



Shenzhen GUOREN Certification Technology Service Co., Ltd.

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

FCC PART 15 SUBPART C TEST REPORT
FCC PART 15.247

Report Reference No...... : GRCTR240902004-01

FCC ID..... : 2BK29-AST211

Compiled by

(position+printed name+signature)..: Testing Engineer Jimmy Wang

Supervised by

(position+printed name+signature)..: Project Engineer Kelley Zhang

Approved by

(position+printed name+signature)..: Manager Sam Wang

Date of issue.....: Sep. 12, 2024

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.....: **shenzhenshiliyichengkejiyouxianzerengongsi**

Address.....: 408,NO.578.JIHUA ROAD,BANTIAN COMMUNITY,BANTIAN STREET
,LONGGANG DISTRICT,SHENZHEN GUANGDONG,CHINA

Test specification.....:

Standard.....: **FCC Part 15.247**

Shenzhen GUOREN Certification Technology Service Co., Ltd. All rights reserved.

This publication may be reproduced in whole or in part for non-commercial purposes as long as the Shenzhen GUOREN Certification Technology Service Co., Ltd. is acknowledged as copyright owner and source of the material. Shenzhen GUOREN Certification Technology Service Co., Ltd. takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Test item description.....: eye massager

Trade Mark.....: klobela

Manufacturer.....: **shenzhenshiliyichengkejiyouxianzerengongsi**

Model/Type reference.....: AST-211

Listed Models: AST-213,EM-203,AST-211Black,AST-214W,AST-214B,AST-215,AST-216,AST-217,AST-218,TH-612,TH-611

Firmware Version.....: V1.0

Hardware Version.....: V1.0

Modulation: GFSK, $\pi/4$ DQPSK,8DPSK

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

Rating.....: 5.0V---1.0A(charged by Power Adapter)or
3.7V---4.44wh(By Li-ion rechargeable battery)

Result.....: **PASS**

TEST REPORT

Equipment under Test : eye massager

Model /Type : AST-211

Listed Models : AST-213,EM-203,AST-211Black,AST-214W,AST-214B,AST-215,AST-216,AST-217,AST-218,TH-612,TH-611

Applicant : **shenzhenshiliyichengkejiyouxianzerengongsi**

Address : 408,NO.578.JIHUA ROAD,BANTIAN COMMUNITY,BANTIAN STREET, LONGGANG DISTRICT, SHENZHEN GUANGDONG, CHINA

Manufacturer : **shenzhenshiliyichengkejiyouxianzerengongsi**

Address : 408,NO.578.JIHUA ROAD,BANTIAN COMMUNITY,BANTIAN STREET, LONGGANG DISTRICT, SHENZHEN GUANGDONG, CHINA

Test Result:	PASS
---------------------	-------------

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.

Contents

1 TEST STANDARDS	4
2 SUMMARY	5
2.1 General Remarks	5
2.2 Product Description	5
2.3 Equipment Under Test	5
2.4 Short description of the Equipment under Test (EUT)	5
2.5 EUT configuration	5
2.6 EUT operation mode	6
2.7 Block Diagram of Test Setup	6
2.8 Related Submittal(s) / Grant (s)	6
2.9 Modifications	6
3 TEST ENVIRONMENT	7
3.1 Address of the test laboratory	7
3.2 Test Facility	7
3.3 Environmental conditions	7
3.4 Summary of measurement results	8
3.5 Statement of the measurement uncertainty	8
3.6 Equipments Used during the Test	9
4 TEST CONDITIONS AND RESULTS	10
4.1 AC Power Conducted Emission	10
4.2 Radiated Emission	13
4.3 Maximum Peak Output Power	19
4.4 20dB Bandwidth	20
4.5 Frequency Separation	24
4.6 Number of hopping frequency	26
4.7 Time of Occupancy (Dwell Time)	28
4.8 Out-of-band Emissions	32
4.9 Pseudorandom Frequency Hopping Sequence	41
4.10 Antenna Requirement	42
5 TEST SETUP PHOTOS OF THE EUT	43
6 PHOTOS OF THE EUT	44

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	:	Sep. 03, 2024
Testing commenced on	:	Sep. 03, 2024
Testing concluded on	:	Sep. 12, 2024

2.2 Product Description

Product Name:	eye massager
Model/Type reference:	AST-211
Listed Models:	AST-213,EM-203,AST-211Black,AST-214W,AST-214B,AST-215,AST-216,AST-217,AST-218,TH-612,TH-611(The products are identical in interior structure, electrical circuits and components, just model names and color are different.)
Power supply:	5.0V $\overline{\text{---}}$ 1.0A(charged by Power Adapter)or 3.7V $\overline{\text{---}}$ 4.44wh(By Li-ion rechargeable battery)
Testing sample ID:	GRCTR240902004-1# (Engineer sample), GRCTR240902004-2# (Normal sample)
Bluetooth	
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):	5.84 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	:	☐ 230V / 50 Hz	☐ 120V / 60Hz
		☐ 12 V DC	☐ 24 V DC
		☒ Other (specified in blank below)	

5.0V $\overline{\text{---}}$ 1.0A(charged by Power Adapter)

2.4 Short description of the Equipment under Test (EUT)

This is a eye massager.

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

2.5 EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

● - supplied by the manufacturer

○ - supplied by the lab

○ Adapter	M/N:	JYR9-05
	Manufacturer:	Jiyin
	Rate:	Input:AC100-240V 50/60Hz, 0.3A Output:DC 5V,2A

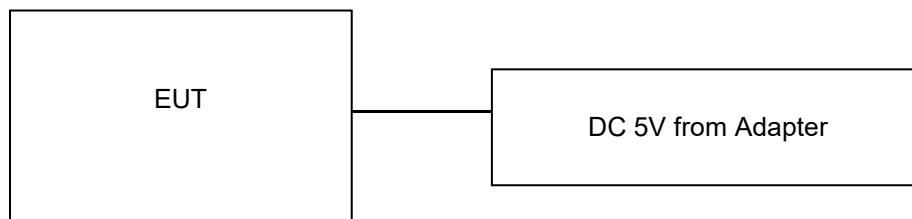
2.6 EUT operation mode

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

2.7 Block Diagram of Test Setup



2.8 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.

2.9 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	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Middle	Compliant
§15.247(a)(1)	Number of Hopping channels	GFSK Π/4DQPSK 8DPSK	☒ Full	GFSK	☒ Full	Compliant
§15.247(a)(1)	Time of Occupancy (dwell time)	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Middle	Compliant
§15.247(a)(1)	Spectrum bandwidth of aFHSS system 20dB bandwidth	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	Compliant
§15.247(b)(1)	Maximum output peak power	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	Compliant
§15.247(d)	Band edge compliance conducted	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Highest	Compliant
§15.205	Band edge compliance radiated	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Highest	Compliant
§15.247(d)	TX spurious emissions conducted	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	Compliant
§15.247(d)	TX spurious emissions radiated	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Lowest ☒ Middle ☒ Highest	Compliant
§15.209(a)	TX spurious Emissions radiated Below 1GHz	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ Middle	Compliant
§15.107(a) §15.207	Conducted Emissions 9KHz-30 MHz	GFSK Π/4DQPSK 8DPSK	☒ Lowest ☒ Middle ☒ Highest	GFSK	☒ 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)
Max output power	30MHz~18GHz	0.54 dB	(1)
Spectrum bandwidth	/	1.2%	(1)

