

FCC/ISED Test Report

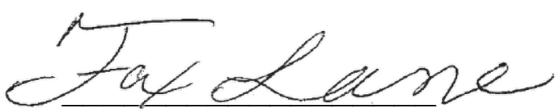
Prepared for: Garmin International, Inc.

Address: 1200 E. 151st Street
Olathe, Kansas, 66062, USA

Product: A04263

Test Report No: R20220817-20-E5B

Approved by:


Fox Lane
EMC Test Engineer

DATE: September 14, 2022

Total Pages: 139

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REVISION PAGE

Rev. No.	Date	Description
0	2 September 2022	Original – FLane Prepared by FLane
A	6 September 2022	Corrected antenna gain calculation – FL
B	14 September 2022	Corrected IC number and IC Test Site Number

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1.0 SUMMARY OF TEST RESULTS

The worst-case measurements were reported in this report. Summary of test results presented in this report correspond to the following section:

FCC Part 15.247

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 2

APPLIED STANDARDS AND REGULATIONS		
Standard Section	Test Type	Result
FCC Part 15.35 RSS Gen, Issue 5, Section 6.10	Duty Cycle	Pass
FCC Part 15.247(b)(3) RSS-247 Issue 2 Section 5.4(d)	Peak output power	Pass
FCC Part 15.247(a)(2) RSS-247 Issue 2 Section 5.2	Bandwidth	Pass
FCC Part 15.209 RSS-Gen Issue 5, Section 7.3	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.247 (unrestricted) RSS-247 Issue 2 Section 5.5, RSS-Gen Issue 5, Section 8.9	Transmitter Radiated Emissions	Pass
FCC Part 15.247(e) RSS-247 Issue 2 Section 5.2	Power Spectral Density	Pass
FCC Part 15.209, 15.247(d) RSS-247 Issue 2 Section 5.5	Band Edge Measurement	Pass
FCC Part 15.207 RSS-Gen Issue 5, Section 8.8	Conducted Emissions	Pass

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2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	A04263
IC	1792A-04263
FCC ID	IPH-04263
EUT Received	18 August 2022
EUT Tested	19 August 2022- 26 August 2022
Serial No.	3422062008 (Radiated Measurements) 3422062025 (Conducted Measurements)
Operating Band	2400 – 2483.5 MHz
Device Type	☐ GMSK ☐ GFSK ☐ BT BR ☐ BT EDR 2MB ☐ BT EDR 3MB ☒ 802.11x
Power Supply / Voltage	Internal Battery/ 5VDC Charger: Garmin (Phi Hong) MN: AQ27A-59CFA (Representative Power Supply)
Antenna Type / Gain (dBi)	Trace Antenna -6.95 dBi (See Section 4.8 for more details)

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:

Data Rates:

Modulation	Low/High Data rate
802.11b	1MB/11MB
802.11g	6MB/54MB
802.11n	MCS0/MCS7

For 802.11x Transmissions:

Channel	Frequency
Low	2412 MHz
Mid	2437 MHz
High	2462 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
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	Nic Johnson	Technical Manager	Review and Editing
2	Blake Winter	Test Engineer	Testing
3	Grace Larsen	Test Engineer	Testing
4	Ethan Schmidt	Test Technician	Testing

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 19, 2022	July 19, 2024
Keysight MXE Signal Analyzer (26.5GHz)**	N9038A	MY56400083	July 19, 2022	July 19, 2024
Keysight EXA Signal Analyzer**	N9010A	MY56070862	July 20, 2021	July 20, 2023
SunAR RF Motion	JB1	A082918-1	July 26, 2022	July 26, 2023
EMCO Horn Antenna	3115	6416	July 28, 2021	July 28, 2022
EMCO Horn Antenna***	3116	2576	March 9, 2020	March 9, 2023
Com-Power LISN, Single Phase**	LI-220C	20070017	July 18, 2022	July 18, 2024
8447F POT H64 Preamplifier*	8447F POT H64	3113AD4667	March 21, 2022	March 21, 2024
Rohde & Schwarz Preamplifier**	TS-PR18	3545700803	August 22, 2022	August 22, 2024
Trilithic High Pass Filter*	6HC330	23042	March 21, 2022	March 21, 2024
ETS – Lindgren- VSWR on 10m Chamber***	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	July 30, 2020	July 30, 2023
NCEE Labs-NSA on 10m Chamber*	10m Semi-anechoic chamber-NSA	NCEE-001	May 25, 2022	May 25, 2024
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	March 21, 2022	March 21, 2024
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	September 24, 2021	September 24, 2023
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3864	September 24, 2021	September 24, 2023
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	September 24, 2021	September 24, 2023
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	September 24, 2021	September 24, 2023
N connector bulkhead (control room)*	PE9128	NCEEBH2	September 24, 2021	September 24, 2023

*Internal Characterization

**2 Year Cal Cycle

***3 Year Cal Cycle

Notes:

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

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.

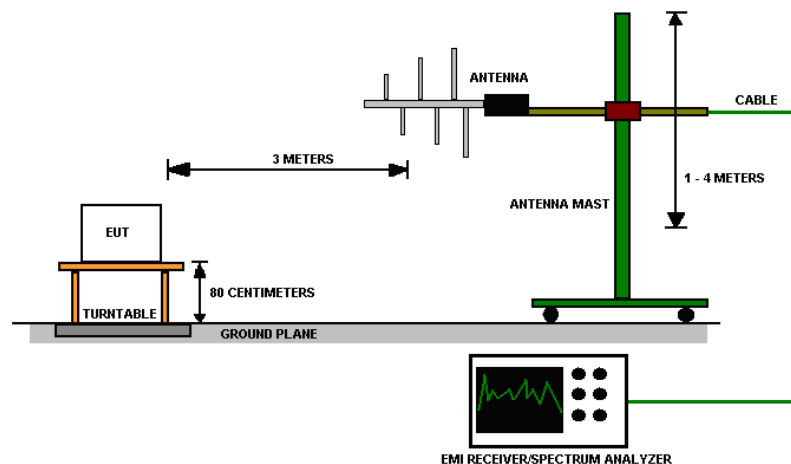


Figure 2 - Radiated Emissions Test Setup



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4.0 RESULTS**DTS Radio Measurements Low Data Rate**

CHANNEL	Transmitter	Occupied Bandwidth (MHz)	6 dB Bandwidth (MHz)	AVERAGE OUTPUT POWER (dBm)	AVERAGE OUTPUT POWER (mW)	PSD (dBm)	RESULT
Low	802.11 b	15.22	10.04	15.670	36.898	-5.324	PASS
Mid	802.11 b	15.26	10.06	15.250	33.497	1.06	PASS
High	802.11 b	15.39	10.06	14.930	31.117	0.313	PASS
Low	802.11 g	16.82	16.43	13.700	23.442	-9.781	PASS
Mid	802.11 g	16.84	16.51	13.480	22.284	-9.654	PASS
High	802.11 g	16.74	16.55	9.240	8.395	-14.575	PASS
Low	802.11 n	17.61	17.62	14.050	25.410	-10.504	PASS
Mid	802.11 n	17.67	17.62	13.600	22.909	-11.513	PASS
High	802.11 n	17.57	17.64	10.260	10.617	-14.759	PASS

Occupied Bandwidth = N/A; 6 dB Bandwidth Limit = 500 kHz Output Power Limit = 30 dBm; PSD Limit = 8 dBm

Unrestricted Band-Edge Low Data Rate

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level (dBuV)	Relative Fundamental (dBuV)	Delta (dB)	Min Delta (dB)	Result
Low	802.11 b	2390.00	81.37	114.04	32.67	30.00	PASS
Low	802.11 g	2390.00	76.60	107.57	30.97	30.00	PASS
Low	802.11 n	2390.00	77.83	108.43	30.60	30.00	PASS
High	802.11 b	2483.50	59.39	113.01	53.63	30.00	PASS
High	802.11 g	2483.50	65.33	103.22	37.89	30.00	PASS
High	802.11 n	2483.50	69.24	103.81	34.57	30.00	PASS

Radiated Peak Restricted Band-Edge Low Data Rate

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)	Margin	Result
Low	802.11 b	2390.00	56.18	Peak	73.98	17.80	PASS
Low	802.11 g	2390.00	65.98	Peak	73.98	8.00	PASS
Low	802.11 n	2390.00	67.08	Peak	73.98	6.90	PASS
High	802.11 b	2483.50	56.73	Peak	73.98	17.25	PASS
High	802.11 g	2483.50	55.97	Peak	73.98	18.01	PASS
High	802.11 n	2483.50	58.67	Peak	73.98	15.31	PASS

*Limit shown is the peak limit taken from FCC Part 15.209



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Radiated Average Restricted Band-Edge Low Data Rate

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)	Margin	Result
Low	802.11 b	2390.00	45.93	Average	53.98	8.05	PASS
Low	802.11 g	2390.00	51.67	Average	53.98	2.31	PASS
Low	802.11 n	2390.00	52.13	Average	53.98	1.85	PASS
High	802.11 b	2483.50	46.56	Average	53.98	7.42	PASS
High	802.11 g	2483.50	44.12	Average	53.98	9.86	PASS
High	802.11 n	2483.50	45.34	Average	53.98	8.64	PASS

*Limit shown is the average limit taken from FCC Part 15.209



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DTS Radio Measurements High Data Rate

CHANNEL	Transmitter	Occupied Bandwidth (MHz)	6 dB Bandwidth (MHz)	AVERAGE OUTPUT POWER (dBm)	AVERAGE OUTPUT POWER (mW)	PSD (dBm)	RESULT
Low	802.11 b	14.81	9.04	15.430	34.914	-7.499	PASS
Mid	802.11 b	14.83	9.04	15.240	33.420	-7.803	PASS
High	802.11 b	14.93	9.04	14.990	31.550	-7.962	PASS
Low	802.11 g	16.60	16.54	10.940	12.417	-13.26	PASS
Mid	802.11 g	16.61	16.53	10.580	11.429	-13.852	PASS
High	802.11 g	16.59	16.55	8.720	7.447	-14.919	PASS
Low	802.11 n	17.464	17.66	8.97	7.889	-15.361	PASS
Mid	802.11 n	17.509	17.57	8.72	7.447	-15.983	PASS
High	802.11 n	17.536	17.65	8.25	6.683	-16.169	PASS

Occupied Bandwidth = N/A; 6 dB Bandwidth Limit =500 kHz

Output Power Limit = 30 dBm; PSD Limit = 8 dBm

Unrestricted Band-Edge High Data Rate

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level (dBuV)	Relative Fundamental (dBuV)	Delta (dB)	Min Delta (dB)	Result
Low	802.11 b	2400.00	81.00	113.53	32.54	30.00	PASS
Low	802.11 g	2400.00	74.24	105.78	31.54	30.00	PASS
Low	802.11 n	2400.00	68.01	104.44	36.43	30.00	PASS
High	802.11 b	2483.50	65.99	113.06	47.07	30.00	PASS
High	802.11 g	2483.50	65.84	104.12	38.28	30.00	PASS
High	802.11 n	2483.50	65.09	102.74	37.65	30.00	PASS

Radiated Peak Restricted Band-Edge High Data Rate

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)	Margin	Result
Low	802.11 b	2390.00	56.68	Peak	73.98	17.30	PASS
Low	802.11 g	2390.00	63.65	Peak	73.98	10.33	PASS
Low	802.11 n	2390.00	60.76	Peak	73.98	13.22	PASS
High	802.11 b	2483.50	56.83	Peak	73.98	17.15	PASS
High	802.11 g	2483.50	59.54	Peak	73.98	14.44	PASS
High	802.11 n	2483.50	58.62	Peak	73.98	15.36	PASS

*Limit shown is the peak limit taken from FCC Part 15.209



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Radiated Average Restricted Band-Edge High Data Rate

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)	Margin	Result
Low	802.11 b	2390.00	44.55	Average	53.98	9.43	PASS
Low	802.11 g	2390.00	47.96	Average	53.98	6.02	PASS
Low	802.11 n	2390.00	46.83	Average	53.98	7.15	PASS
High	802.11 b	2483.50	45.56	Average	53.98	8.42	PASS
High	802.11 g	2483.50	44.58	Average	53.98	9.40	PASS
High	802.11 n	2483.50	43.77	Average	53.98	10.21	PASS

*Limit shown is the average limit taken from FCC Part 15.209



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4.1 OUTPUT POWER

Test Method: Power measurements were performed using ANSI C63.10, Section 11.9.2.2.2.

Limits of power measurements:

For FCC Part 15.247 Device:

The maximum allowed 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 the measurements were found to be compliant.
3. The measurements are listed in the tables in section 4.0.



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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 the measurements were found to be compliant.
3. The measurements are listed in the tables in section 4.0.



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4.3 DUTY CYCLE

Test Method:

All Modulations/Transmitters in this report had a duty cycle of >98%

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.

Test setup:

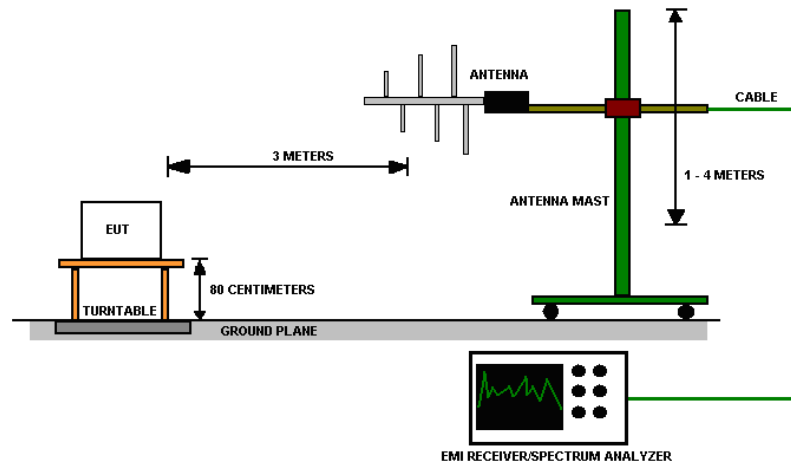


Figure 3 - Radiated Emissions Test Setup

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:

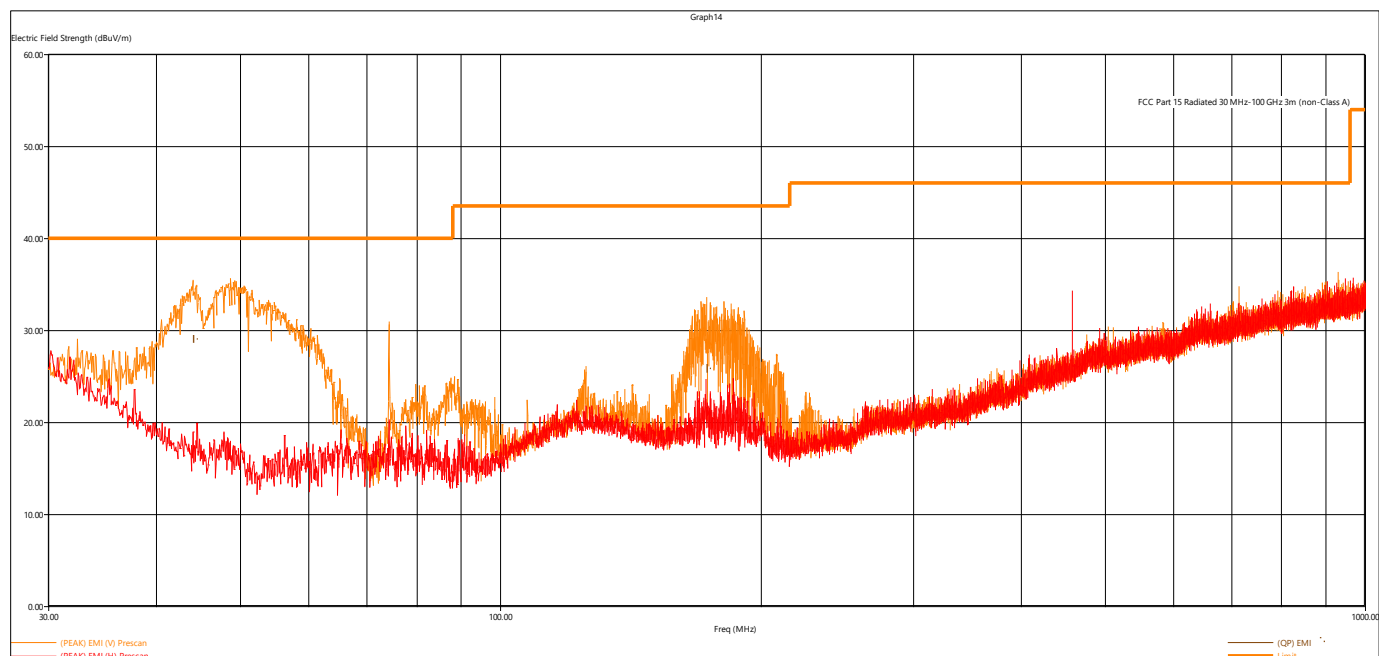


Figure 4 - Radiated Emissions Plot, Receive

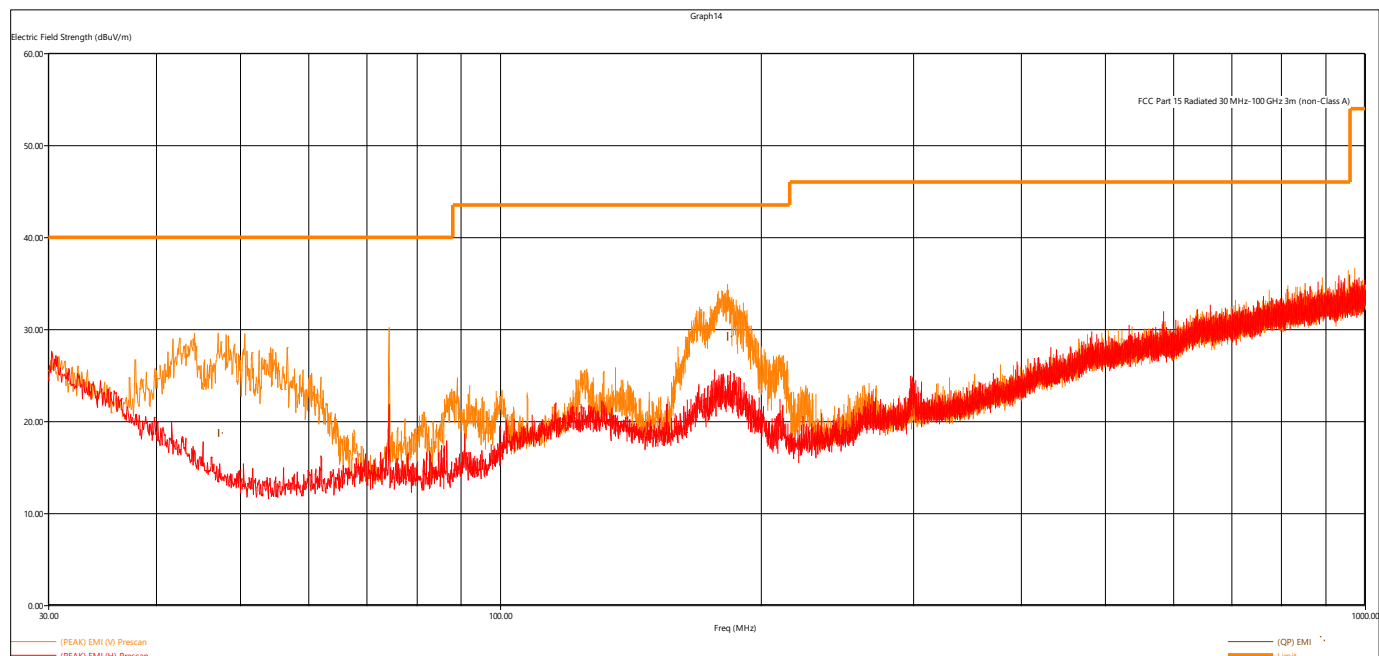


Figure 5 - Radiated Emissions Plot, 802.11b 1MB

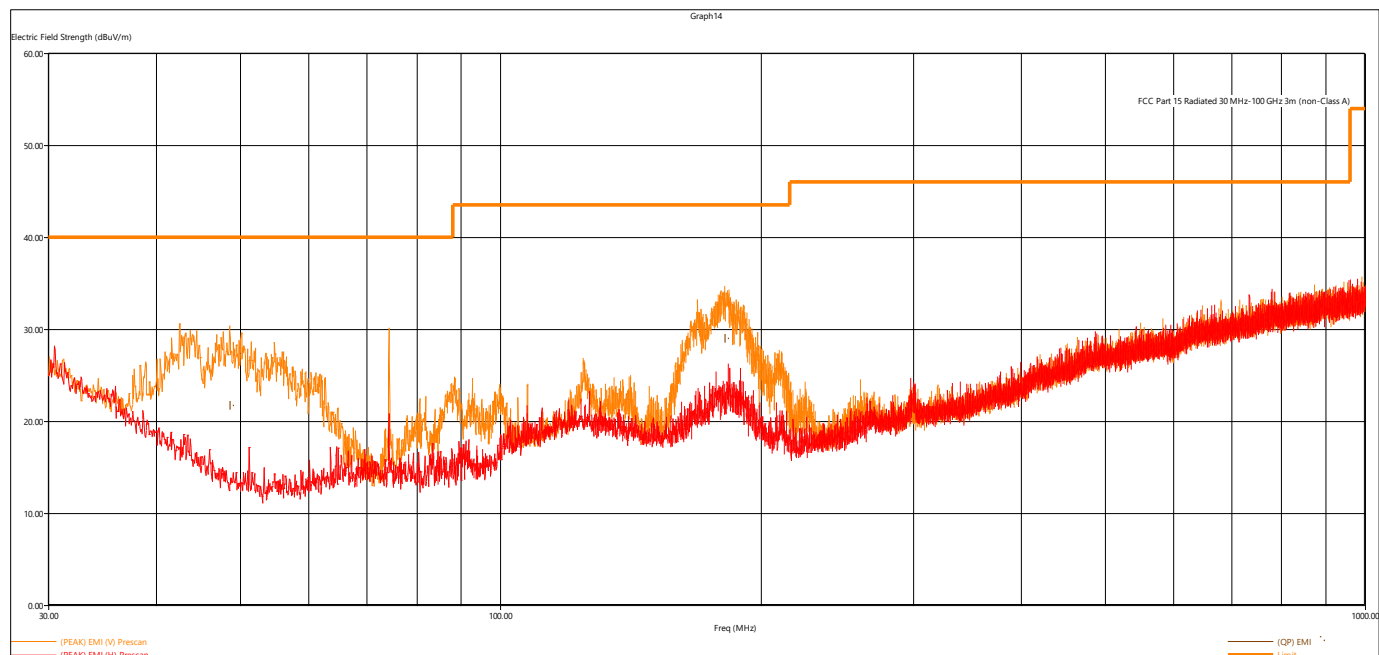


Figure 6 - Radiated Emissions Plot, 802.11b 1MB

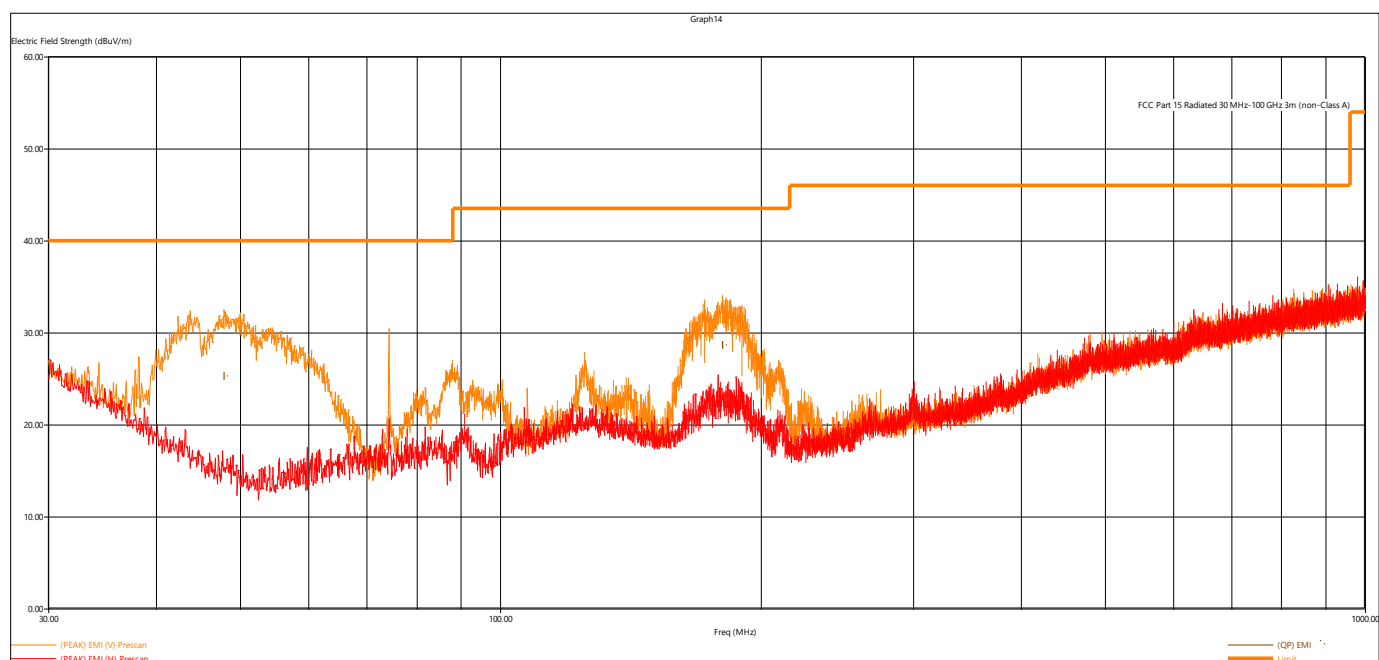


Figure 7 - Radiated Emissions Plot, 802.11g 6MB

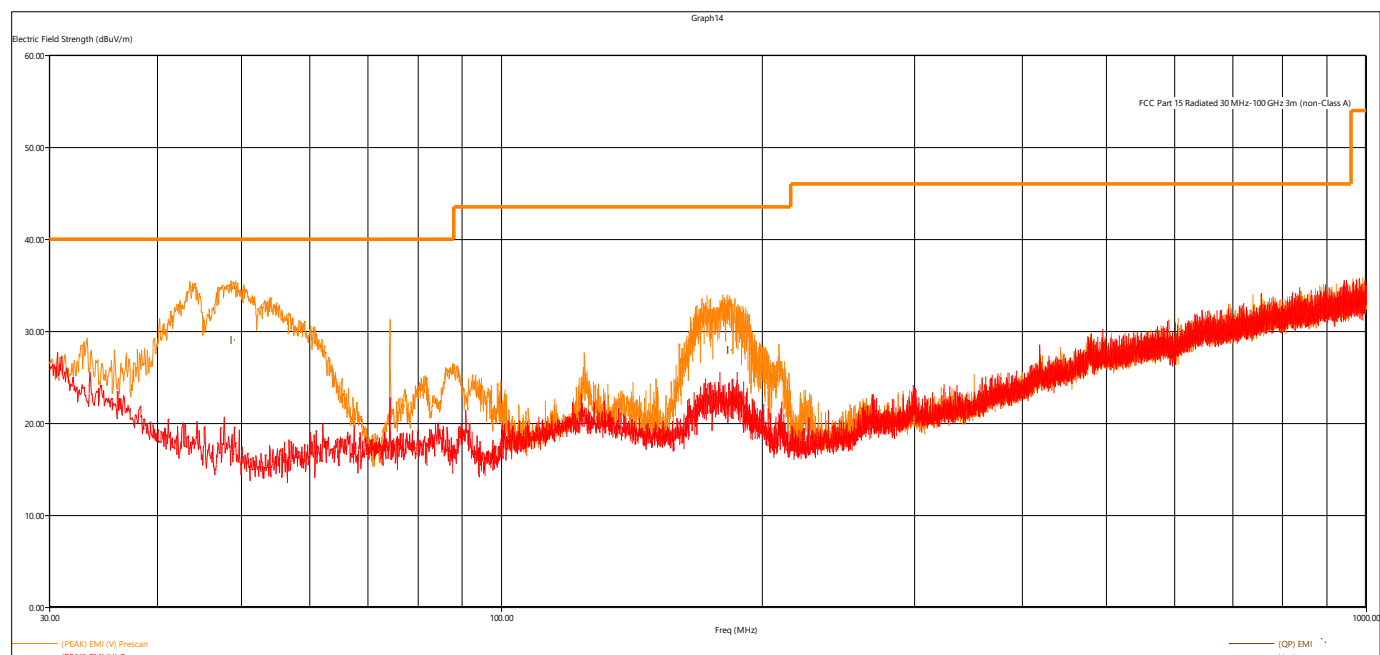


Figure 8 - Radiated Emissions Plot, 802.11g 54MB

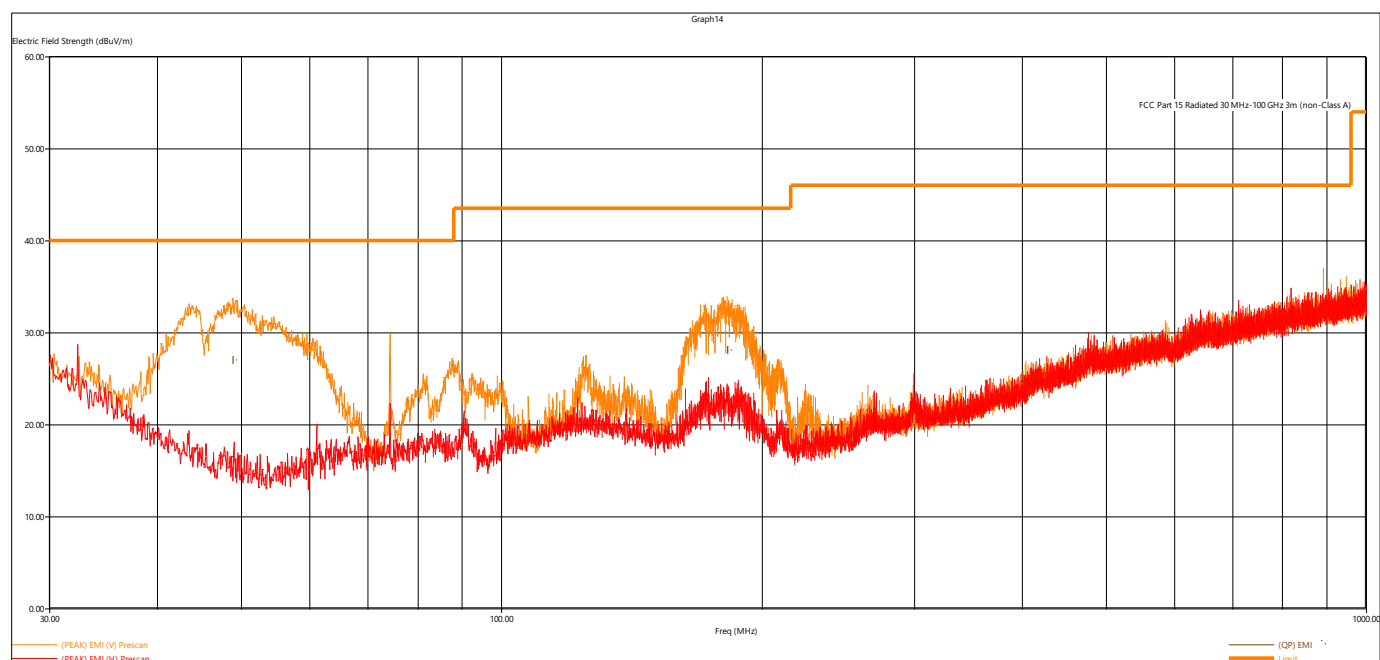


Figure 9 - Radiated Emissions Plot, 802.11n MCS0

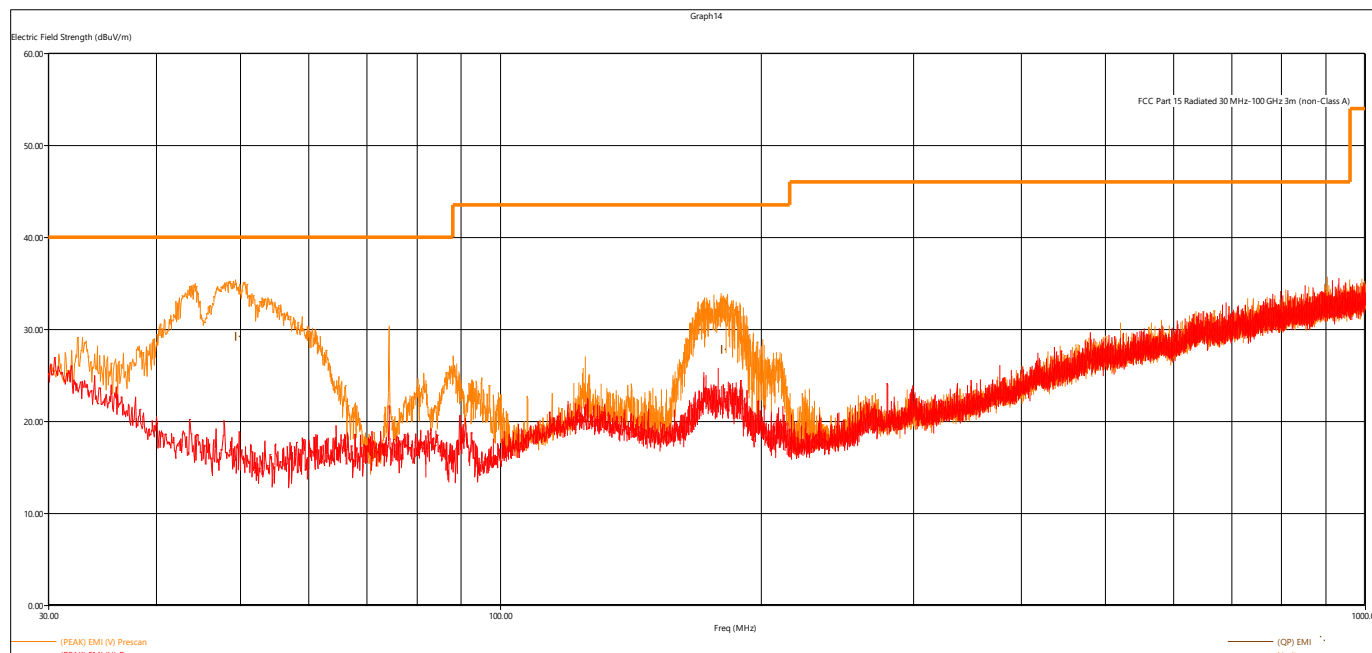


Figure 10 - Radiated Emissions Plot, 802.11n MCS7

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 other emission levels were very low against the limit.
4. Margin value = Emission level - Limit value

Quasi-Peak Measurements, 802.11x								
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dBμV/m	dBμV/m	dB	cm.	deg.			
47.268960	18.70	40.00	21.30	210.00	142.00	V	Low	802.11b 1MB
182.917680	29.11	43.52	14.41	104.00	122.00	V	Low	802.11b 1MB
48.487680	21.62	40.00	18.38	151.00	326.00	V	Low	802.11b 11MB
181.403040	28.90	43.52	14.62	104.00	138.00	V	Low	802.11b 11MB
47.873520	25.27	40.00	14.73	141.00	345.00	V	Low	802.11g 6MB
180.399120	28.63	43.52	14.89	105.00	109.00	V	Low	802.11g 6MB
48.532800	28.99	40.00	11.01	113.00	230.00	V	Low	802.11g 54MB
182.283360	27.86	43.52	15.66	112.00	126.00	V	Low	802.11g 54MB
48.811200	26.99	40.00	13.01	118.00	360.00	V	Low	802.11n MCS0
182.231760	28.03	43.52	15.49	115.00	123.00	V	Low	802.11n MCS0
49.323600	29.15	40.00	10.85	105.00	340.00	V	Low	802.11n MCS7
179.904000	27.75	43.52	15.77	111.00	83.00	V	Low	802.11n MCS7
44.099280	28.97	40.00	11.03	107.00	249.00	V	Receive	
173.046480	25.76	43.52	17.76	118.00	100.00	V	Receive	

All other measurements were found to be at least 6 dB below the limit. Worst case emissions are reported.

Peak Measurements, 802.11x								
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dBμV/m	dBμV/m	dB	cm.	deg.			
2412.844000	97.21	NA	NA	152	30	V	Low	802.11b 1MB
2436.204000	97.51	NA	NA	188	35	V	Mid	802.11b 1MB
2461.058000	97.93	NA	NA	253	37	V	High	802.11b 1MB
2411.460000	100.64	NA	NA	157	29	V	Low	802.11b 11MB
2437.524000	101.47	NA	NA	190	35	V	Mid	802.11b 11MB
2461.068000	101.67	NA	NA	256	36	V	High	802.11b 11MB
2415.152000	98.70	NA	NA	153	26	V	Low	802.11g 6MHz
2439.272000	101.45	NA	NA	121	36	V	Mid	802.11g 6MHz
2459.944000	95.89	NA	NA	120	30	V	High	802.11g 6MHz
2415.194000	96.46	NA	NA	148	37	V	Low	802.11g 54MHz
2439.766000	96.70	NA	NA	203	23	V	Mid	802.11g 54MHz
2460.210000	97.33	NA	NA	185	32	V	High	802.11g 54MHz
2413.644000	98.81	NA	NA	300	62	V	Low	802.11n MCS0
2439.892000	100.01	NA	NA	174	37	V	Mid	802.11n MCS0
2463.540000	96.41	NA	NA	173	39	V	High	802.11n MCS0
2411.138000	95.28	NA	NA	518	31	V	Low	802.11n MCS7
2435.408000	89.79	NA	NA	519	134	H	Mid	802.11n MCS7
2433.640000	94.41	NA	NA	112	29	V	Mid	802.11n MCS7
2465.580000	95.13	NA	NA	560	34	V	High	802.11n MCS7

The EUT was maximized on all 3 orthogonal axes. The worst-case is shown in the plot and table above.
All other measurements were found to be at least 6 dB Below the limit.

Average Measurements, 802.11x								
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dBμV/m	dBμV/m	dB	cm.	deg.			
2412.844000	94.39	NA	NA	152	30	V	Low	802.11b 1MB
2436.204000	94.68	NA	NA	188	35	V	Mid	802.11b 1MB
2461.058000	94.77	NA	NA	253	37	V	High	802.11b 1MB
2411.460000	93.31	NA	NA	157	29	V	Low	802.11b 11MB
2437.524000	93.86	NA	NA	190	35	V	Mid	802.11b 11MB
2461.068000	93.88	NA	NA	256	36	V	High	802.11b 11MB
2415.152000	89.08	NA	NA	153	26	V	Low	802.11g 6MHz
2439.272000	91.87	NA	NA	121	36	V	Mid	802.11g 6MHz
2459.944000	85.89	NA	NA	120	30	V	High	802.11g 6MHz
2415.194000	86.28	NA	NA	148	37	V	Low	802.11g 54MHz
2439.766000	86.10	NA	NA	203	23	V	Mid	802.11g 54MHz



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2460.210000	86.33	NA	NA	185	32	V	High	802.11g 54MHz
2413.644000	87.79	NA	NA	300	62	V	Low	802.11n MCS0
2439.892000	90.49	NA	NA	174	37	V	Mid	802.11n MCS0
2463.540000	87.02	NA	NA	173	39	V	High	802.11n MCS0
2411.138000	84.42	NA	NA	518	31	V	Low	802.11n MCS7
2435.408000	78.84	NA	NA	519	134	H	Mid	802.11n MCS7
2433.640000	83.87	NA	NA	112	29	V	Mid	802.11n MCS7
2465.580000	83.96	NA	NA	560	34	V	High	802.11n MCS7

The EUT was maximized on all 3 orthogonal axes. The worst-case is shown in the plot and table above.
All other measurements were found to be at least 6 dB Below the limit.

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4.5 CONDUCTED SPURIOUS EMISSIONS

Test Method: ANSI C63.10-2013, Section 6.7

Limits of spurious emissions:

From FCC Part 15.247:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

Test procedures:

The highest emissions level was measured and recorded. All spurious measurements were evaluated to 30dB below the fundamental. More details can be found in section 3.4 of this report. The line shown in the plots is a reference line placed at -20dBm.

Deviations from test standard:

Test performed at 120kHz RBW

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:

Data rates and channels were investigated and worst case was reported, no emissions exceeded the limits.

There was no distinguishable difference between low and high data rate.

