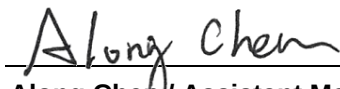


FCC Test Report

FCC ID : SQGBL654PA
Equipment : Bluetooth v5 Power Amplified Module
Model No. : BL654PA
Brand Name : Laird Connectivity
Applicant : Laird Connectivity
Address : W66N220 Commerce Court, Cedarburg,
Wisconsin 53012, USA
Standard : 47 CFR FCC Part 15.247
Received Date : Apr. 01, 2019
Tested Date : May 16 ~ May 29, 2019

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:



Along Chen / Assistant Manager

Approved by:



Gary Chang / Manager



Table of Contents

1	GENERAL DESCRIPTION	5
1.1	Information.....	5
1.2	Local Support Equipment List	8
1.3	Test Setup Chart	8
1.4	Test Equipment List and Calibration Data.....	9
1.5	Test Standards	10
1.6	Deviation from Test Standard and Measurement Procedure.....	10
1.7	Measurement Uncertainty	10
2	TEST CONFIGURATION.....	11
2.1	Testing Condition	11
2.2	The Worst Test Modes and Channel Details	12
3	TRANSMITTER TEST RESULTS	14
3.1	Conducted Emissions.....	14
3.2	6dB and Occupied Bandwidth.....	21
3.3	RF Output Power.....	30
3.4	Power Spectral Density	33
3.5	Emissions in Restricted Frequency Bands.....	42
3.6	Emissions in non-restricted Frequency Bands.....	127
4	TEST LABORATORY INFORMATION	134

Release Record

Report No.	Version	Description	Issued Date
FR940104AE	Rev. 01	Initial issue	Aug. 30, 2019

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	AC Power Line Conducted Emissions	[dBuV]: 0.162MHz 51.34 (Margin -14.00dB) - QP	Pass
15.247(d) 15.209	Radiated Emissions	Meet the requirement of limit	Pass
15.247(b)(3)	Maximum Output Power	Power [dBm]: 18.47	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

Declaration of Conformity:

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

Comments and Explanations:

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

1 General Description

1.1 Information

1.1.1 Product Details

The device supports integrated and external antenna.

Brand Name	Model Name	Product Name	Description
Laird	BL654PA	Bluetooth v5 Power Amplified Module	integrated antenna
			external 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
				1 Mbps
				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	Connector Type Antenna
2	Laird	FlexPIFA	001-0022	PIFA	IPEX MHF4	2	Connector Type Antenna
3	Laird	2.4GHz Dipole Antenna	001-0001	Dipole	RP-SMA Male	2	Connector Type Antenna
4	Mag.Layers	EDA-8709-2 G4C1-B27-CY	0600-00057	Dipole	IPEX MHF4	2	Connector Type Antenna
5	Laird	mFlexPIFA	EFA2400A3S-10MH4L	PIFA	IPEX MHF4	2	Connector Type Antenna
6	Laird	Laird NFC	0600-00061	NFC	N/A	---	Printed PCB Antenna & Connector Type Antenna
7	Laird	BL654 PCB printed antenna	NA	Printed PCB	N/A	0	Printed PCB Antenna

1.1.4 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	DC 3.3V from host
--------------------------	-------------------

Note: Normal Voltage REG1 mode operation with REG1 DCDC ON and external voltage 3.3V.

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	BleDtmRfTool, version: V8.00		
Duty Cycle and Duty Factor	Modulation Mode	Duty Cycle (%)	Duty Factor (dB)
	GFSK/125kbps	98.99%	0.04
	GFSK/1Mbps	93.33%	0.30
	GFSK/2Mbps	86.39%	0.64

1.1.8 Power Index of Test Tool

Power index of Power Table 1

Modulation Mode	Test Frequency (MHz)		
	2402	2440	2480
GFSK/125kbps	At+dtmcf 1 -8 with 14dBm setting	At+dtmcf 1 -8 with 14dBm setting	At+dtmcf 1 -8 with 14dBm setting
GFSK/1Mbps	At+dtmcf 1 -4 with 18dBm setting	At+dtmcf 1 -4 with 18dBm setting	At+dtmcf 1 -4 with 18dBm setting
GFSK/2Mbps	At+dtmcf 1 -4 with 18dBm setting	At+dtmcf 1 -4 with 18dBm setting	At+dtmcf 1 -4 with 18dBm setting

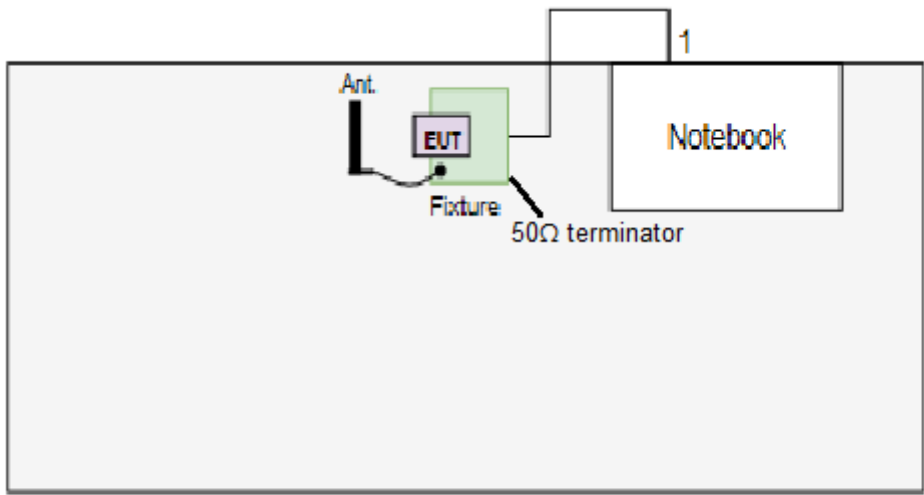
Power Index of Power Table 2

Modulation Mode	Test Frequency (MHz)		
	2402	2440	2480
GFSK/125kbps	At+dtmcf 1 -40 with -26dBm setting	At+dtmcf 1 -40 with -26dBm setting	At+dtmcf 1 -40 with -26dBm setting
GFSK/1Mbps	At+dtmcf 1 -40 with -26dBm setting	At+dtmcf 1 -40 with -26dBm setting	At+dtmcf 1 -40 with -26dBm setting
GFSK/2Mbps	At+dtmcf 1 -40 with -26dBm setting	At+dtmcf 1 -40 with -26dBm setting	At+dtmcf 1 -40 with -26dBm setting

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 – conducted emission	
	
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	May 29, 2019				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101657	Jan. 08, 2019	Jan. 07, 2020
LISN	R&S	ENV216	101579	Mar. 08, 2019	Mar. 07, 2020
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Oct. 23, 2018	Oct. 22, 2019
Measurement Software	AUDIX	e3	6.120210k	NA	NA

Note: Calibration Interval of instruments listed above is one year.

Test Item	Radiated Emission				
Test Site	966 chamber 3 / (03CH03-WS)				
Tested Date	May 16, 2019				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101499	Jan. 07, 2019	Jan. 06, 2020
Receiver	R&S	ESR3	101658	Dec. 11, 2018	Dec. 10, 2019
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-685	Apr. 17, 2019	Apr. 16, 2020
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1206	Jan. 07, 2019	Jan. 06, 2020
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 15, 2018	Nov. 14, 2019
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 09, 2018	Nov. 08, 2019
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Oct. 08, 2018	Oct. 07, 2019
Preamplifier	EMC	EMC02325	980187	Aug. 24, 2018	Aug. 23, 2019
Preamplifier	Agilent	83017A	MY53270014	Aug. 09, 2018	Aug. 08, 2019
Preamplifier	EMC	EMC184045B	980192	Aug. 09, 2018	Aug. 08, 2019
RF cable-3M	HUBER+SUHNER	SUCOFLEX104	MY22620/4	Oct. 01, 2018	Sep. 30, 2019
RF cable-8M	EMC	EMC104-SM-SM-8000	181107	Oct. 01, 2018	Sep. 30, 2019
RF cable-1M	HUBER+SUHNER	SUCOFLEX104	MY22624/4	Oct. 01, 2018	Sep. 30, 2019
LF cable-0.8M	EMC	EMC8D-NM-NM-8000	EMC8D-NM-NM-800-001	Oct. 01, 2018	Sep. 30, 2019
LF cable-3M	EMC	EMC8D-NM-NM-3000	131103	Oct. 01, 2018	Sep. 30, 2019
LF cable-13M	EMC	EMC8D-NM-NM-13000	131104	Oct. 01, 2018	Sep. 30, 2019
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. 11, 2019				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101063	Apr. 17, 2019	Apr. 16, 2020
Power Meter	Anritsu	ML2495A	1241002	Oct. 09, 2018	Oct. 08, 2019
Power Sensor	Anritsu	MA2411B	1207366	Oct. 09, 2018	Oct. 08, 2019
DC POWER SOURCE	GW INSTEK	GPC-6030D	EM892433	Oct. 25, 2018	Oct. 24, 2019
Measurement Software	Sporton	SENSE-15247_FS	V5.10.2	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 15.247 Meas Guidance v05r02

1.6 Deviation from Test Standard and Measurement Procedure

None

1.7 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	± 34.130 Hz
Conducted power	± 0.808 dB
Power density	± 0.583 dB
Conducted emission	± 2.715 dB
AC conducted emission	± 2.92 dB
Radiated emission ≤ 1 GHz	± 3.96 dB
Radiated emission > 1 GHz	± 4.51 dB

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	23°C / 64%	Alex Tsai
Radiated Emissions	03CH03-WS	24°C / 63%	Roger Lu
RF Conducted	TH01-WS	22°C / 64%	Aska Huang

- FCC Designation No.: TW0009
- FCC site registration No.: 207696
- ISSED#: 10807A
- CAB identifier: TW2732

2.2 The Worst Test Modes and Channel Details

Highest power level

Test item	Mode	Test Frequency (MHz)	Data Rate	Test Configuration	Conducted / Radiated measurement	Mode
AC Power Line Conducted Emissions	BT LE	2480 2480 2480	125kbps 1Mbps 2Mbps	1	Conducted	TX
Radiated Emissions $\leq$ 1GHz	BT LE	2480 2480 2480	125kbps 1Mbps 2Mbps	2	Radiated	TX
Antenna port conducted emission $\leq$ 1GHz	BT LE	2480 2480 2480	125kbps 1Mbps 2Mbps	1	Conducted	TX
Maximum Output Power 6dB bandwidth Power spectral density	BT LE	2402, 2440, 2480 2402, 2440, 2480 2402, 2440, 2480	125kbps 1Mbps 2Mbps	1	Conducted	TX
Radiated Emissions > 1GHz	BT LE	2402, 2440, 2480 2402, 2440, 2480 2402, 2440, 2480	125kbps 1Mbps 2Mbps	2	Radiated	TX
Antenna port conducted emission > 1GHz	BT LE	2402, 2440, 2480 2402, 2440, 2480 2402, 2440, 2480	125kbps 1Mbps 2Mbps	1	Conducted	TX

NOTE:

- The EUT supports two DC voltage options, DC 5V & 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.
- The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Z-plane** results were found as the worst case and were shown in this report.
- Test configurations are listed as below:
 - Configuration 2: Antenna: Laird NFC + 2.4GHz Dipole Antenna
 - Configuration 7: Antenna: Laird NFC+ 50 Ω terminator
- All test items of each data rates are tested with below power index and duty cycle
 GFSK/125kbps: At+dtmcfg 1 -8 with 14dBm setting / duty cycle: 98.99 %
 GFSK/1Mbps: At+dtmcfg 1 -4 with 18dBm setting / duty cycle: 93.33 %
 GFSK/2Mbps: At+dtmcfg 1 -4 with 18dBm setting / duty cycle: 86.39 %
- Duty cycle correction factor of 1Mbps / 2 Mbps is applied to band edge measurement of antenna port conducted emission measurement.
- FW: BL654PA_v29.3.3.5-PALNA-26_Dtm_High_Duty_Cycle is applied to perform all test items except duty cycle of normal operation measurement.
 FW: BL654_and_BL654PA_Firmware_For_Upgrade_v29_3_4_0_r0 is used to perform duty cycle of normal operation measurement.
- Packet payload length is 37

Lowest power level

Test item	Mode	Test Frequency (MHz)	Data Rate	Test Configuration	Conducted / Radiated measurement	Mode
Radiated Emissions $\leq$ 1GHz	BT LE	2480 2480 2480	125kbps 1Mbps 2Mbps	2	Radiated	TX
Antenna port conducted emission $\leq$ 1GHz	BT LE	2480 2480 2480	125kbps 1Mbps 2Mbps	1	Conducted	TX
Maximum Output Power 6dB bandwidth Power spectral density	BT LE	2402, 2440, 2480 2402, 2440, 2480 2402, 2440, 2480	125kbps 1Mbps 2Mbps	1	Conducted	TX
Radiated Emissions $>$ 1GHz	BT LE	2402, 2440, 2480 2402, 2440, 2480 2402, 2440, 2480	125kbps 1Mbps 2Mbps	2	Radiated	TX
Antenna port conducted emission $>$ 1GHz	BT LE	2402, 2440, 2480 2402, 2440, 2480 2402, 2440, 2480	125kbps 1Mbps 2Mbps	1	Conducted	TX

NOTE:

- The EUT supports two DC voltage options, DC 5V & 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.
- The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Z-plane** results were found as the worst case and were shown in this report.
- Test configurations are listed as below:
 - Configuration 2: Antenna: Laird NFC + 2.4GHz Dipole Antenna
 - Configuration 7: Antenna:Laird NFC+ 50 Ω terminator
- All test items of each data rates are tested with below power index and duty cycle
 GFSK/125kbps: At+dtmcfgr 1 -40 with -26dBm setting / duty cycle: 98.99 %
 GFSK/1Mbps: At+dtmcfgr 1 -40 with -26dBm setting / duty cycle: 93.33 %
 GFSK/2Mbps: At+dtmcfgr 1 -40 with -26dBm setting / duty cycle: 86.39 %
- FW: BL654PA_v29.3.3.5-PALNA-26_Dtm_High_Duty_Cycle is applied to perform all test items except duty cycle of normal operation measurement.
 FW: BL654_and_BL654PA_Firmware_For_Upgrade_v29_3_4_0_r0 is applied to perform duty cycle of normal operation measurement.
- Packet payload length is 37

3 Transmitter Test Results

3.1 Conducted Emissions

3.1.1 Limit of Conducted Emissions

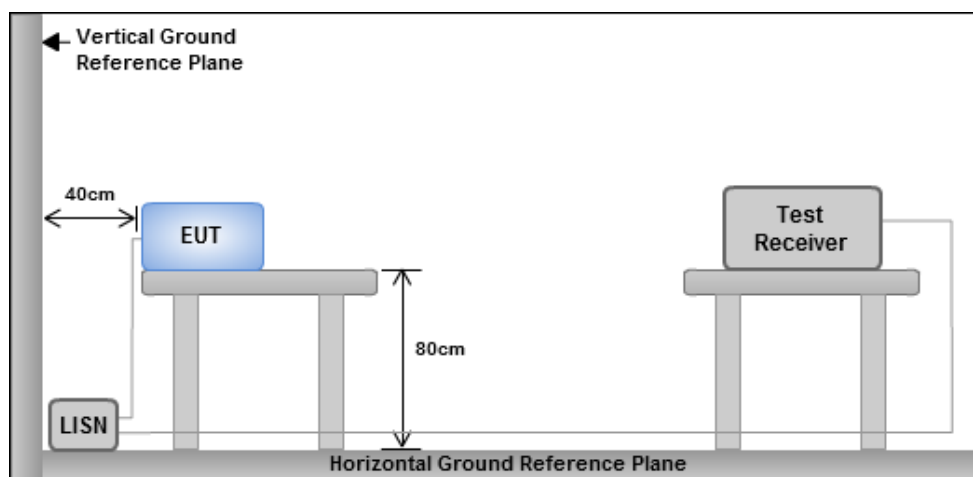
Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50

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

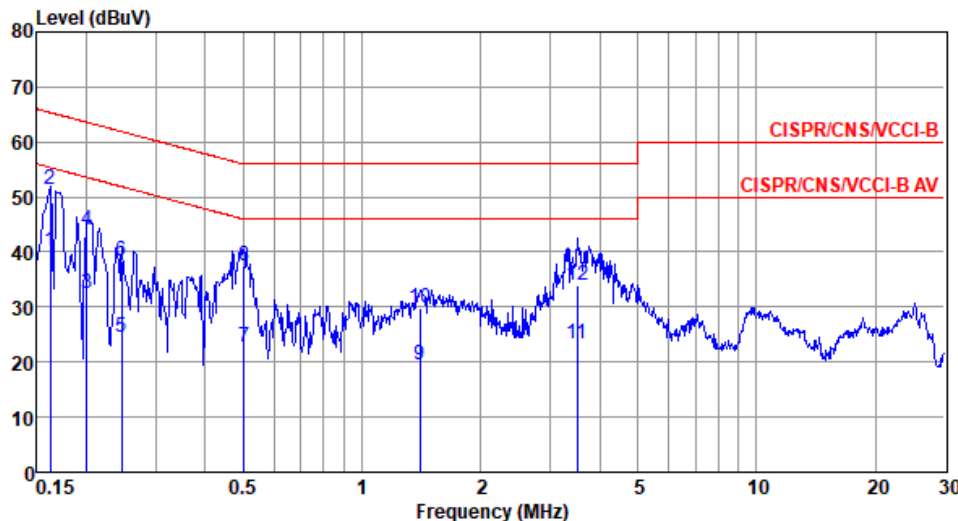
3.1.3 Test Setup



- 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-125kbps	Test Freq. (MHz)	2480
Power Phase	Line		

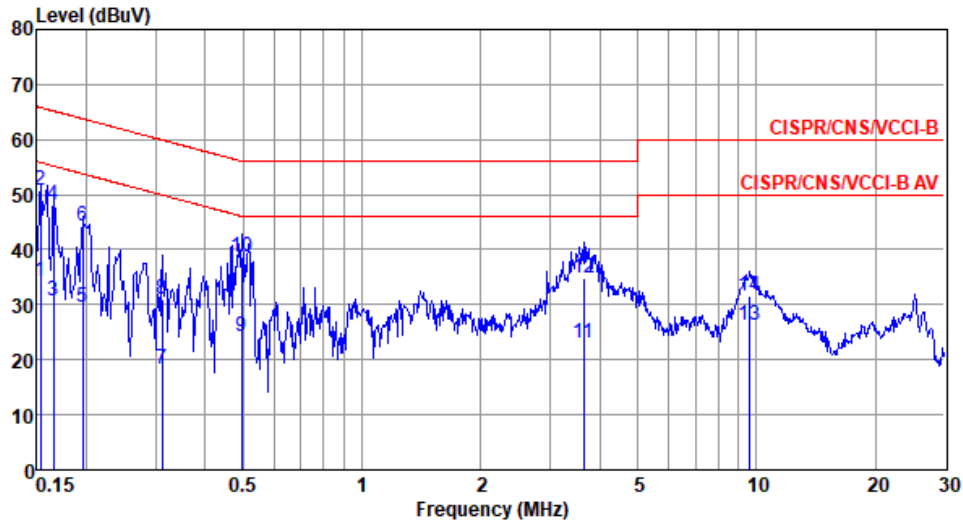


	Freq MHz	Level dBUV	Limit Line dBUV	Over Limit dB	Read Level dBUV	LISN factor dB	cable loss dB	Remark
1	0.162	40.18	55.34	-15.16	30.59	9.53	0.06	Average
2*	0.162	51.34	65.34	-14.00	41.75	9.53	0.06	QP
3	0.201	32.58	53.58	-21.00	22.97	9.54	0.07	Average
4	0.201	44.09	63.58	-19.49	34.48	9.54	0.07	QP
5	0.246	24.63	51.91	-27.28	15.01	9.55	0.07	Average
6	0.246	38.26	61.91	-23.65	28.64	9.55	0.07	QP
7	0.502	22.79	46.00	-23.21	13.13	9.58	0.08	Average
8	0.502	37.50	56.00	-18.50	27.84	9.58	0.08	QP
9	1.403	19.43	46.00	-26.57	9.70	9.60	0.13	Average
10	1.403	29.80	56.00	-26.20	20.07	9.60	0.13	QP
11	3.509	23.21	46.00	-22.79	13.34	9.61	0.26	Average
12	3.509	33.84	56.00	-22.16	23.97	9.61	0.26	QP

Note 1: Level (dBUV) = Read Level (dBUV) + LISN Factor (dB) + Cable Loss (dB).

2: Over Limit (dB) = Level (dBUV) – Limit Line (dBUV).

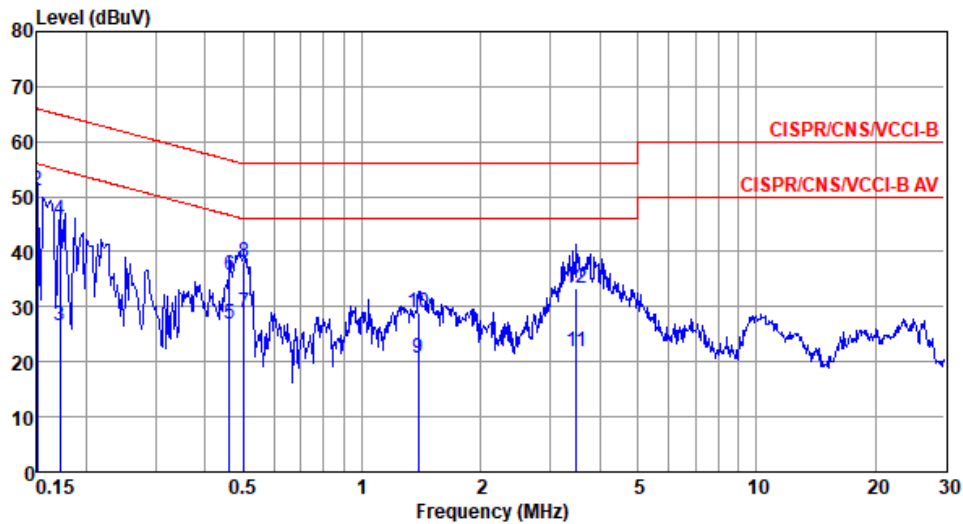
Modulation Mode	BT LE-125kbps	Test Freq. (MHz)	2480
Power Phase	Neutral		



	Freq	Level	Limit	Over	Read	LISN	cable	
	MHz	dBuV	Line dBuV	Limit dB	Level dBuV	factor dB	loss dB	Remark
1	0.153	34.29	55.82	-21.53	24.67	9.57	0.05	Average
2*	0.153	50.92	65.82	-14.90	41.30	9.57	0.05	QP
3	0.165	30.81	55.21	-24.40	21.18	9.57	0.06	Average
4	0.165	48.04	65.21	-17.17	38.41	9.57	0.06	QP
5	0.195	29.65	53.80	-24.15	20.00	9.58	0.07	Average
6	0.195	44.14	63.80	-19.66	34.49	9.58	0.07	QP
7	0.312	18.18	49.93	-31.75	8.50	9.60	0.08	Average
8	0.312	30.87	59.93	-29.06	21.19	9.60	0.08	QP
9	0.494	24.26	46.10	-21.84	14.56	9.62	0.08	Average
10	0.494	38.65	56.10	-17.45	28.95	9.62	0.08	QP
11	3.642	23.01	46.00	-22.99	13.09	9.66	0.26	Average
12	3.642	34.94	56.00	-21.06	25.02	9.66	0.26	QP
13	9.603	26.28	50.00	-23.72	16.14	9.71	0.43	Average
14	9.603	31.58	60.00	-28.42	21.44	9.71	0.43	QP

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

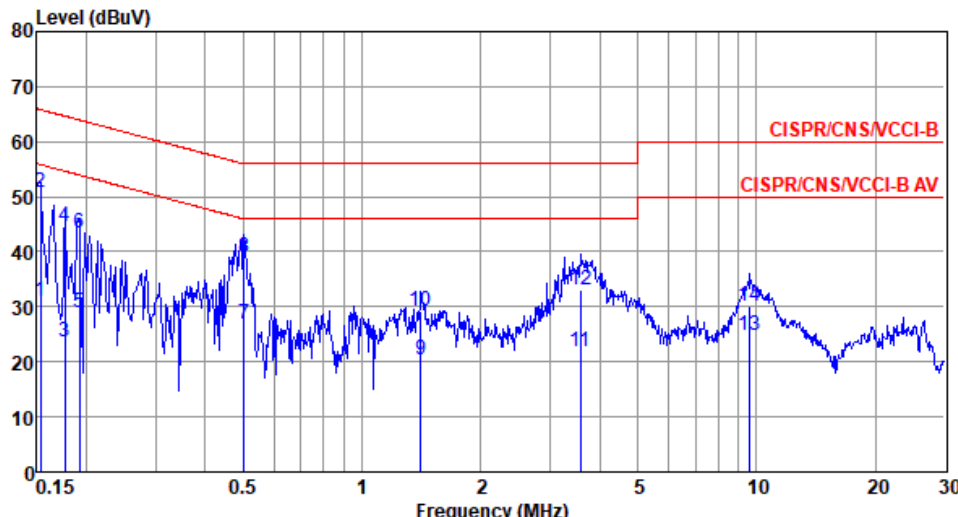
Modulation Mode	BT LE-1Mbps	Test Freq. (MHz)	2480
Power Phase	Line		



	Freq	Level	Limit	Over	Read	LISN	cable	Remark
	MHz	dBuV	Line dBuV	Limit dB	Level dBuV	factor dB	loss dB	
1	0.150	32.60	56.00	-23.40	23.02	9.53	0.05	Average
2*	0.150	51.08	66.00	-14.92	41.50	9.53	0.05	QP
3	0.171	26.69	54.90	-28.21	17.10	9.53	0.06	Average
4	0.171	45.71	64.90	-19.19	36.12	9.53	0.06	QP
5	0.461	26.94	46.67	-19.73	17.29	9.57	0.08	Average
6	0.461	35.69	56.67	-20.98	26.04	9.57	0.08	QP
7	0.502	28.98	46.00	-17.02	19.32	9.58	0.08	Average
8	0.502	38.20	56.00	-17.80	28.54	9.58	0.08	QP
9	1.388	20.52	46.00	-25.48	10.79	9.60	0.13	Average
10	1.388	29.01	56.00	-26.99	19.28	9.60	0.13	QP
11	3.491	21.77	46.00	-24.23	11.90	9.61	0.26	Average
12	3.491	33.27	56.00	-22.73	23.40	9.61	0.26	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		

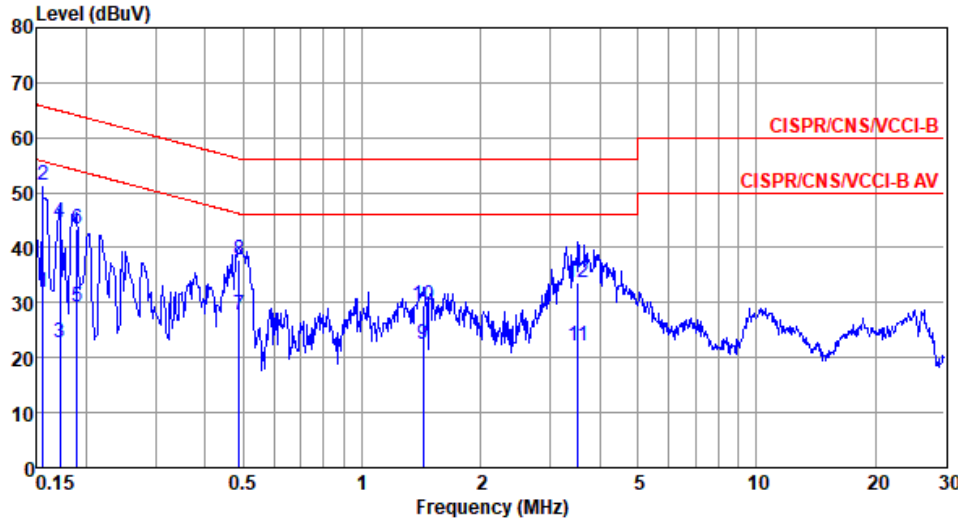


	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.153	31.14	55.82	-24.68	21.52	9.57	0.05	Average
2*	0.153	50.77	65.82	-15.05	41.15	9.57	0.05	QP
3	0.177	23.73	54.64	-30.91	14.09	9.58	0.06	Average
4	0.177	44.46	64.64	-20.18	34.82	9.58	0.06	QP
5	0.192	28.86	53.93	-25.07	19.21	9.58	0.07	Average
6	0.192	43.50	63.93	-20.43	33.85	9.58	0.07	QP
7	0.502	26.76	46.00	-19.24	17.06	9.62	0.08	Average
8	0.502	39.10	56.00	-16.90	29.40	9.62	0.08	QP
9	1.411	20.45	46.00	-25.55	10.68	9.64	0.13	Average
10	1.411	29.09	56.00	-26.91	19.32	9.64	0.13	QP
11	3.584	21.71	46.00	-24.29	11.79	9.66	0.26	Average
12	3.584	33.02	56.00	-22.98	23.10	9.66	0.26	QP
13	9.603	24.87	50.00	-25.13	14.73	9.71	0.43	Average
14	9.603	30.18	60.00	-29.82	20.04	9.71	0.43	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).

