TEST REPORT

Applicant Name :	Shenzhen VanTop Technology & Innovation Co., Ltd.
Address :	506, BLDG 4, MinQi Technology Park, No. 65 Lishan Road, Pingshan Community,Taoyuan Street, Nanshan District, Shenzhen, China
Report Number :	RA230110-01784E-RF-00
FCC ID:	2AQ3A-SG500CR2422

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type:	REMOTE
Model No.:	DR-SG500C
Multiple Model(s) No.:	DR-SG500E, DR-SG500F
Trade Mark:	N/A
Date Received:	2023/01/10
Report Date:	2023/03/31

Test Result:	Pass*

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

Prepared and Checked By:

Nick Fang
EMC Engineer

Approved By:

Candy Li
EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "★ ".
Shenzhen Accurate Technology Co., Ltd. is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with an asterisk '*'. Customer model name, addresses, names, trademarks etc. are not considered data.
This report cannot be reproduced except in full, without prior written approval of the Company. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested. This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

TABLE OF CONTENTS

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	RA230110-01784E-RF-00	Original Report	2023/03/31

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	REMOTE
Tested Model	DR-SG500C
Multiple Models	DR-SG500E, DR-SG500F (model difference see product declaration letter of similarity)
Frequency Range	2405-2478MHz
Maximum conducted Peak output power	7.44dBm
Modulation Technique	GFSK
Antenna Specification*	2.29dBi (provided by the applicant)
Voltage Range	DC3.7V from battery or DC 5V from USB port for charging
Sample serial number	1YFF-1 for RF Conducted Test 1YG-2 for Radiated Emissions (Assigned by ATC)
Sample/EUT Status	Good condition

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.209 and 15.247 rules.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

All emissions measurement was performed at Shenzhen Accurate Technology Co., Ltd. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Each test item follows test standards and with no deviation.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF Frequency		$0.082*10^{-7}$
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	9kHz - 30MHz	2.66dB
	30MHz - 1GHz	4.28dB
	1GHz - 18GHz	4.98dB
	18GHz - 26.5GHz	5.06dB
	26.5GHz - 40GHz	4.72dB
Temperature		1℃
Humidity		6%
Supply voltages		0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 708358, the FCC Designation No.: CN1189. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

Listed by Innovation, Science and Economic Development Canada (ISEDC), the Registration Number is 5077A.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2405	4	2424	8	2444	12	2464
1	2409	5	2429	9	2449	13	2469
2	2414	6	2434	10	2454	14	2474
3	2419	7	2440	11	2459	15	2478

Channel 0, 8, 15 was tested

EUT Exercise Software

No exercise software was used, EUT was confirgured in testing mode by applicnat and the power level is default*. The power level was provided by applicant

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

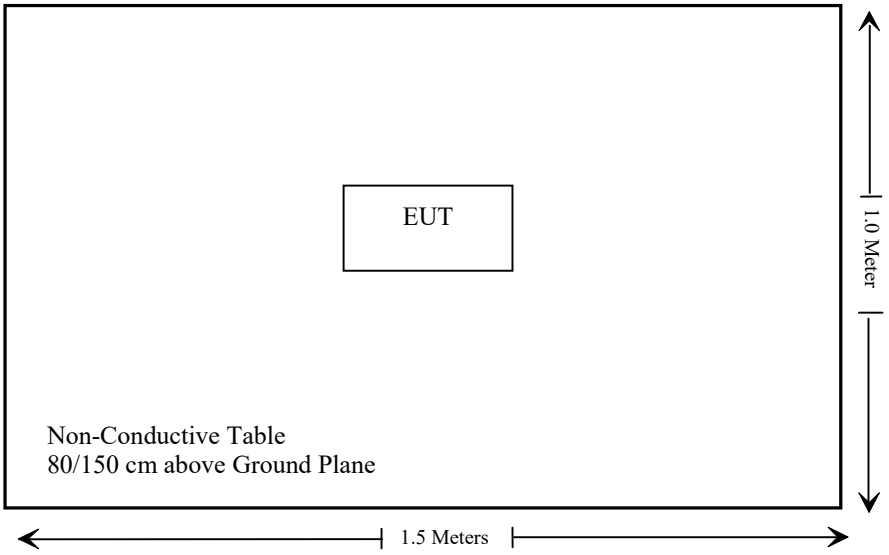
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

Cable Description	Length (m)	From/Port	To
/	/	/	/

Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§1.1307&§2.1093	RF EXPOSURE	Compliant
§15.203	Antenna Requirement	Compliant
§15.207(a)	AC Line Conducted Emissions	Not Applicable
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliant
§15.247(a)(1)	20 dB Emission Bandwidth	Compliant
§15.247(a)(1)	Channel Separation Test	Compliant
§15.247(a)(1)(i)	Time of Occupancy (Dwell Time)	Compliant
§15.247(a)(1)(i)	Quantity of hopping channel Test	Compliant
§15.247(b)(2)	Peak Output Power Measurement	Compliant
§15.247(d)	Band edges	Compliant

Not Applicable: The RF function cannot use when in charging.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emissions Test					
Rohde& Schwarz	Test Receiver	ESR	102725	2022/11/25	2023/11/24
Rohde&Schwarz	Spectrum Analyzer	FSV40	101949	2022/11/25	2023/11/24
SONOMA INSTRUMENT	Amplifier	310 N	186131	2022/11/08	2023/11/07
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2022/11/08	2023/11/07
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2022/11/30	2025/11/29
Radiated Emission Test Software: e3 19821b (V9)					
Unknown	RF Coaxial Cable	No.10	N050	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.11	N1000	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.12	N040	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.13	N300	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.14	N800	2022/11/25	2023/11/24
RF Conducted Test					
Rohde&Schwarz	Spectrum Analyzer	FSV-40	101948	2022/11/25	2023/11/24
WEINSCHEL	10dB Attenuator	5324	AU 3842	2022/11/25	2023/11/24
Unknown	RF Cable	Unknown	3	Each time	

*** Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC§15.247 (i), §1.1307 (b)(1)&§2.1093 – RF EXPOSURE

Applicable Standard

According to FCC §2.1093 and §1.1307(b)(1), systems operating under the provisions of this sectionshall be operated in a manner that ensure that the public is not exposed to radio frequency energylevel in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR testExclusion.

Measurement Result

For worst case:

Frequency (MHz)	Tune-up power (dBm)	Tune-up power (mW)	Distance (mm)	Calculated value	Threshold (1-g SAR)	SAR Test Exclusion
2478	8.0	6.31	5.0	1.99	3.0	**Yes**

Result: No SAR test is required

FCC §15.203 – ANTENNA REQUIREMENT

Applicable Standard

According to FCC § 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 shall be considered sufficient to comply with the provisions of this Section. 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.

Antenna Connector Construction

The EUT has one internal Antenna arrangement which was permanently attached and the antenna gain is 2.29dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliance.

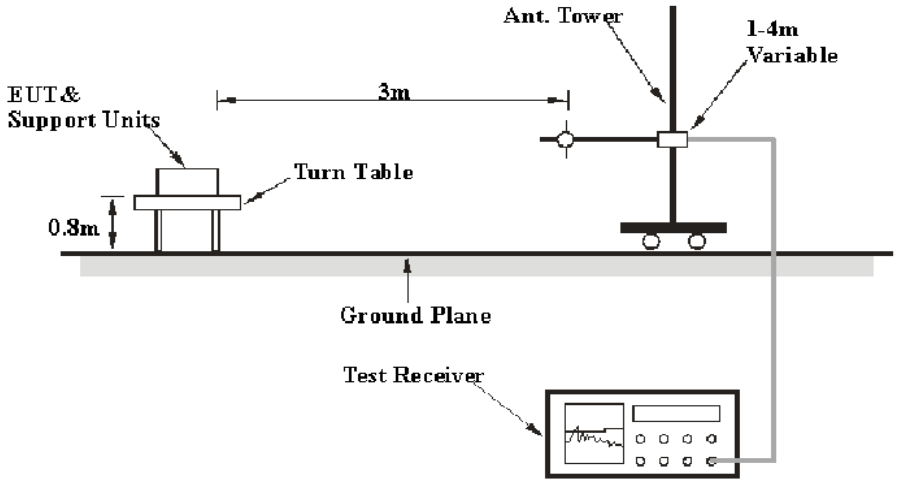
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

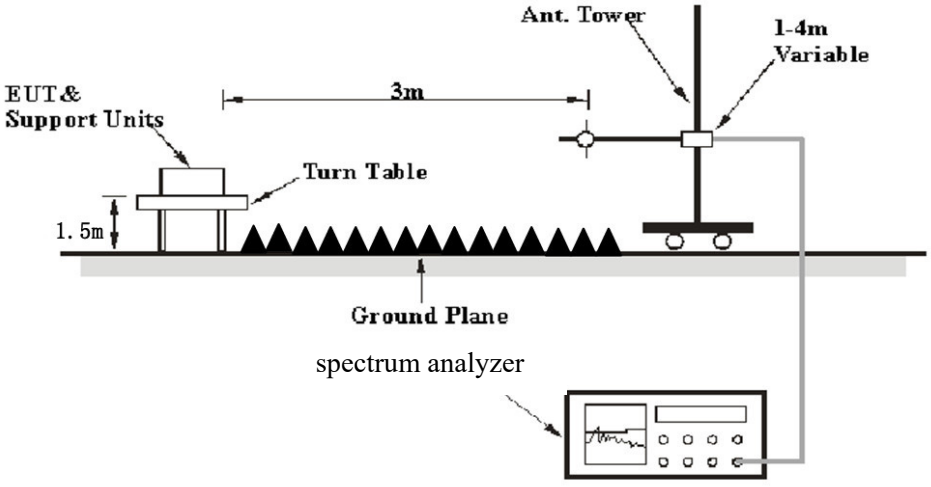
FCC §15.205; §15.209; §15.247(d)

