FCC Test Report

FCC ID	:	**SQGBL651**
Equipment	:	**Bluetooth 5.0 Module w/Integrated PCB Antenna** **(Refer to item 1.1.1 for more details)**
Model No.	:	**BL651**
Brand Name	:	**Laird**
Applicant	:	**Laird Technologies**
Address	:	**W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA**
Standard	:	**47 CFR FCC Part 15.247**
Received Date	:	**May 28, 2018**
Tested Date	:	**Jun. 01 ~ Jun. 06, 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

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Release Record

Report No.	Version	Description	Issued Date
FR852803AE	Rev. 01	Initial issue	Aug. 22, 2018

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	AC Power Line Conducted Emissions	[dBuV]: 0.369MHz 34.13 (Margin -14.39dB) - AV	Pass
15.247(d) 15.209	Radiated Emissions	Meet the requirement of limit	Pass
15.247(b)(3)	Maximum Output Power	Power [dBm]: 4.93	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

1.1.1 Product Details

The following models are provided to this EUT.

Brand Name	Model Name	Product Name	Description
Laird	BL651	Bluetooth 5.0 Module w/Integrated PCB Antenna	Printed PCB Antenna
		Bluetooth 5.0 Module w/External Antenna	MHF4 Connector Type Antenna

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	V5.0 LE	2402-2480	0-39 [40]	1 Mbps
2400-2483.5	V5.0 LE	2402-2480	0-39 [40]	2 Mbps
Note 1: Bluetooth LE (Low energy) uses GFSK modulation.				

1.1.3 Antenna Details

Ant. No.	Manufacturer	Model	Laird Part Number	Type	Connector	Gain (dBi)	Remarks
1	Laird	NanoBlue	EBL2400A1-10MH4L	PCB Dipole	IPEX MHF4	2	MHF4 Connector Type Antenna
2	Laird	FlexPIFA	001-0022	PIFA	IPEX MHF4	2	MHF4 Connector Type Antenna
3	Mag.Layers	EDA-8709-2G4C1-B27-CY	0600-00057	Dipole	IPEX MHF4	2	MHF4 Connector Type Antenna
4	Laird	mFlexPIFA	EFA2400A3S-10MH4L	PIFA	IPEX MHF4	2	MHF4 Connector Type Antenna
5	Laird	PCB printed antenna	NA	Printed PCB	N/A	0	Printed PCB Antenna

Note: Antenna 3 was chosen for final rest

1.1.4 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	DC 1.8V & DC 3.3V 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: 7.94		
Duty Cycle and Duty Factor	Modulation Mode	Duty cycle (%)	Duty factor (dB)
	GFSK/1Mbps	65.57%	1.83
	GFSK/2Mbps	35.32%	4.52

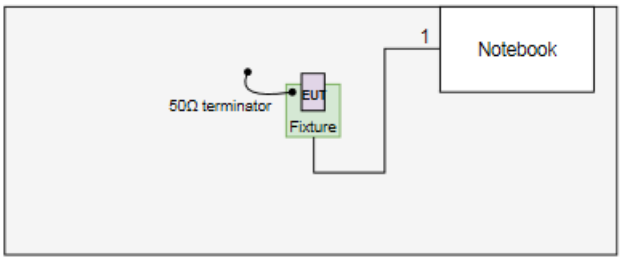
1.1.8 Power Setting

Modulation Mode	Test Frequency (MHz)		
	2402	2440	2480
GFSK/1Mbps	default	default	default
GFSK/2Mbps	default	default	default

1.2 Local Support Equipment List

Support Equipment List					
No.	**Equipment**	**Brand**	**Model**	**FCC ID**	**Remarks**
1	Notebook	DELL	Latitude E6430	DoC	---
2	50Ω terminator	---	---	---	---
3	Fixture	---	---	---	Provided by applicant.

1.3 Test Setup Chart

Test Setup Diagram	
	
No.	**Signal cable / Length (m)**
1	USB, 1m shielded.

1.4 Test Equipment List and Calibration Data

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	Jun. 06, 2018				
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 chamber1 / (03CH01-WS)				
Tested Date	Jun. 01 ~ Jun. 04, 2018				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101498	Dec. 04, 2017	Dec. 03, 2018
Receiver	R&S	ESR3	101658	Nov. 20, 2017	Nov. 19, 2018
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Jul. 25, 2017	Jul. 24, 2018
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1096	Dec. 20, 2017	Dec. 19, 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	980225	Jul. 28, 2017	Jul. 27, 2018
Preamplifier	Agilent	83017A	MY39501308	Oct. 06, 2017	Oct. 05, 2018
Preamplifier	EMC	EMC184045B	980192	Aug. 22, 2017	Aug. 21, 2018
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16140/4	May 09, 2018	May 08, 2019
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16019/4	Dec. 07, 2017	Dec. 06, 2018
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16139/4	Dec. 07, 2017	Dec. 06, 2018
LF cable 1M	EMC	EMCCFD400-NM-NM-1000	16052	Dec. 07, 2017	Dec. 06, 2018
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Dec. 07, 2017	Dec. 06, 2018
LF cable 10M	Woken	CFD400NL-LW	CFD400NL-002	Dec. 07, 2017	Dec. 06, 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)				
Tested Date	Jun. 01, 2018				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101063	Apr. 16, 2018	Apr. 15, 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	±5.63 dB

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	23°C / 55%	Alex Tsai
Radiated Emissions	03CH01-WS	24°C / 62%	Vincent Yeh Akun Chung
RF Conducted	TH01-WS	24°C / 54%	Brad Wu Aska Haung

- FCC Designation No.: TW2732
- FCC site registration No.: 181692
- IC site registration No.: 10807A-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 Radiated Emissions ≤ 1GHz	BT LE BT LE	2440 2440	1Mbps 2Mbps	---
Maximum Output Power 6dB bandwidth Power spectral density Radiated Emissions > 1GHz	BT LE BT LE	2402, 2440, 2480 2402, 2440, 2480	1Mbps 2Mbps	---

NOTE:

1. The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Y-plane** results were found as the worst case and were shown in this report.
2. The EUT supports two DC voltage options, DC 1.8V & DC 3.3V. Both options were assessed and **DC 3.3V** was found to be the worst case and was selected for the final test.
3. 50Ω terminator is connected to antenna port of EUT for radiated emission measurement.

3 Transmitter Test Results

3.1 Conducted Emissions

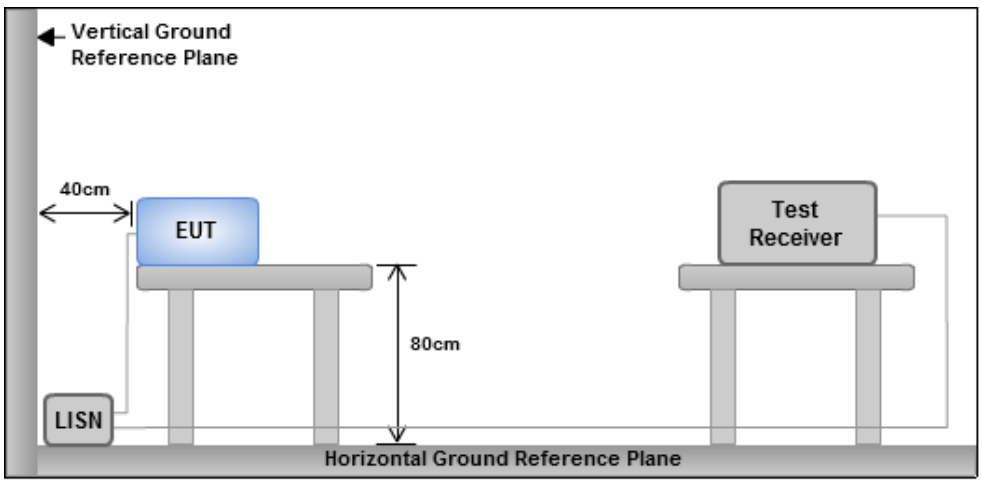
3.1.1 Limit of Conducted Emissions

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

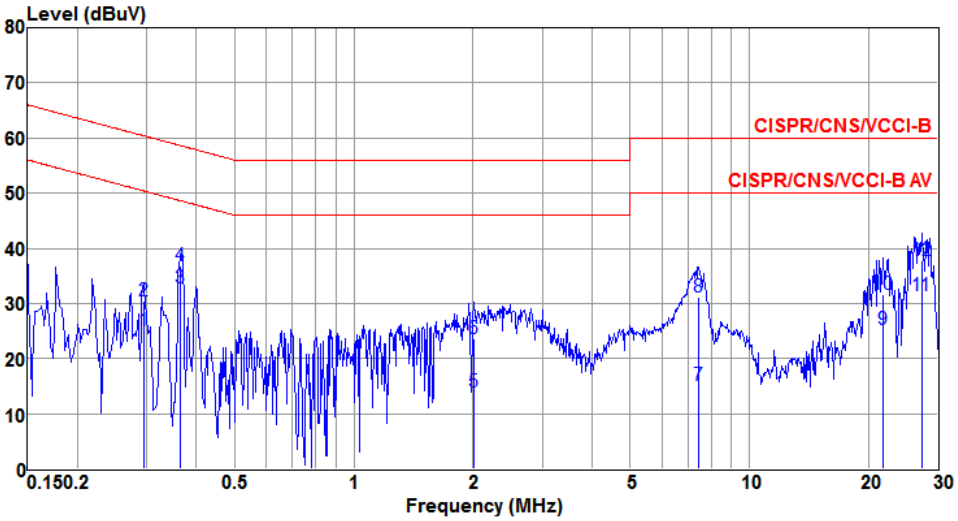


Note: 1. Support units were connected to second LISN.

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

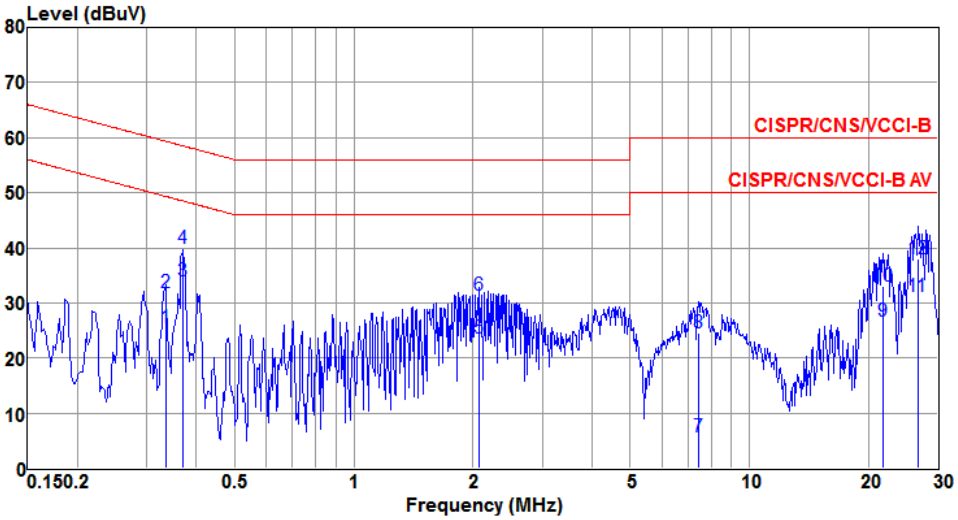
Modulation Mode	BT LE-1Mbps	Test Freq. (MHz)	2440
Power Phase	Line		



	Freq	Level	Limit Line	Over Limit	Read Level	LISN factor	cable loss	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	dB	
1	0.294	24.96	50.41	-25.45	24.86	0.08	0.02	Average
2	0.294	30.50	60.41	-29.91	30.40	0.08	0.02	QP
3@	0.365	32.81	48.61	-15.80	32.71	0.08	0.02	Average
4	0.365	36.80	58.61	-21.81	36.70	0.08	0.02	QP
5	2.012	13.97	46.00	-32.03	13.76	0.11	0.10	Average
6	2.012	23.66	56.00	-32.34	23.45	0.11	0.10	QP
7	7.446	15.10	50.00	-34.90	14.63	0.18	0.29	Average
8	7.446	31.27	60.00	-28.73	30.80	0.18	0.29	QP
9	21.830	25.20	50.00	-24.80	24.57	0.27	0.36	Average
10	21.830	31.73	60.00	-28.27	31.10	0.27	0.36	QP
11	27.271	31.29	50.00	-18.71	30.61	0.29	0.39	Average
12	27.271	37.88	60.00	-22.12	37.20	0.29	0.39	QP

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

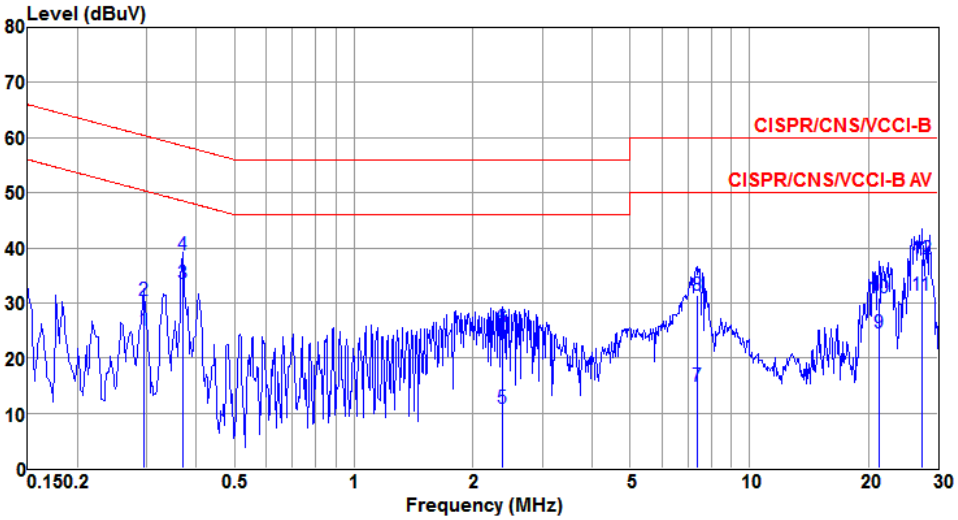
Modulation Mode	BT LE-1Mbps	Test Freq. (MHz)	2440
Power Phase	Neutral		



	Freq	Level	Limit Line	Over Limit	Read Level	LISN factor	cable loss	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	dB	
1	0.334	25.49	49.35	-23.86	25.43	0.04	0.02	Average
2	0.334	31.83	59.35	-27.52	31.77	0.04	0.02	QP
3@	0.369	34.08	48.52	-14.44	34.02	0.04	0.02	Average
4	0.369	39.83	58.52	-18.69	39.77	0.04	0.02	QP
5	2.066	23.57	46.00	-22.43	23.39	0.07	0.11	Average
6	2.066	31.34	56.00	-24.66	31.16	0.07	0.11	QP
7	7.446	5.77	50.00	-44.23	5.34	0.14	0.29	Average
8	7.446	24.49	60.00	-35.51	24.06	0.14	0.29	QP
9	21.830	26.70	50.00	-23.30	26.06	0.28	0.36	Average
10	21.830	33.07	60.00	-26.93	32.43	0.28	0.36	QP
11	26.699	31.07	50.00	-18.93	30.38	0.30	0.39	Average
12	26.699	37.96	60.00	-22.04	37.27	0.30	0.39	QP

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

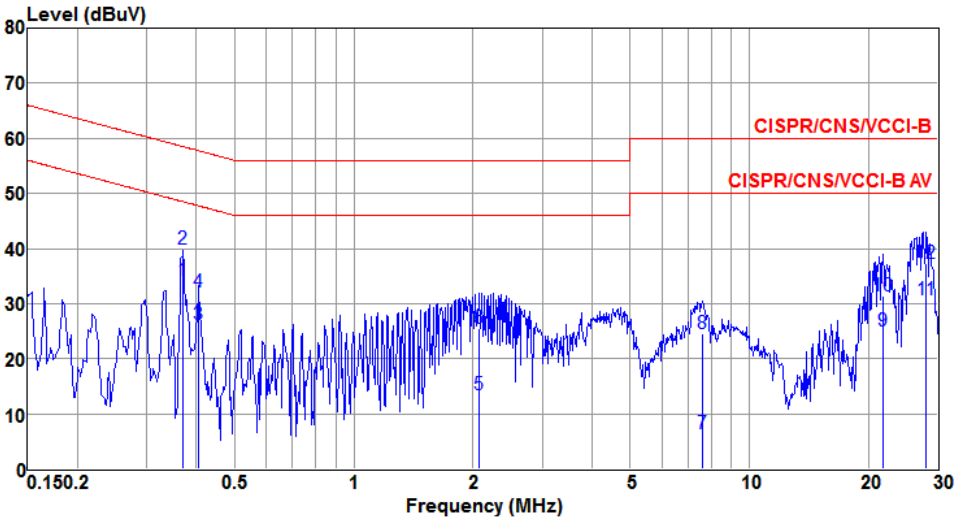
Modulation Mode	BT LE-2Mbps	Test Freq. (MHz)	2440
Power Phase	Line		



