TEST REPORT

Applicant Name:	JINGSHAN JINGYANG ELECTRONICS CO., LTD
Address:	Group 1, Sanyang Village, Sanyang Town, Jingshan City, Jingmen City, Hubei Province, China
Report Number:	2401V33212E-RF-00
FCC ID:	2BFYM-TWS122R

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type:	OPEN EAR SPORT HOOK TRUE WIRELESS EARBUDS
Model No.:	PATW-1031-BK
Multiple Model(s) No.:	TWS122
Trade Mark:	Prime Audio
Date Received:	2024/07/24
Issue Date:	2024/08/20

Test Result:	Pass▲

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

Prepared and Checked By:

Jojo Guo
RF Engineer

Approved By:

Nancy Wang
RF Supervisor

Note: The information marked # is provided by the applicant, the laboratory is not responsible for its authenticity and this information can affect the validity of the result in the test report. Customer model name, addresses, names, trademarks etc. are included.
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TABLE OF CONTENTS

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	2401V33212E-RF-00	Original Report	2024/08/20

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	OPEN EAR SPORT HOOK TRUE WIRELESS EARBUDS
Tested Model	PATW-1031-BK
Multiple Model(s)	TWS122
UPC Number	195207094775
SKU Number	9154689
Frequency Range	Bluetooth: 2402~2480MHz
Transmit Peak Power	1.38dBm
Modulation Technique	Bluetooth: GFSK, π/4-DQPSK
Antenna Specification#	1.72dBi (provided by the applicant)
Voltage Range	DC 3.7V from battery
Sample serial number	2OZC-1 for Radiated Emissions Test 2OZC-2 for RF Conducted Test (Assigned by BACL, Shenzhen)
Sample/EUT Status	Good condition
Adapter Information	N/A
Note: The Multiple models are electrically identical with the test model except for model name. Please refer to the declaration letter# for more detail, which was provided by manufacturer.	

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 Bay Area Compliance Laboratories Corp. (Shenzhen). 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 output power, conducted		0.72 dB(k=2, 95% level of confidence)
AC Power Lines Conducted Emissions	9kHz-150kHz	3.94dB(k=2, 95% level of confidence)
	150kHz-30MHz	3.84dB(k=2, 95% level of confidence)
Radiated Emissions	9kHz - 30MHz	3.30dB(k=2, 95% level of confidence)
	30MHz~200MHz (Horizontal)	4.48dB(k=2, 95% level of confidence)
	30MHz~200MHz (Vertical)	4.55dB(k=2, 95% level of confidence)
	200MHz~1000MHz (Horizontal)	4.85dB(k=2, 95% level of confidence)
	200MHz~1000MHz (Vertical)	5.05dB(k=2, 95% level of confidence)
	1GHz - 6GHz	5.35dB(k=2, 95% level of confidence)
	6GHz - 18GHz	5.44dB(k=2, 95% level of confidence)
	18GHz - 40GHz	5.16dB(k=2, 95% level of confidence)
Temperature		±1℃
Humidity		±1%
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 Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 5F(B-West) , 6F, 7F, the 3rd Phase of Wan Li Industrial Building D, Shihua Rd, FuTian Free Trade Zone, Shenzhen, China.

The lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 715558, the FCC Designation No. : CN5045.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	40	2442
1	2403	41	2443
2	2404	42	2444
…	…	…	…
…	…	…	…
36	2438	75	2477
37	2439	76	2478
38	2440	77	2479
39	2441	78	2480

EUT was tested with Channel 0, 39 and 78.

EUT Exercise Software

"FCC-assist-1.0.2.2"$^{\#}$ exercise software was used and the power level is 10$^{\#}$. The software and power level was provided by the applicant.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

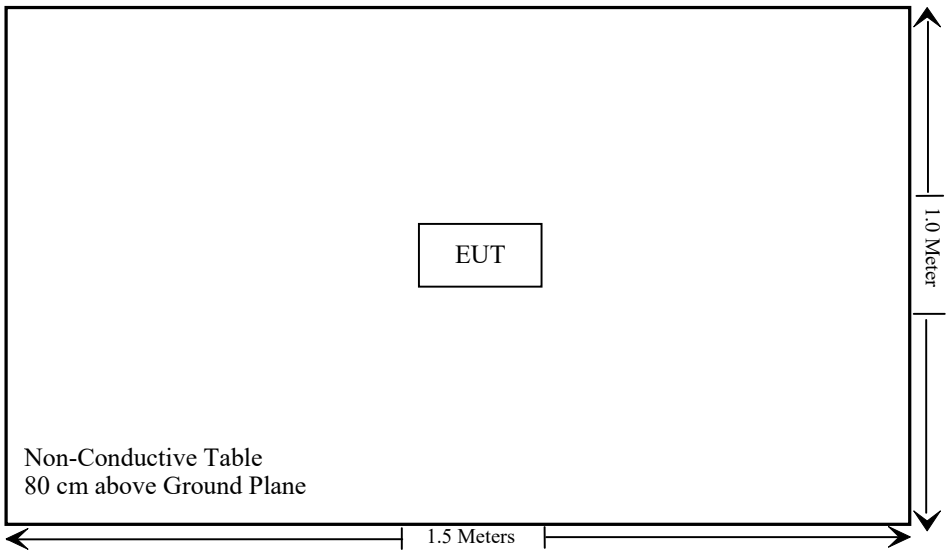
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

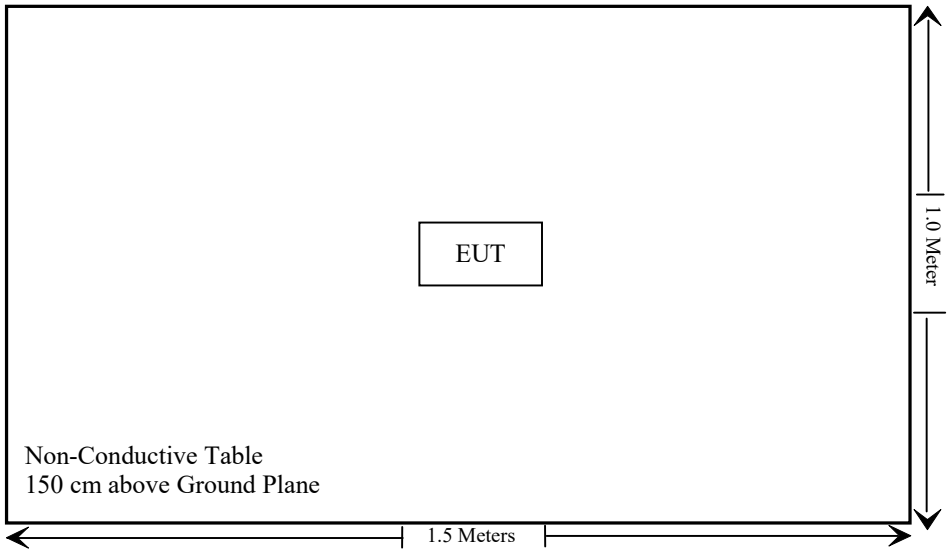
Cable Description	Length (m)	From Port	To
/	/	/	/

Block Diagram of Test Setup

For Radiated Emissions below 1GHz:



For Radiated Emissions above 1GHz:



SUMMARY OF TEST RESULTS

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

Not Applicable: The Bluetooth function cannot use when charging.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test					
R&S	EMI Test Receiver	ESR3	102455	2024/01/16	2025/01/15
Sonoma instrument	Pre-amplifier	310 N	186238	2024/05/21	2025/05/20
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2023/07/20	2026/07/19
BACL	Active Loop Antenna	1313-1A	4031911	2024/03/21	2025/03/20
Unknown	Cable	Chamber Cable 1	F-03-EM236	2024/06/18	2025/06/17
Unknown	Cable	Chamber Cable 4	EC-007	2024/06/18	2025/06/17
Audix	EMI Test software	E3	19821b(V9)	NCR	NCR
Rohde & Schwarz	Spectrum Analyzer	FSV40	101605	2024/03/27	2025/03/26
COM-POWER	Pre-amplifier	PA-122	181919	2024/06/18	2025/06/17
Schwarzbeck	Horn Antenna	BBHA9120D(1201)	1143	2023/07/26	2026/07/25
Unknown	RF Cable	KMSE	0735	2024/06/18	2025/06/17
Unknown	RF Cable	UFA147	219661	2024/06/18	2025/06/17
SNSD	2.4G Band Reject filter	BSF2402-2480MN-0898-001	2.4G filter	2024/06/27	2025/06/26
A.H.System	Pre-amplifier	PAM-1840VH	190	2024/06/18	2025/06/17
Electro-Mechanics Co	Horn Antenna	3116	2026	2023/09/18	2026/09/17
UTIFLEX	RF Cable	NO. 13	232308-001	2024/06/18	2025/06/17
RF Conducted Test					
Tonscend	RF control Unit	JS0806-2	19D8060154	2023/09/06	2024/09/05
Rohde & Schwarz	Signal and Spectrum Analyzer	FSV40	101473	2024/01/16	2025/01/15
Unknown	10dB Attenuator	Unknown	F-03-EM122	2024/06/27	2025/06/26

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) 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 section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level 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 test Exclusion.

Measurement Result

For worst case:

Mode	Frequency (MHz)	Max tune-up conducted power# (dBm)	Max tune-up conducted power# (mW)	Distance (mm)	Calculated value	Threshold (1-g SAR)	SAR Test Exclusion
BT	2402-2480	1.5	1.41	5	0.4	3	Yes

Result: Compliant

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.

Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

Antenna Connector Construction

The EUT has one internal antenna arrangement, which was permanently attached, the antenna gain[#] is 1.72dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliant

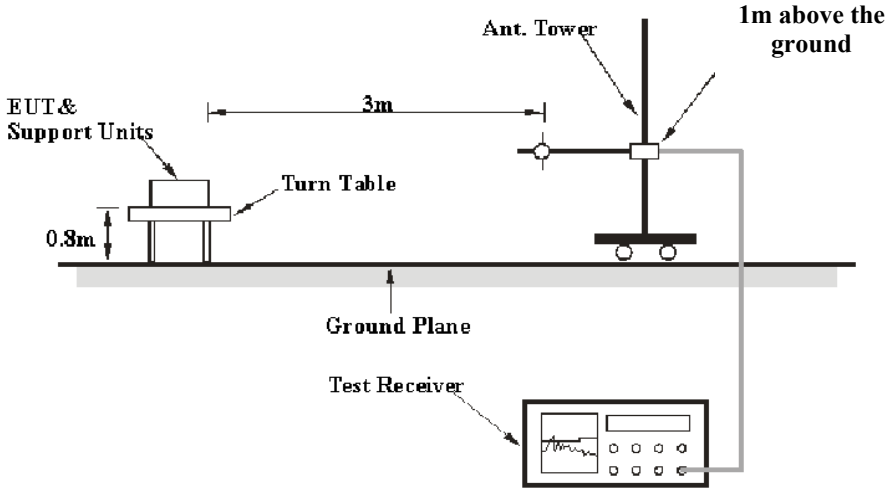
FCC §15.205, §15.209 & §15.247(d) - RADIATED EMISSIONS

Applicable Standard

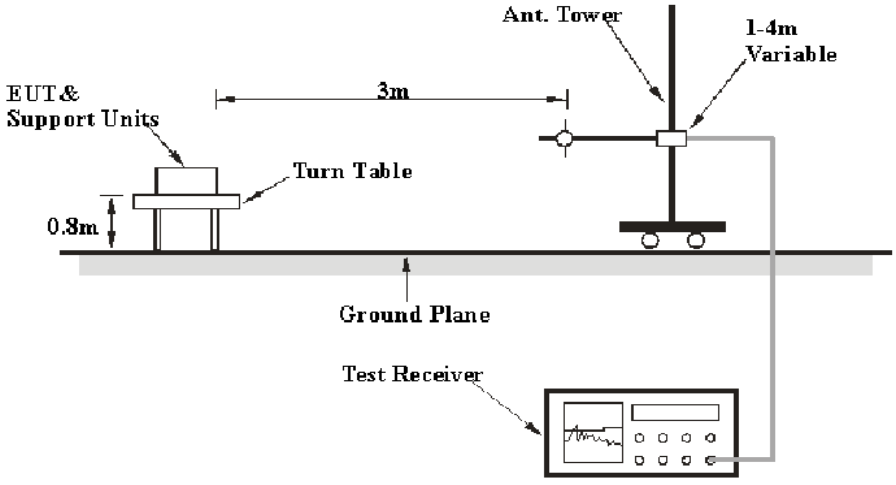
FCC §15.205; §15.209; §15.247(d)

