



FCC PART 15 SUBPART C TEST REPORT
FCC PART 15.247

Report Reference No..... : GRCTR230502009-01

FCC ID..... : 2AT12-G20

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Date of issue..... : Jun. 27, 2023

Testing Laboratory Name..... : Shenzhen GUOREN Certification Technology Service Co., Ltd.

Address..... : 101#, Building K & Building T, The Second Industrial Zone, Jiazitang Community, Fenghuang Street, Guangming District, Shenzhen, China

Applicant's name..... : SHENZHEN GREENJOY TECHNOLOGY CO.,LTD.

Address..... : 2606,UnitA,Building11,Shenzhen Bay Technology and Science Eco-Park,Nanshan,Shenzhen

Test specification..... :

Standard..... : FCC Part 15.247

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Test item description..... : GOLF Waver Launch Monitor

Trade Mark..... : GOLFJOY

Manufacturer..... : SHENZHEN GREENJOY TECHNOLOGY CO.,LTD.

Model/Type reference..... : G20

Listed Models ..... : G2X

Firmware Version..... : RD\_V1.0.4

Hardware Version..... : 24G\_Radar\_V3.0.1\_MB、24G\_Radar\_V3.0\_RF

Modulation ..... : GFSK, Π/4DQPSK,8DPSK

Frequency..... : From 2402MHz to 2480MHz

Rating..... : 5.0V ---2.0A(charged by DC 5V Power Adapter ) or 3.8V ---3200mAh (By Li-ion rechargeable battery)

Result..... : PASS

# TEST REPORT

Equipment under Test : GOLF Waver Launch Monitor

Model /Type : G20

Listed Models : G2X

**Applicant** : **SHENZHEN GREENJOY TECHNOLOGY CO.,LTD.**

Address : 2606,UnitA,Building11,Shenzhen Bay Technology and Science Eco-Park,Nanshan,Shenzhen

**Manufacturer** : **SHENZHEN GREENJOY TECHNOLOGY CO.,LTD.**

Address : 2606,UnitA,Building11,Shenzhen Bay Technology and Science Eco-Park,Nanshan,Shenzhen

<b>Test Result:</b>	<b>PASS</b>
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The test report merely corresponds to the test sample.  
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

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# **1 TEST STANDARDS**

The tests were performed according to following standards:

[FCC Rules Part 15.247](#): Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

[ANSI C63.10-2013](#): American National Standard for Testing Unlicensed Wireless Devices

## 2 SUMMARY

### 2.1 General Remarks

Date of receipt of test sample	:	May. 16, 2023
Testing commenced on	:	May. 16, 2023
Testing concluded on	:	Jun. 27, 2023

### 2.2 Product Description

Product Name:	GOLF Waver Launch Monitor
Model/Type reference:	G20
Listed Models:	G2X (The products are identical in interior structure, electrical circuits and components, just model names and color are different.)
Power supply:	5.0V $\overline{\text{---}}$ 2.0A(charged by DC 5V Power Adapter ) or 3.8V $\overline{\text{---}}$ 3200mAh (By Li-ion rechargeable battery)
Adapter Information:	M/N:A319-050200U-US2 Input:AC 100-240V 50/60Hz 0.35A Output:5V/2A
Testing sample ID:	GRCTR230502009-1# (Engineer sample), GRCTR230502009-2# (Normal sample)
<b>Bluetooth</b>	
Supported Type:	Bluetooth BR/EDR
Modulation:	GFSK, $\pi/4$ DQPSK, 8DPSK
Operation frequency:	2402MHz~2480MHz
Channel number:	79
Channel separation:	1MHz
Antenna type:	PCB antenna
Antenna gain*(Supplied by the customer):	3.76 dBi
Remark:*When the information provided by the customer was used to calculate test results, if the information provided by the customer is not accurate, shenzhen GUOREN Certification Technology Service Co., Ltd. does not assume any responsibility.	

### 2.3 Equipment Under Test

#### Power supply system utilised

Power supply voltage	:	<input type="radio"/> 230V / 50 Hz	<input type="radio"/> 120V / 60Hz
		<input type="radio"/> 12 V DC	<input type="radio"/> 24 V DC
		<input checked="" type="radio"/> Other (specified in blank below)	

DC 5.0V from external circuit

### 2.4 Short description of the Equipment under Test (EUT)

This is a GOLF Waver Launch Monitor.

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

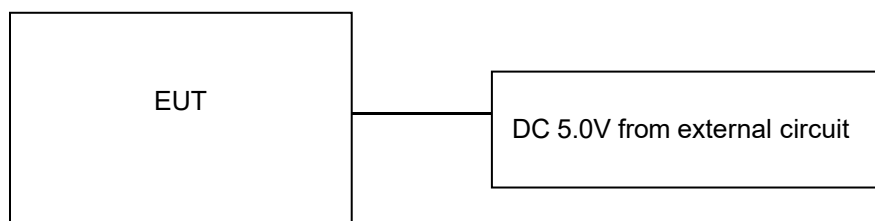
## 2.5 EUT operation mode

The Applicant provides communication tools software(SecureCRT) to control the EUT for staying in continuous transmitting (Duty Cycle more than 98%) and receiving mode for testing .There are 79 channels provided to the EUT and Channel 00/39/78 were selected to test.

### Operation Frequency:

Channel	Frequency (MHz)
00	2402
01	2403
:	:
38	2440
39	2441
40	2442
:	:
77	2479
78	2480

## 2.6 Block Diagram of Test Setup



## 2.7 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for the device filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

## 2.8 Modifications

No modifications were implemented to meet testing criteria.

### **3 TEST ENVIRONMENT**

#### **3.1 Address of the test laboratory**

**Shenzhen GUOREN Certification Technology Service Co., Ltd.**

101#, Building K & Building T, The Second Industrial Zone, Jiazitang Community, Fenghuang Street, Guangming District, Shenzhen, China

#### **3.2 Test Facility**

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

**FCC-Registration No.: 920798 Designation Number: CN1304**

Shenzhen GUOREN Certification Technology Service Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

**A2LA-Lab Cert. No.: 6202.01**

Shenzhen GUOREN Certification Technology Service Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

**ISED#: 27264 CAB identifier: CN0115**

Shenzhen GUOREN Certification Technology Service Co., Ltd. has been listed by Innovation, Science and Economic Development Canada to perform electromagnetic emission measurement.

**CNAS-Lab Code: L15631**

Shenzhen GUOREN Certification Technology Service Co., Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories for the Competence of Testing and Calibration Laboratories.

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010.

#### **3.3 Environmental conditions**

During the measurement the environmental conditions were within the listed ranges:

Normal Temperature	15-35 °C
Relative Humidity	30-60 %
Air Pressure	950-1050mbar

### 3.4 Summary of measurement results

Test Specification clause	Test case	Test Mode	Test Channel	Recorded In Report		Test result
§15.247(a)(1)	Carrier Frequency separation	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Middle	Compliant
§15.247(a)(1)	Number of Hopping channels	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Full	GFSK	<input checked="" type="checkbox"/> Full	Compliant
§15.247(a)(1)	Time of Occupancy (dwell time)	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Middle	Compliant
§15.247(a)(1)	Spectrum bandwidth of aFHSS system 20dB bandwidth	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	Compliant
§15.247(b)(1)	Maximum output peak power	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	Compliant
§15.247(d)	Band edge compliance conducted	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Highest	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Highest	Compliant
§15.205	Band edge compliance radiated	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Highest	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Highest	Compliant
§15.247(d)	TX spurious emissions conducted	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	Compliant
§15.247(d)	TX spurious emissions radiated	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	Compliant
§15.209(a)	TX spurious Emissions radiated Below 1GHz	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK	<input checked="" type="checkbox"/> Middle	Compliant
§15.107(a) §15.207	Conducted Emissions 9KHz-30 MHz	GFSK π/4DQPSK 8DPSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK	<input checked="" type="checkbox"/> Middle	Compliant

Remark:

1. The measurement uncertainty is not included in the test result.
2. We tested all test mode and recorded worst case in report.
3. N/A means “not applicable”.

### 3.5 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01 “Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1” and TR-100028-02 “Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2” and is documented in the Shenzhen GUOREN Certification Technology Service Co., Ltd. quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for Shenzhen GUOREN Certification Technology Service Co., Ltd.:

Test	Range	Measurement Uncertainty	Notes
Radiated Emission	30~1000MHz	4.06 dB	(1)
Radiated Emission	1~18GHz	5.14 dB	(1)
Radiated Emission	18-40GHz	5.38 dB	(1)
Conducted Disturbance	0.15~30MHz	2.14 dB	(1)

- (1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.



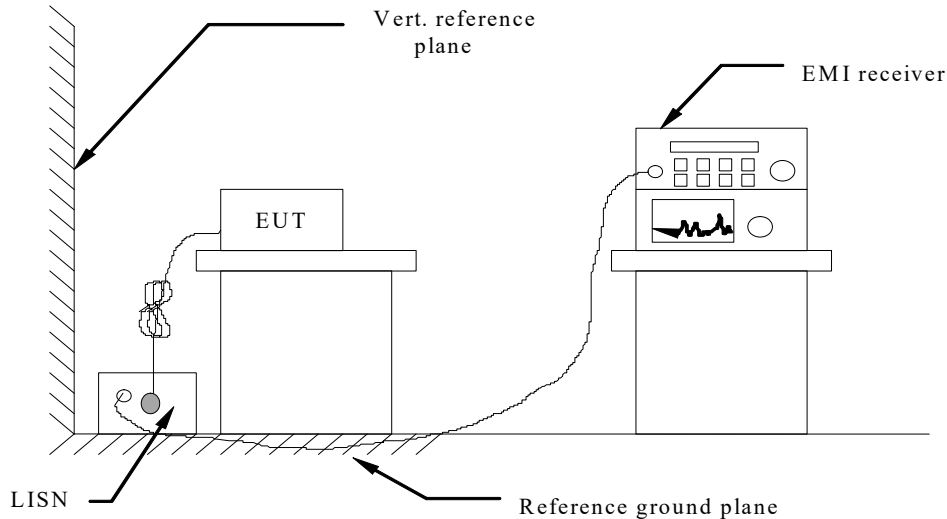
### 3.6 Equipments Used during the Test

Test Equipment	Manufacturer	Model No.	Equipment No.	Calibration Date	Calibration Due Date
LISN	R&S	ENV216	GRCTEE009	2022/10/12	2023/10/11
LISN	R&S	ENV216	GRCTEE010	2022/10/12	2023/10/11
EMI Test Receiver	R&S	ESPI	GRCTEE017	2022/10/12	2023/10/11
EMI Test Receiver	R&S	ESCI	GRCTEE008	2022/10/12	2023/10/11
Spectrum Analyzer	Agilent	N9020A	GRCTEE002	2022/10/12	2023/10/11
Spectrum Analyzer	R&S	FSP	GRCTEE003	2022/10/12	2023/10/11
Vector Signal generator	Agilent	N5181A	GRCTEE007	2022/10/12	2023/10/11
Analog Signal Generator	R&S	SML03	GRCTEE006	2022/10/12	2023/10/11
Climate Chamber	QIYA	LCD-9530	GRCTES016	2022/10/12	2023/10/11
Ultra-Broadband Antenna	Schwarzbeck	VULB9163	GRCTEE018	2020/10/25	2023/10/24
Horn Antenna	Schwarzbeck	BBHA 9120D	GRCTEE019	2020/10/25	2023/10/24
Loop Antenna	Zhinan	ZN30900C	GRCTEE020	2020/10/25	2023/10/24
Horn Antenna	Beijing Hangwei Dayang	OBH100400	GRCTEE049	2021/1/18	2024/1/17
Amplifier	Schwarzbeck	BBV 9745	GRCTEE021	2022/10/12	2023/10/11
Amplifier	Taiwan chengyi	EMC051845B	GRCTEE022	2022/10/12	2023/10/11
Temperature/Humidity Meter	Huaguan	HG-308	GRCTES037	2022/10/12	2023/10/11
Directional coupler	NARDA	4226-10	GRCTEE004	2022/10/12	2023/10/11
High-Pass Filter	XingBo	XBLBQ-GTA18	GRCTEE053	2022/10/12	2023/10/11
High-Pass Filter	XingBo	XBLBQ-GTA27	GRCTEE054	2022/10/12	2023/10/11
Automated filter bank	Tonscend	JS0806-F	GRCTEE055	2022/10/12	2023/10/11
Power Sensor	Agilent	U2021XA	GRCTEE070	2022/10/12	2023/10/11
EMI Test Software	ROHDE & SCHWARZ	ESK1-V1.71	GRCTEE060	N/A	N/A
EMI Test Software	Fera	EZ-EMC	GRCTEE061	N/A	N/A

## 4 TEST CONDITIONS AND RESULTS

### 4.1 AC Power Conducted Emission

#### TEST CONFIGURATION



#### TEST PROCEDURE

- 1 The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system, a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10-2013.
- 2 Support equipment, if needed, was placed as per ANSI C63.10-2013
- 3 All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10-2013
- 4 The EUT received power from variable frequency power supply, the AC 120V/60Hz and AC 240V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
- 5 All support equipments received AC power from a second LISN, if any.
- 6 The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
- 7 Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
- 8 During the above scans, the emissions were maximized by cable manipulation.

