

TEST REPORT

Applicant Name: Southern Telecom Inc.
Address: 5601 1st Ave, 2nd Floor, Brooklyn, New York, 11220, United States
Report Number: 2401S68918-RF-00
FCC ID: 2ABV4-WTRSPK

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type: HELLO KITTY XL WATER SPK
Model No.: HKXLWTRSPK-FB
Multiple Model(s) No.: N/A
Trade Mark: HELLO KITTY
Date Received: 2024/04/07
Issue Date: 2024/05/21

Test Result:

Pass▲

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

Prepared and Checked By:

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jojo Guo
RF Engineer

Approved By:

Nancy Wang

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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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	2401S68918-RF-00	Original Report	2024/05/21

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	HELLO KITTY XL WATER SPK
Tested Model	HKXLWTRSPK-FB
Multiple Model(s)	N/A
Frequency Range	Bluetooth: 2402~2480MHz
Transmit Peak Power	0.51dBm
Modulation Technique	Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK
Antenna Specification [#]	-0.58dBi (provided by the applicant)
Voltage Range	DC 5V from USB port
Sample serial number	OSEB118528-3 for Conducted and Radiated Emissions Test OSEB118528-2 for RF Conducted Test (Assigned by BACL, Shenzhen)
Sample/EUT Status	Good condition
Adapter Information	N/A

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, 15.207, 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°C
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

“bt-tool v1.1.0”[#] exercise software was used and the power level is 4[#]. 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

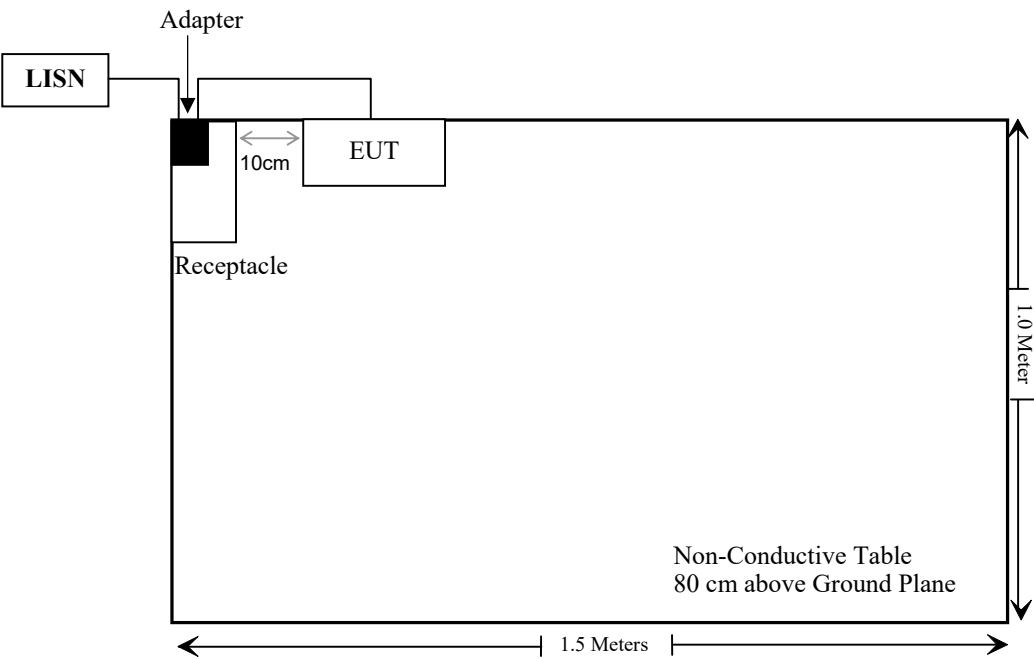
Manufacturer	Description	Model	Serial Number
HUAWEI	Adapter	HW-100400C01	Unknown

External I/O Cable

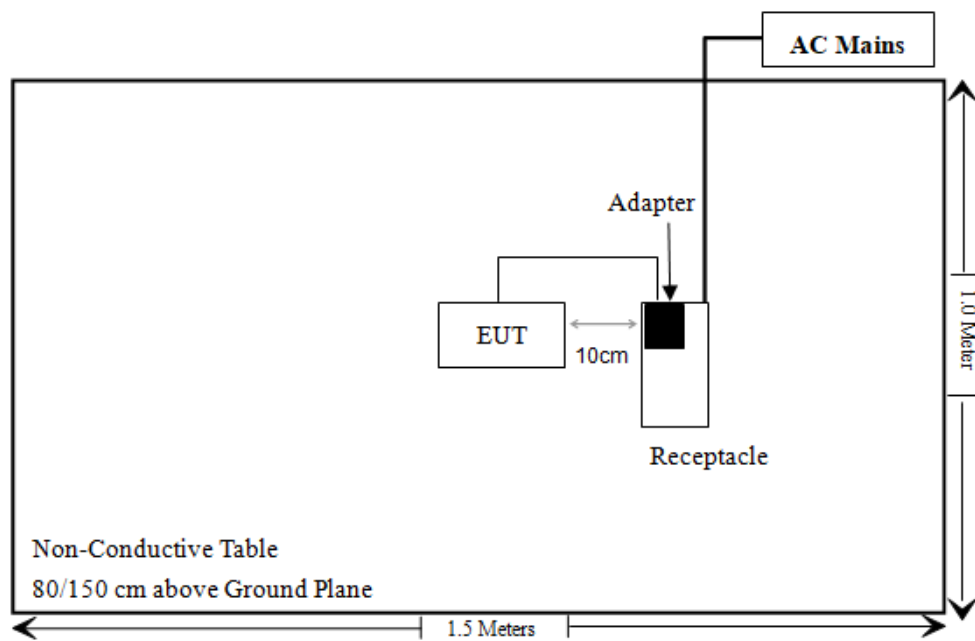
Cable Description	Length (m)	From Port	To
Un-shielding Detachable USB Cable	1.0	EUT	Adapter

Block Diagram of Test Setup

For Conducted Emissions:



For Radiated Emissions:



SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
FCC§1.1307 ,§2.1091	MPE-Based Exemption	Compliant
FCC §15.203	Antenna Requirement	Compliant
FCC §15.207(a)	AC Line Conducted Emissions	Compliant
FCC §15.205, §15.209, §15.247(d)	Radiated Emissions	Compliant
FCC §15.247(a)(1)	20 dB Emission Bandwidth & 99% Occupied 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

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2024/01/16	2025/01/15
Rohde & Schwarz	LISN	ENV216	101613	2024/01/16	2025/01/15
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2023/08/03	2024/08/02
Unknown	CE Cable	CE Cable	UF A210B-1-0720-504504	2023/08/03	2024/08/02
Audix	EMI Test software	E3	191218	NCR	NCR
Radiated Emission Test					
R&S	EMI Test Receiver	ESR3	102455	2024/01/16	2025/01/15
Sonoma instrument	Pre-amplifier	310 N	186238	2023/06/08	2024/06/07
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2023/07/20	2024/07/19
BACL	Active Loop Antenna	1313-1A	4031911	2024/03/21	2025/03/20
Unknown	Cable	Chamber Cable 1	F-03-EM236	2023/08/03	2024/08/02
Unknown	Cable	Chamber Cable 4	EC-007	2023/08/03	2024/08/02
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	2023/06/29	2024/06/28
Schwarzbeck	Horn Antenna	BBHA9120D(1201)	1143	2023/07/26	2024/07/25
Unknown	RF Cable	KMSE	0735	2023/10/08	2024/10/07
Unknown	RF Cable	UFA147	219661	2023/10/08	2024/10/07
SNSD	2.4G Band Reject filter	BSF2402-2480MN-0898-001	2.4G filter	2023/08/03	2024/08/02
A.H.System	Pre-amplifier	PAM-1840VH	190	2023/08/03	2024/08/02
Electro-Mechanics Co	Horn Antenna	3116	9510-2270	2023/09/18	2026/09/17
Audix	EMI Test software	E3	191218(V9)	NCR	NCR
RF Conducted Test					
R&S	SPECTRUM ANALYZER	FSU26	200120	2024/01/08	2025/01/07
Unknown	10dB Attenuator	Unknown	F-03-EM190	2023/07/04	2024/07/03

* **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 1.1307 (B) & §2.1091- MPE-BASED EXEMPTION

Applicable Standard

According to subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

According to KDB 447498 D04 Interim General RF Exposure Guidance

MPE-Based Exemption:

General frequency and separation-distance dependent MPE-based effective radiated power (ERP) thresholds are in Table B.1 [Table 1 of § 1.1307(b)(1)(i)(C)] to support an exemption from further evaluation from 300 kHz through 100 GHz.

Table 1 to § 1.1307(b)(3)(i)(C) - Single RF Sources Subject to Routine Environmental Evaluation

RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	$1,920 R^2$.
1.34-30	$3,450 R^2/f^2$.
30-300	$3.83 R^2$.
300-1,500	$0.0128 R^2 f$.
1,500-100,000	$19.2 R^2$.

R is the minimum separation distance in meters

f = frequency in MHz

Result

Mode	Frequency (MHz)	Tune up conducted power [#]	Antenna Gain [#]		ERP		Evaluation Distance (m)	ERP Limit (mW)
		(dBm)	(dBi)	(dBd)	(dBm)	(mW)		
BT	2402-2480	1.0	-0.58	-2.73	-1.73	0.67	0.2	768

Note: 1. The tune up conducted power and antenna gain was declared by the applicant.

2. 0dBd=2.15dBi

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

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.

Antenna Connector Construction

The EUT has one internal antenna arrangement, which was permanently attached, the antenna gain[#] is -0.58dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliant

FCC §15.207 (a) - AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

Factor & Over Limit Calculation

The factor is calculated by adding LISN VDF (Voltage Division Factor) and Cable Loss. The basic equation is as follows:

$$\text{Factor} = \text{LISN VDF} + \text{Cable Loss}$$

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

$$\begin{aligned}\text{Over Limit} &= \text{Level} - \text{Limit} \\ \text{Level} &= \text{Read Level} + \text{Factor}\end{aligned}$$

Note: The term "cable loss" refers to the combination of a cable and a 10dB transient limiter (attenuator).

Test Data

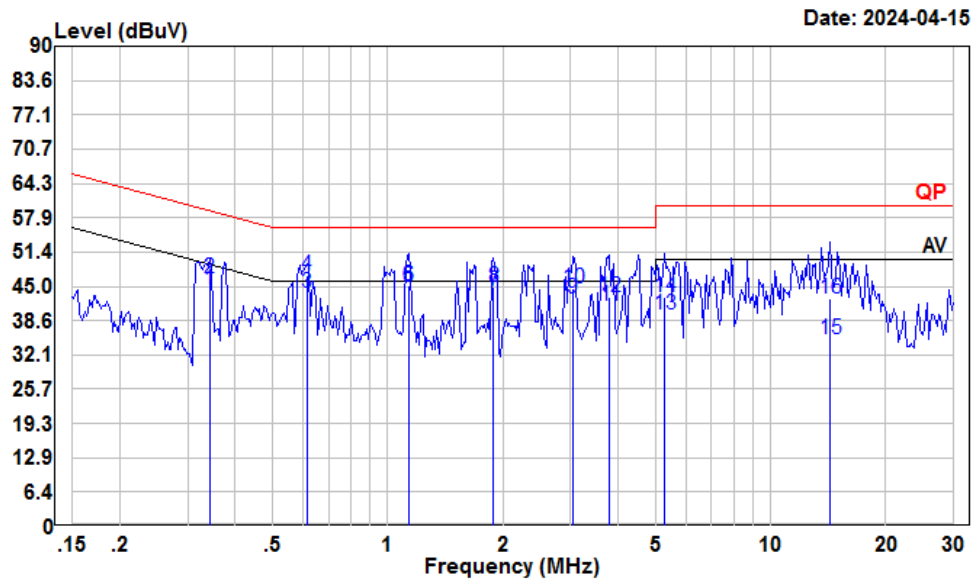
Environmental Conditions

Temperature:	26 °C
Relative Humidity:	60 %
ATM Pressure:	101.0 kPa

The testing was performed by Macy Shi on 2024-04-15.

