

TEST REPORT

Applicant Name : Polygroup Evergreen Limited
Address : Unit 606, 6th Floor, Fairmont House, No.8 Cotton Tree Drive,
Central, Hong Kong
Report Number : RA230301-09499E-RFB
FCC ID: 2A62O-TBC007
IC: 28592-TBC007

Test Standard (s)

FCC PART 15.247; RSS-GEN ISSUE 5, FEBRUARY 2021 AMENDMENT 2; RSS-247, ISSUE 2,
FEBRUARY 2017

Sample Description

Product Type: Controller
Model No.: TBC007-24V
Multiple Model(s) No.: N/A
Trade Mark: N/A
Date Received: 2023/03/01
Report Date: 2023/04/18

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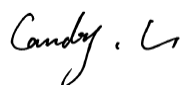
* In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:

Approved By:



Nick Fang
EMC Engineer



Candy Li
EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "★".

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	RA230301-09499E-RFB	Original Report	2023-04-18

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

HVIN	TBC007-24V
FVIN	2.8.15
Frequency Range	BLE 1M: 2402-2480MHz Wi-Fi: 2412-2462MHz
Maximum Conducted Output Power	BLE 1M: 5.33dBm (peak) Wi-Fi: 14.98dBm (average)
Modulation Technique	BLE: GFSK Wi-Fi: DSSS, OFDM
Antenna Specification*	3.42dBi (It is provided by the applicant)
Voltage Range	DC 24V from adapter
Sample serial number	23UJ_2 for Conducted and Radiated Emissions 23UJ_1 for RF Conducted Test (Assigned by ATC)
Sample/EUT Status	Good condition
Adapter information	Model: TS-48W24V Input: AC 120V~60Hz, 0.83A Output: DC 24V, 2A

Objective

This report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's rules and RSS-GEN Issue 5, February 2021 Amendment 2 and RSS-247, Issue 2, February 2017 of the Innovation, Science and Economic Development Canada rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.207, 15.209, 15.247 rules and RSS-Gen, RSS-247.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliant Testing of Unlicensed Wireless Devices and RSS-GEN Issue 5, February 2021 Amendment 2 and RSS-247, Issue 2, February 2017.

And KDB 558074 D01 15.247 Meas Guidance v05r02.

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

Each test item follows test standards and with no deviation.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF Frequency		0.082×10^{-7}
RF output power, conducted		0.71dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	9kHz - 30MHz	2.06dB
	30MHz - 1GHz	5.08dB
	1GHz - 18GHz	4.96dB
	18GHz - 26.5GHz	5.16dB
	26.5GHz - 40GHz	4.64dB
Temperature		1°C
Humidity		6%
Supply voltages		0.4%

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

Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the Floor 1, KuMaKe Building, Dongzhou Community, Guangming Street, Guangming District, Shenzhen, Guangdong, China.

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

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0016. The Registration Number is 30241.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

Channel List

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2412	8	2447
2	2417	9	2452
3	2422	10	2457
4	2427	11	2462
5	2432	/	/
6	2437	/	/
7	2442	/	/

EUT was tested with Channel 1, 6 and 11 for 802.11b/g/n20 mode.
Channel 3, 6 and 9 for 802.11n40 mode.

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2442
1	2404	21	2444
2	2406	22	2446
3	2408	23	2448
4	2410	24	2450
5	2412	25	2452
6	2414	26	2454
7	2416	27	2456
8	2418	28	2458
9	2420	29	2460
10	2422	30	2462
11	2424	31	2464
12	2426	32	2466
13	2428	33	2468
14	2430	34	2470
15	2432	35	2472
16	2434	36	2474
17	2436	37	2476
18	2438	38	2478
19	2440	39	2480

EUT was tested with Channel 0, 19 and 39.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

“EspRFTTestTool.exe”* was used. The software and power level was provided by the applicant.

The device was tested with the worst case was performed as below:

Mode	Data rate	Power level*		
		Low channel	Middle channel	High channel
802.11b	1Mbps	0	0	0
802.11g	6Mbps	0	0	0
802.11n-HT20	MCS0	0	0	0
802.11n-HT40	MCS0	0	0	0
BLE	/	6	6	6

Local Support Equipment List and Details

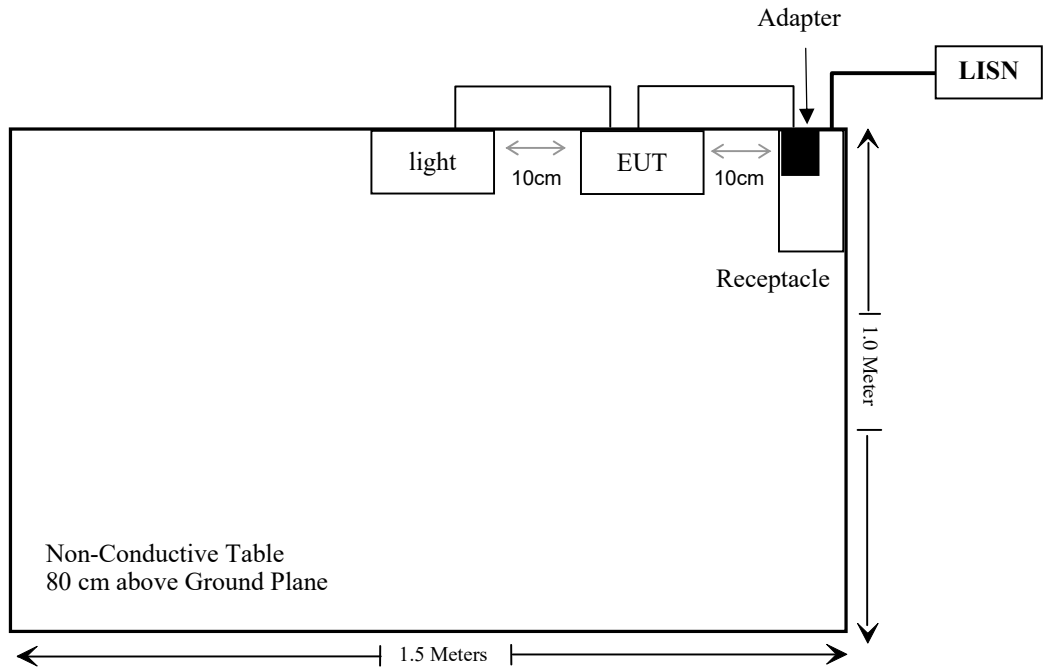
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

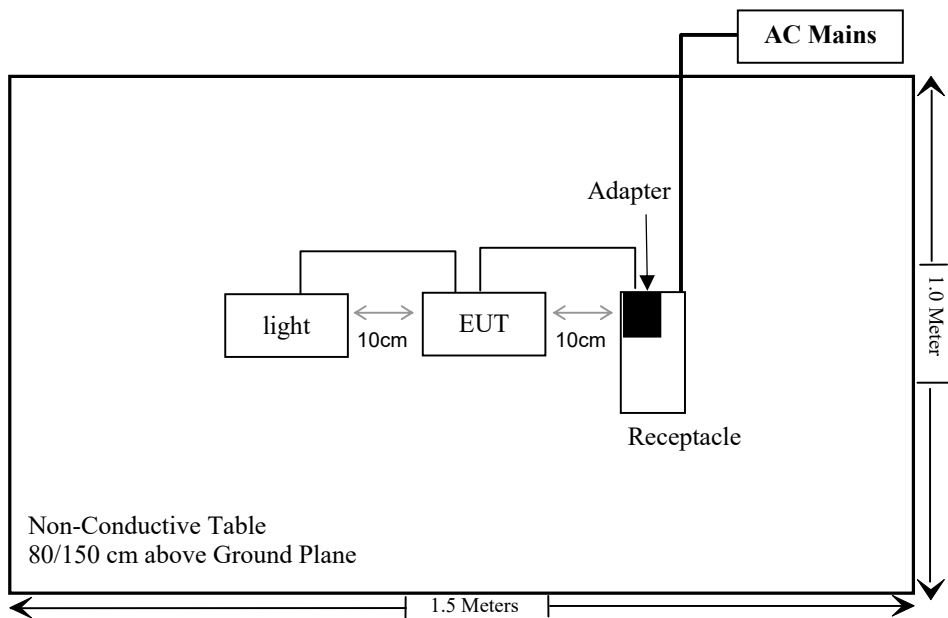
Cable Description	Length (m)	From Port	To
/	/	/	/

Block Diagram of Test Setup

For conducted emission:



For radiated emission:



SUMMARY OF TEST RESULTS

FCC Rules	ISED Rules	Description of Test	Result
§15.247 (i), §2.1091	RSS-102 § 2.5.2	Maximum Permissible Exposure (MPE)& RF Exposure	Compliant
§15.203	RSS-Gen §6.8	Antenna Requirement	Compliant
§15.207 (a)	RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
§15.205, §15.209, §15.247(d)	RSS-GEN § 8.10 & RSS-247 § 5.5	Spurious Emissions	Compliant
§15.247 (a)(2)	RSS- Gen§6.7 RSS-247 § 5.2 (a)	99% Occupied Bandwidth & 6 dB Emission Bandwidth	Compliant
§15.247(b)(3)	RSS-247 § 5.4(d)	Maximum Conducted Output Power	Compliant
§15.247(d)	RSS-247 § 5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
§15.247(e)	RSS-247 § 5.2 (b)	Power Spectral Density	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde& Schwarz	EMI Test Receiver	ESCI	100784	2022/11/25	2023/11/24
Rohde & Schwarz	L.I.S.N.	ENV216	101314	2022/11/25	2023/11/24
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2022/12/07	2023/12/06
Unknown	RF Coaxial Cable	No.17	N0350	2022/11/25	2023/11/24
Conducted Emission Test Software: e3 19821b (V9)					
Radiated Emissions Test					
Rohde& Schwarz	Test Receiver	ESR	102725	2022/11/25	2023/11/24
Rohde&Schwarz	Spectrum Analyzer	FSV40	101949	2022/11/25	2023/11/24
SONOMA INSTRUMENT	Amplifier	310 N	186131	2022/11/08	2023/11/07
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2022/11/08	2023/11/07
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2022/11/08	2023/11/07
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2022/11/30	2025/11/29
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2022/12/26	2025/12/25
Radiated Emission Test Software: e3 19821b (V9)					
Unknown	RF Coaxial Cable	No.10	N050	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.11	N1000	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.12	N040	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.13	N300	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.14	N800	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.15	N600	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.16	N650	2022/11/25	2023/11/24

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
Rohde&Schwarz	Spectrum Analyzer	FSV-40	101590	2022/11/25	2023/11/24
Tonscend	RF Control Unit	JS0806-2	19G8060182	2022/10/24	2023/10/23
Agilent	Power Sensor	U2021XA	MY5425003	2023/02/25	2024/02/24
WEINSCHEL	10dB Attenuator	5324	AU 3842	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.31	RF-01	Each time	

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

FCC §15.247 (i) & §1.1307 (b) (3) & §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.

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 (W)
		(dBm)	(dBi)	(dBd)	(dBm)	(W)		
BT	2402-2480	9.0	3.42	1.27	10.27	0.011	0.2	0.768
BLE	2402-2480	6.0	3.42	1.27	7.27	0.005	0.2	0.768
2.4G Wi-Fi	2412-2462	16.0	3.42	1.27	17.27	0.053	0.2	0.768

Note: 1. The tune up conducted power and antenna gain was declared by the applicant.
2. The BT cannot transmit at the same time with the Wi-Fi
3. 0dBd=2.15dBi

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

Result: Compliant.

RSS-102 § 2.5.2 –EXEMPTION LIMITS FOR ROUTINE EVALUATION-RF EXPOSURE EVALUATION

Applicable Standard

According to RSS-102 § (2.5.2):

2.5.2 Exemption Limits for Routine Evaluation — RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz⁶ and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $22.48/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

Calculated Data:

Mode	Frequency (MHz)	Maximum tune-up conducted power	Antenna Gain (dBi)	Maximum tune-up EIRP		Evaluation Distance (cm)	Limit (W)
		(dBm)		(dBm)	(W)		
BT	2402-2480	9.0	3.42	12.42	0.017	20	2.68
BLE	2402-2480	6.0	3.42	10.42	0.011	20	2.68
2.4G Wi-Fi	2412-2462	16.0	3.42	19.42	0.087	20	2.68

Note: 1. The tune up conducted power and antenna gain was declared by the applicant.
2. The BT cannot transmit at the same time with the Wi-Fi

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

Result: The RF Exposure evaluation can be exempted.

§ 15.203 & RSS-Gen §6.8 ANTENNA REQUIREMENT

Applicable Standard

According to § 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 user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

- a. Antenna must be permanently attached to the unit.
- b. Antenna must use a unique type of connector to attach to the EUT.
- c. Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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 and the maximum antenna gain is 3.42dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Antenna Type	Antenna Gain	Impedance	Frequency Range
PCB	3.42dBi	50 Ω	2.4~2.5GHz

Result: Compliance

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

Applicable Standard

FCC § 15.207 (a) & RSS-GEN §8.8

Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in table 4, as measured using a 50 μ H / 50 Ω line impedance stabilization network. This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.

For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in table 4 shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

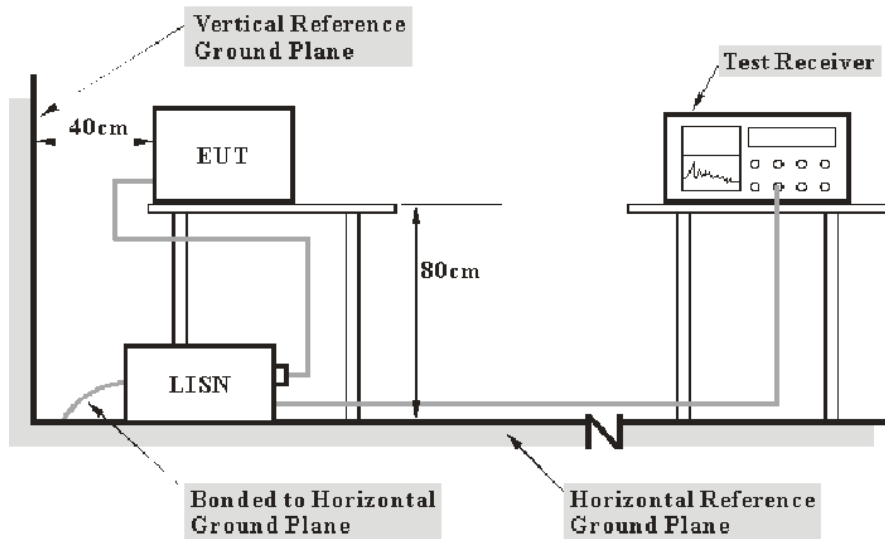
Table 4 - AC Power Lines Conducted Emission Limits		
Frequency range (MHz)	Conducted limit (dB μ V)	
	Quasi-Peak	Average
0.15 – 0.5	66 to 56 ¹	56 to 46 ¹
0.5 – 5	56	46
5 – 30	60	50

Note 1: The level decreases linearly with the logarithm of the frequency.

For an EUT with a permanent or detachable antenna operating between 150 kHz and 30 MHz, the AC power-line conducted emissions must be measured using the following configurations:

- Perform the AC power-line conducted emissions test with the antenna connected to determine compliance with the limits of table 4 outside the transmitter's fundamental emission band.
- Retest with a dummy load instead of the antenna to determine compliance with the limits of table 4 within the transmitter's fundamental emission band. For a detachable antenna, remove the antenna and connect a suitable dummy load to the antenna connector. For a permanent antenna, remove the antenna and terminate the RF output with a dummy load or network that simulates the antenna in the fundamental frequency band.

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 setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 & RSS-247/RSS-Gen limits.

The spacing between the peripherals was 10 cm.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

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.

Corrected Factor & Margin Calculation

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

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

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

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

Test Data

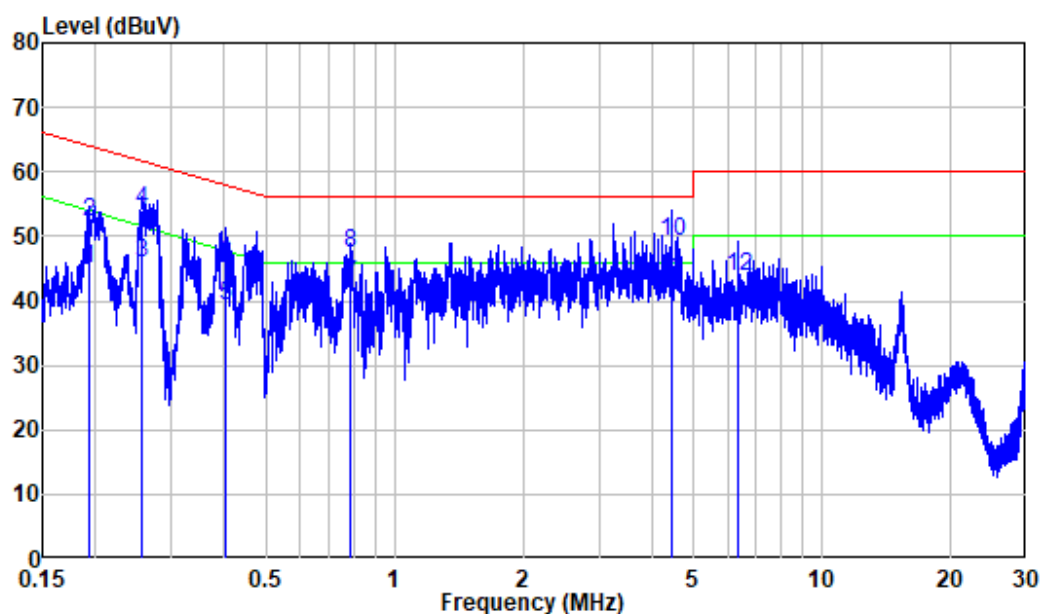
Environmental Conditions

Temperature:	23°C
Relative Humidity:	49%
ATM Pressure:	101.0 kPa

The testing was performed by Jerry on 2023-04-12.

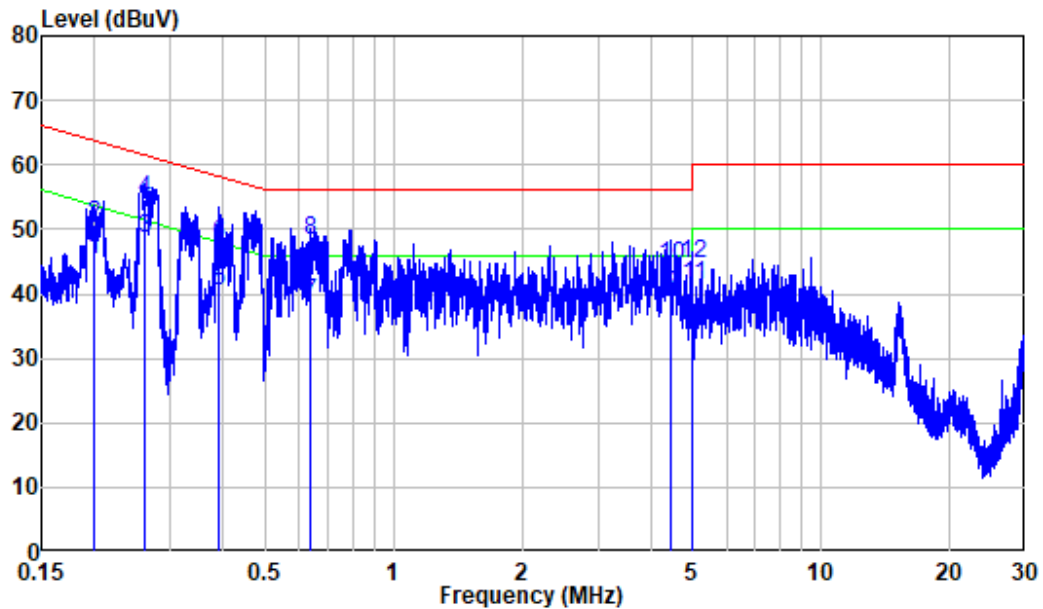
EUT operation mode: Transmitting(worst case is 802.11g, middle channel)

AC 120V/60 Hz, Line



Site : Shielding Room
 Condition: Line
 Job No. : RA230301-09499E-RF
 Mode : 2.4G WIFI Transmitting
 Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.192	10.29	34.84	45.13	53.94	-8.81	Average
2	0.192	10.29	41.90	52.19	63.94	-11.75	QP
3	0.257	10.30	35.51	45.81	51.53	-5.72	Average
4	0.257	10.30	43.62	53.92	61.53	-7.61	QP
5	0.404	10.30	28.95	39.25	47.77	-8.52	Average
6	0.404	10.30	35.29	45.59	57.77	-12.18	QP
7	0.787	10.41	32.16	42.57	46.00	-3.43	Average
8	0.787	10.41	36.88	47.29	56.00	-8.71	QP
9	4.442	10.42	32.59	43.01	46.00	-2.99	Average
10	4.442	10.42	38.80	49.22	56.00	-6.78	QP
11	6.352	10.38	27.95	38.33	50.00	-11.67	Average
12	6.352	10.38	33.47	43.85	60.00	-16.15	QP

AC 120V/60 Hz, Neutral

Site : Shielding Room
 Condition: Neutral
 Job No. : RA230301-09499E-RF
 Mode : 2.4G WIFI Transmitting
 Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.199	9.80	35.60	45.40	53.65	-8.25	Average
2	0.199	9.80	40.85	50.65	63.65	-13.00	QP
3	0.261	9.80	38.76	48.56	51.38	-2.82	Average
4	0.261	9.80	44.94	54.74	61.38	-6.64	QP
5	0.390	9.80	30.65	40.45	48.06	-7.61	Average
6	0.390	9.80	37.93	47.73	58.06	-10.33	QP
7	0.639	9.81	28.89	38.70	46.00	-7.30	Average
8	0.639	9.81	38.50	48.31	56.00	-7.69	QP
9	4.433	9.84	30.06	39.90	46.00	-6.10	Average
10	4.433	9.84	34.68	44.52	56.00	-11.48	QP
11	5.001	9.85	31.40	41.25	50.00	-8.75	Average
12	5.001	9.85	34.80	44.65	60.00	-15.35	QP