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

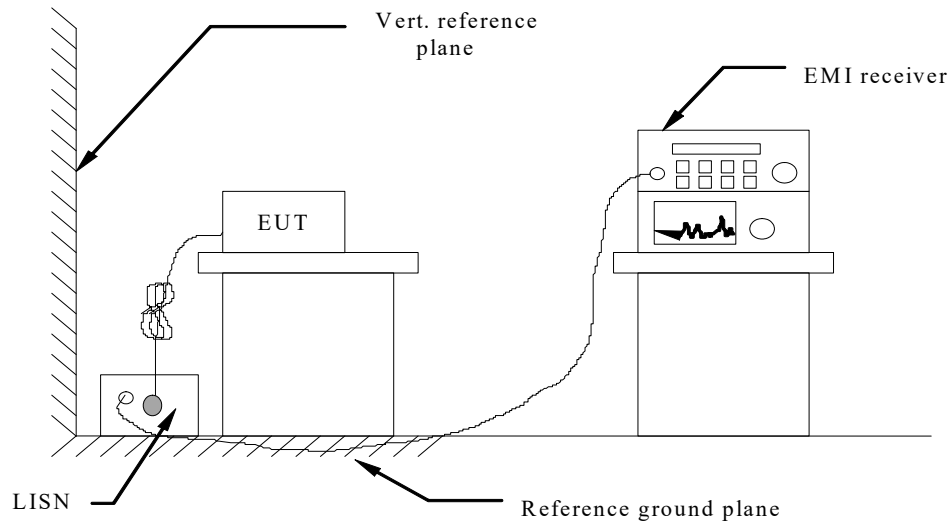
3.6 Equipments Used during the Test

Test Equipment	Manufacturer	Model No.	Equipment No.	Calibration Date	Calibration Due Date
LISN	R&S	ENV216	GRCTEE009	2023/09/27	2024/09/26
LISN	R&S	ENV216	GRCTEE010	2023/09/27	2024/09/26
EMI Test Receiver	R&S	ESPI	GRCTEE017	2023/09/28	2024/09/27
EMI Test Receiver	R&S	ESCI	GRCTEE008	2023/09/27	2024/09/26
Spectrum Analyzer	Agilent	N9020A	GRCTEE002	2023/09/27	2024/09/26
Spectrum Analyzer	R&S	FSP	GRCTEE003	2023/09/28	2024/09/27
Vector Signal generator	Agilent	N5181A	GRCTEE007	2023/09/27	2024/09/26
Analog Signal Generator	R&S	SML03	GRCTEE006	2023/09/27	2024/09/26
Climate Chamber	QIYA	LCD-9530	GRCTES016	2023/09/27	2024/09/26
Ultra-Broadband Antenna	Schwarzbeck	VULB9163	GRCTEE018	2023/09/28	2026/09/27
Horn Antenna	Schwarzbeck	BBHA 9120D	GRCTEE019	2023/09/28	2026/09/27
Loop Antenna	Zhinan	ZN30900C	GRCTEE020	2023/10/15	2026/10/14
Horn Antenna	Beijing Hangwei Dayang	OBH100400	GRCTEE049	2023/09/28	2026/09/27
Amplifier	Schwarzbeck	BBV 9745	GRCTEE021	2023/09/27	2024/09/26
Amplifier	Taiwan chengyi	EMC051845B	GRCTEE022	2023/09/28	2024/09/27
Temperature/Humidity Meter	Huaguan	HG-308	GRCTES037	2023/09/27	2024/09/26
Directional coupler	NARDA	4226-10	GRCTEE004	2023/09/27	2024/09/26
High-Pass Filter	XingBo	XBLBQ-GTA18	GRCTEE053	2023/09/27	2024/09/26
High-Pass Filter	XingBo	XBLBQ-GTA27	GRCTEE054	2023/09/27	2024/09/26
Automated filter bank	Tonscend	JS0806-F	GRCTEE055	2023/09/27	2024/09/26
Power Sensor	Agilent	U2021XA	GRCTEE070	2023/09/27	2024/09/26
Cable	Times	Cable-CE	GRCTEE086	2023/09/27	2024/09/26
Cable	Times	Cable-RE-1	GRCTEE087	2023/09/27	2024/09/26
Cable	Times	Cable-RE-2	GRCTEE088	2023/09/27	2024/09/26
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.

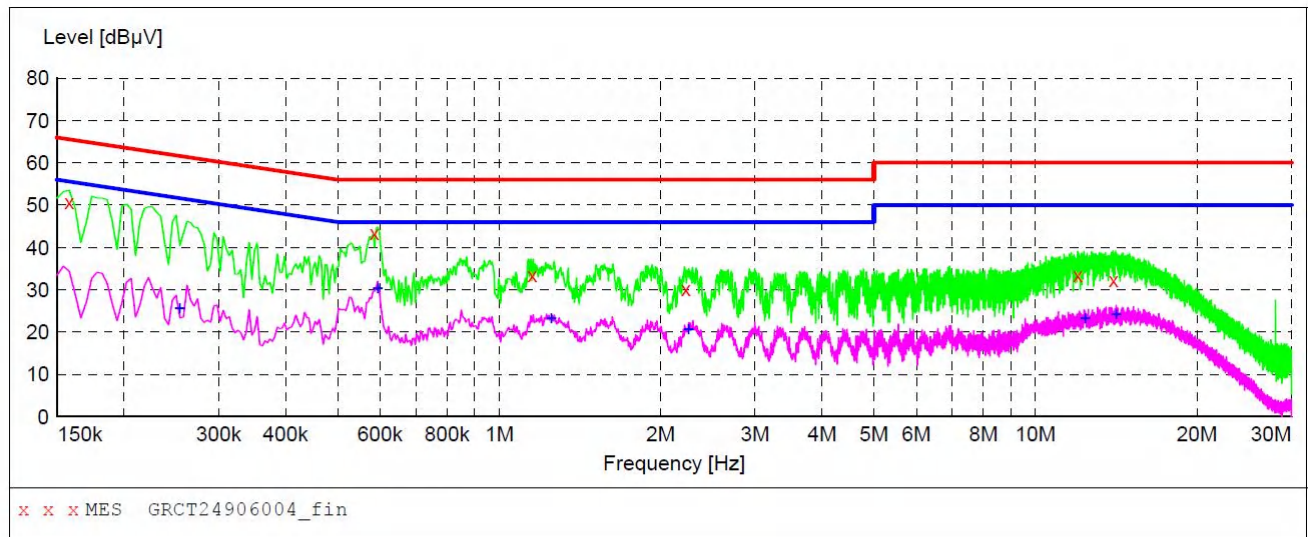
TEST RESULTS

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. 120 VAC, 50/60 Hz power supply has been tested, the worst result of 120 VAC, 60 Hz was reported as below:

Power supply:	DC 5V from Adapter AC 120V/60Hz	Polarization	L
---------------	------------------------------------	--------------	---



MEASUREMENT RESULT: "GRCT24906004_fin"

9/6/2024 5:11AM

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Detector	Line	PE
0.158000	50.70	9.5	66	14.9	QP	L1	GND
0.586000	43.30	9.6	56	12.7	QP	L1	GND
1.154000	33.40	10.0	56	22.6	QP	L1	GND
2.230000	30.20	10.0	56	25.8	QP	L1	GND
11.998000	33.40	10.0	60	26.6	QP	L1	GND
13.978000	32.40	10.0	60	27.6	QP	L1	GND

MEASUREMENT RESULT: "GRCT24906004_fin2"

9/6/2024 5:11AM

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Detector	Line	PE
0.254000	25.70	9.7	52	25.9	AV	L1	GND
0.594000	30.50	9.6	46	15.5	AV	L1	GND
1.250000	23.20	10.0	46	22.8	AV	L1	GND
2.254000	20.70	10.0	46	25.3	AV	L1	GND
12.366000	23.30	10.0	50	26.7	AV	L1	GND
14.126000	24.20	10.0	50	25.8	AV	L1	GND

Note:1).Level (dBμV)= Reading (dBμV)+ Transducer (dB)

