


FCC/ISED Test Report

Prepared for: Hunter Douglas

Address: 1 Duette Way,
Broomfield, CO 80020

Product: 1012000449, 2015000036, and 1012000565

Test Report No: R20210324-21-E1C

Approved by: 

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DATE: 25 April 2024

Total Pages: 53

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REVISION PAGE

Rev. No.	Date	Description
0	16 January 2024	Issued by FLane Prepared by FLane
A	25 February 2024	Re-issued report. No change in data. Verified data in report to be valid. -FLane
B	8 March 2024	Updated data referencing plan and corrected items from TCB comments.
C	24 April 2024	Updated model numbers throughout the report - KV



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1.0 SUMMARY OF TEST RESULTS


The purpose of this report is to compare the results from the previous model. The device was investigated to ensure it complies with updated standards such as RSS-247 Issue 3. This data is leveraged from a previous model FCC ID: UXUPC6. Worst case emissions were investigated and found to be compliant negligibly different from the previous model.

The EUT has been tested according to the following specifications:

- (1) US Code of Federal Regulations, Title 47, Part 15
- (2) ISSED RSS-Gen, Issue 5
- (3) ISSED RSS-247, Issue 3

APPLIED STANDARDS AND REGULATIONS		
Standard Section	Test Type	Result
FCC Part 15.35 RSS Gen, Issue 5, Section 6.10	Duty Cycle	Complies
FCC Part 15.247(b)(3) RSS-247 Issue 3, Section 5.4(d)	Peak output power	Complies
FCC Part 15.247(a)(2) RSS-247 Issue 3, Section 5.2 (a)	Bandwidth	Complies
FCC Part 15.209 RSS-Gen Issue 5, Section 7.3	Receiver Radiated Emissions	Complies
FCC Part 15.209 (restricted bands), 15.247 (unrestricted) RSS-247 Issue 3, Section 5.5, RSS-Gen Issue 5, Section 8.9	Transmitter Radiated Emissions	Complies
FCC Part 15.247(e) RSS-247 Issue 3, Section 5.2 (b)	Power Spectral Density	Complies
FCC Part 15.209, 15.247(d) RSS-247 Issue 3, Section 5.5	Band Edge Measurement	Complies
FCC Part 15.207 RSS-Gen Issue 5, Section 7.2	AC Conducted Emissions	Complies

See Section 4 for details on the test methods used for each test.

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Test Plan / Spot-check plan – tested on variant model on November 13, 2023

(1) US Code of Federal Regulations, Title 47, Part 15

APPLIED STANDARDS AND REGULATIONS			
Standard Section	Test Type	Variant 1 certified	Variant 2 New certification
FCC Part 15.35	Duty Cycle	Full test	Full test**
FCC Part 15.247(b)(3)	Peak output power	Full test	Full test**
FCC Part 15.247(a)(2)	Bandwidth	Full test	Full test**
FCC Part 15.209	Receiver Radiated Emissions	Full test	Full test**
FCC Part 15.209 (restricted bands)	Transmitter Radiated Emissions	Full test	Spot-check*
FCC Part 15.247 (unrestricted)	Transmitter Radiated Emissions	Full test	Full test**
FCC Part 15.247(e)	Power Spectral Density	Full test	Full test**
FCC Part 15.209, 15.247(d)	Band Edge Measurement	Full test	Spot-check*
FCC Part 15.207	AC Conducted Emissions	Full test	Full test**

*Spot-check will include verification of 2 worse-case test frequencies to ensure that the device remains compliant and the margin has not decreased by more than 2 dB.

**Full testing data will be referenced from original certification actual testing. Justification has been provided with the Equipment Compliance Review (ECR) plan submitted to the TCB and FCC.

The purpose of this test plan is to compare the results from the previous model. The device was investigated to ensure it complies with updated standards such as RSS-247 Issue 3. This data is leveraged from a previous model FCC ID: UXUPC6. Worst case emissions were investigated and found to be compliant negligibly different from the previous model.



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2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	1012000449, 2015000036, and 1012000565
FCC ID	UXUPC7
IC ID	7316A-PC7
EUT Received	20 November 2020 (Variant 1) 30 October 2023 (Variant 2)
EUT Tested	23 November 2020- 27 January 2021 (Variant 1) Spot check: Nov 13, 2023 (Variant 2)
Serial No.	00220 (conducted antenna port measurements); 00219 (radiated measurements); 91557130 (spot check on 2 nd variant) Serial numbers assigned by the test lab except for variant 2 model.
Operating Band	2400 MHz – 2483.5 MHz
Device Type	<input checked="" type="checkbox"/> BLE <input checked="" type="checkbox"/> NRF
Power Supply / Voltage	TP-POE-48 SN:139049622D RC03

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

2.2 DESCRIPTION OF TEST MODES

The operating range of the EUT is dependent on the device type found in section 2.1:

The only modulations/transmitters used in this specific radio is BLE and Nordics proprietary Bluetooth modes.


For Bluetooth Transmissions:

Channel	Frequency
Low	2402 MHz
Mid	2440 MHz
High	2480 MHz

These are the only representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

2.3 DESCRIPTION OF SUPPORT UNITS

None

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3.0 LABORATORY AND GENERAL TEST DESCRIPTION

3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
 4740 Discovery Drive
 Lincoln, NE 68521

A2LA Certificate Number: 1953.01
 FCC Accredited Test Site Designation No: US1060
 Industry Canada Test Site Registration No: 4294A-1
 NCC CAB Identification No: US0177

Environmental conditions varied slightly throughout the tests:

Relative humidity of $35 \pm 4\%$
 Temperature of $22 \pm 3^\circ$ Celsius




3.2 TEST PERSONNEL

No.	PERSONNEL	TITLE	ROLE
1	Fox Lane	Test Engineer	Testing and Report
2	Karthik Vepuri	Test Engineer	Review

Notes:

All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.


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3.3 TEST EQUIPMENT

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer (44GHz)	N9038A	MY59050109	July 17, 2023	July 17, 2025
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	July 17, 2023	July 17, 2025
Keysight EXA Signal Analyzer	N9010A	MY56070862	July 18, 2023	July 17, 2025
ETS-Lindgren Red Horn Antenna	3115	218576	July 31, 2023	July 30, 2024
SunAR RF Motion	JB1	A091418	July 27, 2023	July 26, 2024
8447F POT H64 Preamplifier*	8447F POT H64	3113AD4667	March 21, 2022	March 21, 2024
Agilent Preamp*	87405A	3950M00669	June 5, 2023	June 5, 2025
Rohde & Schwarz Preamplifier*	TS-PR18	3545700803	June 5, 2023	June 5, 2025
Trilithic High Pass Filter*	6HC330	23042	June 5, 2023	June 5, 2025
Com-Power LISN, Single Phase	LI-220C	20070017	July 17, 2023	July 17, 2025
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	June 5, 2023	June 5, 2025
ETS – Lindgren- VSWR on 10m Chamber	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	July 30, 2020	July 30, 2024
NCEE Labs-NSA on 10m Chamber*	10m Semi-anechoic chamber-NSA	NCEE-001	May 25, 2022	May 25, 2025
RF Cable (antenna to 10m chamber bulkhead)	FSCM 64639	01E3872	June 5, 2023	June 5, 2025
RF Cable (10m chamber bulkhead to control room bulkhead)	FSCM 64639	01E3874	June 5, 2023	June 5, 2025
RF Cable (control room bulkhead to test receiver)	FSCM 64639	01F1206	June 5, 2023	June 5, 2025
N connector bulkhead (10m chamber)	PE9128	NCEE BH1	June 5, 2023	June 5, 2025
TDK Emissions Lab Software	V11.25	700307	NA	NA

*Internal Characterization

Notes: All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.

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3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMENTS

Measurement type presented in this report (Please see the checked box below):

Conducted ☒

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.



Figure 1 - Bandwidth Measurements Test Setup

Radiated ☒

All the radiated measurements were taken at a distance of 3m from the EUT. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

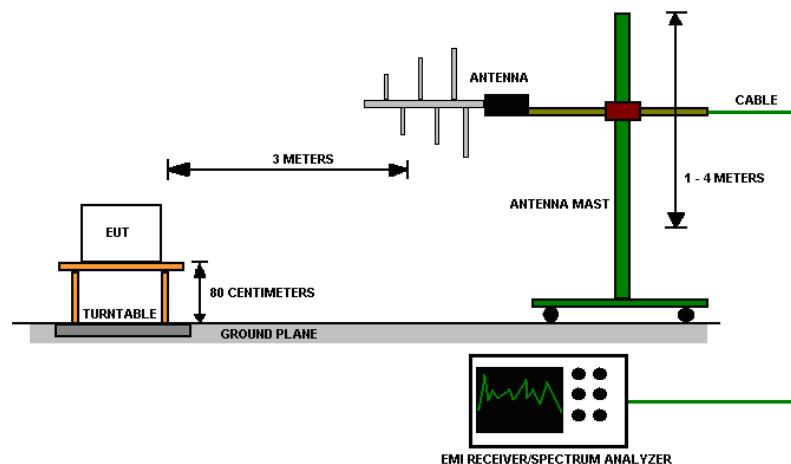


Figure 2 - Radiated Emissions Test Setup



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4.0 RESULTS

Conducted DTS Radio Measurements

CHANNEL	Transmitter	Occupied Bandwidth (kHz)	6 dB Bandwidth (kHz)	PEAK OUTPUT POWER (dBm)	PEAK OUTPUT POWER (mW)	PSD (dBm)	RESULT
Low	GMSK	2073.00	1257.00	7.144	5.181	-8.364	PASS
Mid	GMSK	2063.70	1165.00	7.306	5.378	-8.419	PASS
High	GMSK	2069.50	1248.00	6.872	4.866	-9.798	PASS
Low	NRF	1859.40	886.00	7.403	5.499	-5.653	PASS
Mid	NRF	1872.00	843.40	7.387	5.479	-5.598	PASS
High	NRF	1824.20	886.40	7.440	5.546	-4.803	PASS
Occupied Bandwidth = N/A; 6 dB Bandwidth Limit = 500 kHz				Peak Output Power Limit = 30 dBm; PSD Limit = 8 dBm			

Radiated Unrestricted Band-Edge

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level (dBm)	Relative Fundamental (dBm)	Delta (dB)	Min Delta (dB)	Result
Low	BLE	2400.00	-45.32	-14.74	30.59	20.00	PASS
Low	NRF	2400.00	-52.79	-14.65	38.15	20.00	PASS
High**	BLE	2483.50	-61.04**	-23.97**	37.06	20.00	PASS
High**	NRF	2483.50	-61.12**	-20.04**	41.08	20.00	PASS

*Graphs in Appendix C include corrections, but they are intended to be relative measurements.

**Higher bandedge measurements show dBuV in the graphs presented in appendix C, they were converted from dBuV to dBm ($\text{dBm} = \text{dBuV} - 107$).

Radiated Peak Restricted Band-Edge

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)	Margin	Result
Low	BLE	2386.10	60.04	Peak	73.98	13.94	PASS
Low	NRF	2387.30	60.00	Peak	73.98	13.98	PASS
High	BLE	2497.30	59.11	Peak	73.98	14.88	PASS
High	NRF	2496.30	59.17	Peak	73.98	14.81	PASS

*Limit shown is the peak limit taken from FCC Part 15.209; Graphs in Appendix C include corrections.



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Radiated Average Restricted Band-Edge							
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)	Margin	Result
Low	BLE	2389.90	48.48	Average	53.98	5.50	PASS
Low	NRF	2389.90	48.52	Average	53.98	5.46	PASS
High	BLE	2495.90	47.78	Average	53.98	6.20	PASS
High	NRF	2496.50	47.80	Average	53.98	6.18	PASS
*Limit shown is the average limit taken from FCC Part 15.209; Graphs in Appendix C include corrections.							



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4.1 OUTPUT POWER

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of power measurements:

For FCC Part 15.247 Device:

The maximum allowed peak output power is 30 dBm.

Test procedures:

Details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the output power plots can be found in the Appendix C.
2. All data is in the table in results section 4.0.
3. All the measurements were found to be compliant.



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4.2 BANDWIDTH

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of bandwidth measurements:

For FCC Part 15.247 Device:

The 99% occupied bandwidth is for informational purpose only. The 6dB bandwidth of the signal must be greater than 500 kHz.

Test procedures:

Details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Test setup details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the bandwidth plots can be found in the Appendix C.
2. All data is in the table in results section 4.0.
3. All the measurements were found to be compliant.



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4.3 DUTY CYCLE

Test Method: NA

4.4 RADIATED EMISSIONS

Test Method: ANSI C63.10-2013, Section 6.5, 6.6

Limits for radiated emissions measurements:

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH ($\mu\text{V/m}$)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = $20 * \log * \text{Emission level } (\mu\text{V/m})$.
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.
4. The EUT was tested for spurious emissions while running off of battery power and external USB power. The worse-case emissions were produced while running off of USB power, so results from this mode are presented.



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Test procedures:

- a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements from 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna was a broadband antenna, and its height 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 used to make the measurement.
- d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.
- e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.
- f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise, the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- g. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions.
- h. During the preview scan, the EUT was tested with all 3 radios transmitting simultaneously to investigate for any intermodulation products. In cases where intermodulation products were found, they were maximized and presented in the tables

Test setup:

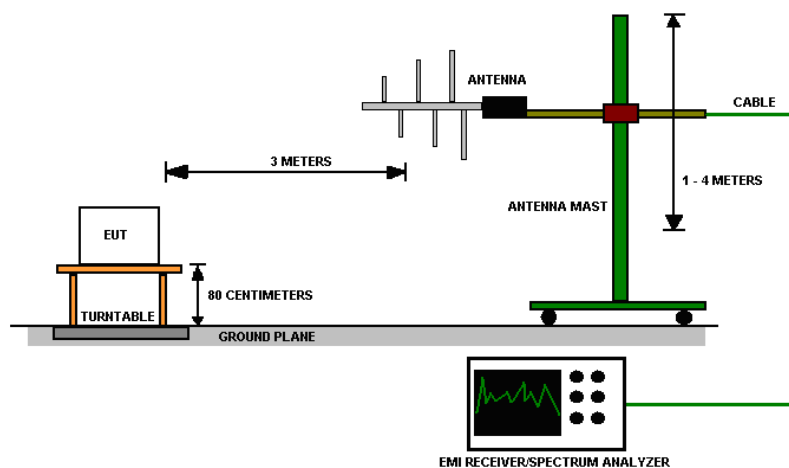


Figure 3 - Radiated Emissions Test Setup

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.
2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

Deviations from test standard:

No deviation.

EUT operating conditions

Details can be found in section 2.1 of this report.