Note 2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

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

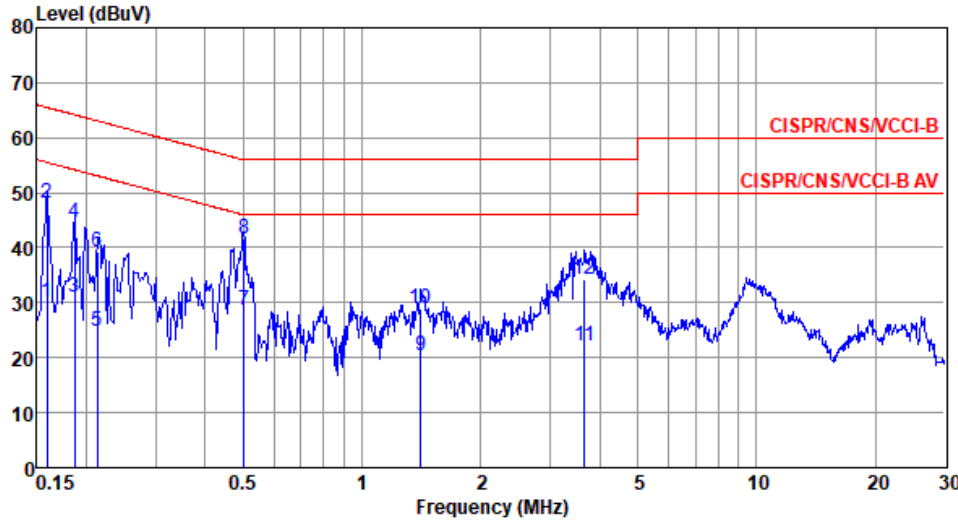


	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.156	31.94	55.69	-23.75	22.36	9.53	0.05	Average
2*	0.156	51.26	65.69	-14.43	41.68	9.53	0.05	QP
3	0.171	22.83	54.90	-32.07	13.24	9.53	0.06	Average
4	0.171	44.57	64.90	-20.33	34.98	9.53	0.06	QP
5	0.189	29.21	54.06	-24.85	19.60	9.54	0.07	Average
6	0.189	43.32	64.06	-20.74	33.71	9.54	0.07	QP
7	0.489	27.64	46.19	-18.55	17.98	9.58	0.08	Average
8	0.489	37.80	56.19	-18.39	28.14	9.58	0.08	QP
9	1.426	22.31	46.00	-23.69	12.58	9.60	0.13	Average
10	1.426	29.44	56.00	-26.56	19.71	9.60	0.13	QP
11	3.528	22.18	46.00	-23.82	12.31	9.61	0.26	Average
12	3.528	33.68	56.00	-22.32	23.81	9.61	0.26	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	30.24	55.52	-25.28	20.62	9.57	0.05	Average
2	0.159	48.13	65.52	-17.39	38.51	9.57	0.05	QP
3	0.186	30.95	54.20	-23.25	21.30	9.58	0.07	Average
4	0.186	44.51	64.20	-19.69	34.86	9.58	0.07	QP
5	0.213	24.68	53.10	-28.42	15.03	9.58	0.07	Average
6	0.213	39.35	63.10	-23.75	29.70	9.58	0.07	QP
7	0.502	28.72	46.00	-17.28	19.02	9.62	0.08	Average
8*	0.502	41.68	56.00	-14.32	31.98	9.62	0.08	QP
9	1.411	20.38	46.00	-25.62	10.61	9.64	0.13	Average
10	1.411	28.93	56.00	-27.07	19.16	9.64	0.13	QP
11	3.661	22.14	46.00	-23.86	12.22	9.66	0.26	Average
12	3.661	34.18	56.00	-21.82	24.26	9.66	0.26	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

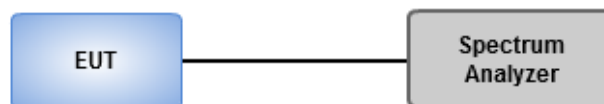
6dB Bandwidth

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



Highest power level

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)
2.4-2.4835GHz	-	-	-	-	-
BT-LE0.125_Nss1_1TX	728.261k	1.078M	1M08F1D	688.406k	1.071M
BT-LE(1Mbps)	699.275k	1.056M	1M06F1D	688.406k	1.046M
BT-LE(2Mbps)	1.174M	2.041M	2M04F1D	1.167M	2.033M

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

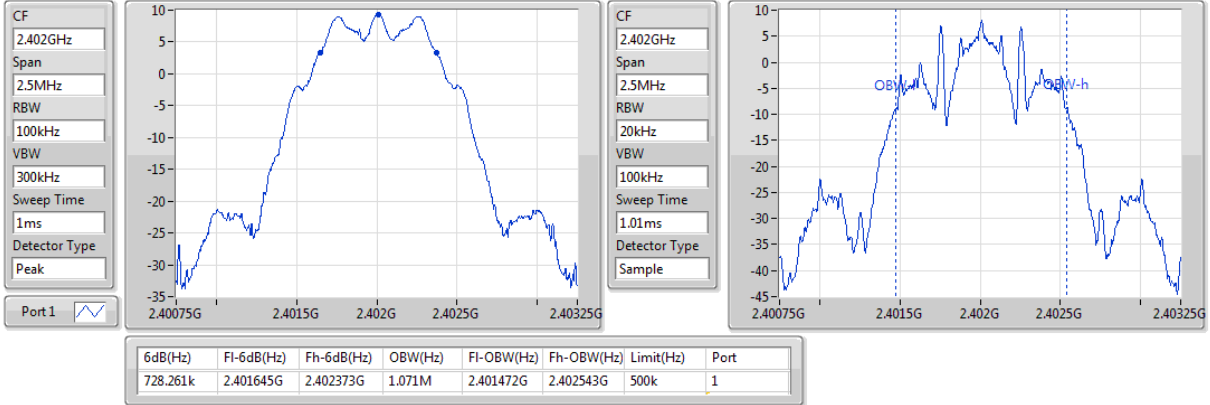
Mode	Result	Limit (Hz)	Port 1-N dB (Hz)	Port 1-OBW (Hz)
BT-LE0.125_Nss1_1TX	-	-	-	-
2402MHz	Pass	500k	728.261k	1.071M
2440MHz	Pass	500k	724.638k	1.078M
2480MHz	Pass	500k	688.406k	1.075M
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	500k	692.029k	1.046M
2440MHz	Pass	500k	688.406k	1.053M
2480MHz	Pass	500k	699.275k	1.056M
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	500k	1.167M	2.033M
2440MHz	Pass	500k	1.174M	2.041M
2480MHz	Pass	500k	1.174M	2.041M

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

BT-LE0.125_Nss1_1TX

EBW

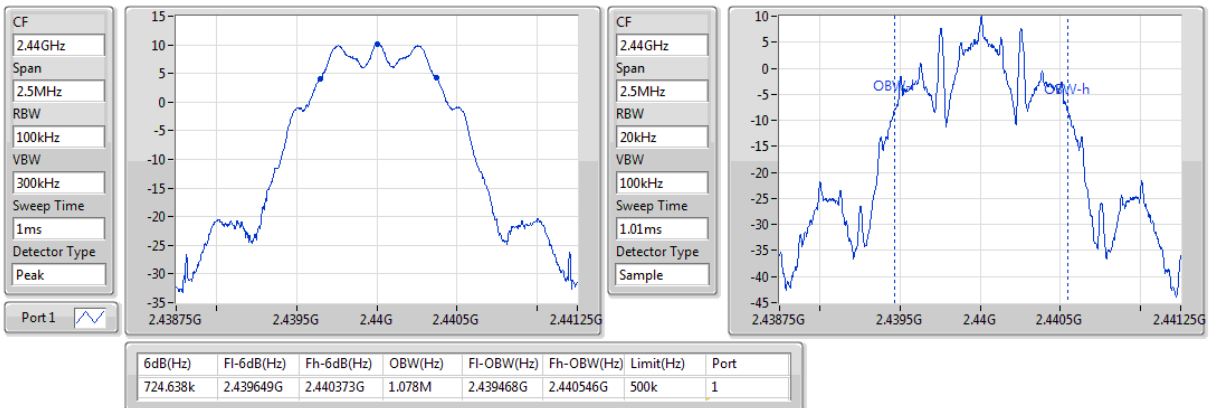
2402MHz



BT-LE0.125_Nss1_1TX

EBW

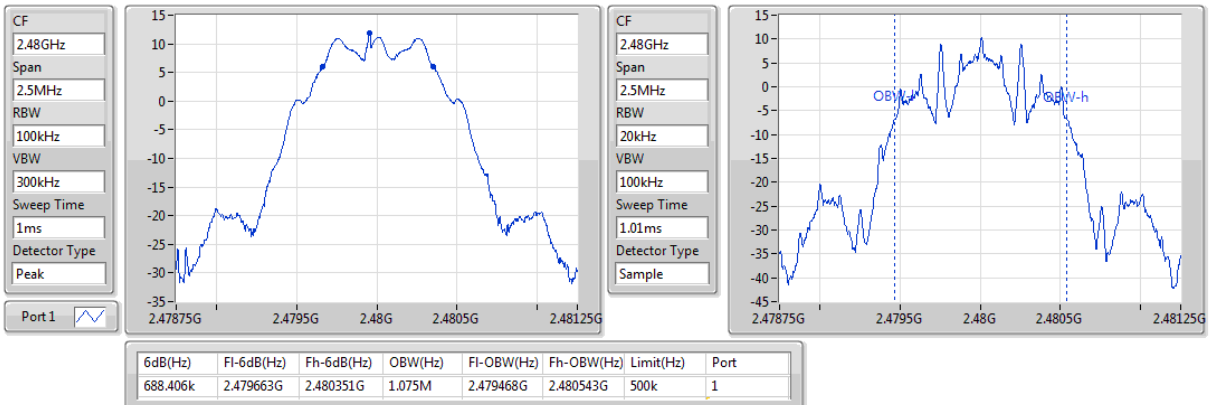
2440MHz



BT-LE0.125_Nss1_1TX

EBW

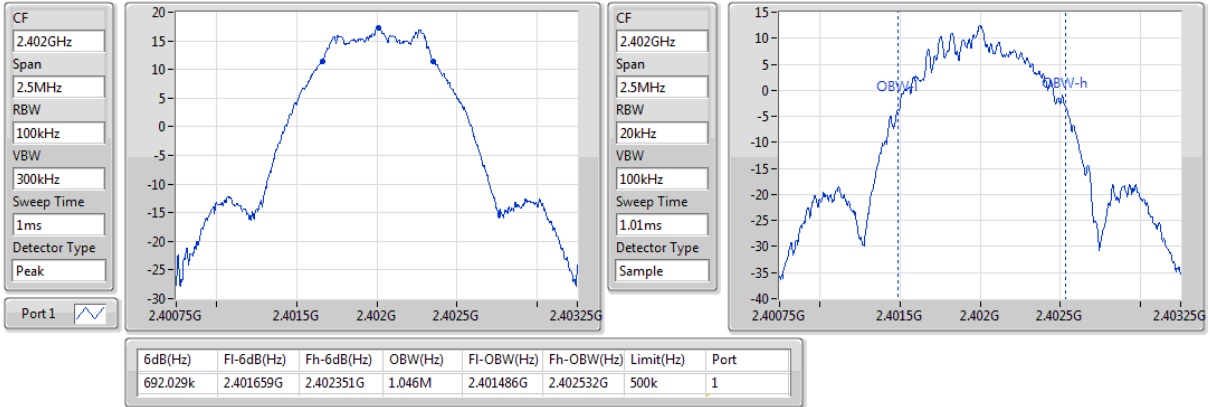
2480MHz



BT-LE(1Mbps)

EBW

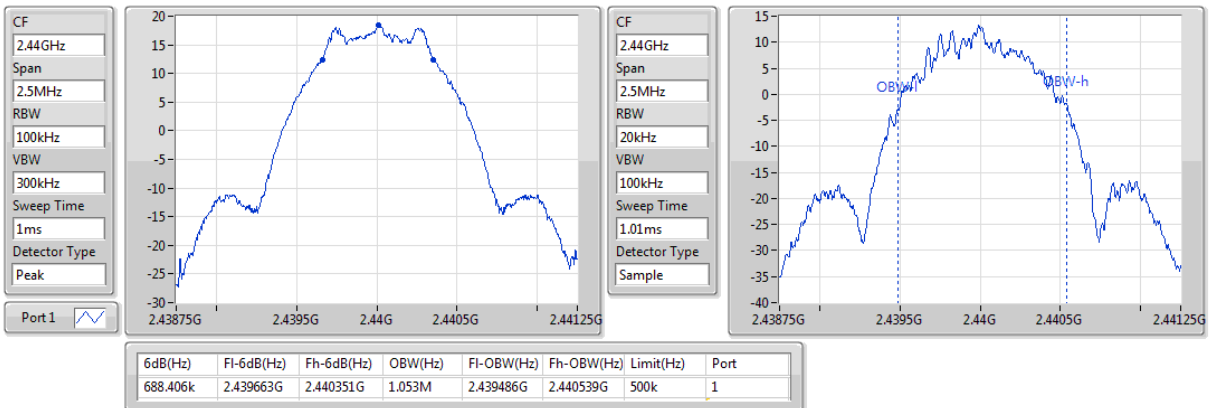
2402MHz



BT-LE(1Mbps)

EBW

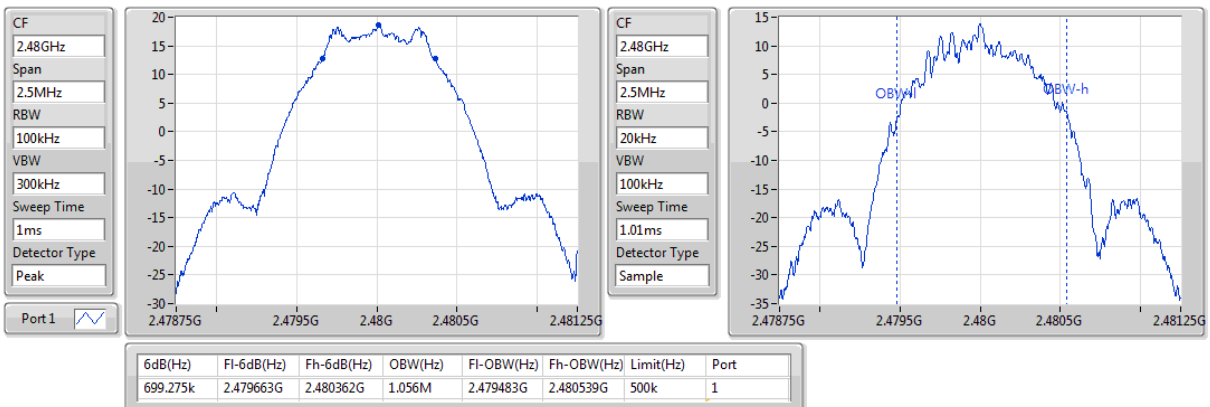
2440MHz



BT-LE(1Mbps)

EBW

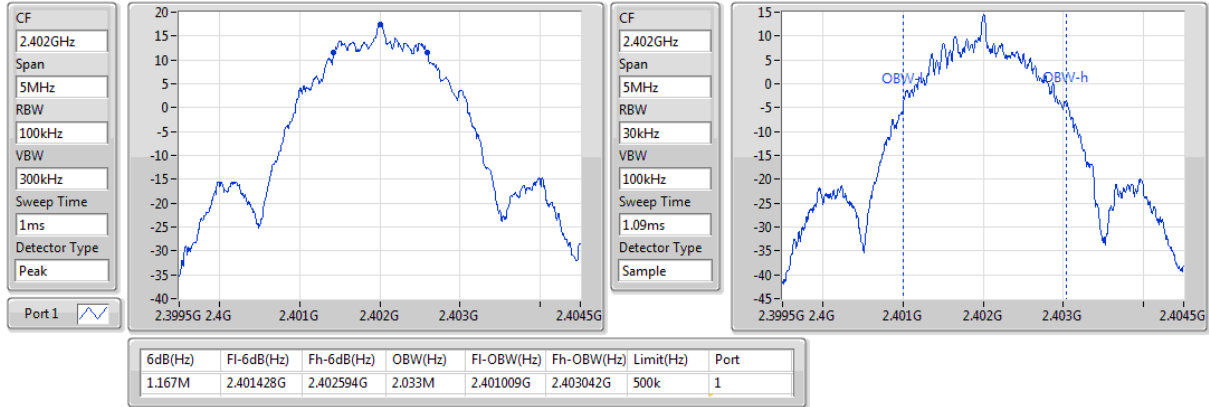
2480MHz



BT-LE(2Mbps)

EBW

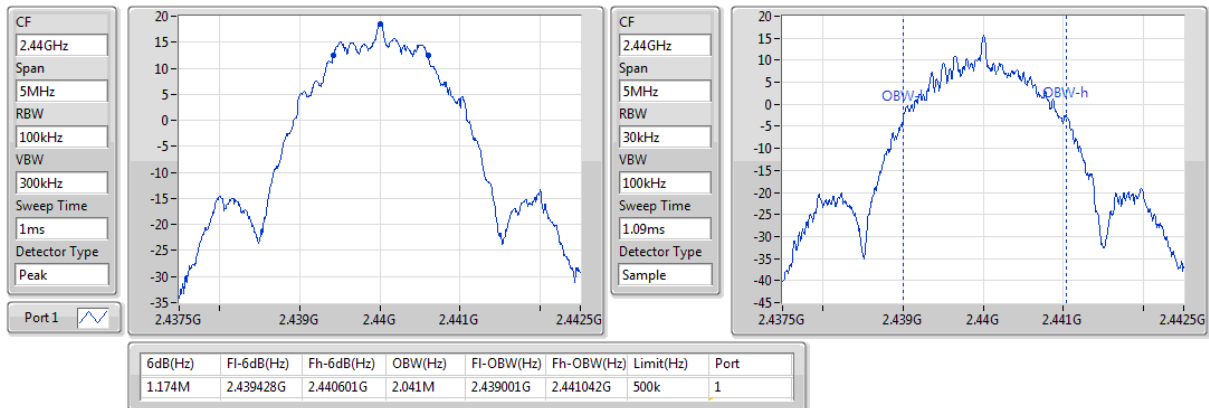
2402MHz



BT-LE(2Mbps)

EBW

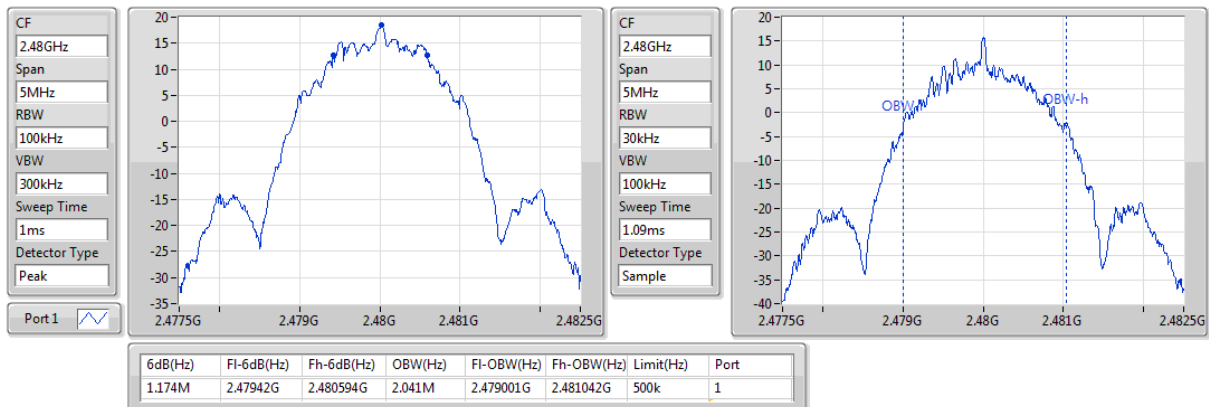
2440MHz



BT-LE(2Mbps)

EBW

2480MHz



Lowest power level

3.2.5 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)
2.4-2.4835GHz	-	-	-	-	-
BT-LE0.125_Nss1_1TX	724.638k	1.078M	1M08F1D	612.319k	1.075M
BT-LE(1Mbps)	710.145k	1.053M	1M05F1D	688.406k	1.042M
BT-LE(2Mbps)	1.181M	2.048M	2M05F1D	1.159M	2.033M

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

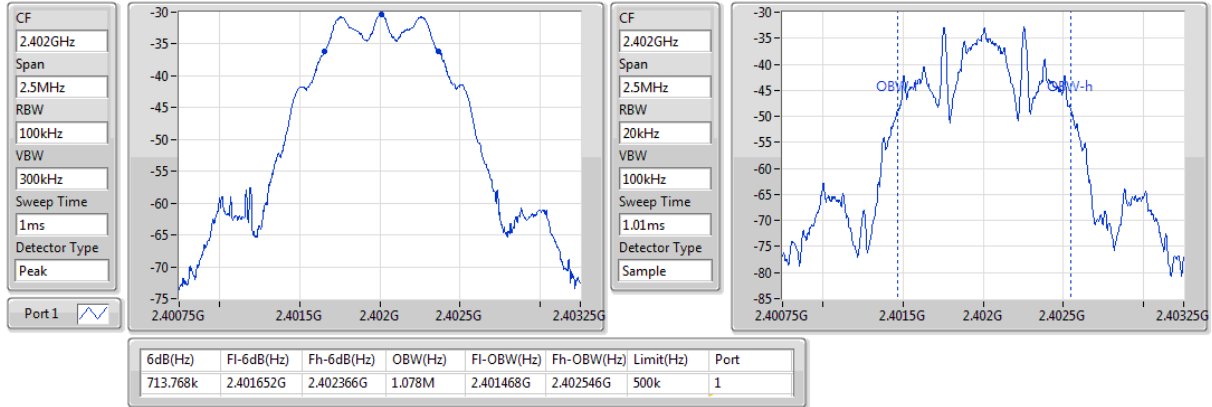
Mode	Result	Limit (Hz)	Port 1-N dB (Hz)	Port 1-OBW (Hz)
BT-LE0.125_Nss1_1TX	-	-	-	-
2402MHz	Pass	500k	713.768k	1.078M
2440MHz	Pass	500k	612.319k	1.075M
2480MHz	Pass	500k	724.638k	1.078M
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	500k	710.145k	1.042M
2440MHz	Pass	500k	702.899k	1.049M
2480MHz	Pass	500k	688.406k	1.053M
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	500k	1.159M	2.033M
2440MHz	Pass	500k	1.181M	2.033M
2480MHz	Pass	500k	1.159M	2.048M

