

FCC/IC - TEST REPORT

Report Number : **68.940.21.0056.01** Date of Issue: September 30, 2021

Model : **NL59**

Product Type : Nanoleaf Lines

Applicant : NANOGRID LIMITED

Address : Room 1301, 13/F, Excel Centre, 483A Castle Peak Road, Lai Chi Kok,
Kowloon, HONG KONG

Production Facility : SEVECO GLOBAL LTD.

Address : 2 Jianxiang St. Hanxishui Chashan Town, 523377 Dongguan,
Guangdong, PEOPLE'S REPUBLIC OF CHINA

Test Result : ☒ **Positive** ☐ **Negative**

Total pages including Appendices : 55

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2 Details about the Test Laboratory

Details about the Test Laboratory

Test Site 1

Company name: TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch
Building 12&13, Zhiheng Wisdomland Business Park,
Nantou Checkpoint Road 2, Nanshan District,
Shenzhen City, 518052,
P. R. China

FCC Registration Number: 514049

FCC Designation Number: CN5009

ISED#: 10320A

CAB identifier: CN0077

Telephone: 86 755 8828 6998
Fax: 86 755 8828 5299

3 Description of the Equipment under Test

Description of the Equipment Under Test

Product/PMN: Nanoleaf Lines

Model no./HVIN: NL59

HMN: NIL

FCC ID: 2AEWY-NL59

IC: 20489-NL59

Options and accessories: NIL

Ratings: 100-240VAC; 50/60Hz; 47.5W

Adapter: Model: DSL-42WA-42 420100
Input: 100-240VAC; 50/60Hz; 1.0A
Output: 42.0VDC; 1.0A; 42.0W

RF Transmission Frequency: 2412-2462MHz

No. of Operated Channel: 11

Modulation: CCK, DQPSK, DBPSK for 802.11b
QPSK, BPSK for 802.11g/n

Duty Cycle: 100%

Antenna Type: Integral Antenna

Antenna Gain: 2.15dBi

Description of the EUT: The Equipment Under Test (EUT) is a Nanoleaf Lines supports 2.4GHz WI-FI function.

4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2020 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators
RSS-Gen Issue 5, Amendment 2, February 2021	RSS-Gen — General Requirements for Compliance of Radio Apparatus
RSS-247 Issue 2 February 2017	Digital Transmission Systems (DTS), Frequency Hopping Systems (FHSS) and License-Exempt Local Area Network (LE-LAN) Devices

All the test methods were according to KDB558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10 (2013).

5 Summary of Test Results

Technical Requirements					
FCC Part 15 Subpart C/RSS-247 Issue 2/RSS-Gen Issue 5					
Test Condition			Pages	Test Result	Test Site
§15.207	RSS-GEN 8.8	Conducted emission AC power port	10	Pass	Site 1
§15.247(b)(1)	RSS-247 Clause 5.4(b)	Conducted AV output power for FHSS	--	N/A	--
§15.247(b)(3)	RSS-247 Clause 5.4(d)	Conducted peak output power for DTS	13	Pass	Site 1
§15.247(e)	RSS-247 Clause 5.2(b)	Power spectral density	25	Pass	Site 1
§15.247(a)(2)	RSS-247 Clause 5.2(a)	6dB bandwidth	15	Pass	Site 1
§15.247(a)(1)	RSS-247 Clause 5.1(a)	20dB Occupied bandwidth	--	N/A	--
--	RSS-GEN 6.7	99% Occupied Bandwidth	20	Pass	Site 1
§15.247(a)(1)	RSS-247 Clause 5.1(b)	Carrier frequency separation	--	N/A	--
§15.247(a)(1)(i) ii)	RSS-247 Clause 5.1(d)	Number of hopping frequencies	--	N/A	--
§15.247(a)(1)(i) ii)	RSS-247 Clause 5.1(d)	Dwell Time	--	N/A	--
§15.247(d)	RSS-247 Clause 5.5	Spurious RF conducted emissions	30	Pass	Site 1
§15.247(d)	RSS-247 Clause 5.5	Band edge	43	Pass	Site 1
§15.247(d) & §15.209 & §15.205	RSS-247 Clause 5.5 & RSS-GEN 6.13 RSS-GEN 8.9 RSS-GEN 8.10	Spurious radiated emissions for transmitter	47	Pass	Site 1
§15.203	RSS-GEN 6.8	Antenna requirement	See note 1	Pass	--

Remark 1: N/A – Not Applicable.

Note 1: The EUT uses an Integrated Metal Antenna 2.15dBi max. According to §15.203, it is considered sufficiently to comply with the provisions of this section.

6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: 2AEWY-NL59 and IC: 20489-NL59 complies with Section 15.207, 15.205, 15.209, 15.247 of the FCC Part 15, Subpart C Rules; RSS-Gen Issue 5 and RSS-247 issue 2.

SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

□ - **Not** Performed

The Equipment under Test

■ - **Fulfills** the general approval requirements.

□ - **Does not** fulfill the general approval requirements.

Sample Received Date: July 19, 2021

Testing Start Date: July 19, 2021

Testing End Date: August 23, 2021

- TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch -

Reviewed by:

Prepared by:

Tested by:



Dawi Xu
EMC Project Manager



Henry Chen
EMC Project Engineer

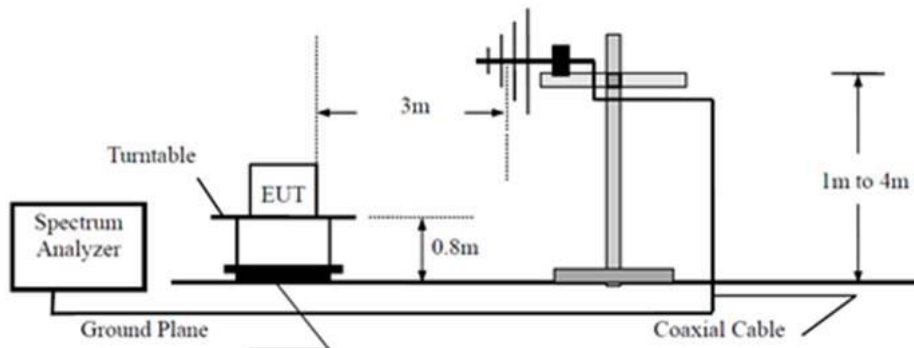


Louise Liu
EMC Test Engineer

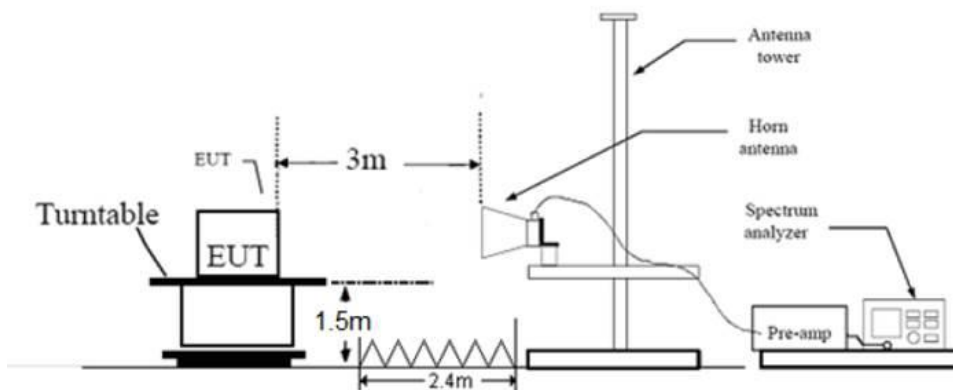
7 Test Setups

7.1 Radiated test setups

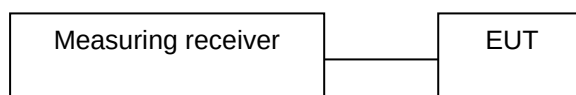
Below 1GHz



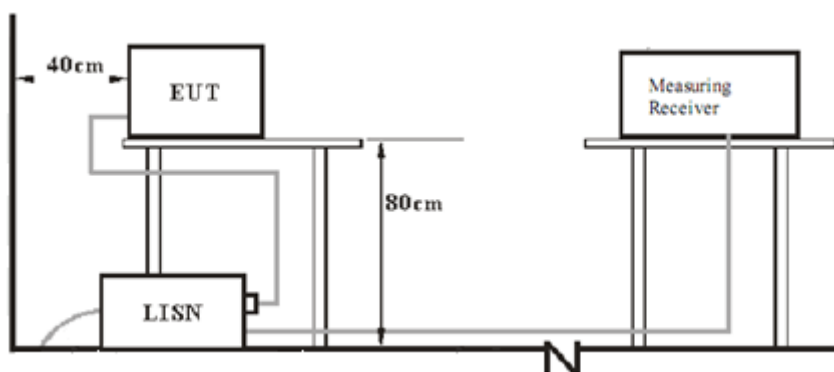
Above 1GHz



7.2 Conducted RF test setups



7.3 AC Power Line Conducted Emission test setups



8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.	S/N
---	---	---	---

Test software information:

Test Software Version	QA tool	
Modulation	Setting TX Power	Packet Type
802.11b	15	---
802.11g	12	---
802.11nHT20	10	---
802.11Nht40	9	---

The system was configured to channel 1, 6 and 11 for the test.

9 Technical Requirement

9.1 Conducted Emission

Test Method

1. The EUT was placed on a table, which is 0.8m above ground plane
2. The power line of the EUT is connected to the AC mains through an Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. A EMI test receiver is used to test the emissions from both sides of AC line

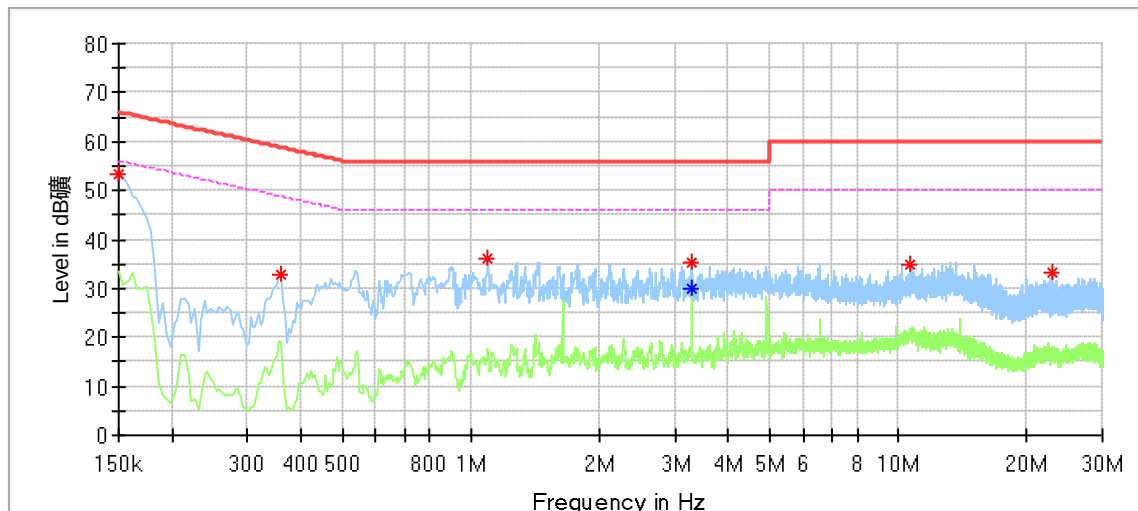
Limit

Frequency MHz	QP Limit dB μ V	AV Limit dB μ V
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

Note: “*” means Decreasing line;

Conducted Emission

Product Type : Nanoleaf Lines
 M/N : NL59
 Operating Condition : Normal working with transmitting
 Test Specification : Power Line, Live
 Comment : AC 120V/60Hz



Critical Freqs

Frequency (MHz)	MaxPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Line	Corr. (dB)
0.150000	53.20	---	66.00	12.80	L1	9.63
0.358000	32.70	---	58.78	26.08	L1	9.64
1.098000	36.24	---	56.00	19.76	L1	9.66
3.282000	35.15	---	56.00	20.85	L1	9.72
3.282000	---	29.74	46.00	16.26	L1	9.72
10.610000	34.88	---	60.00	25.12	L1	9.88
22.850000	33.03	---	60.00	26.97	L1	10.07

Remark :

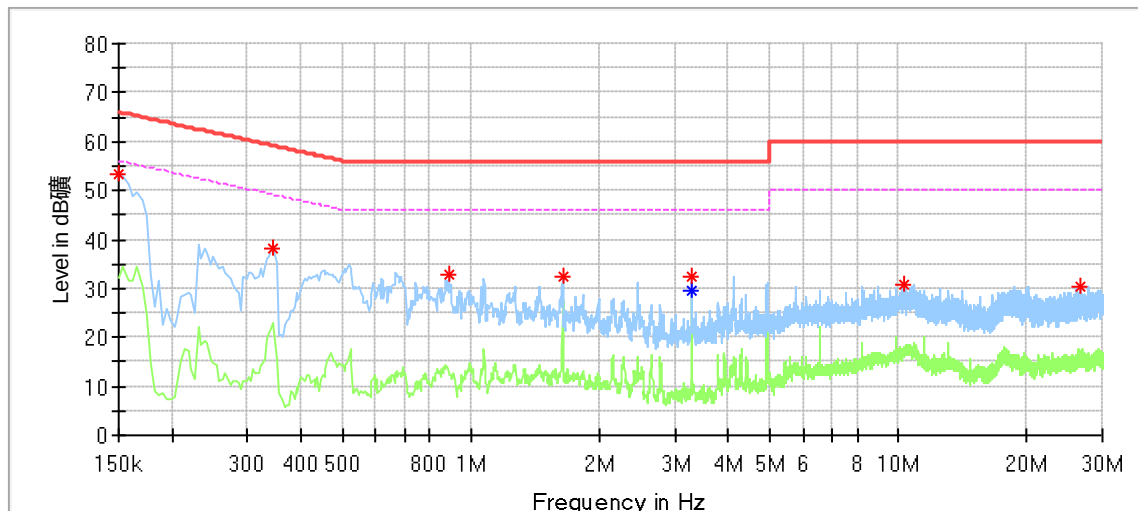
Level=Reading Level + Correction Factor

Correction Factor=Cable Loss + LISN Factor

(The Reading Level is recorded by software which is not shown in the sheet)

Conducted Emission

Product Type : Nanoleaf Lines
 M/N : NL59
 Operating Condition : Normal working with transmitting
 Test Specification : Power Line, Neutral
 Comment : AC 120V/60Hz



Critical Freqs

Frequency (MHz)	MaxPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Line	Corr. (dB)
0.150000	53.53	---	66.00	12.47	N	9.61
0.346000	38.25	---	59.06	20.81	N	9.64
0.890000	32.75	---	56.00	23.25	N	9.65
1.642000	32.58	---	56.00	23.42	N	9.67
3.282000	32.60	---	56.00	23.40	N	9.71
3.282000	---	29.68	46.00	16.32	N	9.71
10.290000	30.69	---	60.00	29.31	N	9.87
26.690000	30.56	---	60.00	29.44	N	10.09

Remark :

Level=Reading Level + Correction Factor

Correction Factor=Cable Loss + LISN Factor

(The Reading Level is recorded by software which is not shown in the sheet)

9.2 Conducted peak output power

Test Method

1. Connect the power meter to the EUT
 - a) The EUT is configured to transmit continuously, or to transmit with a constant duty factor.
 - b) At all times the EUT is transmitting at its maximum power control level.
 - c) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.
2. Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
3. Adjust the measurement in dBm by adding $10\log(1/x)$, where x is the duty cycle to the measurement result.

Limits

According to §15.247 (b) (1), conducted peak output power limit as below:

Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤1	≤30

Test result

802.11b

Frequency MHz	Conducted Peak Output Power dBm	Antenna Gain dBi	EIRP dBm	Result
Top channel 2412MHz	12.5	2.15	14.65	Pass
Middle channel 2437MHz	12.5	2.15	14.65	Pass
Bottom channel 2462MHz	12.6	2.15	14.75	Pass

802.11g

Frequency MHz	Conducted Peak Output Power dBm	Antenna Gain dBi	EIRP dBm	Result
Top channel 2412MHz	10.2	2.15	12.35	Pass
Middle channel 2437MHz	10.2	2.15	12.35	Pass
Bottom channel 2462MHz	10.1	2.15	12.25	Pass

802.11nHT20

Frequency MHz	Conducted Peak Output Power dBm	Antenna Gain dBi	EIRP dBm	Result
Top channel 2412MHz	9.1	2.15	11.25	Pass
Middle channel 2437MHz	9.1	2.15	11.25	Pass
Bottom channel 2462MHz	9.1	2.15	11.25	Pass

802.11nHT40

Frequency MHz	Conducted Peak Output Power dBm	Antenna Gain dBi	EIRP dBm	Result
Top channel 2422MHz	4.8	2.15	6.95	Pass
Middle channel 2437MHz	4.9	2.15	6.95	Pass
Bottom channel 2452MHz	3.9	2.15	5.95	Pass

Note:

EIRP [dBm] = A [dBm] + G[dBi]. Where, A = Average Power, G = Antenna Gain

9.3 6dB bandwidth

Test Method

1. Use the following spectrum analyzer settings:
RBW=100K, VBW $\geq$ 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
2. Use the automatic bandwidth measurement capability of an instrument, may be employed using the X dB bandwidth mode with X set to 6 dB, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be $\geq$ 6 dB.
3. Allow the trace to stabilize, record the X dB Bandwidth value.

