FCC Test Report

FCC ID	:	**SQGBL654**
Equipment	:	**Bluetooth 5.0 BLE Data Module**
Model No.	:	**BL654**
Brand Name	:	**Laird**
Applicant	:	**Laird Technologies**
Address	:	**W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA**
Standard	:	**47 CFR FCC Part 15.247**
Received Date	:	**Jan. 30, 2018**
Tested Date	:	**Feb. 06 ~ Apr. 24, 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
FR813002	Rev. 01	Initial issue	Jun. 25, 2018

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	AC Power Line Conducted Emissions	[dBuV]: 0.159MHz 44.46 (Margin -11.06dB) - AV	Pass
15.247(d) 15.209	Radiated Emissions	Meet the requirement of limit	Pass
15.247(b)(3)	Maximum Output Power	Power [dBm]: 7.56	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	BL654	Bluetooth 5.0 BLE Data Module	With Printed PCB Antenna
			With 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]	125 kbps
				500 kbps
				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.	Brand	Model	Type	Connector	Gain (dBi)	Remark
1	Laird	NanoBlue	PCB Dipole	IPEX MHF4	2	Connector Type Antenna
2	Laird	FlexPIFA	PCB Dipole	IPEX MHF4	2	Connector Type Antenna
3	Laird	FlexNotch	PCB Dipole	IPEX MHF4	2	Connector Type Antenna
4	Mag.Layers	EDA-8709-2G4C1-B27-CY	Dipole	IPEX MHF4	2	Connector Type Antenna
5	Laird	mFlexPIFA	PIFA	IPEX MHF4	2	Connector Type Antenna
6	Laird	Laird NFC	NFC	N/A	N/A	Printed PCB Antenna & Connector Type Antenna
7	Laird	BL654-SA PCB printed antenna	Printed PCB	N/A	0	Printed PCB Antenna
8	Walsin	RFDPA870900SBAB8G1	Dipole	SMA	2	Connector Type Antenna

Note: Antenna 4 was chosen for final test

1.1.4 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	1.8Vdc & 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: 7.94		
Duty Cycle and Duty Factor	Modulation Mode	Duty cycle (%)	Duty factor (dB)
	GFSK/125kbps	84.54%	0.73
	GFSK/500kbps	62.11%	2.07
	GFSK/1Mbps	64.81%	1.88
	GFSK/2Mbps	36.15%	4.42

1.1.8 Power Setting

Modulation Mode	Test Frequency (MHz)		
	2402	2440	2480
GFSK/125kbps	Default	Default	Default
GFSK/500kbps	Default	Default	Default
GFSK/1Mbps	Default	Default	Default
GFSK/2Mbps	Default	Default	Default

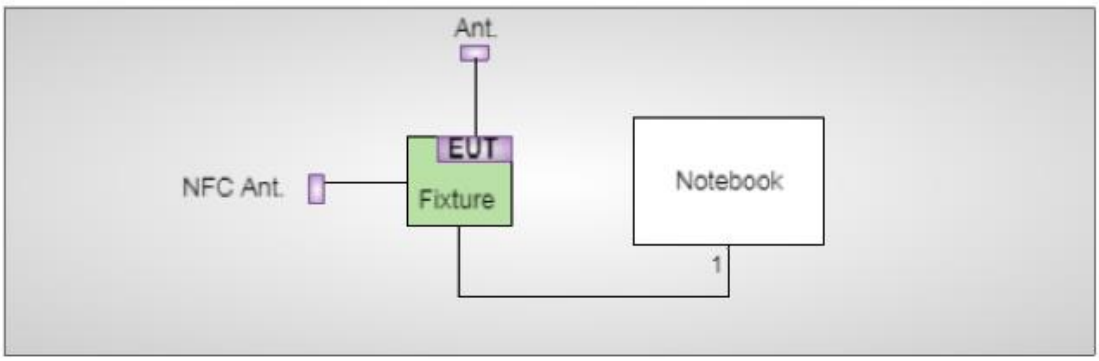
1.2 Local Support Equipment List

Support Equipment List					
No.	**Equipment**	**Brand**	**Model**	**FCC ID**	**Signal cable / Length (m)**
1	Notebook	DELL	Latitude E6430	DoC	USB, 0.75m shielded.
2	50Ω load	---	---	---	---
3	Fixture	---	---	---	---

Note: Fixture is provided by applicant.

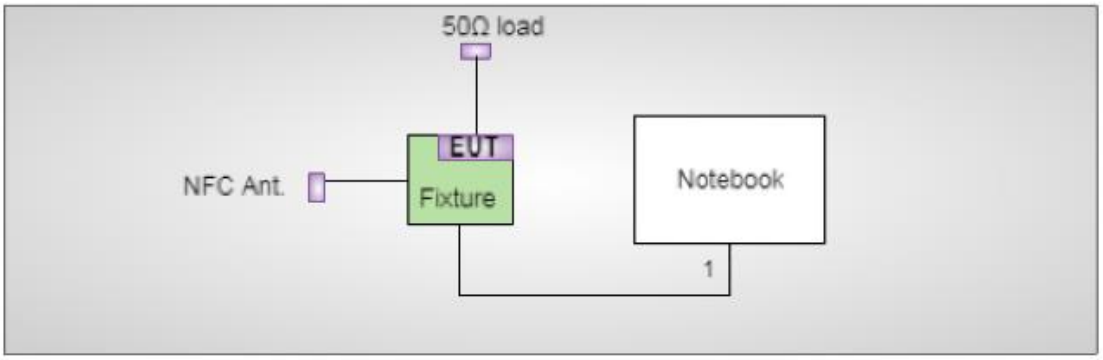
1.3 Test Setup Chart

Test Setup Diagram – conducted emission



1. USB cable, 0.75m shielded.

Test Setup Diagram – radiated emission



1. USB cable, 0.75m shielded.

1.4 Test Equipment List and Calibration Data

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	Apr. 24, 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
LISN (Support Unit)	SCHWARZBECK	Schwarzbeck 8127	8127-666	Nov. 24, 2017	Nov. 23, 2018
RF Cable-CON	EMC	EMCCFD300-BM-BM-6000	50821	Dec. 18, 2017	Dec. 17, 2018
50 ohm terminal (Support Unit)	NA	50	04	May 12, 2017	May 11, 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	Feb. 06 ~ Feb. 07, 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
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	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	MY16014/4	Dec. 07, 2017	Dec. 06, 2018
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	Feb. 19 ~ Feb. 20, 2018				
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	±5.63 dB

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	23°C / 59%	Alex Tsai
Radiated Emissions	03CH01-WS	21-22°C / 64-65%	Akun Chung Roger Lu
RF Conducted	TH01-WS	22°C / 64%	Brad Wu

- 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	2480 2480	1Mbps 2Mbps	---
Maximum Output Power 6dB bandwidth Power spectral density	BT LE BT LE BT LE BT LE	2402, 2440, 2480 2402, 2440, 2480 2402, 2440, 2480 2402, 2440, 2480	125kbps 500kbps 1Mbps 2Mbps	---
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 Transmitter Test Results

3.1 Conducted Emissions

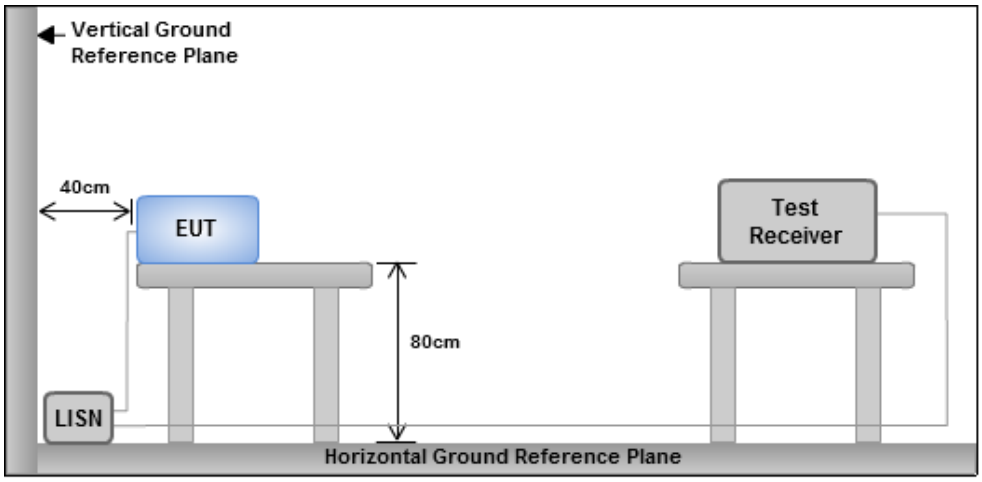
3.1.1 Limit of Conducted Emissions

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

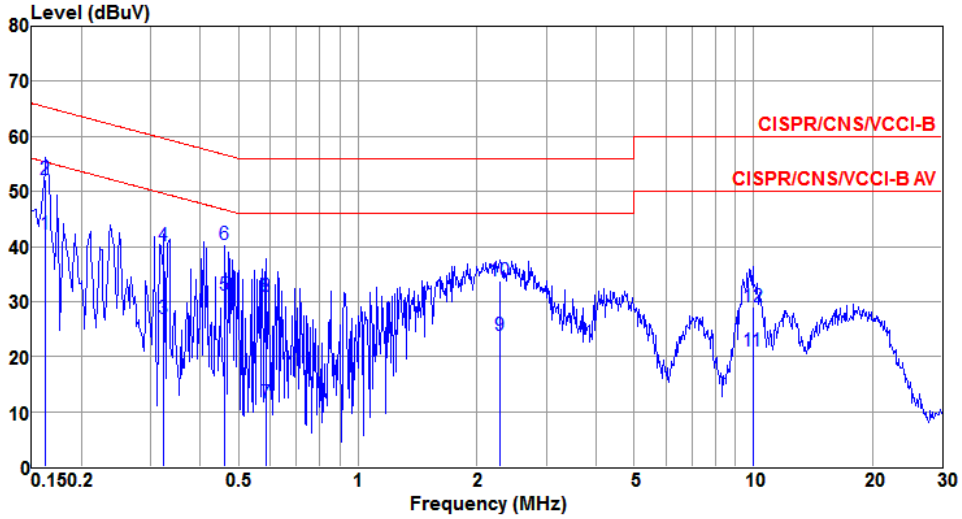
3.1.3 Test Setup



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

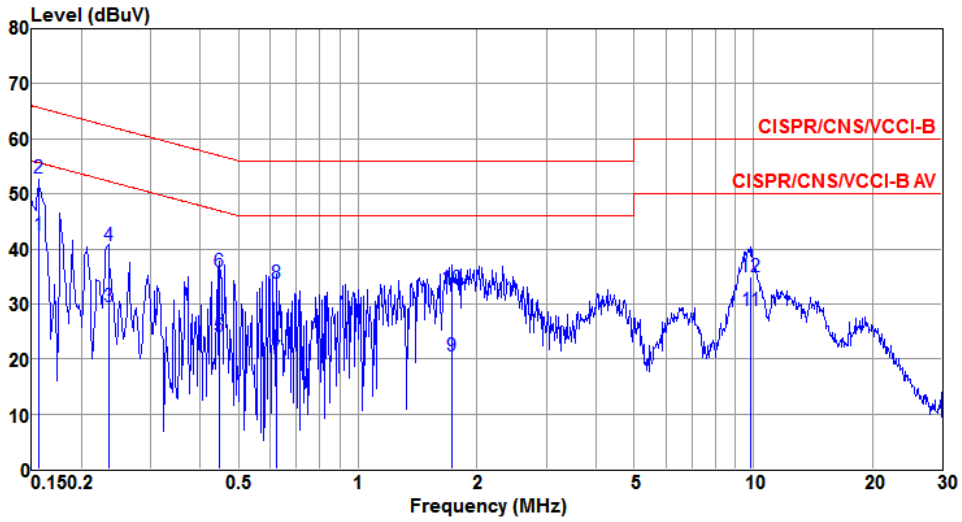
Modulation Mode	BT LE-1Mbps	Test Freq. (MHz)	2480
Power Phase	Line		



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1@	0.162	42.31	55.34	-13.03	42.22	0.07	0.02	Average
2	0.162	52.27	65.34	-13.07	52.18	0.07	0.02	QP
3	0.323	26.86	49.62	-22.76	26.76	0.08	0.02	Average
4	0.323	40.03	59.62	-19.59	39.93	0.08	0.02	QP
5	0.461	31.20	46.67	-15.47	31.10	0.08	0.02	Average
6	0.461	40.40	56.67	-16.27	40.30	0.08	0.02	QP
7	0.585	11.47	46.00	-34.53	11.37	0.08	0.02	Average
8	0.585	30.91	56.00	-25.09	30.81	0.08	0.02	QP
9	2.285	23.91	46.00	-22.09	23.68	0.11	0.12	Average
10	2.285	33.77	56.00	-22.23	33.54	0.11	0.12	QP
11	9.966	20.95	50.00	-29.05	20.43	0.20	0.32	Average
12	9.966	29.10	60.00	-30.90	28.58	0.20	0.32	QP

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

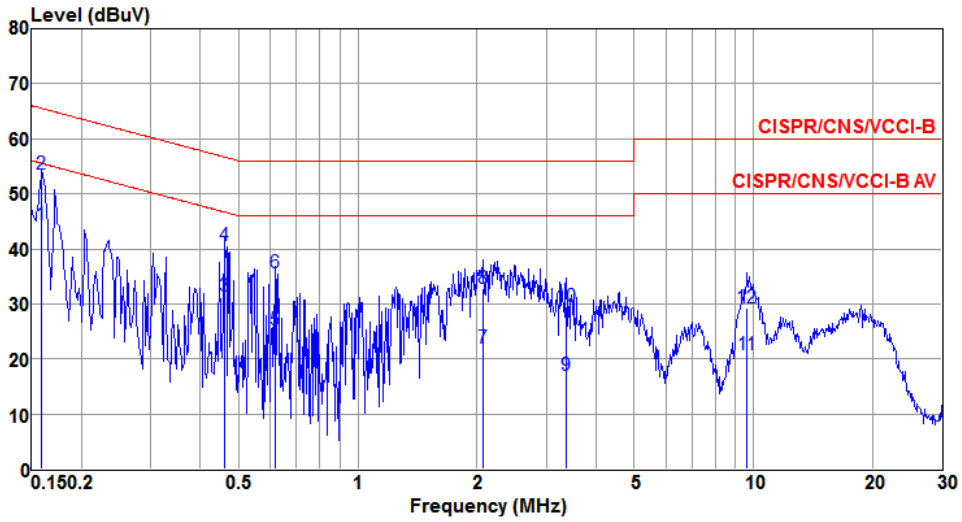
Modulation Mode	BT LE-1Mbps	Test Freq. (MHz)	2480
Power Phase	Neutral		