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

BT-LE0.125_Nss1_1TX

EBW

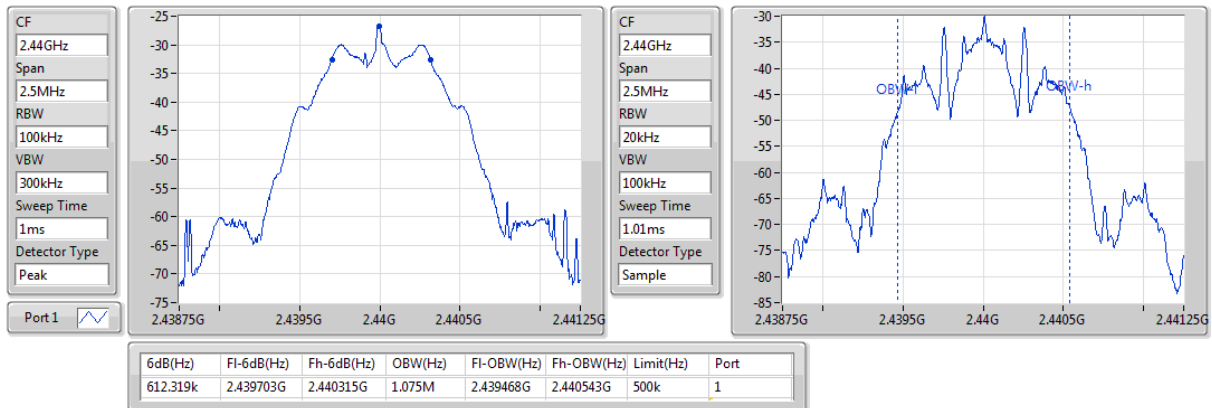
2402MHz



BT-LE0.125_Nss1_1TX

EBW

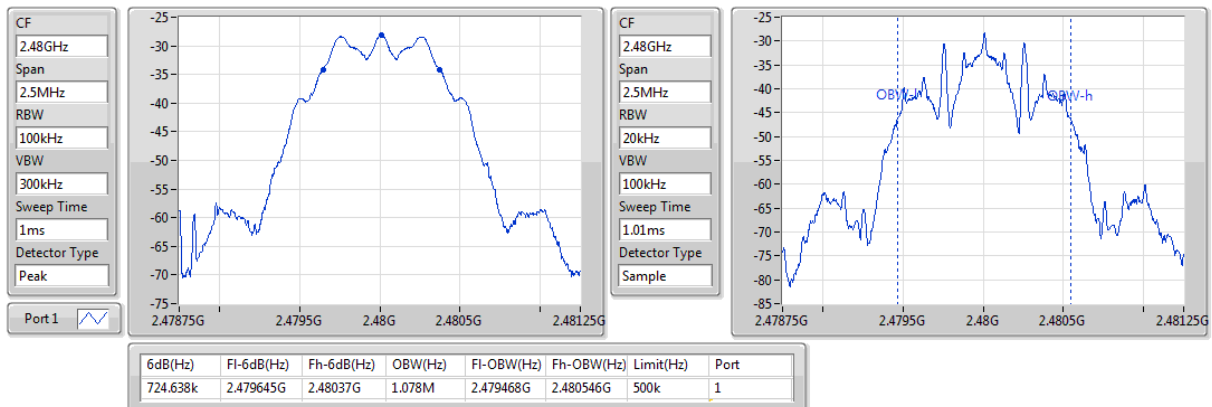
2440MHz



BT-LE0.125_Nss1_1TX

EBW

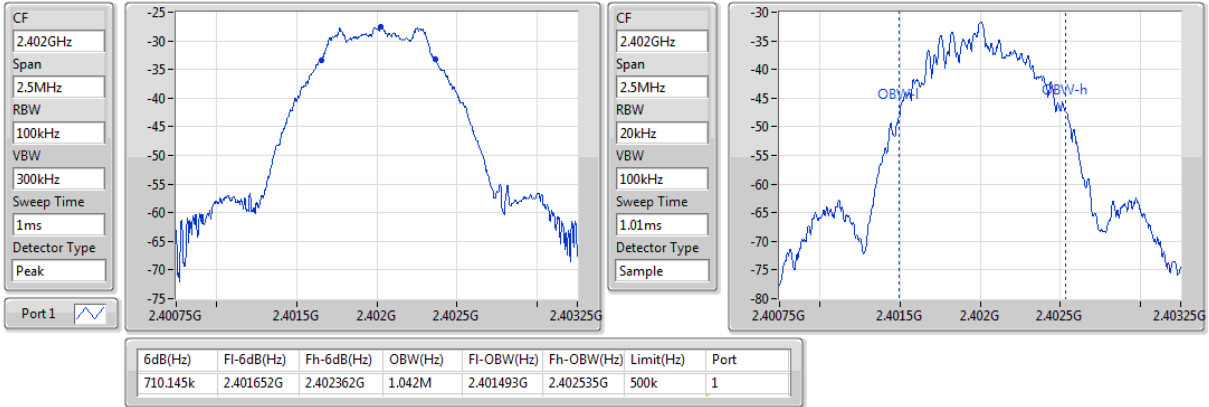
2480MHz



BT-LE(1Mbps)

EBW

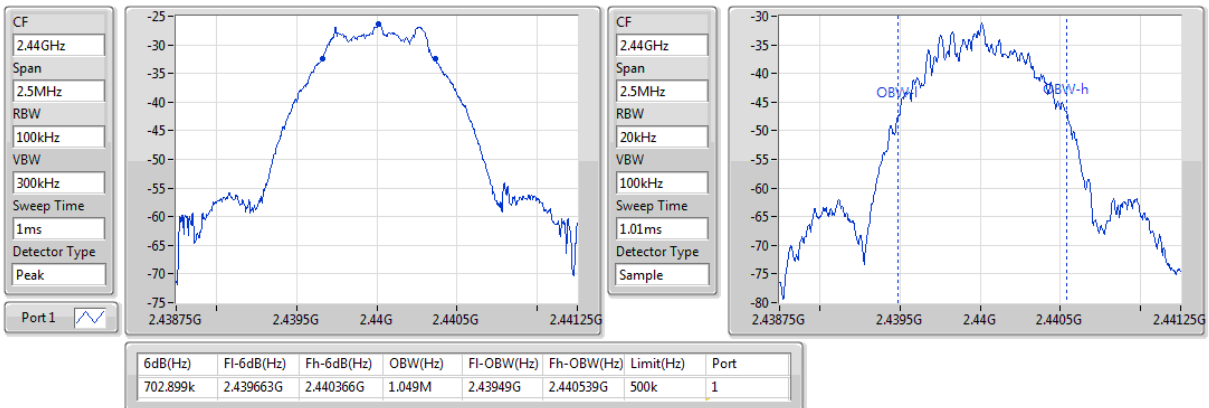
2402MHz



BT-LE(1Mbps)

EBW

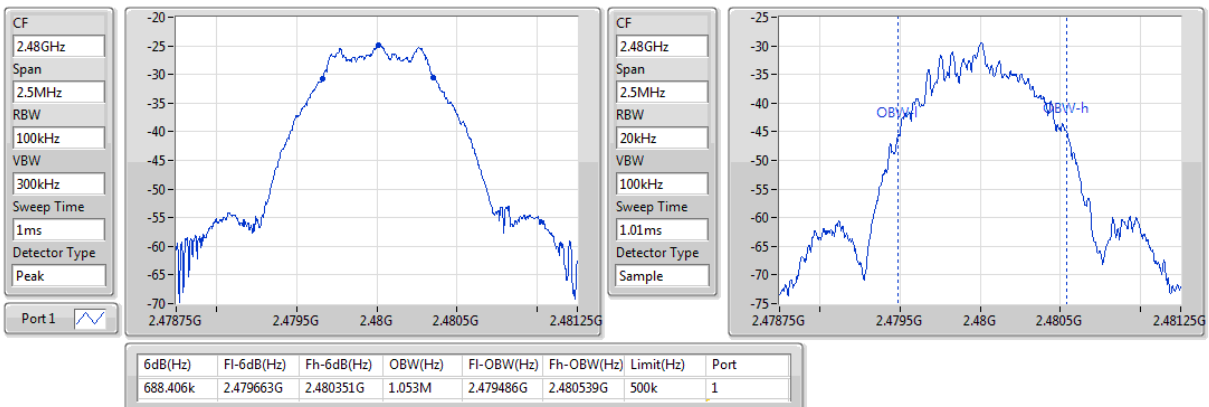
2440MHz



BT-LE(1Mbps)

EBW

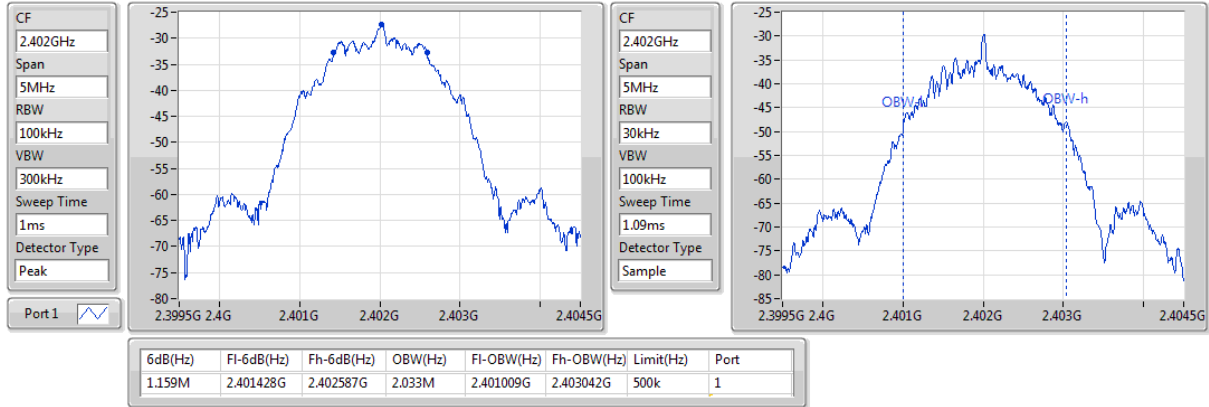
2480MHz



BT-LE(2Mbps)

EBW

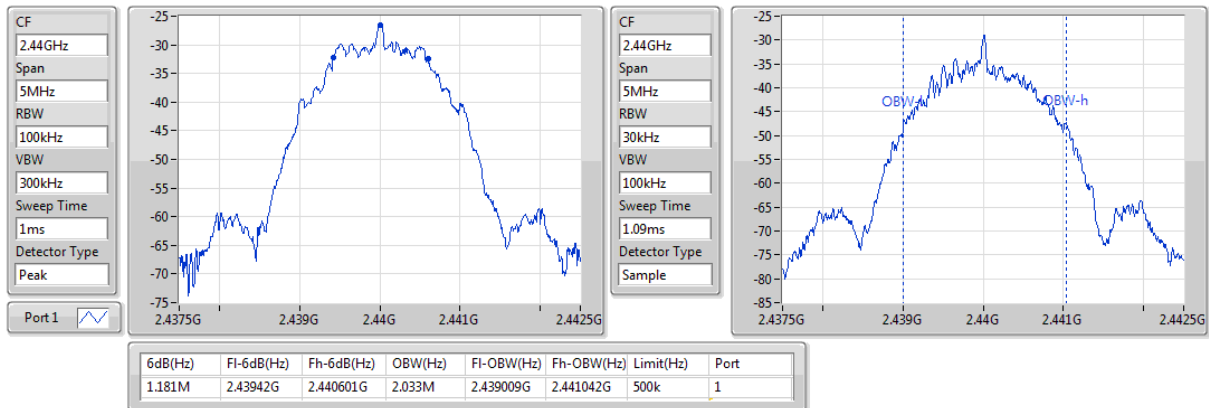
2402MHz



BT-LE(2Mbps)

EBW

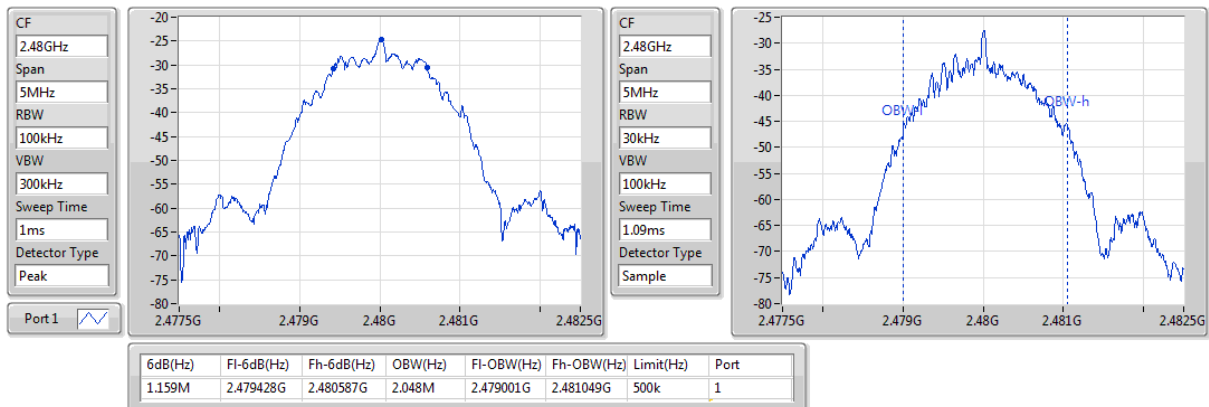
2440MHz



BT-LE(2Mbps)

EBW

2480MHz



3.3 RF Output Power

3.3.1 Limit of RF Output Power

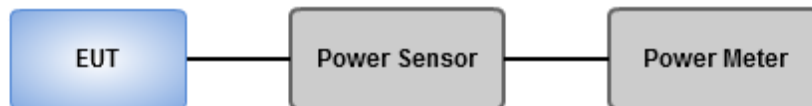
Conducted power shall not exceed 1Watt.

Antenna gain $\leq 6\text{dBi}$, 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



Highest power level

3.3.4 Test Result of Maximum Output Power

Summary

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-LE0.125_Nss1_1TX	14.21	0.02636
BT-LE(1Mbps)	18.33	0.06808
BT-LE(2Mbps)	18.47	0.07031

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-LE0.125_Nss1_1TX	-	-	-	-
2402MHz	Pass	2.00	11.67	30.00
2440MHz	Pass	2.00	13.46	30.00
2480MHz	Pass	2.00	14.21	30.00
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	17.22	30.00
2440MHz	Pass	2.00	18.23	30.00
2480MHz	Pass	2.00	18.33	30.00
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	2.00	17.32	30.00
2440MHz	Pass	2.00	18.37	30.00
2480MHz	Pass	2.00	18.47	30.00

Lowest power level

3.3.5 Test Result of Maximum Output Power

Summary

Mode	Power	Power
	(dBm)	(W)
2.4-2.4835GHz	-	-
BT-LE0.125_Nss1_1TX	-24.67	0.00000
BT-LE(1Mbps)	-24.75	0.00000
BT-LE(2Mbps)	-24.76	0.00000

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-LE0.125_Nss1_1TX	-	-	-	-
2402MHz	Pass	2.00	-27.38	30.00
2440MHz	Pass	2.00	-26.36	30.00
2480MHz	Pass	2.00	-24.67	30.00
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	-27.47	30.00
2440MHz	Pass	2.00	-26.44	30.00
2480MHz	Pass	2.00	-24.75	30.00
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	2.00	-27.53	30.00
2440MHz	Pass	2.00	-26.48	30.00
2480MHz	Pass	2.00	-24.76	30.00

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

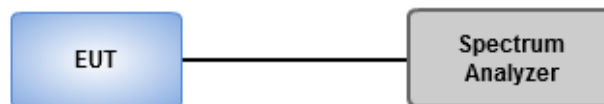
Average PSD, duty cycle $\geq 98\%$ (GFSK/125kbps)

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 $< 98\%$ (GFSK/1 Mbps, 2 Mbps)

1. Set the RBW = 3 kHz, VBW = 10 kHz. Detector = RMS.
2. Set the sweep time to: ≥ 10 (number of measurement points in sweep) $\times$ (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



Highest power level

3.4.4 Test Result of Power Spectral Density

Summary

Mode	PD (dBm/RBW)
2.4-2.4835GHz	-
BT-LE0.125_Nss1_1TX	7.83
BT-LE(1Mbps)	-1.32
BT-LE(2Mbps)	-2.46

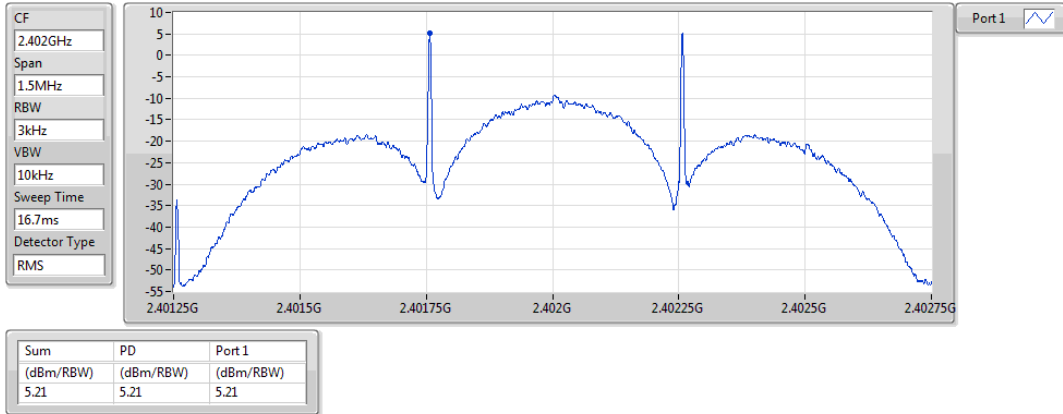
Result

Mode	Result	Gain (dBi)	PD (dBm/RBW)	PD Limit (dBm/RBW)
BT-LE0.125_Nss1_1TX	-	-	-	-
2402MHz	Pass	2.00	5.21	8.00
2440MHz	Pass	2.00	6.73	8.00
2480MHz	Pass	2.00	7.83	8.00
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	-2.33	8.00
2440MHz	Pass	2.00	-1.32	8.00
2480MHz	Pass	2.00	-1.34	8.00
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	2.00	-4.17	8.00
2440MHz	Pass	2.00	-3.02	8.00
2480MHz	Pass	2.00	-2.46	8.00

BT-LE0.125_Nss1_1TX

PSD

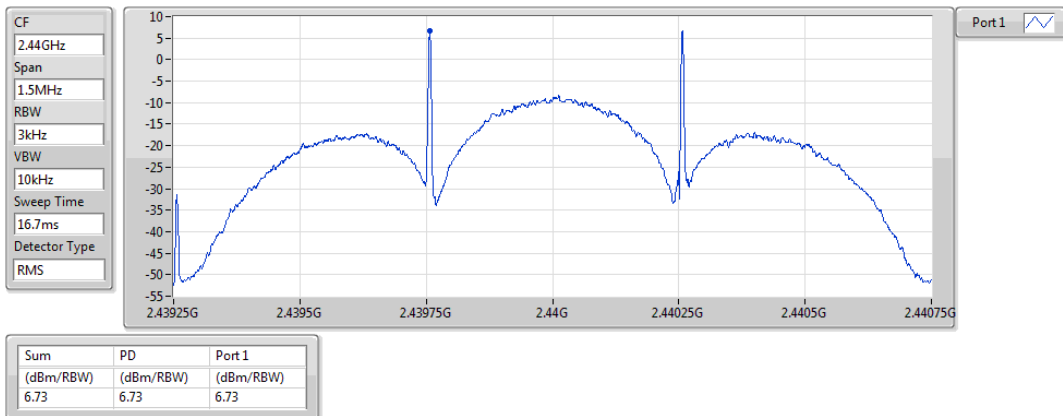
2402MHz



BT-LE0.125_Nss1_1TX

PSD

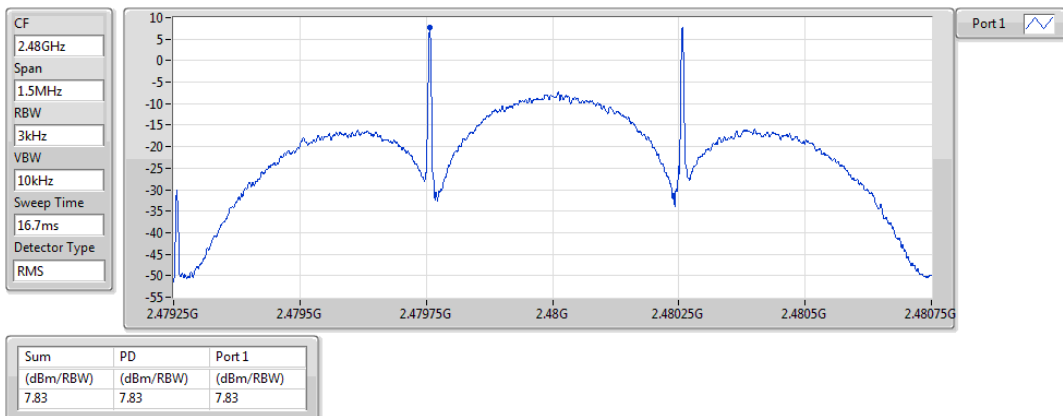
2440MHz



BT-LE0.125_Nss1_1TX

PSD

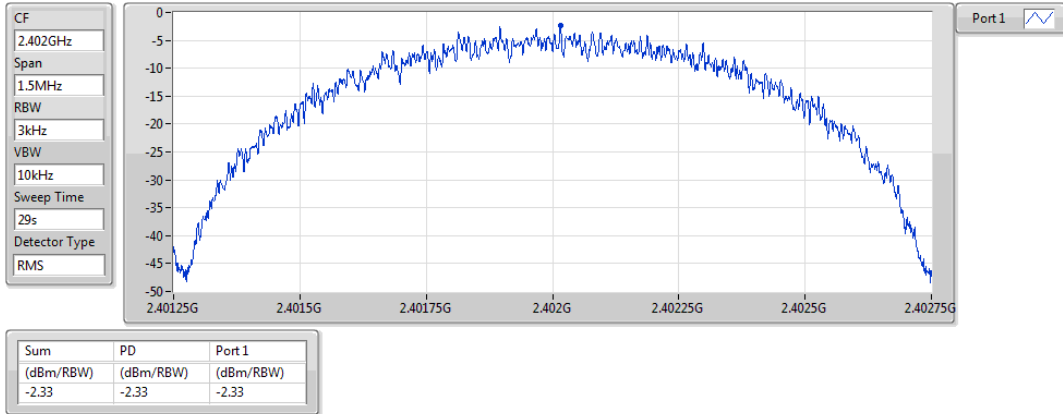
2480MHz



BT-LE(1Mbps)

PSD

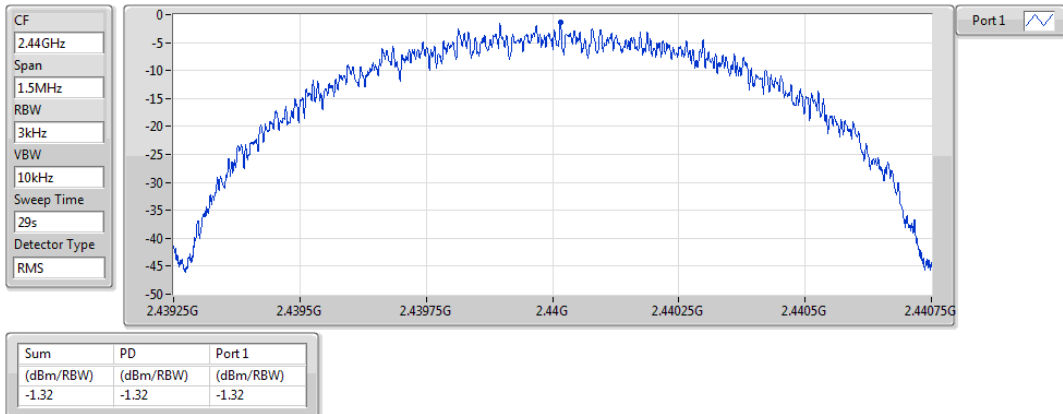
2402MHz



BT-LE(1Mbps)

PSD

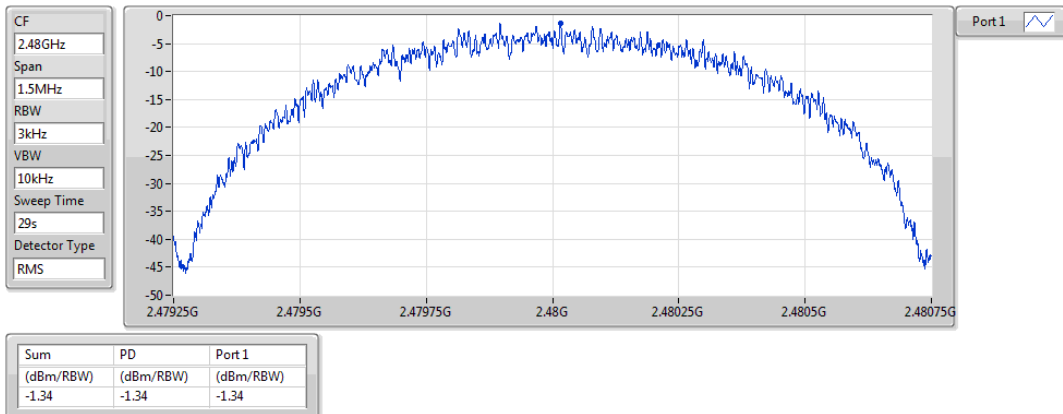
2440MHz



BT-LE(1Mbps)

PSD

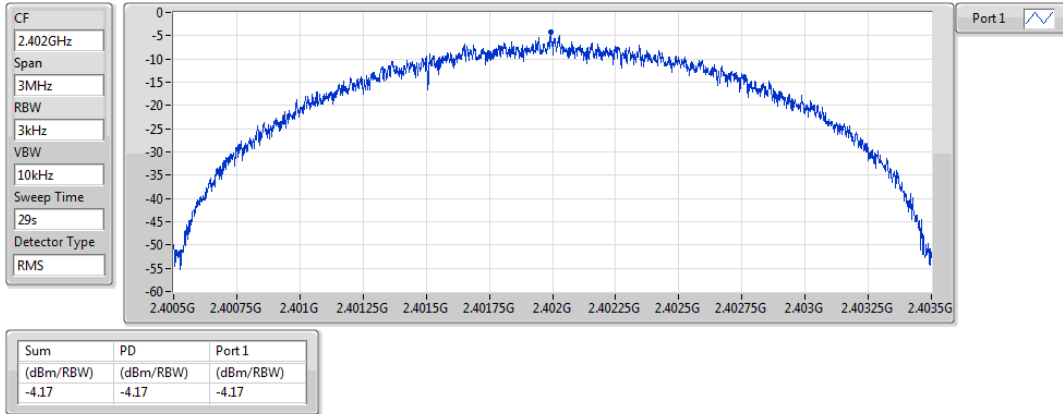
2480MHz



BT-LE(2Mbps)