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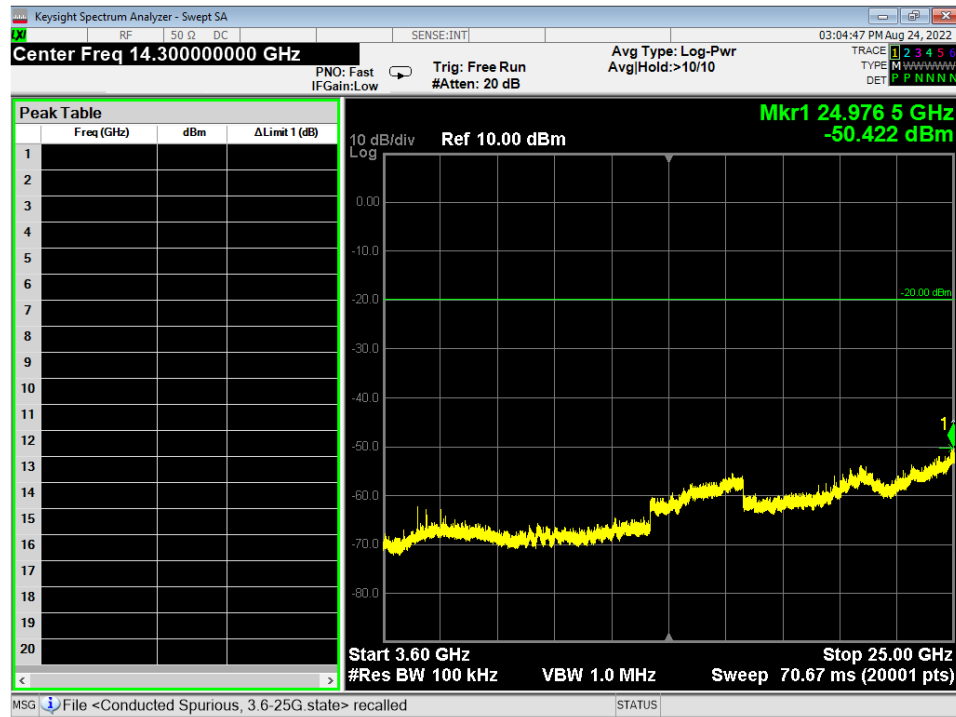


Figure 13 - Radiated Emissions Plot, WIFI 802.11b, 3.6G – 25G, Low

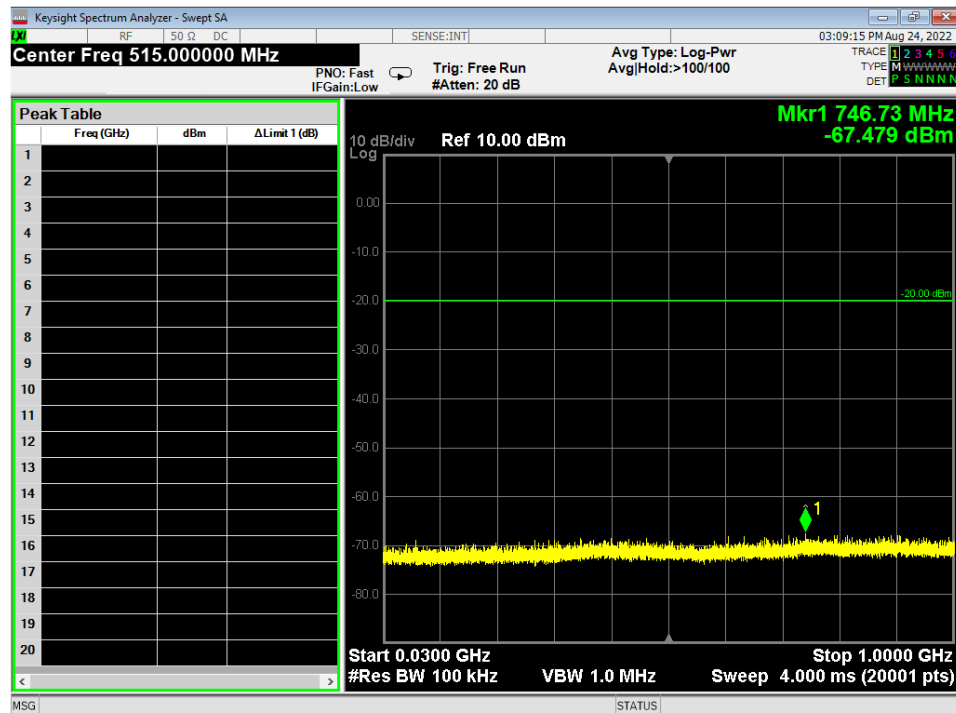


Figure 14 - Radiated Emissions Plot, WIFI 802.11g, 30M – 1G, Low

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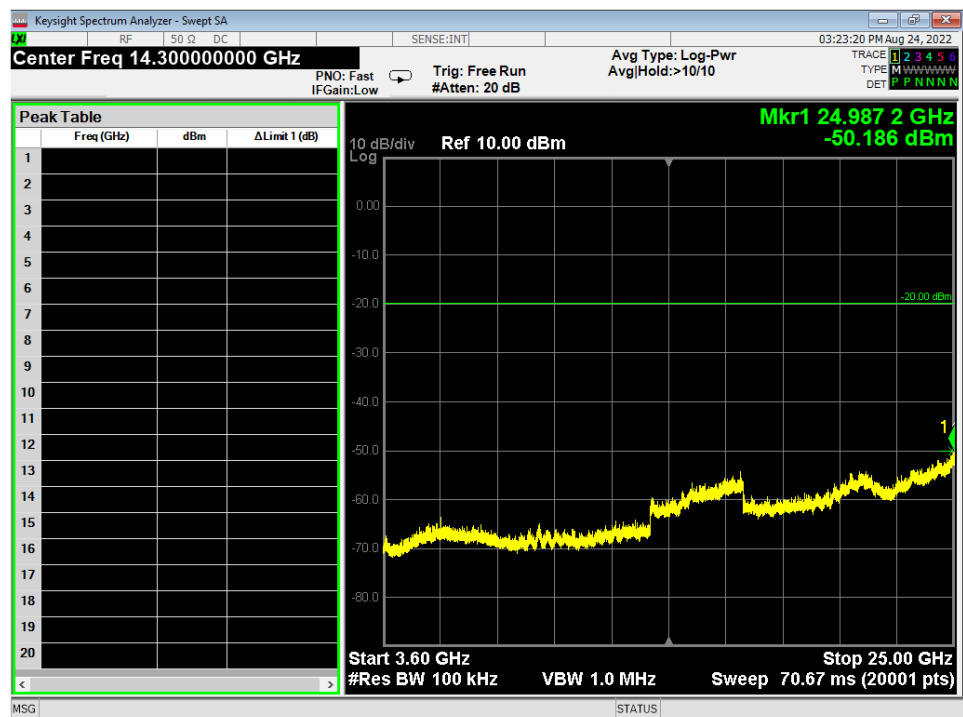


Figure 19 - Radiated Emissions Plot, WIFI 802.11n, 3.6G – 25G, Low

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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:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c))

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.



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Test results:

Pass

Comments:

1. All the band edge plots can be found in the Appendix C.
2. 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.
3. 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 15.247 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:

1. All the Power Spectral Density (PSD) plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. The measurements are reported on the graph.
4. The measurements are listed in the tables in section 4.0.

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:

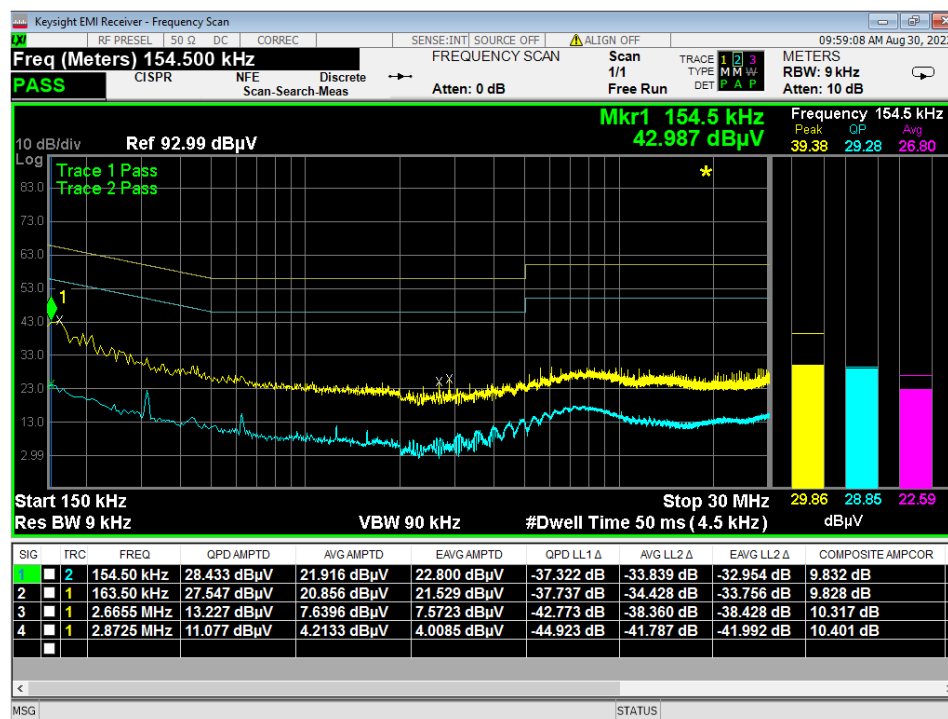


Figure 20 - Conducted Emissions Plot, Line, TX

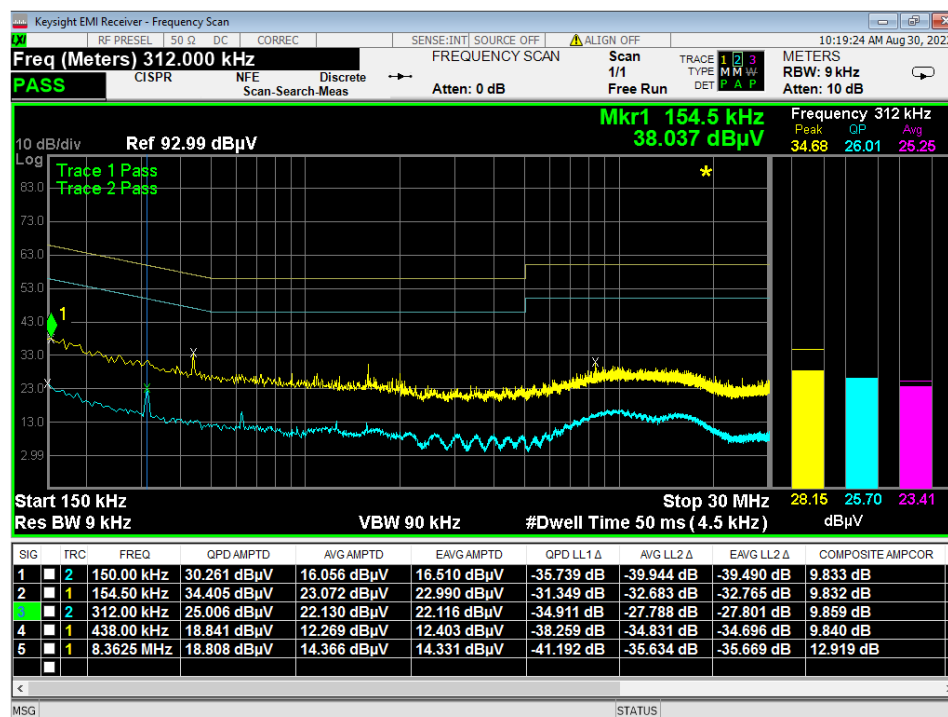


Figure 21 - Conducted Emissions Plot, Neutral, TX

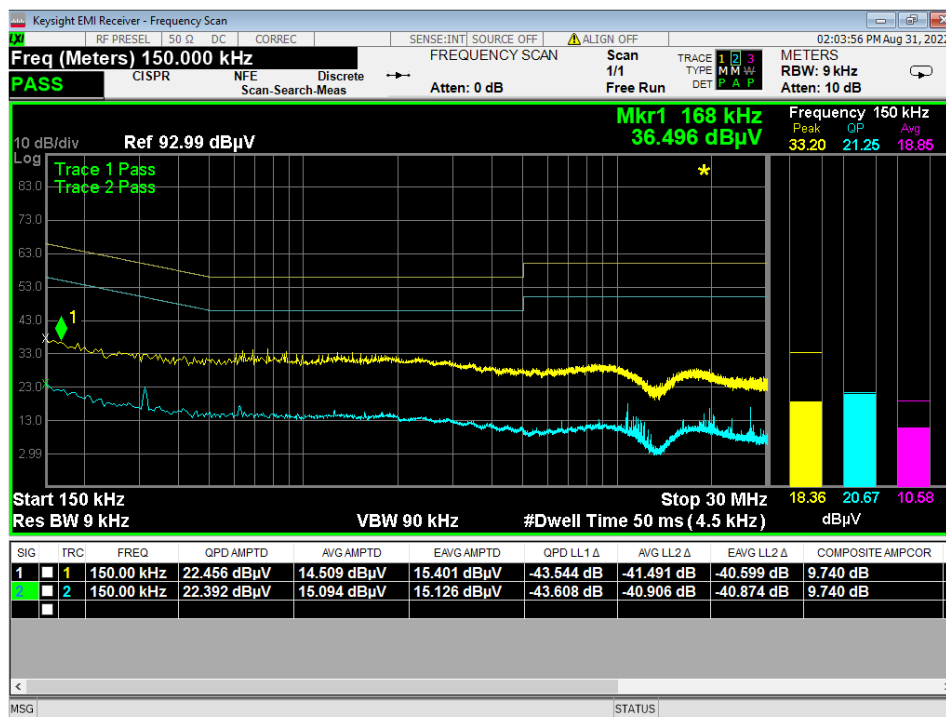


Figure 22 - Conducted Emissions Plot, Line, IDLE

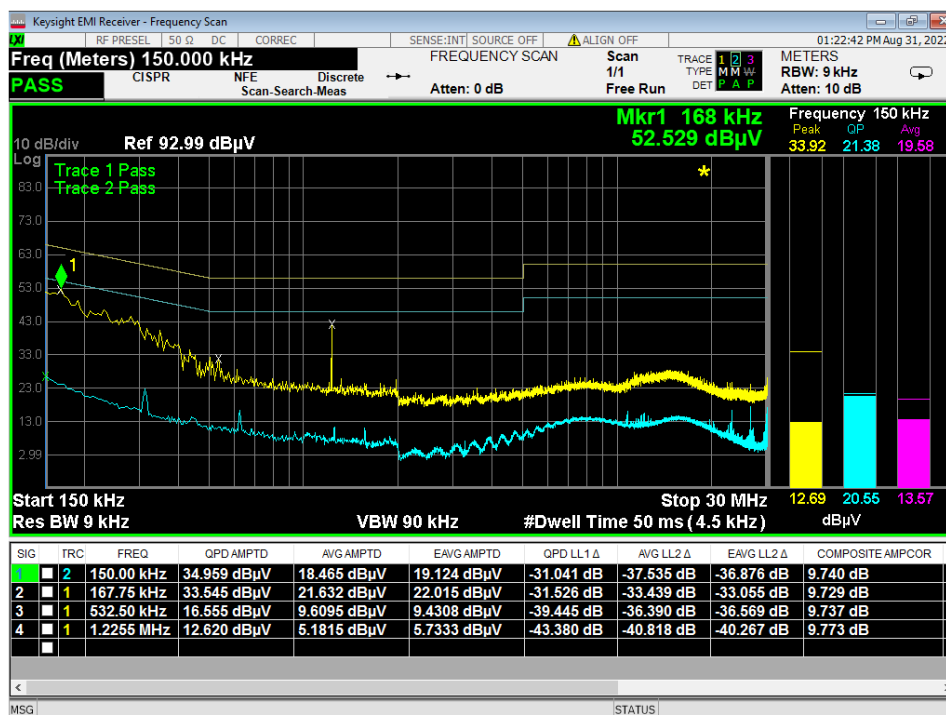


Figure 23 - Conducted Emissions Plot, Neutral, IDLE



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4.8 ANTENNA GAIN

Test procedures:

Device's conducted power was measured then the same measurement was repeated on a radiated sample at 3m test distance and converted to E.I.R.P.

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:

Antenna Gain:

Radiated EIRP – Conducted Power = Antenna gain
 $8.72 \text{ dBm} - 15.67 \text{ dBm} = -6.95 \text{ dBi}$

Comments:

1. Device was compared only on the highest power modulation/transmitter and the results were used for all other modulations/transmitters within that frequency band (2400 – 2483.5 MHz band)

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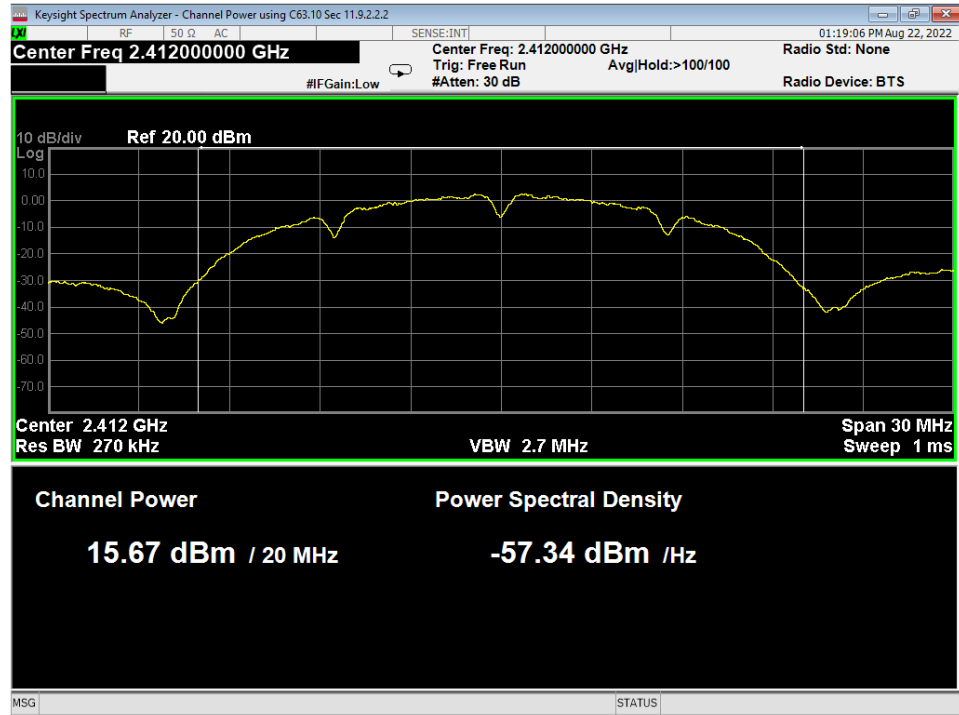


Figure 24 – Conducted Average Power Measurement, 802.11b 1MB

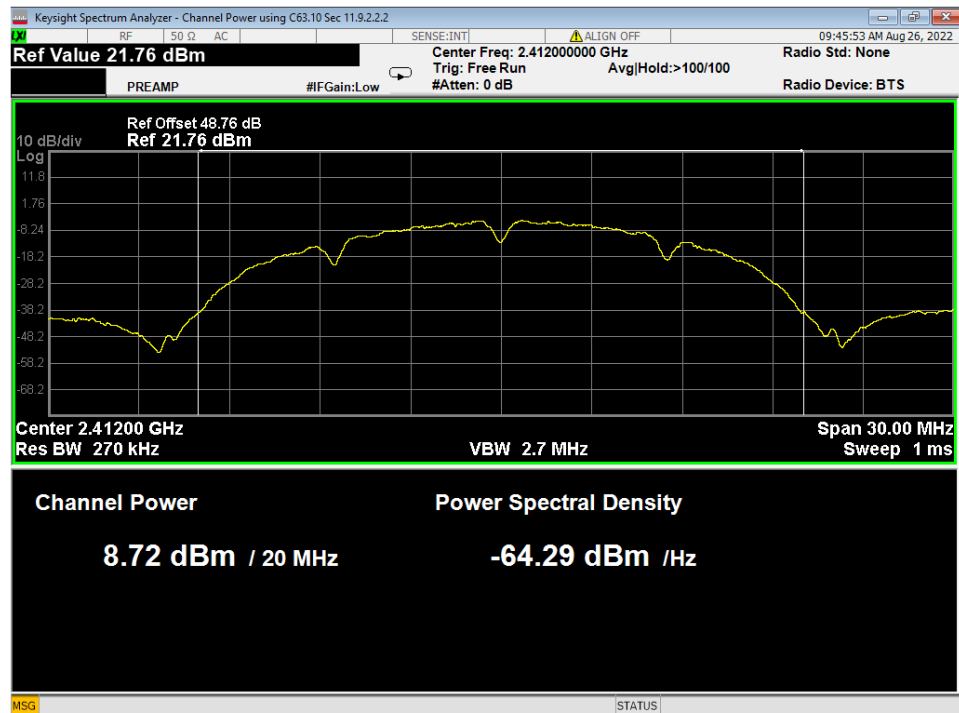


Figure 25 – Radiated Average Power Measurement, Corrections and EIRP conversion included in offset, 802.11b 1MB



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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:

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

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



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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;

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

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

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

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

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

Conversion from 3m field strength to EIRP (d=3):

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

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

$10\log(10^9)$ 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%.



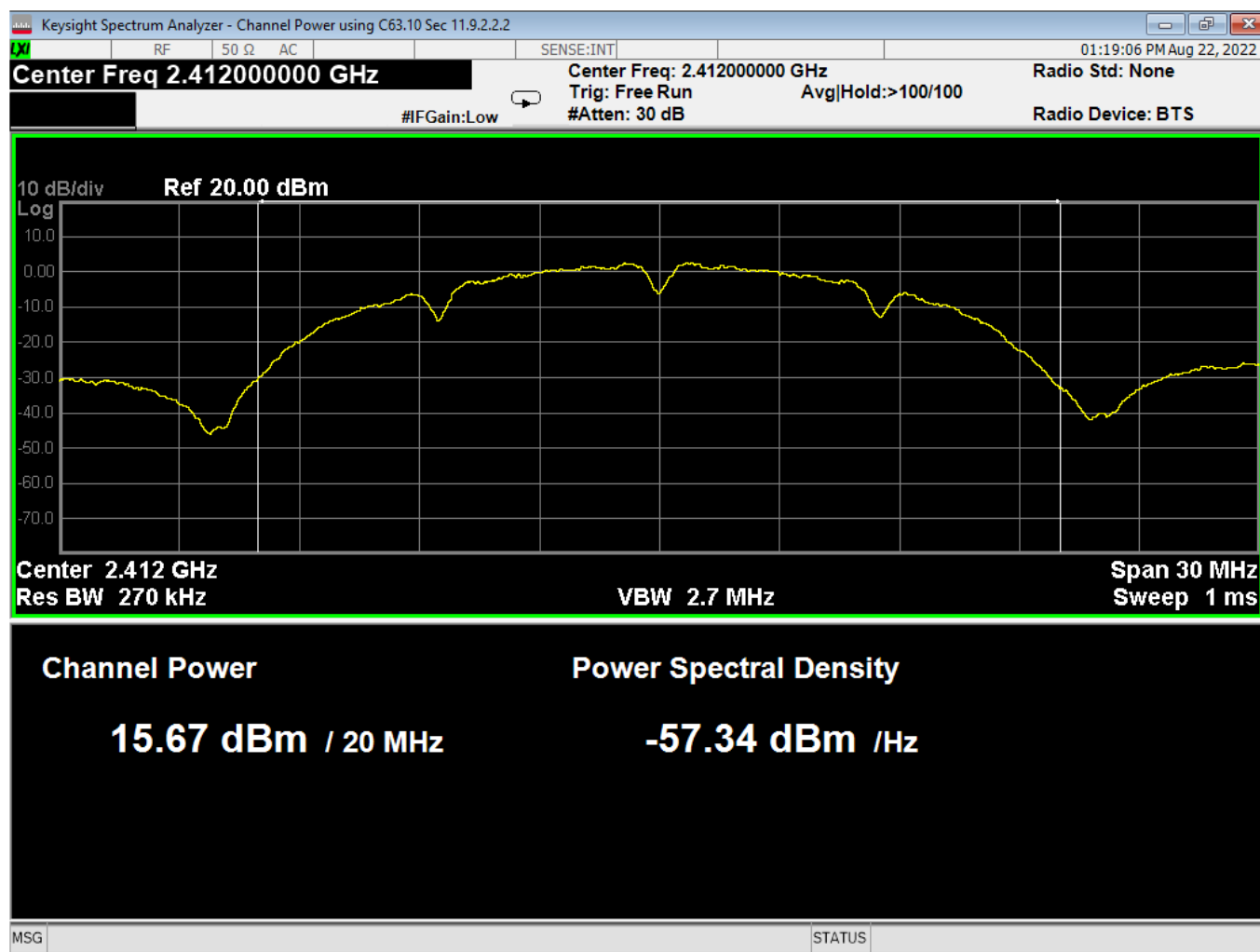
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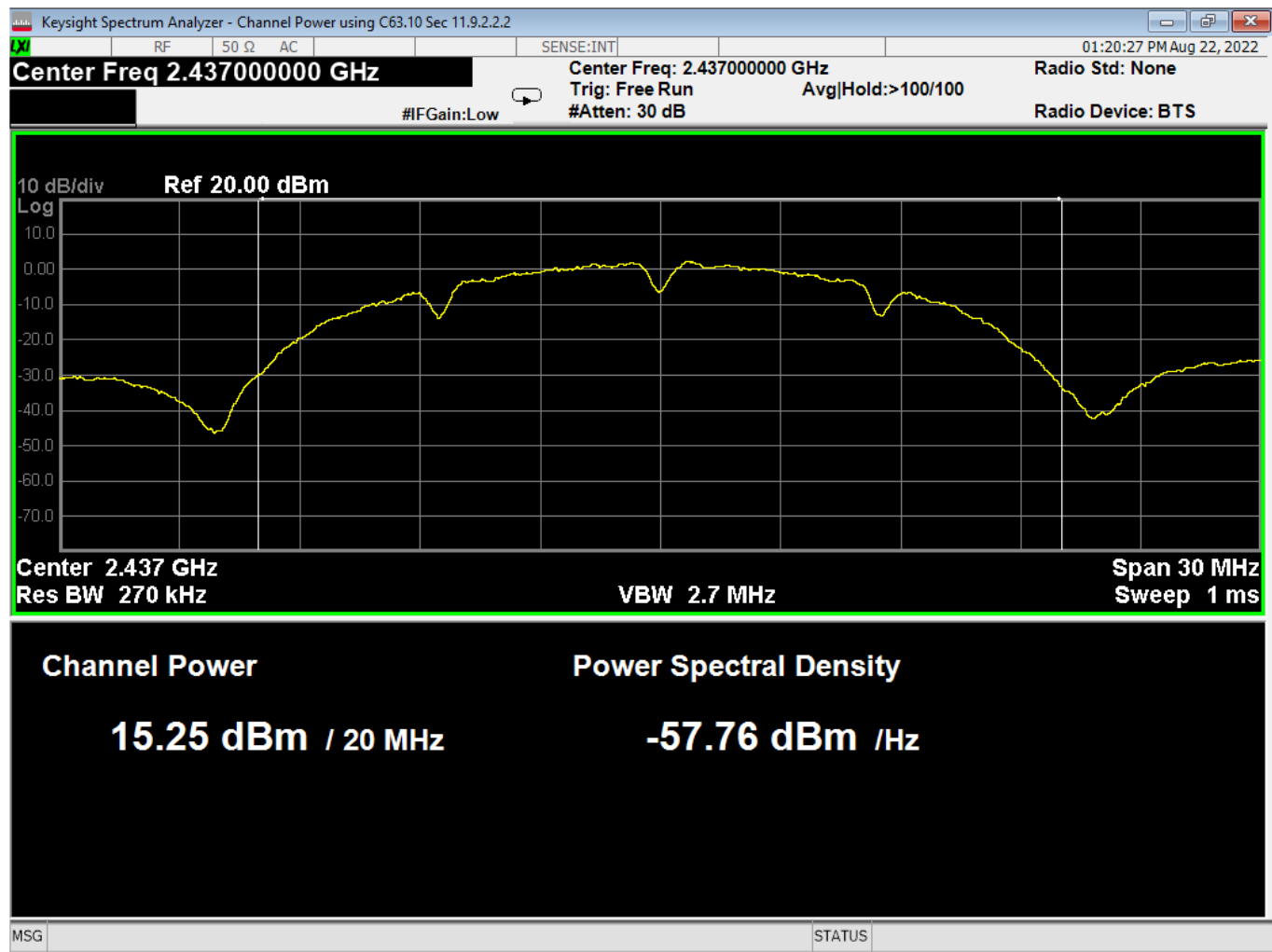
APPENDIX C – GRAPHS AND TABLES



01 Average Power, Low, Wifi B, Low Data Rate



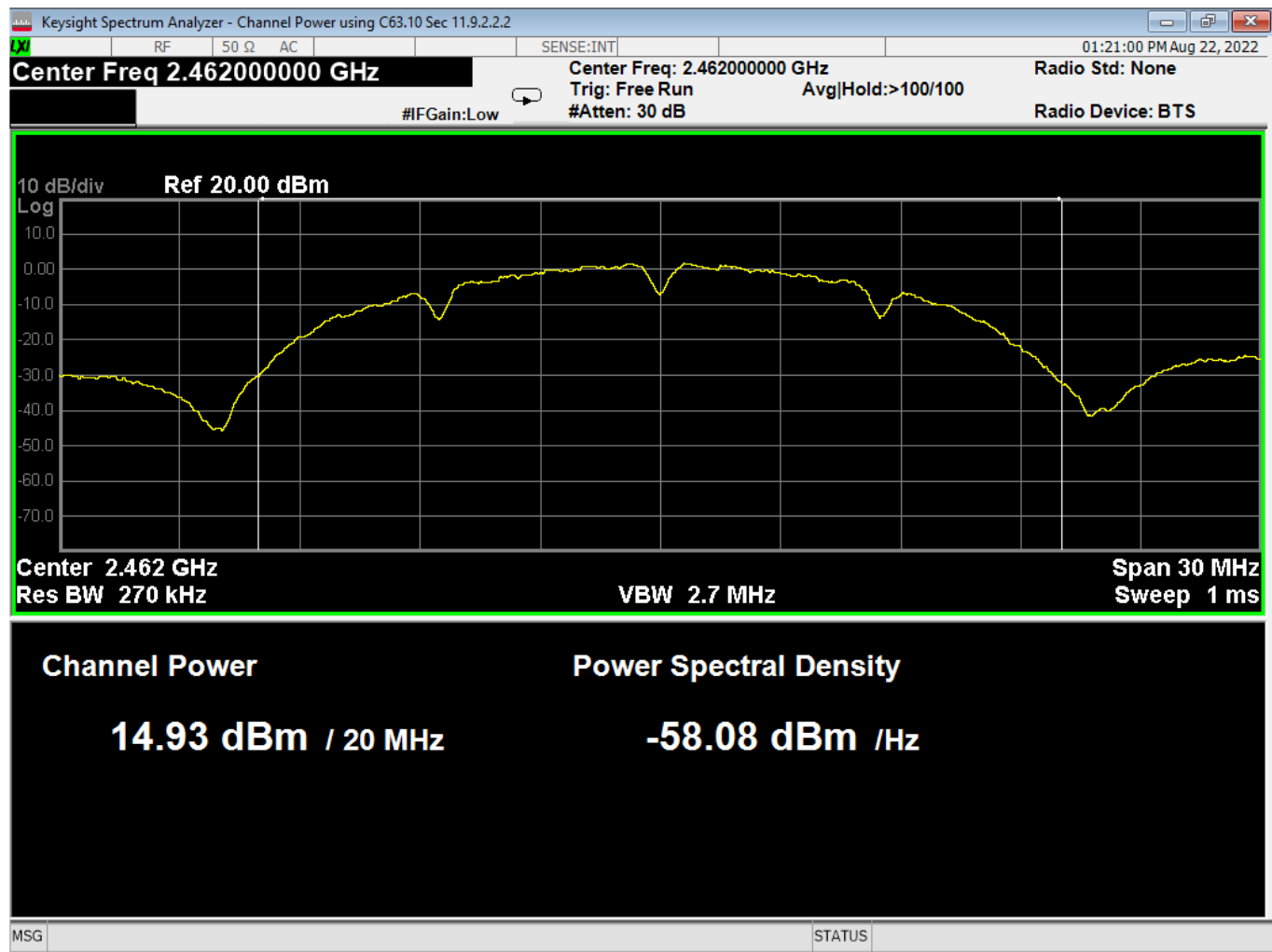
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02 Average Power, Mid, Wifi B, Low Data Rate



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03 Average Power, High, Wifi B, Low Data Rate

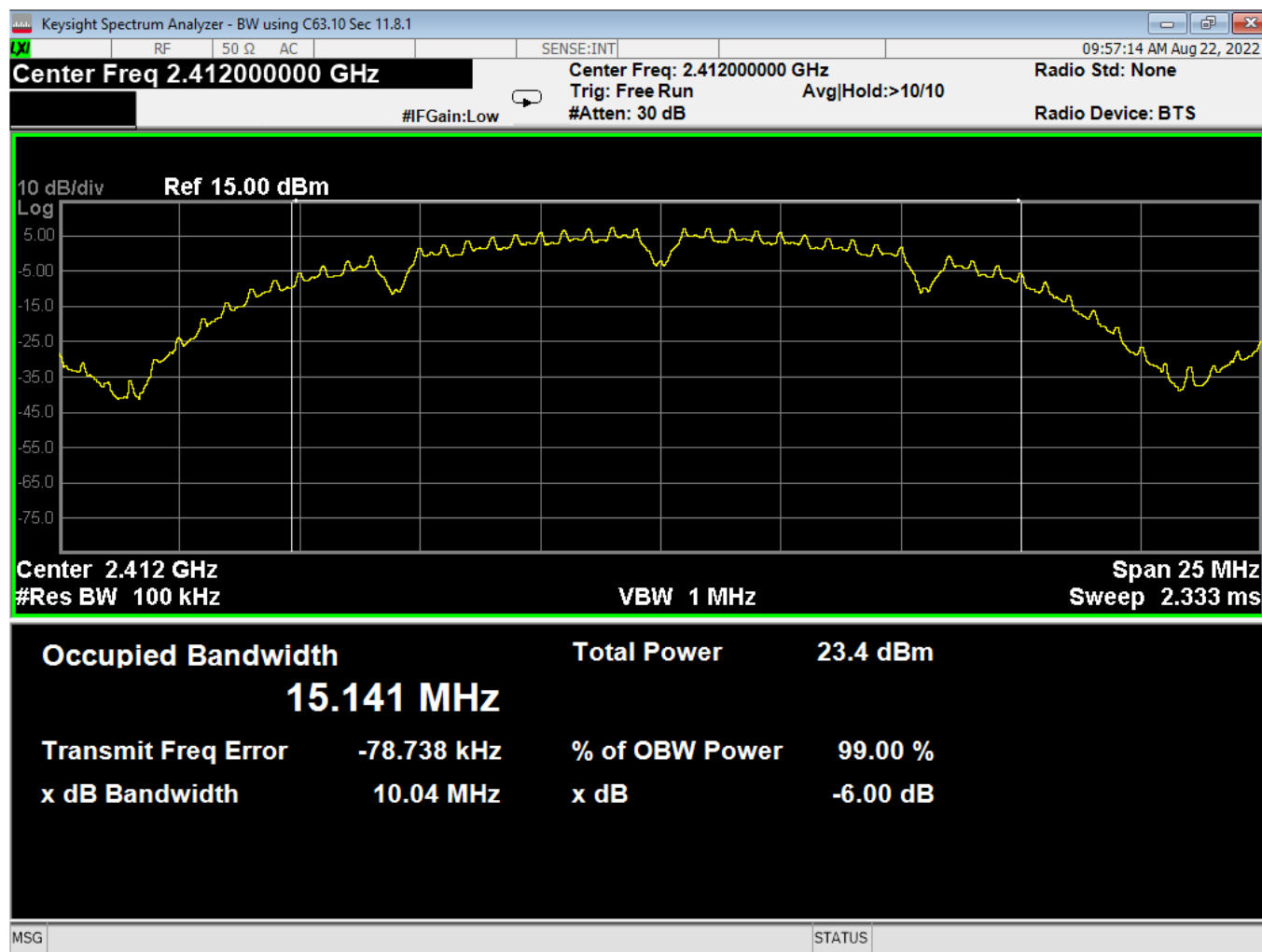


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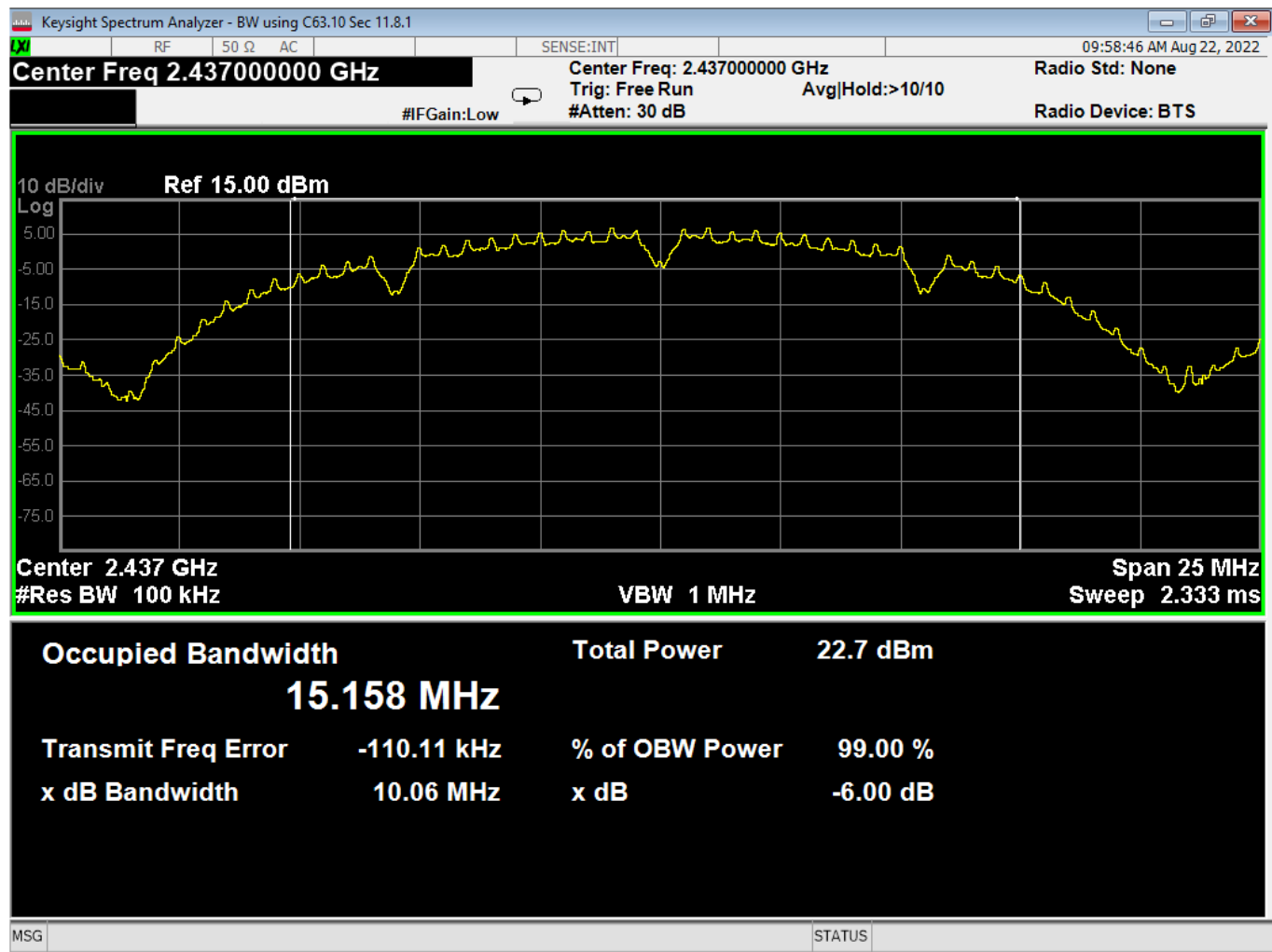
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04 6dB Bandwidth, Low, Wifi B, Low Data Rate



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05 6dB Bandwidth, Mid, Wifi B, Low Data Rate

