



FCC - TEST REPORT

Report Number : **709502306225-00D** Date of Issue: January 22, 2024

Model : LKOUT P

Product Type : Wireless Display

Applicant : Fellowes Inc

Address : 1789 Norwood Avenue Itasca, IL 60143 United States

Production Facility : Fellowes Office Products(Suzhou) Co, Ltd

Address : 1# Shilin Road, Suzhou New & Hi-tech District,
215151 Suzhou, Jiangsu, People's Republic of China

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

Total pages including
Appendices : 68



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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
1	First Issue	01/22/2024

3 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

Telephone: +86 21 6141 0123

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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: Wireless Display

Model no.: LKOUT P

FCC ID: IDH-RMTDSPY

Options and accessories: NA

Rating: DC 12V for Wireless Display
100-240V~, 50/60Hz for adapter

RF Transmission Frequency: 2402~2480MHz for Bluetooth
For 2.4G & 5G Wi-Fi
For 802.11b/g/n-HT20: 2412~2462 MHz
For 802.11n-HT40: 2422~2452 MHz
5180~5240 MHz (U-NII-1)
5745~5825 MHz (U-NII-3)
WCDMA Band II/IV/V
LTE Band 2/4/5/12/13/14/66/71

No. of Operated Channel: 79 channels for Bluetooth 2.1+EDR

Ch	Fre (MH)	Ch	Fre (MH)	Ch	Fre (MH)	Ch	Fre (MH)	Ch	Fre (MH)
1	2402	17	2418	33	2434	49	2450	65	2466
2	2403	18	2419	34	2435	50	2451	66	2467
3	2404	19	2420	35	2436	51	2452	67	2468
4	2405	20	2421	36	2437	52	2453	68	2469
5	2406	21	2422	37	2438	53	2454	69	2470
6	2407	22	2423	38	2439	54	2455	70	2471
7	2408	23	2424	39	2440	55	2456	71	2472
8	2409	24	2425	40	2441	56	2457	72	2473
9	2410	25	2426	41	2442	57	2458	73	2474
10	2411	26	2427	42	2443	58	2459	74	2475
11	2412	27	2428	43	2444	59	2460	75	2476
12	2413	28	2429	44	2445	60	2461	76	2477
13	2414	29	2430	45	2446	61	2462	77	2478
14	2415	30	2431	46	2447	62	2463	78	2479
15	2416	31	2432	47	2448	63	2464	79	2480
16	2417	32	2433	48	2449	64	2465		

40 channels for Bluetooth 4.2 BLE

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

2.4GHz WIFI: 11 for 802.11b/802.11g/802.11(H20);
7 for 802.11n(HT40)

802.11b/g/n(HT20)				802.11n(HT40)			
Ch	Fre(MHz)	Ch	Fre(MHz)	Ch	Fre(MHz)	Ch	Fre(MHz)
1	2412	7	2442	3	2422	8	2447MHz
2	2417	8	2447	4	2427	9	2452MHz
3	2422	9	2452	5	2432		
4	2427	10	2457	6	2437		
5	2432	11	2462	7	2442		
6	2437						

5180~5240 MHz (U-NII-1):

4 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20):

Channel	Frequency (MHz)	Channel	Frequency (MHz)
36	5180	44	5220
40	5200	48	5240

2 channels are provided for 802.11n (HT40), 802.11ac (VHT40):

Channel	Frequency (MHz)	Channel	Frequency (MHz)
38	5190	46	5230

1 channel is provided for 802.11ac (VHT80):

Channel	Frequency (MHz)
42	5210

5745~5825 MHz (U-NII-3): Channel 149 – 165

5 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20):

Channel	Frequency (MHz)	Channel	Frequency (MHz)
149	5745	161	5805
153	5765	165	5825
157	5785		

2 channels are provided for 802.11n (HT40), 802.11ac (VHT40):

Channel	Frequency (MHz)	Channel	Frequency (MHz)
151	5755	159	5795

1 channel is provided for 802.11ac (VHT80):

Channel	Frequency (MHz)
155	5755

Modulation:	Bluetooth 2.1+EDR FHSS: GFSK, $\pi/4$ DQPSK, 8DPSK Bluetooth 4.2+BLE DHSS: GFSK For Wi-Fi: Direct Sequence Spread Spectrum (DSSS) for 802.11b Orthogonal Frequency Division Multiplexing (OFDM) for 802.11a/b/g/n/ac
Hardware Version:	V2.0
Software Version:	11.0.1_#7210_10.1_2168A1-V2.0
Data speed:	1. Bluetooth 2.1+EDR FHSS: 1Mbps, 2Mbps, 3Mbps 2. Bluetooth 4.2+BLE DHSS: 1Mbps 3. Wi-Fi: 11b 1 ~ 11Mbps, 11g/a 6 ~ 54Mbps, 11n HT20 6.5 ~ 72.2Mbps, 11n HT 40 13.5 ~ 150Mbps, 11ac VHT40 13.5 ~ 200Mbps, 11ac VHT80 29.3 ~ 433.3Mbps
Antenna Type:	PCB Antenna
Antenna Gain:	1.99dBi for 2.4GHz; 1.98dBi for 5GHz
Description of the EUT:	The Equipment Under Test (EUT) is an Infrared Thermal Camera with Bluetooth and Wi-Fi Module. The EUT support Bluetooth 4.2+EDR and support BLE function and Wi-Fi operated at 5GHz and 2.4GHz. Only Bluetooth 4.2+EDR included in this report.
Test sample no.:	SHA-749413-2 (RF Conducted); SHA-749413-3 (RF Radiated)

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.



5 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2021 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 C63.10-2020.



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	14-18	Site 1	☒	☐	☐
§15.247 (b) (1)	Conducted peak output power	19-23	Site 1	☒	☐	☐
§15.247(a)(1)	20dB bandwidth	24-28	Site 1	☒	☐	☐
§15.247(a)(1)	Carrier frequency separation	29-31	Site 1	☒	☐	☐
§15.247(a)(1)(iii)	Number of hopping frequencies	32-33	Site 1	☒	☐	☐
§15.247(a)(1)(iii)	Dwell Time - Average Time of Occupancy	34-37	Site 1	☒	☐	☐
§15.247(a)(2)	6dB bandwidth	---	---	☐	☐	☒
§15.247(e)	Power spectral density	---	---	☐	☐	☒
§15.247(e)	Spurious RF conducted emissions	38-44	Site 1	☒	☐	☐
§15.247(d)	Band edge	45-57	Site 1	☒	☐	☐
§15.247(d) & §15.209 & §15.205	Spurious radiated emissions for transmitter	58-64	Site 1	☒	☐	☐
§15.203	Antenna requirement	See note 1		☒	☐	☐

Remark 1: N/A – Not Applicable.

Note 1: The EUT uses a PCB antenna, which gain is 1.99dBi for 2.4GHz and 1.98dBi for 5GHz. 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: IDH-RMTDSPY complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C rules.

This report is only for Bluetooth 2.1+EDR.

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: August 10, 2023

Testing Start Date: August 14, 2023

Testing End Date: December 21, 2023

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

Reviewed by:

Prepared by:

Tested by:



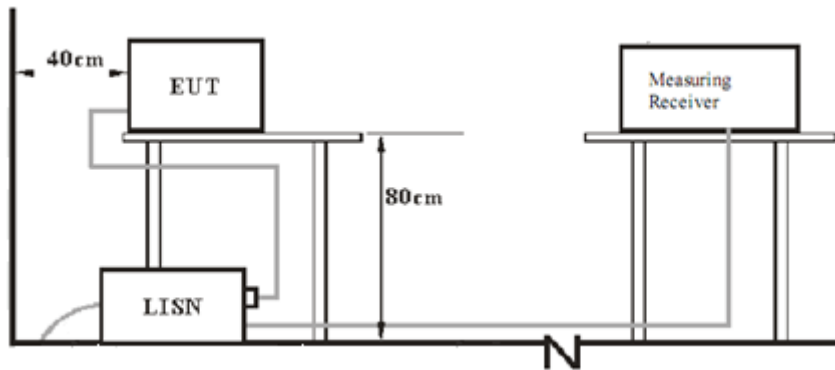
Hui TONG
Review Engineer

Jiayi XU
Project Engineer

Cheng Huali
Test Engineer

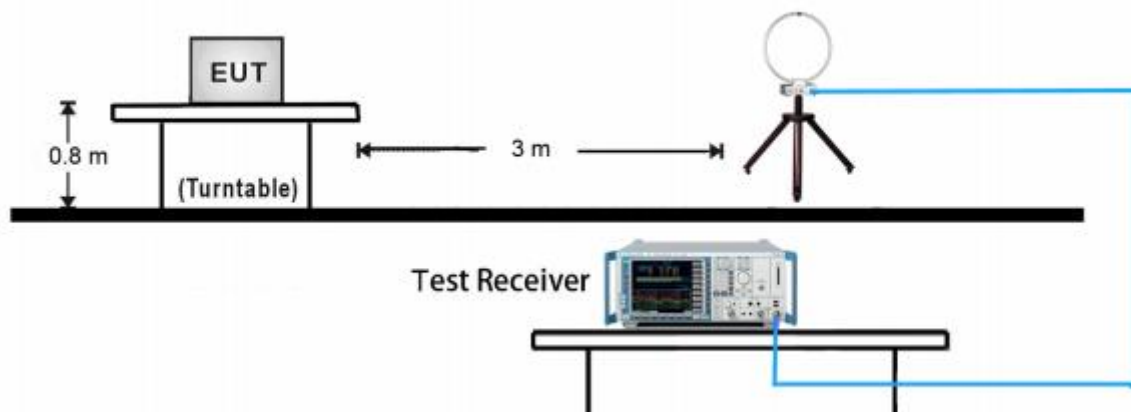
8 Test Setups

7.1 AC Power Line Conducted Emission test setups

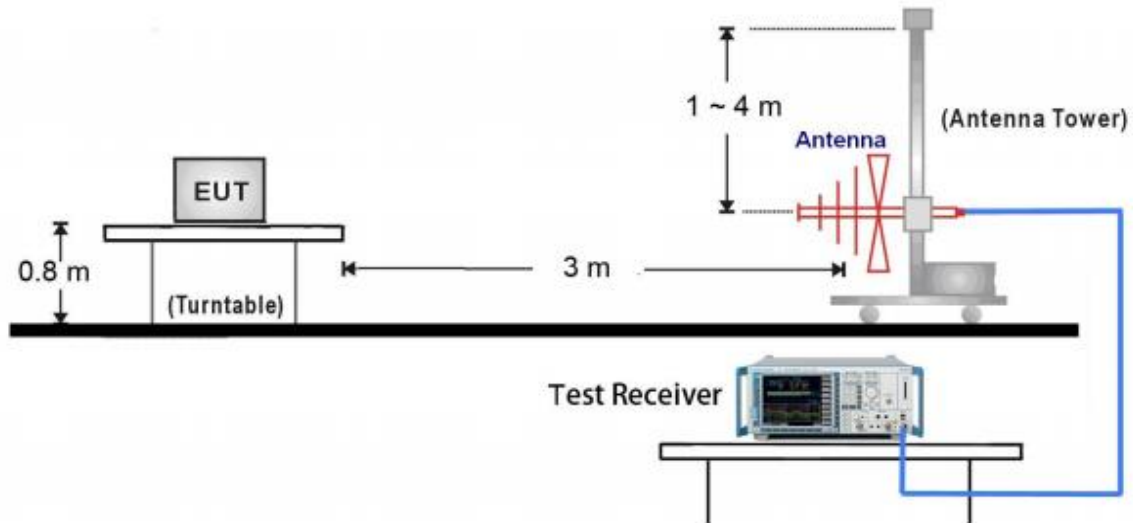


7.2 Radiated test setups

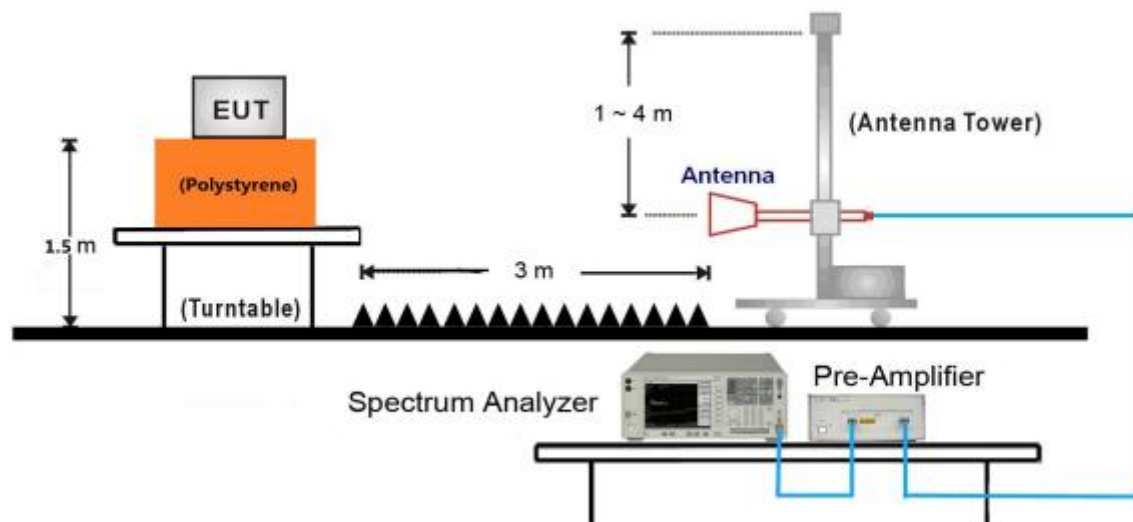
9kHz ~ 30MHz Test Setup:



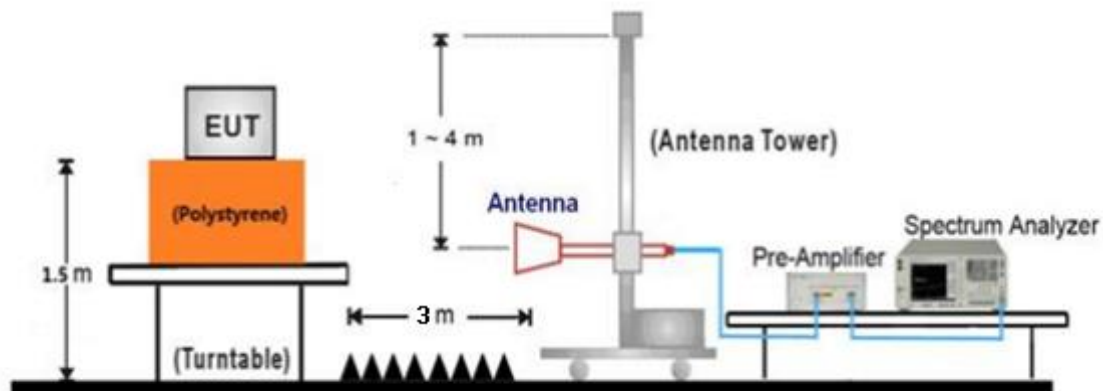
30MHz ~ 1GHz Test Setup:



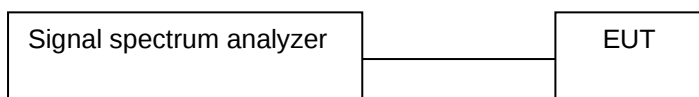
1GHz ~ 18GHz Test Setup:



18GHz ~ 25GHz Test Setup:



7.3 Conducted RF test setups



9 Systems test configuration

Auxiliary Equipment Used during Test:

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

Test software: adb commend, which used to control the EUT in continues transmitting mode

The system was configured to hopping mode and non-hopping mode.

Hopping mode: typical working mode (normal hopping status)

Mode	Tested Channel	Modulation	Index Value (Power level setting)
DH5	0	GFSK	0x17
	40	GFSK	0x17
	78	GFSK	0x17
2DH5	0	$\pi/4$ -DQPSK	0x18
	40	$\pi/4$ -DQPSK	0x18
	78	$\pi/4$ -DQPSK	0x18
3DH5	0	8DPSK	0x18
	40	8DPSK	0x18
	78	8DPSK	0x18

The system was configured to hopping mode and non-hopping mode.

Hopping mode: typical working mode (normal hopping status)

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 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. Both sides of AC line were checked for maximum conducted interference.
6. The frequency range from 150 kHz to 30 MHz was searched.
7. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

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

*Decreases with the logarithm of the frequency.



Conducted Emission

150k-30MHz Conducted Emission Test

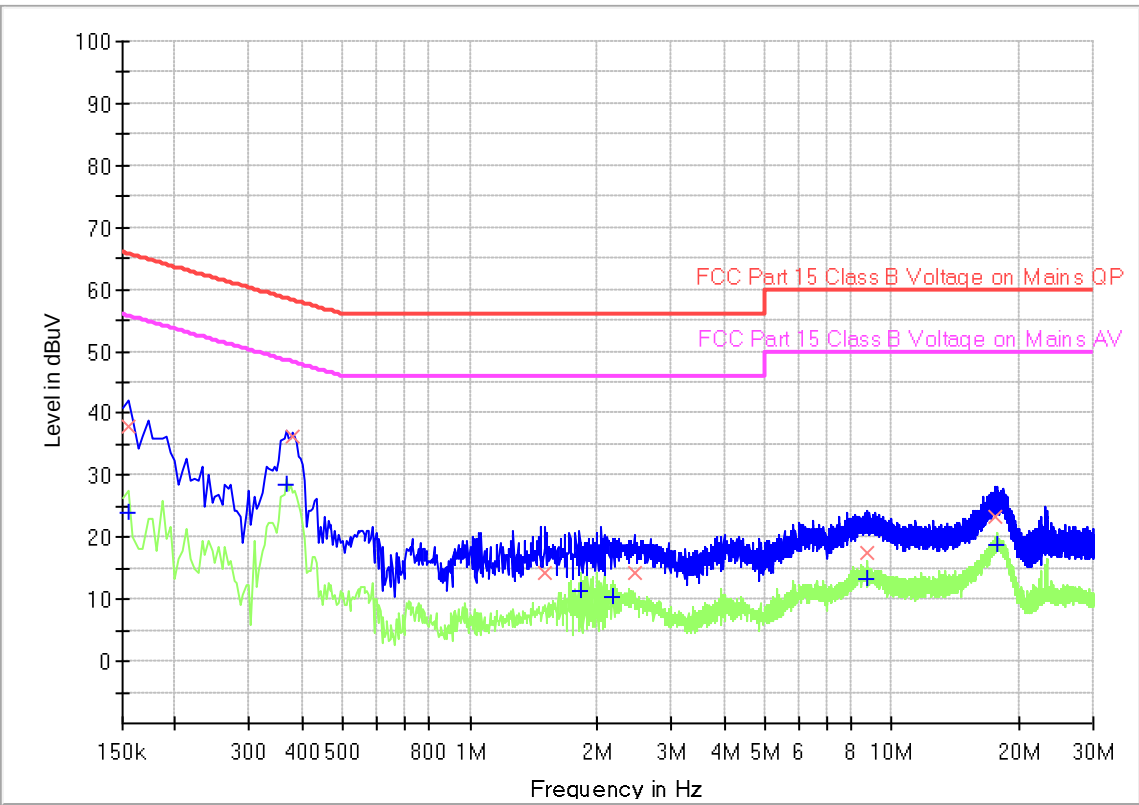
EUT Information

EUT Name: Wireless Display
Model: LKOUT P
Client: Fellowes Inc.
Op Cond: Power on, transmitting 2402MHz at DH5, AC 120V/560Hz, T24.1, H39.1%, P102.5kPa
Operator: Cheng Huali
Standard: FCC Part 15.207(a)
Comment: Phase L
Sample No.: SHA-749413-2

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	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	---	23.95	55.75	31.80	1000.0	9.000	L1	19.4
0.154500	37.85	---	65.75	27.90	1000.0	9.000	L1	19.4
0.366000	---	28.65	48.59	19.94	1000.0	9.000	L1	19.5
0.379500	36.23	---	58.29	22.06	1000.0	9.000	L1	19.5
1.509000	14.21	---	56.00	41.79	1000.0	9.000	L1	19.5
1.828500	---	11.47	46.00	34.53	1000.0	9.000	L1	19.5
2.179500	---	10.36	46.00	35.64	1000.0	9.000	L1	19.5
2.449500	14.15	---	56.00	41.85	1000.0	9.000	L1	19.5
8.718000	17.57	---	60.00	42.43	1000.0	9.000	L1	19.8
8.754000	---	13.45	50.00	36.55	1000.0	9.000	L1	19.8
17.619000	23.42	---	60.00	36.58	1000.0	9.000	L1	20.2
17.731500	---	18.75	50.00	31.25	1000.0	9.000	L1	20.2