§15.205, §15.209, §15.247(d) & RSS-GEN § 8.10 & RSS-247 § 5.5 SPURIOUS EMISSIONS

Applicable Standard

FCC §15.247 (d); §15.209; §15.205;

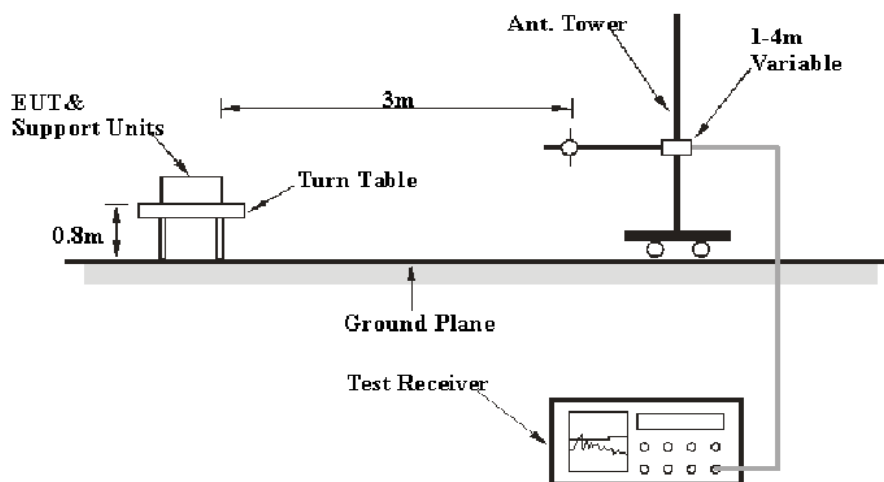
According to RSS-GEN § 8.10 & RSS-247 § 5.5

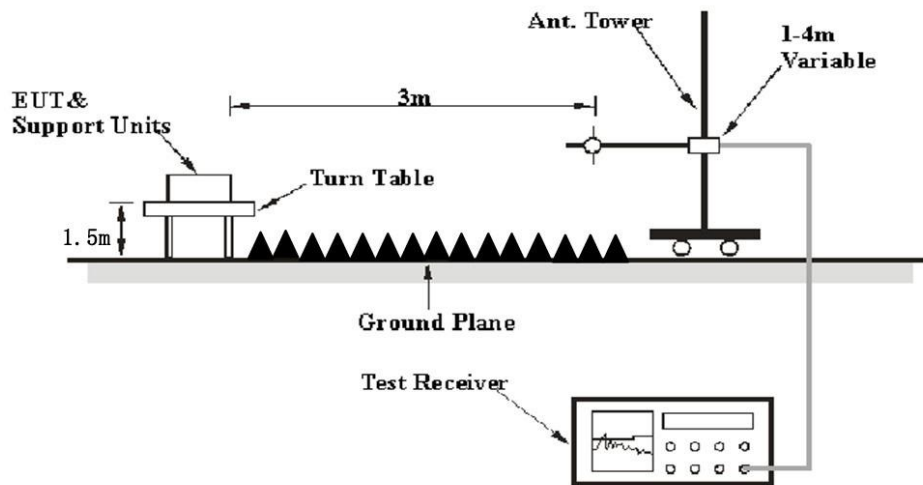
Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to the restricted frequency bands apply: (a) The transmit frequency, including fundamental components of modulation, of licence-exempt radio apparatus shall not fall within the restricted frequency bands listed in table 7 except for apparatus compliant with RSS-287, Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD). (b) Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6. (c) Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

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(d), 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.

EUT Setup

Below 1 GHz:



Above 1GHz:

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

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz ^{Note 1}	/	Average
	1MHz	> 1/T ^{Note 2}	/	Average

Note 1: when duty cycle is no less than 98%

Note 2: when duty cycle is less than 98%

Test Procedure

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

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

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

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.

Repeat above procedures until all measured frequencies were complete.

Corrected Amplitude & 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 or 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:

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

Test Data

Environmental Conditions

Temperature:	23.6~24℃
Relative Humidity:	50~56%
ATM Pressure:	101.0 kPa

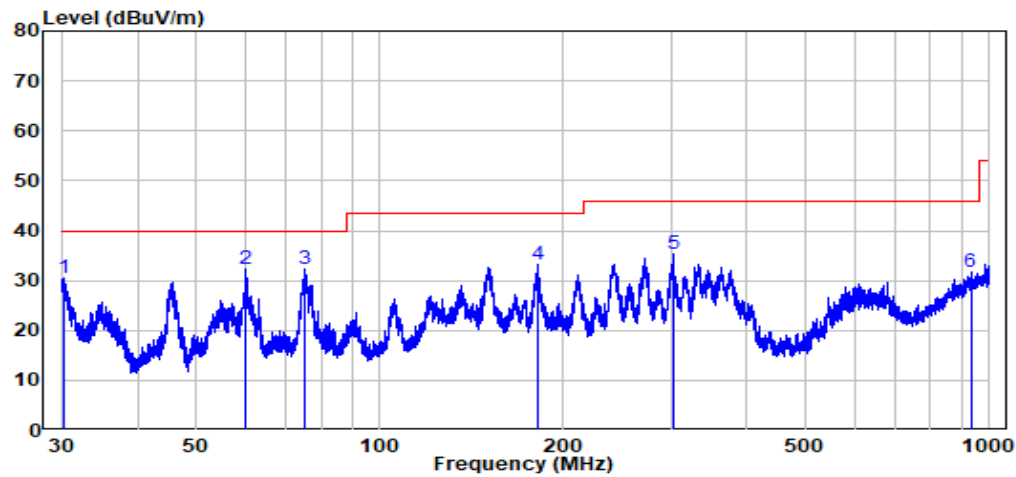
The testing was performed by Jason Liu on 2023-04-12 for below 1GHz, Jimi Zheng on 2023-04-11 and 2023-04-12 for above 1GHz.

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

30 MHz~1 GHz: (worst case is 802.11g mode, low channel)

Note: When the test result of Peak was less than the limit of QP more than 6dB, just the peak level was recorded

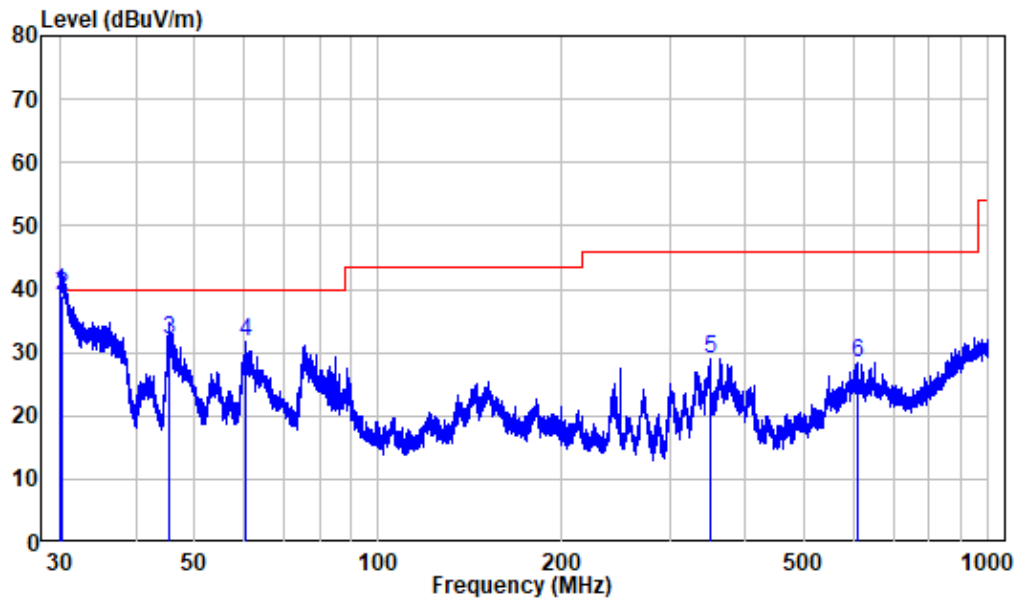
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : RA230301-09499E-RF
Test Mode: 2.4G WIFI Transmitting

	Freq Factor		Read Level	Level	Limit	Over	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	30.384	-14.33	44.79	30.46	40.00	-9.54	Peak
2	60.227	-13.82	46.05	32.23	40.00	-7.77	Peak
3	75.281	-13.43	45.65	32.22	40.00	-7.78	Peak
4	181.841	-10.34	43.62	33.28	43.50	-10.22	Peak
5	302.614	-15.49	50.75	35.26	46.00	-10.74	Peak
6	931.863	0.39	31.21	31.60	46.00	-14.40	Peak

Vertical



Site : chamber

Condition: 3m VERTICAL

Job No. : RA230301-09499E-RF

Test Mode: 2.4G WIFI Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	30.000	-14.30	53.70	39.40	40.00	-0.60	QP
2	30.370	-14.33	53.40	39.07	40.00	-0.93	QP
3	45.475	-14.29	46.20	31.91	40.00	-8.09	QP
4	60.625	-13.83	45.45	31.62	40.00	-8.38	Peak
5	349.097	-12.15	41.25	29.10	46.00	-16.90	Peak
6	610.992	-9.60	38.07	28.47	46.00	-17.53	Peak

For Wi-Fi

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
802.11b									
Low Channel 2412MHz									
2328.96	66.15	PK	338	1.9	H	-10.57	55.58	74	-18.42
2328.96	52.10	AV	338	1.9	H	-10.57	41.53	54	-12.47
2313.96	66.32	PK	216	1.6	V	-10.41	55.91	74	-18.09
2313.96	52.01	AV	216	1.6	V	-10.41	41.60	54	-12.40
2390	65.91	PK	138	2.3	H	-10.70	55.21	74	-18.79
2390	53.06	AV	138	2.3	H	-10.70	42.36	54	-11.64
2390	65.34	PK	255	2.2	V	-10.70	54.64	74	-19.36
2390	53.03	AV	255	2.2	V	-10.70	42.33	54	-11.67
4824	64.19	PK	200	1.8	H	-6.10	58.09	74	-15.91
4824	55.32	AV	200	1.8	H	-6.10	49.22	54	-4.78
4824	65.61	PK	359	1.2	V	-6.10	59.51	74	-14.49
4824	56.80	AV	359	1.2	V	-6.10	50.70	54	-3.30
Middle Channel 2437MHz									
4874	63.84	PK	187	1.4	H	-5.95	57.89	74	-16.11
4874	54.16	AV	187	1.4	H	-5.95	48.21	54	-5.79
4874	64.60	PK	259	1.6	V	-5.95	58.65	74	-15.35
4874	55.03	AV	259	1.6	V	-5.95	49.08	54	-4.92
High Channel 2462MHz									
2483.5	65.36	PK	272	1.9	H	-10.55	54.81	74	-19.19
2483.5	53.48	AV	272	1.9	H	-10.55	42.93	54	-11.07
2483.5	65.71	PK	331	1.7	V	-10.55	55.16	74	-18.84
2483.5	53.47	AV	331	1.7	V	-10.55	42.92	54	-11.08
2488.25	68.48	PK	344	2.4	H	-10.51	57.97	74	-16.03
2488.25	53.57	AV	344	2.4	H	-10.51	43.06	54	-10.94
2489.4	67.55	PK	11	2.2	V	-10.50	57.05	74	-16.95
2489.4	53.59	AV	11	2.2	V	-10.50	43.09	54	-10.91
4924	64.62	PK	315	1.9	H	-5.67	58.95	74	-15.05
4924	55.27	AV	315	1.9	H	-5.67	49.60	54	-4.40
4924	65.07	PK	223	2.3	V	-5.67	59.40	74	-14.60
4924	56.46	AV	223	2.3	V	-5.67	50.79	54	-3.21

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
802.11g									
Low Channel 2412MHz									
2333.88	66.45	PK	182	2.2	H	-10.62	55.83	74	-18.17
2333.88	52.35	AV	182	2.2	H	-10.62	41.73	54	-12.27
2332.44	66.64	PK	334	1.9	V	-10.60	56.04	74	-17.96
2332.44	52.39	AV	334	1.9	V	-10.60	41.79	54	-12.21
2390	65.23	PK	129	2	H	-10.70	54.53	74	-19.47
2390	53.21	AV	129	2	H	-10.70	42.51	54	-11.49
2390	65.14	PK	284	2.2	V	-10.70	54.44	74	-19.56
2390	53.23	AV	284	2.2	V	-10.70	42.53	54	-11.47
4824	61.58	PK	162	1.2	H	-6.10	55.48	74	-18.52
4824	46.90	AV	162	1.2	H	-6.10	40.80	54	-13.20
4824	62.45	PK	146	2	V	-6.10	56.35	74	-17.65
4824	48.36	AV	146	2	V	-6.10	42.26	54	-11.74
Middle Channel 2437MHz									
4874	62.63	PK	115	1.1	H	-5.95	56.68	74	-17.32
4874	48.39	AV	115	1.1	H	-5.95	42.44	54	-11.56
4874	63.50	PK	106	1.1	V	-5.95	57.55	74	-16.45
4874	49.84	AV	106	1.1	V	-5.95	43.89	54	-10.11
High Channel 2462MHz									
2483.5	66.66	PK	249	1.4	H	-10.55	56.11	74	-17.89
2483.5	53.55	AV	249	1.4	H	-10.55	43	54	-11.00
2483.5	66.44	PK	235	1.1	V	-10.55	55.89	74	-18.11
2483.5	53.54	AV	235	1.1	V	-10.55	42.99	54	-11.01
2485.45	67.67	PK	221	1.4	H	-10.53	57.14	74	-16.86
2485.45	53.70	AV	221	1.4	H	-10.53	43.17	54	-10.83
2488.4	67.71	PK	126	1.1	V	-10.51	57.2	74	-16.80
2488.4	53.67	AV	126	1.1	V	-10.51	43.16	54	-10.84
4924	63.10	PK	31	2.2	H	-5.67	57.43	74	-16.57
4924	49.76	AV	31	2.2	H	-5.67	44.09	54	-9.91
4924	64.90	PK	195	1.9	V	-5.67	59.23	74	-14.77
4924	50.75	AV	195	1.9	V	-5.67	45.08	54	-8.92

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
802.11n20									
Low Channel 2412MHz									
2357.4	68.69	PK	155	2	H	-10.77	57.92	74	-16.08
2357.4	53.22	AV	155	2	H	-10.77	42.45	54	-11.55
2359.68	67.71	PK	346	1.8	V	-10.77	56.94	74	-17.06
2359.68	53.24	AV	346	1.8	V	-10.77	42.47	54	-11.53
2390	65.67	PK	117	2	H	-10.70	54.97	74	-19.03
2390	53.23	AV	117	2	H	-10.70	42.53	54	-11.47
2390	65.86	PK	341	1.7	V	-10.70	55.16	74	-18.84
2390	53.25	AV	341	1.7	V	-10.70	42.55	54	-11.45
4824	62.90	PK	291	1.5	H	-6.10	56.80	74	-17.20
4824	47.83	AV	291	1.5	H	-6.10	41.73	54	-12.27
4824	63.88	PK	359	1.4	V	-6.10	57.78	74	-16.22
4824	48.71	AV	359	1.4	V	-6.10	42.61	54	-11.39
Middle Channel 2437MHz									
4874	64.18	PK	324	2.1	H	-5.95	58.23	74	-15.77
4874	48.65	AV	324	2.1	H	-5.95	42.7	54	-11.30
4874	64.76	PK	13	1.4	V	-5.95	58.81	74	-15.19
4874	49.39	AV	13	1.4	V	-5.95	43.44	54	-10.56
High Channel 2462MHz									
2483.5	66.34	PK	140	2	H	-10.55	55.79	74	-18.21
2483.5	53.55	AV	140	2	H	-10.55	43	54	-11.00
2483.5	65.45	PK	134	2	V	-10.55	54.9	74	-19.10
2483.5	53.58	AV	134	2	V	-10.55	43.03	54	-10.97
2495.1	67.67	PK	10	1.2	H	-10.46	57.21	74	-16.79
2495.1	53.65	AV	10	1.2	H	-10.46	43.19	54	-10.81
2485.85	67.70	PK	68	1.6	V	-10.53	57.17	74	-16.83
2485.85	53.72	AV	68	1.6	V	-10.53	43.19	54	-10.81
4924	64.82	PK	178	2.2	H	-5.67	59.15	74	-14.85
4924	49.39	AV	178	2.2	H	-5.67	43.72	54	-10.28
4924	64.97	PK	29	1.3	V	-5.67	59.30	74	-14.70
4924	50.45	AV	29	1.3	V	-5.67	44.78	54	-9.22

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
802.11n40									
Low Channel 2422MHz									
2310.39	66.61	PK	96	1.1	H	-10.37	56.24	74	-17.76
2310.39	52.15	AV	96	1.1	H	-10.37	41.78	54	-12.22
2364.08	68.03	PK	88	1.4	V	-10.76	57.27	74	-16.73
2364.08	53.22	AV	88	1.4	V	-10.76	42.46	54	-11.54
2390	65.36	PK	274	1.6	H	-10.70	54.66	74	-19.34
2390	53.24	AV	274	1.6	H	-10.70	42.54	54	-11.46
2390	66.14	PK	154	1.7	V	-10.70	55.44	74	-18.56
2390	53.25	AV	154	1.7	V	-10.70	42.55	54	-11.45
4844	60.27	PK	217	1.8	H	-6.09	54.18	74	-19.82
4844	46.55	AV	217	1.8	H	-6.09	40.46	54	-13.54
4844	61.04	PK	345	2.1	V	-6.09	54.95	74	-19.05
4844	47.68	AV	345	2.1	V	-6.09	41.59	54	-12.41
Middle Channel 2437MHz									
4874	60.94	PK	312	1.3	H	-5.95	54.99	74	-19.01
4874	47.16	AV	312	1.3	H	-5.95	41.21	54	-12.79
4874	61.83	PK	195	1.5	V	-5.95	55.88	74	-18.12
4874	48.15	AV	195	1.5	V	-5.95	42.2	54	-11.80
High Channel 2452MHz									
2483.5	65.97	PK	241	1	H	-10.55	55.42	74	-18.58
2483.5	53.55	AV	241	1	H	-10.55	43	54	-11.00
2483.5	66.92	PK	143	1.4	V	-10.55	56.37	74	-17.63
2483.5	53.60	AV	143	1.4	V	-10.55	43.05	54	-10.95
2492.79	68.33	PK	265	1.2	H	-10.48	57.85	74	-16.15
2492.79	53.66	AV	265	1.2	H	-10.48	43.18	54	-10.82
2494.47	67.84	PK	329	2.4	V	-10.46	57.38	74	-16.62
2494.47	53.65	AV	329	2.4	V	-10.46	43.19	54	-10.81
4904	61.19	PK	168	1	H	-5.77	55.42	74	-18.58
4904	47.52	AV	168	1	H	-5.77	41.75	54	-12.25
4904	62.16	PK	166	1.2	V	-5.77	56.39	74	-17.61
4904	48.56	AV	166	1.2	V	-5.77	42.79	54	-11.21

BLE 1M:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
BLE1M									
Low Channel 2402MHz									
2351.1	68.21	PK	296	2.1	H	-10.79	57.42	74	-16.58
2351.1	53.58	AV	296	2.1	H	-10.79	42.79	54	-11.21
2338.7	66.66	PK	351	1.1	V	-10.67	55.99	74	-18.01
2338.7	52.70	AV	351	1.1	V	-10.67	42.03	54	-11.97
2390	65.97	PK	290	2.2	H	-10.70	55.27	74	-18.73
2390	53.21	AV	290	2.2	H	-10.70	42.51	54	-11.49
2390	65.43	PK	75	1.2	V	-10.70	54.73	74	-19.27
2390	53.26	AV	75	1.2	V	-10.70	42.56	54	-11.44
4804	61.16	PK	170	1.5	H	-6.11	55.05	74	-18.95
4804	48.80	AV	170	1.5	H	-6.11	42.69	54	-11.31
4804	61.40	PK	23	1.6	V	-6.11	55.29	74	-18.71
4804	49.06	AV	23	1.6	V	-6.11	42.95	54	-11.05
Middle Channel 2440MHz									
4880	61.80	PK	178	1.5	H	-5.91	55.89	74	-18.11
4880	49.11	AV	178	1.5	H	-5.91	43.2	54	-10.80
4880	61.55	PK	214	2.3	V	-5.91	55.64	74	-18.36
4880	49.59	AV	214	2.3	V	-5.91	43.68	54	-10.32
High Channel 2480MHz									
2483.5	65.57	PK	9	1	H	-10.55	55.02	74	-18.98
2483.5	53.54	AV	9	1	H	-10.55	42.99	54	-11.01
2483.5	66.31	PK	42	1.7	V	-10.55	55.76	74	-18.24
2483.5	53.78	AV	42	1.7	V	-10.55	43.23	54	-10.77
2496.7	67.73	PK	65	2.3	H	-10.45	57.28	74	-16.72
2496.7	54.03	AV	65	2.3	H	-10.45	43.58	54	-10.42
2499.76	67.86	PK	45	2.4	V	-10.42	57.44	74	-16.56
2499.76	54.10	AV	45	2.4	V	-10.42	43.68	54	-10.32
4960	61.82	PK	286	1.4	H	-5.47	56.35	74	-17.65
4960	49.53	AV	286	1.4	H	-5.47	44.06	54	-9.94
4960	61.25	PK	48	1.6	V	-5.47	55.78	74	-18.22
4960	49.70	AV	48	1.6	V	-5.47	44.23	54	-9.77

