Conducted Emissions



3.5.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

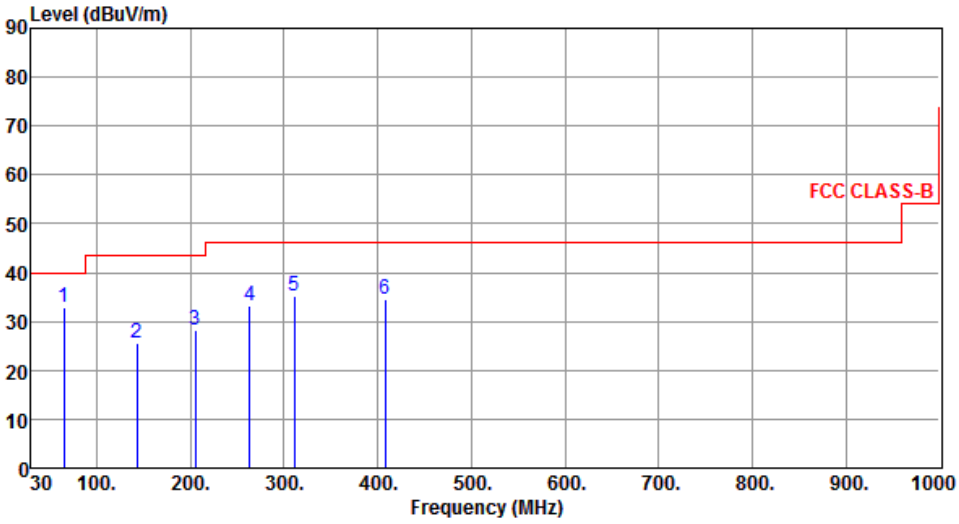
Modulation	GFSK	**Test Freq. (MHz)**	2440
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	64.92	36.38	40.00	-3.62	46.02	-9.64	Peak	---	---
2	173.56	30.05	43.50	-13.45	38.85	-8.80	Peak	---	---
3	252.13	34.59	46.00	-11.41	43.71	-9.12	Peak	---	---
4	263.77	36.83	46.00	-9.17	45.61	-8.78	Peak	---	---
5	311.30	37.27	46.00	-8.73	44.61	-7.34	Peak	---	---
6	408.30	32.20	46.00	-13.80	37.06	-4.86	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

Modulation	GFSK	Test Freq. (MHz)	2440
Polarization	Vertical		

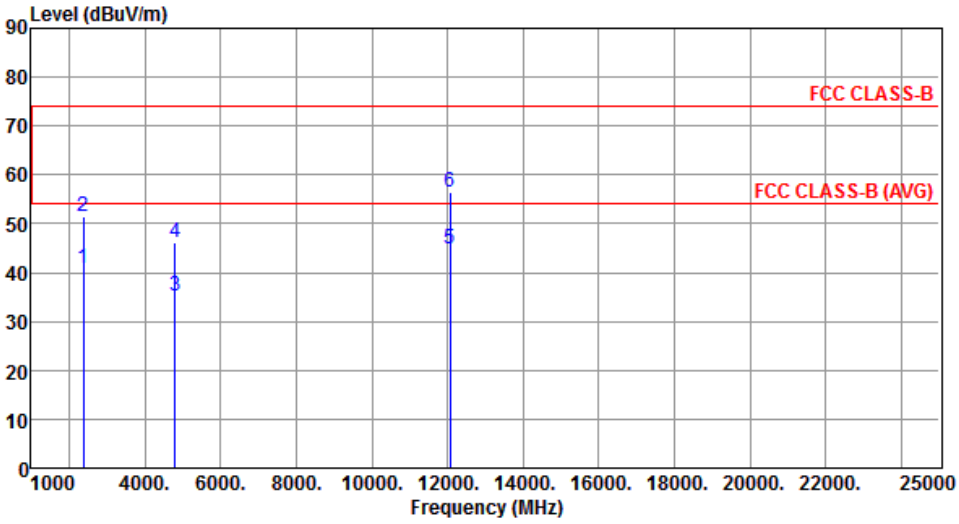


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	64.92	33.04	40.00	-6.96	42.68	-9.64	Peak	---	---
2	142.52	25.67	43.50	-17.83	34.11	-8.44	Peak	---	---
3	205.57	28.26	43.50	-15.24	39.13	-10.87	Peak	---	---
4	263.77	33.18	46.00	-12.82	41.96	-8.78	Peak	---	---
5	311.30	35.24	46.00	-10.76	42.58	-7.34	Peak	---	---
6	408.30	34.61	46.00	-11.39	39.47	-4.86	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

3.5.5 Transmitter Radiated Unwanted Emissions (Above 1GHz)

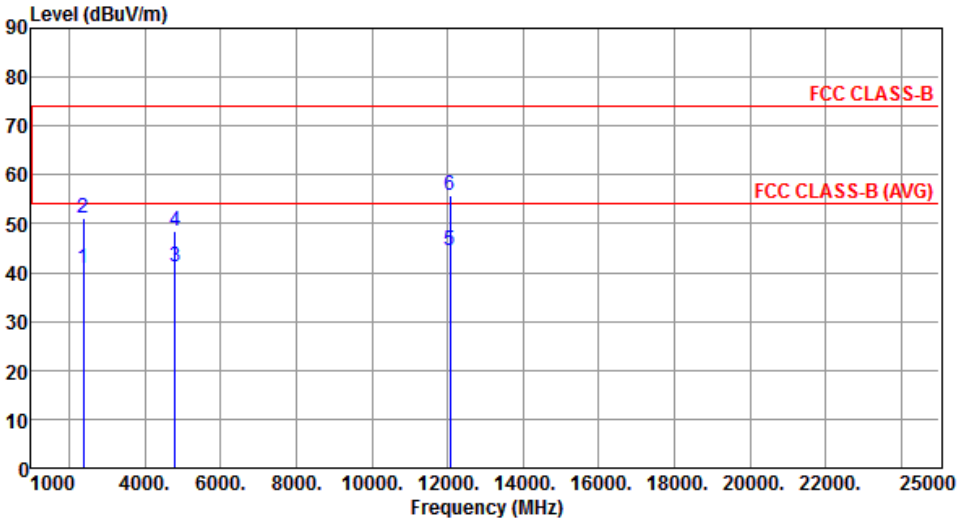
Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	40.79	54.00	-13.21	42.00	-1.21	Average	109	140
2	2390.00	51.44	74.00	-22.56	52.65	-1.21	Peak	109	140
3	4804.00	35.36	54.00	-18.64	29.75	5.61	Average	285	142
4	4804.00	46.18	74.00	-27.82	40.57	5.61	Peak	285	142
5	12060.00	44.67	54.00	-9.33	29.00	15.67	Average	100	145
6	12060.00	56.31	74.00	-17.69	40.64	15.67	Peak	100	145