#### AC Power Conducted Emission Limit

For intentional device, according to § 15.207(a) AC Power Conducted Emission Limits is as following:

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

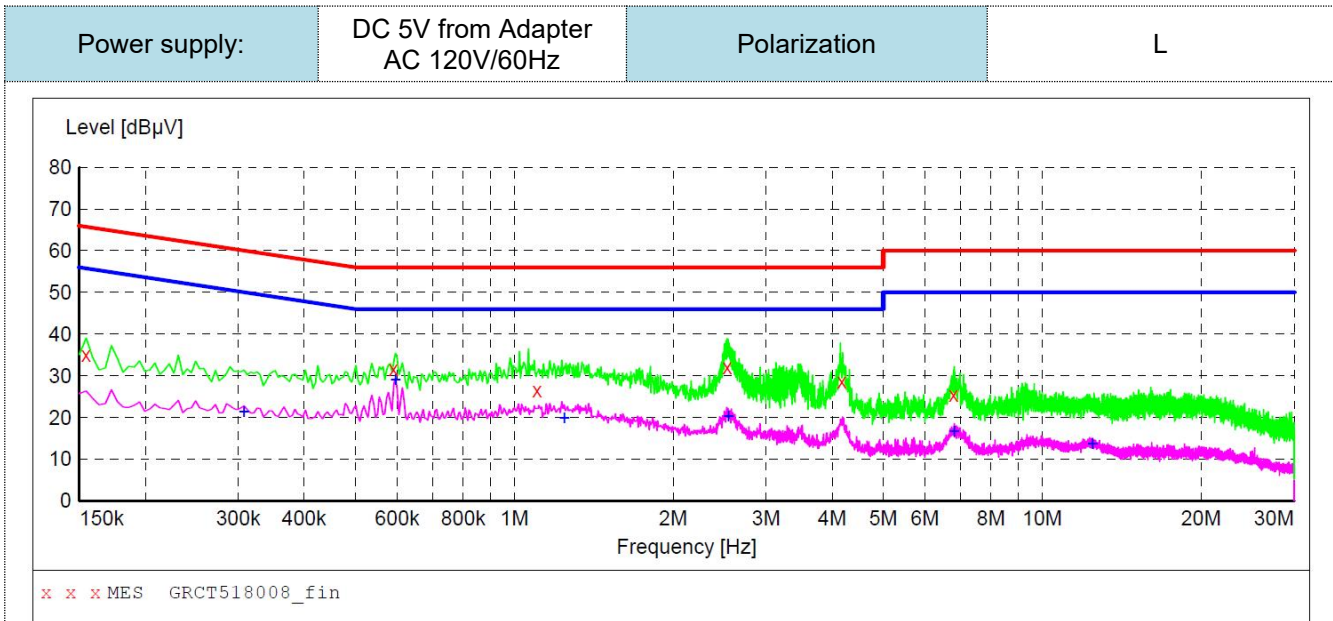
\* Decreases with the logarithm of the frequency.

#### TEST RESULTS

Remark:

1. All modes of GFSK,  $\pi/4$  DQPSK and 8DPSK were test at Low, Middle, and High channel; only the worst result of GFSK Middle Channel was reported as below:

2. Both 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz power supply have been tested, only the worst result of 120 VAC, 60 Hz was reported as below:



**MEASUREMENT RESULT: "GRCT518008\_fin"**

5/18/2023 10:00AM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.154500	35.00	9.7	66	30.8	QP	L1	GND
0.591000	31.60	9.8	56	24.4	QP	L1	GND
1.104000	26.60	9.6	56	29.4	QP	L1	GND
2.530500	32.00	9.7	56	24.0	QP	L1	GND
4.173000	28.70	9.5	56	27.3	QP	L1	GND
6.796500	25.50	9.8	60	34.5	QP	L1	GND

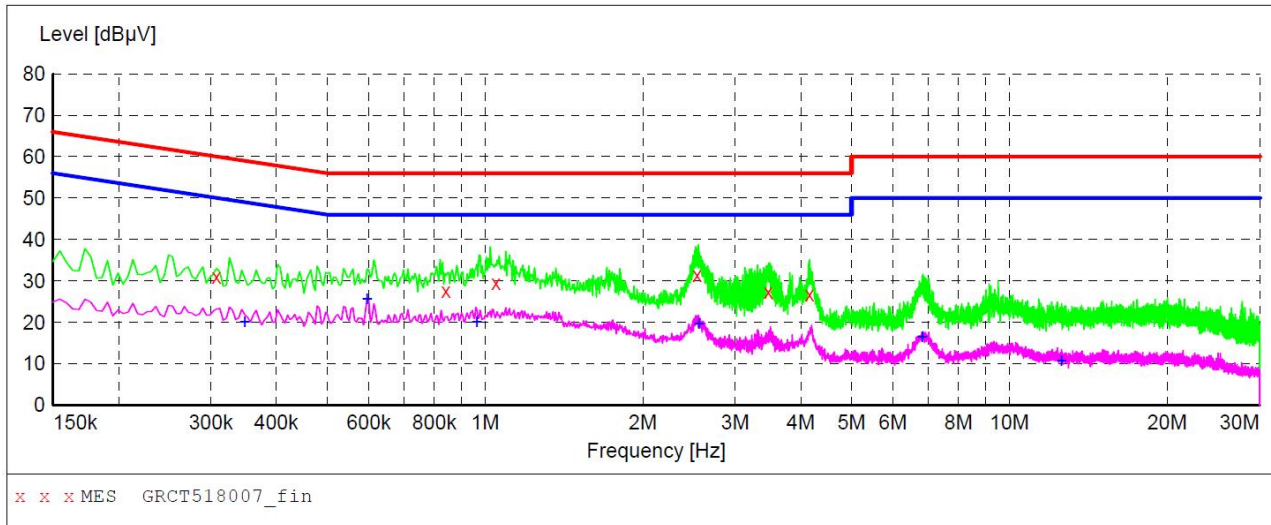
**MEASUREMENT RESULT: "GRCT518008\_fin2"**

5/18/2023 10:00AM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.307500	21.50	9.9	50	28.5	AV	L1	GND
0.595500	29.10	9.8	46	16.9	AV	L1	GND
1.243500	19.90	9.7	46	26.1	AV	L1	GND
2.544000	20.40	9.7	46	25.6	AV	L1	GND
6.810000	16.70	9.8	50	33.3	AV	L1	GND
12.448500	13.80	9.7	50	36.2	AV	L1	GND

- Note:1).Level (dBµV)= Reading (dBµV)+ Transducer (dB)  
 2). Transducer (dB)=insertion loss of LISN (dB) + Cable loss (dB)  
 3). Margin(dB) = Limit (dBµV) - Level (dBµV)

Power supply:	DC 5V from Adapter AC 120V/60Hz	Polarization	N
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**MEASUREMENT RESULT: "GRCT518007\_fin"**

5/18/2023 9:57AM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.307500	31.10	9.9	60	28.9	QP	N	GND
0.843000	27.70	9.7	56	28.3	QP	N	GND
1.050000	29.40	9.6	56	26.6	QP	N	GND
2.539500	31.40	9.7	56	24.6	QP	N	GND
3.471000	27.40	9.6	56	28.6	QP	N	GND
4.159500	26.80	9.5	56	29.2	QP	N	GND

**MEASUREMENT RESULT: "GRCT518007\_fin2"**

5/18/2023 9:57AM

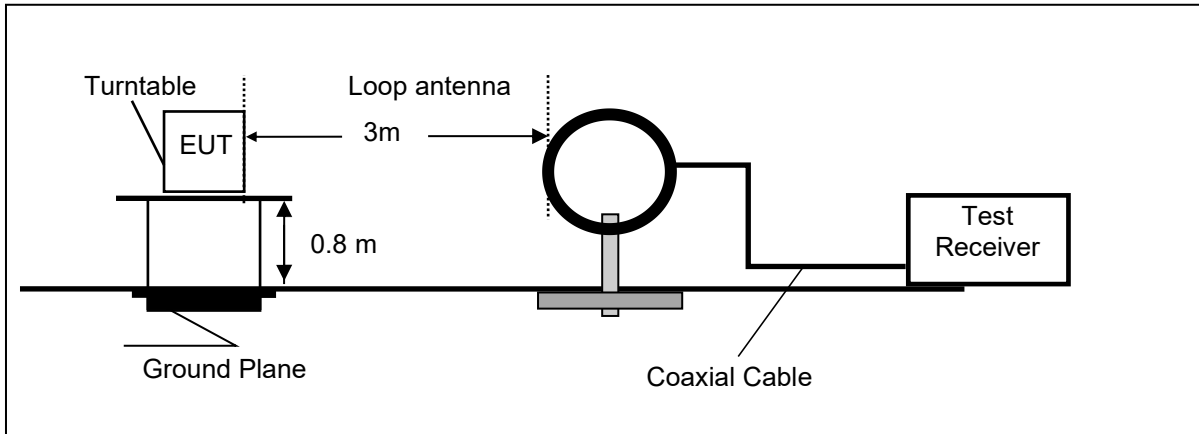
Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.348000	20.20	9.8	49	28.8	AV	N	GND
0.595500	25.70	9.8	46	20.3	AV	N	GND
0.964500	20.20	9.6	46	25.8	AV	N	GND
2.557500	19.70	9.7	46	26.3	AV	N	GND
6.819000	16.50	9.8	50	33.5	AV	N	GND
12.561000	10.80	9.7	50	39.2	AV	N	GND

- Note:1).Level (dBµV)= Reading (dBµV)+ Transducer (dB)  
 2). Transducer (dB)=insertion loss of LISN (dB) + Cable loss (dB)  
 3). Margin(dB) = Limit (dBµV) - Level (dBµV)

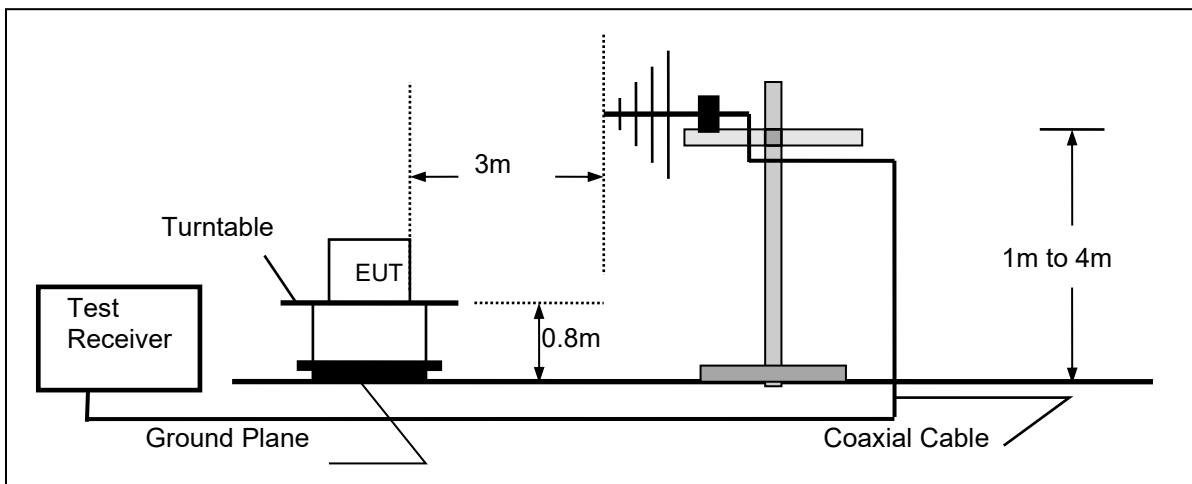
## 4.2 Radiated Emission

### TEST CONFIGURATION

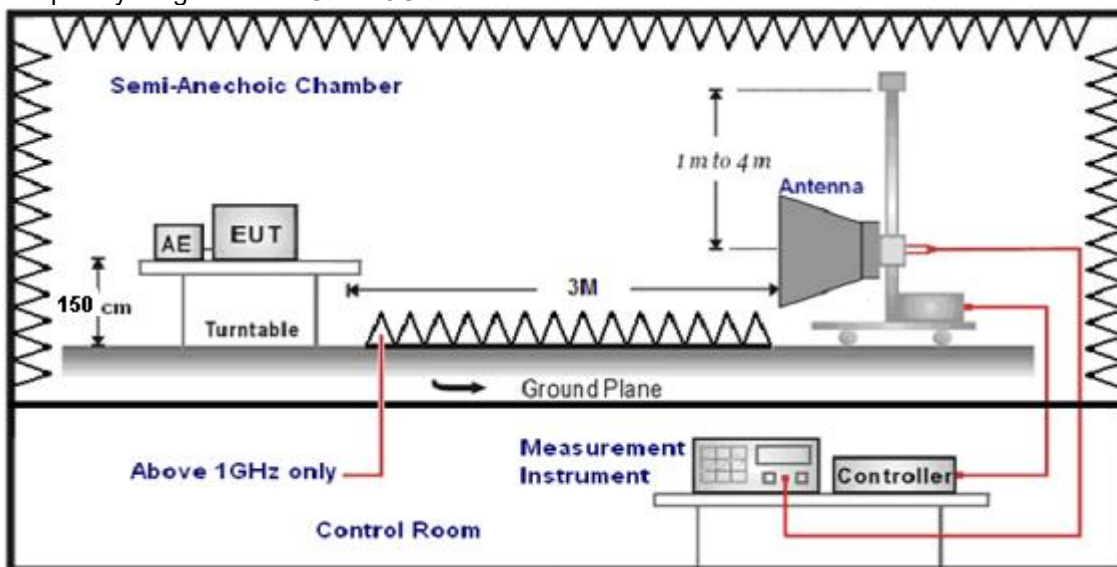
Frequency range 9 KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz



**TEST PROCEDURE**

1. The EUT was placed on a turn table which is 0.8m above ground plane when testing frequency range 9 KHz –1GHz, the EUT was placed on a turn table which is 1.5m above ground plane when testing frequency range 1GHz – 25GHz.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0° to 360° to acquire the highest emissions from EUT.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.
5. Radiated emission test frequency band from 9KHz to 25GHz.
6. The distance between test antenna and EUT as following table states:

Test Frequency range	Test Antenna Type	Test Distance
9KHz-30MHz	Active Loop Antenna	3
30MHz-1GHz	Ultra-Broadband Antenna	3
1GHz-18GHz	Double Ridged Horn Antenna	3
18GHz-25GHz	Horn Antenna	1

7. Setting test receiver/spectrum as following table states:

Test Frequency range	Test Receiver/Spectrum Setting	Detector
9KHz-150KHz	RBW=200Hz/VBW=3KHz, Sweep time=Auto	QP
150KHz-30MHz	RBW=9KHz/VBW=100KHz, Sweep time=Auto	QP
30MHz-1GHz	RBW=120KHz/VBW=1000KHz, Sweep time=Auto	QP
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

**Field Strength Calculation**

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor(if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

$$\text{Transd} = \text{AF} + \text{CL} - \text{AG}$$

**RADIATION LIMIT**

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission from intentional radiators at a distance of 3 meters shall not exceed the following table. According to § 15.247(d), in any 100kHz bandwidth outside the frequency band in which the EUT is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

