



TEST REPORT

Applicant: Qingdao Thunderobot Technology Co., Ltd.
Address of Applicant: No. 1 Haier Rd., Laoshan District, Qingdao, Shandong, China
Manufacturer: Qingdao Thunderobot Technology Co., Ltd.
Address of Manufacturer: No. 1 Haier Rd., Laoshan District, Qingdao, Shandong, China
Product Name: Triple-Mode Mechanical Keyboard
Model No.: ZERO98
Trade Mark: N/A
FCC ID: 2BFDF-ZERO98
Applicable standards: 47CFR Part 15.247
Date of Test: Jul.23, 2026-Aug.18, 2026
Date of report issued: Aug.22, 2026

Remark:

The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full without prior written permission of the company.

The report would be invalid without specific stamp of test institute and the signatures of compiler and approver

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1 Test Summary

Test Item	Section	Result	Test by
Antenna Requirement	47CFR Part 15.203/15.247 (b) (4)	Pass	/
AC Power Line Conducted Emission	47CFR Part 15.207	Pass	Jason Huang
Conducted Peak Output Power	47CFR Part 15.247 (b)(1)	Pass	Kara Wu
20dB Occupied Bandwidth	47CFR Part 15.247 (a)(1)	Pass	Kara Wu
Carrier Frequencies Separation	47CFR Part 15.247 (a)(1)	Pass	Kara Wu
Hopping Channel Number	47CFR Part 15.247 (a)(1)(iii)	Pass	Kara Wu
Dwell Time	47CFR Part 15.247 (a)(1)(iii)	Pass	Kara Wu
Radiated Emission	47CFR Part 15.205/15.209	Pass	Jason Huang
Band Edge	47CFR Part 15.247(d) 47CFR part 15.205/15.209	Pass	Kara Wu

Remarks:

1. Pass: The EUT complies with the essential requirements in the standard.
2. Test according to ANSI C63.10-2020 + Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024 and KDB558074 D01 15.247 Meas Guidance v05r02.
3. Note: Compliance determination rules
 - 1). The Compliance determination of test results does not take into account measurement uncertainty. Measurement results are determined based on regulatory limitations or requirements specified by the applicant/manufacture. If measurement uncertainty is taken into account, the applicant/manufacture will bear all possible risks of non-compliance.
 - 2). The measurement uncertainty please refer to each test result in the "Measurement Uncertainty"

Measurement Uncertainty

Test Item	Measurement Uncertainty	Notes
Occupied Channel Bandwidth	0.72%	(1)
RF output power, conducted	±0.67 dB	(1)
Power Spectral Density, conducted	±0.51 dB	(1)
Unwanted Emissions, conducted	±0.64 dB	(1)
AC Power Line Conducted Emission	± 3.38 dB	(1)
Radiated emissions 9K-30MHz	±4.26 dB	(1)
Radiated emissions 30M- 1GHz	±4.88 dB	(1)
Radiated emissions 1GHz-18GHz	± 4.16 dB	(1)
Radiated emissions 18GHz-40GHz	±4.14 dB	(1)
Frequency error	Uc=6X10 ⁻⁷	(1)
Dwell Time	±0.03	(1)

Note (1): The measurement uncertainty is for coverage factor of k=2 and a level of confidence of 95%.

2 General Information

2.1 General Description of EUT

Product Name:	Triple-Mode Mechanical Keyboard
Model No.:	ZERO98
Difference of model(s):	N/A
Test Model:	ZERO98
Hardware Version:	V1.0
Software Version:	V20.03
Power supply:	DC 5V or DC 3.7V From Battery
Battery:	DC 3.7V 5000mAh
Adapter:	N/A
Radio Technology:	Bluetooth
Operation Frequency:	2402MHz~2480MHz
Channel numbers:	79
Channel separation:	1MHz
Modulation type:	GFSK
Antenna Type:	PCB antenna
Antenna gain:	-4.51dBi

Note:

1. For more details, refer to the user's manual of the EUT.

2. Antenna information is provided by applicant, Testing lab is not responsible for the accuracy of the information.

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

2.2 Test mode

Conducted test	Link mode
RF and Radiated test	Transmitting mode (Keep the EUT in Max. power level continuously transmitting mode.)

2.3 Description of Support Units

No.	Description	Manufacturer	Model	Serial Number
1	Adapter	MDY-11-EM	/	Xiaomi
2	Laptop	MDF-16	/	HUAWEI

2.4 Test Facility

Test laboratory:	Shenzhen ETR Standard Technology Co., Ltd.
CNAS Registration Number:	L11864
A2LA Certificate Number:	6640.01
FCC Designation Number:	CN1326
FCC Test Firm Registration:	183064
IC Company Number:	28440
Laboratory location:	No.103, No.10, Phase I, Zone 3, Xinxing Industrial Park, Xinhe, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China

2.5 Additional Instructions

Test Software	Manufacturer-specific serial commands
Power level setup	Default

3 Test Instruments list

Item	Equipment name	Manufacturer	Model	Serial No.	Calibration date	Due date
1	EMI Test Receiver	Rohde&schwarz	ESCI7	101214	2026.3.05	2027.3.04
2	EMI Test Receiver	Rohde&schwarz	ESCI3	102696	2026.3.05	2027.3.04
3	Loop Antenna	schwarabeck	FMZB 1519 B	128	2026.3.08	2028.3.07
4	Broadband antenna	schwarabeck	VULB9168	1064	2026.3.11	2028.3.10
5	Horn antenna	schwarabeck	BBHA9120D	2288	2026.3.08	2028.3.07
6	amplifier	EMtrace	RP01A	50117	2026.3.05	2027.3.04
7	AMN	schwarabeck	NSLK8127	8127483	2026.3.05	2027.3.04
8	AMN	ETS	3186/2NM	1132	2026.3.05	2027.3.04
9	10dB attenuator	HUBER+SUHN R	10dB	/	2026.3.05	2027.3.04
10	amplifier	Space-Dtronics	EWLAN0118G- P40	19113001	2026.3.05	2027.3.04
11	Filter	Xingbo	XBLBQ-GTA19	210410-3-1	2026.3.05	2027.3.04
12	Spectrum analyzer	KEYSIGHT	N9020A	MY55370280	2026.3.05	2027.3.04
13	Power control box	MWRFTtest	MW100-PSB	MW201020JYT	2026.3.05	2027.3.04
14	Power Sensor	Keysight	U2021XA	MY54111006	2026.3.05	2027.3.04
15	amplifier	SKET	LNPA_1840-50 (18-40GHz)	19113001	2026.3.05	2027.3.04
16	Horn antenna	schwarabeck	BBHA 9170	946	2026.3.08	2028.3.07
17	Spectrum analyzer	Rohde&schwarz	FSU40	1166.1660K43	2026.3.05	2027.3.04
18	Temp. & Humidity Chamber	Jiecheng Instrument	QA-LP-80	20160705001	2026/3/06	2027/3/05

Note: the calibration interval of the above test instruments is 12 or 24 months and the calibrations are traceable to international system unit (SI).

Software Name	Manufacturer	Model	Version
RF test software	MWRFTtest	MTS 8310	V2.0.0.0
Conducted test software	EZ-EMC	Farad	Ver.EMC-CON 3A1.1
Radiated test software	EZ-EMC	Farad	Ver.FA-03A2 RE

4 Test results and Measurement Data

4.1 Antenna requirement

Standard requirement:	FCC Part15 C Section 15.203 /247(b) (4)
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(b) (4) requirement: The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.	
E.U.T Antenna:	
The antenna is PCB antenna, the best case gain of the is -4.51dBi, reference to the Internal photos for details.	

4.2 Conducted Emissions

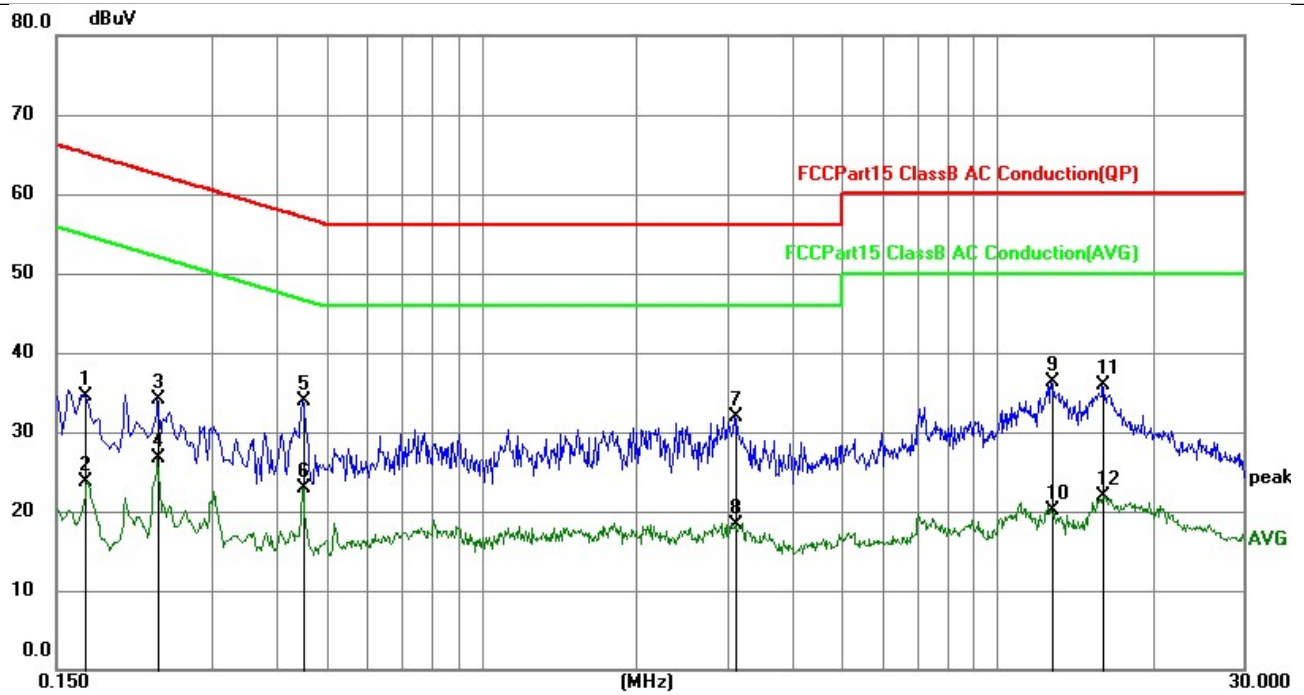
Test Requirement:	47CRF Part 15.207					
Test Method:	ANSI C63.10-2020 + Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024 §6.2					
Test Frequency Range:	150KHz to 30MHz					
Receiver setup:	RBW=9KHz, VBW=30KHz, Sweep time=auto					
Limit:	Frequency range (MHz)		Limit (dBuV)			
			Quasi-peak		Average	
	0.15-0.5		66 to 56*		56 to 46*	
	0.5-5		56		46	
	5-30		60		50	
* Decreases with the logarithm of the frequency.						
Test setup:	Reference Plane 40cm LISN AUX Equipment E.U.T 80cm LISN Filter EMI Receiver AC power Test table/Insulation plane Remark: E.U.T: Equipment Under Test LISN: Line Impedance Stabilization Network Test table height=0.8m					
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 C63.10:2020 on conducted measurement.					
Test Instruments:	Refer to section 3.0 for details					
Test mode:	Refer to section 2.2 for details					
Test environment:	Temp.:	23.2°C	Humid.:	41%	Press.:	1002 mbar
Test voltage:	AC 120V, 60Hz					
Test results:	Pass					

Remark:

1. Both high voltage and low voltage have been tested, and the report only shows the worst case data with AC 120V/60Hz.

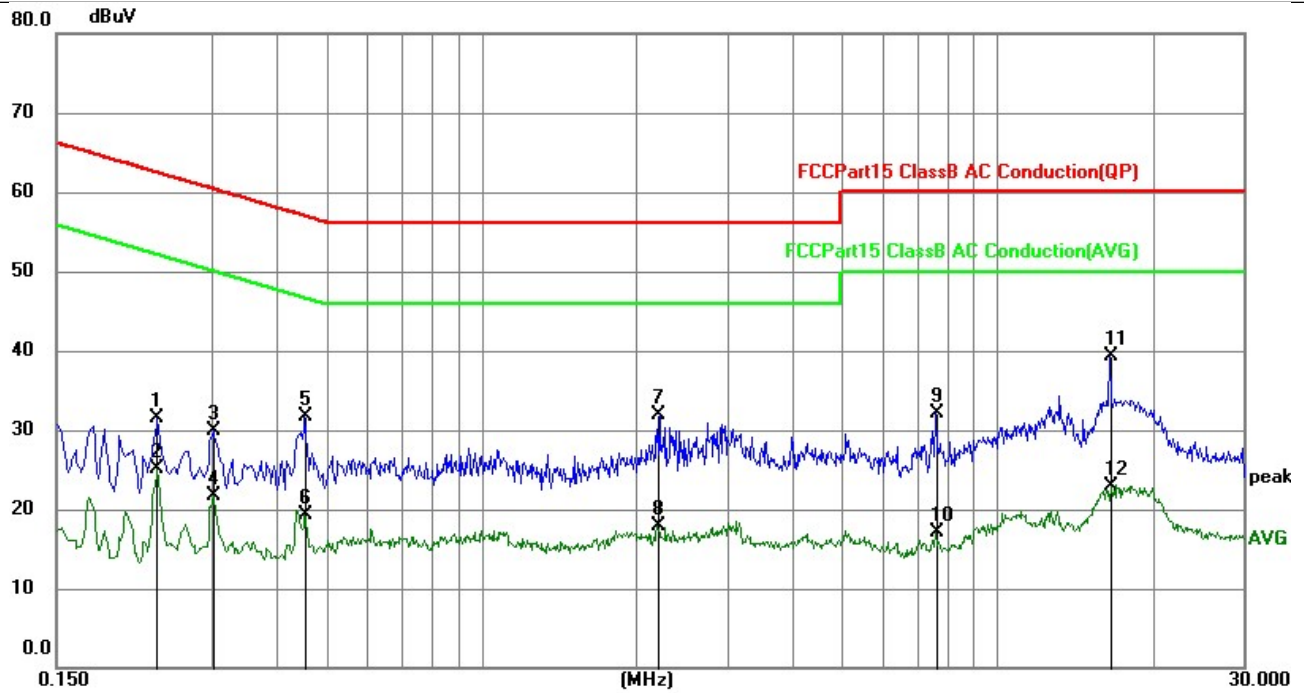
Measurement data:

Line:



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.1711	24.48	9.97	34.45	64.91	-30.46	QP
2	0.1711	13.82	9.97	23.79	54.91	-31.12	AVG
3	0.2354	24.04	9.98	34.02	62.26	-28.24	QP
4	0.2354	16.63	9.98	26.61	52.26	-25.65	AVG
5	0.4515	23.82	10.06	33.88	56.85	-22.97	QP
6	0.4515	12.93	10.06	22.99	46.85	-23.86	AVG
7	3.0929	21.92	10.01	31.93	56.00	-24.07	QP
8	3.0929	8.28	10.01	18.29	46.00	-27.71	AVG
9	12.7454	26.34	10.04	36.38	60.00	-23.62	QP
10	12.7454	10.12	10.04	20.16	50.00	-29.84	AVG
11	16.0395	25.85	9.99	35.84	60.00	-24.16	QP
12	16.0395	11.82	9.99	21.81	50.00	-28.19	AVG

Neutral:

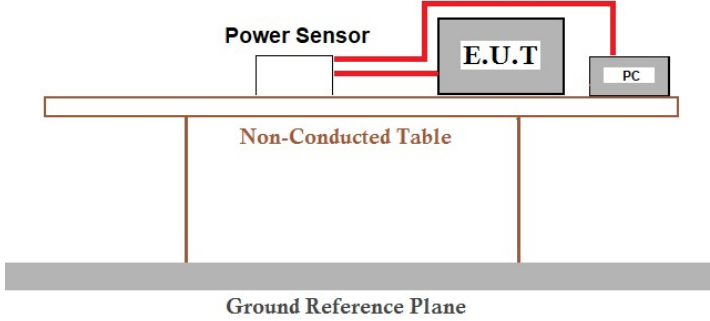


No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.2353	21.50	9.98	31.48	62.26	-30.78	QP
2	0.2353	15.13	9.98	25.11	52.26	-27.15	AVG
3	0.3029	19.80	10.01	29.81	60.16	-30.35	QP
4	0.3029	11.71	10.01	21.72	50.16	-28.44	AVG
5	0.4560	21.59	10.07	31.66	56.77	-25.11	QP
6	0.4560	9.29	10.07	19.36	46.77	-27.41	AVG
7	2.1974	21.90	10.00	31.90	56.00	-24.10	QP
8	2.1974	7.91	10.00	17.91	46.00	-28.09	AVG
9	7.6063	22.10	10.06	32.16	60.00	-27.84	QP
10	7.6063	7.00	10.06	17.06	50.00	-32.94	AVG
11	16.5345	29.37	9.98	39.35	60.00	-20.65	QP
12	16.5345	12.85	9.98	22.83	50.00	-27.17	AVG

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.
3. Final Level = Receiver Read level + LISN Factor + Cable Loss

4.3 Conducted Peak Output Power

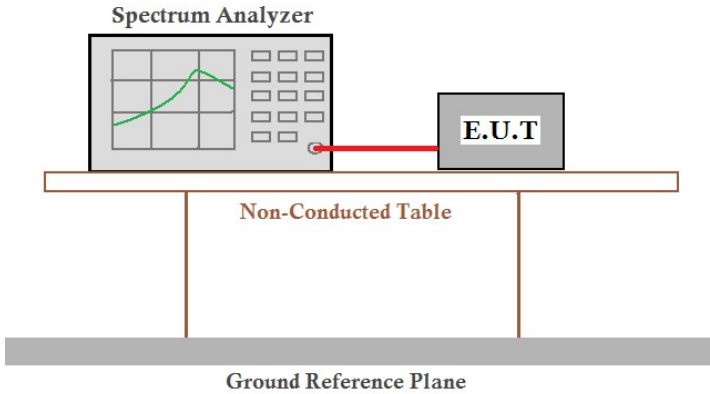
Test Requirement:	47CRF Part 15.247 (b)(1)	
Test Method:	KDB558074 D01 15.247 Meas Guidance v05r02 <i>ANSI C63.10-2020 + Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024 §7.8.5</i>	
Limit:	Output Power :20.97dBm	
Test setup:	 The diagram illustrates the test setup. A 'Power Sensor' is connected via red lines to an 'E.U.T' (Equipment Under Test) and a 'PC'. Both the 'E.U.T' and 'PC' are placed on a 'Non-Conducted Table'. This table is supported by two vertical legs and sits on a 'Ground Reference Plane', which is represented by a thick grey bar at the bottom.	
Test Instruments:	Refer to section 3.0 for details	
Test mode:	Refer to section 2.2 for details	
Test environment:	Temp.: 23.2°C	Humid.: 41%RH
Test voltage:	DC 3.7V from battery	
Test results:	Pass	



Measurement Result

Mode	Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
GFSK	Lowest	-1.82	20.97	Pass
	Middle	-2.71		
	Highest	-2.28		

4.4 20dB Emission Bandwidth

Test Requirement:	47CRF Part 15.247 (a)(1)	
Test Method:	ANSI C63.10-2020 + Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024 §6.9.2	
Limit:	N/A	
Test setup:		
Test Instruments:	Refer to section 3.0 for details	
Test mode:	Refer to section 2.2 for details	
Test environment:	Temp.: 23.2°C	Humid.: 41%RH
Test voltage:	DC 3.7V from battery	
Test results:	Pass	

Measurement Data

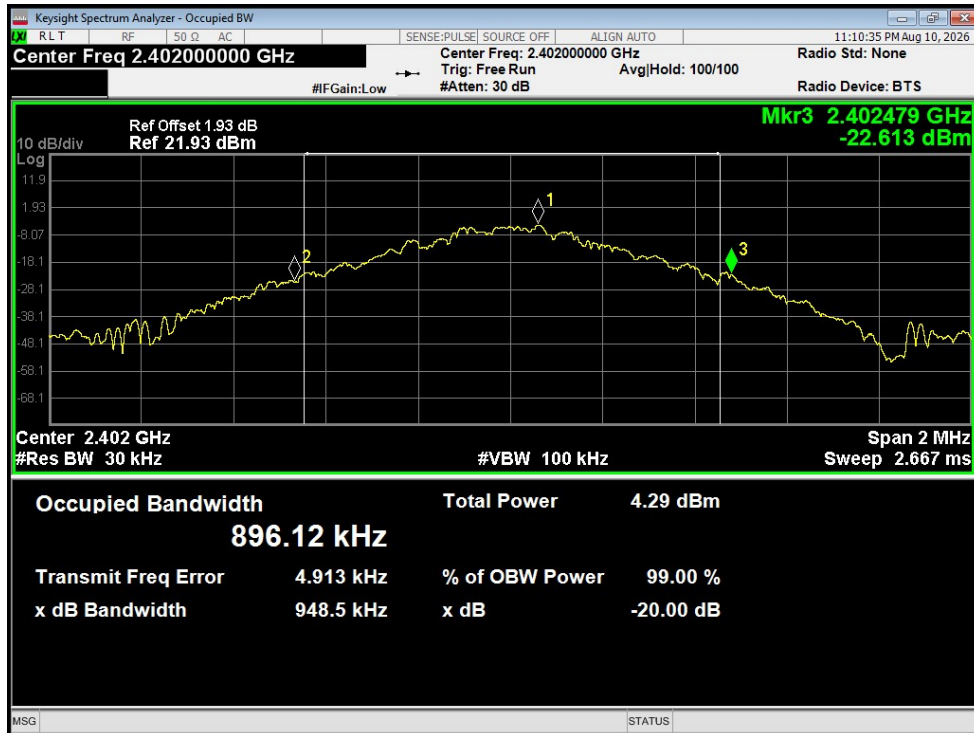
Mode	Test channel	20dB Emission Bandwidth (MHz)	Result
GFSK	Lowest	0.948	Pass
	Middle	0.954	
	Highest	1.019	

Remark: Test performed at worst case in DH5 mode separately.

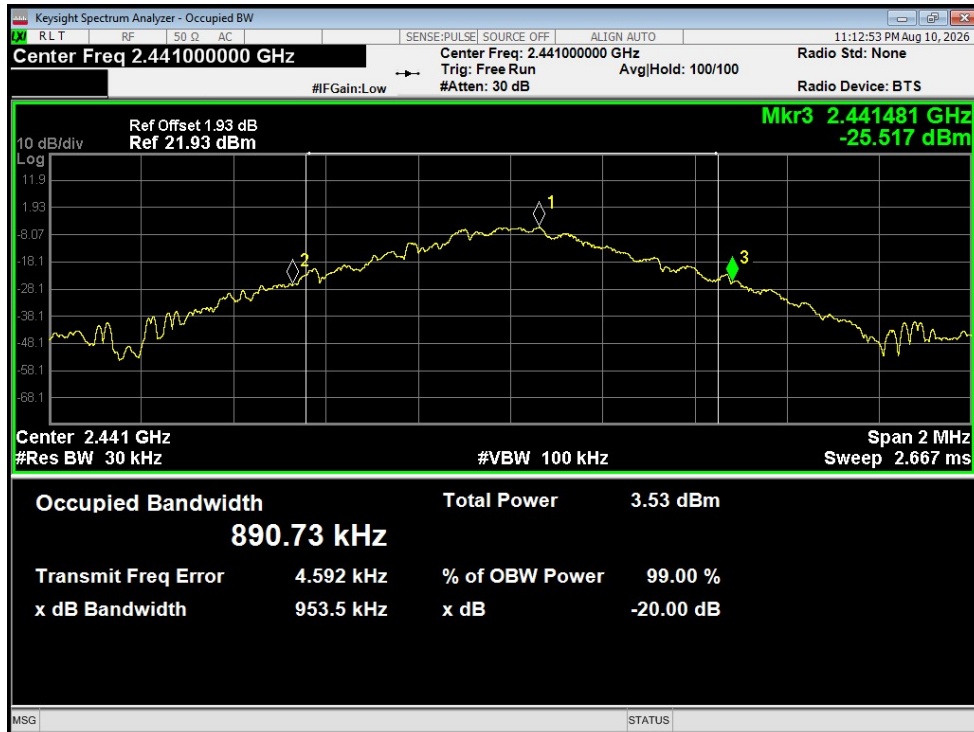


Test plot as follows:

-20dB Bandwidth NVNT 1-DH5 2402MHz Ant1

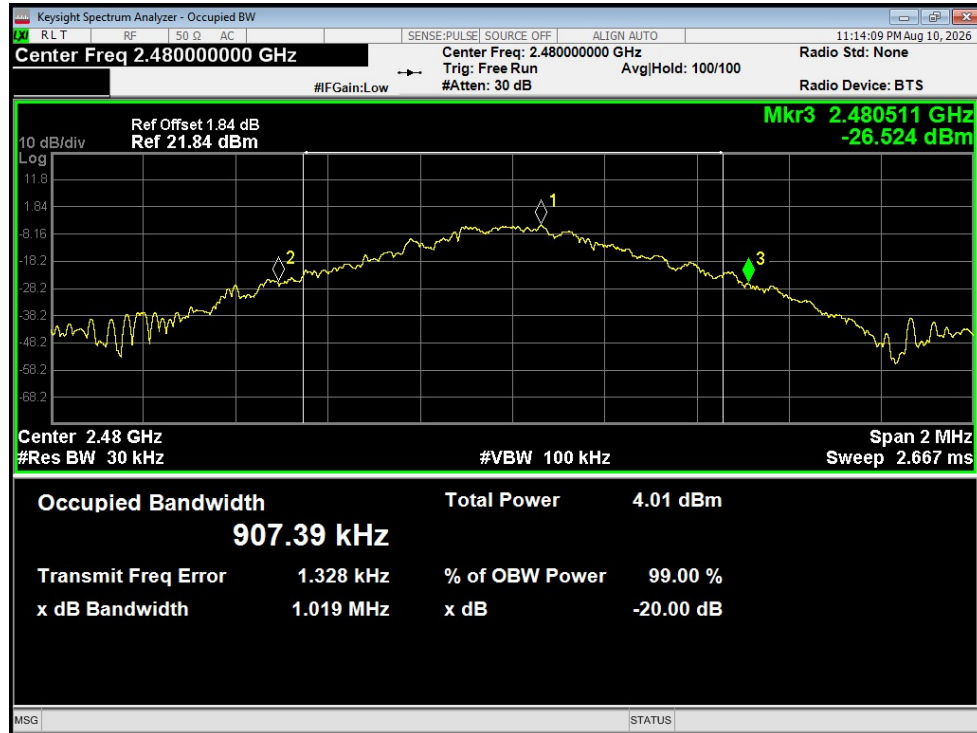


-20dB Bandwidth NVNT 1-DH5 2441MHz Ant1

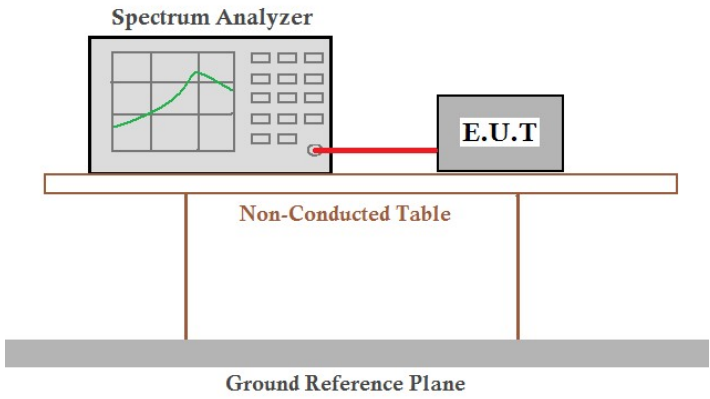




-20dB Bandwidth NVNT 1-DH5 2480MHz Ant1



4.5 Carrier Frequencies Separation

Test Requirement:	47CRF Part 15.247 (a)(1)	
Test Method:	ANSI C63.10-2020 + Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024 §7.8.2	
Receiver setup:	RBW=300KHz, VBW=1000KHz, detector=Peak	
Limit:	>0.025MHz or 2/3 of the 20dB bandwidth (whichever is greater)	
Test setup:		
Test Instruments:	Refer to section 3.0 for details	
Test mode:	Refer to section 2.2 for details	
Test environment:	Temp.: 23.2°C	Humid.: 41%RH
Test voltage:	DC 3.7V from battery	
Test results:	Pass	

Measurement Data

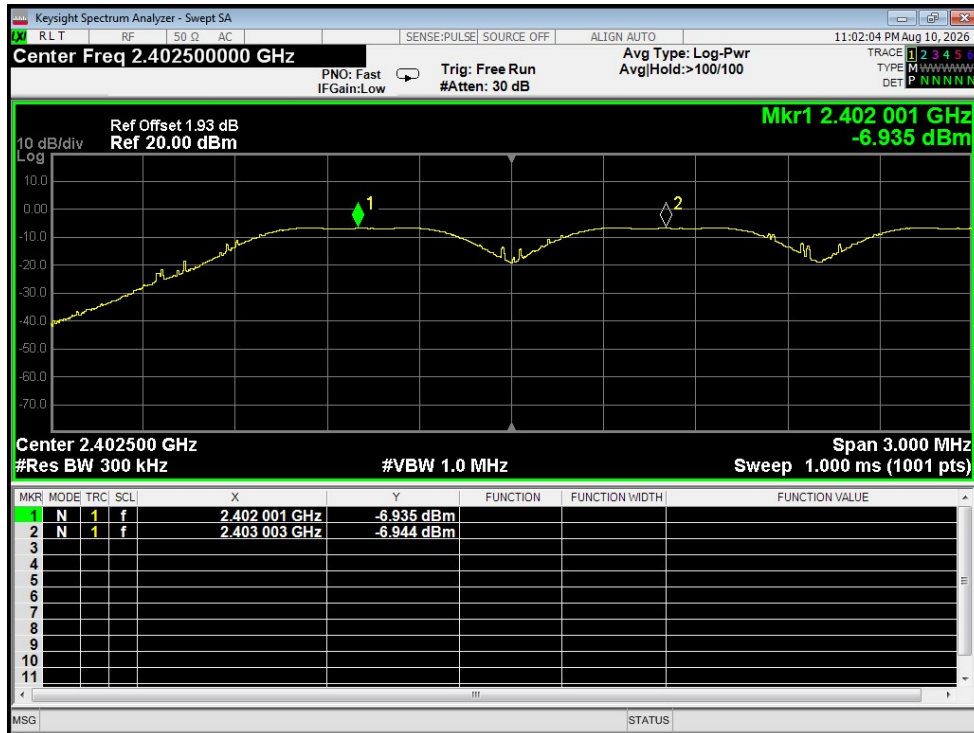
Mode	Test channel	Carrier Frequencies Separation (MHz)	Limit (MHz)	Result
GFSK	Lowest	1.002	0.948	Pass
	Middle	1.005	0.954	Pass
	Highest	1.002	1.019	Pass

Note:

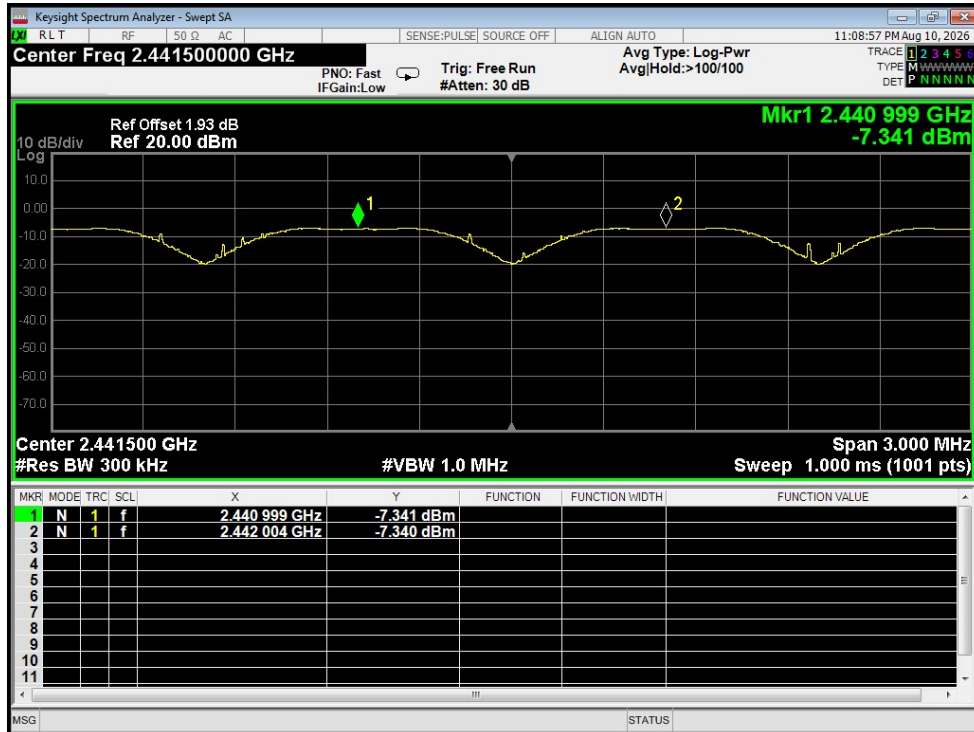
1. Limit According to section 4.4.
2. Test performed at worst case in DH5mode separately.

Test plot as follows:

CFS NVNT 1-DH5 2402MHz Ant1

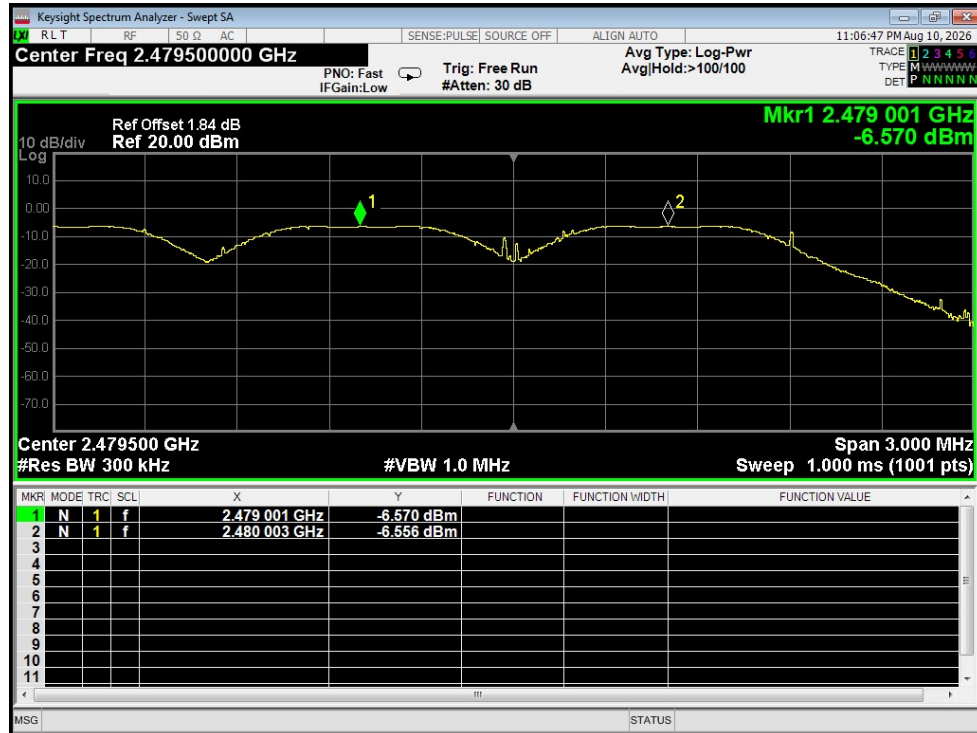


CFS NVNT 1-DH5 2441MHz Ant1

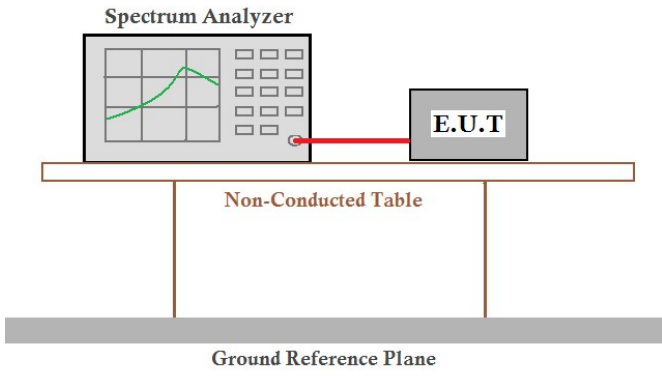




CFS NVNT 1-DH5 2480MHz Ant1



4.6 Hopping Channel Number

Test Requirement:	47CRF Part 15.247 (a)(1)(iii)	
Test Method:	ANSI C63.10-2020 + Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024 §7.8.3	
Receiver setup:	RBW=100kHz, VBW=300kHz, Frequency range=2400MHz-2483.5MHz, Detector=Peak	
Limit:	15 channels	
Test setup:		
Test Instruments:	Refer to section 3.0 for details	
Test mode:	Refer to section 2.2 for details	
Test environment:	Temp.: 23.2°C	Humid.: 41%RH
Test voltage:	DC 3.7V from battery	
Test results:	Pass	