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

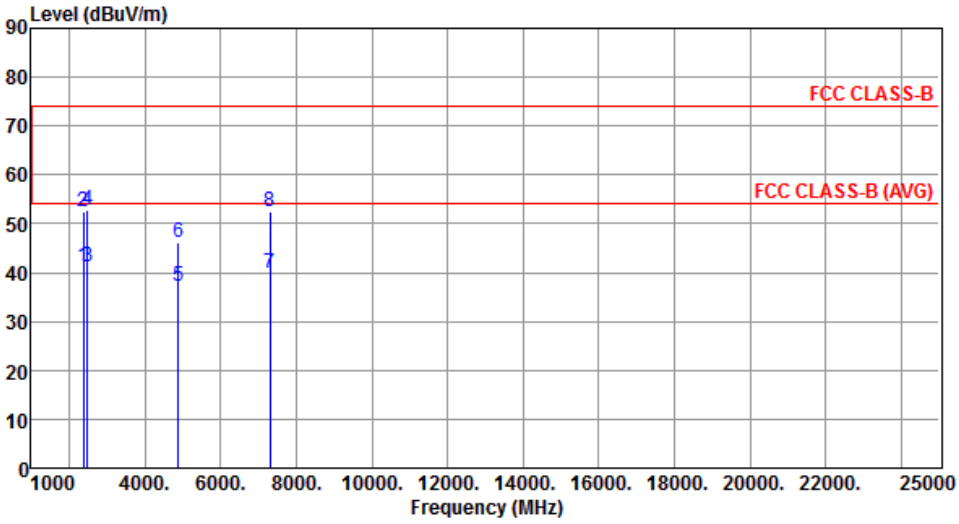
Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	40.70	54.00	-13.30	41.91	-1.21	Average	320	89
2	2390.00	51.30	74.00	-22.70	52.51	-1.21	Peak	320	89
3	4804.00	41.29	54.00	-12.71	35.68	5.61	Average	313	199
4	4804.00	48.39	74.00	-25.61	42.78	5.61	Peak	313	199
5	12060.00	44.46	54.00	-9.54	28.79	15.67	Average	100	90
6	12060.00	55.90	74.00	-18.10	40.23	15.67	Peak	100	90

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

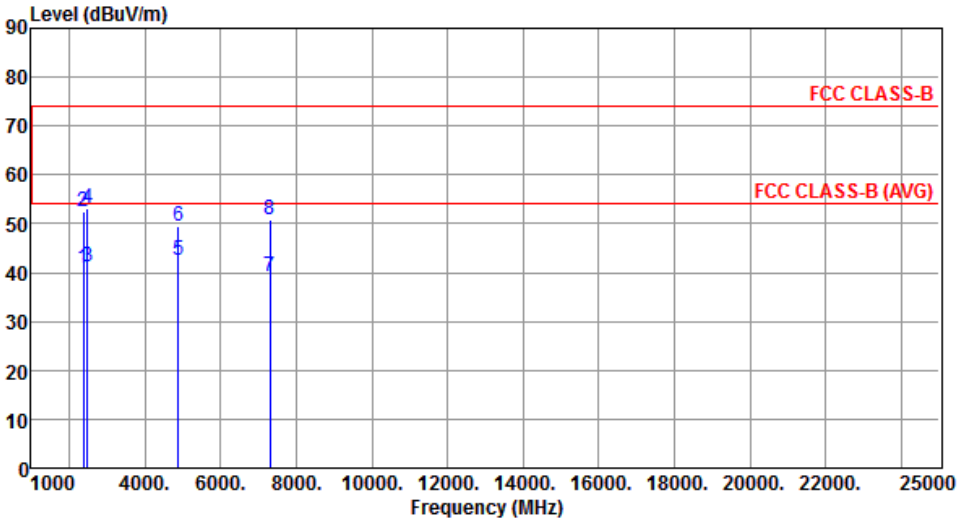
Modulation	GFSK	Test Freq. (MHz)	2440
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	41.17	54.00	-12.83	42.38	-1.21	Average	100	141
2	2390.00	52.48	74.00	-21.52	53.69	-1.21	Peak	100	141
3	2483.50	41.09	54.00	-12.91	41.95	-0.86	Average	100	141
4	2483.50	52.86	74.00	-21.14	53.72	-0.86	Peak	100	141
5	4880.00	37.05	54.00	-16.95	31.23	5.82	Average	290	148
6	4880.00	46.28	74.00	-27.72	40.46	5.82	Peak	290	148
7	7320.00	39.89	54.00	-14.11	28.90	10.99	Average	125	70
8	7320.00	52.35	74.00	-21.65	41.36	10.99	Peak	125	70