2). Transducer (dB)=insertion loss of LISN (dB) + Cable loss (dB)

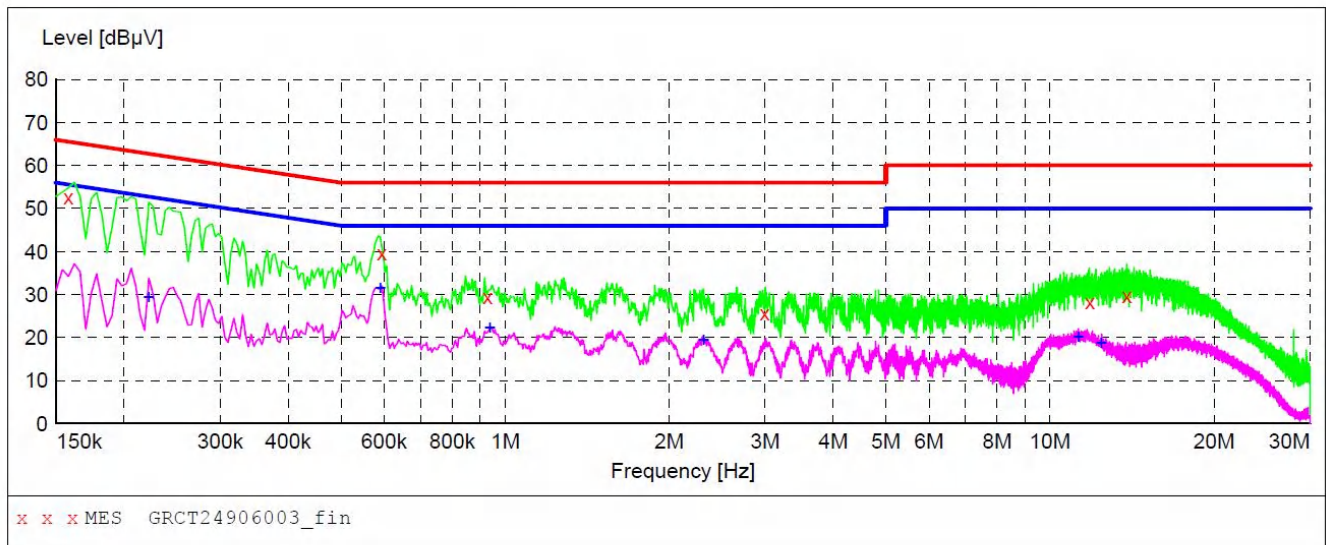
3). Margin(dB) = Limit (dBμV) - Level (dBμV)

Power supply:

DC 5V from Adapter
AC 120V/60Hz

Polarization

N

**MEASUREMENT RESULT: "GRCT24906003_fin"**

9/6/2024 5:07AM

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Detector	Line	PE
0.158000	52.60	9.5	66	13.0	QP	N	GND
0.594000	39.70	9.6	56	16.3	QP	N	GND
0.930000	29.40	9.8	56	26.6	QP	N	GND
2.998000	25.70	10.0	56	30.3	QP	N	GND
11.854000	28.20	10.0	60	31.8	QP	N	GND
13.846000	29.80	10.0	60	30.2	QP	N	GND

MEASUREMENT RESULT: "GRCT24906003_fin2"

9/6/2024 5:07AM

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Detector	Line	PE
0.222000	29.50	9.6	53	23.2	AV	N	GND
0.590000	31.70	9.6	46	14.3	AV	N	GND
0.938000	22.30	9.8	46	23.7	AV	N	GND
2.314000	19.50	10.0	46	26.5	AV	N	GND
11.262000	20.20	10.0	50	29.8	AV	N	GND
12.406000	18.90	10.0	50	31.1	AV	N	GND

Note:1).Level (dBμV)= Reading (dBμV)+ Transducer (dB)

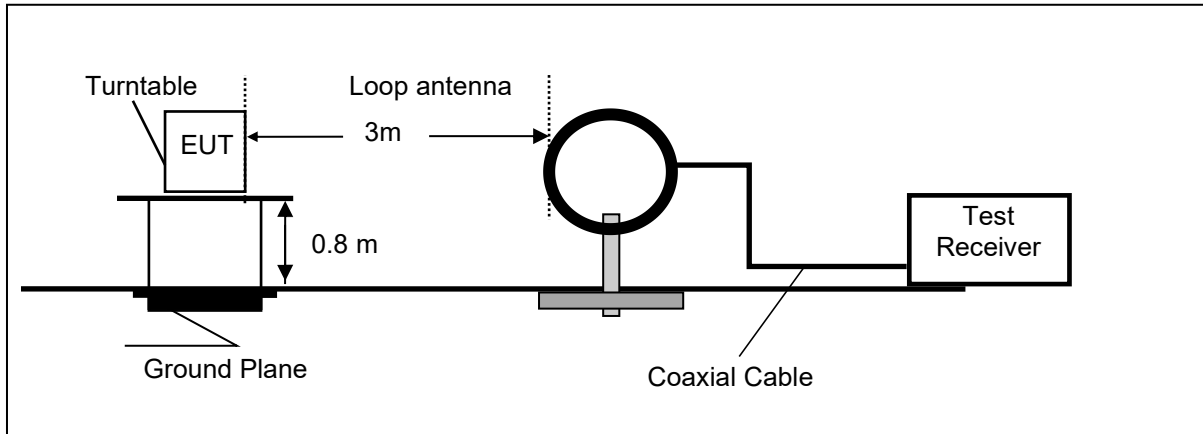
2). Transducer (dB)=insertion loss of LISN (dB) + Cable loss (dB)

3). Margin(dB) = Limit (dBμV) - Level (dBμV)

