

TEST REPORT

Applicant Name: Grandstream Networks, Inc.
Address: 126 Brookline Ave., 3rd Floor Boston, MA 02215, USA
Report Number: 2401T31849E-RFA
FCC ID: YZZGRP2613W
IC: 11964A-GRP2613W

Test Standard (s)

FCC PART 15.247; RSS-GEN ISSUE 5, FEBRUARY 2021 AMENDMENT 2;
RSS-247 ISSUE 3, AUGUST 2023

Sample Description

Product Type: IP Phone
Model No.: GRP2613W
Multiple Model(s) No.: N/A
Trade Mark: GRANDSTREAM
Date Received: 2024/05/28
Issue Date: 2024/08/05

Test Result:	Pass▲
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▲ In the configuration tested, the EUT complied with the standards above.

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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	2401T31849E-RFA	Original Report	2024/08/05

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

HVIN	GRP2613W
FVIN	0.3.14.15
Product	IP Phone
Tested Model	GRP2613W
Multiple Model(s)	N/A
Frequency Range	Bluetooth: 2402-2480MHz
Transmit Power	12.25dBm
Modulation Technique	Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK
Antenna Specification [#]	2.38dBi (provided by the applicant)
Voltage Range	DC 44-57V From POE or DC 5V From Adapter
Sample serial number	2M23-1 for Conducted and Radiated Emissions Test 2M23-4 for RF Conducted Test (Assigned by BACL, Shenzhen)
Sample/EUT Status	Good condition
Adapter Information	Adapter 1 Model: A318-050060W-US1 Input: 100-240V~50-60Hz, 0.15A Output: DC 5.0V, 0.6A Adapter 2 Model: DCT06W050060US-D0 Input: 100-240V~50/60Hz, 200mA Output: DC 5.0V, 0.6A Adapter 3 Model: GQ06-050060-ZU Input: 100-240V~50/60Hz, 0.3A Max Output: DC 5.0V, 0.6A

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules and RSS-247 Issue 3, August 2023, RSS-GEN Issue 5, Feb. 2021Amendment 2 of the Innovation, Science and Economic Development Canada 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 and RSS-247 Issue 3, August 2023, RSS-GEN Issue 5, Feb. 2021Amendment 2 of the Innovation, Science and Economic Development Canada rules.

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.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0023.

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

Software “putty.exe[#]” was used and the power level is 4[#]. The 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
BULL	Socket	GN-415K	5503290068073
DELL	PC	Latitude E5430	JG3NLV1
NOKIA	POE	G0545-530-060-PSE1000	N/A
Yealink	Earphone	N/A	N/A
IMAGITECH	Router	AX1800	YWT0023080000064

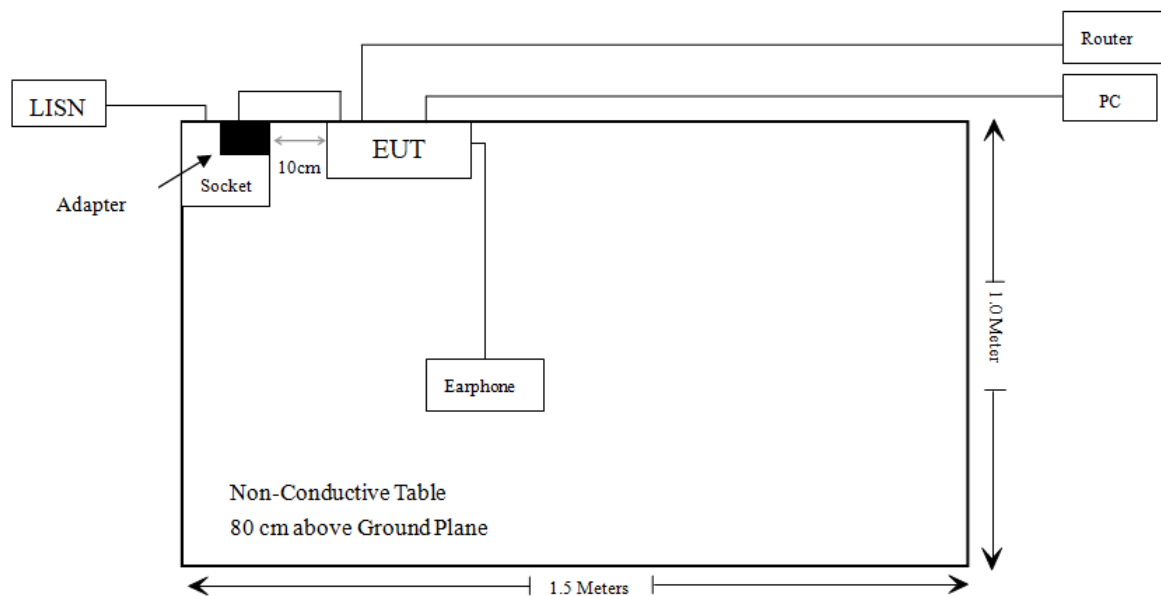
External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielded un-detachable AC cable	1.2	Socket	LISN/ AC Mains
Un-shielded un-detachable DC cable	1.8	Adapter	EUT
Un-shielded detachable RJ45 cable	3.0	EUT	Router
Un-shielded detachable RJ45 cable	3.0	EUT	PC
Un-shielded detachable RJ11 cable	1.8	EUT	Earphone
Un-shielded detachable AC cable	1.5	POE	LISN
Un-shielded detachable RJ45 cable	1.0	POE	EUT
Un-shielded detachable RJ45 cable	3.0	POE	IP Phone
Un-shielded detachable RJ45 cable	10.0	EUT	PC
Un-shielded detachable RJ45 cable	10.0	EUT	Router
Un-shielded detachable RJ45 cable	10.0	EUT	POE

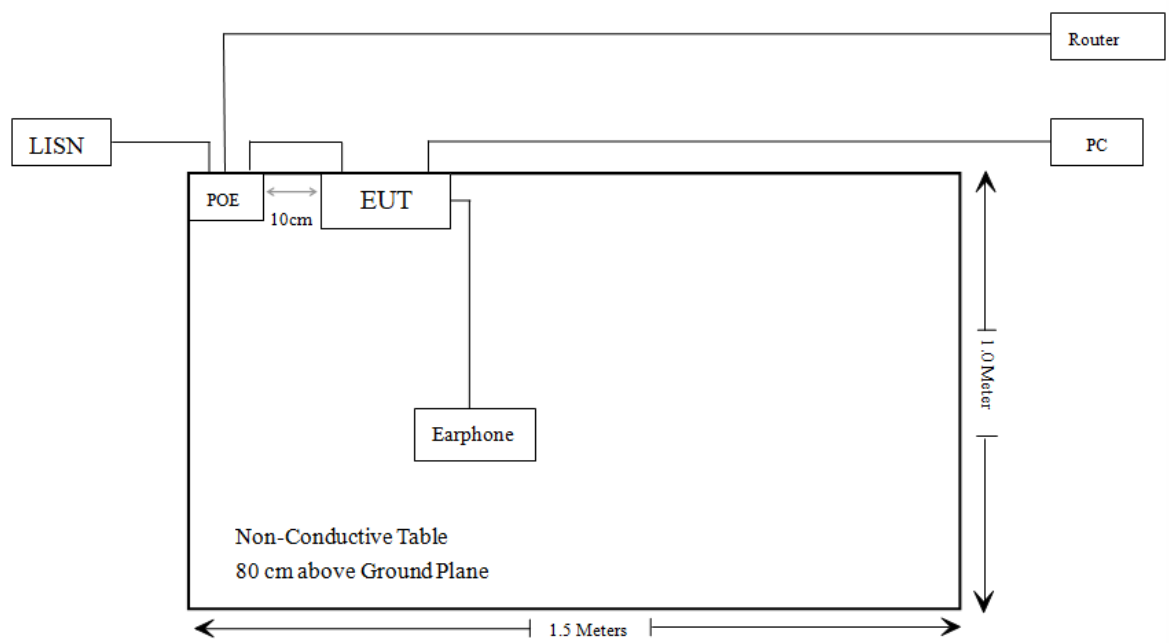
Block Diagram of Test Setup

For Conducted Emissions:

For Adapter:

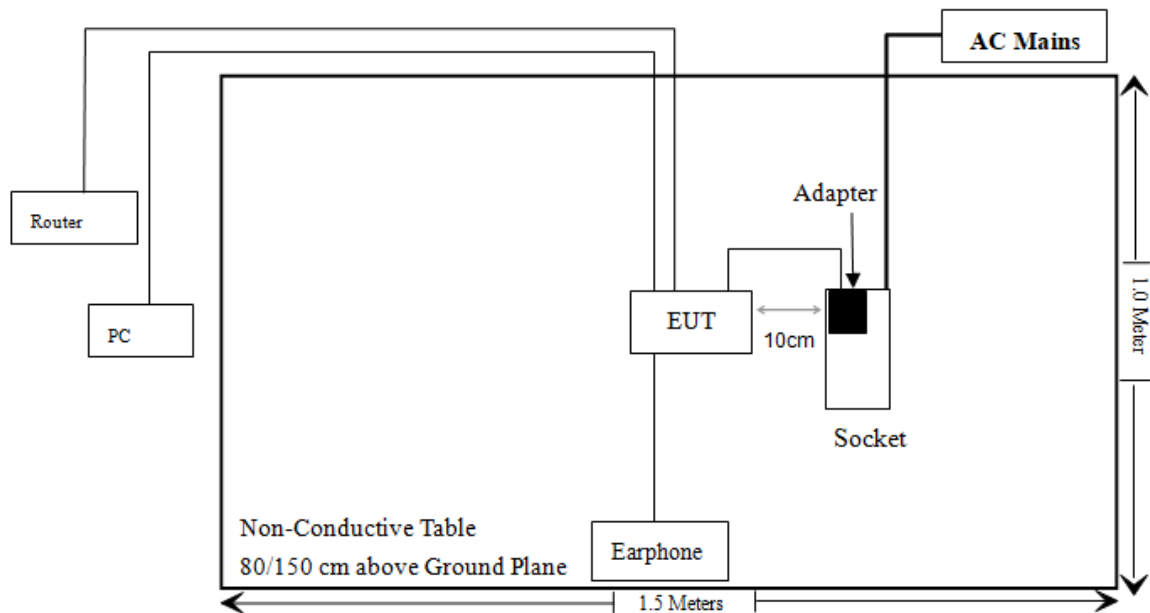


For POE:

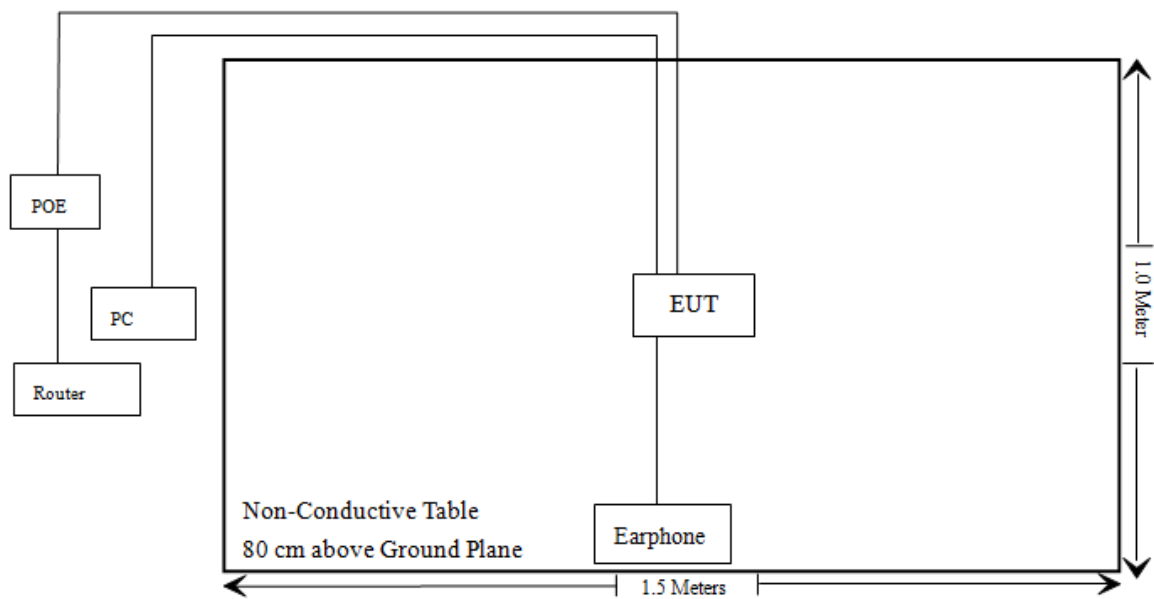


For Radiated Emissions:

For Adapter:



For POE:



SUMMARY OF TEST RESULTS

FCC Rules	RSS Rules	Description of Test	Result
FCC §1.1307(b) & 2.1091	RSS-102 § 4	Maximum Permissible Exposure(MPE)& Exposure Limits	Compliant
FCC §15.203	RSS-Gen §6.8	Antenna Requirement	Compliant
FCC §15.207(a)	RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §15.205, §15.209, §15.247(d)	RSS-247 § 5.5, RSS-GEN § 8.10	Radiated Emissions	Compliant
FCC §15.247(a)(1)	RSS-247 § 5.1(a), RSS-GEN § 6.7	20 dB Emission Bandwidth & 99% Occupied Bandwidth	Compliant
FCC §15.247(a)(1)	RSS-247 § 5.1 (b)	Channel Separation Test	Compliant
FCC §15.247(a)(1)(iii)	RSS-247 § 5.1 (d)	Time of Occupancy (Dwell Time)	Compliant
FCC §15.247(a)(1)(iii)	RSS-247 § 5.1 (d)	Quantity of hopping channel Test	Compliant
FCC §15.247(b)(1)	RSS-247 § 5.1(b) & § 5.4(b)	Peak Output Power Measurement	Compliant
FCC §15.247(d)	RSS-247 § 5.5	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	2024/05/21	2025/05/20
Unknown	CE Cable	Unknown	UF A210B-1-0720-504504	2024/05/21	2025/05/20
Audix	EMI Test software	E3	191218(V9)	NCR	NCR
Radiated Emission Test					
Rohde & Schwarz	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
Unknown	Cable	Chamber A Cable 1	N/A	2024/06/18	2025/06/17
Unknown	Cable	XH500C	J-10M-A	2024/06/18	2025/06/17
BACL	Active Loop Antenna	1313-1A	4031911	2024/05/14	2027/05/13
Unknown	Cable	2Y194	0735	2024/05/21	2025/05/20
Unknown	Cable	PNG214	1354	2024/05/21	2025/05/20
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	735	2024/06/18	2025/06/17
Unknown	RF Cable	UFA147	219661	2024/06/18	2025/06/17
Unknown	RF Cable	XH750A-N	J-10M	2024/06/18	2025/06/17
JD	Multiplex Switch Test Control Set	DT7220FSU	DQ77926	2024/06/18	2025/06/17
Audix	EMI Test software	E3	191218(V9)	NCR	NCR
Electro-Mechanics Co	Horn Antenna	3116	9510-2270	2023/09/18	2026/09/17
UTIFLEX	RF Cable	NO. 13	232308-001	2023/08/03	2024/08/02

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
Tonscend	RF control Unit	JS0806-2	19D8060154	2023/09/06	2024/09/05
Rohde &Schwarz	Spectrum Analyzer	FSV40	101473	2024/01/16	2025/01/15
MARCONI	10dB Attenuator	6534/3	2942	2023/07/04	2024/07/03
Unknown	RF Cable	65475	01670515	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 - MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and 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.

Limits for General Population/Uncontrolled Exposure

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (Minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Result**For worst case:**

Mode	Frequency (MHz)	Antenna Gain [#]		Tune up conducted power [#]		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
BT	2402-2480	2.38	1.73	12.5	17.78	20	0.006	1
BLE	2402-2480	2.38	1.73	7.5	5.62	20	0.002	1
2.4G Wi-Fi	2412-2462	2.38	1.73	24.5	281.84	20	0.097	1
5.2G Wi-Fi	5180-5240	4.01	2.52	16.0	39.81	20	0.020	1
5.3G Wi-Fi	5260-5320	4.01	2.52	16.0	39.81	20	0.020	1
5.6G Wi-Fi	5500-5720	4.01	2.52	16.0	39.81	20	0.020	1
5.8G Wi-Fi	5745-5825	4.01	2.52	17.5	56.23	20	0.028	1

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

According to applicant, the Bluetooth and Wi-Fi can transmit at same time, the 2.4G Wi-Fi and 5G Wi-Fi cannot transmit at same time

Simultaneous transmitting consideration (worst case):

The ratio= $MPE_{Wi-Fi}/limit_{Wi-Fi} + MPE_{BT}/limit_{BT} = 0.006/1 + 0.097/1 = 0.103 < 1.0$

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

Result: Compliant.

RSS-102 § 4 - EXPOSURE LIMITS

Applicable Standard

According to RSS-102 § 4:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²¹	83	90	-	Instantaneous [*]
0.1-10	-	0.73/ <i>f</i>	-	6 ^{**}
1.1-10	87/ <i>f</i> ^{0.5}	-	-	6 ^{**}
10-20	27.46	0.0728	-2	6
20-48	58.07/ <i>f</i> ^{0.25}	0.1540/ <i>f</i> ^{0.25}	8.944/ <i>f</i> ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 <i>f</i> ^{0.3417}	0.008335 <i>f</i> ^{0.3417}	0.02619 <i>f</i> ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ <i>f</i> ^{1.2}
150000-300000	0.158 <i>f</i> ^{0.5}	4.21 x 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 x 10 ⁻⁵ <i>f</i>	616000/ <i>f</i>

Note: *f* is frequency in MHz.

^{*} Based on nerve stimulation (NS).

^{**} Based on specific absorption rate (SAR).

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. W/m²)

P = power input to the antenna (in appropriate units, e.g., W).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For worst case:

Mode	Frequency (MHz)	Antenna Gain [#]		Max Tune-up Power [#]		Evaluation Distance (m)	Power Density (W/m ²)	MPE Limit (W/m ²)
		(dBi)	(numeric)	(dBm)	(W)			
BT	2402-2480	2.38	1.73	12.5	0.018	0.2	0.062	5.35
BLE	2402-2480	2.38	1.73	7.5	0.006	0.2	0.021	5.35
2.4G Wi-Fi	2412-2462	2.38	1.73	24.5	0.282	0.2	0.971	5.37
5.2G Wi-Fi	5180-5240	4.01	2.52	16.0	0.040	0.2	0.201	9.05
5.3G Wi-Fi	5260-5320	4.01	2.52	16.0	0.040	0.2	0.201	9.14
5.6G Wi-Fi	5500-5720	4.01	2.52	16.0	0.040	0.2	0.201	9.43
5.8G Wi-Fi	5745-5825	4.01	2.52	17.5	0.056	0.2	0.281	9.71

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

According to applicant, the Bluetooth and Wi-Fi can transmit at same time, the 2.4G Wi-Fi and 5G Wi-Fi cannot transmit at same time

Simultaneous transmitting consideration (worst case):

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.062/5.35 + 0.971/5.35 = 0.193 < 1.0$$

Result: Compliance

Note: To maintain compliance with the RF exposure guidelines, place the equipment at least 0.3 m from nearby persons.

FCC §15.203 & RSS-GEN §6.8 - 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.

According to FCC § 15.203, the applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device. Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

Antenna Connector Construction

The EUT has one internal antenna arrangement which was permanently attached for Bluetooth and the maximum antenna gain[#] is 2.38dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Antenna Type	Antenna Gain [#]	Impedance	Frequency Range
Dipole	2.38dBi	50Ω	2.4~2.5GHz

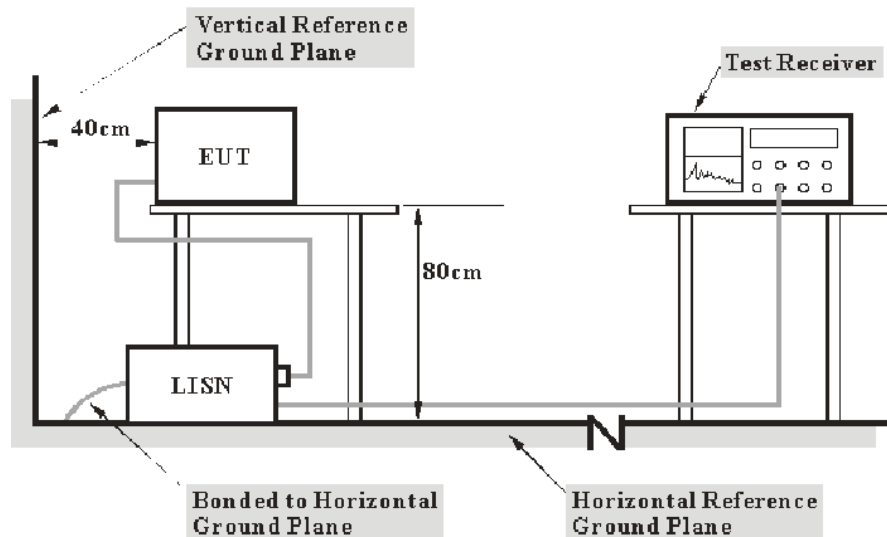
Result: Compliant

FCC §15.207 (a) & RSS-GEN § 8.8 - AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a), RSS-GEN § 8.8

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 & RSS-Gen.

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

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).

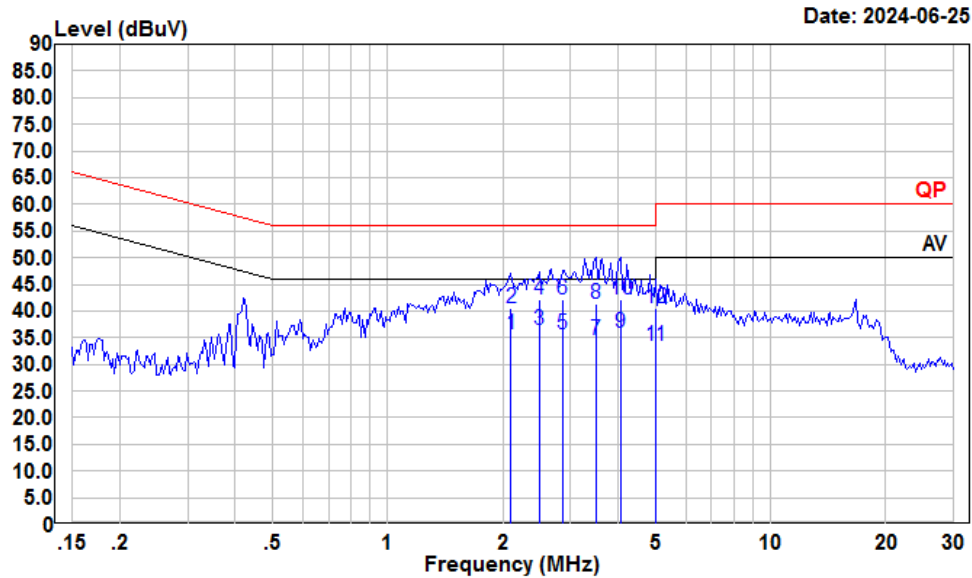
Test Data

Environmental Conditions

Temperature:	22~26 °C
Relative Humidity:	60~64 %
ATM Pressure:	101.0 kPa

The testing was performed by Macy Shi from 2024-06-25 to 2024-07-02.

EUT operation mode: Transmitting (maximum output power mode 8DPSK Low channel)

*For Adapter 1***AC 120V/60 Hz, Line**

Condition: Line

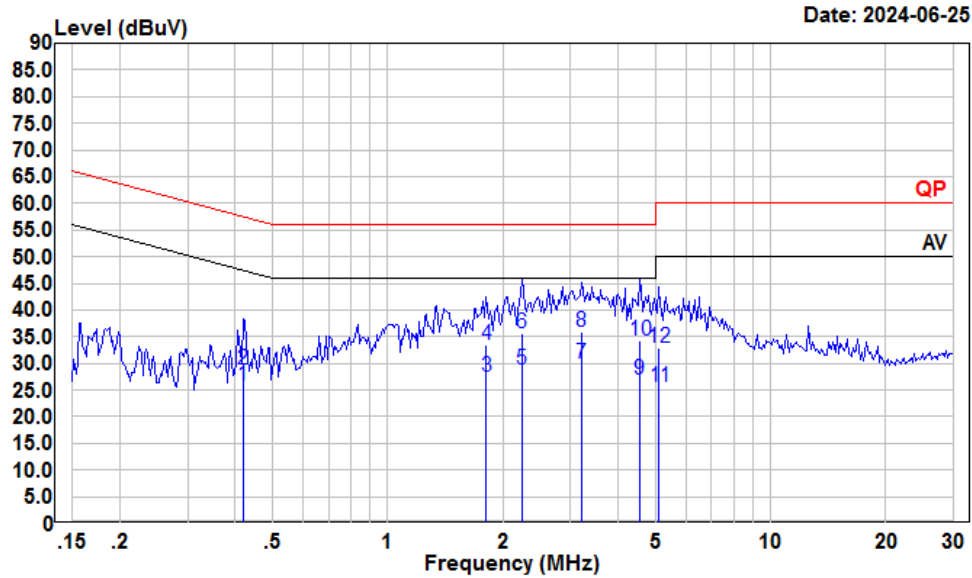
Project : 2401T31849E-RF

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	2.10	14.90	35.67	10.58	10.19	46.00	-10.33	Average
2	2.10	19.70	40.47	10.58	10.19	56.00	-15.53	QP
3	2.49	15.80	36.48	10.51	10.17	46.00	-9.52	Average
4	2.49	21.40	42.08	10.51	10.17	56.00	-13.92	QP
5	2.85	14.99	35.62	10.45	10.18	46.00	-10.38	Average
6	2.85	21.49	42.12	10.45	10.18	56.00	-13.88	QP
7	3.49	14.10	34.65	10.36	10.19	46.00	-11.35	Average
8	3.49	20.80	41.35	10.36	10.19	56.00	-14.65	QP
9	4.05	15.49	36.00	10.30	10.21	46.00	-10.00	Average
10	4.05	21.70	42.21	10.30	10.21	56.00	-13.79	QP
11	5.01	12.93	33.49	10.38	10.18	50.00	-16.51	Average
12	5.01	19.93	40.49	10.38	10.18	60.00	-19.51	QP

AC 120V/60 Hz, Neutral



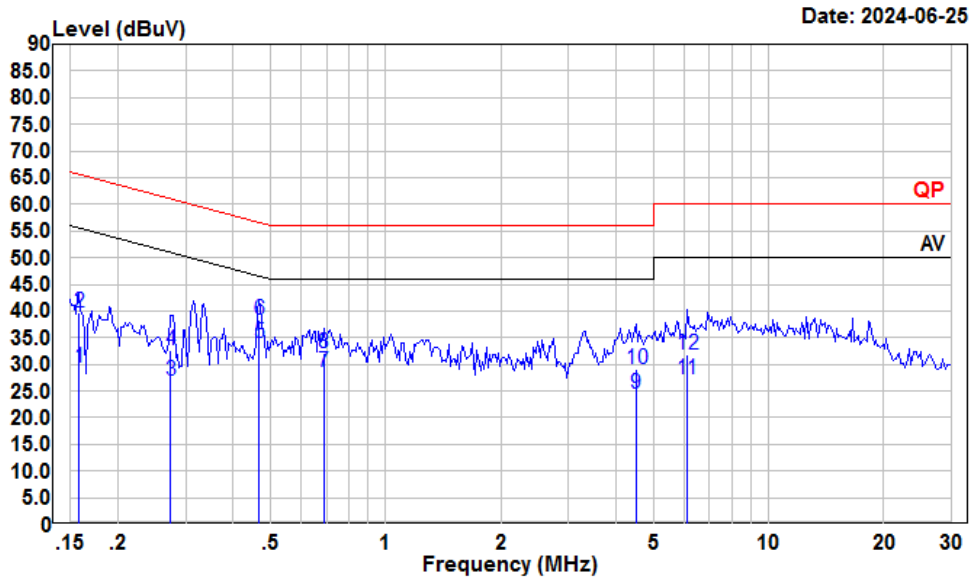
Condition: Neutral

Project : 2401T31849E-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	0.42	5.18	25.93	10.64	10.11	47.46	-21.53	Average
2	0.42	8.01	28.76	10.64	10.11	57.46	-28.70	QP
3	1.81	6.75	27.40	10.47	10.18	46.00	-18.60	Average
4	1.81	12.94	33.59	10.47	10.18	56.00	-22.41	QP
5	2.24	8.33	28.91	10.40	10.18	46.00	-17.09	Average
6	2.24	14.96	35.54	10.40	10.18	56.00	-20.46	QP
7	3.21	9.20	29.79	10.40	10.19	46.00	-16.21	Average
8	3.21	15.30	35.89	10.40	10.19	56.00	-20.11	QP
9	4.55	6.20	26.86	10.47	10.19	46.00	-19.14	Average
10	4.55	13.60	34.26	10.47	10.19	56.00	-21.74	QP
11	5.11	4.73	25.44	10.53	10.18	50.00	-24.56	Average
12	5.11	12.21	32.92	10.53	10.18	60.00	-27.08	QP

