

FCC Test Report

FCC ID : SQGBL653U
Equipment : Bluetooth 5.1 Nano BLE Data Module
Model No. : BL653μ
Brand Name : Laird Connectivity
Applicant : Laird Connectivity
Address : W66N220 Commerce Court, Cedarburg,
Wisconsin 53012, USA
Standard : 47 CFR FCC Part 15.247
Received Date : Jun. 17, 2020
Tested Date : Aug. 13 ~ Aug. 19, 2020

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



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Release Record

Report No.	Version	Description	Issued Date
FR061704	Rev. 01	Initial issue	Nov. 10, 2020

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	AC Power Line Conducted Emissions	[dBuV]: 4.622MHz 51.47 (Margin -4.53dB) - QP	Pass
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]: 46.56MHz 34.23 (Margin -5.77dB) - PK	Pass
15.247(b)(3)	Maximum Output Power	Power [dBm]: 8.00	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

Model Name	Part Number	Remarks
BL653μ	453-00059	Chip Antenna
	453-00060	RF Trace Pin 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	V5.1 LE	2402-2480	0-39 [40]	125 kbps
				500 kbps
				1 Mbps
				2 Mbps
Note: Bluetooth LE (Low energy) uses GFSK modulation.				

1.1.3 Antenna Details

Manufacturer	Model	Laird Part Number	Type	Connector	Gain (dBi)
Laird	NanoBlue	EBL2400A1-10 MH4L	PCB Dipole	IPEX MHF4	2
Laird	FlexPIFA	001-0022	PCB Dipole	IPEX MHF4	2
Mag.Layers	EDA-8709-2G4 C1-B27-CY	0600-00057	Dipole	IPEX MHF4	2
Laird	mFlexPIFA	EFA2400A3S-1 0MH4L	PIFA	IPEX MHF4	2
Laird	Laird NFC	0600-00061	NFC	N/A	--
Yageo	ANT1608LL14R 2400A	N/A	Chip Antenna	N/A	2

1.1.4 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	Option 1: DC 5V from host Option 2: DC 3.3V from host Option 3: DC 1.7V from host
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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, V7.94	
Modulation Mode	Duty Cycle Of Test Signal (%)	Duty Factor (dB)
GFSK-125kbps	84.99%	0.71
GFSK-500kbps	58.90%	2.30
GFSK-1Mbps	64.22%	1.92
GFSK-2Mbps	34.58%	4.61

1.1.8 Power Index of Test Tool

Low Power

Modulation Mode	Test Frequency (MHz)		
	2402	2440	2480
GFSK/125kbps	-40	-40	-40
GFSK/500kbps	-40	-40	-40
GFSK/1Mbps	-40	-40	-40
GFSK/2Mbps	-40	-40	-40

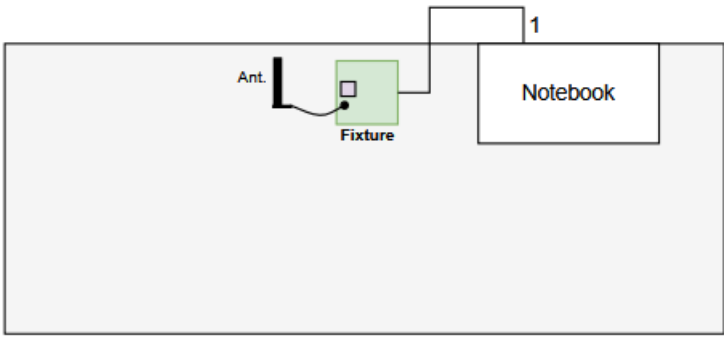
High Power

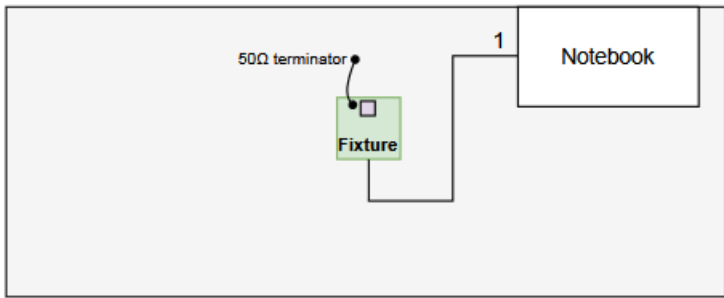
Modulation Mode	Test Frequency (MHz)		
	2402	2440	2480
GFSK/125kbps	8	8	8
GFSK/500kbps	8	8	8
GFSK/1Mbps	8	8	8
GFSK/2Mbps	8	8	8

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.

Test Setup Diagram – radiated 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	Aug. 19, 2020				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101658	Dec. 12, 2019	Dec. 11, 2020
LISN	R&S	ENV216	101579	Mar. 12, 2020	Mar. 11, 2021
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Oct. 22, 2019	Oct. 21, 2020
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 / (03CH03-WS)				
Tested Date	Aug. 13, 2020				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101499	Jan. 09, 2020	Jan. 08, 2021
Receiver	R&S	ESR3	101657	Feb. 14, 2020	Feb. 13, 2021
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-685	Apr. 29, 2020	Apr. 28, 2021
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1206	Dec. 27, 2019	Dec. 26, 2020
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 15, 2019	Nov. 14, 2020
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 13, 2019	Nov. 12, 2020
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Oct. 07, 2019	Oct. 06, 2020
Preamplifier	EMC	EMC02325	980187	Aug. 14, 2019	Aug. 13, 2020
Preamplifier	Agilent	83017A	MY53270014	Jul. 30, 2020	Jul. 29, 2021
Preamplifier	EMC	EMC184045B	980192	Jul. 21, 2020	Jul. 20, 2021
RF cable-3M	HUBER+SUHNER	SUCOFLEX104	MY22620/4	Sep. 27, 2019	Sep. 26, 2020
RF cable-8M	EMC	EMC104-SM-SM-8000	181107	Sep. 27, 2019	Sep. 26, 2020
RF cable-1M	HUBER+SUHNER	SUCOFLEX104	MY22624/4	Sep. 27, 2019	Sep. 26, 2020
LF cable-0.8M	EMC	EMC8D-NM-NM-8000	EMC8D-NM-NM-800-001	Sep. 27, 2019	Sep. 26, 2020
LF cable-3M	EMC	EMC8D-NM-NM-3000	131103	Sep. 27, 2019	Sep. 26, 2020
LF cable-13M	EMC	EMC8D-NM-NM-13000	131104	Sep. 27, 2019	Sep. 26, 2020
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	Aug. 13, 2020				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101499	Jan. 09, 2020	Jan. 08, 2021
Power Meter	Anritsu	ML2495A	1241002	Oct. 23, 2019	Oct. 22, 2020
Power Sensor	Anritsu	MA2411B	1207366	Oct. 23, 2019	Oct. 22, 2020
DC POWER SOURCE	GW INSTEK	GPC-6030D	GES855395	Oct. 29, 2019	Oct. 28, 2020
Measurement Software	--	SENSE-15247_FS	V5.10.7	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.5 Test Standards

47 CFR FCC Part 15.247
ANSI C63.10-2013

1.6 Reference Guidance

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

1.7 Deviation from Test Standard and Measurement Procedure

None

1.8 Measurement Uncertainty

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 ≤ 1GHz	±3.96 dB
Radiated emission > 1GHz	±4.51 dB

2 Test Configuration

2.1 Testing Facility

Test Laboratory	International Certification Corp.
Test Site	CO01-WS, TH01-WS
Address of Test Site	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.
Test Site	03CH03-WS
Address of Test Site	No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.

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

2.2 The Worst Test Modes and Channel Details

Test item	Mode	Test Frequency (MHz)	Data Rate	Remarks
AC Power Line Conducted Emissions Radiated Emissions $\leq$ 1GHz	BT LE-High Power	2480	1Mbps	With Mag.Layers Dipole antenna
Maximum Output Power 6dB bandwidth Power spectral density	BT LE-Low Power BT LE-High Power	2402, 2440, 2480	125kbps 500kbps 1Mbps 2Mbps	---
Radiated Emissions $\leq$ 1GHz	BT LE-Low Power BT LE-High Power	2480	1Mbps	---
Radiated Emissions $>$ 1GHz	BT LE-Low Power BT LE-High Power	2402, 2440, 2480	1Mbps 2Mbps	---

NOTE:

- The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Z-plane** result was found as the worst case and was shown in this report.
- The EUT supports 3 DC voltage options, 3.3Vdc / 3.7Vdc and 5Vdc. Three options were assessed and **3.3Vdc** was found to be the worst case and was selected for the final test.
- The EUT supports 2 power setting. Both options were assessed and presented in the following sections.
- 50 Ω terminator was connected to antenna port of EUT for radiated emission measurement.
- Two samples of EUT had been covered during the pretest and found that **Part No. 453-00060** was the worst case for final test. (Part No. 453-00059 & Part No. 453-00060)

3 Transmitter Test Results

3.1 Conducted Emissions

3.1.1 Limit of Conducted Emissions

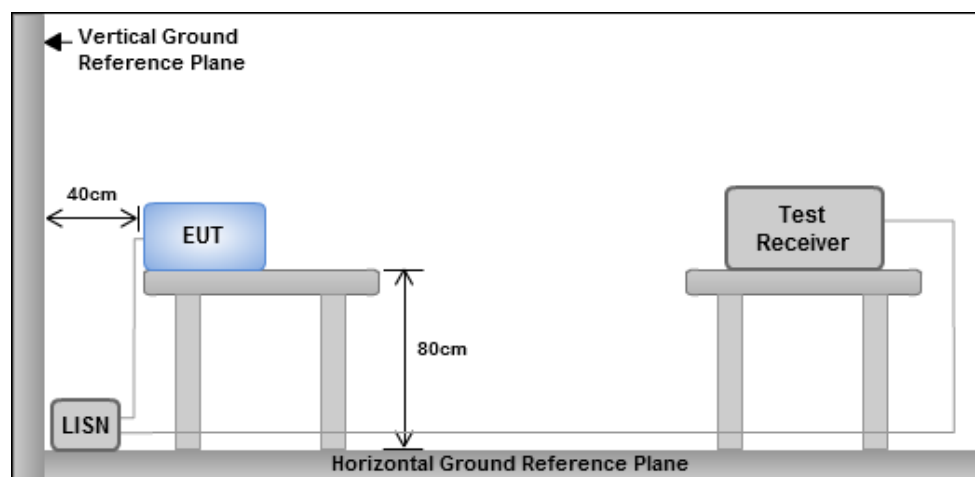
Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50

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

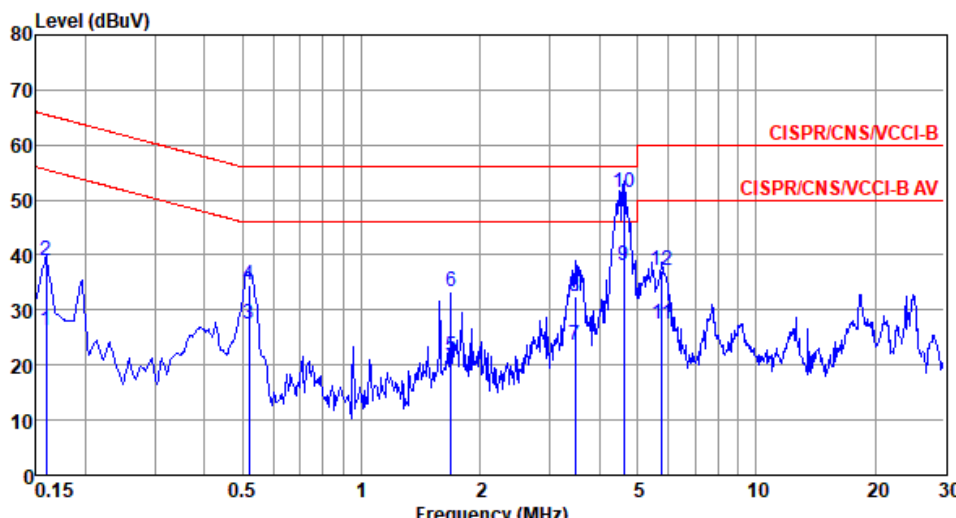
3.1.3 Test Setup



- 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-High Power	Test Freq. (MHz)	2480
Power Phase	Line		

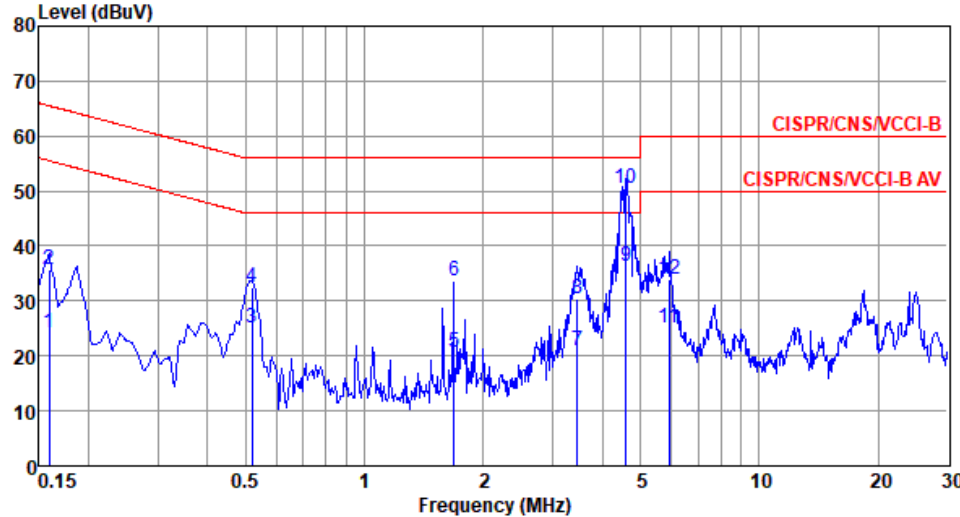


	Freq MHz	Level dBUA	Limit dBUA	Over Limit dB	Read Level dBUA	LISN factor dB	cable loss dB	Remark
1	0.159	26.24	55.52	-29.28	16.55	9.64	0.05	Average
2	0.159	38.93	65.52	-26.59	29.24	9.64	0.05	QP
3	0.518	27.33	46.00	-18.67	17.61	9.63	0.09	Average
4	0.518	34.45	56.00	-21.55	24.73	9.63	0.09	QP
5	1.684	21.60	46.00	-24.40	11.79	9.64	0.17	Average
6	1.684	33.42	56.00	-22.58	23.61	9.64	0.17	QP
7	3.472	23.71	46.00	-22.29	13.79	9.65	0.27	Average
8	3.472	32.42	56.00	-23.58	22.50	9.65	0.27	QP
9	4.622	37.96	46.00	-8.04	27.99	9.66	0.31	Average
10*	4.622	51.47	56.00	-4.53	41.50	9.66	0.31	QP
11	5.774	27.56	50.00	-22.44	17.56	9.67	0.33	Average
12	5.774	37.15	60.00	-22.85	27.15	9.67	0.33	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-High Power	Test Freq. (MHz)	2480
Power Phase	Neutral		



	Freq MHz	Level dBuA	Limit Line dBuA	Over Limit dB	Read Level dBuA	LISN factor dB	cable loss dB	Remark
1	0.159	24.12	55.52	-31.40	14.41	9.66	0.05	Average
2	0.159	35.76	65.52	-29.76	26.05	9.66	0.05	QP
3	0.518	25.13	46.00	-20.87	15.39	9.65	0.09	Average
4	0.518	32.35	56.00	-23.65	22.61	9.65	0.09	QP
5	1.684	20.62	46.00	-25.38	10.79	9.66	0.17	Average
6	1.684	33.56	56.00	-22.44	23.73	9.66	0.17	QP
7	3.454	20.91	46.00	-25.09	10.97	9.67	0.27	Average
8	3.454	30.45	56.00	-25.55	20.51	9.67	0.27	QP
9	4.598	36.18	46.00	-9.82	26.19	9.68	0.31	Average
10*	4.598	50.58	56.00	-5.42	40.59	9.68	0.31	QP
11	5.898	25.03	50.00	-24.97	15.00	9.70	0.33	Average
12	5.898	33.82	60.00	-26.18	23.79	9.70	0.33	QP

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

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

3.2 6dB and Occupied Bandwidth

3.2.1 Limit of 6dB Bandwidth

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

3.2.2 Test Procedures

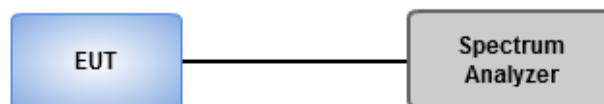
6dB Bandwidth

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

Occupied Bandwidth

1. Set resolution bandwidth (RBW) = 1% ~ 5 % of OBW, Video bandwidth = 3 x RBW.
2. Detector = Sample, Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. Use the OBW measurement function of spectrum analyzer to measure the occupied bandwidth.

3.2.3 Test Setup



3.2.4 Test Result of 6dB and Occupied Bandwidth

Ambient Condition	25°C / 67%	Tested By	Aska Huang
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Low Power Summary

Mode	Max-N dB (Hz)	Max-OBW (Hz)	ITU-Code	Min-N dB (Hz)	Min-OBW (Hz)
2.4-2.4835GHz	-	-	-	-	-
BT-LE(125kbps)	608.696k	1.074M	1M07F1D	608.696k	1.071M
BT-LE(500kbps)	699.275k	1.045M	1M05F1D	684.783k	1.042M
BT-LE(1Mbps)	699.275k	1.048M	1M05F1D	692.029k	1.042M
BT-LE(2Mbps)	1.138M	2.038M	2M04F1D	1.123M	2.026M

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

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

Result

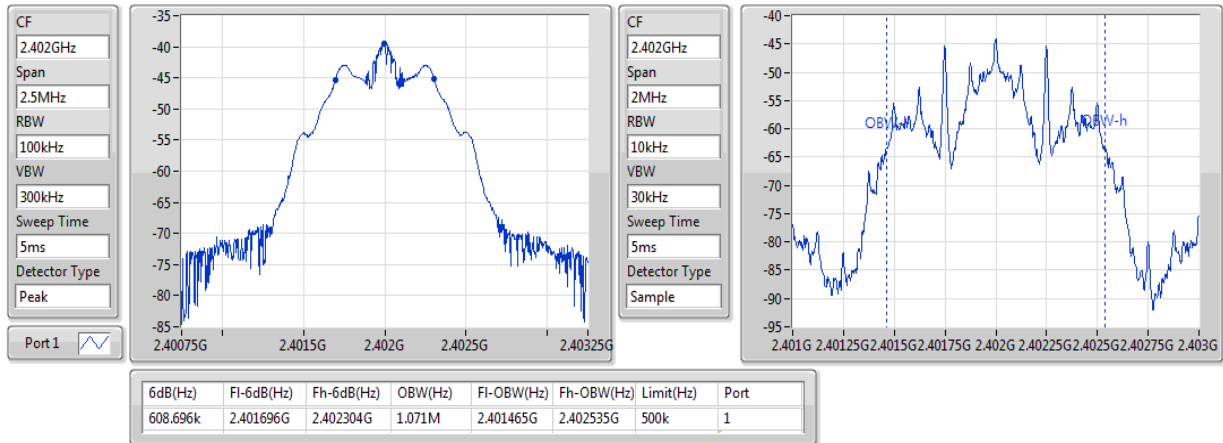
Mode	Result	Limit (Hz)	Port 1-N dB (Hz)	Port 1-OBW (Hz)
BT-LE(125kbps)	-	-	-	-
2402MHz	Pass	500k	608.696k	1.071M
2440MHz	Pass	500k	608.696k	1.071M
2480MHz	Pass	500k	608.696k	1.074M
BT-LE(500kbps)	-	-	-	-
2402MHz	Pass	500k	699.275k	1.042M
2440MHz	Pass	500k	695.652k	1.045M
2480MHz	Pass	500k	684.783k	1.045M
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	500k	692.029k	1.042M
2440MHz	Pass	500k	692.029k	1.045M
2480MHz	Pass	500k	699.275k	1.048M
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	500k	1.123M	2.026M
2440MHz	Pass	500k	1.13M	2.032M
2480MHz	Pass	500k	1.138M	2.038M

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

BT-LE(125kbps)

EBW-DTS

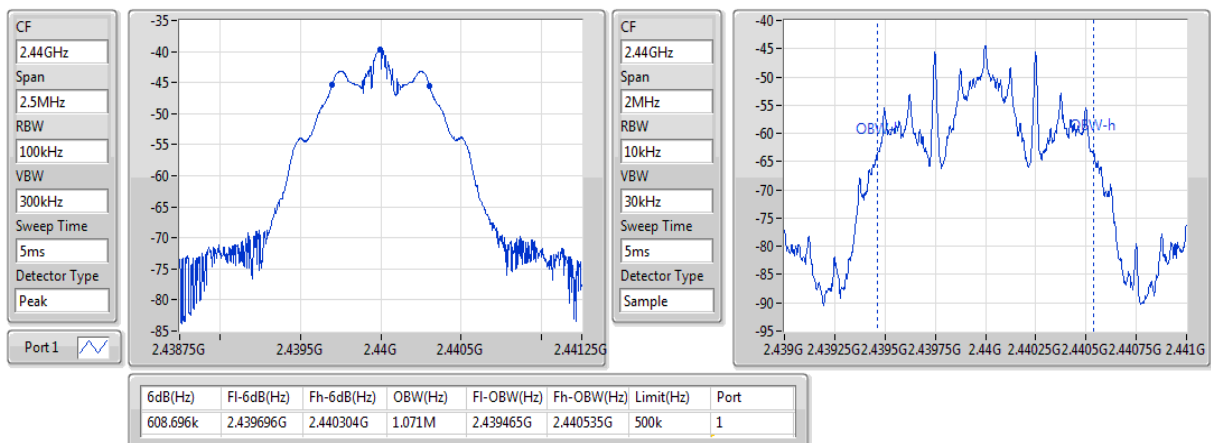
2402MHz



BT-LE(125kbps)

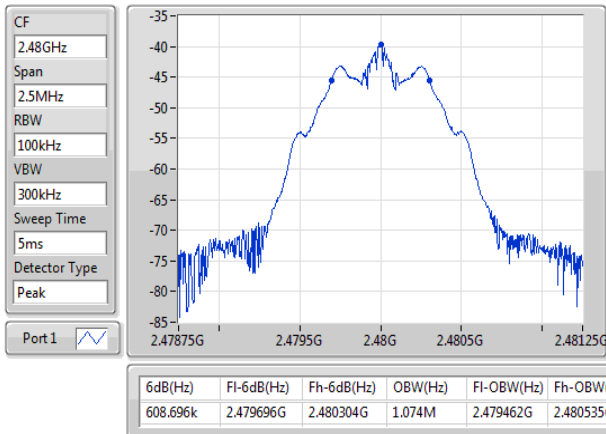
EBW-DTS

2440MHz

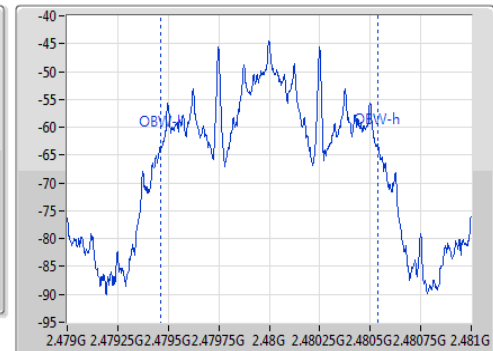


BT-LE(125kbps)

2480MHz

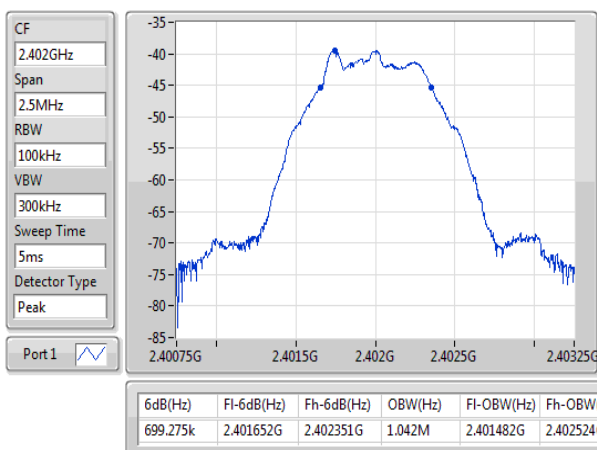


EBW-DTS

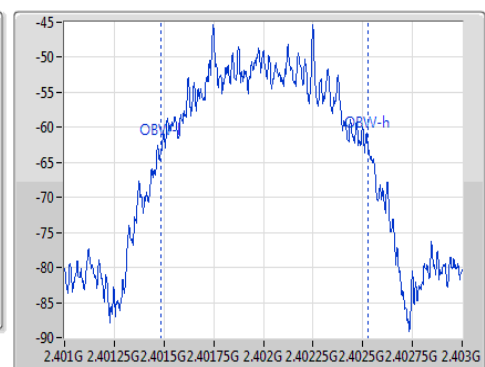


BT-LE(500kbps)

2402MHz

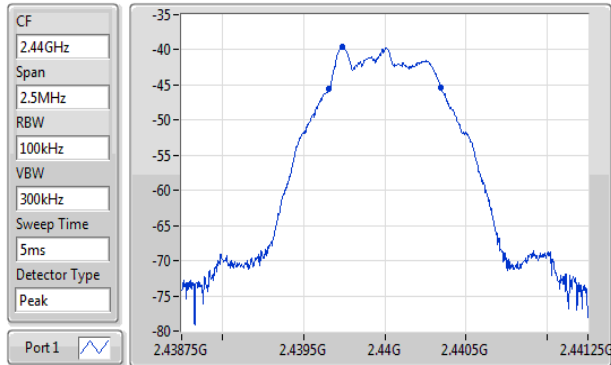


EBW-DTS



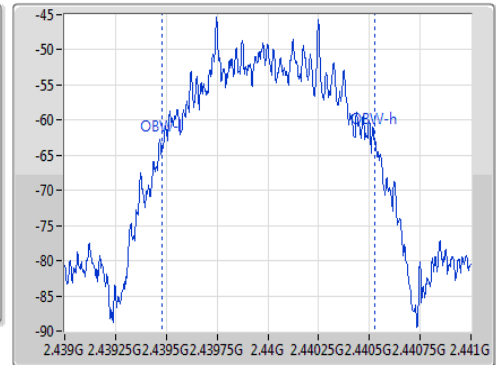
BT-LE(500kbps)

2440MHz



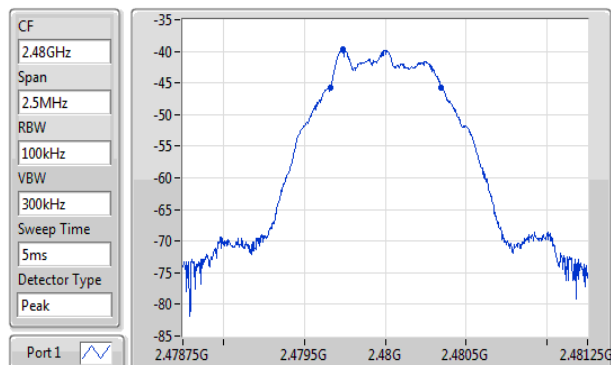
6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
695.652k	2.439652G	2.440348G	1.045M	2.439479G	2.440524G	500k	1

EBW-DTS



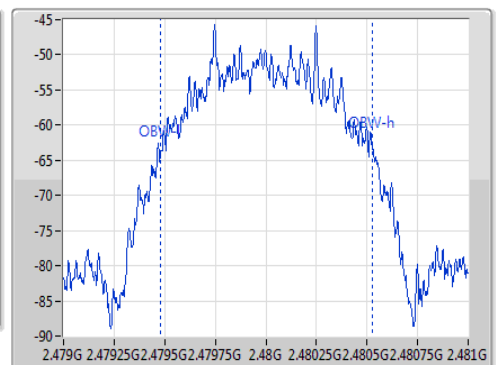
BT-LE(500kbps)

2480MHz



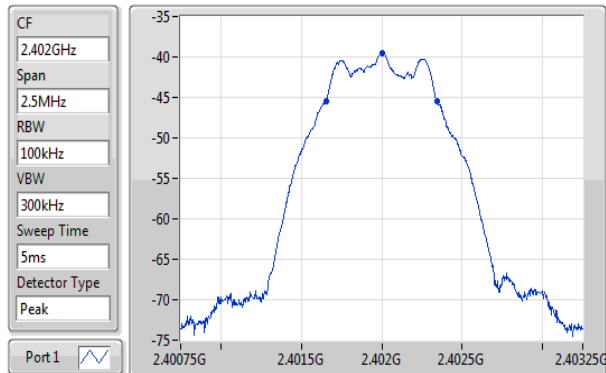
6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
684.783k	2.479663G	2.480348G	1.045M	2.479479G	2.480524G	500k	1

EBW-DTS



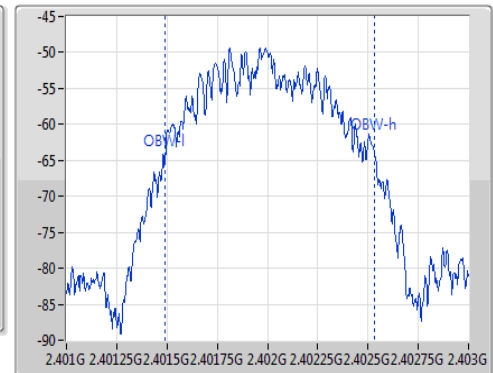
BT-LE(1Mbps)

2402MHz



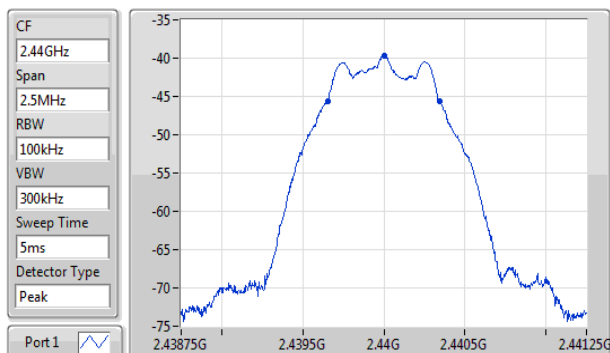
6dB(Hz)	FI-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	FI-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
692.029k	2.401652G	2.402344G	1.042M	2.401488G	2.40253G	500k	1