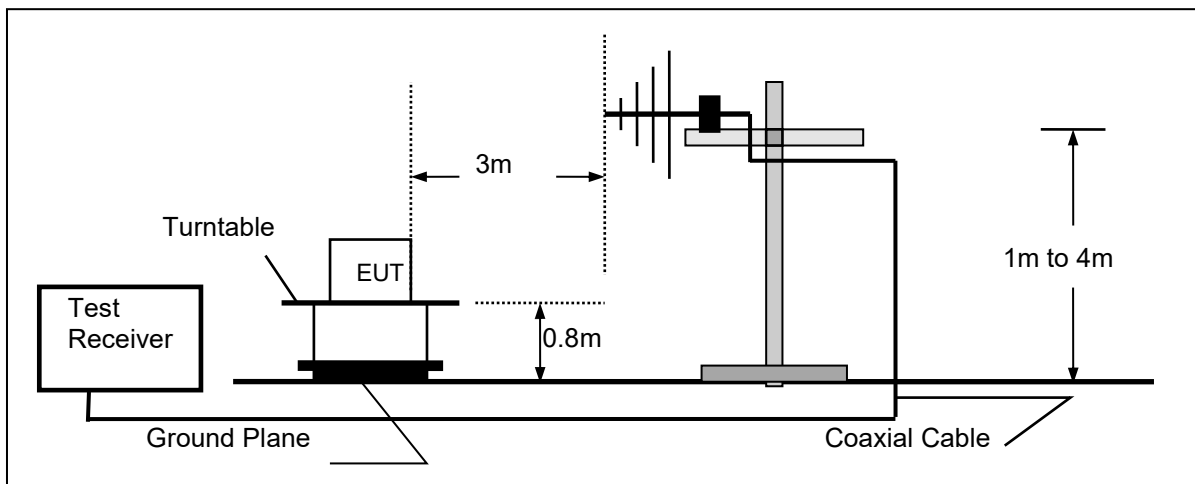
4.2 Radiated Emission

TEST CONFIGURATION

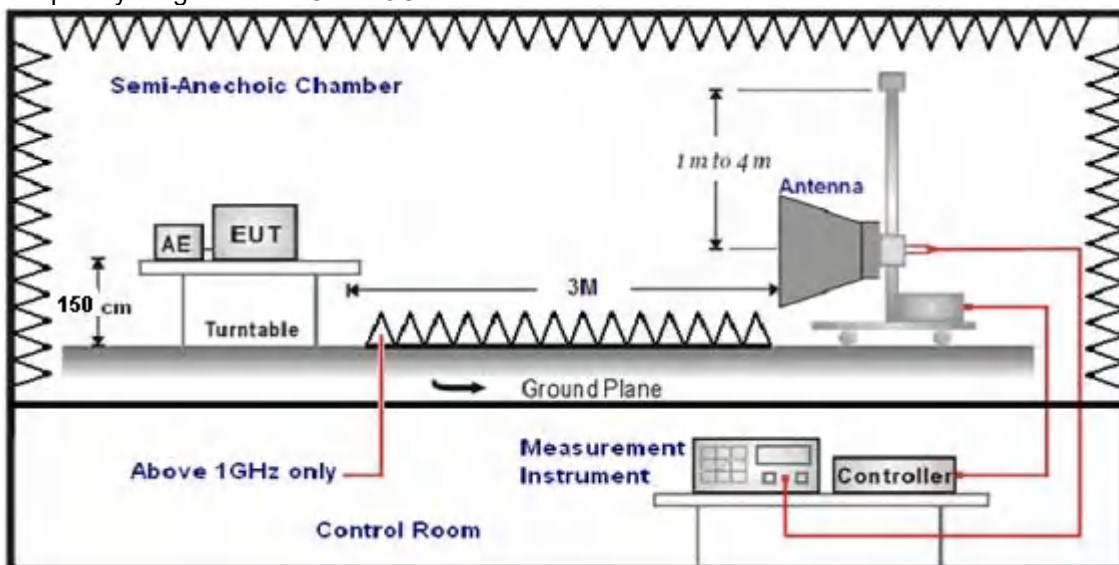
Frequency range 9 KHz – 30MHz



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	

$$Transd=AF +CL-AG$$

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	$20\log(2400/F(KHz))+40\log(300/3)$	$2400/F(KHz)$
0.49-1.705	3	$20\log(24000/F(KHz))+ 40\log(30/3)$	$24000/F(KHz)$
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, $\pi/4$ 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**Horizontal****Radiated Emission Measurement**

Site LAB

Polarization: **Horizontal**

Temperature: 22(C)

Limit: FCC Part15 RE-Class B_30-1000MHz

Power: AC120V/60Hz

Humidity: 52 %

EUT: eye massager

Distance: 3m

M/N: AST-211

Mode: GFSK DH5 CH 39

Note: N/A

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 *	261.0583	47.50	-18.00	29.50	46.00	-16.50	peak	200	8	P	
2	191.0738	44.83	-19.66	25.17	43.50	-18.33	peak	100	282	P	
3	139.8508	45.56	-21.95	23.61	43.50	-19.89	peak	200	254	P	
4	78.1389	42.17	-22.37	19.80	40.00	-20.20	peak	200	227	P	
5	43.2017	31.31	-17.67	13.64	40.00	-26.36	peak	100	291	P	
6	30.3173	31.57	-19.88	11.69	40.00	-28.31	peak	100	108	P	

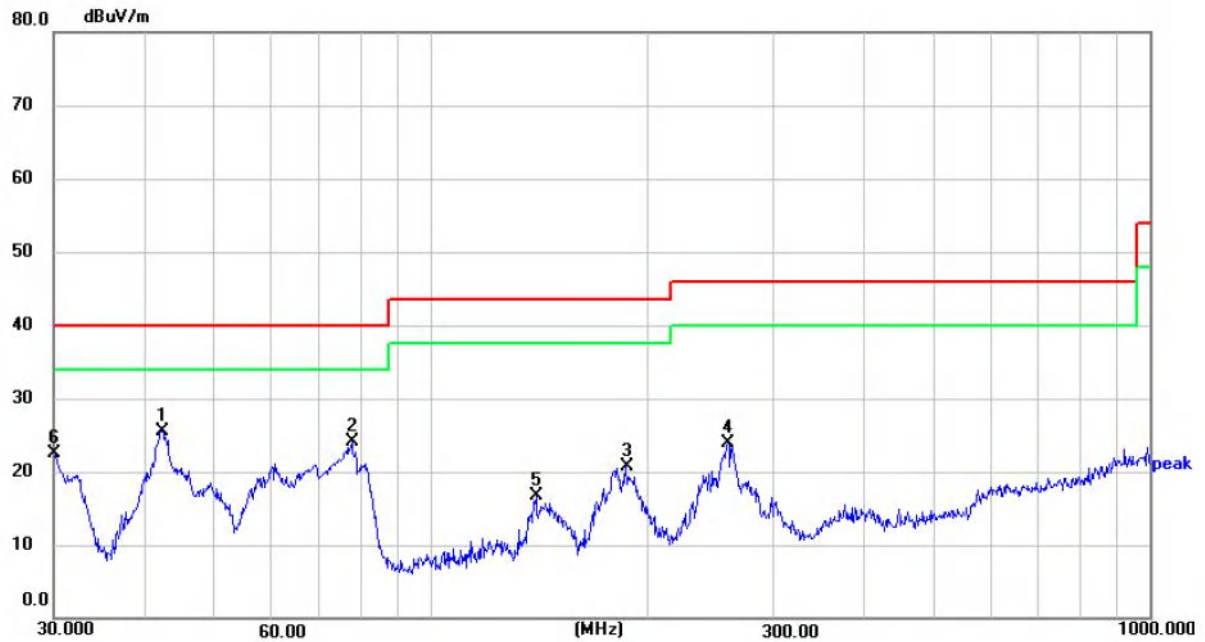
Note:1).Level (dBuV/m)= Reading (dBuV)+ Factor (dB/m)

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: 22(C)