Limit

Limit [kHz]

≥ 500

Test result

802.11b

Frequency MHz	6dB bandwidth MHz	Result
Bottom channel 2412MHz	9.640	Pass
Middle channel 2437MHz	9.640	Pass
Top channel 2462MHz	10.120	Pass

802.11g

Frequency MHz	6dB bandwidth MHz	Result
Bottom channel 2412MHz	15.760	Pass
Middle channel 2437MHz	15.200	Pass
Top channel 2462MHz	15.200	Pass

802.11nHT20

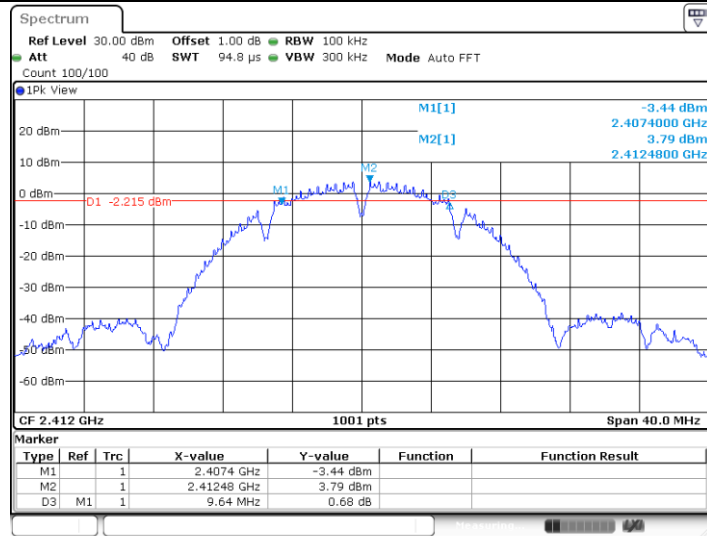
Frequency MHz	6dB bandwidth MHz	Result
Bottom channel 2412MHz	15.200	Pass
Middle channel 2437MHz	15.200	Pass
Top channel 2462MHz	15.160	Pass

802.11nHT40

Frequency MHz	6dB bandwidth MHz	Result
Bottom channel 2422MHz	34.000	Pass
Middle channel 2437MHz	34.080	Pass
Top channel 2452MHz	35.200	Pass

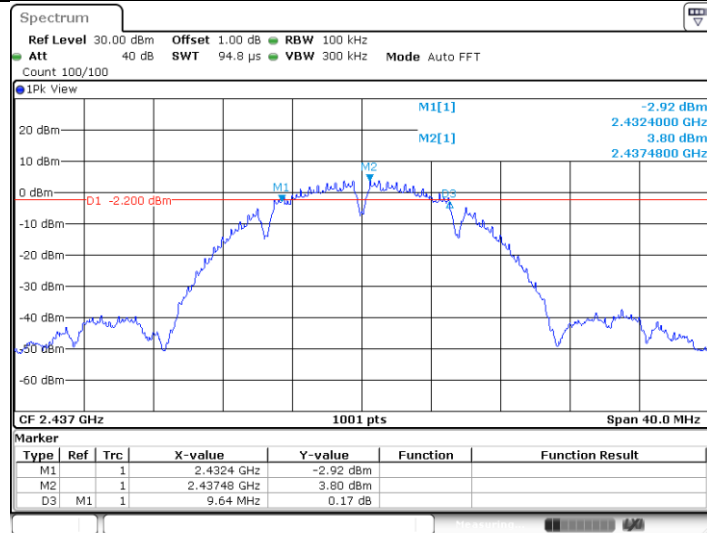
Test Graphs

11B_Ant1_2412



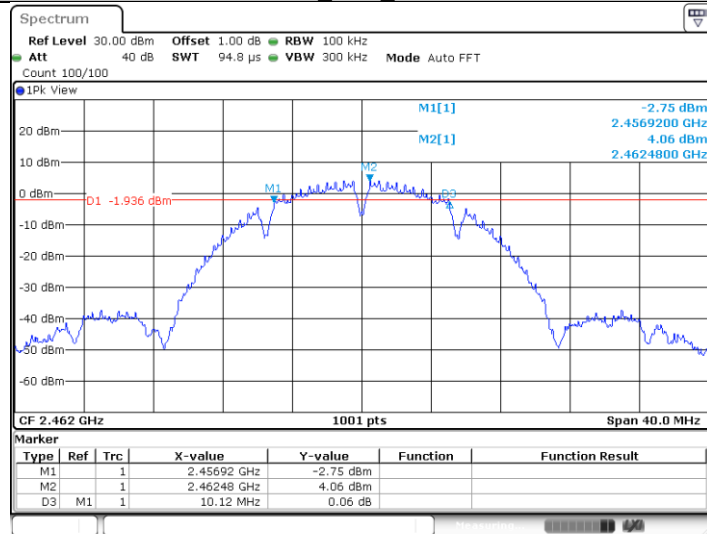
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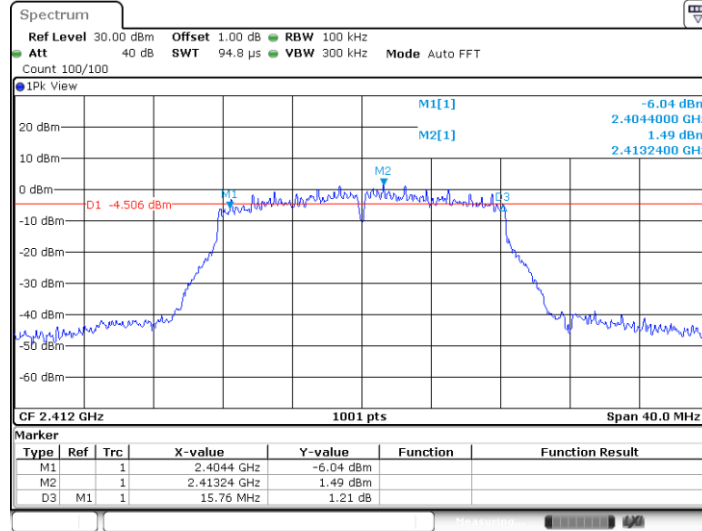
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11B_Ant1_2462



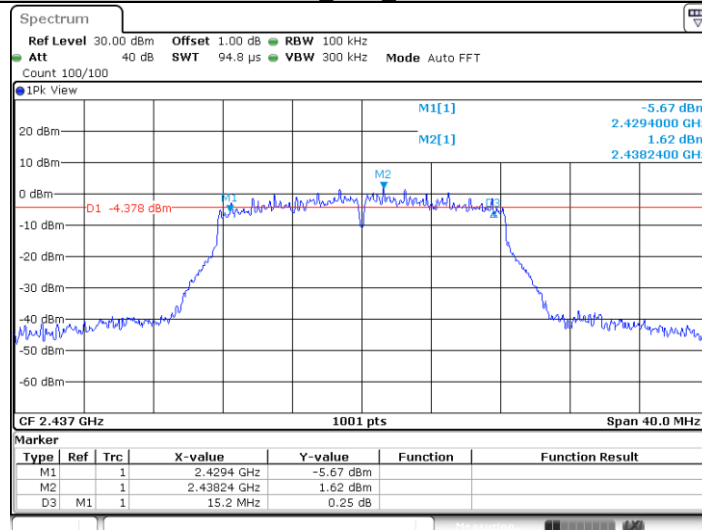
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11G Ant1 2412



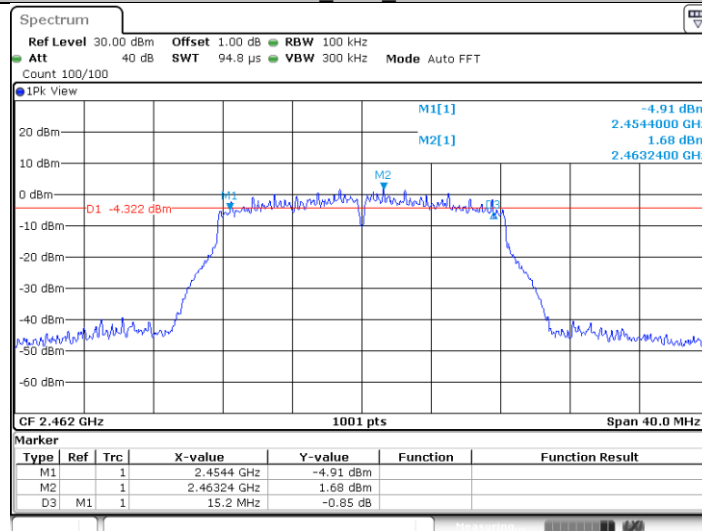
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11G Ant1 2437



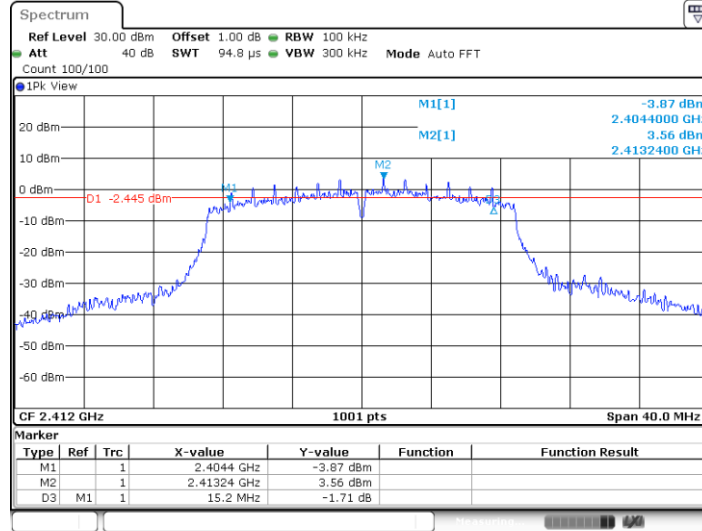
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11G Ant1 2462



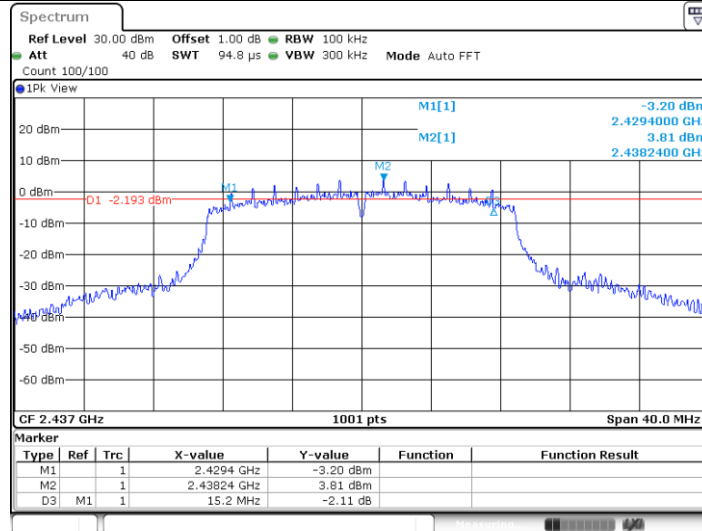
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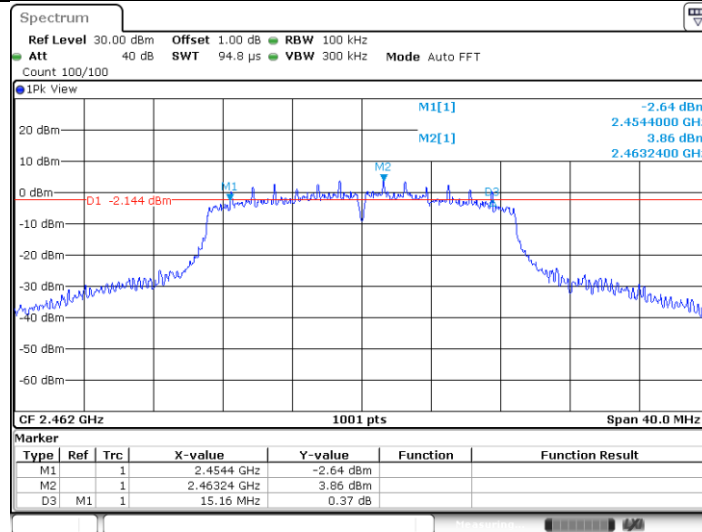
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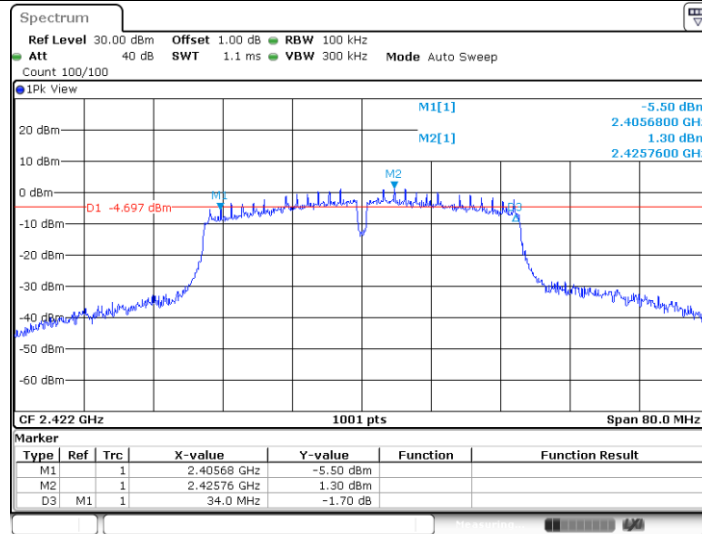
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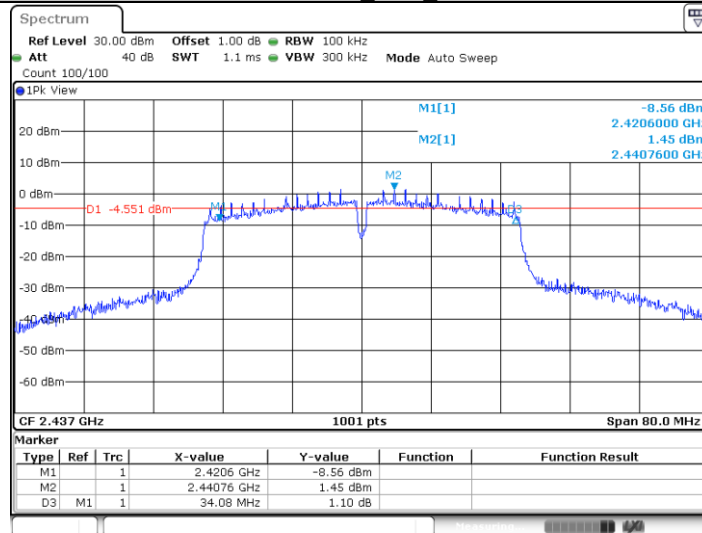
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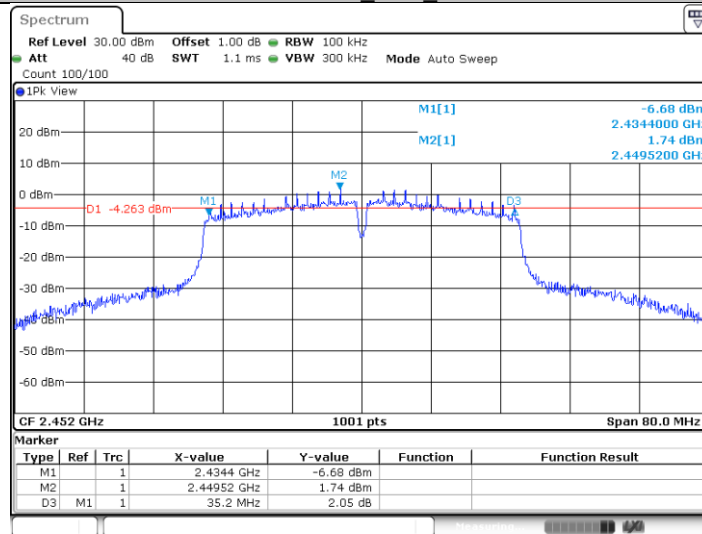
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11N40SISO_Ant1_2437



Date: 19 JUL 2021 14:03:35

11N40SISO_Ant1_2452



Date: 19 JUL 2021 14:06:07

9.4 99% bandwidth

Test Method

4. Use the following spectrum analyzer settings:
RBW=100K, VBW $\geq$ 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
5. Use the automatic bandwidth measurement capability of an instrument, may be employed using the X dB bandwidth mode with X set to 6 dB, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.
6. Allow the trace to stabilize, record the X dB Bandwidth value.