150k-30MHz Conducted Emission Test

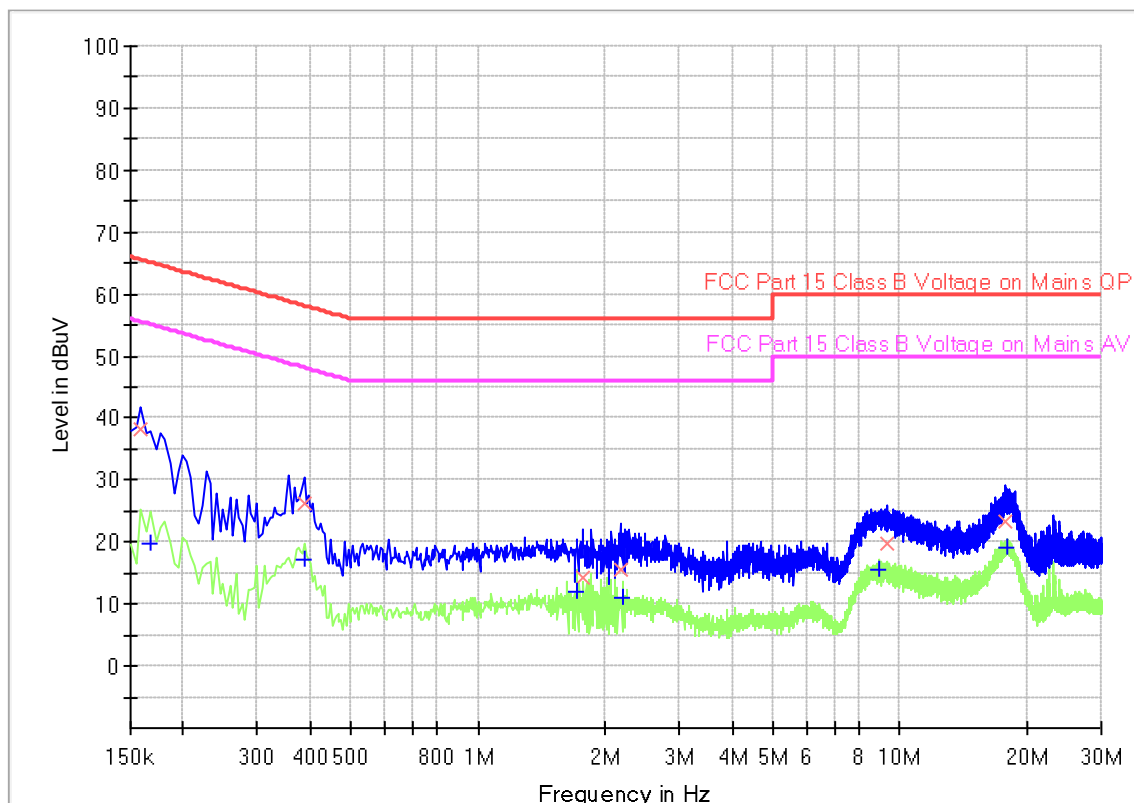
EUT Information

EUT Name:	Wireless Display
Model	LKOUT P
Client:	Fellowes Inc.
Op Cond	Power on, transmitting 2402MHz at DH5, AC 120V/560Hz, T24.1, H39.1%, P102.5kPa
Operator:	Cheng Huali
Standard	FCC Part 15.207(a)
Comment:	Phase N
Sample No.:	SHA-749413-2

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	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)
0.159000	38.06	---	65.52	27.46	1000.0	9.000	N	19.4
0.168000	---	19.84	55.06	35.22	1000.0	9.000	N	19.4
0.388500	---	17.22	48.10	30.88	1000.0	9.000	N	19.4
0.388500	26.37	---	58.10	31.73	1000.0	9.000	N	19.4
1.711500	---	11.94	46.00	34.06	1000.0	9.000	N	19.5
1.770000	14.23	---	56.00	41.77	1000.0	9.000	N	19.5
2.170500	15.55	---	56.00	40.45	1000.0	9.000	N	19.5
2.206500	---	10.91	46.00	35.09	1000.0	9.000	N	19.5
8.920500	---	15.42	50.00	34.58	1000.0	9.000	N	19.7
9.339000	19.80	---	60.00	40.20	1000.0	9.000	N	19.7
17.709000	23.46	---	60.00	36.54	1000.0	9.000	N	20.0
17.992500	---	19.13	50.00	30.87	1000.0	9.000	N	20.0

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)

10.2 Conducted Peak Output Power

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 and enable the EUT transmit continuously
3. Use the following test receiver settings:
Span = approximately 5 times the 20dB bandwidth, centered on a hopping channel
RBW > the 20dB bandwidth of the emission being measured, VBW ≥ RBW,
Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power and record the results in the test report.
5. Repeat above procedures until all frequencies measured were complete.

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

Conducted Peak Output Power

Bluetooth Mode GFSK modulation Test Result

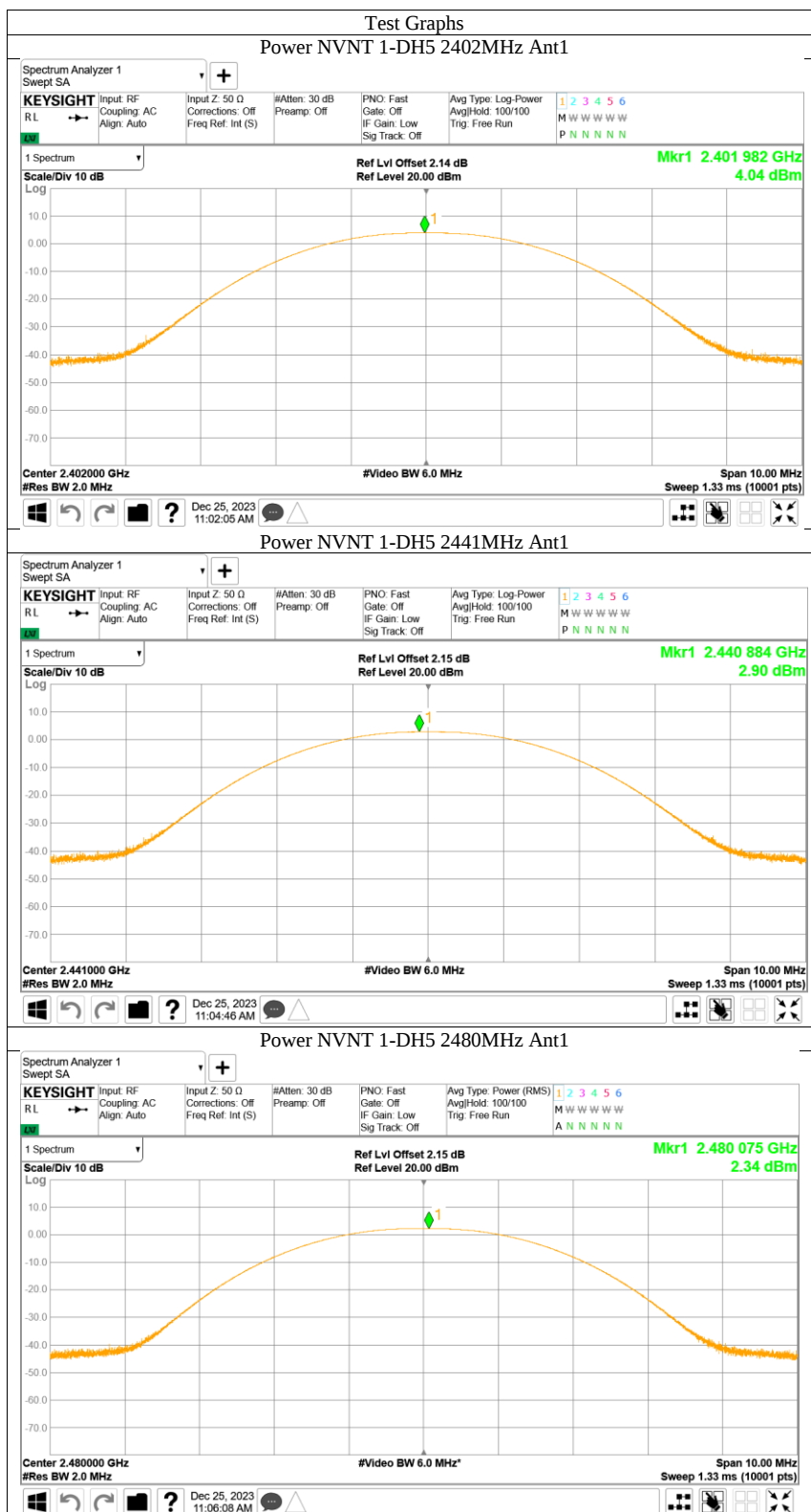
Frequency MHz	Conducted Peak Output Power dBm	Limit dBm	Result
Low channel 2402MHz	4.04	30	Pass
Middle channel 2441MHz	2.90	30	Pass
High channel 2480MHz	2.34	30	Pass

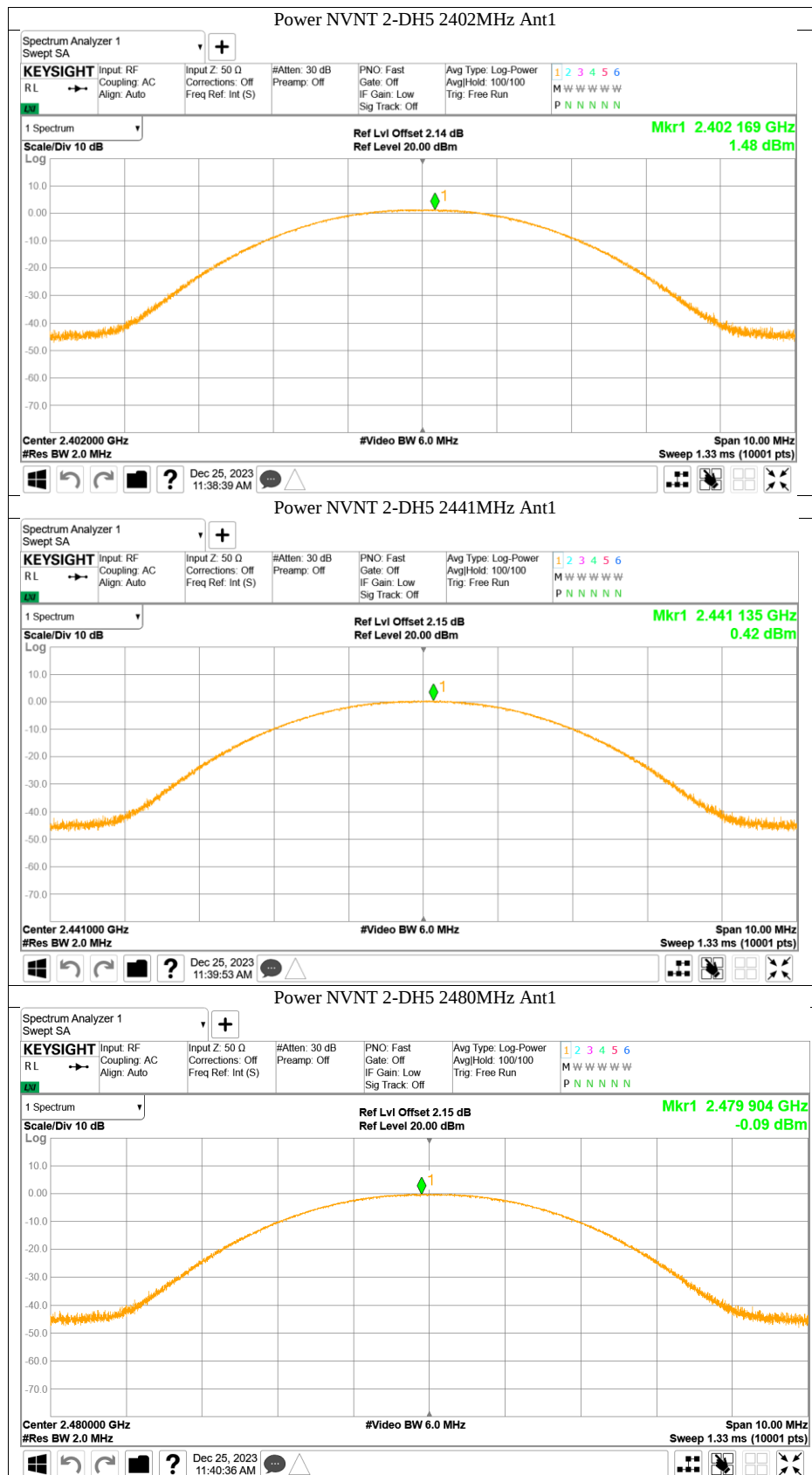
Bluetooth Mode $\pi/4$ -DQPSK modulation Test Result

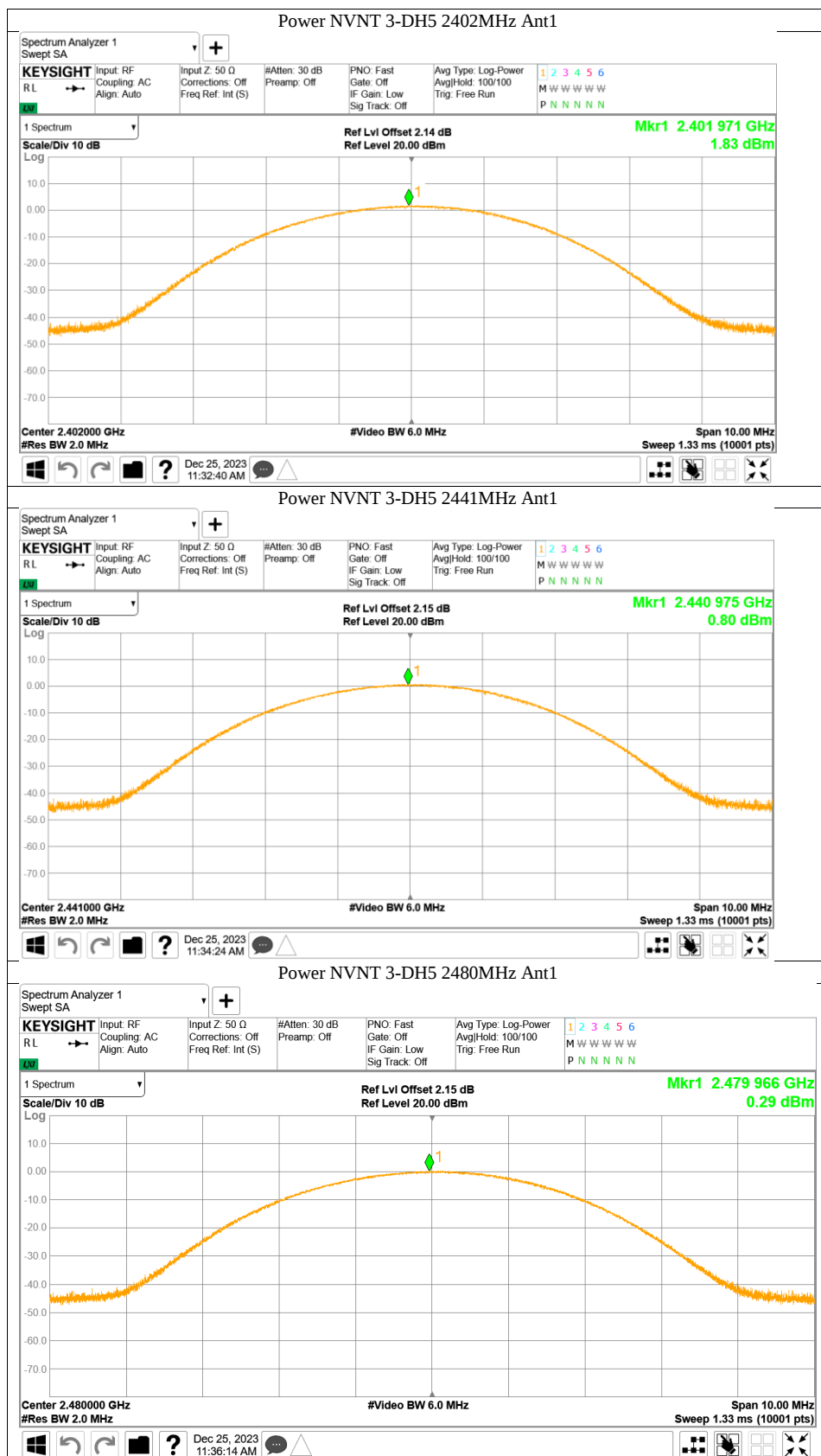
Frequency MHz	Conducted Peak Output Power dBm	Limit dBm	Result
Low channel 2402MHz	1.48	30	Pass
Middle channel 2441MHz	0.42	30	Pass
High channel 2480MHz	-0.09	30	Pass

Bluetooth Mode 8DPSK modulation Test Result

Frequency MHz	Conducted Peak Output Power dBm	Limit dBm	Result
Low channel 2402MHz	1.83	30	Pass
Middle channel 2441MHz	0.80	30	Pass
High channel 2480MHz	0.28	30	Pass









10.3 20 dB bandwidth

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 and enable the EUT transmit continuously.
- 3. Use the following test receiver settings:
Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
RBW ≥ 1% to 5% of the 20 dB bandwidth/99% OBW, VBW≥3RBW,
Sweep = auto, Detector function = peak, Trace = max hold
- 4. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Measure the frequency difference of two frequencies that were attenuated 20 dB/99% OBW from the reference level. Record the frequency difference as the emission bandwidth. Record the results.
- 5. Repeat above procedures until all frequencies measured were complete.

Limit

Limit [MHz]

N/A

20 dB bandwidth

Bluetooth Mode GFSK Modulation test result

Frequency MHz	20 dB Bandwidth MHz	Result
2402	1.03	Pass
2441	1.033	Pass
2480	1.034	Pass

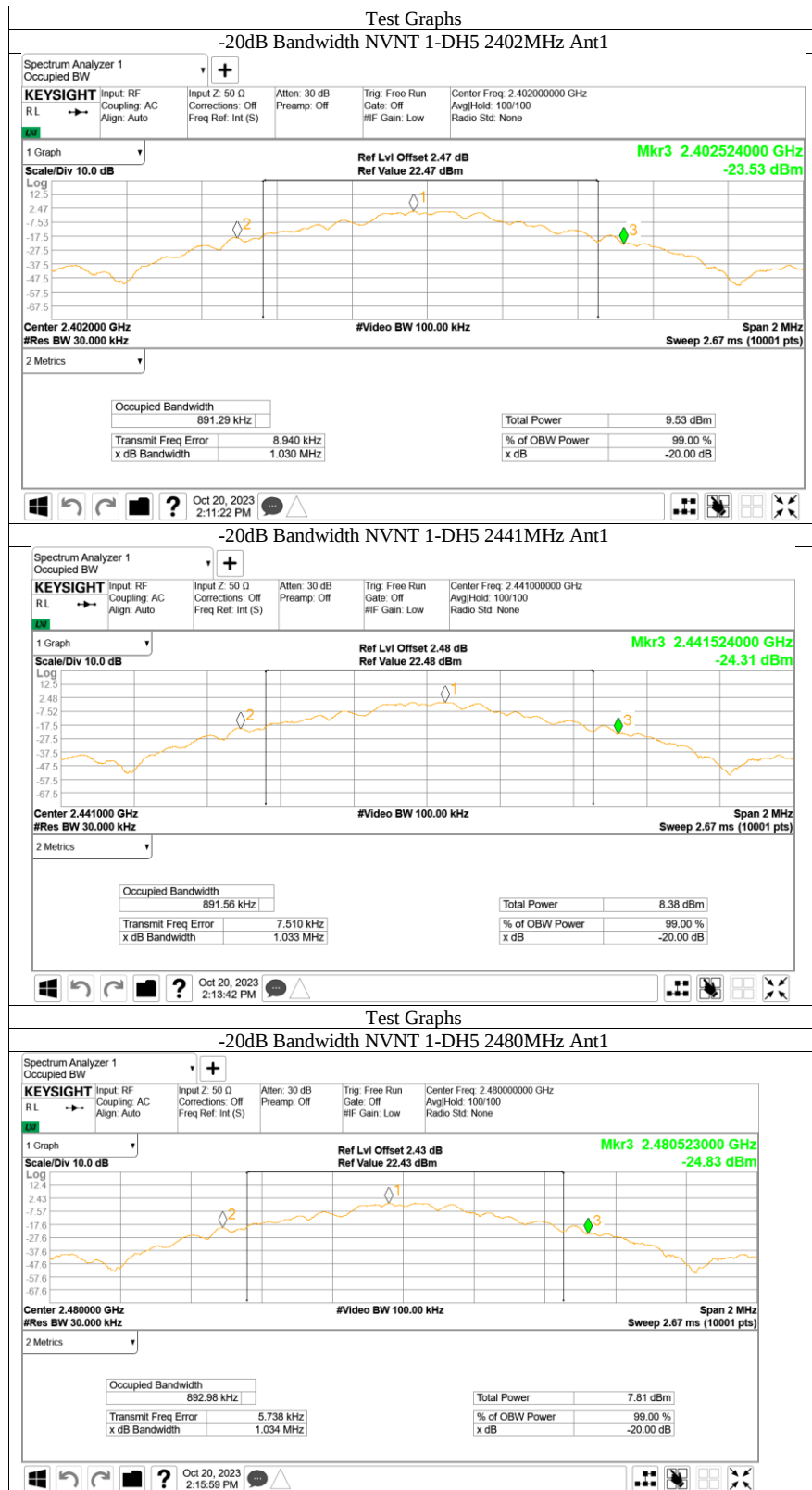
20 dB bandwidthBluetooth Mode $\pi/4$ -DQPSK Modulation test result