Limit: FCC Part15 RE-Class B_30-1000MHz

Power: AC120V/60Hz

Humidity: 52 %

EUT: eye massager

Distance: 3m

M/N: AST-211

Mode: GFSK DH5 CH 39

Note: N/A

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 *	42.4508	43.28	-17.72	25.56	40.00	-14.44	peak	100	61	P	
2	77.8654	46.40	-22.33	24.07	40.00	-15.93	peak	100	209	P	
3	187.0958	40.78	-20.13	20.65	43.50	-22.85	peak	100	323	P	
4	259.2338	41.97	-18.06	23.91	46.00	-22.09	peak	100	9	P	
5	140.3421	38.69	-21.92	16.77	43.50	-26.73	peak	100	35	P	
6	30.0000	42.48	-19.90	22.58	40.00	-17.42	peak	100	297	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	52.85	PK	74	21.15	74.01	28.42	5.14	54.72	-21.16
4804.00	41.98	AV	54	12.02	63.14	28.42	5.14	54.72	-21.16
7206.00	48.01	PK	74	25.99	62.43	34.15	6.46	55.03	-14.42
7206.00	37.48	AV	54	16.52	51.90	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	52.32	PK	74	21.68	73.48	28.42	5.14	54.72	-21.16
4804.00	42.55	AV	54	11.45	63.71	28.42	5.14	54.72	-21.16
7206.00	48.14	PK	74	25.86	62.56	34.15	6.46	55.03	-14.42
7206.00	37.66	AV	54	16.34	52.08	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	55.51	PK	74	18.49	75.75	28.76	5.34	54.34	-20.24
4882.00	42.09	AV	54	11.91	62.33	28.76	5.34	54.34	-20.24
7323.00	48.54	PK	74	25.46	62.17	34.41	6.83	54.87	-13.63
7323.00	37.67	AV	54	16.33	51.30	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	53.58	PK	74	20.42	73.82	28.76	5.34	54.34	-20.24
4882.00	43.93	AV	54	10.07	64.17	28.76	5.34	54.34	-20.24
7323.00	50.35	PK	74	23.65	63.98	34.41	6.83	54.87	-13.63
7323.00	38.16	AV	54	15.84	51.79	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	54.58	PK	74	19.42	74.11	29.52	5.63	54.68	-19.53
4960.00	42.83	AV	54	11.17	62.36	29.52	5.63	54.68	-19.53
7440.00	49.30	PK	74	24.70	62.50	34.49	7.23	54.92	-13.2
7440.00	38.34	PK	54	15.66	51.54	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	56.09	PK	74	17.91	75.62	29.52	5.63	54.68	-19.53
4960.00	42.61	AV	54	11.39	65.66	29.52	5.63	54.68	-19.53
7440.00	49.78	PK	74	24.22	62.98	34.49	7.23	54.92	-13.2
7440.00	39.30	PK	54	14.70	52.50	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	58.10	PK	74	15.90	82.82	25.72	4.32	54.76	-24.72
2390.00	41.07	AV	54	12.93	65.79	25.72	4.32	54.76	-24.72
2400.00	57.48	PK	74	16.52	81.74	25.73	4.33	54.75	-24.26
2400.00	41.97	AV	54	12.03	66.23	25.73	4.33	54.75	-24.26
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	57.49	PK	74	16.51	82.21	25.72	4.32	54.76	-24.72
2390.00	41.01	AV	54	12.99	65.73	25.72	4.32	54.76	-24.72
2400.00	56.31	PK	74	17.69	80.57	25.73	4.33	54.75	-24.26
2400.00	40.48	AV	54	13.52	64.74	25.73	4.33	54.75	-24.26
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	57.69	PK	74	16.31	82.26	25.78	4.48	54.83	-24.57
2483.50	41.11	AV	54	12.89	65.68	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	55.84	PK	74	18.16	80.41	25.78	4.48	54.83	-24.57
2483.50	40.92	AV	54	13.08	65.49	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	3.23	20.97	Pass
	39	3.10		
	78	2.98		
$\pi/4$ DQPSK	00	5.63	20.97	Pass
	39	5.31		
	78	5.19		
8DPSK	00	6.17	20.97	Pass
	39	5.92		
	78	5.73		

Note: The test results including the cable loss.

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

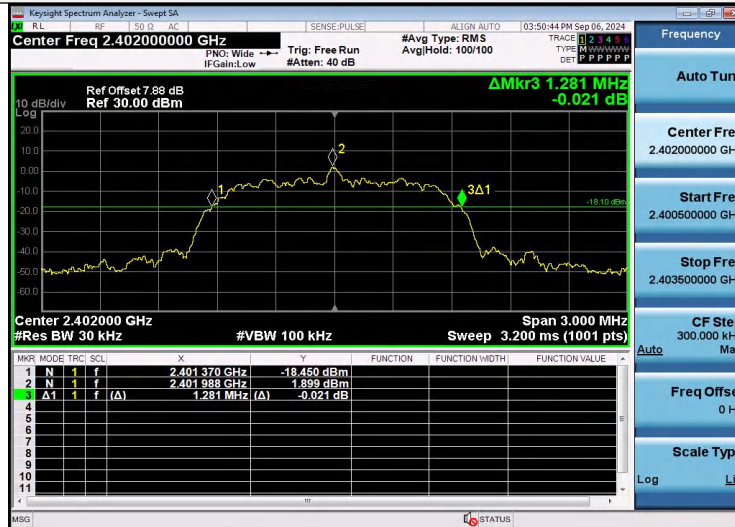


Test Results

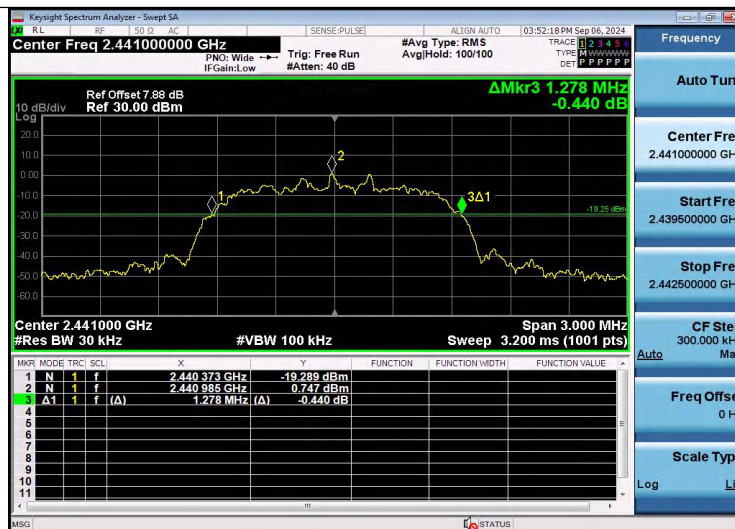
Modulation	Channel	20dB bandwidth (MHz)	Result
GFSK	00	0.966	Pass
	39	0.957	
	78	0.939	
$\pi/4$ DQPSK	00	1.281	
	39	1.278	
	78	1.323	
8DPSK	00	1.314	
	39	1.293	
	78	1.287	

Test plot as follows:



$\pi/4$ DQPSK Modulation

CH00



CH39



CH78

8DPSK Modulation

Keysight Spectrum Analyzer - Swept SA

Center Freq 2.402000000 GHz

Ref Offset 7.88 dB
Ref 30.00 dBm

Δ Mkr3 1.314 MHz
0.007 dB

Center 2.402000 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3.000 MHz
Sweep 3.200 ms (1001 pts)

MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.401346 GHz	-20.931 dBm			
2	N	1	f	2.402009 GHz	-0.914 dBm			
3	Δ	1	f (Δ)	1.314 MHz (Δ)	0.007 dB			

CH00

Keysight Spectrum Analyzer - Swept SA

Center Freq 2.441000000 GHz

Ref Offset 7.88 dB
Ref 30.00 dBm

Δ Mkr3 1.293 MHz
0.050 dB

Center 2.441000 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3.000 MHz
Sweep 3.200 ms (1001 pts)

MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.440365 GHz	-18.425 dBm			
2	N	1	f	2.440994 GHz	1.721 dBm			
3	Δ	1	f (Δ)	1.293 MHz (Δ)	0.050 dB			

CH39

Keysight Spectrum Analyzer - Swept SA

Center Freq 2.480000000 GHz

Ref Offset 8.2 dB
Ref 30.00 dBm

Δ Mkr3 1.287 MHz
0.266 dB

Center 2.480000 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3.000 MHz
Sweep 3.200 ms (1001 pts)

MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.479362 GHz	-19.545 dBm			
2	N	1	f	2.479832 GHz	1.175 dBm			
3	Δ	1	f (Δ)	1.287 MHz (Δ)	0.266 dB			

CH78

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. CH39 and CH40 was measured by spectrum analyzer with 300 KHz RBW and 300 KHz VBW.

