



Certificate No.: 3745.01



China

FCC - TEST REPORT

Report Number : **709502300844-00A** Date of Issue: Mar.15,2023

Model : TSW-T1, TSW-T2, TSW-T4, TSW-T****(* can be 0-9, A-Z or blank, only for different connection interface no impact on functions)

Product Type : Communication Stick

Applicant : Ningbo Lingzhu Technology CO., Ltd.

Address : No.578,Building 7,No.535 Kangqiao South Road,
Jiangbei District Ningbo City,Zhejiang Province China

Manufacturer : Ningbo Lingzhu Technology CO., Ltd.

Address : No.578,Building 7,No.535 Kangqiao South Road,
Jiangbei District Ningbo City,Zhejiang Province China

Test Result : **Positive** **Negative**

Total pages including Appendices : 56



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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. Shanghai Branch
No.16 Lane, 1951 Du Hui Road,
Shanghai 201108,
P.R. China

Test Firm FCC
Registration
Number: 820234

Designation
number: CN1183

IC Company
Number: 25988

CAB identifier: CN0101

Telephone: +86 21 6141 0123
Fax: +86 21 6140 8600



3 Description of the Equipment under Test

Product: Communication Stick

Model no.: TSW-T1, TSW-T2, TSW-T4, TSW-T****(* can be 0-9, A-Z or blank, only for different connection interface no impact on functions)

FCC ID: 2A789-TSW-T

Options and accessories: NA

Rating: 5.0V-12.0V DC

RF Transmission Frequency: For 802.11b/g/n(HT20): 2412~2462 MHz (Wi-Fi)
For 802.15.1:2402~2480 MHz

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

Report Number: **709502300844-00A**



China

Antenna Type: Stick antenna

Antenna Gain: 3.37dBi

Description of the EUT: The Equipment Under Test (EUT) is a Communication Stick which support 2.4GHz Wi-Fi and BLE 4.2(only support 1Mbps data rate). We tested it and listed the worst data in this report. All models have the same electrical construction, only for different is connection interface. We chose model TSW-T1 to perform all tests.

Test sample no.: SHA-709227-2

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, antenna gain or any information supplied.



4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators

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



5 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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247 (b) (1)	Conducted peak output power	18	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(a)(1)	20dB bandwidth	---	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
§15.247(a)(1)	Carrier frequency separation	---	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
§15.247(a)(1)(iii)	Number of hopping frequencies	---	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
§15.247(a)(1)(iii)	Dwell Time	---	---	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
§15.247(a)(2)	6dB bandwidth	19-22	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(e)	Power spectral density	23-26	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(d)	Spurious RF conducted emissions	27-36	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(d)	Band edge	37-43	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.247(d) & §15.209	Spurious radiated emissions for transmitter	44-52	Site 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
§15.203	Antenna requirement	See note 1		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Remark 1: N/A – Not Applicable.

Note 1: The EUT uses a stick antenna, which gain is 3.37dBi. In accordance 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: 2A789-TSW-T, complies with Section 15.207, 15.209, 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 709502300844-00B.

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: February 24, 2023

Testing Start Date: January 24, 2023

Testing End Date: March 14, 2023

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

Reviewed by:

Prepared by:

Tested by:

Hui Tong



Jiayi Xu

Cheng Huali

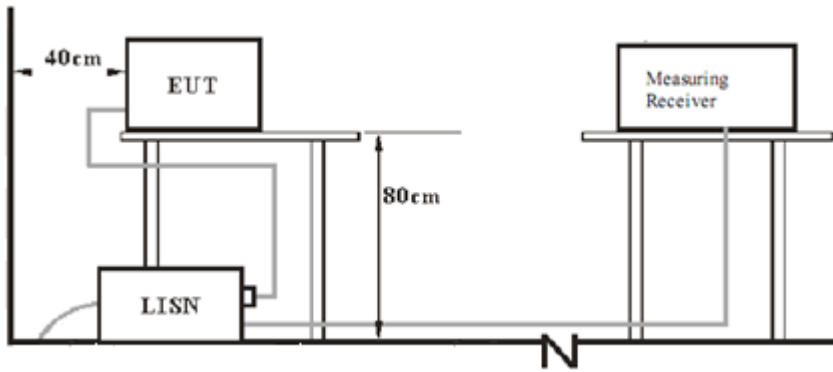
Hui TONG
Review Engineer

Jiayi XU
Project Engineer

Cheng Huali
Test Engineer

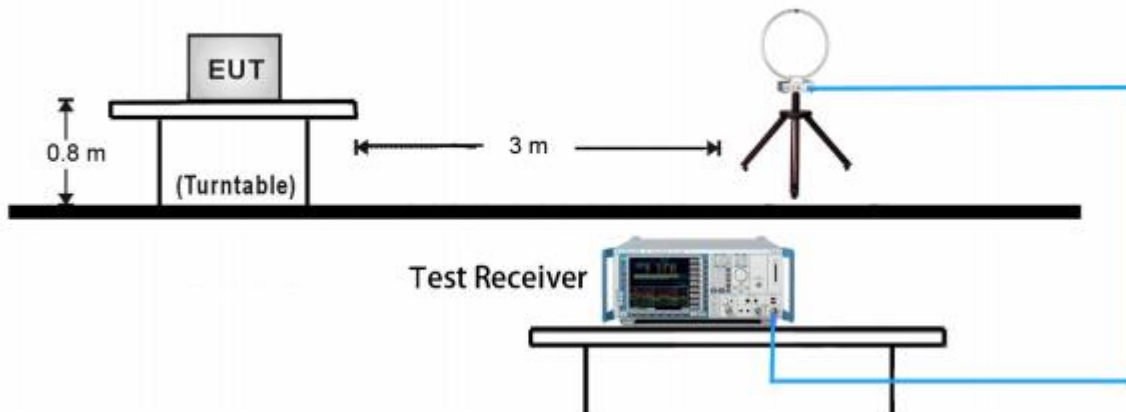
7 Test Setups

7.1 AC Power Line Conducted Emission test setups

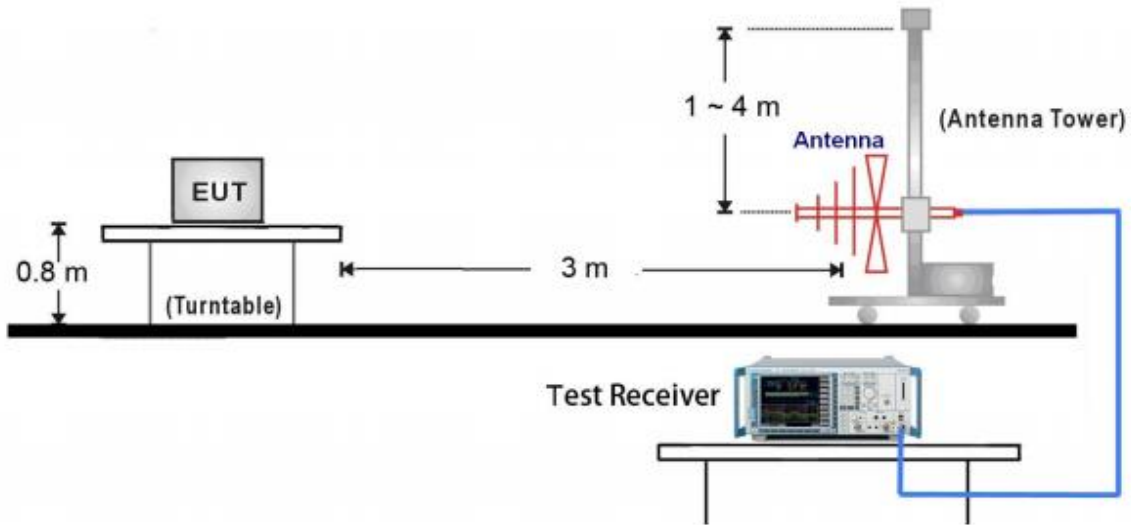


7.2 Radiated test setups

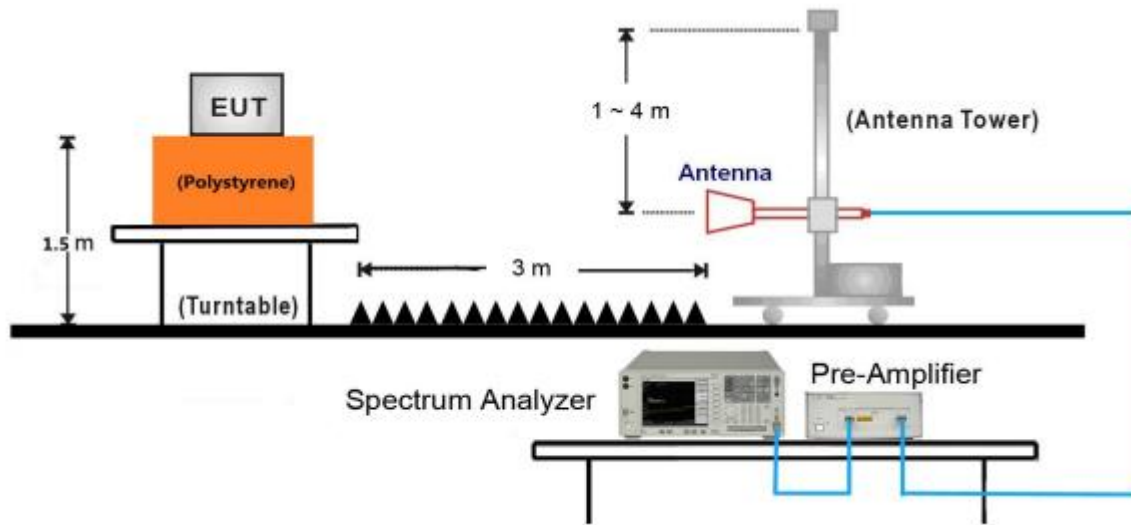
9kHz ~ 30MHz Test Setup:



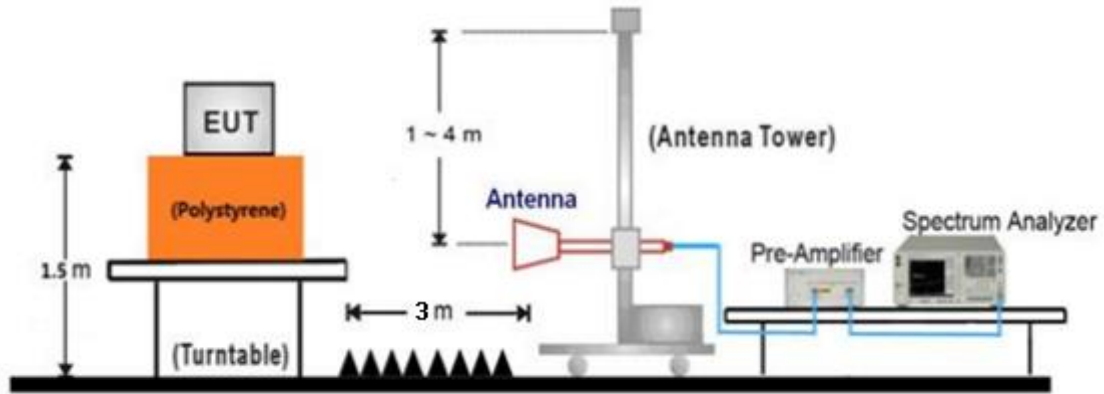
30MHz ~ 1GHz Test Setup:



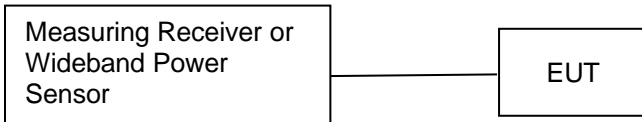
1GHz ~ 18GHz Test Setup:



18GHz ~ 25GHz Test Setup:



7.3 Conducted RF test setups



8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)	S/N(LENGTH)
Notebook	Lenovo	E470	PF-OU5TS7 17/09
AC/DC adapter	--	KA12C-0502000US	--

Test software: AmebaZ2_mptool_1V3

The system was configured to channel 1(2412MHz), 6(2437MHz), and 11(2462MHz) for 802.11 b/g/n(HT20) test.

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.



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 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

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

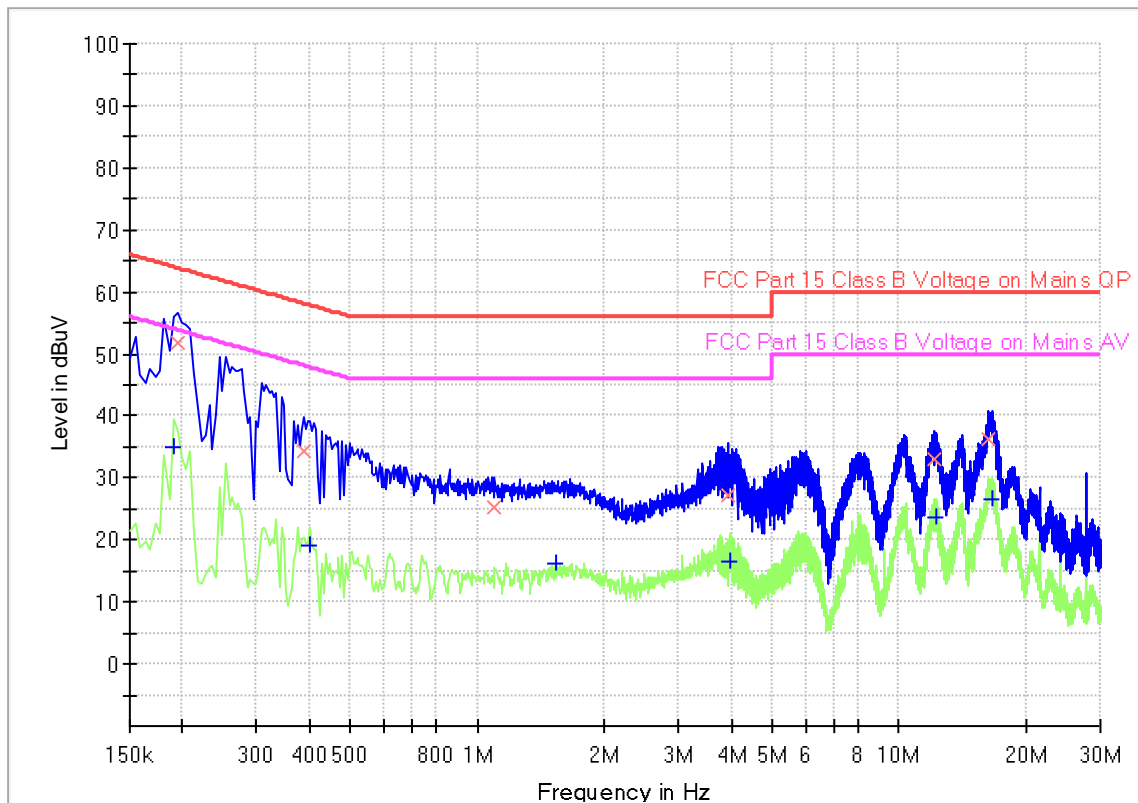
EUT Information

EUT Name: Communication Stick
 Model: TSW-T1
 Client: Ningbo Lingzhu Technology CO., Ltd.
 Op Cond: Power on, TX_g_2462MHz, AC 120V/60Hz, T20.3, H40.1%, P102.7kPa
 Operator: Cheng Huali
 Standard: FCC 15.207(a)
 Comment: Phase L
 Sample No.: SHA-709227-2

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	20 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)
0.190500	---	34.83	54.01	19.18	1000.0	9.000	L1	19.6
0.195000	51.84	---	63.82	11.98	1000.0	9.000	L1	19.6
0.388500	34.43	---	58.10	23.67	1000.0	9.000	L1	19.6
0.402000	---	19.17	47.81	28.64	1000.0	9.000	L1	19.6
1.099500	25.13	---	56.00	30.87	1000.0	9.000	L1	19.6
1.531500	---	16.13	46.00	29.87	1000.0	9.000	L1	19.6
3.948000	27.20	---	56.00	28.80	1000.0	9.000	L1	19.6
3.979500	---	16.55	46.00	29.45	1000.0	9.000	L1	19.6
12.097500	33.05	---	60.00	26.95	1000.0	9.000	L1	19.8
12.232500	---	23.77	50.00	26.23	1000.0	9.000	L1	19.8
16.282500	36.21	---	60.00	23.79	1000.0	9.000	L1	19.9
16.597500	---	26.61	50.00	23.39	1000.0	9.000	L1	19.9