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209 and FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

The EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	PK

For average measurement:

use the duty cycle factor correction factor method per 15.35(c).
Duty cycle=On time/100milliseconds, On time=N1*L1+N2*L2+…Nn-1*Ln-1+Nn*Ln,
where N1 is number of type 1 pulses, L1 is length of type 1 pulse, etc.
Average Emission Level=Peak Emission Level+20*log(Duty cycle)

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

Corrected Factor & Margin Calculation

The Corrected Factor is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain. The basic equation is as follows:

Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain

The "**Over Limit or Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a overlimit/margin of -7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin/Over Limit = Corrected Amplitude/Level-Limit
Corrected Amplitude/Level = Reading + Corrected Factor

Test Data

Environmental Conditions

Temperature:	24~26℃
Relative Humidity:	55~57 %
ATM Pressure:	101.0 kPa

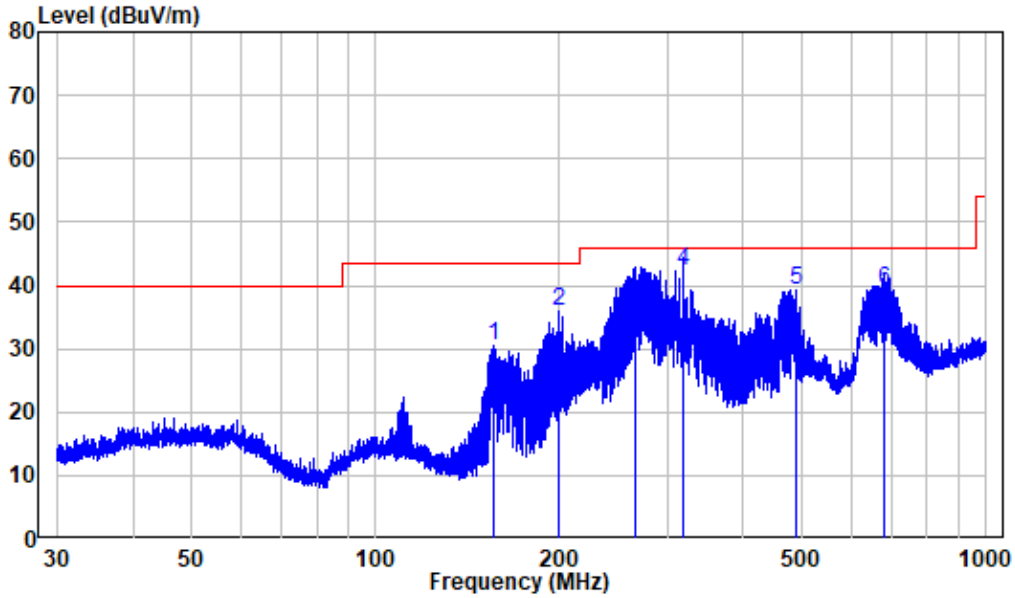
The testing was performed by Jimi Zheng on 2023-02-03 for below 1GHz, and Jimi Zheng on 2023-02-16 for above 1GHz.

EUT operation mode: Transmitting (Pre-scan in the X,Y and Z axes of orientation, the worst case X-axes orientation was recorded)

30MHz-1GHz: *(worst case is low channel)*

Note: When the test result of peak was less than the limit of QP more than 6dB, so just peak value were recorded.

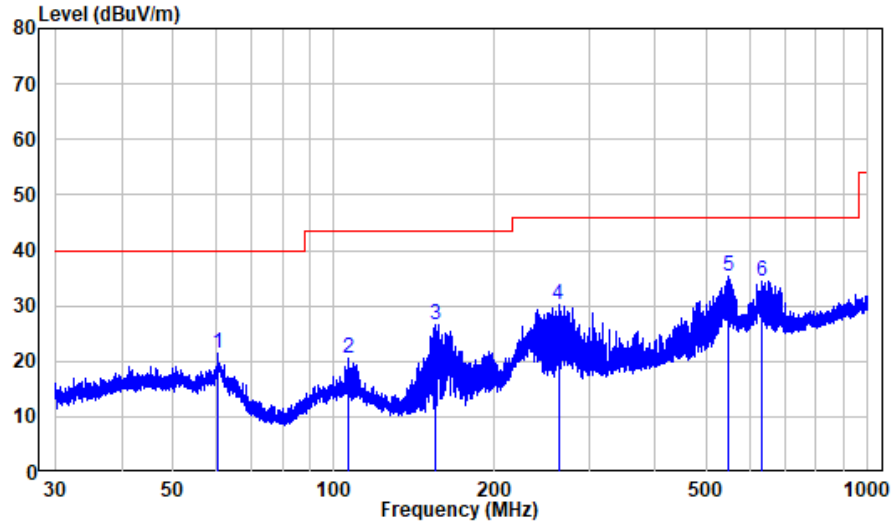
Horizontal:



Site : chamber
Condition: 3m HORIZONTAL
Job No. : RA230110-01784E-RF
Test Mode: Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	155.637	-14.87	45.35	30.48	43.50	-13.02	Peak
2	199.286	-11.45	47.43	35.98	43.50	-7.52	Peak
3	266.609	-10.38	47.50	37.12	46.00	-8.88	QP
4	318.817	-8.52	50.81	42.29	46.00	-3.71	QP
5	489.670	-4.69	43.88	39.19	46.00	-6.81	Peak
6	680.258	-1.50	40.70	39.20	46.00	-6.80	QP

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : RA230110-01784E-RF
Test Mode: Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	60.465	-10.81	32.12	21.31	40.00	-18.69	Peak
2	106.245	-11.93	32.39	20.46	43.50	-23.04	Peak
3	154.685	-14.96	41.67	26.71	43.50	-16.79	Peak
4	263.357	-10.50	40.69	30.19	46.00	-15.81	Peak
5	549.260	-4.03	39.49	35.46	46.00	-10.54	Peak
6	635.298	-1.99	36.39	34.40	46.00	-11.60	Peak

Above 1GHz:

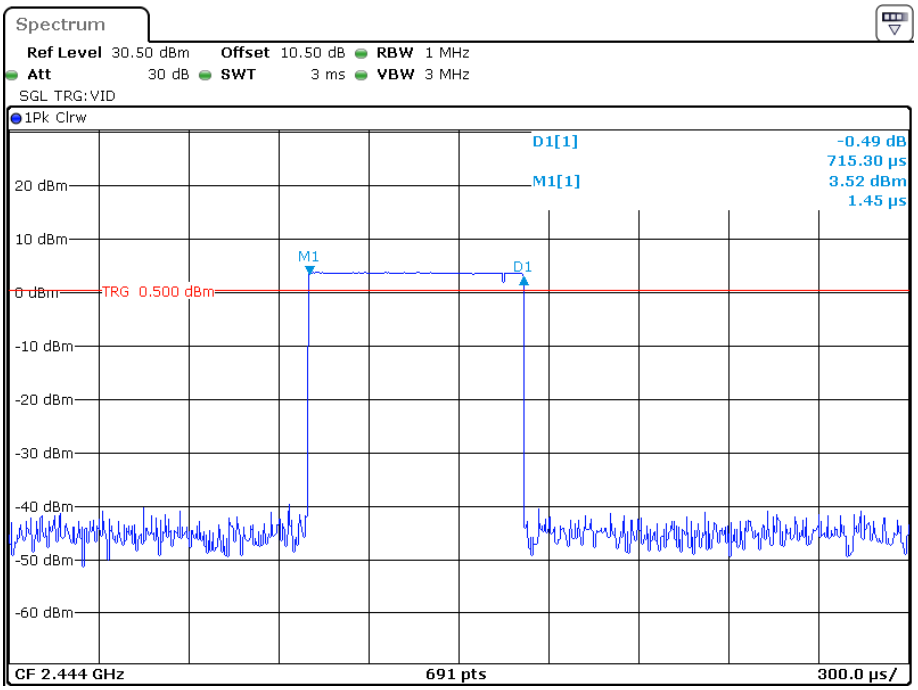
Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
Low Channel(2405MHz)									
2310	62.39	PK	131	1.2	H	-7.24	55.15	74	-18.85
2310	61.48	PK	110	1.2	V	-7.24	54.24	74	-19.76
2390	72.22	PK	309	1.5	H	-7.22	65.00	74	-9.00
2390	65.20	PK	198	2.1	V	-7.22	57.98	74	-16.02
4810	71.11	PK	168	1.5	H	-3.52	67.59	74	-6.41
4810	75.82	PK	311	1.5	V	-3.52	72.30	74	-1.70
Middle Channel(2444MHz)									
4888	72.58	PK	208	1.1	H	-3.33	69.25	74	-4.75
4888	76.33	PK	202	1.1	V	-3.33	73.00	74	-1.00
High Channel(2478 MHz)									
2483.5	79.92	PK	27	1.5	H	-7.20	72.72	74	-1.28
2483.5	78.77	PK	112	1.6	V	-7.20	71.57	74	-2.43
2500	73.11	PK	159	1.6	H	-7.18	65.93	74	-8.07
2500	67.21	PK	87	2.3	V	-7.18	60.03	74	-13.97
4956	70.27	PK	53	1.3	H	-3.02	67.25	74	-6.75
4956	74.75	PK	10	1.3	V	-3.02	71.73	74	-2.27