Note:

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

Absolute Level (Corrected Amplitude) = Factor + Reading

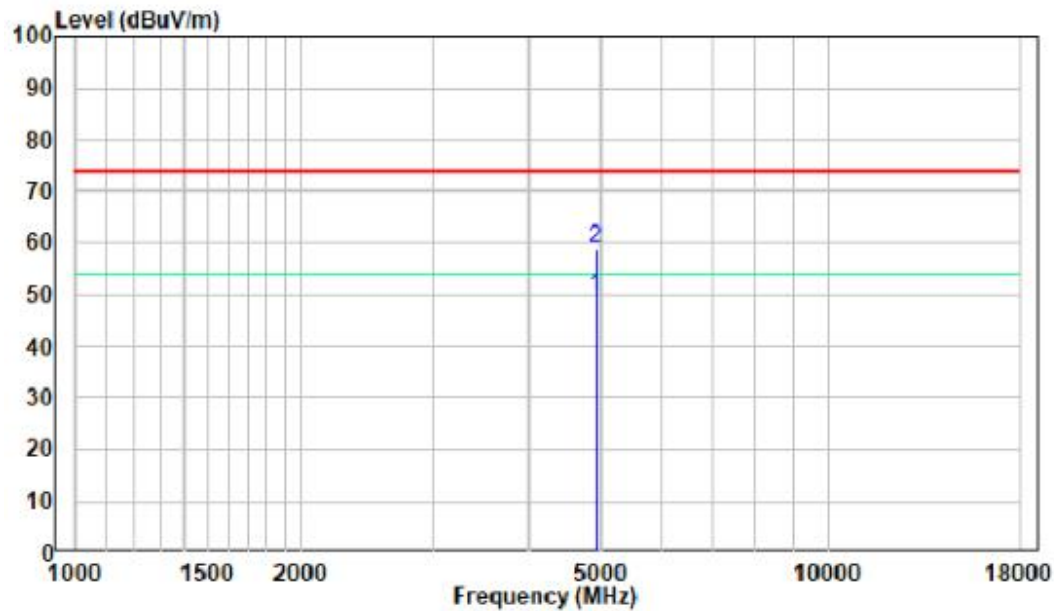
Margin = Absolute Level (Corrected Amplitude) – Limit

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

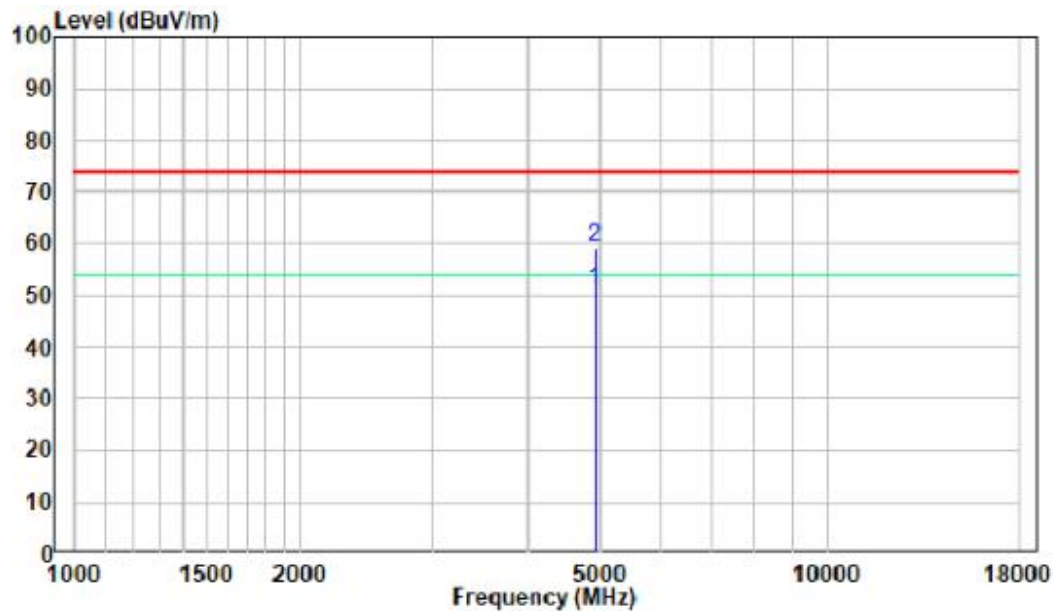
The test result of peak was less than the limit of average, so just peak value were recorded.

1 GHz - 18 GHz: (Pre-Scan plots)
2.4G WIFI 802.11b, High channel

Horizontal



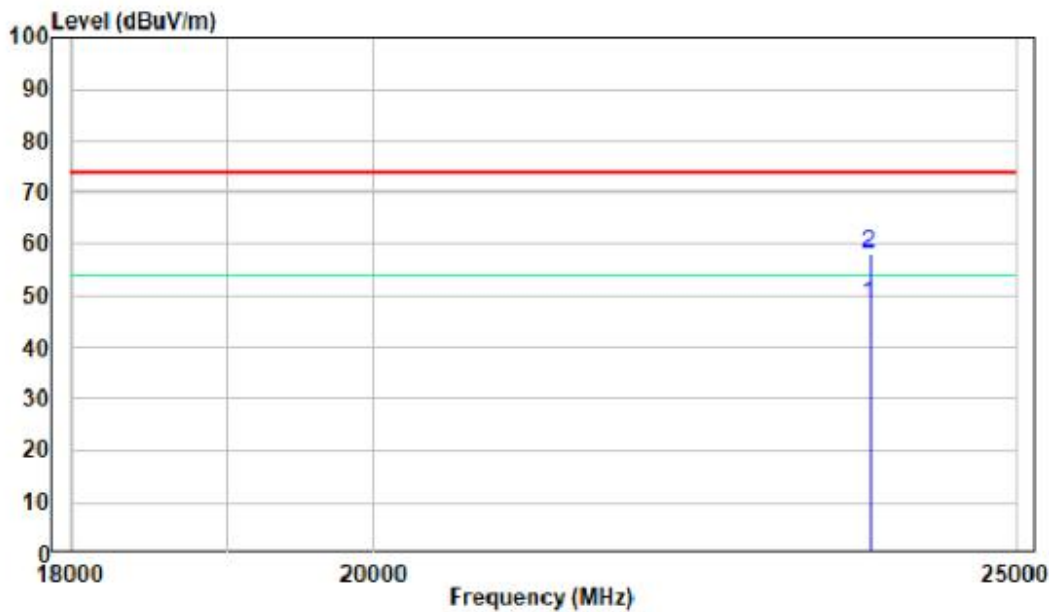
Vertical



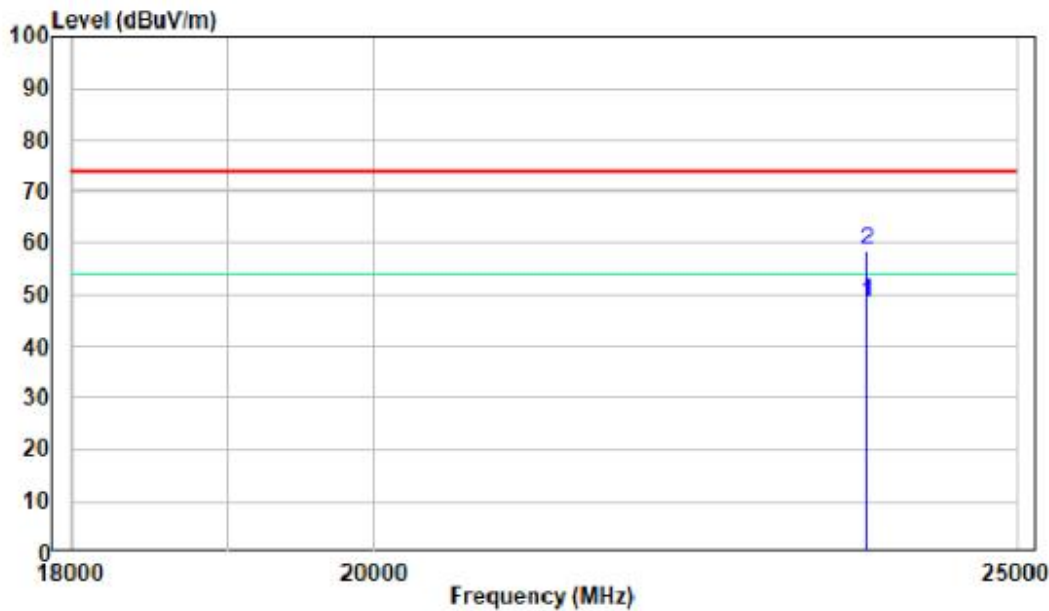
18-25GHz: (Pre-Scan plots)

2.4G WIFI 802.11b, High channel

Horizontal



Vertical



§15.247 (a)(2) & RSS-Gen§6.7 RSS-247 § 5.2 (a) 99% OCCUPIED BANDWIDTH & 6 dB EMISSION BANDWIDTH

Applicable Standard

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

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 “6 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 6 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 11.8.1 & Clause 6.9.3

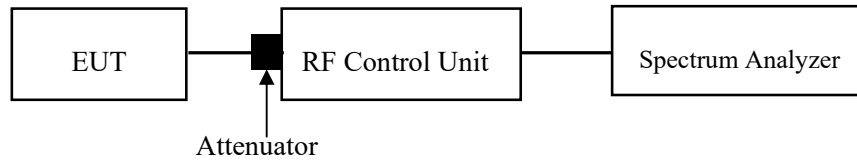
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

The following conditions shall be observed for measuring the occupied bandwidth and 6 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 / 6 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 / 6 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:	26~27℃
Relative Humidity:	52~56%
ATM Pressure:	101.0 kPa

The testing was performed by Nick Fang on 2023-04-13 and 2023-04-18.

EUT operation mode: Transmitting

Test Result Compliant. Please refer to the Appendix BLE & Appendix Wi-Fi.

§15.247(b)(3) & RSS-247 § 5.4(d) MAXIMUM CONDUCTED OUTPUT POWER

Applicable Standard

According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

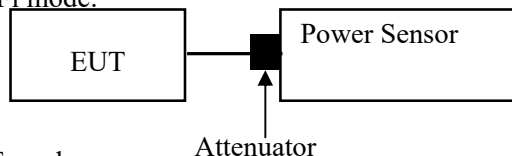
As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

Test Procedure

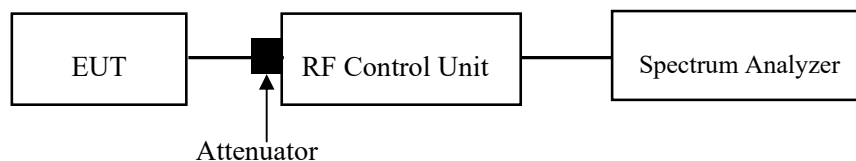
Test Method: ANSI C63.10-2013 Clause 11.9.1.1 for BLE & Clause 11.9.2.3 for Wi-Fi

1. Place the EUT on a bench and set it 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.

For Wi-Fi mode:



For BLE mode:



Test Data**Environmental Conditions**

Temperature:	26~27°C
Relative Humidity:	52~56%
ATM Pressure:	101.0 kPa

The testing was performed by Nick Fang on 2023-04-13 and 2023-04-18.

EUT operation mode: Transmitting

Test Result Compliant. Please refer to the Appendix BLE & Appendix Wi-Fi.

§ 15.247(d) & RSS-247 § 5.5 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

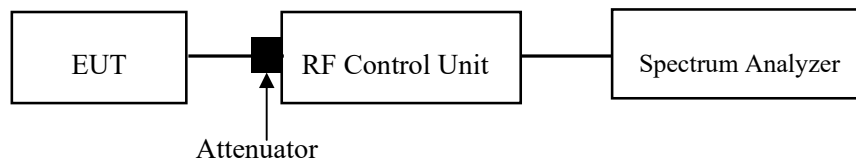
Applicable Standard

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 11.11

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 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:	26~27°C
Relative Humidity:	52~56%
ATM Pressure:	101.0 kPa

The testing was performed by Nick Fang on 2023-04-13 and 2023-04-18.

EUT operation mode: Transmitting

Test Result Compliant. Please refer to the Appendix BLE & Appendix Wi-Fi.

§15.247(e) & RSS-247 § 5.2 (b) POWER SPECTRAL DENSITY

Applicable Standard

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

Test Procedure

Test Method: ANSI C63.10-2013 Clause 11.10.2

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW to: $3\text{kHz} \leq \text{RBW} \leq 100\text{ kHz}$.
3. Set the VBW $\geq 3 \times \text{RBW}$.
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

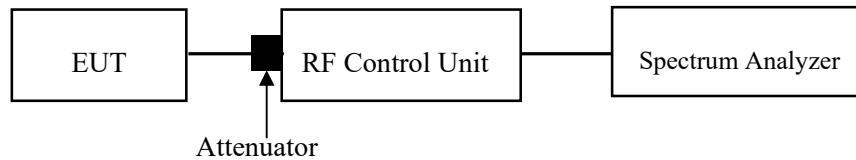
Test Method: ANSI C63.10-2013 Clause 11.10.3 & 11.10.5

Use this procedure when the maximum average conducted output power in the fundamental emission is used to demonstrate compliance.

1. Measure the duty cycle (D) of the transmitter output signal as described in ANSI C63.10-2013 11.6.
2. Set the RBW to: $3\text{kHz} \leq \text{RBW} \leq 100\text{ kHz}$.
3. Set the VBW $\geq 3 \times \text{RBW}$.
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = Power Averaging (rms).
6. Ensure that the number of measurement points in the sweep $\geq [2 \times \text{span} / \text{RBW}]$.
7. Sweep time = auto couple.
8. Trace mode = trace averaging (rms) mode over a minimum of 100 traces.
9. Allow trace to fully stabilize.
10. Use the peak marker function to determine the maximum amplitude level.
11. When the EUT cannot be configured to transmit continuously (i.e., $D < 98\%$), when sweep triggering/signal gating cannot be used to measure only when the EUT is transmitting at its maximum power control level, and when the transmission duty cycle is constant (i.e., duty cycle variations are

less than $\pm 2\%$), add $[10 \log (1 / D)]$, where D is the duty cycle measured in step 1), to the measured PSD to compute the average PSD during the actual transmission time.

12. When the EUT transmits continuously (or with a $D \geq 98\%$), step 11 is not required.
13. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



Test Data

Environmental Conditions

Temperature:	26~27°C
Relative Humidity:	52~56%
ATM Pressure:	101.0 kPa

The testing was performed by Nick Fang on 2023-04-13 and 2023-04-18.

EUT operation mode: Transmitting

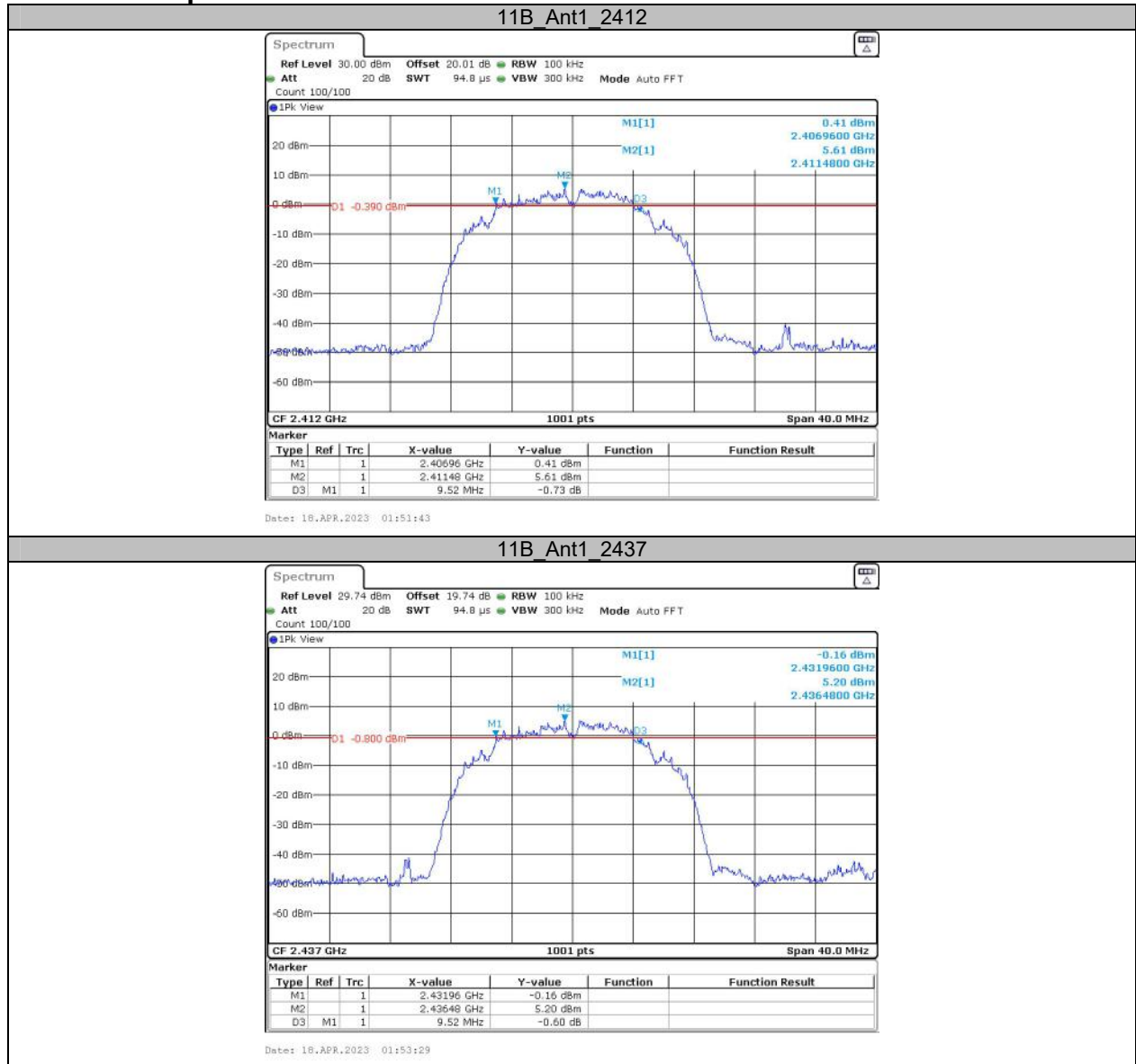
Test Result: Compliant. Please refer to the Appendix Wi-Fi and Appendix BLE.

