FCC PART 15.247
TEST REPORT

On Behalf of

CLICKWIN LLC.

530 S. Los Angeles St. Unit 2, Los Angeles, CA 90013. United States

FCC ID: 2BEF7-KB-TWS-C33
Model: KB-TWS-C33

March 13, 2024

This Report Concerns:	**Equipment Type:**
☒ Original Report	TWS Earphone

Test Engineer: LBi Li / LBi Li

Report Number: **QCT24CR-1334E-01**

Test Date: March 5~13, 2024

Reviewed By: Gordon Tan/ Gordon Tan

Approved By: Kendy Wang / Kendy Wang

Prepared By: **Shenzhen QC Testing Laboratory Co., Ltd.**
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Revision History of This Test Report

Report Number	Description	Issued Date
QCT24CR-1334E-01	Initial Issue	2024-3-13

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1. GENERAL INFORMATION

1.1 Product Description for Equipment under Test (EUT)

EUT Description:	TWS Earphone
Model No.:	KB-TWS-C33
Tested Model:	KB-TWS-C33
Sample(s) Status:	Engineer sample
Operation Frequency:	2402MHz~2480MHz
Channel numbers:	79
Channel separation:	1MHz
Modulation type:	GFSK, π/4-DQPSK, 8-DPSK
Antenna Type:	Chip Antenna
Antenna gain*1:	2.78dBi
Power supply:	DC 5V(Powered by adapter) DC 3.7V(Powered by battery)
Trade Mark:	KB KBOD
Applicant:	CLICKWIN LLC.
Address:	530 S. Los Angeles St. Unit 2, Los Angeles, CA 90013. United States
Manufacturer:	GUANGDONG YILIAN INDUSTRIAL CO., LTD
Address:	No.319, Shipai Section, Dongyuan Avenue, Shipai Town, Dongguan City, Guangdong Province
Sample No.:	Y24C1334E01LY

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	2402MHz	21	2422MHz	41	2442MHz	61	2462MHz
2	2403MHz	22	2423MHz	42	2443MHz	62	2463MHz
3	2404MHz	23	2424MHz	43	2444MHz	63	2464MHz
4	2405MHz	24	2425MHz	44	2445MHz	64	2465MHz
5	2406MHz	25	2426MHz	45	2446MHz	65	2466MHz
6	2407MHz	26	2427MHz	46	2447MHz	66	2467MHz
7	2408MHz	27	2428MHz	47	2448MHz	67	2468MHz
8	2409MHz	28	2429MHz	48	2449MHz	68	2469MHz
9	2410MHz	29	2430MHz	49	2450MHz	69	2470MHz
10	2411MHz	30	2431MHz	50	2451MHz	70	2471MHz
11	2412MHz	31	2432MHz	51	2452MHz	71	2472MHz
12	2413MHz	32	2433MHz	52	2453MHz	72	2473MHz
13	2414MHz	33	2434MHz	53	2454MHz	73	2474MHz
14	2415MHz	34	2435MHz	54	2455MHz	74	2475MHz
15	2416MHz	35	2436MHz	55	2456MHz	75	2476MHz
16	2417MHz	36	2437MHz	56	2457MHz	76	2477MHz
17	2418MHz	37	2438MHz	57	2458MHz	77	2478MHz
18	2419MHz	38	2439MHz	58	2459MHz	78	2479MHz
19	2420MHz	39	2440MHz	59	2460MHz	79	2480MHz
20	2421MHz	40	2441MHz	60	2461MHz		

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	Channel	Frequency
The lowest channel	2402MHz	The middle channel	2441MHz
The Highest channel	2480MHz		

1.2.2 EUT Exercise Software

" FCC_assist_1.0.2.2 " 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	Serial Number
MDY	Adapter	Input: 100-240V~ 50/60Hz Output: 5V ⎓ 1A	/

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	15.203/15.247 (c)	Pass
AC Power Line Conducted Emission	15.207	Pass
Conducted Peak Output Power	15.247 (b)(1)	Pass
20dB Occupied Bandwidth	15.247 (a)(1)	Pass
Carrier Frequencies Separation	15.247 (a)(1)	Pass
Hopping Channel Number	15.247 (b)(1)	Pass
Dwell Time	15.247 (a)(1)(iii)	Pass
Radiated Emission	15.205/15.209	Pass
Band Edge	15.247(d)	Pass

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

2. 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	R&S	ESIB 7	2277573376	2023.03.21	2024.03.20
2	Artificial Mains Network	SCHWARZBECK	NSLK8126	8126200	2023.03.21	2024.03.20
3	PULSE LIMITER	R&S	ESH3-Z2	100058	2023.03.21	2024.03.20
4	EMITEST RECEIVER	ROHDE & SCHWARZ	ESCS30	834115/014	2023.03.21	2024.03.20
Conducted Emission Measurement Software: TS						

3.2 Radiated Emission Test

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1.	Spectrum Analyzer	ROHDE&SCHWARZ	FSV 40	101458	2023.04.12	2024.04.11
2.	Loop Antenna	EMCO	6502	2133	2022.07.23	2024.07.22
3.	Logarithmic compound broadband Antenna	SCKWARZBECK	VULB9168	VULB9168-1-588	2023.04.01	2025.03.31
4.	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB 7	2277573376	2023.04.12	2024.04.11
5.	EMI Test Receiver	R&S	ESPI	101131	2023.03.21	2024.03.20
6.	Horn Antenna	SCHWARZBECK	BBHA9120D	02069	2023.04.01	2025.03.31
7.	Horn Antenna	COM-MW	ZLB7-18-40G -950	12221225	2023.01.12	2025.01.09
8.	Amplifier	R&S	BBV9721	9721-031	2023.03.21	2024.03.20
9.	Amplifier	HPX	BP-01G-18G	210902	2023.03.21	2024.03.20
10.	Pre-amplifier	COM-MW	DLAN-18000 -40000-02	10229104	2023.03.21	2024.03.20
11.	966 Chamber	ZhongYu Electron	9*6*6	/	2022.07.25	2025.07.24
Radiated Emission Measurement Software: EZ_EMC						

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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	2023.03.21	2024.03.20
2.	Spectrum Analyzer	ROHDE& SCHWARZ	FSV 40	101458	2023.04.12	2024.04.11
3.	Signal Generator	Agilent	N5182A	MY50141563	2023.03.21	2024.03.20
4.	RF Automatic Test System	MW	MW100-RFCB/ MW100-PSB	MW2007004	2023.03.21	2024.03.20
RF Conducted Measurement Software: MTS 8310						

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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 Chip Antenna, the best case gain of the antenna is 2.78dBi, reference to the Internal photo for details.

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5. Conducted Emissions

5.1 Applicable Standard

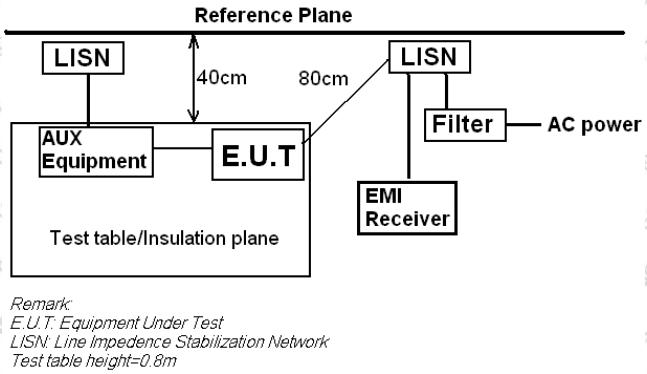
FCC Part15 C Section 15.207

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	23.6℃	Humidity	44%
ATM Pressure	101.1kPa	Antenna Gain	2.78dBi
Test by	LBi Li	Test result	PASS

Test voltage: AC 120V/60Hz

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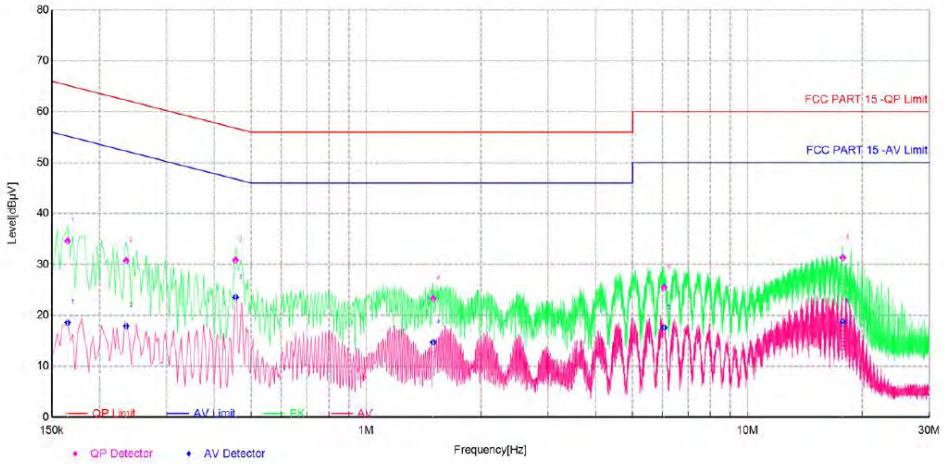
Measurement data:

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	0.165	10.08	34.61	65.21	30.60	18.60	55.21	36.61	L	PASS
2	0.235	10.36	30.77	62.27	31.50	17.92	52.27	34.35	L	PASS
3	0.455	10.17	30.85	56.78	25.93	23.57	46.78	23.21	L	PASS
4	1.5	10.09	23.32	56.00	32.68	14.76	46.00	31.24	L	PASS
5	6.0455	10.26	25.46	60.00	34.54	17.60	50.00	32.40	L	PASS
6	17.7905	10.37	31.35	60.00	28.65	18.73	50.00	31.27	L	PASS

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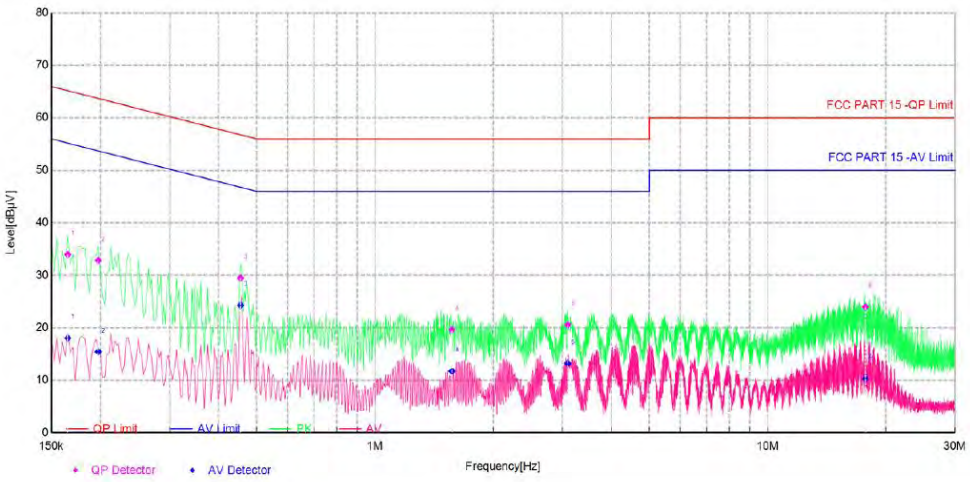
Neutral:



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	10.08	33.95	65.21	31.26	18.05	55.21	37.16	N	PASS
2	0.1975	10.30	32.83	63.72	30.89	15.42	53.72	38.30	N	PASS
3	0.455	10.35	29.47	56.78	27.31	24.30	46.78	22.48	N	PASS
4	1.57	10.08	19.62	56.00	36.38	11.74	46.00	34.26	N	PASS
5	3.098	10.30	20.56	56.00	35.44	13.20	46.00	32.80	N	PASS
6	17.7365	10.40	23.98	60.00	36.02	10.32	50.00	39.68	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

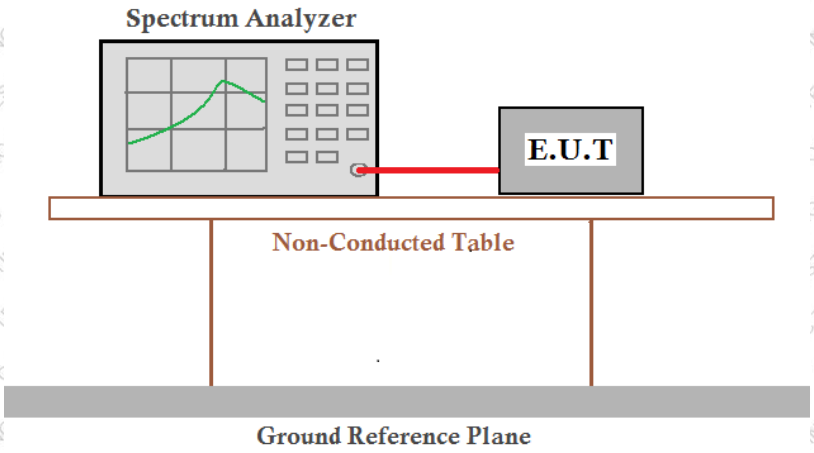
6.1 Applicable Standard

FCC Part15 C Section 15.247 (a)(1)

6.2 Limit

For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

6.3 Test setup



6.4 Test Data

Temperature	23.5 ℃	Humidity	50 %
ATM Pressure	101.1kPa	Antenna Gain	2.78dBi
Test by	LBi Li	Test result	PASS

Please refer to following table and plots.

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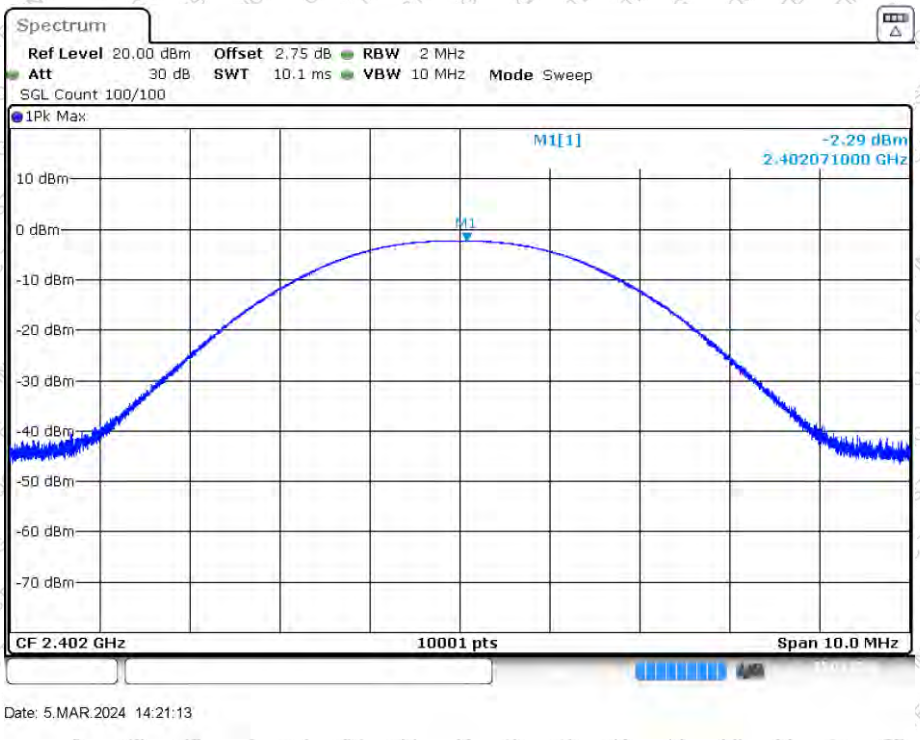
Output Power:

Mode	Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
GFSK	Lowest	-2.29	20.97	Pass
	Middle	-1.43		
	Highest	-2.09		
π/4-DQPSK	Lowest	-1.43	20.97	Pass
	Middle	-0.51		
	Highest	-1.15		
8-DPSK	Lowest	-1.4	20.97	Pass
	Middle	**-0.48**		
	Highest	-1.13		

Power NVNT 1-DH1 2402MHz Ant1



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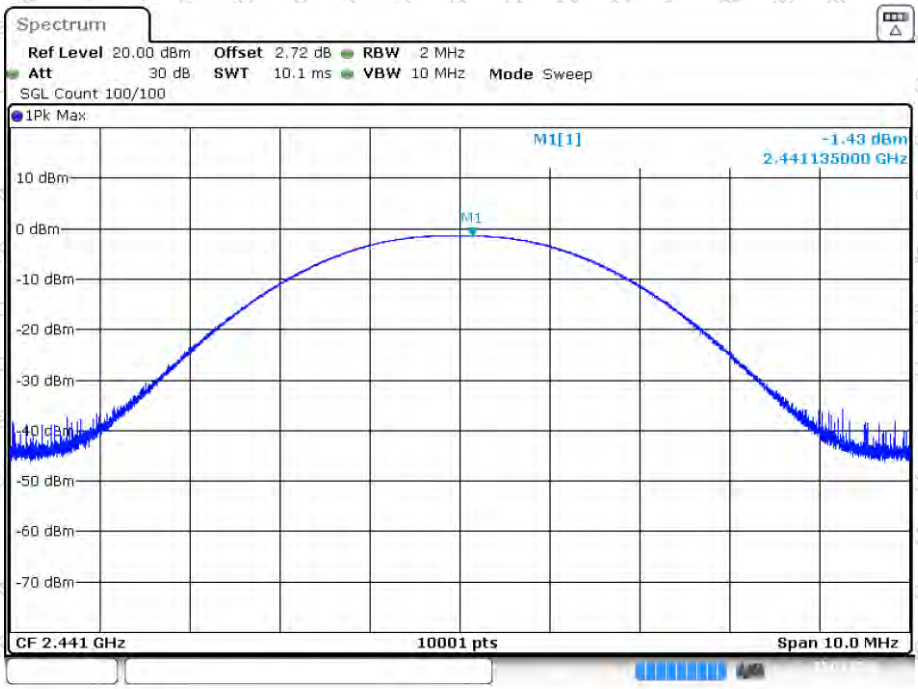
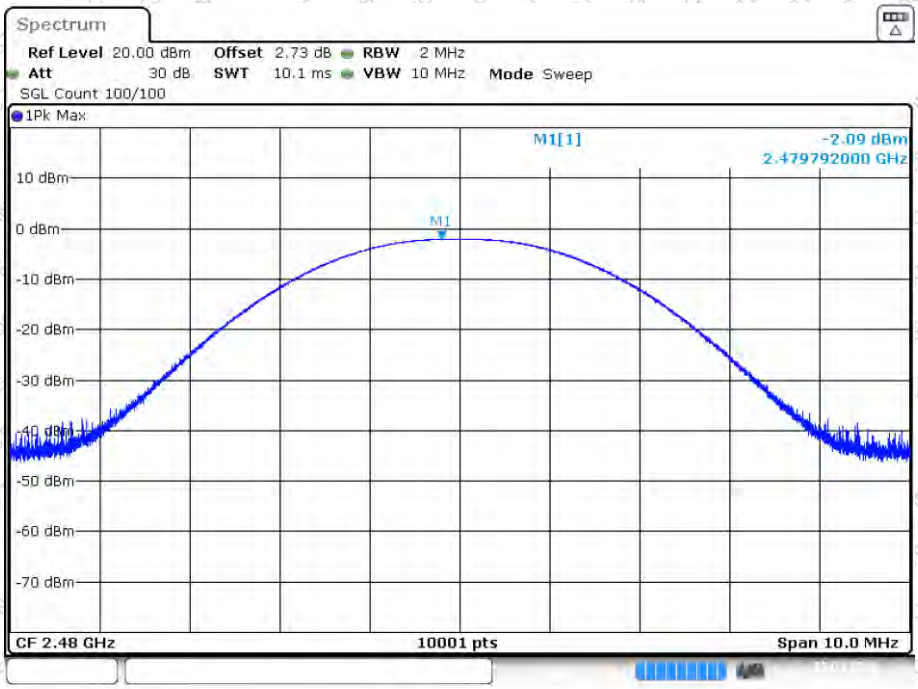
Power NVNT 1-DH1 2441MHz Ant1