EUT Setup

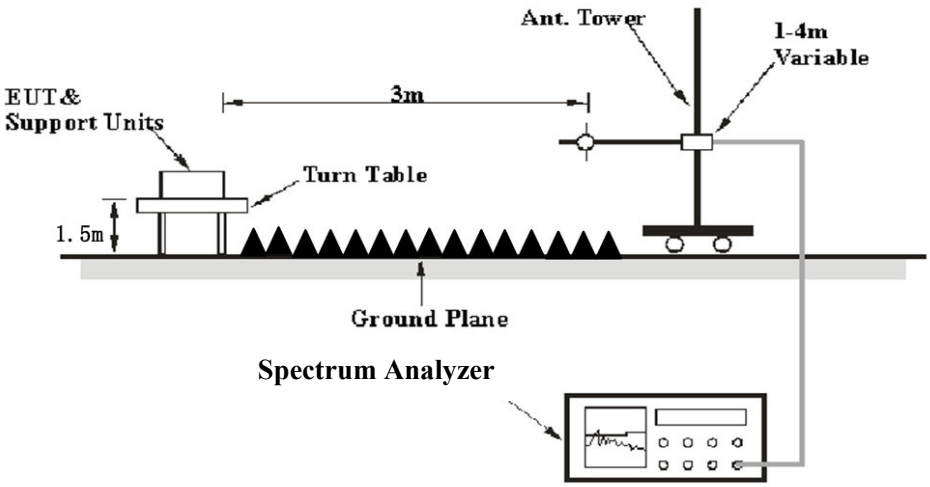
9 kHz-30MHz:



30MHz-1GHz:



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
9 kHz – 150 kHz	/	/	200 Hz	QP
	300 Hz	1 kHz	/	PK
150 kHz – 30 MHz	/	/	9 kHz	QP
	10 kHz	30 kHz	/	PK
30 MHz – 1000 MHz	/	/	120 kHz	QP
	100 kHz	300 kHz	/	PK
Above 1 GHz	Harmonics & Band Edge			
	1MHz	3 MHz	/	PK
	Average Emission Level=Peak Emission Level+20*log(Duty cycle)			
	Other Emissions			
	1MHz	3 MHz	/	PK
	1MHz	10 Hz	/	Average

For Duty cycle 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.

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 except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz, average detection modes for frequency bands 9–90 kHz and 110–490 kHz, peak and average detection modes for frequencies above 1 GHz.

For 9 kHz-30MHz, the report shall list the six emissions with the smallest margin relative to the limit, for each of the three antenna orientations (parallel, perpendicular, and ground-parallel) unless the margin is greater than 20 dB.

If the maximized peak measured value complies with under the QP/Average limit more than 6dB, then it is unnecessary to perform an QP/Average measurement.

All emissions under the average limit and under the noise floor have not recorded in the report.

Factor & Over Limit/Margin Calculation

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

Factor = Antenna Factor + Cable Loss - Amplifier Gain

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

Over Limit/Margin = Level/Corrected Amplitude – Limit
Level / Corrected Amplitude = Read Level + Factor

Test Data

Environmental Conditions

Temperature:	24~25.6 ℃
Relative Humidity:	50~55 %
ATM Pressure:	101 kPa

The testing was performed by Anson Su on 2024-07-30 for below 1GHz and and Dylan Yang on 2024-07-31and 2024-08-03 for above 1GHz.

Test mode: Transmitting

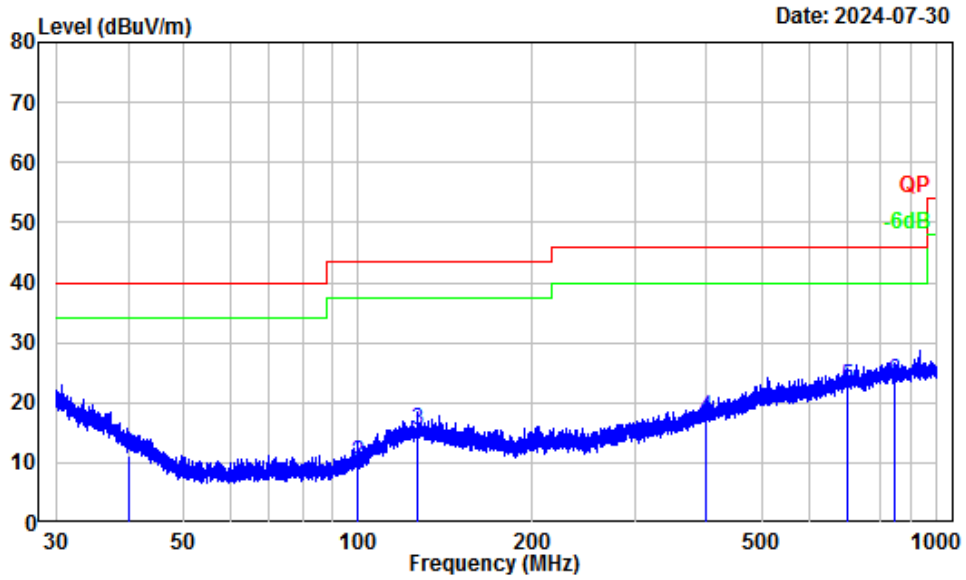
Note: After pre-scan in the X, Y and Z axes of orientation, the worst case z-axis of orientation were recorded.

9 kHz-30MHz: *(Maximum output power mode, π/4-DQPSK Low Channel)*

The amplitude of spurious emissions attenuated more than 20 dB below the limit was not recorded.

30MHz-1GHz: *(Maximum output power mode, π/4-DQPSK Low Channel)*

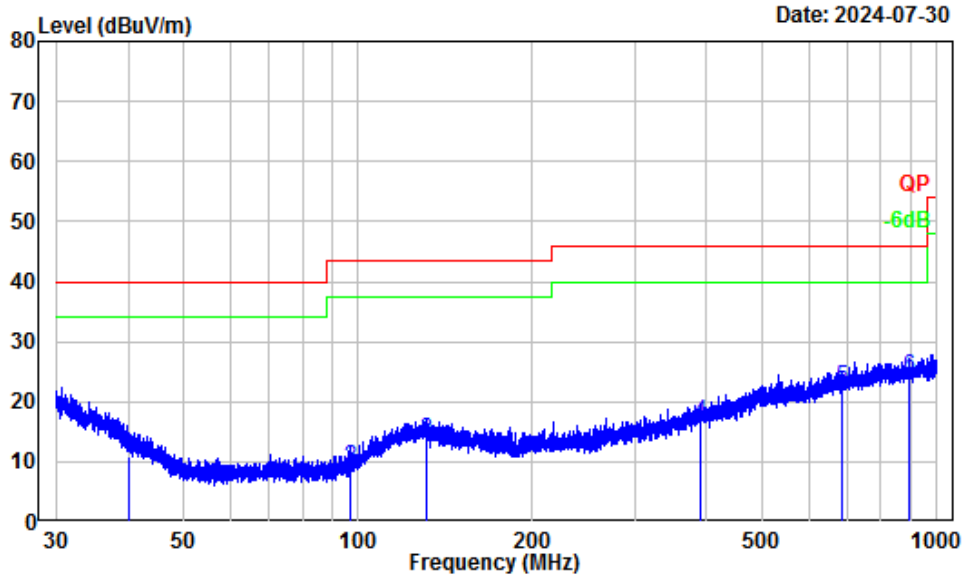
Horizontal



Site : Chamber A
Condition : 3m Horizontal
Project Number: 2401V33212E-RF
Test Mode : BT
Tester : Anson Su

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	40.08	-12.42	23.44	11.02	40.00	-28.98	QP
2	99.40	-16.02	25.94	9.92	43.50	-33.58	QP
3	126.16	-11.30	26.65	15.35	43.50	-28.15	QP
4	398.33	-8.47	25.90	17.43	46.00	-28.57	QP
5	698.39	-3.54	26.26	22.72	46.00	-23.28	QP
6	843.24	-1.78	25.41	23.63	46.00	-22.37	QP

Vertical



Site : Chamber A
Condition : 3m Vertical
Project Number: 2401V33212E-RF
Test Mode : BT
Tester : Anson Su

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	40.01	-12.38	23.19	10.81	40.00	-29.19	QP
2	97.11	-16.49	25.46	8.97	43.50	-34.53	QP
3	131.01	-11.28	24.98	13.70	43.50	-29.80	QP
4	390.38	-8.75	25.42	16.67	46.00	-29.33	QP
5	684.45	-3.70	26.01	22.31	46.00	-23.69	QP
6	895.03	-1.35	25.55	24.20	46.00	-21.80	QP

Above 1GHz:

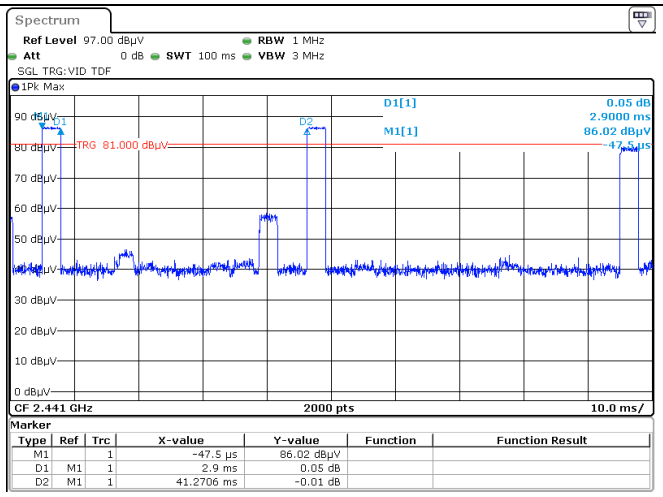
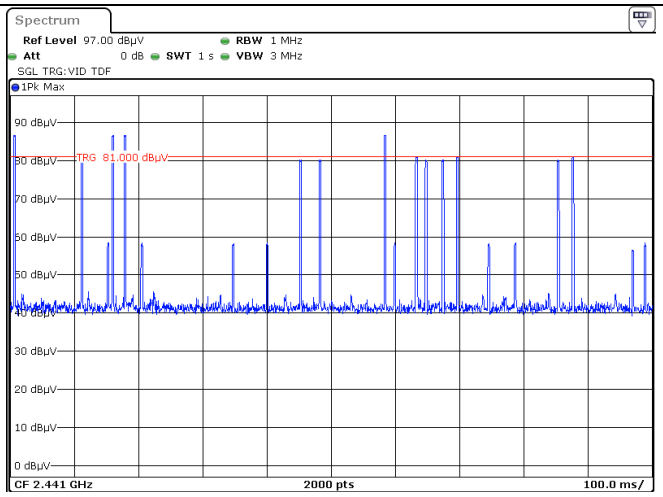
Frequency (MHz)	Receiver		Polar (H/V)	Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/AV					
Maximum output power mode, π/4-DQPSK							
Low Channel 2402MHz							
2353.94	54.88	PK	H	-2.93	51.95	74.00	-22.05
2363.43	54.04	PK	V	-2.93	51.11	74.00	-22.89
4804.00	48.74	PK	H	1.69	50.43	74.00	-23.57
4804.00	47.42	PK	V	1.69	49.11	74.00	-24.89
Middle Channel 2441MHz							
4882.00	49.68	PK	H	1.69	51.37	74.00	-22.63
4882.00	47.85	PK	V	1.69	49.54	74.00	-24.46
High Channel 2480MHz							
2483.88	54.69	PK	H	-3.17	51.52	74.00	-22.48
2490.02	54.44	PK	V	-3.18	51.26	74.00	-22.74
4960.00	51.31	PK	H	2.77	54.08	74.00	-19.92
4960.00	47.92	PK	V	2.77	50.69	74.00	-23.31

Note:
Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Factor + Reading
Margin = Corrected. Amplitude - Limit
The other spurious emission which is in the noise floor level was not recorded.

