FCC PART 15.247
TEST REPORT

On Behalf of

Zhiwei Robotics Corp.

Room 603, 2 Boyun Road, Pudong, Shanghai P.R.China

FCC ID: 2AIDMLPDF1091
Model: DFR1080, DFR1081, DFR1090, DFR1091

November 2, 2024

This Report Concerns:	**Equipment Type:**
☒ Original Report	LattePanda Sigma

Test Engineer:	LBi Li / LBi Li
Report Number:	**QCT24JR-0163E-02**
Test Date:	October 18, 2024 ~ November 2, 2024
Reviewed By:	Vincent Yang / Vincent Yang
Approved By:	Kendy Wang / Kendy Wang
Prepared By:	**Shenzhen QC Testing Laboratory Co., Ltd.** East of 1/F., Building E, Xinghong Science Park, No.111, Shuiku Road, Fenghuanggang, Xixiang Street, Bao'an District, Shenzhen, Guangdong, China **Tel: 0755-23008269** **Fax: 0755-23726780**

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Revision History of This Test Report

Report Number	Description	Issued Date
QCT24JR-0163E-02	Initial Issue	2024-11-02

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1. GENERAL INFORMATION

1.1 Product Description for Equipment under Test (EUT)

EUT Description:	LattePanda Sigma
Model No.:	DFR1080, DFR1081, DFR1090, DFR1091
Model Difference:	all the models are electrical identical including the same software parameter and hardware design (i.e., circuit design, PCB Layout, RF module/circuit, antenna type(s) and antenna location, components on PCB, etc.,), same mechanical structure and design (including product enclosure, materials, etc.,), the only differences are capacity of Memory and SSD. All tests were conducted on the models (DFR1091) and the test result was passed. Difference testing was performed on the model (DFR1081), testing Conducted Emission and spurious emission (30MHz - 1GHz).
Tested Model:	DFR1091, DFR1081
Sample(s) Status:	Engineer sample
Packet Type:	Bluetooth LE(1Mbps, 2Mbps)
Operation Frequency:	2402MHz~2480MHz
Channel numbers:	40
Channel separation:	2MHz
Modulation type:	GFSK
Antenna Type:	Internal Antenna
Antenna gain*1:	1.56dBi max for 2.4GHz Ant1
Power supply:	DC 19V/4.7A (Powered by adapter)
Accessories:	Adapter Model: ADP-90MD H Input:100-240V~, 1.5A, 50-60Hz Output:19V/4.7A, 90.1W Manufacturer: DELTA ELECTRONICS, INC.
Trade Mark:	N/A
Applicant:	Zhiwei Robotics Corp.
Address:	Room 603, 2 Boyun Road, Pudong, Shanghai P.R.China
Manufacturer:	Zhiwei Robotics Corp.
Address:	Room 603, 2 Boyun Road, Pudong, Shanghai P.R.China
Sample No.:	Y24J0163E01WC(DFR1091), Y24J0163E02WC(DFR1081)

Note: *1This information provided by Manufacturer, SZ QC Lab is not responsible for the accuracy of this information.

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1.2 System Test Configuration

1.2.1 Channel List

Operation Frequency each of channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
1	2402 MHz	11	2422 MHz	21	2442 MHz	31	2462 MHz
2	2404 MHz	12	2424 MHz	22	2444 MHz	32	2464 MHz
3	2406 MHz	13	2426 MHz	23	2446 MHz	33	2466 MHz
4	2408 MHz	14	2428 MHz	24	2448 MHz	34	2468 MHz
5	2410 MHz	15	2430 MHz	25	2450 MHz	35	2470 MHz
6	2412 MHz	16	2432 MHz	26	2452 MHz	36	2472 MHz
7	2414 MHz	17	2434 MHz	27	2454 MHz	37	2474 MHz
8	2416 MHz	18	2436 MHz	28	2456 MHz	38	2476 MHz
9	2418 MHz	19	2438 MHz	29	2458 MHz	39	2478 MHz
10	2420 MHz	20	2440 MHz	30	2460 MHz	40	2480 MHz

Note:

In section 15.31(m), regards to the operating frequency range over 10 MHz, the Lowest frequency, the middle frequency, and the highest frequency of channel were selected to perform the test, and the selected channel see below:

Channel	Frequency
The lowest channel	2402MHz
The middle channel	2440MHz
The Highest channel	2480MHz

1.2.2 EUT Exercise Software

" DRTU " exercise software was used to test, The power level is Default. The software and power level was provided by the applicant.

1.2.3 Support Equipment

Manufacturer	Description	Model	Remark
Keyboard	HP	6CB78PA# AB2	1.5m，un-shielding， No Core
Mouse	DELL	CN-049PRO	1.5m，un-shielding， No Core
Flat Panel Monitor	DELL	S2721QS	Input: 100-240V~, 50/60Hz, 1.5A

1.2.4 Test mode

Transmitting mode: Keep the EUT in continuously transmitting.

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1.3 Test Facility

Test Firm : Shenzhen QC Testing Laboratory Co., Ltd.

The testing quality ability of our laboratory meet with "Quality Law of People's Republic of China" Clause 19. The testing quality system of our laboratory meets with ISO/IEC-17025 requirements. This approval result is accepted by MRA of APLAC.

Our test facility is recognized, certified, or accredited by the following organizations:

CNAS – Registration No.: L8464

The EMC Laboratory has been accredited by CNAS, and in compliance with ISO/IEC 17025:2017 General Requirements for testing Laboratories.

A2LA Certificate Number: 6759.01

The EMC Laboratory has been accredited by A2LA, and in compliance with ISO/IEC 17025:2017 General Requirements for testing Laboratories.

FCC Registration Number: 561109

The EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications commission.

IC Registration Number: 29628

CAB identifier: CN0141

The EMC Laboratory has been registered and fully described in a report filed with the (IC) Industry Canada.

1.4 Measurement Uncertainty

Parameter	Uncertainty
Occupied Channel Bandwidth	±1.42 x10^{-4}%
RF output power, conducted	±1.06dB
Power Spectral Density, conducted	±1.06dB
Unwanted Emissions, conducted	±2.51dB
AC Power Line Conducted Emission	±1.80dB
Radiated Spurious Emission test (9kHz-30MHz)	±2.66dB
Radiated Spurious Emission test (30MHz-1000MHz)	±4.04dB
Radiated Spurious Emission test (1000MHz-18000MHz)	±4.70 dB
Radiated Spurious Emission test (18GHz-40GHz)	±4.80dB
Temperature	±0.8℃
Humidity	±3.2%
DC and low frequency voltages	±0.1%
Time	±5%
Duty cycle	±5%

Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2

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2. Summary of Test Results

Test Item	Section	Result
Antenna Requirement	FCC part 15.203/15.247 (c)	Pass
AC Power Line Conducted Emission	FCC part 15.207	Pass
Conducted Peak Output Power	FCC part 15.247 (b)(3)	Pass
Channel Bandwidth & 99% Occupied Bandwidth	FCC part 15.247 (a)(2)	Pass
Power Spectral Density	FCC part 15.247 (e)	Pass
Band Edge	FCC part 15.247(d)	Pass
Spurious Emissions	FCC part 15.205/15.209	Pass

Note: 1. Pass: The EUT complies with the essential requirements in the standard.

2.Test according to ANSI C63.10:2013

3.. All indications of Pass/Fail in this report are opinions expressed by Shenzhen QC Testing Laboratory Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.

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3. List of Test and Measurement Instruments

3.1 Conducted Emission Test

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1	EMI Test Receiver	Rohde&Schwarz	ESIB 7	2277573376	2024.03.14	2025.03.13
2	EMI Test Receiver	Rohde&Schwarz	ESCI3	101820	2024.08.06	2025.08.05
3	Artificial Mains Network	SCHWARZBECK	NSLK8126	8126200	2024.08.06	2025.08.05
4	PULSE LIMITER	Rohde&Schwarz	ESH3-Z2	100058	2024.03.14	2025.03.13
Conducted Emission Measurement Software: TS+ JS32-CE Ver 5.0.0						

3.2 Radiated Emission Test

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1.	EMI Test Receiver	R&S	ESIB 7	2277573376	2024.03.14	2025.03.13
2.	EMI Test Receiver	ESPI3	ESPI3	101131	2024.03.14	2025.03.13
3.	Spectrum Analyzer	Rohde&Schwarz	FSV 40	101458	2024.03.14	2025.03.13
4.	TRILOG Broadband Test-Antenna	SCHWARZBECK	VULB9168	VULB9168-588	2023.04.01	2025.03.31
5.	Loop Antenna	EMCO	6502	2133	2023.03.18	2025.03.17
6.	horn antenna	SCHWARZBECK	BBHA9120D	2069	2023.04.01	2025.03.31
7.	Horn Antenna	COM-MW	ZLB7-18-40G -950	12221225	2023.01.12	2025.01.09
8.	Pre-amplifier	MITEQ	TTA0001-18	2063645	2024.03.27	2025.03.26
9.	Pre-amplifier	COM-MW	DLAN-18000 -40000-02	10229104	2024.03.14	2025.03.13
10.	966 Camber	ZhongYU	9*6*6	/	2023.05.08	2026.05.07
Radiated Emission Measurement Software: EZ_EMC Ver QCT03A2 RE+						

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3.3 RF Conducted test

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1.	Wideband Radio Communication Tester	Rohde & Schwarz	CW500	151583	2024.03.14	2025.03.13
2.	Spectrum Analyzer	ROHDE& SCHWARZ	FSV 40	101458	2024.03.14	2025.03.13
3.	Signal Generator	Agilent	N5182A	MY50141563	2024.03.14	2025.03.13
4.	RF Automatic Test System	MW	MW100-RFCB/ MW100-PSB	MW2007004	2024.03.14	2025.03.13
RF Conducted Measurement Software: MTS 8310 Ver 2.0.0.0						

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4. Antenna requirement

Standard requirement: FCC Part15 C Section 15.203 /247(c)

15.203 requirement:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

15.247(c) (1)(i) requirement:
(i) Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

EUT Antenna: The Ant is Internal Antenna, the best case gain of the antenna is 1.56dBi, reference to the Internal photo for details.

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5. Conducted Emissions

5.1 Applicable Standard

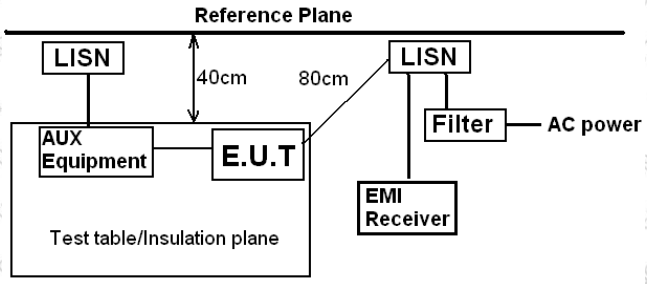
FCC Part15 C Section 15.207

5.2 Limit

Frequency range (MHz)	Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

Note *: The level decreases linearly with the logarithm of the frequency.

5.3 Test setup



Remark:
E.U.T: Equipment Under Test
LISN: Line Impedence Stabilization Network
Test table height=0.8m

5.4 EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.
RBW=9 kHz, VBW=30 kHz, Sweep time=auto

5.5 Test procedure

1. The E.U.T and simulators are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm/50uH coupling impedance for the measuring equipment.
2. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. (Please refer to the block diagram of the test setup and photographs).
3. Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.

5.6 Test Data

Temperature	23 ℃	Humidity	52%
ATM Pressure	101.1kPa	Antenna Gain	1.56dBi
Test by	LBi Li	Test result	PASS

Test voltage: AC 120V/60Hz

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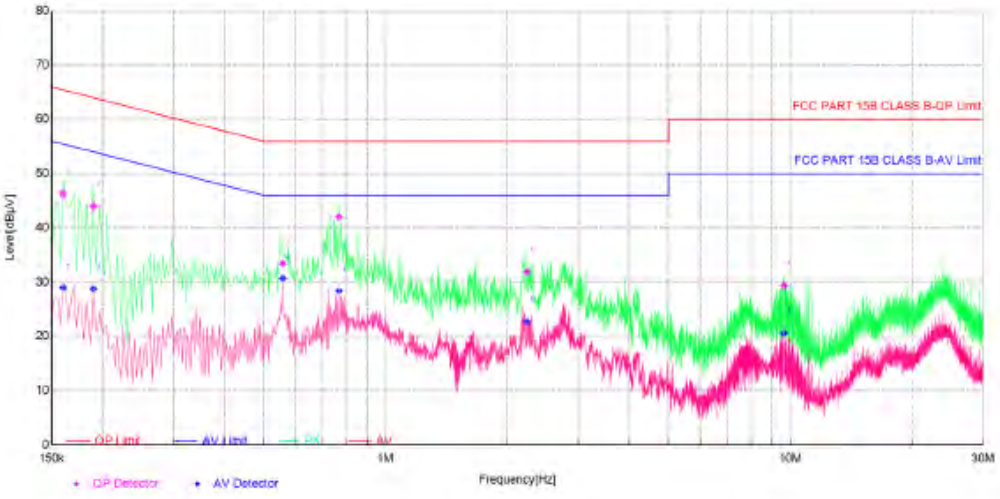
Model: DFR1091

Measurement data:

Pre-scan all test modes, found worst case at GFSK 2402MHz, and so only show the test result of GFSK 2402MHz

Line:



Final Data List

NO.	Freq. [MHz]	Factor[dB]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]	Phase	Verdict
1	0.16	10.59	46.27	65.46	19.19	28.98	55.46	26.48	L	PASS
2	0.19	10.65	43.98	64.04	20.06	28.75	54.04	25.29	L	PASS
3	0.5575	10.74	33.41	56.00	22.59	30.70	46.00	15.30	L	PASS
4	0.7675	10.74	41.98	56.00	14.02	28.40	46.00	17.60	L	PASS
5	2.2385	10.69	31.86	56.00	24.14	22.72	46.00	23.28	L	PASS
6	9.65	10.79	29.39	60.00	30.61	20.59	50.00	29.41	L	PASS

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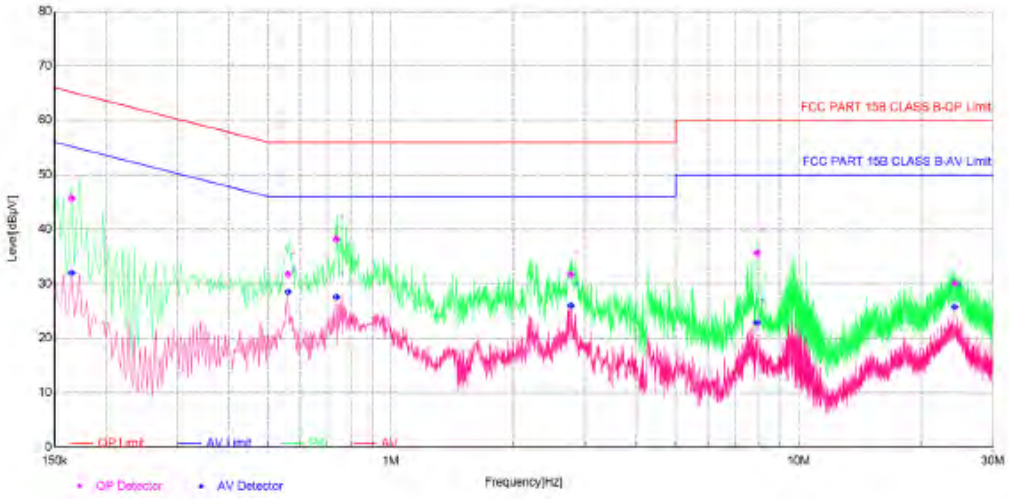
Neutral:



Final Data List										
NO.	Freq. [MHz]	Factor[dB]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]	Phase	Verdict
1	0.165	10.48	45.66	65.21	19.55	32.00	55.21	23.21	N	PASS
2	0.56	10.64	31.72	56.00	24.28	28.54	46.00	17.46	N	PASS
3	0.735	10.75	38.12	56.00	17.88	27.59	46.00	18.41	N	PASS
4	2.765	10.66	31.67	56.00	24.33	25.96	46.00	20.04	N	PASS
5	7.922	10.52	35.60	60.00	24.40	22.81	50.00	27.19	N	PASS
6	24.122	10.81	30.07	60.00	29.93	25.72	50.00	24.28	N	PASS

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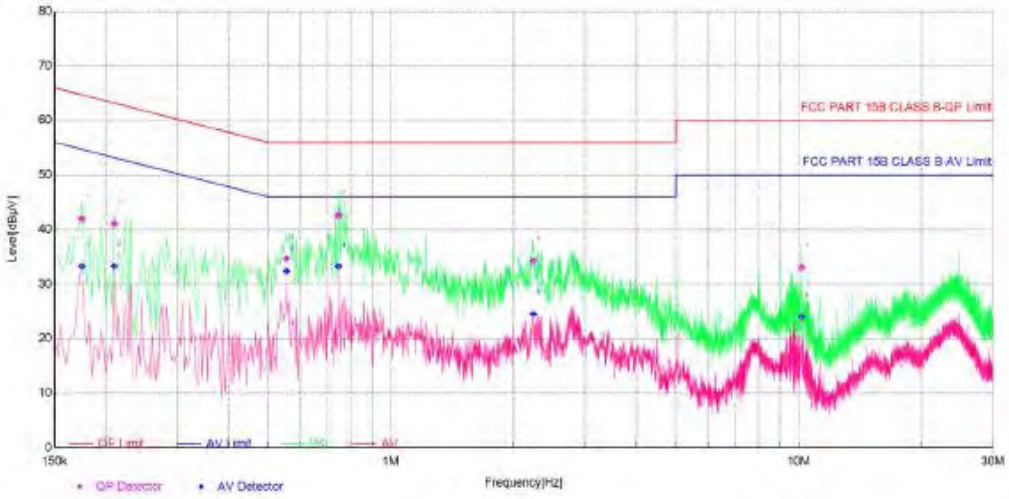
Model: DFR1081