Limit

Limit [kHz]

Test result

802.11b

Frequency MHz	99% bandwidth MHz	Result
Bottom channel 2412MHz	14.266	Pass
Middle channel 2437MHz	14.266	Pass
Top channel 2462MHz	14.346	Pass

802.11g

Frequency MHz	99% bandwidth MHz	Result
Bottom channel 2412MHz	16.743	Pass
Middle channel 2437MHz	16.743	Pass
Top channel 2462MHz	16.703	Pass

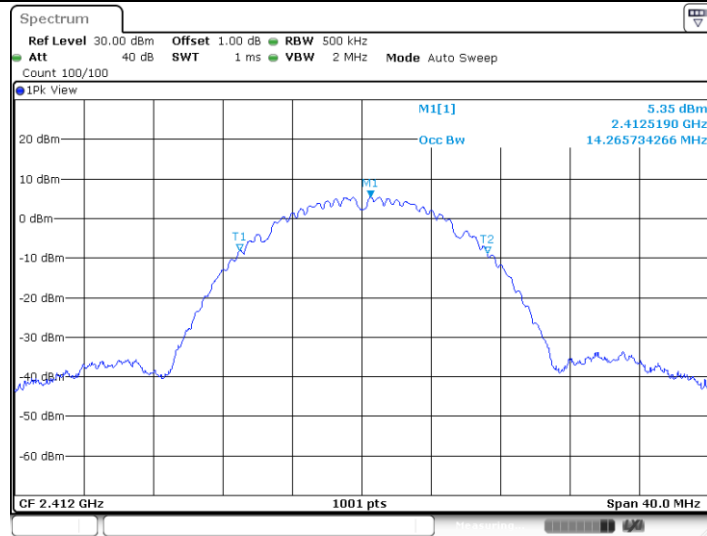
802.11nHT20

Frequency MHz	99% bandwidth MHz	Result
Bottom channel 2412MHz	18.062	Pass
Middle channel 2437MHz	18.182	Pass
Top channel 2462MHz	18.262	Pass

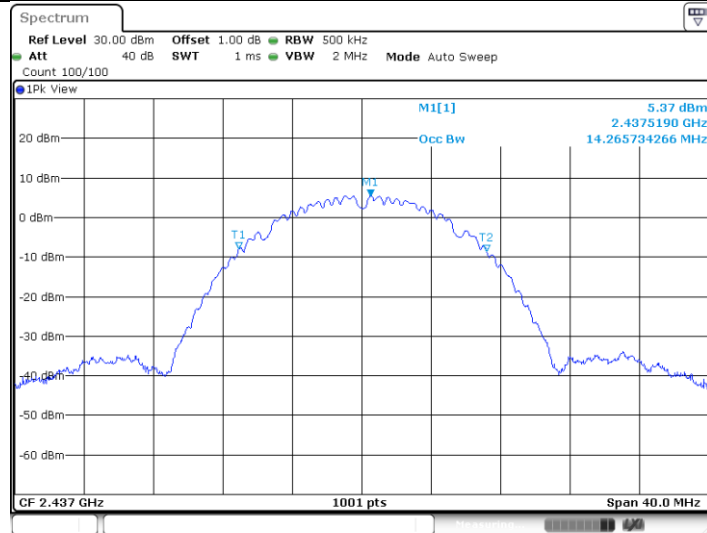
802.11nHT40

Frequency MHz	99% bandwidth MHz	Result
Bottom channel 2422MHz	36.204	Pass
Middle channel 2437MHz	36.204	Pass
Top channel 2452MHz	36.284	Pass

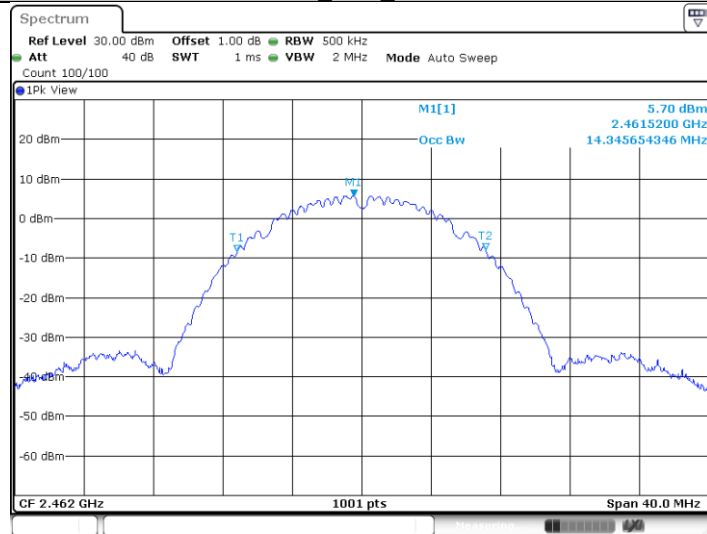
Test Graphs

11B_Ant1_2412

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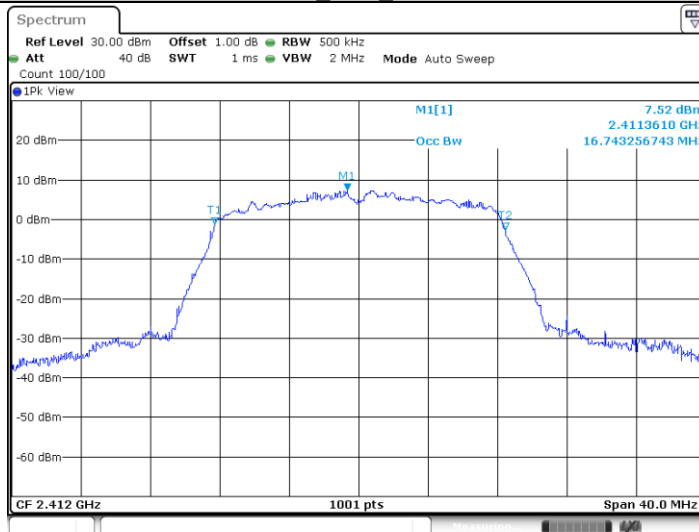
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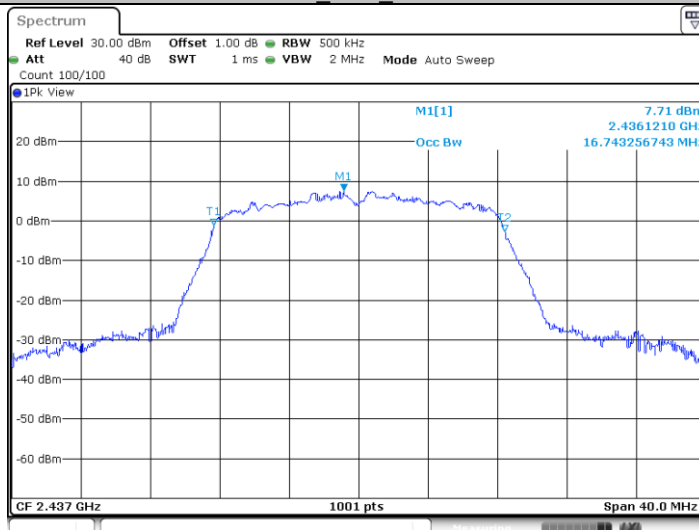
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11G Ant1 2412



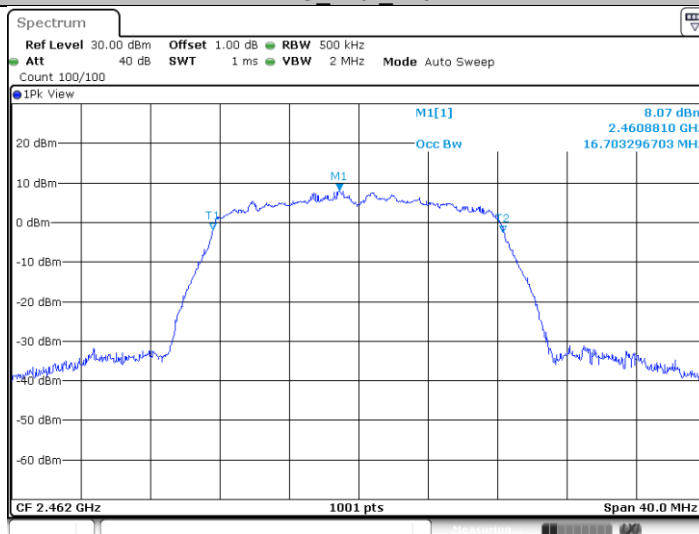
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11G Ant1 2437



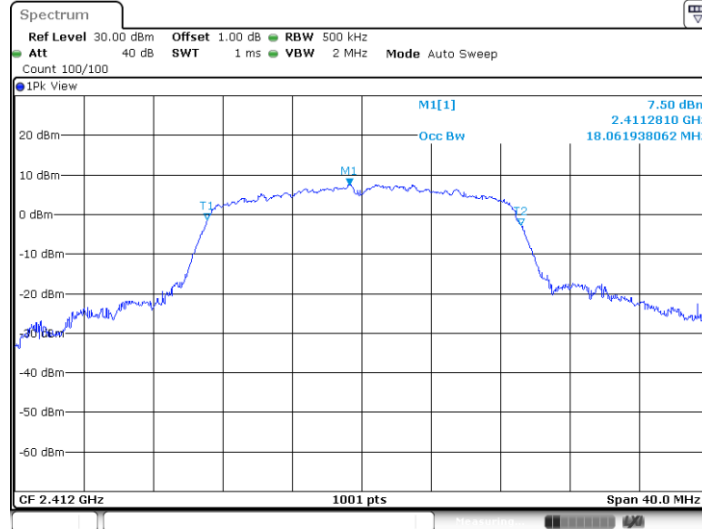
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11G Ant1 2462



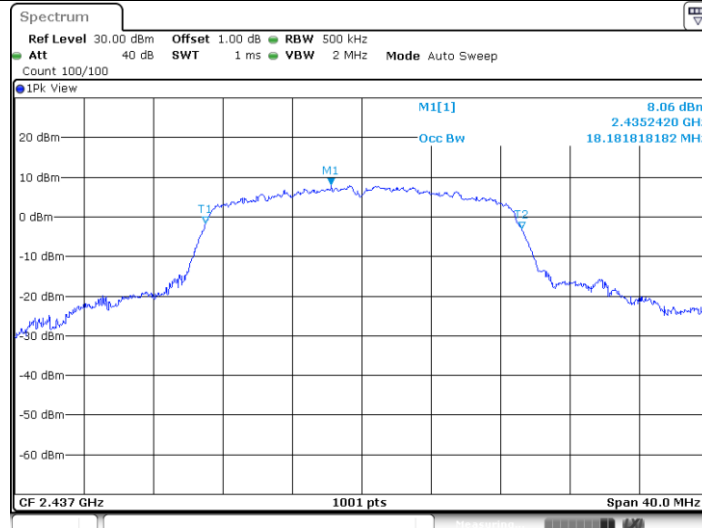
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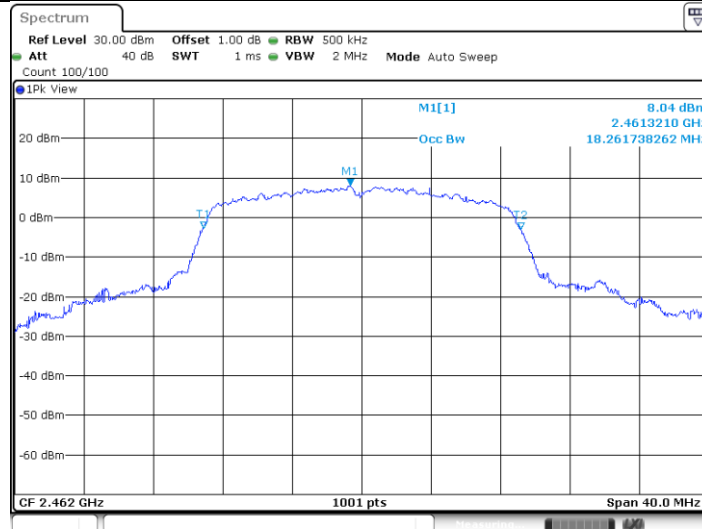
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11N20SISO_Ant1_2437



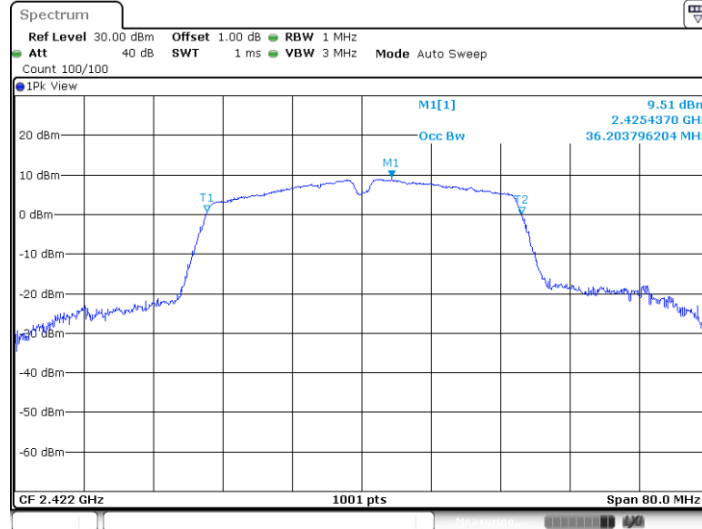
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11N20SISO_Ant1_2462



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11N40SISO_Ant1_2422



Date: 19 JUL 2021 13:59:46

11N40SISO_Ant1_2437



Date: 19 JUL 2021 14:03:45

11N40SISO_Ant1_2452



Date: 19 JUL 2021 14:06:18

9.5 Power spectral density

Test Method

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance:

1. Set analyzer center frequency to DTS channel center frequency. RBW=3kHz, VBW $\geq$ 3RBW, Span=1.5 times DTS bandwidth, Detector=Peak, Sweep=auto, Trace= max hold.
2. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
3. Repeat above procedures until other frequencies measured were completed.

Limit

Limit [dBm/3KHz]

≤ 8

Test result

802.11b

Frequency MHz	Power spectral density dBm/3KHz	Result
Top channel 2412MHz	2.95	Pass
Middle channel 2437MHz	2.88	Pass
Bottom channel 2462MHz	1.11	Pass

802.11g

Frequency MHz	Power spectral density dBm/3KHz	Result
Top channel 2412MHz	-14.72	Pass
Middle channel 2437MHz	-14.98	Pass
Bottom channel 2462MHz	-14.37	Pass

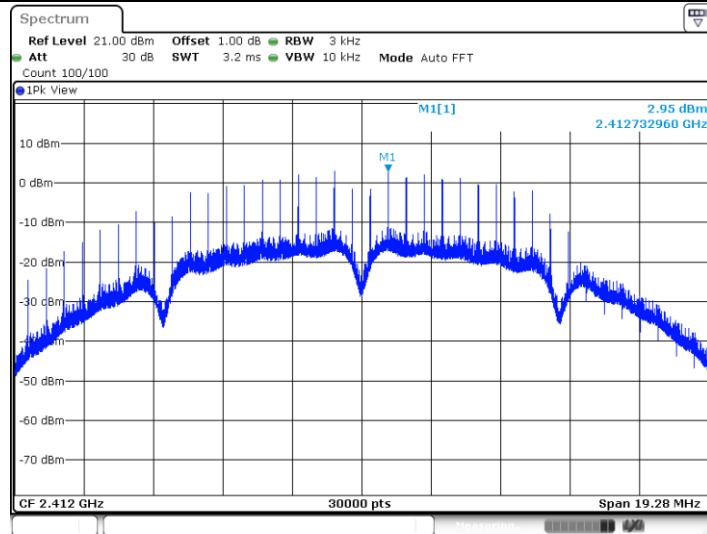
802.11nHT20

Frequency MHz	Power spectral density dBm/3KHz	Result
Top channel 2412MHz	-12.61	Pass
Middle channel 2437MHz	-12.54	Pass
Bottom channel 2462MHz	-12.1	Pass

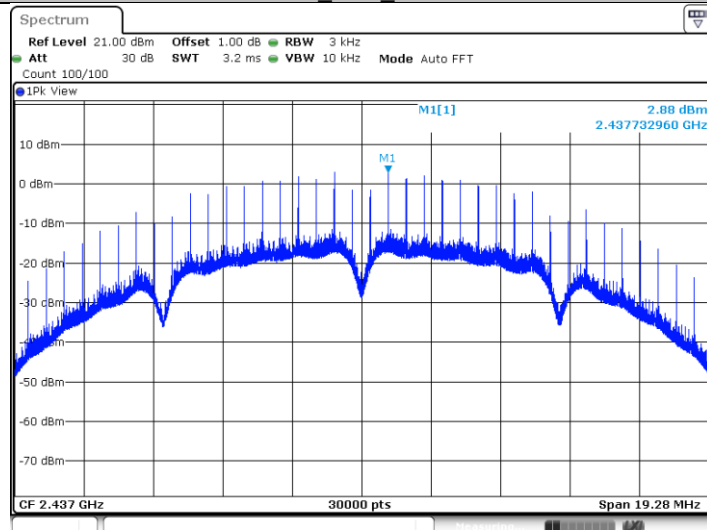
802.11nHT40

Frequency MHz	Power spectral density dBm/3KHz	Result
Top channel 2422MHz	-14.24	Pass
Middle channel 2437MHz	-14.05	Pass
Bottom channel 2452MHz	-13.6	Pass

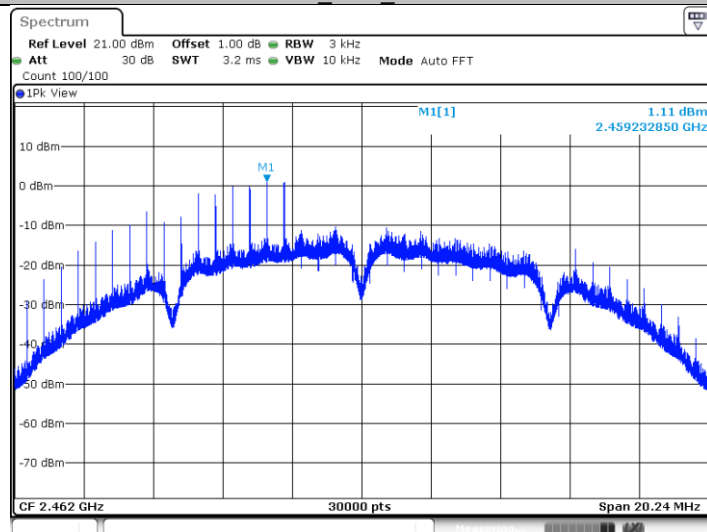
Test Graphs

11B_Ant1_2412

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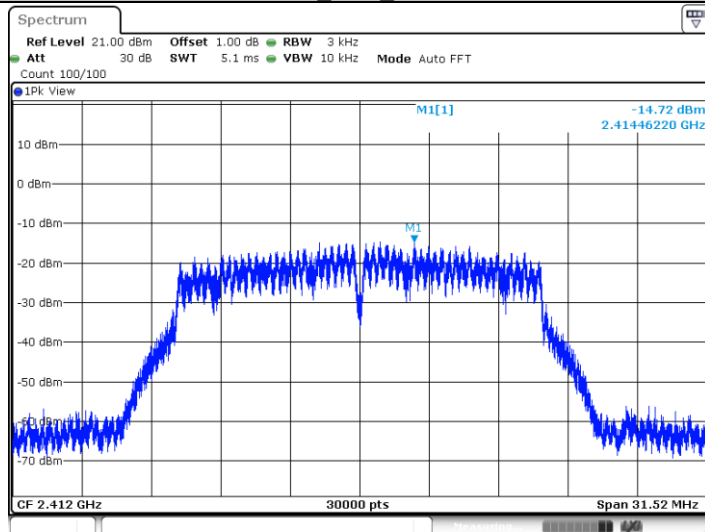
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11B_Ant1_2462