TEST CONFIGURATION



TEST RESULTS

Modulation	Channel	Channel Separation (MHz)	Limit	Result
GFSK	CH39	0.994	0.644MHz	Pass
	CH40			
$\pi/4$ DQPSK	CH39	0.992	0.882MHz	Pass
	CH40			
8DPSK	CH39	1.000	0.876MHz	Pass
	CH40			

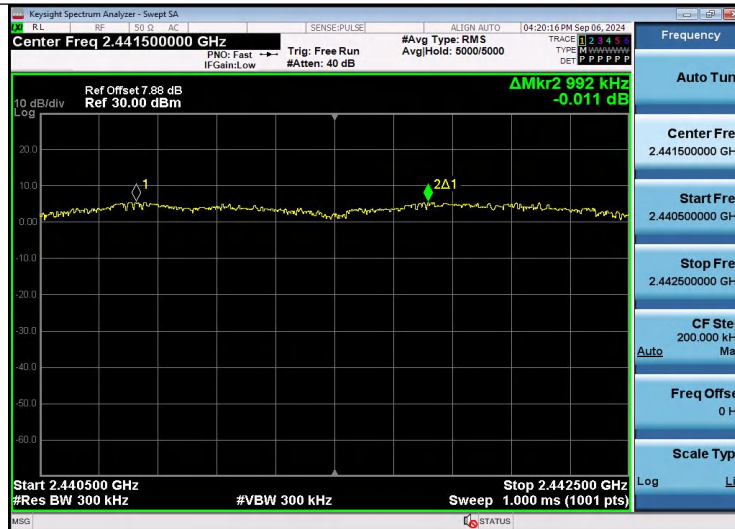
Note:

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

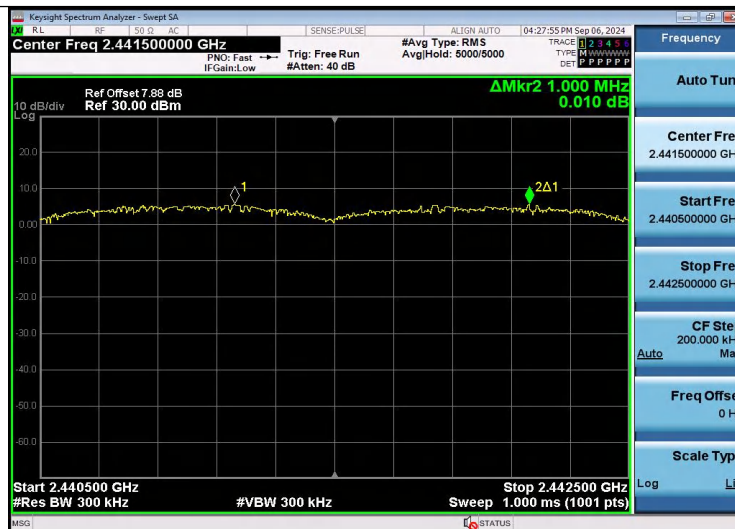
Test plot as follows:



GFSK



$\pi/4$ DQPSK



8DPSK

4.6 Number of hopping frequency

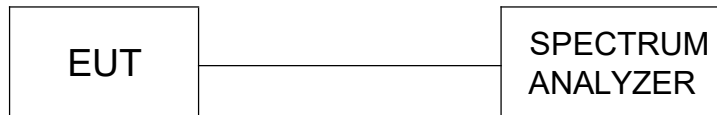
Limit

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.

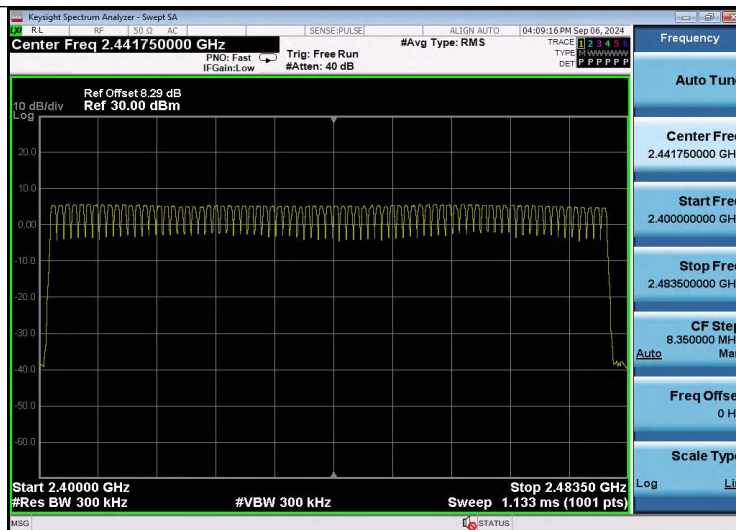
Test Configuration



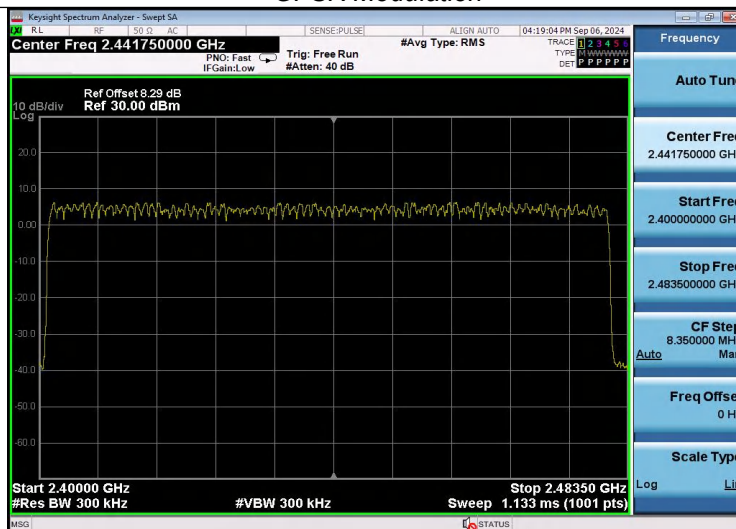
Test Results

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

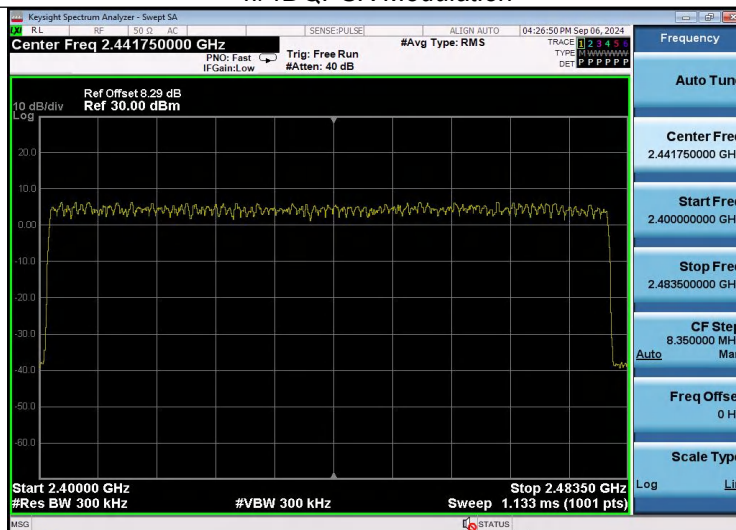
Test plot as follows:



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	0.381	0.122	0.40	Pass
	DH3	1.637	0.262		
	DH5	2.885	0.308		
π/4DQPSK	2-DH1	0.390	0.125	0.40	Pass
	2-DH3	1.643	0.263		
	2-DH5	2.889	0.308		
8DPSK	3-DH1	0.390	0.125	0.40	Pass
	3-DH3	1.642	0.263		
	3-DH5	2.892	0.308		