PSD

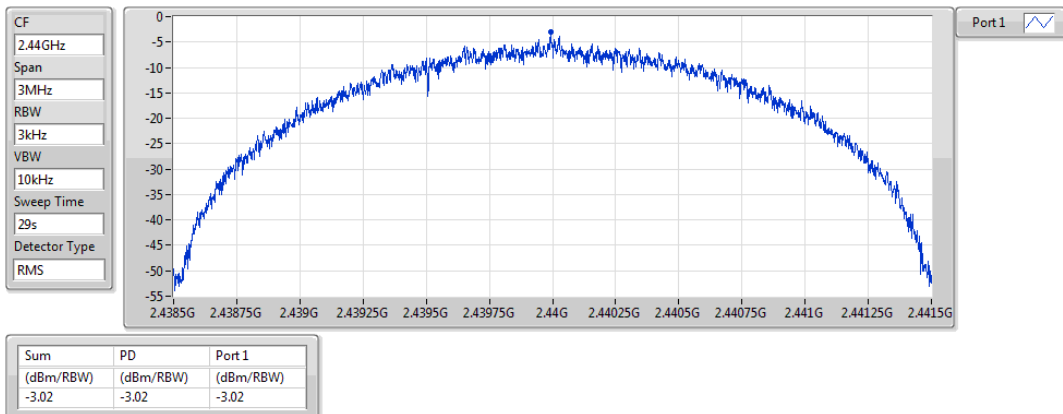
2402MHz



BT-LE(2Mbps)

PSD

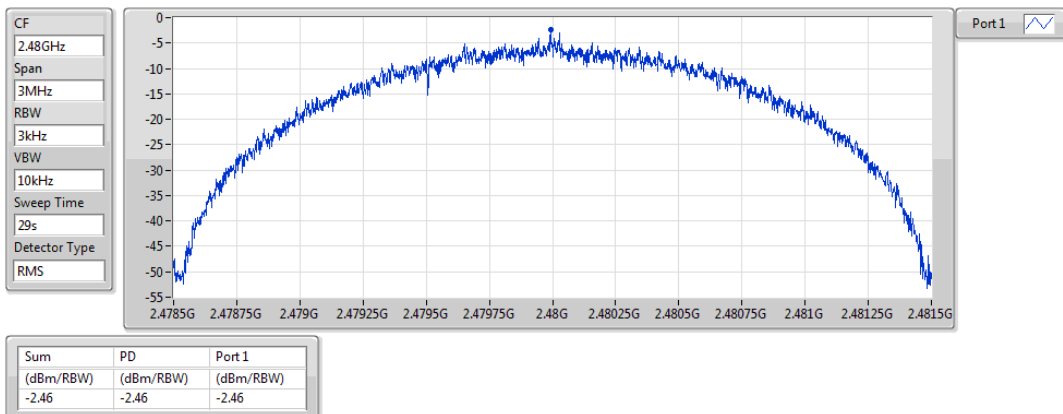
2440MHz



BT-LE(2Mbps)

PSD

2480MHz



Lowest power level

3.4.5 Test Result of Power Spectral Density

Summary

Mode	PD (dBm/RBW)
2.4-2.4835GHz	-
BT-LE0.125_Nss1_1TX	-30.88
BT-LE(1Mbps)	-44.85
BT-LE(2Mbps)	-45.85

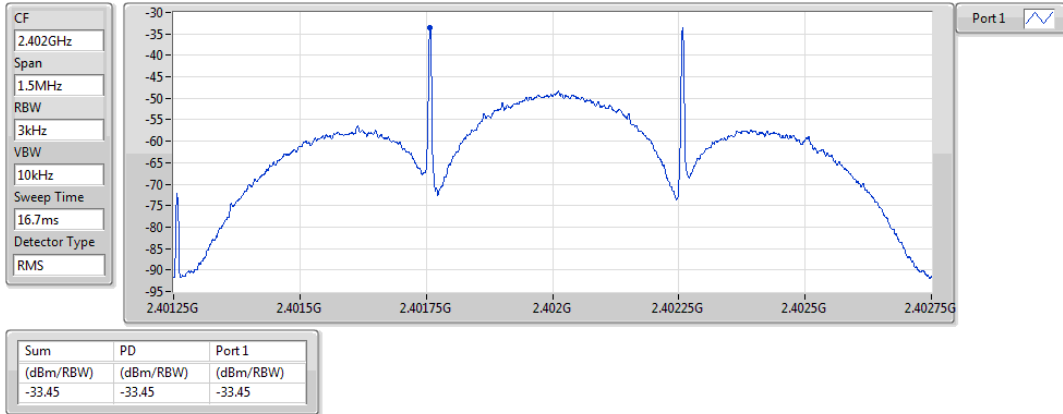
Result

Mode	Result	Gain (dBi)	PD (dBm/RBW)	PD Limit (dBm/RBW)
BT-LE0.125_Nss1_1TX	-	-	-	-
2402MHz	Pass	2.00	-33.45	8.00
2440MHz	Pass	2.00	-32.60	8.00
2480MHz	Pass	2.00	-30.88	8.00
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	-46.69	8.00
2440MHz	Pass	2.00	-45.91	8.00
2480MHz	Pass	2.00	-44.85	8.00
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	2.00	-48.63	8.00
2440MHz	Pass	2.00	-47.85	8.00
2480MHz	Pass	2.00	-45.85	8.00

BT-LE0.125_Nss1_1TX

PSD

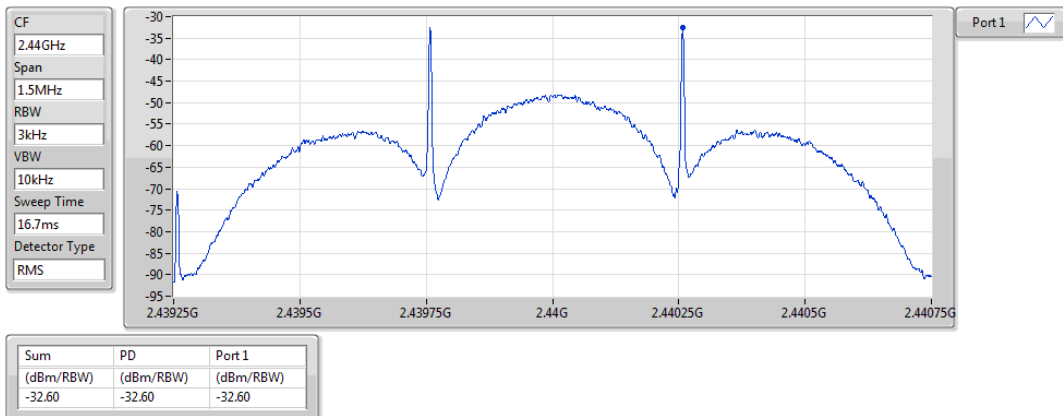
2402MHz



BT-LE0.125_Nss1_1TX

PSD

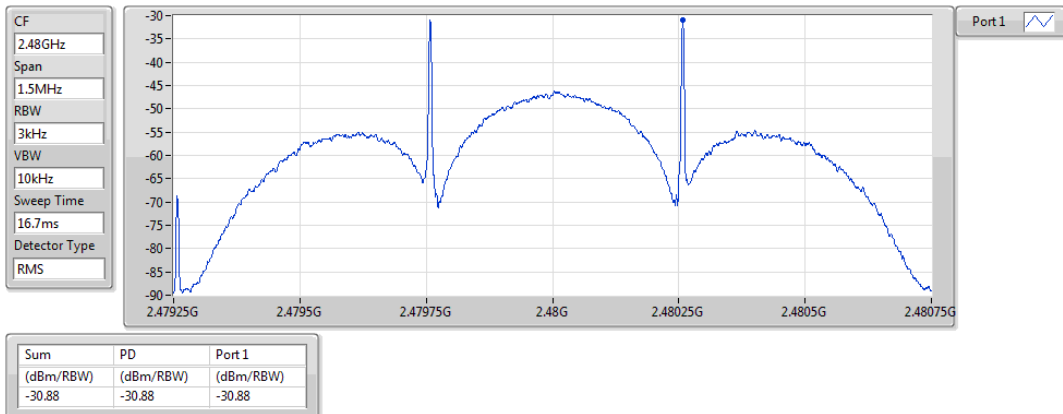
2440MHz



BT-LE0.125_Nss1_1TX

PSD

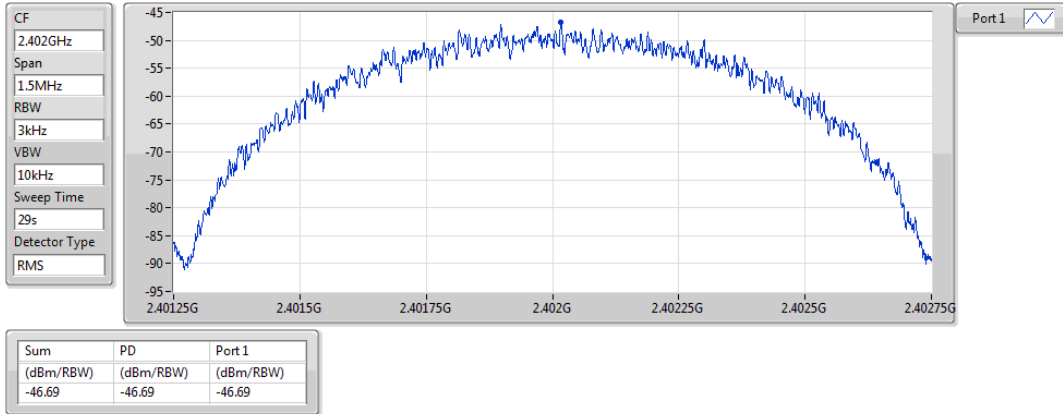
2480MHz



BT-LE(1Mbps)

PSD

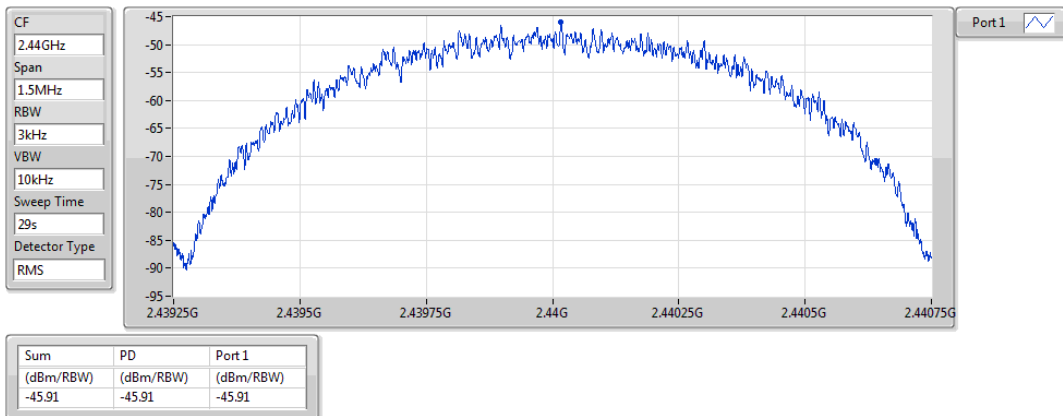
2402MHz



BT-LE(1Mbps)

PSD

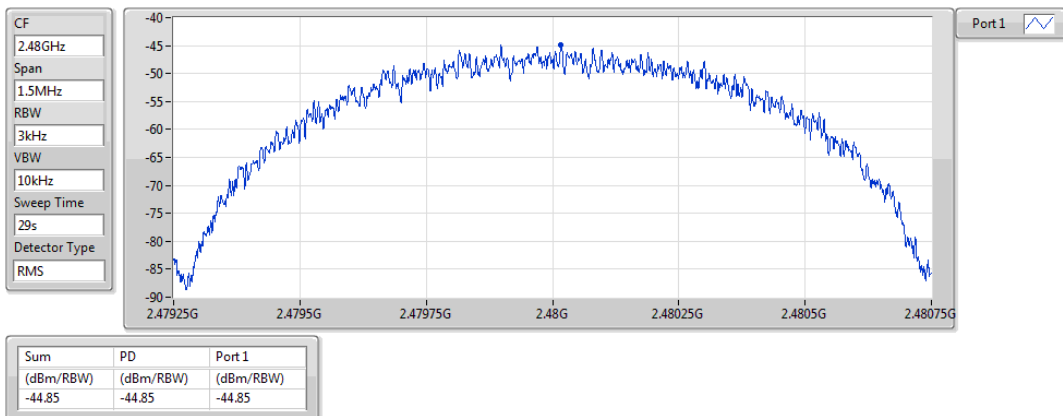
2440MHz



BT-LE(1Mbps)

PSD

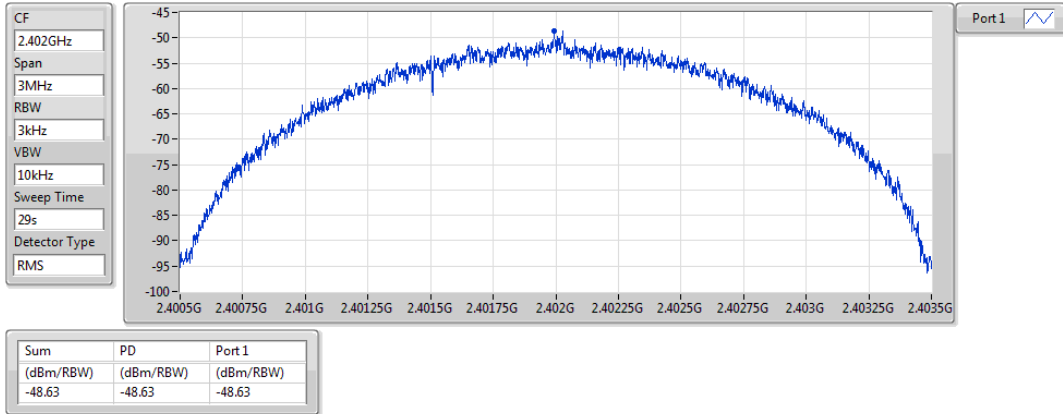
2480MHz



BT-LE(2Mbps)

PSD

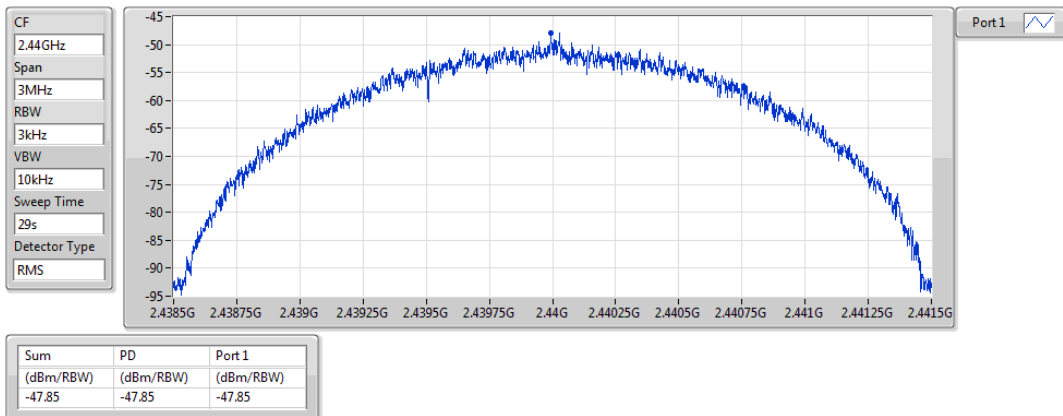
2402MHz



BT-LE(2Mbps)

PSD

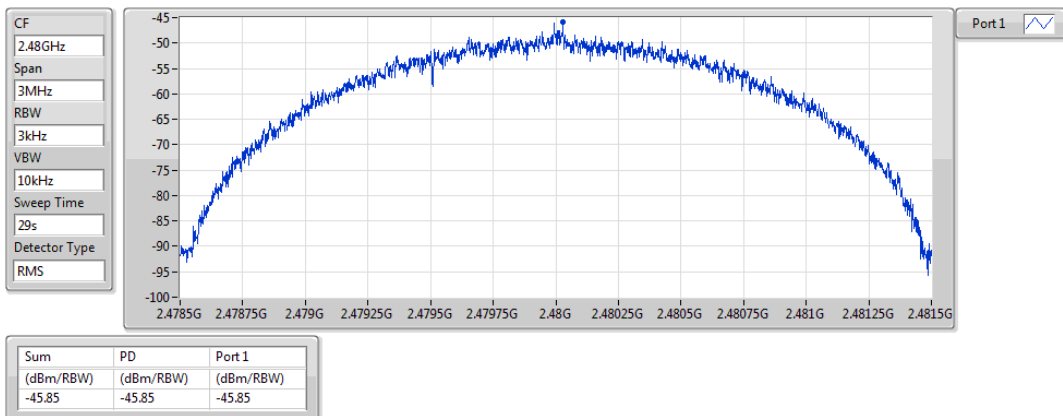
2440MHz



BT-LE(2Mbps)

PSD

2480MHz



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

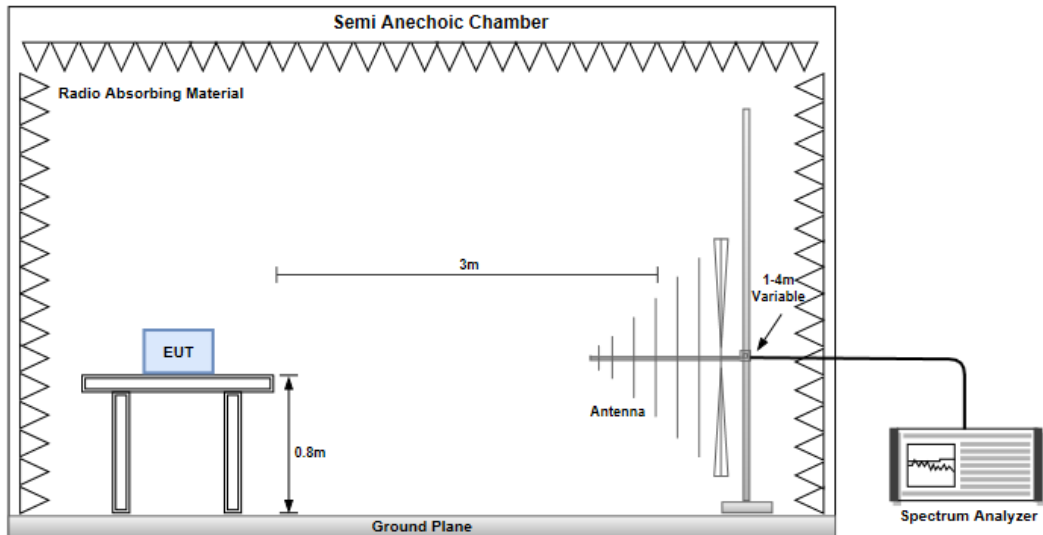
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission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

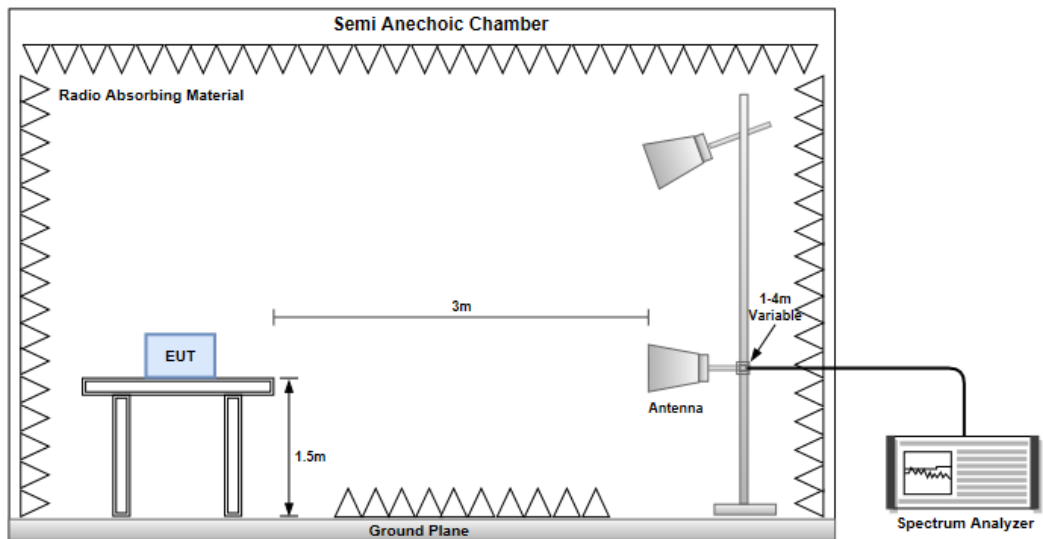
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above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

3.5.3 Test Setup

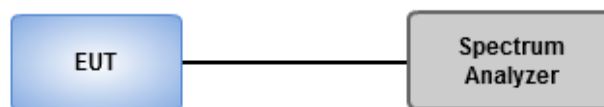
Radiated Emissions below 1 GHz



Radiated Emissions above 1 GHz



Conducted Emissions



Highest power level

3.5.4 Transmitter Conducted Unwanted Emissions (Below 1 GHz)

Modulation Mode		BT LE-125kbps		Frequency	2480MHz		
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000MHz	-65.99	2.00	4.70	-59.29	35.97	40.00	-4.03

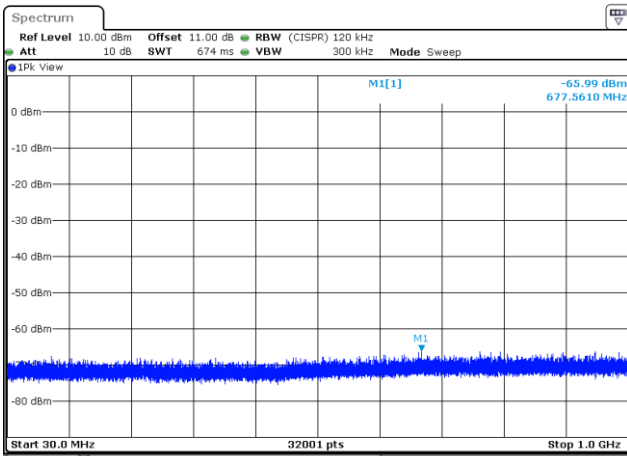
Modulation Mode		BT LE-1Mbps		Frequency	2480MHz		
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000MHz	-65.40	2.00	4.70	-58.70	36.56	40.00	-3.44

Modulation Mode		BT LE-2Mbps		Frequency	2480MHz		
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000MHz	-65.73	2.00	4.70	-59.03	36.23	40.00	-3.77

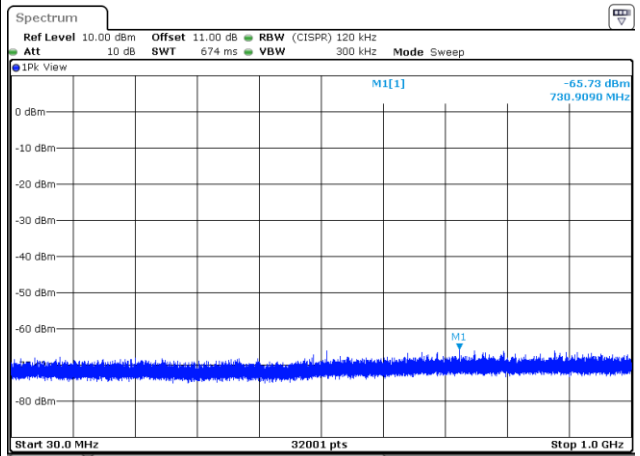
Note:

1. GRF = Ground Reflection Factor
2. DG = Directional Gain.
3. Worst case of emission limit below 1GHz is selected to be limit.
4. $E\text{-Field} = EIRP - 20\log(3) + 104.8$