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.156	42.49	55.69	-13.20	42.44	0.04	0.01	Average
2@	0.156	52.98	65.69	-12.71	52.93	0.04	0.01	QP
3	0.234	29.43	52.30	-22.87	29.36	0.04	0.03	Average
4	0.234	40.68	62.30	-21.62	40.61	0.04	0.03	QP
5	0.447	24.01	46.93	-22.92	23.95	0.04	0.02	Average
6	0.447	35.78	56.93	-21.15	35.72	0.04	0.02	QP
7	0.621	20.17	46.00	-25.83	20.11	0.04	0.02	Average
8	0.621	33.79	56.00	-22.21	33.73	0.04	0.02	QP
9	1.725	20.50	46.00	-25.50	20.34	0.07	0.09	Average
10	1.725	32.90	56.00	-23.10	32.74	0.07	0.09	QP
11	9.861	28.73	50.00	-21.27	28.24	0.17	0.32	Average
12	9.861	34.97	60.00	-25.03	34.48	0.17	0.32	QP

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

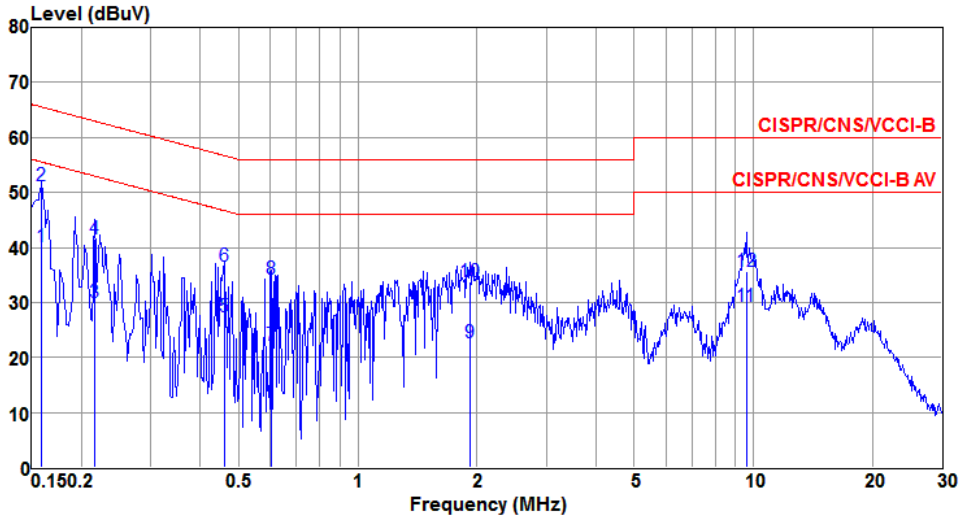
Modulation Mode	BT LE-2Mbps	Test Freq. (MHz)	2480
Power Phase	Line		



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1@	0.159	44.46	55.52	-11.06	44.38	0.07	0.01	Average
2	0.159	53.56	65.52	-11.96	53.48	0.07	0.01	QP
3	0.459	31.51	46.71	-15.20	31.41	0.08	0.02	Average
4	0.459	40.70	56.71	-16.01	40.60	0.08	0.02	QP
5	0.617	25.16	46.00	-20.84	25.06	0.08	0.02	Average
6	0.617	35.71	56.00	-20.29	35.61	0.08	0.02	QP
7	2.066	22.02	46.00	-23.98	21.80	0.11	0.11	Average
8	2.066	32.92	56.00	-23.08	32.70	0.11	0.11	QP
9	3.364	17.08	46.00	-28.92	16.77	0.12	0.19	Average
10	3.364	29.46	56.00	-26.54	29.15	0.12	0.19	QP
11	9.654	20.68	50.00	-29.32	20.16	0.20	0.32	Average
12	9.654	29.22	60.00	-30.78	28.70	0.20	0.32	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)	2480
Power Phase	Neutral		



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.159	40.15	55.52	-15.37	40.10	0.04	0.01	Average
2@	0.159	51.22	65.52	-14.30	51.17	0.04	0.01	QP
3	0.216	29.89	52.96	-23.07	29.82	0.04	0.03	Average
4	0.216	41.64	62.96	-21.32	41.57	0.04	0.03	QP
5	0.459	27.41	46.71	-19.30	27.35	0.04	0.02	Average
6	0.459	36.69	56.71	-20.02	36.63	0.04	0.02	QP
7	0.604	22.31	46.00	-23.69	22.25	0.04	0.02	Average
8	0.604	34.19	56.00	-21.81	34.13	0.04	0.02	QP
9	1.918	22.73	46.00	-23.27	22.56	0.07	0.10	Average
10	1.918	33.69	56.00	-22.31	33.52	0.07	0.10	QP
11	9.603	29.23	50.00	-20.77	28.74	0.17	0.32	Average
12	9.603	35.64	60.00	-24.36	35.15	0.17	0.32	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

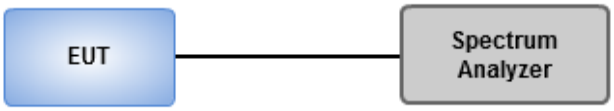
6dB Bandwidth

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

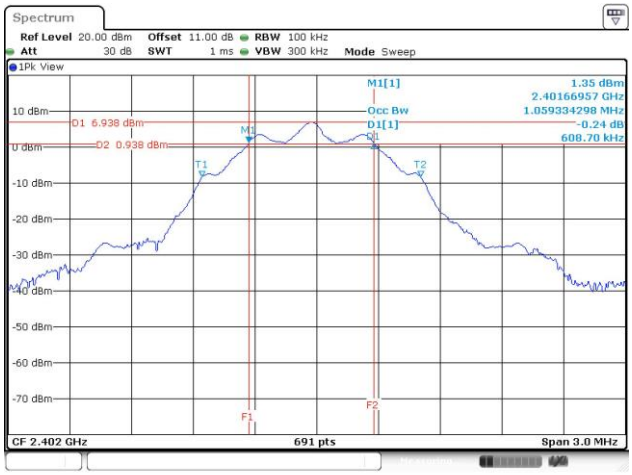
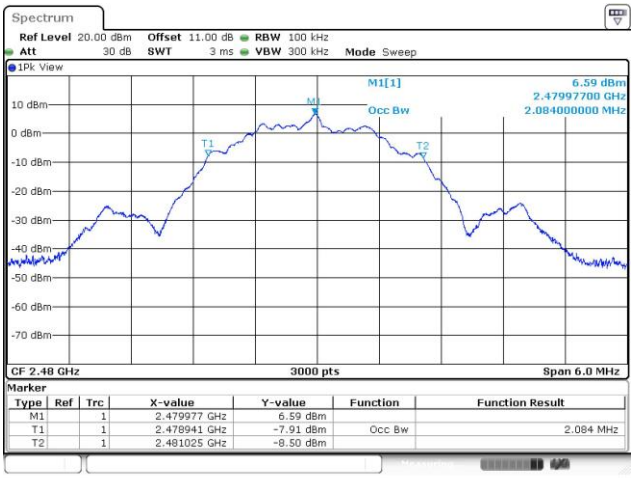
1. Set resolution bandwidth (RBW) = 100 kHz, Video bandwidth = 300 kHz.
2. Detector = Sample, Trace mode = max hold.
3 Sweep = auto couple, Allow the trace to stabilize.
4. Use the OBW measurement function of spectrum analyzer to measure the occupied bandwidth.

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-125kbps	2402	0.609	1.06	500
BT LE-125kbps	2440	0.613	1.06	500
BT LE-125kbps	2480	0.613	1.07	500
BT LE-500kbps	2402	0.700	1.04	500
BT LE-500kbps	2440	0.696	1.04	500
BT LE-500kbps	2480	0.700	1.05	500
BT LE-1Mbps	2402	0.691	1.05	500
BT LE-1Mbps	2440	0.687	1.05	500
BT LE-1Mbps	2480	0.696	1.05	500
BT LE-2Mbps	2402	1.139	2.07	500
BT LE-2Mbps	2440	1.148	2.08	500
BT LE-2Mbps	2480	1.148	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.

☐ Antenna gain > 6dBi

☐ Non Fixed, point to point operations.
The conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dB

☐ Fixed, point to point operations
Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point Operations, maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 5725–5850 MHz band that are used exclusively for fixed, point-to-point operations ,no any corresponding reduction is in transmitter peak output power

3.3.2 Test Procedures

☒ Maximum Peak Conducted Output Power

☐ **Spectrum analyzer**

1. Set RBW = 1MHz, VBW = 3MHz, Detector = Peak.
2. Sweep time = auto, Trace mode = max hold, Allow trace to fully stabilize.
3. Use the spectrum analyzer channel power measurement function with the band limits set equal to the DTS bandwidth edges.

☒ **Power meter**

1. A broadband Peak 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.

☒ Maximum Conducted Average Output Power (For reference only)

☒ **Power meter**

1. A broadband Average 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-125kbps	2402	5.321083	7.26	30	2	9.26	36
BT LE-125kbps	2440	5.584702	7.47	30	2	9.47	36
BT LE-125kbps	2480	5.701643	7.56	30	2	9.56	36
BT LE-500kbps	2402	5.321083	7.26	30	2	9.26	36
BT LE-500kbps	2440	5.559043	7.45	30	2	9.45	36
BT LE-500kbps	2480	5.688529	7.55	30	2	9.55	36
BT LE-1Mbps	2402	5.308844	7.25	30	2	9.25	36
BT LE-1Mbps	2440	5.571857	7.46	30	2	9.46	36
BT LE-1Mbps	2480	5.688529	7.55	30	2	9.55	36
BT LE-2Mbps	2402	5.308844	7.25	30	2	9.25	36
BT LE-2Mbps	2440	5.559043	7.45	30	2	9.45	36
BT LE-2Mbps	2480	5.675446	7.54	30	2	9.54	36

Mode	Freq. (MHz)	AV Power (mW)	AV Power (dBm)	Limit (dBm)
BT LE-125kbps	2402	5.248075	7.20	---
BT LE-125kbps	2440	5.508077	7.41	---
BT LE-125kbps	2480	5.623413	7.50	---
BT LE-500kbps	2402	5.236004	7.19	---
BT LE-500kbps	2440	5.495409	7.40	---
BT LE-500kbps	2480	5.61048	7.49	---
BT LE-1Mbps	2402	5.236004	7.19	---
BT LE-1Mbps	2440	5.495409	7.40	---
BT LE-1Mbps	2480	5.61048	7.49	---
BT LE-2Mbps	2402	5.236004	7.19	---
BT LE-2Mbps	2440	5.48277	7.39	---
BT LE-2Mbps	2480	5.61048	7.49	---

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

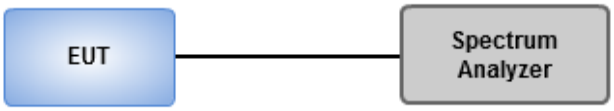
☒ Maximum peak conducted output power was used to demonstrate compliance to the fundamental output power limit.

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

☐ Maximum (average) conducted output power was used to demonstrate compliance to the fundamental output power limit.

1. Set the RBW = 100kHz, VBW = 300 kHz.
2. Detector = RMS, Sweep time = auto couple.
3. Set the sweep time to: ≥ 10 x (number of measurement points in sweep) x (maximum data rate per stream).
4. Perform the measurement over a single sweep.
5. Use the peak marker function to determine the maximum amplitude level.

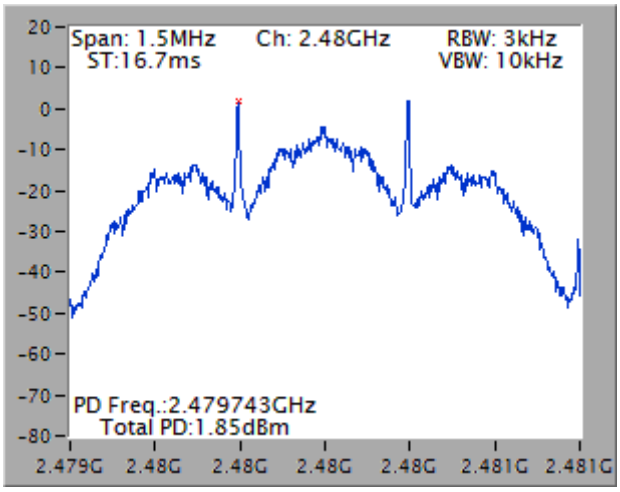
3.4.3 Test Setup



3.4.4 Test Result of Power Spectral Density

Mode	Freq. (MHz)	Total Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
BT LE-125kbps	2402	1.16	8
BT LE-125kbps	2440	1.06	8
BT LE-125kbps	2480	1.85	8
BT LE-500kbps	2402	0.96	8
BT LE-500kbps	2440	0.85	8
BT LE-500kbps	2480	1.60	8
BT LE-1Mbps	2402	-8.08	8
BT LE-1Mbps	2440	-8.53	8
BT LE-1Mbps	2480	-7.95	8
BT LE-2Mbps	2402	-10.60	8
BT LE-2Mbps	2440	-10.91	8
BT LE-2Mbps	2480	-10.34	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

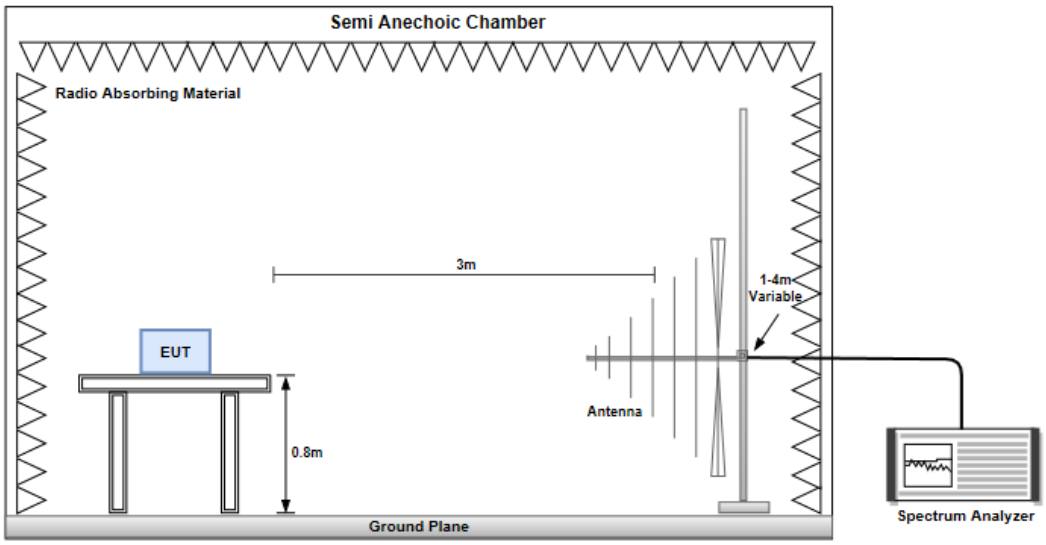
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission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