Test results:

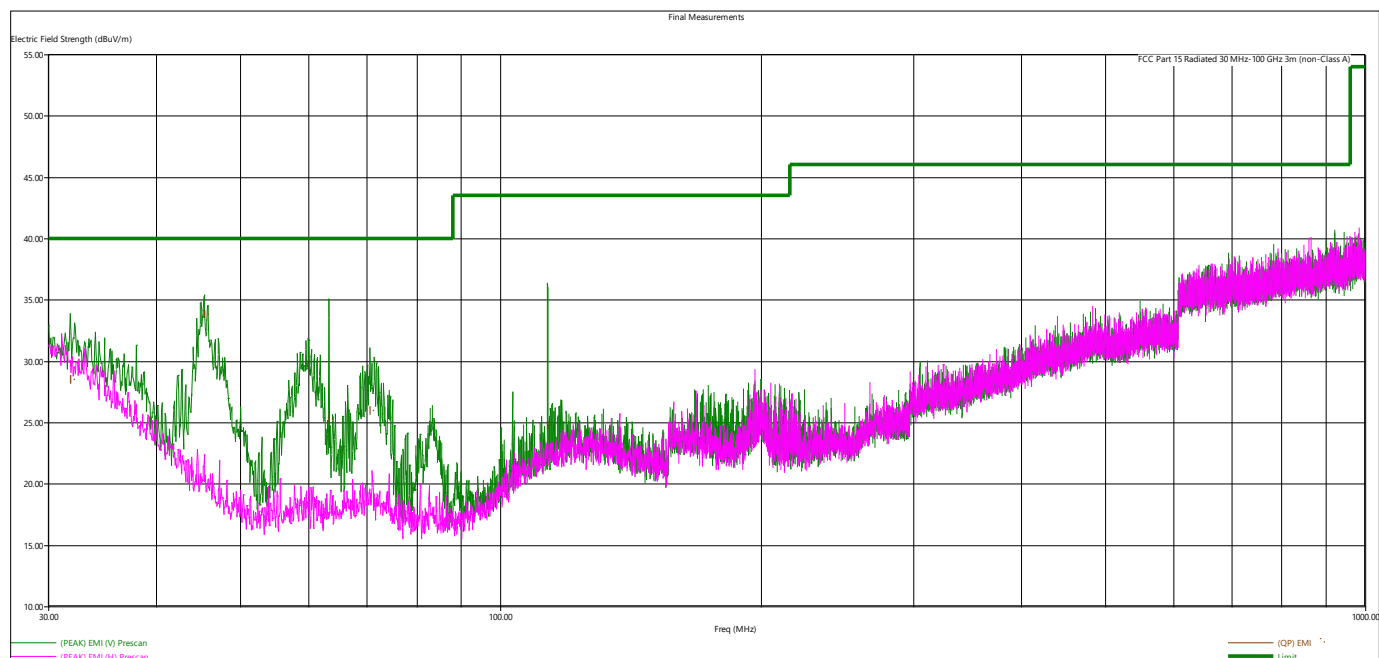


Figure 4 - Radiated Emissions Plot, Receive

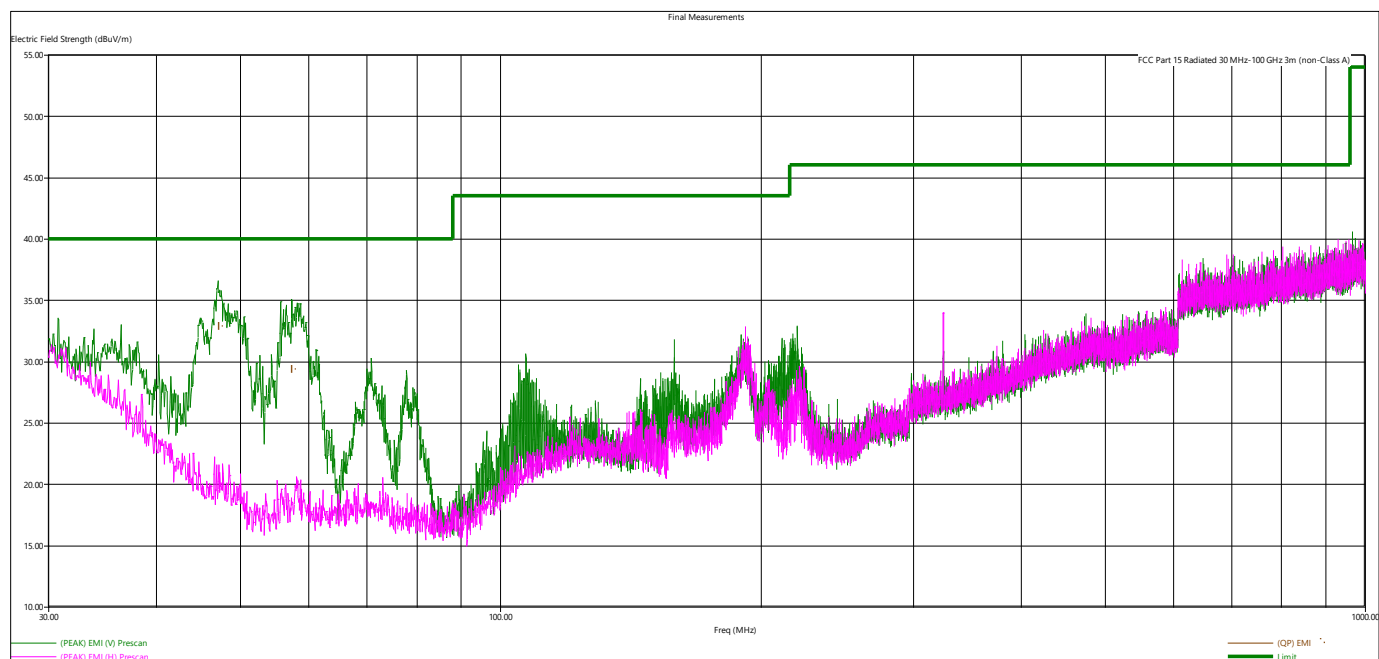


Figure 5 - Radiated Emissions Plot, Low Channel, BLE

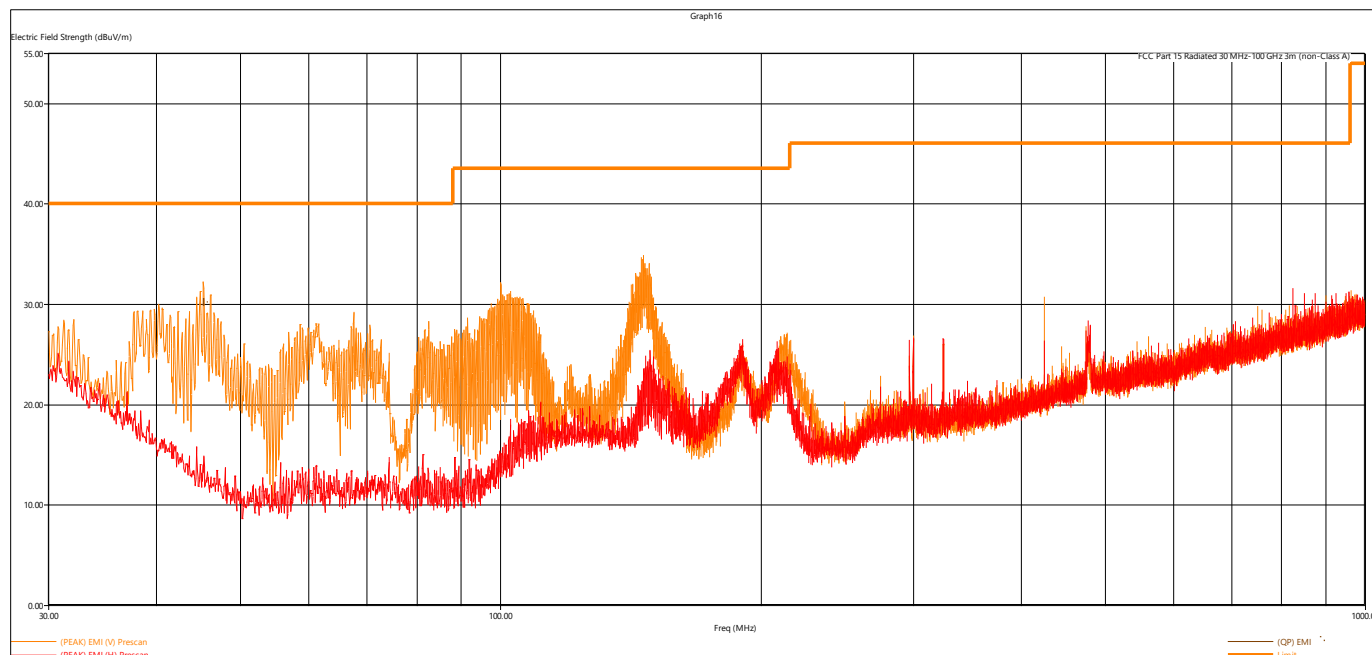


Figure 6 - Radiated Emissions Plot, High Channel, NRF

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The worst-case emissions were presented in this section.
4. Margin value = Emission level – Limit value
5. The lowest, middle and high channel were all examined in the 30 MHz – 1 GHz range. The worse-case is shown.

Quasi-Peak Measurements								
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dBuV/m	dBuV/m	dB	cm.	deg.			
45.323760	30.13	40.00	9.87	128	140	V	High	NRF
47.226720	32.84	40.00	7.16	106	294	V	Low	GMSK
57.381600	29.33	40.00	10.67	135	342	V	Low	GMSK
31.744800	28.43	40.00	11.57	217	314	V	RX mode	
45.358080	33.80	40.00	6.20	107	0	V	RX mode	
63.394080	25.26	40.00	14.74	119	144	V	RX mode	
70.470000	25.91	40.00	14.09	139	32	V	RX mode	
113.075040	24.76	43.52	18.76	105	360	V	RX mode	

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above.



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Peak Measurements


Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.			
2402.294000	102.52	NA	NA	156.000	27.000	H	Low	NRF
2402.504000	102.78	NA	NA	189.000	153.000	H	Low	GMSK
4804.800000	46.51	73.98	27.47	131.000	87.000	V	Low	NRF
4880.206000	44.91	73.98	29.07	131.000	131.000	V	Mid	NRF
4959.612000	44.59	73.98	29.39	149.000	308.000	H	High	NRF
4804.000000	44.75	73.98	29.23	151.000	45.000	V	Low	GMSK
4879.184000	44.62	73.98	29.36	156.000	359.000	H	Mid	GMSK
4958.928000	44.68	73.98	29.30	163.000	306.000	H	High	GMSK
1261.562000	36.18	73.98	37.80	200.000	360.000	V	Rx mode	
2464.212000	40.81	73.98	33.17	300.000	219.000	V	Rx mode	

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above.

Average Measurements

Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.			
2402.294000	99.64	NA	NA	156	27	H	Low	NRF
2402.504000	96.52	NA	NA	189	153	H	Low	GMSK
4804.800000	34.73	53.98	19.25	131	87	V	Low	NRF
4880.206000	34.13	53.98	19.85	131	131	V	Mid	NRF
4959.612000	33.32	53.98	20.66	149	308	H	High	NRF
4804.000000	32.60	53.98	21.38	151	45	V	Low	GMSK
4879.184000	31.64	53.98	22.34	156	359	H	Mid	GMSK
4958.928000	32.15	53.98	21.83	163	306	H	High	GMSK
1261.562000	22.21	53.98	31.77	200	360	V	Rx mode	
2464.212000	24.65	53.98	29.33	300	219	V	Rx mode	

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above.

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4.5 BAND EDGES

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of band-edge measurements:

For FCC Part 15.247 Device:

For emissions outside of the allowed band of operation (2400.0MHz – 2480.0MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

Test procedures:

The highest emissions level beyond the band-edge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.209. More details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Test setup details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

1. All the band edge plots can be found in the Appendix C.
2. All data is in the table in results section 4.0.
3. If the device falls under FCC Part 15.247 (Details can be found in summary of test results), compliance is shown in the unrestricted band edges by showing minimum delta of 20 dB between peak and the band edge.
4. The restricted band edge compliance is shown by comparing to the general limit defined in Part 15.209. The limit shown in the graph accounts for the antenna gain of the device.



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4.6 POWER SPECTRAL DENSITY

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of power measurements:

For FCC Part 15.249 Device:

Not Applicable

For FCC Part 15.247 Device:

The maximum PSD allowed is 8 dBm.

Test procedures:

Details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Pass

Comments:

4. All the Power Spectral Density (PSD) plots can be found in the Appendix C.
5. All the measurements were found to be compliant.
6. The measurements are reported on the graph.

4.7 CONDUCTED AC MAINS EMISSIONS

Test Method: ANSI C63.10-2013, Section(s) 6.2

Limits for conducted emissions measurements:

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

Notes:

1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

Test Procedures:

- a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
- b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
- c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits are not reported.
- d. Results were compared to the 15.207 limits.

Deviation from the test standard:

No deviation

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test Results:

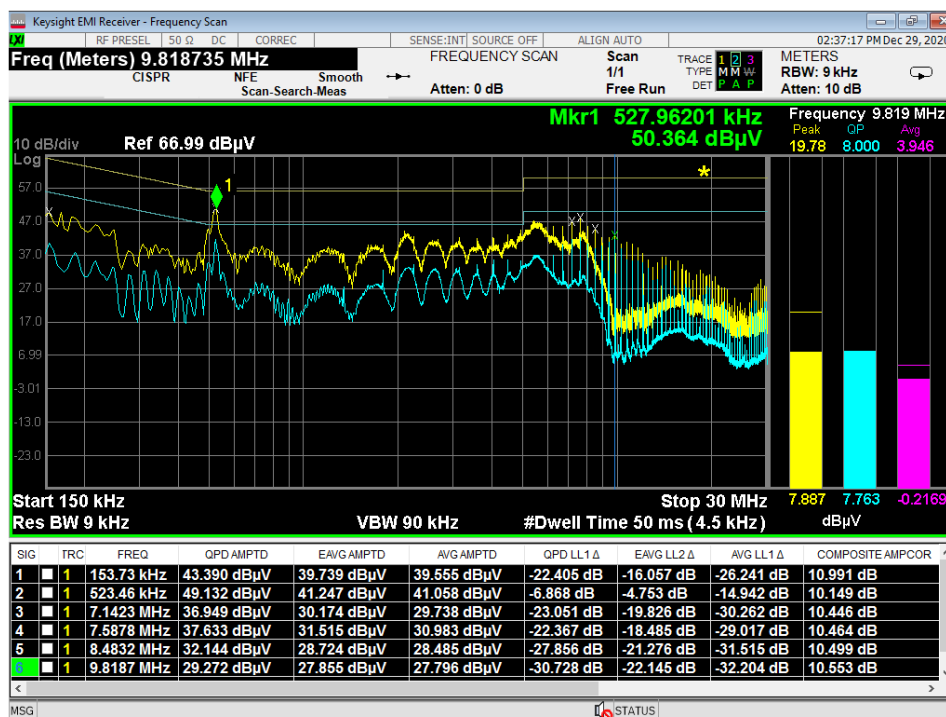


Figure 7 - Conducted Emissions Plot, Line

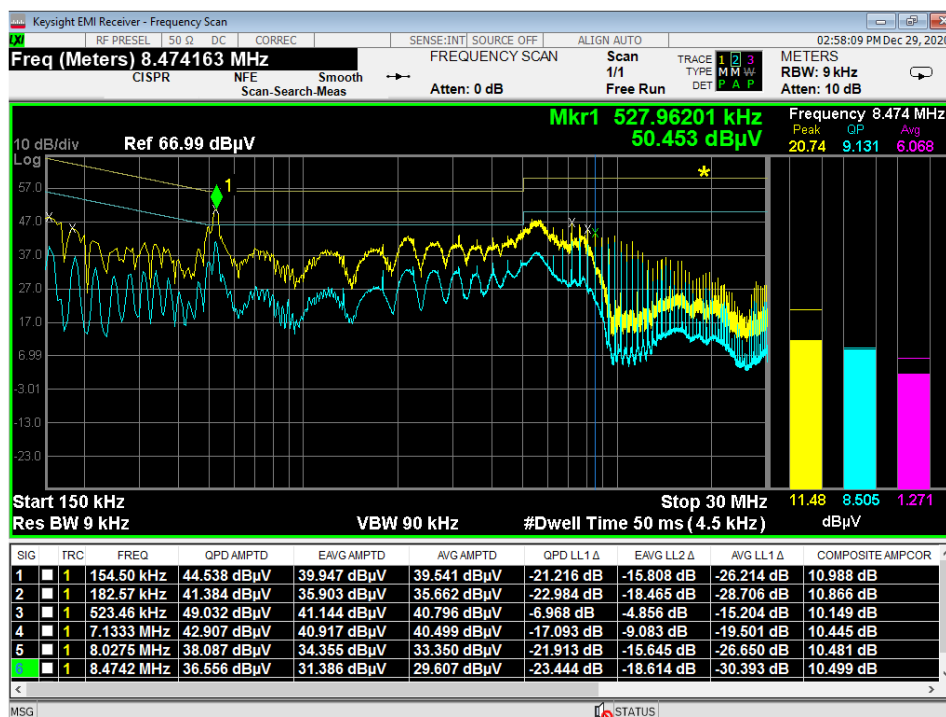



Figure 8 - Conducted Emissions Plot, Neutral

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APPENDIX A: SAMPLE CALCULATION

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF - (-CF + AG) + AV$$

FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dB μ V is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dB μ V/m.

$$FS = 55 + 12 - (-1.1 + 20) + 0 = 48.1 \text{ dB}\mu\text{V/m}$$

The 48.1 dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm} [(48.1 \text{ dB}\mu\text{V/m})/20] = 254.1 \mu\text{V/m}$$

AV is calculated by the taking the $20 \cdot \log(T_{\text{on}}/100)$ where T_{on} is the maximum transmission time in any 100ms window.

