

FCC - TEST REPORT

Report Number : **709502403550-00A** Date of Issue: May 15,2024Model : T1-2S-NLProduct Type : Wi-Fi and Bluetooth ModuleApplicant : Hangzhou Tuya Information Technology Co.,LtdAddress : Room 301,Building 1,Huace Center,Xihu District,
Hangzhou,Zhejiang, ChinaManufacturer : Hangzhou Tuya Information Technology Co.,LtdAddress : Room 301,Building 1,Huace Center,Xihu District,
Hangzhou,Zhejiang, ChinaTest Result : ☒ **Positive** ☐ **Negative**Total pages including
Appendices : 56

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2 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
-00A	First Issue	05/15/2024

3 Details about the Test Laboratory

Test Site 1

Company name: TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
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FCC Registration No.: 820234

FCC Designation Number: CN1183

ISED CAB identifier CN0101

IC Registration No.: 31668

4 Description of the Equipment under Test

Product: Wi-Fi and Bluetooth Module

Model no.: T1-2S-NL

FCC ID: 2ANDL-T1-2S-NL

Rating: 3.0-3.6V DC

RF Transmission Frequency: Wi-Fi:2412-2462MHz
Bluetooth LE:2402~2480MHz

No. of Operated Channel: 2.4GHz WIFI: 11 for 802.11b/g/n(HT20)
2.4GHz BLE: 40

Modulation: Direct Sequence Spread Spectrum (DSSS) for 802.11b
Orthogonal Frequency Division Multiplexing (OFDM) for 802.11g/n; 2.4GHz BLE: GFSK

Channel list:

802.11b/g/n(HT20)			
Ch	Fre(MHz)	Ch	Fre(MHz)
1	2412	7	2442
2	2417	8	2447
3	2422	9	2452
4	2427	10	2457
5	2432	11	2462
6	2437		

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



Antenna type:	Onboard PCB antenna
Antenna Gain:	2.2dBi
Description of the EUT:	The Equipment Under Test (EUT) is a Wi-Fi and Bluetooth module which support 2.4GHz Wi-Fi and BLE 5.2(support 1Mbps data rate). We tested it and listed the worst data in this report.
Test sample no.:	SHA-810228-1 (RF radiated); SHA-810228-2 (RF conducted)

The sample's mentioned in this report is/are submitted/ supplied/ manufactured by client. The laboratory therefore assumes no responsibility for accuracy of information on the brand name, model number, origin of manufacture, consignment or any information supplied.



5 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2023 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators

All the test methods were according to KDB 558074 D01 15.247 Meas Guidance v05r02 Measurement Guidance and ANSI C63.10-2013.

6 Summary of Test Results

Technical Requirements						
FCC Part 15 Subpart C						
Test Condition		Pages	Test Site	Test Result		
				Pass	Fail	N/A
§15.207	Conducted emission AC power port	13-17	Site 1	☒	☐	☐
§15.247 (b) (3)	Conducted peak output power	18	Site 1	☒	☐	☐
§15.247(a)(1)	20dB bandwidth	---	---	☐	☐	☒
§15.247(a)(1)	Carrier frequency separation	---	---	☐	☐	☒
§15.247(a)(1)(iii)	Number of hopping frequencies	---	---	☐	☐	☒
§15.247(a)(1)(iii)	Dwell Time	---	---	☐	☐	☒
§15.247(a)(2)	6dB bandwidth	19-22	Site 1	☒	☐	☐
§15.247(e)	Power spectral density	23-26	Site 1	☒	☐	☐
§15.247(d)	Spurious RF conducted emissions	27-36	Site 1	☒	☐	☐
§15.247(d)	Band edge	37-43	Site 1	☒	☐	☐
§15.247(d) & §15.209	Spurious radiated emissions for transmitter	44-52	Site 1	☒	☐	☐
§15.203	Antenna requirement	See note 1		☒	☐	☐

Remark 1: N/A – Not Applicable.

Note 1: The EUT uses PCB antenna, which gain is 2.2dBi. In accordance to §15.203, It is considered sufficiently to comply with the provisions of this section.



7 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID:2ANDL-T1-2S-NL, complies with Section 15.207,15.209,15.231,15.247 of the FCC Part 15, Subpart C Rules.

This report is only for the 2.4GHz Wi-Fi test report, for the 2.4GHz BLE test report please refer to 709502403550-00B.

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: April 26, 2024

Testing Start Date: April 26, 2024

Testing End Date: May 6, 2024

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

Reviewed by:

Prepared by:

Tested by:

Hui TONG
Review Engineer

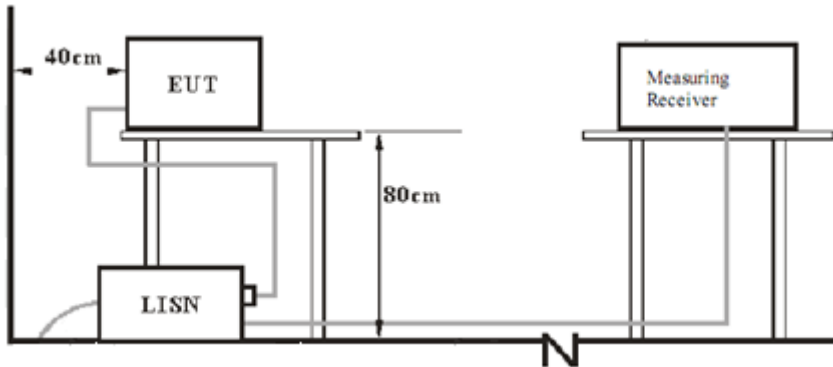


Jiaxi XU
Project Engineer

Cheng Huali
Test Engineer

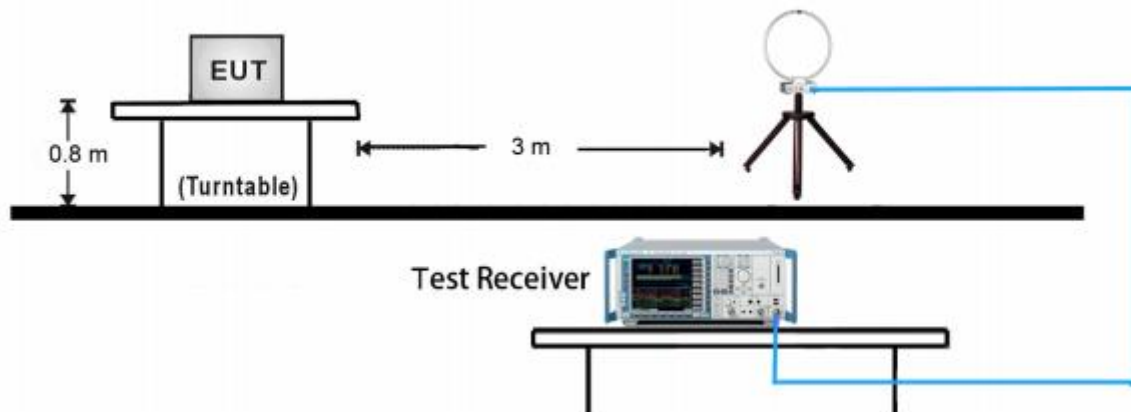
8 Test Setups

7.1 AC Power Line Conducted Emission test setups

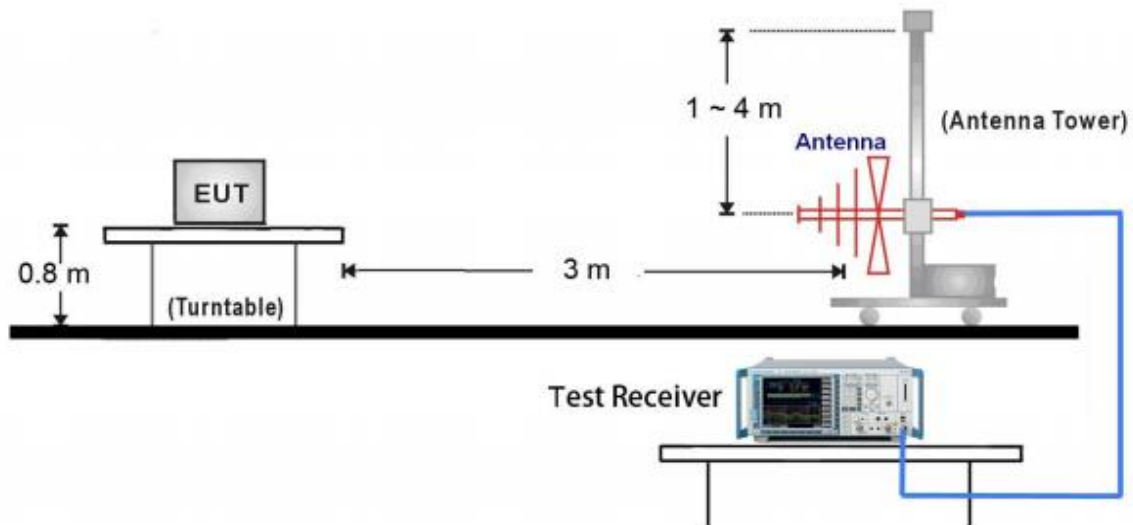


7.2 Radiated test setups

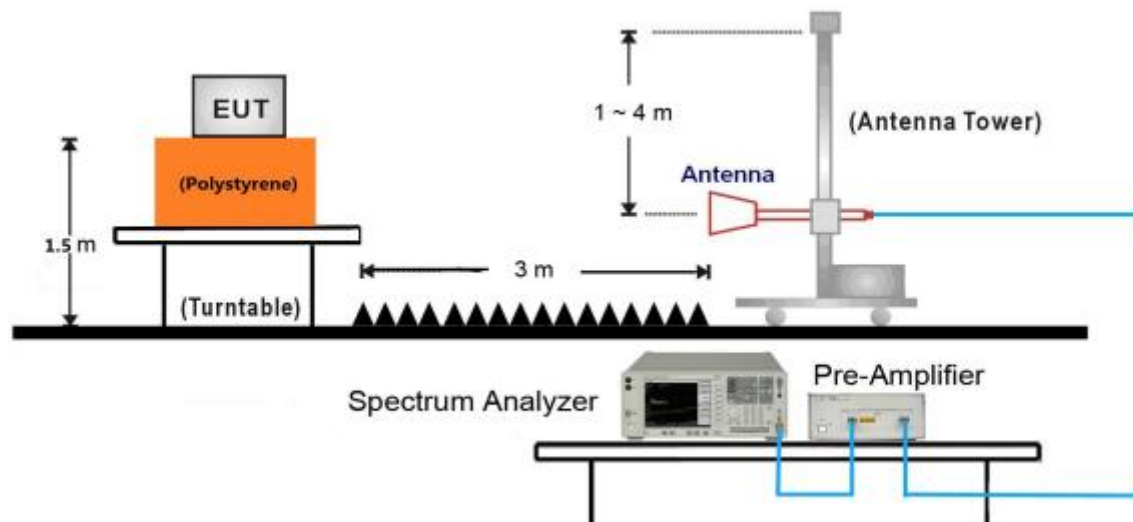
9kHz ~ 30MHz Test Setup:



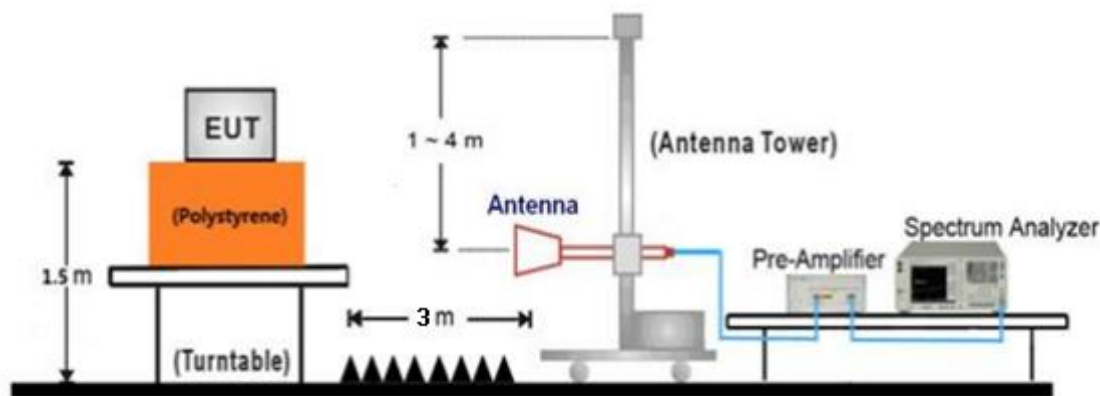
30MHz ~ 1GHz Test Setup:



1GHz ~ 18GHz Test Setup:

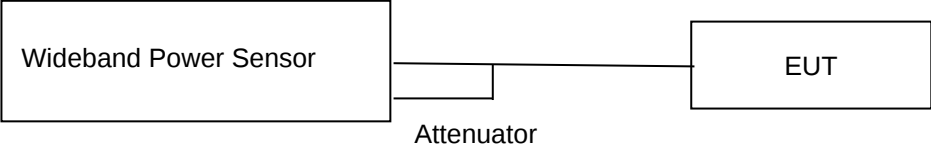


18GHz ~ 25GHz Test Setup:

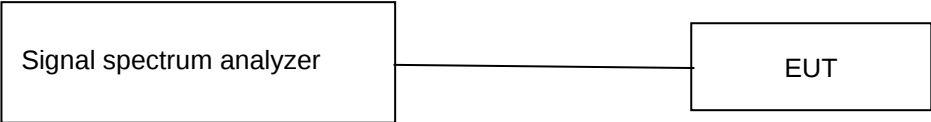


7.3 Conducted RF test setups

For Conducted peak output power



For other test items



9 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)	S/N(LENGTH)
Notebook	Lenovo	E470	PF-OU5TS7 17/09

Test software: Beken Wi-Fi test tool v1.7.4

Test Mode Applicability and Tested Channel Detail:

Mode	Tested Channel	Data Rate (Mbps)	Modulation	Index Value (Power level setting)
802.11b	1	1	CCK	75
	6	1	CCK	75
	11	1	CCK	75
802.11g	1	6	OFDM	92
	6	6	OFDM	92
	11	6	OFDM	92
802.11n HT20	1	MCS0	OFDM	88
	6	MCS0	OFDM	88
	11	MCS0	OFDM	88

Non-hopping mode: The system was configured to operate at a signal channel transmitting. The test software allows the configuration and operation at the worst-case duty and the highest transmit power.

10 Technical Requirement

10.1 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 a 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

According to §15.207, conducted emissions limit as below:

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

Decreasing linearly with logarithm of the frequency

Conducted Emission

150k-30MHz Conducted Emission Test

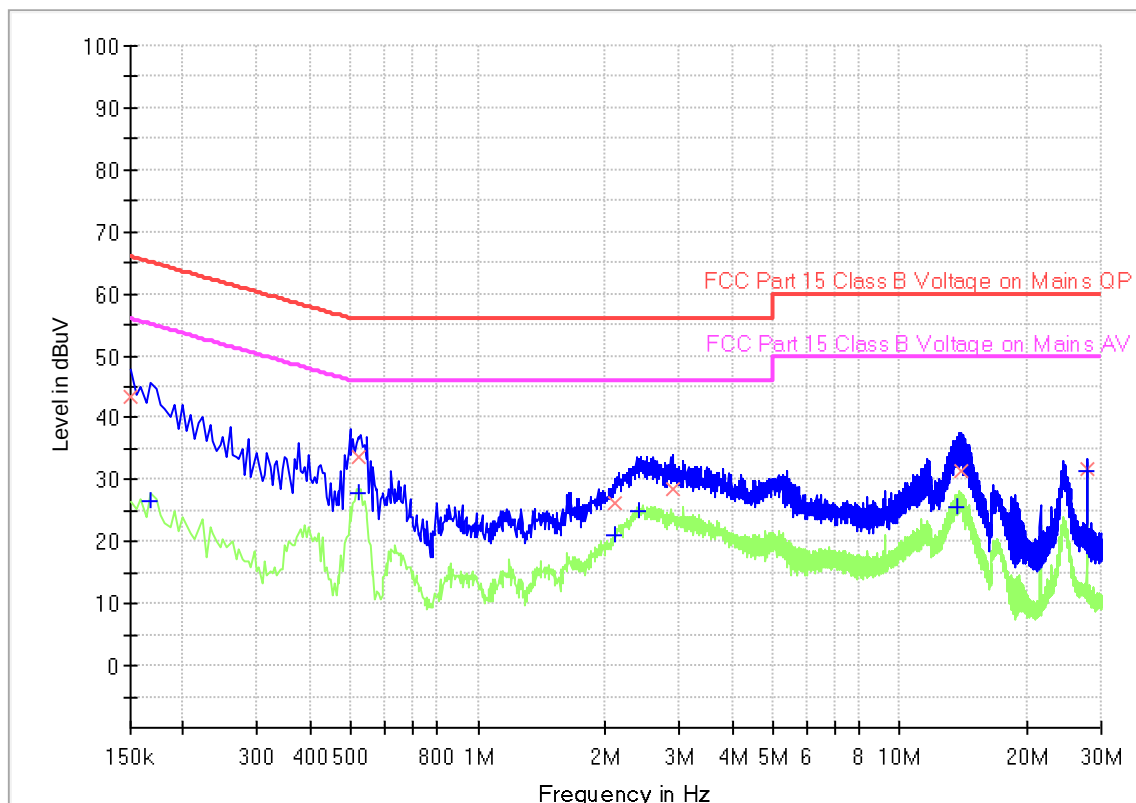
EUT Information

EUT Name: Wi-Fi and BLE Module
 Model: T1-2S-NL
 Client: Hangzhou Tuya Information Co., Ltd
 Op Cond: Power on, TX_2462MHz at g mode, AC 120V/60Hz
 Operator: Huali CHENG
 Standard: FCC Part 15.207(a)
 Comment: Phase L
 Sample No.: SHA-810228-1

