



TEST REPORT

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Report Number : SH1220110-01295E-RF-00B
FCC ID: 2AQNML20

Test Standard (s)

FCC Part 15.247

Sample Description

Product: LCD Control Card
Model No.: L20
Date Received: 2022-01-10
Date of Test: 2022-01-21 to 2022-04-25
Report Date: 2022-05-13

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

Prepared and Checked By:



Black Ding
EMC Engineer

Approved By:



Candy Li
EMC Engineer

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

Shenzhen Accurate Technology Co., Ltd. is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with an asterisk "*". Customer model name, addresses, names, trademarks etc. are not considered data.

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	LCD Control Card
Tested Model	L20
Frequency Range	Wi-Fi: 2412-2462MHz
Maximum Conducted Peak Output Power	Wi-Fi: 16.48dBm(802.11b), 15.96dBm(802.11g), 14.89dBm(802.11n20), 14.64dBm(802.11n40)
Modulation Technique	Wi-Fi: DSSS, OFDM
Antenna Specification*	Antenna gain: 5.0dBi(provided by the applicant)
Voltage Range	DC 12V from adapter
Sample serial number	SH1220110-01295E-RF-S1
Sample/EUT Status	Good condition

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's 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 Compliance Testing of Unlicensed Wireless Devices, 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.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	30MHz - 1GHz	4.28dB
	1GHz - 18GHz	4.98dB
	18GHz - 26.5GHz	5.06dB
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 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. 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 4297.01

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 5077A.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

For 802.11b, 802.11g, 802.11n-HT20 and 802.11n-HT40 mode, total 11 channels are provided to testing:

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

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

802.11n-HT40 mode was tested with Channel 3, 6 and 9.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

Software “Engineering mode”* was used during testing and power level as below:

Mode	Data Rate (Mbps)	Power Level*
802.11 b	1	30
802.11 g	6	35
802.11 n20	MCS0	32
802.11 n40	MCS0	35

The worse-case data rates are determined to be as above for each mode based upon investigations by measuring the output power and PSD across all data rates, bandwidths and modulations.

Duty cycle

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

Support Equipment List and Details

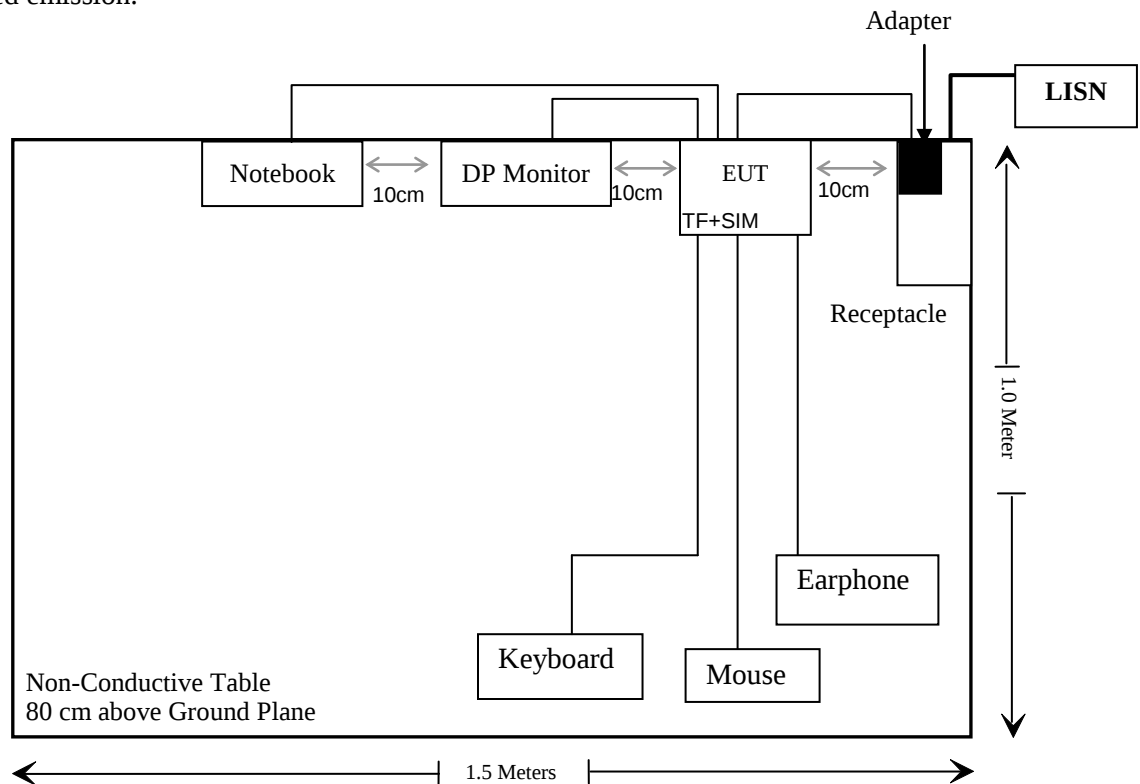
Manufacturer	Description	Model	Serial Number
SHENZHEN FRECOM ELECTRONICS CO.,LTD.	Adapter	F18W8-120150S PAUY	E257831
Unknown	Earphone	Unknown	Unknown
PHILIPS	DP Monitor	275M7C	Unknown
Lenovo	Notebook	T430	Unknown
DELL	Keyboard	L100	CN0RH66658985C018C
DELL	Mouse	MOC5UG	Unknown
Kingston	TF card	SDCS2/32GB	Unknown

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Detachable DC Cable	1.0	EUT	Adapter
Shielding Detachable HDMI Cable	1.5	EUT	DP Monitor
Un-shielding Detachable Earphone Cable	1.0	EUT	Earphone
Un-shielding Detachable RJ45 Cable	1.0	EUT	Notebook
Unshielded Detachable USB Cable	1.5	EUT	Mouse
Unshielded Detachable USB Cable	1.5	EUT	Keyboard

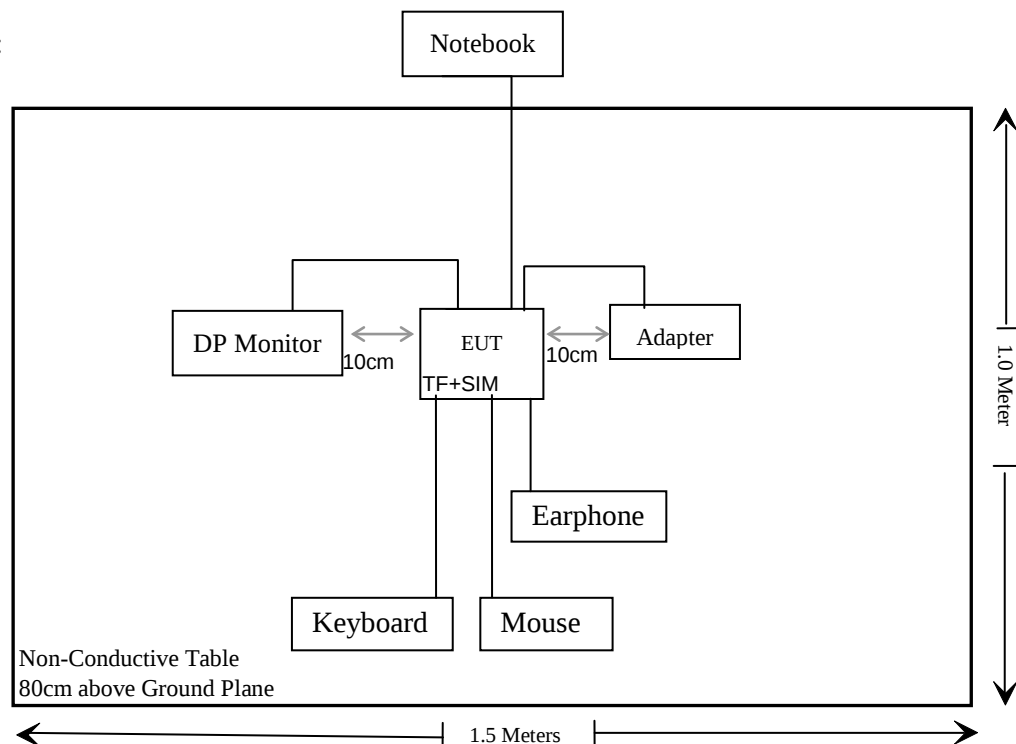
Block Diagram of Test Setup

For conducted emission:

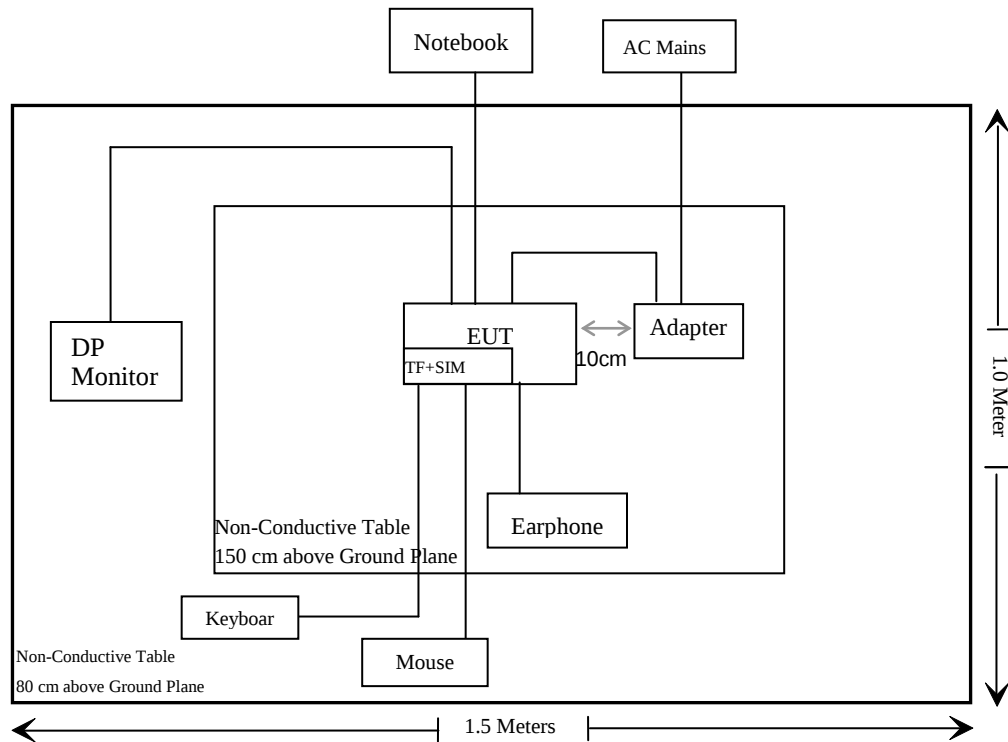


For Radiated emission:

Below 1GHz:



Above 1GHz:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§1.1307 (b)	RF Exposure	Compliant
§15.203	Antenna Requirement	Compliant
§15.207 (a)	AC Line Conducted Emissions	Compliant
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliant
§15.247 (a)(2)	6 dB Emission Bandwidth & Occupied Bandwidth	Compliant
§15.247(b)(3)	Maximum Conducted Output Power	Compliant
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliant
§15.247(e)	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	2021/12/13	2022/12/12
Rohde & Schwarz	L.I.S.N.	ENV216	101314	2021/12/13	2022/12/12
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2021/12/13	2022/12/12
Unknown	RF Coaxial Cable	No.17	N0350	2021/12/14	2022/12/13
Conducted Emission Test Software: e3 19821b (V9)					
Radiated Emissions Test					
Rohde & Schwarz	Test Receiver	ESR	102725	2021/12/13	2022/12/12
Rohde & Schwarz	Spectrum Analyzer	FSV40	101949	2021/12/13	2022/12/12
SONOMA INSTRUMENT	Amplifier	310 N	186131	2021/11/09	2022/11/08
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2021/11/09	2022/11/08
Quinstar	Amplifier	QLW-184055 36-J0	15964001002	2021/11/11	2022/11/10
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2020/01/05	2023/01/04
Wainwright	High Pass Filter	WHKX3.6/18 G-10SS	5	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.10	N050	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.11	N1000	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.12	N040	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.13	N300	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.14	N800	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.15	N600	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.16	N650	2021/12/14	2022/12/13
Radiated Emission Test Software: e3 19821b (V9)					
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2021/12/13	2022/12/12
Rohde & Schwarz	Open Switch and Control Unit	OSP120 + OSP-B157	101244 + 100866	2021/12/13	2022/12/12
WEINSCHTEL	10dB Attenuator	5324	AU 3842	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.32	RF-02	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 §1.1307 (B) – RF EXPOSURE

Applicable Standard

According to FCC §1.1307(b), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D04 Interim General RF Exposure Guidance v01, clause 2.1.3.1-SAR-Based Exemption:

A more comprehensive exemption, considering a variable power threshold that depends on both the separation distance and power, is provided in § 1.1307(b)(3)(i)(B). This exemption is applicable to the frequency range between 300 MHz and 6 GHz, with test separation distances between 0.5 cm and 40 cm, and for all RF sources in fixed, mobile, and portable device exposure conditions.

Accordingly, a RF source is considered an RF exempt device if its available maximum time-averaged (matched conducted) power or its effective radiated power (ERP), whichever is greater, are below a specified threshold. This exemption threshold was derived based on general population 1-g SAR requirements and is detailed in Appendix C.

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

d = the separation distance (cm);

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.

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

Where:

a = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(B) of this section for P_{th}, including existing exempt transmitters and those being added.

b = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(C) of this section for Threshold ERP, including existing exempt transmitters and those being added.

c = number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance including existing evaluated transmitters.

P_i = the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source i at a distance between 0.5 cm and 40 cm (inclusive).

P_{th,i} = the exemption threshold power (P_{th}) according to paragraph (b)(3)(i)(B) of this section for fixed, mobile, or portable RF source i.

ERP_j = the ERP of fixed, mobile, or portable RF source j.

ERP_{th,j} = exemption threshold ERP for fixed, mobile, or portable RF source j, at a distance of at least $\lambda/2\pi$ according to the applicable formula of paragraph (b)(3)(i)(C) of this section.

Evaluated_k = the maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation at the location of exposure.

Exposure Limit_k = either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable RF source k, as applicable from § 1.1310 of this chapter.

Test Result

For worst case:

Mode	Frequency	Maximum Tune-up Conducted Power	Antenna Gain		ERP		Distance	SAR-Based Exclusion Threshold P_{th}	SAR-Based Exclusion
	MHz	dBm	dBi	dBd	dBm	mW	(mm)	mW	
BT	2402-2480	2	5	2.85	4.85	3.05	200	3060	Yes
2.4G Wi-Fi	2412-2462	16.5	5	2.85	19.35	86.10	200	3060	Yes
WCDMA B2	1850-1910	25	4	1.85	26.85	484.17	200	3060	Yes
WCDMA B4	1710-1755	25	4	1.85	26.85	484.17	200	3060	Yes
WCDMA B5	824-849	25	4	1.85	26.85	484.17	200	1681	Yes
LTE B2	1850-1910	25	4	1.85	26.85	484.17	200	3060	Yes
LTE B4	1710-1755	25	4	1.85	26.85	484.17	200	3060	Yes
LTE B5	824-849	25	4	1.85	26.85	484.17	200	1681	Yes
LTE B12	699-716	25	4	1.85	26.85	484.17	200	1426	Yes
LTE B13	777-787	25	4	1.85	26.85	484.17	200	1585	Yes
LTE B14	788-798	25	4	1.85	26.85	484.17	200	1607	Yes
LTE B66	1710-1780	25	4	1.85	26.85	484.17	200	3060	Yes
LTE B71	663-698	25	4	1.85	26.85	484.17	200	1352	Yes

Note 1: The tune-up power was declared by the applicant.

Note 2: 0dBd=2.15dBi.

Note 3: The BT and Wi-Fi can't transmit at the same time.

Note 4: The BT or Wi-Fi can transmit at the same time with the WWAN.

Note 5: Please refer to the FCC ID: XMR201808EC25AF about the power for the LTE module

Simultaneous transmitting consideration (worst case):

The ratio= $EEPE_{2.4G\ Wi-Fi} / \text{limit} + EPE_{LTE\ B71} / \text{limit} = 86.10/3060 + 484.17/1352 = 0.386 < 1.0$

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

Result: Compliant.

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 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.

Antenna Connector Construction

The EUT has one external antenna arrangement, which was used a unique coupling and the antenna gain is 5dBi, fulfill the requirement of this section. Please refer to the EUT photos.

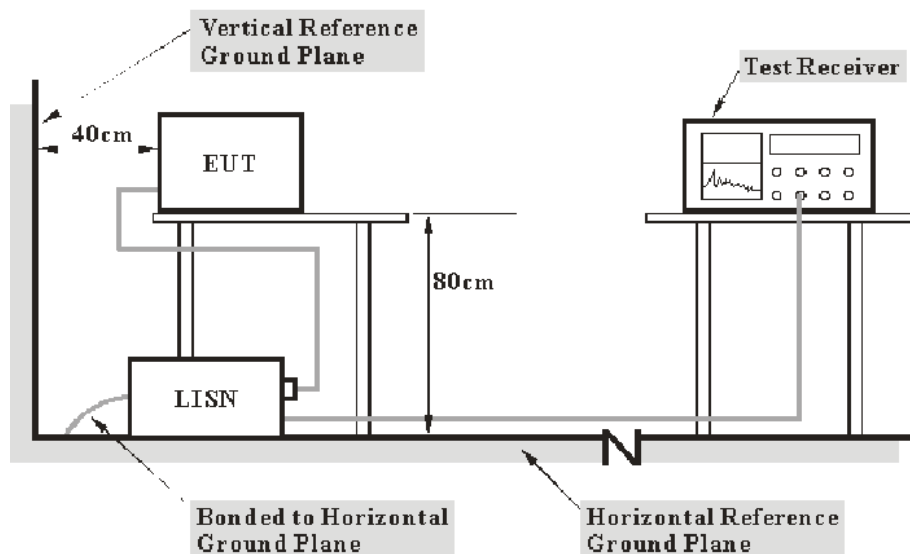
Result: Compliant.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207

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 limits.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

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

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

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

Test Procedure

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

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

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

Factor & Margin Calculation

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

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

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

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

Test Data

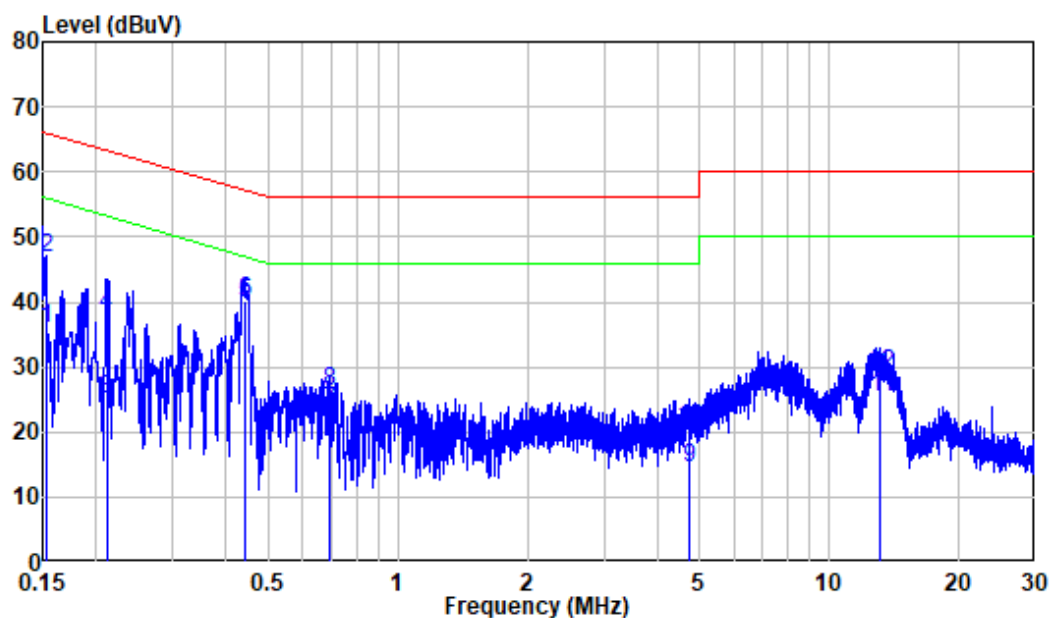
Environmental Conditions

Temperature:	25 °C
Relative Humidity:	47 %
ATM Pressure:	101.2 kPa

The testing was performed by Caro Hu on 2022-04-25

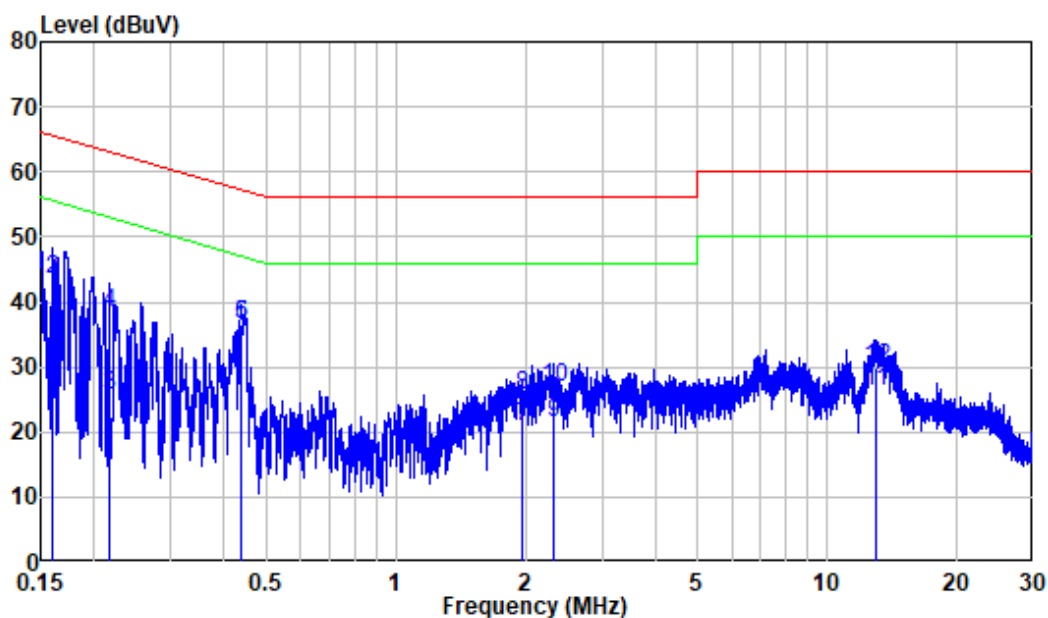
EUT operation mode: Transmitting (Worst case for 802.11n40 mode Low Channel as below)

AC 120V/60 Hz, Line



Site : Shielding Room
 Condition: Line
 Job No. : SH1220110-01295E-RF
 Mode : 2.4G WIFI Transmitting
 Model : L20
 Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.153	9.80	26.00	35.80	55.86	-20.06	Average
2	0.153	9.80	37.01	46.81	65.86	-19.05	QP
3	0.211	9.80	15.32	25.12	53.17	-28.05	Average
4	0.211	9.80	28.15	37.95	63.17	-25.22	QP
5	0.441	9.80	30.16	39.96	47.05	-7.09	Average
6	0.441	9.80	30.43	40.23	57.05	-16.82	QP
7	0.696	9.81	13.47	23.28	46.00	-22.72	Average
8	0.696	9.81	16.39	26.20	56.00	-29.80	QP
9	4.718	9.85	4.79	14.64	46.00	-31.36	Average
10	4.718	9.85	10.80	20.65	56.00	-35.35	QP
11	13.127	9.93	15.51	25.44	50.00	-24.56	Average
12	13.127	9.93	19.11	29.04	60.00	-30.96	QP

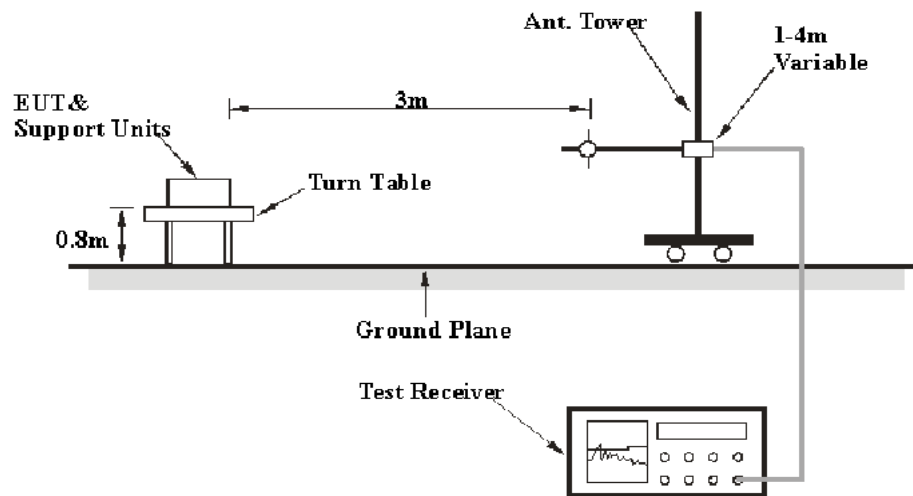
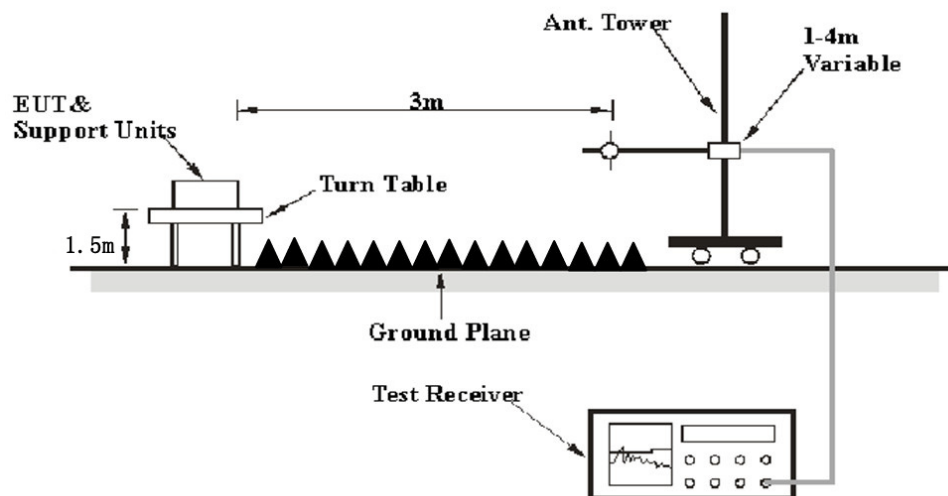
AC 120V/60 Hz, Neutral

Site : Shielding Room
 Condition: Neutral
 Job No. : SH1220110-01295E-RF
 Mode : 2.4G WIFI Transmitting
 Model : L20
 Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit	Over	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.160	9.80	18.41	28.21	55.49	-27.28	Average
2	0.160	9.80	33.72	43.52	65.49	-21.97	QP
3	0.216	9.80	15.89	25.69	52.96	-27.27	Average
4	0.216	9.80	28.63	38.43	62.96	-24.53	QP
5	0.437	9.80	26.76	36.56	47.12	-10.56	Average
6	0.437	9.80	26.71	36.51	57.12	-20.61	QP
7	1.953	9.82	11.02	20.84	46.00	-25.16	Average
8	1.953	9.82	15.81	25.63	56.00	-30.37	QP
9	2.324	9.82	11.57	21.39	46.00	-24.61	Average
10	2.324	9.82	17.16	26.98	56.00	-29.02	QP
11	12.954	10.03	16.23	26.26	50.00	-23.74	Average
12	12.954	10.03	19.88	29.91	60.00	-30.09	QP

FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS**Applicable Standard**

FCC §15.247 (d); §15.209; §15.205;

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. The specification used was the FCC 15.209, and FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

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%

If the maximized peak measured value complies with the limit, then it is unnecessary to perform QP/Average measurement.