EBW-DTS



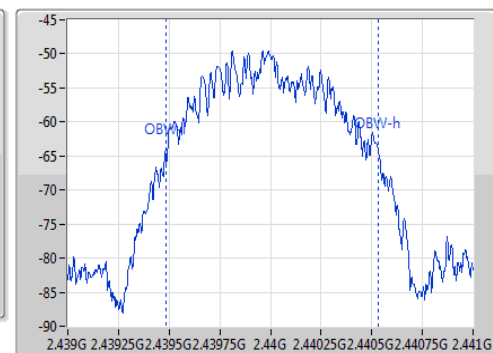
BT-LE(1Mbps)

2440MHz



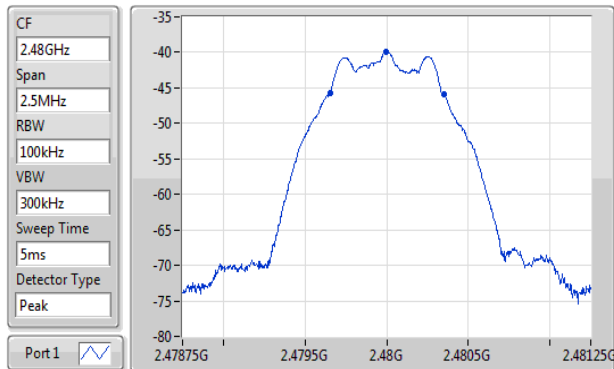
6dB(Hz)	FI-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	FI-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
692.029k	2.439652G	2.440344G	1.045M	2.439485G	2.44053G	500k	1

EBW-DTS



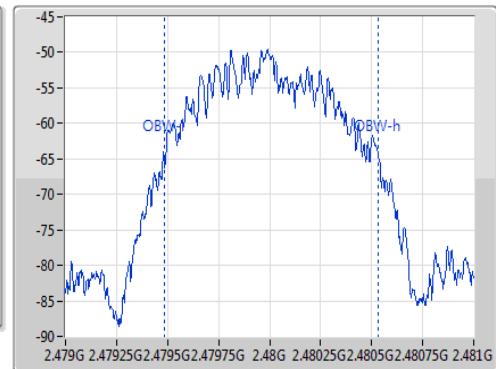
BT-LE(1Mbps)

2480MHz



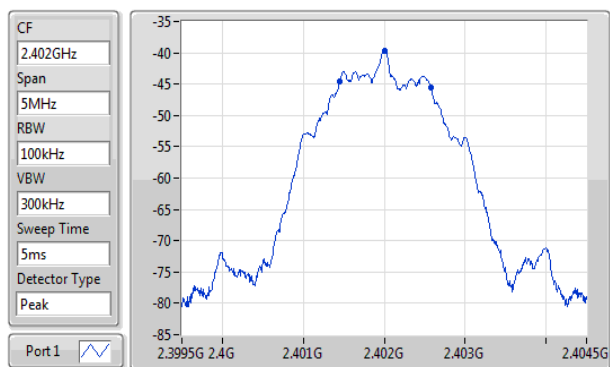
6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
699.275k	2.479652G	2.480351G	1.048M	2.479482G	2.48053G	500k	1

EBW-DTS



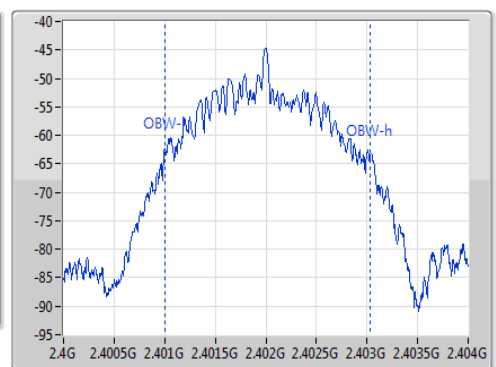
BT-LE(2Mbps)

2402MHz



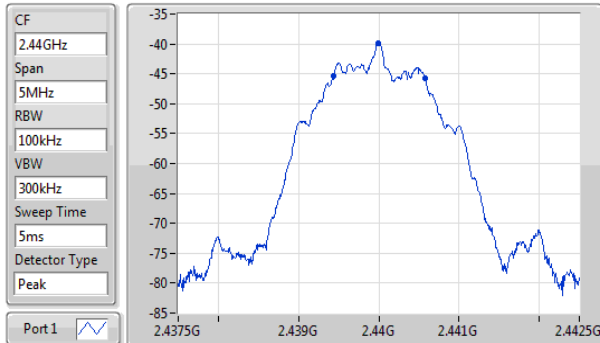
6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
1.123M	2.401449G	2.402572G	2.026M	2.401004G	2.40303G	500k	1

EBW-DTS



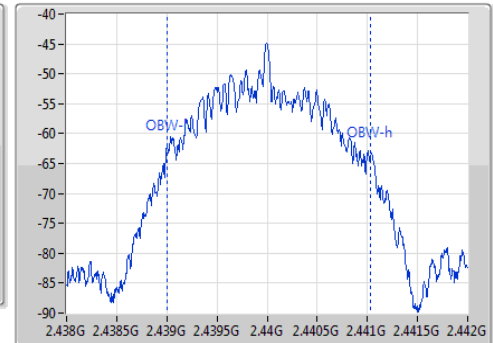
BT-LE(2Mbps)

2440MHz



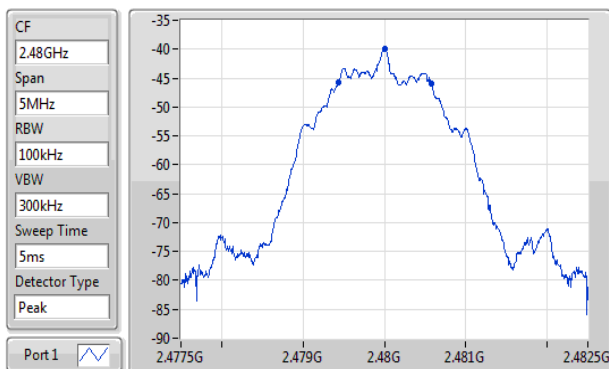
6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
1.13M	2.439442G	2.440572G	2.032M	2.438999G	2.44103G	500k	1

EBW-DTS



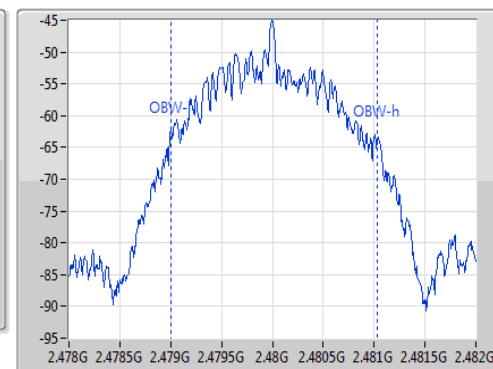
BT-LE(2Mbps)

2480MHz



6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
1.138M	2.479435G	2.480572G	2.038M	2.478999G	2.481036G	500k	1

EBW-DTS



High Power Summary

Mode	Max-N dB (Hz)	Max-OBW (Hz)	ITU-Code	Min-N dB (Hz)	Min-OBW (Hz)
2.4-2.4835GHz	-	-	-	-	-
BT-LE(125kbps)	612.319k	1.074M	1M07F1D	608.696k	1.071M
BT-LE(500kbps)	699.275k	1.048M	1M05F1D	684.783k	1.042M
BT-LE(1Mbps)	699.275k	1.051M	1M05F1D	688.406k	1.048M
BT-LE(2Mbps)	1.138M	2.038M	2M04F1D	1.123M	2.032M

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

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

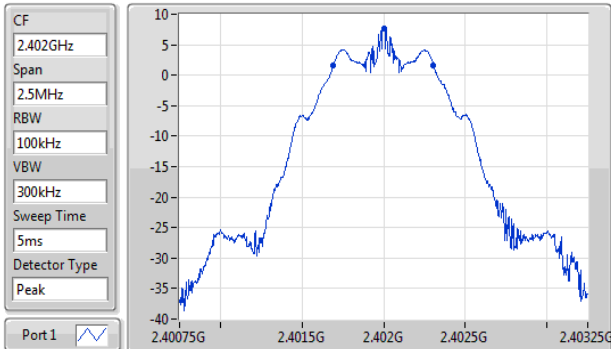
Result

Mode	Result	Limit (Hz)	Port 1-N dB (Hz)	Port 1-OBW (Hz)
BT-LE(125kbps)	-	-	-	-
2402MHz	Pass	500k	612.319k	1.071M
2440MHz	Pass	500k	608.696k	1.074M
2480MHz	Pass	500k	608.696k	1.074M
BT-LE(500kbps)	-	-	-	-
2402MHz	Pass	500k	684.783k	1.042M
2440MHz	Pass	500k	688.406k	1.045M
2480MHz	Pass	500k	699.275k	1.048M
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	500k	688.406k	1.048M
2440MHz	Pass	500k	699.275k	1.051M
2480MHz	Pass	500k	699.275k	1.048M
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	500k	1.123M	2.032M
2440MHz	Pass	500k	1.13M	2.038M
2480MHz	Pass	500k	1.138M	2.038M

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

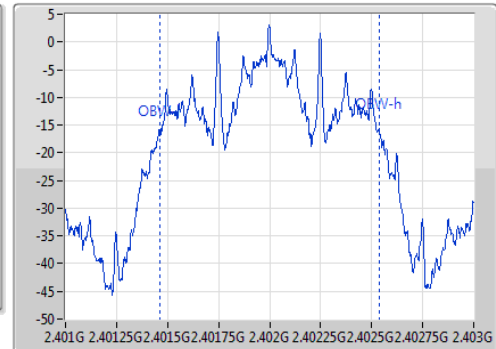
BT-LE(125kbps)

2402MHz



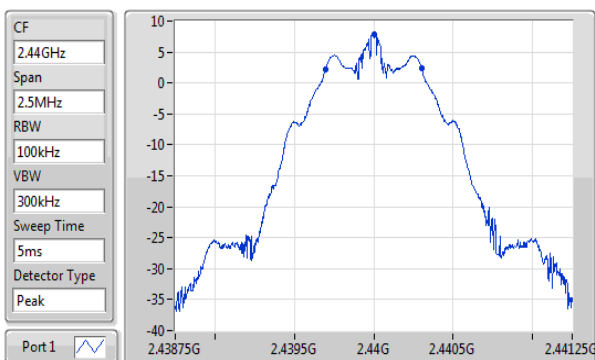
6dB(Hz)	FI-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	FI-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
612.319k	2.401692G	2.402304G	1.071M	2.401465G	2.402535G	500k	1

EBW-DTS



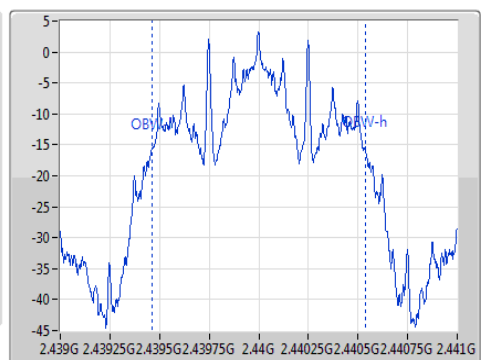
BT-LE(125kbps)

2440MHz



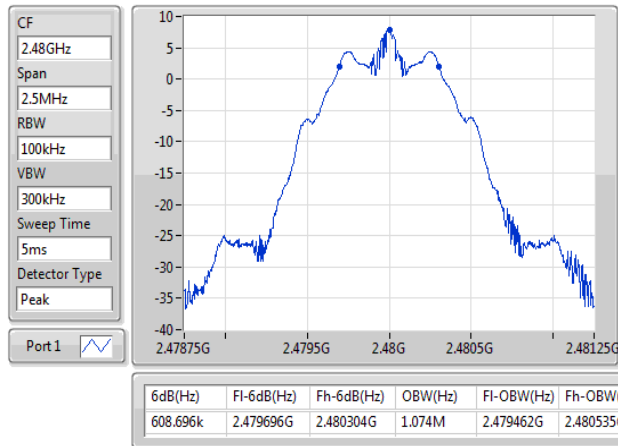
6dB(Hz)	FI-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	FI-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
608.696k	2.439696G	2.440304G	1.074M	2.439462G	2.440535G	500k	1

EBW-DTS

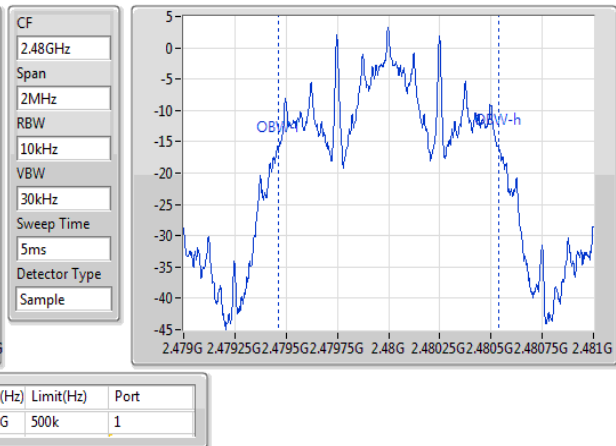


BT-LE(125kbps)

2480MHz

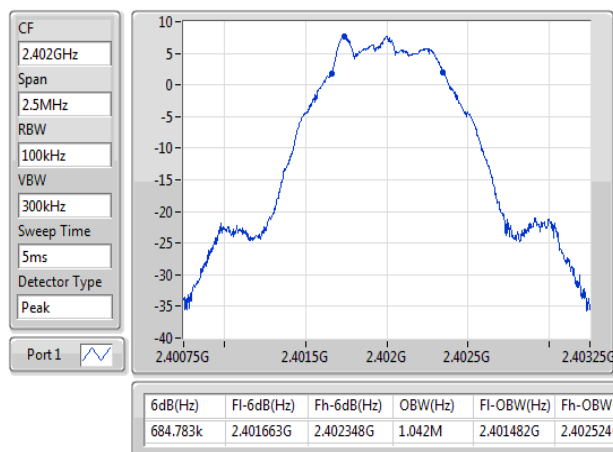


EBW-DTS

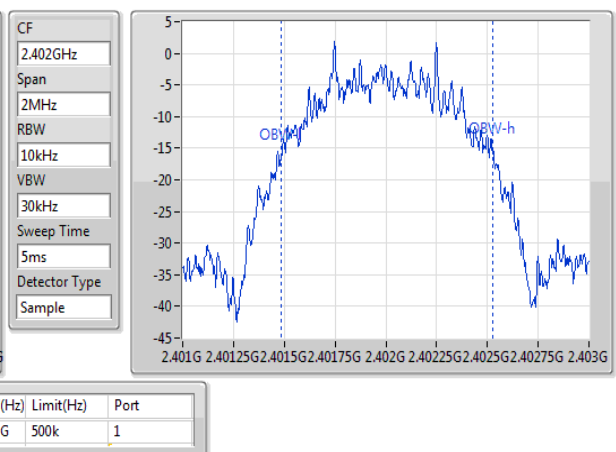


BT-LE(500kbps)

2402MHz

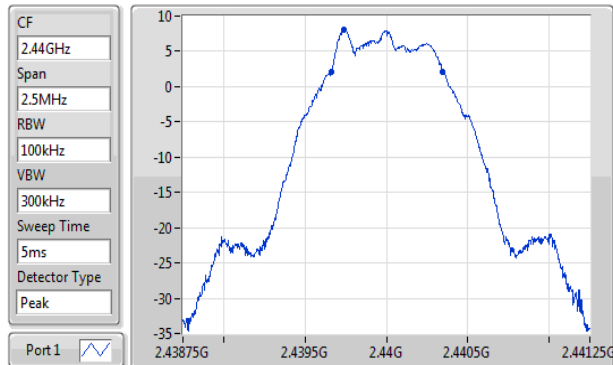


EBW-DTS



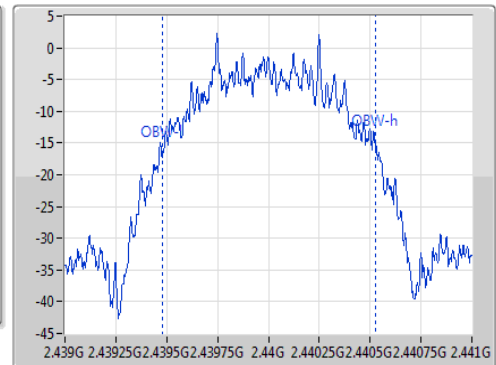
BT-LE(500kbps)

2440MHz



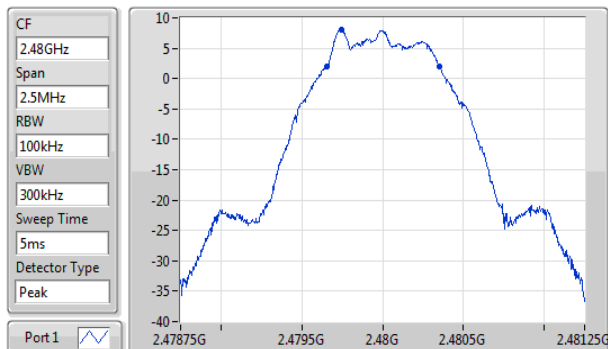
6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
688.406k	2.439659G	2.440348G	1.045M	2.439479G	2.440524G	500k	1

EBW-DTS



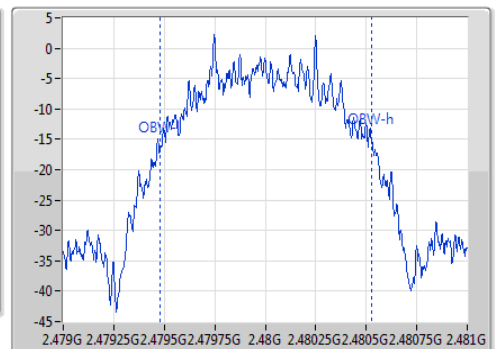
BT-LE(500kbps)

2480MHz



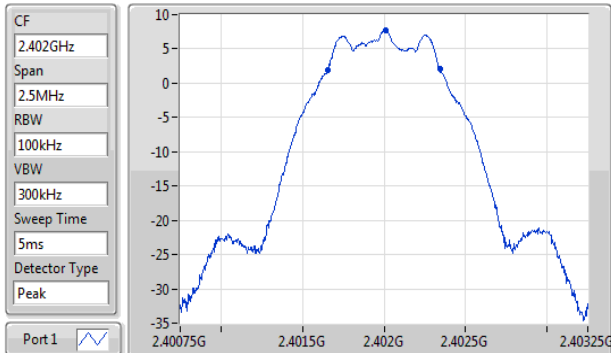
6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
699.275k	2.479652G	2.480351G	1.048M	2.479479G	2.480527G	500k	1

EBW-DTS



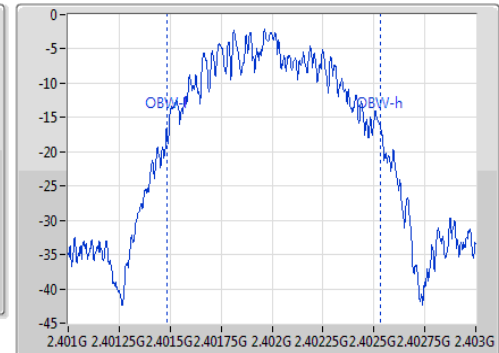
BT-LE(1Mbps)

2402MHz



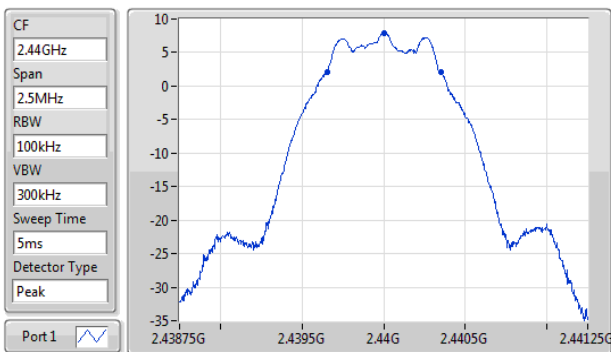
6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
688.406k	2.401656G	2.402344G	1.048M	2.401485G	2.402533G	500k	1

EBW-DTS



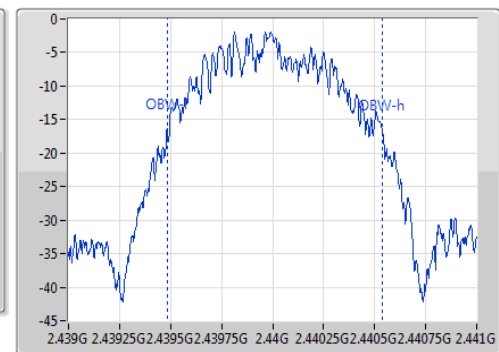
BT-LE(1Mbps)

2440MHz



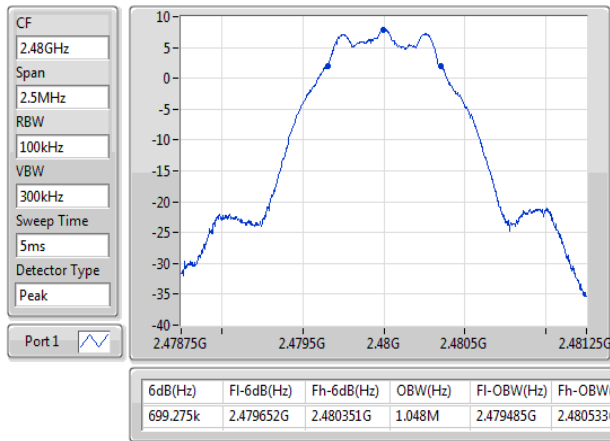
6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
699.275k	2.439656G	2.440355G	1.051M	2.439485G	2.440535G	500k	1

EBW-DTS

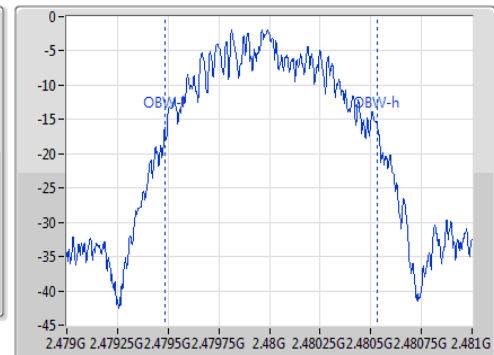


BT-LE(1Mbps)

2480MHz

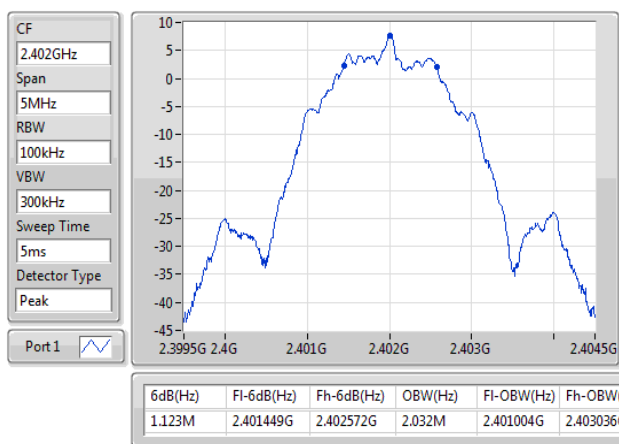


EBW-DTS

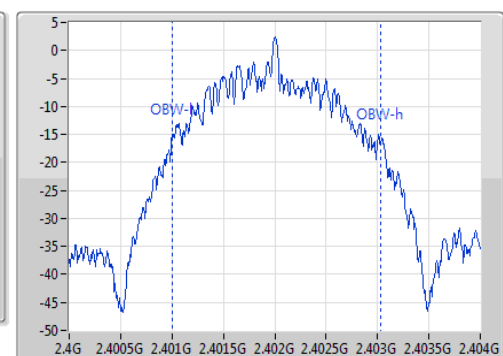


BT-LE(2Mbps)

2402MHz

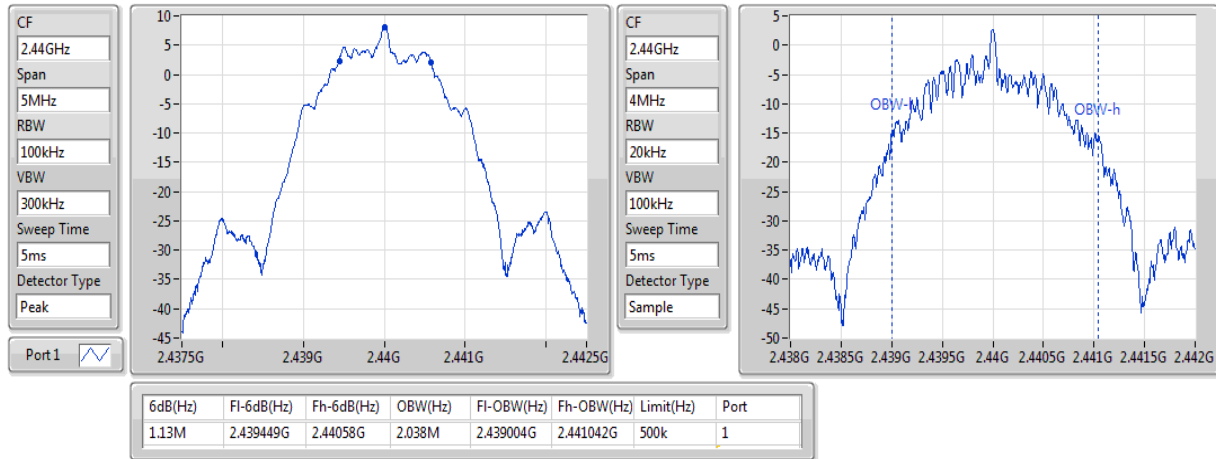


EBW-DTS



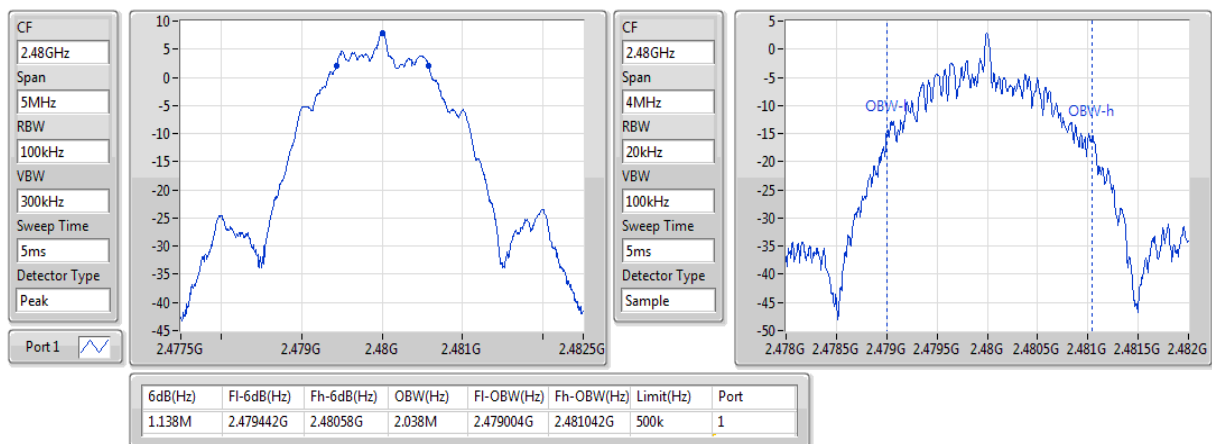
BT-LE(2Mbps)

2440MHz



BT-LE(2Mbps)

2480MHz



3.3 RF Output Power

3.3.1 Limit of RF Output Power

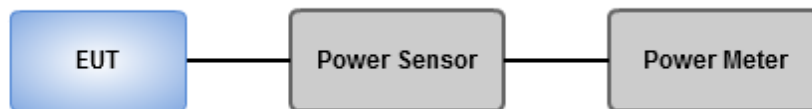
Conducted power shall not exceed 1 Watt.

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



3.3.4 Test Result of Maximum Output Power

Ambient Condition	25°C / 67%	Tested By	Aska Huang
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Low Power

Summary of Peak Conducted Output Power

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-LE(125kbps)	-37.46	0.00000
BT-LE(500kbps)	-37.45	0.00000
BT-LE(1Mbps)	-37.44	0.00000
BT-LE(2Mbps)	-37.38	0.00000

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-LE(125kbps)	-	-	-	-
2402MHz	Pass	2.00	-37.46	30.00
2440MHz	Pass	2.00	-37.74	30.00
2480MHz	Pass	2.00	-38.36	30.00
BT-LE(500kbps)	-	-	-	-
2402MHz	Pass	2.00	-37.45	30.00
2440MHz	Pass	2.00	-37.84	30.00
2480MHz	Pass	2.00	-38.45	30.00
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	-37.44	30.00
2440MHz	Pass	2.00	-37.65	30.00
2480MHz	Pass	2.00	-38.30	30.00
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	2.00	-37.38	30.00
2440MHz	Pass	2.00	-37.78	30.00
2480MHz	Pass	2.00	-38.32	30.00

Summary of Conducted (Average) Output Power

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-LE(125kbps)	-37.80	0.00000
BT-LE(500kbps)	-37.81	0.00000
BT-LE(1Mbps)	-37.66	0.00000
BT-LE(2Mbps)	-37.76	0.00000

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-LE(125kbps)	-	-	-	-
2402MHz	Pass	2.00	-37.80	-
2440MHz	Pass	2.00	-38.08	-
2480MHz	Pass	2.00	-38.77	-
BT-LE(500kbps)	-	-	-	-
2402MHz	Pass	2.00	-37.81	-
2440MHz	Pass	2.00	-38.13	--
2480MHz	Pass	2.00	-39.01	-
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	-37.66	-
2440MHz	Pass	2.00	-37.96	-
2480MHz	Pass	2.00	-38.71	-
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	2.00	-37.76	-
2440MHz	Pass	2.00	-38.07	-
2480MHz	Pass	2.00	-38.72	-

Note: Average power is for reference only.