Scan Setup: Voltage with 2-Line-LISN pre [EMI conducted]

Hardware Setup: Voltage with 2-Line-LISN
 Receiver: [ESR 3]
 Level Unit: dBuV

Subrange	Step Size	Detectors	IF BW	Meas. Time	Preamp
9 kHz - 150 kHz	100 Hz	PK+	200 Hz	0.02 s	0 dB
150 kHz - 30 MHz	4.5 kHz	PK+; AVG	9 kHz	0.01 s	0 dB





Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.150000	43.25	---	66.00	22.75	1000.0	9.000	L1	19.4
0.168000	---	26.47	55.06	28.59	1000.0	9.000	L1	19.4
0.519000	33.72	---	56.00	22.28	1000.0	9.000	L1	19.4
0.519000	---	28.00	46.00	18.00	1000.0	9.000	L1	19.4
2.103000	26.17	---	56.00	29.83	1000.0	9.000	L1	19.5
2.116500	---	21.12	46.00	24.88	1000.0	9.000	L1	19.5
2.400000	---	24.96	46.00	21.04	1000.0	9.000	L1	19.5
2.890500	28.42	---	56.00	27.58	1000.0	9.000	L1	19.5
13.735500	---	25.74	50.00	24.26	1000.0	9.000	L1	20.0
13.911000	31.28	---	60.00	28.72	1000.0	9.000	L1	20.0
27.649500	31.68	---	60.00	28.32	1000.0	9.000	L1	21.1
27.649500	---	31.32	50.00	18.68	1000.0	9.000	L1	21.1

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

150k-30MHz Conducted Emission Test

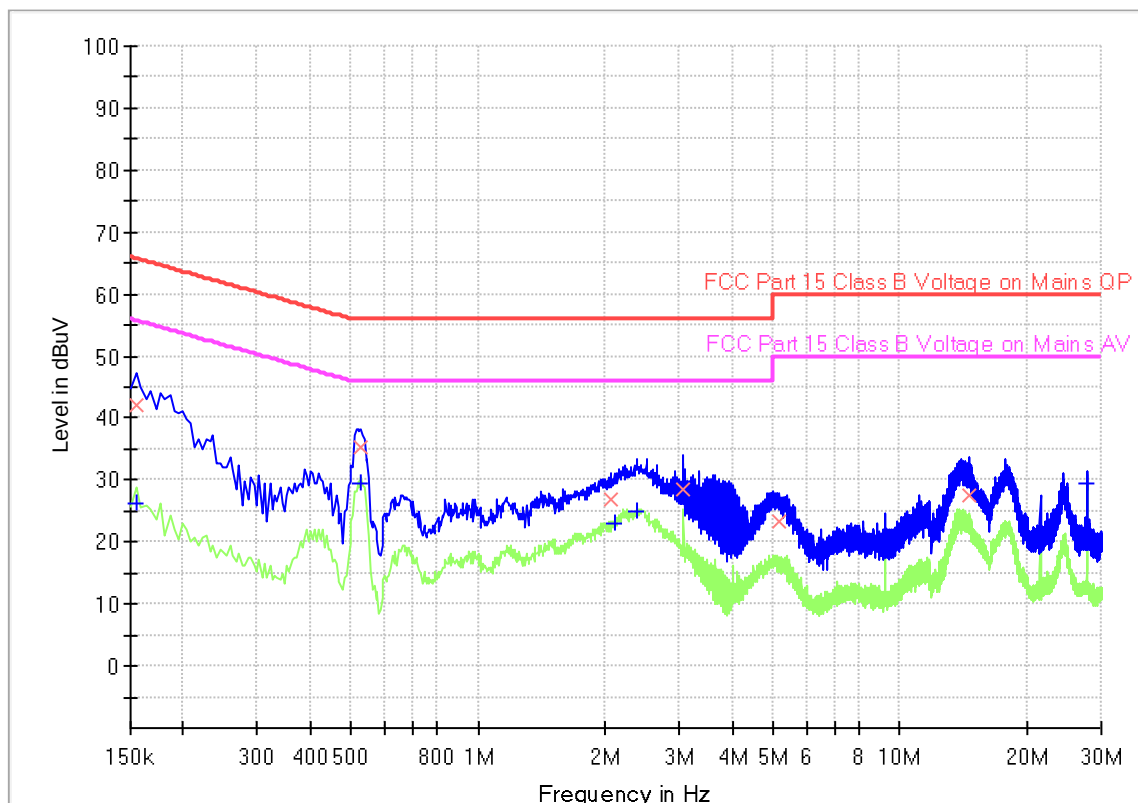
EUT Information

EUT Name: Wi-Fi and BLE Module
 Model: T1-2S-NL
 Client: Hangzhou Tuya Information Co., Ltd
 Op Cond: Power on, TX_2462MHz at g mode, AC 120V/60Hz
 Operator: Huali CHENG
 Standard: FCC Part 15.207(a)
 Comment: Phase N
 Sample No.: SHA-810228-1

Scan Setup: Voltage with 2-Line-LISN pre [EMI conducted]

Hardware Setup: Voltage with 2-Line-LISN
 Receiver: [ESR 3]
 Level Unit: dBuV

Subrange	Step Size	Detectors	IF BW	Meas. Time	Preamplifier
9 kHz - 150 kHz	100 Hz	PK+	200 Hz	0.02 s	0 dB
150 kHz - 30 MHz	4.5 kHz	PK+; AVG	9 kHz	0.01 s	0 dB





Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.154500	---	26.15	55.75	29.60	1000.0	9.000	N	19.4
0.154500	42.17	---	65.75	23.58	1000.0	9.000	N	19.4
0.528000	---	29.61	46.00	16.39	1000.0	9.000	N	19.5
0.528000	35.20	---	56.00	20.80	1000.0	9.000	N	19.5
2.067000	27.03	---	56.00	28.97	1000.0	9.000	N	19.5
2.116500	---	23.15	46.00	22.85	1000.0	9.000	N	19.5
2.382000	---	24.83	46.00	21.17	1000.0	9.000	N	19.5
3.070500	28.35	---	56.00	27.65	1000.0	9.000	N	19.5
5.176500	23.37	---	60.00	36.63	1000.0	9.000	N	19.6
9.217500	---	19.67	50.00	30.33	1000.0	9.000	N	19.7
14.590500	27.60	---	60.00	32.40	1000.0	9.000	N	19.9
27.649500	---	29.55	50.00	20.45	1000.0	9.000	N	20.7

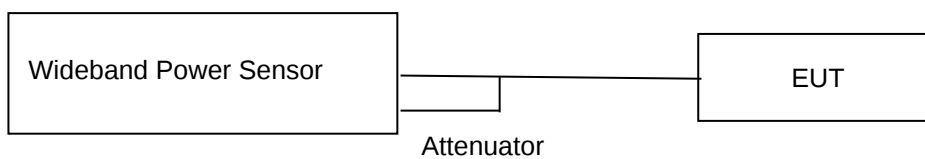
Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

10.2 Conducted peak output power

Test Method

- 1) The EUT is configured to transmit continuously, or to transmit with a constant duty cycle.
- 2) At all times when the EUT is transmitting, it shall be transmitting at its maximum power control level.
- 3) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.
- 4) Measure the peak power of the transmitter. This measurement is a peak over both the ON and OFF periods of the transmitter.



Wideband Power Sensor conducted test setup

Limits

According to §15.247 (b) (3) conducted peak output power limit as below:

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

Test result as below

802.11b

Frequency (MHz)	Conducted Peak Output Power(dBm)	Result
Low channel 2412MHz	17.51	Pass
Middle channel 2437MHz	17.28	Pass
High channel 2462MHz	17.19	Pass

802.11g

Frequency (MHz)	Conducted Peak Output Power(dBm)	Result
Low channel 2412MHz	22.39	Pass
Middle channel 2437MHz	22.37	Pass
High channel 2462MHz	22.46	Pass

802.11n(HT20)

Frequency (MHz)	Conducted Peak Output Power(dBm)	Result
Low channel 2412MHz	20.55	Pass
Middle channel 2437MHz	20.37	Pass
High channel 2462MHz	20.26	Pass

10.36dB bandwidth

Test Method

1. The RF output of EUT was connected to the spectrum analyzer. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
RBW=100KHz, VBW $\geq$ 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Use the automatic bandwidth measurement capability of an instrument, use the X dB bandwidth mode with X set to 6 dB.
5. Allow the trace to stabilize, record the 6 dB Bandwidth value.

Limit

Limit [kHz]

