



TEST Report

Applicant: Shenzhen Elecrow Limited

Address of Applicant: Elecrow, 5th Floor, Fengze Building B, Nanchang Huafeng Industrial Park, Hangcheng Street Hangkong Road, Baoan District, Shenzhen city, China

Manufacturer : Shenzhen Elecrow Limited

Address of Manufacturer : Elecrow, 5th Floor, Fengze Building B, Nanchang Huafeng Industrial Park, Hangcheng Street Hangkong Road, Baoan District, Shenzhen city, China

Equipment Under Test (EUT)

Product Name: ThinkNode LoRaWAN Gateway

Model No.: G1-US915

Series model: G2-US915, G3-US915, R1-US915, R2-US915, R3-US915

Trade Mark: N/A

FCC ID: 2BDNA-GS-THINKNODE

Applicable standards: FCC CFR Title 47 Part 15 Subpart C Section 15.247

Date of sample receipt: Sep. 30, 2024

Date of Test: Sep. 30, 2024 ~ Nov. 06, 2024

Date of report issued: Nov. 06, 2024

Test Result : PASS *

* In the configuration tested, the EUT complied with the standards specified above.



Report No.: HTT202409467F01

1. Version

Version No.	Date	Description
00	Nov. 06, 2024	Original

Tested/ Prepared By

Heber He

Date:

Nov. 06, 2024

Project Engineer

Check By:

Bruce Zhu

Date:

Nov. 06, 2024

Reviewer

Approved By :

Kevin Yang

Date:

Nov. 06, 2024

Authorized Signature





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3. Test Summary

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

Remarks:

1. Pass: The EUT complies with the essential requirements in the standard.
2. Test according to ANSI C63.10:2013

Measurement Uncertainty

Test Item	Frequency Range	Measurement Uncertainty	Notes
Radiated Emission	30~1000MHz	4.37 dB	(1)
Radiated Emission	1~18GHz	5.40 dB	(1)
Radiated Emission	18-40GHz	5.45 dB	(1)
Conducted Disturbance	0.15~30MHz	2.68 dB	(1)

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



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4. General Information

4.1. General Description of EUT

Product Name:	ThinkNode LoRaWAN Gateway
Model No.:	G1-US915
Series model:	G2-US915, G3-US915, R1-US915, R2-US915, R3-US915
Test sample(s) ID:	HTT202409467-1(Engineer sample) HTT202409467-2(Normal sample)
Operation Frequency:	2402MHz~2480MHz
Channel numbers:	79
Channel separation:	1MHz
Modulation type:	GFSK, $\pi/4$ -DQPSK, 8-DPSK
Antenna Type:	Chip Antenna
Antenna Gain:	1.32 dBi
Power supply:	DC 12.0V
Adapter information:	Model: DB-1202000-UA Input: AC 100-240V 50/60Hz 0.8A Output: DC 12V 2000mA 24W



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



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4.2. Test mode

Transmitting mode	Keep the EUT in continuously transmitting mode.
<i>Remark: During the test, the test voltage was tuned from 85% to 115% of the nominal rated supply voltage, and found that the worst case was under the nominal rated supply condition. So the report just shows that condition's data.</i>	

4.3. Description of Support Units

None.

4.4. Deviation from Standards

None.

4.5. Abnormalities from Standard Conditions

None.

4.6. Test Facility

The test facility is recognized, certified, or accredited by the following organizations: FCC-Registration No.: 779513 Designation Number: CN1319 Shenzhen HTT Technology Co.,Ltd. has been accredited on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements. A2LA-Lab Cert. No.: 6435.01 Shenzhen HTT Technology Co.,Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement. The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010.

4.7. Test Location

All tests were performed at:
Shenzhen HTT Technology Co.,Ltd. 1F, Building B, Huafeng International Robotics Industrial Park, Hangcheng Road,Nanchang Community, Xixiang Street, Bao'an District, Shenzhen, Guangdong, China Tel: 0755-23595200 Fax: 0755-23595201

4.8. Additional Instructions

Test Software	Special AT test command provided by manufacturer to Keep the EUT in continuously transmitting mode and hopping mode
Power level setup	Default



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5. Test Instruments list

Item	Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. Date (mm-dd-yy)	Cal. Due date (mm-dd-yy)
1	3m Semi- Anechoic Chamber	Shenzhen C.R.T technology co., LTD	9*6*6	HTT-E028	Aug. 10 2024	Aug. 09 2027
2	Control Room	Shenzhen C.R.T technology co., LTD	4.8*3.5*3.0	HTT-E030	Aug. 10 2024	Aug. 09 2027
3	EMI Test Receiver	Rohde&Schwarz	ESCI7	HTT-E022	Apr. 26 2024	Apr. 25 2025
4	Spectrum Analyzer	Rohde&Schwarz	FSP	HTT-E037	Apr. 26 2024	Apr. 25 2025
5	Coaxial Cable	ZDecI	ZT26-NJ-NJ-0.6M	HTT-E018	Apr. 26 2024	Apr. 25 2025
6	Coaxial Cable	ZDecI	ZT26-NJ-SMAJ-2M	HTT-E019	Apr. 26 2024	Apr. 25 2025
7	Coaxial Cable	ZDecI	ZT26-NJ-SMAJ-0.6M	HTT-E020	Apr. 26 2024	Apr. 25 2025
8	Coaxial Cable	ZDecI	ZT26-NJ-SMAJ-8.5M	HTT-E021	Apr. 26 2024	Apr. 25 2025
9	Composite logarithmic antenna	Schwarzbeck	VULB 9168	HTT-E017	May. 21 2024	May. 20 2025
10	Horn Antenna	Schwarzbeck	BBHA9120D	HTT-E016	May. 20 2024	May. 19 2025
11	Loop Antenna	Zhinan	ZN30900C	HTT-E039	Apr. 26 2024	Apr. 25 2025
12	Horn Antenna	Beijing Hangwei Dayang	OBH100400	HTT-E040	Apr. 26 2024	Apr. 25 2025
13	low frequency Amplifier	Sonoma Instrument	310	HTT-E015	Apr. 26 2024	Apr. 25 2025
14	high-frequency Amplifier	HP	8449B	HTT-E014	Apr. 26 2024	Apr. 25 2025
15	Variable frequency power supply	Shenzhen Anbiao Instrument Co., Ltd	ANB-10VA	HTT-082	Apr. 26 2024	Apr. 25 2025
16	EMI Test Receiver	Rohde & Schwarz	ESCS30	HTT-E004	Apr. 26 2024	Apr. 25 2025
17	Artificial Mains	Rohde & Schwarz	ESH3-Z5	HTT-E006	May. 23 2024	May. 22 2025
18	Artificial Mains	Rohde & Schwarz	ENV-216	HTT-E038	May. 23 2024	May. 22 2025
19	Cable Line	Robinson	Z302S-NJ-BNCJ-1.5M	HTT-E001	Apr. 26 2024	Apr. 25 2025
20	Attenuator	Robinson	6810.17A	HTT-E007	Apr. 26 2024	Apr. 25 2025
21	Variable frequency power supply	Shenzhen Yanghong Electric Co., Ltd	YF-650 (5KVA)	HTT-E032	Apr. 26 2024	Apr. 25 2025
22	Control Room	Shenzhen C.R.T technology co., LTD	8*4*3.5	HTT-E029	Aug. 10 2024	Aug. 09 2027
23	DC power supply	Agilent	E3632A	HTT-E023	Apr. 26 2024	Apr. 25 2025
24	EMI Test Receiver	Agilent	N9020A	HTT-E024	Apr. 26 2024	Apr. 25 2025
25	Analog signal generator	Agilent	N5181A	HTT-E025	Apr. 26 2024	Apr. 25 2025
26	Vector signal generator	Agilent	N5182A	HTT-E026	Apr. 26 2024	Apr. 25 2025
27	Power sensor	Keysight	U2021XA	HTT-E027	Apr. 26 2024	Apr. 25 2025
28	Temperature and humidity meter	Shenzhen Anbiao Instrument Co., Ltd	TH10R	HTT-074	Apr. 28 2024	Apr. 27 2025
29	Radiated Emission Test Software	Farad	EZ-EMC	N/A	N/A	N/A
30	Conducted Emission Test Software	Farad	EZ-EMC	N/A	N/A	N/A
31	RF Test Software	panshanrf	TST	N/A	N/A	N/A



6. Test results and Measurement Data

6.1. Conducted Emissions

Test Requirement:	FCC Part15 C Section 15.207						
Test Method:	ANSI C63.10:2013						
Test Frequency Range:	150KHz to 30MHz						
Class / Severity:	Class B						
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 <i>Remark: E.U.T: Equipment Under Test LISN: Line Impedance Stabilization Network Test table height=0.8m</i>						
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 C63.10:2013 on conducted measurement.						
Test Instruments:	Refer to section 6.0 for details						
Test mode:	Refer to section 5.2 for details						
Test environment:	Temp.:	25 °C	Humid.:	52%	Press.:	1012mbar	
Test voltage:	AC 120V, 60Hz						
Test results:	Pass						