150k-30MHz Conducted Emission Test

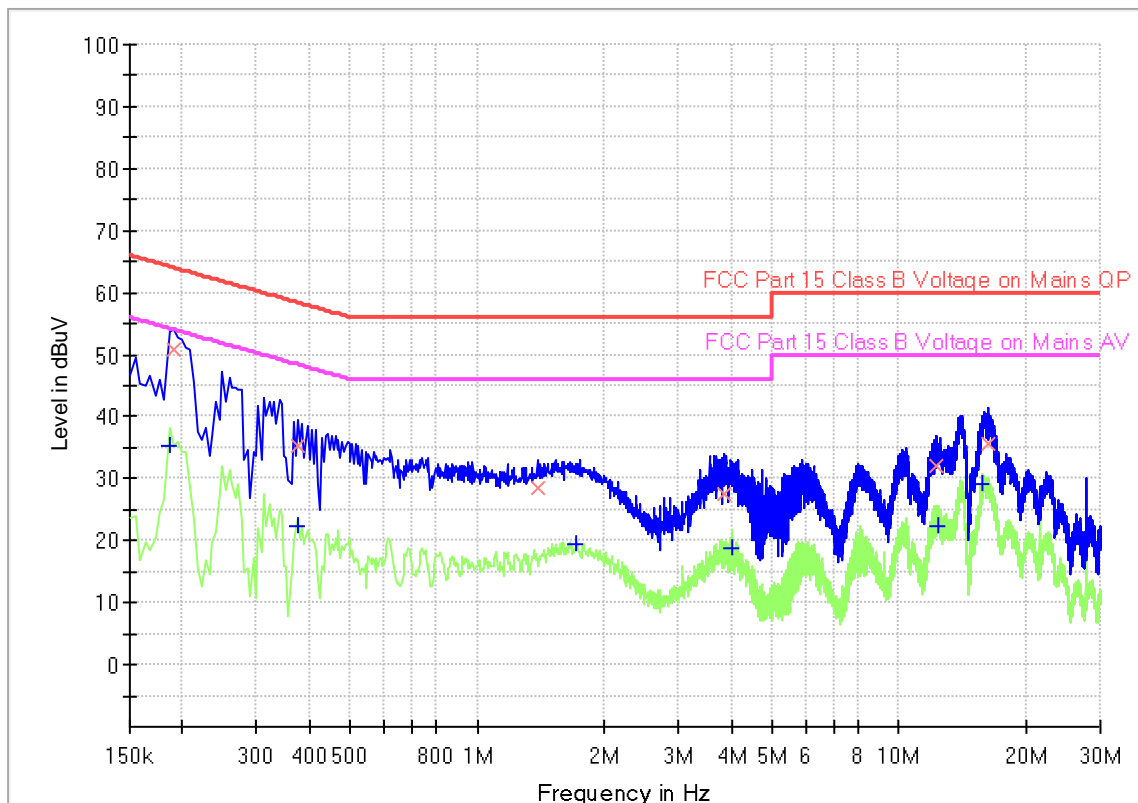
EUT Information

EUT Name: Communication Stick
 Model: TSW-T1
 Client: Ningbo Lingzhu Technology CO., Ltd.
 Op Cond: Power on, TX_g_2462MHz, AC 120V/60Hz, T20.3, H40.1%, P102.7kPa
 Operator: Cheng Huali
 Standard: FCC 15.207(a)
 Comment: Phase N
 Sample No.: SHA-709227-2

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	20 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)
0.186000	---	35.16	54.21	19.05	1000.0	9.000	N	19.6
0.190500	50.68	---	64.01	13.33	1000.0	9.000	N	19.6
0.375000	---	22.29	48.39	26.10	1000.0	9.000	N	19.6
0.375000	35.40	---	58.39	22.99	1000.0	9.000	N	19.6
1.387500	28.62	---	56.00	27.38	1000.0	9.000	N	19.6
1.716000	---	19.30	46.00	26.70	1000.0	9.000	N	19.6
3.844500	27.40	---	56.00	28.60	1000.0	9.000	N	19.7
4.029000	---	18.83	46.00	27.17	1000.0	9.000	N	19.7
12.241500	31.91	---	60.00	28.09	1000.0	9.000	N	19.9
12.322500	---	22.42	50.00	27.58	1000.0	9.000	N	19.9
15.823500	---	29.01	50.00	20.99	1000.0	9.000	N	19.9
16.350000	35.58	---	60.00	24.42	1000.0	9.000	N	19.9

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
 Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator



9.2 Conducted peak output power

Test Method

1. Use the following spectrum analyzer settings:
 RBW > the 6dB bandwidth of the emission being measured, VBW \geq 3RBW, Span \geq 3RBW
 Sweep = auto, Detector function = peak, Trace = max hold.
2. Add a correction factor to the display.
3. Use a power meter to measure the conducted peak output power.

Limits

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

Test result

802.11b

Frequency (MHz)	Conducted Peak Output Power(dBm)	Result
Low channel 2412MHz	18.36	Pass
Middle channel 2437MHz	18.59	Pass
High channel 2462MHz	18.86	Pass

802.11g

Frequency (MHz)	Conducted Peak Output Power(dBm)	Result
Low channel 2412MHz	22.15	Pass
Middle channel 2437MHz	22.45	Pass
High channel 2462MHz	22.65	Pass

802.11n(HT20)

Frequency (MHz)	Conducted Peak Output Power(dBm)	Result
Low channel 2412MHz	21.55	Pass
Middle channel 2437MHz	21.86	Pass
High channel 2462MHz	22.04	Pass



9.3 6dB bandwidth

Test Method

1. Use the following spectrum analyzer settings:
RBW=100K, VBW≥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 ≥ 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
Top channel 2412MHz	9.087	Pass
Middle channel 2437MHz	9.087	Pass
Bottom channel 2462MHz	9.032	Pass

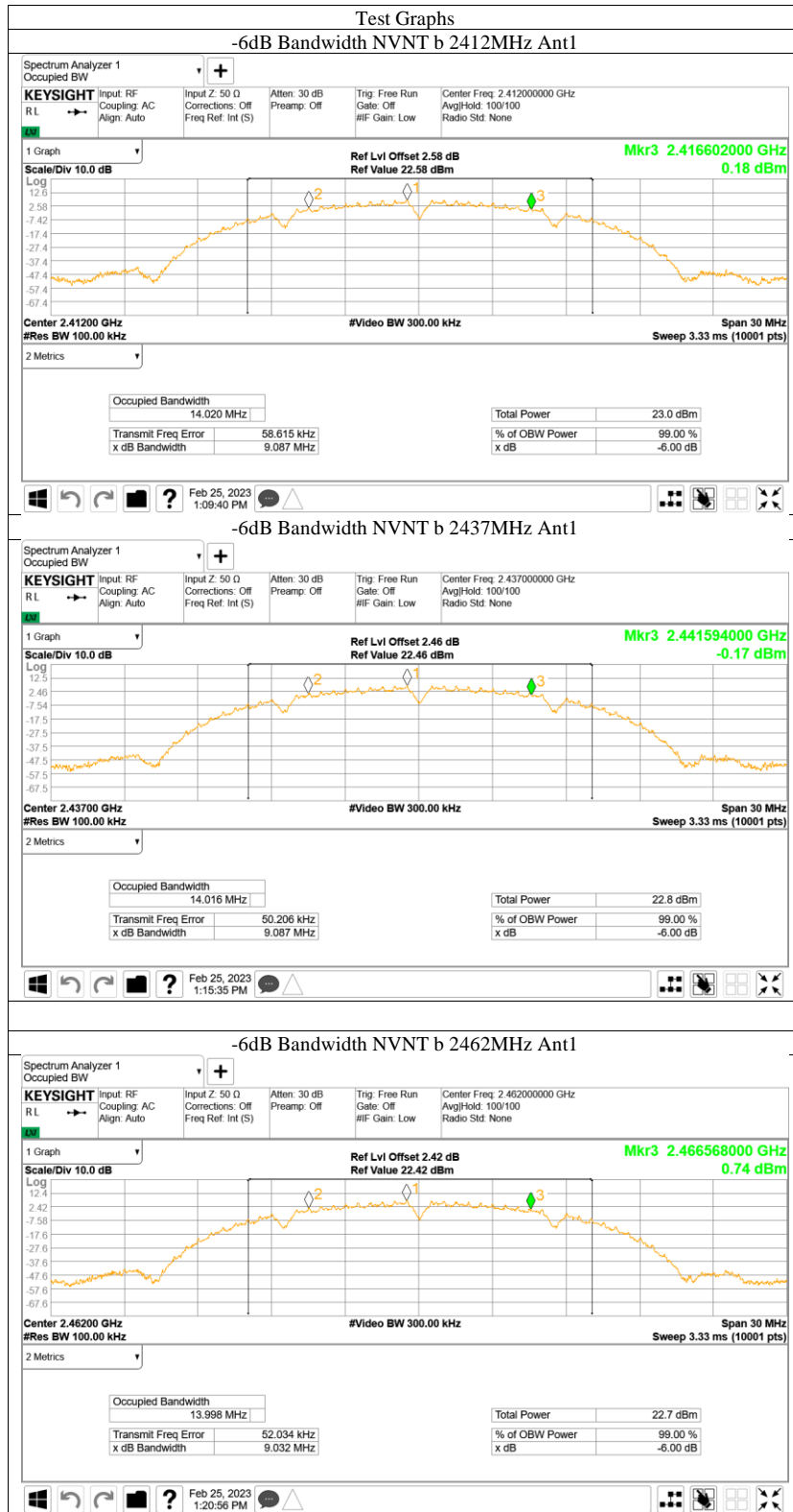
802.11g

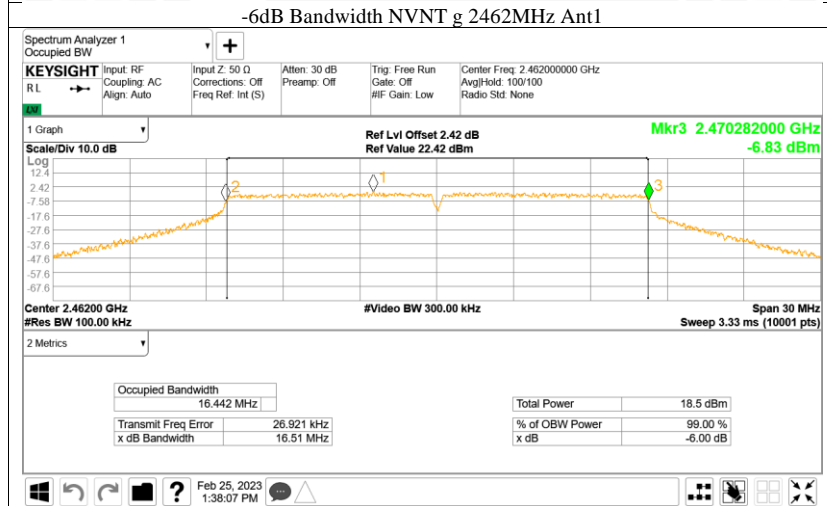
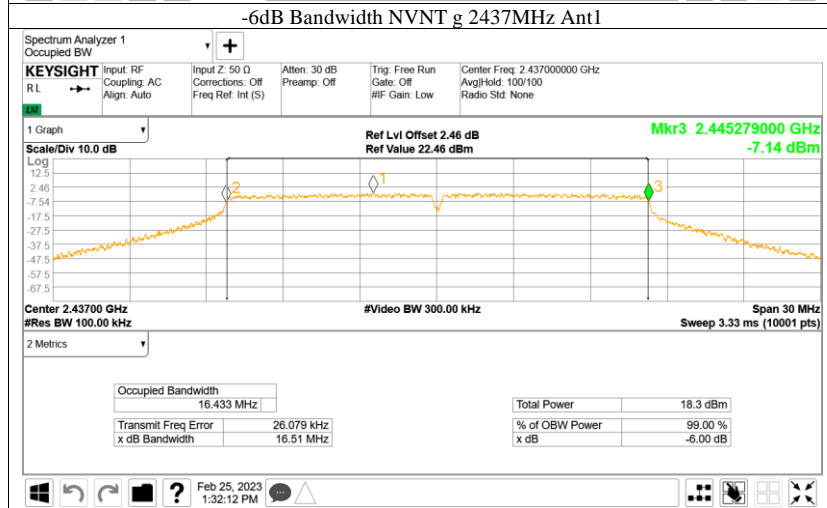
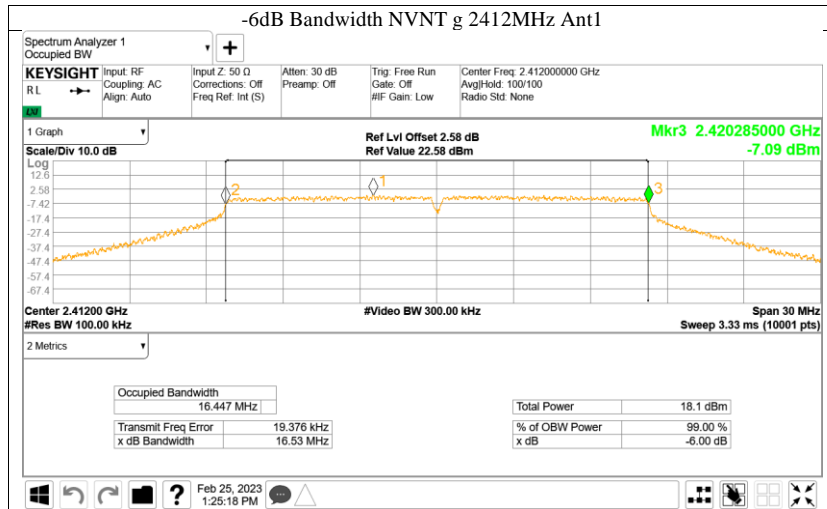
Frequency MHz	6dB bandwidth MHz	Result
Top channel 2412MHz	16.531	Pass
Middle channel 2437MHz	16.506	Pass
Bottom channel 2462MHz	16.510	Pass

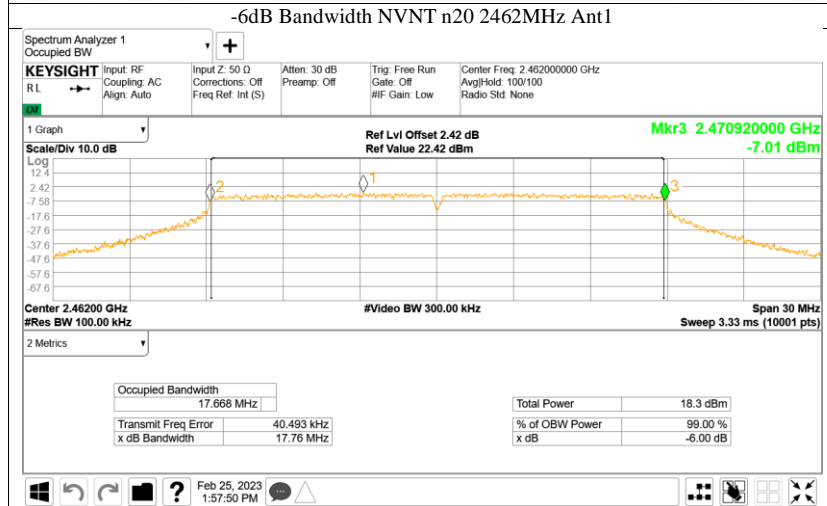
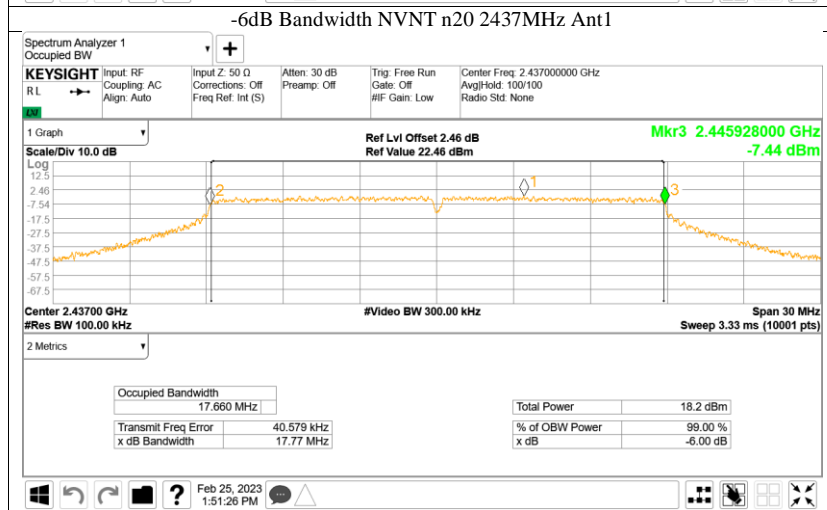
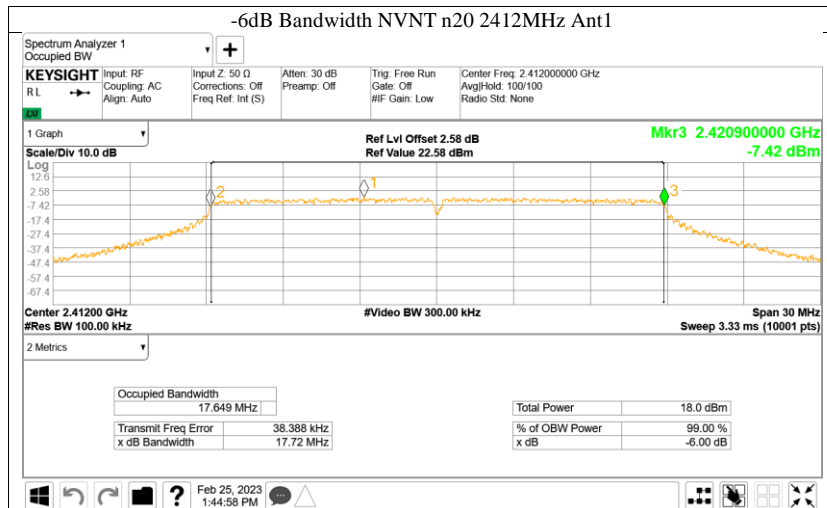
802.11n(HT20)

Frequency MHz	6dB bandwidth MHz	Result
Top channel 2412MHz	17.723	Pass
Middle channel 2437MHz	17.775	Pass
Bottom channel 2462MHz	17.760	Pass

6 dB Bandwidth









9.4 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≥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
Low channel 2412MHz	-12.89	Pass
Middle channel 2437MHz	-13.11	Pass
High channel 2462MHz	-13.12	Pass