Measurement data:

Pre-scan all test modes, found worst case at GFSK 2402MHz, and so only show the test result of GFSK 2402MHz

Line:



Final Data List

NO.	Freq. [MHz]	Factor[dB]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]	Phase	Verdict
1	0.175	10.62	41.96	64.72	22.76	33.26	54.72	21.46	L	PASS
2	0.21	10.67	40.98	63.21	22.23	33.29	53.21	19.92	L	PASS
3	0.555	10.74	34.63	56.00	21.37	32.38	46.00	13.62	L	PASS
4	0.745	10.75	42.58	56.00	13.42	33.25	46.00	12.75	L	PASS
5	2.2385	10.69	34.28	56.00	21.72	24.53	46.00	21.47	L	PASS
6	10.172	10.80	33.03	60.00	26.97	24.00	50.00	26.00	L	PASS

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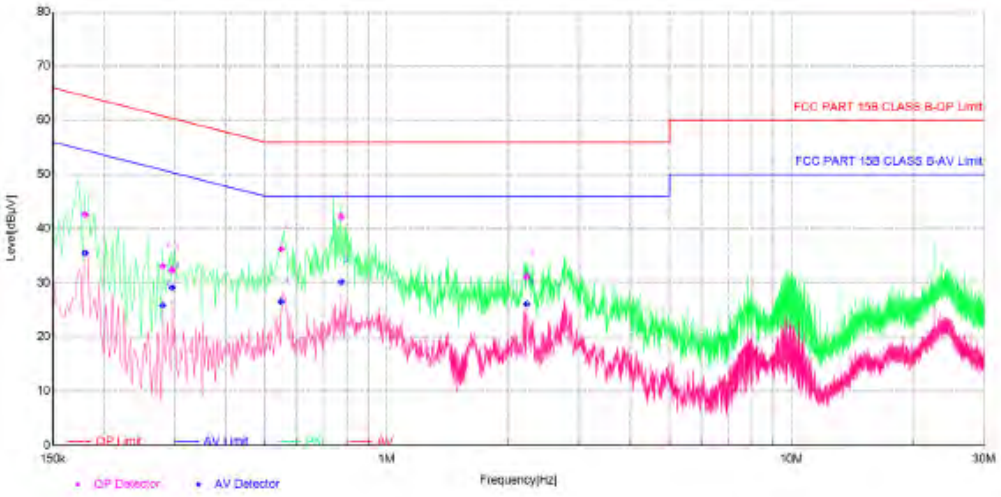
Neutral:



Final Data List										
NO.	Freq. [MHz]	Factor[dB]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]	Phase	Verdict
1	0.18	10.48	42.58	64.49	21.91	35.50	54.49	18.99	N	PASS
2	0.28	10.78	33.10	60.82	27.72	25.82	50.82	25.00	N	PASS
3	0.295	10.84	32.36	60.38	28.02	29.10	50.38	21.28	N	PASS
4	0.55	10.64	36.25	56.00	19.75	26.53	46.00	19.47	N	PASS
5	0.7725	10.73	42.27	56.00	13.73	30.18	46.00	15.82	N	PASS
6	2.2205	10.66	31.14	56.00	24.86	26.07	46.00	19.93	N	PASS

Notes:

1. An initial pre-scan was performed on the line and neutral lines with peak detector.
2. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission.

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6. Conducted Peak Output Power

6.1 Applicable Standard

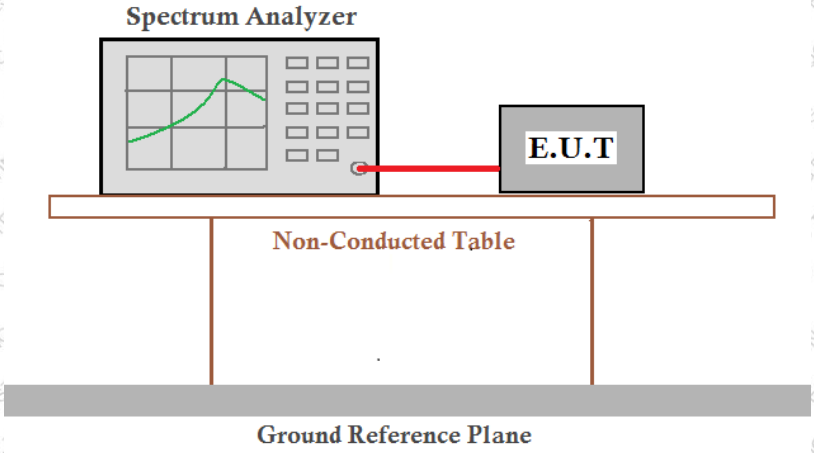
FCC Part15 C Section 15.247 (b)(3)

6.2 Limit

According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

6.3 Test setup



6.4 Test Data

Temperature	23 ℃	Humidity	52 %
ATM Pressure	101.1kPa	Antenna Gain	1.56dBi
Test by	LBi Li	Test result	PASS

Please refer to following table and plots.

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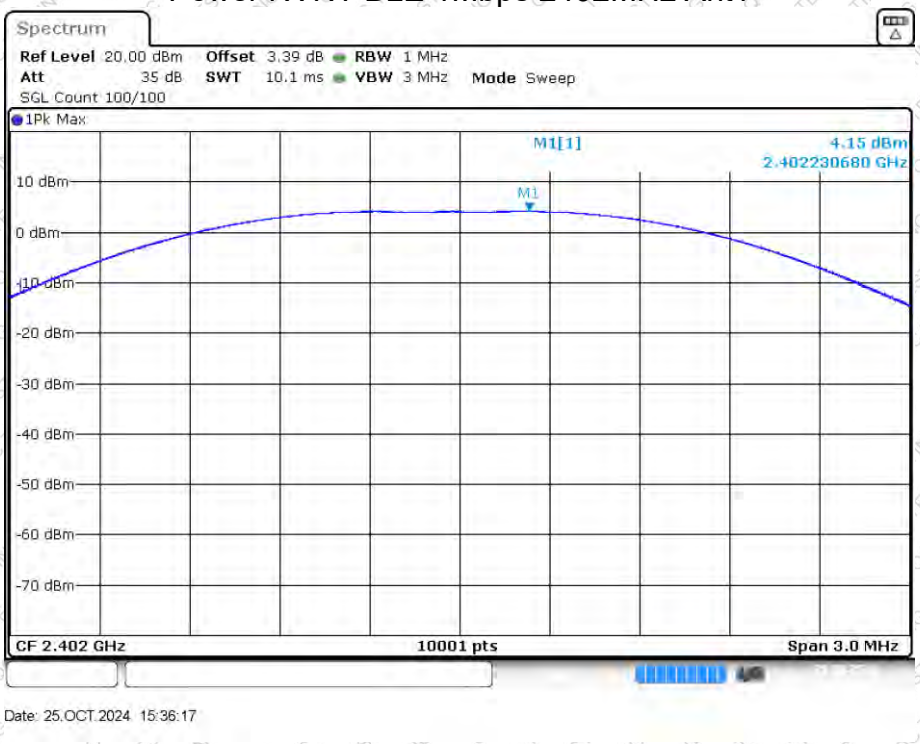
Output Power:

Modulation	CH No.	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Verdict
BLE 1Mbps	Lowest	2402	4.15	≤30	PASS
	Middle	2440	4.01	≤30	PASS
	Highest	2480	4.16	≤30	PASS
BLE 2Mbps	Lowest	2402	4.23	≤30	PASS
	Middle	2440	4.02	≤30	PASS
	Highest	2480	4.13	≤30	PASS

Power NVNT BLE 1Mbps 2402MHz Ant1



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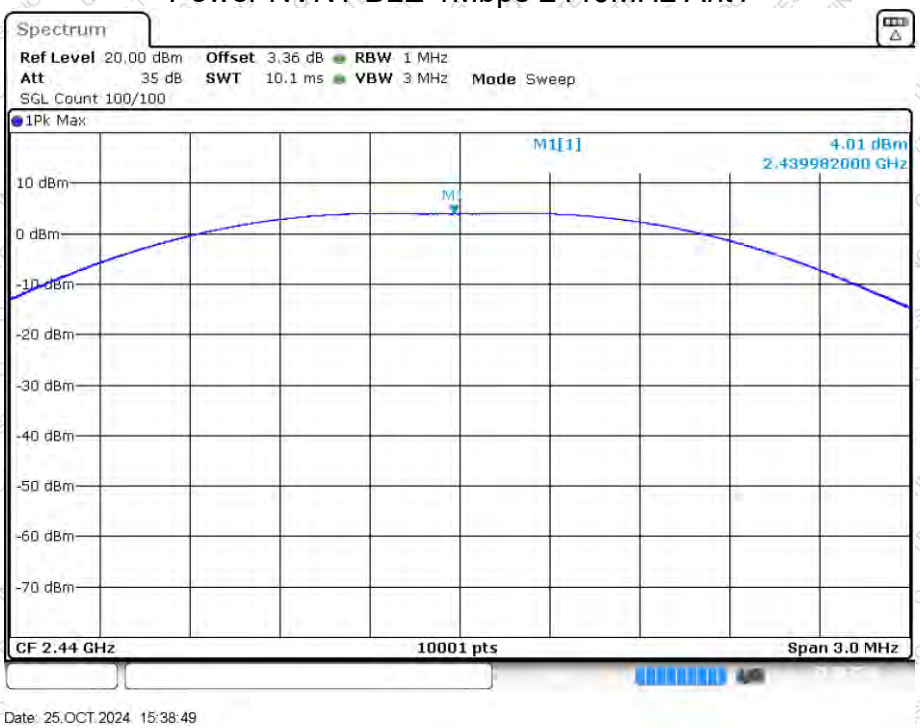
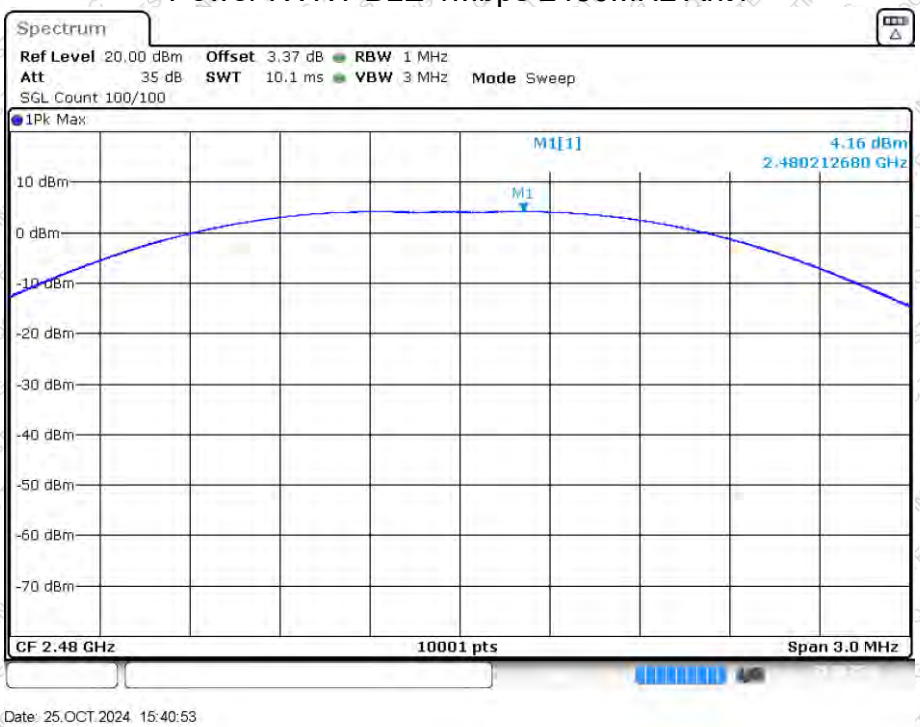
Power NVNT BLE 1Mbps 2440MHz Ant1



Power NVNT BLE 1Mbps 2480MHz Ant1



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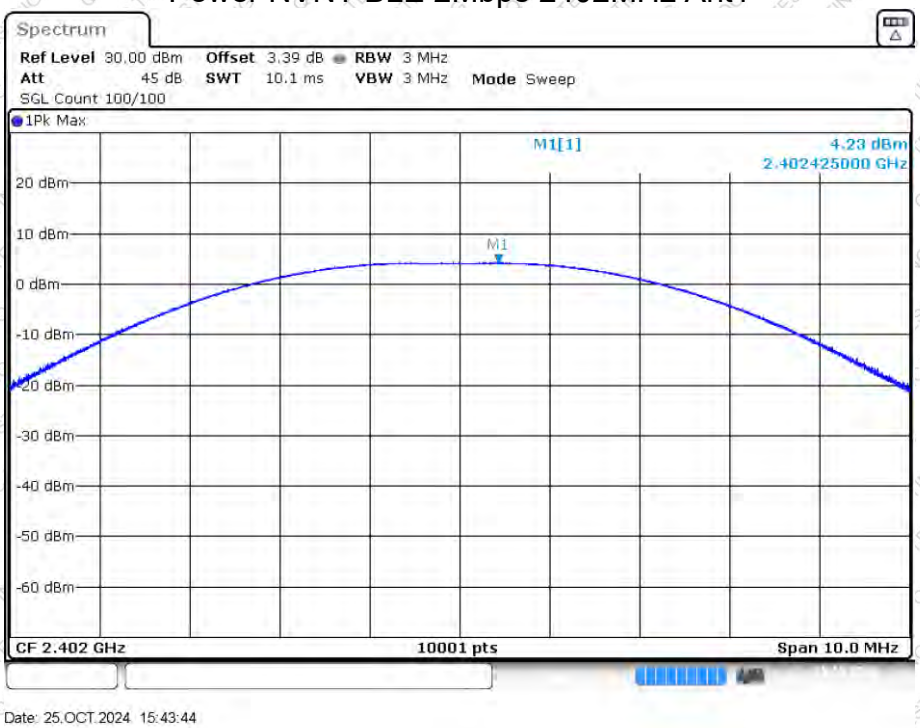
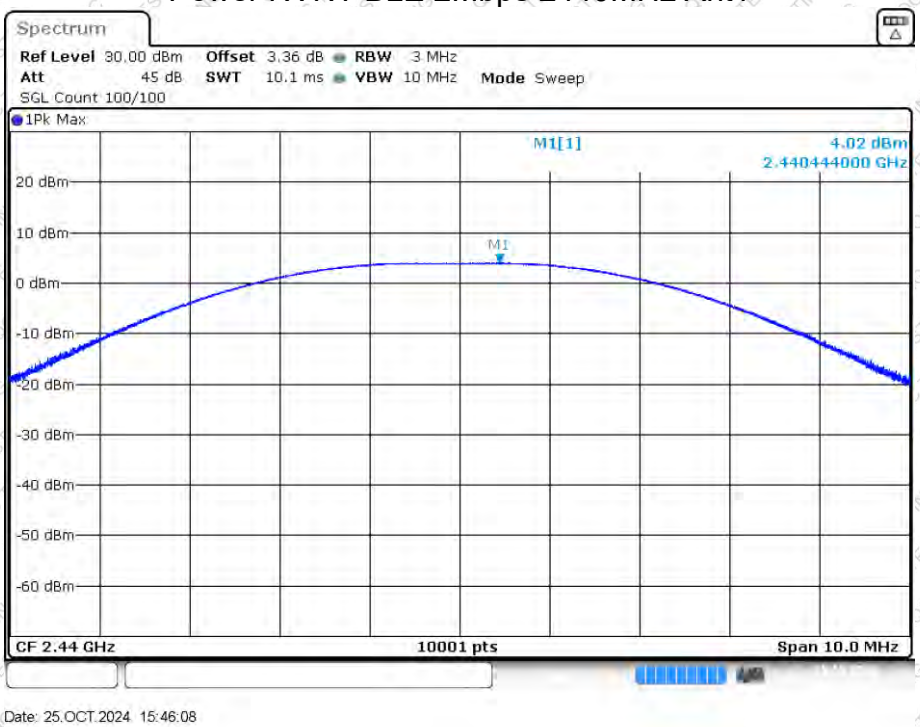
Power NVNT BLE 2Mbps 2402MHz Ant1