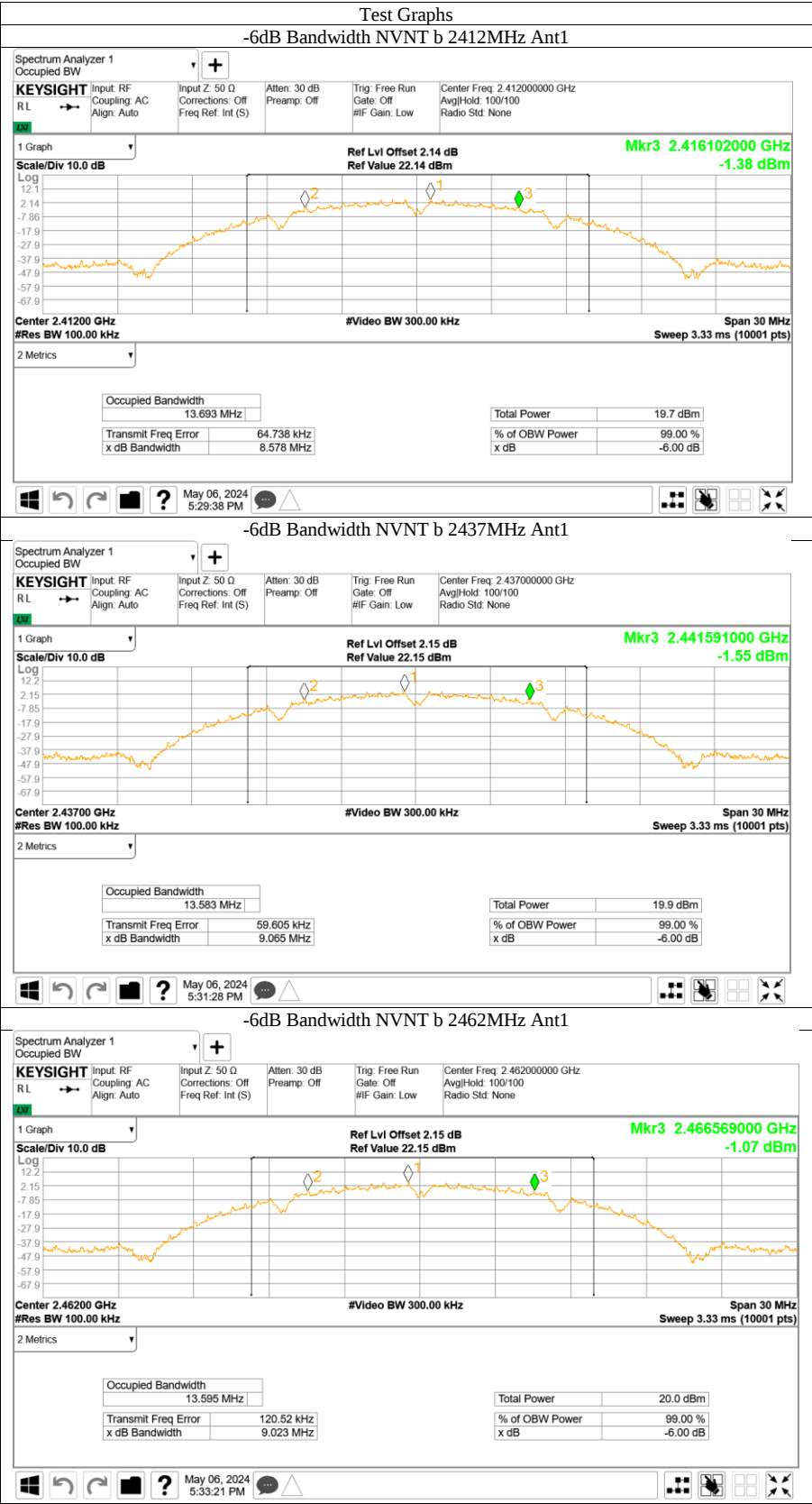
≥ 500

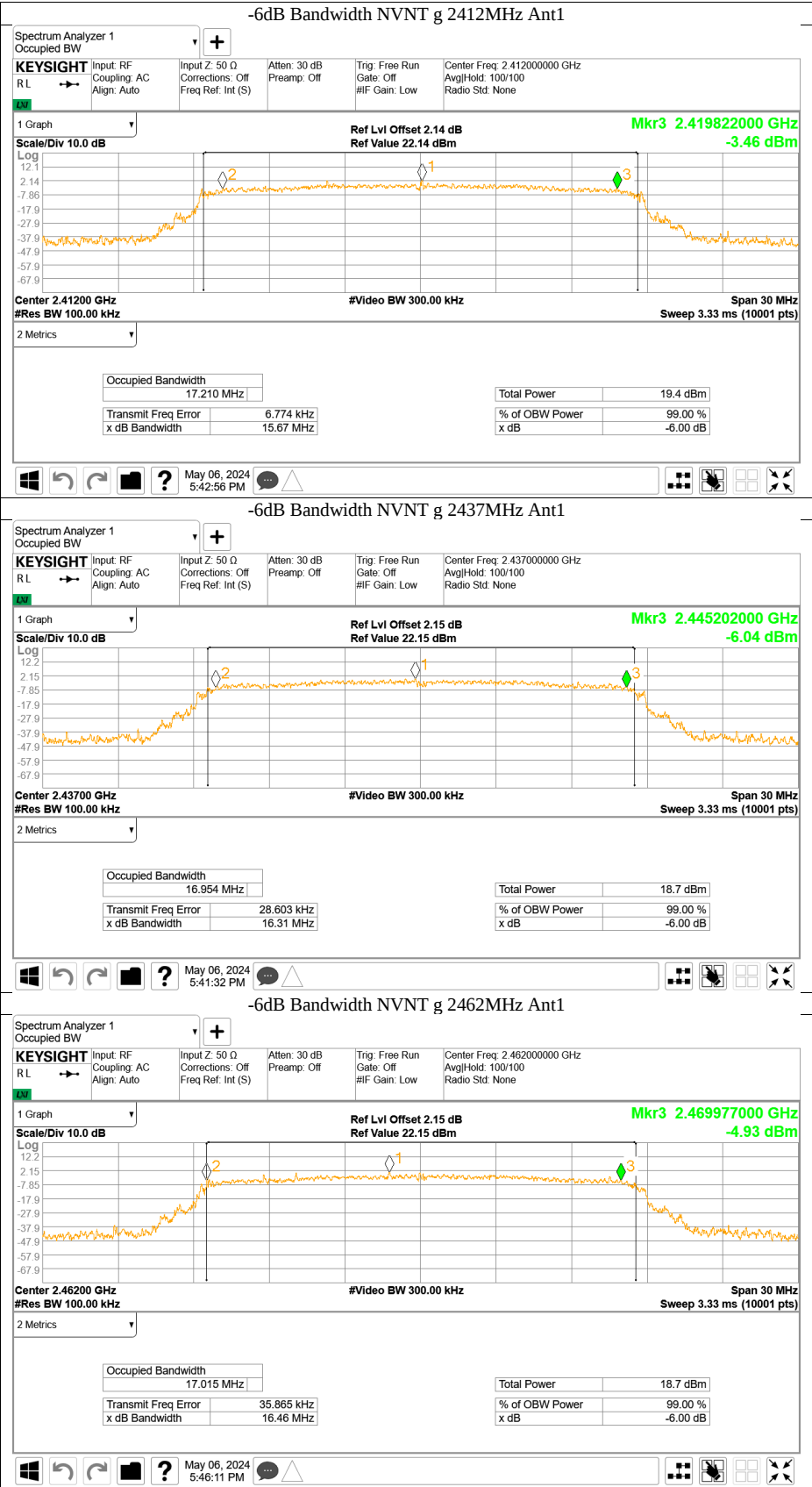
Test result

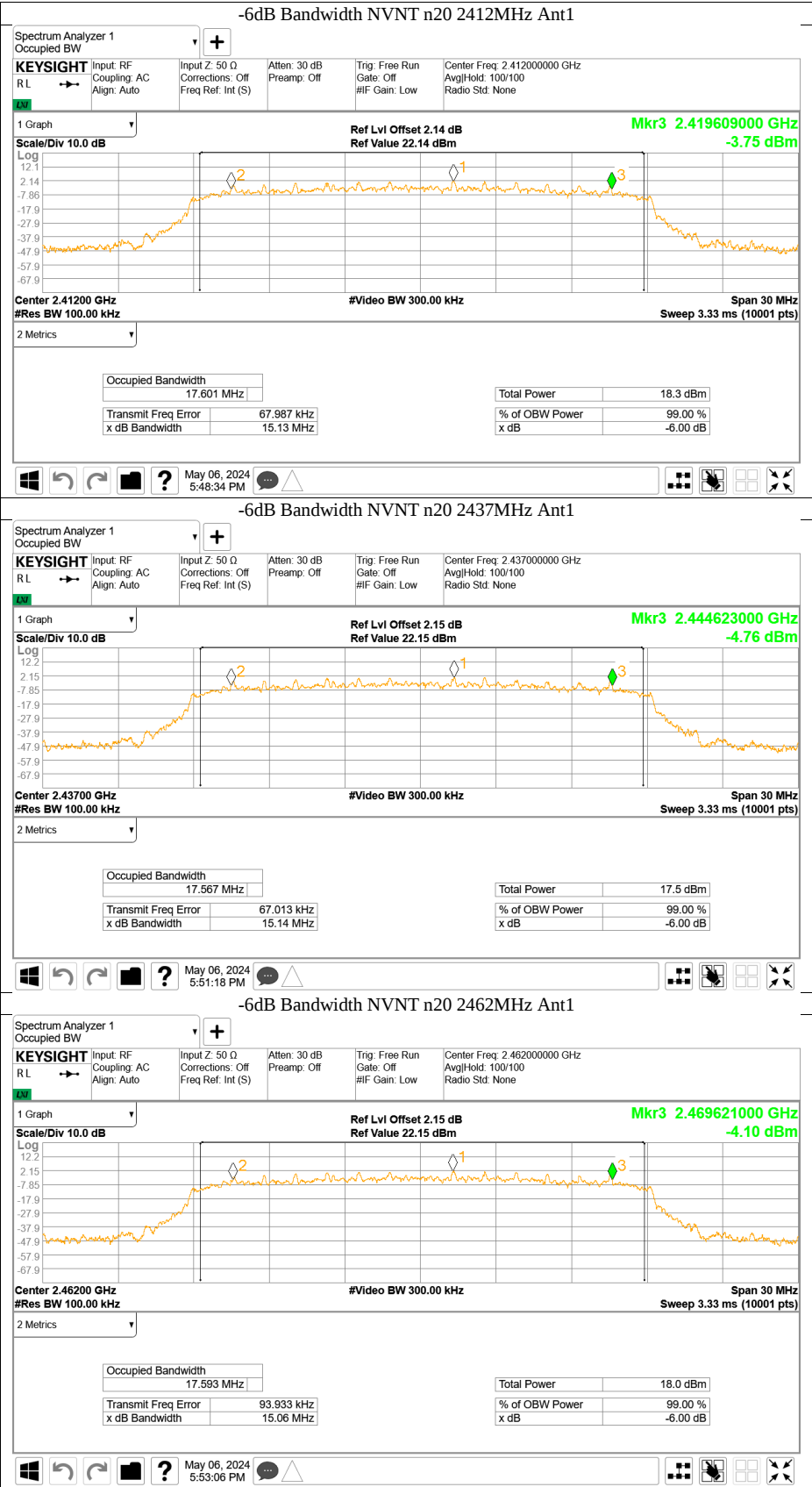
Test Mode	Frequency MHz	6dB bandwidth (MHz)		Result
		result	limit	verdict
802.11b	2412	8.578	≥ 0.5	Pass
	2437	9.065	≥ 0.5	Pass
	2462	9.023	≥ 0.5	Pass
802.11g	2412	15.673	≥ 0.5	Pass
	2437	16.313	≥ 0.5	Pass
	2462	16.462	≥ 0.5	Pass
802.11n(HT20)	2412	15.125	≥ 0.5	Pass
	2437	15.138	≥ 0.5	Pass
	2462	15.058	≥ 0.5	Pass



6 dB Bandwidth







10.4 Power spectral density

Test Method

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

1. The RF output of EUT was connected to the spectrum analyzer. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
4. 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.
5. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
6. Repeat above procedures until other frequencies measured were completed.

Limit

Limit [dBm/3kHz]

≤ 8

Test result
802.11 b

Frequency MHz	Power spectral density dBm/3kHz	Result
Low channel 2412MHz	-9.07	Pass
Middle channel 2437MHz	-9.02	Pass
High channel 2462MHz	-8.72	Pass

802.11 g

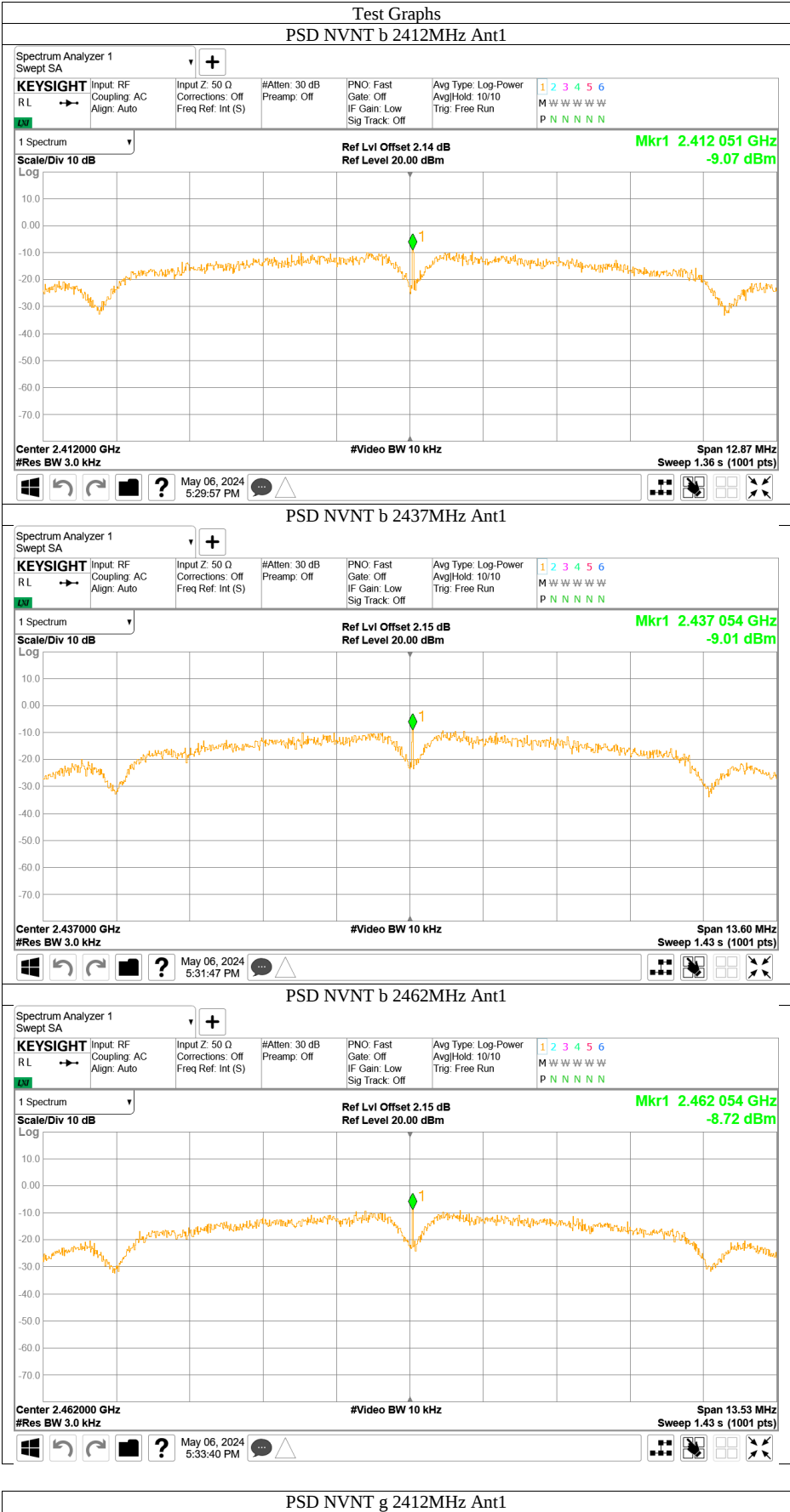
Frequency MHz	Power spectral density dBm/3kHz	Result
Low channel 2412MHz	-11.19	Pass
Middle channel 2437MHz	-10.98	Pass
High channel 2462MHz	-11.3	Pass

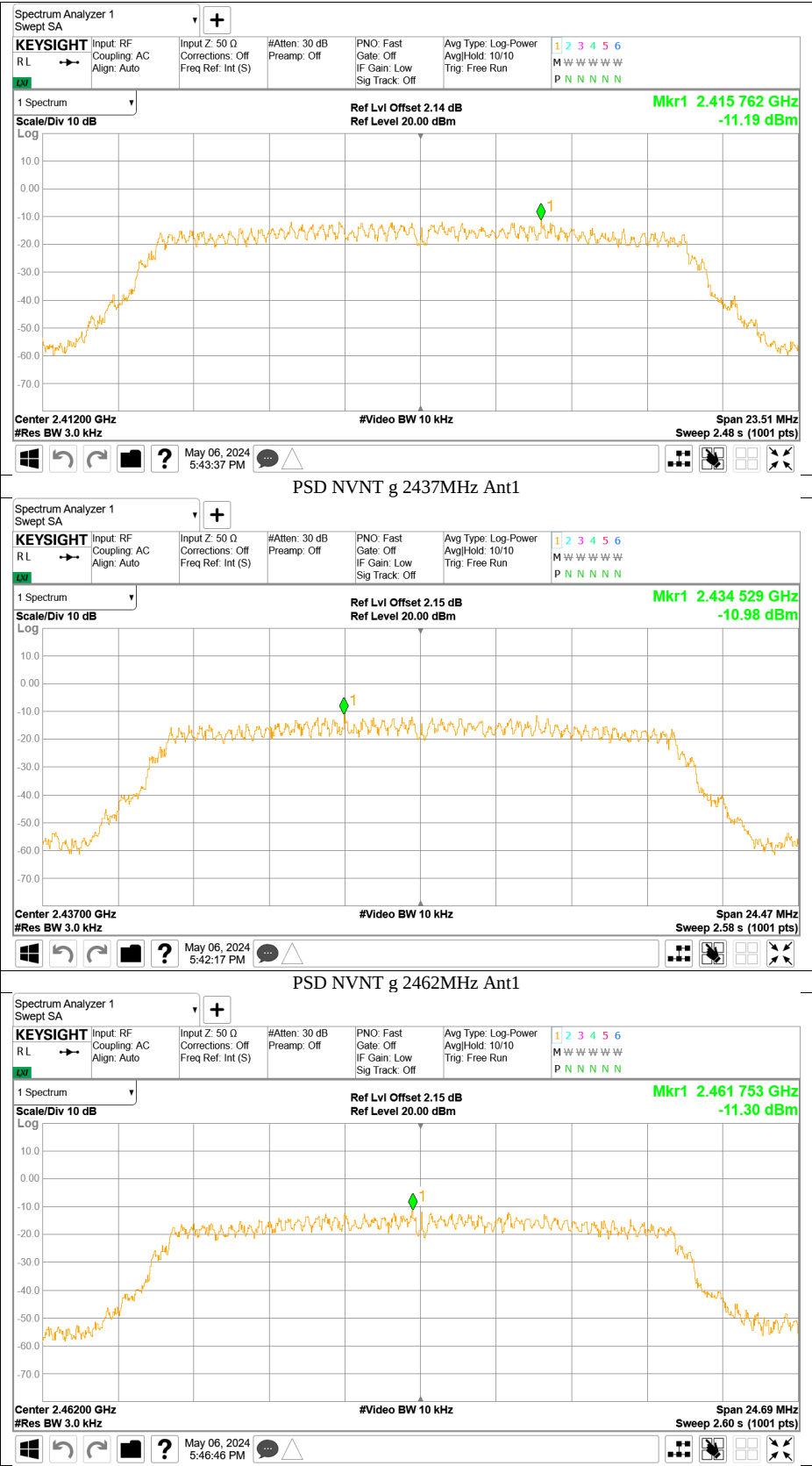
802.11 n (HT20)

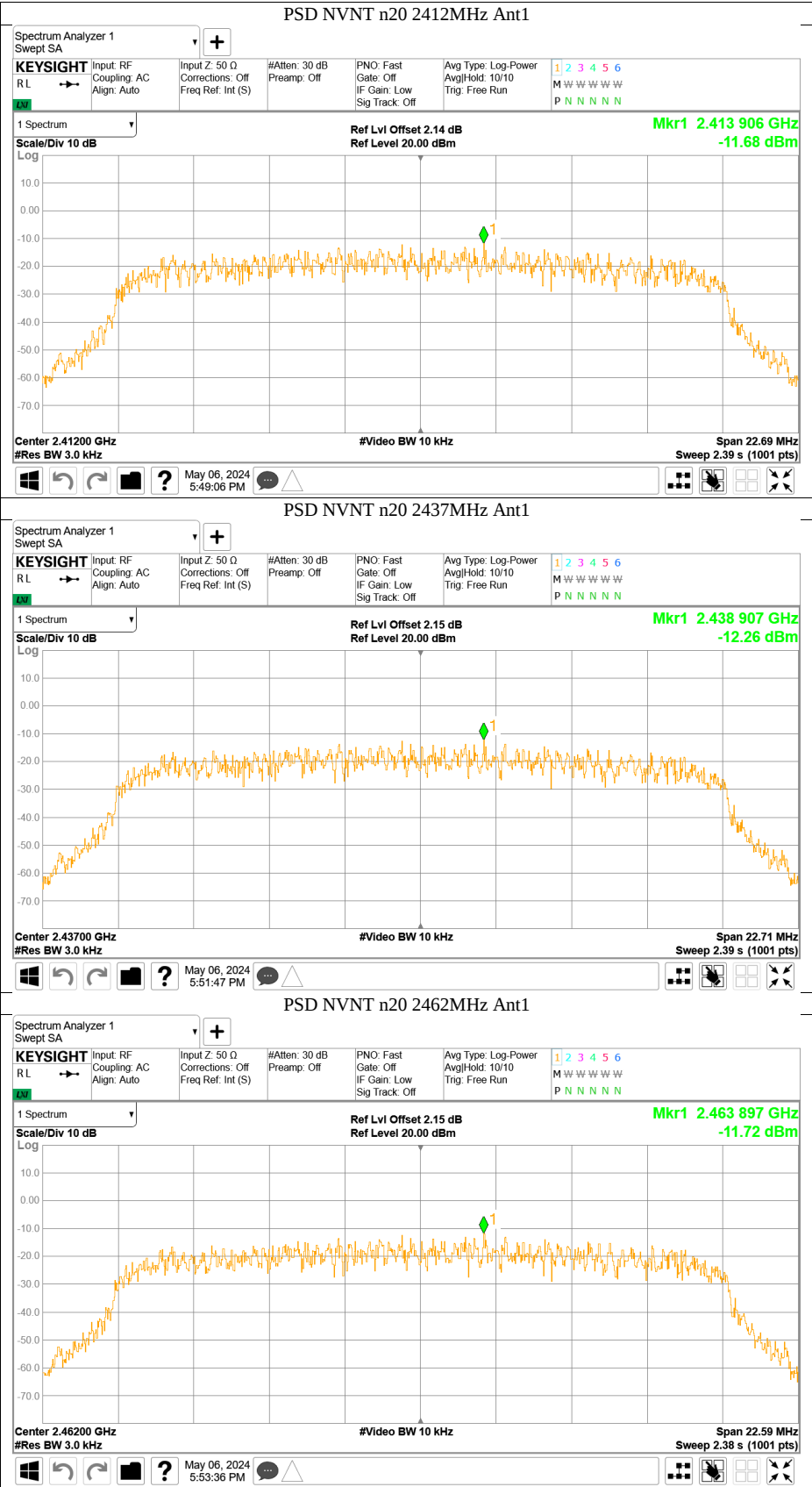
Frequency MHz	Power spectral density dBm/3kHz	Result
Low channel 2412MHz	-11.68	Pass
Middle channel 2437MHz	-12.26	Pass
High channel 2462MHz	-11.72	Pass



Power spectral density







10.5 Spurious RF conducted emissions

Test Method

1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz, VBW $\geq$ 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
5. The level displayed must comply with the limit specified in this Section. Submit these plots.
6. Repeat above procedures until all frequencies measured were complete.