802.11g

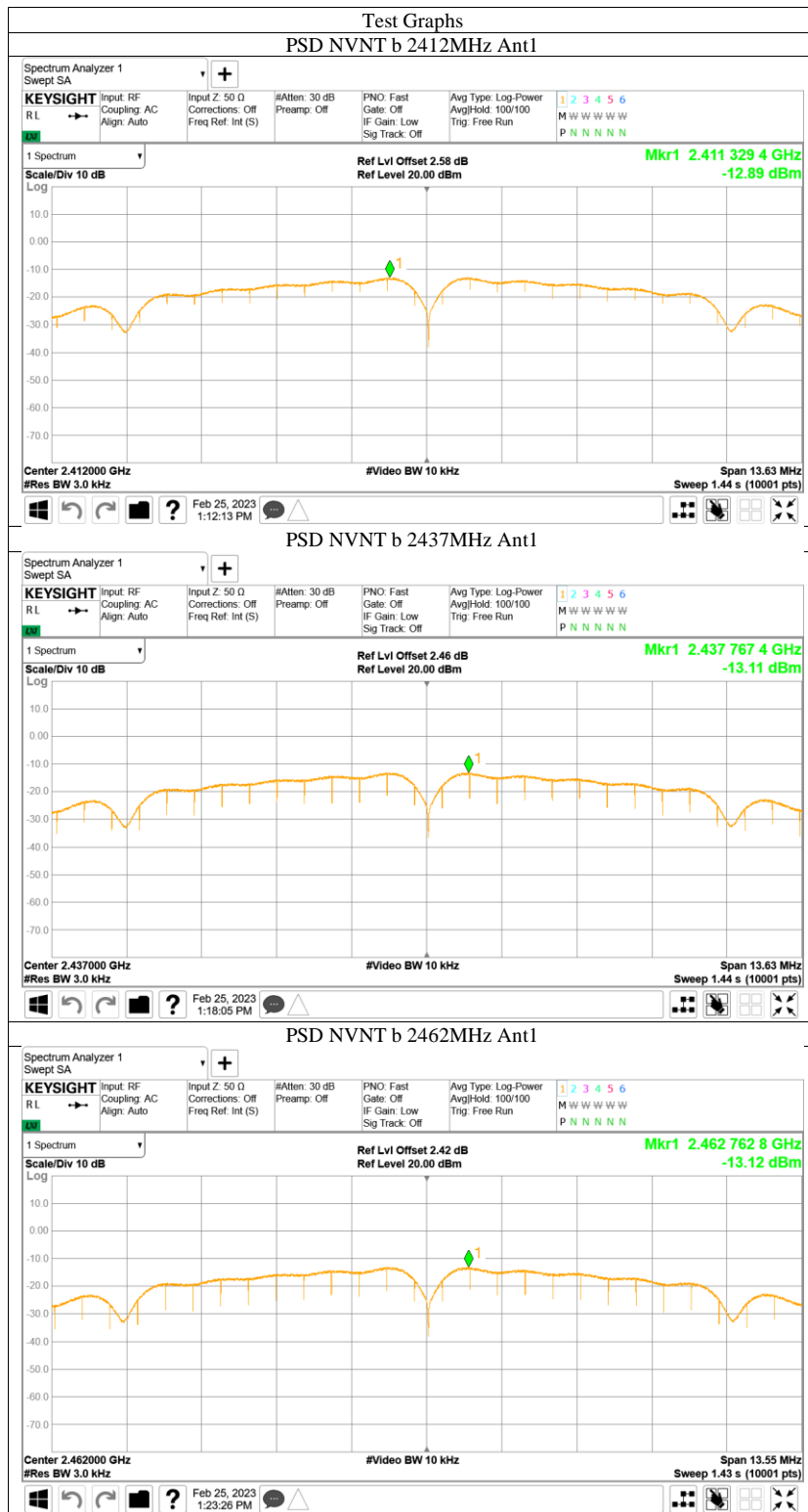
Frequency (MHz)	Power spectral density(dBm/3KHz)	Result
Low channel 2412MHz	-15.53	Pass
Middle channel 2437MHz	-15.37	Pass
High channel 2462MHz	-15.15	Pass

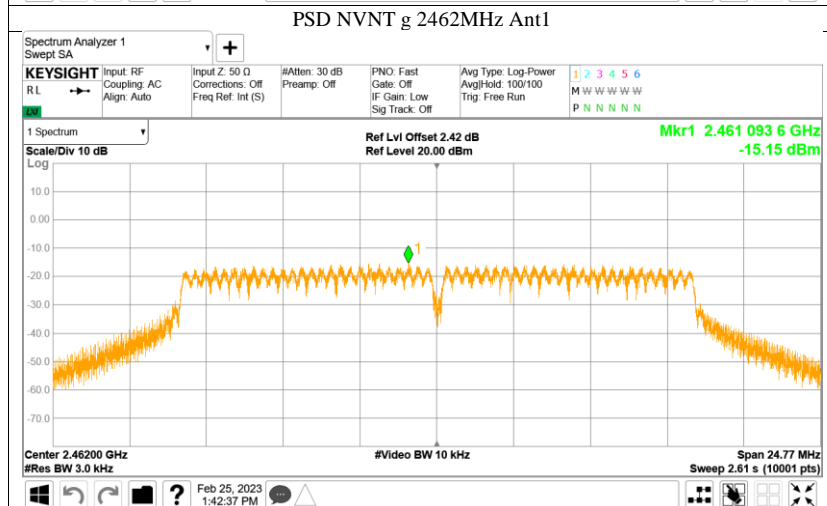
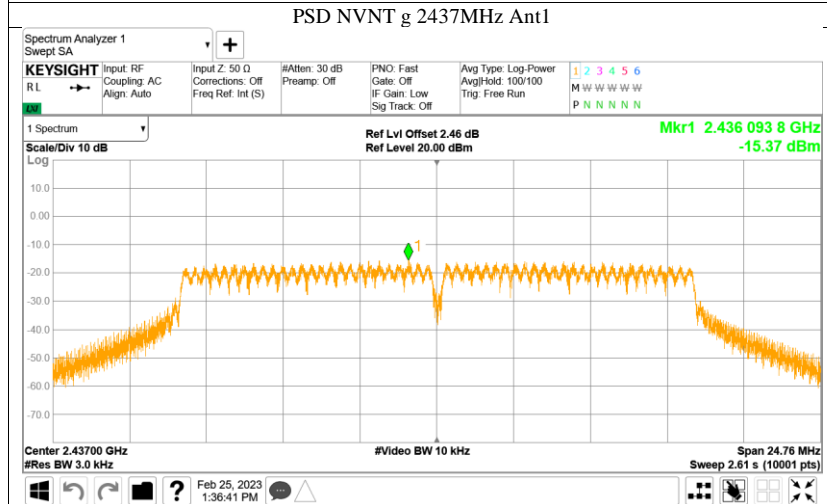
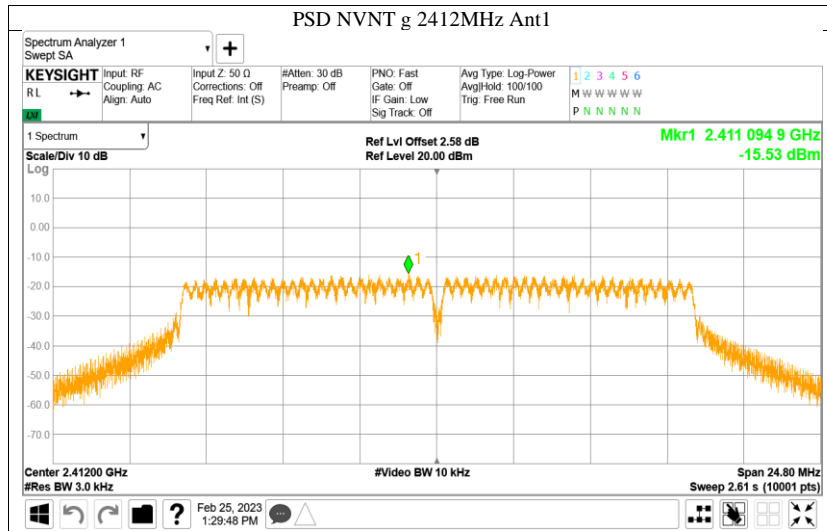
802.11 n(HT20)

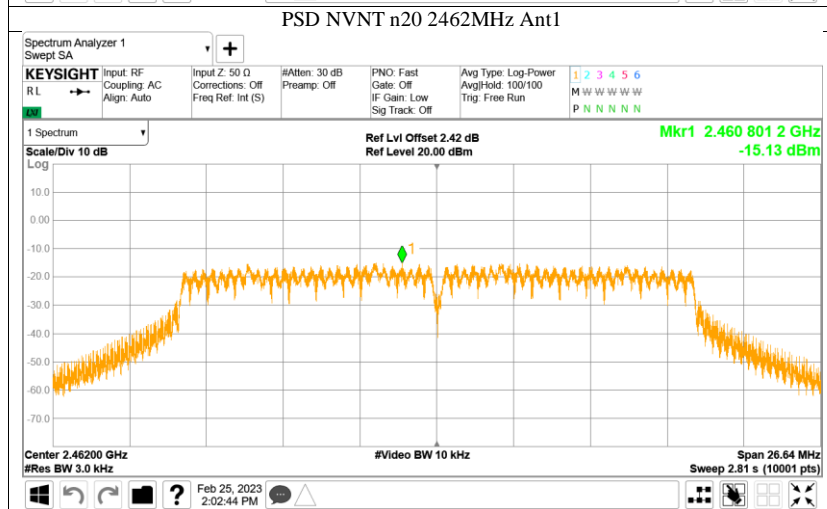
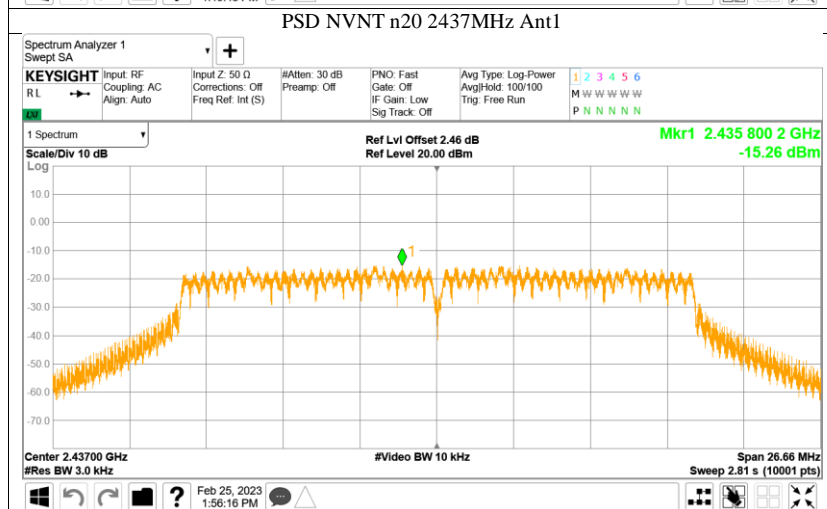
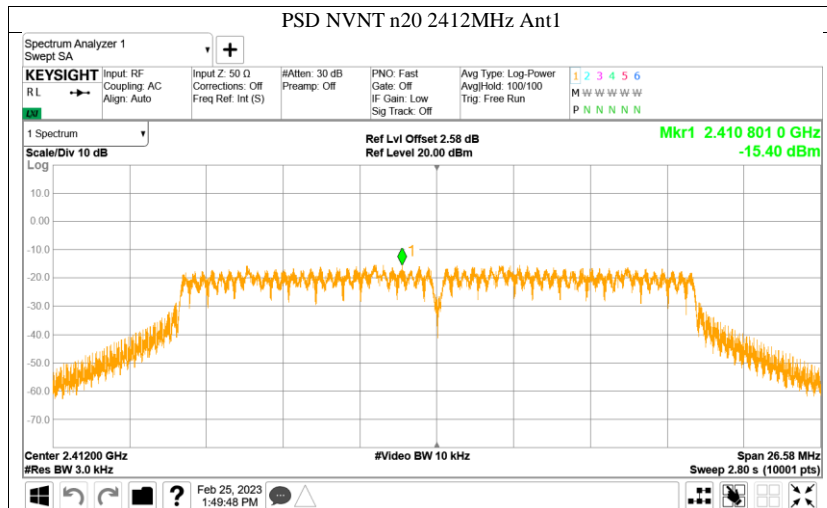
Frequency (MHz)	Power spectral density(dBm/3KHz)	Result
Low channel 2412MHz	-15.40	Pass
Middle channel 2437MHz	-15.26	Pass
High channel 2462MHz	-15.13	Pass



Power spectral density









9.5 Spurious RF conducted emissions

Test Method

1. Establish a reference level by using the following procedure:
 - a. Set RBW=100 kHz. VBW \geq 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

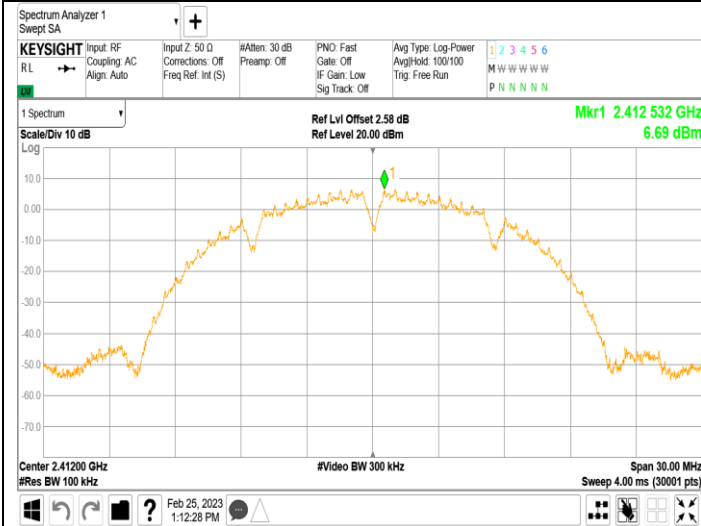
Spurious RF conducted emissions

802.11b

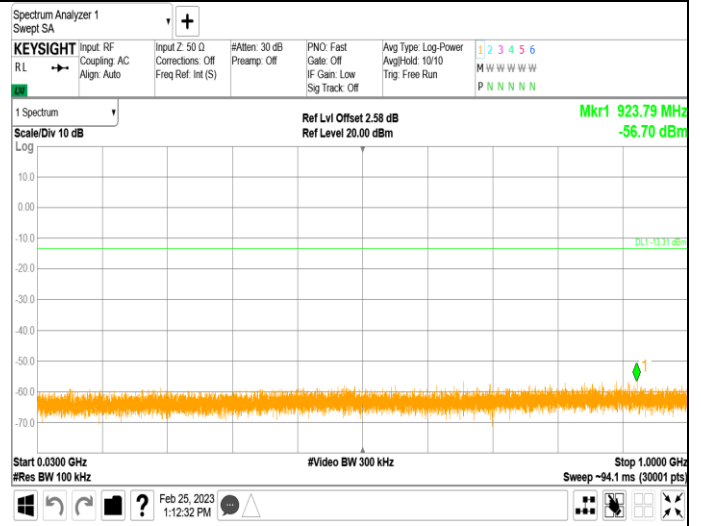
Out-of-Band Emissions

Channel 1 (2412MHz)

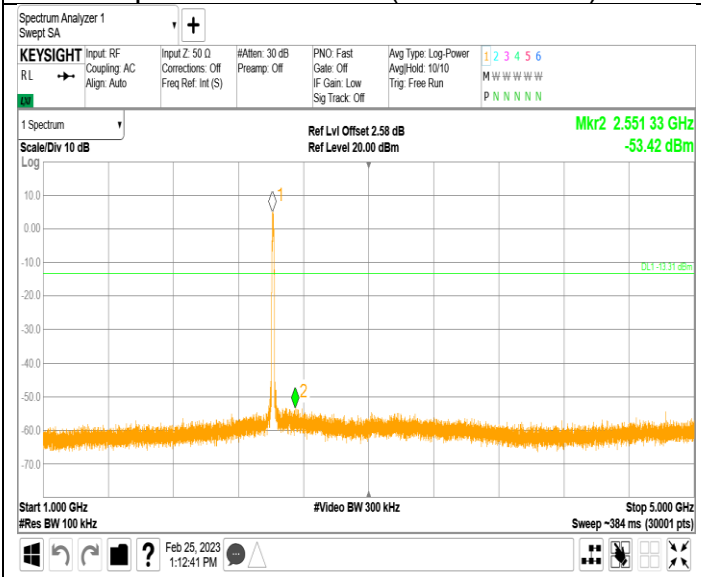
Reference point



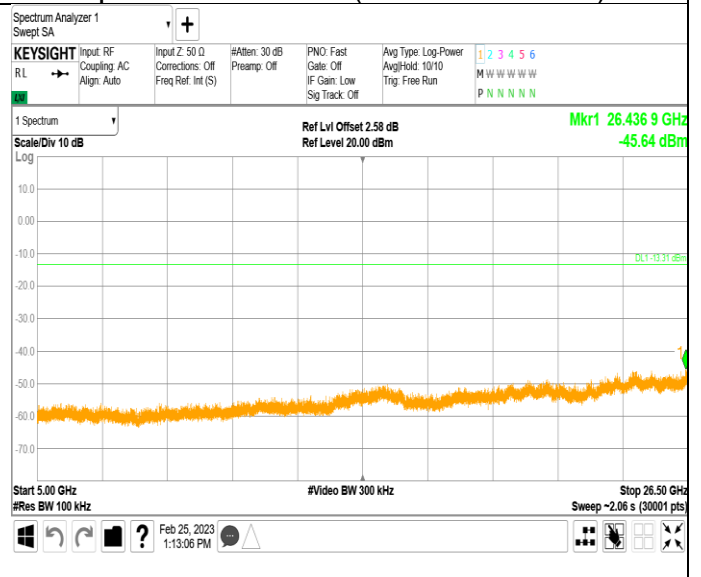
Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)

