



TESTREPORT

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Report Number: RA230406-17345E-RF
FCC ID: 2A7VD-H7033
IC: 28789-H7033

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: Govee Outdoor String Lights H1
Model No.: H7033
Multiple Model(s) No.: N/A
Trade Mark: Govee
Date Received: 2023/04/06
Report Date: 2023/05/25

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

Prepared and Checked By:

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Approved By:

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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	RA230406-17345E-RF	Original Report	2023/05/25

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

HVIN	H7033
Frequency Range	BLE 1M: 2402-2480MHz Wi-Fi: 2412-2462MHz
Maximum Conducted Peak Output Power	BLE 1M: 2.07dBm Wi-Fi: 16.89dBm(802.11b), 10.9dBm(802.11g), 11.21dBm(802.11n-HT20)
Modulation Technique	BLE: GFSK Wi-Fi: DSSS, OFDM
Antenna Specification*	BLE: 3.59dBi Wi-Fi: 3.98dBi (provided by the applicant)
Voltage Range	DC24V from adapter
Sample serial number	RE&CE: 249E-1 RF: 249E-2 (Assigned by ATC)
Sample/EUT Status	Good condition
Adapter information	Model: CW2401500US Input: AC 100-240V, 50/60Hz, 1.2A MAX Output: DC 24.0V, 1.5A

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, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for 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	9k-150KHz	2.74dB, k=2
	150kHz-30MHz	2.92dB, k=2
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℃
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

For Wi-Fi mode, total 11 channels are provided to testing:

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	/	/

For 802.11b, 802.11g, 802.11n-HT20, EUT was tested with Channel 1, 6 and 11.

For BLE 1M mode, 40 channels are provided to testing:

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

“UI_mptool-1V16; sscom v5.13.1.exe *” exercise software was used for test.

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	75	75	75
802.11g	6Mbps	50	50	50
802.11n-HT20	MCS0	50	50	50
BLE	1Mbps	10	10	10

The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the average power, peak power and PSD across all data rates, bandwidths and modulations.

The software and power level was provided by the applicant.

Support Equipment List and Details

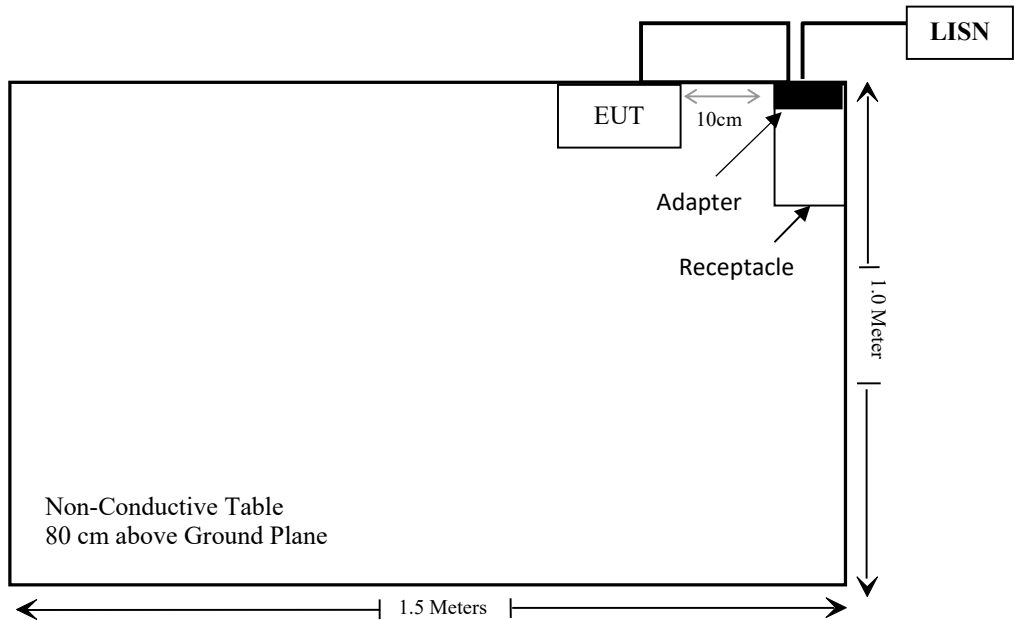
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

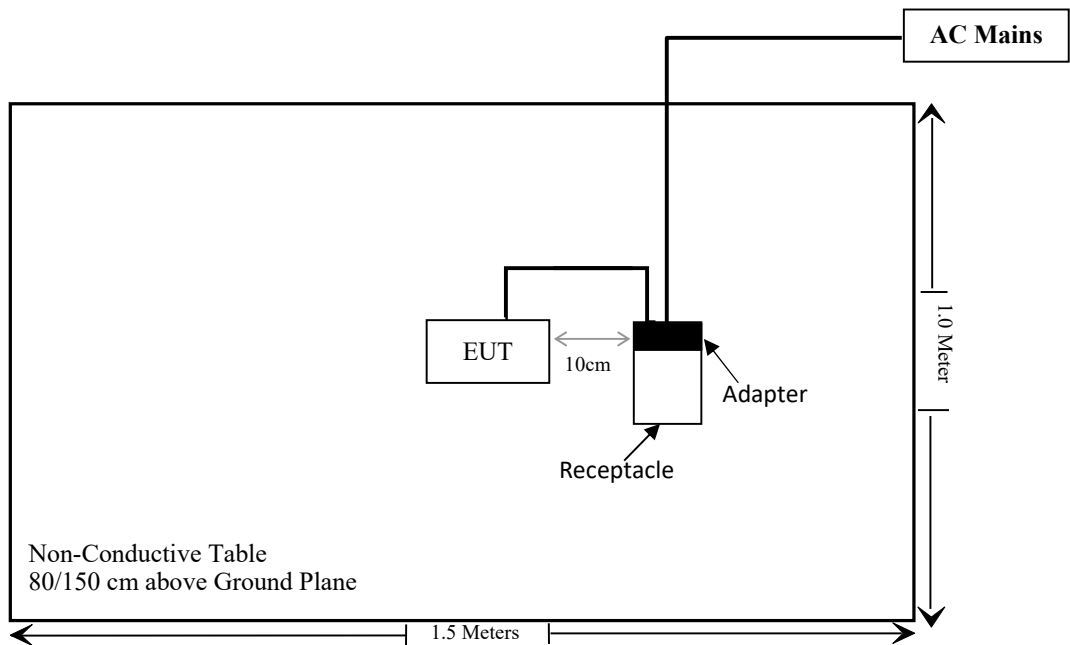
Cable Description	Length (m)	From Port	To
Un-shield Un-Detachable power Cable	0.5	Adapter	EUT

Block Diagram of Test Setup

For conducted emission:



For radiated emission:



SUMMARY OF TEST RESULTS

FCC Rules	RSS Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (3) & §2.1091	RSS-102 § 4	RF Exposure & Exposure Limits	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 (30MHz-1GHz)					
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)					
Radiated Emissions Test (Above 1GHz)					
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
Wainwright	High Pass Filter	WHKX3.6/18 G-10SS	5	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	USB wideband power sensor	U2021XA	MY54250003	2022/06/27	2023/06/26
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- RF EXPOSURE EVALUATION

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	$19.2 R^2$.

For multiple RF sources: Multiple RF sources are exempt if:

in the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation:

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$$

Result

Mode	Frequency (MHz)	Tune up conducted power	Antenna Gain		ERP		Evaluation Distance (m)	ERP Limit (W)
		(dBm)	(dBi)	(dBd)	(dBm)	(W)		
BLE	2402-2480	3	3.59	1.44	4.44	0.00278	0.2	0.768
2.4G Wi-Fi	2412-2462	18	3.98	1.83	19.83	0.09616	0.2	0.768

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

Simultaneous transmitting consideration (worst case):

The ratio= $ERP_{BLE}/limit + ERP_{Wi-Fi}/limit = 0.00278/0.768 + 0.09616/0.768 = 0.12883 < 1.0$, so simultaneous exposure is compliant.

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 ^{ci}	83	90	-	Instantaneous ^c
0.1-10	-	0.73/ <i>f</i>	-	6 ⁱⁱ
1.1-10	87/ <i>f</i> ^{0.5}	-	-	6 ⁱⁱ
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.

^c Based on nerve stimulation (NS).

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

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

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)	(mW)			
BLE	2402-2480	3.59	2.29	3	2.0	0.2	0.0091	5.351
2.4G Wi-Fi	2412-2462	3.98	2.5	18	63.10	0.2	0.314	5.366

Note: Wi-Fi, BLE can transmit simultaneously; the worst condition is below:

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.0091/5.351 + 0.314/5.366 = 0.0602 < 1.0$$

Result: Compliance

Note: To maintain compliance with the RF exposure guidelines, place the equipment at least 0.2 m from nearby persons.

§ 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.

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 two internal antenna arrangement which was permanently attached, one for BLE and one for WI-Fi, fulfill the requirement of this section. Please refer to the EUT photos.

Mode	Antenna Type	Antenna Gain	Impedance
Wi-Fi ANT	PCB	3.98dBi	50 Ω
BLE ANT	PCB	3.59dBi	50 Ω

Result: Compliant

§ 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

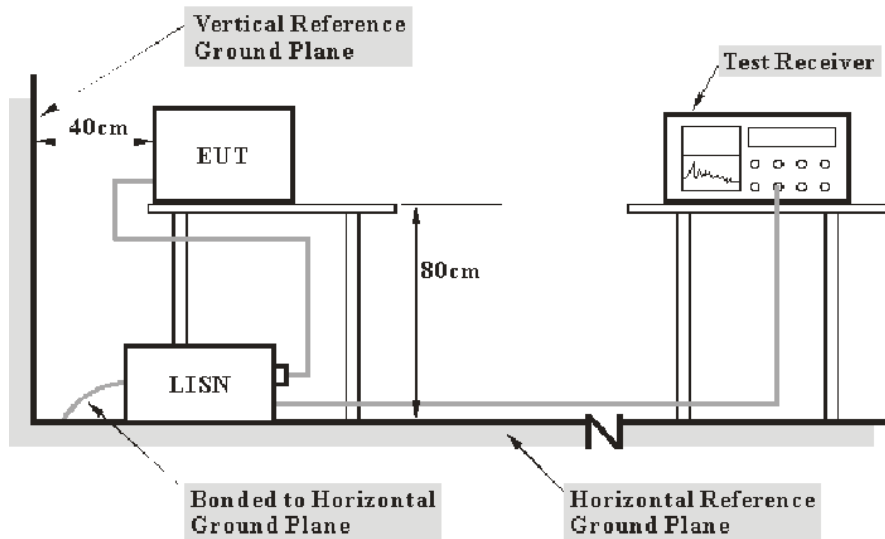
Note 1: The level decreases linearly with the logarithm of the frequency.

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:

(a) 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.

(b) 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) and 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, an Over limit of -7 dB means the emission is 7 dB below the limit. The equation for calculation is as follows:

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

Test Data

Environmental Conditions

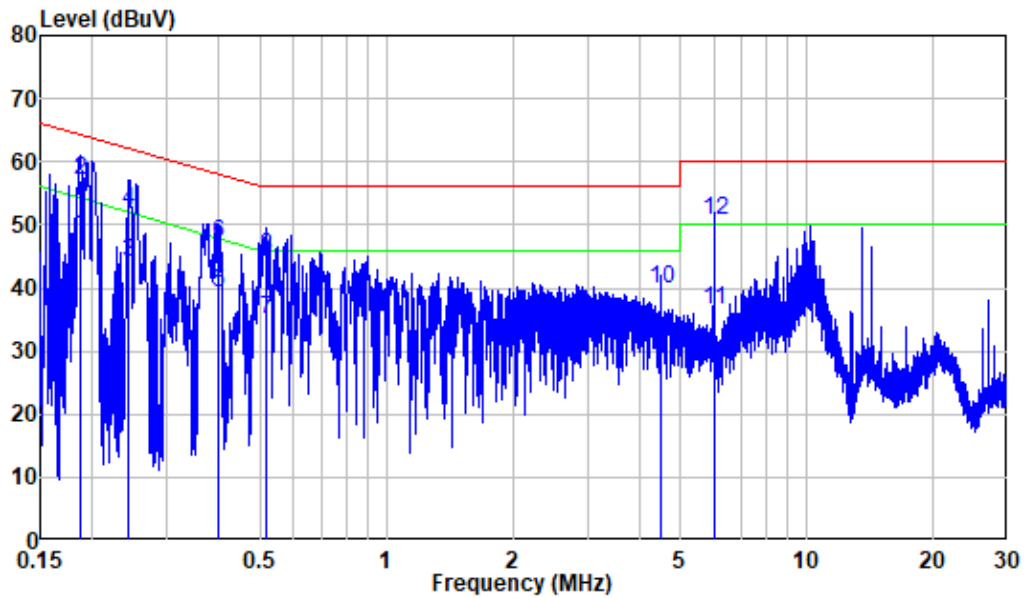
Temperature:	23 °C
Relative Humidity:	49 %
ATM Pressure:	101.0 kPa

The testing was performed by Jerry Wu on 2023-05-18.

EUT operation mode: Transmitting

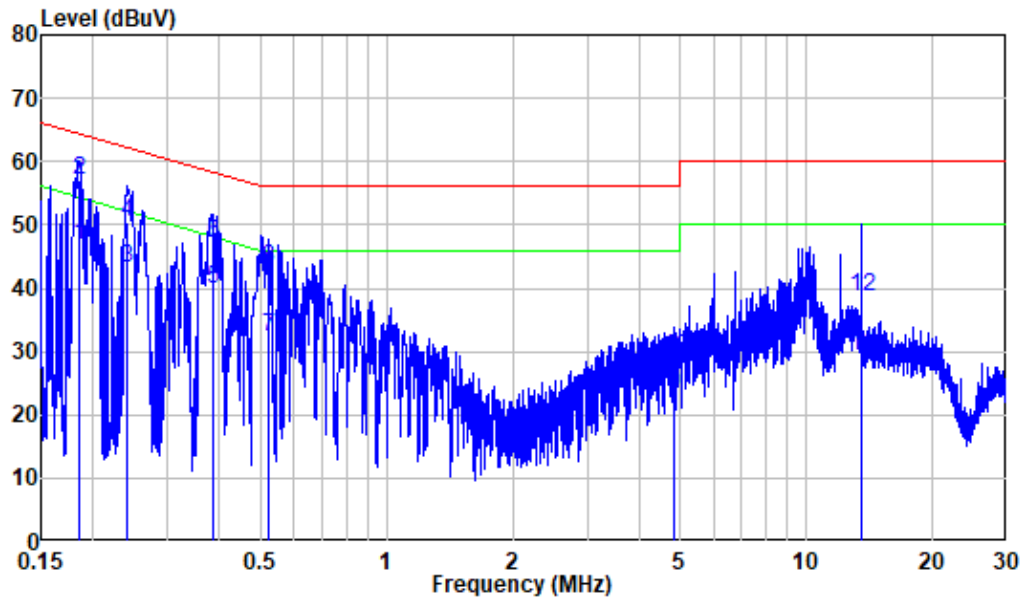
2.4G WiFi mode: (worst case is 802.11n20 mode, high channel)

AC 120V/60 Hz, Line



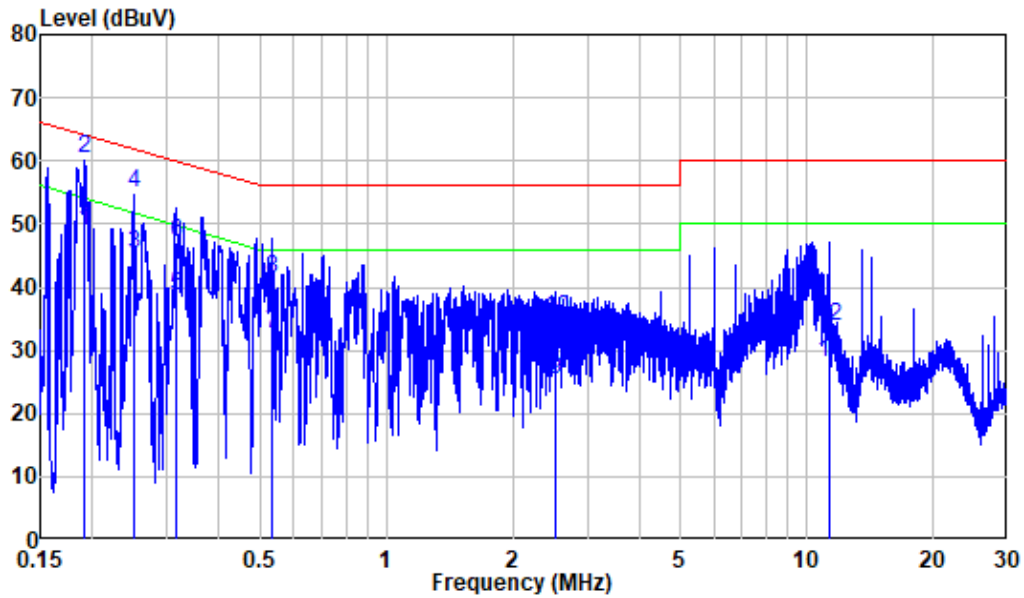
Site : Shielding Room
Condition: Line
Job No. : RA230406-17345E-RF
Mode : 2.4G(Charging+Transmitting)
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.187	10.42	37.98	48.40	54.17	-5.77	Average
2	0.187	10.42	46.72	57.14	64.17	-7.03	QP
3	0.244	10.44	33.54	43.98	51.96	-7.98	Average
4	0.244	10.44	41.66	52.10	61.96	-9.86	QP
5	0.398	10.55	28.66	39.21	47.89	-8.68	Average
6	0.398	10.55	36.63	47.18	57.89	-10.71	QP
7	0.516	10.62	24.50	35.12	46.00	-10.88	Average
8	0.516	10.62	34.32	44.94	56.00	-11.06	QP
9	4.501	10.54	19.82	30.36	46.00	-15.64	Average
10	4.501	10.54	29.30	39.84	56.00	-16.16	QP
11	6.000	10.56	25.84	36.40	50.00	-13.60	Average
12	6.000	10.56	40.23	50.79	60.00	-9.21	QP