High Power

Summary of Peak Conducted Output Power

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-LE(125kbps)	7.99	0.00630
BT-LE(500kbps)	7.97	0.00627
BT-LE(1Mbps)	8.00	0.00631
BT-LE(2Mbps)	7.99	0.00630

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-LE(125kbps)	-	-	-	-
2402MHz	Pass	2.00	7.72	30.00
2440MHz	Pass	2.00	7.88	30.00
2480MHz	Pass	2.00	7.99	30.00
BT-LE(500kbps)	-	-	-	-
2402MHz	Pass	2.00	7.72	30.00
2440MHz	Pass	2.00	7.87	30.00
2480MHz	Pass	2.00	7.97	30.00
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	7.75	30.00
2440MHz	Pass	2.00	7.89	30.00
2480MHz	Pass	2.00	8.00	30.00
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	2.00	7.73	30.00
2440MHz	Pass	2.00	7.88	30.00
2480MHz	Pass	2.00	7.99	30.00

Summary of Conducted (Average) Output Power

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-LE(125kbps)	7.93	0.00621
BT-LE(500kbps)	7.92	0.00619
BT-LE(1Mbps)	7.94	0.00622
BT-LE(2Mbps)	7.93	0.00621

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-LE(125kbps)	-	-	-	-
2402MHz	Pass	2.00	7.67	-
2440MHz	Pass	2.00	7.82	-
2480MHz	Pass	2.00	7.93	-
BT-LE(500kbps)	-	-	-	-
2402MHz	Pass	2.00	7.66	-
2440MHz	Pass	2.00	7.82	-
2480MHz	Pass	2.00	7.92	-
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	7.69	-
2440MHz	Pass	2.00	7.84	-
2480MHz	Pass	2.00	7.94	-
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	2.00	7.67	-
2440MHz	Pass	2.00	7.83	-
2480MHz	Pass	2.00	7.93	-

Note: Average power is for reference only.

3.4 Power Spectral Density

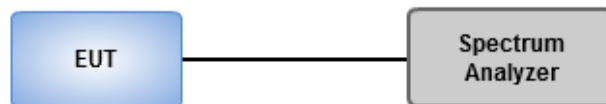
3.4.1 Limit of Power Spectral Density

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

3.4.2 Test Procedures

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

3.4.3 Test Setup



3.4.4 Test Result of Power Spectral Density

Ambient Condition	25°C / 67%	Tested By	Aska Huang
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Low Power Summary

Mode	PD (dBm/RBW)
2.4-2.4835GHz	-
BT-LE(125kbps)	-45.34
BT-LE(500kbps)	-45.67
BT-LE(1Mbps)	-54.77
BT-LE(2Mbps)	-57.15

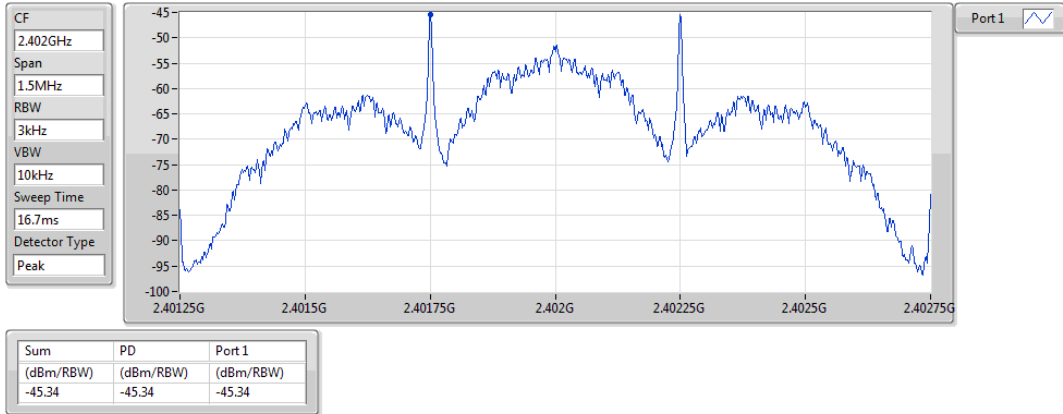
Result

Mode	Result	Gain (dBi)	PD (dBm/RBW)	PD Limit (dBm/RBW)
BT-LE(125kbps)	-	-	-	-
2402MHz	Pass	2.00	-45.34	8.00
2440MHz	Pass	2.00	-45.52	8.00
2480MHz	Pass	2.00	-45.60	8.00
BT-LE(500kbps)	-	-	-	-
2402MHz	Pass	2.00	-45.67	8.00
2440MHz	Pass	2.00	-45.78	8.00
2480MHz	Pass	2.00	-45.88	8.00
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	-54.77	8.00
2440MHz	Pass	2.00	-55.01	8.00
2480MHz	Pass	2.00	-55.15	8.00
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	2.00	-57.15	8.00
2440MHz	Pass	2.00	-57.41	8.00
2480MHz	Pass	2.00	-57.59	8.00

BT-LE(125kbps)

PSD

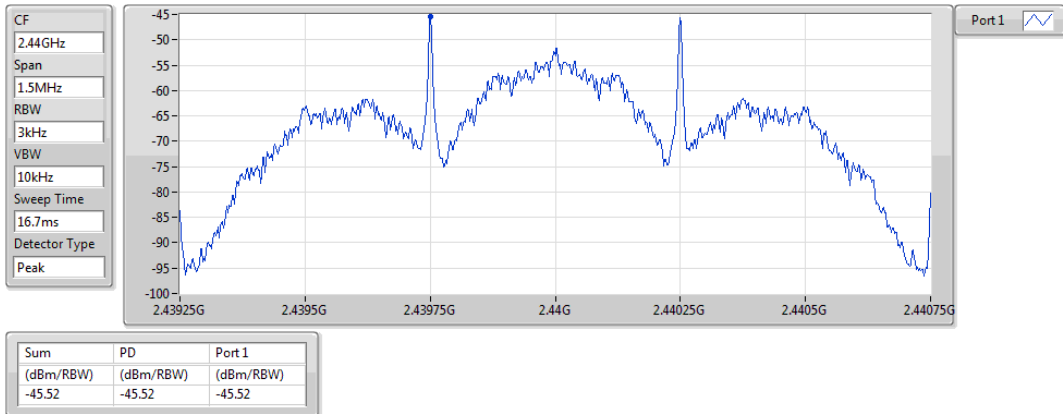
2402MHz



BT-LE(125kbps)

PSD

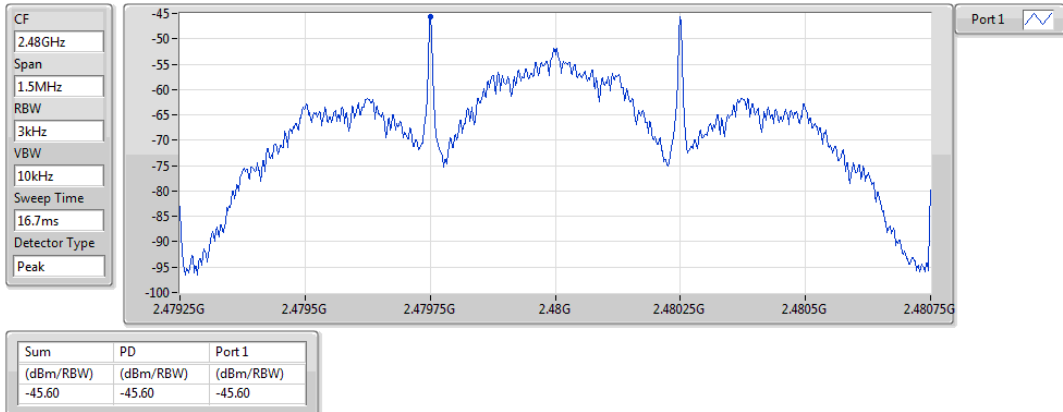
2440MHz



BT-LE(125kbps)

PSD

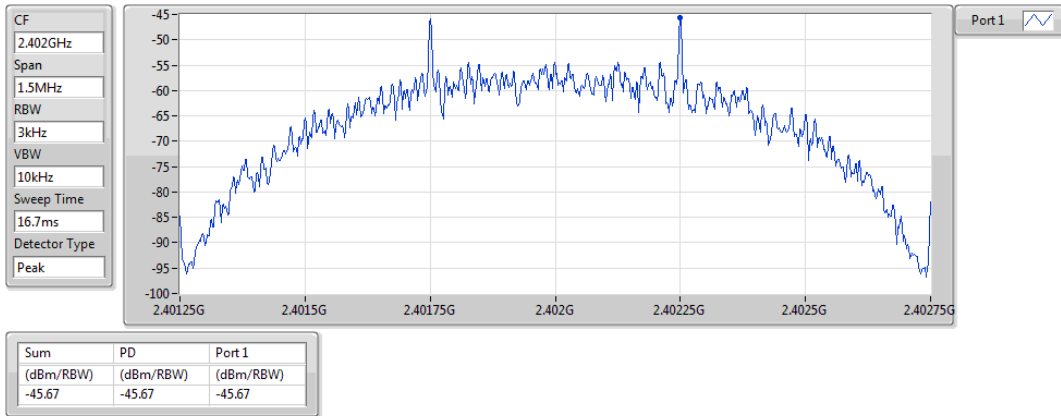
2480MHz



BT-LE(500kbps)

PSD

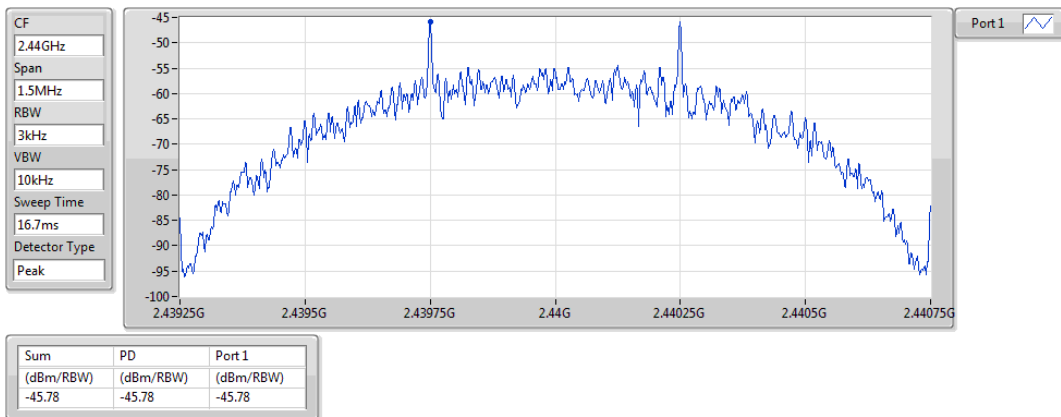
2402MHz



BT-LE(500kbps)

PSD

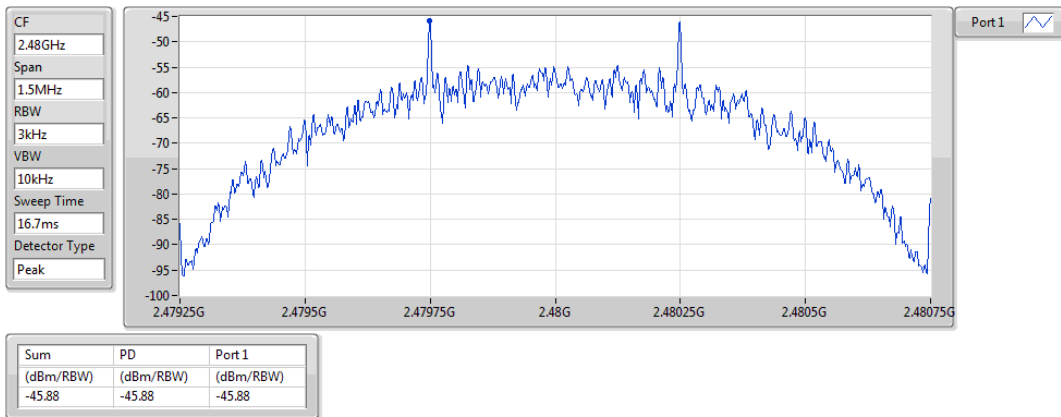
2440MHz



BT-LE(500kbps)

PSD

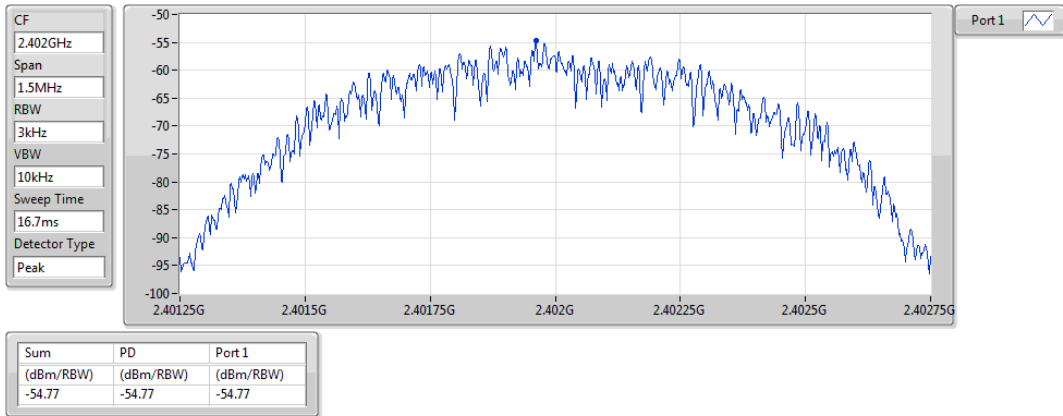
2480MHz



BT-LE(1Mbps)

PSD

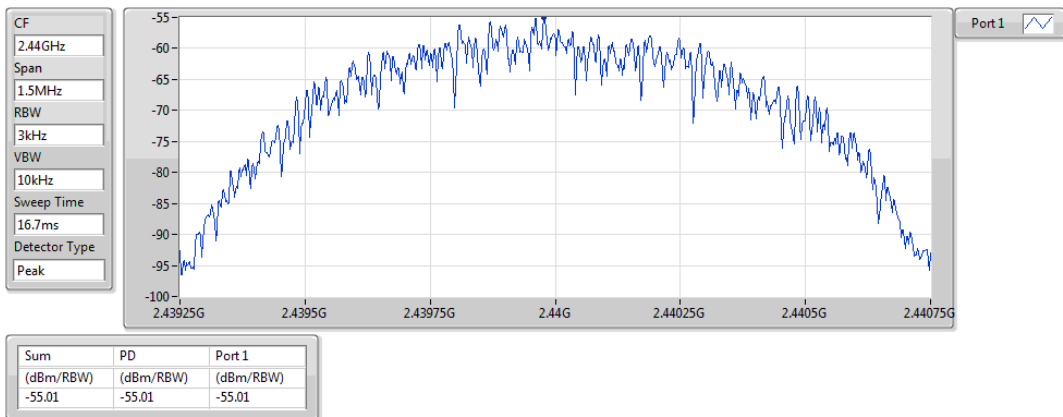
2402MHz



BT-LE(1Mbps)

PSD

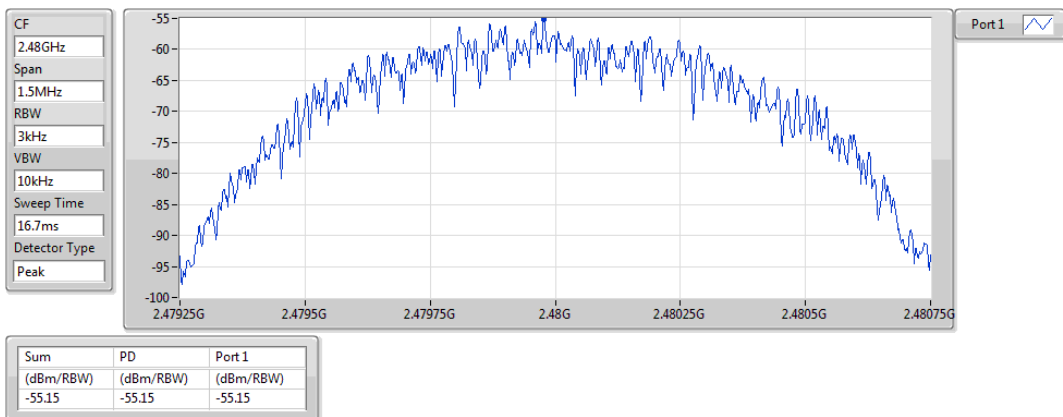
2440MHz



BT-LE(1Mbps)

PSD

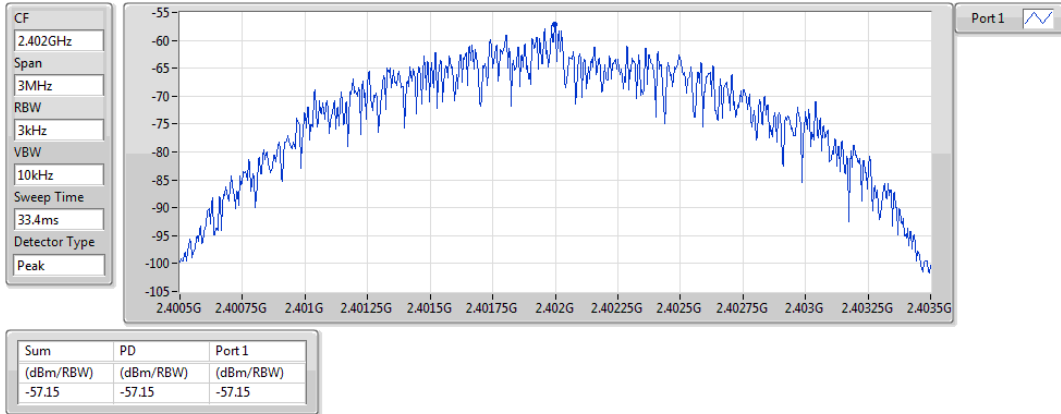
2480MHz



BT-LE(2Mbps)

PSD

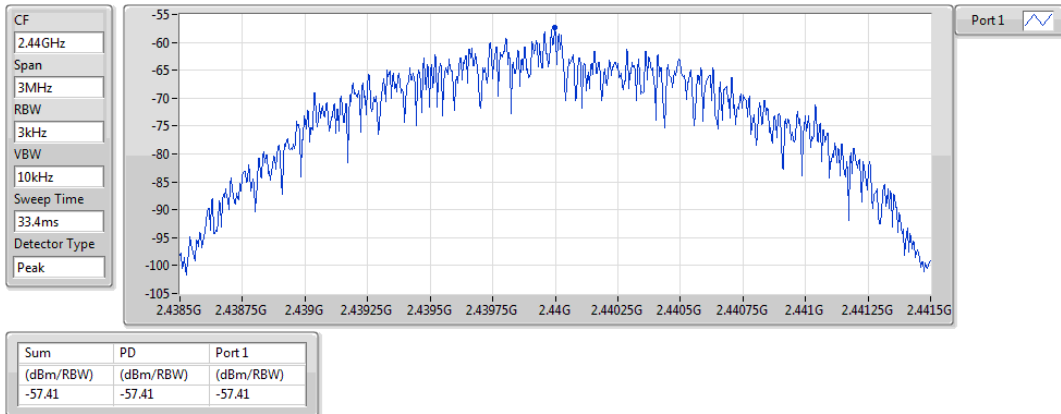
2402MHz



BT-LE(2Mbps)

PSD

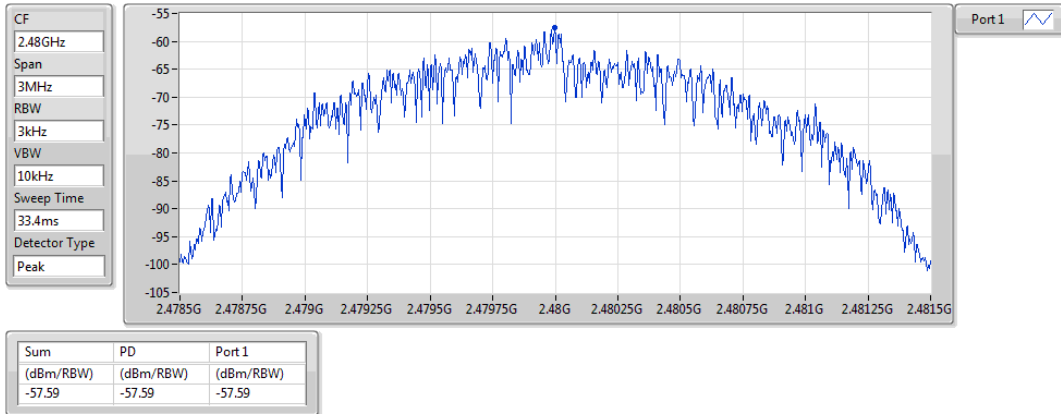
2440MHz



BT-LE(2Mbps)

PSD

2480MHz



High Power Summary

Mode	PD (dBm/RBW)
2.4-2.4835GHz	-
BT-LE(125kbps)	2.08
BT-LE(500kbps)	1.84
BT-LE(1Mbps)	-7.16
BT-LE(2Mbps)	-9.74

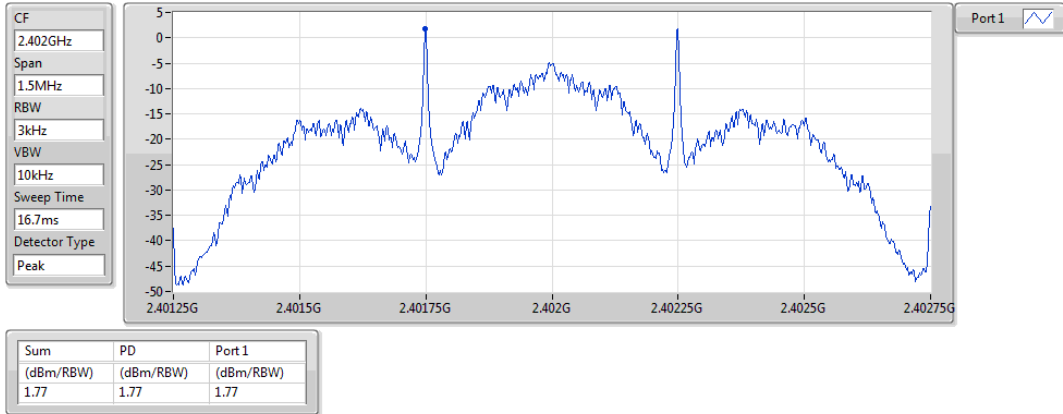
Result

Mode	Result	Gain (dBi)	PD (dBm/RBW)	PD Limit (dBm/RBW)
BT-LE(125kbps)	-	-	-	-
2402MHz	Pass	2.00	1.77	8.00
2440MHz	Pass	2.00	2.08	8.00
2480MHz	Pass	2.00	2.05	8.00
BT-LE(500kbps)	-	-	-	-
2402MHz	Pass	2.00	1.56	8.00
2440MHz	Pass	2.00	1.83	8.00
2480MHz	Pass	2.00	1.84	8.00
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	2.00	-7.76	8.00
2440MHz	Pass	2.00	-7.53	8.00
2480MHz	Pass	2.00	-7.16	8.00
BT-LE(2Mbps)	-	-	-	-
2402MHz	Pass	2.00	-10.19	8.00
2440MHz	Pass	2.00	-9.74	8.00
2480MHz	Pass	2.00	-9.74	8.00

BT-LE(125kbps)

PSD

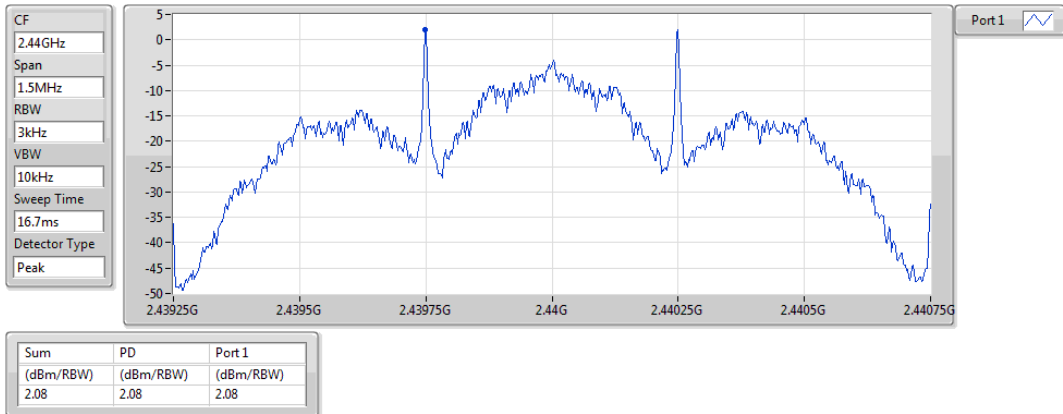
2402MHz



BT-LE(125kbps)

PSD

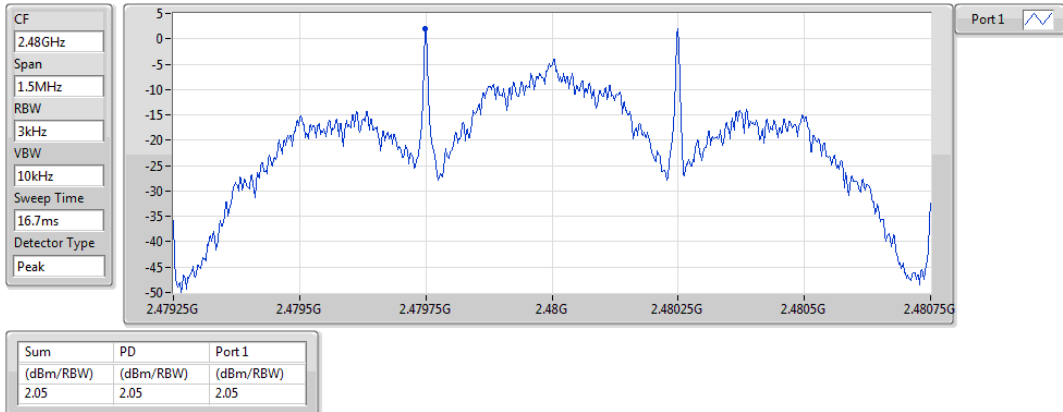
2440MHz



BT-LE(125kbps)

PSD

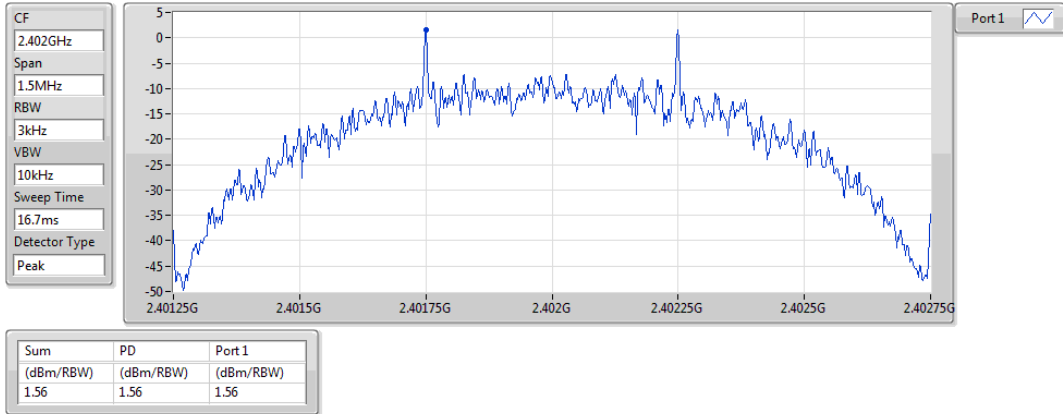
2480MHz



BT-LE(500kbps)

PSD

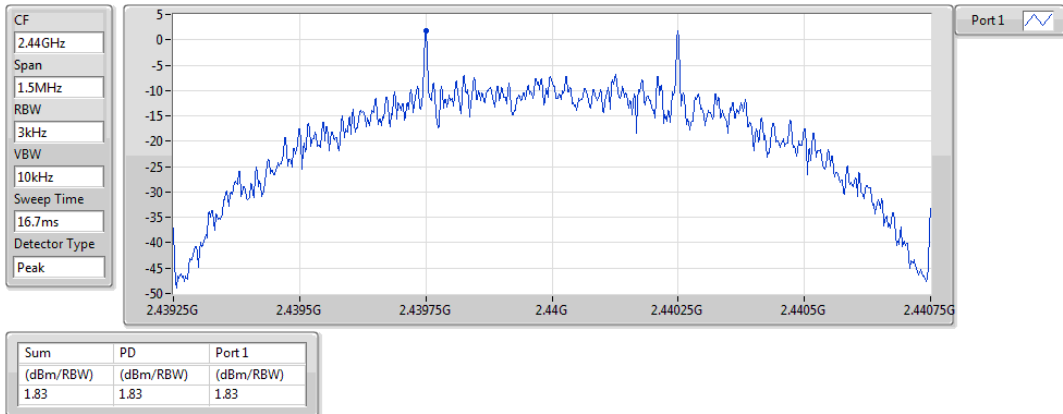
2402MHz



BT-LE(500kbps)

PSD

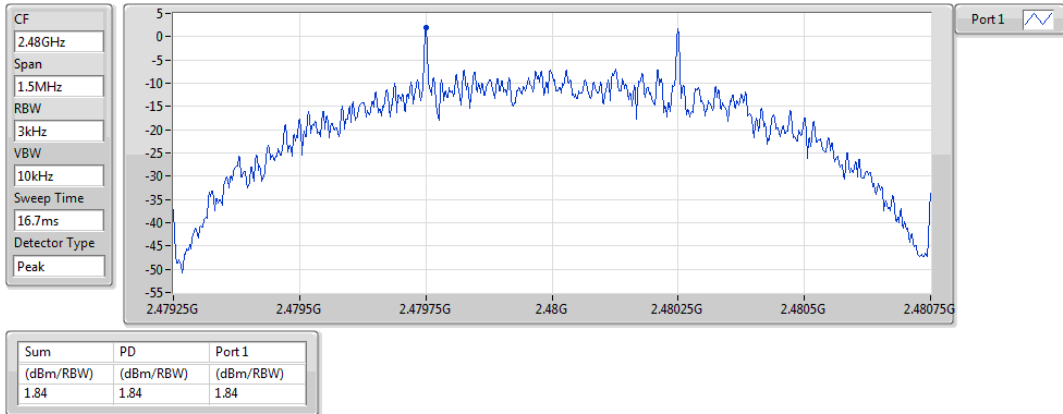
2440MHz



BT-LE(500kbps)