Power NVNT 1-DH1 2480MHz Ant1



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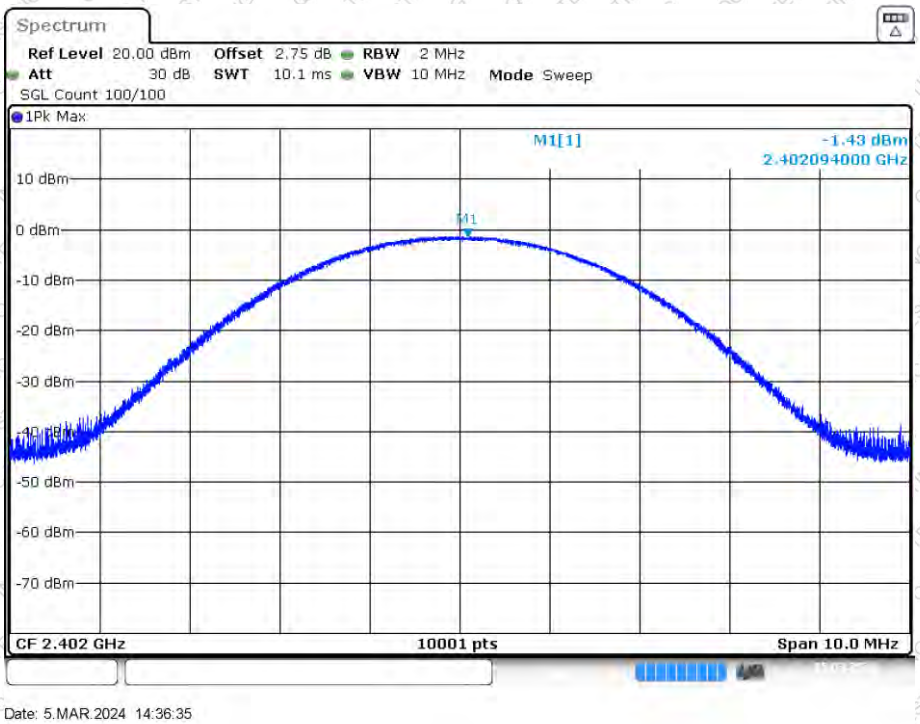
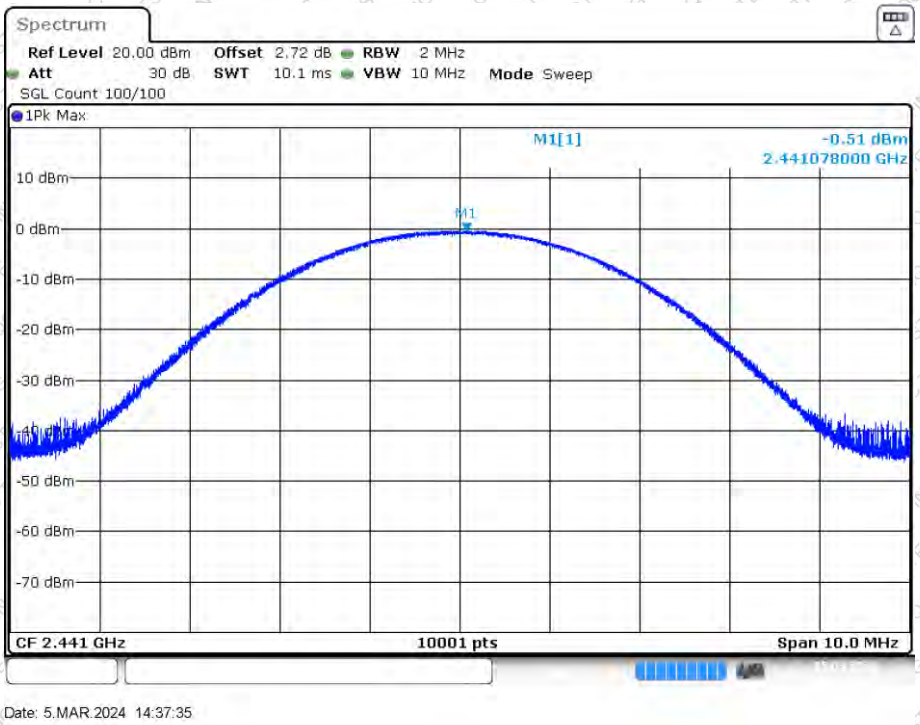
Power NVNT 2-DH1 2402MHz Ant1



Power NVNT 2-DH1 2441MHz Ant1



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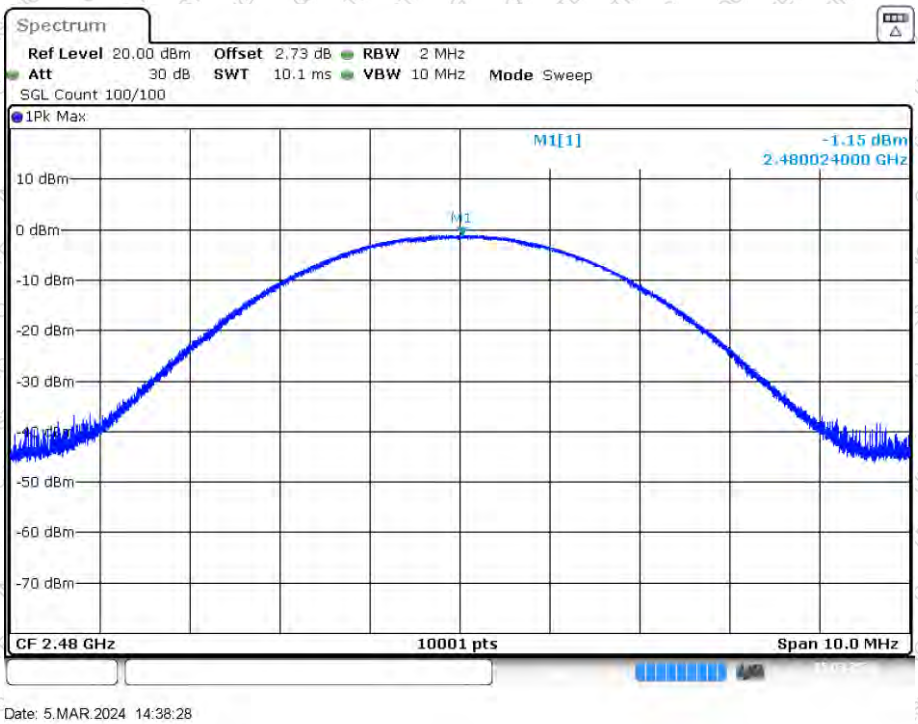
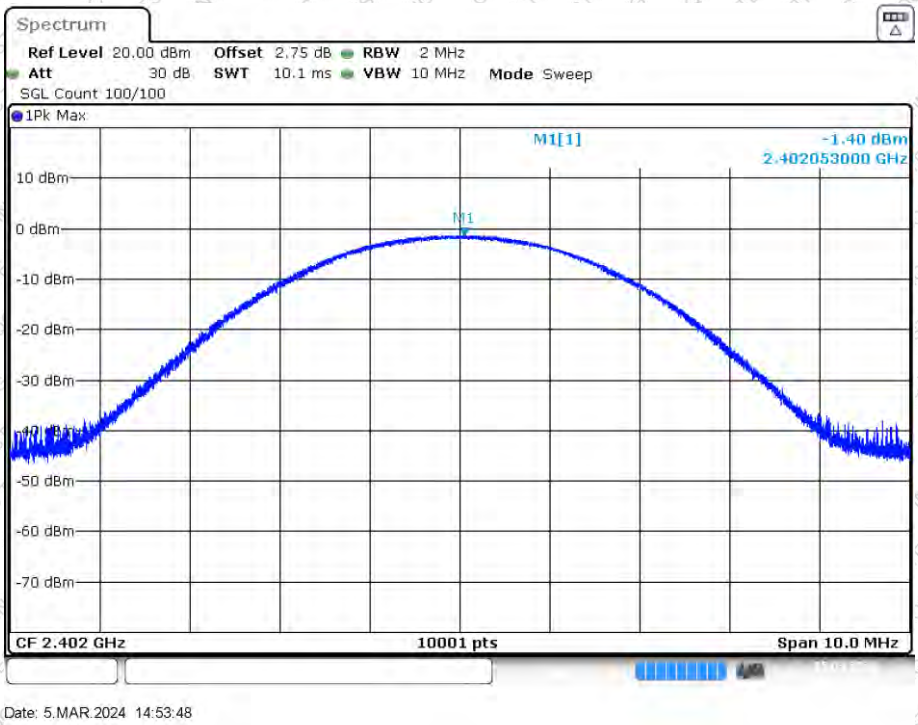
Power NVNT 2-DH1 2480MHz Ant1



Power NVNT 3-DH1 2402MHz Ant1



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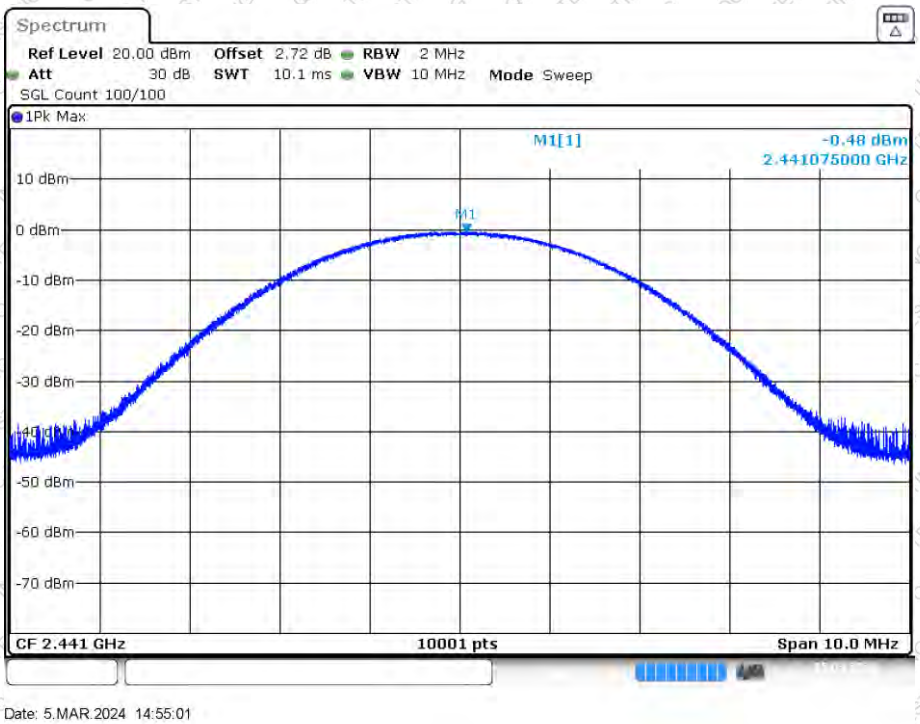
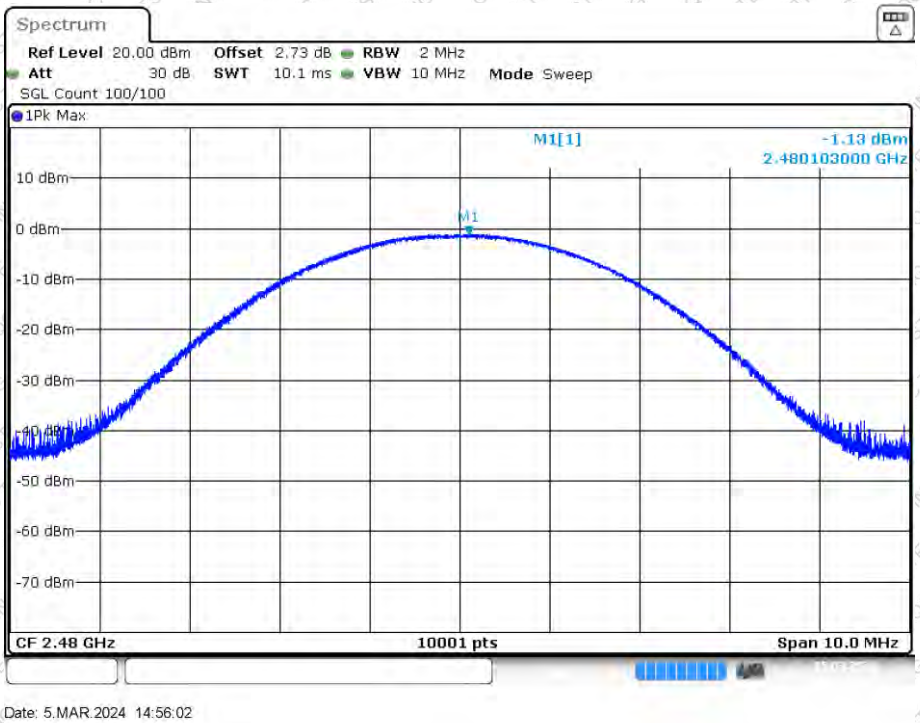
Power NVNT 3-DH1 2441MHz Ant1



Power NVNT 3-DH1 2480MHz Ant1



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7. 20dB Emission Bandwidth

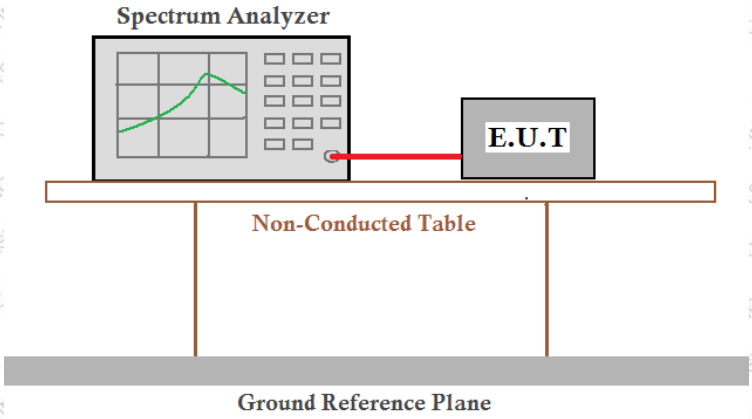
7.1 Applicable Standard

FCC Part15 C Section 15.247 (a)(1)

7.2 Limit

N/A

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	23.5 ℃	Humidity	50 %
ATM Pressure	101.1kPa	Antenna Gain	2.78dBi
Test by	LBi Li	Test result	PASS

Please refer to following table and plots.

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Measurement Data

Test CH	20dB Emission Bandwidth (MHz)			Result
	GFSK	π/4-DQPSK	8-DPSK	
Lowest	0.864	1.238	1.24	Pass
Middle	0.862	1.238	1.241	
Highest	0.867	1.236	1.237	

Test CH	99% Occupy Bandwidth (MHz)			Result
	GFSK	π/4-DQPSK	8-DPSK	
Lowest	0.835	1.162	1.163	Pass
Middle	0.827	1.157	1.159	
Highest	0.825	1.164	1.153	

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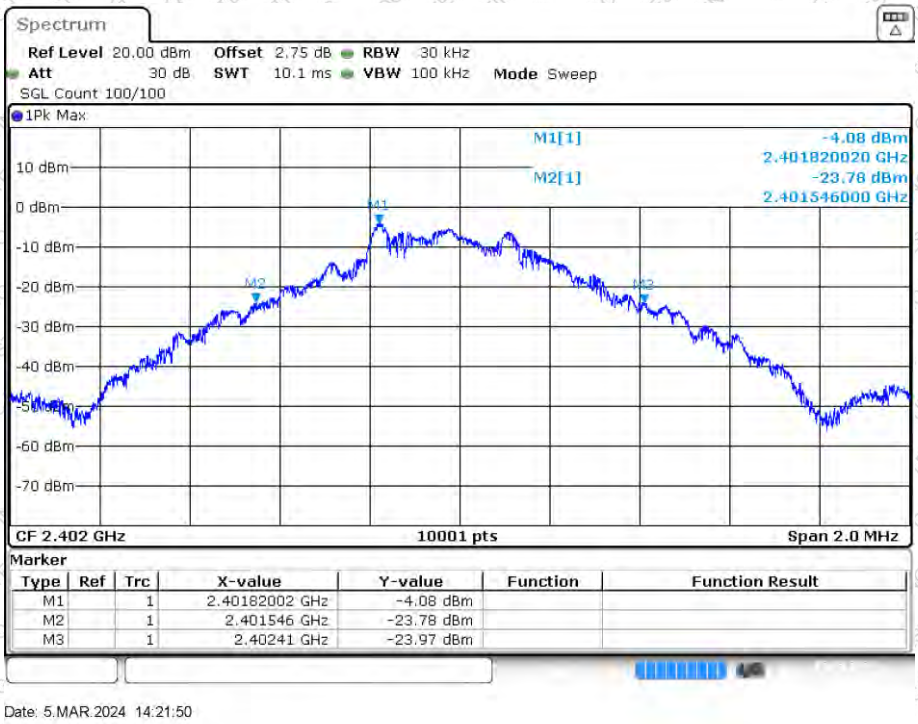
-20dB Bandwidth:

-20dB Bandwidth NVNT 1-DH1 2402MHz Ant1



Date: 5.MAR.2024 14:21:50

-20dB Bandwidth NVNT 1-DH1 2441MHz Ant1

Date: 5.MAR.2024 14:22:42

Address: East of 1/F., Building E, Xinghong Science Park, No.111, Shuiku Road, Fenghuanggang, Xixiang Street, Bao'an District, Shenzhen, Guangdong, China
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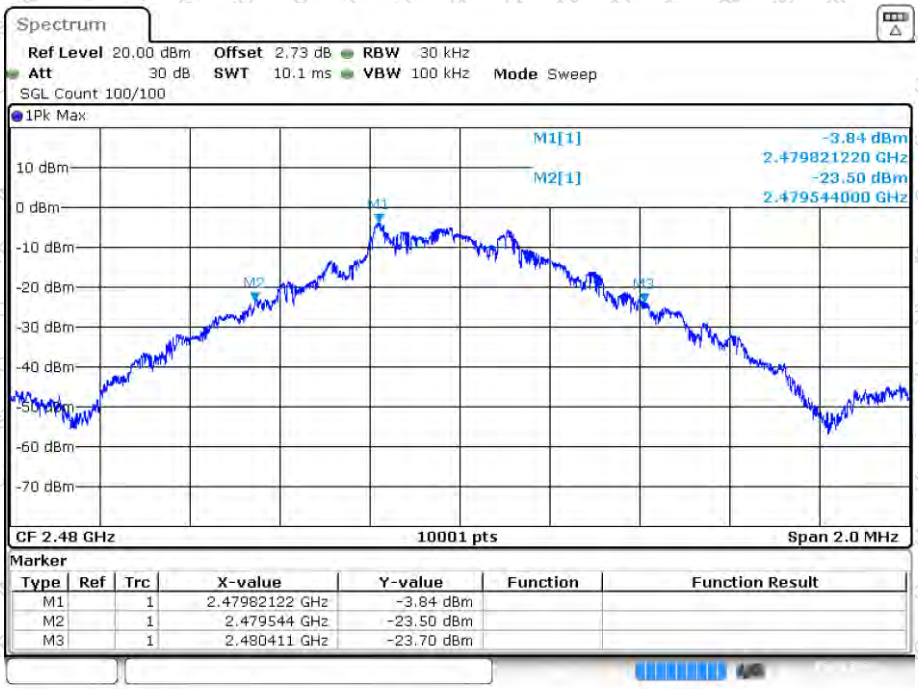
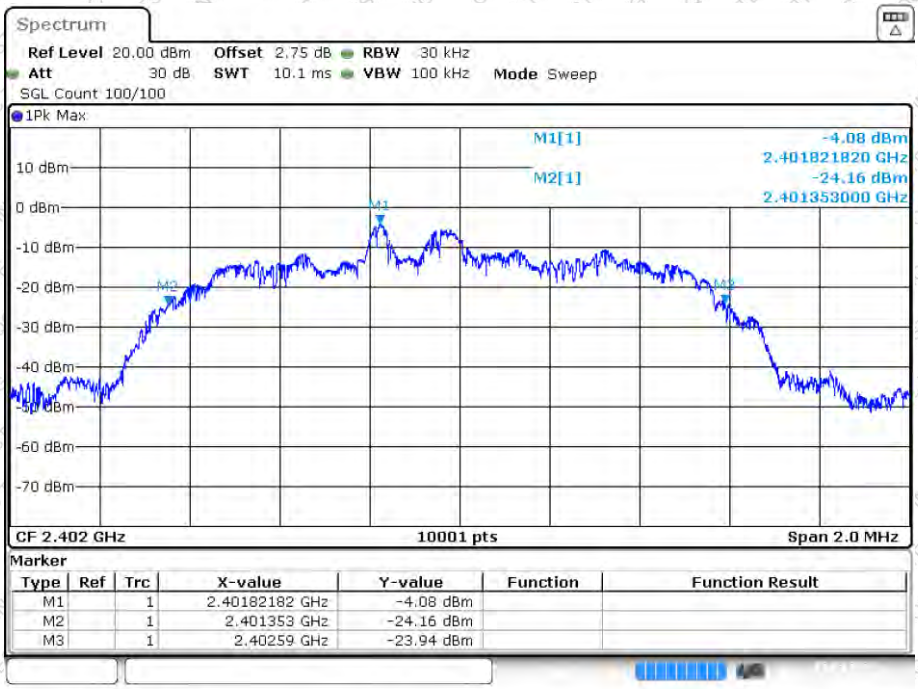
-20dB Bandwidth NVNT 1-DH1 2480MHz Ant1