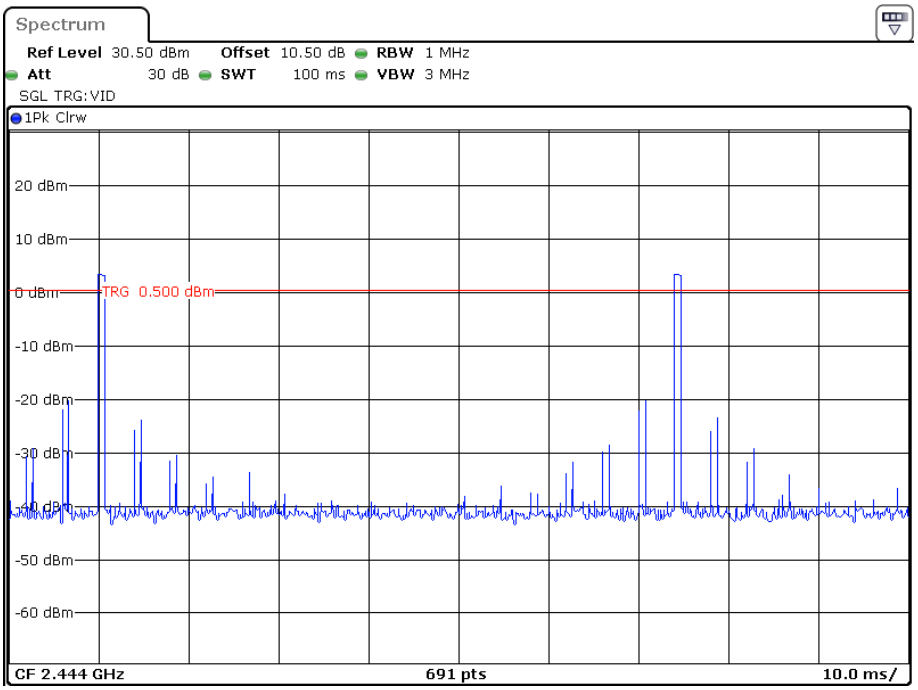
Field Strength of Average							
Frequency (MHz)	Peak Measurement @3m (dBµV/m)	Polar (H/V)	Duty Cycle Factor (dB)	Corrected Ampitude (dBµV/m)	Part 15.247		
					Limit (dBµV/m)	Margin (dB)	Comment
2405MHz							
2310	55.15	H	-36.89	18.26	54	-35.74	Bandedge
2310	54.24	V	-36.89	17.35	54	-36.65	Bandedge
2390	65.00	H	-36.89	28.11	54	-25.89	Bandedge
2390	57.98	V	-36.89	21.09	54	-32.91	Bandedge
4810	67.59	H	-36.89	30.70	54	-23.30	Harmonic
4810	72.30	V	-36.89	35.41	54	-18.59	Harmonic
2444MHz							
4888	69.25	H	-36.89	32.36	54	-21.64	Harmonic
4888	73.00	V	-36.89	36.11	54	-17.89	Harmonic
2478MHz							
2483.5	72.72	H	-36.89	35.83	54	-18.17	Bandedge
2483.5	71.57	V	-36.89	34.68	54	-19.32	Bandedge
2500	65.93	H	-36.89	29.04	54	-24.96	Bandedge
2500	60.03	V	-36.89	23.14	54	-30.86	Bandedge
4956	67.25	H	-36.89	30.36	54	-23.64	Harmonic
4956	71.73	V	-36.89	34.84	54	-19.16	Harmonic

Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Corrected. Amplitude - Limit
The other spurious emission which is 20dB to the limit or in noise floor was not recorded.
Average=Peak level+duty cycle factor

Worst case duty cycle:
Duty cycle = Ton/100ms = 0.715*2/100=0.0143
Duty Cycle Corrected Factor = 20lg (Duty cycle) = 20lg0.0143= -36.89

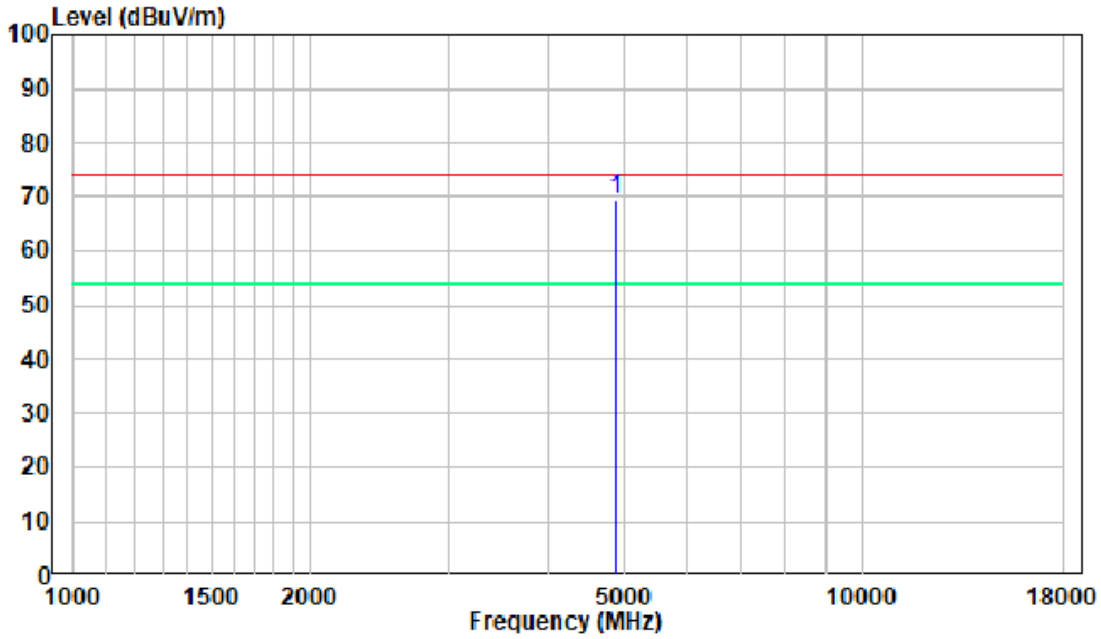
Duty cycle:


Spectrum
Ref Level 30.50 dBm Offset 10.50 dB RBW 1 MHz
Att 30 dB SWT 3 ms VBW 3 MHz
SGL TRG: VID
1Pk Clrw
D1[1] -0.49 dB
715.30 µs
M1[1] 3.52 dBm
1.45 µs
20 dBm
10 dBm
0 dBm
TRG 0.500 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
M1
D1
CF 2.444 GHz
691 pts
300.0 µs/

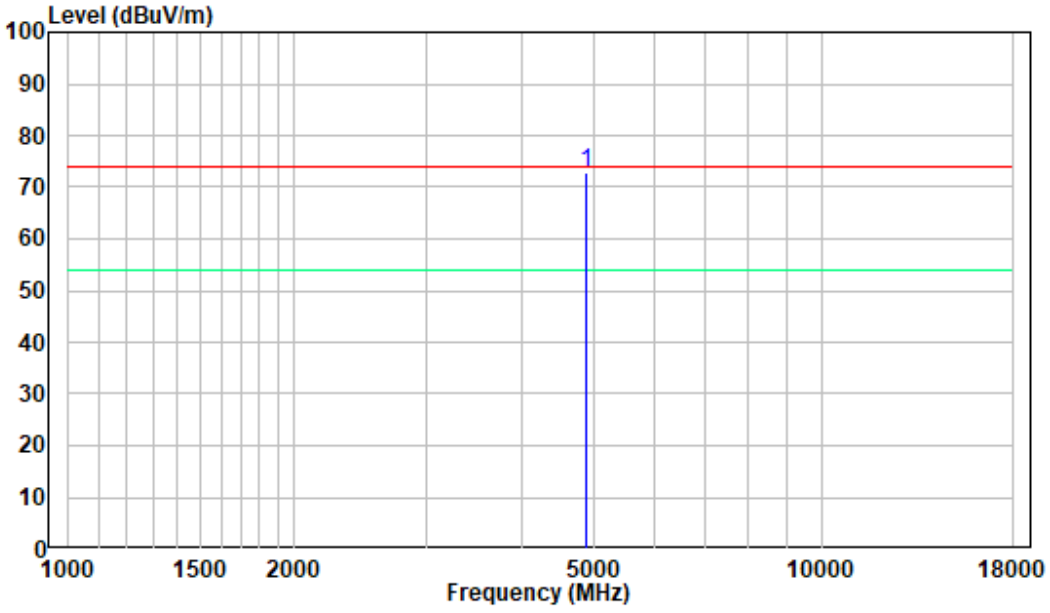

Spectrum
Ref Level 30.50 dBm Offset 10.50 dB RBW 1 MHz
Att 30 dB SWT 100 ms VBW 3 MHz
SGL TRG: VID
1Pk Clrw
20 dBm
10 dBm
0 dBm
TRG 0.500 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
CF 2.444 GHz
691 pts
10.0 ms/