AC 120V/60 Hz, Neutral

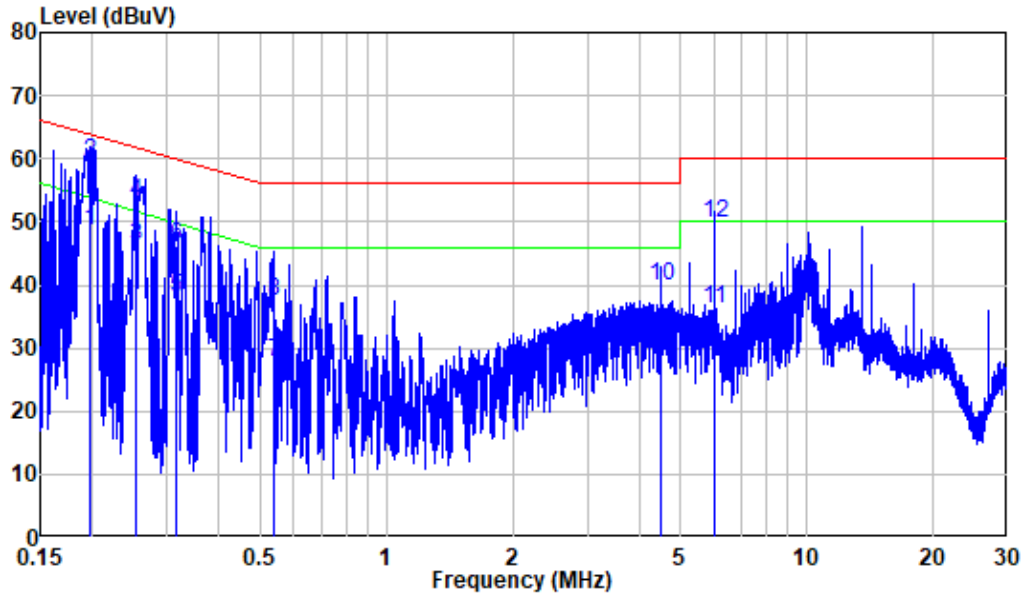
Site : Shielding Room
 Condition: Neutral
 Job No. : RA230406-17345E-RF
 Mode : 2.4G(Charging+Transmitting)
 Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.184	10.40	36.46	46.86	54.29	-7.43	Average
2	0.184	10.40	46.62	57.02	64.29	-7.27	QP
3	0.241	10.42	32.77	43.19	52.06	-8.87	Average
4	0.241	10.42	39.95	50.37	62.06	-11.69	QP
5	0.385	10.47	29.42	39.89	48.17	-8.28	Average
6	0.385	10.47	36.69	47.16	58.17	-11.01	QP
7	0.522	10.51	21.74	32.25	46.00	-13.75	Average
8	0.522	10.51	32.64	43.15	56.00	-12.85	QP
9	4.822	10.52	12.73	23.25	46.00	-22.75	Average
10	4.822	10.52	18.33	28.85	56.00	-27.15	QP
11	13.506	10.20	19.03	29.23	50.00	-20.77	Average
12	13.506	10.20	28.41	38.61	60.00	-21.39	QP

BLE mode: (worst case is low channel)**AC 120V/60 Hz, Line**

Site : Shielding Room
Condition: Line
Job No. : RA230406-17345E-RF
Mode : BLE(Charging+Transmitting)
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.191	10.42	38.39	48.81	53.99	-5.18	Average
2	0.191	10.42	50.02	60.44	63.99	-3.55	QP
3	0.251	10.45	34.93	45.38	51.73	-6.35	Average
4	0.251	10.45	44.55	55.00	61.73	-6.73	QP
5	0.315	10.50	28.27	38.77	49.84	-11.07	Average
6	0.315	10.50	36.72	47.22	59.84	-12.62	QP
7	0.536	10.63	22.07	32.70	46.00	-13.30	Average
8	0.536	10.63	30.67	41.30	56.00	-14.70	QP
9	2.515	10.46	14.93	25.39	46.00	-20.61	Average
10	2.515	10.46	24.63	35.09	56.00	-20.91	QP
11	11.257	10.36	17.83	28.19	50.00	-21.81	Average
12	11.257	10.36	23.40	33.76	60.00	-26.24	QP

AC 120V/60 Hz, Neutral

Site : Shielding Room
 Condition: Neutral
 Job No. : RA230406-17345E-RF
 Mode : BLE(Charging+Transmitting)
 Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.197	10.40	38.15	48.55	53.76	-5.21	Average
2	0.197	10.40	49.15	59.55	63.76	-4.21	QP
3	0.253	10.43	35.62	46.05	51.66	-5.61	Average
4	0.253	10.43	42.65	53.08	61.66	-8.58	QP
5	0.316	10.45	27.51	37.96	49.82	-11.86	Average
6	0.316	10.45	35.67	46.12	59.82	-13.70	QP
7	0.539	10.51	17.22	27.73	46.00	-18.27	Average
8	0.539	10.51	26.91	37.42	56.00	-18.58	QP
9	4.501	10.52	19.94	30.46	46.00	-15.54	Average
10	4.501	10.52	29.38	39.90	56.00	-16.10	QP
11	6.000	10.49	25.79	36.28	50.00	-13.72	Average
12	6.000	10.49	39.23	49.72	60.00	-10.28	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;

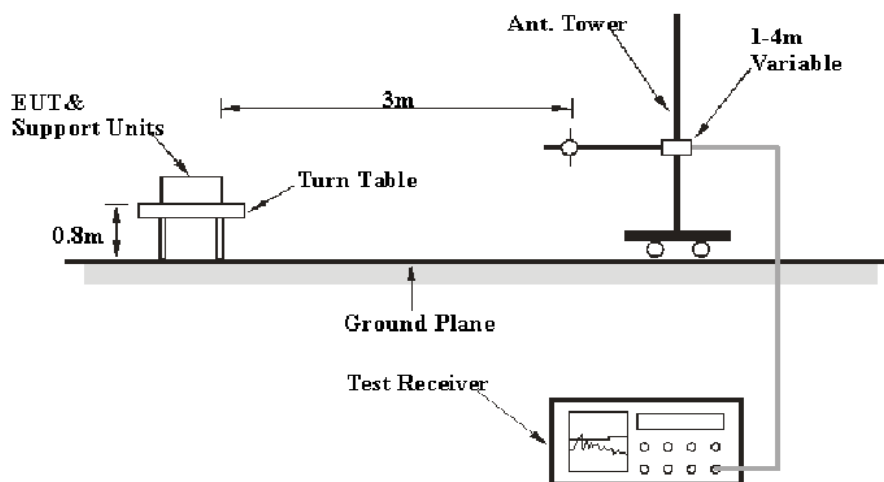
According to RSS-GEN § 8.10 & RSS-247 § 5.5

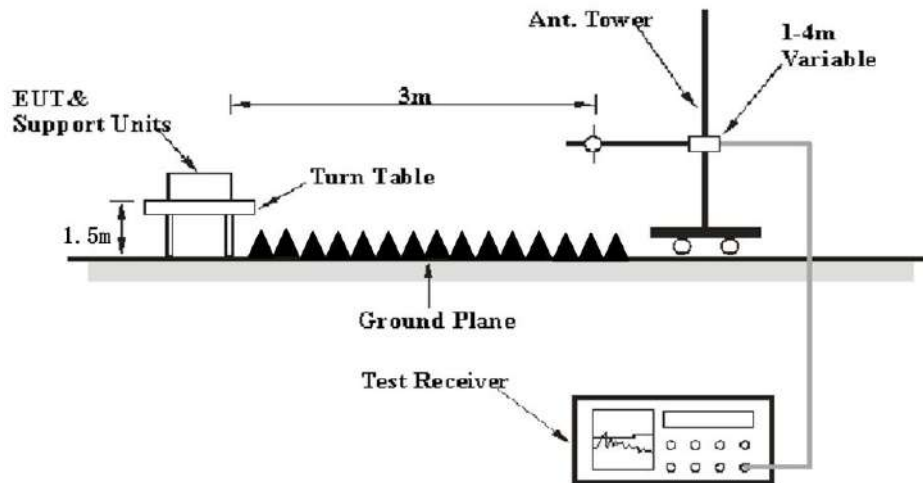
Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to 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.

Factor & 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:	24~25.5 °C
Relative Humidity:	52~57 %
ATM Pressure:	101.0 kPa

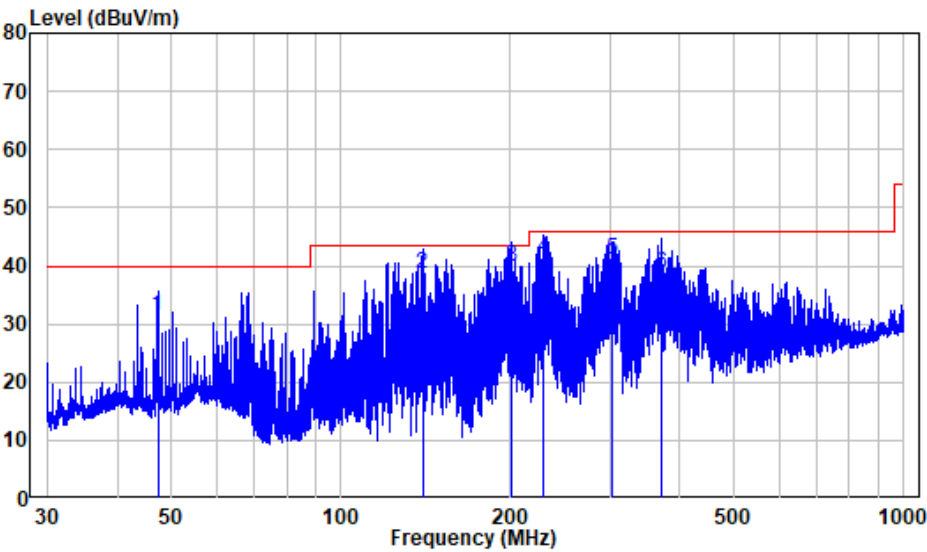
The testing was performed by Jason Liu on 2023-05-09 for below 1GHz and Jimi Zheng on 2023-04-17 for above 1GHz.

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

30 MHz~1 GHz:

Note: When the test result of Peak was more than 6dB below the limit of QP, just the Peak value was recorded.

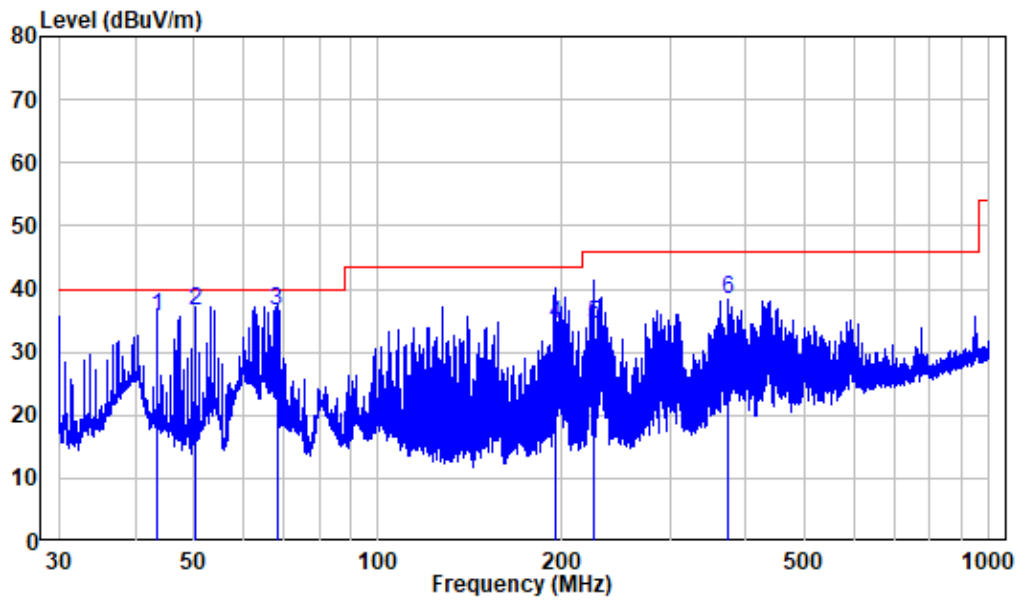
2.4G WiFi: (worst case is 802.11n20 mode, high channel)
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : RA230406-17345E-RF
Test Mode: 2.4G WIFI Transmitting

	Freq	Factor	Read Level	Level	Limit	Over	
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	Remark
1	47.222	-10.00	41.50	31.50	40.00	-8.50	QP
2	139.484	-15.42	54.09	38.67	43.50	-4.83	QP
3	200.249	-11.42	51.40	39.98	43.50	-3.52	QP
4	229.494	-11.13	52.40	41.27	46.00	-4.73	QP
5	302.216	-9.16	50.11	40.95	46.00	-5.05	QP
6	371.353	-7.30	46.00	38.70	46.00	-7.30	QP

Vertical



Site : chamber

Condition: 3m VERTICAL

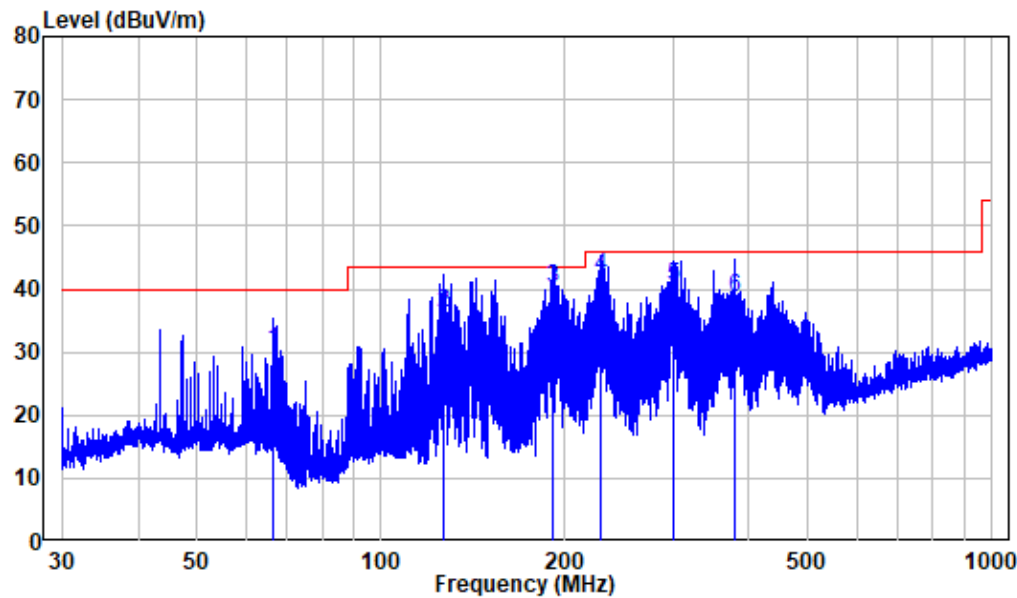
Job No. : RA230406-17345E-RF

Test Mode: 2.4G WIFI Transmitting

	Freq	Factor	Read Level	Limit Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	43.487	-9.93	45.70	35.77	40.00	-4.23	QP
2	50.254	-9.92	46.30	36.38	40.00	-3.62	QP
3	68.241	-13.95	50.60	36.65	40.00	-3.35	QP
4	194.966	-11.43	45.79	34.36	43.50	-9.14	QP
5	225.012	-11.26	45.60	34.34	46.00	-11.66	QP
6	374.294	-7.28	45.55	38.27	46.00	-7.73	Peak

BLE: (worst case is high channel)