Power NVNT BLE 2Mbps 2440MHz Ant1



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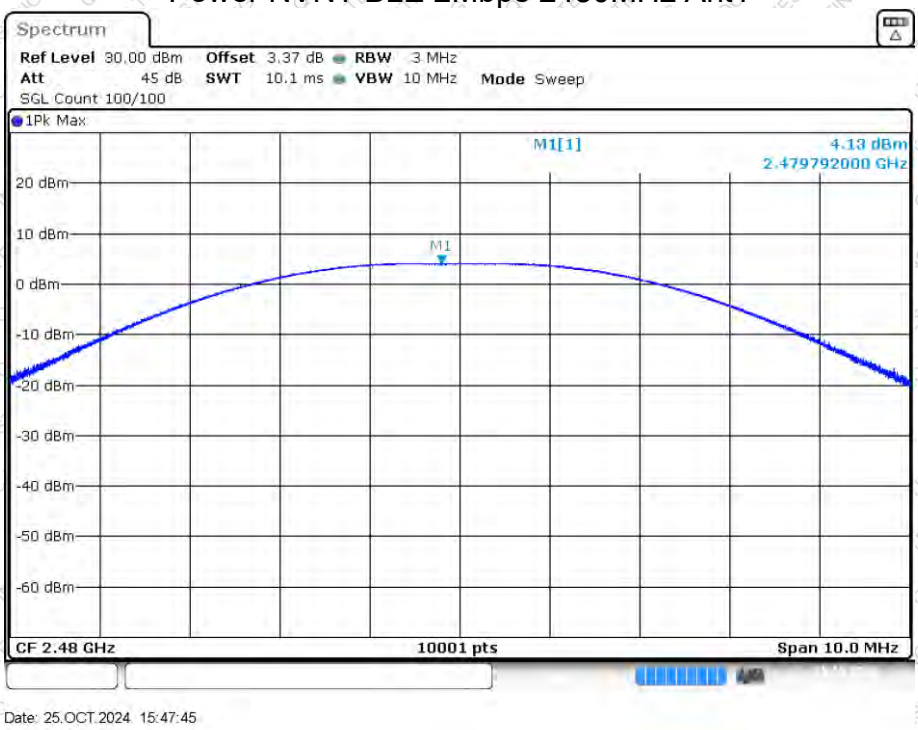
Power NVNT BLE 2Mbps 2480MHz Ant1



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7. Channel Bandwidth & 99% Occupied Bandwidth

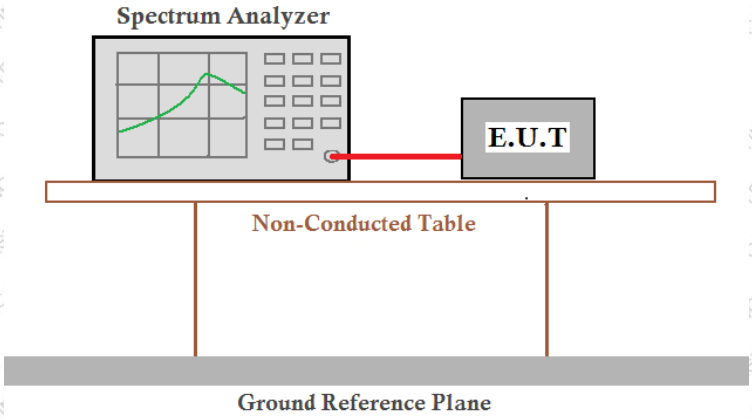
7.1 Applicable Standard

FCC Part15 C Section 15.247 (a)(2)

7.2 Limit

The minimum 6 dB bandwidth shall be 500 kHz.

7.3 Test setup



7.4 Test Procedure

The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

• The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

• The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

7.5 Test Data

Temperature	23 ℃	Humidity	52 %
ATM Pressure	101.1kPa	Antenna Gain	1.56dBi
Test by	LBi Li	Test result	PASS

Please refer to following table and plots.

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DTS Bandwidth:

Modulation	CH No.	Frequency (MHz)	DTS Bandwidth (MHz)	Limit (MHz)	Verdict
BLE 1Mbps	Lowest	2402	0.673	0.5	PASS
	Middle	2440	0.664	0.5	PASS
	Highest	2480	0.685	0.5	PASS
BLE 2Mbps	Lowest	2402	1.102	0.5	PASS
	Middle	2440	1.114	0.5	PASS
	Highest	2480	1.121	0.5	PASS

99% Occupied Bandwidth:

Modulation	CH No.	Frequency (MHz)	99% Bandwidth (MHz)	Limit (MHz)	Verdict
BLE 1Mbps	Lowest	2402	1.041	---	PASS
	Middle	2440	1.036	---	PASS
	Highest	2480	1.037	---	PASS
BLE 2Mbps	Lowest	2402	2.047	---	PASS
	Middle	2440	2.046	---	PASS
	Highest	2480	2.042	---	PASS

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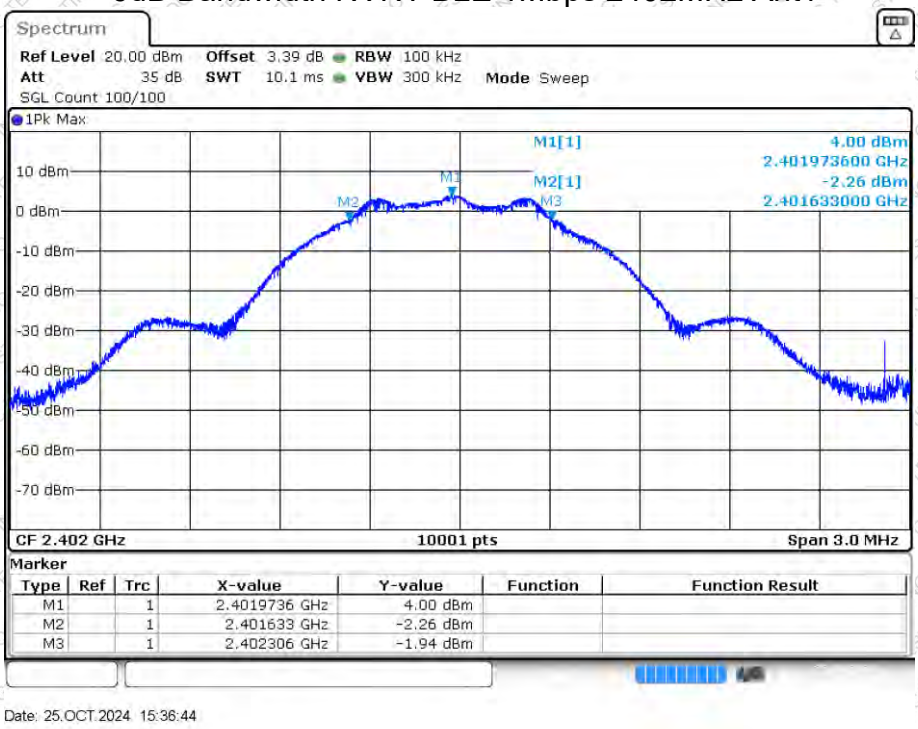
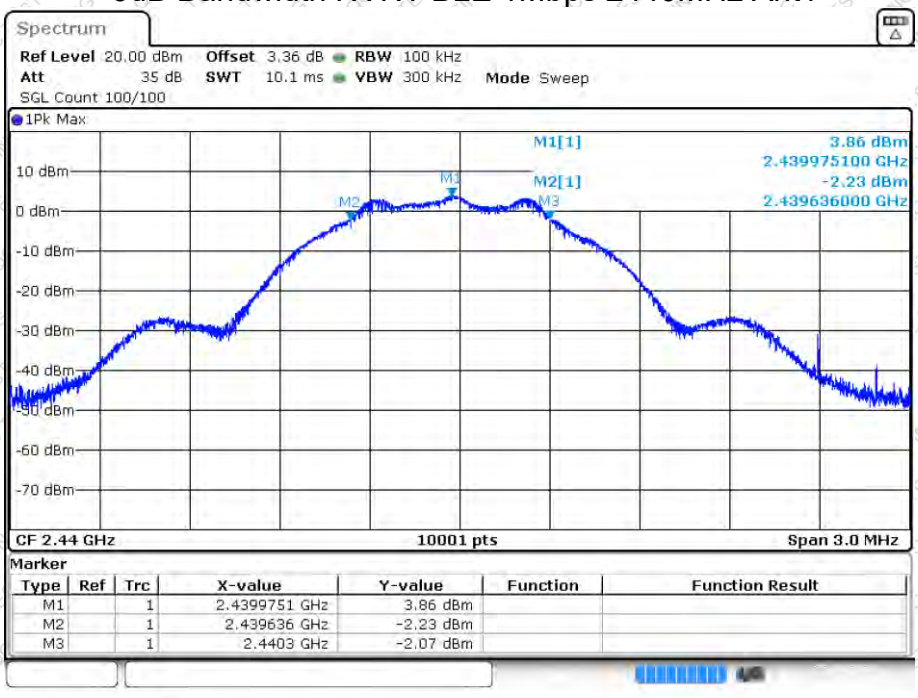
DTS Bandwidth:

-6dB Bandwidth NVNT BLE 1Mbps 2402MHz Ant1



-6dB Bandwidth NVNT BLE 1Mbps 2440MHz Ant1



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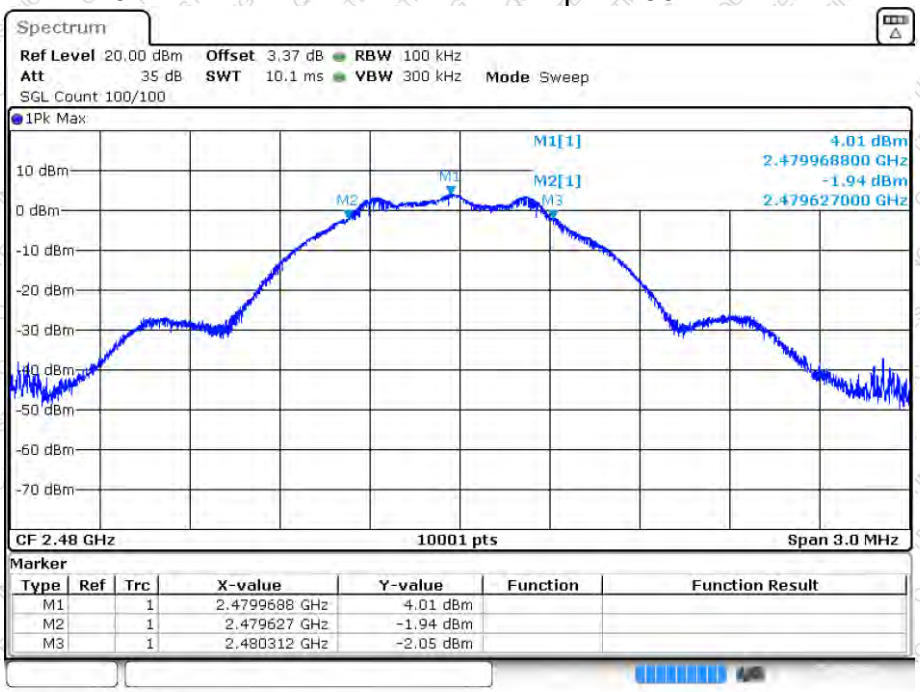
-6dB Bandwidth NVNT BLE 1Mbps 2480MHz Ant1



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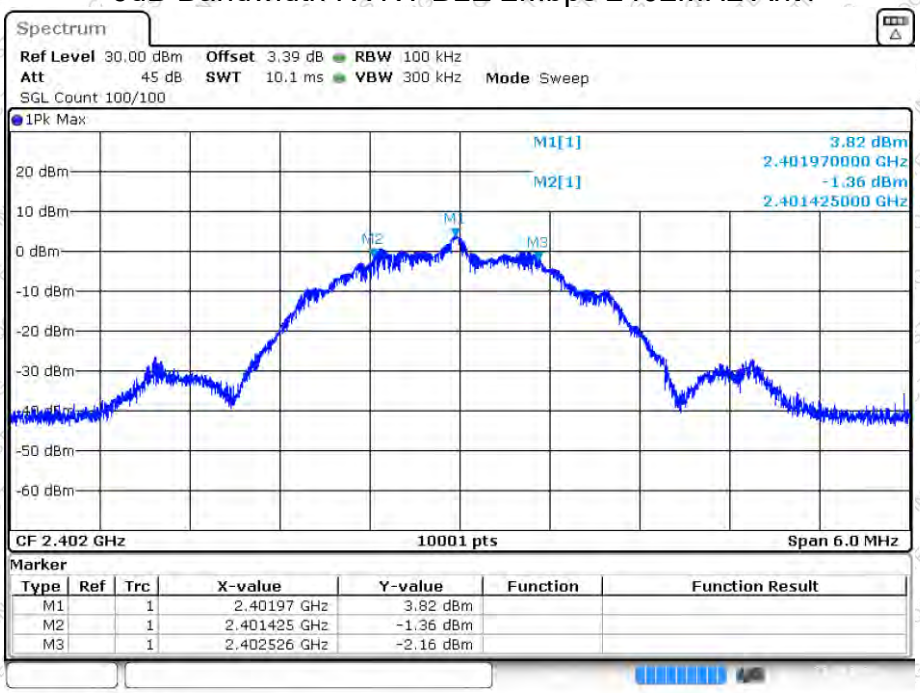
-6dB Bandwidth NVNT BLE 2Mbps 2402MHz Ant1



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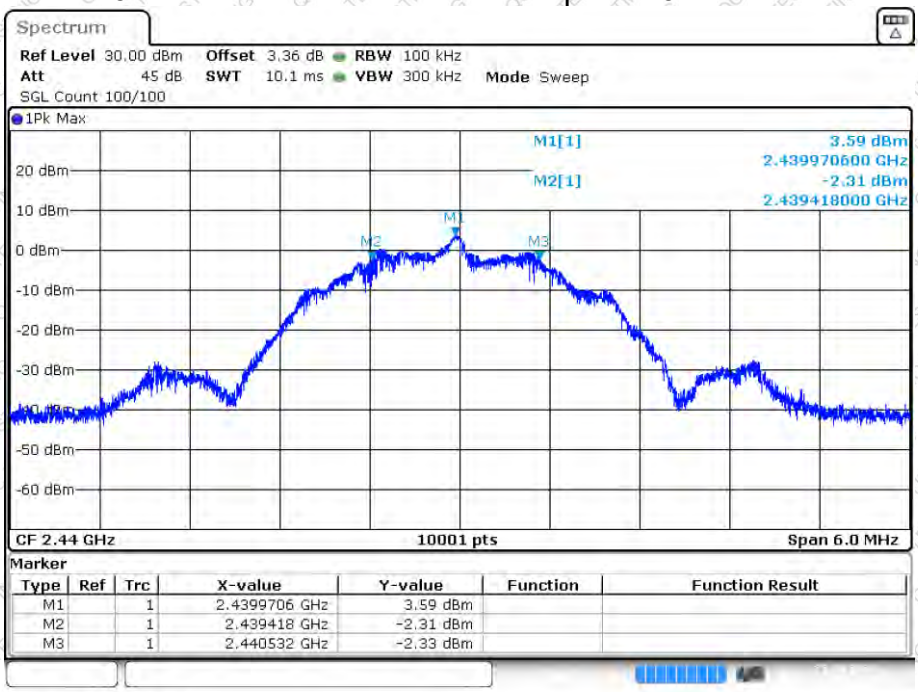
-6dB Bandwidth NVNT BLE 2Mbps 2440MHz Ant1



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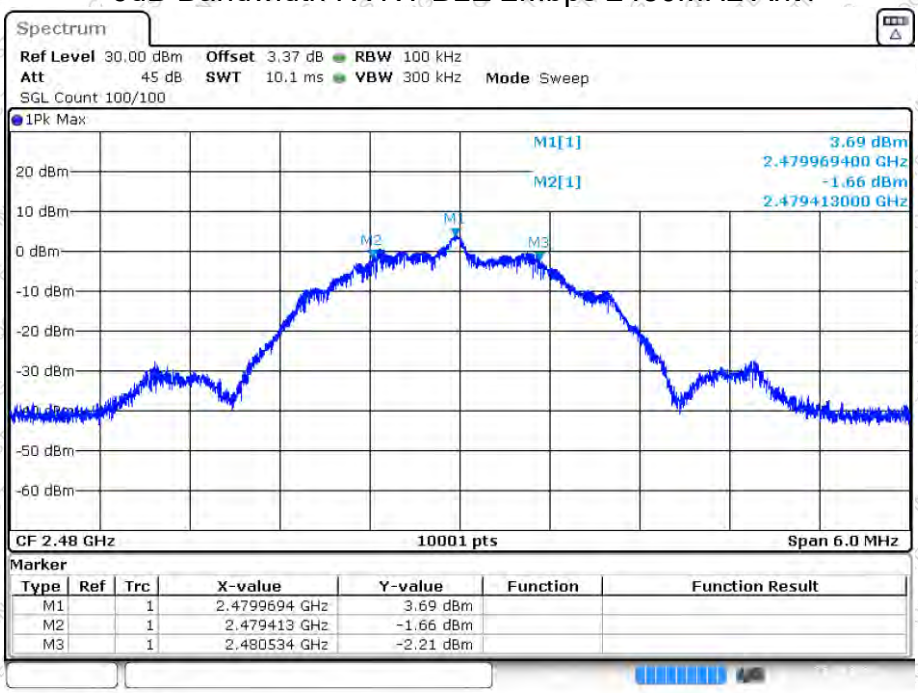
-6dB Bandwidth NVNT BLE 2Mbps 2480MHz Ant1