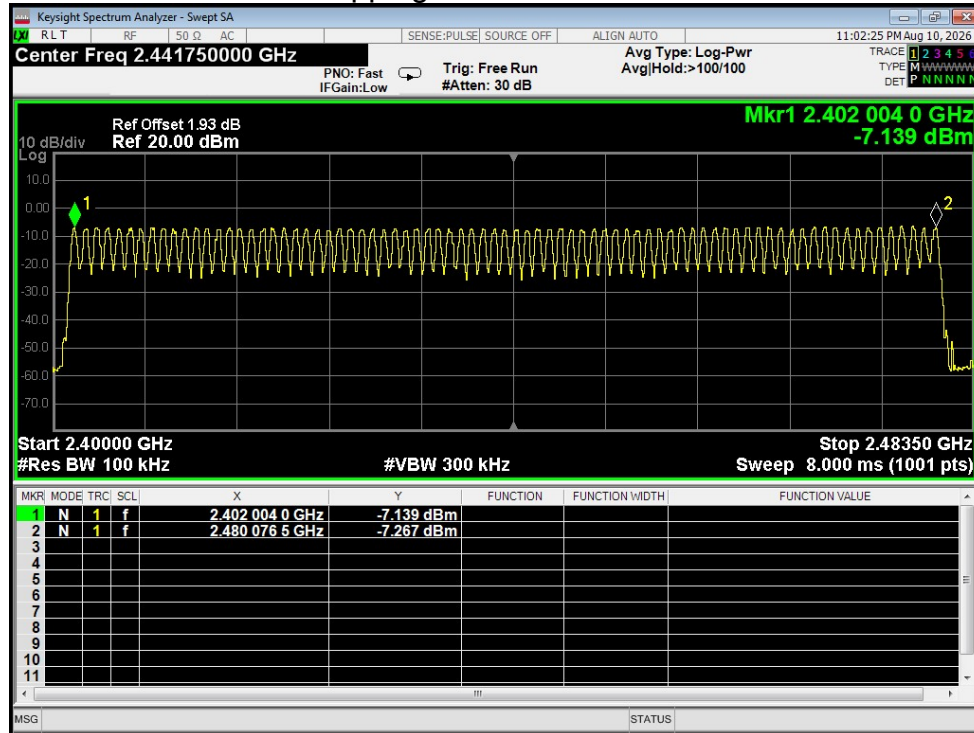
Measurement Data:

Mode	Hopping channel numbers	Limit	Result
GFSK	79	15	Pass

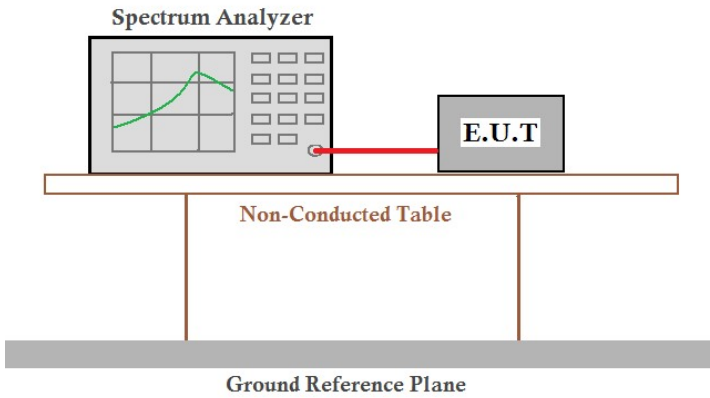


Test plot as follows:

Hopping No. NVNT 1-DH5



4.7 Dwell Time

Test Requirement:	47CRF Part 15.247 (a)(1)(iii)	
Test Method:	ANSI C63.10-2020 + Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024 §7.8.4	
Receiver setup:	RBW=1MHz, VBW=3MHz, Span=0Hz, Detector=Peak	
Limit:	0.4 Second	
Test setup:	 The diagram illustrates the test setup. A Spectrum Analyzer is connected via a red cable to an E.U.T. (Equipment Under Test). Both are placed on a Non-Conducted Table. Below the table is a Ground Reference Plane.	
Test Instruments:	Refer to section 3.0 for details	
Test mode:	Refer to section 2.2 for details	
Test environment:	Temp.: 23.2°C	Humid.: 41%RH
Test voltage:	DC 3.7V from battery	
Test results:	Pass	

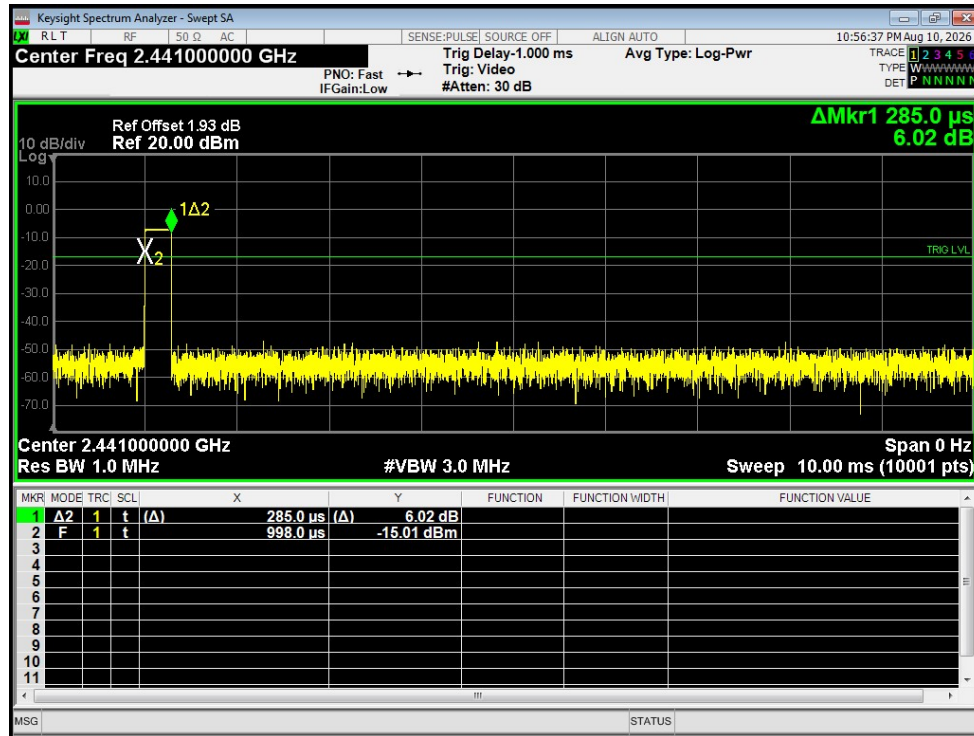


Measurement Result

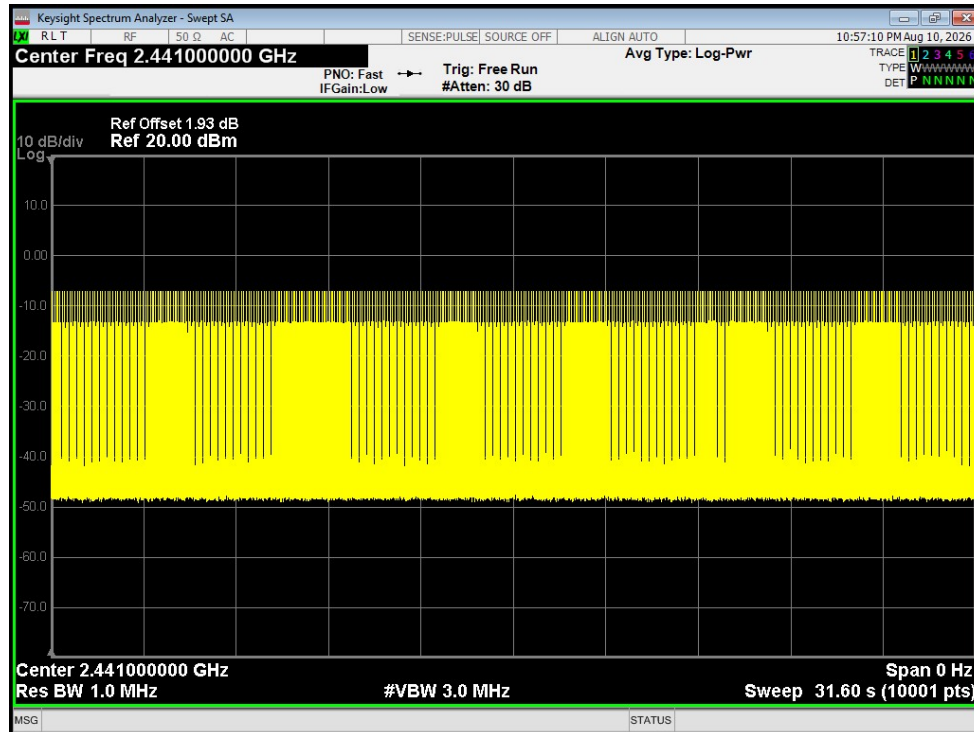
Mode	Frequency (MHz)	Pulse Time (ms)	Total Dwell Time (ms)	Burst Count	Period Time (ms)	Limit (ms)	Result
1-DH1	2441	0.285	104.31	366	31600	400	Pass
1-DH3	2441	1.544	259.392	168	31600	400	Pass
1-DH5	2441	0.285	104.31	366	31600	400	Pass

Test plot as follows:

Dwell NVNT 1-DH1 2441MHz Ant1 One Burst

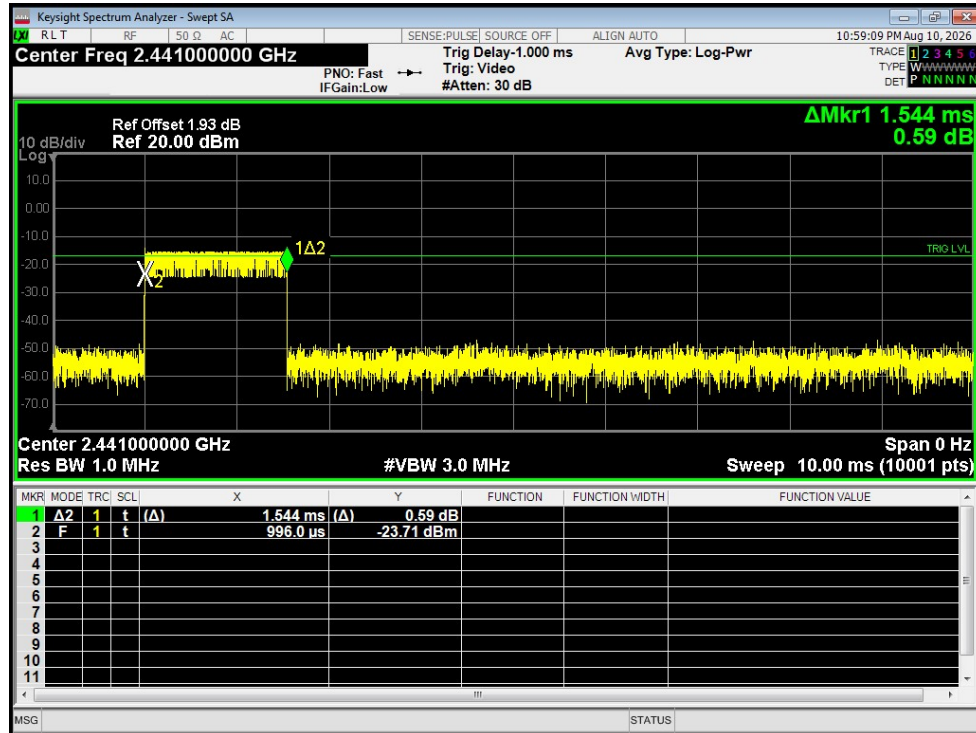


Dwell NVNT 1-DH1 2441MHz Ant1 Accumulated

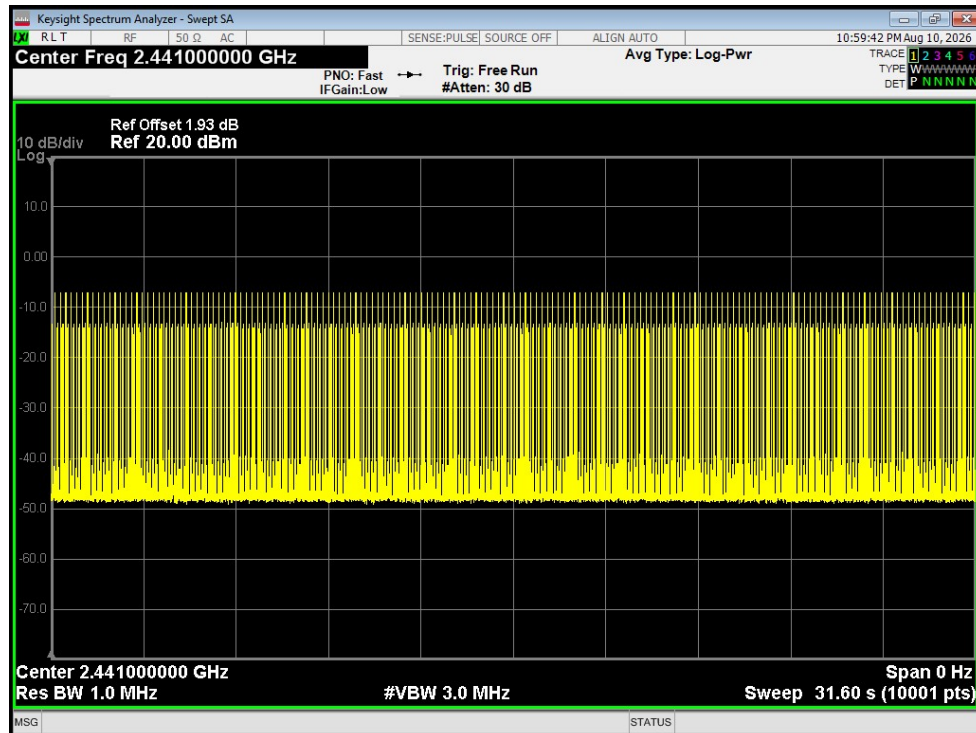




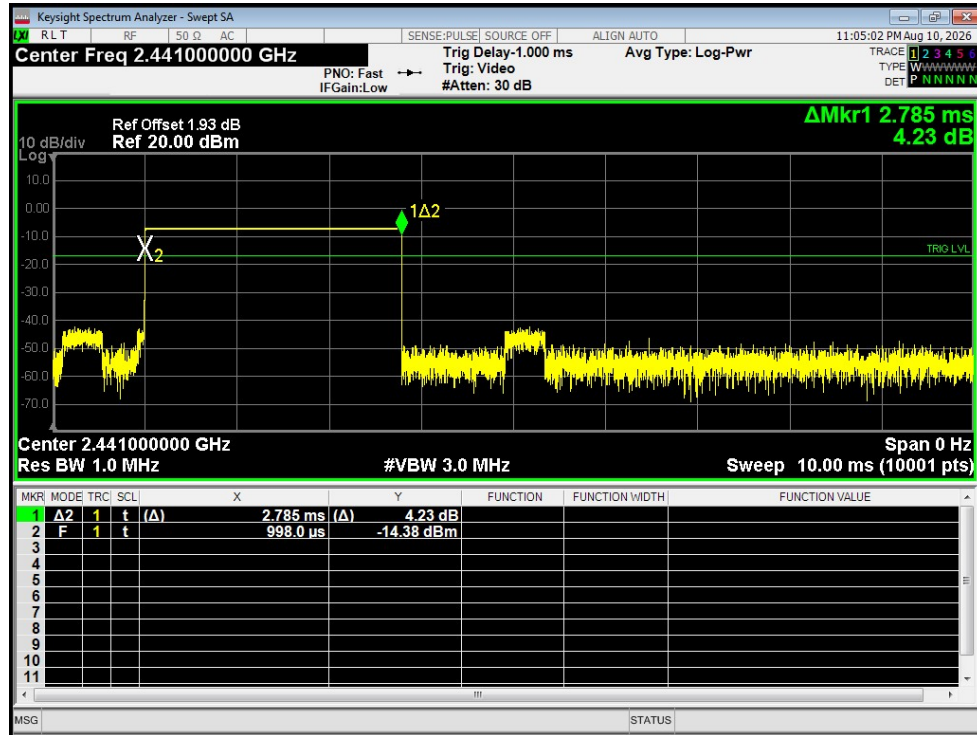
Dwell NVNT 1-DH3 2441MHz Ant1 One Burst



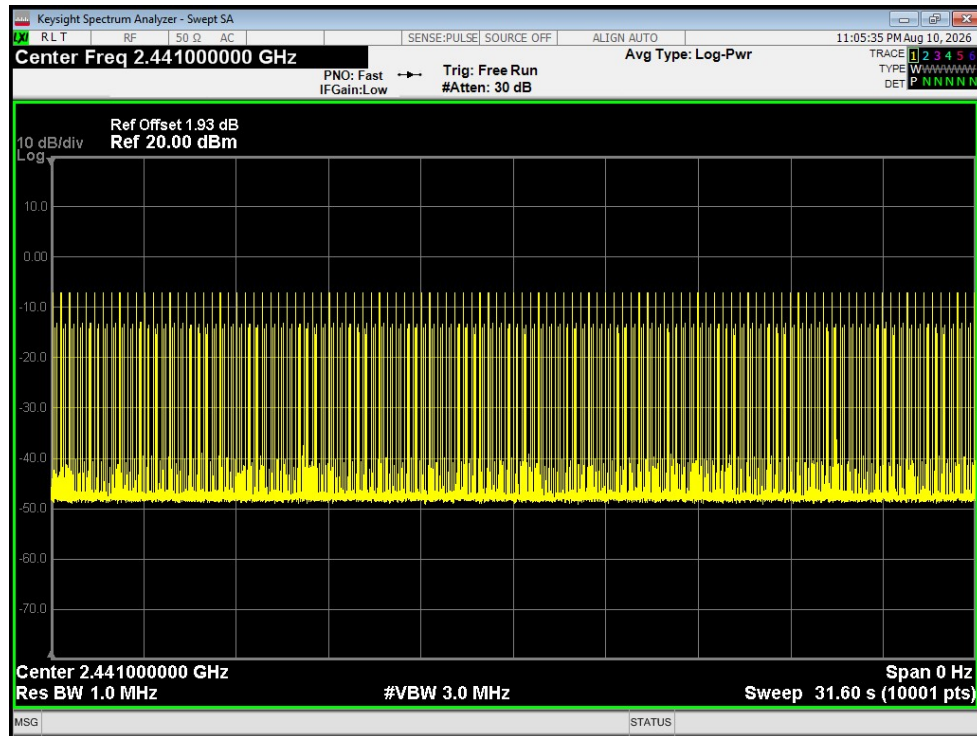
Dwell NVNT 1-DH3 2441MHz Ant1 Accumulated



Dwell NVNT 1-DH5 2441MHz Ant1 One Burst

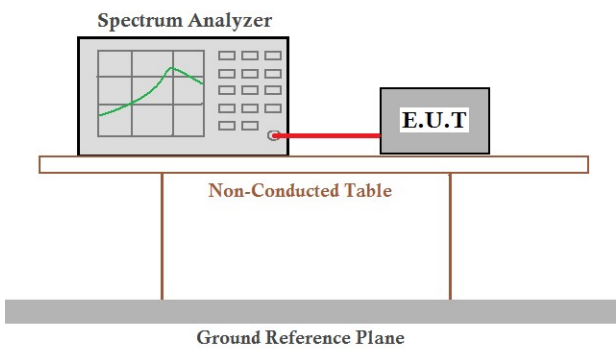


Dwell NVNT 1-DH5 2441MHz Ant1 Accumulated



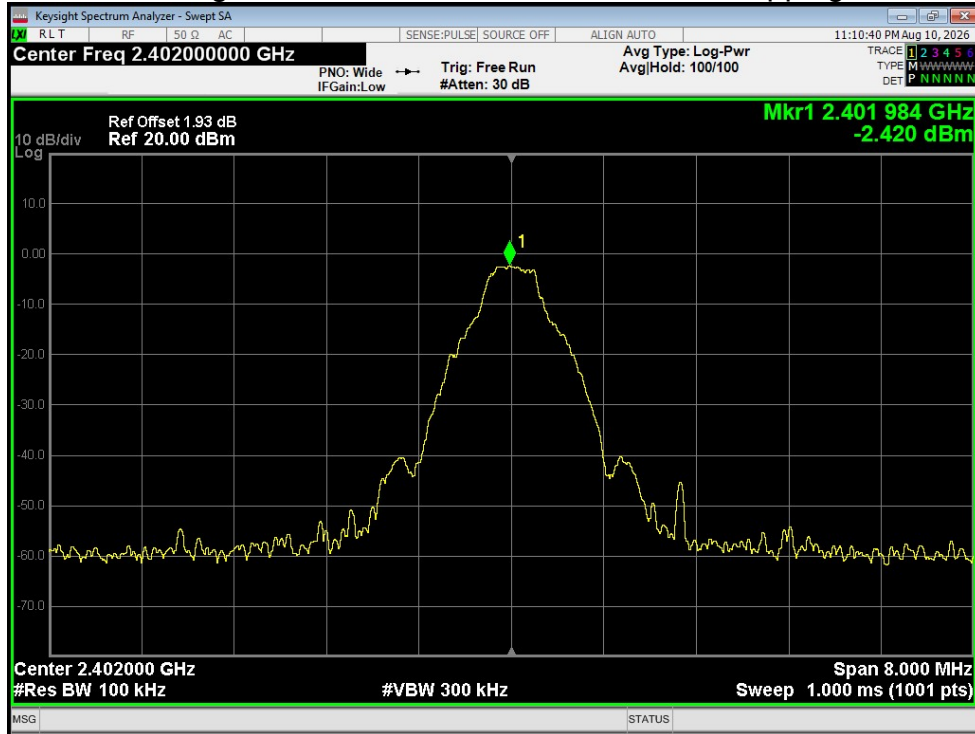
4.8 Band Edge

4.8.1 Conducted Emission Method

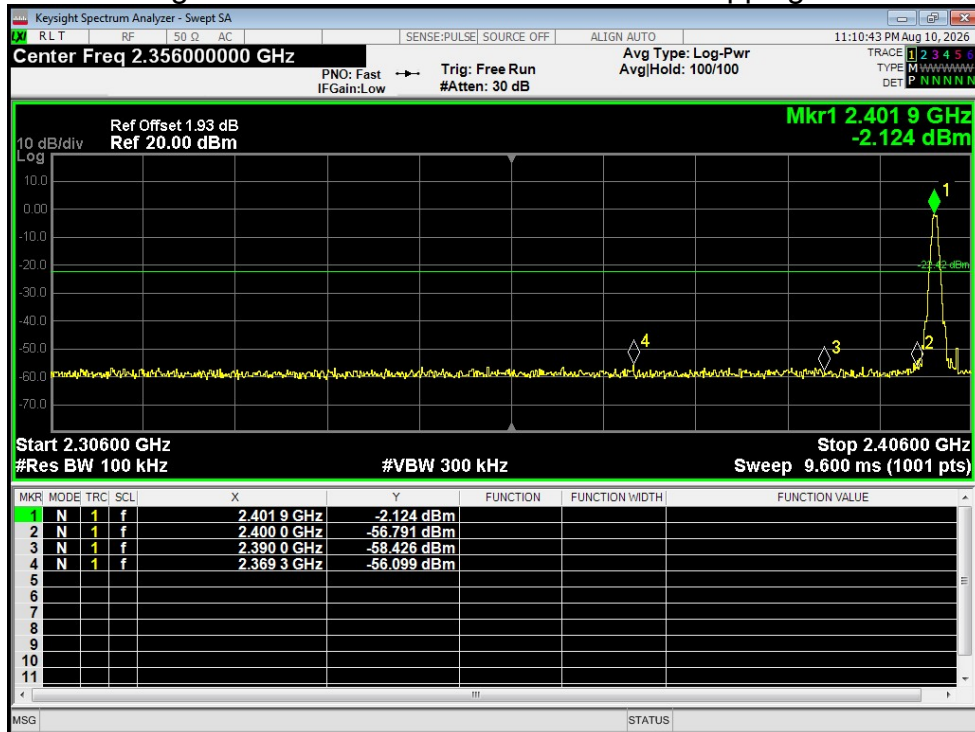
Test Requirement:	47CRF Part 15.247 (d)	
Test Method:	ANSI C63.10-2020 + Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024 §7.8.6	
Receiver setup:	RBW=100kHz, VBW=300kHz, Detector=Peak	
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, 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.	
Test setup:		
Test Instruments:	Refer to section 3.0 for details	
Test mode:	Refer to section 2.2 for details	
Test environment:	Temp.: 23.2°C	Humid.: 41%RH
Test voltage:	DC 3.7V from battery	
Test results:	Pass	

Test plot as follows:

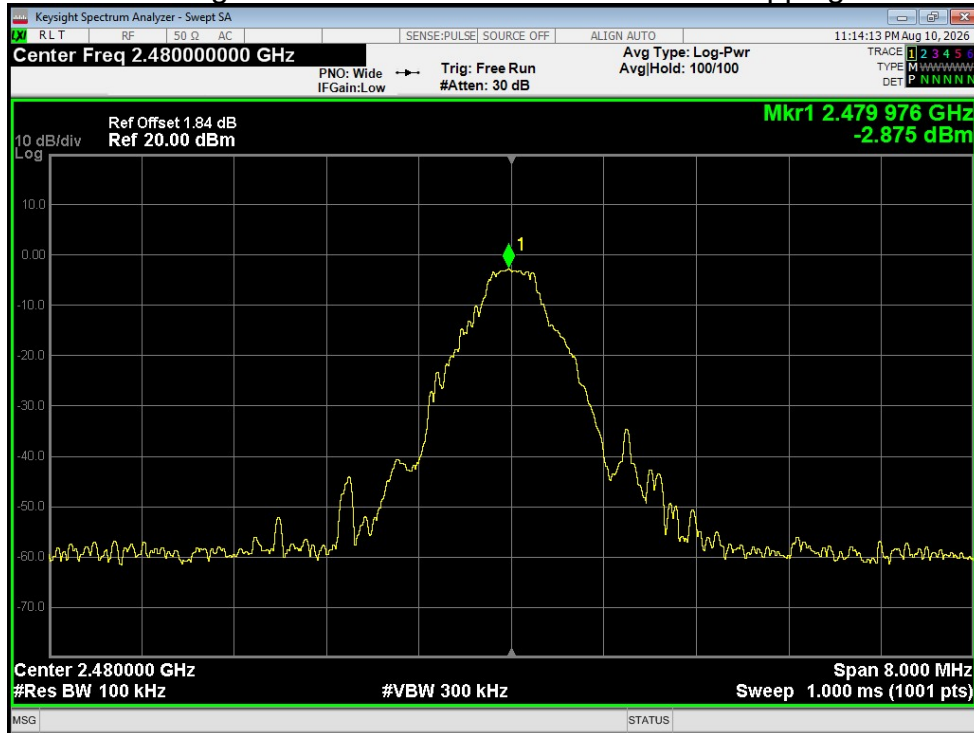
Band Edge NVNT 1-DH5 2402MHz Ant1 No-Hopping Ref



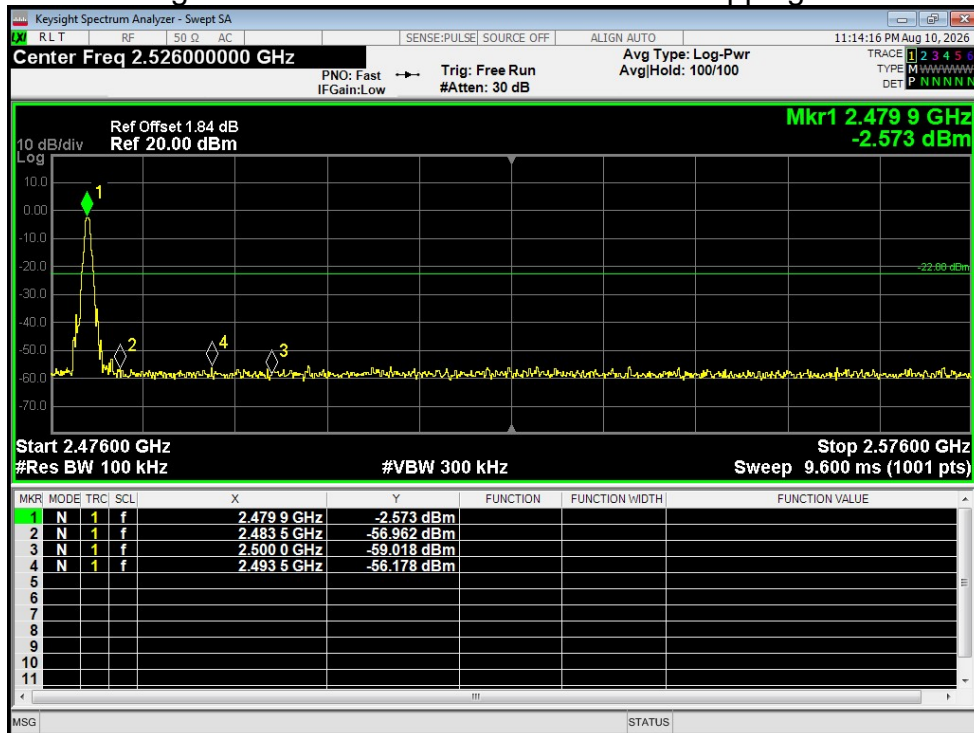
Band Edge NVNT 1-DH5 2402MHz Ant1 No-Hopping Emission



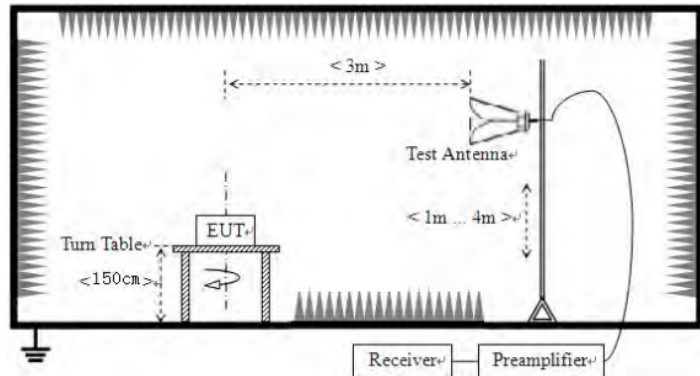
Band Edge NVNT 1-DH5 2480MHz Ant1 No-Hopping Ref



Band Edge NVNT 1-DH5 2480MHz Ant1 No-Hopping Emission



4.8.2 Radiated Emission Method

Test Requirement:	FCC Part15 C Section 15.209 and 15.205				
Test Method:	ANSI C63.10-2020 + Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024				
Test Frequency Range:	All of the restrict bands were tested, only the worst band's (2310MHz to 2500MHz) data was showed.				
Test site:	Measurement Distance: 3m				
Receiver setup:	Frequency	Detector	RBW	VBW	Remark
	Above 1GHz	Peak	1MHz	3MHz	Peak Value
		Peak	1MHz	10Hz	Average Value
Limit:	Frequency		Limit (dBuV/m @3m)		Remark
	Above 1GHz		54.00		Average Value
			74.00		Peak Value
Test setup:					
Test Procedure:	1. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation. 2. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. 3. 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. 4. 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. 5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. 6. 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.				
Test Instruments:	Refer to section 3.0 for details				
Test mode:	Refer to section 2.2 for details				
Test environment:	Temp.: 23.2°C			Humid.: 41%RH	
Test voltage:	DC 3.7V from battery				
Test results:	Pass				

Measurement Data

Test channel:	Lowest
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Peak value:

Frequency (MHz)	Read Level (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Polarization
2310.00	61.99	-13.36	48.63	74.00	-25.37	Horizontal
2390.00	66.03	-13.03	53.00	74.00	-21.00	Horizontal
2310.00	61.58	-13.36	48.22	74.00	-25.78	Vertical
2390.00	65.72	-13.03	52.69	74.00	-21.31	Vertical

Average value:

Frequency (MHz)	Read Level (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2310.00	49.53	-13.36	36.17	54.00	-17.83	Horizontal
2390.00	54.92	-13.03	41.89	54.00	-12.11	Horizontal
2310.00	49.98	-13.36	36.62	54.00	-17.38	Vertical
2390.00	54.89	-13.03	41.86	54.00	-12.14	Vertical

Test channel:	Highest
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Peak value:

Frequency (MHz)	Read Level (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2483.50	67.59	-12.64	54.95	74.00	-19.05	Horizontal
2500.00	61.80	-12.57	49.23	74.00	-24.77	Horizontal
2483.50	67.64	-12.64	55.00	74.00	-19.00	Vertical
2500.00	62.06	-12.57	49.49	74.00	-24.51	Vertical

Average value:

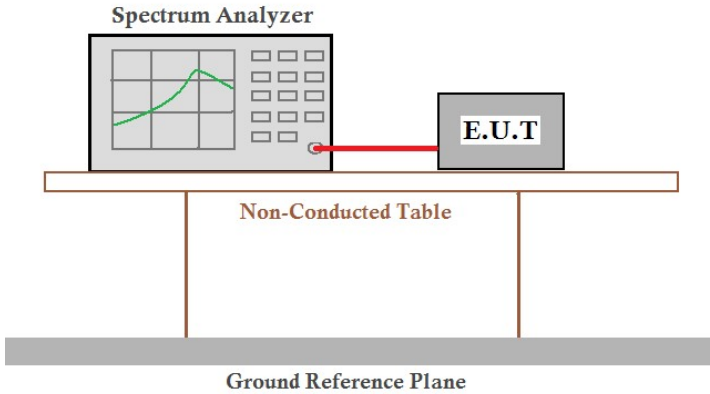
Frequency (MHz)	Read Level (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
2483.50	55.35	-12.64	42.71	54.00	-11.29	Horizontal
2500.00	49.70	-12.57	37.13	54.00	-16.87	Horizontal
2483.50	56.23	-12.64	43.59	54.00	-10.41	Vertical
2500.00	50.82	-12.57	38.25	54.00	-15.75	Vertical

Remarks:

1. Level = Read level + Factor
2. Factor=Antenna Factor + Cable Loss – Preamplifier Factor
3. The emission levels of other frequencies are very lower than the limit and not show in test report.
4. The pre-test were performed on lowest, middle and highest frequencies, only the worst case's (lowest and highest frequencies) data was showed.
5. During the test, pre-scan the GFSK, $\pi/4$ -DQPSK, 8-DPSK modulation, and found the 8-DPSK modulation which it is worse case.

4.9 Spurious Emission

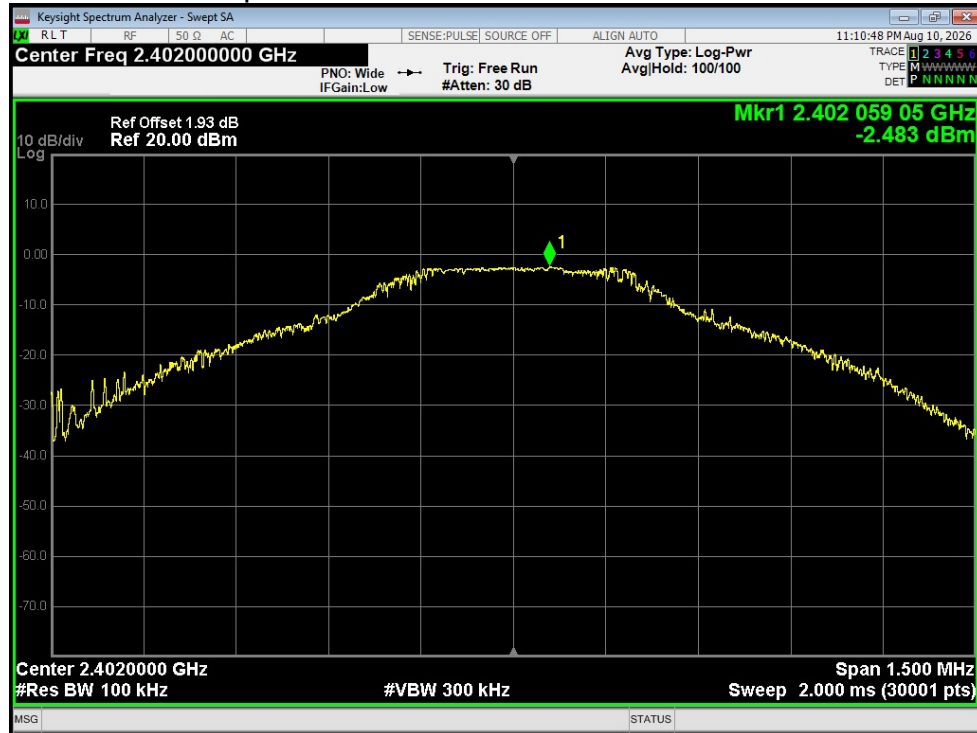
4.9.1 Conducted Emission Method

Test Requirement:	47CRF Part 15.247 (d), 47CRF Part 15.209 and 15.205	
Test Method:	ANSI C63.10-2020 + Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024 §7.8.7	
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.	
Test setup:		
Test Instruments:	Refer to section 3.0 for details	
Test mode:	Refer to section 2.2 for details	
Test environment:	Temp.: 23.2°C	Humid.: 41%RH
Test voltage:	DC 3.7V from battery	
Test results:	Pass	