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.

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:

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

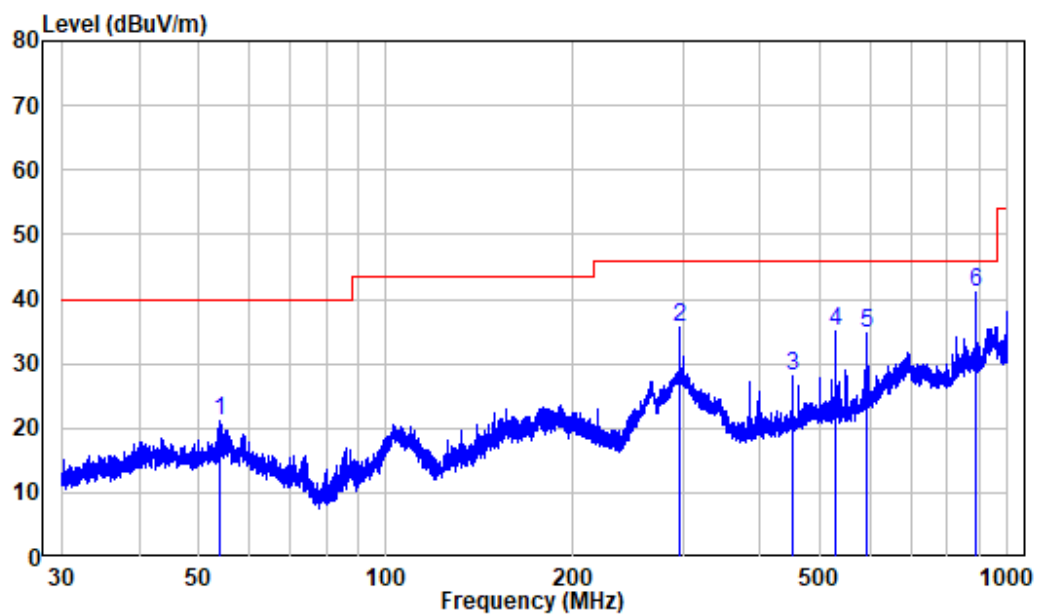
Test Data

Environmental Conditions

Temperature:	21~25 °C
Relative Humidity:	47~55 %
ATM Pressure:	101.0~101.3 kPa

The testing was performed by Chao Mo on 2022-01-28 and Nick Fang on 2022-04-25

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

30MHz-1GHz: (Worst case)**Mode: 2.4G Wi-Fi****Wi-Fi: 802.11n40 mode, Low Channel****Horizontal**

Site : chamber

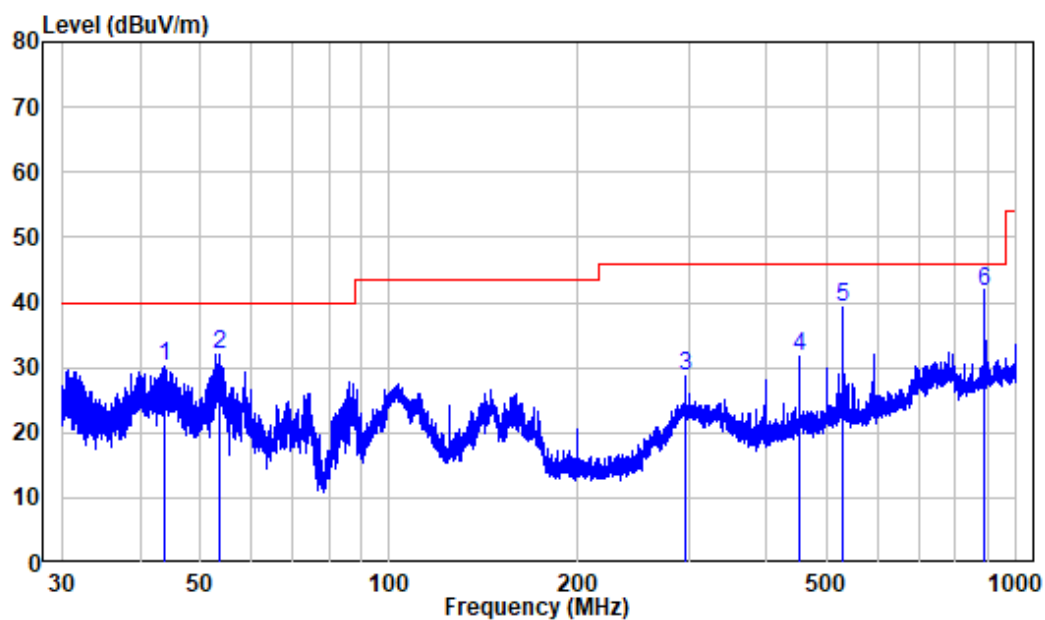
Condition: 3m HORIZONTAL

Job NO. : SH1220110-01295E-RF

MODE : 2.4G WIFI Transmitting

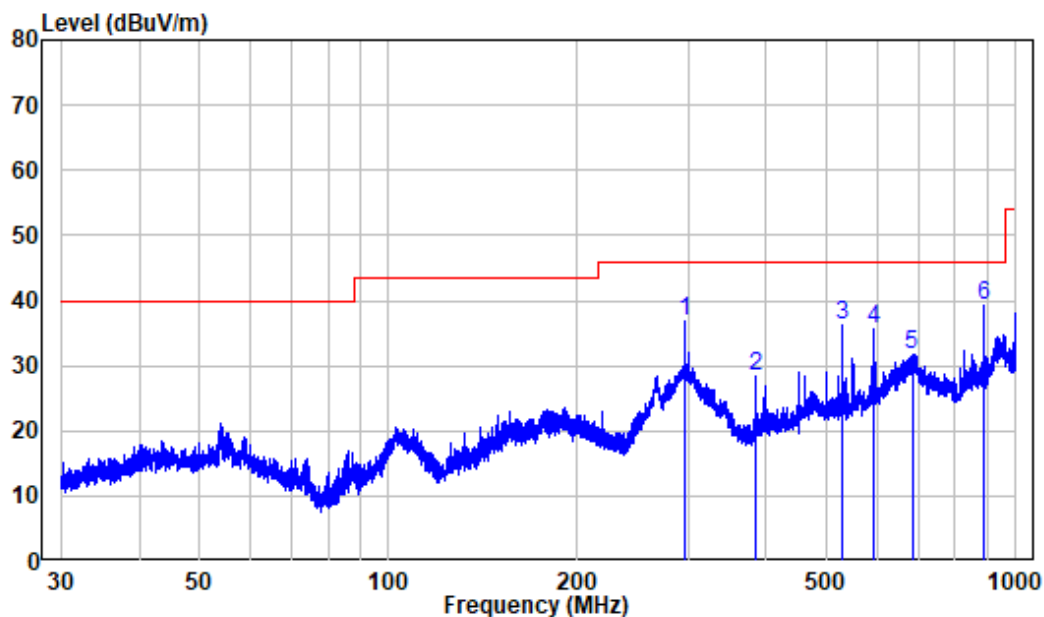
	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	54.142	-10.34	31.59	21.25	40.00	-18.75	Peak
2	296.964	-9.25	45.00	35.75	46.00	-10.25	Peak
3	450.147	-5.62	33.60	27.98	46.00	-18.02	Peak
4	528.014	-4.48	39.60	35.12	46.00	-10.88	Peak
5	594.090	-2.70	37.45	34.75	46.00	-11.25	Peak
6	891.118	0.94	40.01	40.95	46.00	-5.05	QP

Vertical



Site : chamber
Condition: 3m VERTICAL
Job NO. : SH1220110-01295E-RF
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	43.754	-9.91	39.99	30.08	40.00	-9.92	Peak
2	53.412	-10.24	42.34	32.10	40.00	-7.90	Peak
3	296.964	-9.25	38.04	28.79	46.00	-17.21	Peak
4	450.147	-5.62	37.27	31.65	46.00	-14.35	Peak
5	528.014	-4.48	43.81	39.33	46.00	-6.67	Peak
6	891.118	0.94	40.59	41.53	46.00	-4.47	QP

Mode: Co-location, worst case for 802.11n40 mode and LTE Band 2**Horizontal**

Site : chamber

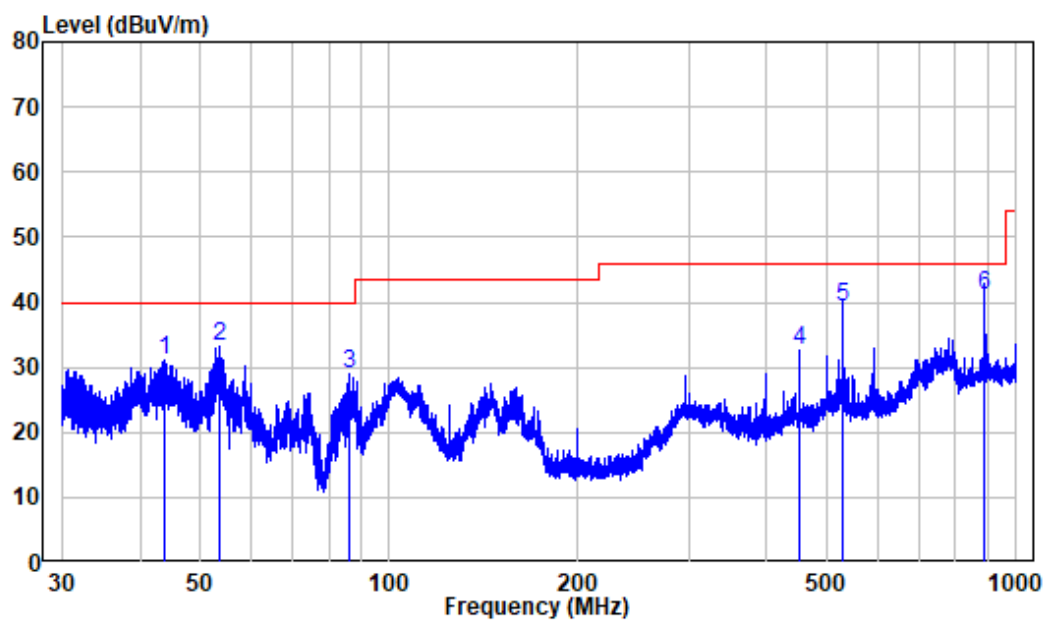
Condition: 3m HORIZONTAL

Job NO. : SH1220110-01295E-RF

MODE : 2.4G WIFI Transmitting + LTE Transmitting

	Freq	Factor	Read Level	Limit Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	296.964	-9.25	46.00	36.75	46.00	-9.25	Peak
2	384.100	-7.08	35.37	28.29	46.00	-17.71	Peak
3	528.014	-4.48	40.60	36.12	46.00	-9.88	Peak
4	594.090	-2.70	38.45	35.75	46.00	-10.25	Peak
5	683.246	-1.50	33.31	31.81	46.00	-14.19	Peak
6	891.118	0.94	38.18	39.12	46.00	-6.88	Peak

Vertical



Site : chamber

Condition: 3m VERTICAL

Job NO. : SH1220110-01295E-RF

MODE : 2.4G WIFI Transmitting + LTE Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	43.754	-9.91	40.99	31.08	40.00	-8.92	Peak
2	53.412	-10.24	43.34	33.10	40.00	-6.90	Peak
3	86.011	-15.20	44.06	28.86	40.00	-11.14	Peak
4	450.147	-5.62	38.27	32.65	46.00	-13.35	Peak
5	528.014	-4.48	43.81	39.33	46.00	-6.67	QP
6	891.118	0.94	40.01	40.95	46.00	-5.05	QP

1-25 GHz:**Wi-Fi:**

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PK/AV		Height (m)	Polar (H/V)				
802.11B, Low Channel									
2310	53.94	PK	127	2.0	H	-7.23	46.71	74	-27.29
2310	54.11	PK	198	1.5	V	-7.23	46.88	74	-27.12
2390	63.09	PK	170	1.8	H	-7.21	55.88	74	-18.12
2390	44.69	AV	170	1.8	H	-7.21	37.48	54	-16.52
2390	61.14	PK	3	1.9	V	-7.21	53.93	74	-20.07
4824	46.97	PK	201	1.7	H	-3.53	43.44	74	-30.56
4824	47.97	PK	169	1.5	V	-3.53	44.44	74	-29.56
802.11B, Middle Channel									
4874	46.63	PK	204	1.6	H	-3.42	43.21	74	-30.79
4874	47.31	PK	58	1.4	V	-3.42	43.89	74	-30.11
802.11B, High Channel									
2483.5	51.79	PK	97	1.0	H	-7.2	44.59	74	-29.41
2483.5	54.65	PK	218	2.0	V	-7.2	47.45	74	-26.55
2500	51.33	PK	65	1.6	H	-7.18	44.15	74	-29.85
2500	51.53	PK	137	2.2	V	-7.18	44.35	74	-29.65
4924	45.96	PK	341	1.7	H	-3.16	42.80	74	-31.20
4924	46.29	PK	290	1.9	V	-3.16	43.13	74	-30.87
802.11G, Low Channel									
2310	51.7	PK	224	1.3	H	-7.23	44.47	74	-29.53
2310	51.01	PK	39	2.1	V	-7.23	43.78	74	-30.22
2390	61.11	PK	52	1.5	H	-7.21	53.90	74	-20.10
2390	63.28	PK	2	1.9	V	-7.21	56.07	74	-17.93
2390	44.41	AV	12	2.0	V	-7.21	37.20	54	-16.80
4824	47.29	PK	12	2.0	H	-3.53	43.76	74	-30.24
4824	47.42	PK	45	1.7	V	-3.53	43.89	74	-30.11
802.11G, Middle Channel									
4874	46.55	PK	203	1.9	H	-3.42	43.13	74	-30.87
4874	47.17	PK	110	1.4	V	-3.42	43.75	74	-30.25
802.11G, High Channel									
2483.5	53.04	PK	9	2.1	H	-7.2	45.84	74	-28.16
2483.5	54.65	PK	163	1.4	V	-7.2	47.45	74	-26.55
2500	51.5	PK	80	2.1	H	-7.18	44.32	74	-29.68
2500	53.84	PK	37	2.0	V	-7.18	46.66	74	-27.34
4924	46.8	PK	236	1.8	H	-3.16	43.64	74	-30.36
4924	46.71	PK	133	1.7	V	-3.16	43.55	74	-30.45

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PK/Ave		Height (m)	Polar (H/V)				
802.11N20, Low Channel									
2310	53	PK	353	2.2	H	-7.23	45.77	74	-28.23
2310	53.32	PK	125	2.0	V	-7.23	46.09	74	-27.91
2390	60.84	PK	46	1.2	H	-7.21	53.63	74	-20.37
2390	61	PK	266	1.5	V	-7.21	53.79	74	-20.21
4824	46.28	PK	2	1.8	H	-3.53	42.75	74	-31.25
4824	47.4	PK	256	1.2	V	-3.53	43.87	74	-30.13
802.11N20, Middle Channel									
4874	45.62	PK	98	2.2	H	-3.42	42.20	74	-31.80
4874	45.2	PK	201	2.0	V	-3.42	41.78	74	-32.22
802.11N20, High Channel									
2483.5	53.69	PK	74	1.4	H	-7.2	46.49	74	-27.51
2483.5	55.82	PK	214	2.0	V	-7.2	48.62	74	-25.38
2500	51.3	PK	176	1.5	H	-7.18	44.12	74	-29.88
2500	51.05	PK	118	1.8	V	-7.18	43.87	74	-30.13
4924	46.78	PK	114	1.5	H	-3.16	43.62	74	-30.38
4924	45.75	PK	168	1.9	V	-3.16	42.59	74	-31.41
802.11N40, Low Channel									
2310	51.48	PK	170	1.1	H	-7.23	44.25	74	-29.75
2310	51.25	PK	309	1.6	V	-7.23	44.02	74	-29.98
2390	60.3	PK	84	1.4	H	-7.21	53.09	74	-20.91
2390	62.35	PK	222	1.7	V	-7.21	55.14	74	-18.86
2390	52.1	AV	222	1.7	V	-7.21	44.89	54	-9.11
4844	47.17	PK	315	1.9	H	-3.54	43.63	74	-30.37
4844	47.92	PK	283	1.6	V	-3.54	44.38	74	-29.62
802.11N40, Middle Channel									
4874	46.68	PK	343	1.8	H	-3.42	43.26	74	-30.74
4874	47.16	PK	261	2.0	V	-3.42	43.74	74	-30.26
802.11N40, High Channel									
2483.5	52.87	PK	324	1.4	H	-7.23	45.64	74	-28.36
2483.5	55.82	PK	148	1.5	V	-7.23	48.59	74	-25.41
2500	51.49	PK	280	1.8	H	-7.21	44.28	74	-29.72
2500	51.75	PK	149	1.7	V	-7.21	44.54	74	-29.46
4904	46.6	PK	159	2.1	H	-3.26	43.34	74	-30.66
4904	47.21	PK	195	1.8	V	-3.26	43.95	74	-30.05

Co-location: (Worst case for 802.11n40 mode and LTE Band 2)

Frequency (MHz)	Receiver		Turntable Angle	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PK/AV	Degree	Height	Polar				
				(m)	(H/V)				
5426.76	50.52	PK	243	1.2	H	-1.79	48.73	74	-25.27
5561.82	49.67	PK	235	1.0	V	-1.31	48.36	74	-25.64

Note:

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

Absolute Level (Corrected Amplitude) = Factor + Reading

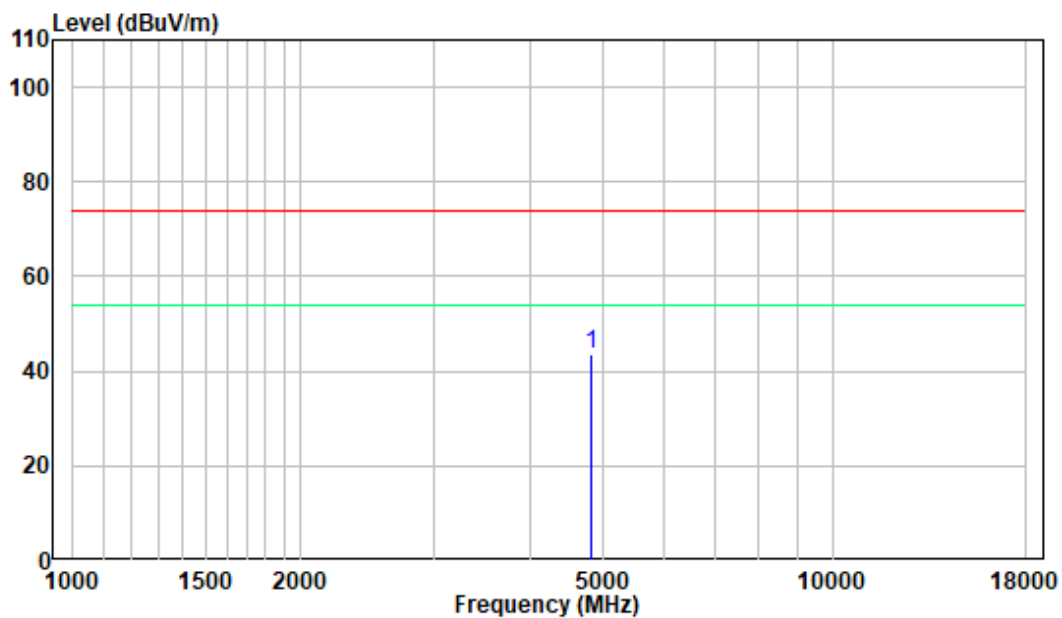
Margin = Absolute Level (Corrected Amplitude) – Limit

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

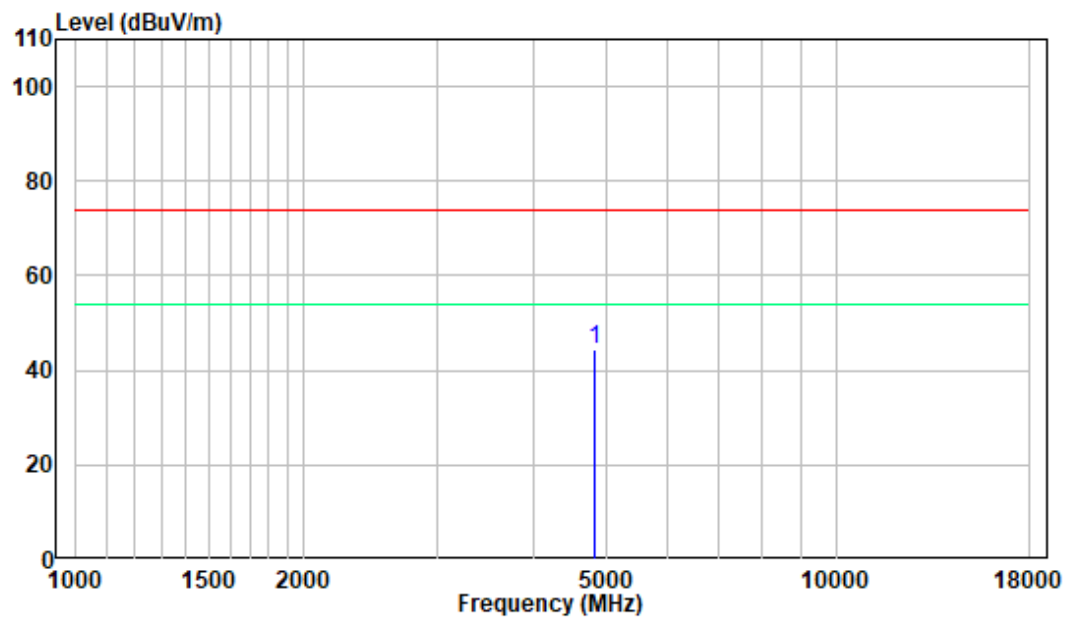
For above 1GHz, the test result of peak was 20dB below to the limit of peak, which can be compliant to the average limit, so just peak value was recorded.