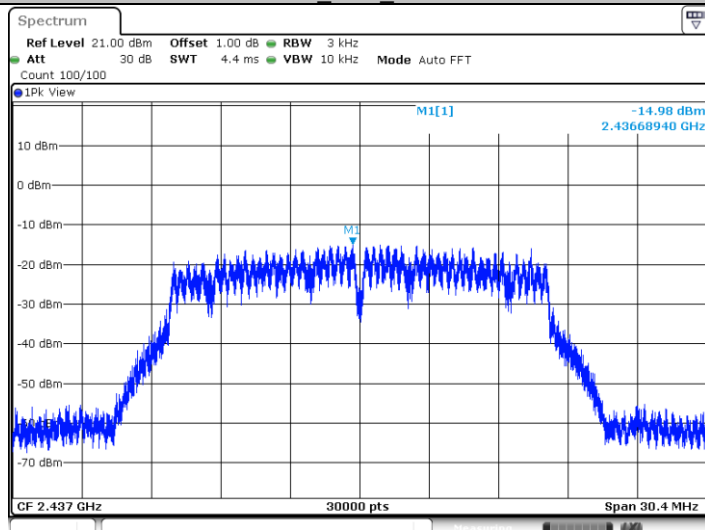
Date: 19 JUL 2021 13:42:29

11G_Ant1_2412



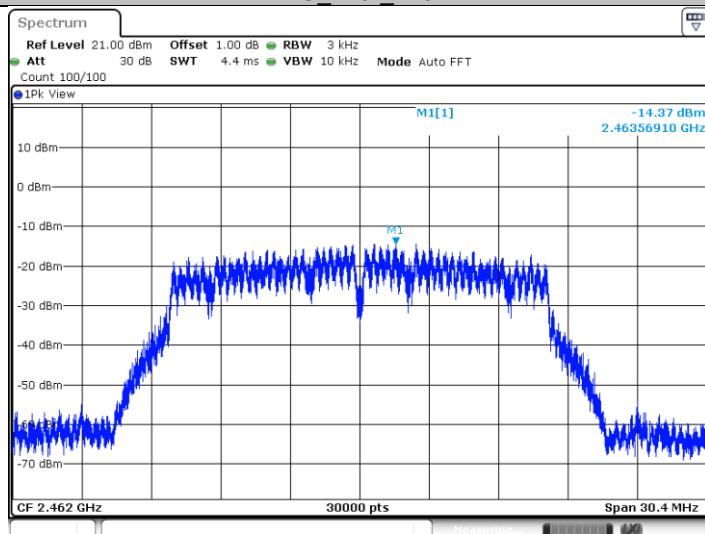
Date: 19 JUL 2021 13:44:44

11G_Ant1_2437



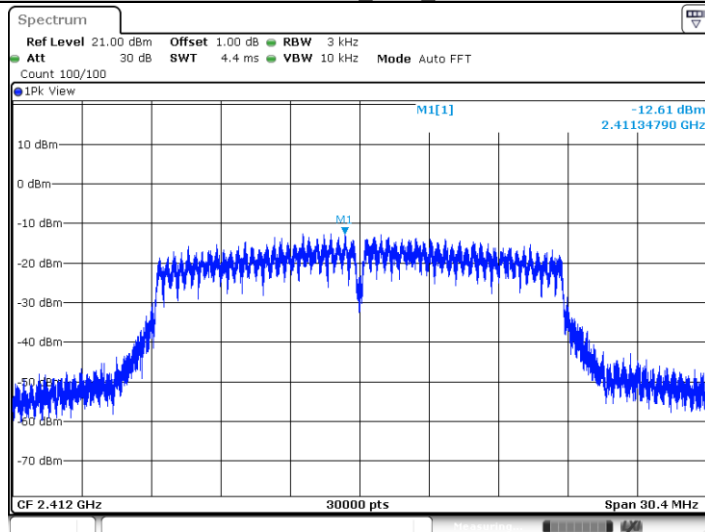
Date: 19 JUL 2021 13:46:35

11G_Ant1_2462



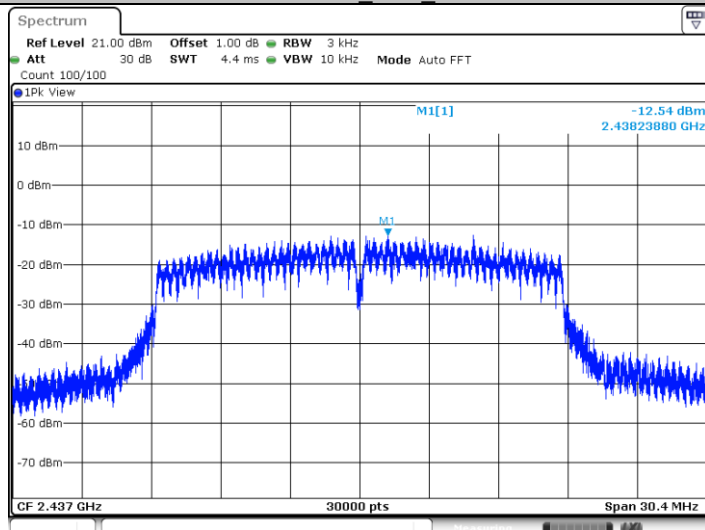
Date: 19 JUL 2021 13:48:06

11N20SISO_Ant1_2412



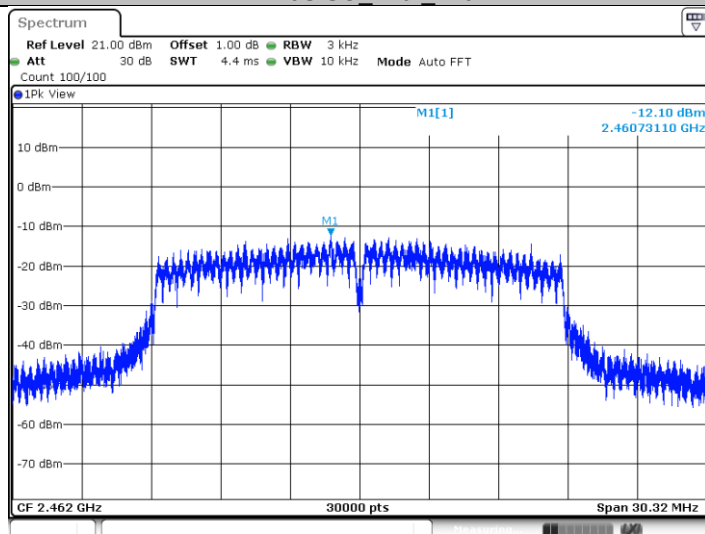
Date: 19 JUL 2021 13:50:24

11N20SISO_Ant1_2437



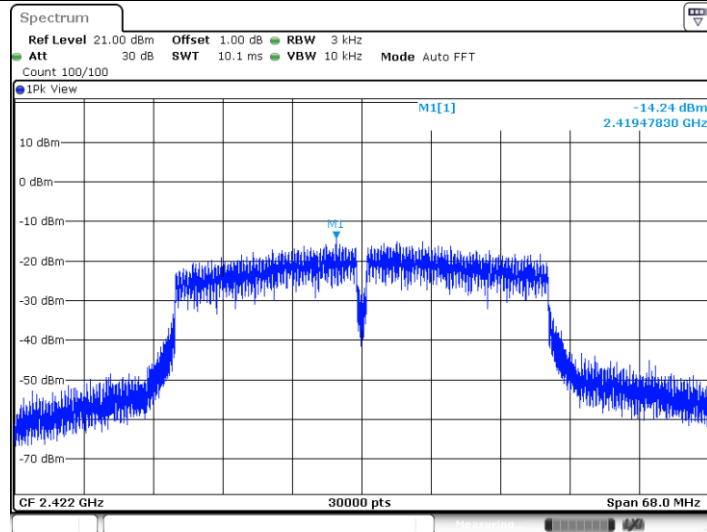
Date: 19 JUL 2021 13:52:19

11N20SISO_Ant1_2462



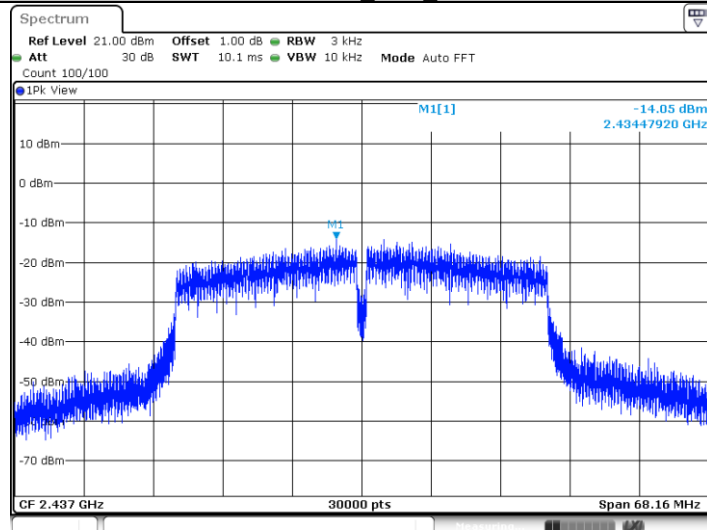
Date: 19 JUL 2021 13:55:35

11N40SISO_Ant1_2422



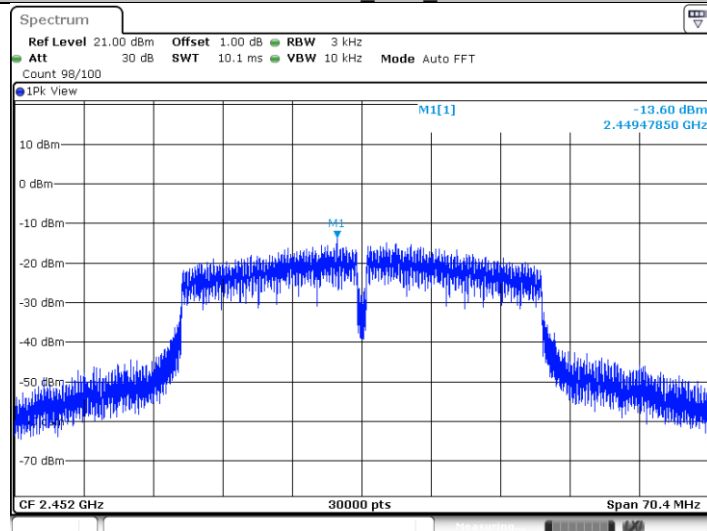
Date: 19 JUL 2021 13:59:58

11N40SISO_Ant1_2437



Date: 19 JUL 2021 14:03:57

11N40SISO_Ant1_2452



Date: 19 JUL 2021 14:06:29

9.6 Spurious RF conducted emissions

Test Method

1. Establish a reference level by using the following procedure:
 - a. Set RBW=100 kHz. VBW≥3RBW. Detector =peak, Sweep time = auto couple, Trace mode = max hold.
 - b. Allow trace to fully stabilize, use the peak marker function to determine the maximum PSD level.
2. Use the maximum PSD level to establish the reference level.
 - a. Set the center frequency and span to encompass frequency range to be measured.
 - b. Use the peak marker function to determine the maximum amplitude level. Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements, report the three highest emissions relative to the limit.
3. Repeat above procedures until other frequencies measured were completed.

Limit

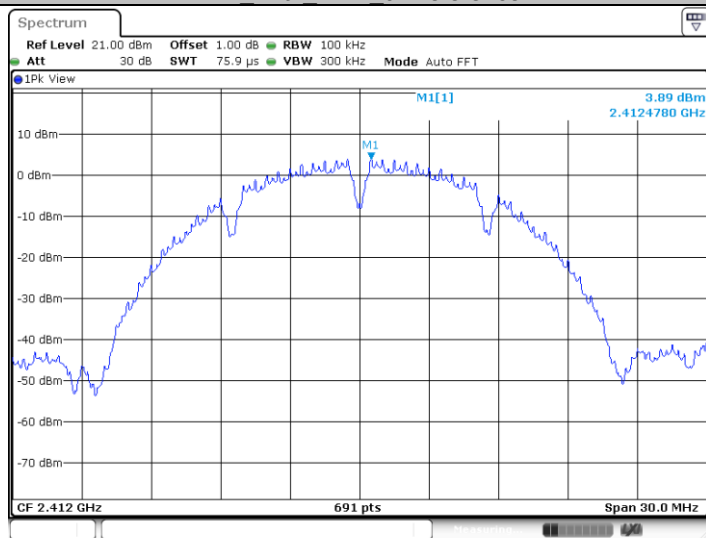
Frequency Range MHz	Limit (dBc)
30-25000	-20

Test result

TestMode	Antenna	Channel	FreqRange	RefLevel	Result	Limit	Verdict
11B	Ant1	2412	Reference	3.89	3.89	---	PASS
			30~1000	30~1000	-64.33	<=-16.11	PASS
			1000~26500	1000~26500	-44.5	<=-16.11	PASS
		2437	Reference	3.80	3.80	---	PASS
			30~1000	30~1000	-65.25	<=-16.2	PASS
			1000~26500	1000~26500	-52.46	<=-16.2	PASS
		2462	Reference	3.98	3.98	---	PASS
			30~1000	30~1000	-65.09	<=-16.02	PASS
			1000~26500	1000~26500	-51.54	<=-16.02	PASS
11G	Ant1	2412	Reference	1.43	1.43	---	PASS
			30~1000	30~1000	-61.22	<=-18.57	PASS
			1000~26500	1000~26500	-45.88	<=-18.57	PASS
		2437	Reference	1.49	1.49	---	PASS
			30~1000	30~1000	-64.25	<=-18.51	PASS
			1000~26500	1000~26500	-52.26	<=-18.51	PASS
		2462	Reference	1.88	1.88	---	PASS
			30~1000	30~1000	-63.84	<=-18.12	PASS
			1000~26500	1000~26500	-51.21	<=-18.12	PASS
11N20SISO	Ant1	2412	Reference	3.61	3.61	---	PASS
			30~1000	30~1000	-59.52	<=-16.39	PASS
			1000~26500	1000~26500	-32.58	<=-16.39	PASS
		2437	Reference	3.70	3.70	---	PASS
			30~1000	30~1000	-60.92	<=-16.3	PASS
			1000~26500	1000~26500	-51.65	<=-16.3	PASS
		2462	Reference	4.03	4.03	---	PASS
			30~1000	30~1000	-60.41	<=-15.97	PASS
			1000~26500	1000~26500	-44.61	<=-15.97	PASS
11N40SISO	Ant1	2422	Reference	1.01	1.01	---	PASS
			30~1000	30~1000	-58.22	<=-18.99	PASS
			1000~26500	1000~26500	-35.51	<=-18.99	PASS
		2437	Reference	0.99	0.99	---	PASS
			30~1000	30~1000	-59.3	<=-19.01	PASS
			1000~26500	1000~26500	-43.58	<=-19.01	PASS
		2452	Reference	1.17	1.17	---	PASS
			30~1000	30~1000	-59.18	<=-18.83	PASS
			1000~26500	1000~26500	-36.51	<=-18.83	PASS