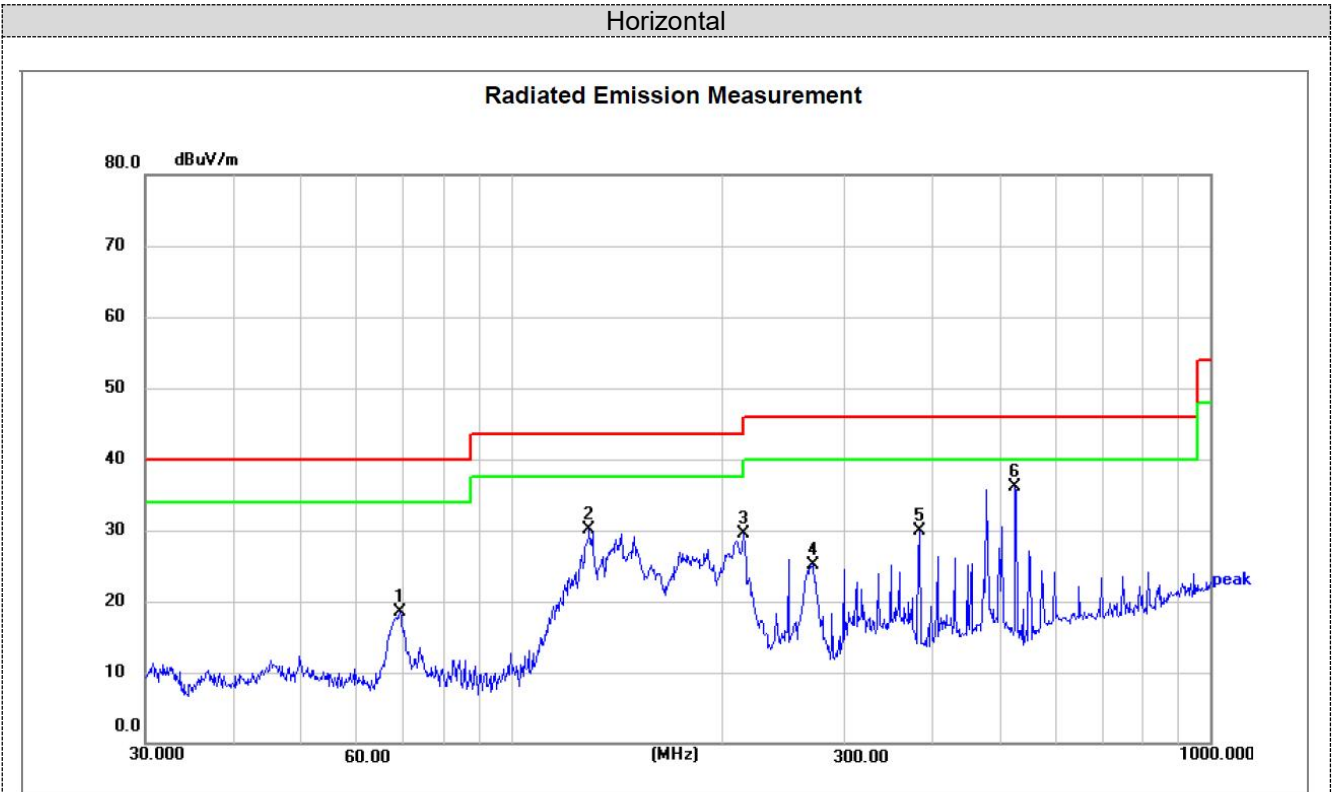
Frequency (MHz)	Distance (Meters)	Radiated (dBµV/m)	Radiated (µV/m)
0.009-0.49	3	$20\log(2400/F(\text{KHz})) + 40\log(300/3)$	$2400/F(\text{KHz})$
0.49-1.705	3	$20\log(24000/F(\text{KHz})) + 40\log(30/3)$	$24000/F(\text{KHz})$
1.705-30	3	$20\log(30) + 40\log(30/3)$	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

**TEST RESULTS**

Remark:

1. This test was performed with EUT in X, Y, Z position and the worse case was found when EUT in X position.
2. We measured Radiated Emission at GFSK,π/4 DQPSK and 8DPSK mode from 9 KHz to 25GHz and recorded worst case at GFSK DH5 mode.
3. For below 1GHz testing recorded worst at GFSK DH5 middle channel.
4. 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.

**For 30MHz-1GHz**



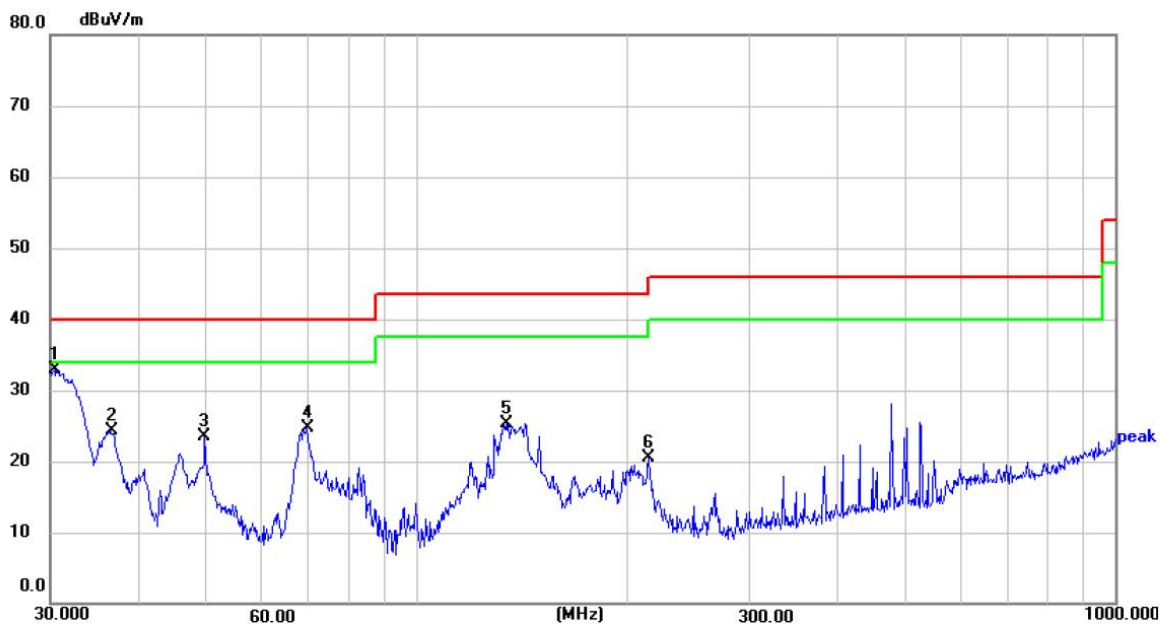
Site LAB	Polarization: <b>Horizontal</b>	Temperature: 24.5(C)
Limit: FCC Part15 RE-Class B_30-1000MHz	Power: AC120V/60Hz	Humidity: 52 %
EUT:	Distance: 3m	
M/N:		
Mode:		
Note:		

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg.)	P/F	Remark
1	69.3568	38.91	-20.41	18.50	40.00	-21.50	peak	199	307	P	
2	129.4677	52.63	-22.58	30.05	43.50	-13.45	peak	199	9	P	
3	215.2678	48.23	-18.80	29.43	43.50	-14.07	peak	100	138	P	
4	270.3748	42.94	-17.76	25.18	46.00	-20.82	peak	199	9	P	
5	383.9318	45.95	-15.97	29.98	46.00	-16.02	peak	100	111	P	
6 *	526.3967	50.24	-14.21	36.03	46.00	-9.97	peak	199	9	P	

- Note:1).Level (dBuV/m)= Reading (dBuV)+ Factor (dB/m)  
 2). Factor(dB/m)=Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB)  
 3). Margin(dB) = Level (dBuV/m) - Limit (dBuV/m)

Vertical

Radiated Emission Measurement



Site LAB Polarization: **Vertical** Temperature: 24.5(C)  
 Limit: FCC Part15 RE-Class B\_30-1000MHz Power: AC120V/60Hz Humidity: 52 %  
 EUT: Distance: 3m  
 M/N:  
 Mode:  
 Note:

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg.)	P/F	Remark
1 *	30.4238	52.79	-19.87	32.92	40.00	-7.08	peak	100	109	P	
2	36.6375	43.36	-19.03	24.33	40.00	-15.67	peak	100	65	P	
3	49.8814	41.02	-17.45	23.57	40.00	-16.43	peak	100	82	P	
4	69.8450	45.25	-20.46	24.79	40.00	-15.21	peak	100	7	P	
5	134.5592	47.65	-22.37	25.28	43.50	-18.22	peak	100	73	P	
6	215.2678	39.39	-18.80	20.59	43.50	-22.91	peak	100	172	P	

- Note:1).Level (dBuV/m)= Reading (dBuV)+ Factor (dB/m)  
 2). Factor(dB/m)=Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB)  
 3). Margin(dB) = Level (dBuV/m) - Limit (dBuV/m)



**For 1GHz to 25GHz**Note: GFSK ,  $\pi/4$  DQPSK and 8DPSK all have been tested, only worse case GFSK is reported.**GFSK (above 1GHz)**

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	54.41	PK	74	19.59	75.57	28.42	5.14	54.72	-21.16
4804.00	42.07	AV	54	11.93	63.23	28.42	5.14	54.72	-21.16
7206.00	50.20	PK	74	23.80	64.62	34.15	6.46	55.03	-14.42
7206.00	40.13	AV	54	13.87	54.55	34.15	6.46	55.03	-14.42

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	52.71	PK	74	21.29	73.87	28.42	5.14	54.72	-21.16
4804.00	41.51	AV	54	12.49	62.67	28.42	5.14	54.72	-21.16
7206.00	49.61	PK	74	24.39	64.03	34.15	6.46	55.03	-14.42
7206.00	39.90	AV	54	14.10	54.32	34.15	6.46	55.03	-14.42

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	52.33	PK	74	21.67	73.49	28.76	5.34	54.34	-20.24
4882.00	40.21	AV	54	13.79	61.37	28.76	5.34	54.34	-20.24
7323.00	50.02	PK	74	23.98	64.44	34.41	6.83	54.87	-13.63
7323.00	37.86	AV	54	16.14	52.28	34.41	6.83	54.87	-13.63

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	52.56	PK	74	21.44	73.72	28.76	5.34	54.34	-20.24
4882.00	40.20	AV	54	13.80	61.36	28.76	5.34	54.34	-20.24
7323.00	49.47	PK	74	24.53	63.89	34.41	6.83	54.87	-13.63
7323.00	37.87	AV	54	16.13	52.29	34.41	6.83	54.87	-13.63

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	53.78	PK	74	20.22	73.31	29.52	5.63	54.68	-19.53
4960.00	42.56	AV	54	11.44	62.09	29.52	5.63	54.68	-19.53
7440.00	51.06	PK	74	22.94	64.26	34.49	7.23	54.92	-13.2
7440.00	39.35	PK	54	14.65	52.55	34.49	7.23	54.92	-13.2

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	53.45	PK	74	20.55	72.98	29.52	5.63	54.68	-19.53
4960.00	42.92	AV	54	11.08	62.45	29.52	5.63	54.68	-19.53
7440.00	52.17	PK	74	21.83	65.37	34.49	7.23	54.92	-13.2
7440.00	39.88	PK	54	14.12	53.08	34.49	7.23	54.92	-13.2

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB) - Pre-amplifier
3. Margin value = Limit value - Emission level.
4. -- Mean the PK detector measured value is below average limit.
5. The other emission levels were very low against the limit.

### Results of Band Edges Test (Radiated)

Note: GFSK,  $\pi/4$  DQPSK and 8DPSK all have been tested, only worse case GFSK is reported.

#### 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	57.19	PK	74	16.81	81.91	25.72	4.32	54.76	-24.72
2390.00	40.04	AV	54	13.96	64.76	25.72	4.32	54.76	-24.72
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	58.62	PK	74	15.38	83.19	25.72	4.32	54.76	-24.72
2390.00	41.78	AV	54	12.22	66.35	25.72	4.32	54.76	-24.72
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	57.58	PK	74	16.42	82.30	25.78	4.48	54.83	-24.57
2483.50	41.80	AV	54	12.20	66.52	25.78	4.48	54.83	-24.57
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	57.71	PK	74	16.29	82.28	25.78	4.48	54.83	-24.57
2483.50	40.30	AV	54	13.70	64.87	25.78	4.48	54.83	-24.57

#### REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB) - Pre-amplifier
3. Margin value = Limit value - Emission level.
4. -- Mean the PK detector measured value is below average limit.
5. The other emission levels were very low against the limit.

### 4.3 Maximum Peak Output Power

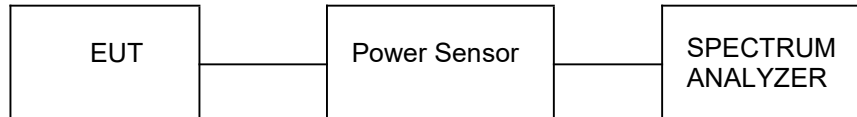
#### Limit

The Maximum Peak Output Power Measurement is 125mW (20.97).

#### Test Procedure

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power sensor.

#### Test Configuration



#### Test Results

Type	Channel	Output power (dBm)	Limit (dBm)	Result
GFSK	00	1.58	20.97	Pass
	39	1.21		
	78	0.89		
$\pi/4$ DQPSK	00	3.33	20.97	Pass
	39	2.75		
	78	2.49		
8DPSK	00	4.13	20.97	Pass
	39	3.68		
	78	3.37		

Note: 1.The test results including the cable lose.

#### 4.4 20dB Bandwidth

##### Limit

For frequency hopping systems operating in the 2400MHz-2483.5MHz no limit for 20dB bandwidth.

##### Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 30 KHz RBW and 100 KHz VBW.