1-18GHz
Pre-scan for High Channel

Horizontal:



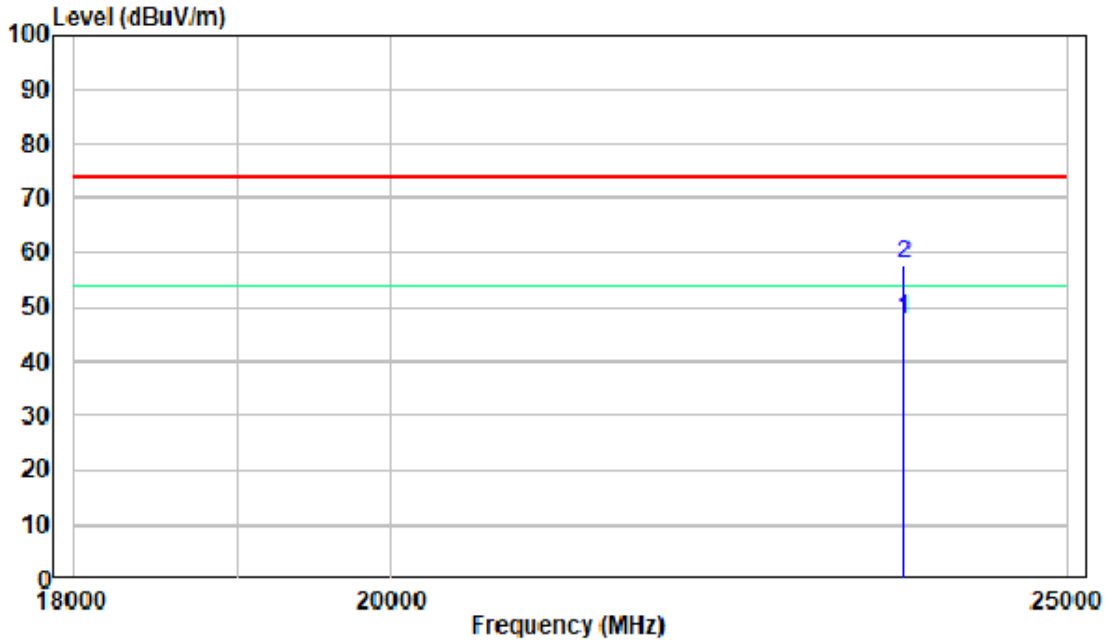
Vertical:



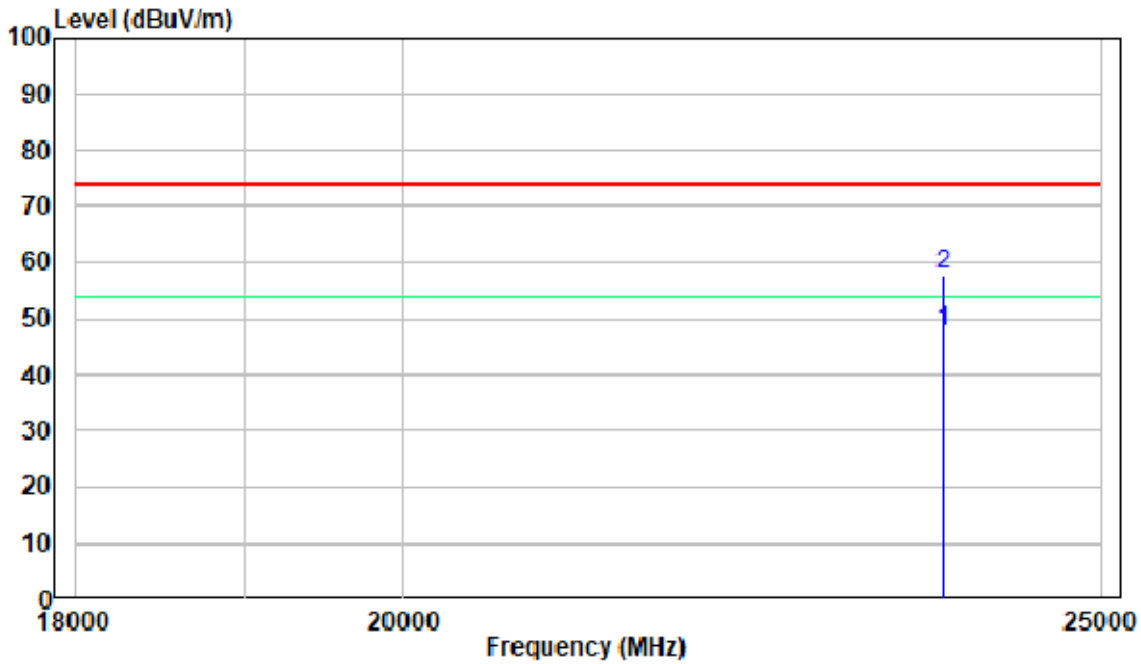
18-25GHz

Pre-scan for High Channel

Horizontal:



Vertical:



FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

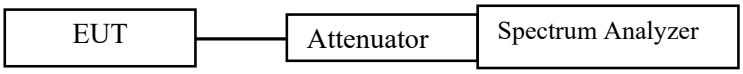
Applicable Standard

Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW. 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 hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.2

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.



Test Data

Environmental Conditions

Temperature:	27.9 ℃
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

The testing was performed by Nick Fang on 2023-02-20.

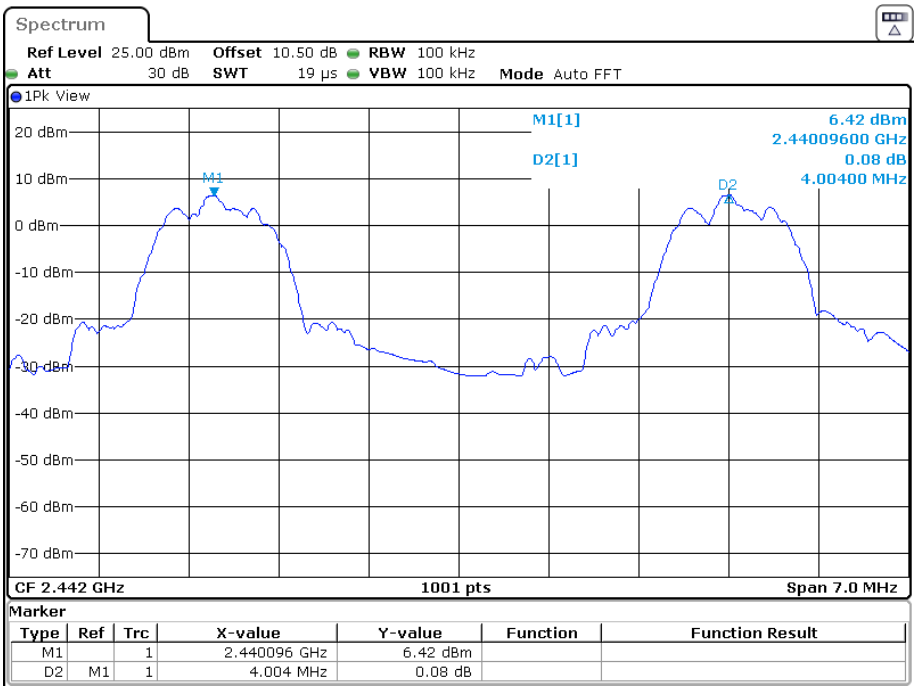
EUT operation mode: Transmitting

Test Result: Compliant.

According to the frequency tabel and analyzer hopping sequence, the worst case as below:

Test Mode	Channel Separation (MHz)	20 dBc BW (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Channel Separation Limit	Result
GFSK					
Hopping	4.004	1.208	0.81	> two-thirds of the 20 dB bandwidth	Pass

Please refer to the below plots:


Spectrum
Ref Level 25.00 dBm Offset 10.50 dB RBW 100 kHz
Att 30 dB SWT 19 µs VBW 100 kHz Mode Auto FFT
1Pk View
M1[1] 6.42 dBm
2.44009600 GHz
D2[1] 0.08 dB
4.00400 MHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D2
CF 2.442 GHz
1001 pts
Span 7.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.440096 GHz 6.42 dBm
D2 M1 1 4.004 MHz 0.08 dB

FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH & 99% OCCUPIED BANDWIDTH

Applicable Standard

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.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.7 & Clause 6.9.2

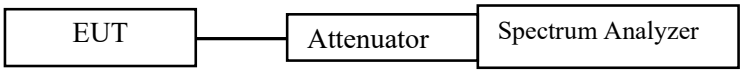
The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

• The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 20 dB bandwidth if the device is not transmitting continuously.

• The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 20 dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.
For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).



Test Data

Environmental Conditions

Temperature:	27.9 ℃
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

The testing was performed by Nick Fang on 2023-02-20.