Limit

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



Spurious RF conducted emissions

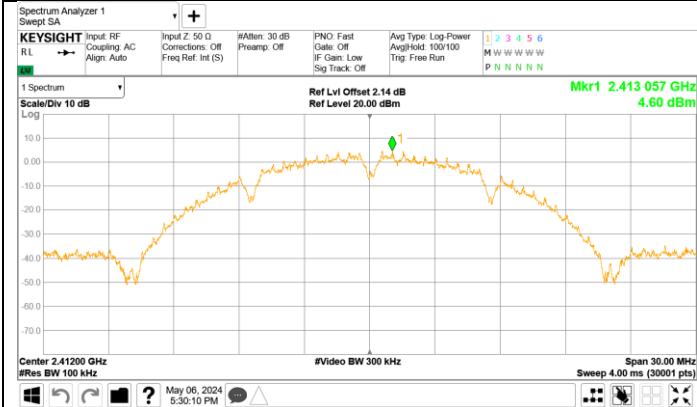
802.11 B

Out-of-Band Emissions

Channel 1 (2412MHz)

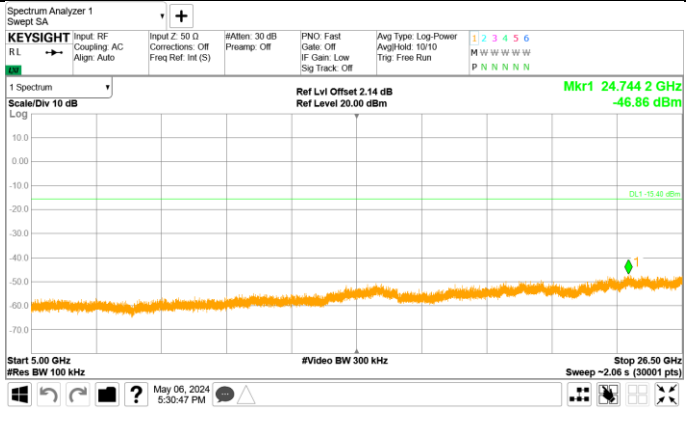
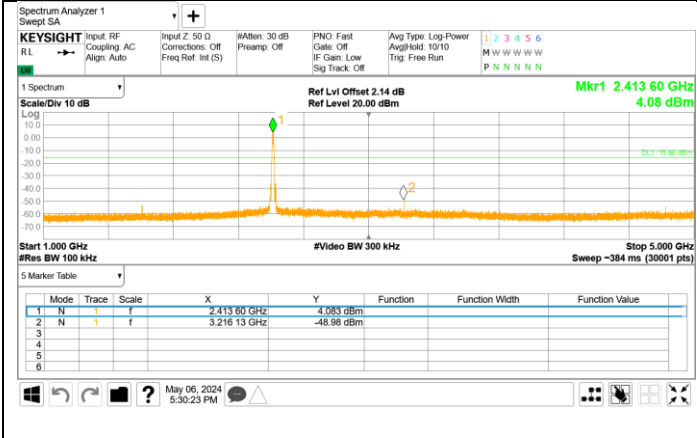
Reference point

Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)

Spurious Emission (5GHz –26.5GHz)

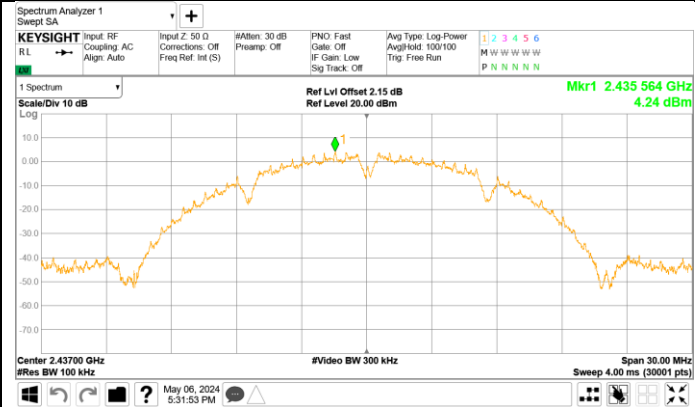




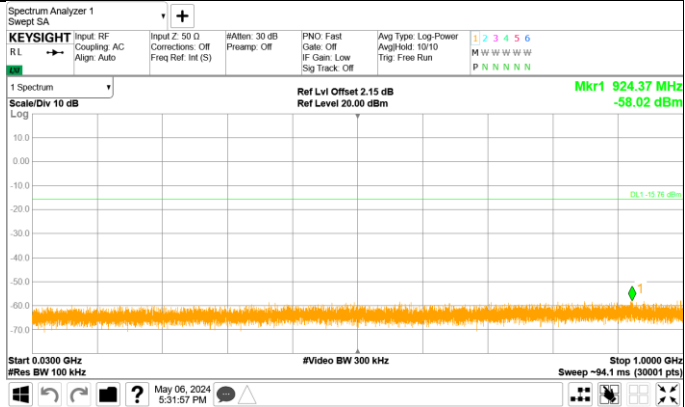
Out-of-Band Emissions

Channel 6 (2437MHz)

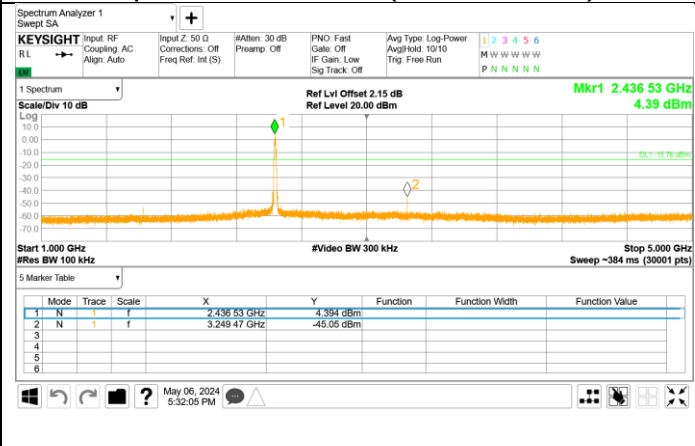
Reference point



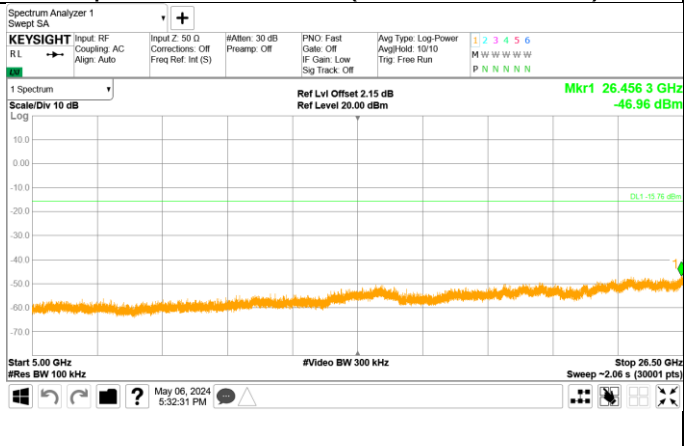
Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)



Spurious Emission (5GHz –26.5GHz)

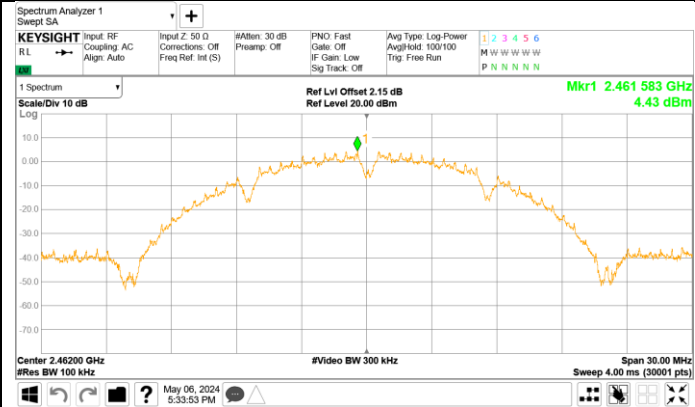




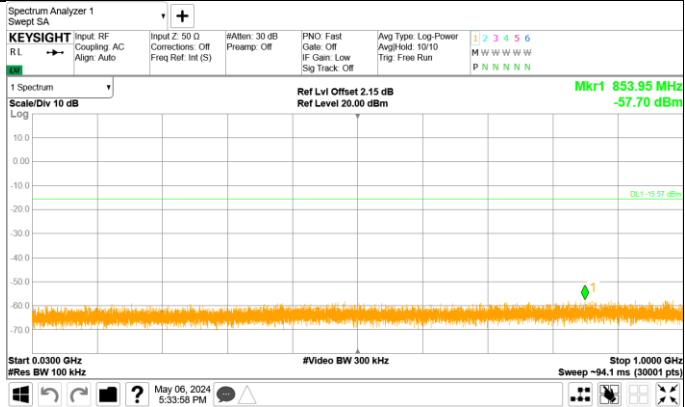
Out-of-Band Emissions

Channel 11 (2462MHz)

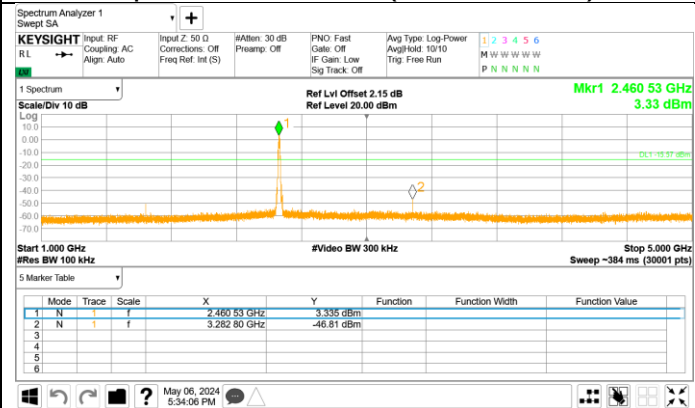
Reference point



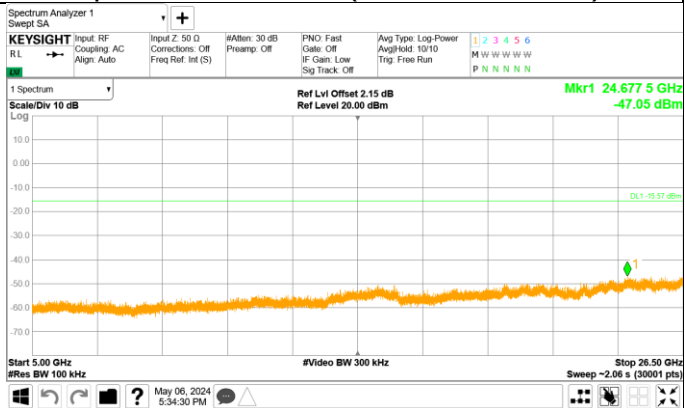
Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)



Spurious Emission (5GHz –26.5GHz)





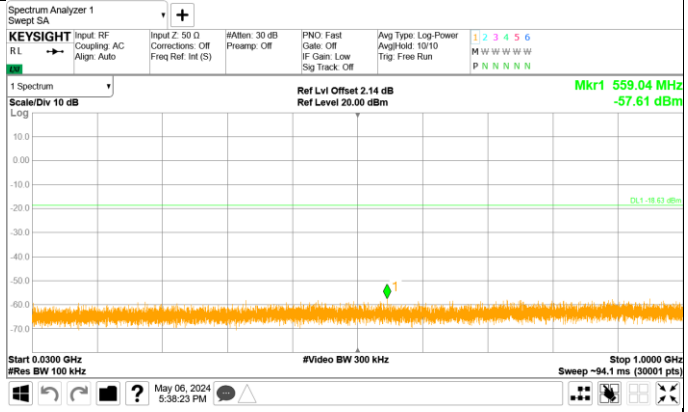
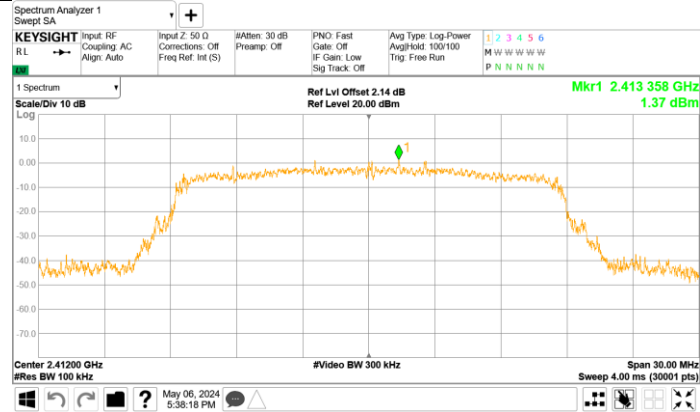
802.11 G

Out-of-Band Emissions

Channel 1 (2412MHz)

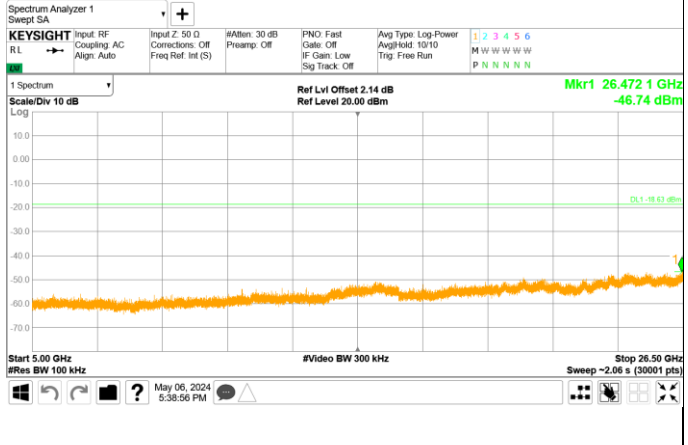
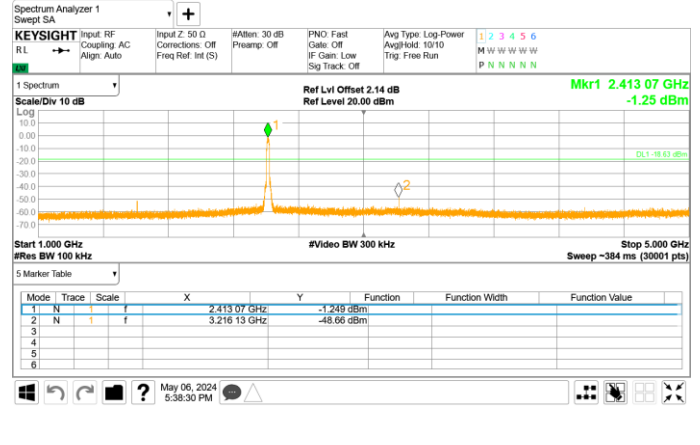
Reference point

Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)

Spurious Emission (5GHz –26.5GHz)

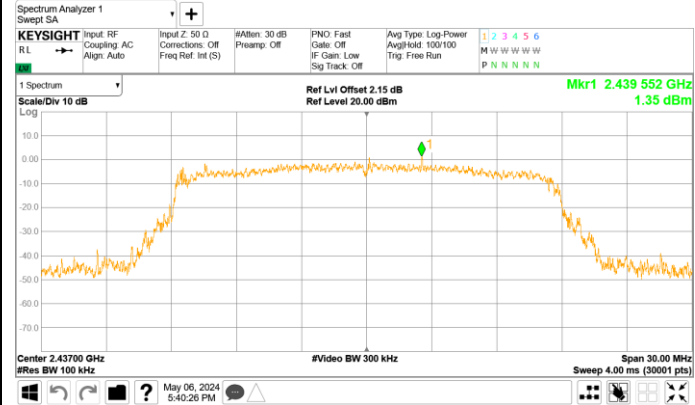




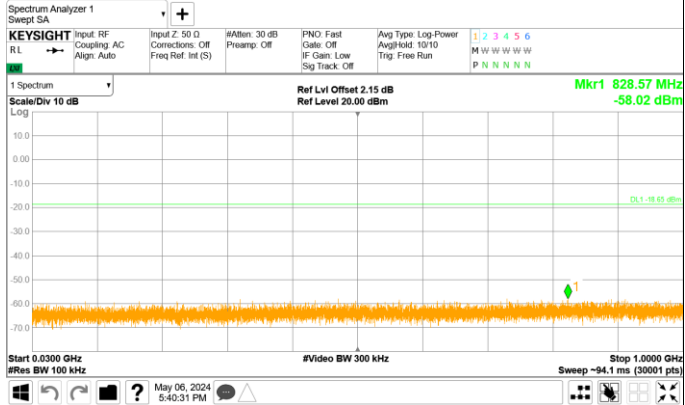
Out-of-Band Emissions

Channel 6 (2437MHz)

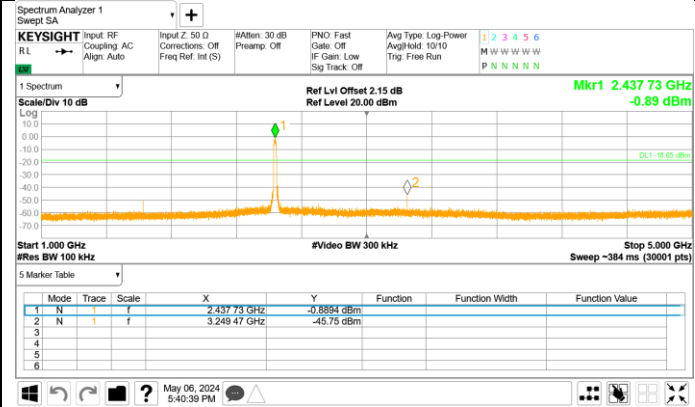
Reference point



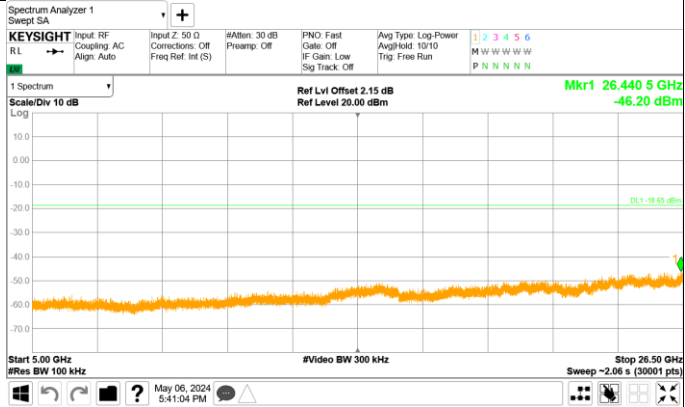
Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)



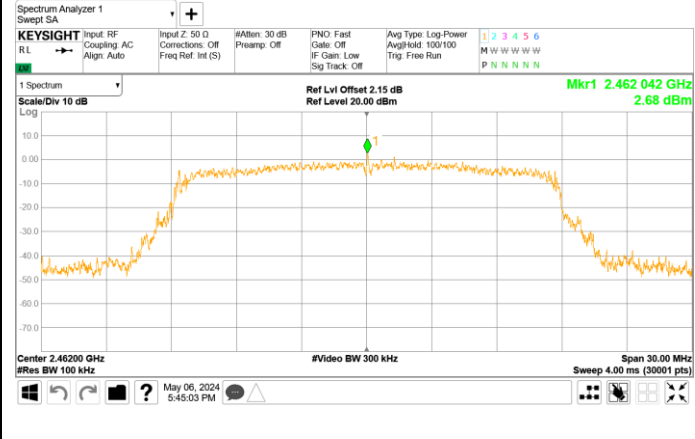
Spurious Emission (5GHz –26.5GHz)