The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

##### Test Configuration



##### Test Results

Modulation	Channel	20dB bandwidth (MHz)	Result
GFSK	00	0.9397	Pass
	39	0.9307	
	78	0.9193	
$\pi/4$ DQPSK	00	1.318	
	39	1.294	
	78	1.291	
8DPSK	00	1.291	
	39	1.309	
	78	1.310	

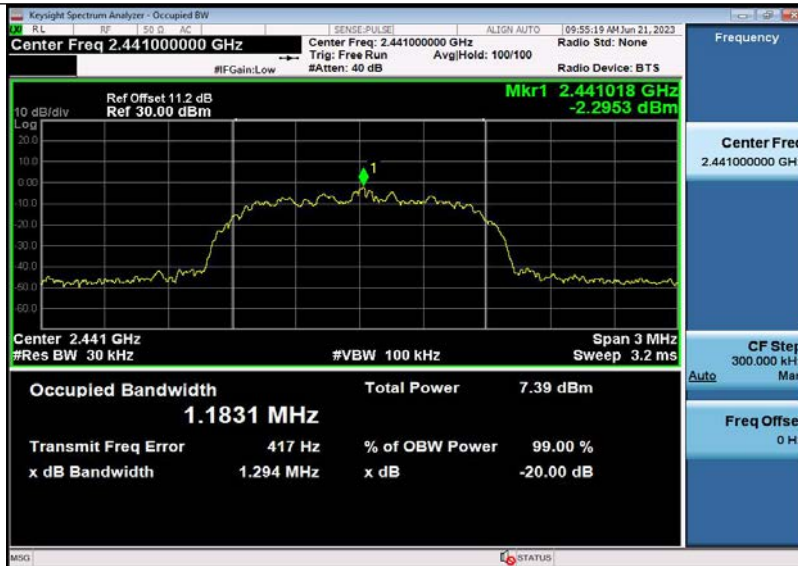
Test plot as follows:



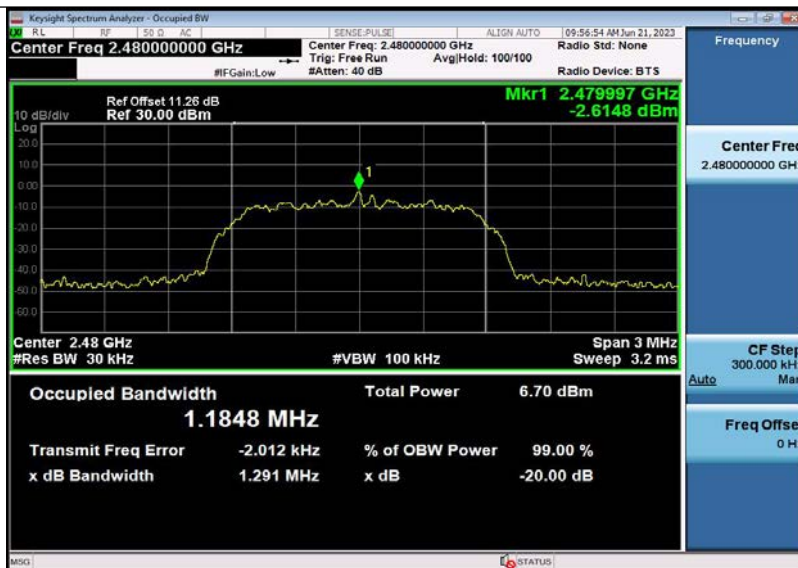
$\pi/4$ DQPSK Modulation



CH00

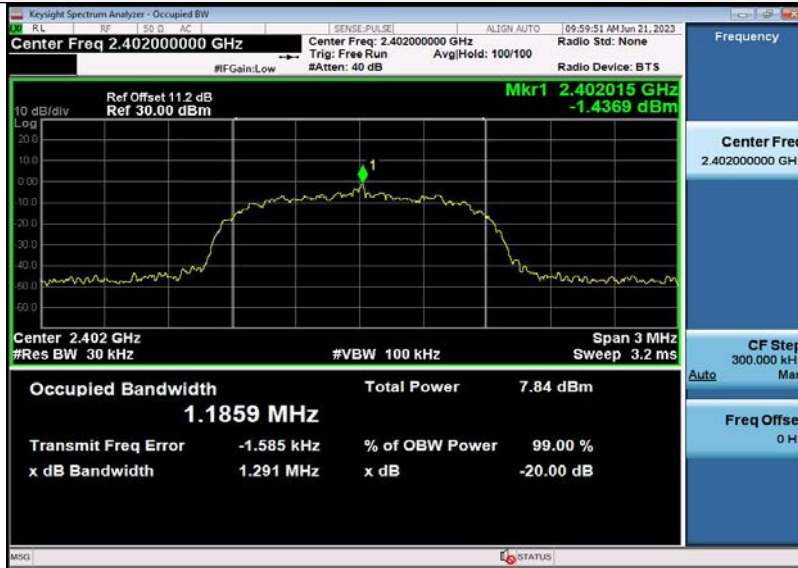


CH39

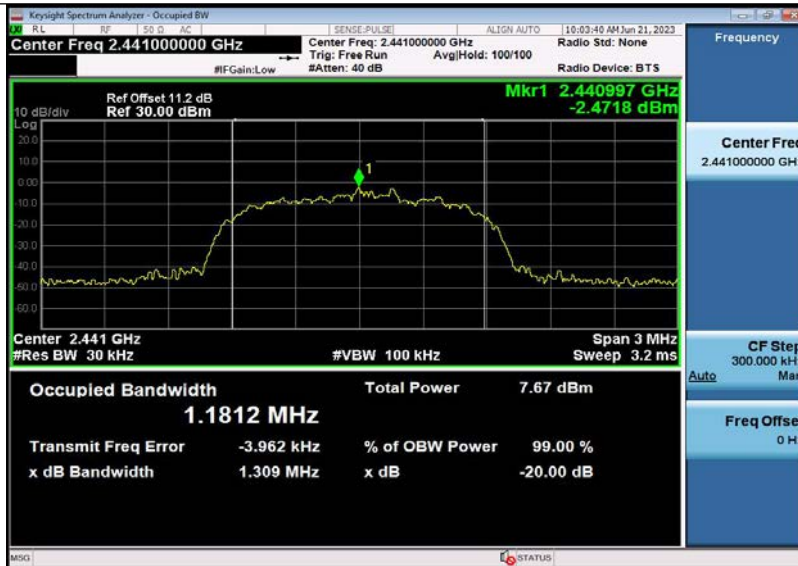


CH78

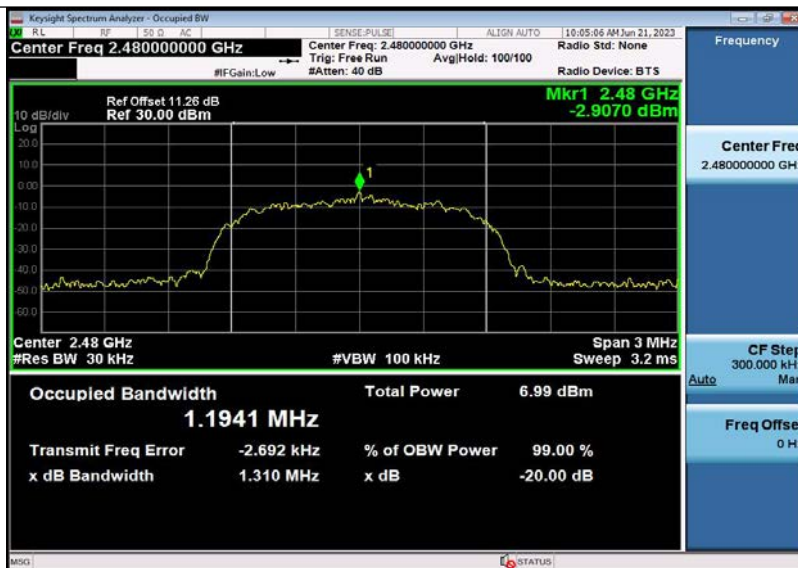
8DPSK Modulation



CH00



CH39



CH78

## 4.5 Frequency Separation

### LIMIT

According to 15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25KHz or the  $2/3 \times 20\text{dB}$  bandwidth of the hopping channel, whichever is greater.

### TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 KHz RBW and 300 KHz VBW.

### TEST CONFIGURATION



### TEST RESULTS

Modulation	Channel	Channel Separation (MHz)	Limit(MHz)	Result
GFSK	CH39	1.020	25KHz or $2/3 \times 20\text{dB}$ bandwidth	Pass
	CH40			
$\pi/4$ DQPSK	CH39	0.988	25KHz or $2/3 \times 20\text{dB}$ bandwidth	Pass
	CH40			
8DPSK	CH39	1.162	25KHz or $2/3 \times 20\text{dB}$ bandwidth	Pass
	CH40			

Note:

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



Test plot as follows:



GFSK



$\pi/4$ DQPSK



8DPSK

## 4.6 Number of hopping frequency

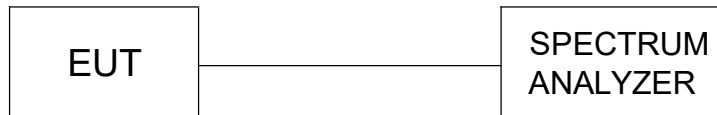
### Limit

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

### Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. Set spectrum analyzer start 2400MHz to 2483.5MHz with 100 KHz RBW and 300 KHz VBW.

### Test Configuration



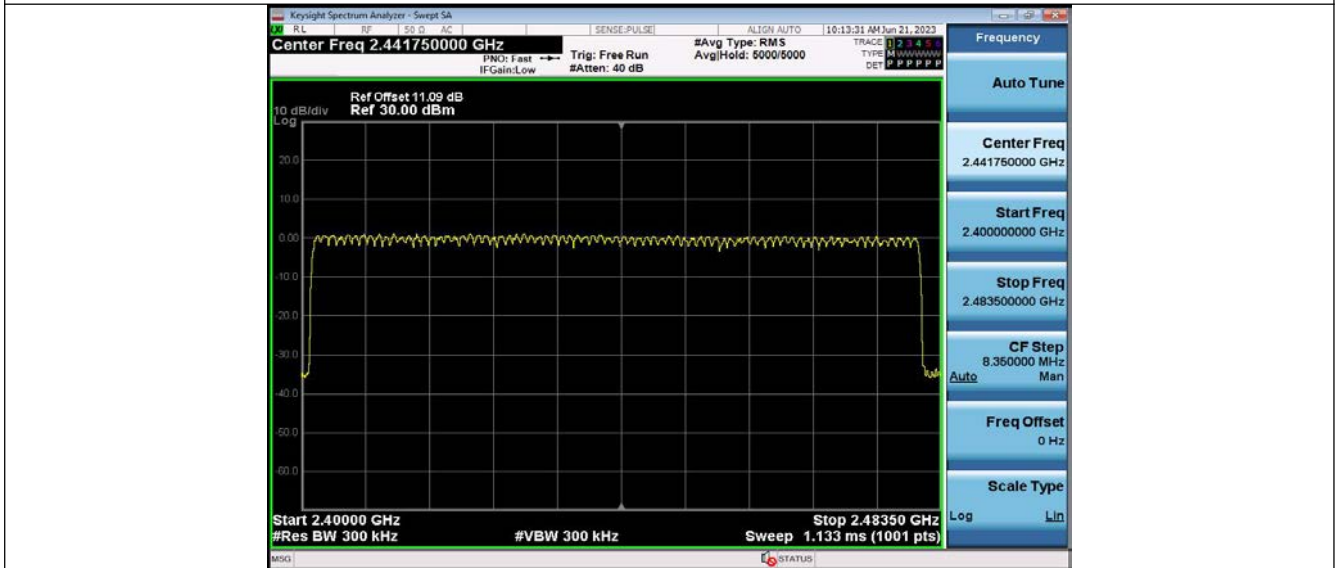
### Test Results

Modulation	Number of Hopping Channel	Limit	Result
GFSK	79	≥15	Pass
$\pi/4$ DQPSK	79		
8DPSK	79		

Test plot as follows:



GFSK Modulation



$\pi/4$ DQPSK Modulation



8DPSK Modulation

## 4.7 Time of Occupancy (Dwell Time)

### Limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

### Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. Set center frequency of spectrum analyzer=operating frequency with 1MHz RBW and 1MHz VBW, Span 0Hz.

### Test Configuration



### Test Results

Modulation	Packet	Burst time (ms)	Dwell time (s)	Limit (s)	Result
GFSK	DH1	0.376	0.120	0.40	Pass
	DH3	1.633	0.261		
	DH5	2.880	0.307		
π/4DQPSK	2-DH1	0.386	0.124	0.40	Pass
	2-DH3	1.638	0.262		
	2-DH5	2.889	0.308		
8DPSK	3-DH1	0.388	0.124	0.40	Pass
	3-DH3	1.639	0.262		
	3-DH5	2.887	0.308		

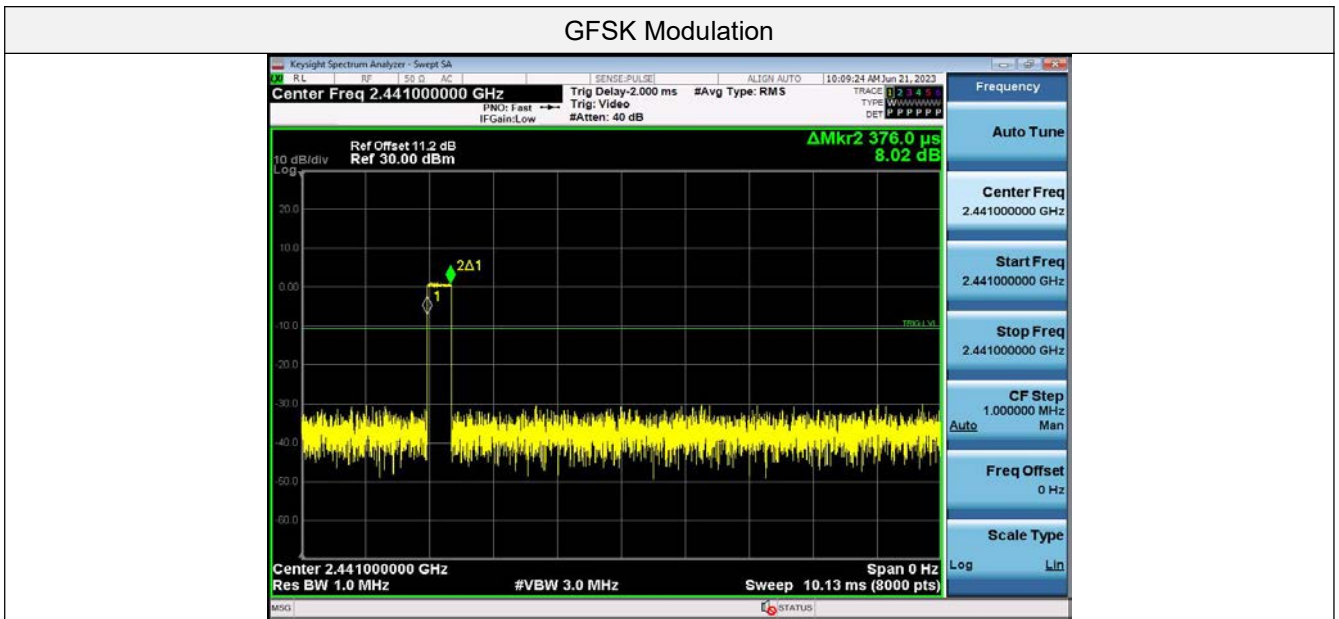
Note: We have tested all mode at high, middle and low channel, and recorded worst case at middle channel.