APPENDIX Wi-Fi

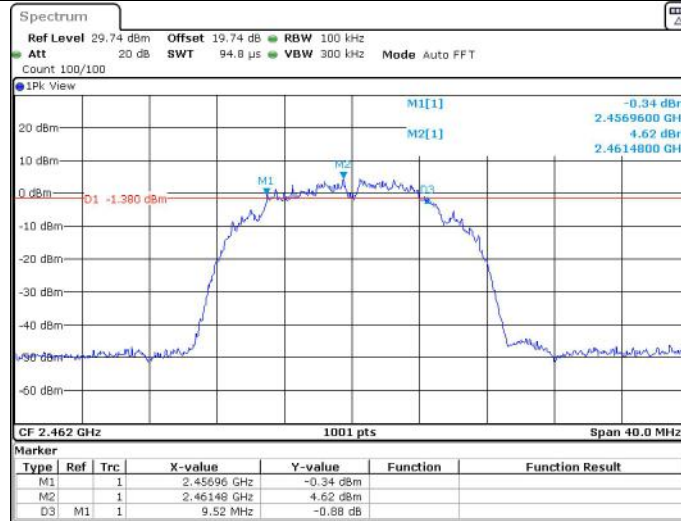
Appendix A: DTS Bandwidth Test Result

Test Mode	Antenna	Frequency[MHz]	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	9.52	2406.96	2416.48	0.5	PASS
		2437	9.52	2431.96	2441.48	0.5	PASS
		2462	9.52	2456.96	2466.48	0.5	PASS
11G	Ant1	2412	16.32	2403.80	2420.12	0.5	PASS
		2437	16.32	2428.80	2445.12	0.5	PASS
		2462	16.36	2453.80	2470.16	0.5	PASS
11N20SISO	Ant1	2412	16.80	2403.56	2420.36	0.5	PASS
		2437	16.80	2428.56	2445.36	0.5	PASS
		2462	16.84	2453.56	2470.40	0.5	PASS
11N40SISO	Ant1	2422	31.92	2406.08	2438.00	0.5	PASS
		2437	31.84	2421.08	2452.92	0.5	PASS
		2452	31.92	2436.08	2468.00	0.5	PASS

Test Graphs

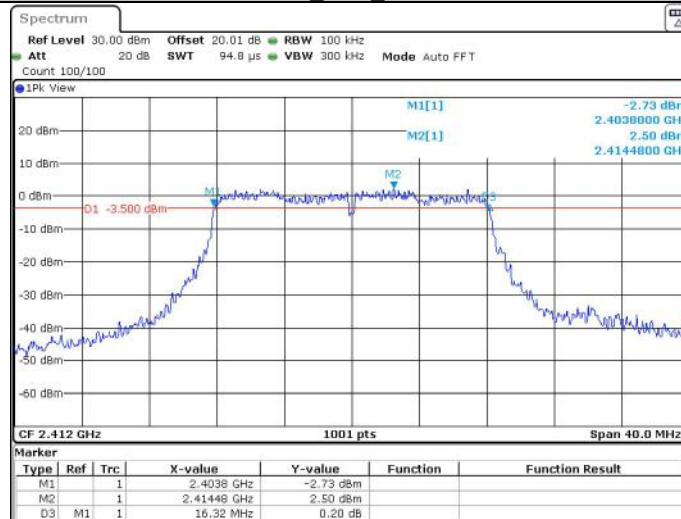


11B_Ant1_2462



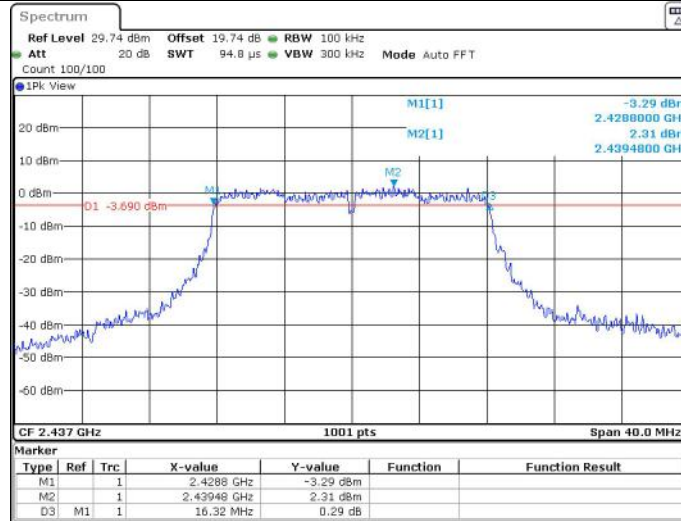
Date: 18.APR.2023 01:54:51

11G_Ant1_2412



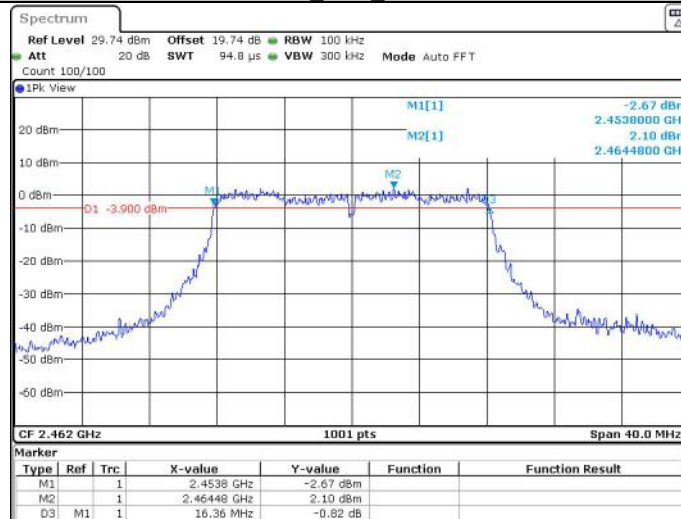
Date: 13.APR.2023 03:15:56

11G_Ant1_2437

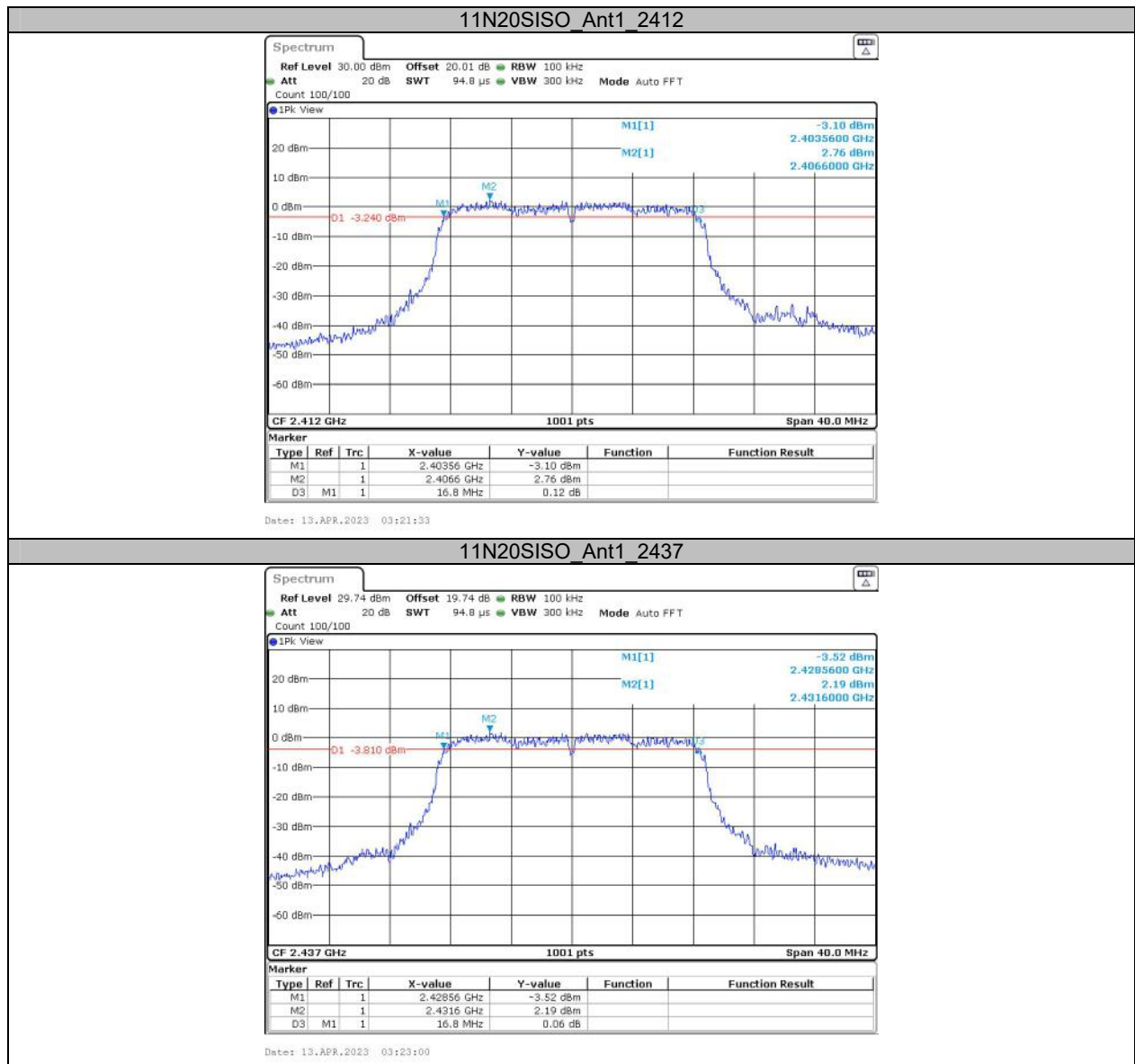


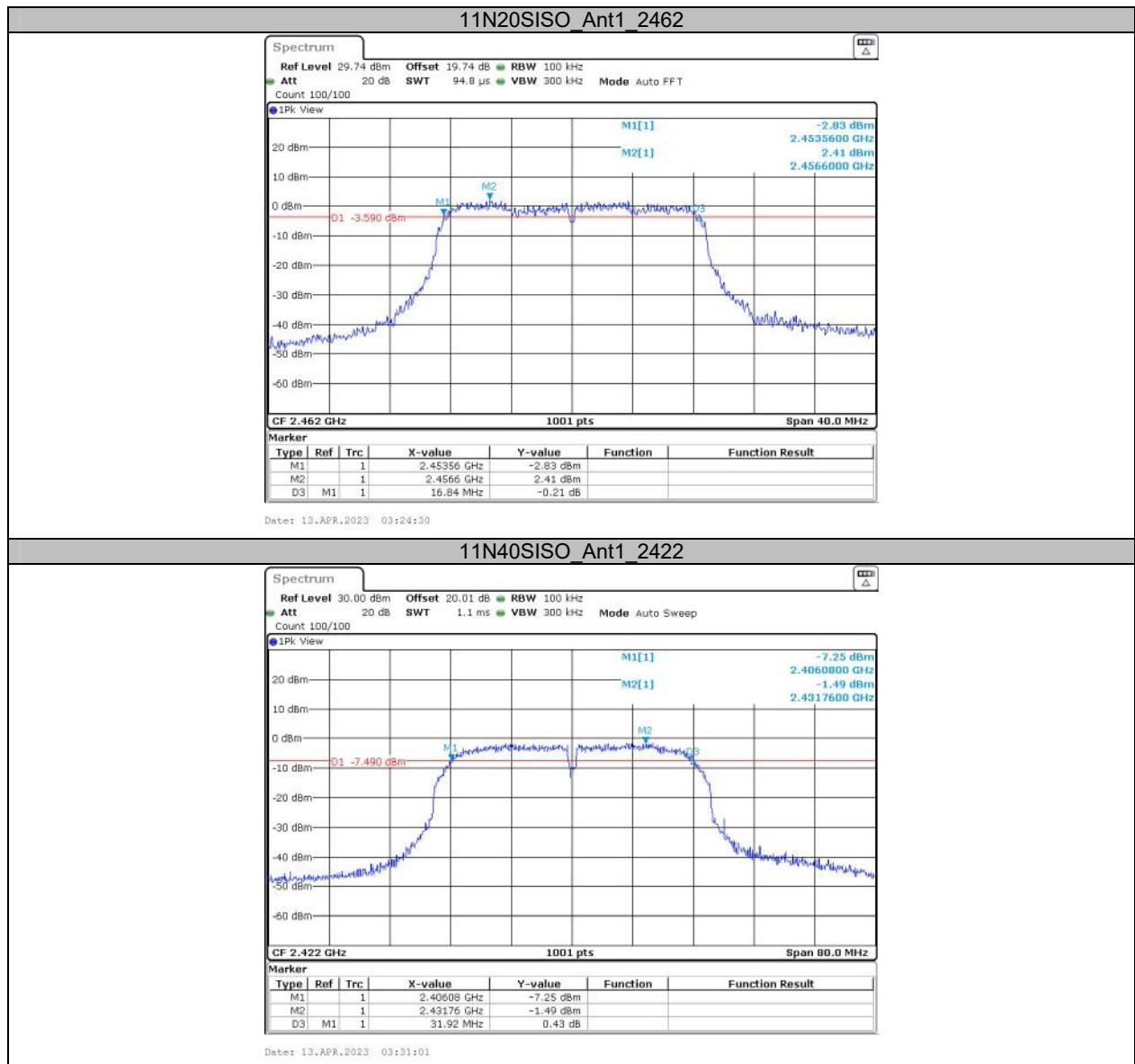
Date: 13.APR.2023 03:18:05

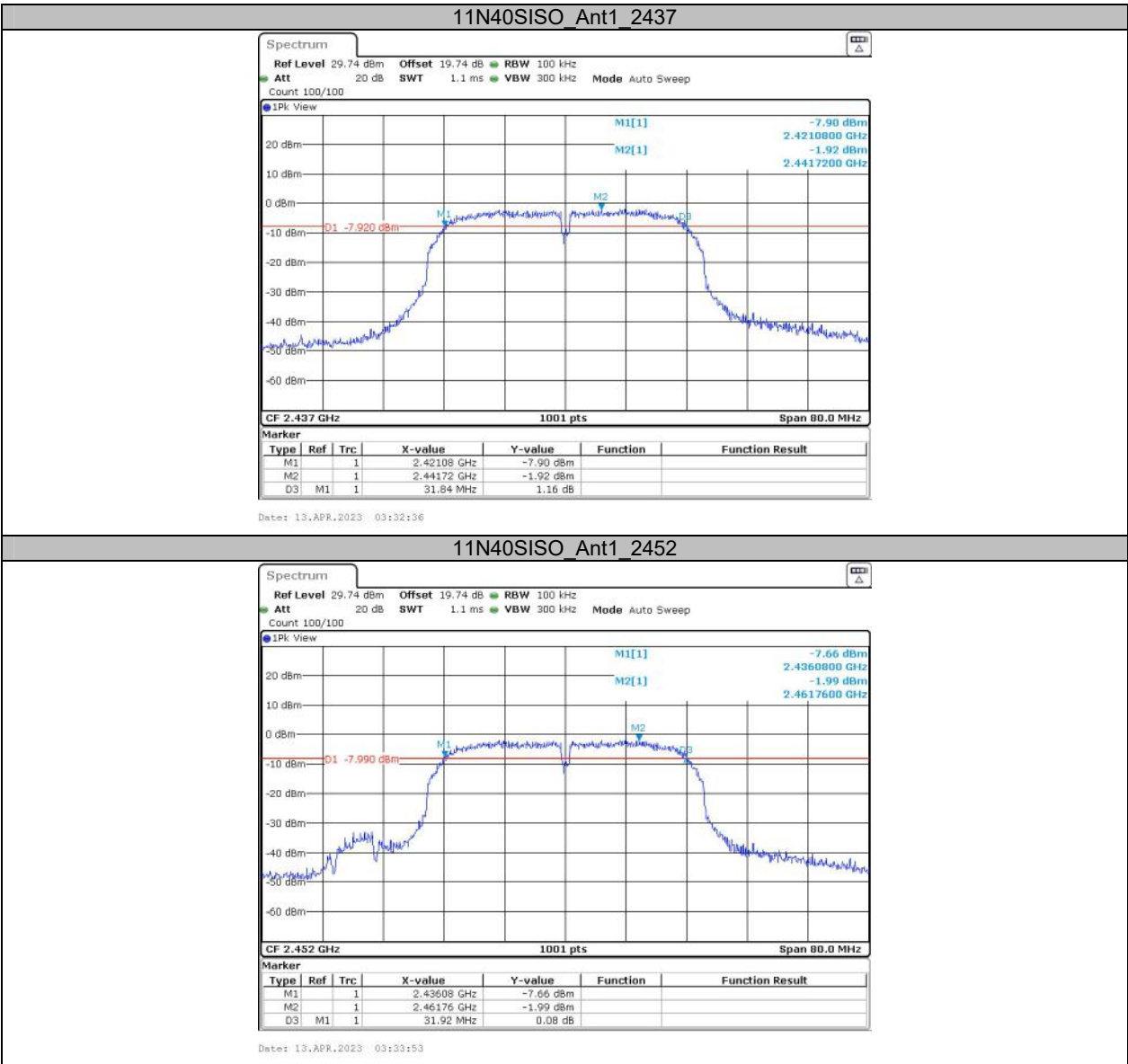
11G_Ant1_2462



Date: 13.APR.2023 03:19:52



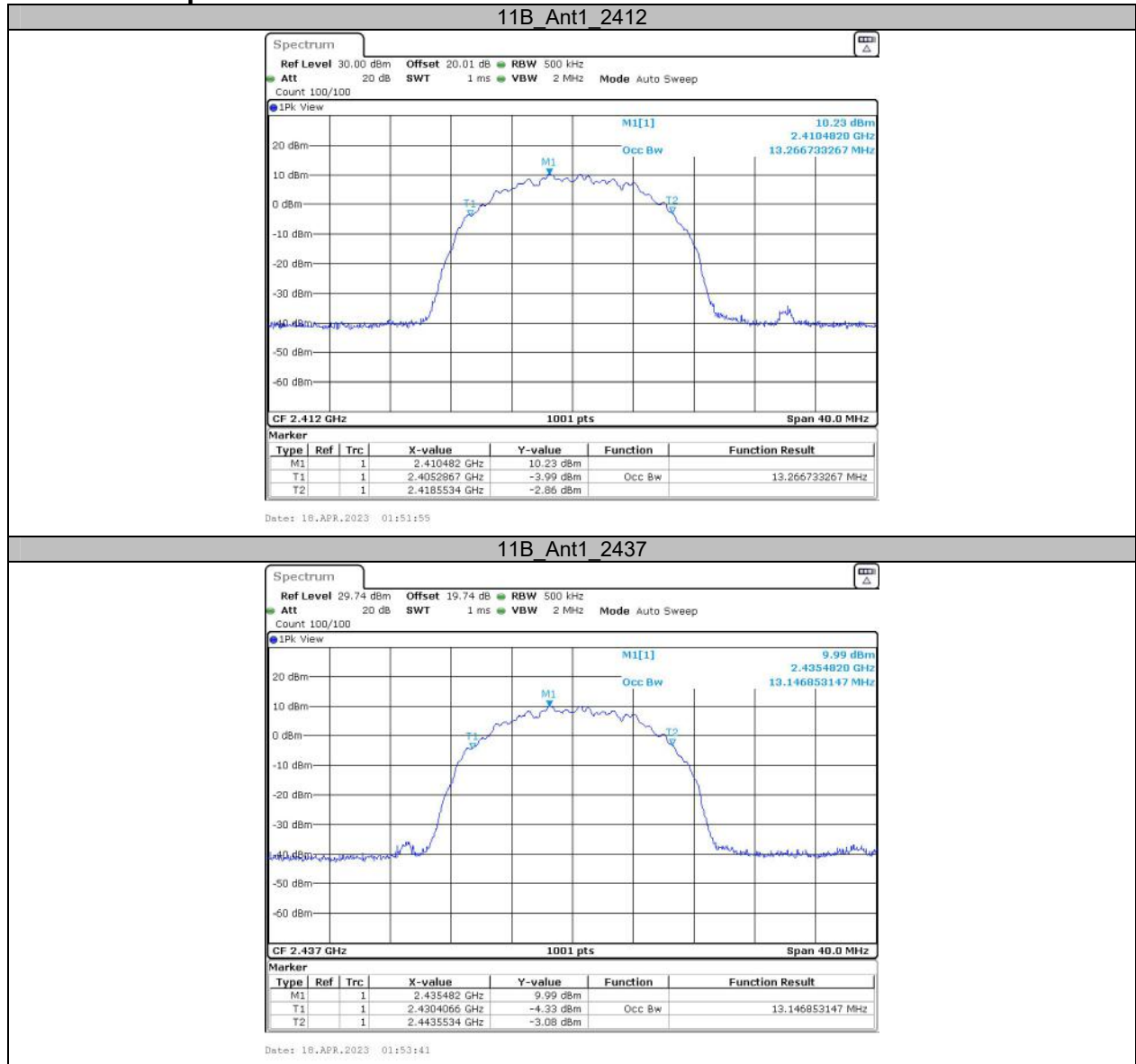




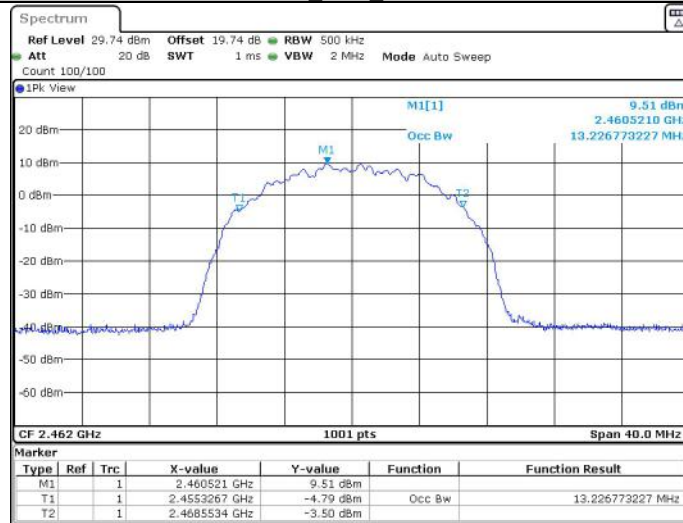
**Appendix B: Occupied Channel Bandwidth
Test Result**

Test Mode	Antenna	ChannelFrequency[MHz]	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MH z]	Verdict
11B	Ant1	2412	13.267	2405.287	2418.553	---	---
		2437	13.147	2430.407	2443.553	---	---
		2462	13.227	2455.327	2468.553	---	---
11G	Ant1	2412	16.503	2403.808	2420.312	---	---
		2437	16.503	2428.808	2445.312	---	---
		2462	16.503	2453.808	2470.312	---	---
11N20SISO	Ant1	2412	17.143	2403.449	2420.591	---	---
		2437	17.143	2428.449	2445.591	---	---
		2462	17.143	2453.449	2470.591	---	---
11N40SISO	Ant1	2422	34.046	2405.057	2439.103	---	---
		2437	33.966	2420.137	2454.103	---	---
		2452	34.046	2435.057	2469.103	---	---