1-18 GHz: (Worst case)

Pre-scan plots
802.11n40 mode, Low Channel
Horizontal

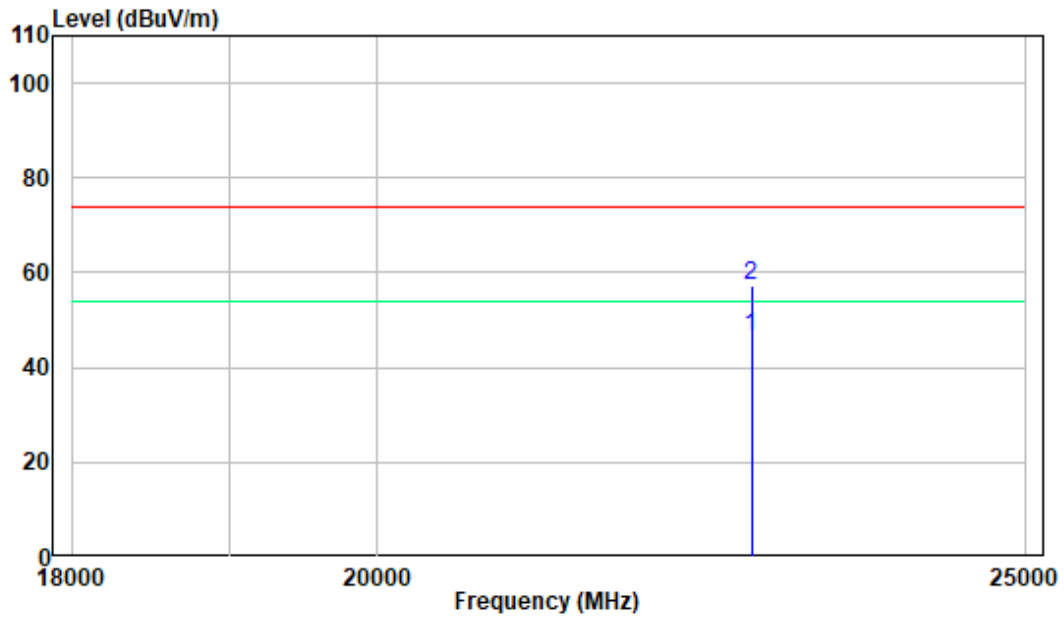


Vertical

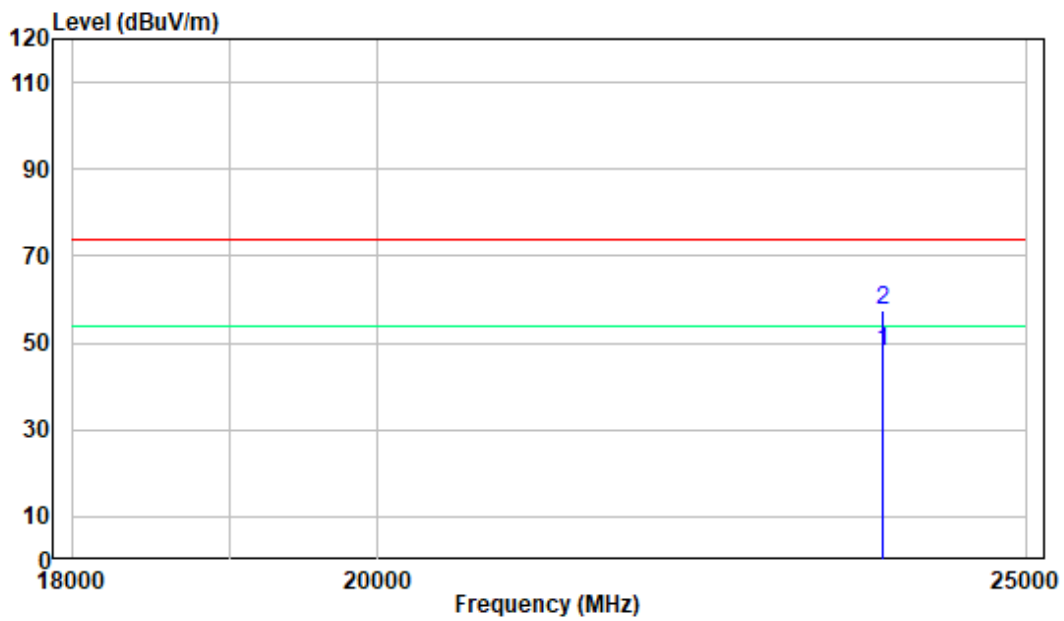


18 -25GHz: (Worst case)

Pre-scan plots
802.11n40 mode, Low Channel
Horizontal



Vertical



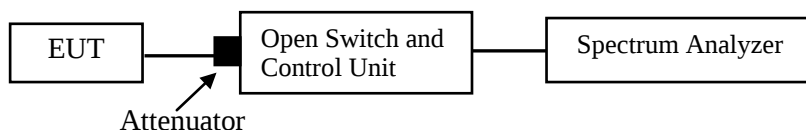
FCC §15.247(A) (2) – 6 DB EMISSION BANDWIDTH & OCCUPIED BANDWIDTH

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.

Test Procedure

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.



Test Data

Environmental Conditions

Temperature:	22 °C
Relative Humidity:	47 %
ATM Pressure:	101.1 kPa

The testing was performed by Paul Liu on 2022-01-21.

EUT operation mode: Transmitting

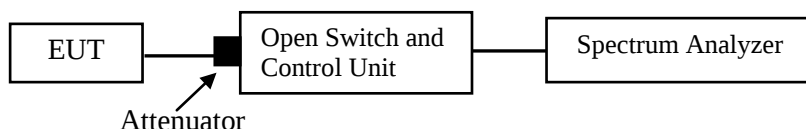
Test Result: Compliant. Please refer to the Appendix Wi-Fi.

FCC §15.247(b) (3) - 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.

Test Procedure

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.

**Test Data****Environmental Conditions**

Temperature:	22 °C
Relative Humidity:	47 %
ATM Pressure:	101.1 kPa

The testing was performed by Paul Liu on 2022-01-21.

EUT operation mode: Transmitting

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

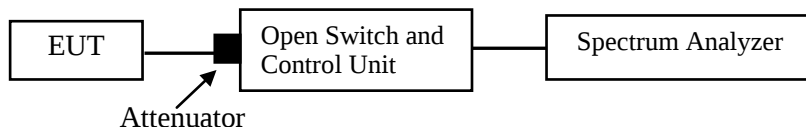
FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

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

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:	22 °C
Relative Humidity:	47 %
ATM Pressure:	101.1 kPa

The testing was performed by Paul Liu on 2022-01-21.

EUT operation mode: Transmitting

Test Result: Compliant.

Conducted Band Edge Result:

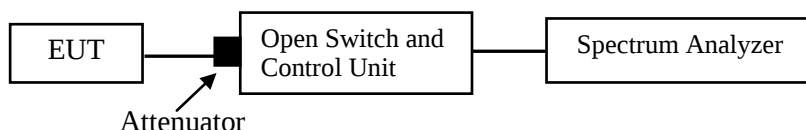
Please refer to the Appendix Wi-Fi.

FCC §15.247(e) - 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.

Test Procedure

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:	22 °C
Relative Humidity:	47 %
ATM Pressure:	101.1 kPa

The testing was performed by Paul Liu on 2022-01-21..

EUT operation mode: Transmitting

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

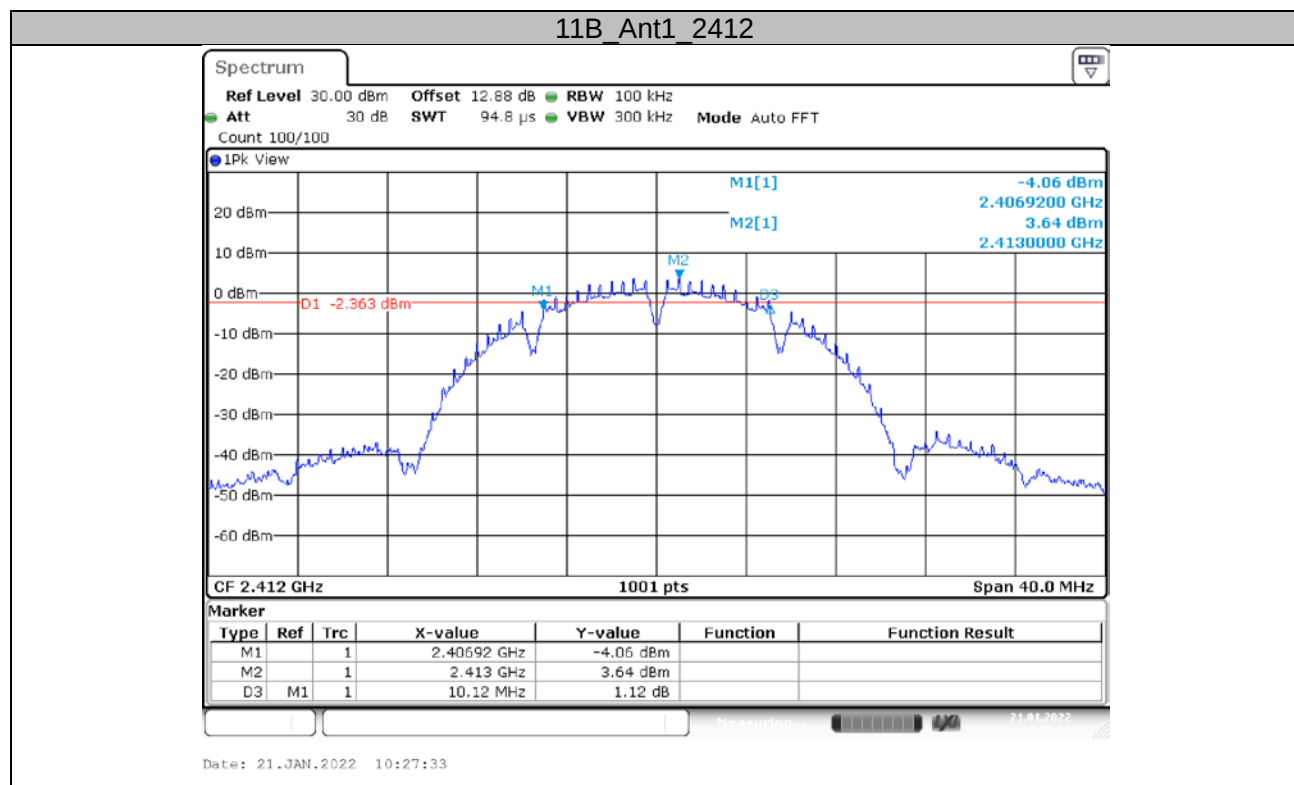
APPENDIX Wi-Fi

Appendix A: 6dB Emission Bandwidth

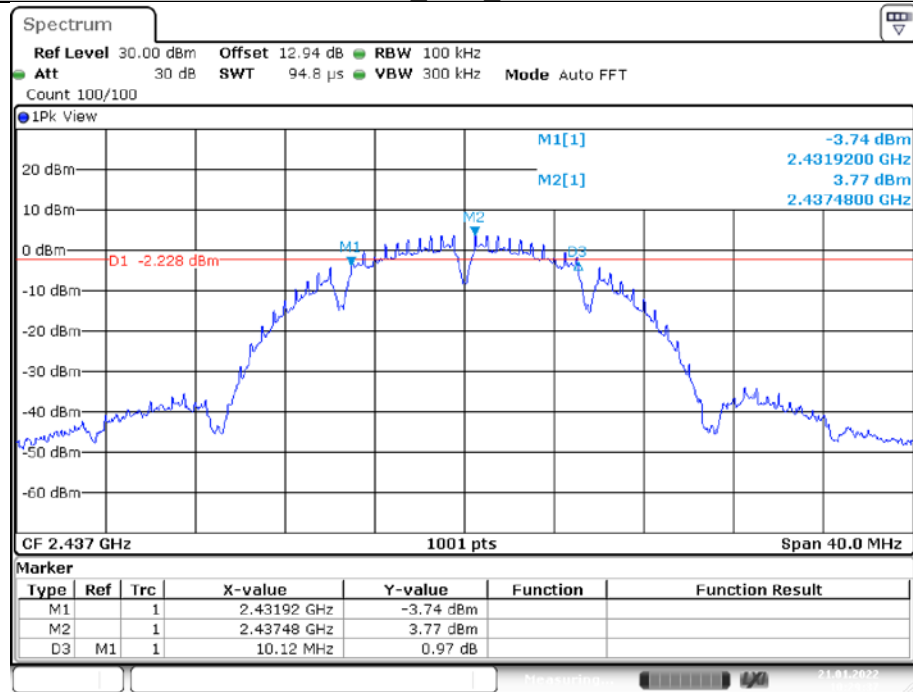
Test Result

TestMode	Antenna	Channel [MHz]	DTS BW [MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	10.120	0.5	PASS
		2437	10.120	0.5	PASS
		2462	9.600	0.5	PASS
11G	Ant1	2412	16.400	0.5	PASS
		2437	16.400	0.5	PASS
		2462	16.400	0.5	PASS
11N20SISO	Ant1	2412	17.280	0.5	PASS
		2437	16.640	0.5	PASS
		2462	17.200	0.5	PASS
11N40SISO	Ant1	2422	35.360	0.5	PASS
		2437	35.360	0.5	PASS
		2452	35.360	0.5	PASS

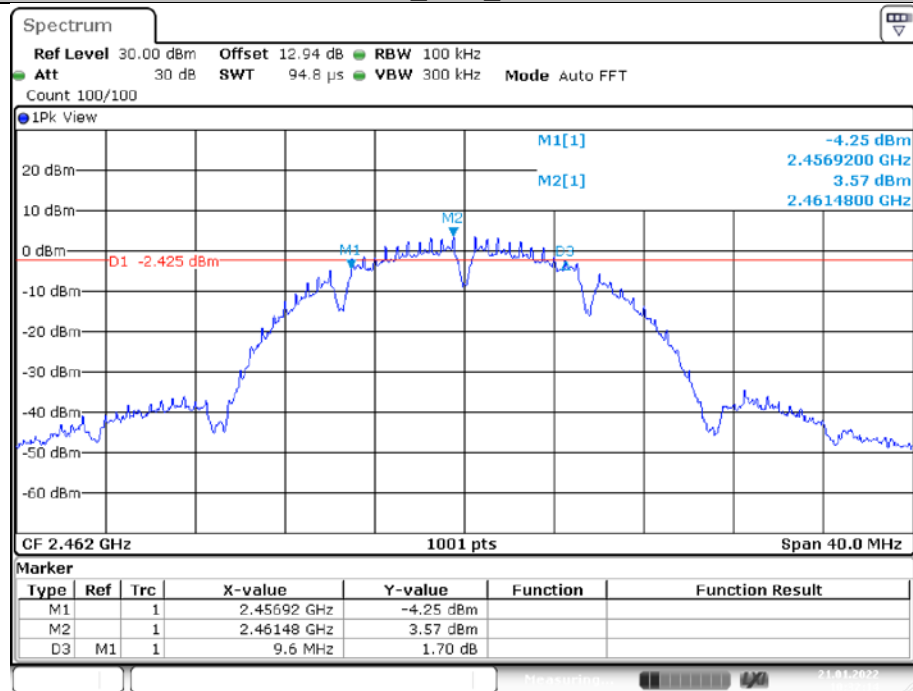
Test Graphs

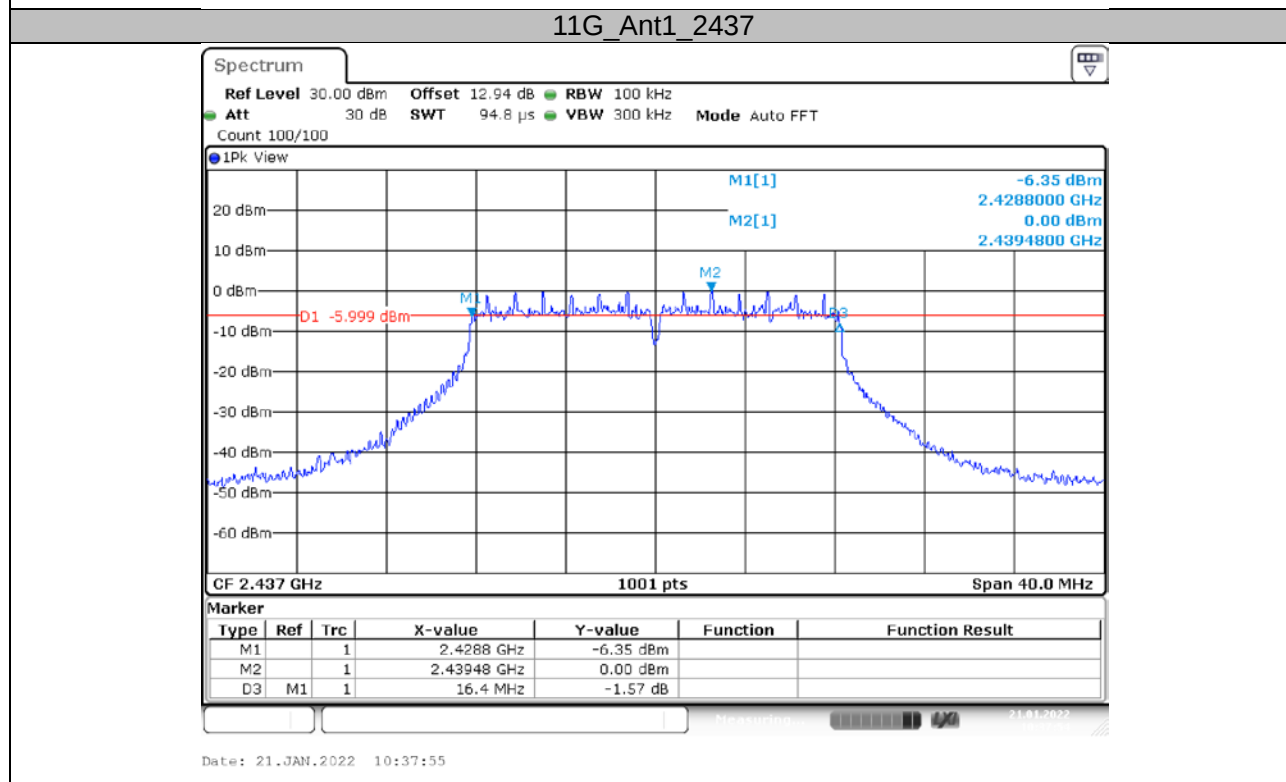
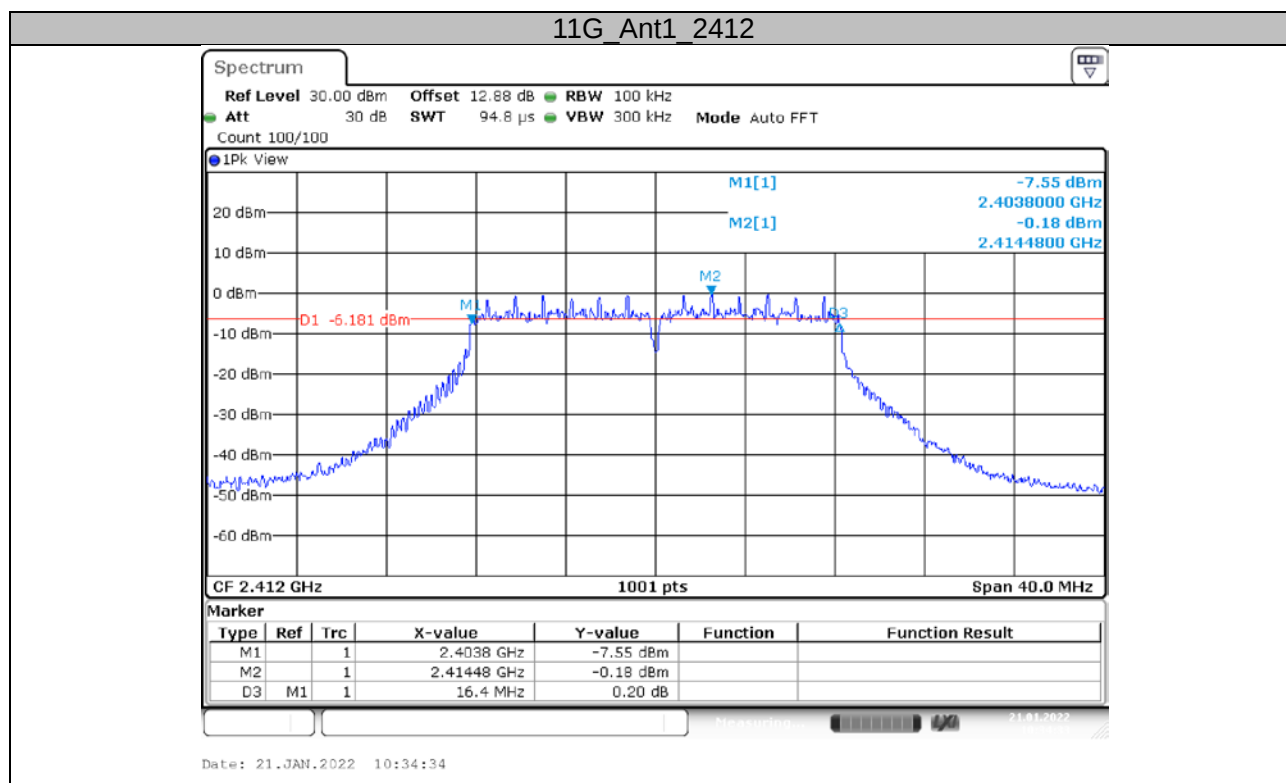