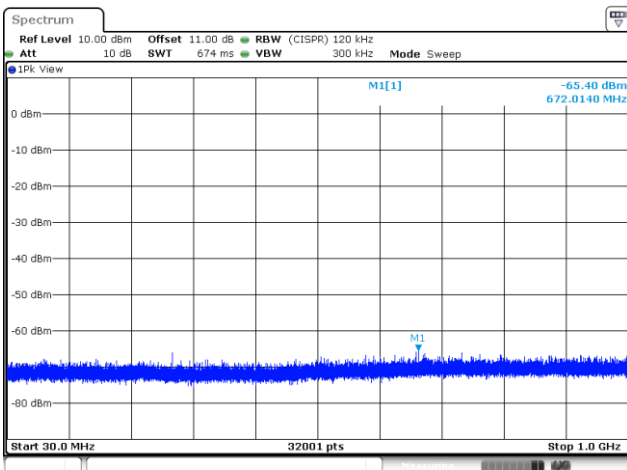
BT LE-125kbps



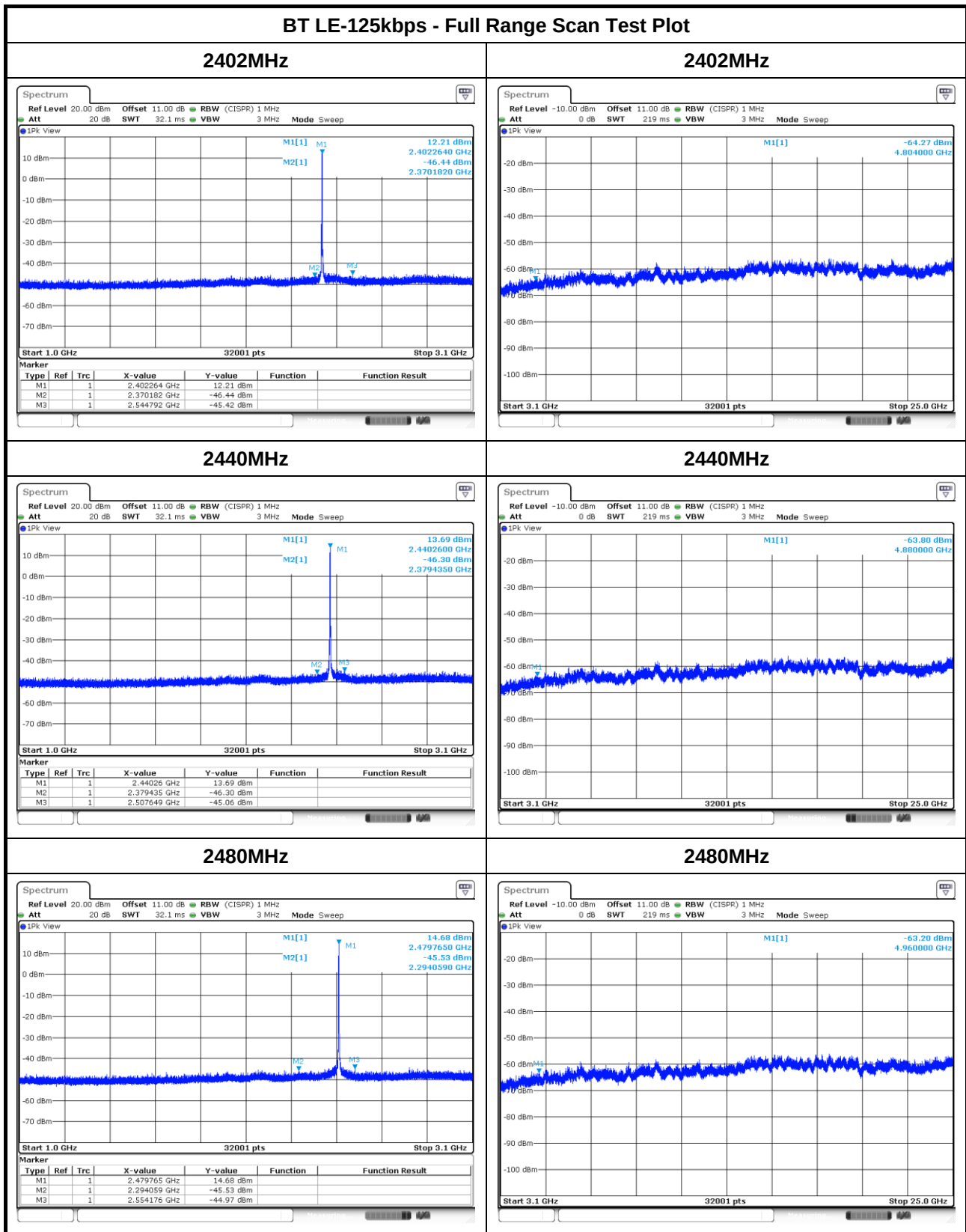
BT LE-2Mbps



BT LE-1Mbps

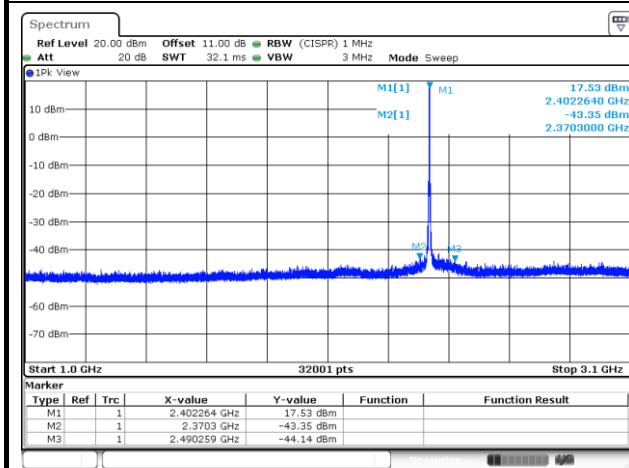


3.5.5 Transmitter Conducted Unwanted Emissions (Above 1GHz)

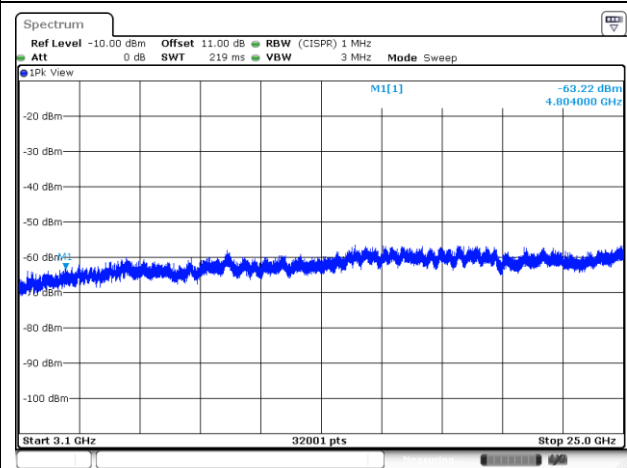


BT LE-1Mbps - Full Range Scan Test Plot

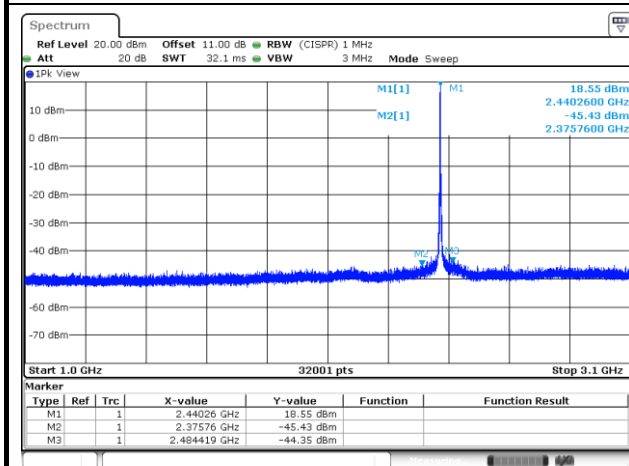
2402MHz



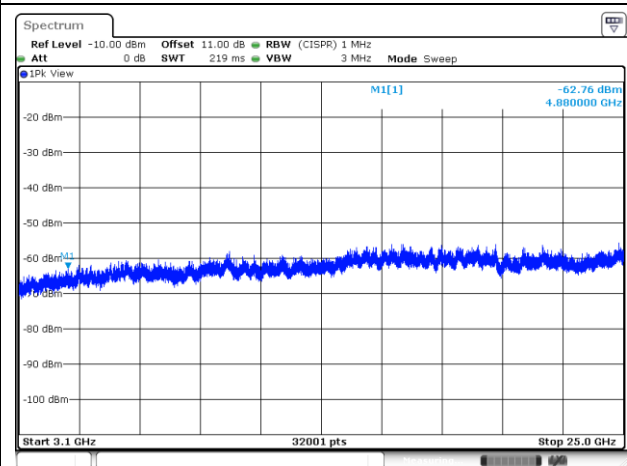
2402MHz



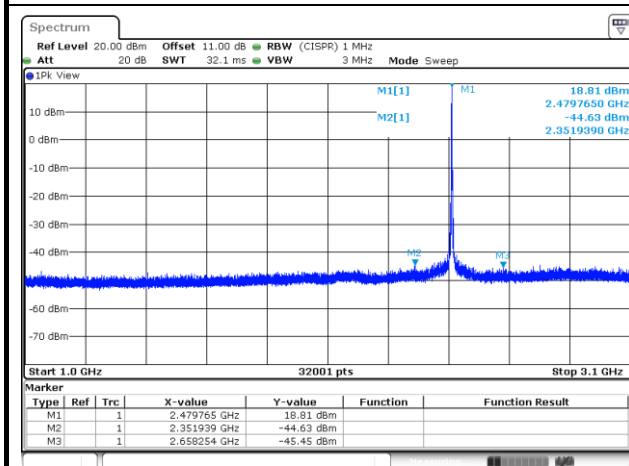
2440MHz



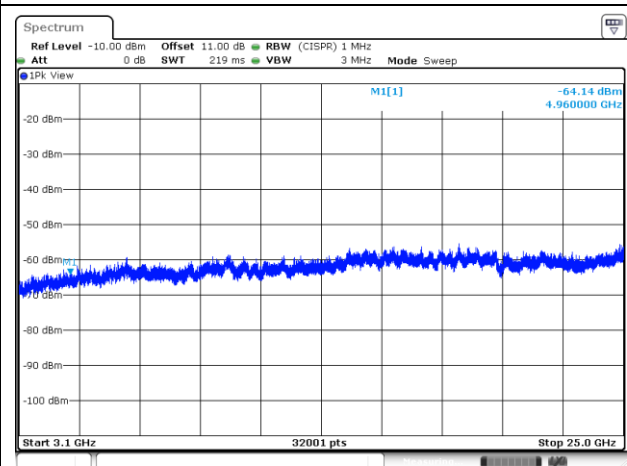
2440MHz



2480MHz

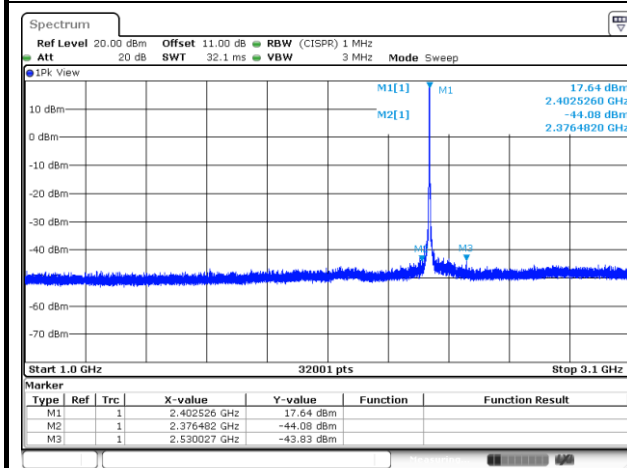


2480MHz

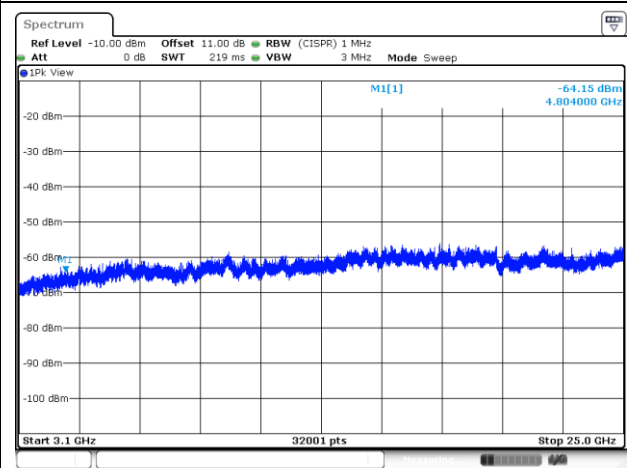


BT LE-2Mbps - Full Range Scan Test Plot

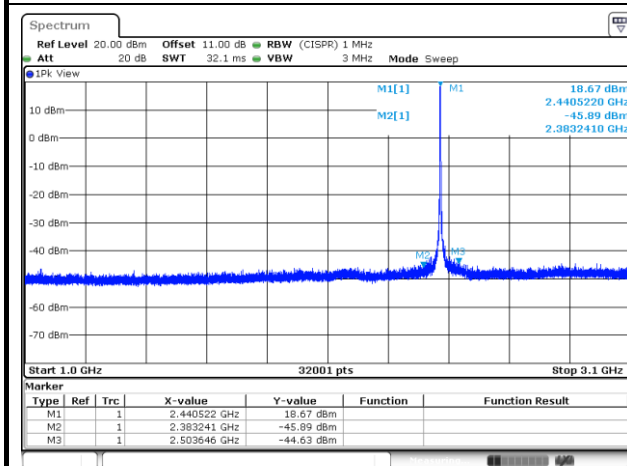
2402MHz



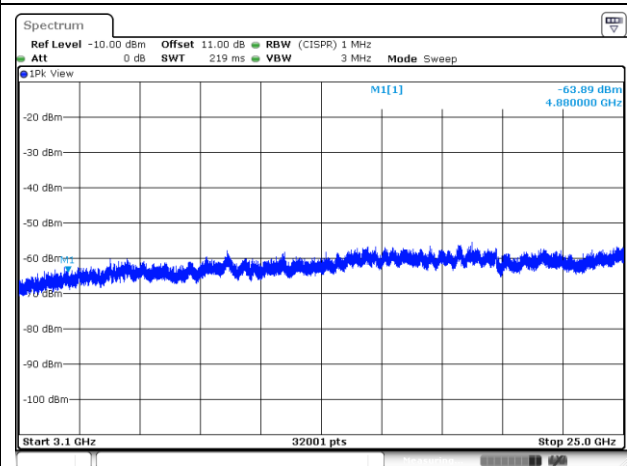
2402MHz



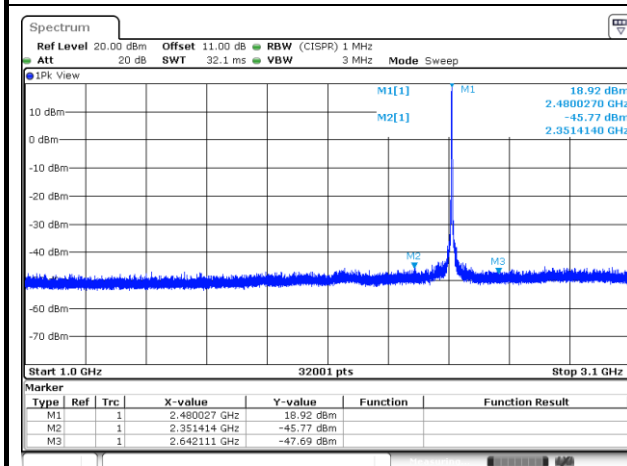
2440MHz



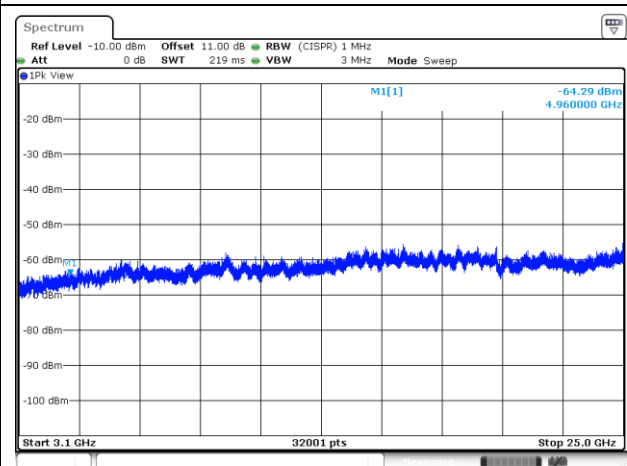
2440MHz



2480MHz



2480MHz



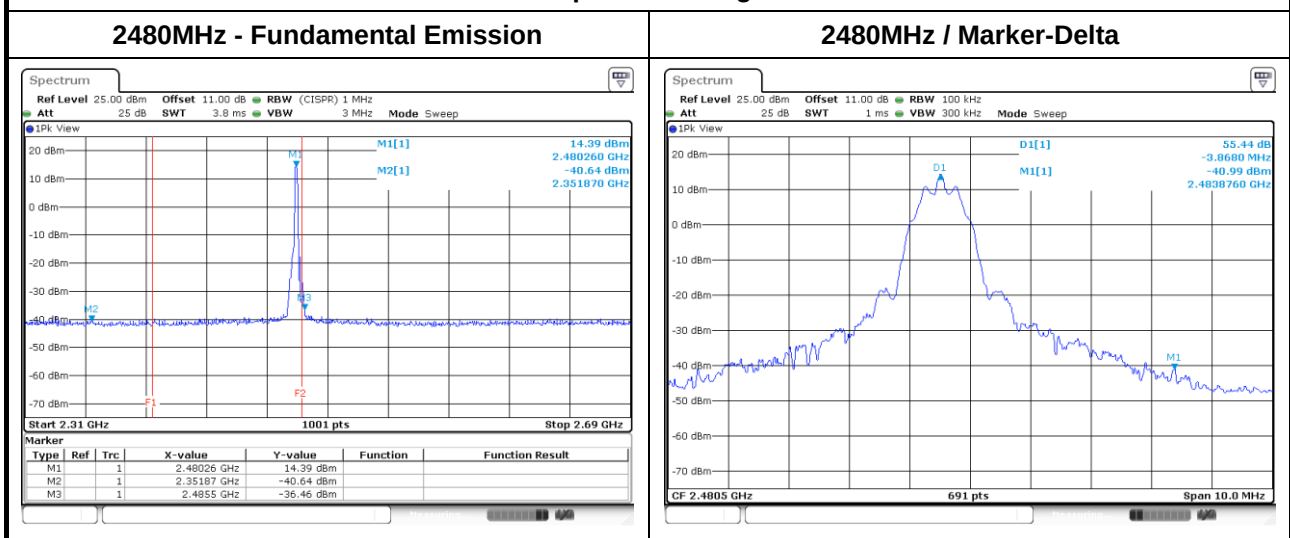
Transmitter Conducted Unwanted Emissions Results in Band Edge

Modulation Mode		BLE 125kbps						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-40.16	2.00	-38.16	57.10	74.00	-16.90	PK
	2310~2390	-52.35	2.00	-50.35	44.91	54.00	-9.09	AV
	2483.5~2690	-39.34	2.00	-37.34	57.92	74.00	-16.08	PK
	2483.5~2690	-53.41	2.00	-51.41	43.85	54.00	-10.15	AV
2440	2310~2390	-40.42	2.00	-38.42	56.84	74.00	-17.16	PK
	2310~2390	-53.84	2.00	-51.84	43.42	54.00	-10.58	AV
	2483.5~2690	-39.31	2.00	-37.31	57.95	74.00	-16.05	PK
	2483.5~2690	-51.68	2.00	-49.68	45.58	54.00	-8.42	AV
2480	2310~2390	-40.64	2.00	-38.64	56.62	74.00	-17.38	PK
	2310~2390	-52.20	2.00	-50.20	45.06	54.00	-8.94	AV
	2483.5~2485.5	-41.05 ^{note3}	2.00	-39.05	56.21	74.00	-17.79	PK
	2483.5~2485.5	-46.50	2.00	-44.50	50.76	54.00	-3.24	AV
	2485.5~2690	-36.46	2.00	-34.46	60.80	74.00	-13.20	PK
	2485.5~2690	-51.26	2.00	-49.26	46.00	54.00	-8.00	AV

Note:

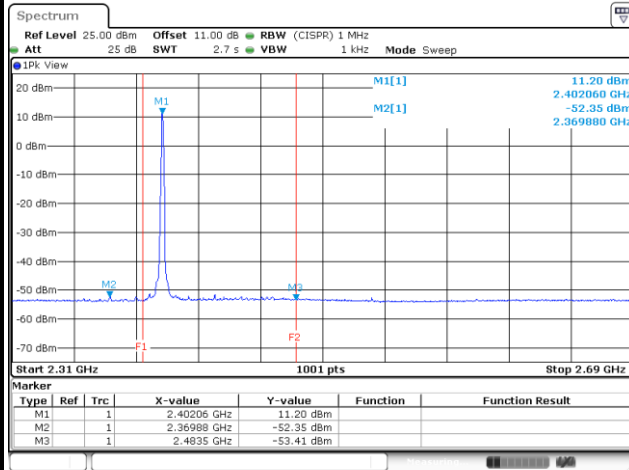
1. DG = Directional Gain.
2. E-Field = EIRP – 20log(3) + 104.8
3. Delta mark method is used to determine PK value. PK value = 14.39 dBm – 55.44 dB = -41.05 dBm

BT LE-125kbps - Band Edge Test Plot

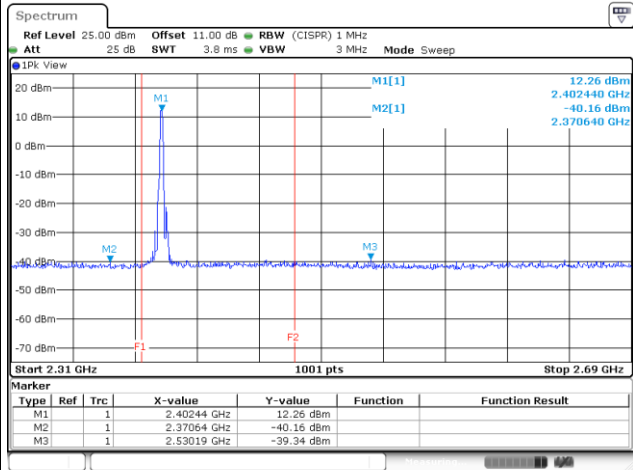


BT LE-125kbps - Band Edge Test Plot

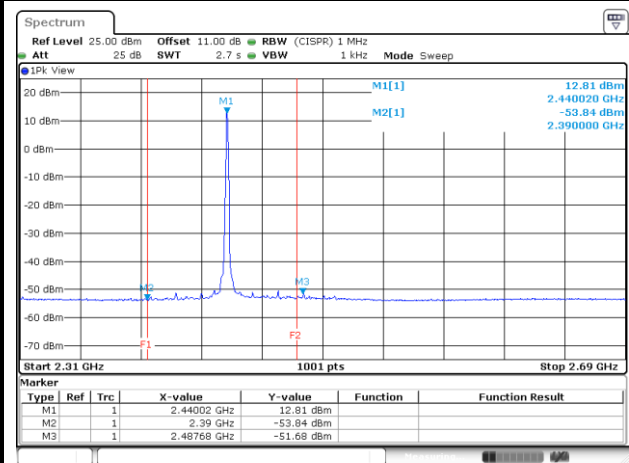
2402MHz - AV



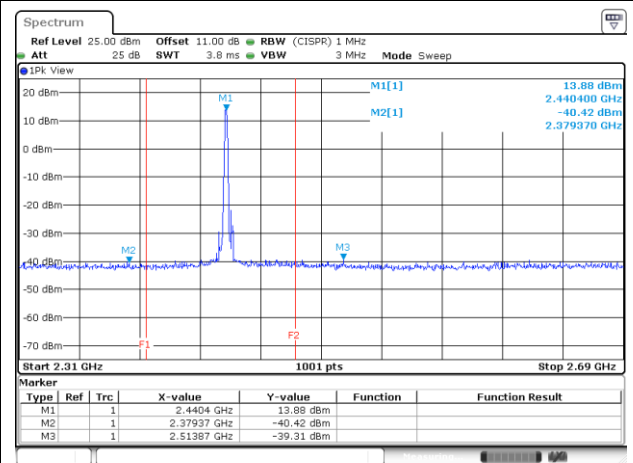
2402MHz - PK



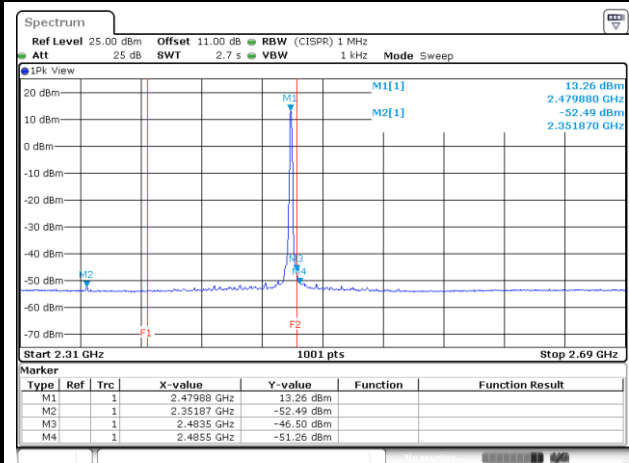
2440MHz - AV



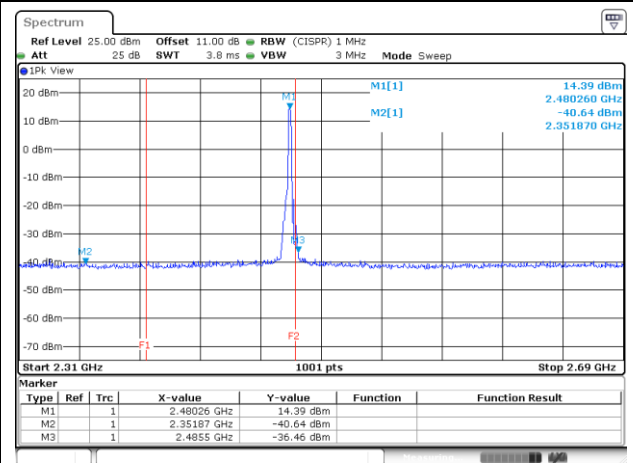
2440MHz - PK



2480MHz - AV



2480MHz - PK



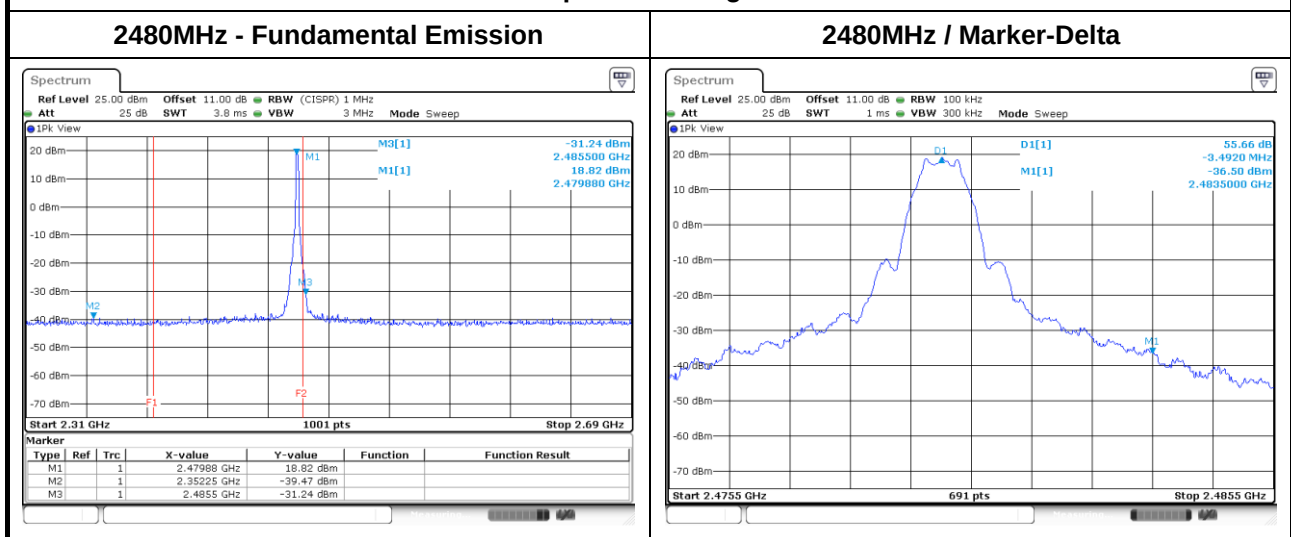
Transmitter Conducted Unwanted Emissions Results in Band Edge