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

$$EIRP \text{ (Watts)} = [\text{Field Strength (V/m)} \times \text{antenna distance (m)}]^2 / 30$$

$$\text{Power (watts)} = 10^{[\text{Power (dBm)}]/10} / 1000$$

$$\text{Voltage (dB}\mu\text{V)} = \text{Power (dBm)} + 107 \text{ (for } 50\Omega \text{ measurement systems)}$$

$$\text{Field Strength (V/m)} = 10^{[\text{Field Strength (dB}\mu\text{V/m)} / 20] / 10^6}$$

$$\text{Gain} = 1 \text{ (numeric gain for isotropic radiator)}$$

$$\text{Conversion from 3m field strength to EIRP (d=3):}$$

$$EIRP = [FS(\text{V/m}) \times d^2] / 30 = FS [0.3] \quad \text{for } d = 3$$

$$EIRP(\text{dBm}) = FS(\text{dB}\mu\text{V/m}) - 10(\log 10^9) + 10\log[0.3] = FS(\text{dB}\mu\text{V/m}) - 95.23$$

$$10\log(10^9) \text{ is the conversion from micro to milli}$$



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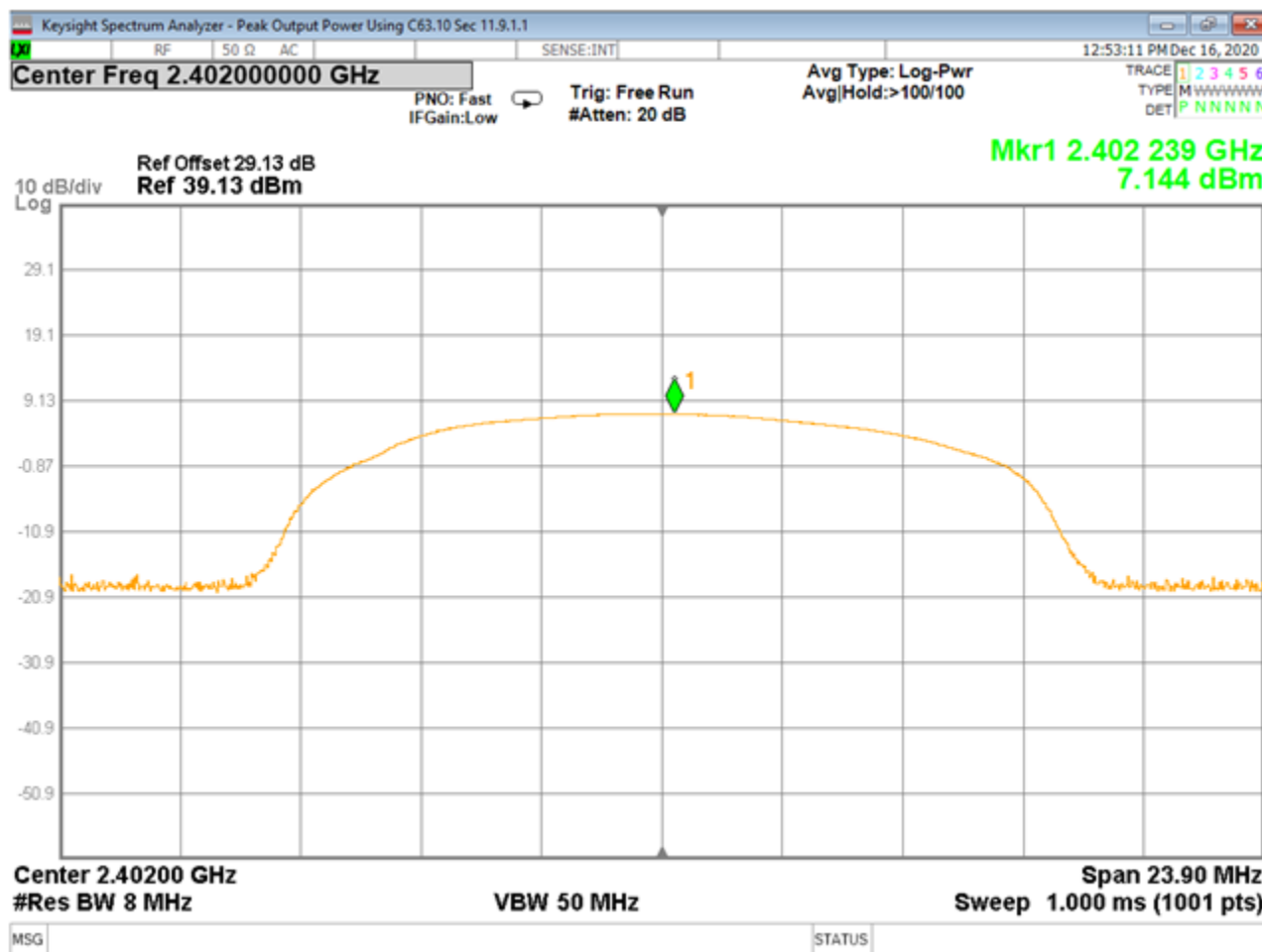
APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	± 4.31
Radiated Emissions, 3m	1GHz - 18GHz	± 5.08
Emissions limits, conducted	30MHz – 18GHz	± 3.03

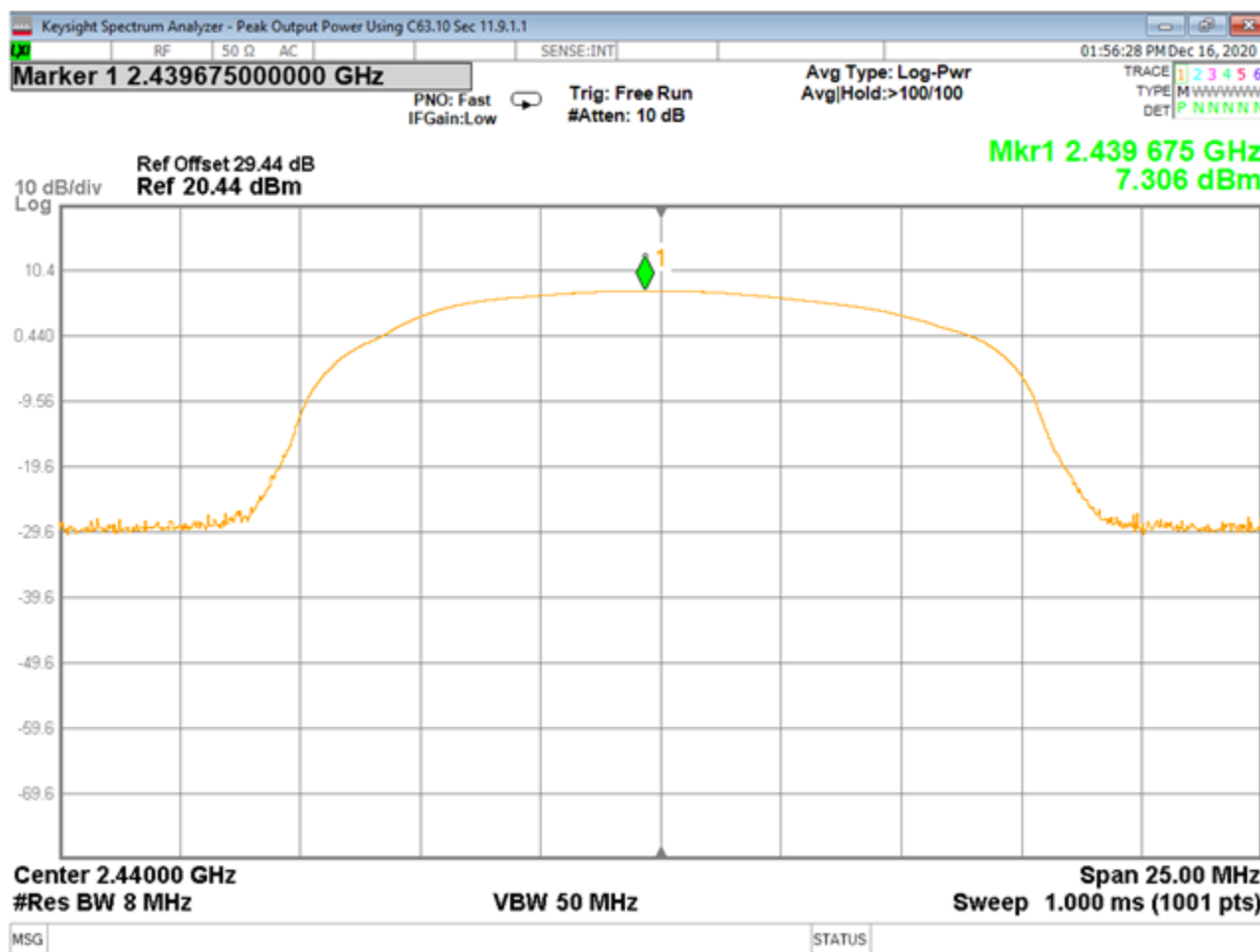
Expanded uncertainty values are calculated to a confidence level of 95%.

APPENDIX C – GRAPHS AND TABLES



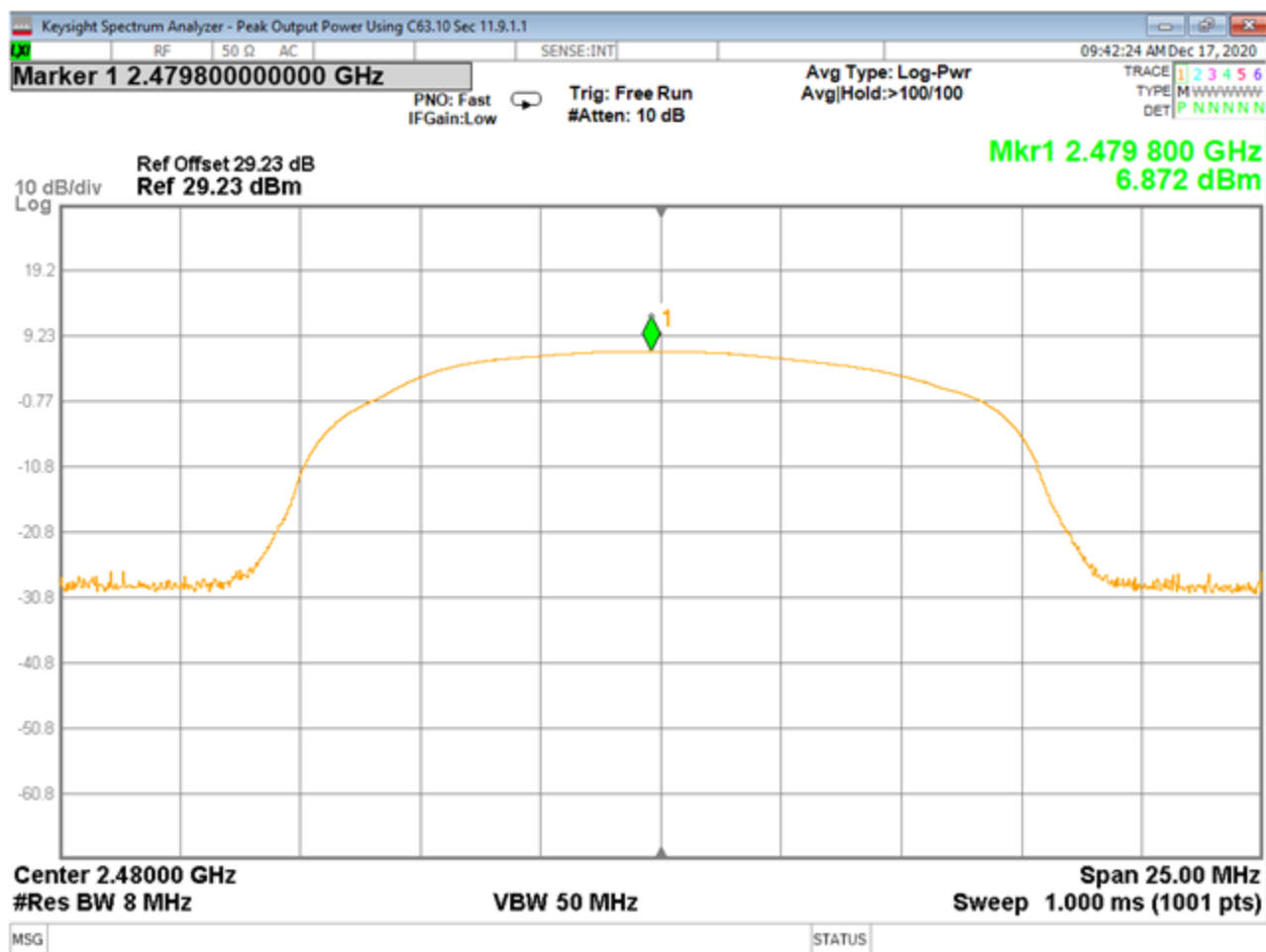
01. Output Power_Radio1_BLE_Low Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



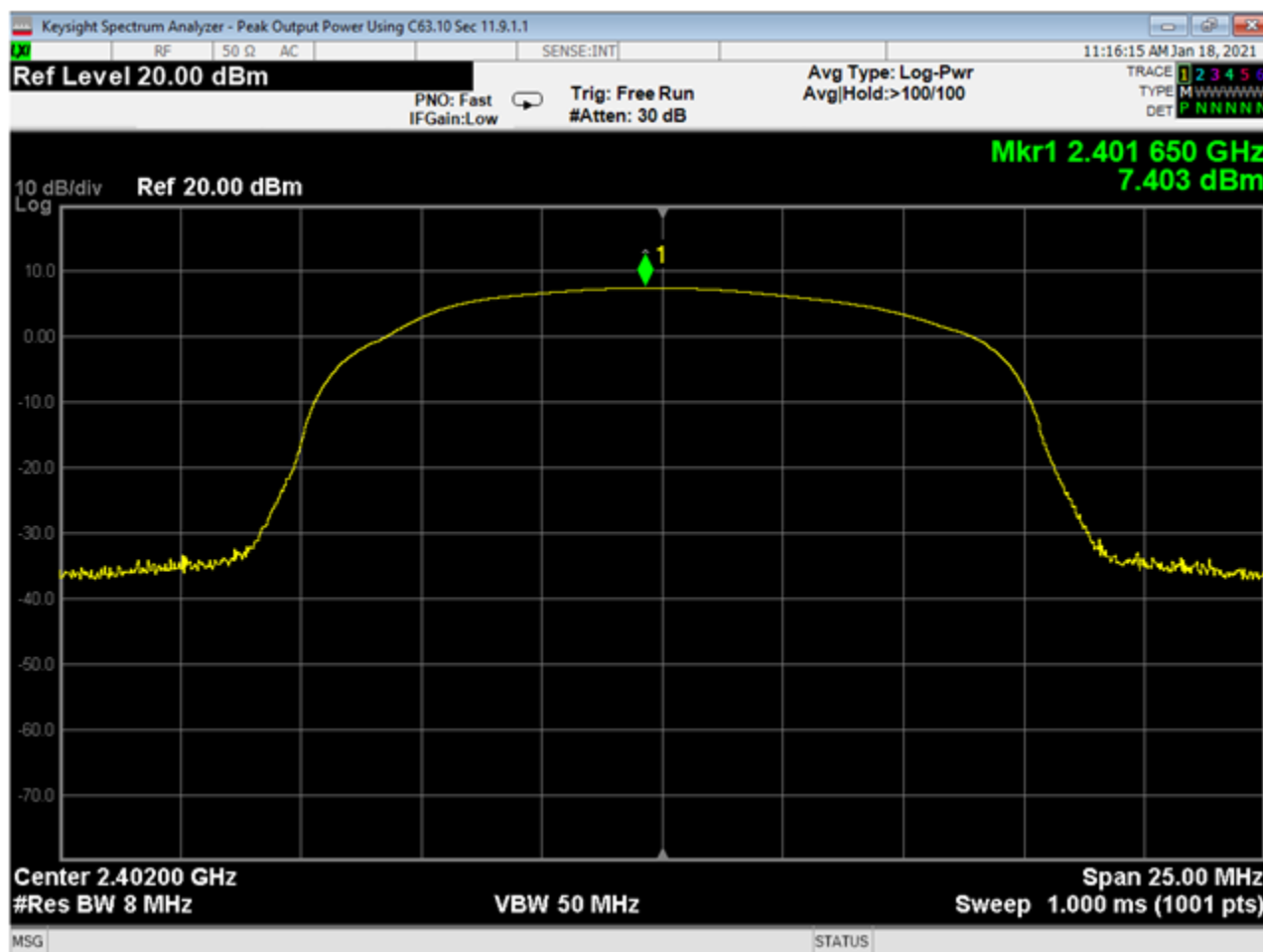
02. Output Power_Radio2_BLE_Mid Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