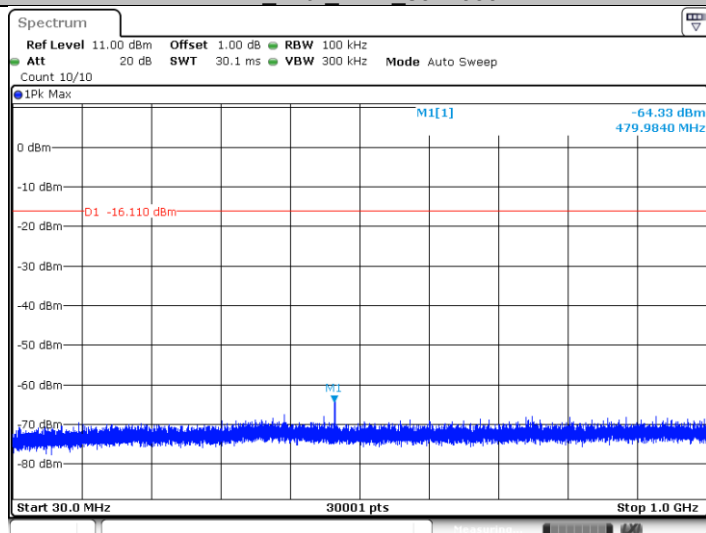
Test Graphs

11B_Ant1_2412_0~Reference



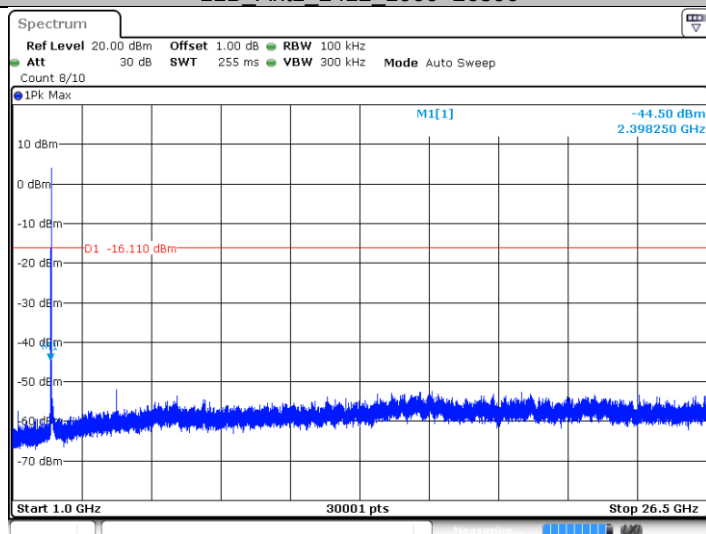
Date: 19 JUL 2021 13:36:09

11B_Ant1_2412_30~1000



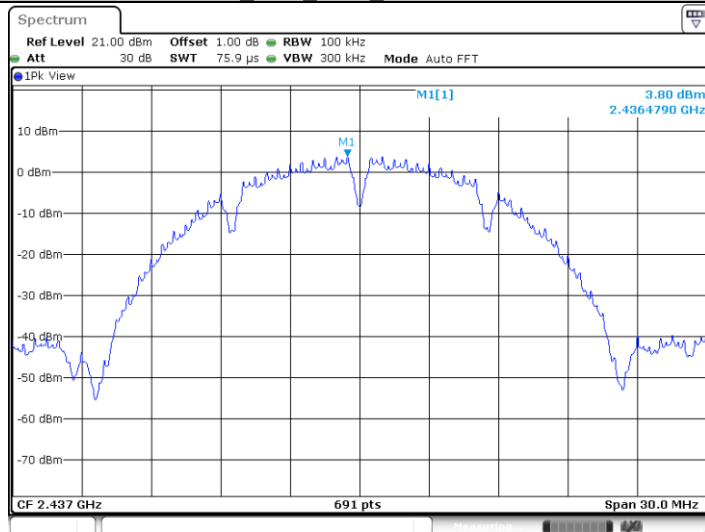
Date: 19 JUL 2021 13:36:15

11B_Ant1_2412_1000~26500



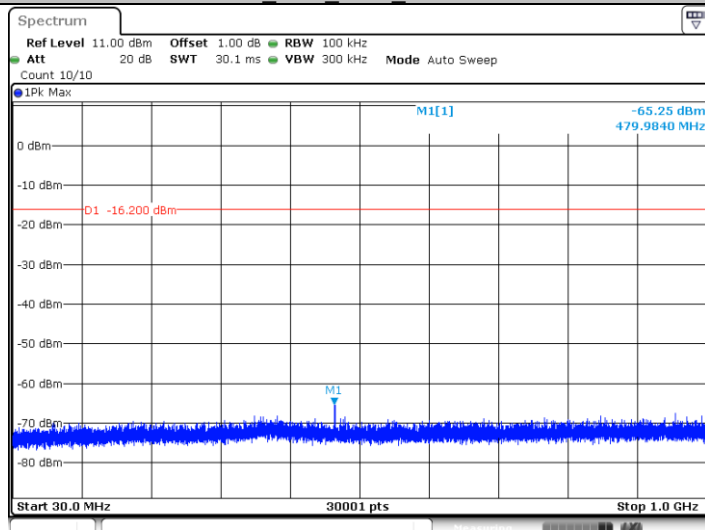
Date: 19 JUL 2021 13:36:23

11B_Ant1_2437_0~Reference



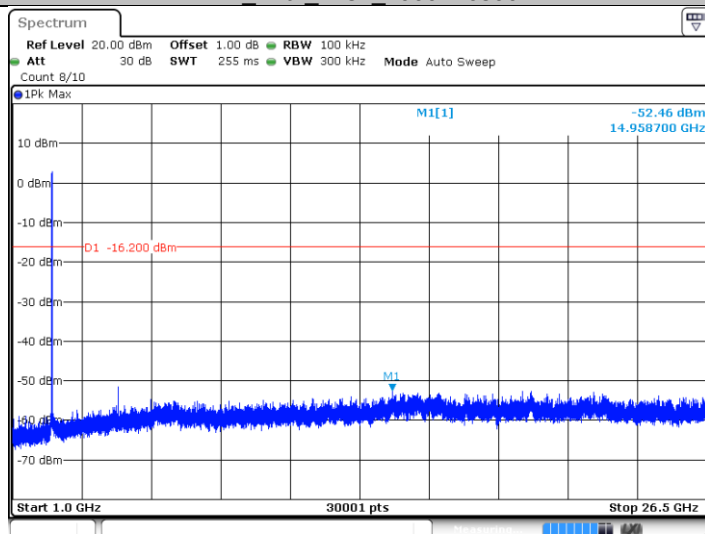
Date: 19 JUL 2021 13:40:49

11B_Ant1_2437_30~1000



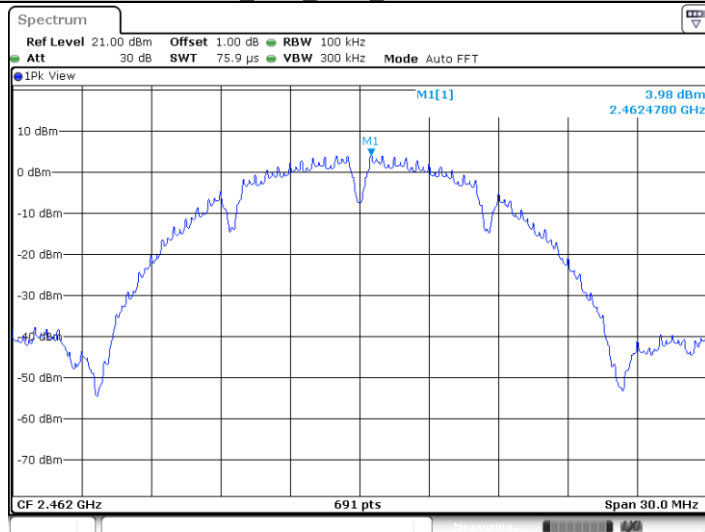
Date: 19 JUL 2021 13:40:55

11B_Ant1_2437_1000~26500



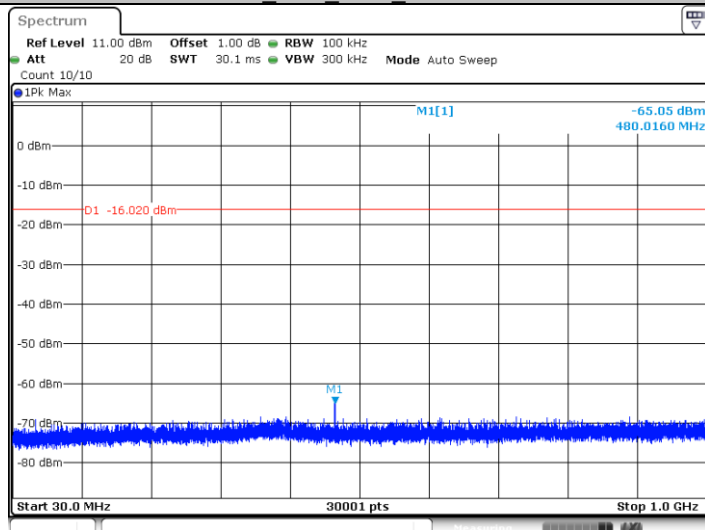
Date: 19 JUL 2021 13:41:03

11B_Ant1_2462_0~Reference



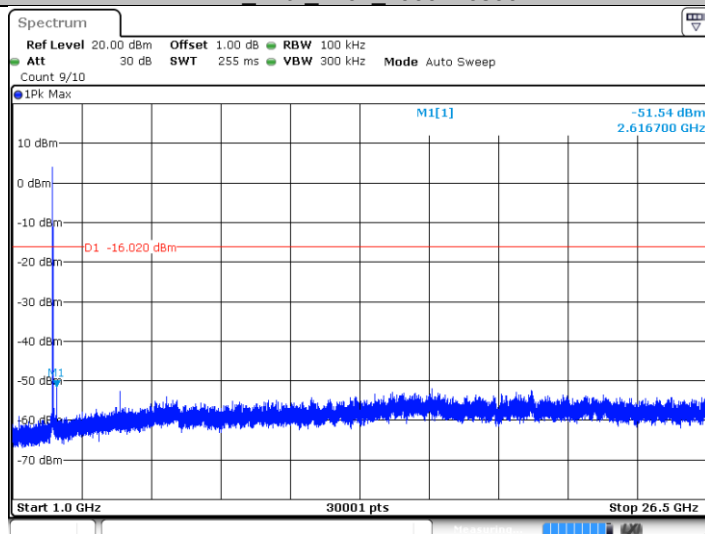
Date: 19 JUL 2021 13:42:43

11B_Ant1_2462_30~1000



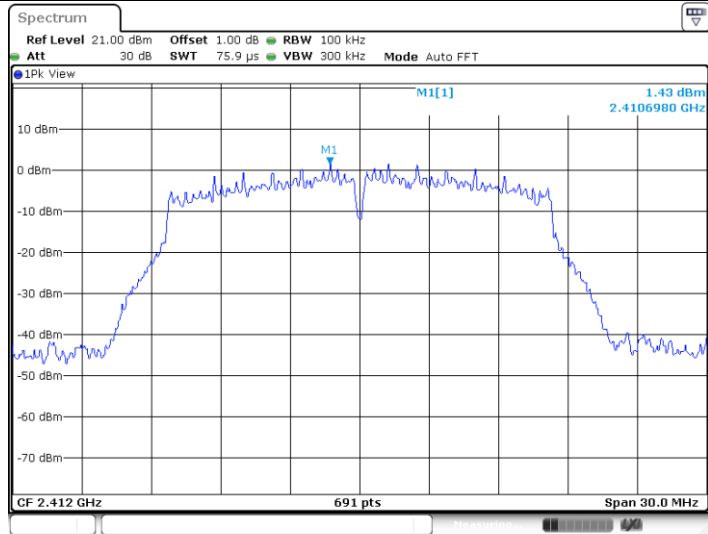
Date: 19 JUL 2021 13:42:50

11B_Ant1_2462_1000~26500



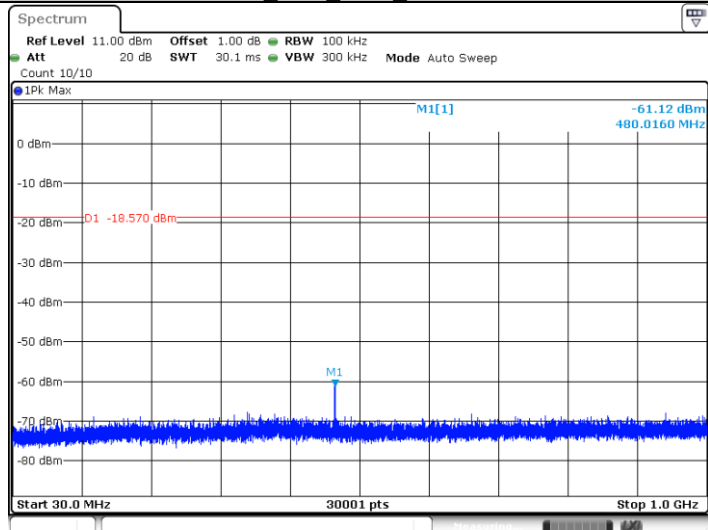
Date: 19 JUL 2021 13:42:57

11G_Ant1_2412_0~Reference



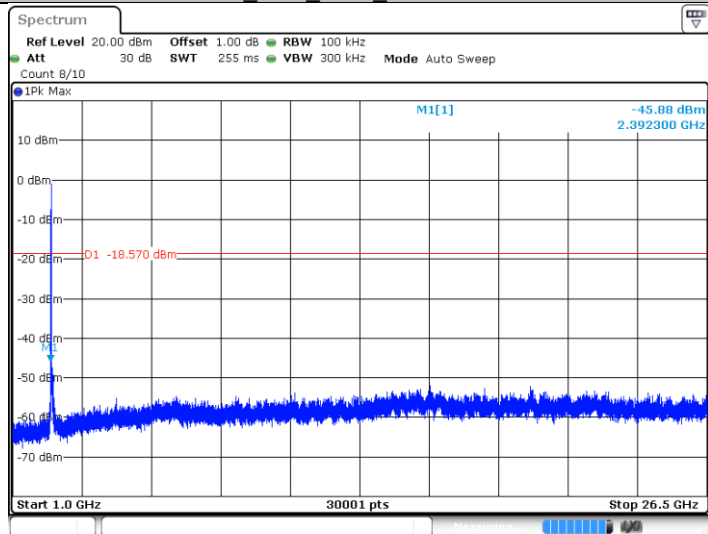
Date: 19 JUL 2021 13:44:59

11G_Ant1_2412_30~1000



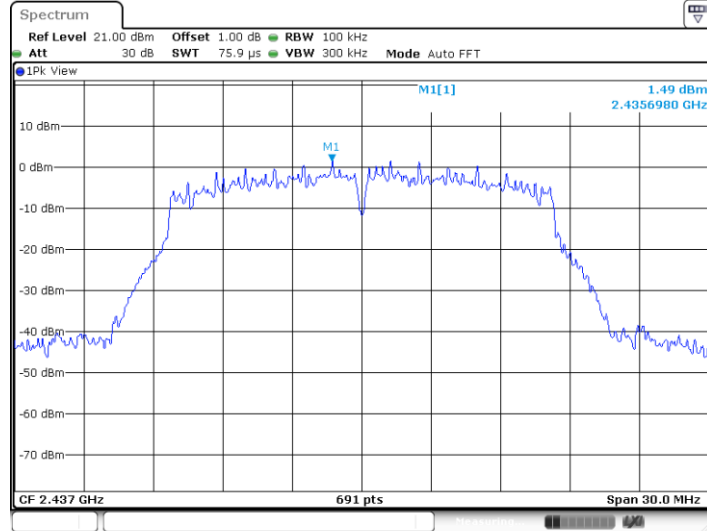
Date: 19 JUL 2021 13:45:05

11G_Ant1_2412_1000~26500



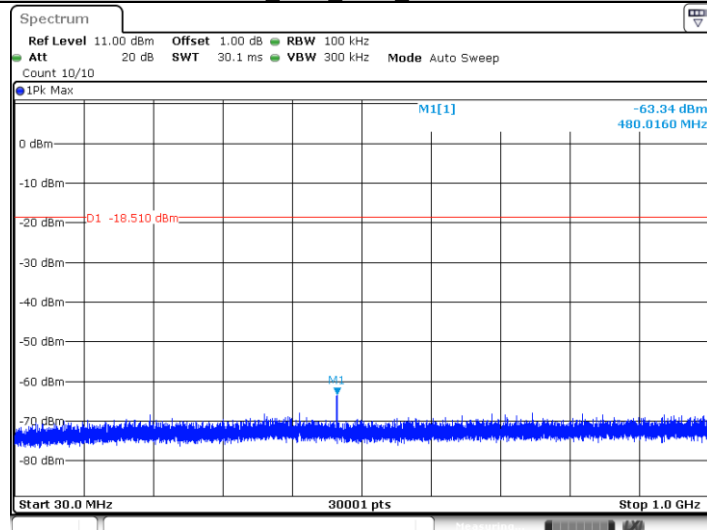
Date: 19 JUL 2021 13:45:13

11G_Ant1_2437_0~Reference



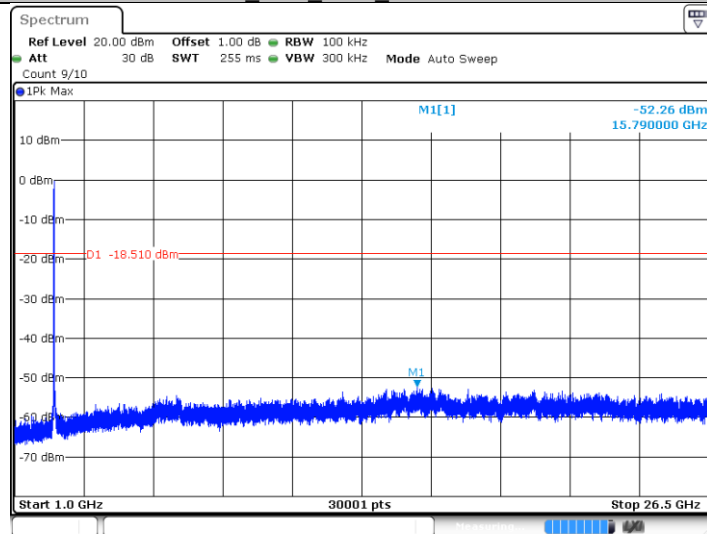
Date: 19 JUL 2021 13:46:41

11G_Ant1_2437_30~1000



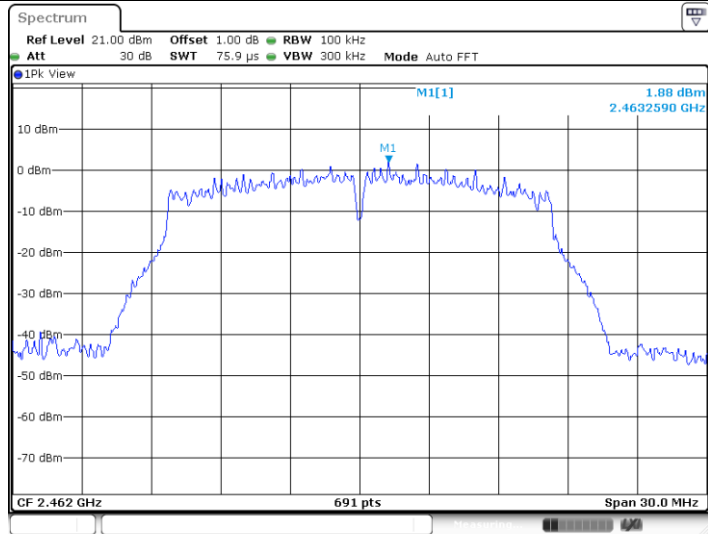
Date: 19 JUL 2021 13:46:47

11G_Ant1_2437_1000~26500