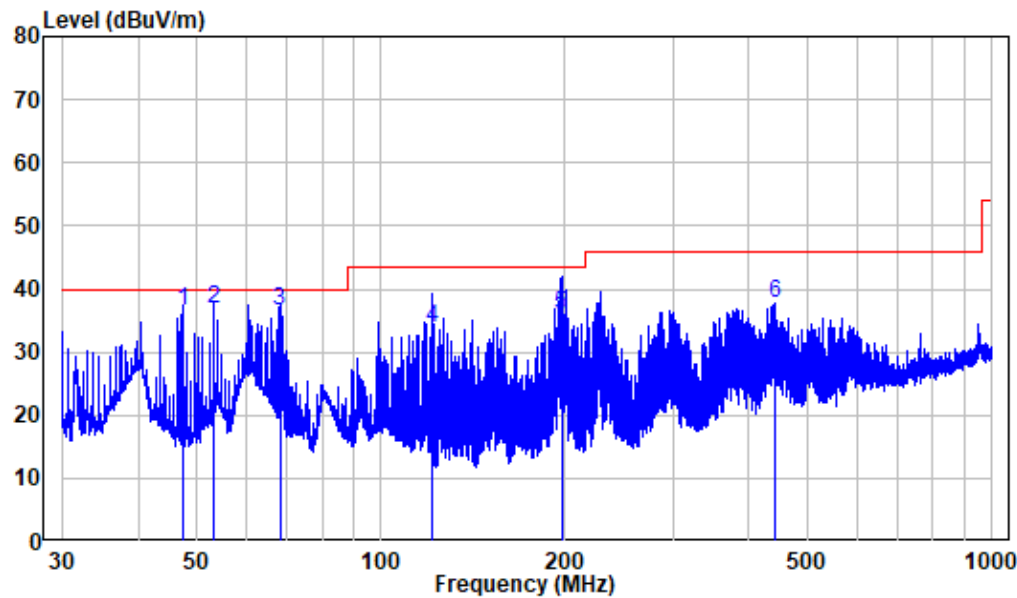
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : RA230406-17345E-RF
Test Mode: BLE Transmitting

	Freq Factor		Read	Limit	Over	Remark
	Level	Level	Line	Limit	Limit	
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB
1	66.703	-13.22	43.30	30.08	40.00	-9.92 QP
2	126.717	-14.51	50.80	36.29	43.50	-7.21 QP
3	191.241	-11.37	51.59	40.22	43.50	-3.28 QP
4	228.791	-11.15	53.20	42.05	46.00	-3.95 QP
5	301.555	-9.18	49.60	40.42	46.00	-5.58 QP
6	378.750	-7.17	45.80	38.63	46.00	-7.37 QP

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : RA230406-17345E-RF
Test Mode: BLE Transmitting

	Freq Factor		Read Level	Limit Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	47.263	-10.00	46.50	36.50	40.00	-3.50	QP
2	53.248	-10.21	47.10	36.89	40.00	-3.11	QP
3	68.241	-13.95	50.40	36.45	40.00	-3.55	QP
4	121.495	-13.83	47.61	33.78	43.50	-9.72	QP
5	197.287	-11.55	47.40	35.85	43.50	-7.65	QP
6	440.969	-5.64	43.28	37.64	46.00	-8.36	Peak

1 GHz-25 GHz:**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)									
2386.01	68.42	PK	280	1.5	H	-10.71	57.71	74	-16.29
2386.01	54.07	AV	280	1.5	H	-10.71	43.36	54	-10.64
2387.48	68.20	PK	352	1.5	V	-10.71	57.49	74	-16.51
2387.48	53.96	AV	352	1.5	V	-10.71	43.25	54	-10.75
2390	66.13	PK	330	1.6	H	-10.70	55.43	74	-18.57
2390	53.52	AV	330	1.6	H	-10.70	42.82	54	-11.18
2390	66.00	PK	85	2.4	V	-10.70	55.30	74	-18.70
2390	53.38	AV	85	2.4	V	-10.70	42.68	54	-11.32
4824	63.57	PK	360	1.1	H	-6.10	57.47	74	-16.53
4824	56.11	AV	360	1.1	H	-6.10	50.01	54	-3.99
4824	62.38	PK	197	1.1	V	-6.10	56.28	74	-17.72
4824	55.03	AV	197	1.1	V	-6.10	48.93	54	-5.07
Middle Channel(2437MHz)									
4874	59.68	PK	155	1.4	H	-5.29	54.39	74	-19.61
4874	52.58	AV	155	1.4	H	-5.29	47.29	54	-6.71
4874	59.03	PK	188	1.7	V	-5.29	53.74	74	-20.26
4874	51.89	AV	188	1.7	V	-5.29	46.6	54	-7.40
High Channel(2462 MHz)									
2483.5	54.90	PK	78	1.1	H	-10.46	44.44	74	-29.56
2483.5	42.40	AV	78	1.1	H	-10.46	31.94	54	-22.06
2483.5	54.05	PK	21	1.6	V	-10.46	43.59	74	-30.41
2483.5	41.58	AV	21	1.6	V	-10.46	31.12	54	-22.88
2483.75	56.88	PK	133	1.6	H	-10.46	46.42	74	-27.58
2483.75	42.45	AV	133	1.6	H	-10.46	31.99	54	-22.01
2483.96	56.03	PK	295	2.4	V	-10.46	45.57	74	-28.43
2483.96	41.56	AV	295	2.4	V	-10.46	31.1	54	-22.90
4924	60.30	PK	252	1.7	H	-5.03	55.27	74	-18.73
4924	53.62	AV	252	1.7	H	-5.03	48.59	54	-5.41
4924	59.97	PK	329	1	V	-5.03	54.94	74	-19.06
4924	49.59	AV	329	1	V	-5.03	44.56	54	-9.44

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)									
2385.25	68.60	PK	59	1.5	H	-10.71	57.89	74	-16.11
2385.25	54.29	AV	59	1.5	H	-10.71	43.58	54	-10.42
2387.68	68.42	PK	27	1.6	V	-10.71	57.71	74	-16.29
2387.68	54.16	AV	27	1.6	V	-10.71	43.45	54	-10.55
2390	66.22	PK	192	1.3	H	-10.70	55.52	74	-18.48
2390	53.66	AV	192	1.3	H	-10.70	42.96	54	-11.04
2390	66.11	PK	33	1.7	V	-10.70	55.41	74	-18.59
2390	53.53	AV	33	1.7	V	-10.70	42.83	54	-11.17
4824	61.55	PK	176	1	H	-6.10	55.45	74	-18.55
4824	46.38	AV	176	1	H	-6.10	40.28	54	-13.72
4824	61.33	PK	4	1.1	V	-6.10	55.23	74	-18.77
4824	46.16	AV	4	1.1	V	-6.10	40.06	54	-13.94
Middle Channel(2437MHz)									
4874	57.90	PK	316	1.4	H	-5.29	52.61	74	-21.39
4874	43.08	AV	316	1.4	H	-5.29	37.79	54	-16.21
4874	57.93	PK	127	1.8	V	-5.29	52.64	74	-21.36
4874	42.68	AV	127	1.8	V	-5.29	37.39	54	-16.61
High Channel(2462 MHz)									
2483.5	53.33	PK	136	2.1	H	-10.46	42.87	74	-31.13
2483.5	41.28	AV	136	2.1	H	-10.46	30.82	54	-23.18
2483.5	52.06	PK	228	2.2	V	-10.46	41.6	74	-32.40
2483.5	40.18	AV	228	2.2	V	-10.46	29.72	54	-24.28
2494.1	55.81	PK	193	2.2	H	-10.37	45.44	74	-28.56
2494.1	41.28	AV	193	2.2	H	-10.37	30.91	54	-23.09
2494.56	55.59	PK	131	2.2	V	-10.37	45.22	74	-28.78
2494.56	40.43	AV	131	2.2	V	-10.37	30.06	54	-23.94
4924	58.07	PK	118	2.1	H	-5.03	53.04	74	-20.96
4924	43.48	AV	118	2.1	H	-5.03	38.45	54	-15.55
4924	58.15	PK	336	2	V	-5.03	53.12	74	-20.88
4924	43.53	AV	336	2	V	-5.03	38.50	54	-15.50

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)									
2384.54	68.87	PK	261	1.8	H	-10.71	58.16	74	-15.84
2384.54	54.53	AV	261	1.8	H	-10.71	43.82	54	-10.18
2388.75	68.67	PK	29	1.6	V	-10.70	57.97	74	-16.03
2388.75	54.38	AV	29	1.6	V	-10.70	43.68	54	-10.32
2390	66.31	PK	60	1.4	H	-10.70	55.61	74	-18.39
2390	53.89	AV	60	1.4	H	-10.70	43.19	54	-10.81
2390	66.20	PK	315	1.8	V	-10.70	55.50	74	-18.50
2390	53.75	AV	315	1.8	V	-10.70	43.05	54	-10.95
4824	62.08	PK	340	1.6	H	-6.10	55.98	74	-18.02
4824	46.97	AV	340	1.6	H	-6.10	40.87	54	-13.13
4824	61.81	PK	323	1.3	V	-6.10	55.71	74	-18.29
4824	46.65	AV	323	1.3	V	-6.10	40.55	54	-13.45
Middle Channel(2437MHz)									
4874	60.68	PK	93	1.5	H	-5.29	55.39	74	-18.61
4874	45.67	AV	93	1.5	H	-5.29	40.38	54	-13.62
4874	60.56	PK	9	1.3	V	-5.29	55.27	74	-18.73
4874	43.50	AV	9	1.3	V	-5.29	38.21	54	-15.79
High Channel(2462 MHz)									
2483.5	66.64	PK	106	2.4	H	-10.46	56.18	74	-17.82
2483.5	45.84	AV	106	2.4	H	-10.46	35.38	54	-18.62
2483.5	65.08	PK	93	2.5	V	-10.46	54.62	74	-19.38
2483.5	45.44	AV	93	2.5	V	-10.46	34.98	54	-19.02
2483.75	67.54	PK	310	2	H	-10.46	57.08	74	-16.92
2483.75	45.81	AV	310	2	H	-10.46	35.35	54	-18.65
2484.55	65.96	PK	17	2.2	V	-10.45	55.51	74	-18.49
2484.55	41.93	AV	17	2.2	V	-10.45	31.48	54	-22.52
4924	61.68	PK	221	1.3	H	-5.03	56.65	74	-17.35
4924	46.64	AV	221	1.3	H	-5.03	41.61	54	-12.39
4924	61.56	PK	286	2.2	V	-5.03	56.53	74	-17.47
4924	45.57	AV	286	2.2	V	-5.03	40.54	54	-13.46

BLE:

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)				
BLE_1M									
Low Channel 2402MHz									
2389.15	69.28	PK	281	2.4	H	-10.70	58.58	74	-15.42
2389.15	59.09	AV	281	2.4	H	-10.70	48.39	54	-5.61
2388.86	69.01	PK	135	1.3	V	-10.70	58.31	74	-15.69
2388.86	58.86	AV	135	1.3	V	-10.70	48.16	54	-5.84
2390	67.49	PK	297	2.2	H	-10.70	56.79	74	-17.21
2390	54.72	AV	297	2.2	H	-10.70	44.02	54	-9.98
2390	67.23	PK	176	1.5	V	-10.70	56.53	74	-17.47
2390	54.45	AV	176	1.5	V	-10.70	43.75	54	-10.25
4804	63.10	PK	291	2	H	-6.11	56.99	74	-17.01
4804	51.41	AV	291	2	H	-6.11	45.30	54	-8.70
4804	61.53	PK	297	1.3	V	-6.11	55.42	74	-18.58
4804	49.74	AV	297	1.3	V	-6.11	43.63	54	-10.37
Middle Channel 2440MHz									
4880	62.61	PK	219	2	H	-5.91	56.7	74	-17.30
4880	50.92	AV	219	2	H	-5.91	45.01	54	-8.99
4880	61.24	PK	347	1.6	V	-5.91	55.33	74	-18.67
4880	49.29	AV	347	1.6	V	-5.91	43.38	54	-10.62
High Channel 2480MHz									
2483.5	74.12	PK	259	1.4	H	-10.55	63.57	74	-10.43
2483.5	60.97	AV	259	1.4	H	-10.55	50.42	54	-3.58
2483.5	73.65	PK	204	2.5	V	-10.55	63.1	74	-10.90
2483.5	60.79	AV	204	2.5	V	-10.55	50.24	54	-3.76
2485.45	75.22	PK	299	1.9	H	-10.53	64.69	74	-9.31
2485.45	61.51	AV	299	1.9	H	-10.53	50.98	54	-3.02
2484.68	74.85	PK	213	2.2	V	-10.54	64.31	74	-9.69
2484.68	61.30	AV	213	2.2	V	-10.54	50.76	54	-3.24
4960	62.00	PK	194	2	H	-5.47	56.53	74	-17.47
4960	49.93	AV	194	2	H	-5.47	44.46	54	-9.54
4960	60.57	PK	194	2.5	V	-5.47	55.10	74	-18.90
4960	48.51	AV	194	2.5	V	-5.47	43.04	54	-10.96

Note:

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

Corrected Amplitude = Corrected Factor + Reading

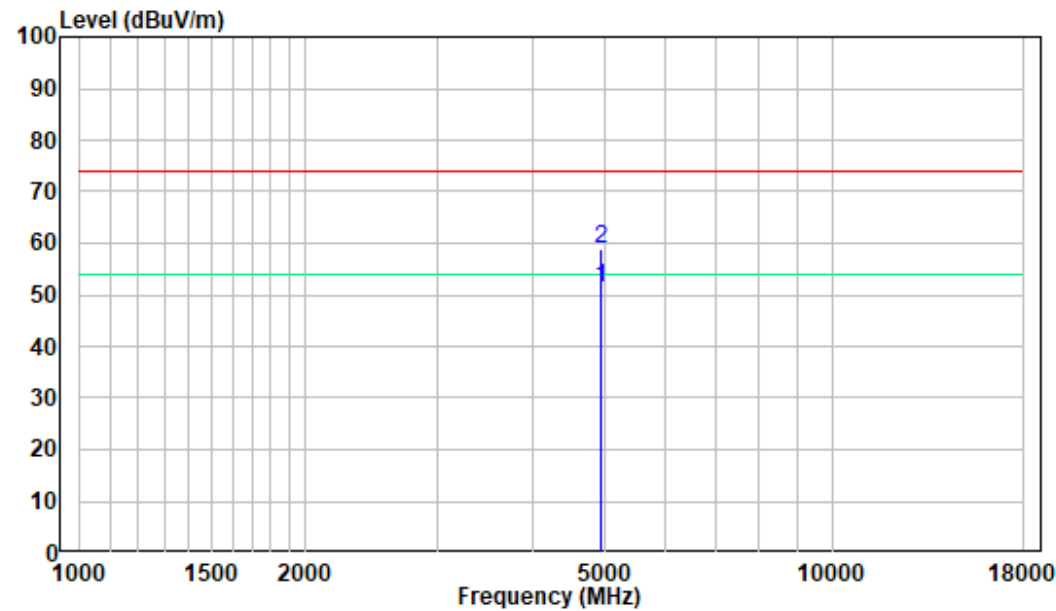
Margin = Corrected Amplitude - Limit

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

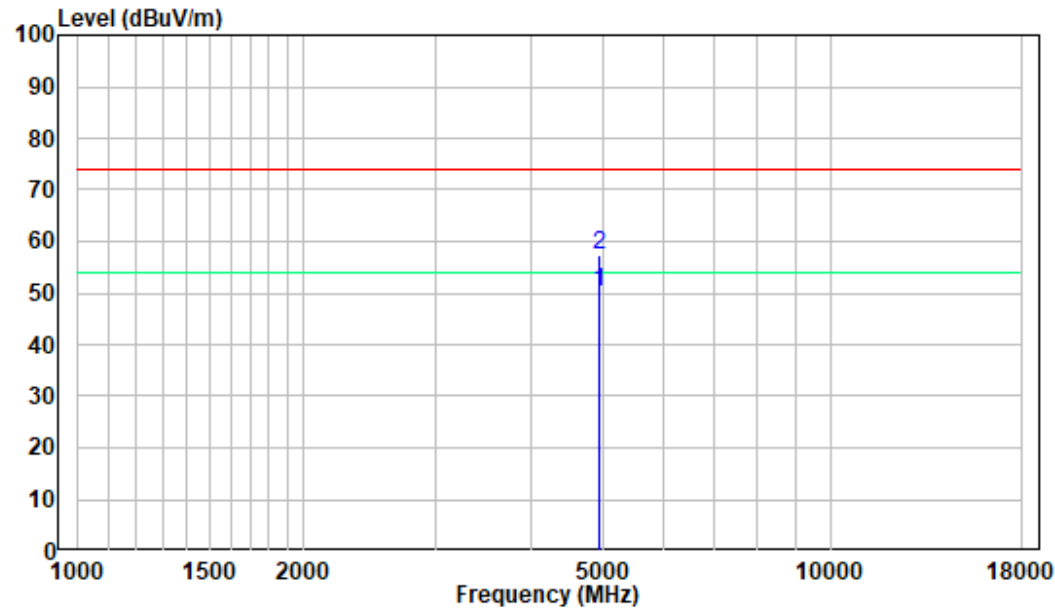
1-18 GHz:

Pre-scan for 802.11b Low Channel

Horizontal



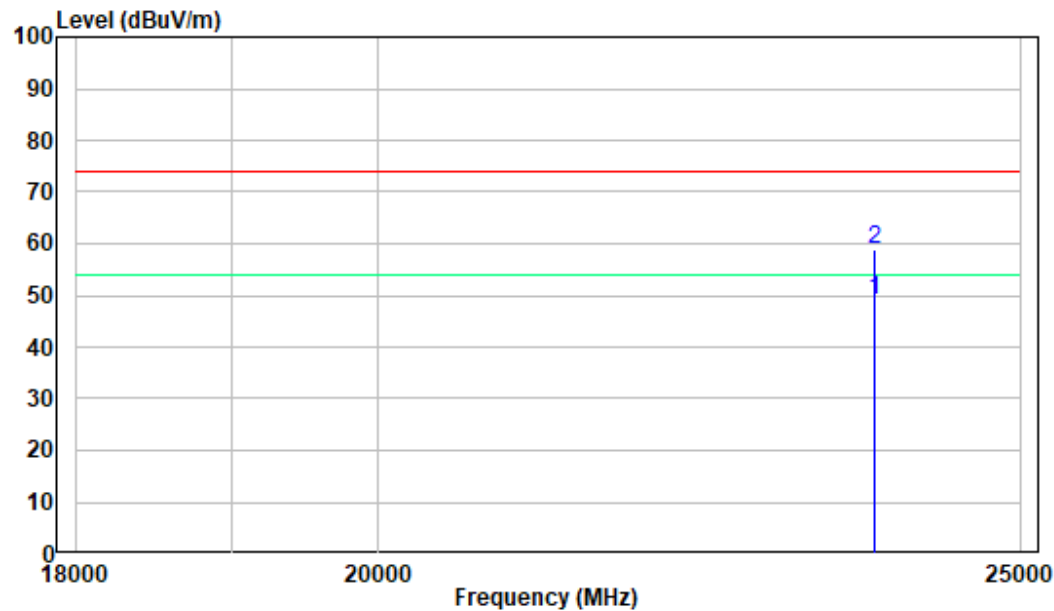
Vertical



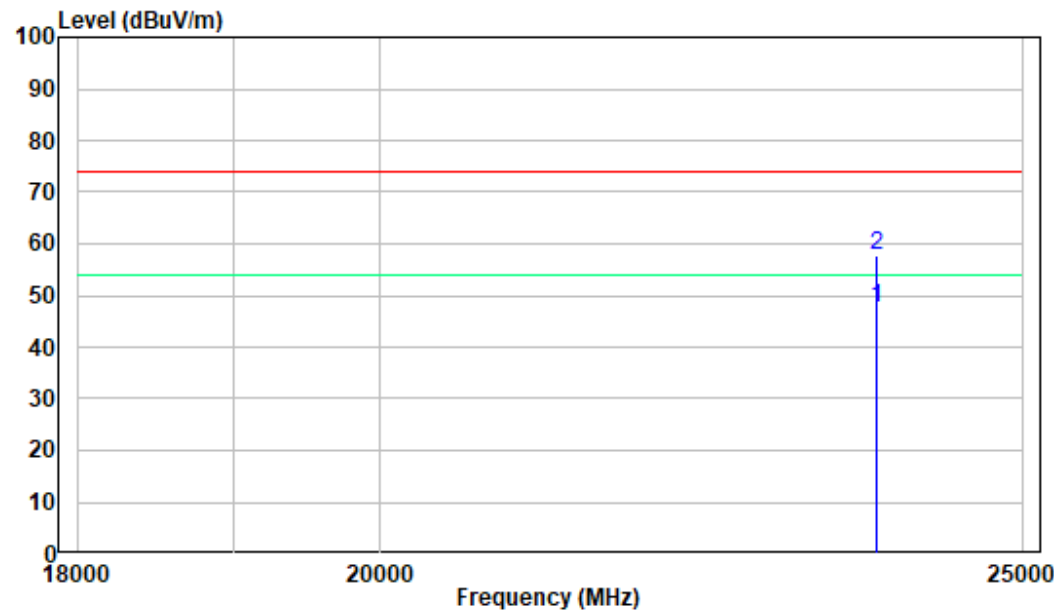
18 -25GHz:

Pre-scan for 802.11b Low 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 and Clause 6.9.3

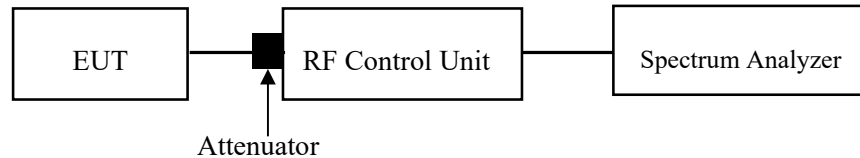
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency 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:	25 °C
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Roger Ling on 2023-05-03.

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).

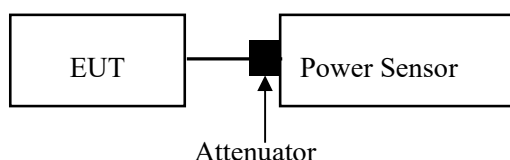
As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the 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

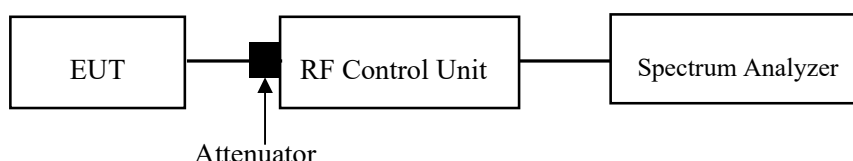
Test Method: ANSI C63.10-2013 Clause 11.9.1.1 for BLE and 11.9.1.3 for Wi-Fi

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

The testing was performed by Roger Ling on 2023-05-03.

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

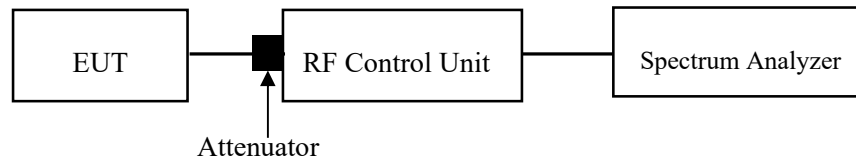
Applicable Standard

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

The testing was performed by Roger Ling on 2023-05-03.

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

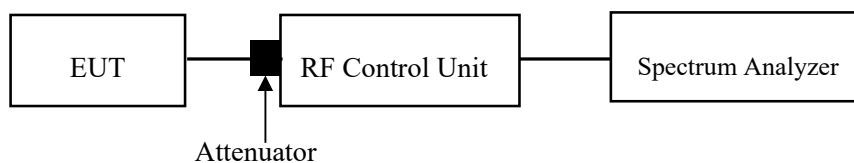
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of 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 Data**Environmental Conditions**

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

The testing was performed by Roger Ling on 2023-05-03.

EUT operation mode: Transmitting

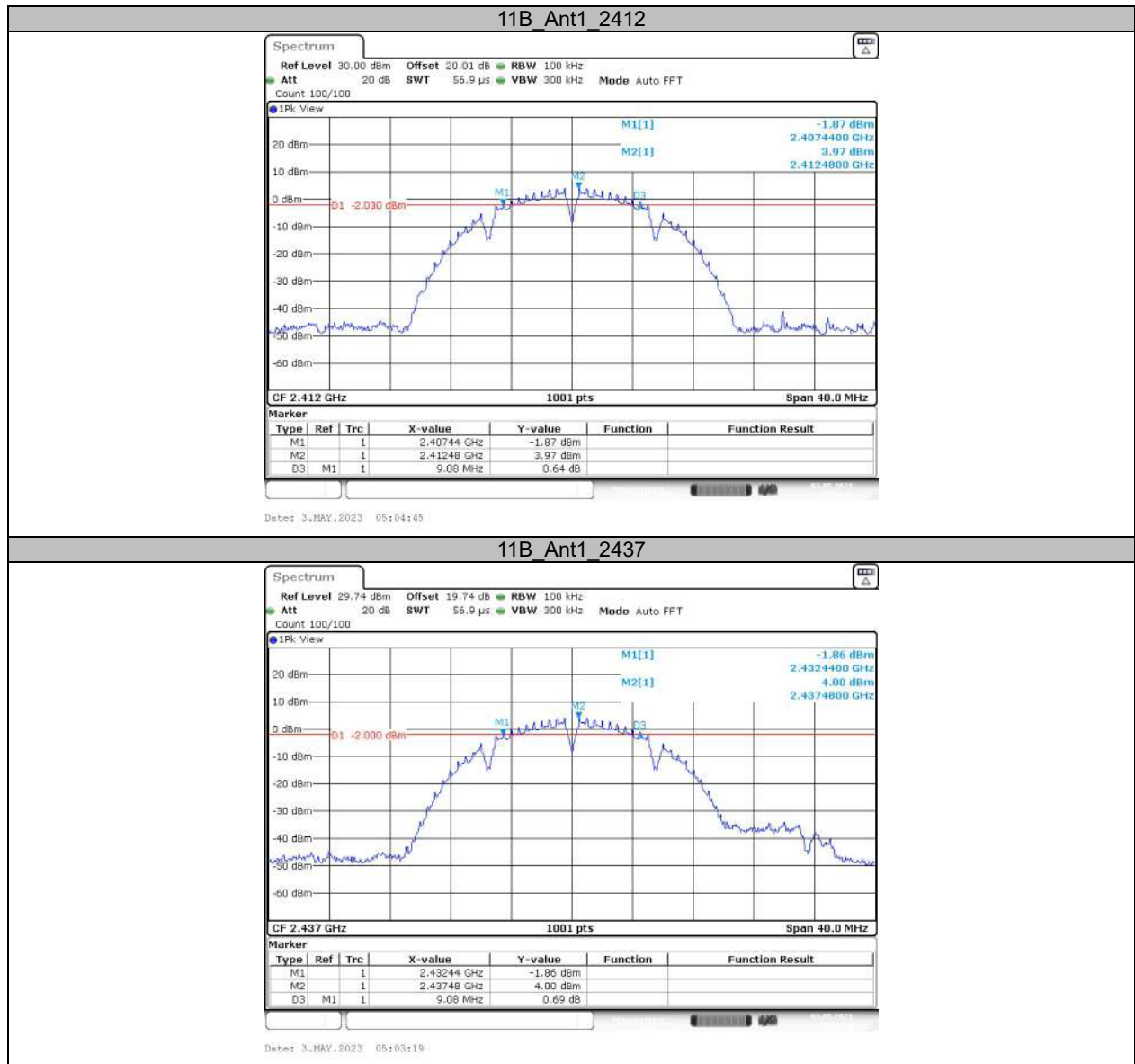
Test Result: Compliant. Please refer to the Appendix Wi-Fi and Appendix BLE.

APPENDIX Wi-Fi

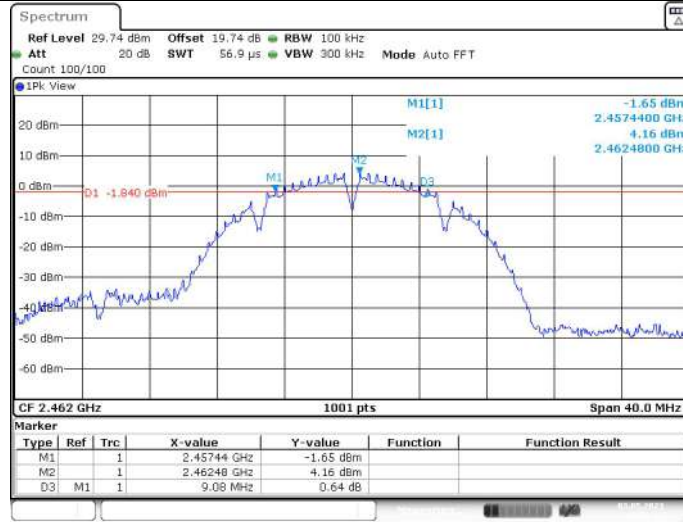
Appendix A: DTS Bandwidth Test Result

Test Mode	Antenna	Frequency[MHz]	DTS BW [MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	9.08	0.5	PASS
		2437	9.08	0.5	PASS
		2462	9.08	0.5	PASS
11G	Ant1	2412	16.56	0.5	PASS
		2437	16.56	0.5	PASS
		2462	16.56	0.5	PASS
11N20SISO	Ant1	2412	17.80	0.5	PASS
		2437	17.80	0.5	PASS
		2462	17.80	0.5	PASS