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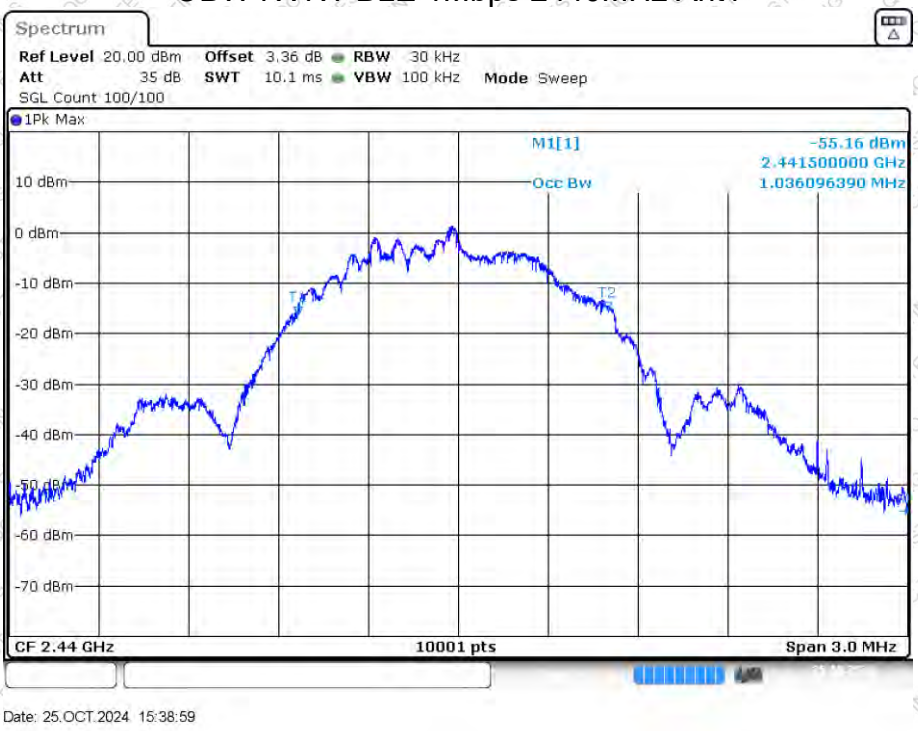
99% Occupied Bandwidth:

OBW NVNT BLE 1Mbps 2402MHz Ant1

OBW NVNT BLE 1Mbps 2440MHz Ant1



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OBW NVNT BLE 1Mbps 2480MHz Ant1

OBW NVNT BLE 2Mbps 2402MHz Ant1

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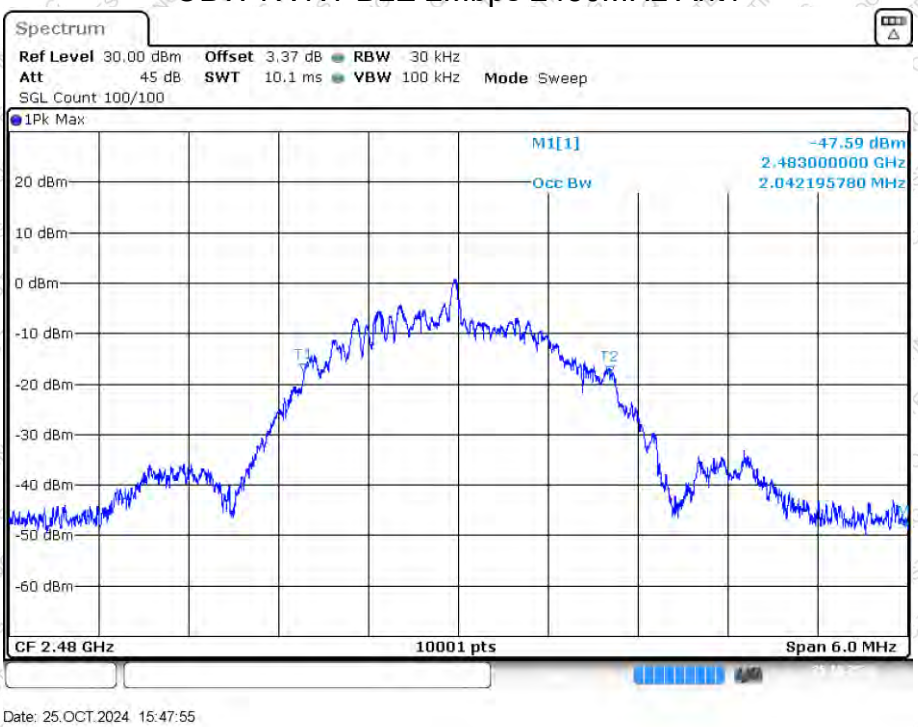
OBW NVNT BLE 2Mbps 2440MHz Ant1

OBW NVNT BLE 2Mbps 2480MHz Ant1



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8. Power Spectral Density

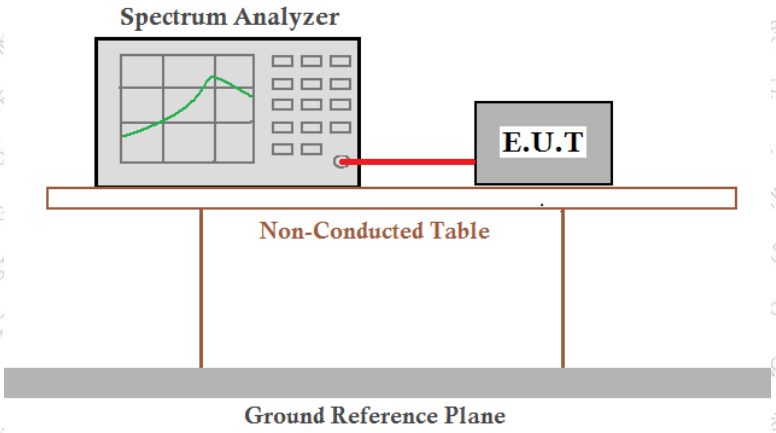
8.1 Applicable Standard

FCC Part15 C Section 15.247 (e)

8.2 Limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

8.3 Test setup



8.4 Test Procedure

Refer to KDB558074 D01 15.247 Meas Guidance v05r02

8.5 Test Data

Temperature	23 ℃	Humidity	52 %
ATM Pressure	101.1kPa	Antenna Gain	1.56dBi
Test by	LBi Li	Test result	PASS

Please refer to following table and plots.

Modulation	Test channel	Power Spectral Density (dBm/3kHz)	Limit(dBm/3kHz)	Result
BLE 1Mbps	Lowest	-10.81	8.00	Pass
	Middle	-11.42		
	Highest	-11.4		
BLE 2Mbps	Lowest	-13.59	8.00	Pass
	Middle	-14.17		
	Highest	-13.83		

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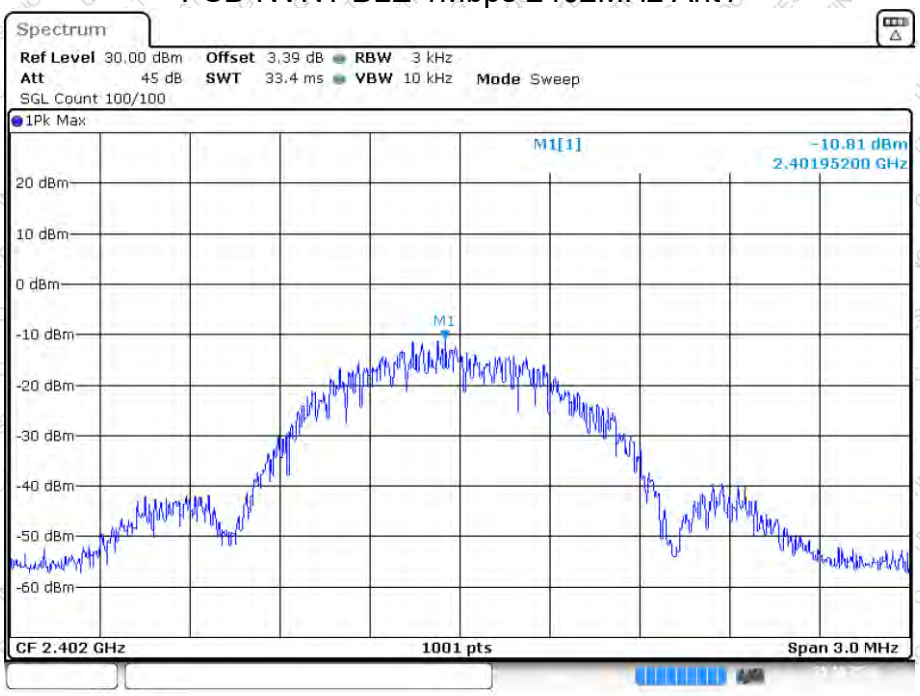
PSD NVNT BLE 1Mbps 2402MHz Ant1



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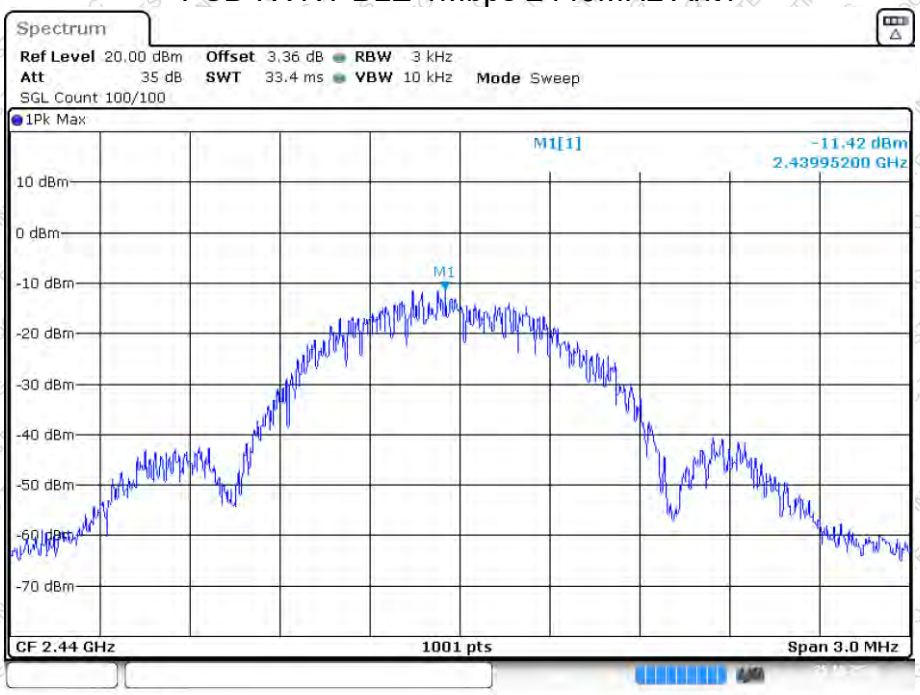
PSD NVNT BLE 1Mbps 2440MHz Ant1



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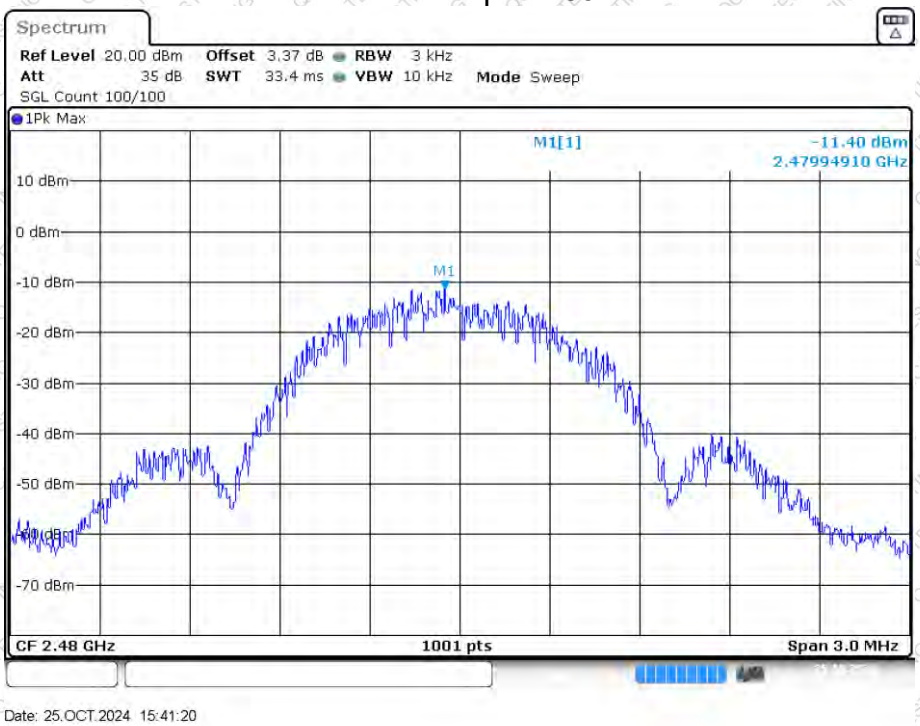
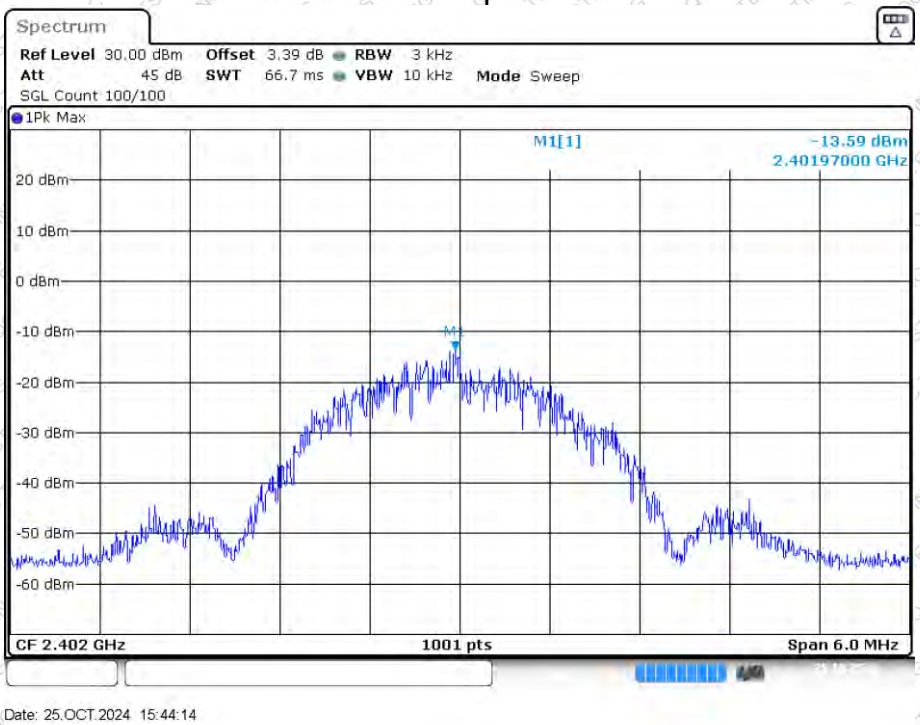
PSD NVNT BLE 1Mbps 2480MHz Ant1



PSD NVNT BLE 2Mbps 2402MHz Ant1



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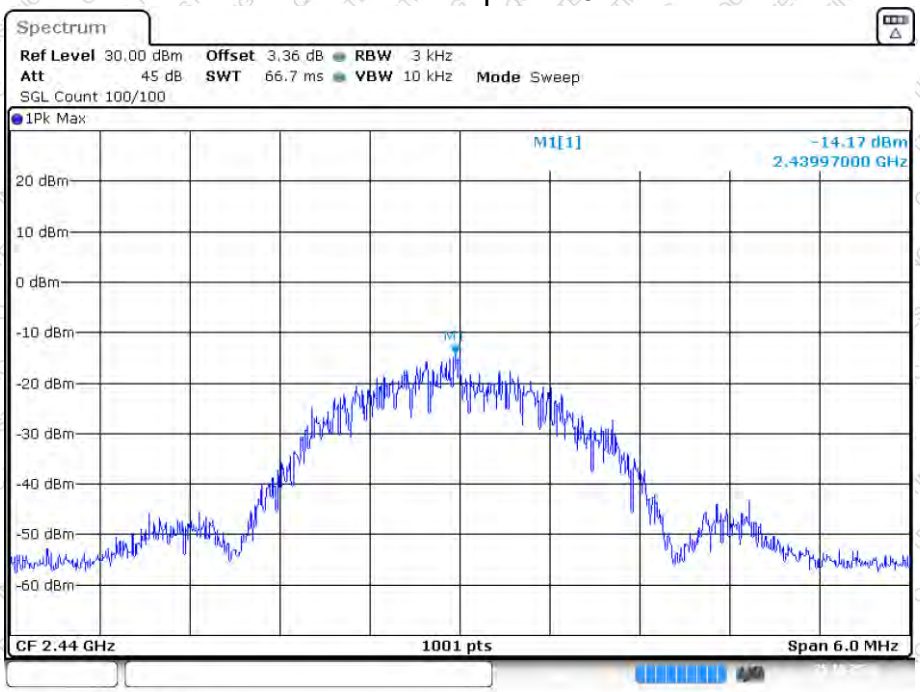
PSD NVNT BLE 2Mbps 2440MHz Ant1



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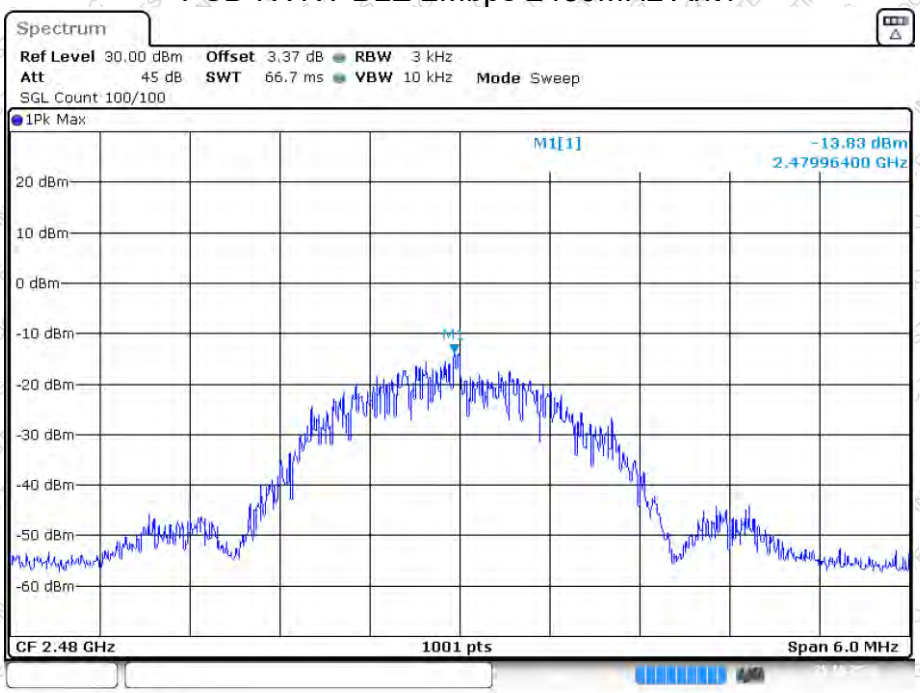
PSD NVNT BLE 2Mbps 2480MHz Ant1



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9. Spurious Emission in Non-restricted & restricted Bands

9.1 Conducted Emission Method

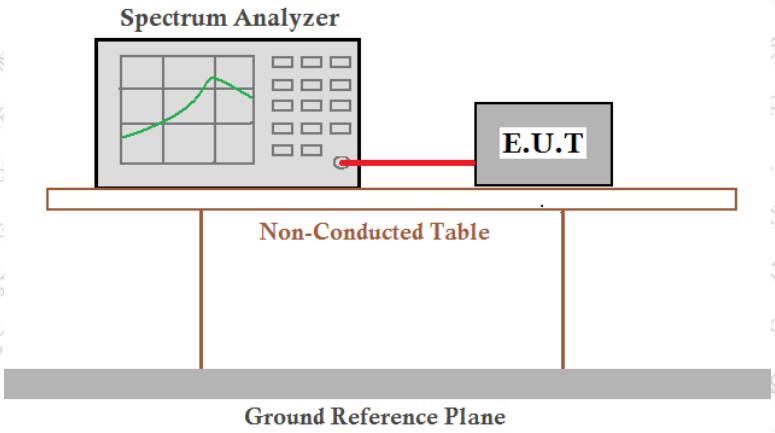
9.1.1 Applicable Standard

FCC Part15 C Section 15.247 (d)

9.1.2 Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

9.1.3 Test setup



9.1.4 Test Procedure

- Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
- Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
- Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
- Repeat above procedures until all measured frequencies were complete.