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

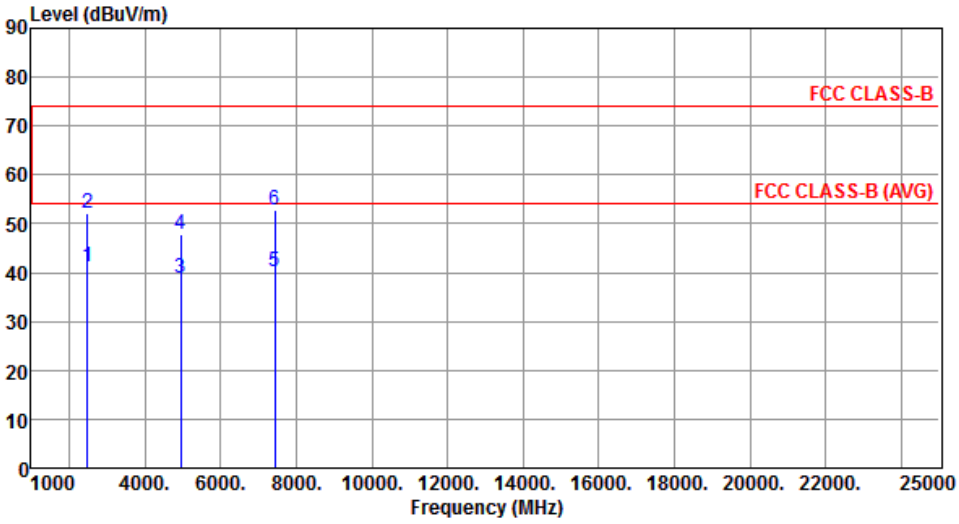
Modulation	GFSK	Test Freq. (MHz)	2440
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	40.85	54.00	-13.15	42.06	-1.21	Average	347	92
2	2390.00	52.51	74.00	-21.49	53.72	-1.21	Peak	347	92
3	2483.50	41.24	54.00	-12.76	42.10	-0.86	Average	347	92
4	2483.50	53.18	74.00	-20.82	54.04	-0.86	Peak	347	92
5	4880.00	42.62	54.00	-11.38	36.80	5.82	Average	333	208
6	4880.00	49.41	74.00	-24.59	43.59	5.82	Peak	333	208
7	7320.00	39.33	54.00	-14.67	28.34	10.99	Average	100	150
8	7320.00	50.69	74.00	-23.31	39.70	10.99	Peak	100	150

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

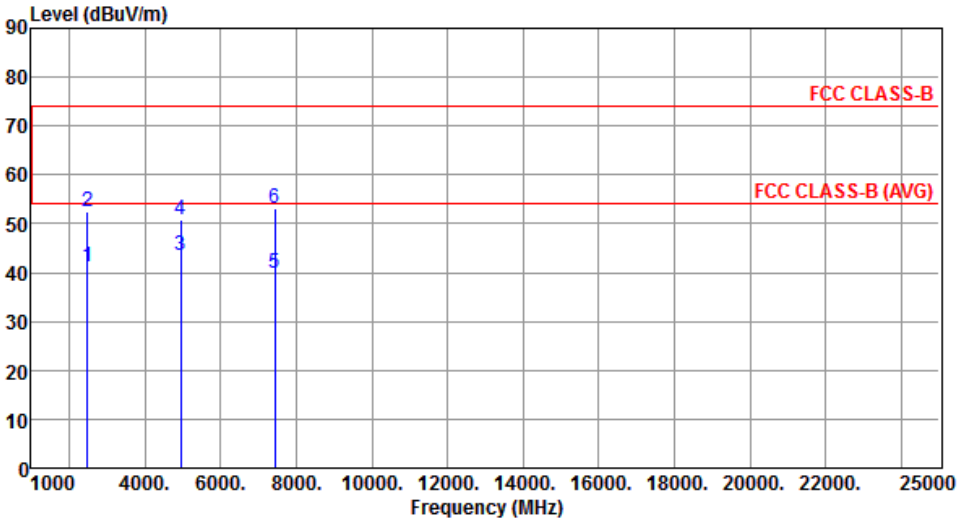
Modulation	GFSK	**Test Freq. (MHz)**	2480
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2483.50	41.05	54.00	-12.95	41.91	-0.86	Average	100	139
2	2483.50	52.13	74.00	-21.87	52.99	-0.86	Peak	100	139
3	4960.00	38.86	54.00	-15.14	32.80	6.06	Average	303	138
4	4960.00	47.77	74.00	-26.23	41.71	6.06	Peak	303	138
5	7440.00	40.23	54.00	-13.77	28.86	11.37	Average	120	80
6	7440.00	52.76	74.00	-21.24	41.39	11.37	Peak	120	80

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Modulation	GFSK	**Test Freq. (MHz)**	2480
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2483.50	41.12	54.00	-12.88	41.98	-0.86	Average	351	91
2	2483.50	52.49	74.00	-21.51	53.35	-0.86	Peak	351	91
3	4960.00	43.60	54.00	-10.40	37.54	6.06	Average	342	200
4	4960.00	50.76	74.00	-23.24	44.70	6.06	Peak	342	200
5	7440.00	39.84	54.00	-14.16	28.47	11.37	Average	118	144
6	7440.00	53.12	74.00	-20.88	41.75	11.37	Peak	118	144

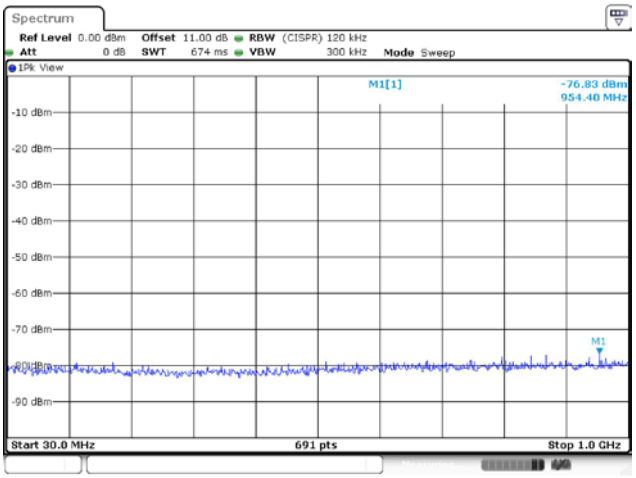
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

3.5.6 Transmitter Conducted Unwanted Emissions (Below 1 GHz)

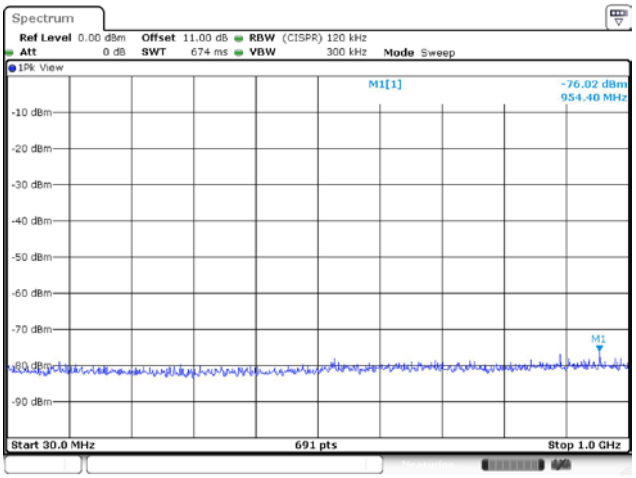
Transmitter Conducted Unwanted Emissions Results in Restrict bands							
Modulation	BT-BLE				**NTx**	1	
Test ch. Freq. (MHz)	**Range (MHz)**	**Max Value (dBm)**	**Gain (dBi)**	**GRF (dB)**	**EIRP (dBm)**	**Limit* (dBm)**	**Margin (dB)**
2402	30-1000	-76.83	2.21	4.7	-69.92	-55.20	-14.72
2440	30-1000	-76.02	2.21	4.7	-69.11	-55.20	-13.91
2480	30-1000	-76.20	2.21	4.7	-69.29	-55.20	-14.09

Note:
1. GRF = Ground Reflection Factor.
2. DG = Directional Gain.
3. Worst case of emission limit below 1GHz is selected to be limit.