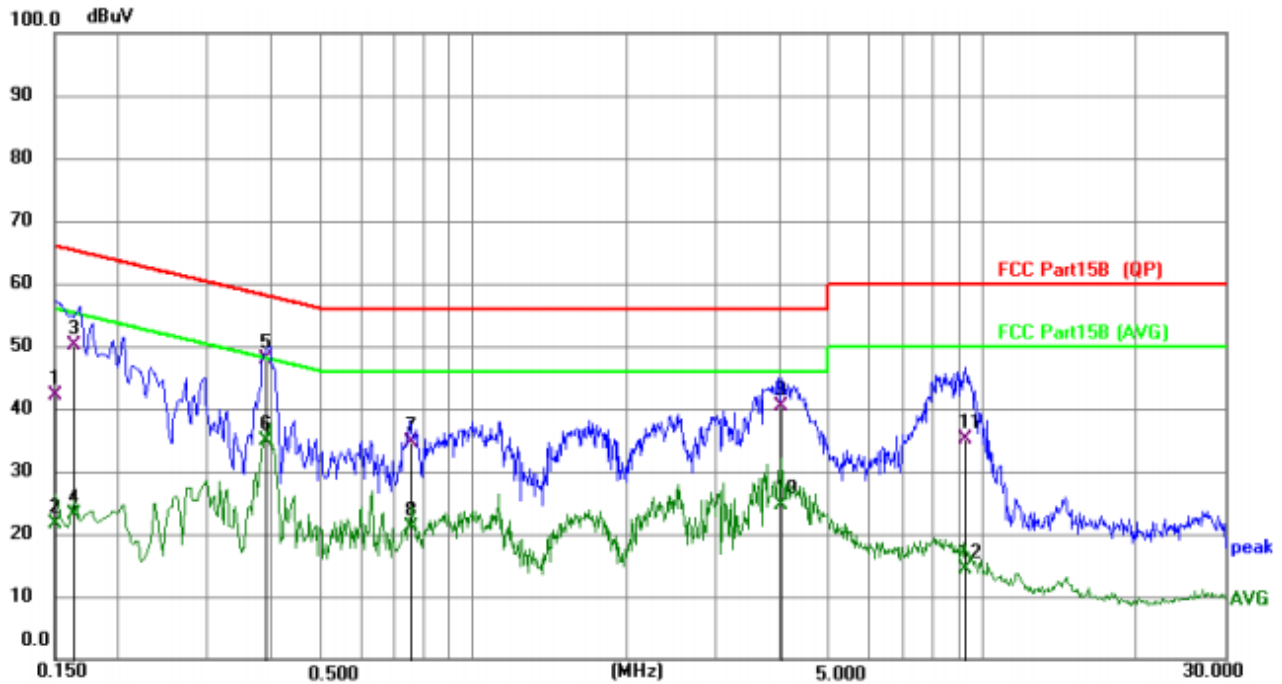
Remark: Based on all tested data, the EUT complied with the FCC Part 15.207 standard limit for a wireless device, and with the worst case as below:



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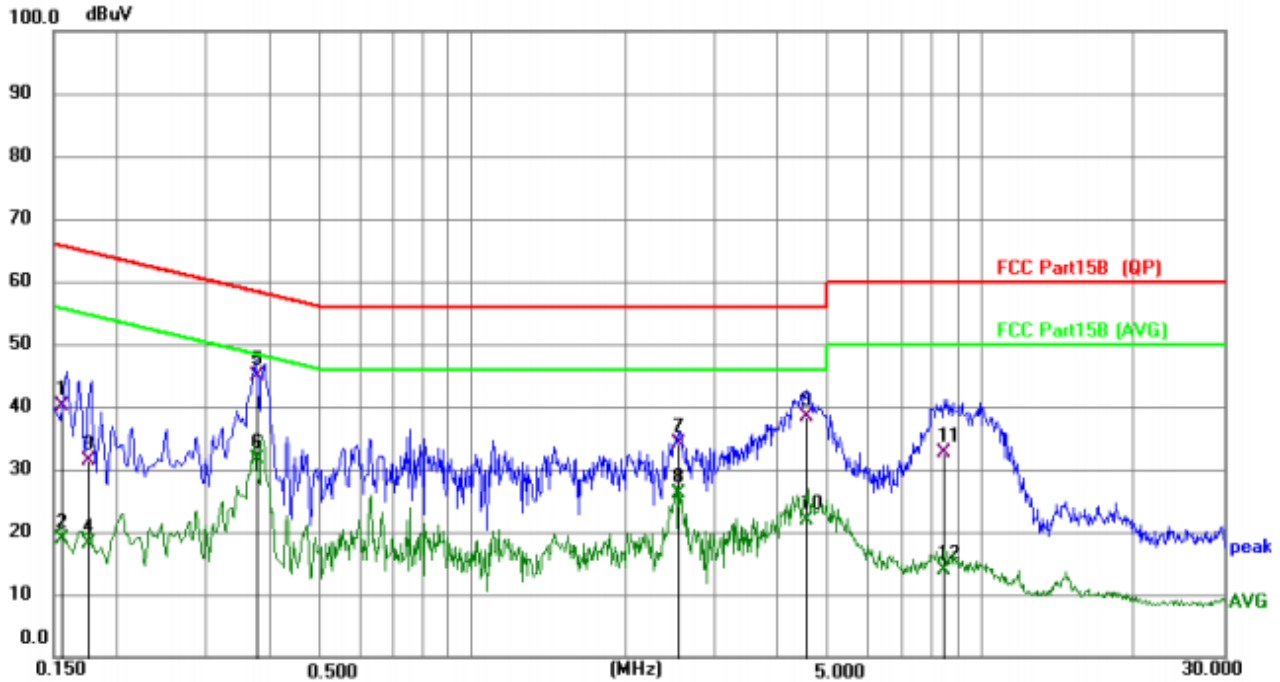
Measurement data:

Line:



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over	
		MHz	Level	Factor	ment			
					dBuV	dBuV	dB	Detector
1		0.1503	32.03	10.16	42.19	65.98	-23.79	QP
2		0.1503	11.51	10.16	21.67	55.98	-34.31	AVG
3		0.1633	39.93	10.18	50.11	65.29	-15.18	QP
4		0.1633	12.94	10.18	23.12	55.29	-32.17	AVG
5	*	0.3914	37.73	10.26	47.99	58.03	-10.04	QP
6		0.3914	24.61	10.26	34.87	48.03	-13.16	AVG
7		0.7538	24.38	10.35	34.73	56.00	-21.27	QP
8		0.7538	10.84	10.35	21.19	46.00	-24.81	AVG
9		4.0293	29.66	10.60	40.26	56.00	-15.74	QP
10		4.0293	14.08	10.60	24.68	46.00	-21.32	AVG
11		9.2954	24.45	10.68	35.13	60.00	-24.87	QP
12		9.2954	3.66	10.68	14.34	50.00	-35.66	AVG

Neutral:



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over	
		MHz	Level	Factor	ment			Detector
				dB	dBuV	dBuV	dB	
1		0.1560	30.09	10.16	40.25	65.67	-25.42	QP
2		0.1560	8.62	10.16	18.78	55.67	-36.89	AVG
3		0.1759	21.16	10.19	31.35	64.68	-33.33	QP
4		0.1759	8.05	10.19	18.24	54.68	-36.44	AVG
5	*	0.3786	34.70	10.25	44.95	58.31	-13.36	QP
6		0.3786	21.38	10.25	31.63	48.31	-16.68	AVG
7		2.5527	23.59	10.43	34.02	56.00	-21.98	QP
8		2.5527	15.71	10.43	26.14	46.00	-19.86	AVG
9		4.5387	27.87	10.53	38.40	56.00	-17.60	QP
10		4.5387	11.31	10.53	21.84	46.00	-24.16	AVG
11		8.4345	21.96	10.78	32.74	60.00	-27.26	QP
12		8.4345	3.19	10.78	13.97	50.00	-36.03	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 Los



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6.2. Conducted Peak Output Power

Test Requirement:	FCC Part15 C Section 15.247 (b)(3)					
Test Method:	ANSI C63.10:2013					
Limit:	30dBm(for GFSK),20.97dBm(for EDR)					
Test setup:	Power sensor and Spectrum analyzer  Non-Conducted Table Ground Reference Plane					
Test Instruments:	Refer to section 6.0 for details					
Test mode:	Refer to section 5.2 for details					
Test results:	Pass					
Test environment:	Temp.:	25 °C	Humid.:	52%	Press.:	1012mbar

Measurement Data

Mode	TX Type	Frequency (MHz)	Packet Type	Maximum Peak Conducted Output Power (dBm)		Verdict
				ANT1	Limit	
GFSK	SISO	2402	DH5	-5.01	≤30	Pass
		2441	DH5	-5.52	≤30	Pass
		2480	DH5	-6.51	≤30	Pass
Pi/4DQPSK	SISO	2402	2DH5	-4.99	≤20.97	Pass
		2441	2DH5	-5.50	≤20.97	Pass
		2480	2DH5	-6.52	≤20.97	Pass
8DPSK	SISO	2402	3DH5	-4.96	≤20.97	Pass
		2441	3DH5	-5.47	≤20.97	Pass
		2480	3DH5	-6.46	≤20.97	Pass



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6.3. 20dB Emission Bandwidth

Test Requirement:	FCC Part15 C Section 15.247 (a)(2)					
Test Method:	ANSI C63.10:2013					
Limit:	N/A					
Test setup:						
Test Instruments:	Refer to section 6.0 for details					
Test mode:	Refer to section 5.2 for details					
Test results:	Pass					
Test environment:	Temp.:	25 °C	Humid.:	52%	Press.:	1012mbar

Measurement Data

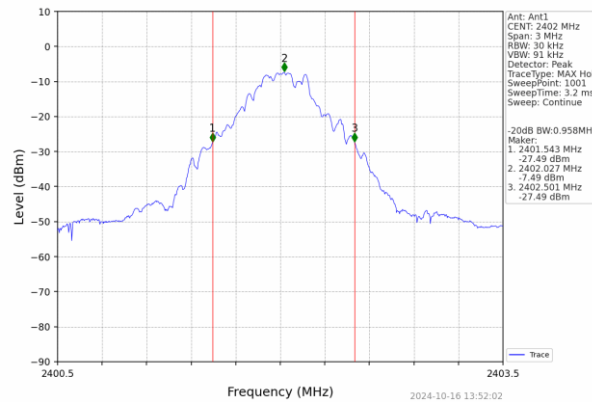
Mode	TX Type	Frequency (MHz)	Packet Type	ANT	20dB Bandwidth (MHz)		Verdict
					Result	Limit	
GFSK	SISO	2402	DH5	1	0.958	/	Pass
		2441	DH5	1	0.952	/	Pass
		2480	DH5	1	0.962	/	Pass
Pi/4DQPSK	SISO	2402	2DH5	1	1.213	/	Pass
		2441	2DH5	1	1.223	/	Pass
		2480	2DH5	1	1.230	/	Pass
8DPSK	SISO	2402	3DH5	1	1.259	/	Pass
		2441	3DH5	1	1.258	/	Pass
		2480	3DH5	1	1.255	/	Pass