Field Strength of Average							
Frequency (MHz)	**Peak Measurement @3m (dBμV/m)**	**Polar (H/V)**	**Duty Cycle Corrected Factor (dB)**	**Average Level (dBμV/m)**	**Limit (dBμV/m)**	**Margin (dB)**	**Comment**
Low Channel 2402MHz							
2353.94	51.95	H	-24.73	27.22	54.00	-26.78	Bandedge
2363.43	51.11	V	-24.73	26.38	54.00	-27.62	Bandedge
4804.00	50.43	H	-24.73	25.70	54.00	-28.30	Harmonic
4804.00	49.11	V	-24.73	24.38	54.00	-29.62	Harmonic
Middle Channel 2441MHz							
4882.00	51.37	H	-24.73	26.64	54.00	-27.36	Harmonic
4882.00	49.54	V	-24.73	24.81	54.00	-29.19	Harmonic
High Channel 2480MHz							
2483.88	51.52	H	-24.73	26.79	54.00	-27.21	Bandedge
2490.02	51.26	V	-24.73	26.53	54.00	-27.47	Bandedge
4960.00	54.08	H	-24.73	29.35	54.00	-24.65	Harmonic
4960.00	50.69	V	-24.73	25.96	54.00	-28.04	Harmonic

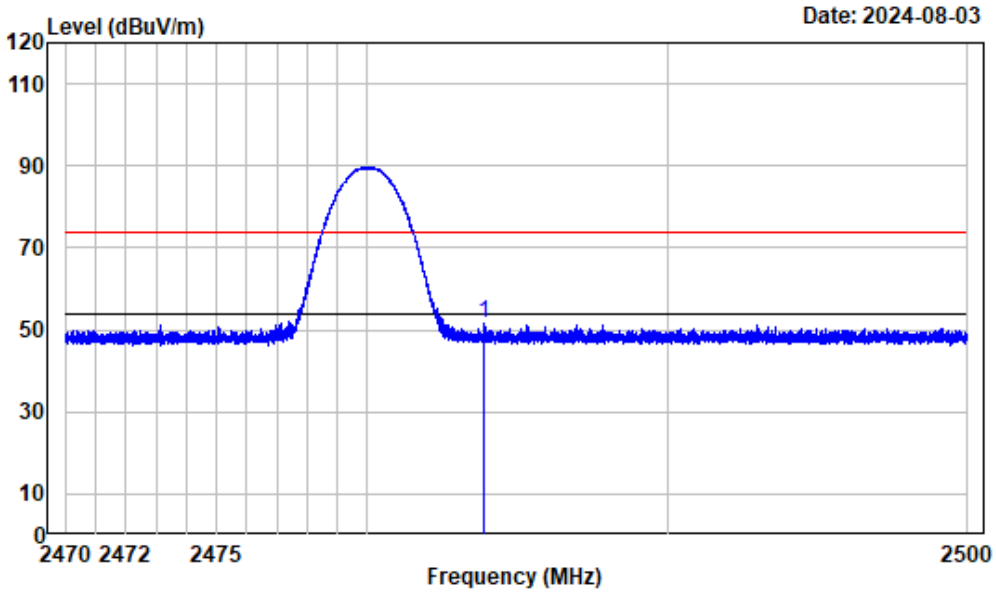
Note: Average level= Peak level+ Duty Cycle Corrected Factor

Worst case duty cycle:
Duty cycle = Ton/100ms = 2.9*2/100=0.058
Duty Cycle Corrected Factor = 20lg (Duty cycle) = 20lg0.058 = -24.73

Duty Cycle（100ms）	
Duty Cycle（1s）	

Test plots for Band Edge Measurements (Radiated):

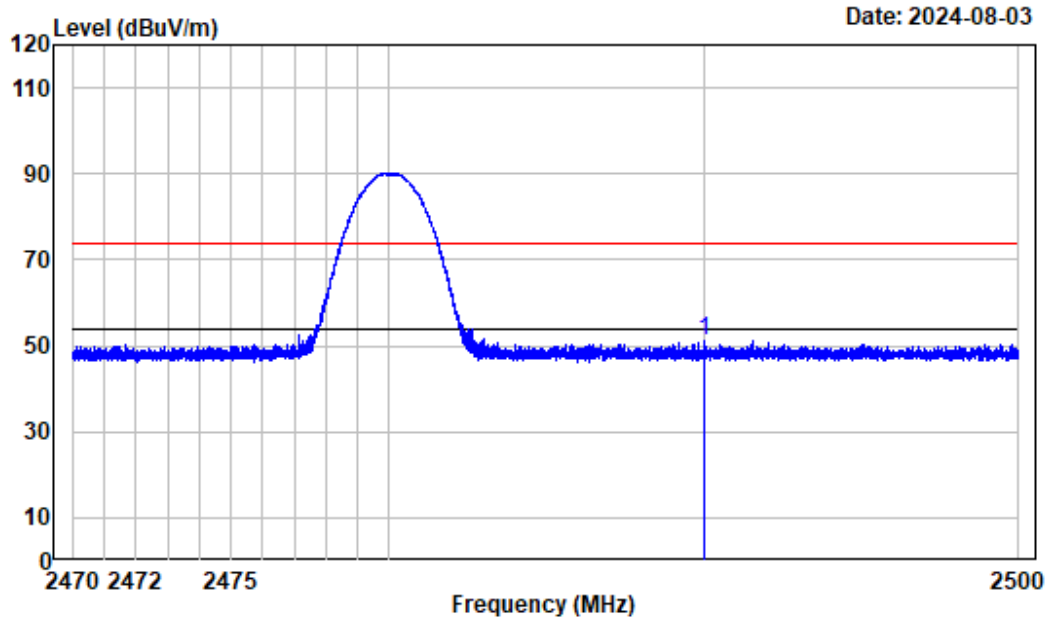
π/4-DQPSK			
Test Channel:	**2480MHz**	**Ant. Polar. :**	**Horizontal**




```
Condition   : Horizontal
Project No.: 2401V33212E-RF
Tester      : Dylan
Note        : BT_2DH5_2480
```

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	2483.883	-3.17	54.69	51.52	74.00	-22.48	peak

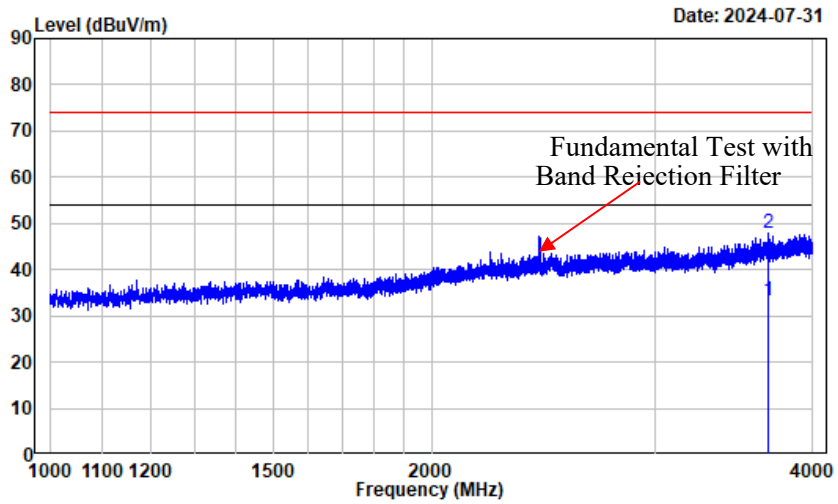
π/4-DQPSK			
Test Channel:	**2480MHz**	**Ant. Polar. :**	**Vertical**



Condition : Vertical
Project No.: 2401V33212E-RF
Tester : Dylan
Note : BT_2DH5_2480

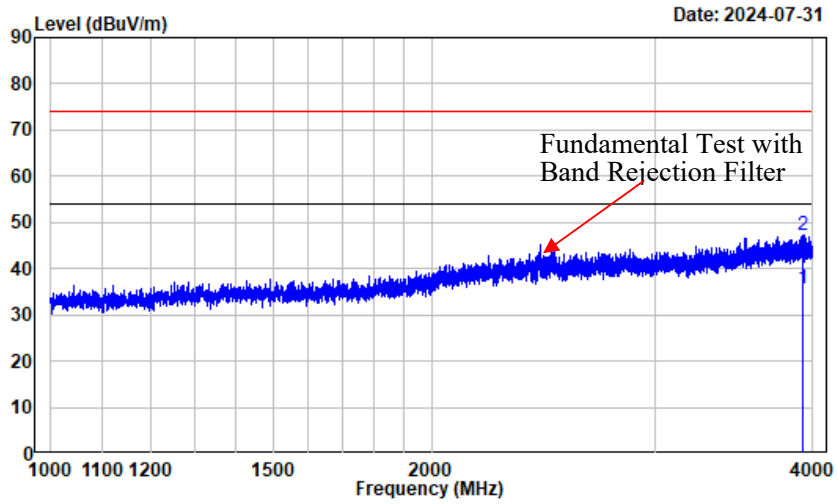
	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	2490.018	-3.18	54.44	51.26	74.00	-22.74	peak

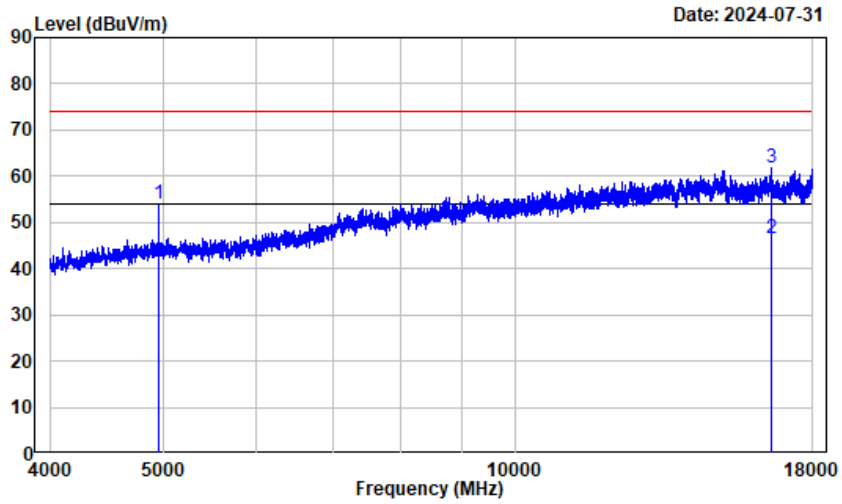
Test plots for Harmonic and Emissions Measurements:

Horizontal	
1-4GHz	


```
Condition   : Horizontal
Project No.: 2401V33212E-RF
Tester      : Dylan
Note        : BT_2DH5_2480
```

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	3692.500	-1.19	34.61	33.42	54.00	-20.58	Average
2	3692.500	-1.19	49.24	48.05	74.00	-25.95	Peak

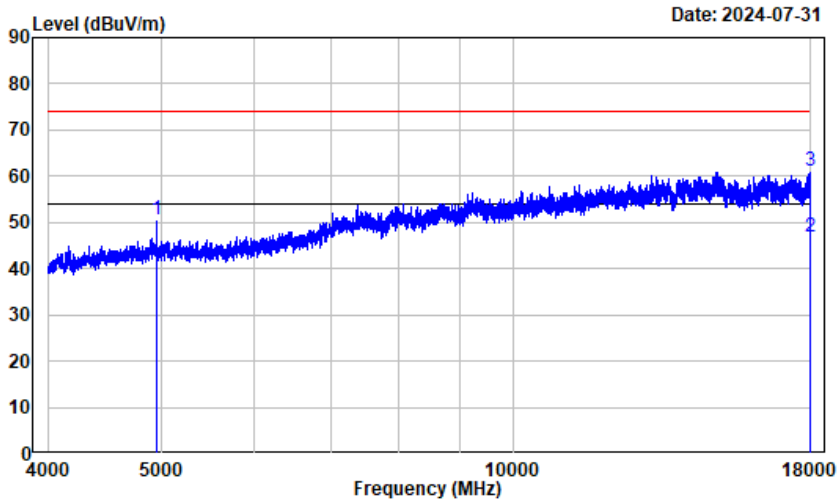
Vertical	
1-4GHz	 Condition : Vertical Project No.: 2401V33212E-RF Tester : Dylan Note : BT_2DH5_2480 | | Freq | Factor | Read Level | Level | Limit Line | Over Limit | Remark | | | MHz | dB/m | dBuV | dBuV/m | dBuV/m | dB | | | 1 | 3932.125 | -0.30 | 35.84 | 35.54 | 54.00 | -18.46 | Average | | 2 | 3932.125 | -0.30 | 47.59 | 47.29 | 74.00 | -26.71 | Peak |

Horizontal	
4-18GHz	 Condition : Horizontal Project No.: 2401V33212E-RF Tester : Dylan Note : BT_2DH5_2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	4960.000	2.77	51.31	54.08	74.00	-19.92	Peak
2	16591.250	15.96	30.53	46.49	54.00	-7.51	Average
3	16591.250	15.96	45.89	61.85	74.00	-12.15	Peak