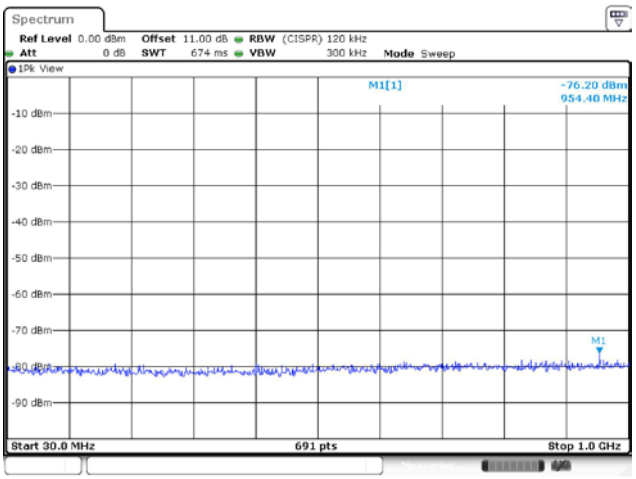
2402MHz



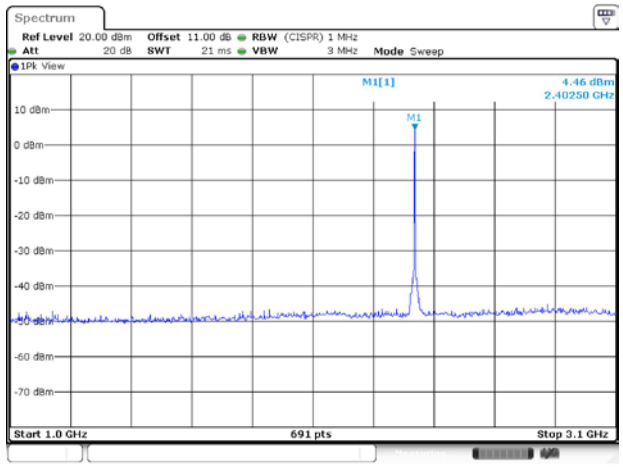
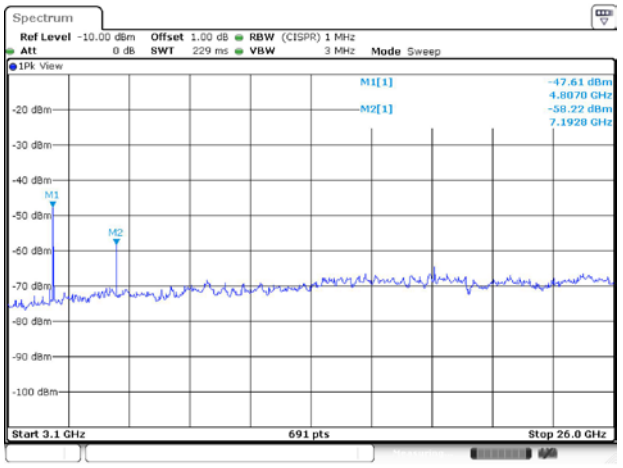
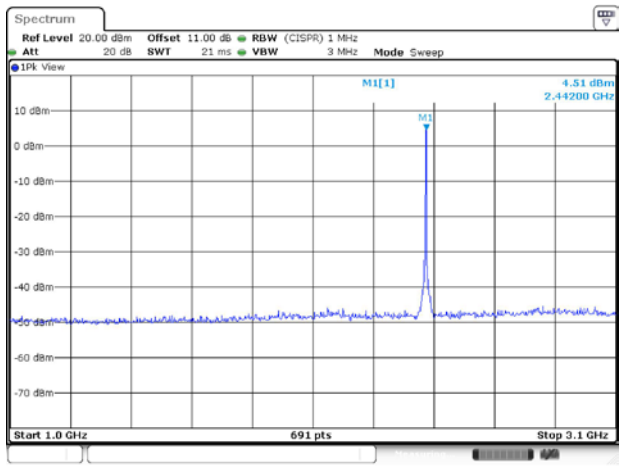
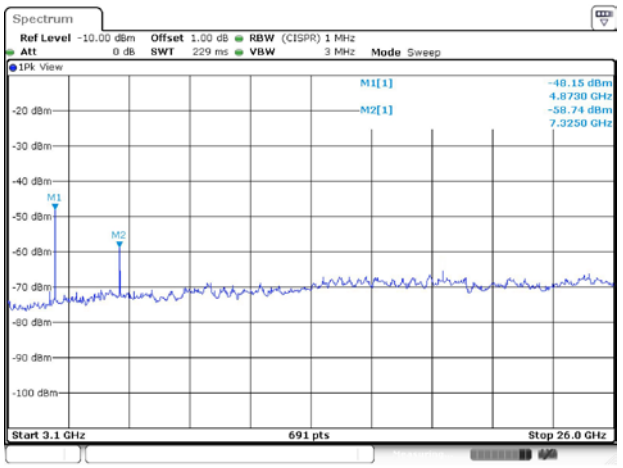
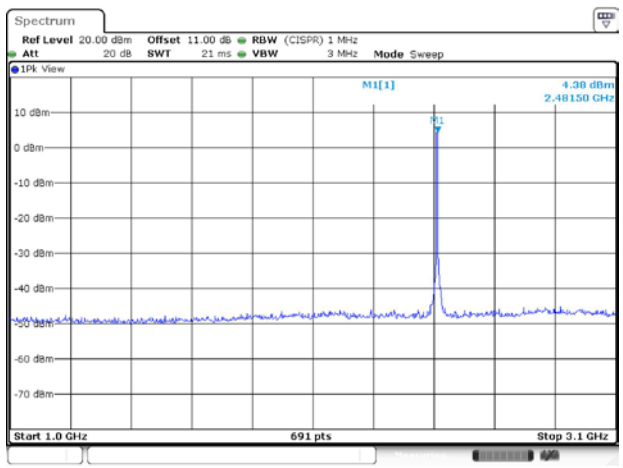
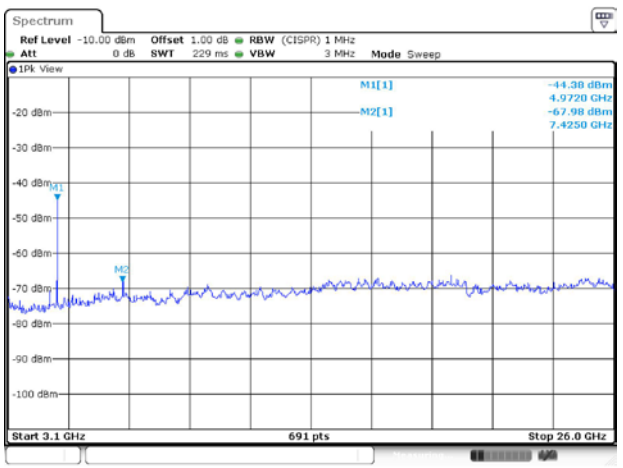
2440 MHz