EUT operation mode: Transmitting (Maximum output power mode, 8DPSK Low Channel)

AC 120V/60 Hz, Line



Condition: Line

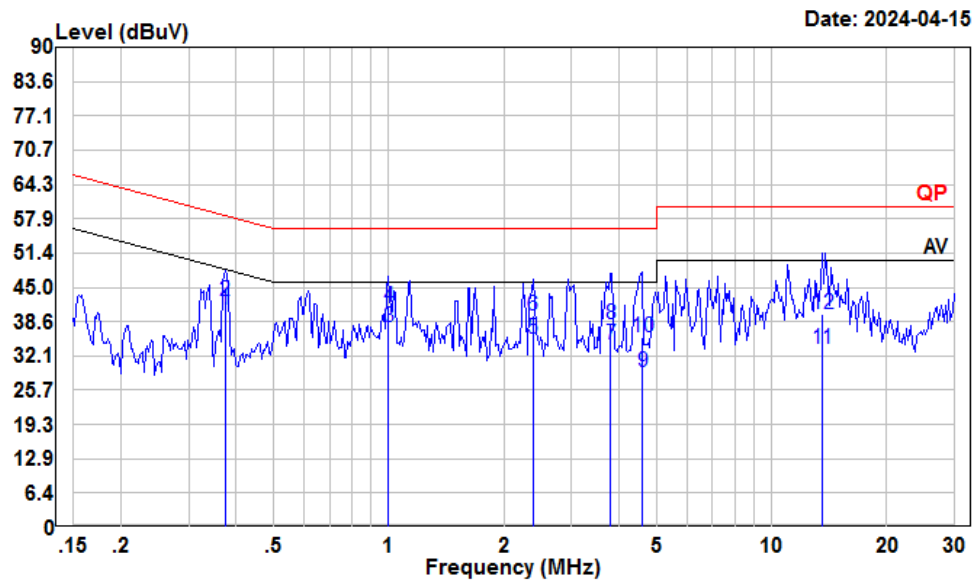
Project : 2401S68918E-RF

Tester : Macy shi

Note : BT

	Freq	Read Level	LISN Level	LISN Factor	Cable Loss	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dB	dBuV	dB	
1	0.34	23.66	44.43	10.62	10.15	49.13	-4.70	Average
2	0.34	25.73	46.50	10.62	10.15	59.13	-12.63	QP
3	0.61	23.00	43.72	10.50	10.22	46.00	-2.28	Average
4	0.61	26.30	47.02	10.50	10.22	56.00	-8.98	QP
5	1.14	24.32	44.86	10.44	10.10	46.00	-1.14	Average
6	1.14	24.71	45.25	10.44	10.10	56.00	-10.75	QP
7	1.89	23.30	44.04	10.58	10.16	46.00	-1.96	Average
8	1.89	24.00	44.74	10.58	10.16	56.00	-11.26	QP
9	3.04	22.10	42.79	10.42	10.27	46.00	-3.21	Average
10	3.04	23.80	44.49	10.42	10.27	56.00	-11.51	QP
11	3.80	20.73	41.31	10.32	10.26	46.00	-4.69	Average
12	3.80	22.52	43.10	10.32	10.26	56.00	-12.90	QP
13	5.28	19.20	39.82	10.40	10.22	50.00	-10.18	Average
14	5.28	22.40	43.02	10.40	10.22	60.00	-16.98	QP
15	14.29	14.38	35.10	10.60	10.12	50.00	-14.90	Average
16	14.29	21.87	42.59	10.60	10.12	60.00	-17.41	QP

AC 120V/60 Hz, Neutral



Condition: Neutral
Project : 2401S68918E-RF
Tester : Macy shi
Note : BT

		Read		LISN	Cable	Limit	Over	
	Freq	Level	Level	Factor	Loss	Line	Limit	Remark
	MHz	dBuV	dBuV	dB	dB	dBuV	dB	
1	0.37	19.89	40.68	10.60	10.19	48.43	-7.75	Average
2	0.37	21.61	42.40	10.60	10.19	58.43	-16.03	QP
3	1.00	16.37	37.48	10.90	10.21	46.00	-8.52	Average
4	1.00	20.33	41.44	10.90	10.21	56.00	-14.56	QP
5	2.38	14.80	35.41	10.40	10.21	46.00	-10.59	Average
6	2.38	19.10	39.71	10.40	10.21	56.00	-16.29	QP
7	3.80	13.50	34.16	10.40	10.26	46.00	-11.84	Average
8	3.80	17.50	38.16	10.40	10.26	56.00	-17.84	QP
9	4.60	8.32	29.03	10.47	10.24	46.00	-16.97	Average
10	4.60	15.00	35.71	10.47	10.24	56.00	-20.29	QP
11	13.55	12.40	33.35	10.80	10.15	50.00	-16.65	Average
12	13.55	19.00	39.95	10.80	10.15	60.00	-20.05	QP

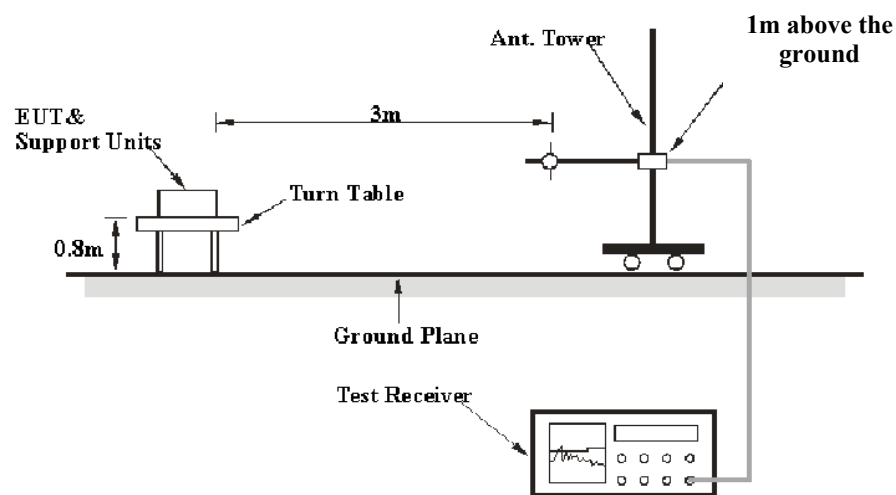
FCC §15.205, §15.209 & §15.247(d) - RADIATED EMISSIONS

Applicable Standard

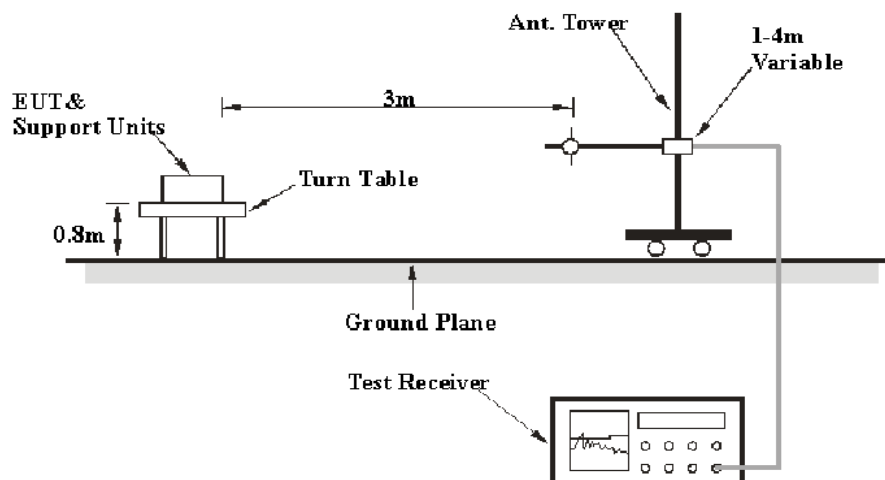
FCC §15.205; §15.209; §15.247(d)

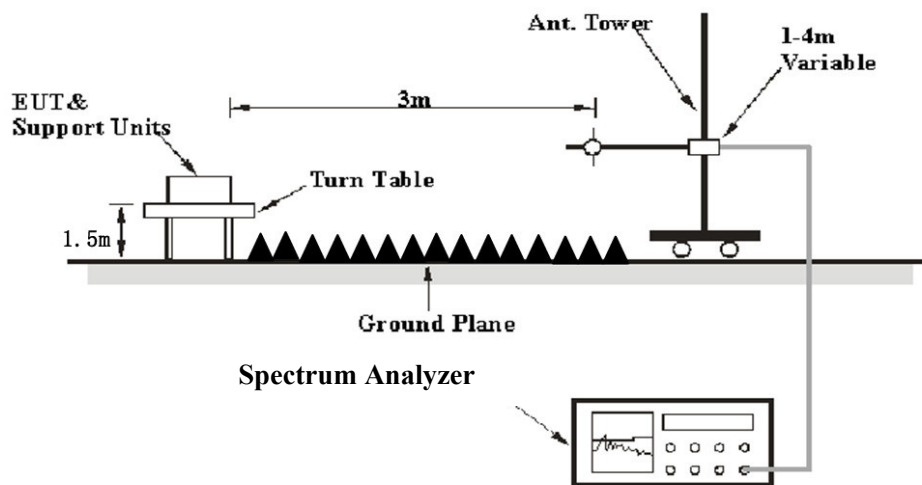
EUT Setup

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= $N_1 \cdot L_1 + N_2 \cdot L_2 + \dots + N_{n-1} \cdot L_{n-1} + N_n \cdot L_n$,

Where N_1 is number of type 1 pulses, L_1 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.

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:

$$\text{Factor} = \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

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:

$$\begin{aligned}\text{Over Limit/Margin} &= \text{Level/Corrected Amplitude} - \text{Limit} \\ \text{Level / Corrected Amplitude} &= \text{Read Level} + \text{Factor}\end{aligned}$$

Test Data

Environmental Conditions

Temperature:	25~25.3 °C
Relative Humidity:	50~54 %
ATM Pressure:	101.0 kPa

The testing was performed by Warren Huang on 2024-04-17 for below 1GHz and Tyler Wu on 2024-05-14 and 2024-05-15 for above 1GHz.

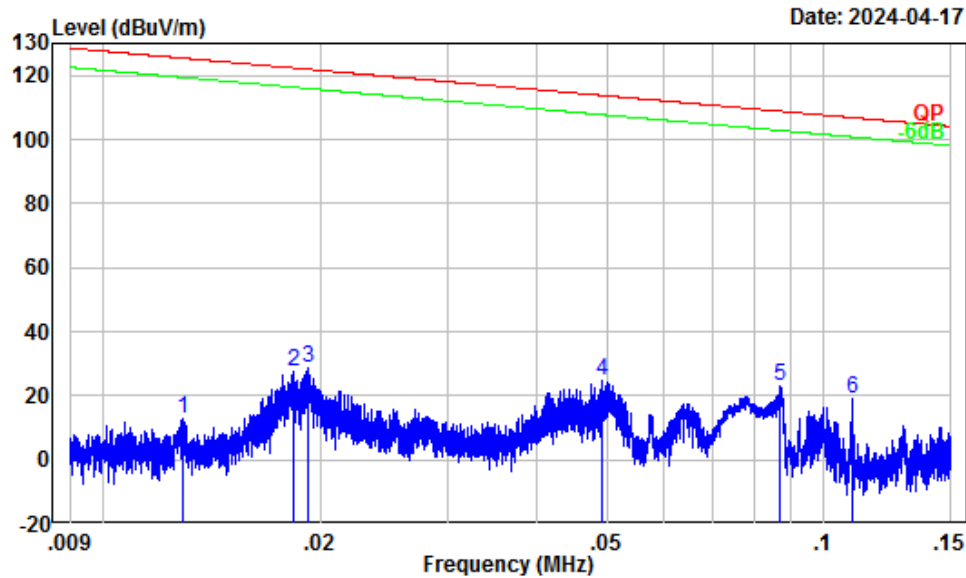
Test mode: Transmitting

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

9 kHz-30MHz: (Maximum output power mode, 8DPSK Low Channel)

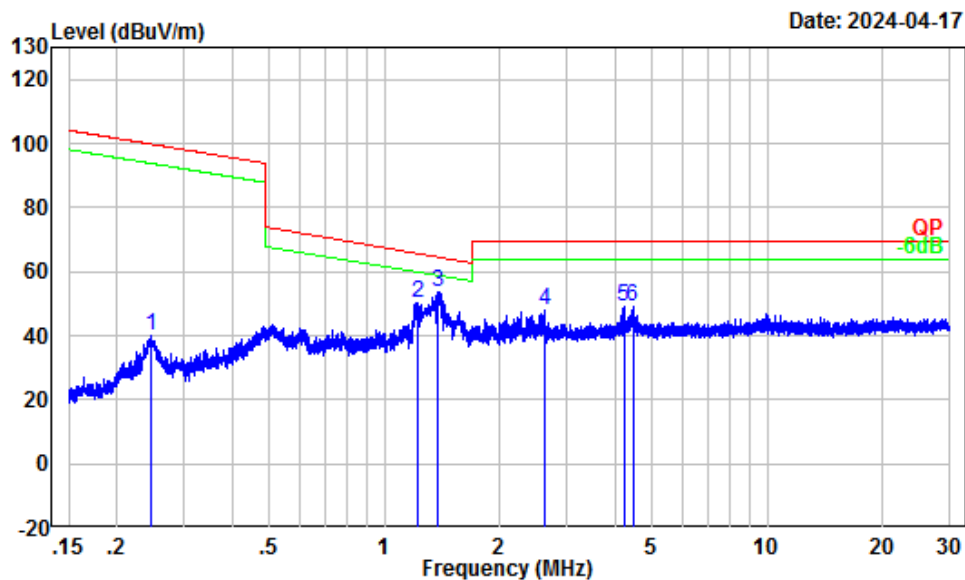
Note: When the test result of peak was less than the limit of QP/Average more than 6dB, just peak value were recorded.