Date: 5.MAR.2024 14:23:41

-20dB Bandwidth NVNT 2-DH1 2402MHz Ant1



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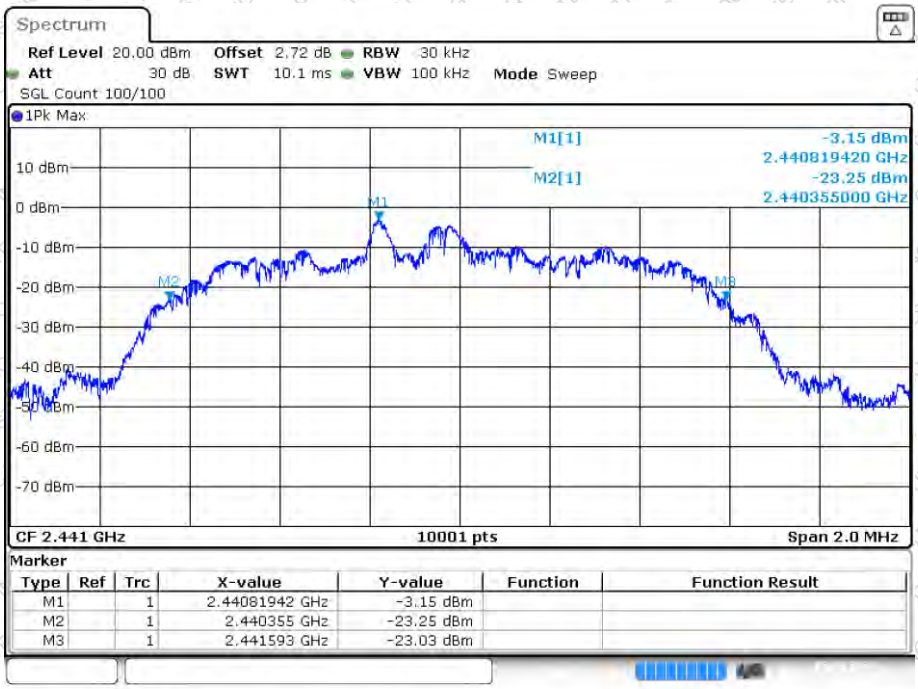
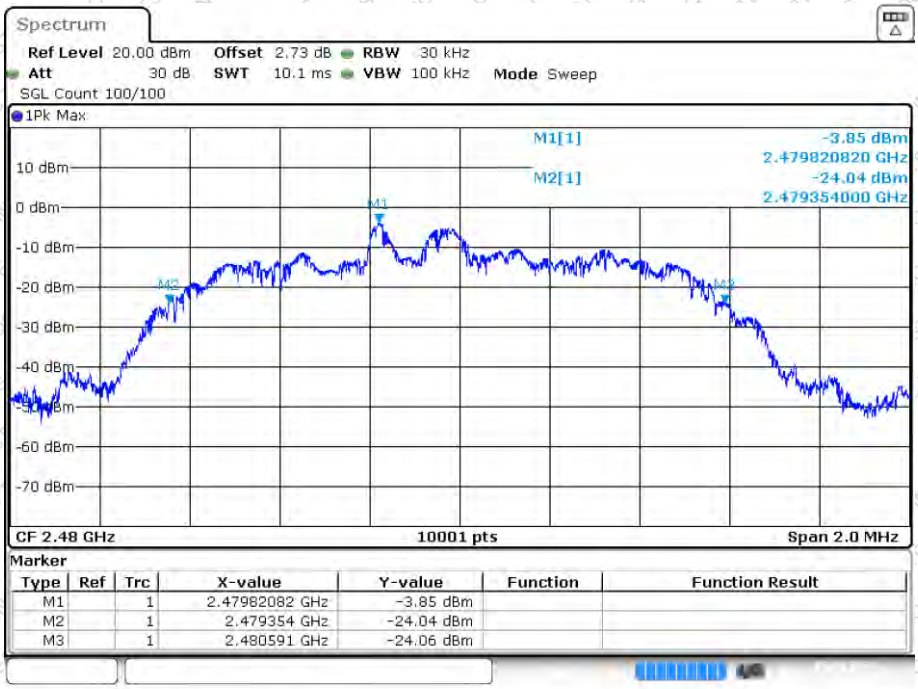
-20dB Bandwidth NVNT 2-DH1 2441MHz Ant1



Date: 5.MAR.2024 14:38:11

-20dB Bandwidth NVNT 2-DH1 2480MHz Ant1



Date: 5.MAR.2024 14:39:11

Address: East of 1/F., Building E, Xinghong Science Park, No.111, Shuiku Road, Fenghuanggang, Xixiang Street, Bao'an District, Shenzhen, Guangdong, China
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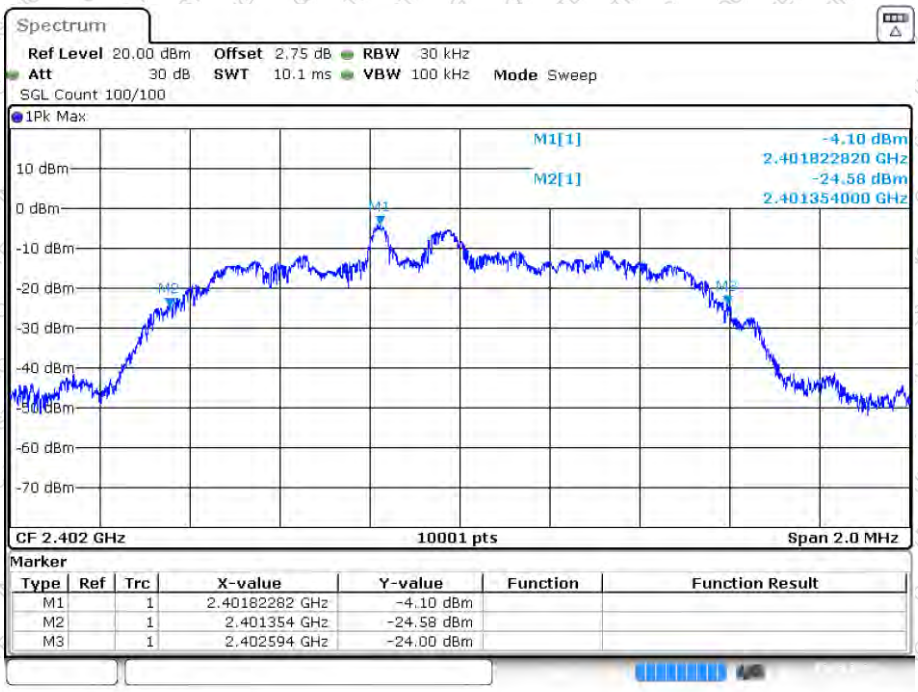
-20dB Bandwidth NVNT 3-DH1 2402MHz Ant1



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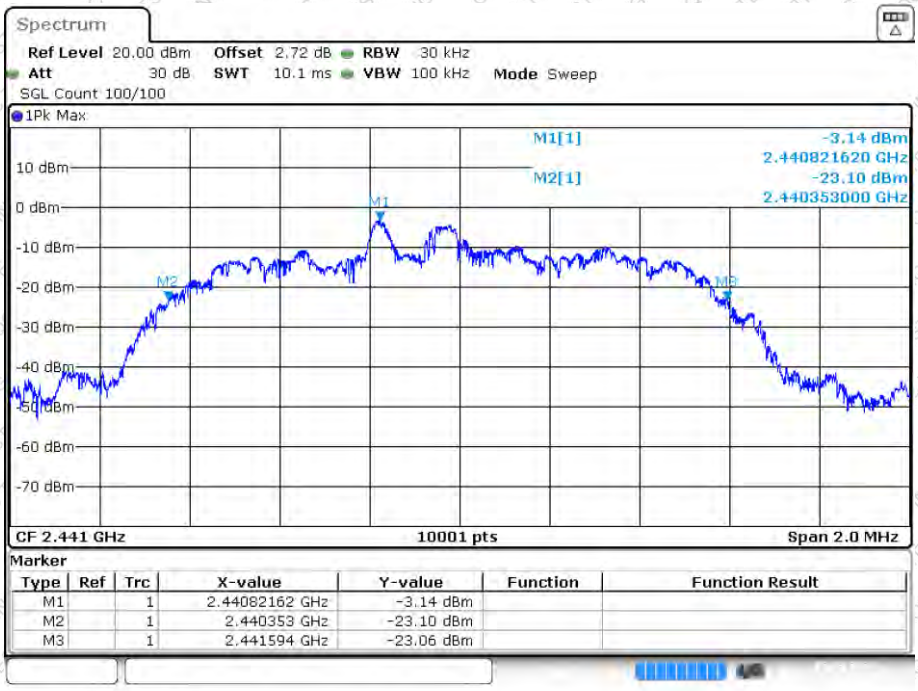
-20dB Bandwidth NVNT 3-DH1 2441MHz Ant1



Date: 5.MAR.2024 14:55:41

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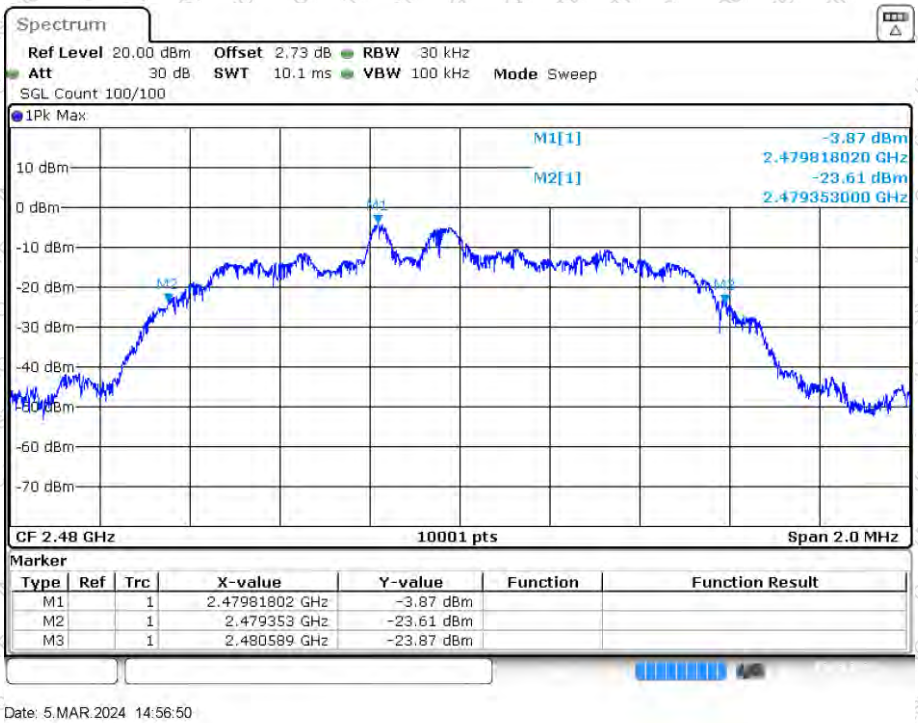
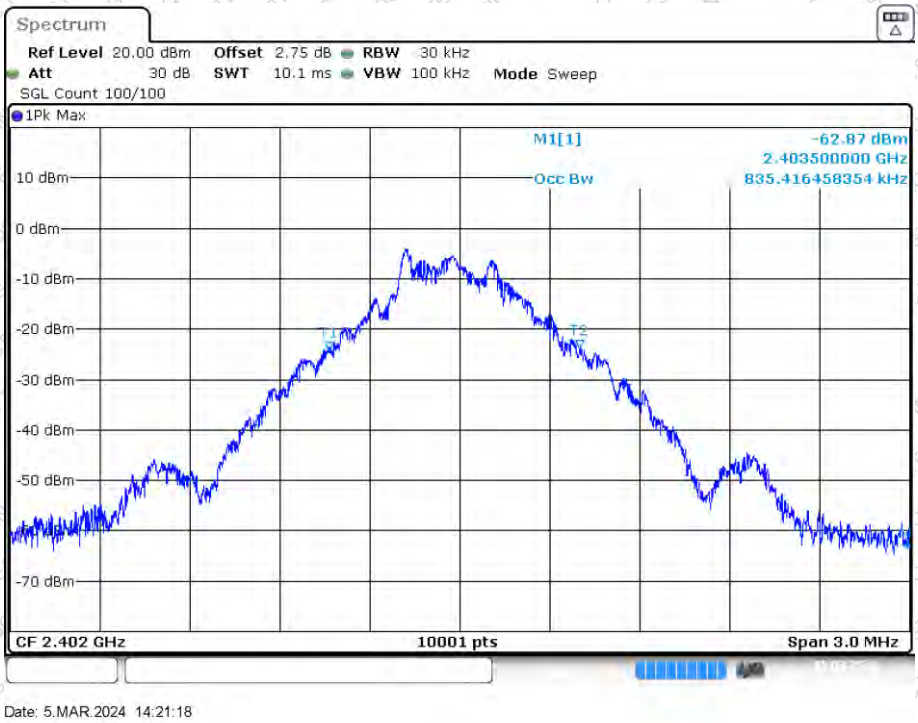
-20dB Bandwidth NVNT 3-DH1 2480MHz Ant1



99% Occupied Bandwidth:

OBW NVNT 1-DH1 2402MHz Ant1



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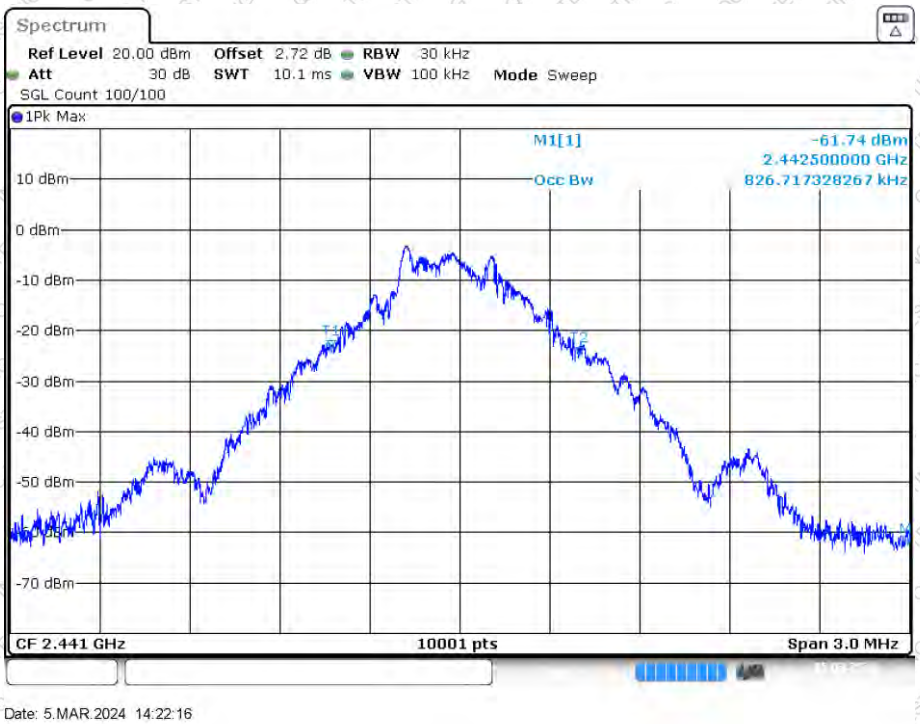
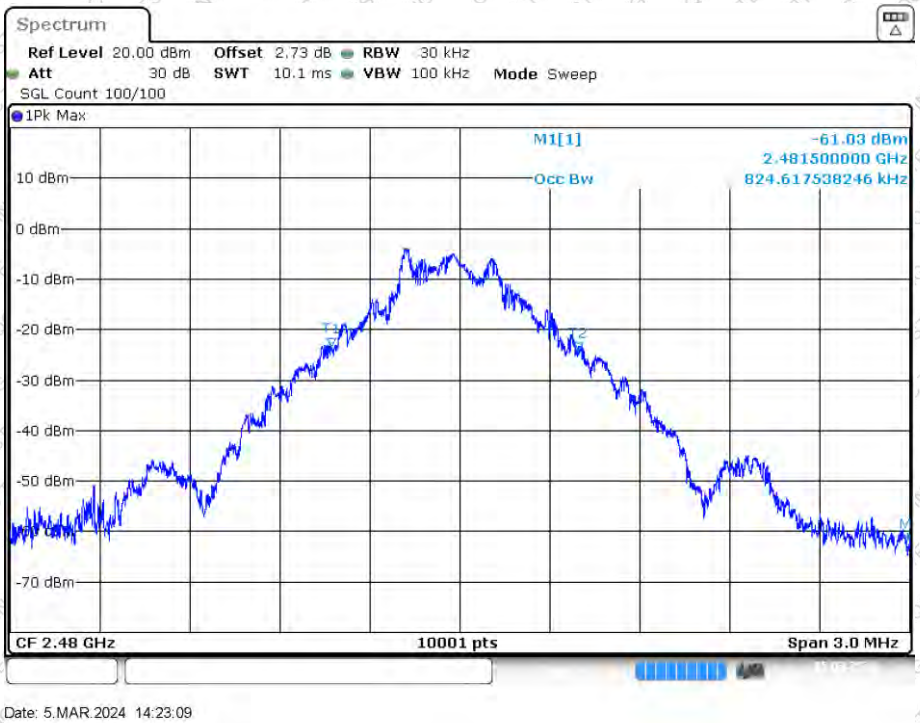
OBW NVNT 1-DH1 2441MHz Ant1