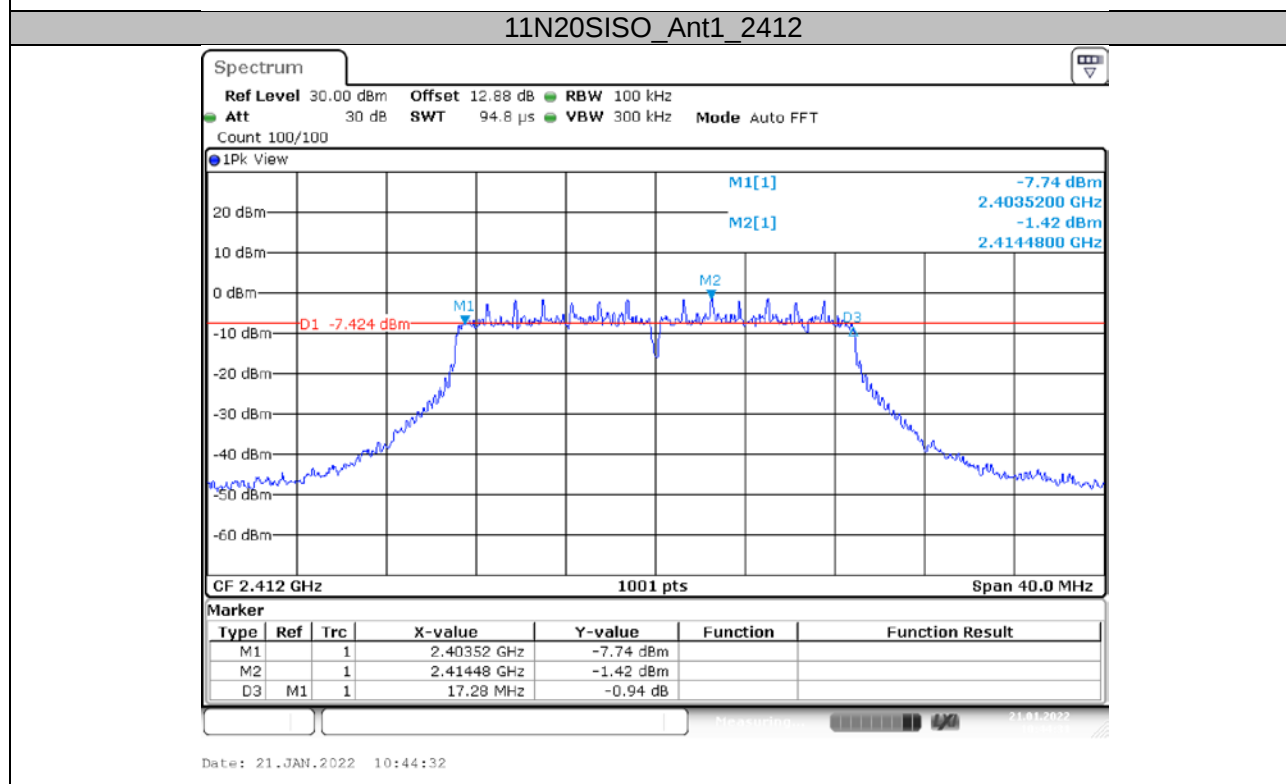
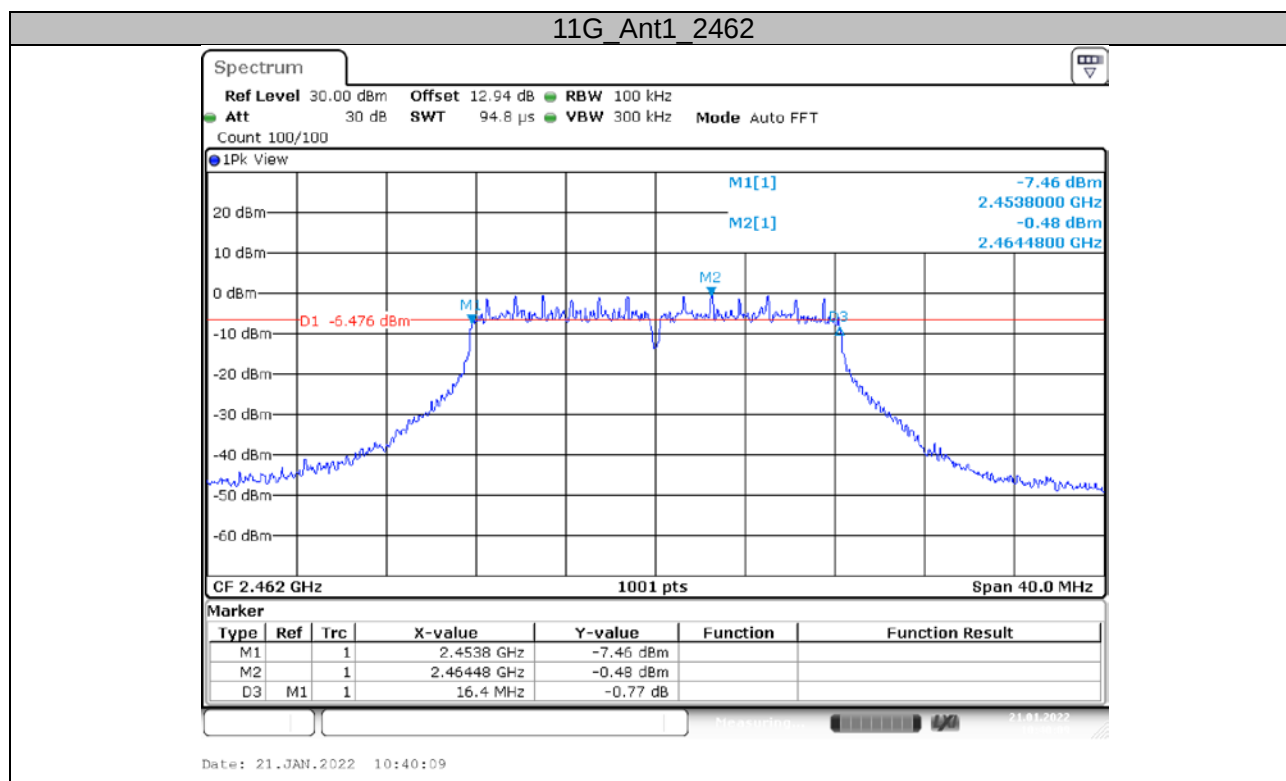
11B_Ant1_2437



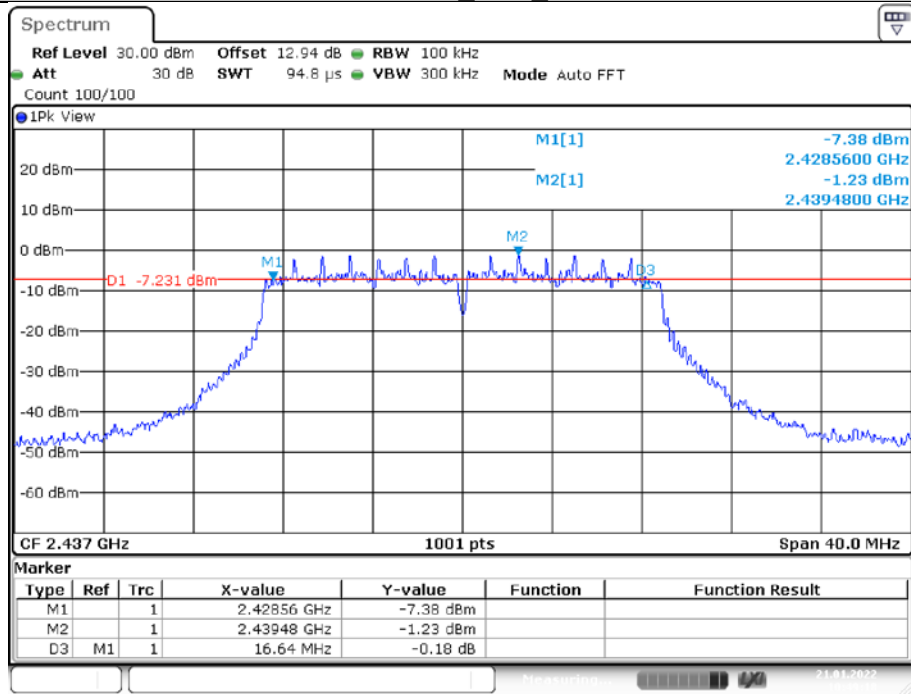
11B_Ant1_2462



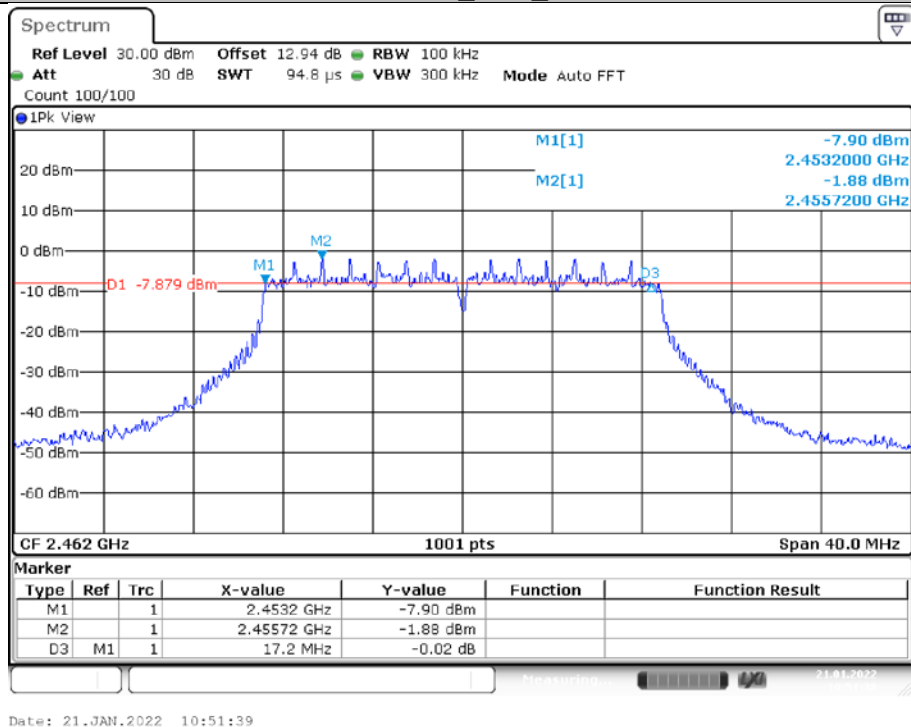




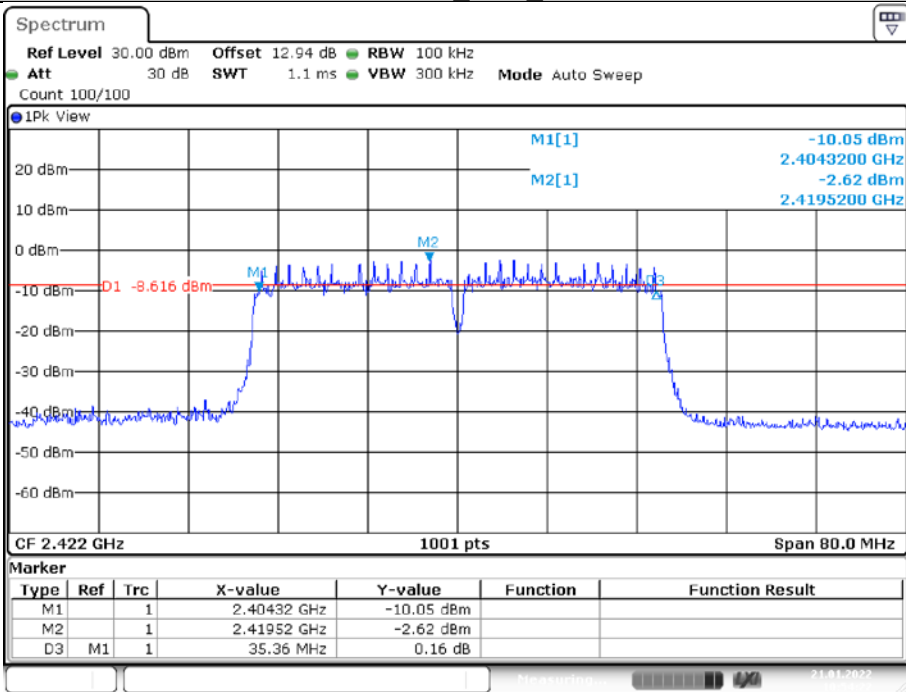
11N20SISO_Ant1_2437



11N20SISO_Ant1_2462

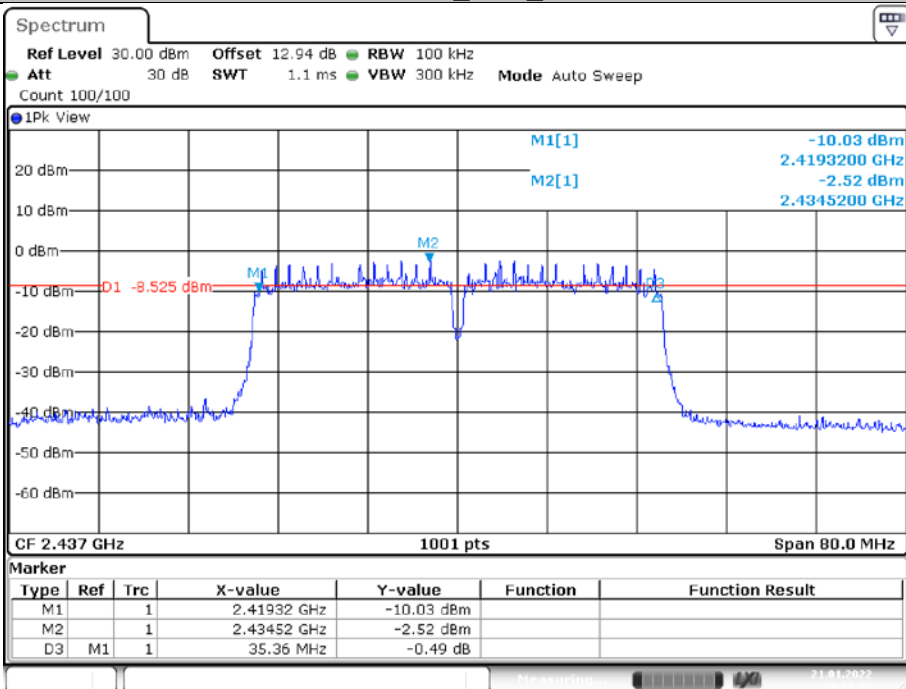


11N40SISO_Ant1_2422

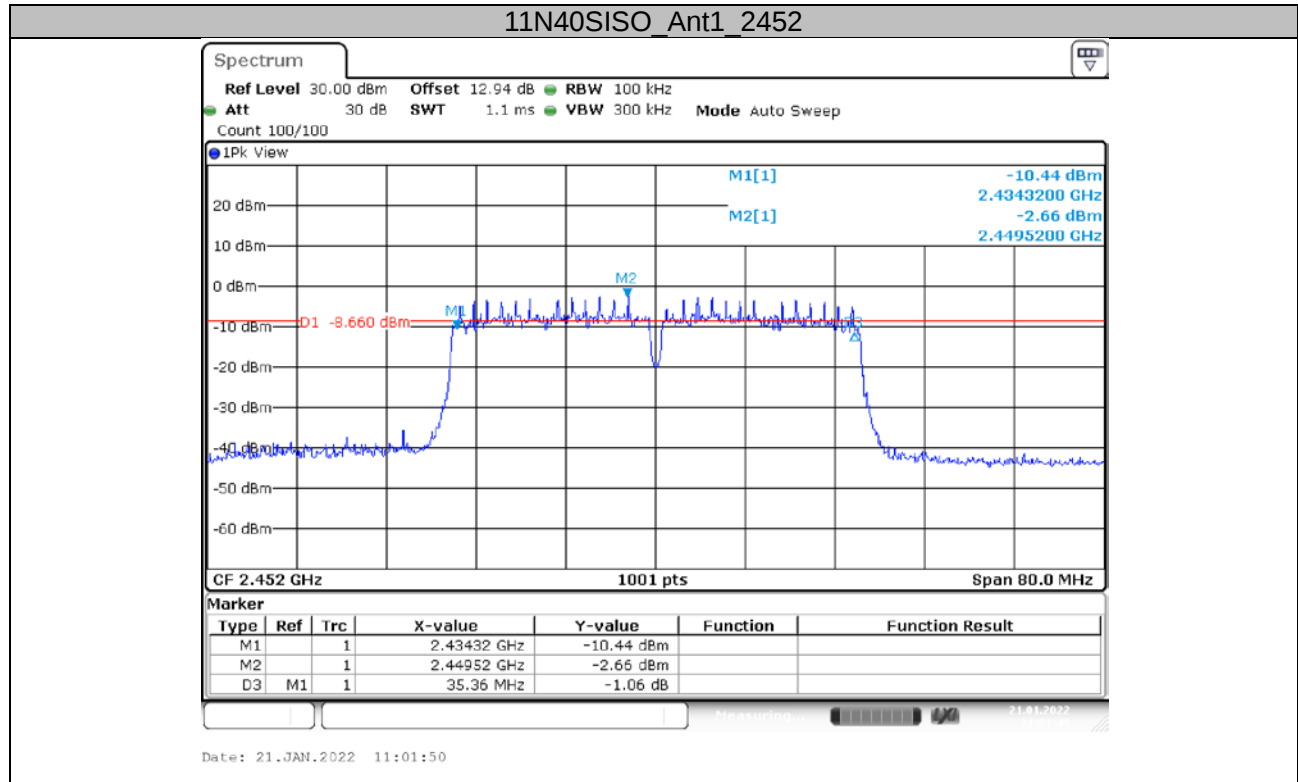


Date: 21.JAN.2022 10:54:23

11N40SISO_Ant1_2437



Date: 21.JAN.2022 10:57:54

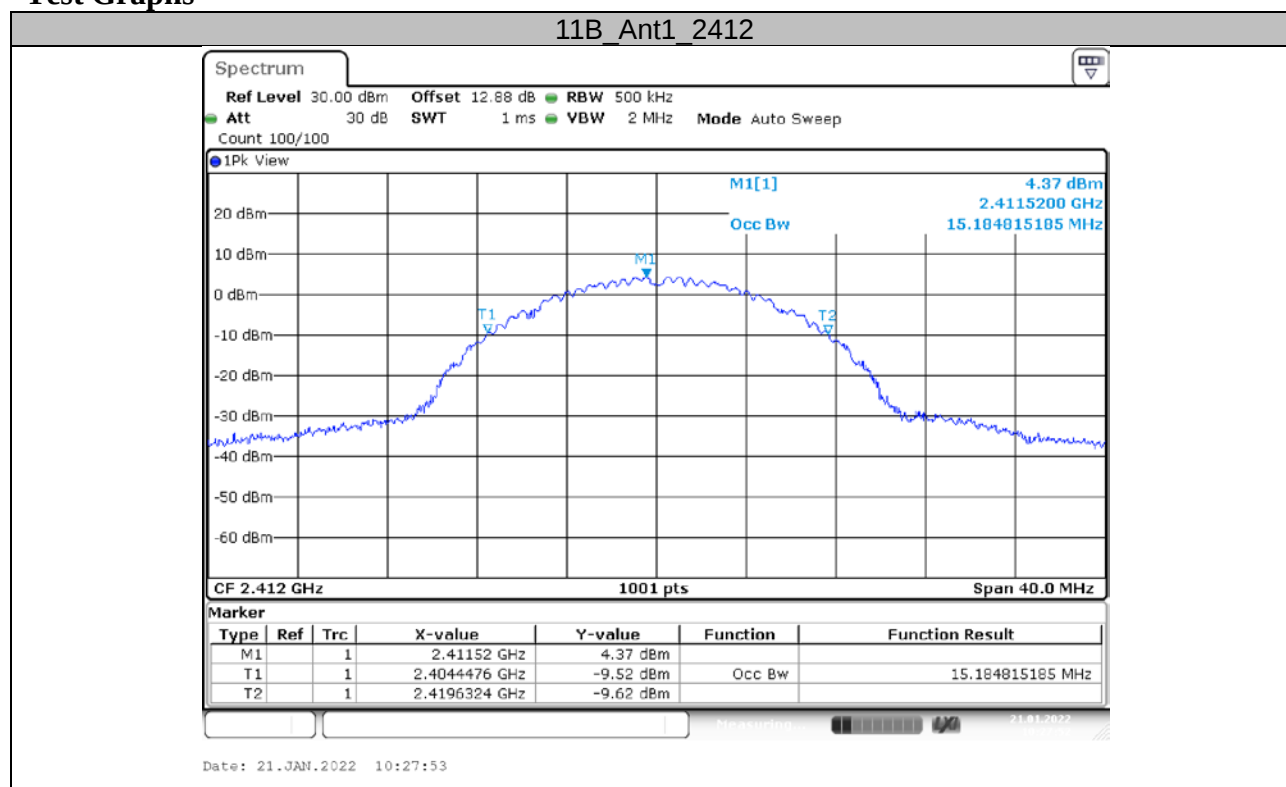


Appendix B: Occupied channel bandwidth

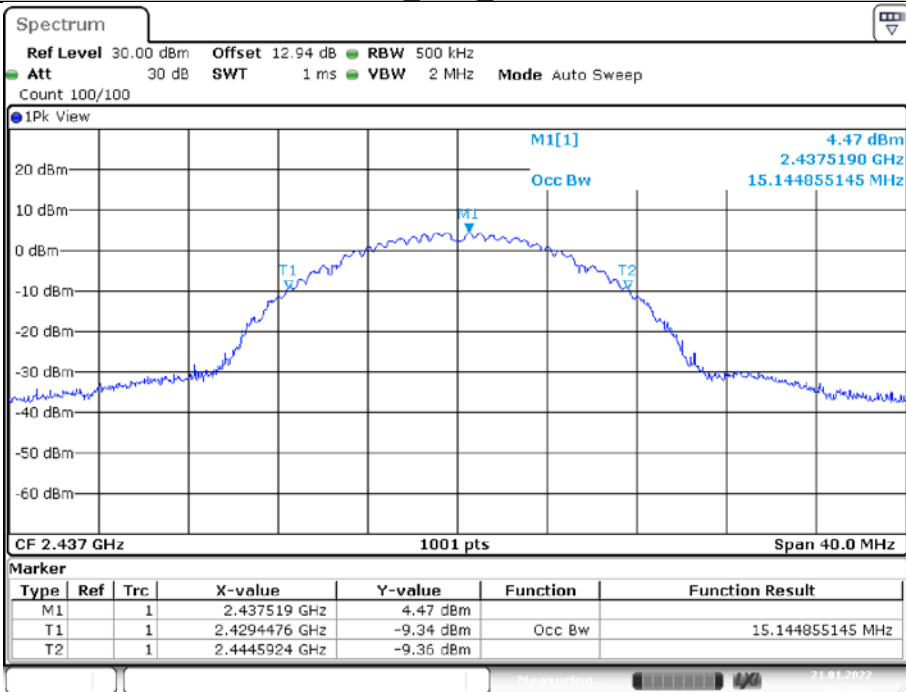
Test Result

TestMode	Antenna	Channel [MHz]	OCB [MHz]	Verdict
11B	Ant1	2412	15.185	PASS
		2437	15.145	PASS
		2462	15.145	PASS
11G	Ant1	2412	17.622	PASS
		2437	17.502	PASS
		2462	17.463	PASS
11N20SISO	Ant1	2412	18.661	PASS
		2437	18.541	PASS
		2462	18.621	PASS
11N40SISO	Ant1	2422	36.044	PASS
		2437	36.044	PASS
		2452	36.124	PASS