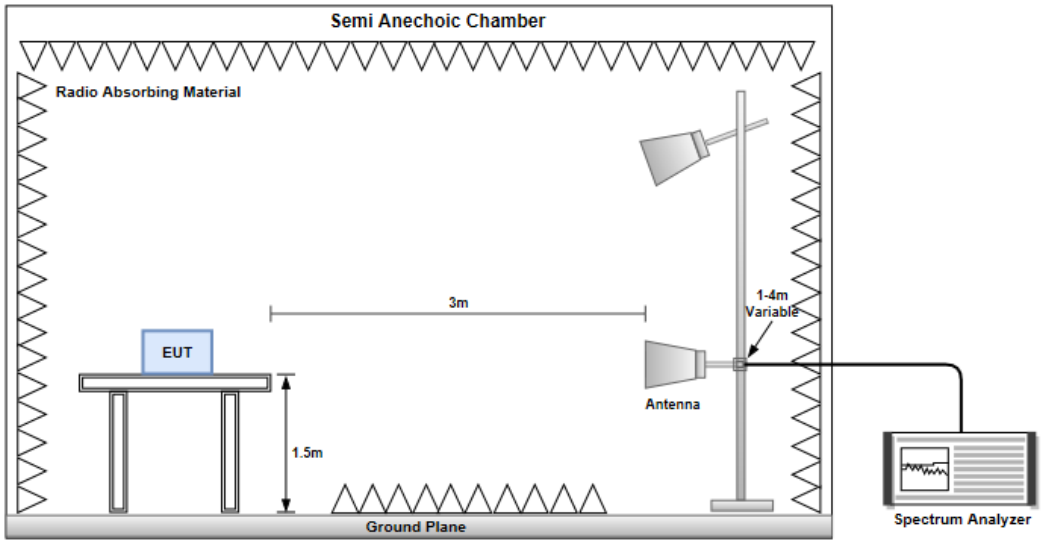
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above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

3.5.3 Test Setup

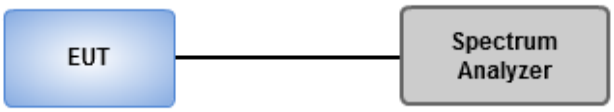
Radiated Emissions below 1 GHz



Radiated Emissions above 1 GHz

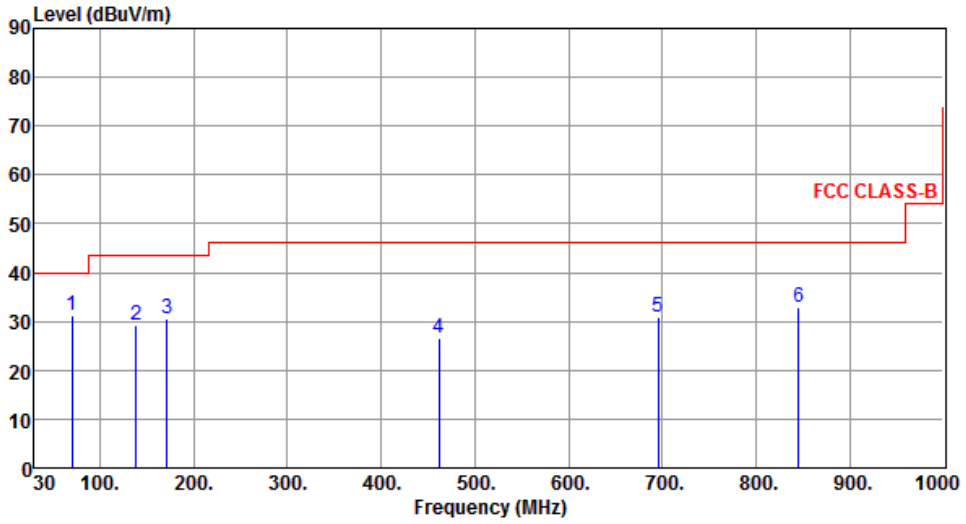


Conducted Emissions



3.5.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

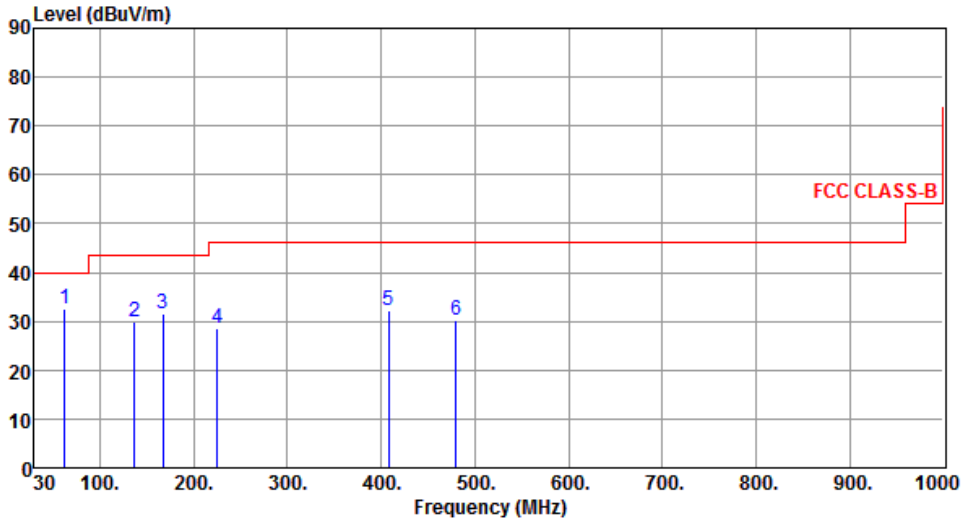
Modulation	BT LE-1Mbps	**Test Freq. (MHz)**	2480
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	69.77	31.10	40.00	-8.90	41.76	-10.66	Peak	---	---
2	138.64	29.25	43.50	-14.25	37.98	-8.73	Peak	---	---
3	171.62	30.42	43.50	-13.08	39.16	-8.74	Peak	---	---
4	461.65	26.65	46.00	-19.35	30.22	-3.57	Peak	---	---
5	695.42	30.79	46.00	-15.21	30.11	0.68	Peak	---	---
6	845.77	32.95	46.00	-13.05	29.80	3.15	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.

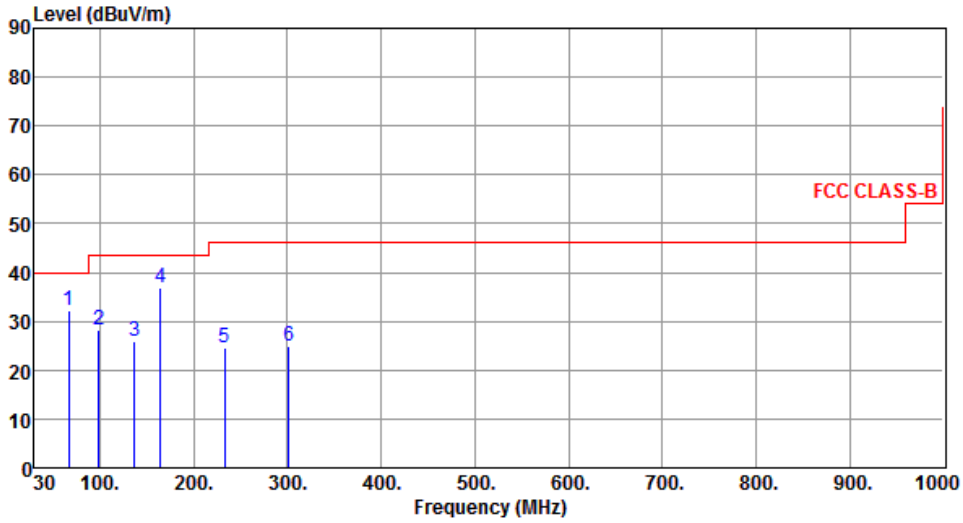
Modulation	BT LE-1Mbps	Test Freq. (MHz)	2480
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	62.01	32.45	40.00	-7.55	41.34	-8.89	Peak	---	---
2	136.70	29.92	43.50	-13.58	38.84	-8.92	Peak	---	---
3	166.77	31.41	43.50	-12.09	39.85	-8.44	Peak	---	---
4	224.97	28.54	46.00	-17.46	39.06	-10.52	Peak	---	---
5	408.30	32.10	46.00	-13.90	36.85	-4.75	Peak	---	---
6	480.08	30.31	46.00	-15.69	33.53	-3.22	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.

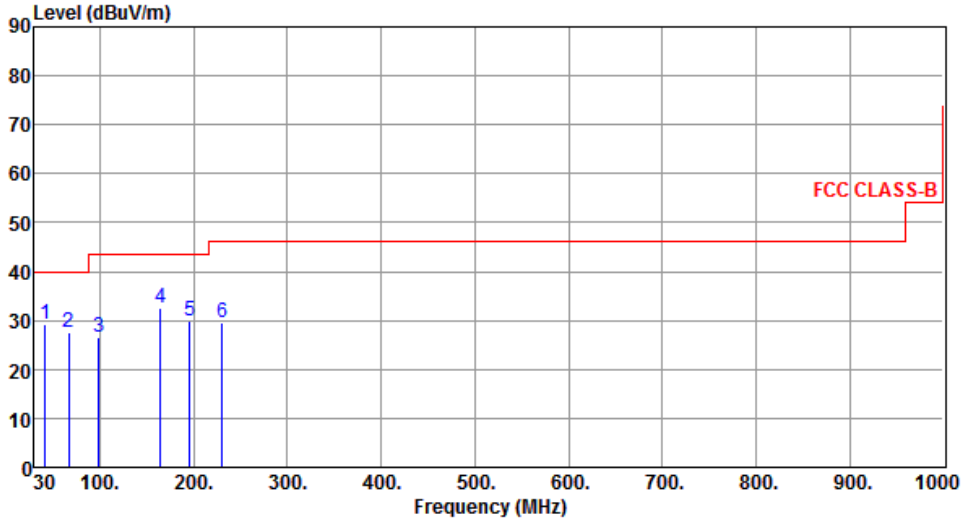
Modulation	BT LE-2Mbps	Test Freq. (MHz)	2480
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	66.86	32.33	40.00	-7.67	42.33	-10.00	Peak	---	---
2	98.87	28.34	43.50	-15.16	41.48	-13.14	Peak	---	---
3	136.70	25.87	43.50	-17.63	34.79	-8.92	Peak	---	---
4	164.83	36.97	43.50	-6.53	45.34	-8.37	Peak	---	---
5	232.73	24.50	46.00	-21.50	34.60	-10.10	Peak	---	---
6	301.60	24.77	46.00	-21.23	32.37	-7.60	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)	2480
Polarization	Vertical		

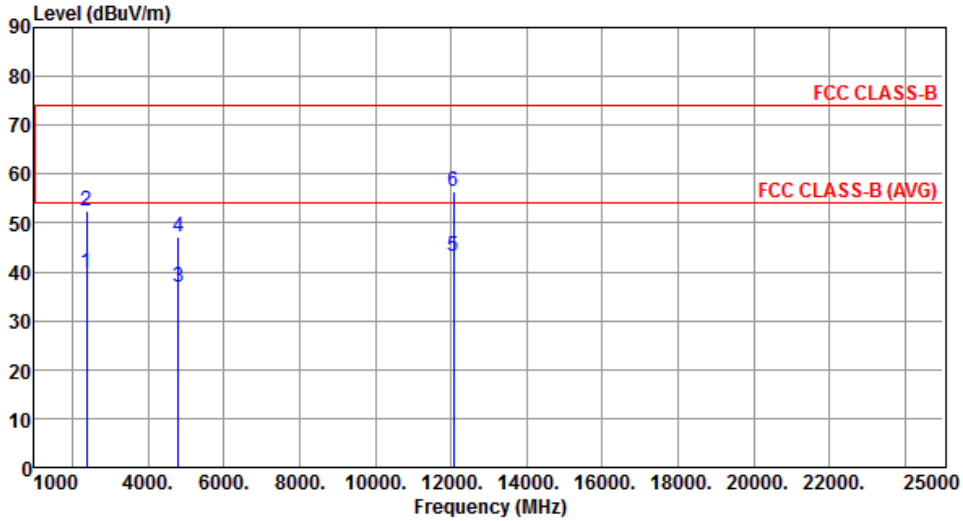


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	41.64	29.07	40.00	-10.93	37.07	-8.00	Peak	---	---
2	66.86	27.57	40.00	-12.43	37.57	-10.00	Peak	---	---
3	98.87	26.55	43.50	-16.95	39.69	-13.14	Peak	---	---
4	164.83	32.57	43.50	-10.93	40.94	-8.37	Peak	---	---
5	195.87	29.92	43.50	-13.58	40.65	-10.73	Peak	---	---
6	230.79	29.52	46.00	-16.48	39.73	-10.21	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)

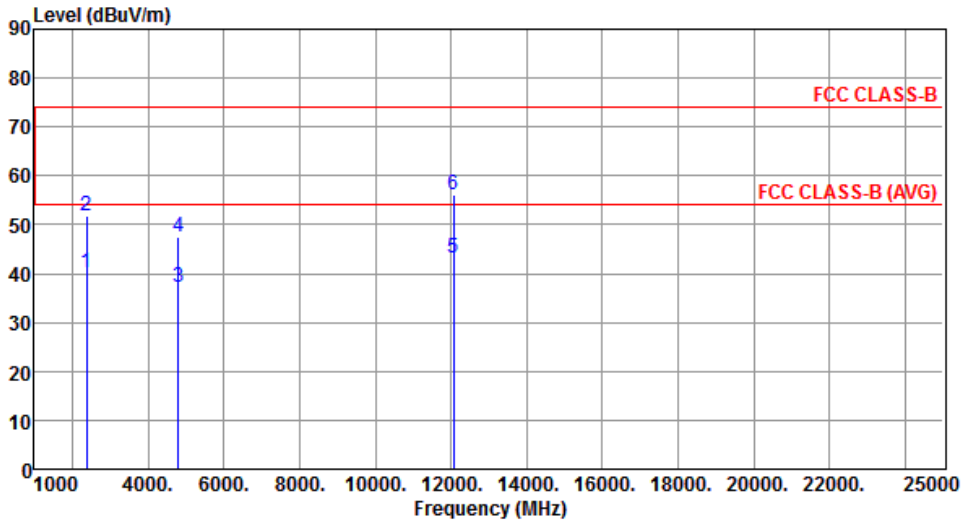
Modulation	BT LE-1Mbps	**Test Freq. (MHz)**	2402
Polarization	Horizontal		



	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	39.71	54.00	-14.29	43.31	-3.60	Average	263	180
2	2390.00	52.56	74.00	-21.44	56.16	-3.60	Peak	263	180
3	4804.00	37.01	54.00	-16.99	33.47	3.54	Average	296	309
4	4804.00	47.23	74.00	-26.77	43.69	3.54	Peak	296	309
5	12060.00	43.33	54.00	-10.67	30.19	13.14	Average	100	175
6	12060.00	56.48	74.00	-17.52	43.34	13.14	Peak	100	175

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).