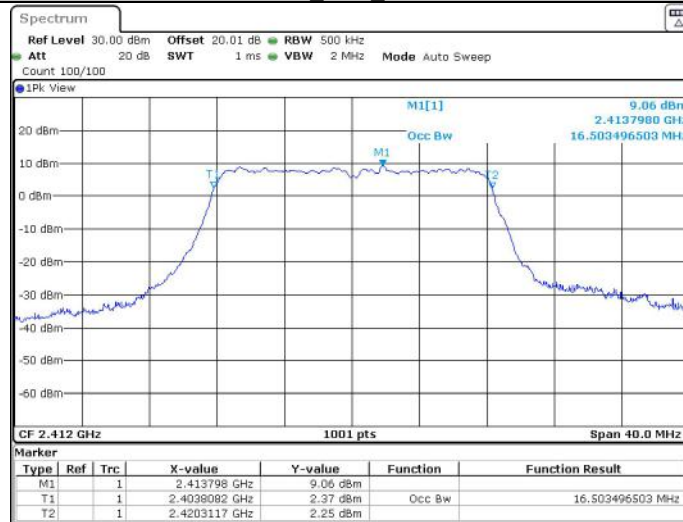
Test Graphs



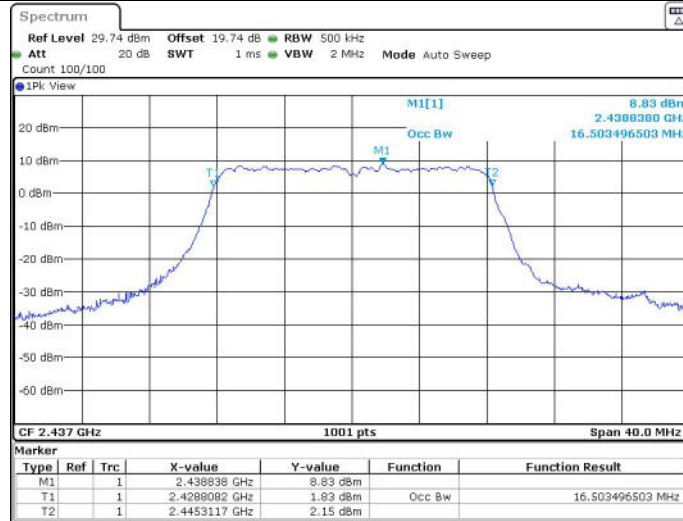
11B_Ant1_2462



11G_Ant1_2412



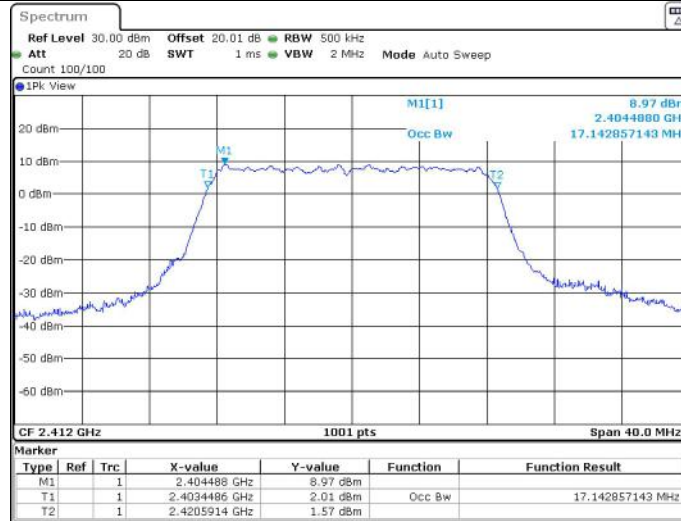
11G_Ant1_2437



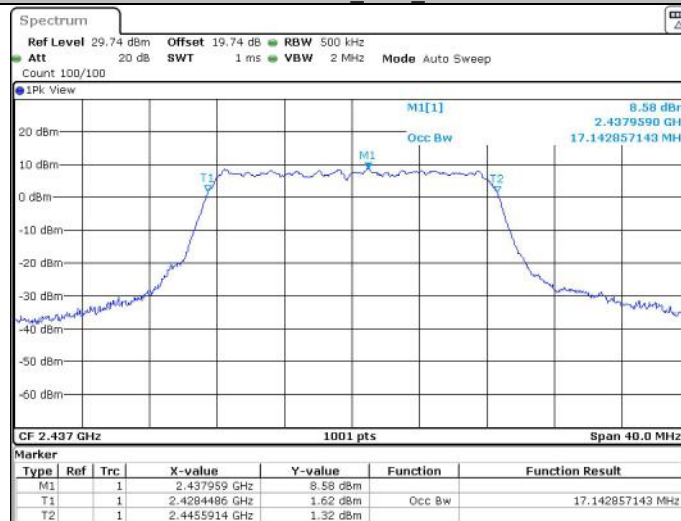
11G_Ant1_2462

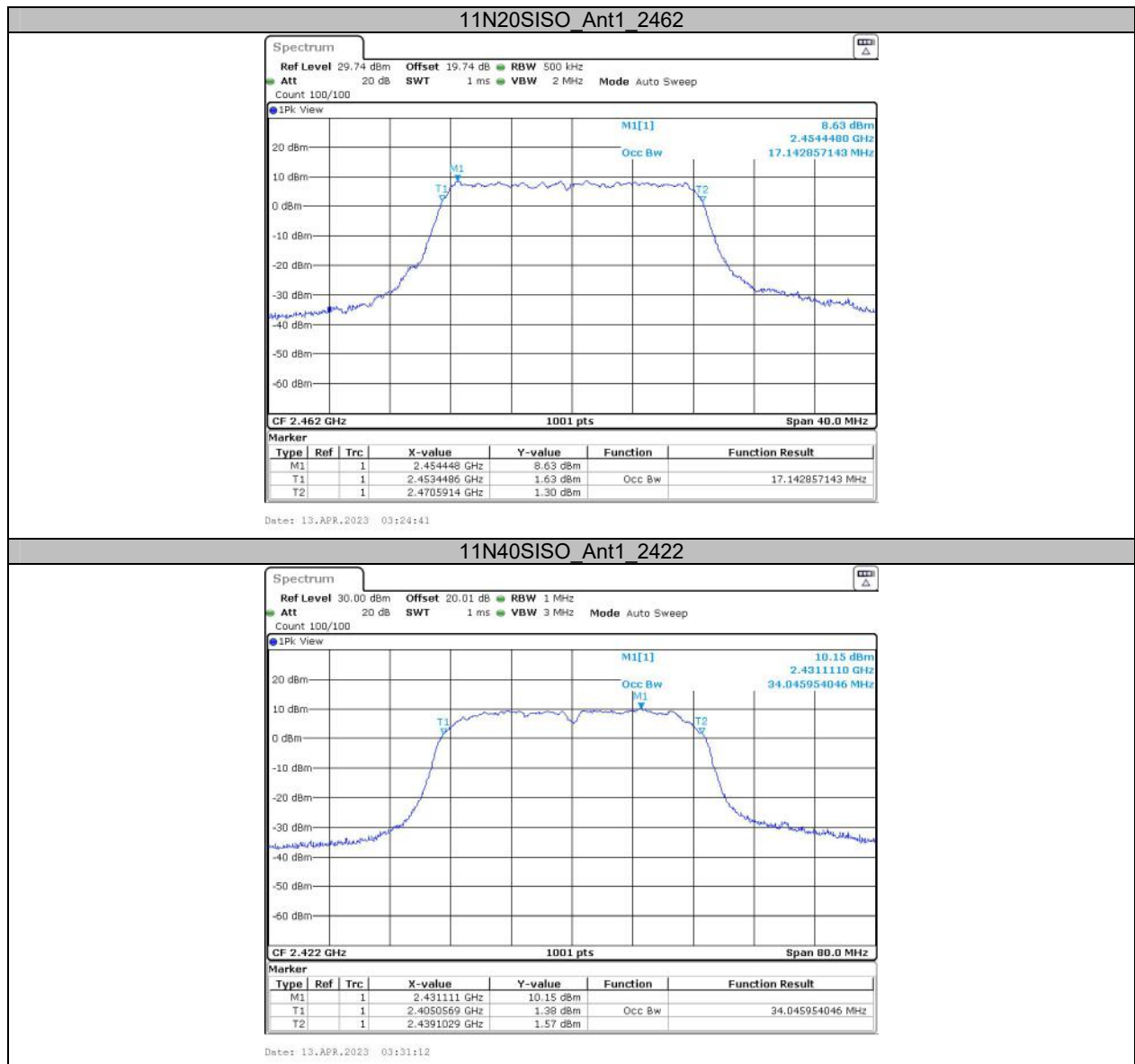


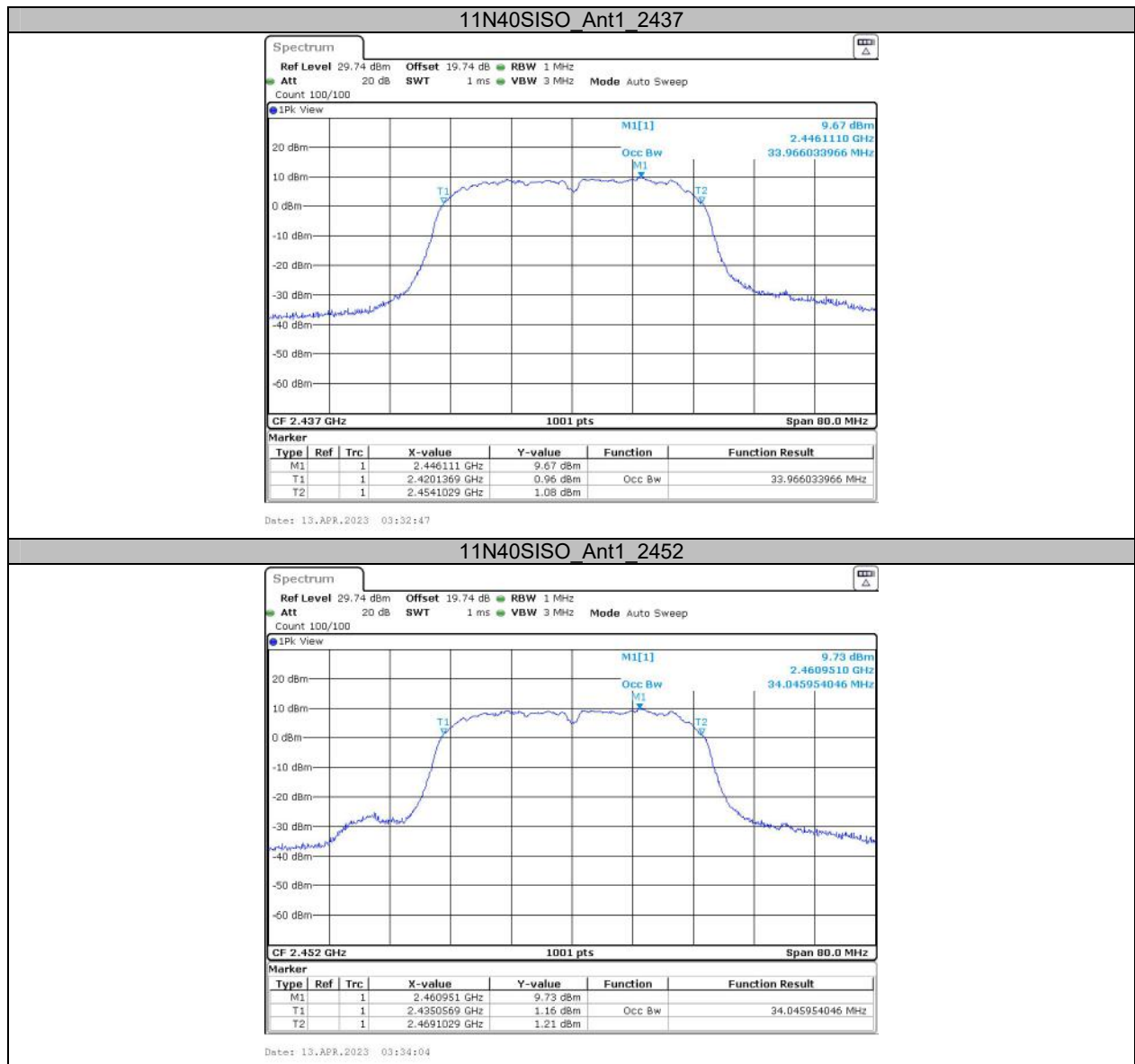
11N20SISO_Ant1_2412



11N20SISO_Ant1_2437







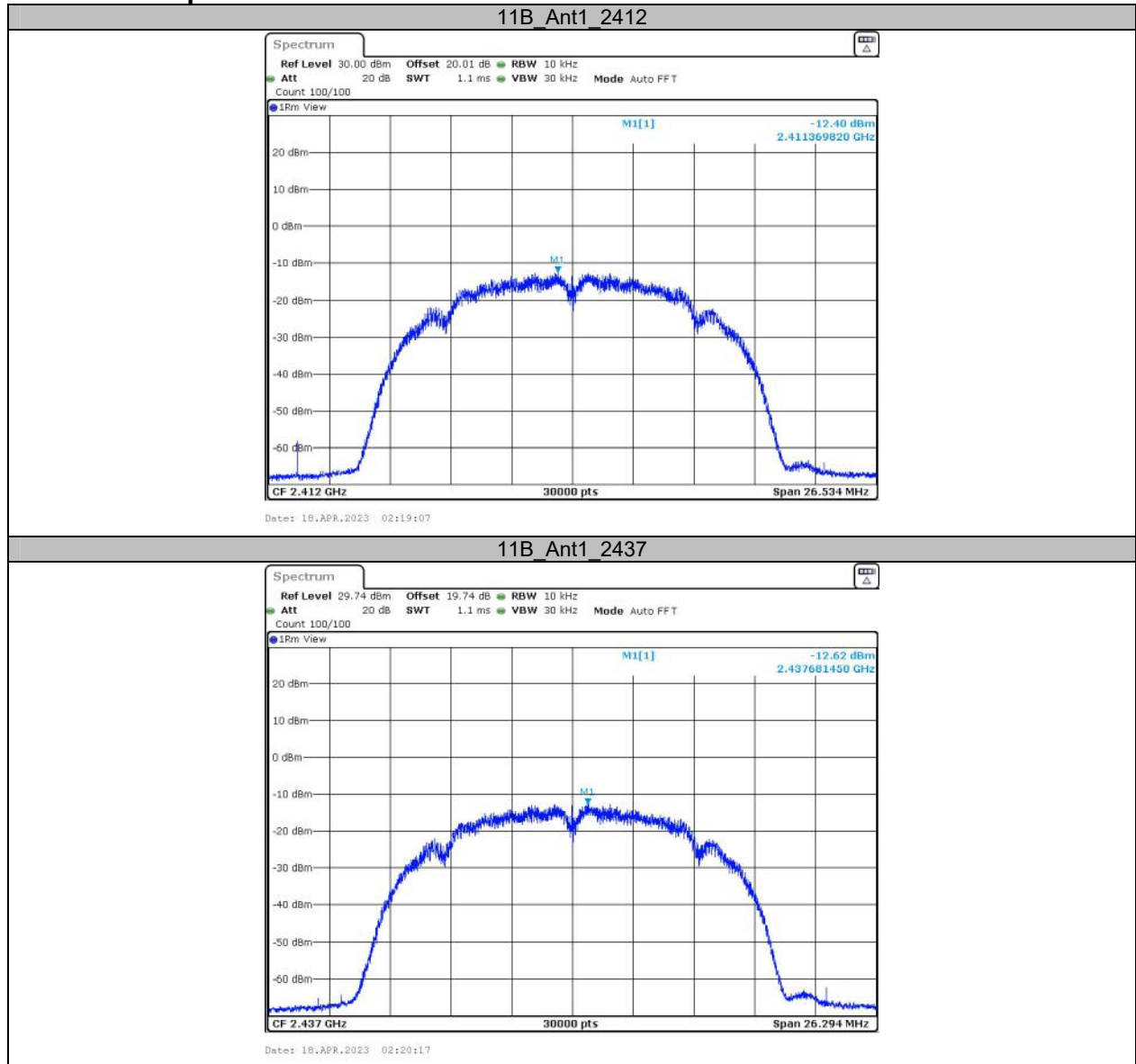
Appendix C: Maximum conducted output power**Test Result Average**

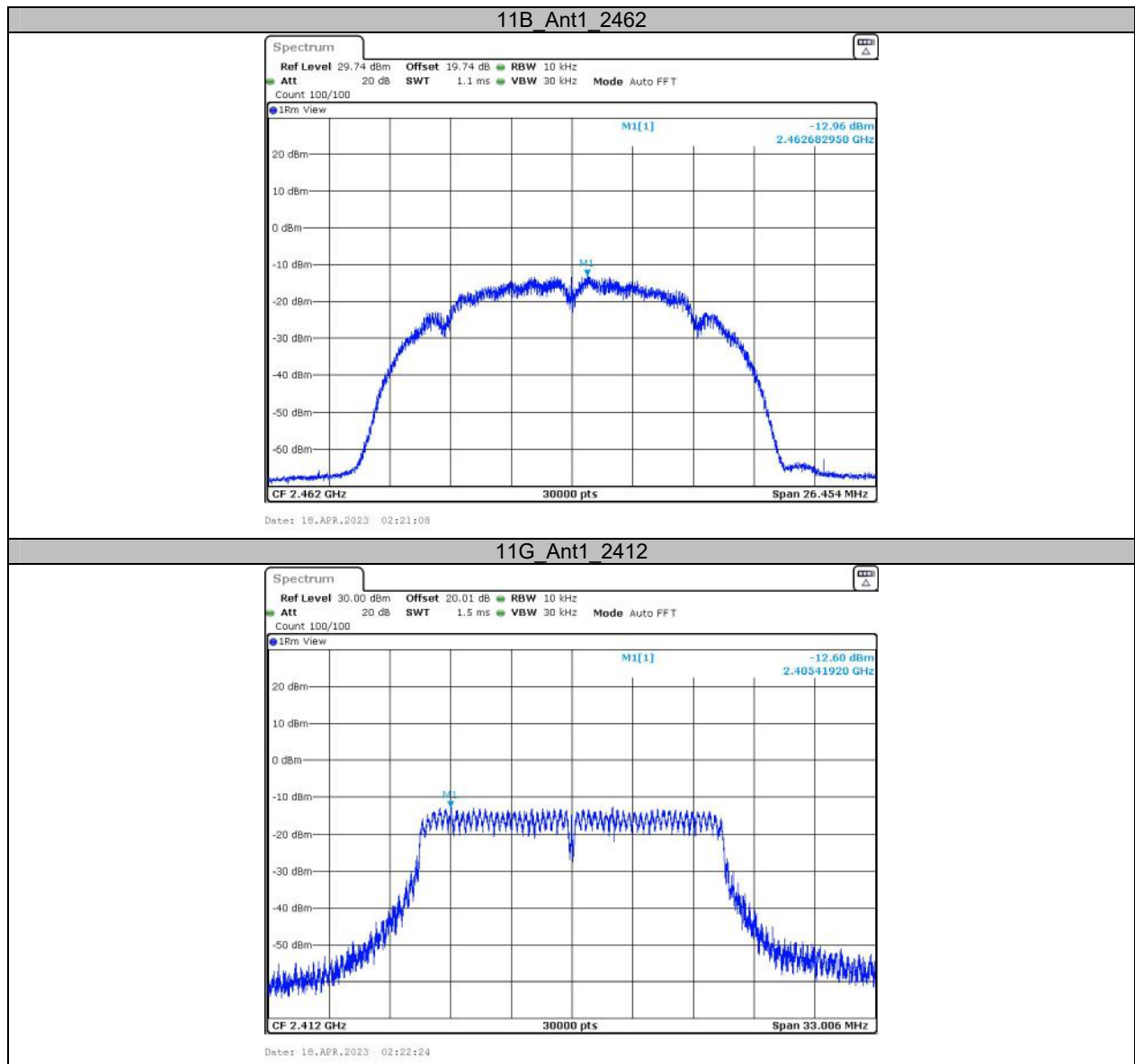
Test Mode	Antenna	Frequency[MHz]	AveragePower[dBm]	Conducted Limit[dBm]	Verdict
11B	Ant1	2412	12.90	≤30.00	PASS
		2437	12.51	≤30.00	PASS
		2462	12.64	≤30.00	PASS
11G	Ant1	2412	14.98	≤30.00	PASS
		2437	14.75	≤30.00	PASS
		2462	14.78	≤30.00	PASS
11N20SISO	Ant1	2412	14.69	≤30.00	PASS
		2437	14.50	≤30.00	PASS
		2462	14.50	≤30.00	PASS
11N40SISO	Ant1	2422	14.17	≤30.00	PASS
		2437	14.02	≤30.00	PASS
		2452	14.21	≤30.00	PASS

Note: Antenna Gain is 3.42 dBi, the max. EIRP is 18.4 dBm, the RSS-247 limit is 36dBm

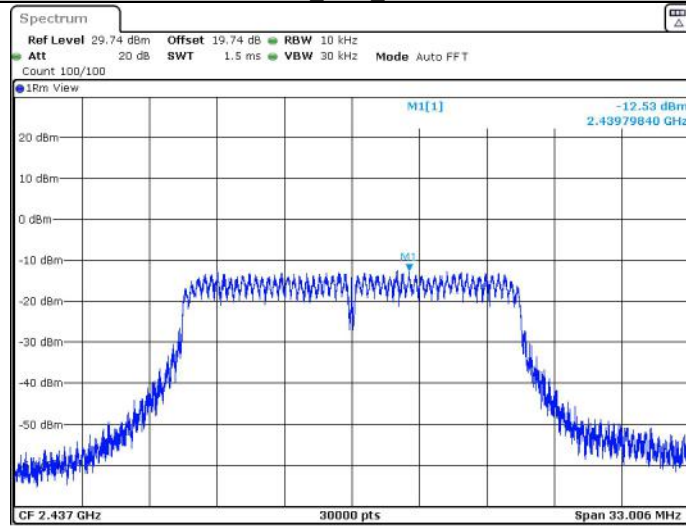
**Appendix D: Maximum power spectral density
Test Result**

Test Mode	Antenna	Frequency[MHz]	Result[dBm/10kHz]	Limit[dBm/3kHz]	Verdict
11B	Ant1	2412	-12.4	≤8.00	PASS
		2437	-12.62	≤8.00	PASS
		2462	-12.96	≤8.00	PASS
11G	Ant1	2412	-12.6	≤8.00	PASS
		2437	-12.53	≤8.00	PASS
		2462	-12.36	≤8.00	PASS
11N20SISO	Ant1	2412	-12.64	≤8.00	PASS
		2437	-12.4	≤8.00	PASS
		2462	-12.94	≤8.00	PASS
11N40SISO	Ant1	2422	-15.39	≤8.00	PASS
		2437	-15.25	≤8.00	PASS
		2452	-15.95	≤8.00	PASS