OBW NVNT 1-DH1 2480MHz Ant1



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OBW NVNT 2-DH1 2402MHz Ant1

OBW NVNT 2-DH1 2441MHz Ant1

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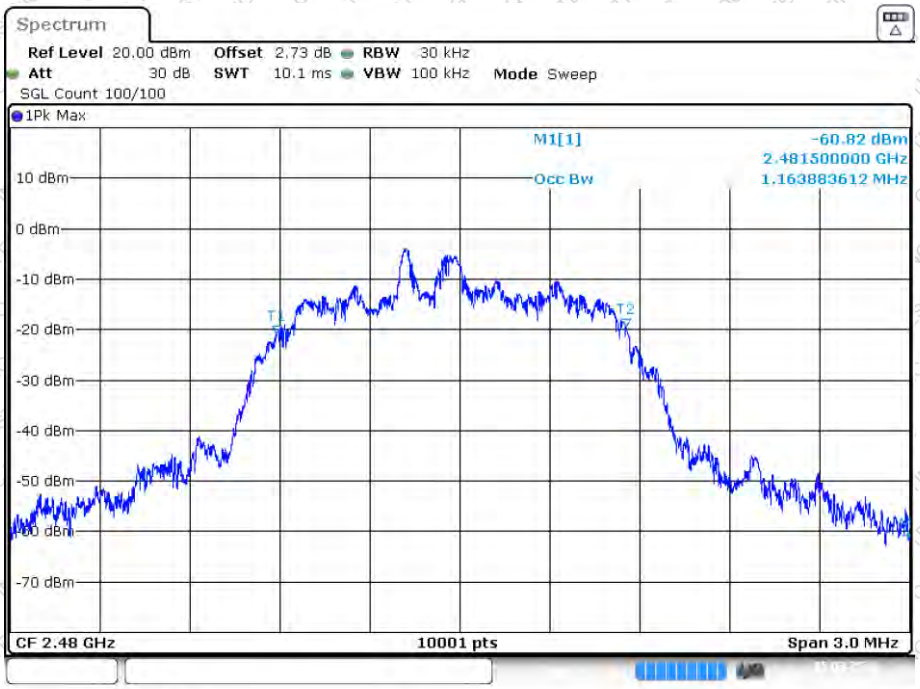
OBW NVNT 2-DH1 2480MHz Ant1



OBW NVNT 3-DH1 2402MHz Ant1

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OBW NVNT 3-DH1 2441MHz Ant1

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8. Carrier Frequencies Separation

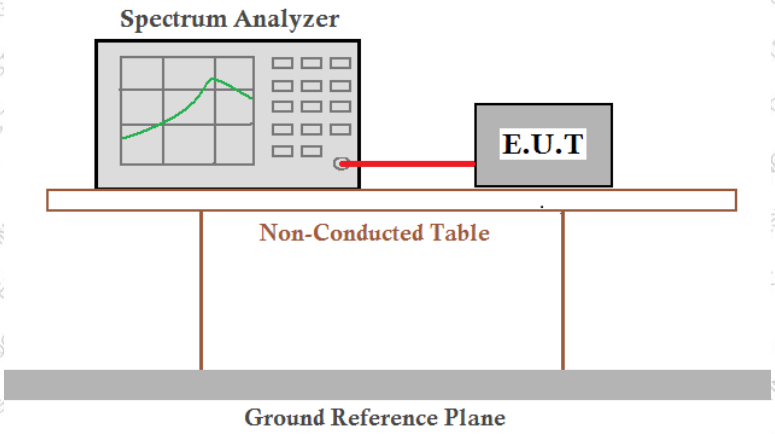
8.1 Applicable Standard

FCC Part15 C Section 15.247 (a)(1)

8.2 Limit

Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

8.3 Test setup



8.4 Test Procedure

1. Set the EUT in transmitting mode, max hold the channel.
2. Set the adjacent channel of the EUT and max hold another trace.
3. Measure the channel separation.

8.5 Test Data

Temperature	23.5 ℃	Humidity	50 %
ATM Pressure	101.1kPa	Antenna Gain	2.78dBi
Test by	LBi Li	Test result	PASS

Please refer to following table and plots.

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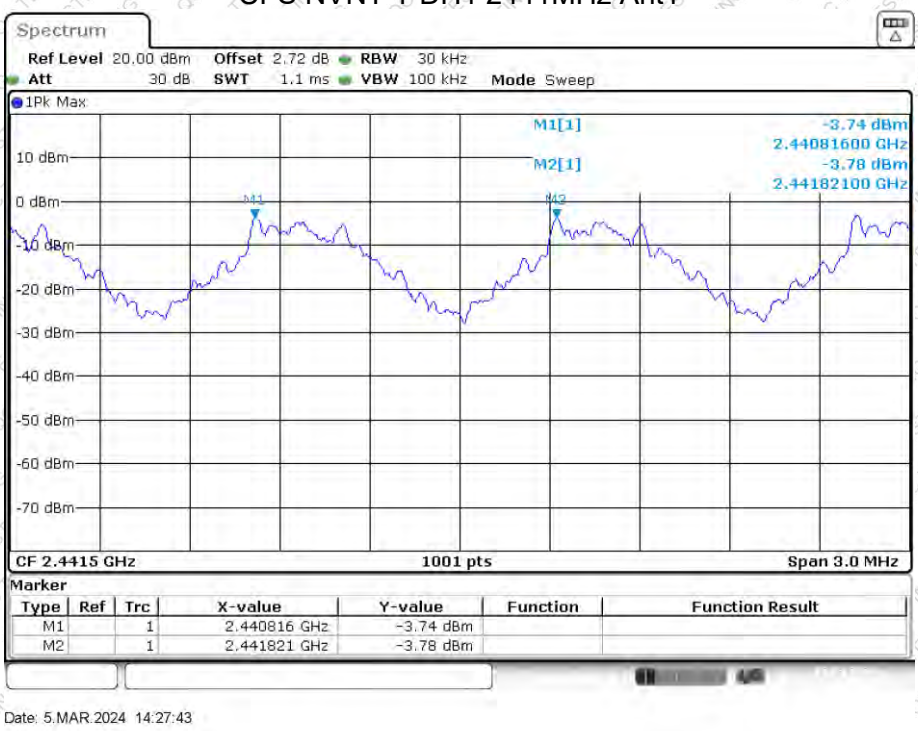
Measurement Data

Mode	Test channel	Carrier Frequencies Separation (kHz)	Limit (kHz)	Result
GFSK	Middle	1.005	631.33	Pass
π/4-DQPSK	Middle	1.002	823.33	Pass
8-DPSK	Middle	1.005	826.67	Pass

Mode	20dB bandwidth (kHz) (worse case)	Limit (kHz) (Carrier Frequencies Separation)
GFSK	867	631.33
π/4-DQPSK	1238	823.33
8-DPSK	1241	826.67

Note: According to section 7.5
*Limit = (2/3) * 20dB bandwidth*

CFS NVNT 1-DH1 2441MHz Ant1



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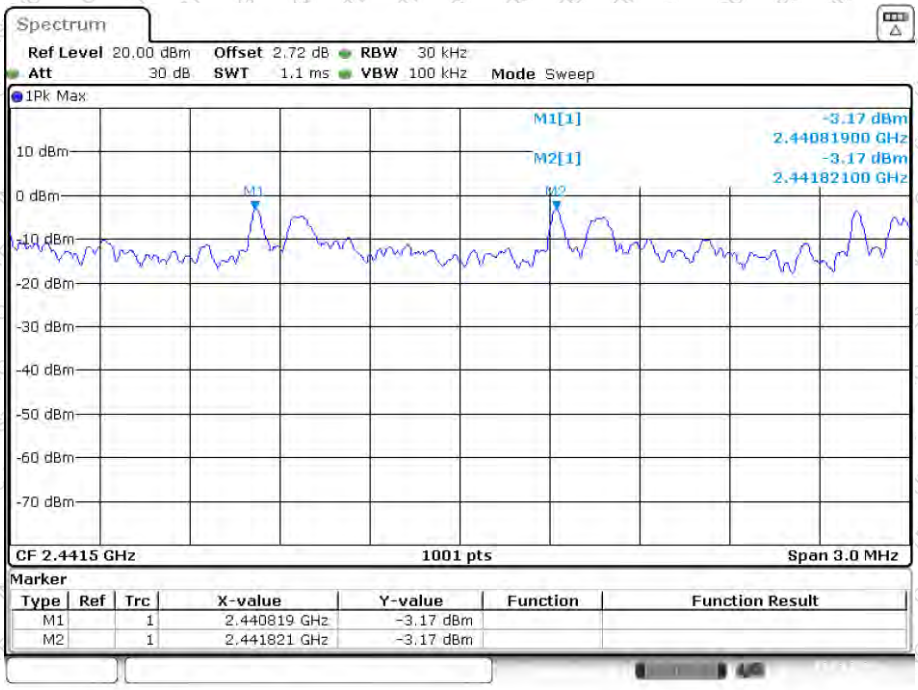
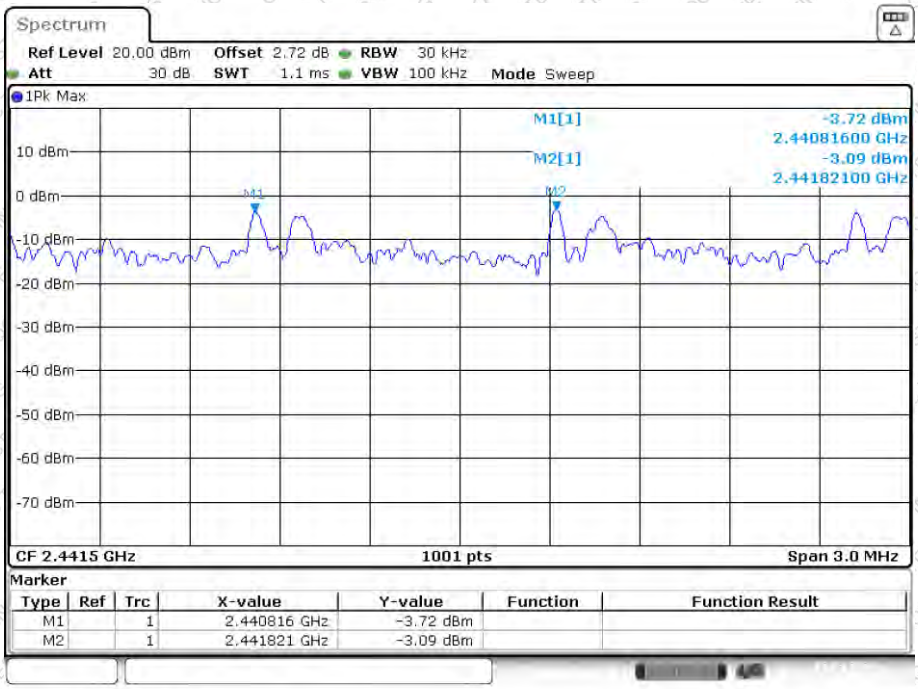
CFS NVNT 2-DH1 2441MHz Ant1



Date: 5.MAR.2024 14:33:18

CFS NVNT 3-DH1 2441MHz Ant1



Date: 5.MAR.2024 14:59:28

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9. Hopping Channel Number

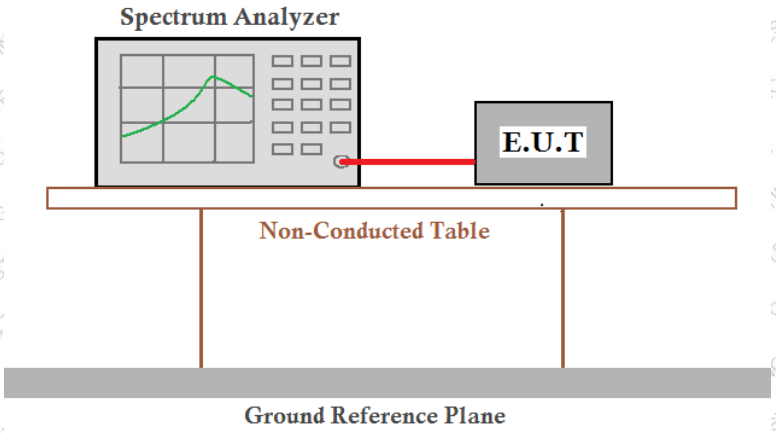
9.1 Applicable Standard

FCC Part15 C Section 15.247 (a) (1) (iii)

9.2 Limit

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

9.3 Test setup



9.4 Test Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the max-hold function record the quantity of the channel.

9.5 Test Data

Temperature	23.5 ℃	Humidity	50 %
ATM Pressure	101.1kPa	Antenna Gain	2.78dBi
Test by	LBi Li	Test result	PASS

Please refer to following table and plots.

Measurement Data:

Mode	Hopping channel numbers	Limit	Result
GFSK	79	15	Pass
π/4-DQPSK	79	15	Pass
8-DPSK	79	15	Pass

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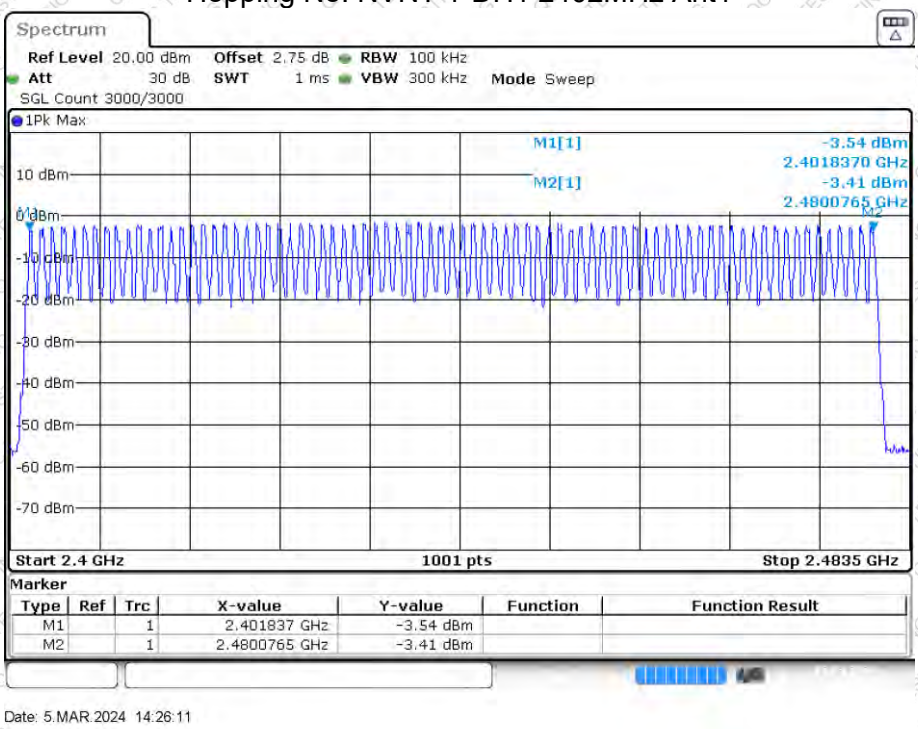
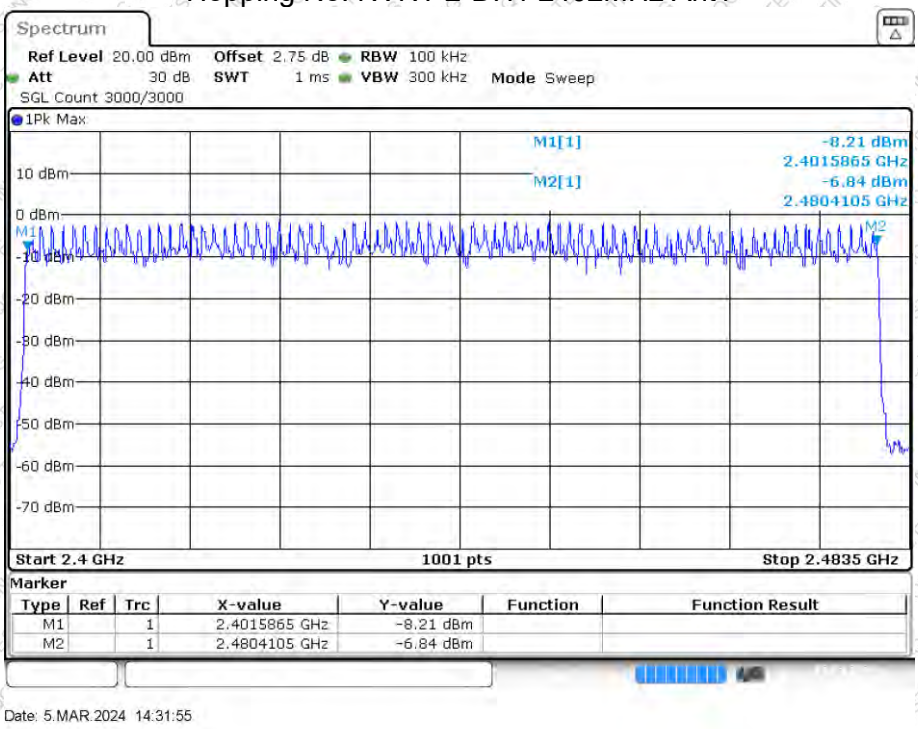
Hopping No. NVNT 1-DH1 2402MHz Ant1



Date: 5.MAR.2024 14:26:11

Hopping No. NVNT 2-DH1 2402MHz Ant1



Date: 5.MAR.2024 14:31:55

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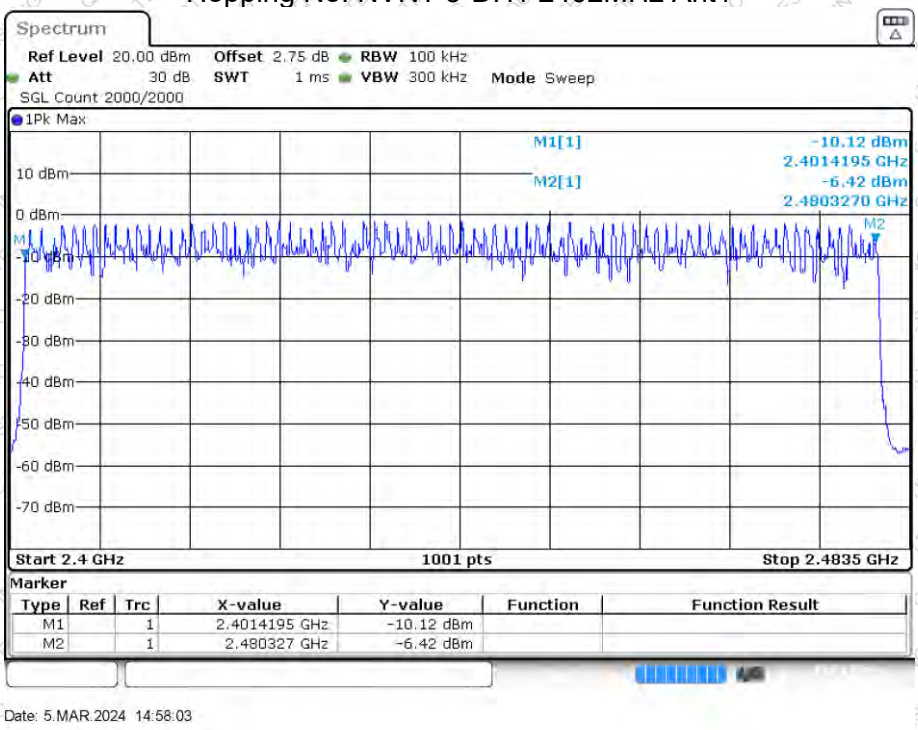
Hopping No. NVNT 3-DH1 2402MHz Ant1



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10. Dwell Time

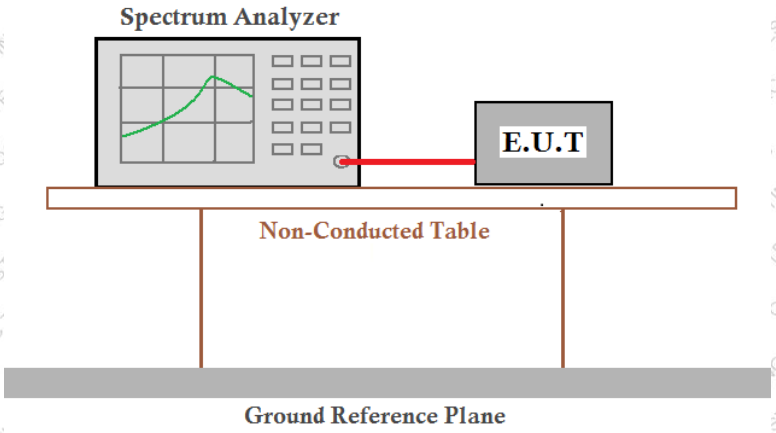
10.1 Applicable Standard

FCC Part15 C Section 15.247 (a)(1)(iii)

10.2 Limit

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

10.3 Test setup



10.4 Test Data

Temperature	23.5 ℃	Humidity	50 %
ATM Pressure	101.1kPa	Antenna Gain	2.78dBi
Test by	LBi Li	Test result	PASS

Please refer to following table and plots.