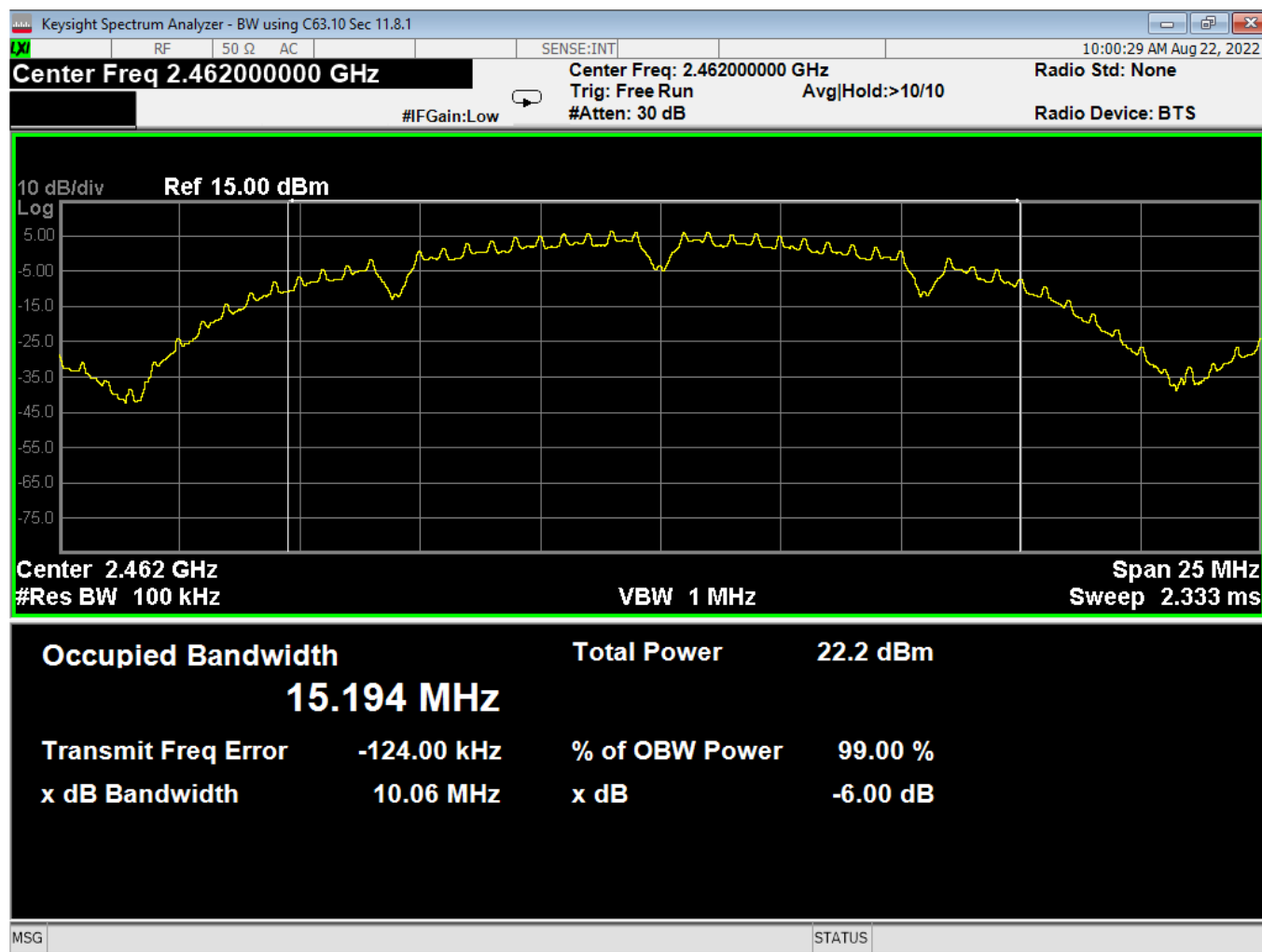


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06 6dB Bandwidth, High, Wifi B, Low Data Rate



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07 PSD, Low, Wifi B, Low Data Rate

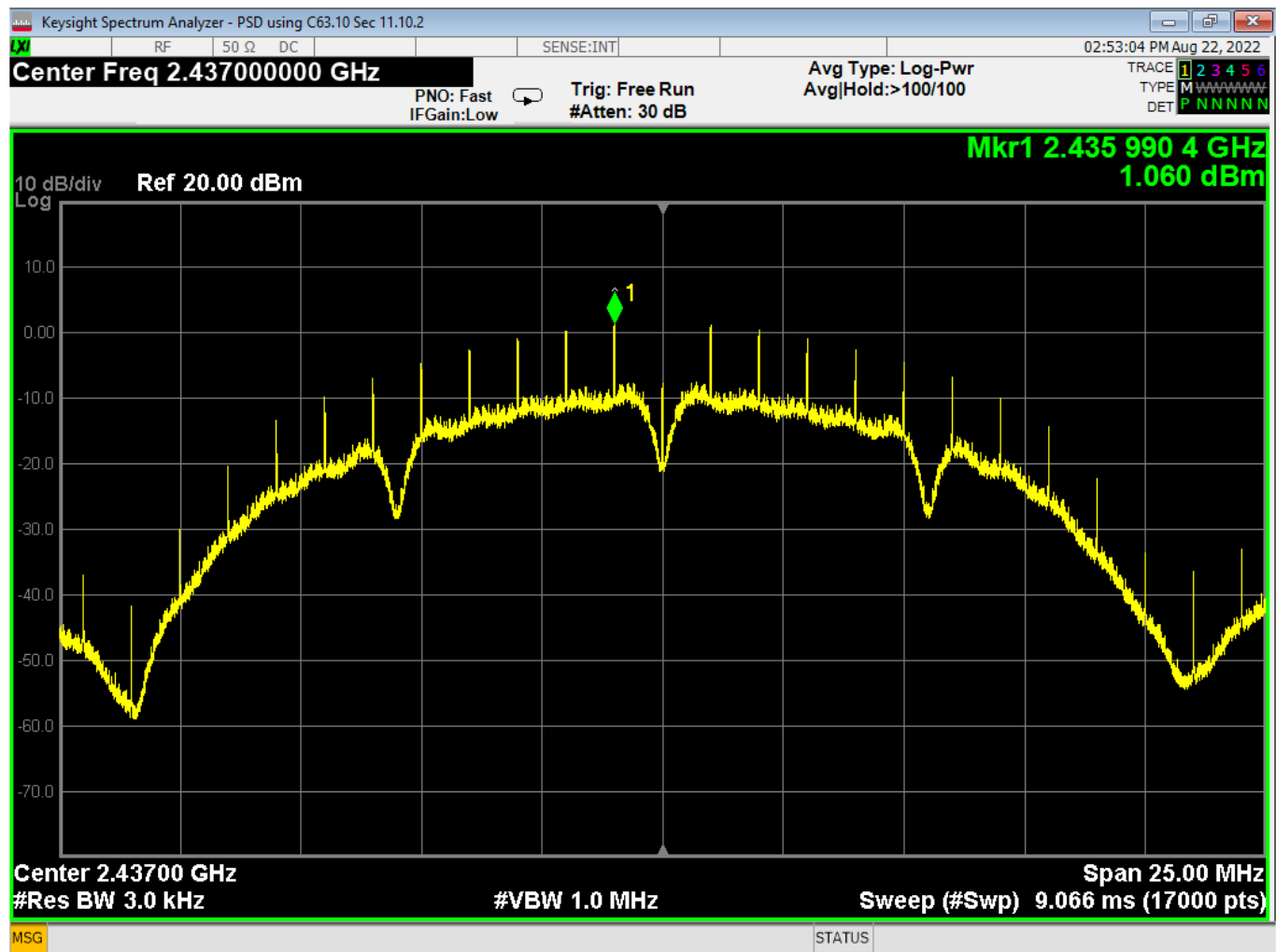


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08 PSD, Mid, Wifi B, Low Data Rate

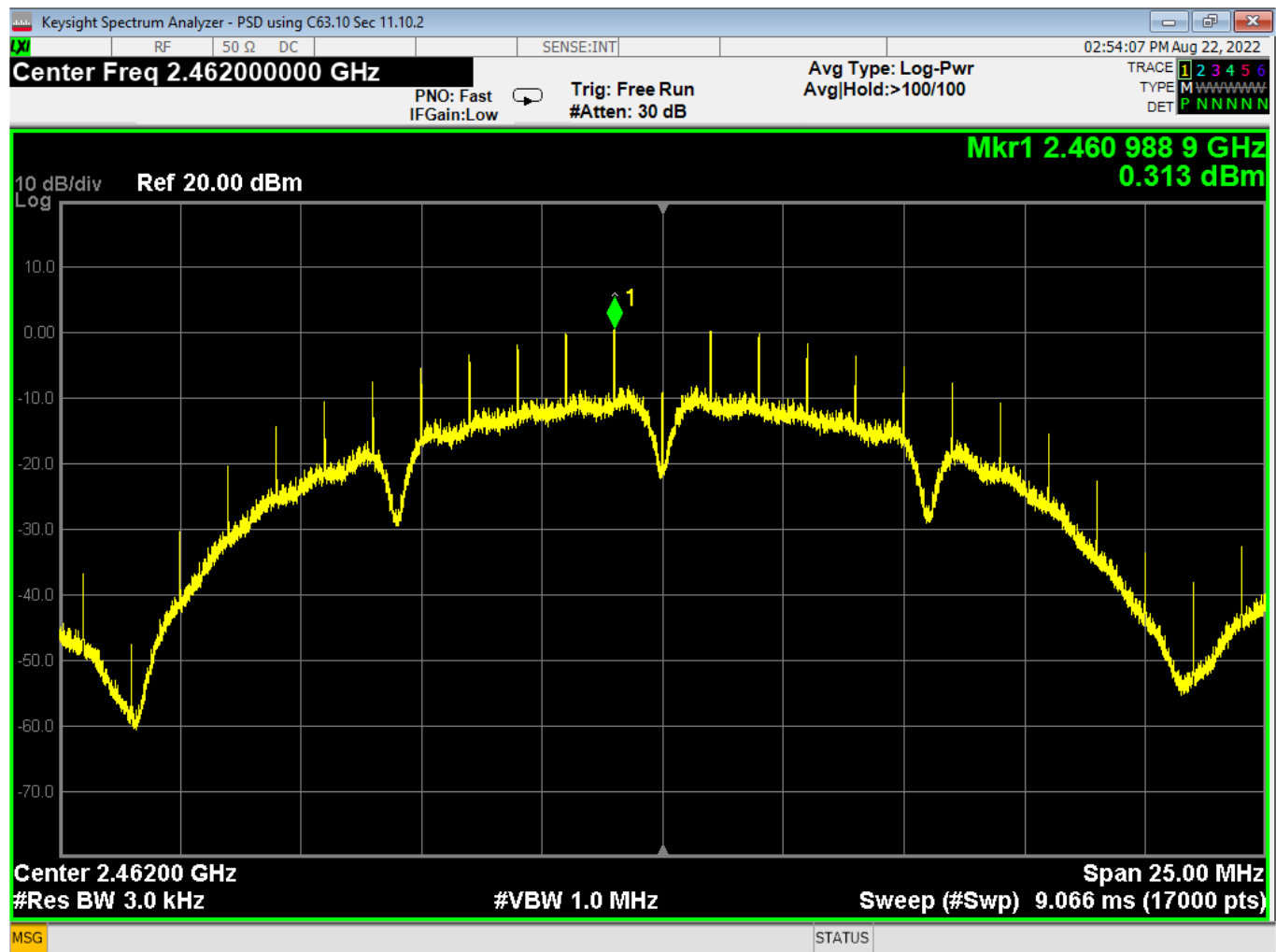


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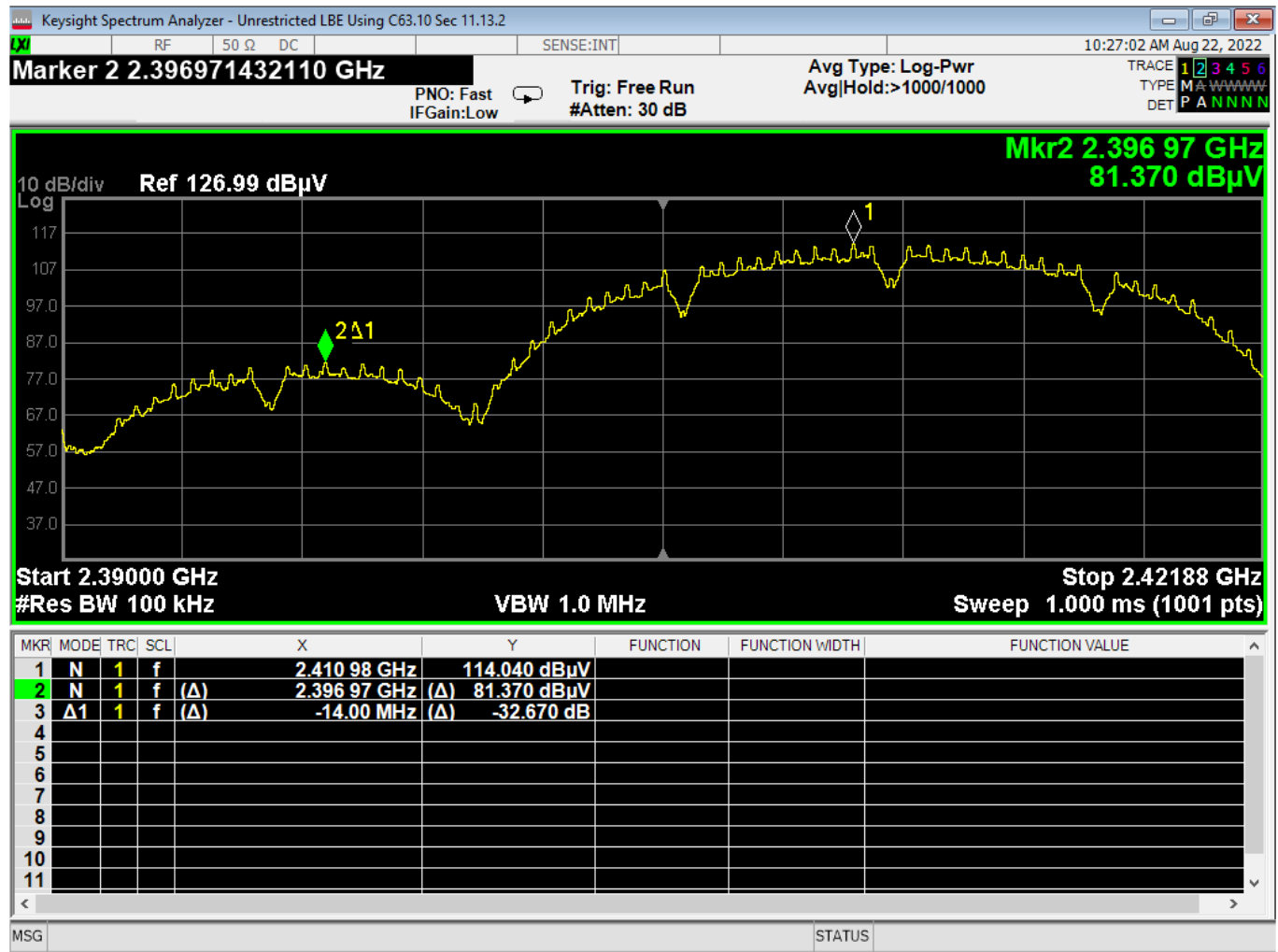
B

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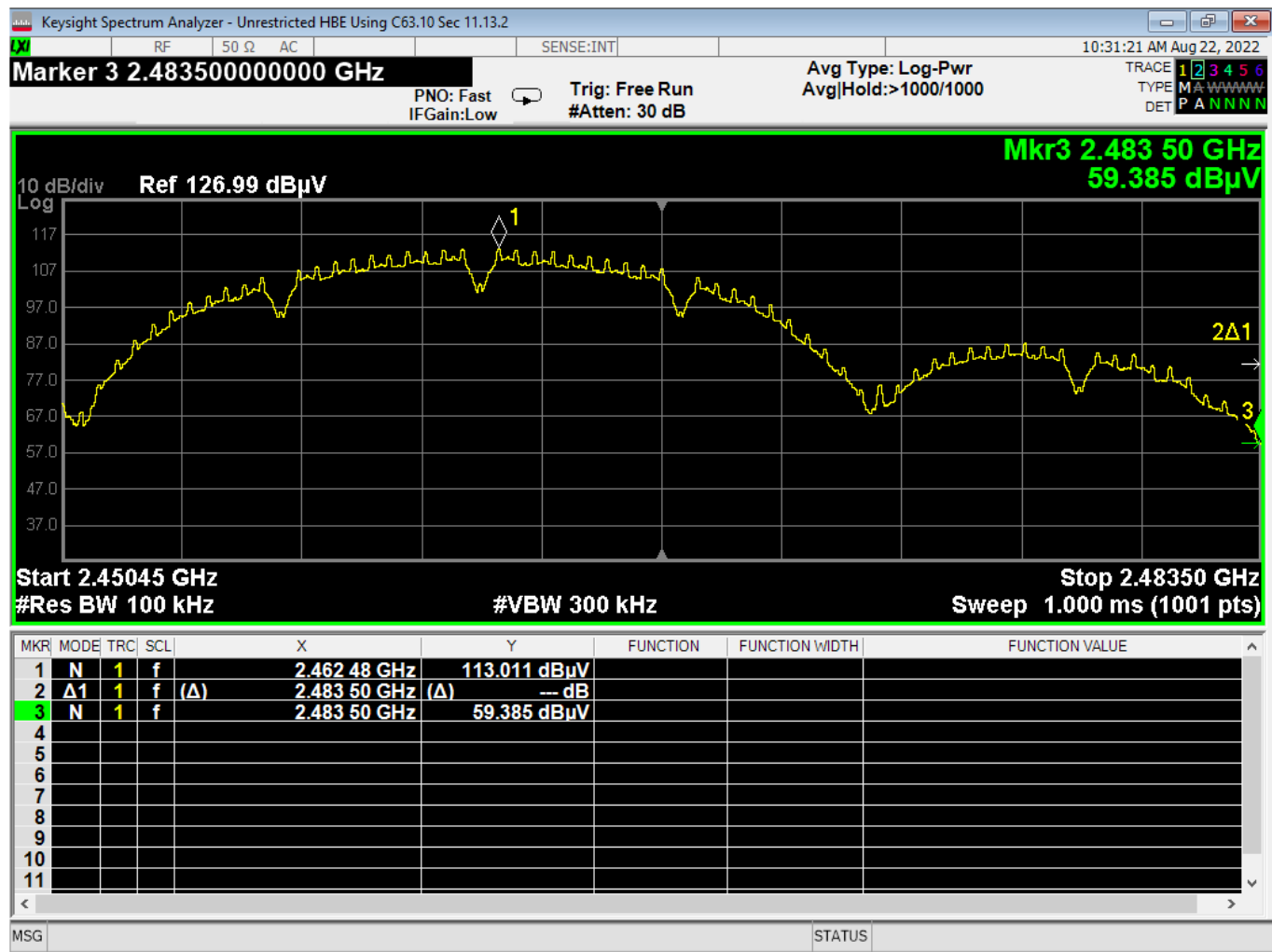


09 PSD, High, Wifi B, Low Data Rate

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10 Lower Bandedge, Unrestricted, Wifi B, Low Data Rate



11 Higher Bandedge, Unrestricted, Wifi B, Low Data Rate

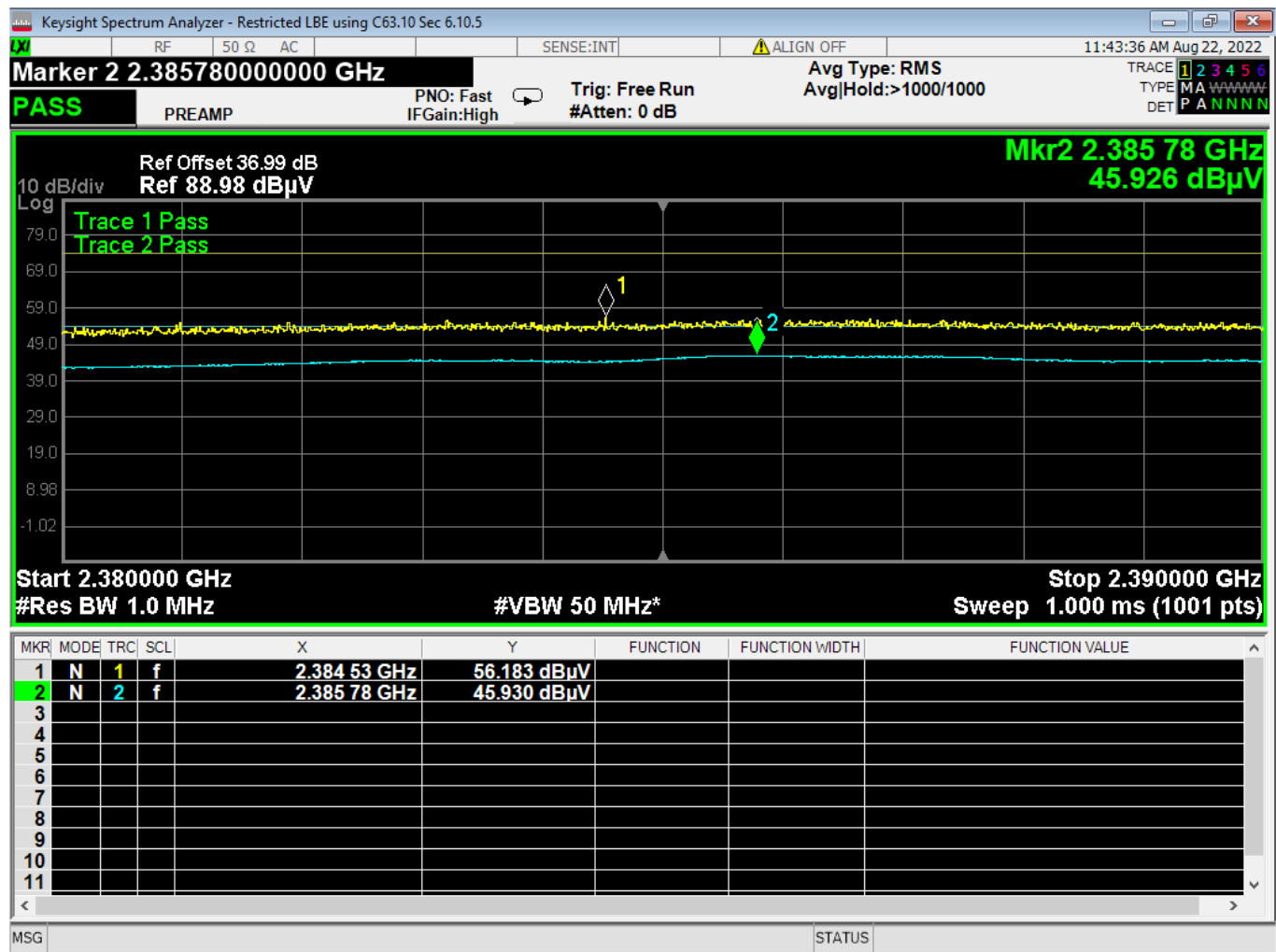


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12 Lower Bandedge, Restricted, Wifi B, Low Data Rate

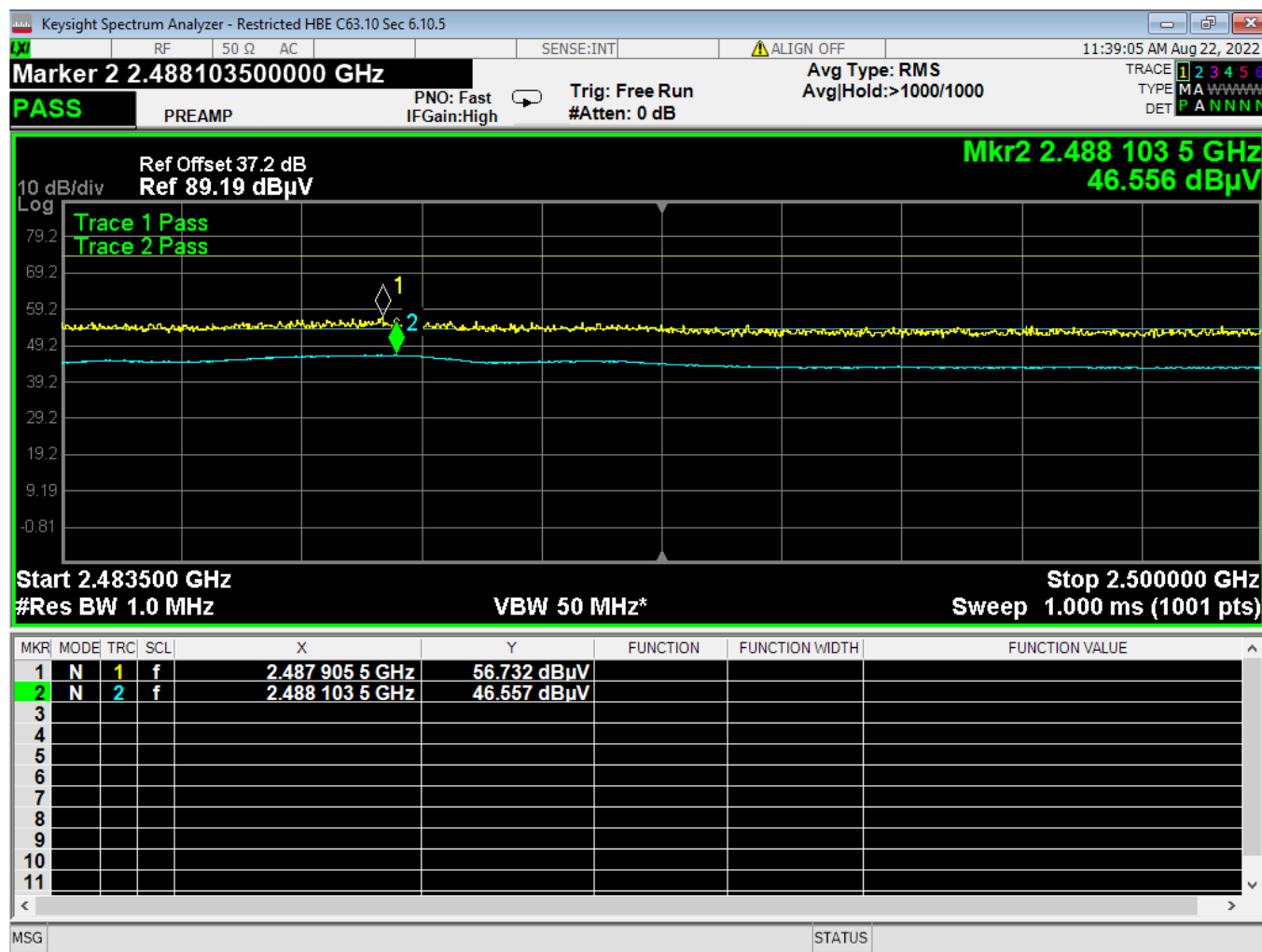


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13 Higher Bandedge, Restricted, Wifi B, Low Data Rate

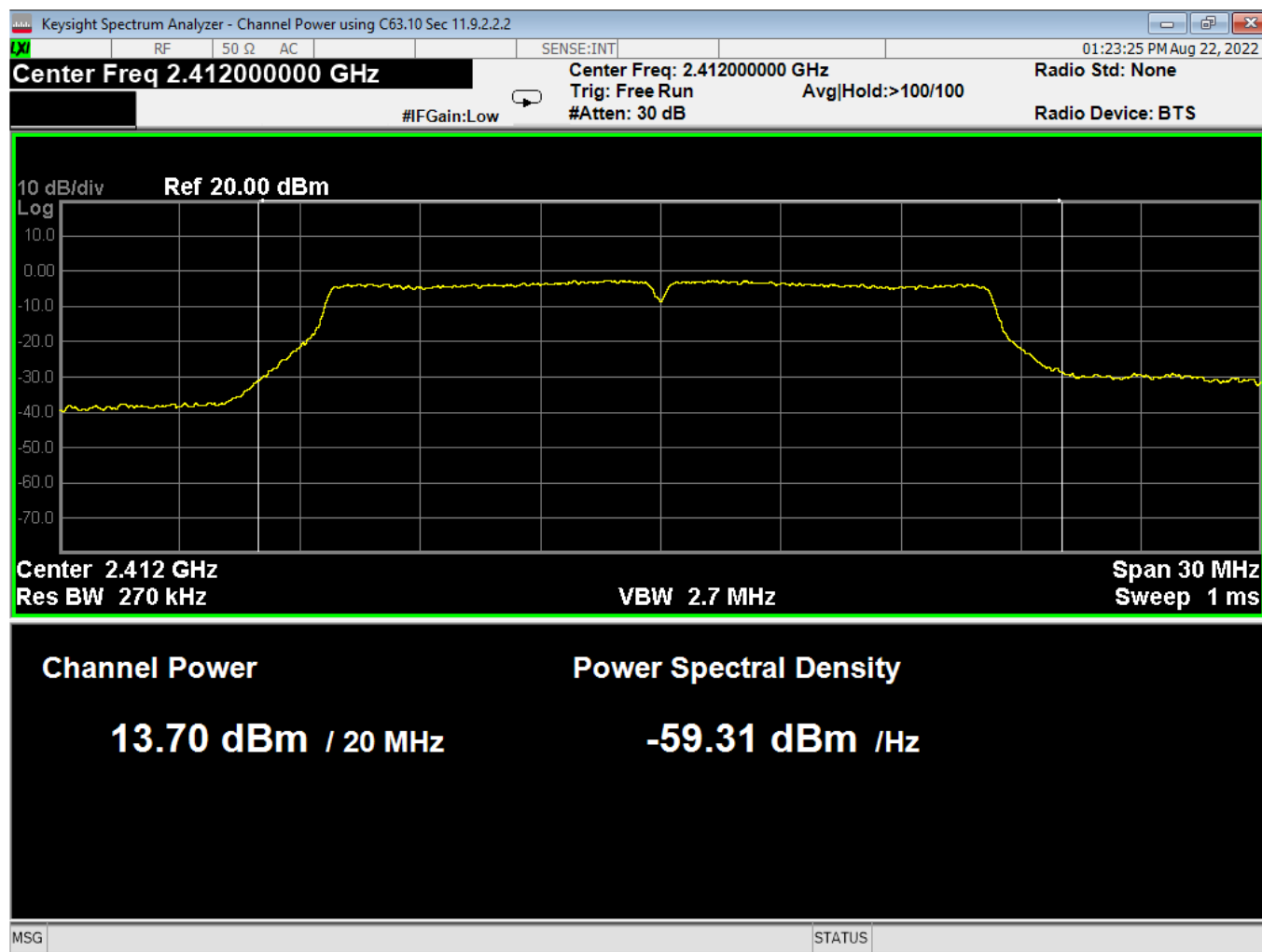


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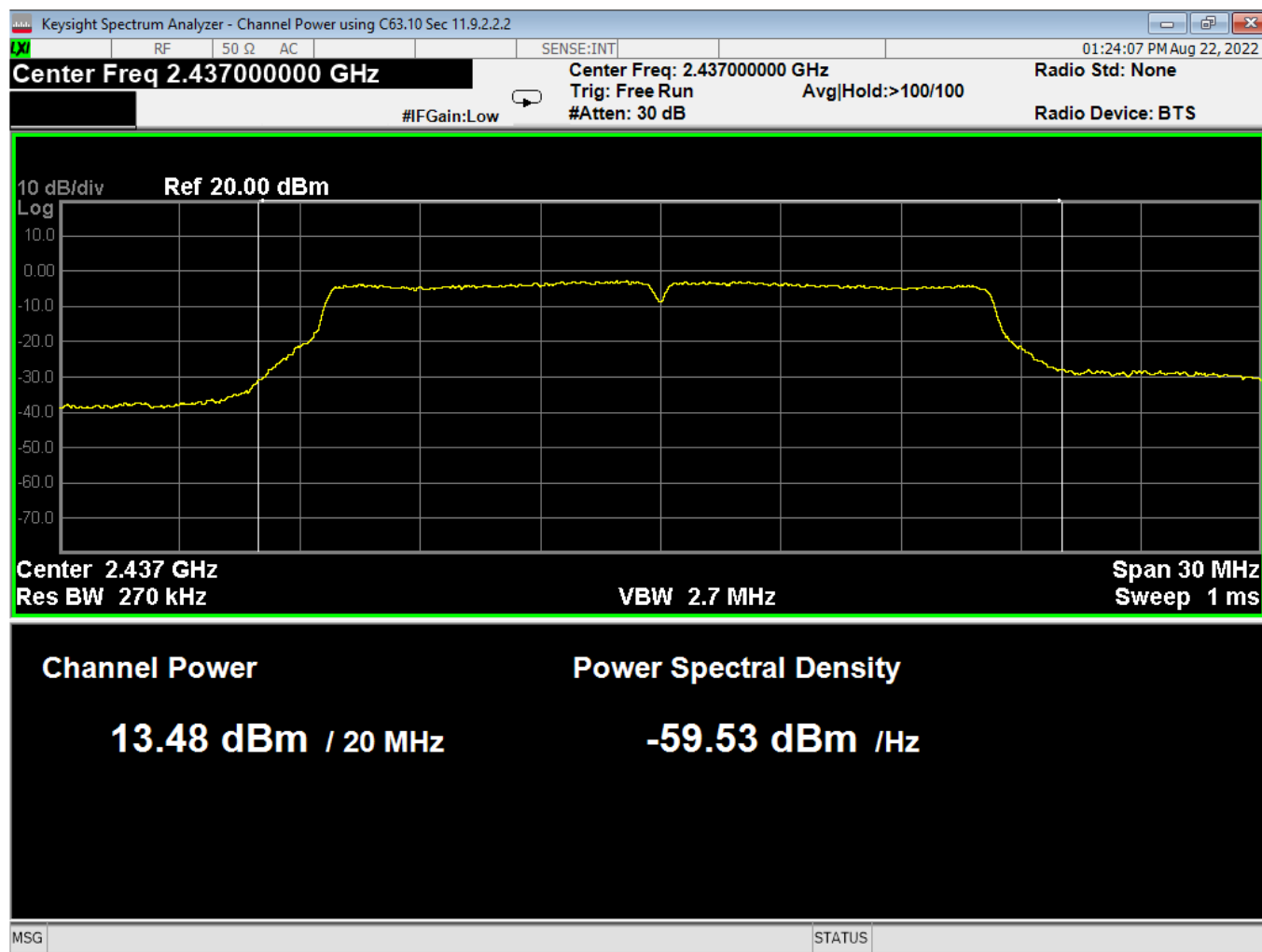
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14 Average Power, Low, Wifi G, Low Data Rate



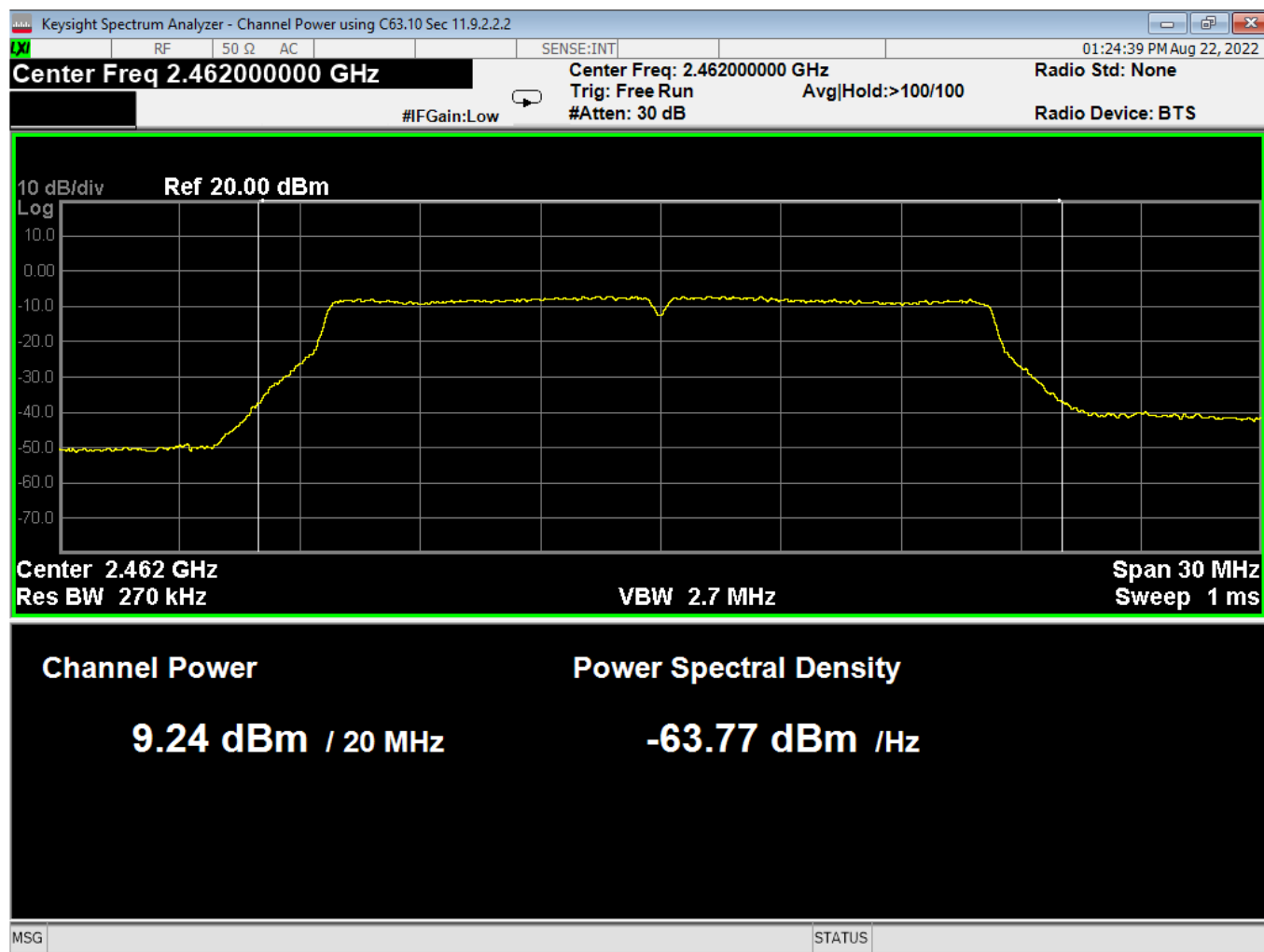
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15 Average Power, Mid, Wifi G, Low Data Rate



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16 Average Power, High, Wifi G, Low Data Rate

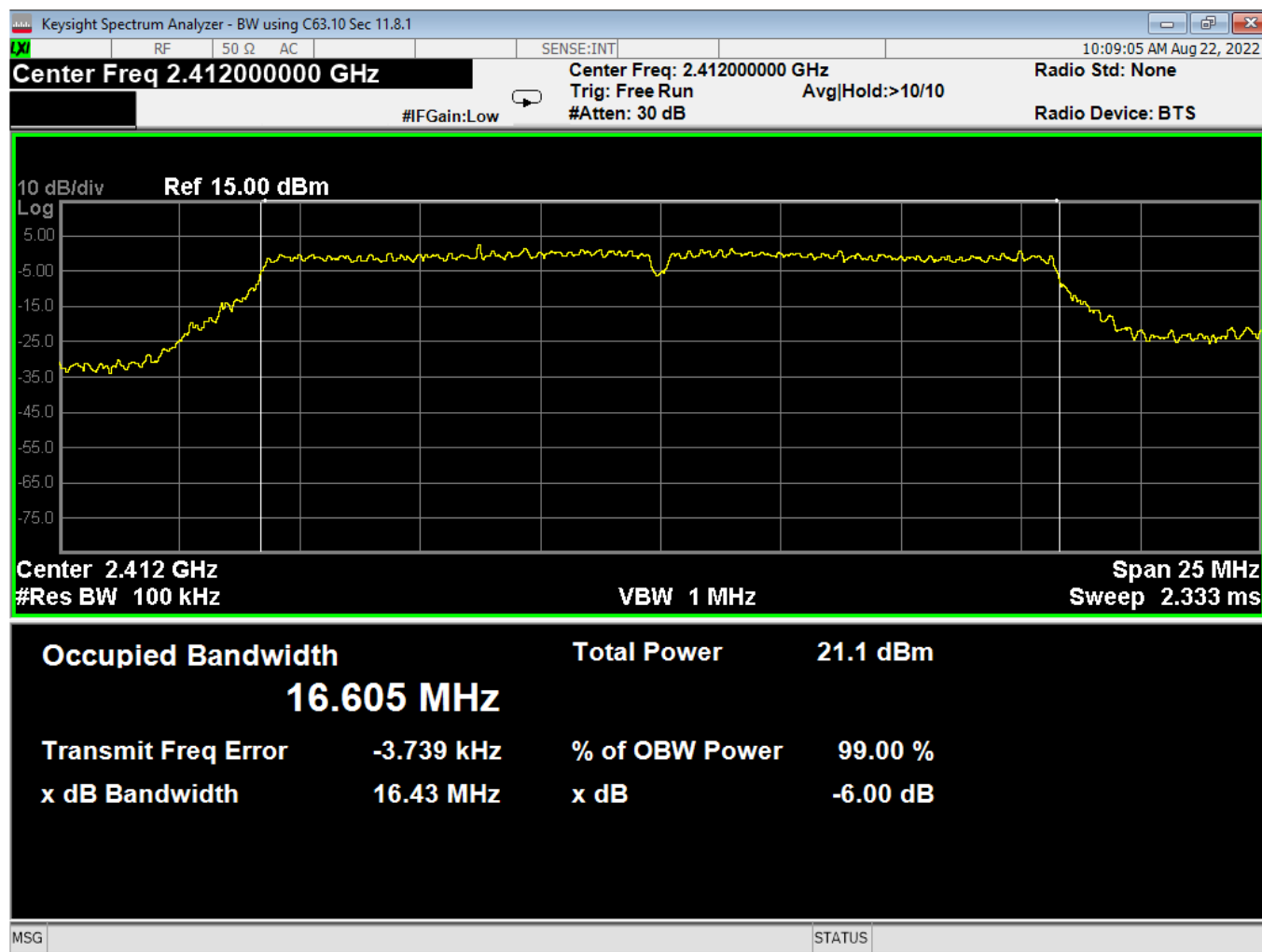


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17 6dB Bandwidth, Low, Wifi G, Low Data Rate

