FCC TEST REPORT

FCC ID: 2BKAL-IMUBOX

On Behalf of

APOGEO SP. Z O.O.

gnss receiver

Model No.: IMUBox 300.

Prepared for	:	APOGEO SP. Z O.O.
Address	:	LUKASIEWICZA 10, 31429 KRAKOW, MALOPOLSKA, POLAND

Prepared By	:	Shenzhen Alpha Product Testing Co., Ltd.
Address	:	Building i, No.2, Lixin Road, Fuyong Street, Bao'an District, 518103, Shenzhen, Guangdong, China

Report Number	:	A2406137-C01-R07
Date of Receipt	:	June 19, 2024
Date of Test	:	June 19, 2024 - July 12, 2024
Date of Report	:	July 12, 2024
Version Number	:	V0
Test Result	**:**	**Pass**

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TEST REPORT DECLARATION

Applicant	:	APOGEO SP. Z O.O.
Address	:	LUKASIEWICZA 10, 31429 KRAKOW, MALOPOLSKA, POLAND
Manufacturer	:	Guangxi Goodsurvey Navigation Terminal Co.
Address	:	Room 03, 7th Floor, Unit 3, Building 3, Xianggui Mansion, Lijiang Junfu, No. 256 Linjiang Road, Guilin, Guangxi, China
EUT Description	:	gnss receiver
		(A) Model No. : IMUBox 300.
		(B) Trademark : SPATRIA

Measurement Standard Used:

FCC Rules and Regulations Part 15 Subpart C Section 15.247

The device described above is tested by Shenzhen Alpha Product Testing Co., Ltd. to determine the maximum emission levels emanating from the device. The maximum emission levels are compared to the FCC Part 15 Subpart C limits both conducted and radiated emissions. The test results are contained in this test report and Shenzhen Alpha Product Testing Co., Ltd. is assumed of full responsibility for the accuracy and completeness of these tests.

After the test, our opinion is that EUT compliance with the requirement of the above standards.

This report applies to above tested sample only. This report shall not be reproduced in parts without written approval of Shenzhen Alpha Product Testing Co., Ltd.

Tested by (name + signature).....…..:	Yannis Wen Project Engineer	Yannis Wen
Approved by (name + signature)…....:	Jack Xu Project Manager	Jack Xu
Date of issue……..:	July 12, 2024	

Revision History

Revision	Issue Date	Revisions	Revised By
V0	July 12, 2024	Initial released Issue	Yannis Wen

1. SUMMARY OF STANDARDS AND RESULTS

1.1. Description of Standards and Results

The EUT have been tested according to the applicable standards as referenced below:

Test Item	Standards Paragraph	Result
Maximum Peak Output Power	FCC Part 15: 15.247(b)(1)	P
Bandwidth	FCC Part 15: 15.215	P
Carrier Frequency Separation	FCC Part 15: 15.247(a)(1)	P
Number Of Hopping Channel	FCC Part 15: 15.247(a)(1)	P
Dwell Time	FCC Part 15: 15.247(a)(1)	P
Radiated Emission	FCC Part 15: 15.209, FCC Part 15: 15.247(d)	P
Band Edge Compliance	FCC Part 15: 15.247(d)	P
Power Line Conducted Emissions	FCC Part 15: 15.207	P
Antenna requirement	FCC Part 15: 15.203	P
Note:	1. P is an abbreviation for Pass. 2. F is an abbreviation for Fail. 3. N/A is an abbreviation for Not Applicable.	

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

2. Frequency Stability: The manufacturer stated in the user's manual.

3. The conclusion of this test report is judged by actual test data without considering measurement uncertainty.

2. GENERAL INFORMATION

2.1. Description of Device (EUT)

Description	:	gnss receiver
Model Number	:	IMUBox 300.
Diff	:	N/A
Power supply	:	DC 5V from type-C and DC 7.4V from battery.
Radio Technology	:	Bluetooth EDR/BDR
Operation frequency	:	2402-2480MHz
Channel No.	:	79 Channels
Channel spacing	:	1MHz
Modulation type	:	GFSK, π/4 DQPSK, 8DPSK
Antenna Type	:	PIFA antenna, Maximum Gain is 2.7dBi (Antenna information is provided by applicant.)
Software version	:	V1.0
Hardware version	:	V1.0
Connector cable loss	:	N/A
Intend use environment	:	Residential, commercial and light industrial environment

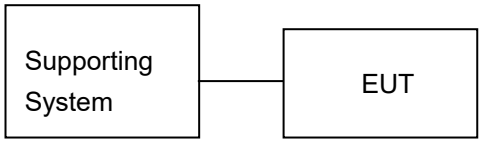
2.2. Accessories of Device (EUT)

Accessories : /
Manufacturer : /
Model : /
INPUT : /
OUTPUT : /

2.3. Tested Supporting System Details

No.	Description	Manufacturer	Model	Serial Number	Certification or SDoC
1.	Notebook PC	Lenovo	Thinkpad E14	--	--

2.4. Block Diagram of connection between EUT and simulators



2.5. Test Mode Description

Tested mode, channel information		
Mode	**Channel**	**Frequency (MHz)**
GFSK- hopping off	Low :CH1	2402
	Middle: CH40	2441
	High: CH79	2480
π/4 DQPSK- hopping off	Low :CH1	2402
	Middle: CH40	2441
	High: CH79	2480
8DPSK- hopping off	Low :CH1	2402
	Middle: CH40	2441
	High: CH79	2480
GFSK-hopping on	Hopping	2402-2480
π/4 DQPSK –hopping on	Hopping	2402-2480
8DPSK –hopping on	Hopping	2402-2480

Channel list

CH	Frequency	CH	Frequency	CH	Frequency	CH	Frequency	CH	Frequency
1	**2402**	18	2419	35	2436	52	2453	69	2470
2	2403	19	2420	36	2437	53	2454	70	2471
3	2404	20	2421	37	2438	54	2455	71	2472
4	2405	21	2422	38	2439	55	2456	72	2473
5	2406	22	2423	39	2440	56	2457	73	2474
6	2407	23	2424	40	**2441**	57	2458	74	2475
7	2408	24	2425	41	2442	58	2459	75	2476
8	2409	25	2426	42	2443	59	2460	76	2477
9	2410	26	2427	43	2444	60	2461	77	2478
10	2411	27	2428	44	2445	61	2462	78	2479
11	2412	28	2429	45	2446	62	2463	79	**2480**
12	2413	29	2430	46	2447	63	2464	/	/
13	2414	30	2431	47	2448	64	2465	/	/
14	2415	31	2432	48	2449	65	2466	/	/
15	2416	32	2433	49	2450	66	2467	/	/
16	2417	33	2434	50	2451	67	2468	/	/
17	2418	34	2435	51	2452	68	2469	/	/

2.6. Test Conditions

Items	Required	Actual
Temperature range:	15-35℃	24℃
Humidity range:	25-75%	56%
Pressure range:	86-106kPa	980kPa

2.7. Test Facility

Shenzhen Alpha Product Testing Co., Ltd
Building i, No.2, Lixin Road, Fuyong Street, Bao'an District, 518103,
Shenzhen, Guangdong, China

June 21, 2018 File on Federal Communication Commission
Registration Number: 293961

July 15, 2019 Certificated by IC
Registration Number: 12135A

2.8. Measurement Uncertainty

(95% confidence levels, k=2)

Item	**Uncertainty**
Uncertainty for Power point Conducted Emissions Test	1.63dB
Uncertainty for Radiation Emission test in 3m chamber (below 30MHz)	3.5dB
Uncertainty for Radiation Emission test in 3m chamber (30MHz to 1GHz)	3.74dB(Polarize: V)
	3.76dB(Polarize: H)
Uncertainty for Radiation Emission test in 3m chamber (1GHz to 25GHz)	3.77dB(Polarize: V)
	3.80dB(Polarize: H)
Uncertainty for Radiation Emission test in 3m chamber (18GHz to 40GHz)	4.31 dB(Polarize: V)
	4.30 dB(Polarize: H)
Uncertainty for radio frequency	5.06×10^{-8}GHz
Uncertainty for conducted RF Power	0.40dB
Uncertainty for temperature	0.2℃
Uncertainty for humidity	1%
Uncertainty for DC and low frequency voltages	0.06%

2.9. Test Equipment List

Equipment	Manufacture	Model No.	Firmware version	Serial No.	Last cal.	Cal Interval
9*6*6 anechoic chamber	CHENYU	9*6*6	/	N/A	2022.05.17	3Year
Spectrum analyzer	ROHDE&SCHWARZ	FSV40-N	2.3	102137	2023.08.16	1Year
Spectrum analyzer	Agilent	N9020A	A.14.16	MY499100060	2023.08.16	1Year
Receiver	ROHDE&SCHWARZ	ESR	2.28 SP1	1316.3003K03-102082-Wa	2023.08.16	1Year
Receiver	R&S	ESCI	4.42 SP1	101165	2023.08.16	1Year
Bilog Antenna	Schwarzbeck	VULB 9168	/	VULB 9168#627	2023.08.28	1Year
Horn Antenna	SCHWARZBECK	BBHA 9120 D	/	2106	2023.08.19	1Year
Loop Antenna	SCHWARZBECK	FMZB 1519B	/	00128	2023.08.19	1Year
RF Cable	Resenberger	Cable 1	/	RE1	2023.08.16	1Year
RF Cable	Resenberger	Cable 2	/	RE2	2023.08.16	1Year
RF Cable	Resenberger	Cable 3	/	CE1	2023.08.16	1Year
Pre-amplifier	HP	HP8347A	/	2834A00455	2023.08.16	1Year
Pre-amplifier	Agilent	8449B	/	3008A02664	2023.08.16	1Year
L.I.S.N.#1	Schwarzbeck	NSLK8126	/	8126-466	2023.08.16	1Year
L.I.S.N.#2	ROHDE&SCHWARZ	ENV216	/	101043	2023.08.16	1Year
Horn Antenna	SCHWARZBECK	BBHA 9170	/	00946	2023.08.19	1Year
Preamplifier	SKET	LNPA_1840-50	/	SK2018101801	2023.08.16	1 Year
Power Meter	Agilent	E9300A	/	MY41496628	2023.08.16	1 Year
Power Sensor	DARE	RPR3006W	/	15100041SNO91	2023.08.16	1 Year
Temp. & Humid. Chamber	Teelong	TL-HW408S	/	TL-20191205-01	2023.07.25	1 Year
Switching Mode Power Supply	JUNKE	JK12010S	/	20140927-6	2023.08.16	1 Year
Adjustable attenuator	MWRFtest	N/A	/	N/A	N/A	N/A
10dB Attenuator	Mini-Circuits	DC-6G	/	N/A	N/A	N/A

Software Information			
Test Item	Software Name	Manufacturer	Version
RE	EZ-EMC	EZ	Alpha-3A1
CE	EZ-EMC	EZ	Alpha-3A1
RF-CE	MTS 8310	MW	V2.0.0.0

3. MAXIMUM PEAK OUTPUT POWER

3.1. Limit

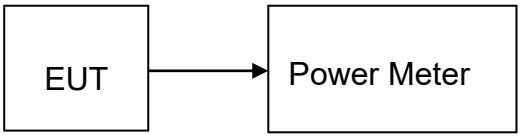
Please refer section 15.247 & RSS-247

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. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts, the e.i.r.p shall not exceed 4W

3.2. Test Procedure

The transmitter output is connected to the RF Power Meter. The RF Power Meter is set to the peak power detection.

3.3. Test Setup



3.4. Test Result

Condition	Mode	Frequency (MHz)	Antenna	Conducted power(dBm)	Limit (dBm)	Verdict
NVNT	1-DH1	2402	Ant1	1.003	21	Pass
NVNT	1-DH1	2441	Ant1	0.609	21	Pass
NVNT	1-DH1	2480	Ant1	-0.829	21	Pass
NVNT	1-DH3	2441	Ant1	0.348	21	Pass
NVNT	1-DH5	2441	Ant1	-0.022	21	Pass
NVNT	2-DH1	2402	Ant1	0.388	21	Pass
NVNT	2-DH1	2441	Ant1	0.442	21	Pass
NVNT	2-DH1	2480	Ant1	-1.317	21	Pass
NVNT	2-DH3	2441	Ant1	1.464	21	Pass
NVNT	2-DH5	2441	Ant1	1.476	21	Pass
NVNT	3-DH1	2402	Ant1	1.496	21	Pass
NVNT	3-DH1	2441	Ant1	1.521	21	Pass
NVNT	3-DH1	2480	Ant1	-0.063	21	Pass
NVNT	3-DH3	2441	Ant1	1.549	21	Pass
NVNT	3-DH5	2441	Ant1	1.698	21	Pass

4. BANDWIDTH

4.1. Limit

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in RSS-GEN, FCC Section 15.247(a)(1), must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated..

4.2. Test Procedure

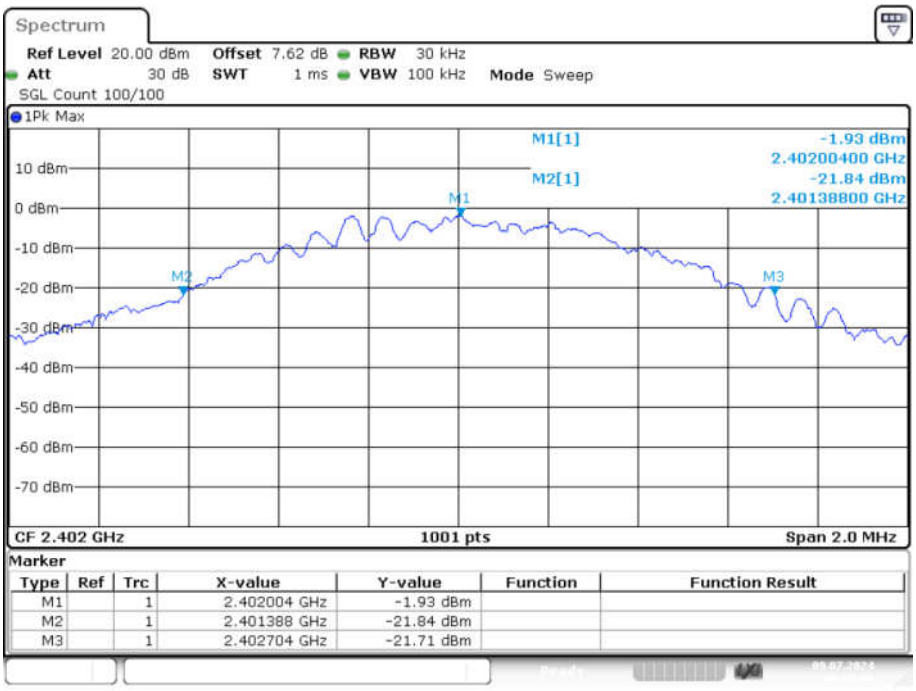
The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 30kHz RBW and 100kHz VBW. The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

4.3. Test Result

-20dB Bandwidth

Condition	Mode	Frequency (MHz)	Antenna	-20 dB Bandwidth (MHz)	Limit -20 dB Bandwidth (MHz)	Verdict
NVNT	1-DH1	2402	Ant1	1.316	/	Pass
NVNT	1-DH1	2441	Ant1	1.318	/	Pass
NVNT	1-DH1	2480	Ant1	1.318	/	Pass
NVNT	2-DH1	2402	Ant1	1.378	/	Pass
NVNT	2-DH1	2441	Ant1	1.376	/	Pass
NVNT	2-DH1	2480	Ant1	1.374	/	Pass
NVNT	3-DH1	2402	Ant1	1.376	/	Pass
NVNT	3-DH1	2441	Ant1	1.408	/	Pass
NVNT	3-DH1	2480	Ant1	1.412	/	Pass

-20dB Bandwidth NVNT 1-DH1 2402MHz Ant1



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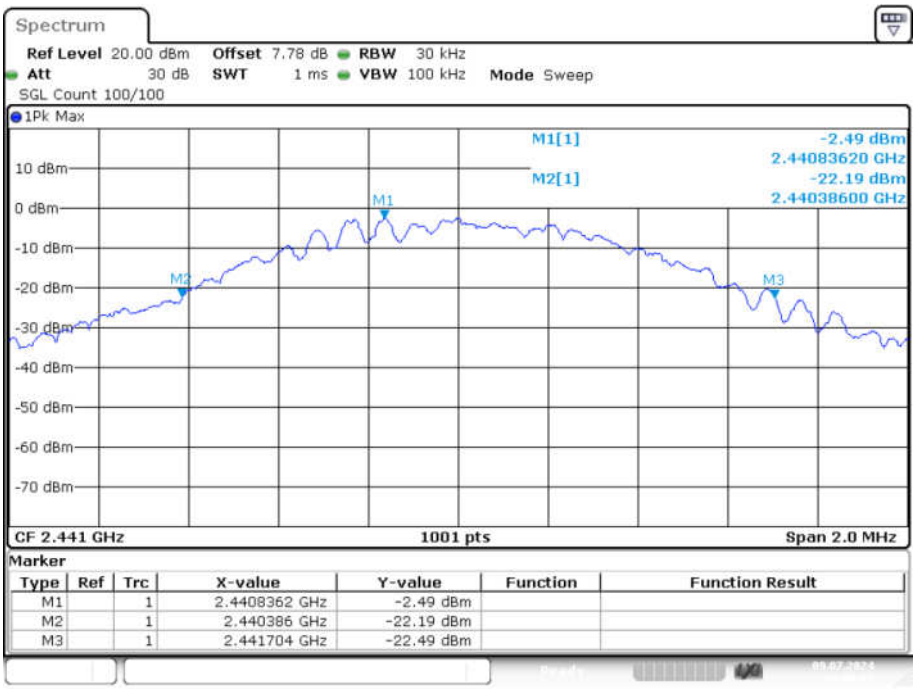
-20dB Bandwidth NVNT 1-DH1 2441MHz Ant1



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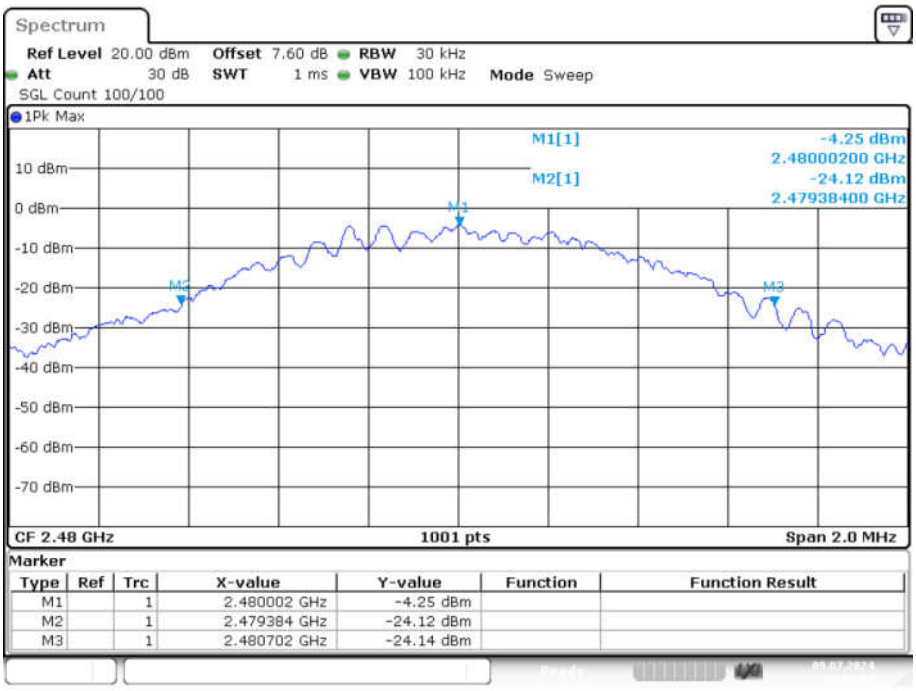

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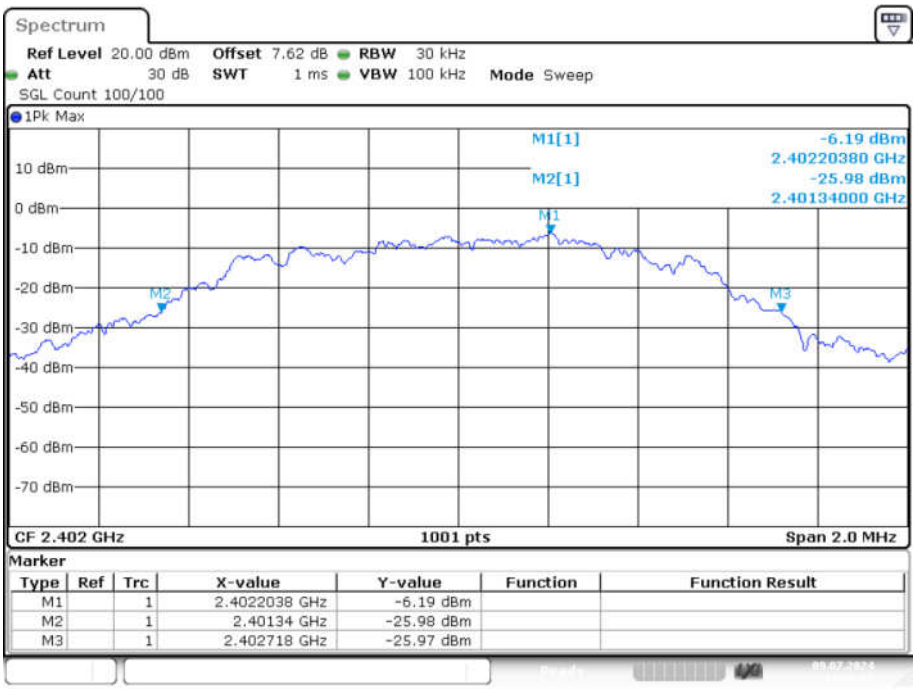
-20dB Bandwidth NVNT 2-DH1 2402MHz Ant1



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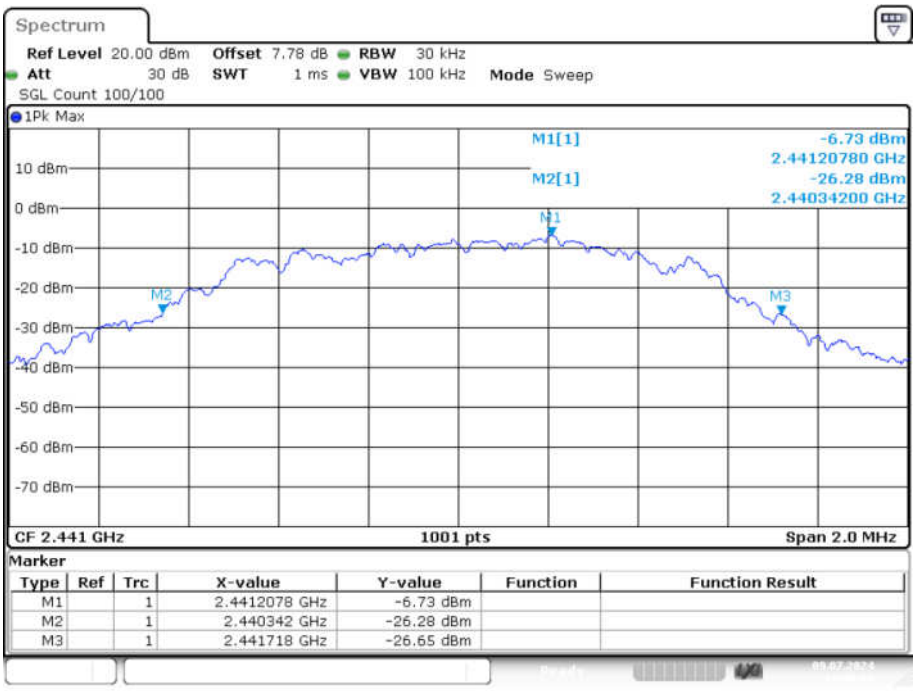
-20dB Bandwidth NVNT 2-DH1 2441MHz Ant1



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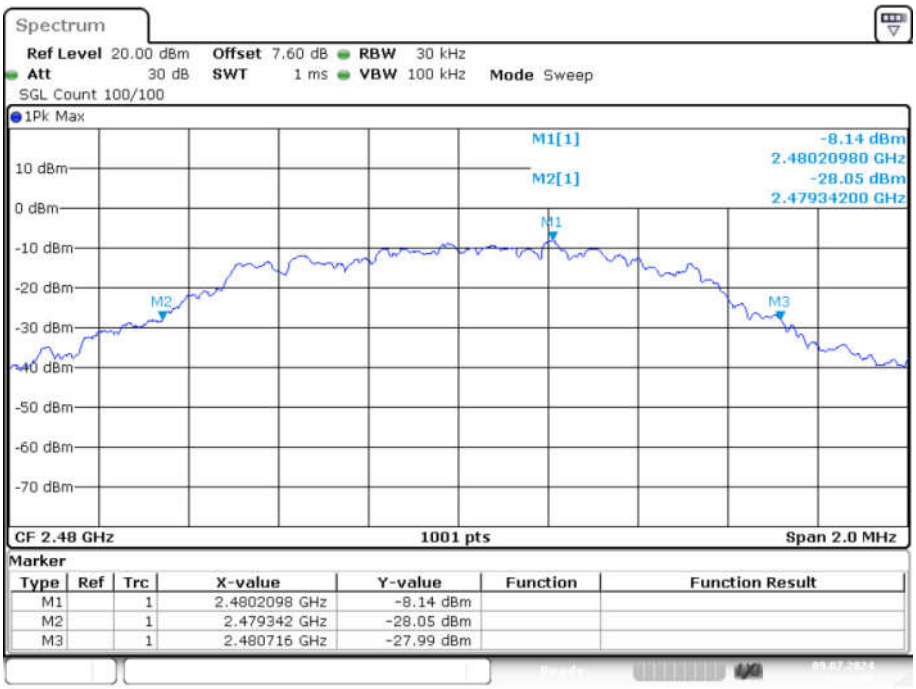
-20dB Bandwidth NVNT 2-DH1 2480MHz Ant1