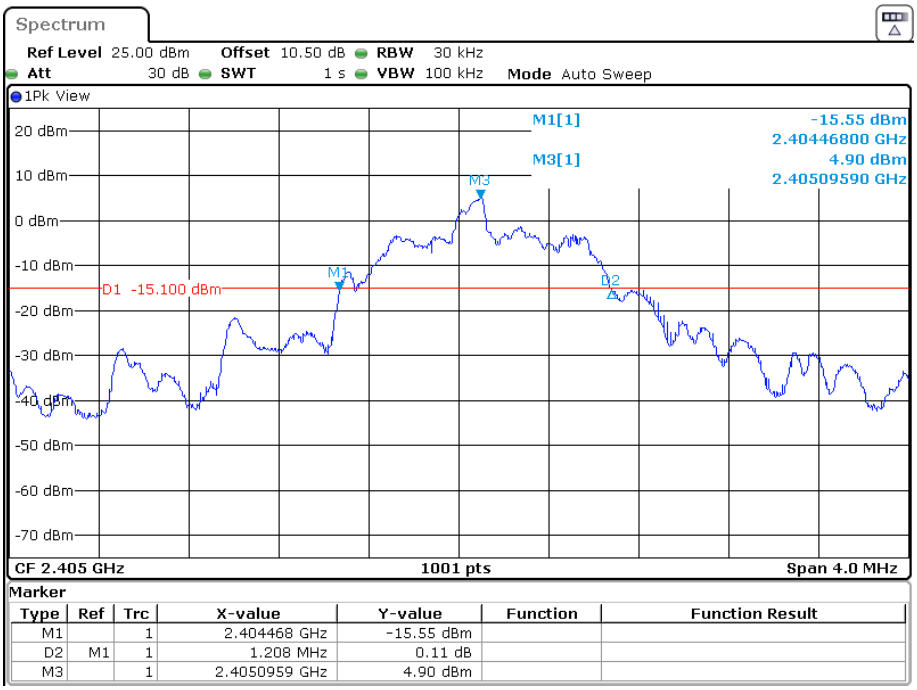
EUT operation mode: Transmitting

Test Result: Compliant.

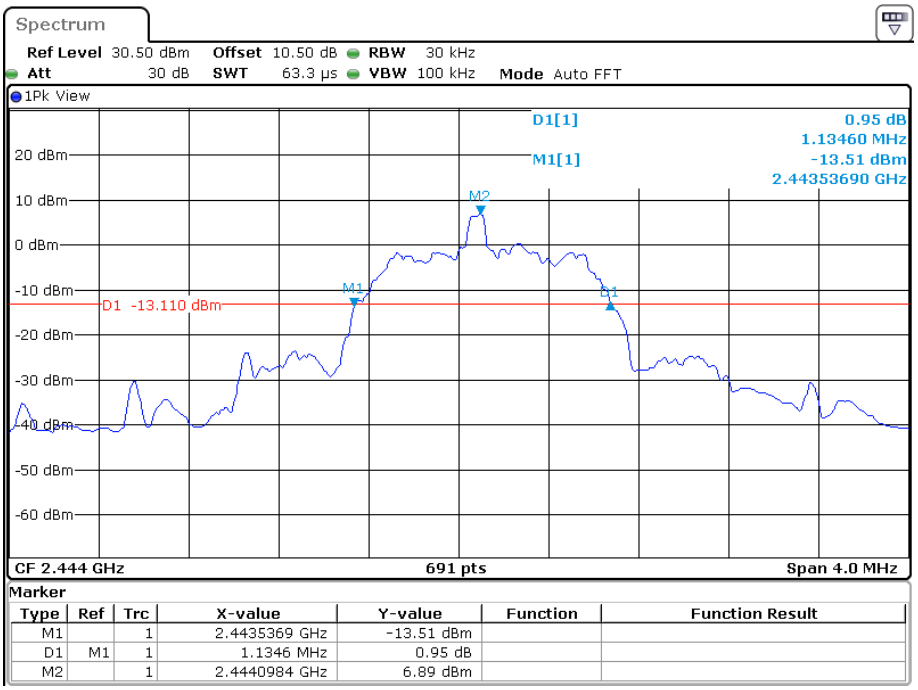
Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)	OBW (MHz)
GFSK	Low	2405	1.208	1.287
	Middle	2444	1.135	1.071
	High	2478	1.136	1.079