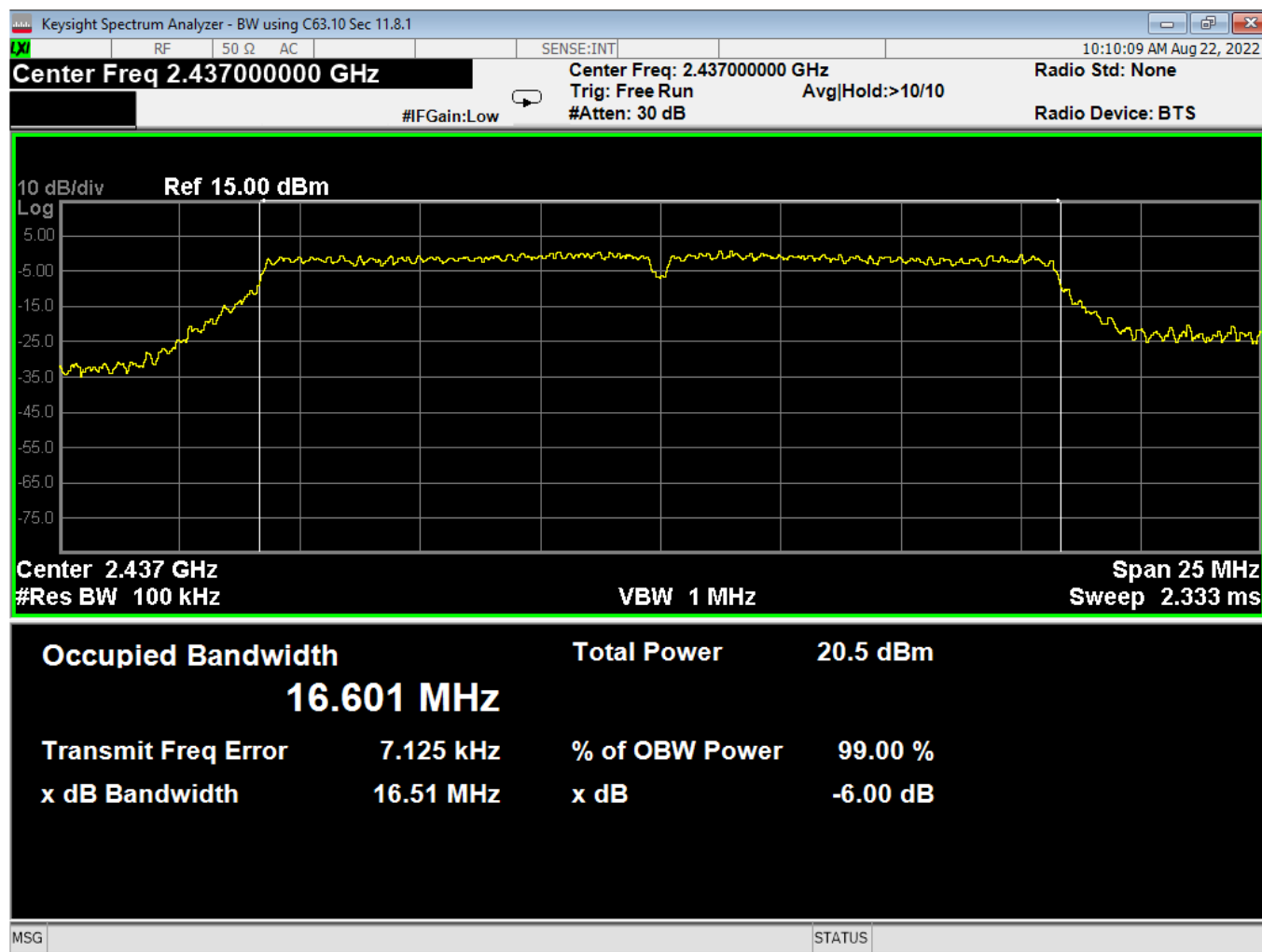


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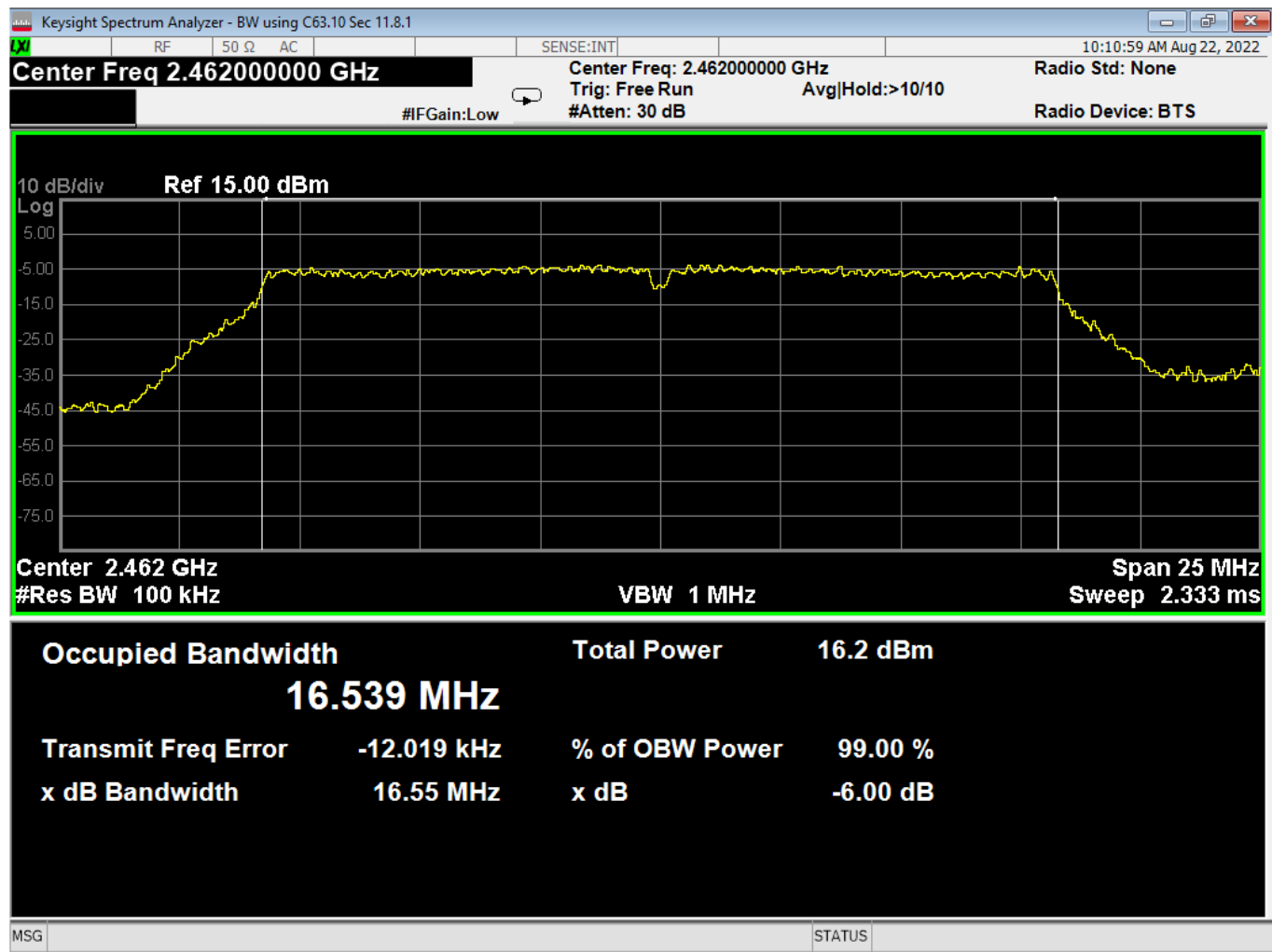
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18 6dB Bandwidth, Mid, Wifi G, Low Data Rate



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19 6dB Bandwidth, High, Wifi G, Low Data Rate

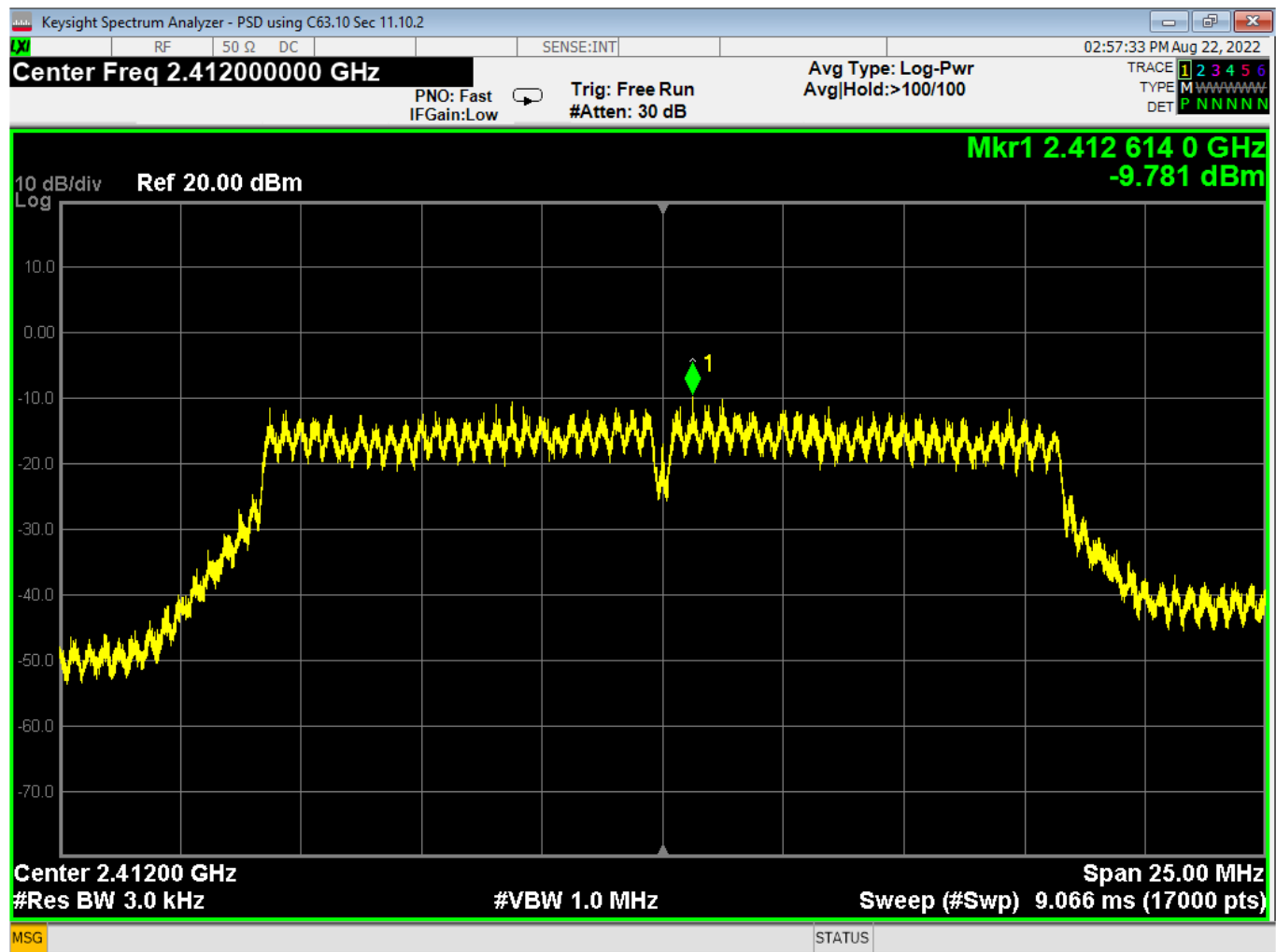


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20 PSD, Low, Wifi G, Low Data Rate

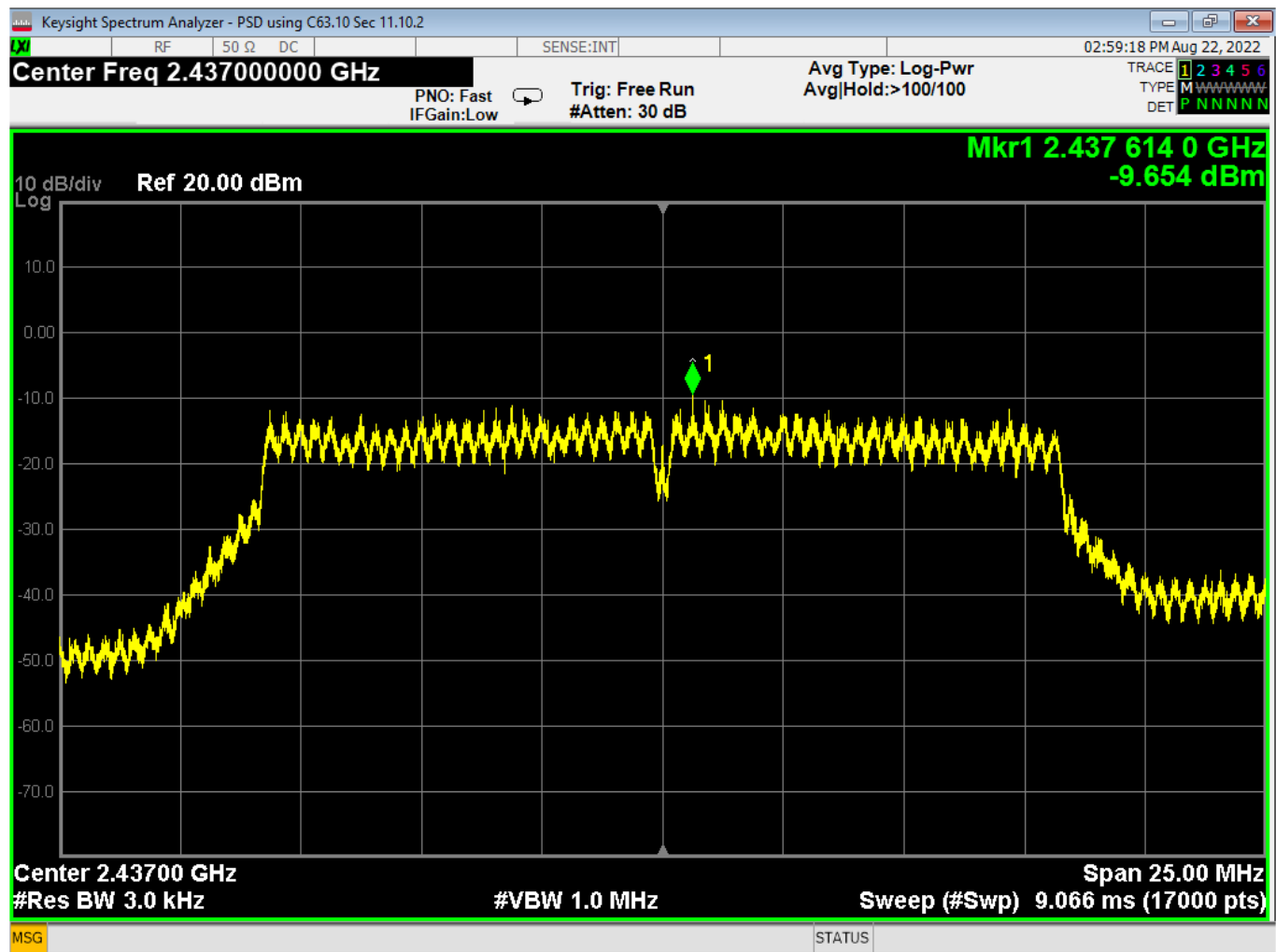


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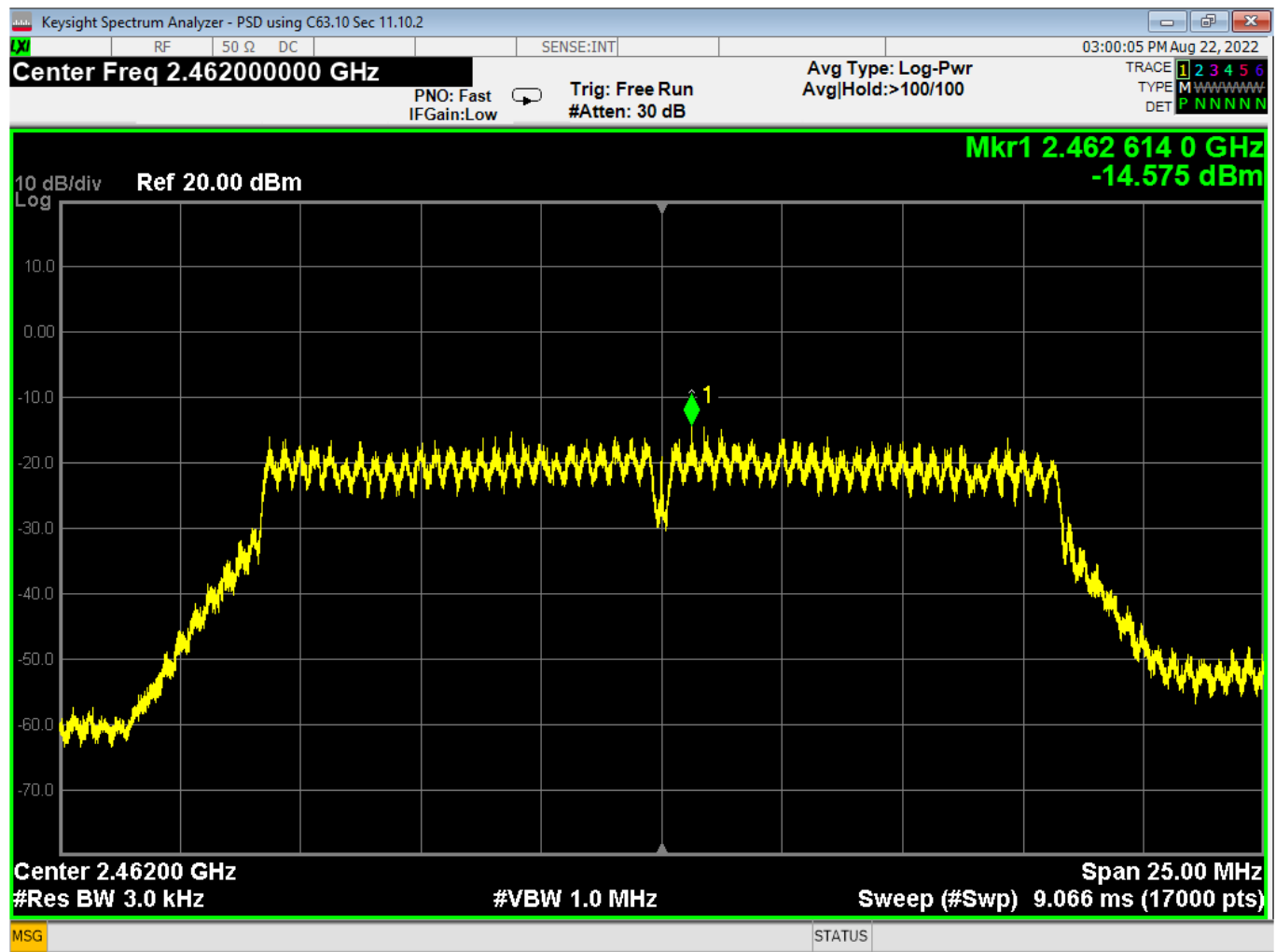
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21 PSD, Mid, Wifi G, Low Data Rate



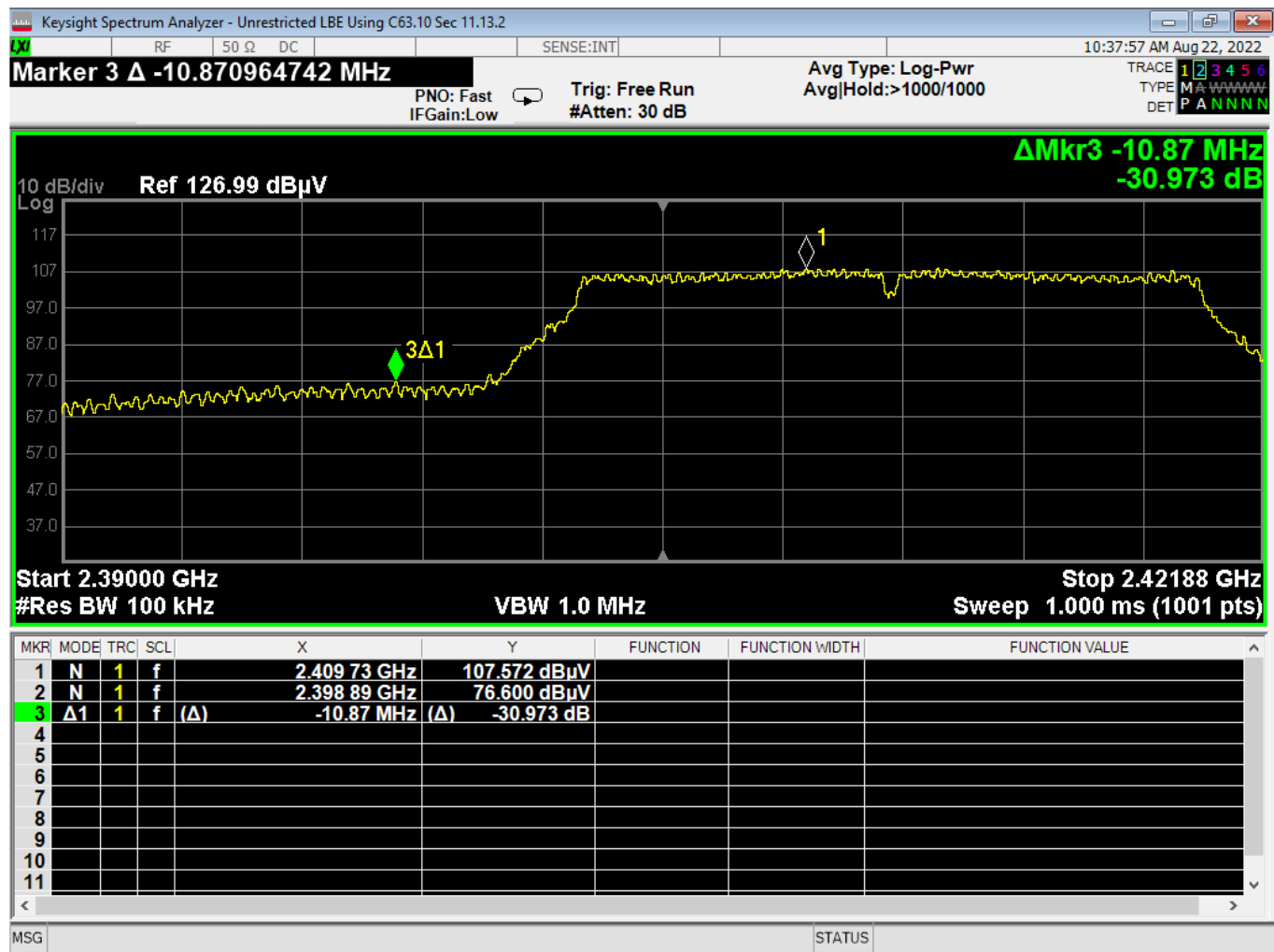
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22 PSD, High, Wifi G, Low Data Rate



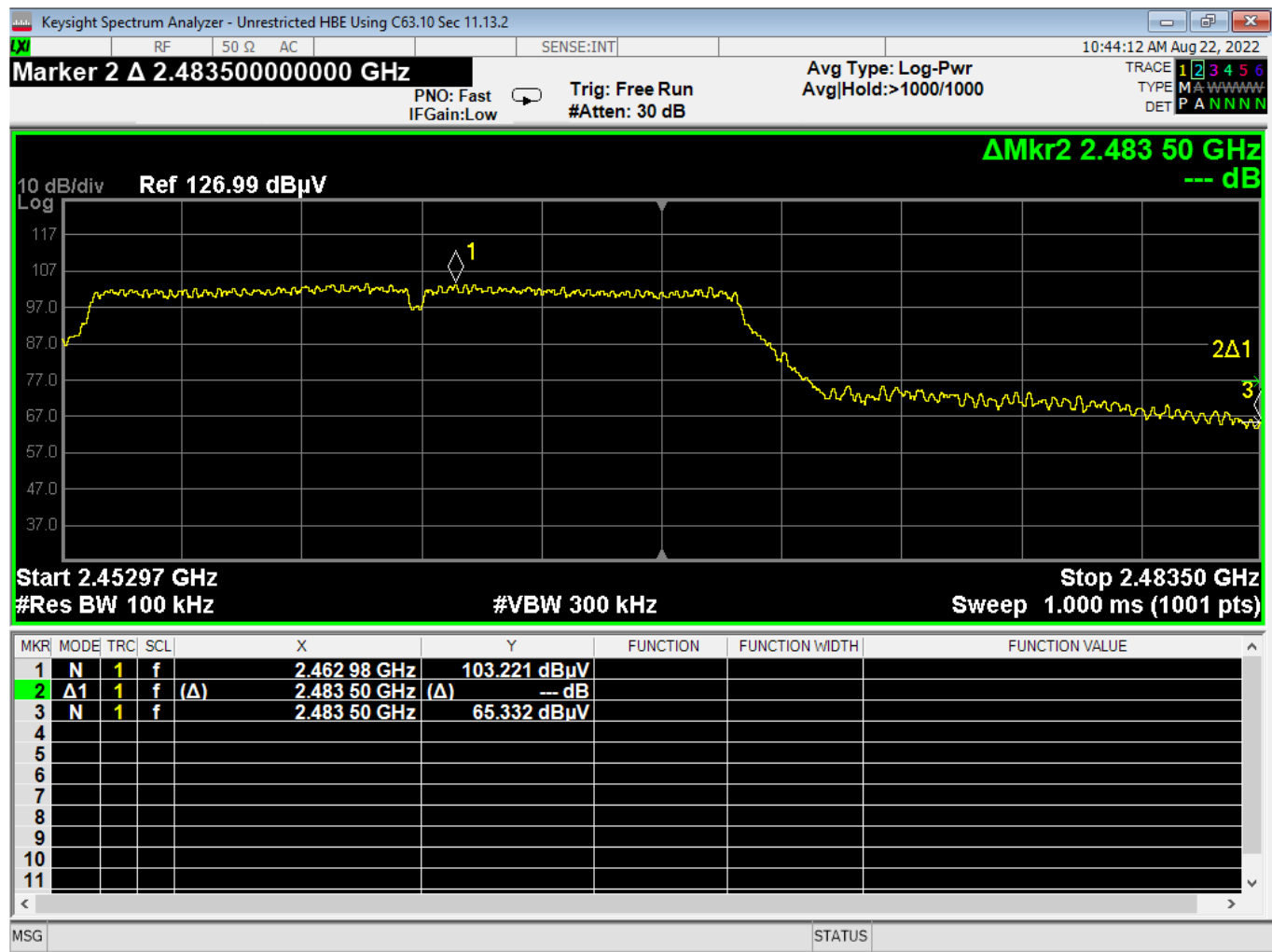
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23 Lower Bandedge, Unrestricted, Wifi G, Low Data Rate

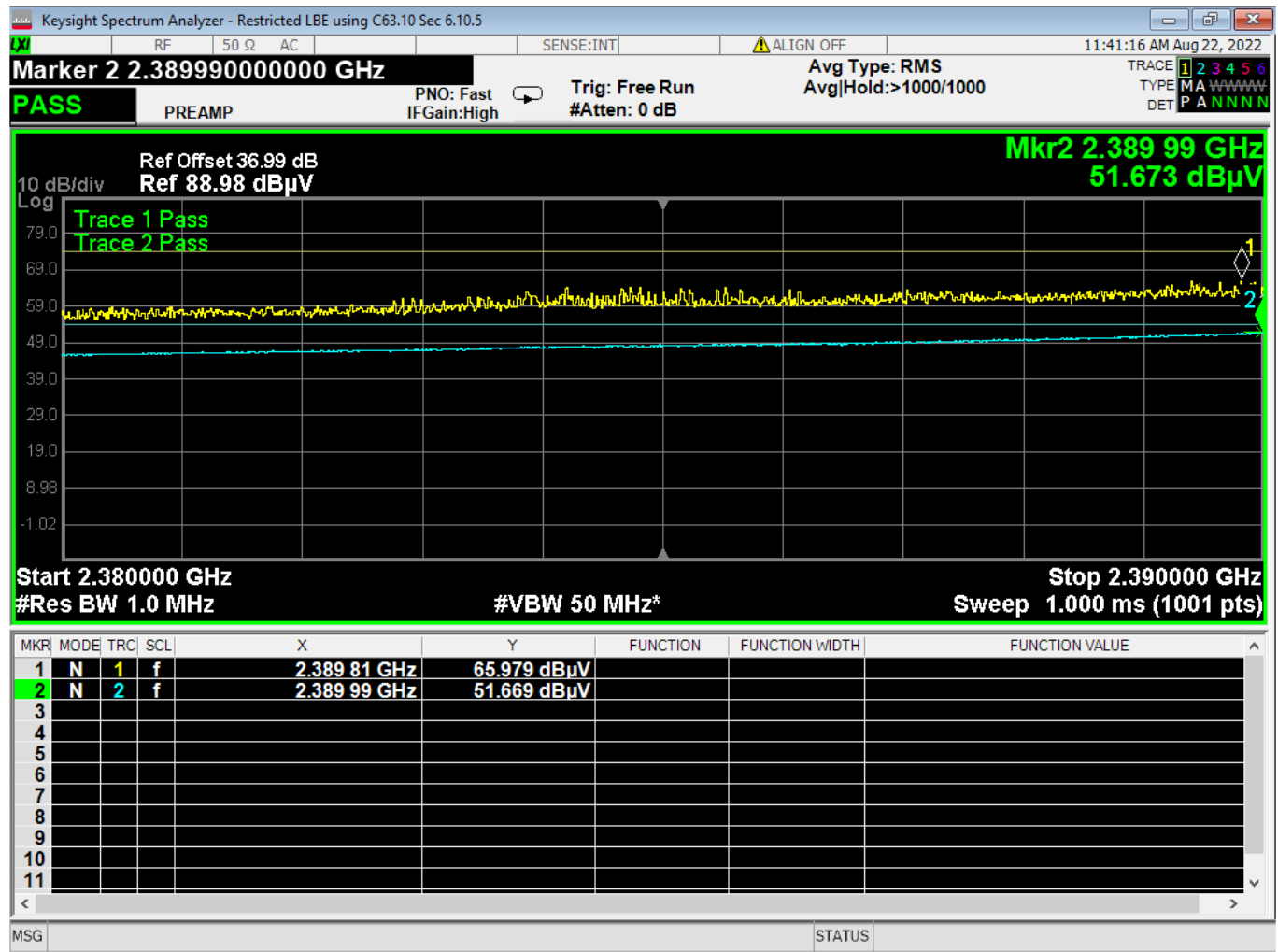


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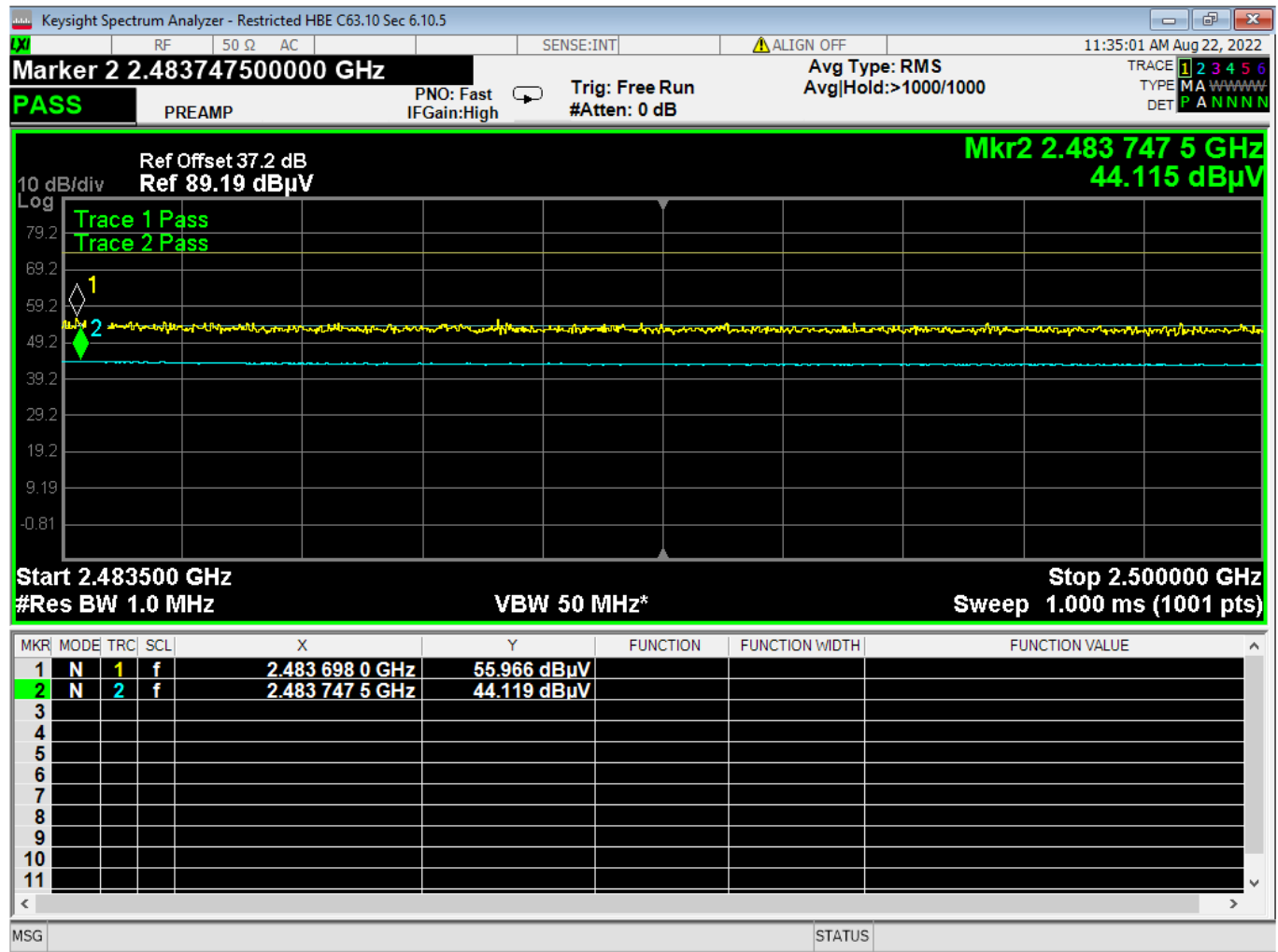
24 Higher Bandedge, Unrestricted, Wifi G, Low Data Rate

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25 Lower Bandedge, Restricted, Wifi G, Low Data Rate

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26 Higher Bandedge, Restricted, Wifi G, Low Data Rate

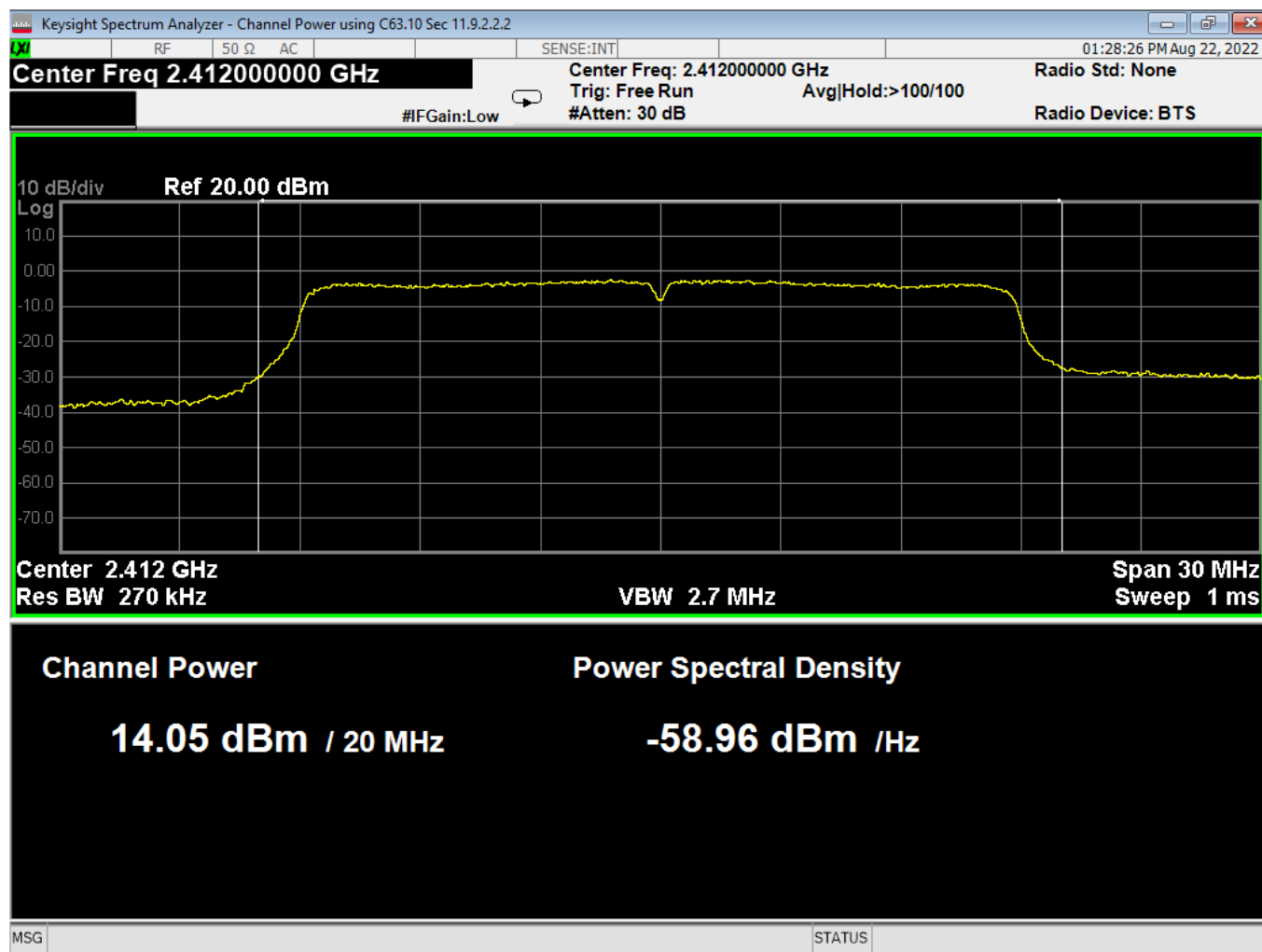


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27 Average Power, Low, Wifi N, Low Data Rate

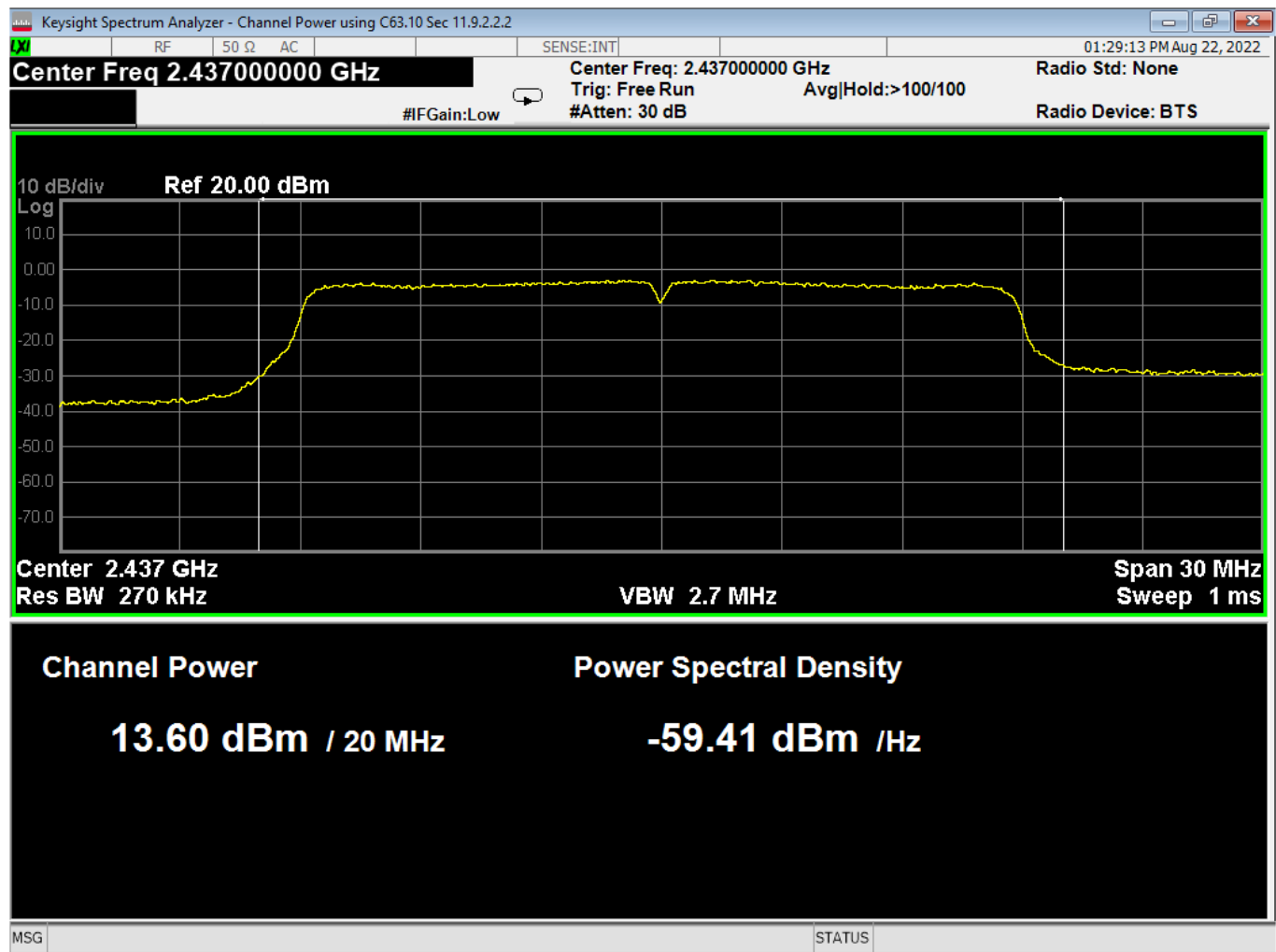


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28 Average Power, Mid, Wifi N, Low Data Rate