	Freq	Level	Limit Line	Over Limit	Read Level	LISN factor	cable loss	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	dB	
1	0.294	24.98	50.41	-25.43	24.88	0.08	0.02	Average
2	0.294	30.53	60.41	-29.88	30.43	0.08	0.02	QP
3@	0.369	33.59	48.52	-14.93	33.49	0.08	0.02	Average
4	0.369	38.69	58.52	-19.83	38.59	0.08	0.02	QP
5	2.371	10.79	46.00	-35.21	10.55	0.11	0.13	Average
6	2.371	25.55	56.00	-30.45	25.31	0.11	0.13	QP
7	7.407	14.92	50.00	-35.08	14.45	0.18	0.29	Average
8	7.407	31.39	60.00	-28.61	30.92	0.18	0.29	QP
9	21.260	24.58	50.00	-25.42	23.96	0.27	0.35	Average
10	21.260	30.97	60.00	-29.03	30.35	0.27	0.35	QP
11	27.271	31.41	50.00	-18.59	30.73	0.29	0.39	Average
12	27.271	38.04	60.00	-21.96	37.36	0.29	0.39	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	BT LE-2Mbps	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@	0.369	34.13	48.52	-14.39	34.07	0.04	0.02	Average
2	0.369	39.83	58.52	-18.69	39.77	0.04	0.02	QP
3	0.404	26.20	47.77	-21.57	26.14	0.04	0.02	Average
4	0.404	32.11	57.77	-25.66	32.05	0.04	0.02	QP
5	2.077	13.51	46.00	-32.49	13.33	0.07	0.11	Average
6	2.077	25.50	56.00	-30.50	25.32	0.07	0.11	QP
7	7.606	6.30	50.00	-43.70	5.86	0.15	0.29	Average
8	7.606	24.48	60.00	-35.52	24.04	0.15	0.29	QP
9	21.715	25.00	50.00	-25.00	24.36	0.28	0.36	Average
10	21.715	31.47	60.00	-28.53	30.83	0.28	0.36	QP
11	28.003	30.60	50.00	-19.40	29.90	0.30	0.40	Average
12	28.003	37.28	60.00	-22.72	36.58	0.30	0.40	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

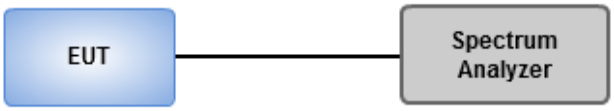
6dB Bandwidth

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) = 1% ~ 5 % of OBW, Video bandwidth = 3 x RBW
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

Summary

Mode	Max-N dB (Hz)	Max-OBW (Hz)	ITU-Code	Min-N dB (Hz)	Min-OBW (Hz)
2.4G	-	-	-	-	-
BT-LE(1Mbps)	688.406k	1.042M	1M04F1D	677.536k	1.038M
BT-LE(2Mbps)	1.138M	2.055M	2M06F1D	1.109M	2.041M

Max-N dB = Maximum 6dB down bandwidth; **Max-OBW** = Maximum 99% occupied bandwidth;
Min-N dB = Minimum 6dB down bandwidth; **Min-OBW** = Minimum 99% occupied bandwidth;

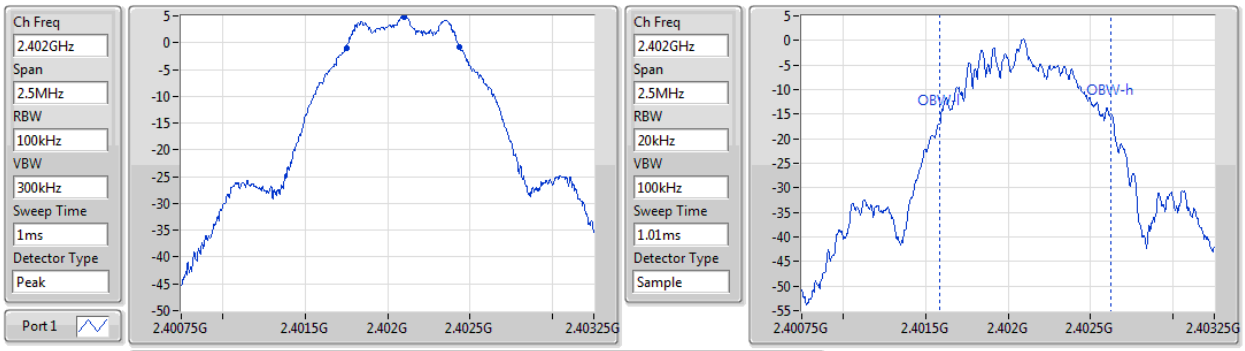
Result

Mode	Result	Limit (Hz)	Port 1-N dB (Hz)	Port 1-OBW (Hz)
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	500k	684.783k	1.038M
2440MHz	Pass	500k	688.406k	1.042M
2480MHz	Pass	500k	677.536k	1.042M
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	500k	1.109M	2.041M
2440MHz	Pass	500k	1.13M	2.048M
2480MHz	Pass	500k	1.138M	2.055M

Port X-N dB = Port **X** 6dB down bandwidth; **Port X-OBW** = Port **X** 99% occupied bandwidth;

BT-LE(1Mbps) **EBW**

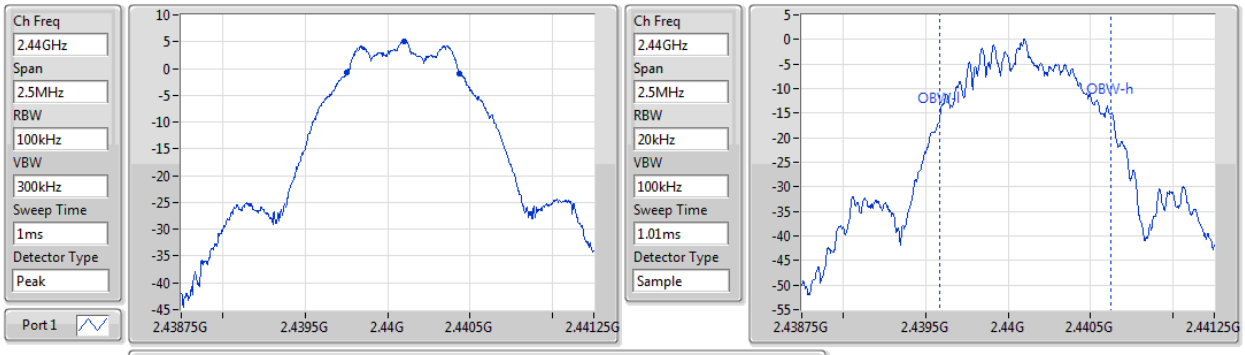
2402MHz



6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
684.783k	2.40175G	2.402435G	1.038M	2.401584G	2.402622G	500k	1

BT-LE(1Mbps) **EBW**

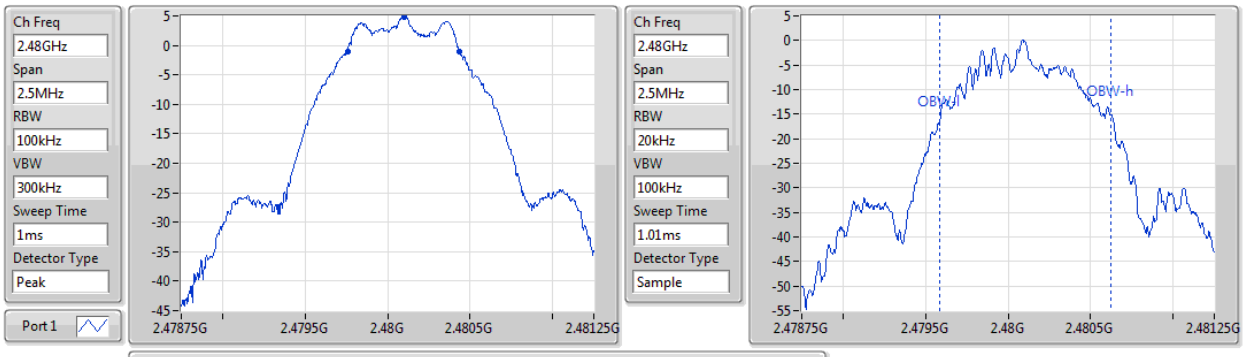
2440MHz



6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
688.406k	2.43975G	2.440438G	1.042M	2.439584G	2.440626G	500k	1

BT-LE(1Mbps) **EBW**

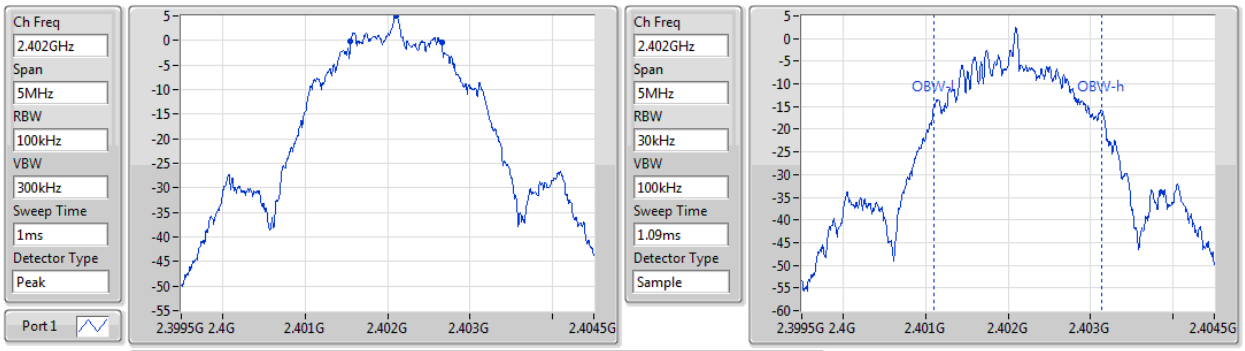
2480MHz



6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
677.536k	2.479757G	2.480435G	1.042M	2.479584G	2.480626G	500k	1

BT-LE(2Mbps) **EBW**

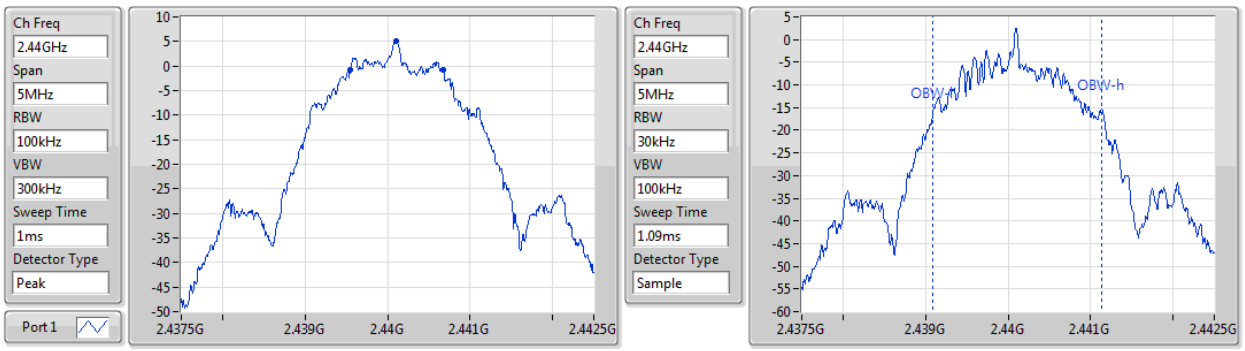
2402MHz



6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
1.109M	2.401551G	2.402659G	2.041M	2.401096G	2.403136G	500k	1

BT-LE(2Mbps) **EBW**

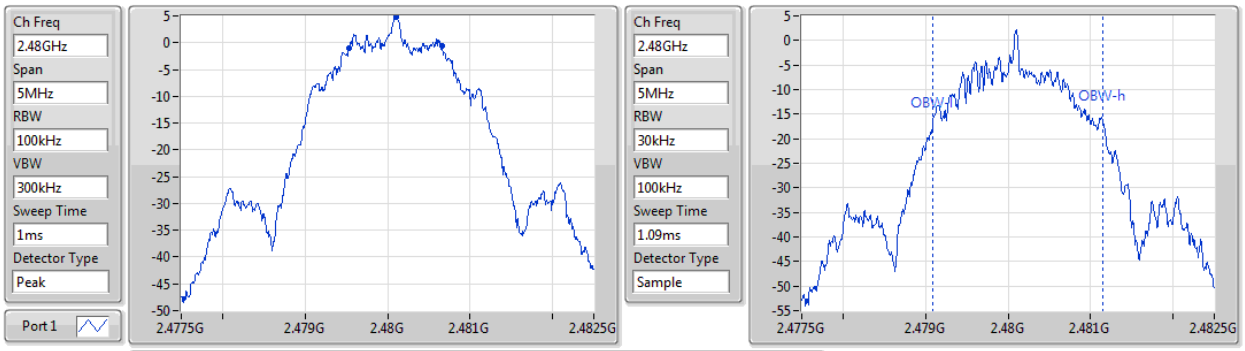
2440MHz



6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
1.13M	2.439543G	2.440674G	2.048M	2.439088G	2.441136G	500k	1

BT-LE(2Mbps) **EBW**

2480MHz



6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
1.138M	2.479529G	2.480667G	2.055M	2.479088G	2.481143G	500k	1

3.3 RF Output Power

3.3.1 Limit of RF Output Power

Conducted power shall not exceed 1 Watt.

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

Summary (Peak Power)

Mode	Power (dBm)	Power (W)
BT-LE(1Mbps)	4.93	0.00311
BT-LE(2Mbps)	4.92	0.00310

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	4.91	30.00
2440MHz	Pass	2.00	4.93	30.00
2480MHz	Pass	2.00	4.88	30.00
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	2.00	4.91	30.00
2440MHz	Pass	2.00	4.92	30.00
2480MHz	Pass	2.00	4.85	30.00

Summary (Average Power)

Mode	Power (dBm)	Power (W)
2.4G	-	-
BT-LE(1Mbps)	4.82	0.00303
BT-LE(2Mbps)	4.81	0.00303

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	4.80	
2440MHz	Pass	2.00	4.82	
2480MHz	Pass	2.00	4.78	
BT-LE(2Mbps)	-	-	-	
2402MHz	Pass	2.00	4.80	
2440MHz	Pass	2.00	4.81	
2480MHz	Pass	2.00	4.76	

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.

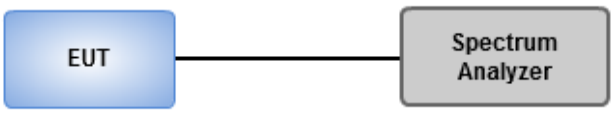
2 Set the sweep time to: ≥ 10 (number of measurement points in sweep) x (total on/off period of the transmitted signal).

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

Summary

Mode	PD (dBm/RBW)
2.4G	-
BT-LE(1Mbps)	-10.34
BT-LE(2Mbps)	-12.56

RBW=3kHz.

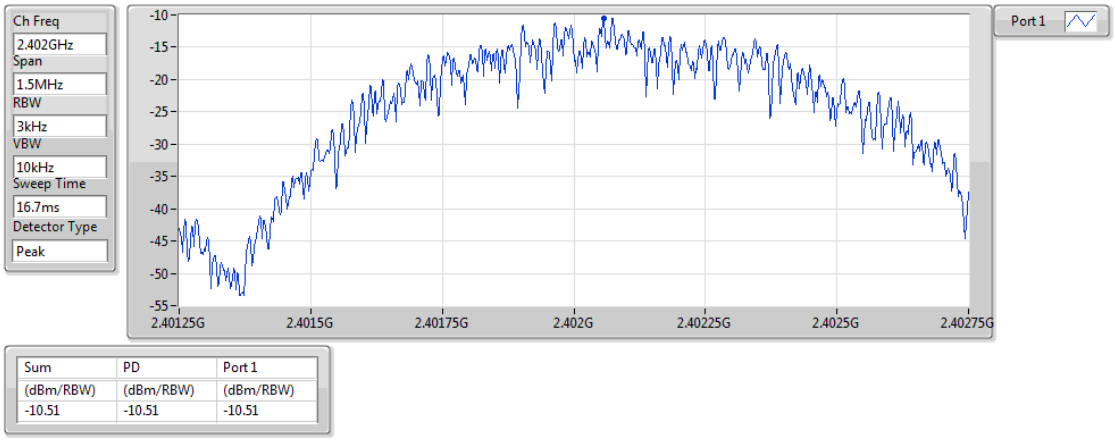
Result

Mode	Result	Gain (dBi)	PD (dBm/RBW)	PD Limit (dBm/RBW)
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	-10.51	8.00
2440MHz	Pass	2.00	-10.34	8.00
2480MHz	Pass	2.00	-10.55	8.00
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	2.00	-12.81	8.00
2440MHz	Pass	2.00	-12.56	8.00
2480MHz	Pass	2.00	-12.88	8.00

RBW=3kHz.