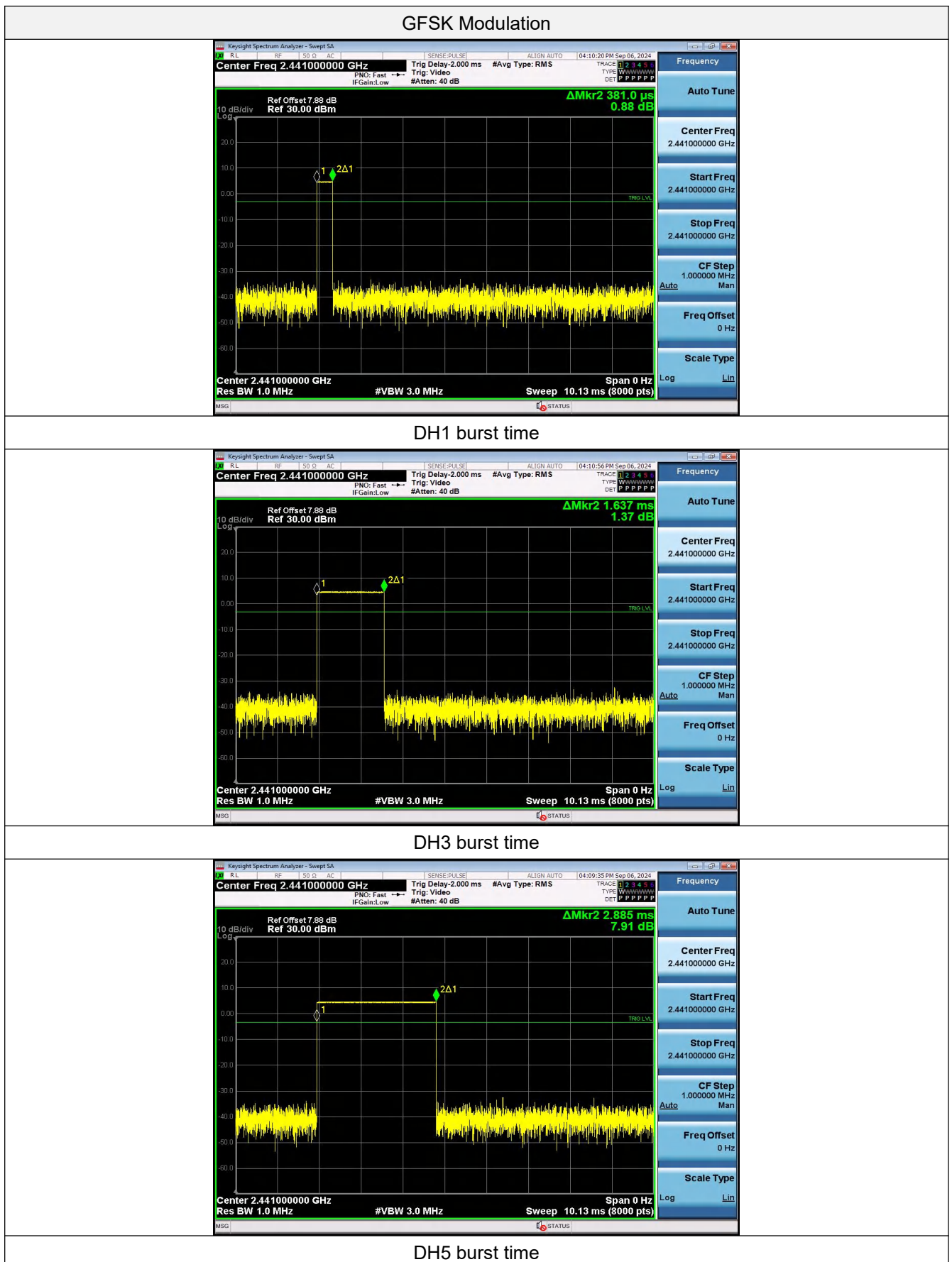
Note: We have tested all mode at high, middle and low channel, and recorded worst case at middle channel.

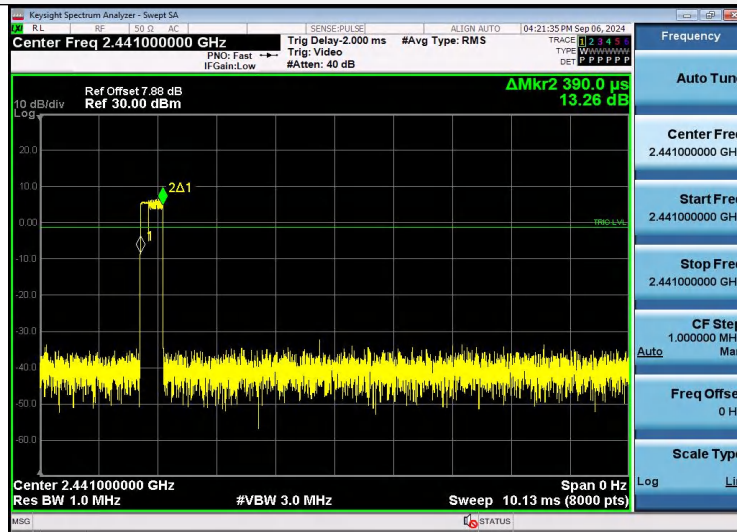
Dwell time = Pulse time (ms) × (1600 ÷ 2 ÷ 79) × 31.6 Second for DH1, 2-DH1, 3-DH1

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

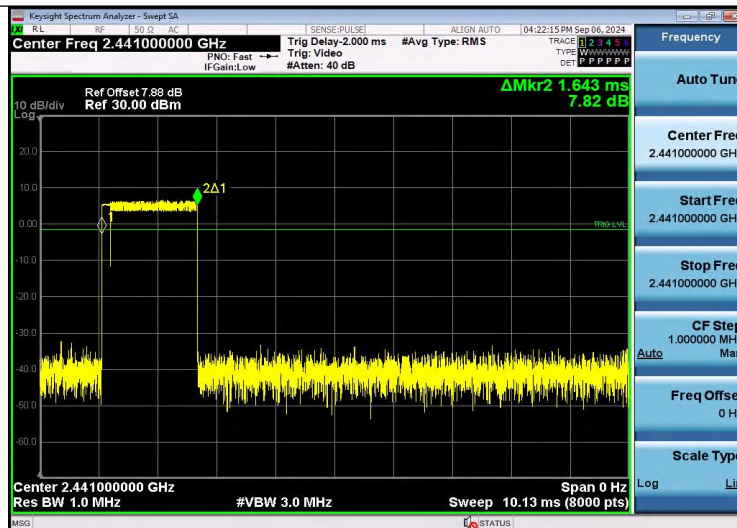
Dwell time = Pulse time (ms) × (1600 ÷ 6 ÷ 79) × 31.6 Second for DH5, 2-DH5, 3-DH5

Test plot as follows:

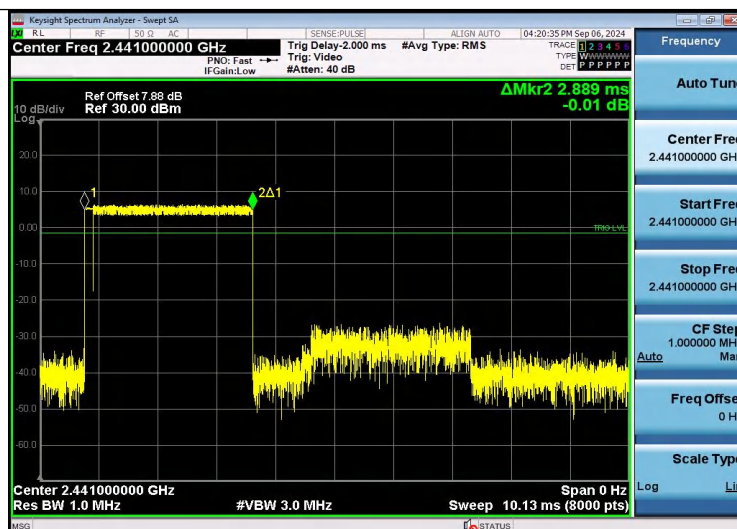


$\pi/4$ DQPSK Modulation

2-DH1 burst time

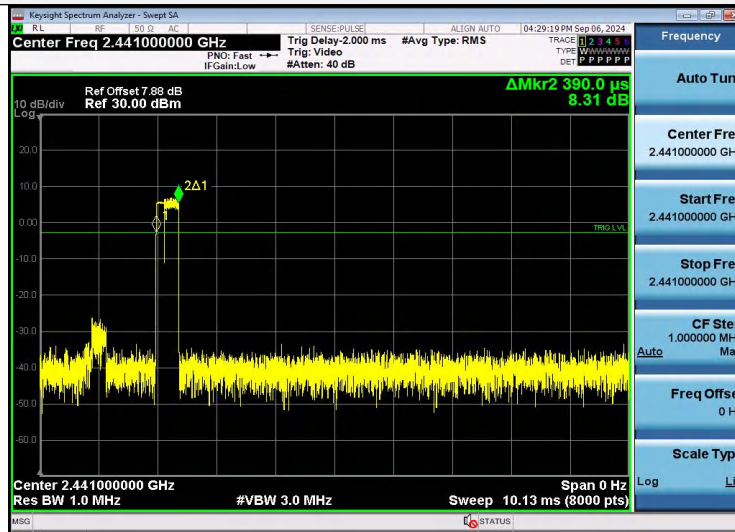


2-DH3 burst time

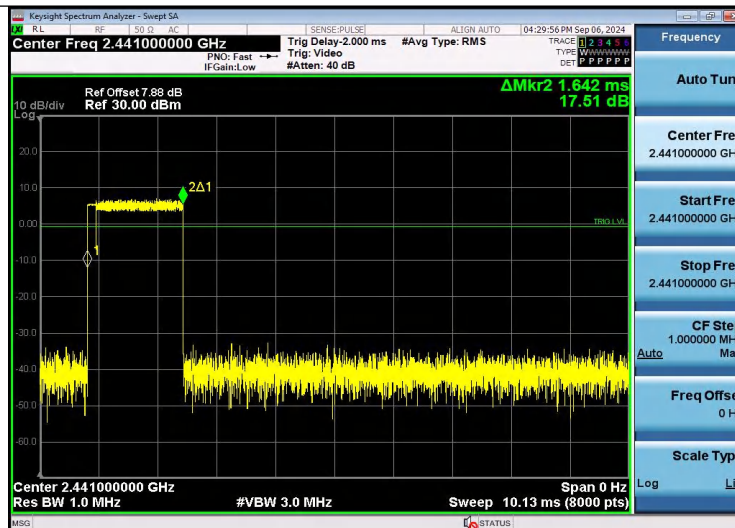


2-DH5 burst time

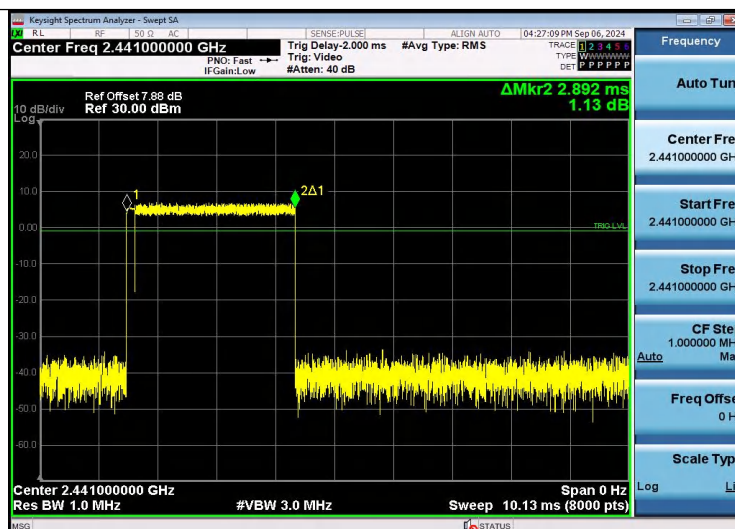
8DPSK Modulation



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



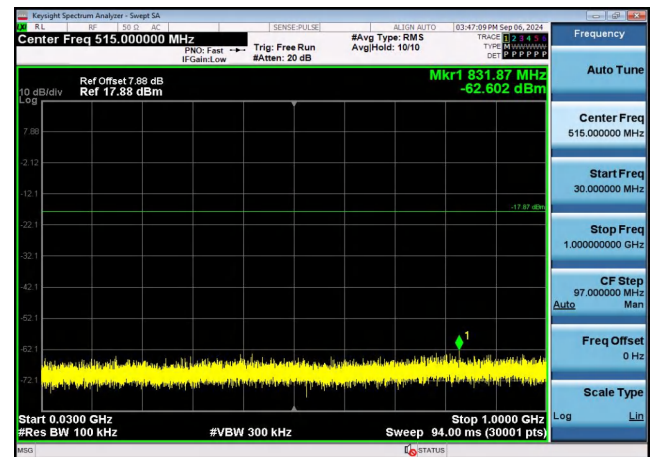
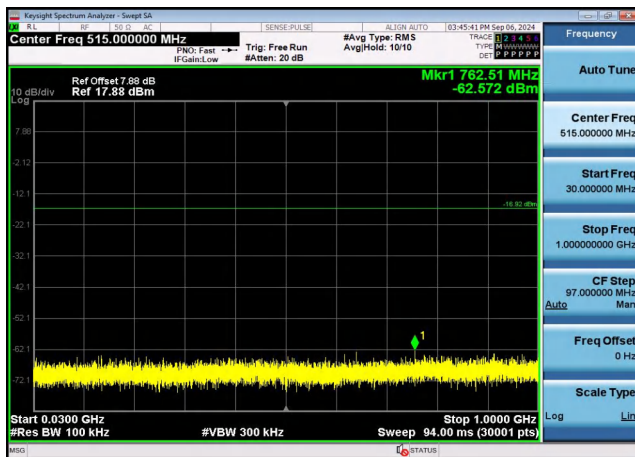
Test Results

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.

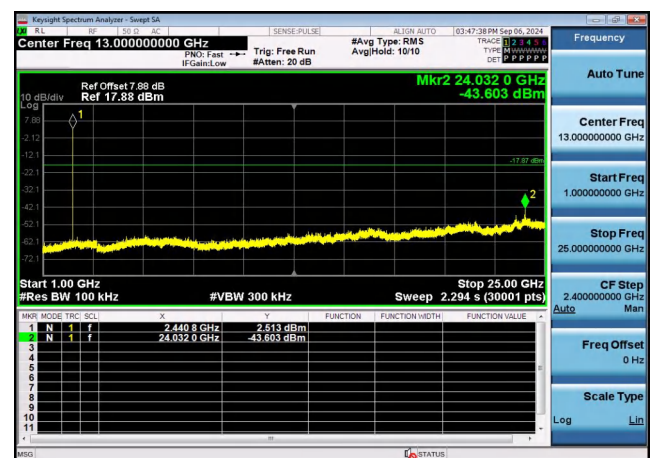
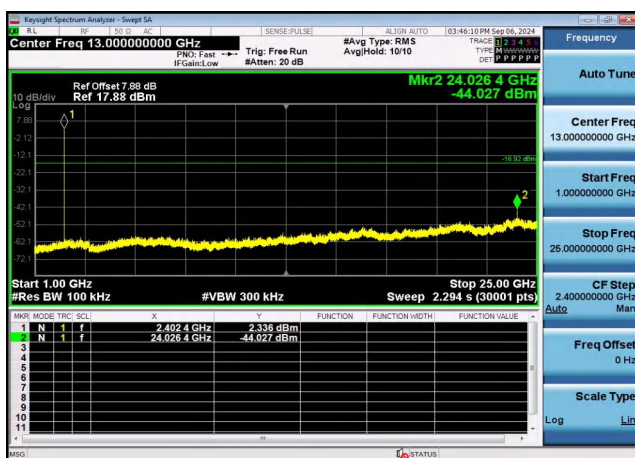
We measured all conditions (DH1, DH3, DH5) and recorded worst case at DH5.

GFSK(CH00)

reference



30MHz-1G



1G-25G