Test Graphs

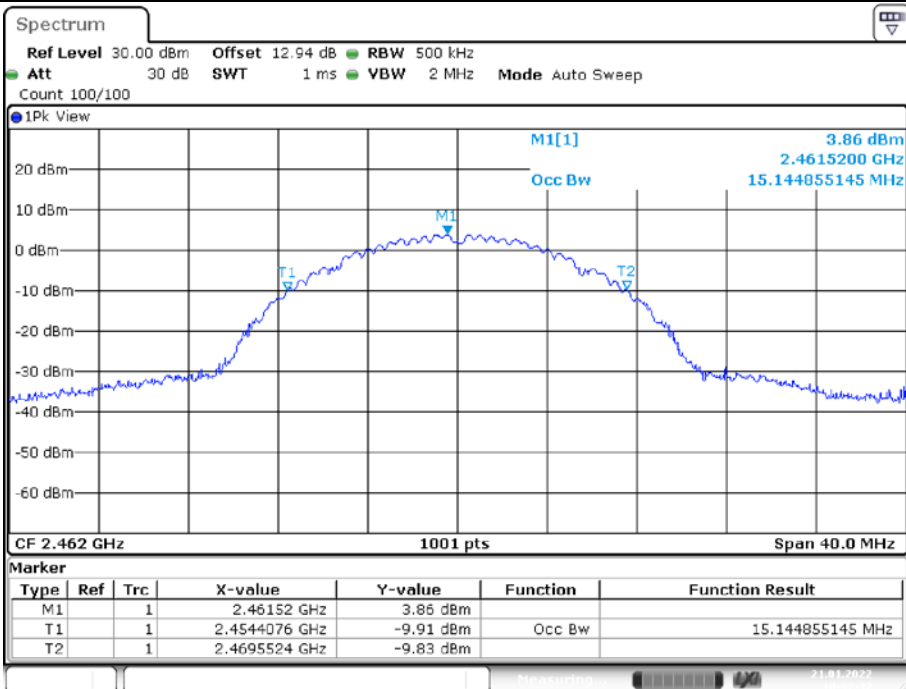


11B_Ant1_2437



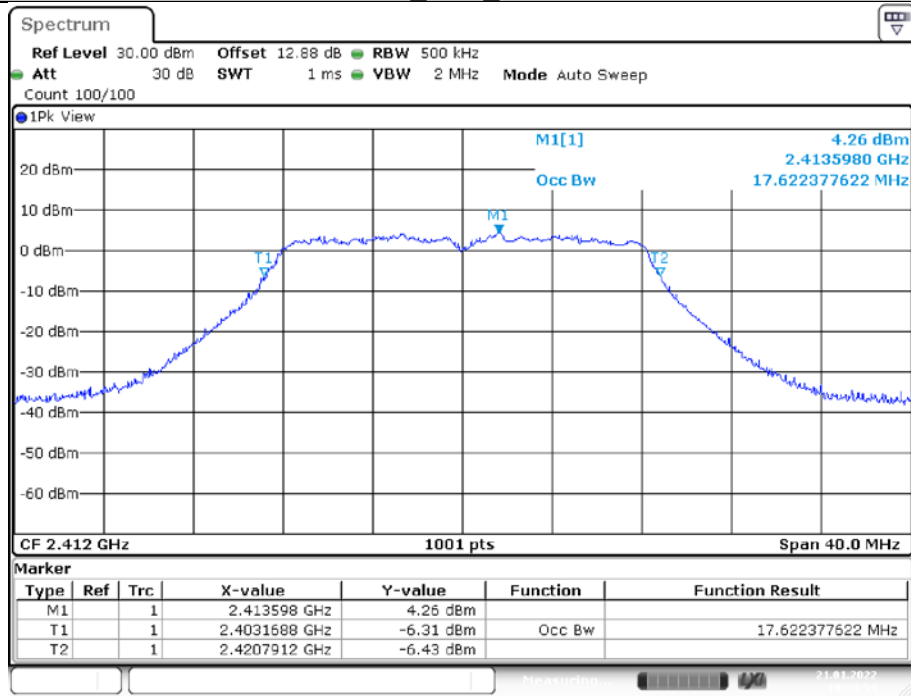
Date: 21.JAN.2022 10:29:55

11B_Ant1_2462



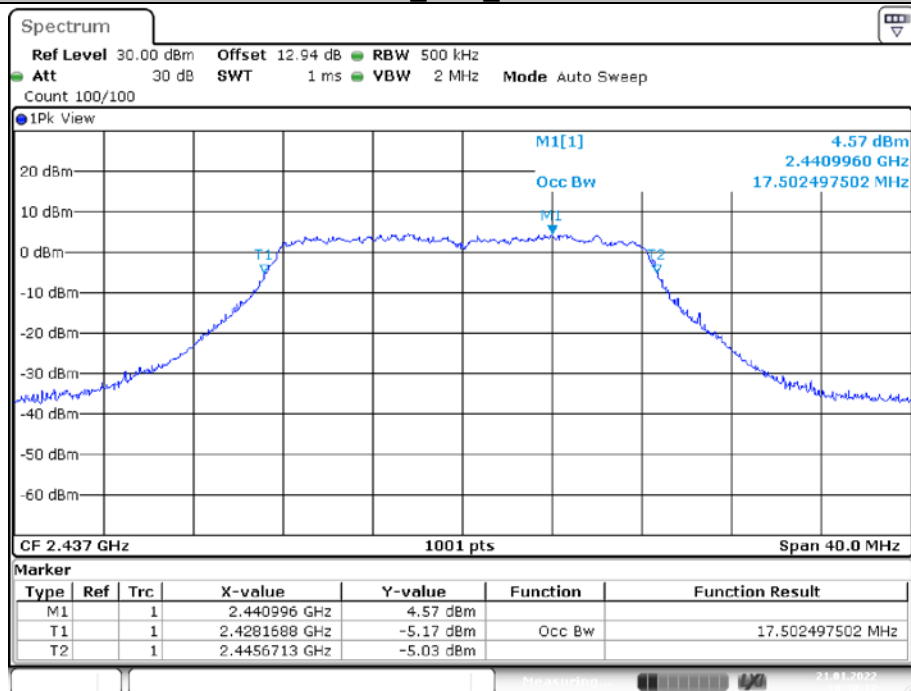
Date: 21.JAN.2022 10:32:33

11G_Ant1_2412



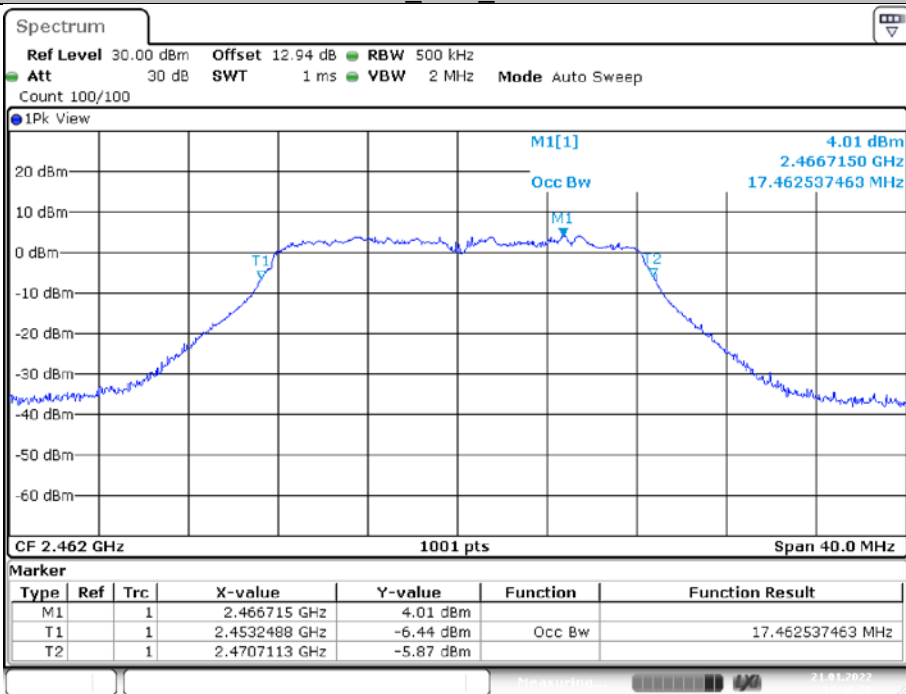
Date: 21.JAN.2022 10:34:55

11G_Ant1_2437



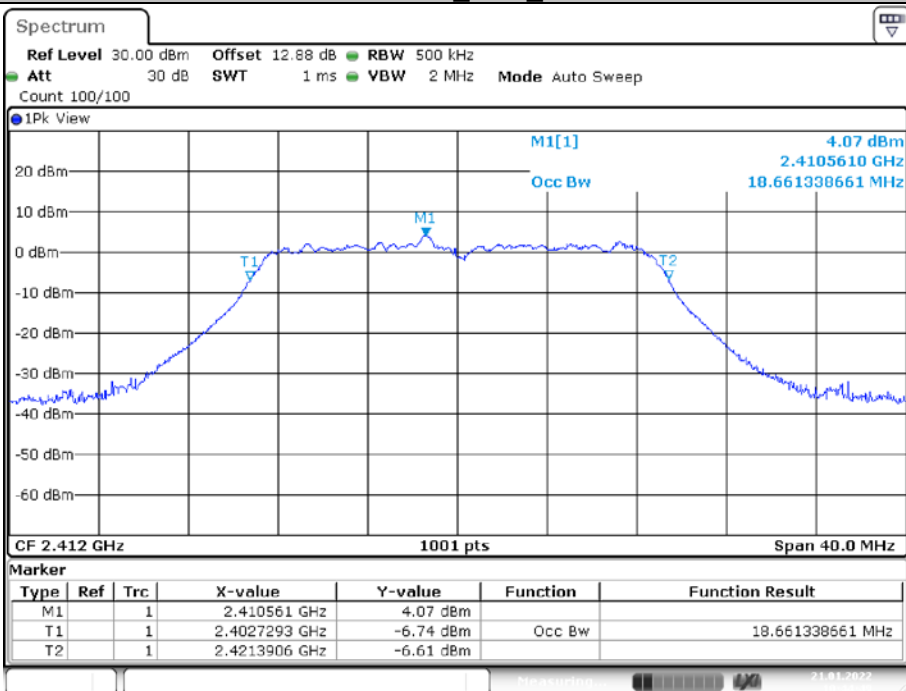
Date: 21.JAN.2022 10:38:18

11G_Ant1_2462



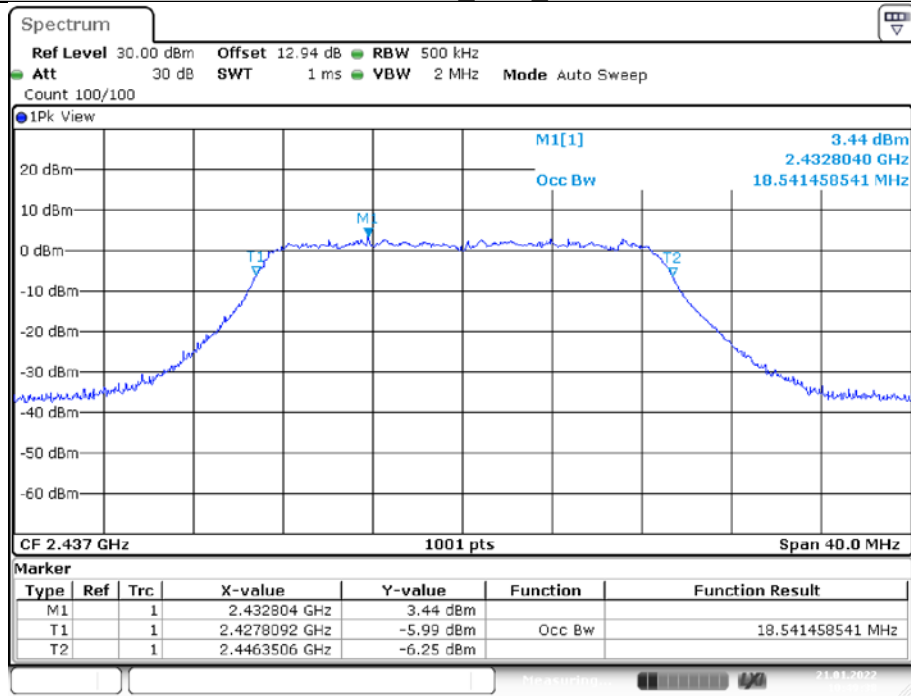
Date: 21.JAN.2022 10:40:27

11N20SISO_Ant1_2412



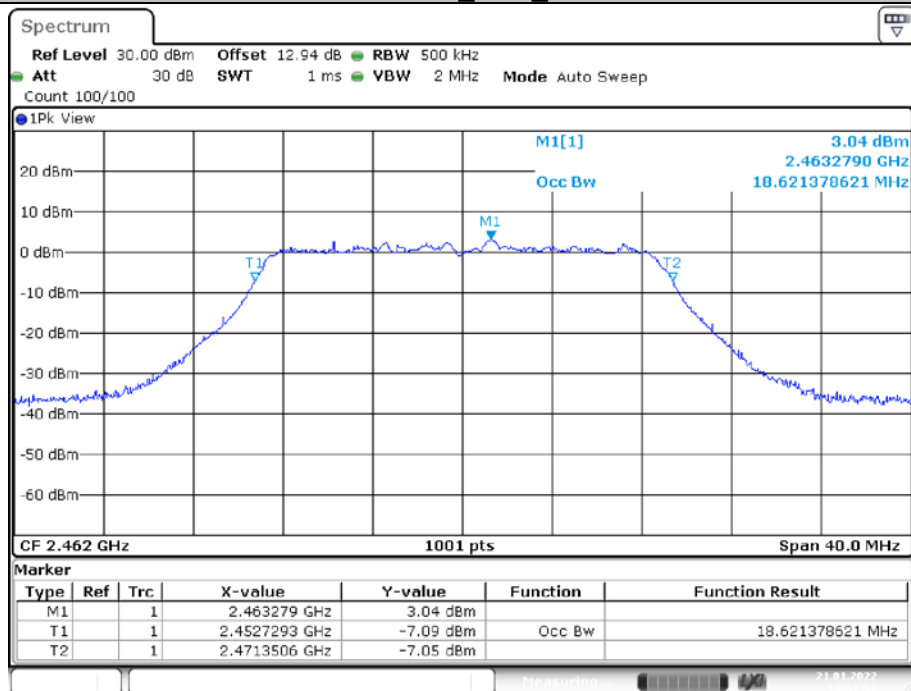
Date: 21.JAN.2022 10:44:48

11N20SISO_Ant1_2437



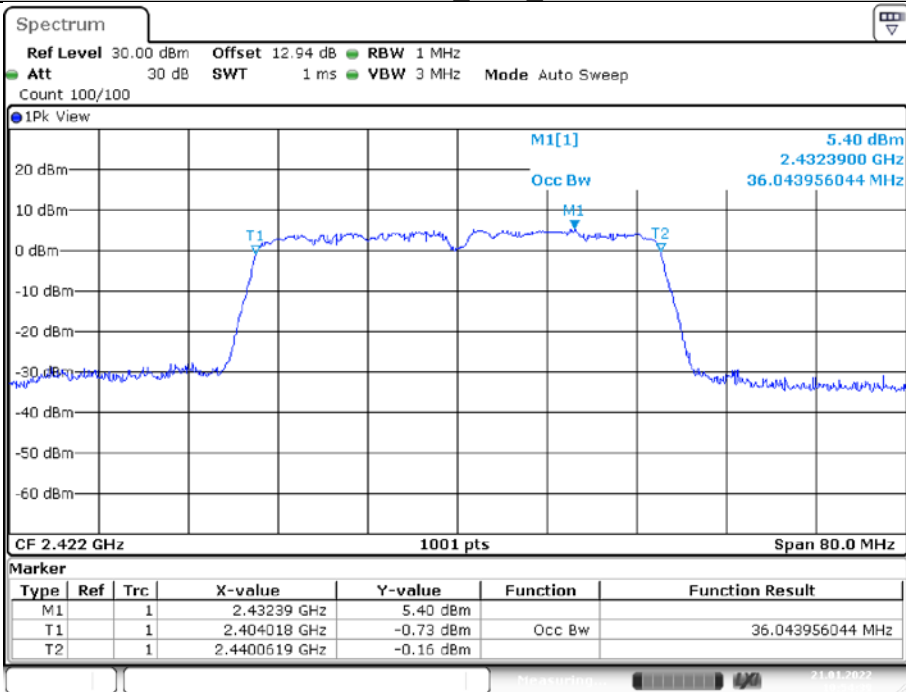
Date: 21.JAN.2022 10:49:38

11N20SISO_Ant1_2462

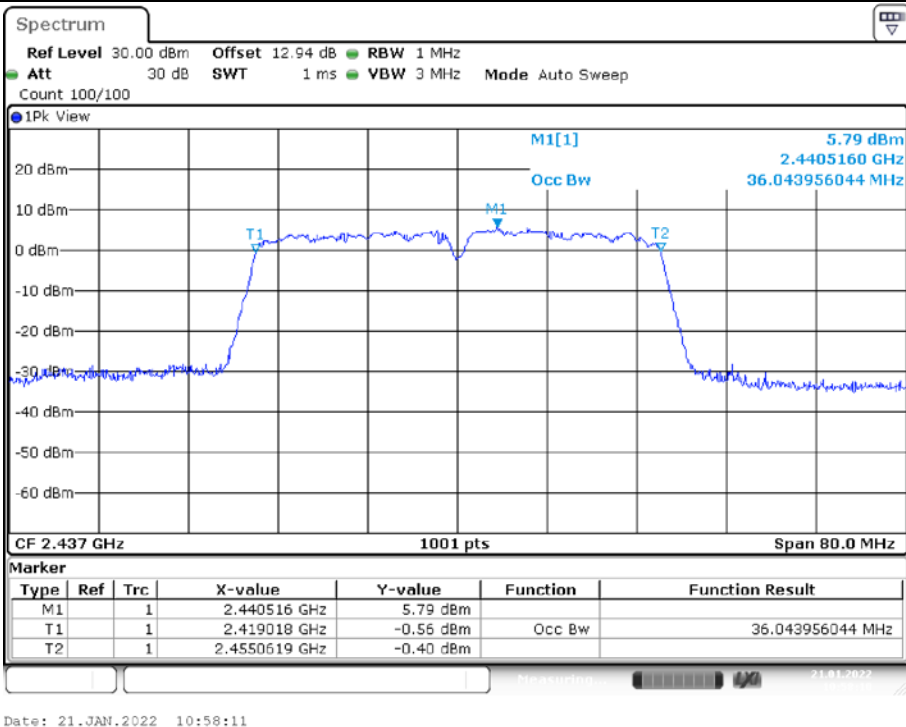


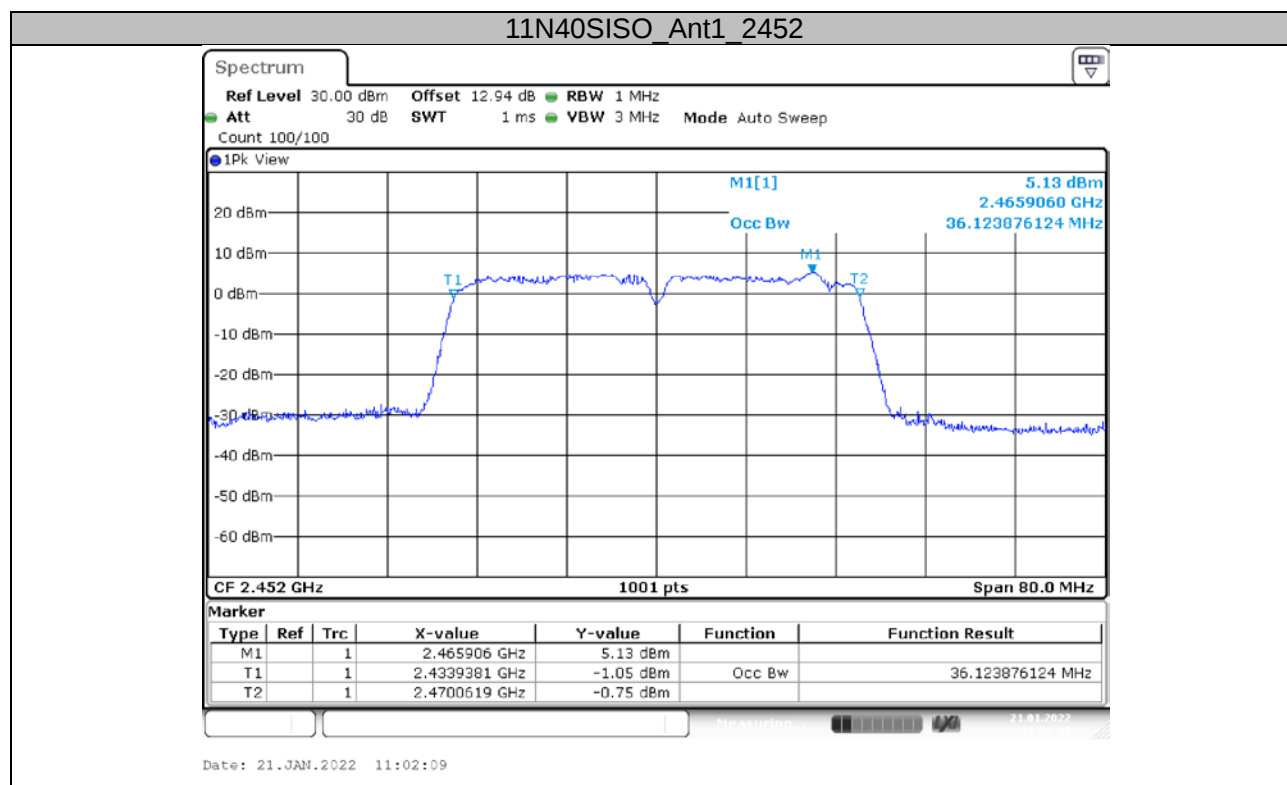
Date: 21.JAN.2022 10:51:57

11N40SISO_Ant1_2422



11N40SISO_Ant1_2437





Appendix C: Maximum conducted output power**Test Result****(PK)**

Test Mode	Antenna	Channel [MHz]	Peak Power Result [dBm]	Limit [dBm]	Verdict
11B	Ant1	2412	16.48	<=30	PASS
		2437	16.31	<=30	PASS
		2462	16.38	<=30	PASS
11G	Ant1	2412	15.52	<=30	PASS
		2437	15.96	<=30	PASS
		2462	15.79	<=30	PASS
11N20SISO	Ant1	2412	14.89	<=30	PASS
		2437	14.31	<=30	PASS
		2462	14.77	<=30	PASS
11N40SISO	Ant1	2422	14.61	<=30	PASS
		2437	14.40	<=30	PASS
		2452	14.64	<=30	PASS

(AV)

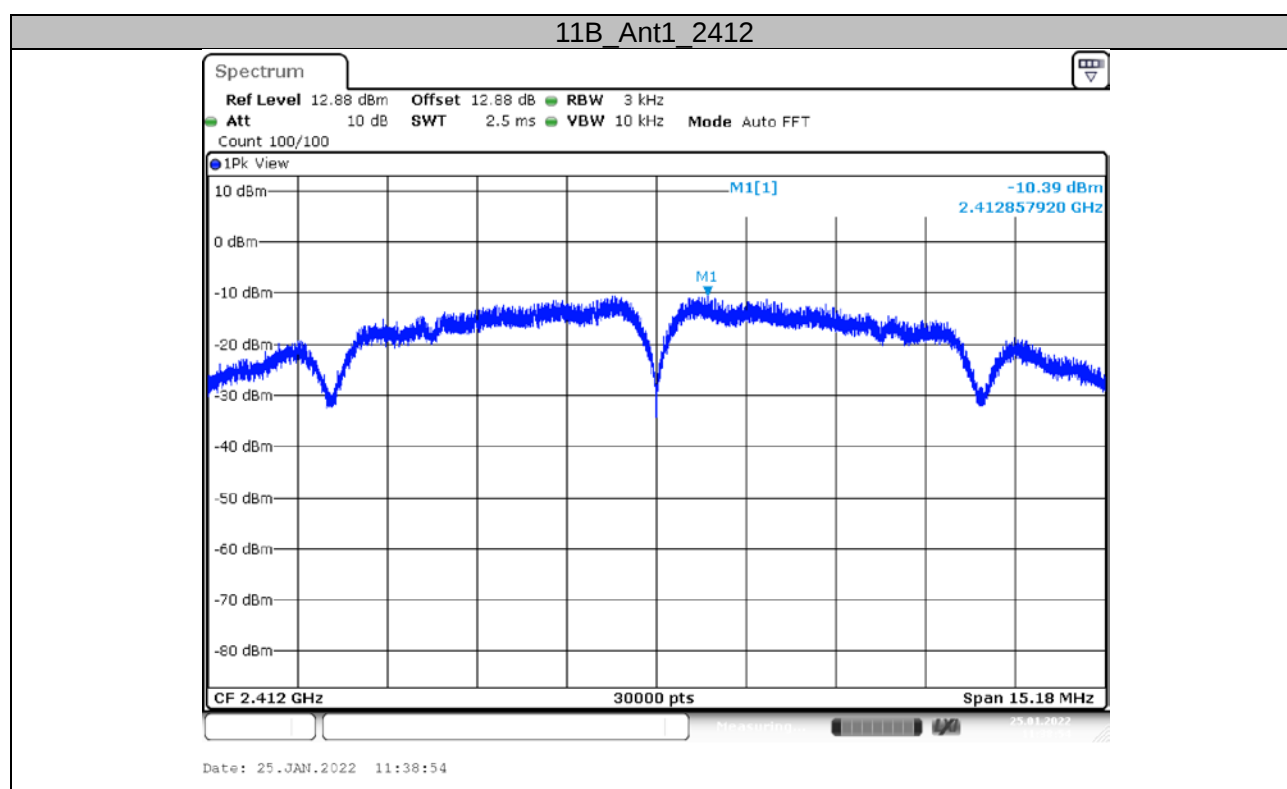
Test Mode	Antenna	Channel [MHz]	Average Power Result [dBm]	Limit [dBm]	Verdict
11B	Ant1	2412	14.32	<=30	PASS
		2437	14.17	<=30	PASS
		2462	14.23	<=30	PASS
11G	Ant1	2412	12.29	<=30	PASS
		2437	12.65	<=30	PASS
		2462	12.48	<=30	PASS
11N20SISO	Ant1	2412	11.06	<=30	PASS
		2437	10.51	<=30	PASS
		2462	10.93	<=30	PASS
11N40SISO	Ant1	2422	8.76	<=30	PASS
		2437	8.54	<=30	PASS
		2452	8.92	<=30	PASS