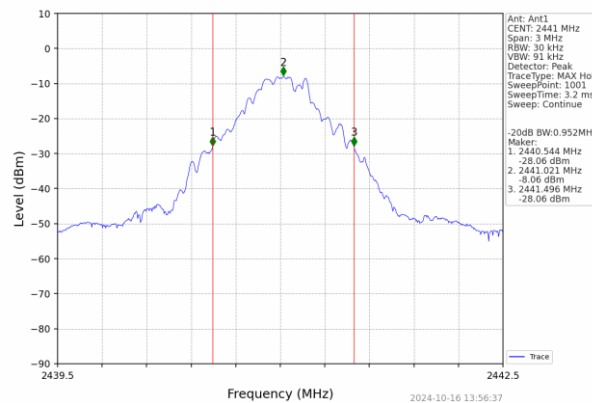
Report No.: HTT202409467F01

Test plot as follows:

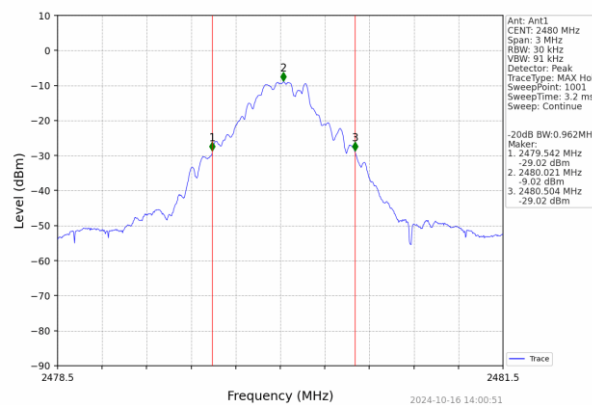
Test mode:	GFSK mode
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Lowest channel



Middle channel

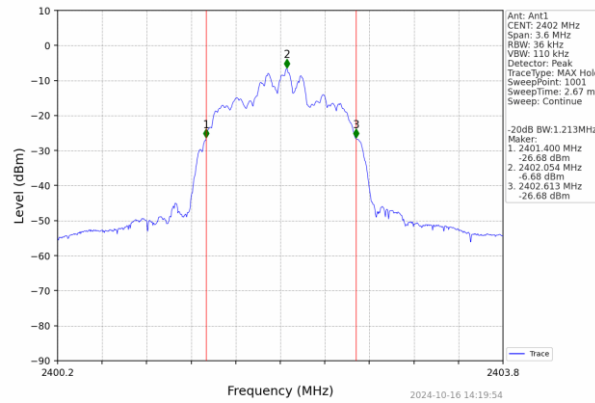


Highest channel

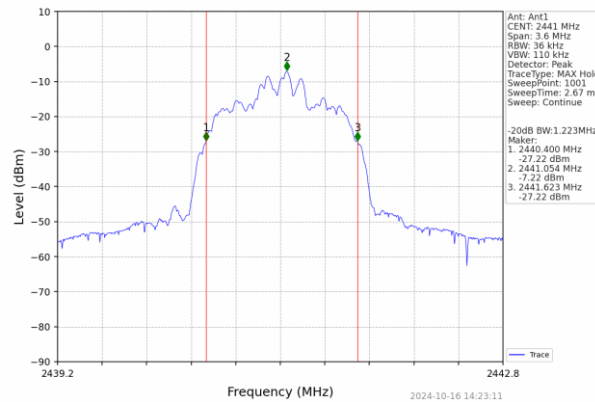


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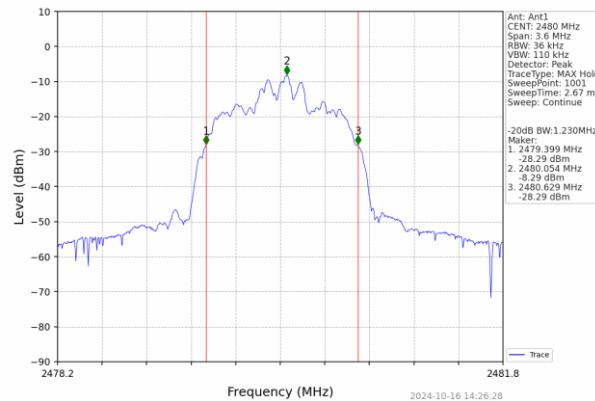
Test mode:	$\pi/4$ -DQPSK mode
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Lowest channel



Middle channel



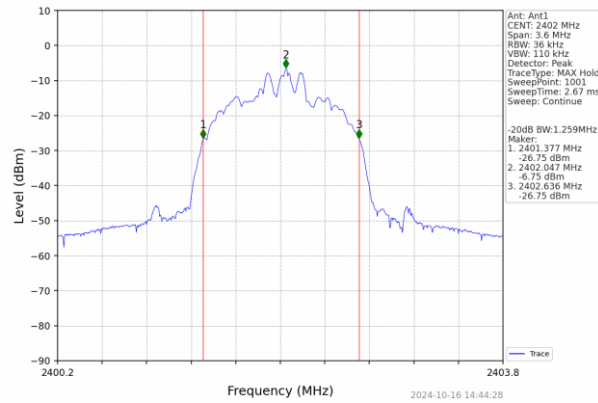
Highest channel



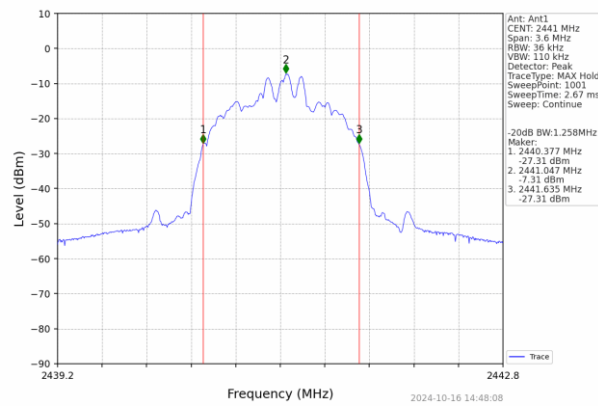
Report No.: HTT202409467F01

Test mode:

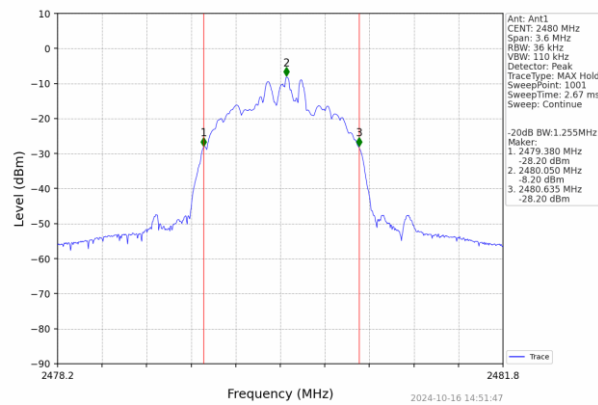
8-DPSK mode



Lowest channel

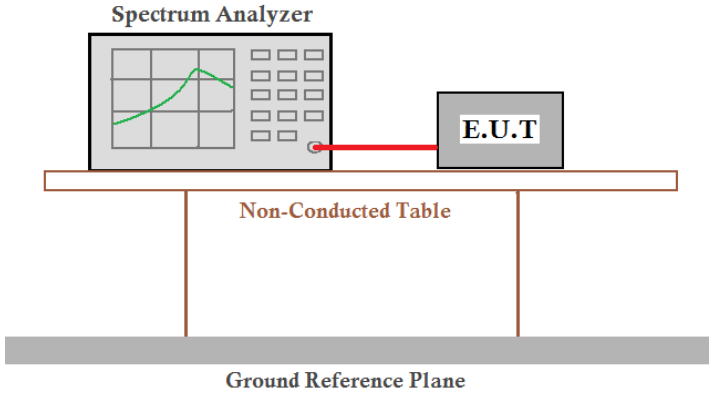


Middle channel



Highest channel

6.4. Frequencies Separation

Test Requirement:	FCC Part15 C Section 15.247 (a)(1)					
Test Method:	ANSI C63.10:2013					
Receiver setup:	RBW=100KHz, VBW=300KHz, detector=Peak					
Limit:	GFSK: 20dB bandwidth $\pi/4$ -DQPSK : 0.025MHz or 2/3 of the 20dB bandwidth (whichever is greater)					
Test setup:						
Test Instruments:	Refer to section 6.0 for details					
Test mode:	Refer to section 5.2 for details					
Test results:	Pass					
Test environment:	Temp.:	25 °C	Humid.:	52%	Press.:	1012mbar

Measurement Data

Mode	Test channel	Frequencies Separation (MHz)	Limit (kHz)	Result
GFSK	Middle	1.002	25KHz or 2/3*20dB bandwidth	Pass
$\pi/4$ -DQPSK	Middle	1.032	25KHz or 2/3*20dB bandwidth	Pass
8-DPSK	Middle	1.030	25KHz or 2/3*20dB bandwidth	Pass

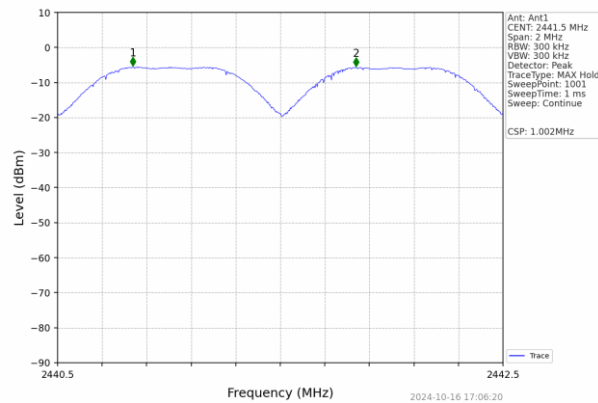
Remark: We have tested all mode at high, middle and low channel, and recorded worst case at middle



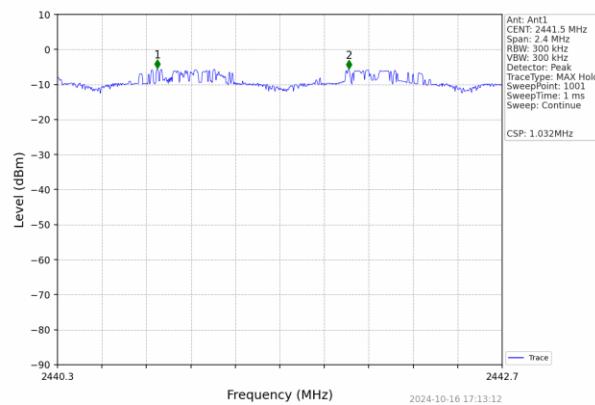
Report No.: HTT202409467F01

Test plot as follows:

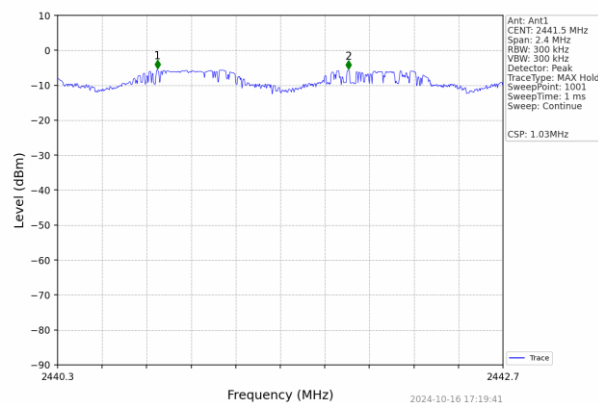
Modulation mode:	GFSK
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Test mode:	$\pi/4$ -DQPSK
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Modulation mode:	8-DPSK
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6.5. Hopping Channel Number

Test Requirement:	FCC Part15 C Section 15.247 (a)(1)(iii)					
Test Method:	ANSI C63.10:2013					
Receiver setup:	RBW=100kHz, VBW=300kHz, Frequency range=2400MHz-2483.5MHz, Detector=Peak					
Limit:	15 channels					
Test setup:						
Test Instruments:	Refer to section 6.0 for details					
Test mode:	Refer to section 5.2 for details					
Test results:	Pass					
Test environment:	Temp.:	25 °C	Humid.:	52%	Press.:	1012mbar

Measurement Data:

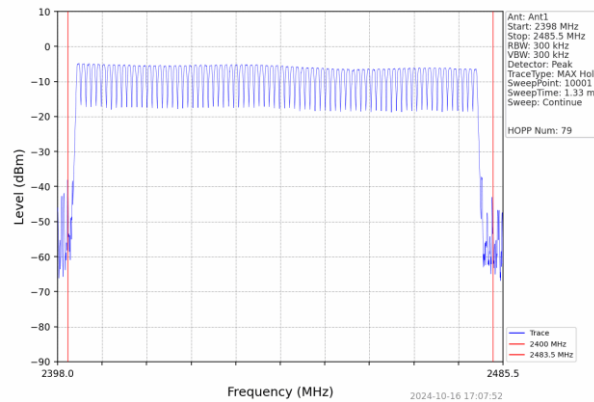
Mode	Hopping channel numbers	Limit	Result
GFSK	79	≥15	Pass
$\pi/4$ -DQPSK	79		Pass
8-DPSK	79		Pass



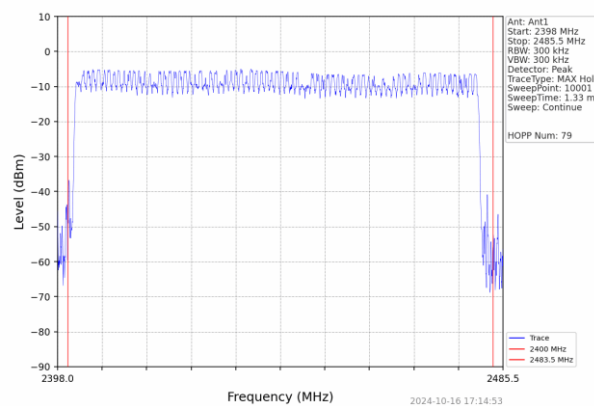
Report No.: HTT202409467F01

Test plot as follows:

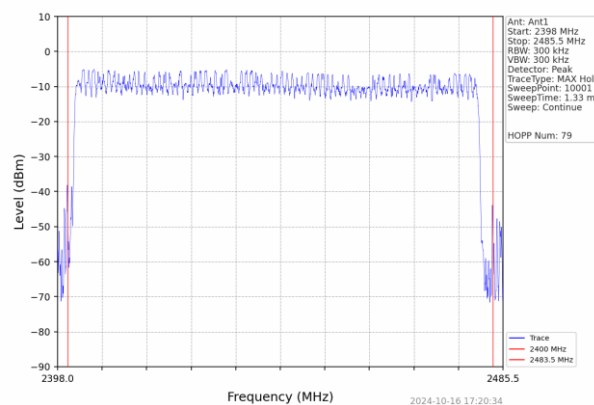
Test mode:	GFSK
------------	------



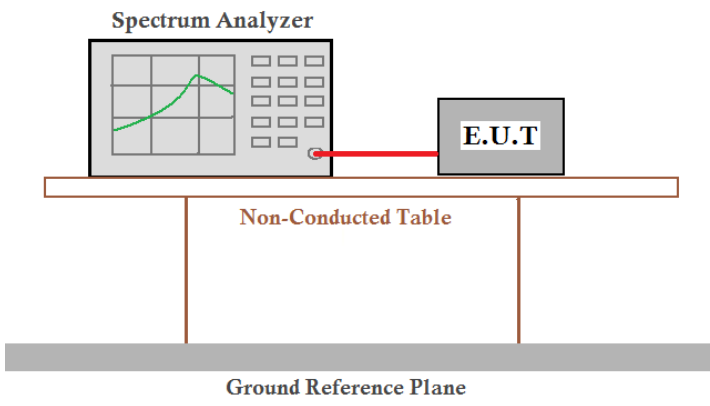
Test mode:	$\pi/4$ -DQPSK
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Test mode:	8-DPSK
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6.6. Dwell Time

Test Requirement:	FCC Part15 C Section 15.247 (a)(1)(iii)					
Test Method:	ANSI C63.10:2013					
Receiver setup:	RBW=1MHz, VBW=1MHz, Span=0Hz, Detector=Peak					
Limit:	0.4 Second					
Test setup:	 The diagram illustrates the test setup. A Spectrum Analyzer is connected to an E.U.T (Equipment Under Test) via a red cable. Both the Spectrum Analyzer and the E.U.T are placed on a Non-Conducted Table. The table is supported by a Ground Reference Plane.					
Test Instruments:	Refer to section 6.0 for details					
Test mode:	Refer to section 5.2 for details					
Test results:	Pass					
Test environment:	Temp.:	25 °C	Humid.:	52%	Press.:	1012mbar

**Measurement Data**

Modulation	Packet	Burst time (ms)	Dwell time (ms)	Limit (ms)	Result
GFSK	DH1	0.386	41.302	400	Pass
	DH3	1.642	95.236		
	DH5	2.890	106.930		
$\pi/4$ DQPSK	2-DH1	0.396	44.748	400	Pass
	2-DH3	1.646	93.822		
	2-DH5	2.896	127.424		
8DPSK	3-DH1	0.396	41.580	400	Pass
	3-DH3	1.644	118.368		
	3-DH5	2.898	107.226		

Note: We have tested all mode at high, middle and low channel, and recorded worst case at middle channel.

Dwell time = Pulse time (ms) $\times$ (1600 $\div$ 2 $\div$ 79) $\times$ 31.6 Second for DH1, 2-DH1, 3-DH1

Dwell time = Pulse time (ms) $\times$ (1600 $\div$ 4 $\div$ 79) $\times$ 31.6 Second for DH3, 2-DH3, 3-DH3

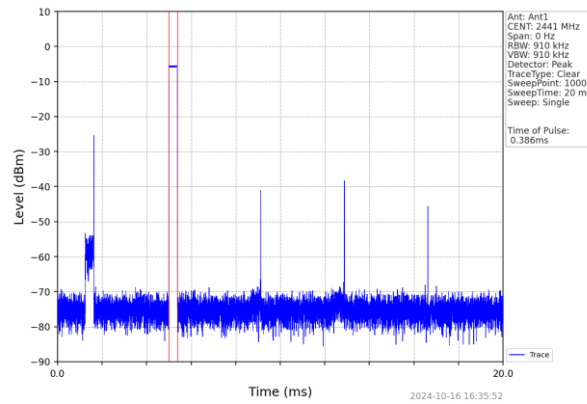
Dwell time = Pulse time (ms) $\times$ (1600 $\div$ 6 $\div$ 79) $\times$ 31.6 Second for DH5, 2-DH5, 3-DH5



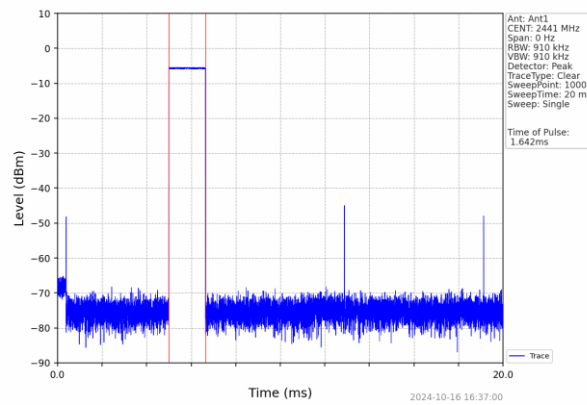
Report No.: HTT202409467F01

Test plot as follows:

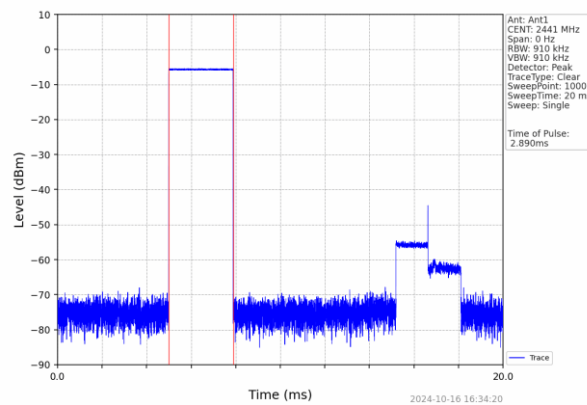
GFSK mode



DH1



DH3

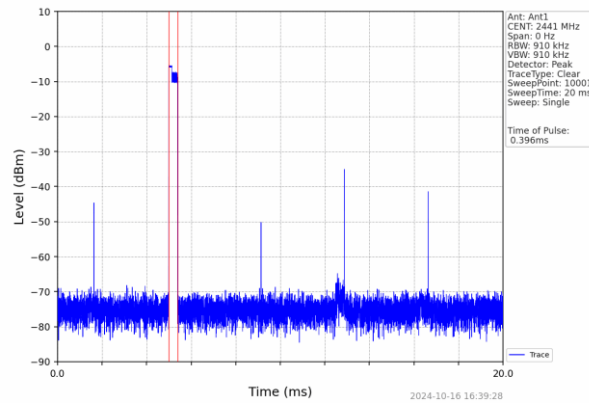


DH5

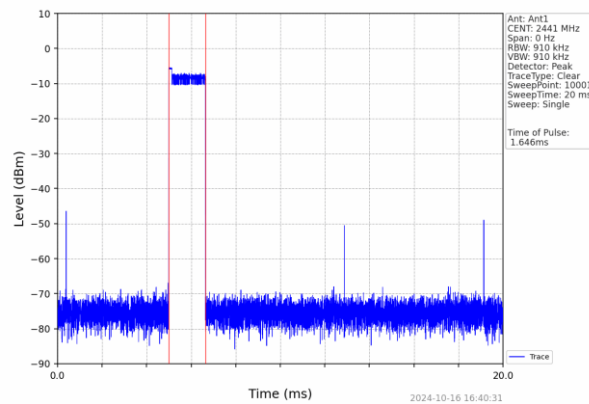


Report No.: HTT202409467F01

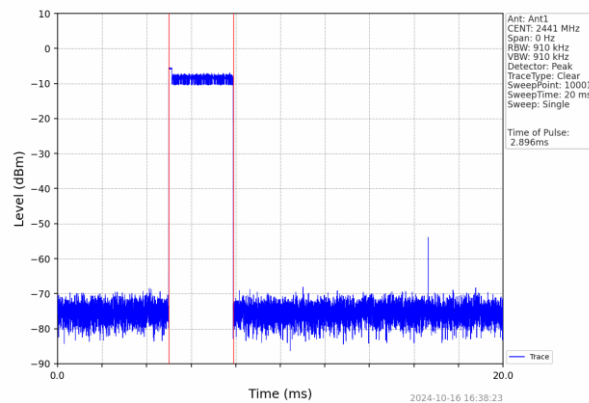
$\pi/4$ -DQPSK mode



2DH1



2DH3

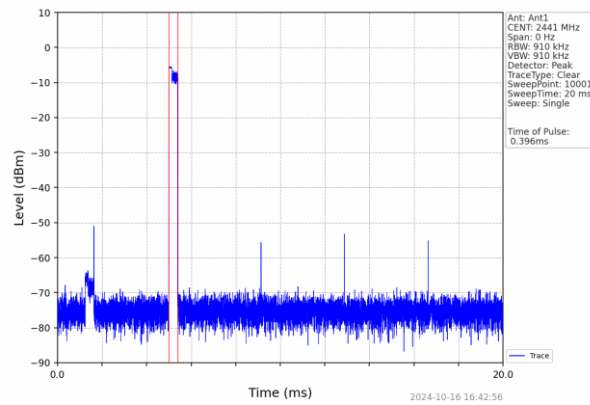


2DH5

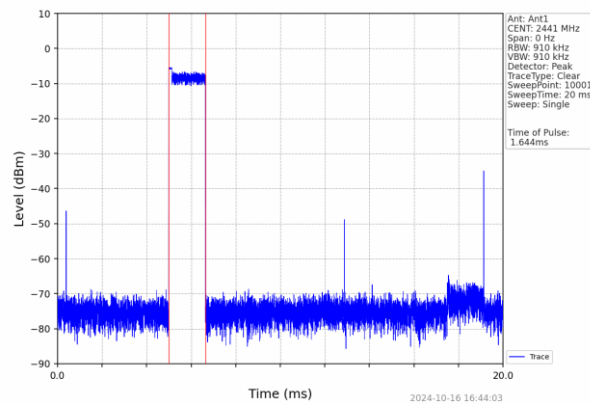


Report No.: HTT202409467F01

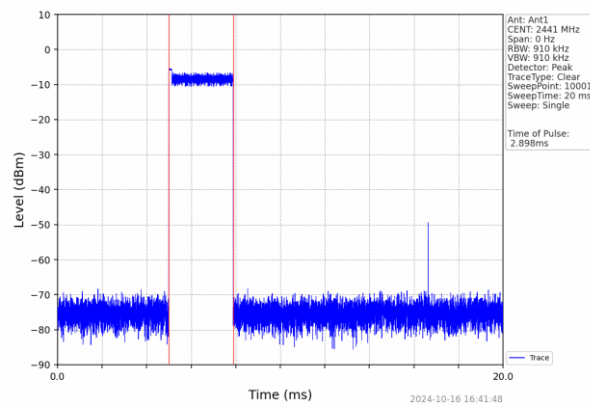
8-DPSK mode



3DH1



3DH3



3DH5

6.7. Band Edge

6.7.1. Conducted Emission Method

Test Requirement:	FCC Part15 C Section 15.247 (d)					
Test Method:	ANSI C63.10:2013					
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:	 The diagram illustrates the test setup for conducted emission measurement. 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, which is supported by a Ground Reference Plane.					
Test Instruments:	Refer to section 6.0 for details					
Test mode:	Refer to section 5.2 for details					
Test results:	Pass					
Test environment:	Temp.:	25 °C	Humid.:	52%	Press.:	1012mbar

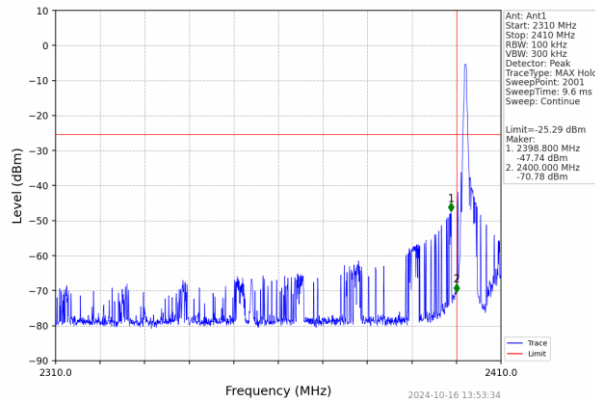


Report No.: HTT202409467F01

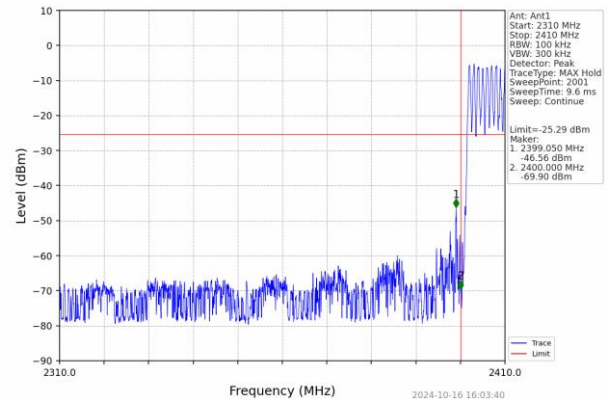
Test plot as follows:

GFSK Mode:

Test channel	Lowest channel
--------------	----------------

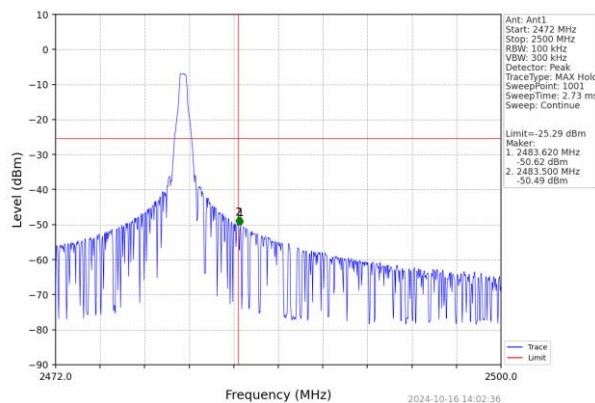


No-hopping mode

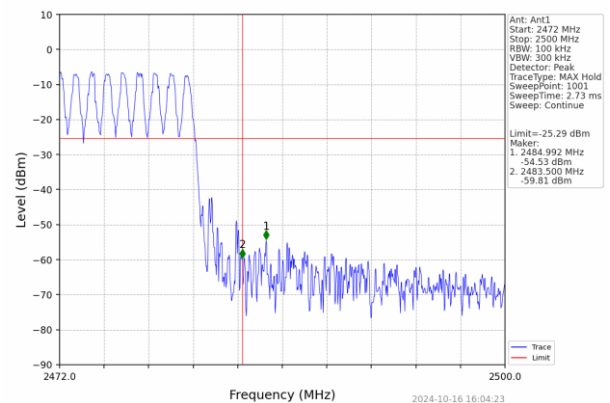


Hopping mode

Test channel:	Highest channel
---------------	-----------------



No-hopping mode



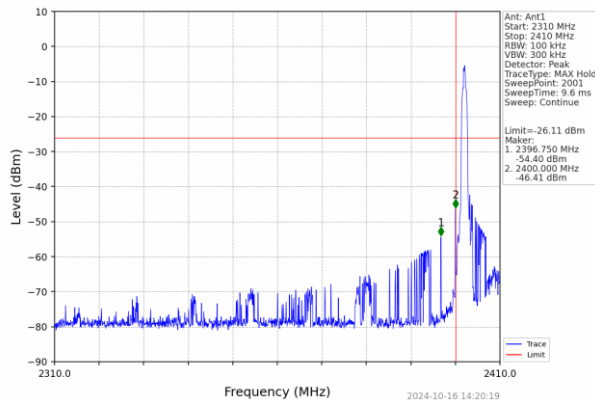
Hopping mode



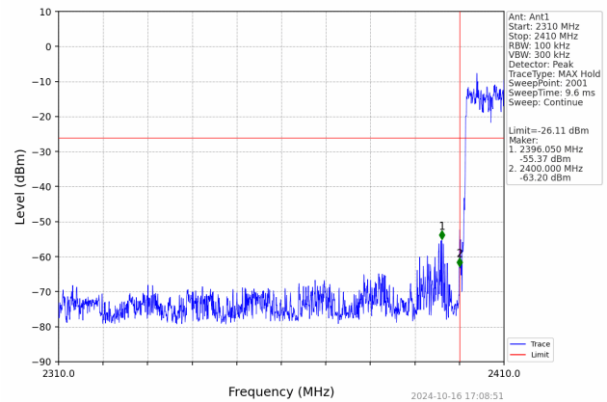
Report No.: HTT202409467F01

$\pi/4$ -DQPSK Mode:

Test channel	Lowest channel
--------------	----------------

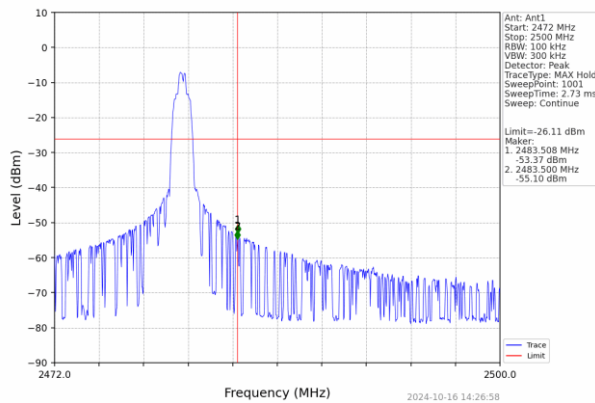


No-hopping mode

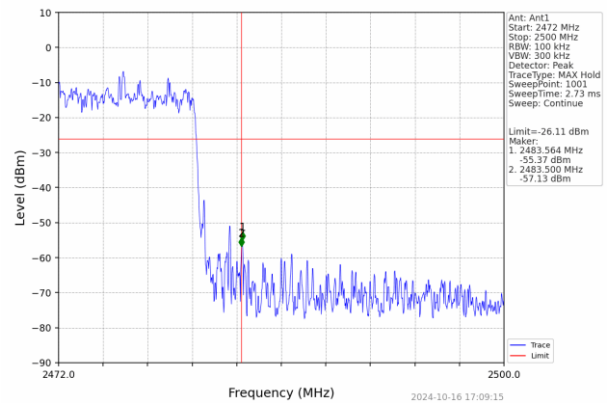


Hopping mode

Test channel:	Highest channel
---------------	-----------------



No-hopping mode

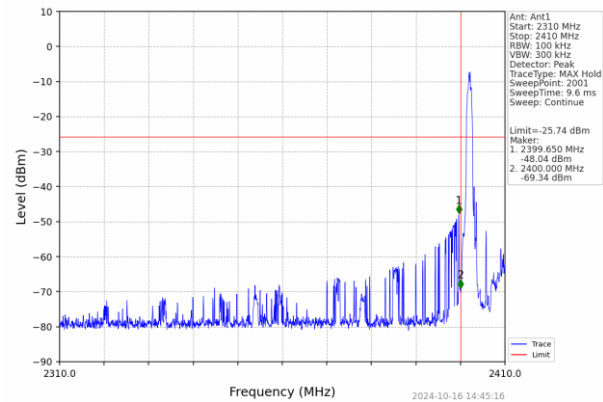


Hopping mode

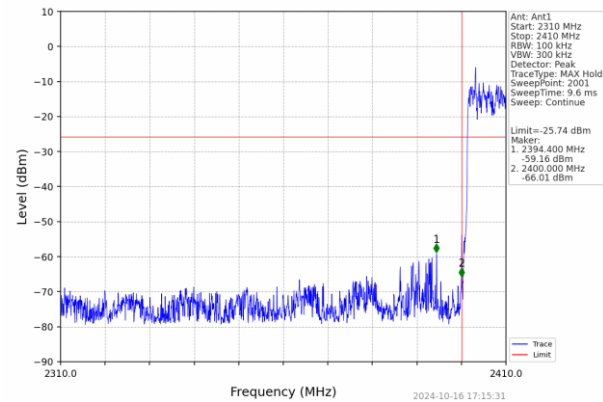


8-DPSK Mode:

Test channel:	Lowest channel
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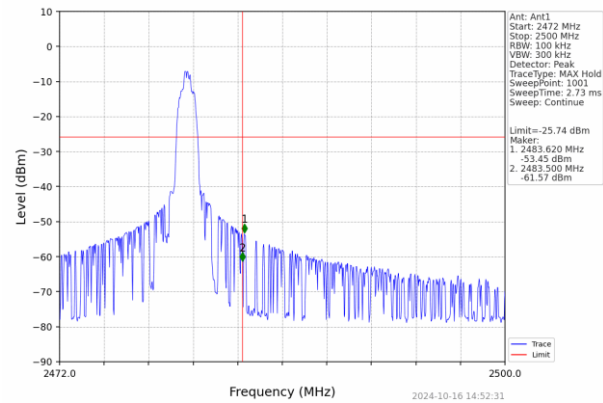


No-hopping mode

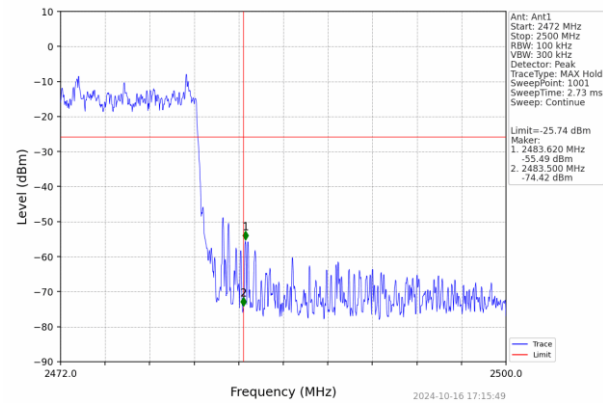


Hopping mode

Test channel:	Highest channel
---------------	-----------------

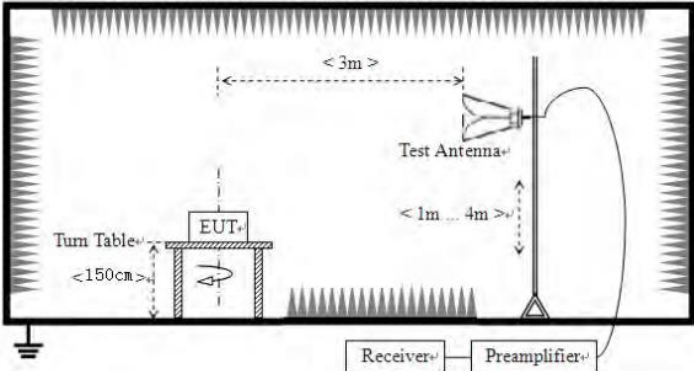


No-hopping mode



Hopping mode

6.7.2. Radiated Emission Method

Test Requirement:	FCC Part15 C Section 15.209 and 15.205						
Test Method:	ANSI C63.10:2013						
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 6.0 for details						
Test mode:	Refer to section 5.2 for details						
Test results:	Pass						
Test environment:	Temp.:	25 °C	Humid.:	52%	Press.:	1012mbar	

**Measurement Data**

Remark: GFSK, Pi/4 DQPSK, 8-DPSK all have been tested, only worse case GFSK is reported.

Operation Mode: GFSK

Frequency(MHz):			2402		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2390.00	60.80	PK	74	13.20	62.19	27.2	4.31	32.9	-1.39
2390.00	46.09	AV	54	7.91	47.48	27.2	4.31	32.9	-1.39
Frequency(MHz):			2402		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2390.00	59.27	PK	74	14.73	60.66	27.2	4.31	32.9	-1.39
2390.00	46.40	AV	54	7.60	47.79	27.2	4.31	32.9	-1.39
Frequency(MHz):			2480		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2483.50	56.41	PK	74	17.59	57.34	27.4	4.47	32.8	-0.93
2483.50	45.18	AV	54	8.82	46.11	27.4	4.47	32.8	-0.93
Frequency(MHz):			2480		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2483.50	54.38	PK	74	19.62	55.31	27.4	4.47	32.8	-0.93
2483.50	44.76	AV	54	9.24	45.69	27.4	4.47	32.8	-0.93

6.8. Spurious Emission

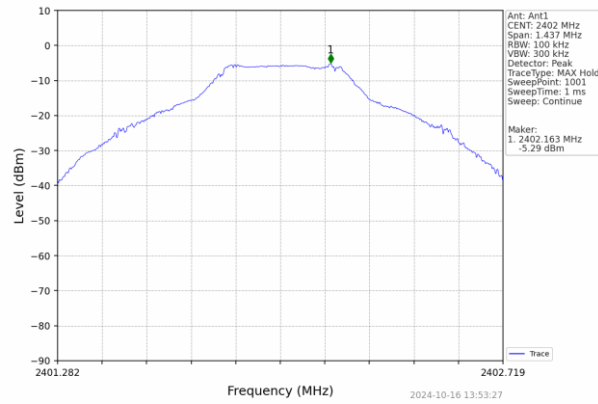
6.8.1. Conducted Emission Method

Test Requirement:	FCC Part15 C Section 15.247 (d)					
Test Method:	ANSI C63.10:2013					
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:	 The diagram illustrates the test setup for conducted emission measurement. 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, which is supported by a Ground Reference Plane.					
Test Instruments:	Refer to section 6.0 for details					
Test mode:	Refer to section 5.2 for details					
Test results:	Pass					
Test environment:	Temp.:	25 °C	Humid.:	52%	Press.:	1012mbar