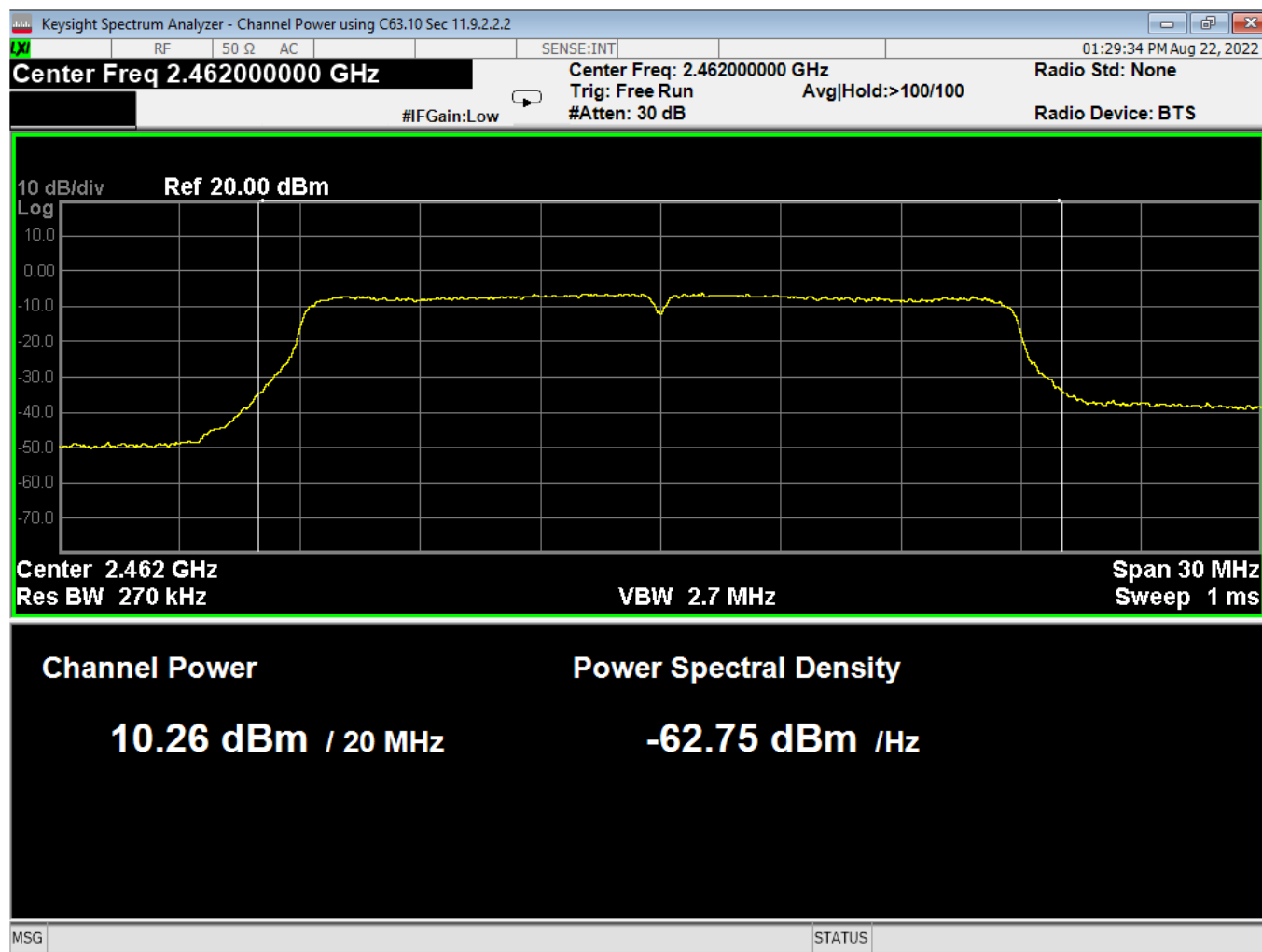


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29 Average Power, High, Wifi N, Low Data Rate

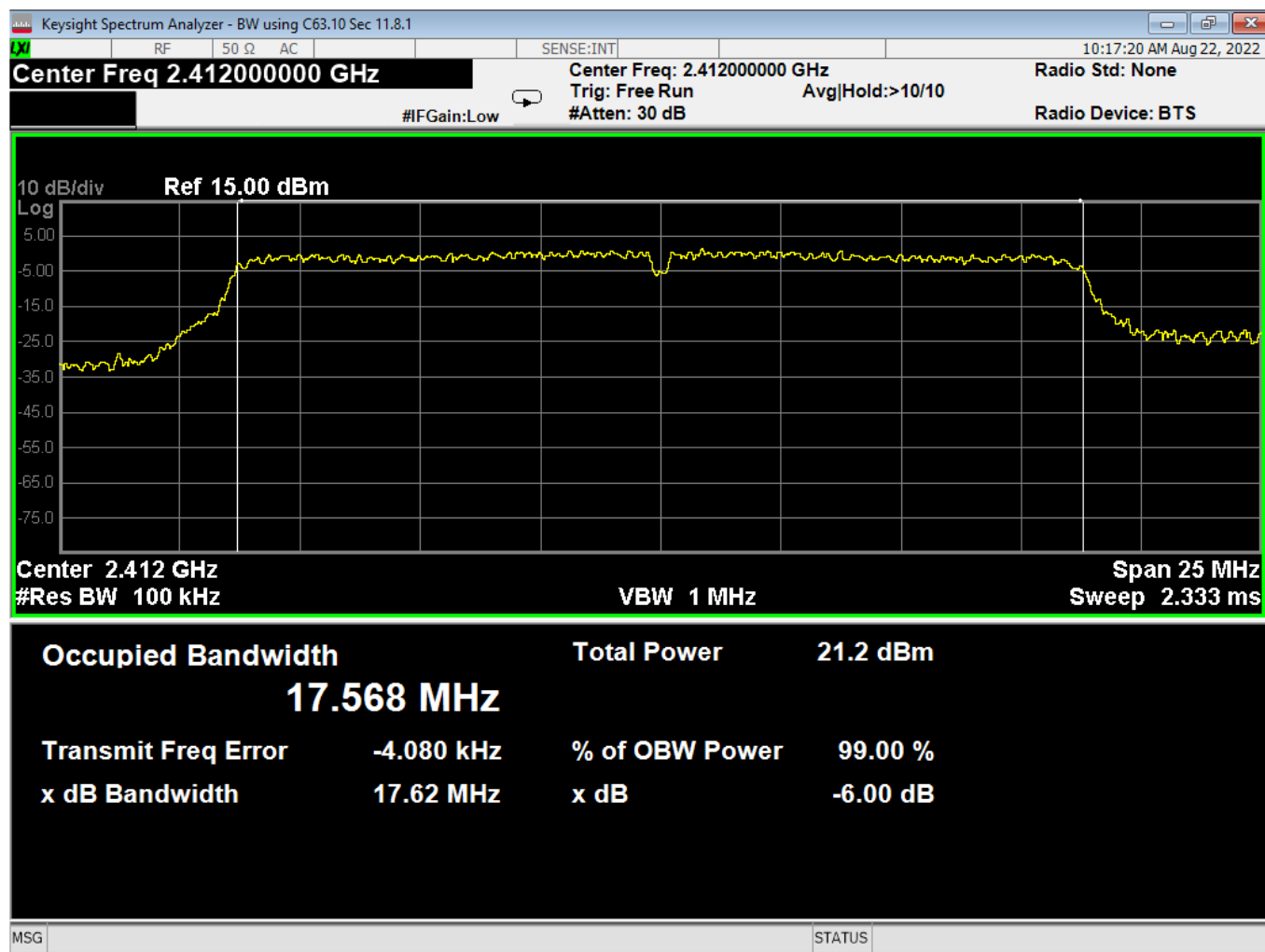


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30 6dB Bandwidth, Low, Wifi N, Low Data Rate

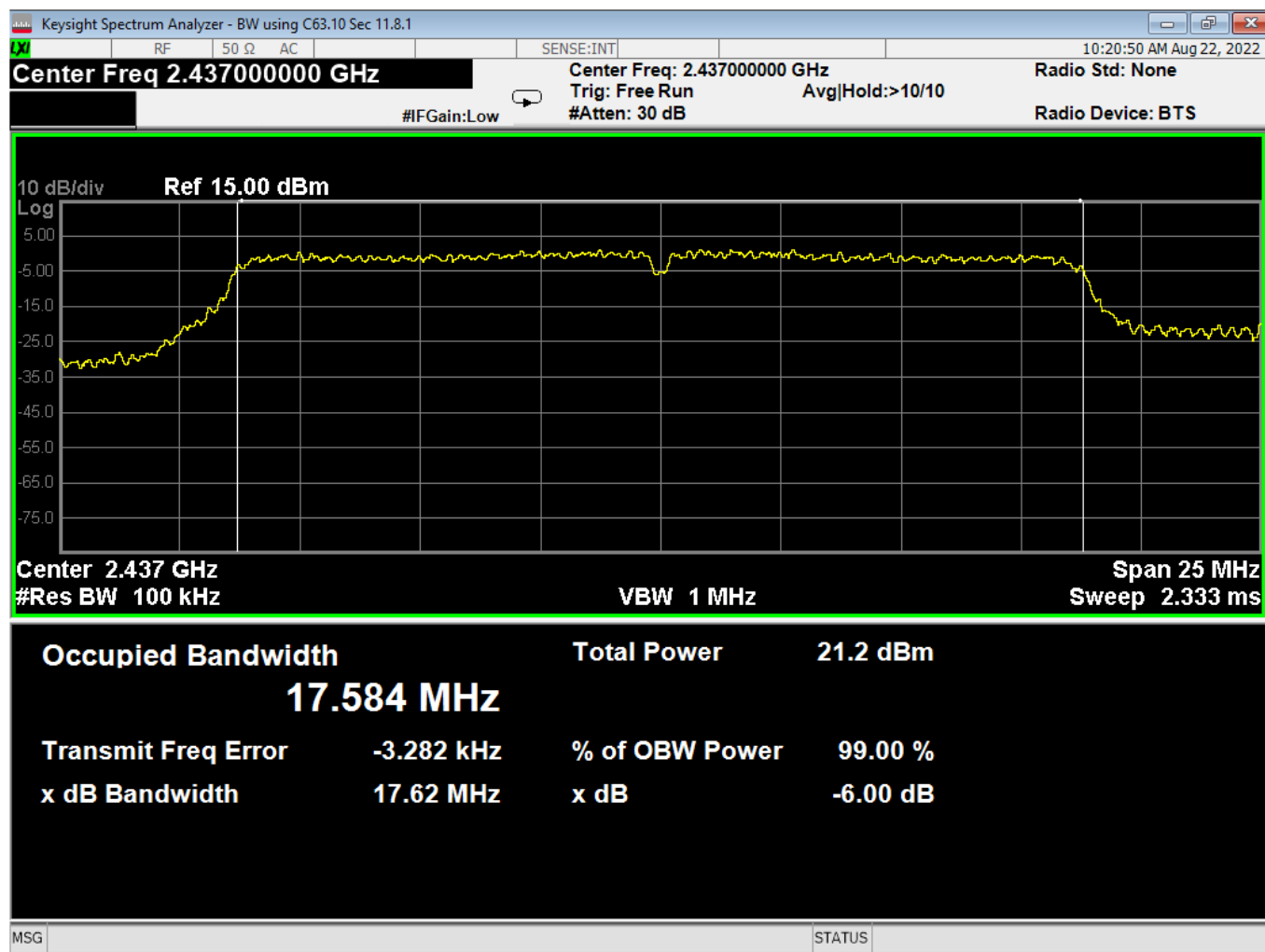


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31 6dB Bandwidth, Mid, Wifi N, Low Data Rate

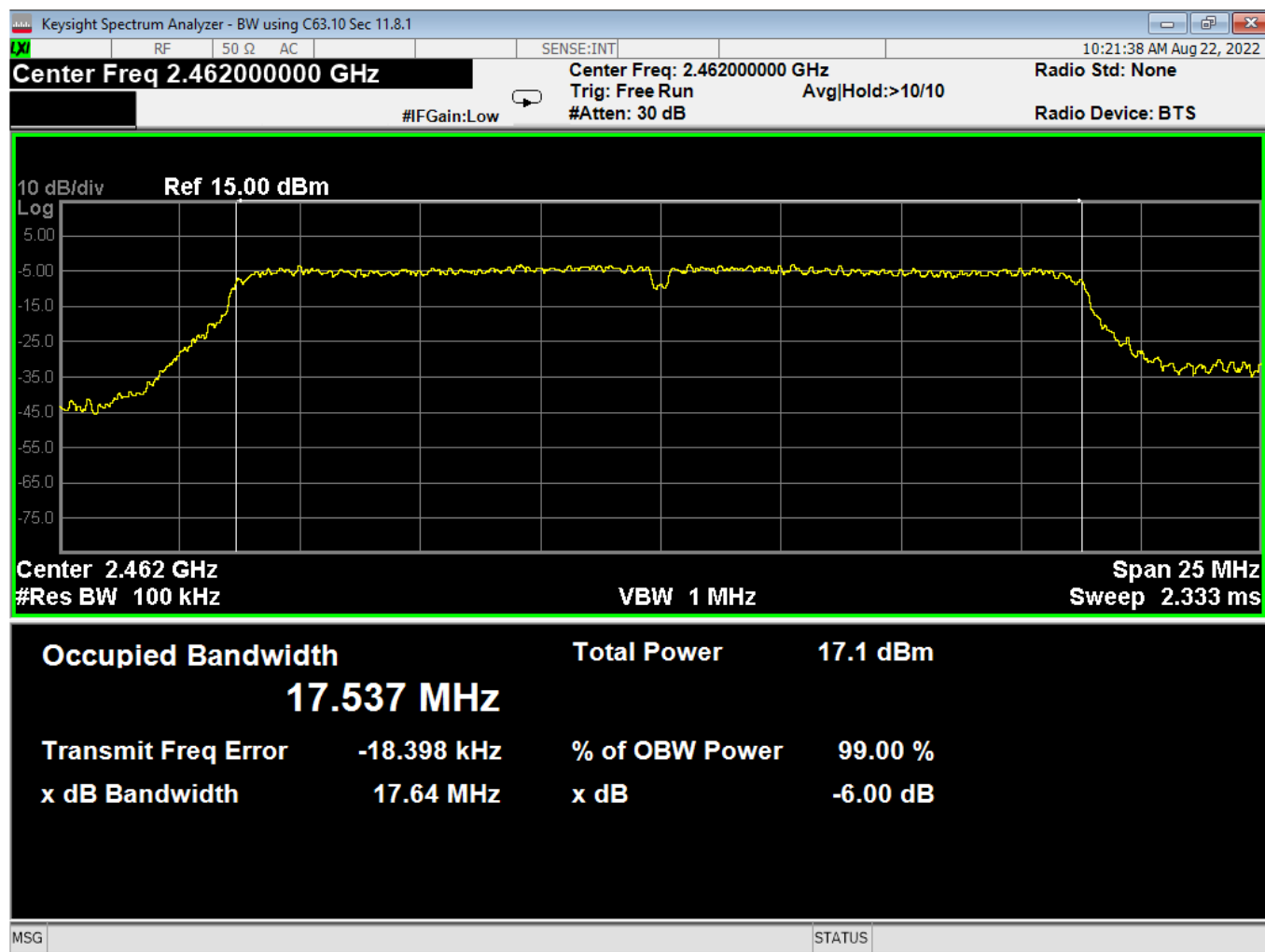


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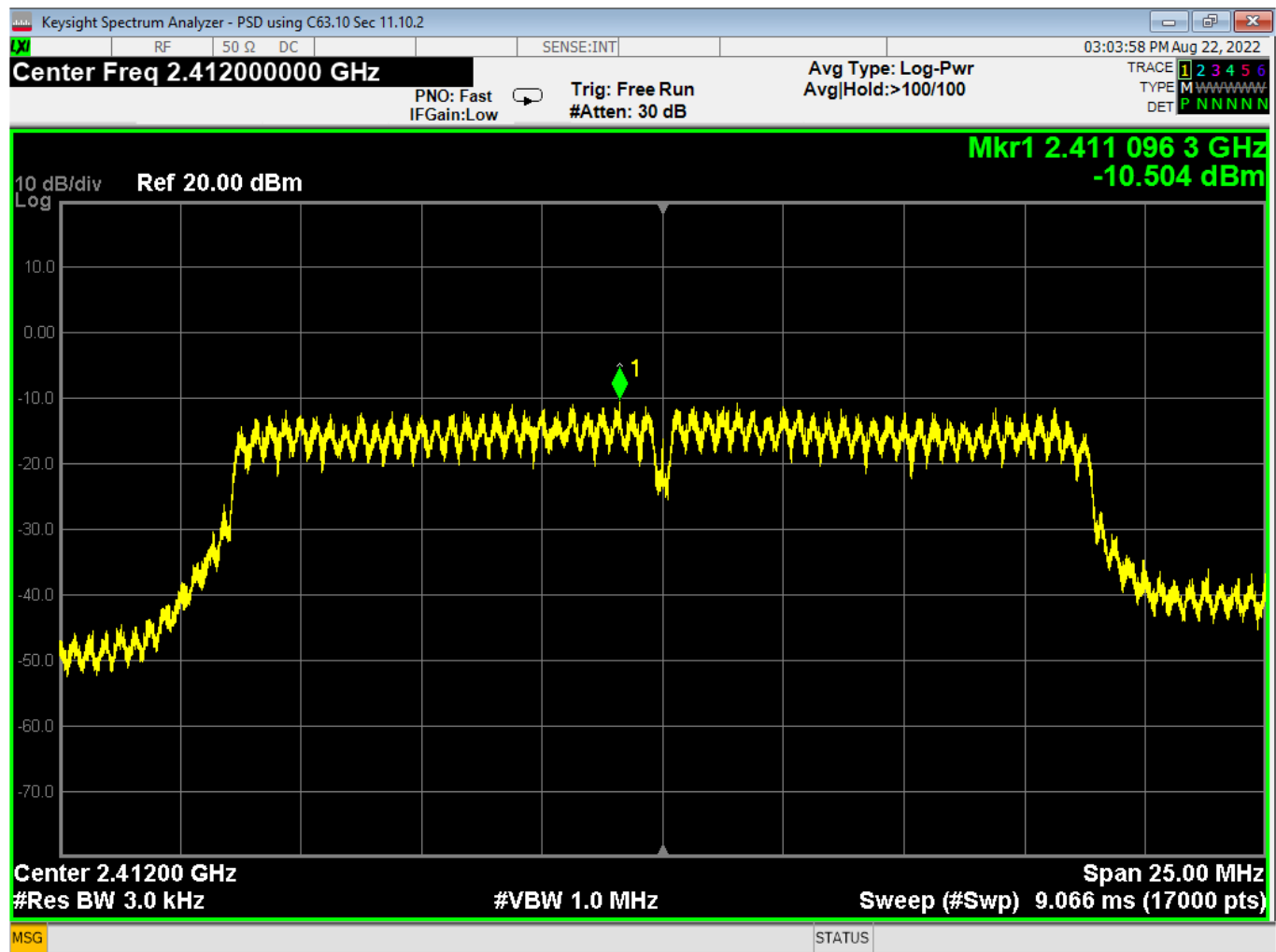
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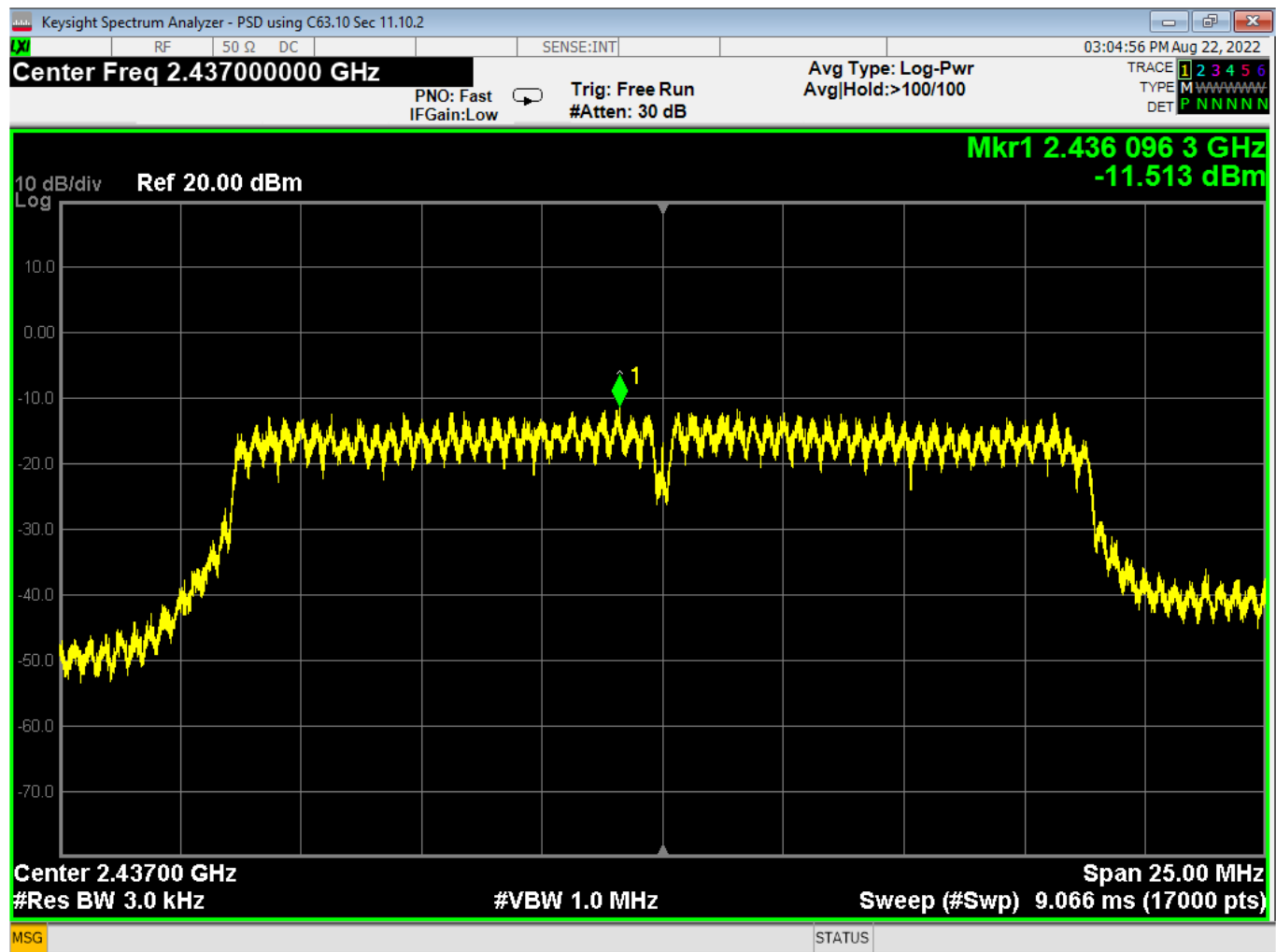
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32 6dB Bandwidth, High, Wifi N, Low Data Rate

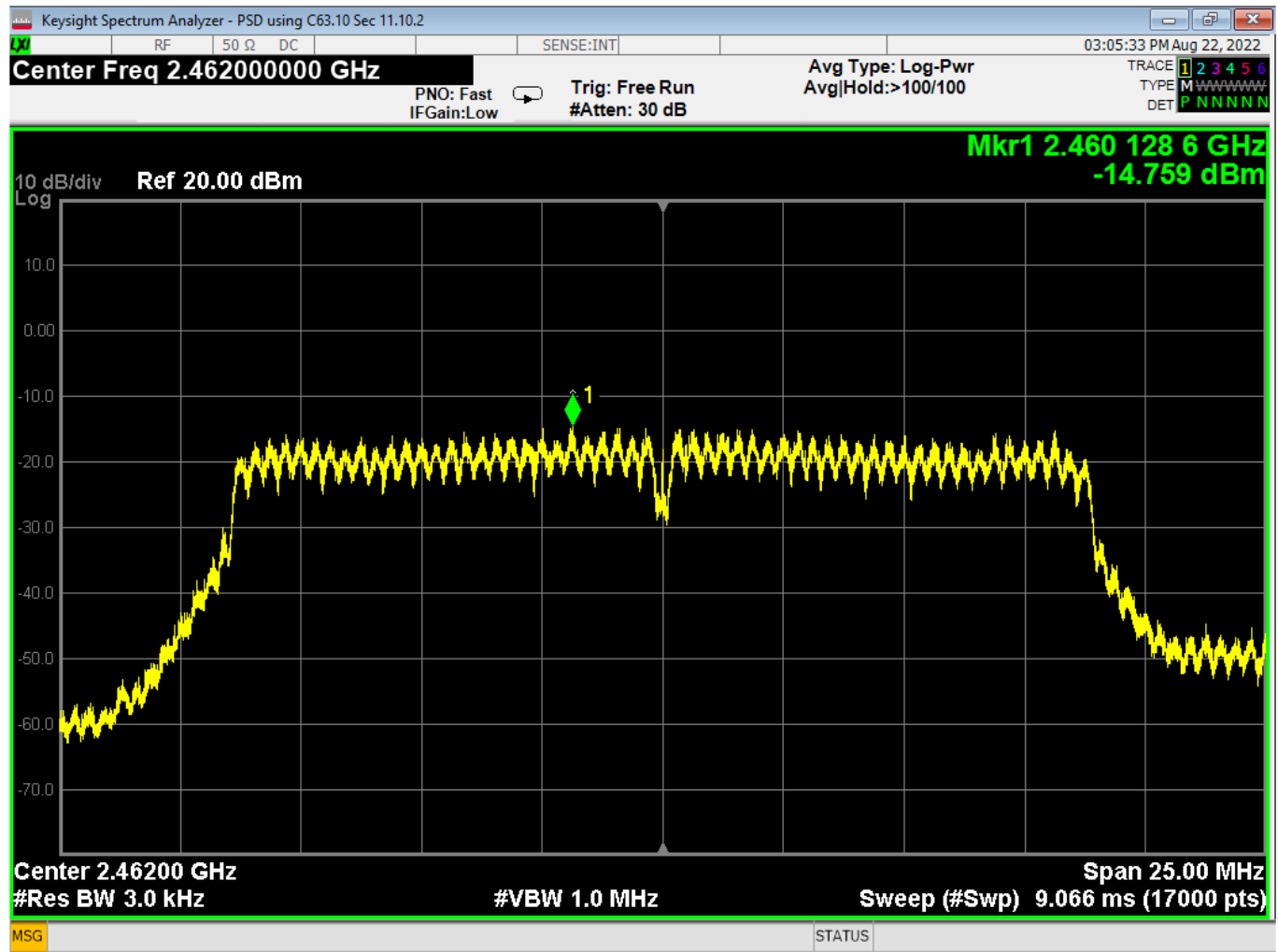


33 PSD, Low, Wifi N, Low Data Rate



34 PSD, Mid, Wifi N, Low Data Rate

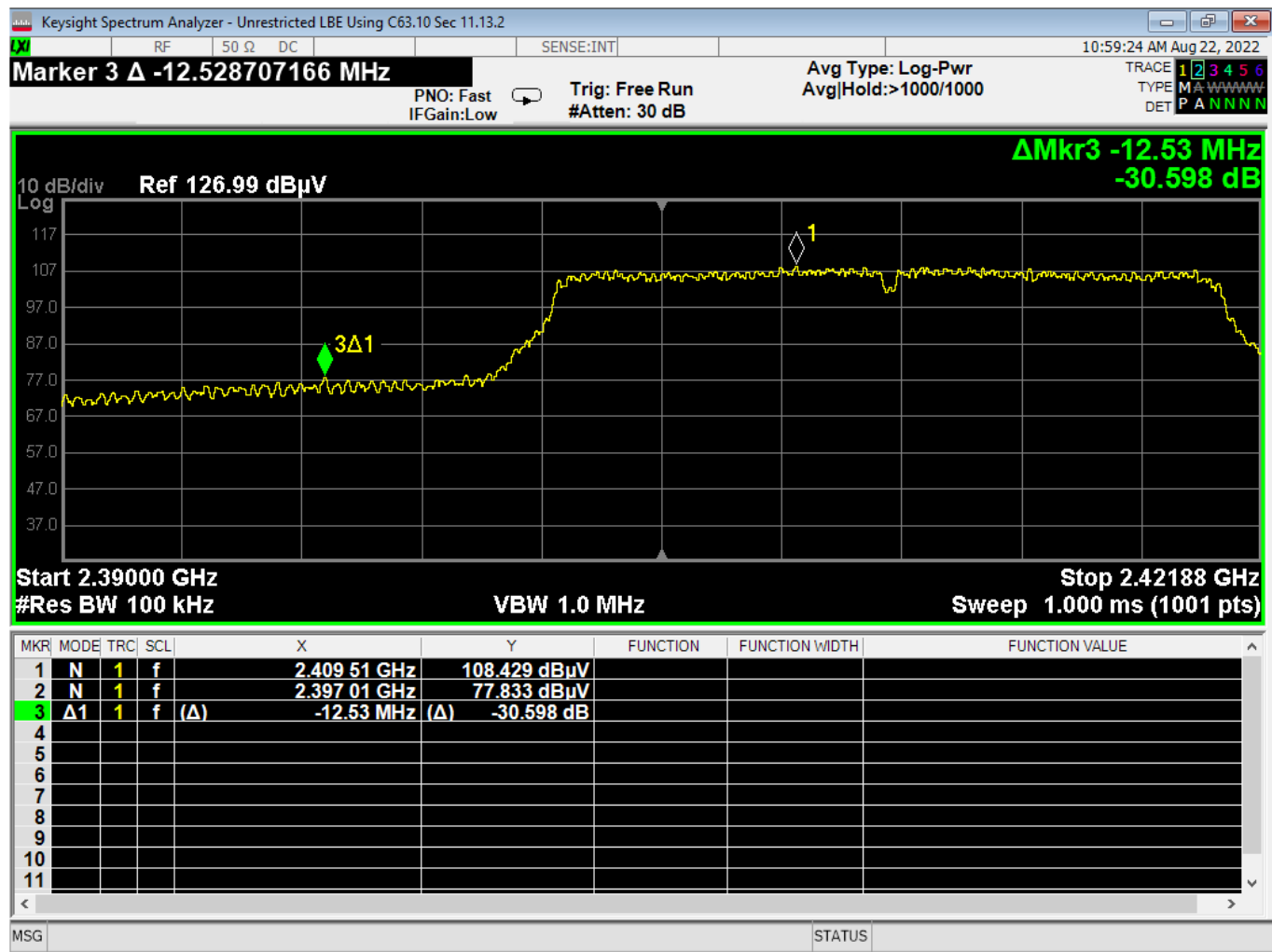
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35 PSD, High, Wifi N, Low Data Rate



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36 Lower Bandedge, Unrestricted, Wifi N, Low Data Rate

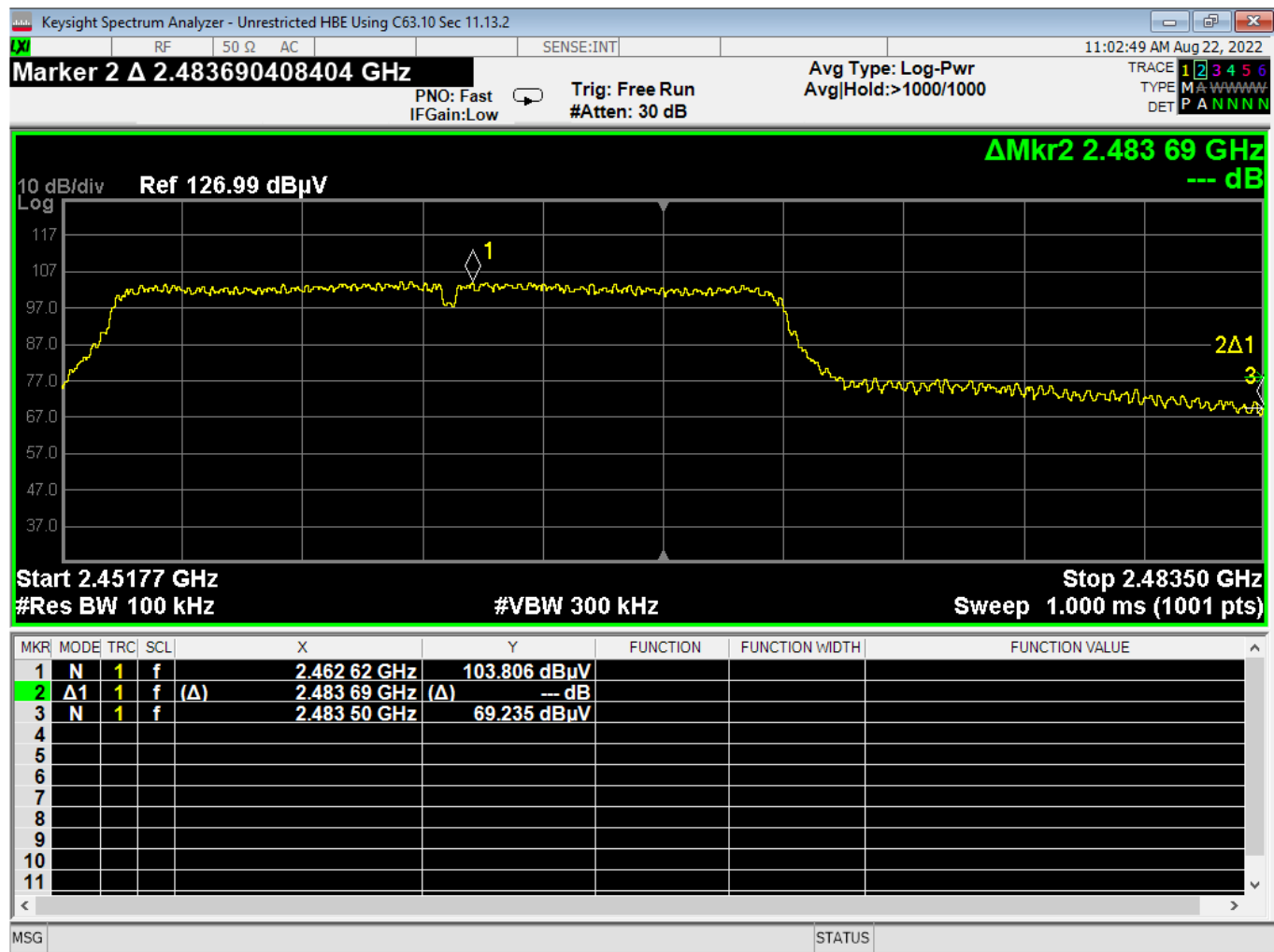


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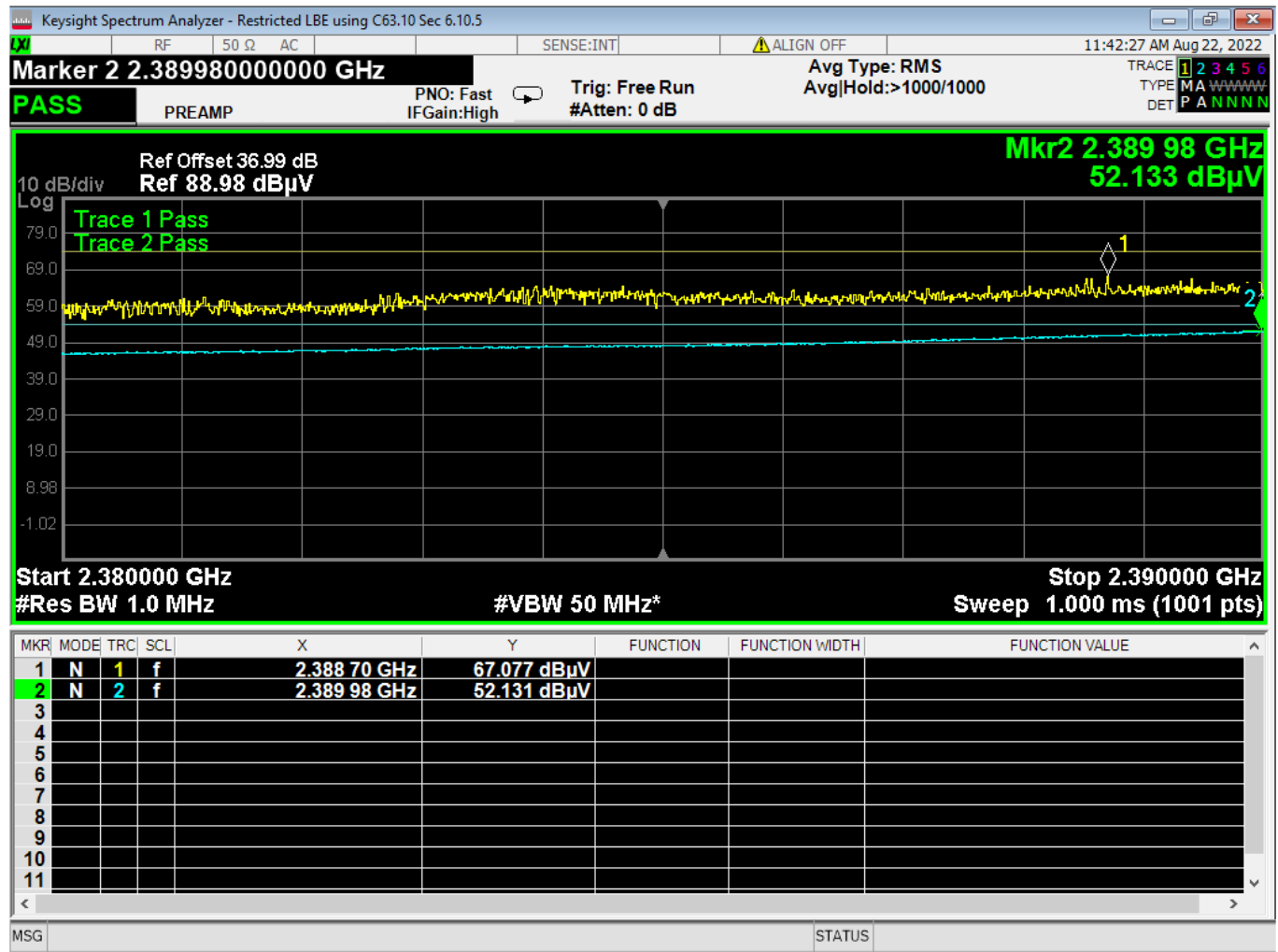
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37 Higher Bandedge, Unrestricted, Wifi N, Low Data Rate

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38 Lower Bandedge, Restricted, Wifi N, Low Data Rate

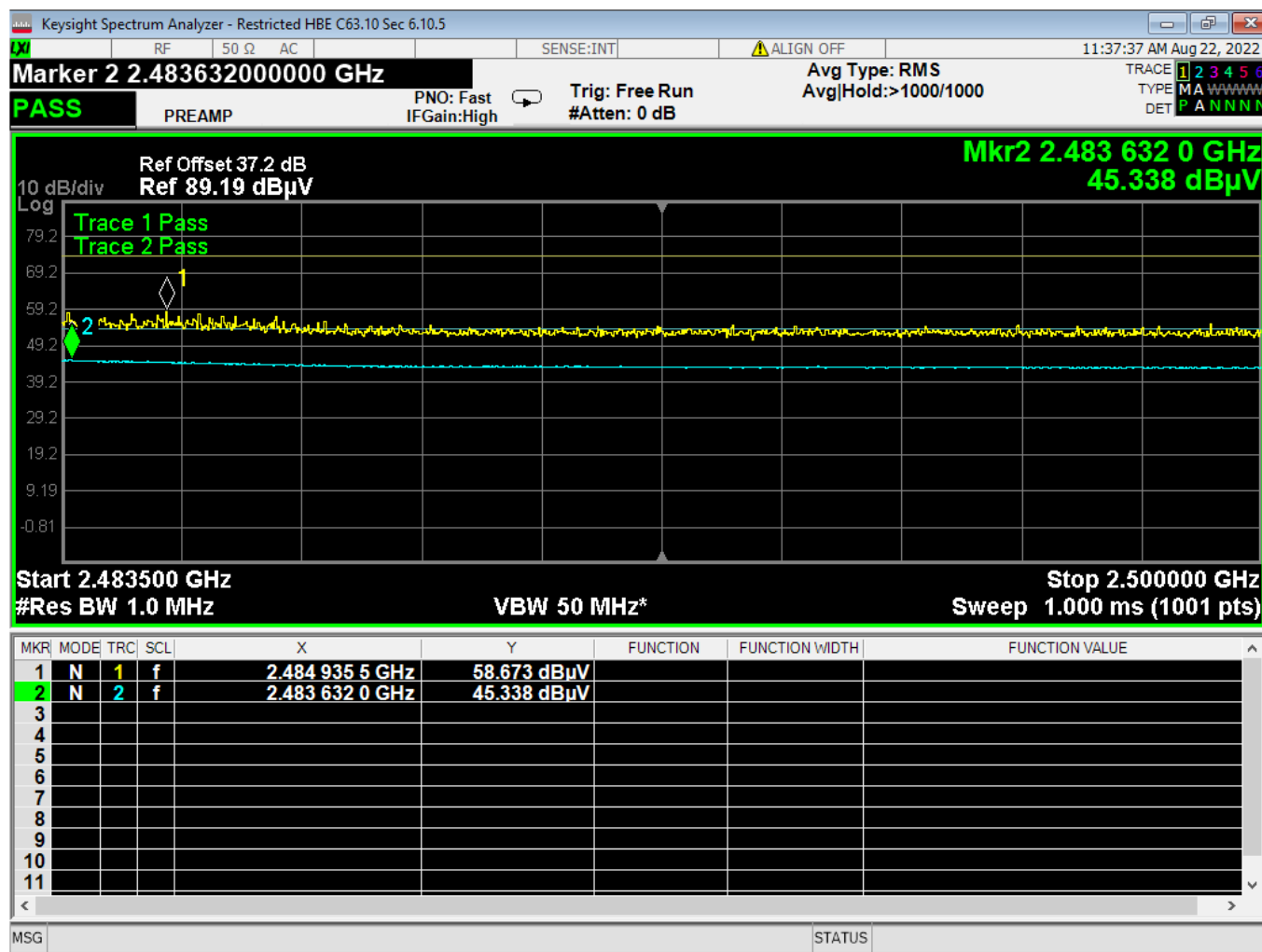


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39 Higher Bandedge, Restricted, Wifi N, Low Data Rate