Dwell time = Pulse time (ms) × (1600 ÷ 2 ÷ 79) × 31.6 Second for DH1, 2-DH1, 3-DH1

Dwell time = Pulse time (ms) × (1600 ÷ 4 ÷ 79) × 31.6 Second for DH3, 2-DH3, 3-DH3

Dwell time = Pulse time (ms) × (1600 ÷ 6 ÷ 79) × 31.6 Second for DH5, 2-DH5, 3-DH5

Test plot as follows:



DH1 burst time

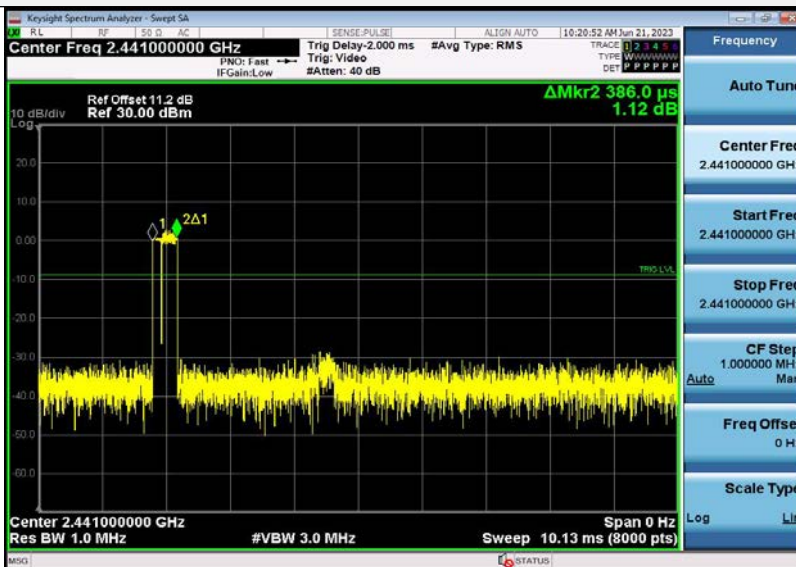


DH3 burst time

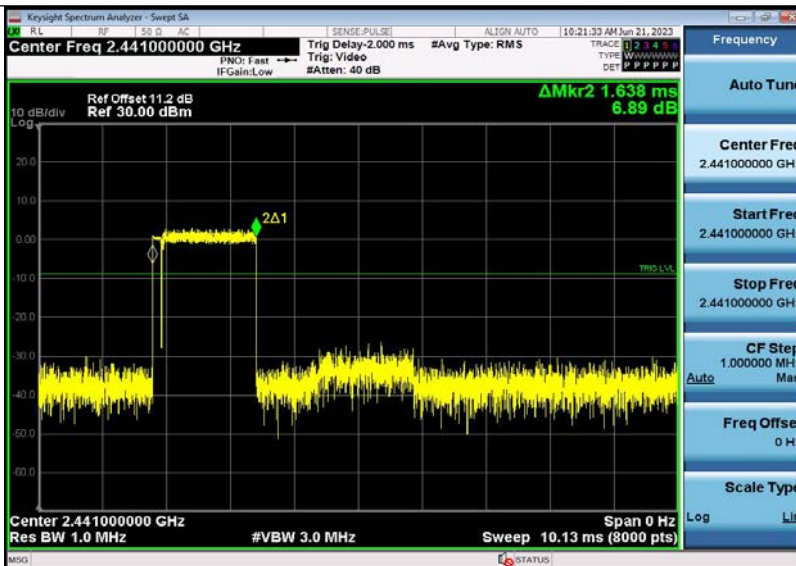


DH5 burst time

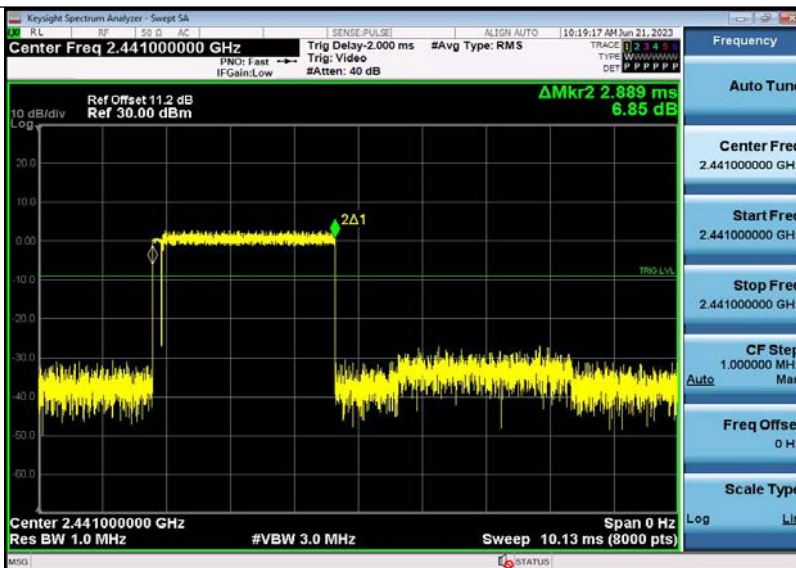
### $\pi/4$ DQPSK Modulation



### 2-DH1 burst time

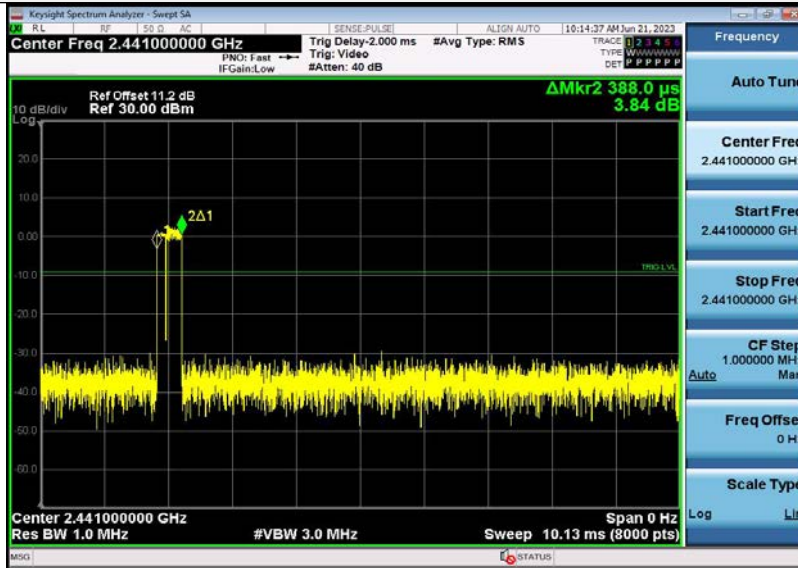


### 2-DH3 burst time

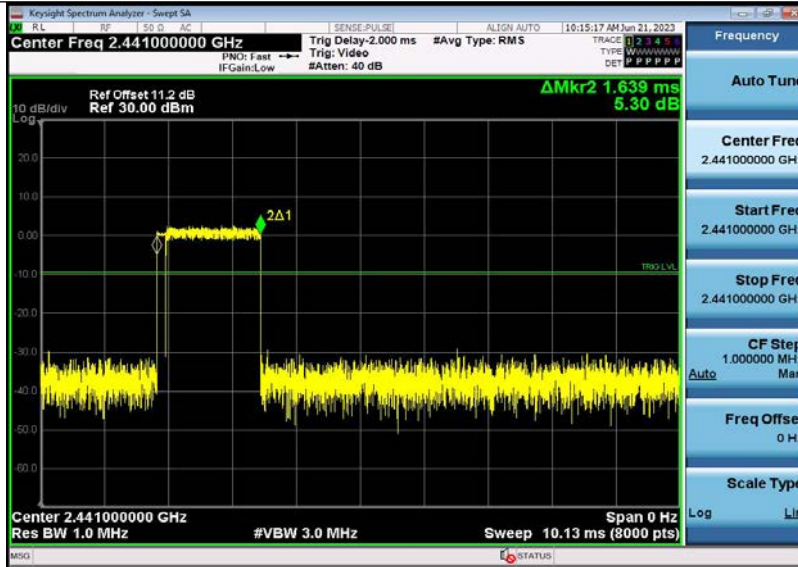


### 2-DH5 burst time

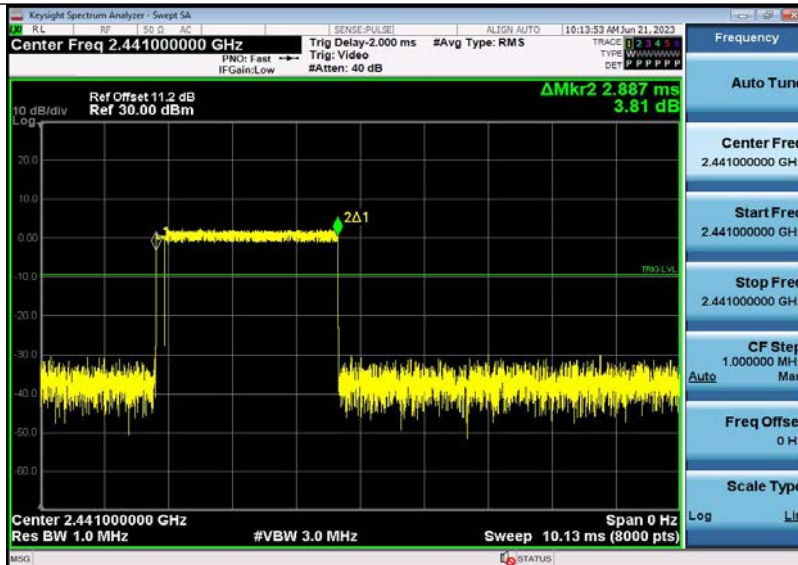
### 8DPSK Modulation



### 3-DH1 burst time



### 3-DH3 burst time



### 3-DH5 burst time

## 4.8 Out-of-band Emissions

### Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

### Test Procedure

Connect the transmitter output to spectrum analyzer using a low loss RF cable, and set the spectrum analyzer to RBW=100 kHz, VBW= 300 kHz, peak detector, and max hold. Measurements utilizing these settings are made of the in-band reference level, bandedge and out-of-band emissions.

### Test Configuration



### Test Results

Remark: The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and bandedge measurement data.

We measured all conditions (DH1, DH3, DH5) and recorded worst case at DH5.



Test plot as follows:

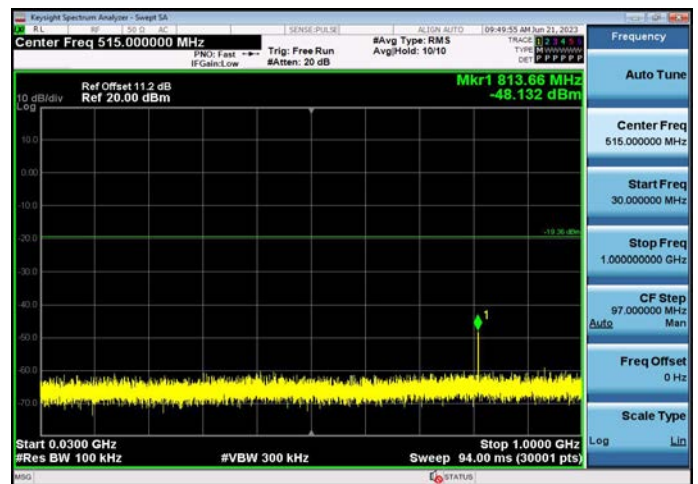
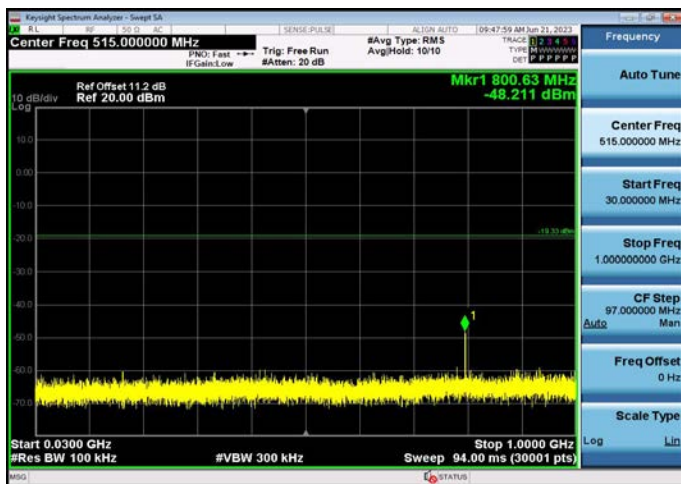
**GFSK(CH00)**

**GFSK(CH39)**



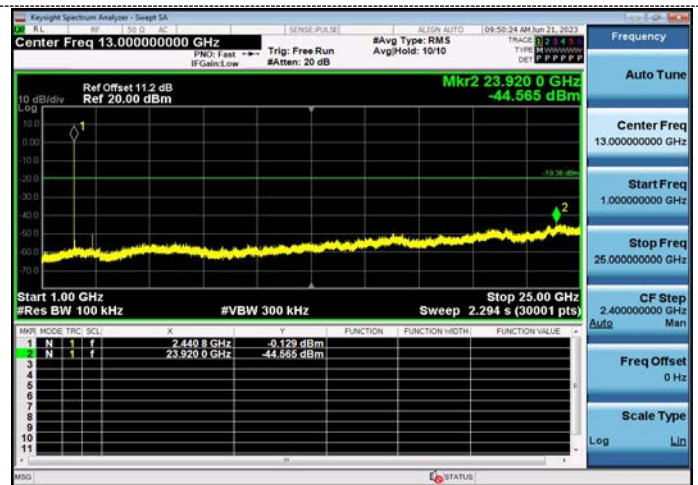
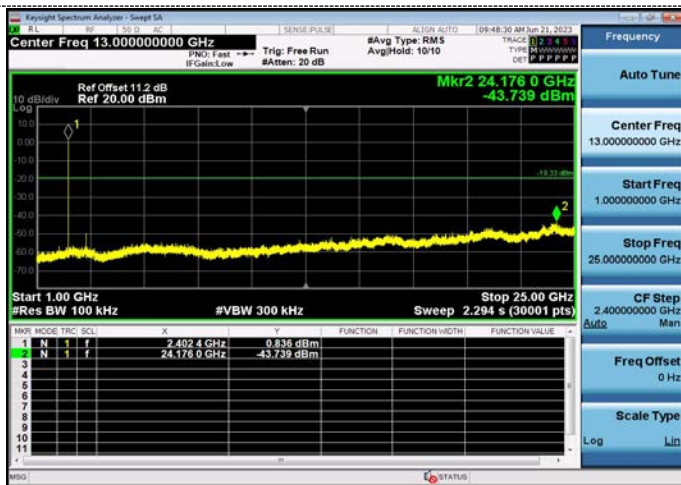
reference

reference



30MHz-1G

30MHz-1G



1G-25G

1G-25G

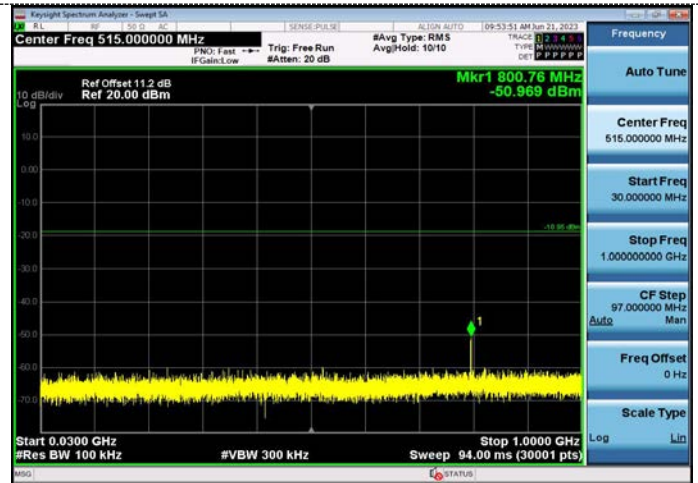
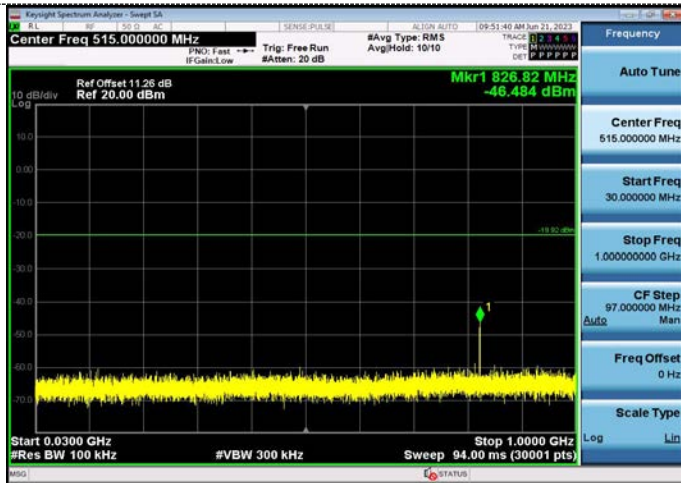
**GFSK(CH78)**