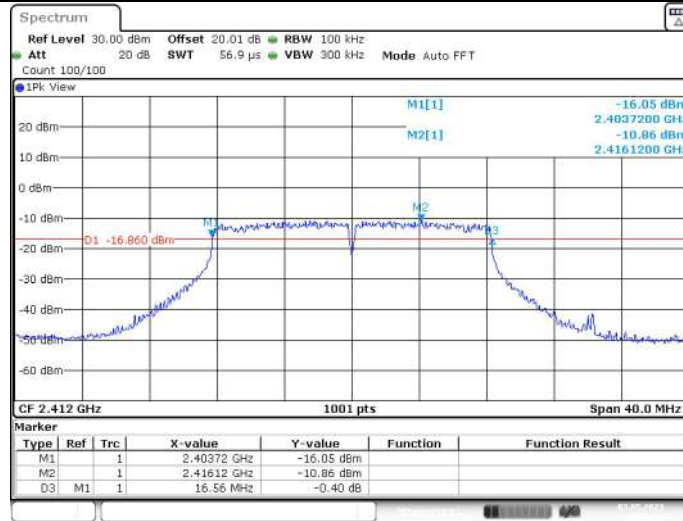
Test Graphs



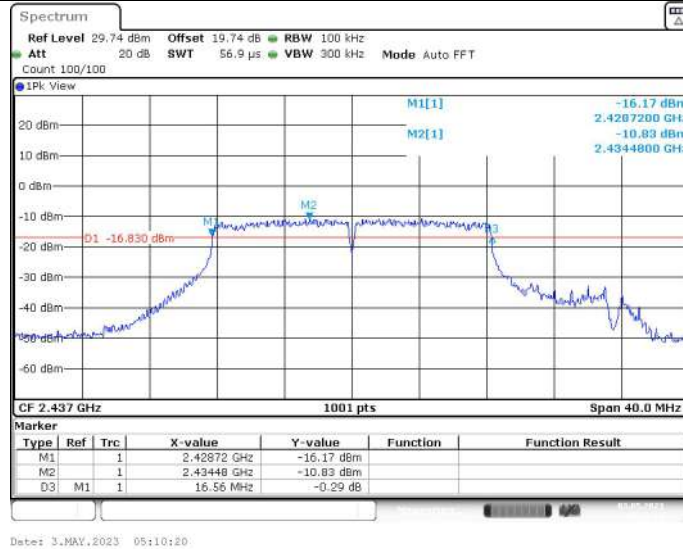
11B_Ant1_2462



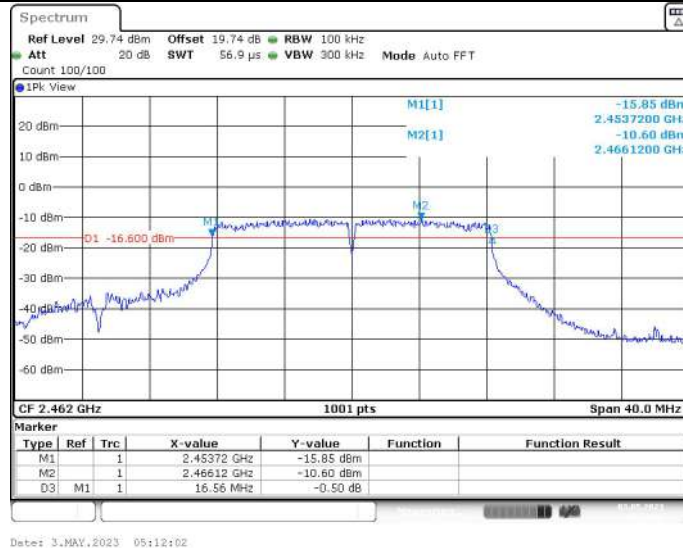
11G_Ant1_2412

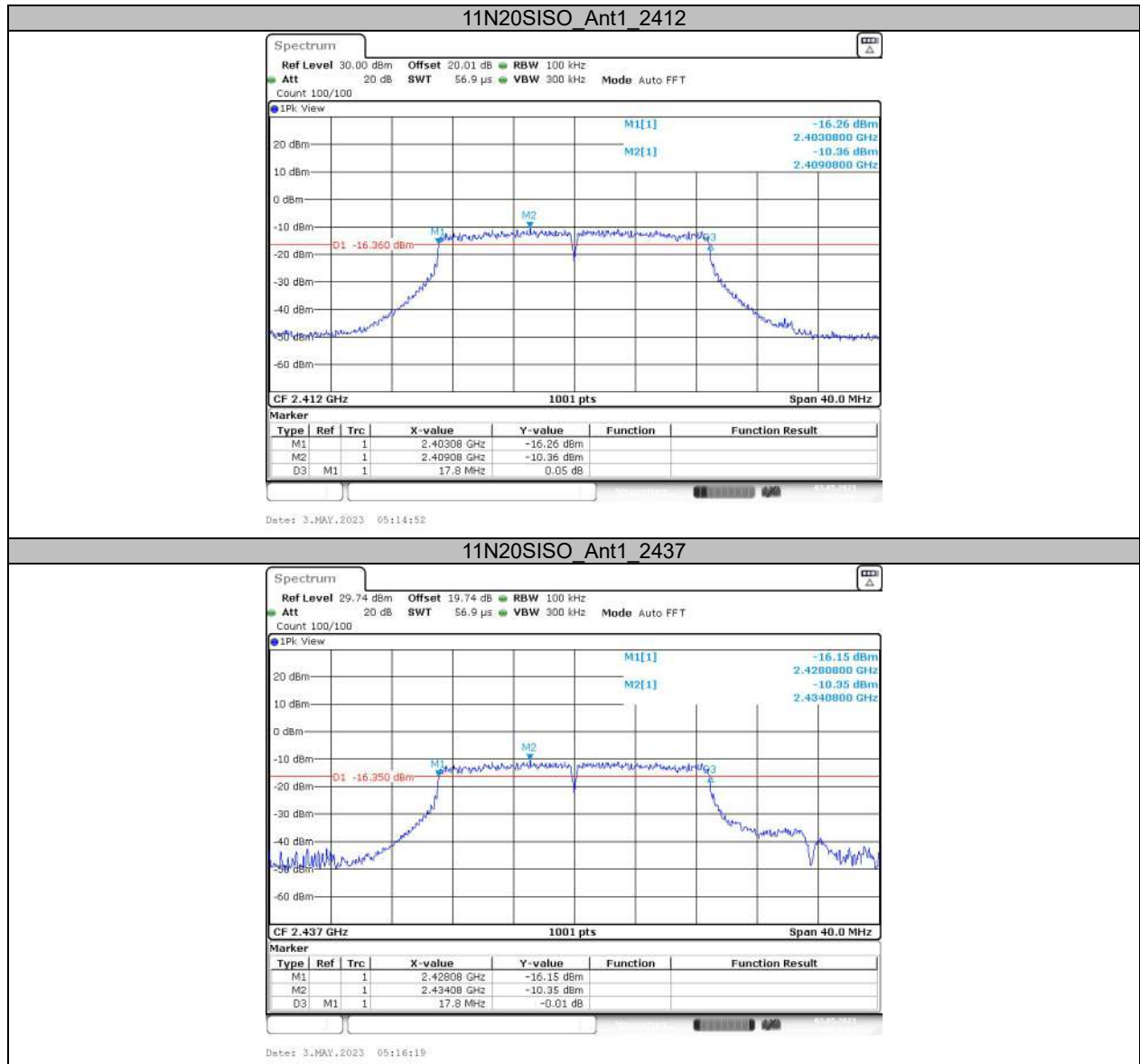


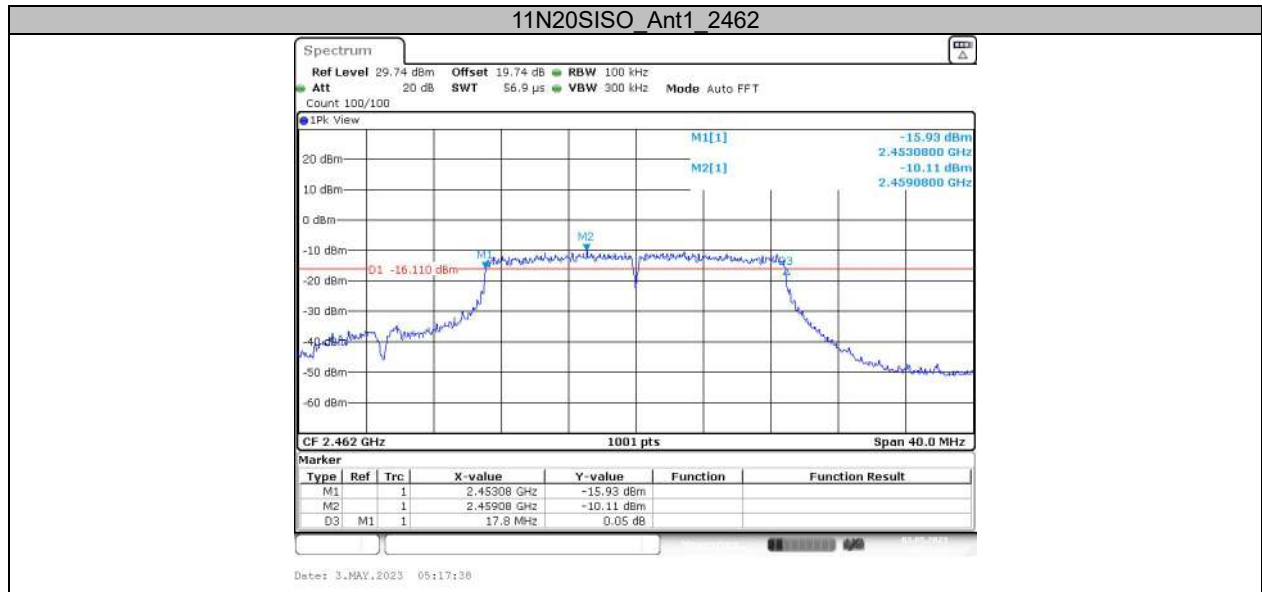
11G_Ant1_2437



11G_Ant1_2462



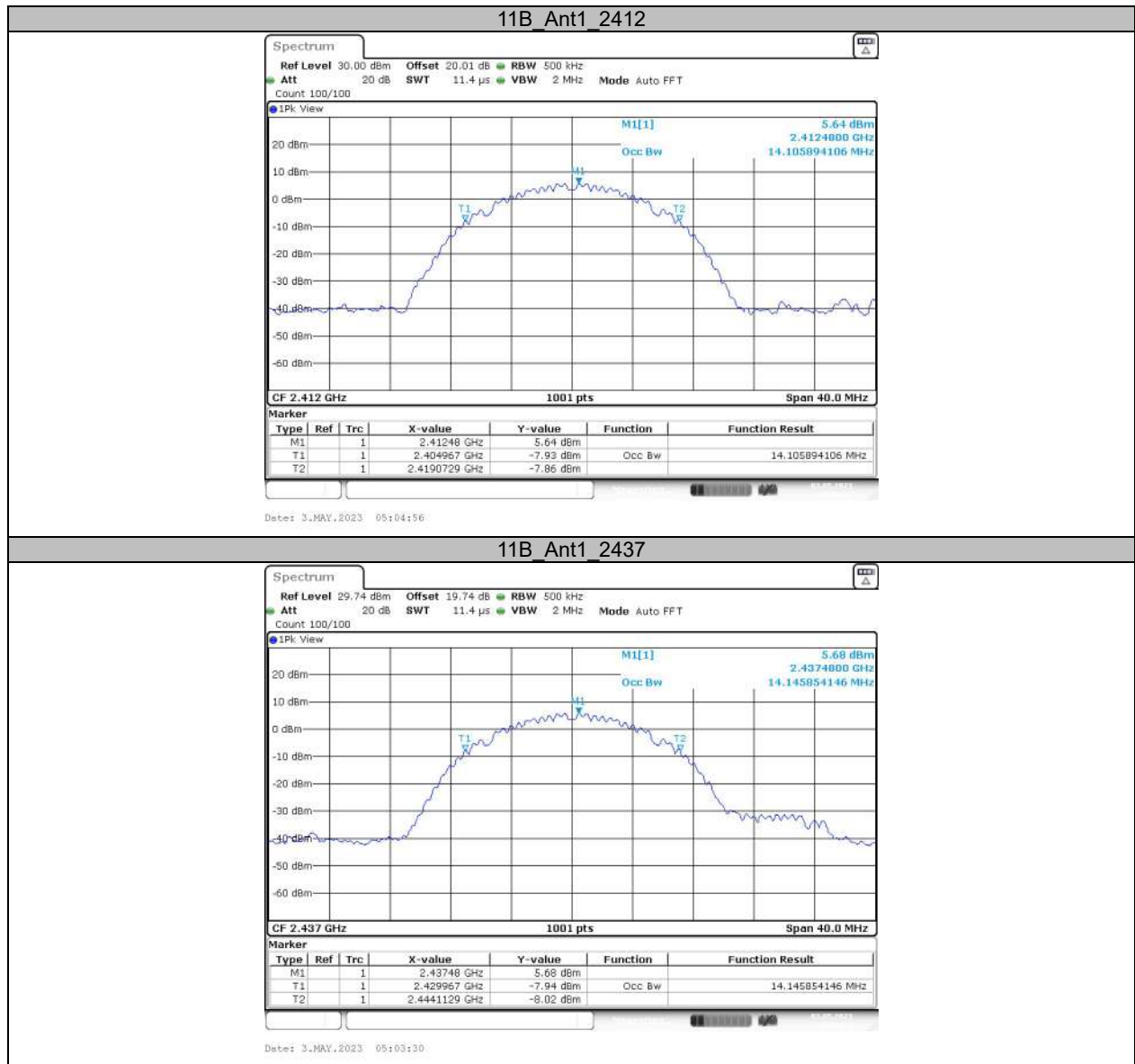




**Appendix B: Occupied Channel Bandwidth
Test Result**

Test Mode	Antenna	ChannelFrequency[MHz]	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	14.106	2404.967	2419.073	---	---
		2437	14.146	2429.967	2444.113	---	---
		2462	14.146	2454.927	2469.073	---	---
11G	Ant1	2412	17.303	2403.289	2420.591	---	---
		2437	17.662	2427.969	2445.631	---	---
		2462	17.622	2452.929	2470.551	---	---
11N20SISO	Ant1	2412	18.462	2402.689	2421.151	---	---
		2437	18.541	2427.649	2446.191	---	---
		2462	18.462	2452.689	2471.151	---	---