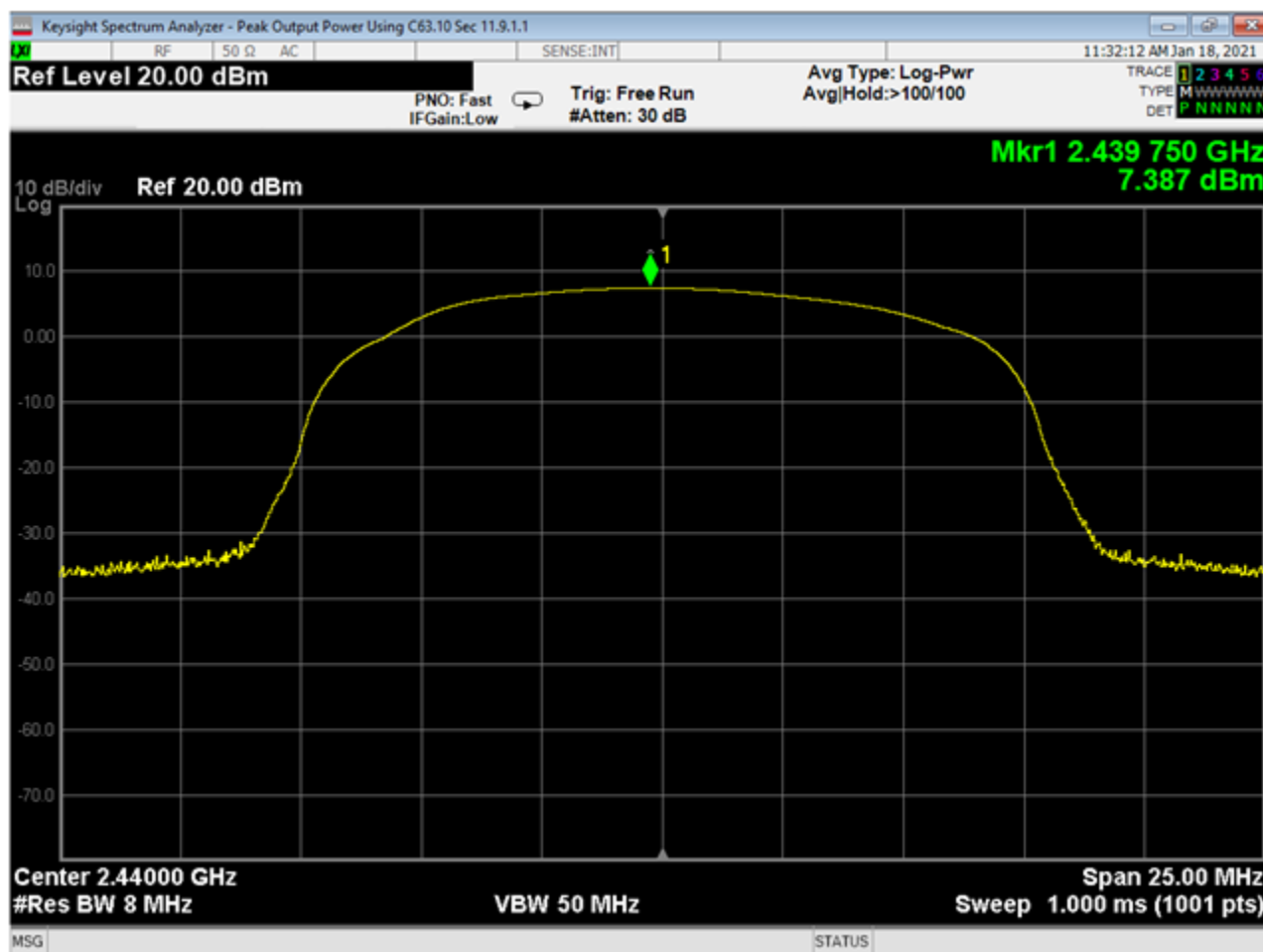
03. Output Power_Radio1_BLE_High Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



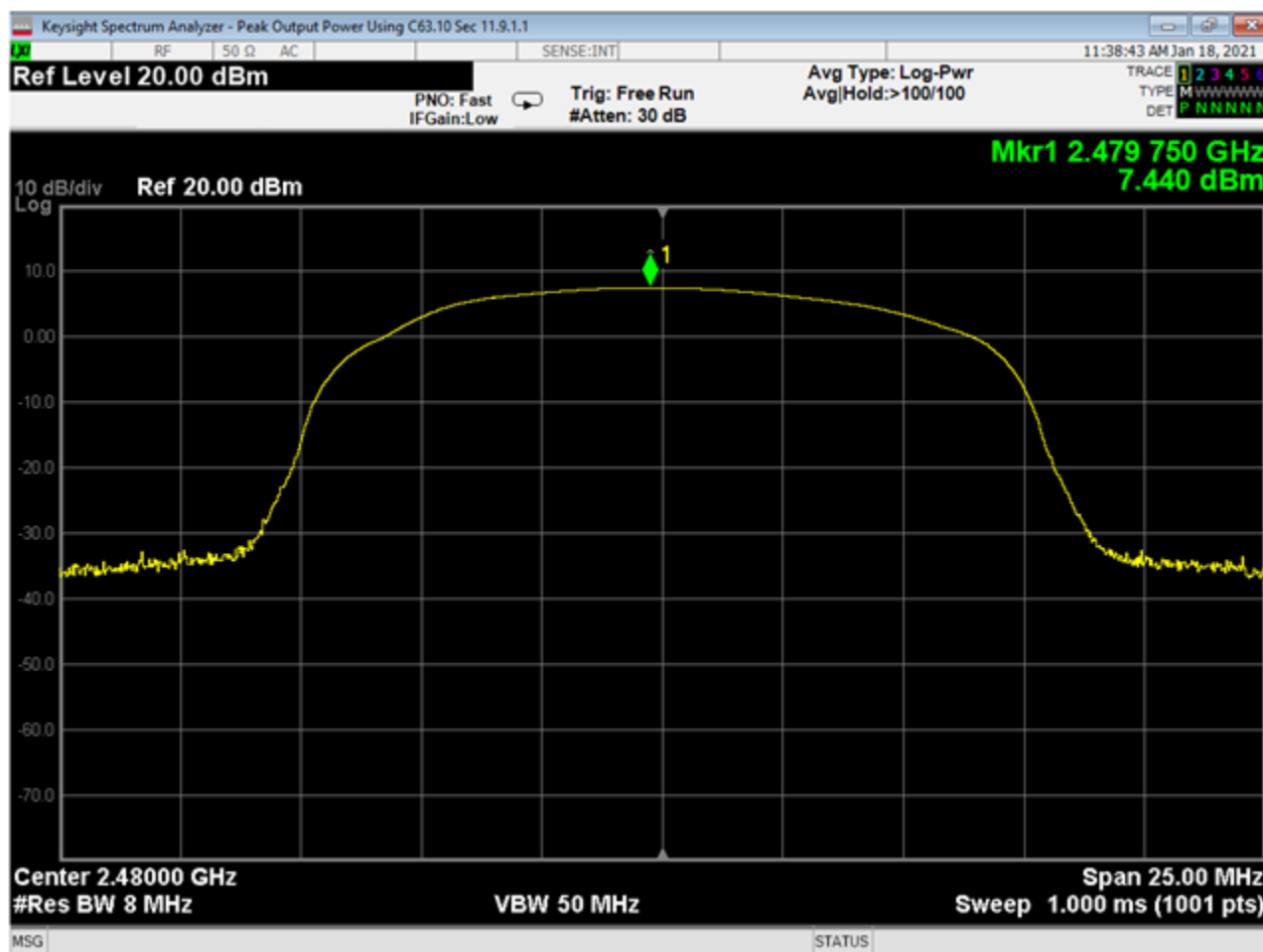
04. Output Power_Radio1_NRF_Low Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



05. Output Power_Radio1_NRF_Mid Channel

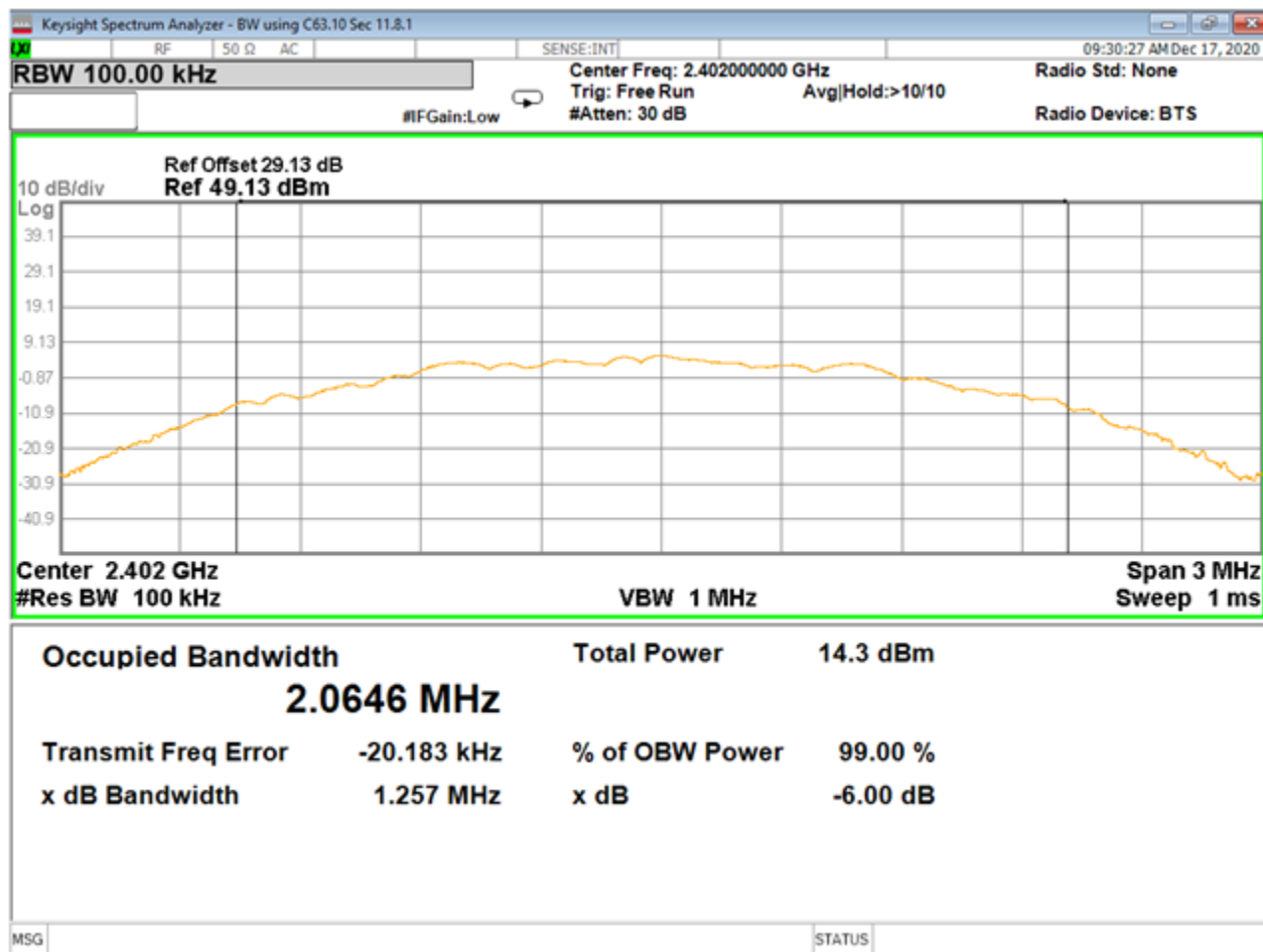
Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



06. Output Power_Radio1_NRF_High Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.

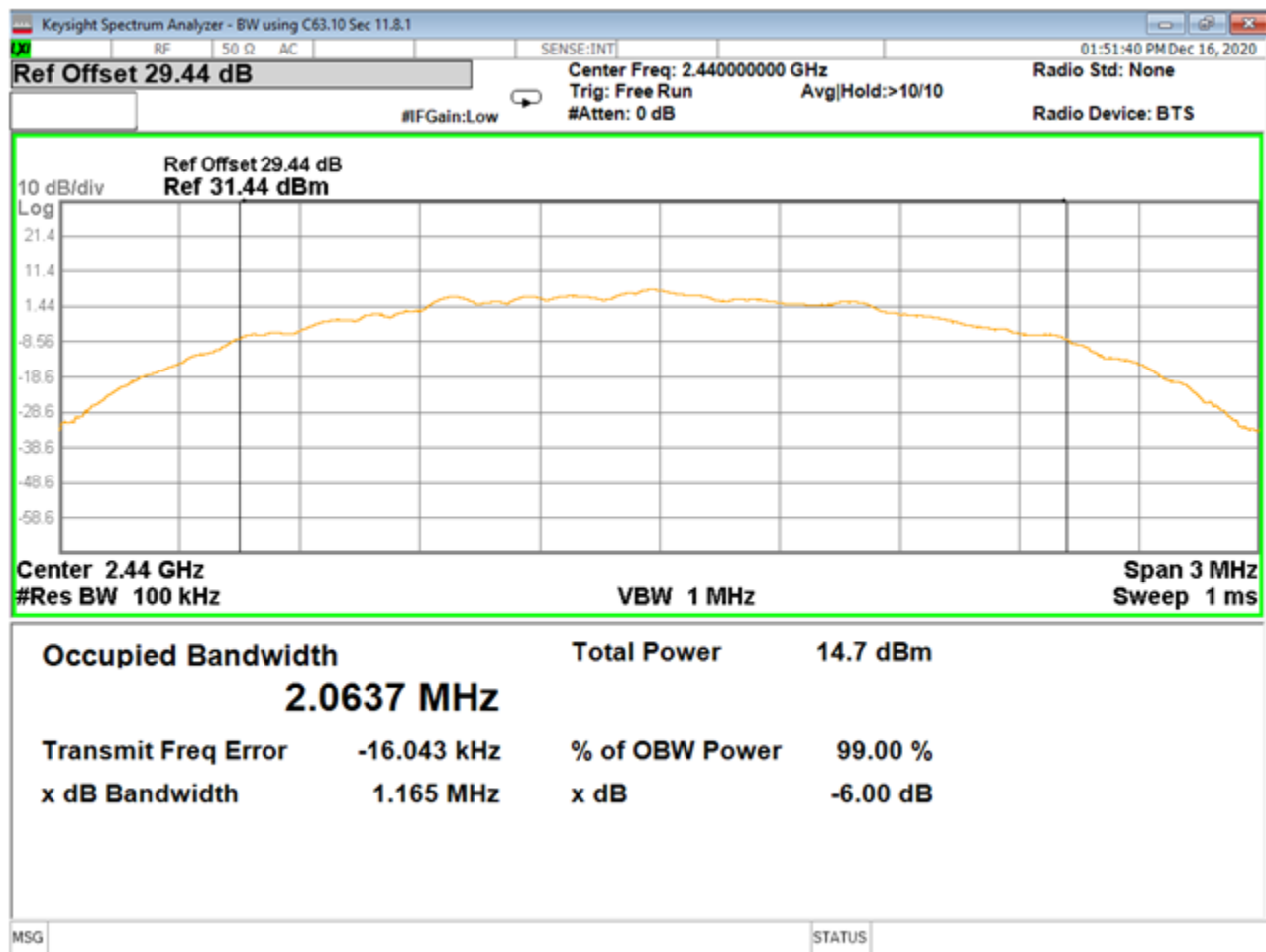
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07. Bandwidth_Radio1_BLE_Low Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.