Please refer to the below plots:
20 dB Emission Bandwidth

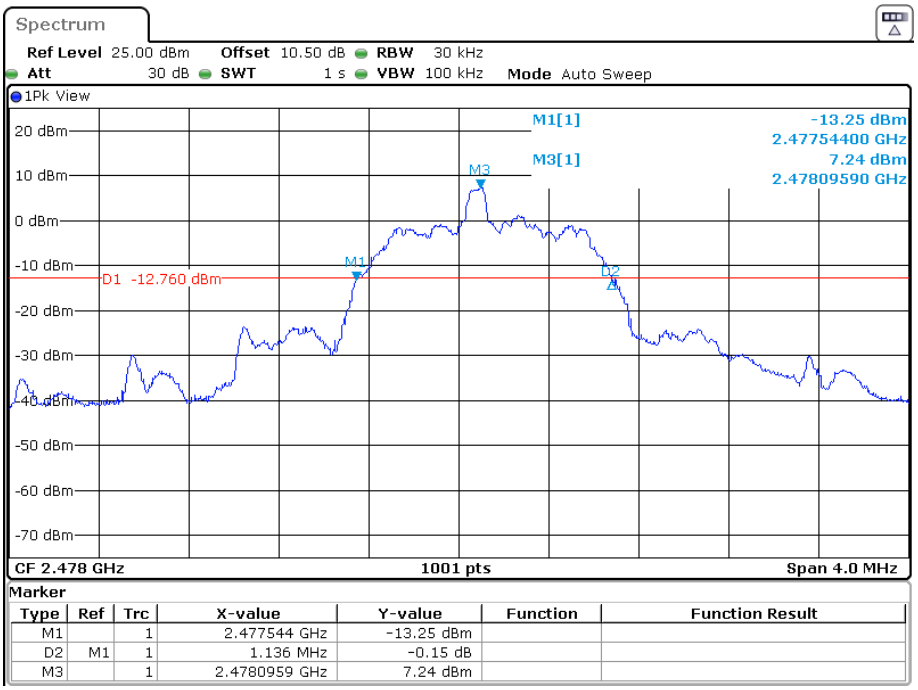
Low Channel



Middle Channel

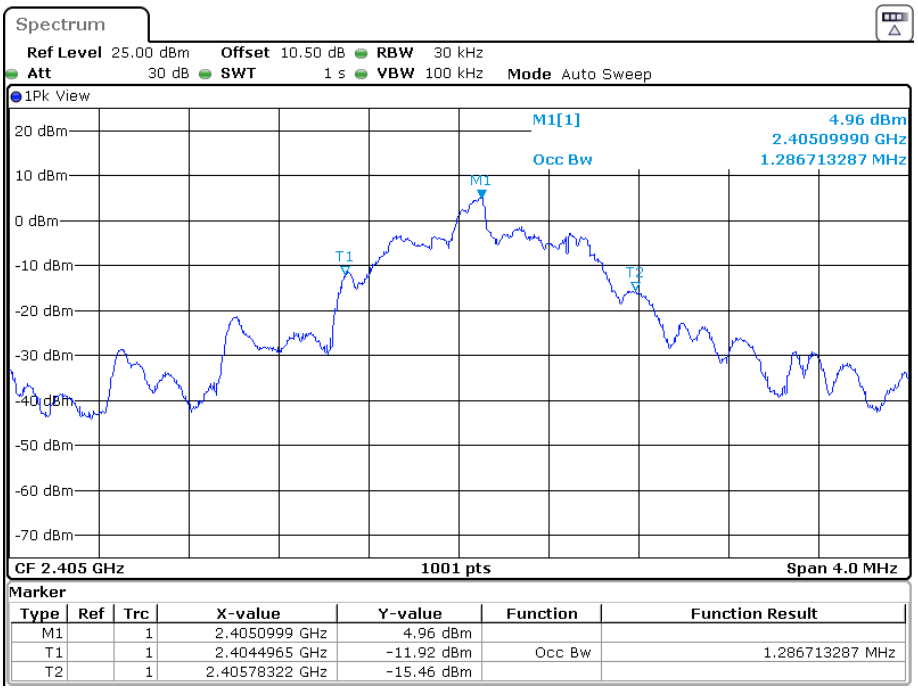


High Channel



99% Occupied Bandwidth

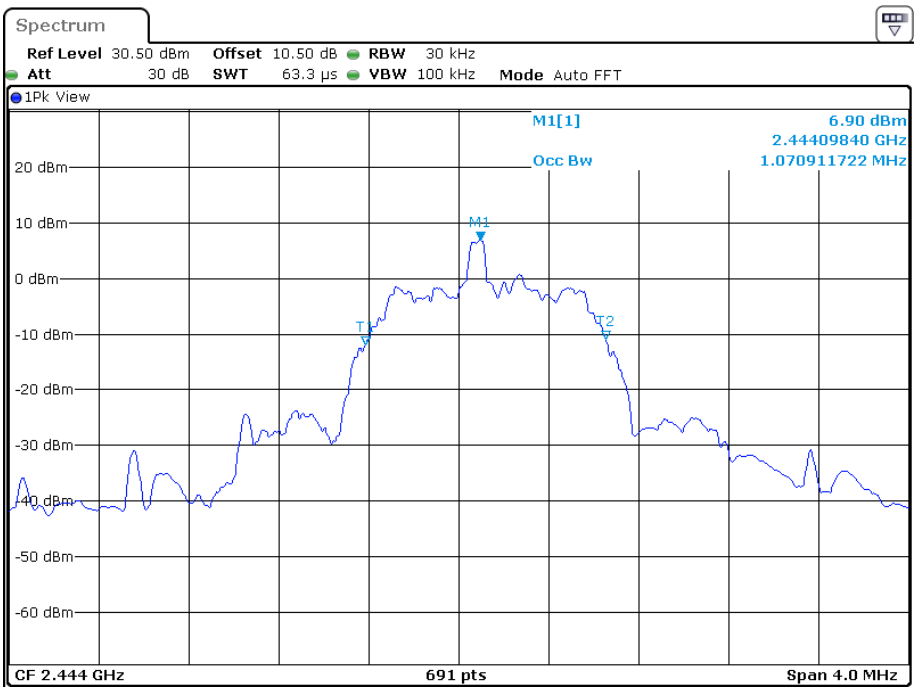
Low Channel



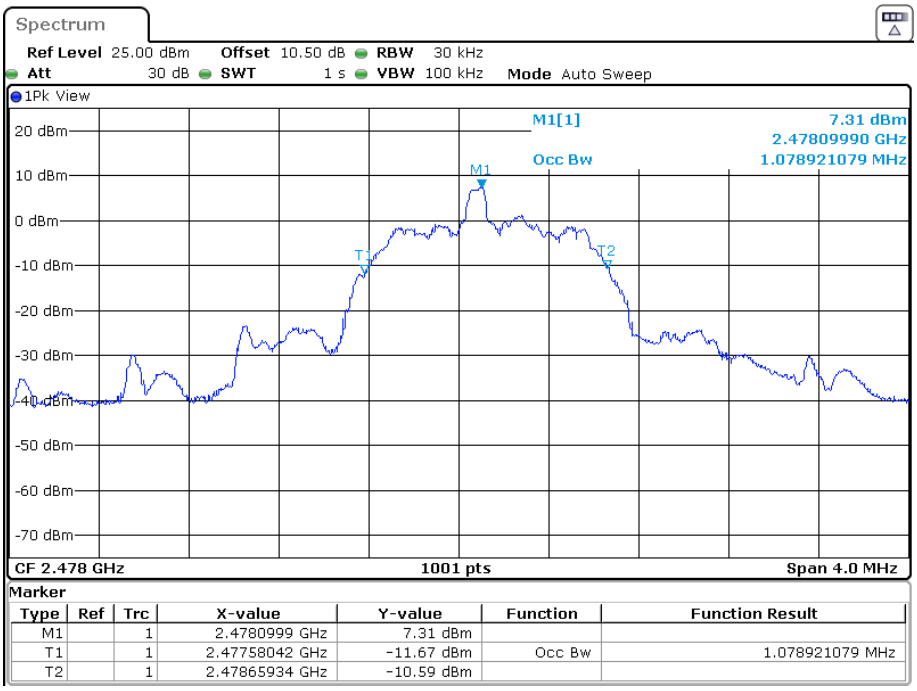
Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4050999 GHz	4.96 dBm		
T1		1	2.4044965 GHz	-11.92 dBm	Occ Bw	1.286713287 MHz
T2		1	2.40578322 GHz	-15.46 dBm		

Middle Channel



High Channel



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4780999 GHz	7.31 dBm		
T1		1	2.47758042 GHz	-11.67 dBm	Occ Bw	1.078921079 MHz
T2		1	2.47865934 GHz	-10.59 dBm		

FCC §15.247(a) (1) (i)-QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

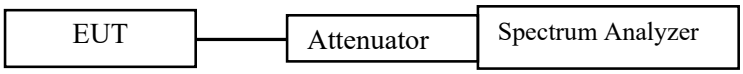
Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.3

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.

2. Set the EUT in hopping mode from first channel to last.

3. By using the max-hold function record the quantity of the channel.



Test Data

Environmental Conditions

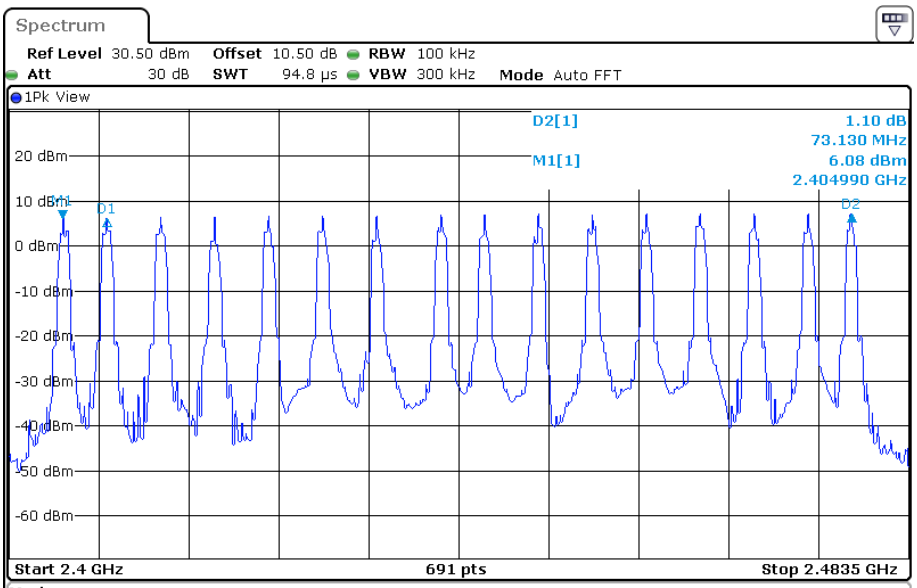
Temperature:	27.9 ℃
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

The testing was performed by Nick Fang on 2023-02-20.

EUT operation mode: Transmitting

Test Result: Compliant.

Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
GFSK	2405-2478	16	≥15



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40499 GHz	6.08 dBm		
D1	M1	1	4.13 MHz	0.21 dB		
D2	M1	1	73.13 MHz	1.10 dB		

FCC §15.247(a) (1) (i) - TIME OF OCCUPANCY (DWELL TIME)

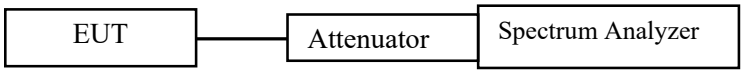
Applicable Standard

Frequency hopping systems in the 2400-2483.5 MHz shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.4

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW ≥ 3×RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses



Test Data

Environmental Conditions

Temperature:	27.9 ℃
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

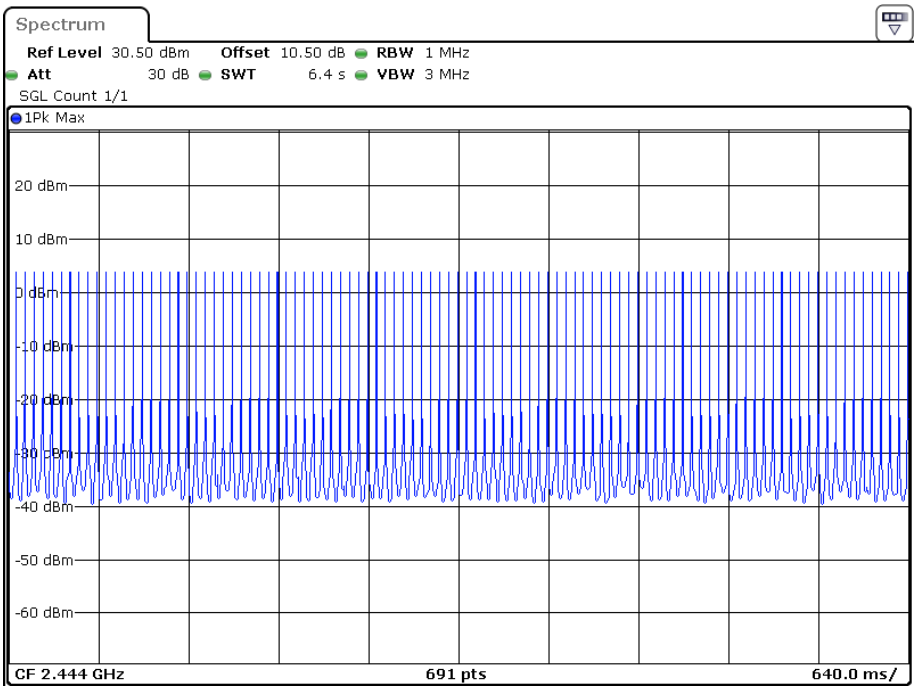
The testing was performed by Nick Fang on 2023-02-20.