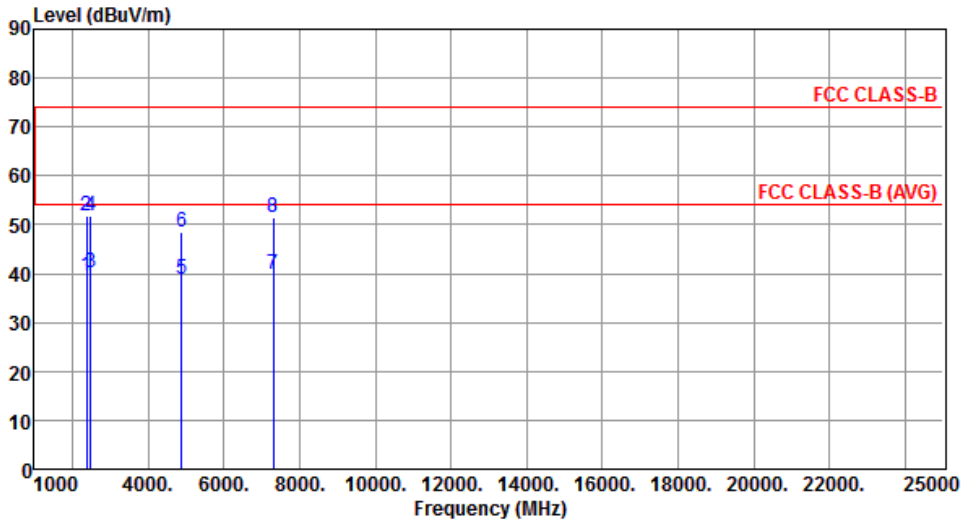
Modulation	BT LE-1Mbps	Test Freq. (MHz)	2402
Polarization	Vertical		



	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	40.04	54.00	-13.96	43.64	-3.60	Average	125	256
2	2390.00	51.91	74.00	-22.09	55.51	-3.60	Peak	125	256
3	4804.00	37.29	54.00	-16.71	33.75	3.54	Average	227	321
4	4804.00	47.59	74.00	-26.41	44.05	3.54	Peak	227	321
5	12060.00	43.15	54.00	-10.85	30.01	13.14	Average	100	255
6	12060.00	56.01	74.00	-17.99	42.87	13.14	Peak	100	255

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).

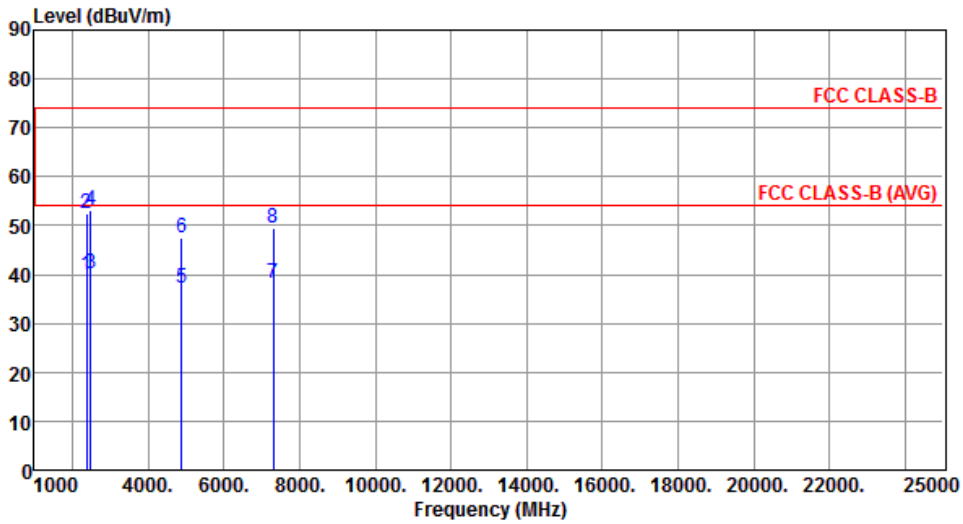
Modulation	BT LE-1Mbps	Test Freq. (MHz)	2440
Polarization	Horizontal		



	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	39.63	54.00	-14.37	43.23	-3.60	Average	259	177
2	2390.00	51.88	74.00	-22.12	55.48	-3.60	Peak	259	177
3	2483.50	40.02	54.00	-13.98	43.21	-3.19	Average	259	177
4	2483.50	51.73	74.00	-22.27	54.92	-3.19	Peak	259	177
5	4880.00	39.00	54.00	-15.00	35.22	3.78	Average	307	301
6	4880.00	48.56	74.00	-25.44	44.78	3.78	Peak	307	301
7	7320.00	39.92	54.00	-14.08	31.78	8.14	Average	100	64
8	7320.00	51.37	74.00	-22.63	43.23	8.14	Peak	100	64

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).

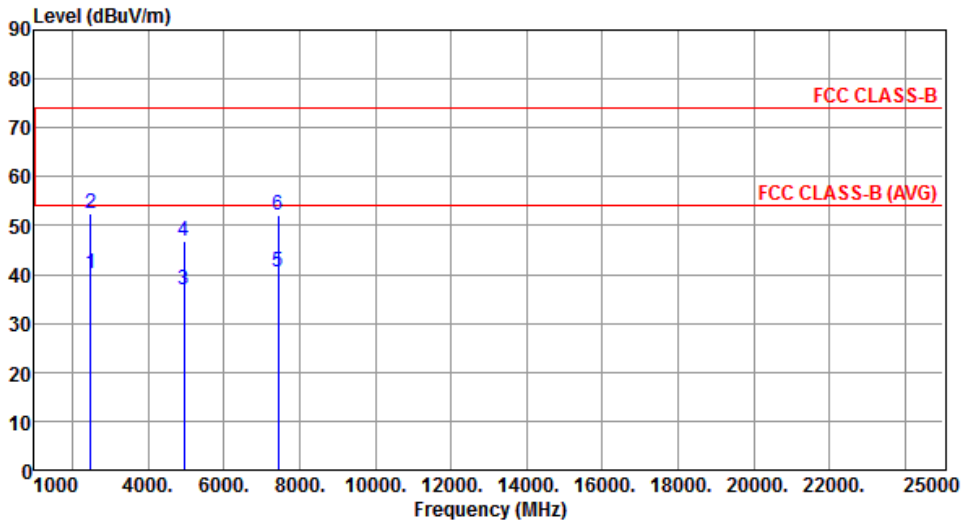
Modulation	BT LE-1Mbps	Test Freq. (MHz)	2440
Polarization	Vertical		



	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	39.85	54.00	-14.15	43.45	-3.60	Average	110	269
2	2390.00	52.34	74.00	-21.66	55.94	-3.60	Peak	110	269
3	2483.50	40.15	54.00	-13.85	43.34	-3.19	Average	110	269
4	2483.50	53.10	74.00	-20.90	56.29	-3.19	Peak	110	269
5	4880.00	37.20	54.00	-16.80	33.42	3.78	Average	229	312
6	4880.00	47.44	74.00	-26.56	43.66	3.78	Peak	229	312
7	7320.00	38.35	54.00	-15.65	30.21	8.14	Average	100	230
8	7320.00	49.54	74.00	-24.46	41.40	8.14	Peak	100	230

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).

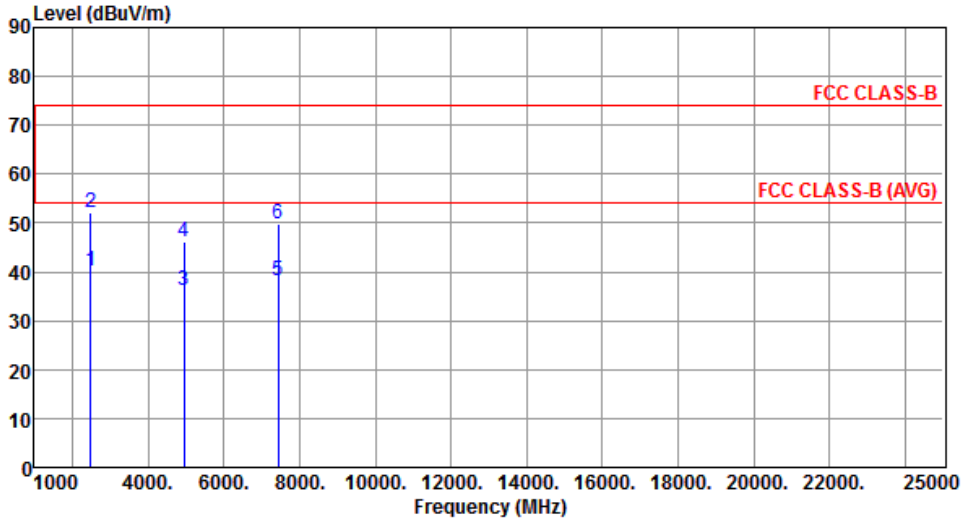
Modulation	BT LE-1Mbps	Test Freq. (MHz)	2480
Polarization	Horizontal		



	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	40.02	54.00	-13.98	43.21	-3.19	Average	252	173
2	2483.50	52.49	74.00	-21.51	55.68	-3.19	Peak	252	173
3	4960.00	36.92	54.00	-17.08	32.89	4.03	Average	301	299
4	4960.00	46.84	74.00	-27.16	42.81	4.03	Peak	301	299
5	7440.00	40.42	54.00	-13.58	32.11	8.31	Average	100	62
6	7440.00	52.08	74.00	-21.92	43.77	8.31	Peak	100	62

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).

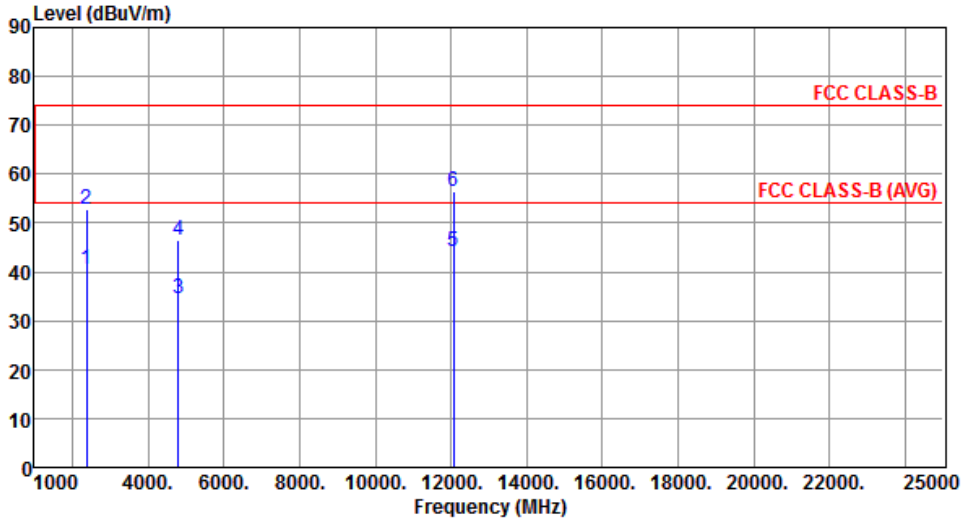
Modulation	BT LE-1Mbps	Test Freq. (MHz)	2480
Polarization	Vertical		



	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	40.11	54.00	-13.89	43.30	-3.19	Average	116	268
2	2483.50	52.13	74.00	-21.87	55.32	-3.19	Peak	116	268
3	4960.00	36.24	54.00	-17.76	32.21	4.03	Average	225	314
4	4960.00	46.20	74.00	-27.80	42.17	4.03	Peak	225	314
5	7440.00	38.31	54.00	-15.69	30.00	8.31	Average	100	235
6	7440.00	49.90	74.00	-24.10	41.59	8.31	Peak	100	235

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).

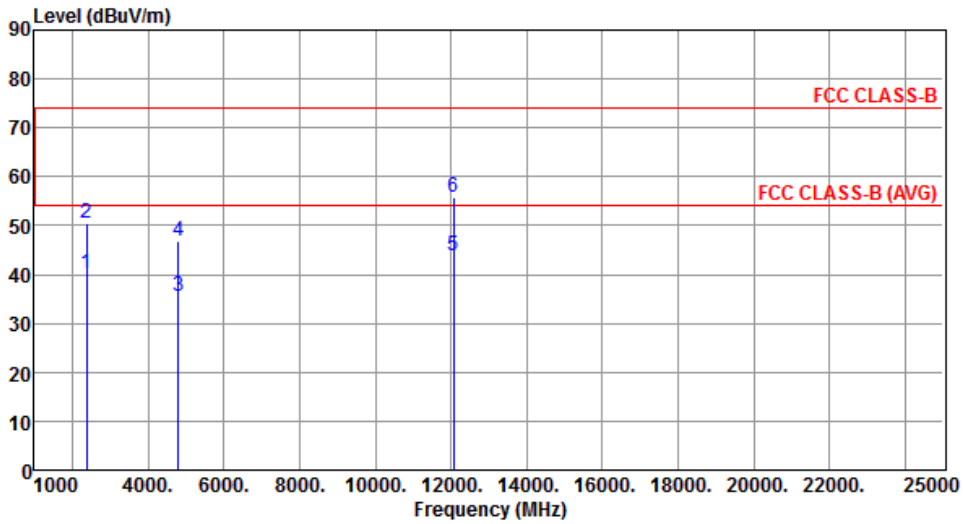
Modulation	BT LE-2Mbps	Test Freq. (MHz)	2402
Polarization	Horizontal		



	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	40.66	54.00	-13.34	44.26	-3.60	Average	255	166
2	2390.00	52.80	74.00	-21.20	56.40	-3.60	Peak	255	166
3	4804.00	34.61	54.00	-19.39	31.07	3.54	Average	288	301
4	4804.00	46.54	74.00	-27.46	43.00	3.54	Peak	288	301
5	12060.00	44.09	54.00	-9.91	30.95	13.14	Average	100	170
6	12060.00	56.34	74.00	-17.66	43.20	13.14	Peak	100	170

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).

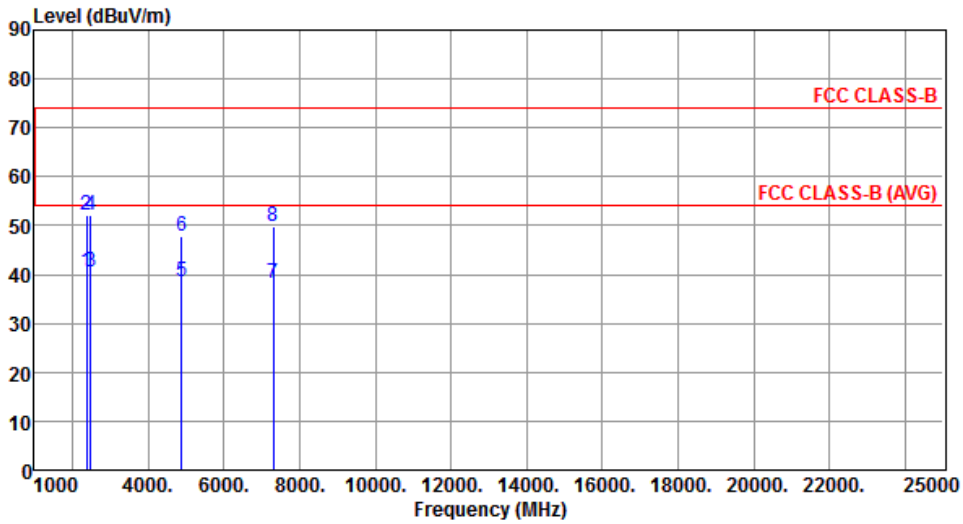
Modulation	BT LE-2Mbps	Test Freq. (MHz)	2402
Polarization	Vertical		



	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	40.34	54.00	-13.66	43.94	-3.60	Average	119	260
2	2390.00	50.63	74.00	-23.37	54.23	-3.60	Peak	119	260
3	4804.00	35.42	54.00	-18.58	31.88	3.54	Average	200	325
4	4804.00	46.74	74.00	-27.26	43.20	3.54	Peak	200	325
5	12060.00	43.84	54.00	-10.16	30.70	13.14	Average	100	258
6	12060.00	55.91	74.00	-18.09	42.77	13.14	Peak	100	258

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).