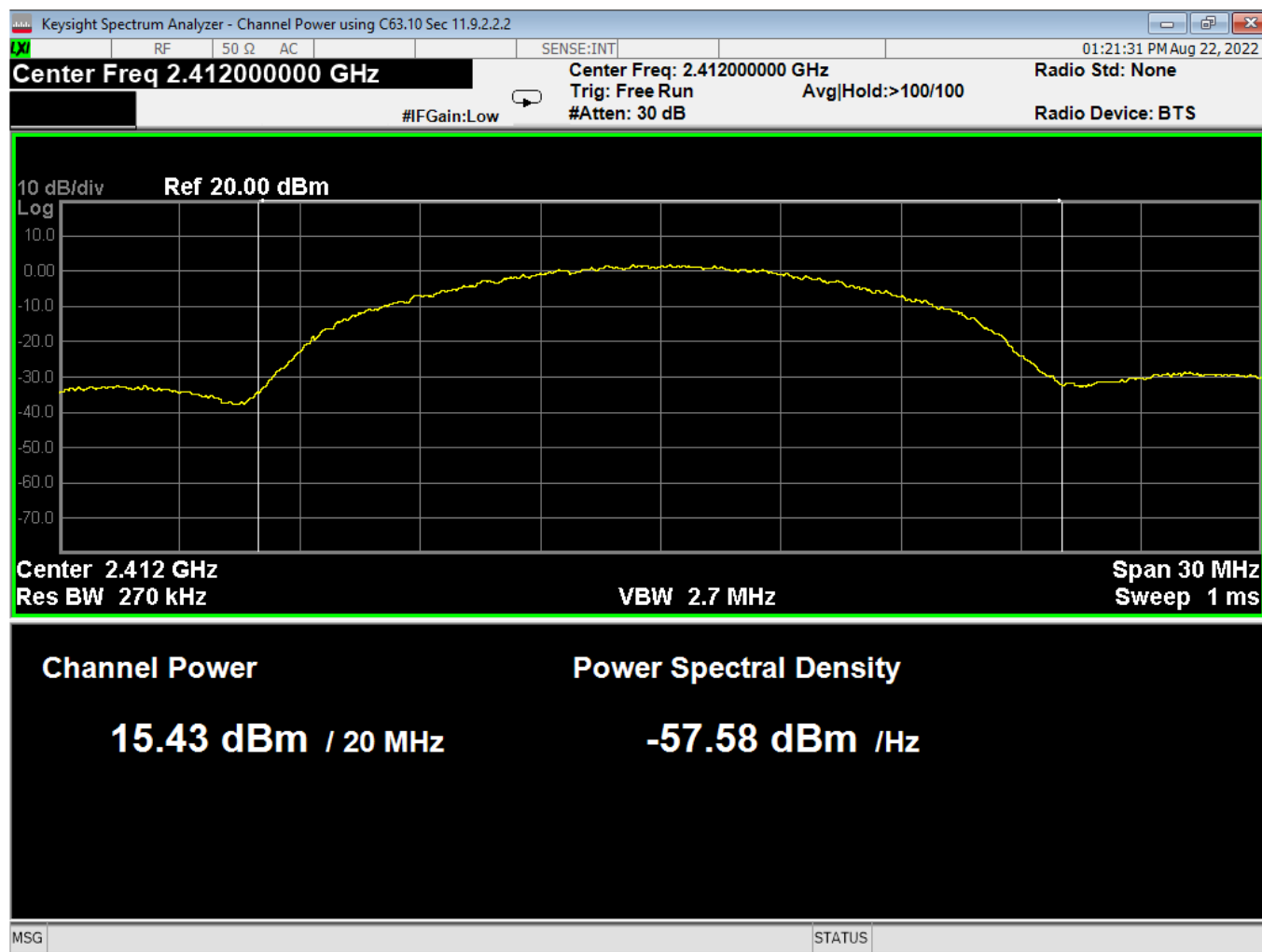


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40 Average Power, Low, Wifi B, High Data Rate

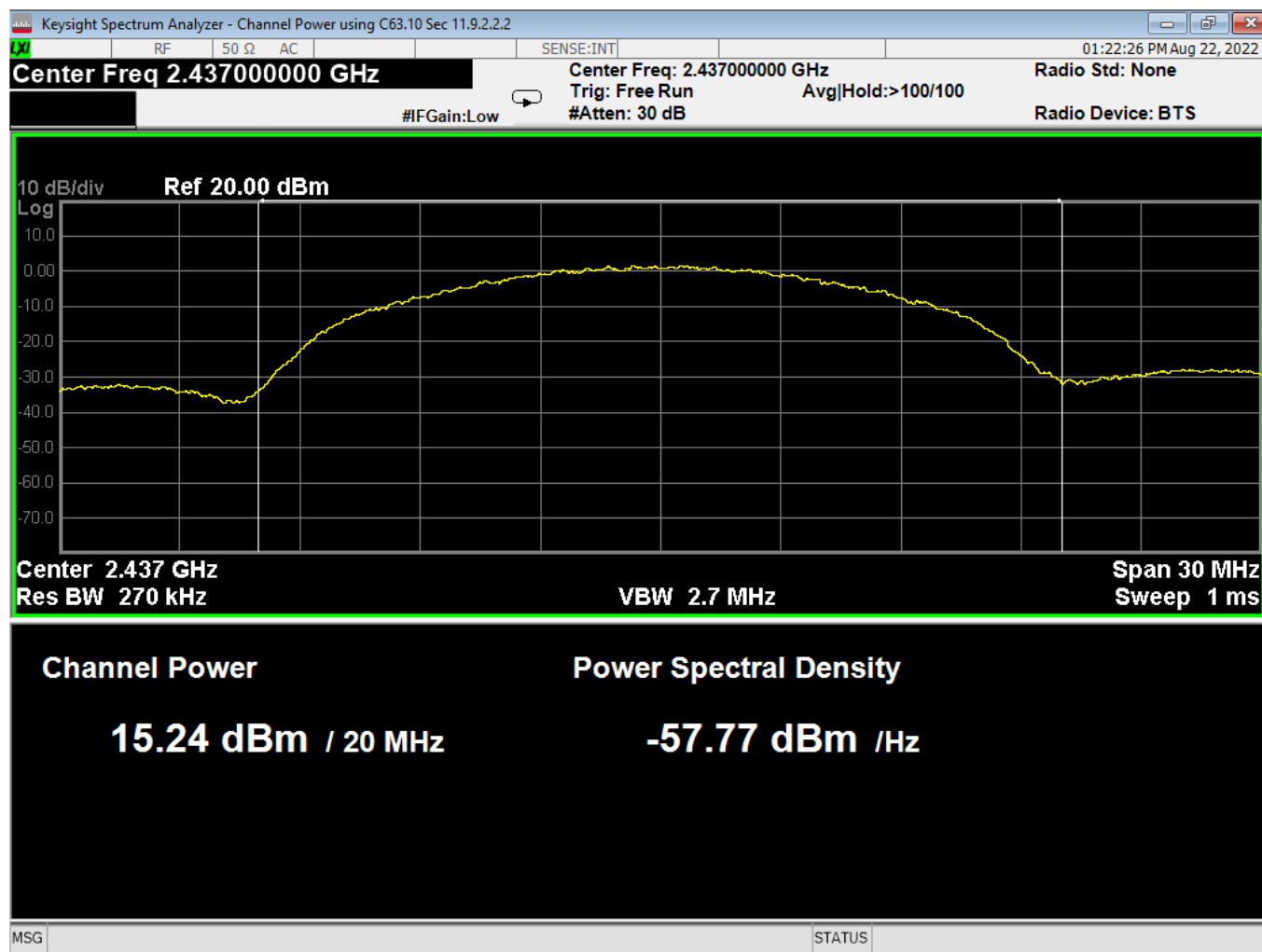


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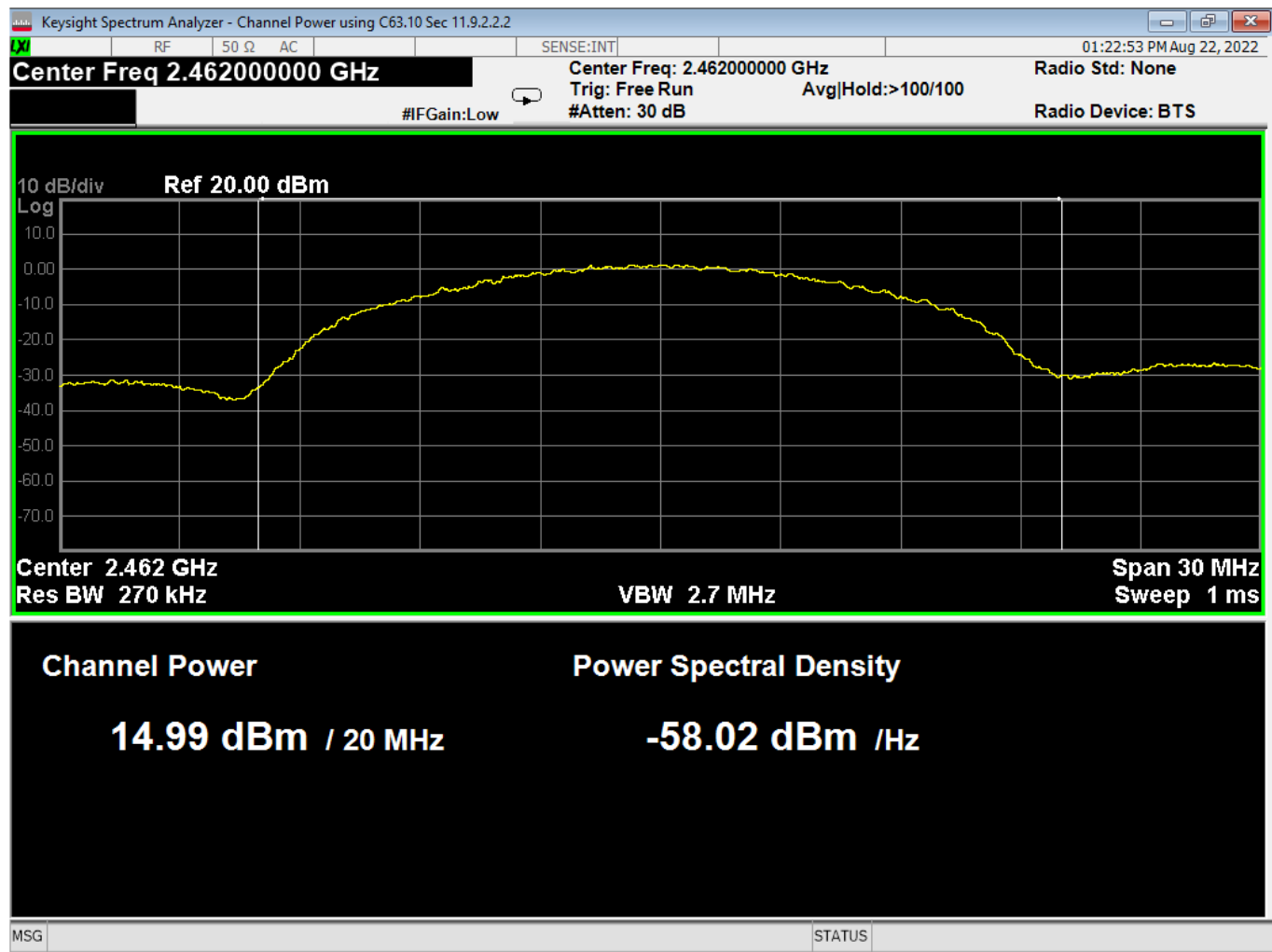
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41 Average Power, Mid, Wifi B, High Data Rate



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42 Average Power, High, Wifi B, High Data Rate

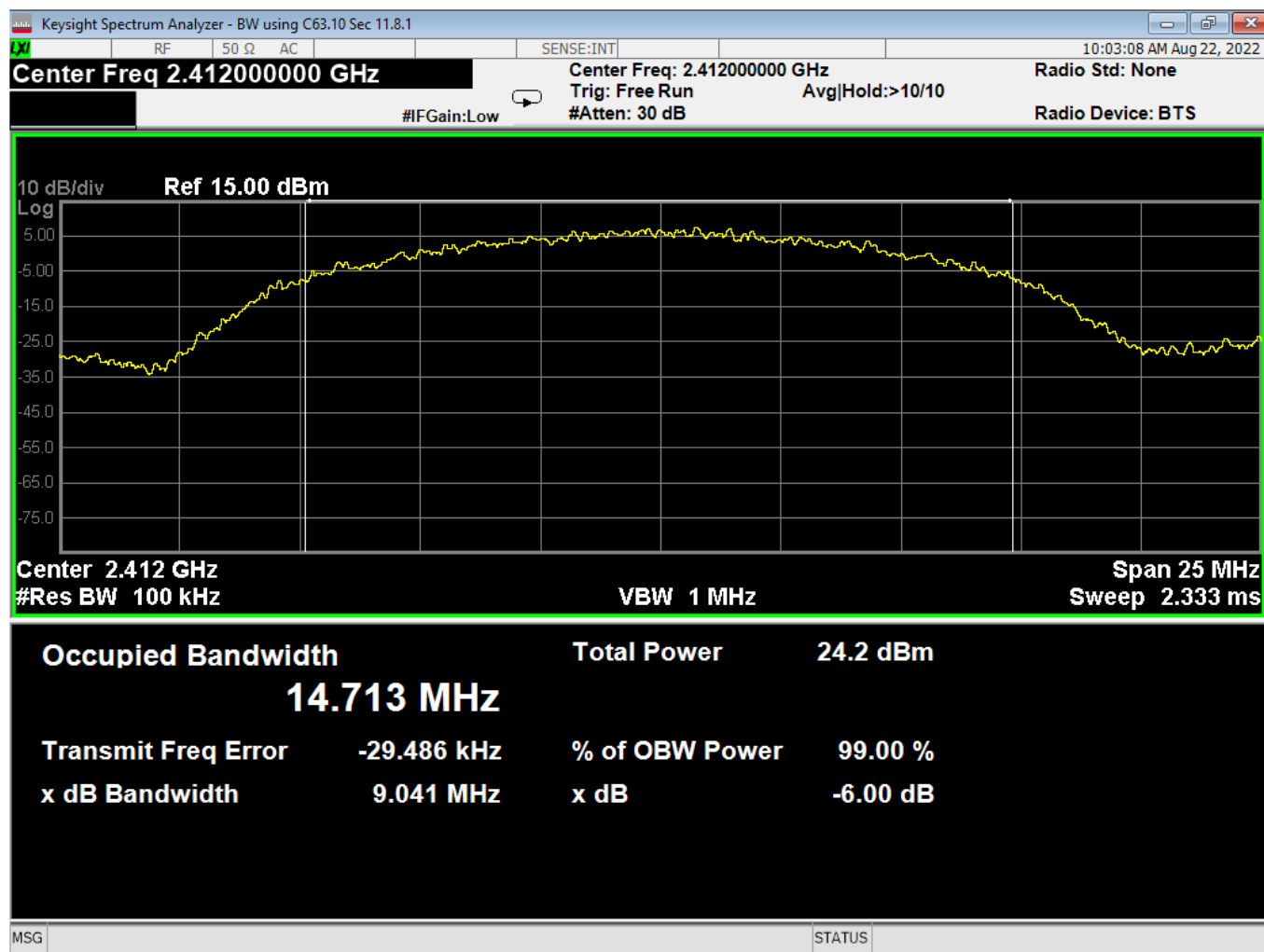


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43 dB Bandwidth, Low, Wifi B, High Data Rate

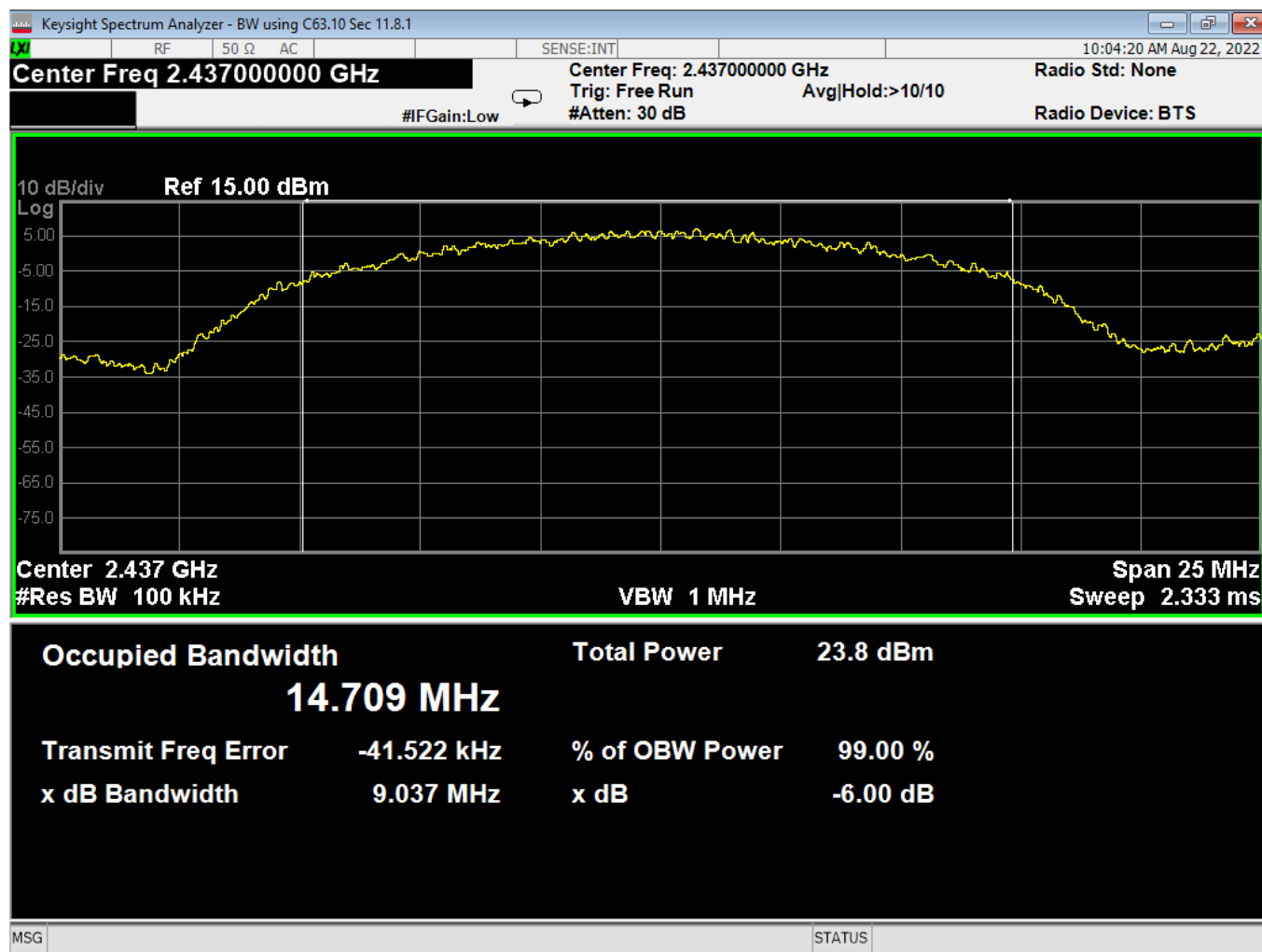


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44 6dB Bandwidth, Mid, Wifi B, High Data Rate

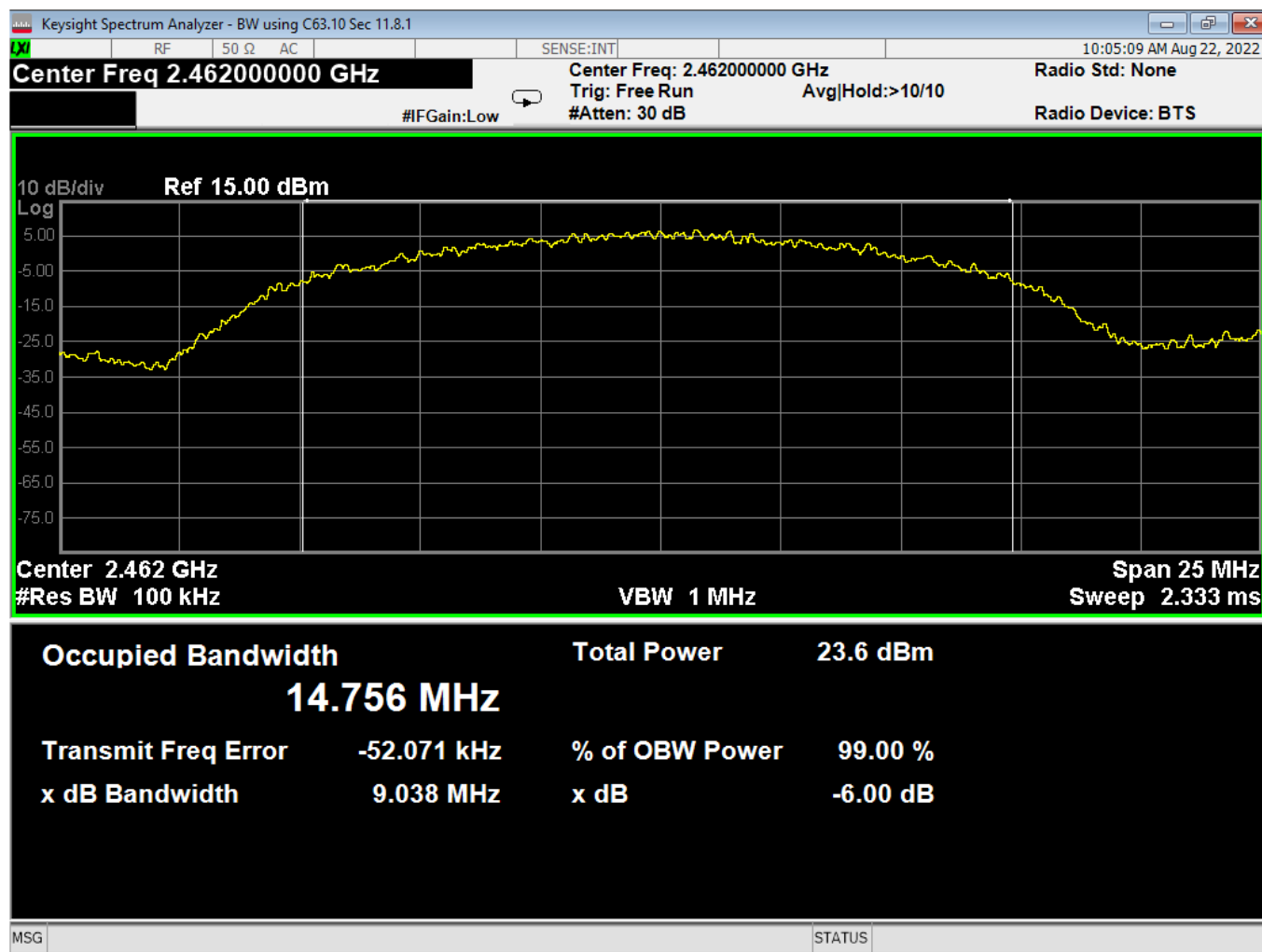


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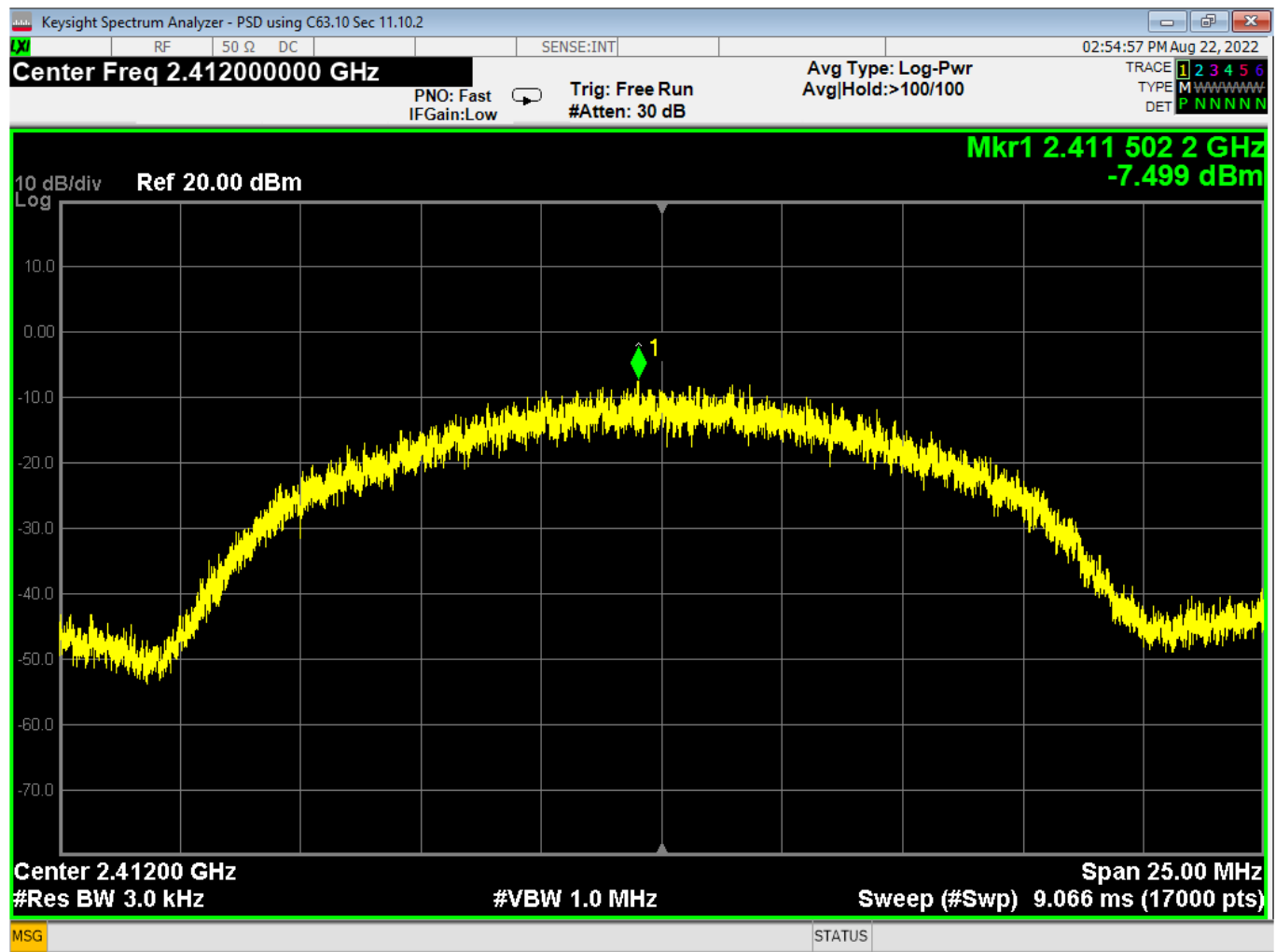
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45 6dB Bandwidth, High, Wifi B, High Data Rate



46 PSD, Low, Wifi B, High Data Rate

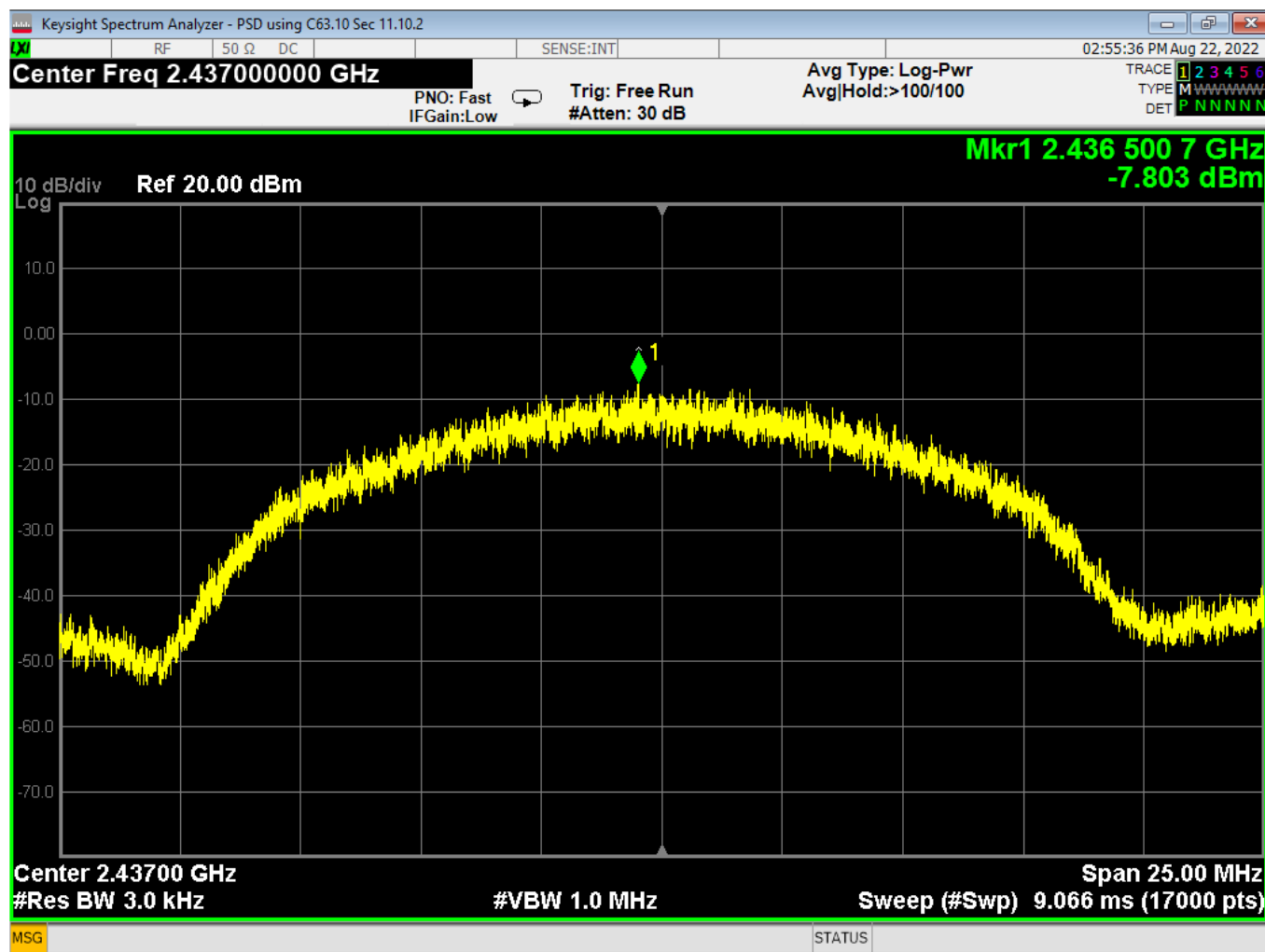


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47 PSD, Mid, Wifi B, High Data Rate

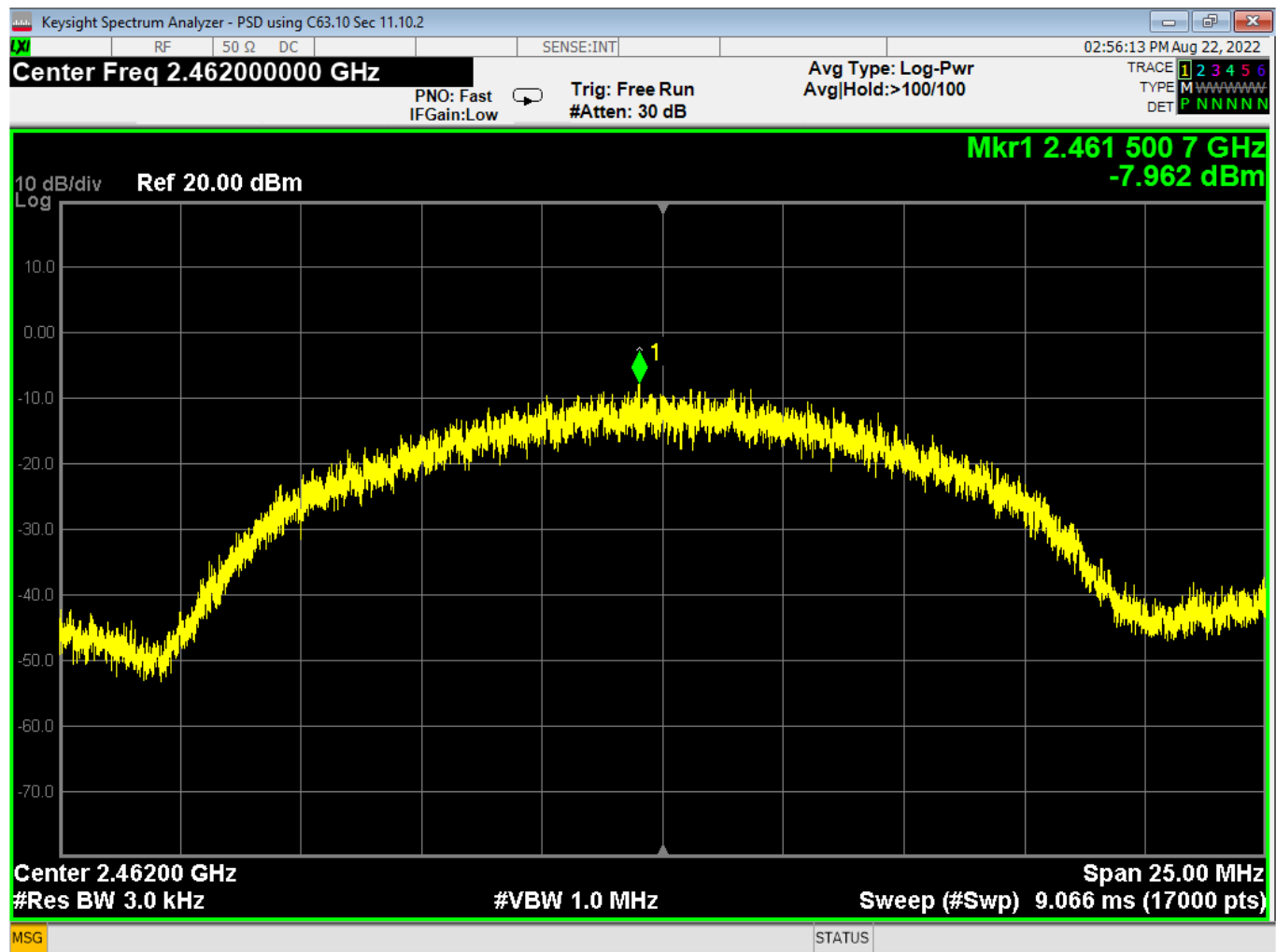


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48 PSD, High, Wifi B, High Data Rate

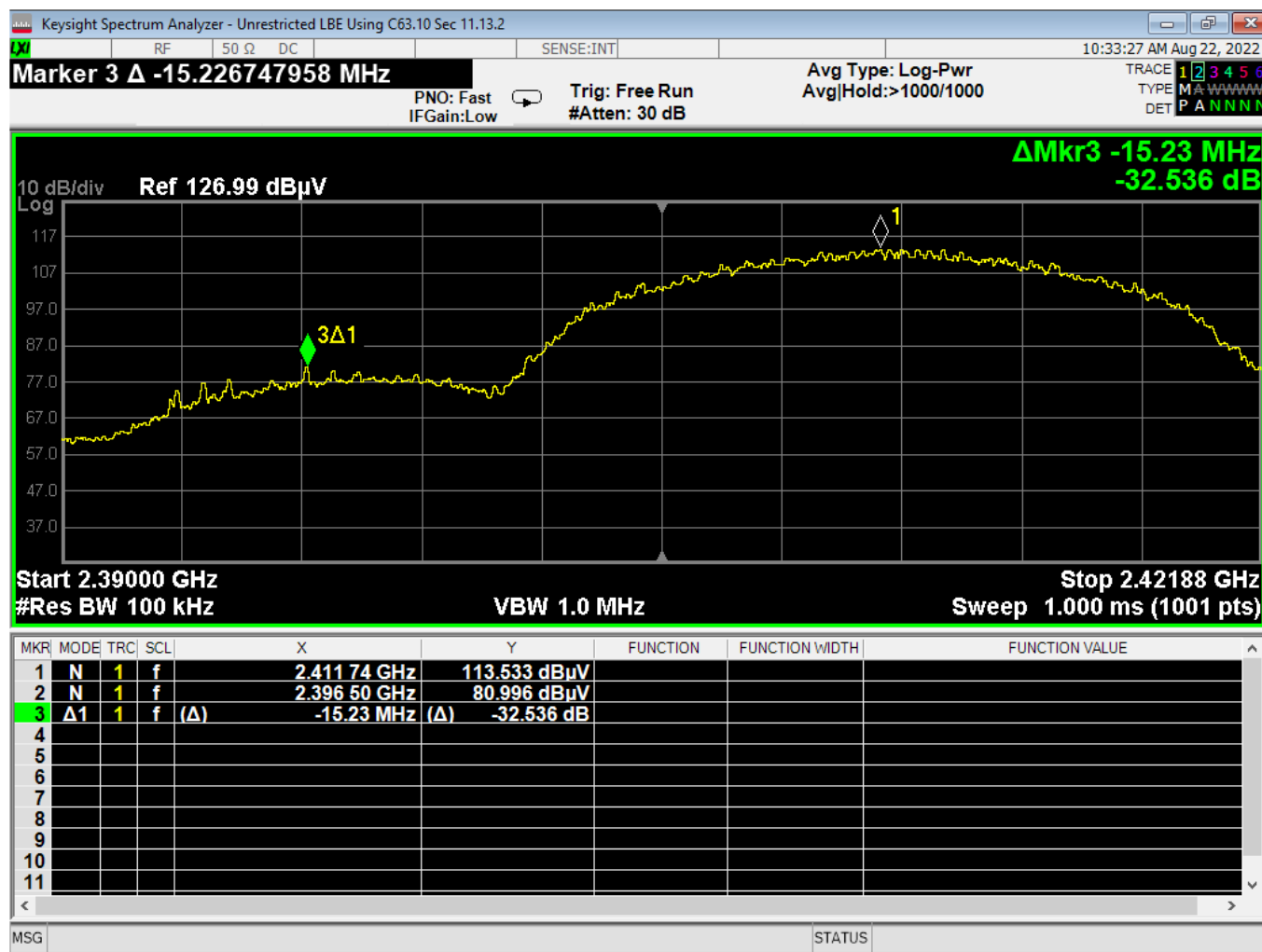


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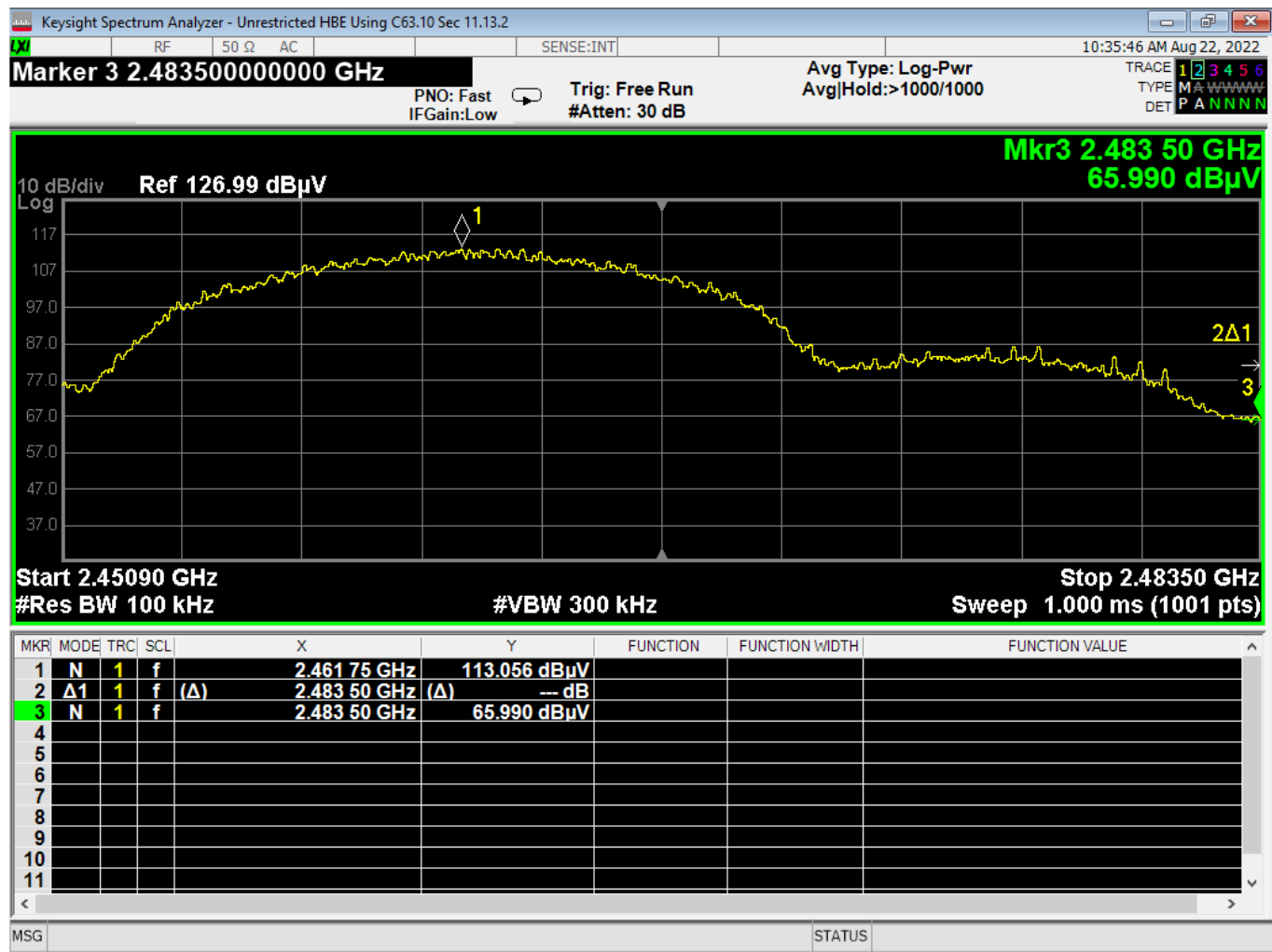
Prepared for: Garmin International, Inc.