Parallel (worst case)



Site : Chamber A
Condition : 3m
Project Number: 2401S68918-RF
Note : BT
Tester : Warren Huang

	Freq	Factor	Read Level	Limit Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	0.01	-5.49	18.22	12.73	125.40	-112.67	Peak
2	0.02	-6.40	33.91	27.51	122.34	-94.83	Peak
3	0.02	-6.42	34.85	28.43	121.90	-93.47	Peak
4	0.05	-1.64	26.11	24.47	113.76	-89.29	Peak
5	0.09	2.12	20.66	22.78	108.81	-86.03	Peak
6	0.11	3.58	15.67	19.25	106.82	-87.57	Peak

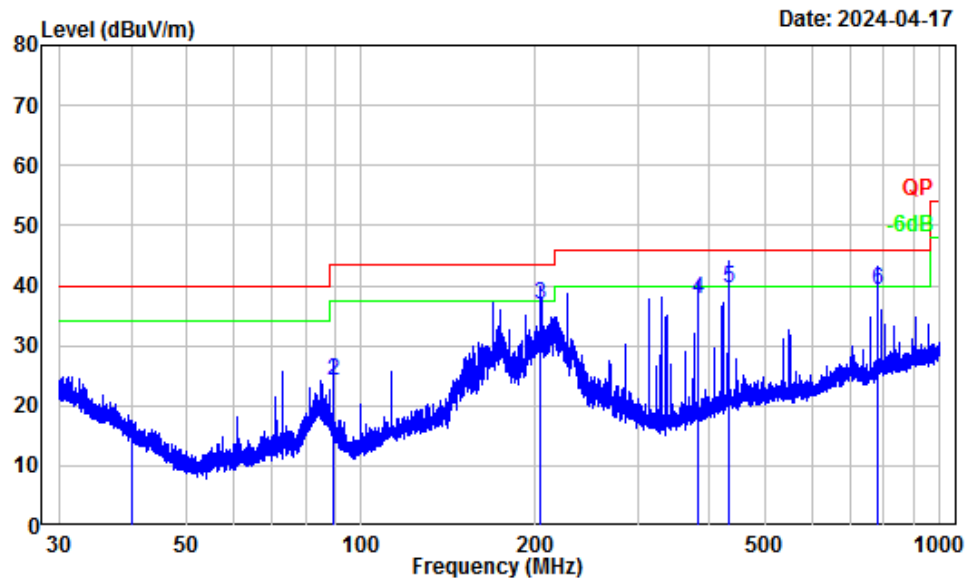


Site : Chamber A
 Condition : 3m
 Project Number: 2401S68918-RF
 Note : BT
 Tester : Warren Huang

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	0.25	9.95	29.96	39.91	99.77	-59.86	Peak
2	1.23	21.84	28.20	50.04	65.66	-15.62	Peak
3	1.38	22.31	31.53	53.84	64.59	-10.75	Peak
4	2.62	24.65	23.14	47.79	69.54	-21.75	Peak
5	4.22	25.79	23.16	48.95	69.54	-20.59	Peak
6	4.46	25.87	23.18	49.05	69.54	-20.49	Peak

30MHz-1GHz: (Maximum output power mode, 8DPSK Low Channel)

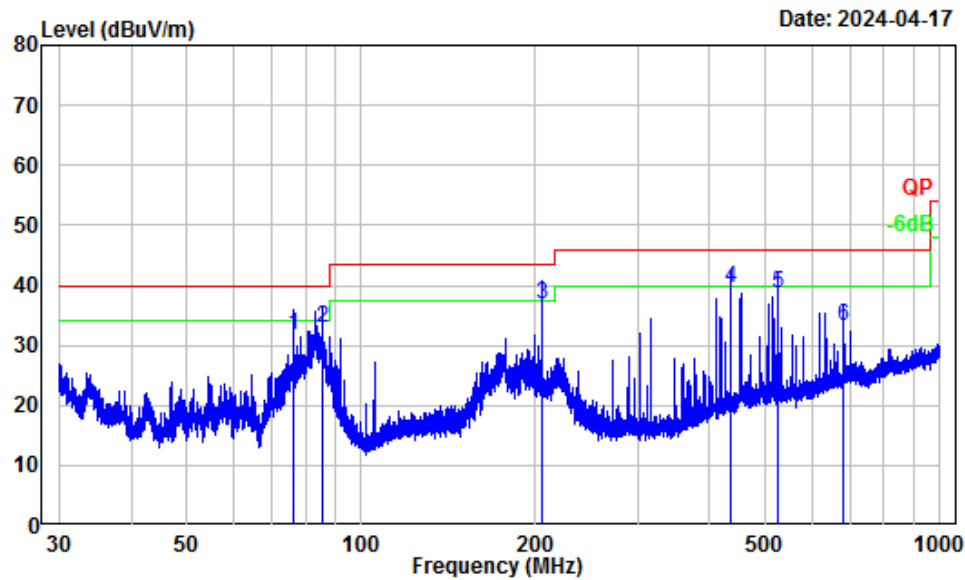
Horizontal



Site : Chamber A
Condition : 3m Horizontal
Project Number: 2401S68918-RF
Note : BT
Tester : Warren Huang

	Freq Factor		Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	40.01	-10.40	23.78	13.38	40.00	-26.62	QP
2	89.43	-16.57	40.68	24.11	43.50	-19.39	QP
3	204.42	-11.10	47.93	36.83	43.50	-6.67	QP
4	382.92	-8.21	45.97	37.76	46.00	-8.24	QP
5	430.84	-6.28	45.69	39.41	46.00	-6.59	QP
6	778.58	-1.03	40.20	39.17	46.00	-6.83	QP

Vertical



Site : Chamber A
Condition : 3m Vertical
Project Number: 2401S68918-RF
Note : BT
Tester : Warren Huang

	Freq Factor		Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	76.31	-17.25	48.80	31.55	40.00	-8.45	QP
2	85.67	-17.30	50.09	32.79	40.00	-7.21	QP
3	205.49	-12.23	49.20	36.97	43.50	-6.53	QP
4	434.26	-6.58	46.18	39.60	46.00	-6.40	QP
5	526.40	-5.05	43.60	38.55	46.00	-7.45	QP
6	680.85	-2.27	35.50	33.23	46.00	-12.77	QP

Above 1GHz:

Frequency (MHz)	Receiver		Polar (H/V)	Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave					
8DPSK							
Low Channel 2402MHz							
2371.38	55.25	PK	H	-2.93	52.32	74	-21.68
2364.93	55.74	PK	V	-2.93	52.81	74	-21.19
4804.00	65.76	PK	H	2.42	68.18	74	-5.82
4804.00	64.52	PK	V	2.42	66.94	74	-7.06
Middle Channel 2441MHz							
4882.00	68.35	PK	H	2.58	70.93	74	-3.07
4882.00	67.31	PK	V	2.58	69.89	74	-4.11
High Channel 2480MHz							
2483.54	62.03	PK	H	-3.17	58.86	74	-15.14
2490.57	53.71	PK	V	-3.18	50.53	74	-23.47
4960.00	65.71	PK	H	2.68	68.39	74	-5.61
4960.00	64.28	PK	V	2.68	66.96	74	-7.04

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.

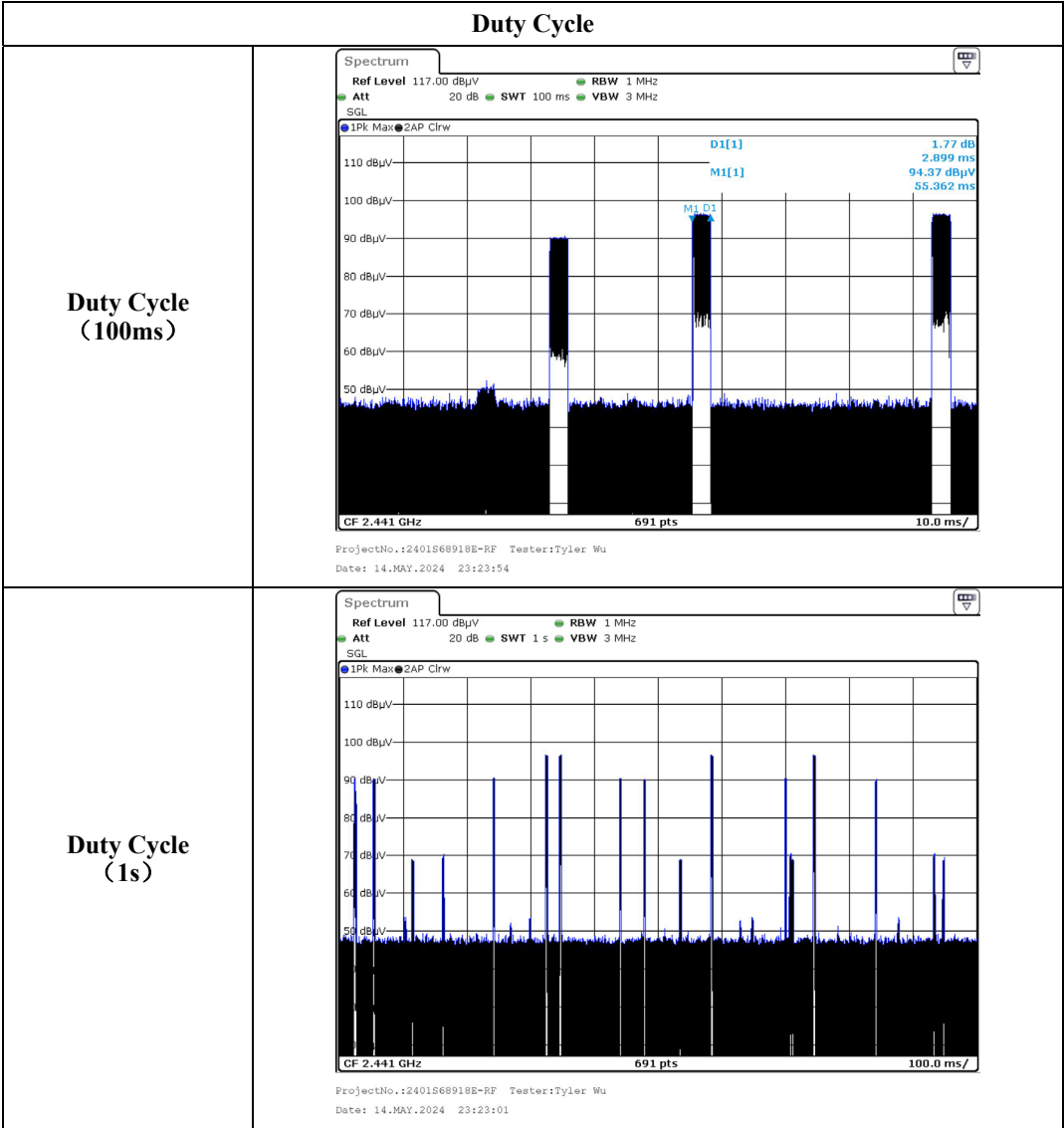
Field Strength of Average							
Frequency (MHz)	Peak Measurement @3m (dBμV/m)	Polar (H/V)	Duty Cycle Correction Factor (dB)	Average level (dBμV/m)	FCC Part 15.247		
					Limit (dBμV/m)	Margin (dB)	Comment
Low Channel 2402MHz							
2371.38	52.32	H	-24.73	27.59	54	-26.41	Bandedge
2364.93	52.81	V	-24.73	28.08	54	-25.92	Bandedge
4804.00	68.18	H	-24.73	43.45	54	-10.55	Harmonic
4804.00	66.94	V	-24.73	42.21	54	-11.79	Harmonic
Middle Channel 2441MHz							
4882.00	70.93	H	-24.73	46.2	54	-7.80	Harmonic
4882.00	69.89	V	-24.73	45.16	54	-8.84	Harmonic
High Channel 2480MHz							
2483.54	58.86	H	-24.73	34.13	54	-19.87	Bandedge
2490.57	50.53	V	-24.73	25.8	54	-28.2	Bandedge
4960.00	68.39	H	-24.73	43.66	54	-10.34	Harmonic
4960.00	66.96	V	-24.73	42.23	54	-11.77	Harmonic

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

Worst case duty cycle:

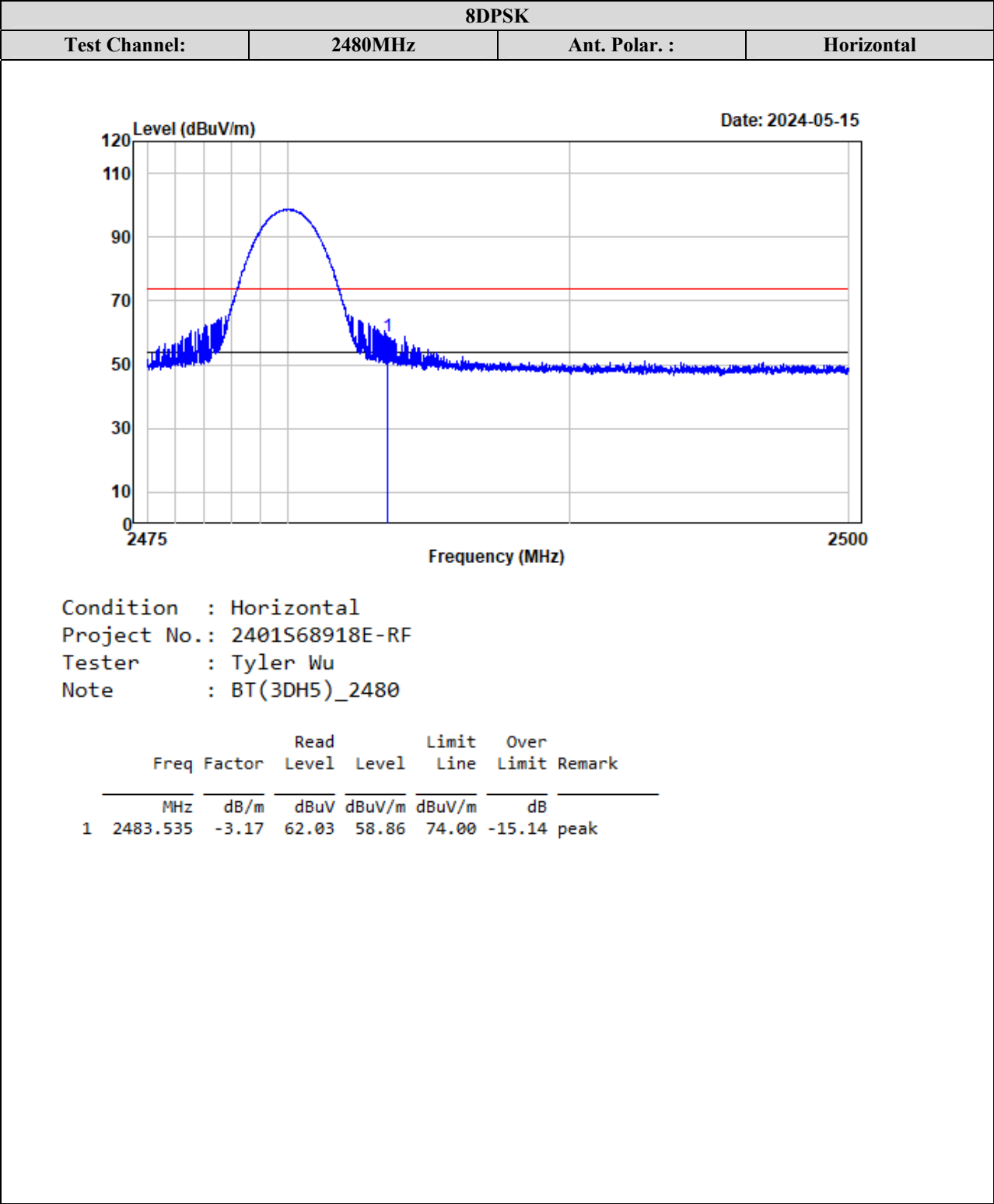
Duty Cycle = Ton/100ms = 2.899*2/100=0.05798

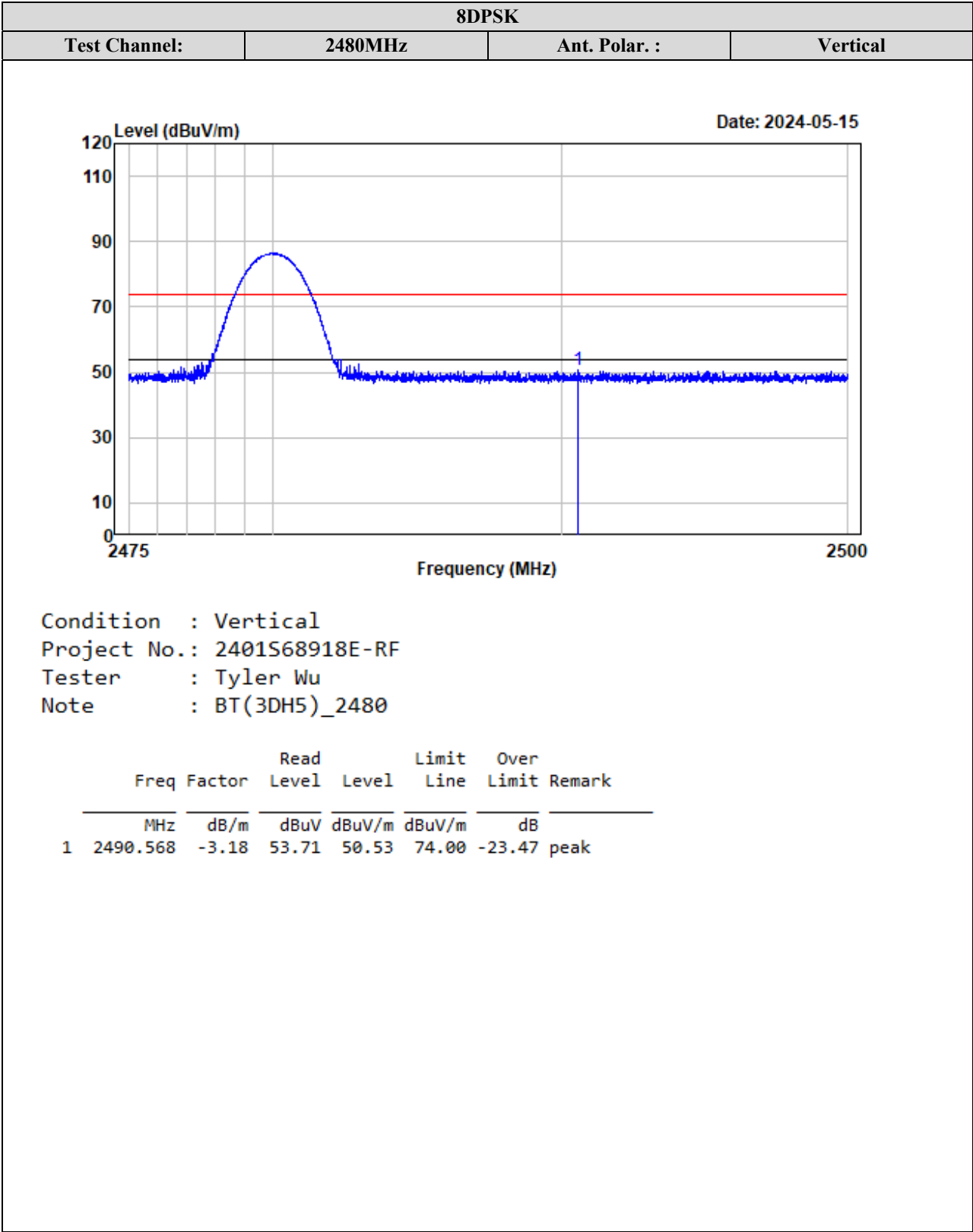
Duty Cycle Corrected Factor = 20lg (Duty Cycle) = 20lg0.05798 = -24.73



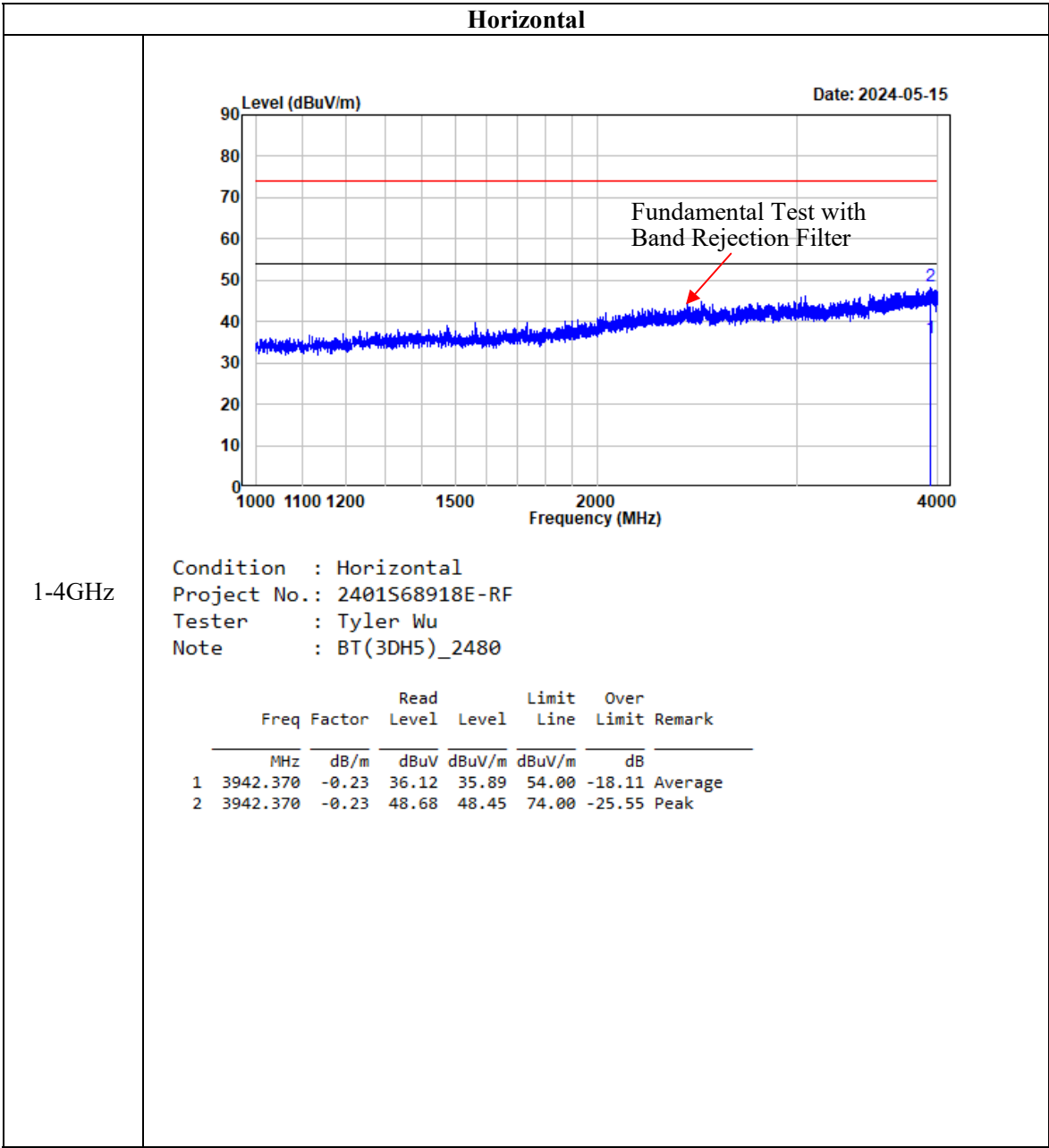
Test plots for example as below:

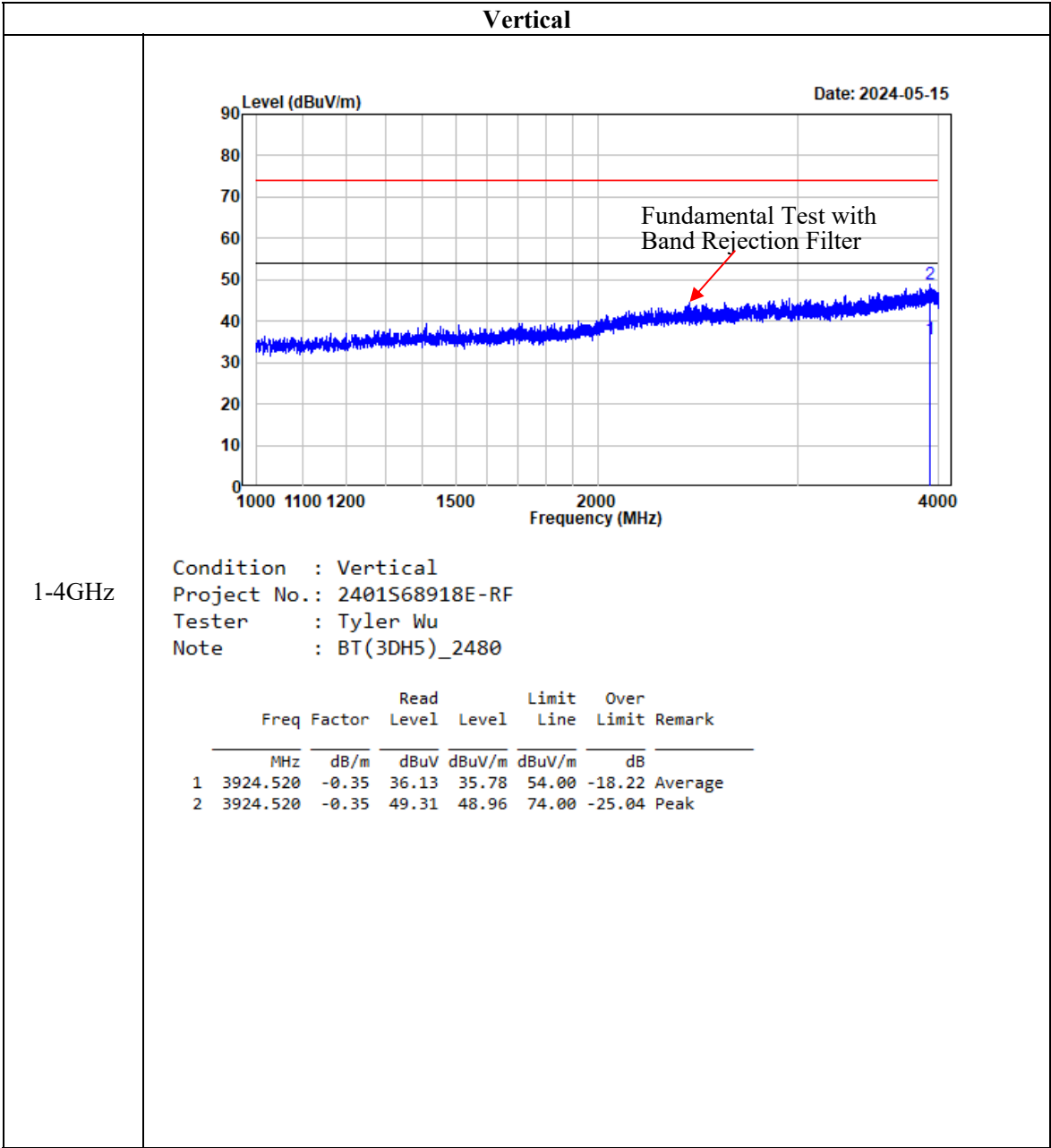
Band Edge Measurements (Radiated):

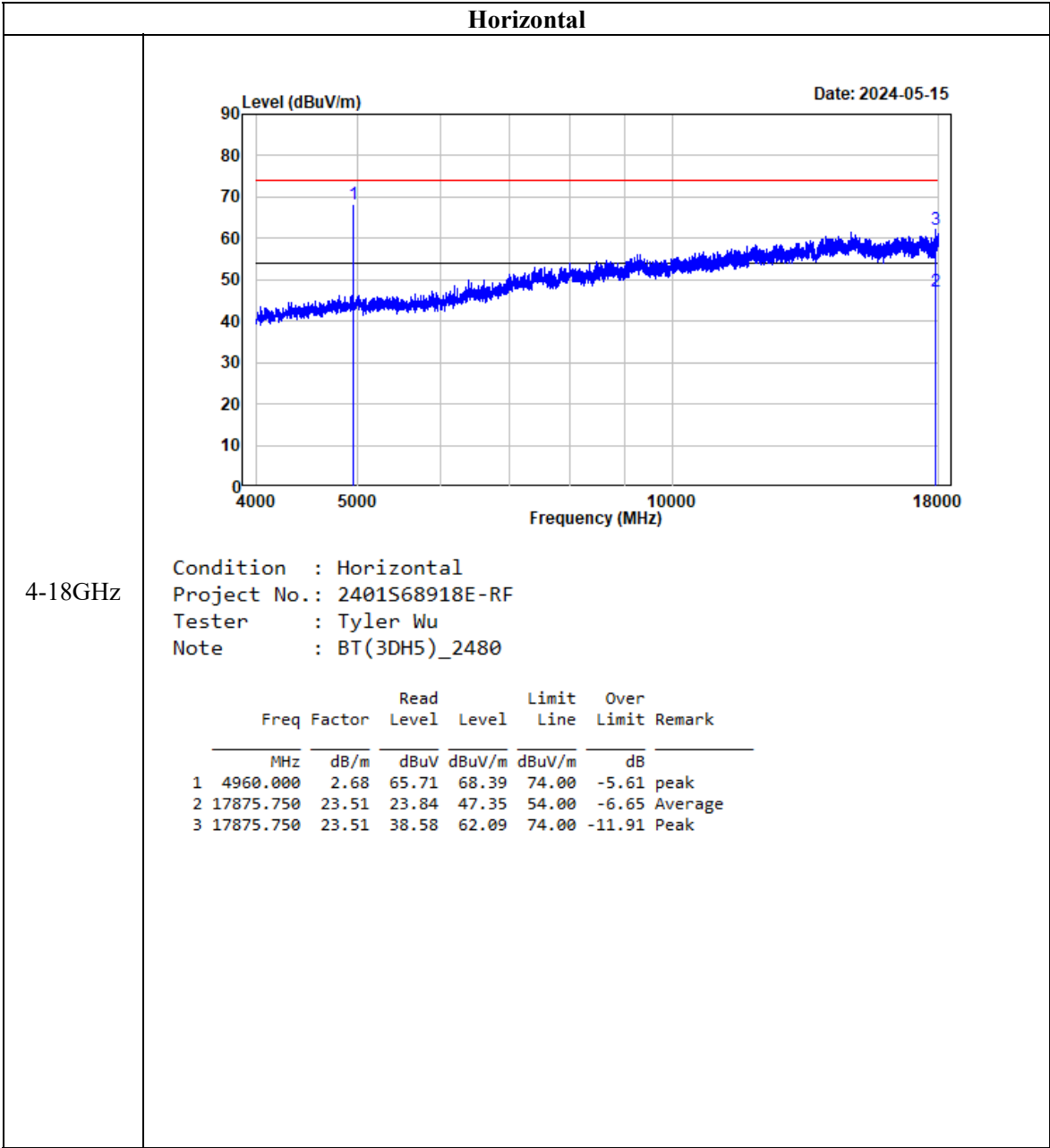


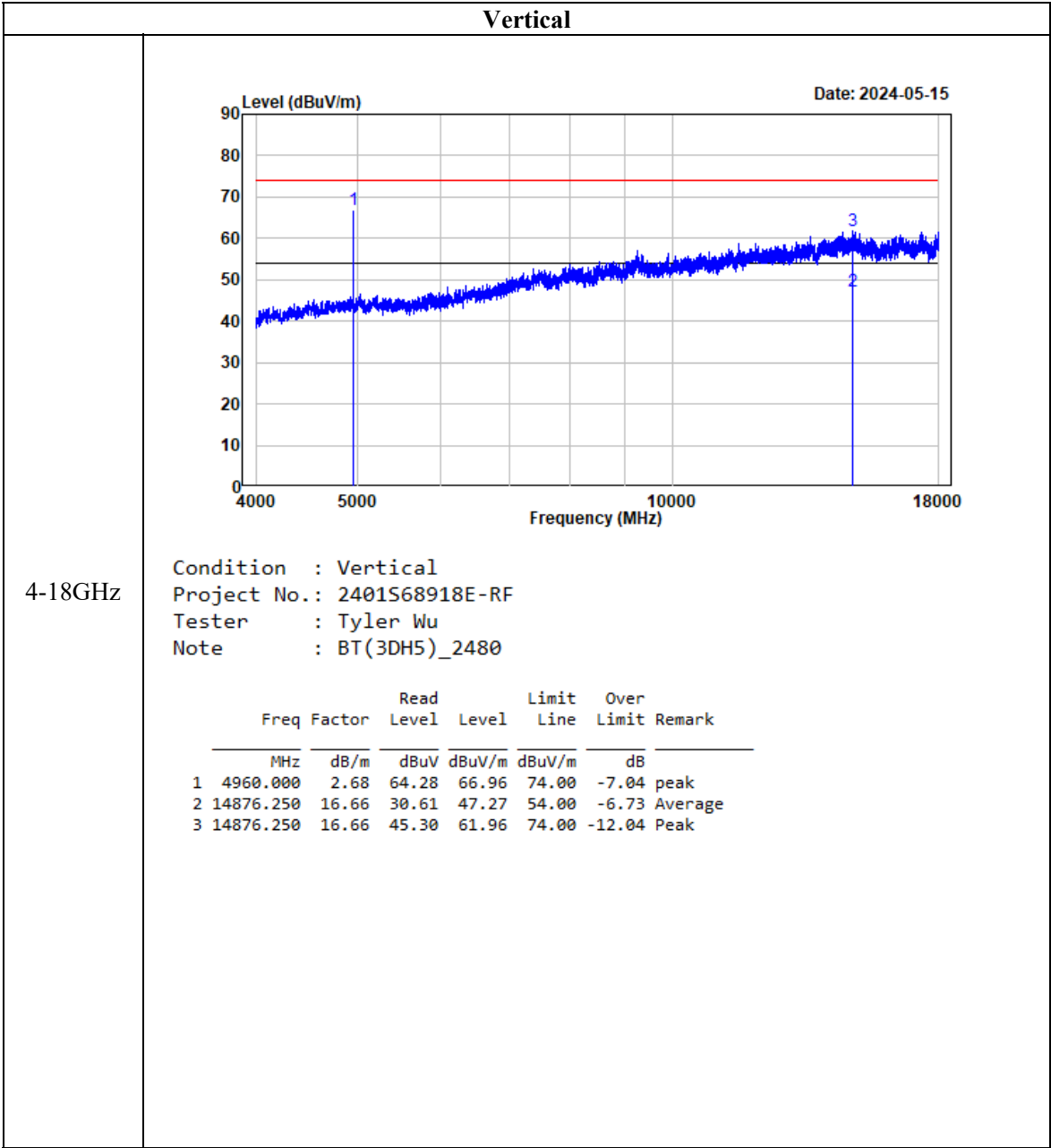


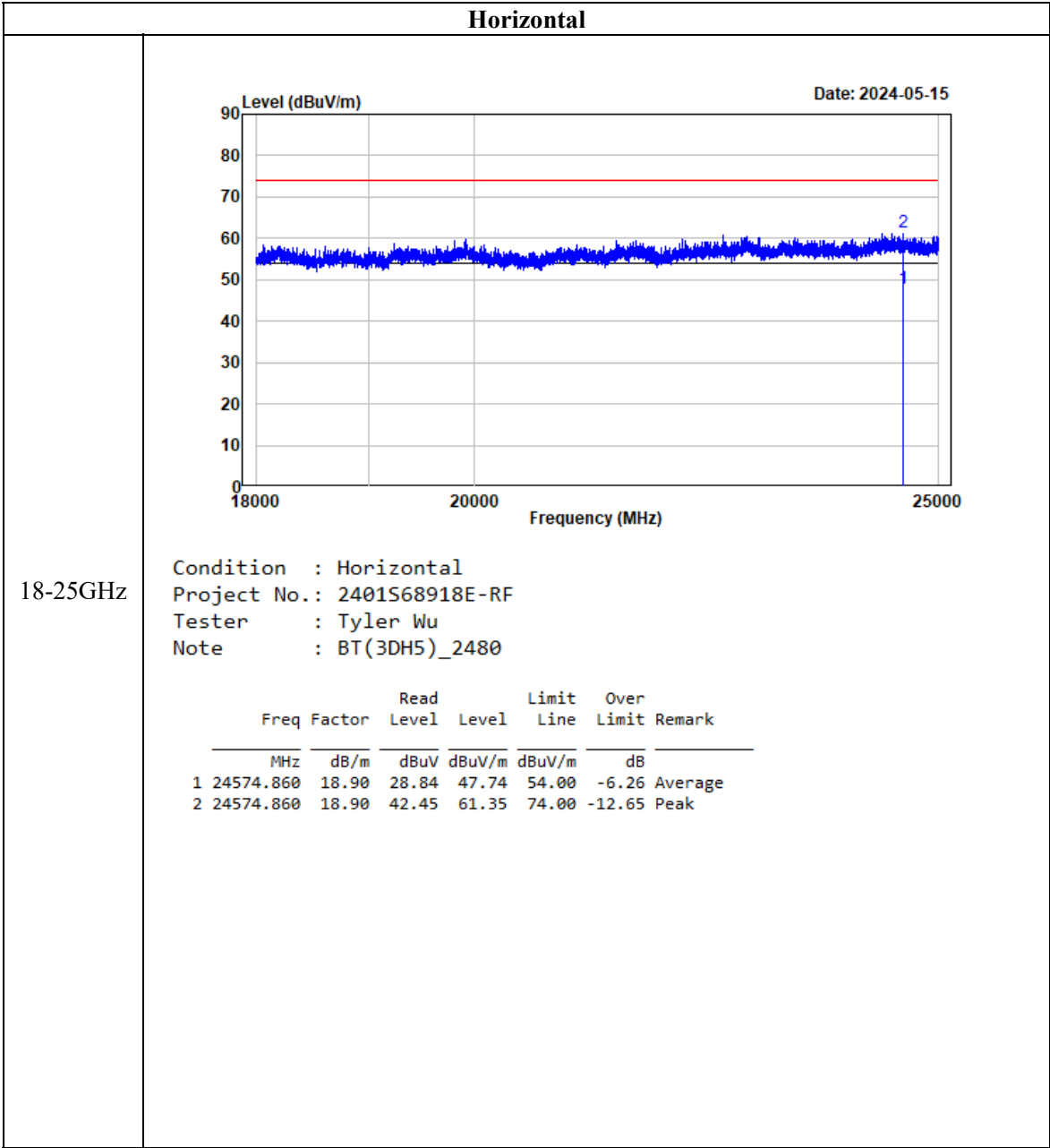
Harmonic Measurements:

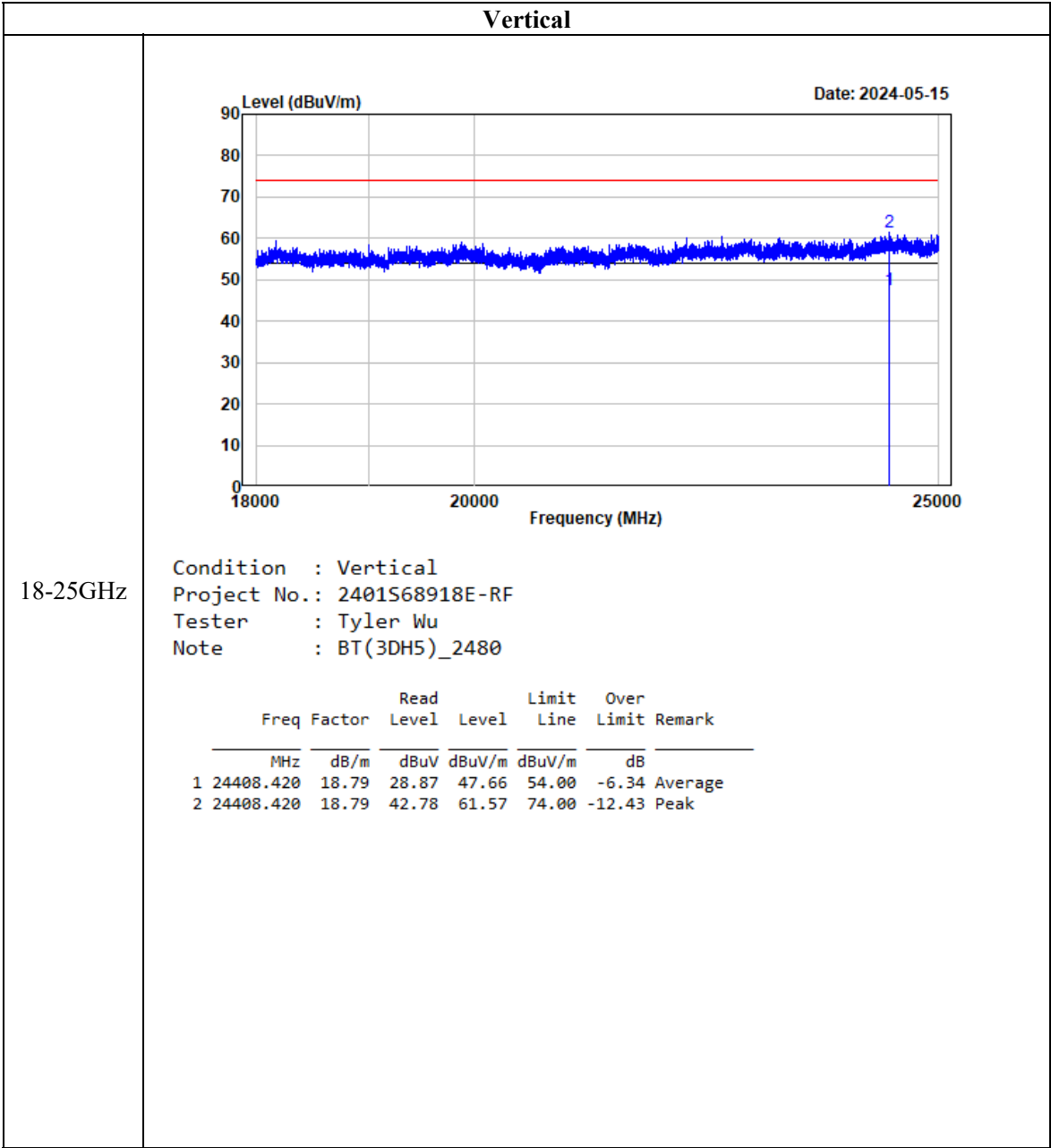












FCC §15.247(a) (1) - CHANNEL SEPARATION TEST

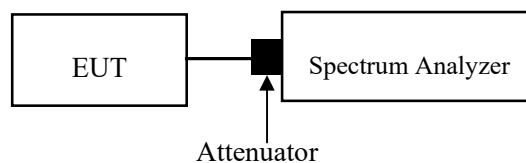
Applicable Standard

Frequency hopping systems shall have hopping 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:	26°C
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

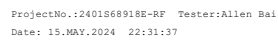
The testing was performed by Allen Bai on 2024-05-15.

EUT operation mode: Transmitting

Test Result: Compliant.

Test Modes	Test Frequency (MHz)	Channel Separation (MHz)	Limits (MHz)
BDR Mode (GFSK)	2402	0.999	0.644
	2441	1.002	0.640
	2480	0.999	0.636
EDR Mode ($\pi/4$ -DQPSK)	2402	1.002	0.862
	2441	0.999	0.860
	2480	0.999	0.860
EDR Mode (8DPSK)	2402	0.999	0.868
	2441	1.002	0.870
	2480	1.002	0.868
Note: Limit = two-thirds of the 20 dB bandwidth			

Low Channel



ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 22:32:48

ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 22:34:03

Ref 25 dBm *Att 30 dB
 *RBW 30 kHz Delta 2 (T1) 0.02 dB
 *VSW 100 kHz
 SWT 15 ms 1.002000000 MHz

Offset 10 5 dB
 Marked 1 [71]
 2.39 dBm
 2.40200000 GHz

1 dB VIEW

Center 2.4025 GHz 300 kHz/ Span 3 MHz

Ref 25 dBm Att 30 dB SWT 15 ms 999.00000000 kHz

Offset 10.5 dB Max Hold 1 [71]

99.80 dBm

2.441000000 GHz

1 PR VIEW

Center: 2.4415 GHz Span: 3 MHz

Ref 25 dBm Att 30 dB SWT 15 ms 999.000000000 kHz

Offset 10.5 dB

Marker 1 [1] 2.47902000 GHz

Delta 2 [1] -0.06 dB

RNB 30 kHz VSW 100 kHz

Center 2.4795 GHz 300 kHz/ Span 3 MHz

Date _____

Low Channel



ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 22:55:41

ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 22:56:55

FCC §15.247(a) (1) - 20 dB EMISSION BANDWIDTH

Applicable Standard

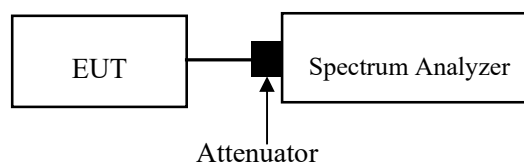
Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test Procedure

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

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 nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW/ 20dB bandwidth and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.



Test Data

Environmental Conditions

Temperature:	26 °C
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

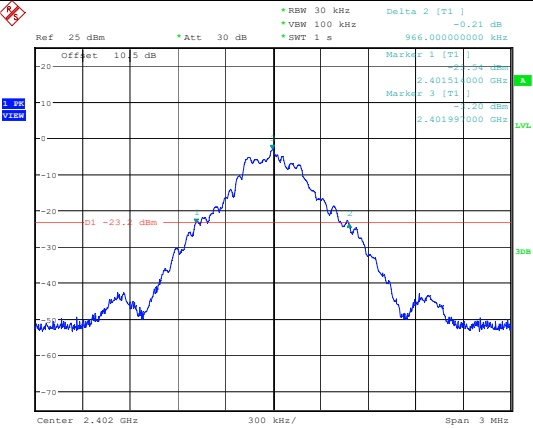
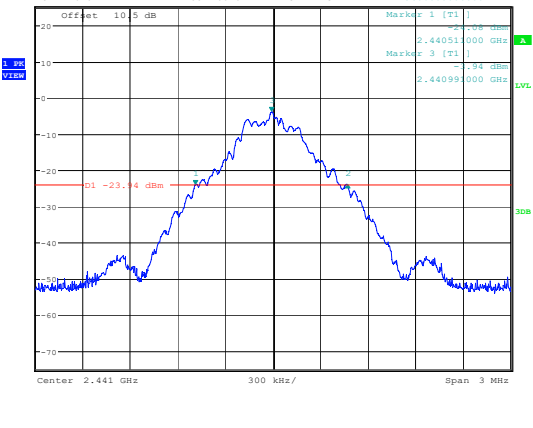
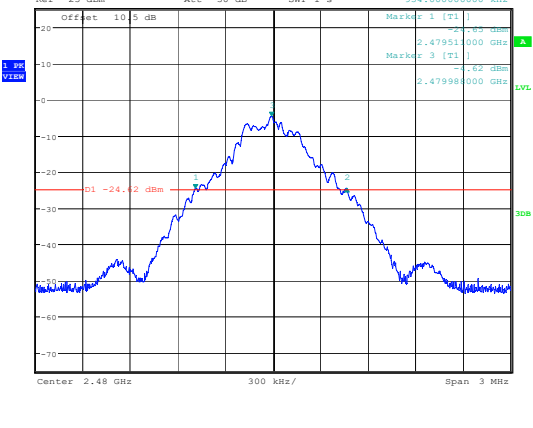
The testing was performed by Allen Bai on 2024-05-15.

EUT operation mode: Transmitting

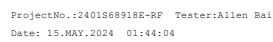
Test Result: Compliant.

Test Modes	Test Channel	Test Frequency (MHz)	20 dB Bandwidth (MHz)
BDR Mode (GFSK)	Lowest	2402	0.966
	Middle	2441	0.960
	Highest	2480	0.954
EDR Mode ($\pi/4$ -DQPSK)	Lowest	2402	1.293
	Middle	2441	1.290
	Highest	2480	1.290
EDR Mode (8DPSK)	Lowest	2402	1.302
	Middle	2441	1.305
	Highest	2480	1.302

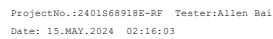
20 dB Bandwidth

Low Channel	BDR Mode (GFSK)  Ref: 25 dBm, Att: 30 dB, RBW: 30 kHz, VBW: 100 kHz, SMT: 1 s, Delta 2 [T1]: -0.21 dB, 966.000000000 kHz Marker 1 [T1]: 2.401510000 GHz, -23.24 dBm, A Marker 3 [T1]: 2.401990000 GHz, -31.20 dBm, LVL D1: -23.2 dBm Center: 2.402 GHz, 300 kHz/, Span: 3 MHz ProjectNo.:2401S68918E-RF Tester:Allen Bai Date: 15.MAY.2024 01:38:36
Middle Channel	 Ref: 25 dBm, Att: 30 dB, RBW: 30 kHz, VBW: 100 kHz, SMT: 1 s, Delta 2 [T1]: 0.05 dB, 960.000000000 kHz Marker 1 [T1]: 2.440510000 GHz, -23.98 dBm, A Marker 3 [T1]: 2.440990000 GHz, -31.94 dBm, LVL D1: -23.94 dBm Center: 2.441 GHz, 300 kHz/, Span: 3 MHz ProjectNo.:2401S68918E-RF Tester:Allen Bai Date: 15.MAY.2024 02:08:39
High Channel	 Ref: 25 dBm, Att: 30 dB, RBW: 30 kHz, VBW: 100 kHz, SMT: 1 s, Delta 2 [T1]: 0.02 dB, 954.000000000 kHz Marker 1 [T1]: 2.479510000 GHz, -24.42 dBm, A Marker 3 [T1]: 2.479980000 GHz, -31.62 dBm, LVL D1: -24.42 dBm Center: 2.48 GHz, 300 kHz/, Span: 3 MHz ProjectNo.:2401S68918E-RF Tester:Allen Bai Date: 15.MAY.2024 02:17:57

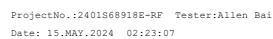
Low Channel



ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 02:16:03



ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 02:23:07



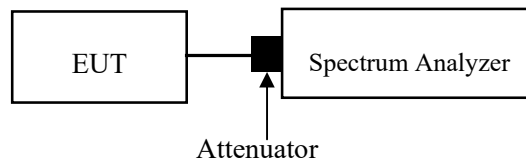
FCC §15.247(a) (1) (iii) - QUANTITY OF HOPPING CHANNEL TEST**Applicable Standard**

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

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**

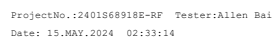
Temperature:	26 °C
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by Allen Bai on 2024-05-15.