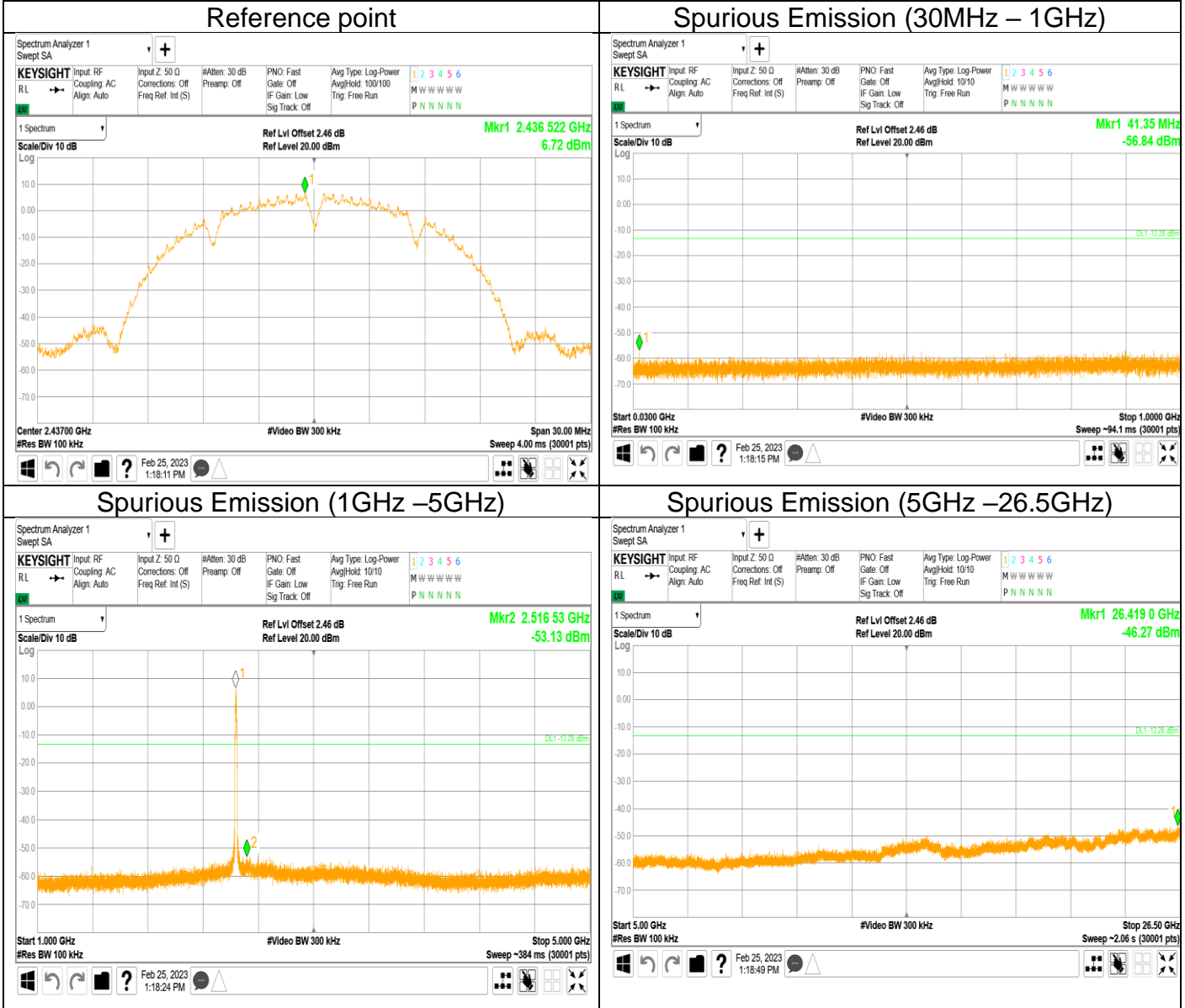


Spurious Emission (5GHz –26.5GHz)





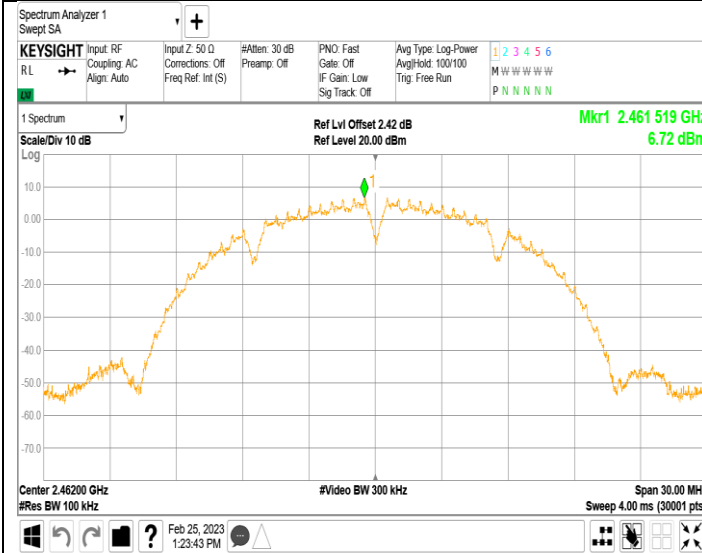
Out-of-Band Emissions Channel 6 (2437MHz)



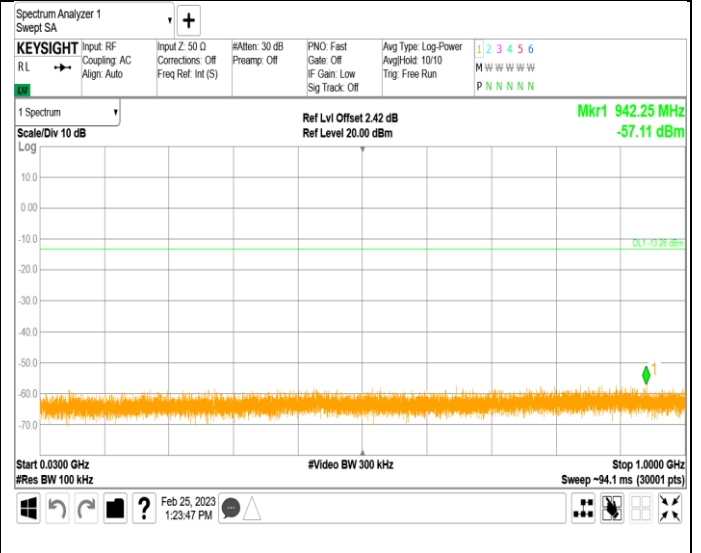


Out-of-Band Emissions
Channel 11 (2462MHz)

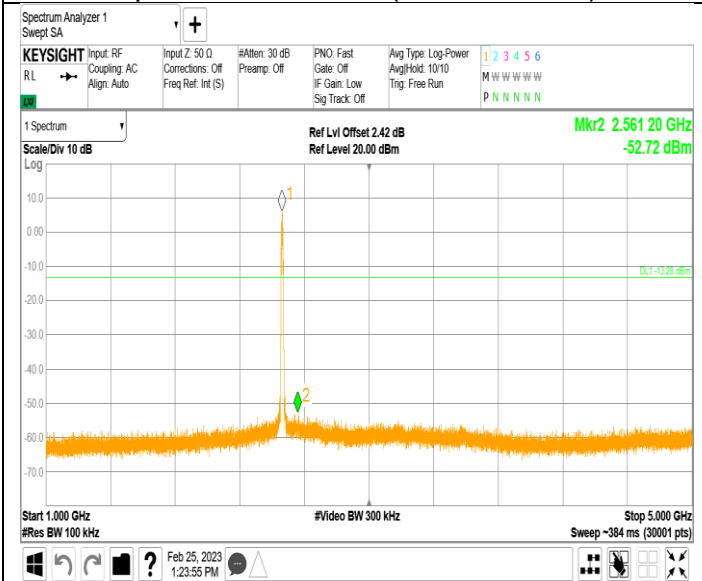
Reference point



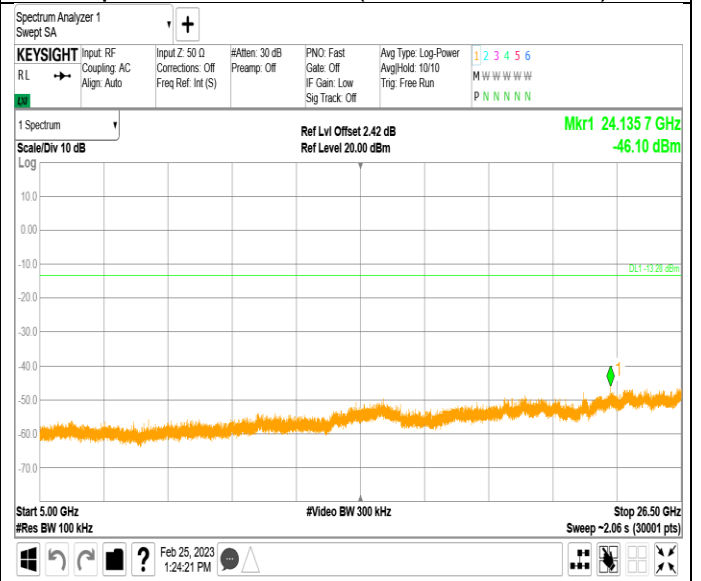
Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)



Spurious Emission (5GHz –26.5GHz)





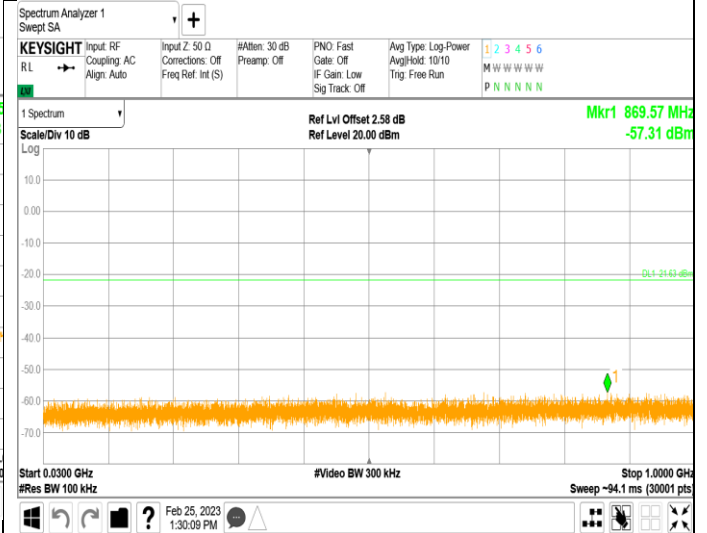
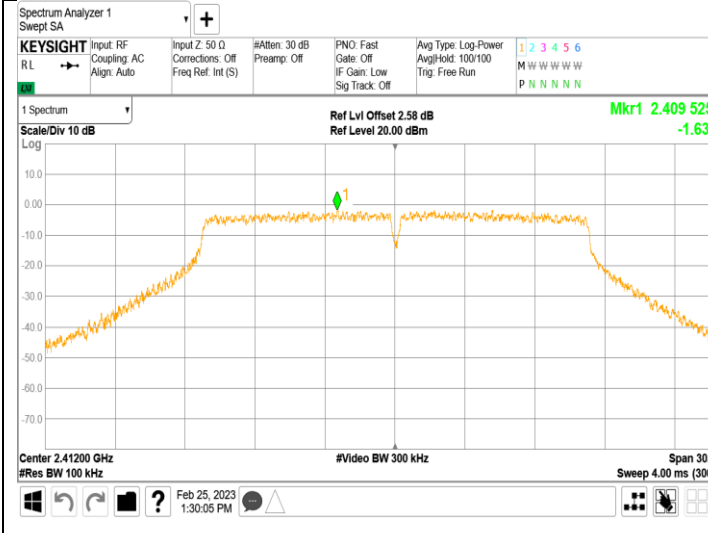
802.11g

Out-of-Band Emissions

Channel 1 (2412MHz)

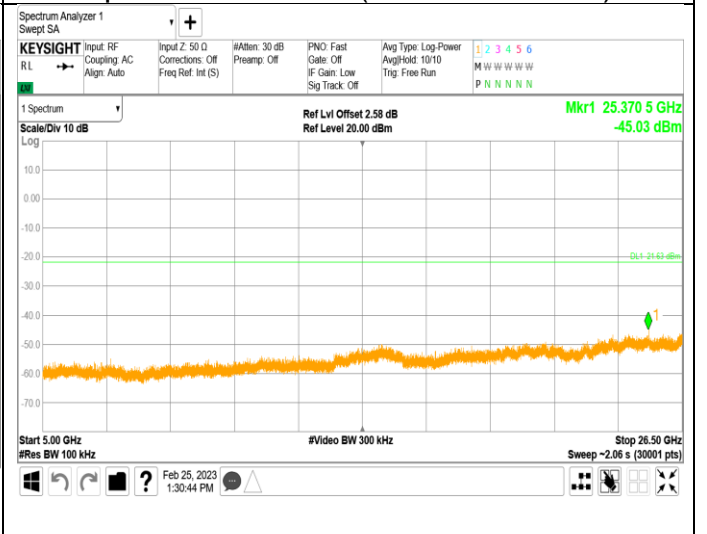
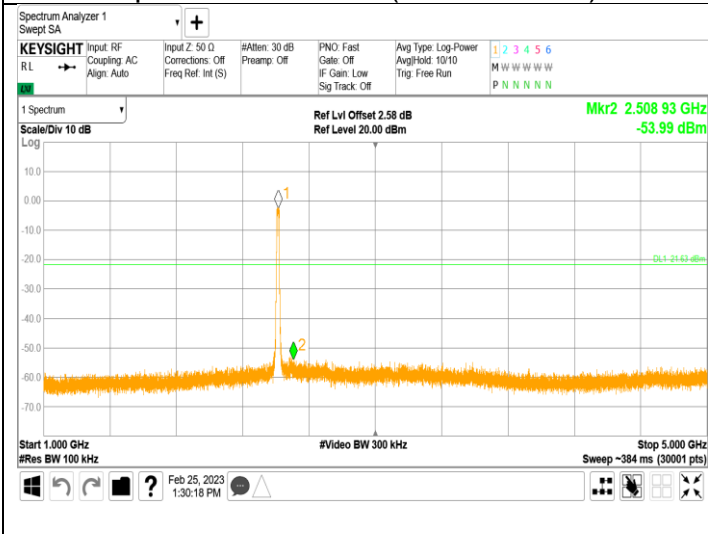
Reference point

Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz – 5GHz)

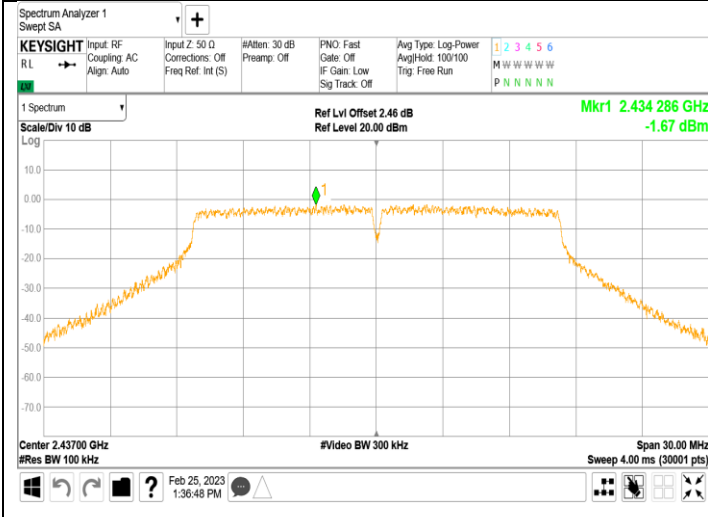
Spurious Emission (5GHz – 26.5GHz)



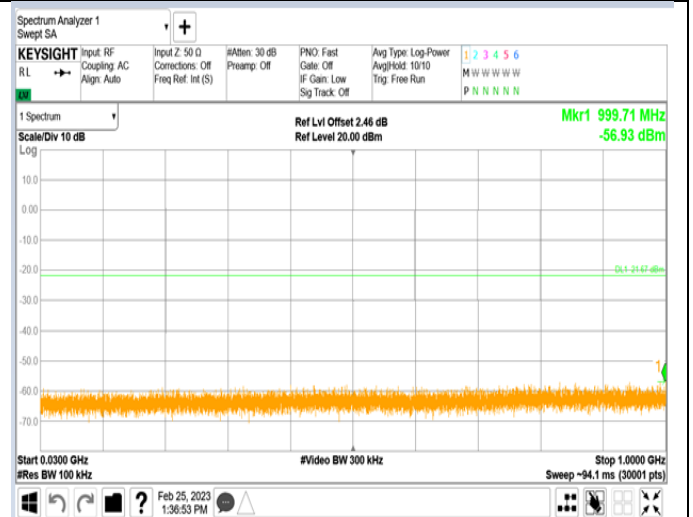


Out-of-Band Emissions
Channel 6 (2437MHz)