9.1.5 Test Data

Temperature	23 ℃	Humidity	52 %
ATM Pressure	101.1kPa	Antenna Gain	1.56dBi
Test by	LBi Li	Test result	PASS

Please refer to following plots.

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Band Edge:

Modulation	Frequency (MHz)	Antenna	Max Value (dBc)	Limit (dBc)	Verdict
BLE 1Mbps	Lowest	2402	-50.93	-20	Pass
	Highest	2480	-47.95	-20	Pass
BLE 2Mbps	Lowest	2402	-38.2	-20	Pass
	Highest	2480	-40.99	-20	Pass

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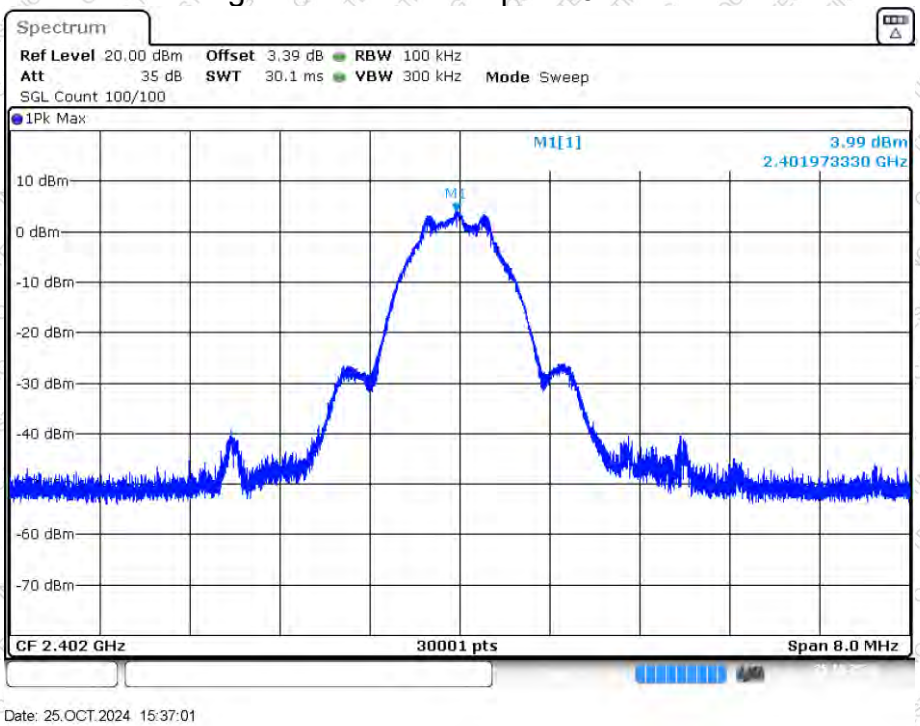
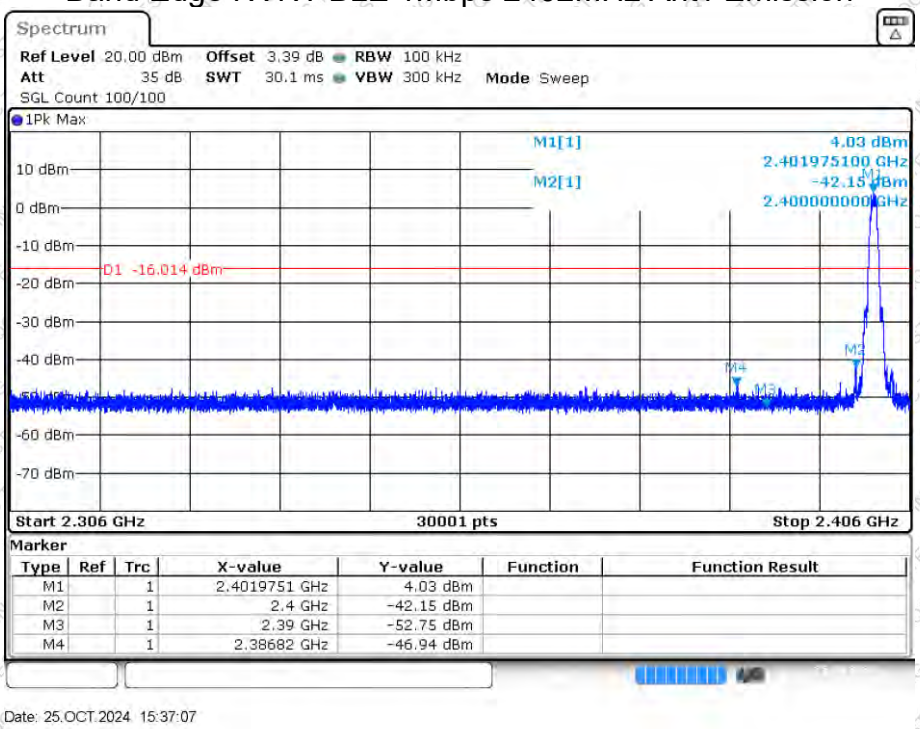
Band Edge NVNT BLE 1Mbps 2402MHz Ant1 Ref



Band Edge NVNT BLE 1Mbps 2402MHz Ant1 Emission



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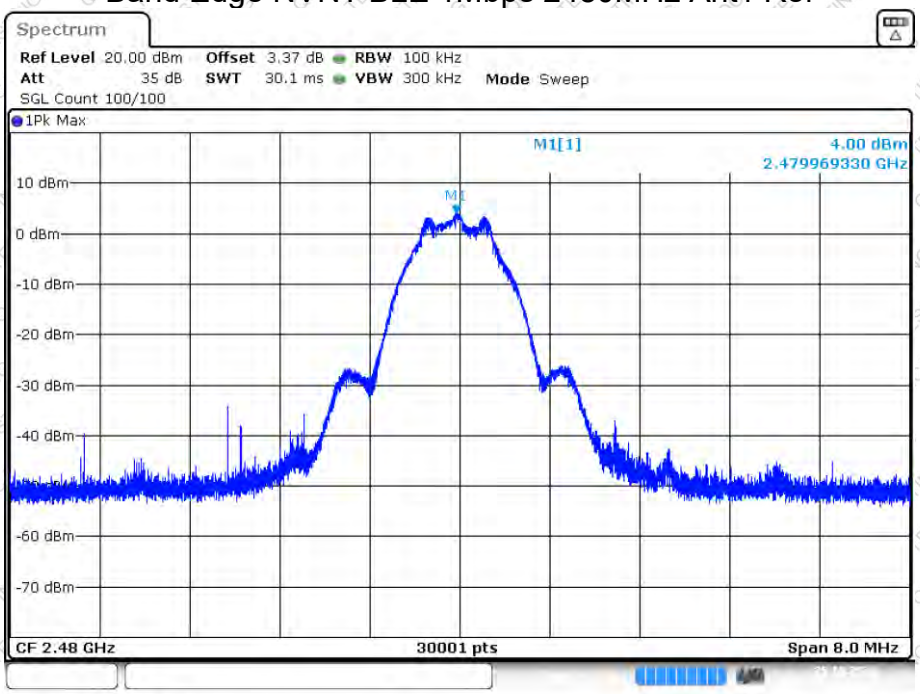
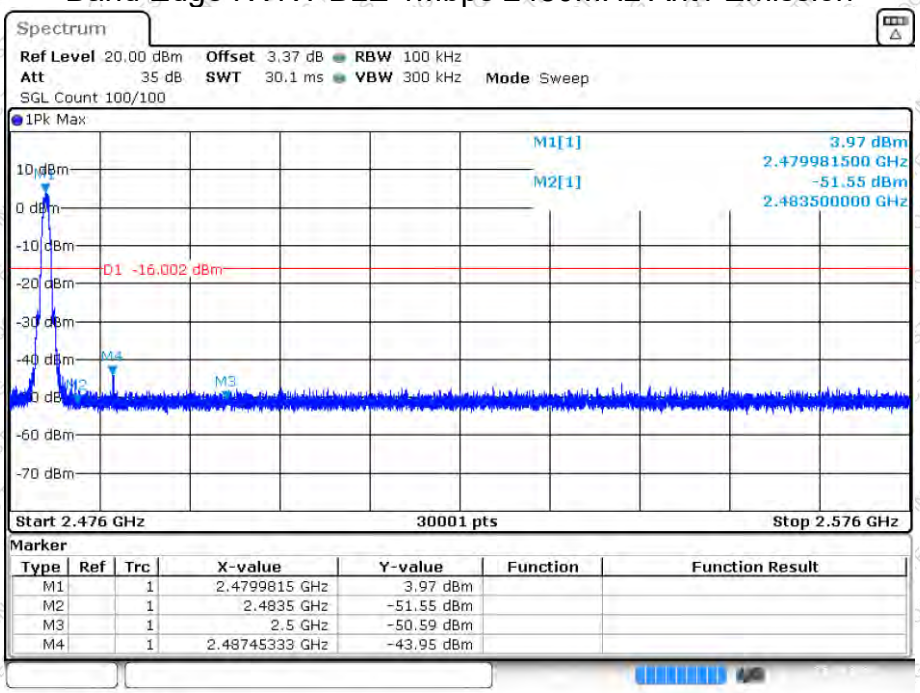
Band Edge NVNT BLE 1Mbps 2480MHz Ant1 Ref



Date: 25.OCT.2024 15:41:28

Band Edge NVNT BLE 1Mbps 2480MHz Ant1 Emission



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4799815 GHz	3.97 dBm		
M2		1	2.4835 GHz	-51.55 dBm		
M3		1	2.5 GHz	-50.59 dBm		
M4		1	2.48745333 GHz	-43.95 dBm		

Date: 25.OCT.2024 15:41:33

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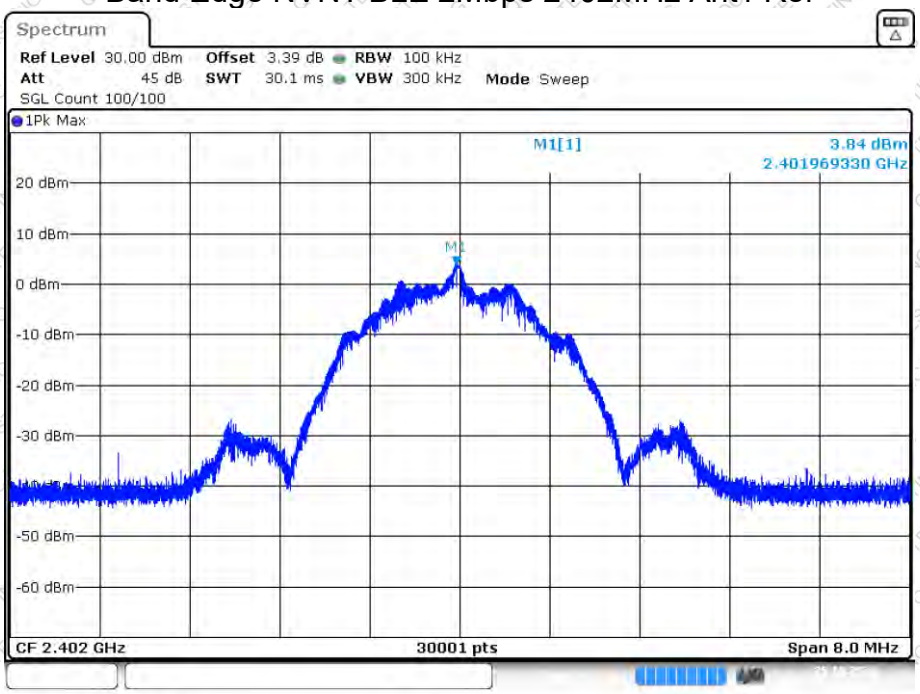
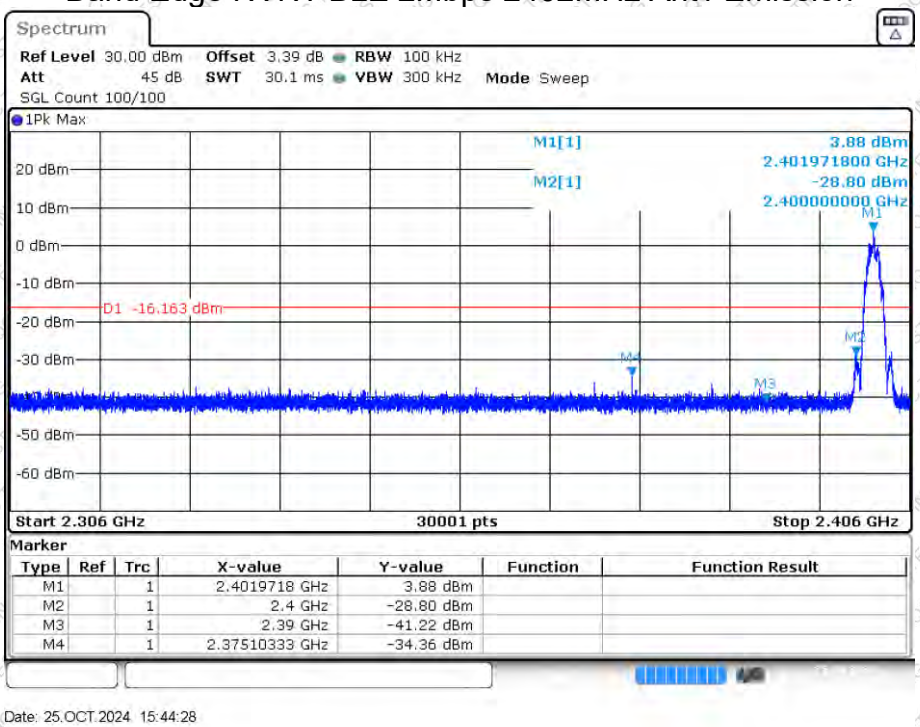
Band Edge NVNT BLE 2Mbps 2402MHz Ant1 Ref



Date: 25.OCT.2024 15:44:22

Band Edge NVNT BLE 2Mbps 2402MHz Ant1 Emission



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4019718 GHz	3.88 dBm		
M2		1	2.4 GHz	-28.80 dBm		
M3		1	2.39 GHz	-41.22 dBm		
M4		1	2.37510333 GHz	-34.36 dBm		