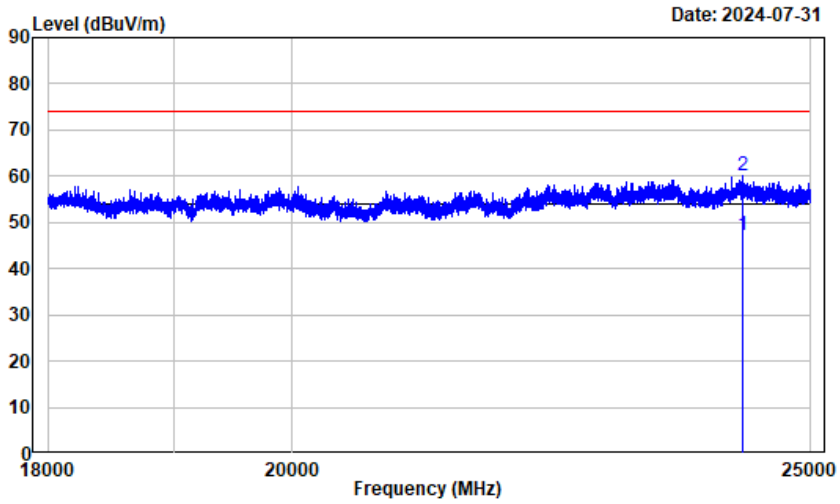
Vertical

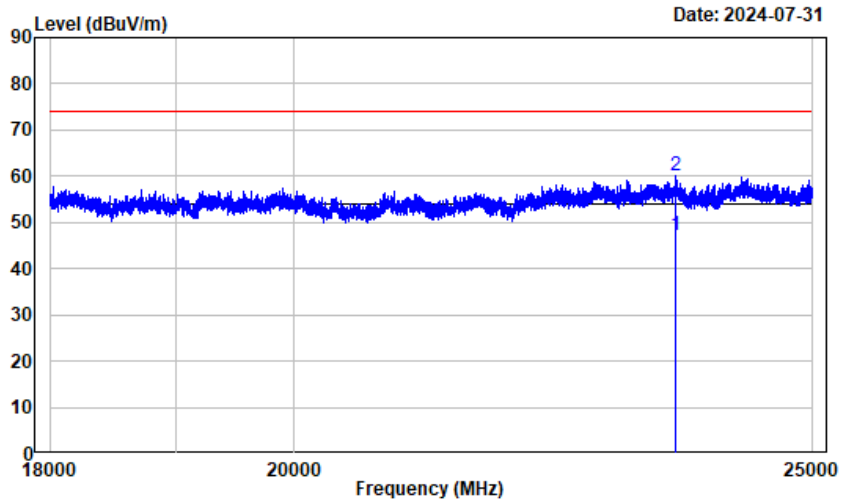
4-18GHz



Condition : Vertical
Project No.: 2401V33212E-RF
Tester : Dylan
Note : BT_2DH5_2480

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	4960.000	2.77	47.92	50.69	74.00	-23.31	Peak
2	18000.000	24.62	22.41	47.03	54.00	-6.97	Average
3	18000.000	24.62	36.62	61.24	74.00	-12.76	Peak

Horizontal	
18-25GHz	 Condition : Horizontal Project No.: 2401V33212E-RF Tester : Dylan Note : BT_2DH5_2480 Freq / Factor / Read Level / Level / Limit Line / Over Limit / Remark MHz / dB/m / dBuV / dBuV/m / dBuV/m / dB 1 24275.500 18.46 28.78 47.24 54.00 -6.76 Average 2 24275.500 18.46 41.60 60.06 74.00 -13.94 peak

Vertical	
18-25GHz	 Condition : Vertical Project No.: 2401V33212E-RF Tester : Dylan Note : BT_2DH5_2480 Freq / Factor / Read Level / Limit Level / Limit Line / Over Limit / Remark MHz / dB/m / dBuV / dBuV/m / dBuV/m / dB 1 23566.750 17.50 29.75 47.25 54.00 -6.75 Average 2 23566.750 17.50 42.52 60.02 74.00 -13.98 peak

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.

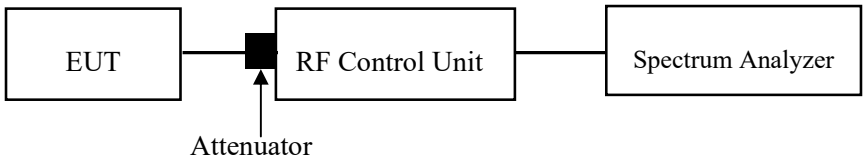
Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.2

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Wide enough to capture the peaks of two adjacent channels.
b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
c) Video (or average) bandwidth (VBW) ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined.



Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101 kPa

The testing was performed by Navilite Cai on 2024-07-31.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(a) (1) - 20 dB EMISSION 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

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level.

d) Steps a) through c) might require iteration to adjust within the specified tolerances.

e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target "−xx dB down" requirement; that is, if the requirement calls for measuring the −20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.

f) Set detection mode to peak and trace mode to max hold.

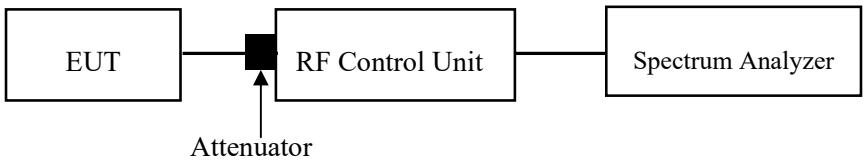
g) Determine the reference value: Set the EUT to transmit an un-modulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).

h) Determine the "−xx dB down amplitude" using [(reference value) − xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.

i) If the reference value is determined by an un-modulated carrier, then turn the EUT modulation on, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).

j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the "− xx dB down amplitude" determined in step h). If a marker is below this "−xx dB down amplitude" value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the "− xx dB down amplitude" determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).



Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101 kPa

The testing was performed by Navilite Cai on 2024-07-31.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

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

Applicable Standard

Frequency hopping systems in the 2400–2483.5 MHz band 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 7.8.3

a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.

b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.

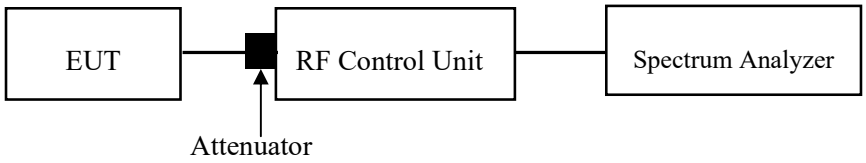
c) VBW ≥ RBW.

d) Sweep: Auto.

e) Detector function: Peak.

f) Trace: Max hold.

It might prove necessary to break the span up into sub ranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels.



Test Data

Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	55 %
ATM Pressure:	101 kPa

The testing was performed by Navilite Cai on 2024-07-31.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(a) (1) (iii) - 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

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Zero span, centered on a hopping channel.
b) RBW shall be ⩽ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
d) Detector function: Peak.
e) Trace: Max hold.

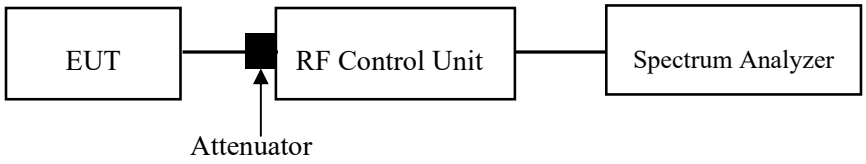
Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

(Number of hops in the period specified in the requirements) =(number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time)

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.



Note 1: A period time=0.4*79=31.6(S), Result=BurstWidth*Totalhops
Note 2: Totalhops=Hopping Number in 3.16s*10
Note 3: Hopping Number in 3.16s=Total of highest signals in 3.16s(Second high signals were other channel)

Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101 kPa

The testing was performed by Navilite Cai on 2024-07-31.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(b) (1) - 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

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

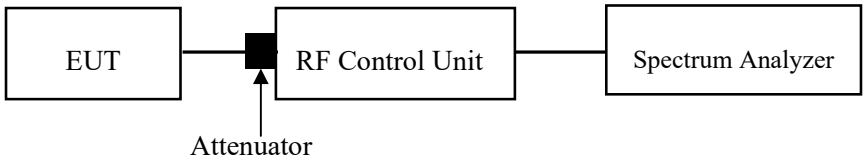
a) Use the following spectrum analyzer settings:

1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
2) RBW > 20 dB bandwidth of the emission being measured.
3) VBW ≥ RBW.
4) Sweep: Auto.
5) Detector function: Peak.
6) Trace: Max hold.

b) Allow trace to stabilize.

c) Use the marker-to-peak function to set the marker to the peak of the emission.

d) The indicated level is the peak output power, after any corrections for external attenuators and cables.



Test Data

Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	55 %
ATM Pressure:	101 kPa

The testing was performed by Navilite Cai on 2024-07-31.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(d) § 5.5 - BAND EDGES TESTING

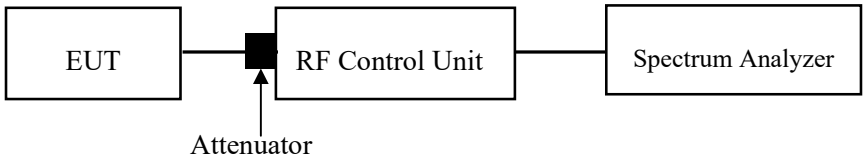
Applicable Standard

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:	25 ℃
Relative Humidity:	55 %
ATM Pressure:	101 kPa

The testing was performed by Navilite Cai on 2024-07-31.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

EUT PHOTOGRAPHS

Please refer to the attachment 2401V33212E-RF External photo and 2401V33212E-RF Internal photo.

TEST SETUP PHOTOGRAPHS

Please refer to the attachment 2401V33212E-RF Test Setup photo.

APPENDIX

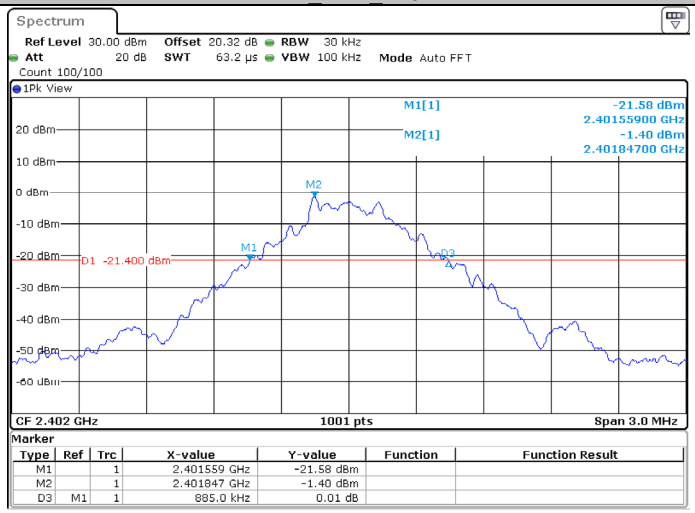
Appendix A: 20dB Emission Bandwidth

Test Result

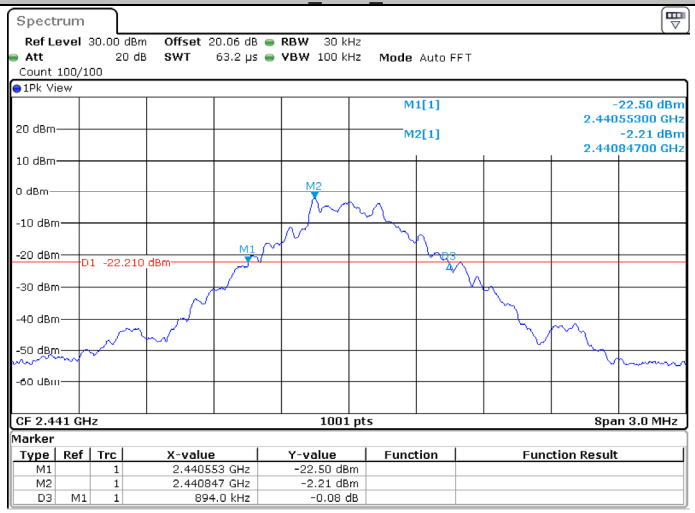
Test Mode	Antenna	Frequency[MHz]	20dB EBW[MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	0.885	2401.56	2402.44	---	---
		2441	0.894	2440.55	2441.45	---	---
		2480	1.002	2479.50	2480.50	---	---
2DH1	Ant1	2402	1.242	2401.38	2402.62	---	---
		2441	1.227	2440.38	2441.61	---	---
		2480	1.227	2479.38	2480.60	---	---