*For Adapter 2***AC 120V/60 Hz, Line**

Condition: Line

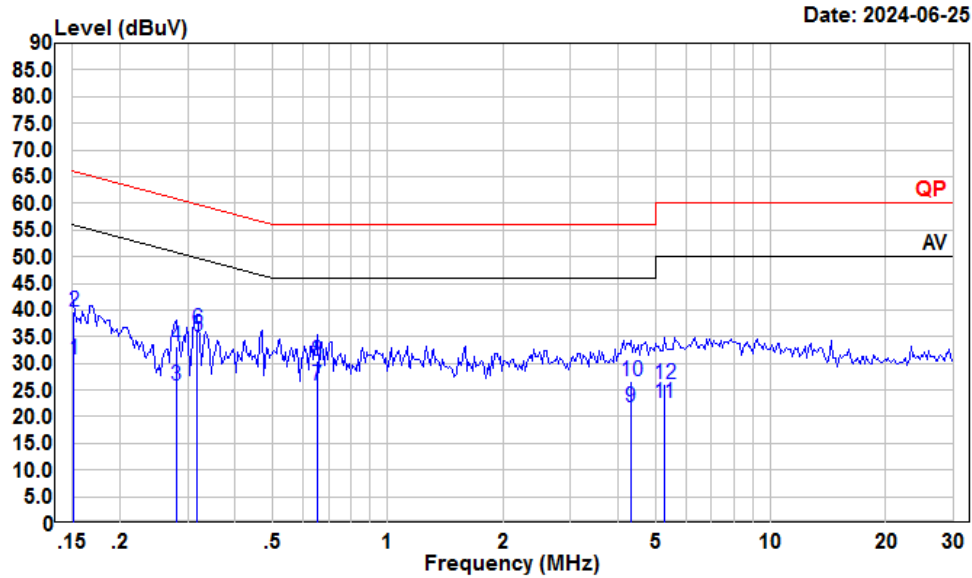
Project : 2401T31849E-RF

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	0.16	8.40	29.40	10.88	10.12	55.56	-26.16	Average
2	0.16	18.74	39.74	10.88	10.12	65.56	-25.82	QP
3	0.27	6.05	26.84	10.70	10.09	50.98	-24.14	Average
4	0.27	11.77	32.56	10.70	10.09	60.98	-28.42	QP
5	0.47	13.36	34.01	10.52	10.13	46.58	-12.57	Average
6	0.47	17.61	38.26	10.52	10.13	56.58	-18.32	QP
7	0.69	7.83	28.48	10.50	10.15	46.00	-17.52	Average
8	0.69	11.49	32.14	10.50	10.15	56.00	-23.86	QP
9	4.50	3.97	24.50	10.34	10.19	46.00	-21.50	Average
10	4.50	8.48	29.01	10.34	10.19	56.00	-26.99	QP
11	6.12	6.68	27.32	10.45	10.19	50.00	-22.68	Average
12	6.12	11.14	31.78	10.45	10.19	60.00	-28.22	QP

AC 120V/60 Hz, Neutral



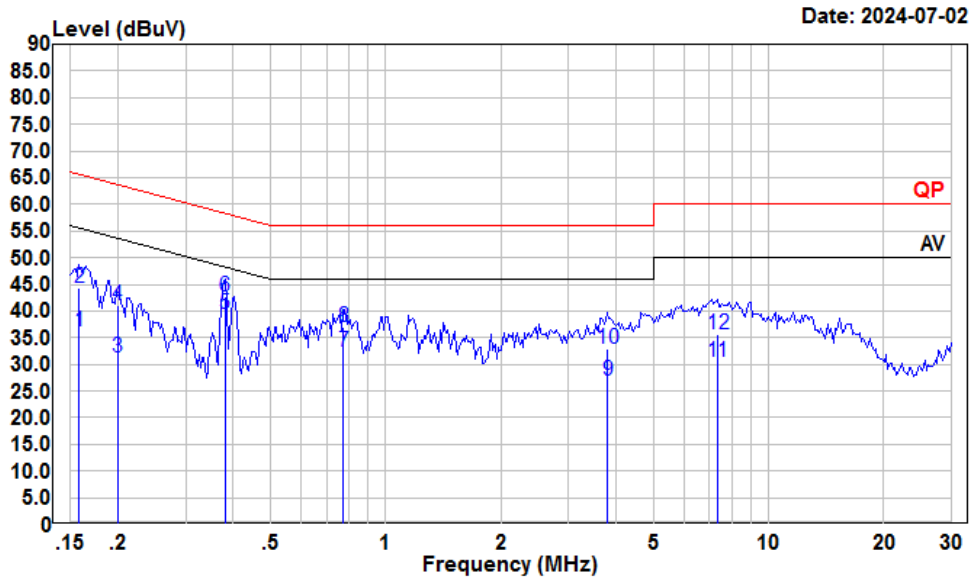
Condition: Neutral

Project : 2401T31849E-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	0.15	9.91	30.63	10.59	10.13	55.91	-25.28	Average
2	0.15	19.05	39.77	10.59	10.13	65.91	-26.14	QP
3	0.28	5.32	25.93	10.51	10.10	50.81	-24.88	Average
4	0.28	12.44	33.05	10.51	10.10	60.81	-27.76	QP
5	0.32	14.55	35.21	10.55	10.11	49.75	-14.54	Average
6	0.32	15.70	36.36	10.55	10.11	59.75	-23.39	QP
7	0.65	4.94	25.78	10.70	10.14	46.00	-20.22	Average
8	0.65	9.67	30.51	10.70	10.14	56.00	-25.49	QP
9	4.32	1.13	21.77	10.44	10.20	46.00	-24.23	Average
10	4.32	6.01	26.65	10.44	10.20	56.00	-29.35	QP
11	5.28	1.79	22.52	10.55	10.18	50.00	-27.48	Average
12	5.28	5.32	26.05	10.55	10.18	60.00	-33.95	QP

*For Adapter 3***AC 120V/60 Hz, Line**

Condition: Line

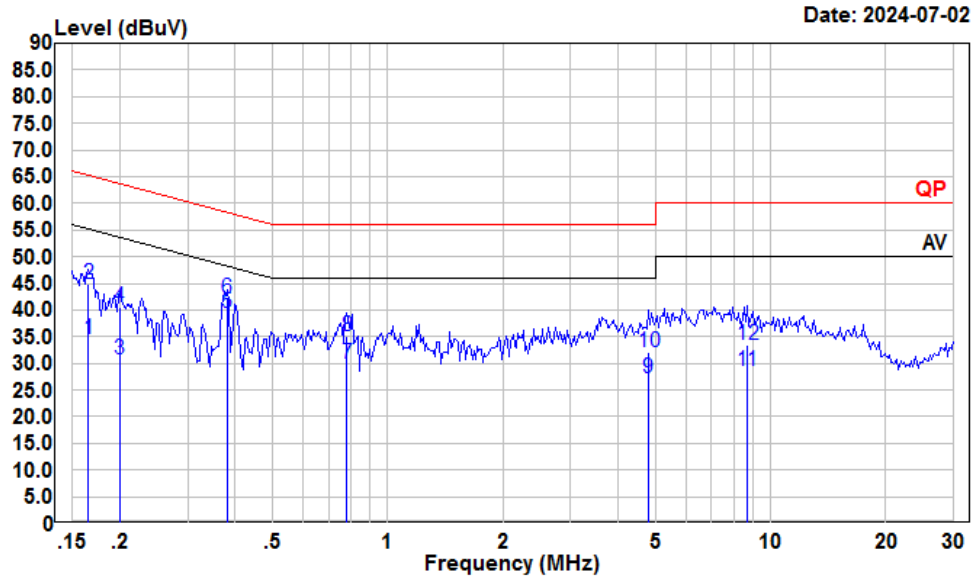
Project : 2401T31849E-RF

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	0.16	15.06	36.06	10.88	10.12	55.56	-19.50	Average
2	0.16	23.33	44.33	10.88	10.12	65.56	-21.23	QP
3	0.20	10.41	31.30	10.80	10.09	53.62	-22.32	Average
4	0.20	20.05	40.94	10.80	10.09	63.62	-22.68	QP
5	0.38	18.72	39.42	10.59	10.11	48.25	-8.83	Average
6	0.38	21.95	42.65	10.59	10.11	58.25	-15.60	QP
7	0.78	11.74	32.34	10.47	10.13	46.00	-13.66	Average
8	0.78	16.31	36.91	10.47	10.13	56.00	-19.09	QP
9	3.80	6.38	26.90	10.32	10.20	46.00	-19.10	Average
10	3.80	12.37	32.89	10.32	10.20	56.00	-23.11	QP
11	7.33	9.72	30.42	10.51	10.19	50.00	-19.58	Average
12	7.33	15.00	35.70	10.51	10.19	60.00	-24.30	QP

AC 120V/60 Hz, Neutral



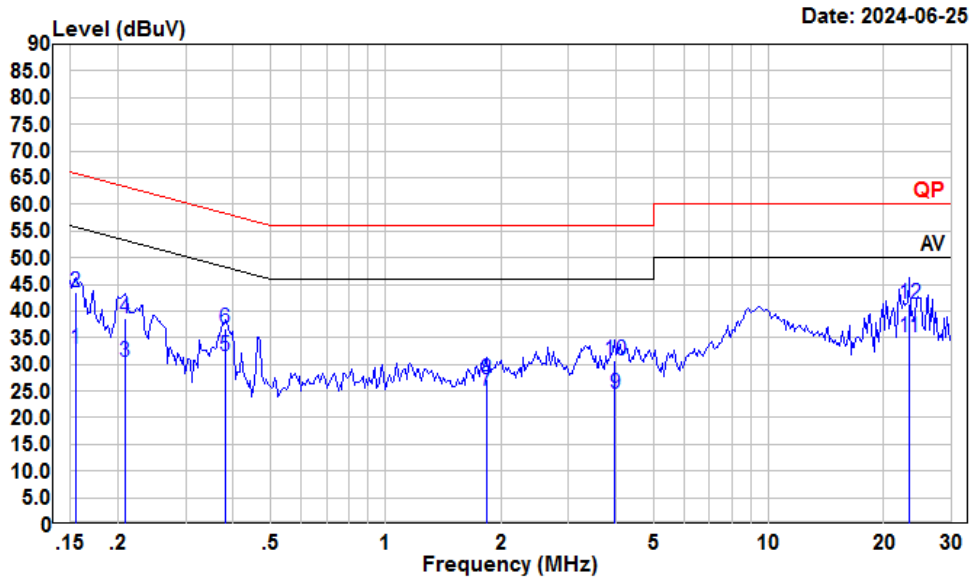
Condition: Neutral

Project : 2401T31849E-RF

tester : Macy.shi

Note : BT

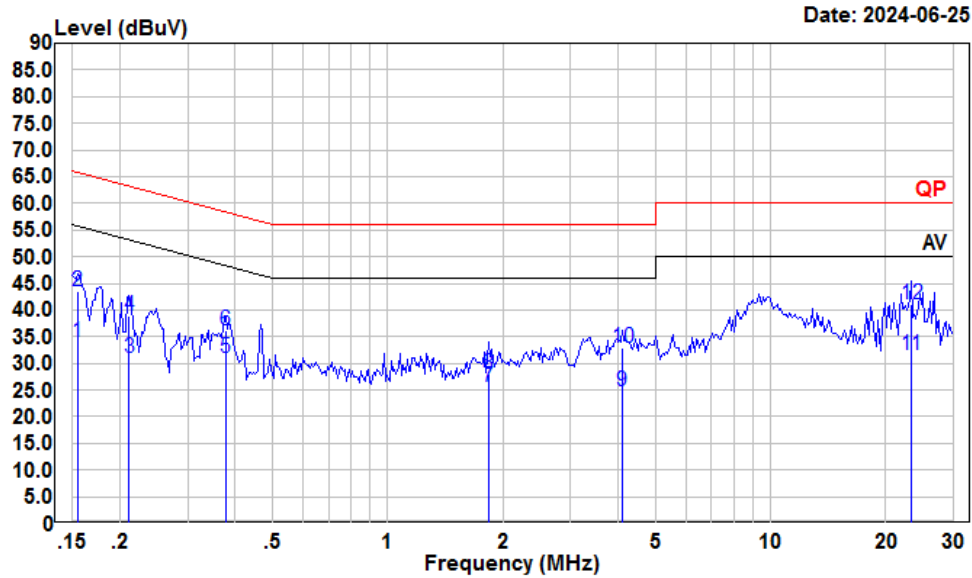
	Freq	Read Level	LISN Level	LISN Factor	Cable Loss	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dB	dBuV	dB	
1	0.17	13.98	34.62	10.53	10.11	55.21	-20.59	Average
2	0.17	24.30	44.94	10.53	10.11	65.21	-20.27	QP
3	0.20	10.33	30.82	10.40	10.09	53.62	-22.80	Average
4	0.20	19.94	40.43	10.40	10.09	63.62	-23.19	QP
5	0.38	18.72	39.44	10.61	10.11	48.25	-8.81	Average
6	0.38	21.45	42.17	10.61	10.11	58.25	-16.08	QP
7	0.78	9.01	29.89	10.76	10.12	46.00	-16.11	Average
8	0.78	14.13	35.01	10.76	10.12	56.00	-20.99	QP
9	4.80	6.48	27.17	10.50	10.19	46.00	-18.83	Average
10	4.80	11.35	32.04	10.50	10.19	56.00	-23.96	QP
11	8.68	7.63	28.59	10.76	10.20	50.00	-21.41	Average
12	8.68	12.58	33.54	10.76	10.20	60.00	-26.46	QP

*For POE***AC 120V/60 Hz, Line**

Condition: Line
Project : 2401T31849E-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	0.15	12.40	32.92	10.40	10.12	55.74	-22.82	Average
2	0.15	22.87	43.39	10.40	10.12	65.74	-22.35	QP
3	0.21	10.06	30.54	10.39	10.09	53.27	-22.73	Average
4	0.21	18.16	38.64	10.39	10.09	63.27	-24.63	QP
5	0.38	11.07	31.44	10.26	10.11	48.25	-16.81	Average
6	0.38	16.27	36.64	10.26	10.11	58.25	-21.61	QP
7	1.83	4.58	25.10	10.34	10.18	46.00	-20.90	Average
8	1.83	6.70	27.22	10.34	10.18	56.00	-28.78	QP
9	3.96	3.85	24.46	10.40	10.21	46.00	-21.54	Average
10	3.96	10.08	30.69	10.40	10.21	56.00	-25.31	QP
11	23.26	14.28	35.12	10.66	10.18	50.00	-14.88	Average
12	23.26	20.42	41.26	10.66	10.18	60.00	-18.74	QP

AC 120V/60 Hz, Neutral



Condition: Neutral

Project : 2401T31849E-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	0.15	13.75	34.11	10.24	10.12	55.74	-21.63	Average
2	0.15	23.05	43.41	10.24	10.12	65.74	-22.33	QP
3	0.21	10.28	30.98	10.61	10.09	53.18	-22.20	Average
4	0.21	18.21	38.91	10.61	10.09	63.18	-24.27	QP
5	0.38	10.23	31.08	10.74	10.11	48.34	-17.26	Average
6	0.38	15.29	36.14	10.74	10.11	58.34	-22.20	QP
7	1.83	5.27	25.58	10.13	10.18	46.00	-20.42	Average
8	1.83	7.63	27.94	10.13	10.18	56.00	-28.06	QP
9	4.09	4.19	24.80	10.40	10.21	46.00	-21.20	Average
10	4.09	12.28	32.89	10.40	10.21	56.00	-23.11	QP
11	23.26	11.19	31.61	10.24	10.18	50.00	-18.39	Average
12	23.26	20.74	41.16	10.24	10.18	60.00	-18.84	QP

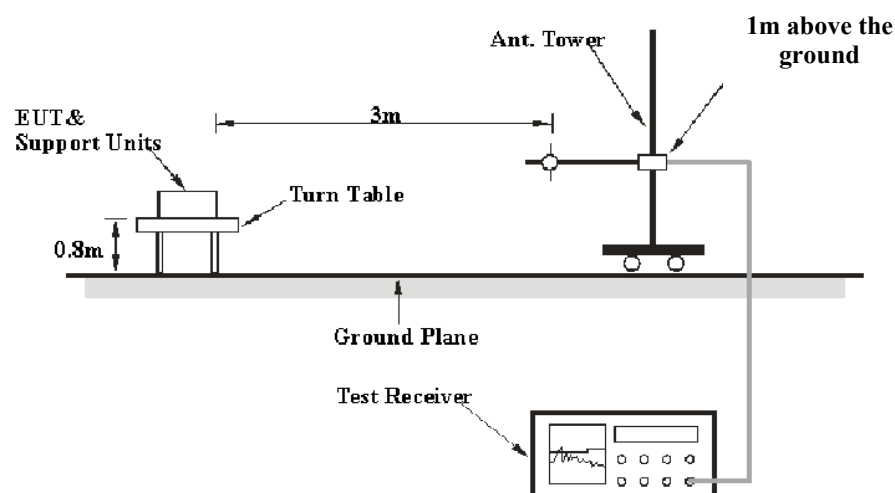
FCC §15.209, §15.205 & §15.247(D) & RSS-247§ 5.5 - SPURIOUS EMISSIONS

Applicable Standard

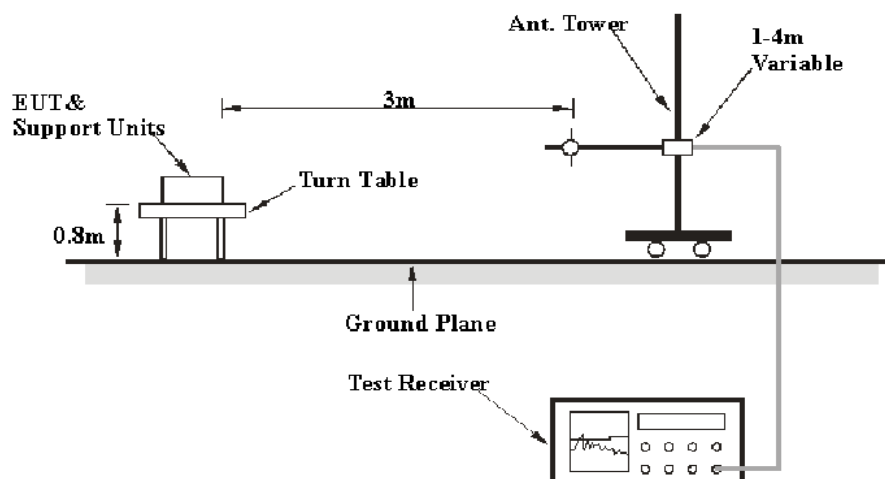
FCC §15.205; §15.209; §15.247(d); RSS-247§ 5.5; RSS-GEN § 8.10

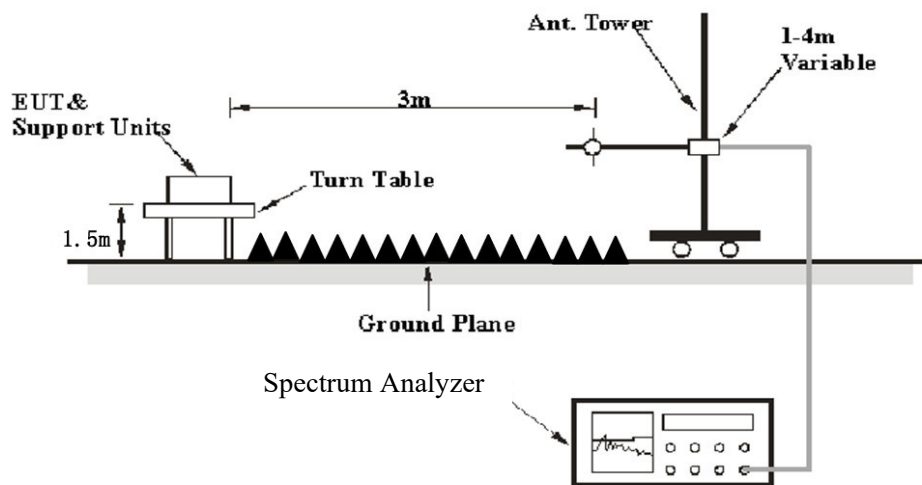
EUT Setup

9 kHz-30MHz:



30MHz-1GHz:



Above 1GHz:

The radiated emission performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, FCC 15.247, RSS-247, RSS-Gen 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.

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:

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

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:

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

Test Data

Environmental Conditions

Temperature:	22~25.5 °C
Relative Humidity:	50~54 %
ATM Pressure:	101.0 kPa

The testing was performed by Anson Su on 2024-07-06 for below 1GHz and Zenos Qiao on 2024-06-30 for above 1GHz.

EUT operation mode: Transmitting

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

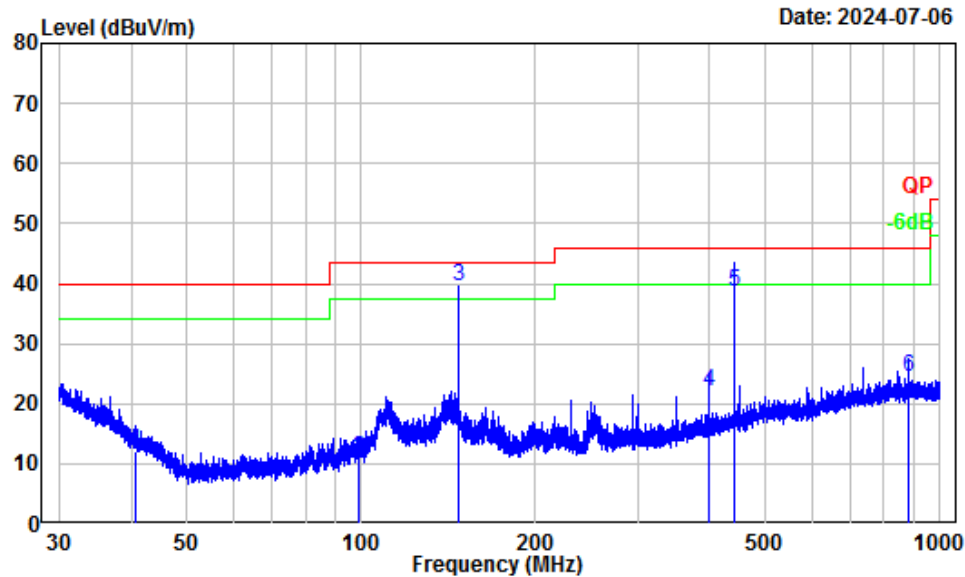
9 kHz-30MHz: *(Maximum output mode, EDR(8DPSK) Low Channel)*

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

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

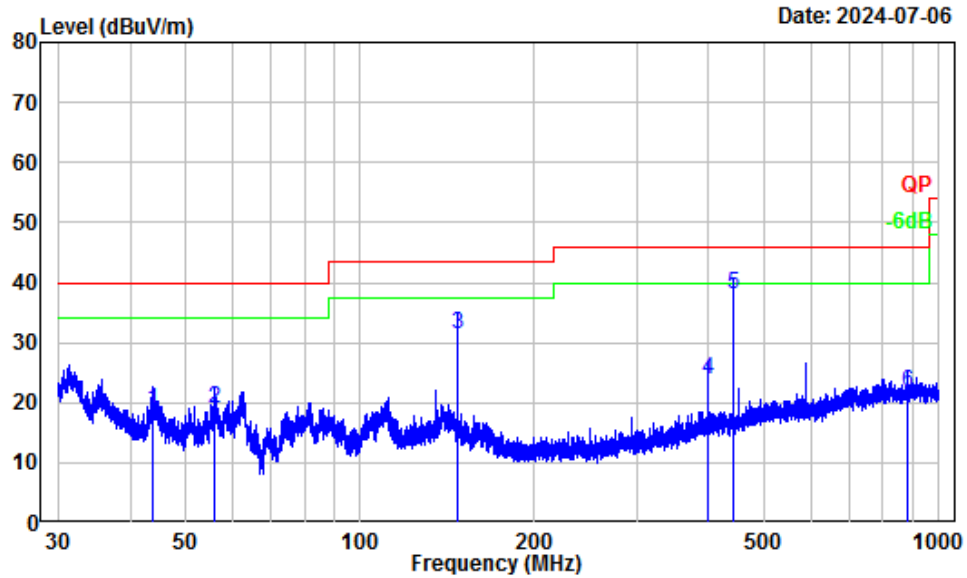
For Adapter 1

Horizontal



Site : Chamber A
Condition : 3m Horizontal
Project Number: 2401T31849E-RF
Test Mode : BT
Tester : Anson Su

	Freq	Factor	Read Level	Level	Limit	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	40.59	-11.89	24.07	12.18	40.00	-27.82	QP
2	99.31	-15.62	26.56	10.94	43.50	-32.56	QP
3	147.47	-13.34	52.80	39.46	43.50	-4.04	QP
4	400.08	-10.59	32.58	21.99	46.00	-24.01	QP
5	442.52	-9.74	48.50	38.76	46.00	-7.24	QP
6	884.89	-4.55	28.94	24.39	46.00	-21.61	QP

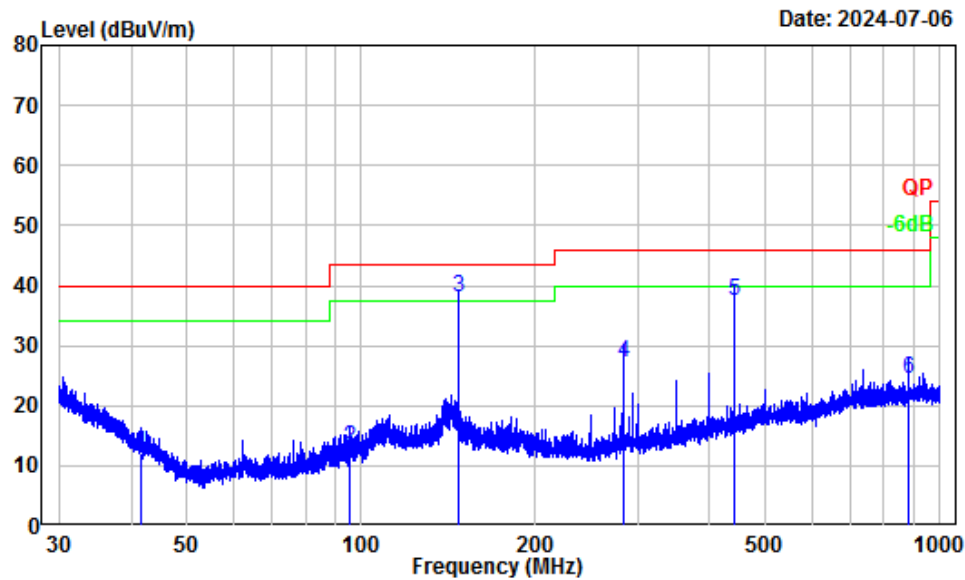
Vertical

Site : Chamber A
 Condition : 3m Vertical
 Project Number: 2401T31849E-RF
 Test Mode : BT
 Tester : Anson Su

	Freq Factor		Read Level	Limit Level	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB
1	43.81	-15.17	33.87	18.70	40.00	-21.30 QP
2	55.95	-18.76	37.79	19.03	40.00	-20.97 QP
3	147.47	-13.72	45.19	31.47	43.50	-12.03 QP
4	400.08	-10.79	34.66	23.87	46.00	-22.13 QP
5	442.52	-10.20	48.20	38.00	46.00	-8.00 QP
6	884.89	-4.92	26.77	21.85	46.00	-24.15 QP

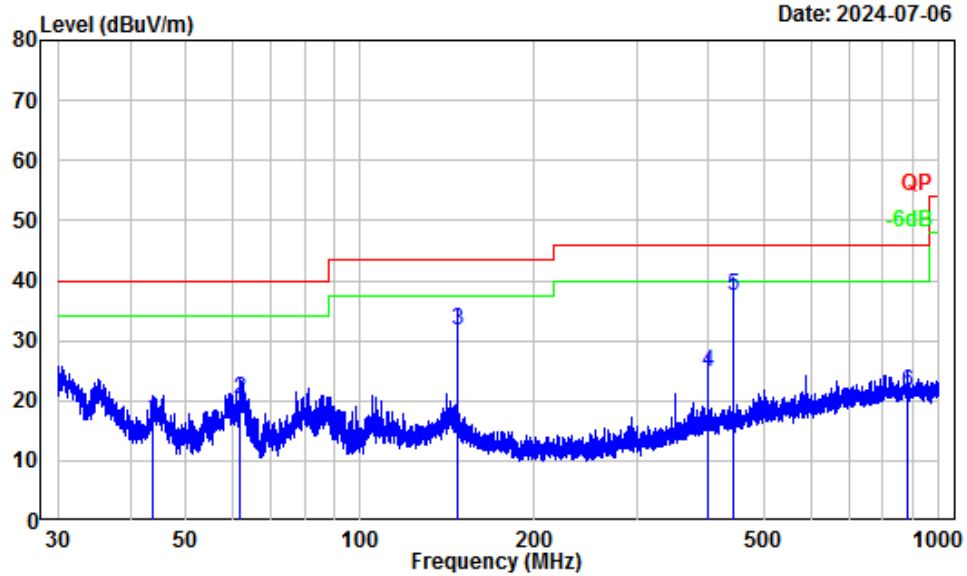
For Adapter 2

Horizontal



Site : Chamber A
Condition : 3m Horizontal
Project Number: 2401T31849E-RF
Test Mode : BT
Tester : Anson Su

		Read		Limit	Over	Remark
Freq Factor		Level	Level	Line	Limit	
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB
1	41.59	-12.53	24.74	12.21	40.00	-27.79 QP
2	95.76	-16.56	29.63	13.07	43.50	-30.43 QP
3	147.47	-13.34	51.30	37.96	43.50	-5.54 QP
4	284.35	-13.32	40.41	27.09	46.00	-18.91 QP
5	442.52	-9.74	47.16	37.42	46.00	-8.58 QP
6	884.89	-4.55	29.11	24.56	46.00	-21.44 QP