Date: 25.OCT.2024 15:44:28

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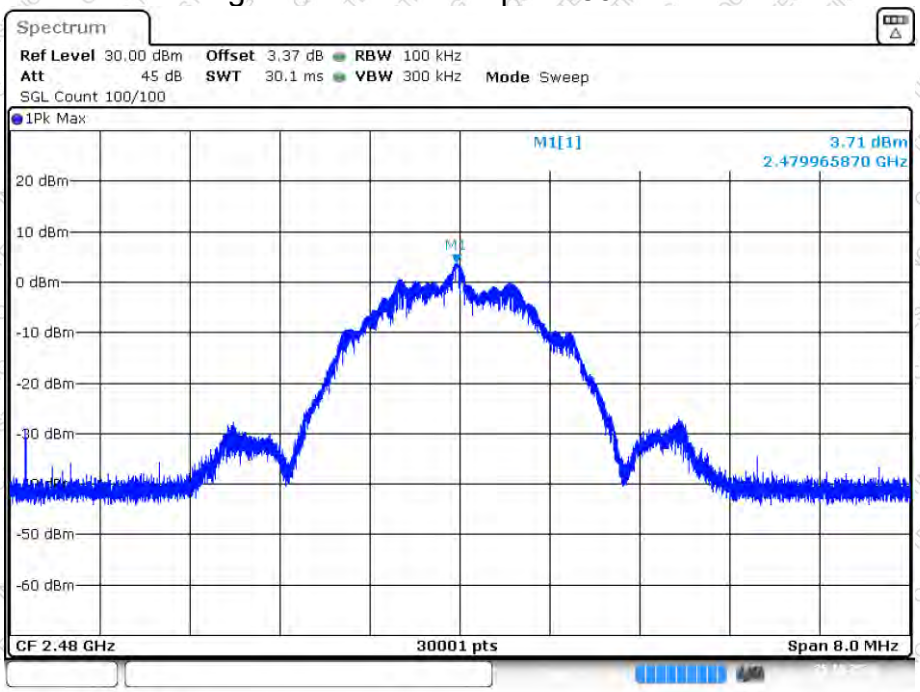
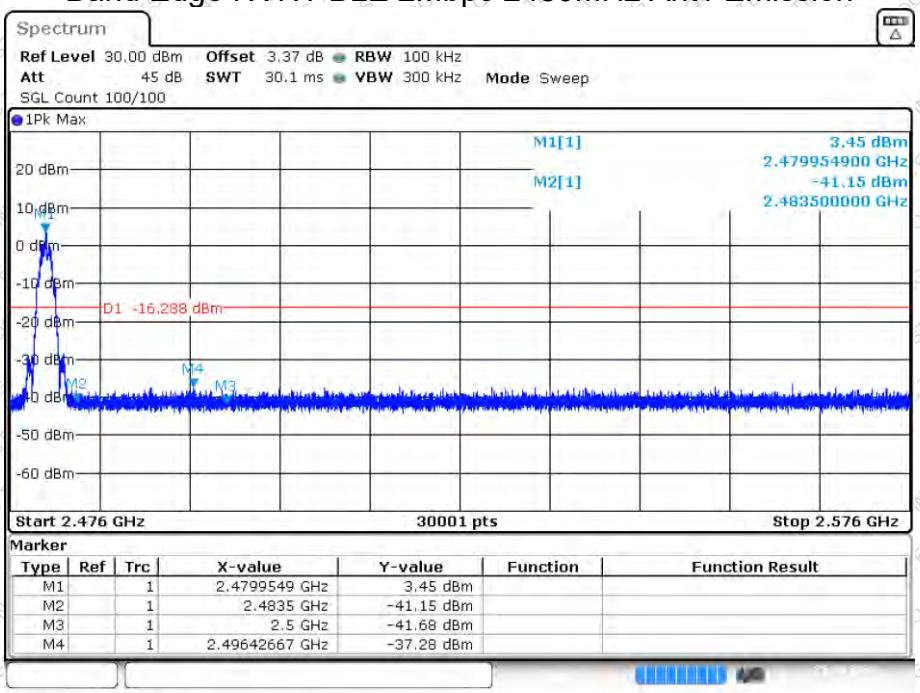
Band Edge NVNT BLE 2Mbps 2480MHz Ant1 Ref



Date: 25.OCT.2024 15:48:23

Band Edge NVNT BLE 2Mbps 2480MHz Ant1 Emission



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4799549 GHz	3.45 dBm		
M2		1	2.4835 GHz	-41.15 dBm		
M3		1	2.5 GHz	-41.68 dBm		
M4		1	2.49642667 GHz	-37.28 dBm		

Date: 25.OCT.2024 15:48:29

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Conducted RF Spurious Emission:

Modulation	Frequency (MHz)	Antenna	Max Value (dBc)	Limit (dBc)	Verdict
BLE 1Mbps	Lowest	2402	-44.53	-20	Pass
	Middle	2440	-44.28	-20	Pass
	Highest	2480	-44.43	-20	Pass
BLE 2Mbps	Lowest	2402	-33.41	-20	Pass
	Middle	2440	-32.58	-20	Pass
	Highest	2480	-34.77	-20	Pass

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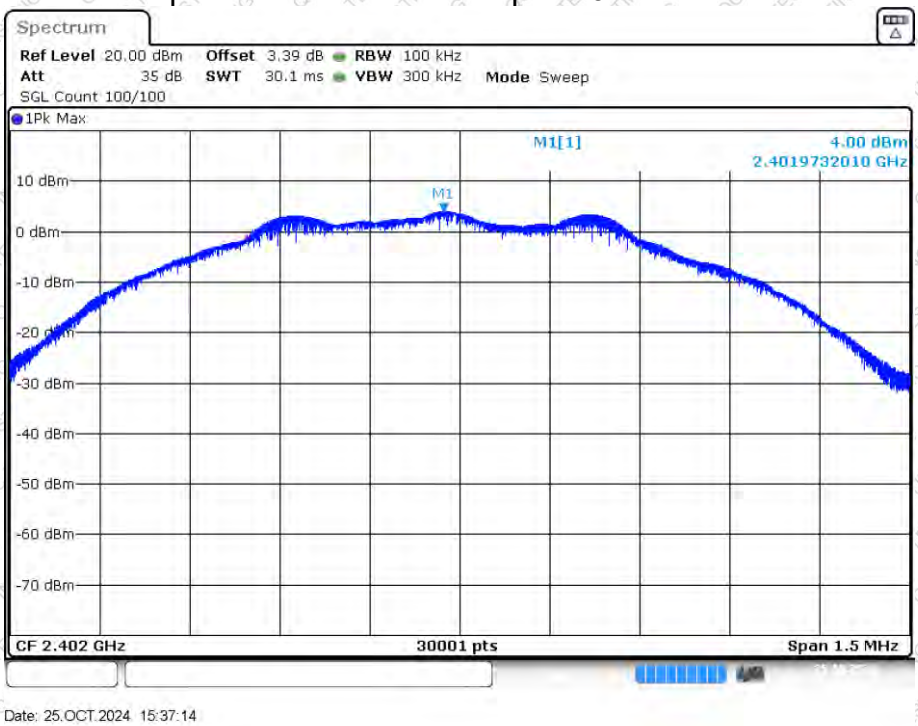
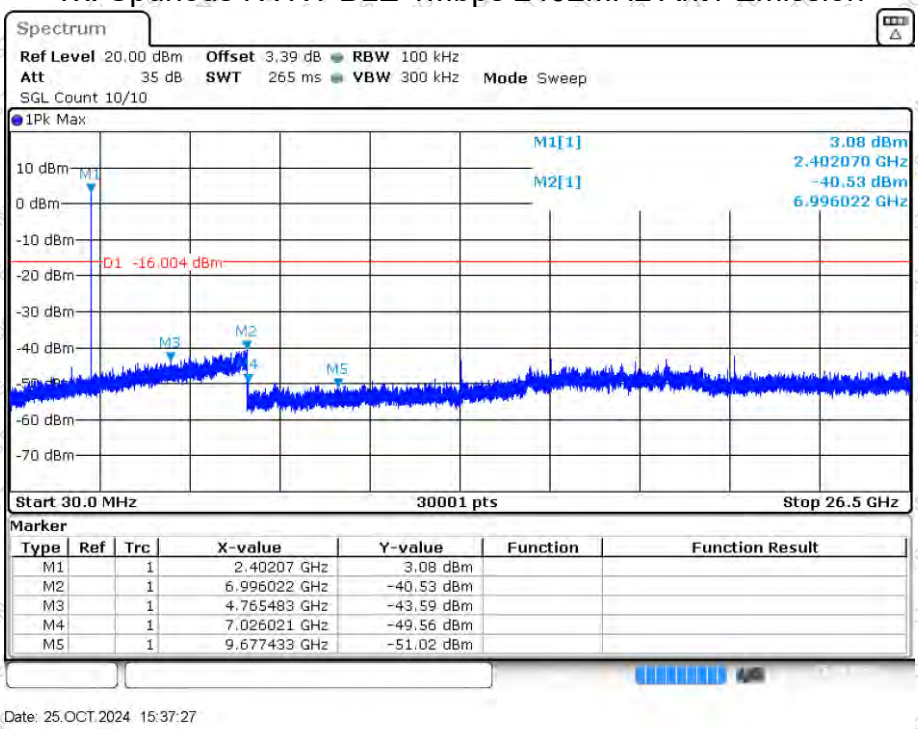
Tx. Spurious NVNT BLE 1Mbps 2402MHz Ant1 Ref



Tx. Spurious NVNT BLE 1Mbps 2402MHz Ant1 Emission



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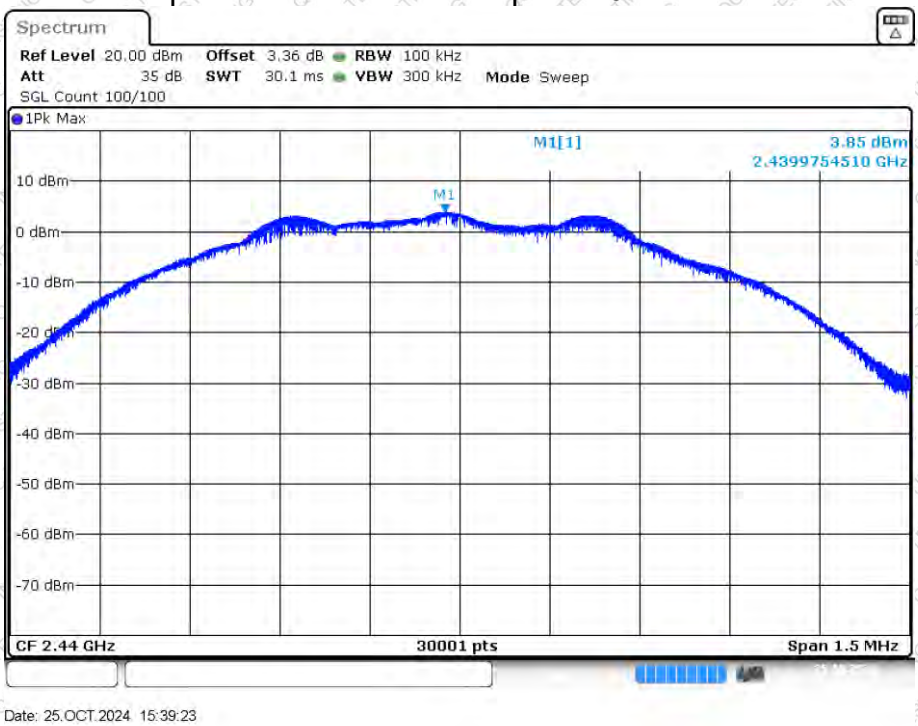
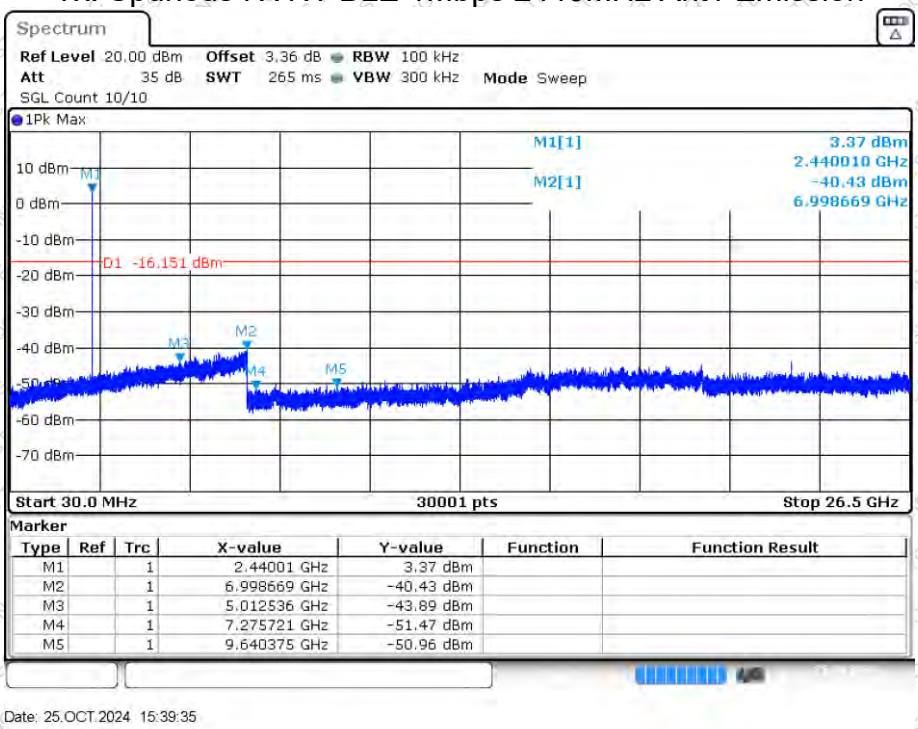
Tx. Spurious NVNT BLE 1Mbps 2440MHz Ant1 Ref



Tx. Spurious NVNT BLE 1Mbps 2440MHz Ant1 Emission



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.44001 GHz	3.37 dBm		
M2		1	6.998669 GHz	-40.43 dBm		
M3		1	5.012536 GHz	-43.89 dBm		
M4		1	7.275721 GHz	-51.47 dBm		
M5		1	9.640375 GHz	-50.96 dBm		

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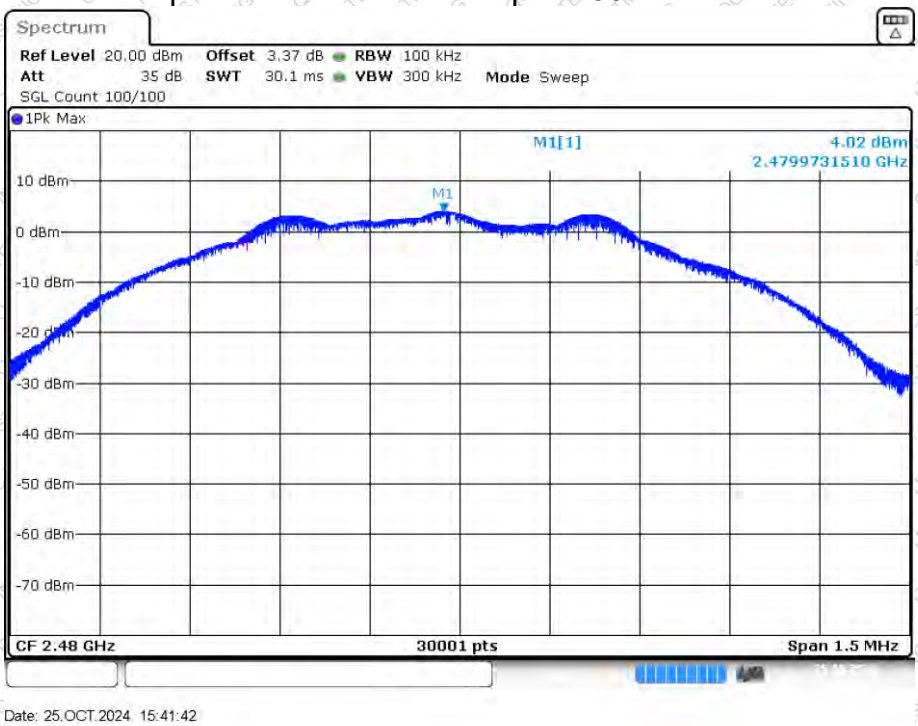
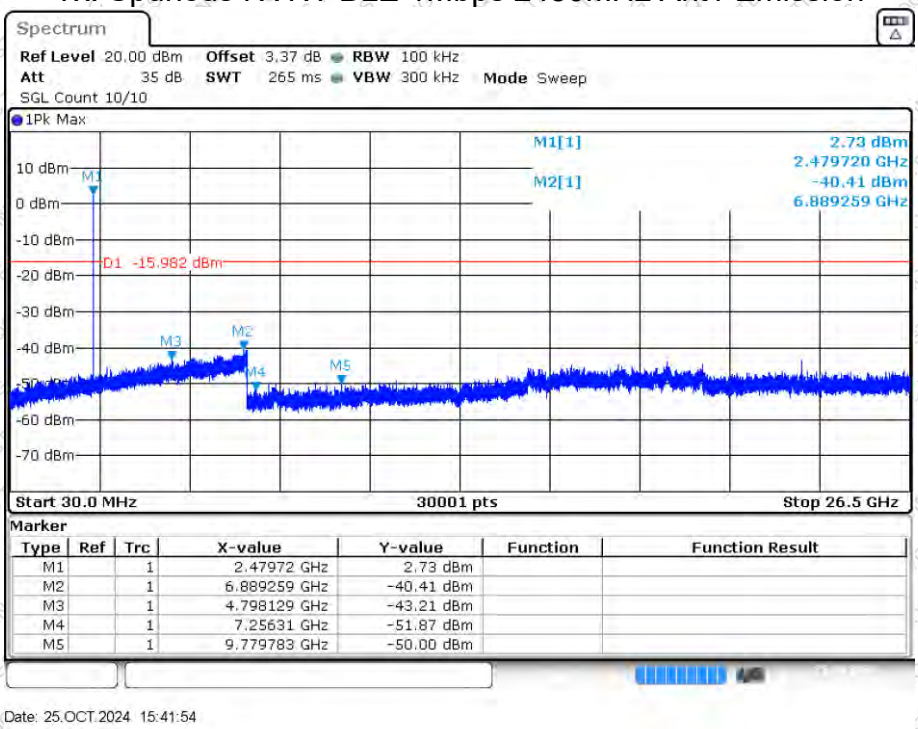
Tx. Spurious NVNT BLE 1Mbps 2480MHz Ant1 Ref