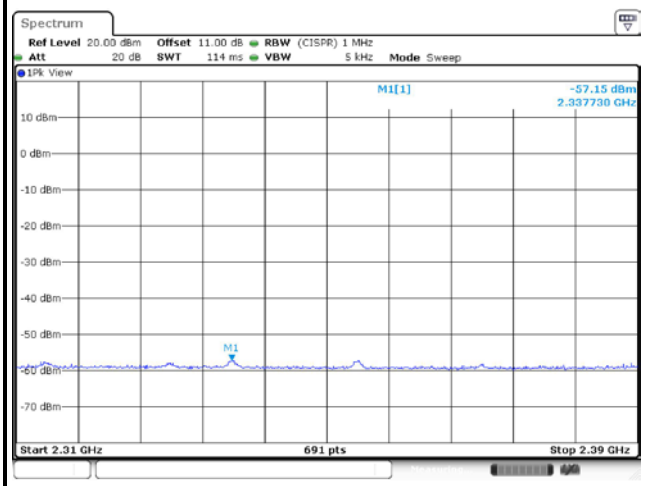
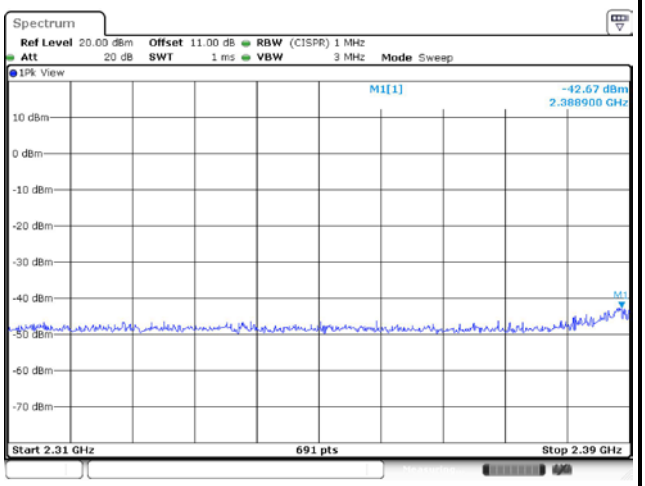
2480MHz