BT-LE(1Mbps) **PSD**

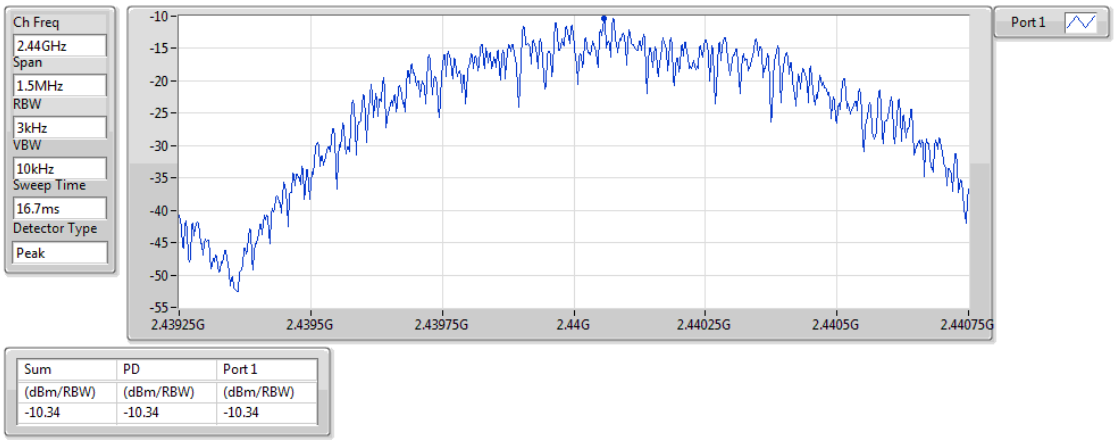
2402MHz



Sum	PD	Port 1
(dBm/RBW)	(dBm/RBW)	(dBm/RBW)
-10.51	-10.51	-10.51

BT-LE(1Mbps) **PSD**

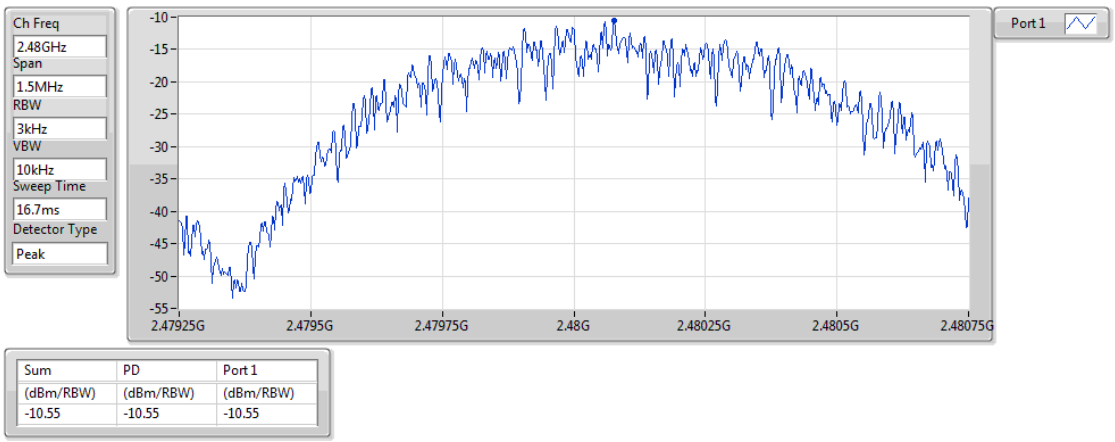
2440MHz



Sum	PD	Port 1
(dBm/RBW)	(dBm/RBW)	(dBm/RBW)
-10.34	-10.34	-10.34

BT-LE(1Mbps) **PSD**

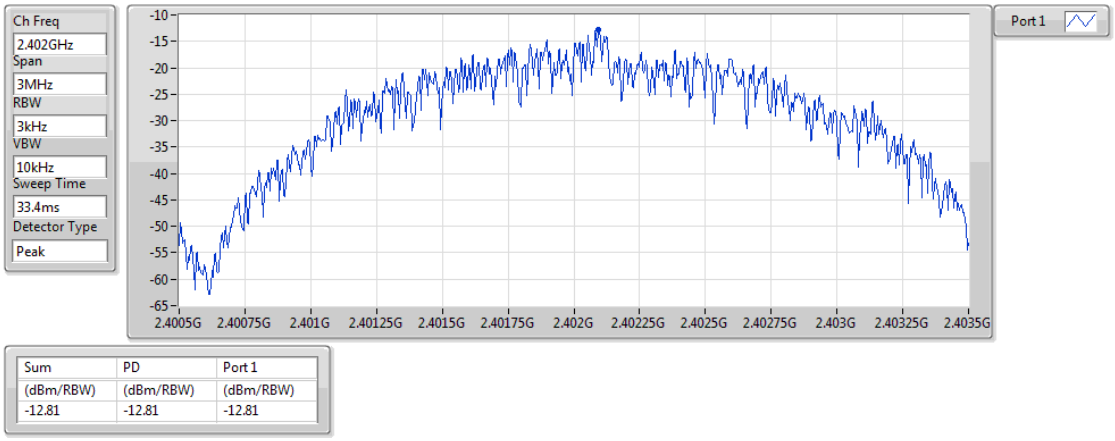
2480MHz



Sum	PD	Port 1
(dBm/RBW)	(dBm/RBW)	(dBm/RBW)
-10.55	-10.55	-10.55

BT-LE(2Mbps) **PSD**

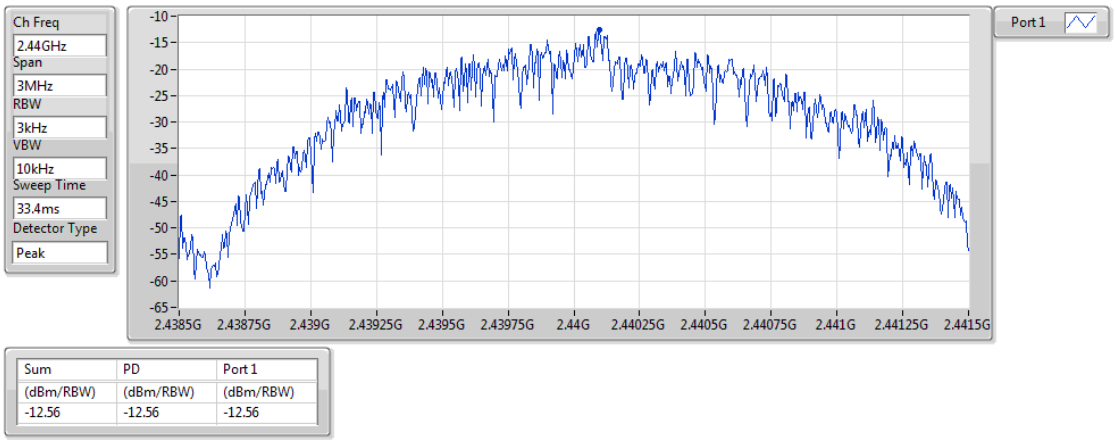
2402MHz



Sum	PD	Port 1
(dBm/RBW)	(dBm/RBW)	(dBm/RBW)
-12.81	-12.81	-12.81

BT-LE(2Mbps) **PSD**

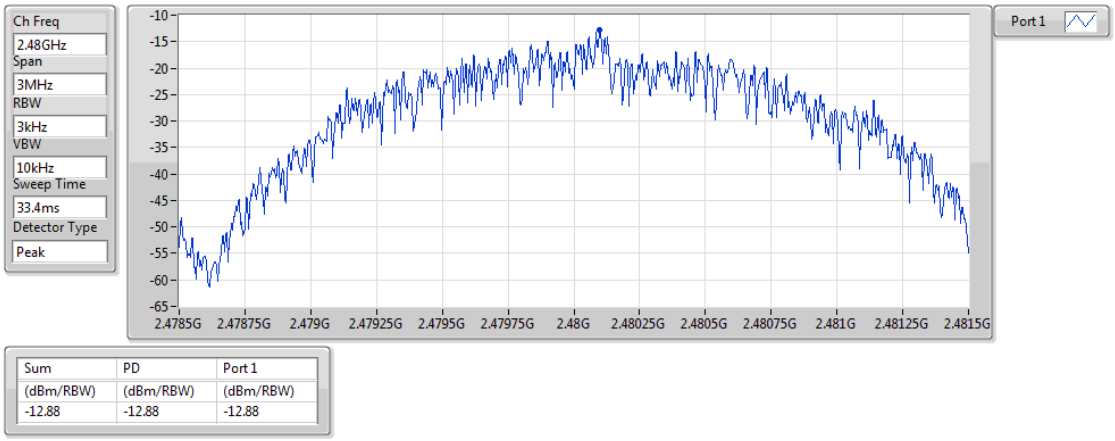
2440MHz



Sum	PD	Port 1
(dBm/RBW)	(dBm/RBW)	(dBm/RBW)
-12.56	-12.56	-12.56

BT-LE(2Mbps) **PSD**

2480MHz



Sum	PD	Port 1
(dBm/RBW)	(dBm/RBW)	(dBm/RBW)
-12.88	-12.88	-12.88

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

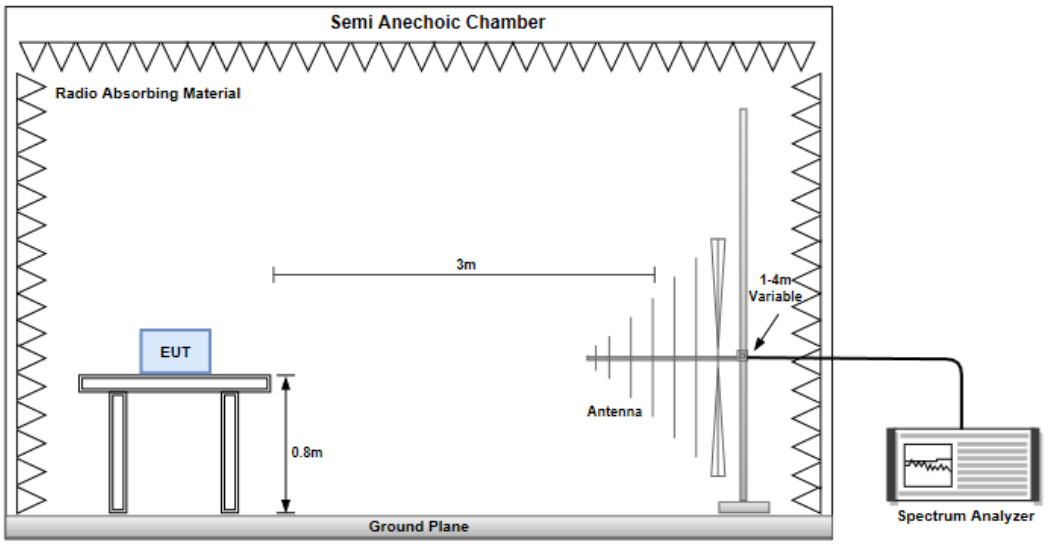
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission 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:

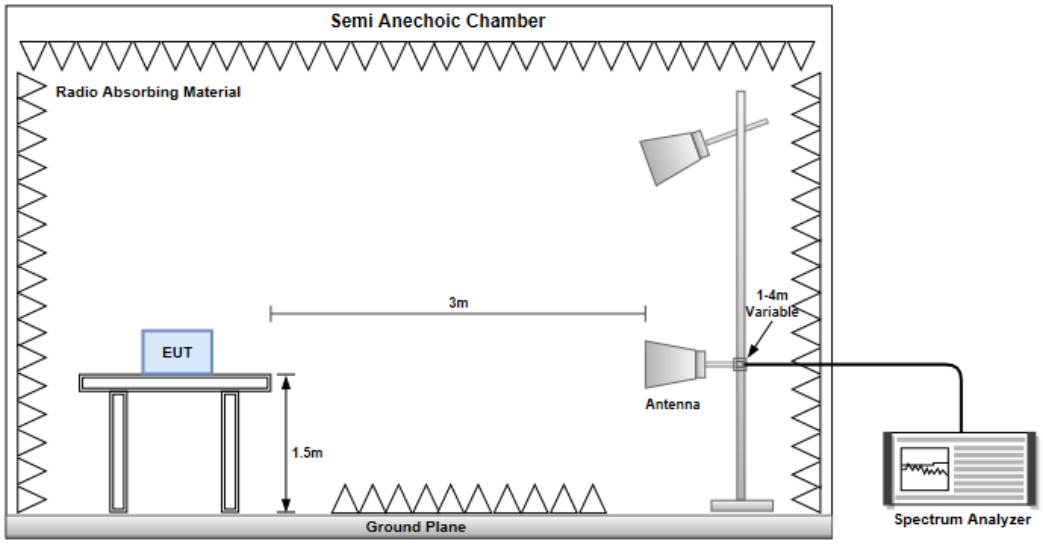
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above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

3.5.3 Test Setup

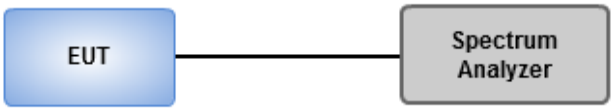
Radiated Emissions below 1 GHz



Radiated Emissions above 1 GHz

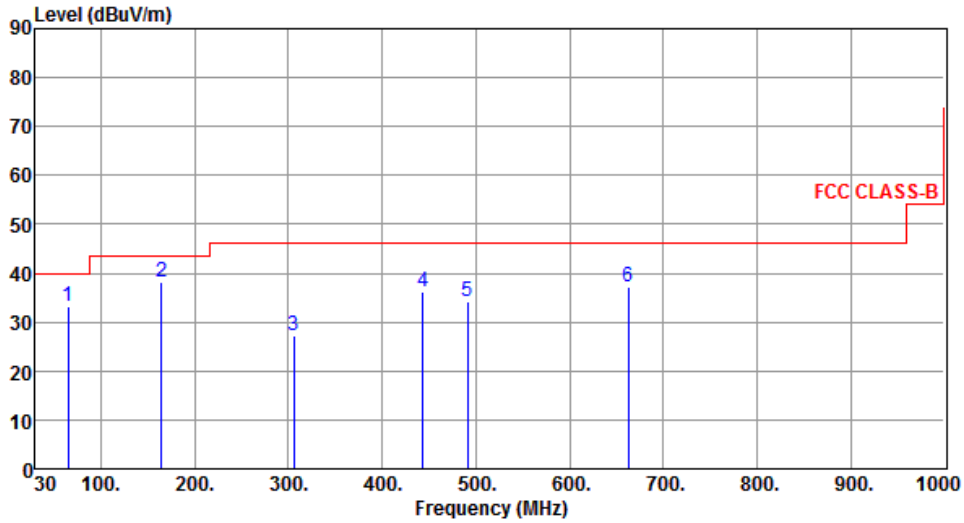


Conducted Emissions



3.5.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

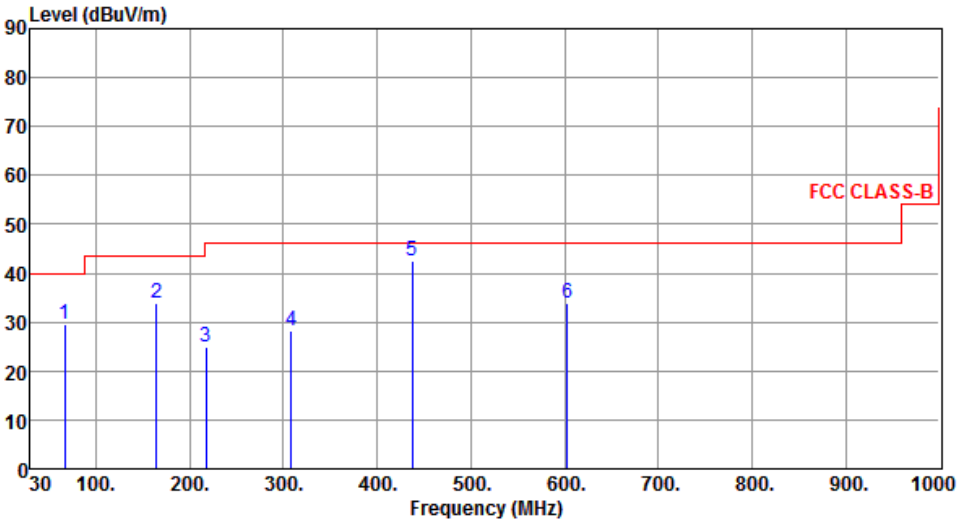
Modulation	BT LE-1Mbps	Test Freq. (MHz)	2440
Polarization	Horizontal		



	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	33.15	40.00	-6.85	42.71	-9.56	Peak	---	---
2	164.83	38.34	43.50	-5.16	46.71	-8.37	Peak	---	---
3	305.48	27.11	46.00	-18.89	34.61	-7.50	Peak	---	---
4	443.22	36.15	46.00	-9.85	40.11	-3.96	Peak	---	---
5	490.75	34.21	46.00	-11.79	37.22	-3.01	Peak	---	---
6	662.44	37.28	46.00	-8.72	37.19	0.09	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.

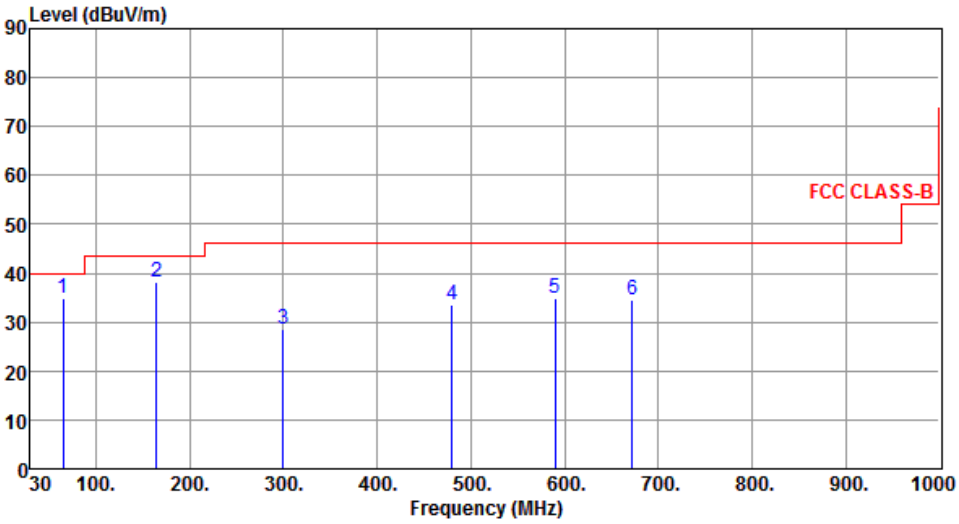
Modulation	BT LE-1Mbps	Test Freq. (MHz)	2440
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	66.86	29.44	40.00	-10.56	39.44	-10.00	Peak	---	---
2	164.83	33.91	43.50	-9.59	42.28	-8.37	Peak	---	---
3	217.21	24.80	46.00	-21.20	35.58	-10.78	Peak	---	---
4	308.39	28.08	46.00	-17.92	35.52	-7.44	Peak	---	---
5	437.40	42.40	46.00	-3.60	46.49	-4.09	Peak	---	---
6	603.27	33.77	46.00	-12.23	34.42	-0.65	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.