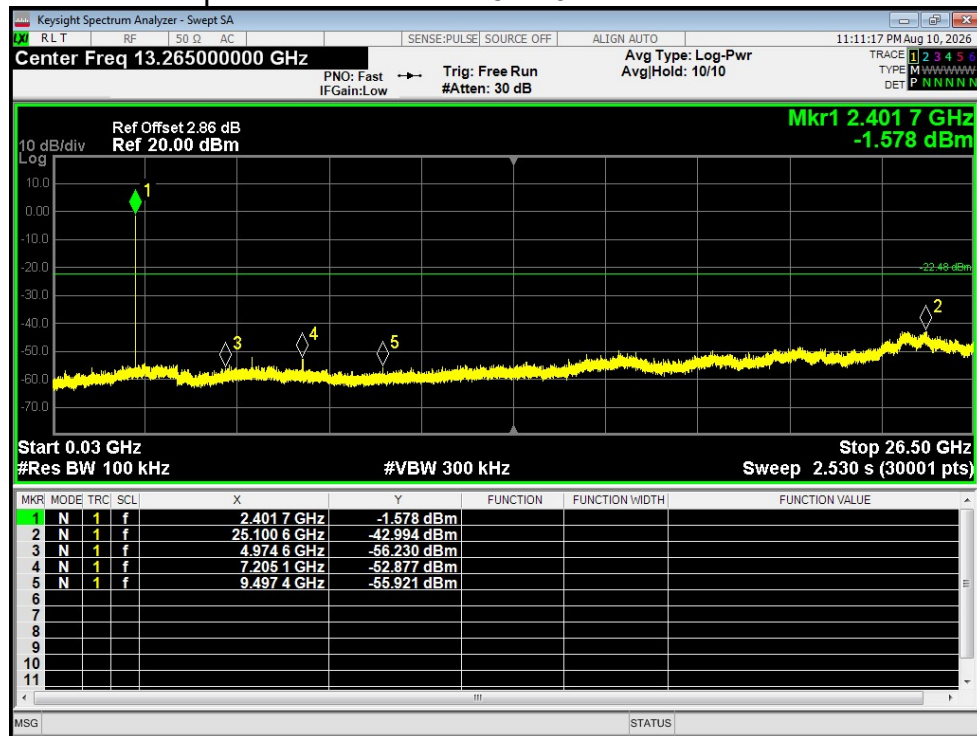
Remark:

1. Cable loss data included in Offset.

Tx. Spurious NVNT 1-DH5 2402MHz Ant1 Ref



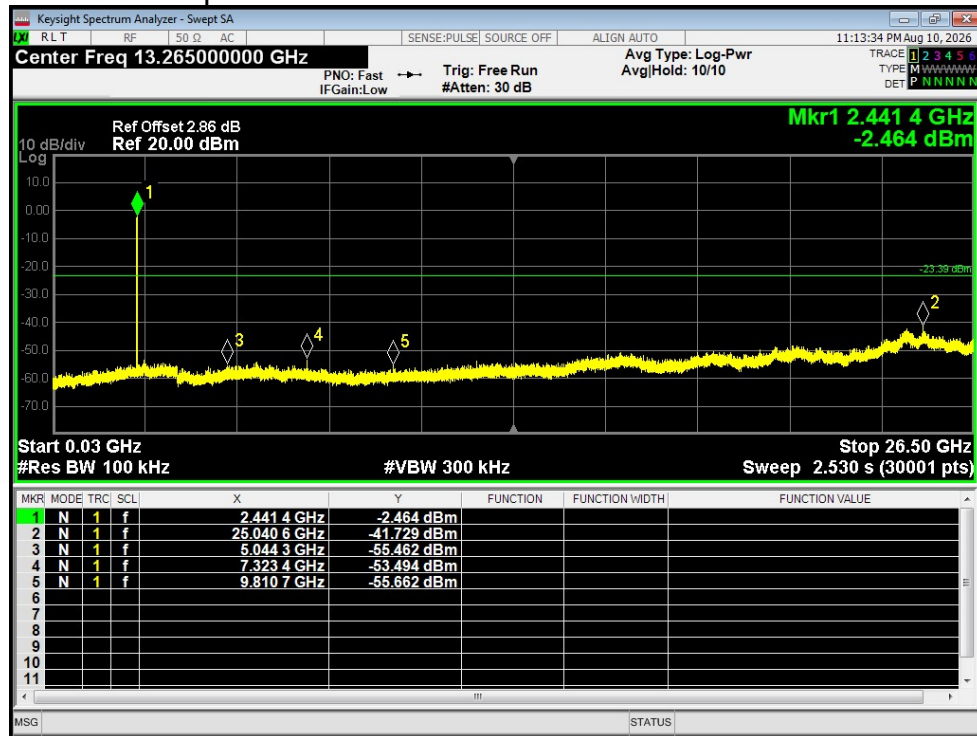
Tx. Spurious NVNT 1-DH5 2402MHz Ant1 Emission



Tx. Spurious NVNT 1-DH5 2441MHz Ant1 Ref



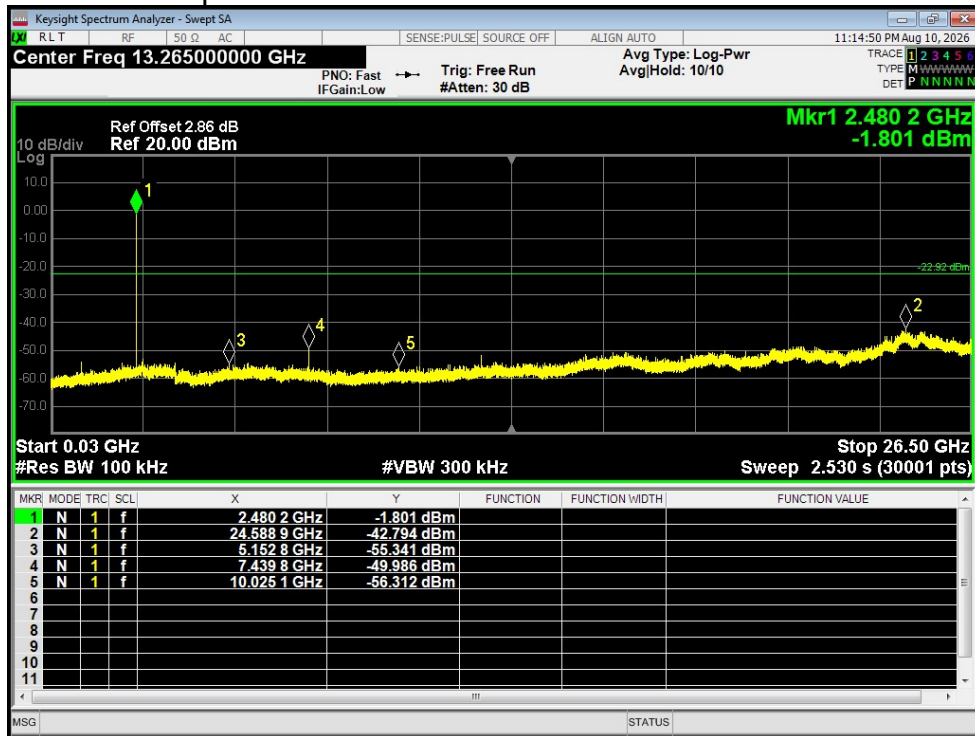
Tx. Spurious NVNT 1-DH5 2441MHz Ant1 Emission



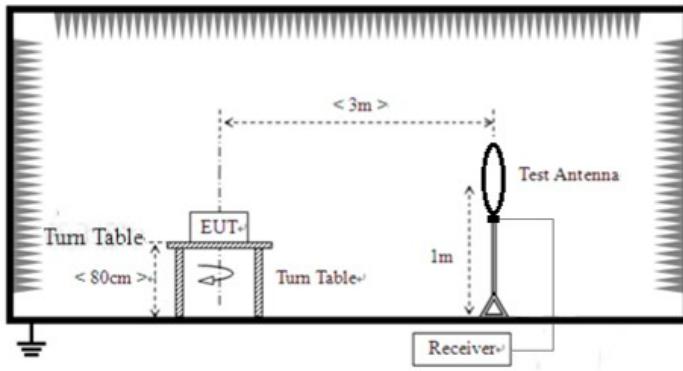
Tx. Spurious NVNT 1-DH5 2480MHz Ant1 Ref

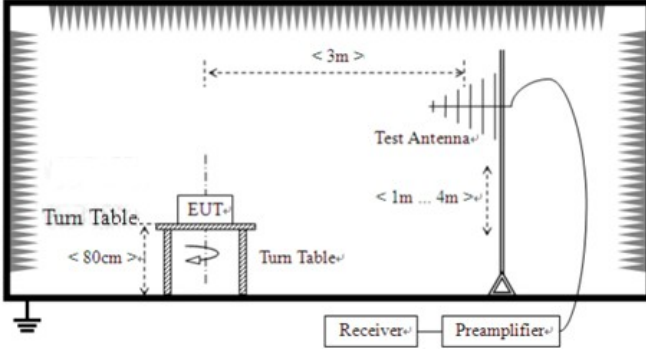
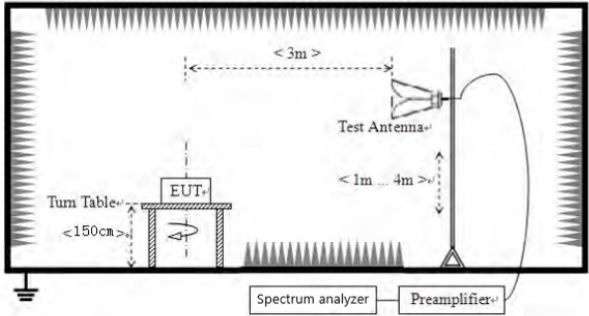


Tx. Spurious NVNT 1-DH5 2480MHz Ant1 Emission



4.9.2 Radiated Emission Method

Test Requirement:	47CRF Part 15.247 (d), 47CRF Part 15.209 and 15.205				
Test Method:	ANSI C63.10-2020 + Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024 § 6.4&6.5&6.6				
Test Frequency Range:	9kHz to 25GHz				
Test site:	Measurement Distance: 3m				
Receiver setup:	Frequency	Detector	RBW	VBW	Value
	9KHz-150KHz	Quasi-peak	200Hz	600Hz	Quasi-peak
	150KHz-30MHz	Quasi-peak	9KHz	30KHz	Quasi-peak
	30MHz-1GHz	Quasi-peak	120KHz	300KHz	Quasi-peak
	Above 1GHz	Peak	1MHz	3MHz	Peak
		Peak	1MHz	10Hz	Average
Limit:	Frequency	Limit (uV/m)	Value	Measurement Distance	
	0.009MHz-0.490MHz	6.37/F(KHz)	QP	300m	
	0.490MHz-1.705MHz	63.7/F(KHz)	QP	30m	
	1.705MHz-30MHz	0.08	QP	30m	
	30MHz-88MHz	100	QP	3m	
	88MHz-216MHz	150	QP		
	216MHz-960MHz	200	QP		
	960MHz-1GHz	500	QP		
	Above 1GHz	500	Average		
		5000	Peak		
Test setup:	For radiated emissions from 9kHz to 30MHz				
					

	For radiated emissions from 30MHz to1GHz  For radiated emissions above 1GHz 
Test Procedure:	1. 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. 2. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. 3. 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. 4. 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. 5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. 6. 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.
Test Instruments:	Refer to section 3.0 for details
Test mode:	Refer to section 2.2 for details
Test results:	Pass

Measurement data:

Remarks:

1. *The report only shows the worst mode.*
2. *Pre-scan all kind of the place mode (X-axis, Y-axis, Z-axis), and found the Y-axis which it is worse case.*