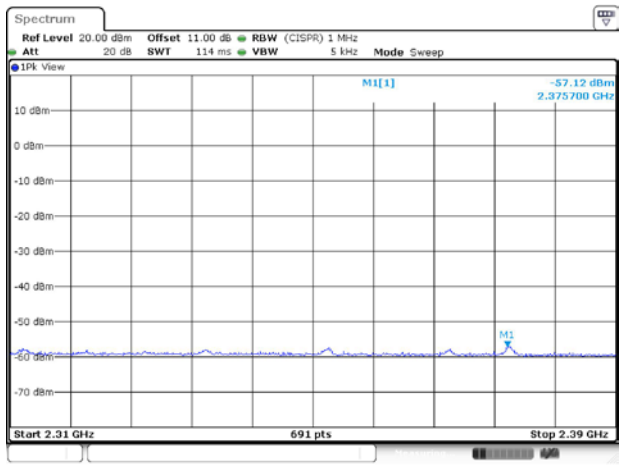
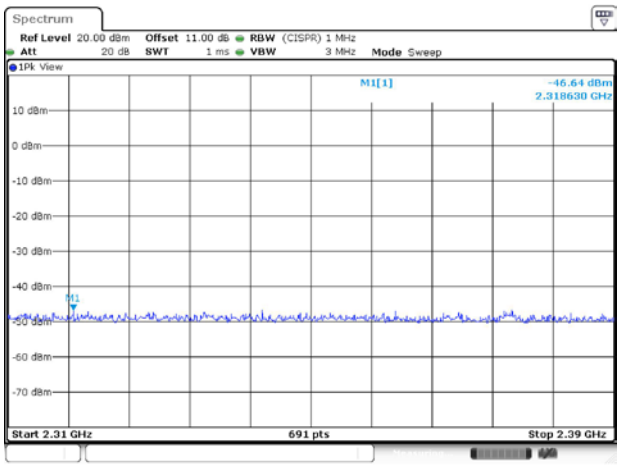
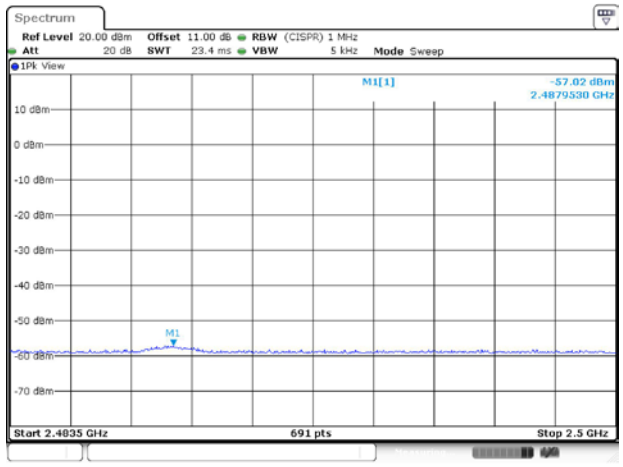
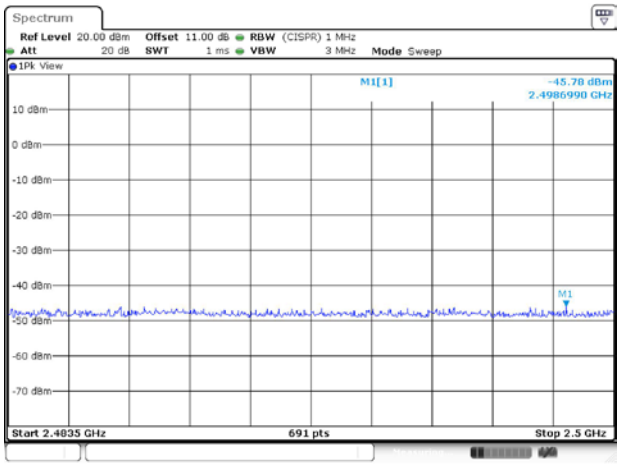
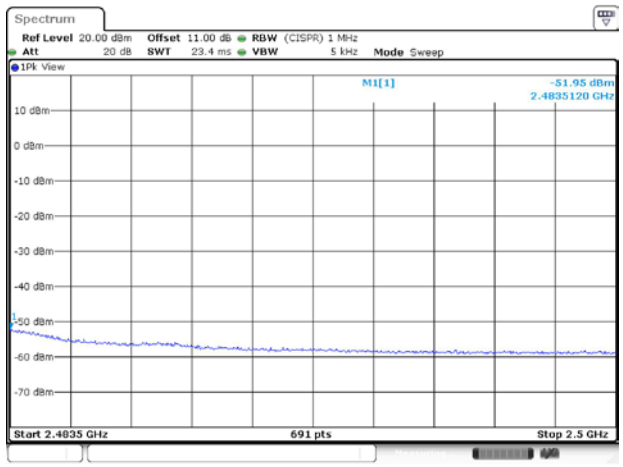
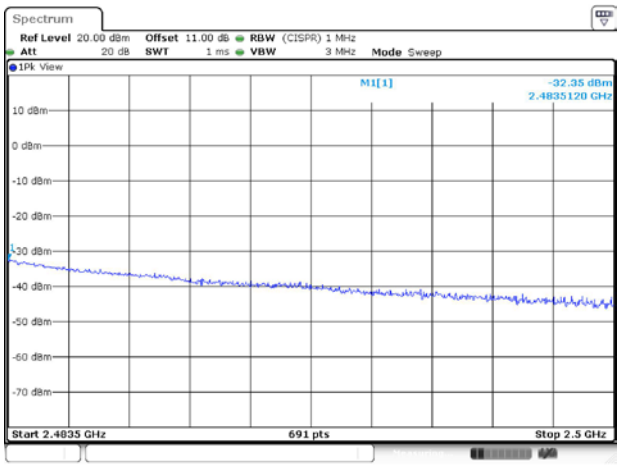


3.5.7 Transmitter Conducted Unwanted Emissions (Above 1GHz)

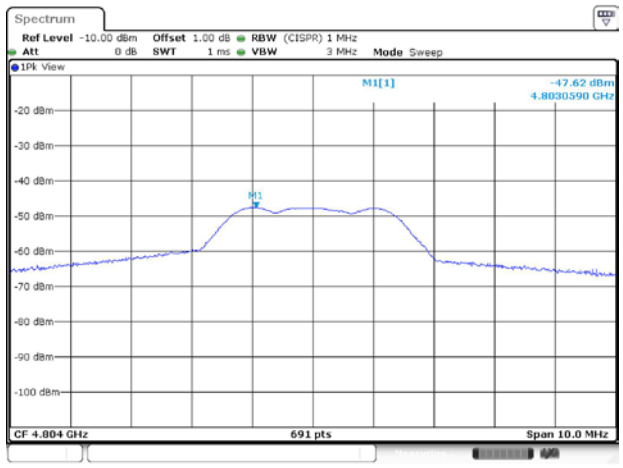
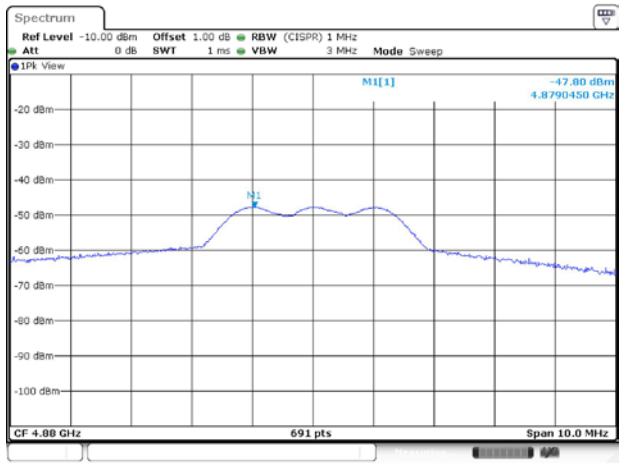
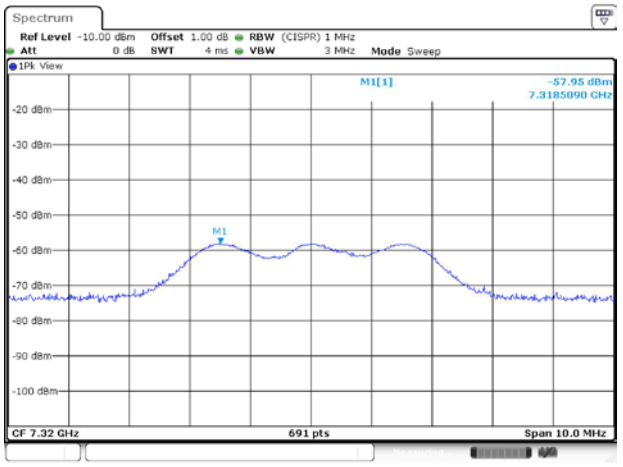
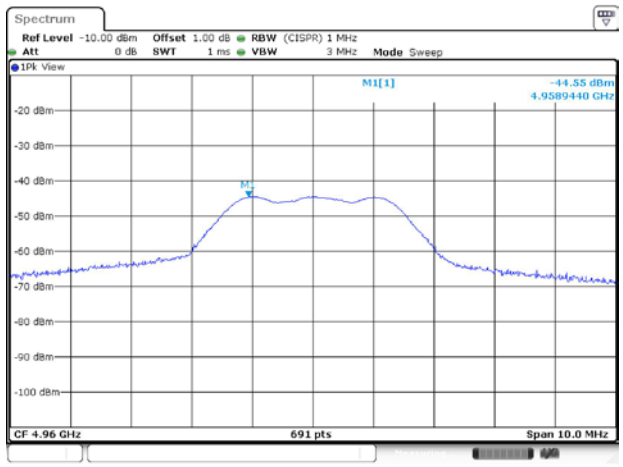
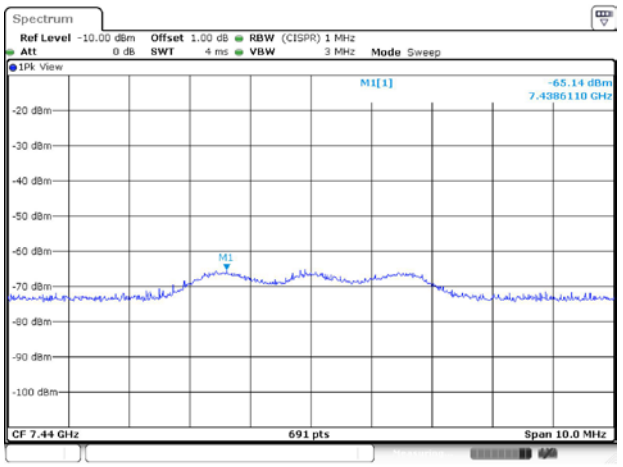
Full Range Scan Test Plot	
2402MHz	**2402MHz**
	