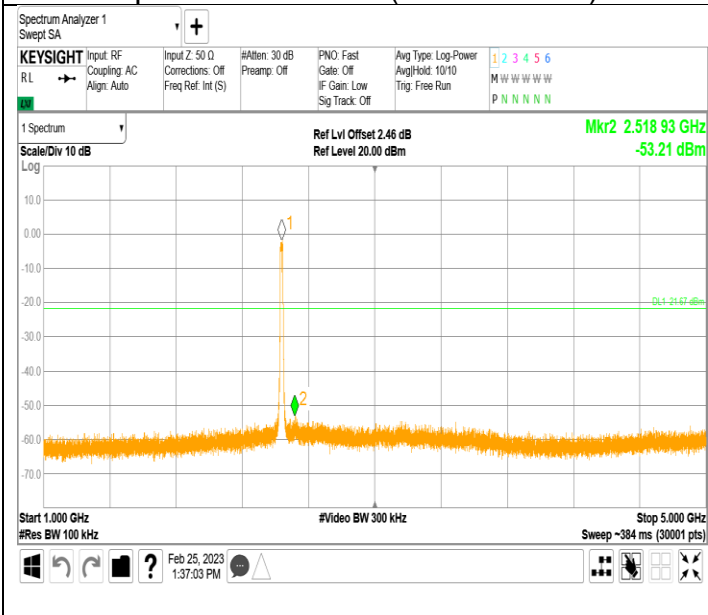
Reference point



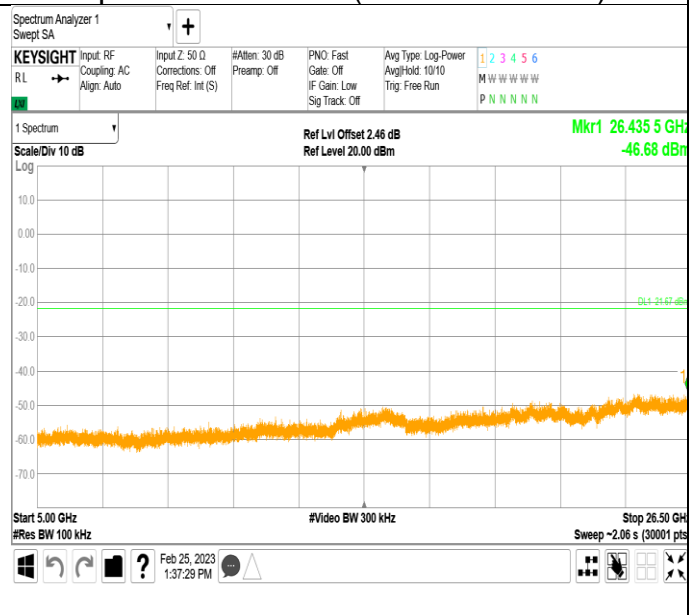
Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)

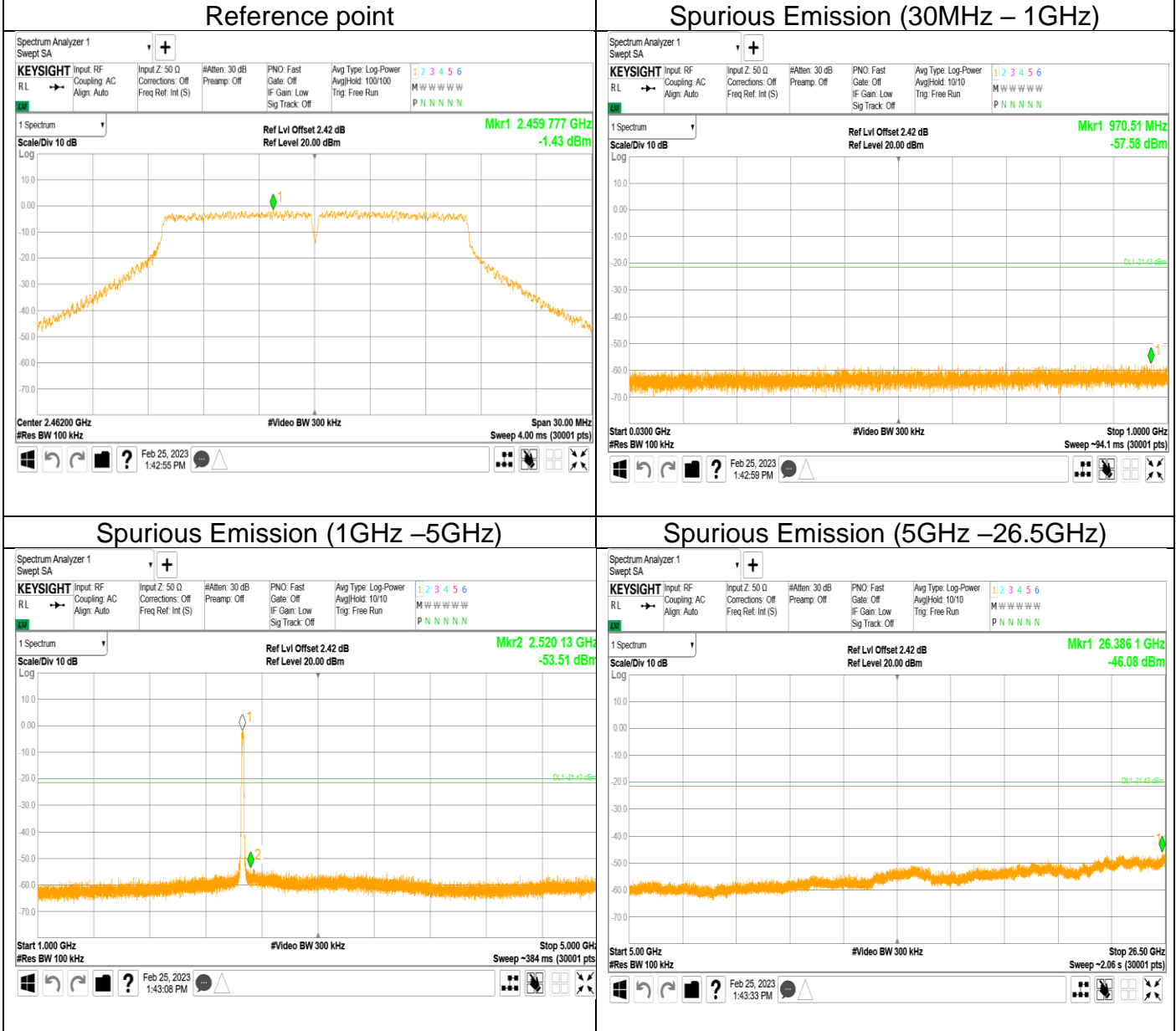


Spurious Emission (5GHz –26.5GHz)





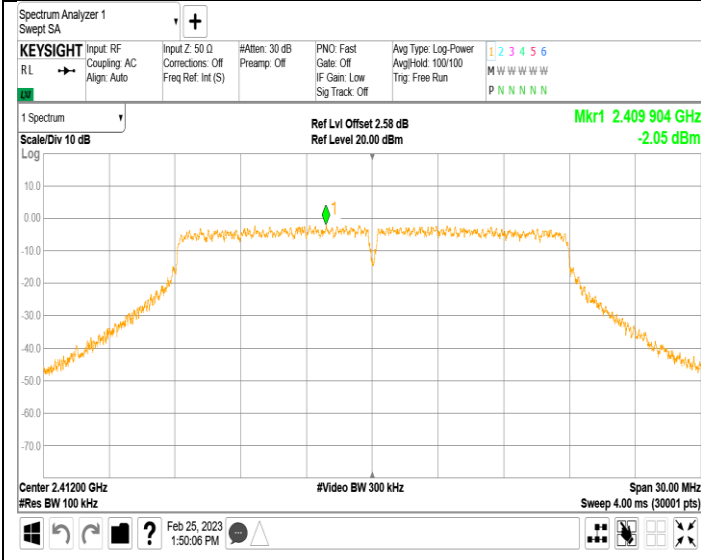
Out-of-Band Emissions Channel 11 (2462MHz)



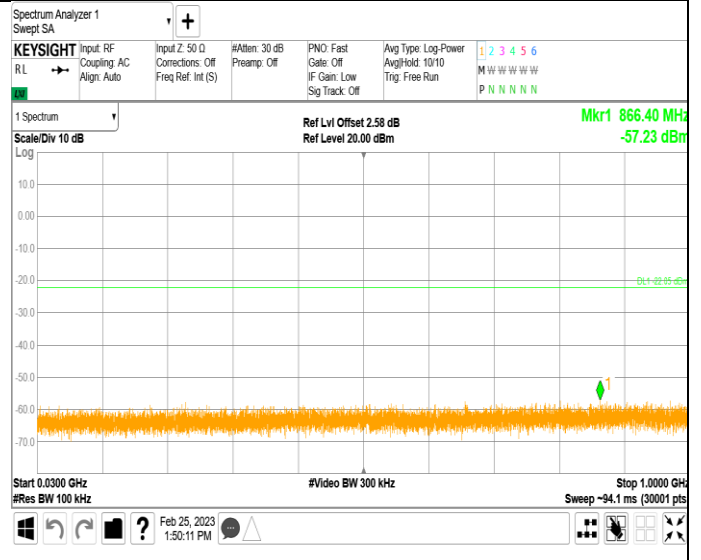


802.11n(HT20)
Out-of-Band Emissions
Channel 1 (2412MHz)

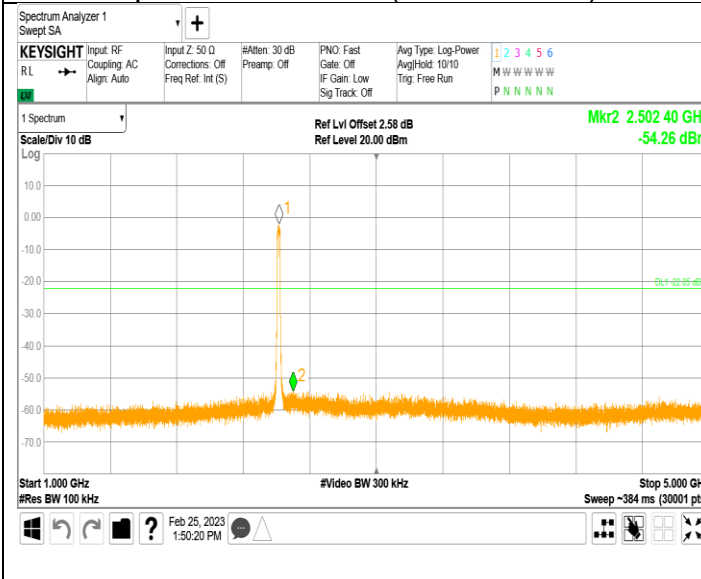
Reference point



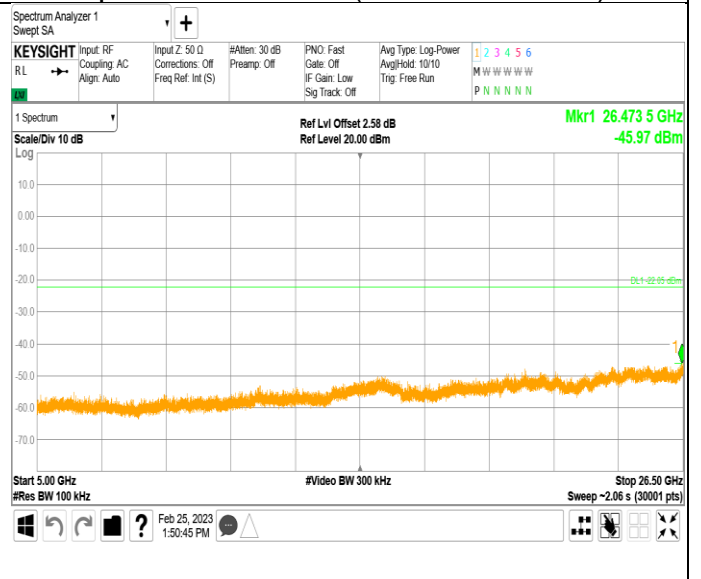
Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)

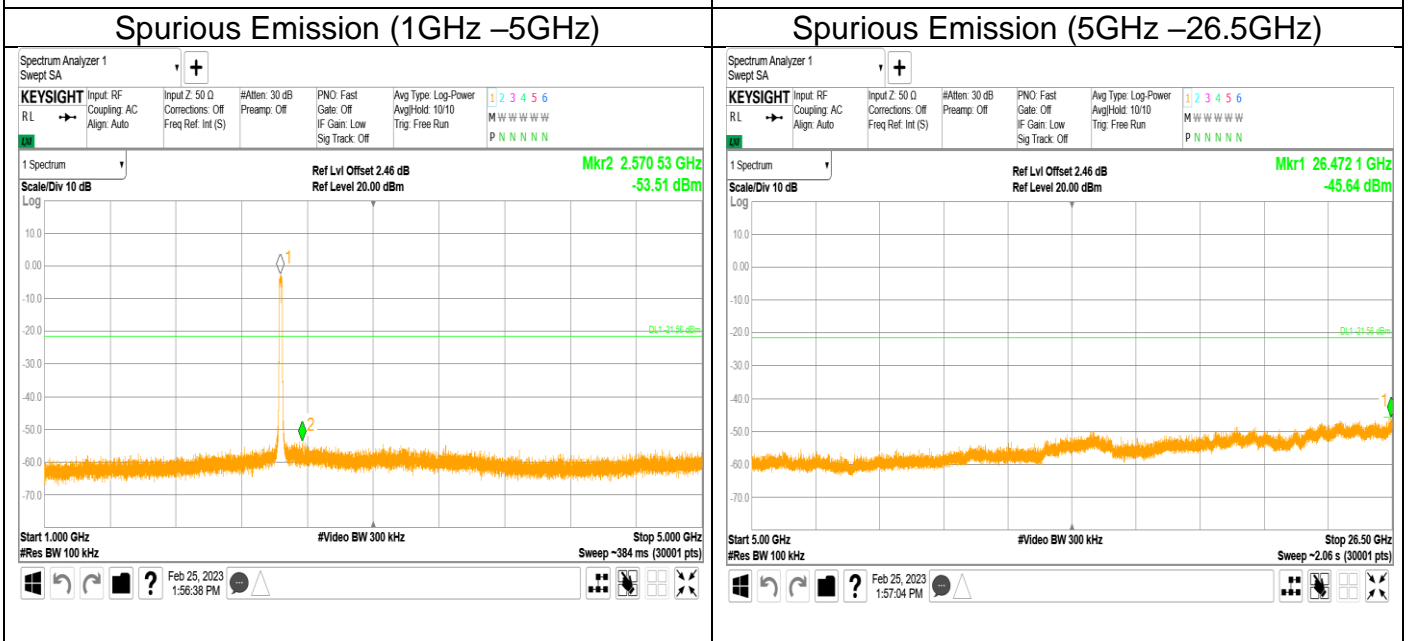
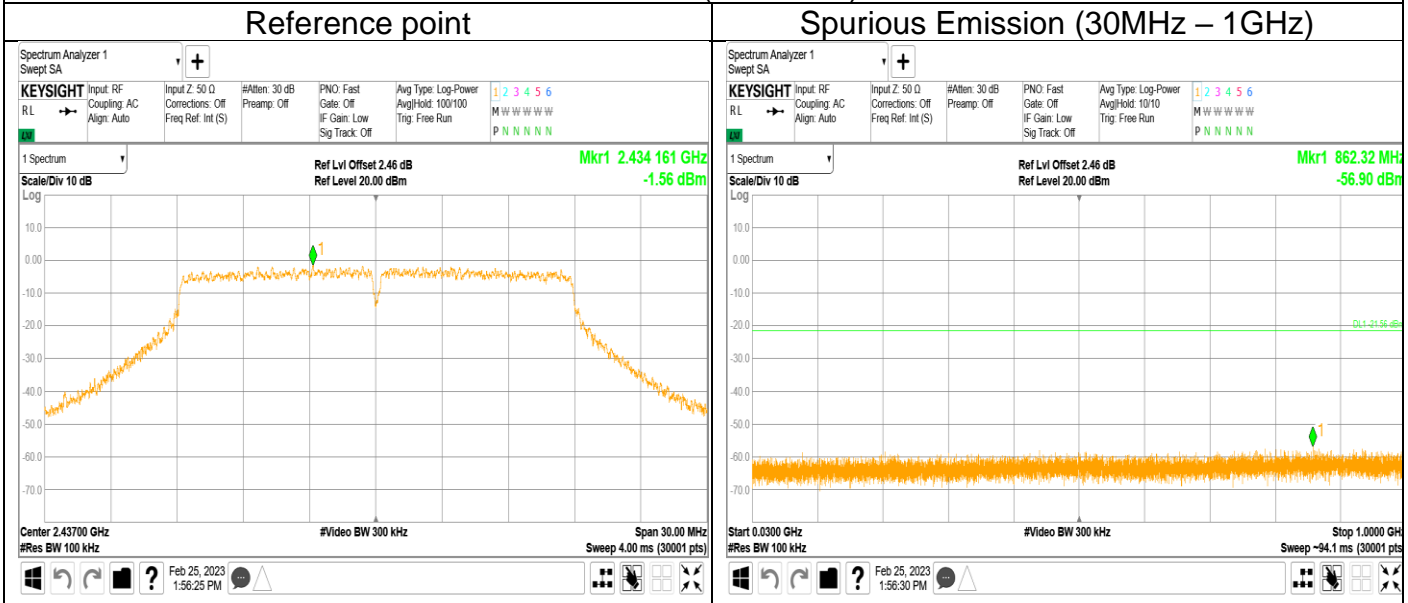


Spurious Emission (5GHz –26.5GHz)