Test Graphs

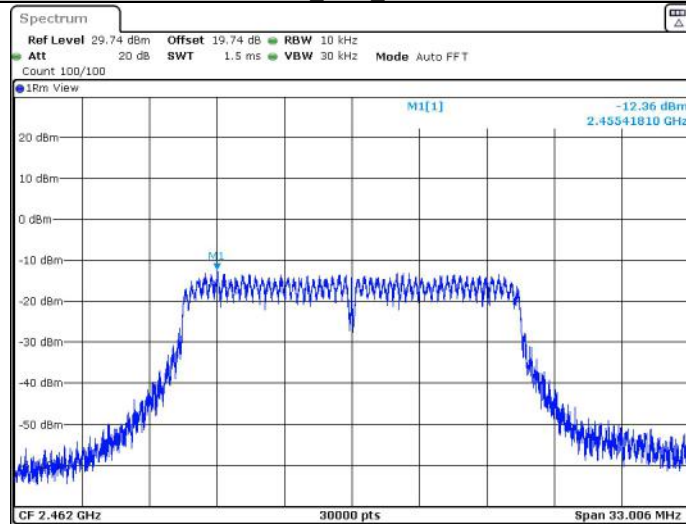


11G_Ant1_2437

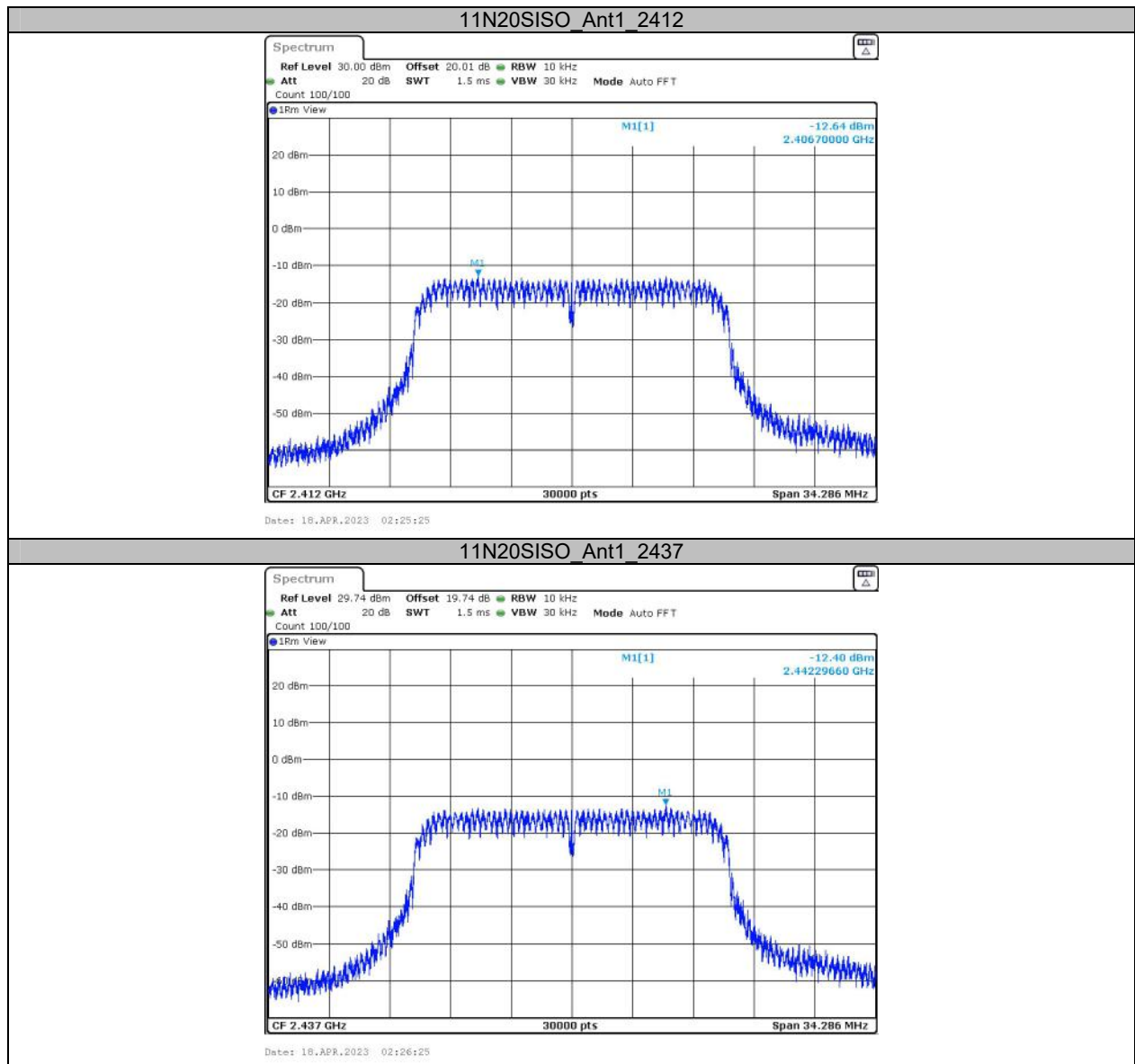


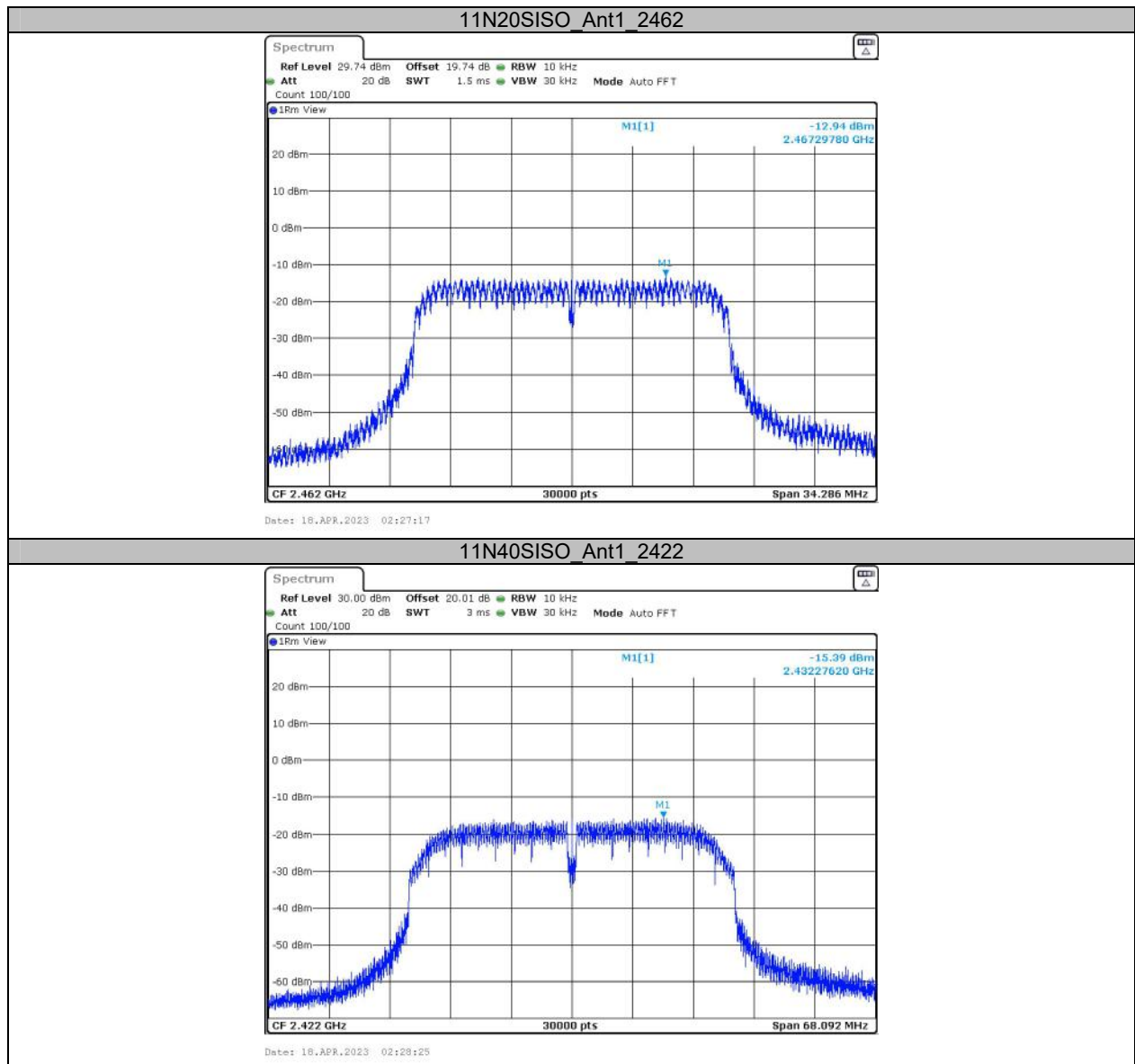
Date: 18.APR.2023 02:23:25

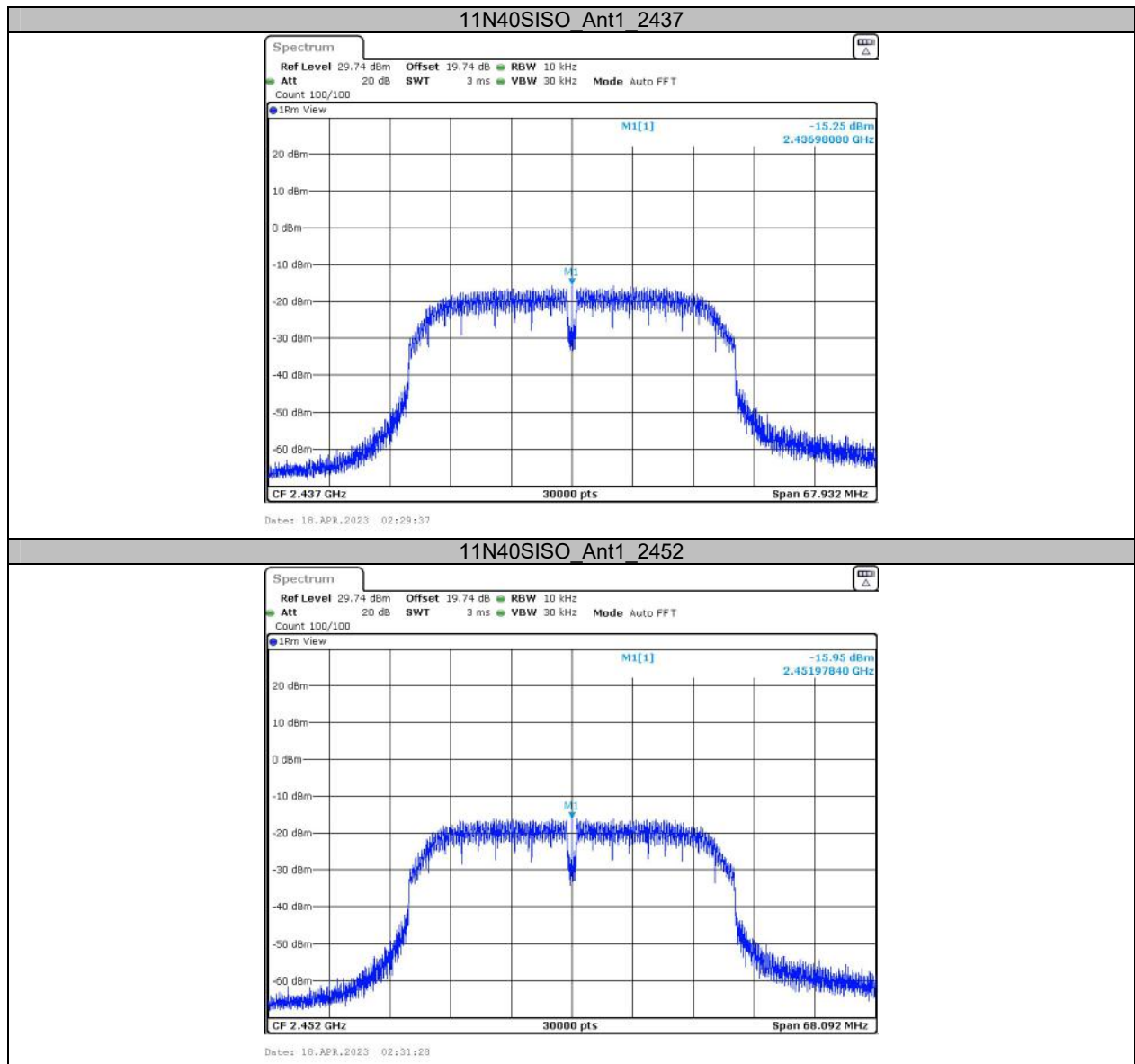
11G_Ant1_2462



Date: 18.APR.2023 02:24:18

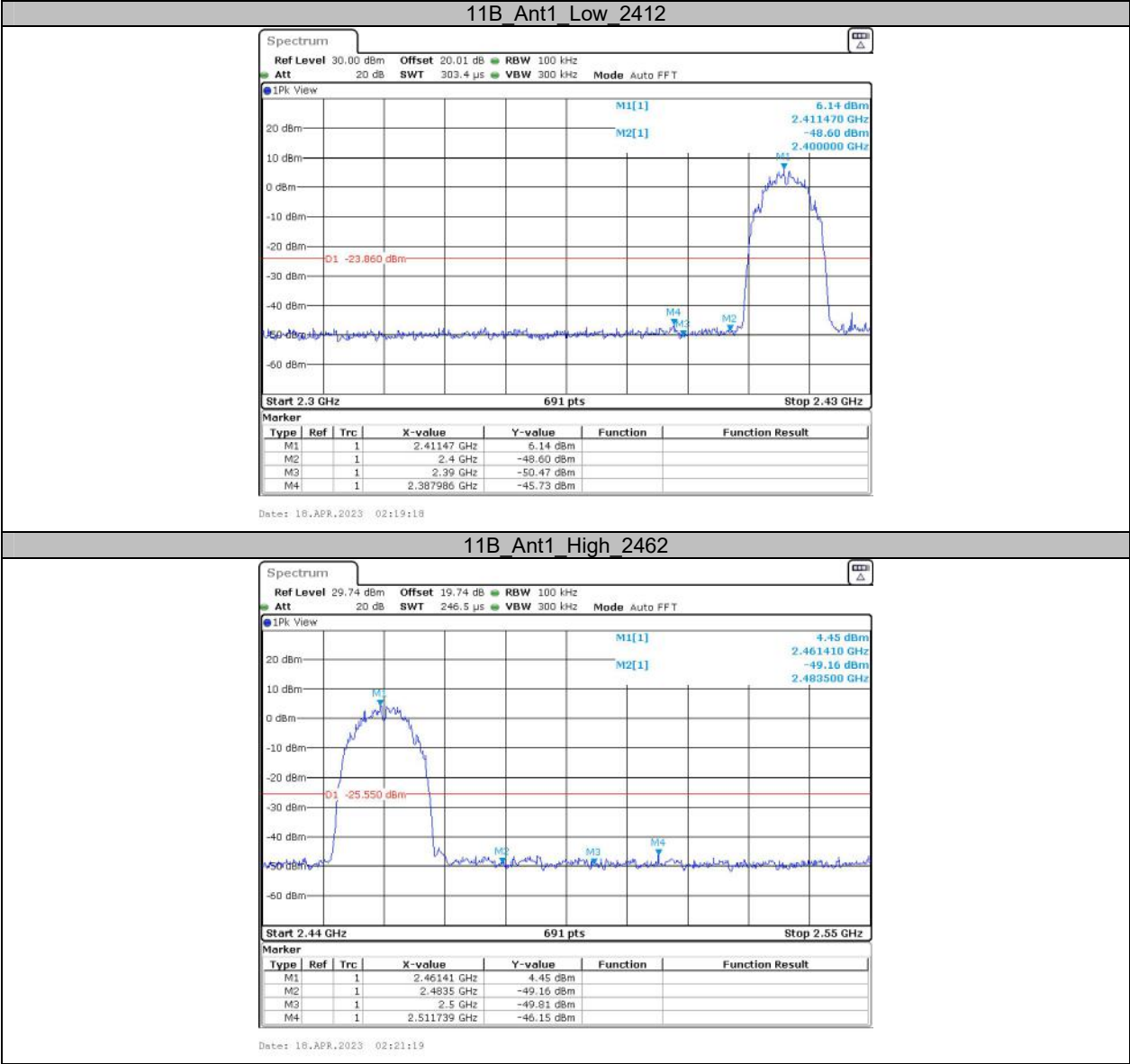




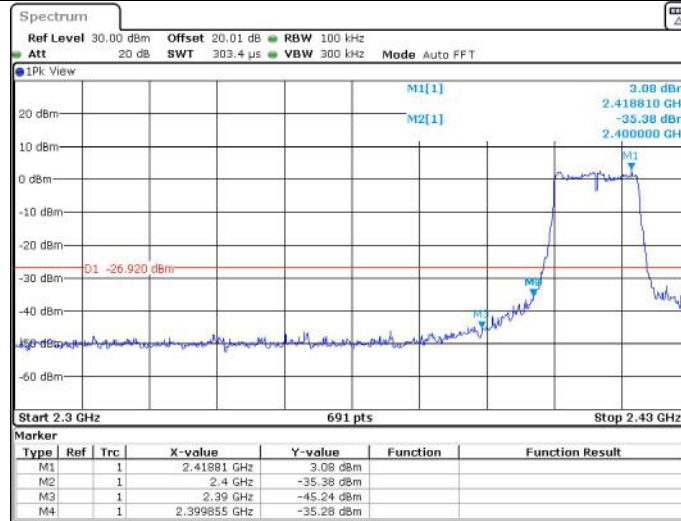


Appendix E: Band edge measurements

Test Graphs

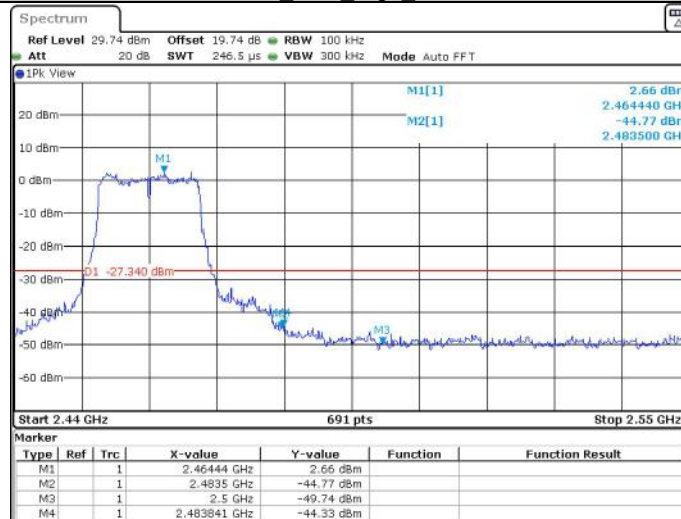


11G Ant1 Low 2412

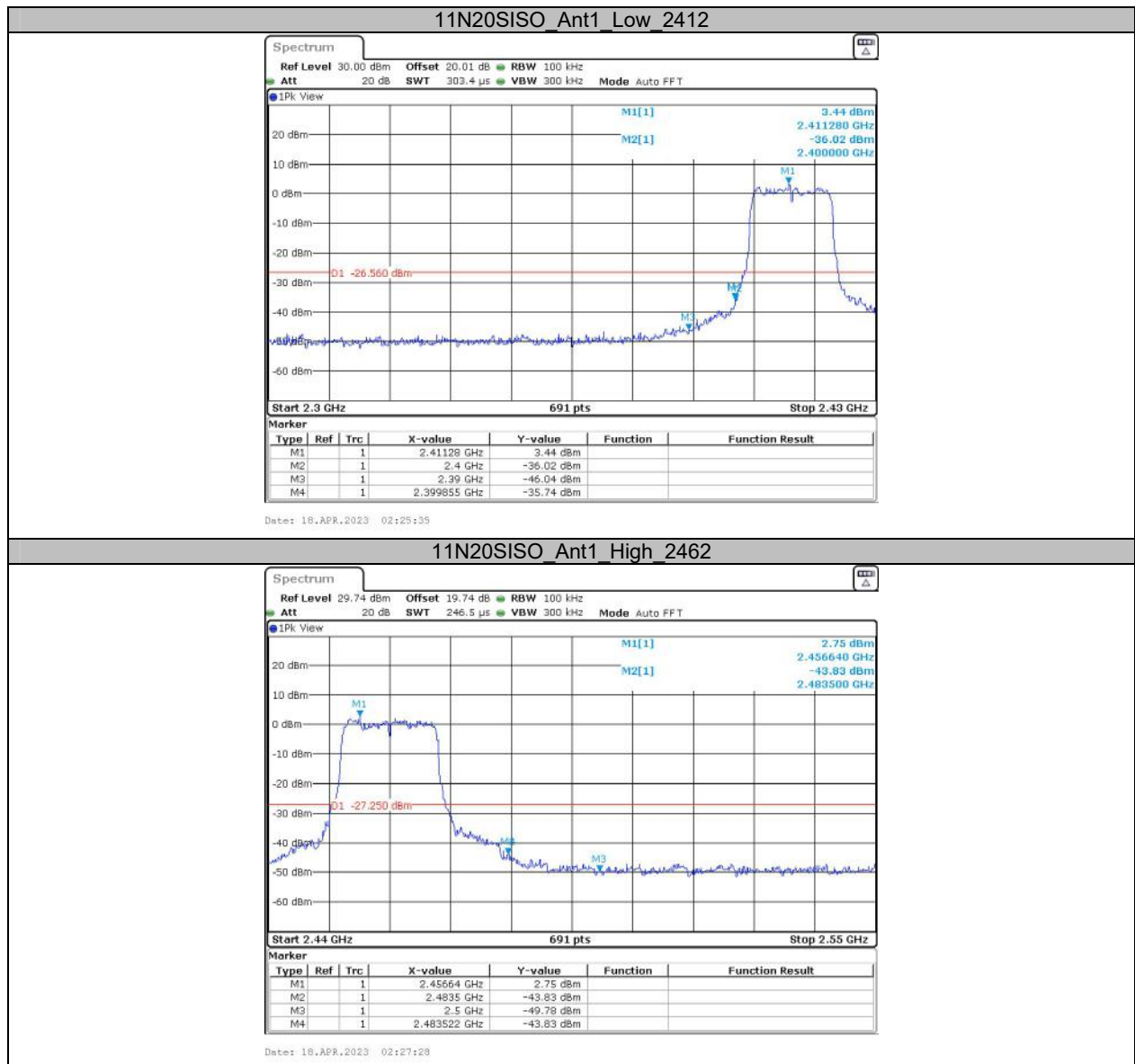


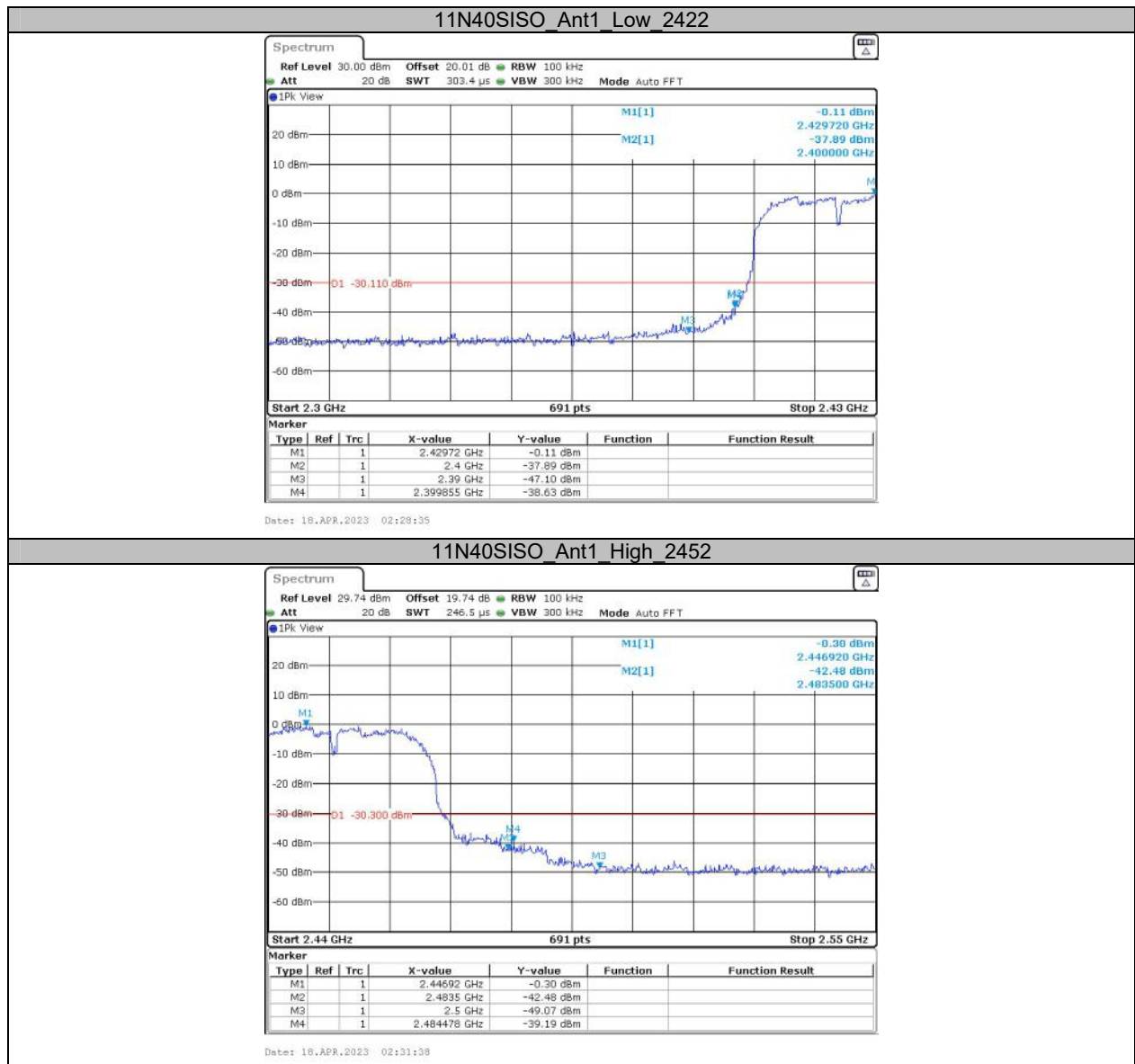
Date: 18.APR.2023 02:22:34

11G Ant1 High 2462



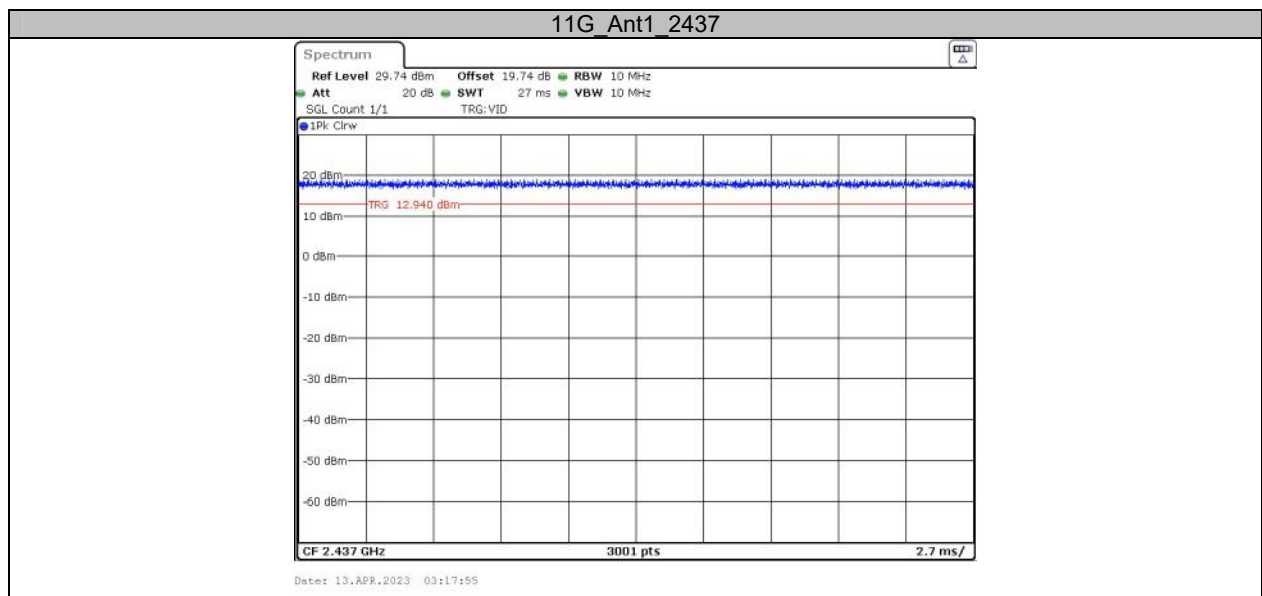
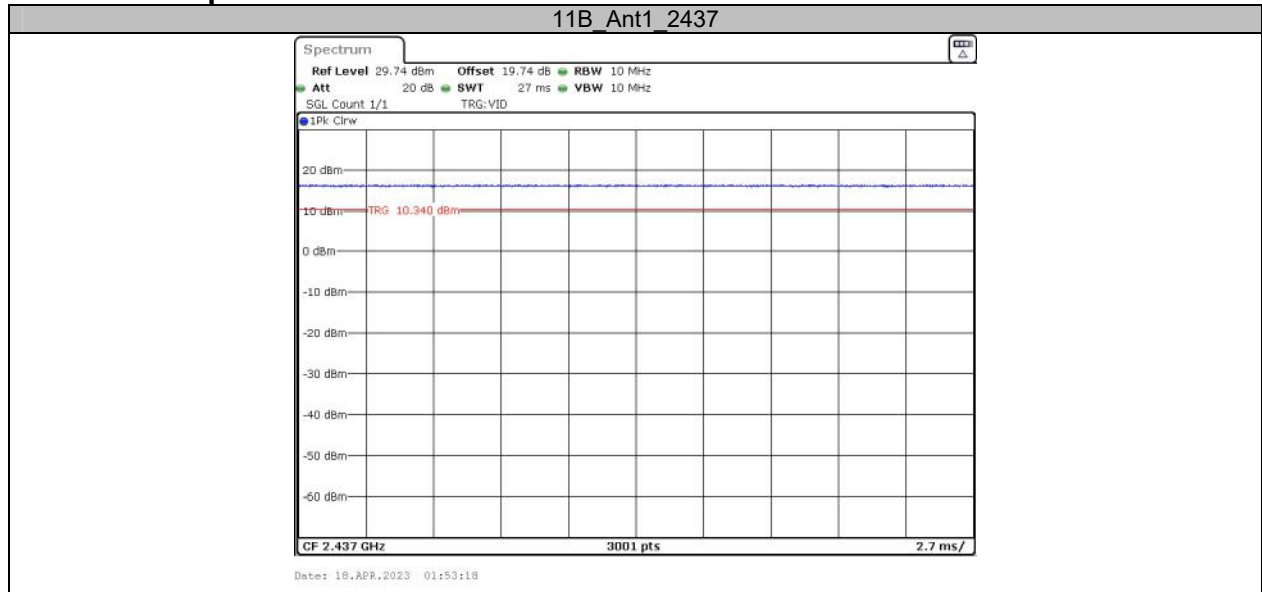
Date: 18.APR.2023 02:24:29

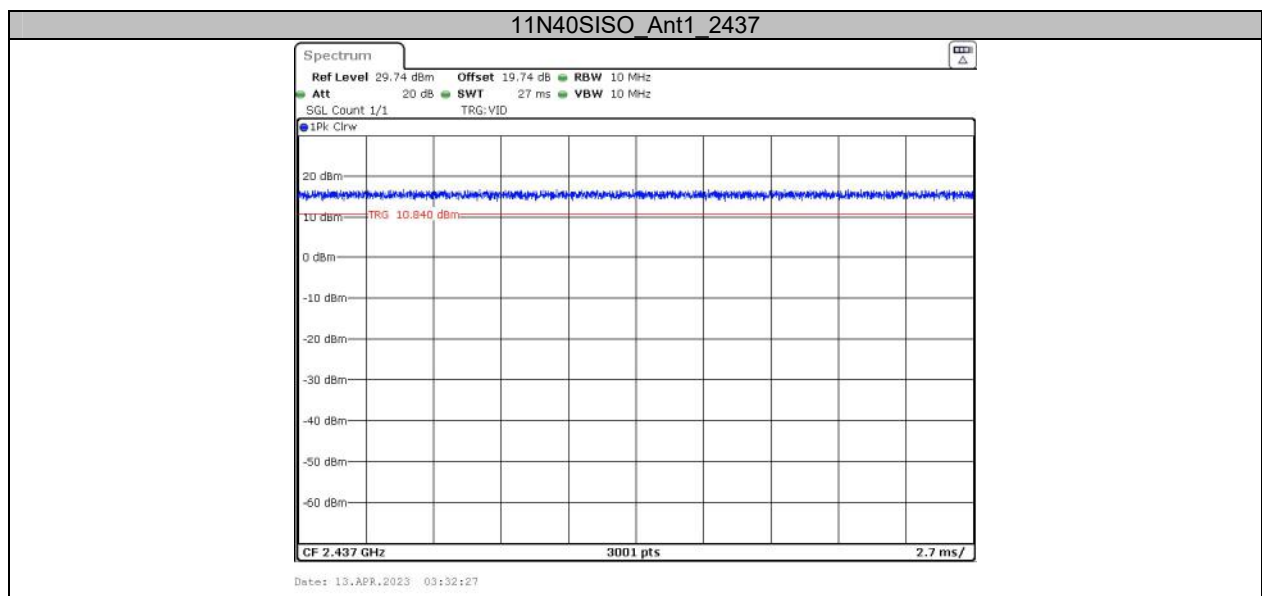
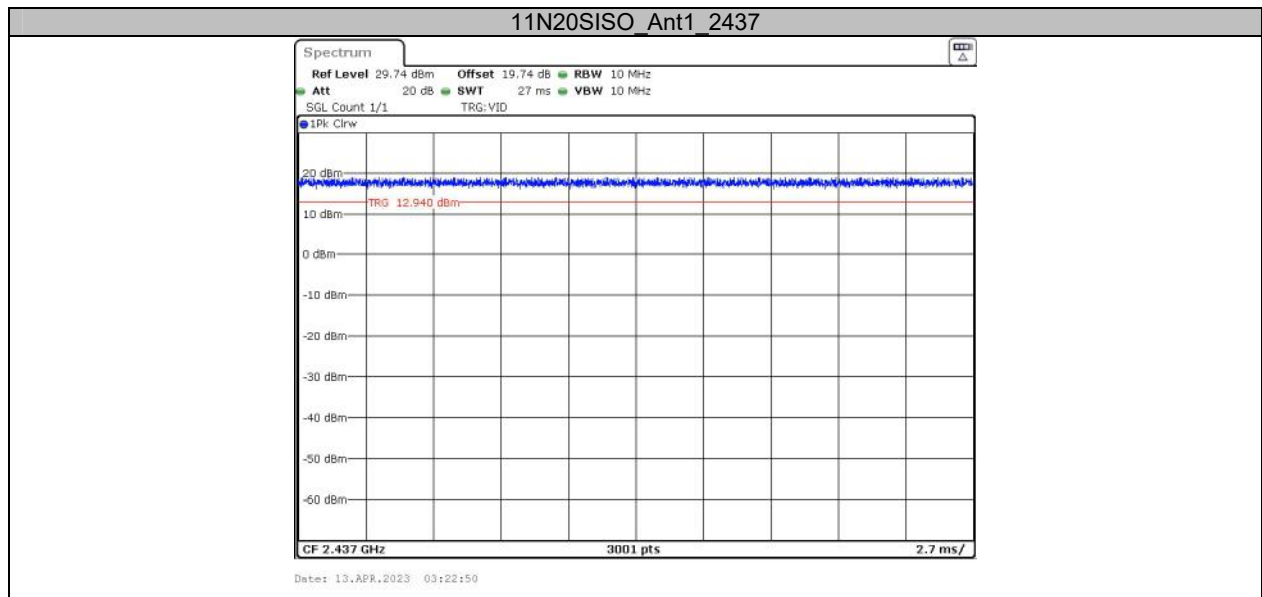




**Appendix F: DutyCycle
Test Result**