49 Lower Bandedge, Unrestricted, Wifi B, High Data Rate

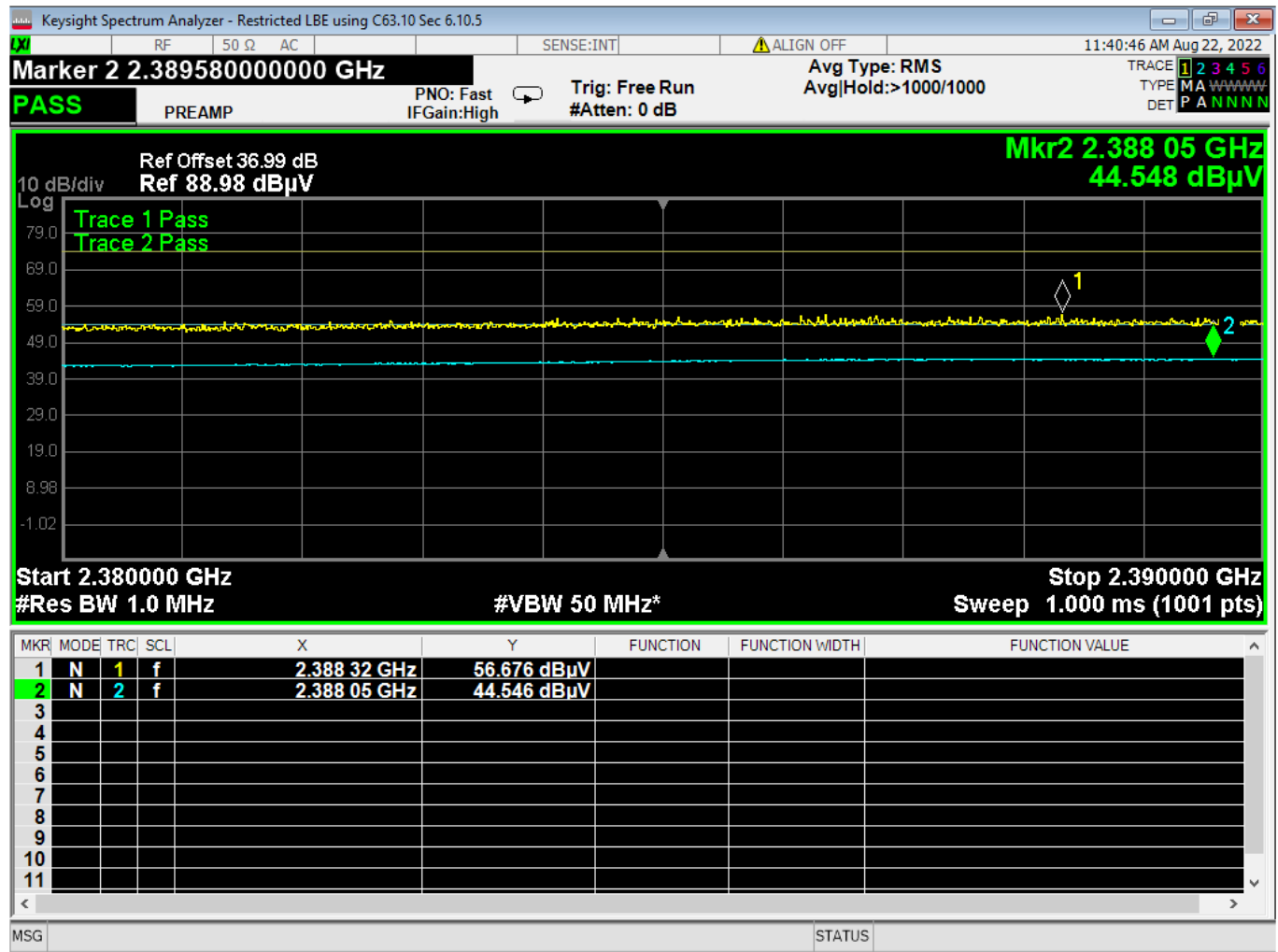


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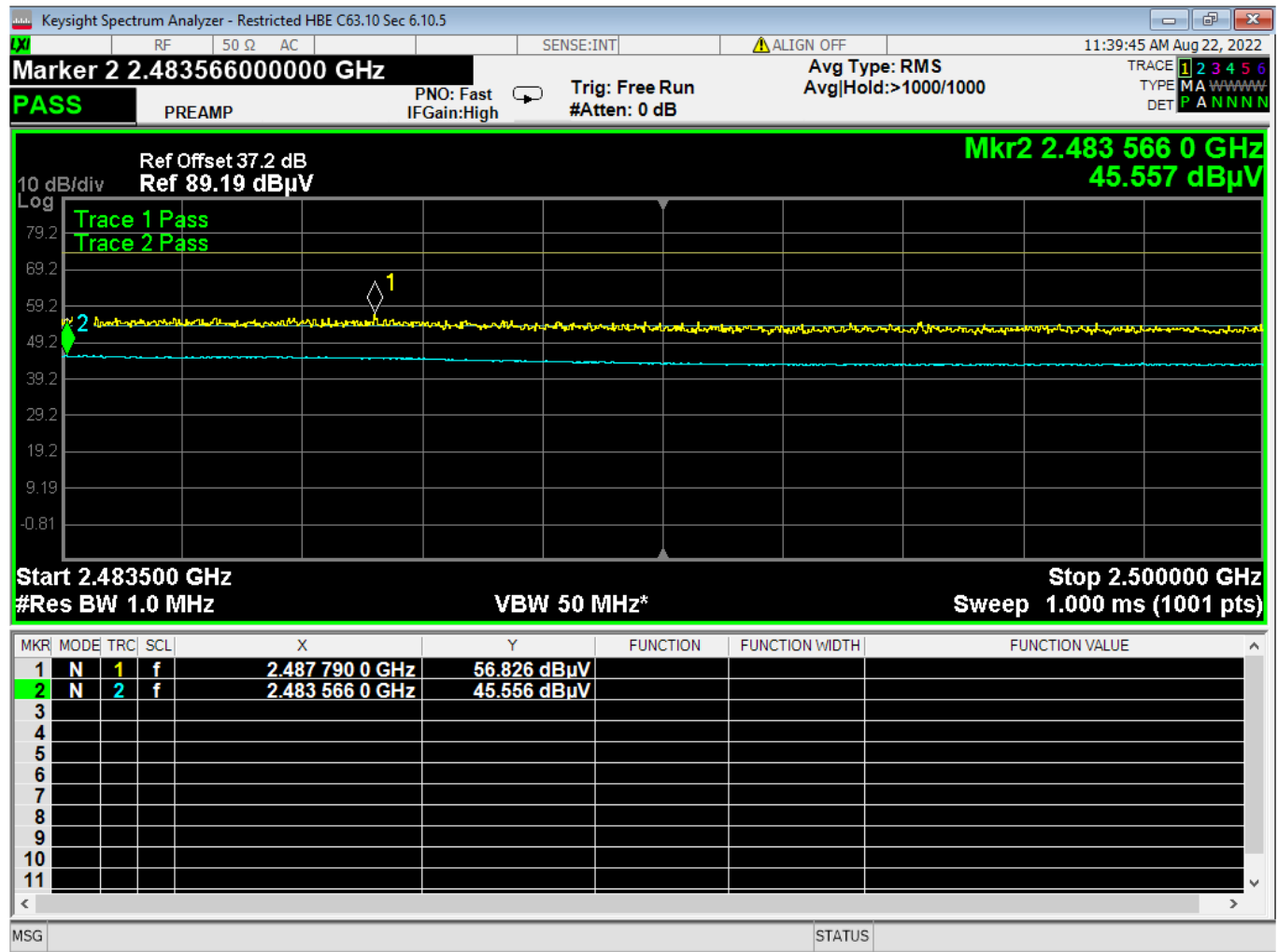
50 Higher Bandedge, Unrestricted, Wifi B, High Data Rate

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51 Lower Bandedge, Restricted, Wifi B, High Data Rate

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52 Higher Bandedge, Restricted, Wifi B, High Data Rate

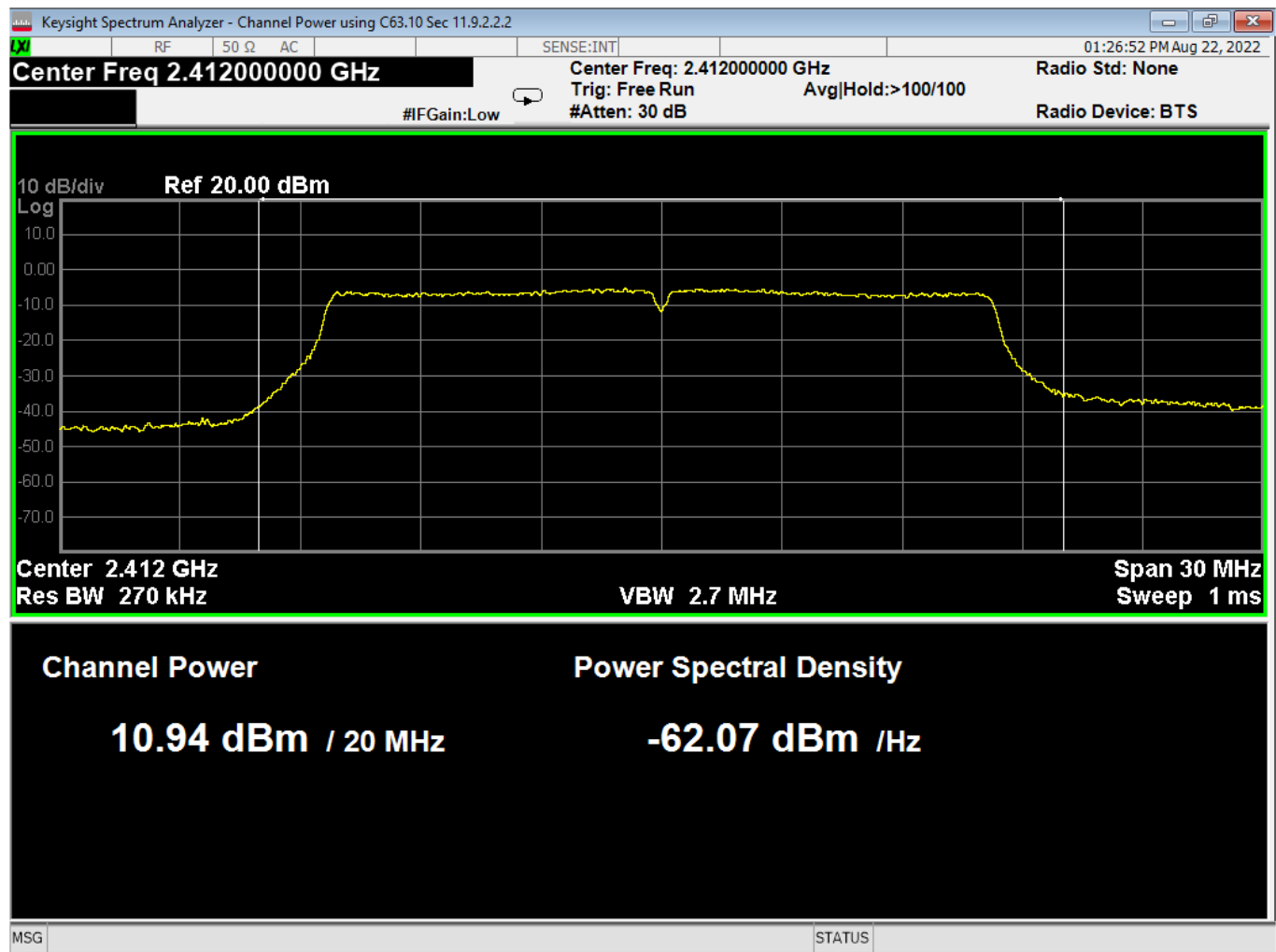


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53 Average Power, Low, Wifi G, High Data Rate

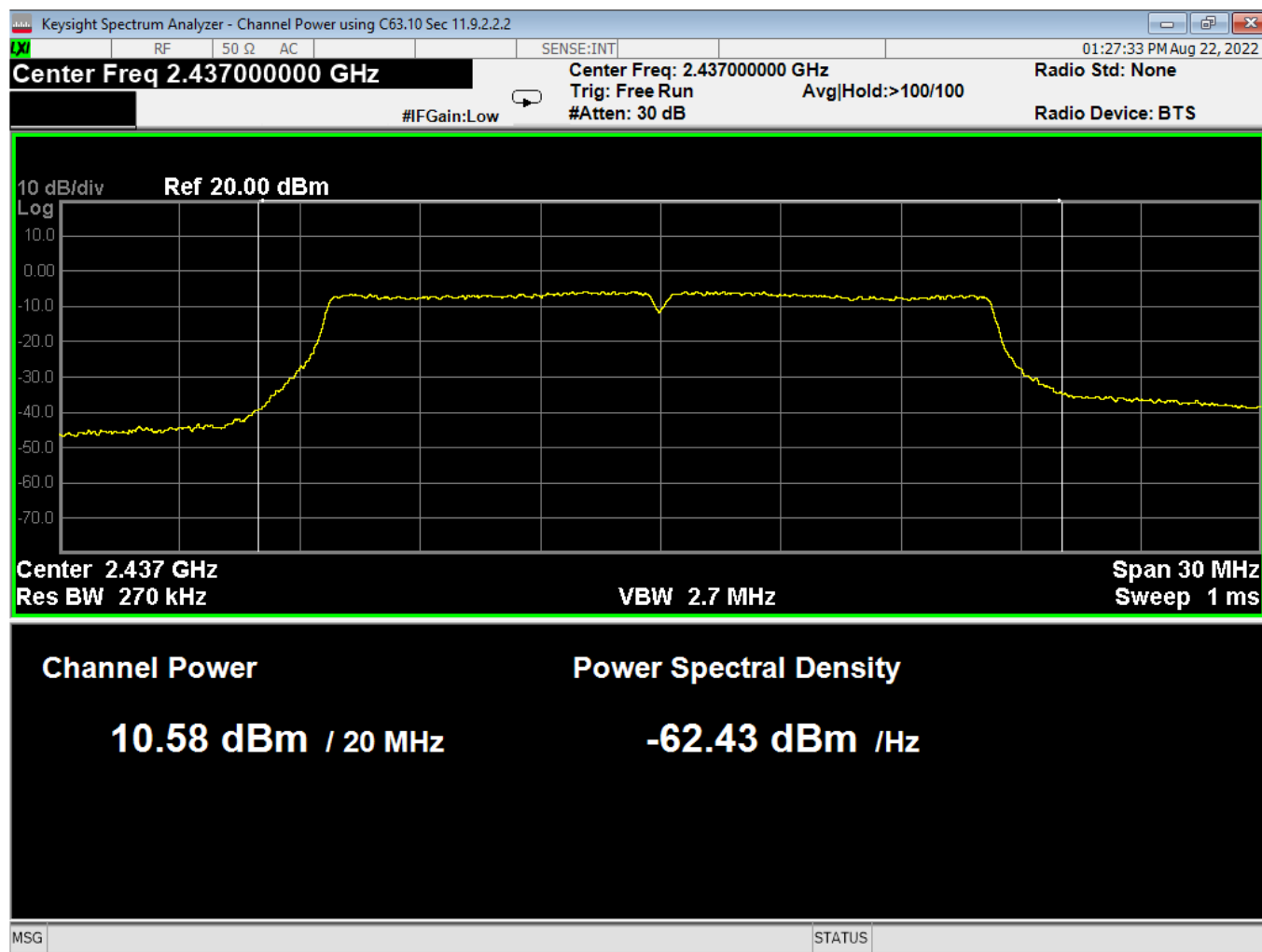


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54 Average Power, Mid, Wifi G, High Data Rate

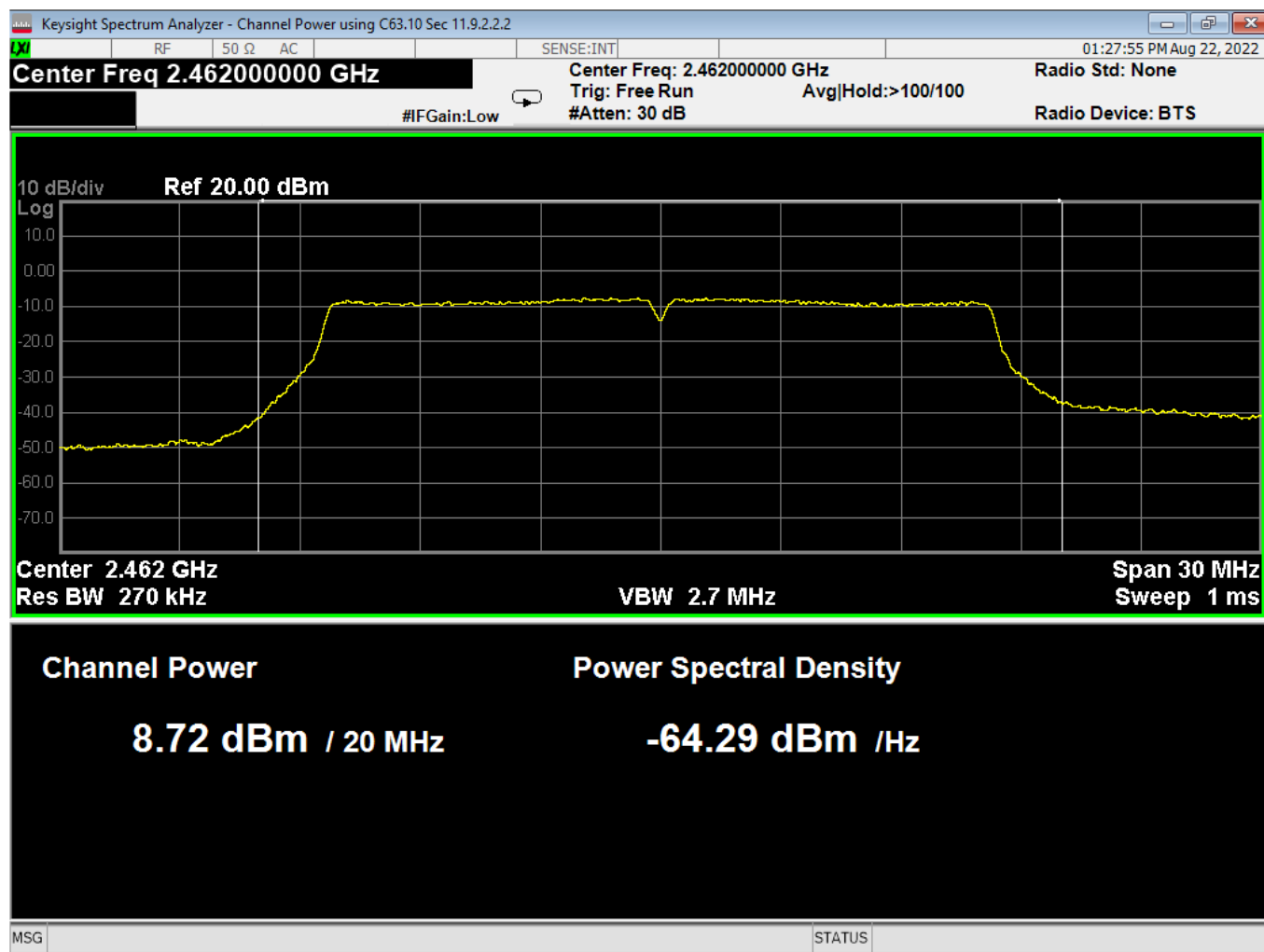


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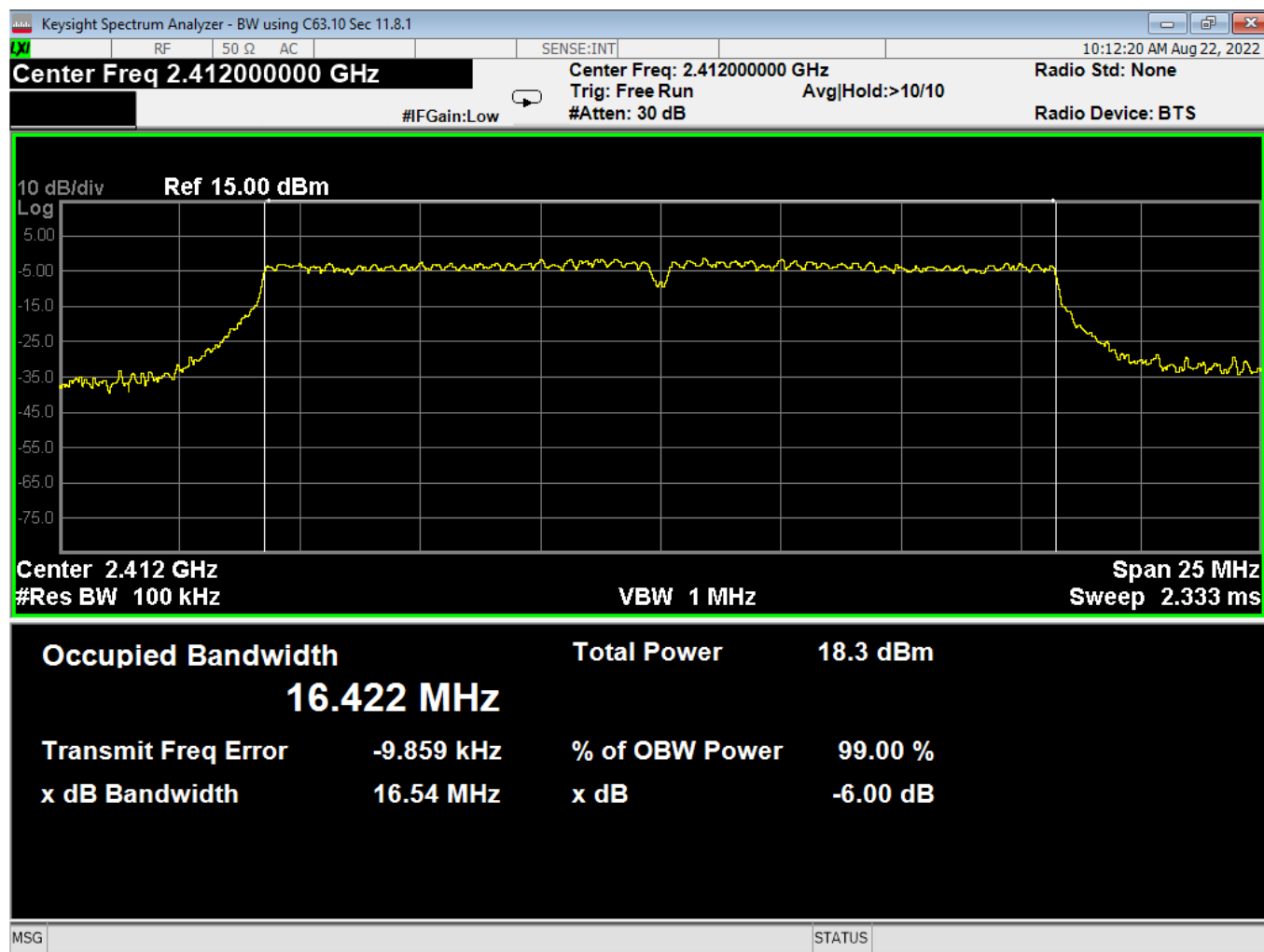
Prepared for: Garmin International, Inc.



55 Average Power, High, Wifi G, High Data Rate



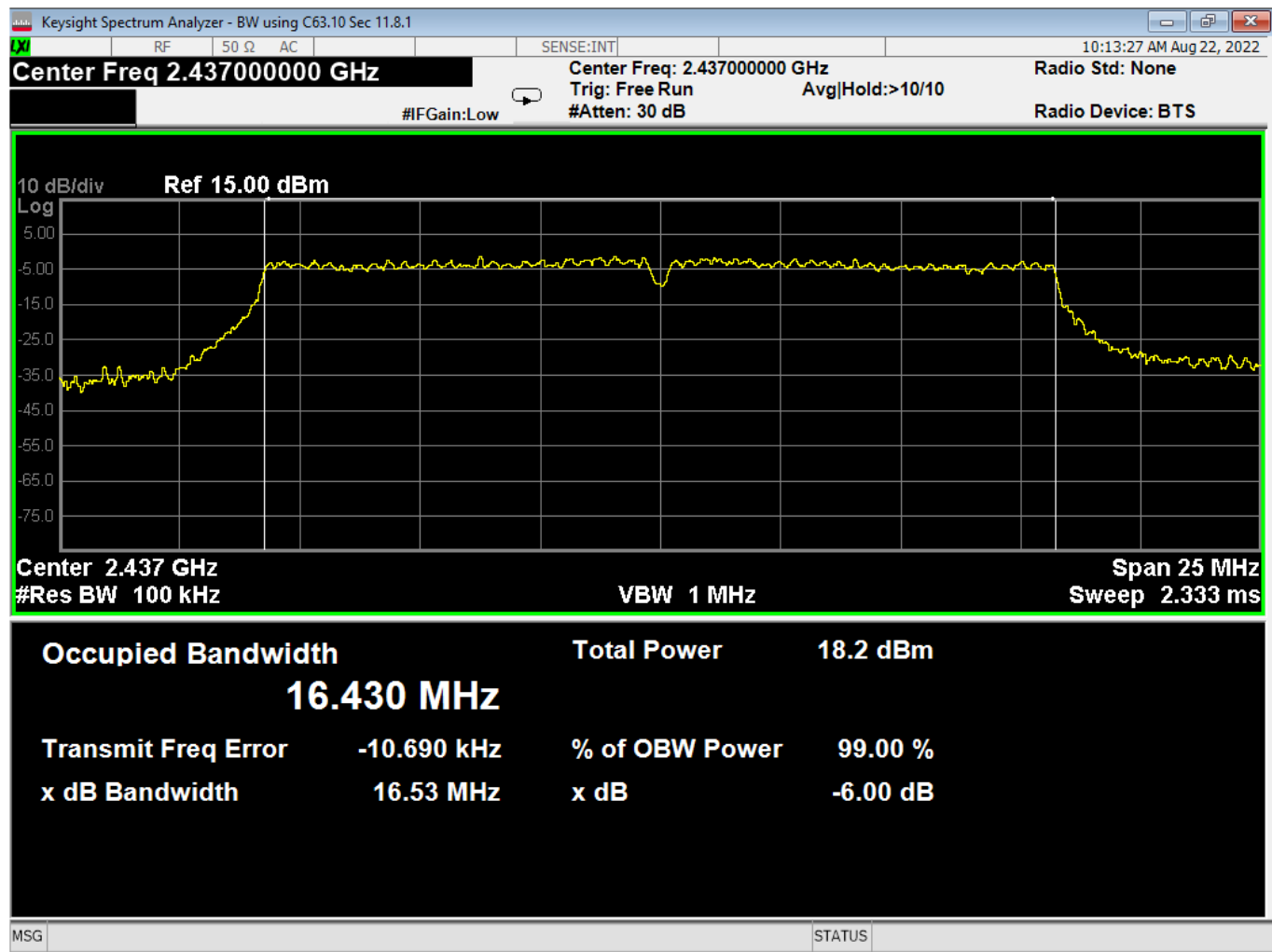
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56 dB Bandwidth, Low, Wifi G, High Data Rate



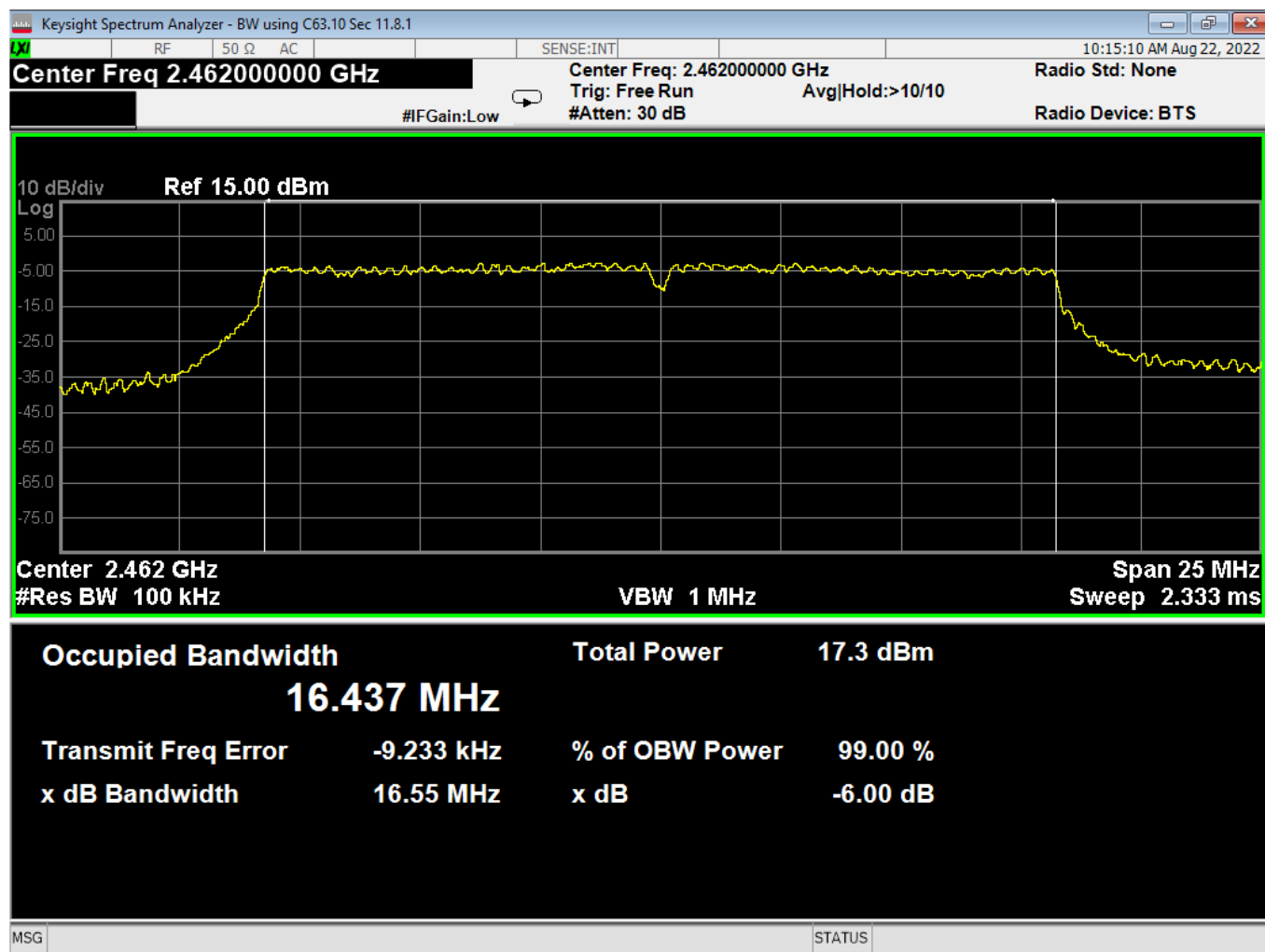
Report Number:	R20220817-20-E5B	Rev	B
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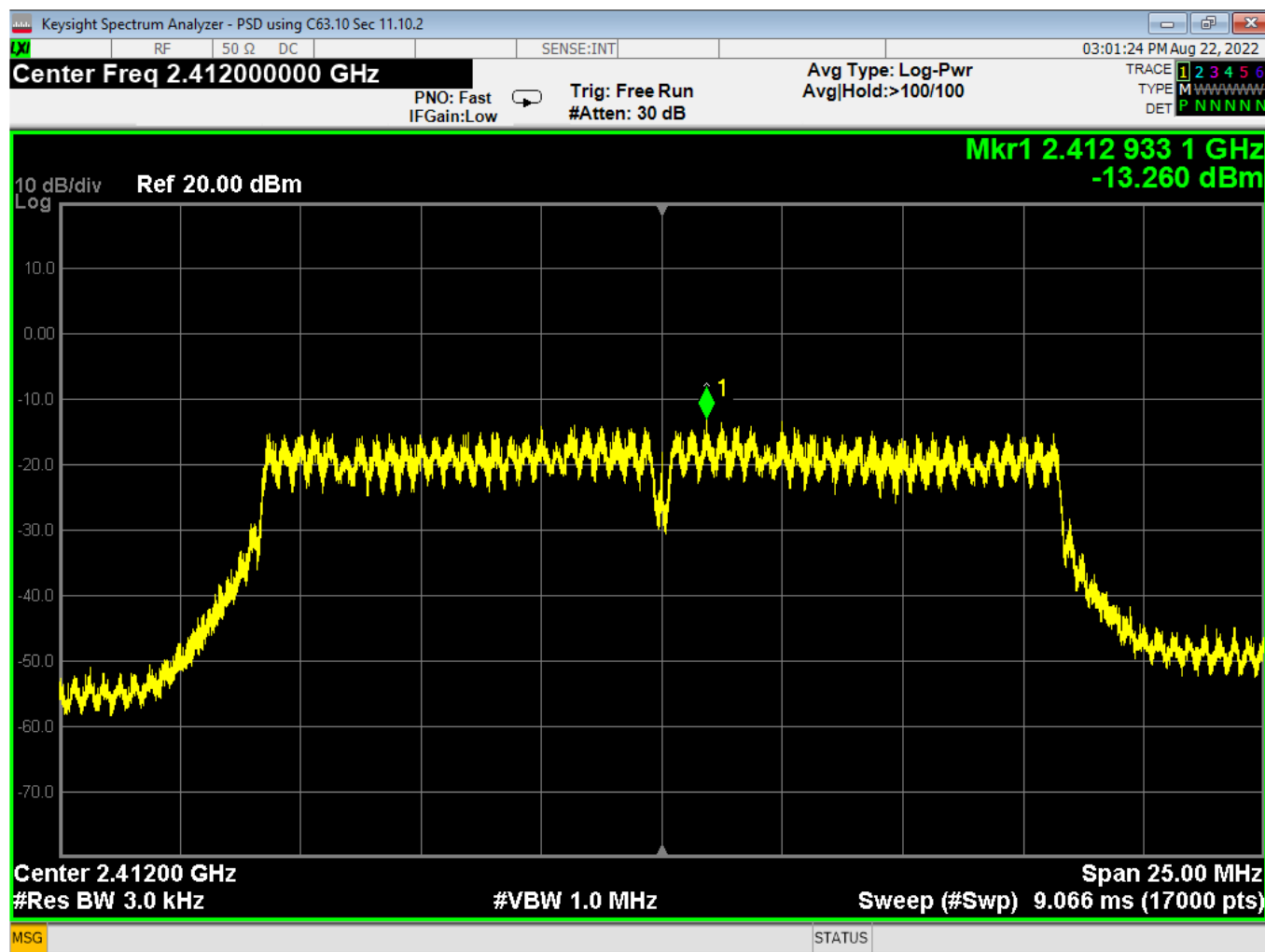
57 6dB Bandwidth, Mid, Wifi G, High Data Rate



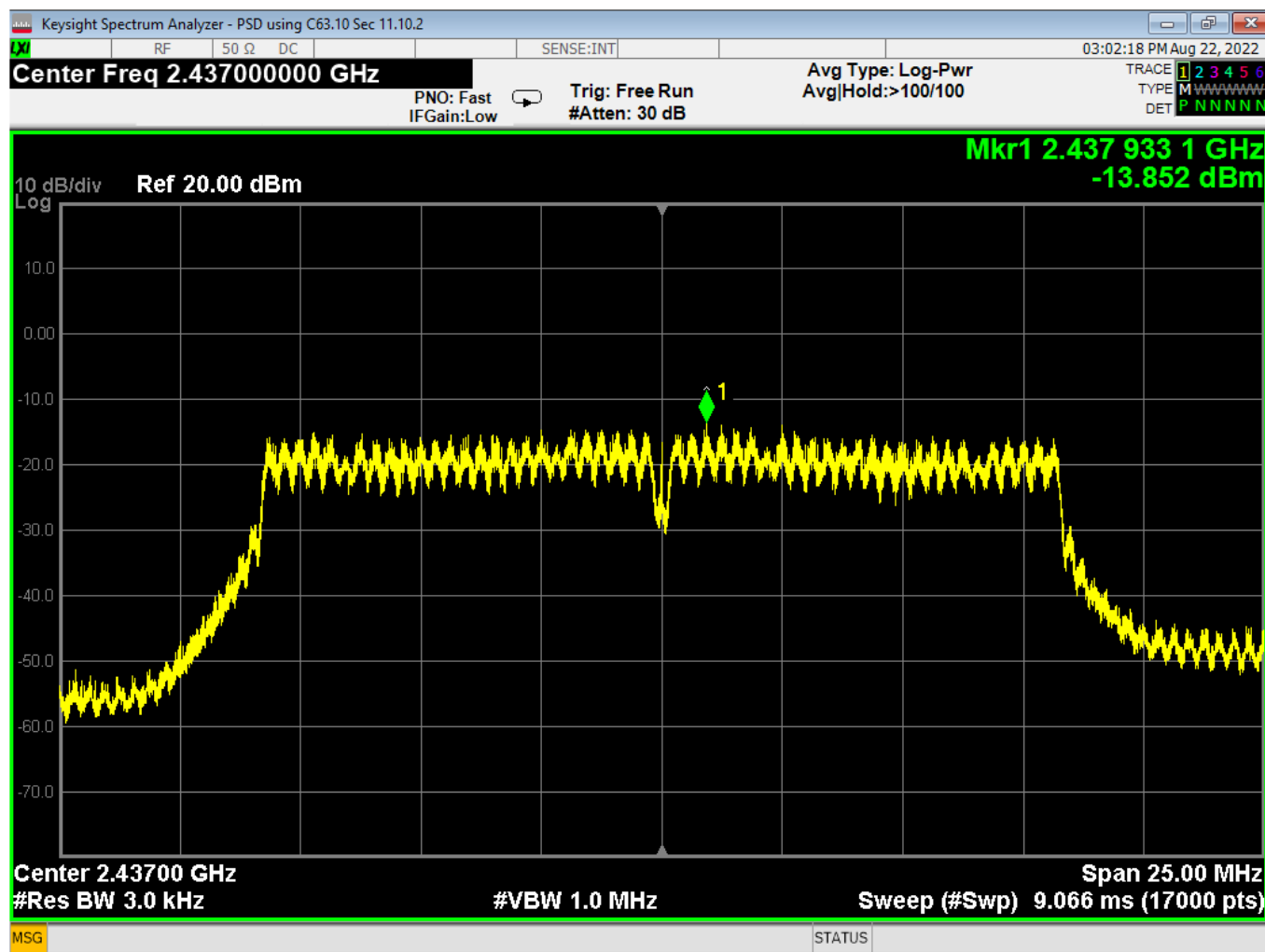
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58 6dB Bandwidth, High, Wifi G, High Data Rate