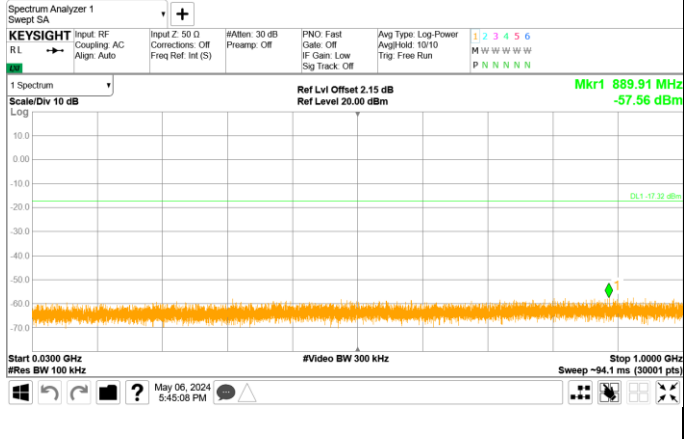


Out-of-Band Emissions
Channel 11 (2462MHz)

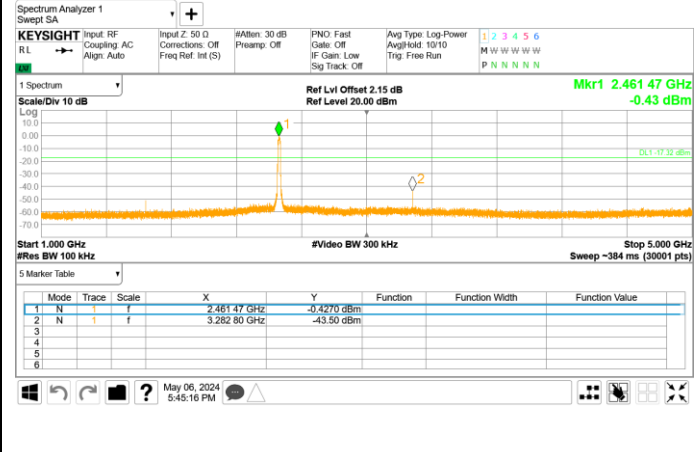
Reference point



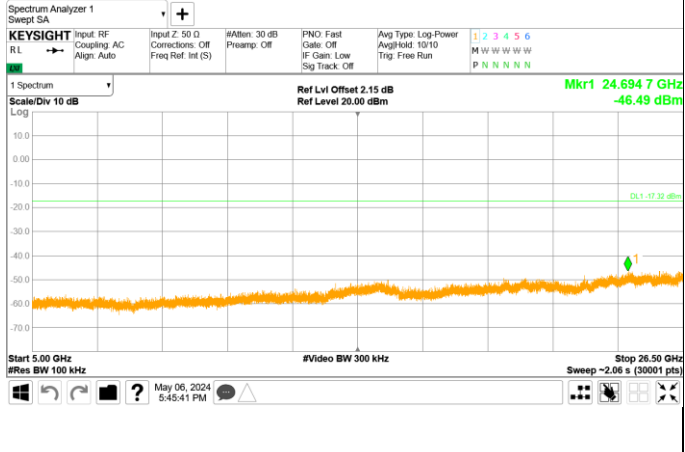
Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)



Spurious Emission (5GHz –26.5GHz)





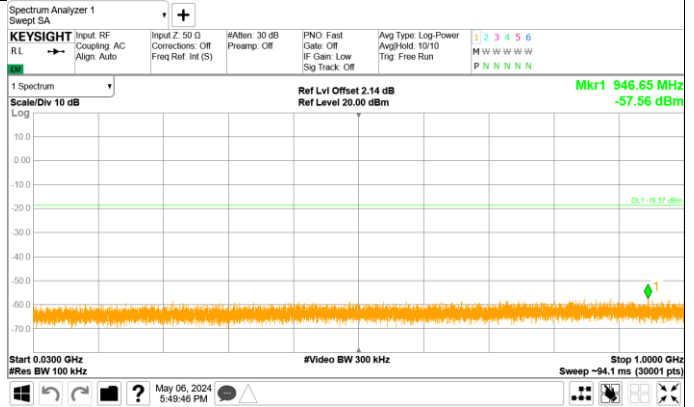
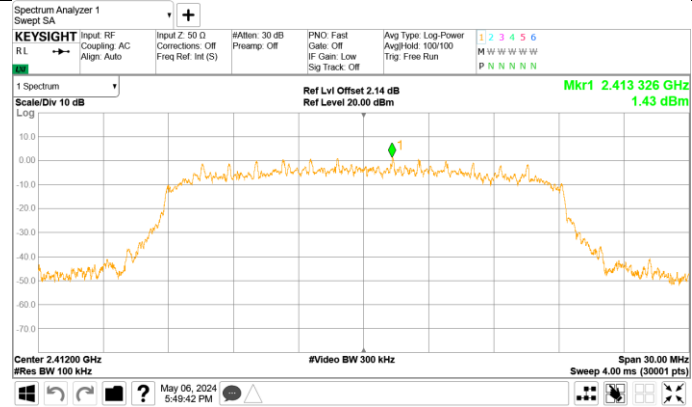
802.11 N HT20

Out-of-Band Emissions

Channel 1 (2412MHz)

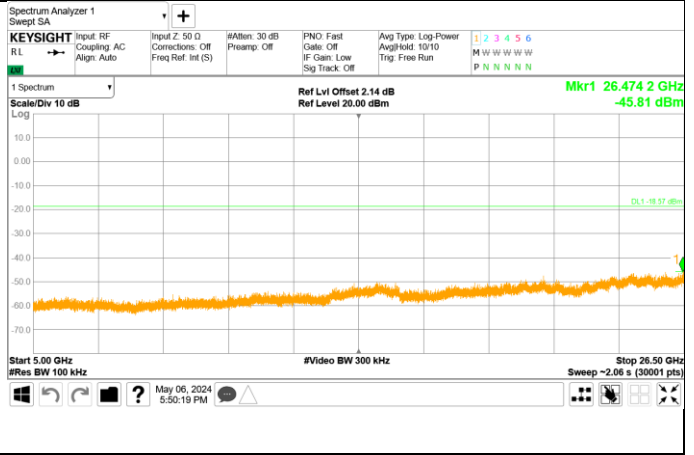
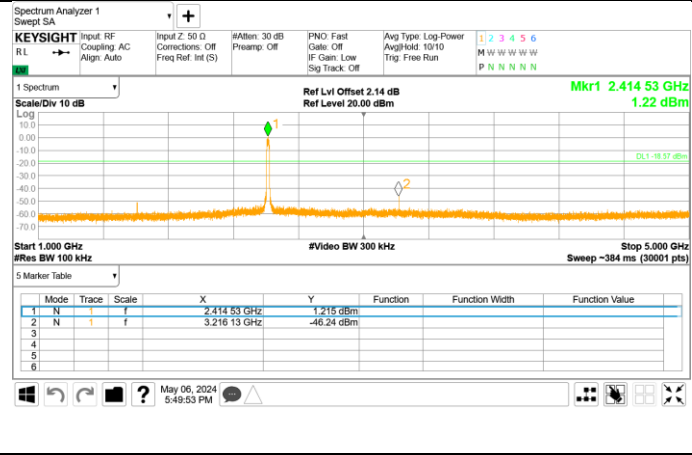
Reference point

Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)

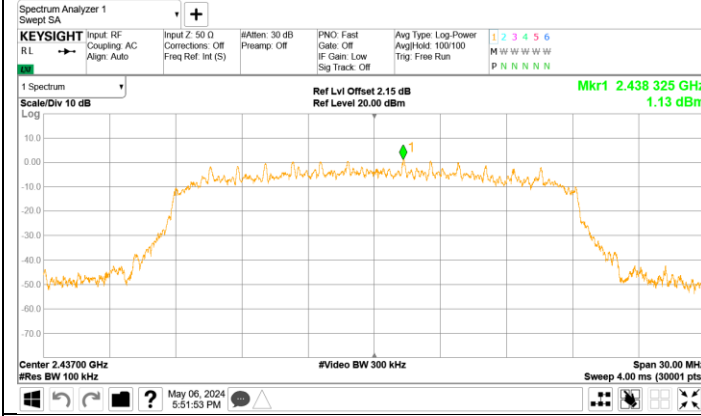
Spurious Emission (5GHz –26.5GHz)



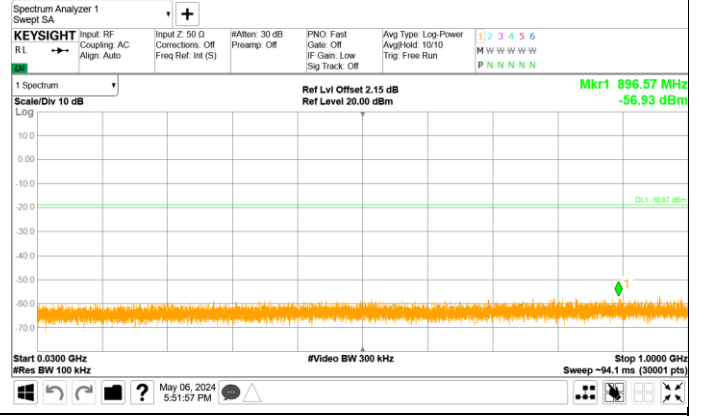


Out-of-Band Emissions
Channel 6 (2437MHz)

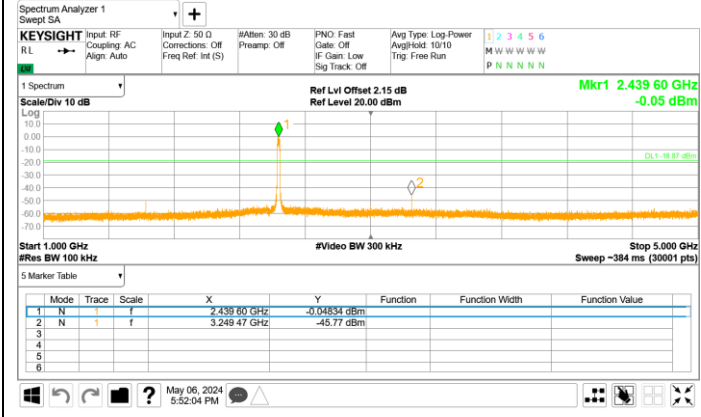
Reference point



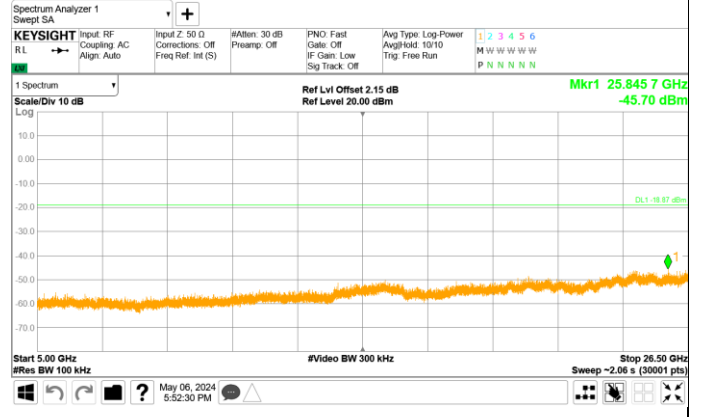
Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)

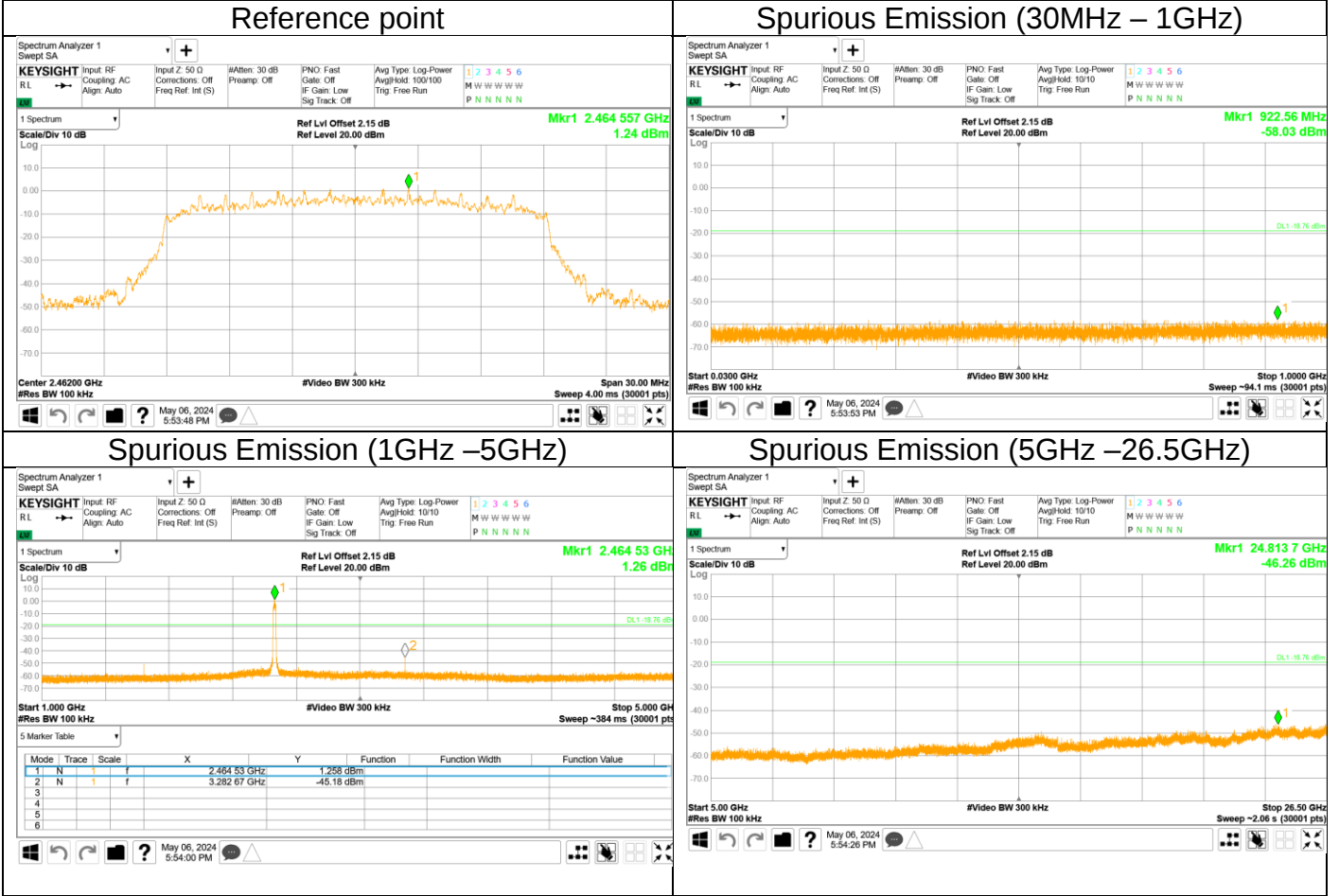


Spurious Emission (5GHz –26.5GHz)





Out-of-Band Emissions
Channel 11 (2462MHz)



10.6 Band edge

Test Method

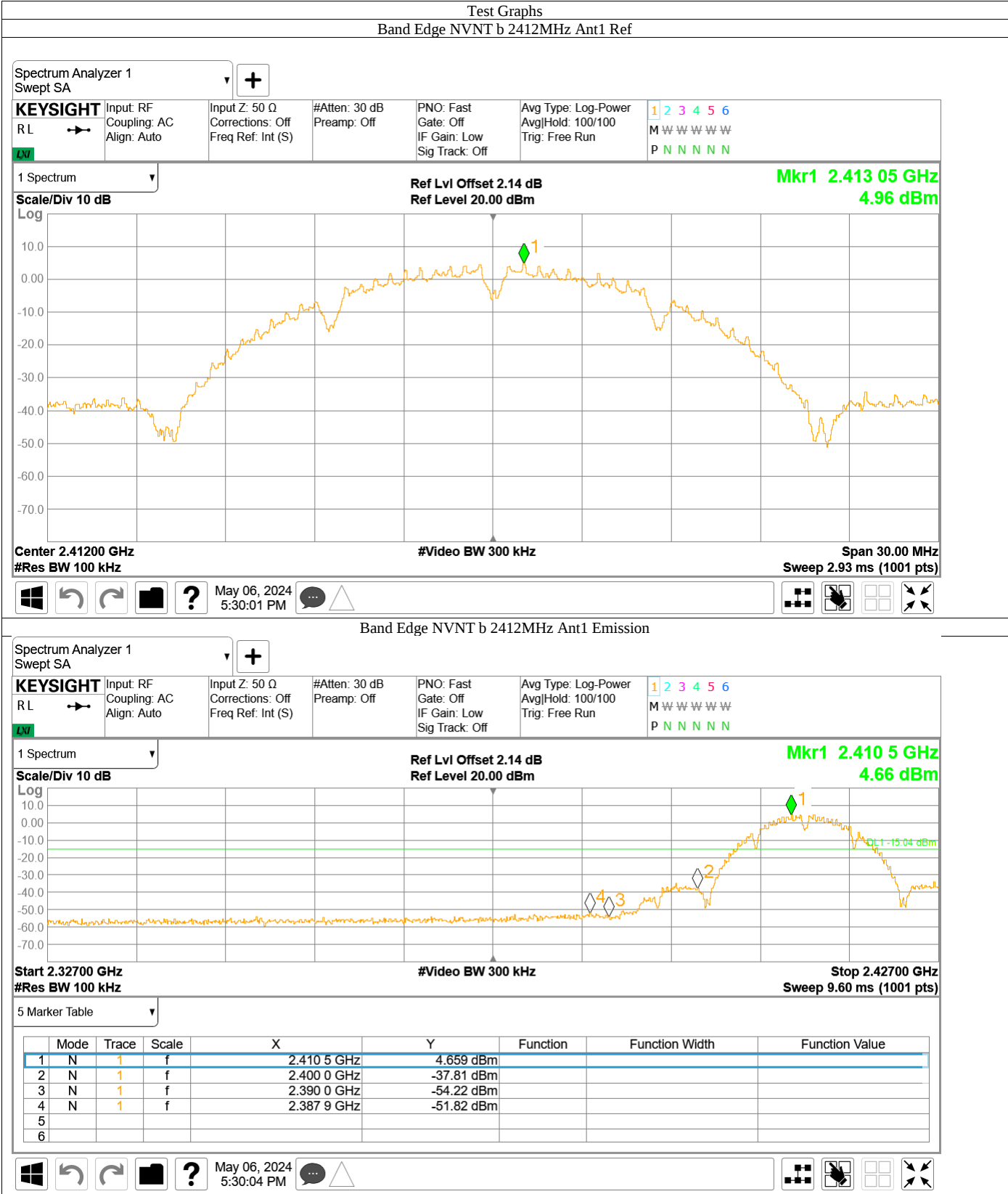
1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. 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 $\geq$ 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize, use the peak and delta measurement to record the result.
5. The level displayed must comply with the limit specified in this Section.
6. Repeat above procedures until all frequencies measured were complete and submit all the plots.