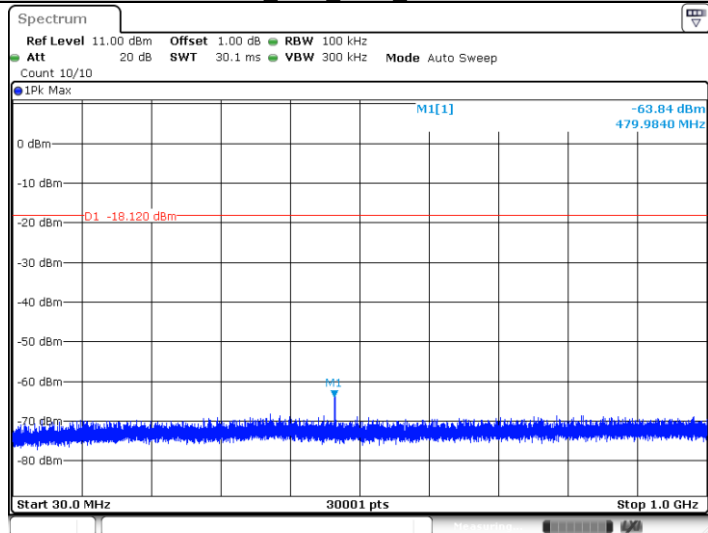


Date: 19 JUL 2021 13:46:55

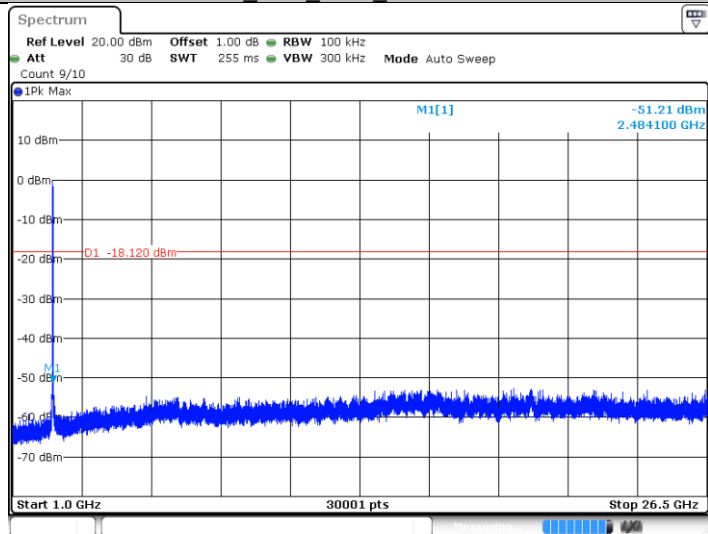
11G_Ant1_2462_0~Reference



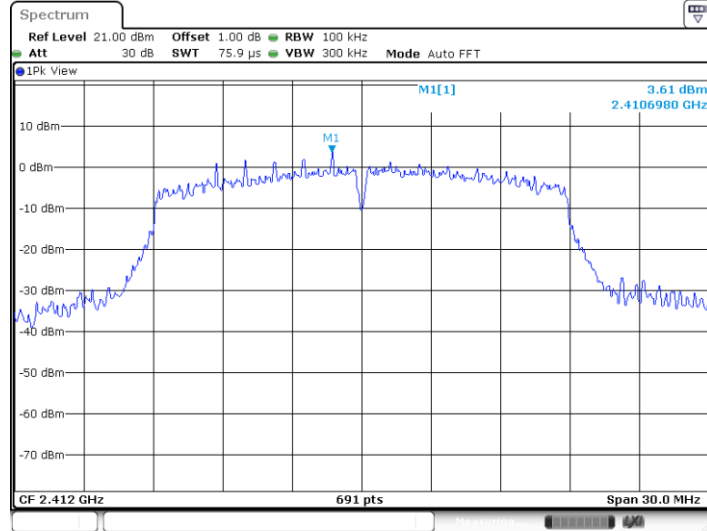
11G_Ant1_2462_30~1000



11G_Ant1_2462_1000~26500

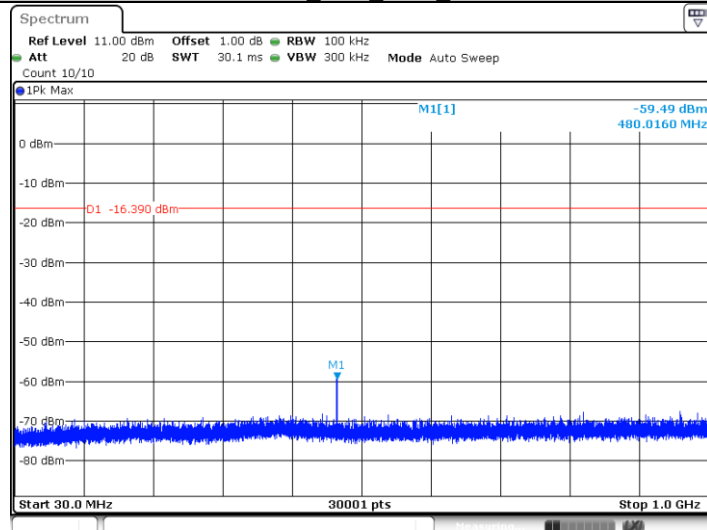


11N20SISO Ant1 2412 0~Reference



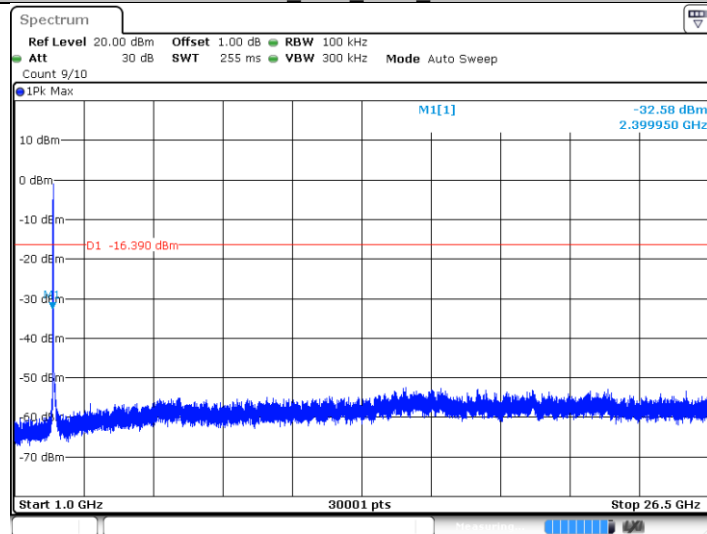
Date: 19 JUL 2021 13:50:38

11N20SISO Ant1 2412 30~1000



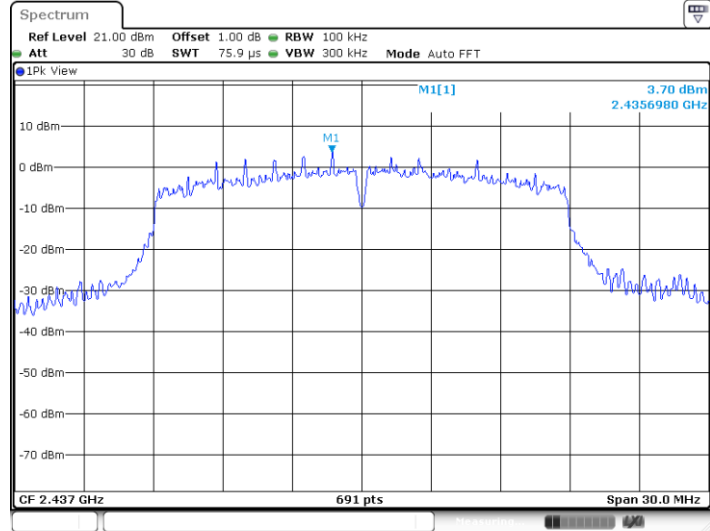
Date: 19 JUL 2021 13:50:44

11N20SISO Ant1 2412 1000~26500



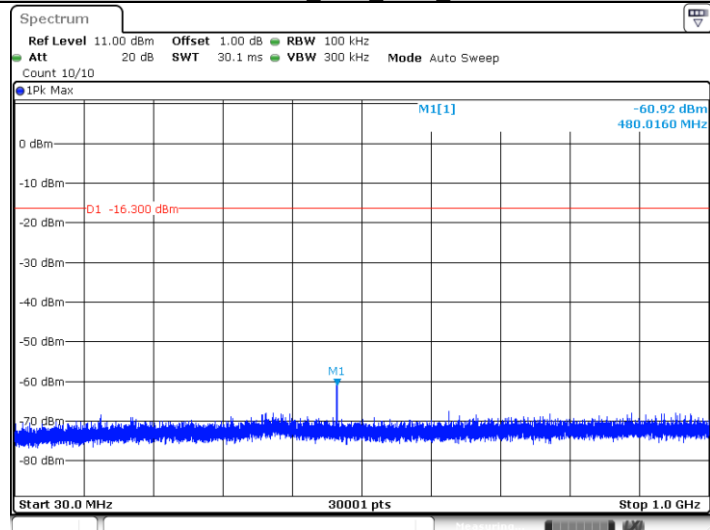
Date: 19 JUL 2021 13:50:52

11N20SISO Ant1 2437 0~Reference



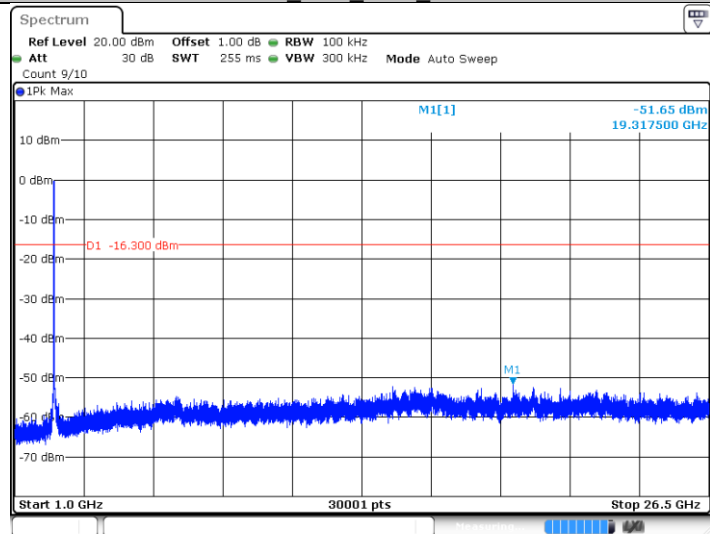
Date: 19 JUL 2021 13:52:24

11N20SISO Ant1 2437 30~1000



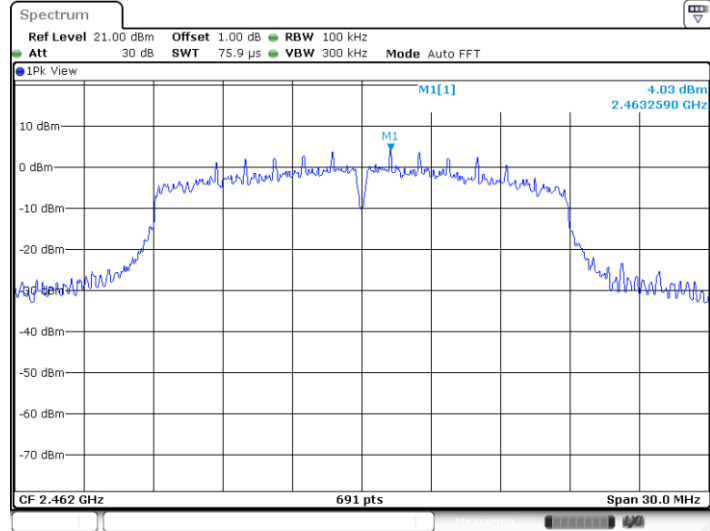
Date: 19 JUL 2021 13:52:30

11N20SISO Ant1 2437 1000~26500



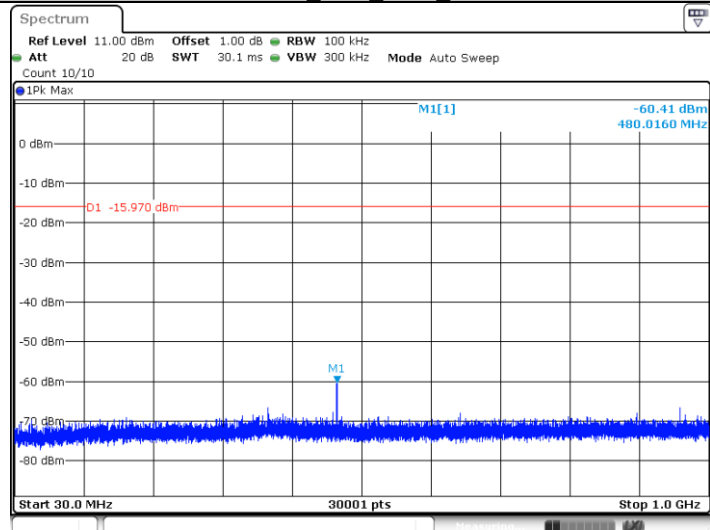
Date: 19 JUL 2021 13:52:38

11N20SISO Ant1 2462 0~Reference



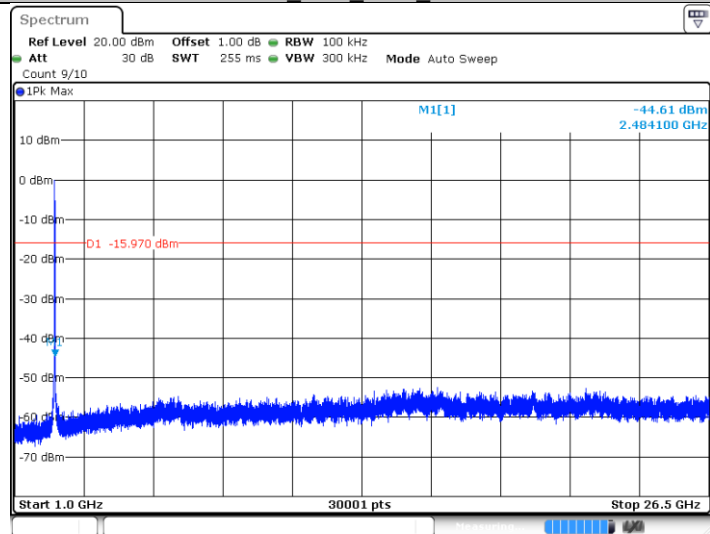
Date: 19 JUL 2021 13:55:49

11N20SISO Ant1 2462 30~1000



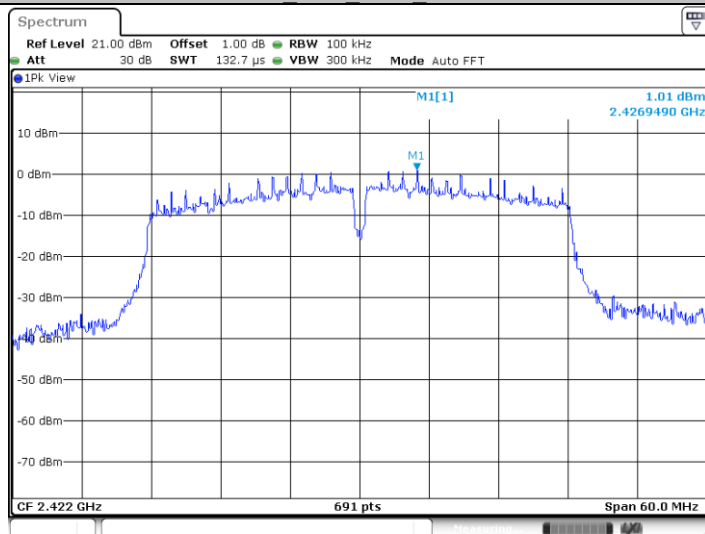
Date: 19 JUL 2021 13:55:56

11N20SISO Ant1 2462 1000~26500



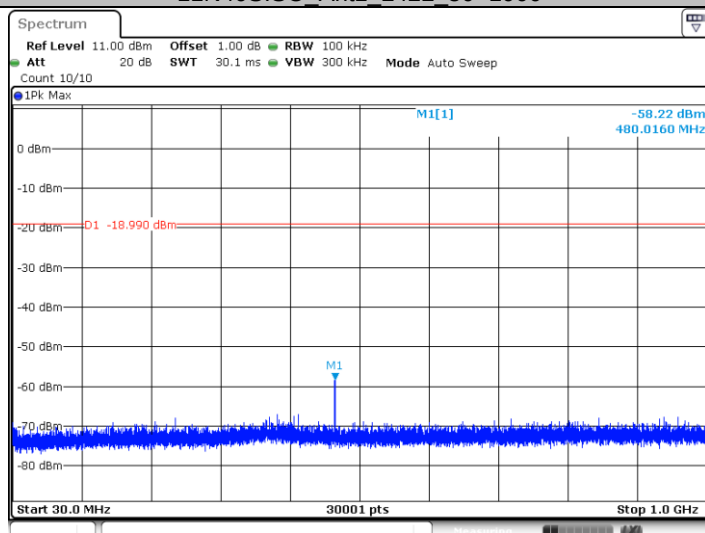
Date: 19 JUL 2021 13:56:03

11N40SISO Ant1 2422 0~Reference



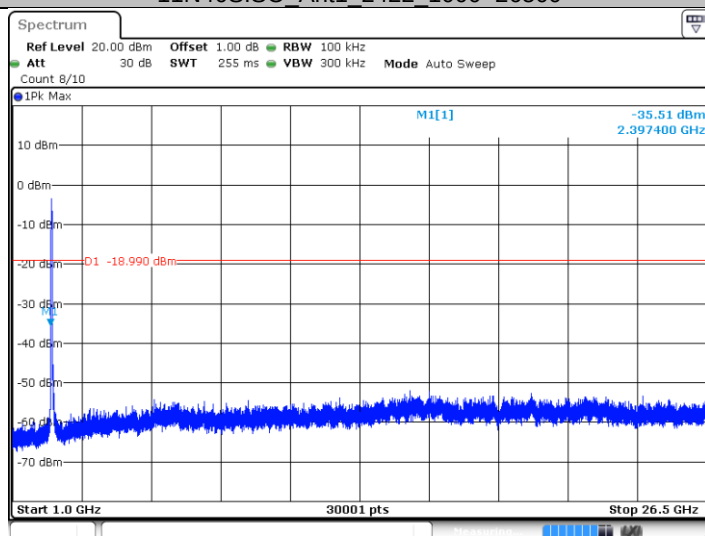
Date: 19 JUL 2021 14:00:12

11N40SISO Ant1 2422 30~1000



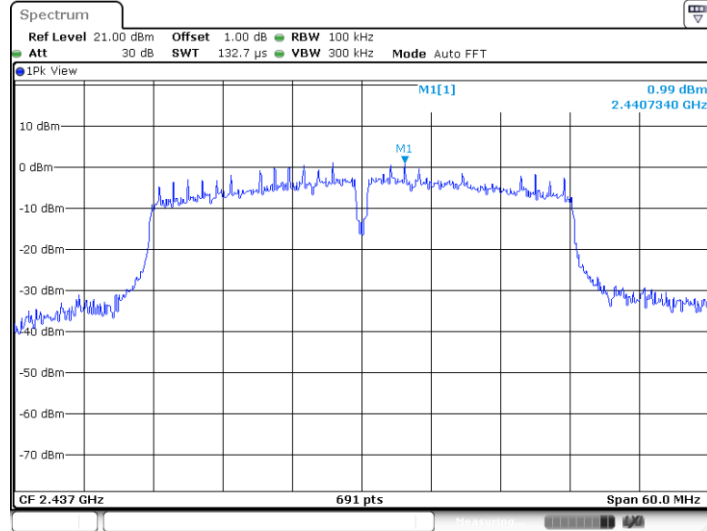
Date: 19 JUL 2021 14:00:18

11N40SISO Ant1 2422 1000~26500