Test Graphs

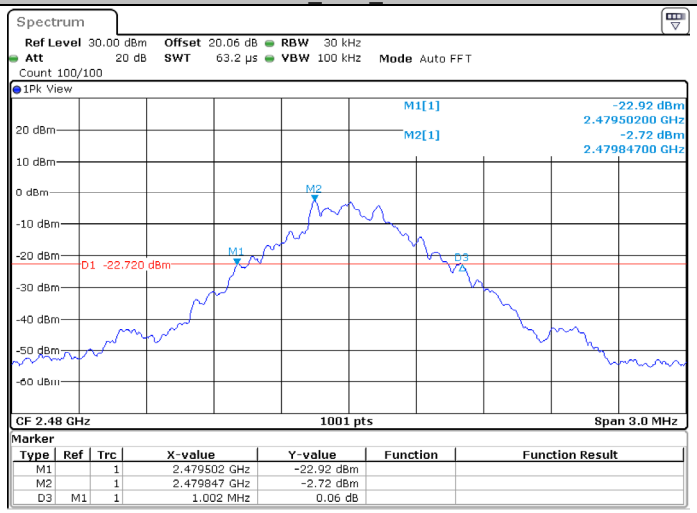
DH1_Ant1_2402



DH1_Ant1_2441

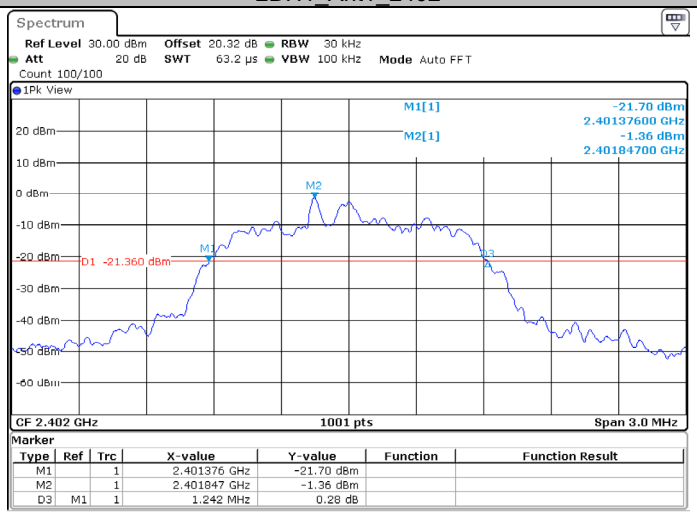


DH1_Ant1_2480



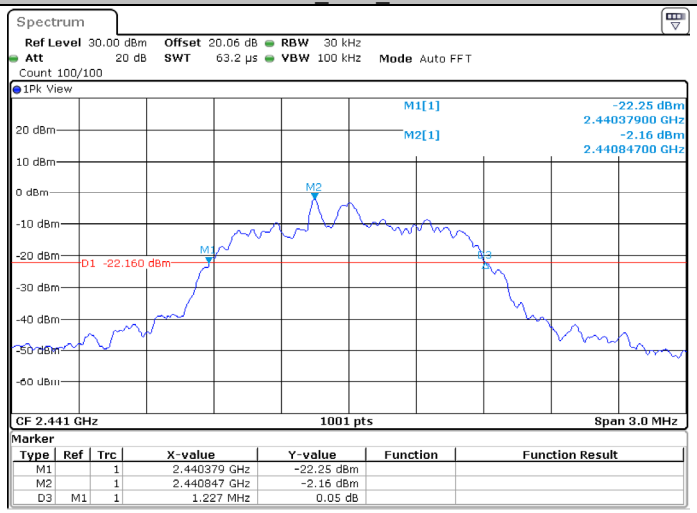
ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 11:05:28

2DH1_Ant1_2402



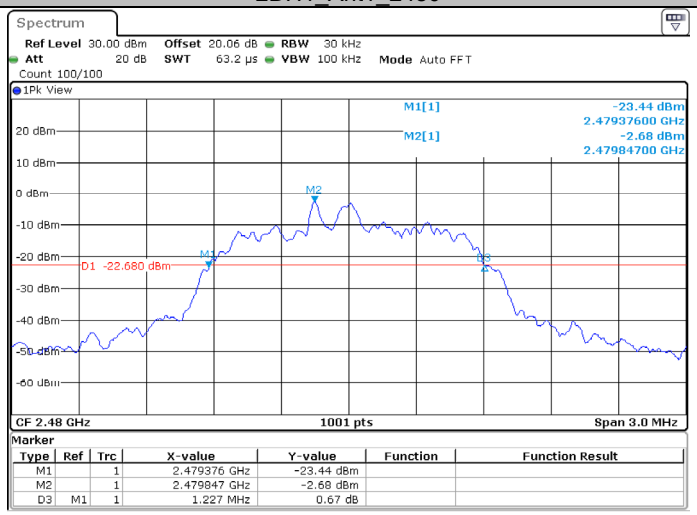
ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 11:08:34

2DH1_Ant1_2441



ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 11:09:57

2DH1_Ant1_2480



ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 11:10:41

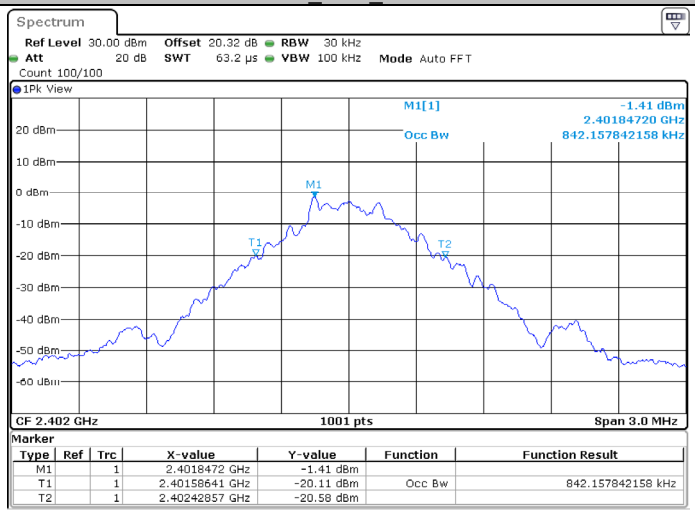
Appendix B: Occupied Channel Bandwidth

Test Result

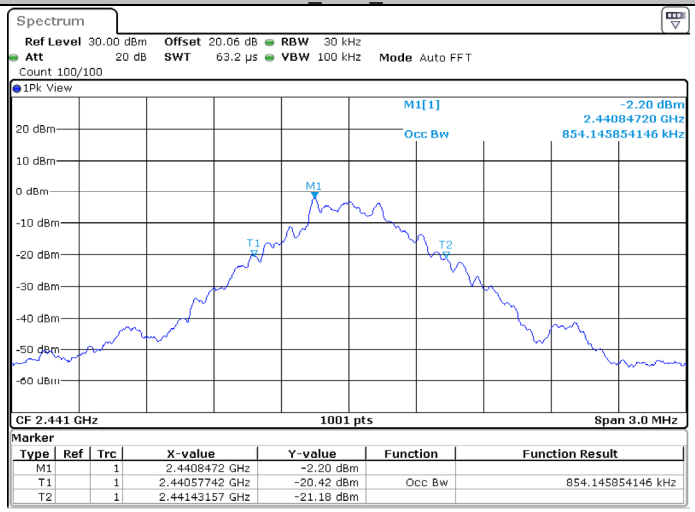
Test Mode	Antenna	Frequency[MHz]	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	0.842	2401.5864	2402.4286	---	---
		2441	0.854	2440.5774	2441.4316	---	---
		2480	0.869	2479.5684	2480.4376	---	---
2DH1	Ant1	2402	1.166	2401.4156	2402.5814	---	---
		2441	1.163	2440.4186	2441.5814	---	---
		2480	1.160	2479.4216	2480.5814	---	---

Test Graphs

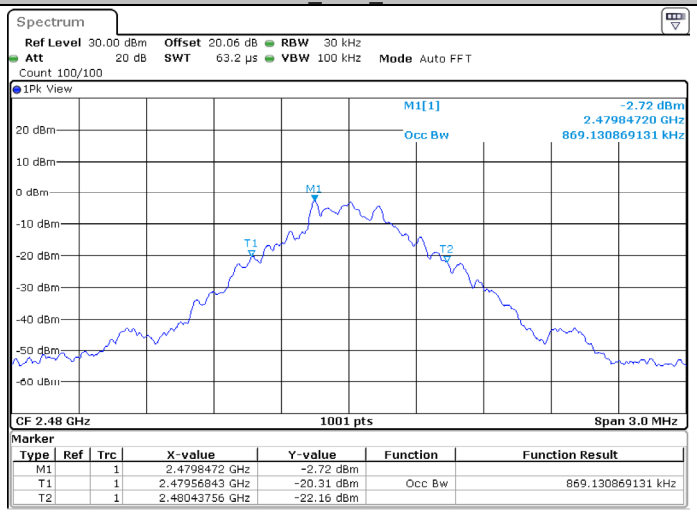
DH1_Ant1_2402



DH1_Ant1_2441



DH1_Ant1_2480

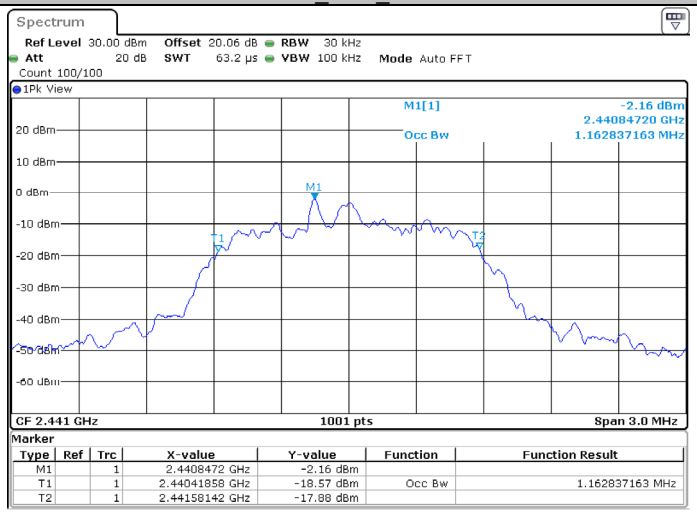


ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 11:05:34

2DH1_Ant1_2402

ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 11:08:40

2DH1_Ant1_2441



2DH1_Ant1_2480

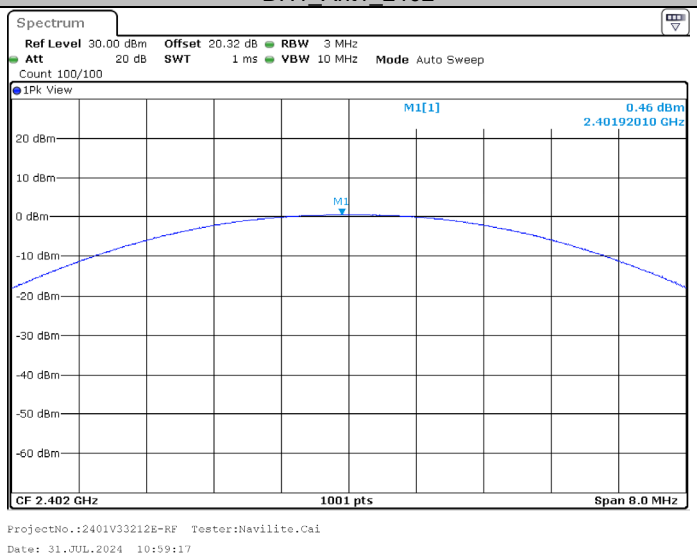
Appendix C: Maximum conducted output power

Test Result

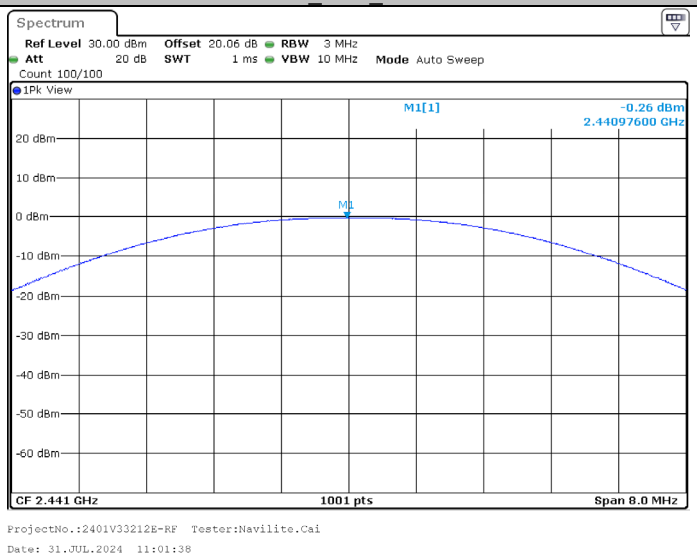
Test Mode	Antenna	Frequency[MHz]	Conducted Peak Power[dBm]	Conducted Limit[dBm]	Verdict
DH1	Ant1	2402	0.46	≤20.97	PASS
		2441	-0.26	≤20.97	PASS
		2480	-0.66	≤20.97	PASS
2DH1	Ant1	2402	1.38	≤20.97	PASS
		2441	0.65	≤20.97	PASS
		2480	0.23	≤20.97	PASS