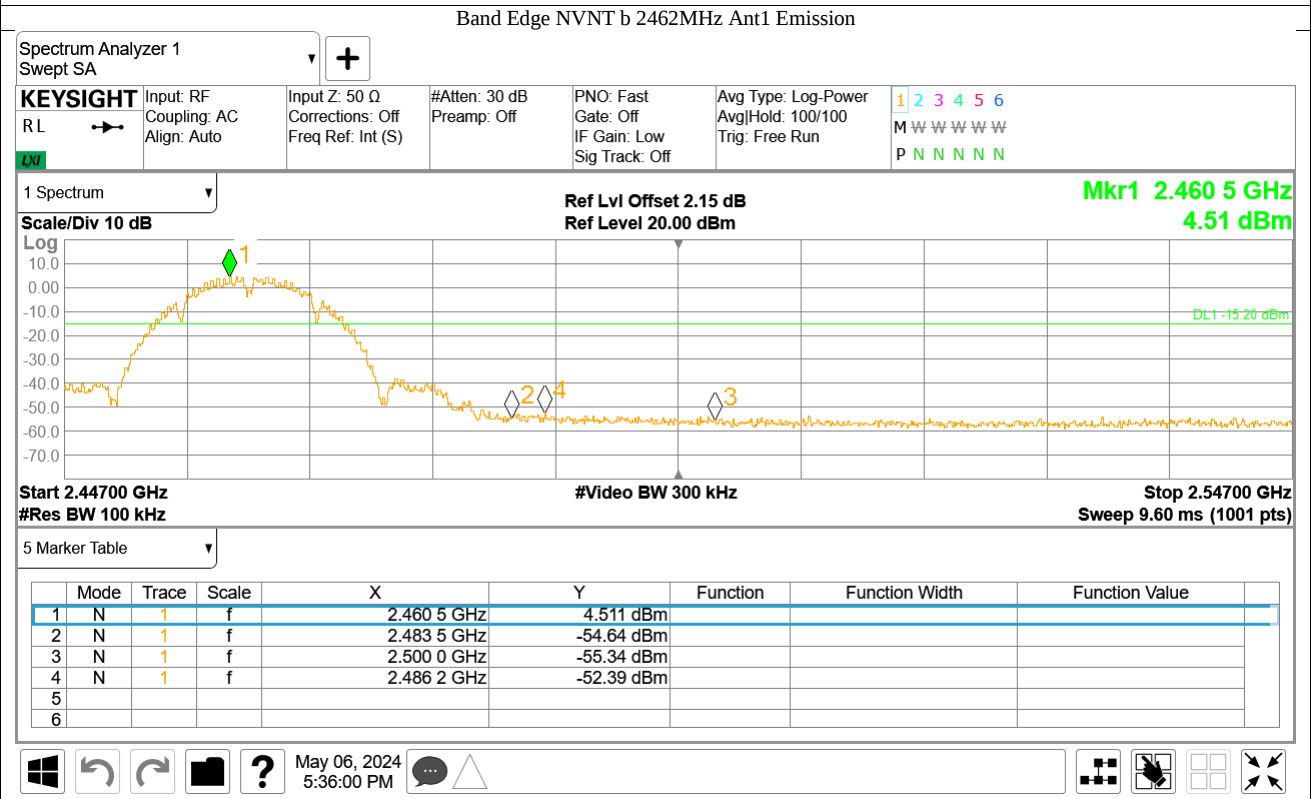
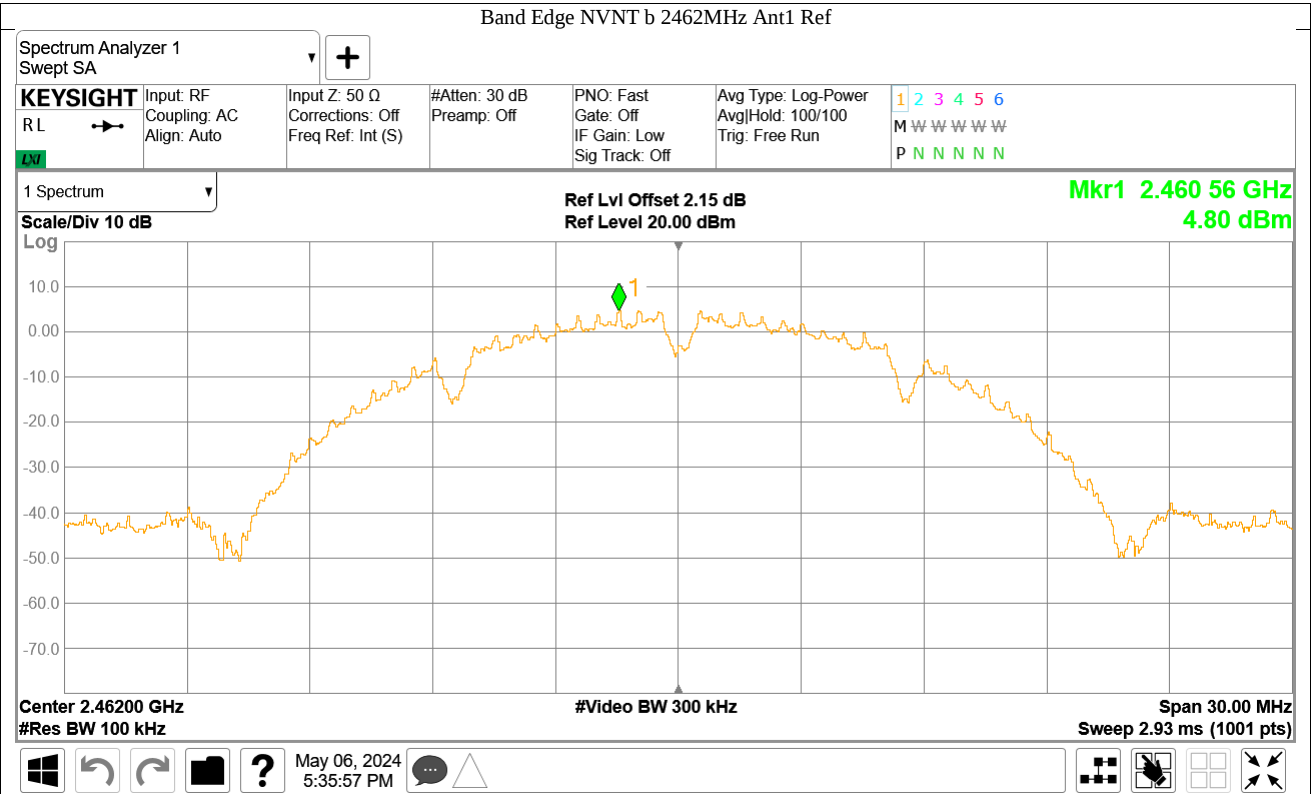
Limit

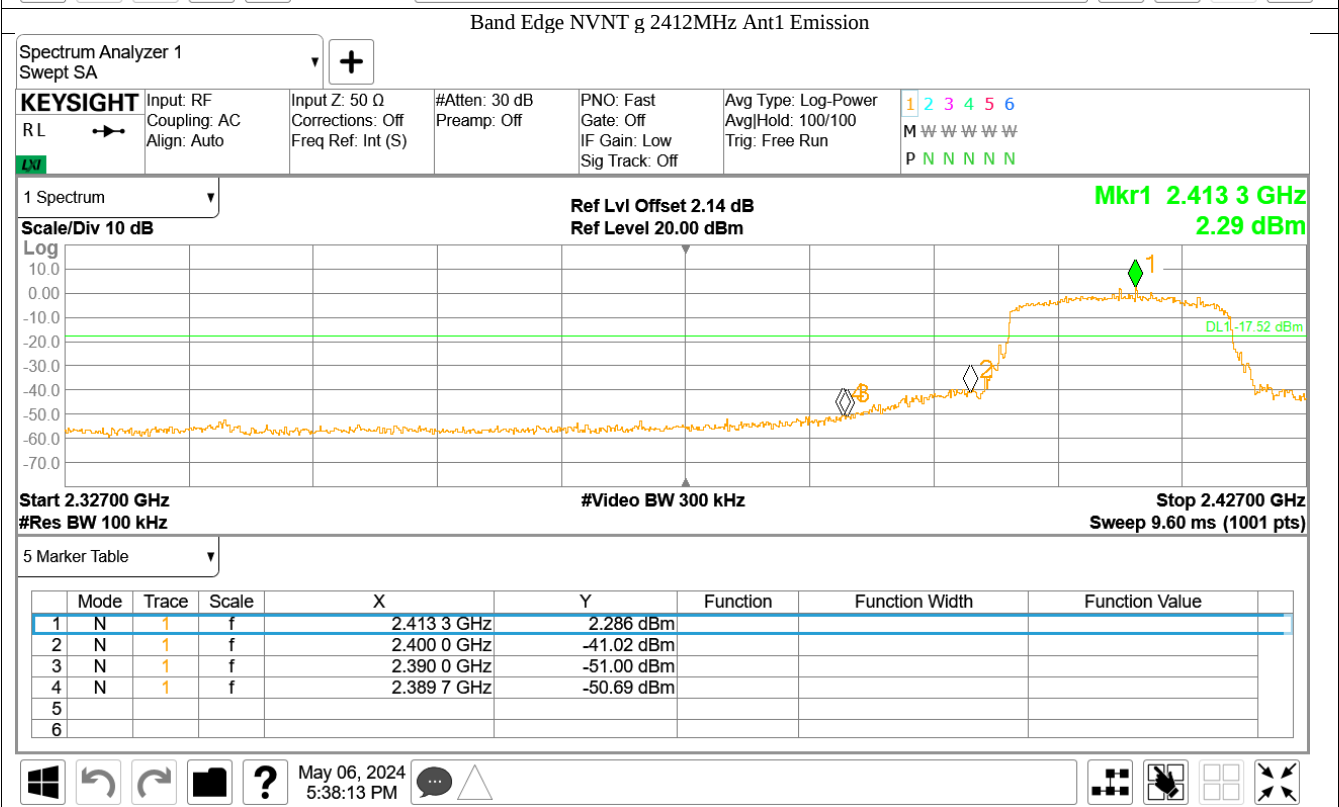
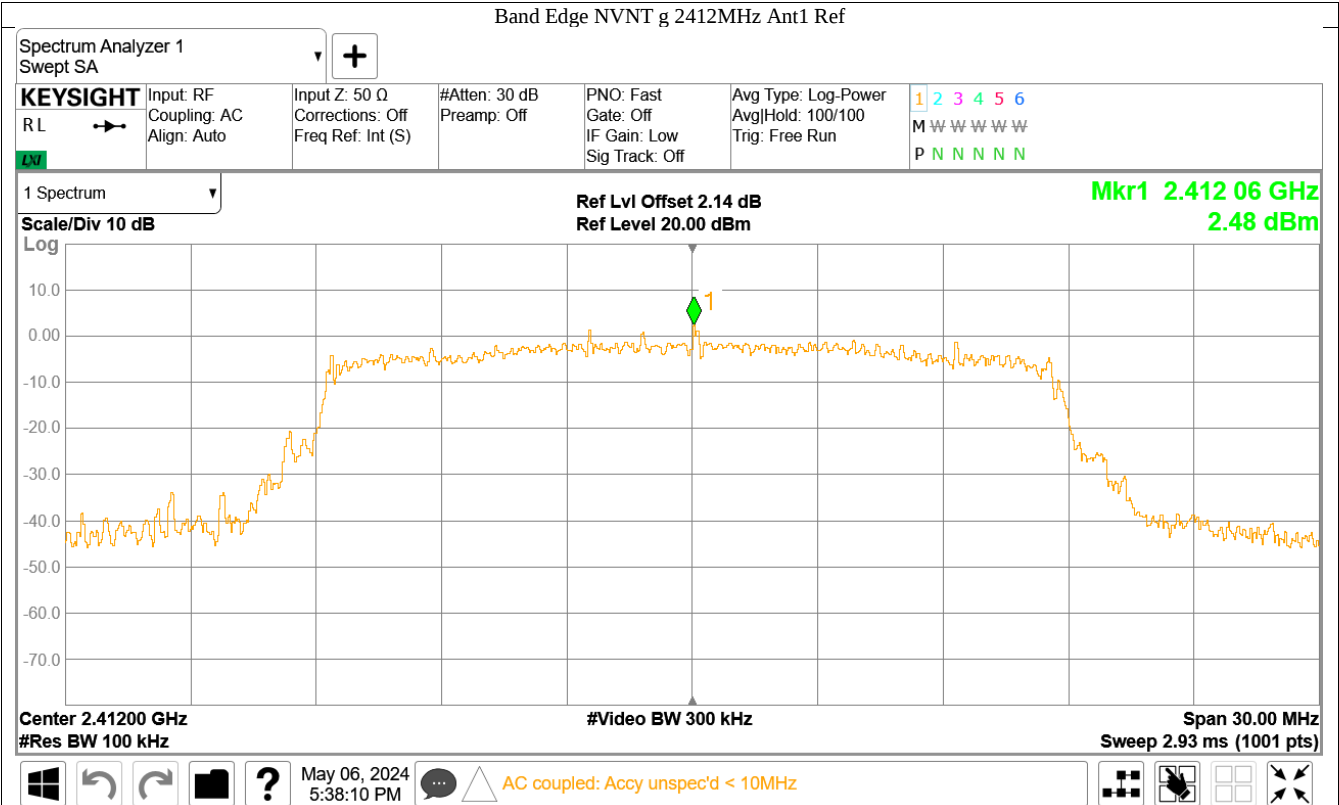
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under § 15.247(b)(3), the attenuation required shall be 30 dB instead of 20 dB.