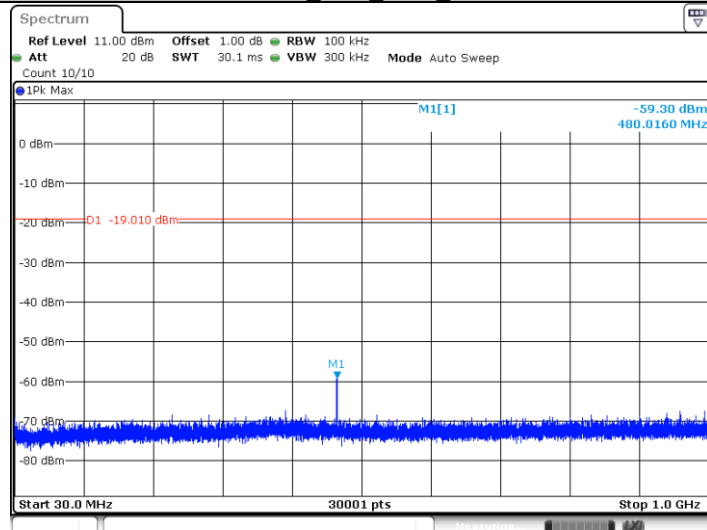
Date: 19 JUL 2021 14:00:26

11N40SISO Ant1 2437 0~Reference



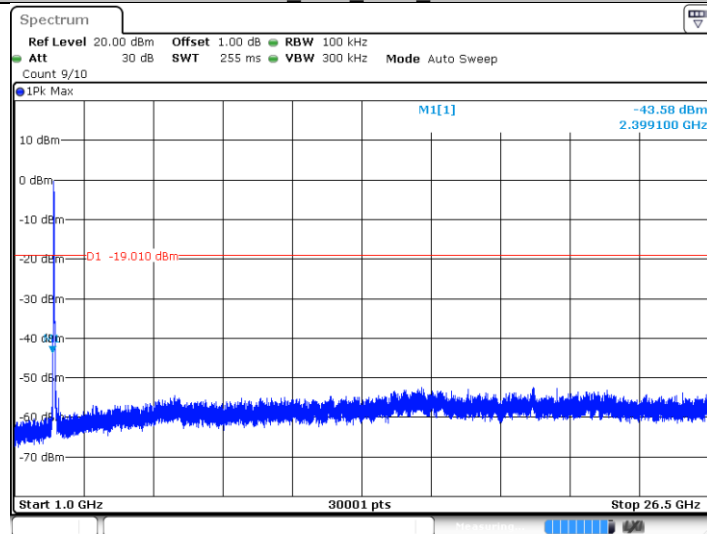
Date: 19 JUL 2021 14:04:02

11N40SISO Ant1 2437 30~1000



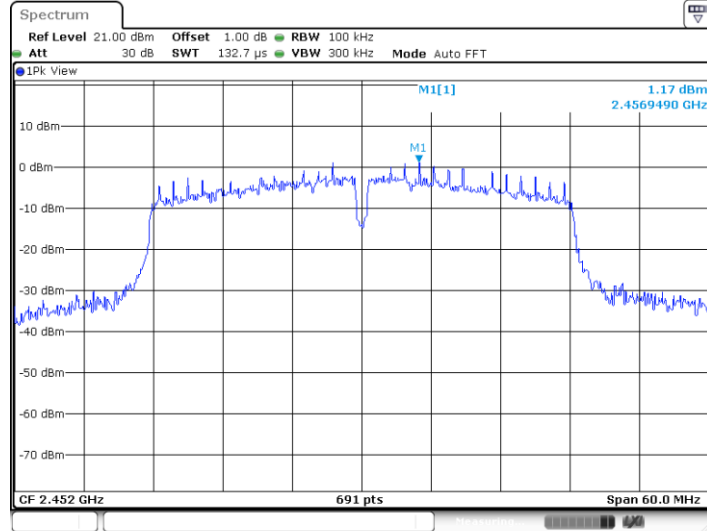
Date: 19 JUL 2021 14:04:08

11N40SISO Ant1 2437 1000~26500



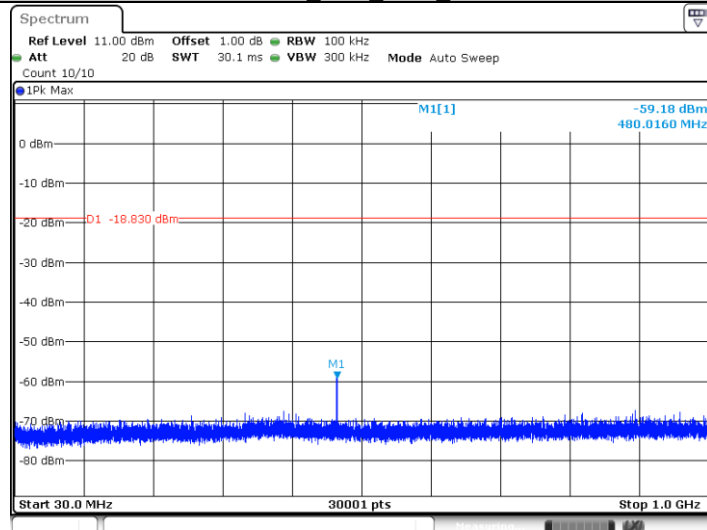
Date: 19 JUL 2021 14:04:16

11N40SISO Ant1 2452 0~Reference



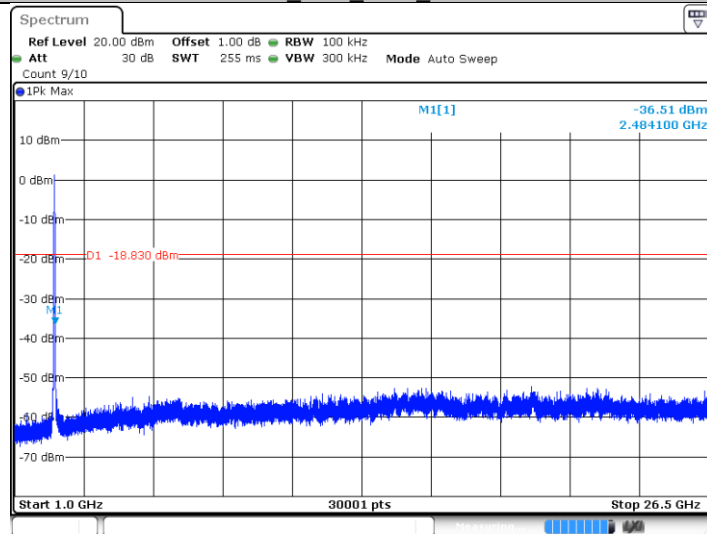
Date: 19 JUL 2021 14:06:44

11N40SISO Ant1 2452 30~1000



Date: 19 JUL 2021 14:06:50

11N40SISO Ant1 2452 1000~26500



Date: 19 JUL 2021 14:06:58

9.7 Band edge

Test Method

- 1 Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz, VBW $\geq$ RBW, Sweep = auto, Detector function = peak, Trace = max hold.
- 2 Allow the trace to stabilize, use the peak and delta measurement to record the result.
- 3 The level displayed must comply with the limit specified in this Section.

Limit

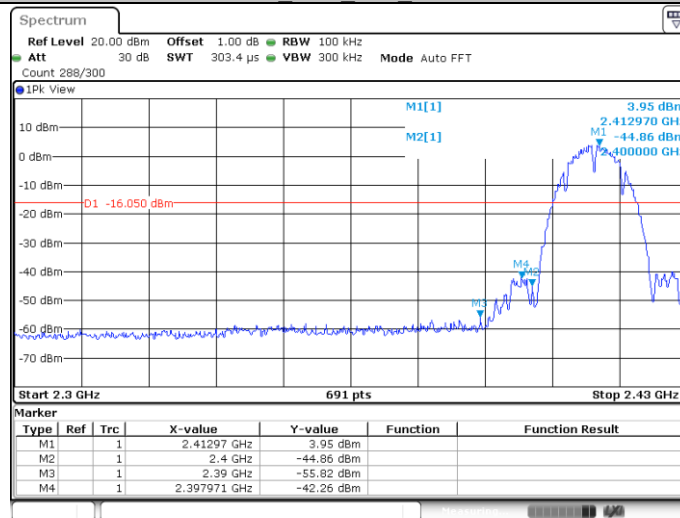
Frequency Range MHz	Limit (dBc)
30-25000	-20

Test result

TestMode	Antenna	ChName	Channel	RefLevel	Result	Limit	Verdict
11B	Ant1	Low	2412	3.95	-42.26	≤ -16.05	PASS
		High	2462	3.91	-54.45	≤ -16.09	PASS
11G	Ant1	Low	2412	1.63	-41.8	≤ -18.37	PASS
		High	2462	1.76	-51.34	≤ -18.24	PASS
11N20SISO	Ant1	Low	2412	3.81	-31.71	≤ -16.19	PASS
		High	2462	2.48	-41.85	≤ -17.52	PASS
11N40SISO	Ant1	Low	2422	1.09	-34.78	≤ -18.91	PASS
		High	2452	1.63	-33.28	≤ -18.37	PASS