Test Graphs

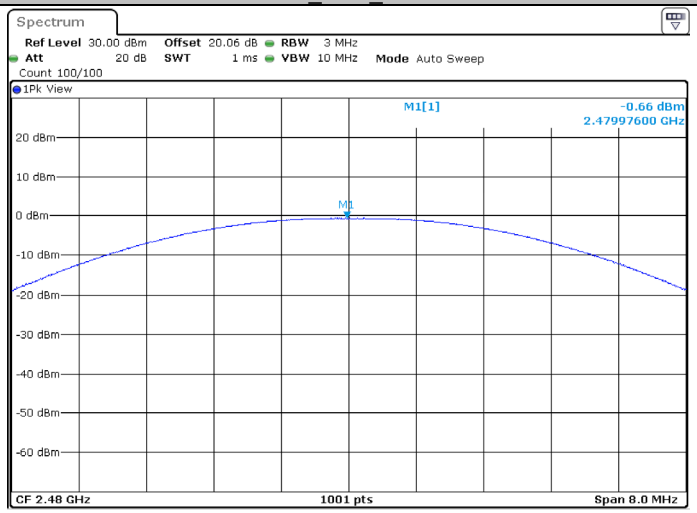
DH1_Ant1_2402



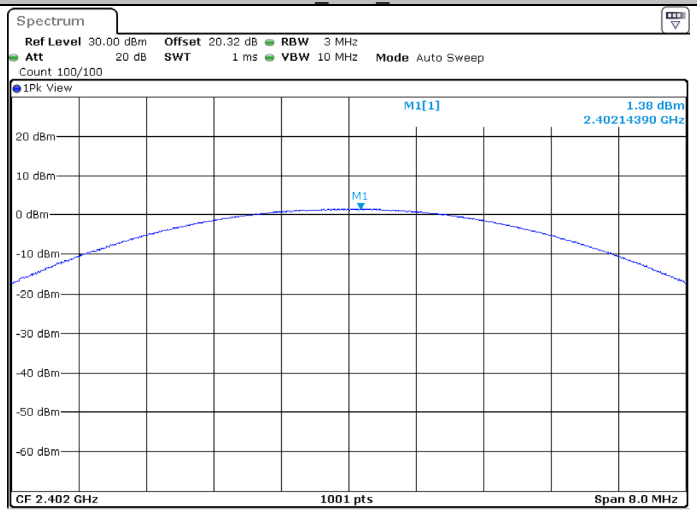
DH1_Ant1_2441



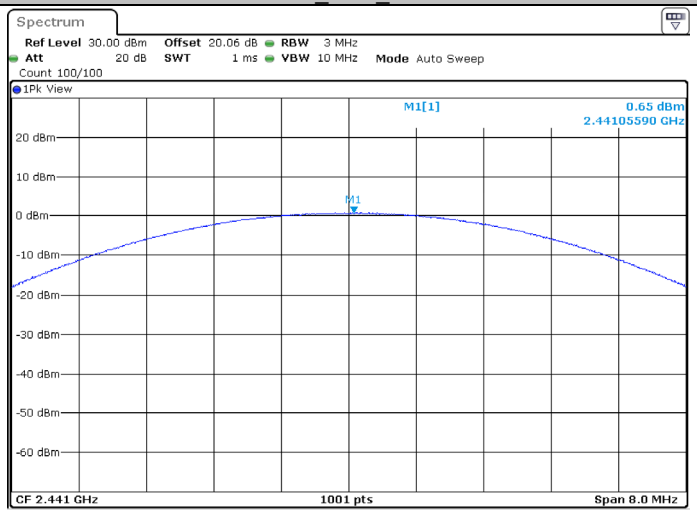
DH1_Ant1_2480



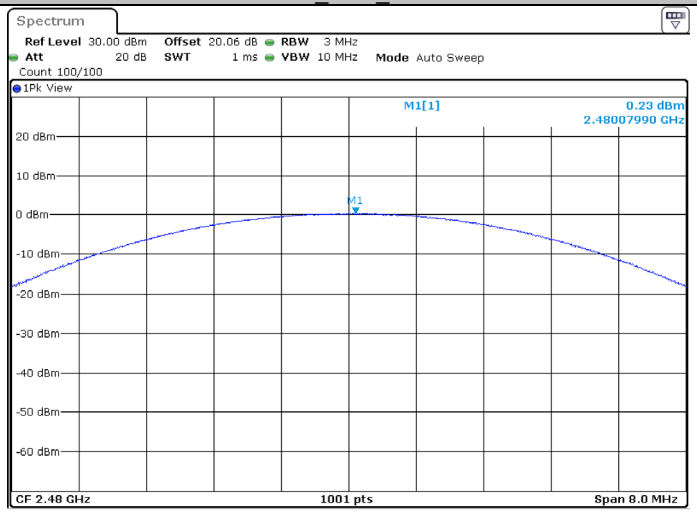
2DH1_Ant1_2402



2DH1_Ant1_2441



2DH1_Ant1_2480



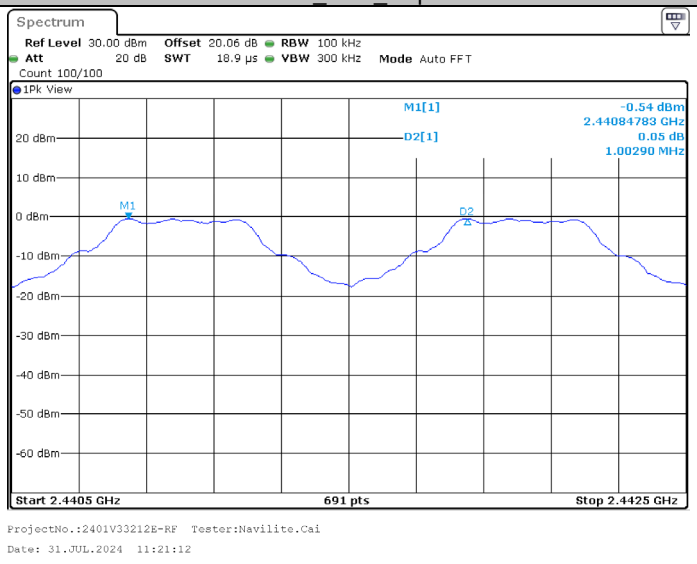
Appendix D: Carrier frequency separation

Test Result

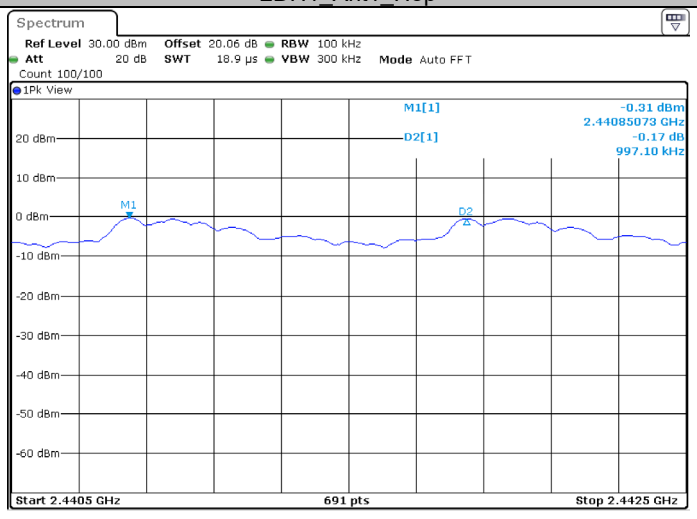
Test Mode	Antenna	Frequency[MHz]	Result[MHz]	Limit[MHz]	Verdict
DH1	Ant1	Hop	1.003	≥0.668	PASS
2DH1	Ant1	Hop	0.997	≥0.828	PASS

Test Graphs

DH1_Ant1_Hop



2DH1_Ant1_Hop



Appendix E: Time of occupancy

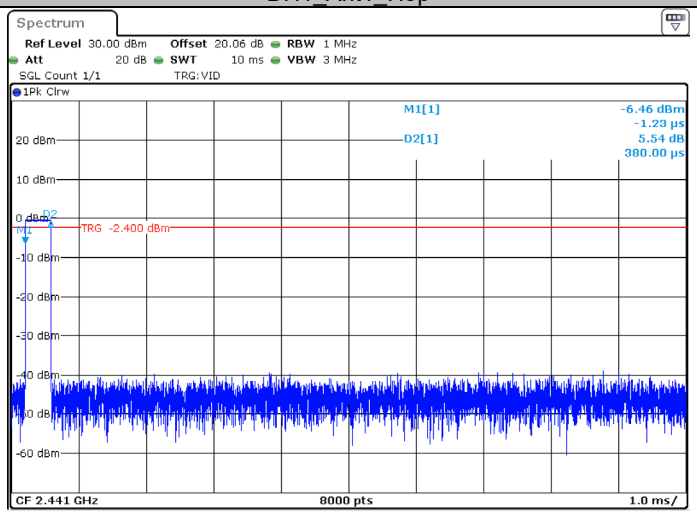
Test Result

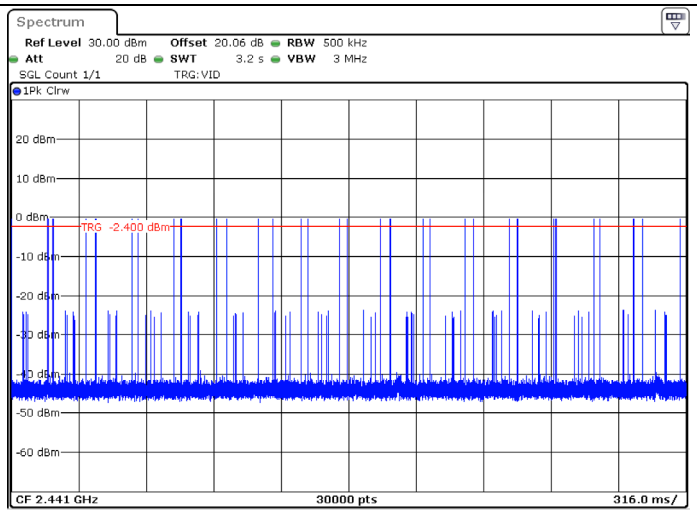
Test Mode	Antenna	Frequency[MHz]	Burst Width [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.380	320	0.122	≤0.4	PASS
DH3	Ant1	Hop	1.628	160	0.260	≤0.4	PASS
DH5	Ant1	Hop	2.869	110	0.316	≤0.4	PASS
2DH1	Ant1	Hop	0.389	320	0.124	≤0.4	PASS
2DH3	Ant1	Hop	1.633	170	0.278	≤0.4	PASS
2DH5	Ant1	Hop	2.873	120	0.345	≤0.4	PASS

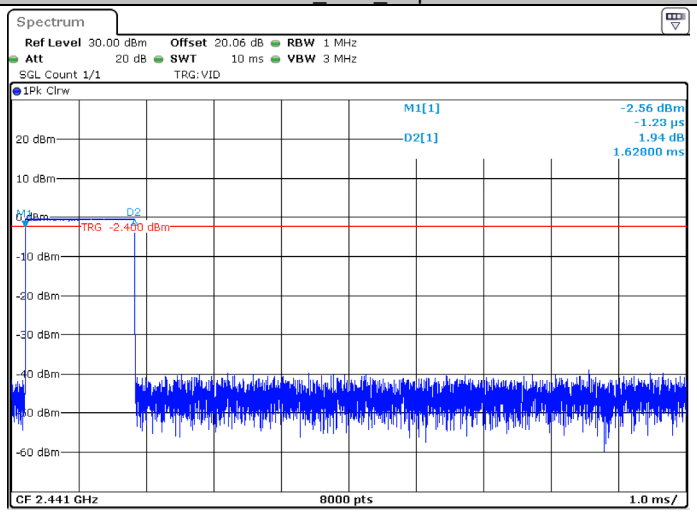
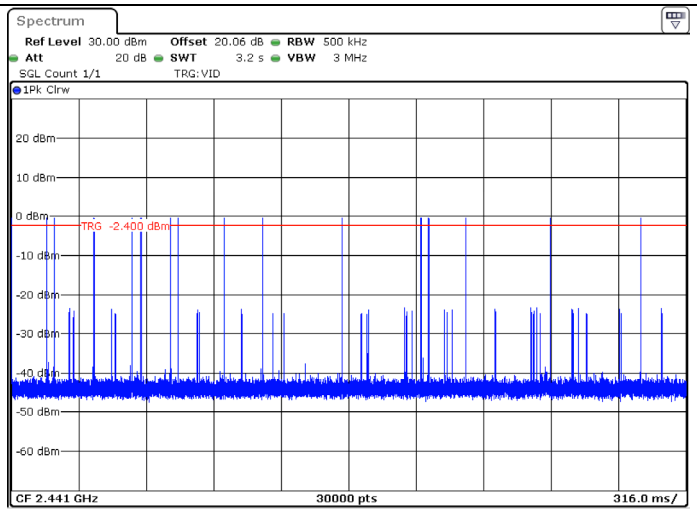
Note 1: A period time=0.4*79=31.6(S), Result=Burst Width*Total Hops
Note 2: Total Hops=Hopping Number in 3.16s*10
Note 3: Hopping Number in 3.16s=Total of highest signals in 3.16s (Second high signals were other channel)