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Mode	Channel	Burst Width [ms]	Total Hops [Num]	Result[s]	Limit[s]	Result
DH1	Hop	0.382	317	0.121	<=0.4	PASS
DH3	Hop	1.638	146	0.239	<=0.4	PASS
DH5	Hop	2.886	105	0.303	<=0.4	PASS
2DH1	Hop	0.391	318	0.124	<=0.4	PASS
2DH3	Hop	1.643	162	0.266	<=0.4	PASS
2DH5	Hop	2.891	84	0.243	<=0.4	PASS
3DH1	Hop	0.391	317	0.124	<=0.4	PASS
3DH3	Hop	1.643	159	0.261	<=0.4	PASS
3DH5	Hop	2.891	104	0.301	<=0.4	PASS

Note: The test period: T= 0.4 Second/Channel x 79 Channel = 31.6 s.

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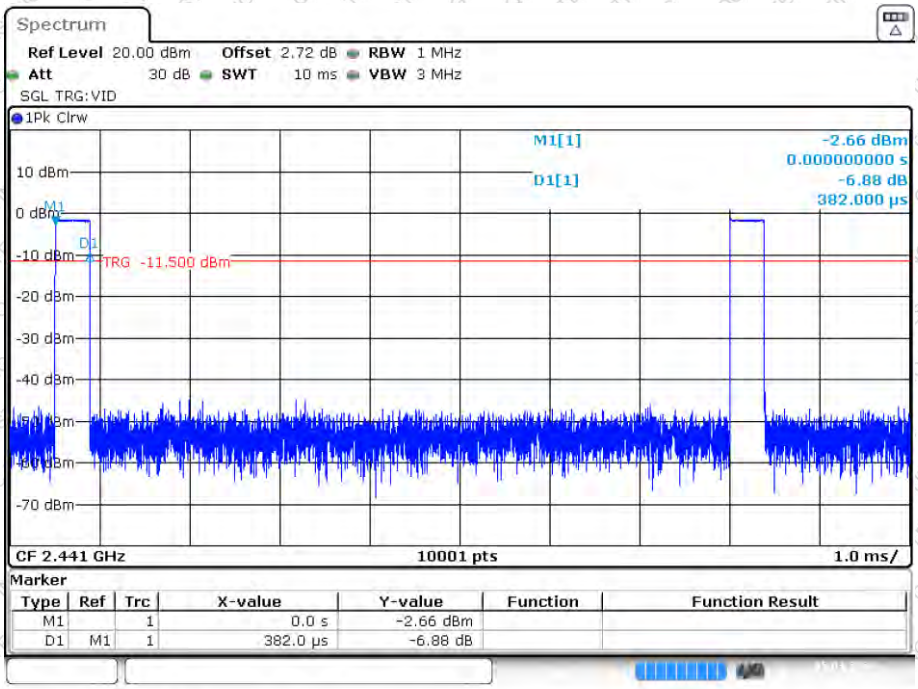
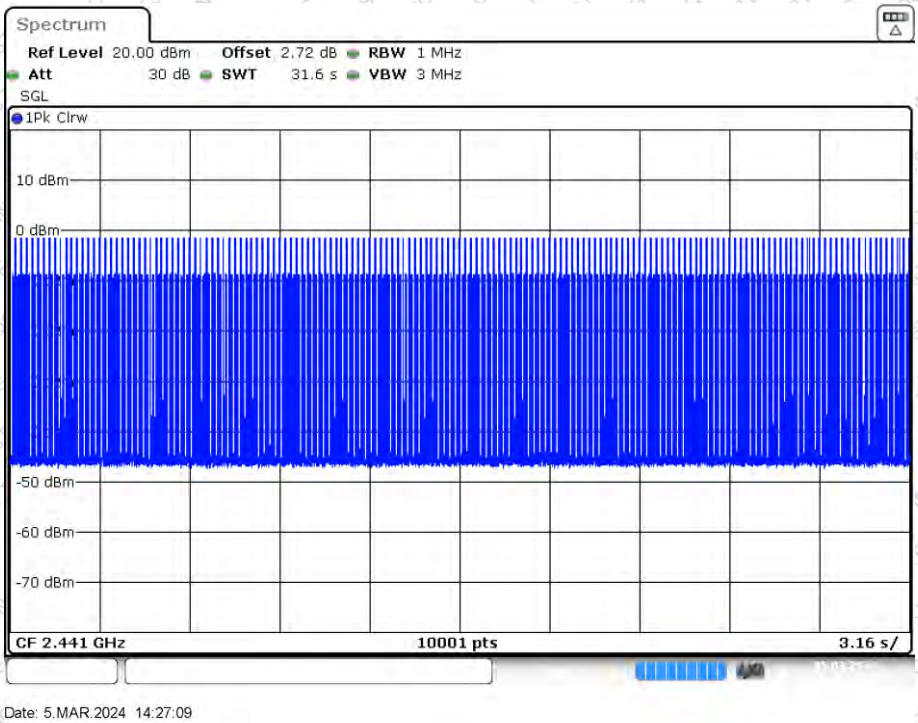
Dwell NVNT 1-DH1 2441MHz Ant1 One Burst



Dwell NVNT 1-DH1 2441MHz Ant1 Accumulated



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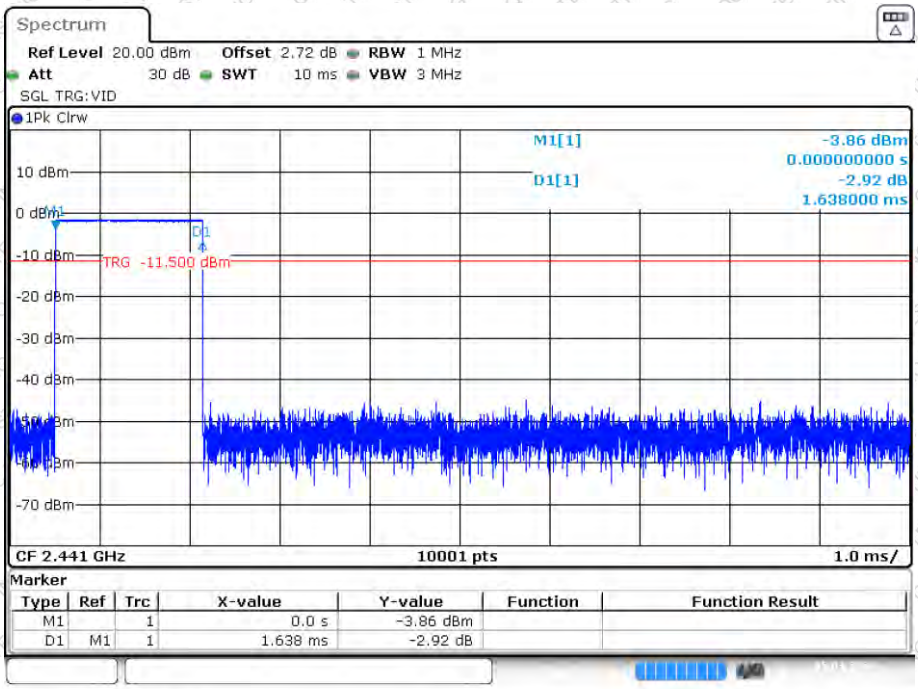
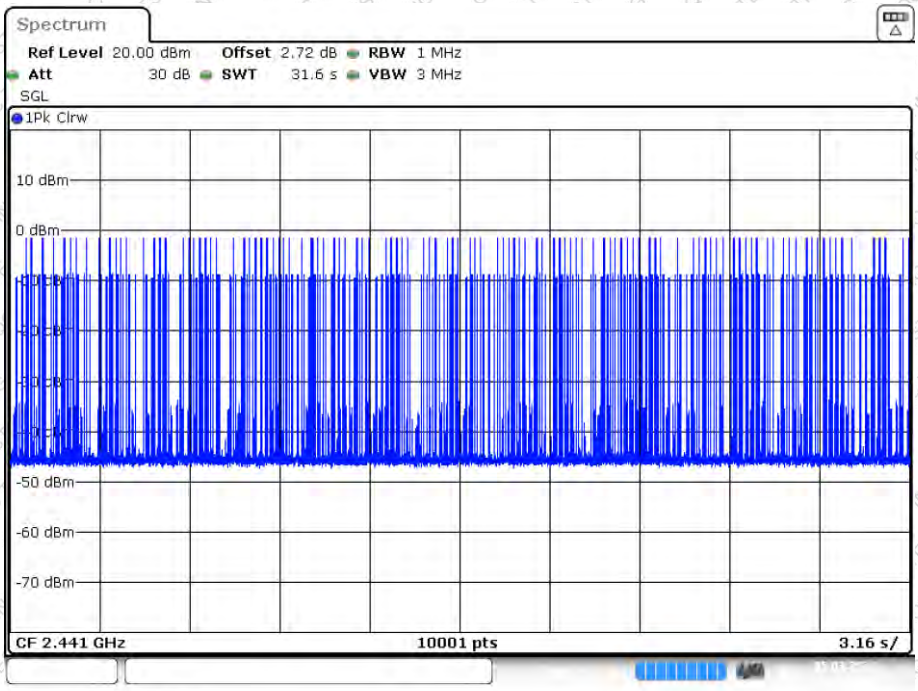
Tel: 0755-23008269 Fax: 0755-23726780 www.qctest.com.cn

Dwell NVNT 1-DH3 2441MHz Ant1 One Burst



Date: 5.MAR.2024 14:28:18

Dwell NVNT 1-DH3 2441MHz Ant1 Accumulated



Date: 5.MAR.2024 14:28:51

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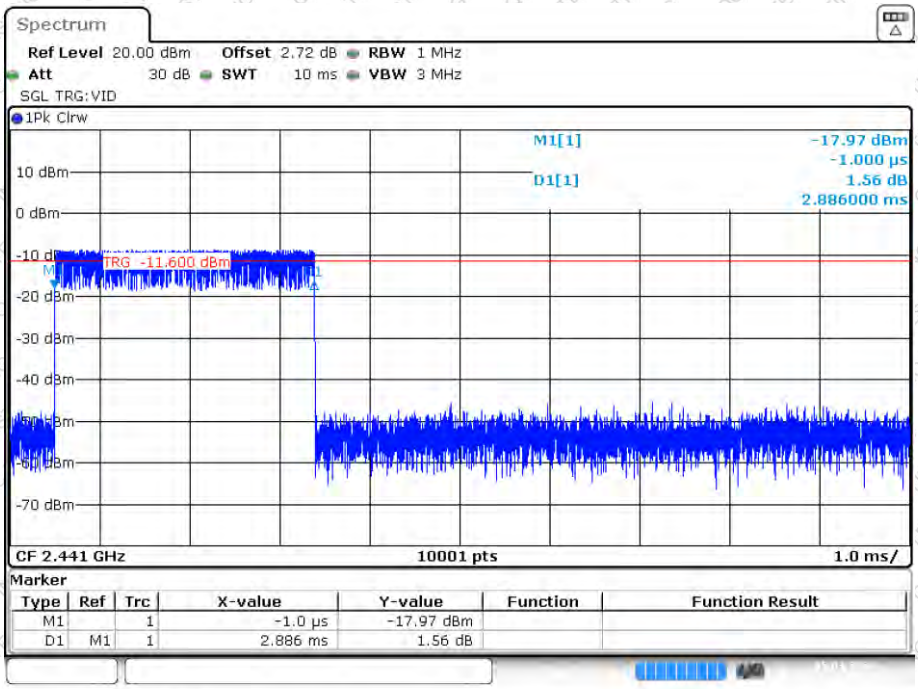
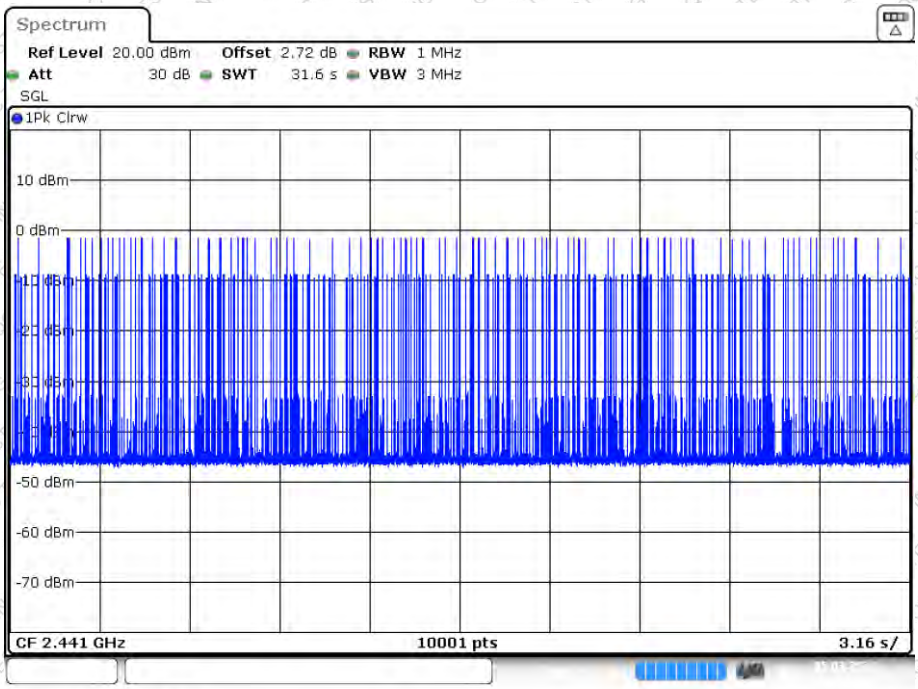
Tel: 0755-23008269 Fax: 0755-23726780 www.qctest.com.cn

Dwell NVNT 1-DH5 2441MHz Ant1 One Burst



Date: 5.MAR.2024 14:29:07

Dwell NVNT 1-DH5 2441MHz Ant1 Accumulated



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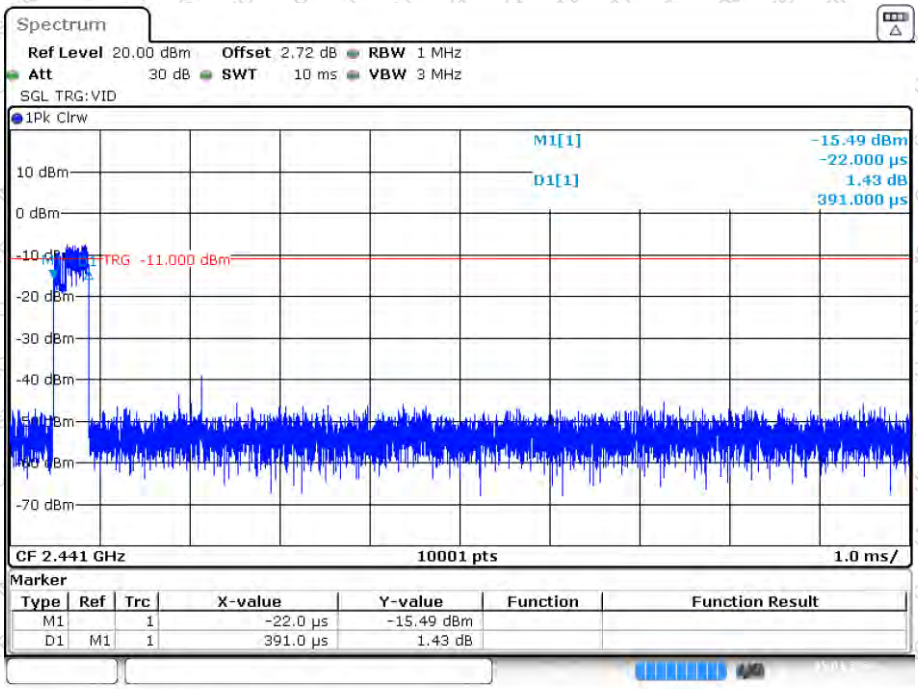
Dwell NVNT 2-DH1 2441MHz Ant1 One Burst



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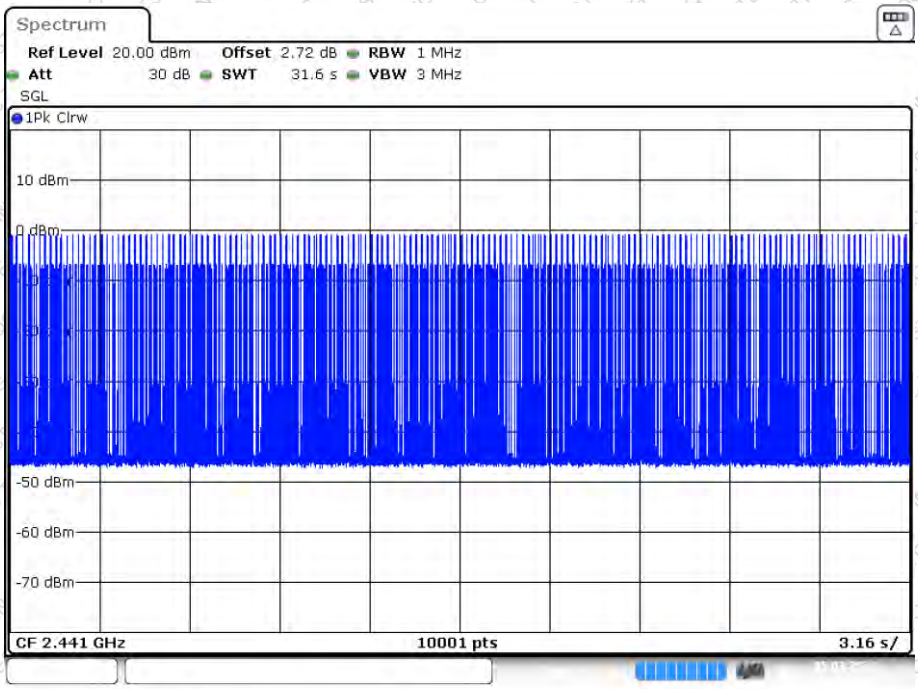

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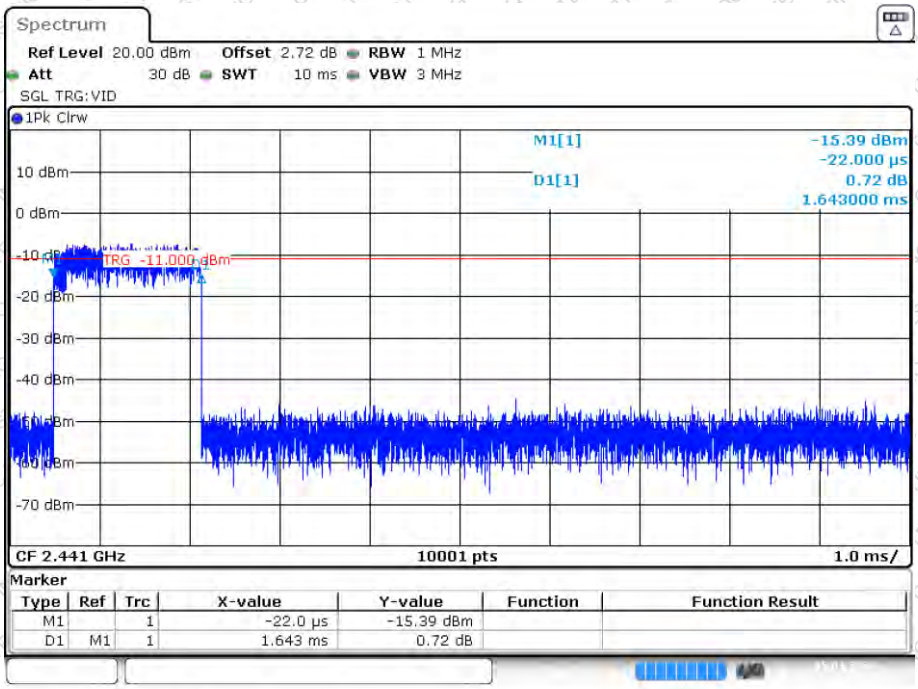
Dwell NVNT 2-DH3 2441MHz Ant1 One Burst