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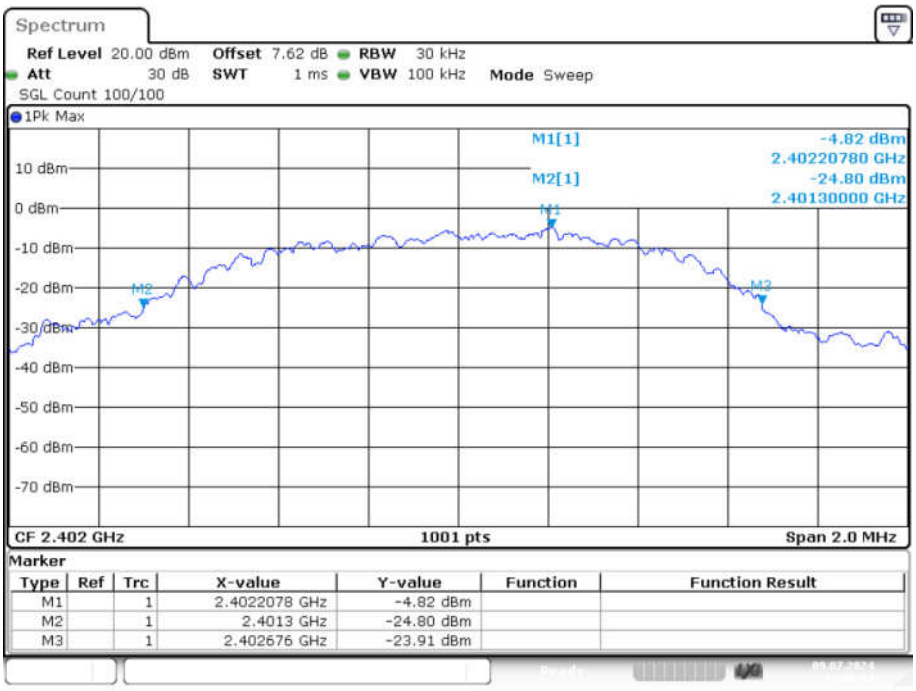
-20dB Bandwidth NVNT 3-DH1 2402MHz Ant1



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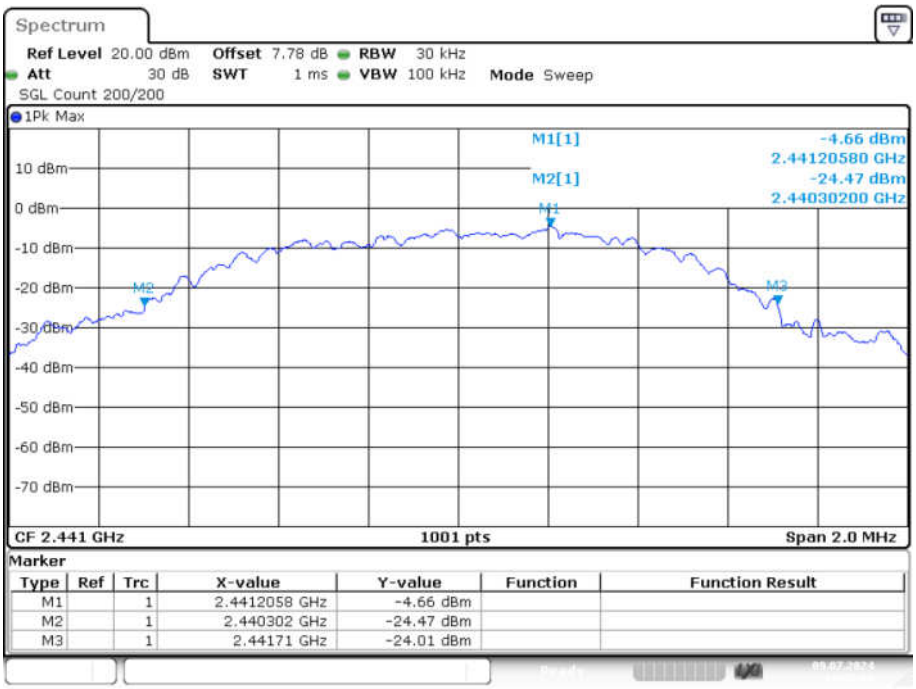
-20dB Bandwidth NVNT 3-DH1 2441MHz Ant1



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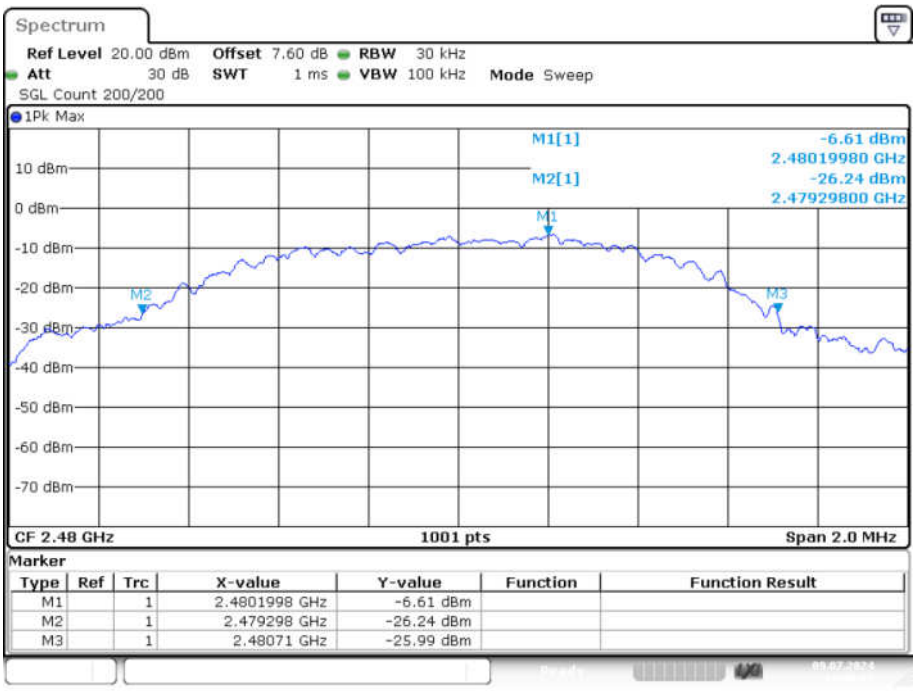
-20dB Bandwidth NVNT 3-DH1 2480MHz Ant1



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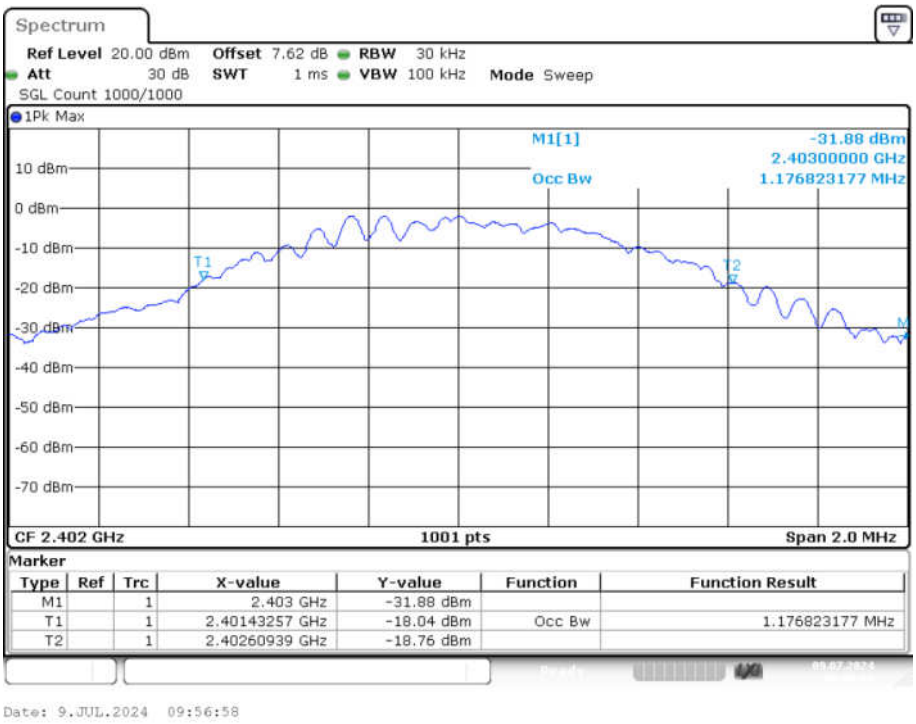
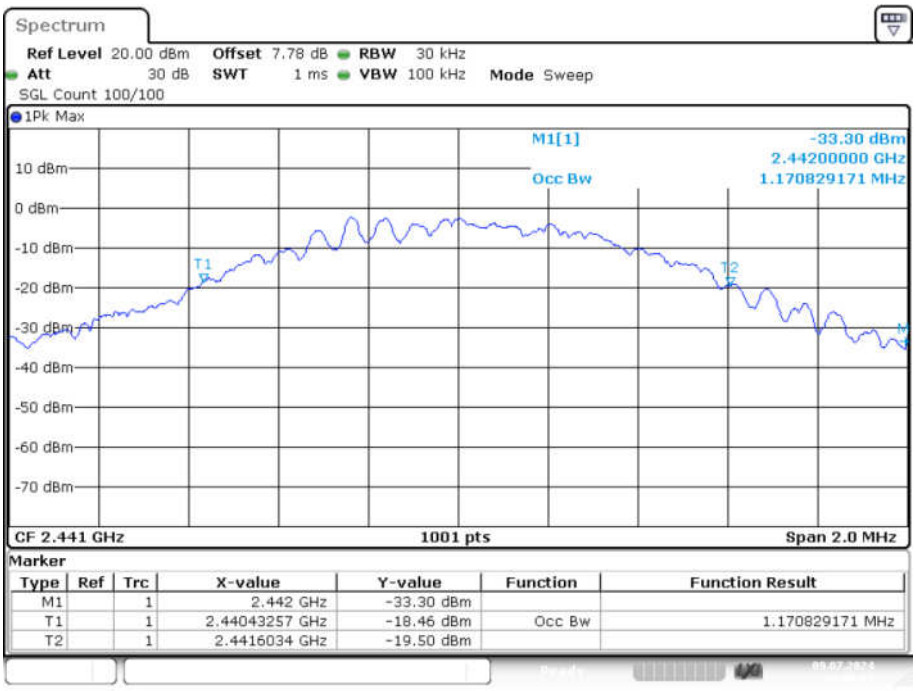
Occupied Channel Bandwidth

Condition	Mode	Frequency (MHz)	Antenna	99% OBW (MHz)
NVNT	1-DH1	2402	Ant1	1.177
NVNT	1-DH1	2441	Ant1	1.171
NVNT	1-DH1	2480	Ant1	1.173
NVNT	2-DH1	2402	Ant1	1.233
NVNT	2-DH1	2441	Ant1	1.225
NVNT	2-DH1	2480	Ant1	1.227
NVNT	3-DH1	2402	Ant1	1.245
NVNT	3-DH1	2441	Ant1	1.239
NVNT	3-DH1	2480	Ant1	1.239

OBW NVNT 1-DH1 2402MHz Ant1



OBW NVNT 1-DH1 2441MHz Ant1



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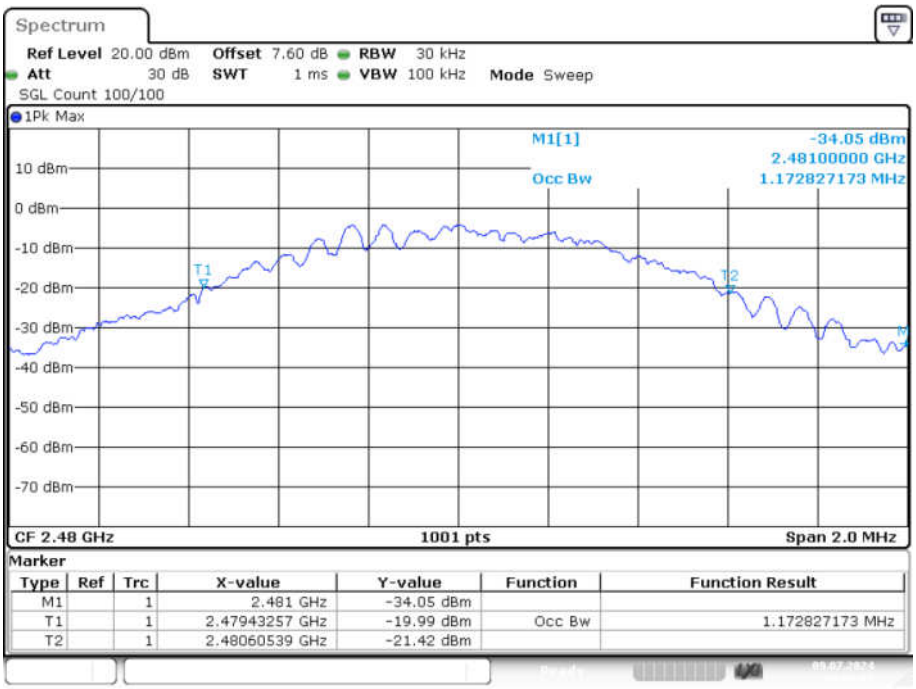
OBW NVNT 1-DH1 2480MHz Ant1



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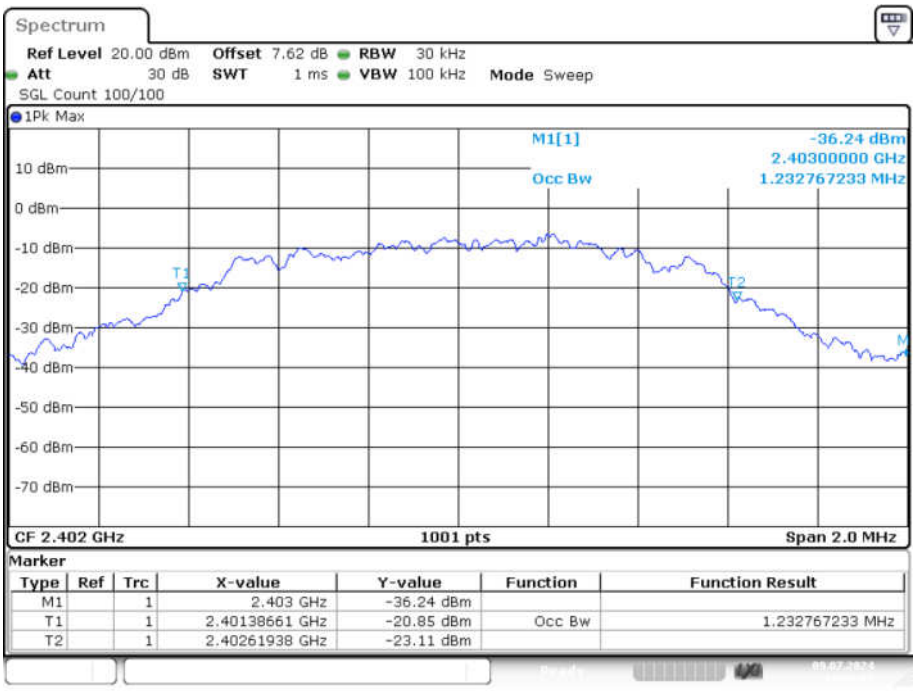
OBW NVNT 2-DH1 2402MHz Ant1



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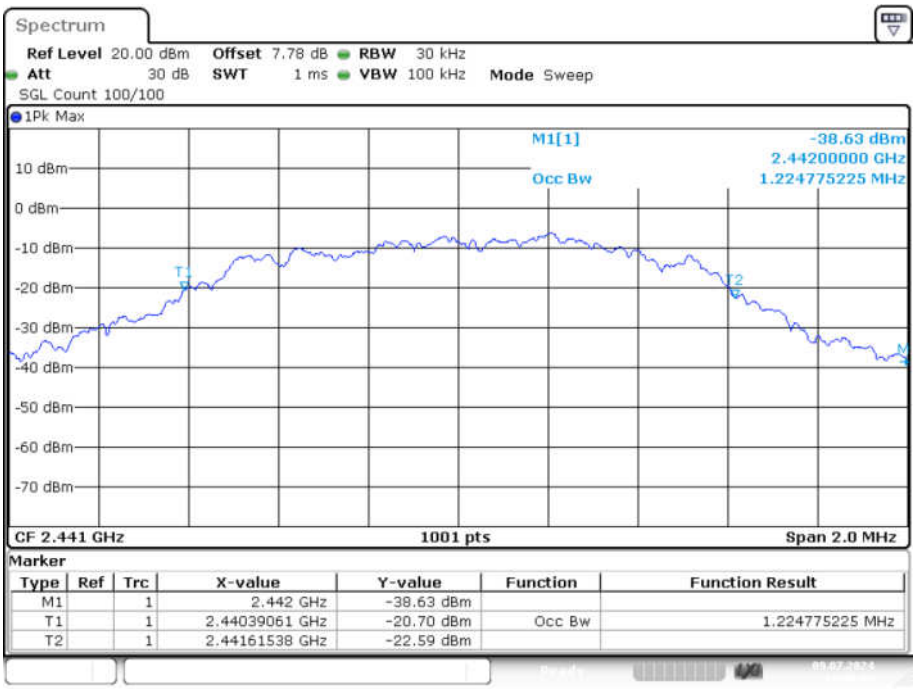
OBW NVNT 2-DH1 2441MHz Ant1



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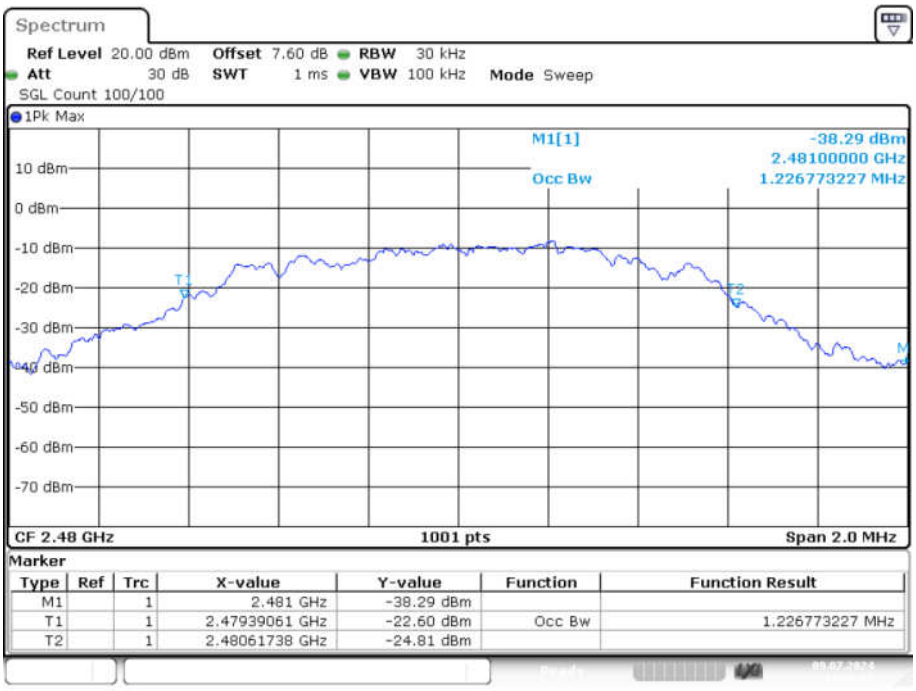
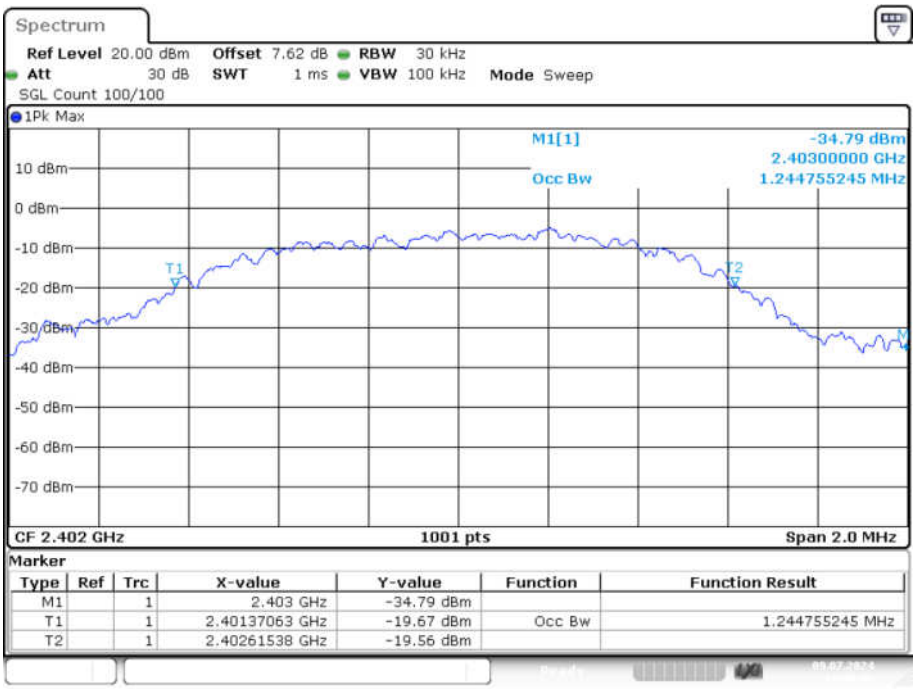
OBW NVNT 2-DH1 2480MHz Ant1



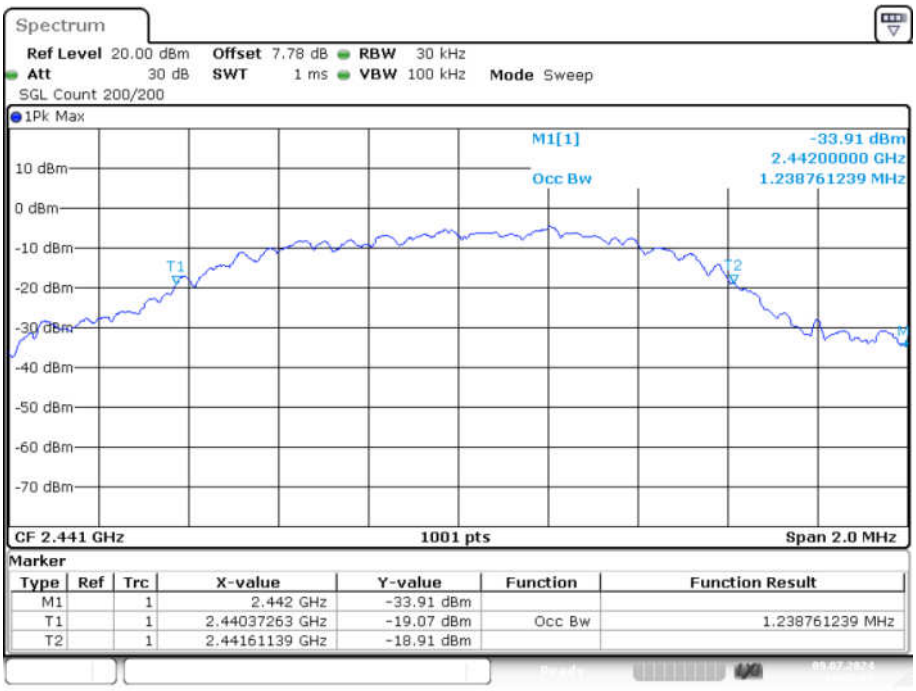
Date: 9.JUL.2024 11:52:47

OBW NVNT 3-DH1 2402MHz Ant1



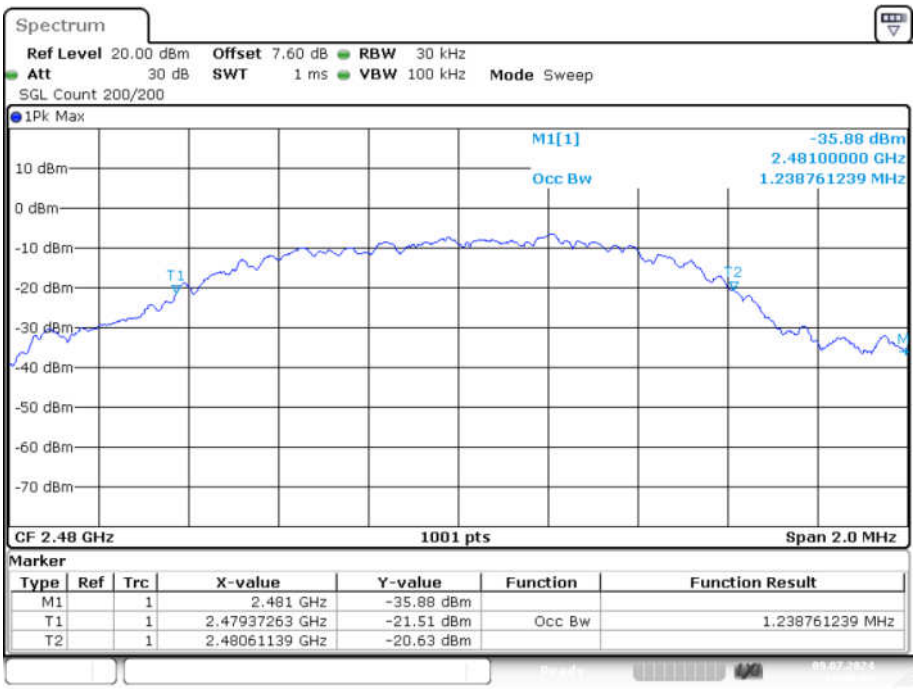
Date: 9.JUL.2024 12:39:45

OBW NVNT 3-DH1 2441MHz Ant1



Date: 9.JUL.2024 12:47:02

OBW NVNT 3-DH1 2480MHz Ant1



Date: 9.JUL.2024 12:49:42

5. CARRIER FREQUENCY SEPARATION

5.1. Limit

Frequency hopping systems shall have hopping 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

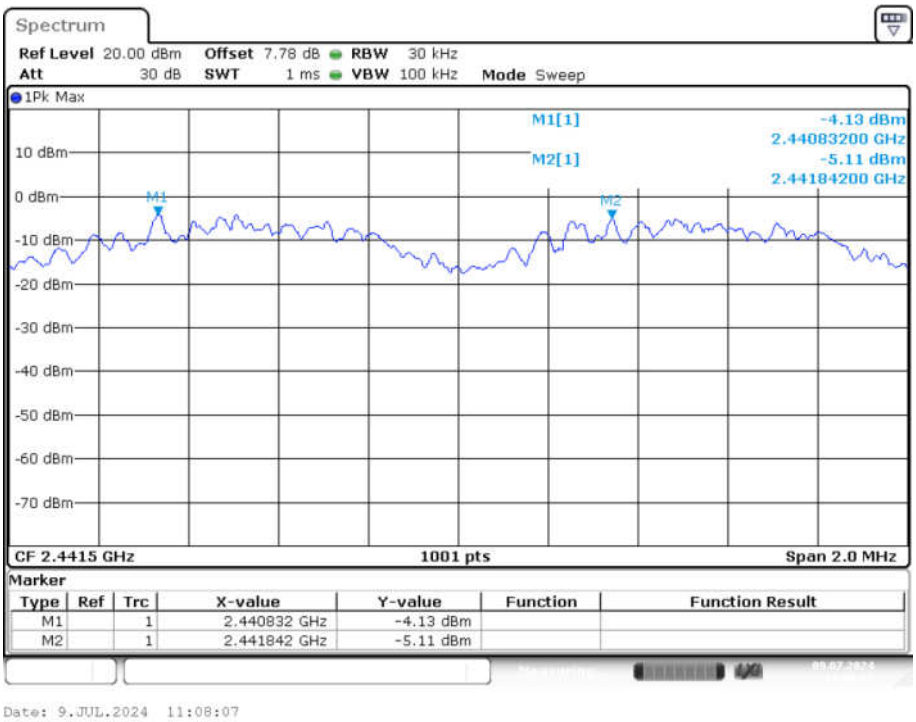
5.2. Test Procedure

The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The carrier frequency was measured by spectrum analyzer with 30kHz RBW and 100kHz VBW.