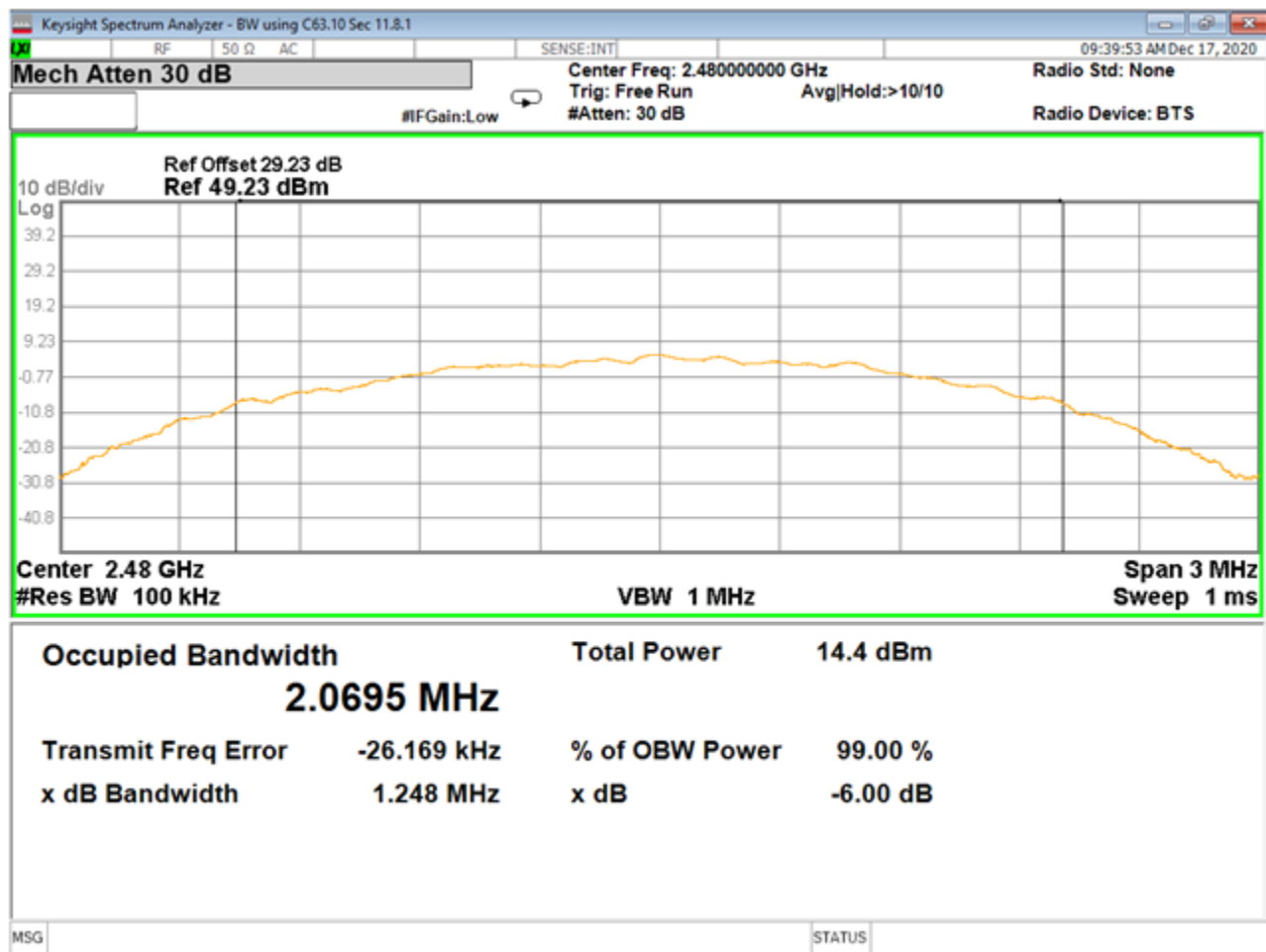
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08. Bandwidth_Radio1_BLE_Mid Channel

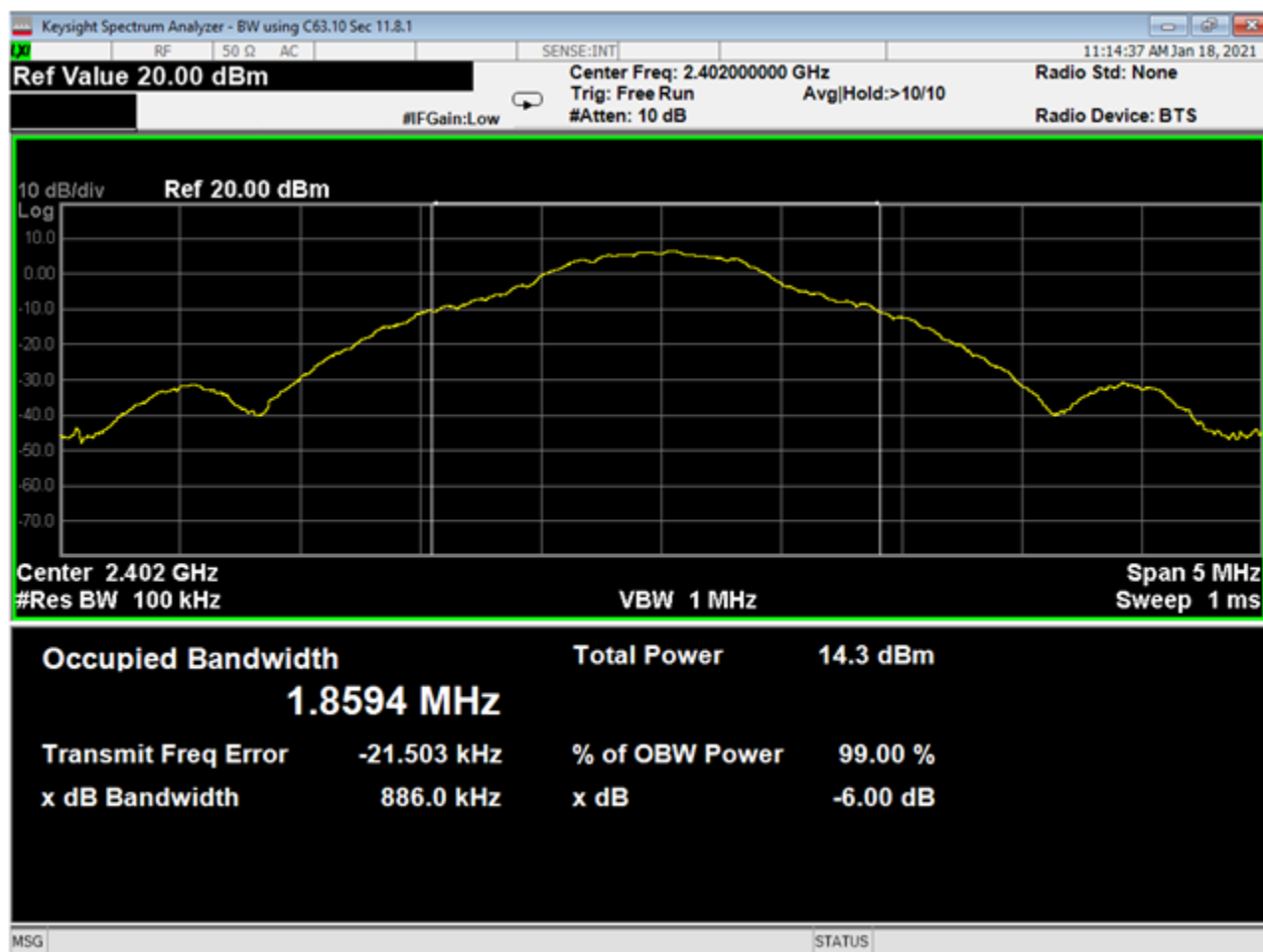
Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.

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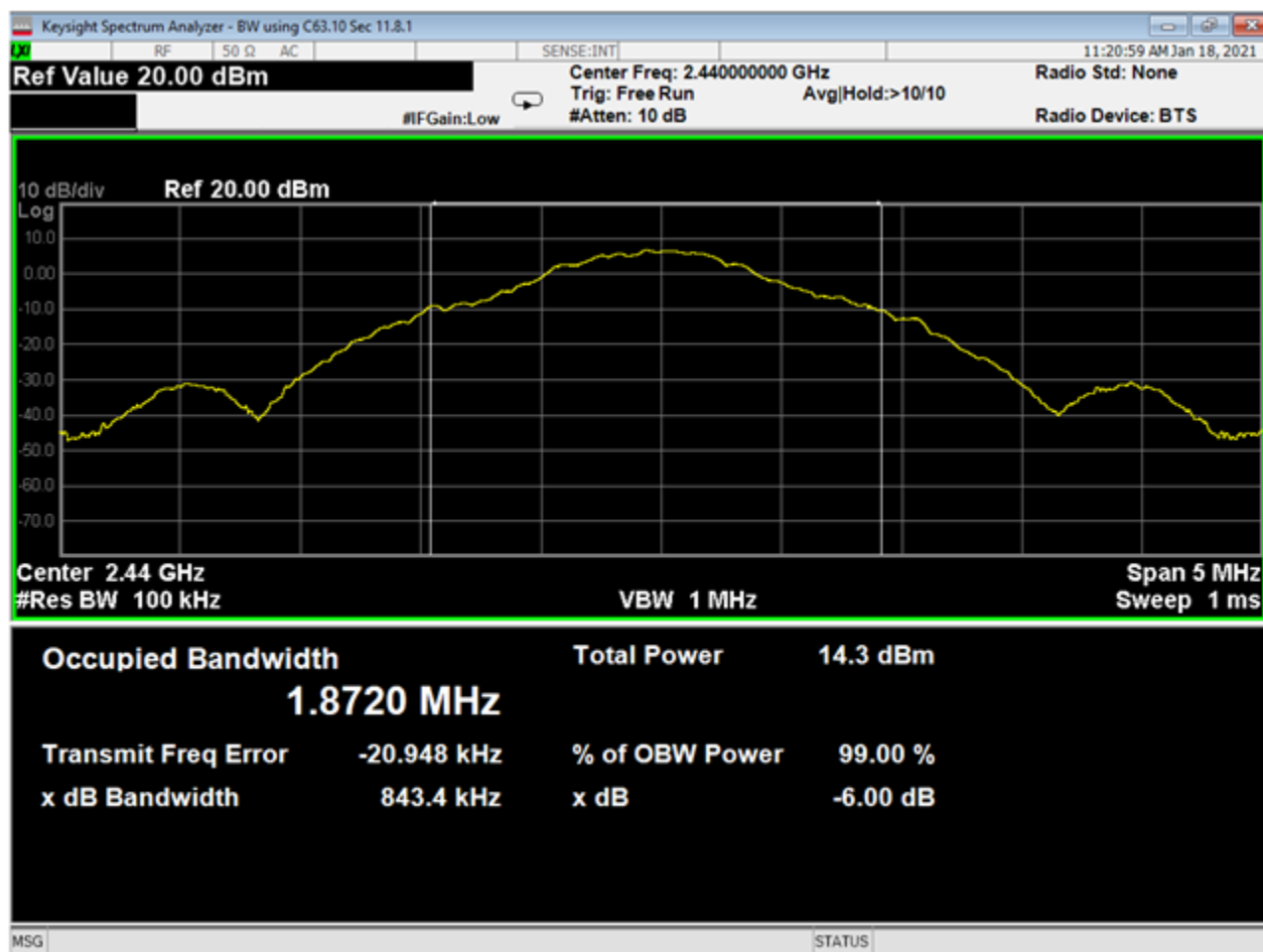
09. Bandwidth_Radio1_BLE_High Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



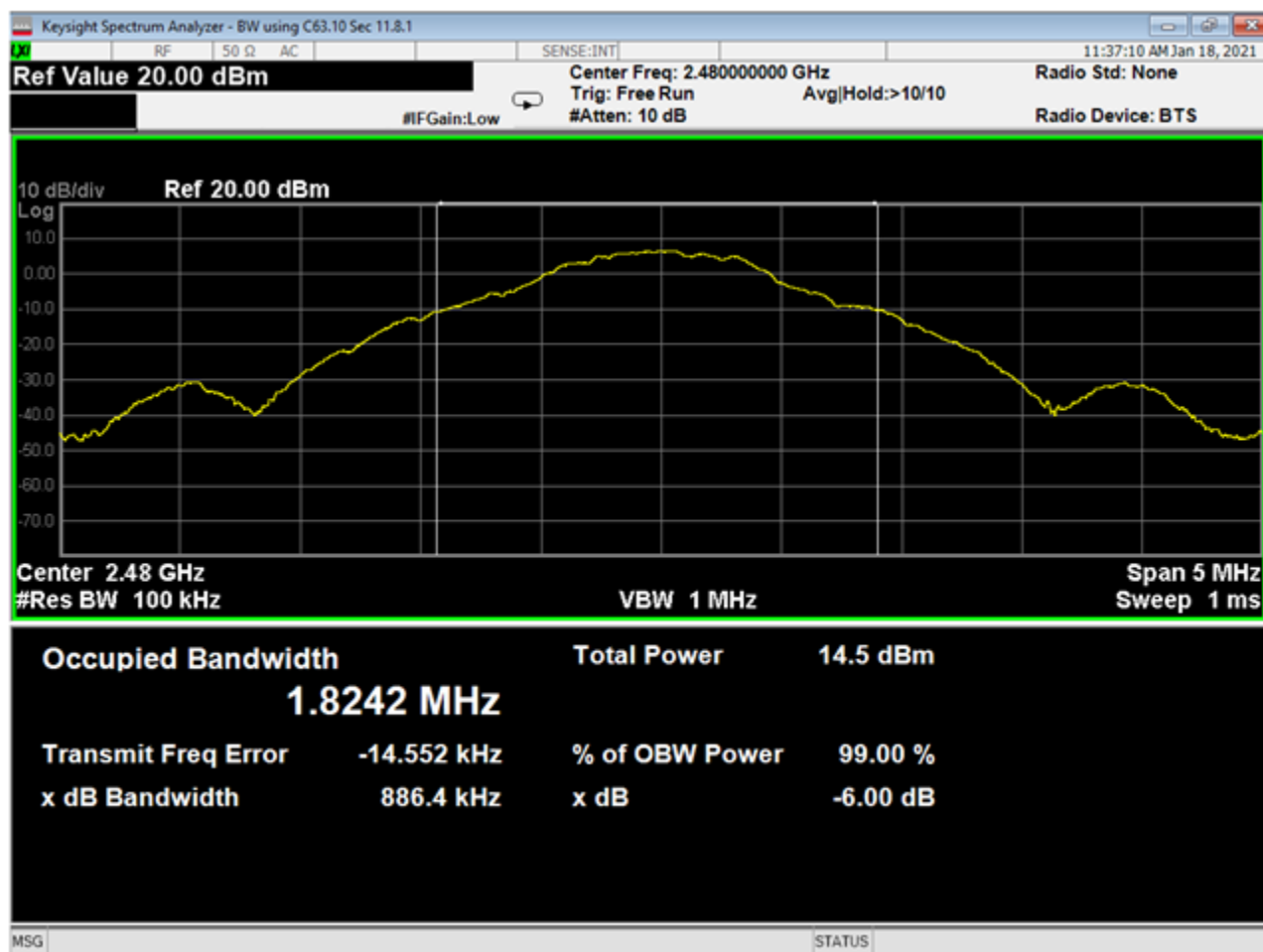
10. Bandwidth_Radio1_NRF_Low Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



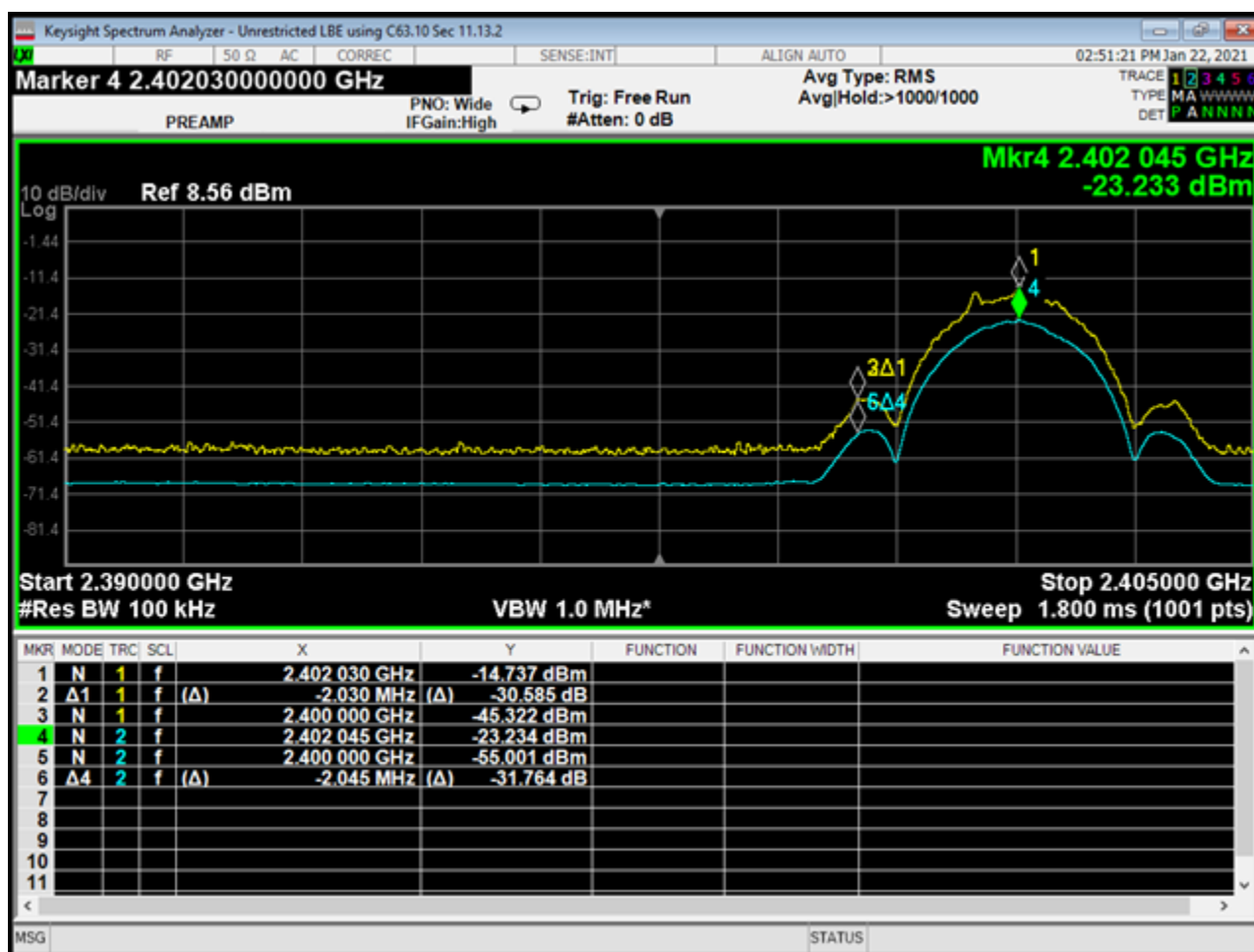
11. Bandwidth_Radio1_NRF_Mid Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