EUT operation mode: Transmitting

Test Result: Compliant.

Test Modes	Frequency Range (MHz)	Number of Hopping Channel	Limits
GFSK	2400-2483.5	79	≥15
$\pi/4$ -DQPSK	2400-2483.5	79	≥15
8DPSK	2400-2483.5	79	≥15

GFSK

Ref 25 dBm Att 30 dB BW 100 kHz VM 100 kHz SMT 10 ms Delta 2 [T1] 78.072500000 MHz

Offset 10.5 dB

Marker 1 [T1] -1.43 dBm 2.402000000 GHz

Start 2.4 GHz 8.35 MHz/ Stop 2.4835 GHz

ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 02:49:31

Ref 25 dBm *Att 30 dB SWF 10 ms 77.905500000 MHz

Offet 10.5 dB Marker 1 [F1] -0.94 dBm

Start 2.4 GHz 8.35 MHz/ Stop 2.4835 GHz

ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 03:02:33

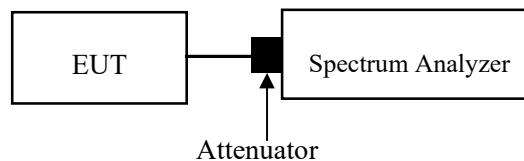
FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME)**Applicable Standard**

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

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW $\geq 3 \times$ 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:	26~27 °C
Relative Humidity:	50~52 %
ATM Pressure:	101.0 kPa

The testing was performed by Allen Bai on 2024-05-15 and 2024-05-17

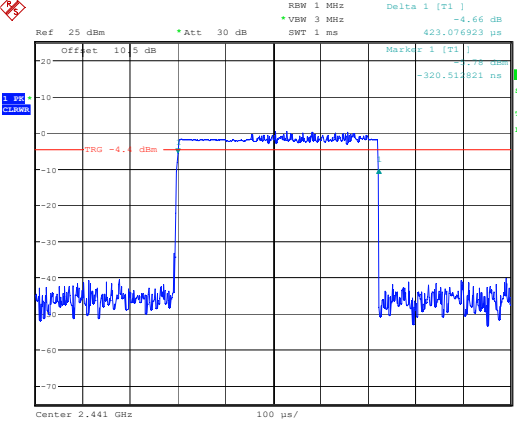
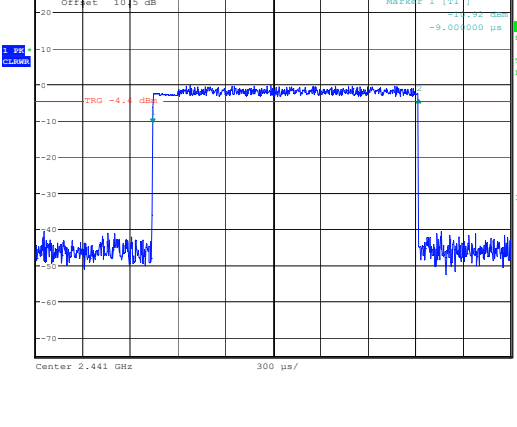
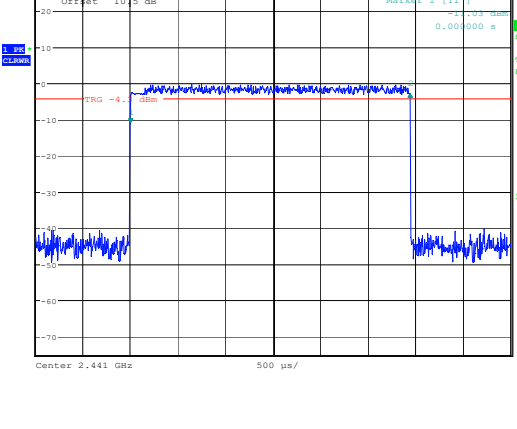
EUT operation mode: Transmitting

Test Result: Compliant.

Test Modes	Packet Type	Test Frequency (MHz)	Pulse width (ms)	Result (s)	Limit (s)
BDR Mode (GFSK)	DH1	2441	0.412	0.132	0.400
	DH3	2441	1.668	0.267	0.400
	DH5	2441	2.930	0.313	0.400
EDR Mode ($\pi/4$ -DQPSK)	2DH1	2441	0.423	0.135	0.400
	2DH3	2441	1.677	0.268	0.400
	2DH5	2441	2.940	0.314	0.400
EDR Mode (8DPSK)	3DH1	2441	0.423	0.135	0.400
	3DH3	2441	1.677	0.268	0.400
	3DH5	2441	2.945	0.314	0.400
Note: DH1/2DH1/3DH1:Dwell time=Pulse time (ms) $\times$ (1600/2/79) $\times$ 31.6 s DH3/2DH3/3DH3:Dwell time=Pulse time (ms) $\times$ (1600/4/79) $\times$ 31.6 s DH5/2DH5/3DH5:Dwell time=Pulse time (ms) $\times$ (1600/6/79) $\times$ 31.6 s					

Version 1.0 (2023/10/07)

Version 1.0 (2023/10/07)

3DH1	EDR Mode (8DPSK)  ProjectNo.:2401S68918E-RF Tester:Allen Bai Date: 17.MAY.2024 13:56:35
3DH3	 ProjectNo.:2401S68918E-RF Tester:Allen Bai Date: 15.MAY.2024 02:53:05
3DH5	 ProjectNo.:2401S68918E-RF Tester:Allen Bai Date: 15.MAY.2024 03:03:23

FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

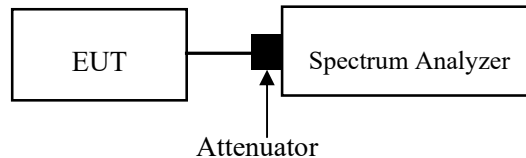
Applicable Standard

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

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:	26 °C
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

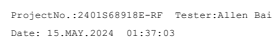
The testing was performed by Allen Bai on 2024-05-15.

EUT operation mode: Transmitting

Test Result: Compliant.

Test Modes	Test Frequency (MHz)	Peak Conducted Output Power (dBm)	Limits (dBm)
BDR Mode (GFSK)	2402	-1.92	21
	2441	-2.66	21
	2480	-3.34	21
EDR Mode ($\pi/4$ -DQPSK)	2402	0.28	21
	2441	-0.31	21
	2480	-1.12	21
EDR Mode (8DPSK)	2402	0.51	21
	2441	0.20	21
	2480	-0.48	21

Low Channel



Ref 25 dBm Att 30 dB SMT 5 ms 2.440930000 GHz

Offset 10.5 dB

Center 2.441 GHz 1 MHz/ Span 10 MHz

Marker 1 [T1] -2.66 dBm

3.98 VdB

ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 02:07:29

Ref 25 dBm Att 30 dB BW 3 MHz VM 10 MHz Span 10 MHz

Marker 1 [T1] -3.34 dBm

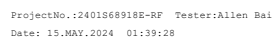
2.479960000 GHz

1. SP VIEW

Center 2.48 GHz 1 MHz/

ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 02:16:47

Low Channel



Ref 25 dBm Att 30 dB SMT 5 ms Marker 1 [T1] -0.31 dBm 2.44080000 GHz

Offset 10.5 dB

Center 2.441 GHz 1 MHz/ Span 10 MHz

ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 02:10:56

Ref 25 dBm Att 30 dB BW 3 MHz VM 10 MHz SWT 5 ms Marker 1 [T1] -1.12 dBm 2.479740000 GHz

Offset 10 5 dB

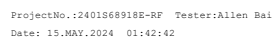
1 dB VIEW

20
10
0
-10
-20
-30
-40
-50
-60
-70

Center 2.48 GHz 1 MHz/ Span 10 MHz

ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 02:19:17

Low Channel



Ref 25 dBm Att 30 dB BW 3 MHz Marker 1 [T1] 0.20 dBm
VBN 10 MHz SMT 5 ms 2.441060000 GHz

Offset 10.5 dB

Center 2.441 GHz 1 MHz/ Span 10 MHz

ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 02:14:54

Ref 25 dBm Att 30 dB SWT 5 ms 2.48000000 GHz

Offet 10 5 dB

20
10
0
-10
-20
-30
-40
-50
-60
-70

Center 2.48 GHz 1 MHz/ Span 10 MHz

1 SP VIEW

Marker 1 [T1] -0.48 dBm

2.48000000 GHz

ProjectNo.:2401S68918E-RF Tester:Allen Bai
Date: 15.MAY.2024 02:21:57

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

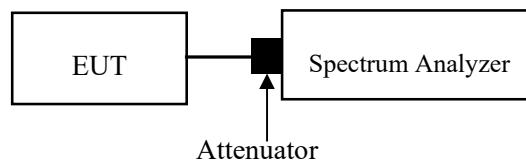
Applicable Standard

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

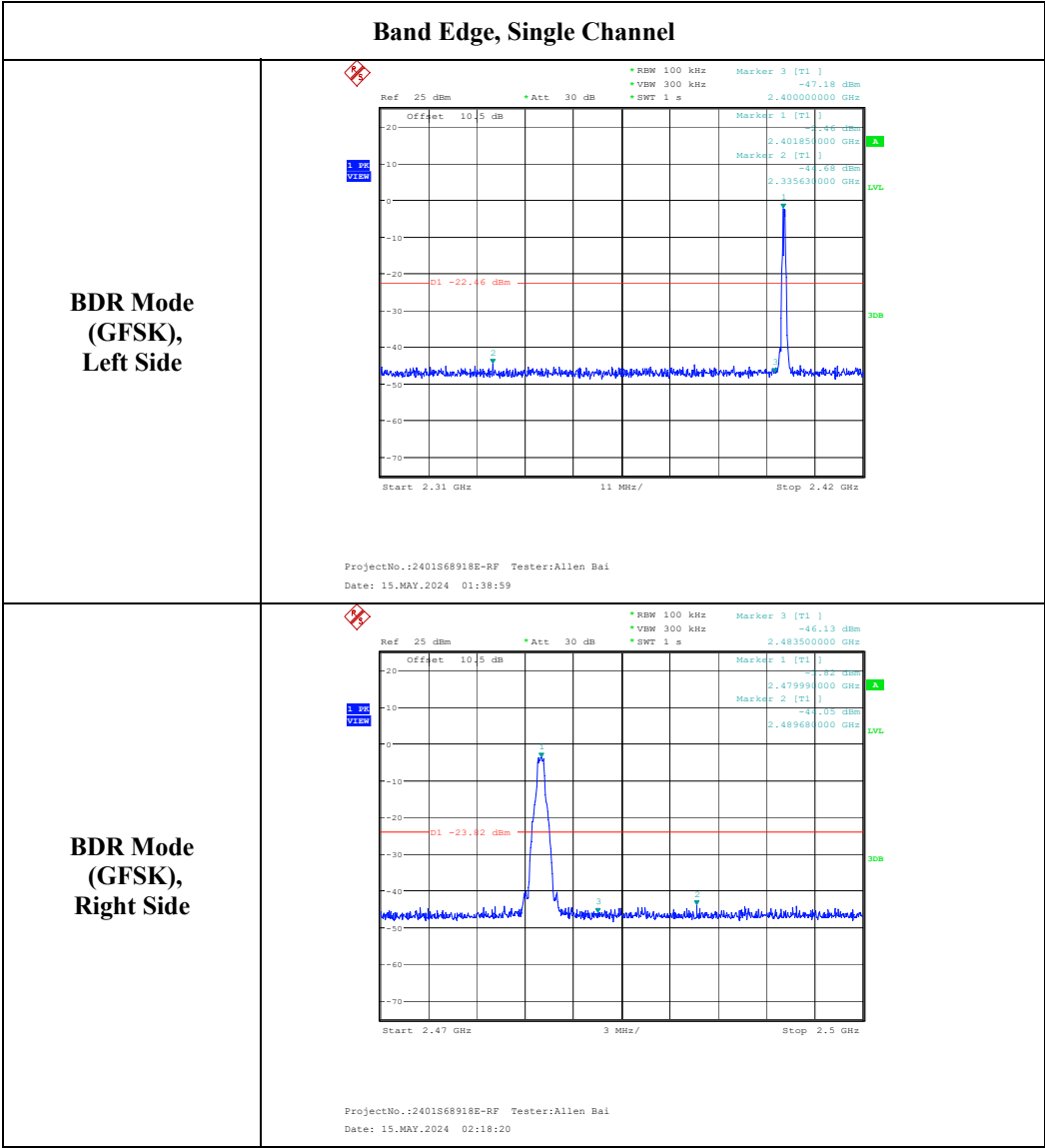
Environmental Conditions

Temperature:	26 °C
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

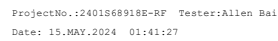
The testing was performed by Allen Bai on 2024-05-15.