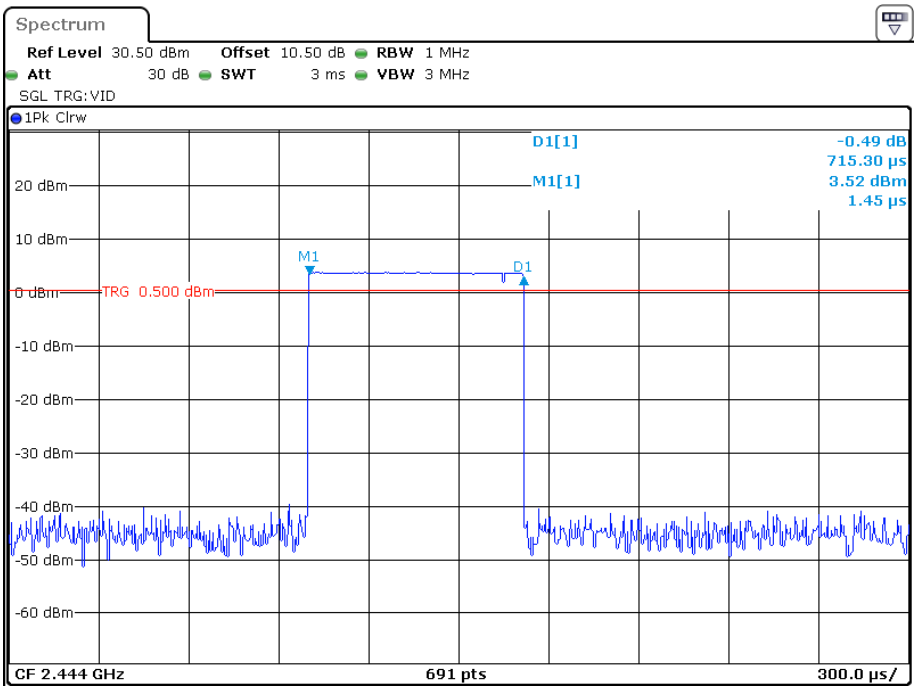
EUT operation mode: Transmitting

Test Result: Compliant.

Test Mode	Channel	Pulse Time [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
GFSK	Hop	0.715	100	0.07	<=0.4	PASS

Note : Period time=0.4s*16=6.4s, Result= Pulse Time*Total hops


Spectrum
Ref Level 30.50 dBm Offset 10.50 dB RBW 1 MHz
Att 30 dB SWT 6.4 s VBW 3 MHz
SGL Count 1/1
1Pk Max
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
CF 2.444 GHz
691 pts
640.0 ms/


Spectrum
Ref Level 30.50 dBm Offset 10.50 dB RBW 1 MHz
Att 30 dB SWT 3 ms VBW 3 MHz
SGL TRG:VID
1Pk Clrw
D1[1] -0.49 dB
715.30 µs
M1[1] 3.52 dBm
1.45 µs
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
M1
D1
TRG 0.500 dBm
CF 2.444 GHz
691 pts
300.0 µs/

FCC §15.247(b) (2) - PEAK OUTPUT POWER MEASUREMENT

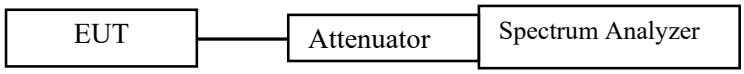
Applicable Standard

According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.5

1. Place the EUT on a bench and set in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.



Test Data

Environmental Conditions

Temperature:	27.9 ℃
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

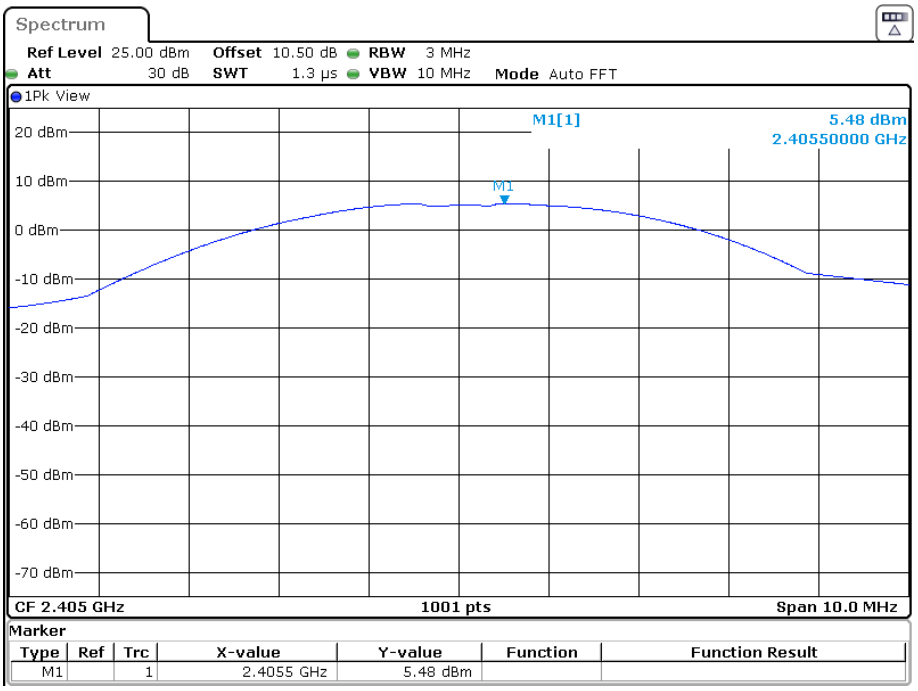
The testing was performed by Nick Fang on 2023-02-20.

EUT operation mode: Transmitting

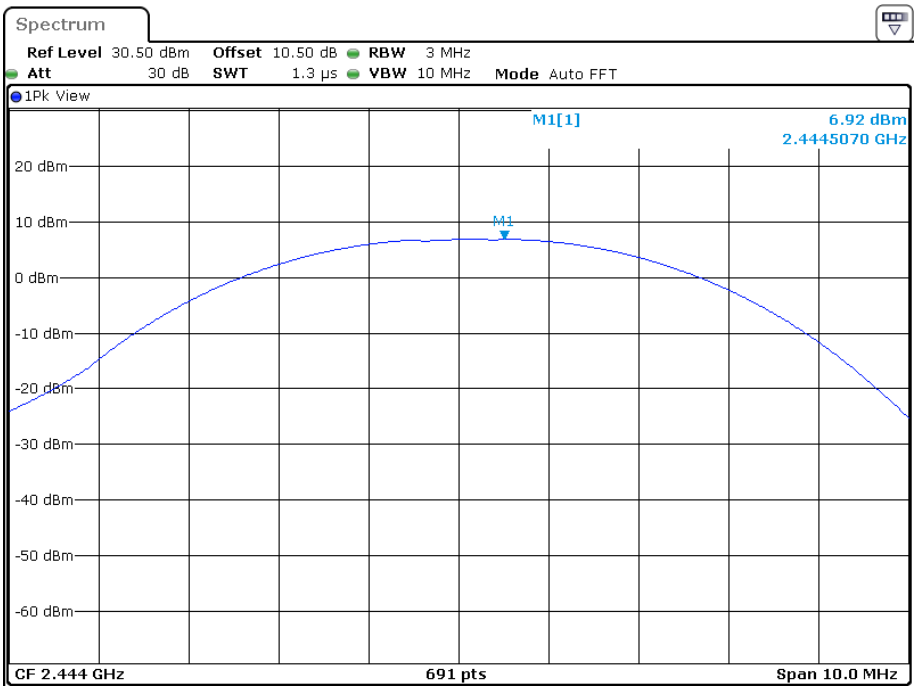
Test Result: Compliant.

Channel	Frequency (MHz)	Peak Output Power (dBm)	Limit (dBm)
Low	2405	5.48	20.97
Middle	2444	6.92	20.97
High	2478	7.44	20.97

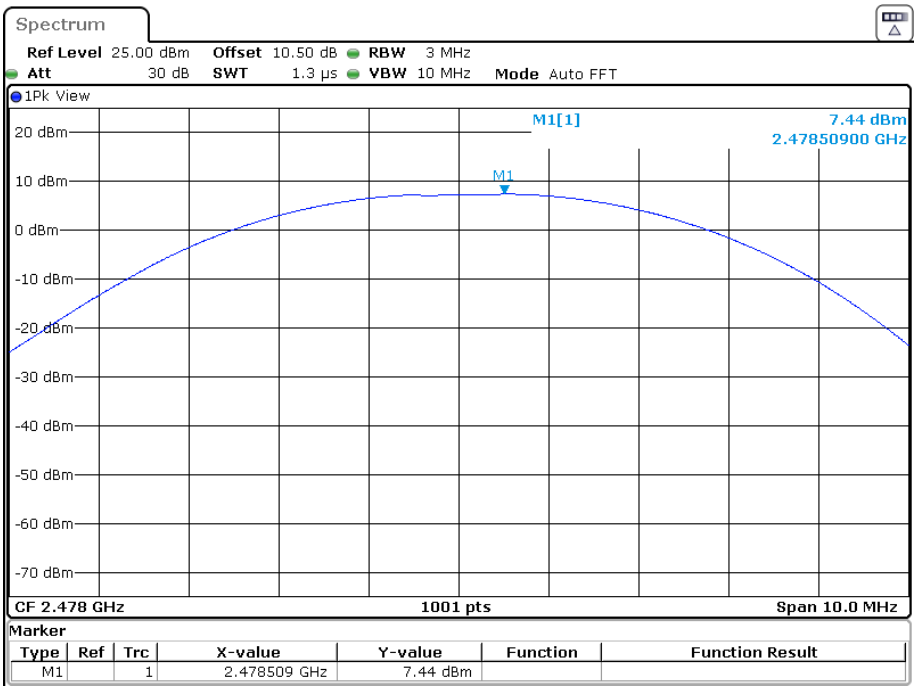
Low channel



Middle channel



High channel



FCC §15.247(d) - BAND EDGES TESTING

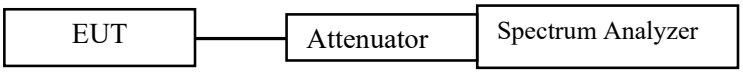
Applicable Standard

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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.6 & Clause 6.10

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.