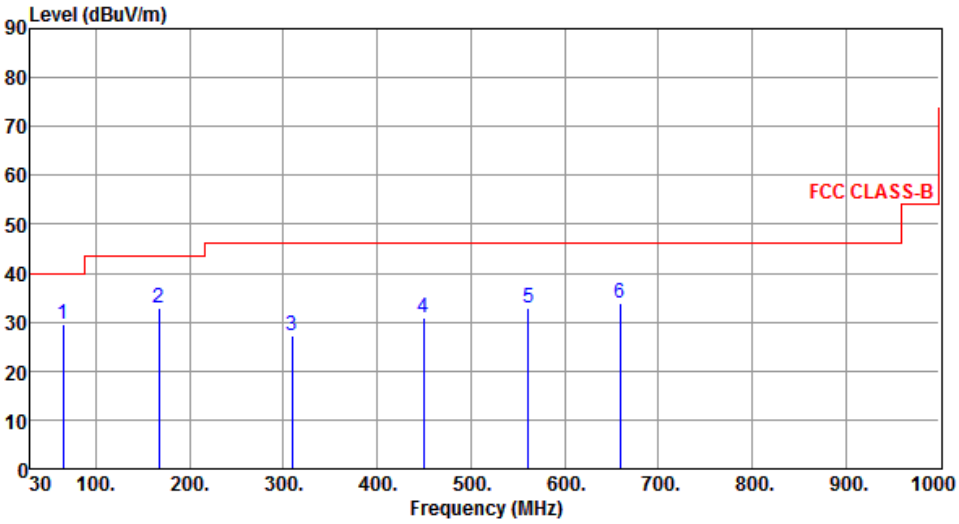
Modulation	BT LE-2Mbps	Test Freq. (MHz)	2440
Polarization	Horizontal		



	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	35.02	40.00	-4.98	44.58	-9.56	Peak	---	---
2	164.83	38.07	43.50	-5.43	46.44	-8.37	Peak	---	---
3	299.66	28.47	46.00	-17.53	36.12	-7.65	Peak	---	---
4	480.08	33.50	46.00	-12.50	36.72	-3.22	Peak	---	---
5	589.69	34.85	46.00	-11.15	35.75	-0.90	Peak	---	---
6	672.14	34.60	46.00	-11.40	34.33	0.27	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	BT LE-2Mbps	Test Freq. (MHz)	2440
Polarization	Vertical		

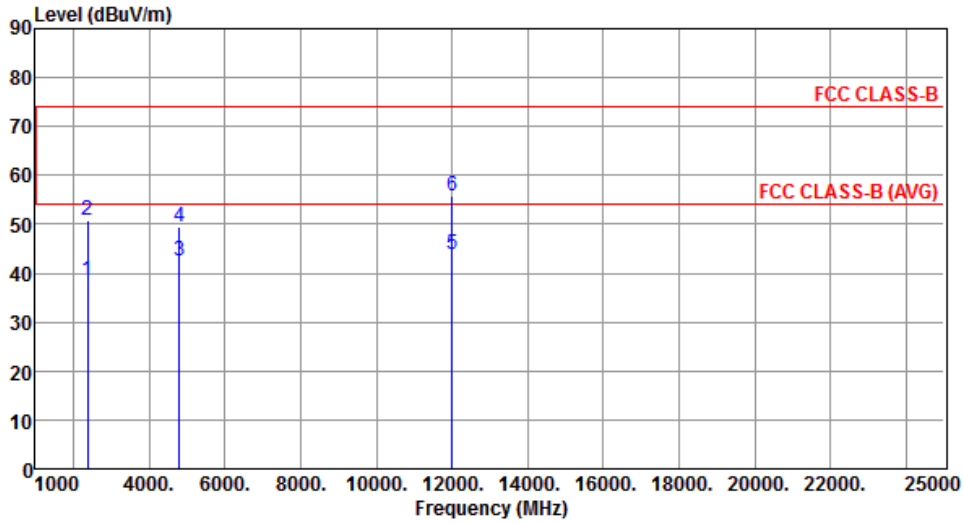


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	64.92	29.67	40.00	-10.33	39.23	-9.56	Peak	---	---
2	166.77	32.82	43.50	-10.68	41.26	-8.44	Peak	---	---
3	309.36	27.39	46.00	-18.61	34.80	-7.41	Peak	---	---
4	450.01	30.84	46.00	-15.16	34.64	-3.80	Peak	---	---
5	561.56	32.83	46.00	-13.17	34.31	-1.48	Peak	---	---
6	659.53	33.99	46.00	-12.01	33.95	0.04	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)

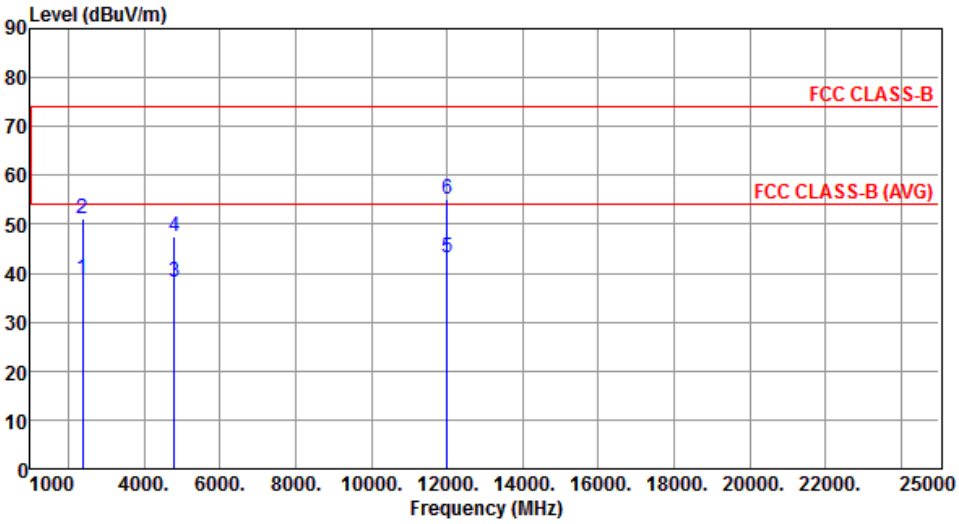
Modulation	BT LE-1Mbps	Test Freq. (MHz)	2402
Polarization	Horizontal		



	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	38.63	54.00	-15.37	42.14	-3.51	Average	100	72
2	2390.00	50.88	74.00	-23.12	54.39	-3.51	Peak	100	72
3	4804.00	42.36	54.00	-11.64	38.89	3.47	Average	205	46
4	4804.00	49.47	74.00	-24.53	46.00	3.47	Peak	205	46
5	12010.00	43.72	54.00	-10.28	30.38	13.34	Average	100	88
6	12010.00	55.85	74.00	-18.15	42.51	13.34	Peak	100	88

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).

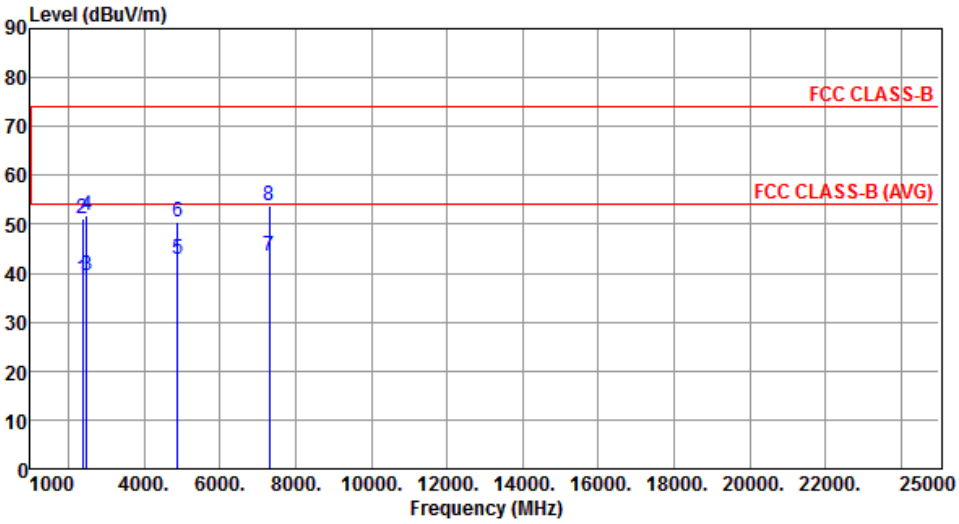
Modulation	BT LE-1Mbps	**Test Freq. (MHz)**	2402
Polarization	Vertical		



	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	38.97	54.00	-15.03	42.48	-3.51	Average	153	257
2	2390.00	51.10	74.00	-22.90	54.61	-3.51	Peak	153	257
3	4804.00	38.28	54.00	-15.72	34.81	3.47	Average	251	130
4	4804.00	47.52	74.00	-26.48	44.05	3.47	Peak	251	130
5	12010.00	43.33	54.00	-10.67	29.99	13.34	Average	100	261
6	12010.00	55.14	74.00	-18.86	41.80	13.34	Peak	100	261

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).

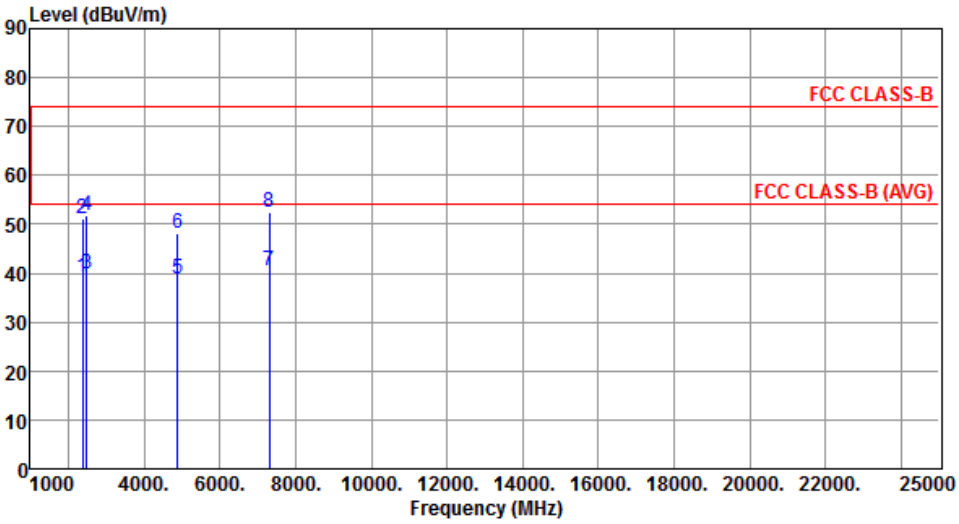
Modulation	BT LE-1Mbps	**Test Freq. (MHz)**	2440
Polarization	Horizontal		



	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	38.77	54.00	-15.23	42.28	-3.51	Average	100	75
2	2390.00	51.07	74.00	-22.93	54.58	-3.51	Peak	100	75
3	2483.50	39.44	54.00	-14.56	42.55	-3.11	Average	100	75
4	2483.50	51.83	74.00	-22.17	54.94	-3.11	Peak	100	75
5	4880.00	42.74	54.00	-11.26	39.03	3.71	Average	192	44
6	4880.00	50.52	74.00	-23.48	46.81	3.71	Peak	192	44
7	7320.00	43.65	54.00	-10.35	35.23	8.42	Average	131	231
8	7320.00	53.88	74.00	-20.12	45.46	8.42	Peak	131	231

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).

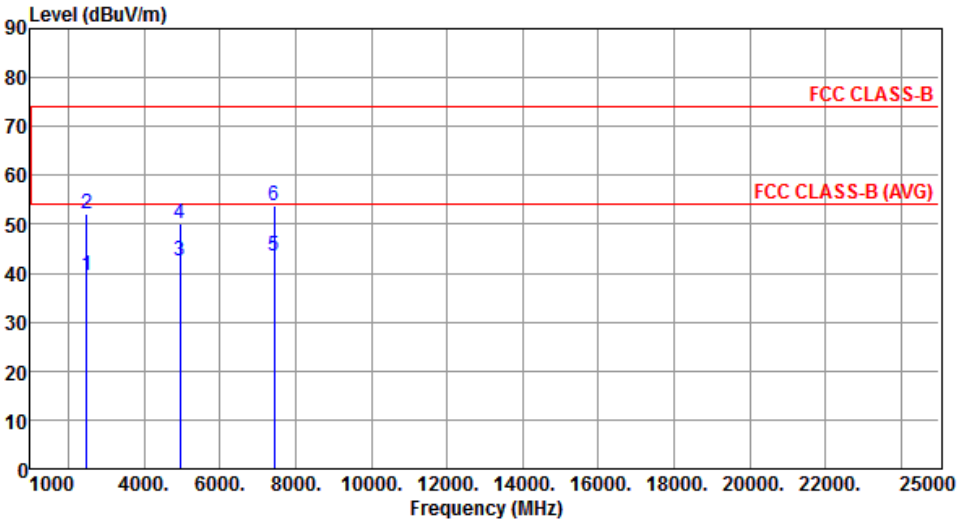
Modulation	BT LE-1Mbps	Test Freq. (MHz)	2440
Polarization	Vertical		



	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	39.06	54.00	-14.94	42.57	-3.51	Average	150	260
2	2390.00	51.16	74.00	-22.84	54.67	-3.51	Peak	150	260
3	2483.50	39.86	54.00	-14.14	42.97	-3.11	Average	150	260
4	2483.50	51.92	74.00	-22.08	55.03	-3.11	Peak	150	260
5	4880.00	38.79	54.00	-15.21	35.08	3.71	Average	248	122
6	4880.00	48.10	74.00	-25.90	44.39	3.71	Peak	248	122
7	7320.00	40.66	54.00	-13.34	32.24	8.42	Average	132	259
8	7320.00	52.47	74.00	-21.53	44.05	8.42	Peak	132	259

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).

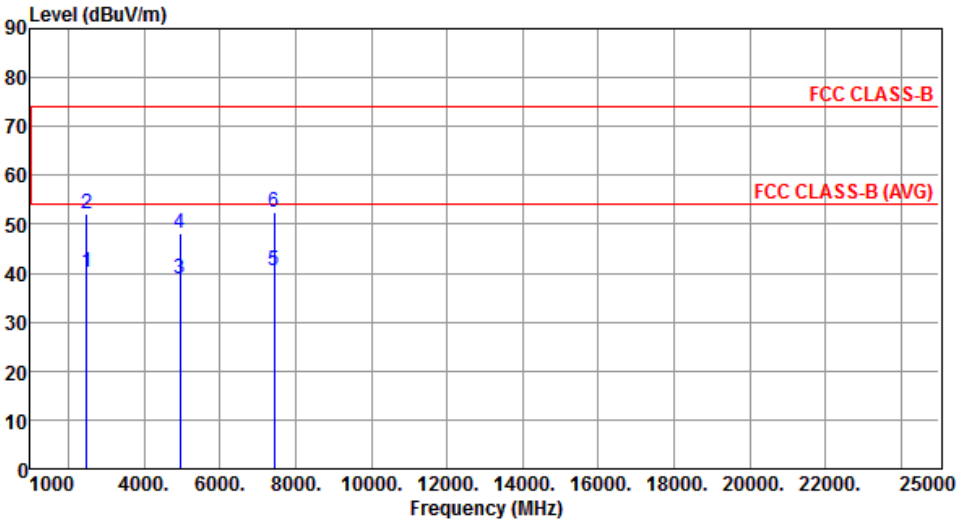
Modulation	BT LE-1Mbps	Test Freq. (MHz)	2480
Polarization	Horizontal		



	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	39.52	54.00	-14.48	42.63	-3.11	Average	100	79
2	2483.50	52.19	74.00	-21.81	55.30	-3.11	Peak	100	79
3	4960.00	42.41	54.00	-11.59	38.45	3.96	Average	199	48
4	4960.00	50.01	74.00	-23.99	46.05	3.96	Peak	199	48
5	7440.00	43.48	54.00	-10.52	34.84	8.64	Average	125	225
6	7440.00	53.74	74.00	-20.26	45.10	8.64	Peak	125	225

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).