**$\pi/4$ DQPSK (CH00)**



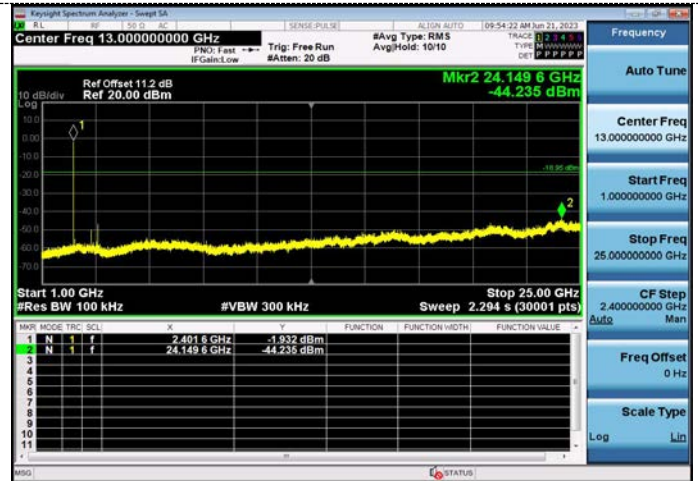
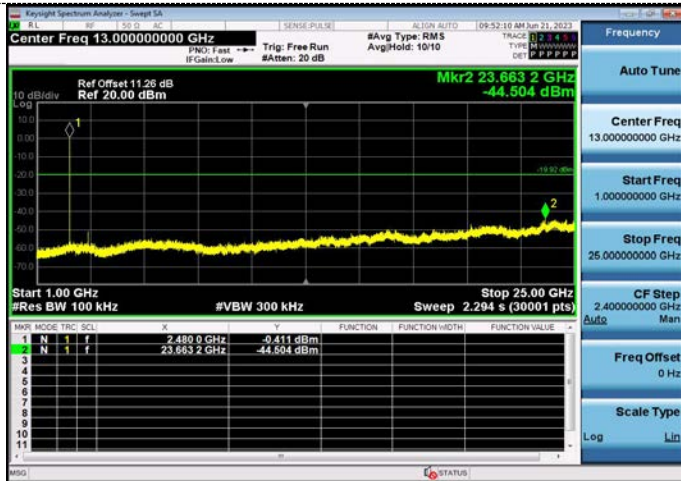
**reference**

**reference**



**30MHz-1G**

**30MHz-1G**



**1G-25G**

**1G-25G**

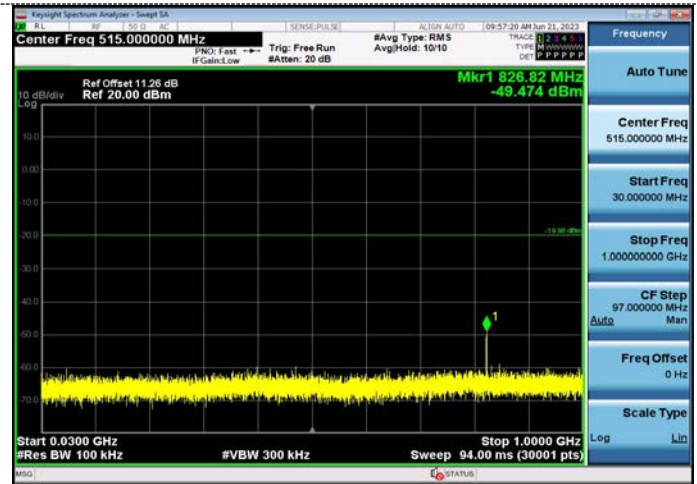
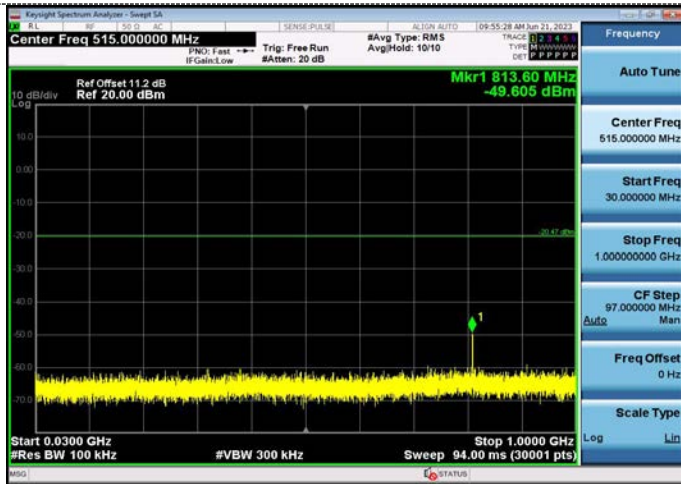
$\pi/4$ DQPSK (CH39)

$\pi/4$ DQPSK (CH78)



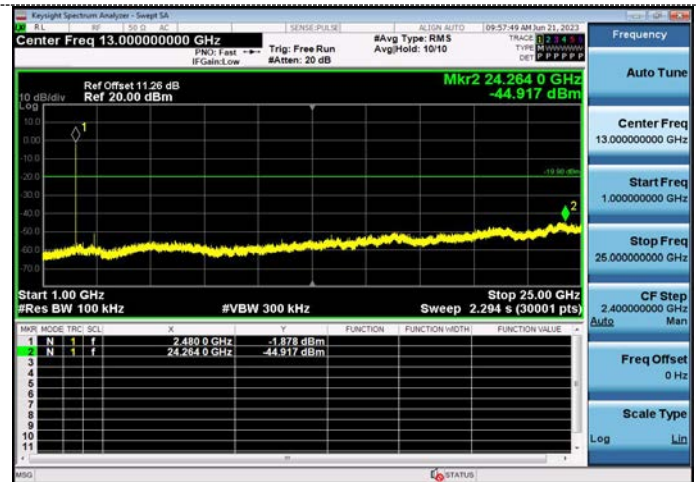
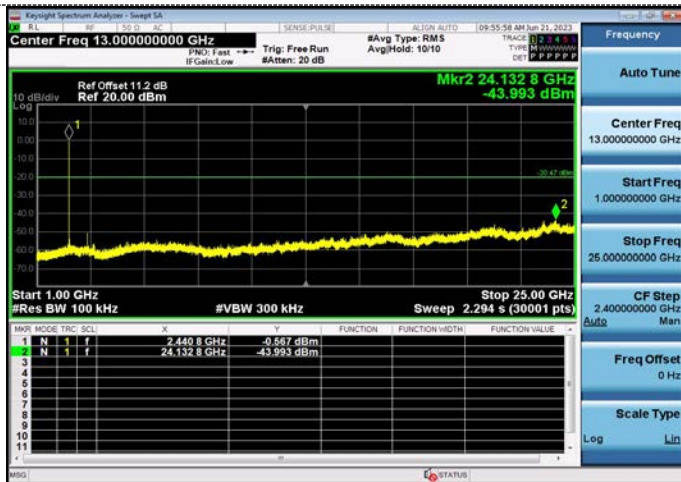
reference

reference



30MHz-1G

30MHz-1G



1G-25G

1G-25G

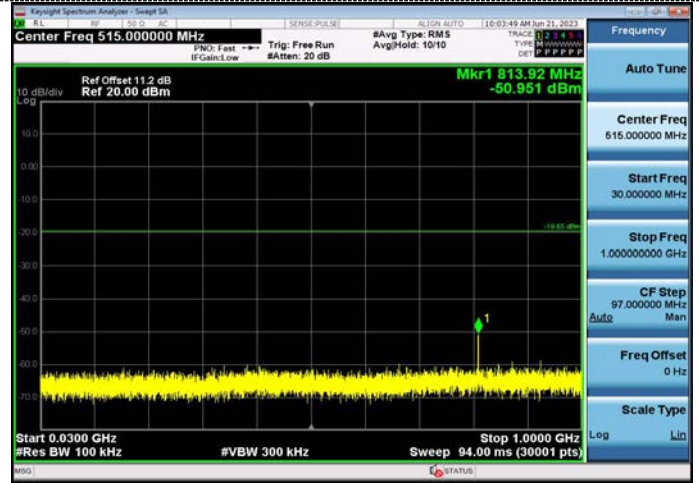
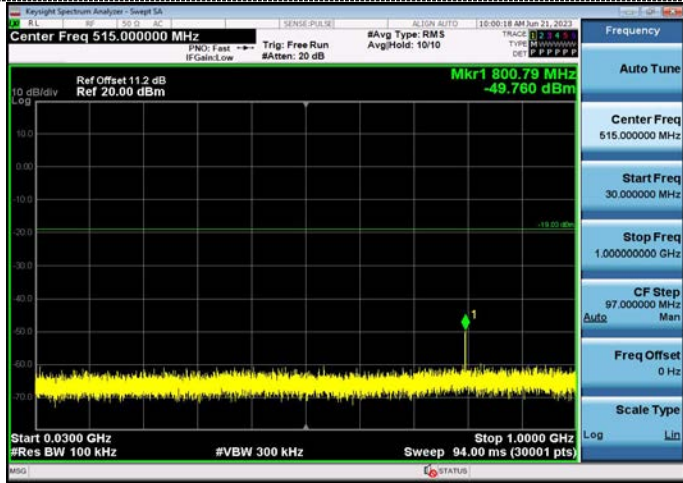
8DPSK (CH00)

8DPSK (CH39)



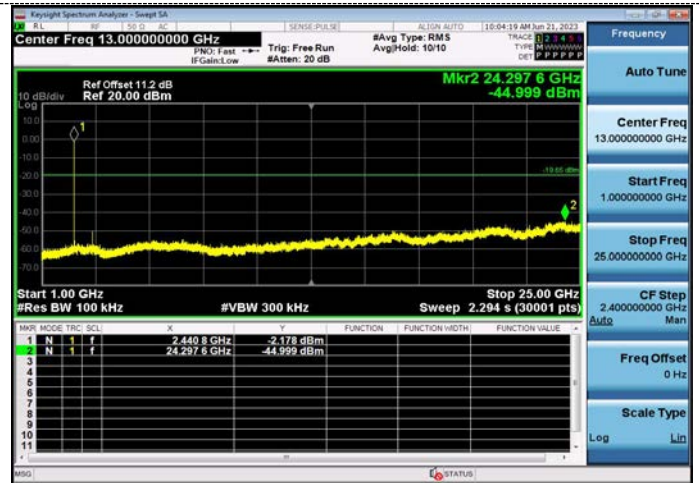
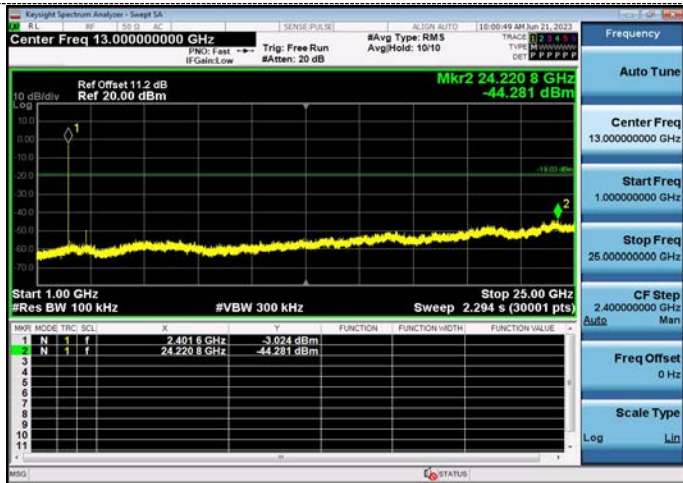
reference