PSD

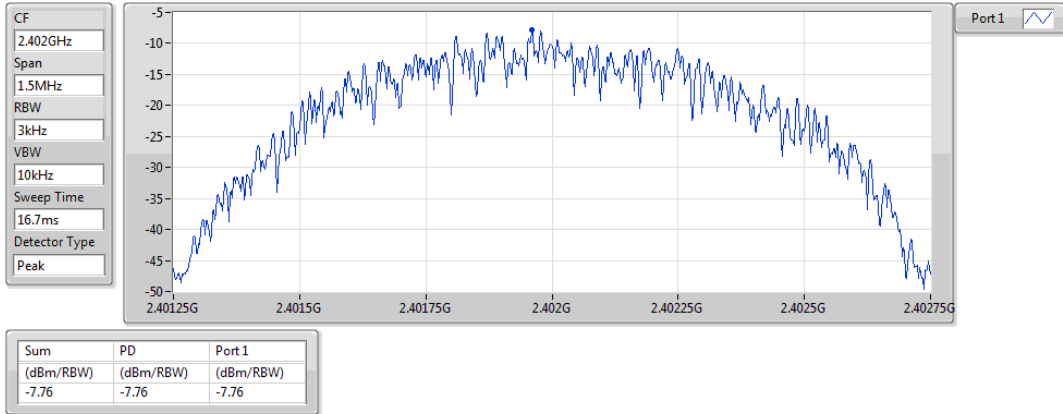
2480MHz



BT-LE(1Mbps)

PSD

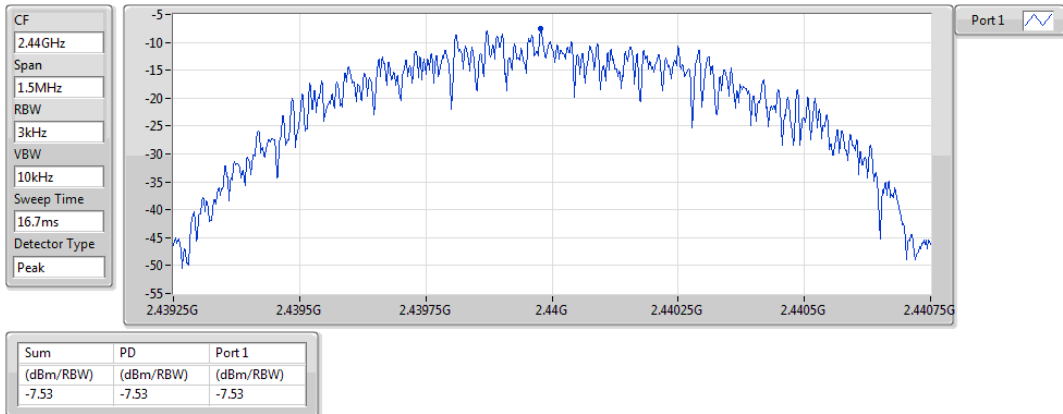
2402MHz



BT-LE(1Mbps)

PSD

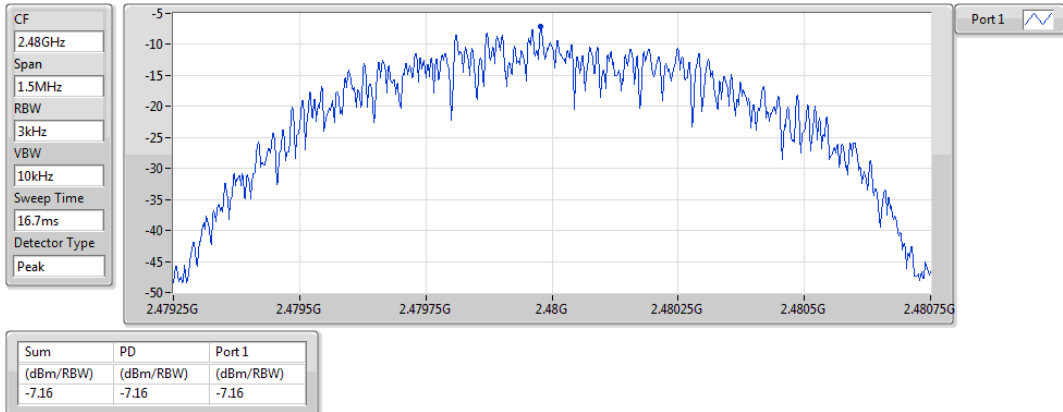
2440MHz



BT-LE(1Mbps)

PSD

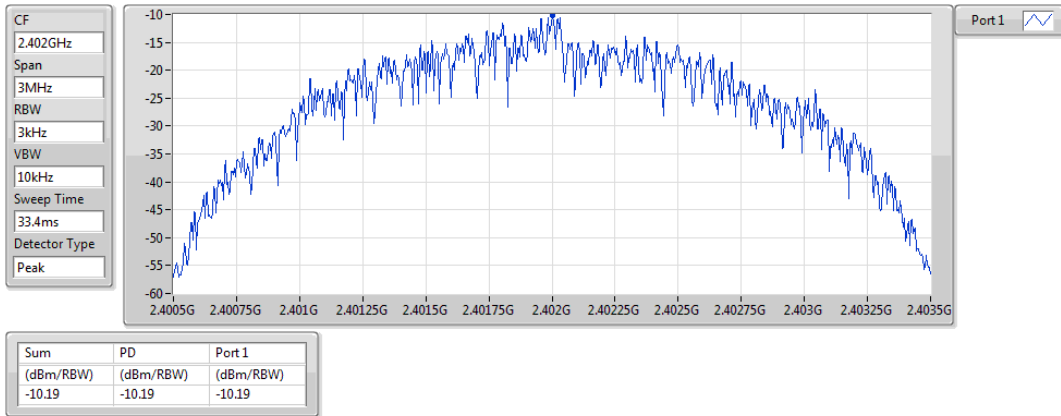
2480MHz



BT-LE(2Mbps)

PSD

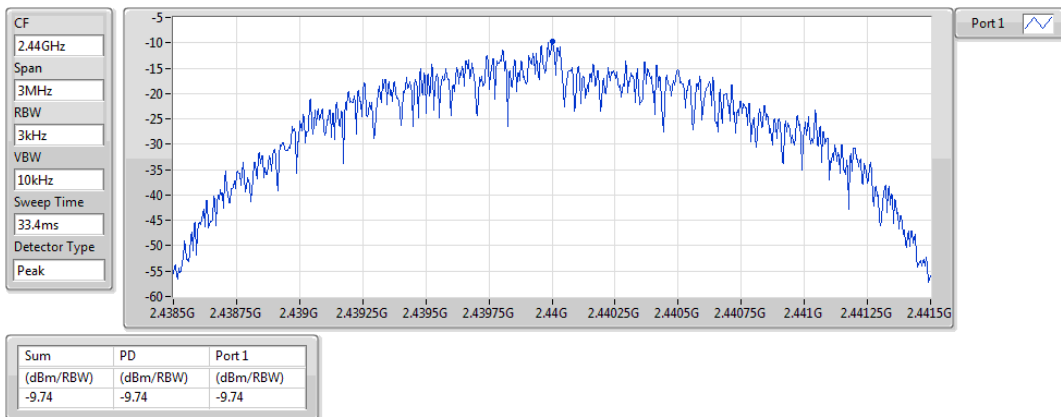
2402MHz



BT-LE(2Mbps)

PSD

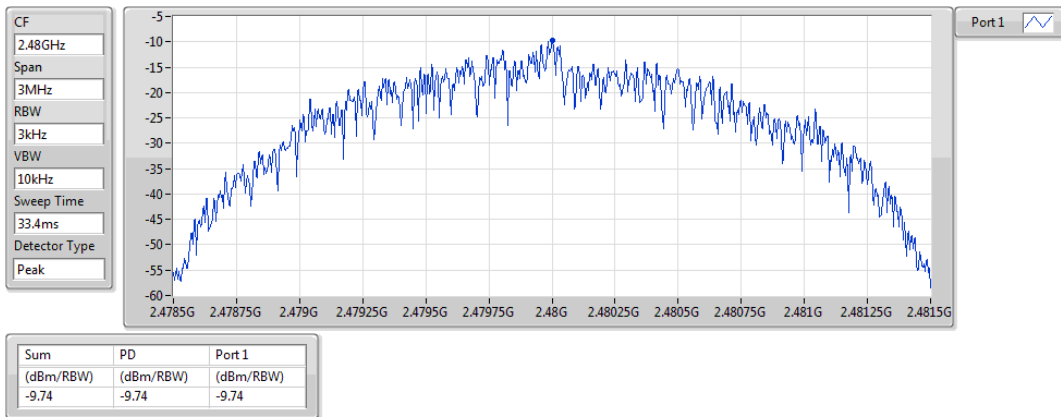
2440MHz



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:
Quasi-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

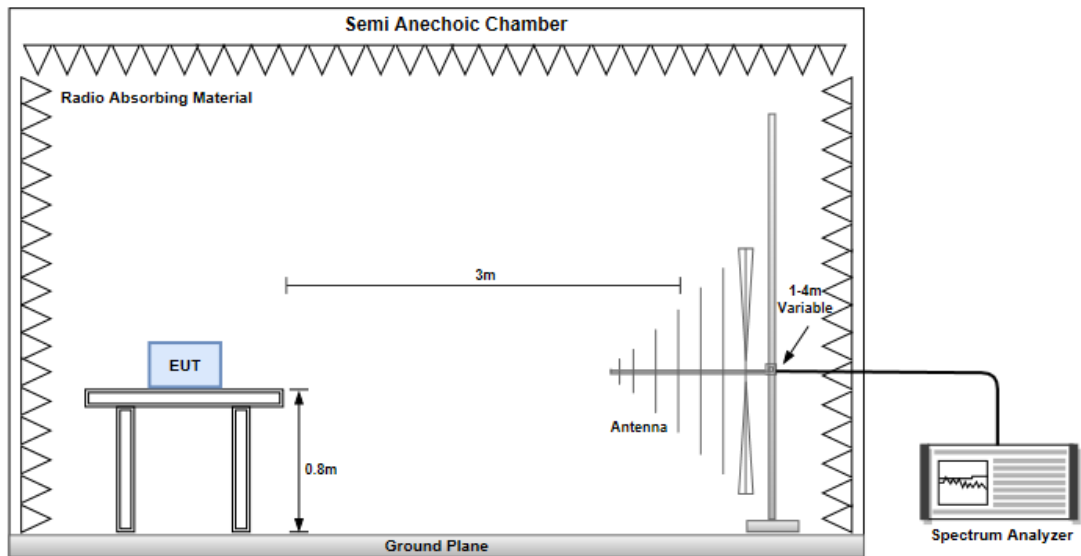
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission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

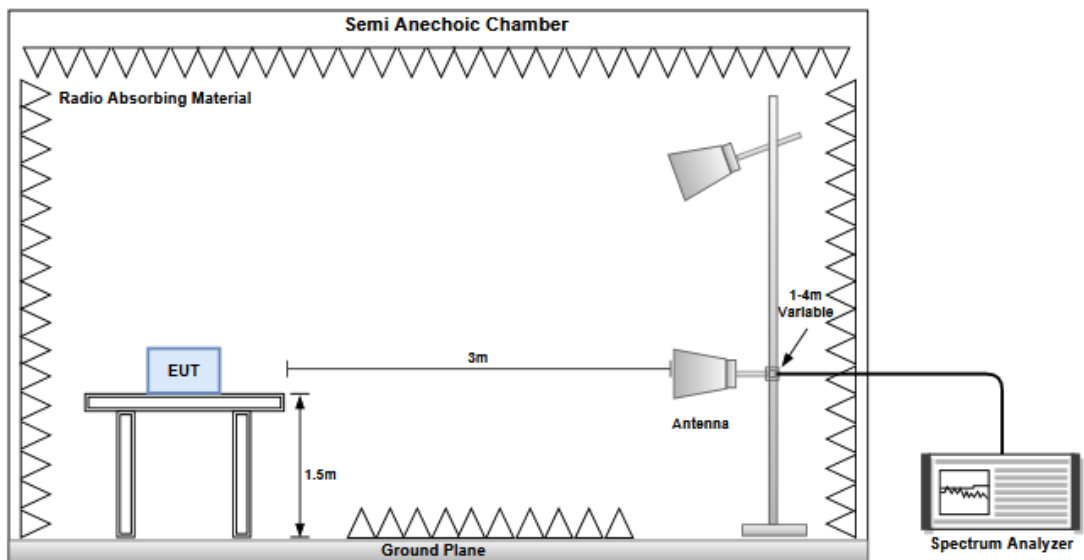
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above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

3.5.3 Test Setup

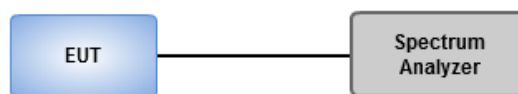
Radiated Emissions below 1 GHz



Radiated Emissions above 1 GHz



Transmitter Conducted Unwanted Emissions (30MHz~25GHz)



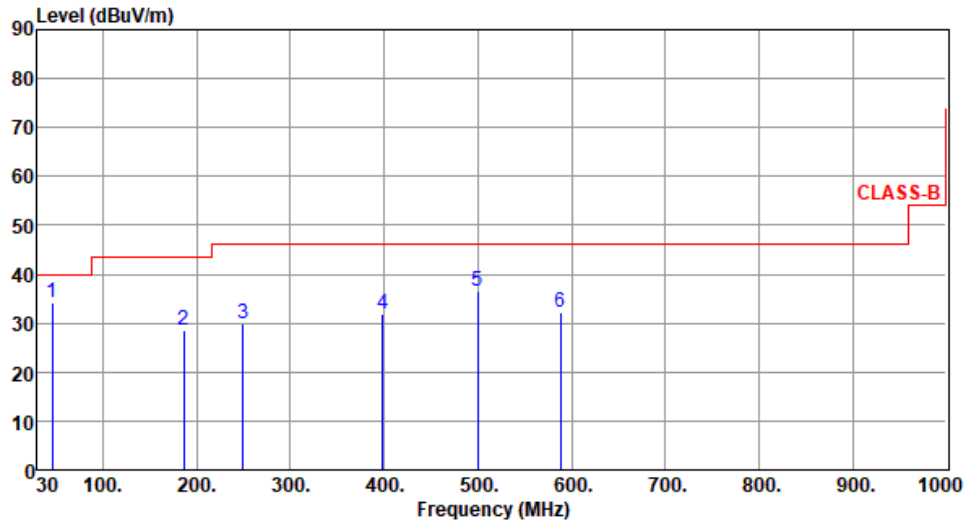
Low Power

3.5.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBUV/m)			

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

Test By :BRAD WU Temperature(°C):23 Humidity(%):63



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	46.23	34.11	40.00	-5.89	42.82	-8.71	Peak	---	---
2	186.25	28.54	43.50	-14.96	39.86	-11.32	Peak	---	---
3	249.23	29.98	46.00	-16.02	40.16	-10.18	Peak	---	---
4	398.87	31.88	46.00	-14.12	37.57	-5.69	Peak	---	---
5	499.56	36.45	46.00	-9.55	39.60	-3.15	Peak	---	---
6	587.85	32.15	46.00	-13.85	33.13	-0.98	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		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBUV/m) <			

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBUV/m)			

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2440
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) </			

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2440
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m)			

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) <			

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) <			

Modulation	BT-LE (2Mbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) </			

Modulation	BT-LE (2Mbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBUV/m)			

Modulation	BT-LE (2Mbps)	Test Freq. (MHz)	2440
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) </			

Modulation	BT-LE (2Mbps)	Test Freq. (MHz)	2440
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) </			

Modulation	BT-LE (2Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) <			

Modulation	BT-LE (2Mbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) <			

High Power

3.5.6 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) </			

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m)			

3.5.7 Transmitter Radiated Unwanted Emissions (Above 1GHz)

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m)			

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBUV/m)			

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2440
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) </			

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2440
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m)			

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) </			

Modulation	BT-LE (1Mbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m)			

Modulation	BT-LE (2Mbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBUV/m) </			

Modulation	BT-LE (2Mbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBUV/m) <			

Modulation	BT-LE (2Mbps)	Test Freq. (MHz)	2440
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m)			

Modulation	BT-LE (2Mbps)	Test Freq. (MHz)	2440
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m)			

Modulation	BT-LE (2Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) </			

Modulation	BT-LE (2Mbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):63			
Level (dBuV/m)			

Low Power

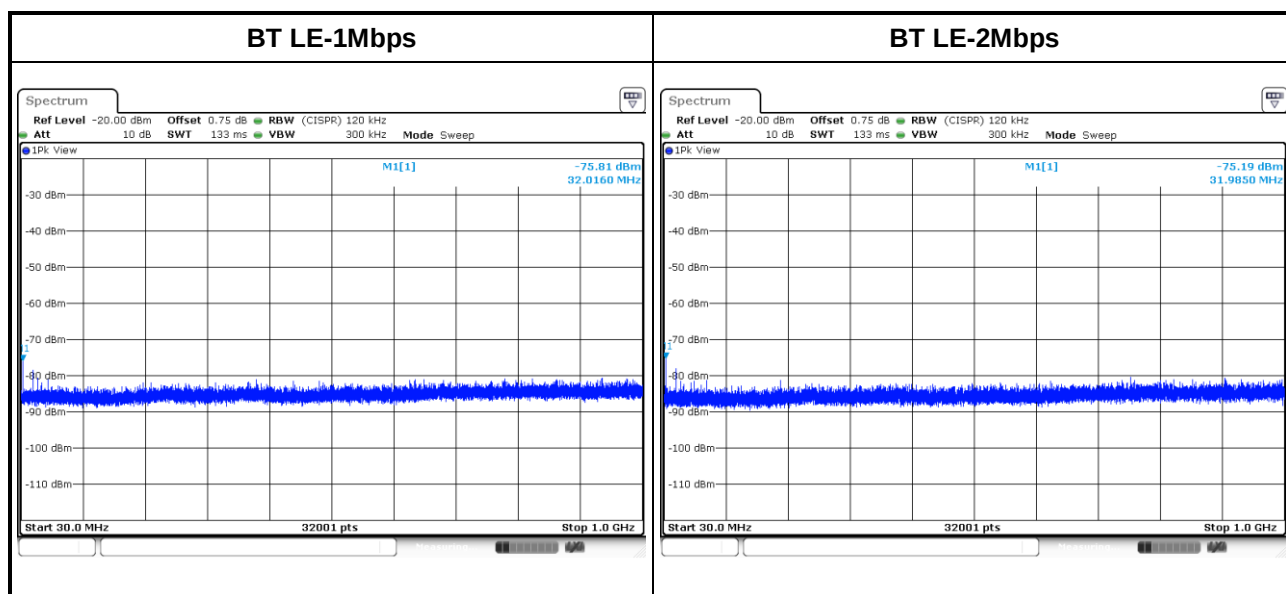
3.5.8 Transmitter Conducted Unwanted Emissions (Below 1 GHz)

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)
30~1000	-75.81	2.00	4.70	-69.11	26.15	40.00	-13.85

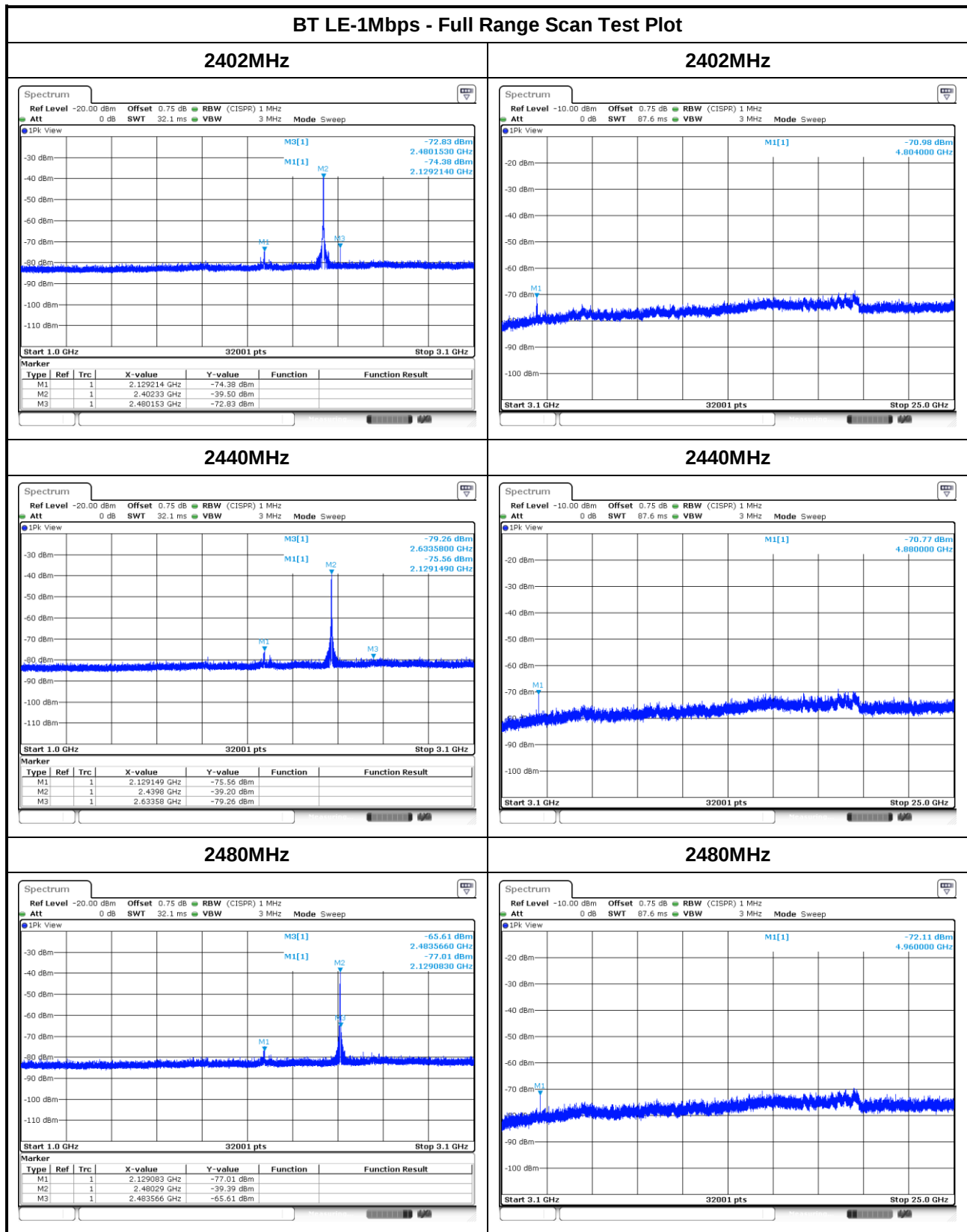
Modulation Mode		BT LE-2Mbps		Frequency		2480MHz	
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000	-75.19	2.00	4.70	-68.49	26.77	40.00	-13.23

Note:

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

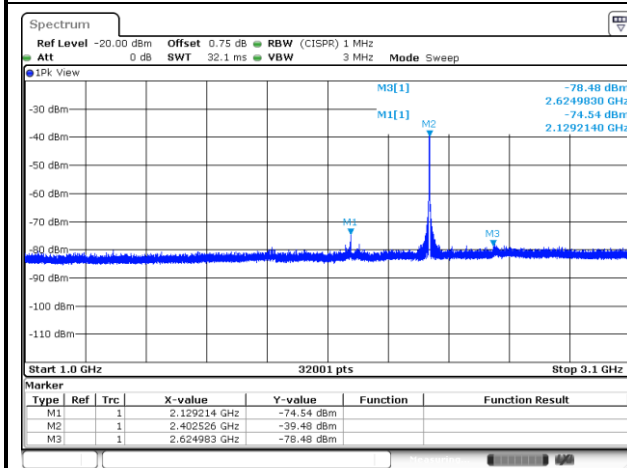


3.5.9 Transmitter Conducted Unwanted Emissions (Above 1GHz)

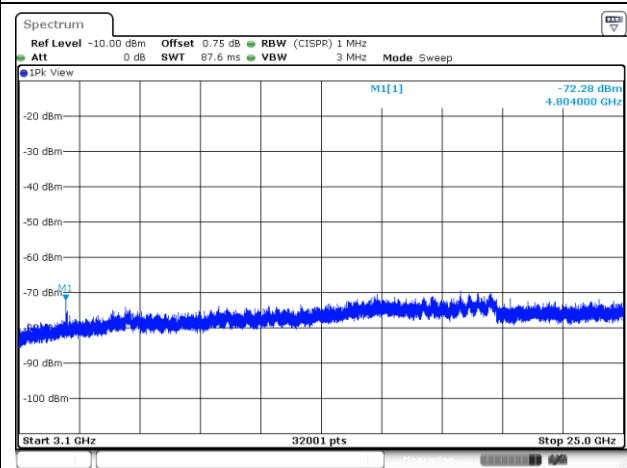


BT LE-2Mbps - Full Range Scan Test Plot

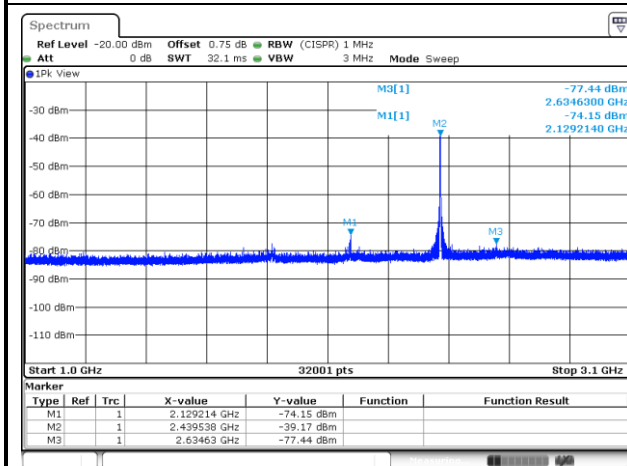
2402MHz



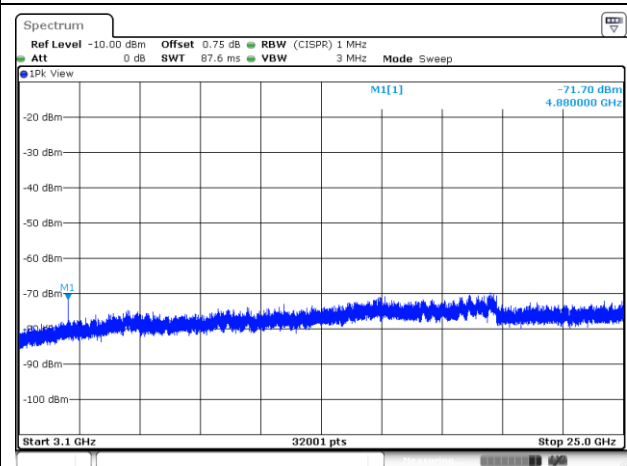
2402MHz



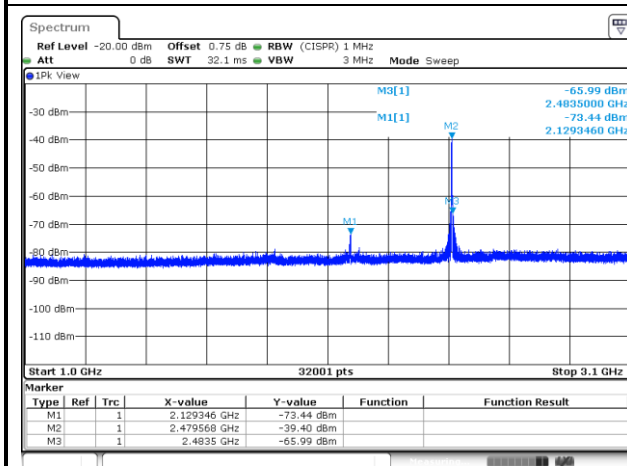
2440MHz



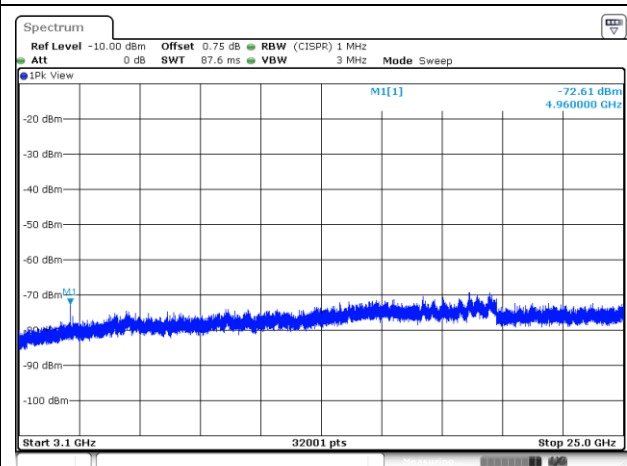
2440MHz



2480MHz



2480MHz



Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		BT LE-1Mbps						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-75.33	2.00	-73.33	21.93	74.00	-52.07	PK
	2310~2390	-93.48	2.00	-91.48	3.78	54.00	-50.22	AV
	2483.5~2500	-81.39	2.00	-79.39	15.87	74.00	-58.13	PK
	2483.5~2500	-92.33	2.00	-90.33	4.93	54.00	-49.07	AV
2440	2310~2390	-81.21	2.00	-79.21	16.05	74.00	-57.95	PK
	2310~2390	-94.09	2.00	-92.09	3.17	54.00	-50.83	AV
	2483.5~2500	-81.68	2.00	-79.68	15.58	74.00	-58.42	PK
	2483.5~2500	-93.40	2.00	-91.40	3.86	54.00	-50.14	AV
2480	2310~2390	-82.75	2.00	-80.75	14.51	74.00	-59.49	PK
	2310~2390	-93.68	2.00	-91.68	3.58	54.00	-50.42	AV
	2485.5~2500	-66.27	2.00	-64.27	30.99	74.00	-43.01	PK
	2483.5~2500	-92.73	2.00	-90.73	4.53	54.00	-49.47	AV

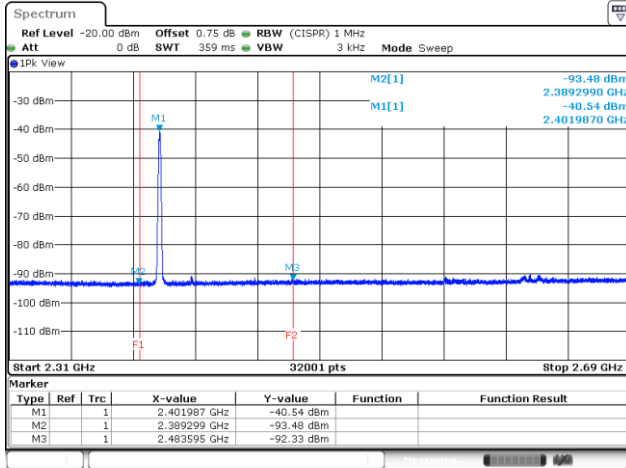
Note: DG = Directional Gain.

Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		BT LE-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	-75.96	2.00	-73.96	21.30	74.00	-52.70	PK
	2310~2390	-93.00	2.00	-91.00	4.26	54.00	-49.74	AV
	2483.5~2500	-80.33	2.00	-78.33	16.93	74.00	-57.07	PK
	2483.5~2500	-92.27	2.00	-90.27	4.99	54.00	-49.01	AV
2440	2310~2390	-80.38	2.00	-78.38	16.88	74.00	-57.12	PK
	2310~2390	-93.39	2.00	-91.39	3.87	54.00	-50.13	AV
	2483.5~2500	-81.51	2.00	-79.51	15.75	74.00	-58.25	PK
	2483.5~2500	-92.87	2.00	-90.87	4.39	54.00	-49.61	AV
2480	2310~2390	-81.78	2.00	-79.78	15.48	74.00	-58.52	PK
	2310~2390	-93.30	2.00	-91.30	3.96	54.00	-50.04	AV
	2485.5~2500	-65.79	2.00	-63.79	31.47	74.00	-42.53	PK
	2483.5~2500	-91.94	2.00	-89.94	5.32	54.00	-48.68	AV

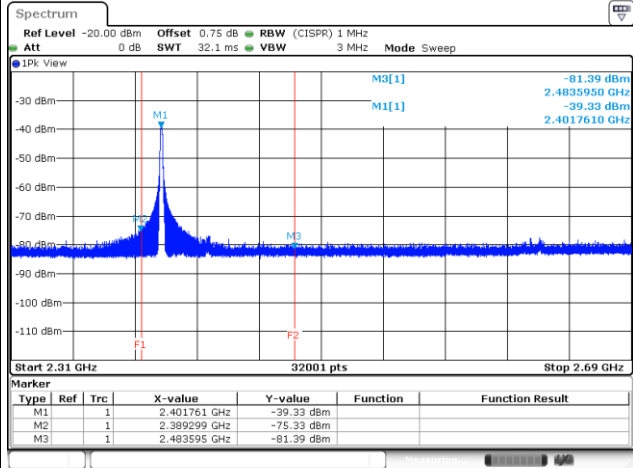
Note: DG = Directional Gain.

Band Edge Test Plot - BT LE-1Mbps

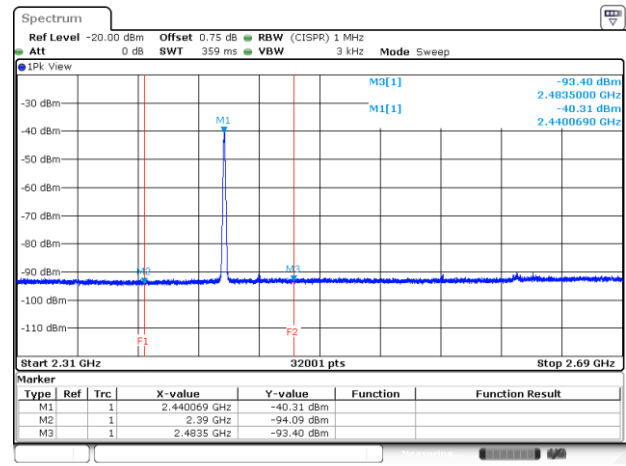
2402MHz - AV



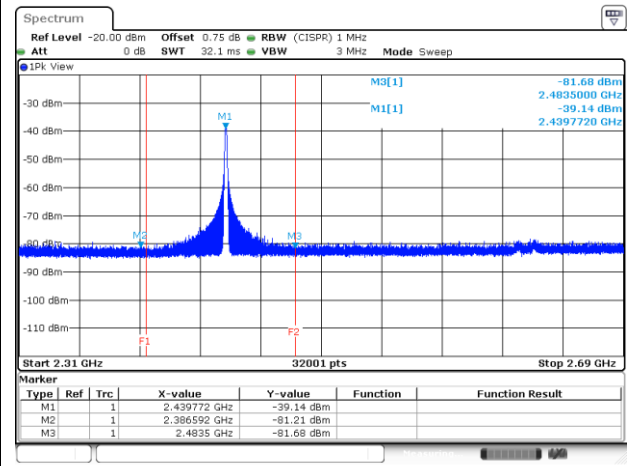
2402MHz - PK



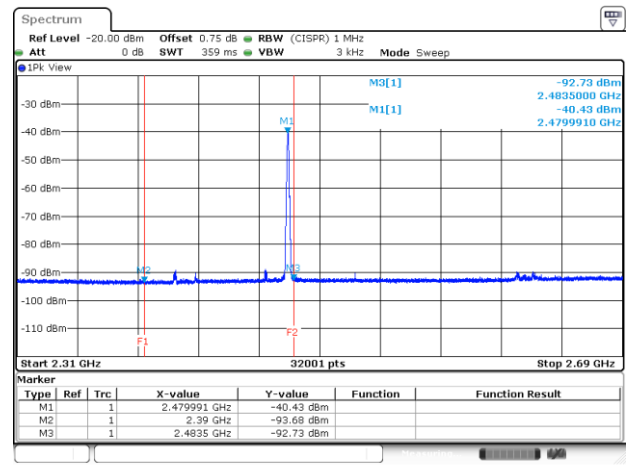
2440MHz - AV



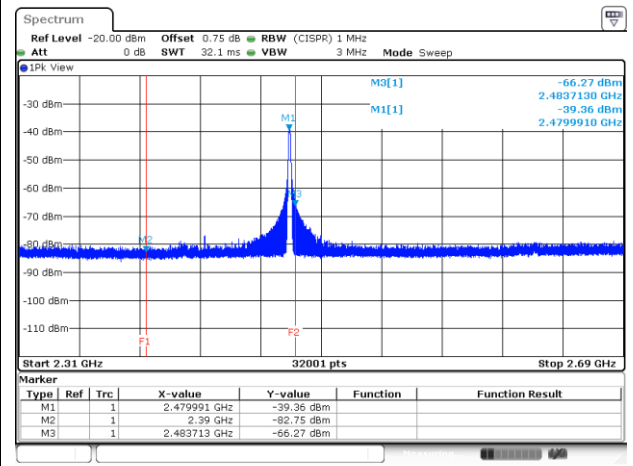
2440MHz - PK



2480MHz - AV

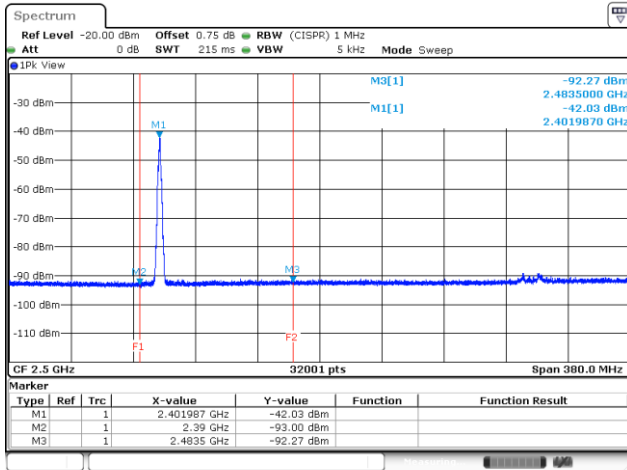


2480MHz - PK

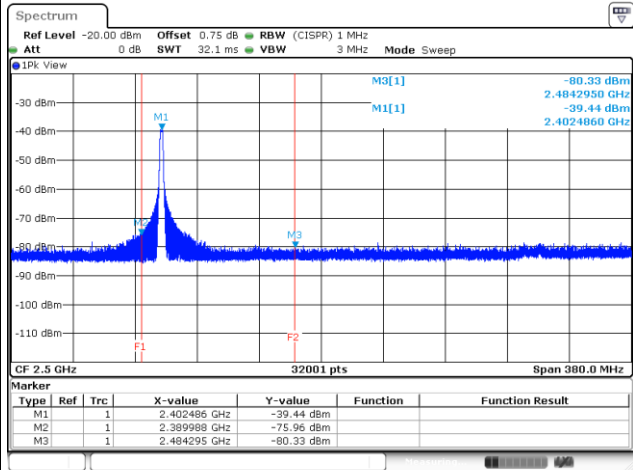


Band Edge Test Plot - BT LE-2Mbps

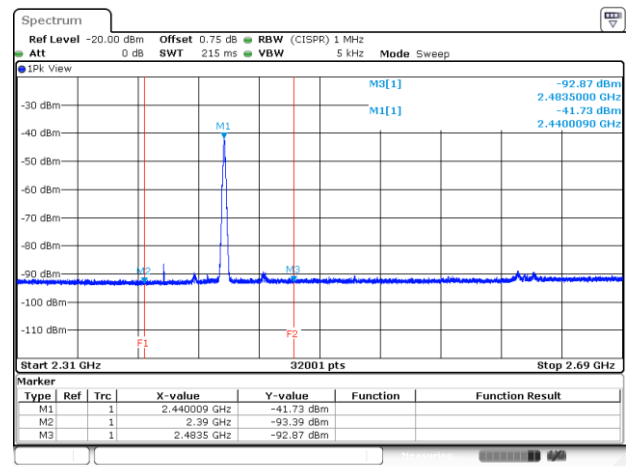
2402MHz - AV



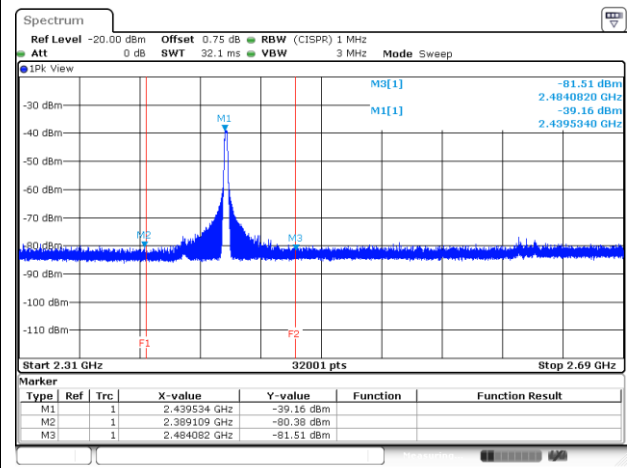
2402MHz - PK



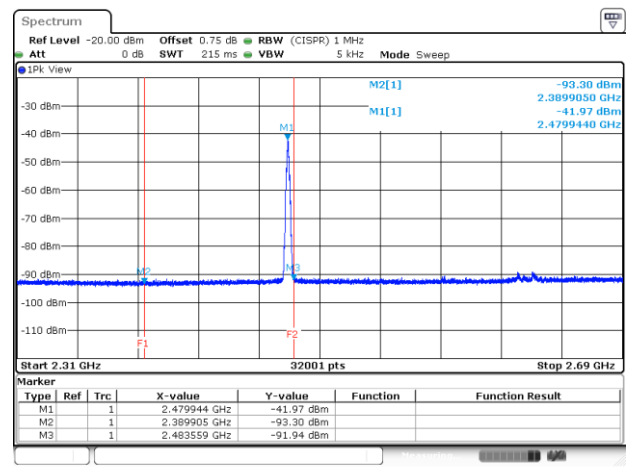
2440MHz - AV



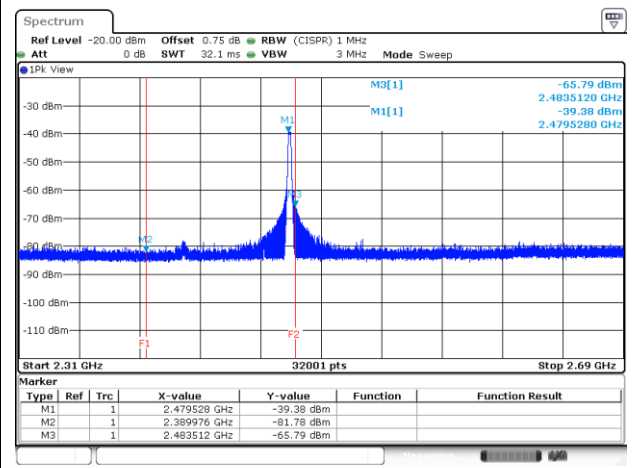
2440MHz - PK



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 (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4804.00	PK	-69.82	2.00	-67.82	27.44	74.00	-46.56

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	-68.84	2.00	-66.84	28.42	74.00	-45.58

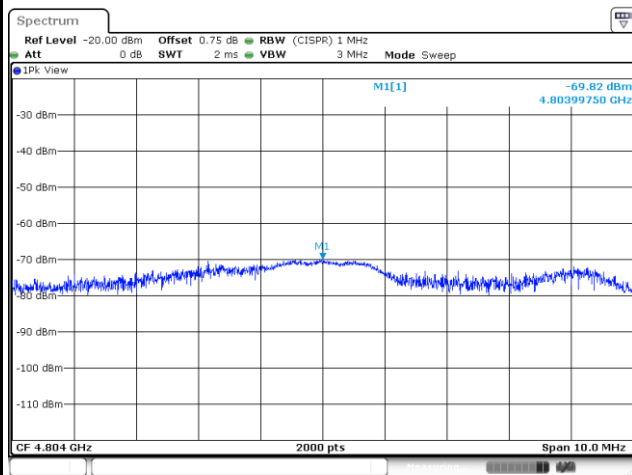
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-1Mbps		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4960.00	PK	-69.37	2.00	-67.37	27.89	74.00	-46.11

Note:

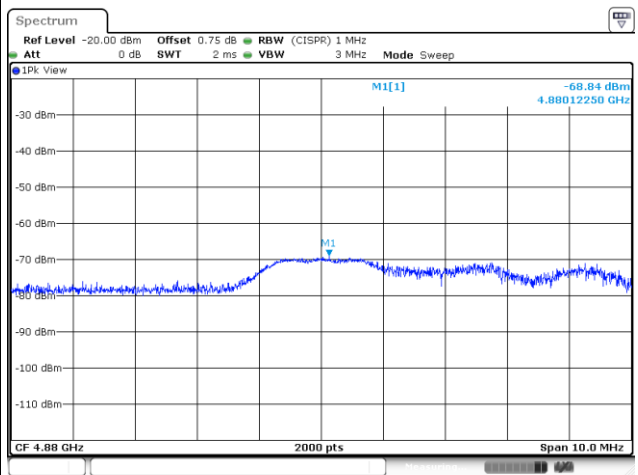
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain.

Test Plots

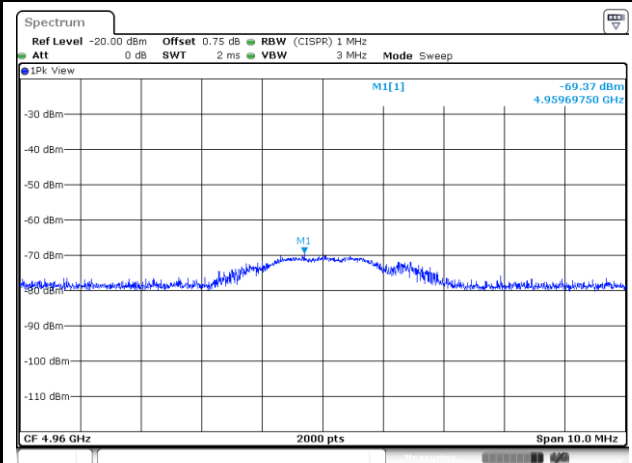
4804MHz - PK



4880MHz - PK



4960MHz - PK



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Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-2Mbps		Frequency		2402MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4804.00	PK	-69.88	2.00	-67.88	27.38	74.00	-46.62

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	-69.27	2.00	-67.27	27.99	74.00	-46.01

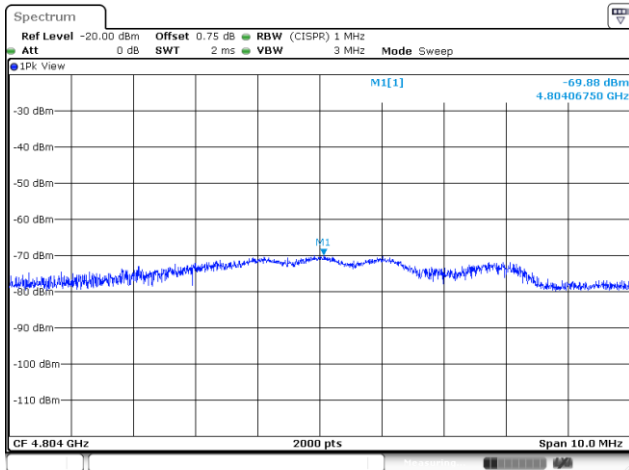
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-2Mbps		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4960.00	PK	-70.03	2.00	-68.03	27.23	74.00	-46.77

Note:

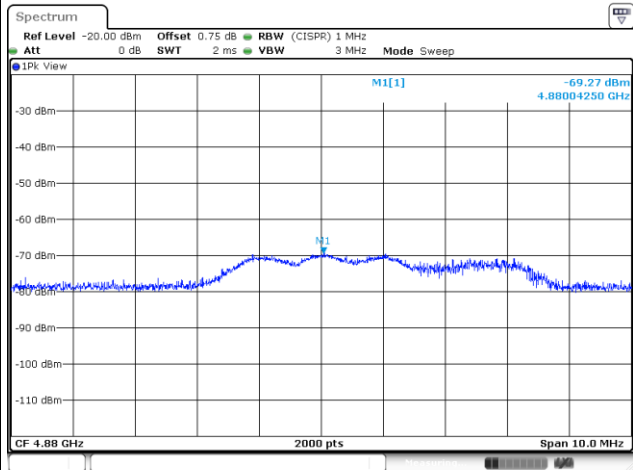
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain.

Test Plots

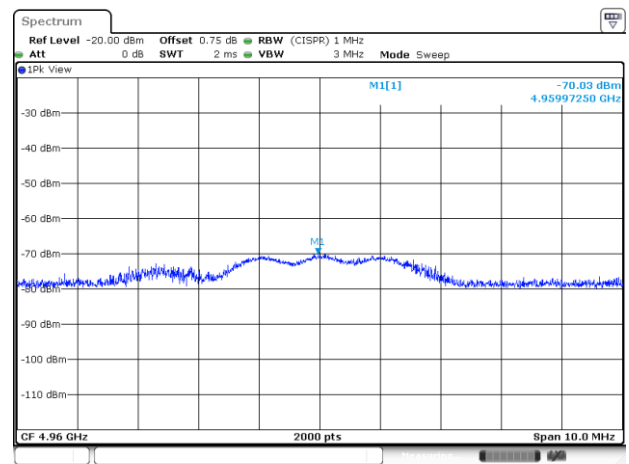
4804MHz - PK



4880MHz - PK



4960MHz - PK



-

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High Power

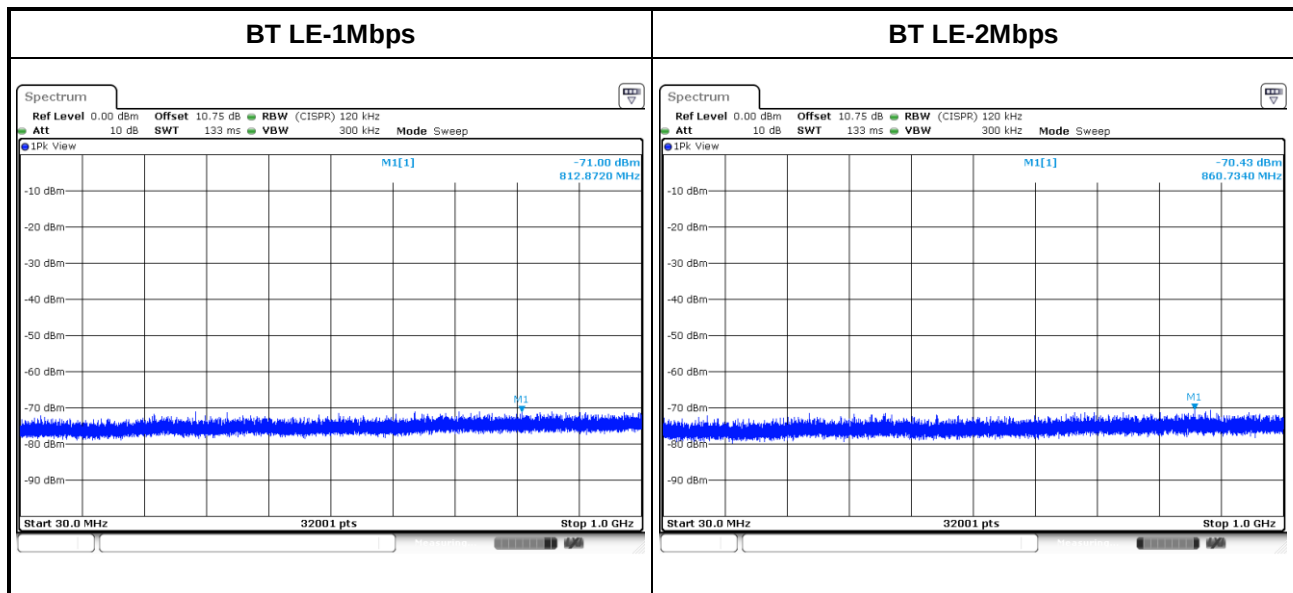
3.5.10 Transmitter Conducted Unwanted Emissions (Below 1 GHz)

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)
30~1000	-71.00	2.00	4.70	-64.30	30.96	40.00	-9.04

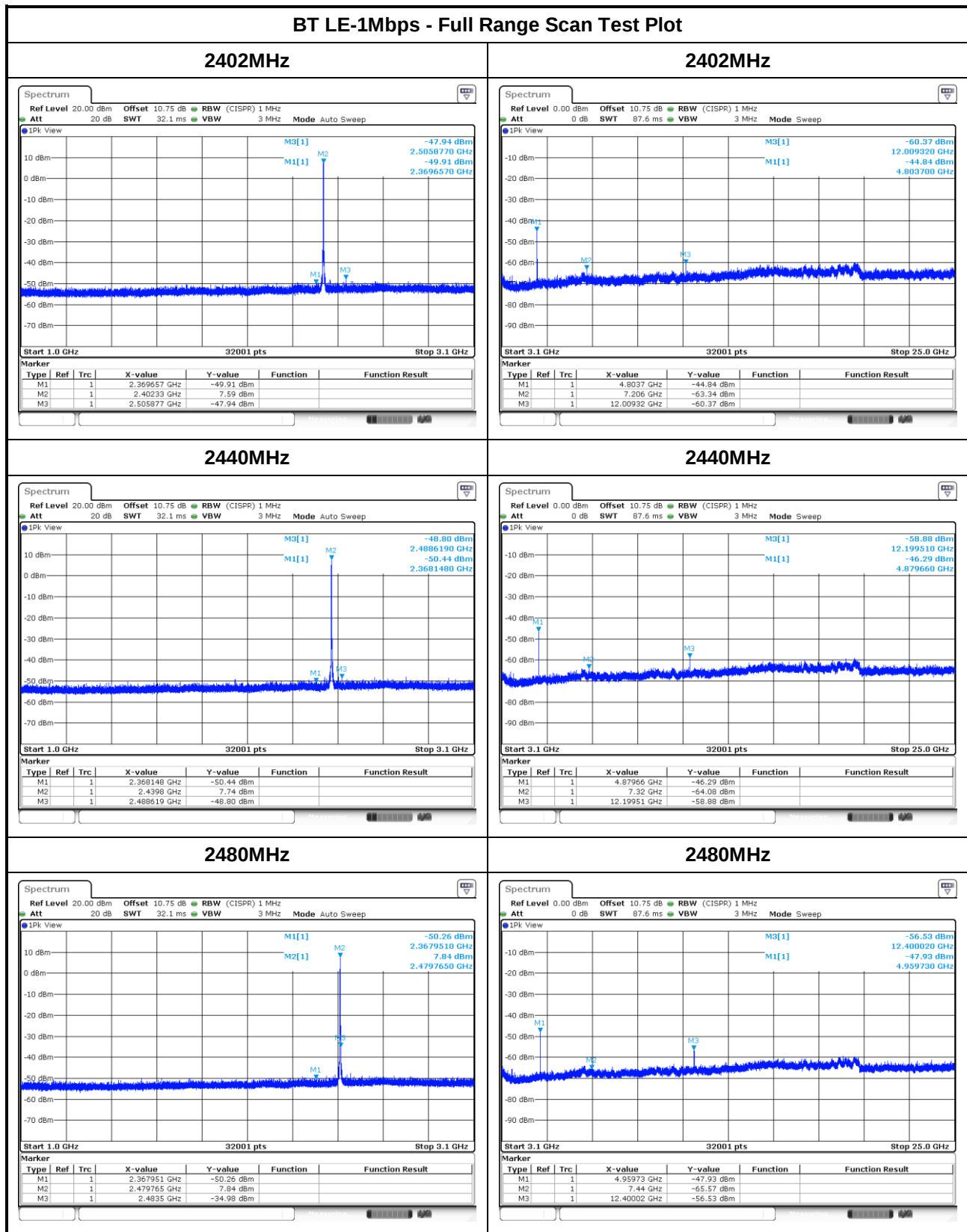
Modulation Mode		BT LE-2Mbps		Frequency		2480MHz	
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000	-70.43	2.00	4.70	-63.73	31.53	40.00	-8.47

Note:

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

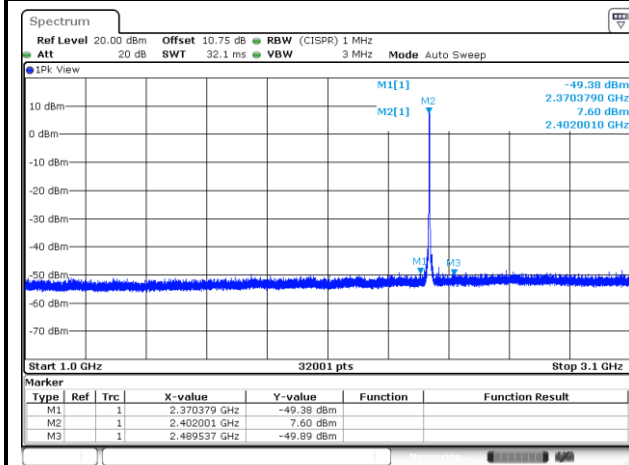


3.5.11 Transmitter Conducted Unwanted Emissions (Above 1GHz)

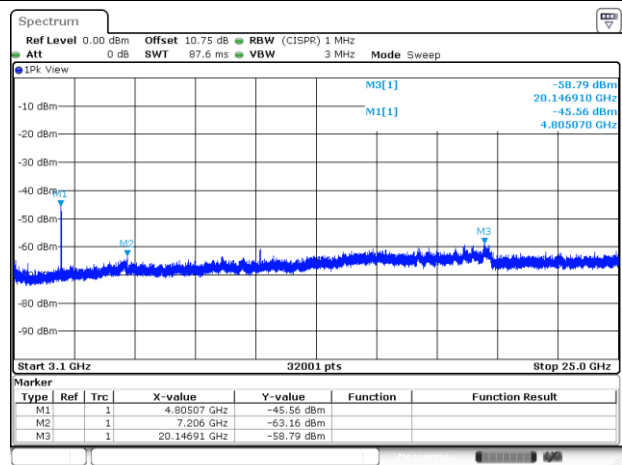


BT LE-2Mbps - Full Range Scan Test Plot

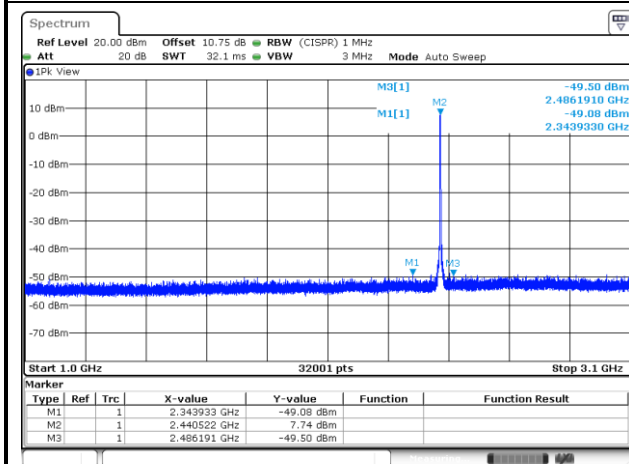
2402MHz



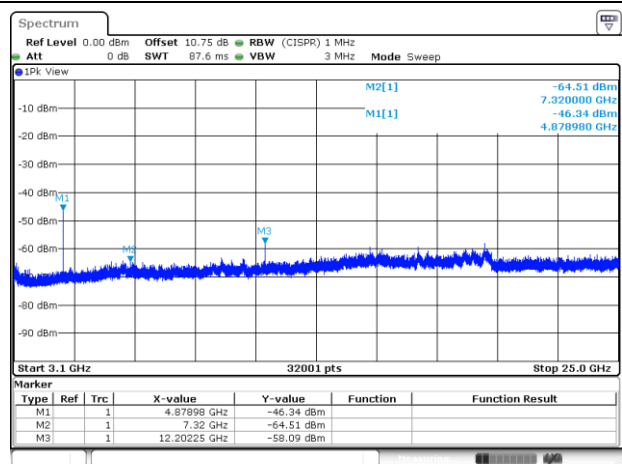
2402MHz



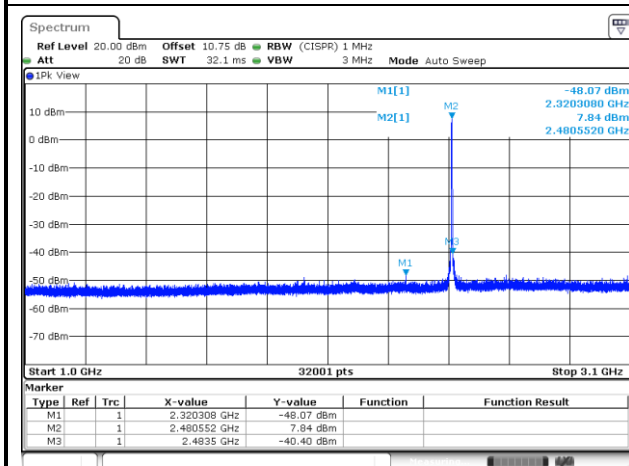
2440MHz



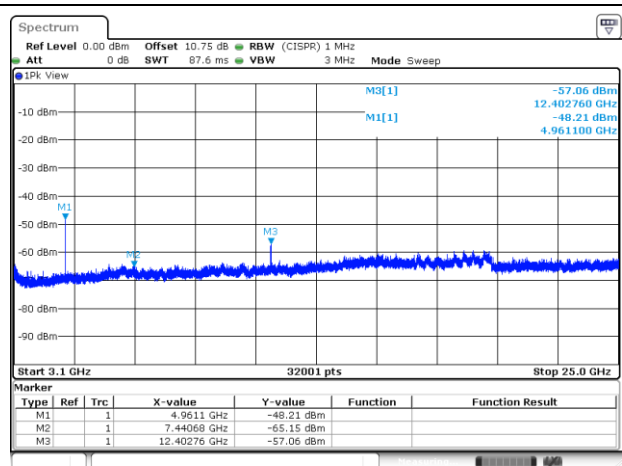
2440MHz



2480MHz



2480MHz



Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		BT LE-1Mbps						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-47.99	2.00	-45.99	49.27	74.00	-24.73	PK
	2310~2390	-57.00	2.00	-55.00	40.26	54.00	-13.74	AV
	2483.5~2500	-49.30	2.00	-47.30	47.96	74.00	-26.04	PK
	2483.5~2500	-59.72	2.00	-57.72	37.54	54.00	-16.46	AV
2440	2310~2390	-47.96	2.00	-45.96	49.30	74.00	-24.70	PK
	2310~2390	-59.64	2.00	-57.64	37.62	54.00	-16.38	AV
	2483.5~2500	-48.79	2.00	-46.79	48.47	74.00	-25.53	PK
	2483.5~2500	-59.62	2.00	-57.62	37.64	54.00	-16.36	AV
2480	2310~2390	-48.89	2.00	-46.89	48.37	74.00	-25.63	PK
	2310~2390	-60.57	2.00	-58.57	36.69	54.00	-17.31	AV
	2485.5~2500	-36.05	2.00	-34.05	61.21	74.00	-12.79	PK
	2483.5~2500	-52.82	2.00	-50.82	44.44	54.00	-9.56	AV

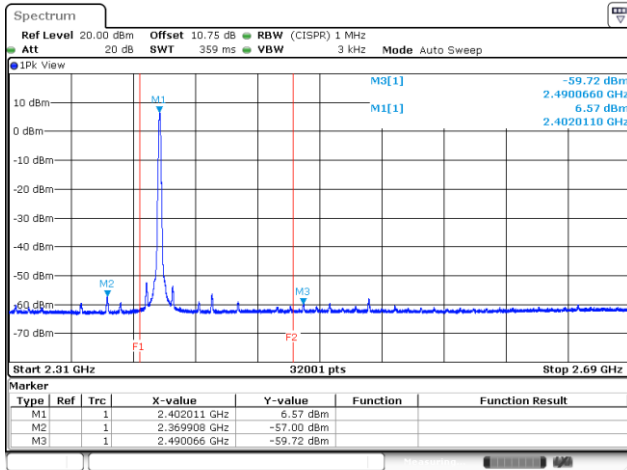
Note: DG = Directional Gain.

Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		BT LE-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	-48.69	2.00	-46.69	48.57	74.00	-25.43	PK
	2310~2390	-58.21	2.00	-56.21	39.05	54.00	-14.95	AV
	2483.5~2500	-50.04	2.00	-48.04	47.22	74.00	-26.78	PK
	2483.5~2500	-60.33	2.00	-58.33	36.93	54.00	-17.07	AV
2440	2310~2390	-50.29	2.00	-48.29	46.97	74.00	-27.03	PK
	2310~2390	-59.81	2.00	-57.81	37.45	54.00	-16.55	AV
	2483.5~2500	-50.16	2.00	-48.16	47.10	74.00	-26.90	PK
	2483.5~2500	-59.56	2.00	-57.56	37.70	54.00	-16.30	AV
2480	2310~2390	-50.54	2.00	-48.54	46.72	74.00	-27.28	PK
	2310~2390	-60.50	2.00	-58.50	36.76	54.00	-17.24	AV
	2485.5~2500	-35.93	2.00	-33.93	61.33	74.00	-12.67	PK
	2483.5~2500	-49.72	2.00	-47.72	47.54	54.00	-6.46	AV

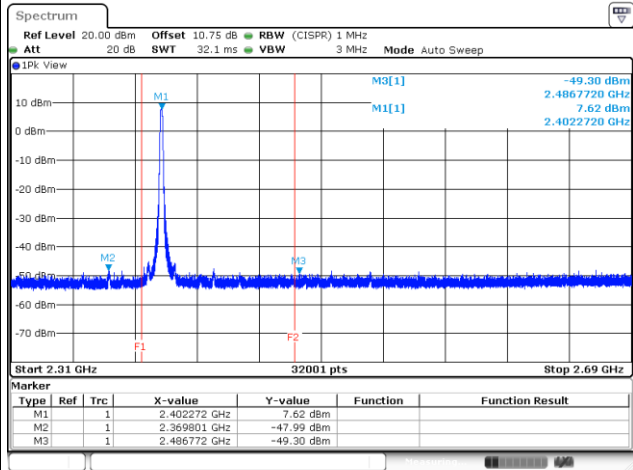
Note: DG = Directional Gain.

Band Edge Test Plot - BT LE-1Mbps

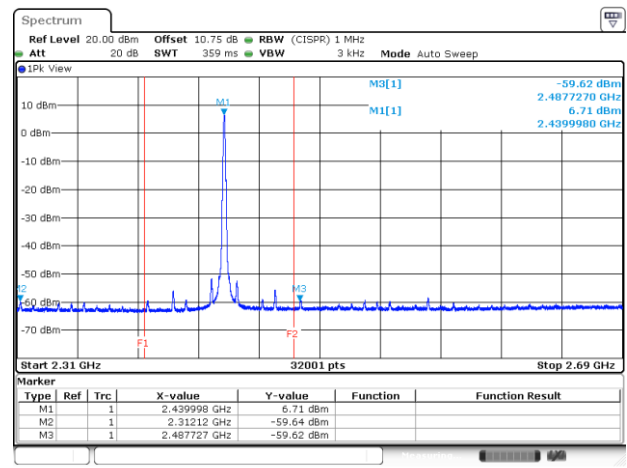
2402MHz - AV



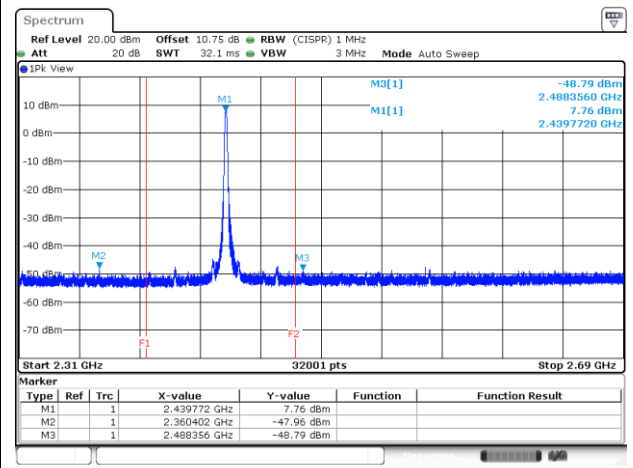
2402MHz - PK



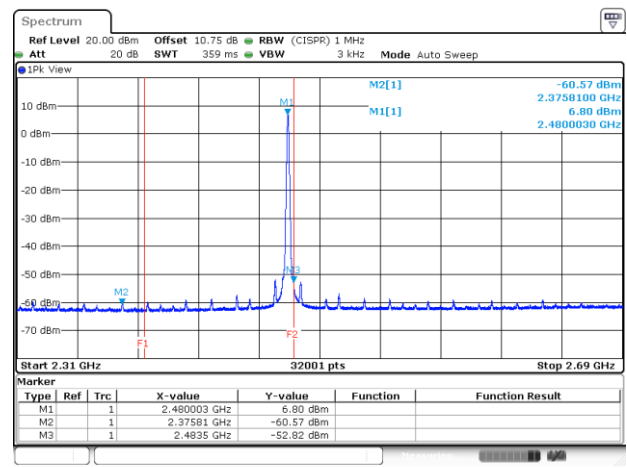
2440MHz - AV



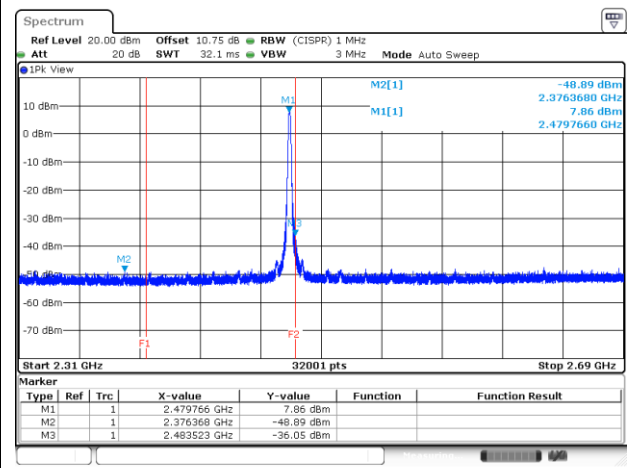
2440MHz - PK



2480MHz - AV

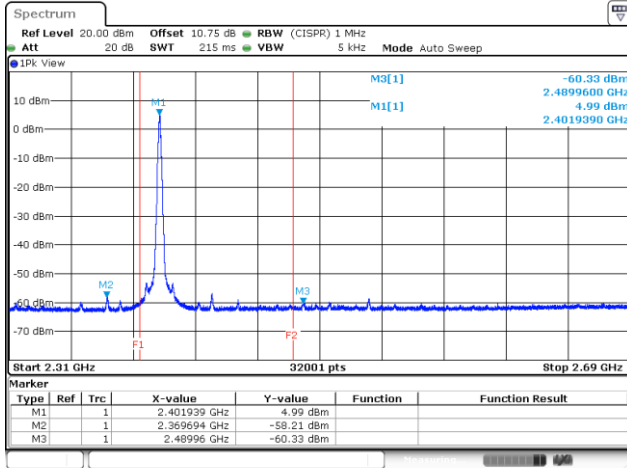


2480MHz - PK

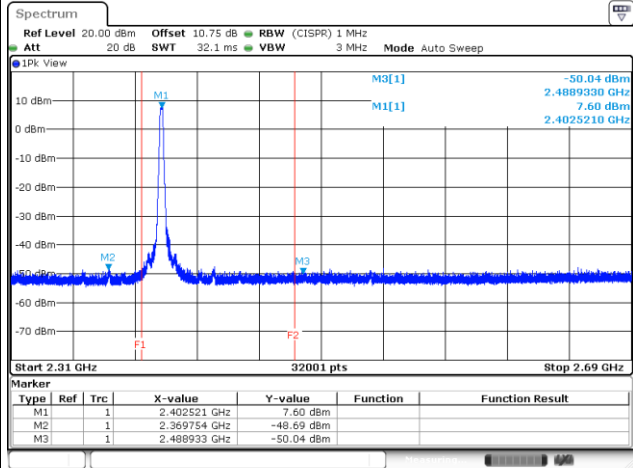


Band Edge Test Plot - BT LE-2Mbps

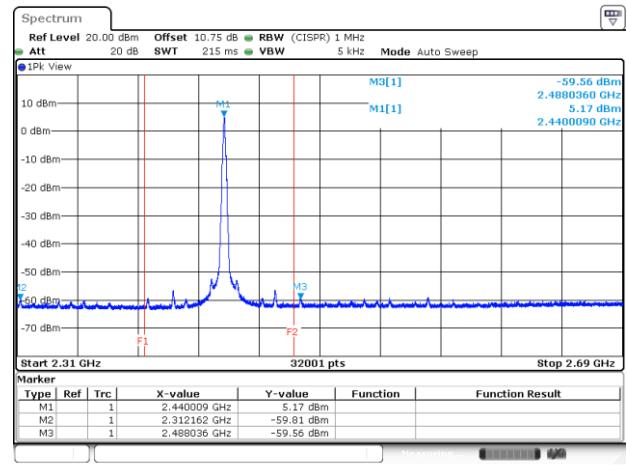
2402MHz - AV



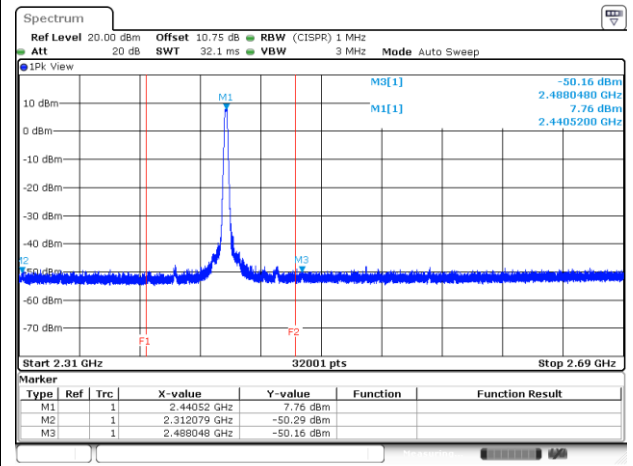
2402MHz - PK



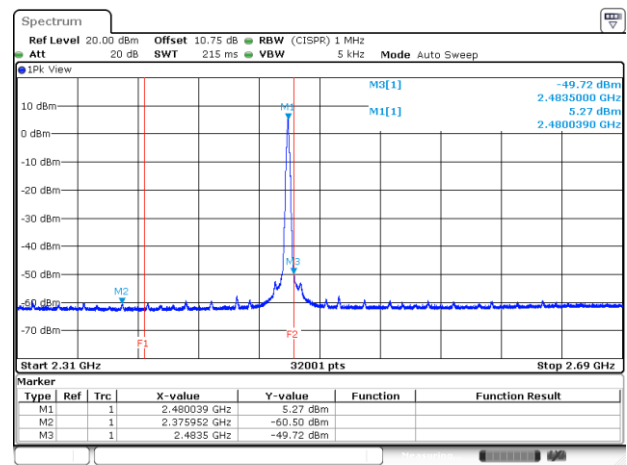
2440MHz - AV



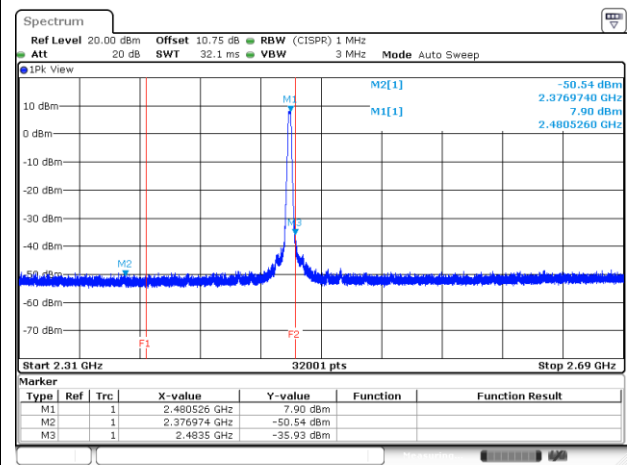
2440MHz - PK



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 (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4804.00	PK	-44.40	2.00	-42.40	52.86	74.00	-21.14
12010.00	PK	-57.94	2.00	-55.94	39.32	74.00	-34.68

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	-45.66	2.00	-43.66	51.60	74.00	-22.40
7320.00	PK	-60.83	2.00	-58.83	36.43	74.00	-37.57
12200.00	PK	-56.34	2.00	-54.34	40.92	74.00	-33.08

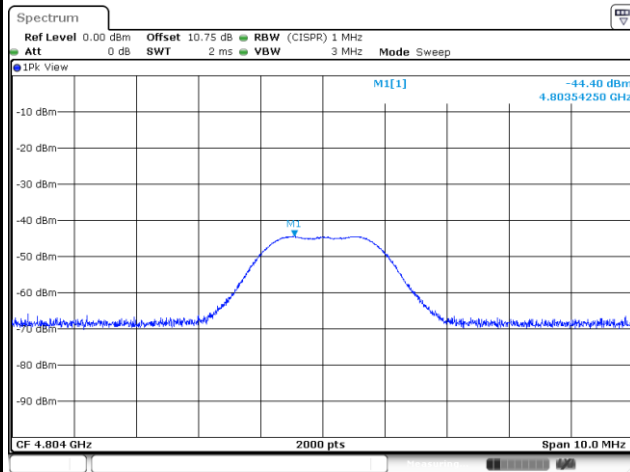
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-1Mbps		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4960.00	PK	-47.49	2.00	-45.49	49.77	74.00	-24.23
7440.00	PK	-62.46	2.00	-60.46	34.80	74.00	-39.20
12400.00	PK	-54.91	6.00	-48.91	46.35	74.00	-27.65

Note:

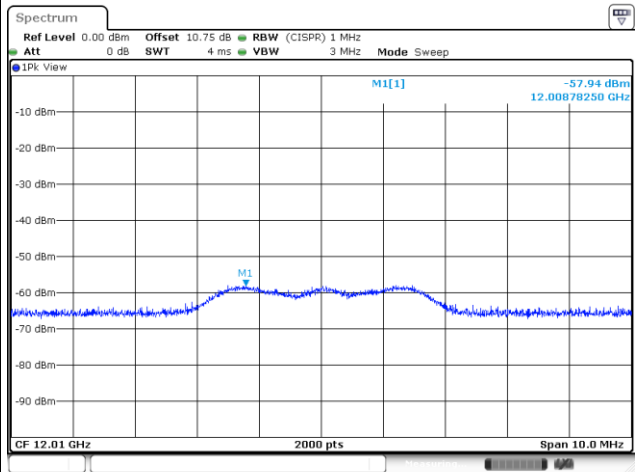
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain.

Test Plots

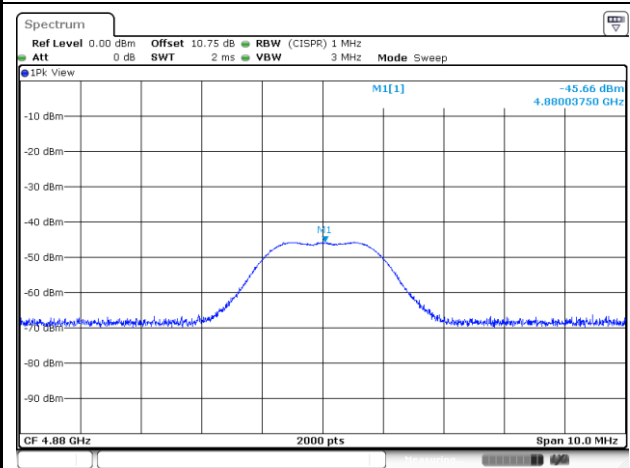
4804MHz - PK



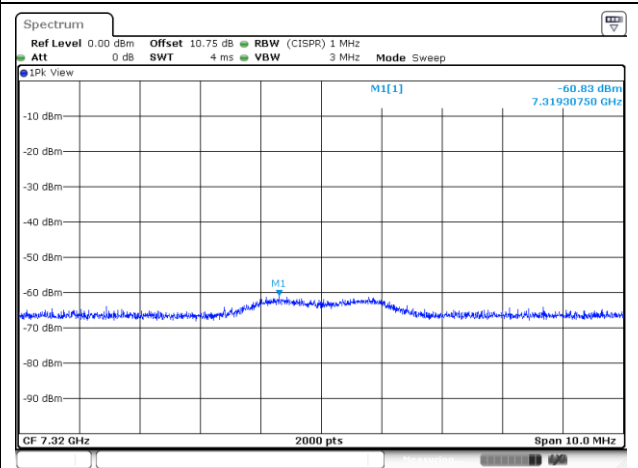
12010MHz - PK



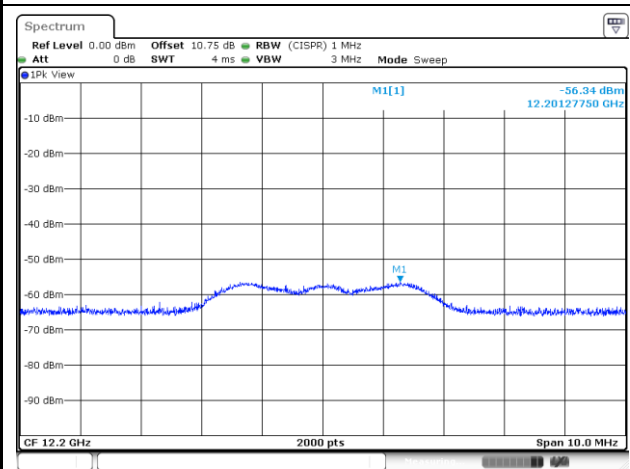
4880MHz - PK



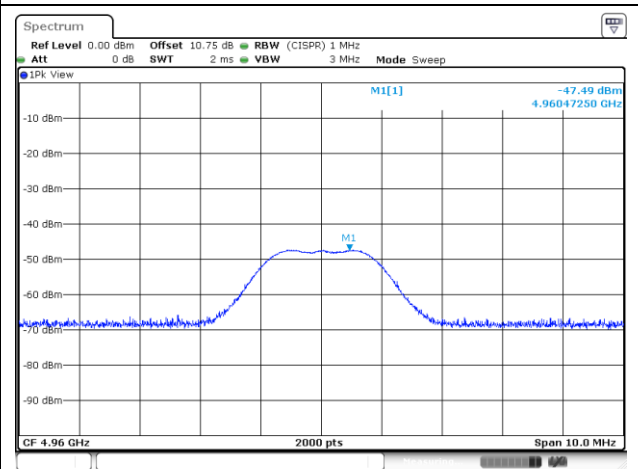
7320MHz - PK



12200MHz - PK

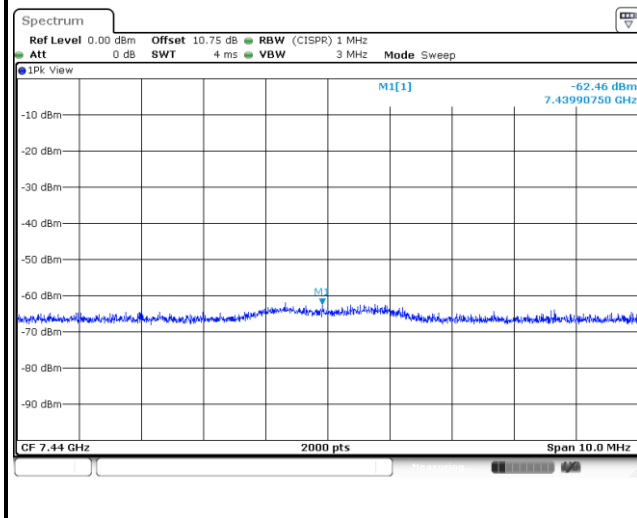


4960MHz - PK

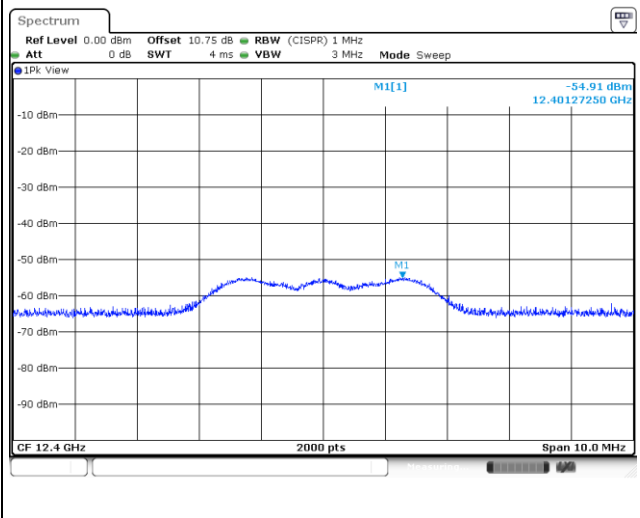


Test Plots

7440MHz - PK



12400MHz - 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	-44.30	2.00	-42.30	52.96	74.00	-21.04
3843.20	PK	-57.80	2.00	-55.80	39.46	74.00	-34.54

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	-45.73	2.00	-43.73	51.53	74.00	-22.47
7320.00	PK	-61.23	2.00	-59.23	36.03	74.00	-37.97
12200.00	PK	-57.02	6.00	-51.02	44.24	74.00	-29.76

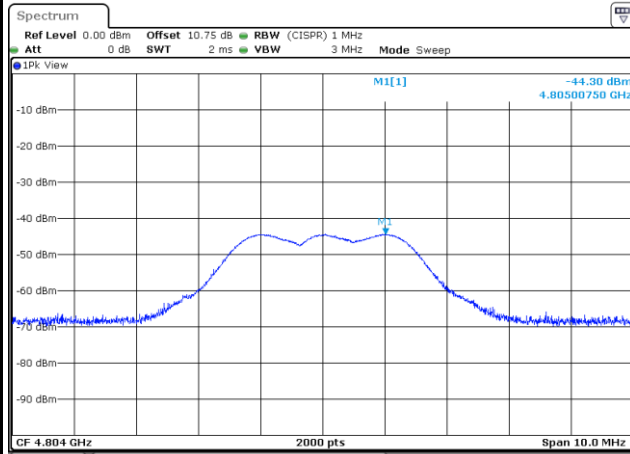
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		BT LE-2Mbps		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4960.00	PK	-47.63	2.00	-45.63	49.63	74.00	-24.37
7440.00	PK	-62.37	2.00	-60.37	34.89	74.00	-39.11
12400.00	PK	-54.96	6.00	-48.96	46.30	74.00	-27.70

Note:

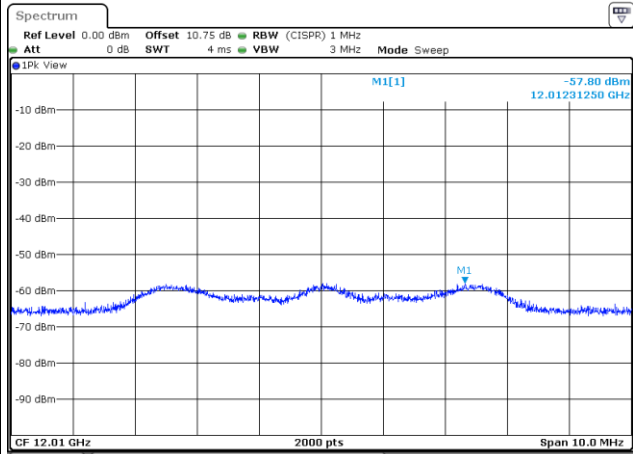
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain.