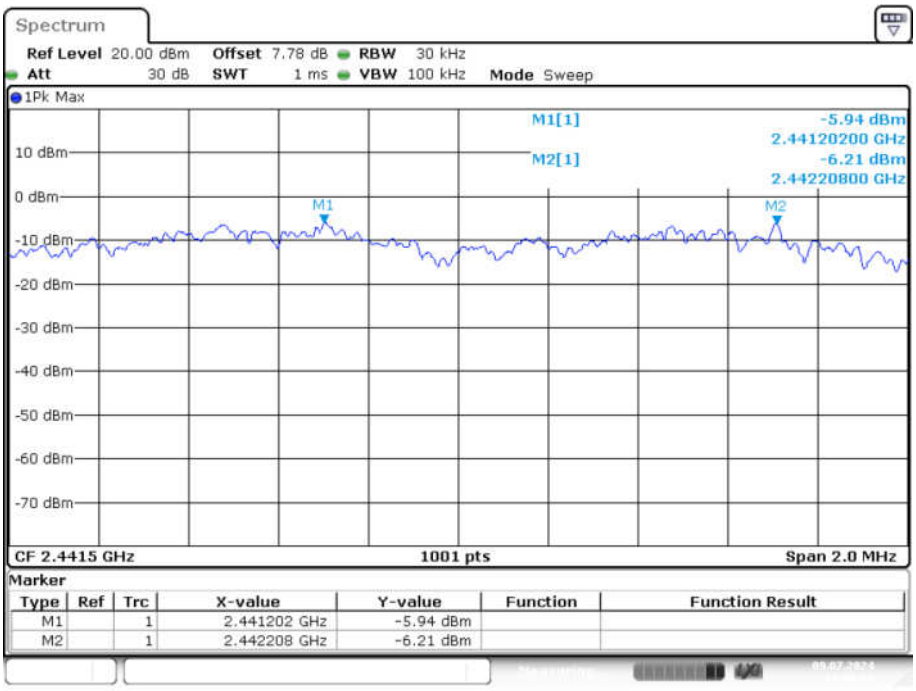
5.3. Test Result

Condition	Mode	Antenna	Hopping Freq1 (MHz)	Hopping Freq2 (MHz)	HFS (MHz)	Limit (MHz)	Verdict
NVNT	1-DH1	Ant1	2440.832	2441.842	1.01	0.87	Pass
NVNT	2-DH1	Ant1	2441.202	2442.208	1.006	0.918	Pass
NVNT	3-DH1	Ant1	2441.206	2442.206	1	0.941	Pass

CFS NVNT 1-DH1 2441MHz Ant1

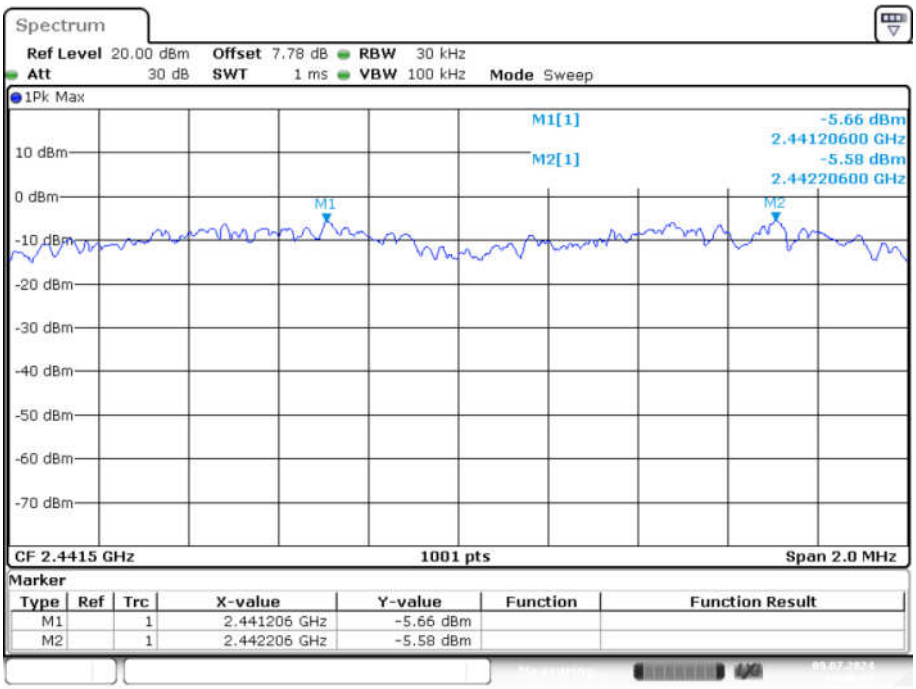


CFS NVNT 2-DH1 2441MHz Ant1



Date: 9.JUL.2024 12:00:50

CFS NVNT 3-DH1 2441MHz Ant1



Date: 9.JUL.2024 14:30:20

6. NUMBER OF HOPPING CHANNEL

6.1. Limit

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels

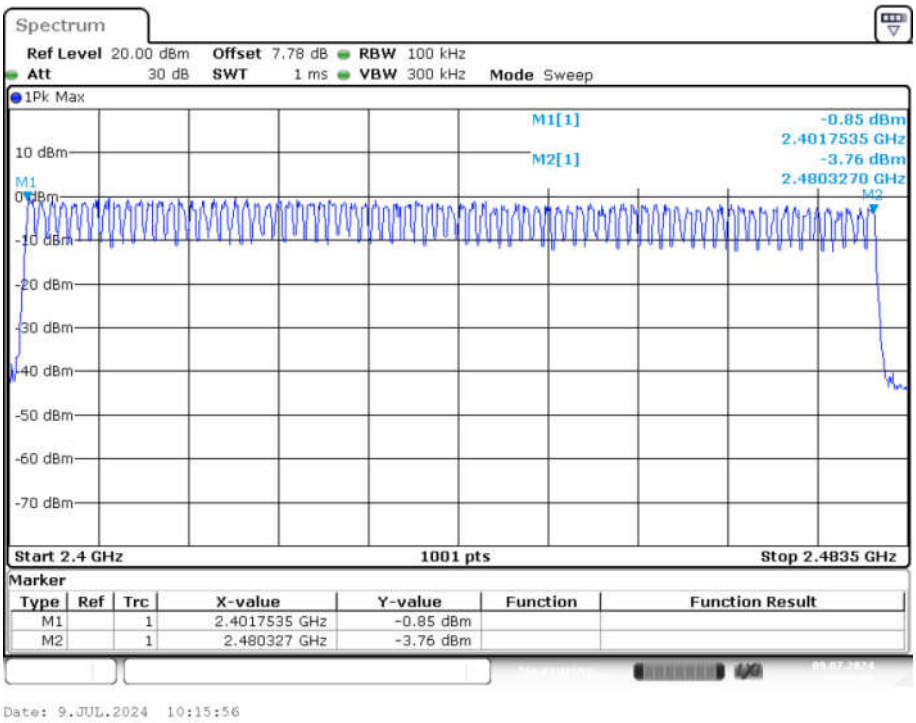
6.2. Test Procedure

The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The number of hopping channel was measured by spectrum analyzer with 100kHz RBW and 300KHz VBW.

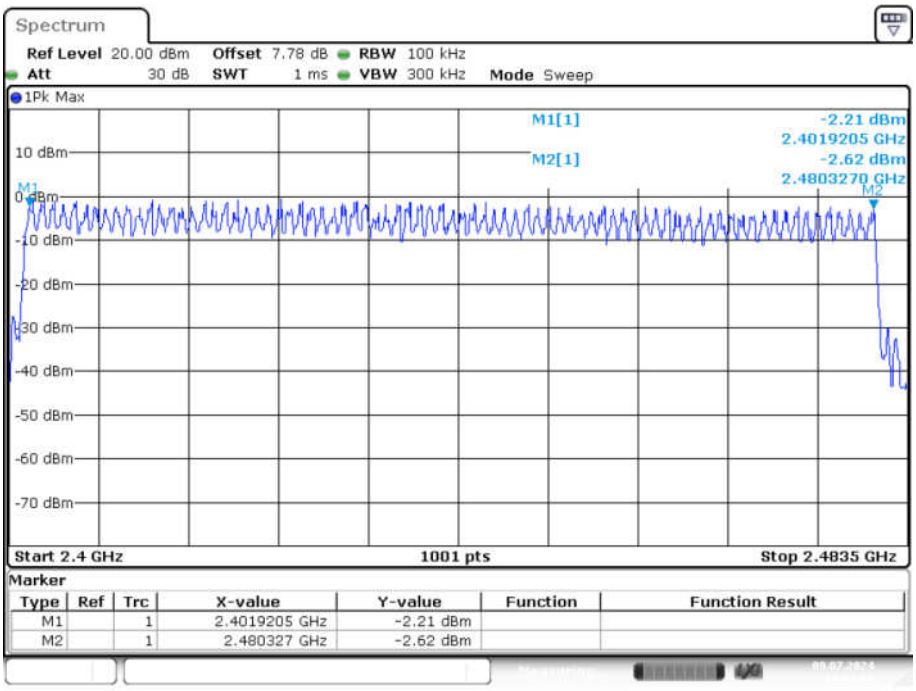
6.3. Test Result

Condition	Mode	Antenna	Hopping Number	Limit	Verdict
NVNT	1-DH1	Ant1	79	15	Pass
NVNT	2-DH1	Ant1	79	15	Pass
NVNT	3-DH1	Ant1	79	15	Pass

Hopping No. NVNT 1-DH1 2441MHz Ant1

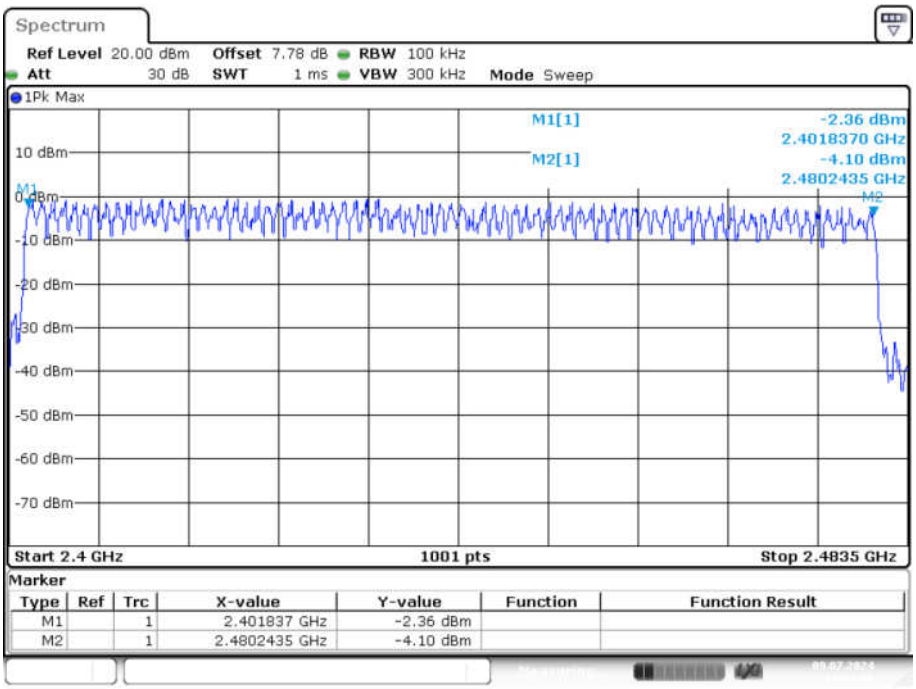


Hopping No. NVNT 2-DH1 2441MHz Ant1



Date: 9.JUL.2024 12:04:17

Hopping No. NVNT 3-DH1 2441MHz Ant1



Date: 9.JUL.2024 14:33:47

7. DWELL TIME

7.1. Test limit

Please refer section15.247 & RSS-247.

According to §15.247(a)(1)(iii), Frequency hopping systems operating in the 2400MHz-2483.5 MHz. The average time of occupancy on any frequency shall not greater than 0.4 s within period of 0.4 sec- onds multiplied by the number of hopping channel employed.

7.2. Test Procedure

7.2.1. Place the EUT on the table and set it in transmitting mode.

7.2.2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

7.2.3. Set center frequency of spectrum analyzer = operating frequency.

7.2.4. Set the spectrum analyzer as RBW=1MHz, VBW=3MHz, Span = 0Hz, Sweep = auto.

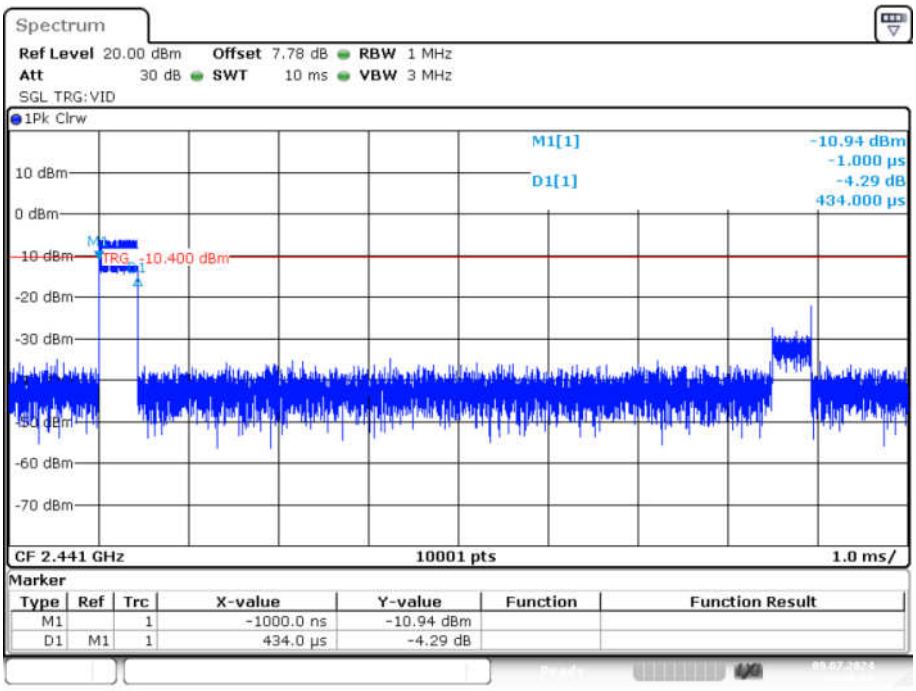
7.2.5. Repeat above procedures until all frequency measured were complete.

7.3. Test Result

Condition	Mode	Frequency (MHz)	Antenna	Pulse Time (ms)	Total Dwell Time (ms)	Burst Count	Period Time (ms)	Limit (ms)	Verdict
NVNT	1-DH1	2441	Ant1	0.434	23.436	54	31600	400	Pass
NVNT	1-DH3	2441	Ant1	1.632	71.808	44	31600	400	Pass
NVNT	1-DH5	2441	Ant1	2.833	118.986	42	31600	400	Pass
NVNT	2-DH1	2441	Ant1	0.492	50.184	102	31600	400	Pass
NVNT	2-DH3	2441	Ant1	1.692	71.064	42	31600	400	Pass
NVNT	2-DH5	2441	Ant1	1.092	46.956	43	31600	400	Pass
NVNT	3-DH1	2441	Ant1	0.418	41.8	100	31600	400	Pass
NVNT	3-DH3	2441	Ant1	1.672	76.912	46	31600	400	Pass
NVNT	3-DH5	2441	Ant1	2.765	96.775	35	31600	400	Pass

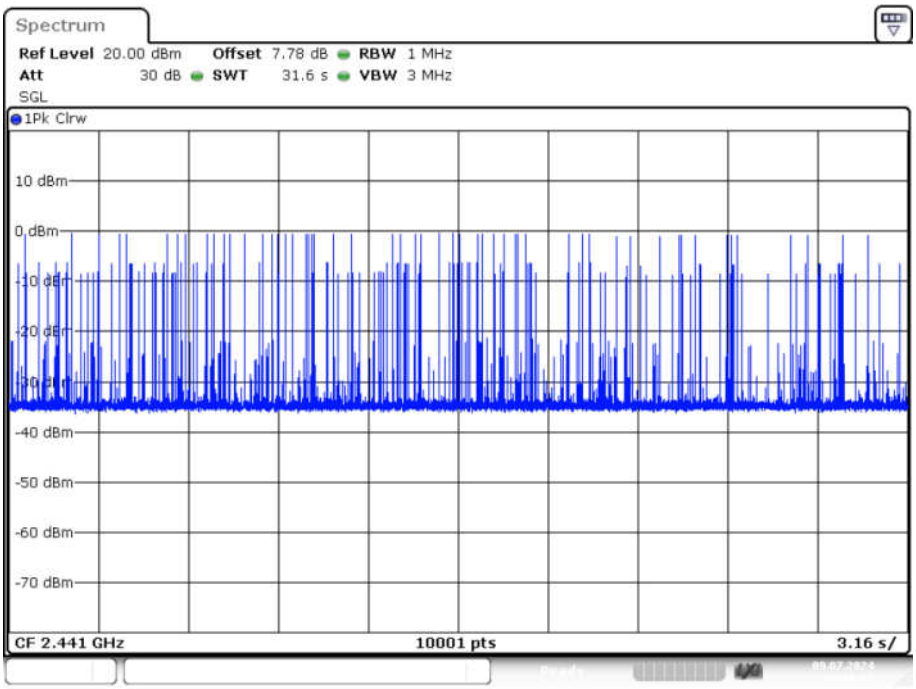
Note: Total Dwell Time= Pulse Time* Burst Count