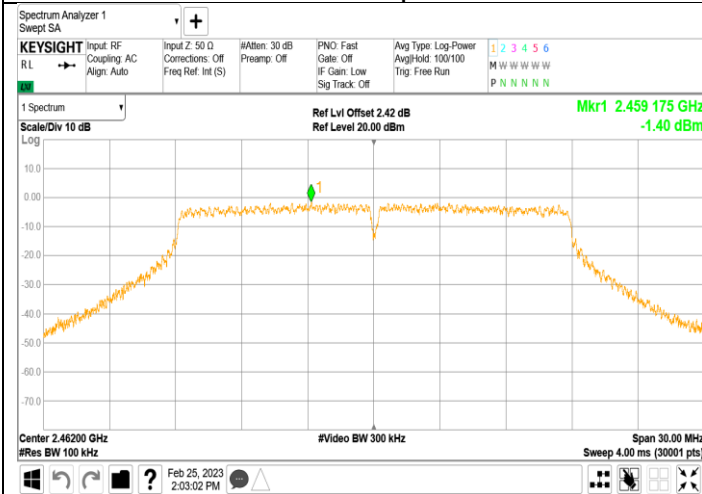
Out-of-Band Emissions Channel 6 (2437MHz)



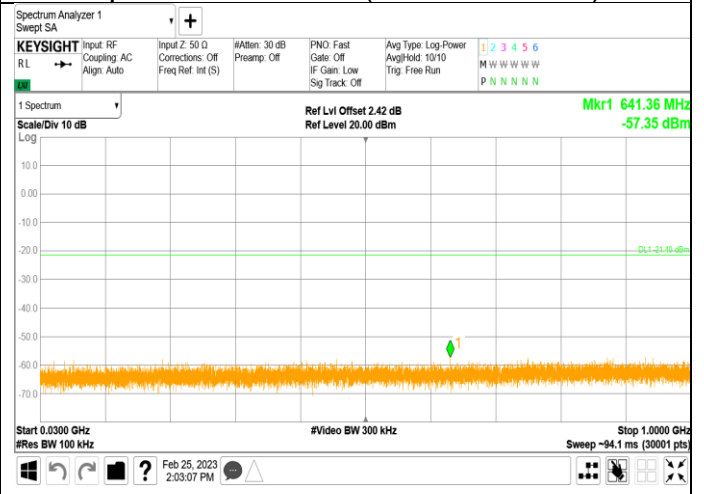


Out-of-Band Emissions
Channel 11 (2462MHz)

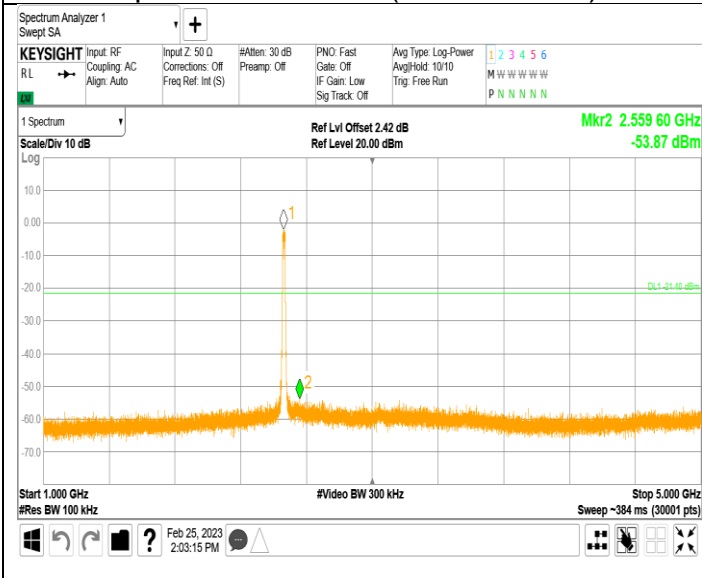
Reference point



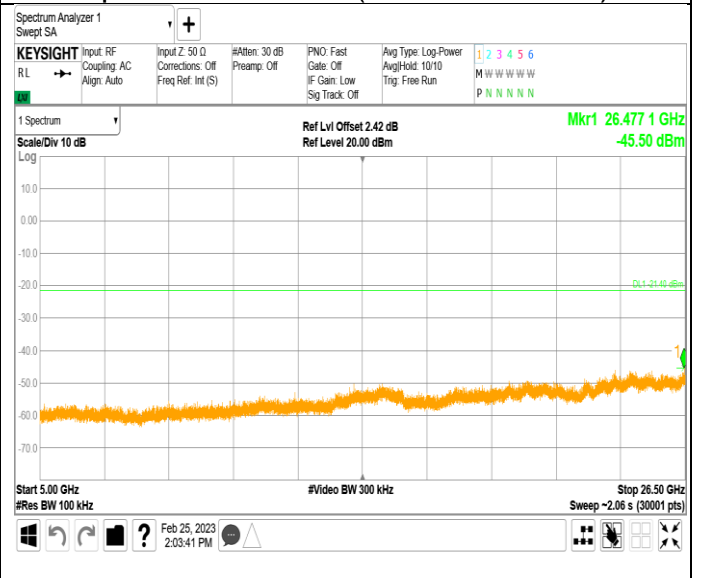
Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)



Spurious Emission (5GHz –26.5GHz)





9.6 Band edge

Test Method

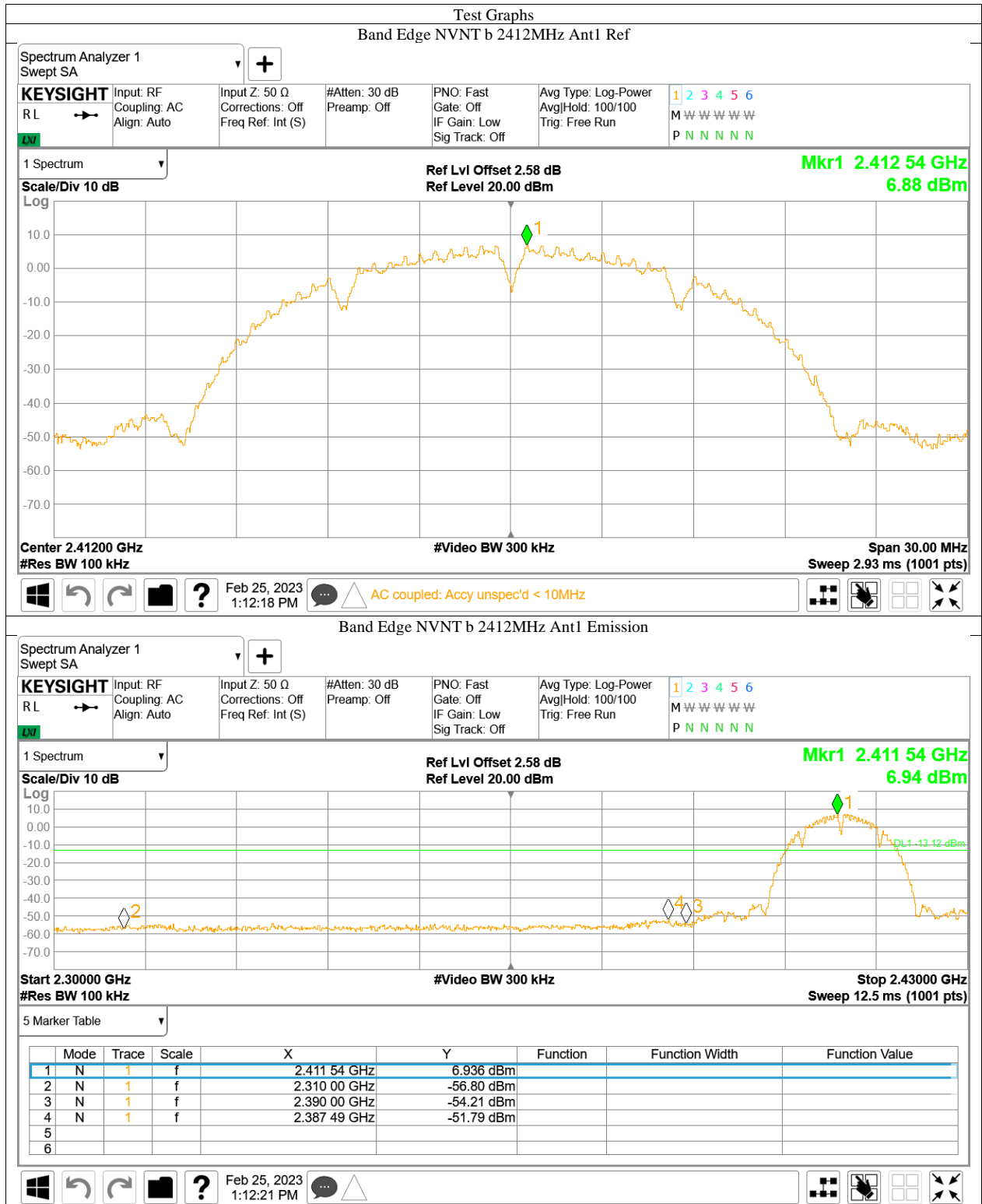
- 1 Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz, VBW \geq RBW, Sweep = auto, Detector function = peak, Trace = max hold.
- 2 Allow the trace to stabilize, use the peak and delta measurement to record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

Limit

In any 100 kHz bandwidth outside the frequency bands in which the spread spectrum 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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) and RSS-Gen8.10, must also comply with the radiated emission limits specified in 15.209(a) (see Section 15.205(c)) and RSS-Gen.