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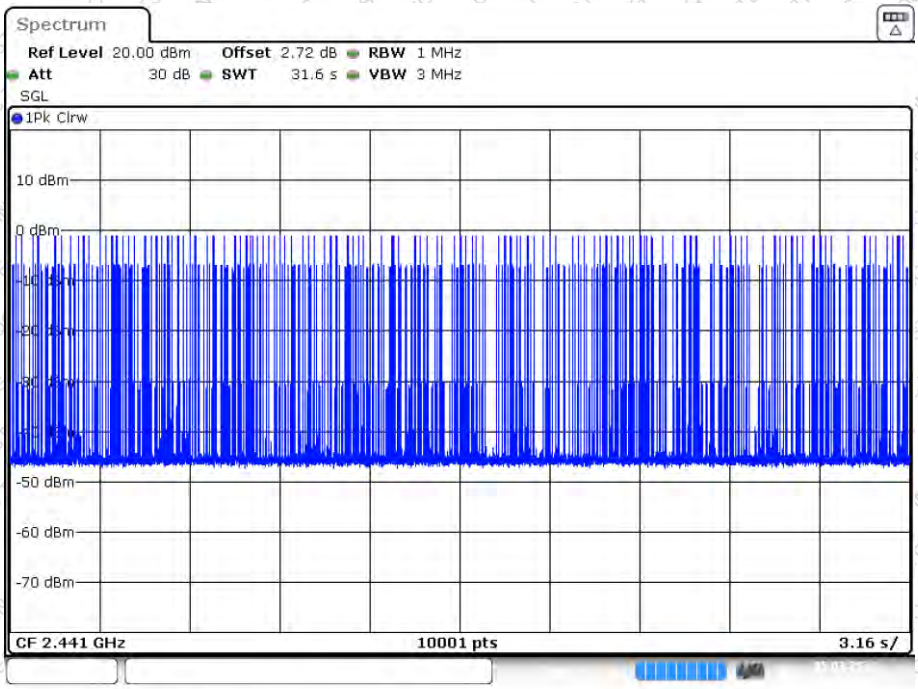

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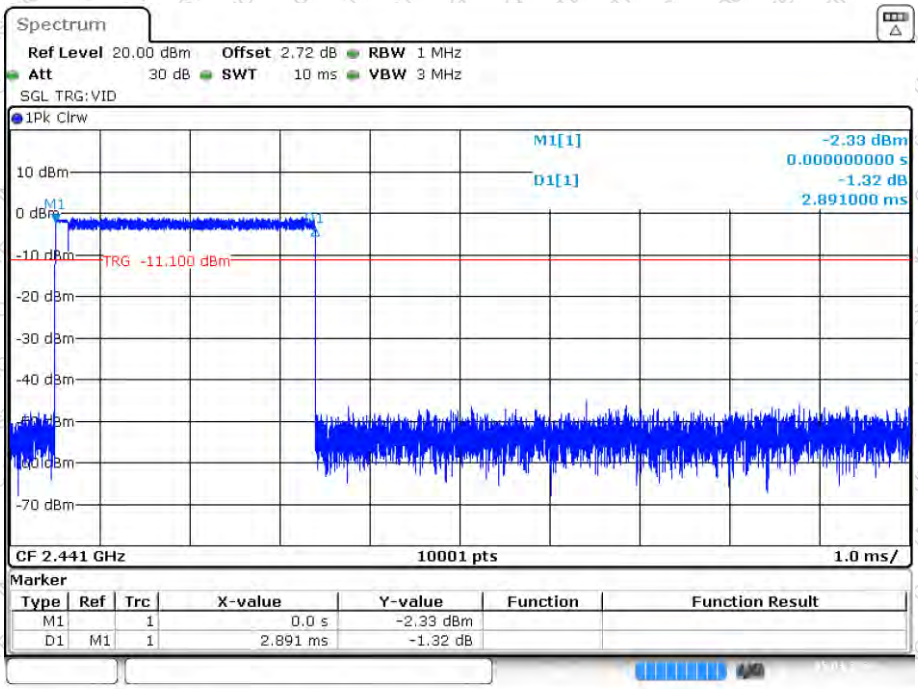
Dwell NVNT 2-DH5 2441MHz Ant1 One Burst



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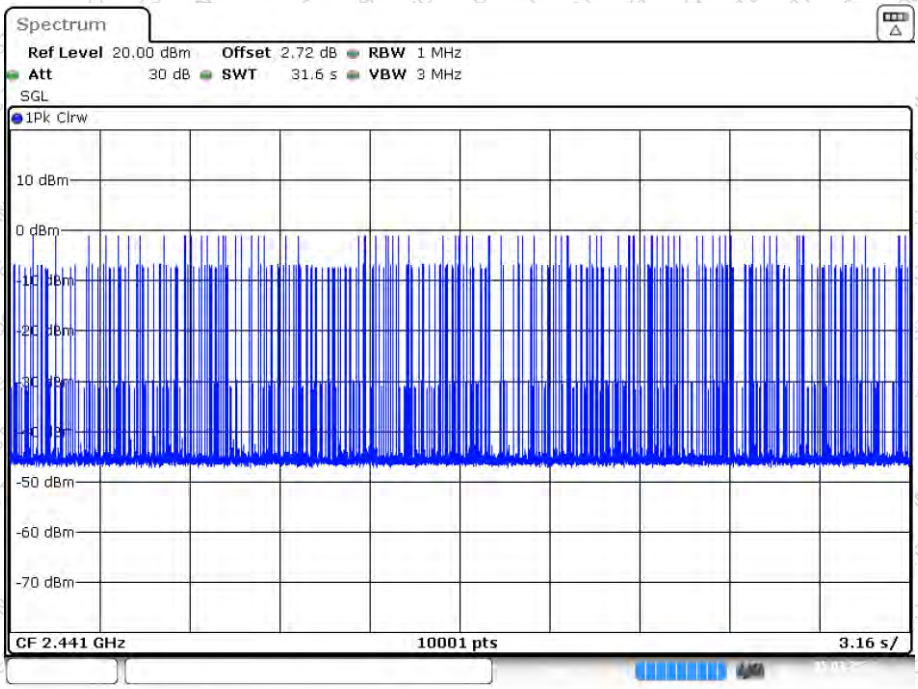

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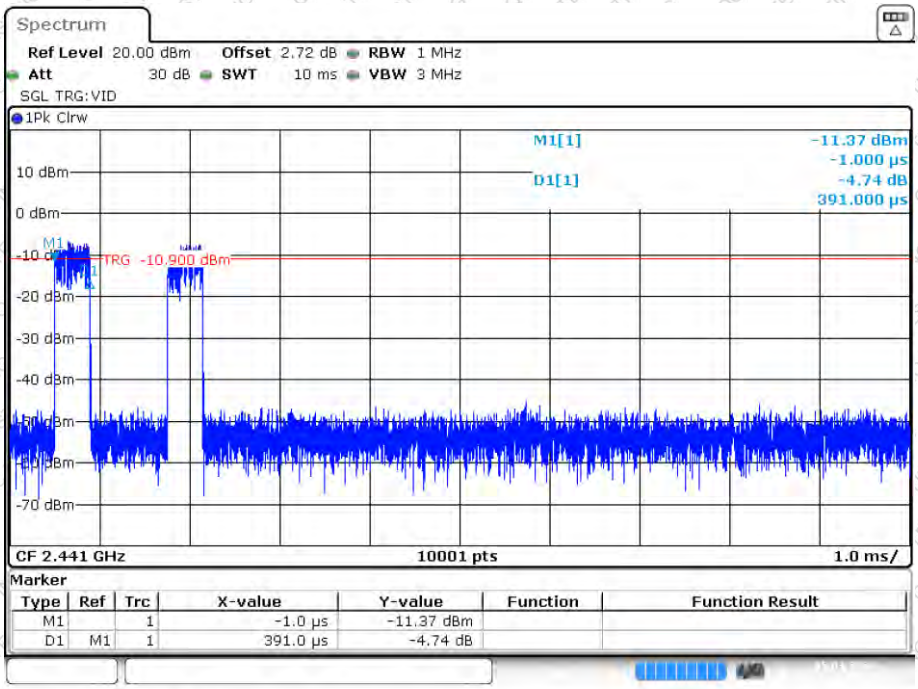
Dwell NVNT 3-DH1 2441MHz Ant1 One Burst



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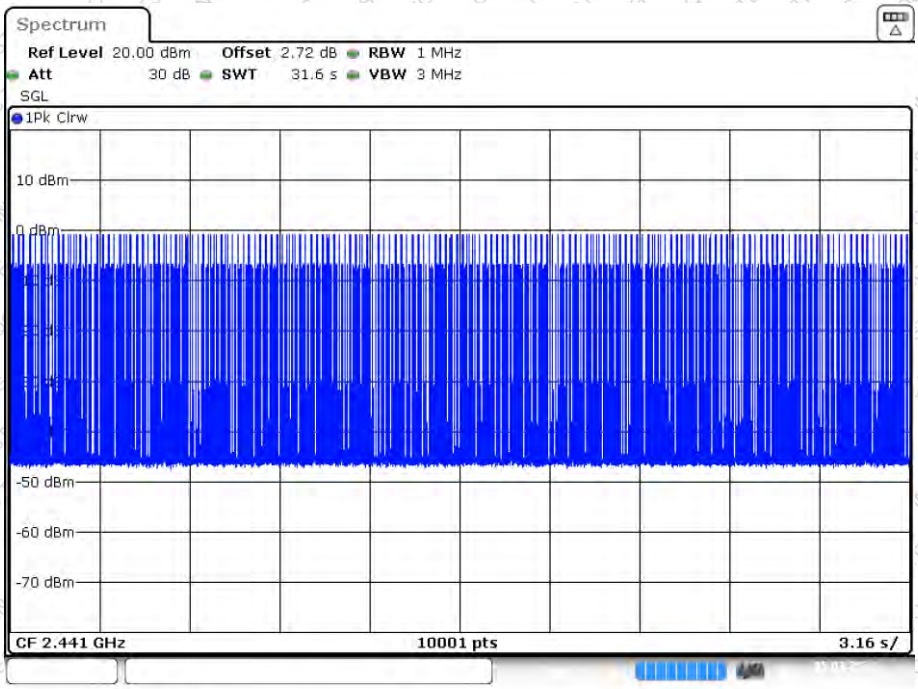

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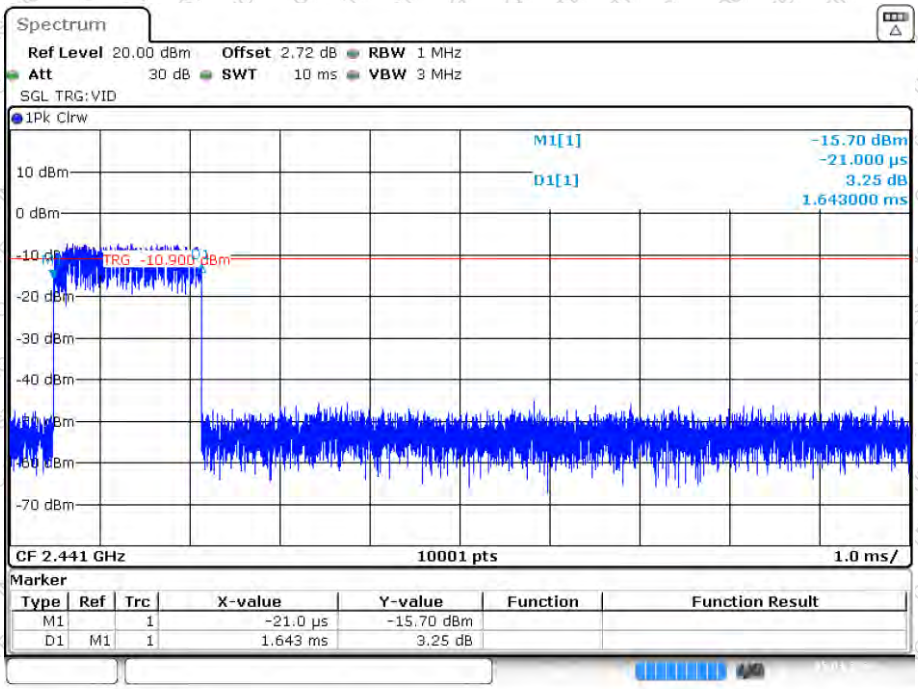
Dwell NVNT 3-DH3 2441MHz Ant1 One Burst



Date: 5.MAR.2024 15:00:10

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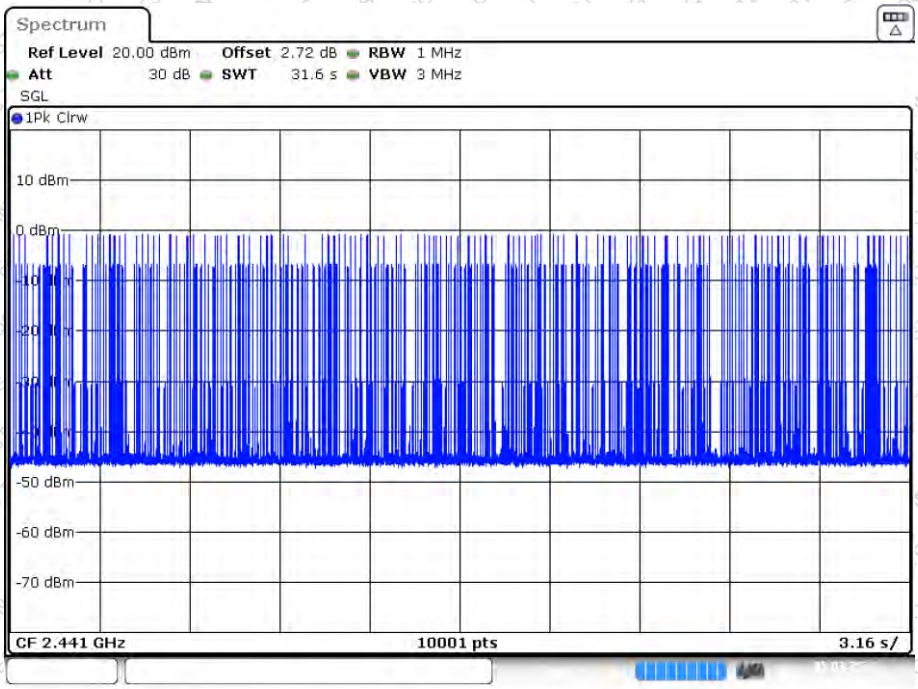

Date: 5.MAR.2024 15:00:43

Address: East of 1/F., Building E, Xinghong Science Park, No.111, Shuiku Road, Fenghuanggang, Xixiang Street, Bao'an District, Shenzhen, Guangdong, China
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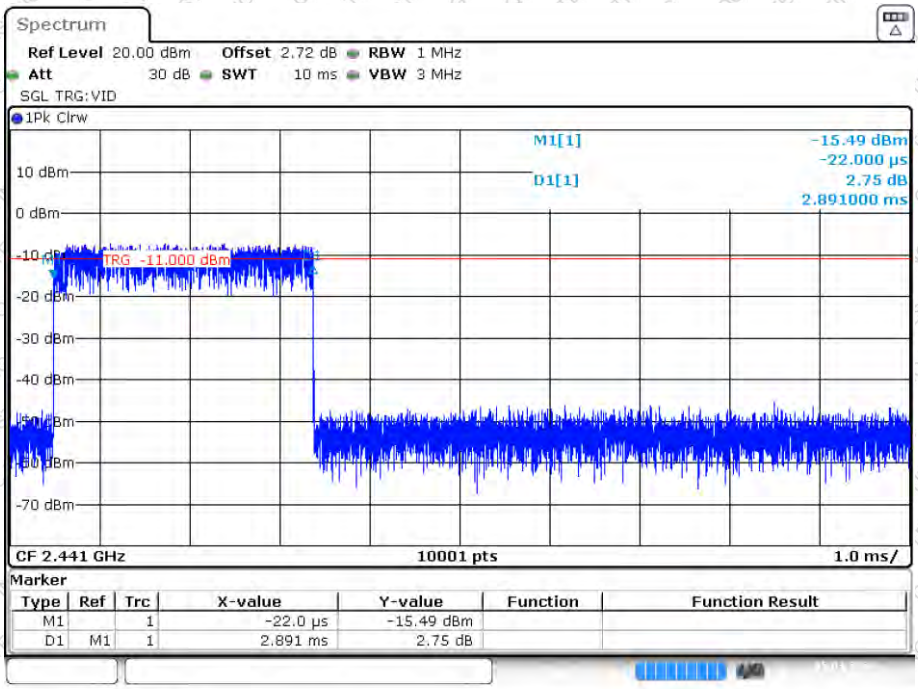
Dwell NVNT 3-DH5 2441MHz Ant1 One Burst



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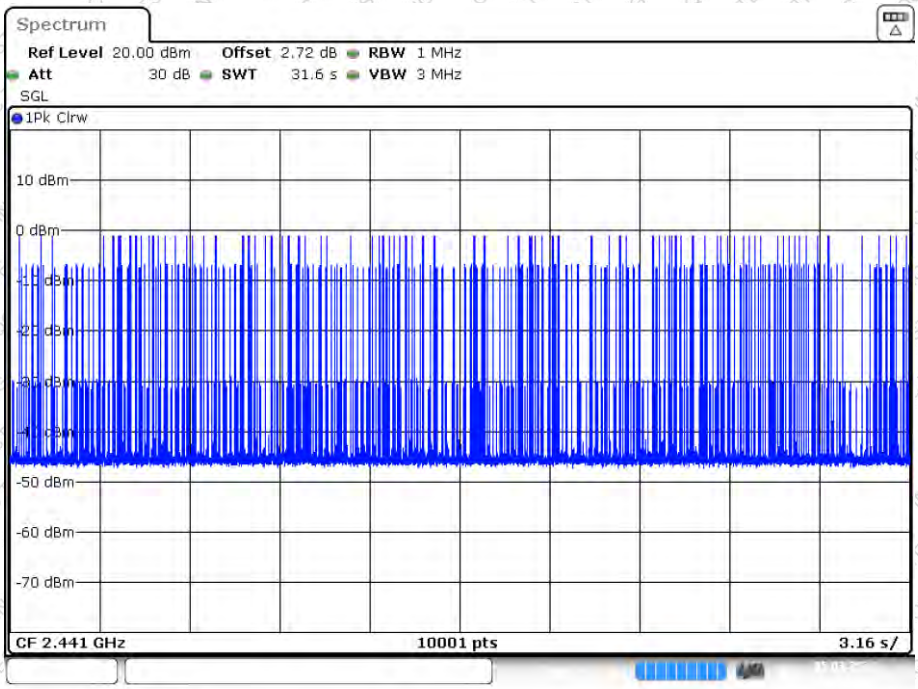

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11. Spurious Emission in Non-restricted & restricted Bands

11.1 Conducted Emission Method

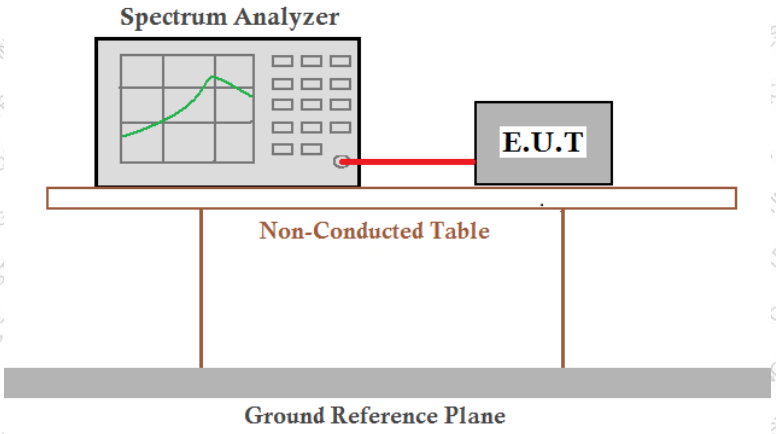
11.1.1 Applicable Standard

FCC Part15 C Section 15.247 (d)

11.1.2 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.