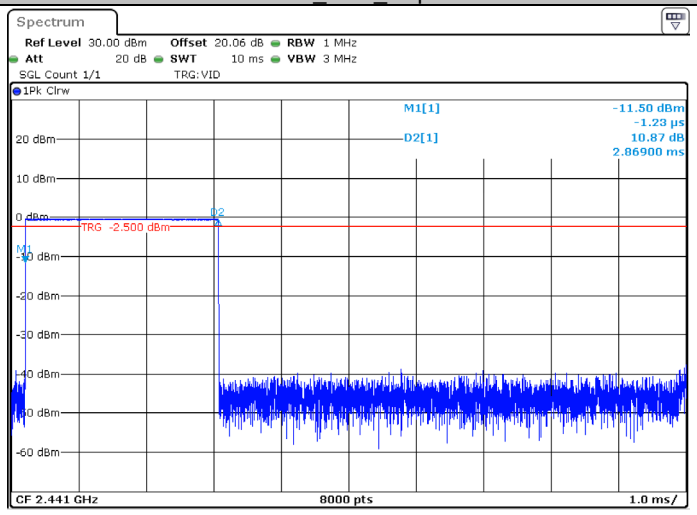
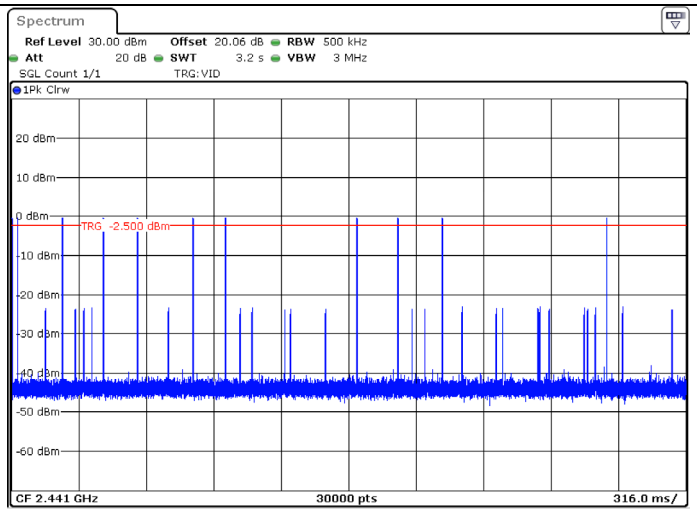
Test Graphs

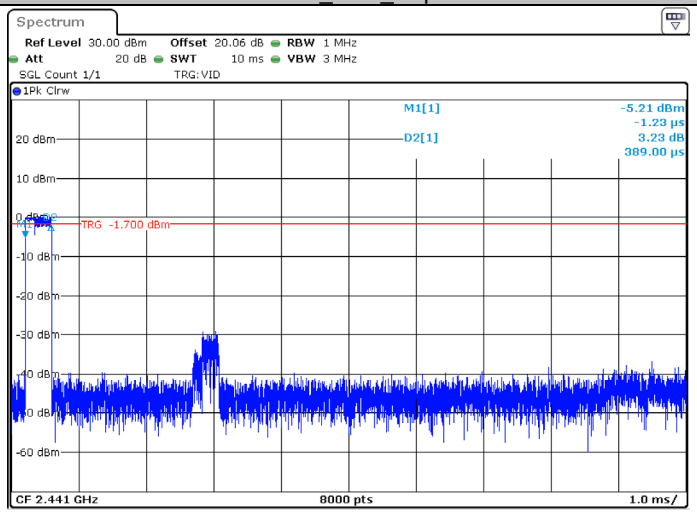
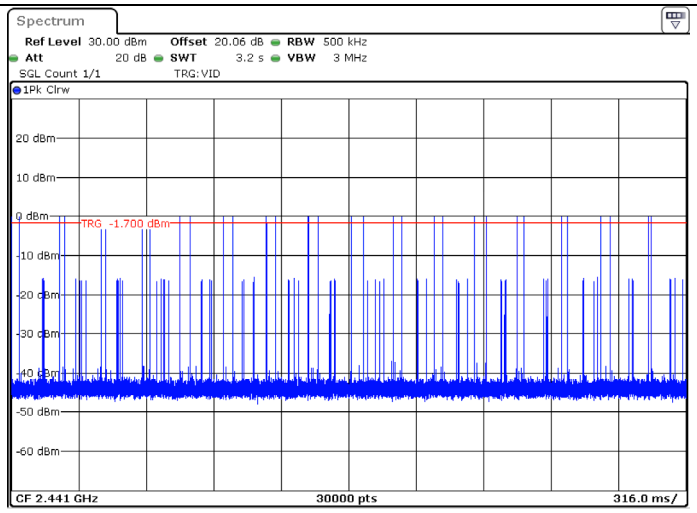
DH1_Ant1_Hop

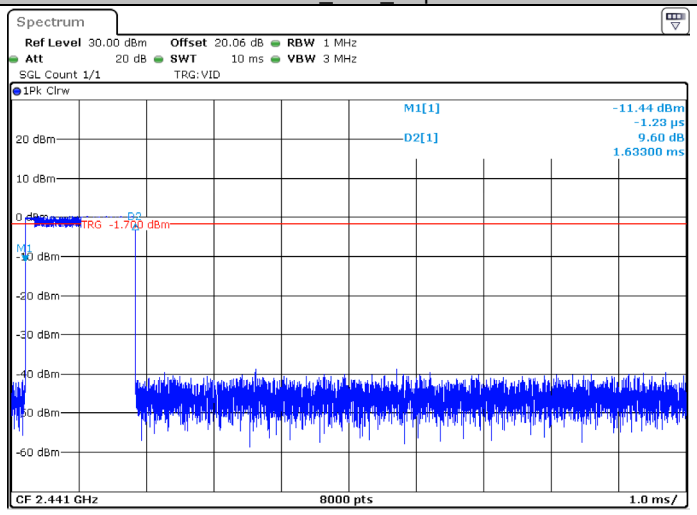
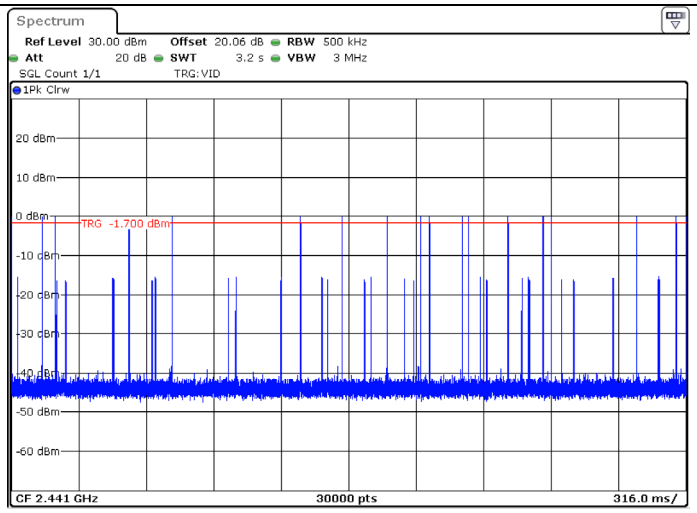


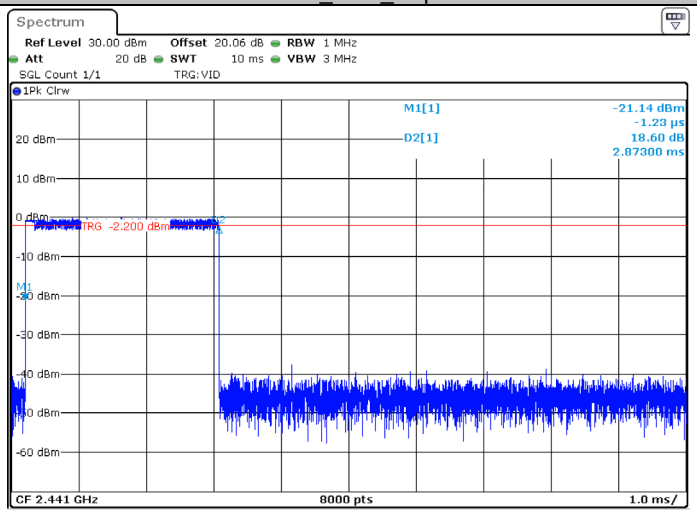
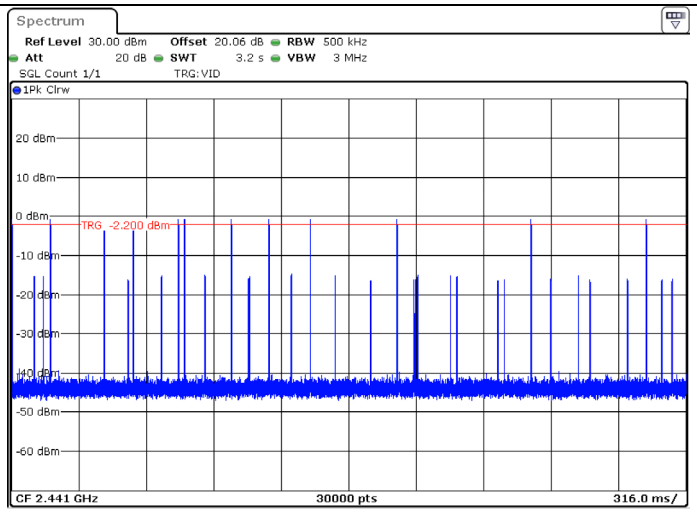


DH3_Ant1_Hop
 ProjectNo.:2401V33212E-RF Tester:Navilite.Cai Date: 31.JUL.2024 11:22:19
 ProjectNo.:2401V33212E-RF Tester:Navilite.Cai Date: 31.JUL.2024 11:22:24

DH5_Ant1_Hop
 Spectrum Ref Level 30.00 dBm Offset 20.06 dB RBW 1 MHz Att 20 dB SWT 10 ms VBW 3 MHz SGL Count 1/1 TRG:VID 1Pk Clrw M1[1] -11.50 dBm -1.23 µs D2[1] 10.87 dB 2.86900 ms 20 dBm 10 dBm 0 dBm TRG -2.500 dBm D2 M1 -10 dBm -20 dBm -30 dBm -40 dBm -50 dBm -60 dBm CF 2.441 GHz 8000 pts 1.0 ms/ ProjectNo.:2401V33212E-RF Tester:Navilite.Cai Date: 31.JUL.2024 11:24:37
 Spectrum Ref Level 30.00 dBm Offset 20.06 dB RBW 500 kHz Att 20 dB SWT 3.2 s VBW 3 MHz SGL Count 1/1 TRG:VID 1Pk Clrw 20 dBm 10 dBm 0 dBm TRG -2.500 dBm -10 dBm -20 dBm -30 dBm -40 dBm -50 dBm -60 dBm CF 2.441 GHz 30000 pts 316.0 ms/ ProjectNo.:2401V33212E-RF Tester:Navilite.Cai Date: 31.JUL.2024 11:24:42

2DH1_Ant1_Hop



2DH3_Ant1_Hop



2DH5_Ant1_Hop



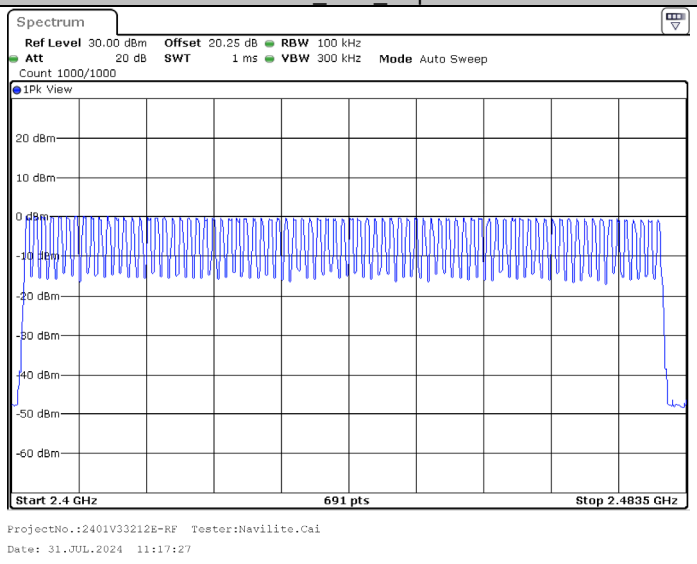
Appendix F: Number of hopping channels

Test Result

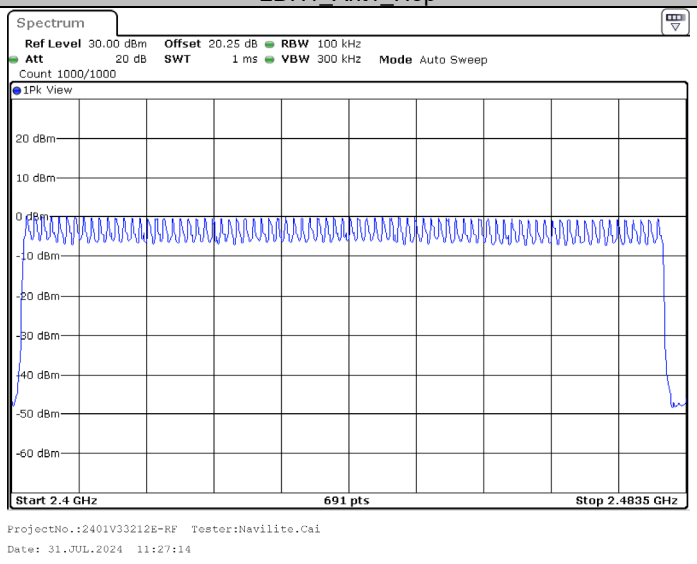
Test Mode	Antenna	Frequency[MHz]	Result[Num]	Limit[Num]	Verdict
DH1	Ant1	Hop	79	≥15	PASS
2DH1	Ant1	Hop	79	≥15	PASS