Test Graphs



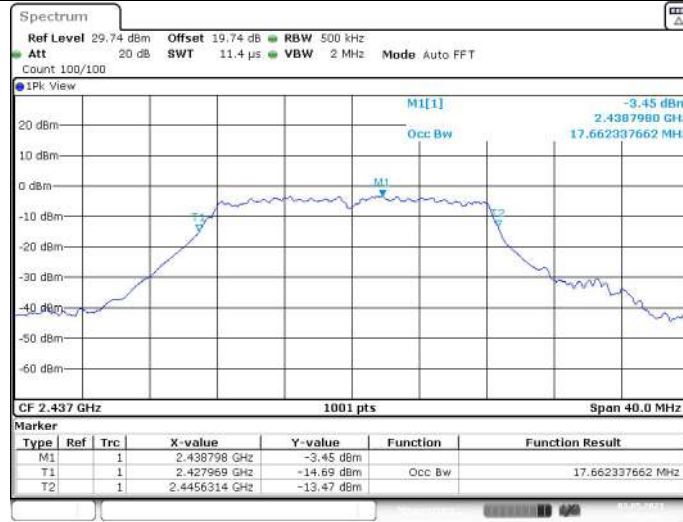
11B_Ant1_2462



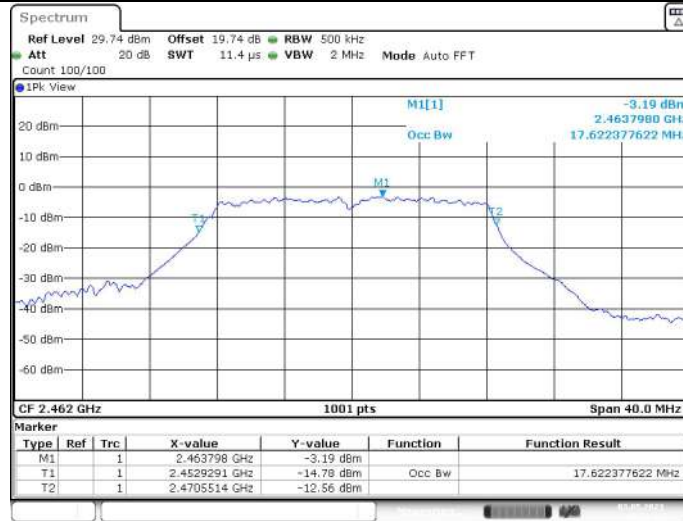
11G_Ant1_2412



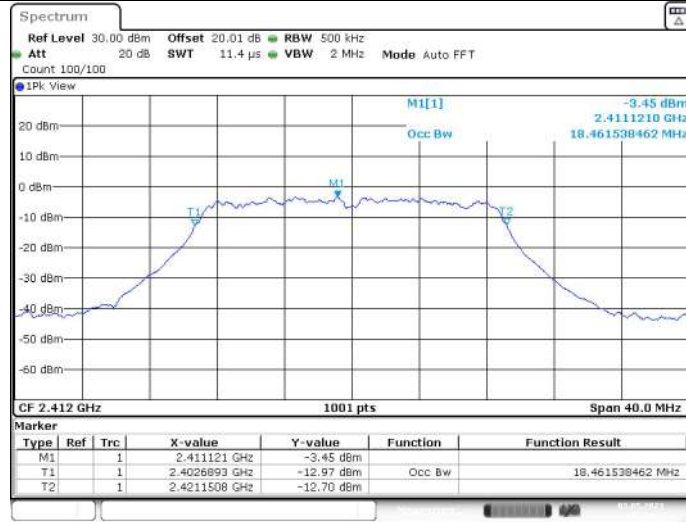
11G_Ant1_2437



11G_Ant1_2462

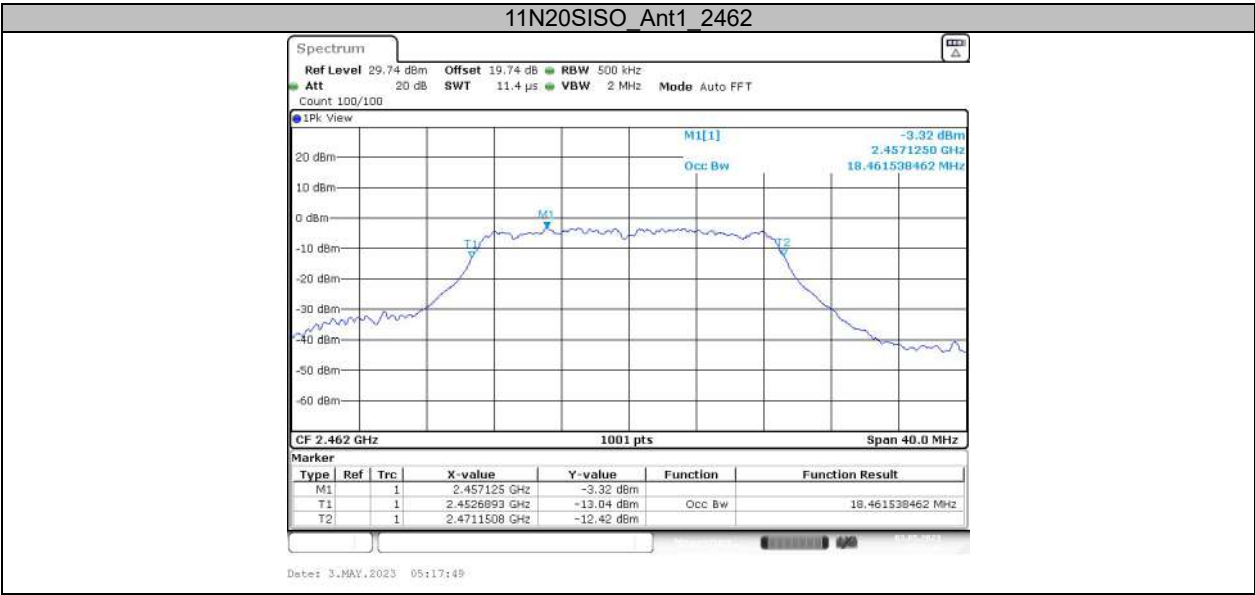


11N20SISO Ant1 2412



11N20SISO Ant1 2437





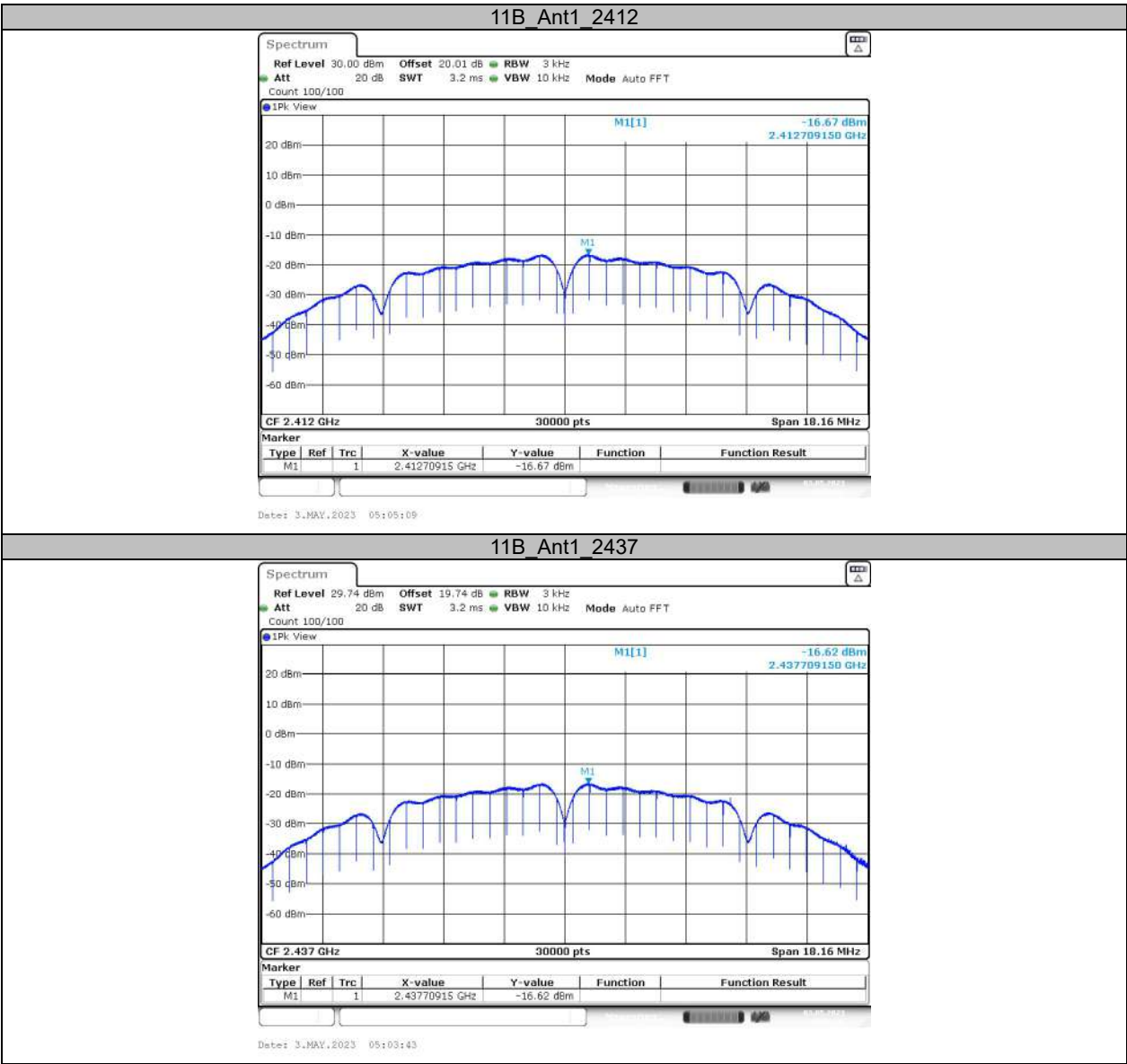
**Appendix C: Maximum conducted output power
Test Result Peak**

Test Mode	Antenna	Frequen cy[MHz]	Peak Power[dBm]	Conducted Limit[dBm]	Antenna Gain [dBi]	EIRP [dBm]	EIRP Limit[dBm]	Verdict
11B	Ant1	2412	16.68	≤30.00	3.98	20.66	≤36.00	PASS
		2437	16.72	≤30.00	3.98	20.7	≤36.00	PASS
		2462	16.89	≤30.00	3.98	20.87	≤36.00	PASS
11G	Ant1	2412	10.65	≤30.00	3.98	14.63	≤36.00	PASS
		2437	10.78	≤30.00	3.98	14.76	≤36.00	PASS
		2462	10.90	≤30.00	3.98	14.88	≤36.00	PASS
11N20SIS O	Ant1	2412	10.95	≤30.00	3.98	14.93	≤36.00	PASS
		2437	11.00	≤30.00	3.98	14.98	≤36.00	PASS
		2462	11.21	≤30.00	3.98	15.19	≤36.00	PASS

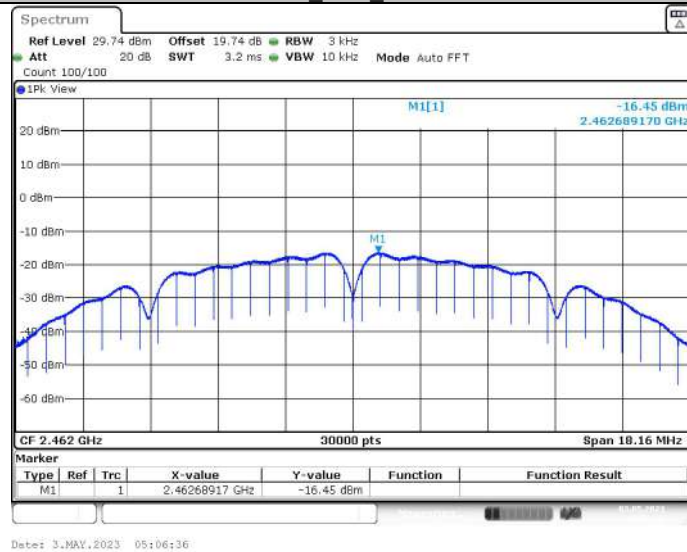
**Appendix D: Maximum power spectral density
Test Result**

Test Mode	Antenna	Frequency[MHz]	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
11B	Ant1	2412	-16.67	≤8.00	PASS
		2437	-16.62	≤8.00	PASS
		2462	-16.45	≤8.00	PASS
11G	Ant1	2412	-25.30	≤8.00	PASS
		2437	-23.85	≤8.00	PASS
		2462	-25.09	≤8.00	PASS
11N20SISO	Ant1	2412	-24.61	≤8.00	PASS
		2437	-24.61	≤8.00	PASS
		2462	-24.37	≤8.00	PASS