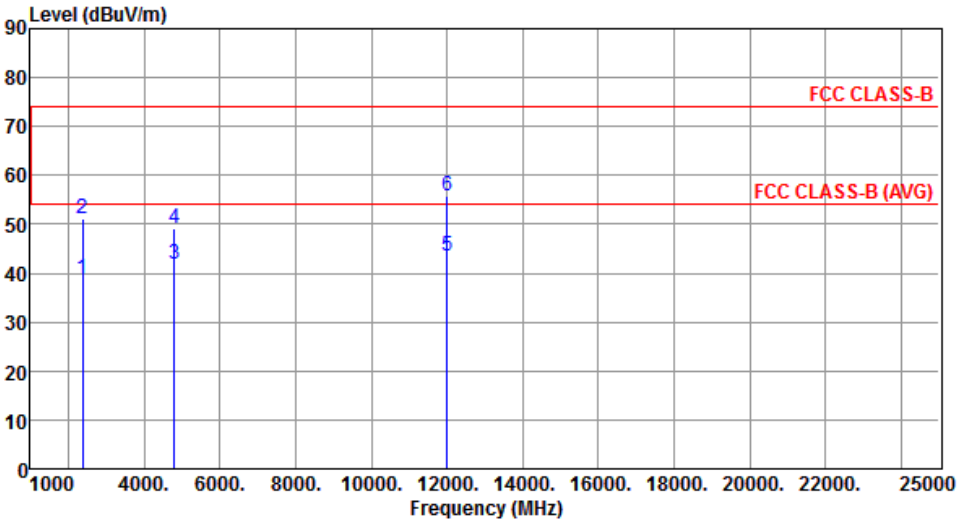
Modulation	BT LE-1Mbps	**Test Freq. (MHz)**	2480
Polarization	Vertical		



	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	40.02	54.00	-13.98	43.13	-3.11	Average	145	261
2	2483.50	52.12	74.00	-21.88	55.23	-3.11	Peak	145	261
3	4960.00	38.80	54.00	-15.20	34.84	3.96	Average	251	126
4	4960.00	48.01	74.00	-25.99	44.05	3.96	Peak	251	126
5	7440.00	40.53	54.00	-13.47	31.89	8.64	Average	125	253
6	7440.00	52.44	74.00	-21.56	43.80	8.64	Peak	125	253

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).

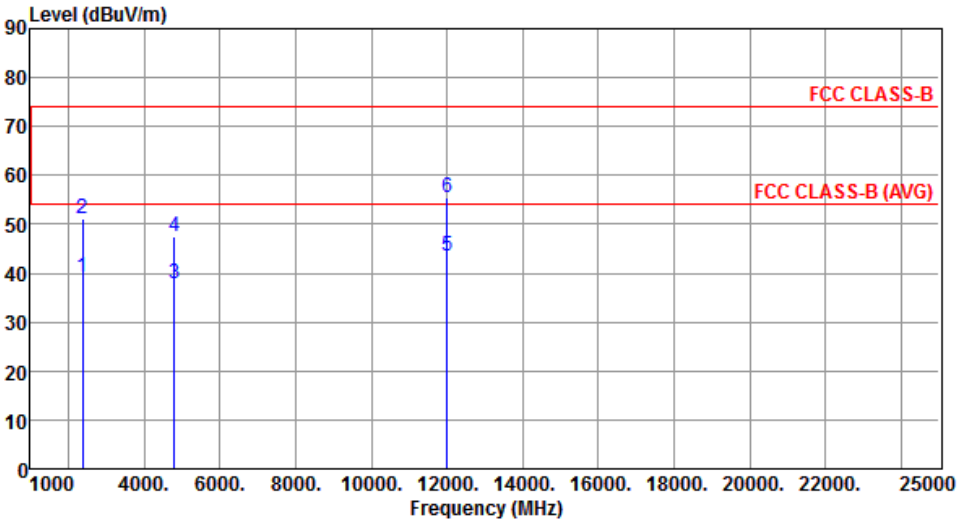
Modulation	BT LE-2Mbps	**Test Freq. (MHz)**	2402
Polarization	Horizontal		



	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	38.84	54.00	-15.16	42.35	-3.51	Average	100	69
2	2390.00	51.01	74.00	-22.99	54.52	-3.51	Peak	100	69
3	4804.00	41.88	54.00	-12.12	38.41	3.47	Average	231	51
4	4804.00	49.14	74.00	-24.86	45.67	3.47	Peak	231	51
5	12010.00	43.62	54.00	-10.38	30.28	13.34	Average	100	90
6	12010.00	55.81	74.00	-18.19	42.47	13.34	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).

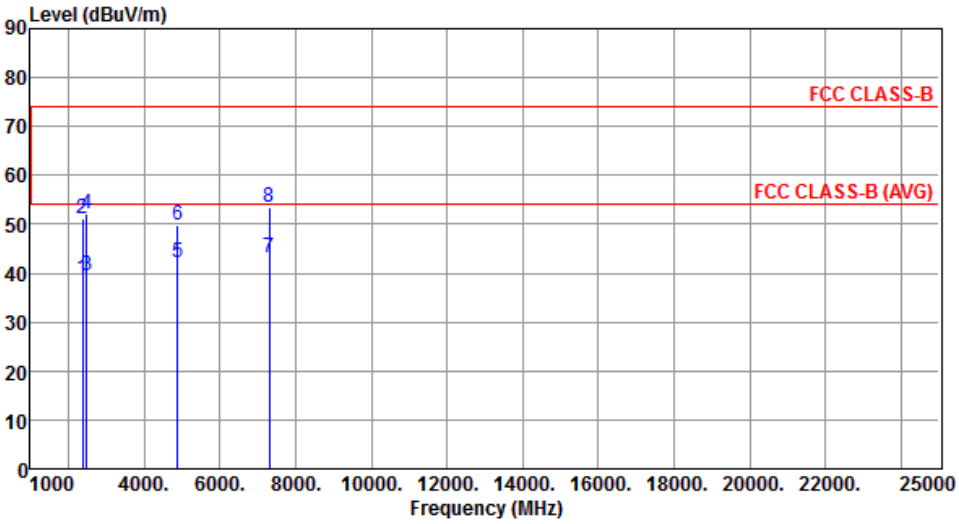
Modulation	BT LE-2Mbps	**Test Freq. (MHz)**	2402
Polarization	Vertical		



	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	39.05	54.00	-14.95	42.56	-3.51	Average	172	251
2	2390.00	51.31	74.00	-22.69	54.82	-3.51	Peak	172	251
3	4804.00	37.94	54.00	-16.06	34.47	3.47	Average	262	125
4	4804.00	47.34	74.00	-26.66	43.87	3.47	Peak	262	125
5	12010.00	43.39	54.00	-10.61	30.05	13.34	Average	100	258
6	12010.00	55.58	74.00	-18.42	42.24	13.34	Peak	100	285

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).

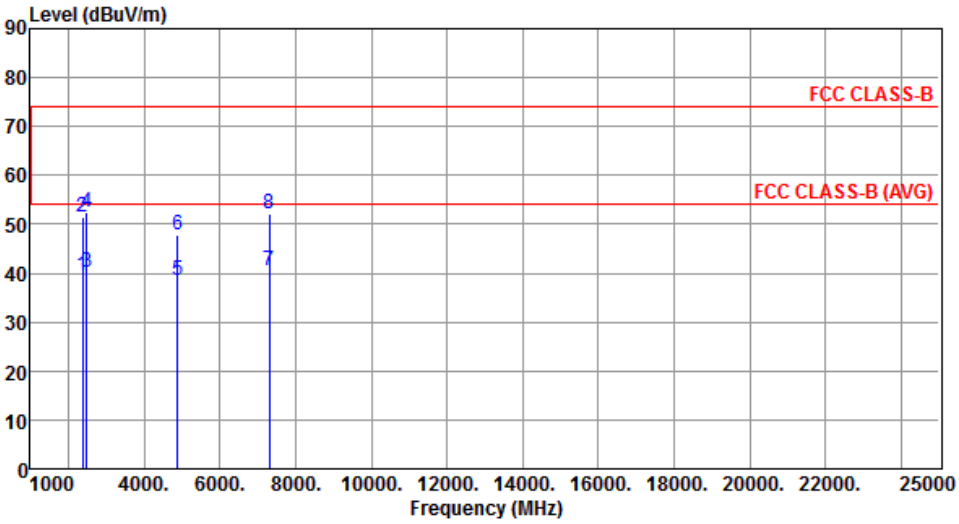
Modulation	BT LE-2Mbps	**Test Freq. (MHz)**	2440
Polarization	Horizontal		



	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	39.00	54.00	-15.00	42.51	-3.51	Average	100	80
2	2390.00	51.16	74.00	-22.84	54.67	-3.51	Peak	100	80
3	2483.50	39.50	54.00	-14.50	42.61	-3.11	Average	100	80
4	2483.50	52.05	74.00	-21.95	55.16	-3.11	Peak	100	80
5	4880.00	42.22	54.00	-11.78	38.51	3.71	Average	212	49
6	4880.00	49.82	74.00	-24.18	46.11	3.71	Peak	212	49
7	7320.00	43.33	54.00	-10.67	34.91	8.42	Average	152	228
8	7320.00	53.42	74.00	-20.58	45.00	8.42	Peak	152	228

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).

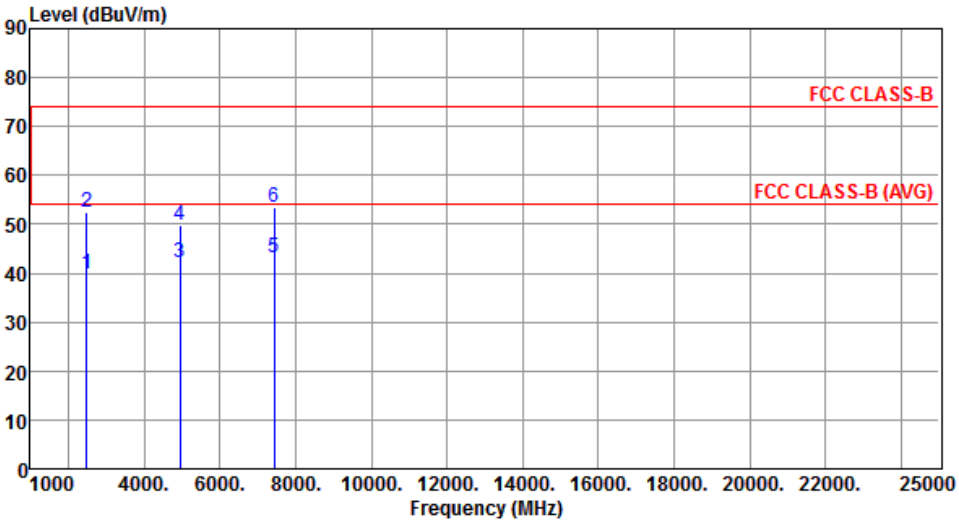
Modulation	BT LE-2Mbps	Test Freq. (MHz)	2440
Polarization	Vertical		



	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	39.36	54.00	-14.64	42.87	-3.51	Average	162	257
2	2390.00	51.47	74.00	-22.53	54.98	-3.51	Peak	162	257
3	2483.50	40.10	54.00	-13.90	43.21	-3.11	Average	162	257
4	2483.50	52.36	74.00	-21.64	55.47	-3.11	Peak	162	257
5	4880.00	38.38	54.00	-15.62	34.67	3.71	Average	231	119
6	4880.00	47.80	74.00	-26.20	44.09	3.71	Peak	231	119
7	7320.00	40.41	54.00	-13.59	31.99	8.42	Average	139	261
8	7320.00	52.22	74.00	-21.78	43.80	8.42	Peak	139	261

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).

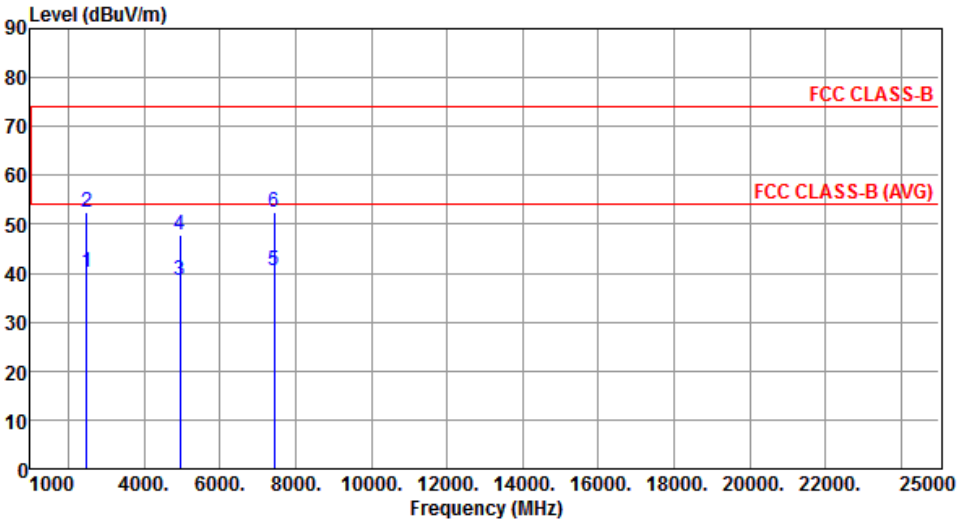
Modulation	BT LE-2Mbps	**Test Freq. (MHz)**	2480
Polarization	Horizontal		



	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	39.70	54.00	-14.30	42.81	-3.11	Average	100	77
2	2483.50	52.42	74.00	-21.58	55.53	-3.11	Peak	100	77
3	4960.00	42.10	54.00	-11.90	38.14	3.96	Average	205	50
4	4960.00	49.75	74.00	-24.25	45.79	3.96	Peak	205	50
5	7440.00	43.18	54.00	-10.82	34.54	8.64	Average	131	223
6	7440.00	53.59	74.00	-20.41	44.95	8.64	Peak	131	223

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	BT LE-2Mbps	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	40.23	54.00	-13.77	43.34	-3.11	Average	156	260
2	2483.50	52.37	74.00	-21.63	55.48	-3.11	Peak	156	260
3	4960.00	38.54	54.00	-15.46	34.58	3.96	Average	260	125
4	4960.00	47.85	74.00	-26.15	43.89	3.96	Peak	260	125
5	7440.00	40.38	54.00	-13.62	31.74	8.64	Average	126	252
6	7440.00	52.35	74.00	-21.65	43.71	8.64	Peak	126	252

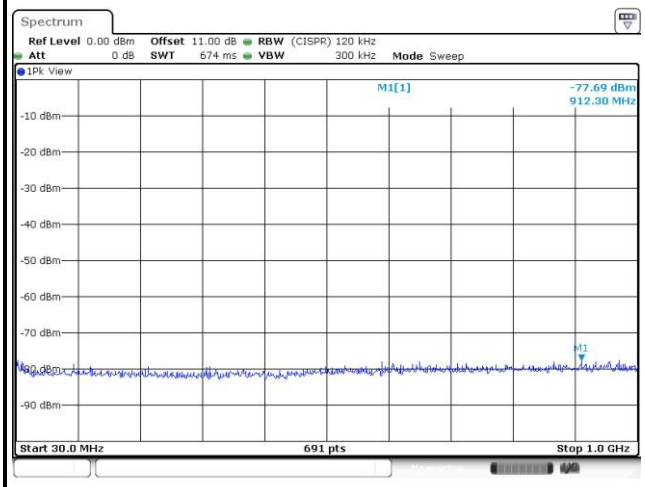
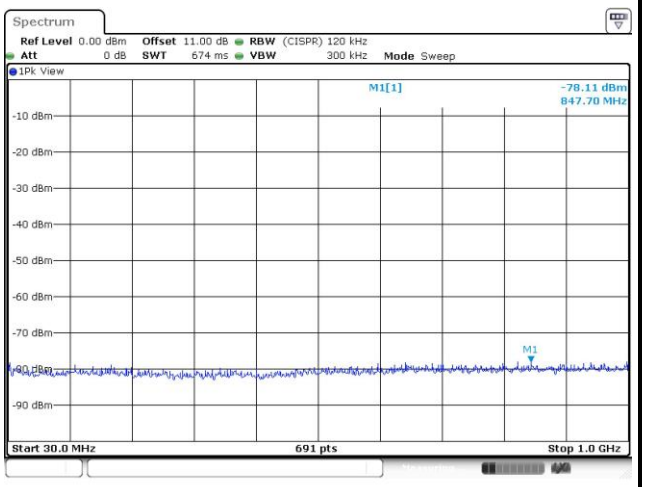
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