Dwell NVNT 1-DH1 2441MHz Ant1 One Burst



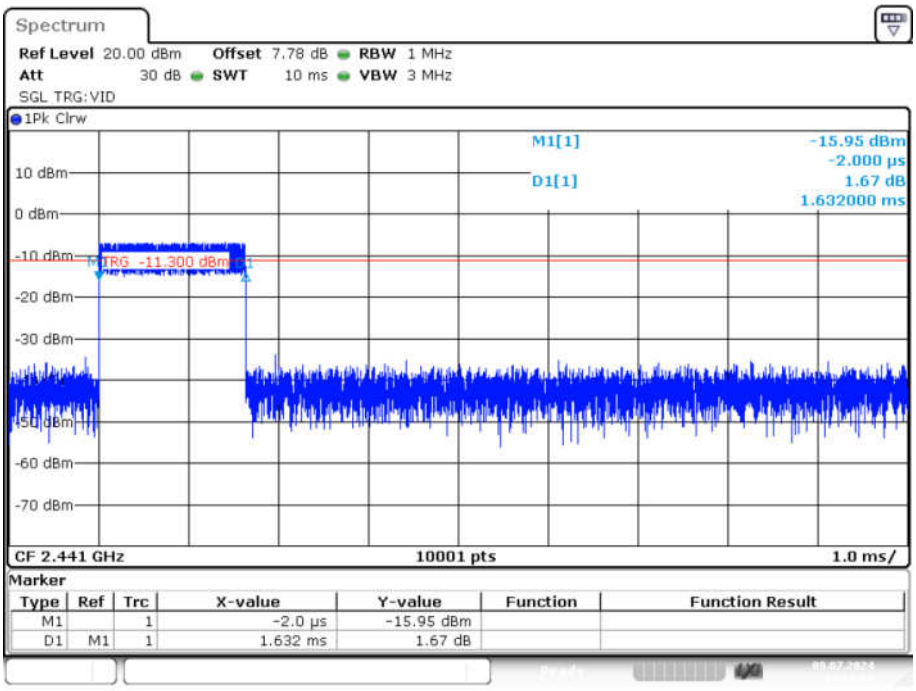
Date: 9.JUL.2024 10:16:03

Dwell NVNT 1-DH1 2441MHz Ant1 Accumulated



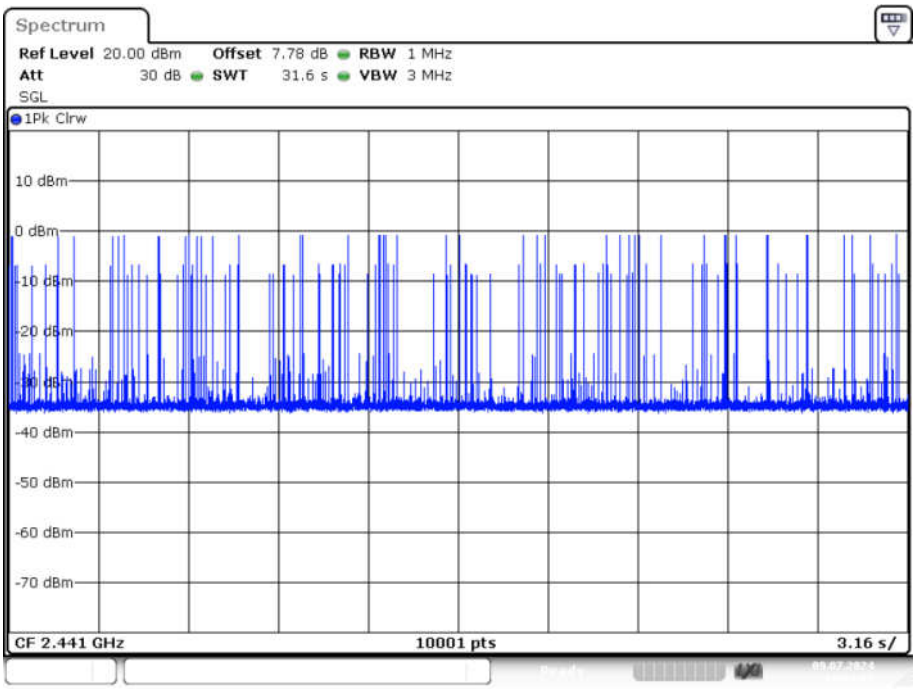
Date: 9.JUL.2024 10:16:38

Dwell NVNT 1-DH3 2441MHz Ant1 One Burst



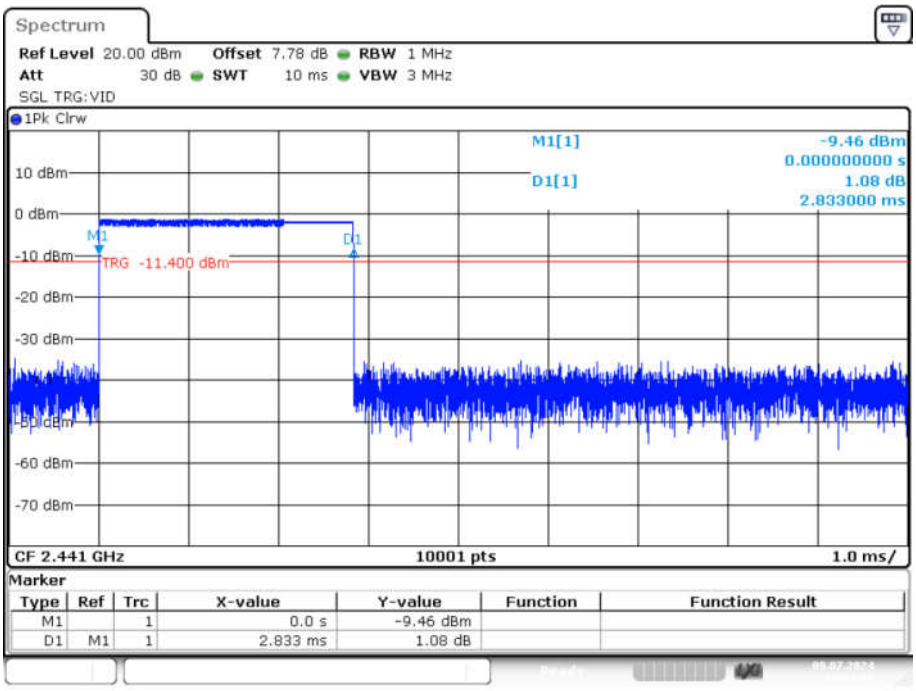
Date: 9.JUL.2024 11:12:51

Dwell NVNT 1-DH3 2441MHz Ant1 Accumulated



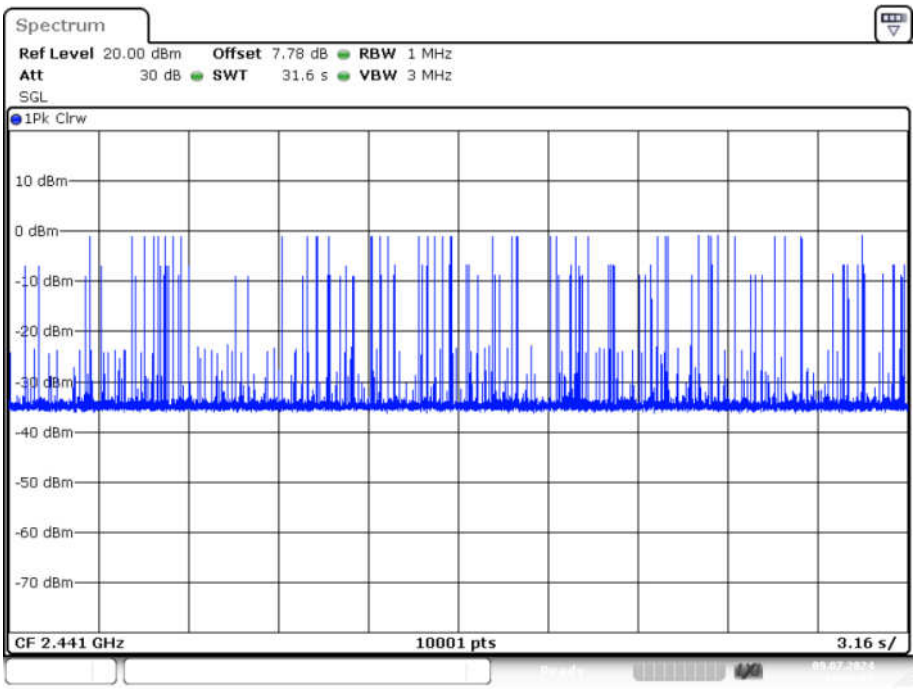
Date: 9.JUL.2024 11:13:25

Dwell NVNT 1-DH5 2441MHz Ant1 One Burst



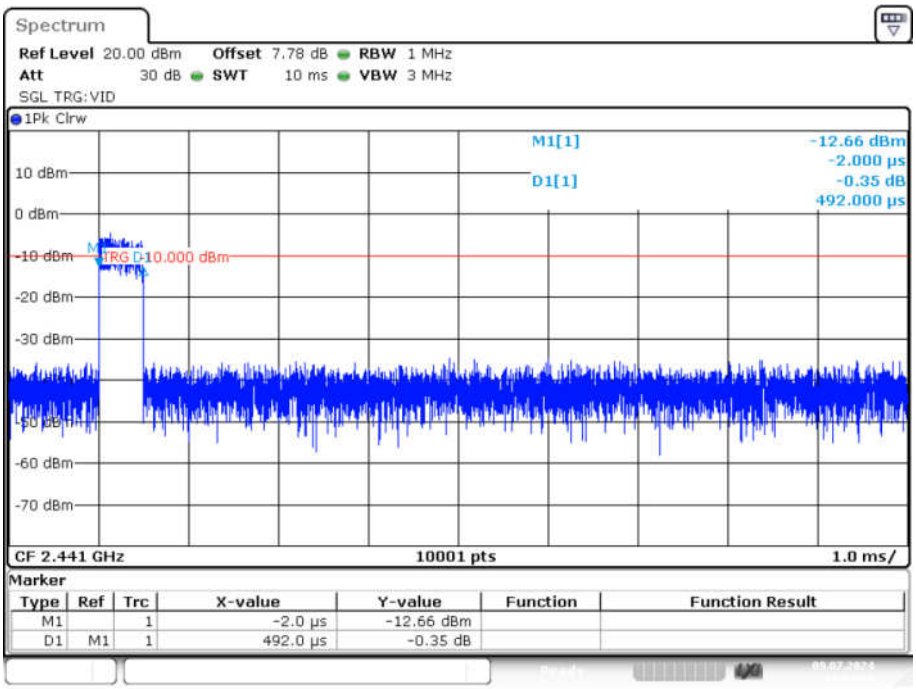
Date: 9.JUL.2024 11:14:52

Dwell NVNT 1-DH5 2441MHz Ant1 Accumulated



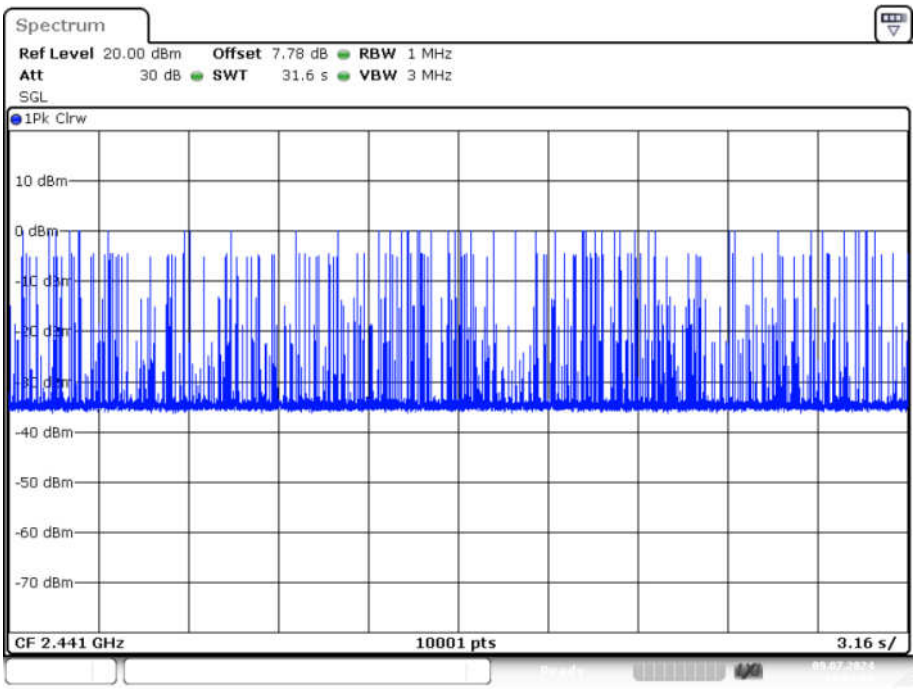
Date: 9.JUL.2024 11:15:27

Dwell NVNT 2-DH1 2441MHz Ant1 One Burst



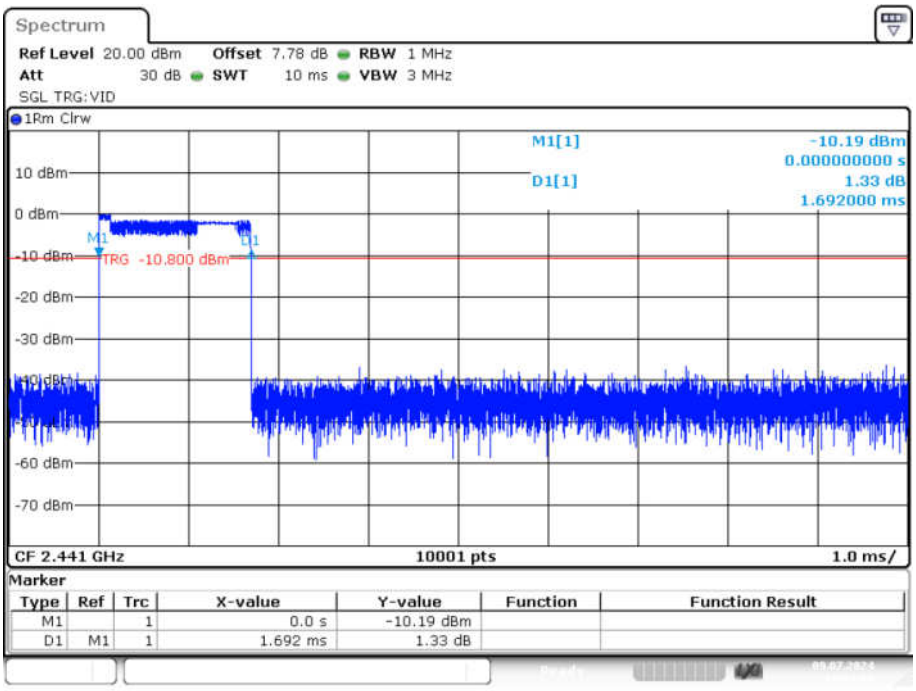
Date: 9.JUL.2024 12:04:24

Dwell NVNT 2-DH1 2441MHz Ant1 Accumulated



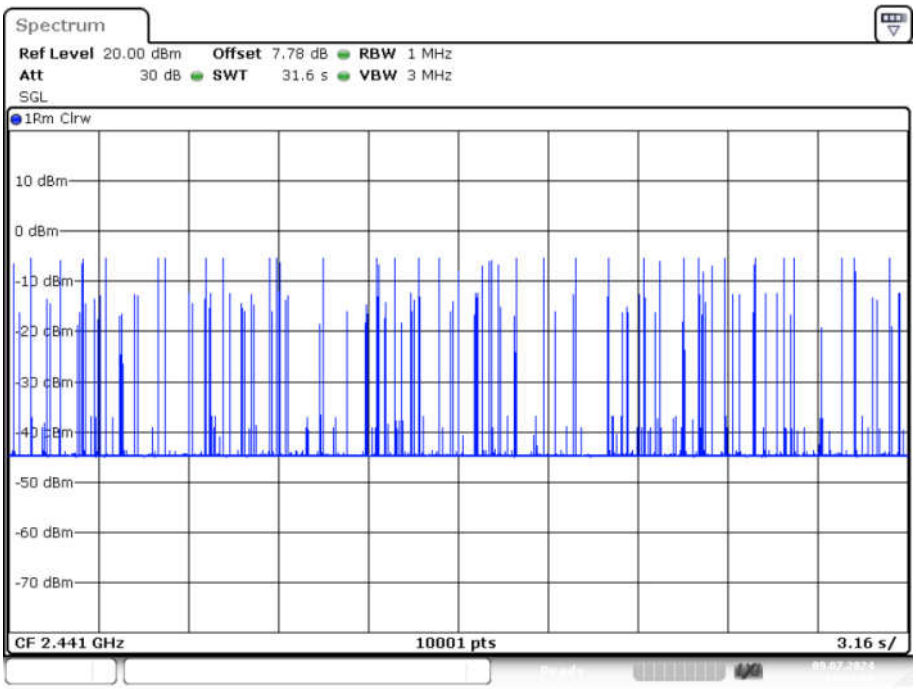
Date: 9.JUL.2024 12:04:58

Dwell NVNT 2-DH3 2441MHz Ant1 One Burst



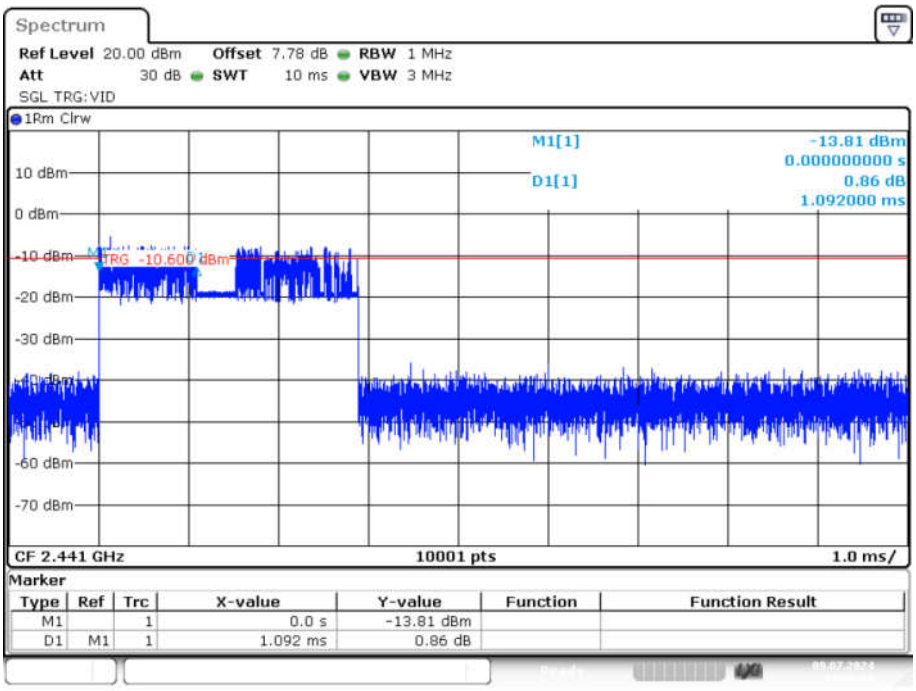
Date: 9.JUL.2024 12:33:15

Dwell NVNT 2-DH3 2441MHz Ant1 Accumulated



Date: 9.JUL.2024 12:33:49

Dwell NVNT 2-DH5 2441MHz Ant1 One Burst



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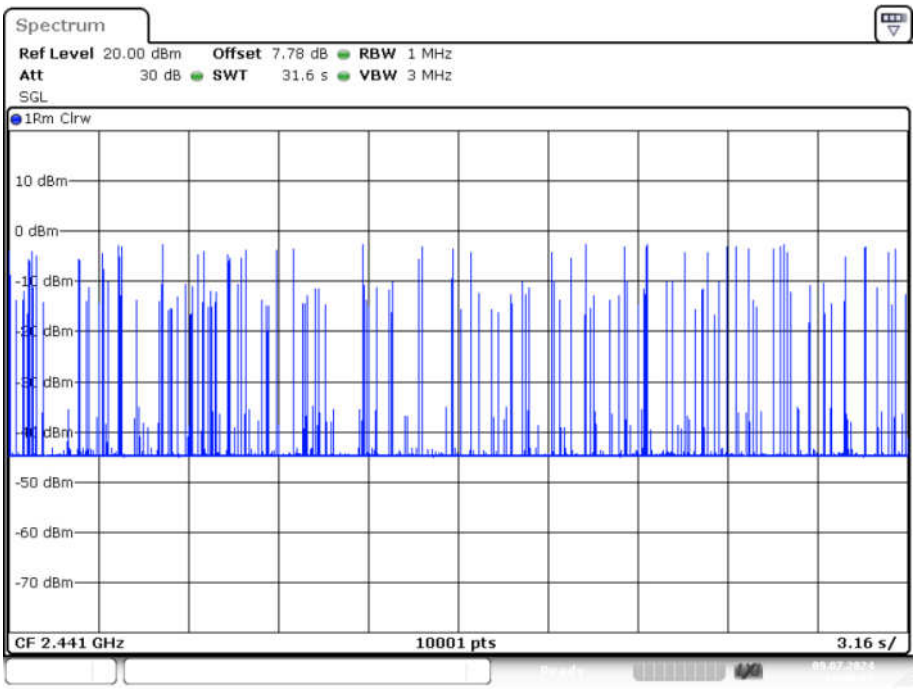
Dwell NVNT 2-DH5 2441MHz Ant1 Accumulated



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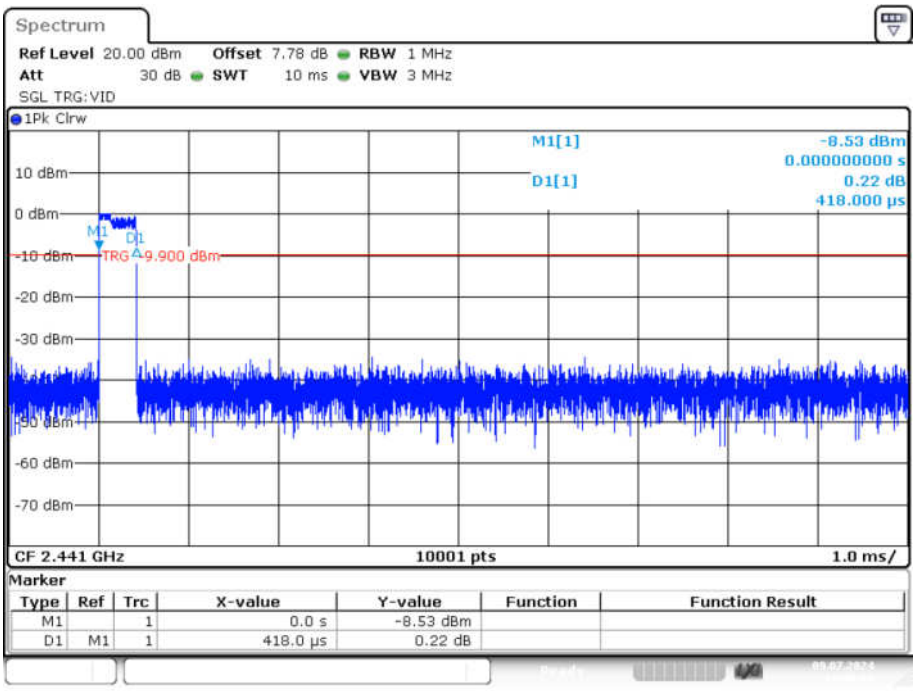
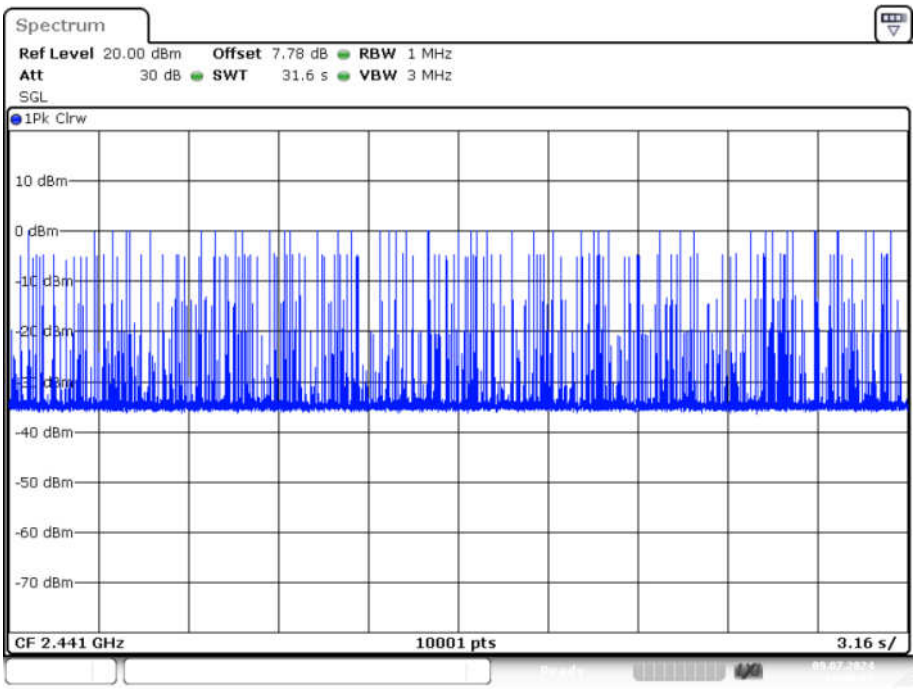
Dwell NVNT 3-DH1 2441MHz Ant1 One Burst



Date: 9.JUL.2024 14:49:20

Dwell NVNT 3-DH1 2441MHz Ant1 Accumulated



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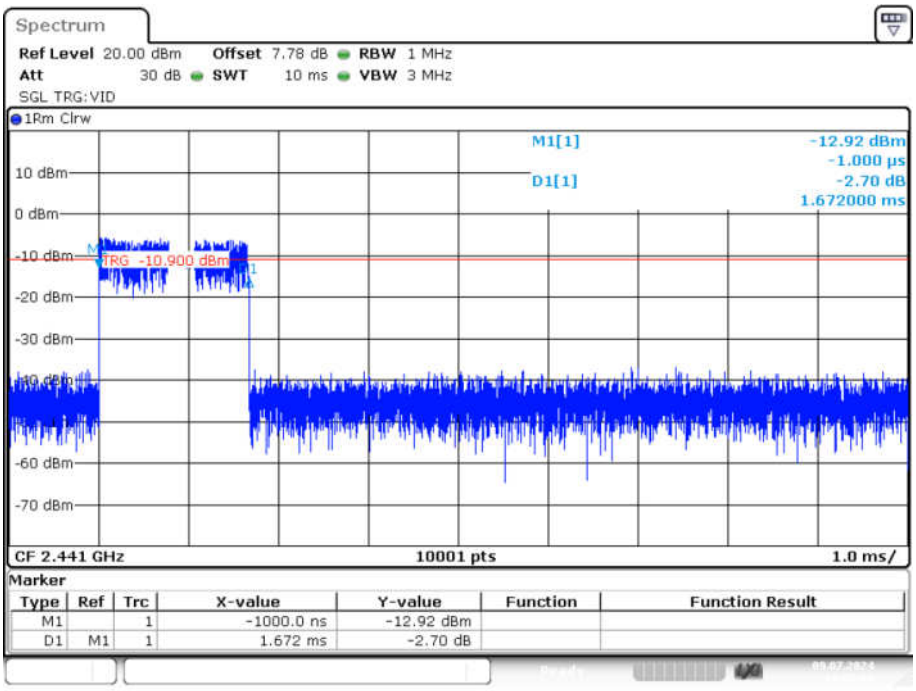
Dwell NVNT 3-DH3 2441MHz Ant1 One Burst



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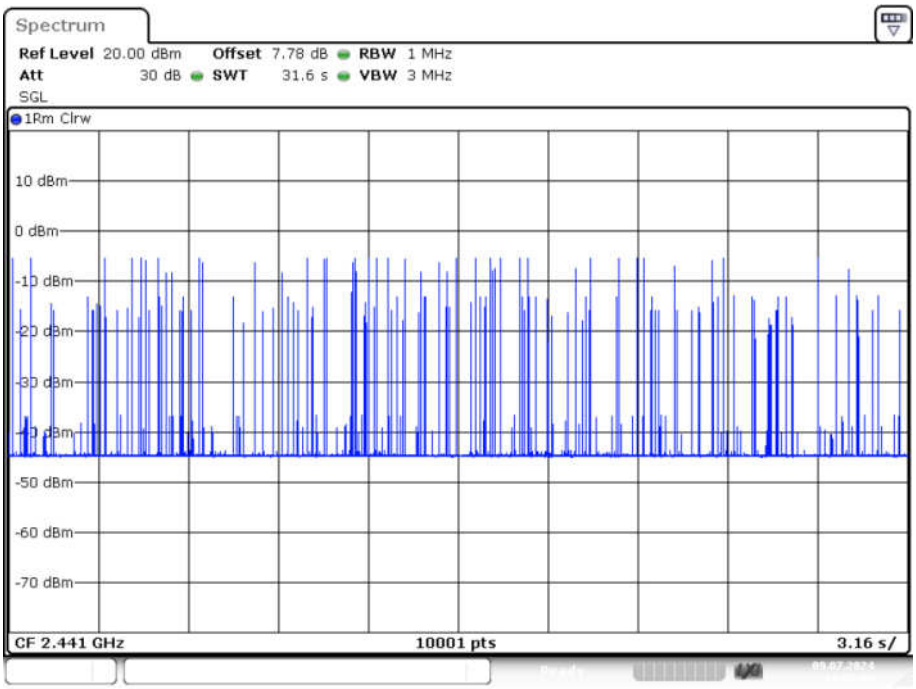
Dwell NVNT 3-DH3 2441MHz Ant1 Accumulated



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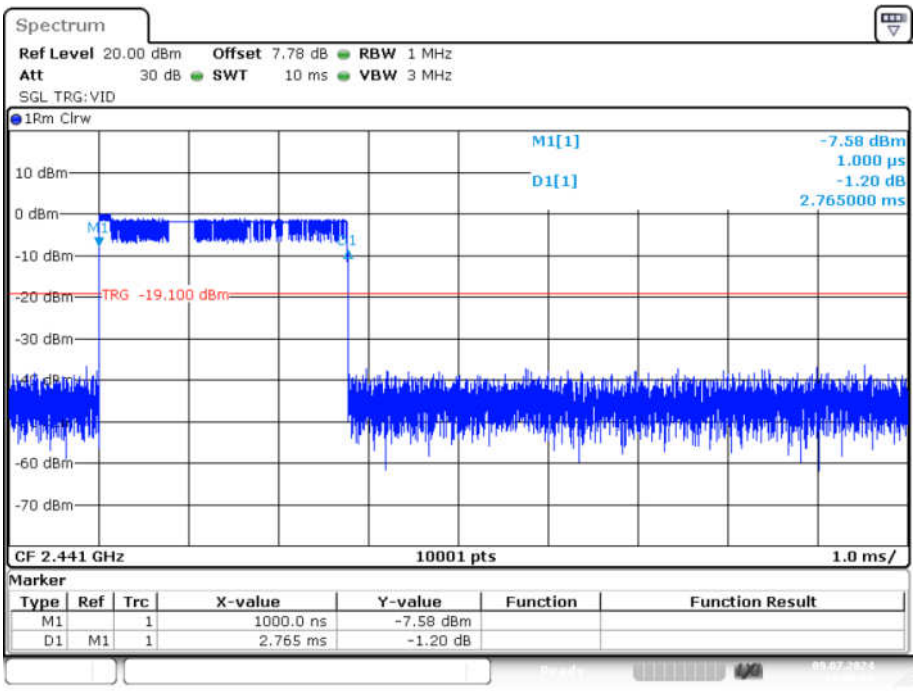
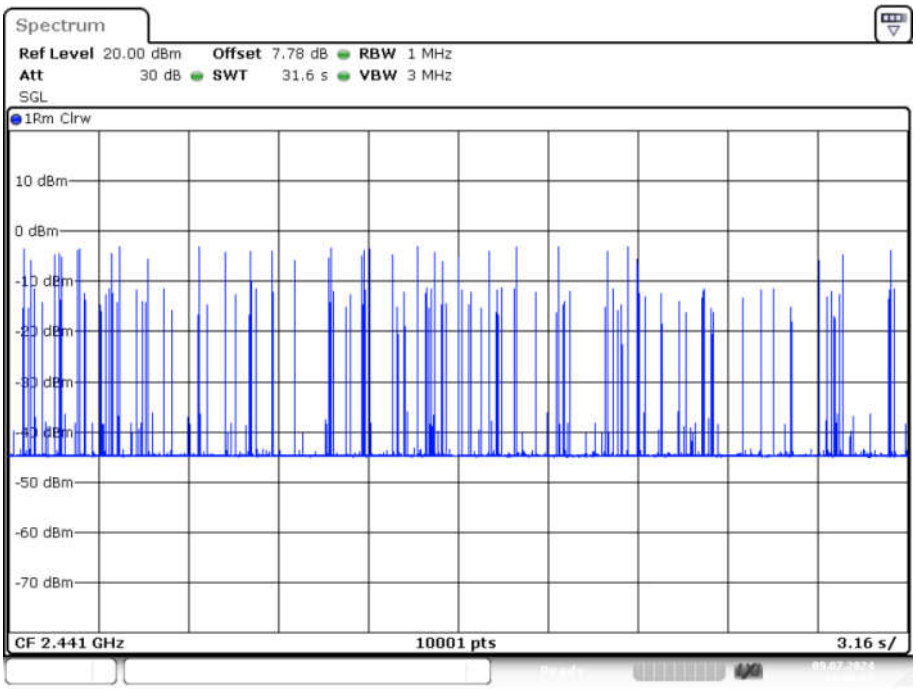
Dwell NVNT 3-DH5 2441MHz Ant1 One Burst



Date: 9.JUL.2024 14:56:17

Dwell NVNT 3-DH5 2441MHz Ant1 Accumulated



Date: 9.JUL.2024 14:56:52

8. RADIATED EMISSIONS

8.1. Limit

All the emissions appearing within 15.205 restricted frequency bands shall not exceed the limits shown in 15.209, all the other emissions shall be at least 20dB below the fundamental emissions, or comply with 15.209 limits.