Test Mode	Antenna	Frequency[MHz]	TransmissionDuration [ms]	Transmission Period [ms]	Duty Cycle [%]
11B	Ant1	2437	27.00	27.00	100.00
11G	Ant1	2437	27.00	27.00	100.00
11N20SISO	Ant1	2437	27.00	27.00	100.00
11N40SISO	Ant1	2437	27.00	27.00	100.00

Test Graphs

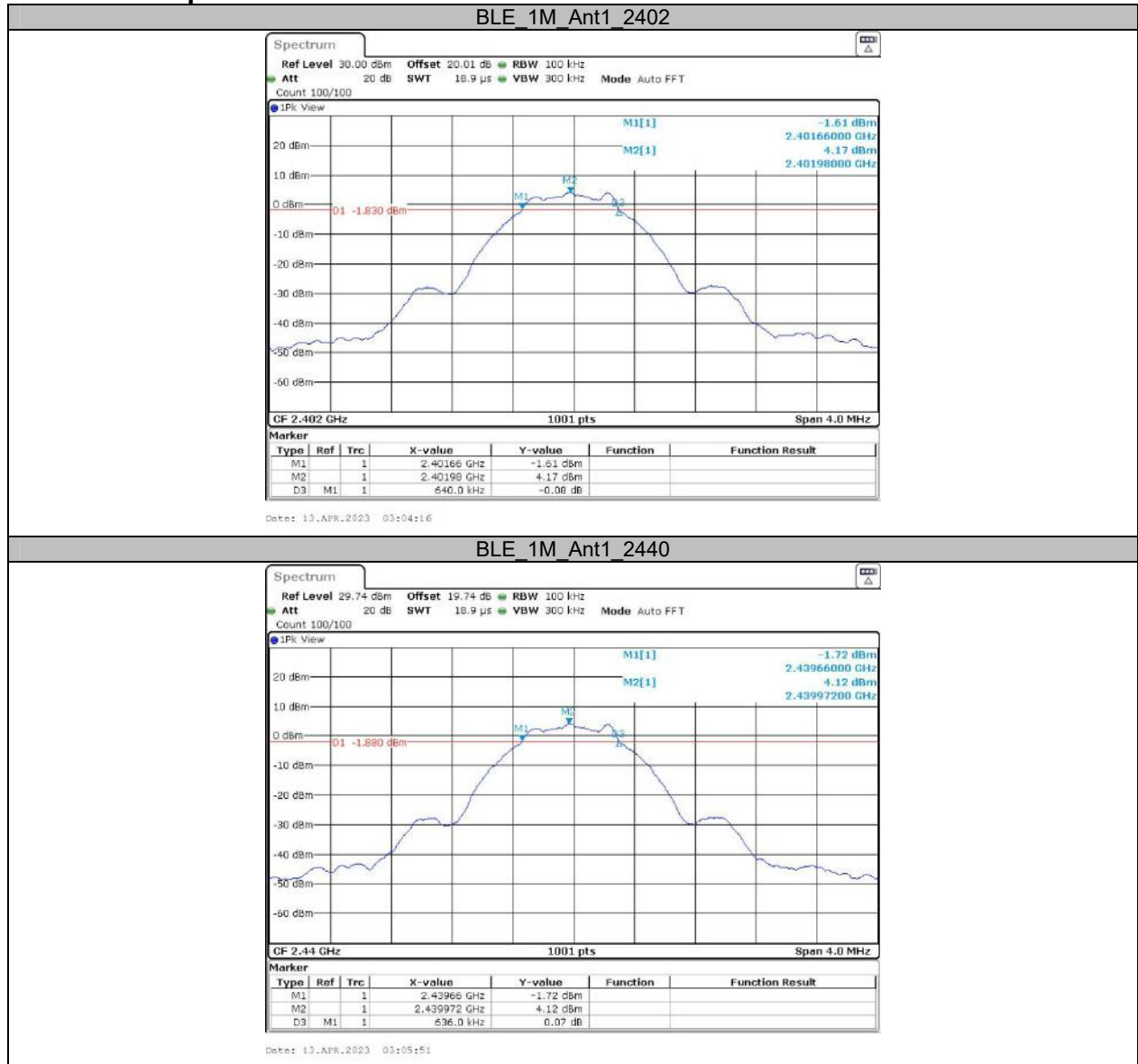


APPENDIX BLE

Appendix A: DTS Bandwidth Test Result

Test Mode	Antenna	Frequency[MHz]	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.64	2401.66	2402.30	0.5	PASS
		2440	0.64	2439.66	2440.30	0.5	PASS
		2480	0.64	2479.66	2480.30	0.5	PASS

Test Graphs

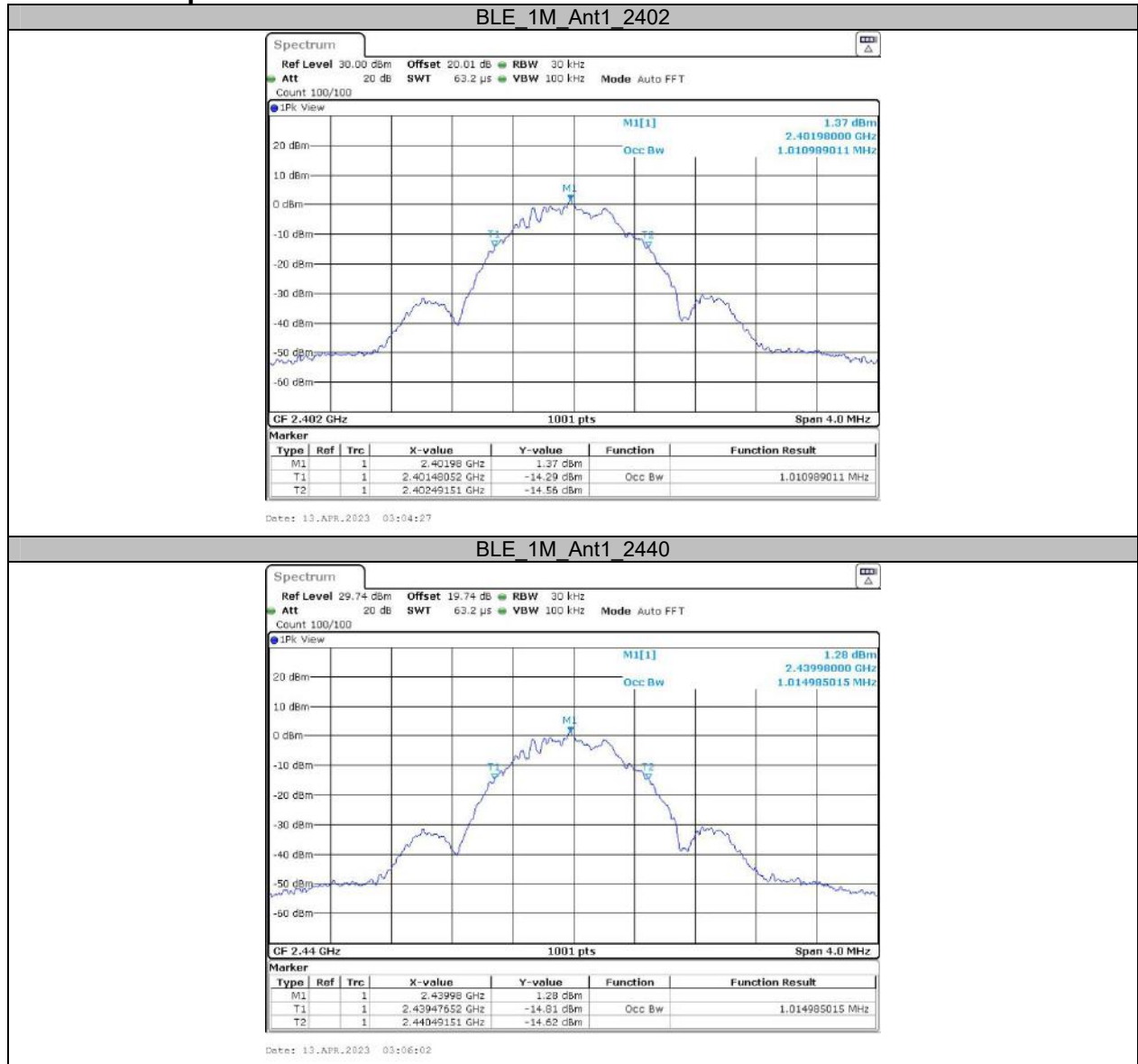




**Appendix B: Occupied Channel Bandwidth
Test Result**

Test Mode	Antenna	Frequency[MHz]	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.011	2401.481	2402.492	---	---
		2440	1.015	2439.477	2440.492	---	---
		2480	1.015	2479.477	2480.492	---	---