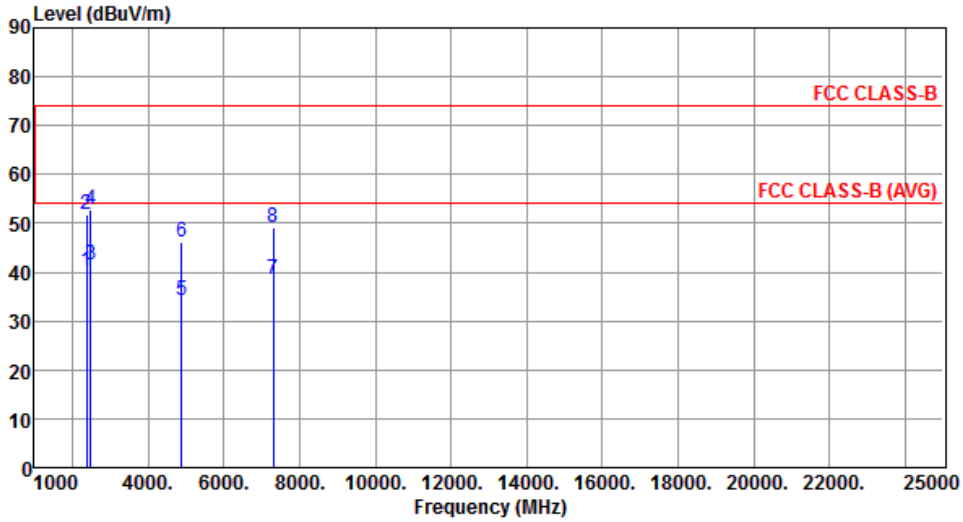
Modulation	BT LE-2Mbps	Test Freq. (MHz)	2440
Polarization	Horizontal		



	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	40.60	54.00	-13.40	44.20	-3.60	Average	258	176
2	2390.00	52.05	74.00	-21.95	55.65	-3.60	Peak	258	176
3	2483.50	40.64	54.00	-13.36	43.83	-3.19	Average	258	176
4	2483.50	52.16	74.00	-21.84	55.35	-3.19	Peak	258	176
5	4880.00	38.44	54.00	-15.56	34.66	3.78	Average	302	306
6	4880.00	47.74	74.00	-26.26	43.96	3.78	Peak	302	306
7	7320.00	38.30	54.00	-15.70	30.16	8.14	Average	100	34
8	7320.00	49.84	74.00	-24.16	41.70	8.14	Peak	100	34

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).

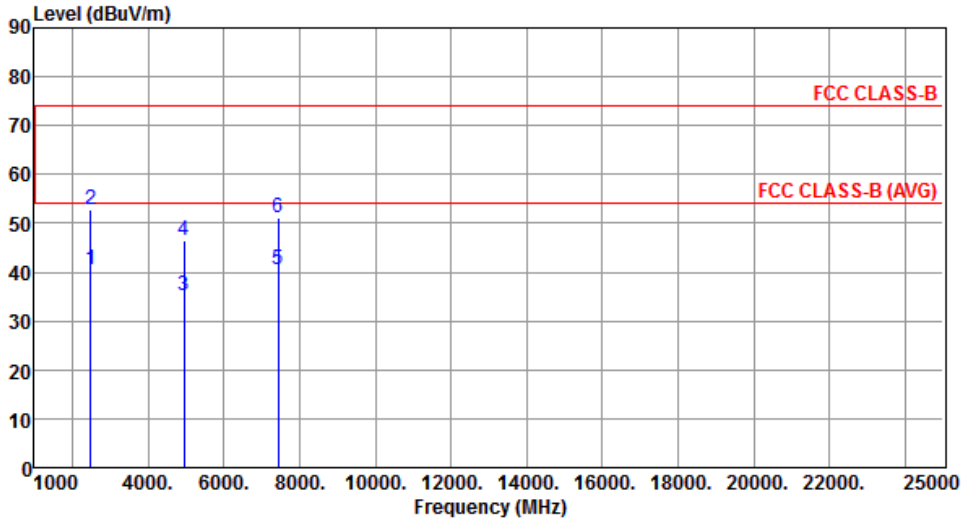
Modulation	BT LE-2Mbps	Test Freq. (MHz)	2440
Polarization	Vertical		



	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	40.26	54.00	-13.74	43.86	-3.60	Average	100	255
2	2390.00	51.94	74.00	-22.06	55.54	-3.60	Peak	100	255
3	2483.50	41.37	54.00	-12.63	44.56	-3.19	Average	100	255
4	2483.50	52.69	74.00	-21.31	55.88	-3.19	Peak	100	255
5	4880.00	34.09	54.00	-19.91	30.31	3.78	Average	100	308
6	4880.00	46.04	74.00	-27.96	42.26	3.78	Peak	100	308
7	7320.00	38.52	54.00	-15.48	30.38	8.14	Average	100	244
8	7320.00	49.26	74.00	-24.74	41.12	8.14	Peak	100	244

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).

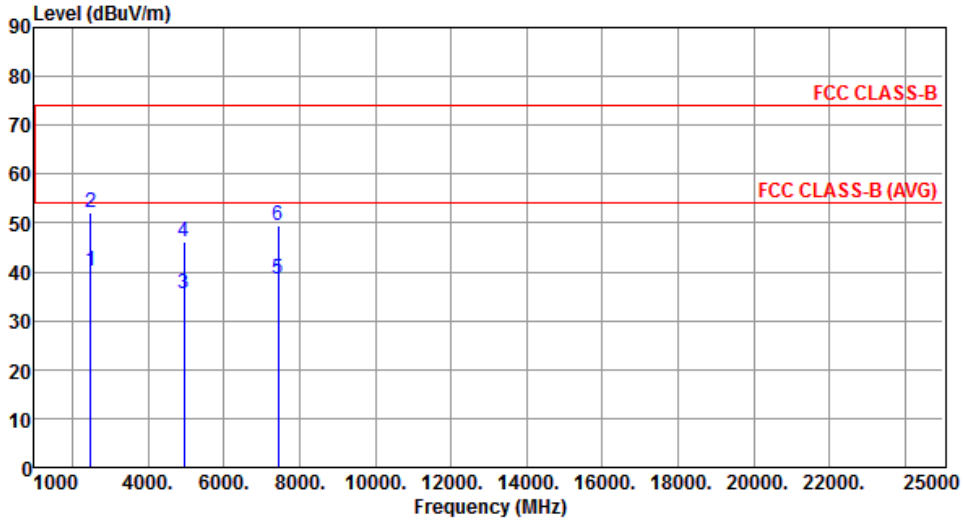
Modulation	BT LE-2Mbps	Test Freq. (MHz)	2480
Polarization	Horizontal		



	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	40.68	54.00	-13.32	43.87	-3.19	Average	250	177
2	2483.50	52.80	74.00	-21.20	55.99	-3.19	Peak	250	177
3	4960.00	35.10	54.00	-18.90	31.07	4.03	Average	298	300
4	4960.00	46.53	74.00	-27.47	42.50	4.03	Peak	298	300
5	7440.00	40.41	54.00	-13.59	32.10	8.31	Average	100	65
6	7440.00	51.29	74.00	-22.71	42.98	8.31	Peak	100	65

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	40.28	54.00	-13.72	43.47	-3.19	Average	120	272
2	2483.50	52.04	74.00	-21.96	55.23	-3.19	Peak	120	272
3	4960.00	35.55	54.00	-18.45	31.52	4.03	Average	260	307
4	4960.00	46.02	74.00	-27.98	41.99	4.03	Peak	260	307
5	7440.00	38.53	54.00	-15.47	30.22	8.31	Average	100	240
6	7440.00	49.60	74.00	-24.40	41.29	8.31	Peak	100	240

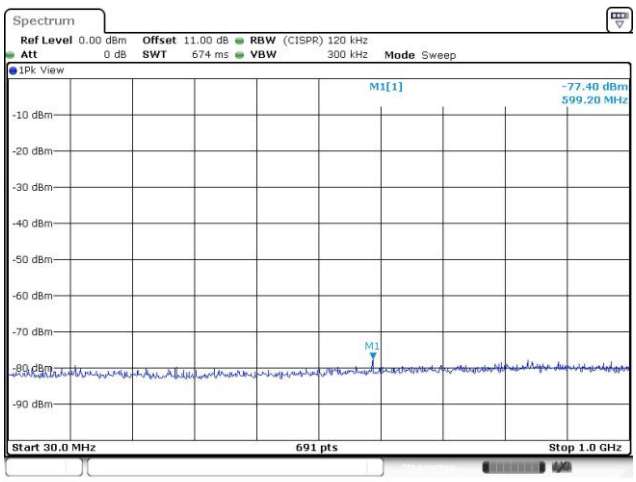
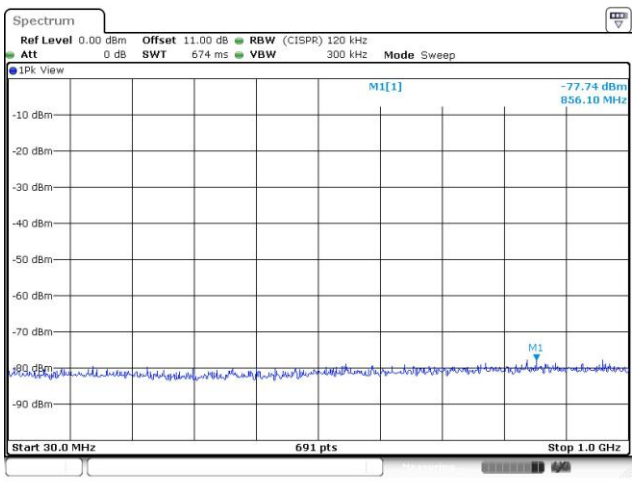
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

3.5.6 Transmitter Conducted Unwanted Emissions (Below 1 GHz)

Modulation Mode		BT LE-1Mbps		Frequency	2402MHz	
Range (MHz)	**Max Value chain0 (dBm)**	**DG (dBi)**	**GRF (dB)**	**EIRP (dBm)**	**Min E-Field Limit (dBm)**	**E-Field Margin (dB)**
30~1000MHz	-77.40	2.00	4.70	-70.70	-55.20	-15.50

Modulation Mode		BT LE-2Mbps		Frequency	2402MHz	
Range (MHz)	**Max Value chain0 (dBm)**	**DG (dBi)**	**GRF (dB)**	**EIRP (dBm)**	**Min E-Field Limit (dBm)**	**E-Field Margin (dB)**
30~1000MHz	-77.74	2.00	4.70	-71.04	-55.20	-15.84

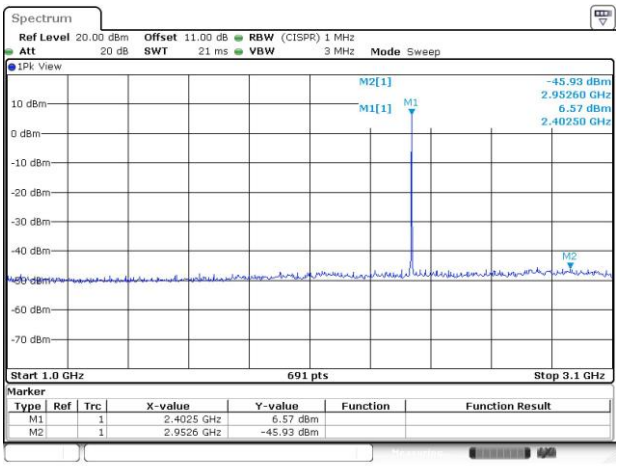
Note:
1. GRF = Ground Reflection Factor.
2. DG = Directional Gain.
3. Worst case of emission limit below 1GHz is selected to be limit.