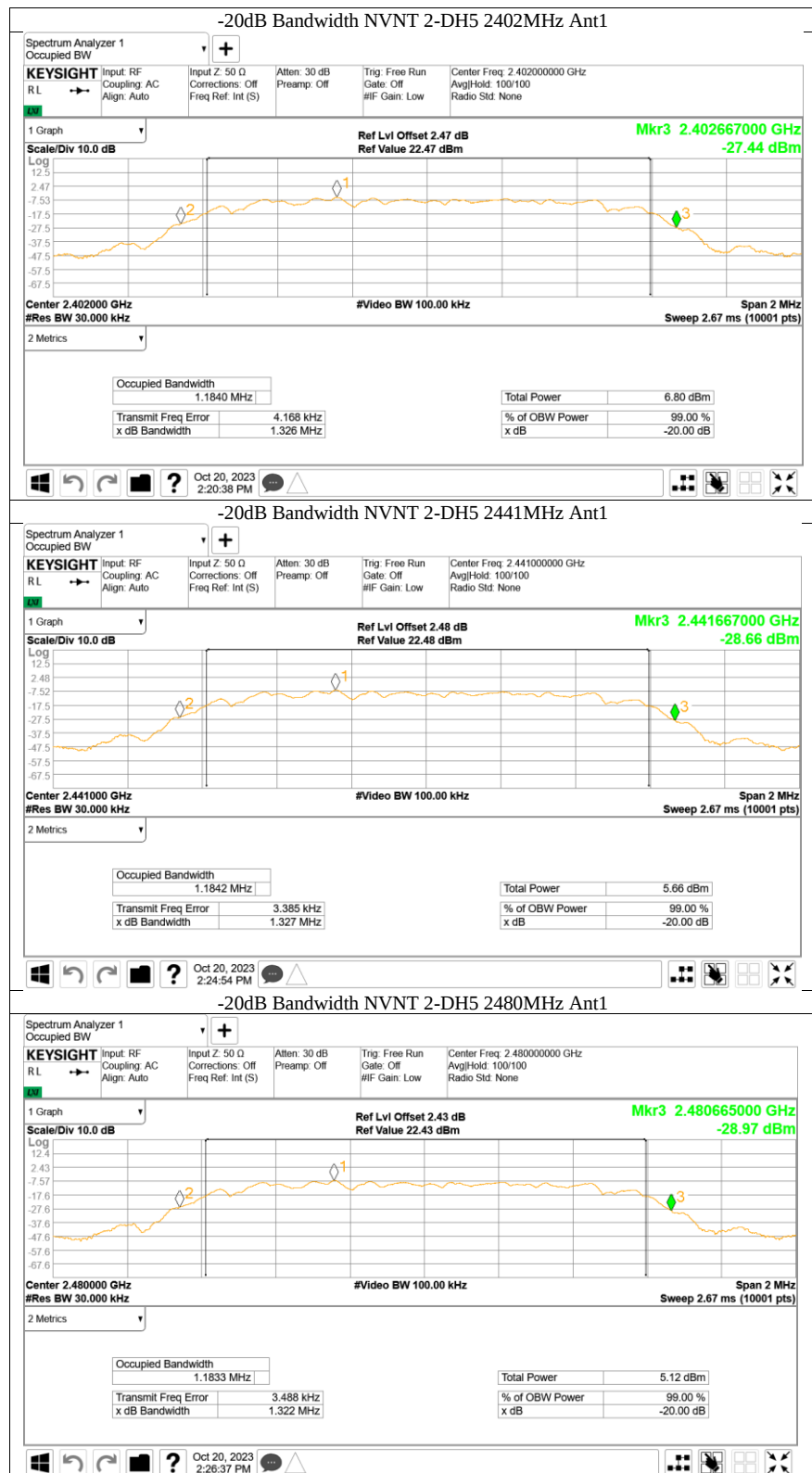
Frequency MHz	20 dB Bandwidth MHz	Result
2402	1.326	Pass
2441	1.327	Pass
2480	1.322	Pass

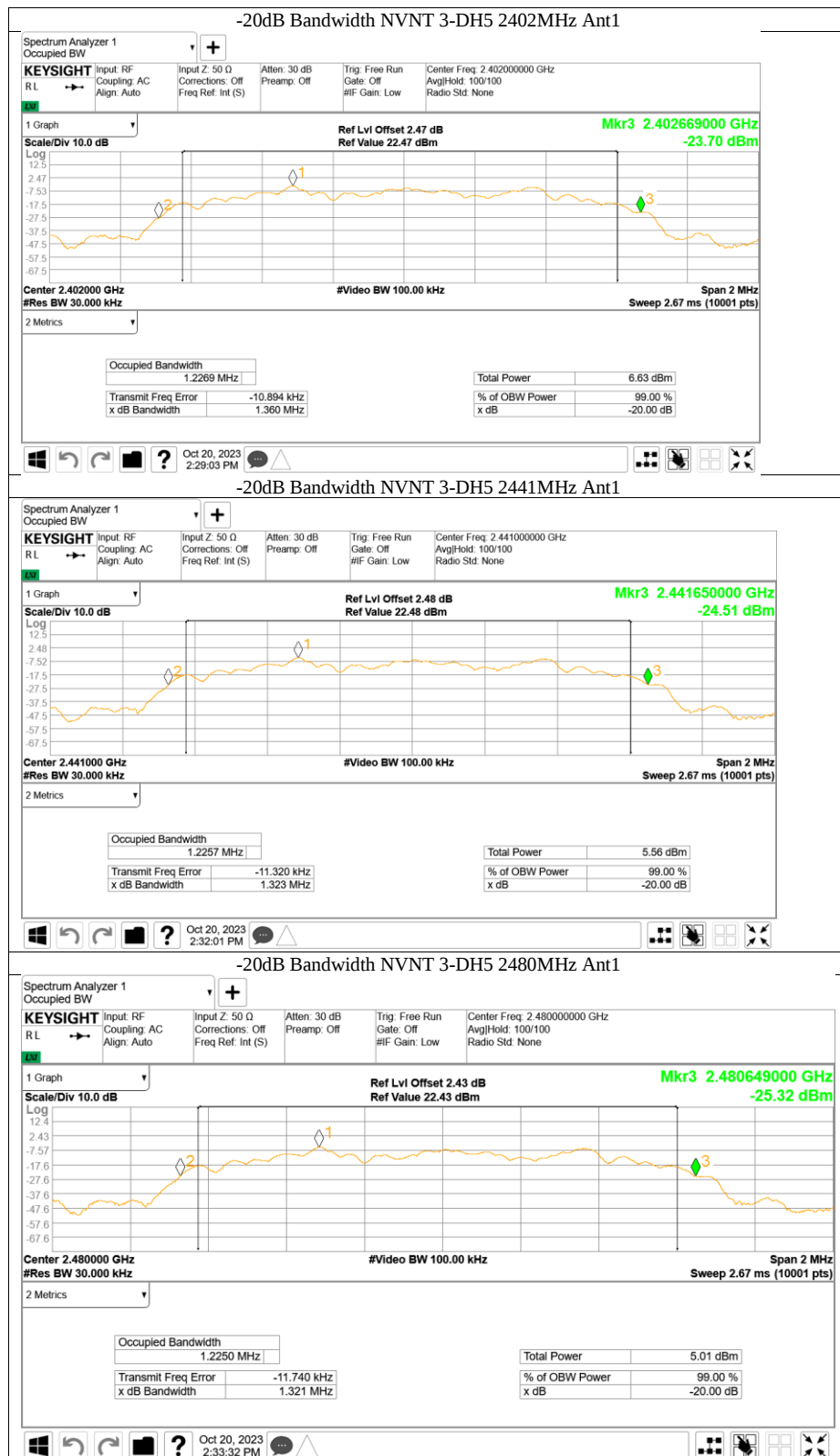
20 dB bandwidth

Bluetooth Mode 8DPSK Modulation test result

Frequency MHz	20 dB Bandwidth MHz	Result
2402	1.36	Pass
2441	1.323	Pass
2480	1.321	Pass

-20dB Bandwidth





10.4 Carrier Frequency Separation

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 and enable the EUT transmit to hopping mode.
3. Use the following spectrum analyzer settings:
Span = wide enough to capture the peaks of two adjacent channels, RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel. VBW $\geq$ RBW, Sweep = auto, Detector function = peak.
4. By using the Max-Hold function record the separation of two adjacent channels.
5. Measure the frequency difference of these two adjacent channels by spectrum analyzer marker function. Record the results.
6. Repeat above procedures until all frequencies measured were complete.

Limit

Limit
kHz

$\geq 25\text{kHz}$ or $2/3$ of the 20 dB bandwidth which is greater

Limit

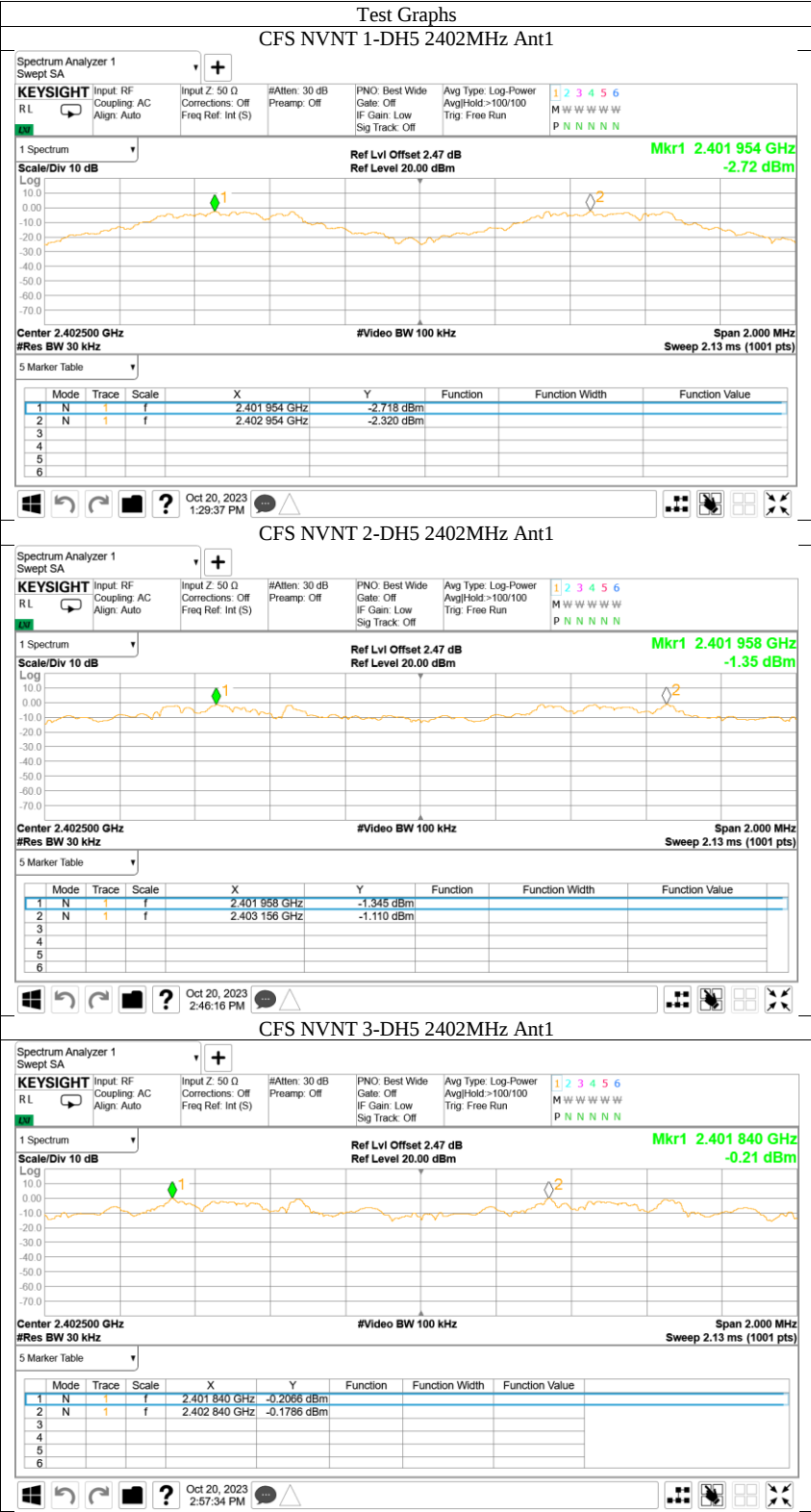
Modulation	2/3 of 20 dB Bandwidth kHz
GFSK	687
$\pi/4$ -DQPSK	884
8DPSK	907

Carrier Frequency Separation

Test result: The measurement was performed with the typical configuration (normal hopping status), here GFSK, $\pi/4$ -DQPSK and 8DPSK modulation mode (low channel) was used to show compliance.

GFSK Modulation test result

Modulation	Frequency MHz	Carrier Frequency Separation kHz	Result
GFSK	2402	1000	Pass
$\pi/4$ -DQPSK	2402	1198	Pass
8DPSK	2402	1000	Pass



10.5 Number of hopping frequencies

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 and enable the EUT transmit to hopping mode.
3. Use the following spectrum analyzer settings:
Span = the frequency band of operation, RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller, VBW $\geq$ RBW, Sweep = auto, Detector function = peak, Trace=Max hold.
4. Allow the trace to stabilize. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

Limit

Limit
number

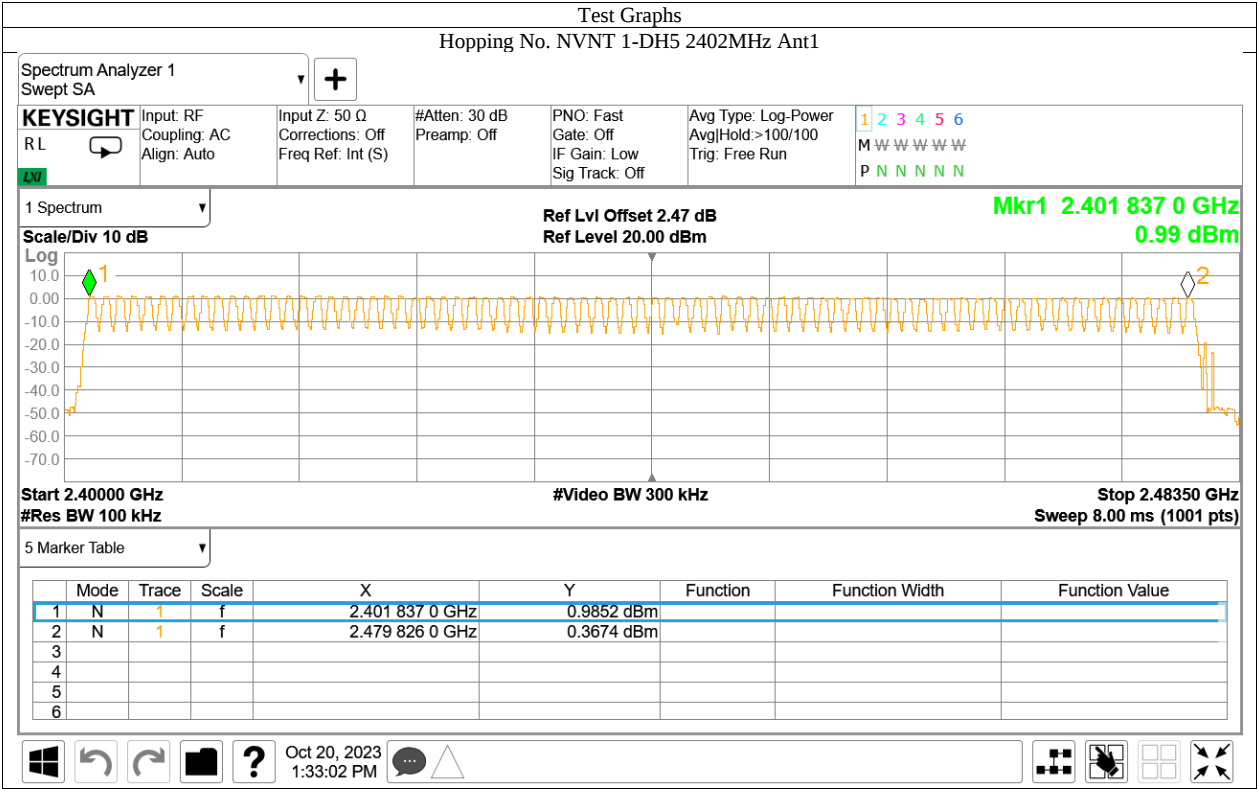
 ≥ 15



Number of hopping frequencies

Test result: The measurement was performed with the typical configuration (normal hopping status), and the total hopping channels is constant for the all modulation mode according with the Bluetooth Core Specification. Here GFSK modulation mode was used to show compliance.

Number of hopping frequencies	Result
79	Pass



10.6 Dwell Time

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 and enable the EUT transmit to hopping mode.
3. Span: Zero span, centered on a hopping channel.
4. RBW shall be $\leq$ channel spacing and where possible RBW should be set $\gg 1 / T$, where T is the expected dwell time per channel.
5. Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
6. Detector function: Peak.
7. Trace: Max hold. Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Limit

The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.



Dwell Time

Dwell time

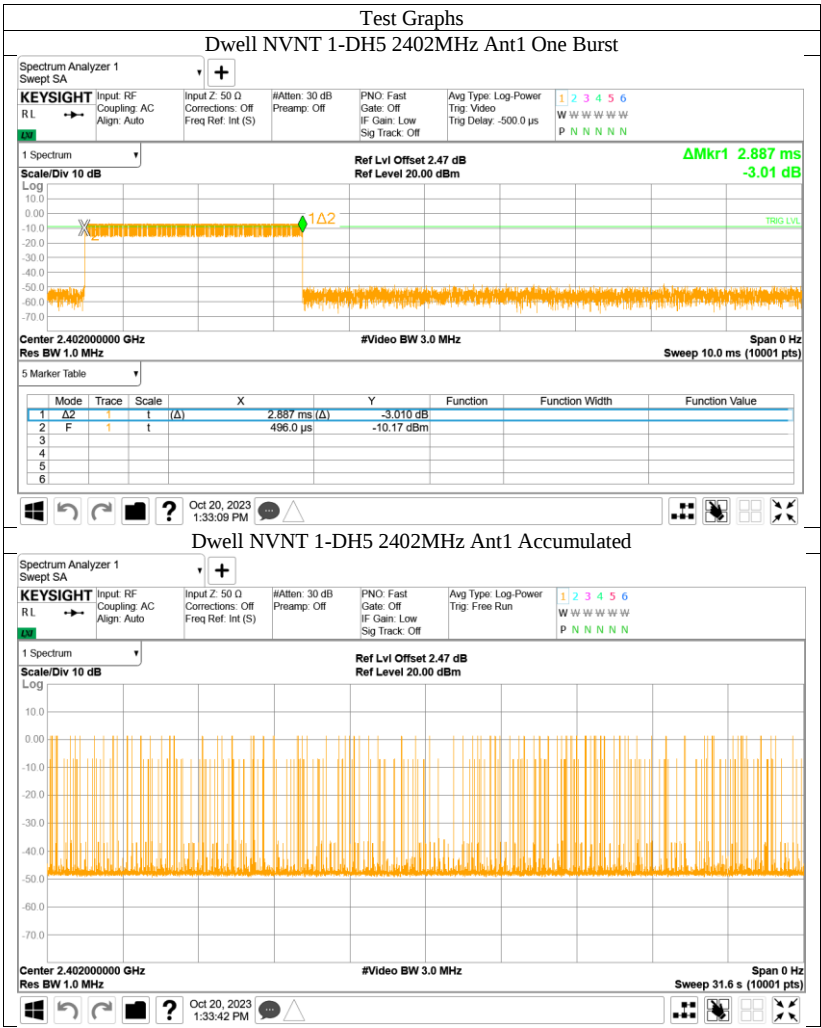
The maximum dwell time shall be 0,4 s.
According to the Bluetooth Core Specification, the worse result (DH5 mode) was reported to show compliance.