Test Graphs

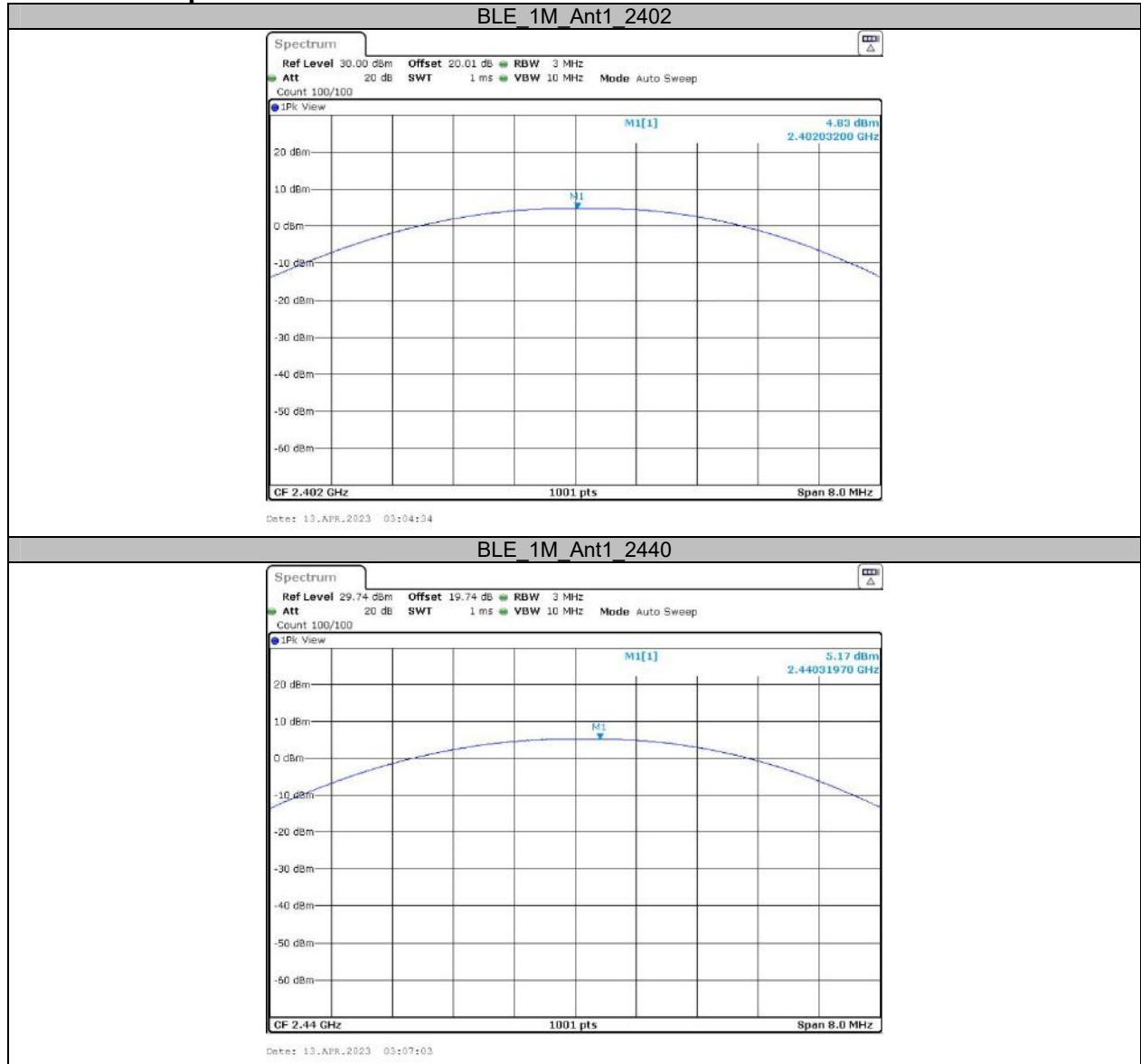


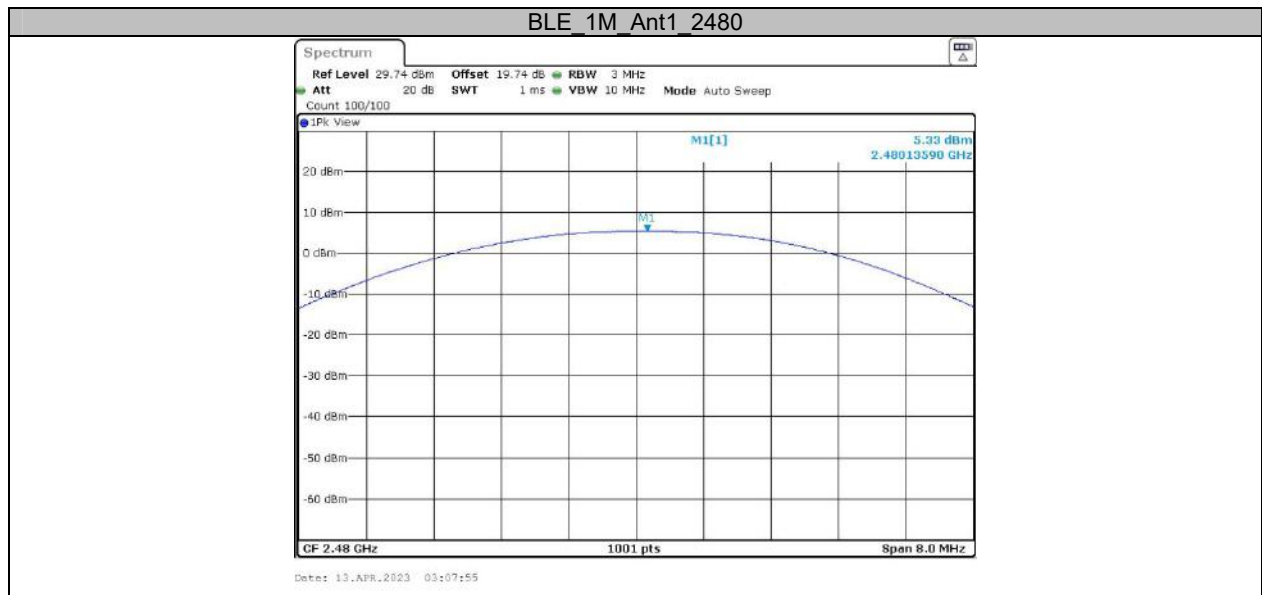


Appendix C: Maximum conducted output power**Test Result Peak**

Test Mode	Antenna	Frequency[MHz]	Conducted Peak Power[dBm]	Conducted Limit[dBm]	Verdict
BLE_1M	Ant1	2402	4.83	≤30	PASS
		2440	5.17	≤30	PASS
		2480	5.33	≤30	PASS

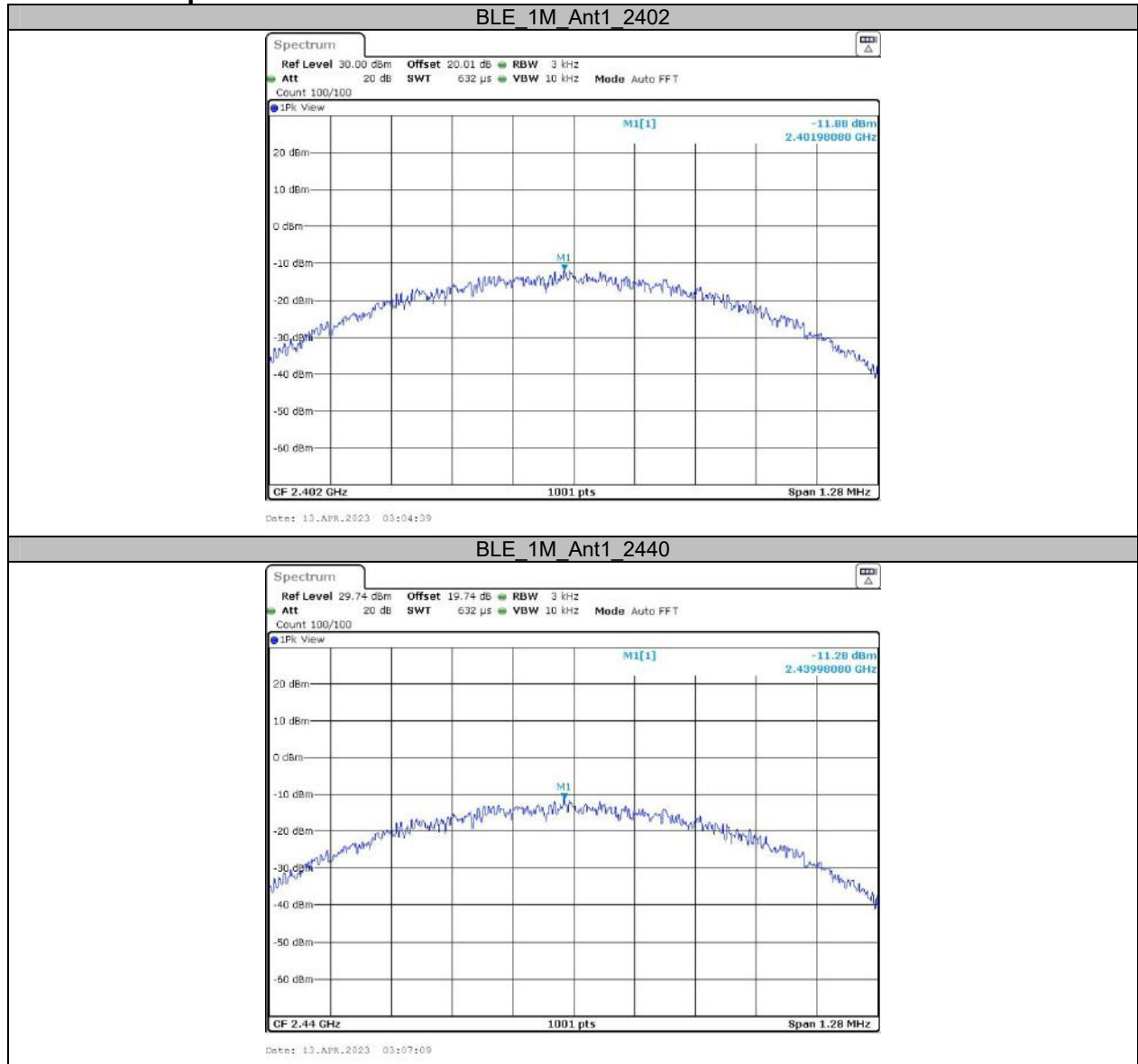
Note: Antenna Gain is 3.42 dBi, the max. EIRP is 8.75 dBm, the RSS-247 limit is 36dBm

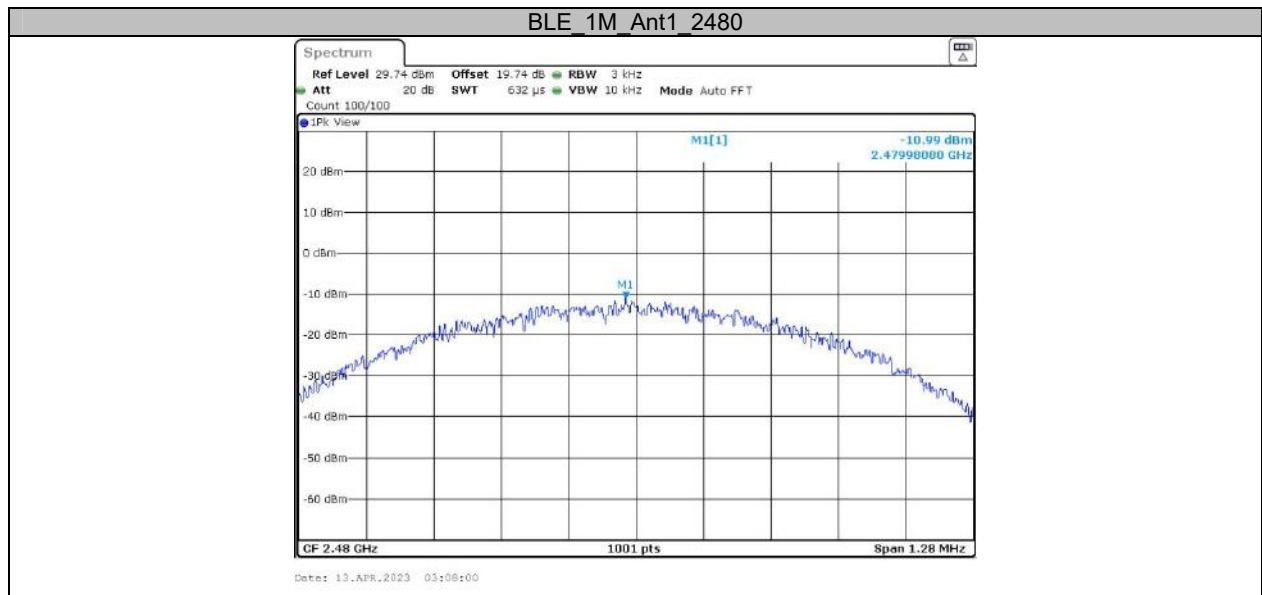
Test Graphs Peak



**Appendix D: Maximum power spectral density
Test Result**

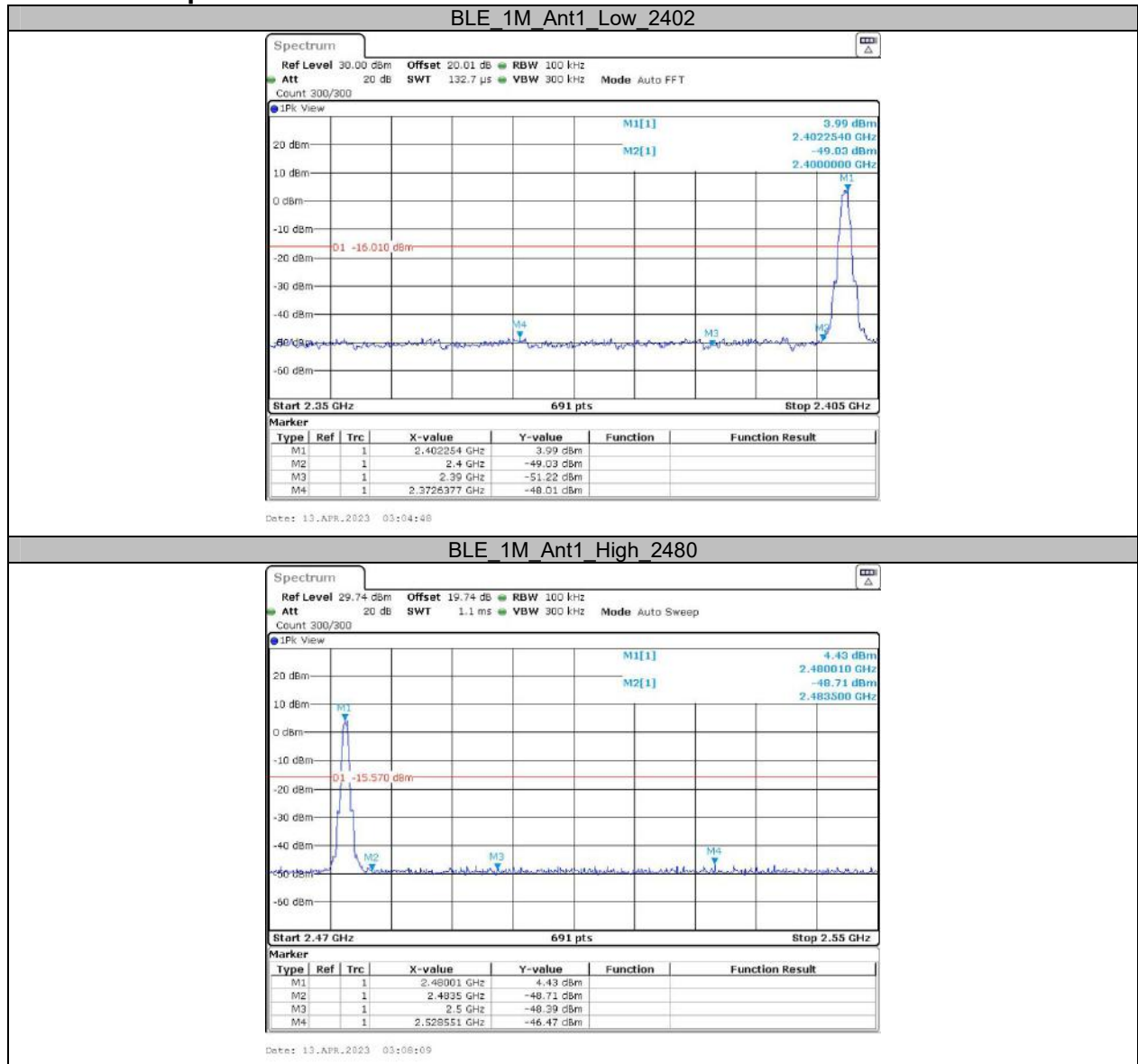
Test Mode	Antenna	Frequency[MHz]	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-11.88	≤8.00	PASS
		2440	-11.28	≤8.00	PASS
		2480	-10.99	≤8.00	PASS

Test Graphs



Appendix E: Band edge measurements

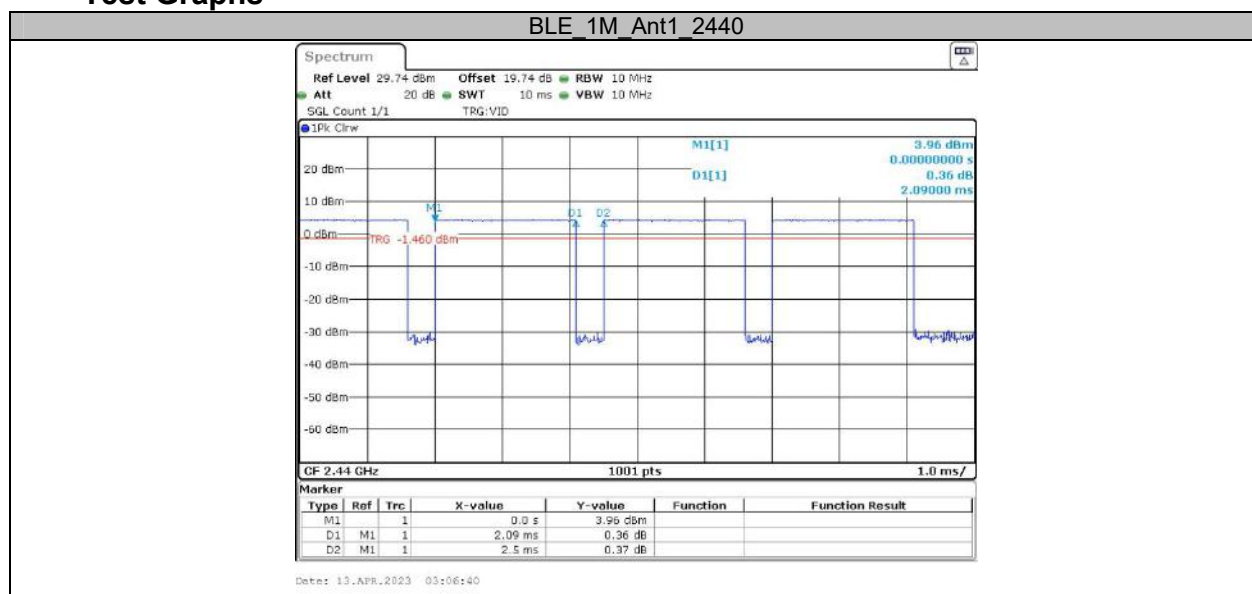
Test Graphs



Appendix F: Duty Cycle Test Result

Test Mode	Frequency[MHz]	ON Time [ms]	Period [ms]	Duty Cycle [%]	Duty Cycle Factor[dB]	1/T (kHz)	VBW Setting (kHz)
BLE_1M	2440	2.09	2.50	83.60	0.78	0.48	1

Test Graphs



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