BT LE-1Mbps	BT LE-2Mbps
	

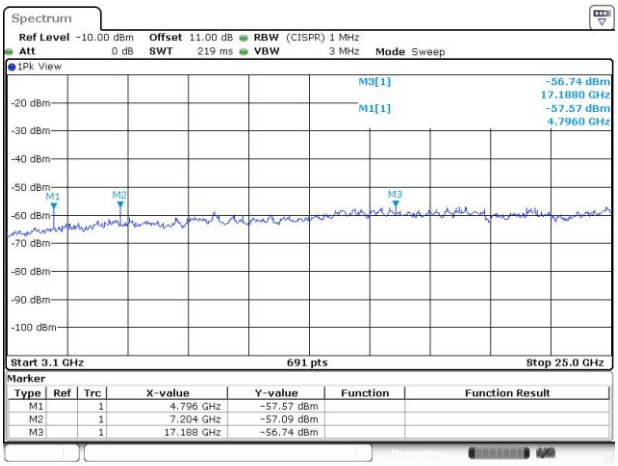
3.5.7 Transmitter Conducted Unwanted Emissions (Above 1GHz)

BT LE-1Mbps - Full Range Scan Test Plot

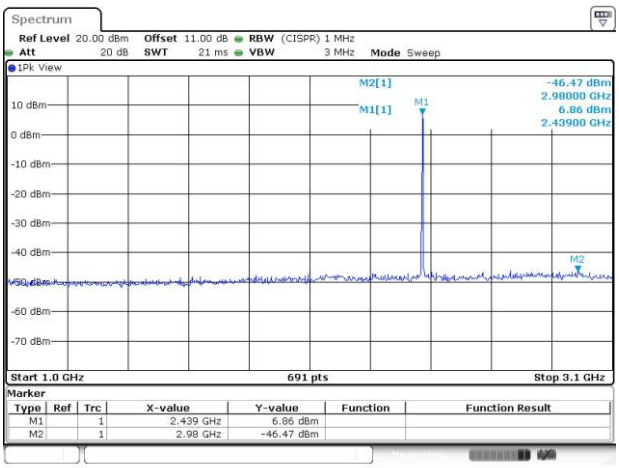
2402MHz



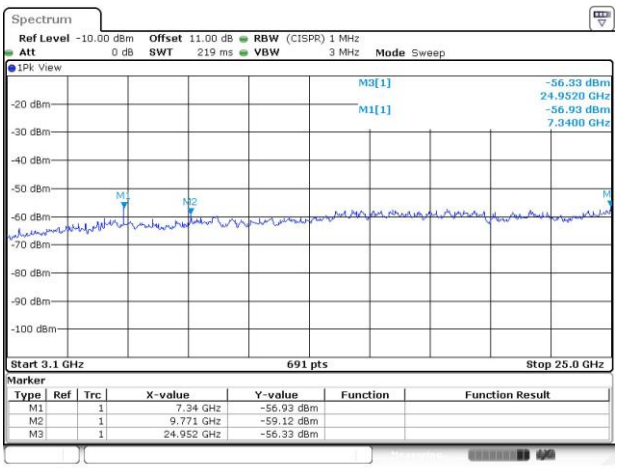
2402MHz



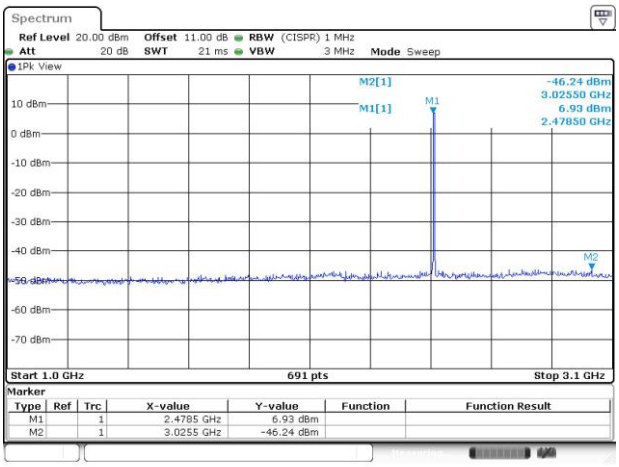
2440MHz



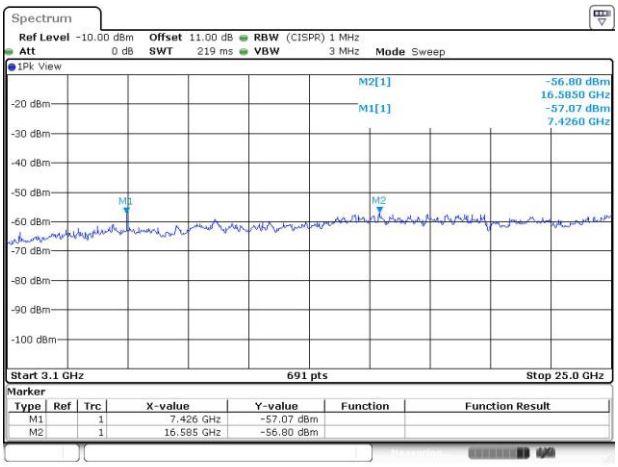
2440MHz



2480MHz

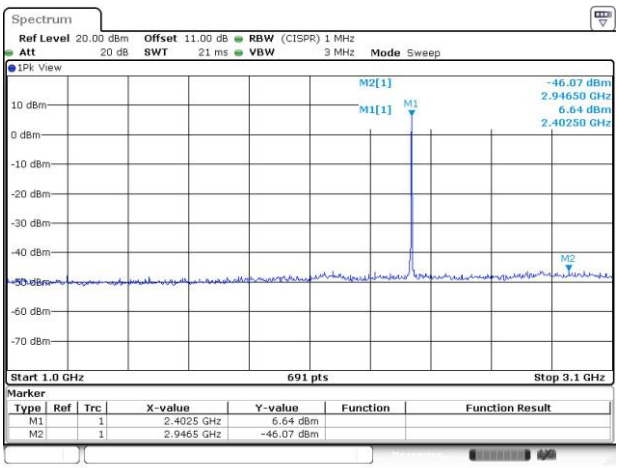


2480MHz

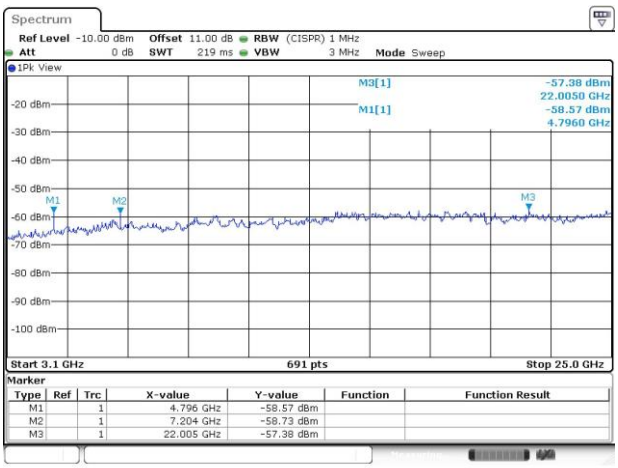


BT LE-2Mbps - Full Range Scan Test Plot

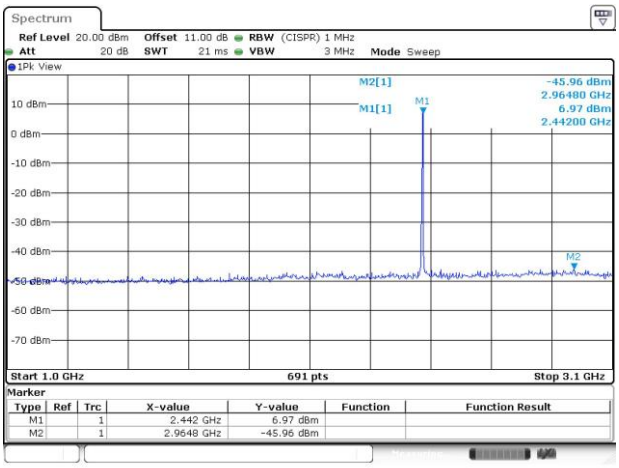
2402MHz



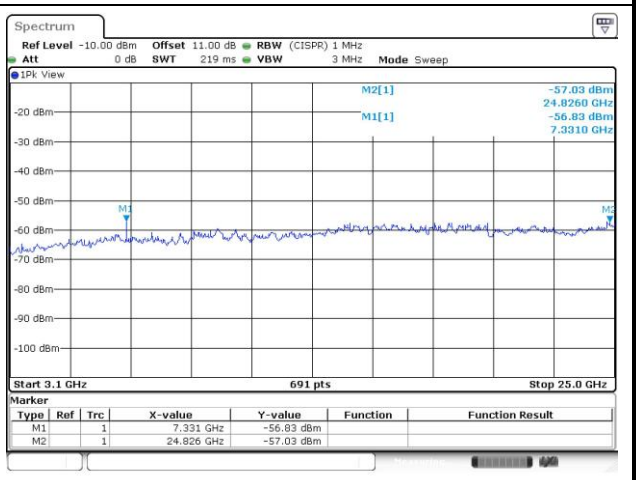
2402MHz



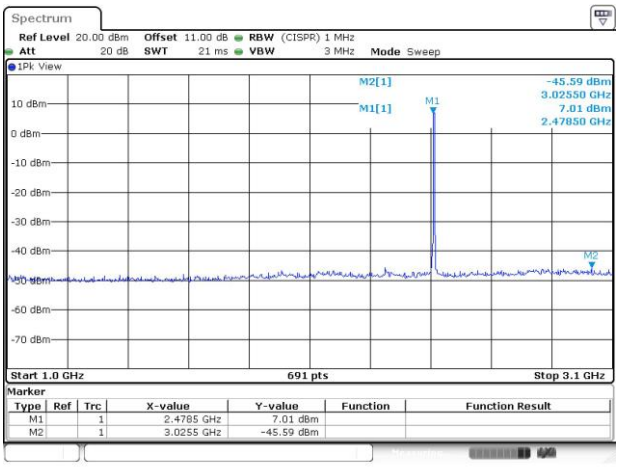
2440MHz



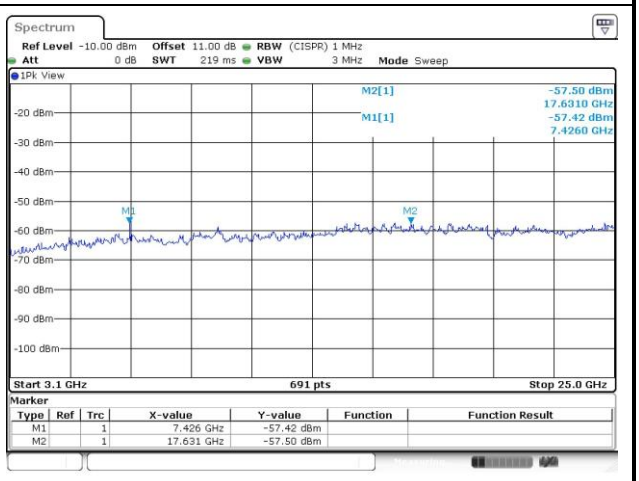
2440MHz



2480MHz



2480MHz

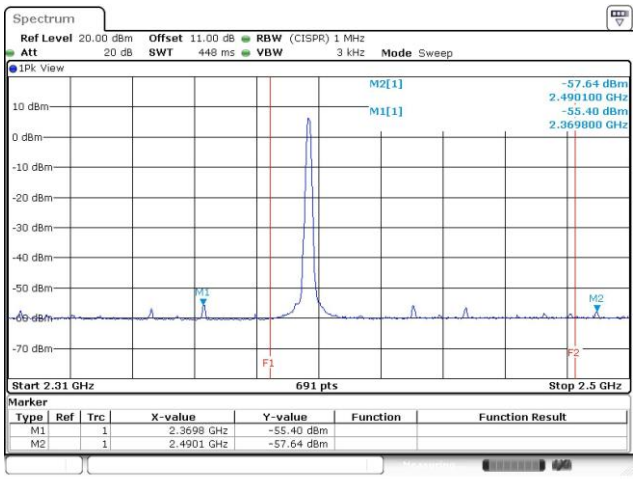


Transmitter Conducted Unwanted Emissions Results in Band Edge							
Modulation Mode		BT LE-1Mbps					
Test ch. Freq. (MHz)	**Range (MHz)**	**Max Value chain0 (dBm)**	**DG (dBi)**	**EIRP (dBm)**	**E-Field Limit (dBm)**	**E-Field Margin (dB)**	**Remark**
2402	2310~2390	-46.76	2.00	-44.76	-21.20	-23.56	PK
	2310~2390	-55.40	2.00	-53.40	-41.20	-12.20	AV
	2483.5~2500	-46.34	2.00	-44.34	-21.20	-23.14	PK
	2483.5~2500	-57.64	2.00	-55.64	-41.20	-14.44	AV
2440	2310~2390	-47.12	2.00	-45.12	-21.20	-23.92	PK
	2310~2390	-57.21	2.00	-55.21	-41.20	-14.01	AV
	2483.5~2500	-47.15	2.00	-45.15	-21.20	-23.95	PK
	2483.5~2500	-56.90	2.00	-54.90	-41.20	-13.70	AV
2480	2310~2390	-46.55	2.00	-44.55	-21.20	-23.35	PK
	2310~2390	-56.93	2.00	-54.93	-41.20	-13.73	AV
	2485.5~2500	-36.05	2.00	-34.05	-21.20	-12.85	PK
	2483.5~2500	-54.75	2.00	-52.75	-41.20	-11.55	AV

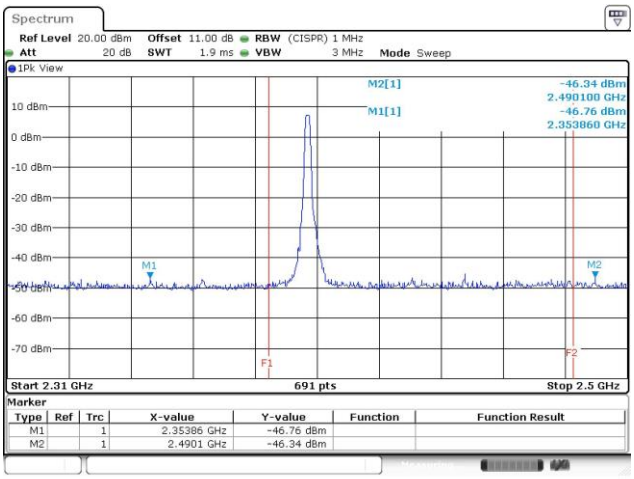
Note: DG = Directional Gain.