Modulation Mode		BLE 1Mbps						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-39.87	2.00	-37.87	57.39	74.00	-16.61	PK
	2310~2390	-49.35	2.00	-47.35	47.91	54.00	-6.09	AV
	2483.5~2690	-40.51	2.00	-38.51	56.75	74.00	-17.25	PK
	2483.5~2690	-51.77	2.00	-49.77	45.49	54.00	-8.51	AV
2440	2310~2390	-39.70	2.00	-37.70	57.56	74.00	-16.44	PK
	2310~2390	-51.67	2.00	-49.67	45.59	54.00	-8.41	AV
	2483.5~2690	-39.14	2.00	-37.14	58.12	74.00	-15.88	PK
	2483.5~2690	-49.60	2.00	-47.60	47.66	54.00	-6.34	AV
2480	2310~2390	-39.47	2.00	-37.47	57.79	74.00	-16.21	PK
	2310~2390	-50.37	2.00	-48.37	46.89	54.00	-7.11	AV
	2483.5~2485.5	-36.84 ^{note3}	2.00	-34.84	60.42	74.00	-13.58	PK
	2483.5~2485.5	-49.49 ^{note4}	2.00	-47.49	47.77	54.00	-6.23	AV
	2485.5~2690	-31.24	2.00	-29.24	66.02	74.00	-7.98	PK
	2485.5~2690	-43.89 ^{note5}	2.00	-41.89	53.37	54.00	-0.63	AV

Note:

1. DG = Directional Gain.
2. E-Field = EIRP – 20log(3) + 104.8
3. Delta mark method is used to determine PK value. PK value = 18.82 dBm – 55.66 dB = -36.84 dBm
4. AV value = PK + DCCF= -36.84 dBm + (-12.65 dB) = -49.49 dBm
5. AV value = PK + DCCF= -31.24 dBm + (-12.65 dB) = -43.89 dBm

BT LE-1Mbps - Band Edge Test Plot



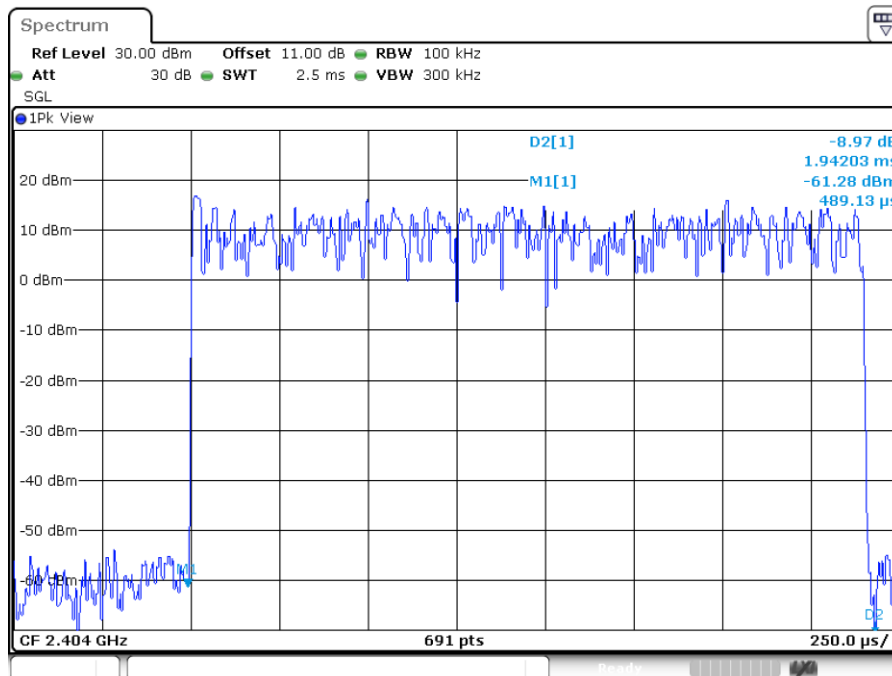
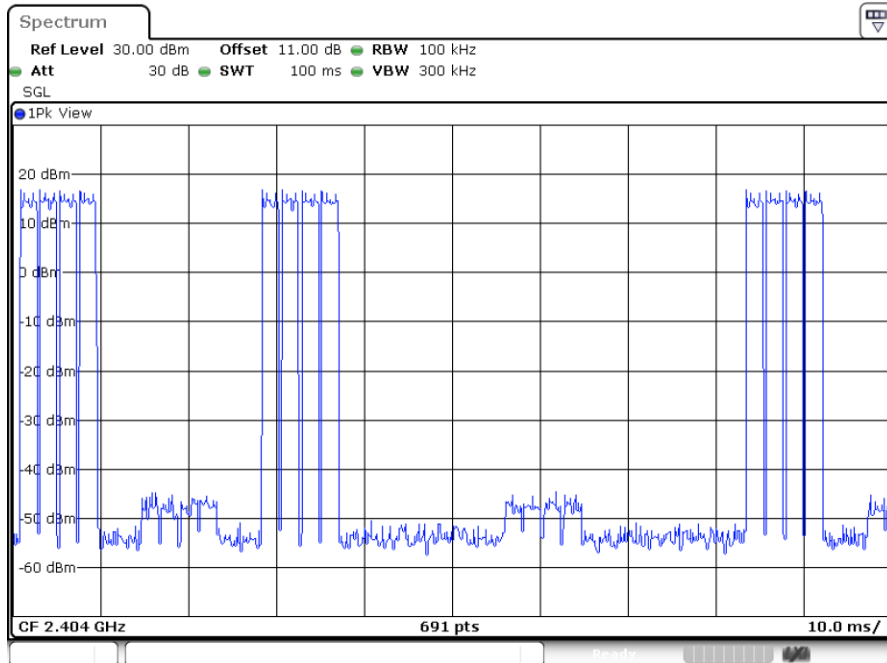
BT LE-1Mbps - Duty cycle of normal operation

HIGH BANDWIDTH setting *

0

Maximum Packet (PDU) length allowed

225bytes

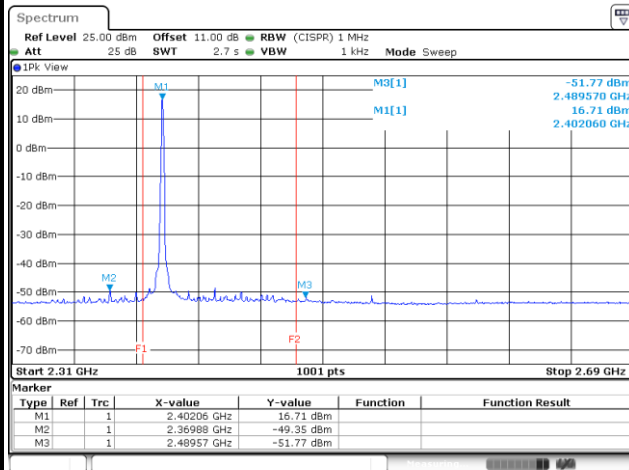


$$20\log (\text{Duty cycle}) = 20\log \frac{1.94203\text{ms} \times 4(\text{packets}) \times 3(\text{transmissions per 100ms})}{100 \text{ ms}} = -12.65 \text{ dB}$$

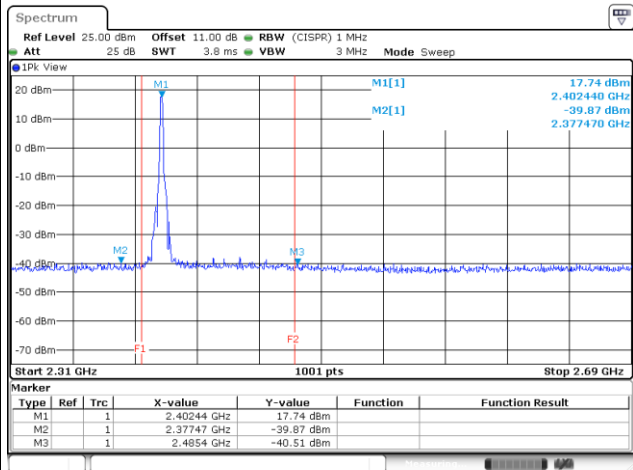
*HIGH BANDWIDTH setting means, the number pf packets produced per BLE connection interval.

BT LE-1Mbps - Band Edge Test Plot

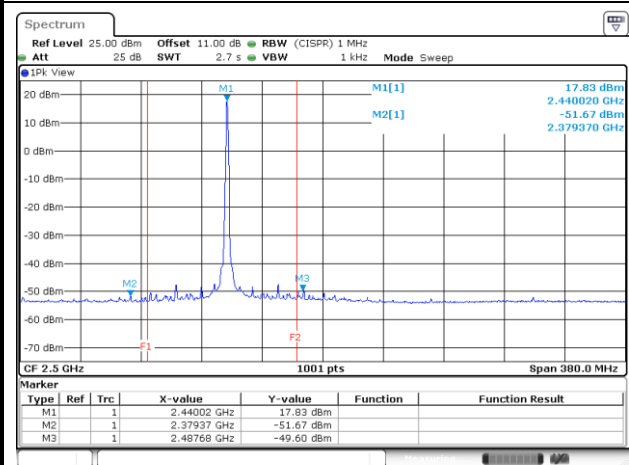
2402MHz - AV



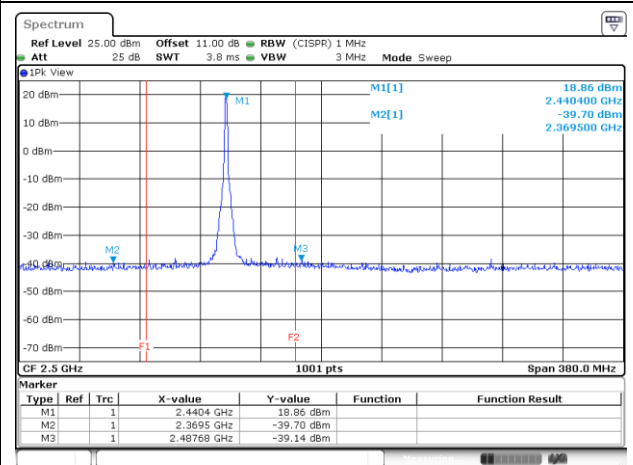
2402MHz - PK



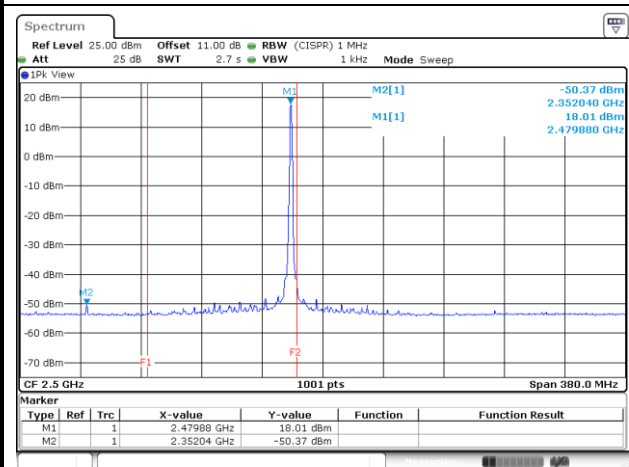
2440MHz - AV



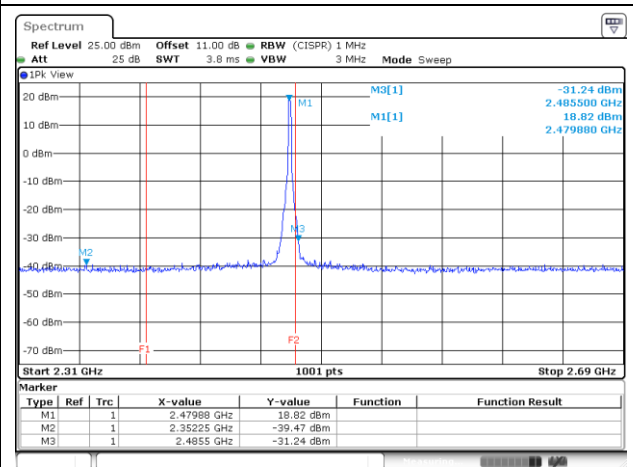
2440MHz - PK



2480MHz - AV



2480MHz - PK



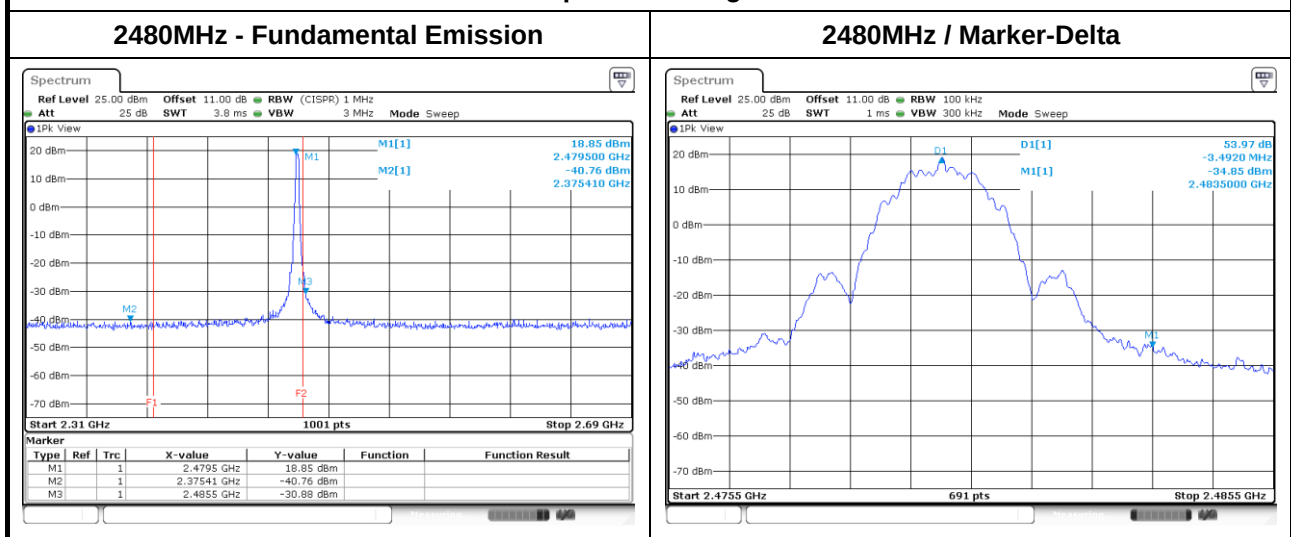
Transmitter Conducted Unwanted Emissions Results in Band Edge

Modulation Mode		BLE 2Mbps						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-37.01	2.00	-35.01	60.25	74.00	-13.75	PK
	2310~2390	-49.72	2.00	-47.72	47.54	54.00	-6.46	AV
	2483.5~2690	-39.76	2.00	-37.76	57.50	74.00	-16.50	PK
	2483.5~2690	-51.82	2.00	-49.82	45.44	54.00	-8.56	AV
2440	2310~2390	-40.38	2.00	-38.38	56.88	74.00	-17.12	PK
	2310~2390	-52.13	2.00	-50.13	45.13	54.00	-8.87	AV
	2483.5~2690	-39.05	2.00	-37.05	58.21	74.00	-15.79	PK
	2483.5~2690	-50.29	2.00	-48.29	46.97	54.00	-7.03	AV
2480	2310~2390	-40.76	2.00	-38.76	56.50	74.00	-17.50	PK
	2310~2390	-50.54	2.00	-48.54	46.72	54.00	-7.28	AV
	2483.5~2485.5	-35.12 ^{note3}	2.00	-33.12	62.14	74.00	-11.86	PK
	2483.5~2485.5	-47.67 ^{note4}	2.00	-45.67	49.59	54.00	-4.41	AV
	2485.5~2690	-30.88	2.00	-28.88	66.38	74.00	-7.62	PK
	2485.5~2690	-43.43 ^{note5}	2.00	-41.43	53.83	54.00	-0.17	AV

Note:

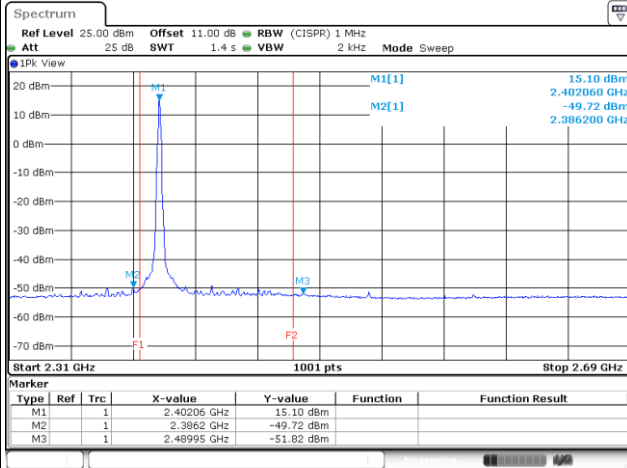
1. DG = Directional Gain.
2. E-Field = EIRP – 20log(3) + 104.8
3. Delta mark method is used to determine PK value. PK value = 18.85 dBm – 53.97 dB = -35.12 dBm
4. AV value = PK + DCCF= -35.12 dBm + (-12.55 dB) = -47.67 dBm
5. AV value = PK + DCCF= -30.88 dBm + (-12.55 dB) = -43.43 dBm

BT LE-2Mbps - Band Edge Test Plot

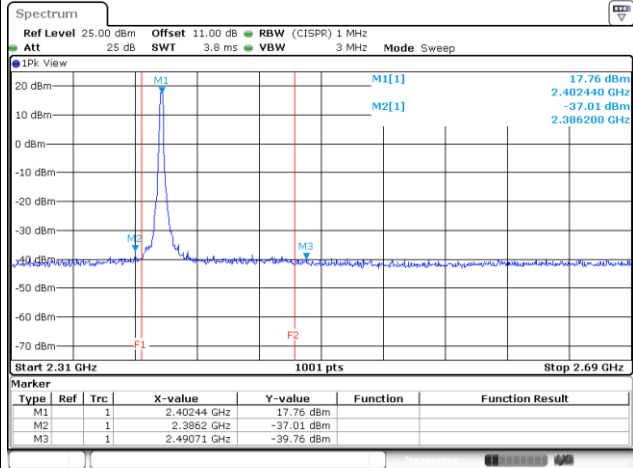


BT LE-2Mbps - Band Edge Test Plot

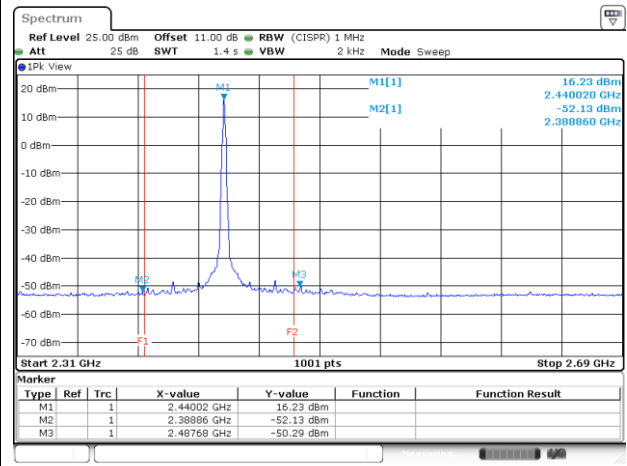
2402MHz - AV



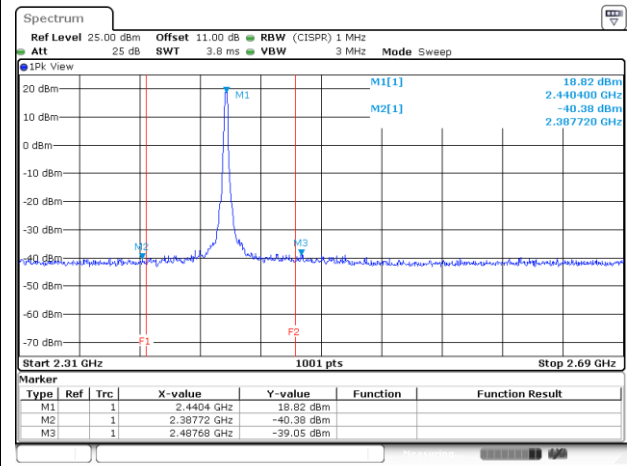
2402MHz - PK



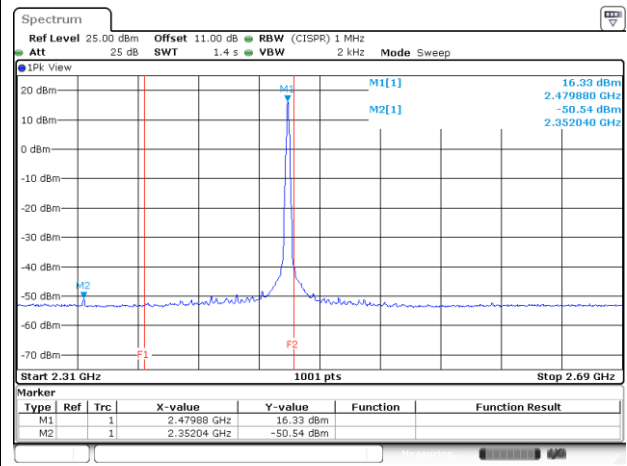
2440MHz - AV



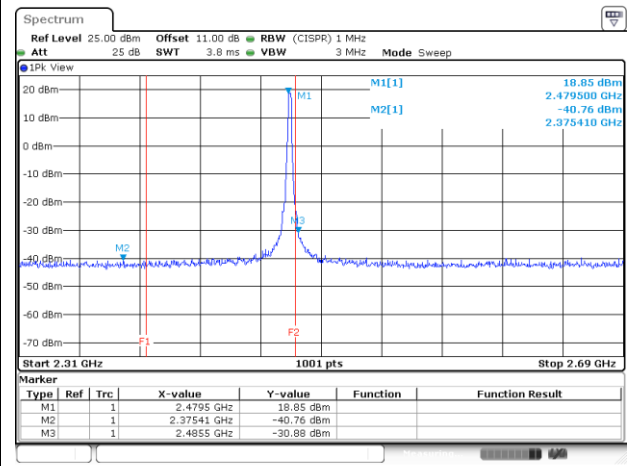
2440MHz - PK



2480MHz - AV



2480MHz - PK



Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-125kbps		Frequency		2402MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4804.00	PK	-62.24	2.00	-60.24	35.02	74.00	-38.98
4804.00	AV	-	2.00	-	-	54.00	-

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-125kbps		Frequency		2440MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4880.00	PK	-61.90	2.00	-59.90	35.36	74.00	-38.64
4880.00	AV	-	2.00	-	-	54.00	-

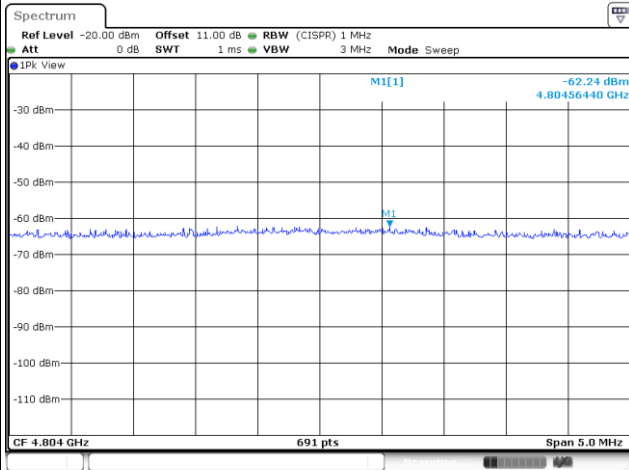
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-125kbps		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4960.00	PK	-62.08	2.00	-60.08	35.18	74.00	-38.82
4960.00	AV	-	2.00	-	-	54.00	-

Note:

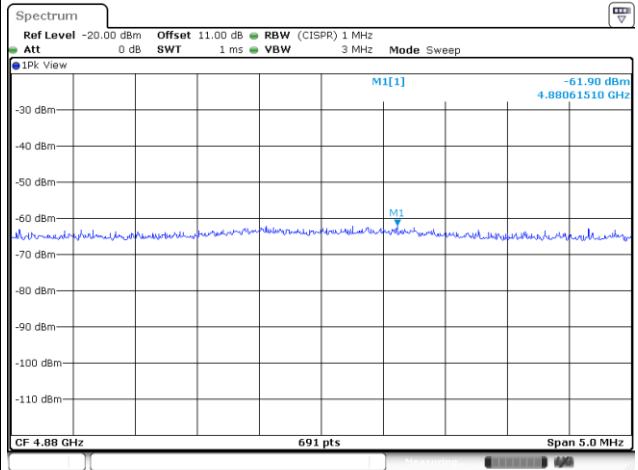
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain
3. E-Field = EIRP – 20log(3) + 104.8

BT LE-125kbps - Test Plots

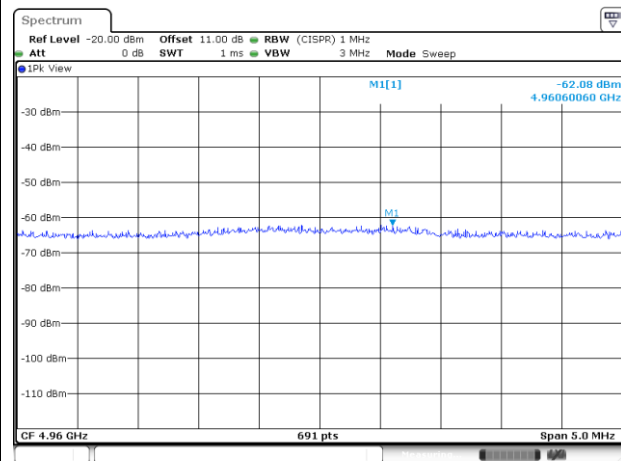
2402MHz - 4804MHz - PK



2440MHz 4880MHz - PK



2480 MHz - 4960MHz - PK



Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-1Mbps		Frequency		2402MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4804.00	PK	-60.99	2.00	-58.99	36.27	74.00	-37.73
4804.00	AV	-	2.00	-	-	54.00	-

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-1Mbps		Frequency		2440MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4880.00	PK	-60.99	2.00	-58.99	36.27	74.00	-37.73
4880.00	AV	-	2.00	-	-	54.00	-