reference



30MHz-1G

30MHz-1G



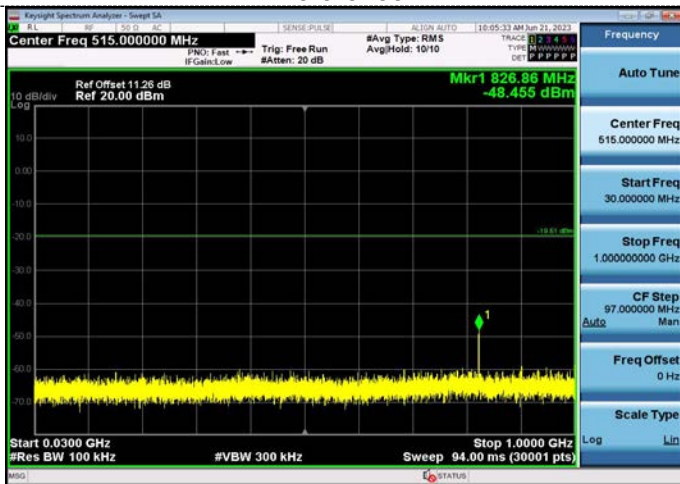
1G-25G

1G-25G

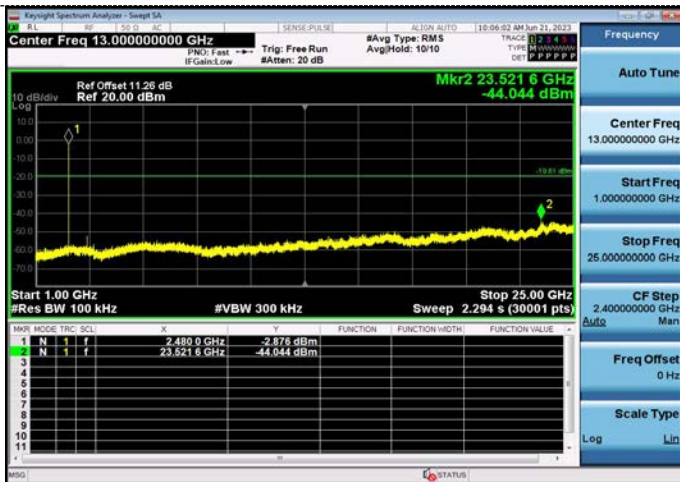
**8DPSK (CH78)**



**reference**



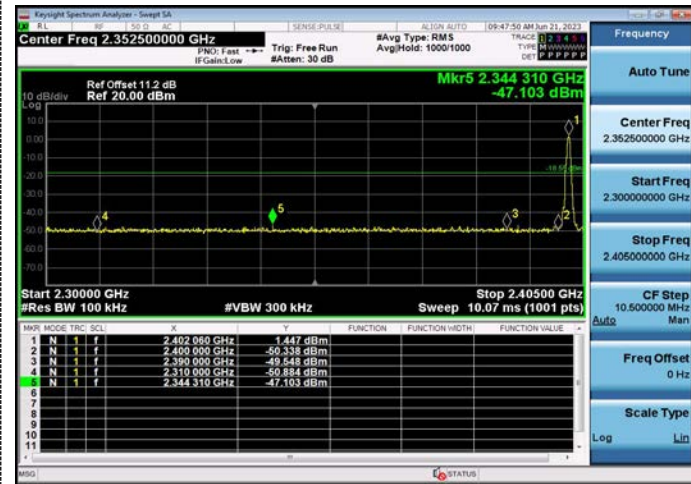
**30MHz-1G**



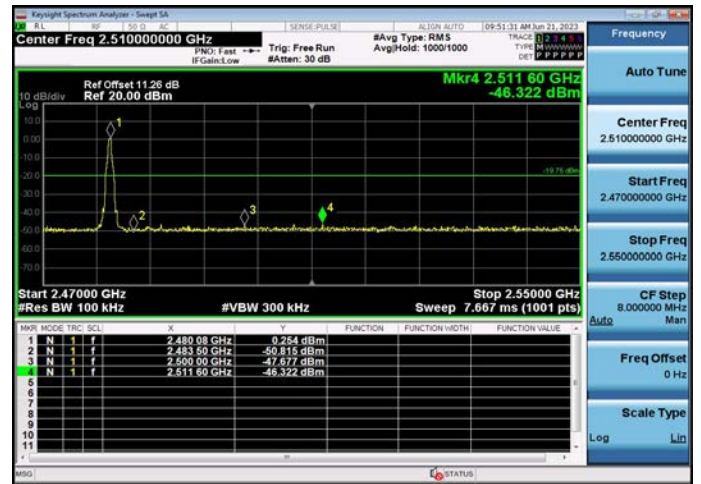
**1G-25G**

**Band-edge Measurements for RF Conducted Emissions:**

**GFSK**

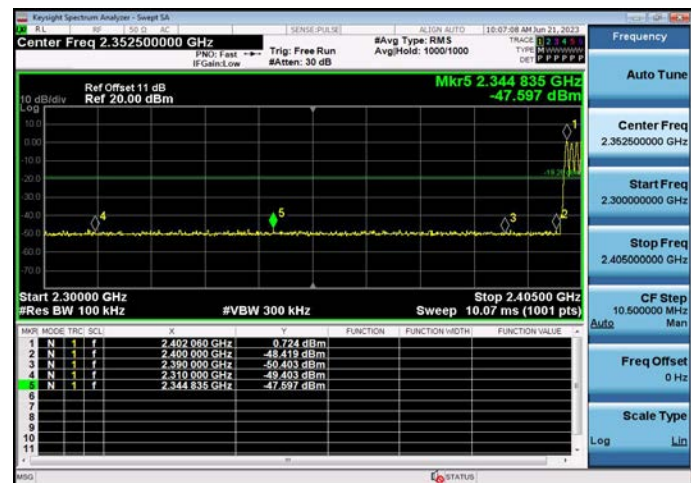


Left bandedge hopping off

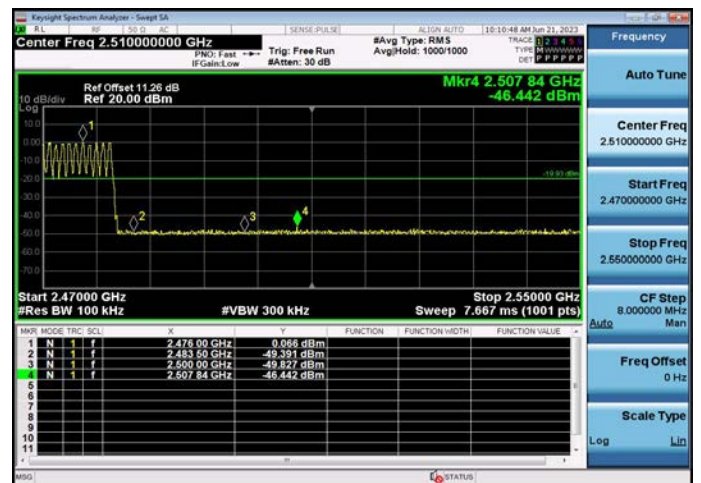


Right bandedge hopping off

**GFSK**

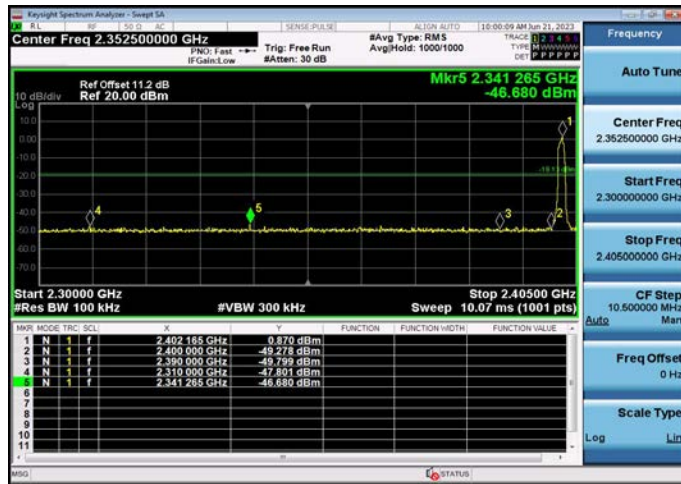


Left bandedge hopping on

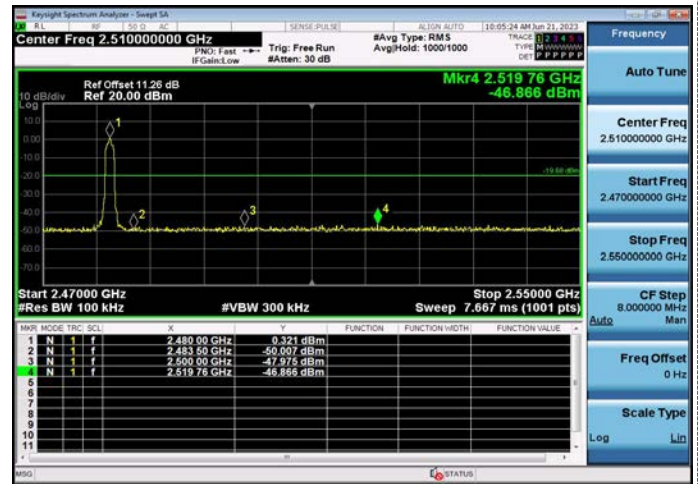


Right bandedge hopping on

$\pi/4$ DQPSK

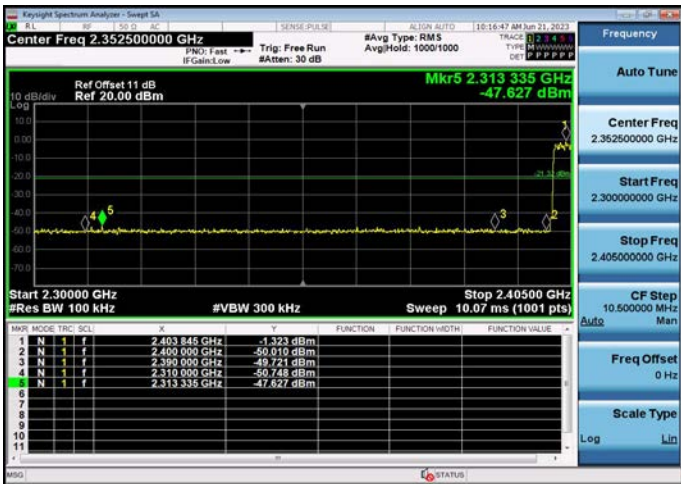


Left bandedge hopping off

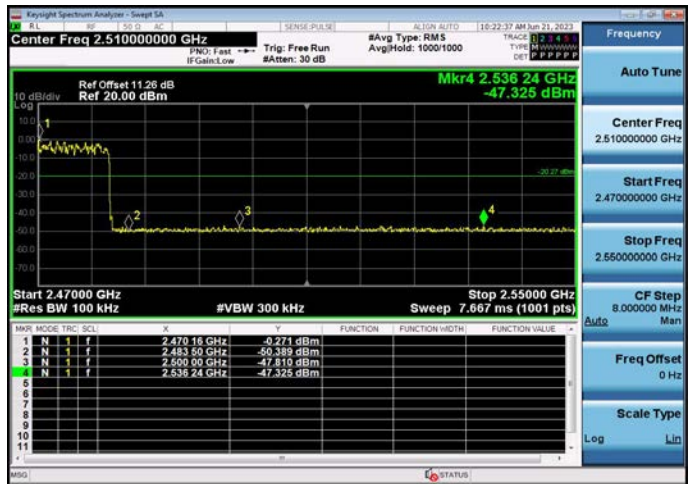


Right bandedge hopping off

$\pi/4$ DQPSK

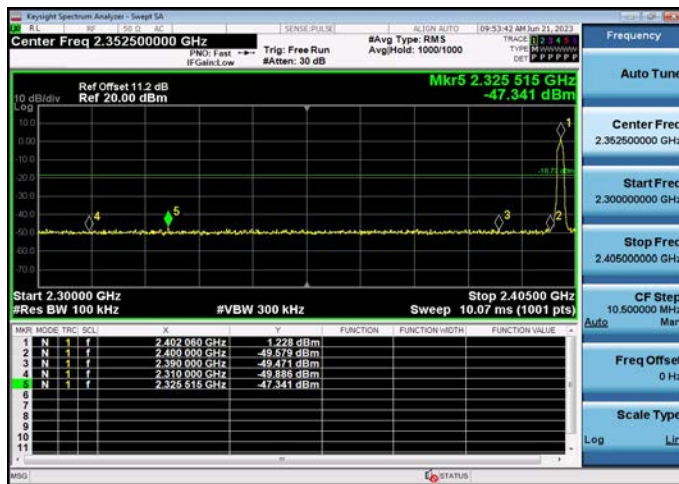


Left bandedge hopping on

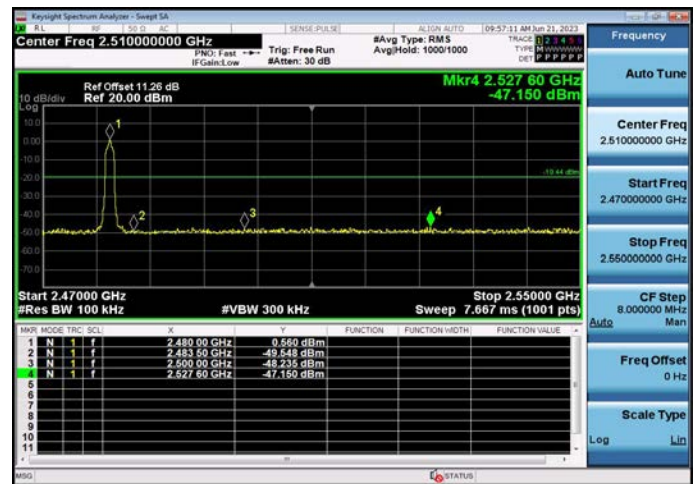


Right bandedge hopping on

8DPSK

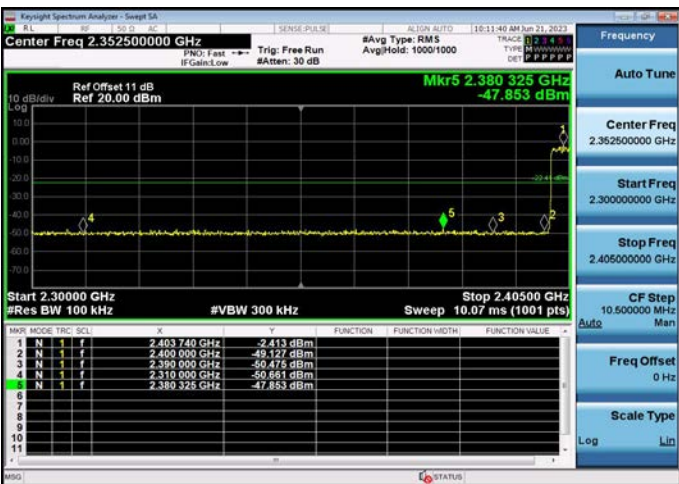


Left bandedge hopping off

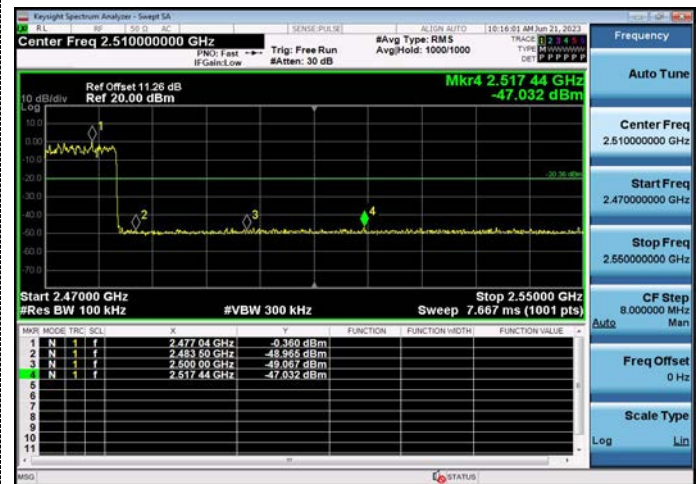


Right bandedge hopping off

8DPSK



Left bandedge hopping on



Right bandedge hopping on



### 4.9 Pseudorandom Frequency Hopping Sequence

**TEST APPLICABLE**

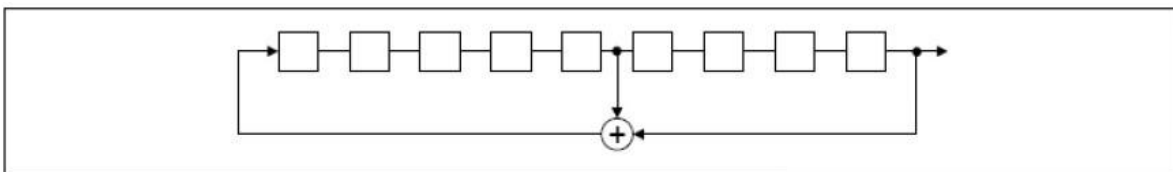
**For 47 CFR Part 15C section 15.247 (a) (1) requirement:**

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

**EUT Pseudorandom Frequency Hopping Sequence Requirement**

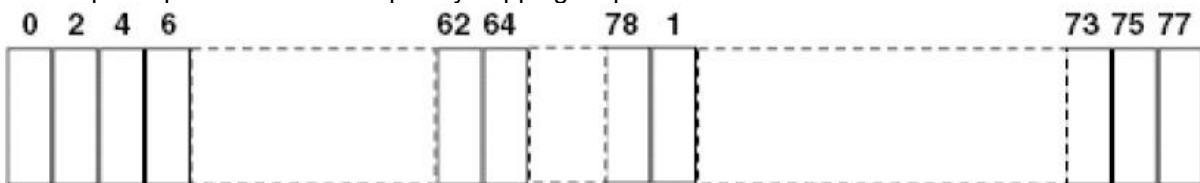
The pseudorandom frequency hopping sequence may be generated in a nine-stage shift register whose 5<sup>th</sup> and 9<sup>th</sup> stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones, for example: the shift register is initialized with nine ones.