Test Graphs

DH1_Ant1_Hop



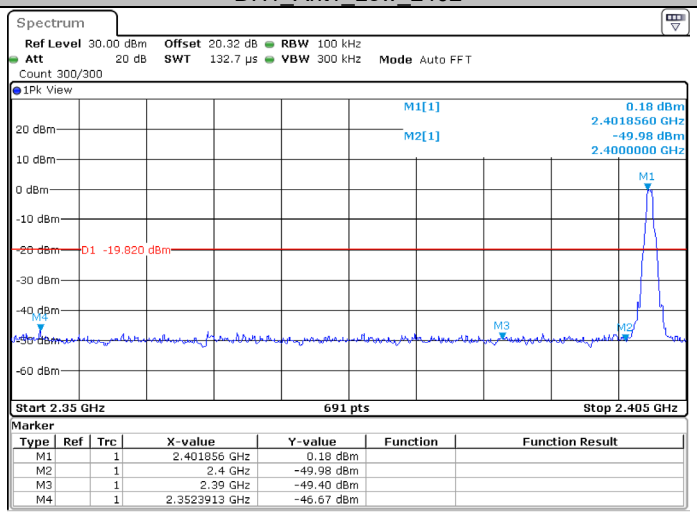
2DH1_Ant1_Hop



Appendix G: Band edge measurements

Test Graphs

DH1_Ant1_Low_2402

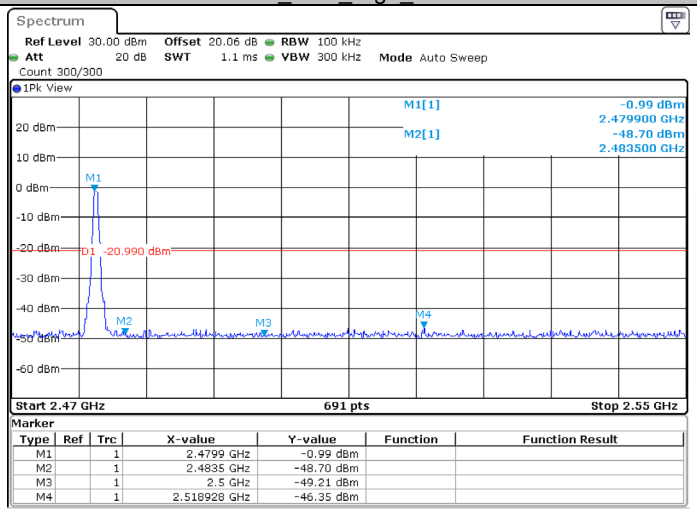


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.401856 GHz	0.18 dBm		
M2		1	2.4 GHz	-49.98 dBm		
M3		1	2.39 GHz	-49.40 dBm		
M4		1	2.3523913 GHz	-46.67 dBm		

ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 10:59:05

DH1_Ant1_High_2480

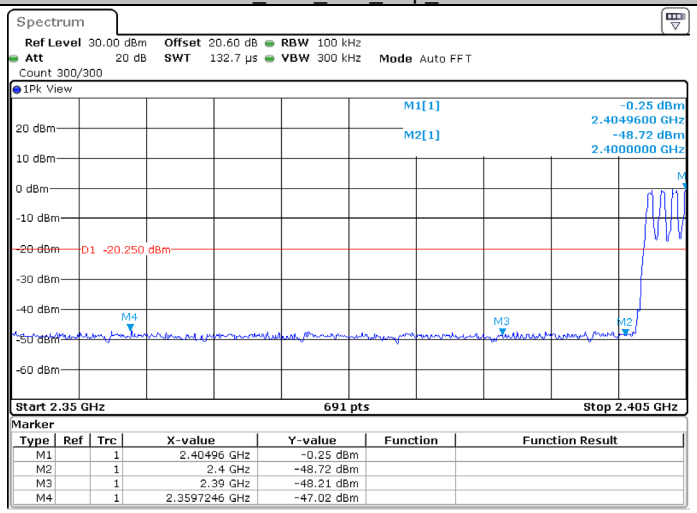


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4799 GHz	-0.99 dBm		
M2		1	2.4835 GHz	-48.70 dBm		
M3		1	2.5 GHz	-49.21 dBm		
M4		1	2.518928 GHz	-46.35 dBm		

ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 11:05:43

DH1_Ant1_Low_Hop_2402

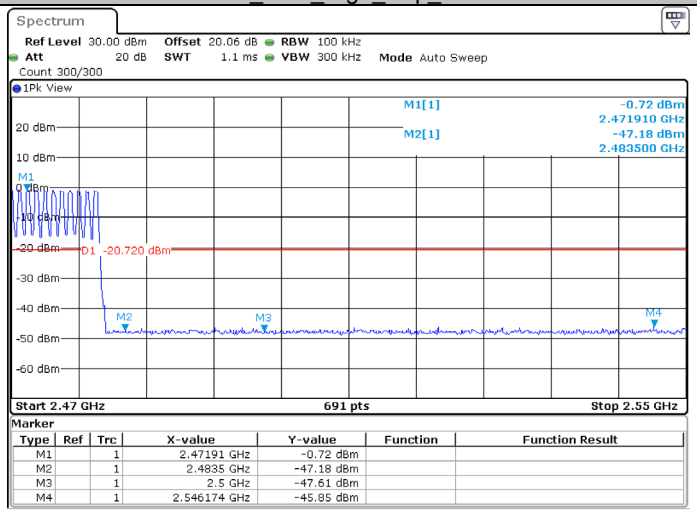


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40496 GHz	-0.25 dBm		
M2		1	2.4 GHz	-48.72 dBm		
M3		1	2.39 GHz	-48.21 dBm		
M4		1	2.3597246 GHz	-47.02 dBm		

ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 13:20:24

DH1_Ant1_High_Hop_2480

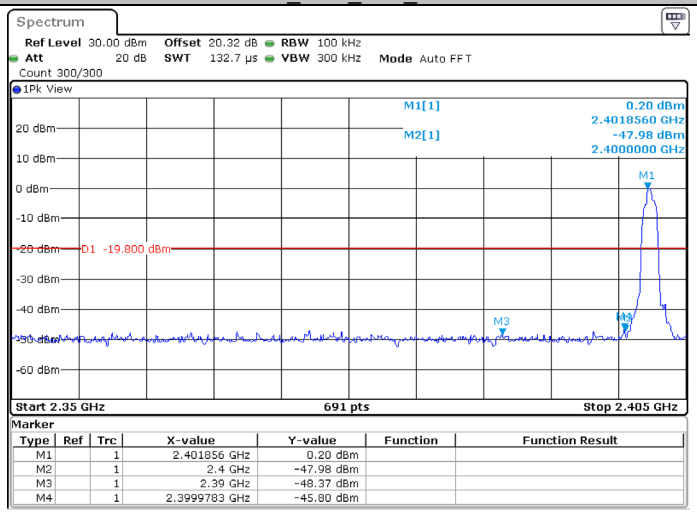


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47191 GHz	-0.72 dBm		
M2		1	2.4835 GHz	-47.18 dBm		
M3		1	2.5 GHz	-47.61 dBm		
M4		1	2.546174 GHz	-45.85 dBm		

ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 11:18:41

2DH1_Ant1_Low_2402

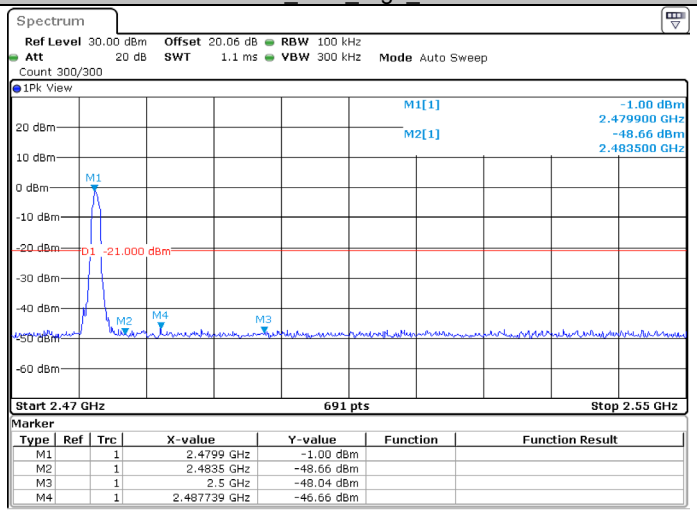


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.401856 GHz	0.20 dBm		
M2		1	2.4 GHz	-47.98 dBm		
M3		1	2.39 GHz	-48.37 dBm		
M4		1	2.3999783 GHz	-45.80 dBm		

ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 11:08:48

2DH1_Ant1_High_2480

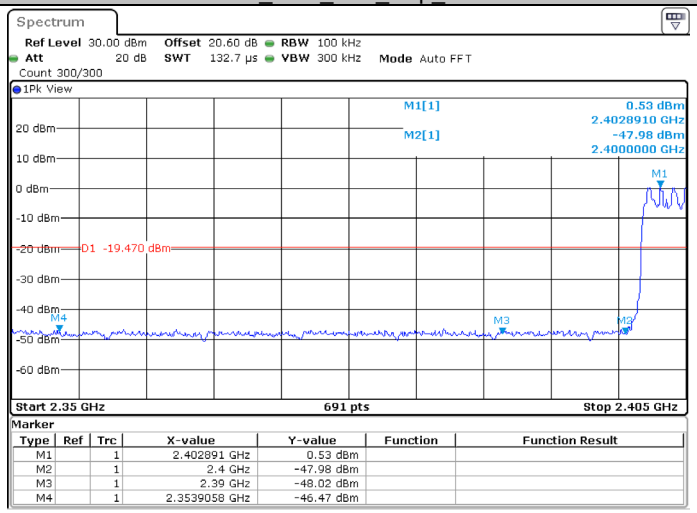


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4799 GHz	-1.00 dBm		
M2		1	2.4835 GHz	-48.66 dBm		
M3		1	2.5 GHz	-48.04 dBm		
M4		1	2.487739 GHz	-46.66 dBm		

ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 11:10:56

2DH1_Ant1_Low_Hop_2402

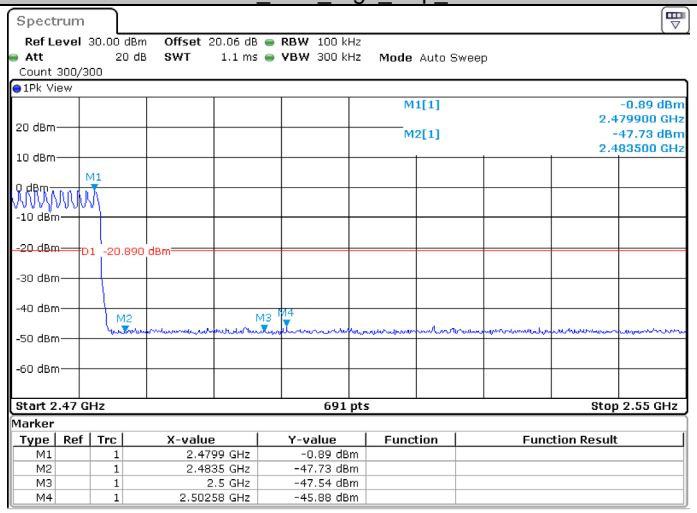


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.402891 GHz	0.53 dBm		
M2		1	2.4 GHz	-47.98 dBm		
M3		1	2.39 GHz	-48.02 dBm		
M4		1	2.3539058 GHz	-46.47 dBm		

ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 11:30:57

2DH1_Ant1_High_Hop_2480



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4799 GHz	-0.89 dBm		
M2		1	2.4835 GHz	-47.73 dBm		
M3		1	2.5 GHz	-47.54 dBm		
M4		1	2.50258 GHz	-45.88 dBm		

ProjectNo.:2401V33212E-RF Tester:Navilite.Cai
Date: 31.JUL.2024 11:28:38

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