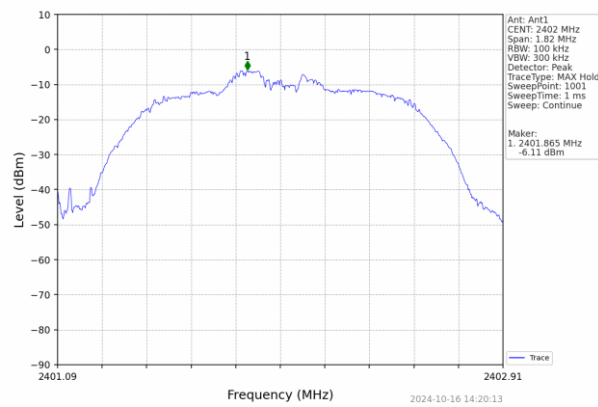


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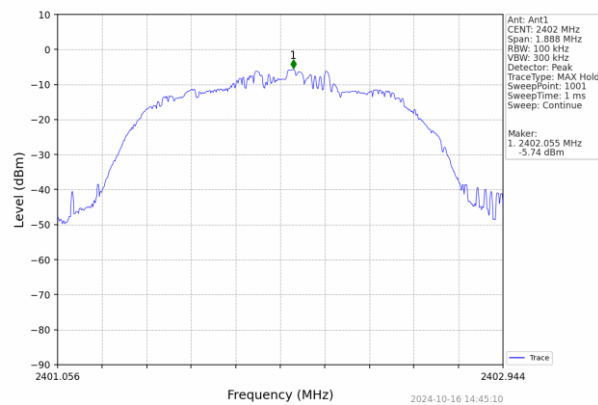
Reference



GFSK



$\pi/4$ QPSK

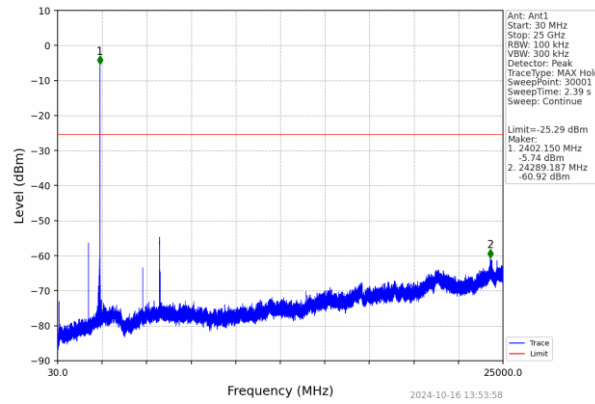


8-DPSK

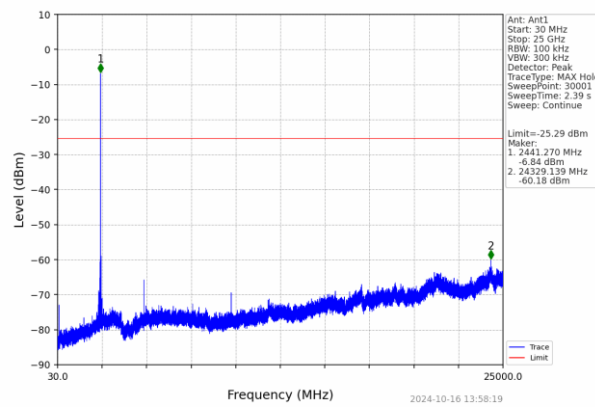


Report No.: HTT202409467F01

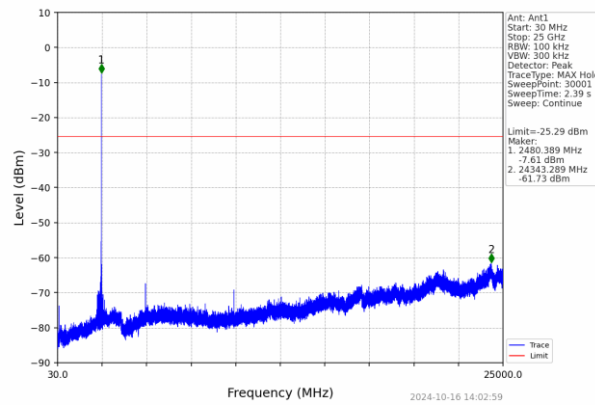
GFSK



CH00



CH39

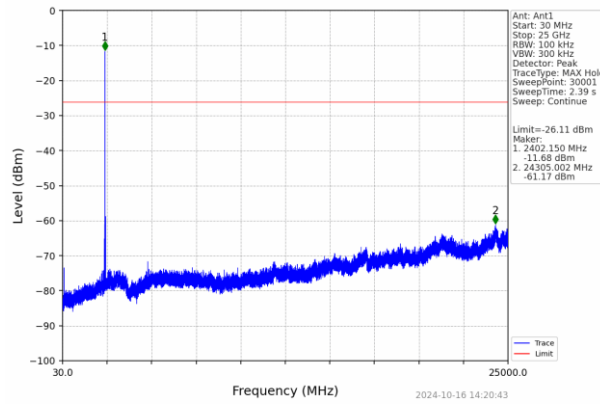


CH78

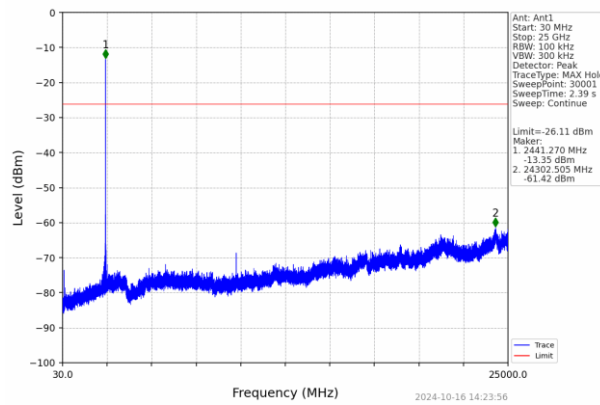


Report No.: HTT202409467F01

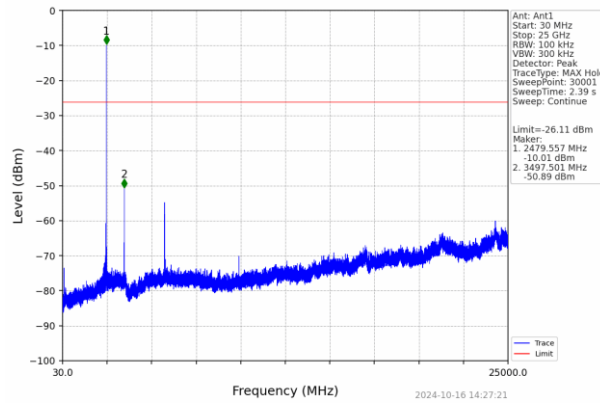
$\pi/4$ DQPSK



CH00



CH39

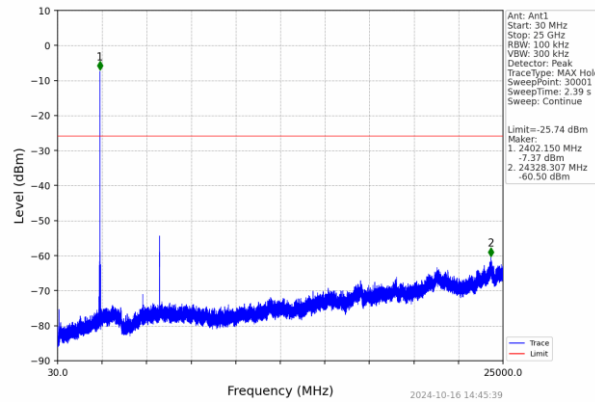


CH78

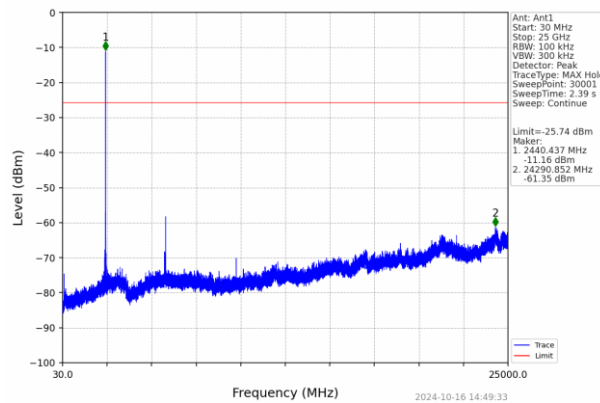


Report No.: HTT202409467F01

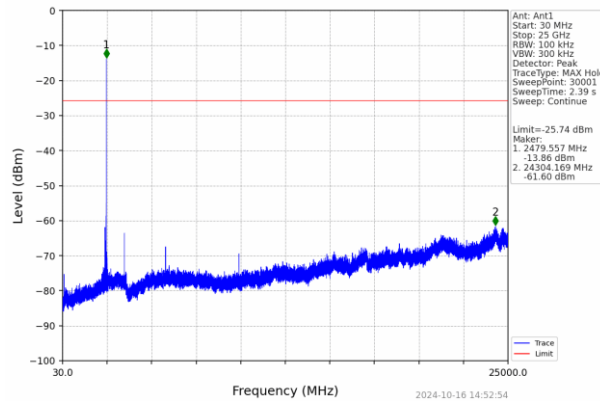
8-DPSK



CH00

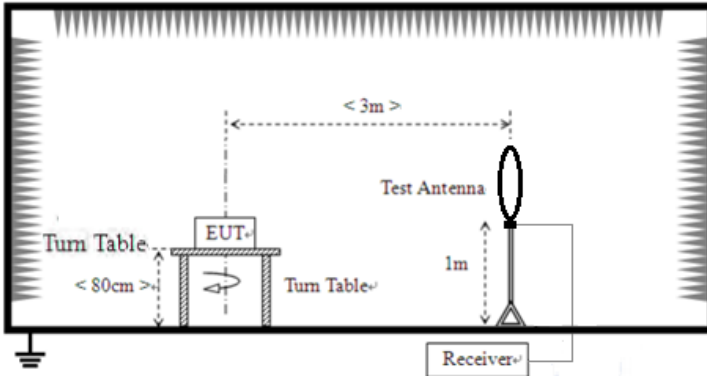


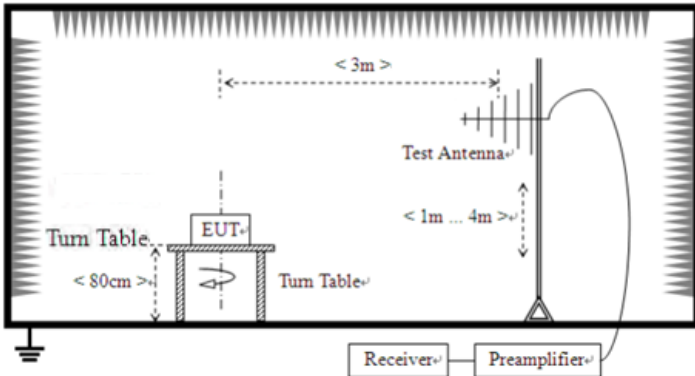
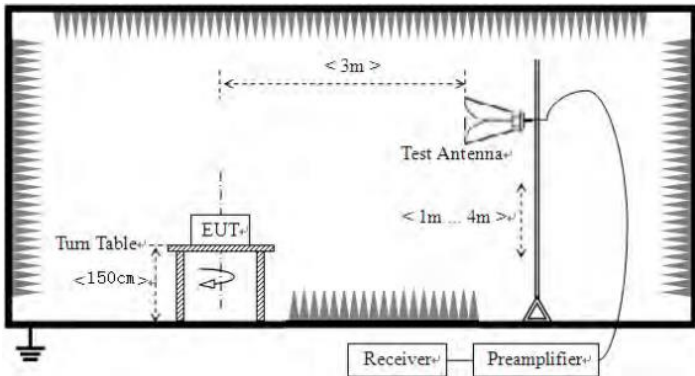
CH39