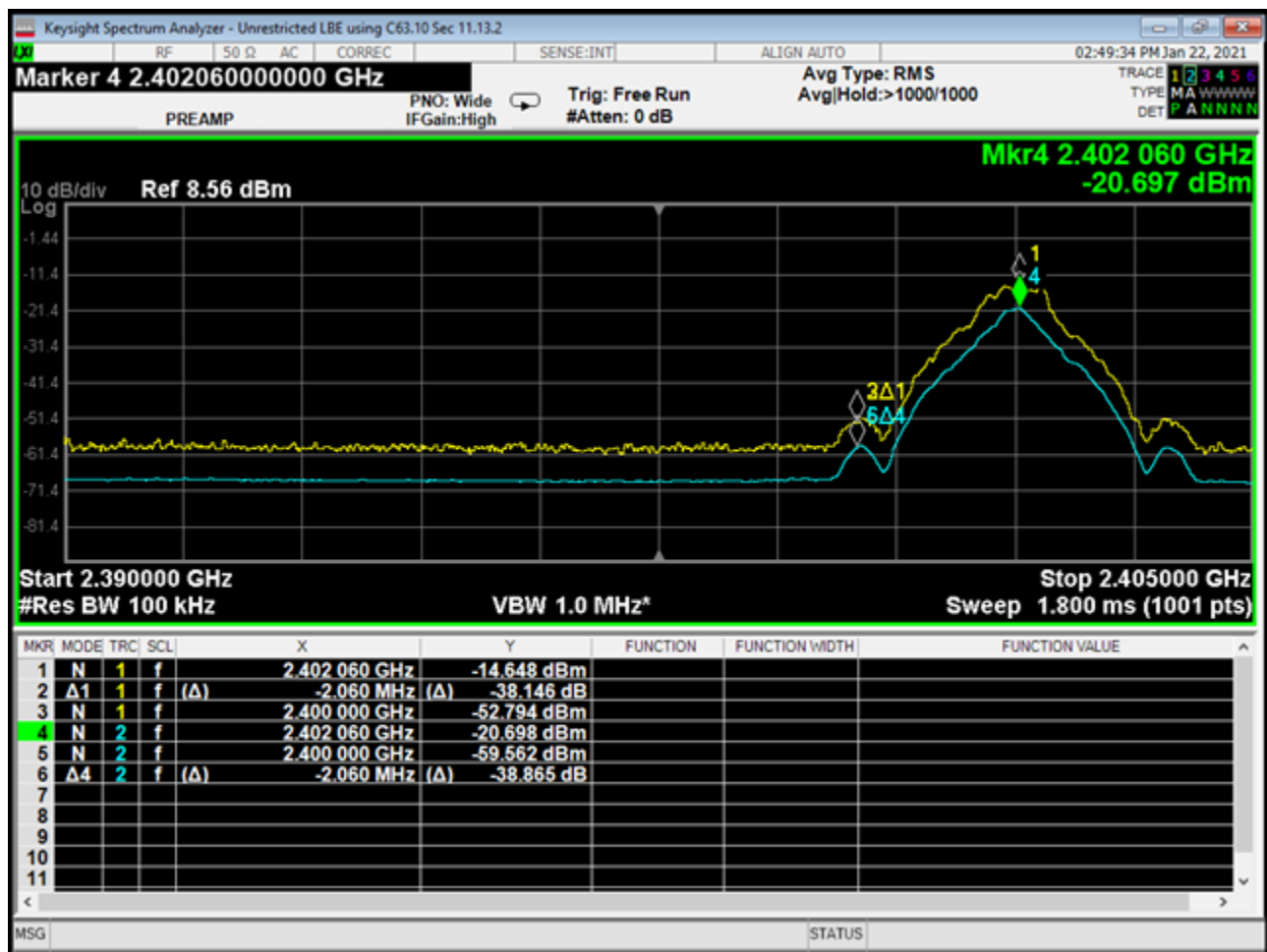
12. Bandwidth_Radio1_NRF_High Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



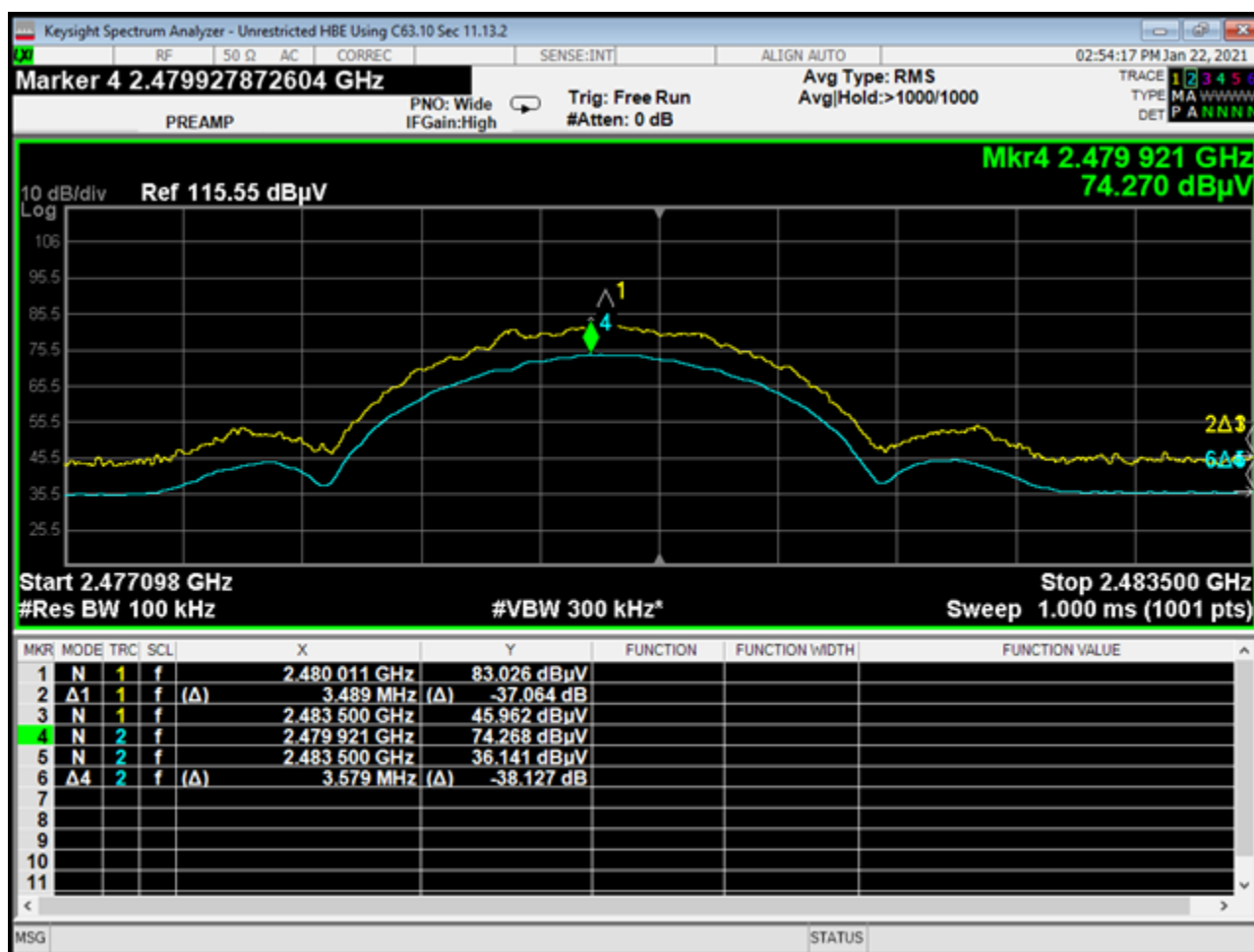
13. Lower Bandedge_Radio 1_BLE_Unrestricted

Relative measurements only. Peak Measurement is used in the results table in section 4.0 of this report.



14. Lower Bandedge_Radio 1_NRF_Unrestricted

Relative measurements only. Peak Measurement is used in the results table in section 4.0 of this report.

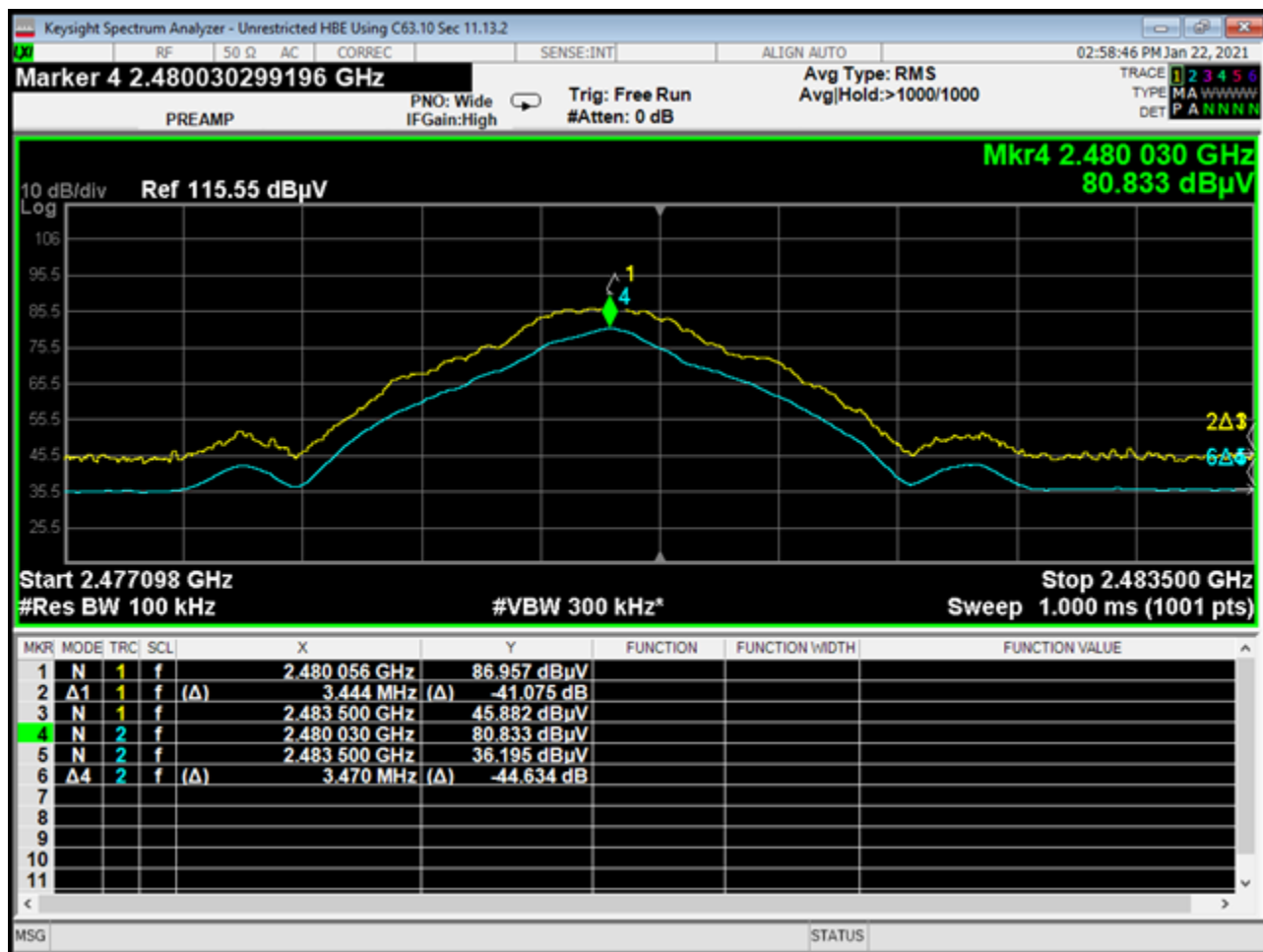


15. High Bandedge_Radio 1_BLE_Unrestricted

Relative measurements only. Peak Measurement is used in the results table in section 4.0 of this report.

Peak Fundamental= 83.026 dBuV=-23.97 dBm (dBm=dBuV-107)

Peak out of band measurement = 45.962 dBuV=-61.04 dBm (dBm=dBuV-107)

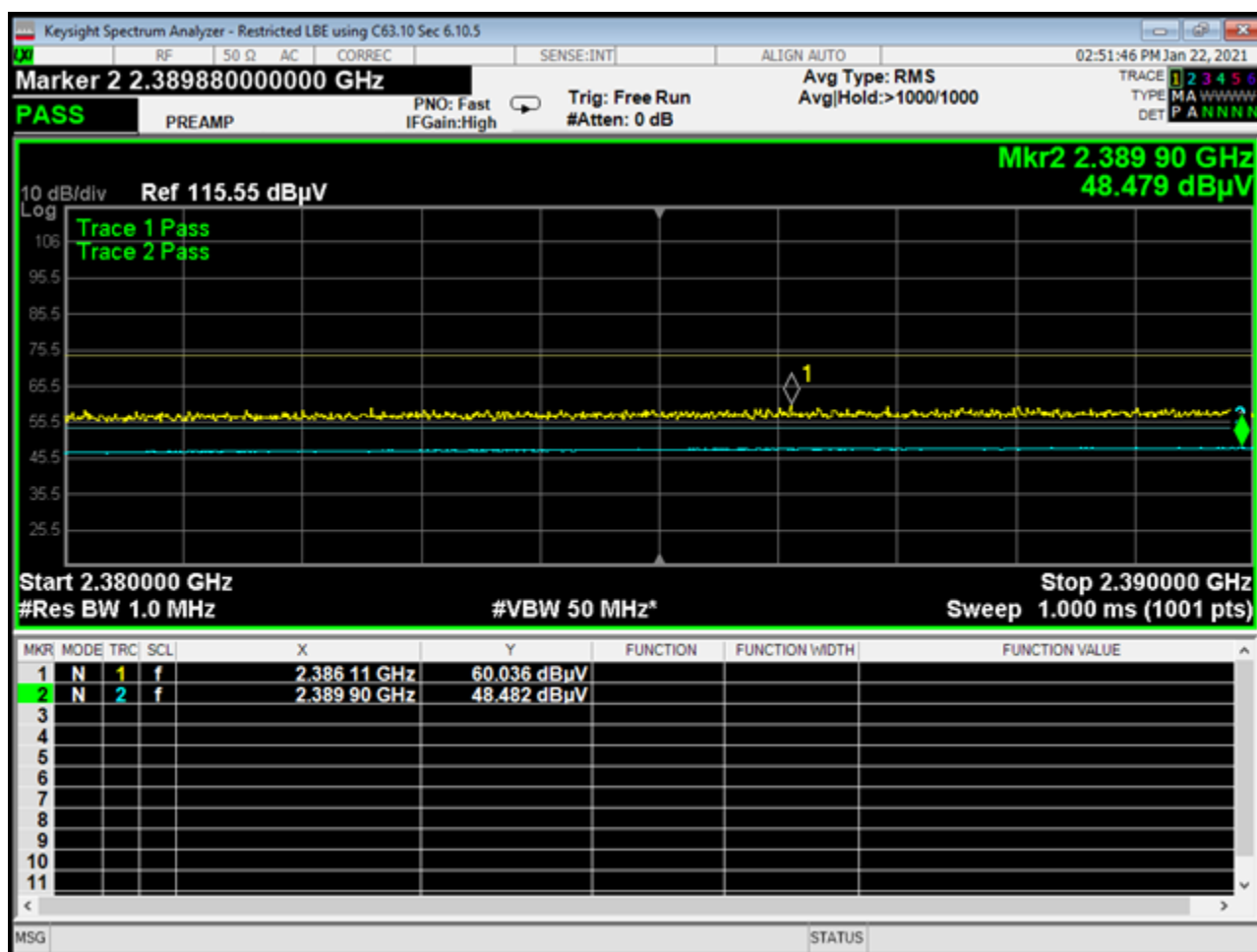


16. High Bandedge_Radio 1_NRF_Unrestricted

Relative measurements only. Peak Measurement is used in the results table in section 4.0 of this report.