Tx. Spurious NVNT BLE 1Mbps 2480MHz Ant1 Emission



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47972 GHz	2.73 dBm		
M2		1	6.889259 GHz	-40.41 dBm		
M3		1	4.798129 GHz	-43.21 dBm		
M4		1	7.25631 GHz	-51.87 dBm		
M5		1	9.779783 GHz	-50.00 dBm		

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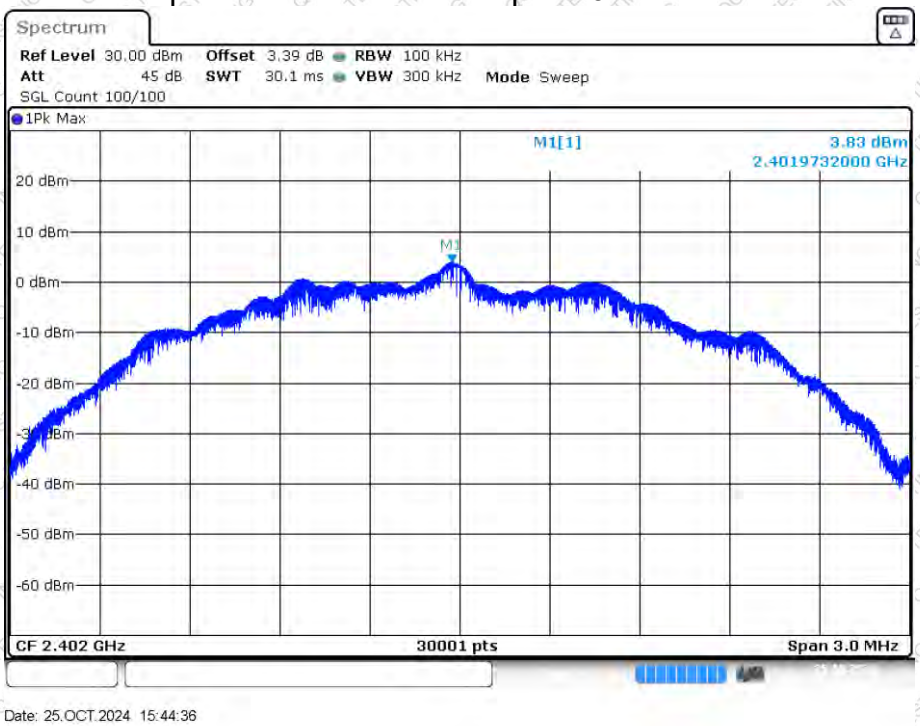
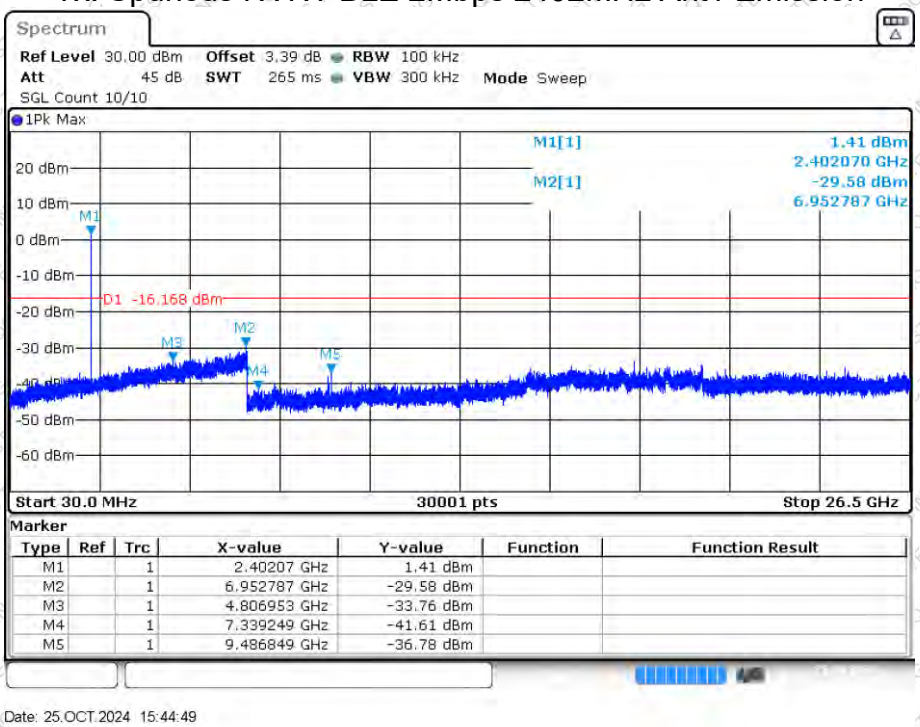
Tx. Spurious NVNT BLE 2Mbps 2402MHz Ant1 Ref



Date: 25.OCT.2024 15:44:36

Tx. Spurious NVNT BLE 2Mbps 2402MHz Ant1 Emission



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40207 GHz	1.41 dBm		
M2		1	6.952787 GHz	-29.58 dBm		
M3		1	4.806953 GHz	-33.76 dBm		
M4		1	7.339249 GHz	-41.61 dBm		
M5		1	9.486849 GHz	-36.78 dBm		

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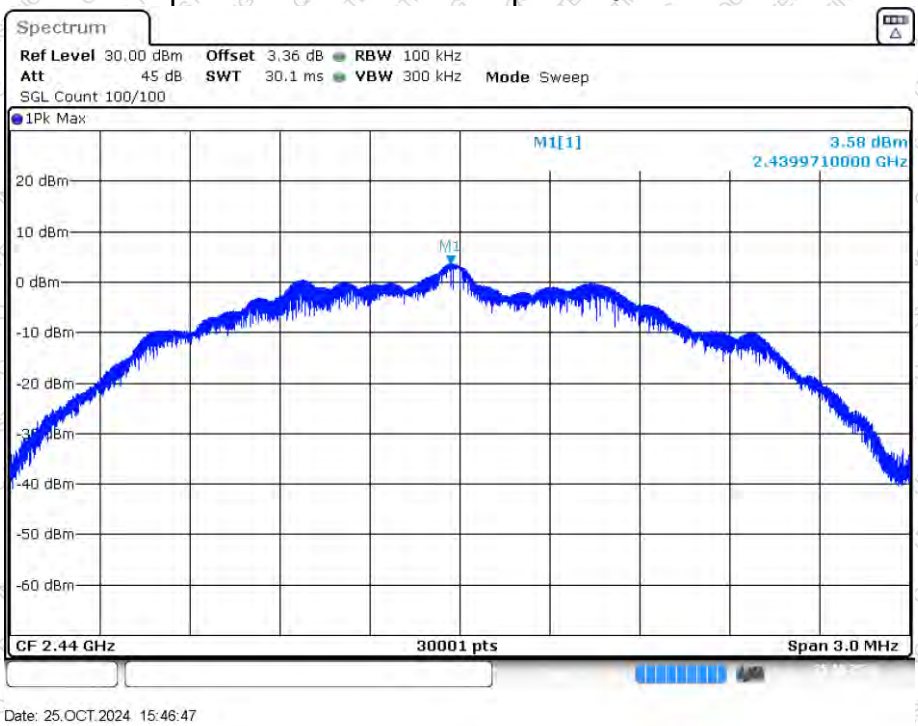
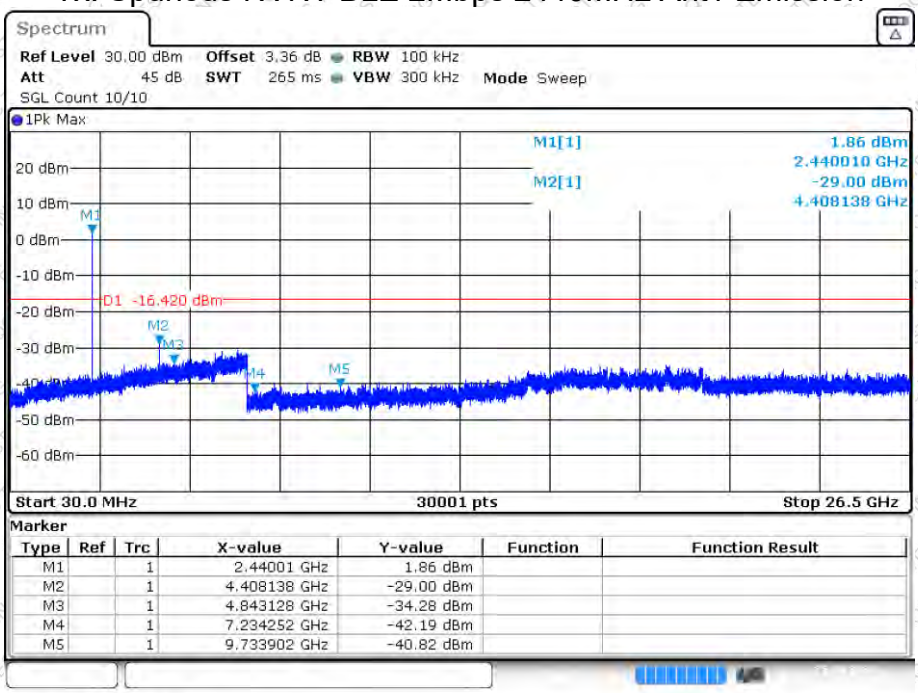
Tx. Spurious NVNT BLE 2Mbps 2440MHz Ant1 Ref



Date: 25.OCT.2024 15:46:47

Tx. Spurious NVNT BLE 2Mbps 2440MHz Ant1 Emission



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.44001 GHz	1.86 dBm		
M2		1	4.408138 GHz	-29.00 dBm		
M3		1	4.843128 GHz	-34.28 dBm		
M4		1	7.234252 GHz	-42.19 dBm		
M5		1	9.733902 GHz	-40.82 dBm		

Date: 25.OCT.2024 15:47:00

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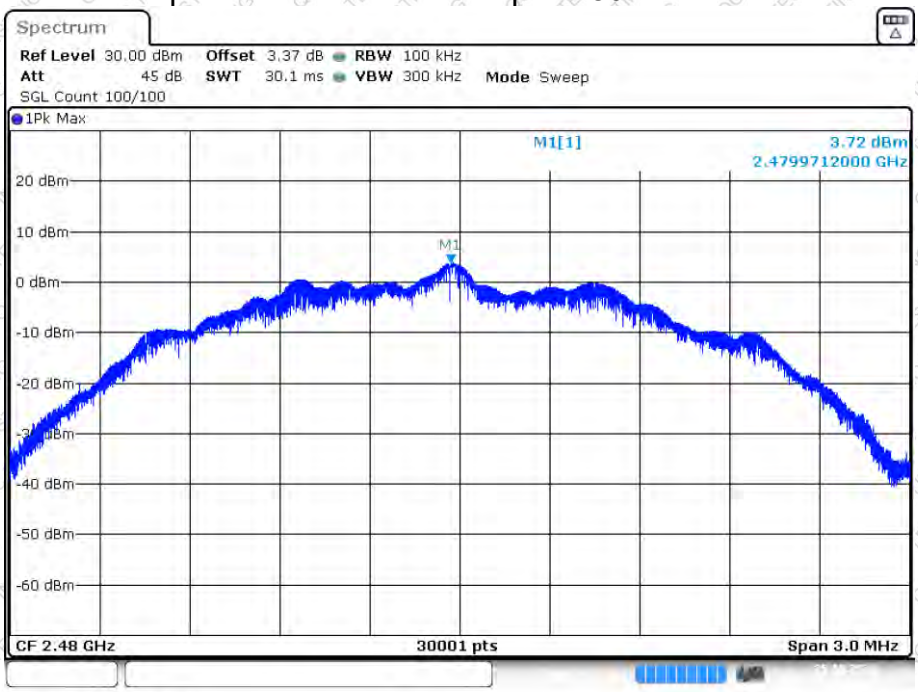
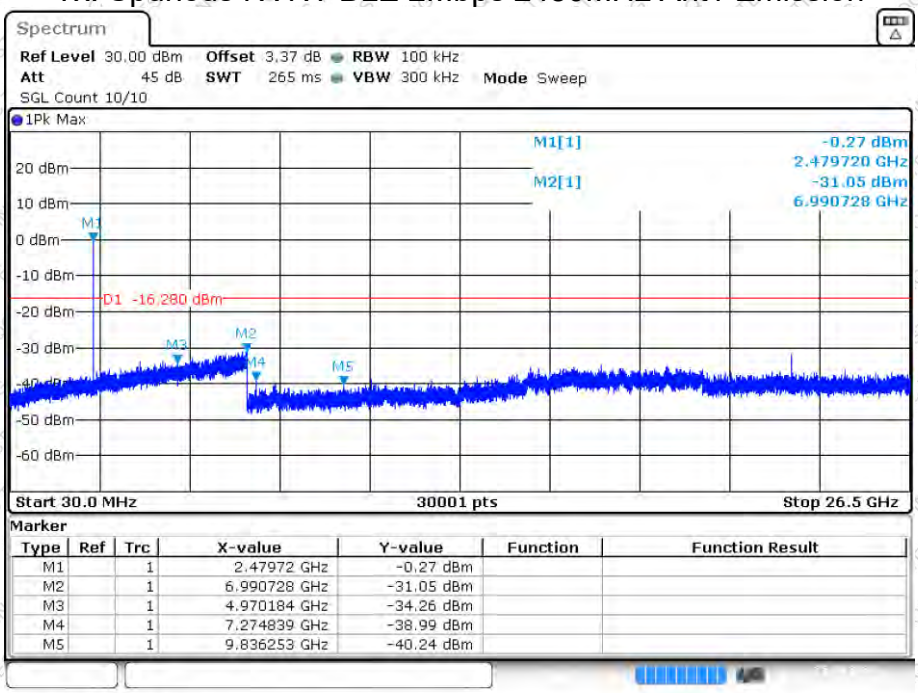
Tx. Spurious NVNT BLE 2Mbps 2480MHz Ant1 Ref



Date: 25.OCT.2024 15:48:39

Tx. Spurious NVNT BLE 2Mbps 2480MHz Ant1 Emission



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47972 GHz	-0.27 dBm		
M2		1	6.990728 GHz	-31.05 dBm		
M3		1	4.970184 GHz	-34.26 dBm		
M4		1	7.274839 GHz	-38.99 dBm		
M5		1	9.836253 GHz	-40.24 dBm		

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9.2 Radiated Emission Method

9.2.1 Applicable Standard

FCC Part15 C Section 15.209 and 15.205

9.2.2 Limit

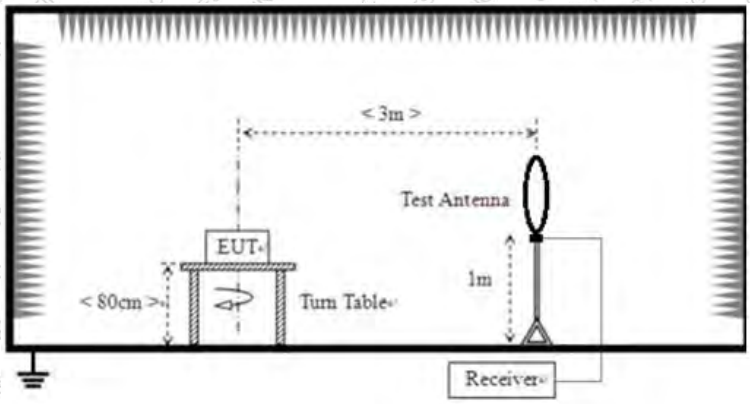
Frequency	Limit (uV/m)	Value	Measurement Distance
0.009MHz-0.490MHz	2400/F(KHz)	QP	300m
0.490MHz-1.705MHz	24000/F(KHz)	QP	30m
1.705MHz-30MHz	30	QP	30m

Frequency	Field Strengths Limits (μV/m at 3 m)	Field Strengths Limits (dBμV/m at 3 m)	Remark
30 – 88	100	40.0	Quasi-peak
88 – 216	150	43.5	Quasi-peak
216 – 960	200	46.0	Quasi-peak
Above 960	500	54.0	Quasi-peak
Above 1GHz	/	74.0	Peak
		54.0	Average

Note: dBμV/m =20log(μV/m)

9.2.3 Test setup

For radiated emissions from 9kHz to 30MHz



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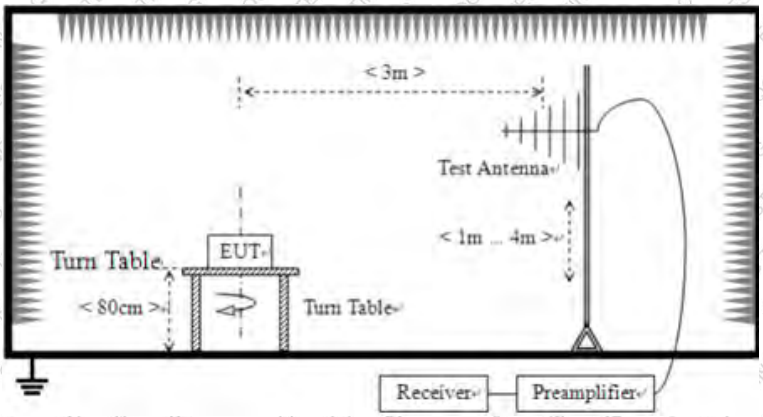
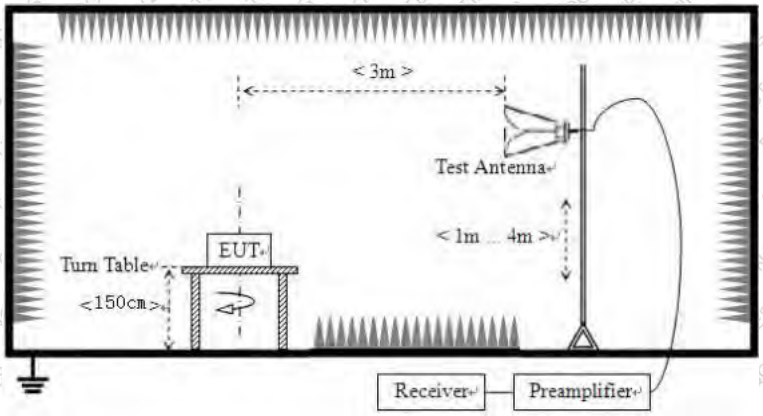
For radiated emissions from 30MHz to1GHz



For radiated emissions above 1GHz



9.2.4 EMI Test Receiver Setup

Frequency	RBW	VBW	IF B/W	Measurement
9KHz-150KHz	200Hz	600Hz	/	QP
150KHz-30MHz	9KHz	30KHz	/	QP
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	Peak
	1 MHz	10 Hz	/	Average

Remark: For the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission test in these three bands are based on measurements employing an average detector.