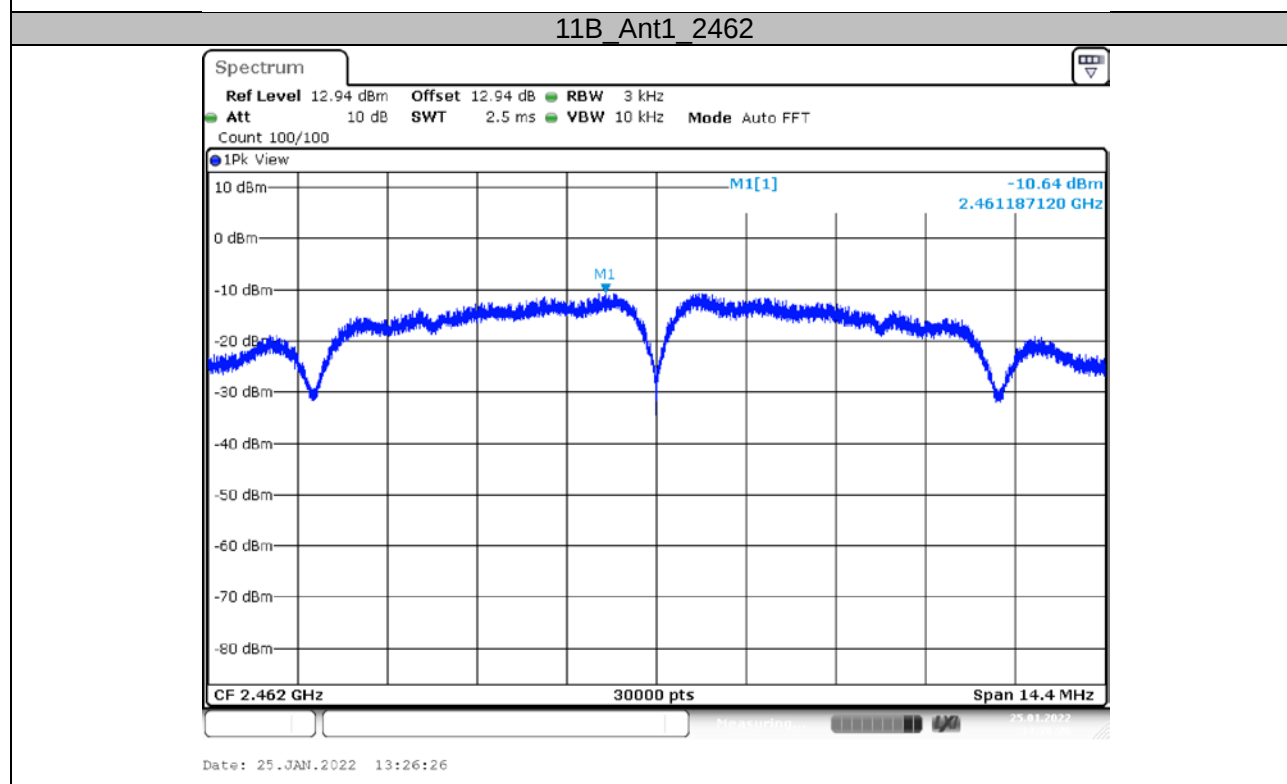
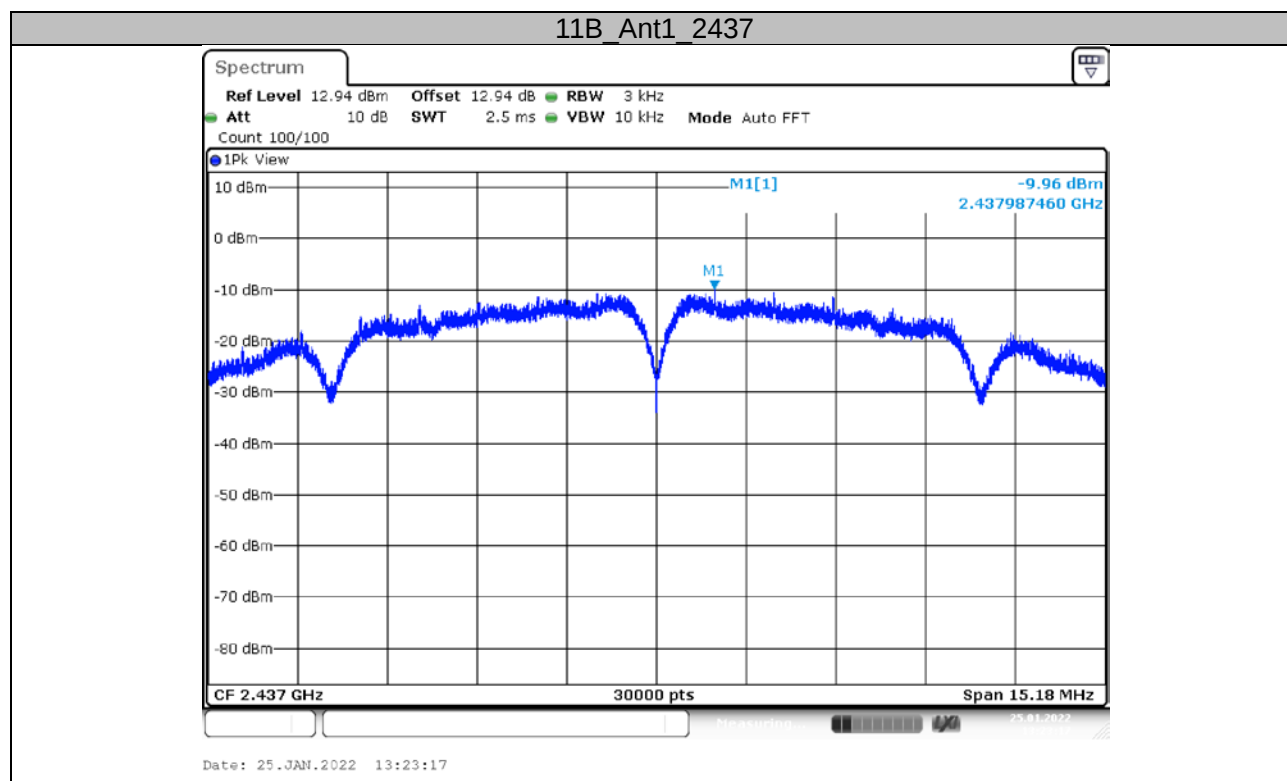
Appendix D: Power spectral density

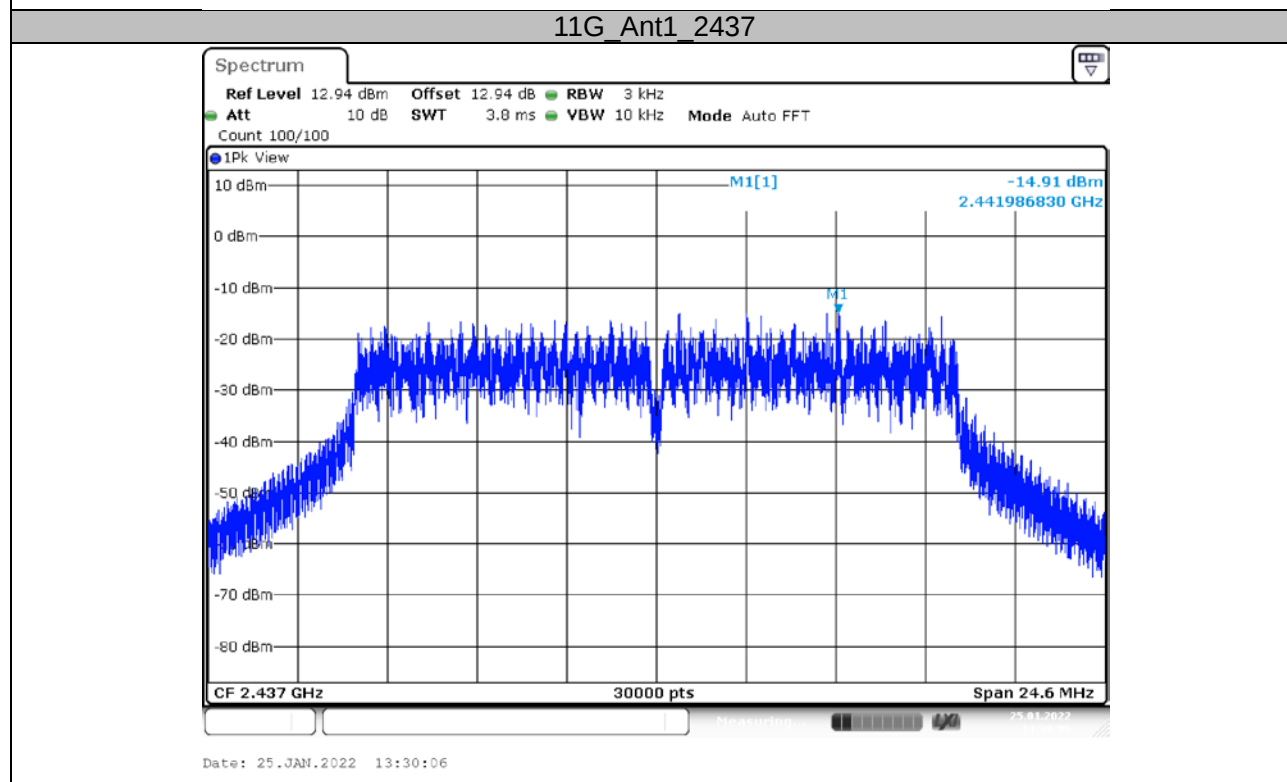
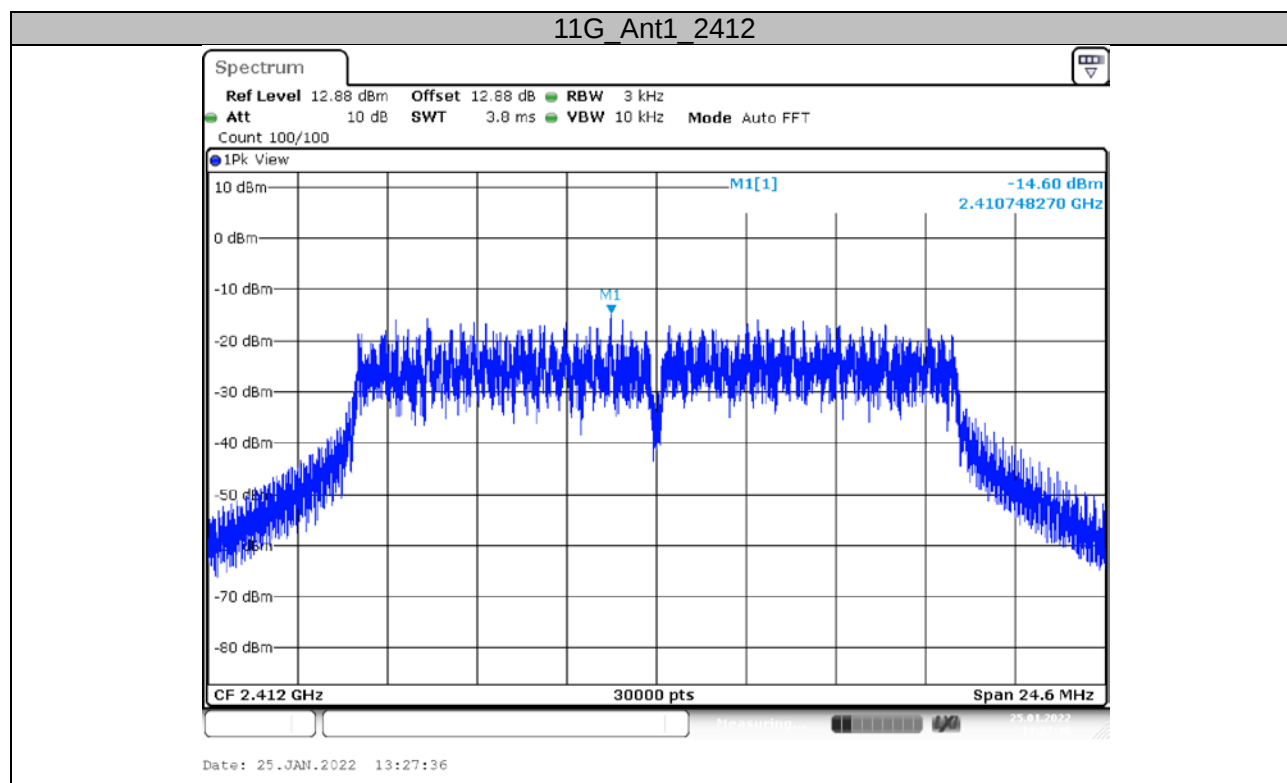
Test Result

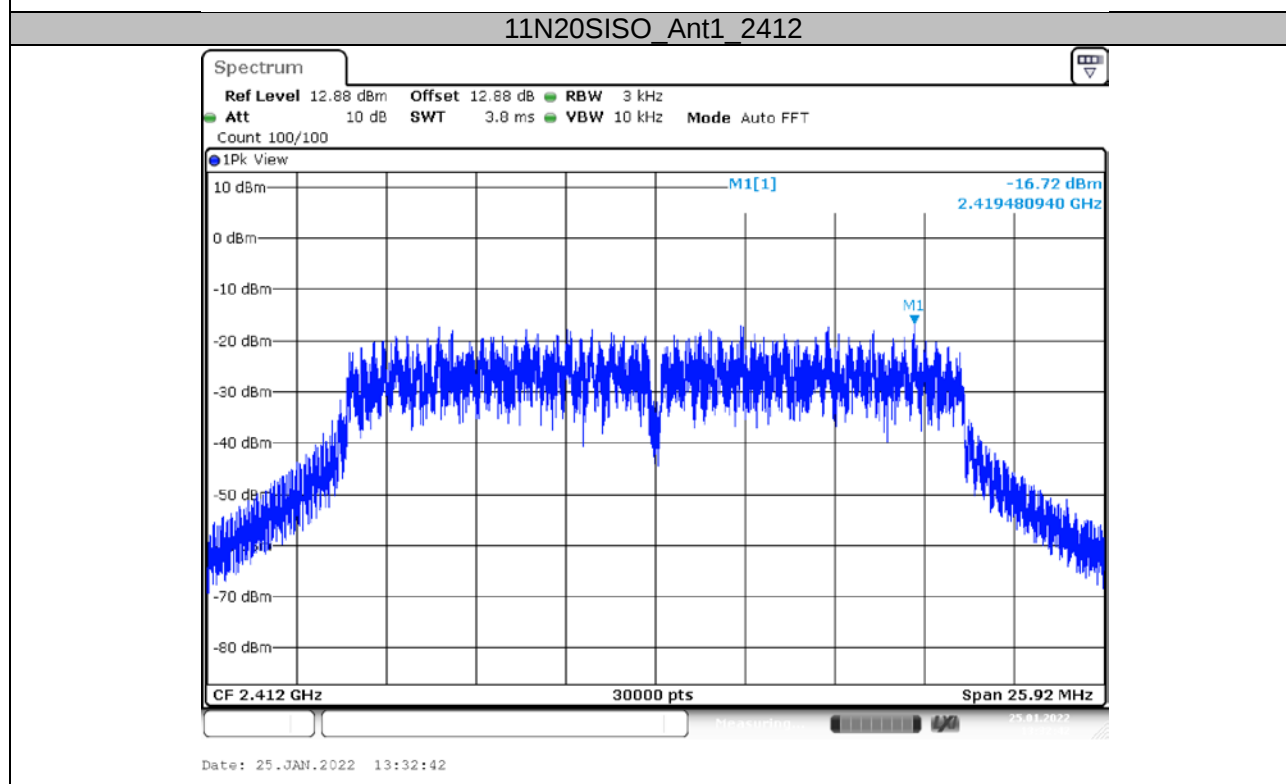
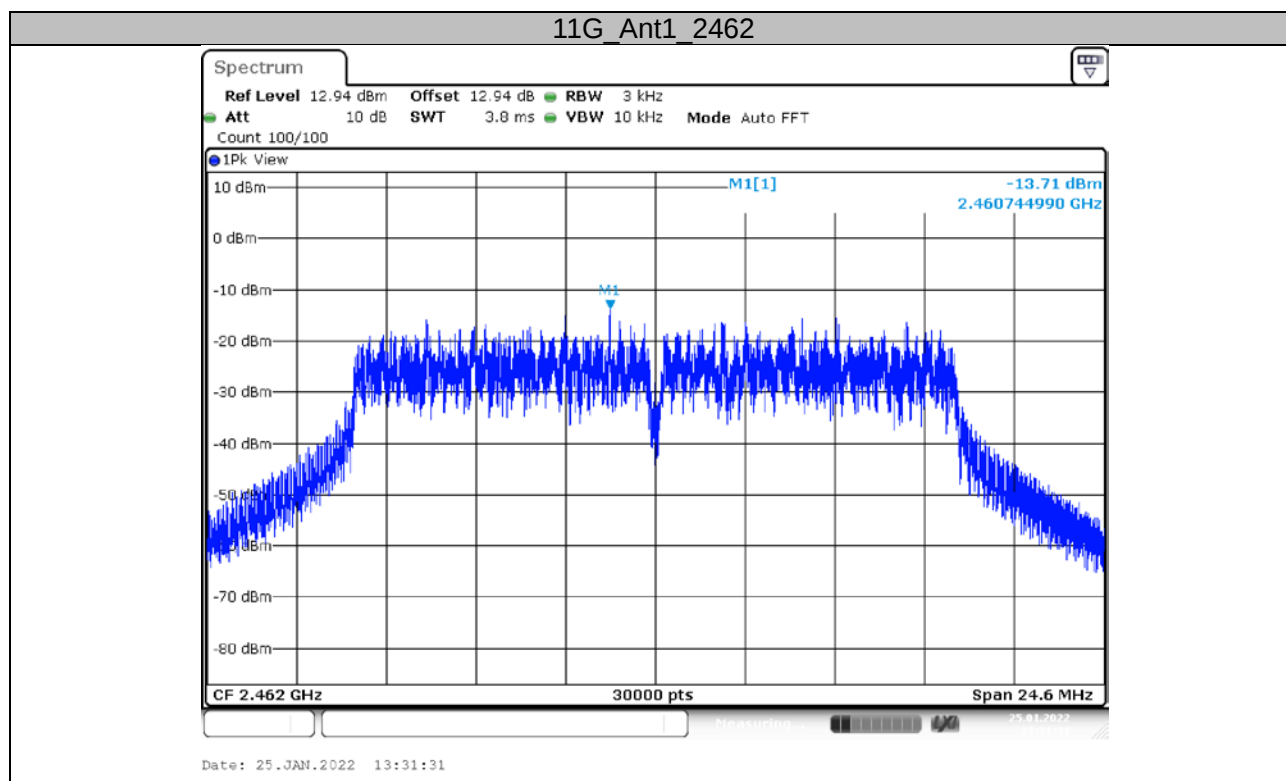
TestMode	Antenna	Channel[MHz]	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
11B	Ant1	2412	-10.39	<=8	PASS
		2437	-9.96	<=8	PASS
		2462	-10.64	<=8	PASS
11G	Ant1	2412	-14.6	<=8	PASS
		2437	-14.91	<=8	PASS
		2462	-13.71	<=8	PASS
11N20SISO	Ant1	2412	-16.72	<=8	PASS
		2437	-16.63	<=8	PASS
		2462	-15.7	<=8	PASS
11N40SISO	Ant1	2422	-17.36	<=8	PASS
		2437	-14.85	<=8	PASS
		2452	-16.93	<=8	PASS