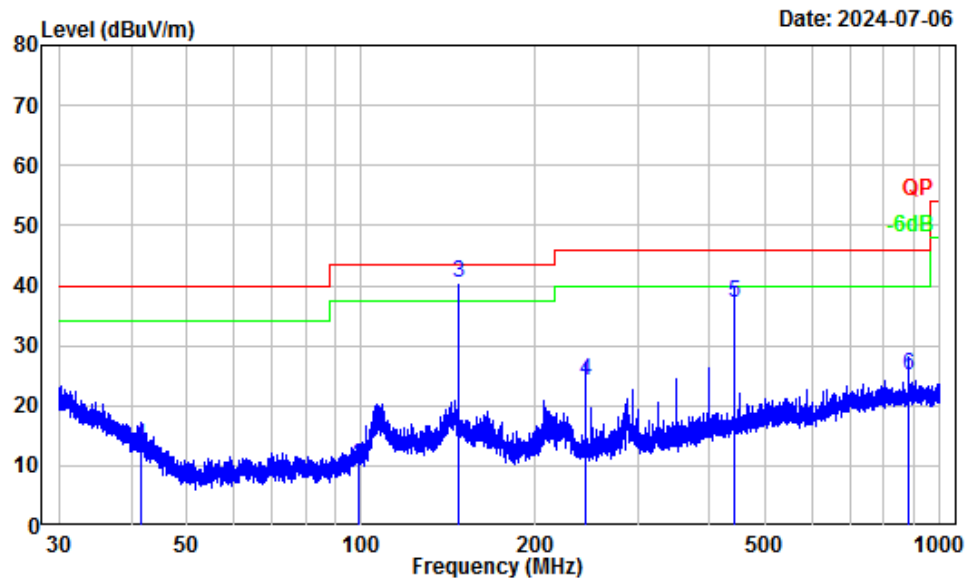
Vertical

Site : Chamber A
Condition : 3m Vertical
Project Number: 2401T31849E-RF
Test Mode : BT
Tester : Anson Su

	Freq Factor		Read Level	Limit Level	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB
1	43.79	-15.16	32.00	16.84	40.00	-23.16 QP
2	62.02	-18.82	38.97	20.15	40.00	-19.85 QP
3	147.47	-13.72	45.49	31.77	43.50	-11.73 QP
4	400.08	-10.79	35.64	24.85	46.00	-21.15 QP
5	442.52	-10.20	47.77	37.57	46.00	-8.43 QP
6	884.89	-4.92	26.50	21.58	46.00	-24.42 QP

For Adapter 3

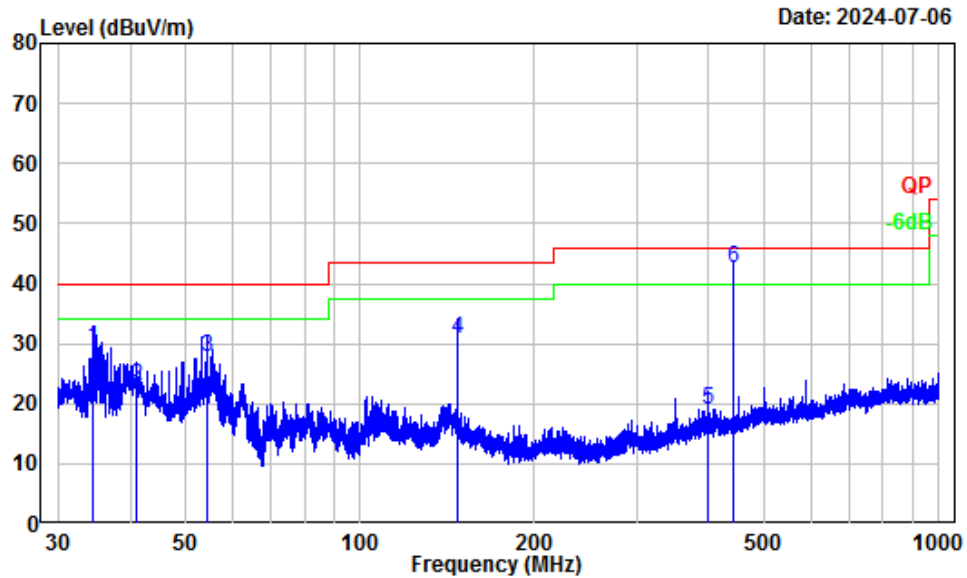
Horizontal



Site : Chamber A
Condition : 3m Horizontal
Project Number: 2401T31849E-RF
Test Mode : BT
Tester : Anson Su

		Read		Limit	Over	Remark
Freq Factor		Level	Level	Line	Limit	
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB
1	41.53	-12.49	25.64	13.15	40.00	-26.85 QP
2	99.01	-15.70	25.59	9.89	43.50	-33.61 QP
3	147.47	-13.34	53.70	40.36	43.50	-3.14 QP
4	243.80	-14.41	38.48	24.07	46.00	-21.93 QP
5	442.52	-9.74	46.78	37.04	46.00	-8.96 QP
6	884.89	-4.55	29.66	25.11	46.00	-20.89 QP

Vertical

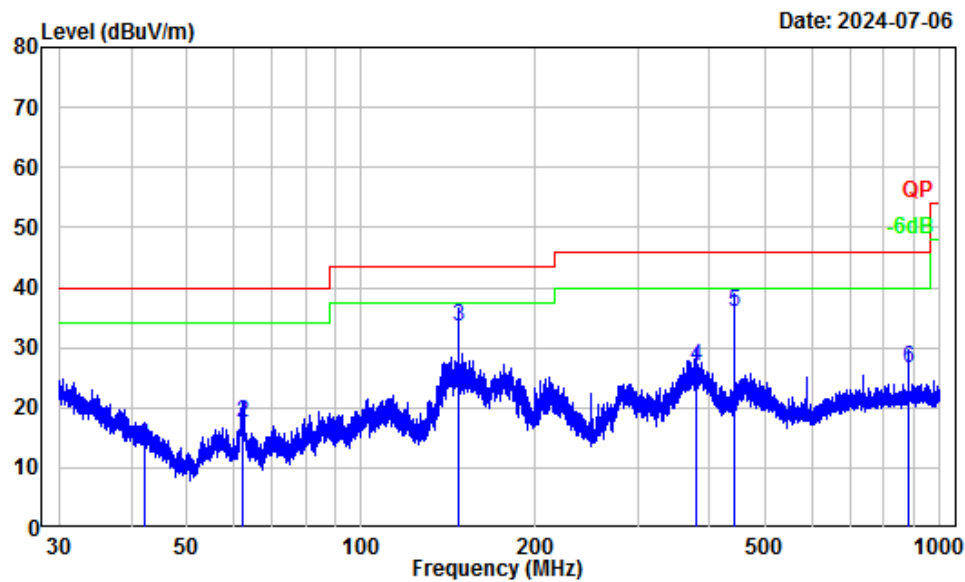


Site : Chamber A
 Condition : 3m Vertical
 Project Number: 2401T31849E-RF
 Test Mode : BT
 Tester : Anson Su

	Freq Factor		Read Level	Limit Level	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dB	
1	34.59	-9.55	38.90	29.35	40.00	-10.65 QP
2	40.95	-13.56	36.37	22.81	40.00	-17.19 QP
3	54.38	-18.72	46.59	27.87	40.00	-12.13 QP
4	147.47	-13.72	44.65	30.93	43.50	-12.57 QP
5	400.08	-10.79	29.78	18.99	46.00	-27.01 QP
6	442.52	-10.20	52.81	42.61	46.00	-3.39 QP

For POE

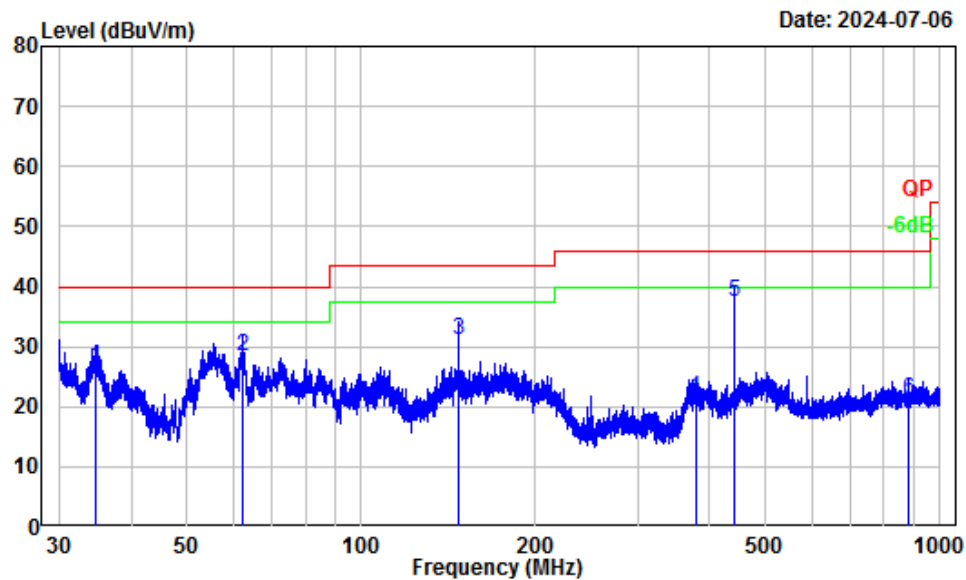
Horizontal



Site : Chamber A
Condition : 3m Horizontal
Project Number: 2401T31849E-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	42.28	-12.97	26.41	13.44	40.00	-26.56	QP
2	62.16	-17.72	35.29	17.57	40.00	-22.43	QP
3	147.47	-13.34	46.79	33.45	43.50	-10.05	QP
4	380.08	-11.15	37.91	26.76	46.00	-19.24	QP
5	442.52	-9.74	45.75	36.01	46.00	-9.99	QP
6	884.89	-4.55	31.15	26.60	46.00	-19.40	QP

Vertical



Site : Chamber A
Condition : 3m Vertical
Project Number: 2401T31849E-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	34.65	-9.59	36.11	26.52	40.00	-13.48	Average
2	62.21	-18.82	47.12	28.30	40.00	-11.70	QP
3	147.47	-13.72	44.72	31.00	43.50	-12.50	QP
4	377.92	-11.45	32.98	21.53	46.00	-24.47	QP
5	442.52	-10.20	47.62	37.42	46.00	-8.58	QP
6	884.89	-4.92	26.18	21.26	46.00	-24.74	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					
GFSK							
Low Channel 2402MHz							
2387.16	55.68	PK	H	-2.93	52.75	74	-21.25
2386.69	55.39	PK	V	-2.93	52.46	74	-21.54
4804.00	57.75	PK	H	2.42	60.17	74	-13.83
4804.00	56.88	PK	V	2.42	59.30	74	-14.70
Middle Channel 2441MHz							
4882.00	56.69	PK	H	2.58	59.27	74	-14.73
4882.00	55.72	PK	V	2.58	58.30	74	-15.70
High Channel 2480MHz							
2483.58	55.73	PK	H	-3.17	52.56	74	-21.44
2483.72	55.58	PK	V	-3.17	52.41	74	-21.59
4960.00	55.54	PK	H	2.68	58.22	74	-15.78
4960.00	54.47	PK	V	2.68	57.15	74	-16.85

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.

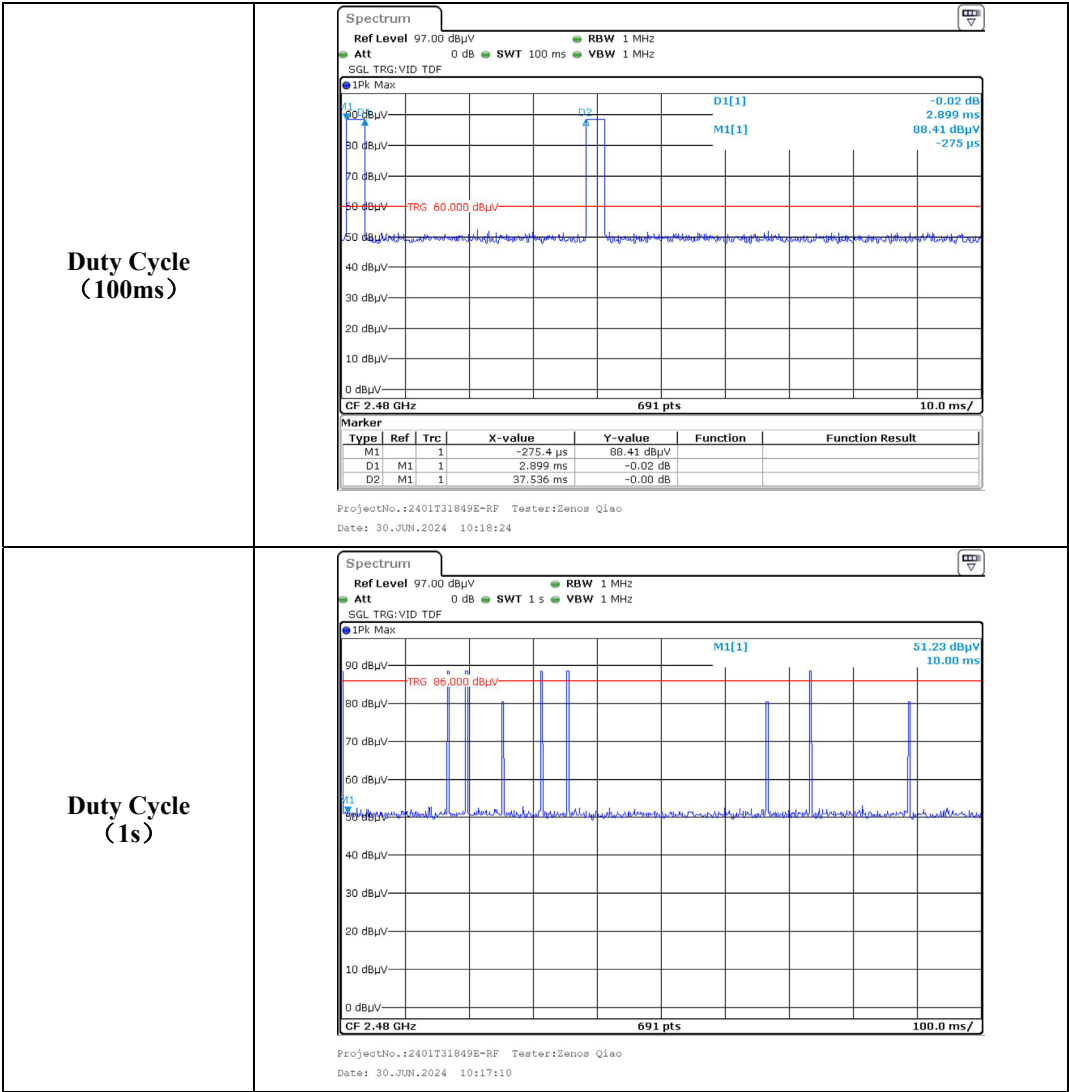
Field Strength of Average							
Frequency (MHz)	Peak Measurement @3m (dBμV/m)	Polar (H/V)	Duty Cycle Corrected Factor (dB)	Average Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Comment
Low Channel 2402MHz							
2387.16	52.75	H	-24.73	28.02	54	-25.98	Bandedge
2386.69	52.46	V	-24.73	27.73	54	-26.27	Bandedge
4804.00	60.17	H	-24.73	35.44	54	-18.56	Harmonic
4804.00	59.30	V	-24.73	34.57	54	-19.43	Harmonic
Middle Channel 2441MHz							
4882.00	59.27	H	-24.73	34.54	54	-19.46	Harmonic
4882.00	58.30	V	-24.73	33.57	54	-20.43	Harmonic
High Channel 2480MHz							
2483.58	52.56	H	-24.73	27.83	54	-26.17	Bandedge
2483.72	52.41	V	-24.73	27.68	54	-26.32	Bandedge
4960.00	58.22	H	-24.73	33.49	54	-20.51	Harmonic
4960.00	57.15	V	-24.73	32.42	54	-21.58	Harmonic

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

Worst case duty cycle:

Duty Cycle = $T_{on}/100ms = 2.899*2/100=0.05798$

Duty Cycle Corrected Factor = $20\lg(\text{Duty Cycle}) = 20\lg 0.05798 = -24.73$



Simultaneous transmitting consideration: (worst case as below)

Frequency (MHz)	Receiver		Polar (H/V)	Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave					
3DH1 2402MHz + 802.11AX40 Mode 5755MHz							
193.30	44.46	QP	H	-14.2	30.26	43.5	-13.24
60.25	53.36	QP	V	-18.86	34.5	40	-5.5
4804.00	49.22	PK	H	2.42	51.64	74	-22.36
4804.00	42.24	AV	H	2.42	44.66	54	-9.34
4804.00	48.76	PK	V	2.42	51.18	74	-22.82
4804.00	42.41	AV	V	2.42	44.83	54	-9.17
11510.00	56.01	PK	H	14.29	41.72	74	-32.28
11510.00	44.8	AV	H	14.29	30.51	54	-23.49
11510.00	56.12	PK	V	14.29	41.83	74	-32.17
11510.00	44.34	AV	V	14.29	30.05	54	-23.95

Note:

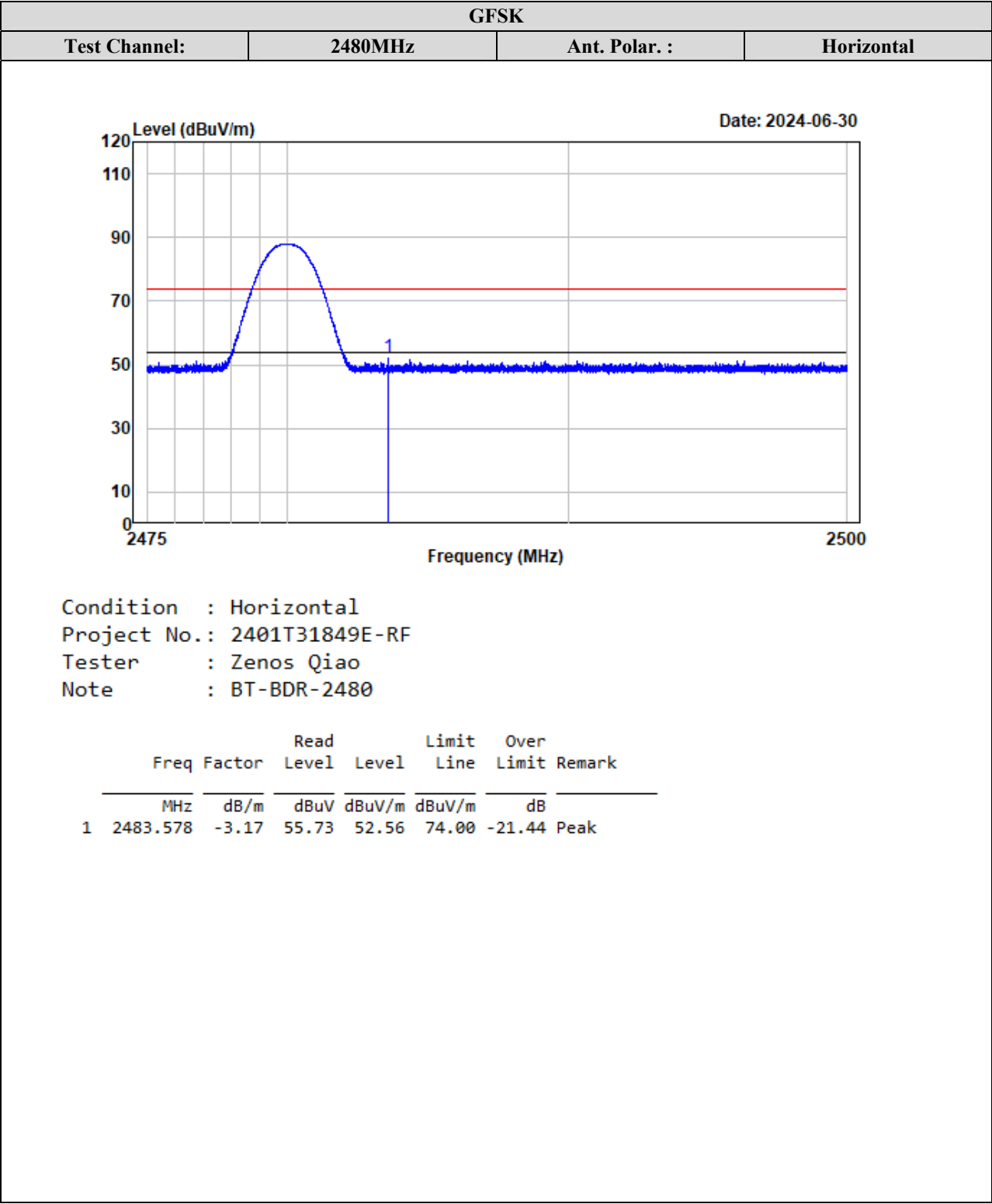
Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

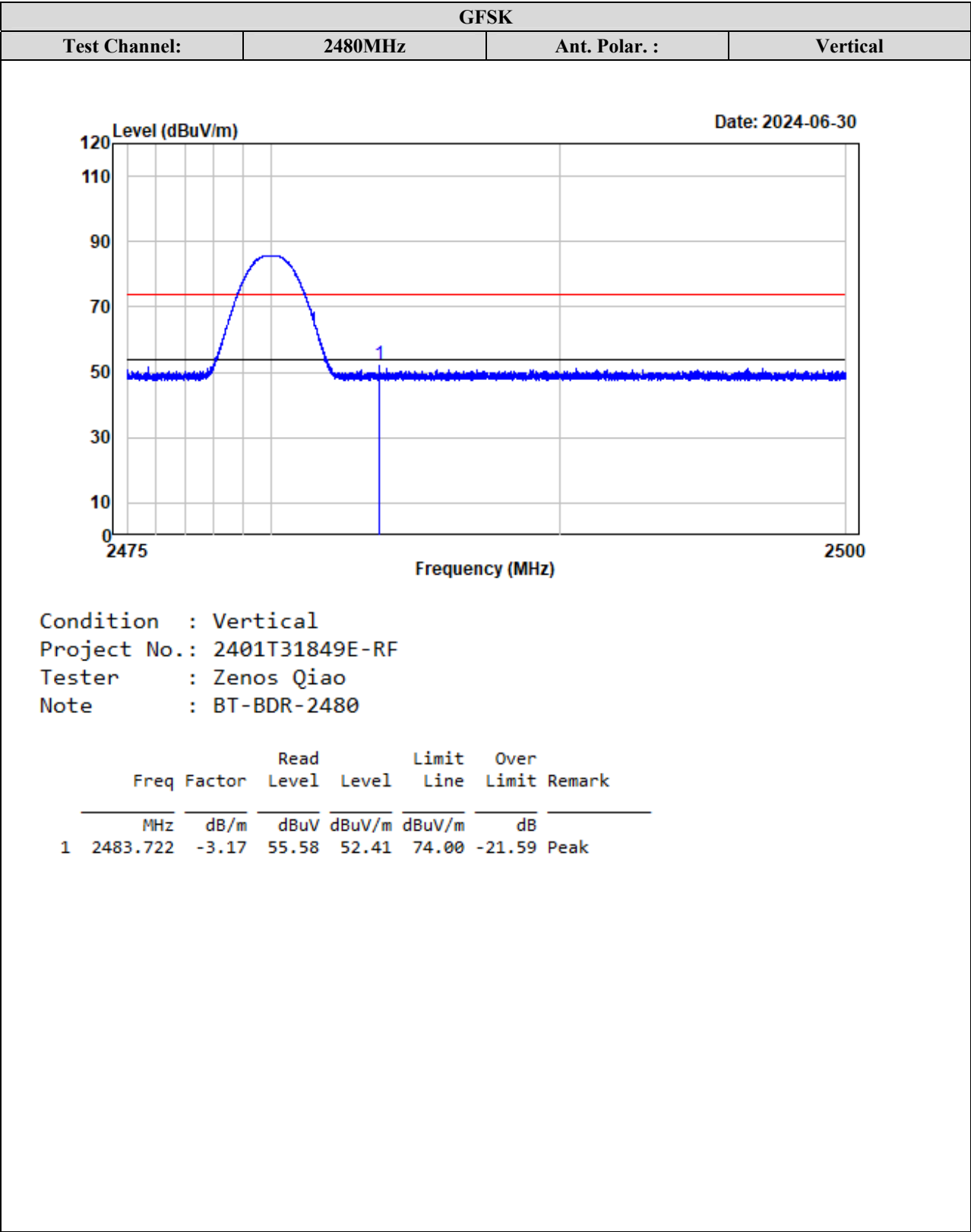
Corrected Amplitude = Factor + Reading

Margin = Corrected. Amplitude - Limit

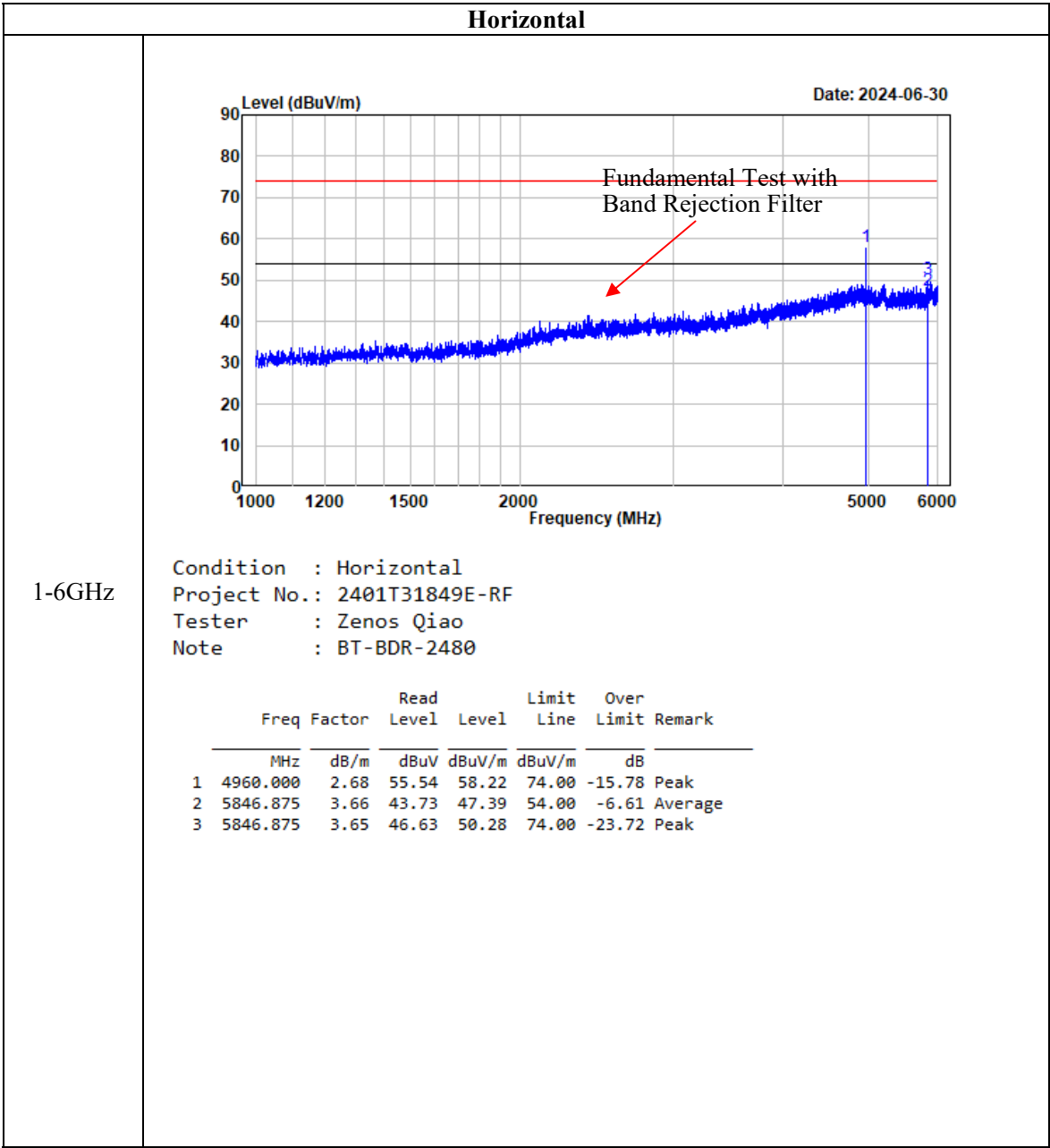
The other spurious emission which is in the noise floor level was not recorded.