9.2.5 Test procedure

- The EUT was placed on the top of a rotating table (0.8m for below 1G and 1.5m for above 1G) above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation.
- The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rota table was turned from 0 degrees to 360 degrees to find the maximum reading.

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- The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

9.2.6 Test Data

Temperature	26 ℃	Humidity	54 %
ATM Pressure	101.1kPa	Antenna Gain	1.56dBi
Test by	LBi Li	Test result	PASS

Test voltage: AC 120V/60Hz

Remarks:

1. Pre-scan all kind of the place mode (X-axis, Y-axis, Z-axis), and found the Y-axis which it is worse case.
2. Data of measurement within frequency range 9kHz-30MHz, 18-26GHz are the noise floor or attenuated more than 20dB below the permissible limits or the field strength is too small to be measured, so test data does not present in this report.

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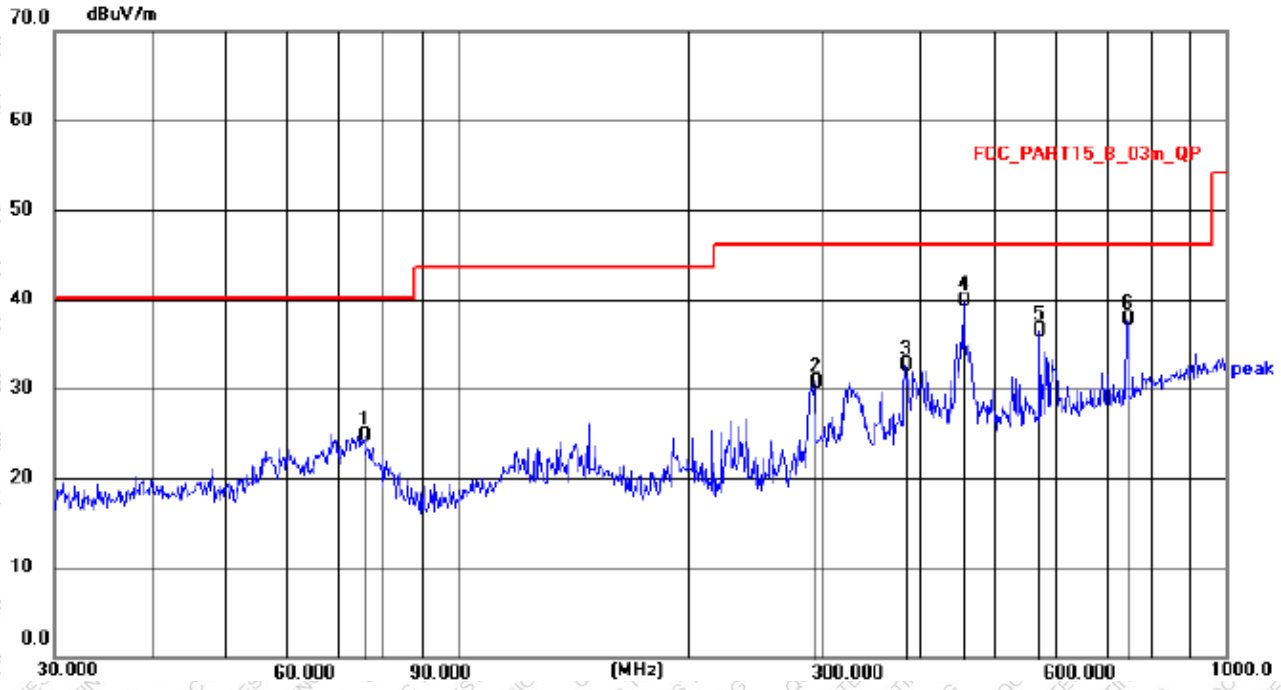
Model:DFR1091

Below 1GHz

Pre-scan all test modes, found worst case at BLE_1Mbps:2402MHz, and so only show the test result of BLE_1Mbps:2402MHz.

Horizontal:



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	75.7114	14.03	10.73	24.76	40.00	15.24	QP
2	292.0583	16.34	14.46	30.80	46.00	15.20	QP
3	382.5879	15.63	17.03	32.66	46.00	13.34	QP
4 *	455.9057	21.14	18.69	39.83	46.00	6.17	QP
5	572.6144	15.59	20.83	36.42	46.00	9.58	QP
6	742.2587	14.06	23.62	37.68	46.00	8.32	QP

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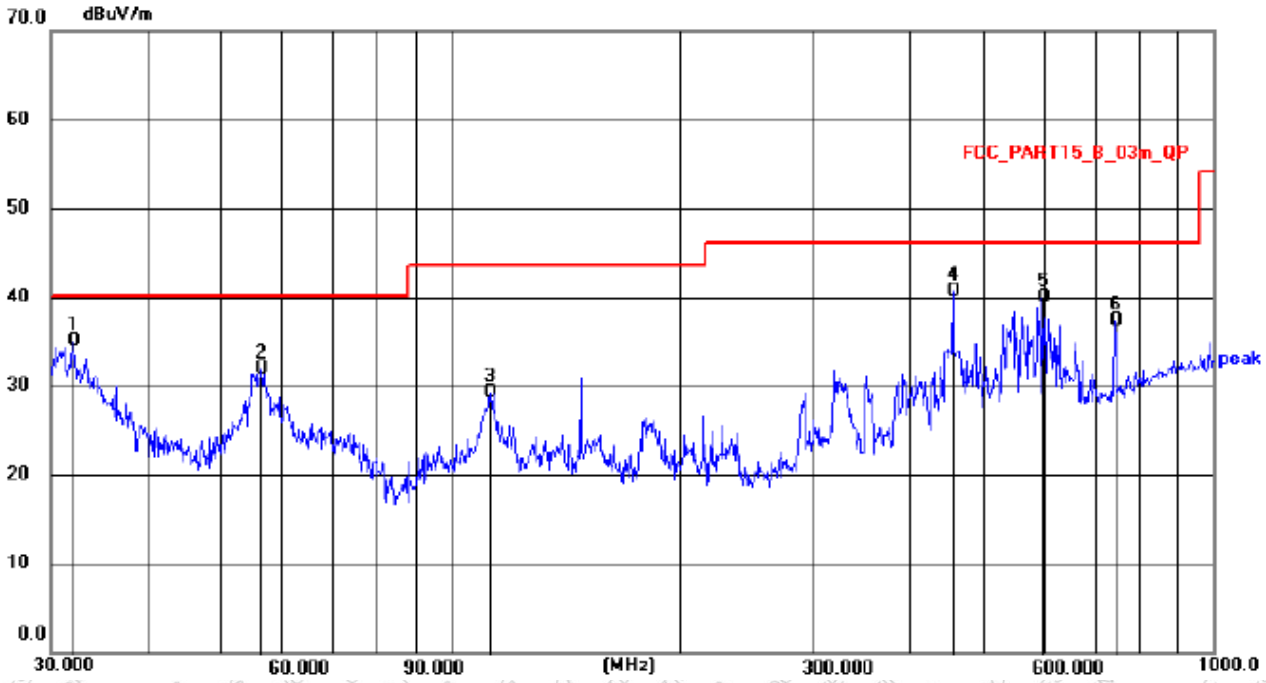
Vertical:



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	31.9546	21.76	13.27	35.03	40.00	4.97	QP
2	56.5929	17.79	14.15	31.94	40.00	8.06	QP
3	112.9196	16.74	12.61	29.35	43.50	14.15	QP
4	455.9057	21.65	19.06	40.71	46.00	5.29	QP
5	597.2234	18.81	21.19	40.00	46.00	6.00	QP
6	742.2587	13.77	23.61	37.38	46.00	8.62	QP

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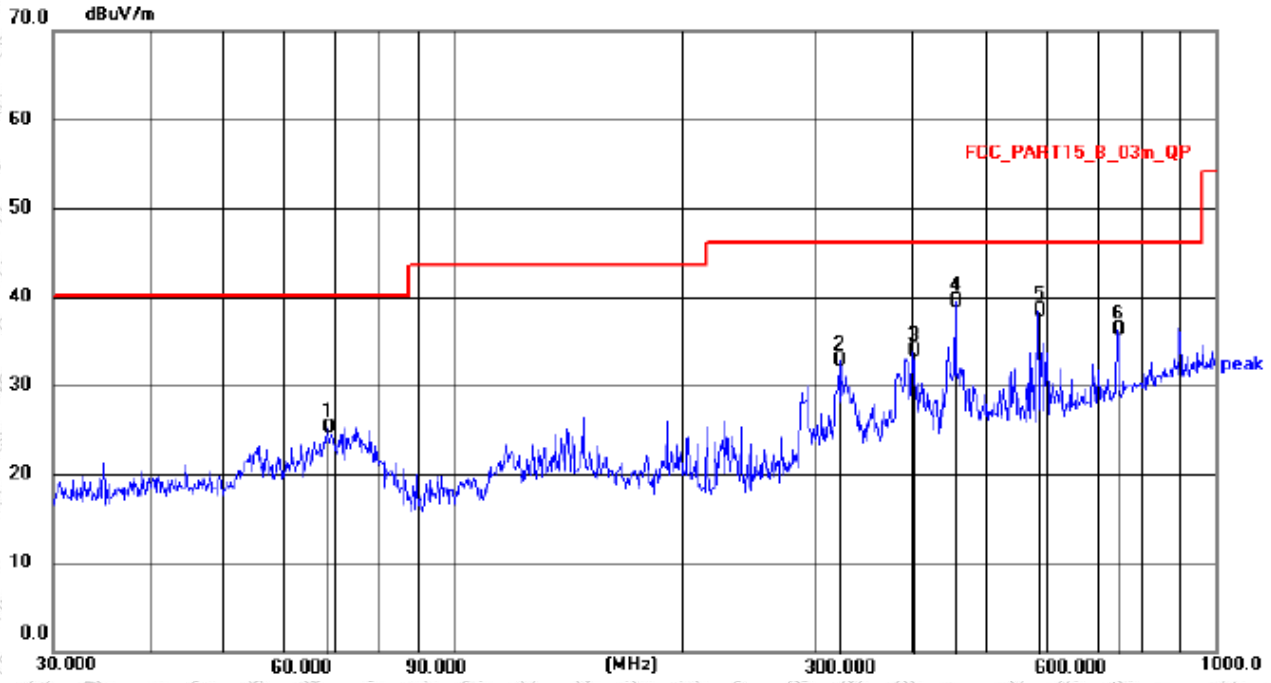
Model:DFR1081

Below 1GHz

Pre-scan all test modes, found worst case at BLE_1Mbps:2402MHz, and so only show the test result of BLE_1Mbps:2402MHz.

Horizontal:



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	68.3908	12.70	12.59	25.29	40.00	14.71	QP
2	321.0608	17.57	15.24	32.81	46.00	13.19	QP
3	400.4319	15.96	17.82	33.78	46.00	12.22	QP
4 *	455.9057	20.49	19.06	39.55	46.00	6.45	QP
5	584.7895	17.37	21.04	38.41	46.00	7.59	QP
6	742.2587	12.65	23.61	36.26	46.00	9.74	QP

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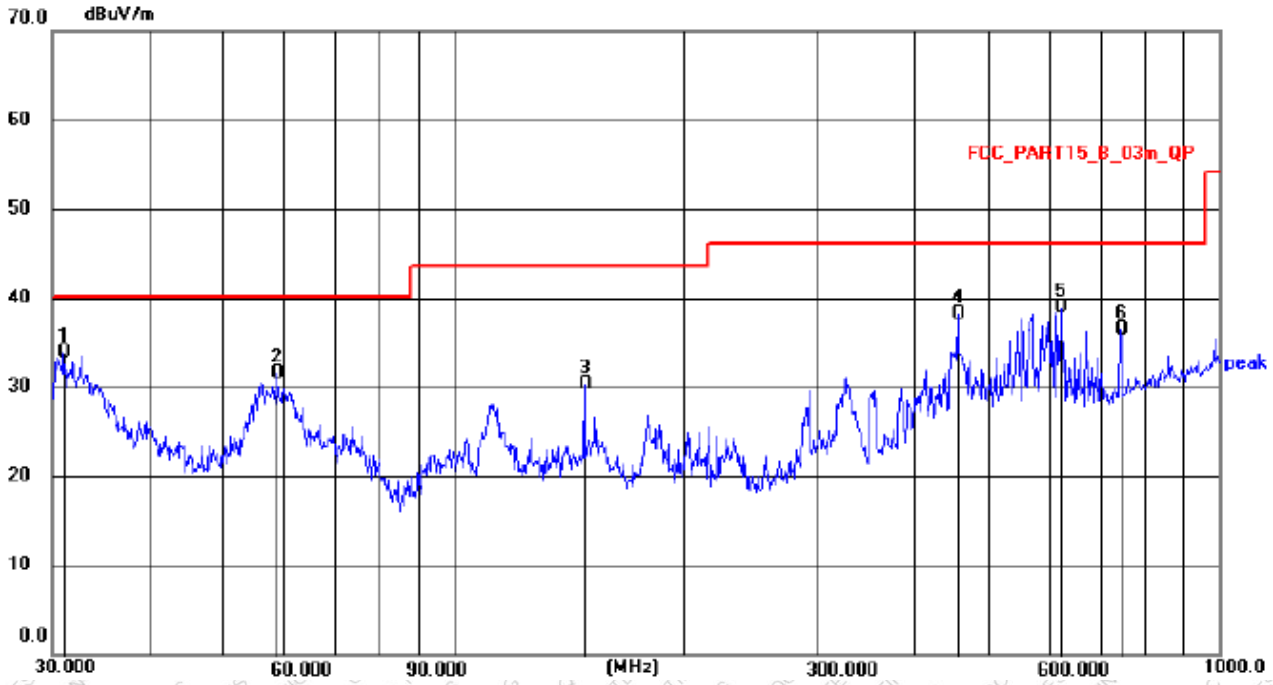
Vertical:



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	30.9619	21.19	12.62	33.81	40.00	6.19	QP
2	59.0251	17.88	13.68	31.56	40.00	8.44	QP
3	148.4410	16.06	14.35	30.41	43.50	13.09	QP
4	455.9057	19.61	18.69	38.30	46.00	7.70	QP
5	622.8900	17.22	21.66	38.88	46.00	7.12	QP
6	742.2587	12.92	23.62	36.54	46.00	9.46	QP

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Above 1GHz

Pre-scan all test modes, found worst case at BLE_1Mbps Mode, and so only show the test result of BLE_1Mbps Mode.

Test channel: Lowest channel

Frequency (MHz)	Read Level (dBμV)	polarization	Factor (dB/m)	Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector
2310	52.22	H	-11.46	40.76	74	33.24	peak
2310	51.16	V	-11.46	39.70	74	34.30	peak
2390	57.63	H	-11.16	46.47	74	27.53	peak
2390	56.88	V	-11.16	45.72	74	28.28	peak
4804	50.71	H	-5.98	44.73	74	29.27	peak
4804	50.83	V	-5.98	44.85	74	29.15	peak

Test channel: Middle channel

Frequency (MHz)	Read Level (dBμV)	polarization	Factor (dB/m)	Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector
4880	50.93	H	-5.71	45.22	74	28.78	peak
4880	50.85	V	-5.71	45.14	74	28.86	peak

Test channel: Highest channel

Frequency (MHz)	Read Level (dBμV)	polarization	Factor (dB/m)	Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector
2483.5	55.77	H	-10.81	44.96	74	29.04	peak
2483.5	54.06	V	-10.81	43.25	74	30.75	peak
2500	55.54	H	-10.75	44.79	74	29.21	peak
2500	54.39	V	-10.75	43.64	74	30.46	peak
4960	50.68	H	-5.45	45.23	74	28.77	peak
4960	51.09	V	-5.45	45.64	74	28.36	peak

Remarks:

1. Level =Receiver Read level + Factor
2. The emission levels of other frequencies are very lower than the limit and not show in test report.
3. If the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

---------- THE END OF TEST REPORT ----------

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