Test Plots

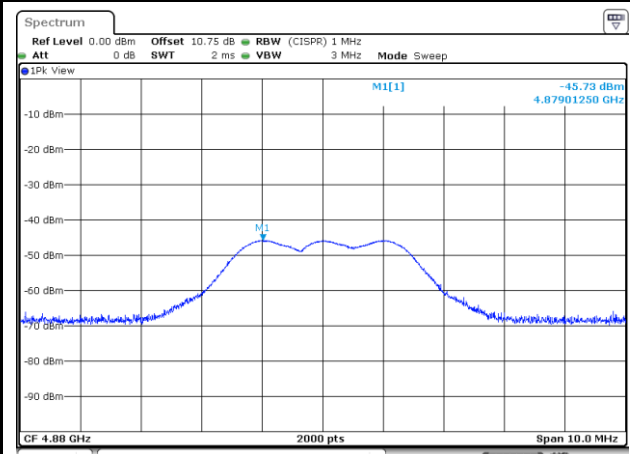
4804MHz - PK



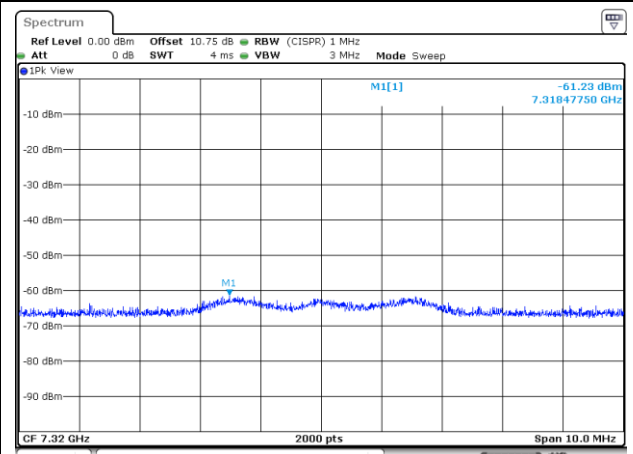
3843.20MHz - PK



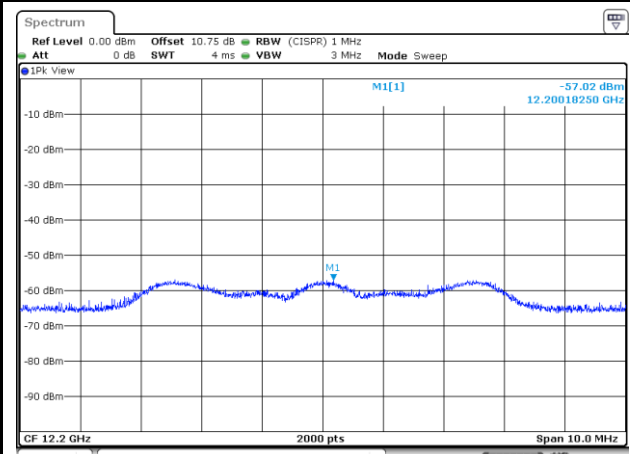
4880MHz - PK



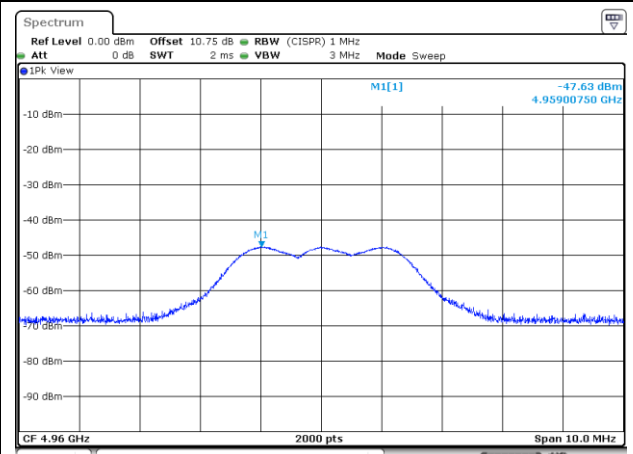
7320MHz - PK



12200MHz - PK

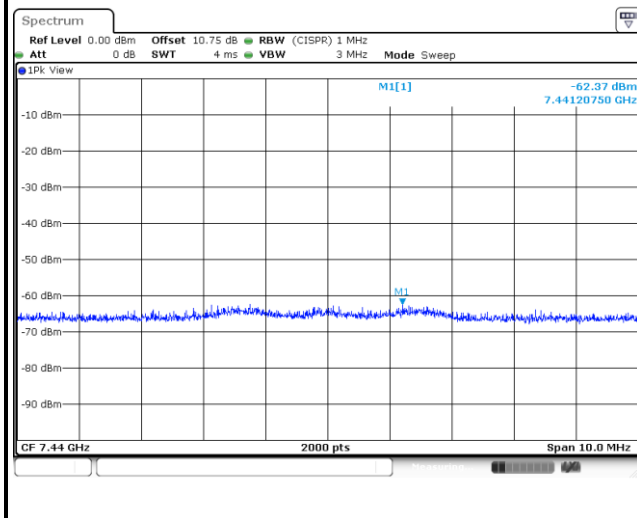


4960MHz - PK

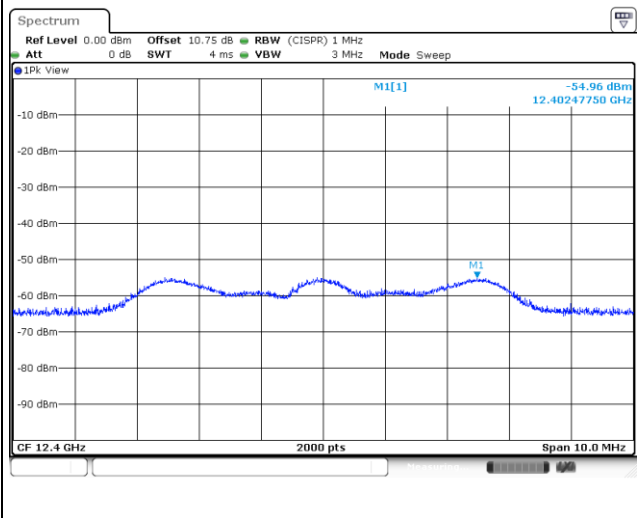


Test Plots

7440MHz - PK



12400MHz - PK



3.6 Emissions in non-restricted Frequency Bands

3.6.1 Emissions in non-restricted frequency bands limit

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

3.6.2 Test Procedures

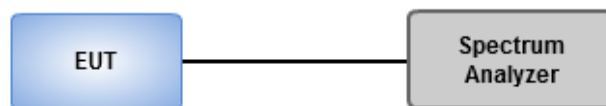
Reference level measurement

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

Emission level measurement

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

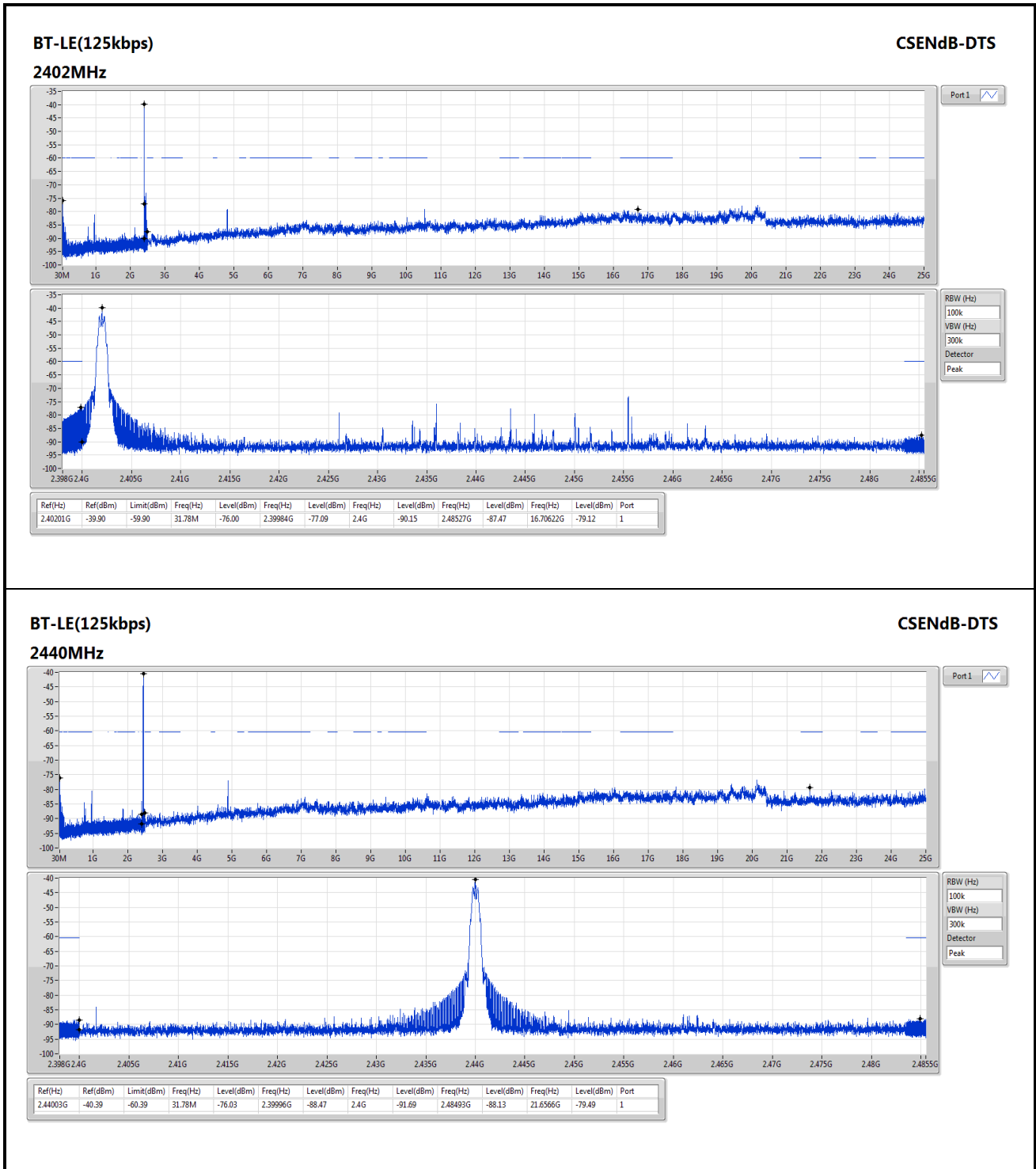
3.6.3 Test Setup



3.6.4 Test Result of Emissions in non-restricted Frequency Bands

Ambient Condition	25°C / 67%	Tested By	Aska Huang
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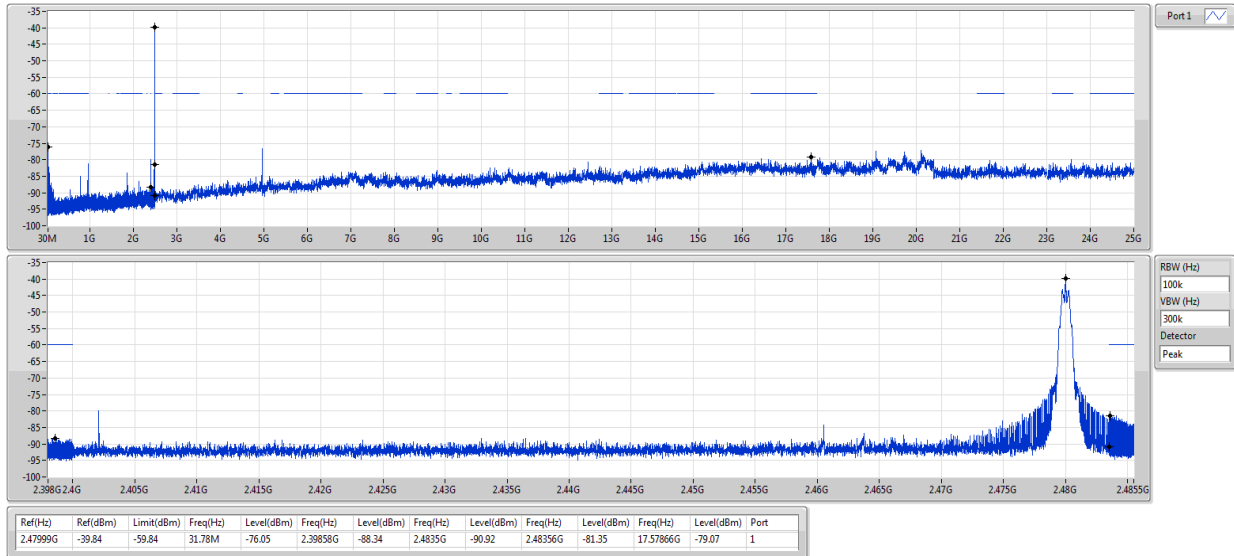
Low Power



BT-LE(125kbps)

CSEndB-DTS

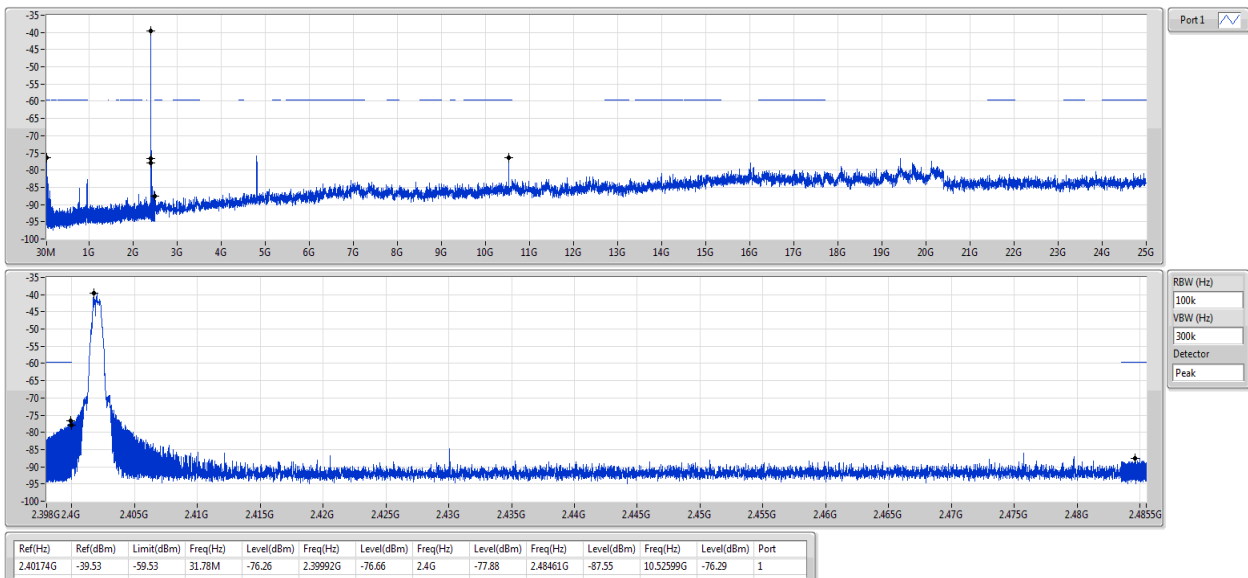
2480MHz



BT-LE(500kbps)

CSEndB-DTS

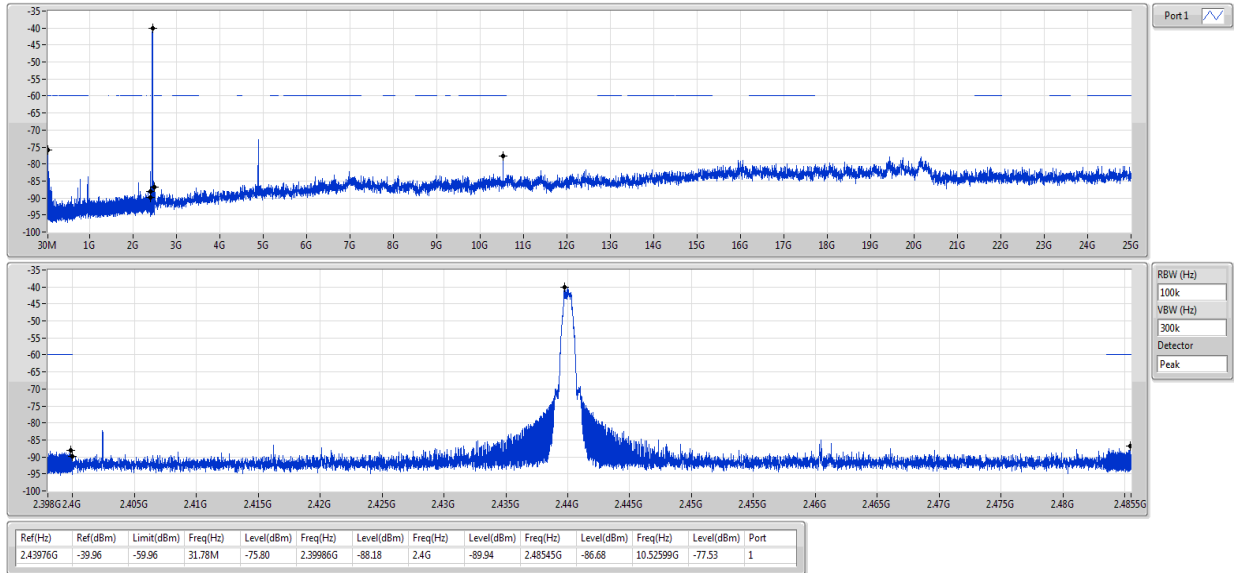
2402MHz



BT-LE(500kbps)

CSEndB-DTS

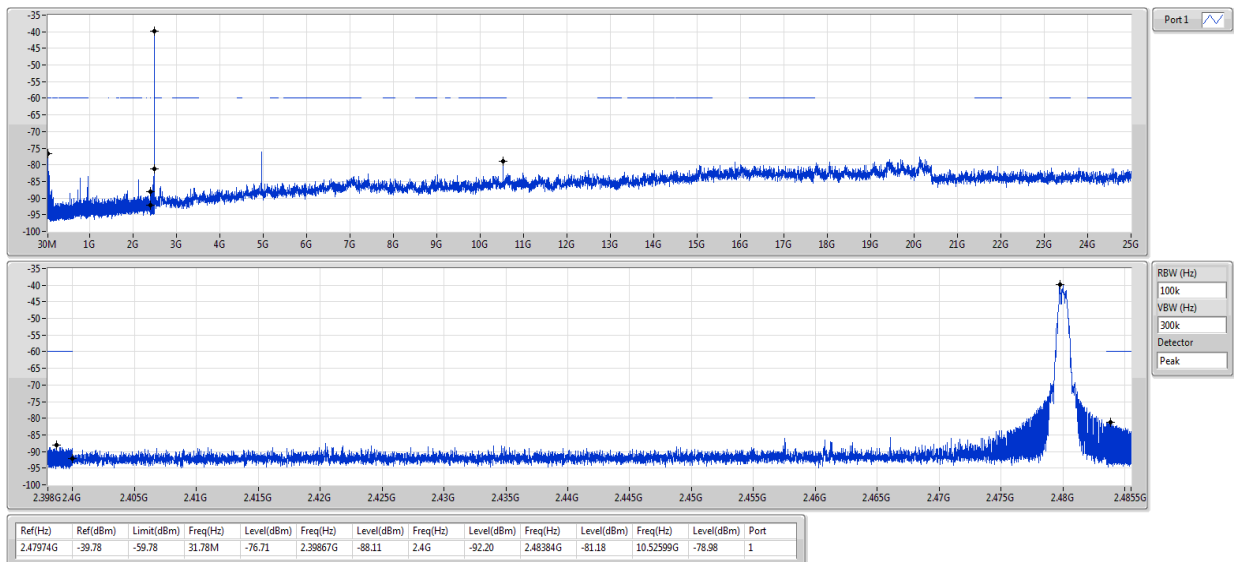
2440MHz



BT-LE(500kbps)

CSEndB-DTS

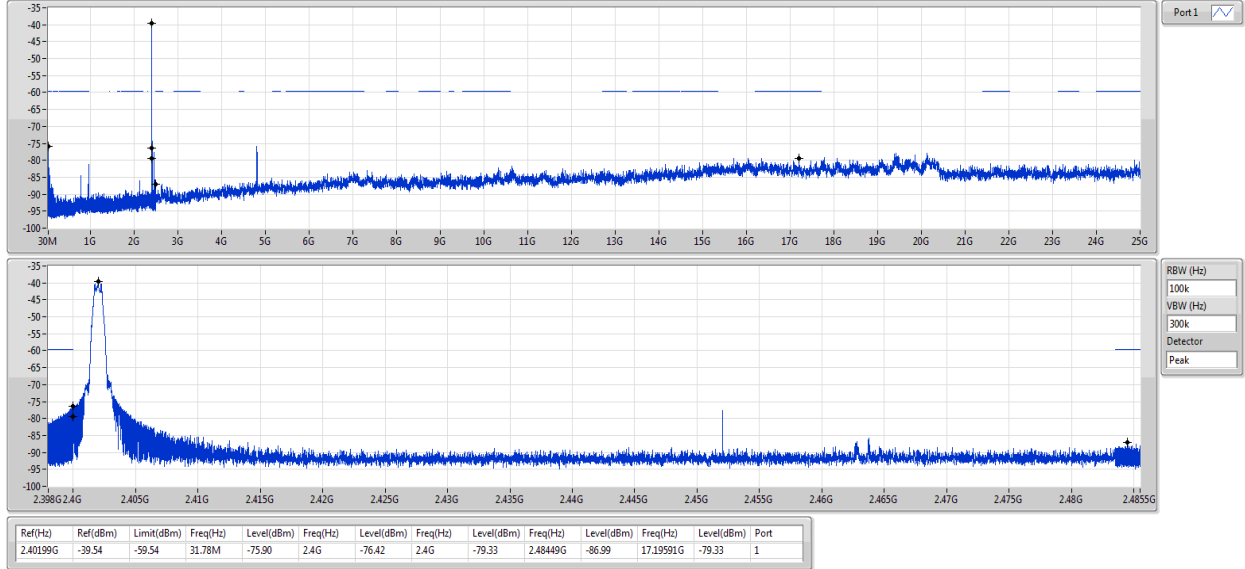
2480MHz



BT-LE(1Mbps)

CSEndB-DTS

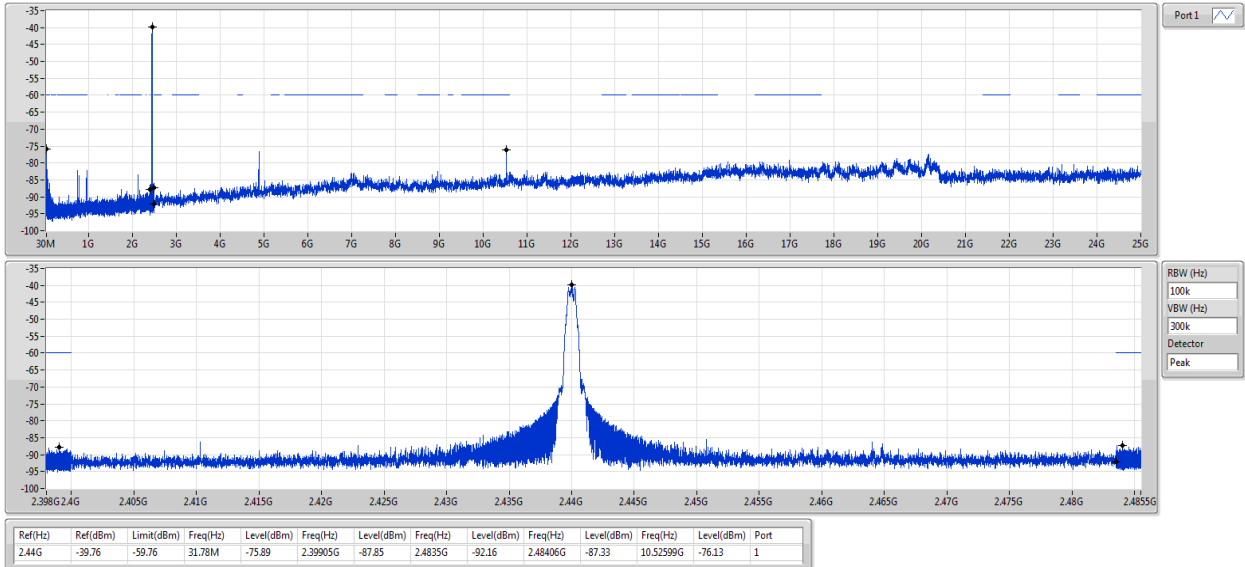
2402MHz



BT-LE(1Mbps)

CSEndB-DTS

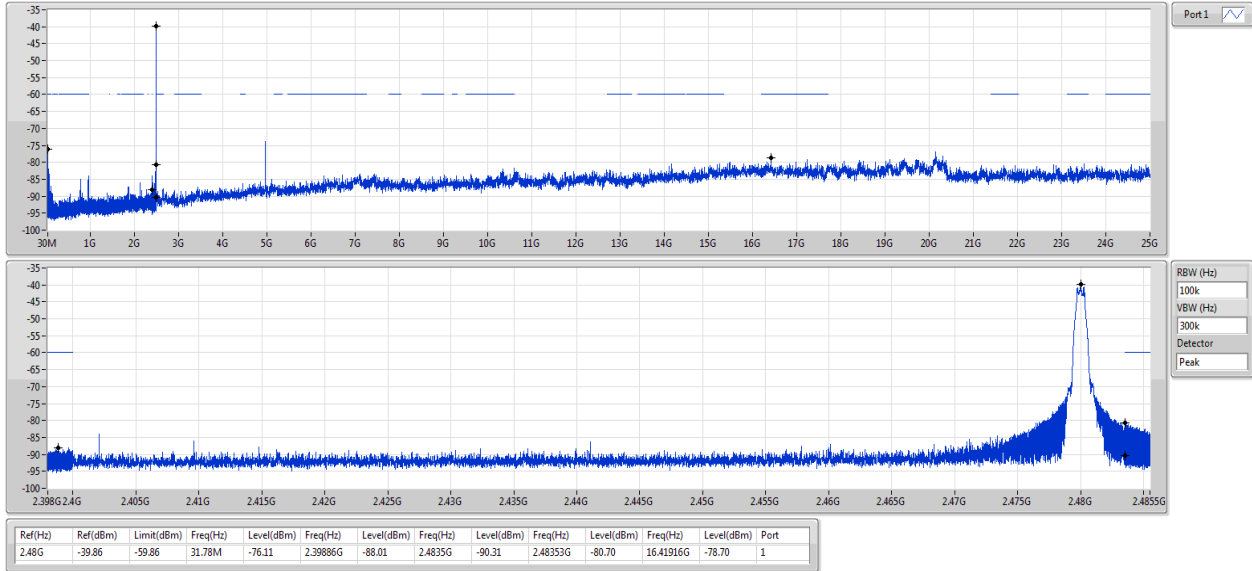
2440MHz



BT-LE(1Mbps)

CSEndB-DTS

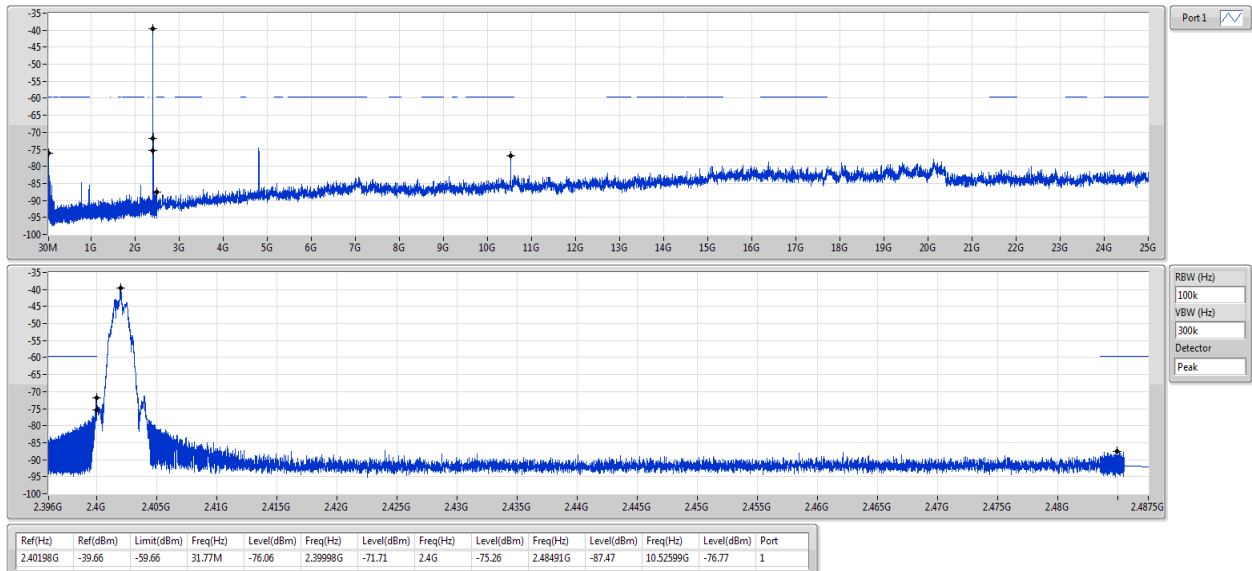
2480MHz



BT-LE(2Mbps)

CSEndB-DTS

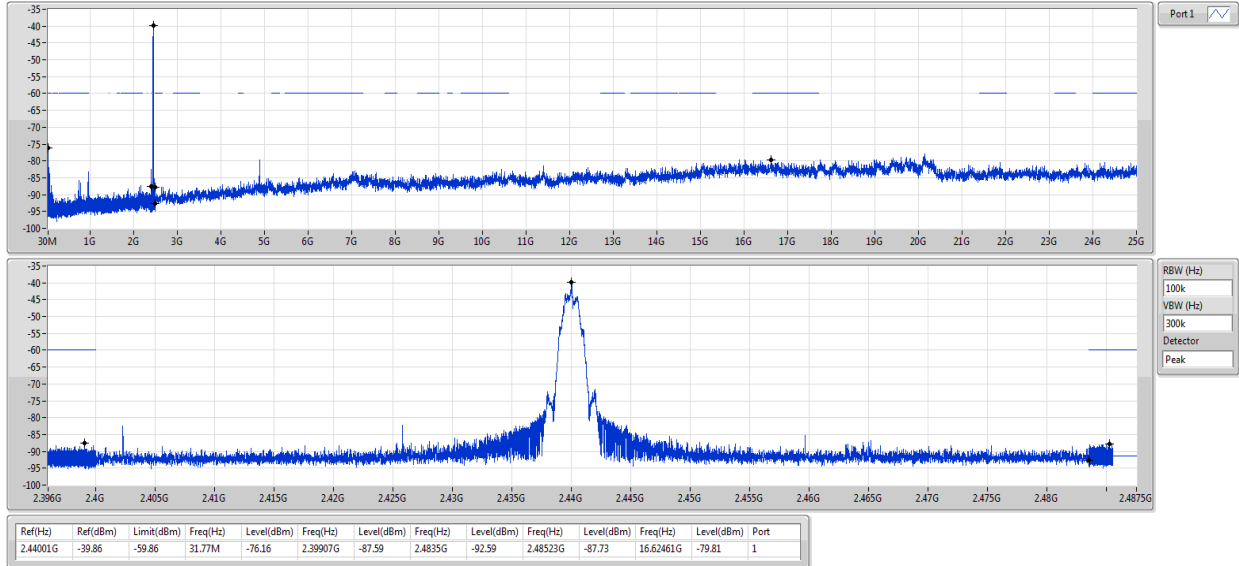
2402MHz



BT-LE(2Mbps)