Test Data

Environmental Conditions

Temperature:	27.9 ℃
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

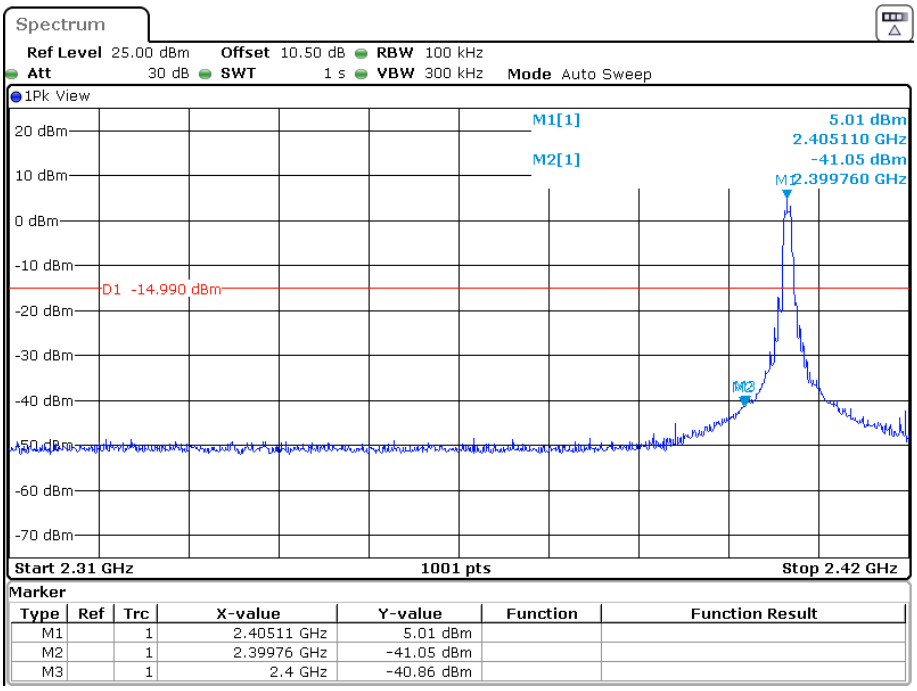
The testing was performed by Nick Fang on 2023-02-20.

EUT operation mode: Transmitting

Test Result: Compliant.

Conducted Band Edge Result:

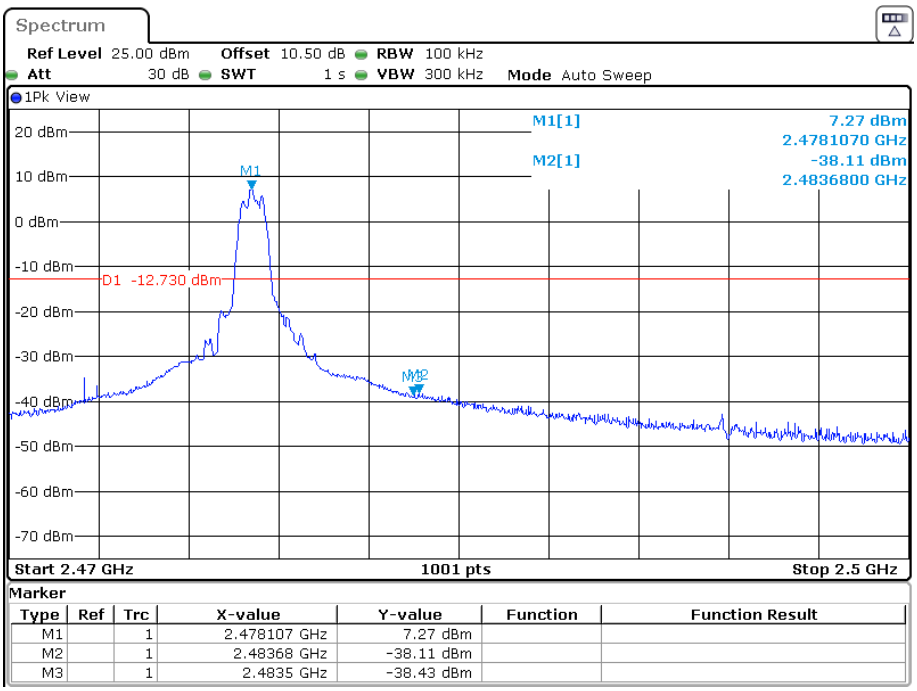
Low



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40511 GHz	5.01 dBm		
M2		1	2.39976 GHz	-41.05 dBm		
M3		1	2.4 GHz	-40.86 dBm		

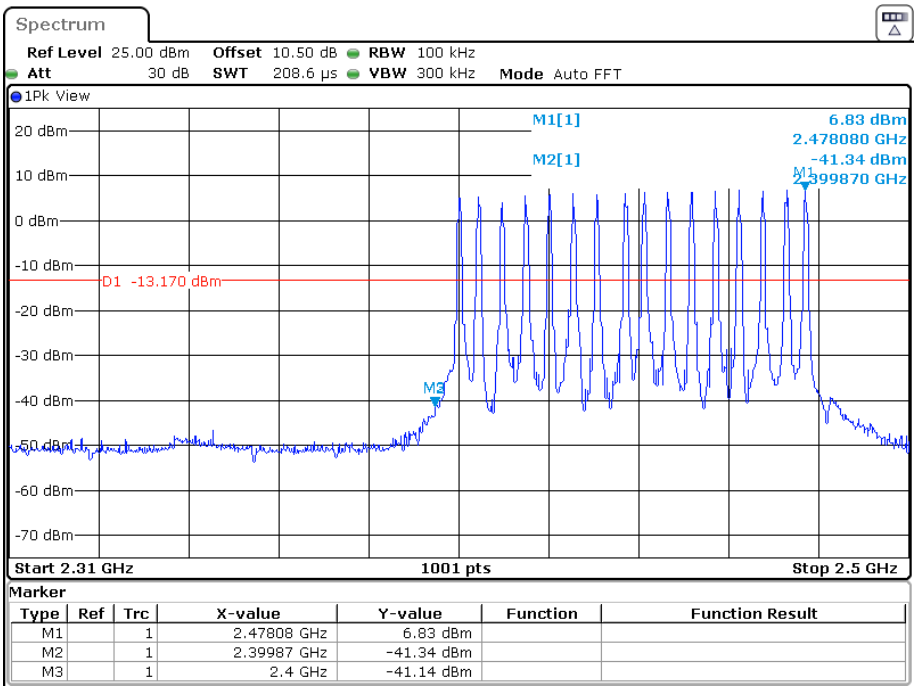
High



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.478107 GHz	7.27 dBm		
M2		1	2.48368 GHz	-38.11 dBm		
M3		1	2.4835 GHz	-38.43 dBm		

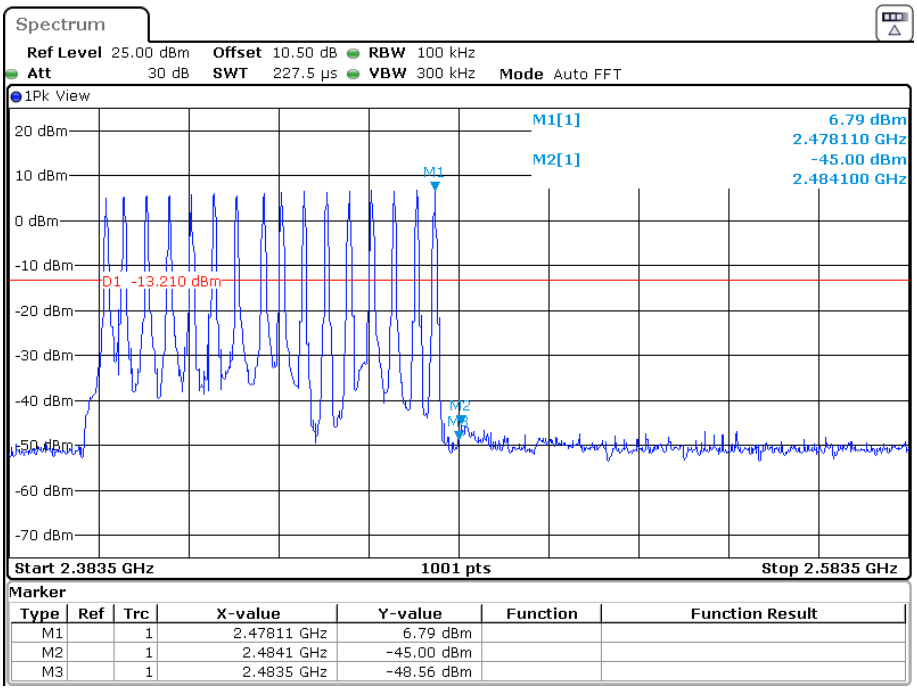
Low_Hop



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47808 GHz	6.83 dBm		
M2		1	2.39987 GHz	-41.34 dBm		
M3		1	2.4 GHz	-41.14 dBm		

High_Hop



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47811 GHz	6.79 dBm		
M2		1	2.4841 GHz	-45.00 dBm		
M3		1	2.4835 GHz	-48.56 dBm		

******* END OF REPORT *******