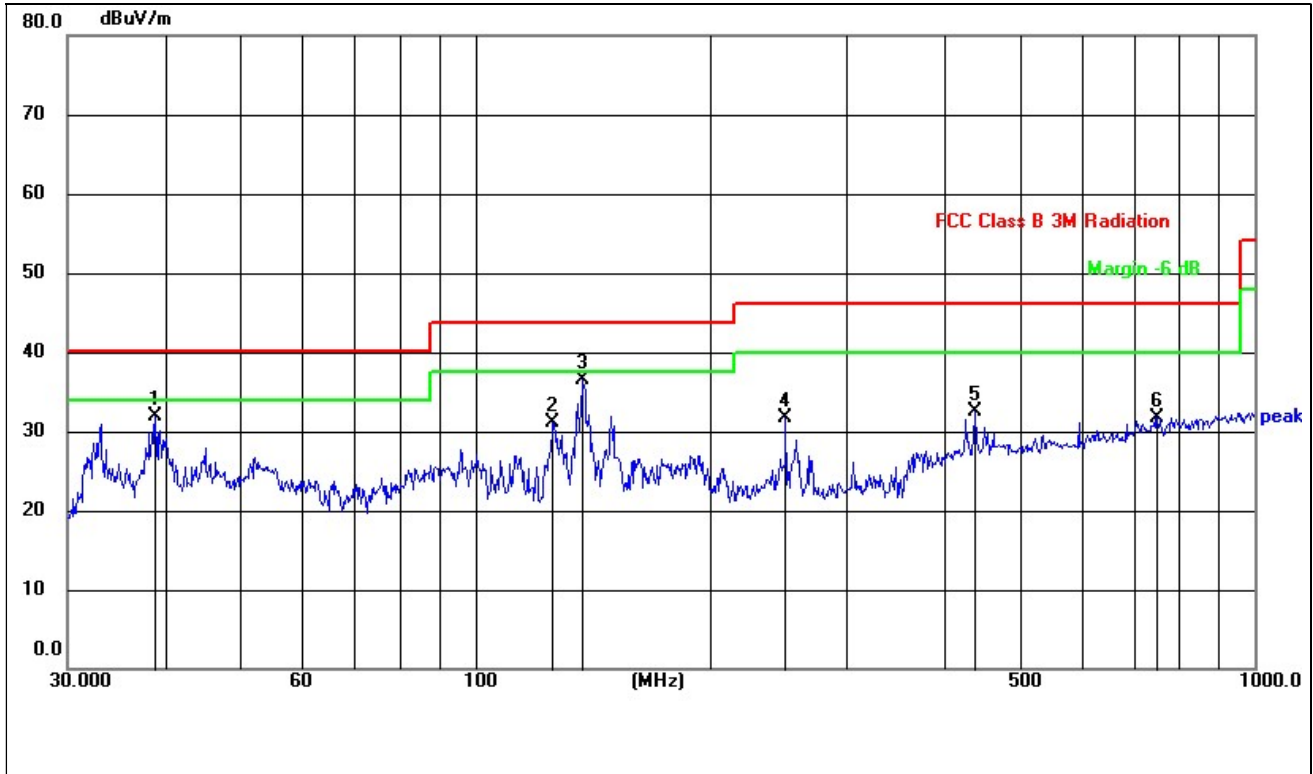
■ **9kHz~30MHz**

The emission from 9 kHz to 30MHz was pre-tested and found the result was 20dB lower than the limit, and according to 47CRF part 15.31(o), the test result no need to reported.

■ Below 1GHz

All modes have been tested, and the report only displays the worst mode (DH5-Hopping) data.

Test polarization:	Horizontal	Test voltage:	DC 5V with DC 3.7V from battery
Temp.:	24.5°C	Humid.:	63%RH

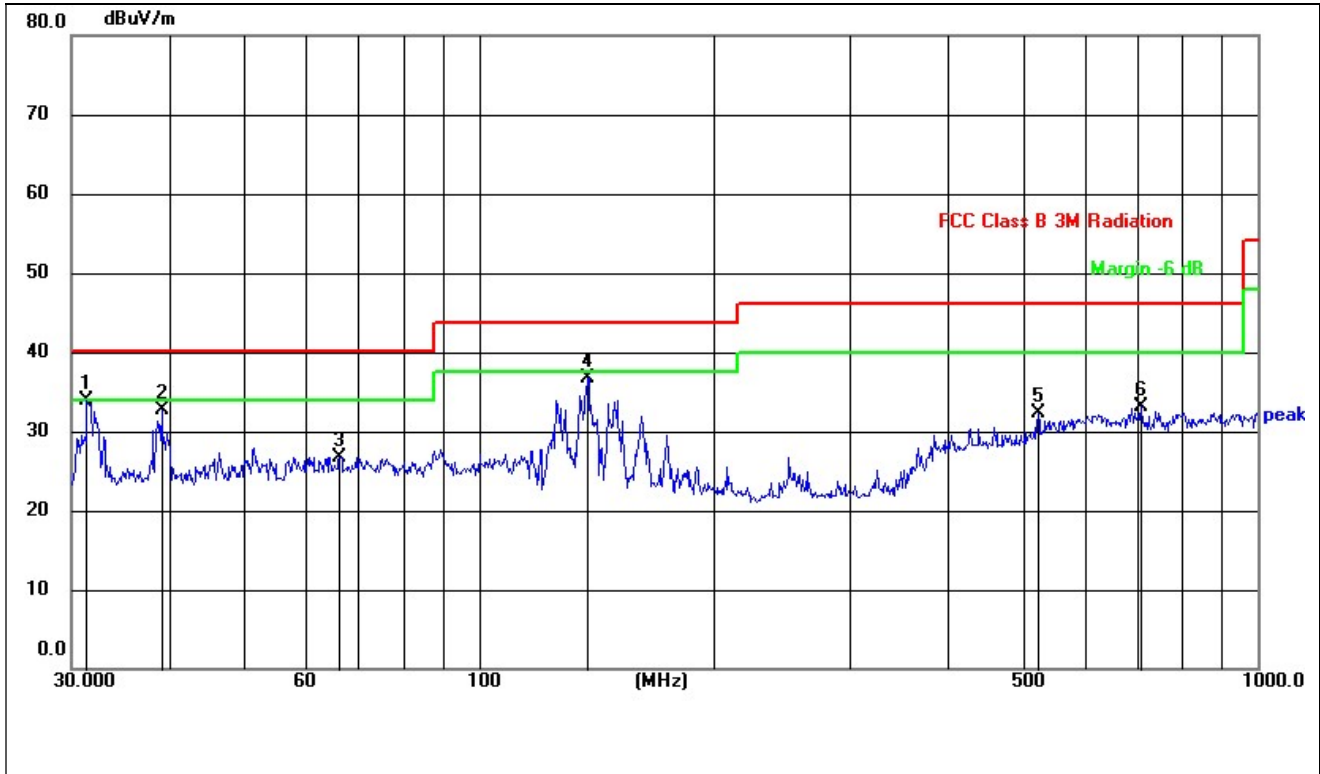


No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	38.8877	53.20	-21.32	31.88	40.00	-8.12	QP
2	125.8863	54.24	-23.12	31.12	43.50	-12.38	QP
3	137.4200	58.67	-22.20	36.47	43.50	-7.03	QP
4	250.3009	54.27	-22.66	31.61	46.00	-14.39	QP
5	438.6553	48.55	-15.99	32.56	46.00	-13.44	QP
6	750.1082	39.72	-7.94	31.78	46.00	-14.22	QP

Factor= Antenna Factor + Cable Loss – Preamplifier Factor

Level = Reading + Factor, Margin=level-Limit

Test polarization:	Vertical	Test voltage:	DC 5V with DC 3.7V from battery
Temp.:	24.5°C	Humid.:	63%RH



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	31.3992	56.45	-22.64	33.81	40.00	-6.19	QP
2	39.1613	54.07	-21.28	32.79	40.00	-7.21	QP
3	66.2660	50.60	-23.84	26.76	40.00	-13.24	QP
4	137.9028	58.89	-22.16	36.73	43.50	-6.77	QP
5	522.7178	45.57	-13.32	32.25	46.00	-13.75	QP
6	709.1820	41.86	-8.77	33.09	46.00	-12.91	QP

Level = Reading + Factor, Margin=level-Limit

Factor= Antenna Factor + Cable Loss – Preamplifier Factor

■ **Above 1GHz**

All modes have been tested, and the report only displays the worst mode (DH5) data.

Test voltage:	DC 3.7V from battery		
Temp.:	24.5°C	Humid.:	63%RH

Test channel:	Lowest
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Peak value:

Frequency (MHz)	Read Level (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4804.00	56.53	-7.69	48.84	74.00	-25.16	Vertical
7206.00	50.95	-1.70	49.25	74.00	-24.75	Vertical
9608.00	50.51	1.31	51.82	74.00	-22.18	Vertical
12010.00	*	--	--	74.00	--	Vertical
14412.00	*	--	--	74.00	--	Vertical
4804.00	55.86	-7.69	48.17	74.00	-25.83	Horizontal
7206.00	50.75	-1.70	49.05	74.00	-24.95	Horizontal
9608.00	49.58	1.31	50.89	74.00	-23.11	Horizontal
12010.00	*	--	--	74.00	--	Horizontal
14412.00	*	--	--	74.00	--	Horizontal

Average value:

Frequency (MHz)	Read Level (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4804.00	42.72	-7.69	35.03	54.00	-18.97	Vertical
7206.00	37.44	-1.70	35.74	54.00	-18.26	Vertical
9608.00	37.31	1.31	38.62	54.00	-15.38	Vertical
12010.00	*	--	--	54.00	--	Vertical
14412.00	*	--	--	54.00	--	Vertical
4804.00	41.75	-7.69	34.06	54.00	-19.94	Horizontal
7206.00	36.27	-1.70	34.57	54.00	-19.43	Horizontal
9608.00	36.82	1.31	38.13	54.00	-15.87	Horizontal
12010.00	*	--	--	54.00	--	Horizontal
14412.00	*	--	--	54.00	--	Horizontal



Test channel:	Middle
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Peak value:

Frequency (MHz)	Read Level (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4882.00	57.29	-7.56	49.73	74.00	-24.27	Vertical
7323.00	49.97	-1.38	48.59	74.00	-25.41	Vertical
9764.00	49.06	1.19	50.25	74.00	-23.75	Vertical
12205.00	*	--	--	74.00	--	Vertical
14646.00	*	--	--	74.00	--	Vertical
4882.00	56.83	-7.56	49.27	74.00	-24.73	Horizontal
7323.00	50.38	-1.38	49.00	74.00	-25.00	Horizontal
9764.00	49.25	1.19	50.44	74.00	-23.56	Horizontal
12205.00	*	--	--	74.00	--	Horizontal
14646.00	*	--	--	74.00	--	Horizontal

Average value:

Frequency (MHz)	Read Level (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit Line (dBuV/m)	Over Limit (dB)	Polarization
4882.00	43.18	-7.56	35.62	54.00	-18.38	Vertical
7323.00	37.62	-1.38	36.24	54.00	-17.76	Vertical
9764.00	36.93	1.19	38.12	54.00	-15.88	Vertical
12205.00	*	--	--	54.00	--	Vertical
14646.00	*	--	--	54.00	--	Vertical
4882.00	43.81	-7.56	36.25	54.00	-17.75	Horizontal
7323.00	36.71	-1.38	35.33	54.00	-18.67	Horizontal
9764.00	36.08	1.19	37.27	54.00	-16.73	Horizontal
12205.00	*	--	--	54.00	--	Horizontal
14646.00	*	--	--	54.00	--	Horizontal



Test channel:	Highest
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Peak value:

Frequency (MHz)	Read Level (dBUV)	Factor (dB/m)	Level (dBUV/m)	Limit Line (dBUV/m)	Over Limit (dB)	Polarization
4960.00	56.65	-7.43	49.22	74.00	-24.78	Vertical
7440.00	51.17	-1.02	50.15	74.00	-23.85	Vertical
9920.00	49.19	1.08	50.27	74.00	-23.73	Vertical
12400.00	*	--	--	74.00	--	Vertical
14880.00	*	--	--	74.00	--	Vertical
4960.00	57.92	-7.43	50.49	74.00	-23.51	Horizontal
7440.00	51.36	-1.02	50.34	74.00	-23.66	Horizontal
9920.00	49.58	1.08	50.66	74.00	-23.34	Horizontal
12400.00	*	--	--	74.00	--	Horizontal
14880.00	*	--	--	74.00	--	Horizontal

Average value:

Frequency (MHz)	Read Level (dBUV)	Factor (dB/m)	Level (dBUV/m)	Limit Line (dBUV/m)	Over Limit (dB)	Polarization
4960.00	43.14	-7.43	35.71	54.00	-18.29	Vertical
7440.00	37.03	-1.02	36.01	54.00	-17.99	Vertical
9920.00	37.08	1.08	38.16	54.00	-15.84	Vertical
12400.00	*	--	--	54.00	--	Vertical
14880.00	*	--	--	54.00	--	Vertical
4960.00	44.48	-7.43	37.05	54.00	-16.95	Horizontal
7440.00	36.24	-1.02	35.22	54.00	-18.78	Horizontal
9920.00	36.46	1.08	37.54	54.00	-16.46	Horizontal
12400.00	*	--	--	54.00	--	Horizontal
14880.00	*	--	--	54.00	--	Horizontal

Remarks:

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor
2. “*”, means this data is the too weak instrument of signal is unable to test.
3. The emission levels of other frequencies are very lower than the limit and not show in test report.

5 Test Setup Photo

Reference to the file No.: ET-26073626SP for details.

6 EUT Constructional Details

Reference to the file No.: ET-26073626EP and ET-26073626IP for details.

-----End-----