Band Edge Test Plot

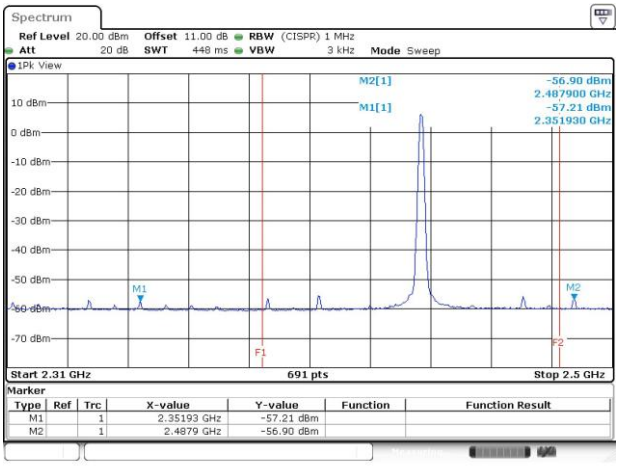
2402MHz - AV



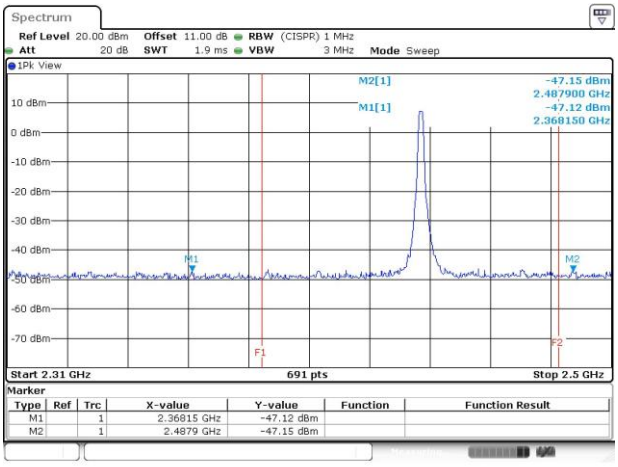
2402MHz - PK



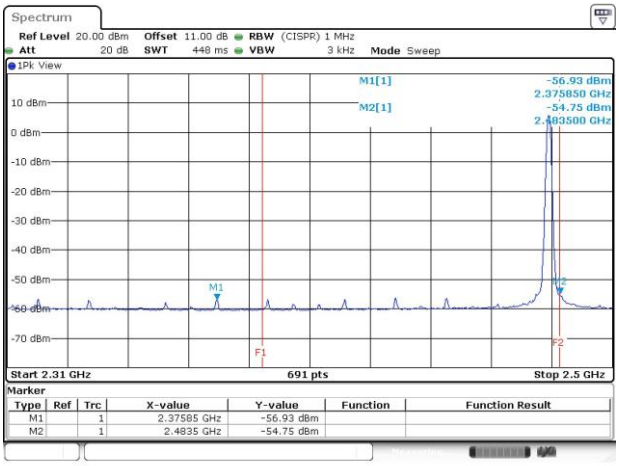
2440MHz - AV



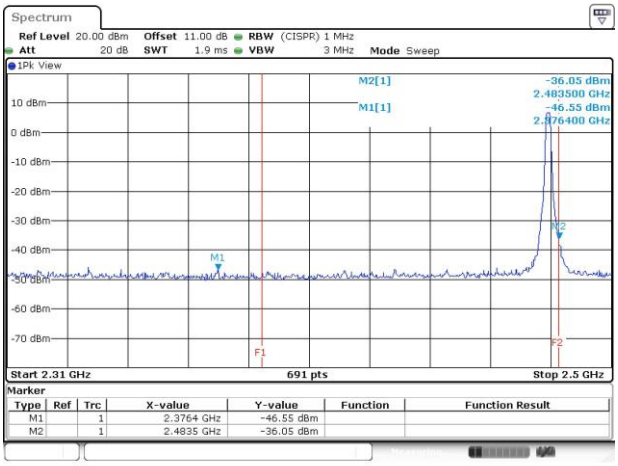
2440MHz - PK



2480MHz - AV



2480MHz - PK

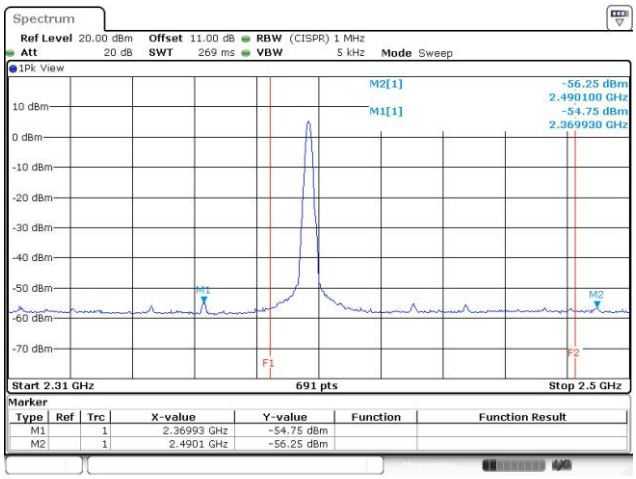


Transmitter Conducted Unwanted Emissions Results in Band Edge							
Modulation Mode		BT LE-2Mbps					
Test ch. Freq. (MHz)	**Range (MHz)**	**Max Value chain0 (dBm)**	**DG (dBi)**	**EIRP (dBm)**	**E-Field Limit (dBm)**	**E-Field Margin (dB)**	**Remark**
2402	2310~2390	-46.91	2.00	-44.91	-21.20	-23.71	PK
	2310~2390	-54.75	2.00	-52.75	-41.20	-11.55	AV
	2483.5~2500	-46.82	2.00	-44.82	-21.20	-23.62	PK
	2483.5~2500	-56.25	2.00	-54.25	-41.20	-13.05	AV
2440	2310~2390	-46.82	2.00	-44.82	-21.20	-23.62	PK
	2310~2390	-55.81	2.00	-53.81	-41.20	-12.61	AV
	2483.5~2500	-46.72	2.00	-44.72	-21.20	-23.52	PK
	2483.5~2500	-55.79	2.00	-53.79	-41.20	-12.59	AV
2480	2310~2390	-47.18	2.00	-45.18	-21.20	-23.98	PK
	2310~2390	-56.16	2.00	-54.16	-41.20	-12.96	AV
	2485.5~2500	-36.07	2.00	-34.07	-21.20	-12.87	PK
	2483.5~2500	-48.44	2.00	-46.44	-41.20	-5.24	AV

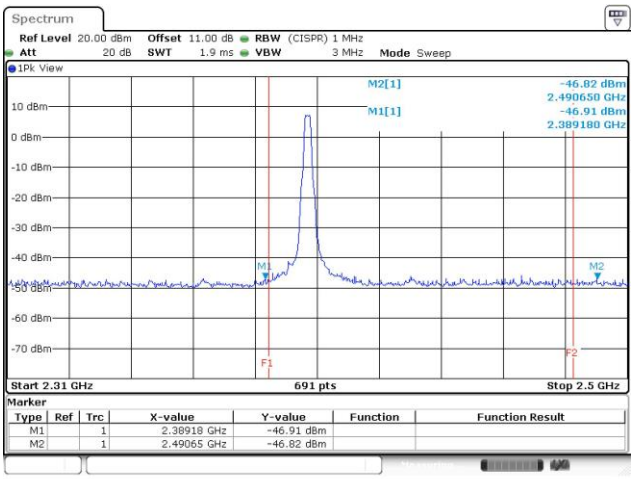
Note: DG = Directional Gain.

Band Edge Test Plot

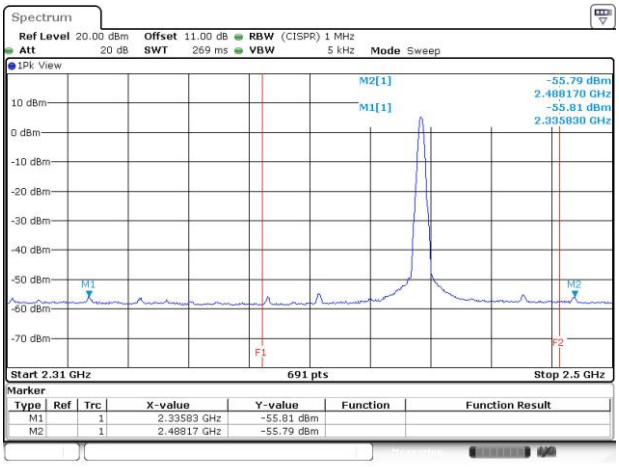
2402MHz - AV



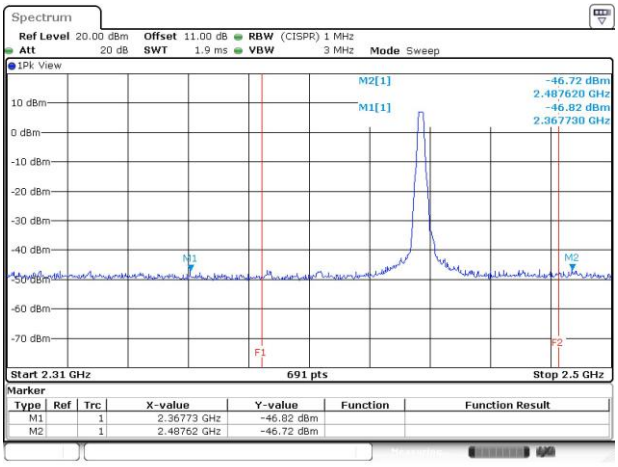
2402MHz - PK



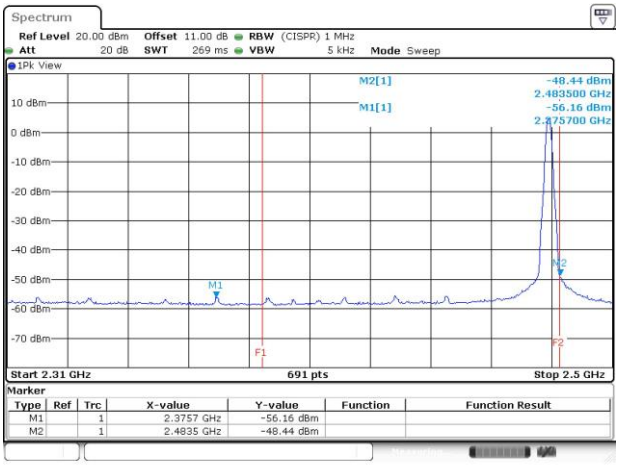
2440MHz - AV



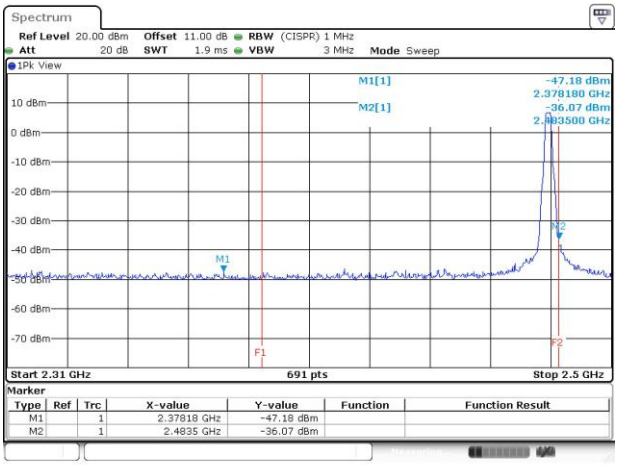
2440MHz - PK



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	-56.36	2.00	-54.36	-21.20	-33.16
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)**
7320.00	PK	-55.72	2.00	-53.72	-21.20	-32.52
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)**
7440.00	PK	-55.66	2.00	-53.66	-21.20	-32.46
7440.00	AV note1	-	2.00	-	-41.20	-

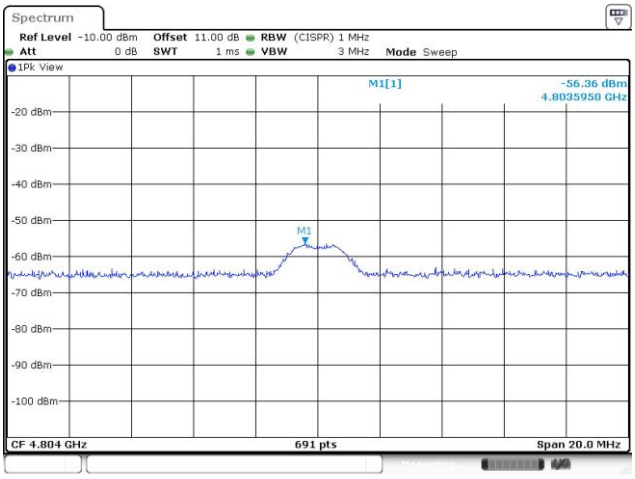
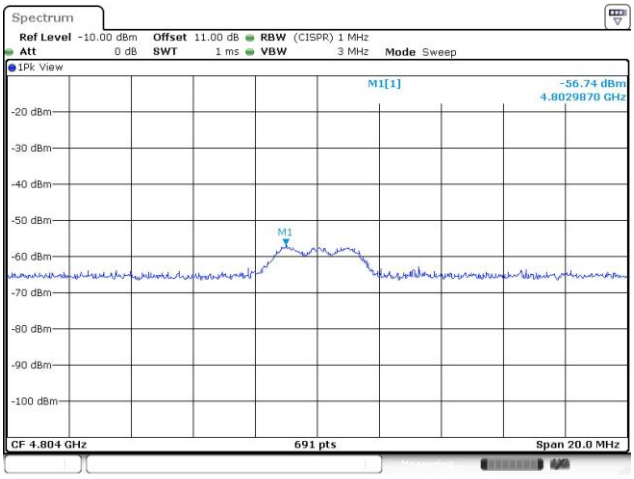
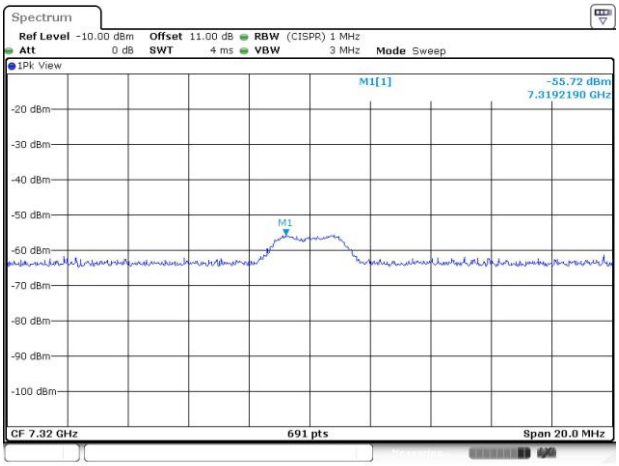
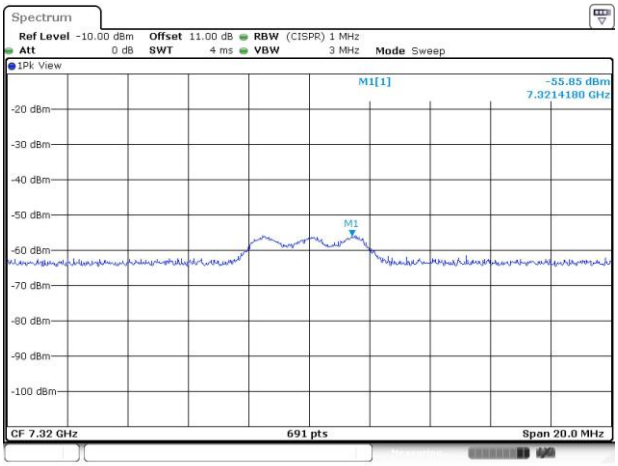
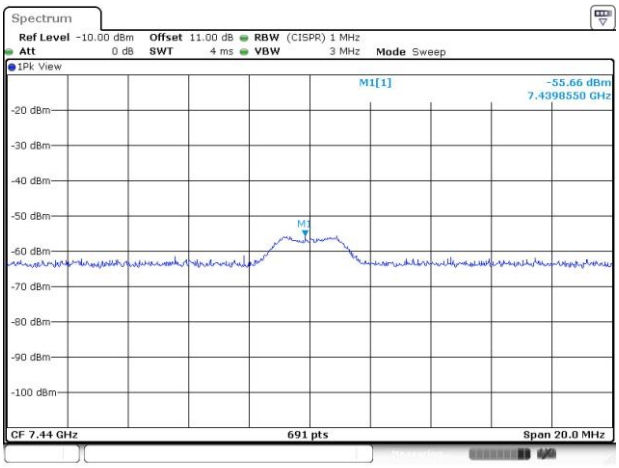
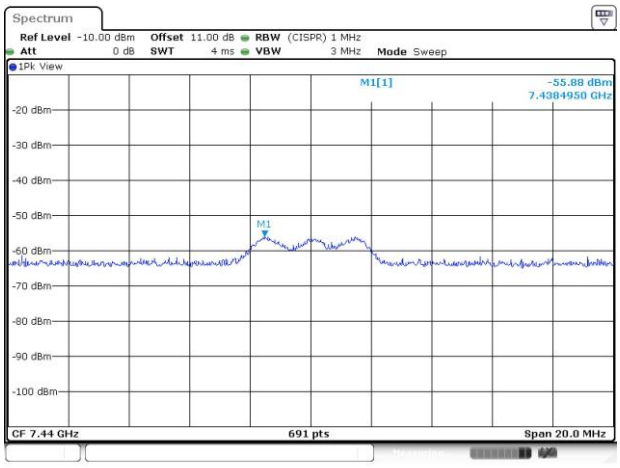
Note:
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain.