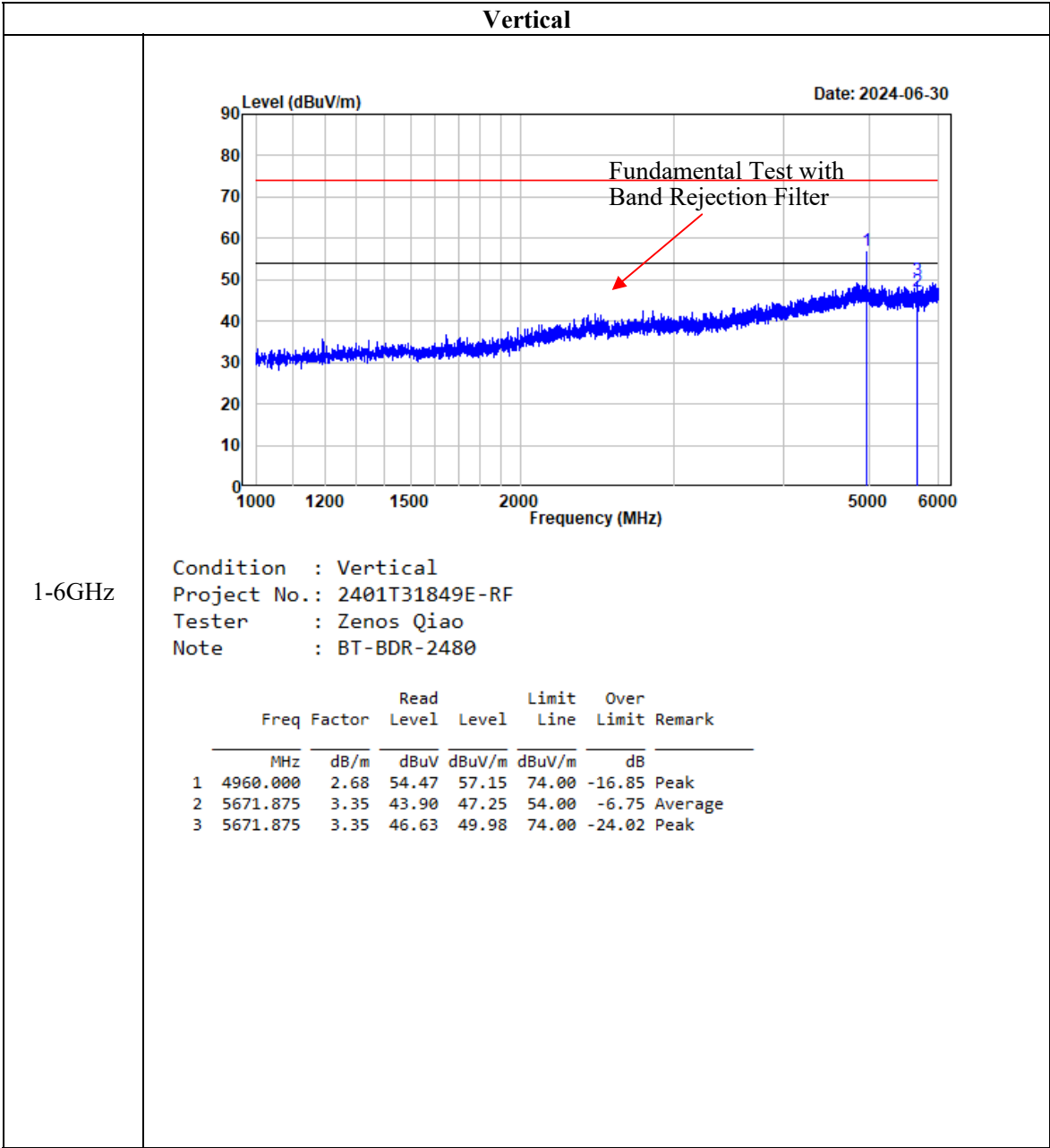
Test plots for Band Edge Measurements (Radiated):

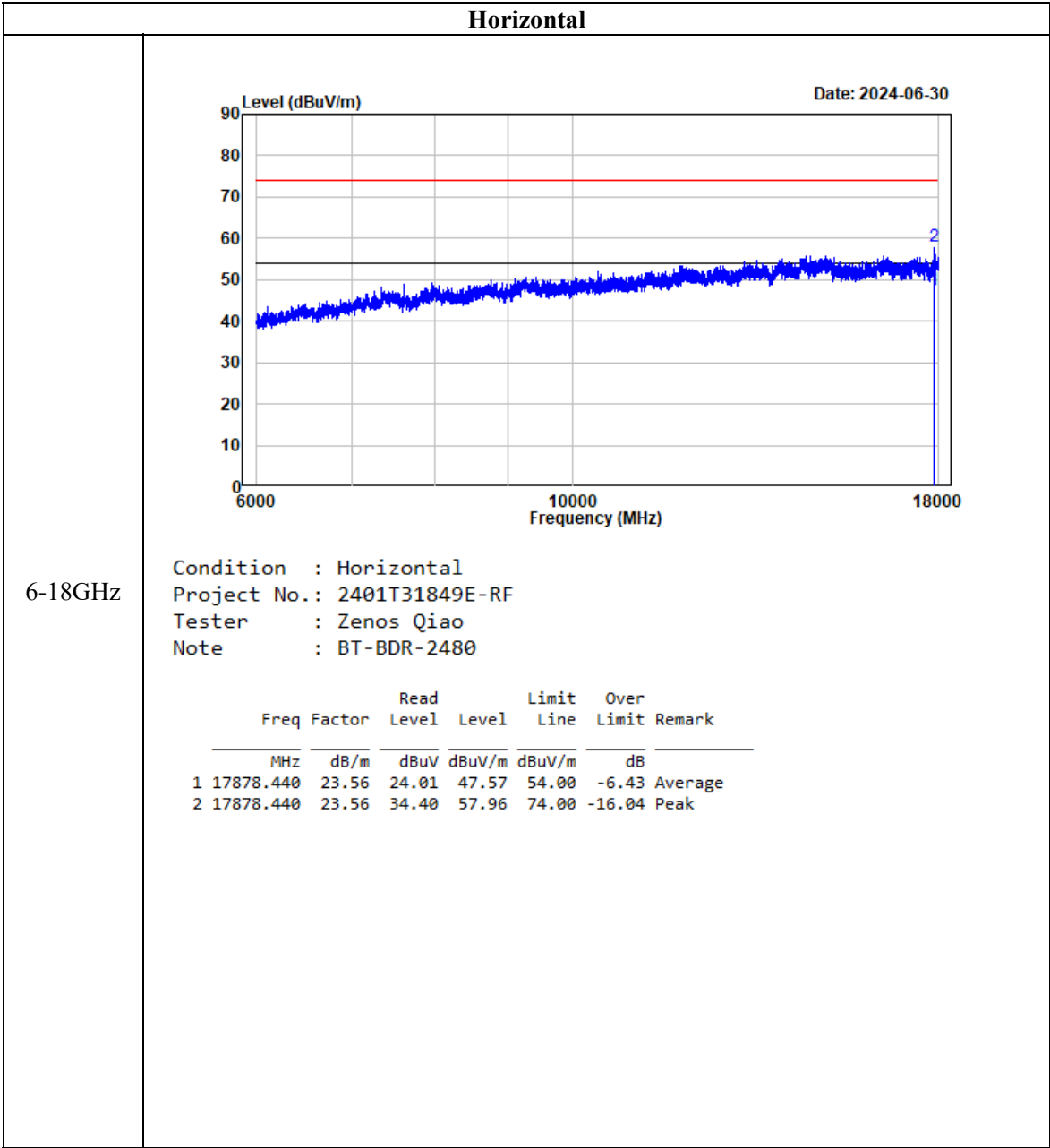


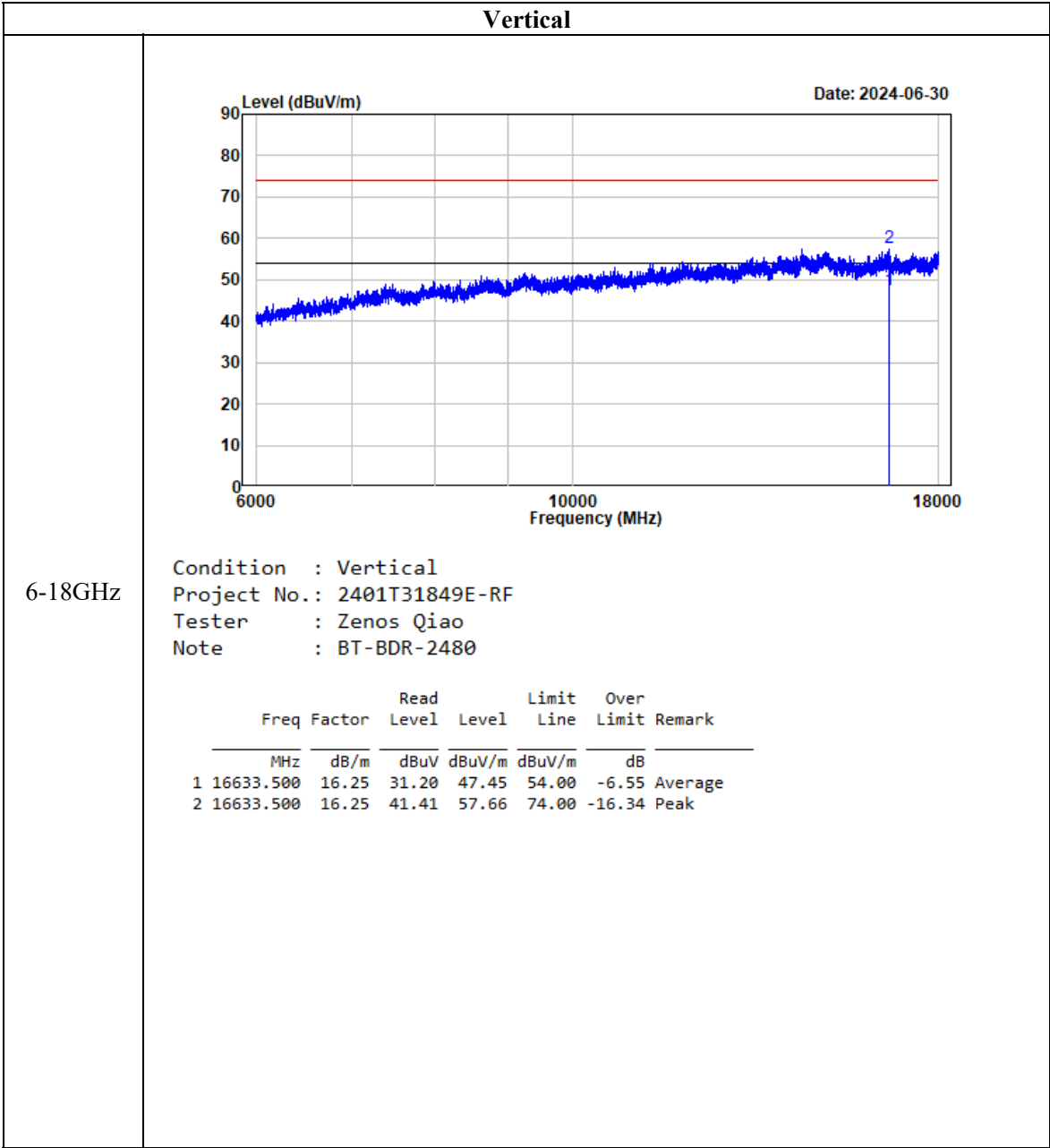


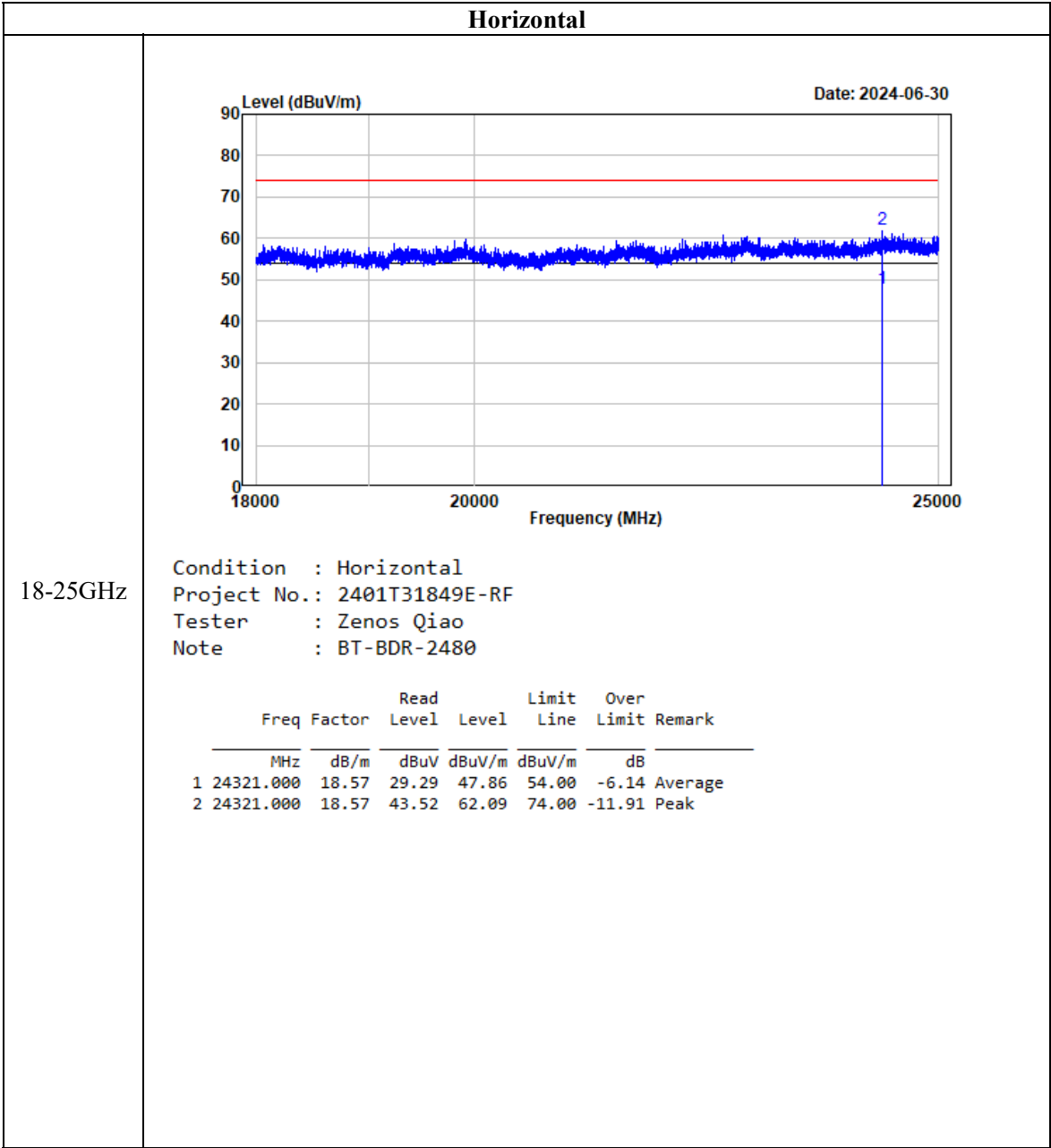
Test plots for Harmonic Measurements:

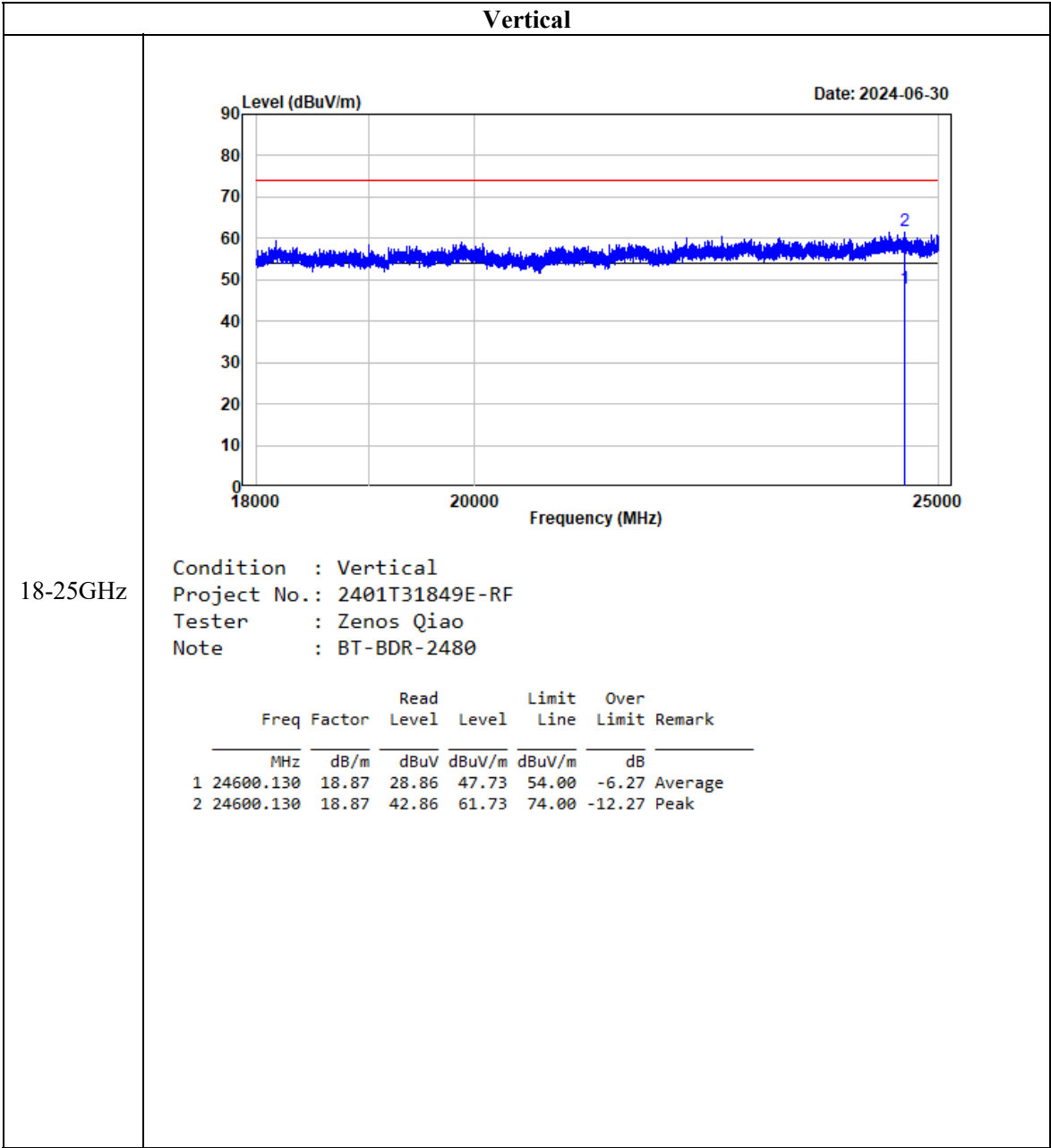












FCC §15.247(a) (1) & RSS-247 § 5.1 (b) - CHANNEL SEPARATION TEST

Applicable Standard

According to FCC §15.247(a) (1):

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.

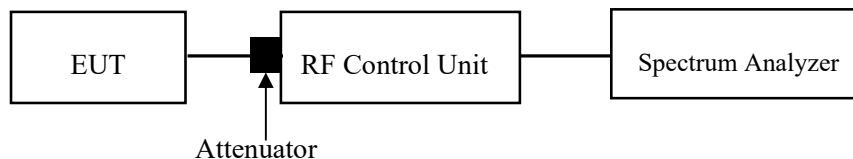
According to RSS-247 § 5.1 (b):

Frequency hopping systems (FHSs) 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, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W. 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, max hold the channel.
2. Set the adjacent channel of the EUT and max hold another trace.
3. Measure the channel separation.



Test Data**Environmental Conditions**

Temperature:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Tom Tan on 2024-06-20.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(a) (1) & RSS-247 § 5.1 (a), RSS-GEN § 6.7 - 20 dB EMISSION BANDWIDTH & 99% OCCUPIED BANDWIDTH

Applicable Standard

According to FCC §15.247(a) (1):

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.

According to RSS-247 § 5.1 (a), RSS-GEN § 6.7:

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the “20 dB bandwidth” is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated 20 dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

Test Procedure

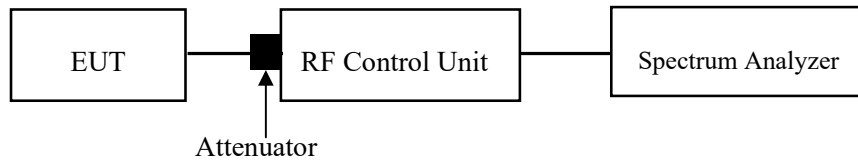
Test Method: ANSI C63.10-2013 Clause 7.8.7 & Clause 6.9.2

The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 20 dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 20 dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).



Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Tom Tan on 2024-06-20.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(a) (1) (iii) & RSS-247 § 5.1 (d) - QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

According to FCC §15.247(a) (1) (iii):

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.

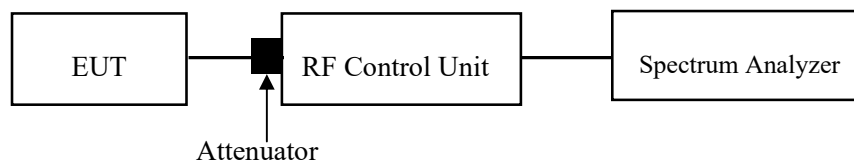
According to RSS-247 § 5.1 (d):

Frequency hopping systems (FHSS) operating in the band 2400-2483.5 MHz shall use at least 15 hopping 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping 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:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Tom Tan on 2024-06-20.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(a) (1) (iii) & RSS-247 § 5.1 (d) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

According to FCC §15.247(a) (1) (iii):

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.

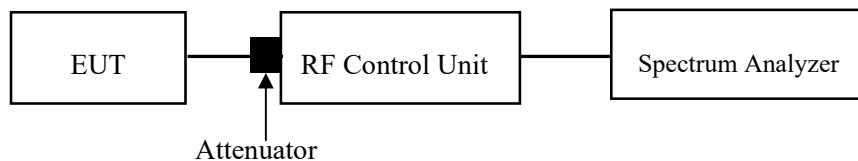
According to RSS-247 § 5.1 (d):

Frequency hopping systems (FHSs) operating in the band 2400-2483.5 MHz shall use at least 15 hopping 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping 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



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:	101.0 kPa

The testing was performed by Tom Tan on 2024-06-20.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(b) (1) & RSS-247§ 5.1(b) &§ 5.4(b) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

According to FCC §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.

According to RSS-247§ 5.1(b) &§ 5.4(b):

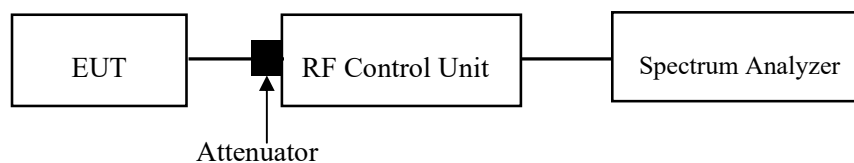
For frequency hopping systems (FHSs) operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W (see Section 5.4(e) for exceptions).

Frequency hopping systems (FHSs) 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, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W.

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:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Tom Tan on 2024-06-20.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(d) & RSS-247 § 5.5 - BAND EDGES TESTING

Applicable Standard

According to FCC §15.247(d).

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)).

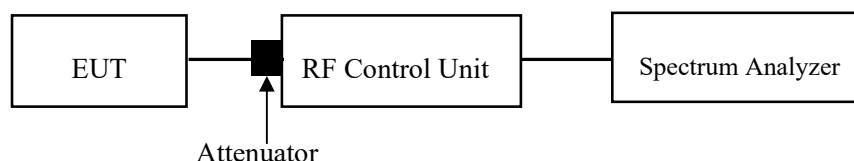
According to RSS-247 § 5.5.

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(e), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

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 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Tom Tan on 2024-06-20.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

EUT PHOTOGRAPHS

Please refer to the attachment 2401T31849E-RF External photo and 2401T31849E-RF Internal photo.

TEST SETUP PHOTOGRAPHS

Please refer to the attachment 2401T31849E-RFA Test Setup photo.