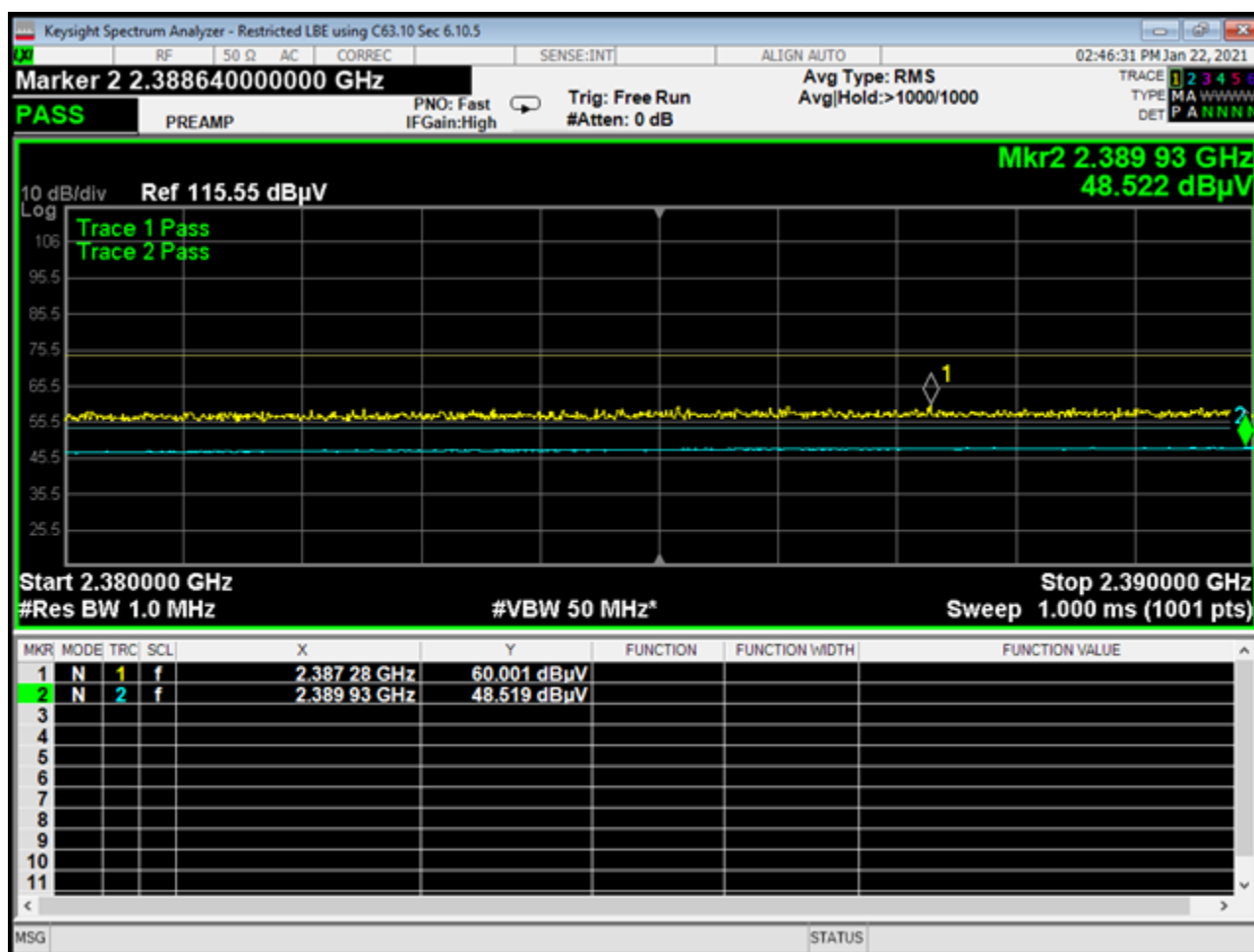
Peak Fundamental= 86.957 dBuV=-20.04 dBm (dBm=dBuV-107)

Peak out of band measurement = 45.882 dBuV=-61.12 dBm (dBm=dBuV-107)



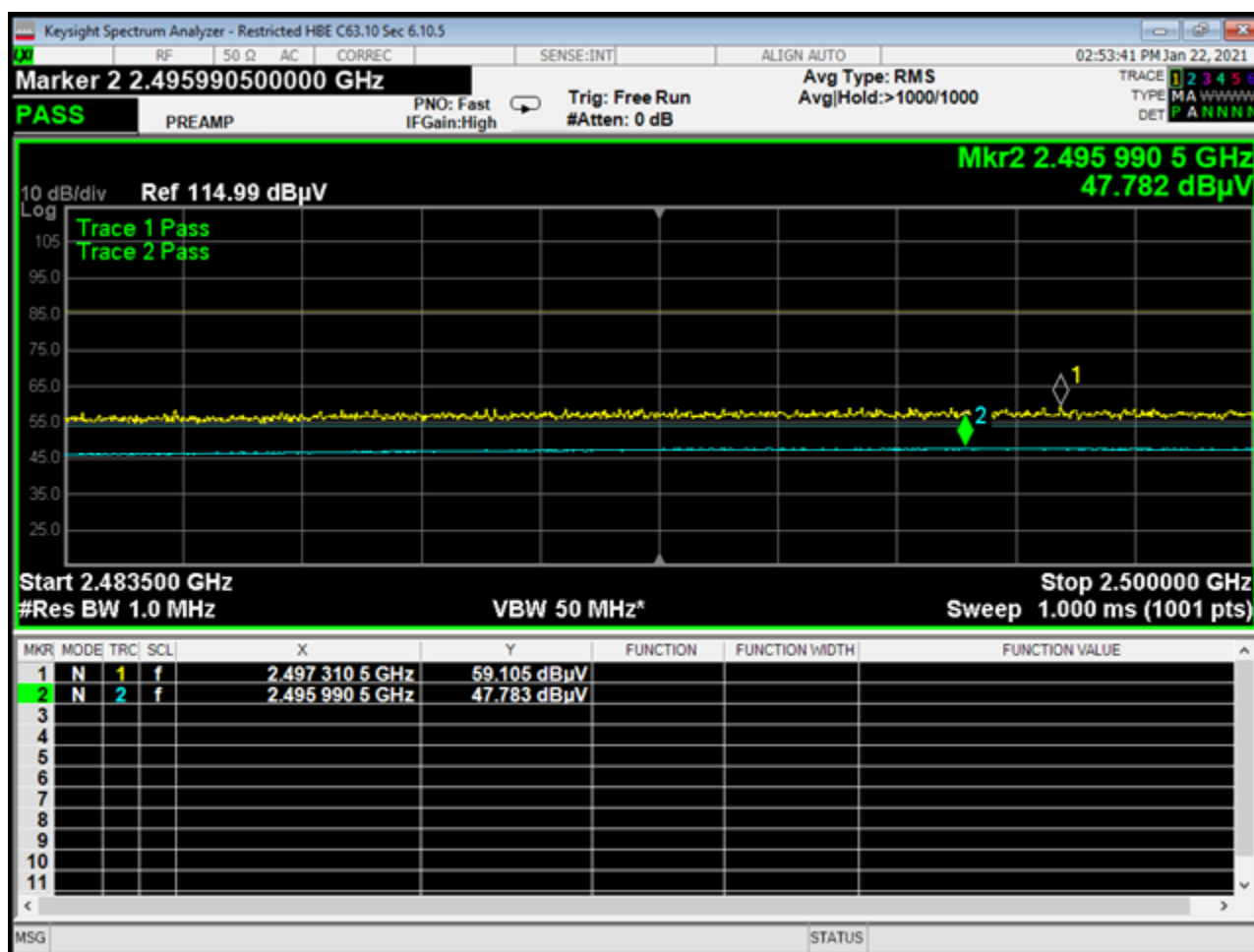
17. Lower Bandedge_Radio 1_BLE_Restricted

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Use of average detector is permitted as the duty cycle of the radio for these tests was >98%. Corrections are included in the graph.



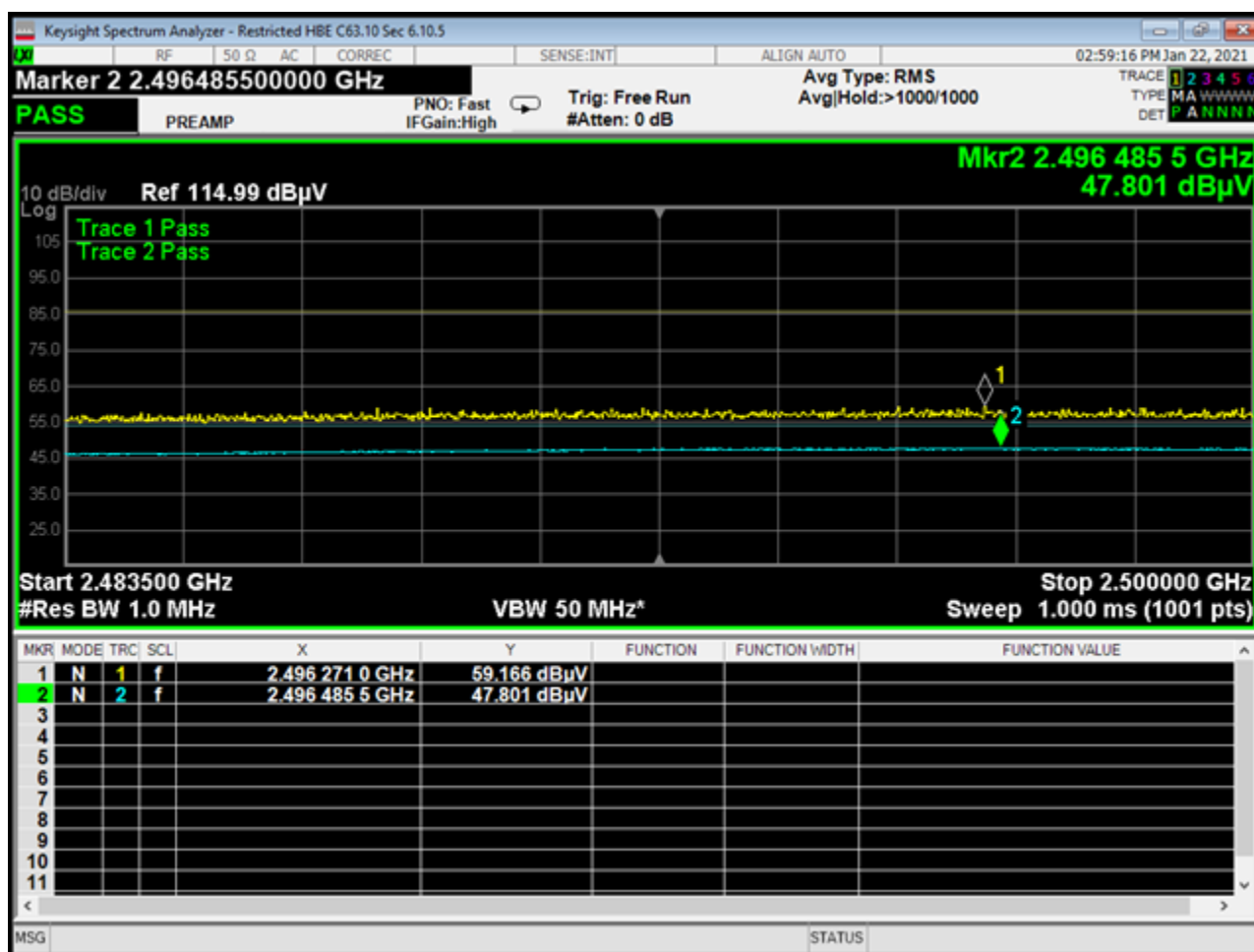
18. Lower Bandedge_Radio 1_NRF_Restricted

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Use of average detector is permitted as the duty cycle of the radio for these tests was >98%. Corrections are included in the graph.



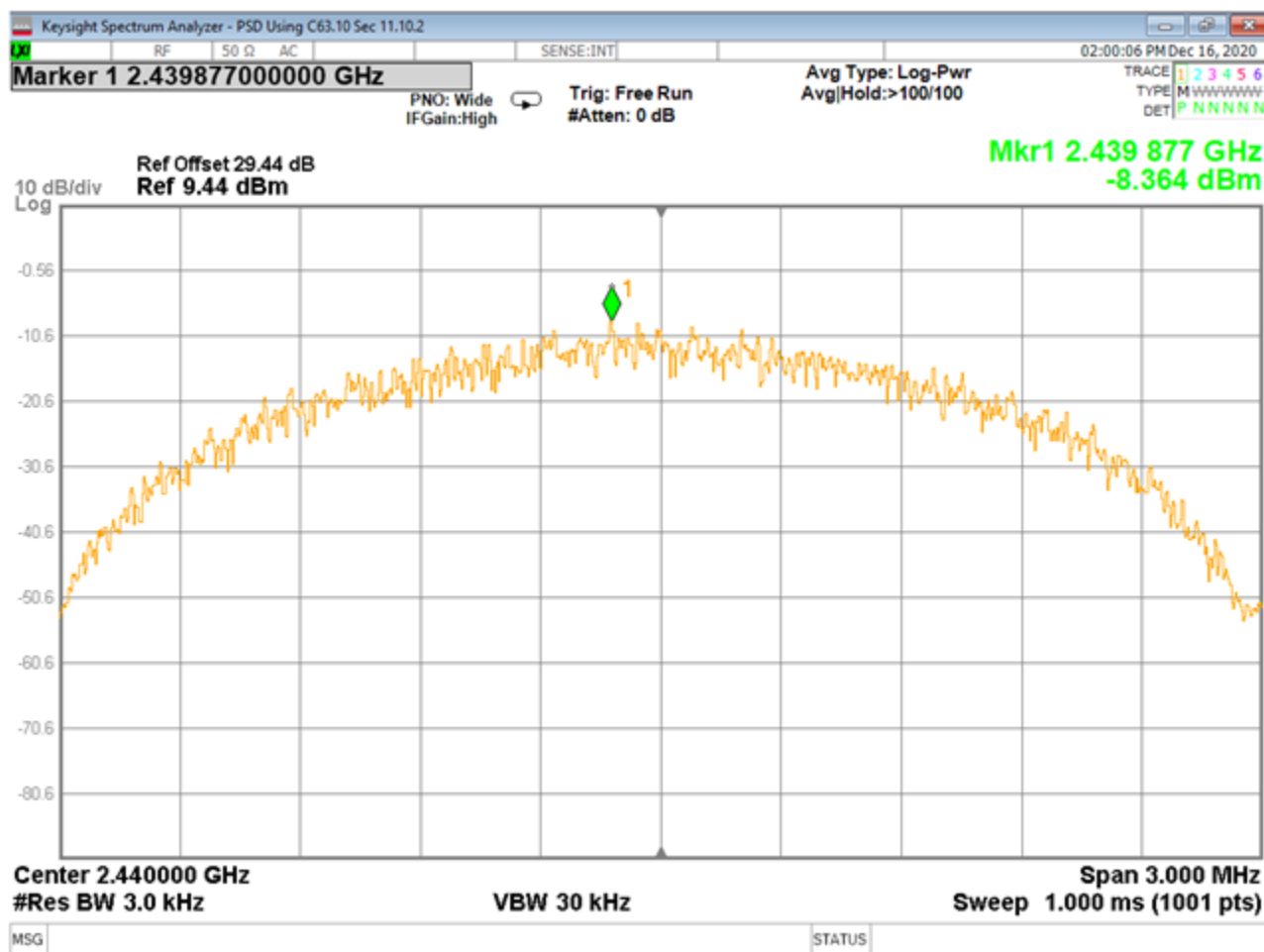
19. High Bandedge_Radio 1_BLE_Restricted

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Use of average detector is permitted as the duty cycle of the radio for these tests was >98%. Corrections are included in the graph.