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	-56.74	2.00	-54.74	-21.20	-33.54
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)**
7320.00	PK	-55.85	2.00	-53.85	-21.20	-32.65
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)**
7440.00	PK	-55.88	2.00	-53.88	-21.20	-32.68
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 / BT LE-1Mbps	Test Plots / BT LE-2Mbps
4804MHz - PK	**4804MHz - PK**
	
7320MHz - PK	**7320MHz - PK**
	
7440MHz - PK	**7440MHz - PK**
	

3.6 Emissions in non-restricted Frequency Bands

3.6.1 Emissions in non-restricted frequency bands limit

The peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz.

3.6.2 Test Procedures

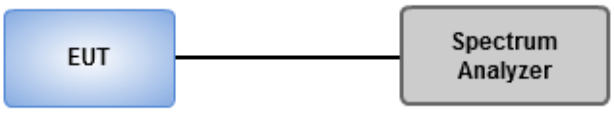
Reference Level Measurement

1. Set the RBW = 100 kHz, VBW = 300 kHz, Detector = peak.
2. Set Sweep time = auto couple, Trace mode = max hold.
3. Allow trace to fully stabilize.
4. Use the peak marker function to determine the maximum amplitude level.

Unwanted Emissions Level Measurement

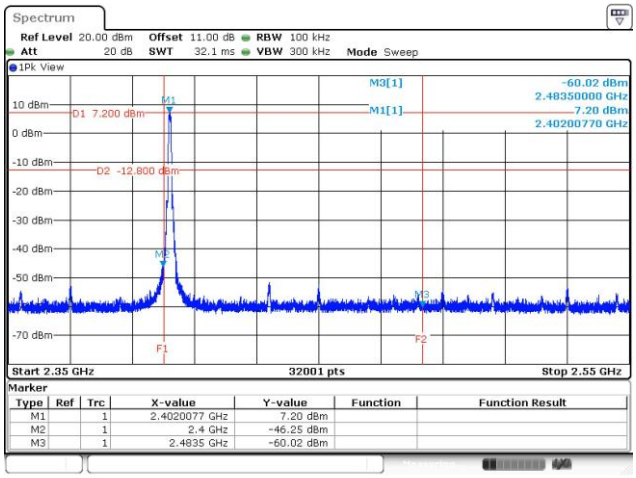
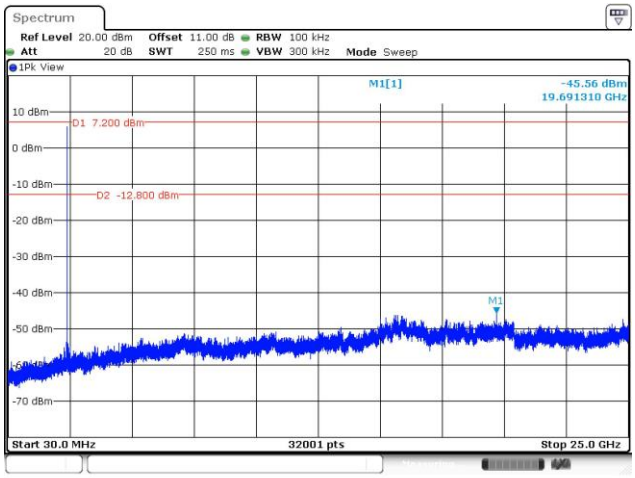
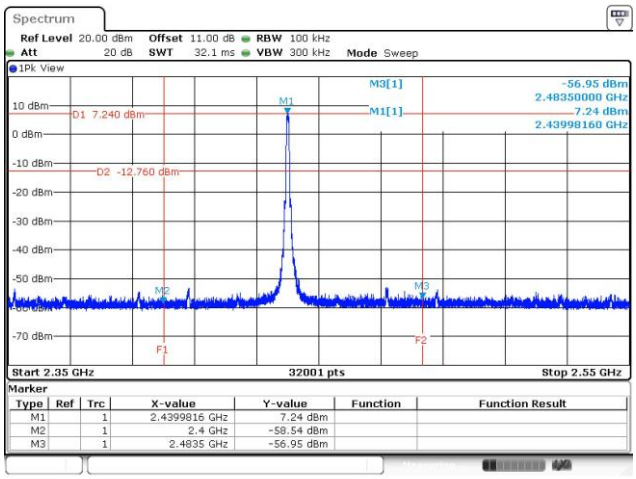
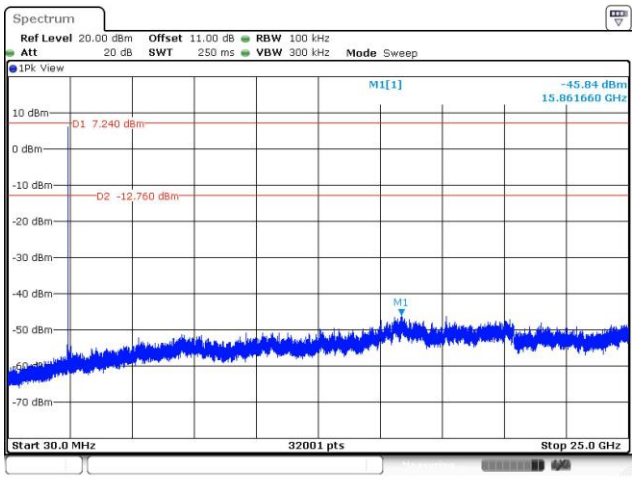
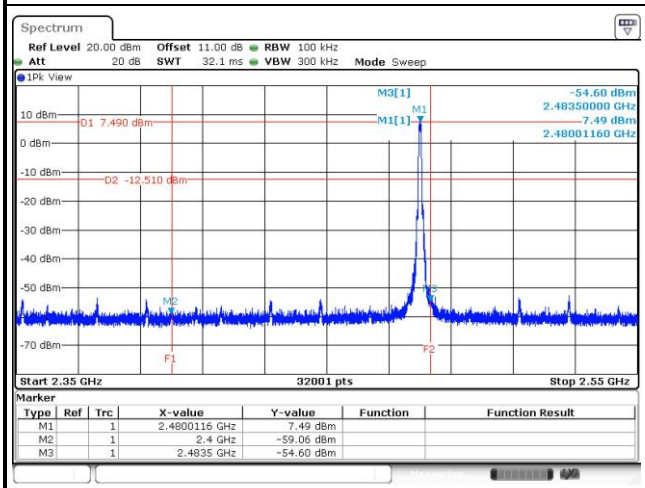
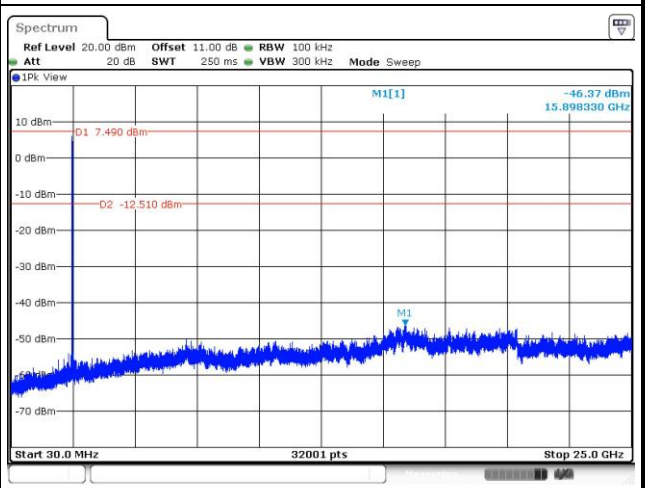
1. Set RBW = 100 kHz, VBW = 300 kHz, Detector = peak.
2. Trace Mode = max hold, Sweep = auto couple.
3. Allow the trace to stabilize.
4. Use peak marker function to determine maximum amplitude of all unwanted emissions within any 100 kHz bandwidth.

3.6.3 Test Setup

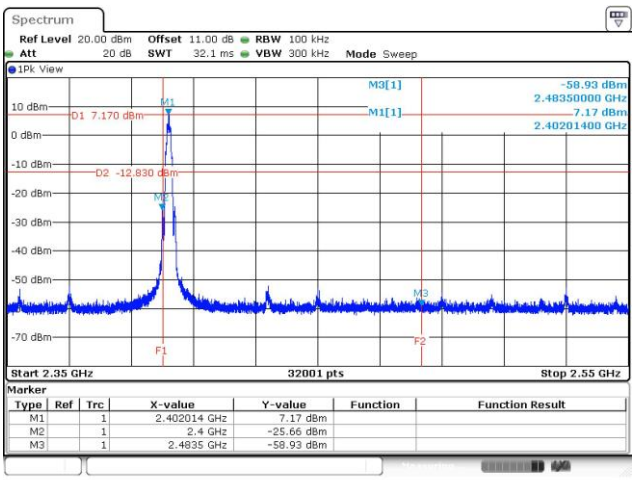
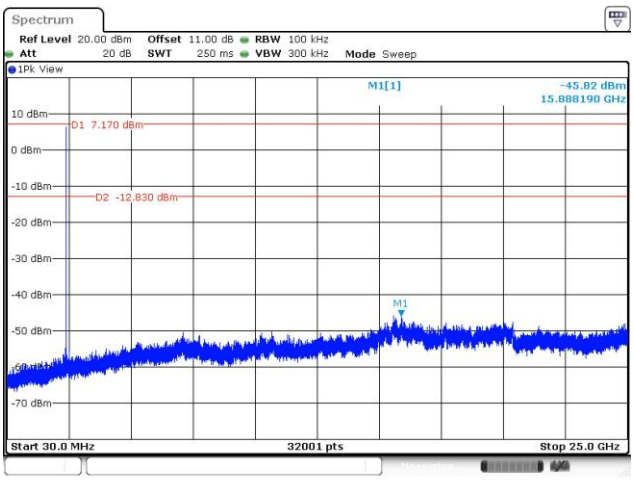
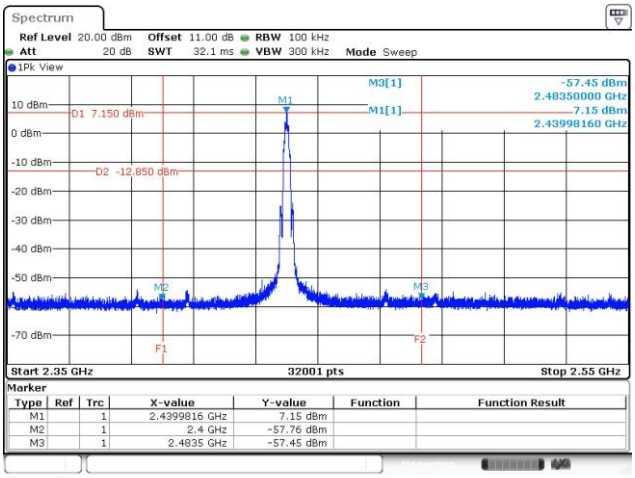
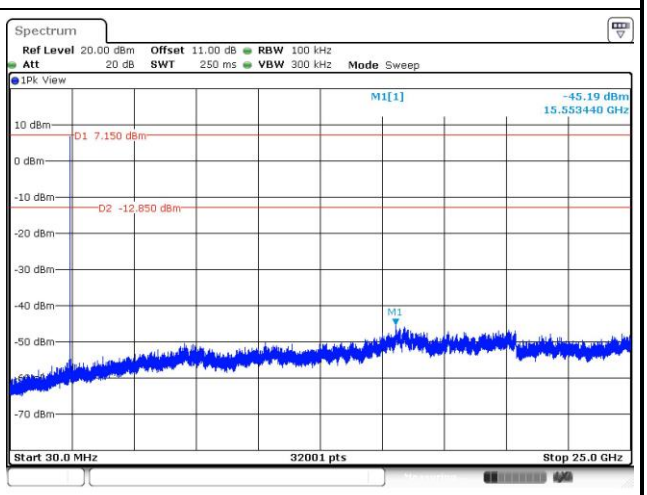
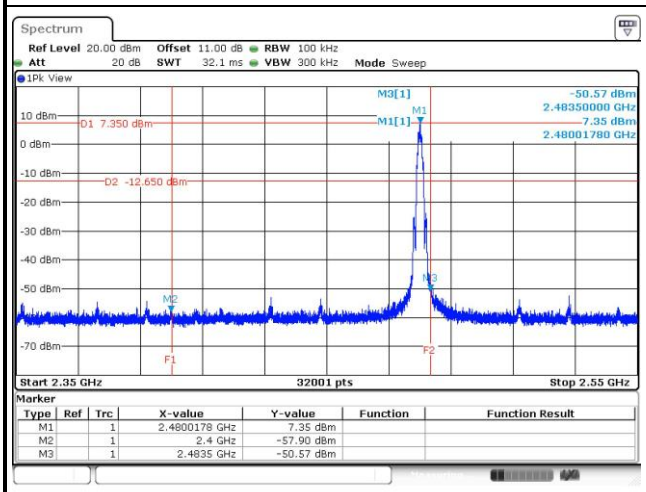
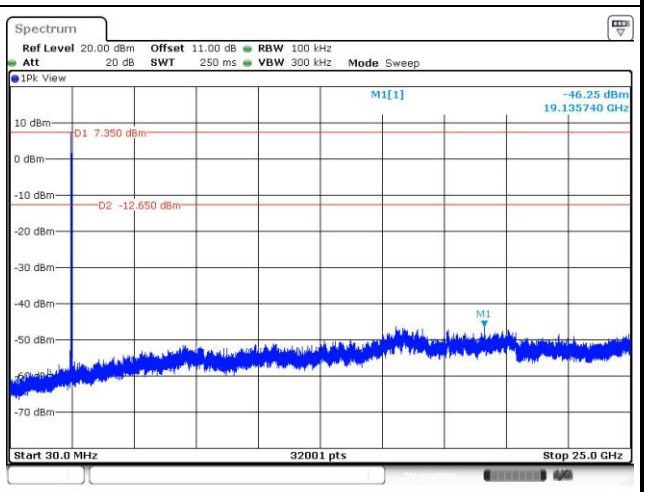


3.6.4 Test Result of Emissions in non-restricted Frequency Bands

BT LE-1Mbps

Tx 2402MHz / Reference Level	Tx 2402MHz / 30MHz~25GHz (down 20dBc)
	
Tx 2440MHz / Reference Level	**Tx 2440MHz / 30MHz~25GHz (down 20dBc)**
	
Tx 2480MHz / Reference Level	**Tx 2480MHz / 30MHz~25GHz (down 20dBc)**
	

BT LE-2Mbps

Tx 2402MHz / Reference Level	Tx 2402MHz / 30MHz~25GHz (down 20dBc)
	
Tx 2440MHz / Reference Level	**Tx 2440MHz / 30MHz~25GHz (down 20dBc)**
	
Tx 2480MHz / Reference Level	**Tx 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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