11.1.3 Test setup



11.1.4 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.

11.1.5 Test Data

Temperature	23.5 ℃	Humidity	50 %
ATM Pressure	101.1kPa	Antenna Gain	2.78dBi
Test by	LBi Li	Test result	PASS

Please refer to following plots.

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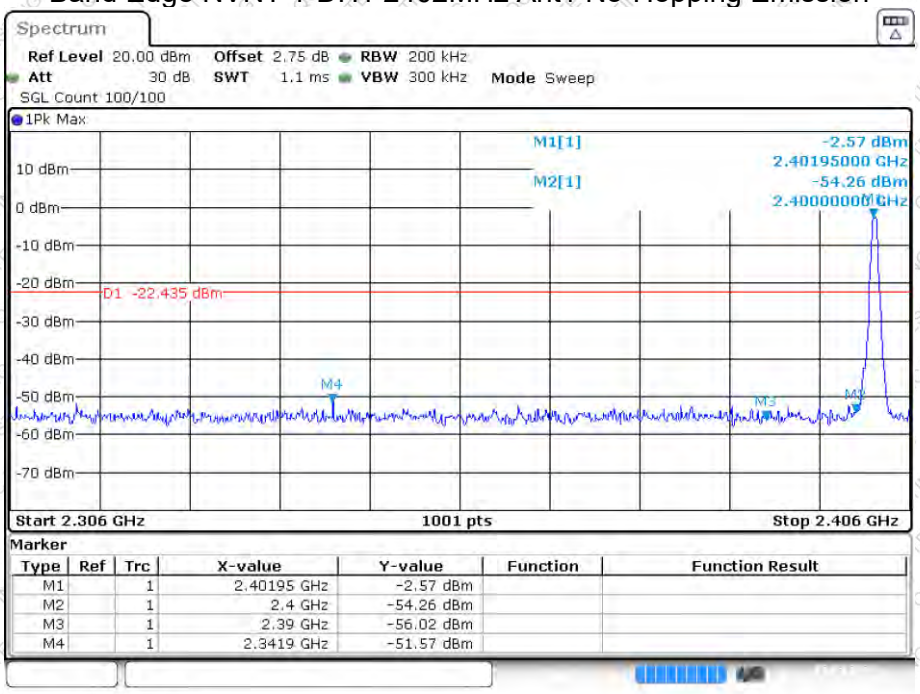
Band Edge NVNT 1-DH1 2402MHz Ant1 No-Hopping Emission



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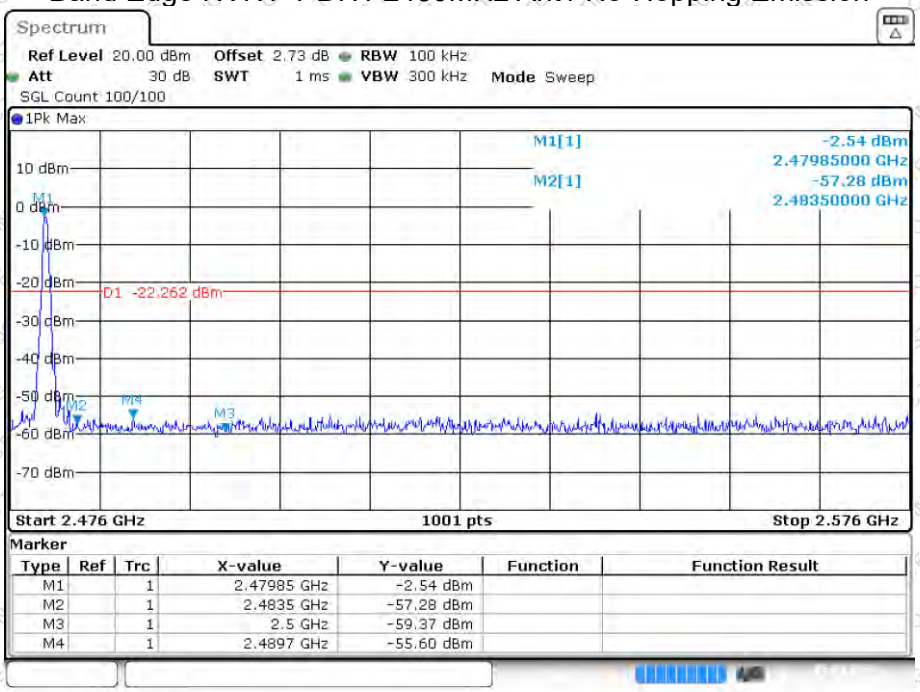
Band Edge NVNT 1-DH1 2480MHz Ant1 No-Hopping Emission



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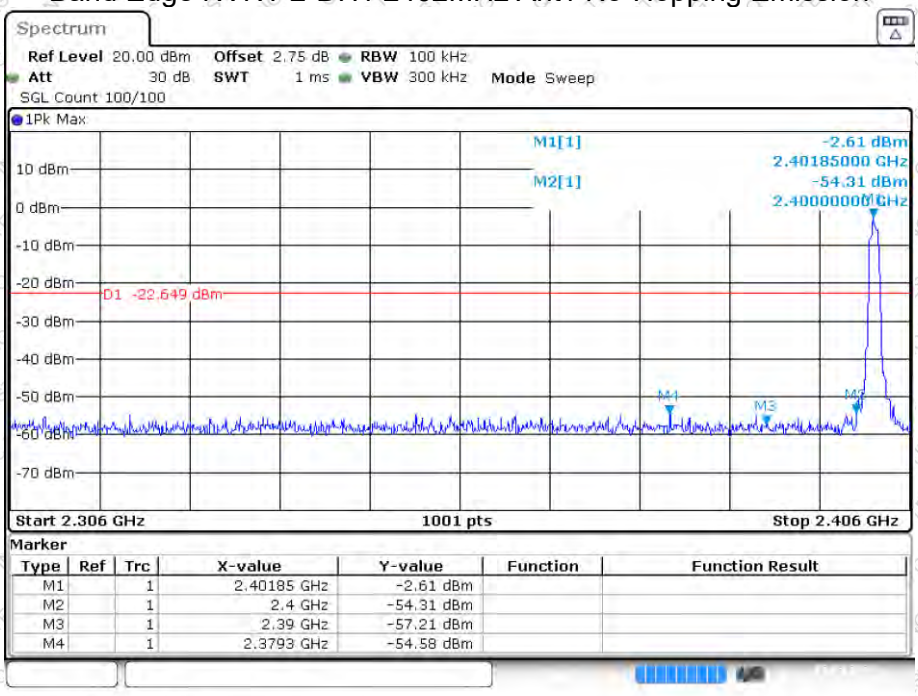
Band Edge NVNT 2-DH1 2402MHz Ant1 No-Hopping Emission

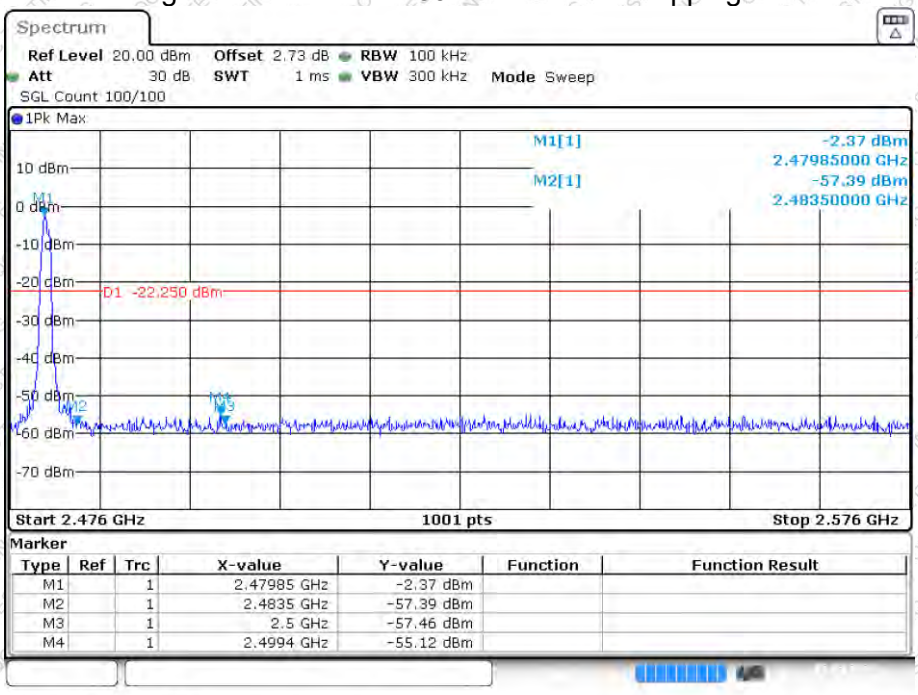


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40185 GHz	-2.61 dBm		
M2		1	2.4 GHz	-54.31 dBm		
M3		1	2.39 GHz	-57.21 dBm		
M4		1	2.3793 GHz	-54.58 dBm		

Date: 5.MAR.2024 14:36:48

Band Edge NVNT 2-DH1 2480MHz Ant1 No-Hopping Emission



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Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47985 GHz	-2.37 dBm		
M2		1	2.4835 GHz	-57.39 dBm		
M3		1	2.5 GHz	-57.46 dBm		
M4		1	2.4994 GHz	-55.12 dBm		

Date: 5.MAR.2024 14:38:41

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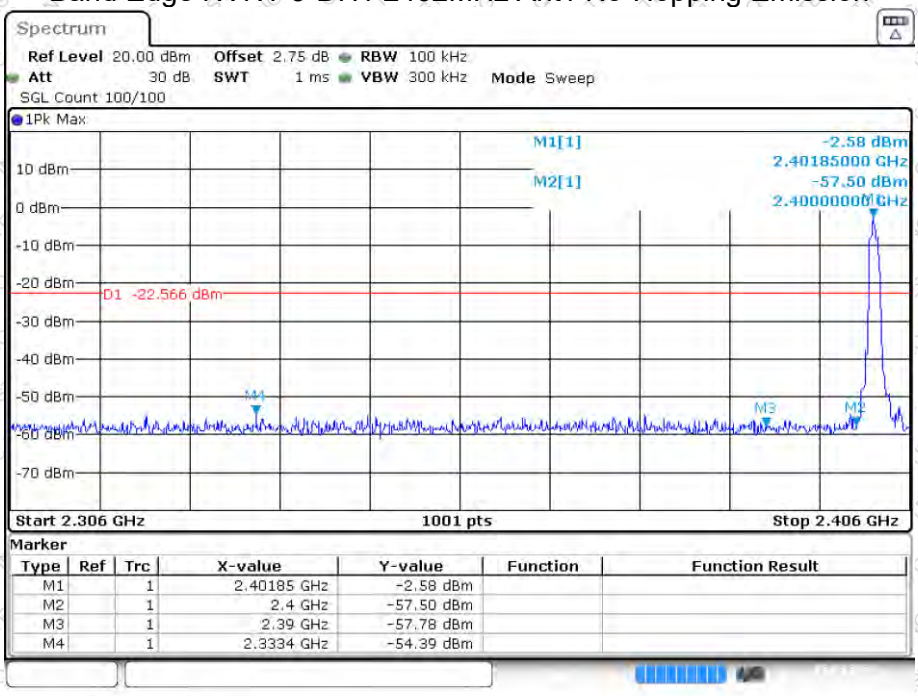
Band Edge NVNT 3-DH1 2402MHz Ant1 No-Hopping Emission



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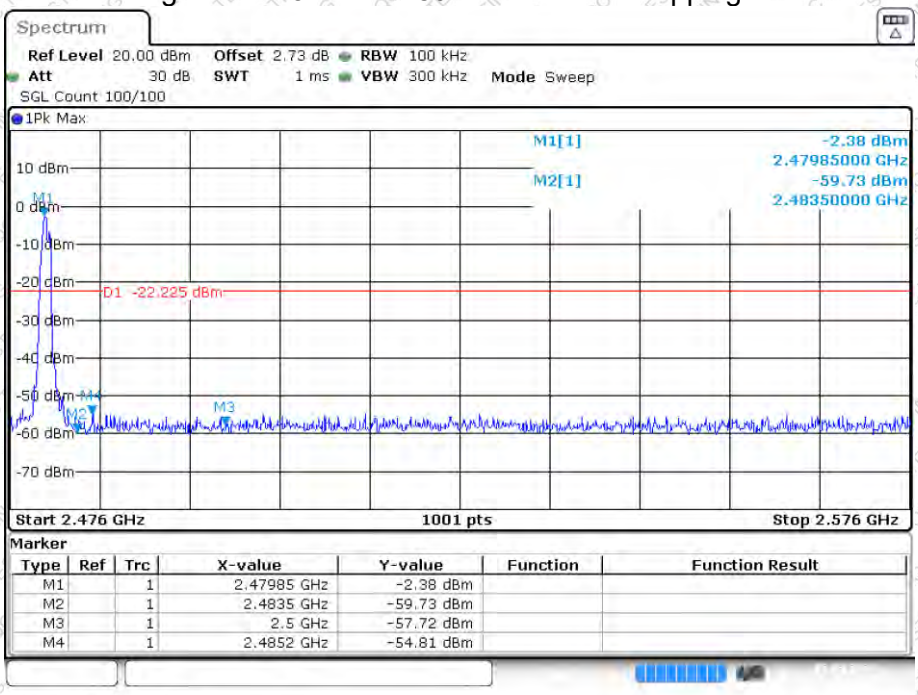
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40185 GHz	-2.58 dBm		
M2		1	2.4 GHz	-57.50 dBm		
M3		1	2.39 GHz	-57.78 dBm		
M4		1	2.3334 GHz	-54.39 dBm		

Date: 5.MAR.2024 14:54:04

Band Edge NVNT 3-DH1 2480MHz Ant1 No-Hopping Emission



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Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47985 GHz	-2.38 dBm		
M2		1	2.4835 GHz	-59.73 dBm		
M3		1	2.5 GHz	-57.72 dBm		
M4		1	2.4852 GHz	-54.81 dBm		

Date: 5.MAR.2024 14:56:18

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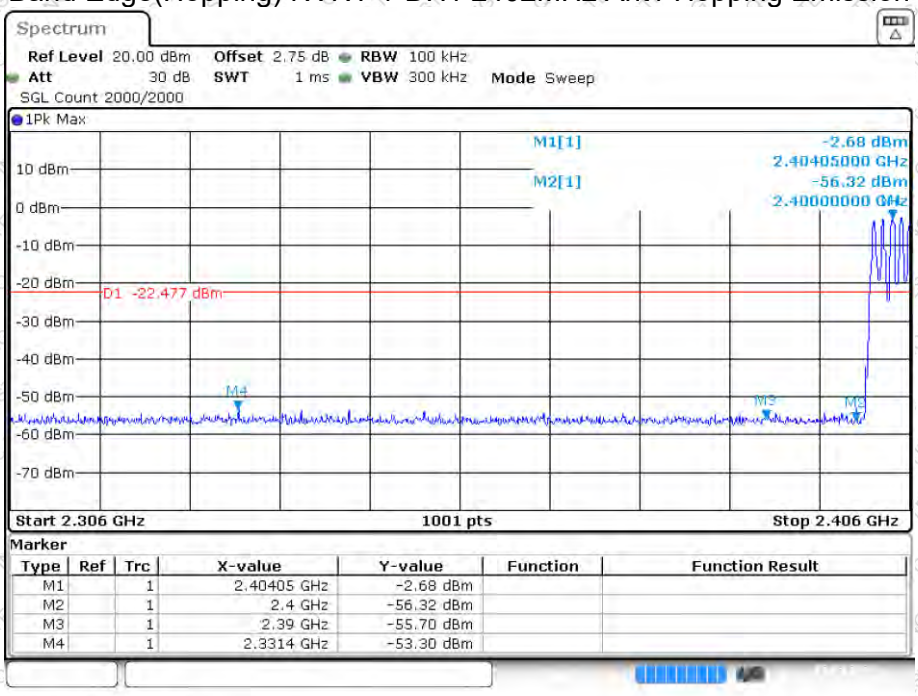
Band Edge(Hopping) NVNT 1-DH1 2402MHz Ant1 Hopping Emission

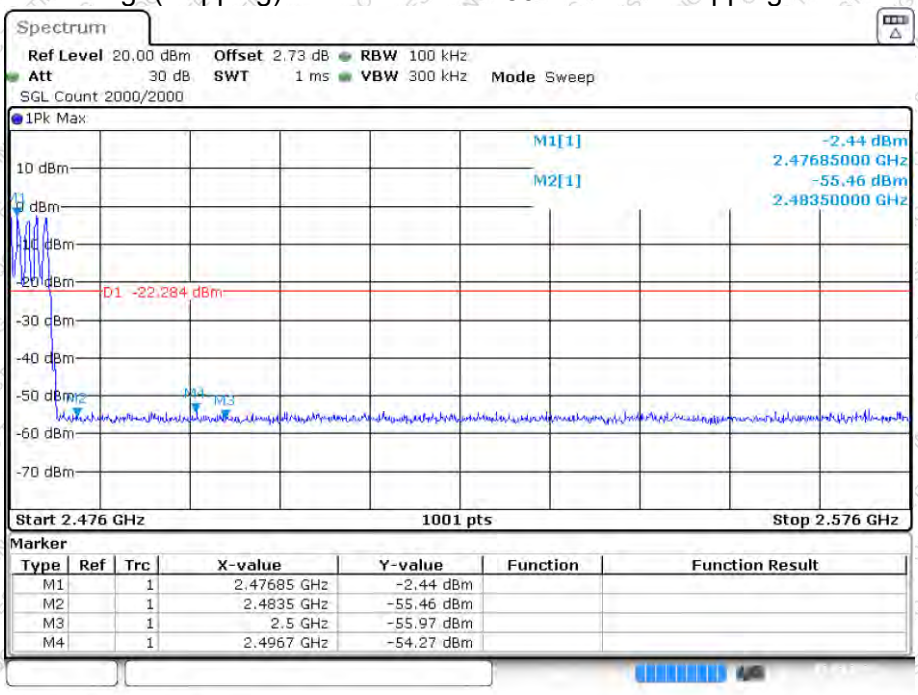


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40405 GHz	-2.68 dBm		
M2		1	2.4 GHz	-56.32 dBm		
M3		1	2.39 GHz	-55.70 dBm		
M4		1	2.3314 GHz	-53.30 dBm		

Date: 5.MAR.2024 14:26:29

Band Edge(Hopping) NVNT 1-DH1 2480MHz Ant1 Hopping Emission



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Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47685 GHz	-2.44 dBm		
M2		1	2.4835 GHz	-55.46 dBm		
M3		1	2.5 GHz	-55.97 dBm		
M4		1	2.4967 GHz	-54.27 dBm		