Test Graphs

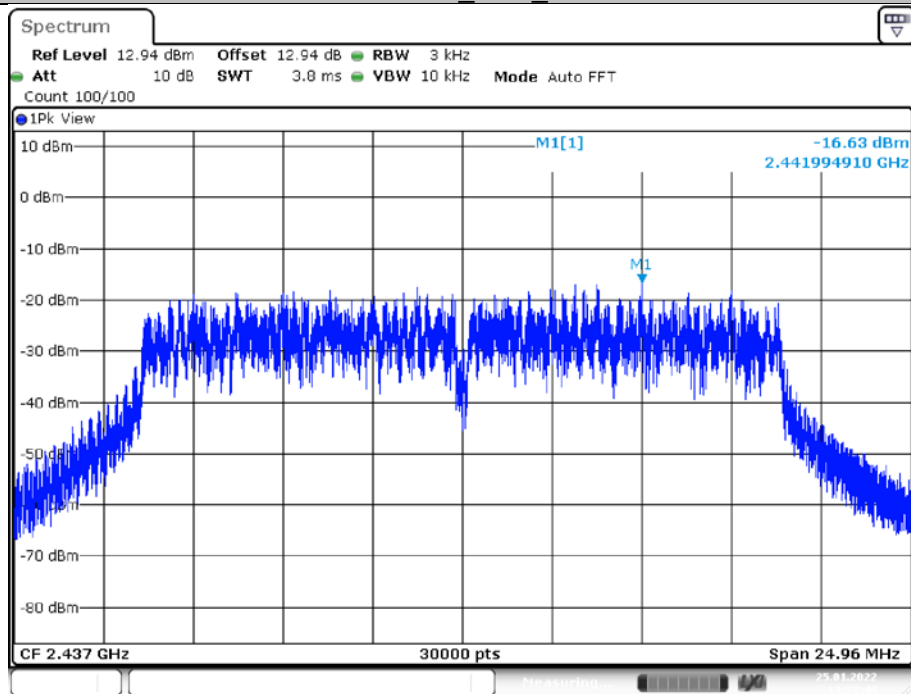




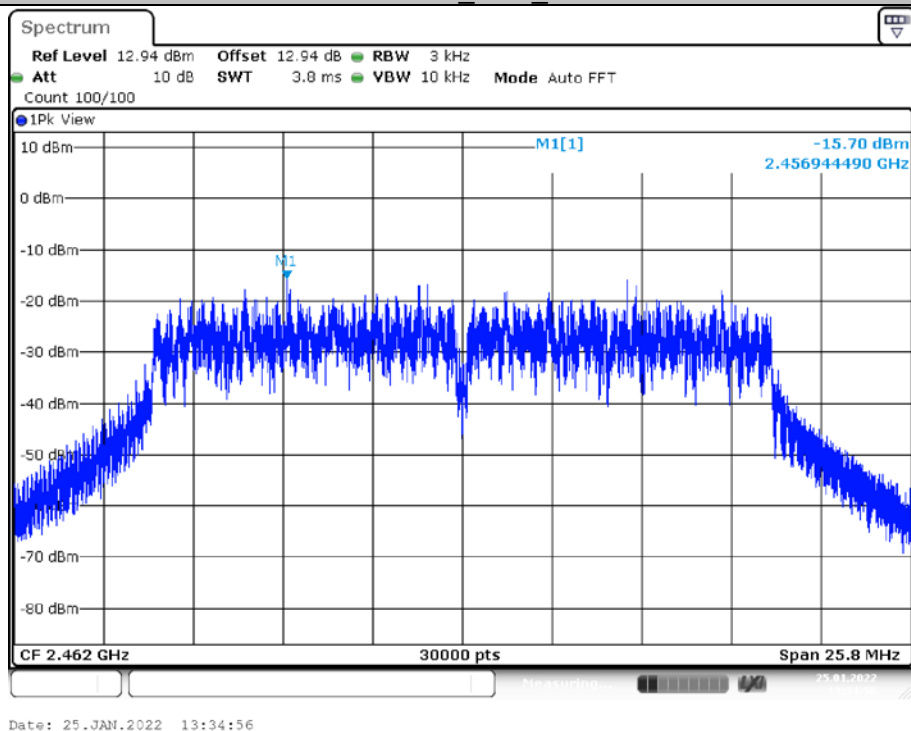




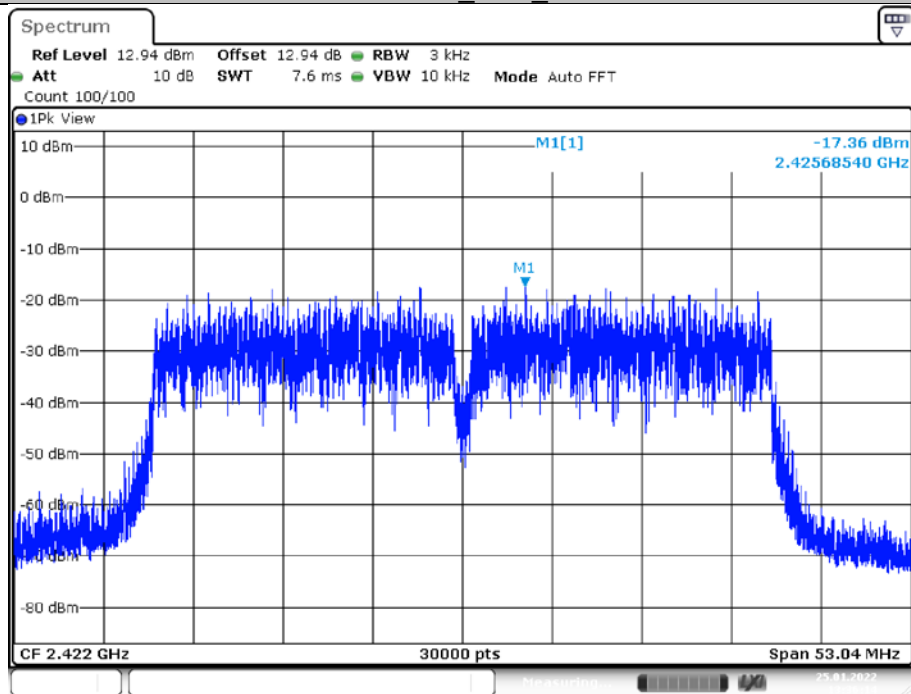
11N20SISO_Ant1_2437



11N20SISO_Ant1_2462

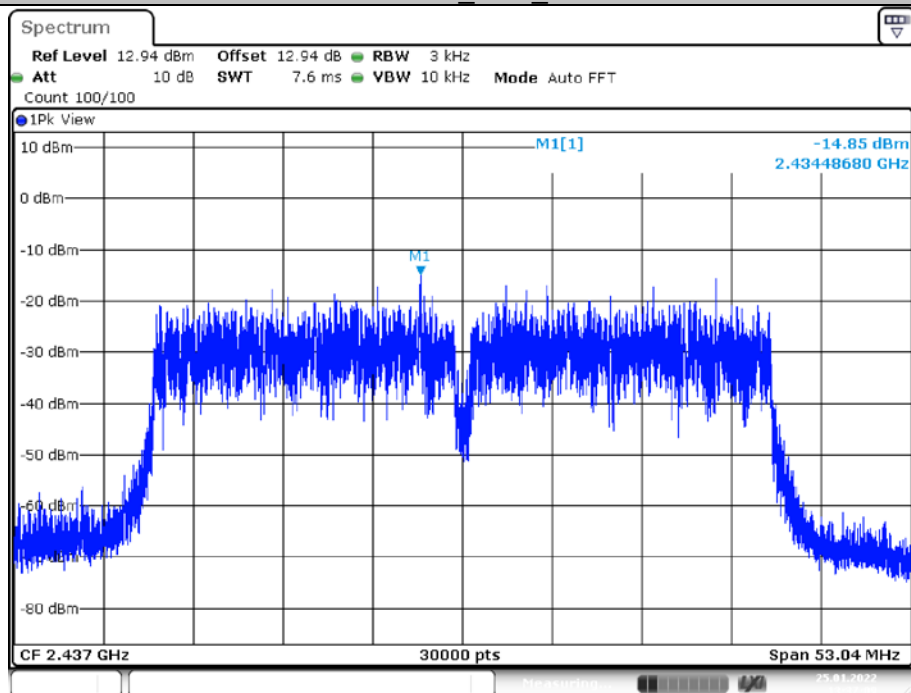


11N40SISO_Ant1_2422

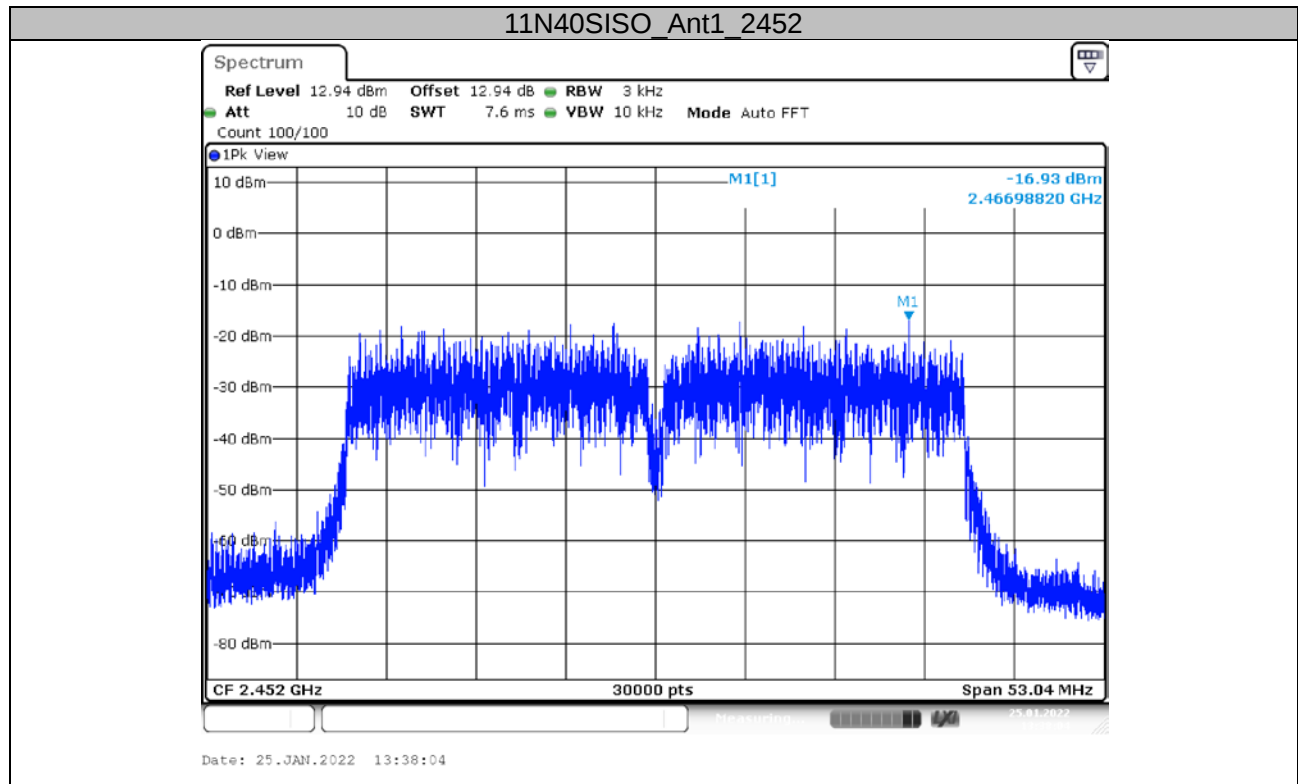


Date: 25.JAN.2022 13:36:14

11N40SISO_Ant1_2437

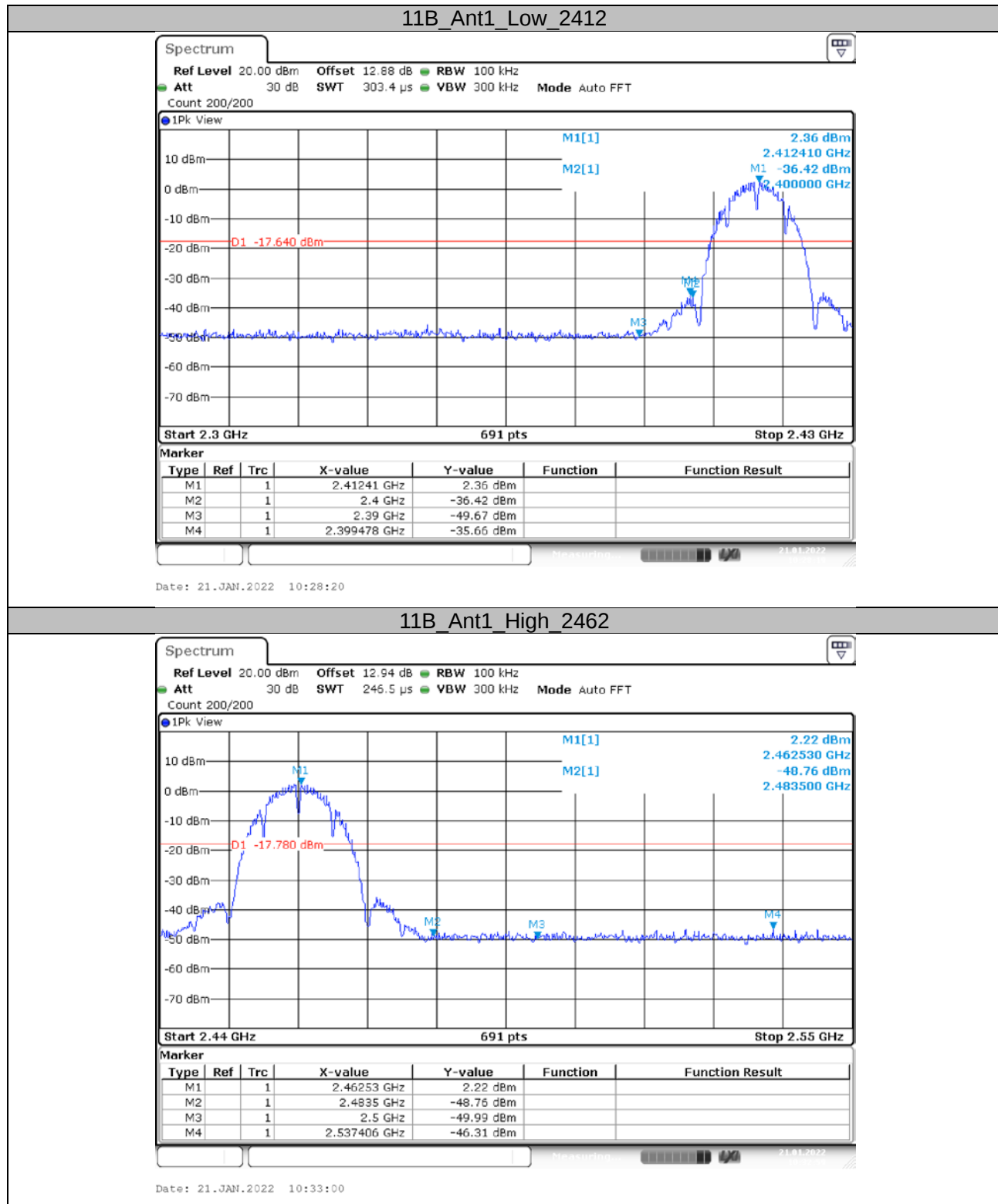


Date: 25.JAN.2022 13:37:09

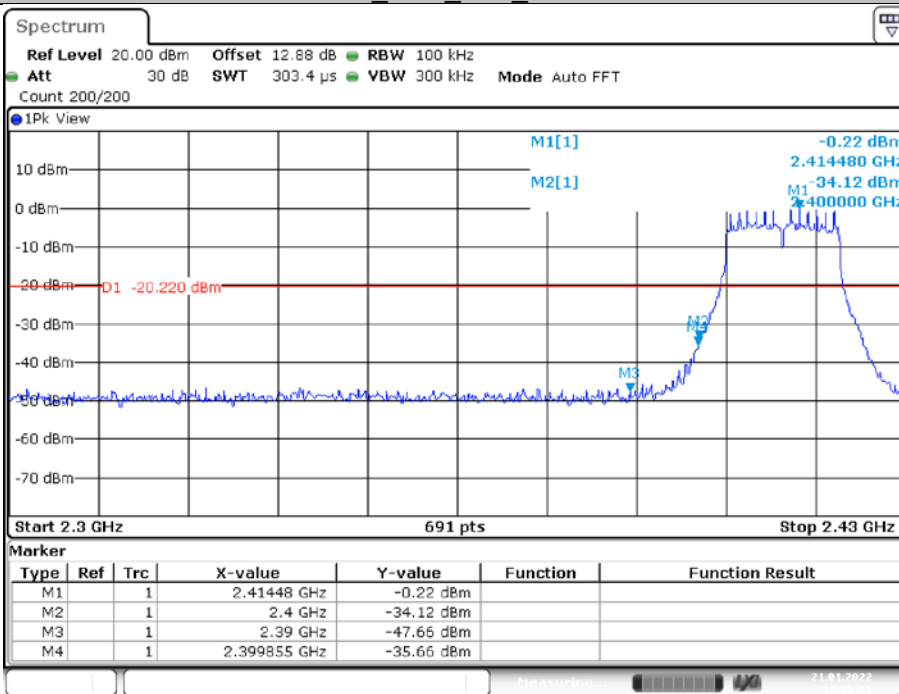


Appendix E: Band edge measurements

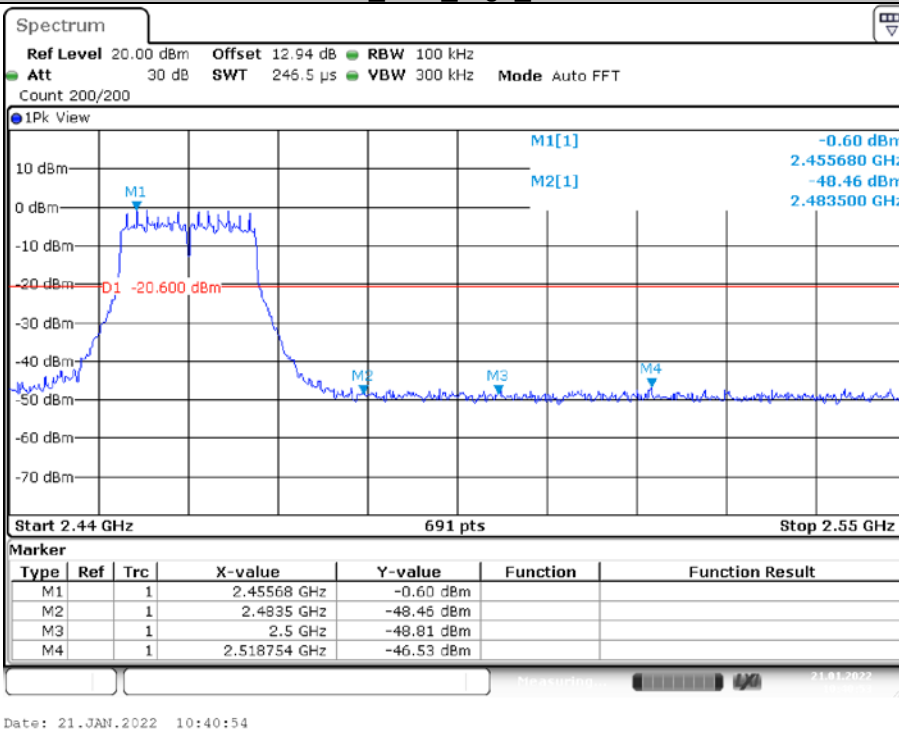
Test Graphs



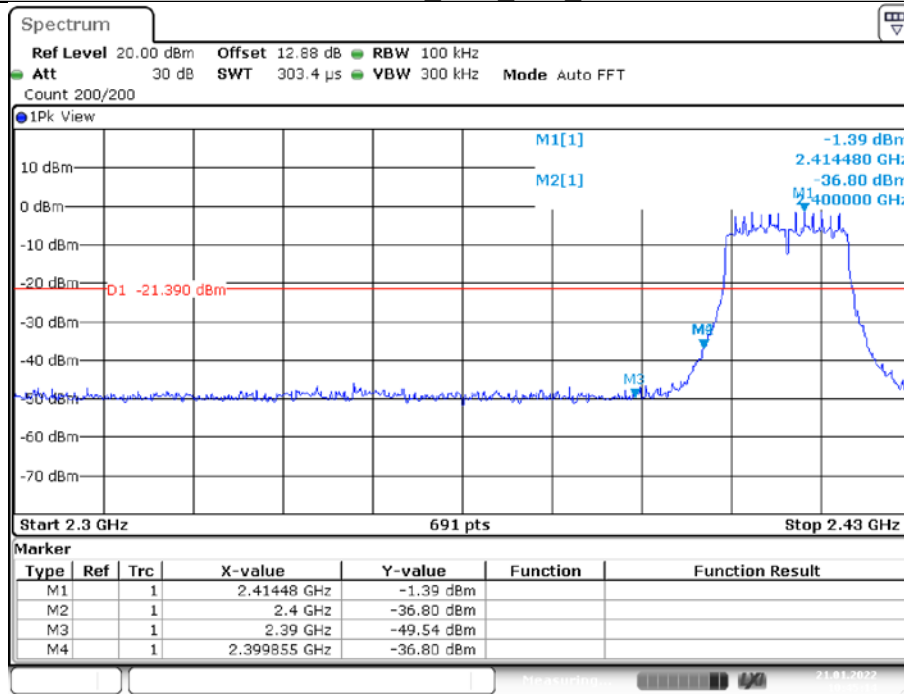
11G_Ant1_Low_2412



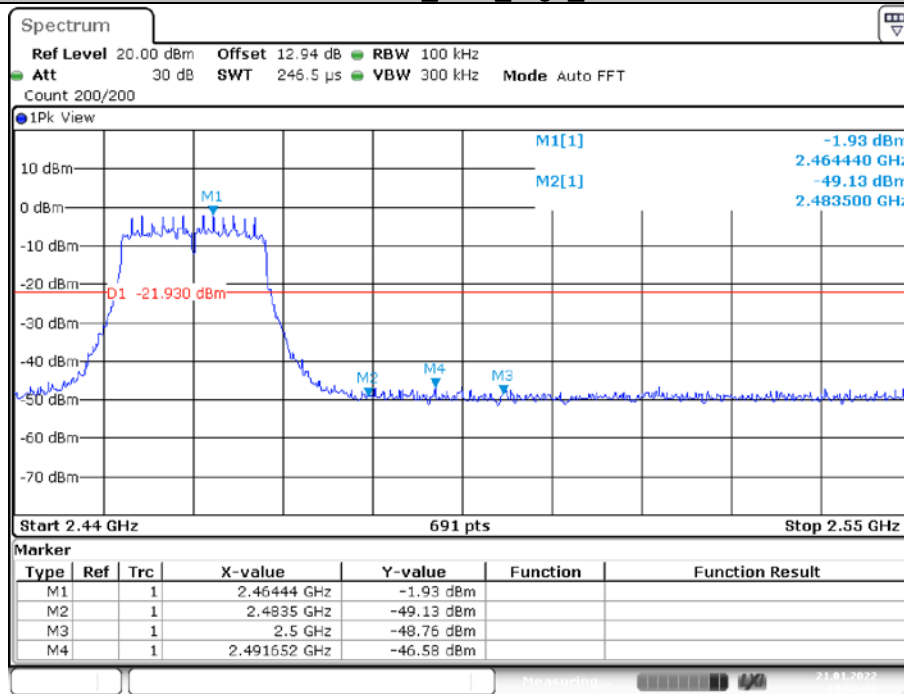
11G_Ant1_High_2462



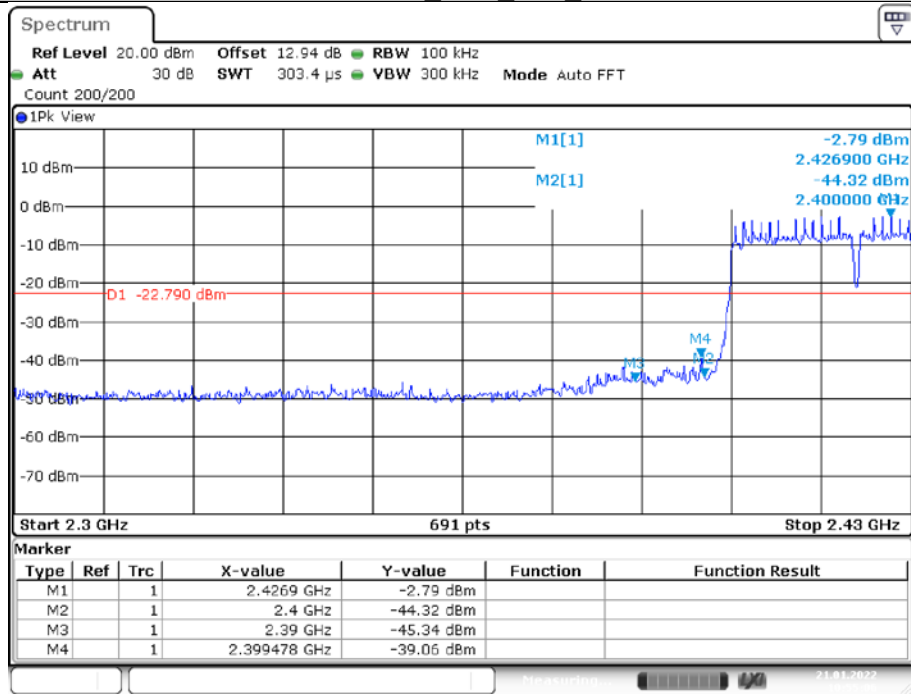
11N20SISO_Ant1_Low_2412



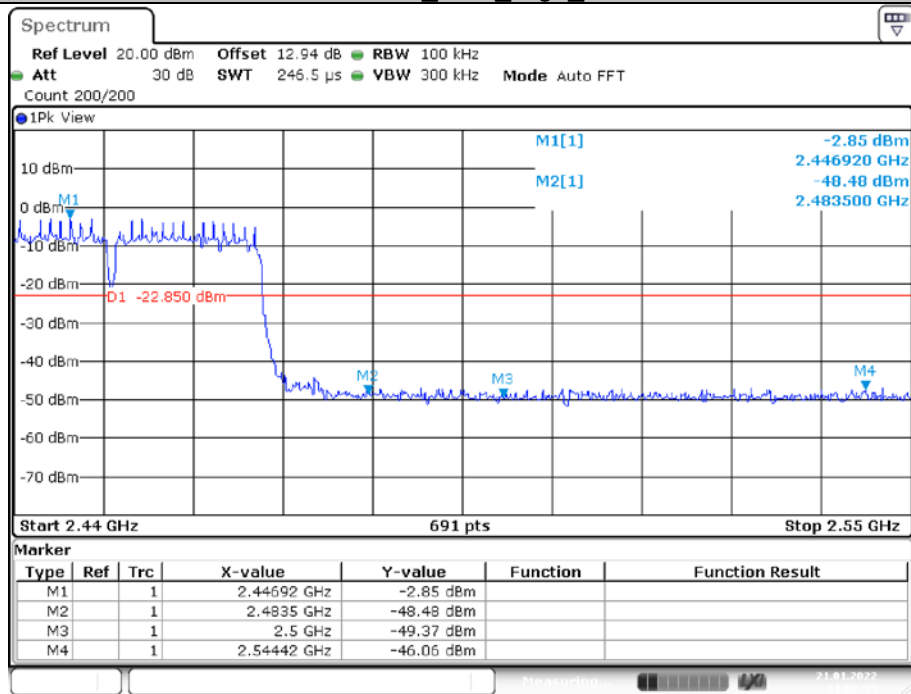
11N20SISO_Ant1_High_2462



11N40SISO_Ant1_Low_2422



11N40SISO_Ant1_High_2452

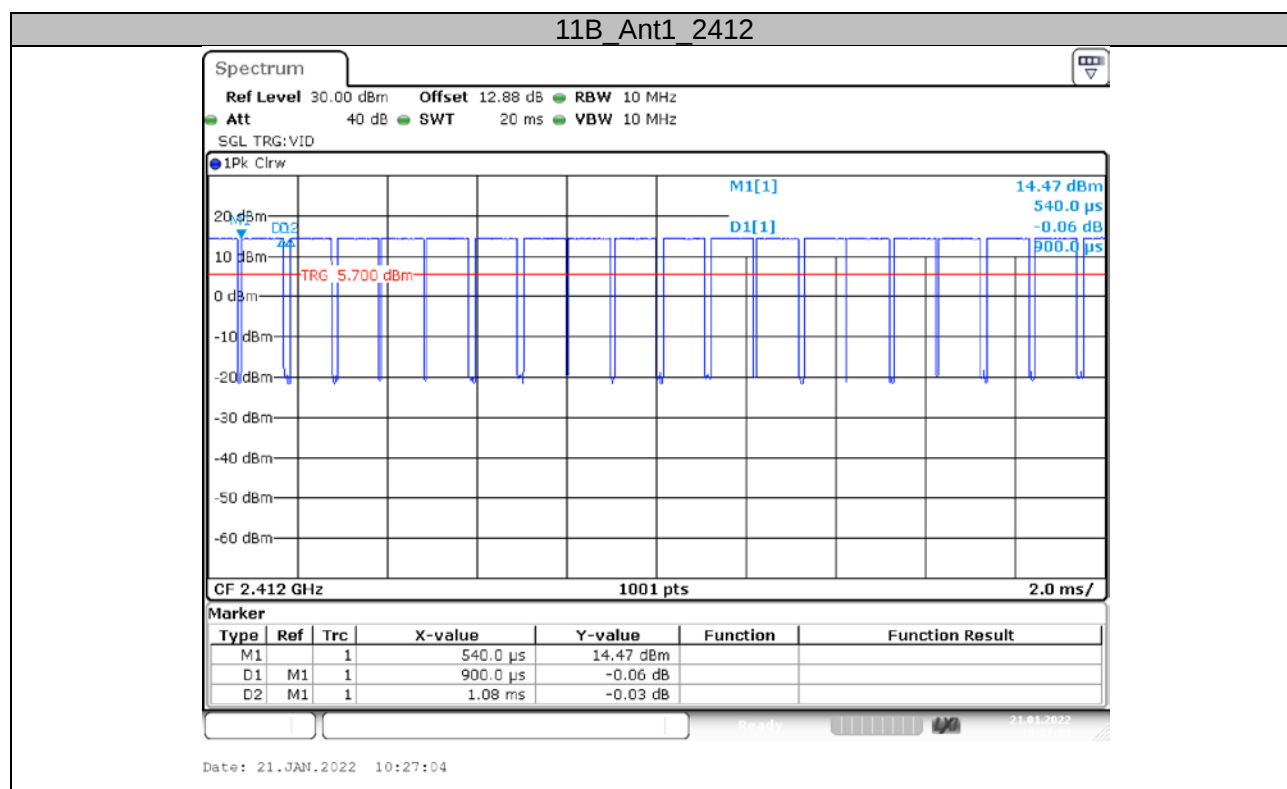


Appendix F: Duty Cycle

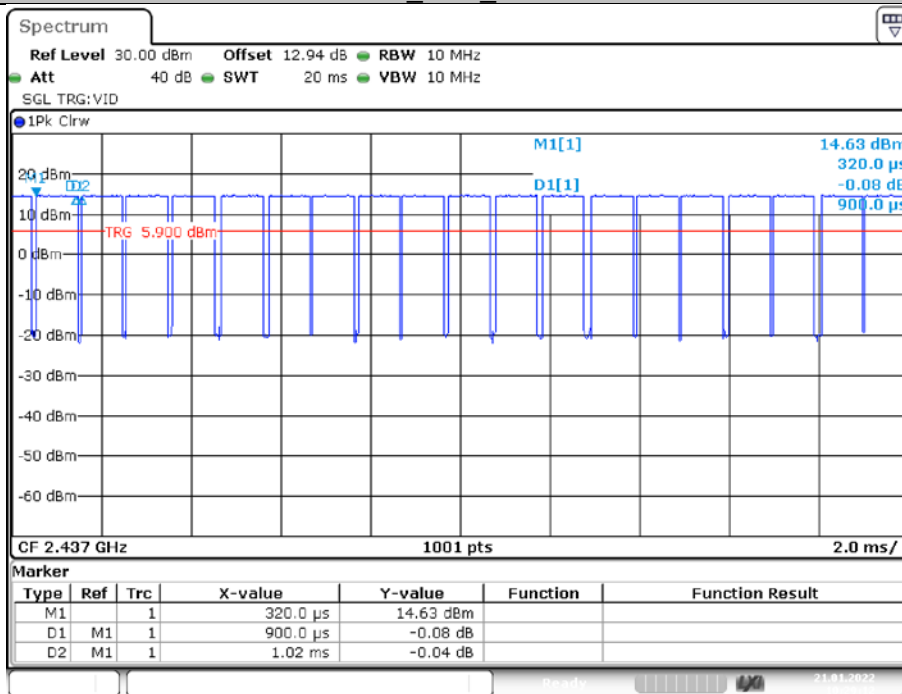
Test Result

TestMode	Antenna	Channel	TransmissionDuration [ms]	Transmission Period [ms]	Duty Cycle [%]
11B	Ant1	2412	0.90	1.08	83.33
		2437	0.90	1.02	88.24
		2462	0.88	1.08	81.48
11G	Ant1	2412	0.13	0.21	61.90
		2437	0.13	0.31	41.94
		2462	0.12	0.31	38.71
11N20SISO	Ant1	2412	0.13	0.24	54.17
		2437	0.14	0.19	73.68
		2462	0.14	0.25	56.00
11N40SISO	Ant1	2422	0.08	0.21	38.10
		2437	0.08	0.24	33.33
		2452	0.08	0.20	40.00