The Dwell Time = Burst Width * Total Hops. The detailed calculations are showed as follows:
The duration for dwell time calculation: 0.4 [s] * hopping number = 0.4 [s] * 79 [ch] = 31.6 [s*ch];
The burst width, which is directly measured, refers to the duration on one channel hop.

Test Result

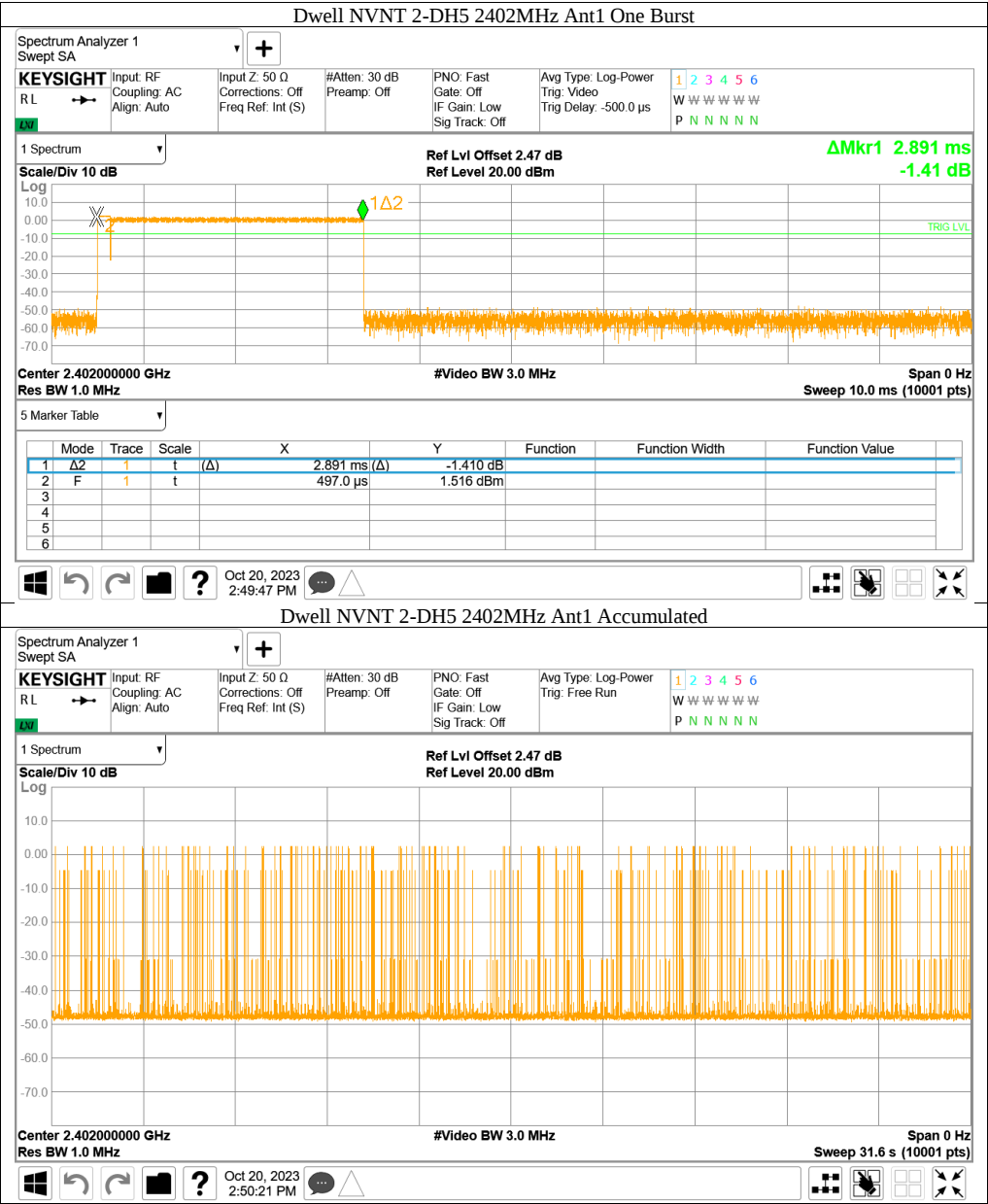
Modulation	Mode	Reading (ms)	Total Hops	Test Result (ms)	Limit (ms)	Result
GFSK	DH5	2.887	94	271.378	< 400	Pass
$\pi/4$ -DQPSK	2DH5	2.891	110	318.01	< 400	Pass
8-DPSK	3DH5	2.894	119	344.386	< 400	Pass

GFSK Modulation



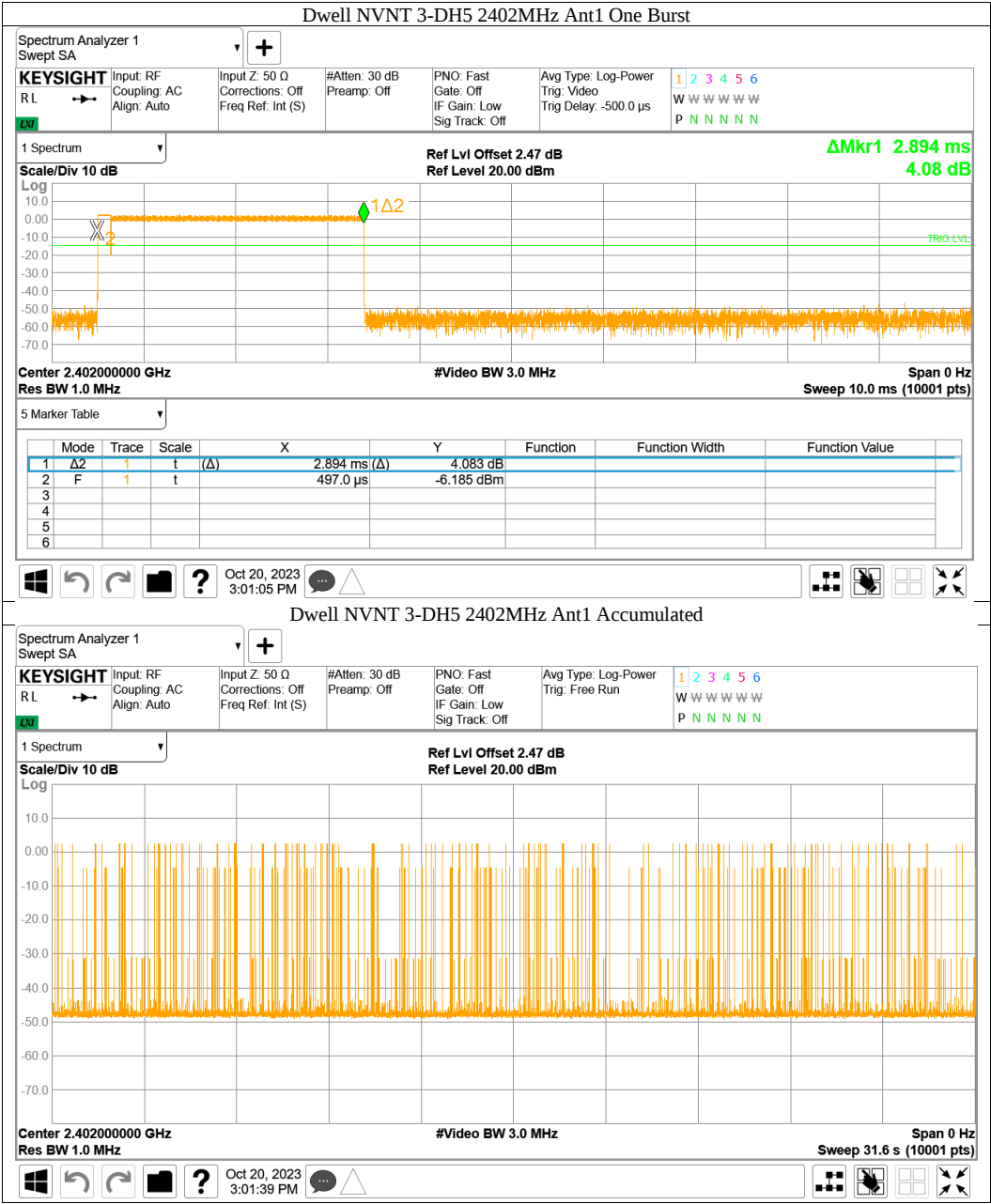


$\pi/4$ -DQPSK Modulation





8-DPSK Modulation



10.7 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 and enable the EUT transmit continuously.
3. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector, Sweep = auto, Span = wide enough to capture the peak level of the in-band emission and all spurious emissions, Trace = max hold. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this Section.
4. Measure and record the results in the test report.
5. The RF fundamental frequency should be excluded against the limit line in the operating frequency

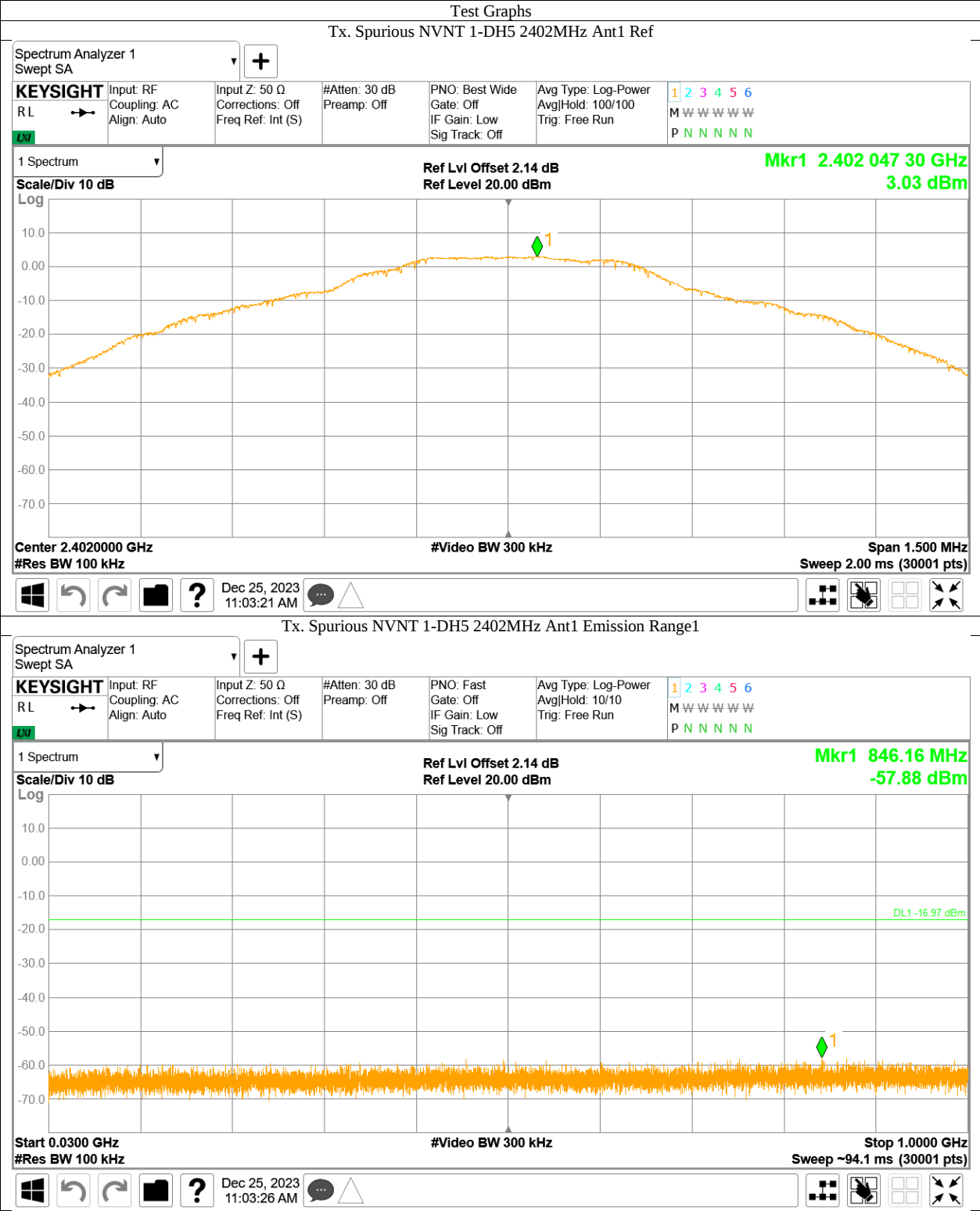
Limit

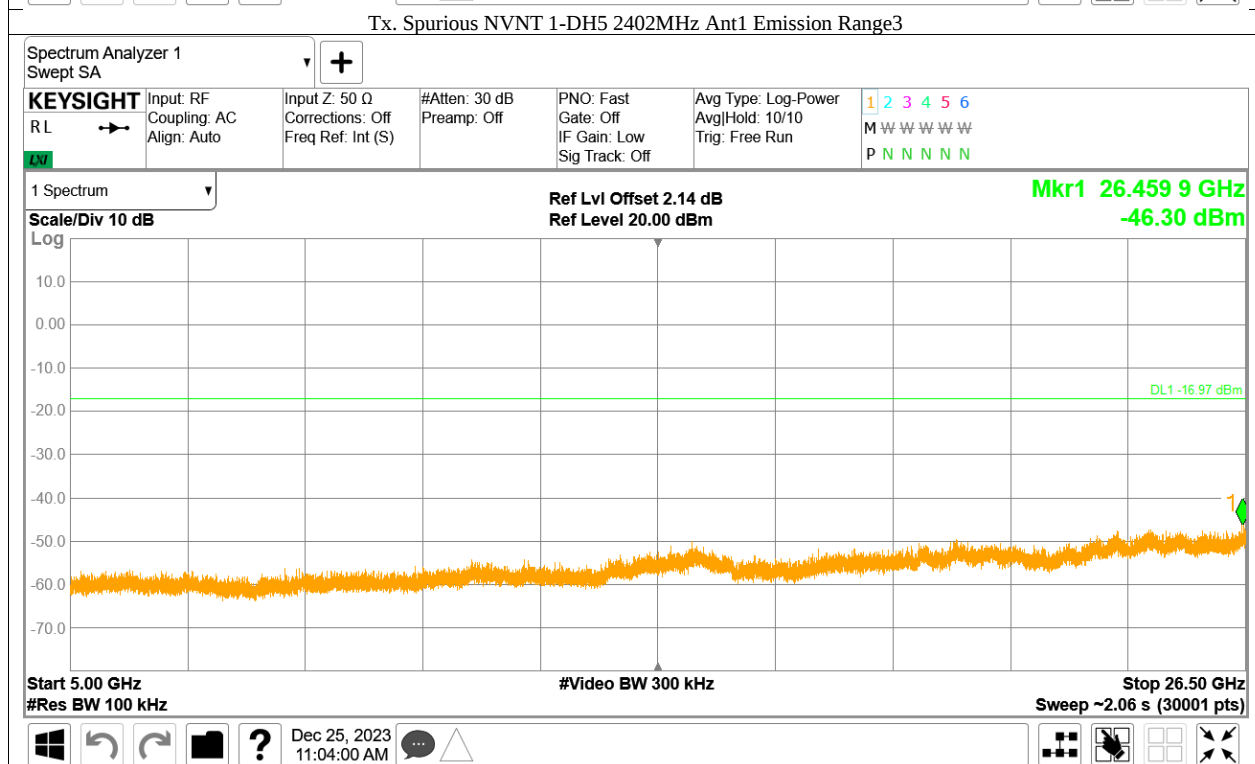
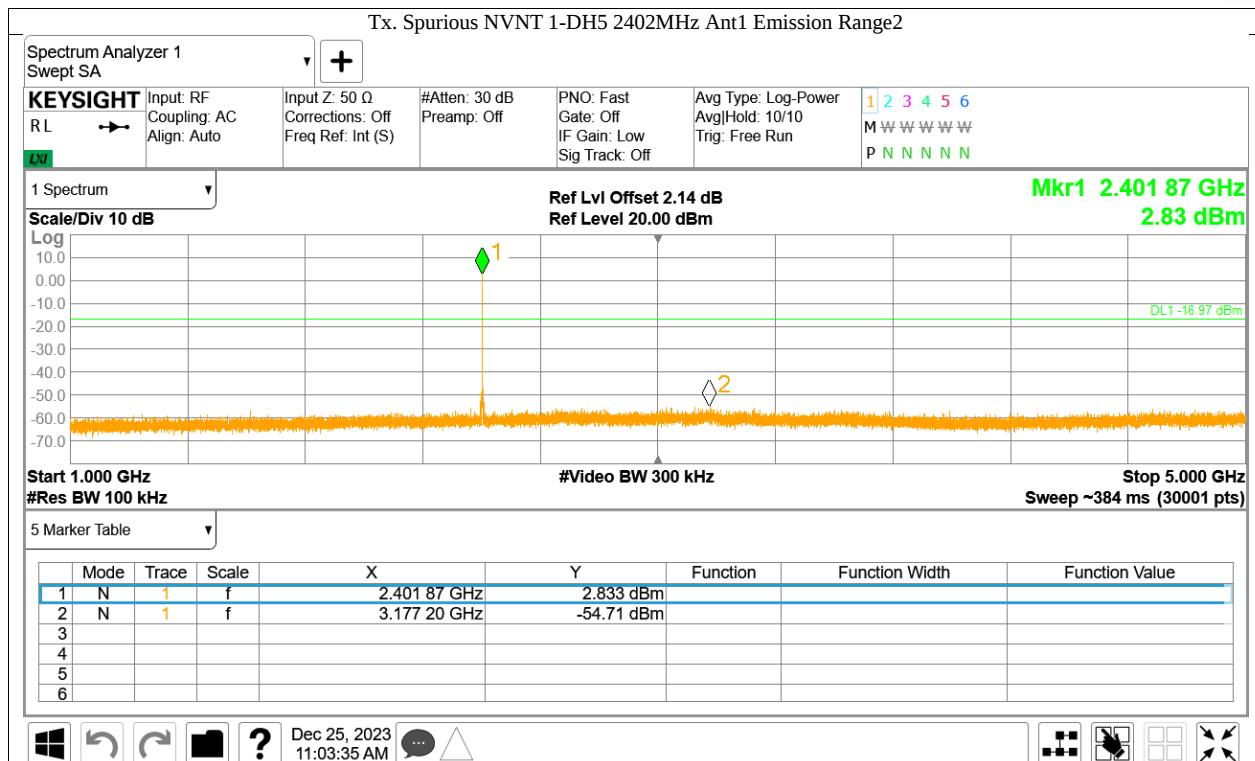
Frequency Range MHz	Limit (dBc)
30-25000	-20