- Number of shift register stages:9
- Length of pseudo-random sequence:29-1=511 bits
- Longest sequence of zeros:8(non-inverted signal)



*Linear Feedback Shift Register for Generation of the PRBS sequence*

An example of pseudorandom frequency hopping sequence as follows:



Each frequency used equally one the average by each transmitter.

The system receiver have input bandwidths that match the hopping channel bandwidths of their corresponding transmitter and shift frequencies in synchronization with the transmitted signals.

## 4.10 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.

And according to FCC 47 CFR Section 15.247 (c), 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.

### **Refer to statement below for compliance**

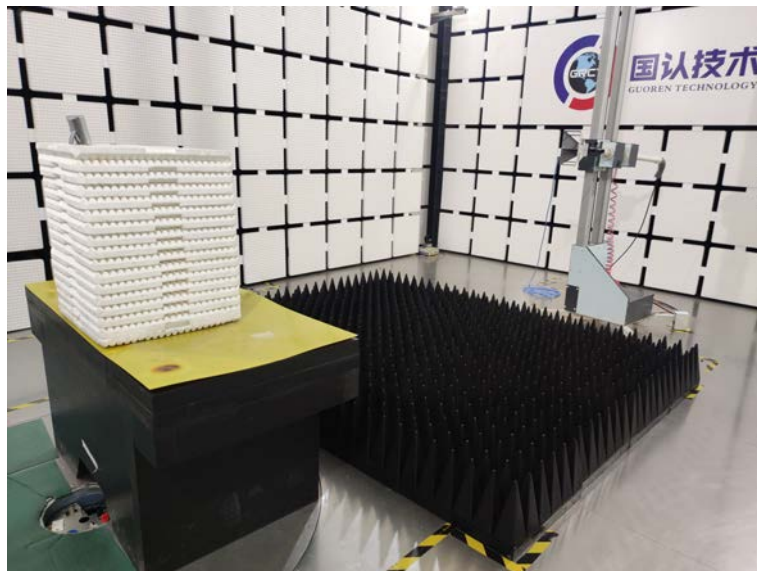
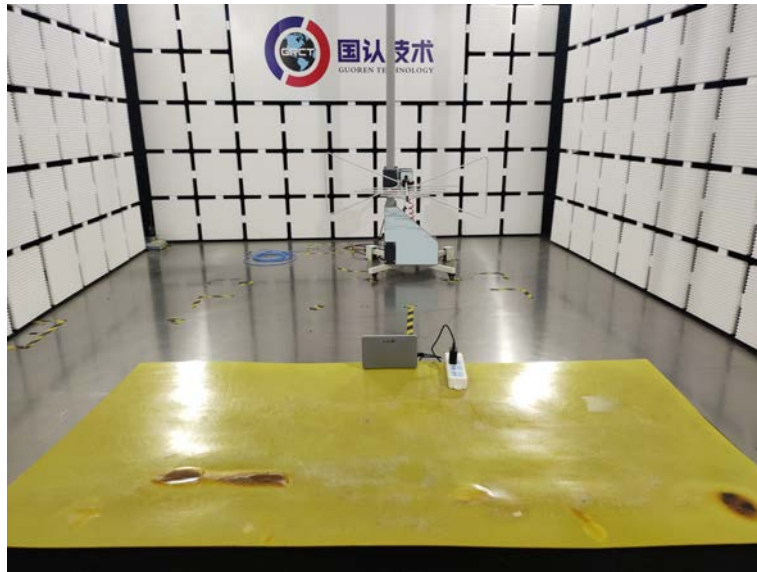
The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed.

### Antenna Connected Construction

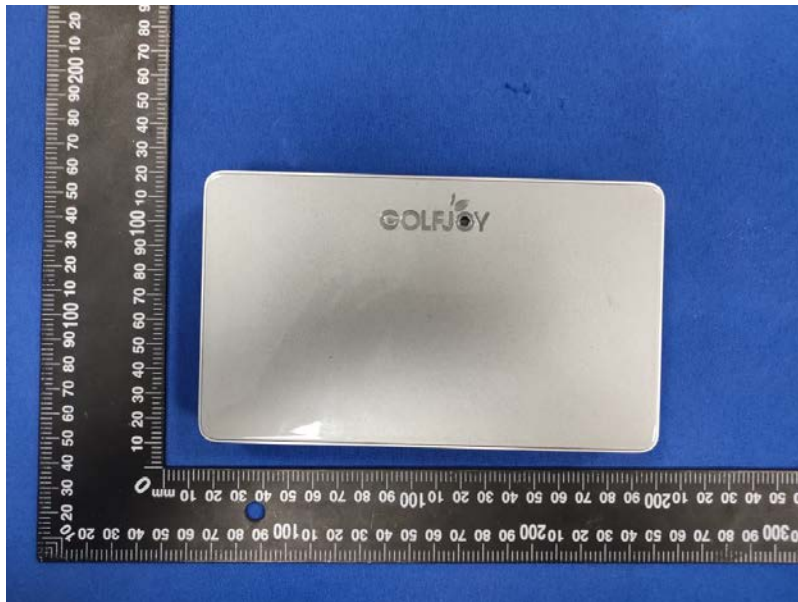
The maximum gain of antenna was 3.76 dBi.

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

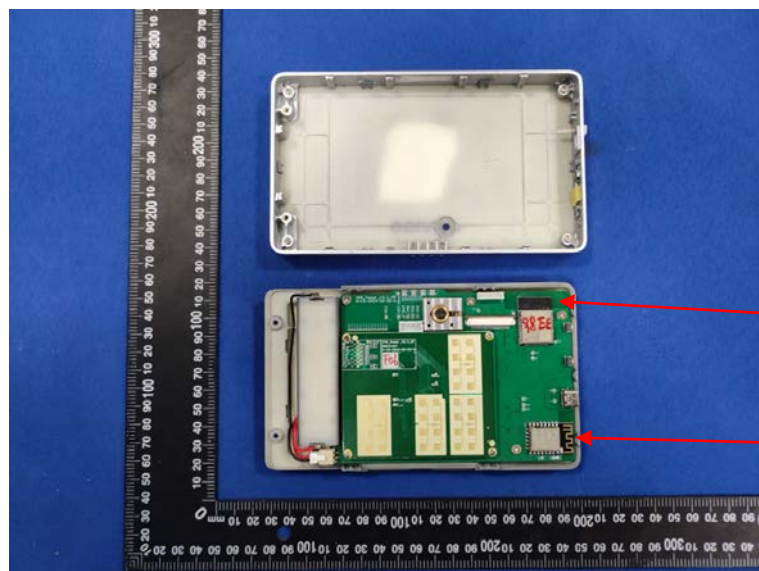
## 5 Test Setup Photos of the EUT



## 6 Photos of the EUT

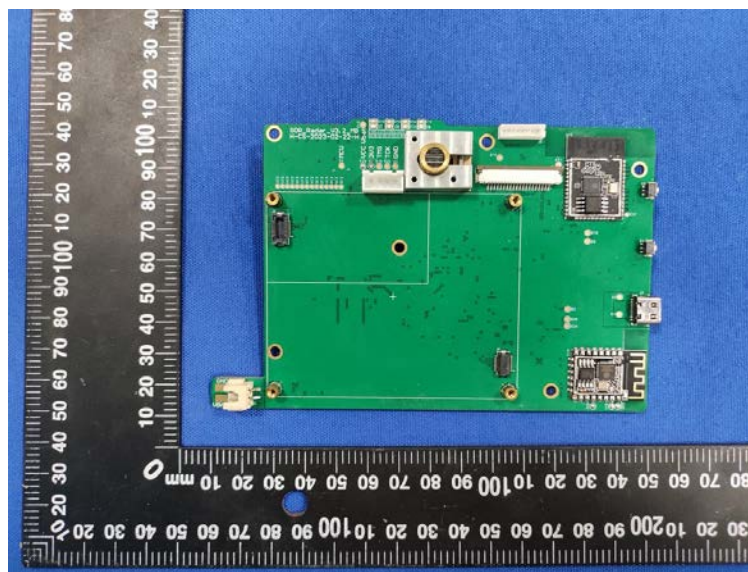


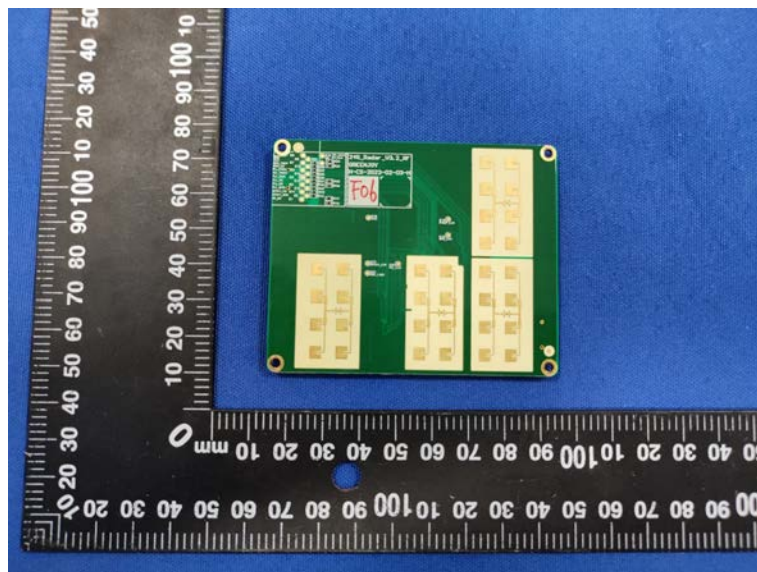
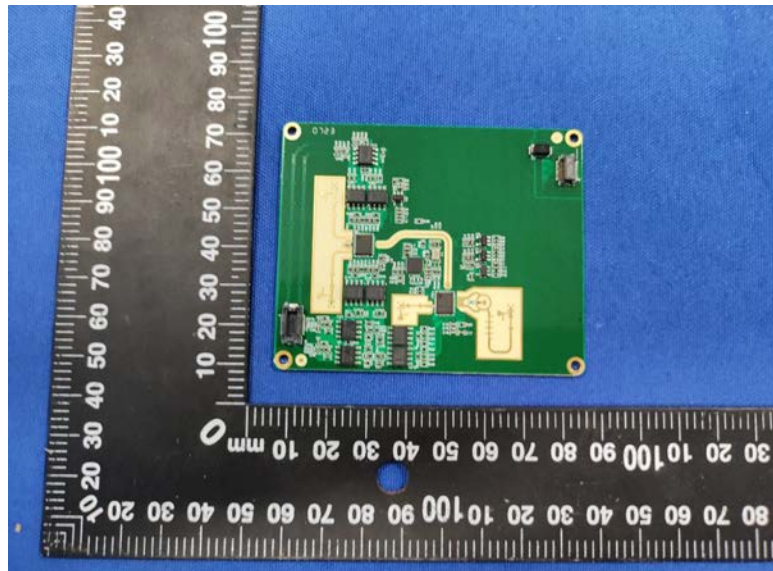
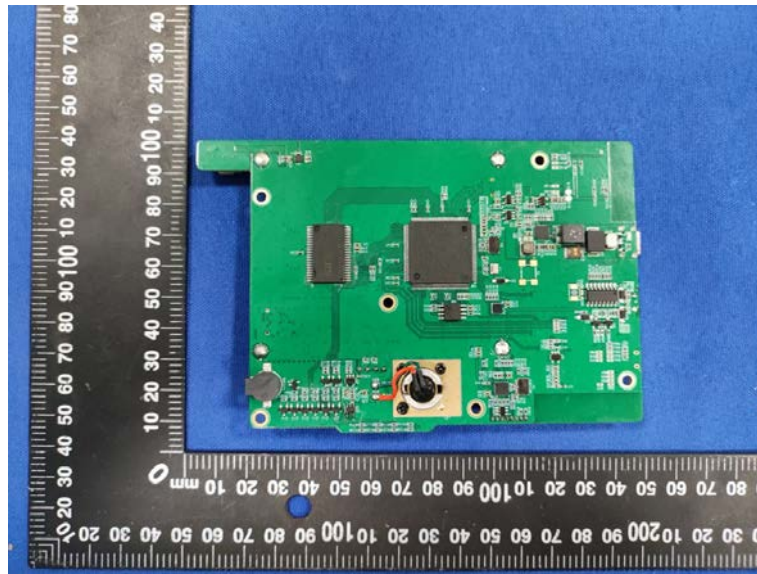




BT  
Antenna

WIFI  
Antenna







\*\*\*\*\* End of Report \*\*\*\*\*