15.205 Restricted frequency band

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])

RSS-GEN Restricted frequency band

Table 7 – Restricted frequency bands Note 1

MHz	MHz	GHz
0.090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 – 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0

6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 – 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 – 8500	
108 – 138		

Note 1: Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

15.209 Limit

FREQUENCY MHz	DISTANCE Meters	FIELD STRENGTHS LIMIT	
		μV/m	dB(μV)/m
0.009-0.490	300	2400/F(KHz)	/
0.490-1.705	30	24000/F(KHz)	/
1.705-30	30	30	29.5
30 ~ 88	3	100	40.0
88 ~ 216	3	150	43.5
216 ~ 960	3	200	46.0
960 ~ 1000	3	500	54.0
Above 1000	3	74.0 dB(μV)/m (Peak) 54.0 dB(μV)/m (Average)	

Note: The peak limit is 20 dB higher than the average limit

Table 5 – General field strength limits at frequencies above 30 MHz

Frequency (MHz)	Field strength (μV/m at 3 m)
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

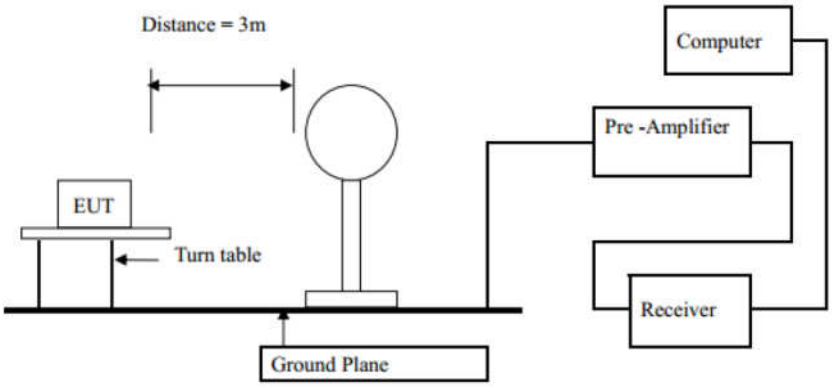
Table 6 – General field strength limits at frequencies below 30 MHz

Frequency	Magnetic field strength (H-Field) (μA/m)	Measurement distance (m)
9 - 490 kHz Note 1	6.37/F (F in kHz)	300
490 - 1705 kHz	63.7/F (F in kHz)	30
1.705 - 30 MHz	0.08	30

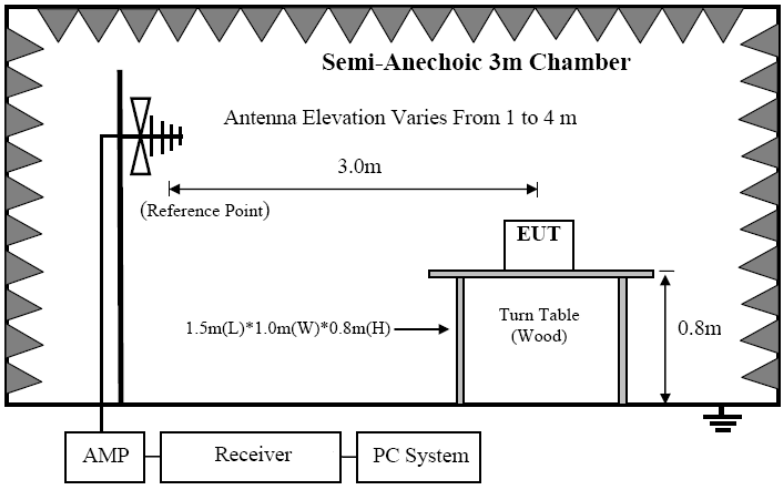
Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

8.2. Block Diagram of Test setup

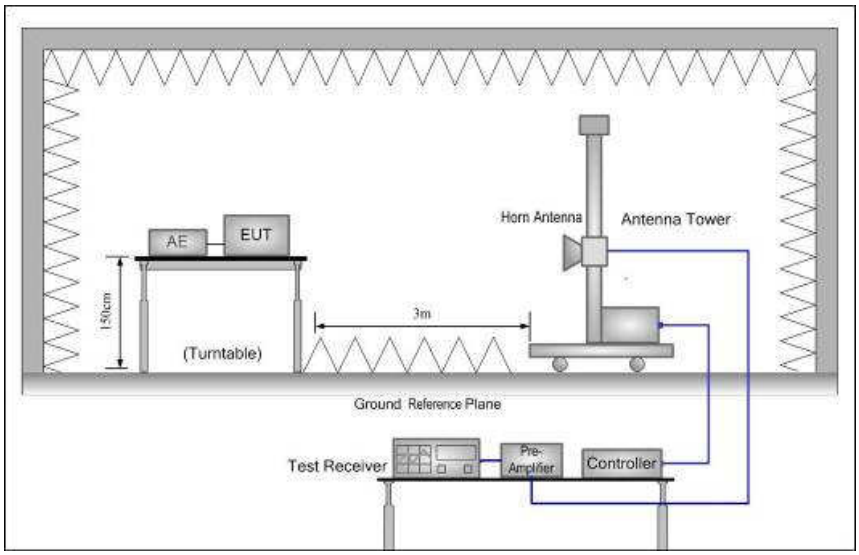
8.2.1 In 3m Anechoic Chamber Test Setup Diagram for below 30MHz



8.2.1 In 3m Anechoic Chamber Test Setup Diagram for below 1GHz



8.2.2 In 3m Anechoic Chamber Test Setup Diagram for frequency above 1GHz



Note: For harmonic emissions test a appropriate high pass filter was inserted in the input port of AMP.

8.3. Test Procedure

(1) EUT was placed on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber.

(2) Setup EUT and simulator as shown in section 1.4 and 6.1

(3) Test antenna was located 3m from the EUT on an adjustable mast. Below pre-scan procedure was first performed in order to find prominent radiated emissions.

(a) Change work frequency or channel of device if practicable.

(b) Change modulation type of device if practicable.

(c) Rotated EUT though three orthogonal axes to determine the attitude of EUT arrangement produces highest emissions

(4) Spectrum frequency from 9KHz to 25GHz (tenth harmonic of fundamental frequency) was investigated

(5) For final emissions measurements at each frequency of interest, the EUT were rotated and the antenna height was varied between 1m and 4m in order to maximize the emission. Measurements in both horizontal and vertical polarities were made and the data was recorded. In order to find the maximum emission, the relative positions of equipments and all of the interface cables were changed according to ANSI C63.10:2013on Radiated Emission test.

(6) For emissions above 1GHz, both Peak and Average level were measured with Spectrum Analyzer, and the RBW is set at 1MHz, VBW is set at 3MHz for Peak measure; RBW is set at 1MHz, VBW is set at 10Hz for Average measure.

8.4. Test Result

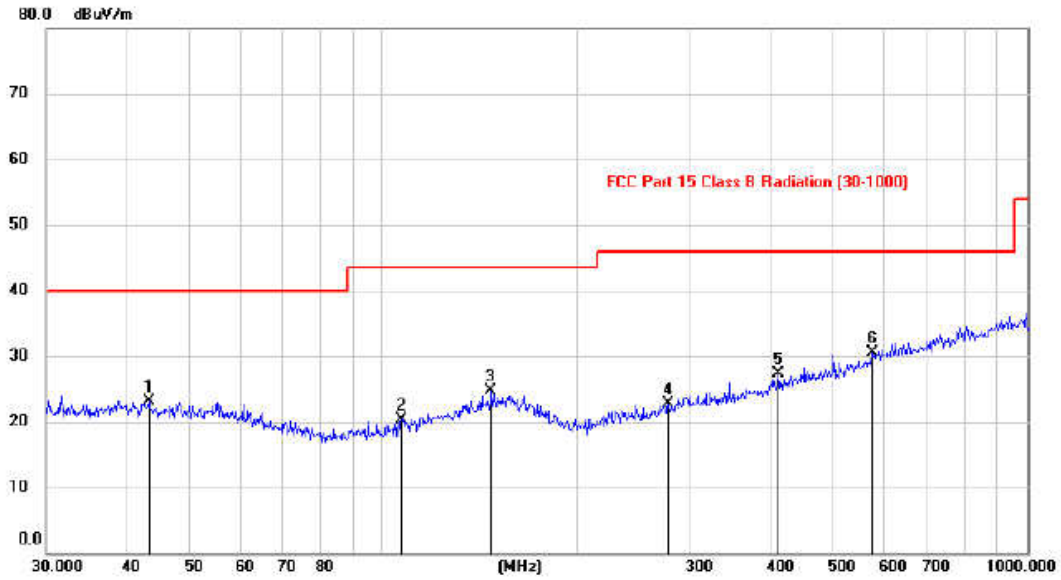
We have scanned the 10th harmonic from 9KHz to the EUT's highest frequency.
Detailed information please see the following page.

From 9KHz to 30MHz: Conclusion: PASS

Note: The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

From 30MHz to 1000MHz: Conclusion: PASS

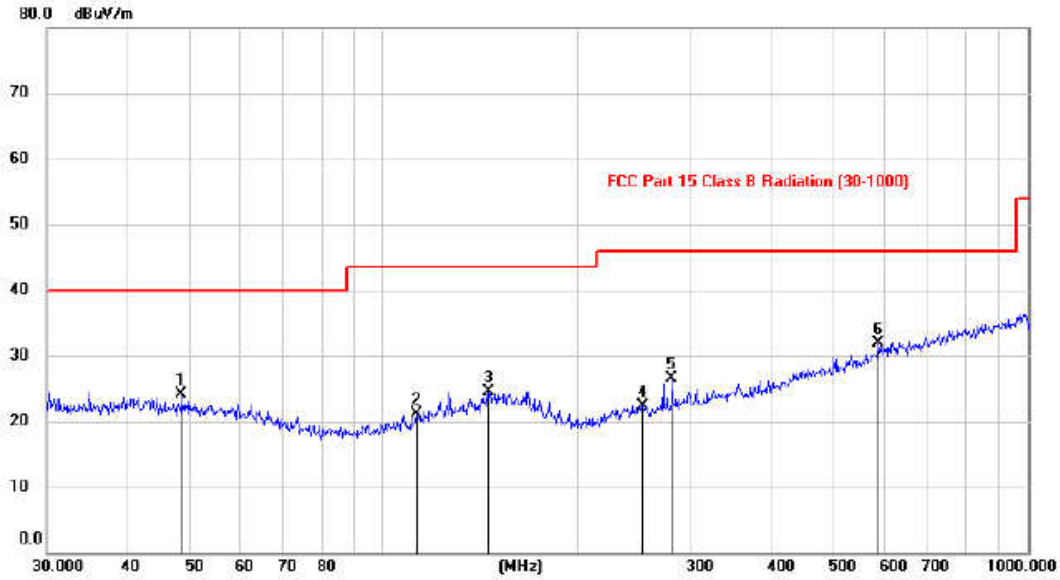
Vertical:



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		43.2674	8.87	14.22	23.09	40.00	-16.91	peak			
2		107.0711	8.84	11.54	20.38	43.50	-23.12	peak			
3		147.3692	9.90	14.86	24.76	43.50	-18.74	peak			
4		277.6447	9.28	13.50	22.78	46.00	-23.22	peak			
5		410.5744	10.75	16.50	27.25	46.00	-18.75	peak			
6	*	575.3651	10.73	19.69	30.42	46.00	-15.58	peak			

Note:1. *:Maximum data; x:Over limit; !:over margin.
2.Measurement=Reading Level+Correct Factor; Correct Factor=Antenna Factor+Cable Loss.

Horizontal:



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		48.5413	10.02	14.06	24.08	40.00	-15.92	peak			
2		112.3404	8.96	12.11	21.07	43.50	-22.43	peak			
3		145.7759	9.83	14.75	24.58	43.50	-18.92	peak			
4		252.2986	9.52	12.82	22.34	46.00	-23.66	peak			
5		280.1548	12.89	13.57	26.46	46.00	-19.54	peak			
6	*	585.6103	11.97	19.94	31.91	46.00	-14.09	peak			

Note:1. *:Maximum data; x:Over limit; !:over margin.
2.Measurement=Reading Level+Correct Factor; Correct Factor=Antenna Factor+Cable Loss.

Remark: All modes have been tested, and only worst data of GFSK 2402MHz was listed in this report.

From 1G-25GHz

Test Mode: GFSK TX Low									
Freq (MHz)	Read Level (dBuV/m)	Polar (H/V)	Antenna Factor (dB/m)	Cable loss(dB)	Amp Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
4804	39.40		33.95	10.18	34.26	49.27	74	-24.73	PK
4804	34.93		33.95	10.18	34.26	44.80	54	-9.20	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
4804	36.57	H	33.95	10.18	34.26	46.44	74	-27.56	PK
4804	30.23	H	33.95	10.18	34.26	40.10	54	-13.90	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
Test Mode: GFSK TX Mid									
4882	37.65	V	33.93	10.2	34.29	47.49	74	-26.51	PK
4882	33.73	V	33.93	10.2	34.29	43.57	54	-10.43	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
4882	35.63	H	33.93	10.2	34.29	45.47	74	-28.53	PK
4882	31.09	H	33.93	10.2	34.29	40.93	54	-13.07	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
Test Mode: GFSK TX High									
4960	45.15	V	33.98	10.22	34.25	55.10	74	-18.9	PK
4960	41.45	V	33.98	10.22	34.25	51.40	54	-2.6	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/
4960	44.75	H	33.98	10.22	34.25	54.70	74	-19.30	PK
4960	34.75	H	33.98	10.22	34.25	44.70	54	-9.30	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/

Note:
1, Result = Read level + Antenna factor + cable loss-Amp factor
2, All the other emissions not reported were too low to read and deemed to comply with FCC limit.

Test Mode: π/4 DQPSK TX Low									
Freq (MHz)	Read Level (dBuV/m)	Polar (H/V)	Antenna Factor (dB/m)	Cable loss(dB)	Amp Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
4804	35.53	V	33.95	10.18	34.26	45.40	74	-28.60	PK
4804	27.33	V	33.95	10.18	34.26	37.20	54	-16.80	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
4804	39.98	H	33.95	10.18	34.26	49.85	74	-21.15	PK
4804	33.86	H	33.95	10.18	34.26	43.70	54	-10.30	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
Test Mode: π/4 DQPSK TX Mid									
4882	35.64	V	33.93	10.2	34.29	45.48	74	-28.52	PK
4882	25.88	V	33.93	10.2	34.29	35.72	54	-18.28	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
4882	40.56	H	33.93	10.2	34.29	50.40	74	-23.60	PK
4882	35.57	H	33.93	10.2	34.29	45.41	54	-8.59	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
Test Mode: π/4 DQPSK TX High									
4960	45.46	V	33.93	10.2	34.29	55.30	74	-18.70	PK
4960	41.66	V	33.93	10.2	34.29	51.50	54	-2.5	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/
4960	38.34	H	33.93	10.2	34.29	48.32	74	-25.68	PK
4960	34.26	H	33.93	10.2	34.29	44.10	54	-9.90	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/

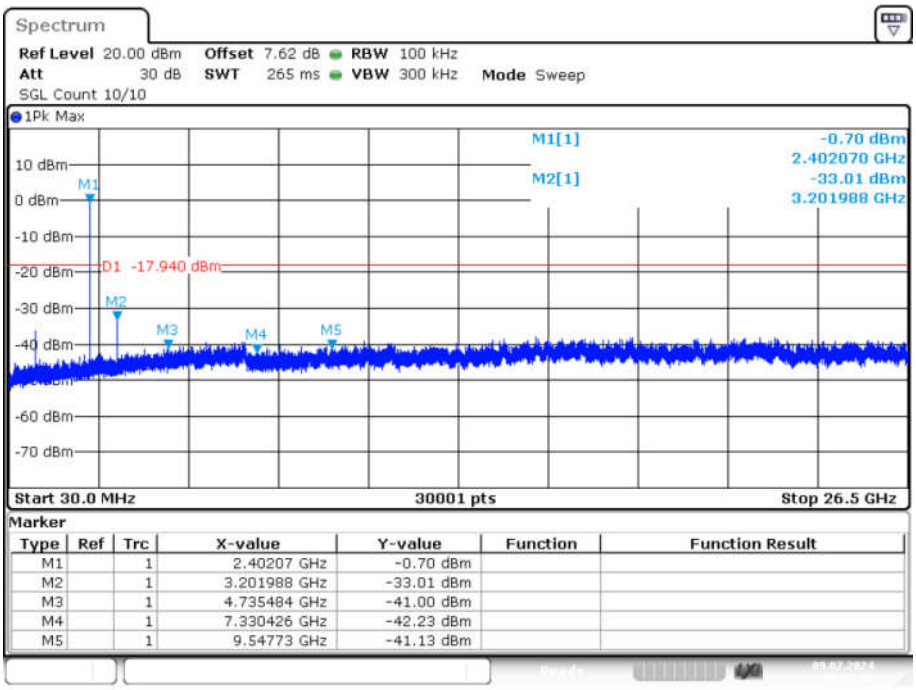
Note:
1, Result = Read level + Antenna factor + cable loss-Amp factor
2, All the other emissions not reported were too low to read and deemed to comply with FCC limit.

Test Mode: 8DPSK TX Low									
Freq (MHz)	Read Level (dBuV/m)	Polar (H/V)	Antenna Factor (dB/m)	Cable loss(dB)	Amp Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
4804	36.63	V	33.95	10.18	34.26	46.50	74	-27.50	PK
4804	33.73	V	33.95	10.18	34.26	43.60	54	-10.40	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
4804	35.16	H	33.95	10.18	34.26	45.03	74	-28.97	PK
4804	28.73	H	33.95	10.18	34.26	38.60	54	-15.40	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
Test Mode: 8DPSK TX Mid									
4882	44.62	V	33.93	10.2	34.29	54.46	74	-19.54	PK
4882	33.32	V	33.93	10.2	34.29	43.16	54	-10.84	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
4882	42.79	H	33.93	10.2	34.29	52.63	74	-21.37	PK
4882	36.34	H	33.93	10.2	34.29	46.18	54	-7.82	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
Test Mode: 8DPSK TX High									
4960	45.45	V	33.98	10.22	34.25	55.40	74	-18.60	PK
4960	41.65	V	33.98	10.22	34.25	51.60	54	-2.40	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/
4960	43.44	H	33.98	10.22	34.25	53.39	74	-20.61	PK
4960	33.85	H	33.98	10.22	34.25	43.80	54	-10.20	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/

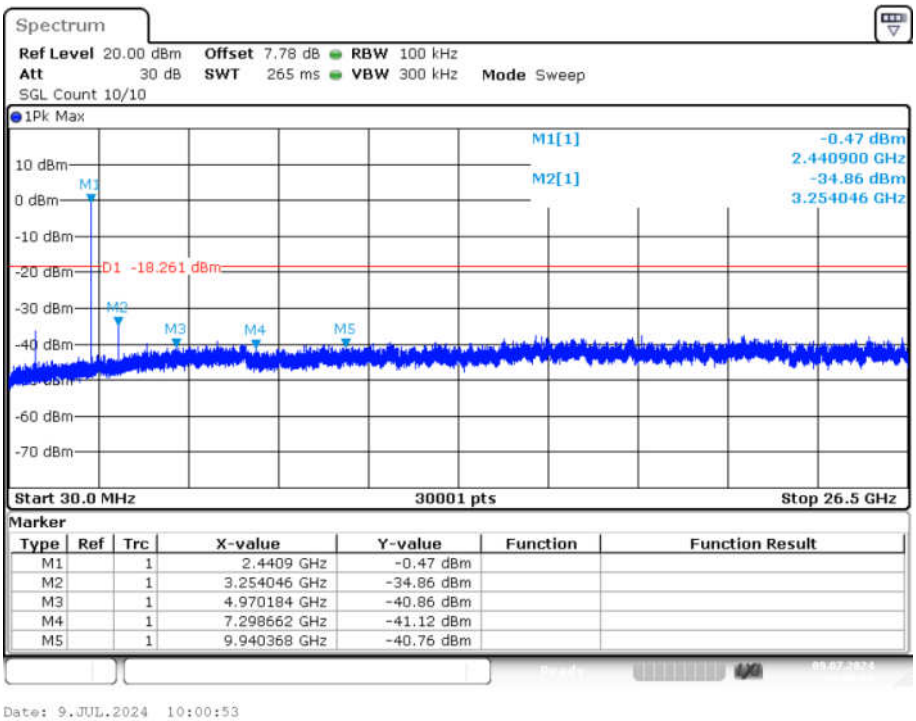
Note:
1, Result = Read level + Antenna factor + cable loss-Amp factor
2, All the other emissions not reported were too low to read and deemed to comply with FCC limit.

Conducted RF Spurious Emission

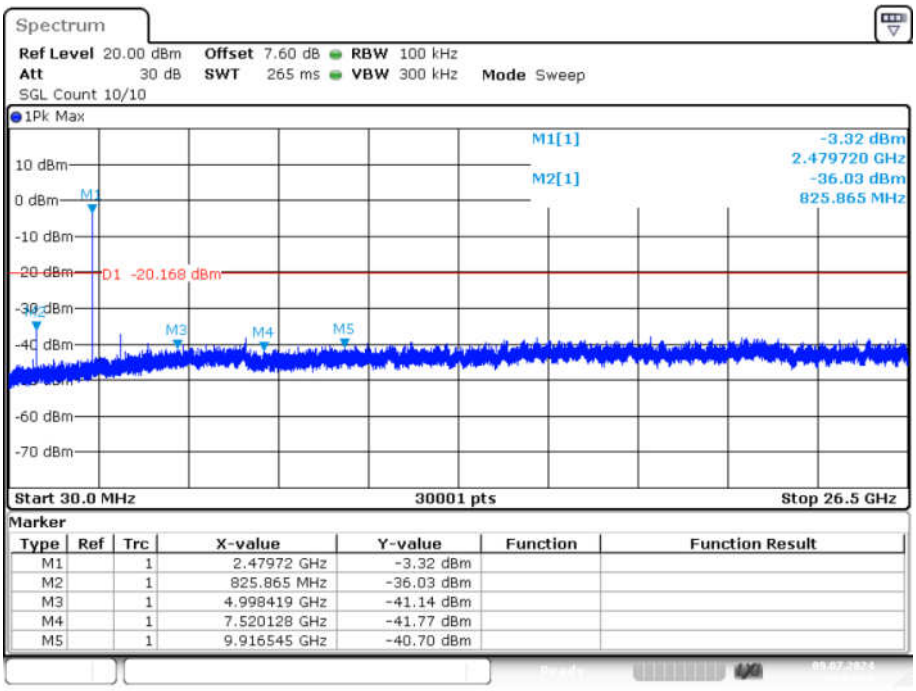
Tx. Spurious NVNT 1-DH1 2402MHz Ant1 Emission



Tx. Spurious NVNT 1-DH1 2441MHz Ant1 Emission



Tx. Spurious NVNT 1-DH1 2480MHz Ant1 Emission

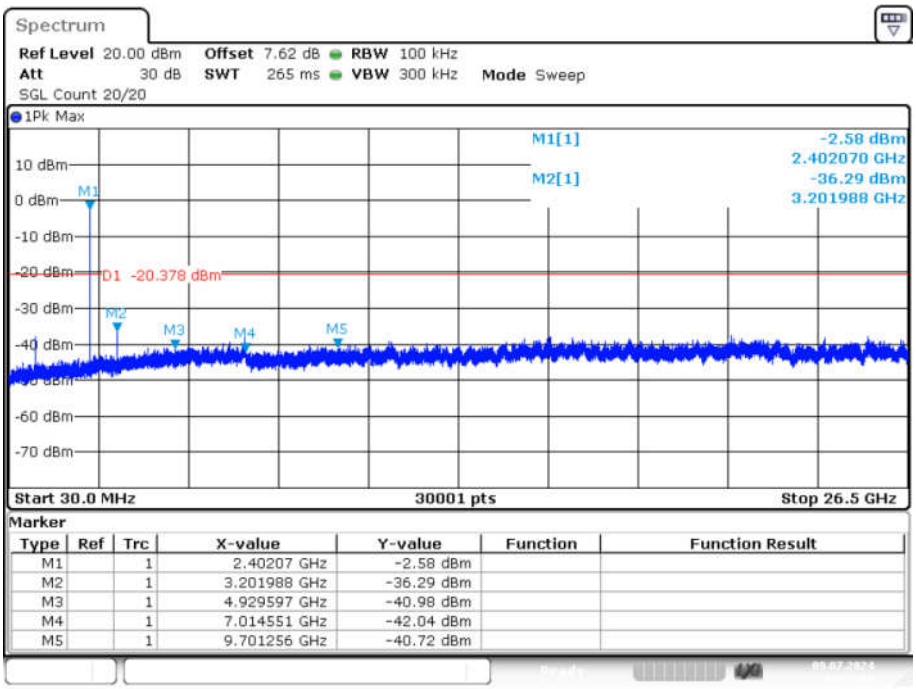


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47972 GHz	-3.32 dBm		
M2		1	825.865 MHz	-36.03 dBm		
M3		1	4.998419 GHz	-41.14 dBm		
M4		1	7.520128 GHz	-41.77 dBm		
M5		1	9.916545 GHz	-40.70 dBm		

Date: 9.JUL.2024 10:04:50

Tx. Spurious NVNT 2-DH1 2402MHz Ant1 Emission

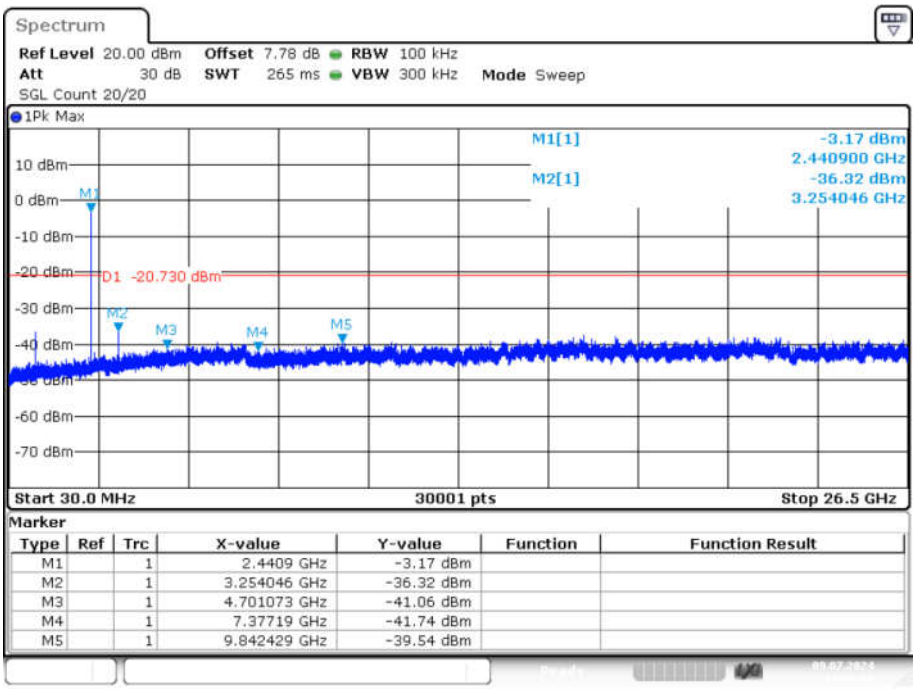


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40207 GHz	-2.58 dBm		
M2		1	3.201988 GHz	-36.29 dBm		
M3		1	4.929597 GHz	-40.98 dBm		
M4		1	7.014551 GHz	-42.04 dBm		
M5		1	9.701256 GHz	-40.72 dBm		