Date: 5.MAR.2024 14:28:00

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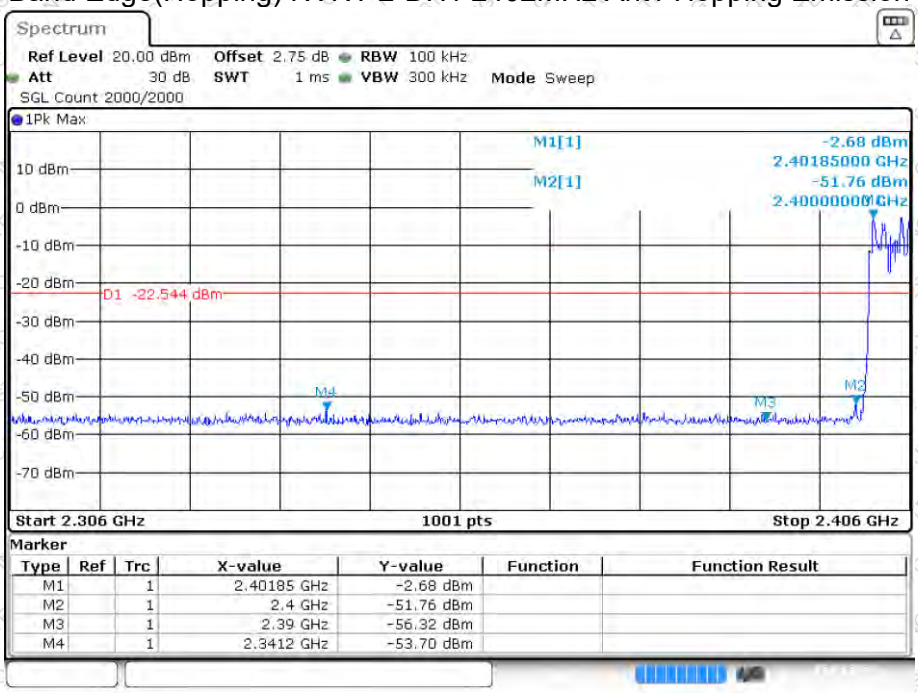
Band Edge(Hopping) NVNT 2-DH1 2402MHz Ant1 Hopping Emission



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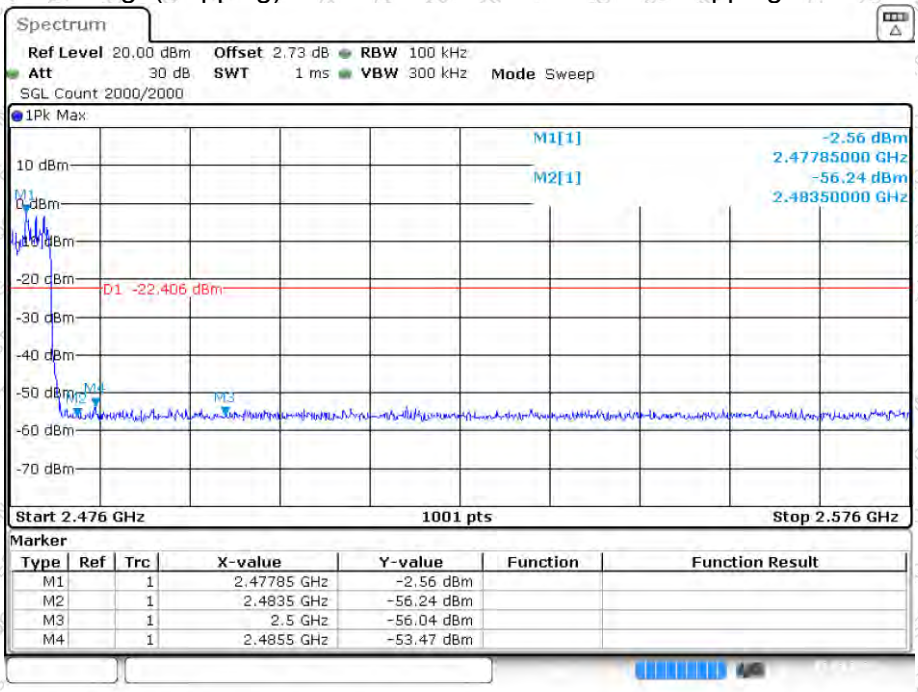
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40185 GHz	-2.68 dBm		
M2		1	2.4 GHz	-51.76 dBm		
M3		1	2.39 GHz	-56.32 dBm		
M4		1	2.3412 GHz	-53.70 dBm		

Date: 5.MAR.2024 14:32:13

Band Edge(Hopping) NVNT 2-DH1 2480MHz Ant1 Hopping Emission



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Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47785 GHz	-2.56 dBm		
M2		1	2.4835 GHz	-56.24 dBm		
M3		1	2.5 GHz	-56.04 dBm		
M4		1	2.4855 GHz	-53.47 dBm		

Date: 5.MAR.2024 14:33:38

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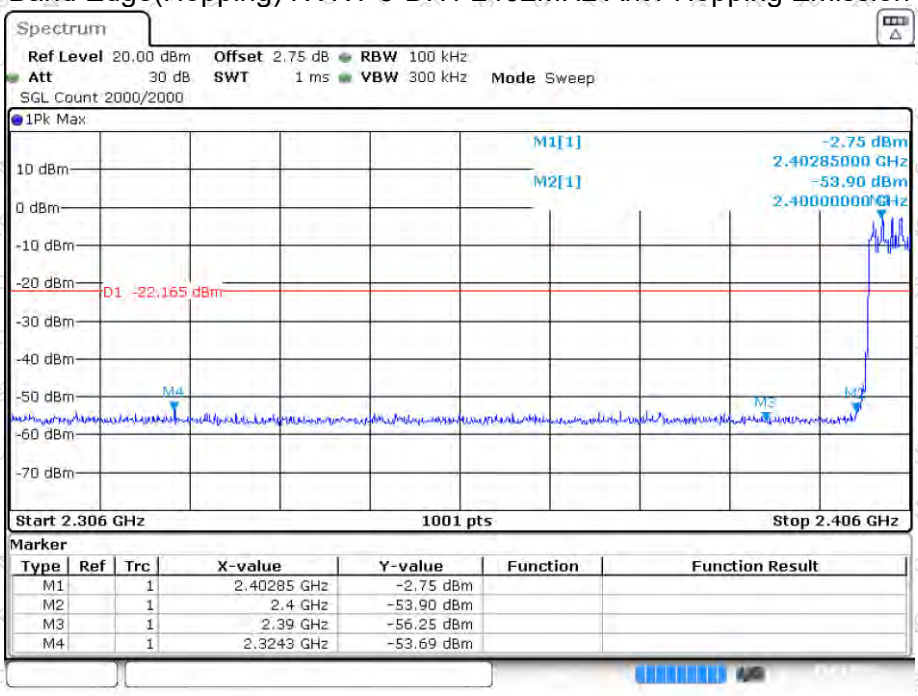
Band Edge(Hopping) NVNT 3-DH1 2402MHz Ant1 Hopping Emission

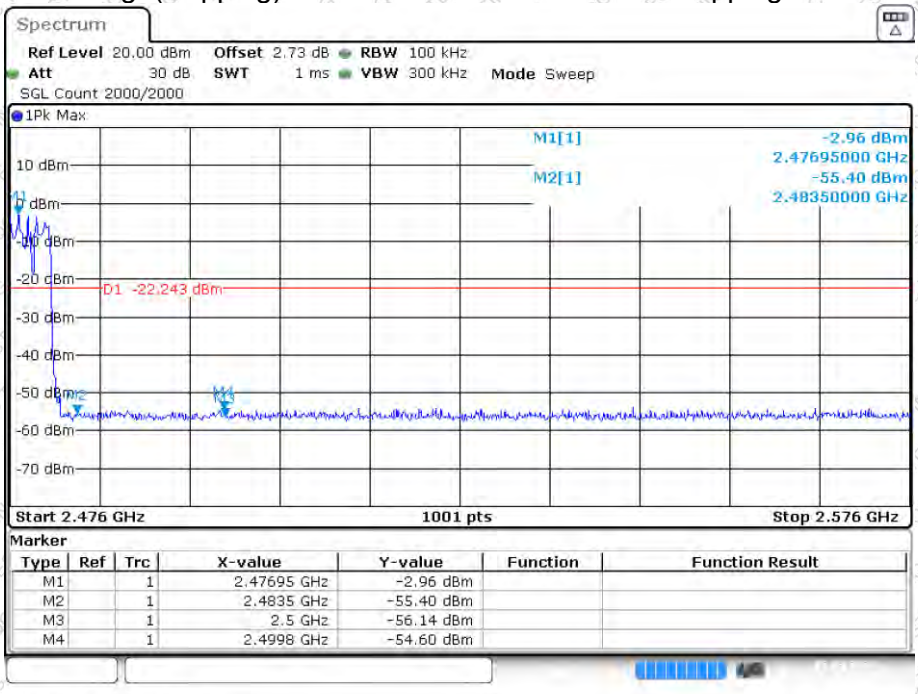


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40285 GHz	-2.75 dBm		
M2		1	2.4 GHz	-53.90 dBm		
M3		1	2.39 GHz	-56.25 dBm		
M4		1	2.3243 GHz	-53.69 dBm		

Date: 5.MAR.2024 14:58:24

Band Edge(Hopping) NVNT 3-DH1 2480MHz Ant1 Hopping Emission



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47695 GHz	-2.96 dBm		
M2		1	2.4835 GHz	-55.40 dBm		
M3		1	2.5 GHz	-56.14 dBm		
M4		1	2.4998 GHz	-54.60 dBm		

Date: 5.MAR.2024 14:59:49

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11.2 Radiated Emission Method

11.2.1 Applicable Standard

FCC Part15 C Section 15.209 and 15.205

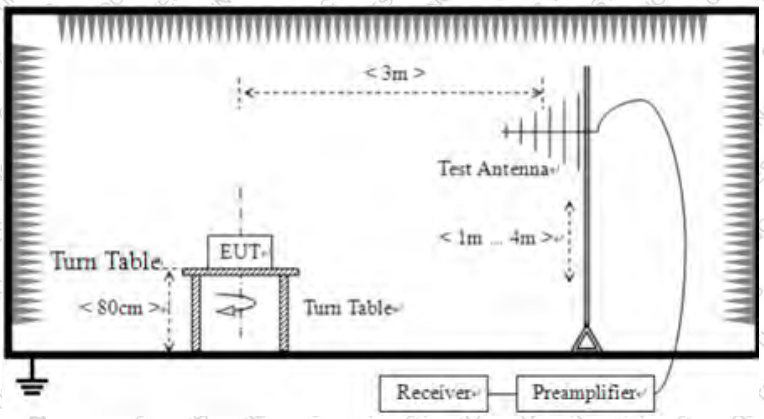
11.2.2 Limit

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	/	54.0	Peak
		74.0	Average

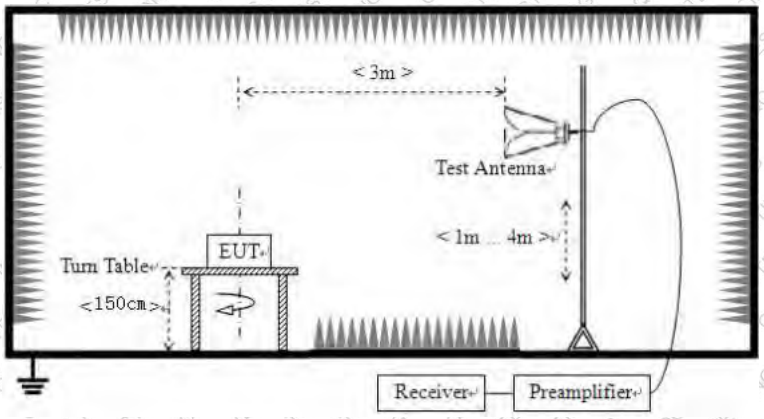
Note: dBμV/m =20log(μV/m)

11.2.3 Test setup

For radiated emissions from 30MHz to1GHz



For radiated emissions from above 1GHz



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11.2.4 EMI Test Receiver Setup

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

11.2.5 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.
- 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.

11.2.6 Test Data

Temperature	25 ℃	Humidity	49%
ATM Pressure	101.1kPa	Antenna Gain	2.78dBi
Test by	LBi Li	Test result	PASS

Test voltage: DC 3.7V.

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. The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

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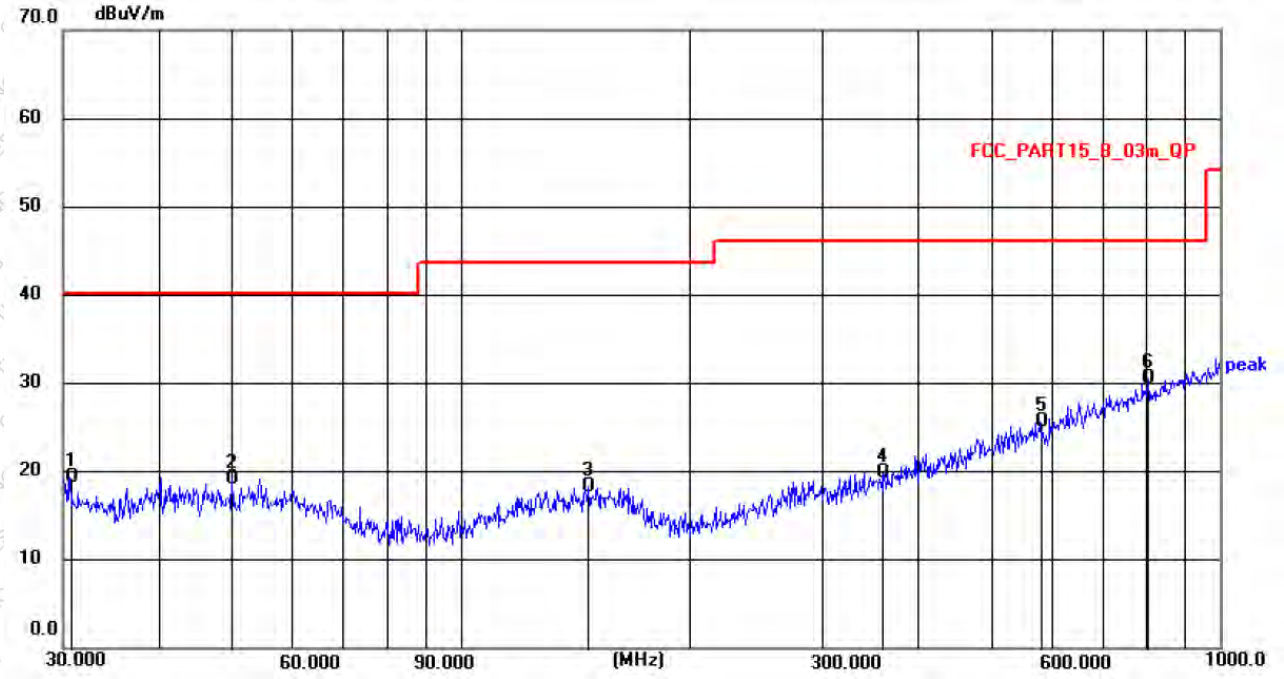
Below 1GHz

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

Horizontal:



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	30.6378	6.24	13.11	19.35	40.00	20.65	QP
2	50.0566	4.61	14.63	19.24	40.00	20.76	QP
3	147.4036	3.78	14.52	18.30	43.50	25.20	QP
4	360.4476	3.40	16.52	19.92	46.00	26.08	QP
5	580.7026	4.56	21.00	25.56	46.00	20.44	QP
6 *	804.6027	6.00	24.56	30.56	46.00	15.44	QP

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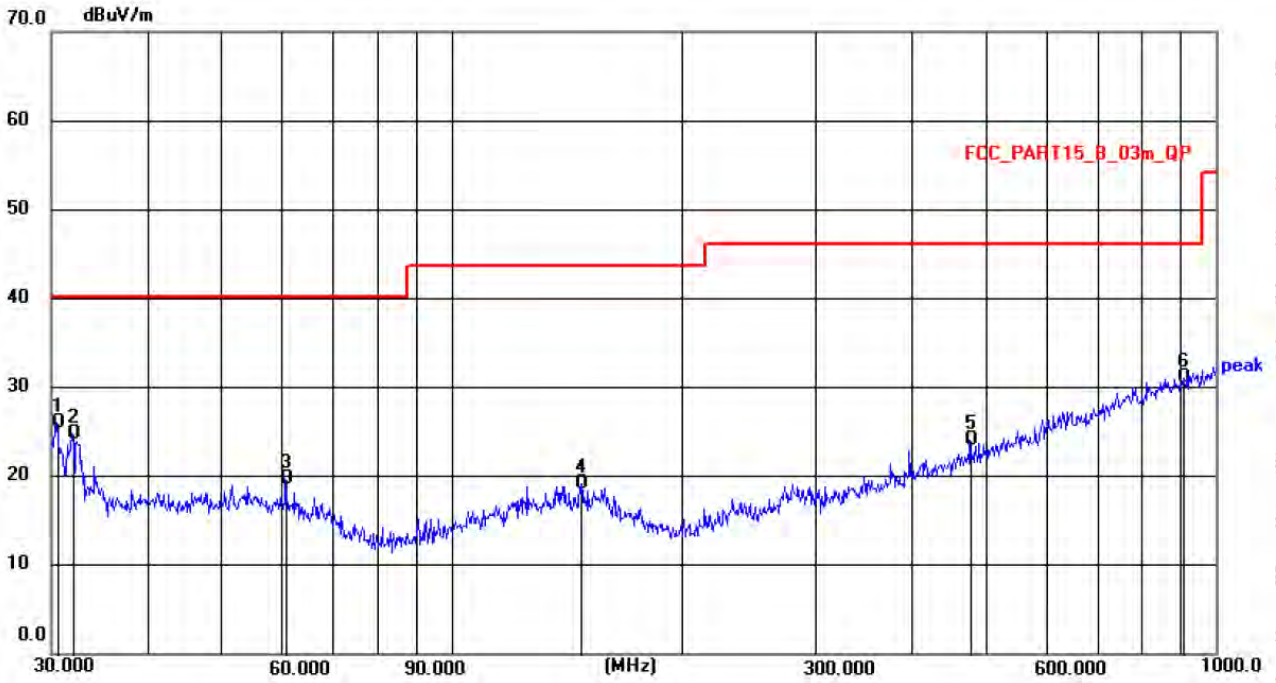
Vertical:



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	30.5306	13.51	12.55	26.06	40.00	13.94	QP
2	31.9546	11.99	12.82	24.81	40.00	15.19	QP
3	60.7044	6.14	13.47	19.61	40.00	20.39	QP
4	147.9214	4.76	14.35	19.11	43.50	24.39	QP
5	477.1694	4.91	19.11	24.02	46.00	21.98	QP
6	906.4824	4.90	26.19	31.09	46.00	14.91	QP

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Above 1GHz

Pre-scan all test modes, found worst case at GFSK Mode, and so only show the test result of GFSK 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	50.12	H	-11.14	38.98	74	35.02	peak
2310	52.15	V	-11.16	40.99	74	33.01	peak
2390	52.81	H	-10.9	41.91	74	32.09	peak
2390	54.24	V	-10.96	43.28	74	30.72	peak
4804	51.51	H	-4.37	47.14	74	26.86	peak
4804	51.38	V	-4.51	46.87	74	27.13	peak

Test channel: Middle channel

Frequency (MHz)	Read Level (dBμV)	polarization	Factor (dB/m)	Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector
4882	51.14	H	-4.1	47.04	74	26.96	peak
4882	49.2	V	-4.23	44.97	74	29.03	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	54.31	H	-10.61	43.7	74	30.3	peak
2483.5	52.67	V	-10.71	41.96	74	32.04	peak
2500	50.27	H	-10.57	39.7	74	34.3	peak
2500	49	V	-10.67	38.33	74	35.67	peak
4960	51.44	H	-3.82	47.62	74	26.38	peak
4960	50.26	V	-3.93	46.33	74	27.67	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.

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

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