3.5.6 Transmitter Conducted Unwanted Emissions (Below 1 GHz)

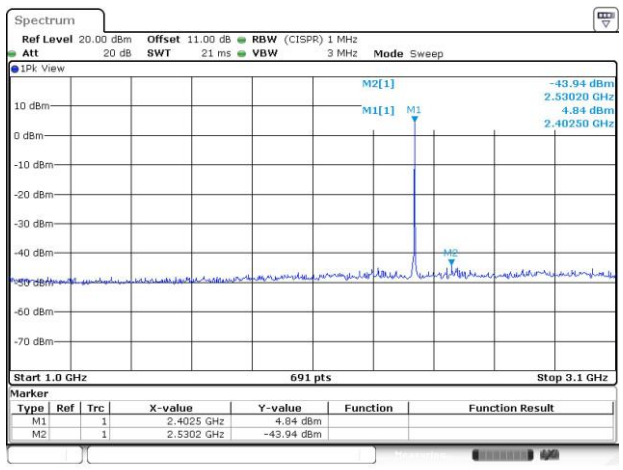
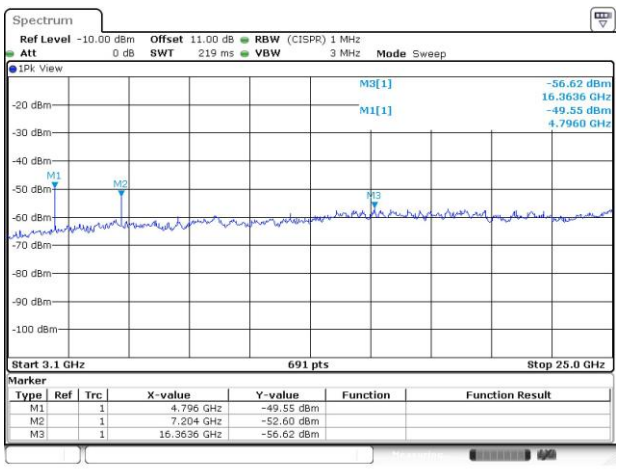
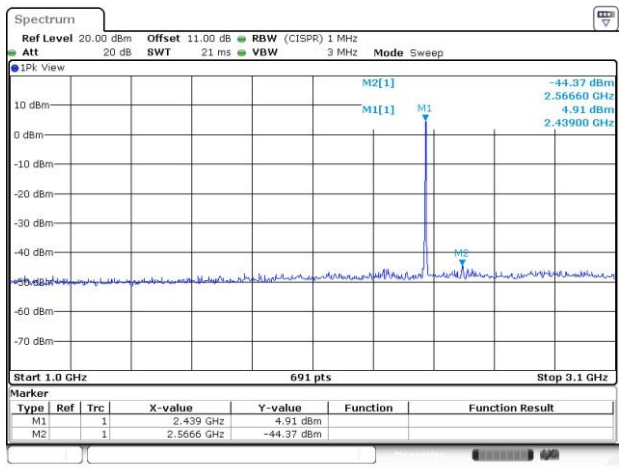
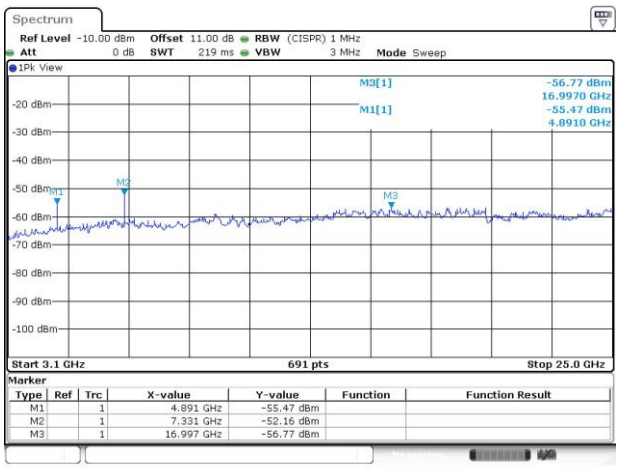
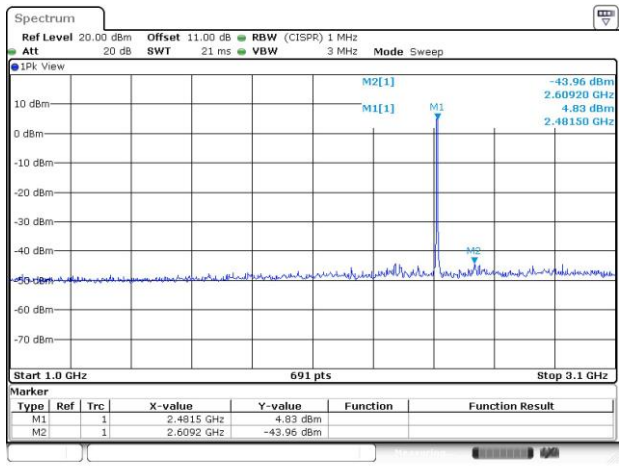
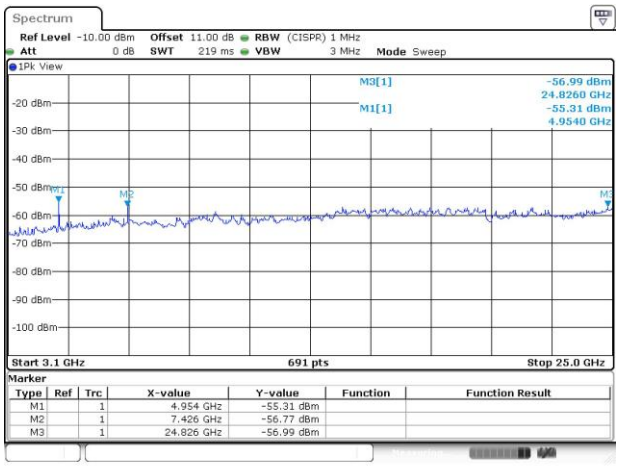
Modulation Mode		BT LE-1Mbps		Frequency	2440MHz	
Range (MHz)	Max Value chain0 (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	Min E-Field Limit (dBm)	E-Field Margin (dB)
30~1000MHz	-77.69	2.00	4.70	-70.99	-55.20	-15.79

Modulation Mode		BT LE-2Mbps		Frequency	2440MHz	
Range (MHz)	Max Value chain0 (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	Min E-Field Limit (dBm)	E-Field Margin (dB)
30~1000MHz	-78.11	2.00	4.70	-71.41	-55.20	-16.21

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

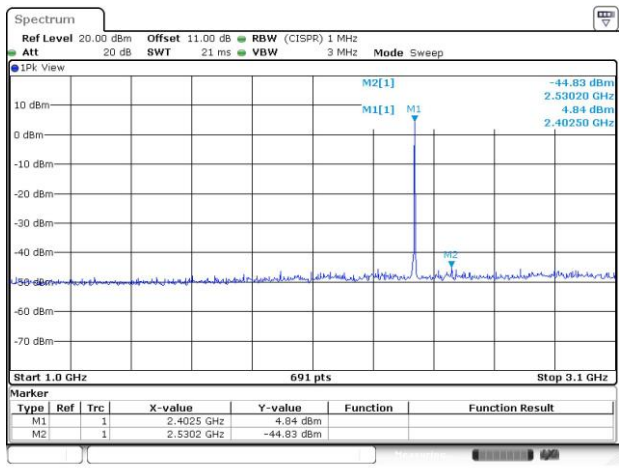
BT LE-1Mbps	BT LE-2Mbps
	

3.5.7 Transmitter Conducted Unwanted Emissions (Above 1GHz)

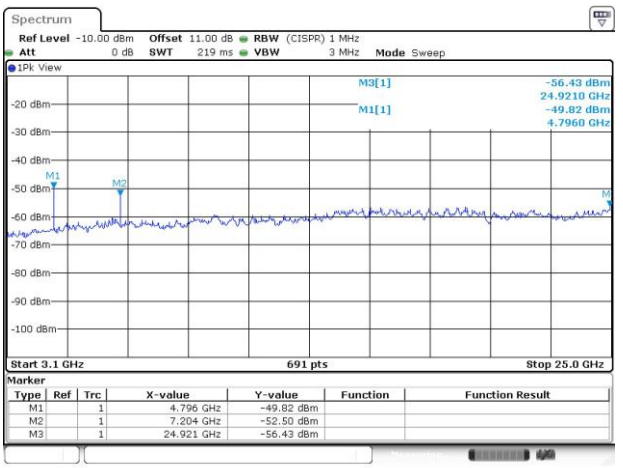
BT LE-1Mbps - Full Range Scan Test Plot	
2402MHz	**2402MHz**
	
2440MHz	**2440MHz**
	
2480MHz	**2480MHz**
	

BT LE-2Mbps - Full Range Scan Test Plot

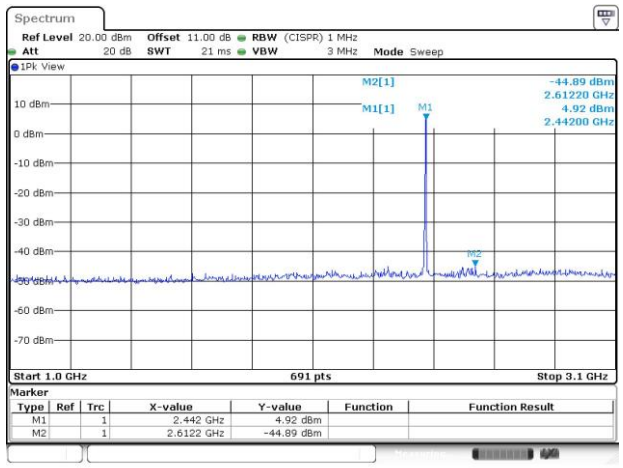
2402MHz



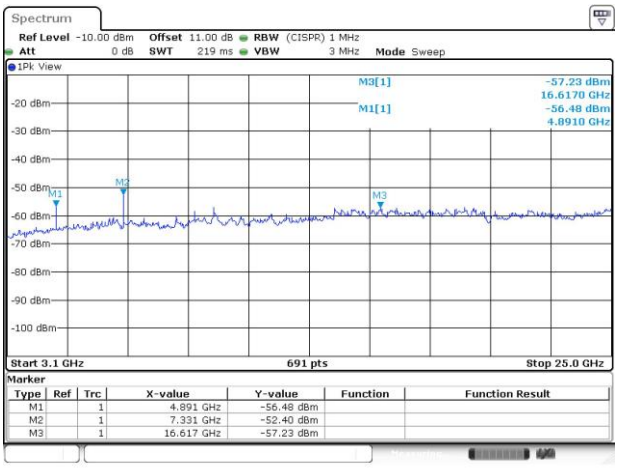
2402MHz



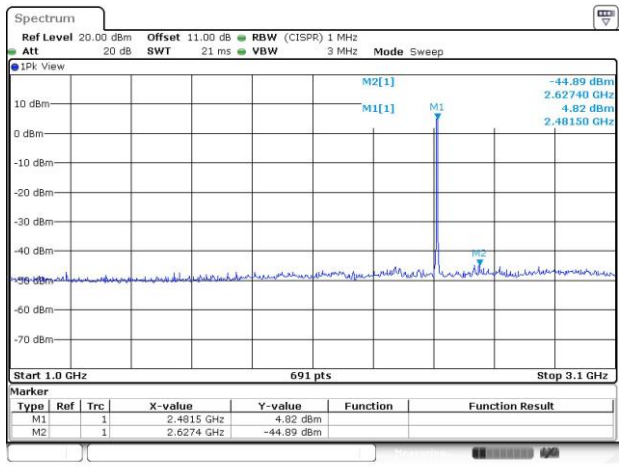
2440MHz



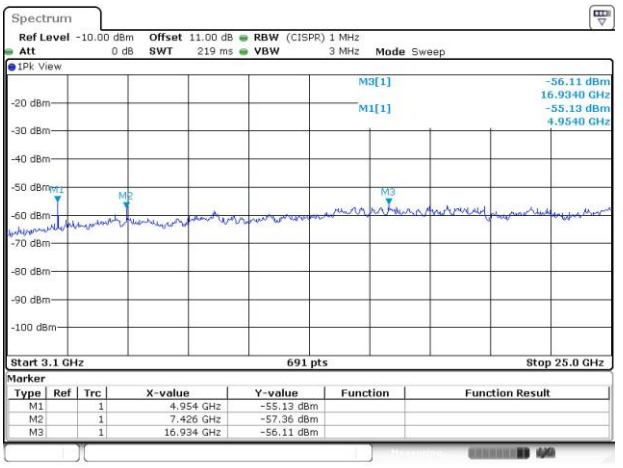
2440MHz



2480MHz



2480MHz

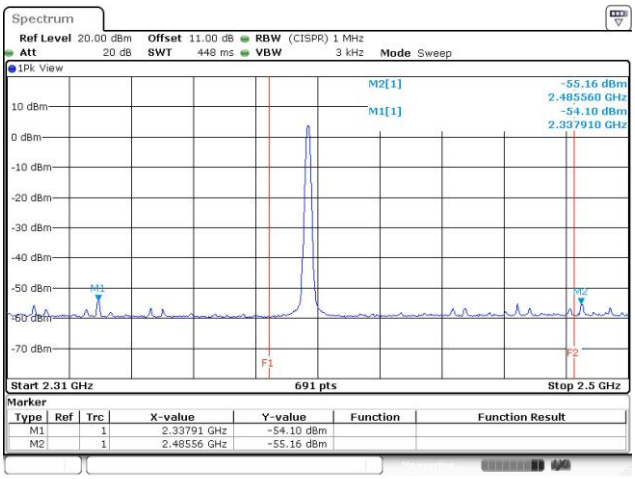


Transmitter Conducted Unwanted Emissions Results in Band Edge							
Modulation Mode		BT LE-1Mbps					
Test ch. Freq. (MHz)	**Range (MHz)**	**Max Value chain0 (dBm)**	**DG (dBi)**	**EIRP (dBm)**	**E-Field Limit (dBm)**	**E-Field Margin (dB)**	**Remark**
2402	2310~2390	-45.96	2.00	-43.96	-21.20	-22.76	PK
	2310~2390	-54.10	2.00	-52.10	-41.20	-10.90	AV
	2483.5~2500	-45.47	2.00	-43.47	-21.20	-22.27	PK
	2483.5~2500	-55.16	2.00	-53.16	-41.20	-11.96	AV
2440	2310~2390	-44.50	2.00	-42.50	-21.20	-21.30	PK
	2310~2390	-51.13	2.00	-49.13	-41.20	-7.93	AV
	2483.5~2500	-46.11	2.00	-44.11	-21.20	-22.91	PK
	2483.5~2500	-56.63	2.00	-54.63	-41.20	-13.43	AV
2480	2310~2390	-44.29	2.00	-42.29	-21.20	-21.09	PK
	2310~2390	-50.56	2.00	-48.56	-41.20	-7.36	AV
	2483.5~2500	-34.34	2.00	-32.34	-21.20	-11.14	PK
	2483.5~2500	-56.52	2.00	-54.52	-41.20	-13.32	AV

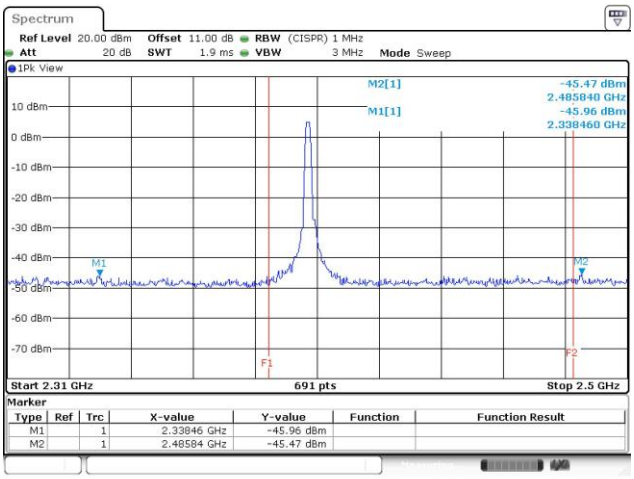
Note:
1. DG = Directional Gain.