2440 MHz	**2440 MHz**
	
2480MHz	**2480MHz**
	

Transmitter Conducted Unwanted Emissions Results in Band Edge							
Modulation		BT-BLE		**NTx**		1	
Test ch. Freq. (MHz)	**Freq (MHz)**	**Measured Value (dBm)**	**Gain (dBi)**	**EIRP (dBm)**	**Limit (dBm)**	**Margin (dB)**	**Remark**
2402	2353.70	-57.15	2.21	-54.94	-41.20	-13.74	AV
	2354.05	-42.67	2.21	-40.46	-21.20	-19.26	PK
2440	2375.70	-57.12	2.21	-54.91	-41.20	-13.71	AV
	2325.22	-46.64	2.21	-44.43	-21.20	-23.23	PK
	2487.88	-57.02	2.21	-54.81	-41.20	-13.61	AV
	2488.24	-45.78	2.21	-43.57	-21.20	-22.37	PK
2480	2483.51	-51.95	2.21	-49.74	-41.20	-8.54	AV
	2483.51	-32.35	2.21	-30.14	-21.20	-8.94	PK

Band Edge Test Plot	
2402MHz - AV	**2402MHz - PK**
	

Band Edge Test Plot	
2440MHz - AV	**2440MHz - PK**
	
2440MHz - AV	**2440MHz - PK**
	
2480MHz - AV	**2480MHz - PK**
	

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation	BT-BLE			**NTx**	1		
Test ch. Freq. (MHz)	**Freq (MHz)**	**Measured Value (dBm)**	**Gain (dBi)**	**EIRP (dBm)**	**Limit (dBm)**	**Margin (dB)**	**Remark**
2402	-	-	2.21	-	-41.20	-	AV
	4804.00	-47.62	2.21	-45.41	-21.20	-24.21	PK
2440	-	-	2.21	-	-41.20	-	AV
	4880.00	-47.80	2.21	-45.59	-21.20	-24.39	PK
	-	-	2.21	-	-41.20	-	AV
	7320.00	-57.95	2.21	-55.74	-21.20	-34.54	PK
2480	-	-	2.21	-	-41.20	-	AV
	4960.00	-44.55	2.21	-42.34	-21.20	-21.14	PK
	-	-	2.21	-	-41.20	-	AV
	7440.00	-65.14	2.21	-62.93	-21.20	-41.73	PK
Note: Average value measurement is not performed if the Peak value below the average limit							

Harmonic Emissions Test Plots	
2402MHz - PK	**---**
	---
2440MHz - PK	**2440MHz - PK**
	
2480MHz - PK	**2480MHz - PK**
	

3.6 Emissions in non-restricted Frequency Bands

3.6.1 Emissions in non-restricted frequency bands limit

Peak power 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

3.6.2 Test Procedures

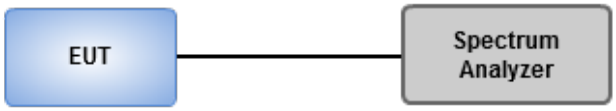
Reference level measurement

1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Use the peak marker function to determine the maximum PSD level