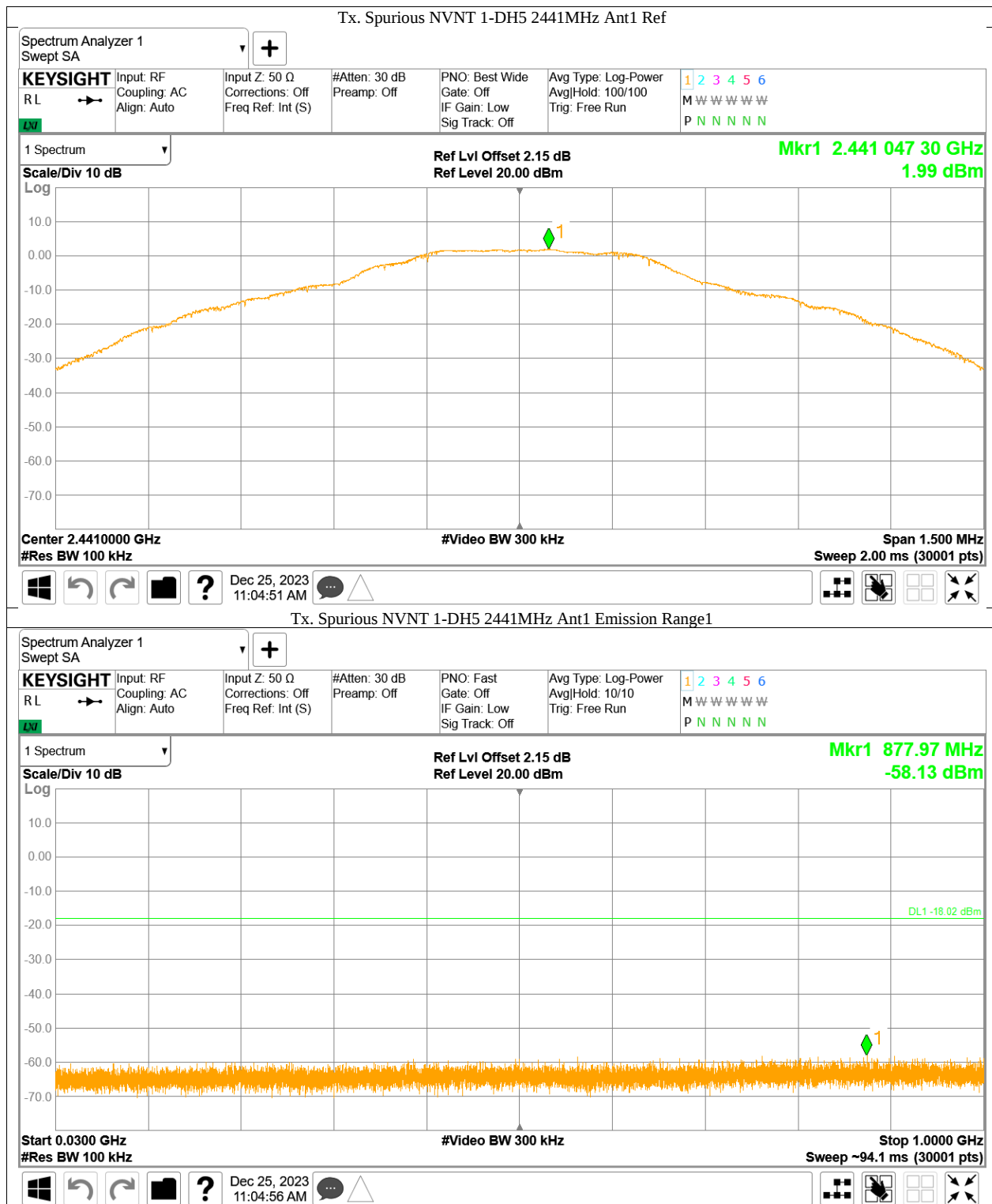


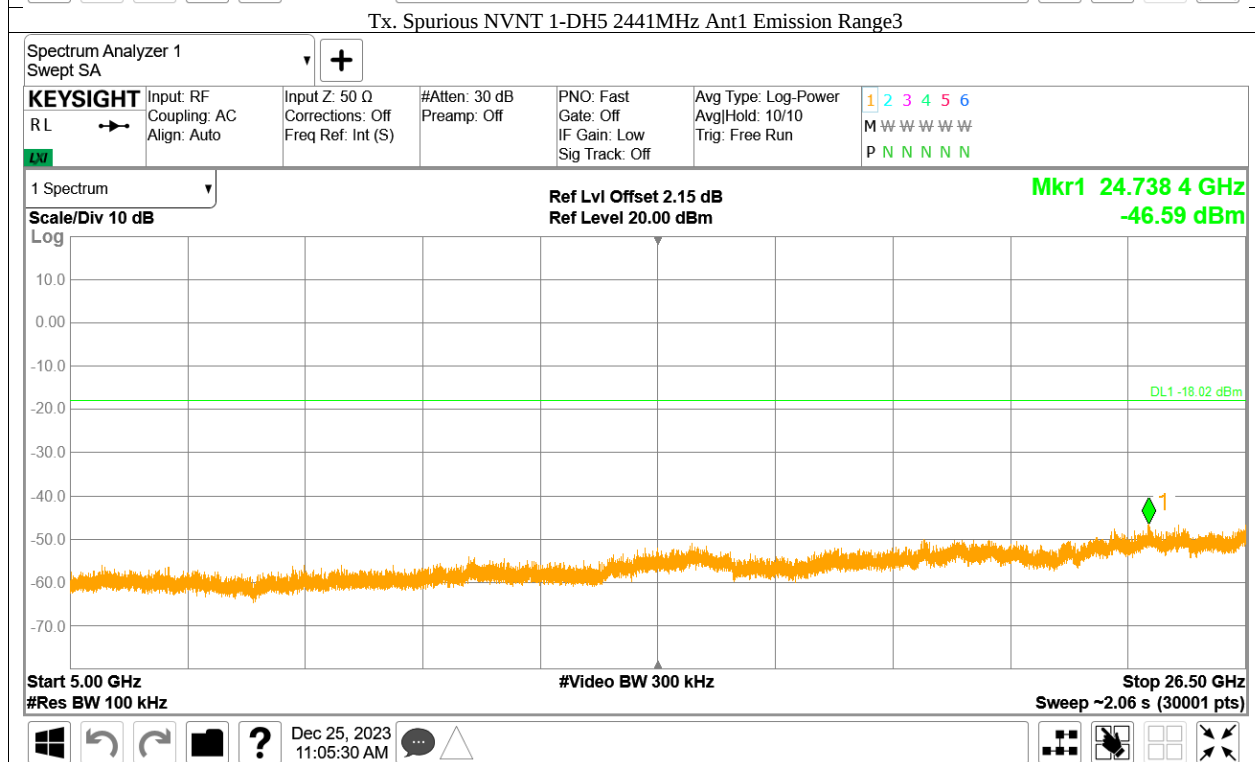
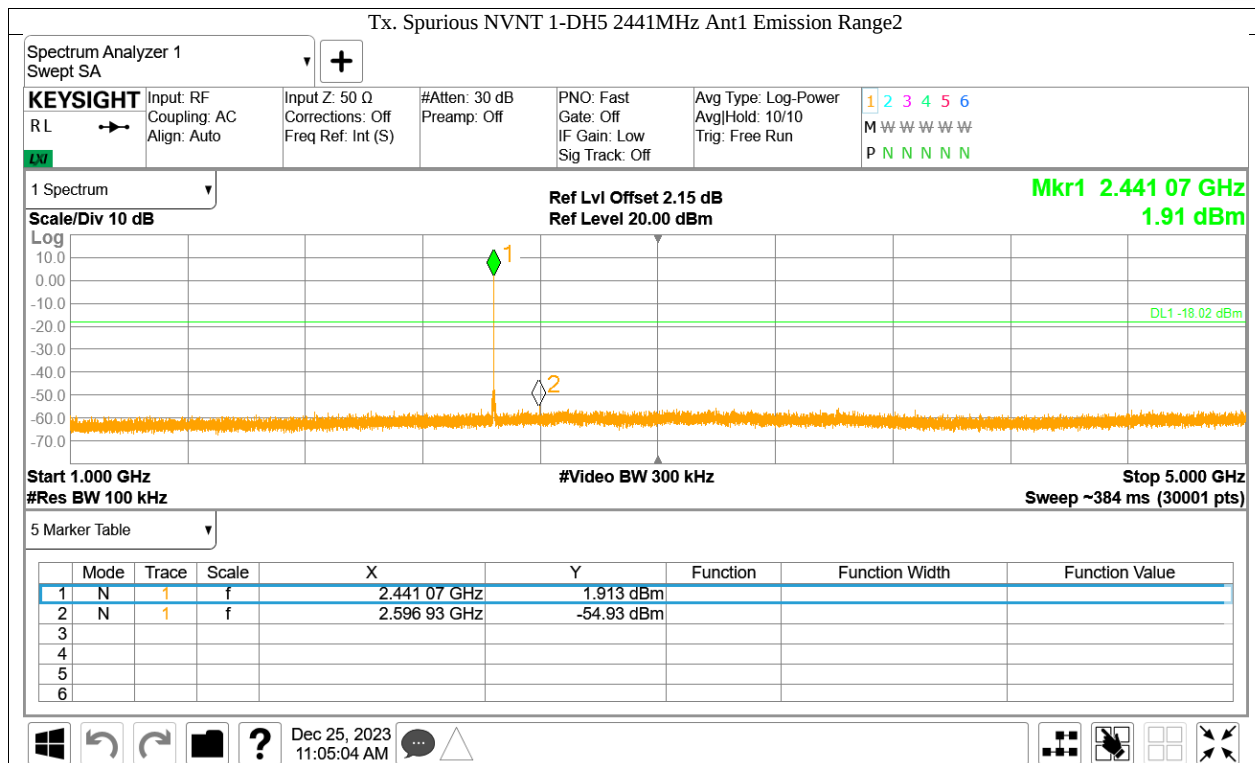
Spurious RF conducted emissions

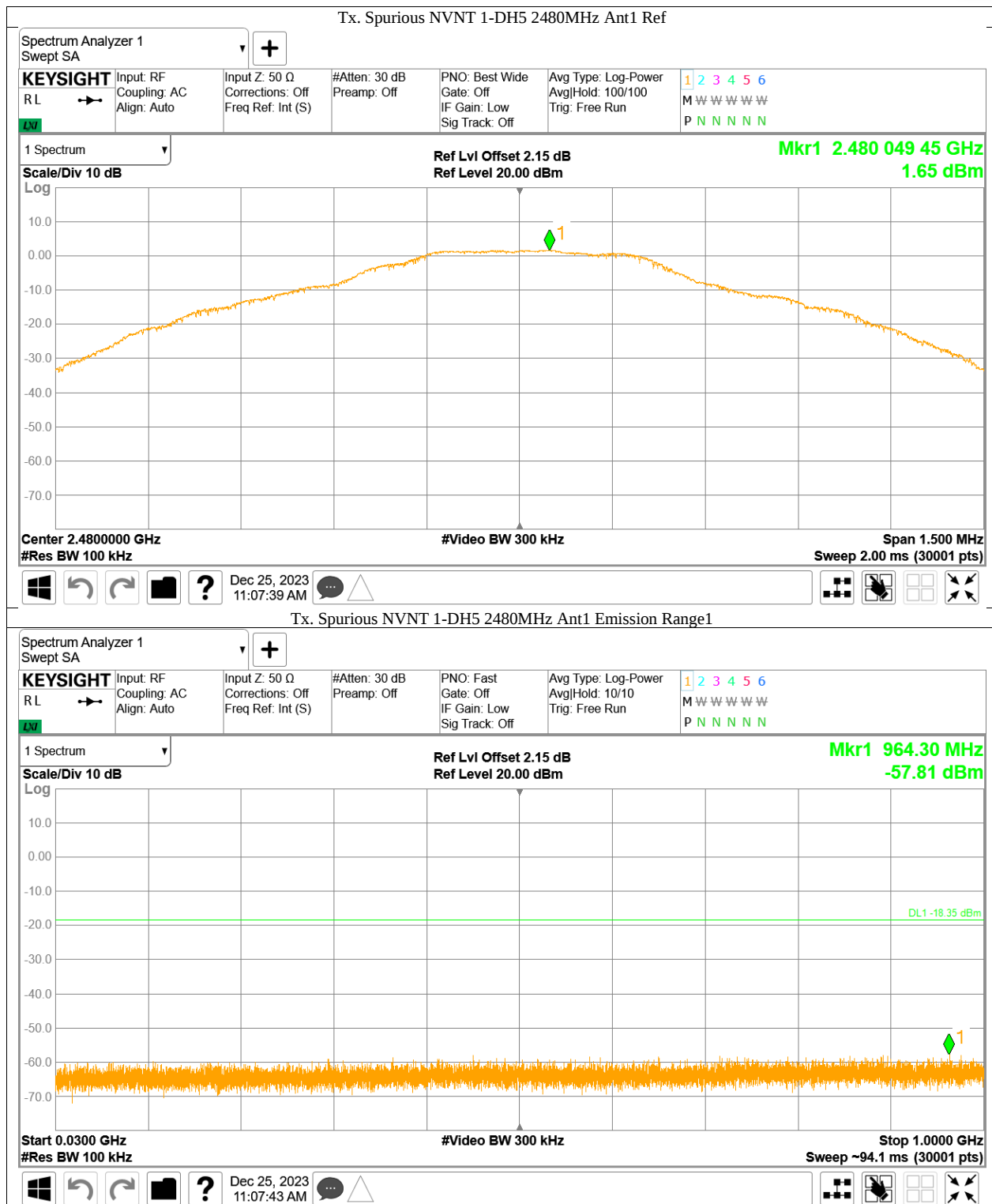
Only the worst case (which is subject to the maximum EIRP, GFSK mode) test result is listed in the report.

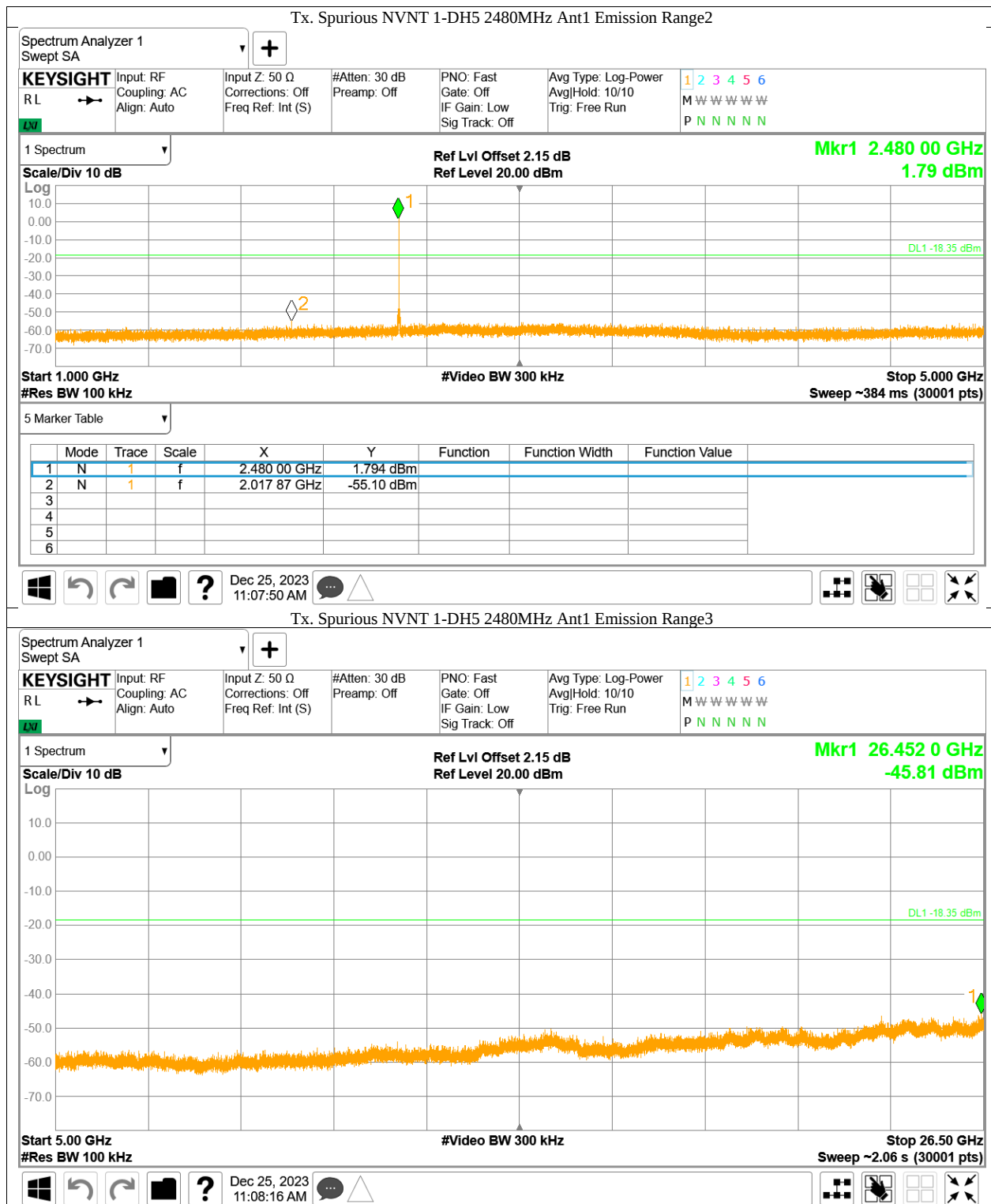












10.8 Band edge testing

Test Method

1. The RF output of EUT was connected to the test receiver by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously. Set the EUT to the lowest frequency channel.
3. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector, Trace: Max hold, Sweep time: Coupled, Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation. Allow the trace to stabilize.
4. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.
5. Set the EUT to the highest frequency channel and repeat step 2) to 4)
6. Enable the EUT hopping mode, repeat the test.

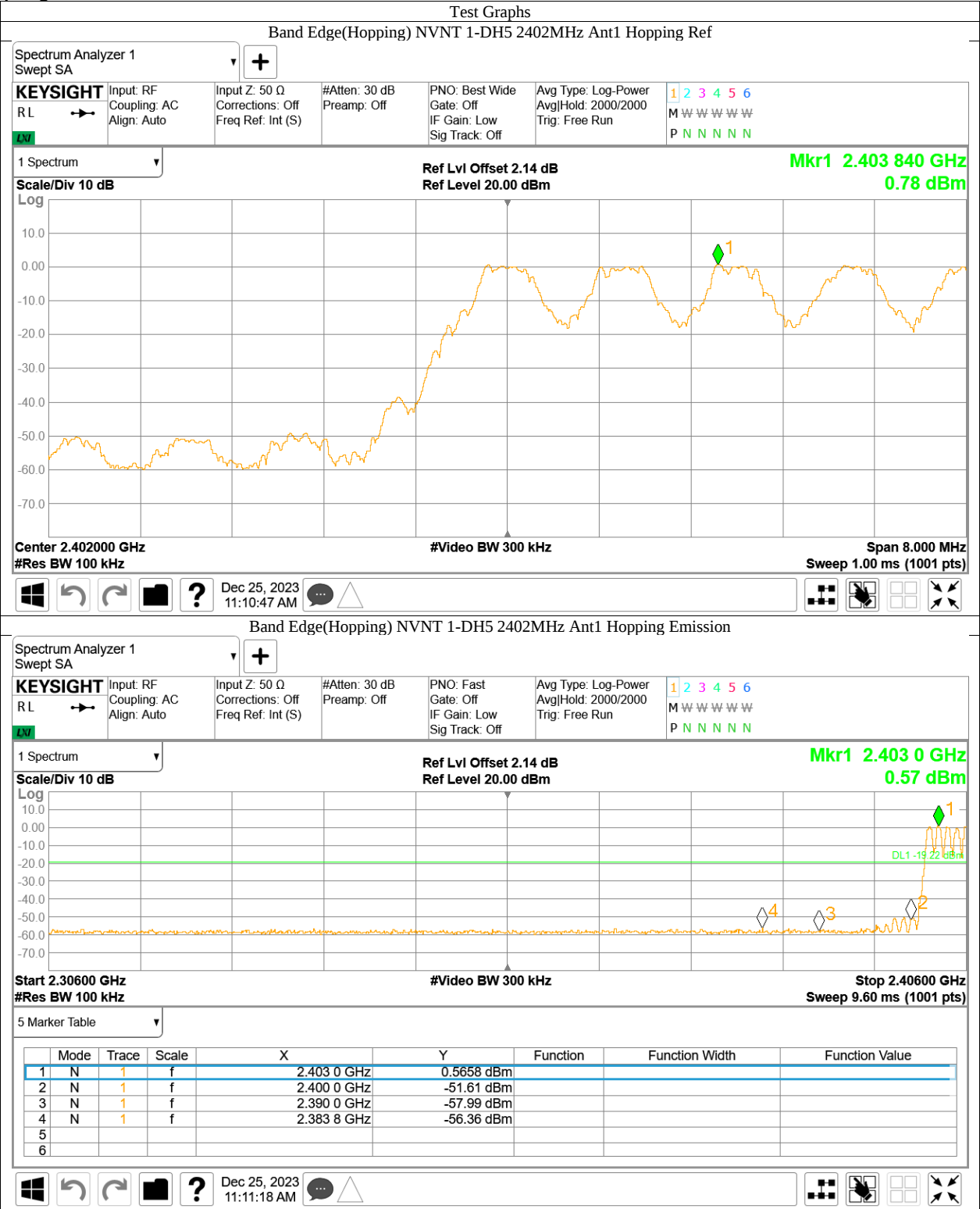
Limit:

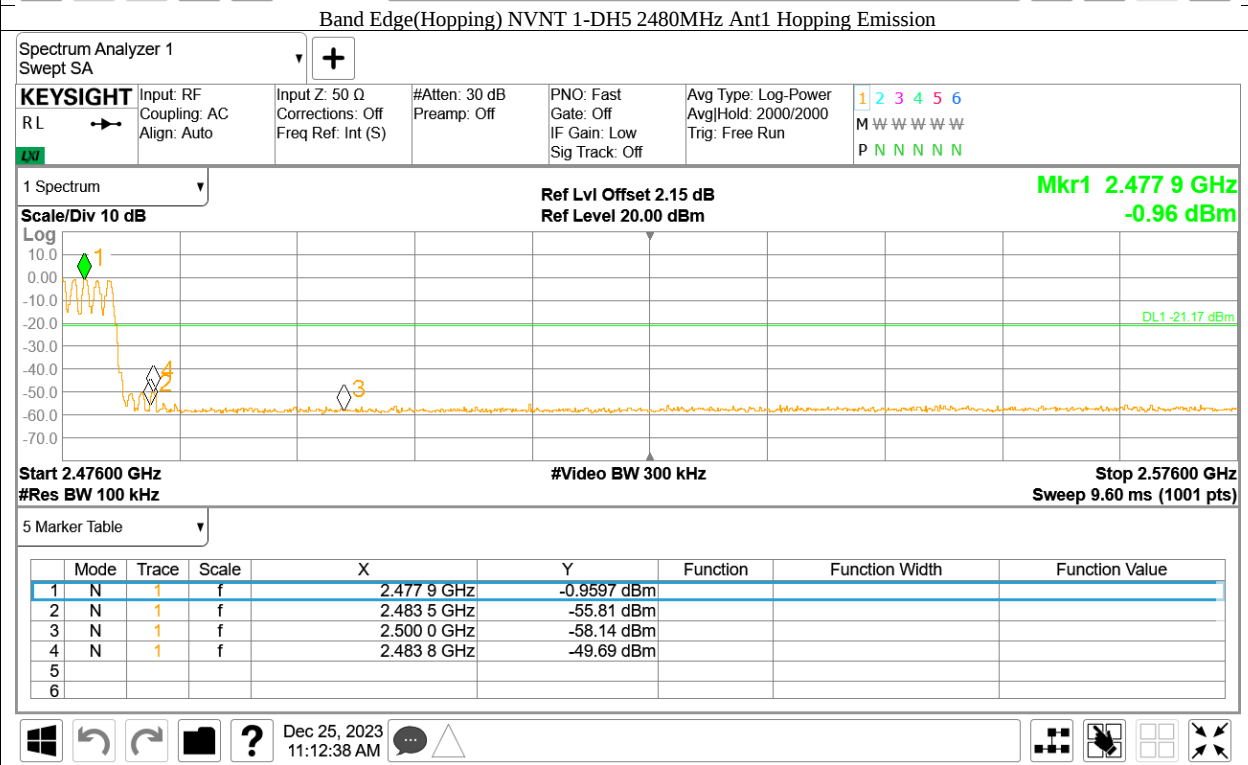
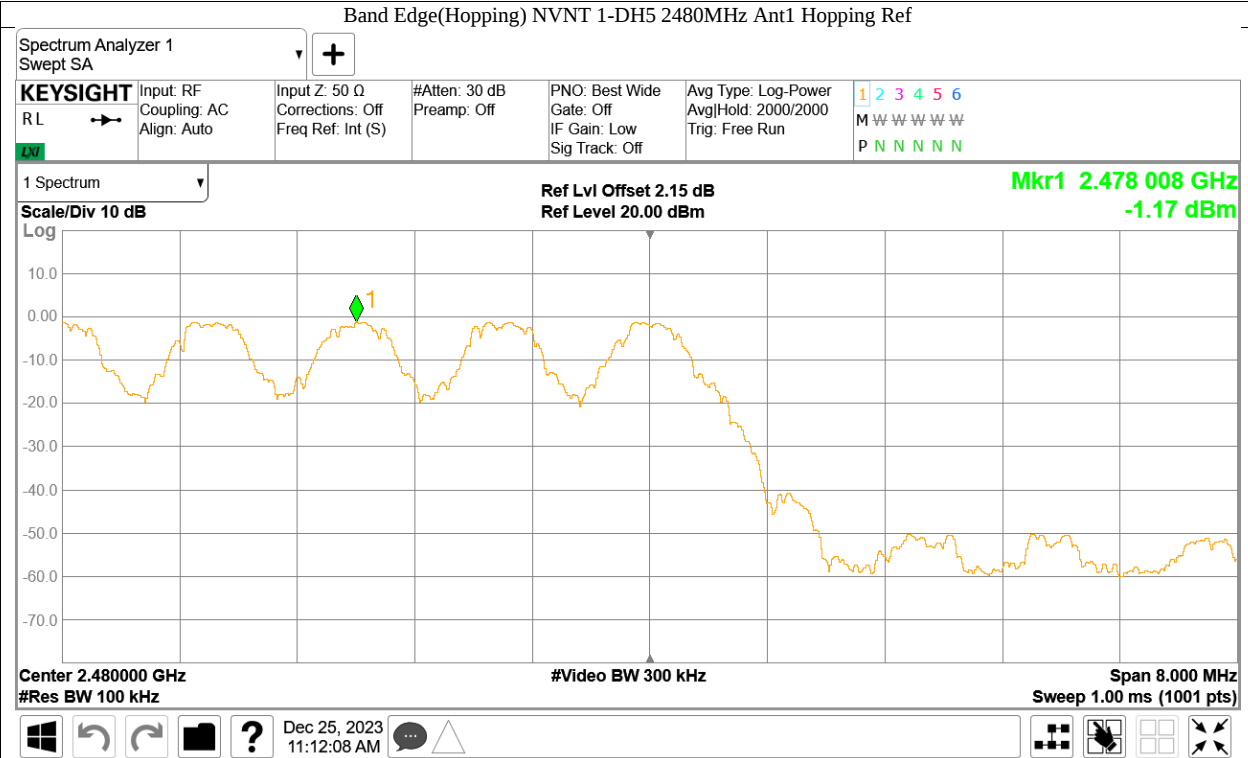
In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits.

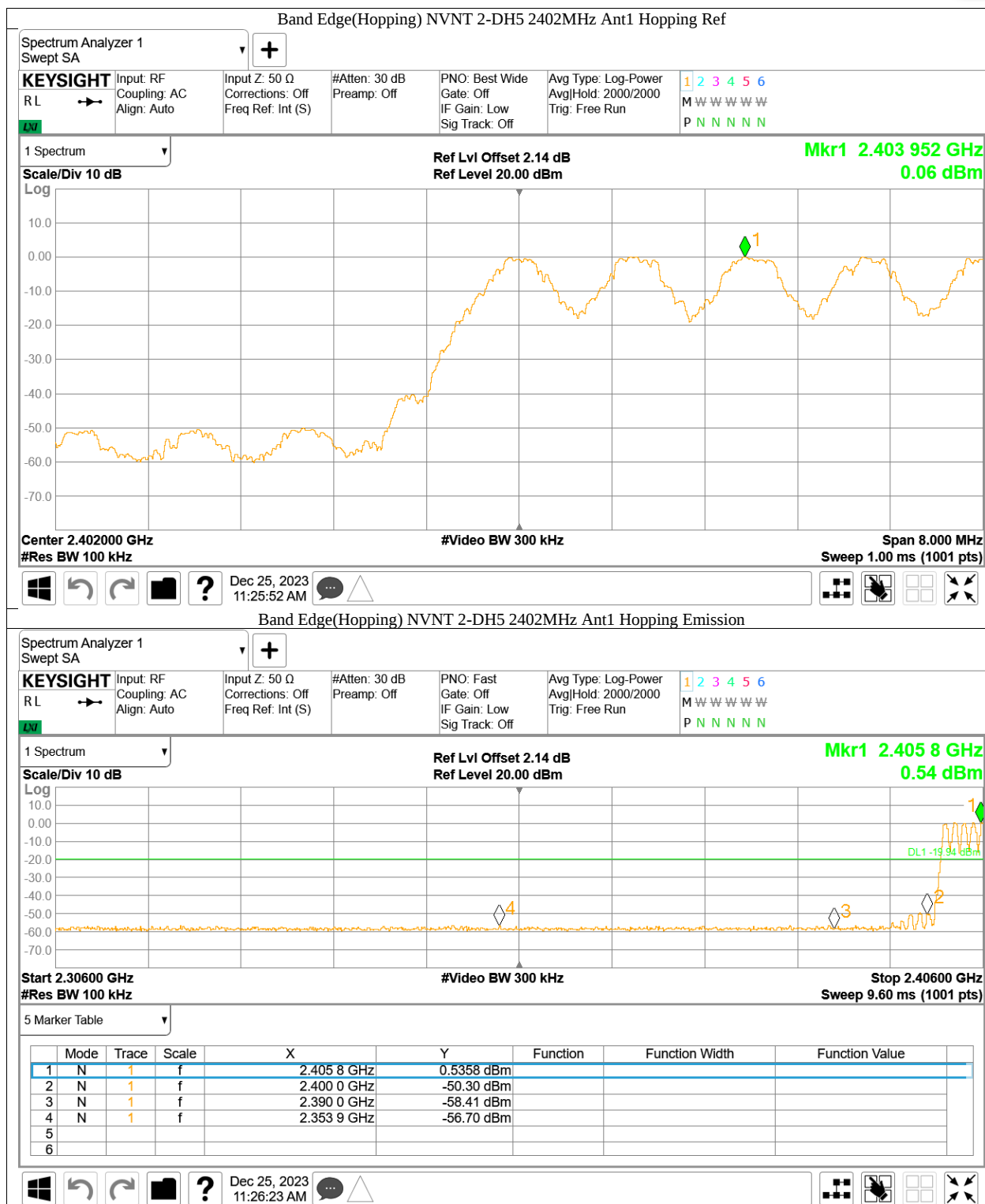


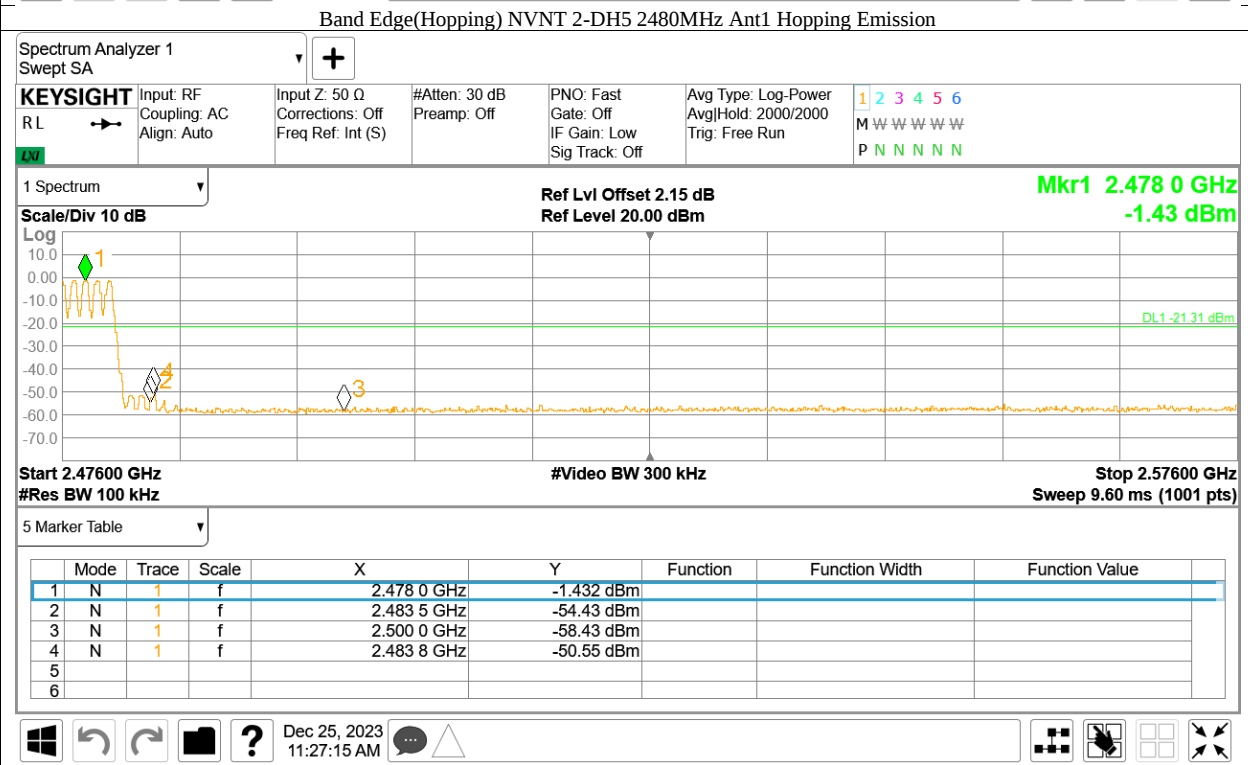
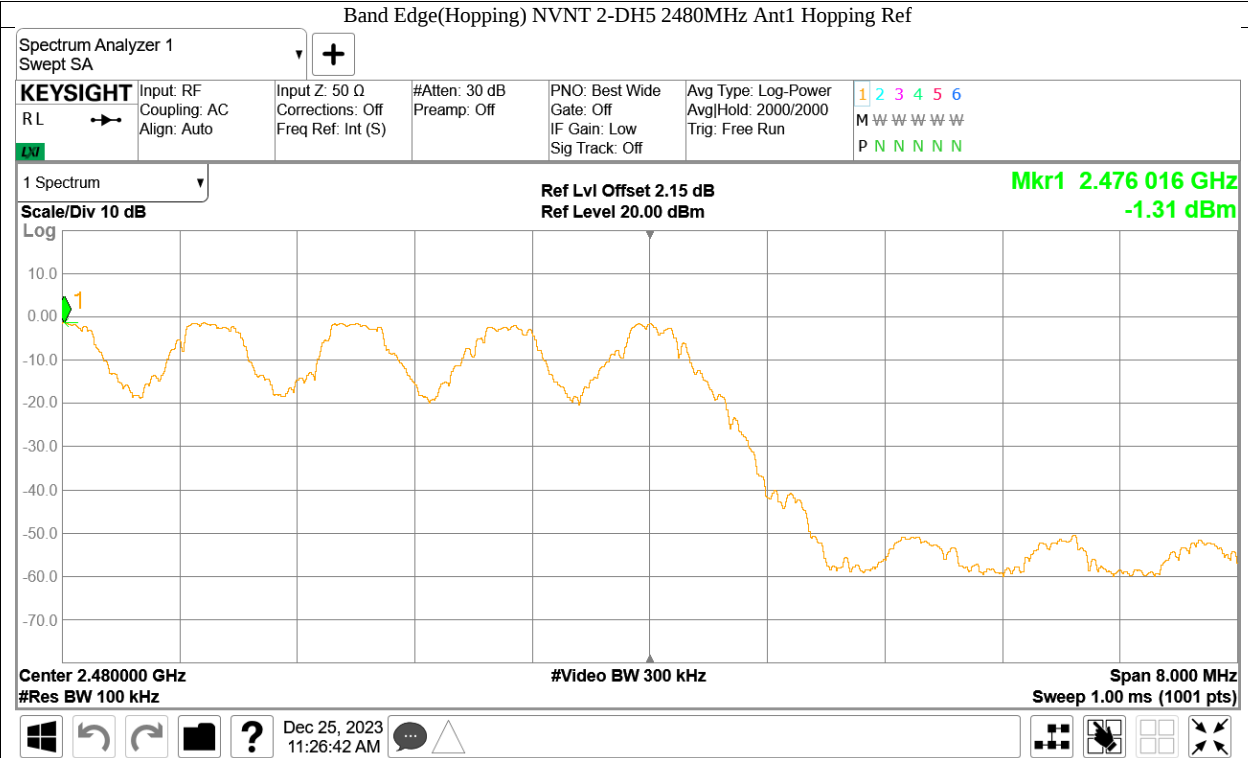
Band edge testing

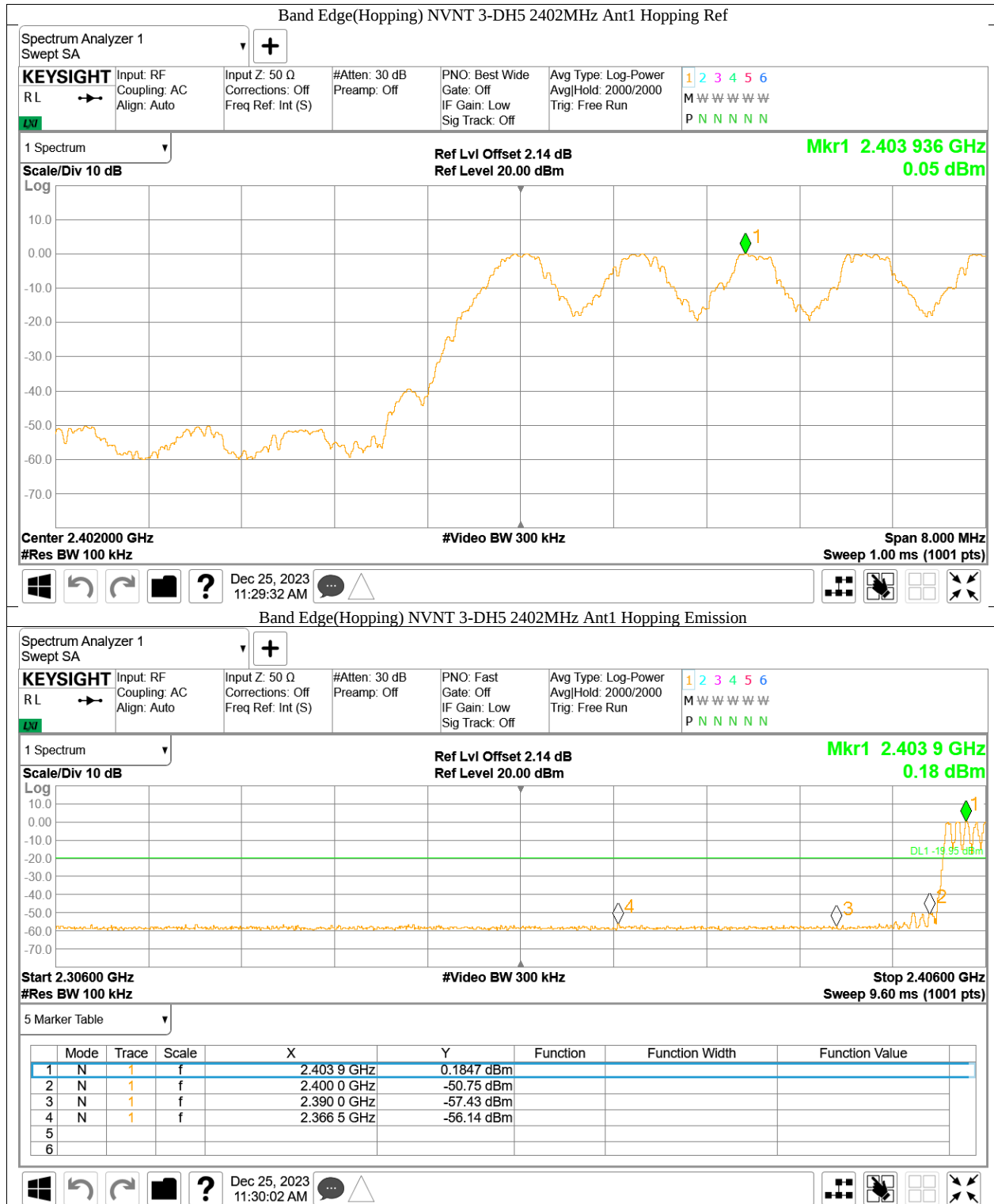
GFSK Modulation Test Result:
Hopping on mode:

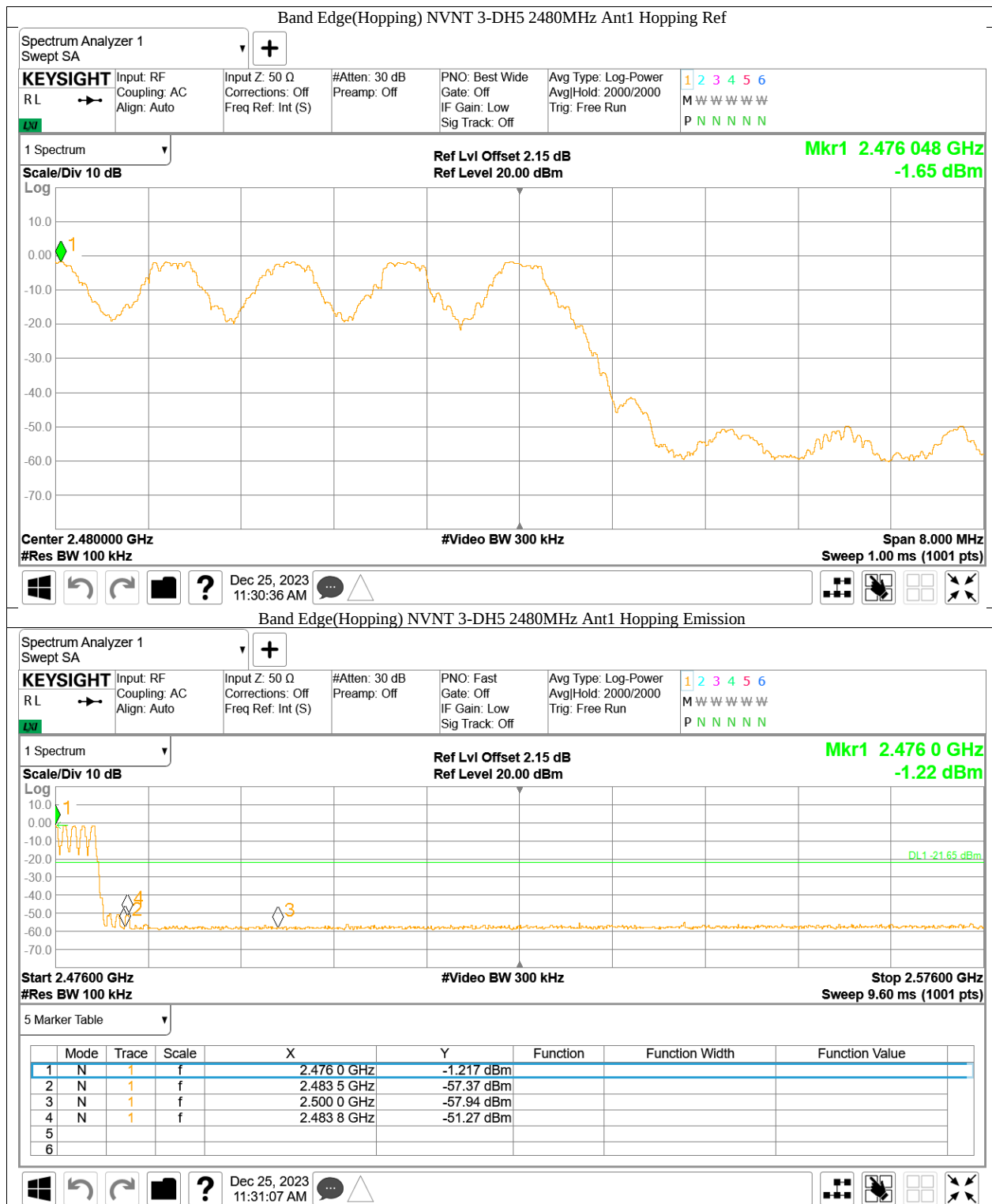






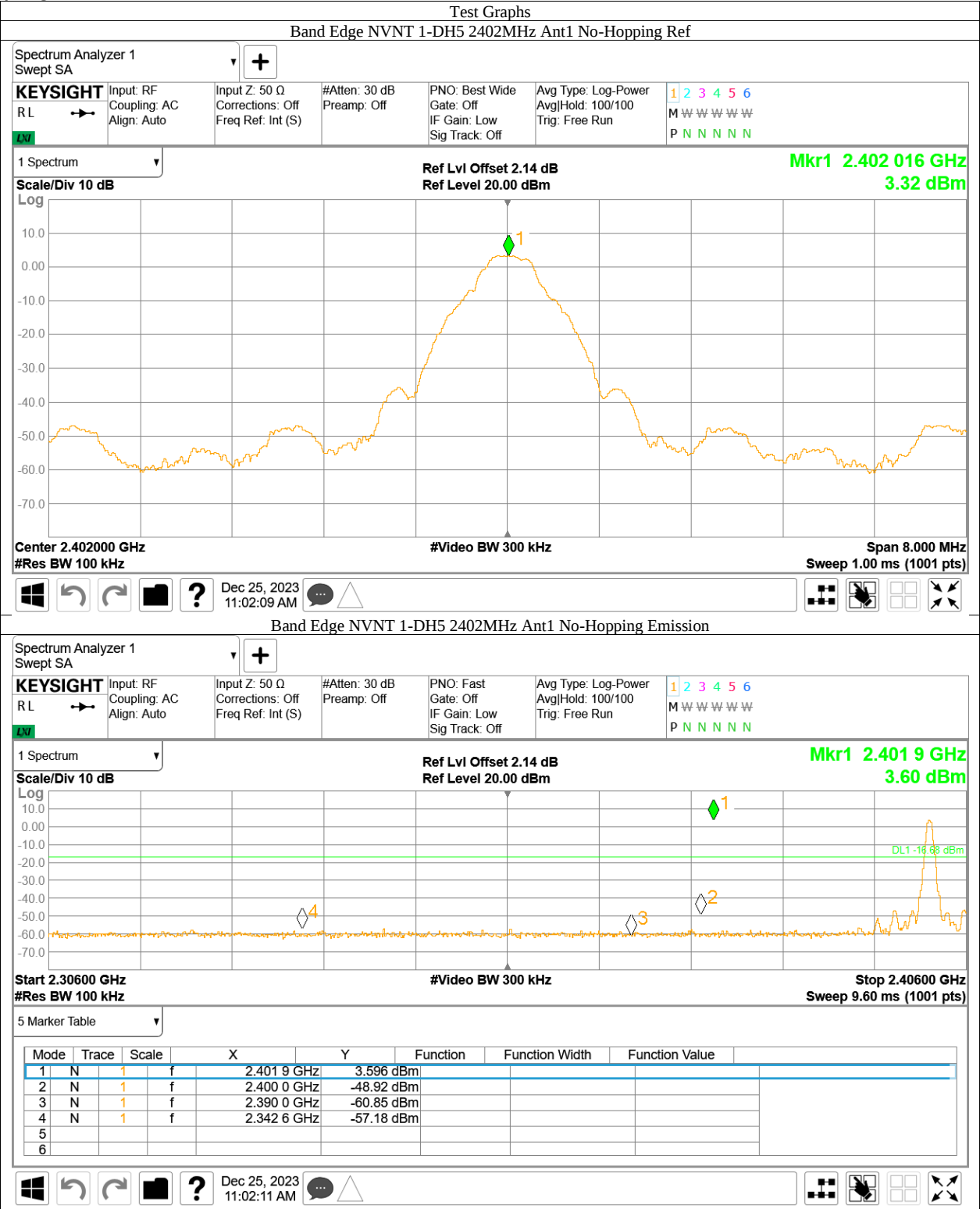


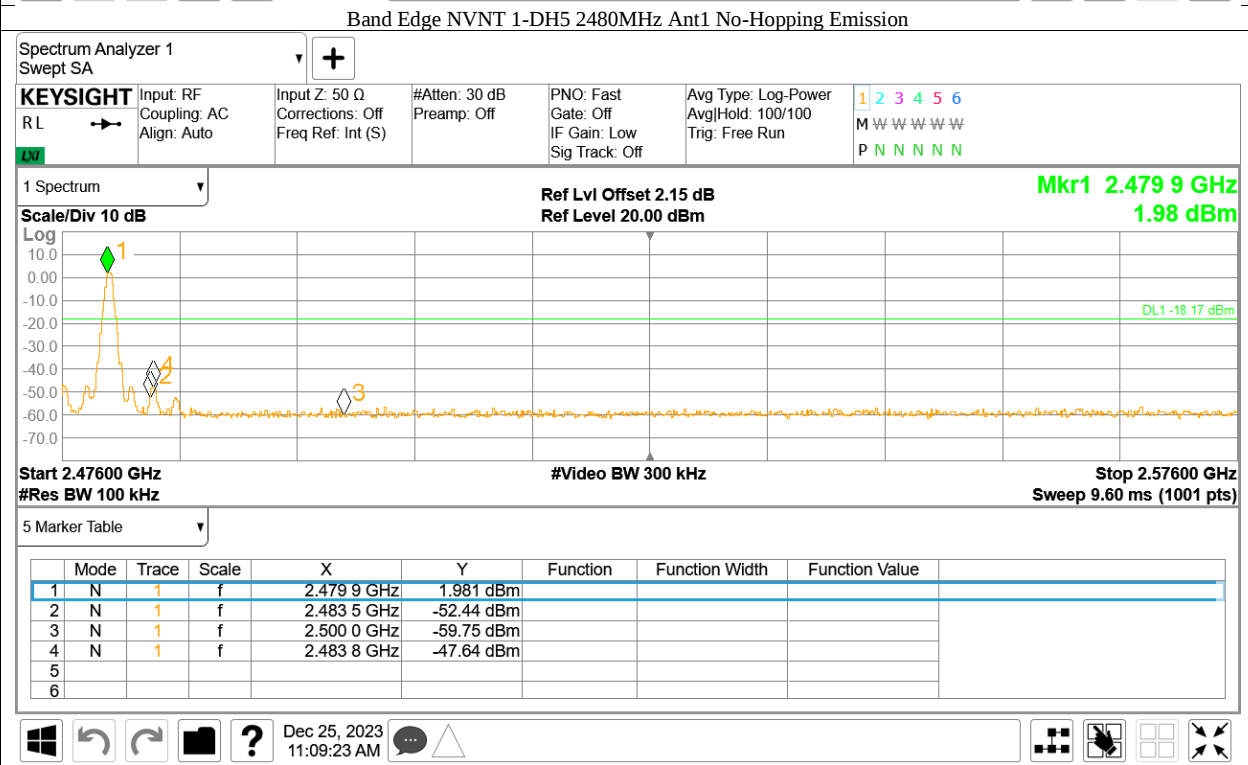
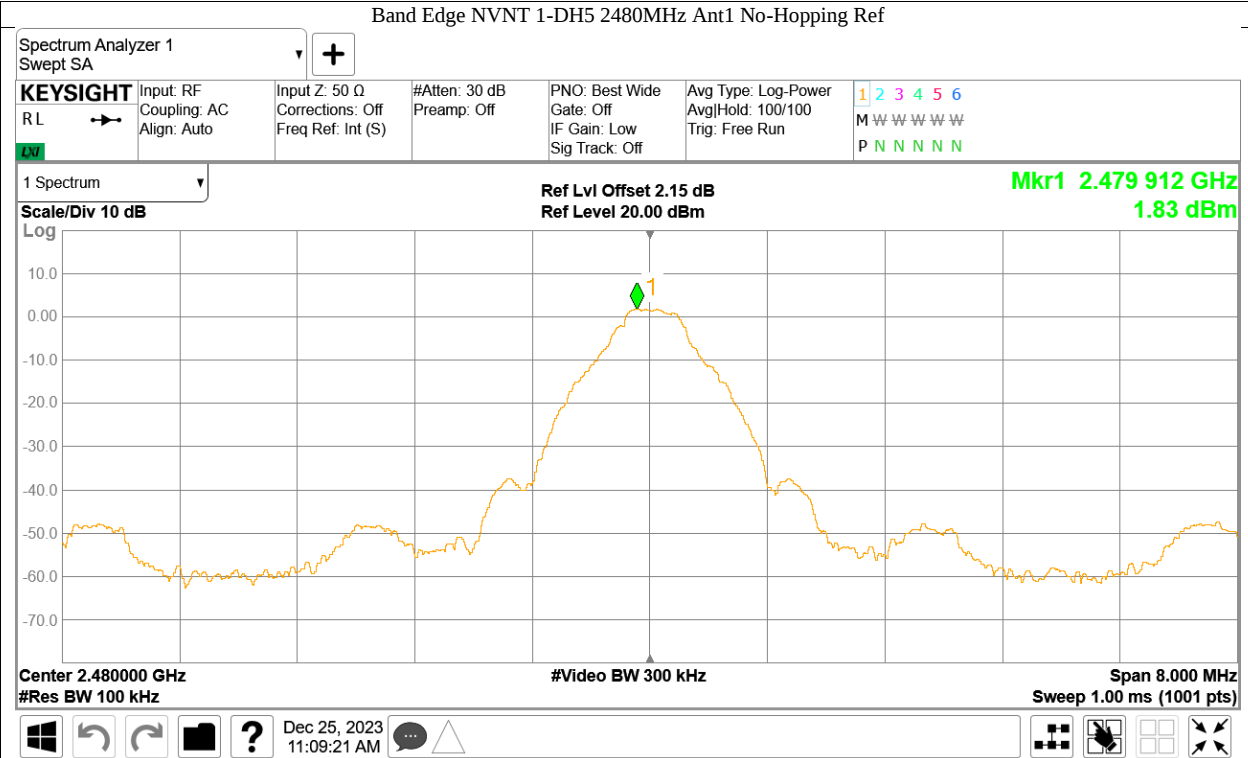


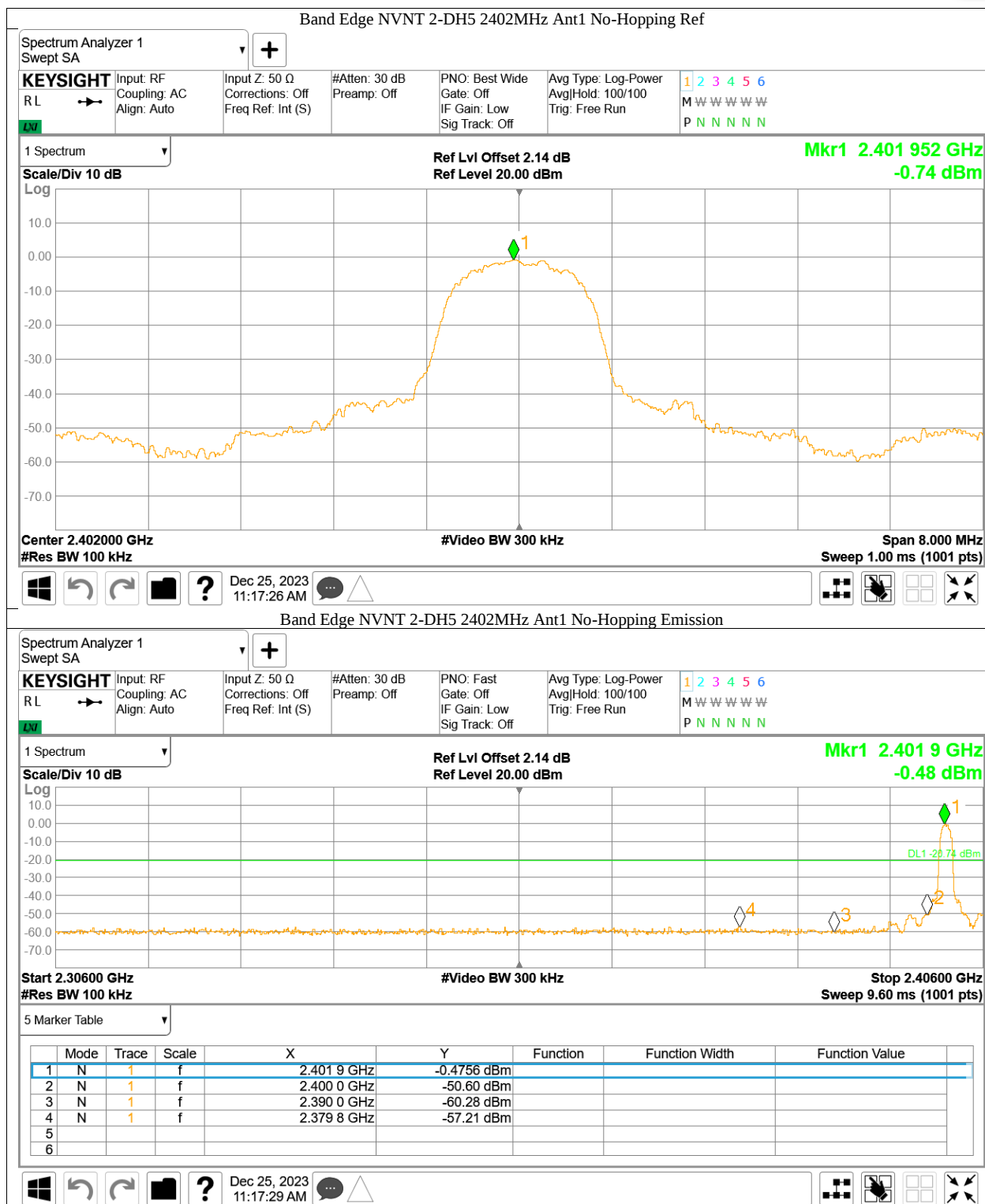


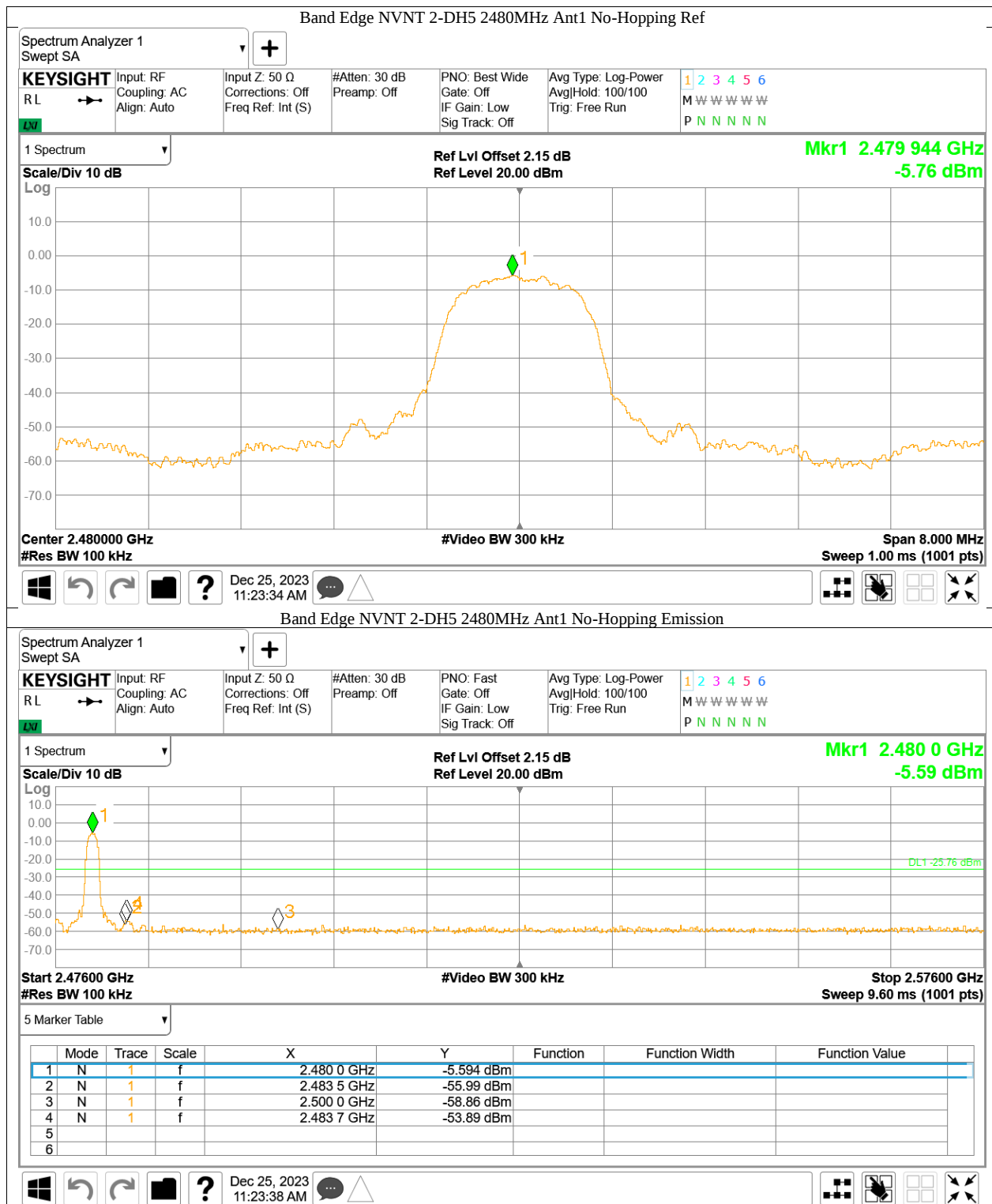


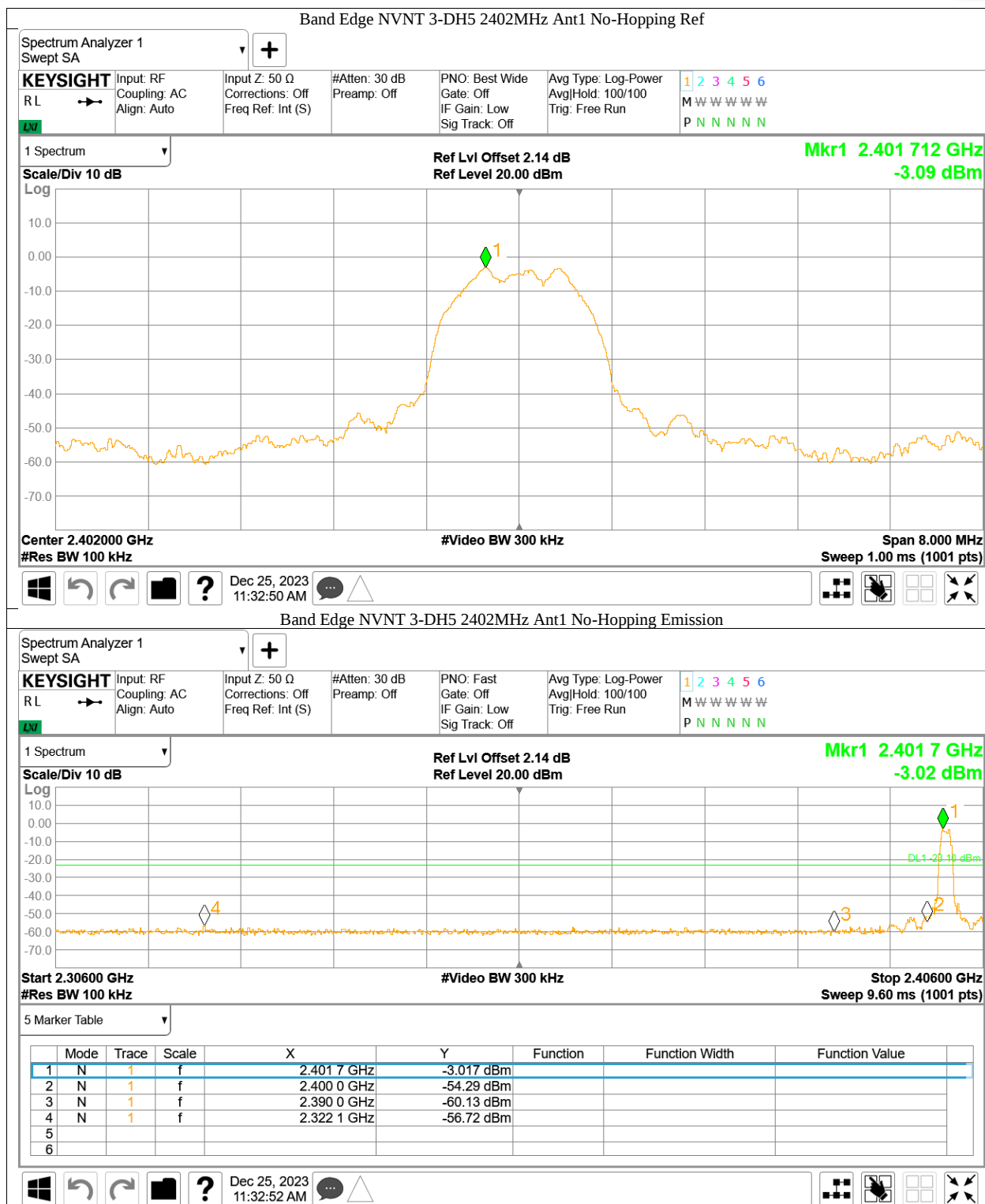
GFSK Modulation Test Result:
Hopping off mode:

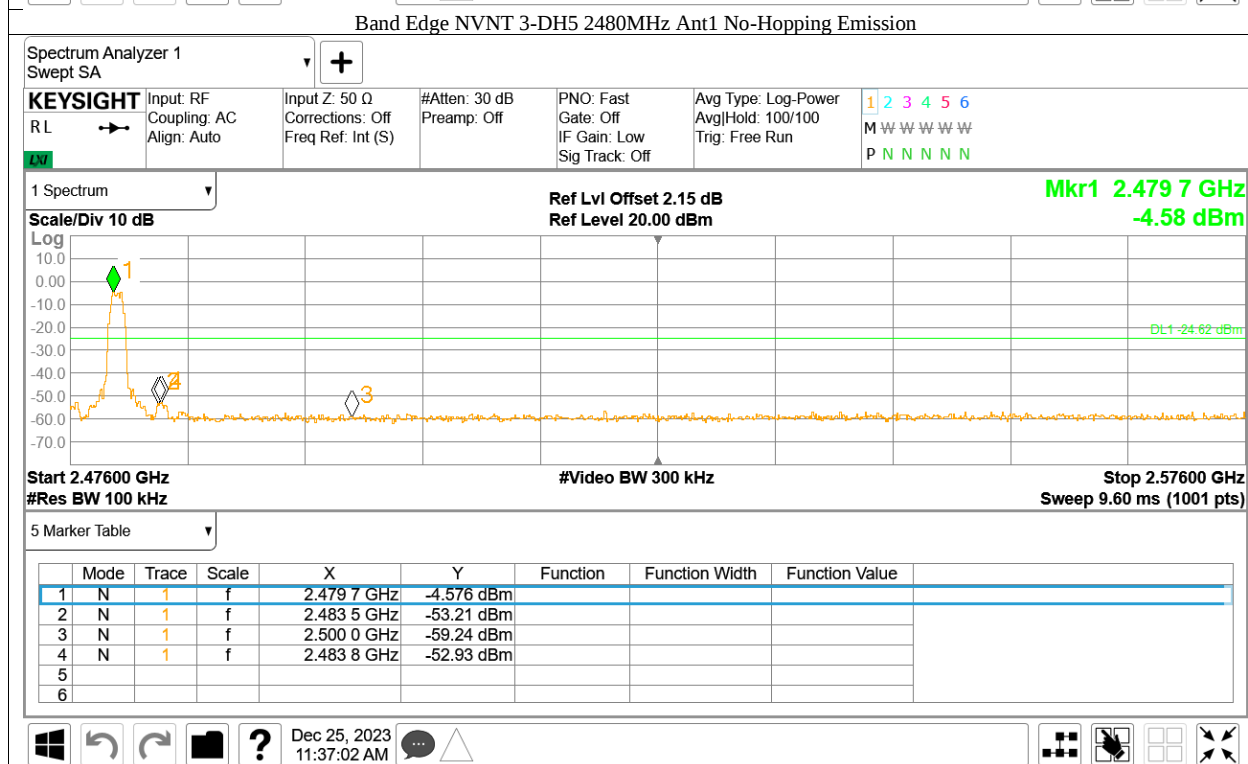
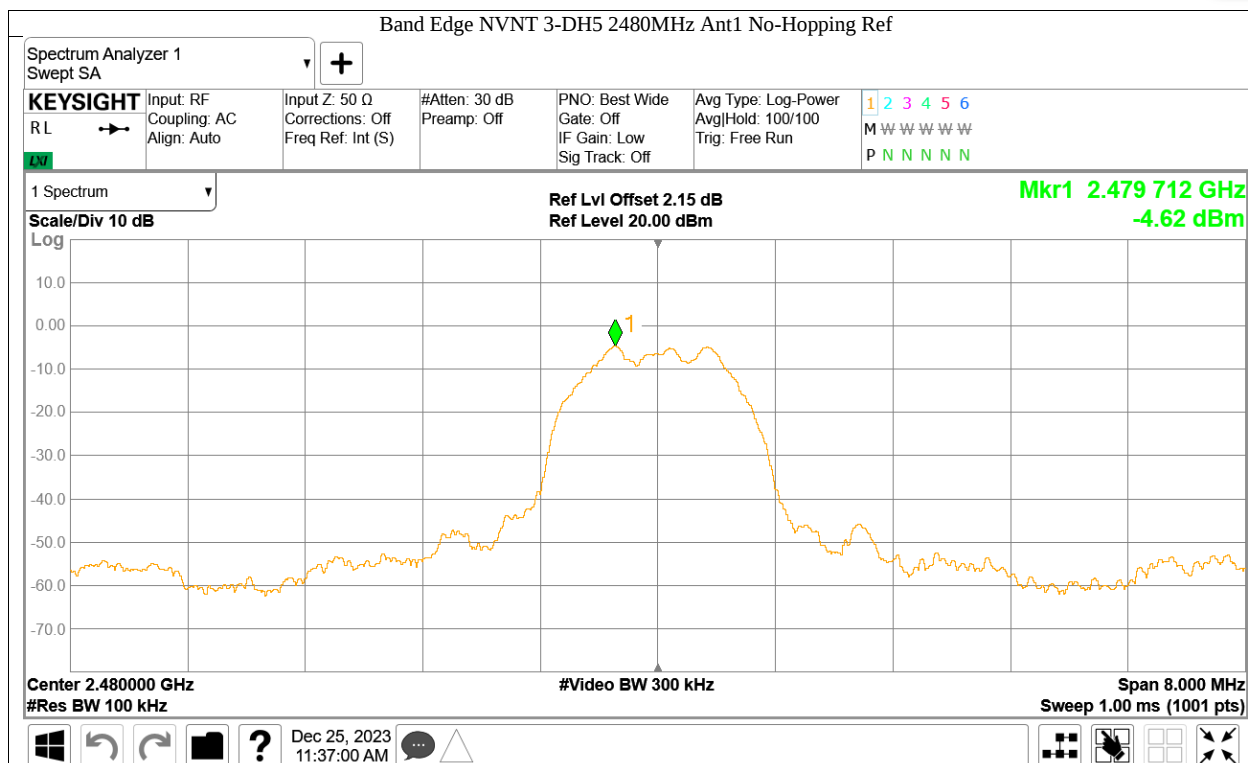












10.9 Spurious radiated emissions for transmitter and receiver

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 meters chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
4. 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.
5. 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.
6. Use the following test receiver settings According to C63.10:
 - (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Set RBW=100 kHz to 120KHz for $f < 1$ GHz; VBW $\geq$ RBW; Sweep = auto; Detector function = QP; Trace = max hold;
 - (3) Set RBW = 1 MHz, VBW= 3MHz for $f \geq 1$ GHz for peak measurement.For average measurement:

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 ($20\log(1/\text{duty cycle})$).

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.
7. Repeat above procedures until all frequencies measured were complete.

Spurious Radiated Emissions for Transmitter

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 & RSS-GEN 8.10, must comply with the radiated emission limits specified in section 15.209 & RSS-Gen 6.13.

Frequency MHz	Field Strength $\mu\text{V/m}$	Field Strength 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 3m(dB $\mu\text{V/m}$)=Limit 300m(dB $\mu\text{V/m}$)+40Log(300m/3m) (Below 30MHz)

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

The only worse case (which is subject to the maximum conducted power, GFSK mode) test result is listed in the report.

Above 1GHz Transmitting spurious emission test result as below:

Bluetooth Mode GFSK Modulation 2402MHz, hopping off

Frequency	Emission Level	Polarization	Limit	Detector	Margin	Result
MHz	dBuV/m		dBuV/m		dBuV/m	
2382.13	43.06	Horizontal	74.0	PK	30.94	Pass
4804.00	39.95	Horizontal	74.0	PK	34.05	Pass
2383.29	43.01	Vertical	74.0	PK	30.99	Pass
4804.10	39.88	Vertical	74.0	PK	34.12	Pass

Bluetooth Mode GFSK Modulation 2441MHz, hopping off

Frequency	Emission Level	Polarization	Limit	Detector	Margin	Result
MHz	dBuV/m		dBuV/m		dBuV/m	
4879.40	39.87	Horizontal	74.0	PK	34.13	Pass
4880.53	39.80	Vertical	74.0	PK	34.20	Pass

Bluetooth Mode GFSK Modulation 2480MHz, hopping off

Frequency	Emission Level	Polarization	Limit	Detector	Margin	Result
MHz	dBuV/m		dBuV/m		dBuV/m	
2483.50	47.17	Horizontal	74.0	PK	26.83	Pass
4961.00	39.92	Horizontal	74.0	PK	34.08	Pass
2483.54	45.03	Vertical	74.0	PK	28.97	Pass
4959.86	40.89	Vertical	74.0	PK	33.11	Pass

Bluetooth Mode GFSK Modulation 2402MHz, hopping on

Frequency	Emission Level	Polarization	Limit	Detector	Margin	Result
MHz	dBuV/m		dBuV/m		dBuV/m	
2383.37	43.42	Horizontal	74.0	PK	30.58	Pass
2381.36	43.62	Vertical	74.0	PK	30.38	Pass

Bluetooth Mode GFSK Modulation 2480MHz, hopping on

Frequency	Emission Level	Polarization	Limit	Detector	Margin	Result
MHz	dBuV/m		dBuV/m		dBuV/m	
2483.57	44.52	Horizontal	74.0	PK	29.48	Pass
2483.62	44.44	Vertical	74.0	PK	29.56	Pass

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:

Model:

Client:

Op Cond:

Operator:

Test Spec:

Comment:

Sample No:

Wireless Display

LKOUT P

Fellows Inc.

Power on, transmitting 2402MHz at DH5, AC 120V/60Hz, T23.9, 47.4%, P102.5kPa

Cheng Huali

FCC Part 15.209(a)

Horizontal

SHA-749413-2

Sweep Setup: RE_VULB9168_pre_Cont_30-1000 [EMI radiated]

Hardware Setup:

Receiver:

Level Unit:

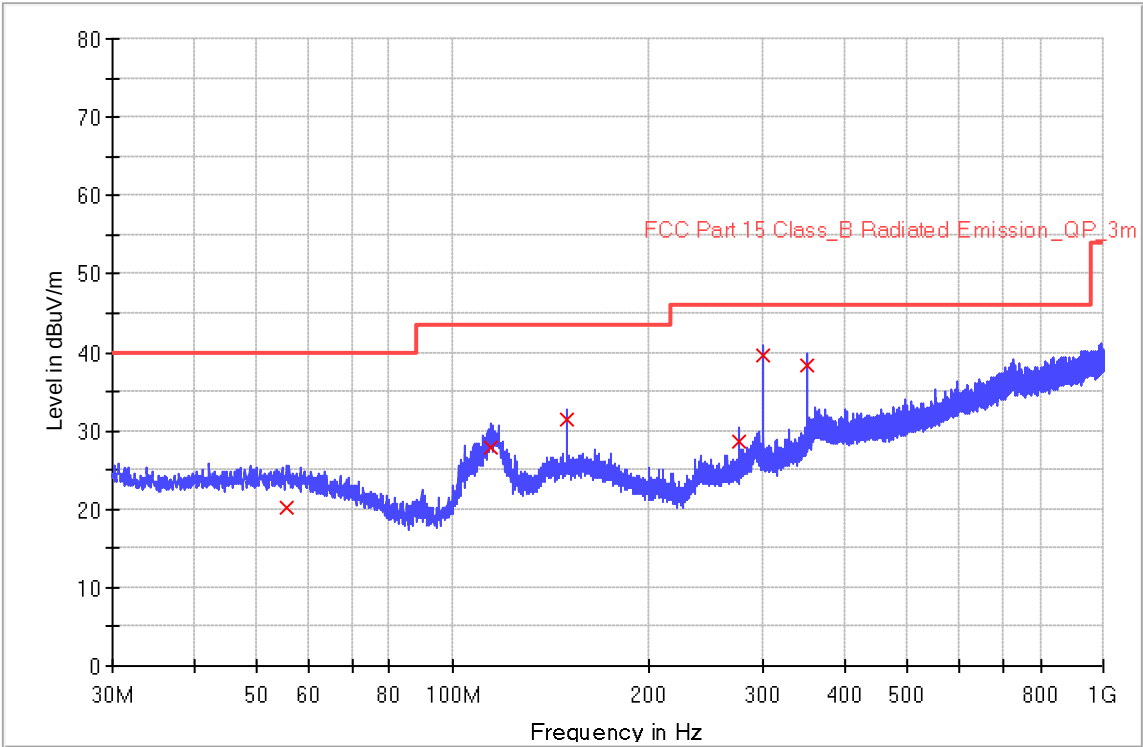
RE_VULB9168

[ESR 3]

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)
55.560000	20.2	1000.0	120.000	132.0	H	315.0	20.4	19.8	40.0
114.760000	27.8	1000.0	120.000	201.0	H	114.0	17.7	15.7	43.5
149.960000	31.3	1000.0	120.000	195.0	H	201.0	20.9	12.2	43.5
274.960000	28.6	1000.0	120.000	154.0	H	97.0	20.7	17.4	46.0
300.000000	39.6	1000.0	120.000	103.0	H	20.0	21.5	6.4	46.0
350.000000	38.4	1000.0	120.000	112.0	H	136.0	22.6	7.6	46.0



30-1000MHz Radiated Emission

EUT Information

EUT Name:

Model:

Client:

Op Cond:

Operator:

Test Spec:

Comment:

Sample No:

Wireless Display

LKOUT P

Fellowes Inc.

Power on, transmitting 2402MHz at DH5, AC 120V/60Hz, T23.9, 47.4%. P102.5kPa

Cheng Huali

FCC Part 15.209(a)

Vertical

SHA-749413-2

Sweep Setup: RE_VULB9168_pre_Cont_30-1000 [EMI radiated]

Hardware Setup:

Receiver:

Level Unit:

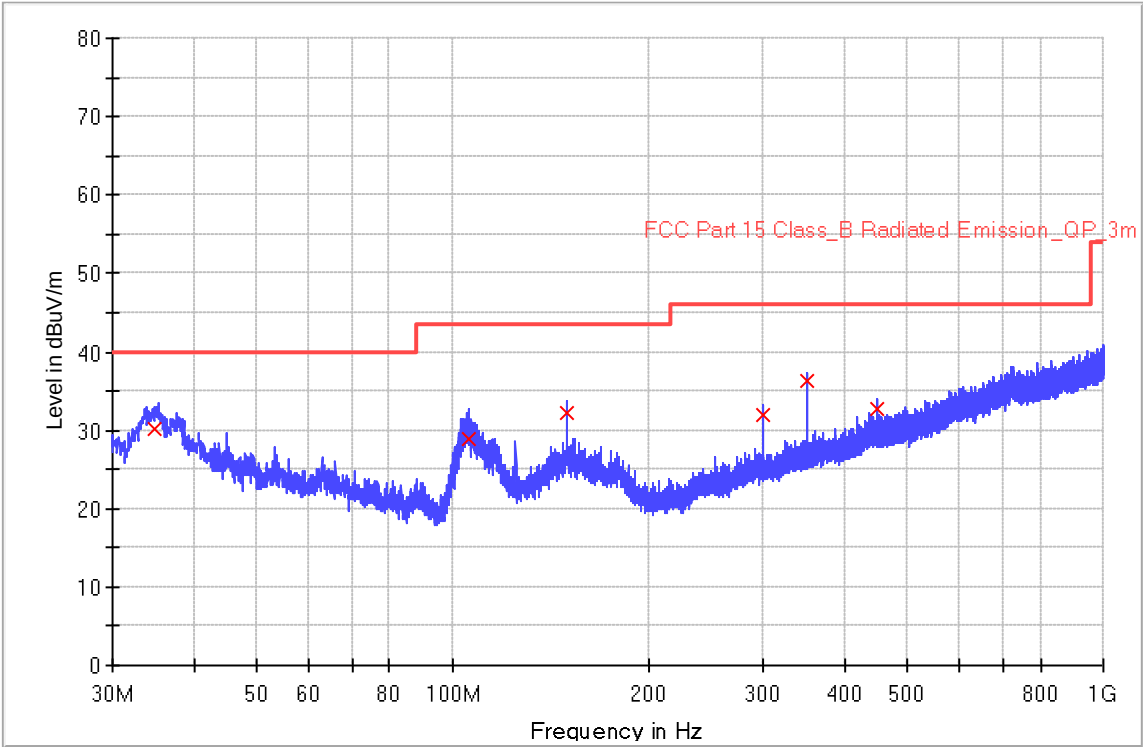
RE_VULB9168

[ESR 3]

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)
34.800000	30.0	1000.0	120.000	116.0	V	45.0	19.4	10.0	40.0
105.800000	28.9	1000.0	120.000	132.0	V	136.0	16.8	14.6	43.5
150.000000	32.3	1000.0	120.000	105.0	V	201.0	20.9	11.2	43.5
299.960000	32.0	1000.0	120.000	135.0	V	118.0	21.5	14.0	46.0
349.960000	36.2	1000.0	120.000	196.0	V	94.0	22.6	9.8	46.0
450.000000	32.7	1000.0	120.000	147.0	V	296.0	25.9	13.3	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	2023-2-10	2024-2-9
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
	Double-ridged waveguide horn antenna	Rohde & Schwarz	HF907	102868	2021-3-15	2024-3-14
	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 Horn Antenna	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
RE	EMC 32	Rohde & Schwarz	V10.50.40
CE	EMC 32	Rohde & Schwarz	V9.15.03

C - Conducted RF tests

- Conducted peak output power
- 20dB bandwidth
- Carrier frequency separation
- Number of hopping frequencies
- Dwell Time - Average Time of Occupancy
- 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	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.

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-----