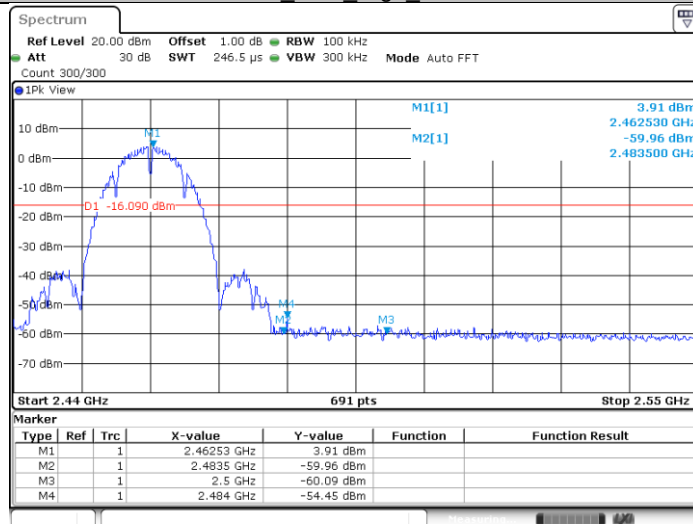
Test Graphs

11B Ant1 Low 2412



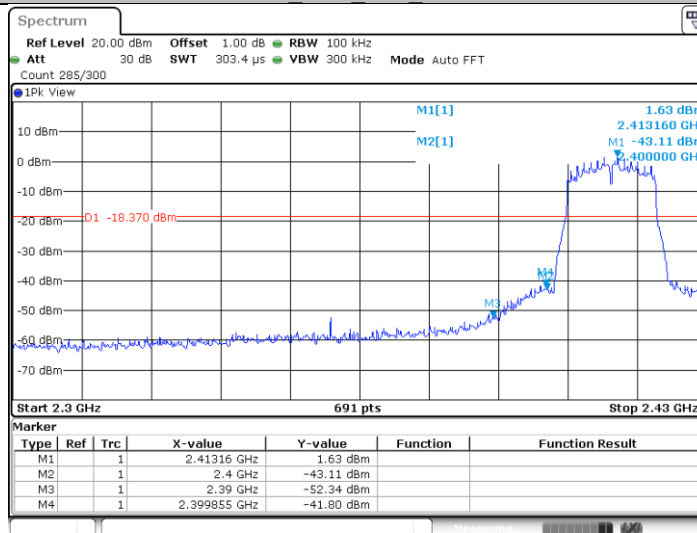
Date: 19.JUL.2021 13:36:03

11B Ant1 High 2462



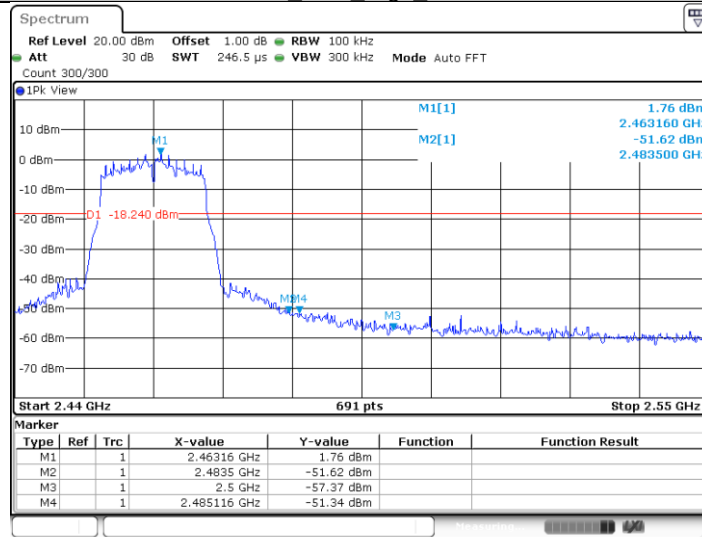
Date: 19.JUL.2021 13:42:38

11G Ant1 Low 2412

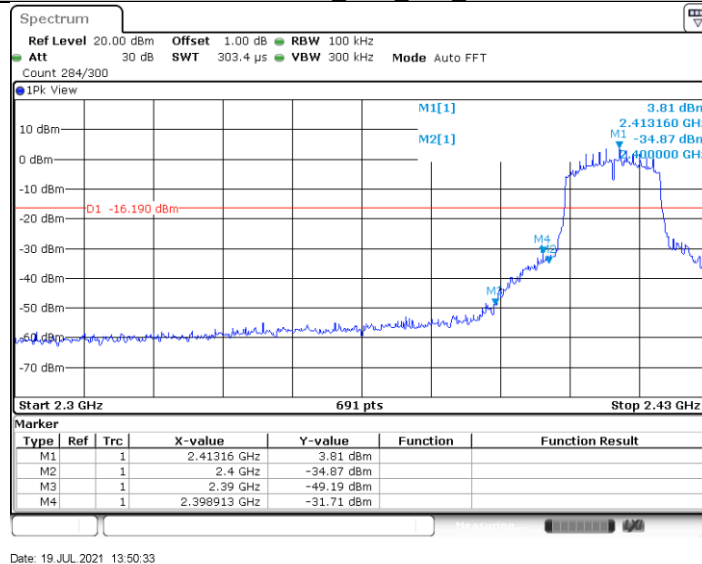


Date: 19.JUL.2021 13:44:53

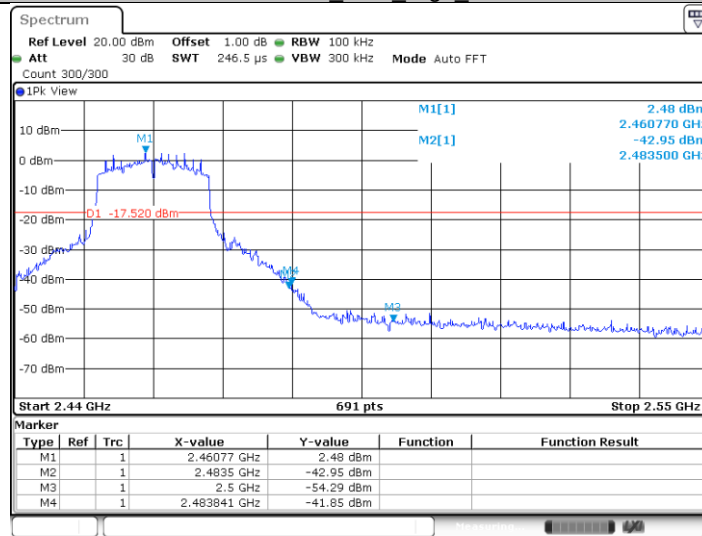
11G Ant1 High 2462

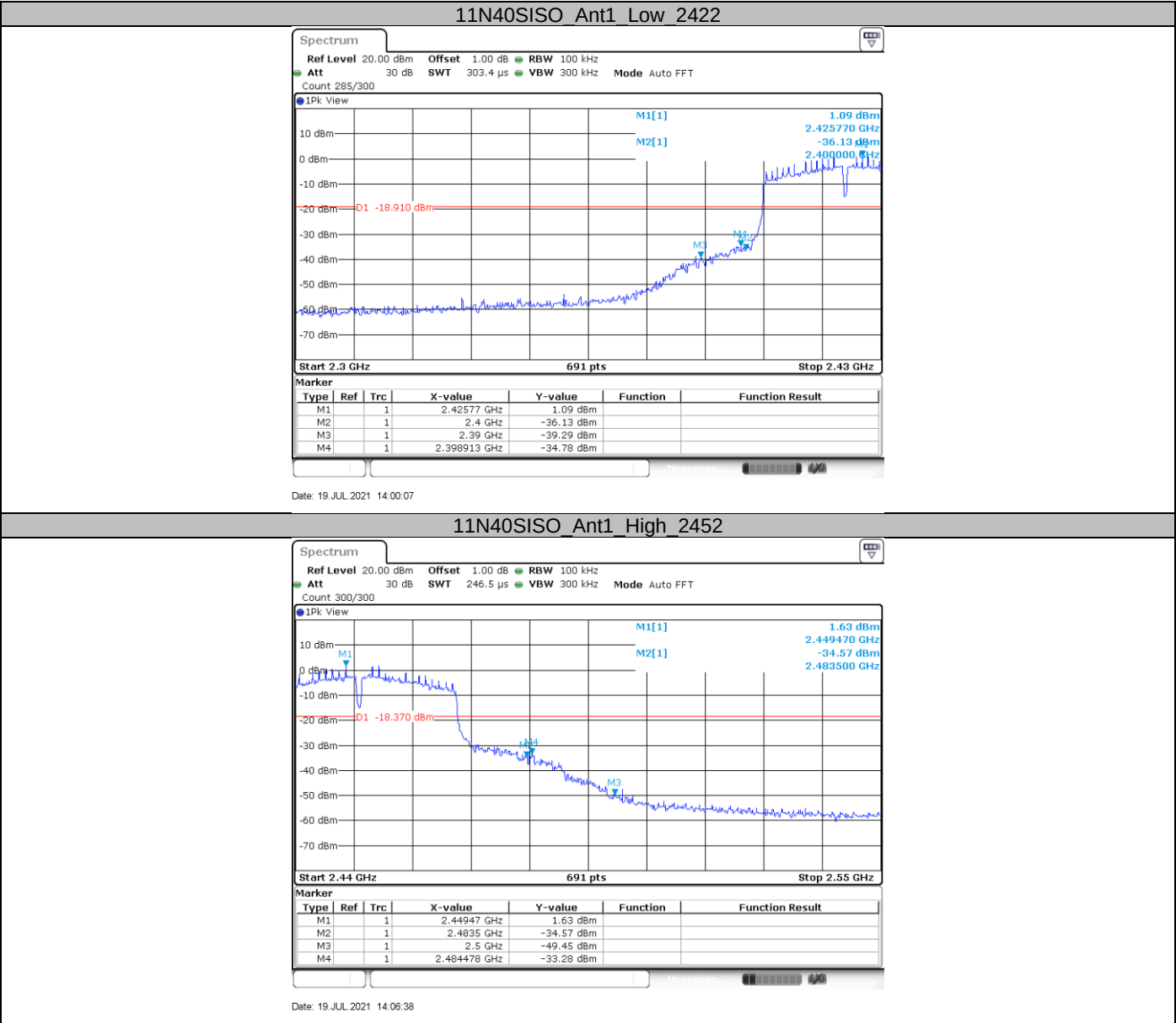


11N20SISO Ant1 Low 2412



11N20SISO Ant1 High 2462





9.8 Spurious radiated emissions for transmitter

Test Method

- 1: The EUT was placed on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- 2: The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
- 3: The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- 4: For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- 5: Use the following spectrum analyzer settings According to C63.10:

For Above 1GHz

Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 1MHz, VBW $\geq$ RBW for peak measurement and VBW = 10Hz for average measurement, Sweep = auto, Detector function = peak, Trace = max hold.

For Below 1GHz

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 KHz, VBW $\geq$ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

Note:

- 1: The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 KHz for Quasi-peak detection (QP) at frequency below 1GHz.
- 2: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 3MHz for peak detection (PK) at frequency above 1GHz.
- 3: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 3MHz for RMS Average ((duty cycle < 98%) for Average detection (AV) at frequency above 1GHz, then the measurement results was added to a correction factor ($20\log(1/\text{duty cycle})$).
- 4: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 10Hz (duty cycle > 98%) for Average detection (AV) at frequency above 1GHz.

Limit

The radio emission outside the operating frequency band 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. Radiated emissions which fall in the restricted bands, as defined in section 15.205, must comply with the radiated emission limits specified in section 15.209.

Frequency MHz	Field Strength uV/m	Field Strength dBµV/m	Detector
30-88	100	40	QP
88-216	150	43.5	QP
216-960	200	46	QP
960-1000	500	54	QP
Above 1000	500	54	AV
Above 1000	5000	74	PK

Spurious radiated emissions for transmitter

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

Transmitting spurious emission test result as below:

802.11b

2412MHz (30MHz – 1GHz)

Frequency MHz	Emission Level dBuV/m	Polarization	Limit dBuV/m	Margin dB	Detector	Corr. dB	Result
152.705000	38.07	Horizontal	43.50	5.43	QP	9.69	Pass
34.311111	31.02	Vertical	40.00	8.98	QP	12.23	Pass

2412MHz (Above 1GHz)

Frequency MHz	Emission Level dBuV/m	Polarization	Limit dBuV/m	Margin dB	Detector	Corr. dB/m	Result
2389.510000*	42.00	Horizontal	74.00	32.00	PK	-3.05	Pass
2389.630000*	41.46	Vertical	74.00	32.54	PK	-3.05	Pass
5320.000000	49.55	Horizontal	74.00	24.45	PK	5.03	Pass
5665.500000	50.15	Vertical	74.00	23.85	PK	5.93	Pass

2437MHz (30MHz – 1GHz)

Frequency MHz	Emission Level dBuV/m	Polarization	Limit dBuV/m	Margin dB	Detector	Corr. dB	Result
--	--	Horizontal	--	--	QP	--	Pass
--	--	Vertical	--	--	QP	--	Pass

2437MHz (Above 1GHz)

Frequency MHz	Emission Level dBuV/m	Polarization	Limit dBuV/m	Margin dB	Detector	Corr. dB	Result
5600.500000	49.78	Horizontal	74.00	24.22	Peak	5.81	Pass
4875.000000*	51.57	Vertical	74.00	22.43	Peak	4.10	Pass

2462MHz (30MHz – 1GHz)

Frequency MHz	Emission Level dBuV/m	Polarization	Limit dBuV/m	Margin dB	Detector	Corr. dB	Result
--	--	Horizontal	--	--	QP	--	Pass
--	--	Vertical	--	--	QP	--	Pass

2462MHz (Above 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
2483.340000*	45.68	Horizontal	74.00	28.32	PK	-2.70	Pass
2483.860000*	42.52	Vertical	74.00	31.48	PK	-2.70	Pass
5619.500000	50.54	Horizontal	74.00	23.46	Peak	5.82	Pass
4721.000000*	49.19	Vertical	74.00	24.81	Peak	3.76	Pass

802.11g

2412MHz (30MHz – 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
--	--	Horizontal	--	--	QP	--	Pass
--	--	Vertical	--	--	QP	--	Pass

2412MHz (Above 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
2390.140000*	56.65	Horizontal	74.00	17.35	Peak	-3.06	Pass
2390.420000*	51.92	Vertical	74.00	22.08	Peak	-3.06	Pass
3889.000000	45.79	Horizontal	74.00	28.21	Peak	1.49	Pass
3779.000000	46.97	Vertical	74.00	27.03	Peak	1.33	Pass

2437MHz (30MHz – 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
--	--	Horizontal	--	--	QP	--	Pass
--	--	Vertical	--	--	QP	--	Pass

2437MHz (Above 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
14962.000000	47.73	Horizontal	74.00	26.27	Peak	13.95	Pass
4630.000000*	48.28	Vertical	74.00	25.72	Peak	3.57	Pass

2462MHz (30MHz – 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
--	--	Horizontal	--	--	QP	--	Pass
--	--	Vertical	--	--	QP	--	Pass

2462MHz (Above 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
2483.560000*	57.25	Horizontal	74.00	16.75	Peak	-2.70	Pass
2483.560000*	48.28	Horizontal	54.00	5.72	Average	-2.70	Pass
2483.500000*	51.00	Vertical	74.00	23.00	Peak	-2.70	Pass
3802.500000	45.69	Horizontal	74.00	28.31	Peak	1.33	Pass
4260.000000	49.19	Vertical	74.00	24.81	Peak	3.11	Pass

802.11nHT20

2412MHz (30MHz – 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
--	--	Horizontal	--	--	QP	--	Pass
--	--	Vertical	--	--	QP	--	Pass

2412MHz (Above 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
2389.980000*	58.07	Horizontal	74.00	15.93	Peak	-3.06	Pass
2389.980000*	52.90	Horizontal	54.00	1.10	Average	-3.06	Pass
2390.640000*	63.77	Vertical	74.00	10.23	Peak	-3.06	Pass
2390.640000*	51.09	Vertical	54.00	2.91	Average	-3.06	Pass
4248.500000	47.78	Horizontal	74.00	26.22	Peak	3.02	Pass
4283.500000	47.79	Vertical	74.00	26.21	Peak	3.21	Pass

2437MHz (30MHz – 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
--	--	Horizontal	--	--	QP	--	Pass
--	--	Vertical	--	--	QP	--	Pass

2437MHz (Above 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
3269.500000	46.43	Horizontal	74.00	27.57	Peak	0.38	Pass
3523.500000	45.15	Vertical	74.00	28.85	Peak	0.58	Pass

2462MHz (30MHz – 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
--	--	Horizontal	--	--	QP	--	Pass
--	--	Vertical	--	--	QP	--	Pass

2462MHz (Above 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
2484.640000*	56.91	Horizontal	74.00	17.09	Peak	-2.70	Pass
2484.640000*	49.71	Horizontal	54.00	4.29	Average	-2.70	Pass
2484.320000*	54.11	Vertical	74.00	19.89	Peak	-2.70	Pass
2484.320000*	46.14	Vertical	54.00	7.86	Average	-2.70	Pass
4746.500000*	48.46	Horizontal	74.00	25.54	Peak	3.78	Pass
4738.000000*	48.74	Vertical	74.00	25.26	Peak	3.77	Pass

802.11nHT40

2422MHz (30MHz – 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
--	--	Horizontal	--	--	QP	--	Pass
--	--	Vertical	--	--	QP	--	Pass

2422MHz (Above 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
2390.020000*	63.77	Horizontal	74.00	10.23	Peak	-3.06	Pass
2390.020000*	53.47	Horizontal	54.00	0.53	Average	-3.06	Pass
2390.080000*	56.26	Vertical	74.00	17.74	Peak	-3.06	Pass
2390.080000*	49.96	Vertical	54.00	5.04	Average	-3.06	Pass
4807.000000*	51.29	Horizontal	74.00	22.71	Peak	3.79	Pass
5907.500000	49.96	Vertical	74.00	24.04	Peak	6.75	Pass

2437MHz (30MHz – 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
--	--	Horizontal	--	--	QP	--	Pass
--	--	Vertical	--	--	QP	--	Pass

2437MHz (Above 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
4807.000000*	46.78	Horizontal	74.00	27.22	Peak	3.79	Pass
5918.500000	50.45	Vertical	74.00	23.55	Peak	6.72	Pass

2452MHz (30MHz – 1GHz)

Frequency	Emission Level	Polarization	Limit	Margin	Detector	Corr.	Result
MHz	dBuV/m		dBµV/m	dB		dB	
--	--	Horizontal	--	--	QP	--	Pass
--	--	Vertical	--	--	QP	--	Pass

2452MHz (Above 1GHz)

Frequency MHz	Emission Level dBuV/m	Polarization	Limit dBuV/m	Margin dB	Detector	Corr. dB	Result
5983.000000	51.05	Horizontal	74.00	22.95	Peak	6.79	Pass
5635.500000	49.08	Vertical	74.00	24.92	Peak	5.83	Pass
2483.500000*	54.24	Horizontal	74.00	19.76	Peak	-2.70	Pass
2483.500000*	50.20	Horizontal	54.00	3.80	Average	-2.70	Pass
2483.620000*	52.96	Vertical	74.00	21.04	Peak	-2.70	Pass
2483.620000*	47.34	Vertical	54.00	6.66	Average	-2.70	Pass

Remark:

- (1) "*" means the emission(s) appear within the restrict bands shall follow the requirement of section 15.205.
- (2) Data of measurement within this frequency range shown "--" in the table above means the reading of emissions are the noise floor or attenuated more than 10dB below the permissible limits or the field strength is too small to be measured.
- (3) Below 1GHz: Level=Reading Level + Correction Factor
Correction Factor=Antenna Factor + Cable Loss
(The Reading Level is recorded by software which is not shown in the sheet)
- (4) Above 1GHz: Level=Reading Level + Correction Factor
Correction Factor=Antenna Factor + Cable Loss – Pre-amplifier
(The Reading Level is recorded by software which is not shown in the sheet)

10 Test Equipment List

Radiated Emission 2# Test

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL INTERVAL (YEAR)	CAL. DUE DATE
EMI Test Receiver	Rohde & Schwarz	ESR 26	68-4-74-14-002	101269	1	2022-6-4
Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9162	68-4-80-19-003	284	1	2022-2-2
Wave Guide Antenna	ETS	3117	68-4-80-19-001	00218954	1	2022-5-24
Pre-amplifier	Rohde & Schwarz	SCU 18F	68-4-29-19-001	100745	1	2021-10-25
Pre-amplifier	Rohde & Schwarz	SCU 08F2	68-4-29-19-004	08400018	1	2021-10-25
Sideband Horn Antenna	Q-PAR	QWH-SL-18-40-K-SG	68-4-80-14-008	12827	1	2022-7-21
Pre-amplifier	Rohde & Schwarz	SCU 40A	68-4-29-14-002	100432	1	2022-7-27
3m Semi-anechoic chamber	TDK	SAC-3 #2	68-4-90-19-006	----	2	2023-5-28
Test software	Rohde & Schwarz	EMC32	68-4-90-19-006-A01	Version10.35.02	N/A	N/A

Conducted Emission 2# Test

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL INTERVAL (YEAR)	CAL. DUE DATE
EMI Test Receiver	Rohde & Schwarz	ESR 3	68-4-74-19-002	102590	1	2022-6-4
LISN	Rohde & Schwarz	ENV216	68-4-87-19-001	102472	1	2022-6-5
ISN	Rohde & Schwarz	ENY81	68-4-87-14-003	100177	1	2022-6-5
ISN	Rohde & Schwarz	ENY81-CA6	68-4-87-14-004	101664	1	2022-6-5
High Voltage Probe	Schwarzbeck	TK9420(VT9420)	68-4-27-14-001	9420-584	1	2022-6-5
RF Current Probe	Rohde & Schwarz	EZ-17	68-4-27-14-002	100816	1	2022-6-5
Attenuator	Shanghai Huaxiang	TS2-26-3	68-4-81-16-003	080928189	1	2022-6-3
Test software	Rohde & Schwarz	EMC32	68-4-90-19-005-A01	Version10.35.02	N/A	N/A
Shielding Room	TDK	CSR #2	68-4-90-19-005	----	1	2022-11-07

RF Conducted Test

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL INTERVAL (YEAR)	CAL. DUE DATE
Signal Analyzer	Rohde & Schwarz	FSV40	68-4-74-14-004	101030	1	2022-6-3
RF Switch Module	Rohde & Schwarz	OSP120/OSP-B157	68-4-93-14-003	101226/100851	1	2022-6-3
Power Splitter	Weinschel	1580	68-4-85-14-001	SC319	1	2022-6-3
10dB Attenuator	Weinschel	4M-10	68-4-81-14-003	43152	1	2022-6-3
10dB Attenuator	R&S	DNF	68-4-81-14-004	DNF-001	1	2022-6-3
10dB Attenuator	R&S	DNF	68-4-81-14-005	DNF-002	1	2022-6-3
10dB Attenuator	R&S	DNF	68-4-81-14-006	DNF-003	1	2022-6-3
10dB Attenuator	R&S	DNF	68-4-81-14-007	DNF-004	1	2022-6-3
Test software	Tonscend	System for BT/WIFI	68-4-74-14-006-A13	Version 2.6.77.0518	N/A	N/A
Shielding Room	TDK	TS8997	68-4-90-19-003	----	1	2022-11-07

11 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

System Measurement Uncertainty

System Measurement Uncertainty	
Items	Extended Uncertainty
Uncertainty for Radiated Spurious Emission 25MHz-3000MHz	Horizontal: 4.35dB; Vertical: 4.44dB;
Uncertainty for Radiated Spurious Emission 3000MHz-18000MHz	Horizontal: 4.30dB; Vertical: 4.29dB;
Uncertainty for Radiated Spurious Emission 18000MHz-40000MHz	Horizontal: 4.51dB; Vertical: 4.50dB;
Uncertainty for Conducted RF test with TS 8997	RF Power Conducted: 1.31dB Frequency test involved: 0.6×10 ⁻⁷ or 1%
Uncertainty for Conducted Emission in new shielding room (68-4-90-19-005) 150kHz-30MHz (for test using AMN ENV216)	3.20dB