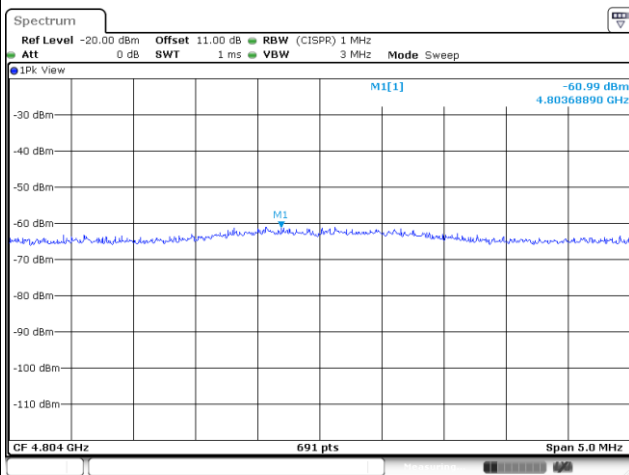
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-1Mbps		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4960.00	PK	-60.82	2.00	-58.82	36.44	74.00	-37.56
4960.00	AV	-	2.00	-	-	54.00	-

Note:

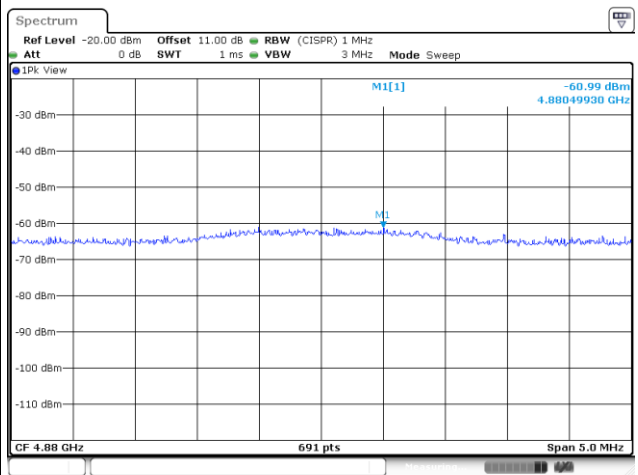
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain
3. E-Field = EIRP – 20log(3) + 104.8

BT LE-1Mbps - Test Plots

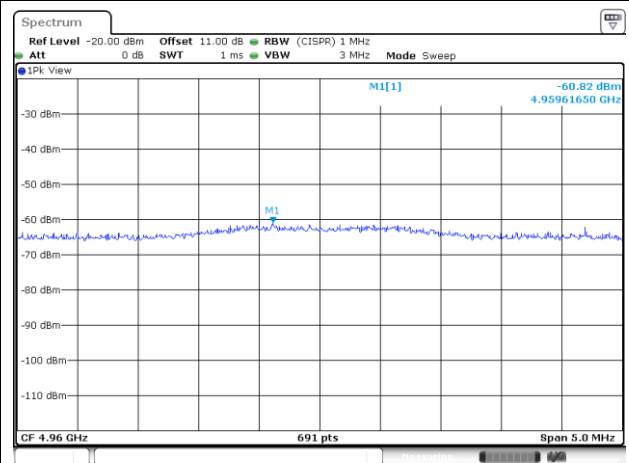
2402MHz - 4804MHz - PK



2440MHz 4880MHz - PK



2480 MHz - 4960MHz - PK



Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-2Mbps		Frequency		2402MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4804.00	PK	-61.30	2.00	-59.30	35.96	74.00	-38.04
4804.00	AV	-	2.00	-	-	54.00	-

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-2Mbps		Frequency		2440MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4880.00	PK	-61.94	2.00	-59.94	35.32	74.00	-38.68
4880.00	AV	-	2.00	-	-	54.00	-

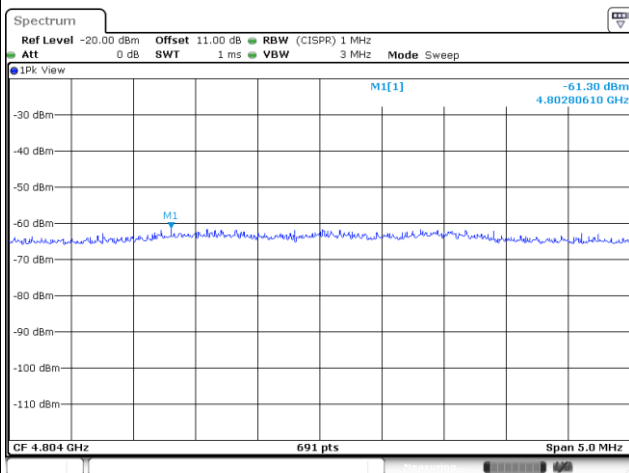
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-2Mbps		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4960.00	PK	-61.15	2.00	-59.15	36.11	74.00	-37.89
4960.00	AV	-	2.00	-	-	54.00	-

Note:

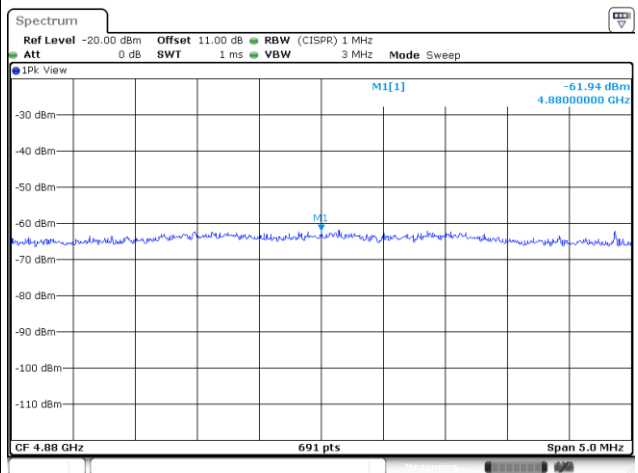
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain
3. E-Field = EIRP – 20log(3) + 104.8

BT LE-2Mbps - Test Plots

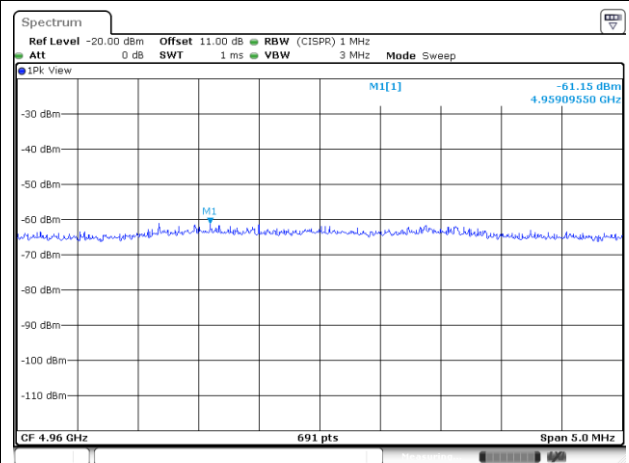
2402MHz - 4804MHz - PK



2440MHz 4880MHz - PK



2480 MHz - 4960MHz - PK



Lowest power level

3.5.6 Transmitter Conducted Unwanted Emissions (Below 1 GHz)

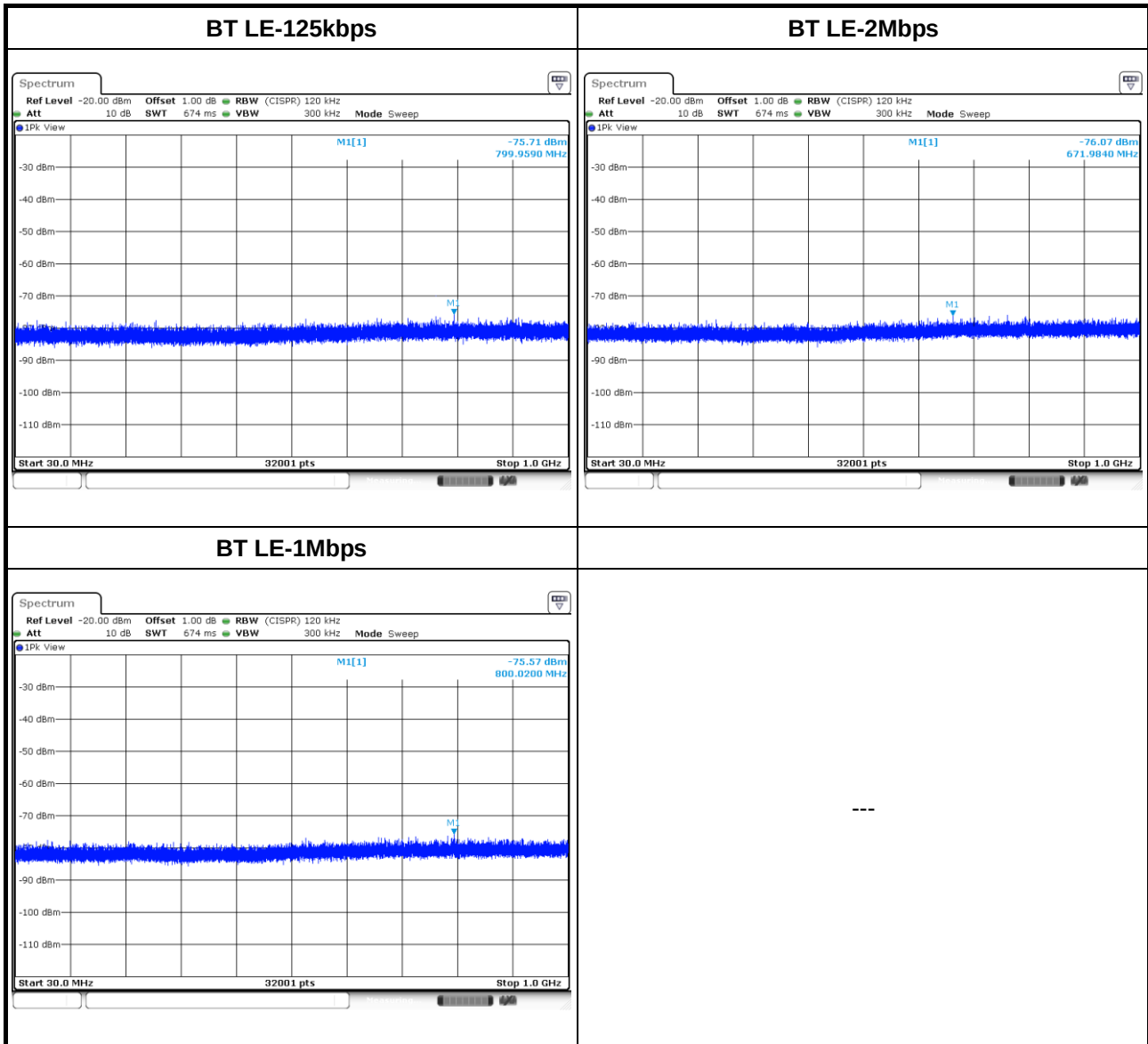
Modulation Mode		BT LE-125kbps		Frequency	2480MHz		
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000MHz	-75.71	2.00	4.70	-69.01	26.25	40.00	-13.75

Modulation Mode		BT LE-1Mbps		Frequency	2480MHz		
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000MHz	-75.57	2.00	4.70	-68.87	26.39	40.00	-13.61

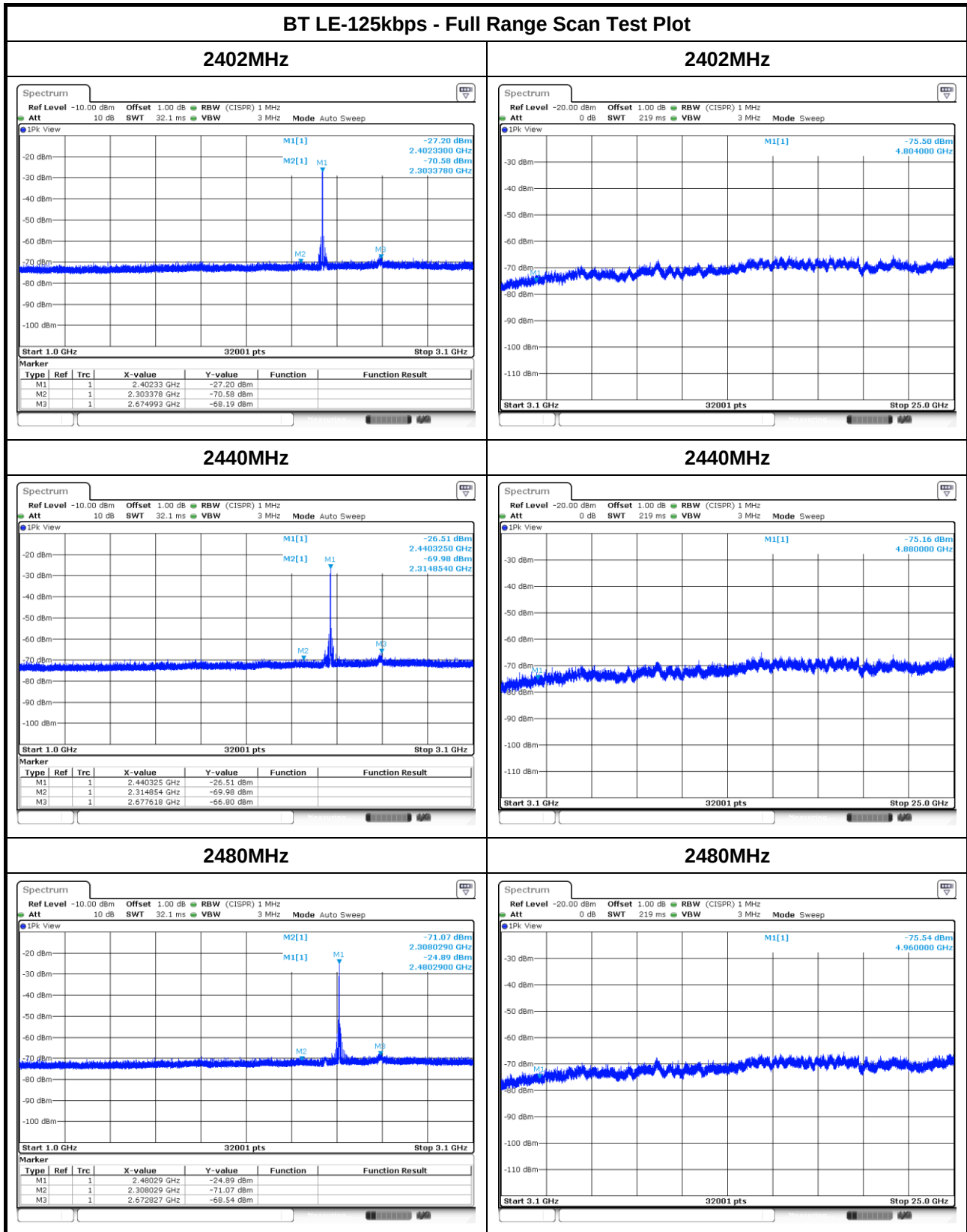
Modulation Mode		BT LE-2Mbps		Frequency	2480MHz		
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000MHz	-76.07	2.00	4.70	-69.37	25.89	40.00	-14.11

Note:

1. GRF = Ground Reflection Factor
2. DG = Directional Gain.
3. Worst case of emission limit below 1GHz is selected to be limit.
4. $E\text{-Field} = EIRP - 20\log(3) + 104.8$

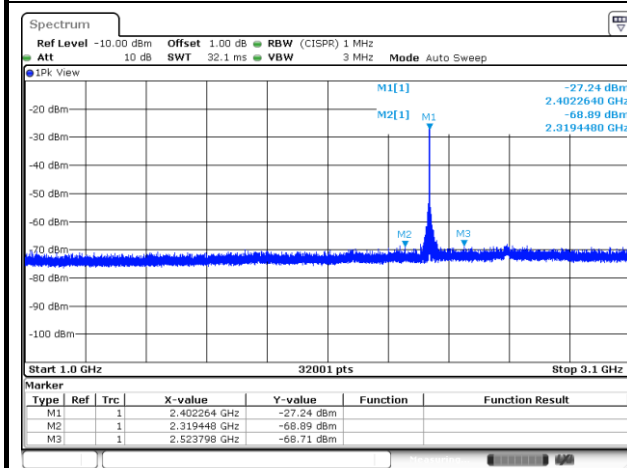


3.5.7 Transmitter Conducted Unwanted Emissions (Above 1GHz)

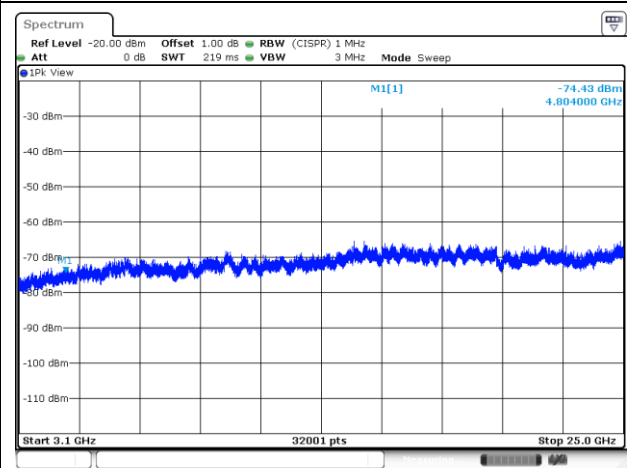


BT LE-1Mbps - Full Range Scan Test Plot

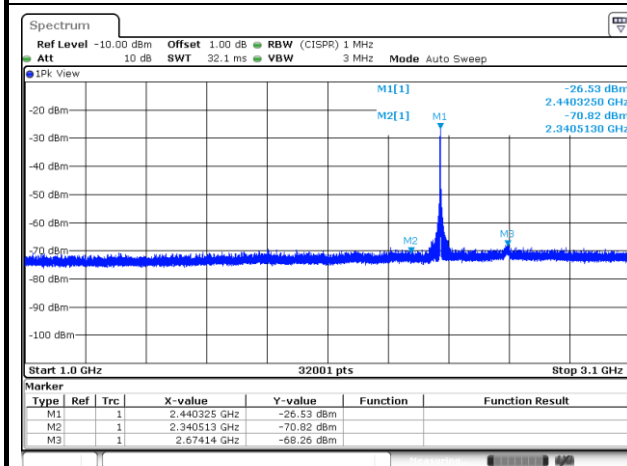
2402MHz



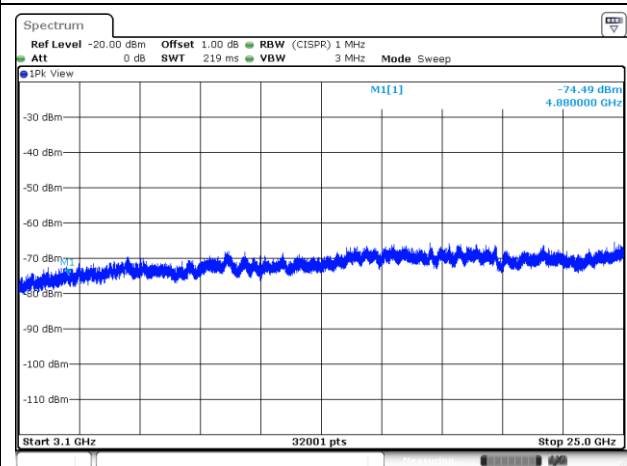
2402MHz



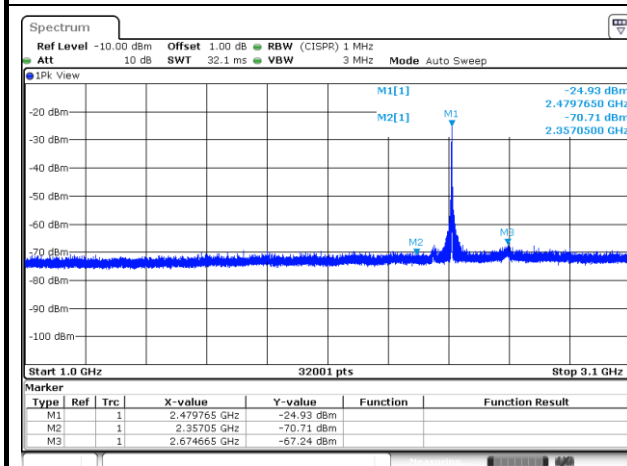
2440MHz



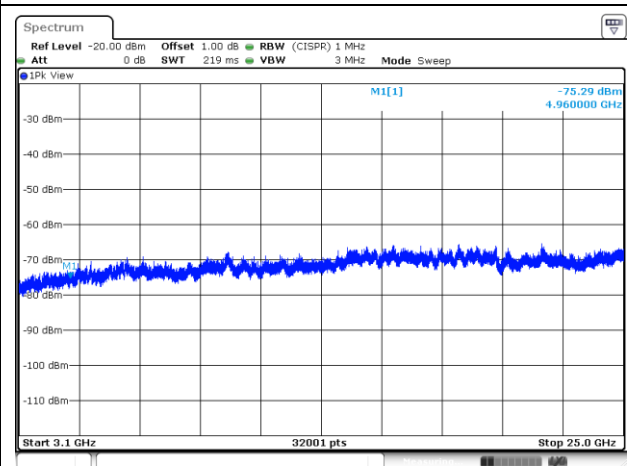
2440MHz



2480MHz

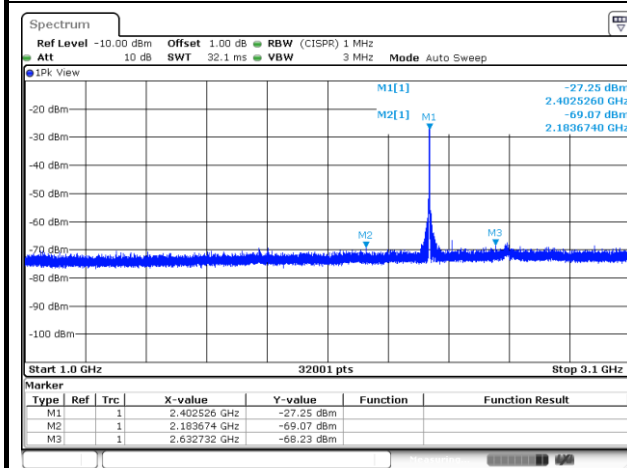


2480MHz

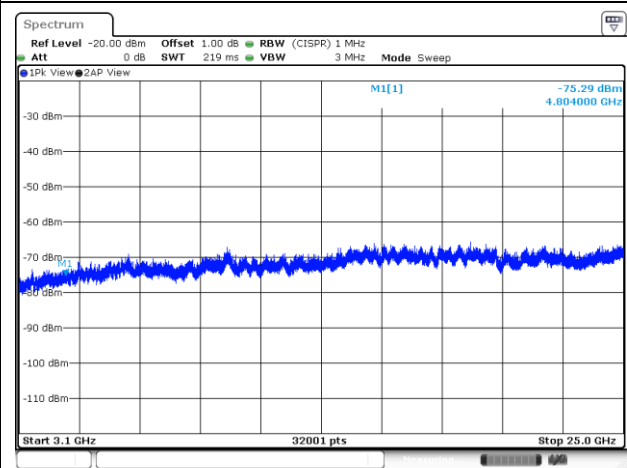


BT LE-2Mbps - Full Range Scan Test Plot

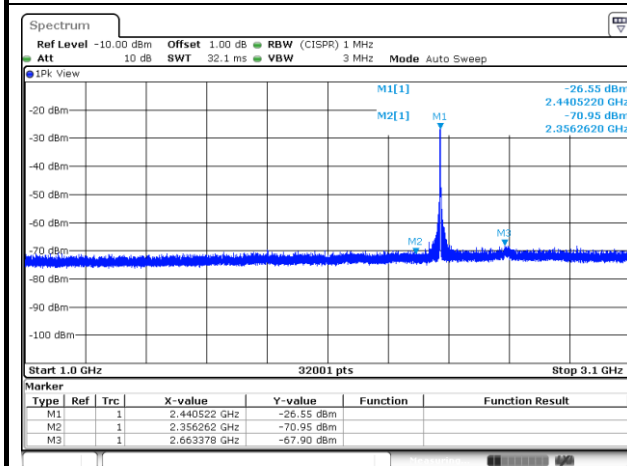
2402MHz



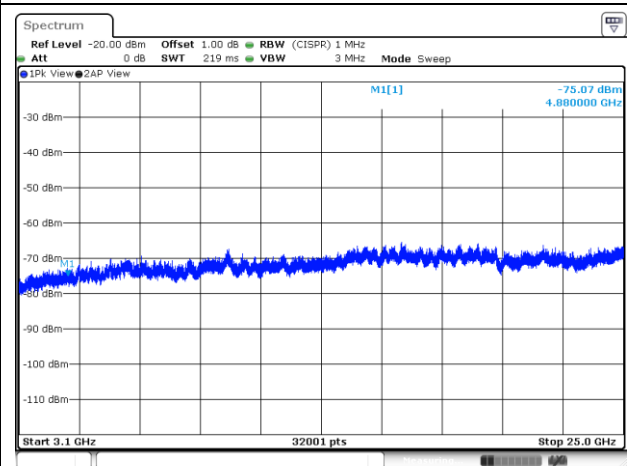
2402MHz



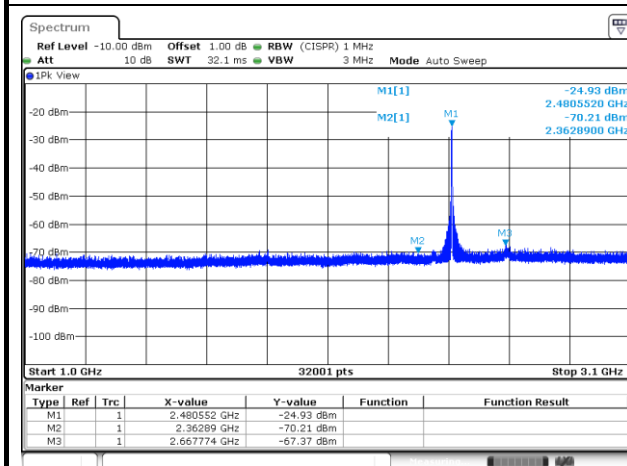
2440MHz



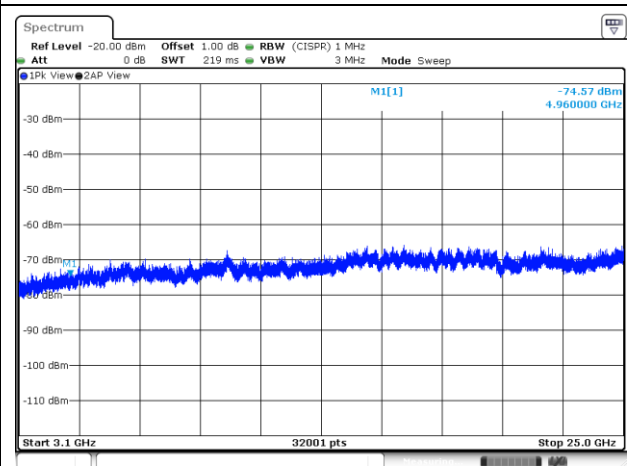
2440MHz



2480MHz



2480MHz



Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		BLE 125kbps						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-63.03	2.00	-61.03	34.23	74	-39.77	PK
	2310~2390	-83.17	2.00	-81.17	14.09	54	-39.91	AV
	2483.5~2500	-69.87	2.00	-67.87	27.39	74	-46.61	PK
	2483.5~2500	-82.69	2.00	-80.69	14.57	54	-39.43	AV
2440	2310~2390	-70.05	2.00	-68.05	27.21	74	-46.79	PK
	2310~2390	-83.33	2.00	-81.33	13.93	54	-40.07	AV
	2483.5~2500	-68.05	2.00	-66.05	29.21	74	-44.79	PK
	2483.5~2500	-82.84	2.00	-80.84	14.42	54	-39.58	AV
2480	2310~2390	-69.42	2.00	-67.42	27.84	74	-46.16	PK
	2310~2390	-83.04	2.00	-81.04	14.22	54	-39.78	AV
	2483.5~2500	-51.04	2.00	-49.04	46.22	74	-27.78	PK
	2483.5~2500	-81.22	2.00	-79.22	16.04	54	-37.96	AV