Band Edge Test Plot

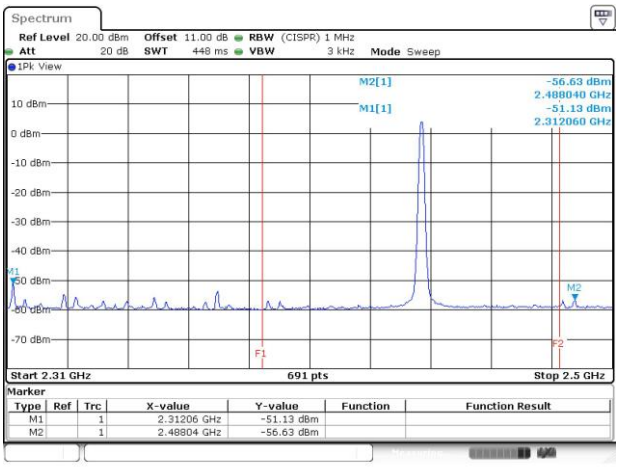
2402MHz - AV



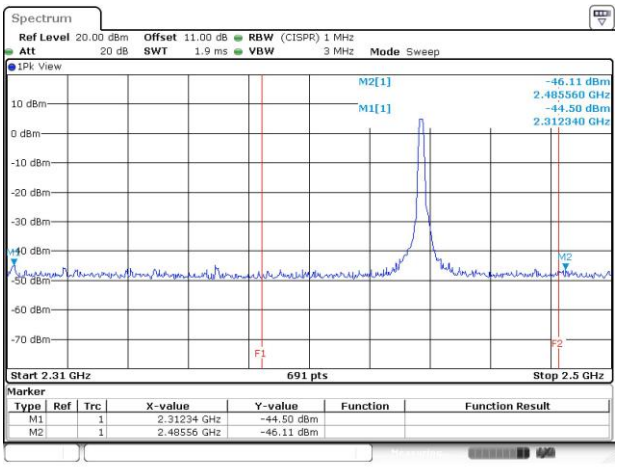
2402MHz - PK



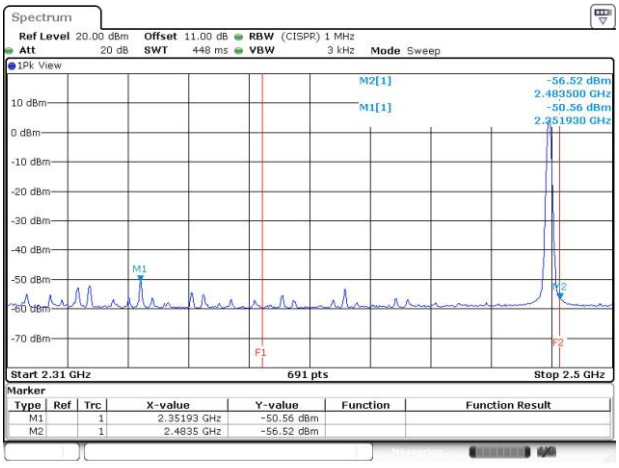
2440MHz - AV



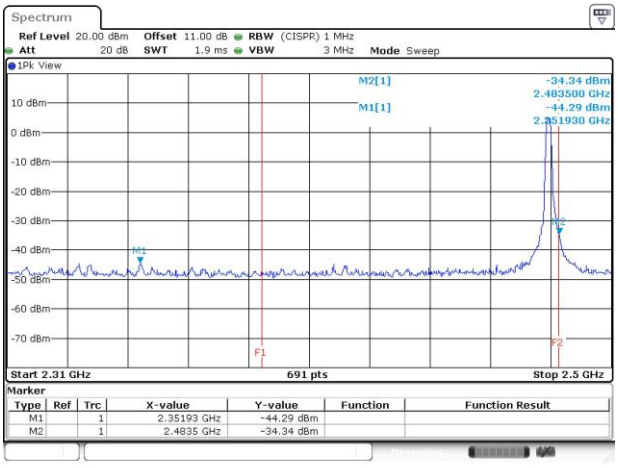
2440MHz - PK



2480MHz - AV



2480MHz - PK

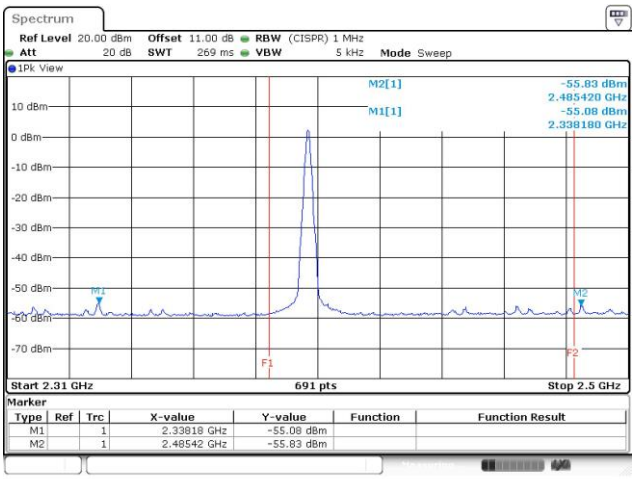


Transmitter Conducted Unwanted Emissions Results in Band Edge							
Modulation Mode		BT LE-2Mbps					
Test ch. Freq. (MHz)	**Range (MHz)**	**Max Value chain0 (dBm)**	**DG (dBi)**	**EIRP (dBm)**	**E-Field Limit (dBm)**	**E-Field Margin (dB)**	**Remark**
2402	2310~2390	-45.56	2.00	-43.56	-21.20	-22.36	PK
	2310~2390	-55.08	2.00	-53.08	-41.20	-11.88	AV
	2483.5~2500	-46.06	2.00	-44.06	-21.20	-22.86	PK
	2483.5~2500	-55.83	2.00	-53.83	-41.20	-12.63	AV
2440	2310~2390	-44.55	2.00	-42.55	-21.20	-21.35	PK
	2310~2390	-52.59	2.00	-50.59	-41.20	-9.39	AV
	2483.5~2500	-46.12	2.00	-44.12	-21.20	-22.92	PK
	2483.5~2500	-56.91	2.00	-54.91	-41.20	-13.71	AV
2480	2310~2390	-44.05	2.00	-42.05	-21.20	-20.85	PK
	2310~2390	-51.64	2.00	-49.64	-41.20	-8.44	AV
	2483.5~2500	-34.28	2.00	-32.28	-21.20	-11.08	PK
	2483.5~2500	-51.01	2.00	-49.01	-41.20	-7.81	AV

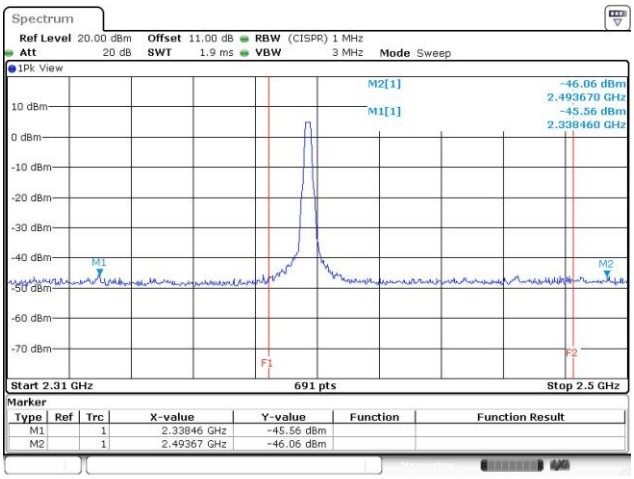
Note:
1. DG = Directional Gain.

Band Edge Test Plot

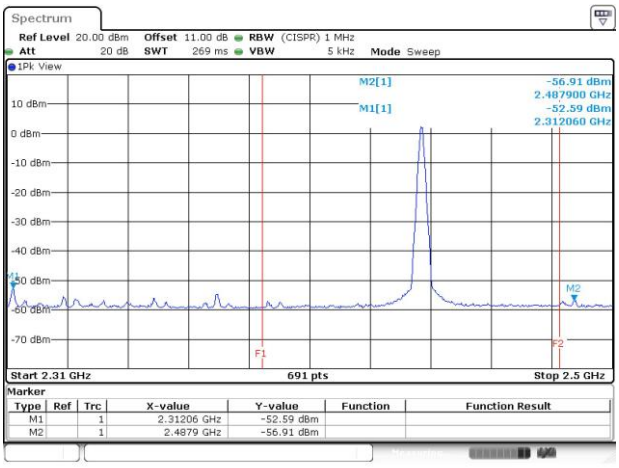
2402MHz - AV



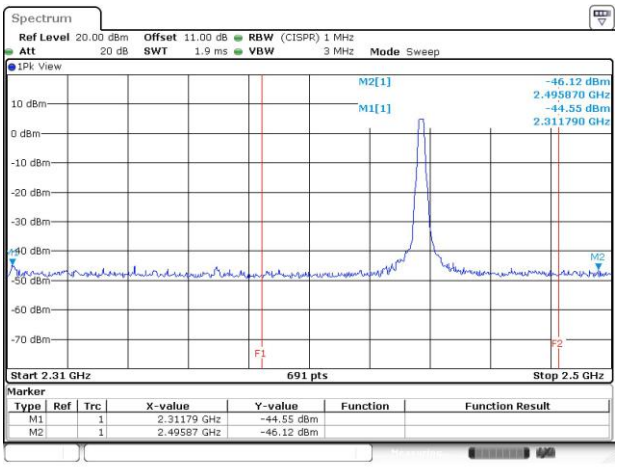
2402MHz - PK



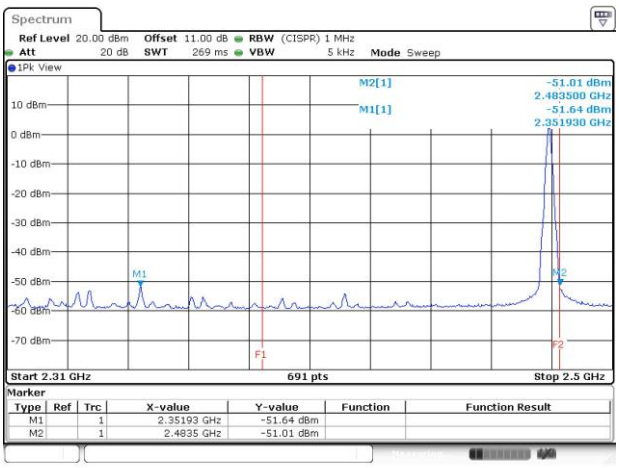
2440MHz - AV



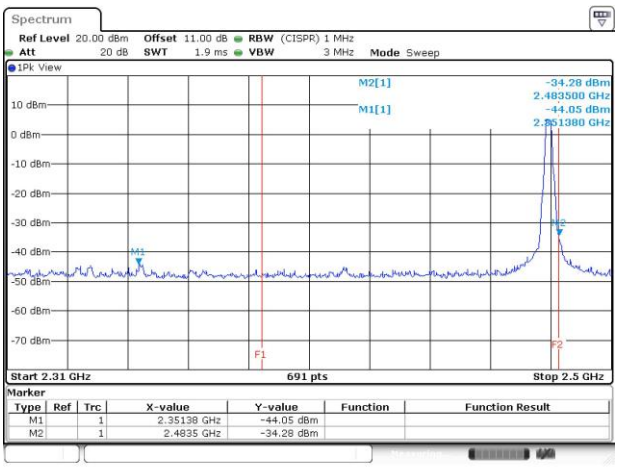
2440MHz - PK



2480MHz - AV



2480MHz - PK



Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band						
Modulation Mode		BT LE-1Mbps		**Frequency**	2402MHz	
Freq. (MHz)	**Remark**	**Max Value chain0 (dBm)**	**DG (dBi)**	**EIRP (dBm)**	**E-Field Limit (dBm)**	**E-Field Margin (dB)**
4804.00	PK	-48.82	2.00	-46.82	-21.20	-25.62
4804.00	AV note1	-	2.00	-	-41.20	-

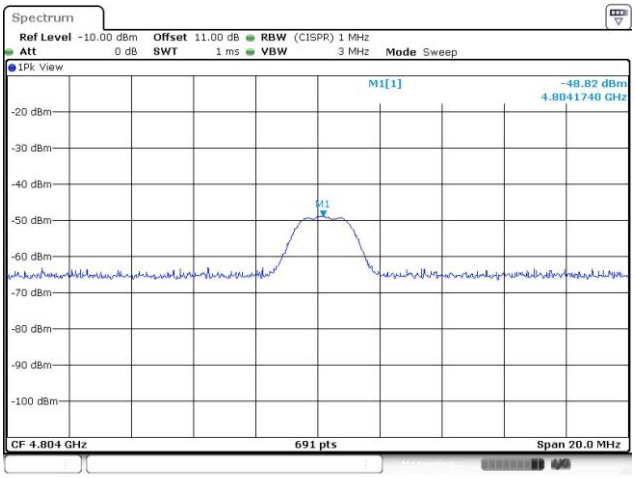
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band						
Modulation Mode		BT LE-1Mbps		**Frequency**	2440MHz	
Freq. (MHz)	**Remark**	**Max Value chain0 (dBm)**	**DG (dBi)**	**EIRP (dBm)**	**E-Field Limit (dBm)**	**E-Field Margin (dB)**
4880.00	PK	-54.20	2.00	-52.20	-21.20	-31.00
4880.00	AV note1	-	2.00	-	-41.20	-
7320.00	PK	-51.26	2.00	-49.26	-21.20	-28.06
7320.00	AV note1	-	2.00	-	-41.20	-

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band						
Modulation Mode		BT LE-1Mbps		**Frequency**	2480MHz	
Freq. (MHz)	**Remark**	**Max Value chain0 (dBm)**	**DG (dBi)**	**EIRP (dBm)**	**E-Field Limit (dBm)**	**E-Field Margin (dB)**
4960.00	PK	-54.03	2.00	-52.03	-21.20	-30.83
4960.00	AV note1	-	2.00	-	-41.20	-
7440.00	PK	-55.78	2.00	-53.78	-21.20	-32.58
7440.00	AV note1	-	2.00	-	-41.20	-

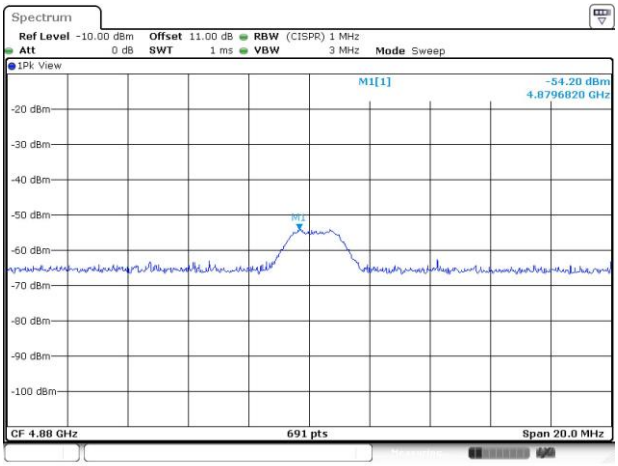
Note:
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain.

Test Plots

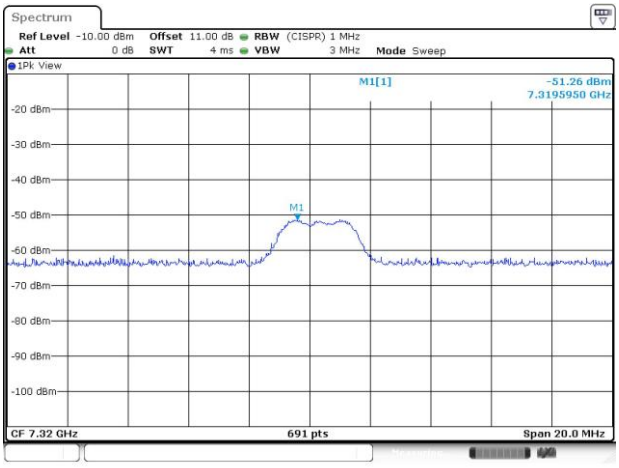
4804MHz - PK



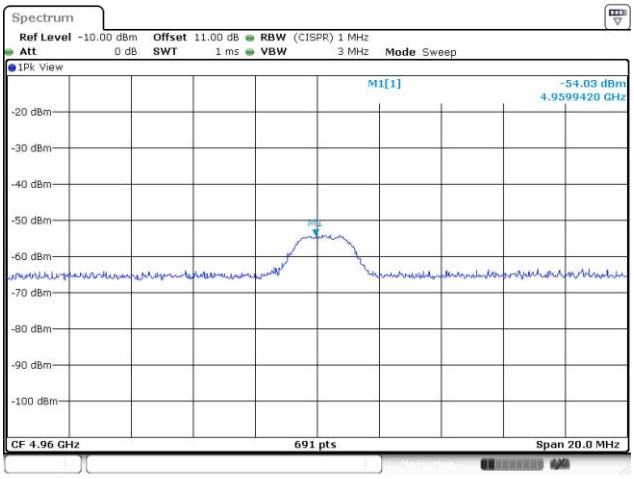
4880MHz - PK



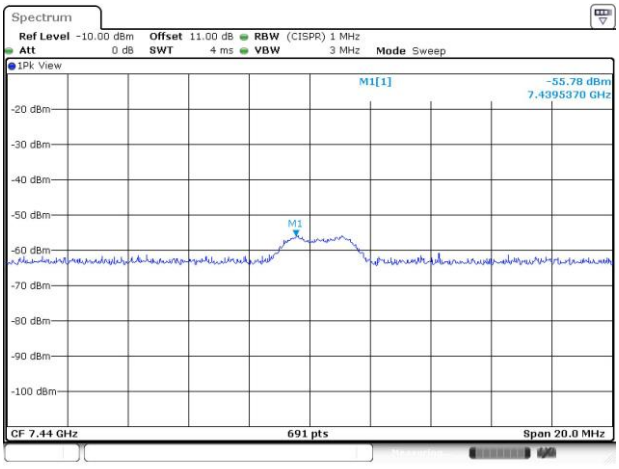
7320MHz - PK



4960MHz - PK



7440MHz - PK



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Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band						
Modulation Mode		BT LE-2Mbps		**Frequency**	2402MHz	
Freq. (MHz)	**Remark**	**Max Value chain0 (dBm)**	**DG (dBi)**	**EIRP (dBm)**	**E-Field Limit (dBm)**	**E-Field Margin (dB)**
4804.00	PK	-48.53	2.00	-46.53	-21.20	-25.33
4804.00	AV note1	-	2.00	-	-41.20	-

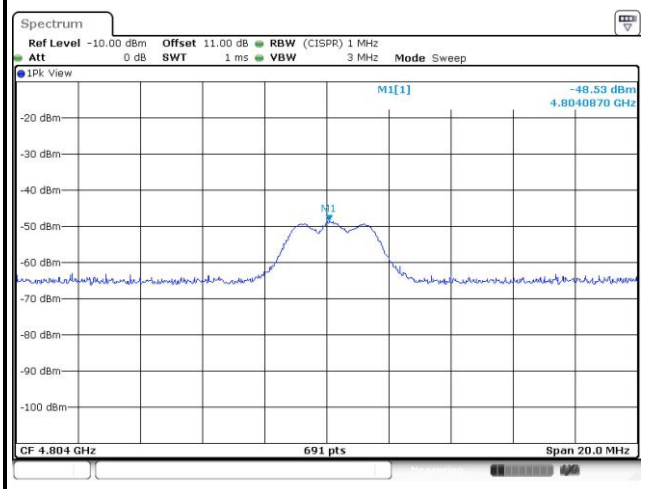
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band						
Modulation Mode		BT LE-2Mbps		**Frequency**	2440MHz	
Freq. (MHz)	**Remark**	**Max Value chain0 (dBm)**	**DG (dBi)**	**EIRP (dBm)**	**E-Field Limit (dBm)**	**E-Field Margin (dB)**
4880.00	PK	-54.51	2.00	-52.51	-21.20	-31.31
4880.00	AV note1	-	2.00	-	-41.20	-
7320.00	PK	-51.48	2.00	-49.48	-21.20	-28.28
7320.00	AV note1	-	2.00	-	-41.20	-

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band						
Modulation Mode		BT LE-2Mbps		**Frequency**	2480MHz	
Freq. (MHz)	**Remark**	**Max Value chain0 (dBm)**	**DG (dBi)**	**EIRP (dBm)**	**E-Field Limit (dBm)**	**E-Field Margin (dB)**
4960.00	PK	-54.06	2.00	-52.06	-21.20	-30.86
4960.00	AV note1	-	2.00	-	-41.20	-
7440.00	PK	-55.97	2.00	-53.97	-21.20	-32.77
7440.00	AV note1	-	2.00	-	-41.20	-

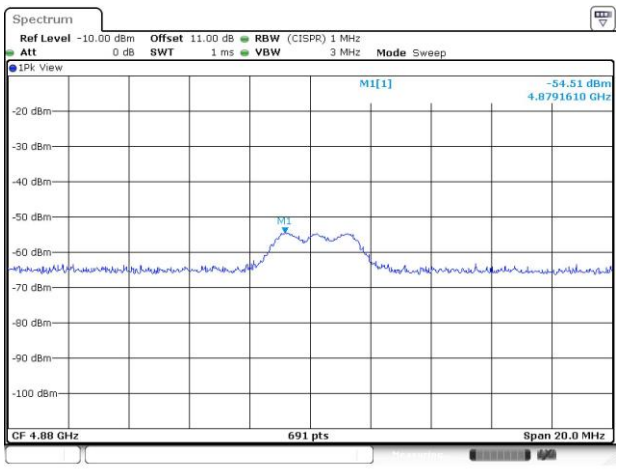
Note:
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain.