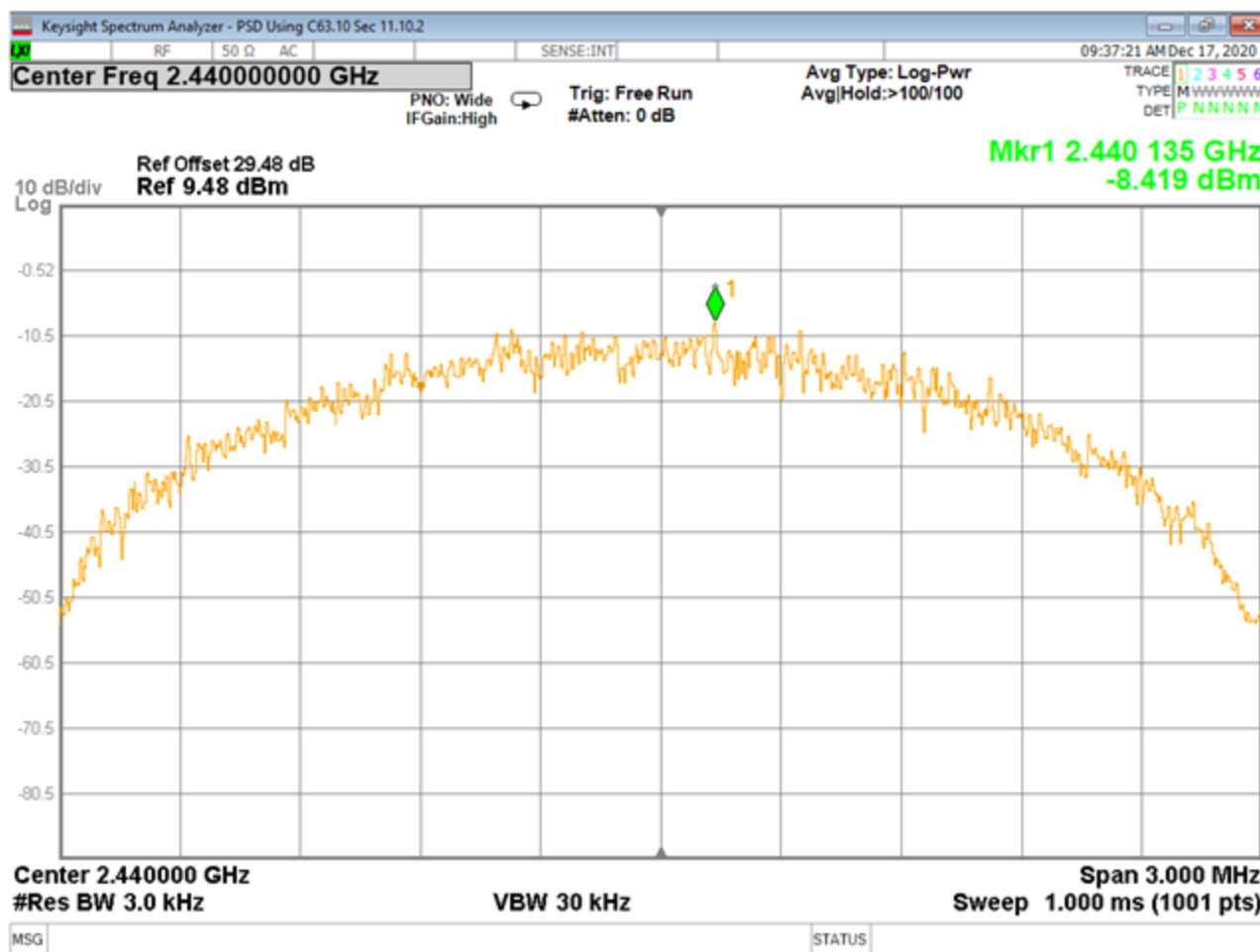
20. High Bandedge_Radio 1_NRF_Restricted

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Use of average detector is permitted as the duty cycle of the radio for these tests was >98%. Corrections are included in the graph.



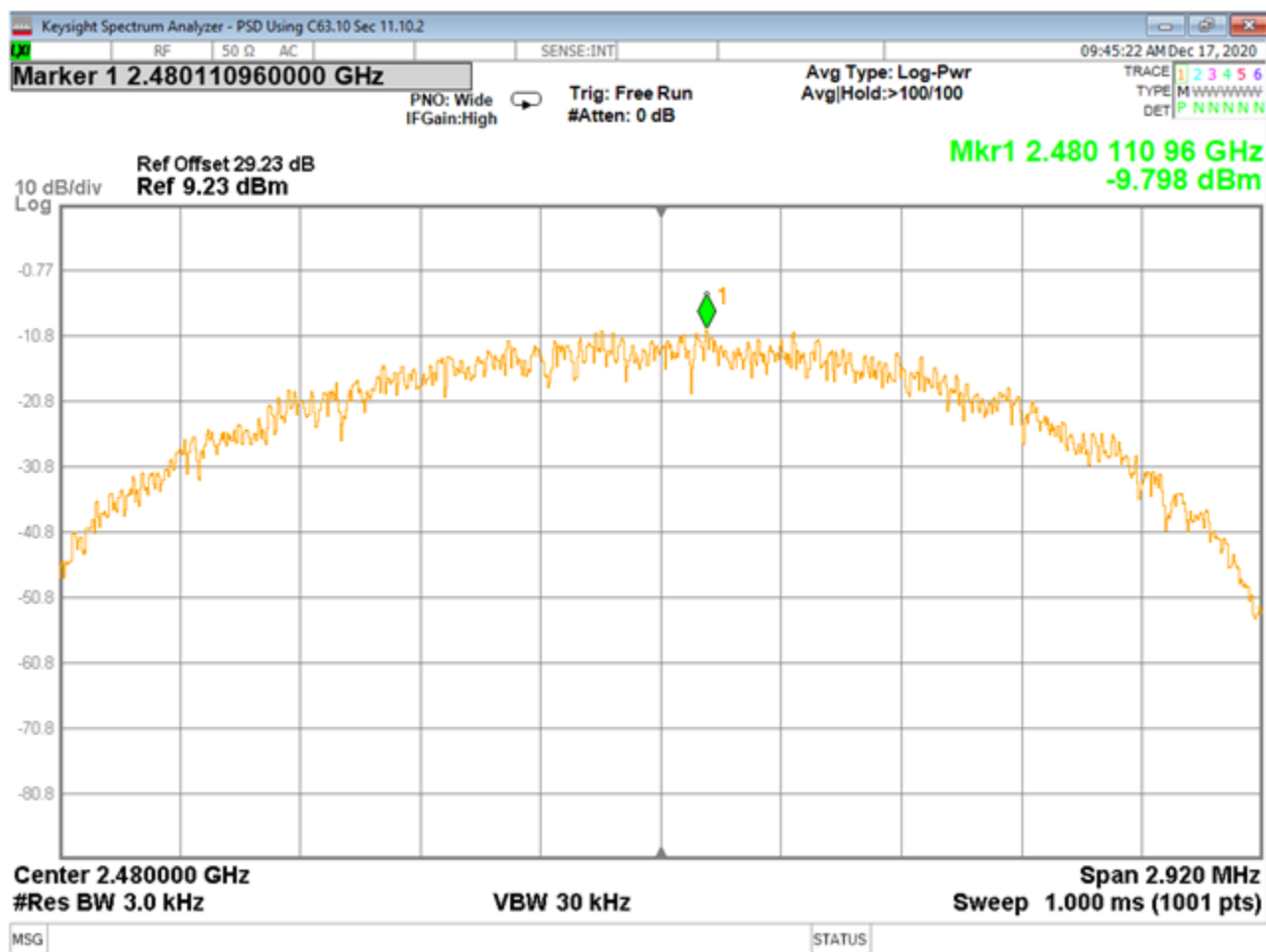
21. Power Spectral Density_Radio1_BLE_Low Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



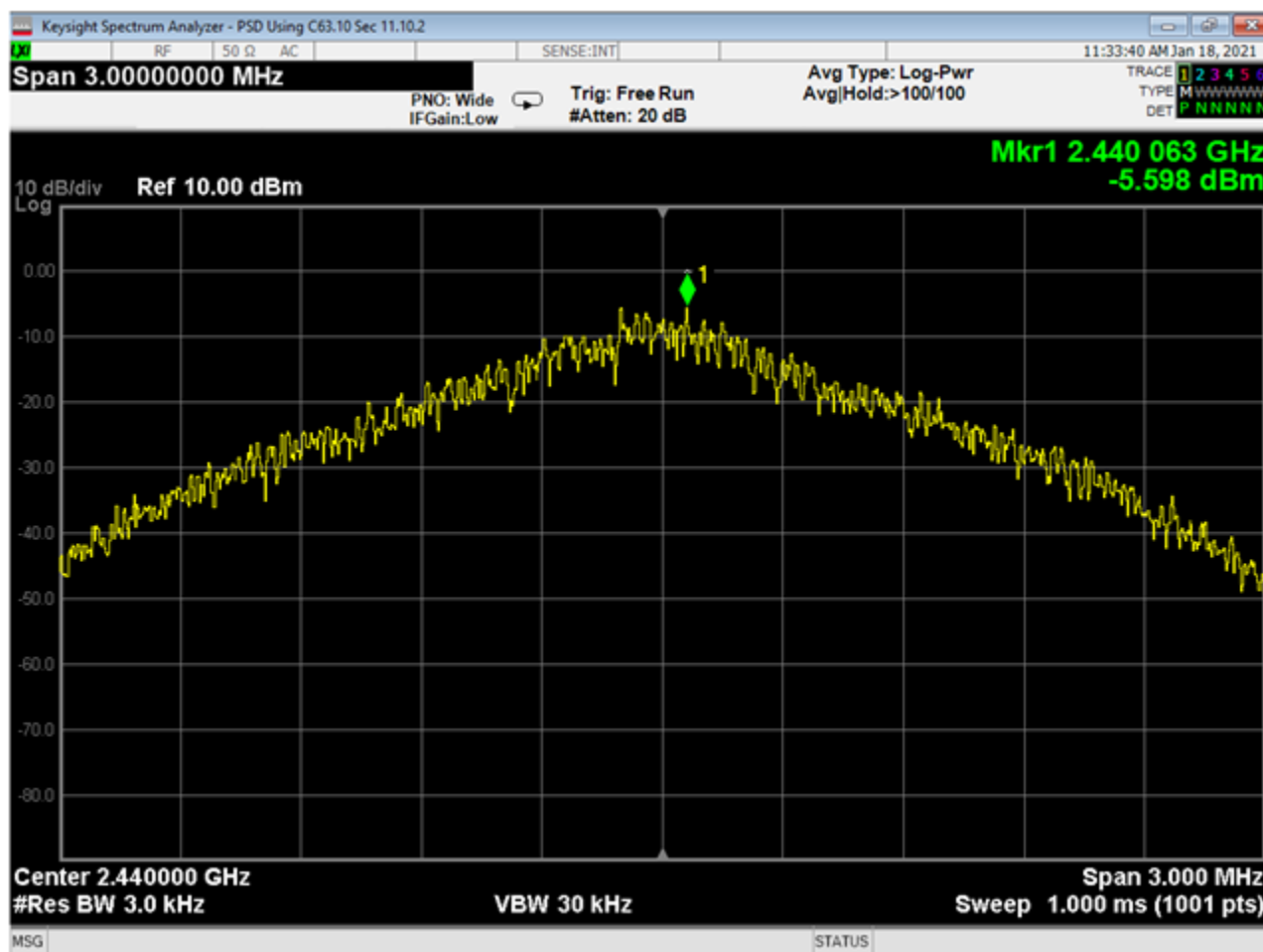
22. Power Spectral Density_Radio1_BLE_Mid Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



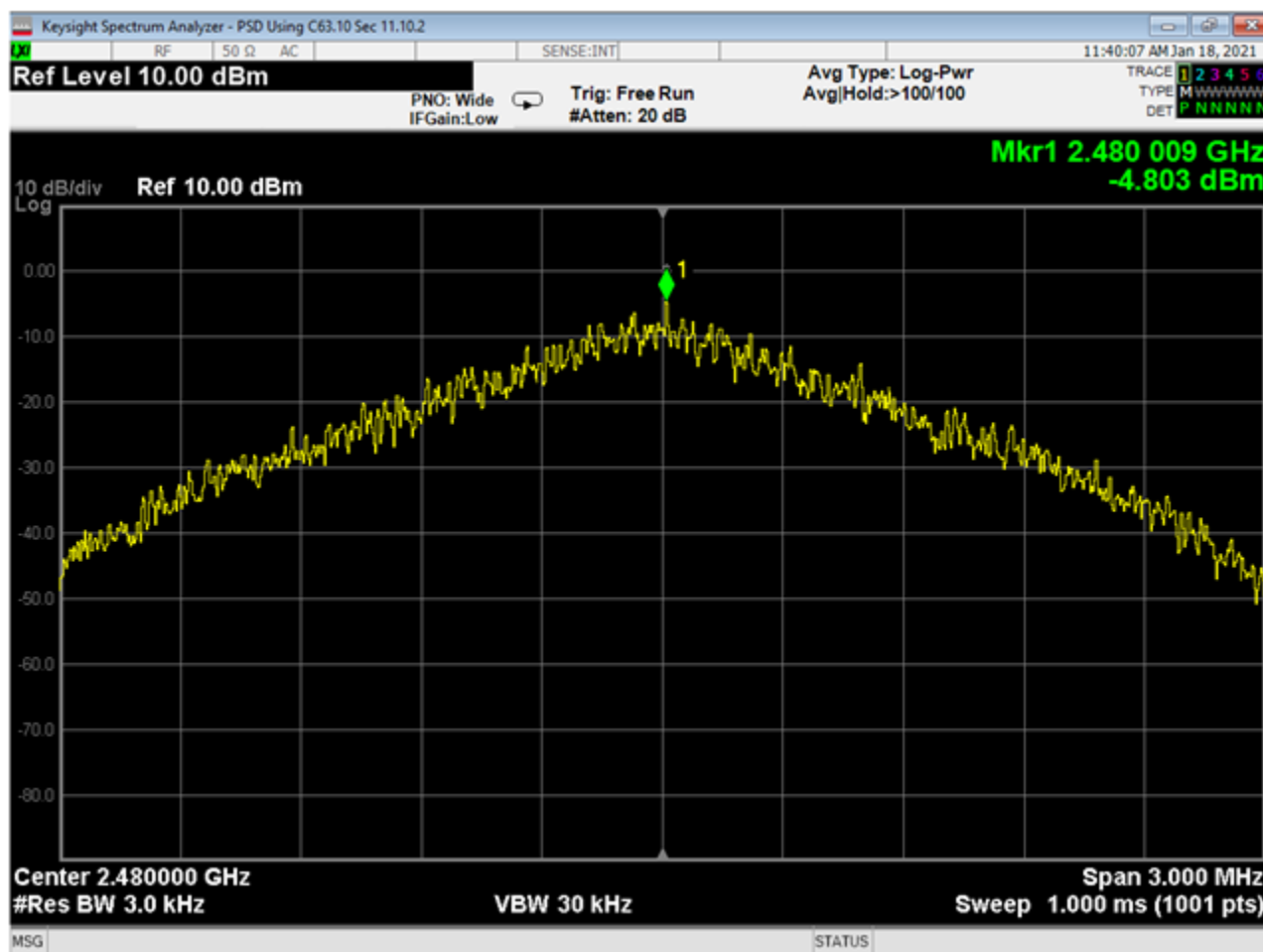
23. Power Spectral Density_Radio1_BLE_High Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



25. Power Spectral Density_Radio1_NRF_Mid Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



26. Power Spectral Density_Radio1_NRF_High Channel

Conducted measurement; Attenuator/ cable loss are included in the measurements, where applicable.



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REPORT END