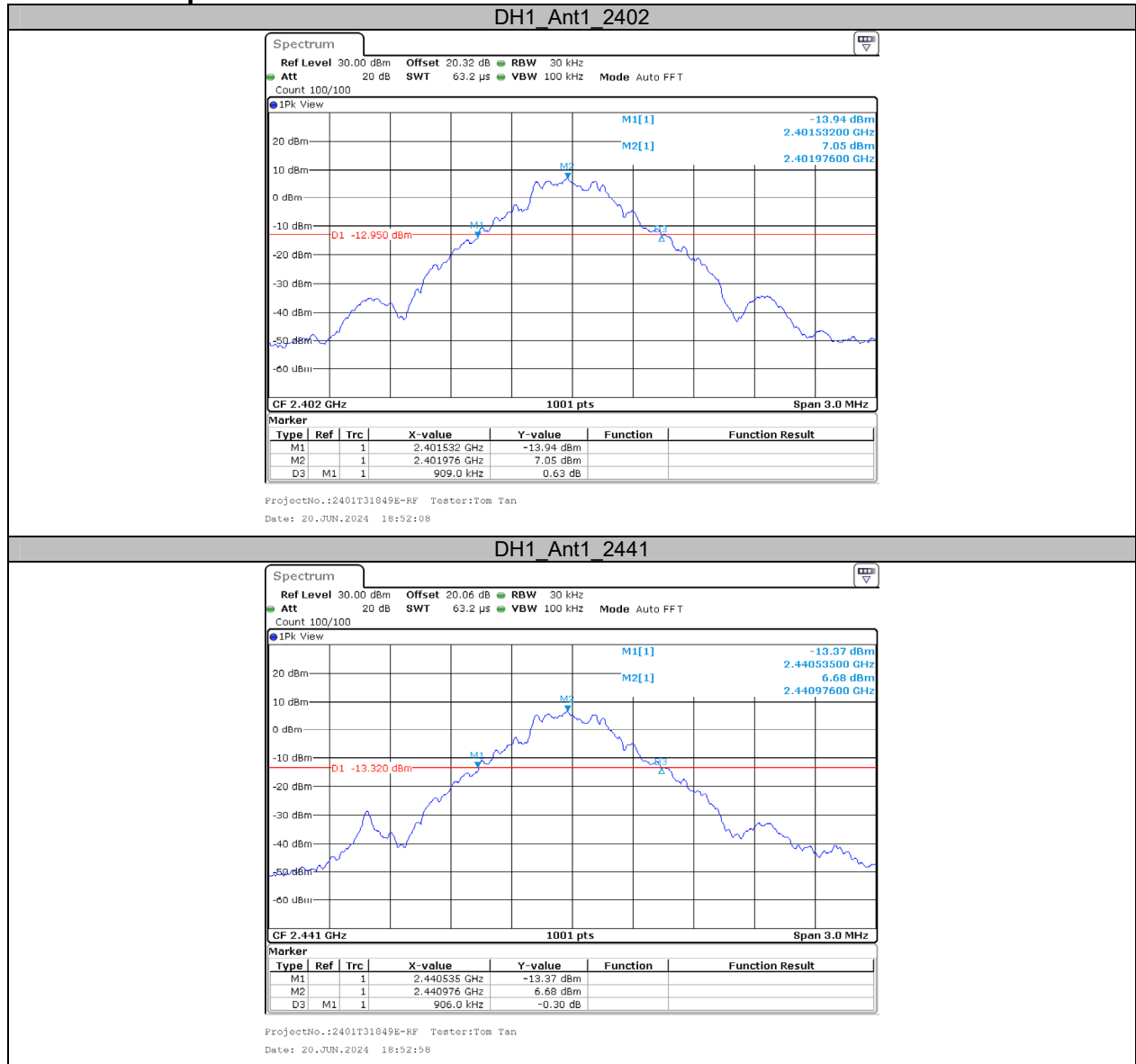
Appendix

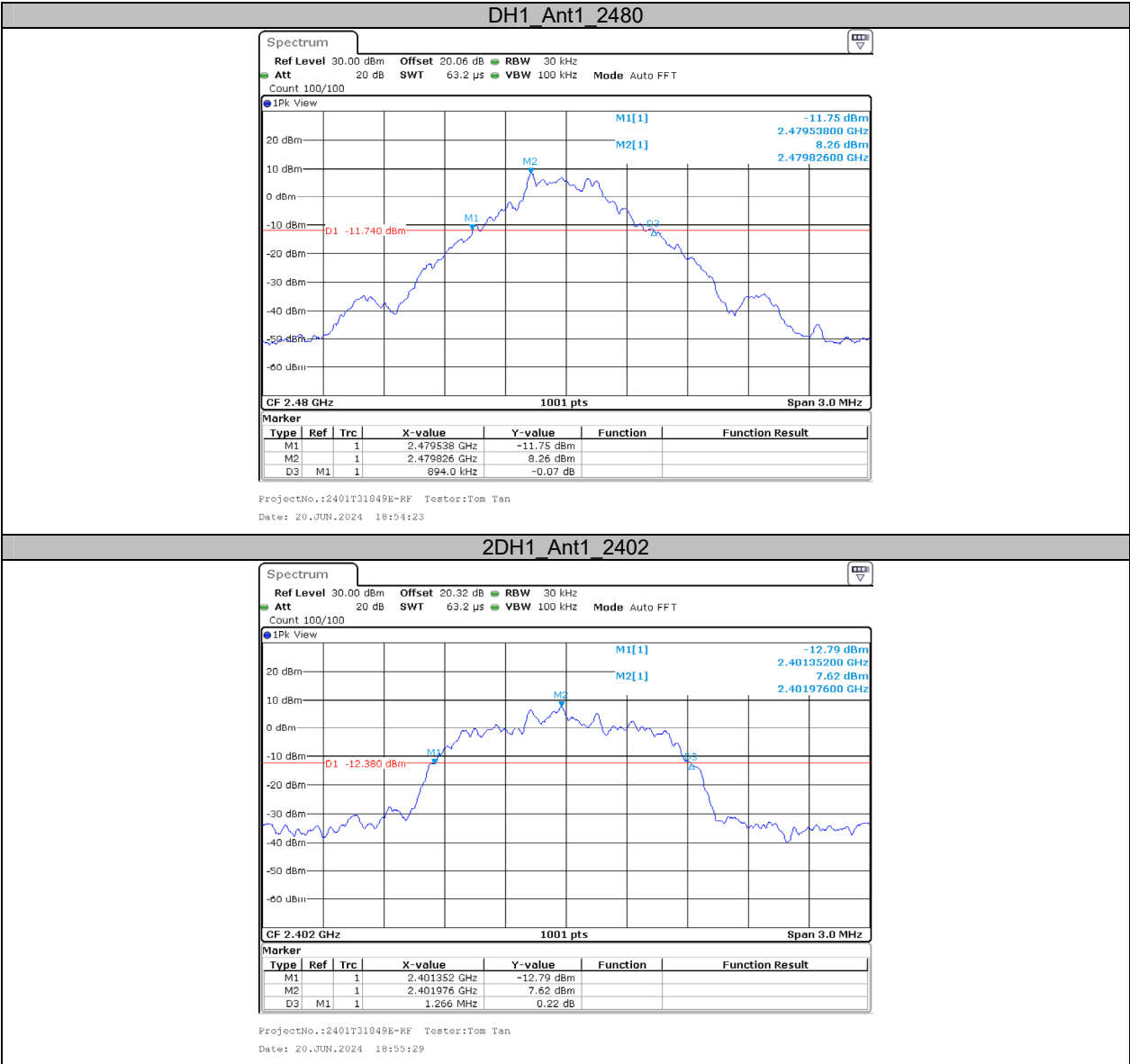
Appendix A: 20dB Emission Bandwidth

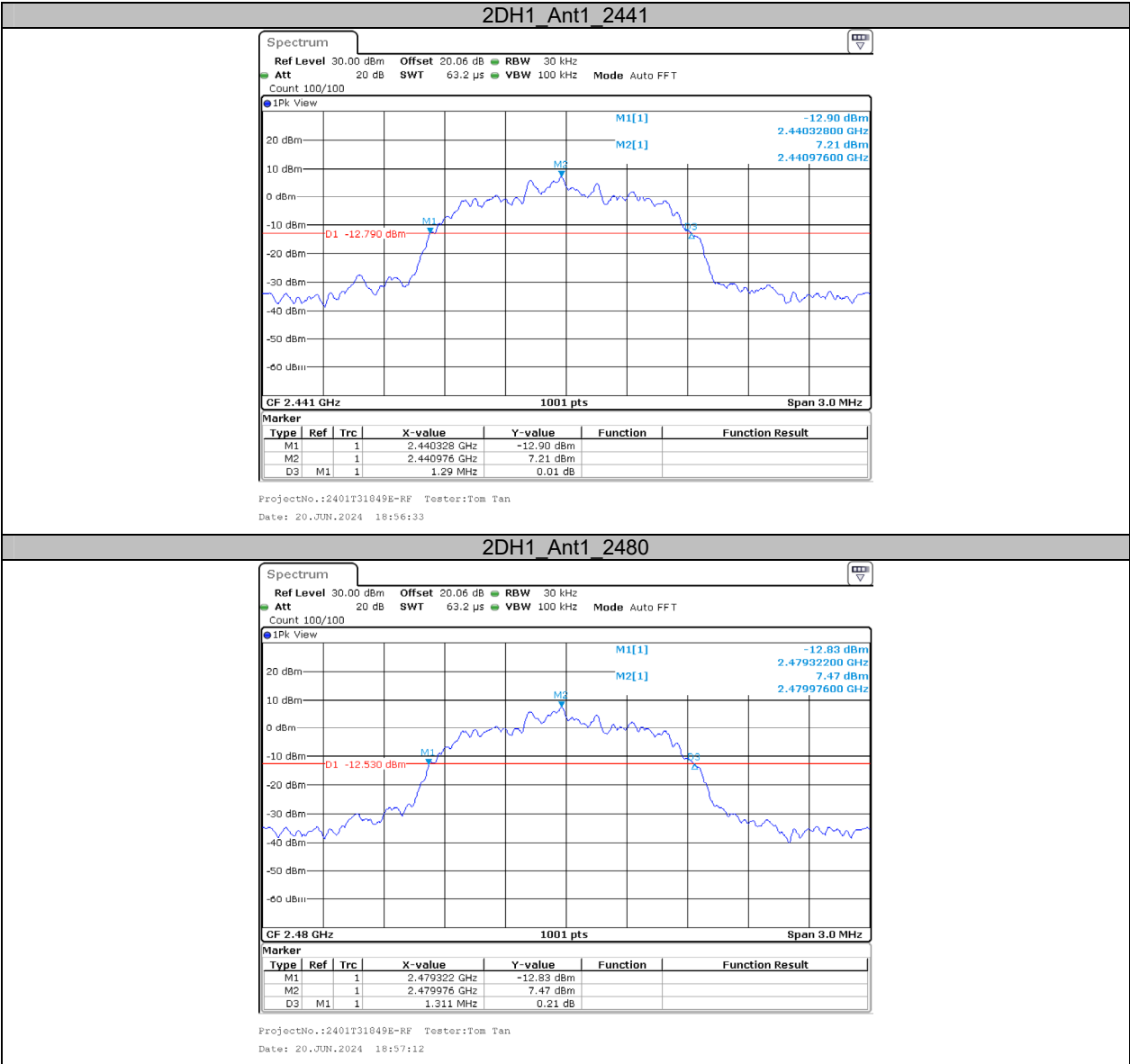
Test Result

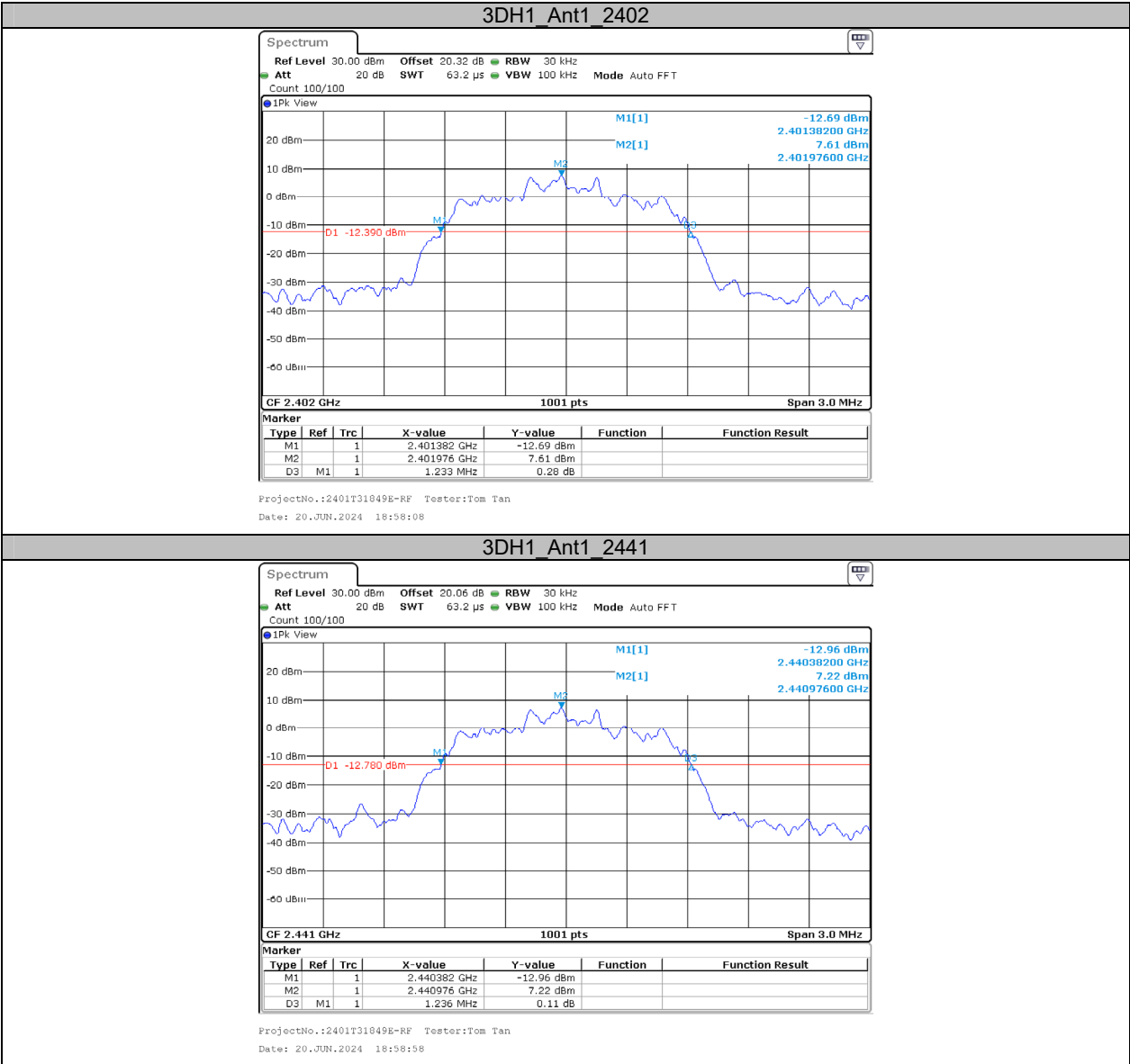
Test Mode	Antenna	Channel	20db EBW[MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	0.91	---	---
		2441	0.91	---	---
		2480	0.89	---	---
2DH1	Ant1	2402	1.27	---	---
		2441	1.29	---	---
		2480	1.31	---	---
3DH1	Ant1	2402	1.23	---	---
		2441	1.24	---	---
		2480	1.24	---	---

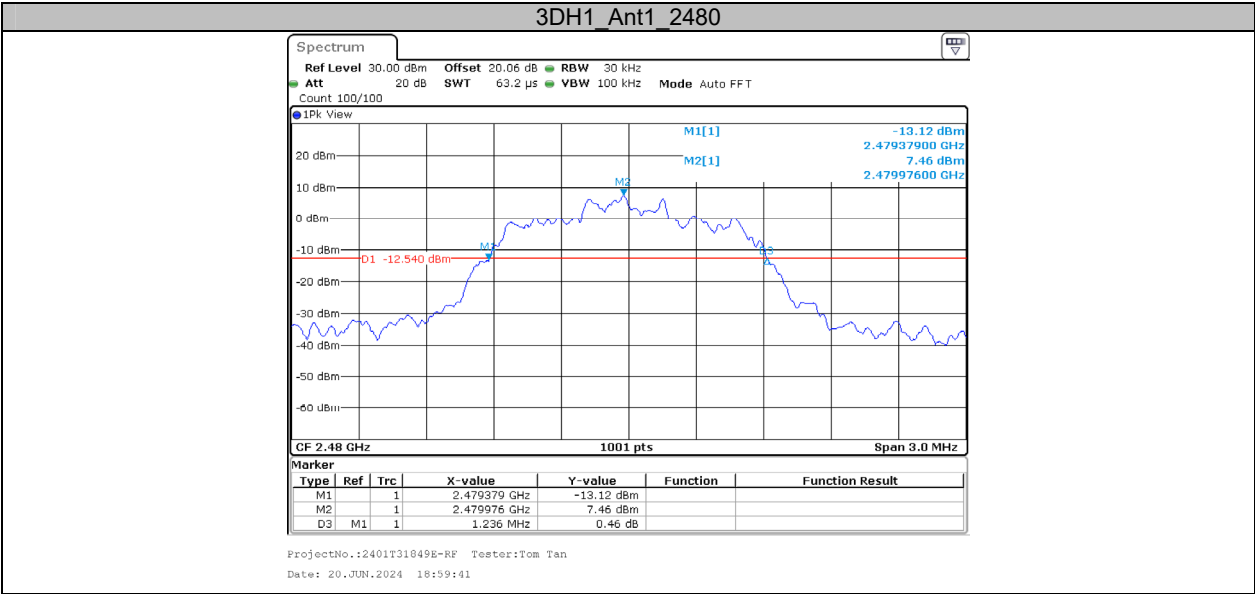
Test Graphs







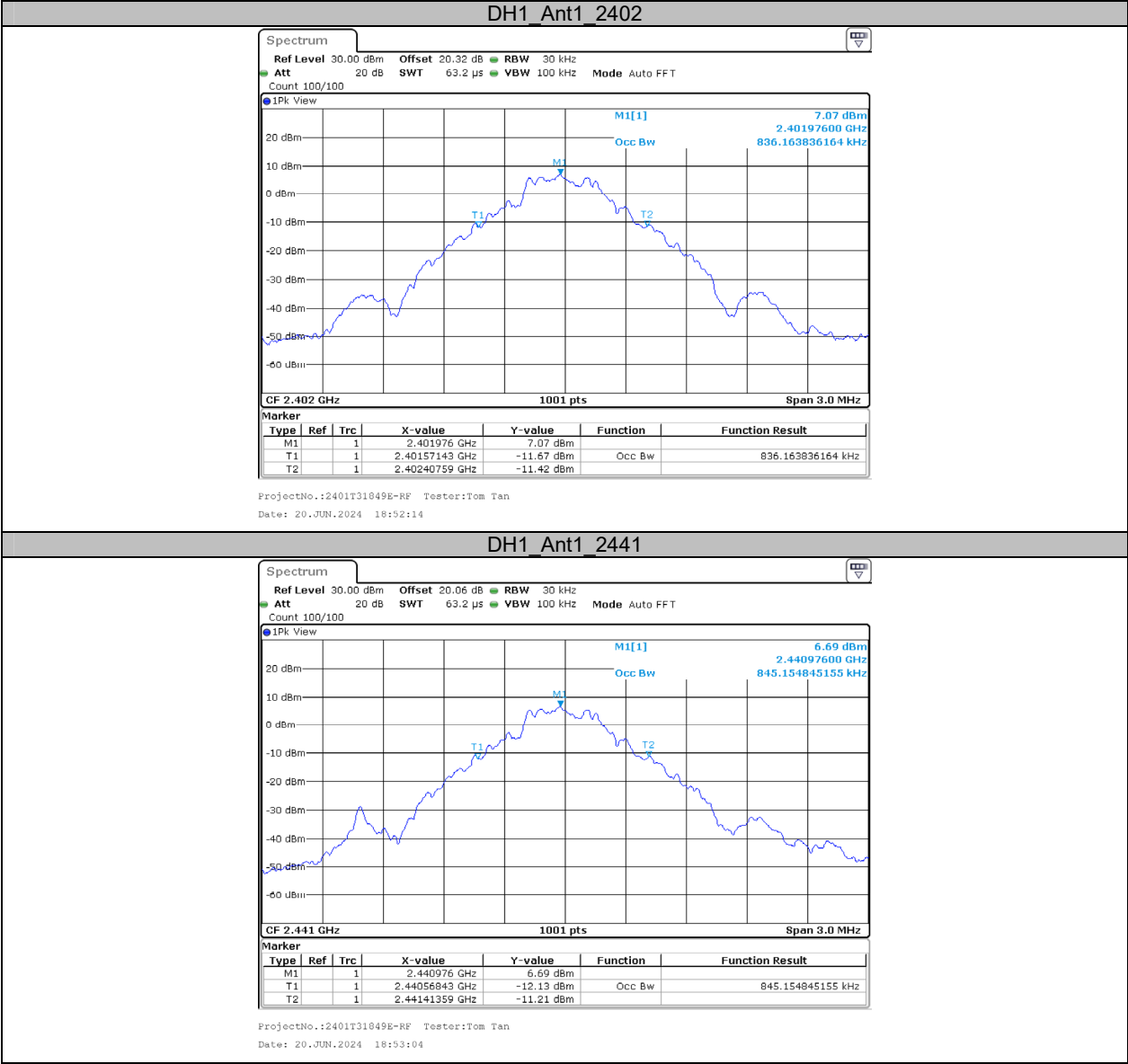


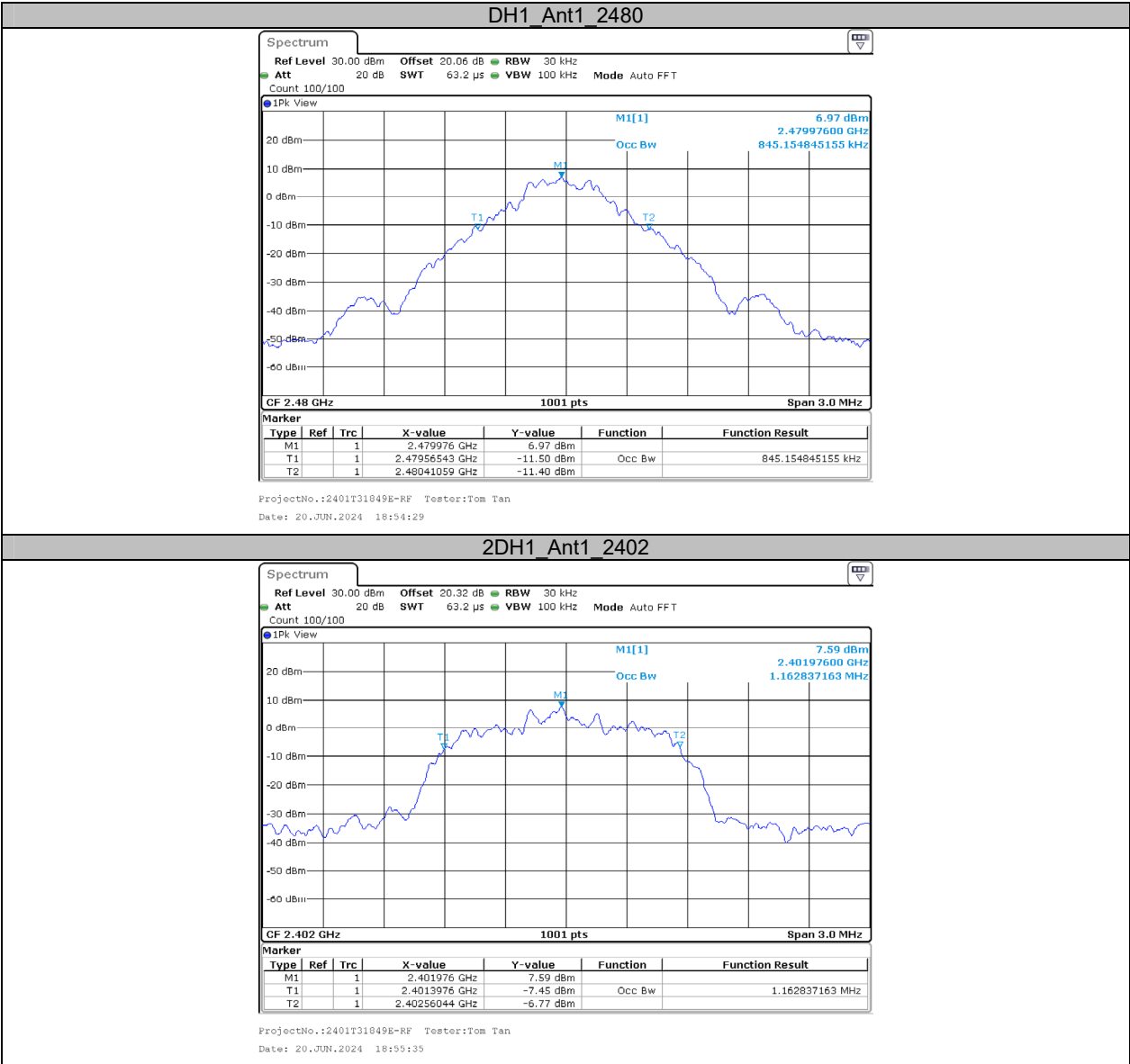


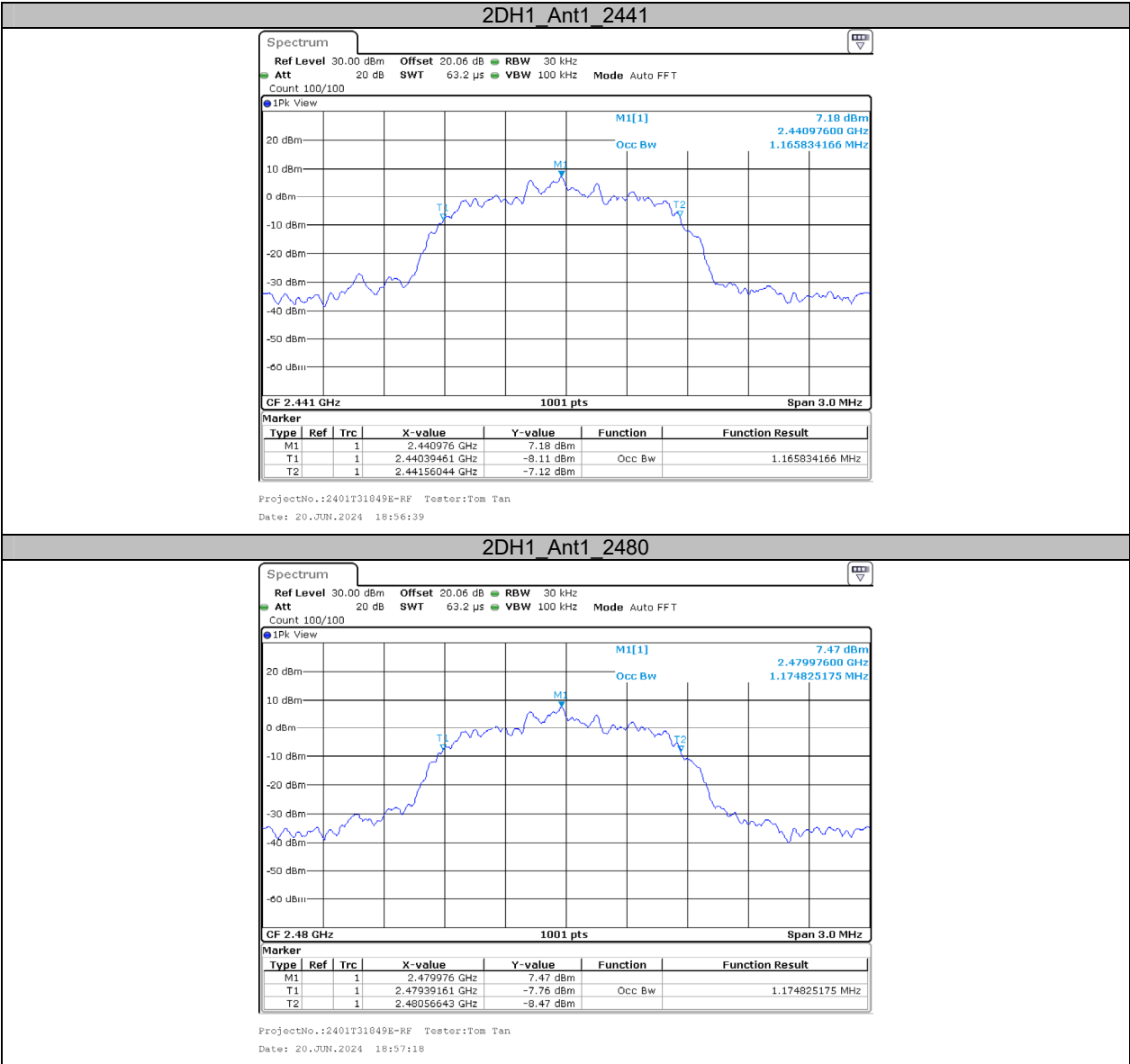
Appendix B: Occupied Channel Bandwidth**Test Result**

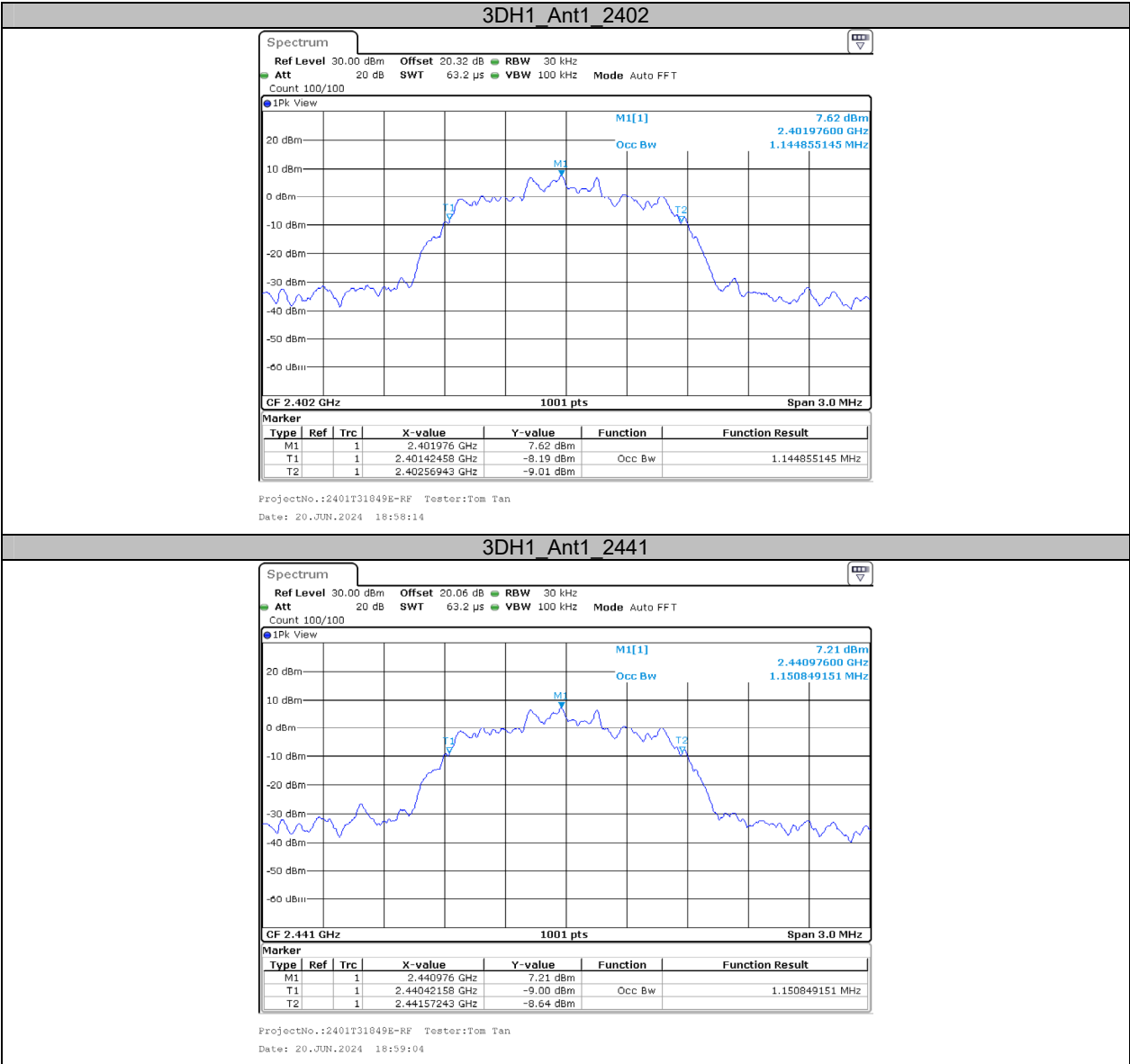
Test Mode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	0.836	---	---
		2441	0.845	---	---
		2480	0.845	---	---
2DH1	Ant1	2402	1.163	---	---
		2441	1.166	---	---
		2480	1.175	---	---
3DH1	Ant1	2402	1.145	---	---
		2441	1.151	---	---
		2480	1.154	---	---