Date: 9.JUL.2024 11:27:20

Tx. Spurious NVNT 2-DH1 2441MHz Ant1 Emission

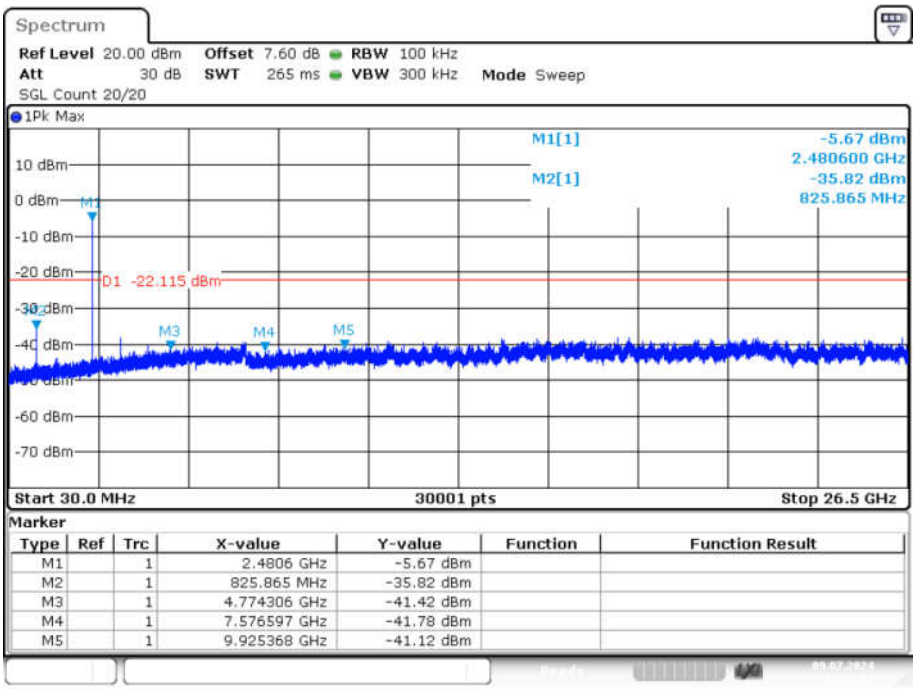


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4409 GHz	-3.17 dBm		
M2		1	3.254046 GHz	-36.32 dBm		
M3		1	4.701073 GHz	-41.06 dBm		
M4		1	7.37719 GHz	-41.74 dBm		
M5		1	9.842429 GHz	-39.54 dBm		

Date: 9.JUL.2024 11:51:39

Tx. Spurious NVNT 2-DH1 2480MHz Ant1 Emission

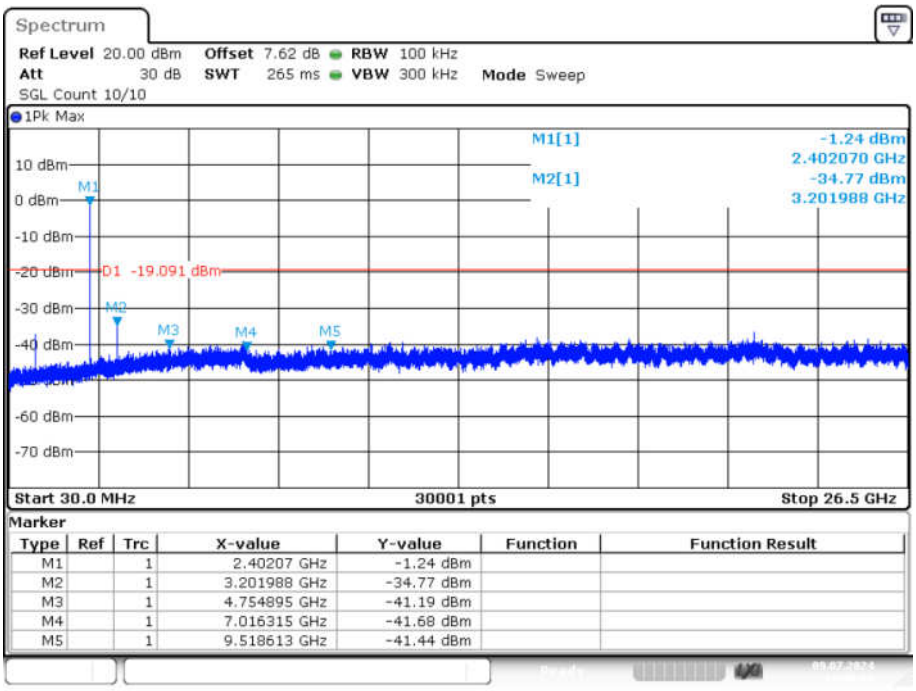


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4806 GHz	-5.67 dBm		
M2		1	825.865 MHz	-35.82 dBm		
M3		1	4.774306 GHz	-41.42 dBm		
M4		1	7.576597 GHz	-41.78 dBm		
M5		1	9.925368 GHz	-41.12 dBm		

Date: 9.JUL.2024 11:53:54

Tx. Spurious NVNT 3-DH1 2402MHz Ant1 Emission



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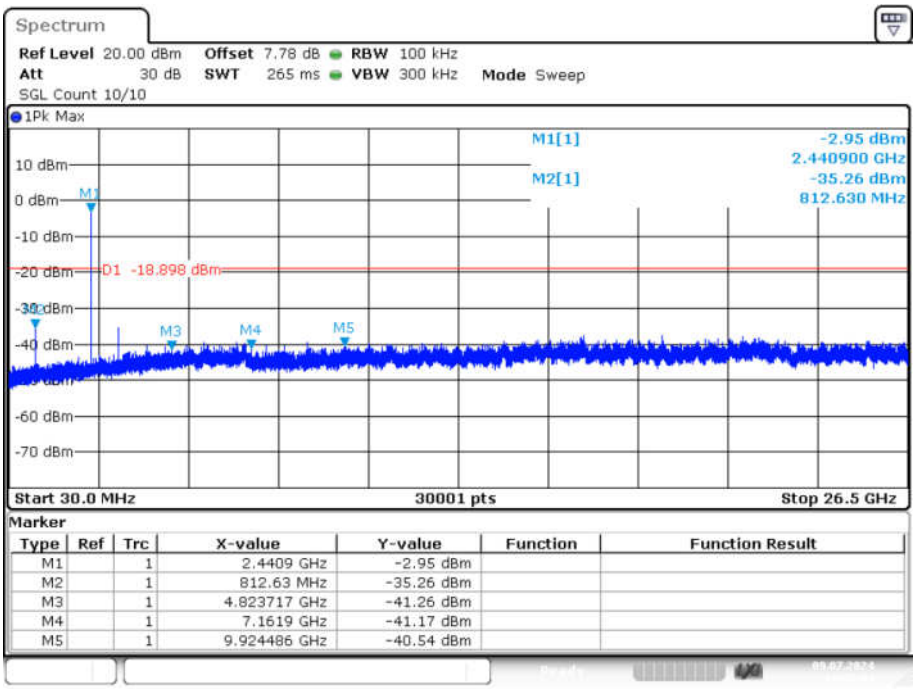
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40207 GHz	-1.24 dBm		
M2		1	3.201988 GHz	-34.77 dBm		
M3		1	4.754895 GHz	-41.19 dBm		
M4		1	7.016315 GHz	-41.68 dBm		
M5		1	9.518613 GHz	-41.44 dBm		

Date: 9.JUL.2024 12:40:30

Tx. Spurious NVNT 3-DH1 2441MHz Ant1 Emission

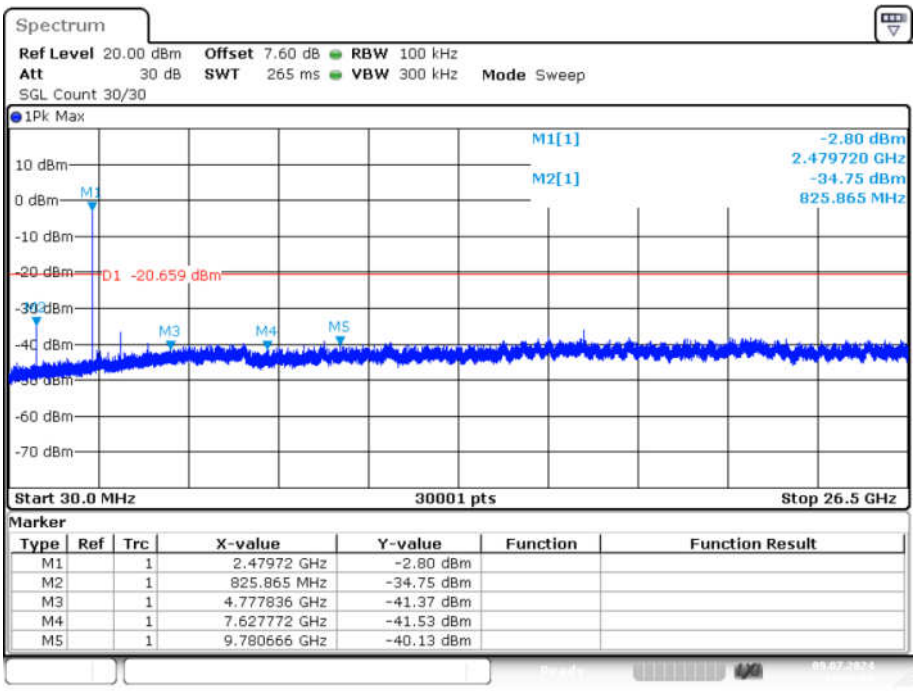


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4409 GHz	-2.95 dBm		
M2		1	812.63 MHz	-35.26 dBm		
M3		1	4.823717 GHz	-41.26 dBm		
M4		1	7.1619 GHz	-41.17 dBm		
M5		1	9.924486 GHz	-40.54 dBm		

Date: 9.JUL.2024 12:47:43

Tx. Spurious NVNT 3-DH1 2480MHz Ant1 Emission



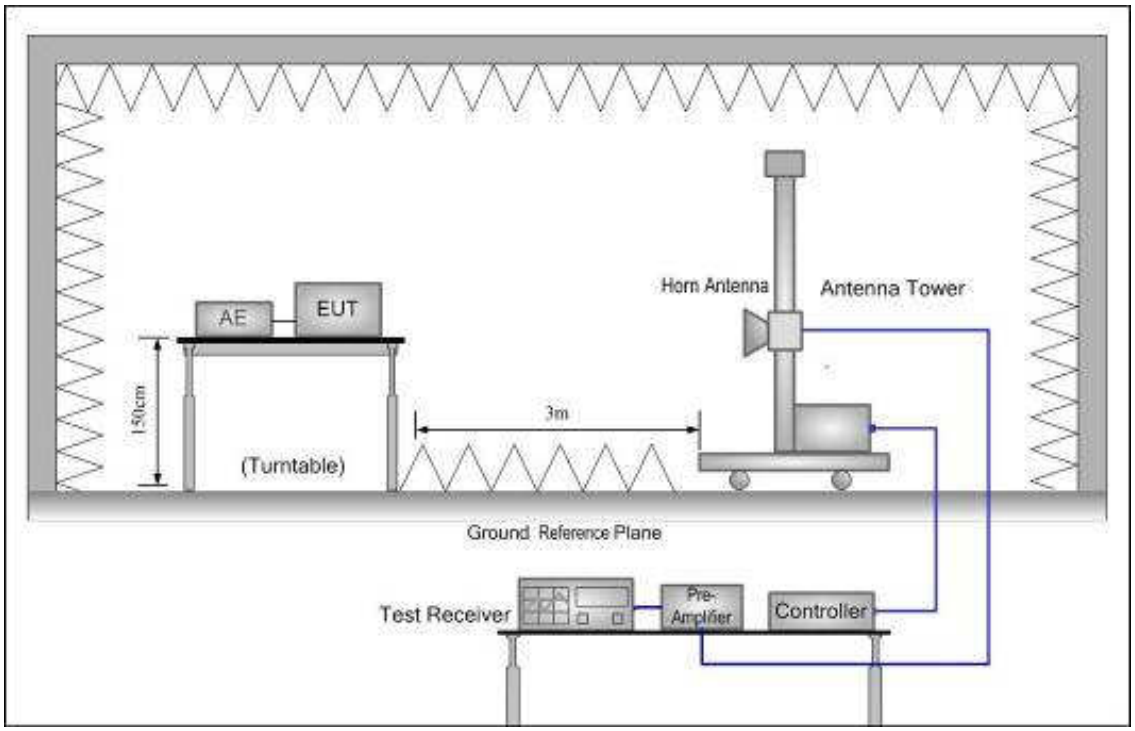
Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47972 GHz	-2.80 dBm		
M2		1	825.865 MHz	-34.75 dBm		
M3		1	4.777836 GHz	-41.37 dBm		
M4		1	7.627772 GHz	-41.53 dBm		
M5		1	9.780666 GHz	-40.13 dBm		

Date: 9.JUL.2024 12:51:01

9. BAND EDGE COMPLIANCE

9.1. Block Diagram of Test Setup



9.2. Limit

All the lower and upper band-edges emissions appearing within restricted frequency bands shall not exceed the limits shown in 15.209, all the other emissions outside operation shall be at least 20dB below the fundamental emissions, or comply with 15.209 and RSS-GEN limits.

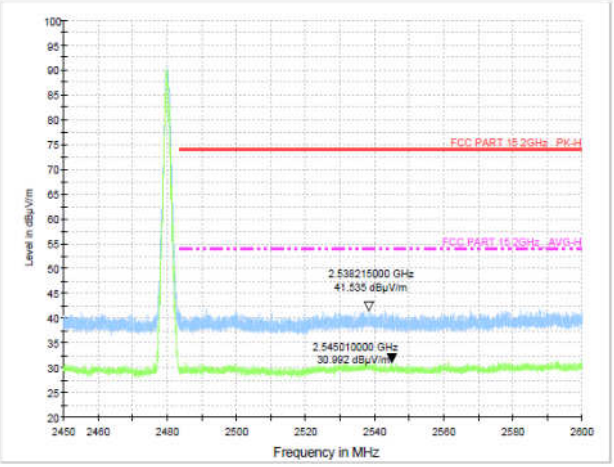
9.3. Test Procedure

All restriction band and non- restriction band have been tested ， only worse case is reported.

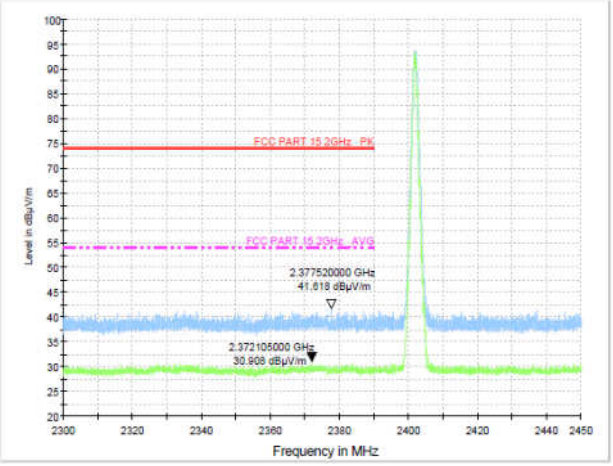
9.4. Test Result

PASS. (See below detailed test data)

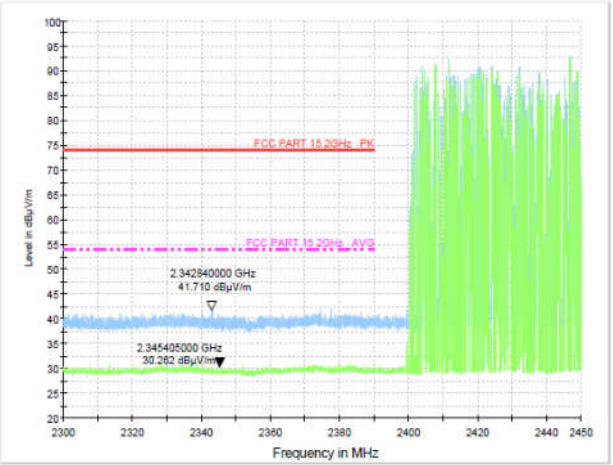
Test Mode: GFSK-Low Hopping-off



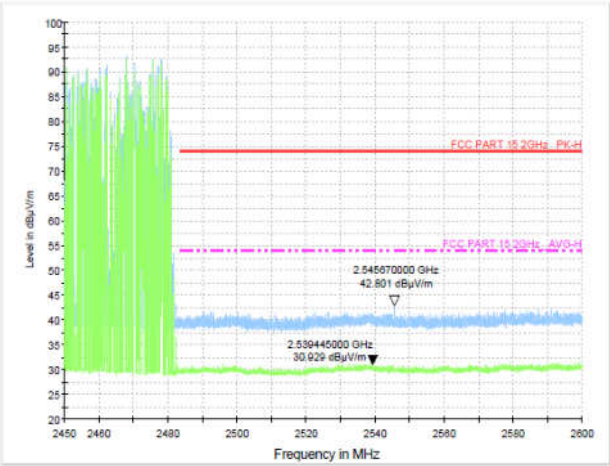
Test Mode: GFSK-High Hopping-off



Test Mode: GFSK-Low Hopping-on



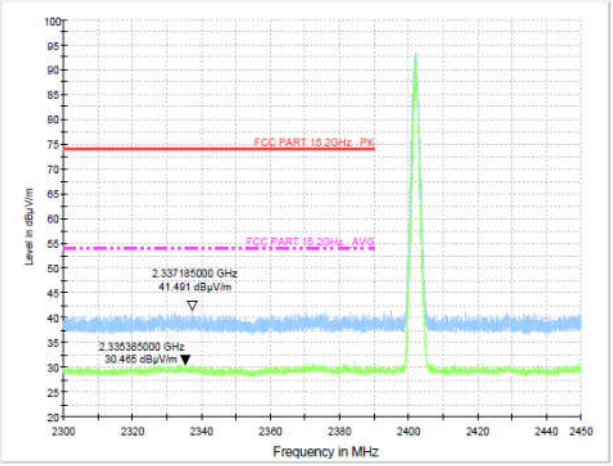
Test Mode: GFSK-High Hopping-on



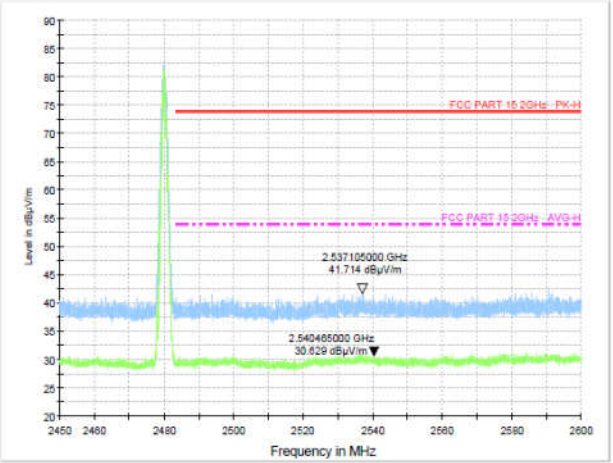
Note: 1. *:Maximum data; x:Over limit; !:over margin.

2.Measurement=Reading Level+Correct Factor; Correct Factor=Antenna Factor+Cable Loss.

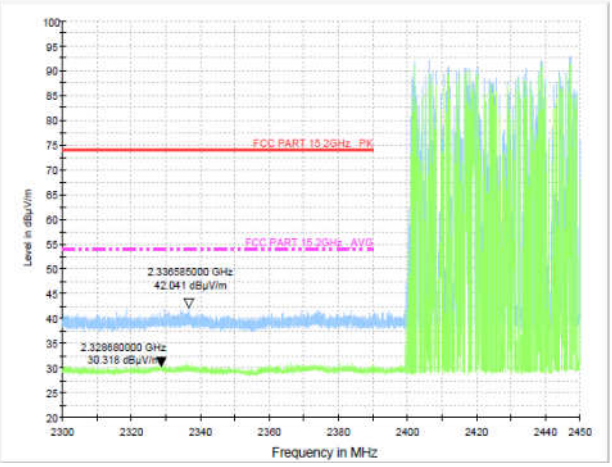
Test Mode: π/4 DQPSK-Low Hopping-off



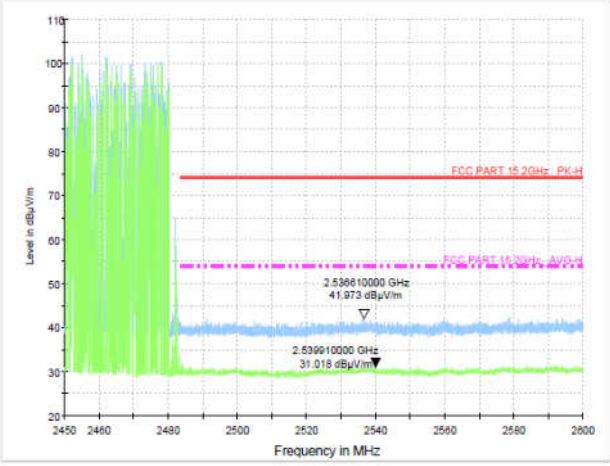
Test Mode: π/4 DQPSK-High Hopping-off



Test Mode: π/4 DQPSK-Low Hopping-on



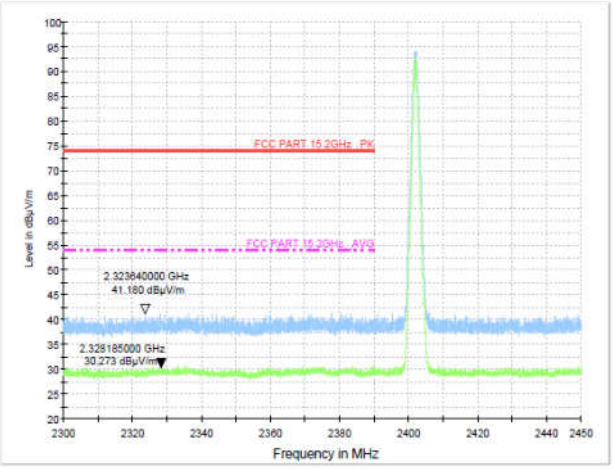
Test Mode: π/4 DQPSK-High Hopping-on



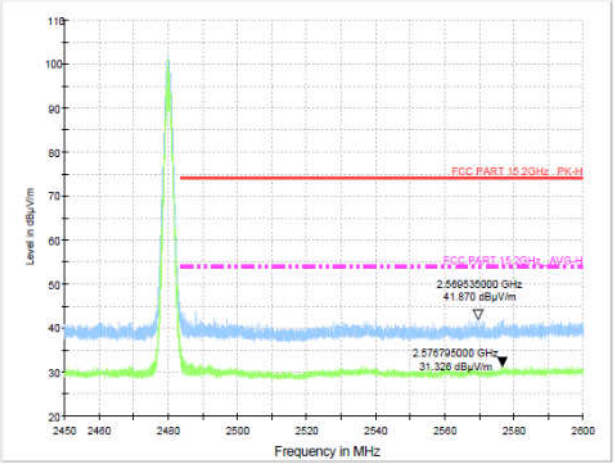
Note: 1. *:Maximum data; x:Over limit; !:over margin.

2.Measurement=Reading Level+Correct Factor; Correct Factor=Antenna Factor+Cable Loss.

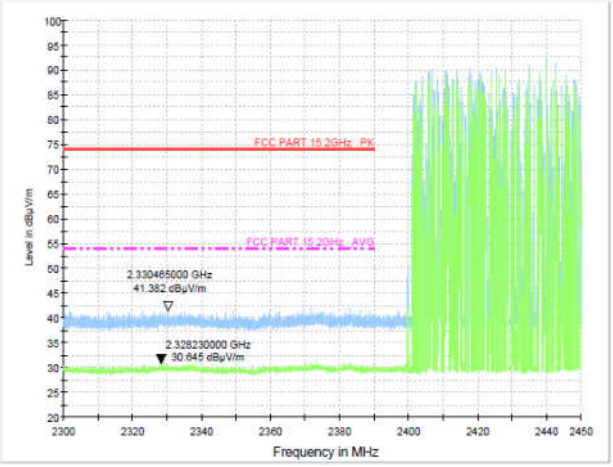
Test Mode: 8DPSK-Low Hopping-off



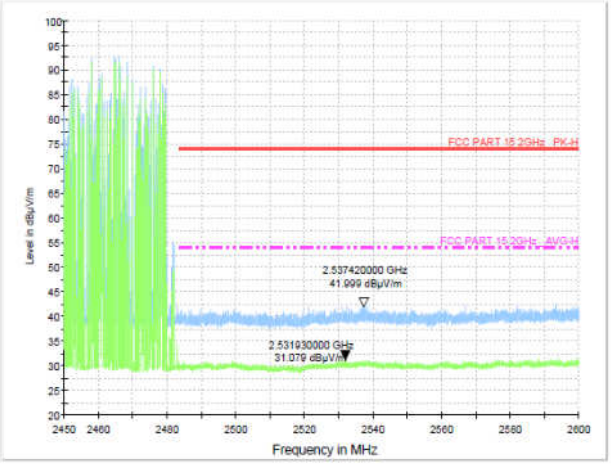
Test Mode: 8DPSK-High Hopping-off



Test Mode: 8DPSK-Low Hopping-on



Test Mode: 8DPSK-High Hopping-on

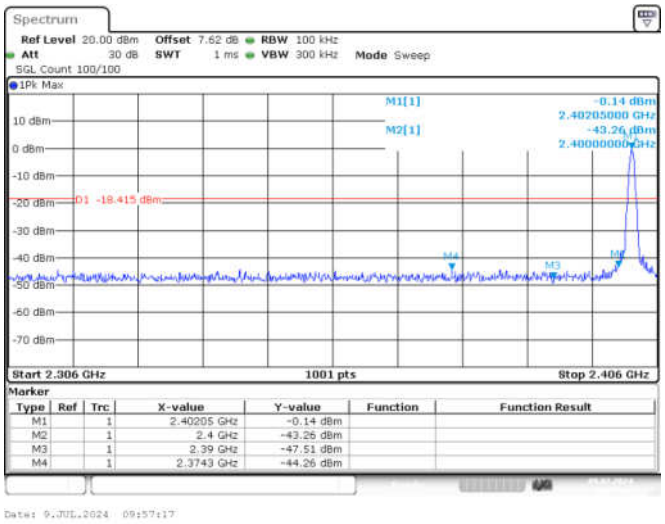
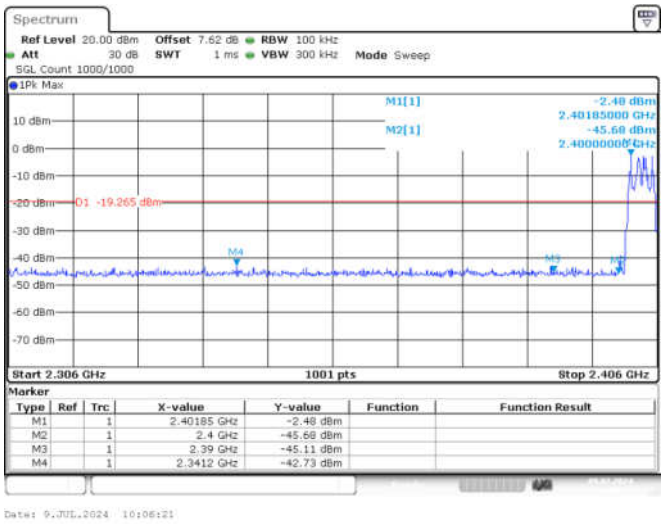


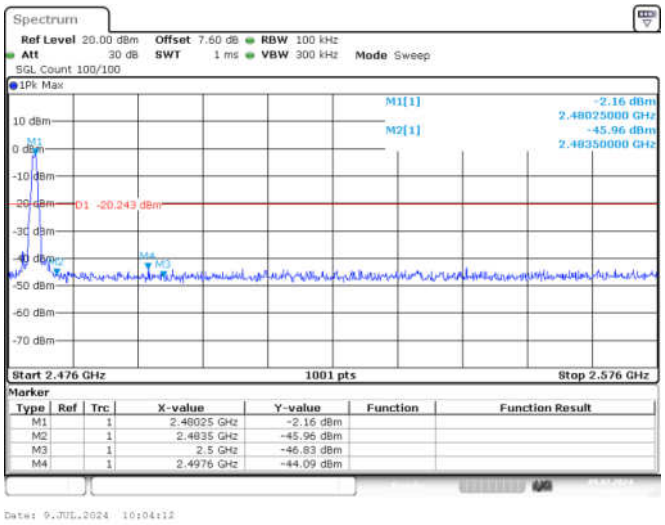
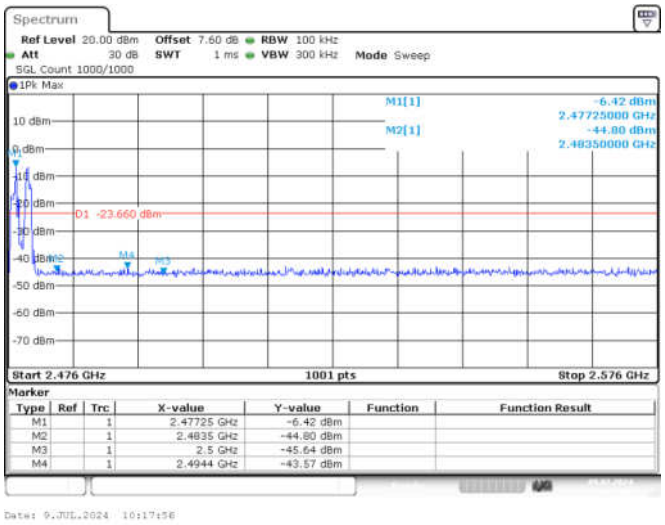
Note: 1. *:Maximum data; x:Over limit; !:over margin.