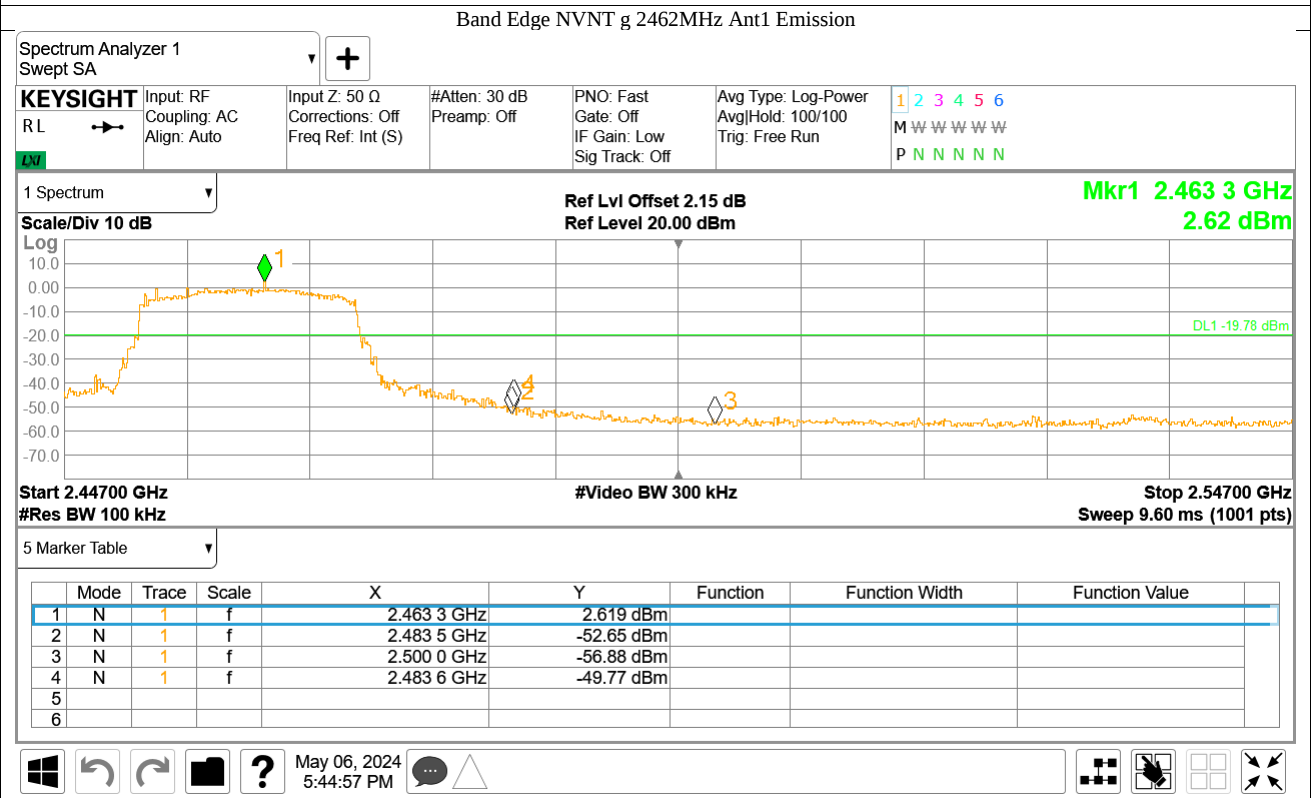
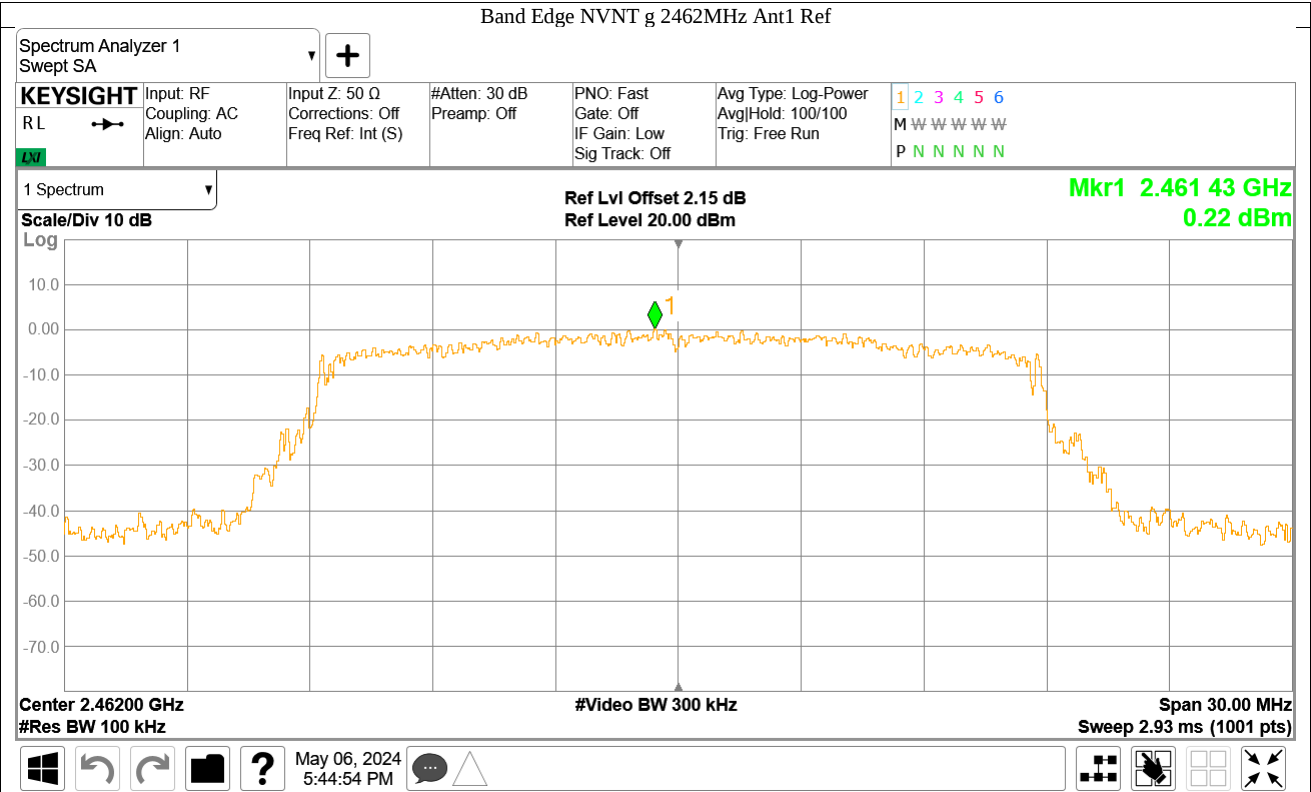


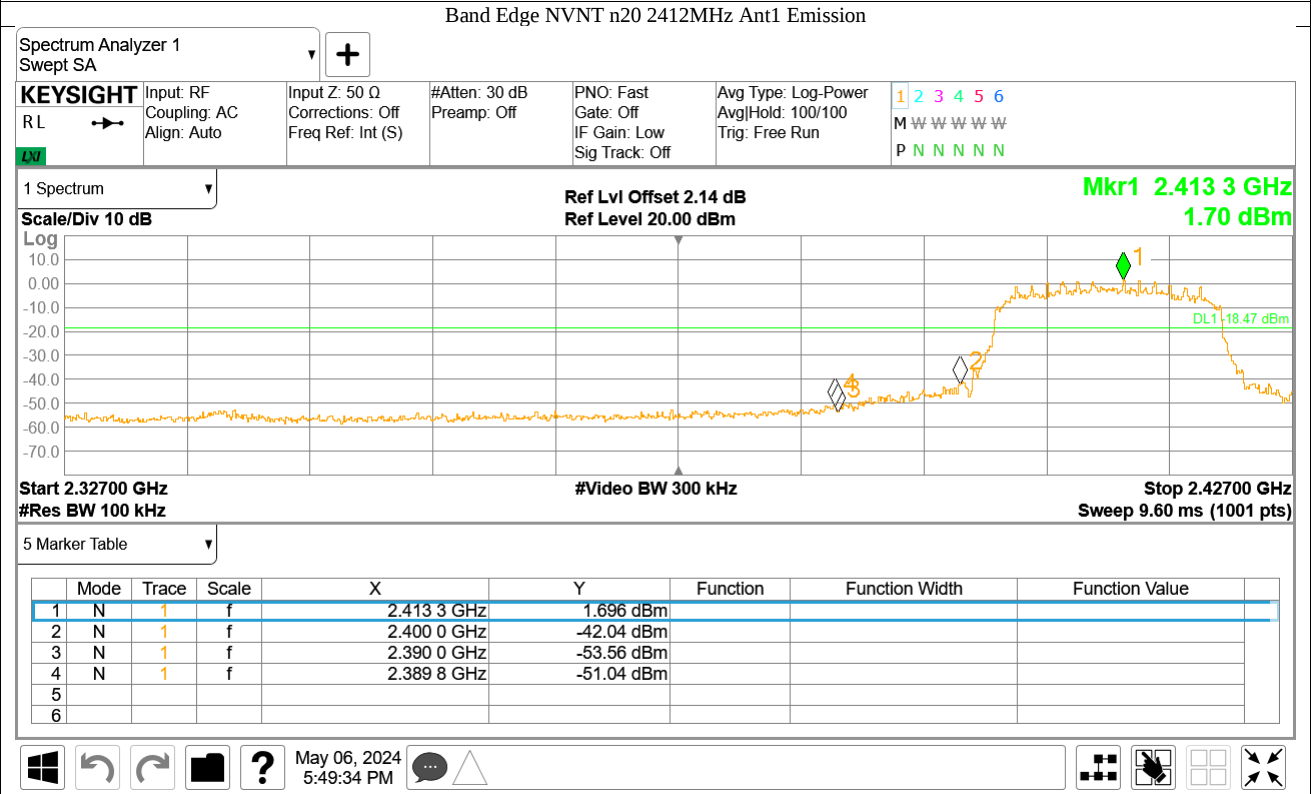
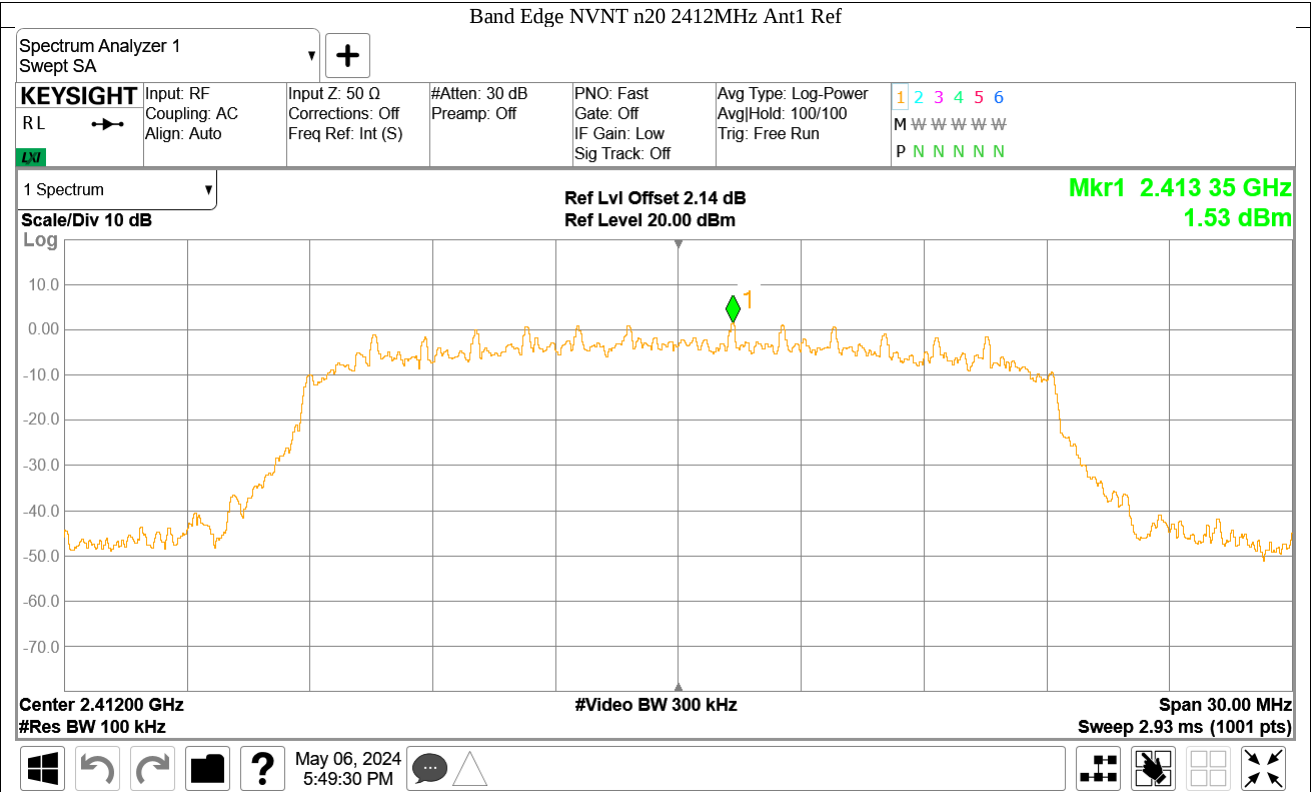
Test result

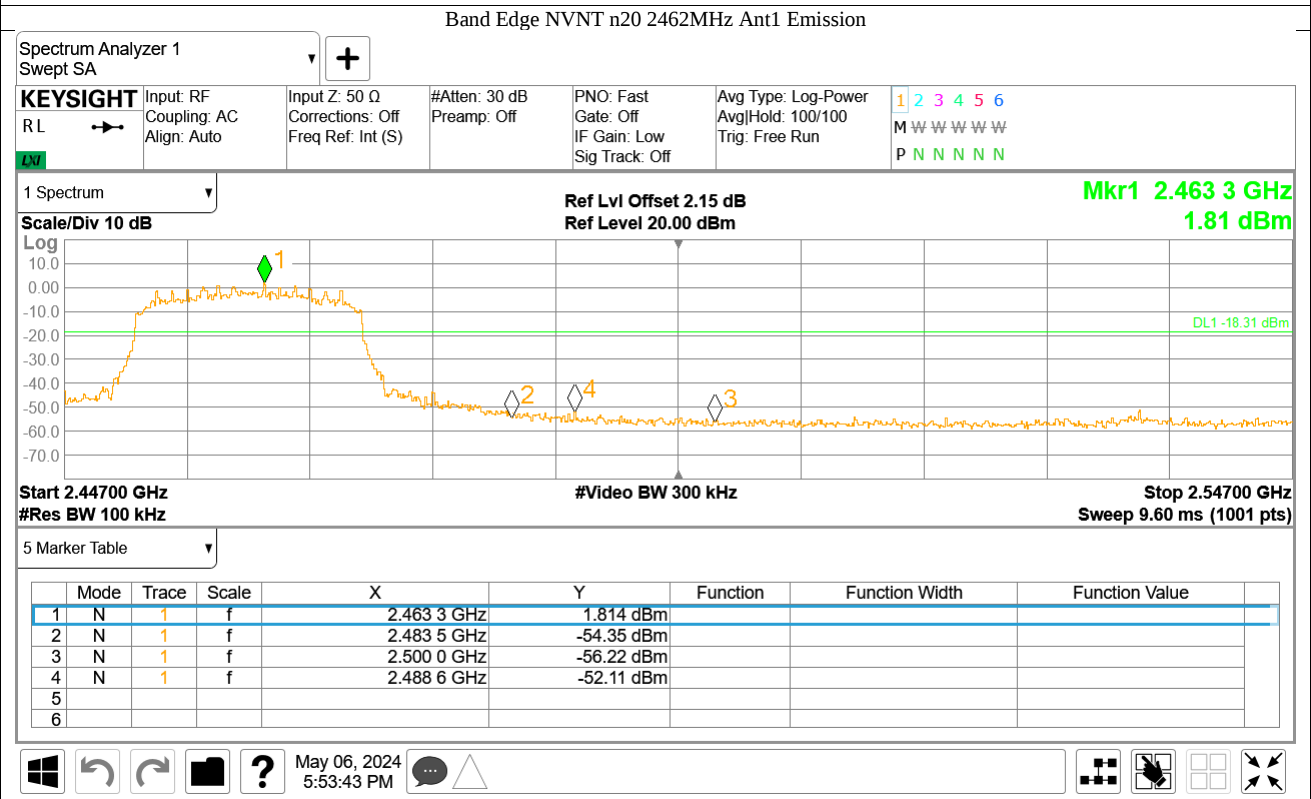
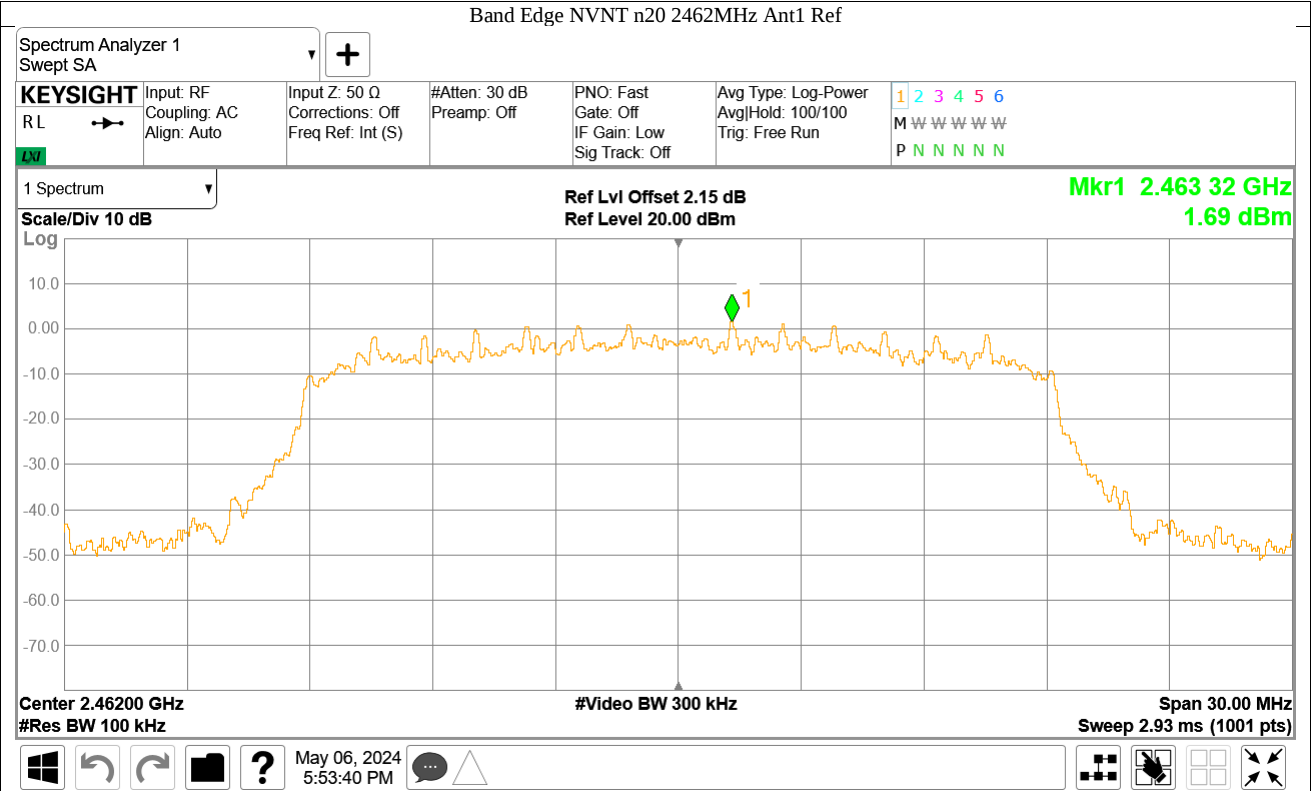












10.7 Spurious radiated emissions for transmitter

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 3 meter 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
 - 1) Procedure for Unwanted Emissions Measurements Below 1000 MHz
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz to 120kHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.
 - 2) For Peak unwanted emissions Above 1GHz:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 1MHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.
Procedures for average unwanted emissions measurements above 1GHz
 - a) RBW = 1MHz.
 - b) $VBW \setminus [3 \times RBW]$.
 - c) Detector = RMS (power averaging), if $[span / (\# \text{ of points in sweep})] \setminus RBW / 2$.
Satisfying this condition can require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, then the detector mode shall be set to peak.
 - d) Averaging type = power (i.e., rms) (As an alternative, the detector and averaging type may be set for linear voltage averaging. Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.)
 - e) Sweep time = auto.
 - f) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, then the number of traces shall be increased by a factor of $1 / D$, where D is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—then rather than turning ON and OFF with the transmit cycle, at least 100 traces shall be averaged.)
 - g) If tests are performed with the EUT transmitting at a duty cycle less than 98%, then a correction factor shall be added to the measurement results prior to comparing with the emission limit, to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
 - 1) If power averaging (rms) mode was used in the preceding step e), then the correction factor is $[10 \log (1 / D)]$, where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 3 dB shall be added to the measured emission levels.