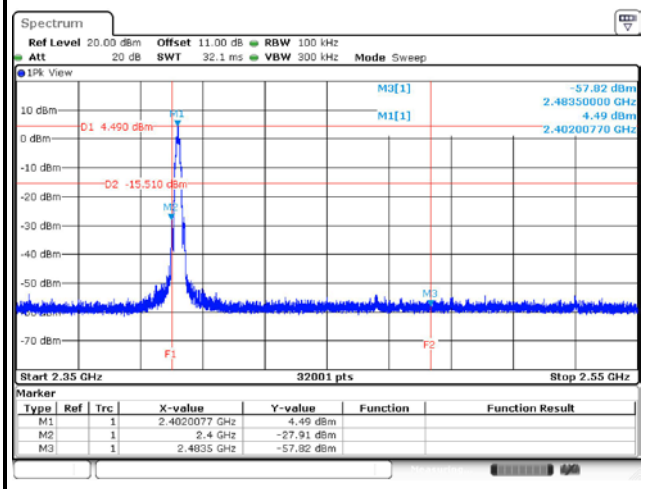
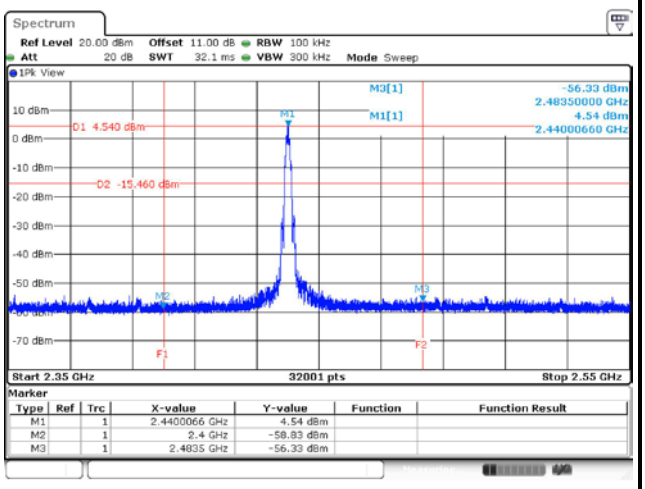
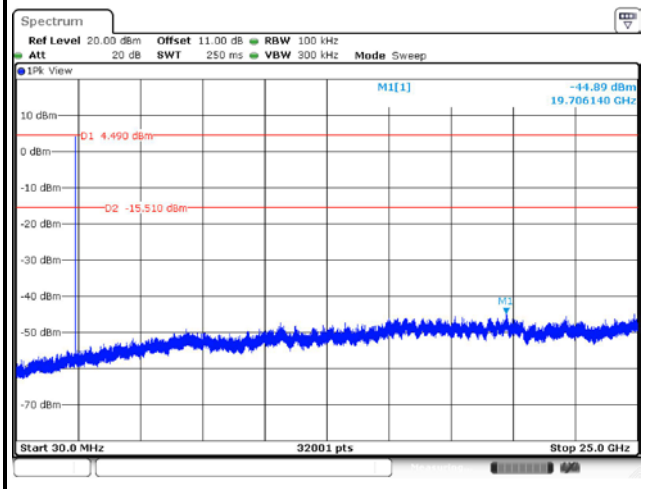
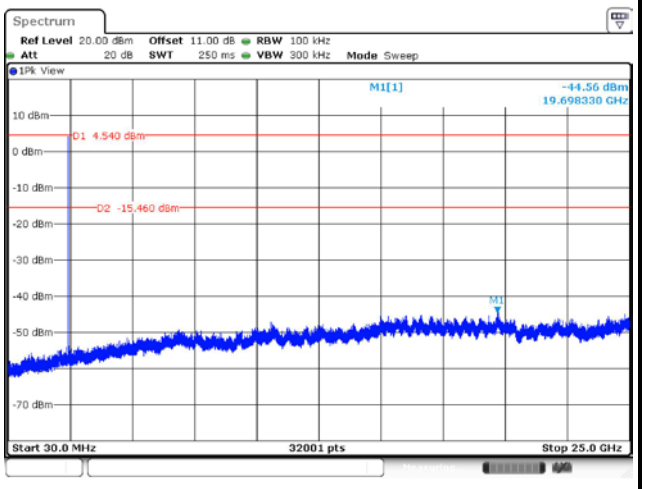
Emission level measurement

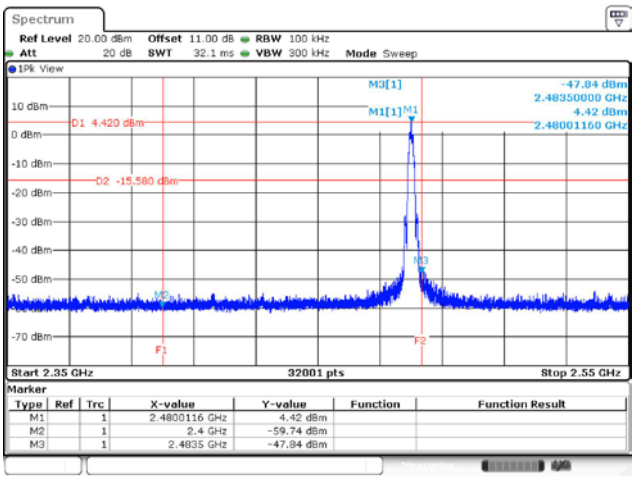
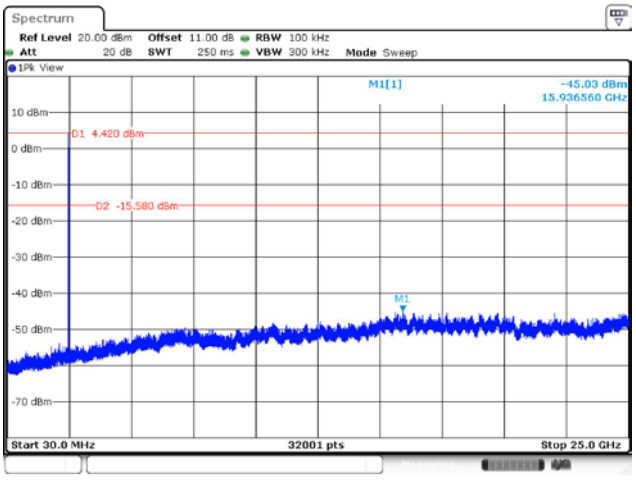
1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Scan Frequency range is up to 25GHz
4. Use the peak marker function to determine the maximum amplitude level

3.6.3 Test Setup



3.6.4 Test Result of Emissions in non-restricted Frequency Bands

TX Freq 2402MHz / 30MHz~25GHz (down 20dBc)	TX Freq 2440MHz / 30MHz~25GHz (down 20dBc)
	
	

TX Freq 2480MHz / 30MHz~25GHz (down 20dBc)	---
	---
	---

4 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website http://www.icertifi.com.tw.

Linkou	**Kwei Shan**	**Kwei Shan Site II**
Tel: 886-2-2601-1640	Tel: 886-3-271-8666	Tel: 886-3-271-8640
No. 30-2, Ding Fwu Tsuen, Lin Kou District, New Taipei City, Taiwan, R.O.C.	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.	No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.

If you have any suggestion, please feel free to contact us as below information.

Tel: 886-3-271-8666
Fax: 886-3-318-0155
Email: ICC_Service@icertifi.com.tw

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