CH78

6.8.2. Radiated Emission Method

Test Requirement:	FCC Part15 C Section 15.209				
Test Method:	ANSI C63.10:2013				
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	2400/F(KHz)	QP	300m	
	0.490MHz-1.705MHz	24000/F(KHz)	QP	30m	
	1.705MHz-30MHz	30	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 6.0 for details
Test mode:	Refer to section 5.2 for details
Test environment:	Temp.: 25 °C Humid.: 52% Press.: 1012mbar



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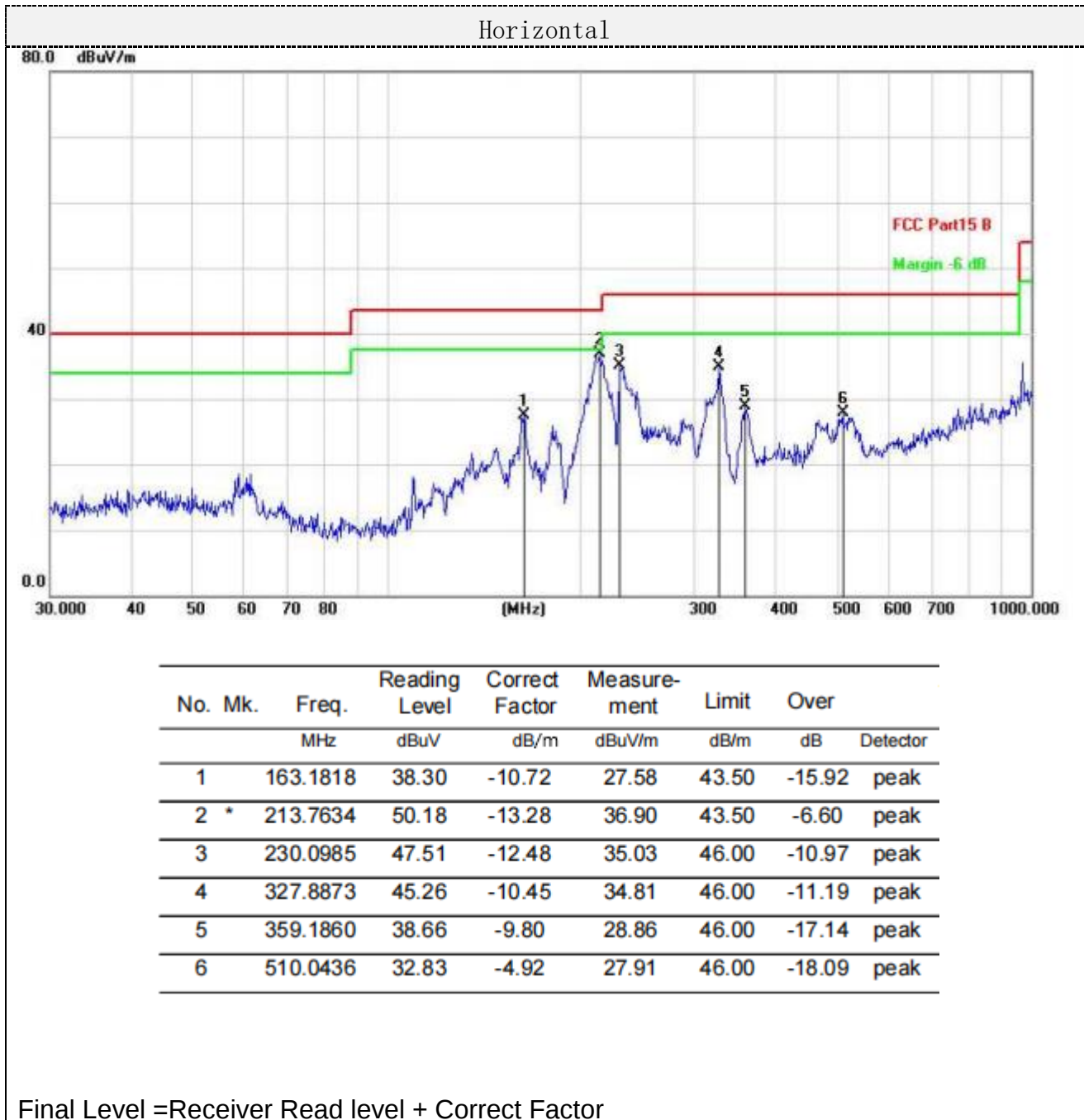
Test voltage:	AC 120V, 60Hz
Test results:	Pass

Measurement data:

Remarks:

1. *During the test, pre-scan the GFSK, $\pi/4$ -DQPSK, 8-DPSK modulation, and found the GFSK modulation which it is worse case.*
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.*
3. *Radiated emission test from 9 KHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9 KHz to 30MHz and not recorded in this report.*
4. *Based on all tested data, the EUT complied with the FCC Part 15.207 standard limit for a wireless device, and with the worst case as DH5 2402MHz as below:*

For 30MHz-1GHz





Report No.: HTT202409467F01

Vertical



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB/m	Measure- ment dBuV/m	Limit dB/m	Over dB	Detector
1		47.4918	40.73	-10.83	29.90	40.00	-10.10	peak
2		60.7044	41.99	-11.73	30.26	40.00	-9.74	peak
3		130.3789	45.68	-12.50	33.18	43.50	-10.32	peak
4	*	240.8304	51.10	-11.81	39.29	46.00	-6.71	peak
5		272.2776	46.99	-11.38	35.61	46.00	-10.39	peak
6		508.2582	40.14	-4.94	35.20	46.00	-10.80	peak

Final Level =Receiver Read level + Correct Factor

**For 1GHz to 25GHz**

Remark: For test above 1GHz GFSK, Pi/4 DQPSK and 8-DPSK were test at Low, Middle, and High channel; only the worst result of GFSK was reported as below:

Frequency(MHz):			2402		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4804.00	58.57	PK	74	15.43	52.87	31	6.5	31.8	5.7
4804.00	42.67	AV	54	11.33	36.97	31	6.5	31.8	5.7
7206.00	52.97	PK	74	21.03	40.32	36	8.15	31.5	12.65
7206.00	44.46	AV	54	9.54	31.81	36	8.15	31.5	12.65

Frequency(MHz):			2402		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4804.00	59.40	PK	74	14.60	53.70	31	6.5	31.8	5.7
4804.00	43.44	AV	54	10.56	37.74	31	6.5	31.8	5.7
7206.00	53.40	PK	74	20.60	40.75	36	8.15	31.5	12.65
7206.00	43.29	AV	54	10.71	30.64	36	8.15	31.5	12.65

Frequency(MHz):			2441		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4882.00	60.98	PK	74	13.02	54.82	31.2	6.61	31.65	6.16
4882.00	44.42	AV	54	9.58	38.26	31.2	6.61	31.65	6.16
7323.00	53.16	PK	74	20.84	40.21	36.2	8.23	31.48	12.95
7323.00	44.11	AV	54	9.89	31.16	36.2	8.23	31.48	12.95



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Frequency(MHz):			2441		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4882.00	60.44	PK	74	13.56	54.28	31.2	6.61	31.65	6.16
4882.00	43.89	AV	54	10.11	37.73	31.2	6.61	31.65	6.16
7323.00	53.71	PK	74	20.29	40.76	36.2	8.23	31.48	12.95
7323.00	43.99	AV	54	10.01	31.04	36.2	8.23	31.48	12.95

Frequency(MHz):			2480		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4960.00	61.71	PK	74	12.29	55.05	31.4	6.76	31.5	6.66
4960.00	42.11	AV	54	11.89	35.45	31.4	6.76	31.5	6.66
7440.00	53.09	PK	74	20.91	39.79	36.4	8.35	31.45	13.3
7440.00	45.22	AV	54	8.78	31.92	36.4	8.35	31.45	13.3

Frequency(MHz):			2480		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4960.00	64.29	PK	74	9.71	57.63	31.4	6.76	31.5	6.66
4960.00	43.90	AV	54	10.10	37.24	31.4	6.76	31.5	6.66
7440.00	53.71	PK	74	20.29	40.41	36.4	8.35	31.45	13.3
7440.00	44.92	AV	54	9.08	31.62	36.4	8.35	31.45	13.3

Remark:

- (1) Data of measurement within this frequency range shown "---" in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
- (2) When the test results of Peak Detected below the limits of Average Detected, the Average Detected is not need completed.



6.9. Antenna Requirement

Standard Applicable

For intentional device, according to FCC 47 CFR Section 15.203:

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

FCC CFR Title 47 Part 15 Subpart C Section 15.247(c) (1) (I):

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

Antenna Connected Construction

The maximum gain of antenna was 1.32 dBi.

Remark: The antenna gain is provided by the customer, if the data provided by the customer is not accurate, Shenzhen HTT Technology Co., Ltd. does not assume any responsibility.



7. Test Setup Photo

Reference to the **appendix I** for details.

8. EUT Constructional Details

Reference to the **appendix II** for details.

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