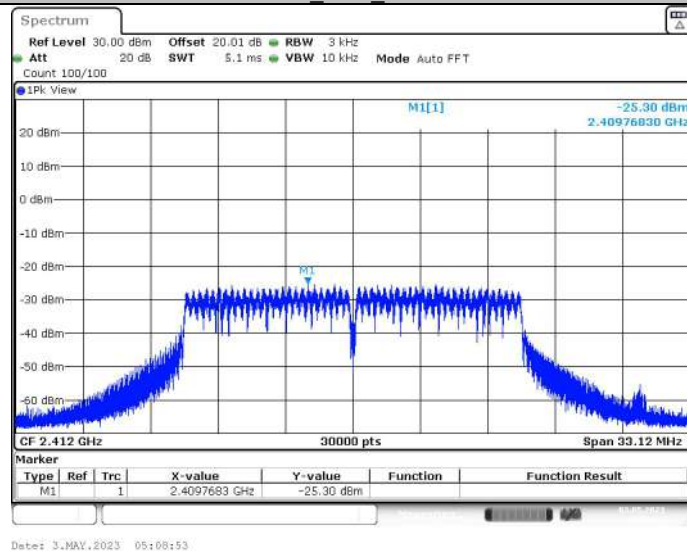
Test Graphs



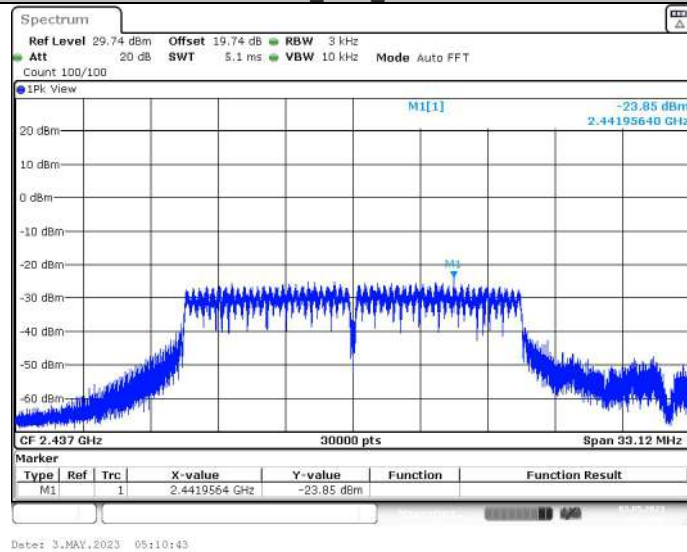
11B_Ant1_2462



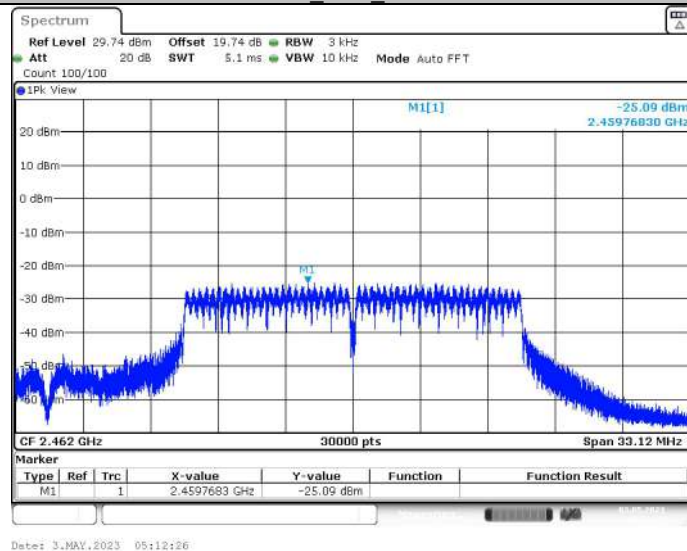
11G_Ant1_2412



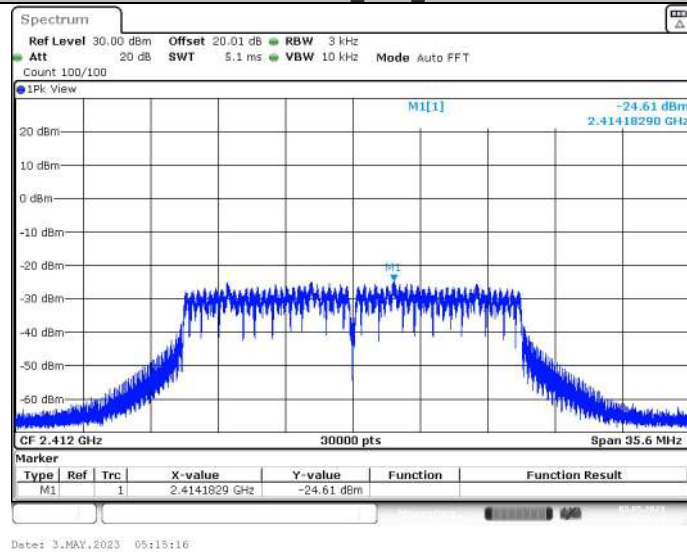
11G_Ant1_2437



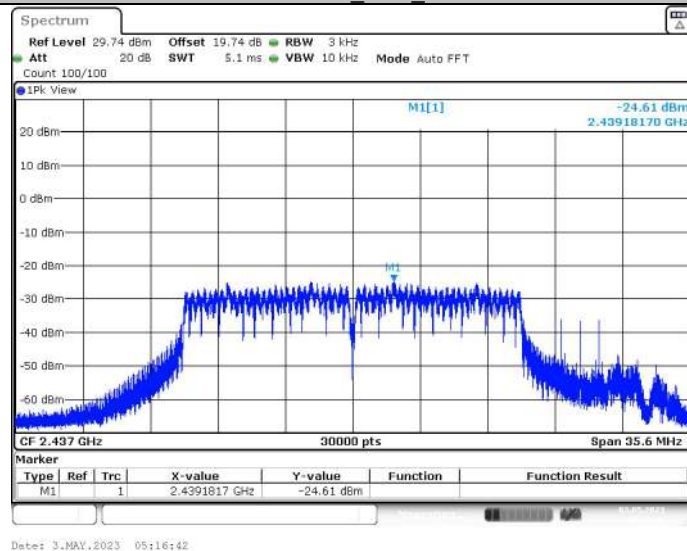
11G_Ant1_2462

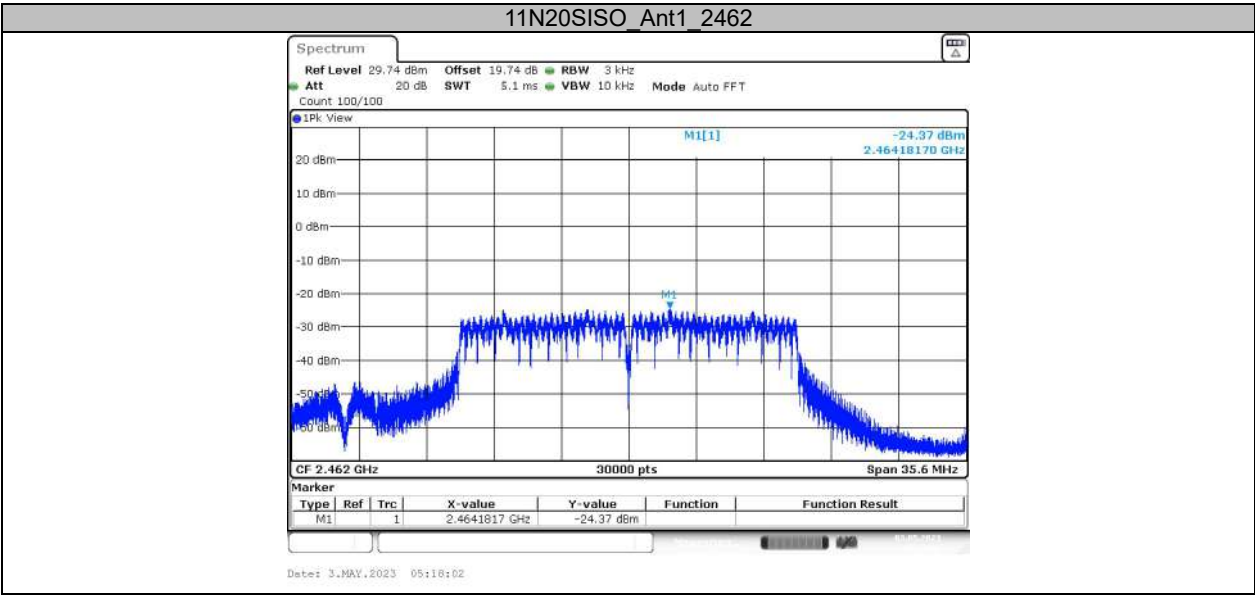


11N20SISO Ant1 2412



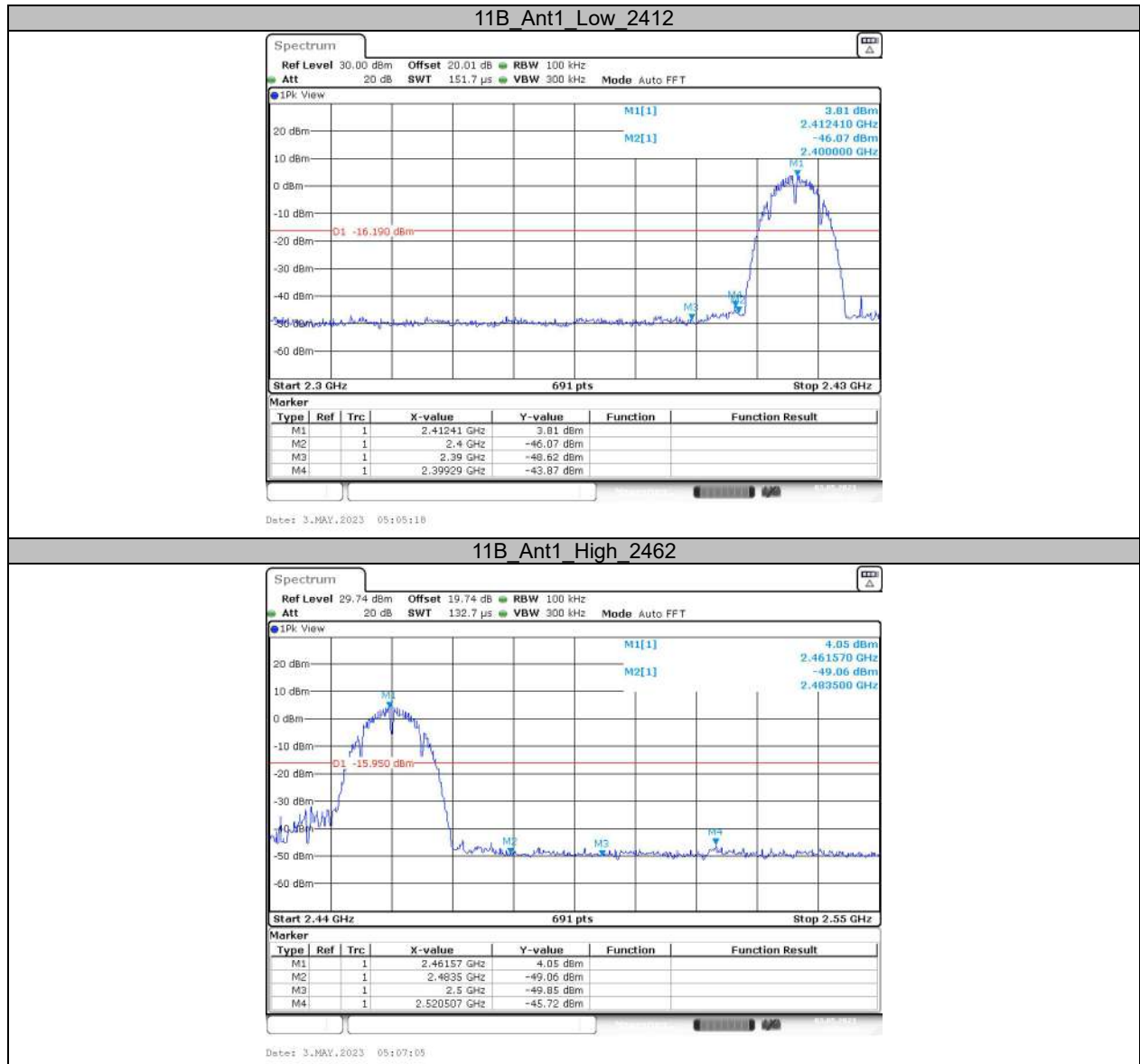
11N20SISO Ant1 2437



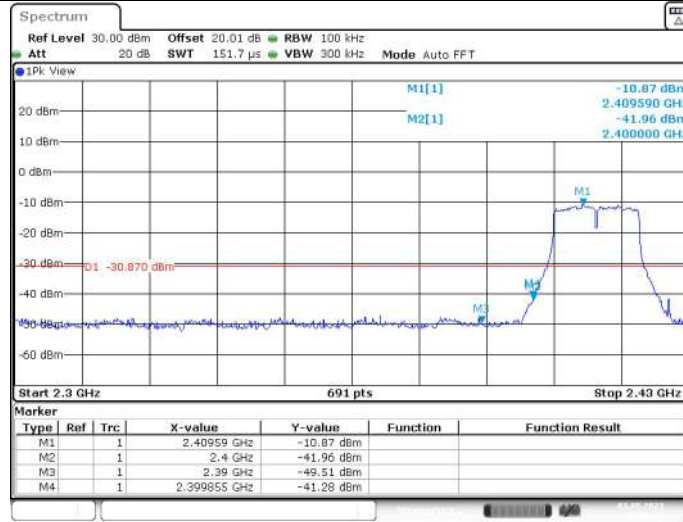


Appendix E: Band edge measurements

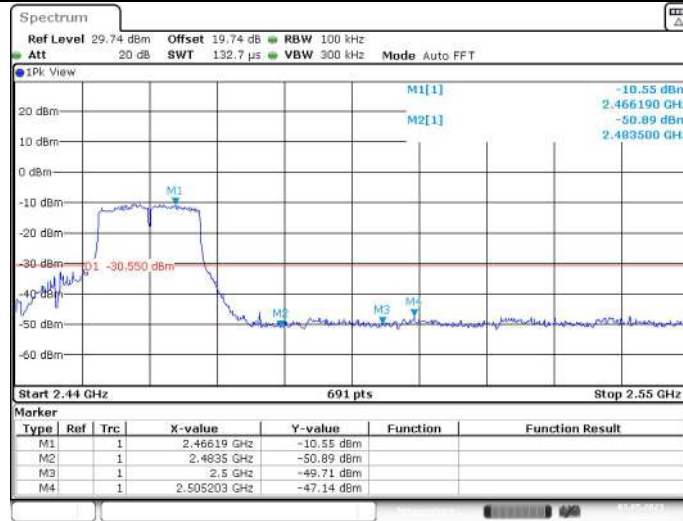
Test Graphs

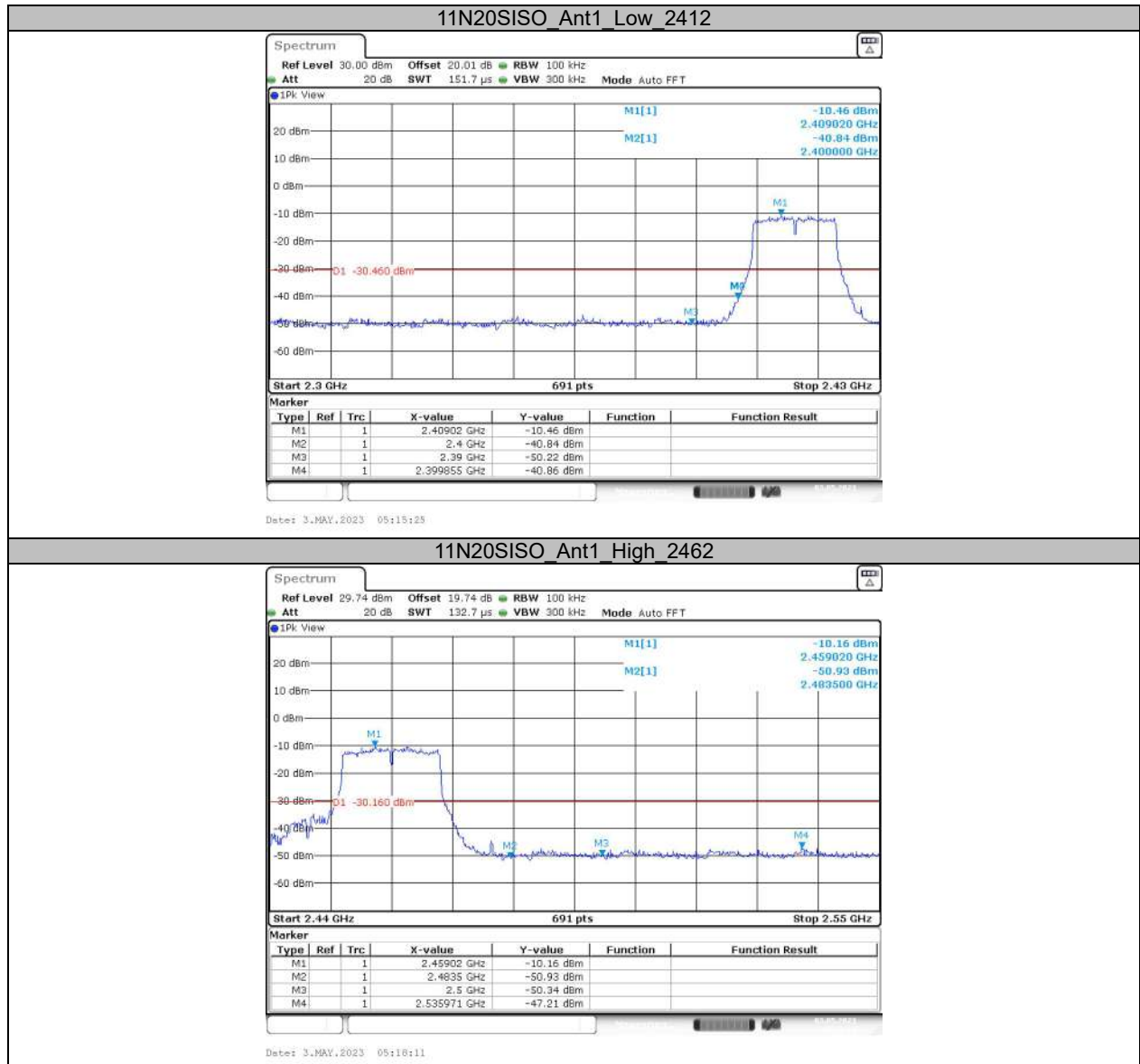


11G Ant1 Low 2412



11G Ant1 High 2462



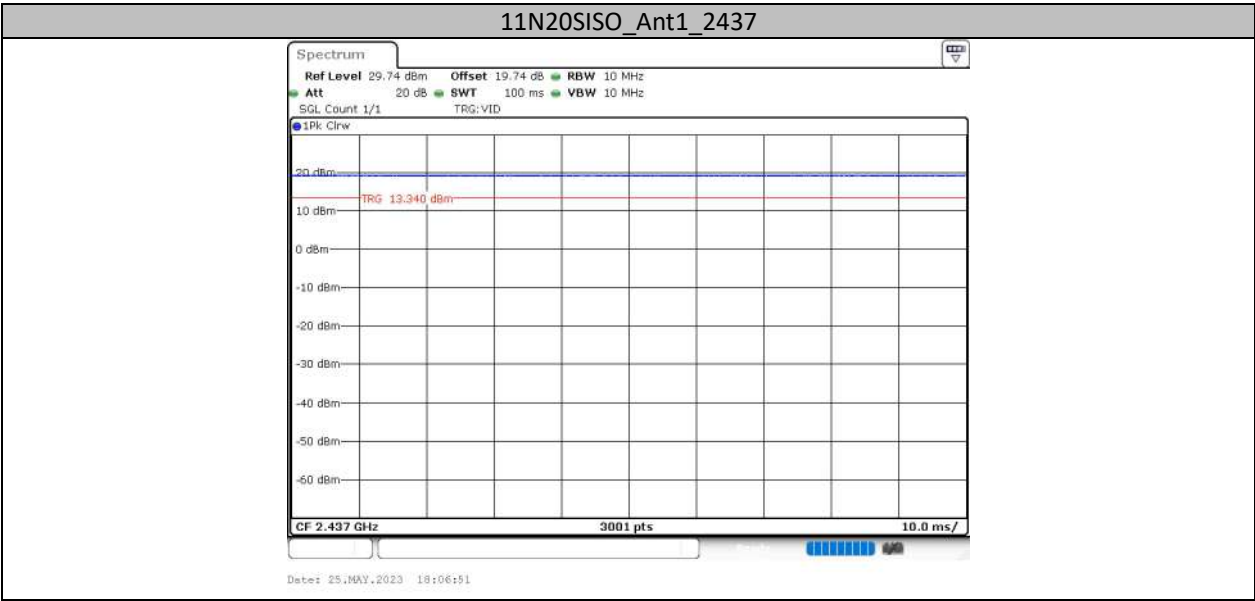


**Appendix F: Duty Cycle
Test Result**

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

Test Graphs



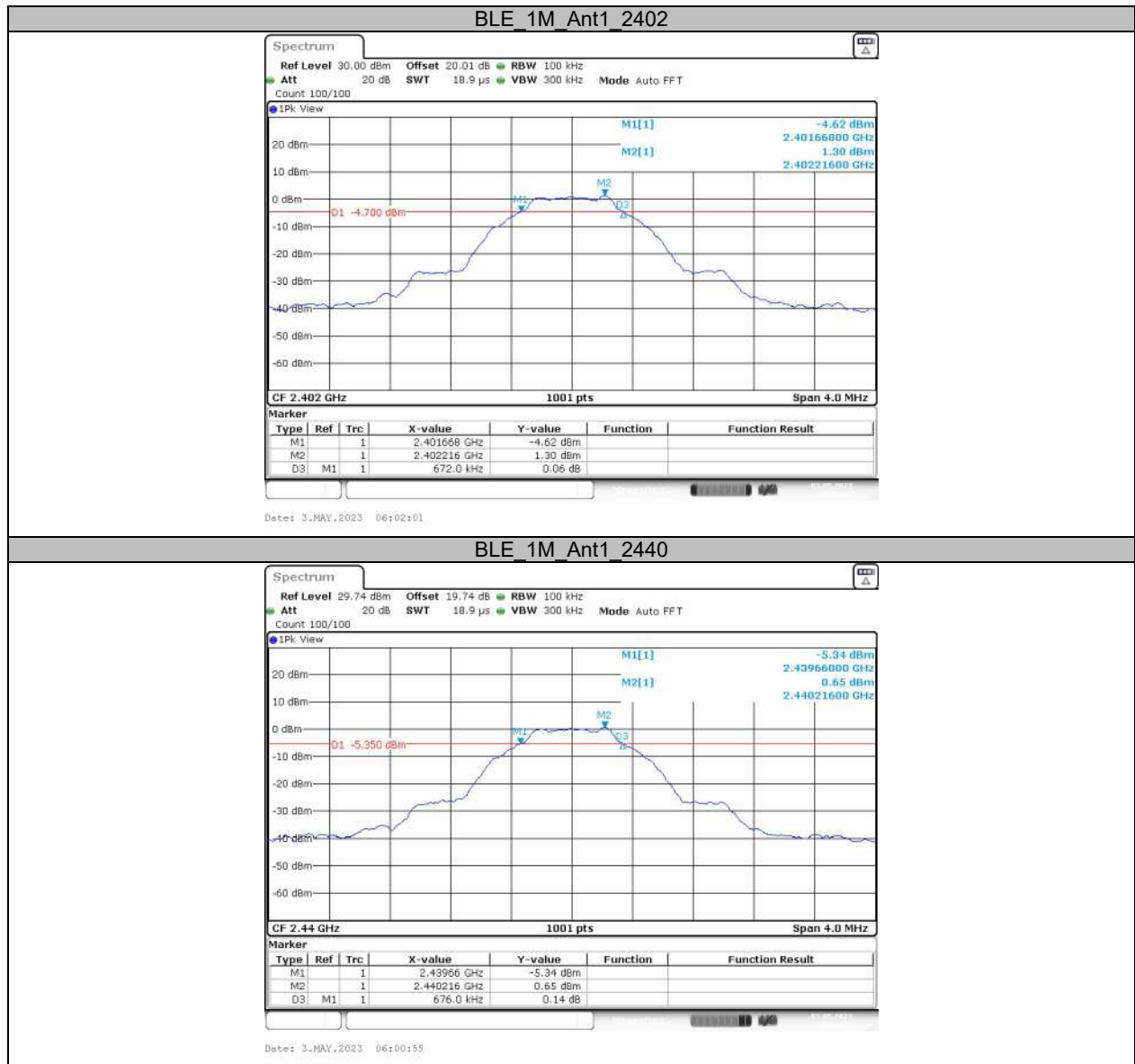


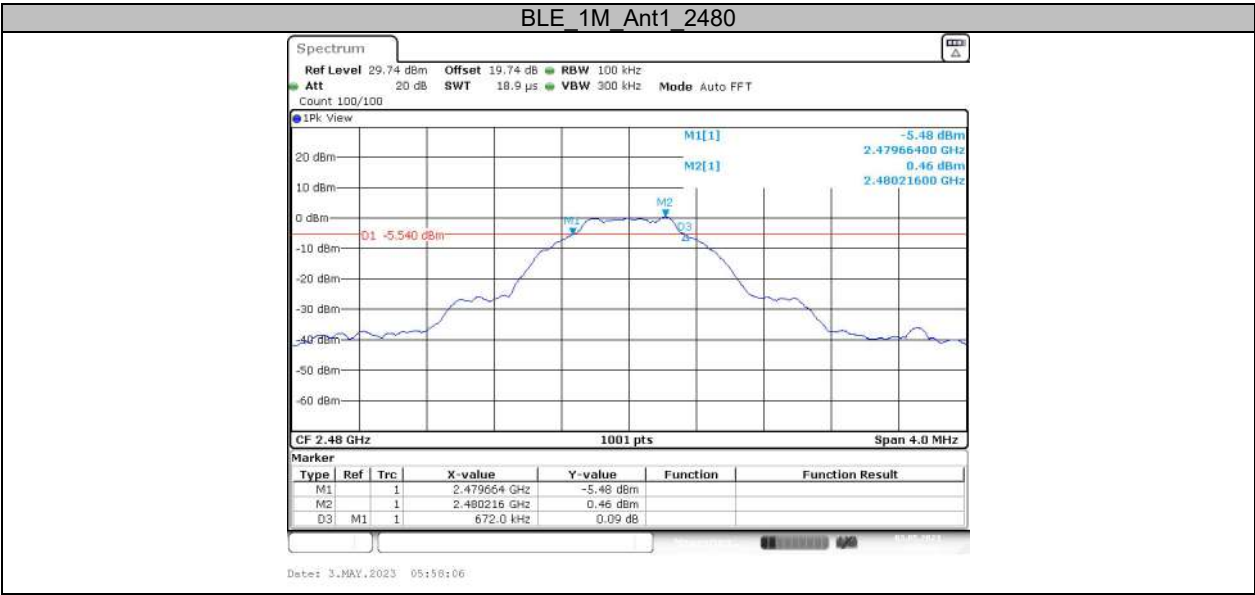
APPENDIX BLE

Appendix A: DTS Bandwidth Test Result

Test Mode	Antenna	Frequency[MHz]	DTS BW [MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.67	0.5	PASS
		2440	0.68	0.5	PASS
		2480	0.67	0.5	PASS