EUT operation mode: Transmitting

Test Result: Compliant.

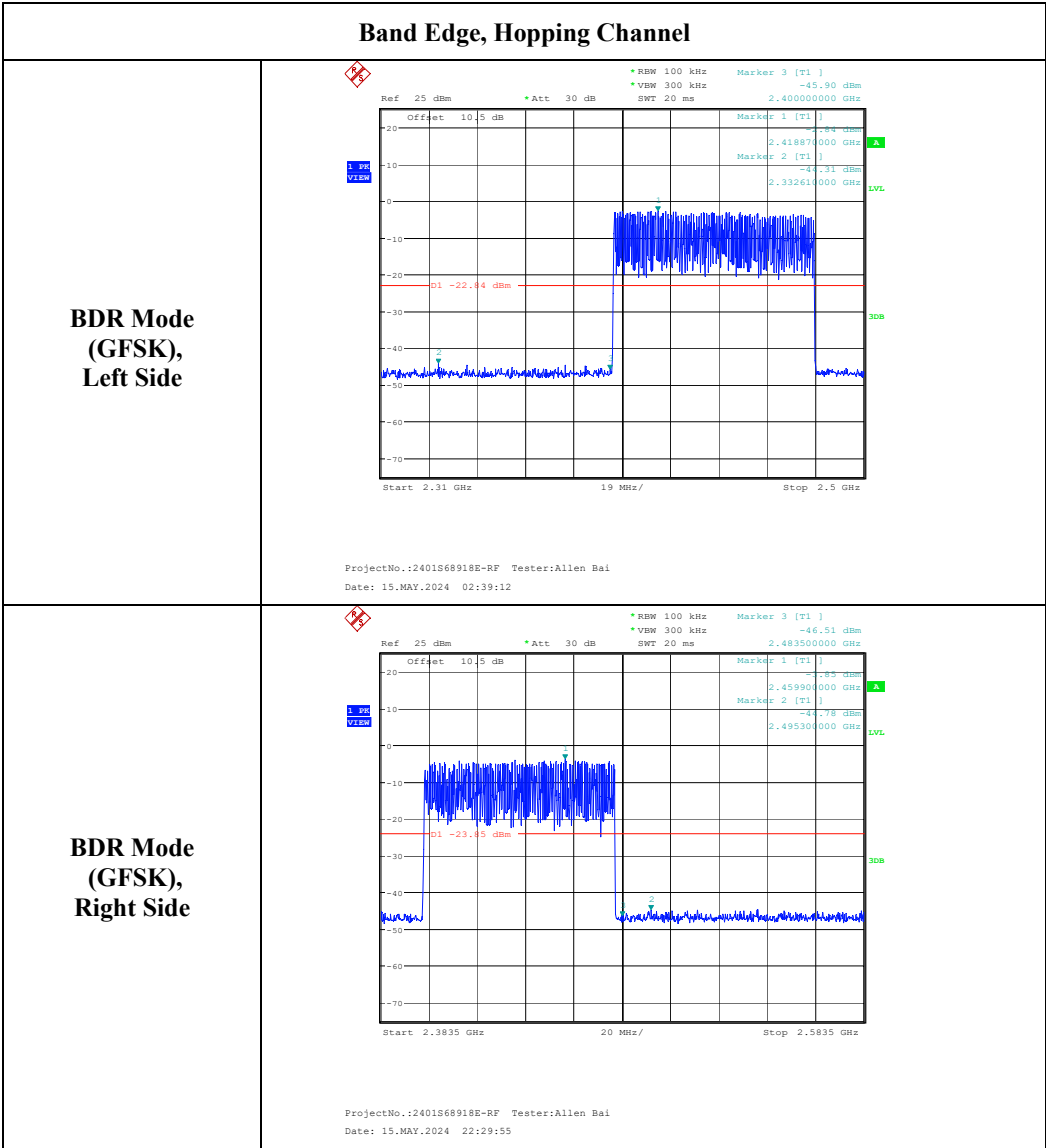


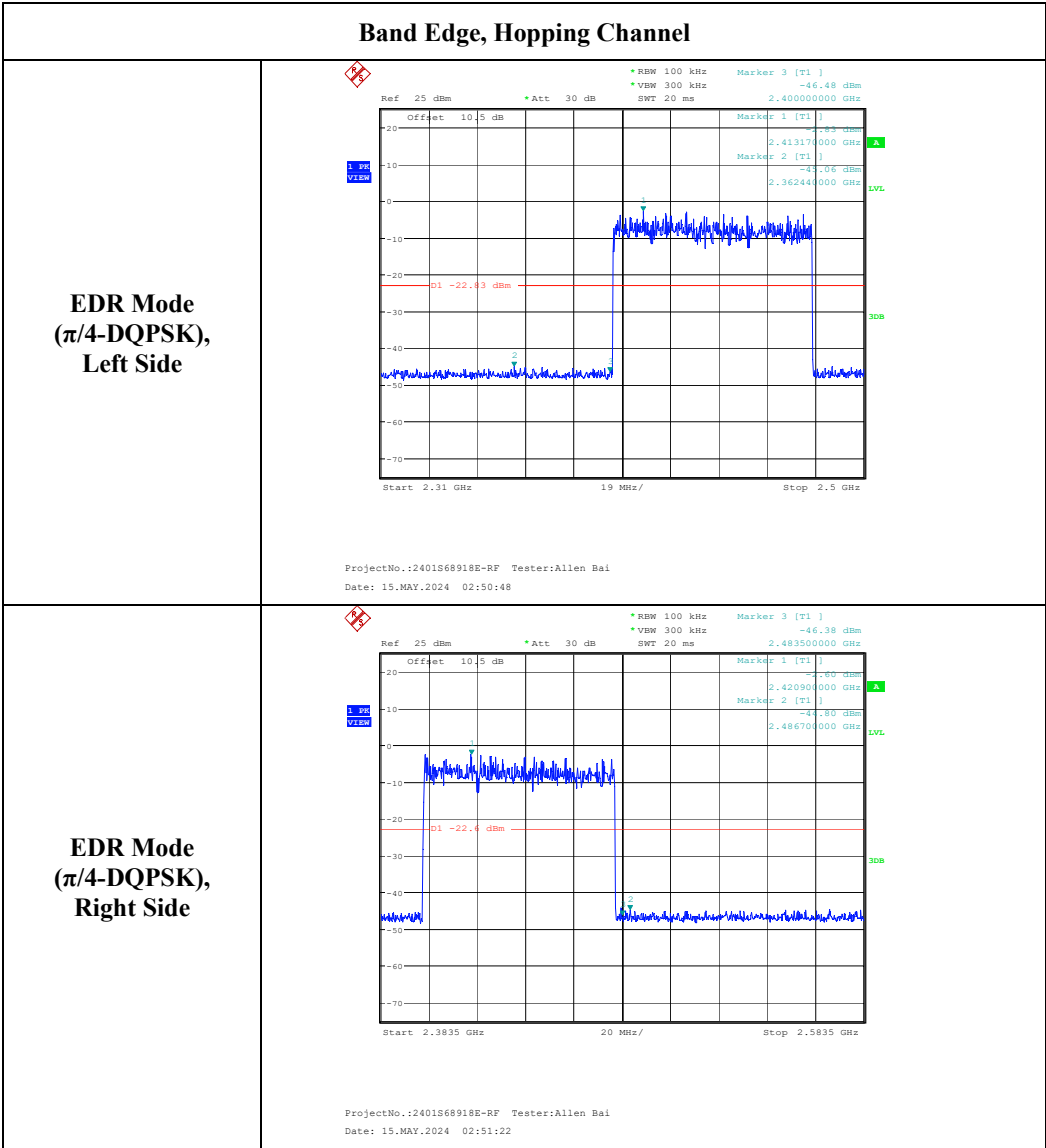
**EDR Mode
($\pi/4$ -DQPSK),
Left Side**

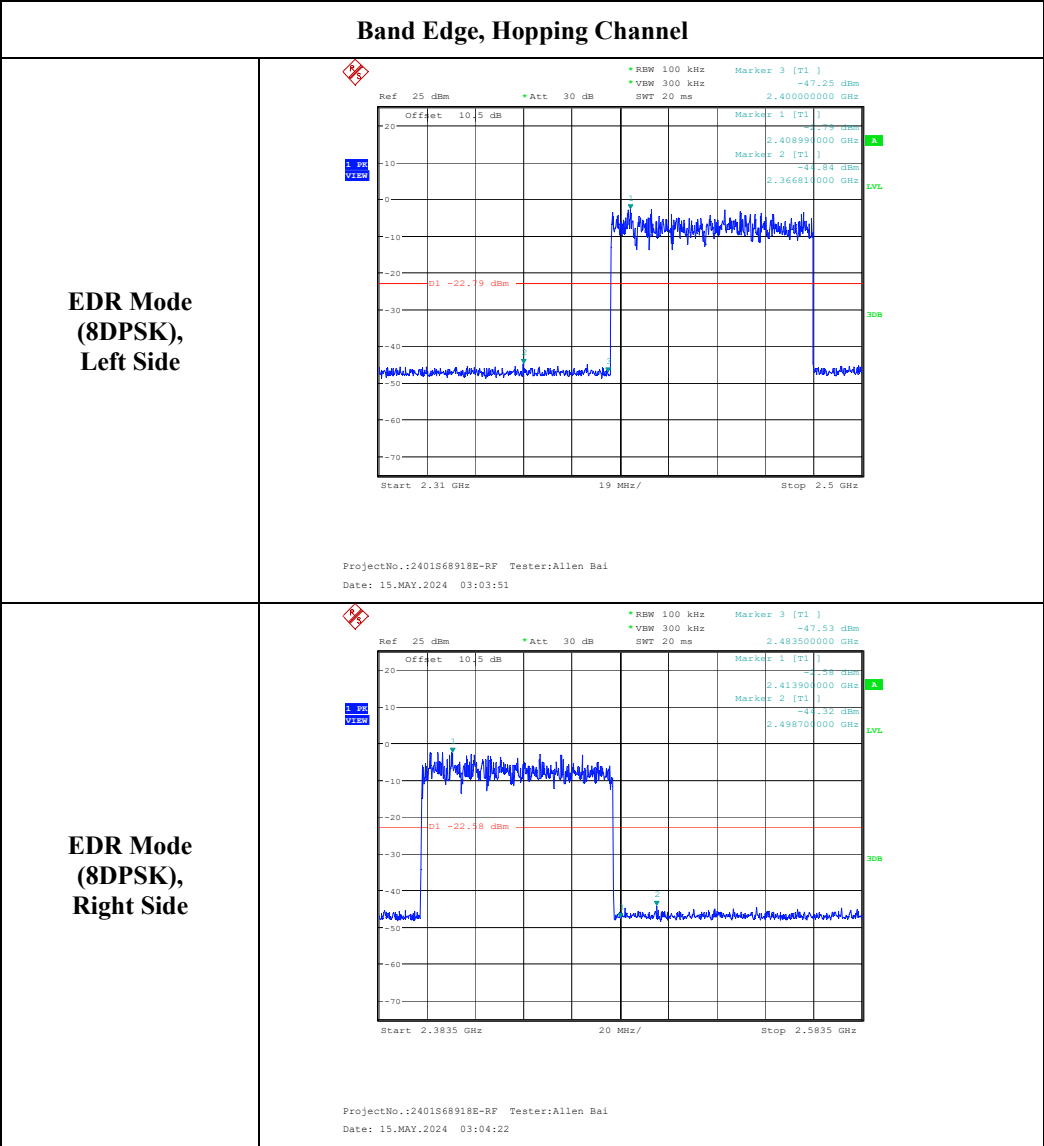


**EDR Mode
($\pi/4$ -DQPSK),
Right Side**









EUT PHOTOGRAPHS

Please refer to the attachment 2401S68918-RF External photo and 2401S68918-RF Internal photo.

TEST SETUP PHOTOGRAPHS

Please refer to the attachment 2401S68918-RF Test Setup photo.

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