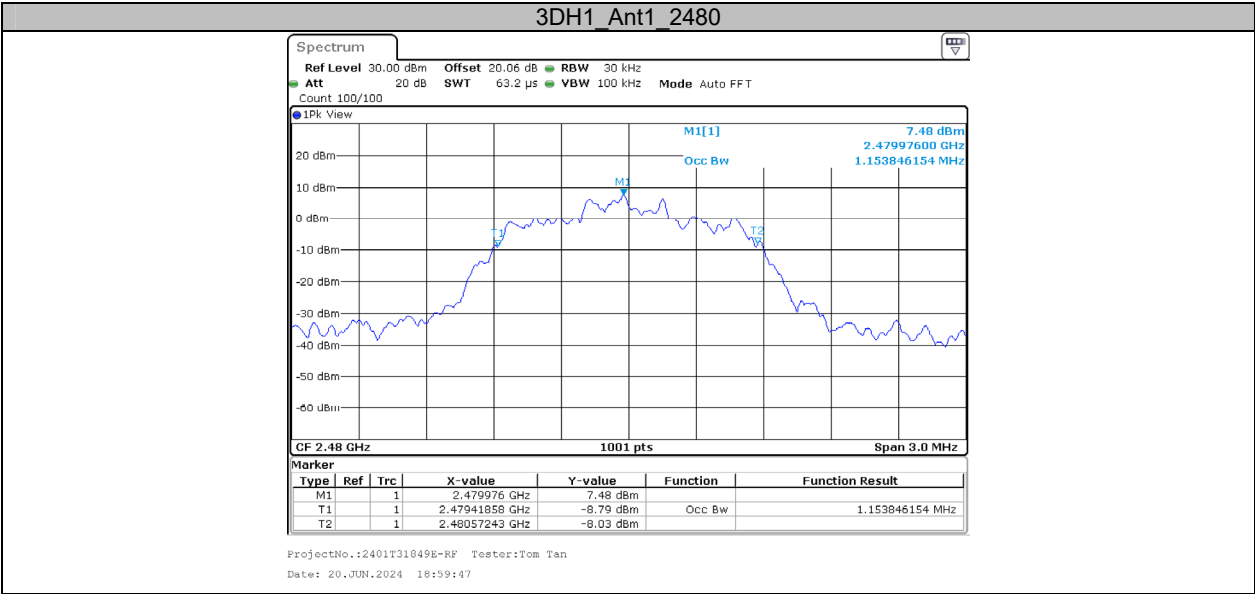
Test Graphs







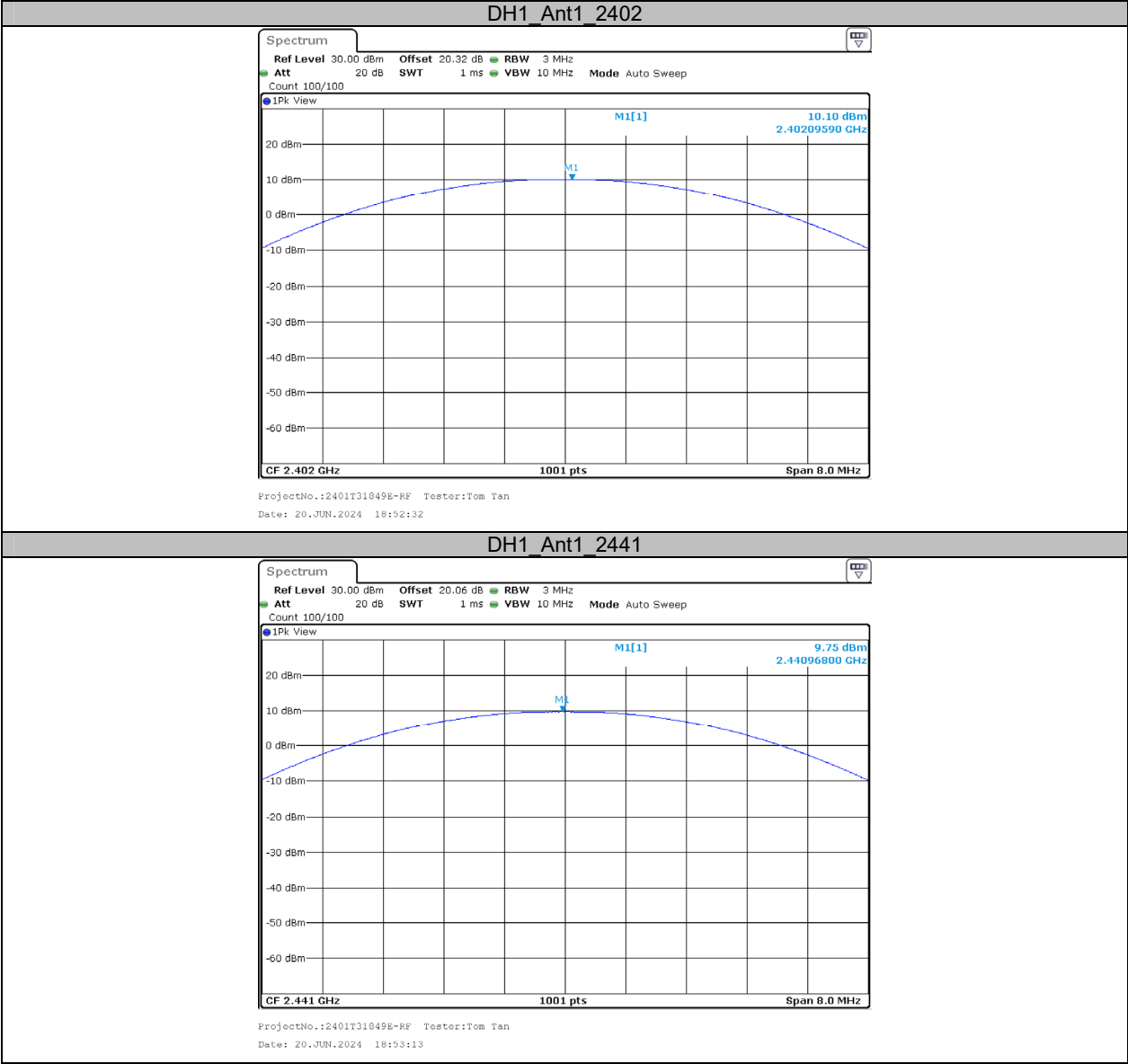


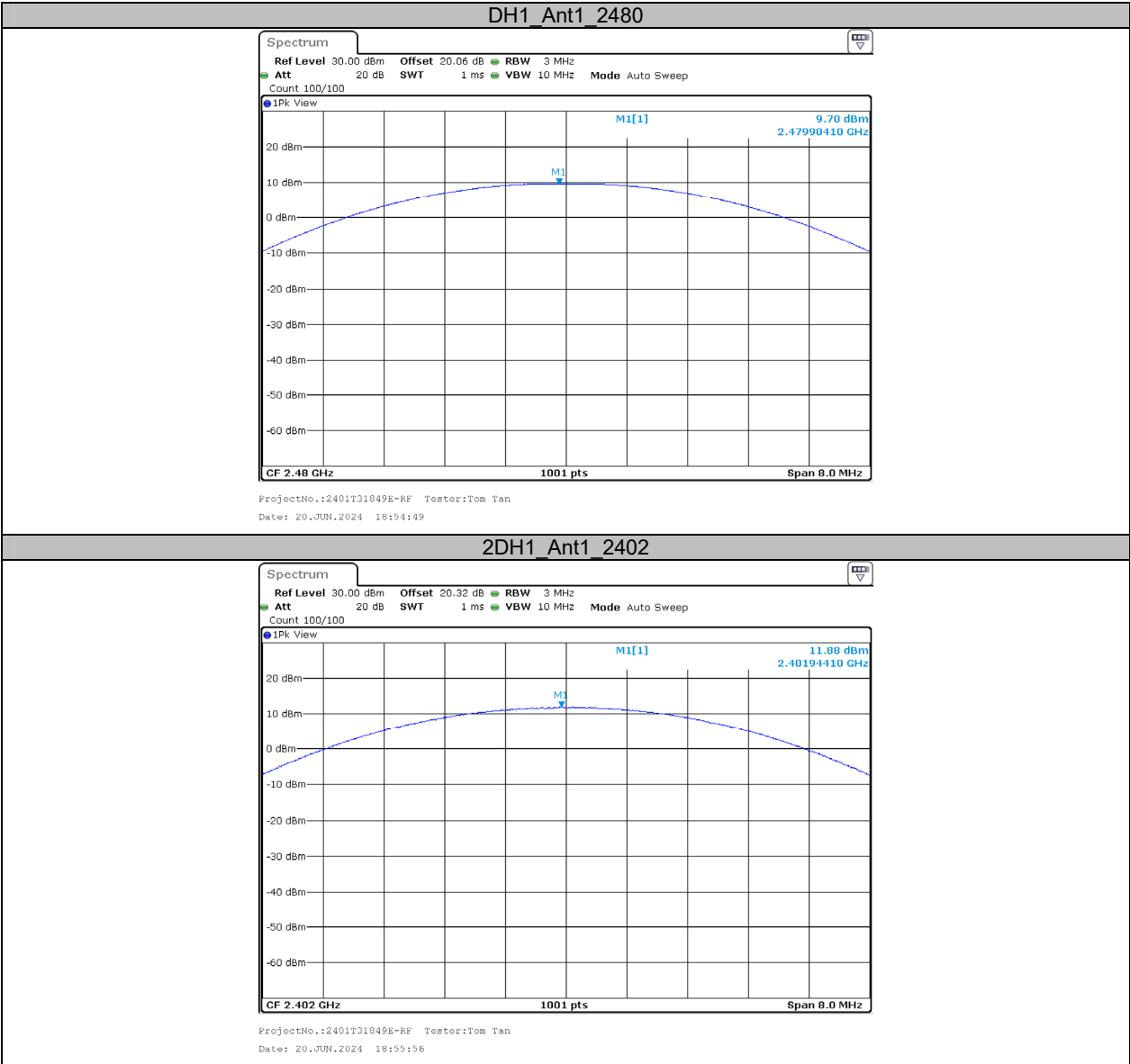


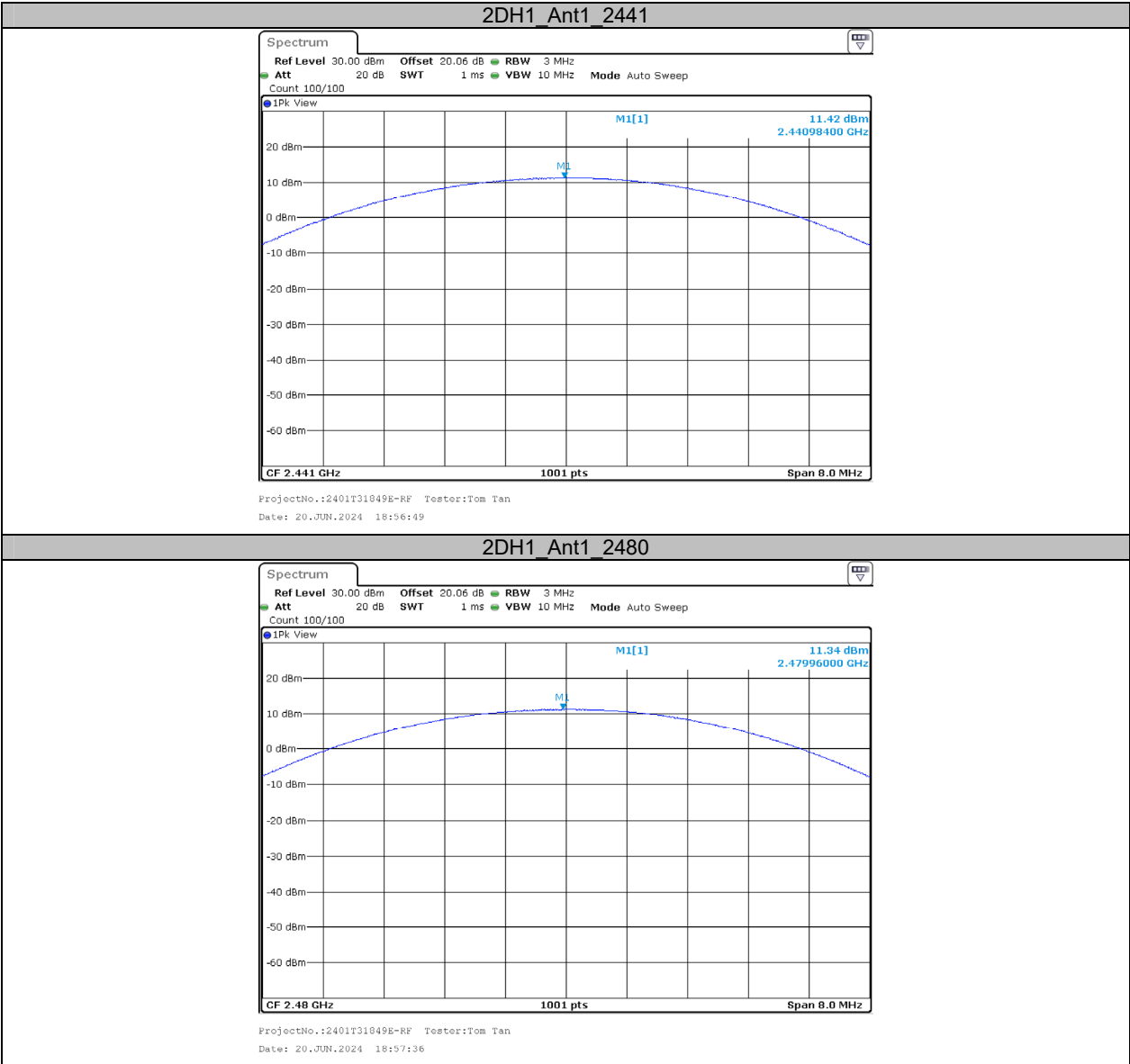
Appendix C: Maximum conducted Peak output power**Test Result**

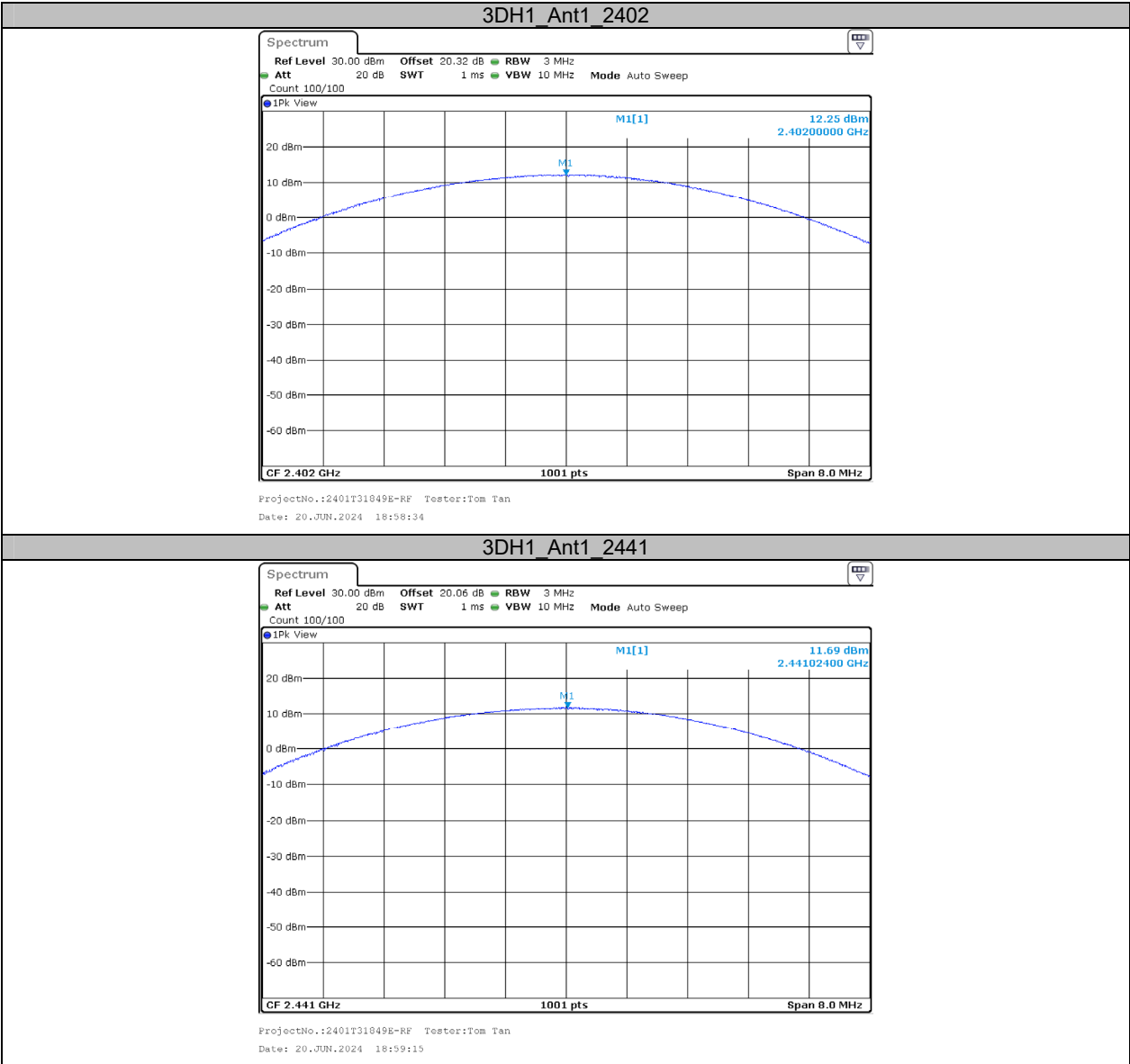
Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	EIRP[dBm]	EIRP Limit[dBm]	Verdict
DH1	Ant1	2402	10.10	≤20.97	12.48	≤36	PASS
		2441	9.75	≤20.97	12.13	≤36	PASS
		2480	9.70	≤20.97	12.08	≤36	PASS
2DH1	Ant1	2402	11.88	≤20.97	14.26	≤36	PASS
		2441	11.42	≤20.97	13.80	≤36	PASS
		2480	11.34	≤20.97	13.72	≤36	PASS
3DH1	Ant1	2402	12.25	≤20.97	14.63	≤36	PASS
		2441	11.69	≤20.97	14.07	≤36	PASS
		2480	11.62	≤20.97	14.00	≤36	PASS

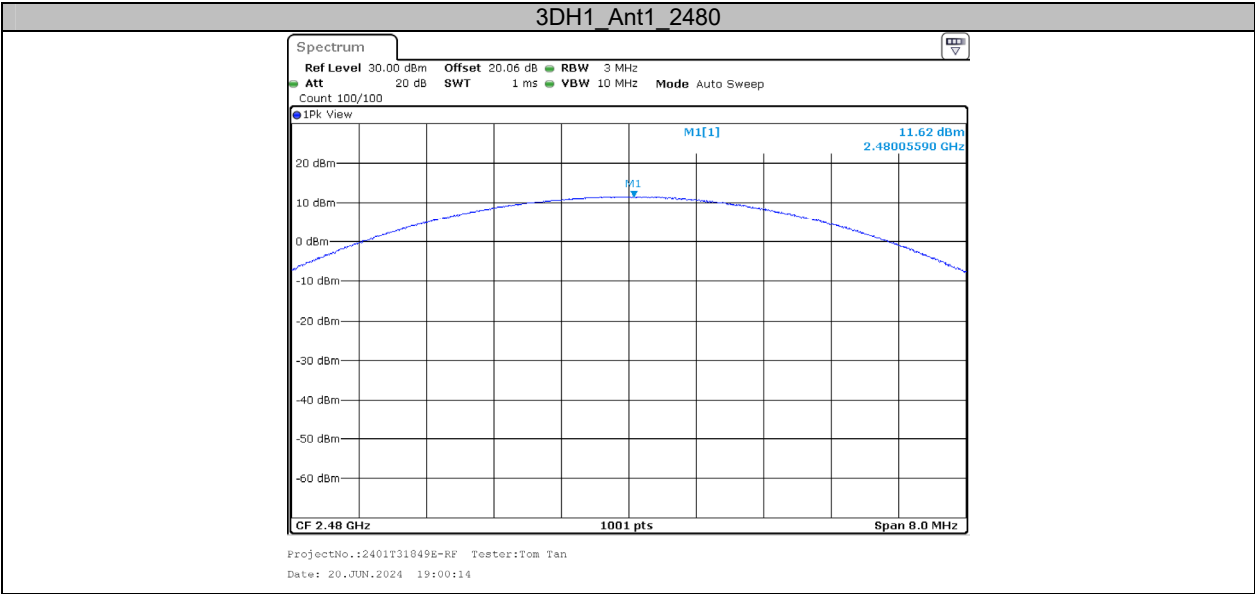
Test Graphs







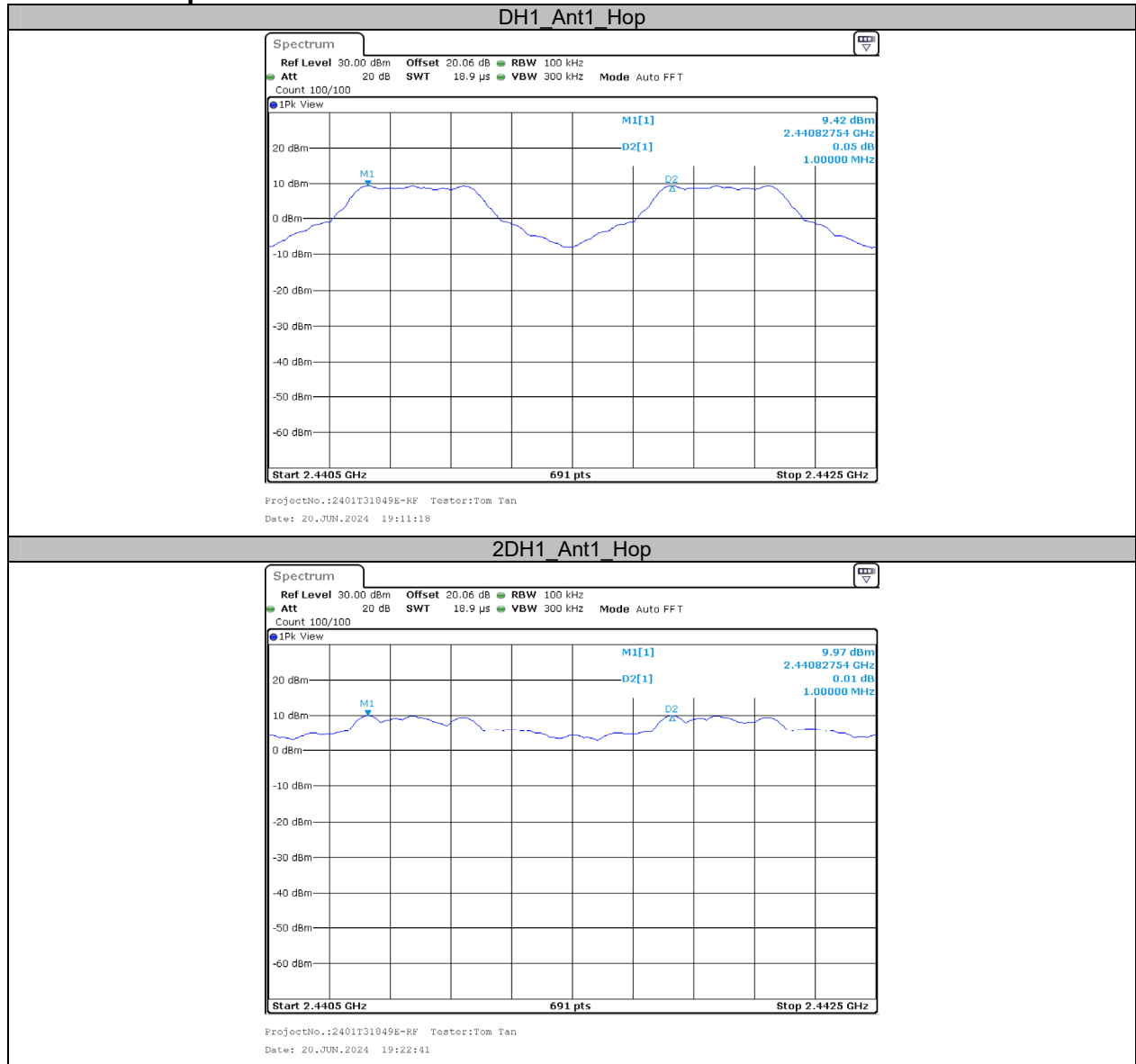


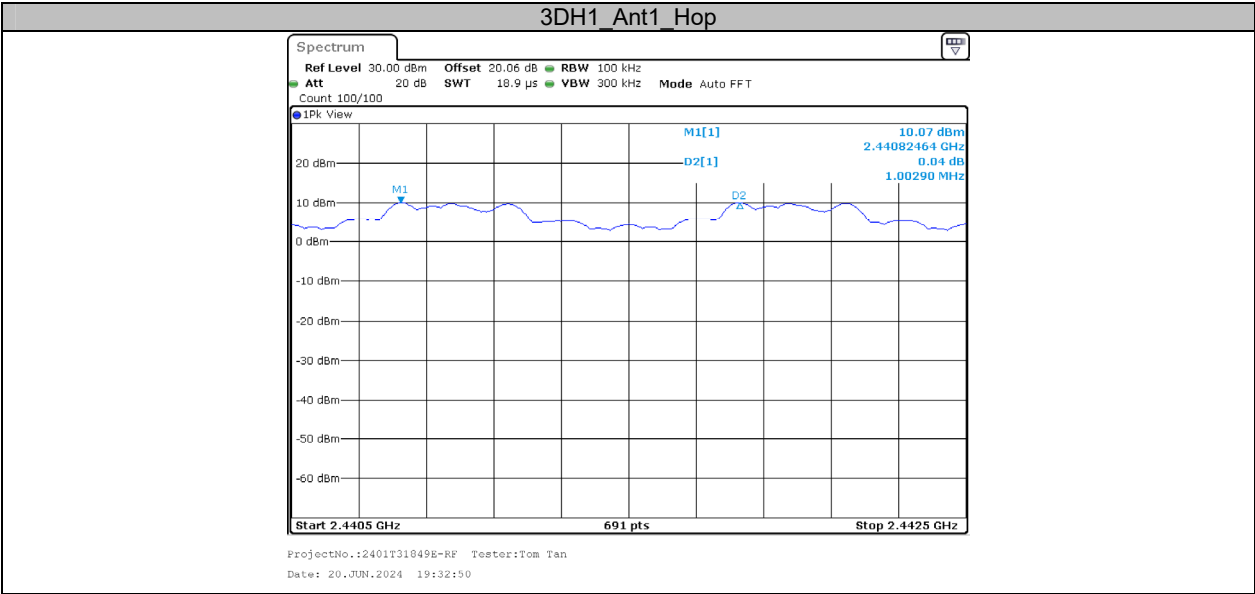


Appendix D: Carrier frequency separation**Test Result**

Test Mode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH1	Ant1	Hop	1	≥ 0.607	PASS
2DH1	Ant1	Hop	1	≥ 0.873	PASS
3DH1	Ant1	Hop	1.003	≥ 0.827	PASS

Test Graphs





Appendix E: Time of occupancy**Test Result**

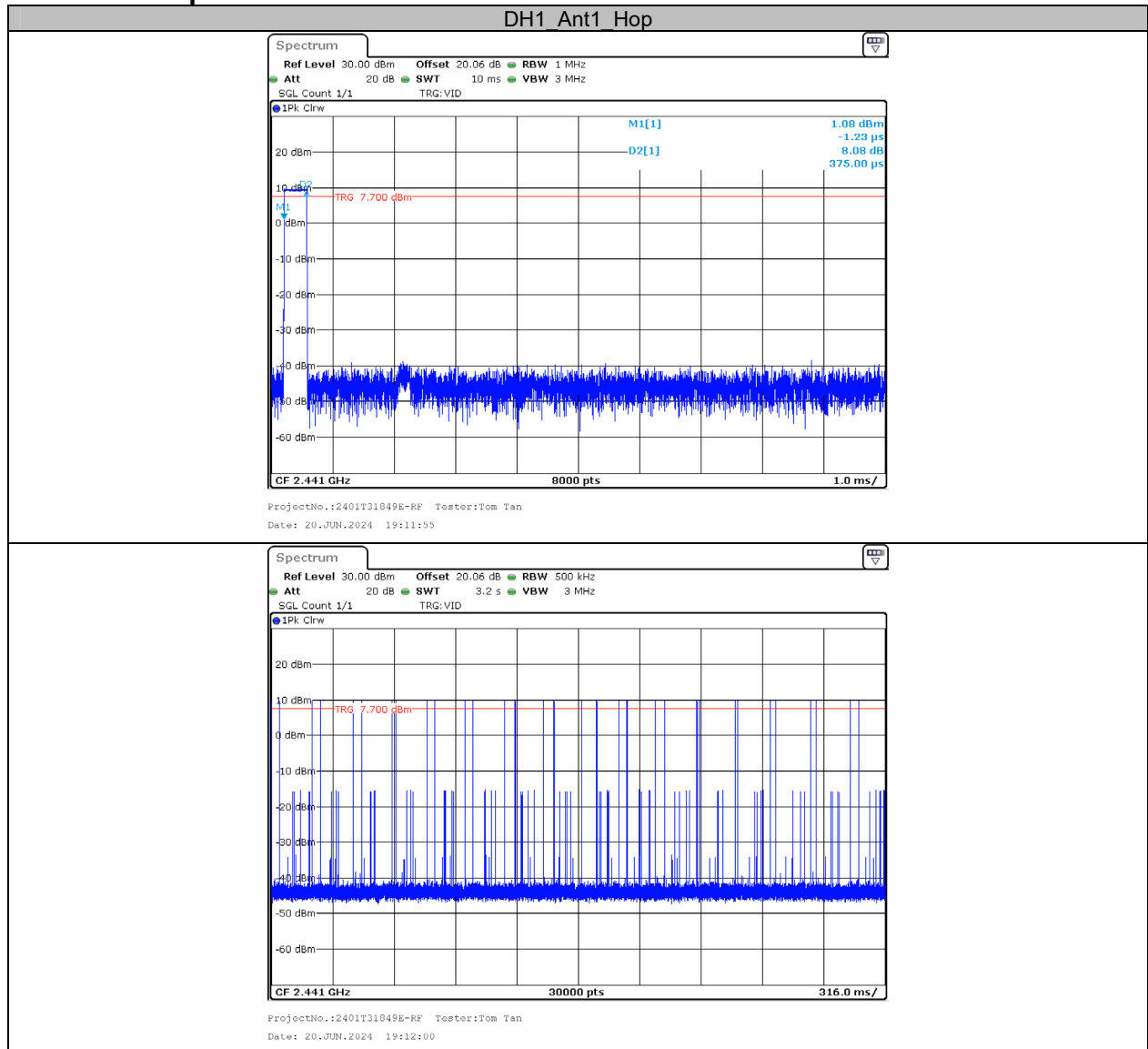
Test Mode	Antenna	Channel	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.375	320	0.120	≤0.4	PASS
DH3	Ant1	Hop	1.623	170	0.276	≤0.4	PASS
DH5	Ant1	Hop	2.863	110	0.315	≤0.4	PASS
2DH1	Ant1	Hop	0.384	320	0.123	≤0.4	PASS
2DH3	Ant1	Hop	1.629	140	0.228	≤0.4	PASS
2DH5	Ant1	Hop	2.870	120	0.344	≤0.4	PASS
3DH1	Ant1	Hop	0.385	320	0.123	≤0.4	PASS
3DH3	Ant1	Hop	1.628	150	0.244	≤0.4	PASS
3DH5	Ant1	Hop	2.870	110	0.316	≤0.4	PASS