Test Graphs

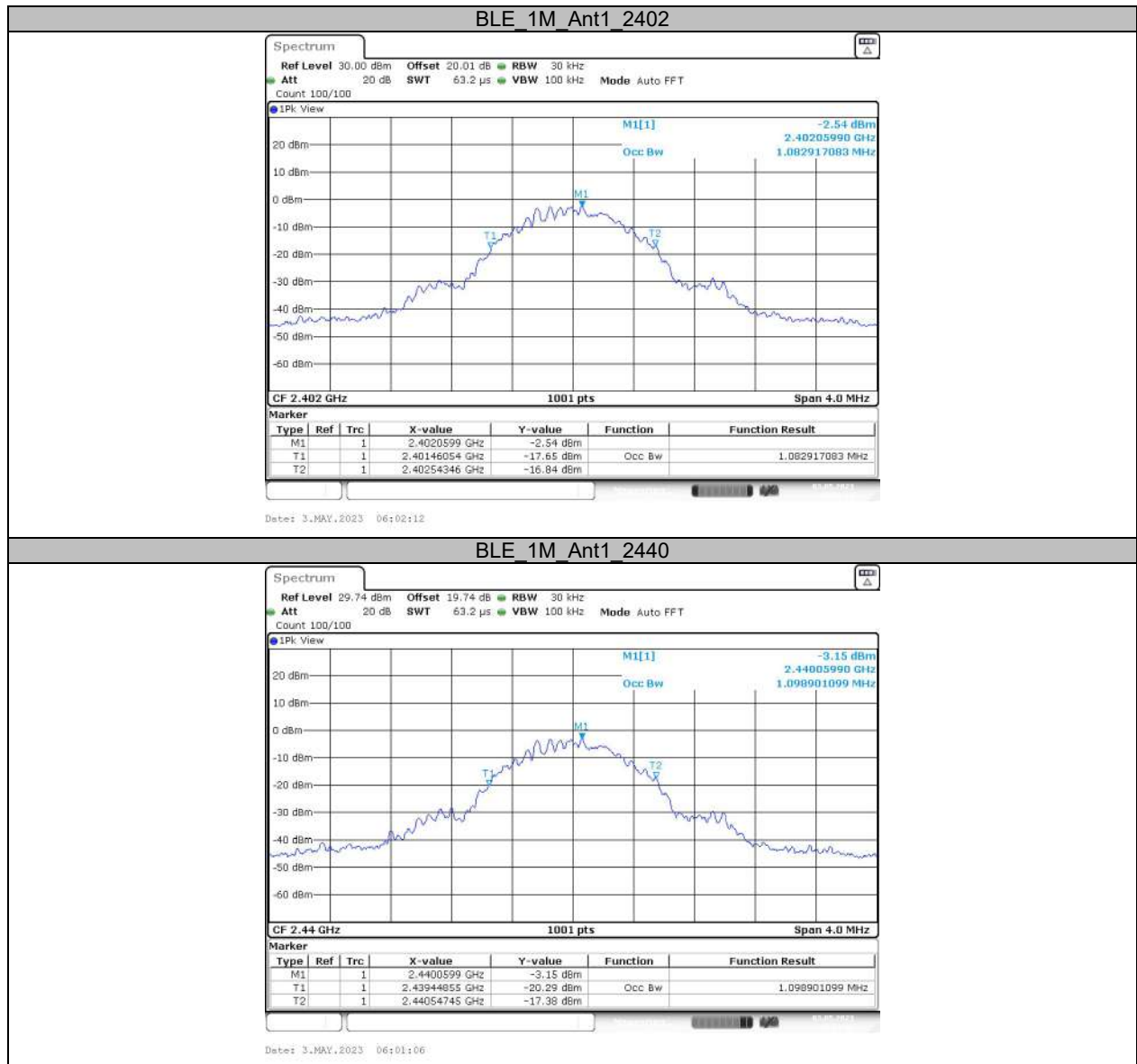




**Appendix B: Occupied Channel Bandwidth
Test Result**

Test Mode	Antenna	Frequency[MHz]	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.083	2401.461	2402.543	---	---
		2440	1.099	2439.449	2440.547	---	---
		2480	1.103	2479.449	2480.551	---	---

Test Graphs





Appendix C: Maximum conducted output power

Test Result Peak

Test Mode	Antenna	Frequency[MHz]	Conducted Peak Power[dBm]	Conducted Limit[dBm]	Antenna Gain [dBi]	EIRP[dBm]	EIRP Limit[dBm]	Verdict
BLE_1M	Ant1	2402	2.07	≤30	3.59	5.66	≤36	PASS
		2440	1.62	≤30	3.59	5.21	≤36	PASS
		2480	1.30	≤30	3.59	4.89	≤36	PASS

Test Graphs Peak

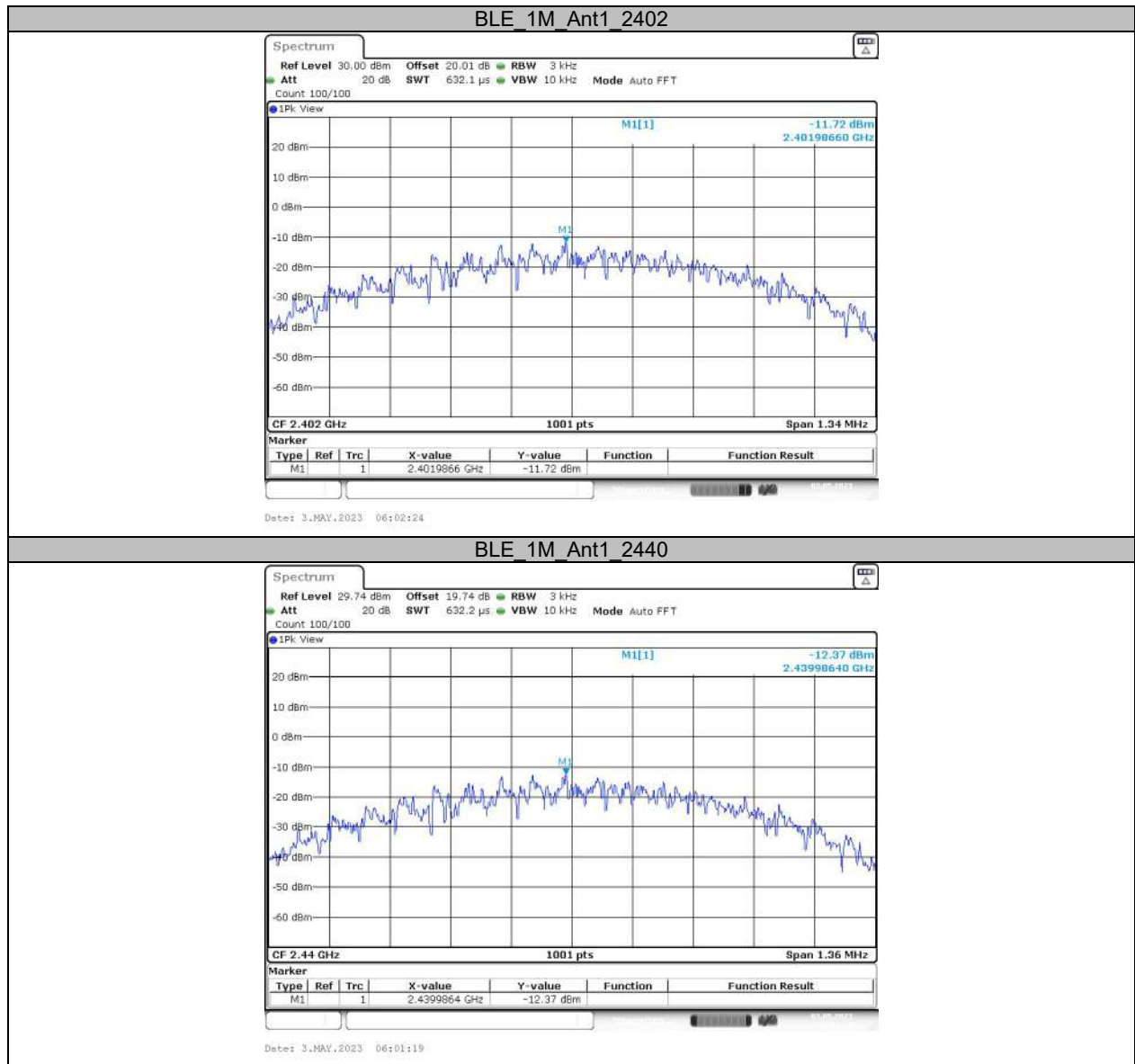


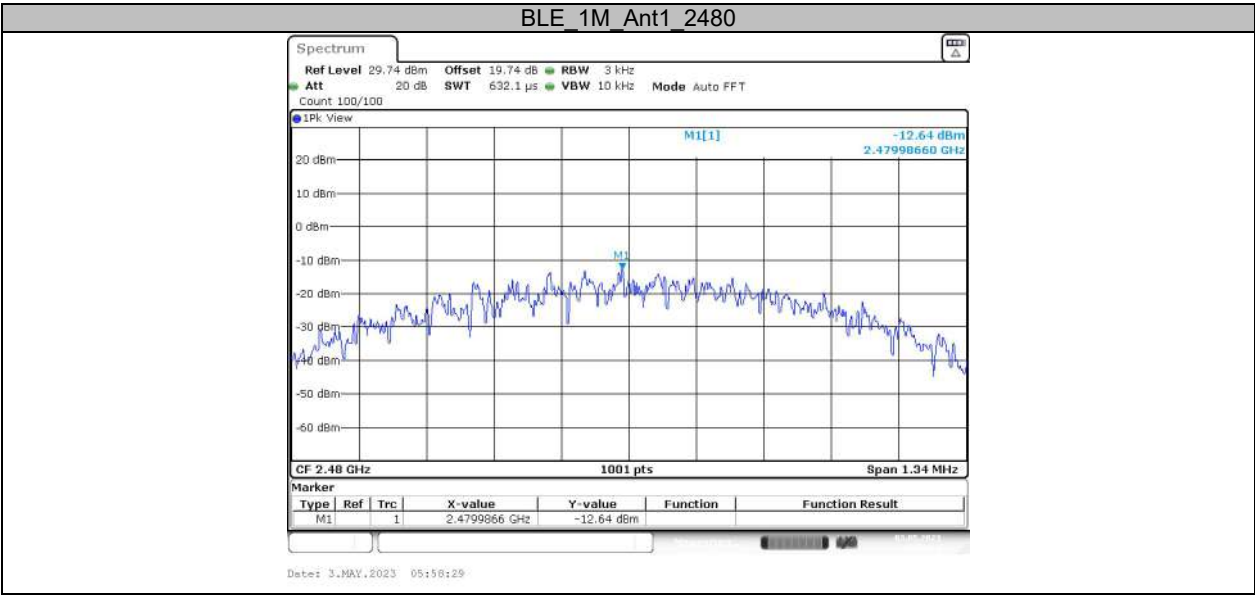


**Appendix D: Maximum power spectral density
Test Result**

Test Mode	Antenna	Frequency[MHz]	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-11.72	≤8.00	PASS
		2440	-12.37	≤8.00	PASS
		2480	-12.64	≤8.00	PASS

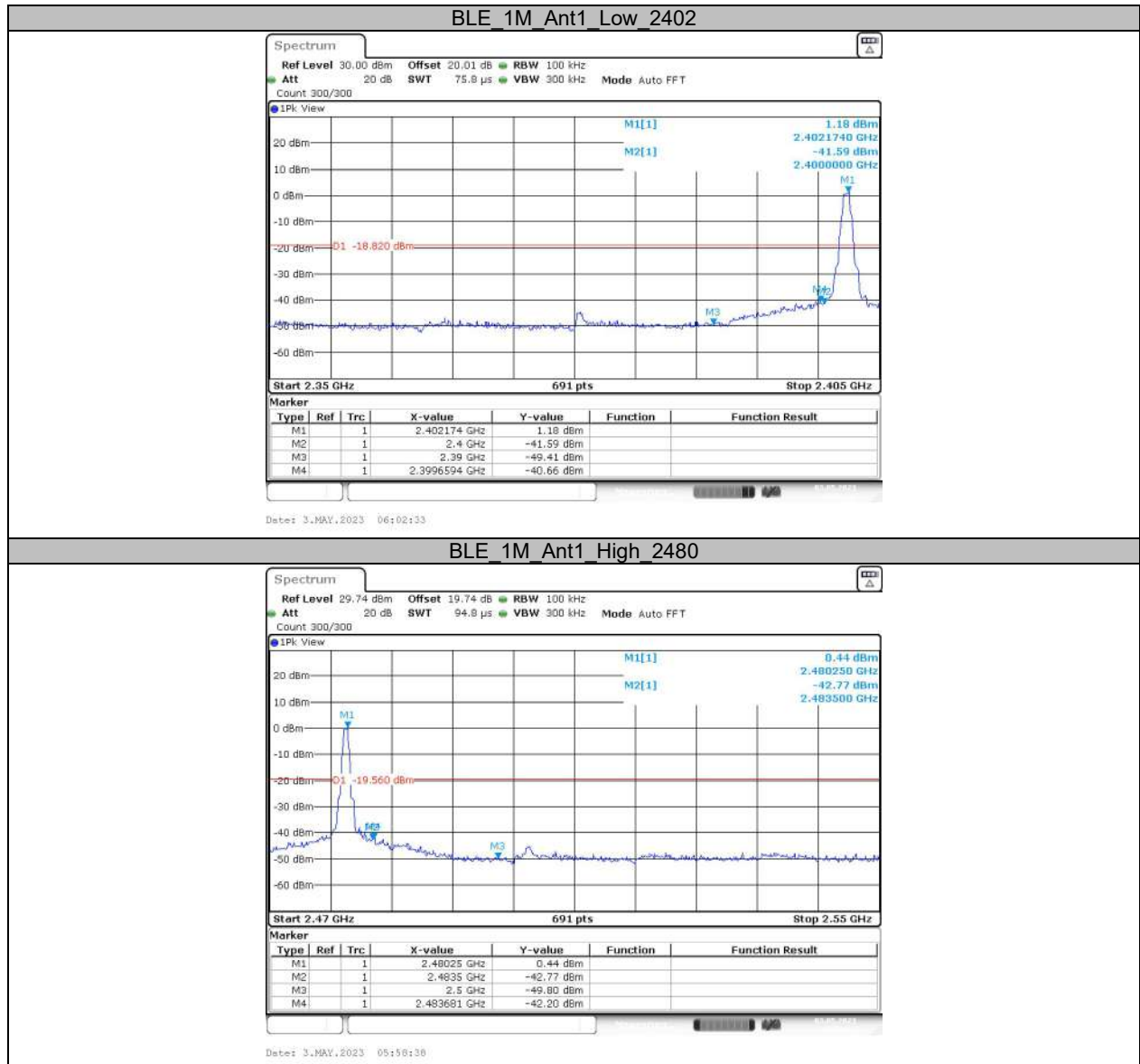
Test Graphs





Appendix E: Band edge measurements

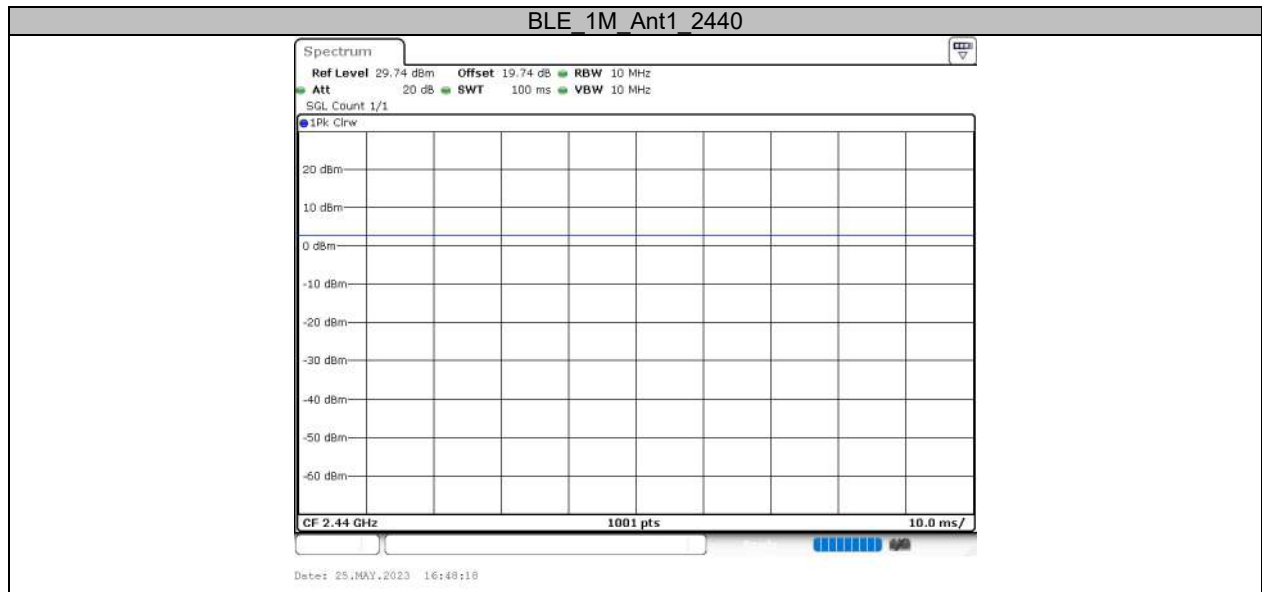
Test Graphs



**Appendix F: Duty Cycle
Test Result**

Test Mode	Antenna	Frequency[MHz]	ON Time [ms]	Period [ms]	Duty Cycle [%]
BLE_1M	Ant1	2440	100.00	100.00	100

Test Graphs



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