Test Graphs

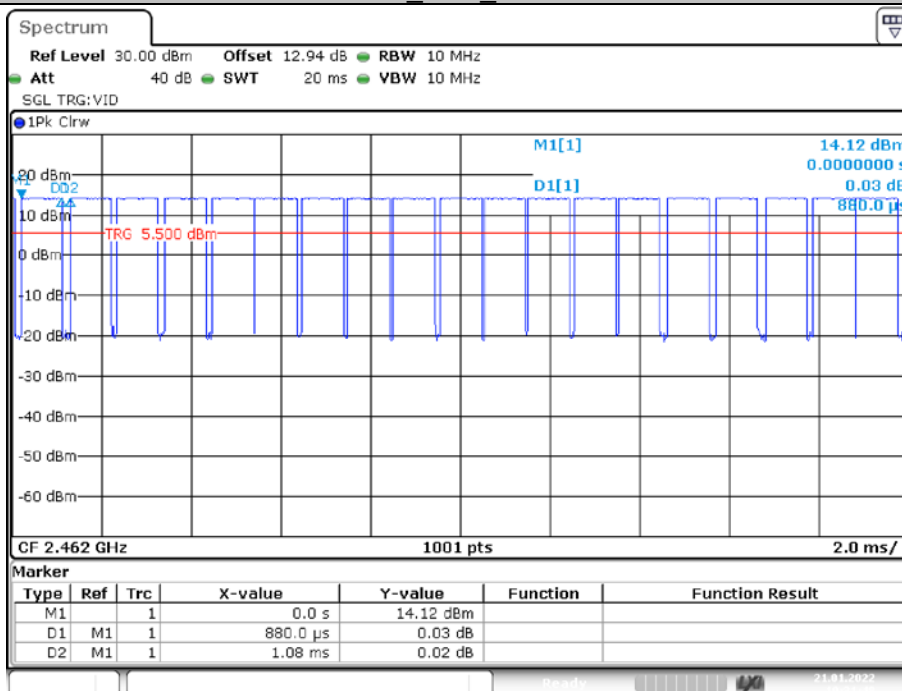


11B_Ant1_2437



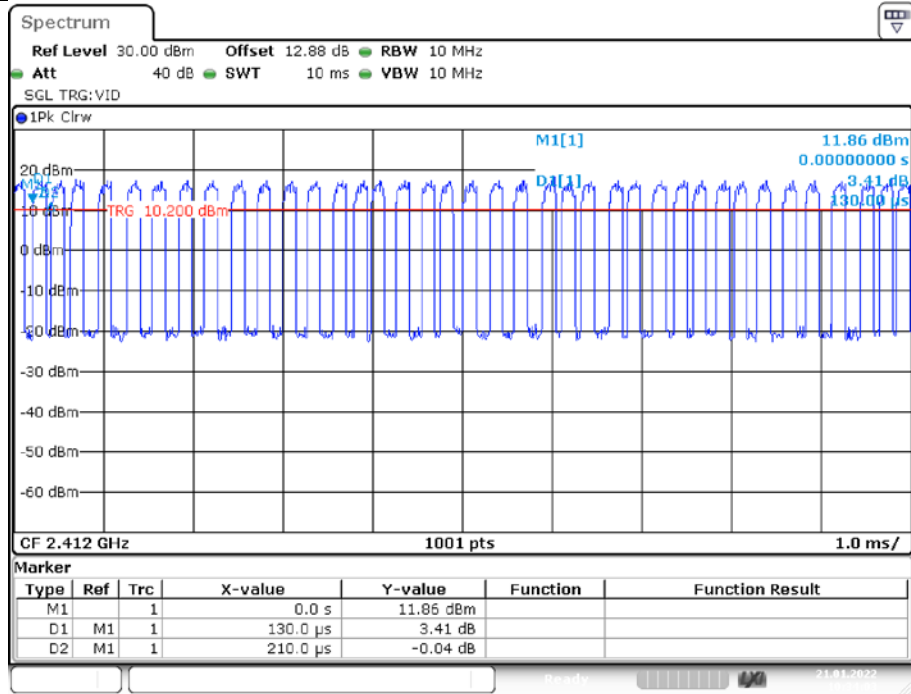
Date: 21.JAN.2022 10:29:11

11B_Ant1_2462

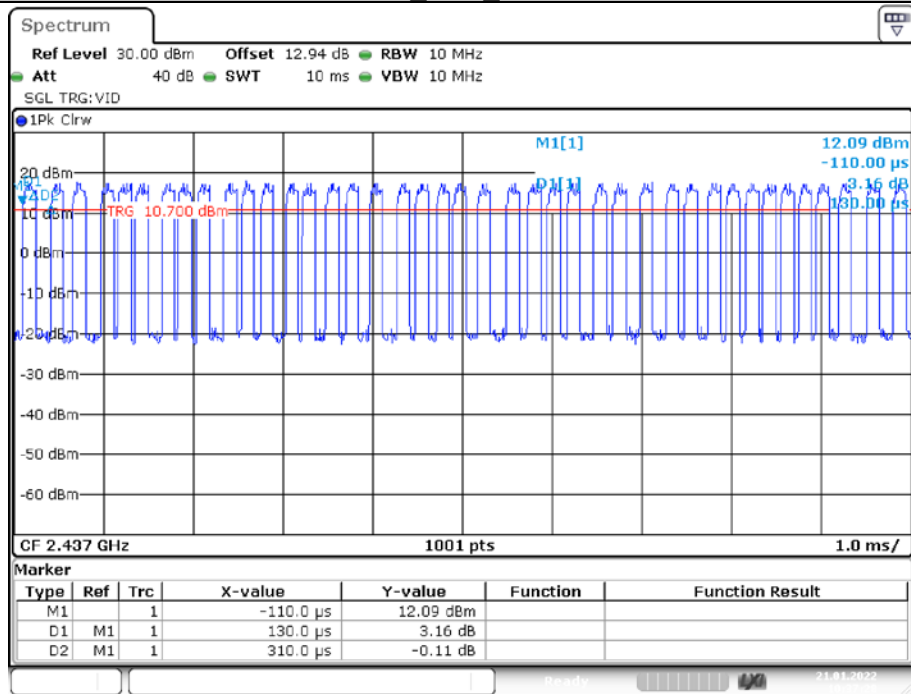


Date: 21.JAN.2022 10:31:49

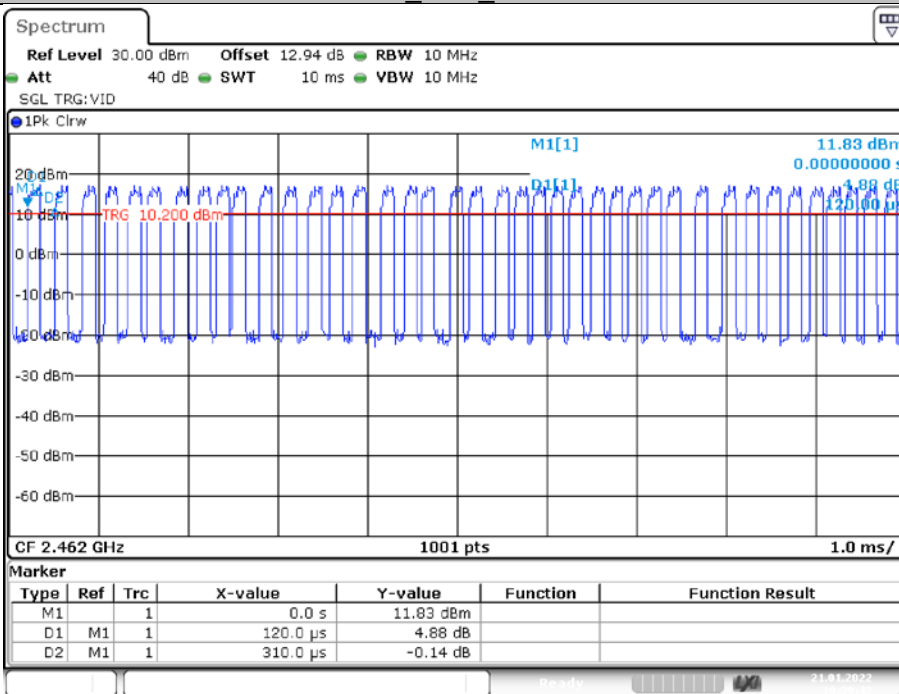
11G_Ant1_2412



11G_Ant1_2437

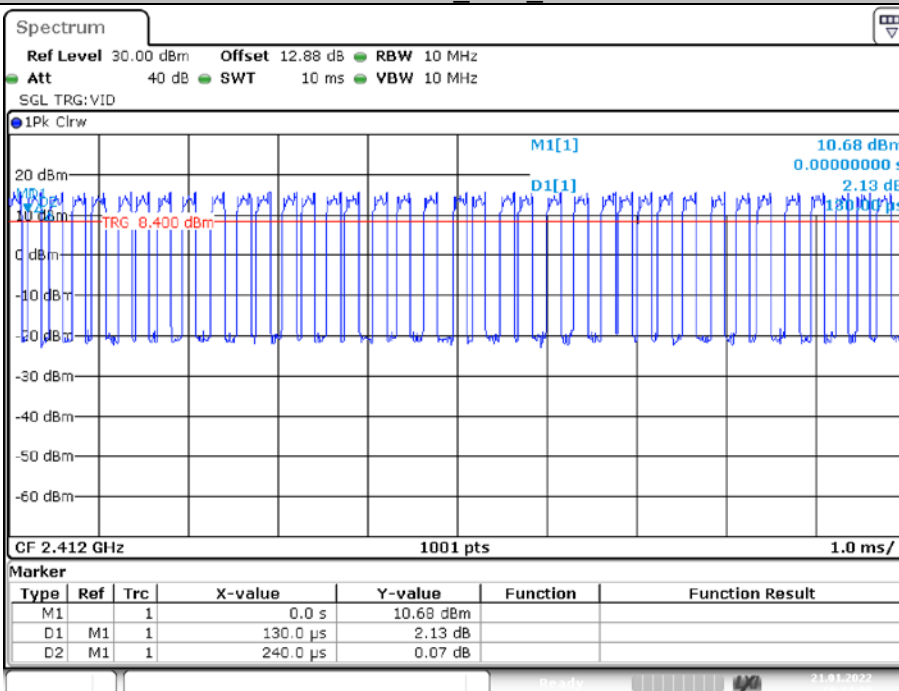


11G_Ant1_2462



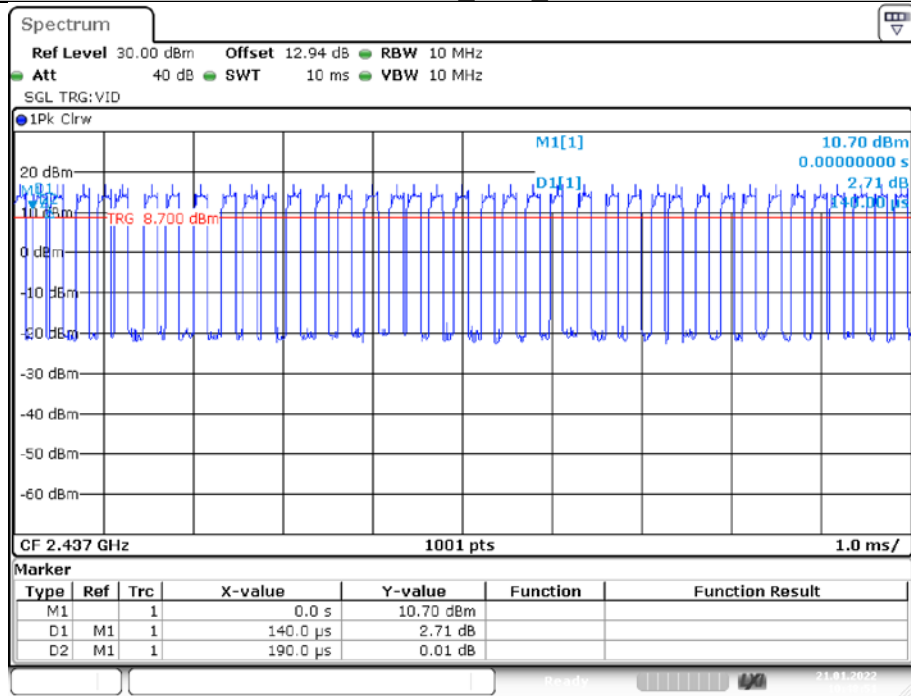
Date: 21.JAN.2022 10:39:43

11N20SISO_Ant1_2412



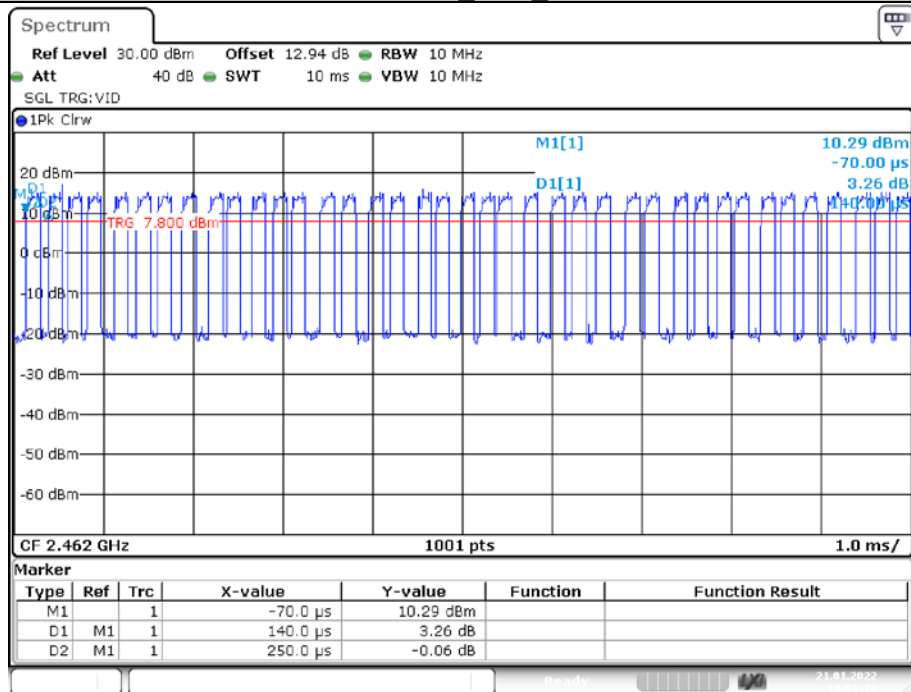
Date: 21.JAN.2022 10:44:05

11N20SISO_Ant1_2437



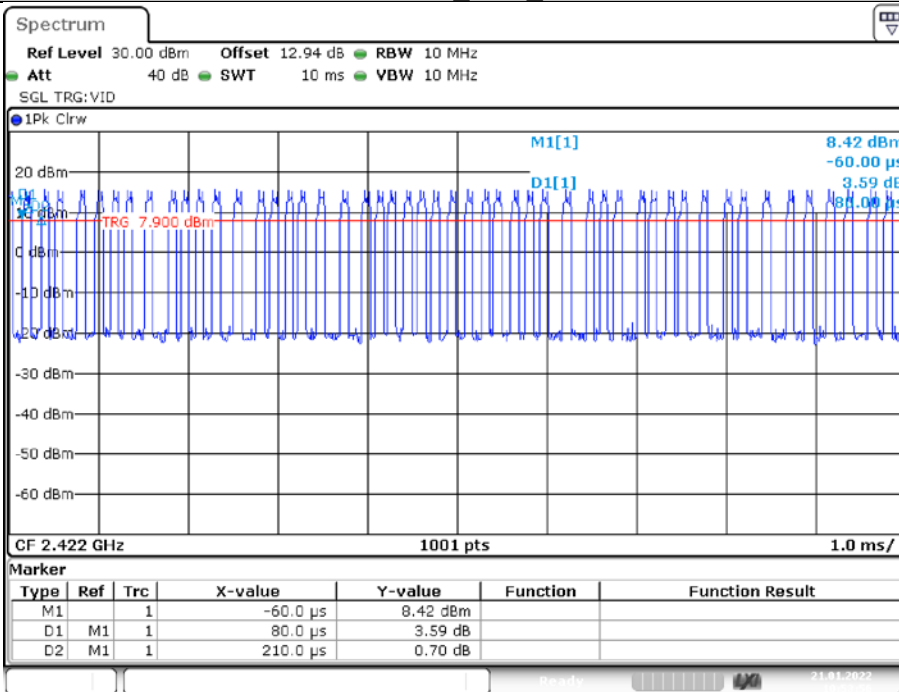
Date: 21.JAN.2022 10:48:52

11N20SISO_Ant1_2462



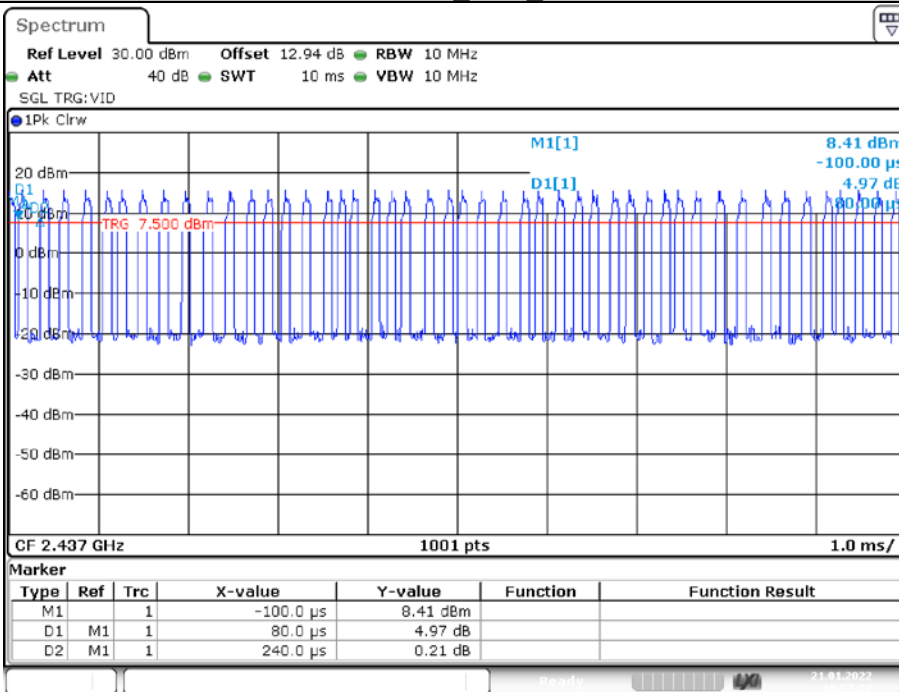
Date: 21.JAN.2022 10:51:13

11N40SISO_Ant1_2422

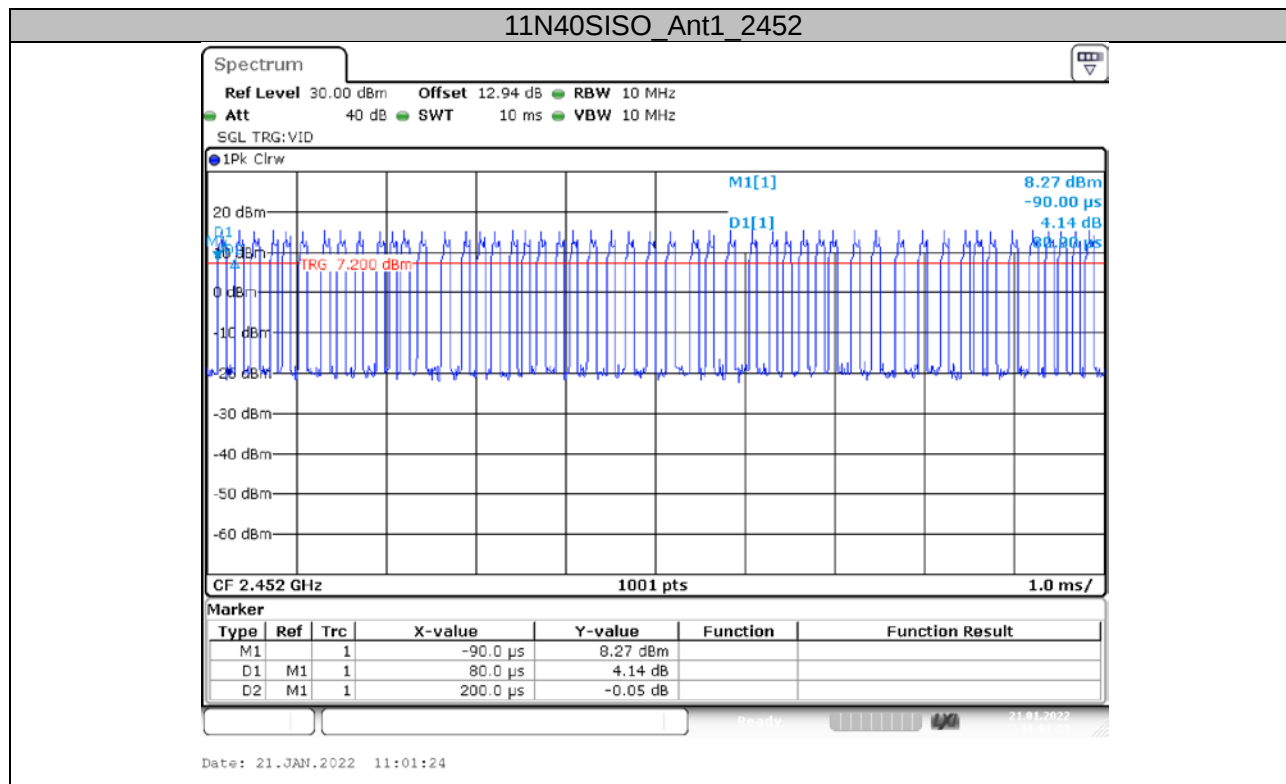


Date: 21.JAN.2022 10:53:57

11N40SISO_Ant1_2437



Date: 21.JAN.2022 10:57:28



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