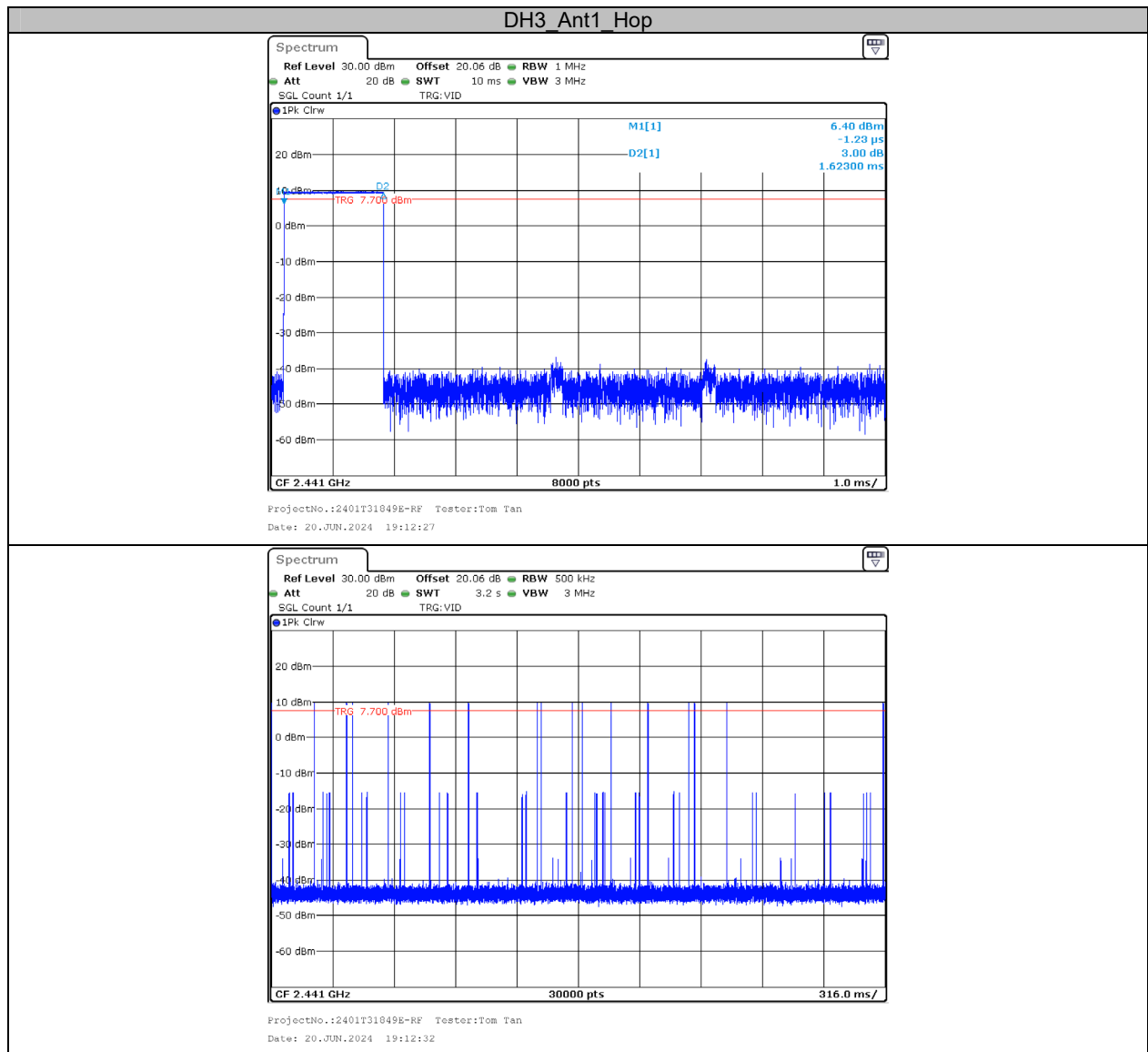
Note 1: A period time= $0.4 \times 79 = 31.6$ (S), Result=BurstWidth*Totalhops

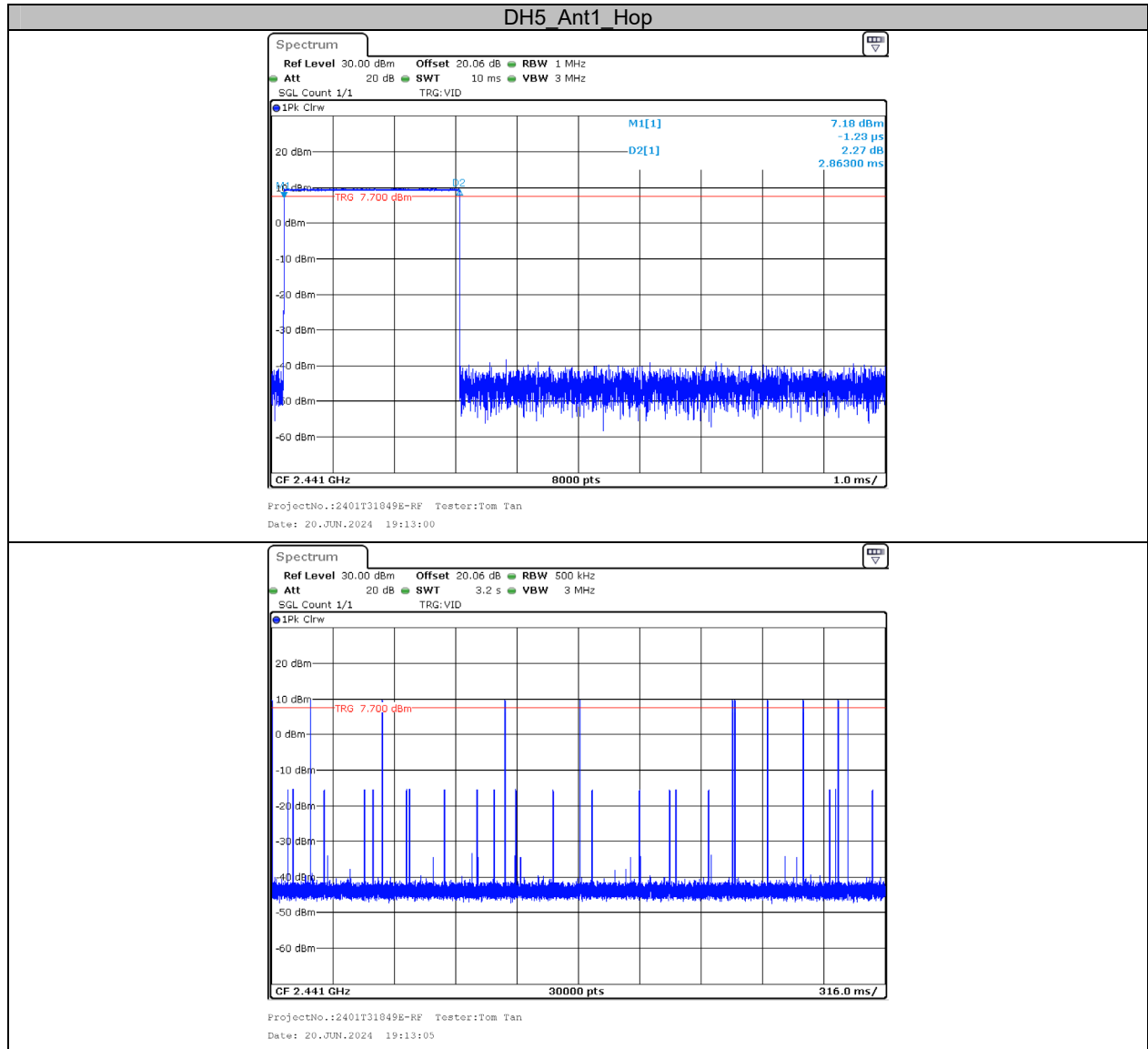
Note 2: Totalhops=Hopping Number in $3.16\text{s} \times 10$

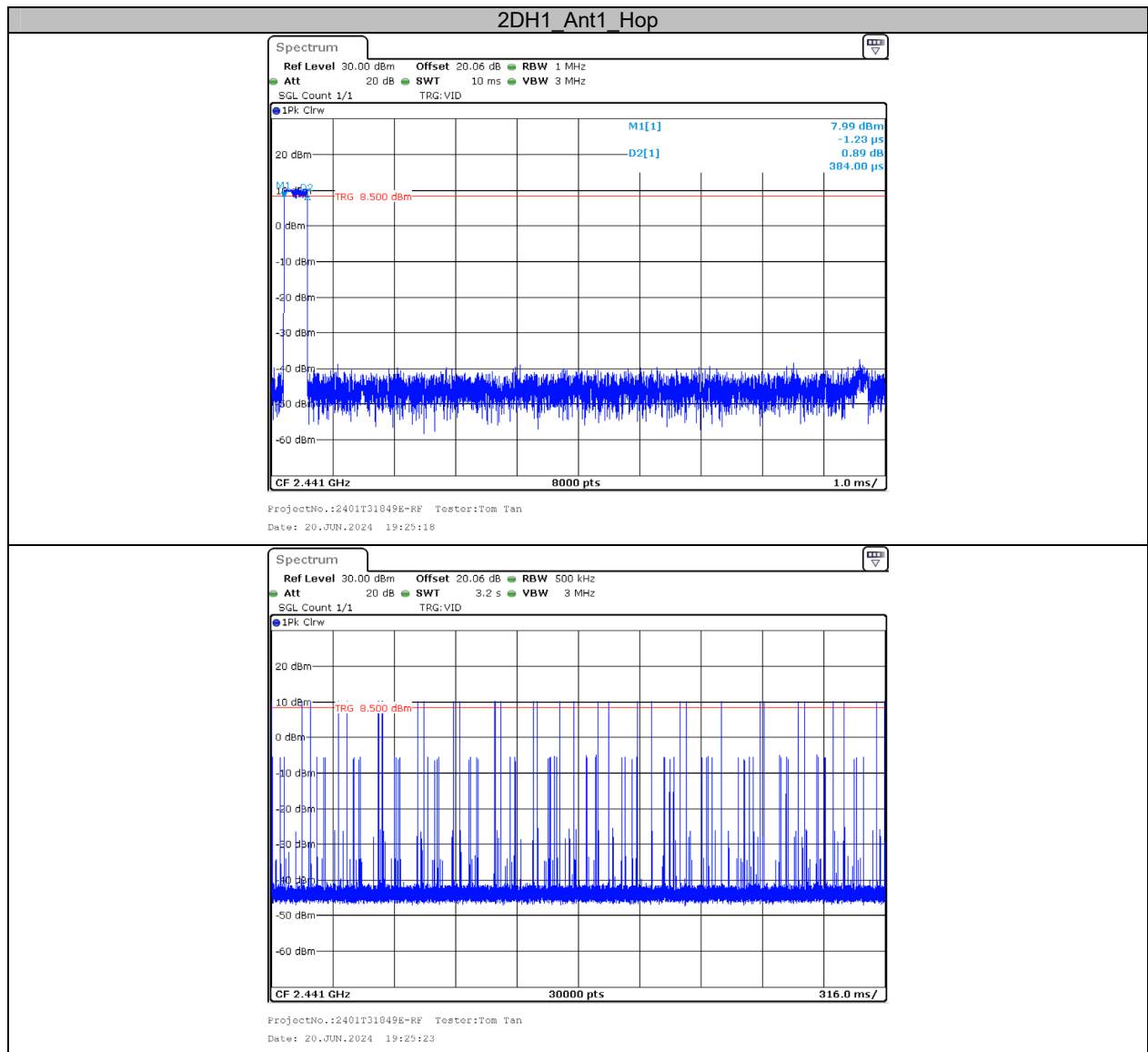
Note 3: Hopping Number in 3.16s =Total of highest signals in 3.16s (Second high signals were other channel)