2.Measurement=Reading Level+Correct Factor; Correct Factor=Antenna Factor+Cable Loss.

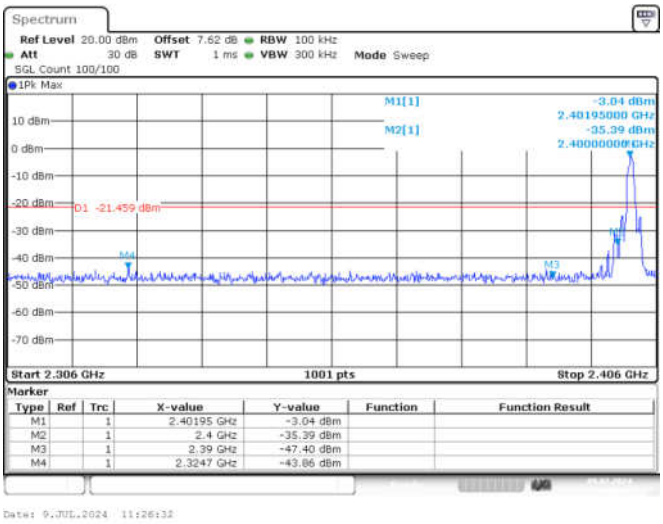
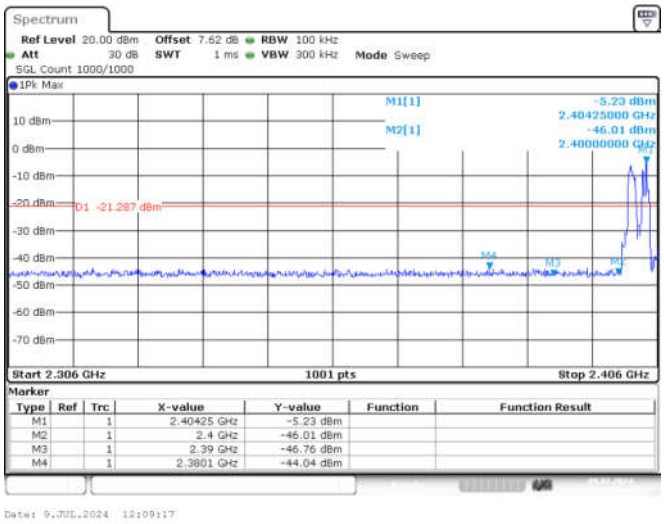
Conducted Method

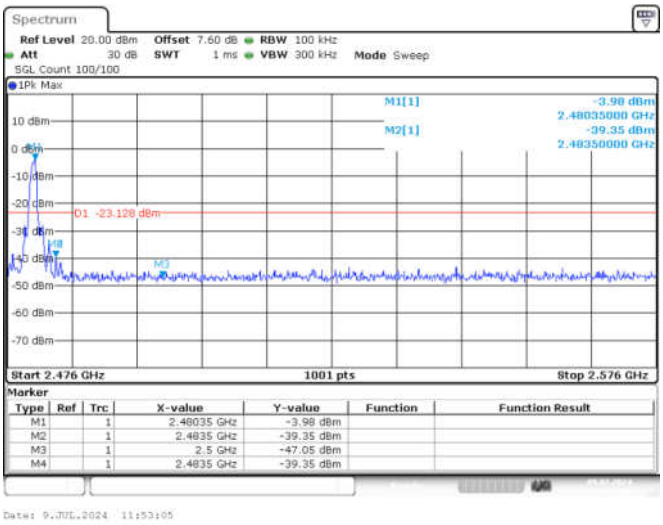
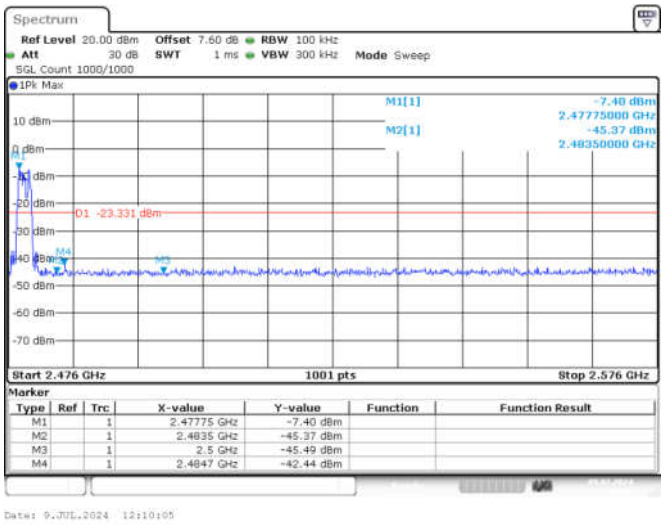
GFSK Mode:

Test channel:	Lowest channel
	
No-hopping mode	Hopping mode

Test channel:	Highest channel
	
No-hopping mode	Hopping mode

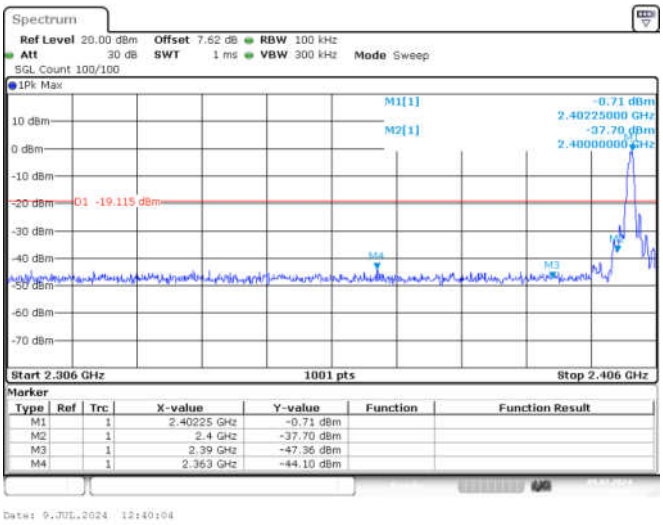
π/4DQPSK Mode:

Test channel:	Lowest channel
	
No-hopping mode	Hopping mode

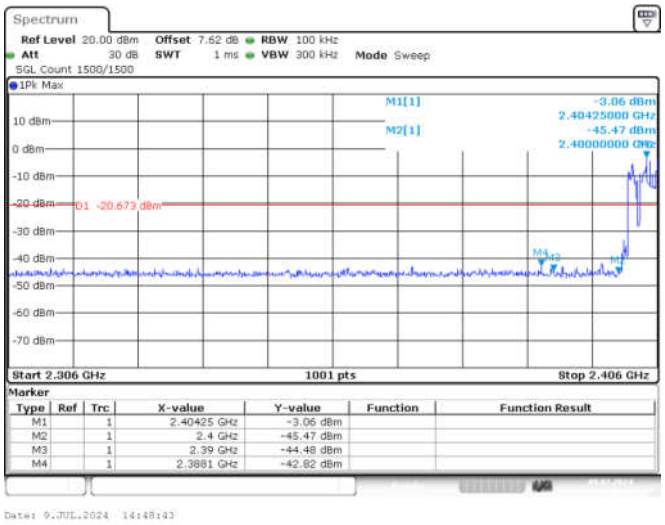
Test channel:	Highest channel
	
No-hopping mode	Hopping mode

8DPSK Mode:

Test channel:	Lowest channel

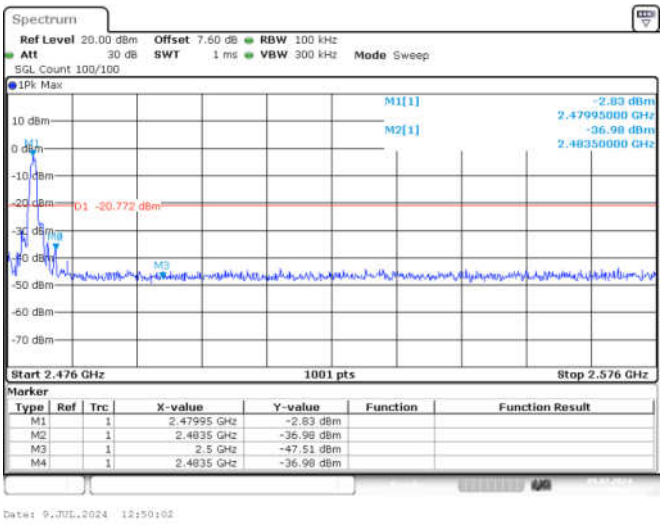


No-hopping mode

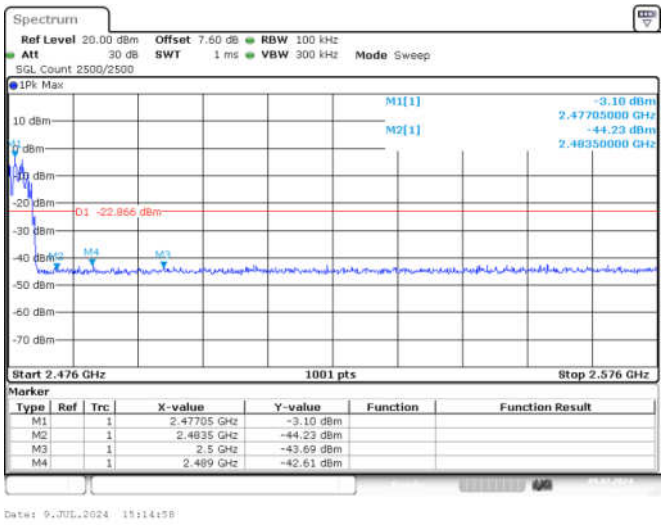


Hopping mode

Test channel:	Highest channel



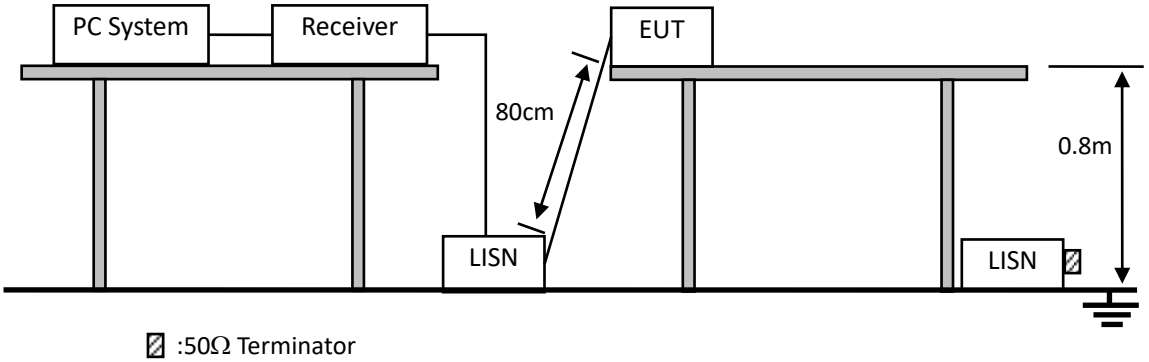
No-hopping mode



Hopping mode

10. POWER LINE CONDUCTED EMISSIONS

10.1.Block Diagram of Test Setup



10.2.Limit

Frequency	Maximum RF Line Voltage	
	Quasi-Peak Level dB(μV)	Average Level dB(μV)
150kHz ~ 500kHz	66 ~ 56*	56 ~ 46*
500kHz ~ 5MHz	56	46
5MHz ~ 30MHz	60	50

Notes: 1. * Decreasing linearly with logarithm of frequency.
2. The lower limit shall apply at the transition frequencies.

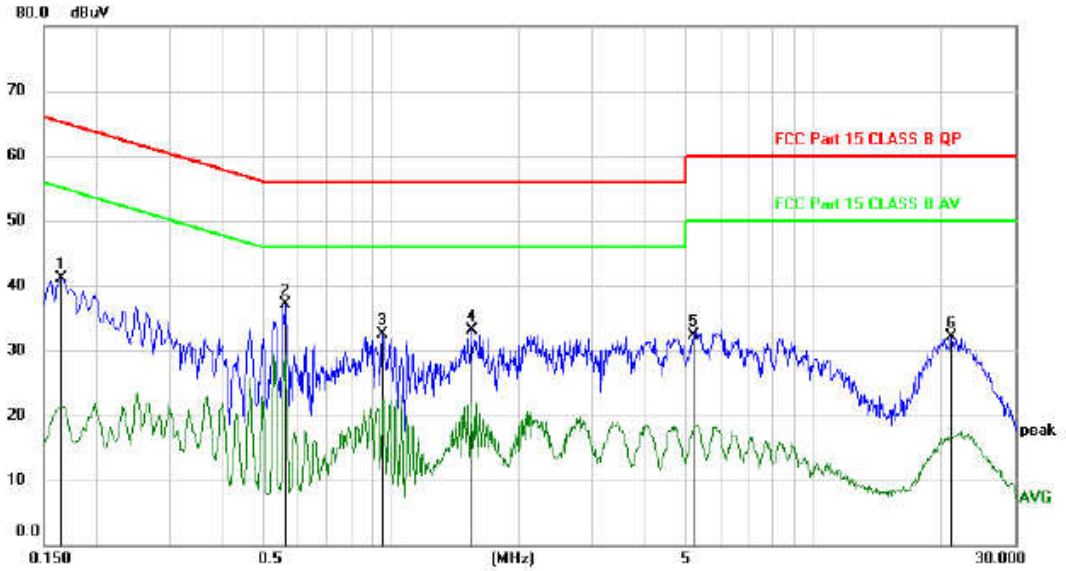
10.3.Test Procedure

(1) The EUT was placed on a non-metallic table, 80cm above the ground plane.
(2) Setup the EUT and simulator as shown in 10.1
(3) The EUT Power connected to the power mains through a power adapter and a line impedance stabilization network (L.I.S.N1). The other peripheral devices power cord connected to the power mains through a line impedance stabilization network (L.I.S.N2), this provided a 50-ohm coupling impedance for the EUT (Please refer to the block diagram of the test setup and photographs). Both sides of power line were checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipments and all of the interface cables were changed according to ANSI C63.10 :2013on conducted Emission test.
(4) The bandwidth of test receiver is set at 10KHz.
(5) The frequency range from 150 KHz to 30MHz is checked.

10.4.Test Result

PASS. (See below detailed test data)
Note: If peak Result comply with AV limit, QP and AV Result is deemed to comply with AV limit

Line:

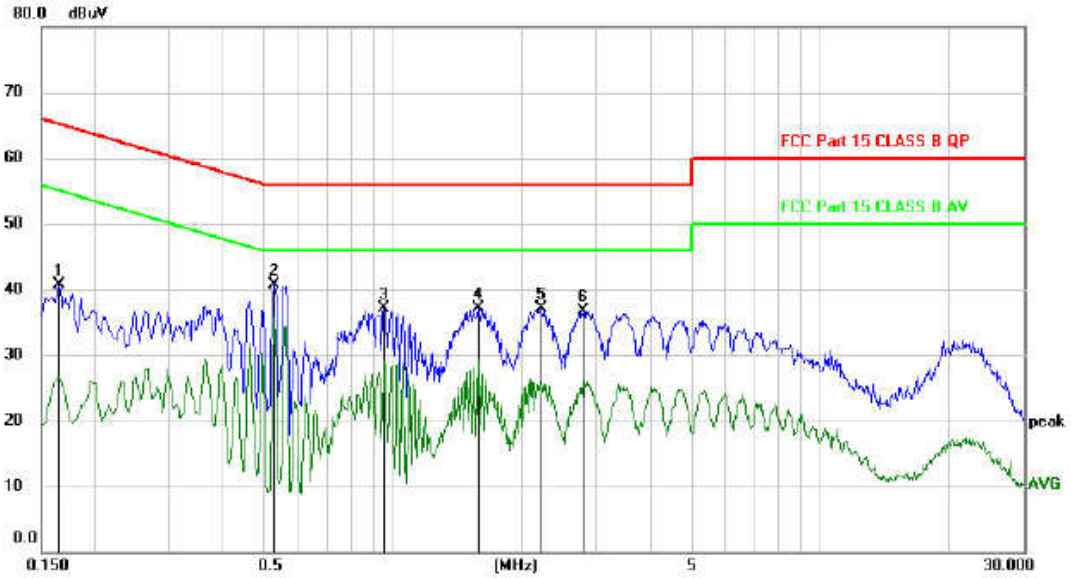


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1650	31.26	9.93	41.19	65.21	-24.02	peak	
2	*	0.5610	27.22	9.94	37.16	56.00	-18.84	peak	
3		0.9510	22.50	9.94	32.44	56.00	-23.56	peak	
4		1.5510	23.13	9.89	33.02	56.00	-22.98	peak	
5		5.2199	22.23	10.05	32.28	60.00	-27.72	peak	
6		21.1920	21.57	10.47	32.04	60.00	-27.96	peak	

*:Maximum data x:Over limit !:over margin (Reference Only

Note: Measurement=Reading Level+Correc Factor. Factor=(LISN or ISN or PLC or Current Probe)Factor+Cable

Neutral:



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1650	30.81	9.93	40.74	65.21	-24.47	peak	
2	*	0.5280	30.73	9.95	40.68	56.00	-15.32	peak	
3		0.9510	27.15	9.94	37.09	56.00	-18.91	peak	
4		1.5809	27.20	9.89	37.09	56.00	-18.91	peak	
5		2.2230	27.12	9.89	37.01	56.00	-18.99	peak	
6		2.7869	26.72	9.94	36.66	56.00	-19.34	peak	

*:Maximum data x:Over limit !:over margin 〈Reference Only

Note: Measurement=Reading Level+Correc Factor. Factor=(LISN or ISN or PLC or Current Probe)Factor+Cable

Note: All modes and channels have been tested and only the GFSK 2402MHz mode with the worst data is listed.

11. ANTENNA REQUIREMENTS

11.1.Limit

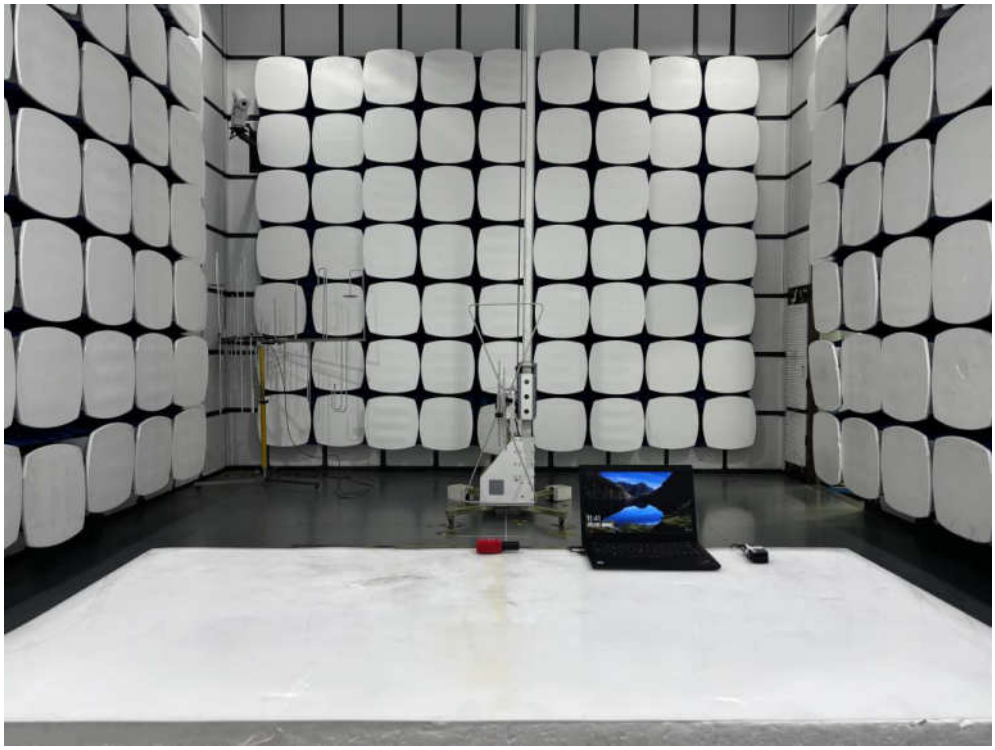
For intentional device, according to FCC 47 CFR Section 15.203 and RSS-GEN, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi..

11.2.Result

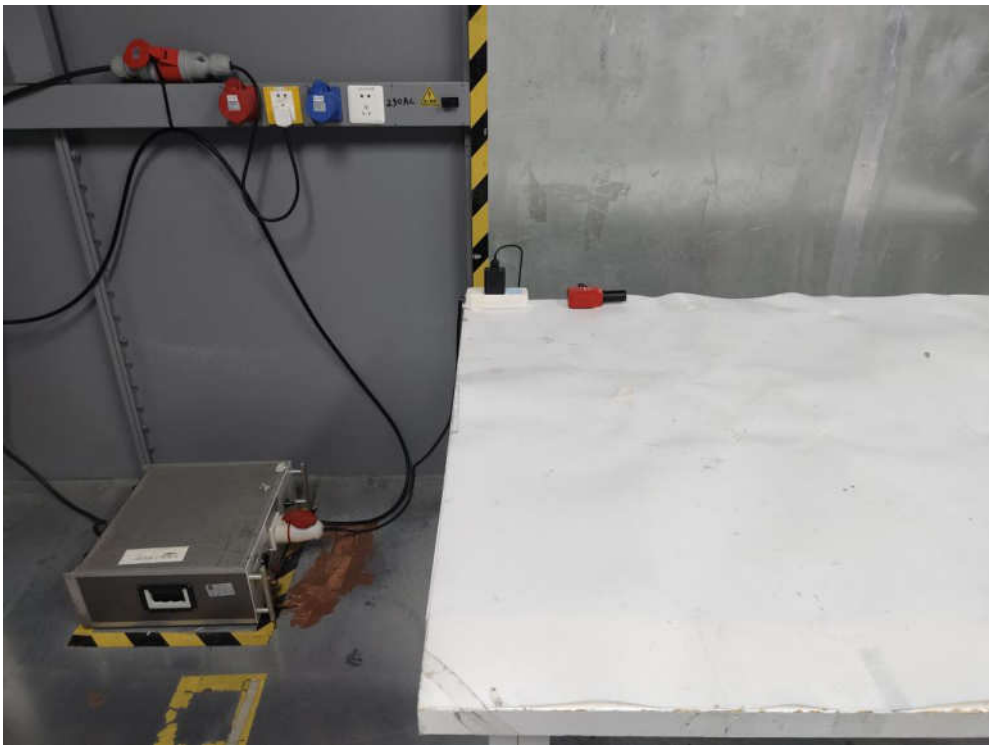
The EUT antenna is Internal Antenna. It complies with the standard requirement.