Note:

1. DG = Directional Gain.
2. E-Field = EIRP – 20log(3) + 104.8

Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		BLE 1Mbps						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-64.09	2.00	-62.09	33.17	74.00	-40.83	PK
	2310~2390	-83.53	2.00	-81.53	13.73	54.00	-40.27	AV
	2483.5~2500	-68.70	2.00	-66.70	28.56	74.00	-45.44	PK
	2483.5~2500	-82.92	2.00	-80.92	14.34	54.00	-39.66	AV
2440	2310~2390	-69.78	2.00	-67.78	27.48	74.00	-46.52	PK
	2310~2390	-83.11	2.00	-81.11	14.15	54.00	-39.85	AV
	2483.5~2500	-68.74	2.00	-66.74	28.52	74.00	-45.48	PK
	2483.5~2500	-82.94	2.00	-80.94	14.32	54.00	-39.68	AV
2480	2310~2390	-71.59	2.00	-69.59	25.67	74.00	-48.33	PK
	2310~2390	-83.17	2.00	-81.17	14.09	54.00	-39.91	AV
	2483.5~2500	-51.29	2.00	-49.29	45.97	74.00	-28.03	PK
	2483.5~2500	-81.02	2.00	-79.02	16.24	54.00	-37.76	AV

Note:

1. DG = Directional Gain.
2. E-Field = EIRP – 20log(3) + 104.8

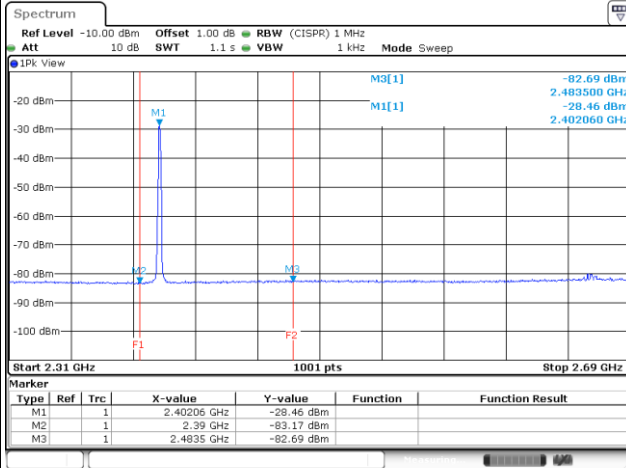
Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		BLE 2Mbps						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-64.49	2.00	-62.49	32.77	74.00	-41.23	PK
	2310~2390	-82.89	2.00	-80.89	14.37	54.00	-39.63	AV
	2483.5~2500	-69.95	2.00	-67.95	27.31	74.00	-46.69	PK
	2483.5~2500	-82.43	2.00	-80.43	14.83	54.00	-39.17	AV
2440	2310~2390	-70.55	2.00	-68.55	26.71	74.00	-47.29	PK
	2310~2390	-83.23	2.00	-81.23	14.03	54.00	-39.97	AV
	2483.5~2500	-67.46	2.00	-65.46	29.80	74.00	-44.20	PK
	2483.5~2500	-82.72	2.00	-80.72	14.54	54.00	-39.46	AV
2480	2310~2390	-70.83	2.00	-68.83	26.43	74.00	-47.57	PK
	2310~2390	-83.3	2.00	-81.30	13.96	54.00	-40.04	AV
	2483.5~2500	-51.2	2.00	-49.20	46.06	74.00	-27.94	PK
	2483.5~2500	-79.46	2.00	-77.46	17.80	54.00	-36.20	AV

Note:

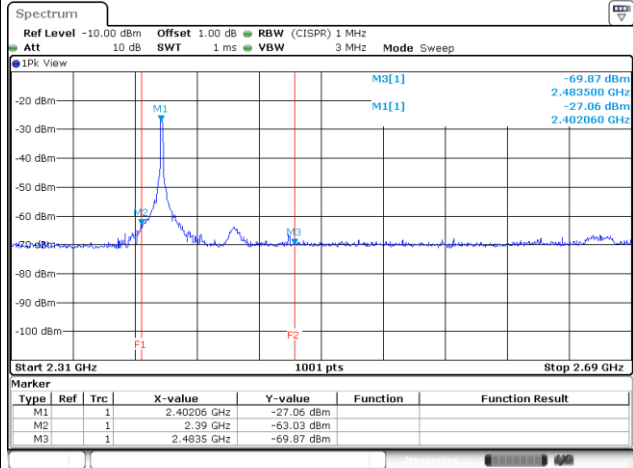
1. DG = Directional Gain.
2. E-Field = EIRP – 20log(3) + 104.8

BT LE-125kbps - Band Edge Test Plot

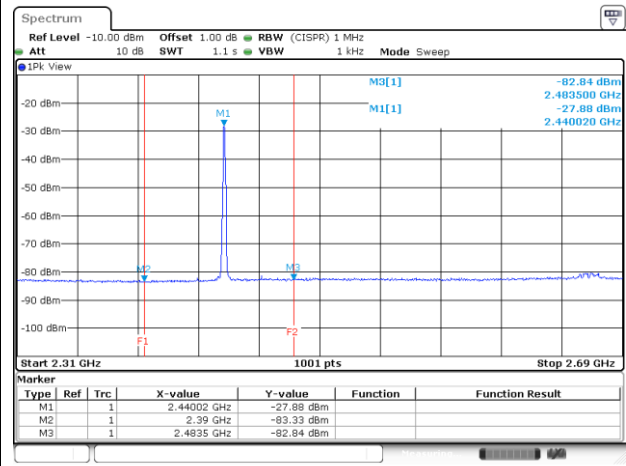
2402MHz - AV



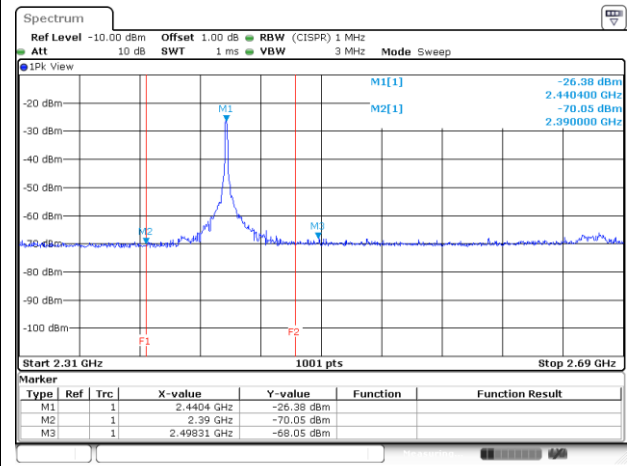
2402MHz - PK



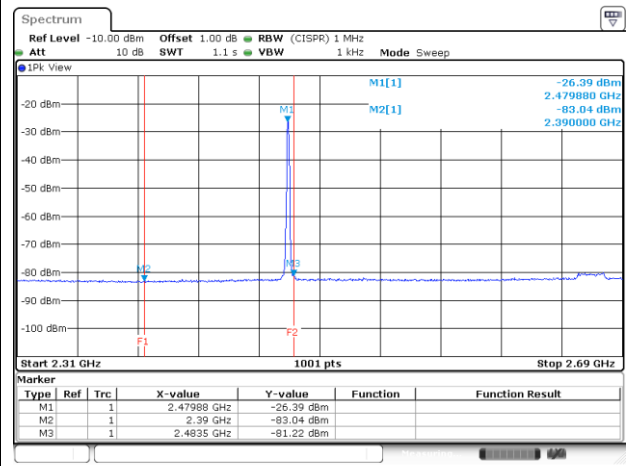
2440MHz - AV



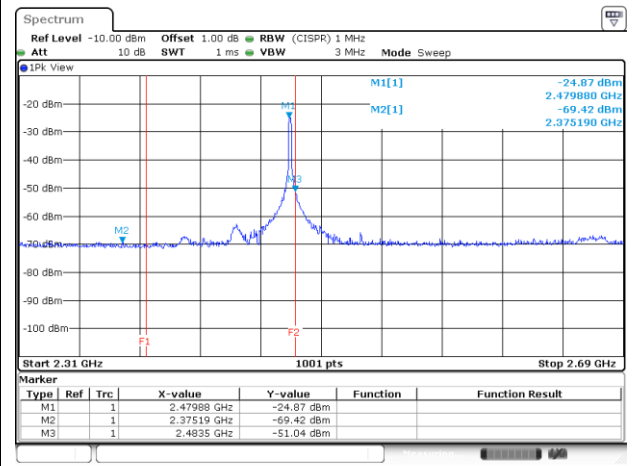
2440MHz - PK



2480MHz - AV

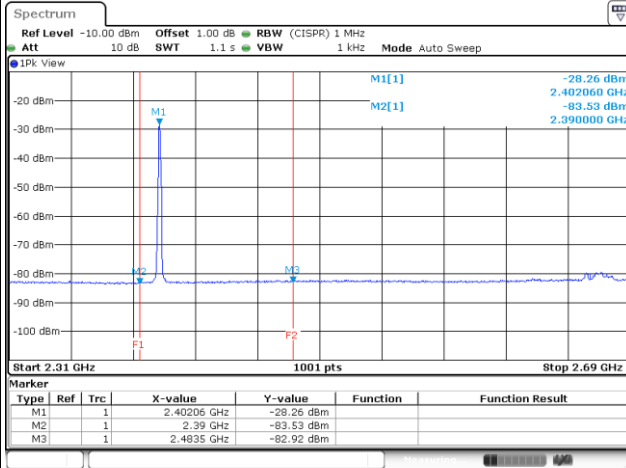


2480MHz - PK

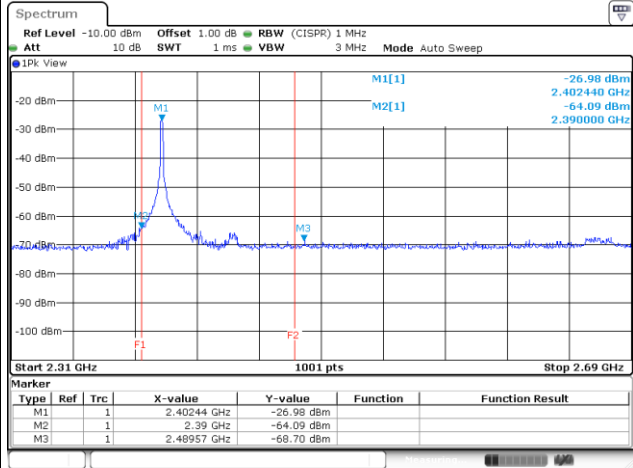


BT LE-1Mbps - Band Edge Test Plot

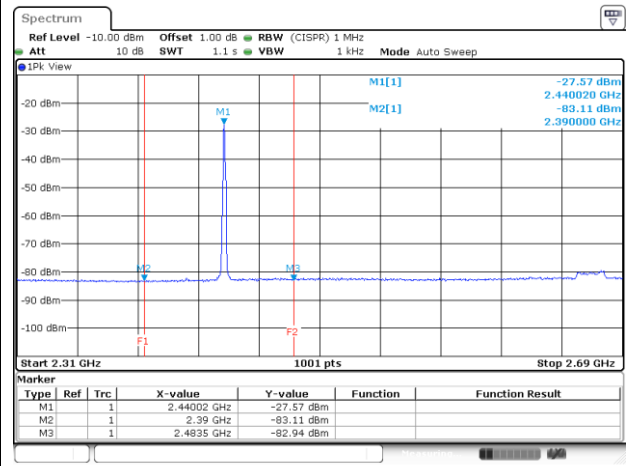
2402MHz - AV



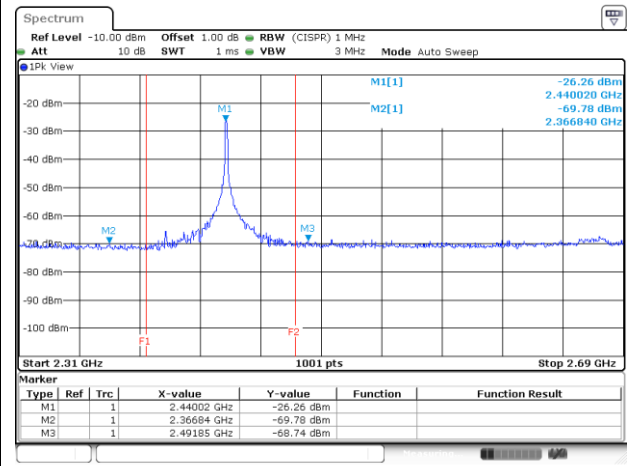
2402MHz - PK



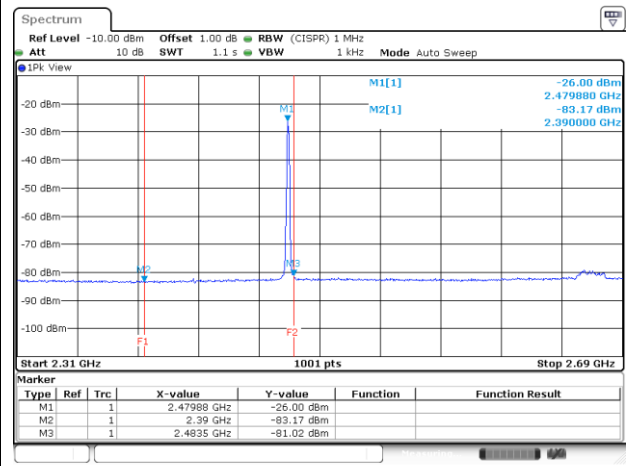
2440MHz - AV



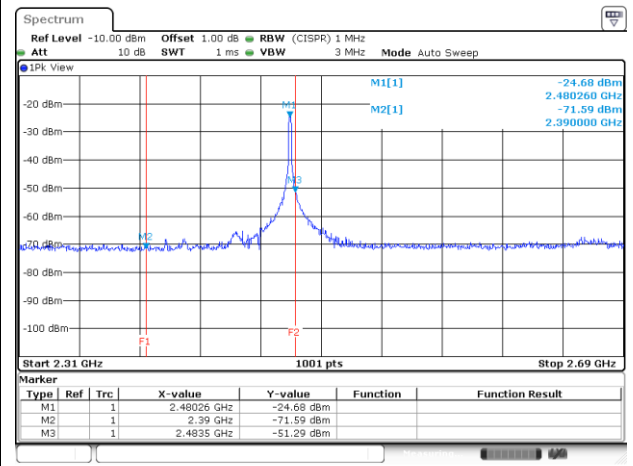
2440MHz - PK



2480MHz - AV

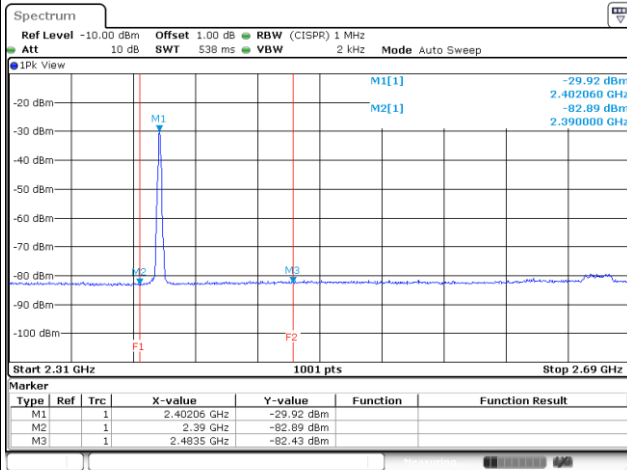


2480MHz - PK

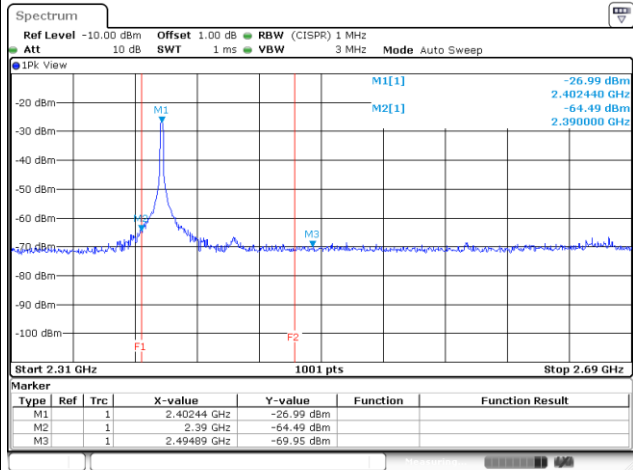


BT LE-2Mbps - Band Edge Test Plot

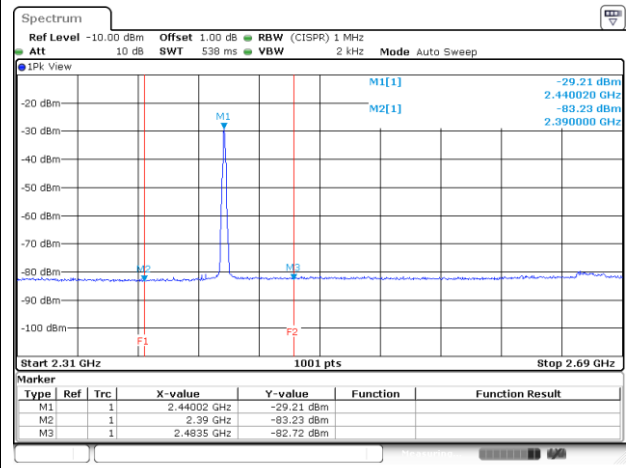
2402MHz - AV



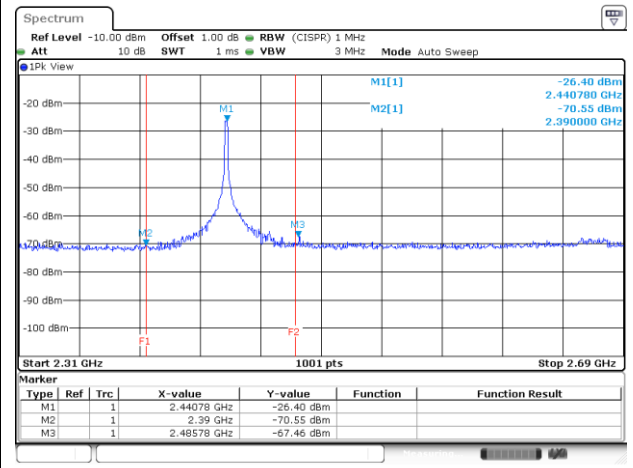
2402MHz - PK



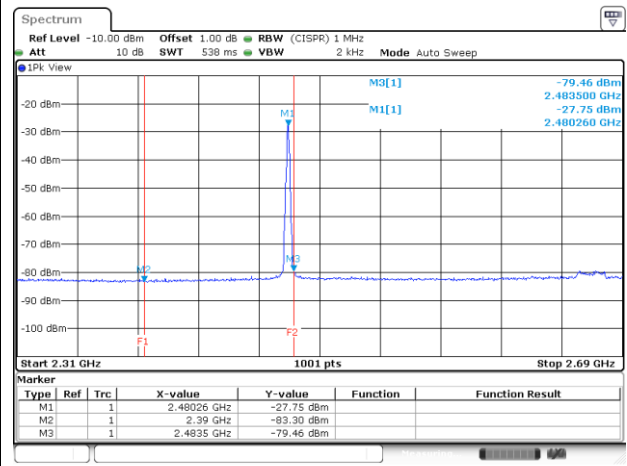
2440MHz - AV



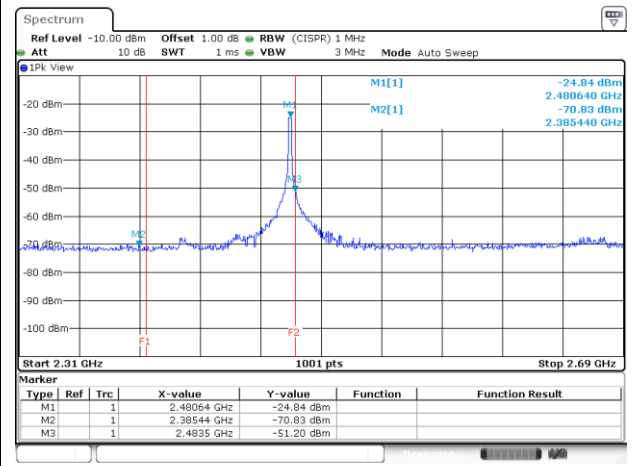
2440MHz - PK



2480MHz - AV



2480MHz - PK



Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-125kbps		Frequency		2402MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4804.00	PK	-71.70	2.00	-69.70	25.56	74.00	-48.44
4804.00	AV	-	2.00	-	-	54.00	-

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-125kbps		Frequency		2440MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4880.00	PK	-71.80	2.00	-69.80	25.46	74.00	-48.54
4880.00	AV	-	2.00	-	-	54.00	-

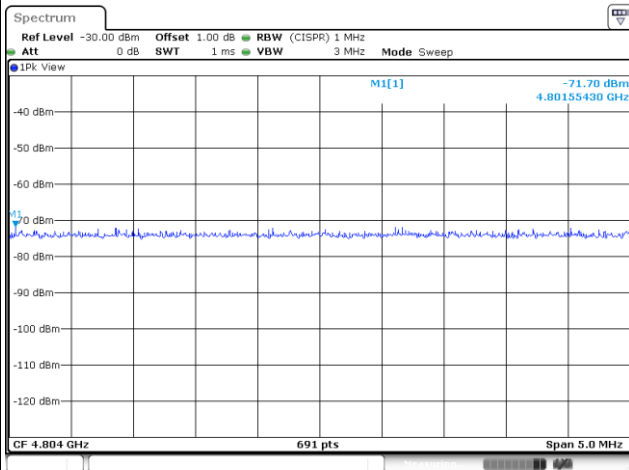
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-125kbps		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4960.00	PK	-72.08	2.00	-70.08	25.18	74.00	-48.82
4960.00	AV	-	2.00	-	-	54.00	-

Note:

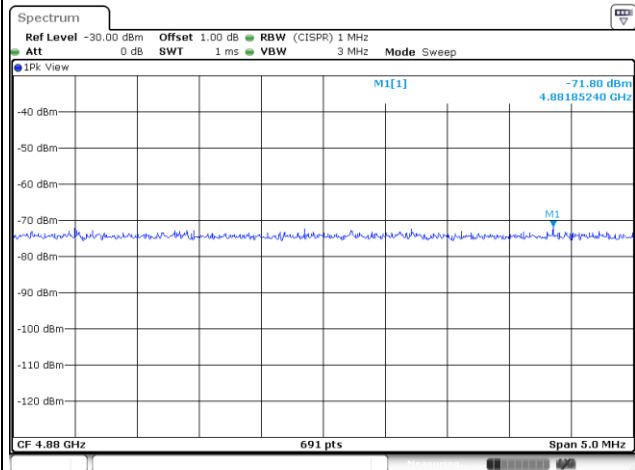
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain
3. $E\text{-Field} = EIRP - 20\log(3) + 104.8$

BT LE-125kbps - Test Plots

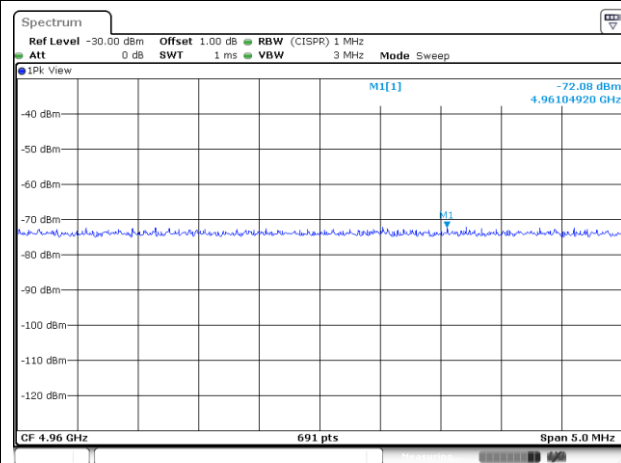
2402MHz - 4804MHz - PK



2440MHz 4880MHz - PK



2480 MHz - 4960MHz - PK



Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-1Mbps		Frequency		2402MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4804.00	PK	-71.96	2.00	-69.96	25.30	74.00	-48.70
4804.00	AV note1	-	2.00	-	-	54.00	-

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-1Mbps		Frequency		2440MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4880.00	PK	-72.25	2.00	-70.25	25.01	74.00	-48.99
4880.00	AV note1	-	2.00	-	-	54.00	-

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-1Mbps		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field* (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4960.00	PK	-72.17	2.00	-70.17	25.09	74.00	-48.91
4960.00	AV note1	-	2.00	-	-	54.00	-

Note:

1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain
3. $E\text{-Field} = EIRP - 20\log(3) + 104.8$