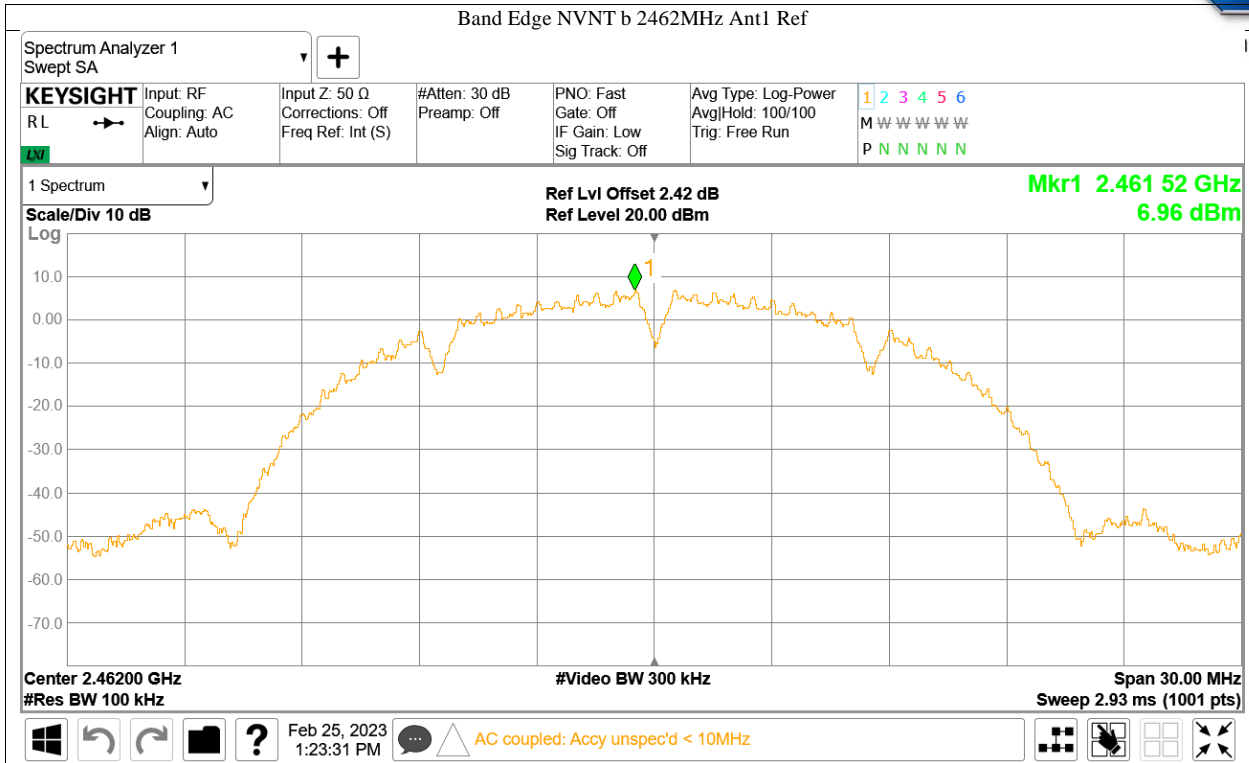
Test result



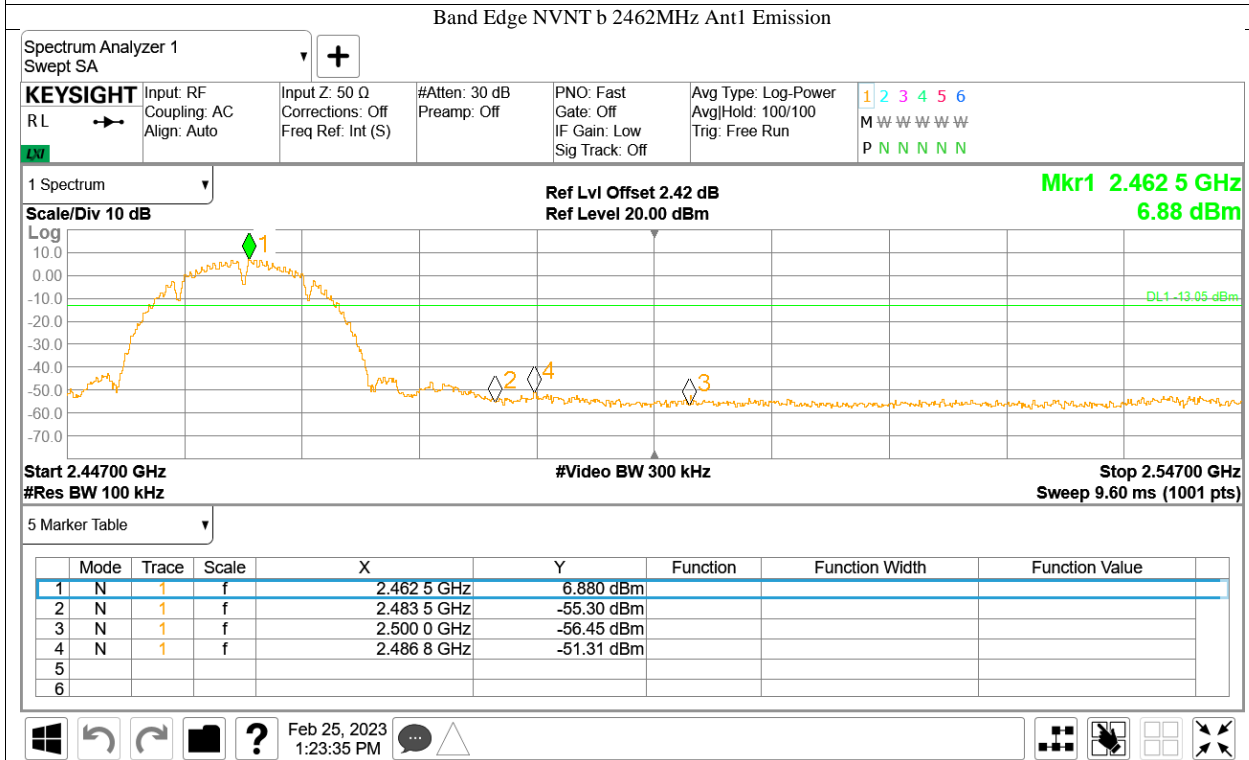


ina

Band Edge NVNT b 2462MHz Ant1 Ref



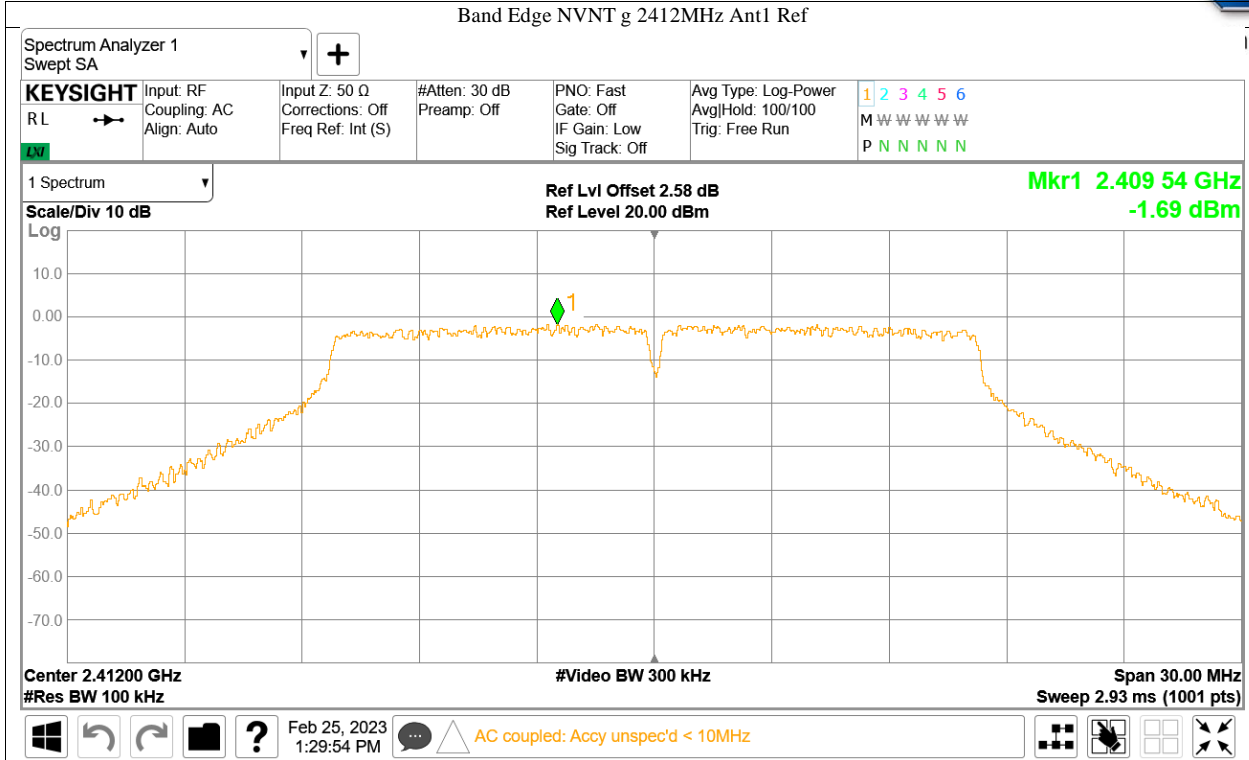
Band Edge NVNT b 2462MHz Ant1 Emission



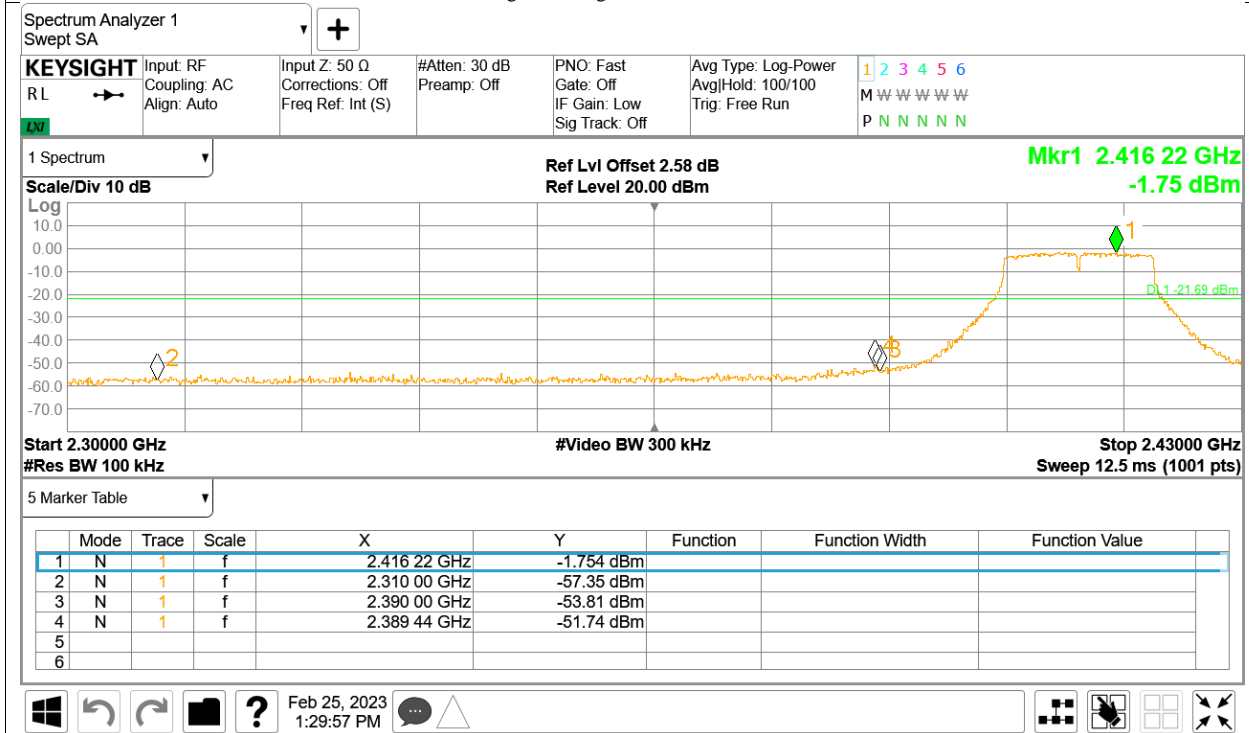


ina

Band Edge NVNT g 2412MHz Ant1 Ref

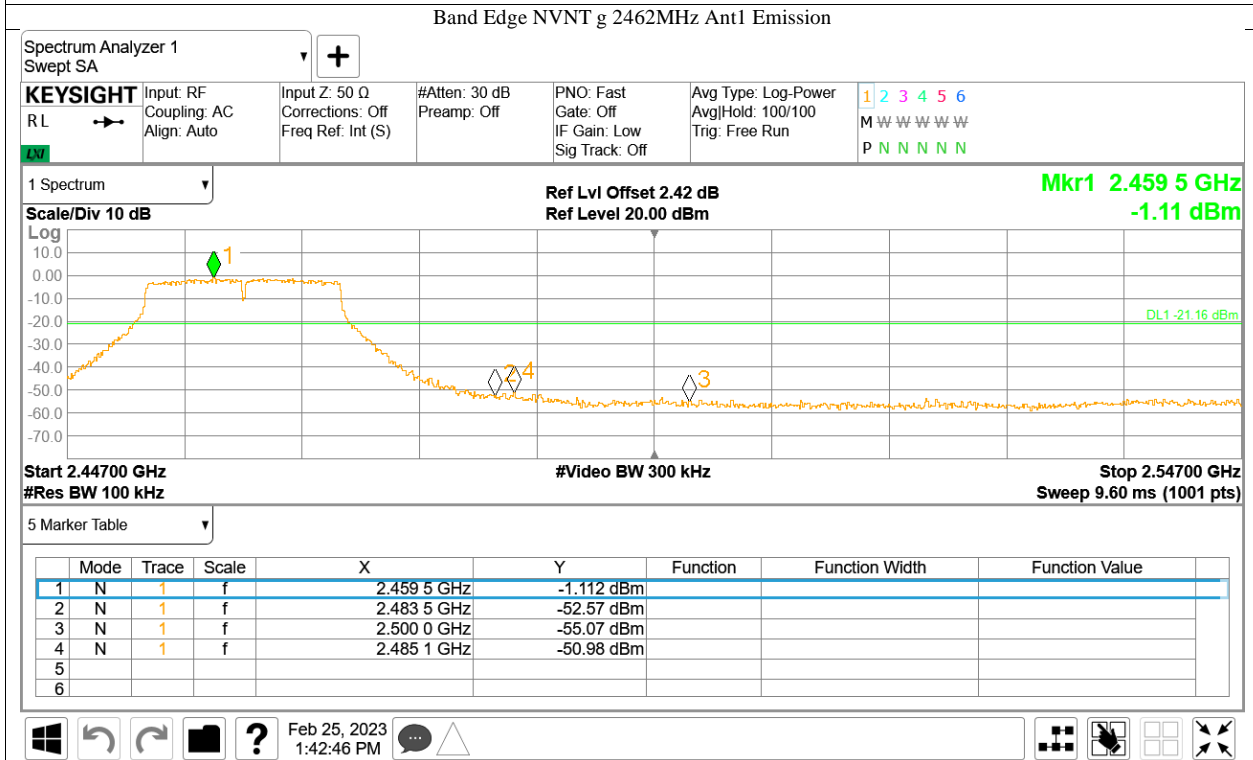
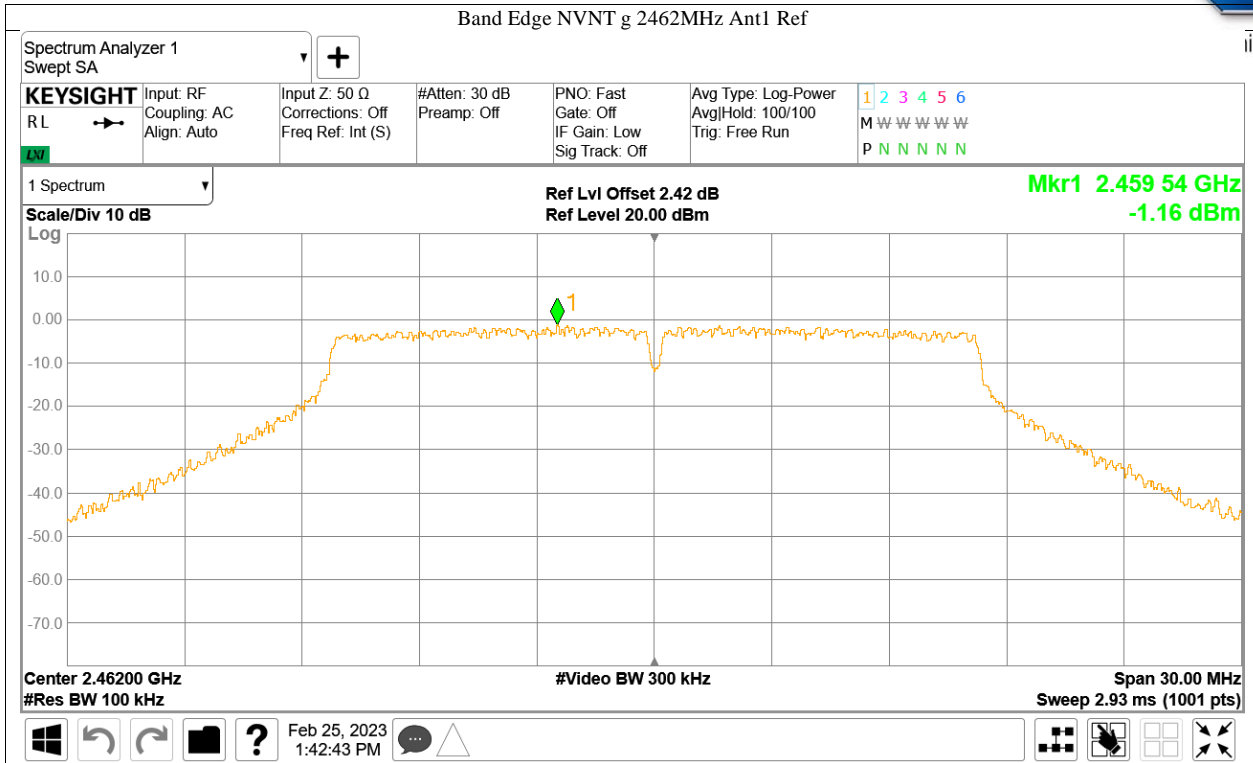


Band Edge NVNT g 2412MHz Ant1 Emission



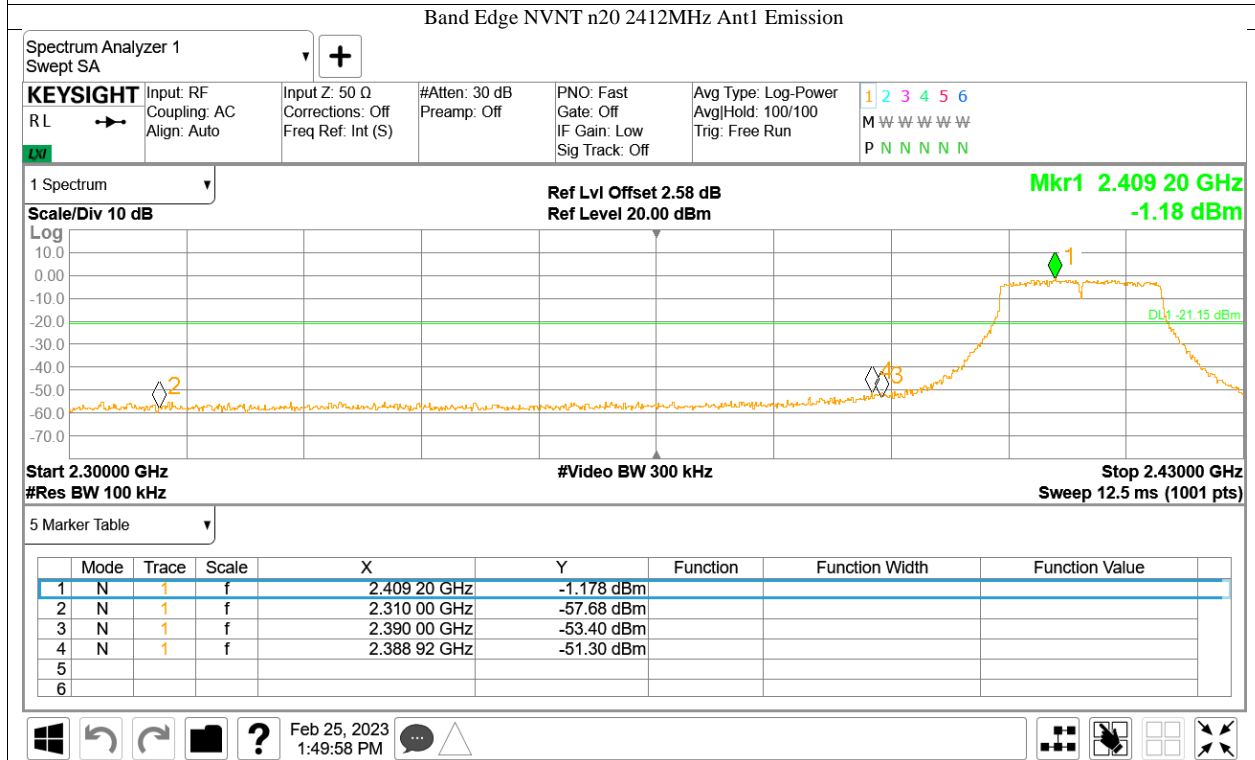
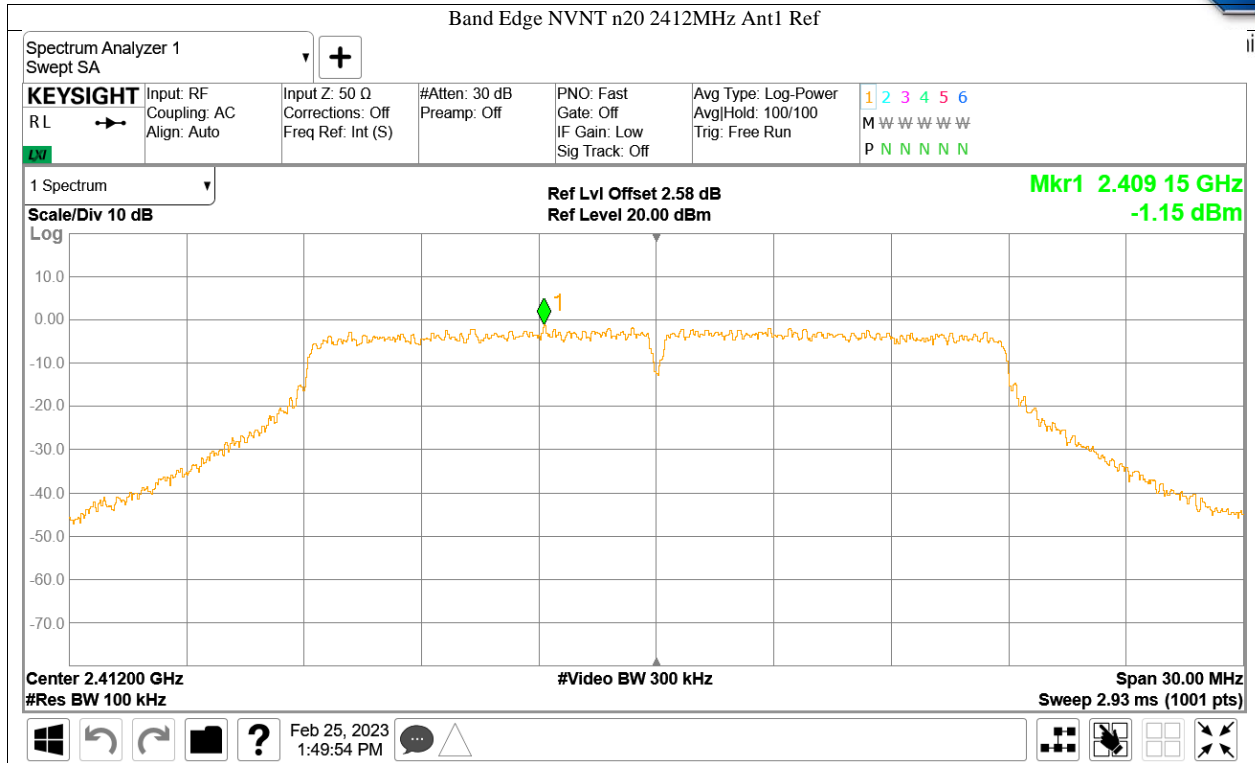