12. TEST SETUP PHOTO

12.1.Photo of Radiated Emission test



12.2.Photo of Conducted Emission test



13. PHOTOS OF EUT

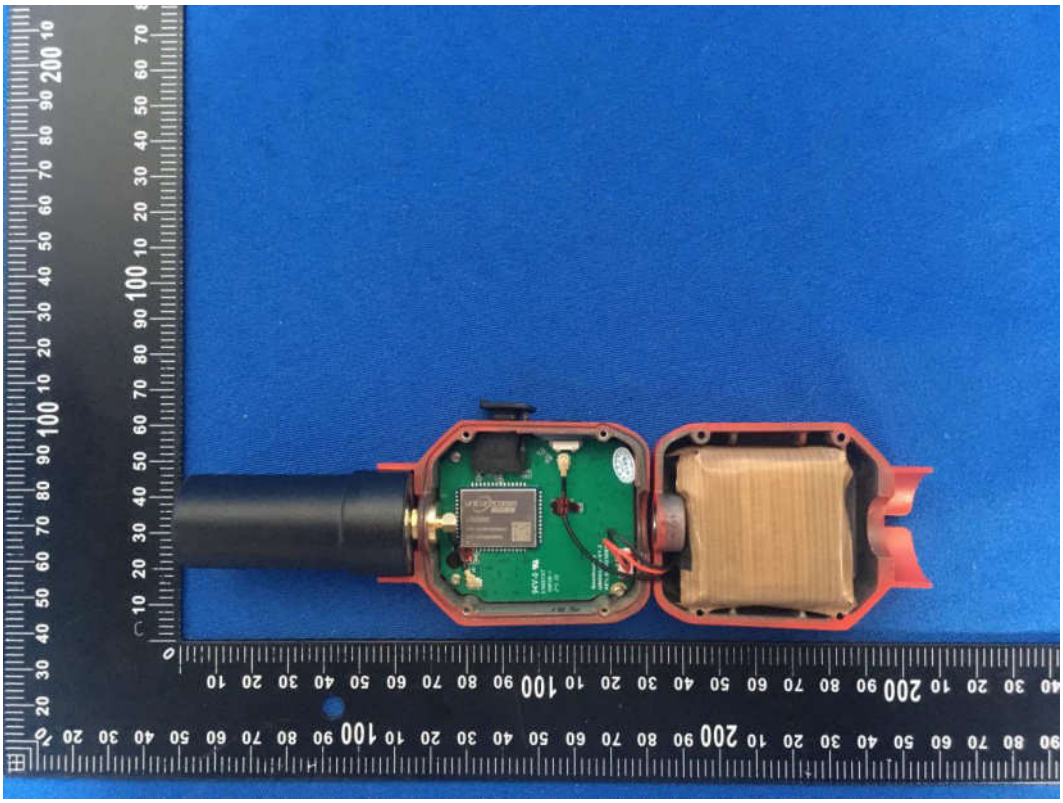
SPATRIA

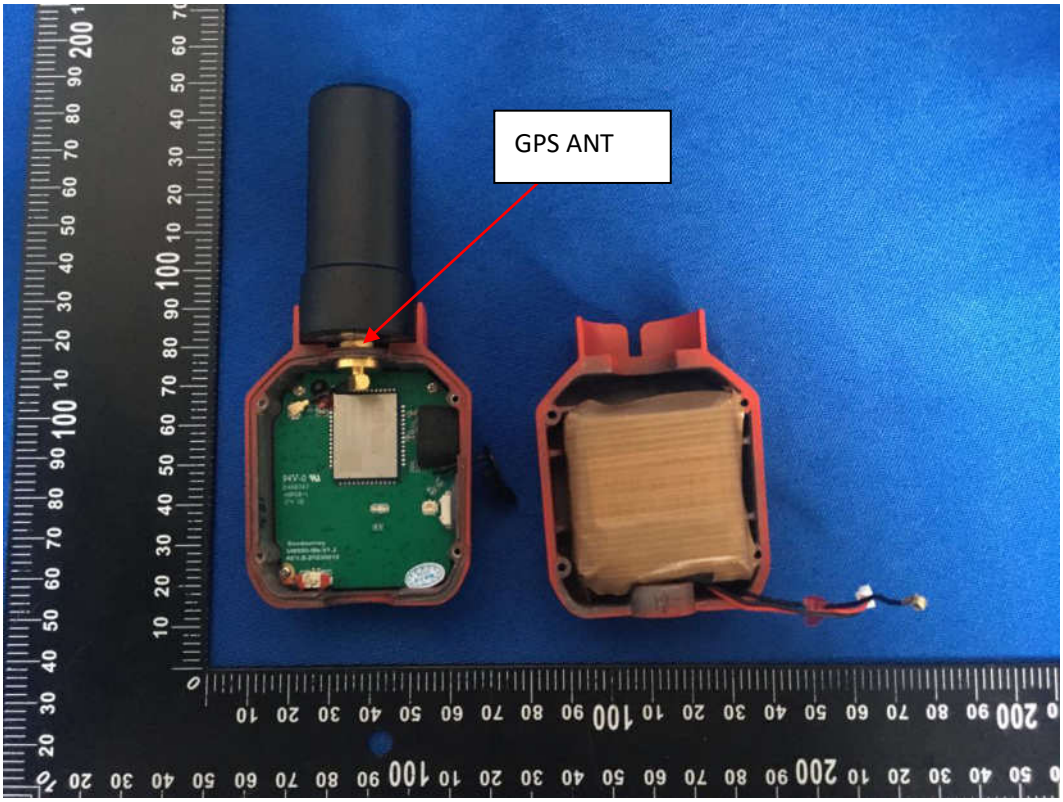
SPATRIA

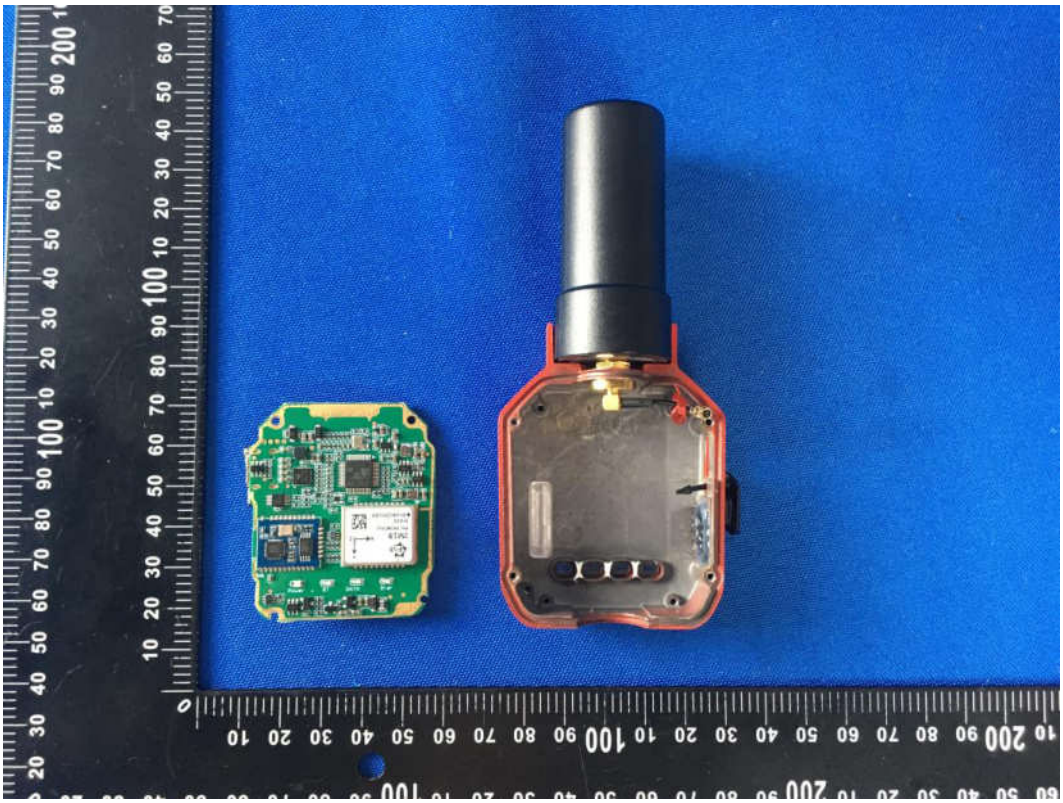
SPATRIA

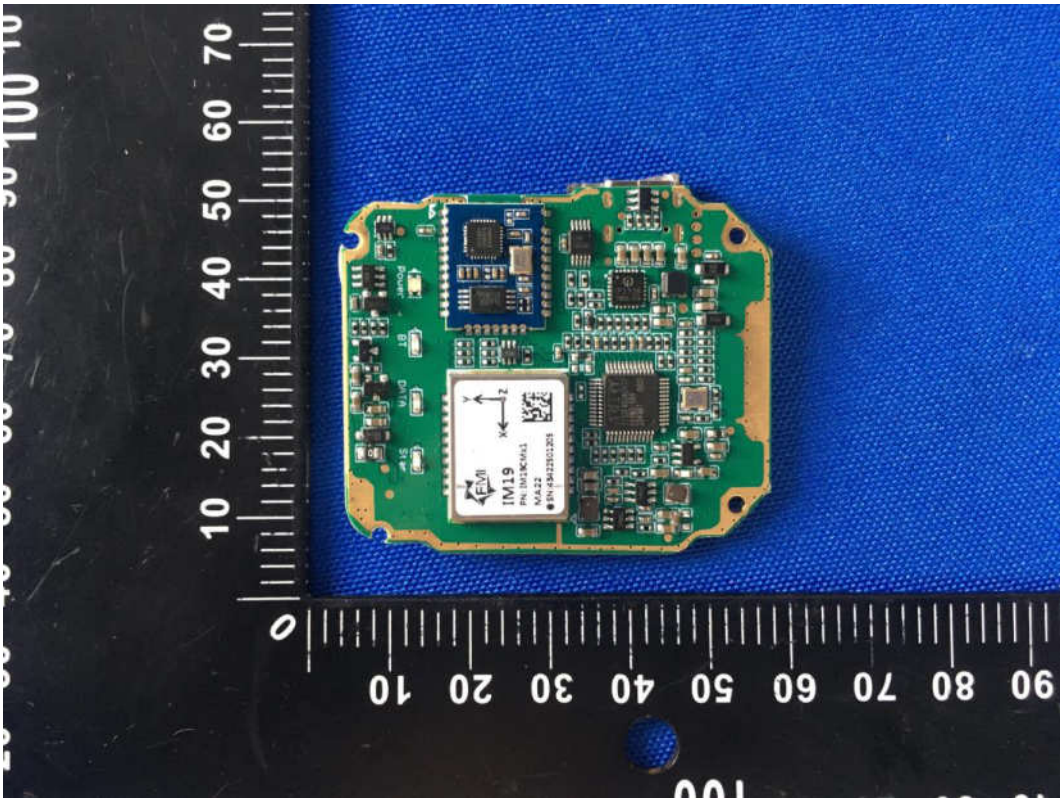
SPATRIA

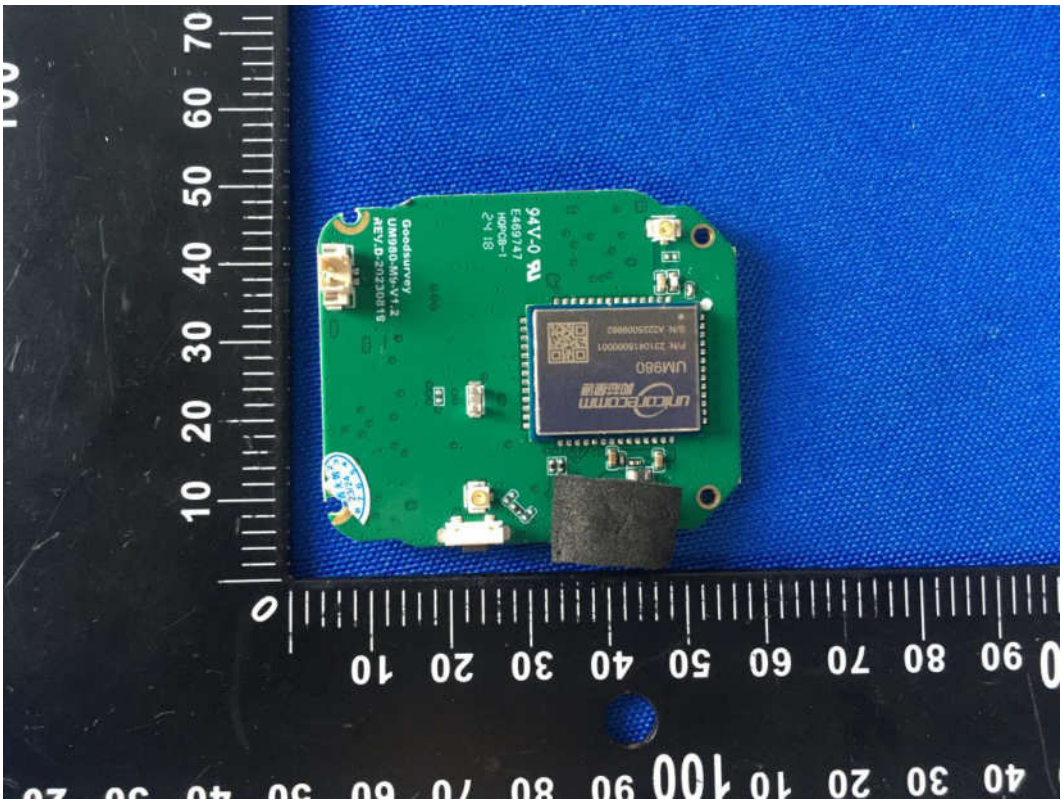
SPATRIA

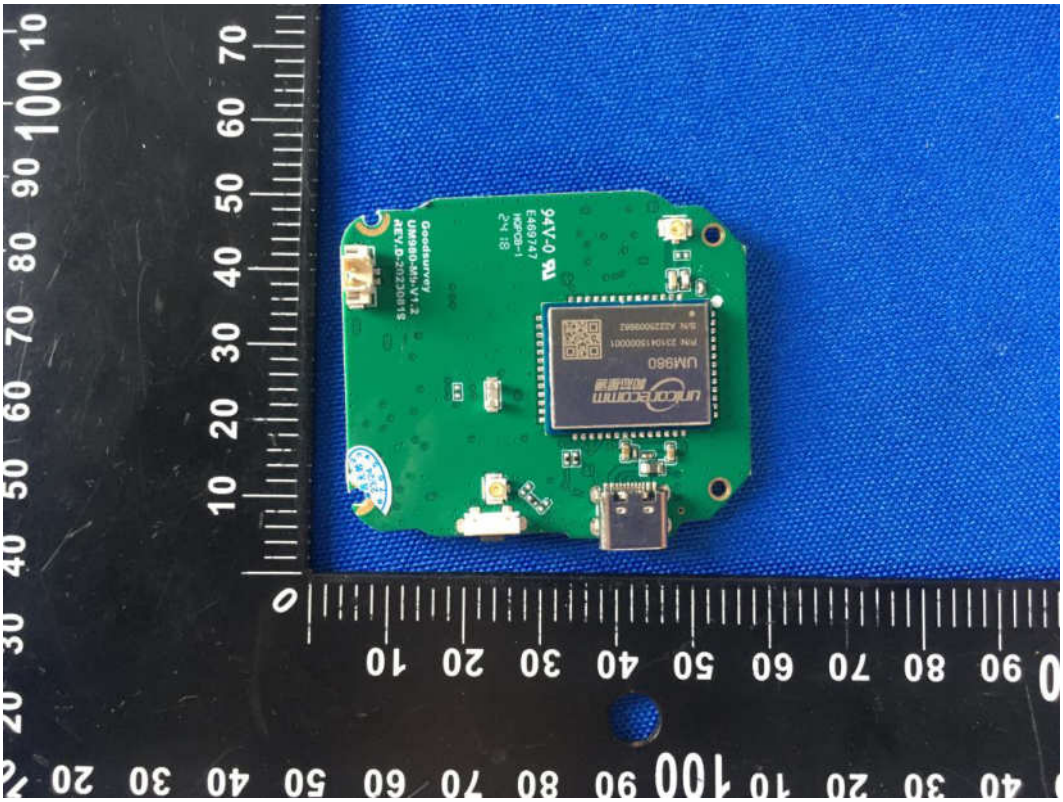



GPS ANT




IM19


Goodsurvey
UM980-Mini-V1.2
REV.D-20230815
94V-0
E469747
HDPCB-1
24 18
UM980


Goodsurvey
UM980-Mini-V1.2
REV.D-20230815
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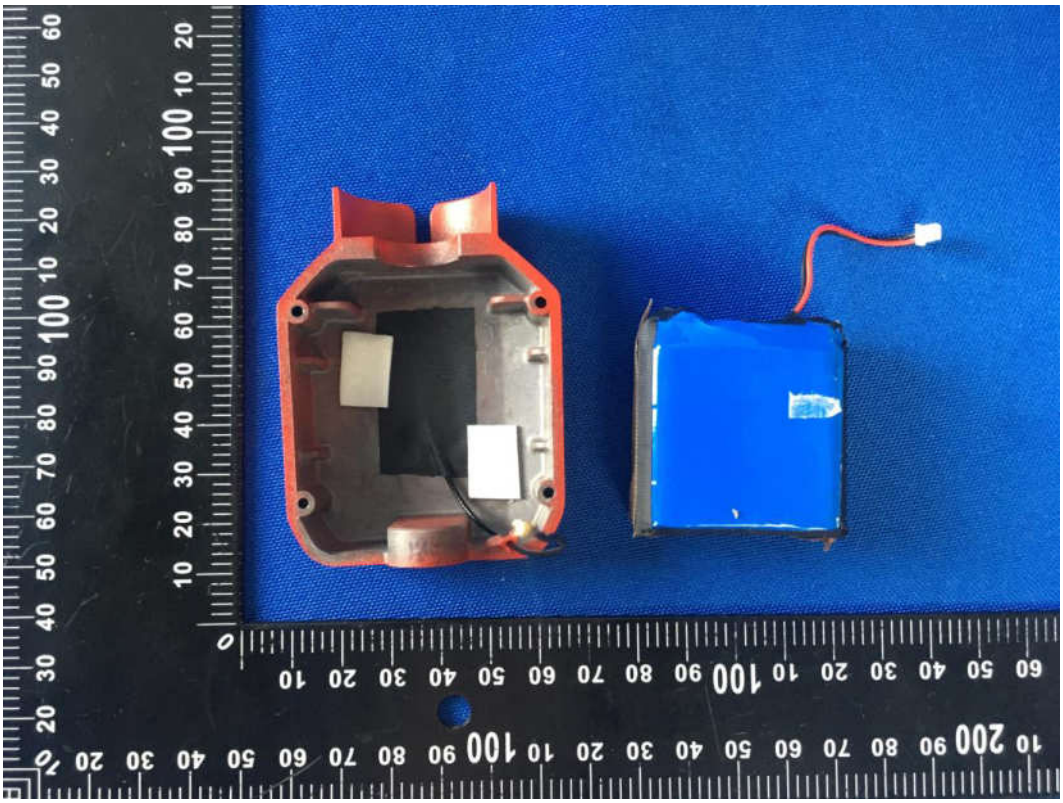
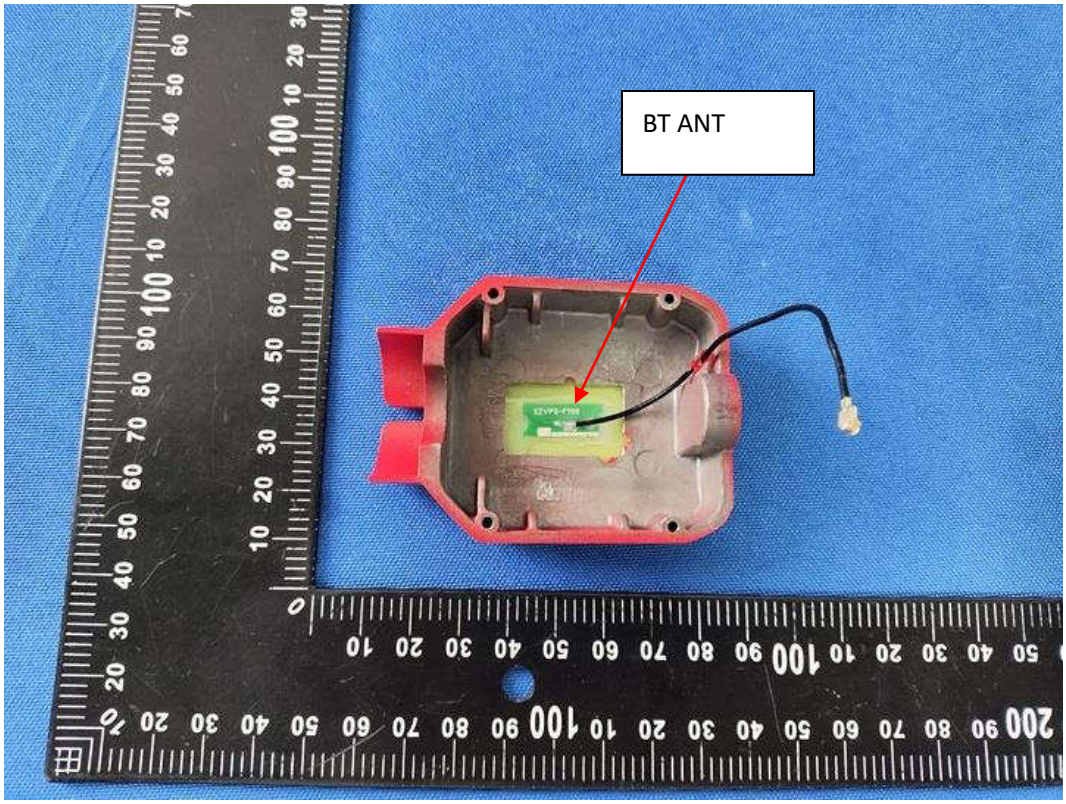
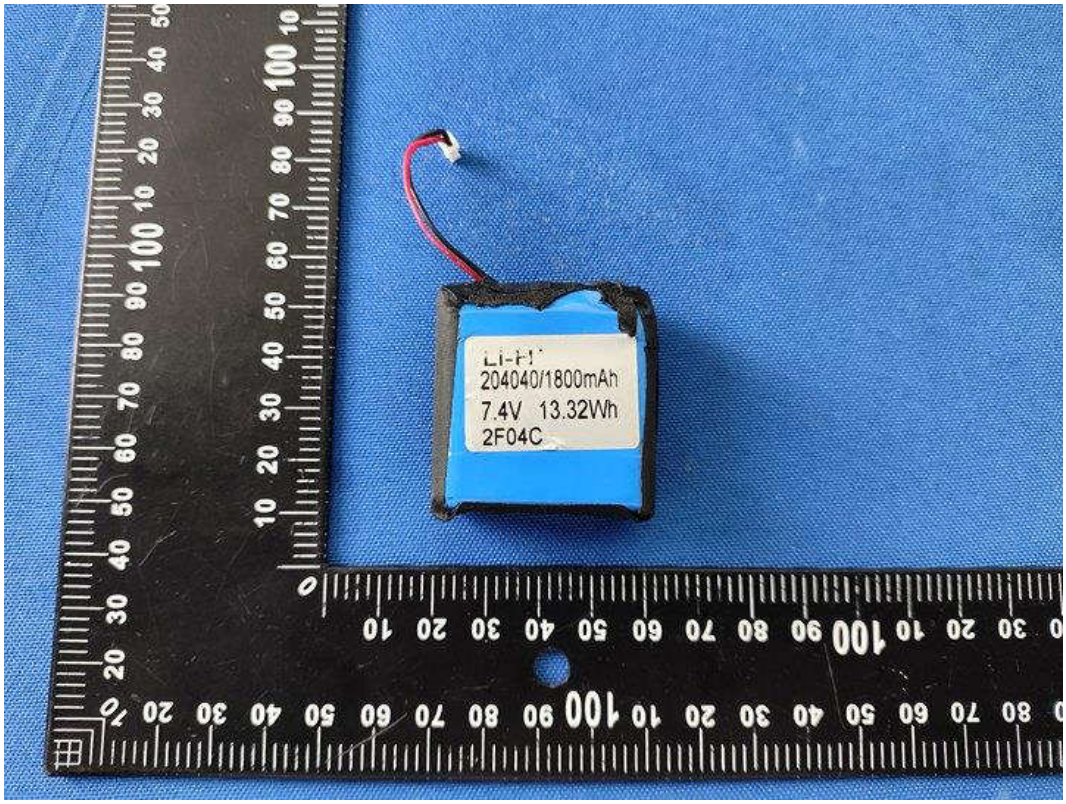
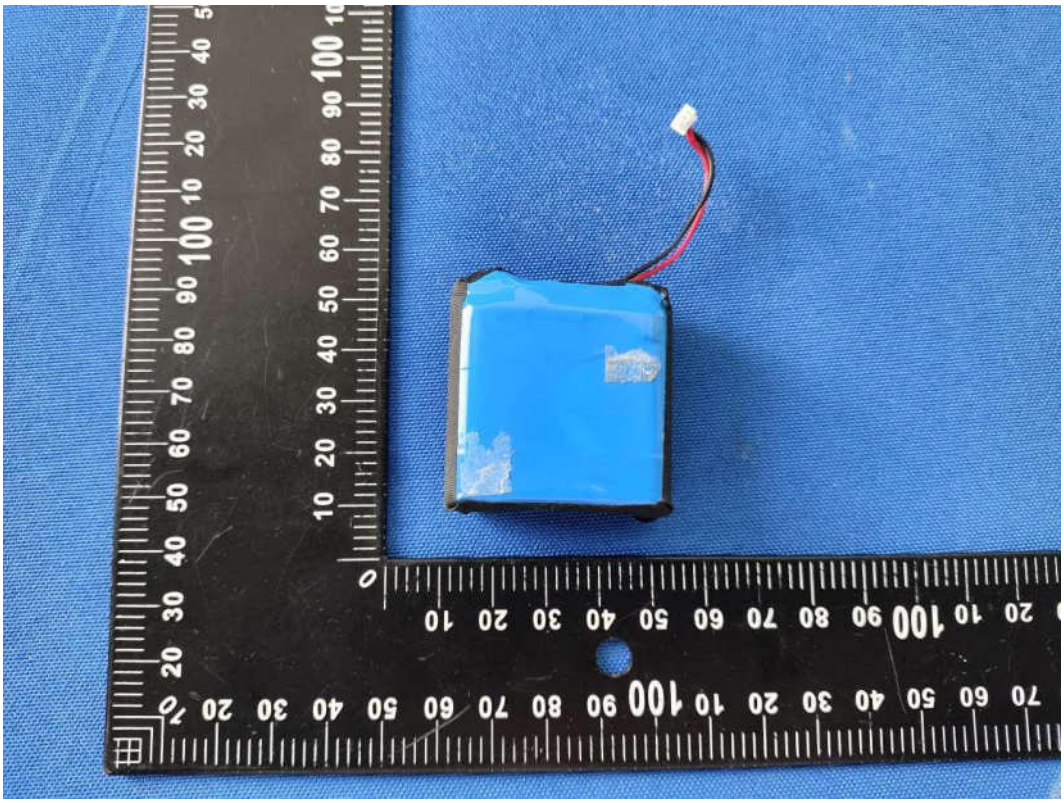
E469747
HDPCB-1
24 18
UM980




BT ANT





-------END OF REPORT-------