2) If linear voltage averaging mode was used in the preceding step e), then the correction factor is $[20 \log (1 / D)]$, where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 6 dB shall be added to the measured emission levels.

3) If a specific emission is demonstrated to be continuous (100% duty cycle) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission (AV) at frequency above 1GHz.

Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under § 15.247(b)(3), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength 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).

Frequency MHz	Field Strength $\mu\text{V/m}$	Field Strength $\text{dB}\mu\text{V/m}$	Detector	Measurement distance meters
0.009-0.490	2400/F(kHz)	48.5-13.8	AV	300
0.490-1.705	24000/F(kHz)	33.8-23.0	QP	30
1.705-30	30	29.5	QP	30
30-88	100	40	QP	3
88-216	150	43.5	QP	3
216-960	200	46	QP	3
960-1000	500	54	QP	3
Above 1000	500	54	AV	3
Above 1000	5000	74	PK	3

Note 1: Limit $3\text{m}(\text{dB}\mu\text{V/m}) = \text{Limit } 300\text{m}(\text{dB}\mu\text{V/m}) + 40\text{Log}(300\text{m}/3\text{m})$ (Below 30MHz)

Note 2: Limit $3\text{m}(\text{dB}\mu\text{V/m}) = \text{Limit } 30\text{m}(\text{dB}\mu\text{V/m}) + 40\text{Log}(30\text{m}/3\text{m})$ (Below 30MHz)

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.

Data of measurement within frequency range 9kHz-30MHz is the noise floor or attenuated more than 20dB below the permissible limits or the field strength is too small to be measured, so test data does not present in this report.

Pre-scan with three orthogonal axis and worst case as X axis listed below table

Test mode:802.11B (2412MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M	Margin (dB)	Detector	Polarization
2385.94	47.08	74.00	26.92	PK	Hoizrnotal
4826.00	41.06	74.00	32.94	PK	Hoizrnotal
2384.07	46.44	74.00	27.56	PK	Vertical
4822.34	40.36	74.00	33.64	PK	Vertical

Test mode:802.11B (2437MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M	Margin (dB)	Detector	Polarization
4876.00	40.75	74.00	33.25	PK	Hoizrnotal
4873.34	41.42	74.00	32.58	PK	Vertical

Test mode:802.11B (2462MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M	Margin (dB)	Detector	Polarization
2483.76	47.32	74.00	26.68	PK	Hoizrnotal
4924.43	40.21	74.00	33.79	PK	Hoizrnotal
2483.51	45.47	74.00	28.53	PK	Vertical
4922.21	40.86	74.00	33.14	PK	Vertical

Test mode:802.11g (2412MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M	Margin (dB)	Detector	Polarization
2389.92	57.93	74.00	16.07	PK	Hoirznotal
2389.92	46.81	54.00	7.19	AV	Hoirznotal
4823.40	40.63	74.00	33.37	PK	Hoirznotal
2389.96	54.20	74.00	19.80	PK	Vertical
2389.96	44.28	54.00	9.72	AV	Vertical
4827.65	39.99	74.00	34.01	PK	Vertical

Test mode:802.11g (2437MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M	Margin (dB)	Detector	Polarization
4874.93	40.31	74.00	33.69	PK	Hoirznotal
4872.81	40.83	74.00	33.17	PK	Vertical

Test mode:802.11g (2462MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M	Margin (dB)	Detector	Polarization
2483.56	56.05	74.00	17.95	PK	Hoirznotal
2483.56	44.70	54.00	9.30	AV	Hoirznotal
4923.28	40.46	74.00	33.54	PK	Hoirznotal
2483.94	51.08	74.00	22.92	PK	Vertical
4924.34	51.95	74.00	22.05	PK	Vertical

Test mode:802.11n20 (2412MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2389.74	51.65	74.00	22.35	PK	Hoirznotal
4822.87	40.03	74.00	33.97	PK	Hoirznotal
2389.86	52.43	74.00	21.57	PK	Vertical
2389.86	42.11	54.00	11.89	AV	Vertical
4823.93	40.52	74.00	33.48	PK	Vertical

Test mode:802.11n20 (2437MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
4874.93	40.04	74.00	33.96	PK	Hoirznotal
4875.46	39.77	74.00	34.23	PK	Vertical

Test mode:802.11n20 (2462MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2483.54	53.12	74.00	20.88	PK	Hoirznotal
2483.54	43.00	54.00	11.00	AV	Hoirznotal
4924.34	40.62	74.00	33.38	PK	Hoirznotal
2483.57	49.68	74.00	24.32	PK	Vertical
4921.68	40.67	74.00	33.33	PK	Vertical

Remark:

- (1) Emission level= Original Receiver Reading + Correct Factor
- (2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
- (3) Margin = limit – Corrected Reading



The worst case of Radiated Emission below 1GHz: X axis transmitting TX at 2462MHz (802.11g)

30-1000MHz Radiated Emission

EUT Information

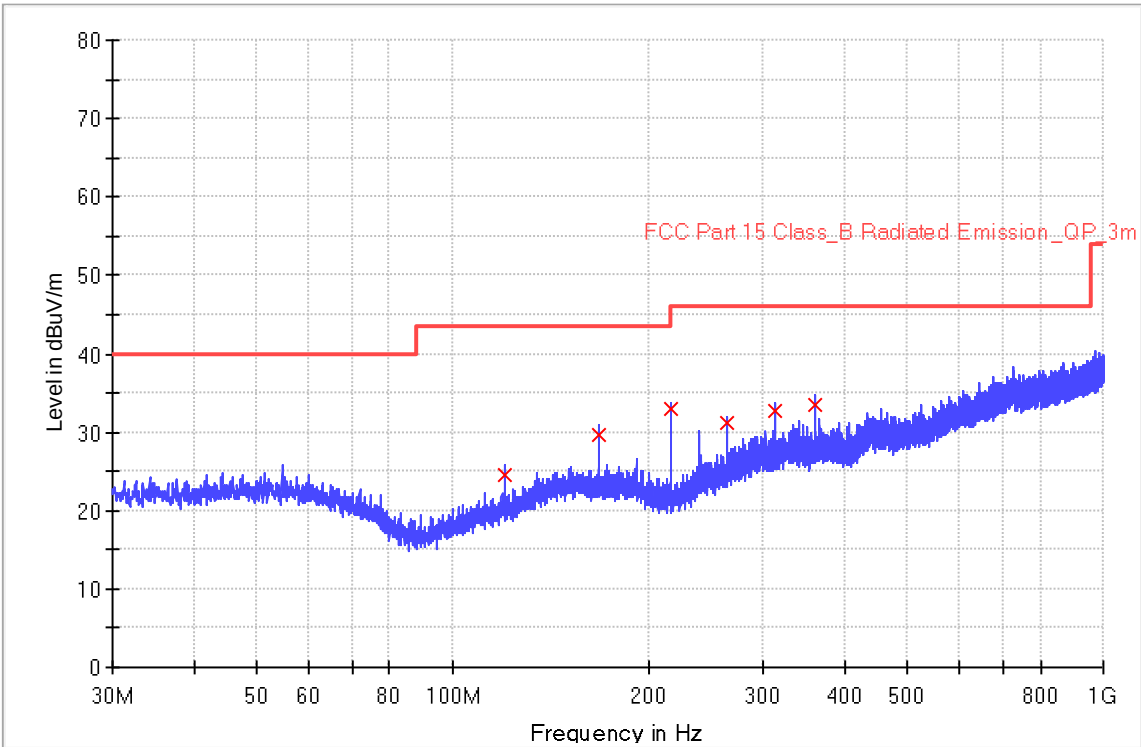
EUT Name: Wi-Fi and BLE Module
Model: T1-2S-NL
Client: Hangzhou Tuya Information Technology Co., Ltd
Op Cond: Power on, TX_2462MHz at g Mode, DC 3.3V
Operator: Huali CHENG
Test Spec: FCC Part 15.209(a)
Comment: Horizontal
Sample No: SHA-810228-1

Sweep Setup: RE_VULB9168_pre_Cont_30-1000 [EMI radiated]

Hardware Setup: RE_VULB9168
Receiver: [ESR 3]
Level Unit: dBuV/m

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	48.5 kHz	PK+	120 kHz	0.2 s	20 dB

RE_VULB9168_pre_Cont_30-1000





Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
119.960000	24.6	1000.0	120.000	142.0	H	119.0	18.1	18.9	43.5
168.000000	29.7	1000.0	120.000	132.0	H	325.0	20.4	13.8	43.5
216.000000	33.0	1000.0	120.000	169.0	H	269.0	17.5	13.0	46.0
263.960000	31.1	1000.0	120.000	115.0	H	85.0	20.1	14.9	46.0
311.960000	32.7	1000.0	120.000	185.0	H	26.0	21.9	13.3	46.0
360.000000	33.6	1000.0	120.000	152.0	H	15.0	23.0	12.4	46.0

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

30-1000MHz Radiated Emission

EUT Information

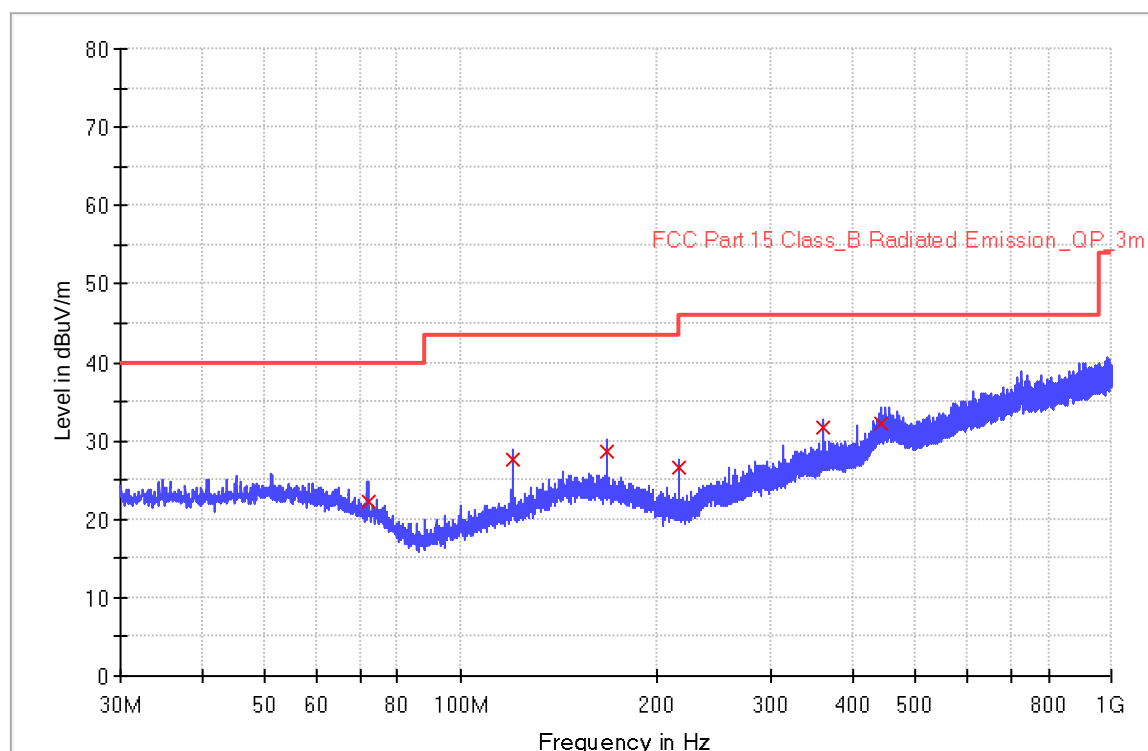
EUT Name: Wi-Fi and BLE Module
Model: T1-2S-NL
Client: Hangzhou Tuya Information Technology Co., Ltd
Op Cond: Power on, TX_2462 at g Mode, DC 3.3V
Operator: Huali CHENG
Test Spec: FCC Part 15.209(a)
Comment: Vertical
Sample No: SHA-810228-1

Sweep Setup: RE_VULB9168_pre_Cont_30-1000 [EMI radiated]

Hardware Setup: RE_VULB9168
Receiver: [ESR 3]
Level Unit: dBuV/m

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	48.5 kHz	PK+	120 kHz	0.2 s	20 dB

RE_VULB9168_pre_Cont_30-1000



Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
71.960000	22.2	1000.0	120.000	100.0	V	225.0	18.2	17.8	40.0
120.000000	27.5	1000.0	120.000	112.0	V	136.0	18.1	16.0	43.5
168.000000	28.7	1000.0	120.000	102.0	V	59.0	20.4	14.8	43.5
216.000000	26.6	1000.0	120.000	113.0	V	206.0	17.5	19.4	46.0
360.000000	31.6	1000.0	120.000	106.0	V	98.0	23.0	14.4	46.0
441.760000	32.1	1000.0	120.000	123.0	V	310.0	25.7	13.9	46.0

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 25GHz), therefore no data appear in the report.

11 Test Equipment List

List of Test Instruments
Test Site1

	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DATE	CAL. DUE DATE
C	Signal spectrum analyzer	Agilent	N9020B	MY59050168	2024-2-19	2025-2-18
	Wideband power sensor	Rohde & Schwarz	NRP-Z81	105903	2024-2-19	2025-2-18
	10dB Attenuator	Aeroflex Weinschel	CG-4689	93459	2024-2-19	2025-2-18
RE	EMI Test Receiver	Rohde & Schwarz	ESR3	101906	2023-8-1	2024-7-31
	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2023-8-1	2024-7-31
	Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9168	961	2021-9-23	2024-9-22
	Horn Antenna	Rohde & Schwarz	HF907	102393	2021-4-13	2024-4-12
	Pre-amplifier	Rohde & Schwarz	SCU-18D	19006451	2023-8-1	2024-7-31
	Loop antenna	Rohde & Schwarz	HFH2-Z2	100443	2023-6-15	2024-6-14
	DOUBLE-RIDGED WAVEGUIDE HORN WITH PRE-AMPLIFIER (18 GHZ - 40 GHZ)	ETS-Lindgren	3116C	00246076	2023-7-7	2026-7-6
	3m Semi-anechoic chamber	TDK	9X6X6	----	2021-5-8	2024-5-7
CE	EMI Test Receiver	Rohde & Schwarz	ESR3	101907	2023-8-1	2024-7-31
	LISN	Rohde & Schwarz	ENV216	101924	2023-8-1	2024-7-31

Measurement Software Information			
Test Item	Software	Manufacturer	Version
C	MTS 8310	MWRFTtest	3.0.0.0
	Power Viewer	Rohde & Schwarz	V 11.0
RE	EMC 32	Rohde & Schwarz	V10.50.40
CE	EMC 32	Rohde & Schwarz	V9.15.03

C - Conducted RF tests

- Conducted peak output power
- 6dB bandwidth and 99% Occupied Bandwidth
- Power spectral density
- Spurious RF conducted emissions
- Band edge

12 System Measurement Uncertainty

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

Items	Extended Uncertainty
Conducted Disturbance at Mains Terminals	150kHz to 30MHz, LISN, 3.16dB
Radiated Disturbance	30MHz to 1GHz, 5.03dB (Horizontal) 5.12dB (Vertical) 1GHz to 18GHz, 5.49dB 18GHz to 40GHz, 5.63dB
Carrier power conducted measurement	50MHz~18GHz, 1.238dB
Spurious Emission Conducted Measurement	9kHz ~40GHz, 1.224dB

Measurement Uncertainty Decision Rule:

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2021, clause 4.4.3 and 4.5.1.



13 Photographs of Test Set-ups

Refer to the < Test Setup photos >.



14 Photographs of EUT

Refer to the < External Photos > & < Internal Photos >.

-----End of Test Report-----