CSEndB-DTS

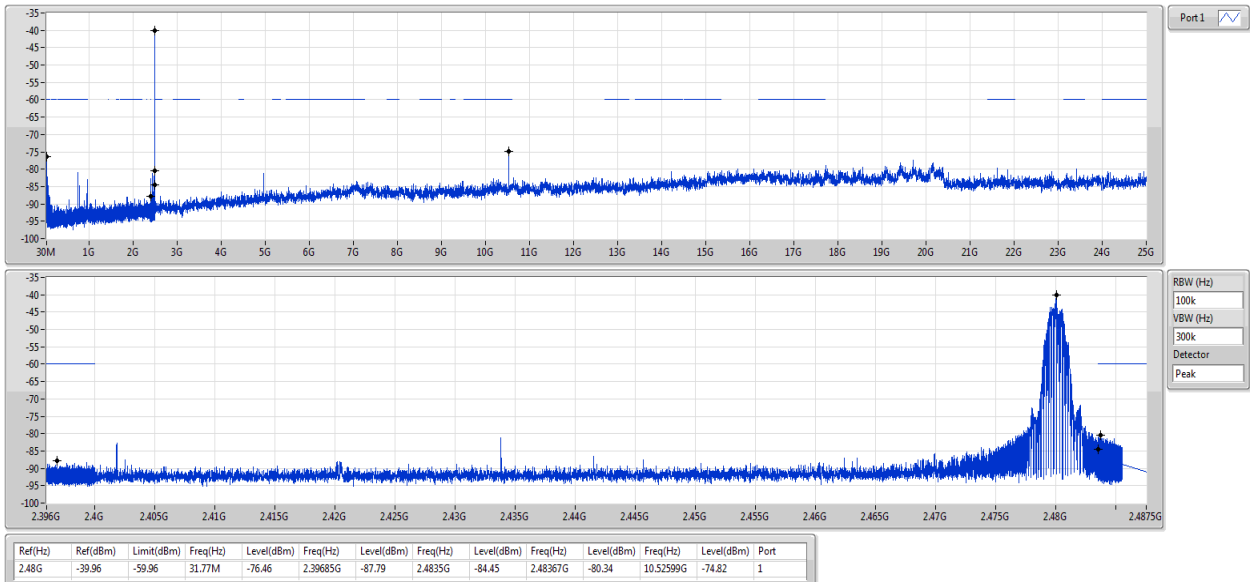
2440MHz



BT-LE(2Mbps)

CSEndB-DTS

2480MHz

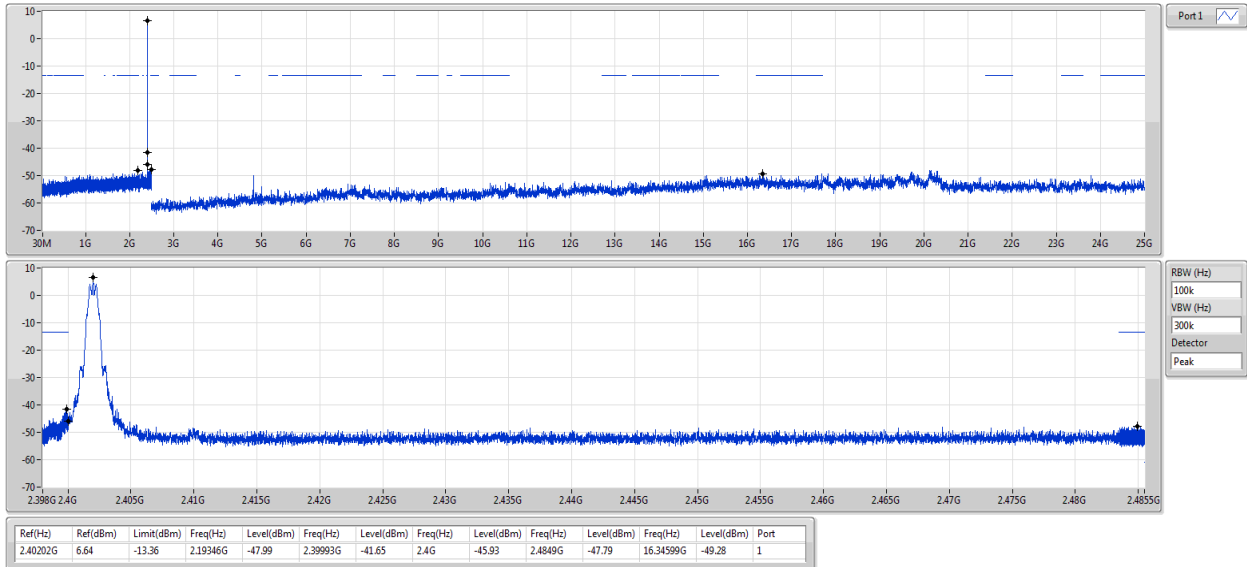


High Power

BT-LE(125kbps)

CSEndB-DTS

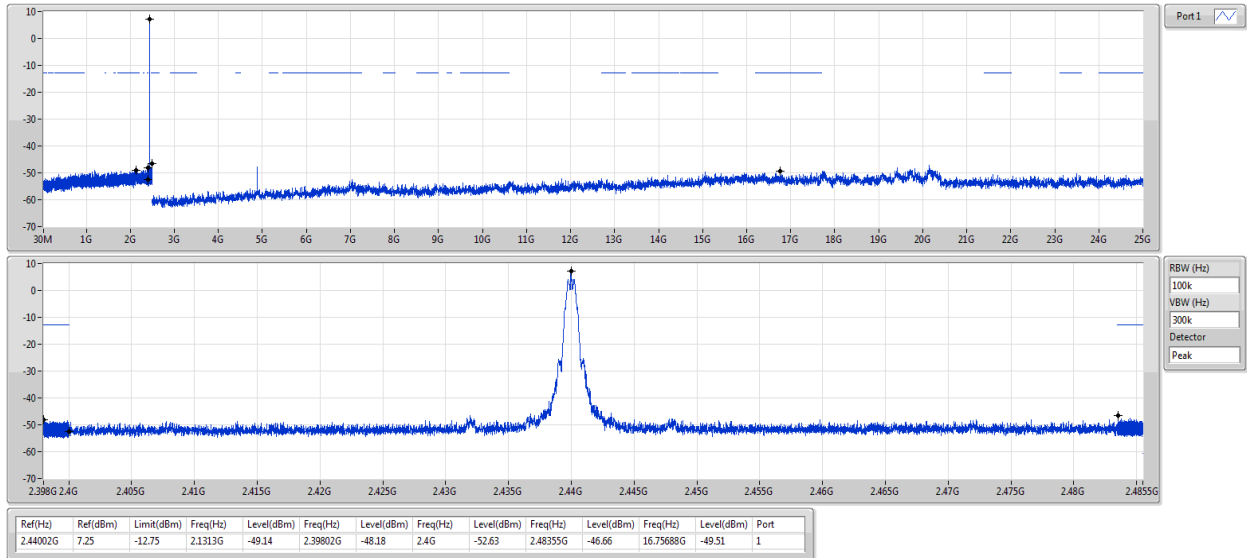
2402MHz



BT-LE(125kbps)

CSEndB-DTS

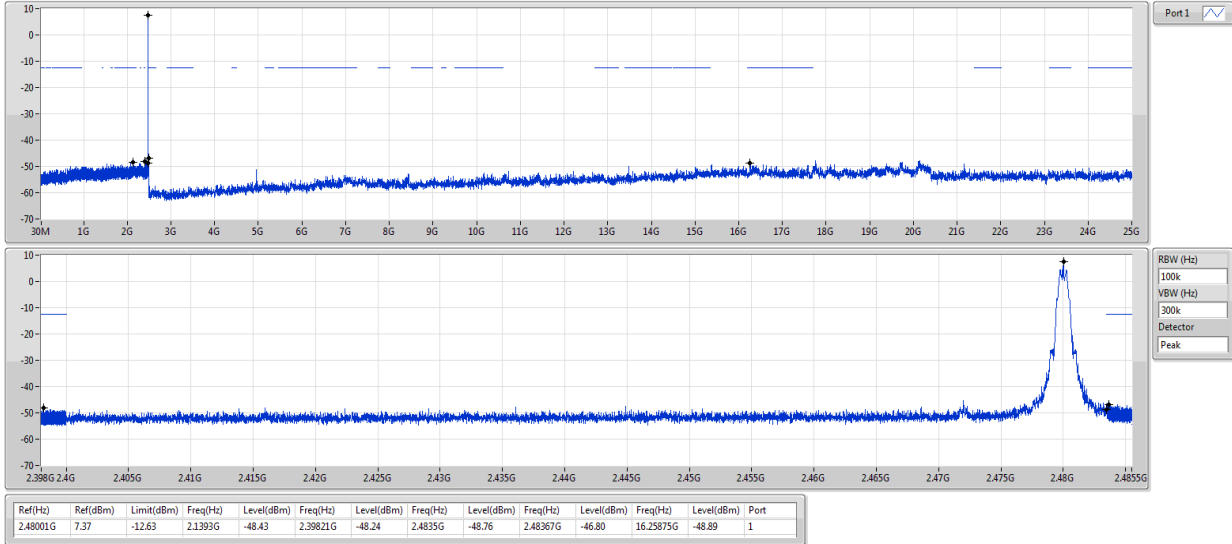
2440MHz



BT-LE(125kbps)

CSEndB-DTS

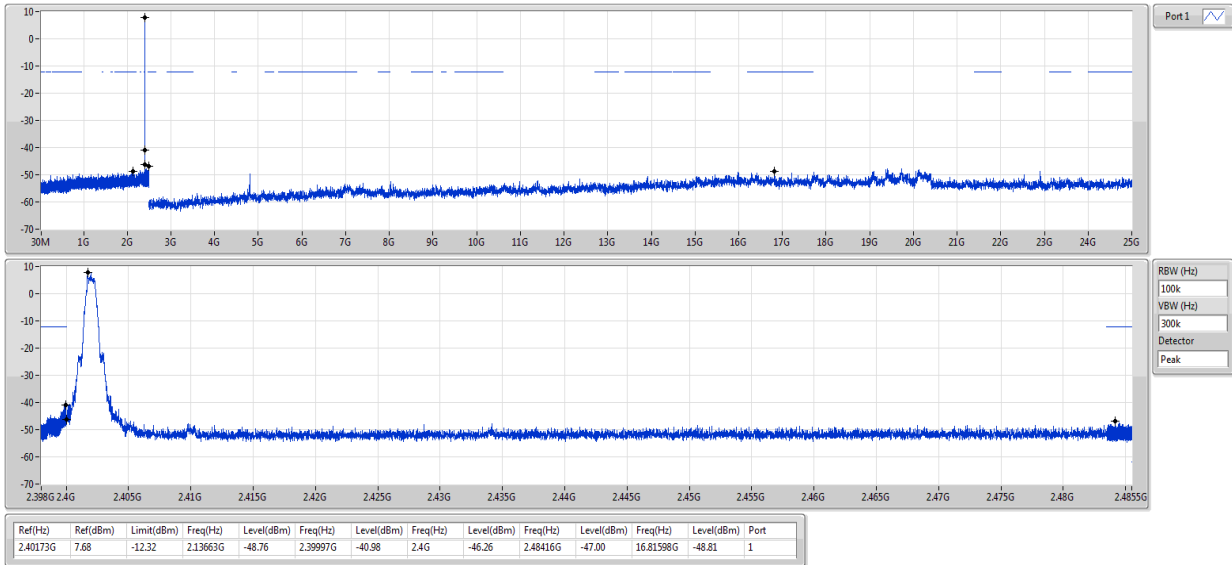
2480MHz



BT-LE(500kbps)

CSEndB-DTS

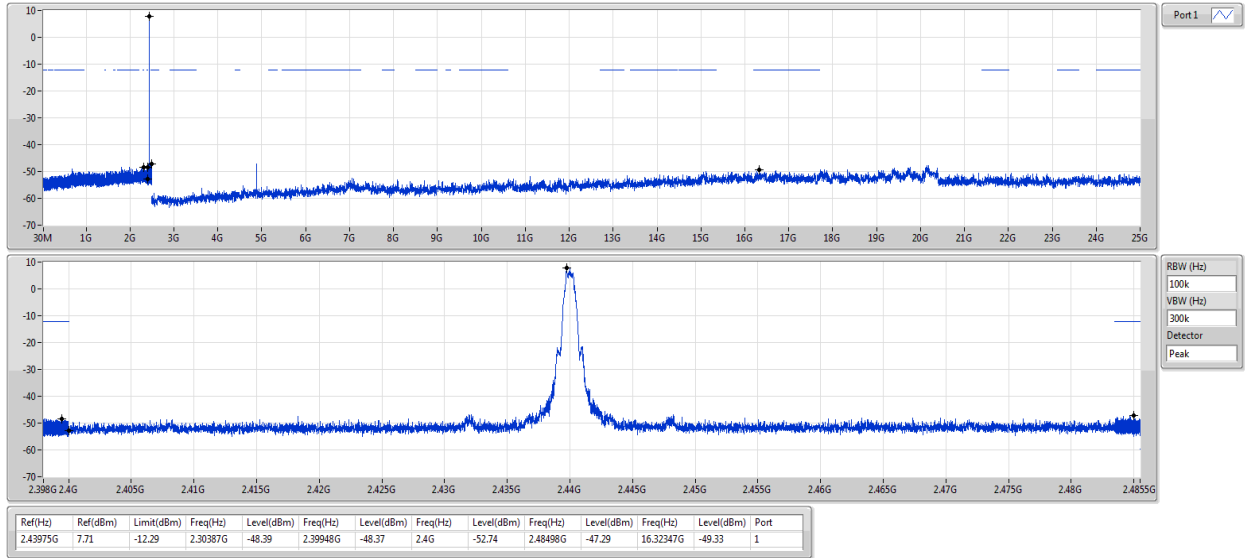
2402MHz



BT-LE(500kbps)

CSENdB-DTS

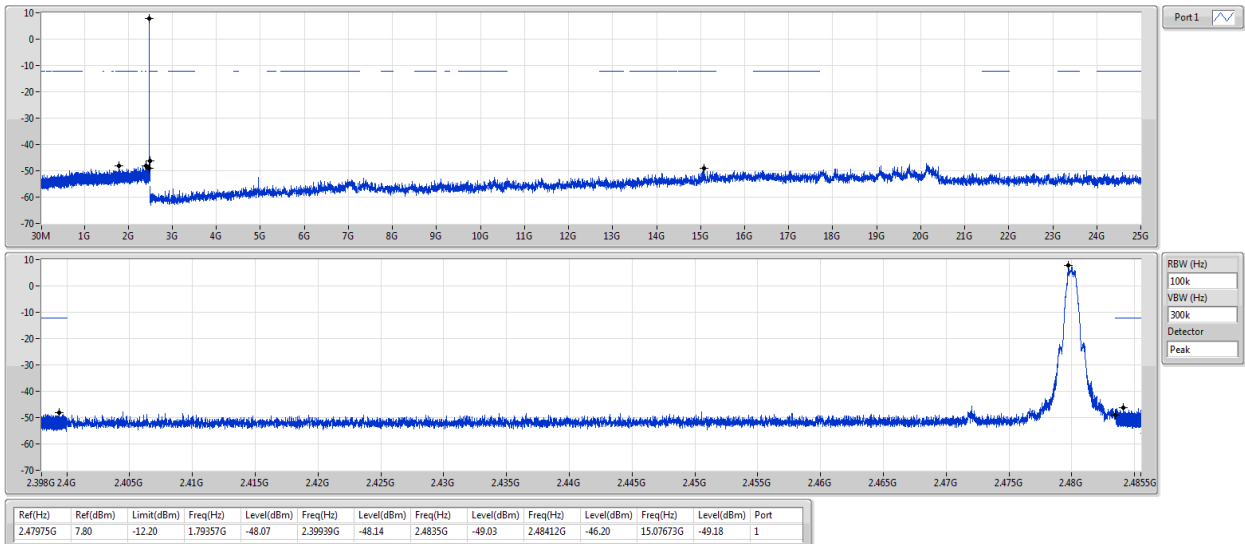
2440MHz



BT-LE(500kbps)

CSENdB-DTS

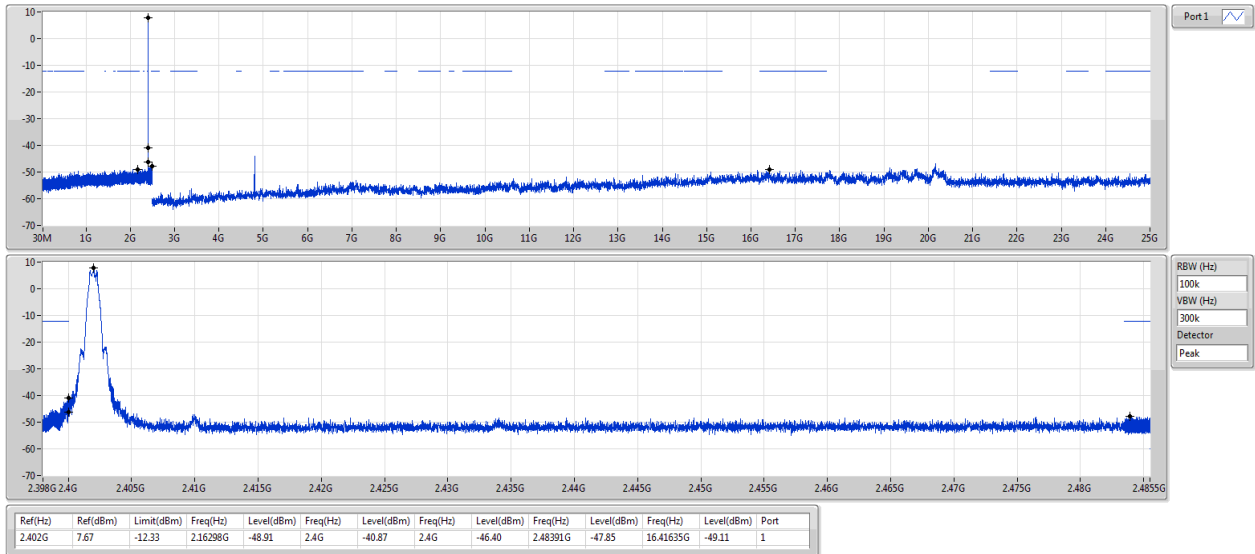
2480MHz



BT-LE(1Mbps)

CSEndB-DTS

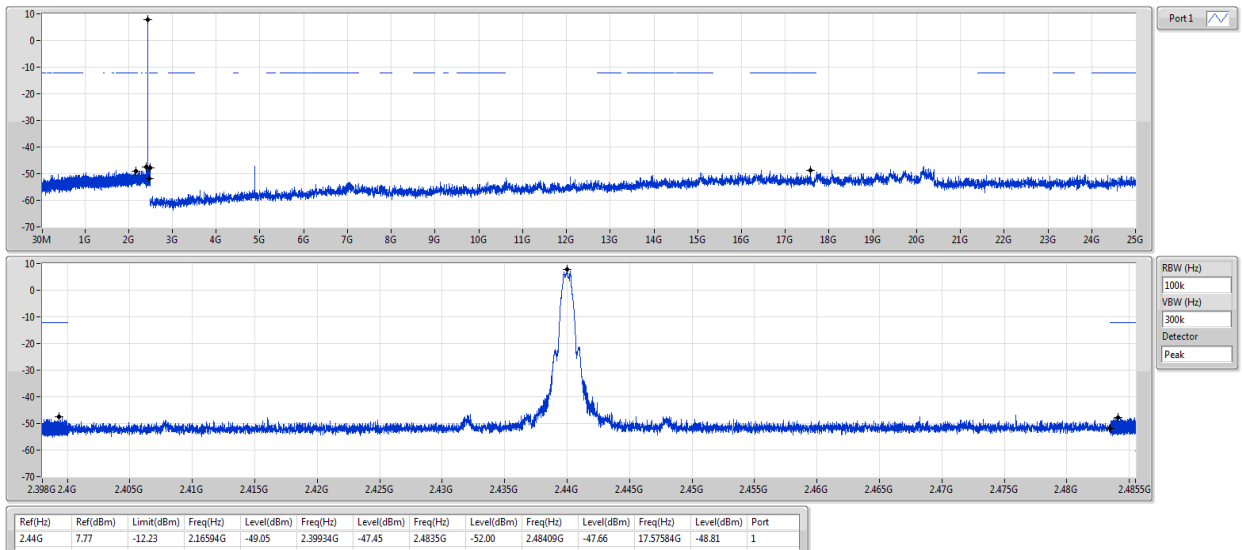
2402MHz



BT-LE(1Mbps)

CSEndB-DTS

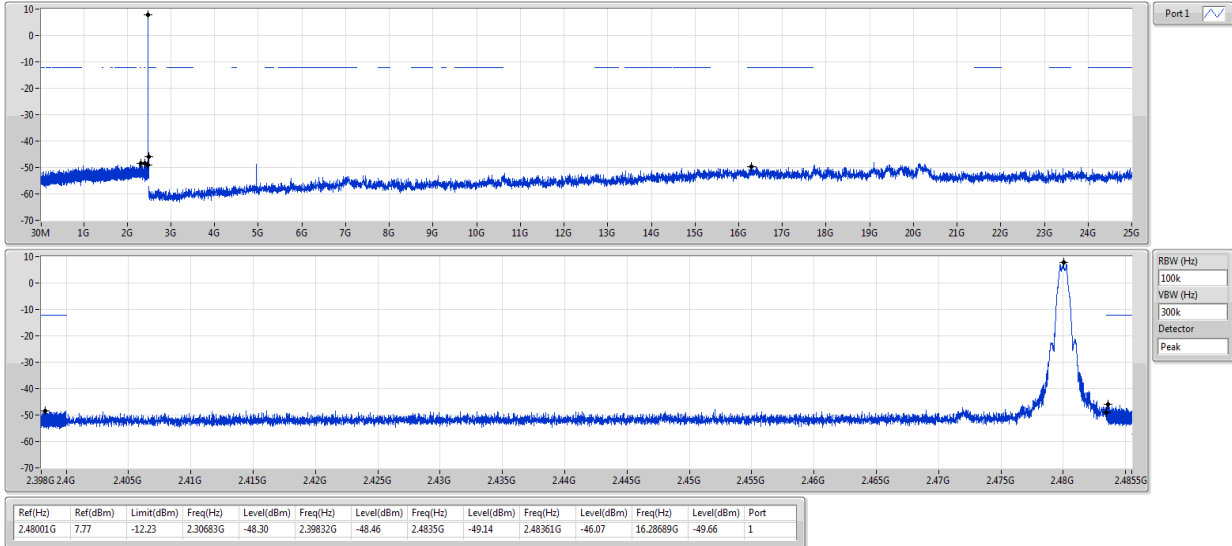
2440MHz



BT-LE(1Mbps)

CSEndB-DTS

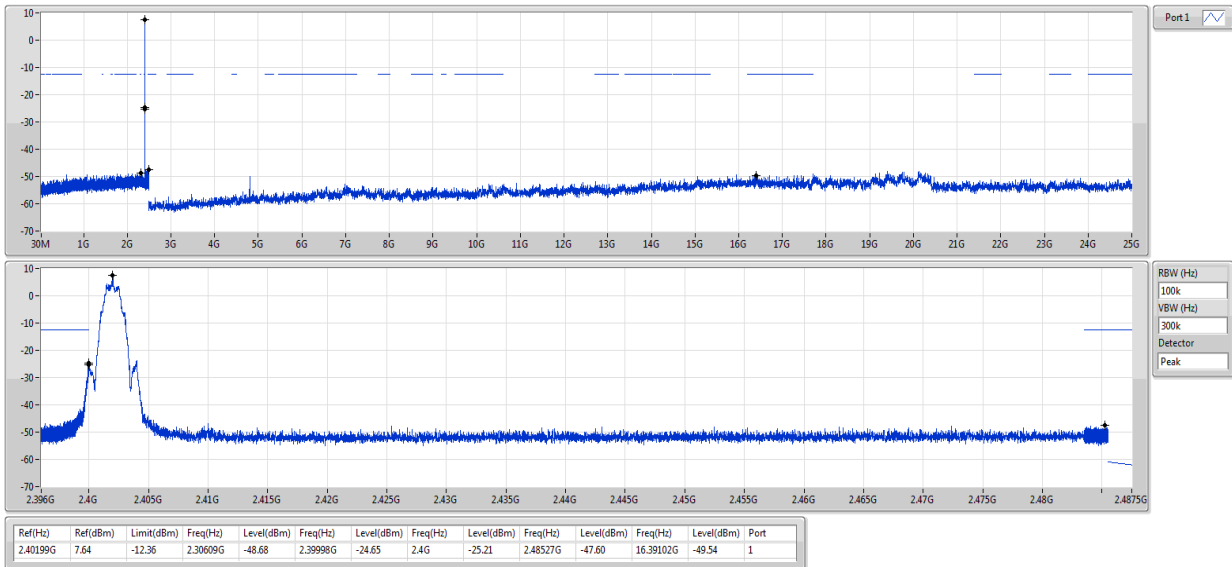
2480MHz



BT-LE(2Mbps)

CSEndB-DTS

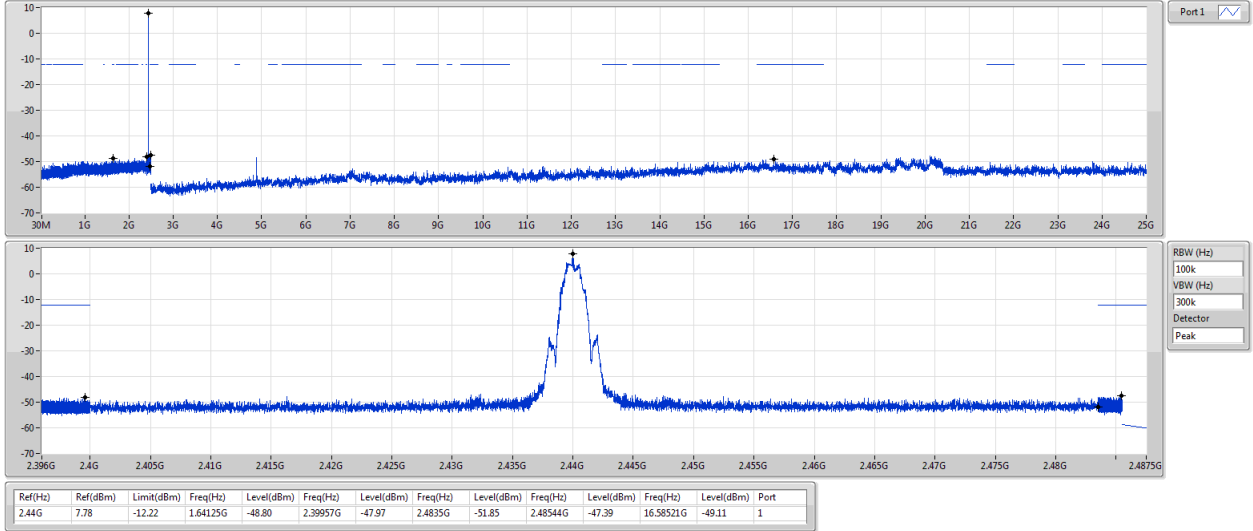
2402MHz



BT-LE(2Mbps)

CSENdB-DTS

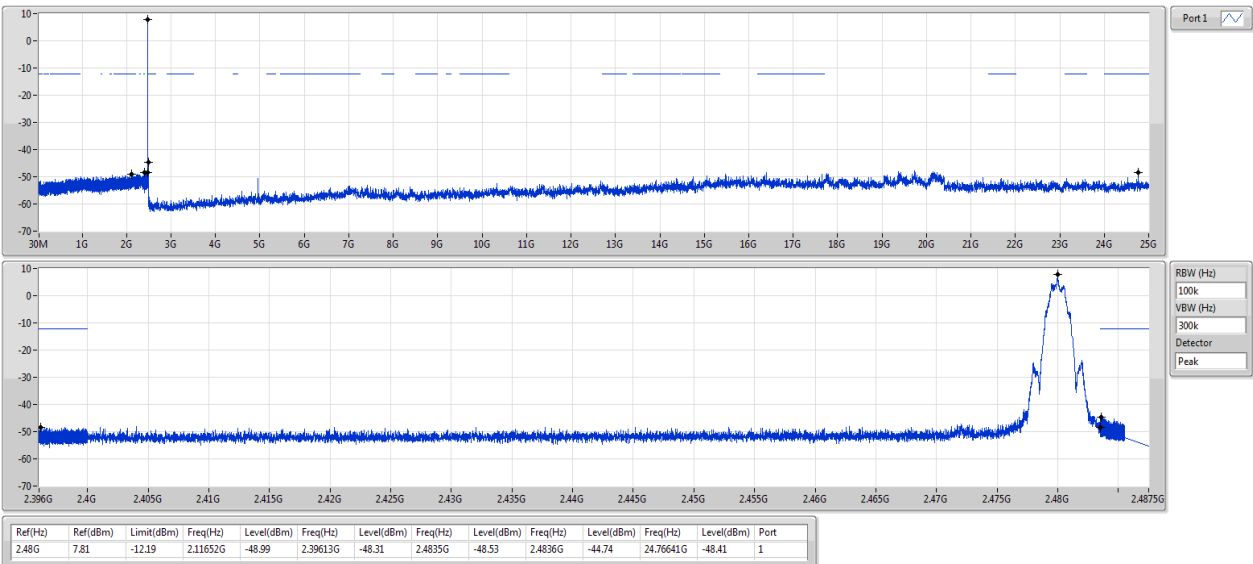
2440MHz



BT-LE(2Mbps)

CSENdB-DTS

2480MHz



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

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No. 30-2, Ding Fwu Tsuen, Lin
Kou District, New Taipei City,
Taiwan, R.O.C.

Kwei Shan

Tel: 886-3-271-8666

No. 3-1, Lane 6, Wen San 3rd St.,
Kwei Shan District, Tao Yuan City
333, Taiwan, R.O.C.

Kwei Shan Site II

Tel: 886-3-271-8640

No. 14-1, Lane 19, Wen San 3rd
St., Kwei Shan District, Tao Yuan
City 333, Taiwan, R.O.C.

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

Tel: 886-3-271-8666

Fax: 886-3-318-0155

Email: ICC_Service@icertifi.com.tw

==END==