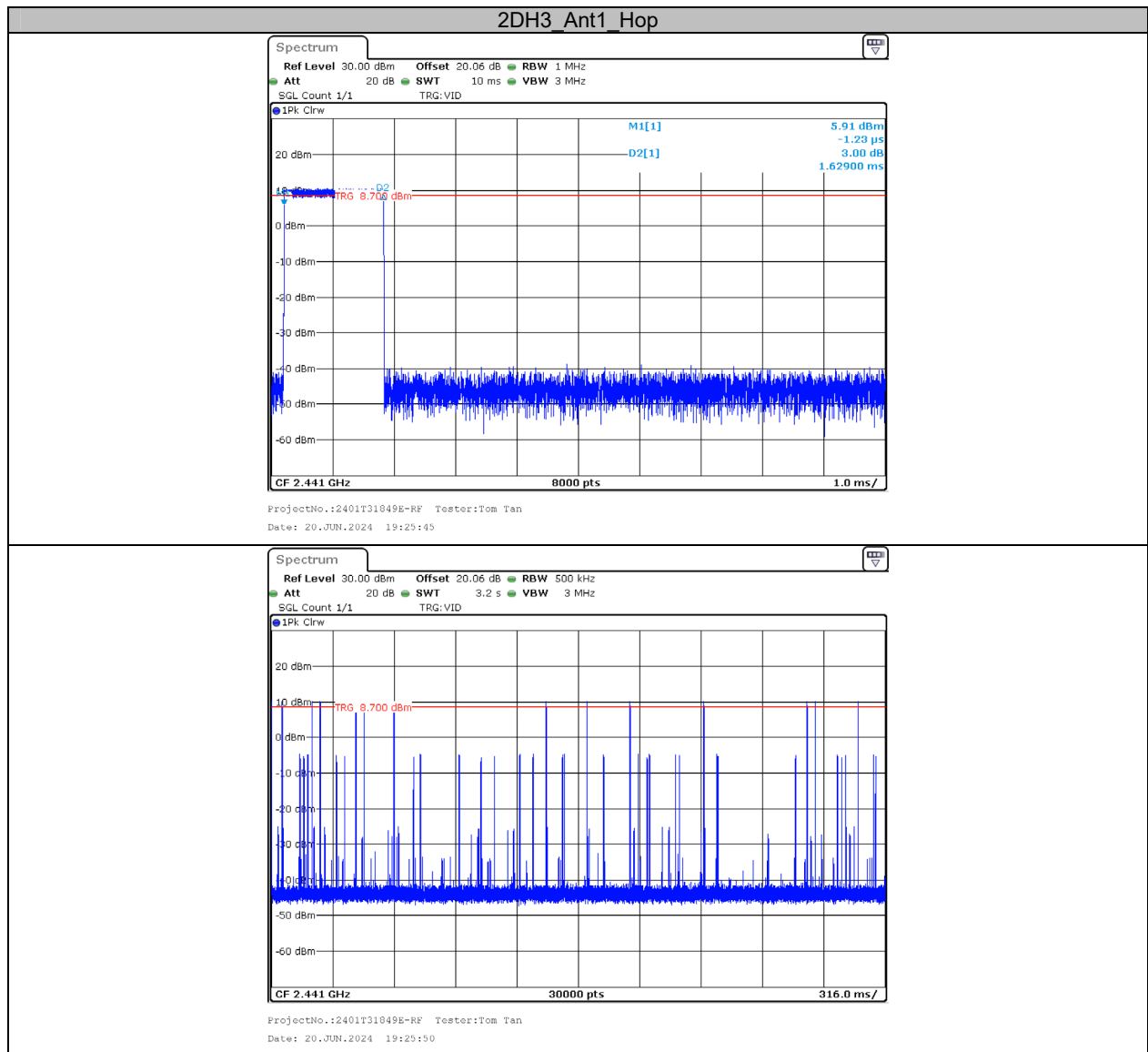
Test Graphs

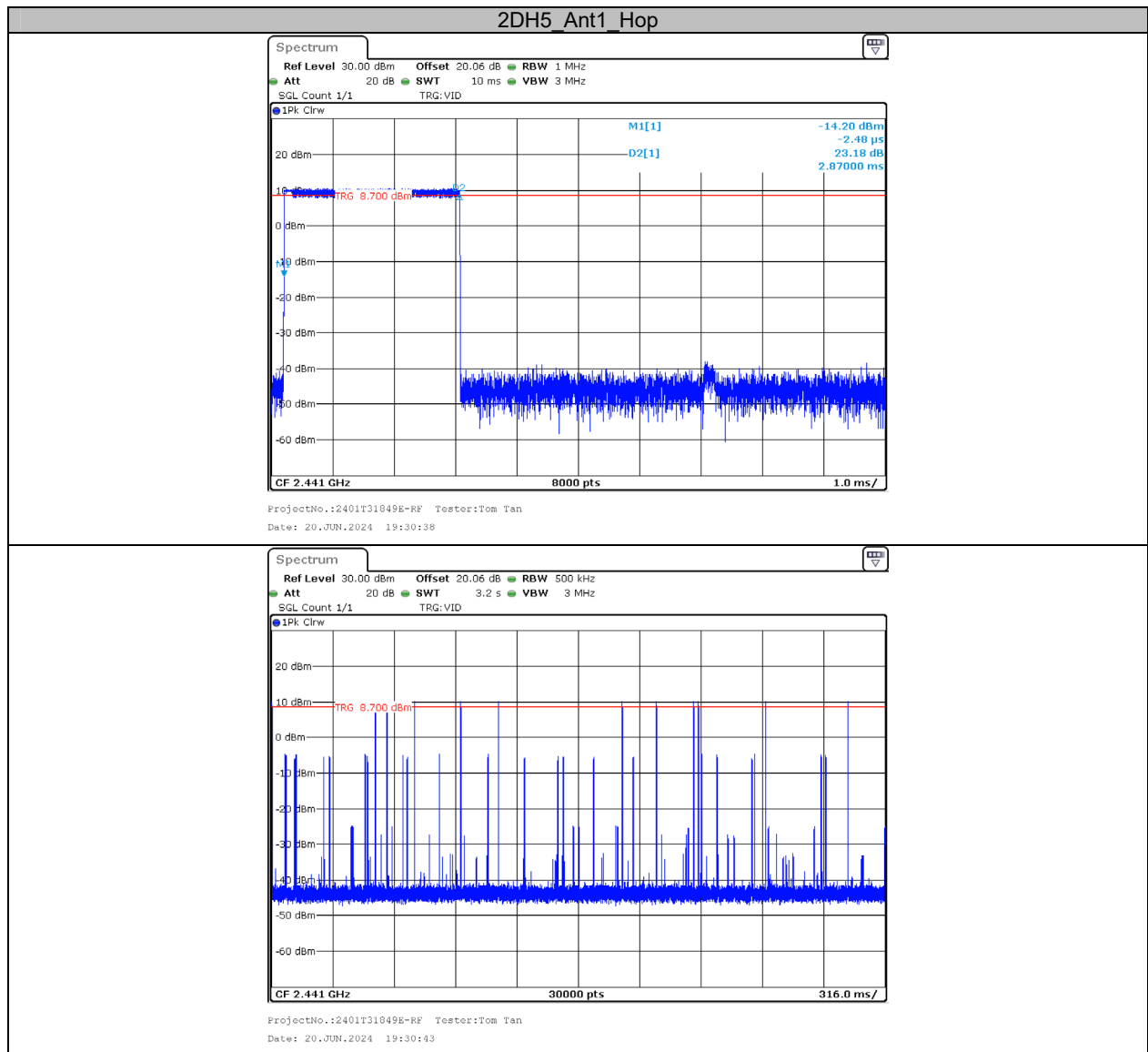


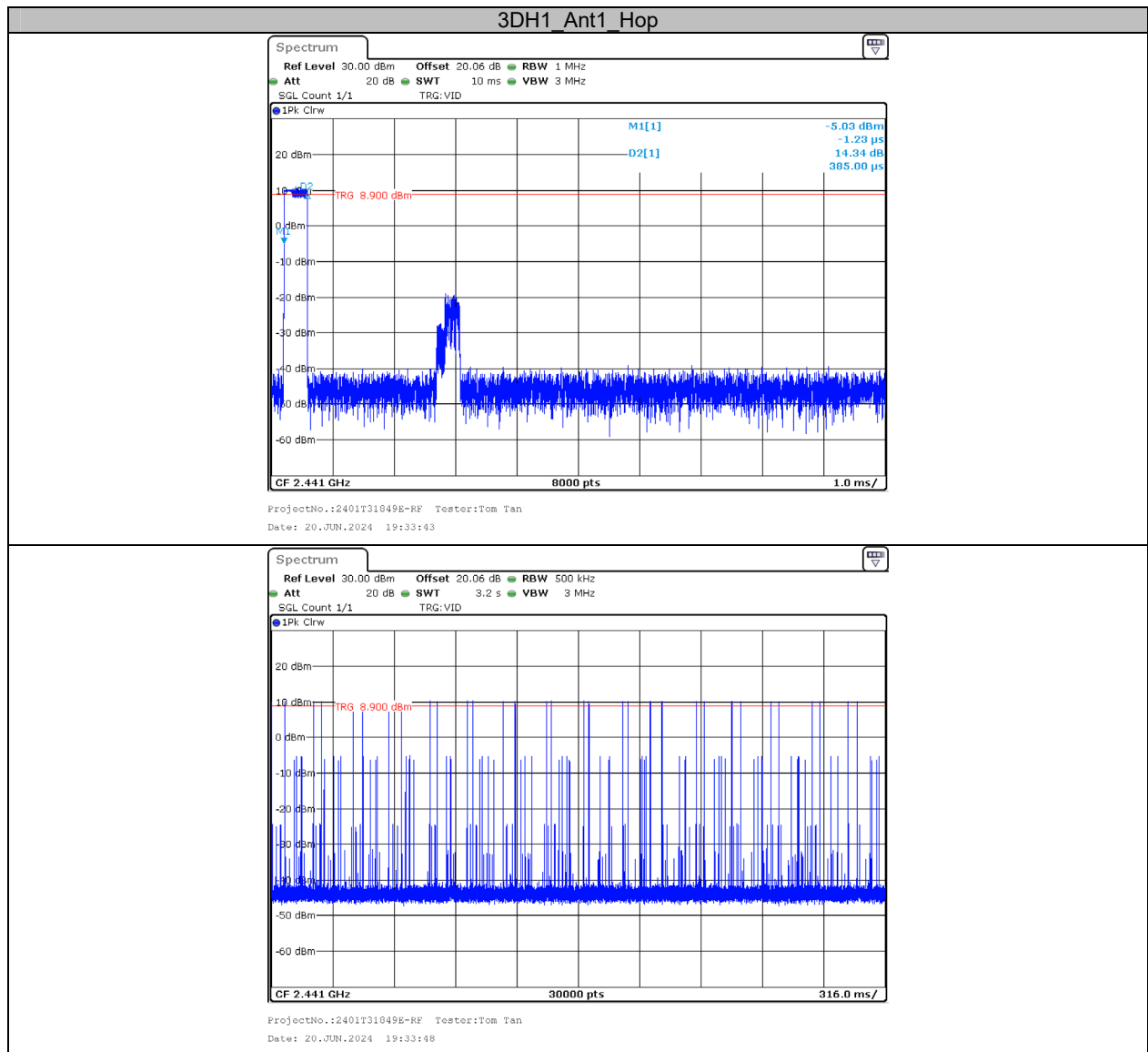


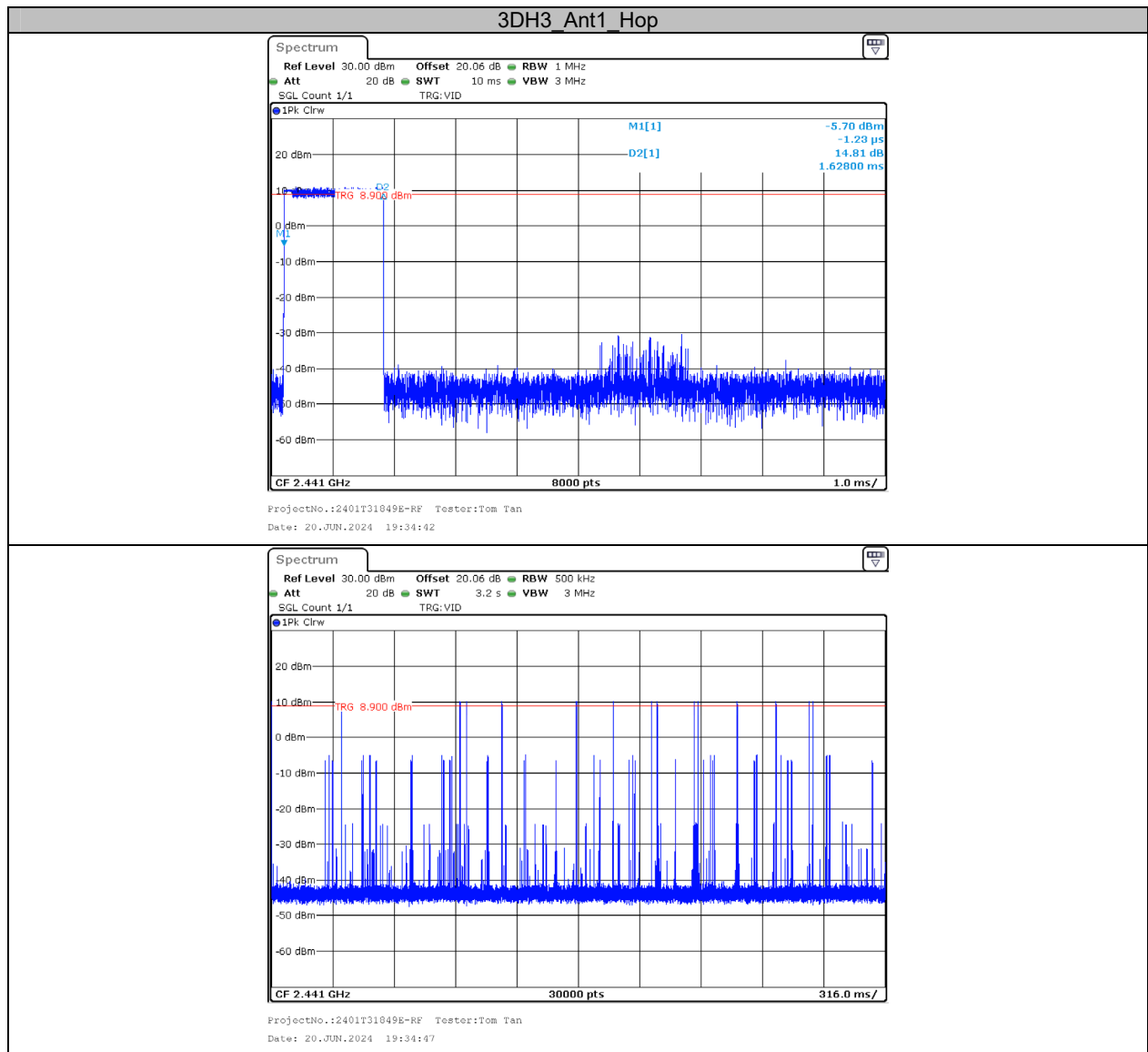


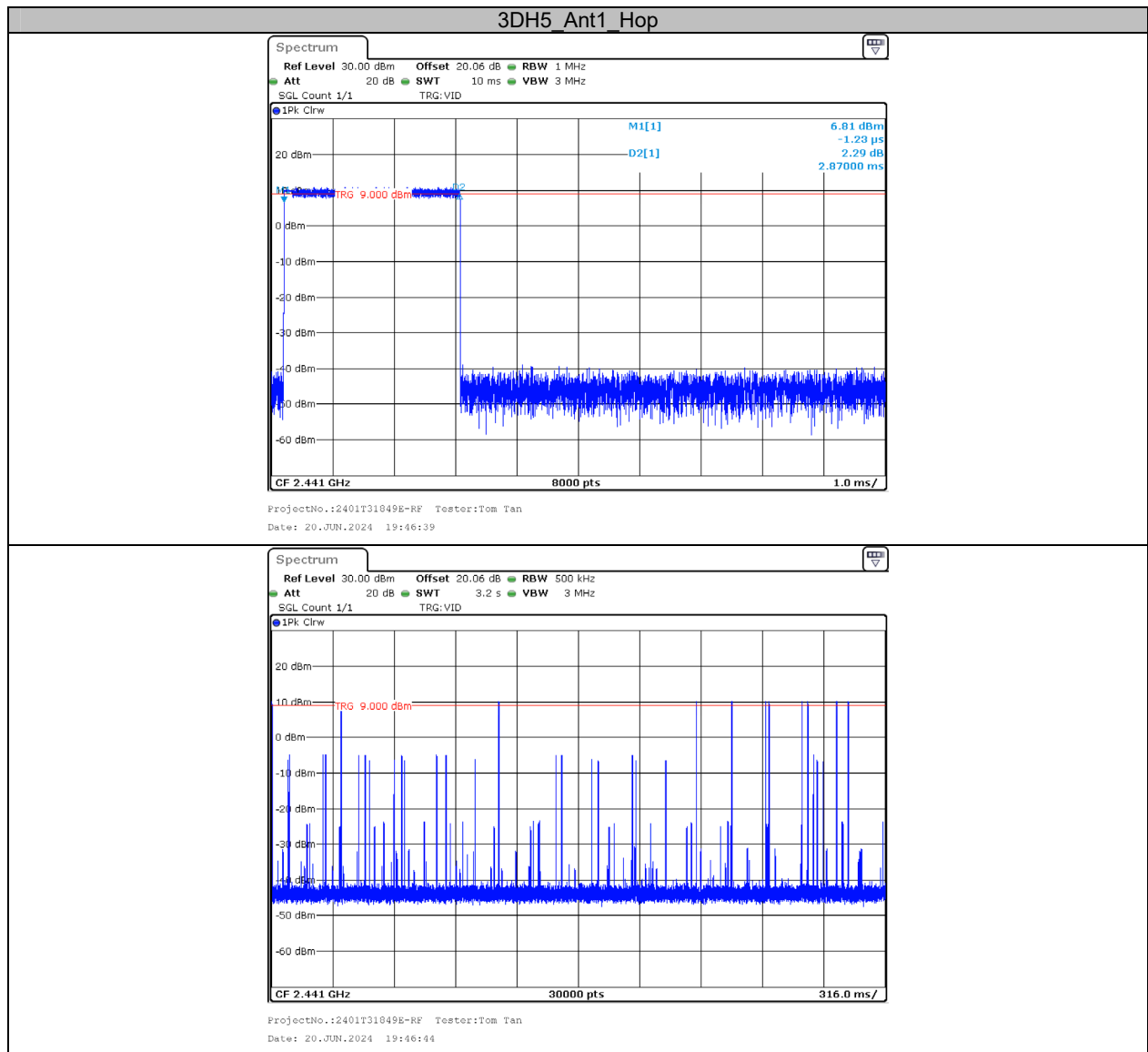








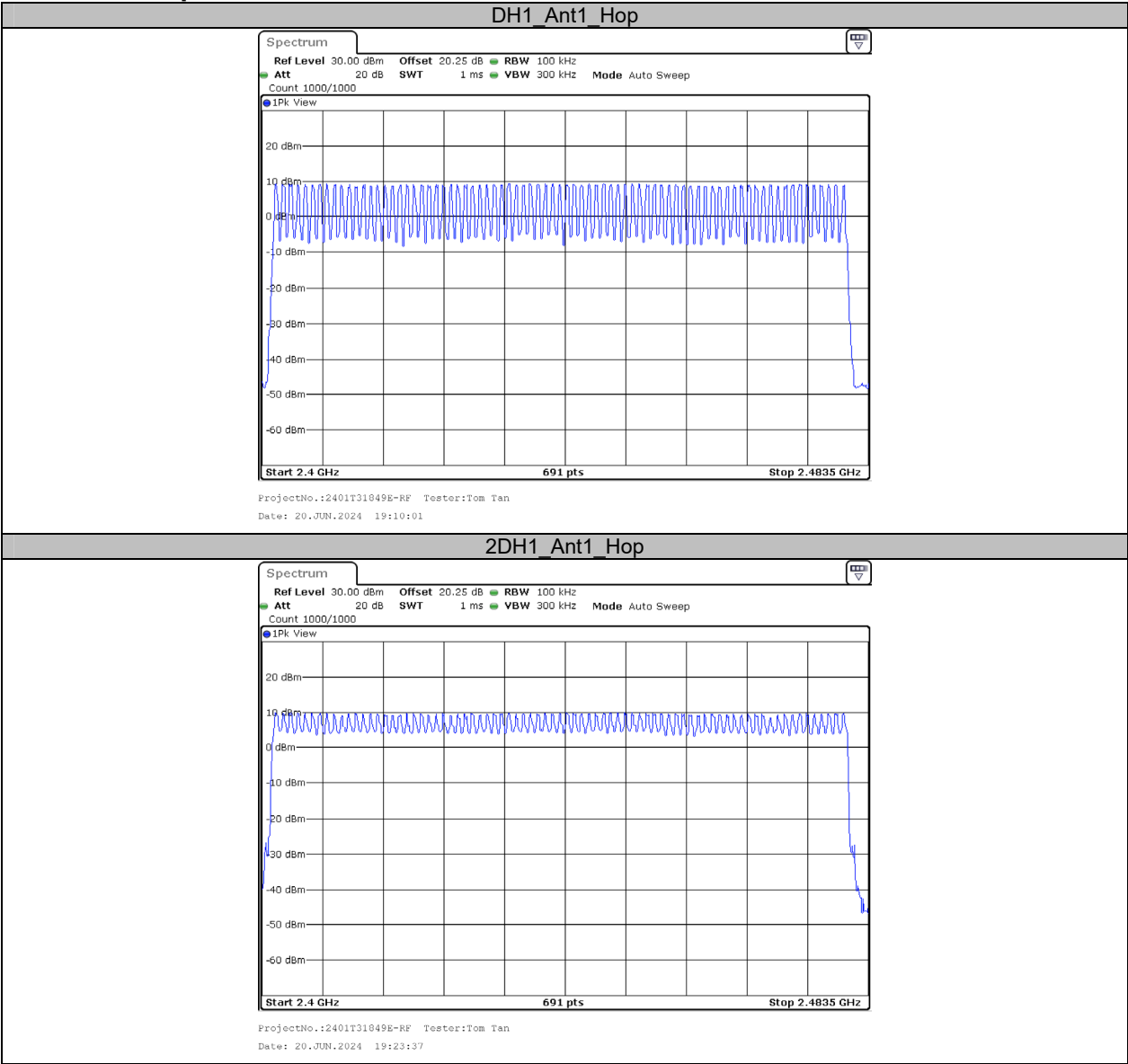


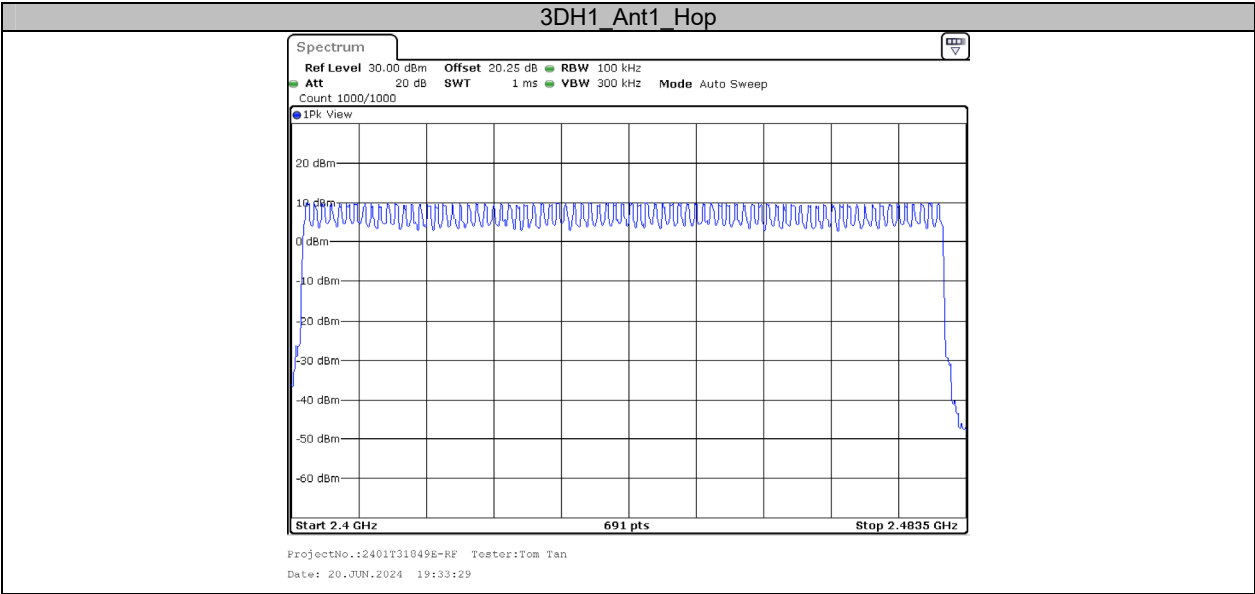


Appendix F: Number of hopping channels**Test Result**

Test Mode	Antenna	Channel	Result[Num]	Limit[Num]	Verdict
DH1	Ant1	Hop	79	≥15	PASS
2DH1	Ant1	Hop	79	≥15	PASS
3DH1	Ant1	Hop	79	≥15	PASS

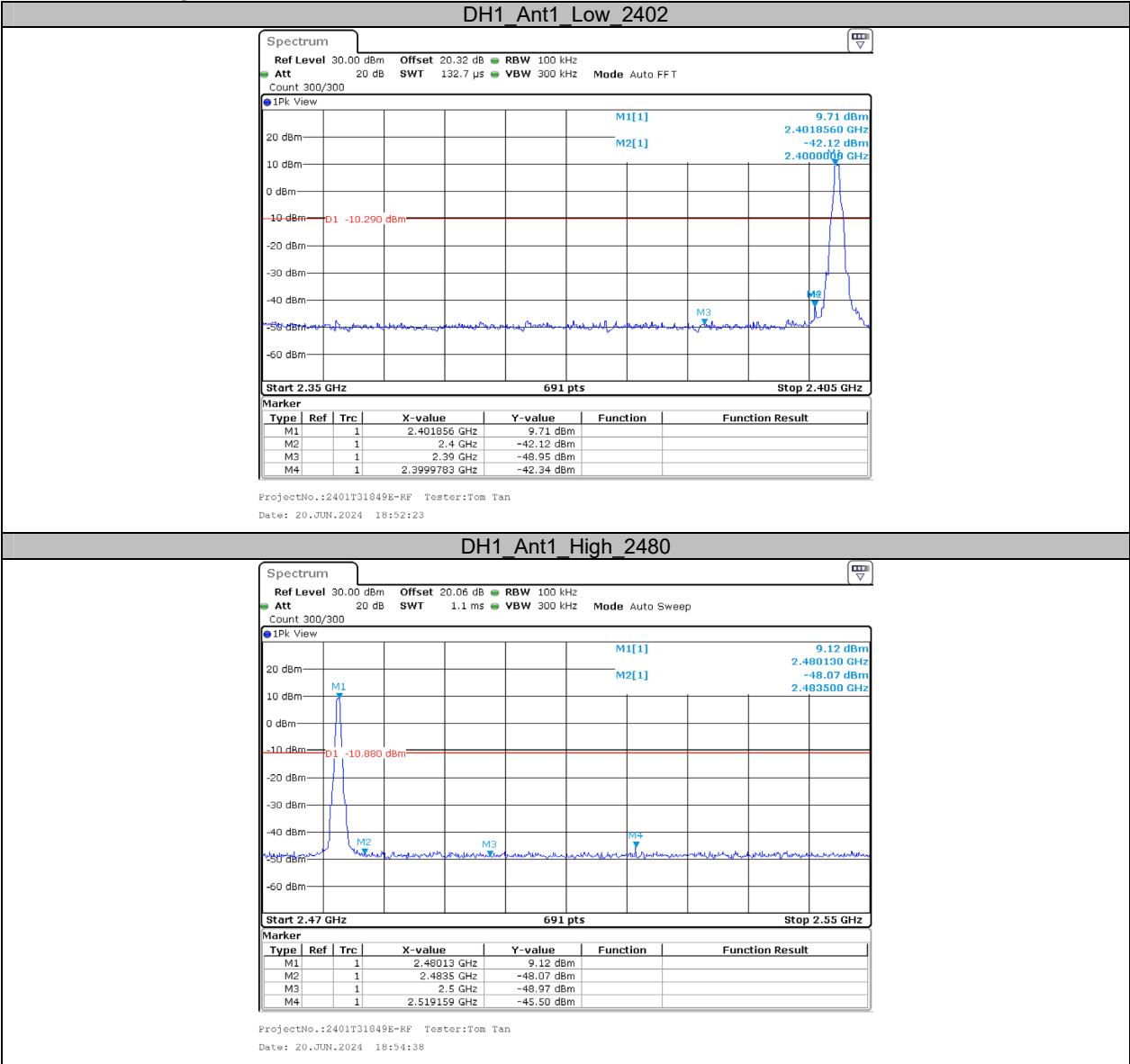
Test Graphs



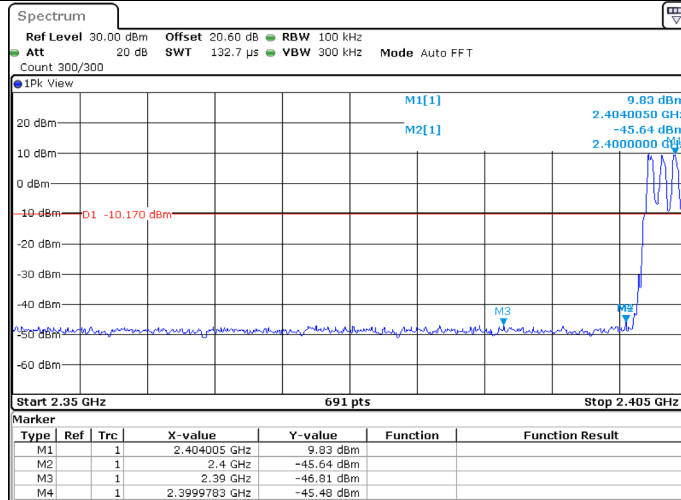


Appendix G: Band edge measurements

Test Graphs

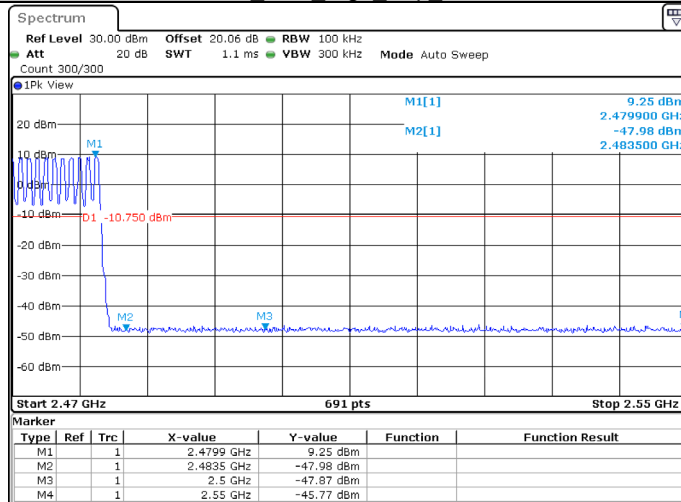


DH1 Ant1 Low Hop 2402

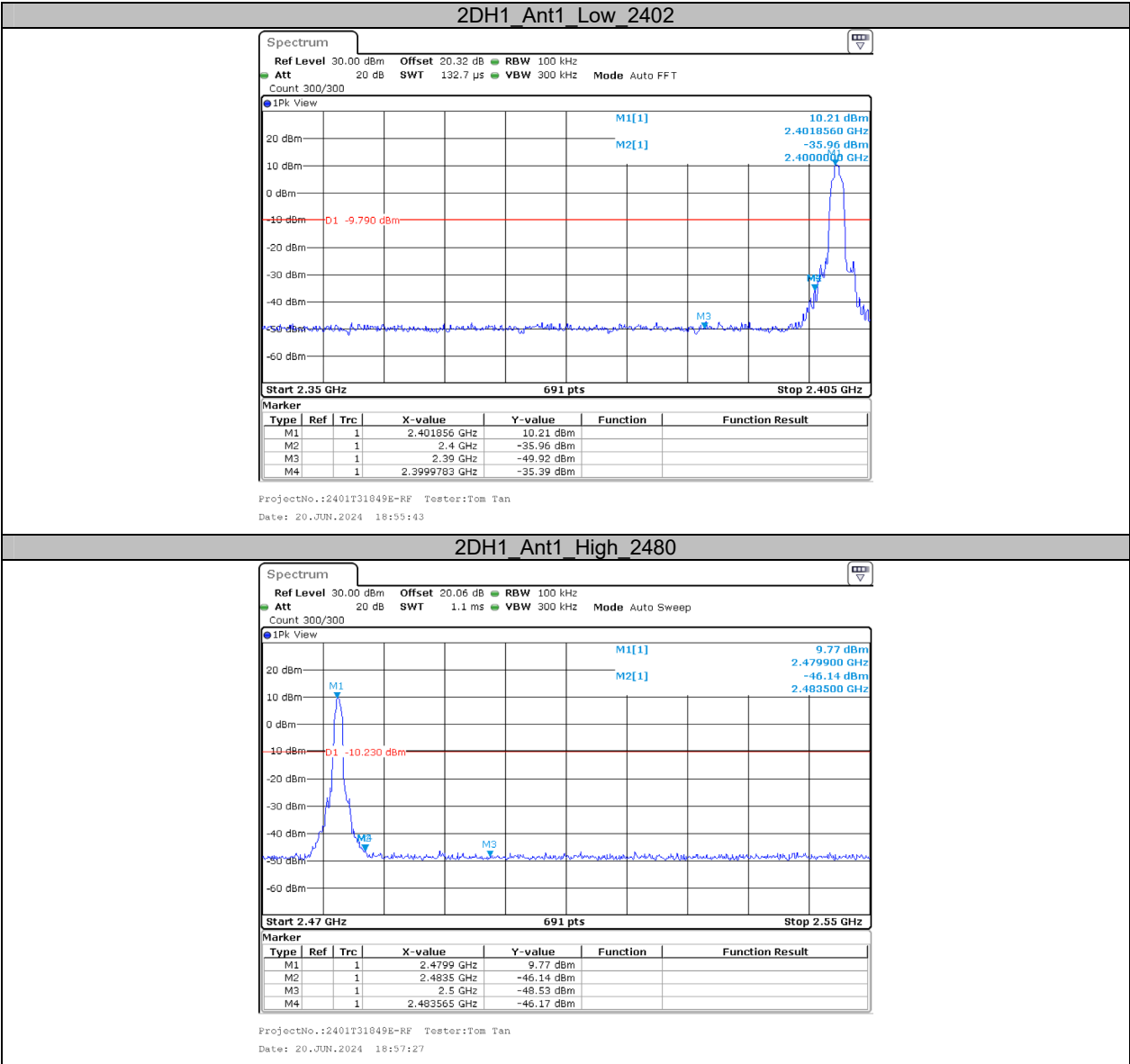


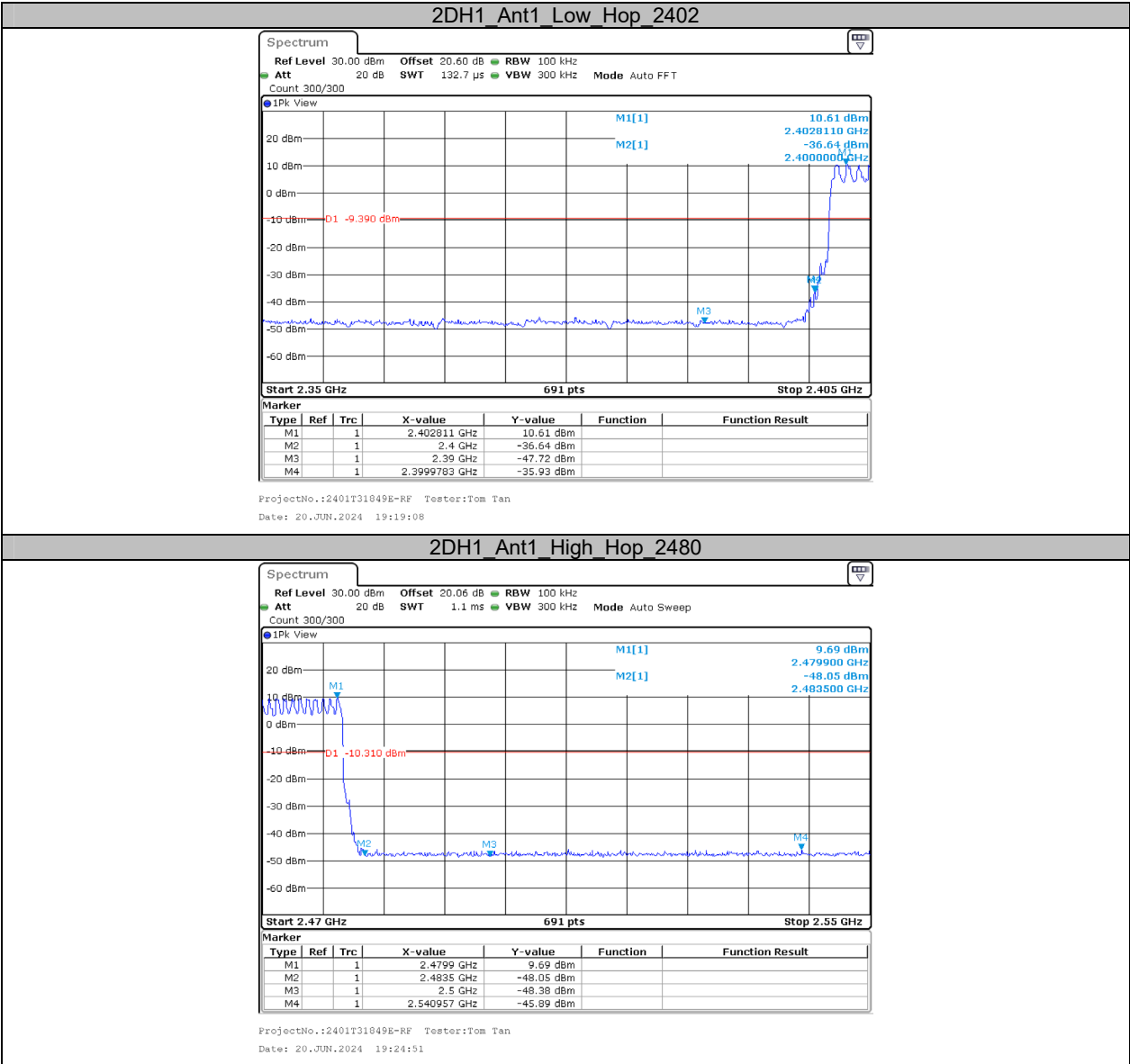
ProjectNo.:2401T31849E-RF Tester:Tom Tan
Date: 20.JUN.2024 19:08:46

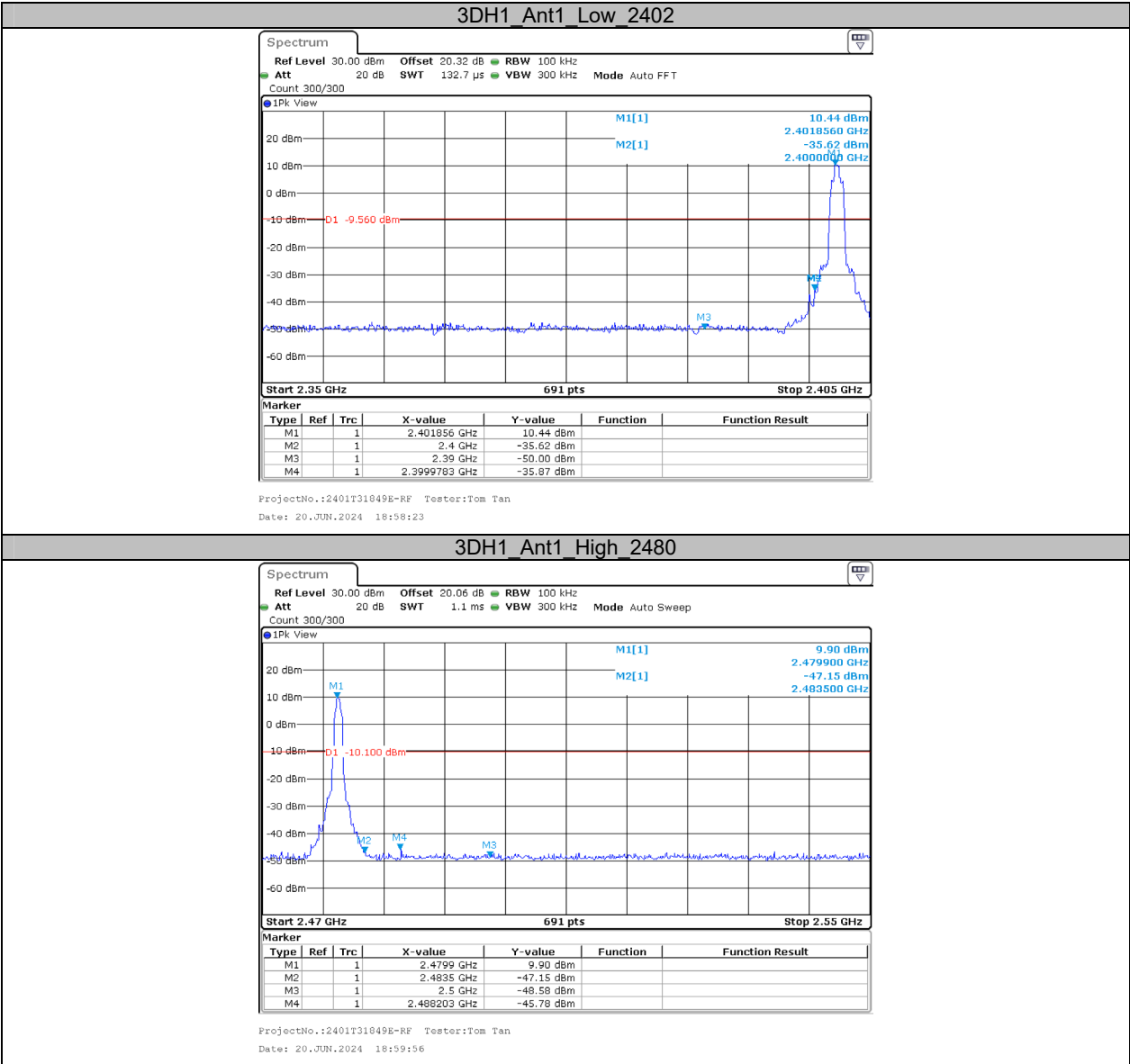
DH1 Ant1 High Hop 2480

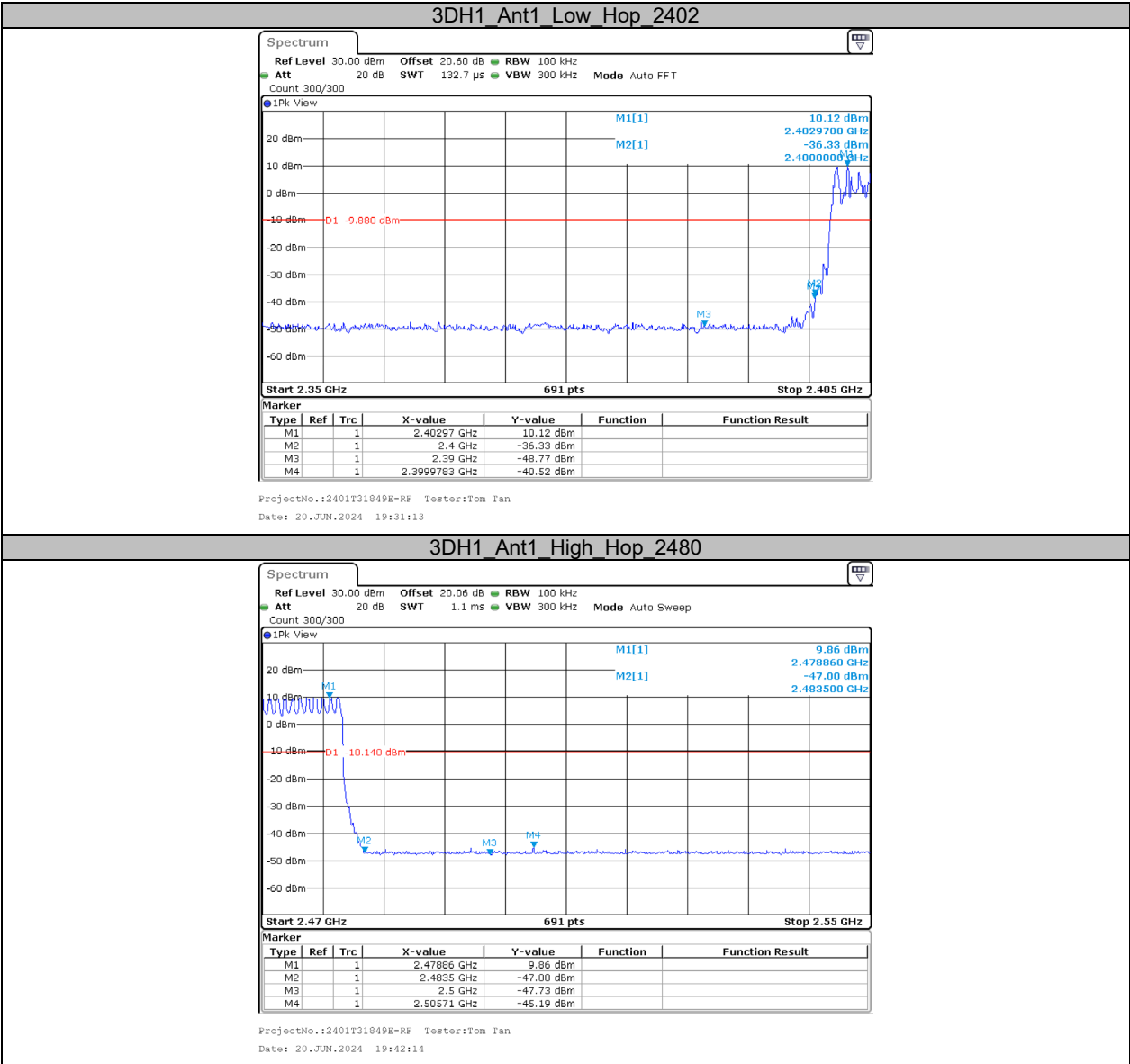


ProjectNo.:2401T31849E-RF Tester:Tom Tan
Date: 20.JUN.2024 19:19:10









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