ina





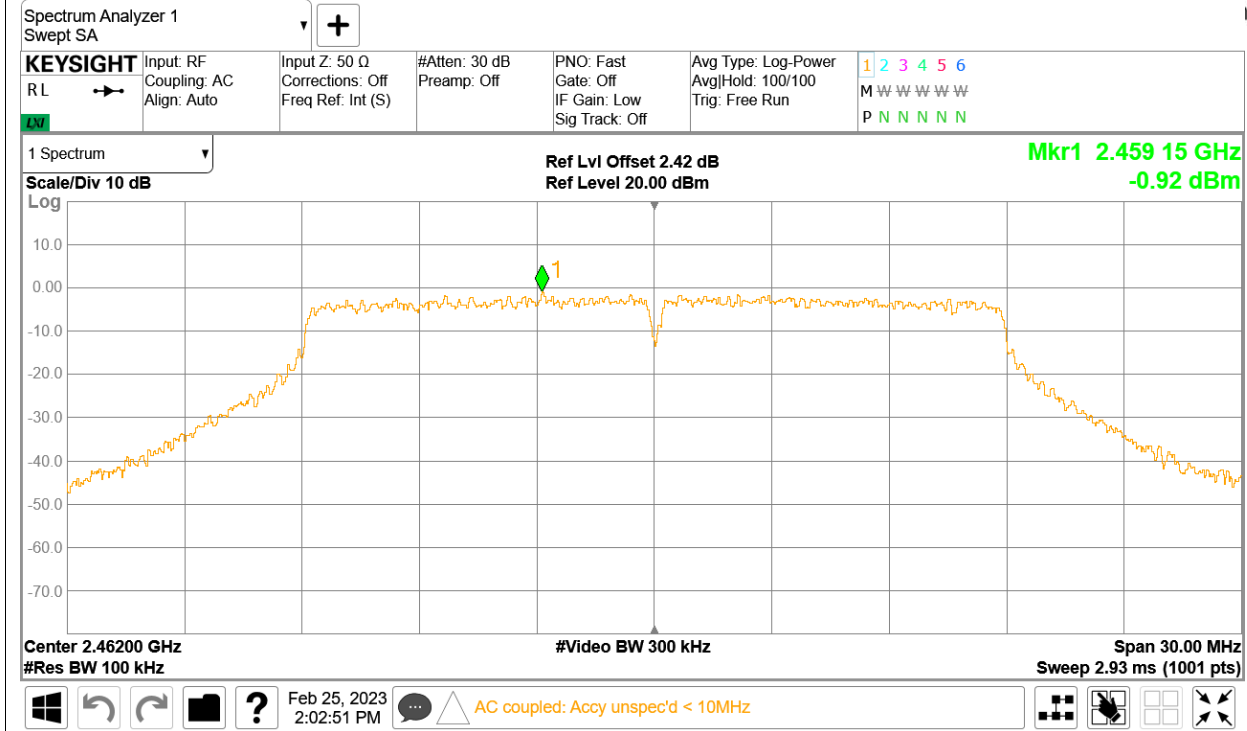
ima



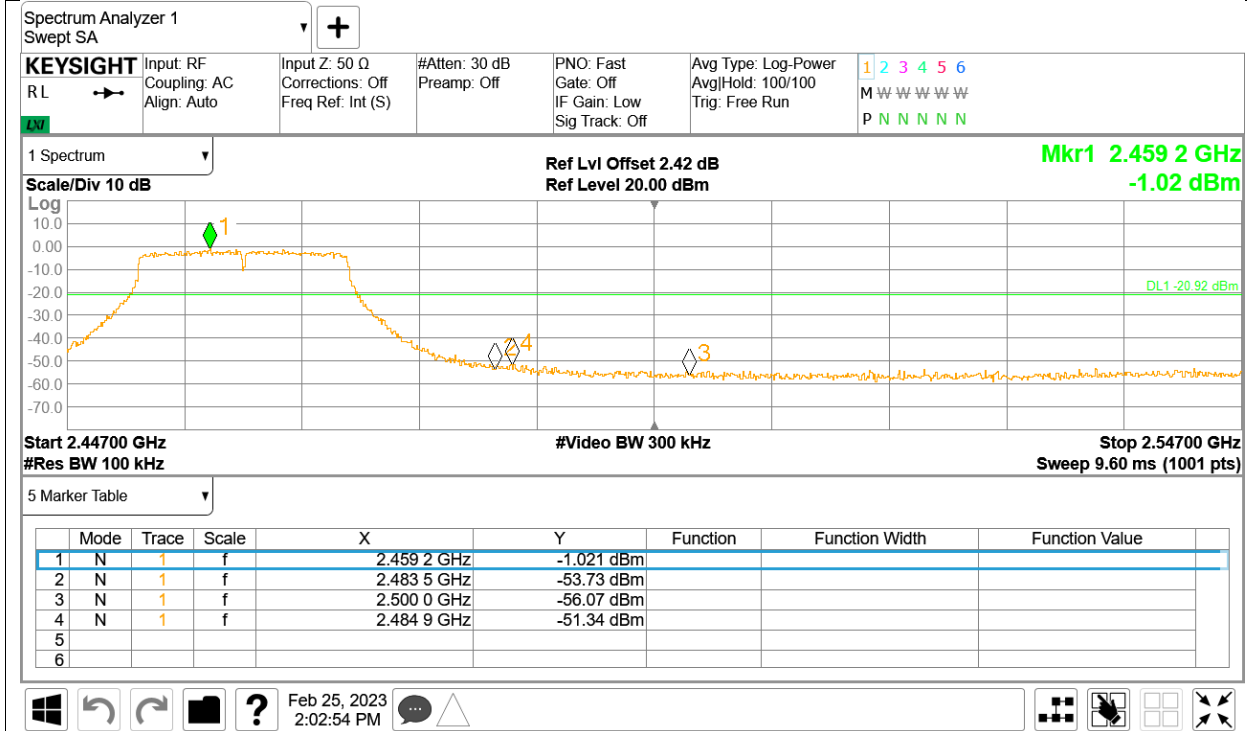


ima

Band Edge NVNT n20 2462MHz Ant1 Ref



Band Edge NVNT n20 2462MHz Ant1 Emission



9.7 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:

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 to 120 kHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

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 1000 MHz

- a) RBW = 1MHz.
- b) VBW ≥ [3 × RBW].
- c) Detector = RMS (power averaging), if $[\text{span} / (\# \text{ of points in sweep})] \leq \text{RBW} / 2$.
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.

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 and RSS-GEN 8.10 must comply with the radiated emission limits specified in section 15.209.

Frequency MHz	Field Strength uV/m	Measured Distance Meters
0.009~0.490	2400/F (kHz)	300
0.490~1.705	24000/F (kHz)	30
1.705~30	30	30

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:

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
2386.74	45.06	74.00	28.94	PK	Hoirznotal
4824.43	46.50	74.00	27.50	PK	Hoirznotal
2385.53	50.79	74.00	23.21	PK	Vertical
4824.43	43.89	74.00	30.11	PK	Vertical

Test mode:802.11B (2437MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
4874.43	47.04	74.00	26.96	PK	Hoirznotal
4874.43	46.38	74.00	27.62	PK	Vertical

Test mode:802.11B (2462MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2483.60	46.26	74.00	27.74	PK	Hoirznotal
4923.60	46.27	74.00	27.73	PK	Hoirznotal
2483.60	52.55	74.00	21.45	PK	Vertical
4924.16	45.02	74.00	28.98	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



Test mode:802.11G (2412MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2384.67	46.14	74.00	27.86	PK	Horiznotal
4824.13	42.02	74.00	31.98	PK	Horiznotal
2389.01	52.17	74.00	21.83	PK	Vertical
4826.13	42.19	74.00	31.81	PK	Vertical

Test mode:802.11G (2437MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
4874.43	41.95	74.00	32.05	PK	Horiznotal
4876.00	41.80	74.00	32.20	PK	Vertical

Test mode:802.11G (2462MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2483.50	46.78	74.00	27.22	PK	Horiznotal
4924.38	42.67	74.00	31.33	PK	Horiznotal
2483.60	54.53	74.00	19.47	PK	Vertical
2483.60	45.80	54.00	8.20	AV	Vertical
4923.60	43.11	74.00	30.89	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

Test mode:802.11N (2412MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2384.94	46.44	74.00	27.56	PK	Horiznotal
4824.43	42.37	74.00	31.63	PK	Horiznotal
2385.68	53.68	74.00	20.32	PK	Vertical
2385.68	43.30	74.00	30.70	AV	Vertical
4823.86	42.44	74.00	31.56	PK	Vertical

Test mode:802.11N (2437MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
4874.11	42.76	74.00	31.24	PK	Horiznotal
4874.23	43.92	74.00	30.08	PK	Vertical

Test mode:802.11N (2462MHz)					
Frequency MHz	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2483.60	48.70	74.00	25.30	PK	Horiznotal
4924.67	42.21	74.00	31.79	PK	Horiznotal
2483.50	56.88	74.00	17.12	PK	Vertical
2483.50	46.60	54.00	7.40	AV	Vertical
4923.60	42.66	74.00	31.34	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:

30-1000MHz Radiated Emission

EUT Information

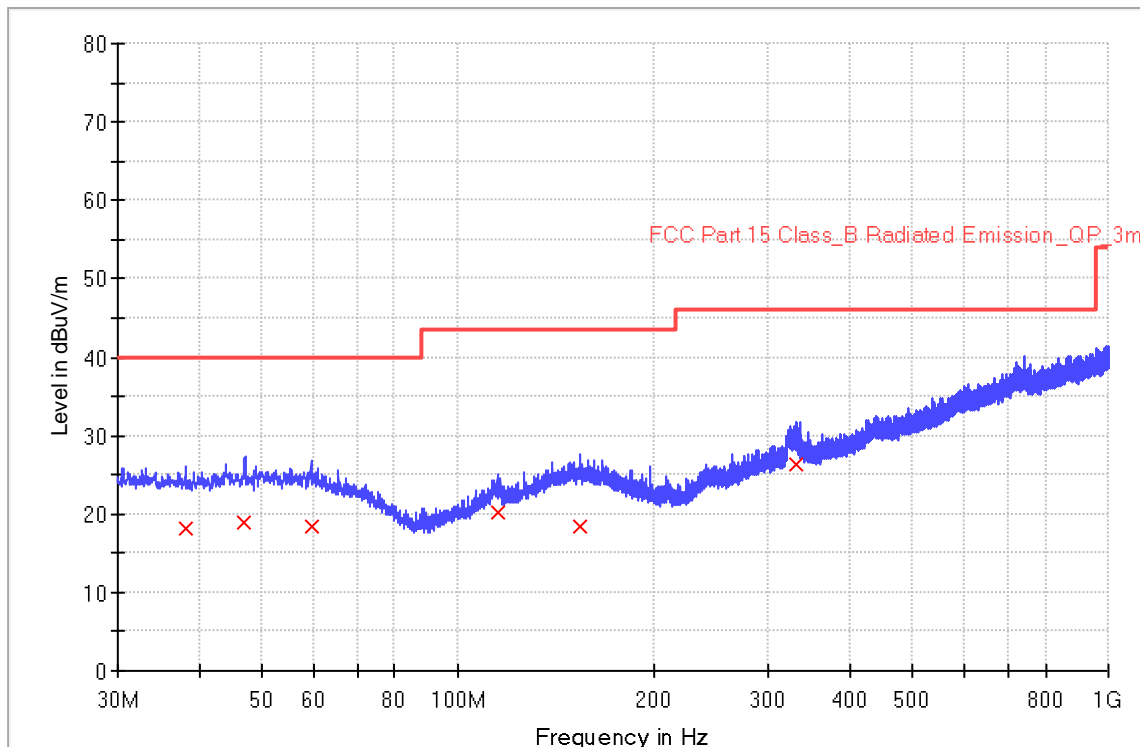
EUT Name:	Communication Stick
Model:	TSW-T1
Client:	Ningbo Lingzhu Technology CO., ITD.
Op Cond:	Power on, TX_G_2462MHz, DC 5V, T20.3, H42.7%, P102.7kPa
Operator:	Cheng Huali
Test Spec:	FCC 15.209(a)
Comment:	Horizontal
Sample No:	SHA-709227-2

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	0.005 s	20 dB

RE_VULB9168_pre_Cont_30-1000





China

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)
38.080000	18.3	1000.0	120.000	159.0	H	284.0	19.7	21.7	40.0
47.040000	18.9	1000.0	120.000	142.0	H	219.0	20.5	21.1	40.0
59.440000	18.4	1000.0	120.000	105.0	H	174.0	20.2	21.6	40.0
114.880000	20.2	1000.0	120.000	100.0	H	119.0	17.7	23.3	43.5
154.400000	18.3	1000.0	120.000	115.0	H	350.0	21.0	25.2	43.5
330.760000	26.4	1000.0	120.000	100.0	H	68.0	22.6	19.6	46.0



30-1000MHz Radiated Emission

EUT Information

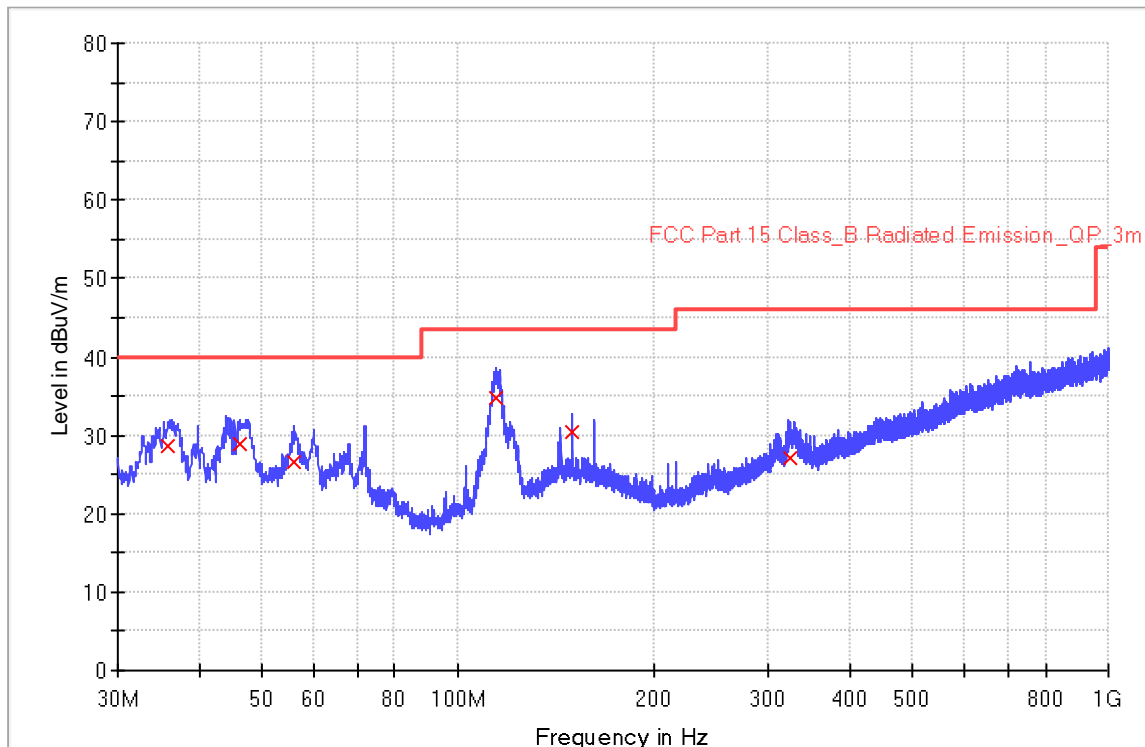
EUT Name:	Communication Stick
Model:	TSW-T1
Client:	Ningbo Lingzhu Technology CO., ITD.
Op Cond:	Power on, TX_G_2462MHz, DC 5V, T20.3, H42.7%, P102.7kPa
Operator:	Cheng Huali
Test Spec:	FCC 15.209(a)
Comment:	Vertical
Sample No:	SHA-709227-2

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	0.005 s	20 dB

RE_VULB9168_pre_Cont_30-1000





China

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)
35.920000	28.6	1000.0	120.000	115.0	V	100.0	19.7	11.4	40.0
46.160000	29.0	1000.0	120.000	157.0	V	144.0	20.4	11.0	40.0
55.960000	26.5	1000.0	120.000	102.0	V	262.0	20.5	13.5	40.0
114.240000	34.8	1000.0	120.000	100.0	V	50.0	17.6	8.7	43.5
149.880000	30.4	1000.0	120.000	146.0	V	204.0	20.9	13.2	43.5
323.880000	27.1	1000.0	120.000	100.0	V	299.0	22.3	18.9	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.



10 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	2023-2-10	2024-2-09
	Wideband power sensor	Rohde & Schwarz	NRP-Z81	105903	2022-03-18	2023-3-17
RE	EMI Test Receiver	Rohde & Schwarz	ESR3	101906	2022-8-1	2023-7-31
	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2022-8-1	2023-7-31
	Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9168	961	2019-9-23	2024-9-22
	Double-ridged waveguide horn antenna	Rohde & Schwarz	HF907	102868	2021-3-15	2024-3-14
	Pre-amplifier	Rohde & Schwarz	SCU-18D	19006451	2022-8-1	2023-7-31
	Loop antenna	Rohde & Schwarz	HFH2-Z2E	100933	2022-6-13	2023-6-12
	DOUBLE-RIDGED WAVEGUIDE HORN WITH PRE-AMPLIFIER (18 GHZ - 40 GHZ)	ETS-Lindgren	3116C-PA	002222727	2020-9-23	2023-9-22
	3m Semi-anechoic chamber	TDK	9X6X6	----	2021-5-8	2024-5-7
CE	EMI Test Receiver	Rohde & Schwarz	ESR3	101907	2022-8-1	2023-7-31
	LISN	Rohde & Schwarz	ENV216	101924	2022-8-1	2023-7-31

Measurement Software Information			
Test Item	Software	Manufacturer	Version
C	MTS 8310	MWRfTest	2.0.0.0
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



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:

Items	Extended Uncertainty
Conducted Disturbance at Mains Terminals	150kHz to 30MHz, LISN, 3.16dB
Radiated Disturbance	9kHz to 30MHz, 3.52dB 30MHz to 1GHz, 5.03dB (Horizontal) 5.12dB (Vertical) 1GHz to 18GHz, 5.49dB 18GHz to 40GHz, 5.63dB
RF Conducted Measurement	Power related: 1.16dB Frequency related: 6.00×10^{-8}

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.



12 Photographs of Test Set-ups

Refer to the < Test Setup photos >.



13 Photographs of EUT

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

THE END