Test Plots

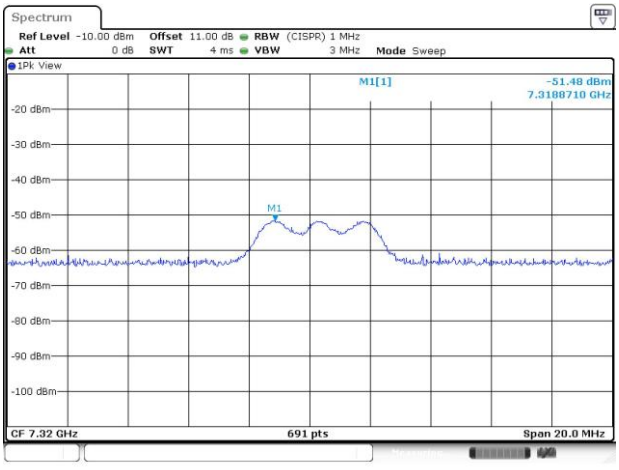
4804MHz - PK



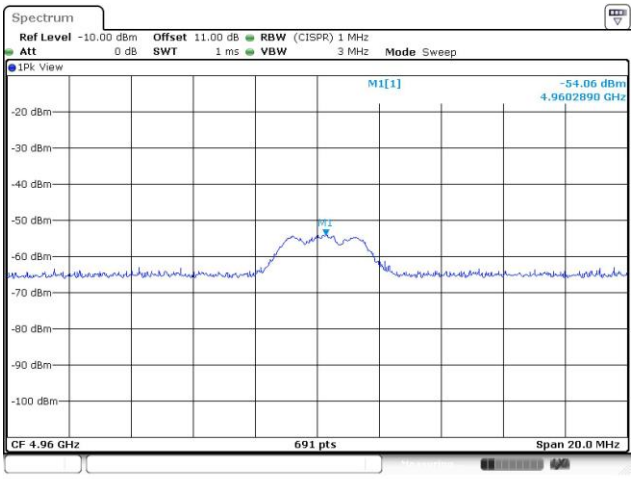
4880MHz - PK



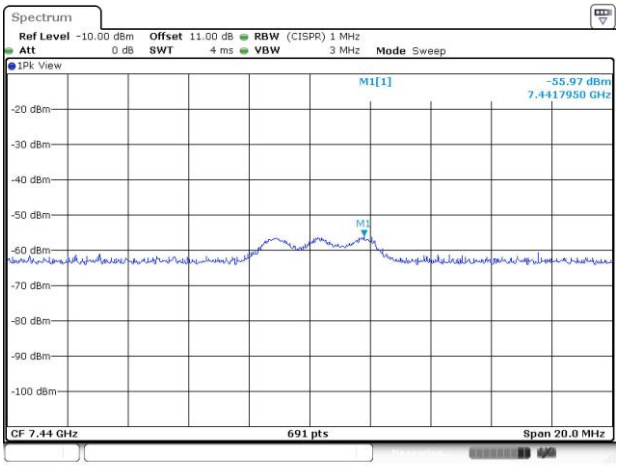
7320MHz - PK



4960MHz - PK



7440MHz - PK



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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

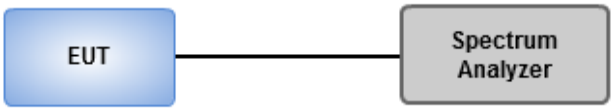
Reference level measurement

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

Summary

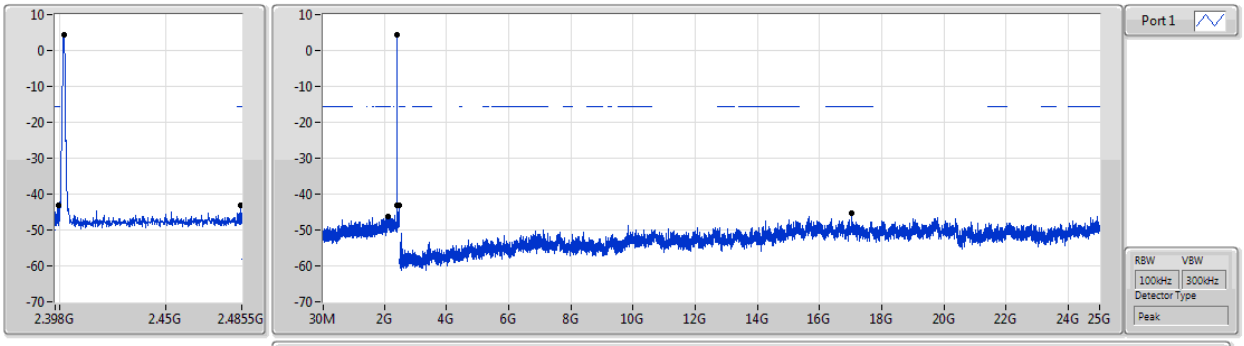
Mode	Result	Ref (Hz)	Ref (dBm)	Limit (dBm)	Freq (Hz)	Level (dBm)	Freq (Hz)	Level (dBm)	Freq (Hz)	Level (dBm)	Freq (Hz)	Level (dBm)	Port
2.4G	-	-	-	-	-	-	-	-	-	-	-	-	-
BT-LE(1Mbps)	Pass	2.48016G	4.64	-15.36	2.14344G	-46.06	2.39946G	-44.36	2.483628G	-42.80	24.901499G	-45.92	1
BT-LE(2Mbps)	Pass	2.402004G	4.75	-15.25	2.10025G	-45.64	2.399992G	-31.24	2.48362G	-44.51	17.300725G	-46.24	1

Result

Mode	Result	Ref (Hz)	Ref (dBm)	Limit (dBm)	Freq (Hz)	Level (dBm)	Freq (Hz)	Level (dBm)	Freq (Hz)	Level (dBm)	Freq (Hz)	Level (dBm)	Port
BT-LE(1Mbps)	-	-	-	-	-	-	-	-	-	-	-	-	-
2402MHz	Pass	2.402004G	4.49	-15.51	2.123312G	-46.31	2.399792G	-43.20	2.48476G	-43.19	17.015795G	-45.31	1
2440MHz	Pass	2.44008G	4.78	-15.22	2.14344G	-45.89	2.399272G	-44.91	2.48454G	-44.29	24.822698G	-46.23	1
2480MHz	Pass	2.48016G	4.64	-15.36	2.14344G	-46.06	2.39946G	-44.36	2.483628G	-42.80	24.901499G	-45.92	1
BT-LE(2Mbps)	-	-	-	-	-	-	-	-	-	-	-	-	-
2402MHz	Pass	2.402004G	4.75	-15.25	2.10025G	-45.64	2.399992G	-31.24	2.48362G	-44.51	17.300725G	-46.24	1
2440MHz	Pass	2.44008G	4.79	-15.21	2.158217G	-46.14	2.398144G	-45.21	2.485084G	-44.34	24.783317G	-46.46	1
2480MHz	Pass	2.48016G	4.51	-15.49	2.078956G	-44.15	2.39668G	-44.90	2.484428G	-43.76	17.320423G	-46.02	1

BT-LE(1Mbps) **CSE NdB**

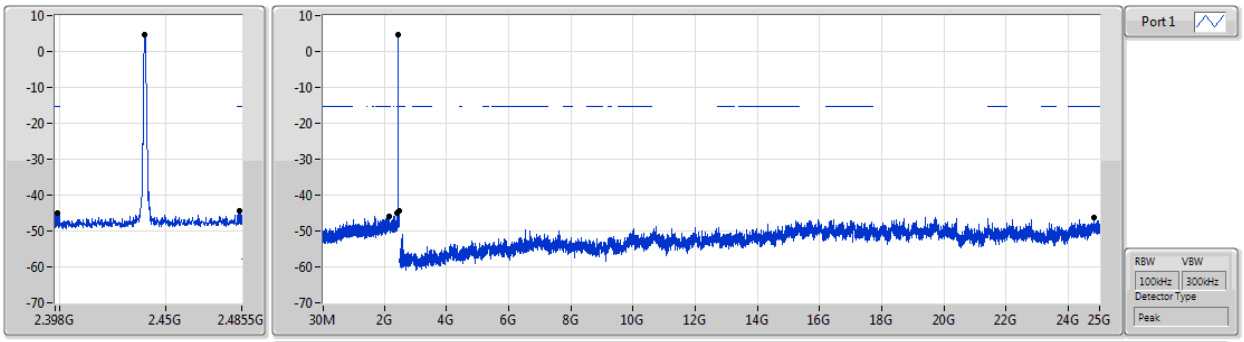
2402MHz



Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.402004G	4.49	-15.51	2.123312G	-46.31	2.399792G	-43.20	2.48476G	-43.19	17.015795G	-45.31	1

BT-LE(1Mbps) **CSE NdB**

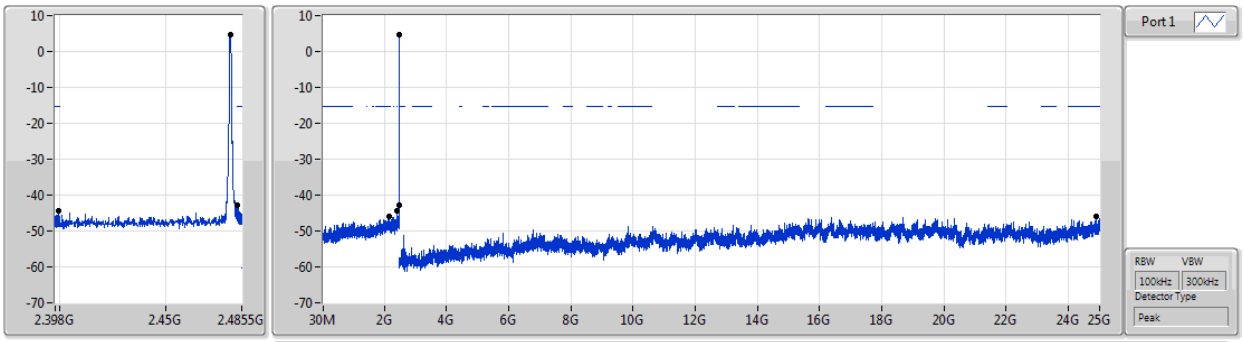
2440MHz



Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.44008G	4.78	-15.22	2.14344G	-45.89	2.399272G	-44.91	2.48454G	-44.29	24.822698G	-46.23	1

BT-LE(1Mbps) **CSE NdB**

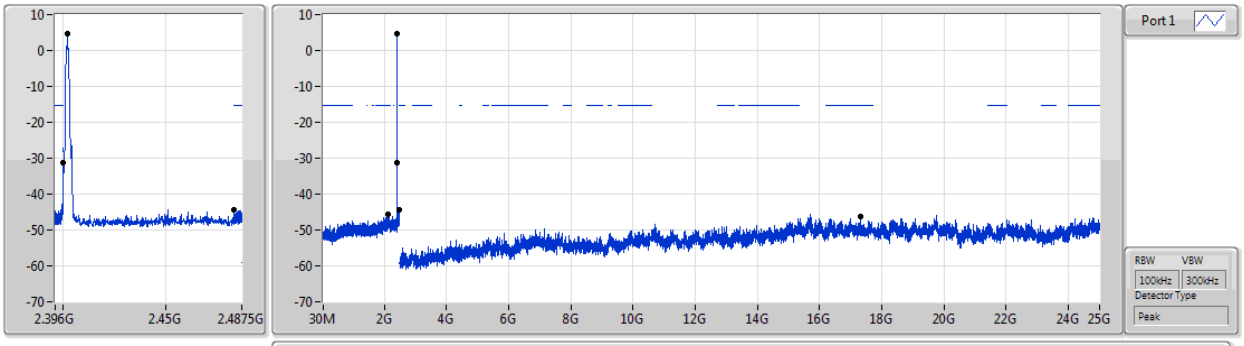
2480MHz



Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.48016G	4.64	-15.36	2.14344G	-46.06	2.39946G	-44.36	2.483628G	-42.80	24.901499G	-45.92	1

BT-LE(2Mbps) **CSE NdB**

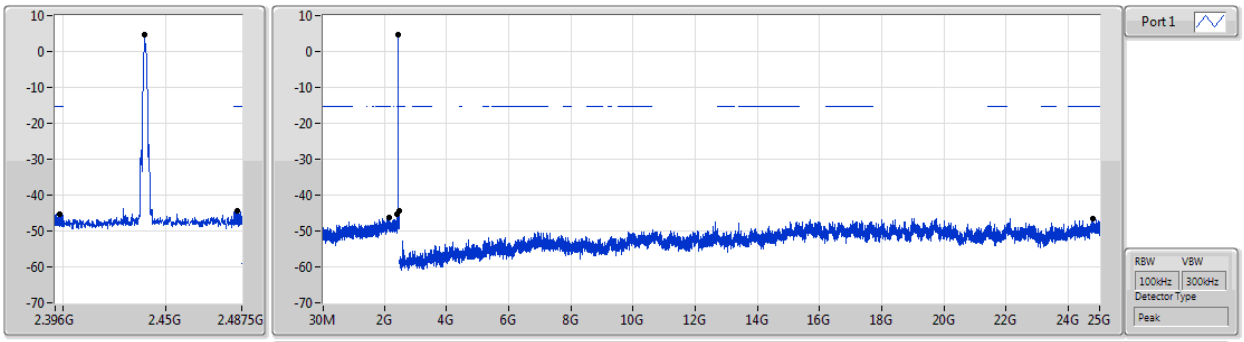
2402MHz



Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.402004G	4.75	-15.25	2.10025G	-45.64	2.399992G	-31.24	2.48362G	-44.51	17.300725G	-46.24	1

BT-LE(2Mbps) **CSE NdB**

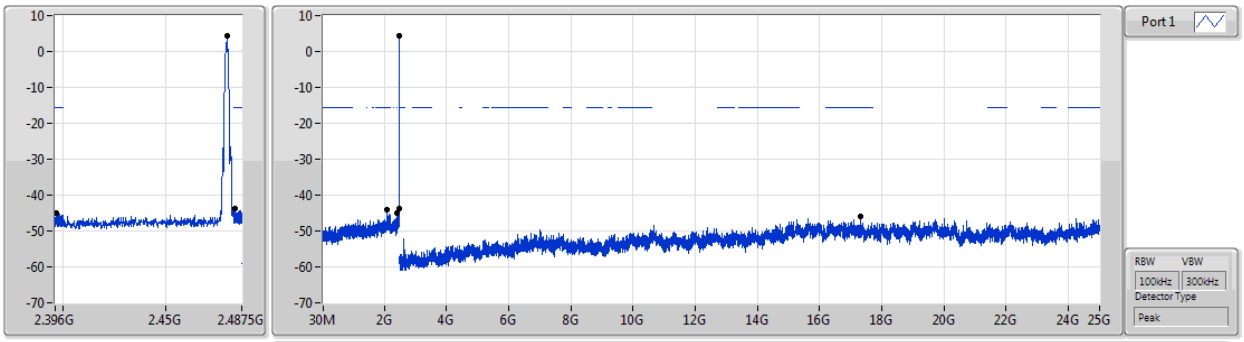
2440MHz



Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.44008G	4.79	-15.21	2.158217G	-46.14	2.398144G	-45.21	2.485084G	-44.34	24.783317G	-46.46	1

BT-LE(2Mbps) **CSE NdB**

2480MHz



Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.48016G	4.51	-15.49	2.078956G	-44.15	2.39668G	-44.90	2.484428G	-43.76	17.320423G	-46.02	1

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

==END==