59 PSD, Low, Wifi G, High Data Rate



60 PSD, Mid, Wifi G, High Data Rate

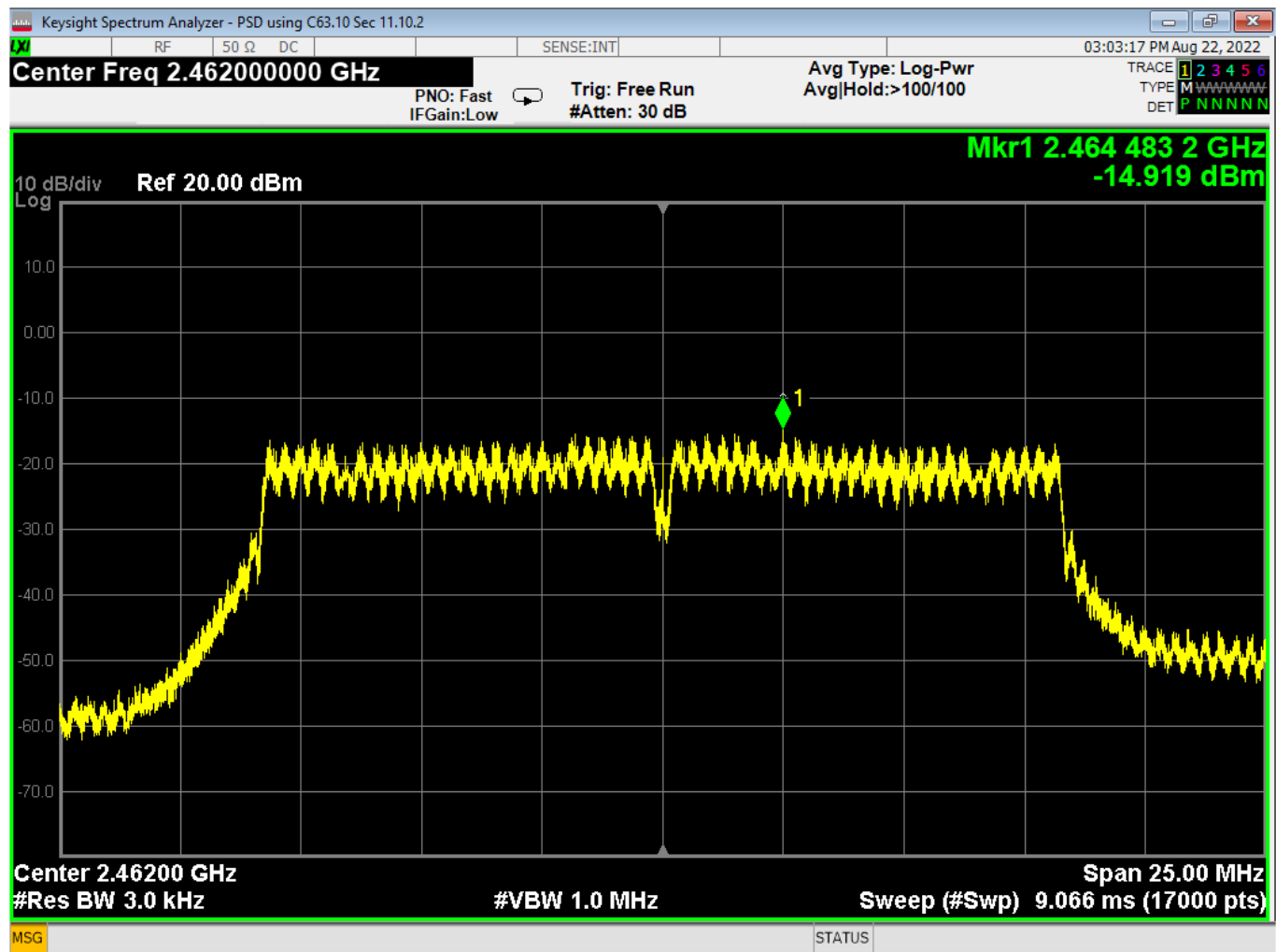


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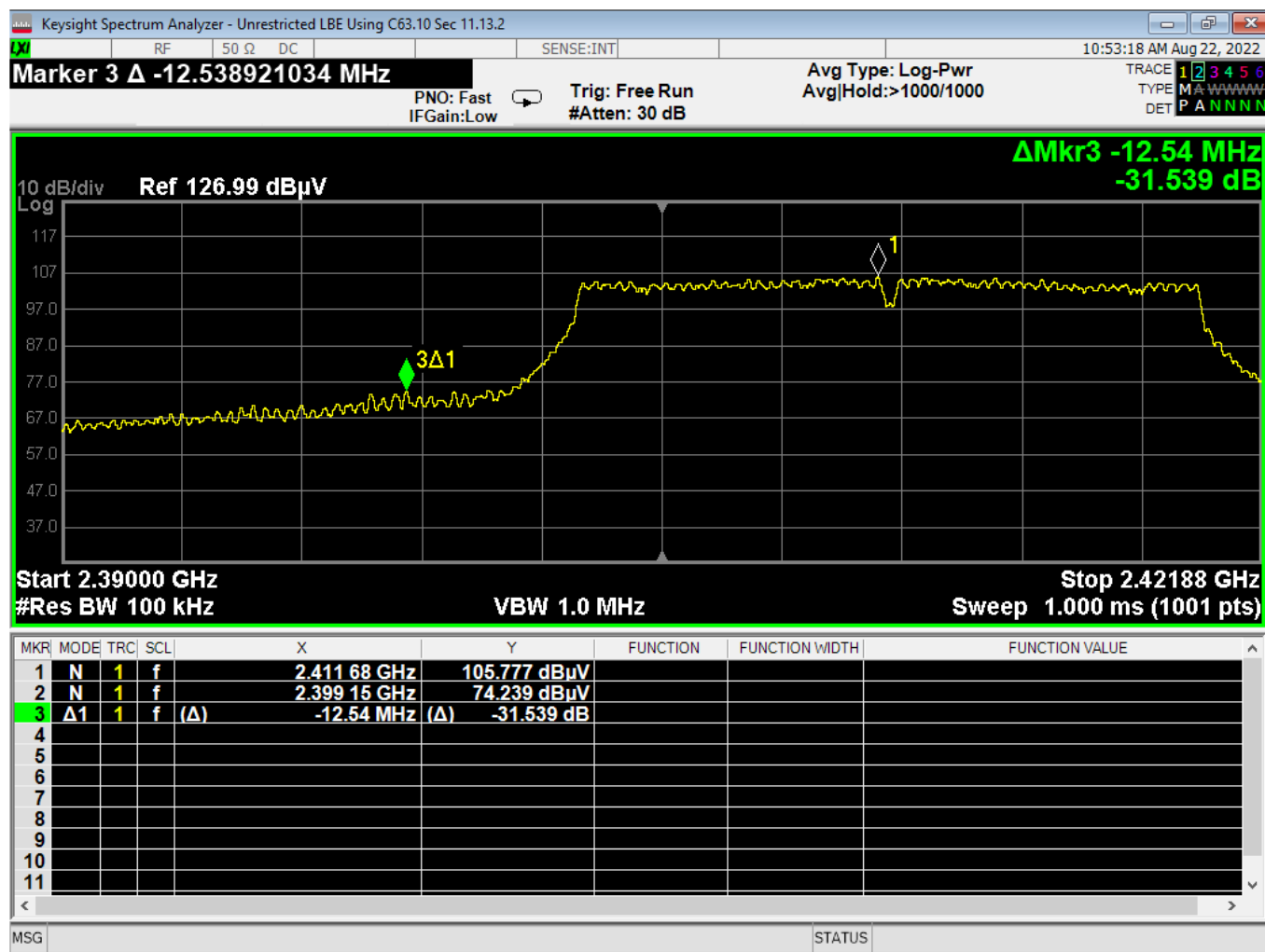
B

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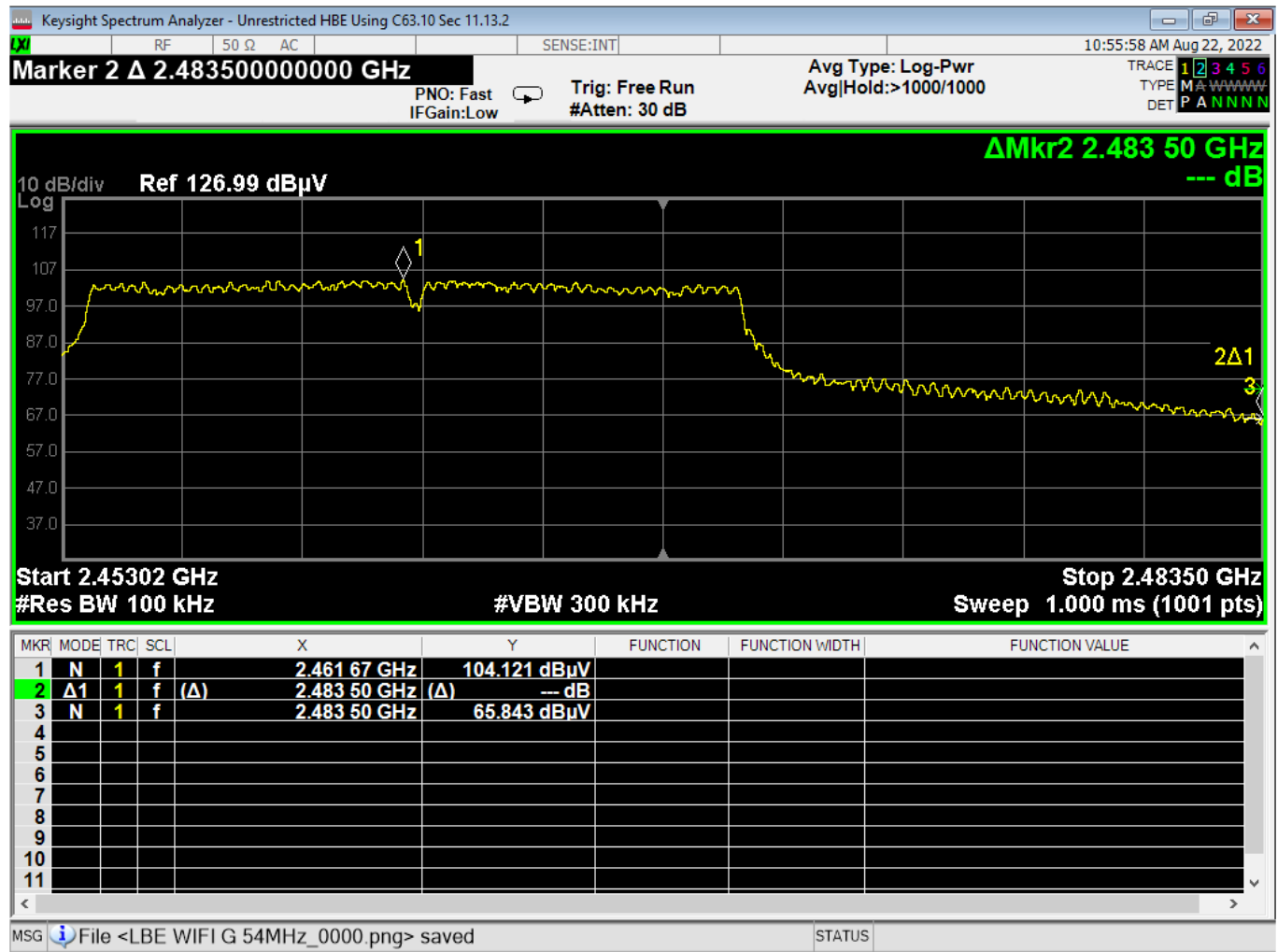
61 PSD, High, Wifi G, High Data Rate

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62 Lower Bandedge, Unrestricted, Wifi G, High Data Rate

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63 Higher Bandedge, Unrestricted, Wifi G, High Data Rate

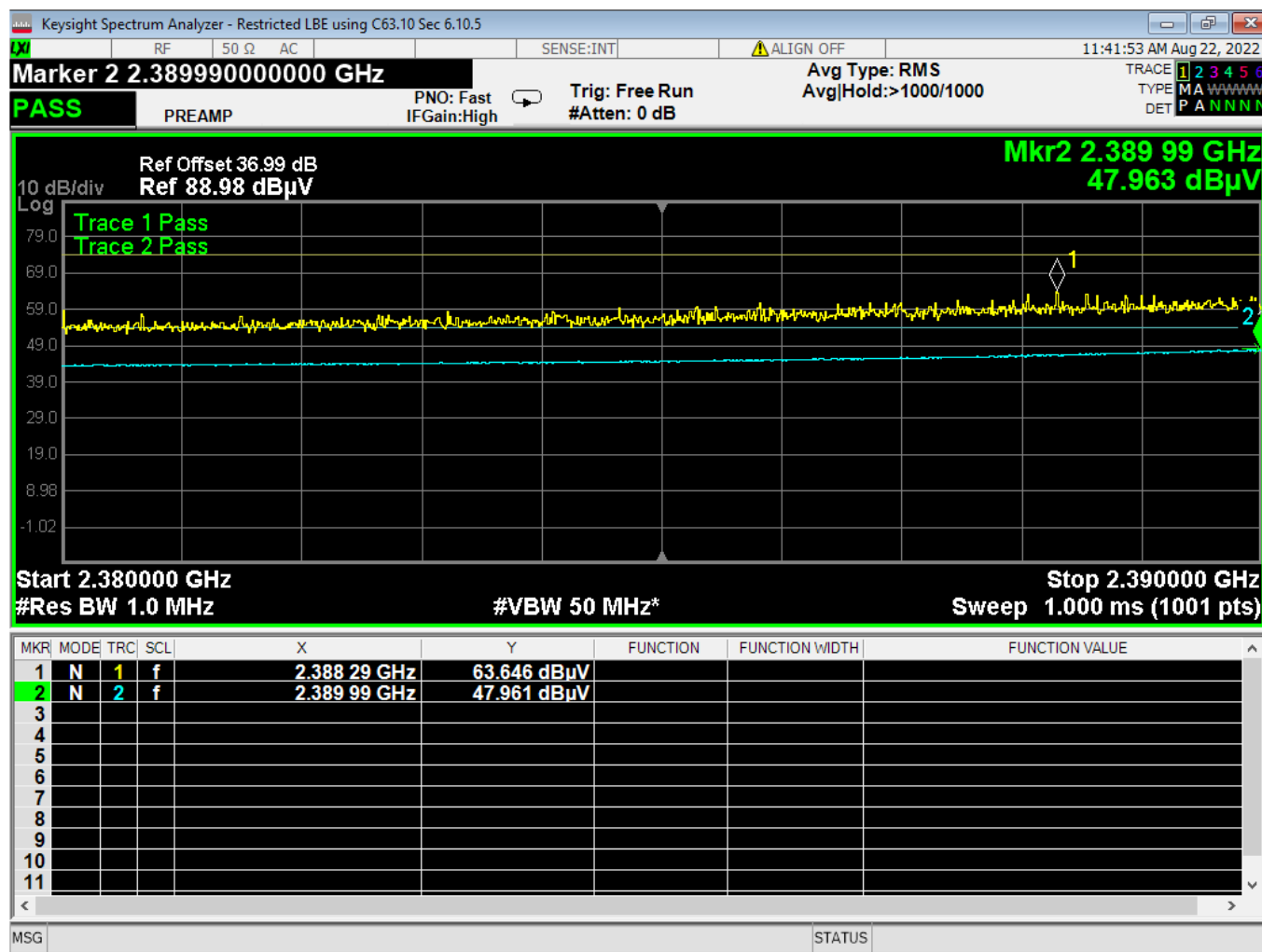


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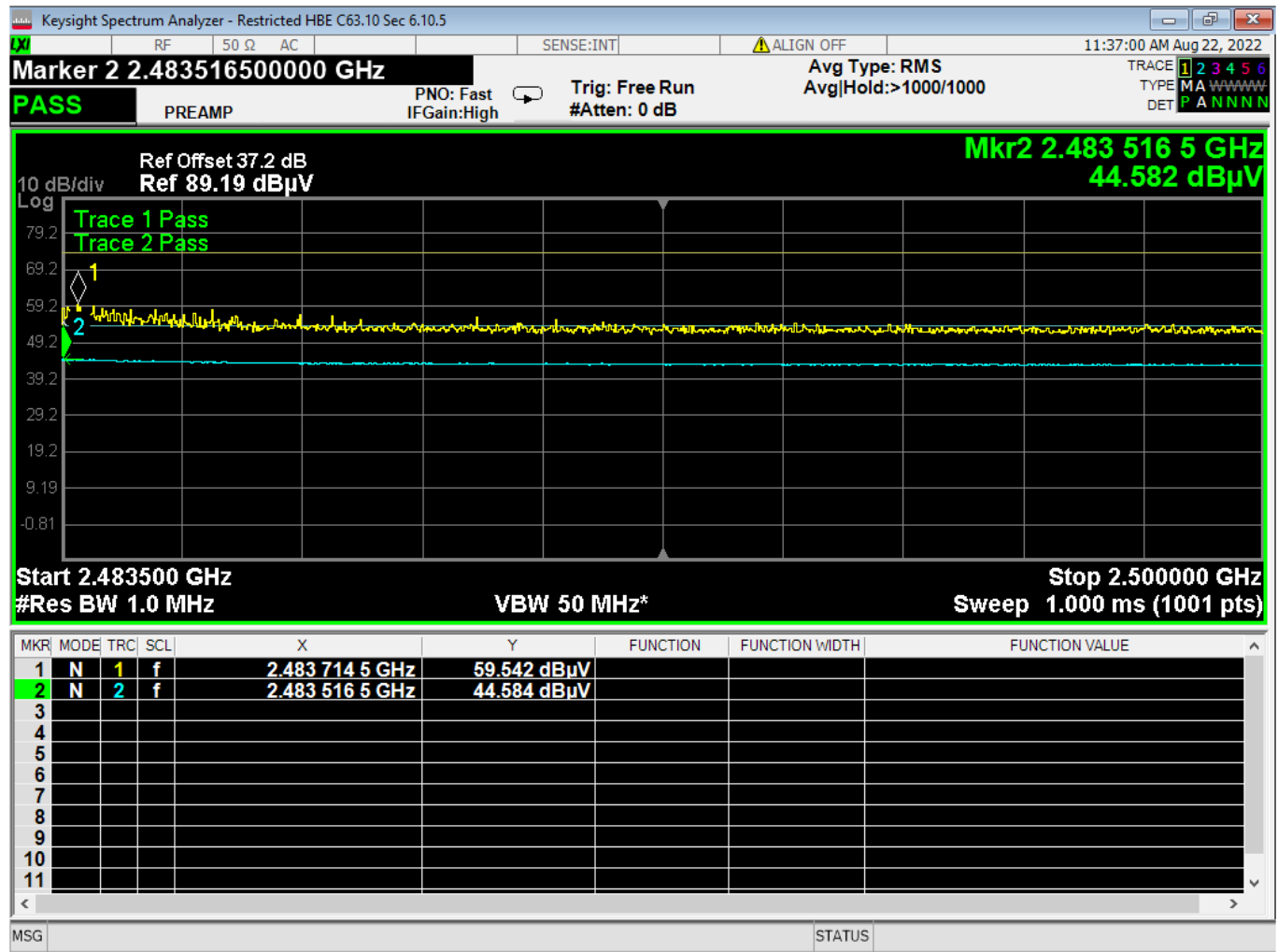
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64 Lower Bandedge, Restricted, Wifi G, High Data Rate

	Report Number:	R20220817-20-E5B	Rev	B
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65 Higher Bandedge, Restricted, Wifi G, High Data Rate

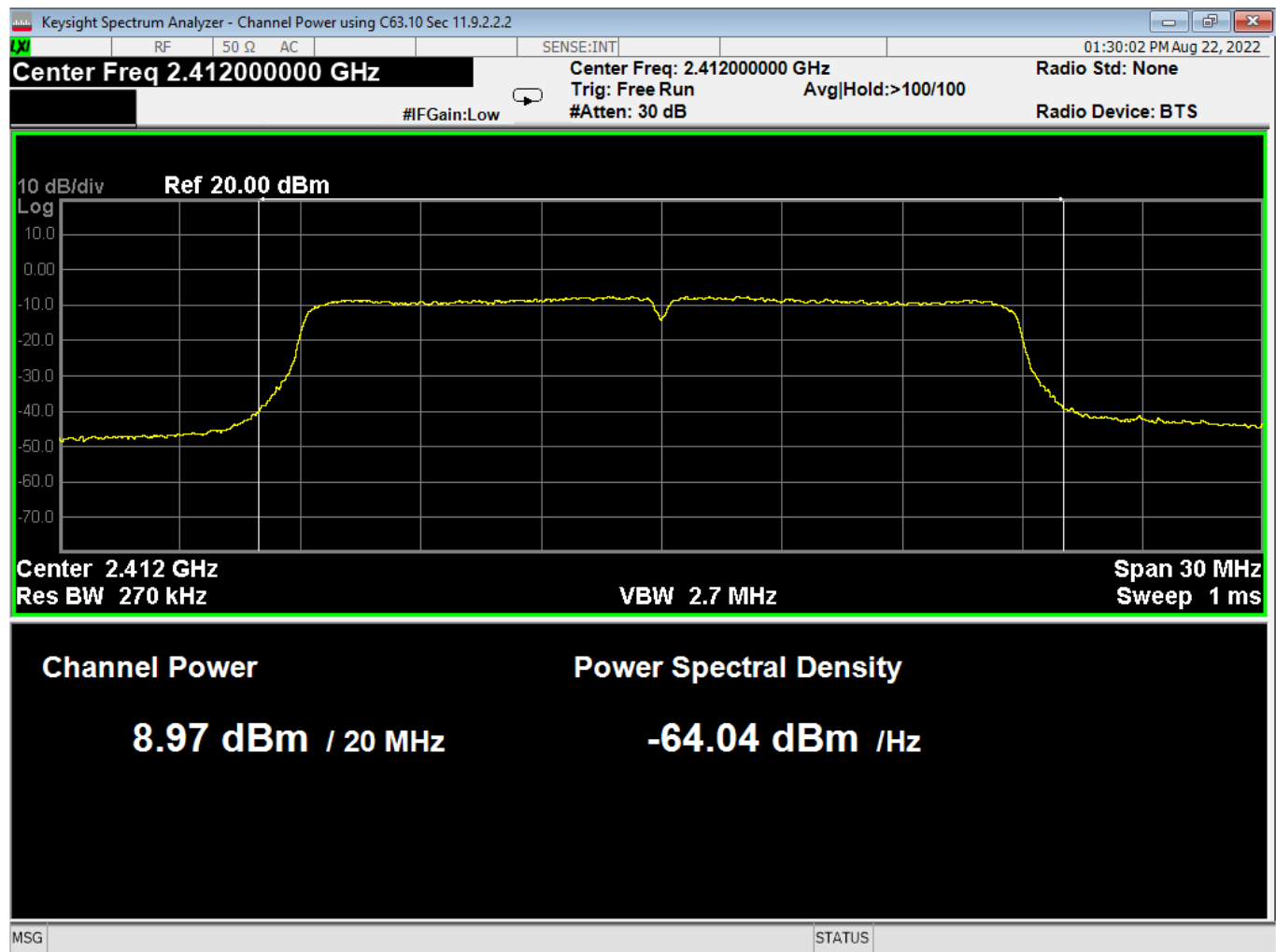


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66 Average Power, Low, Wifi N, High Data Rate

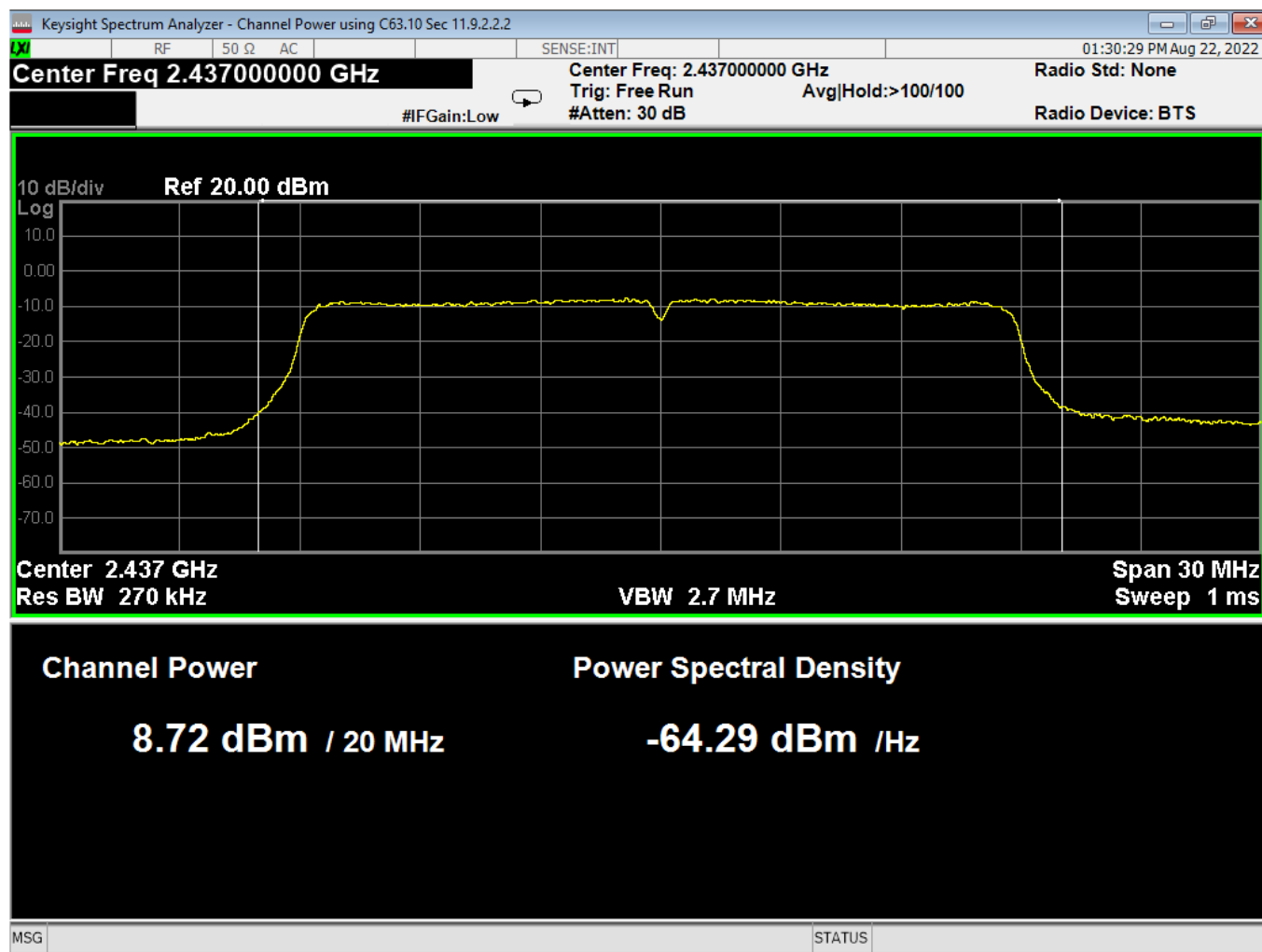


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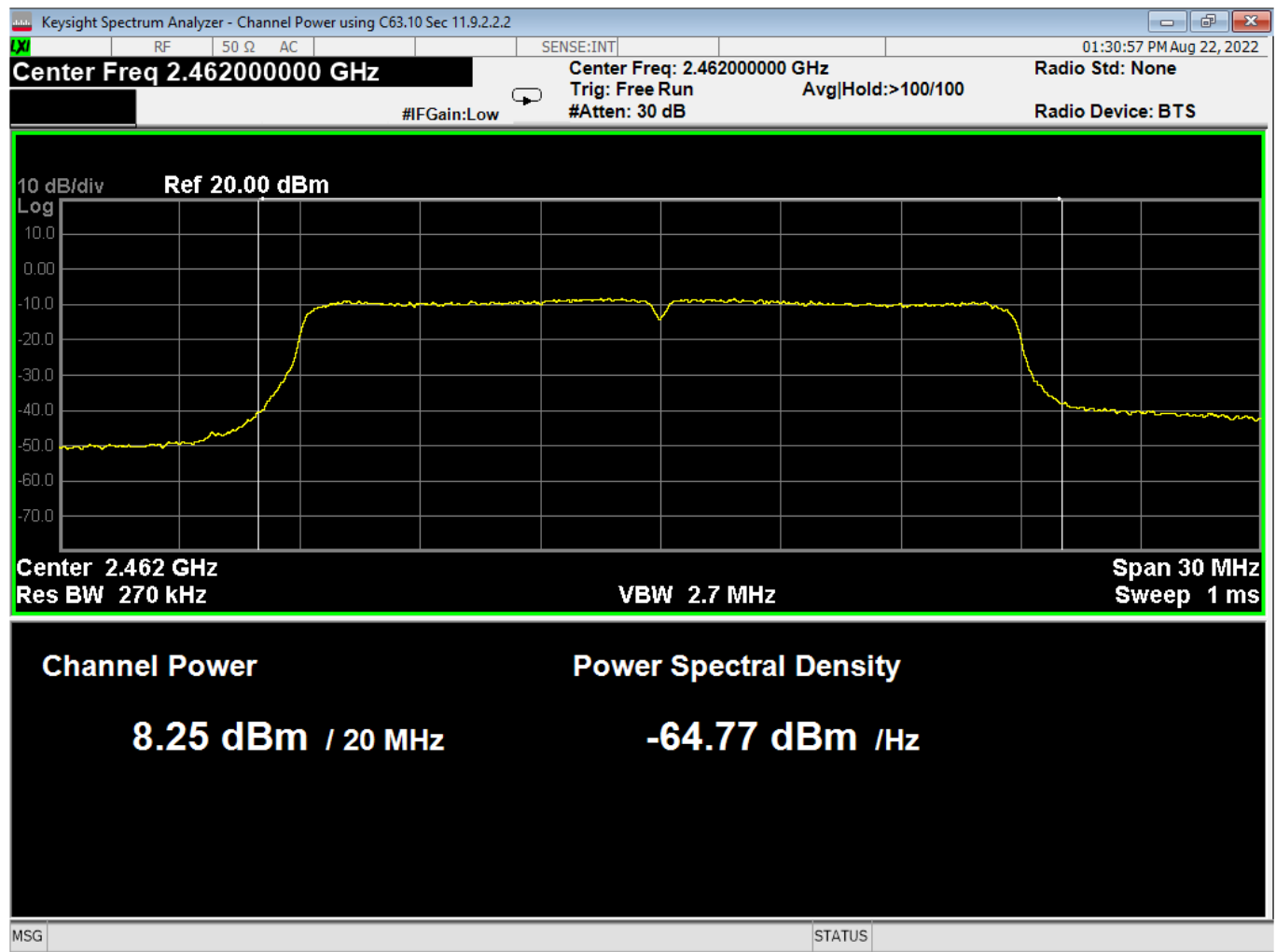
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67 Average Power, Mid, Wifi N, High Data Rate



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68 Average Power, High, Wifi N, High Data Rate

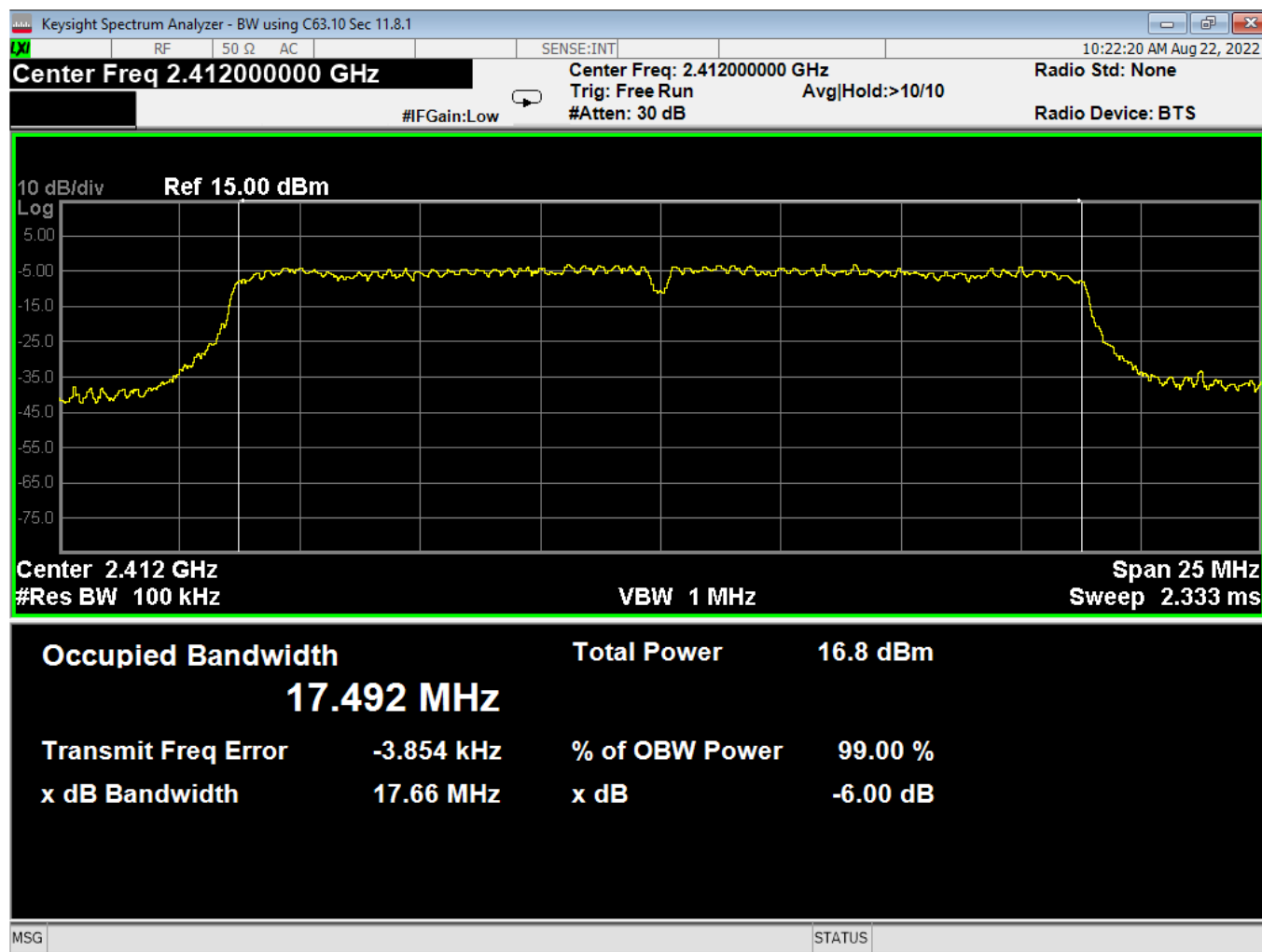


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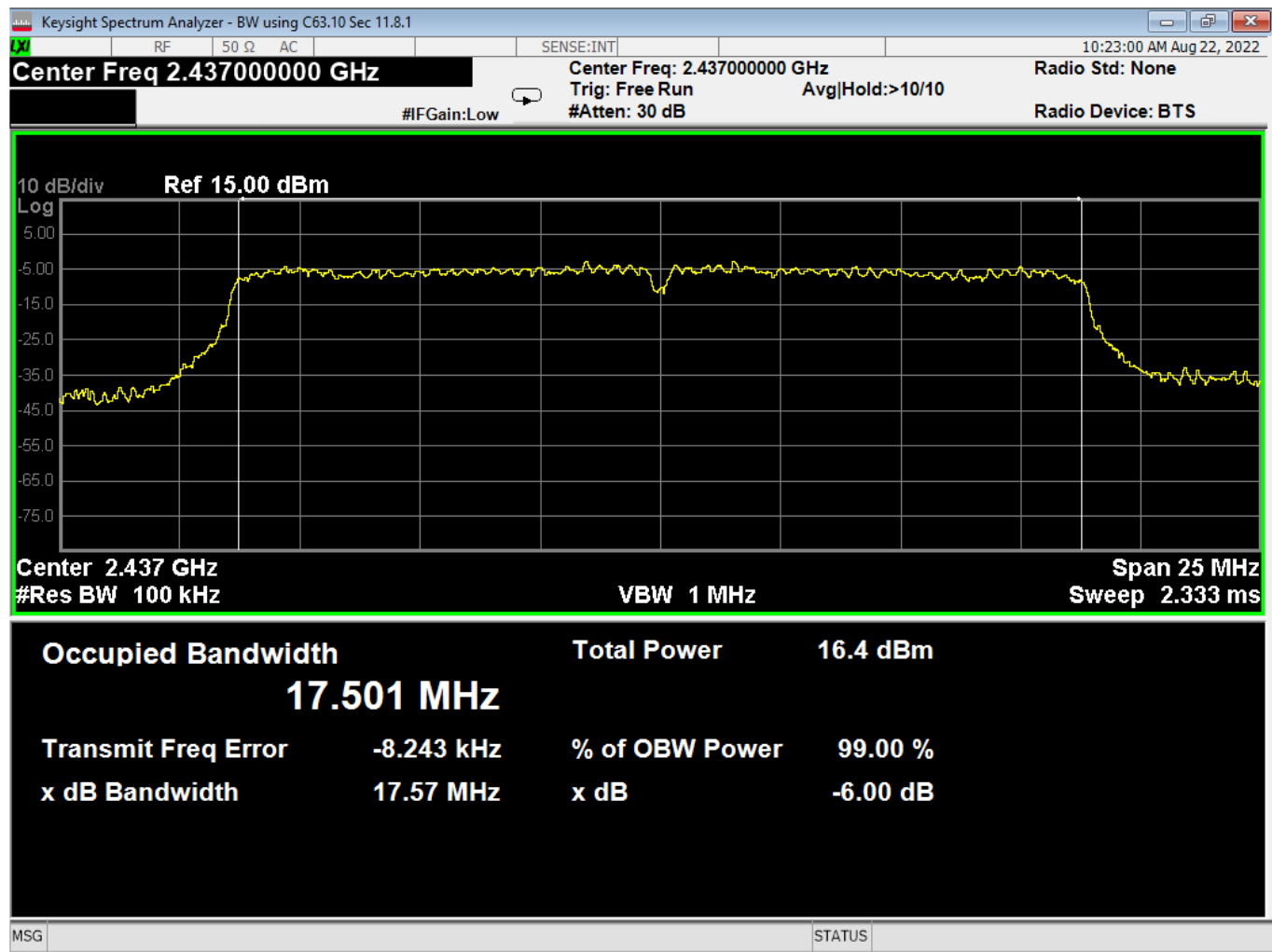
Prepared for: Garmin International, Inc.



69 6dB Bandwidth, Low, Wifi N, High Data Rate



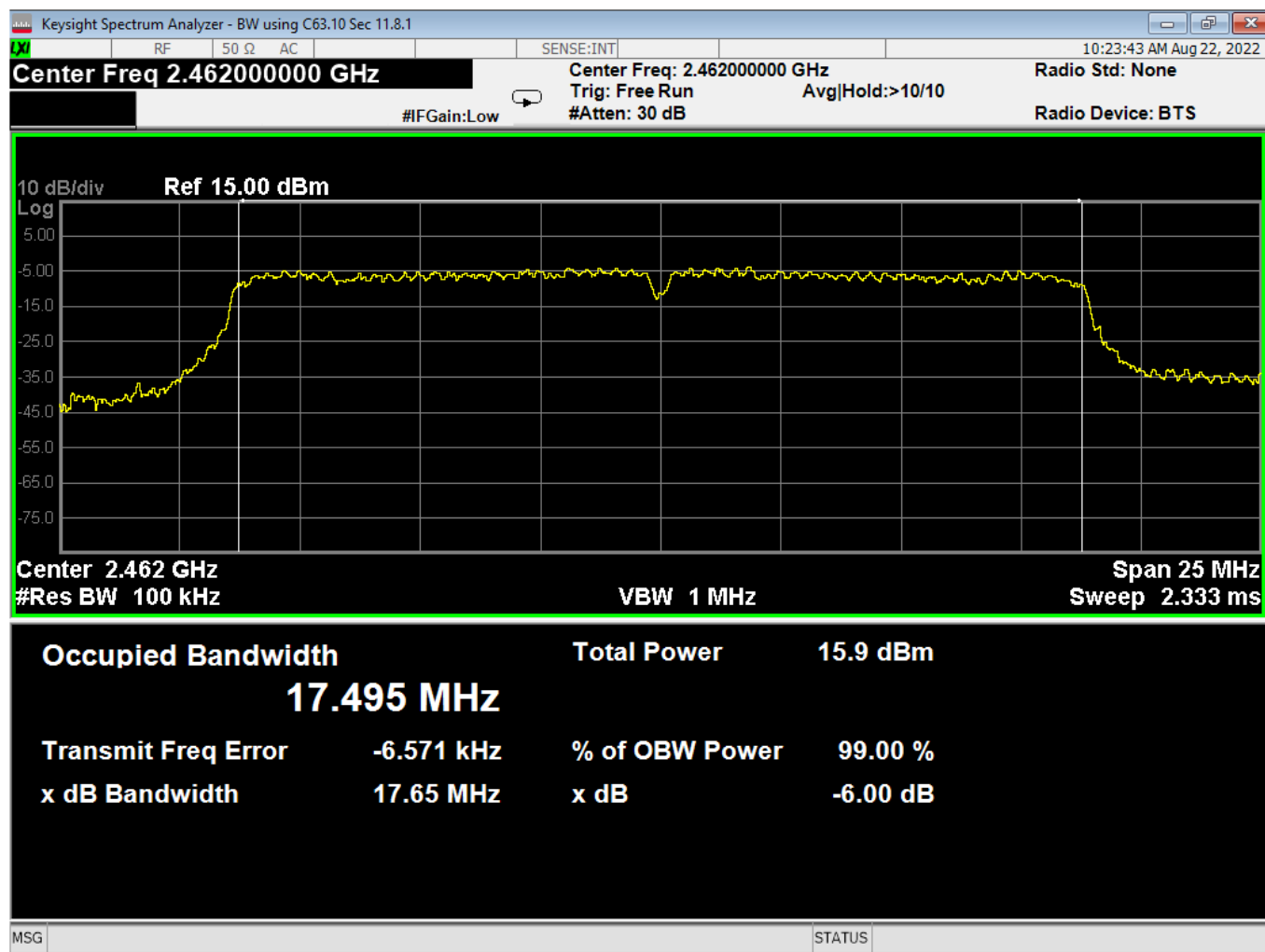
Report Number:	R20220817-20-E5B	Rev	B
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70 6dB Bandwidth, Mid, Wifi N, High Data Rate



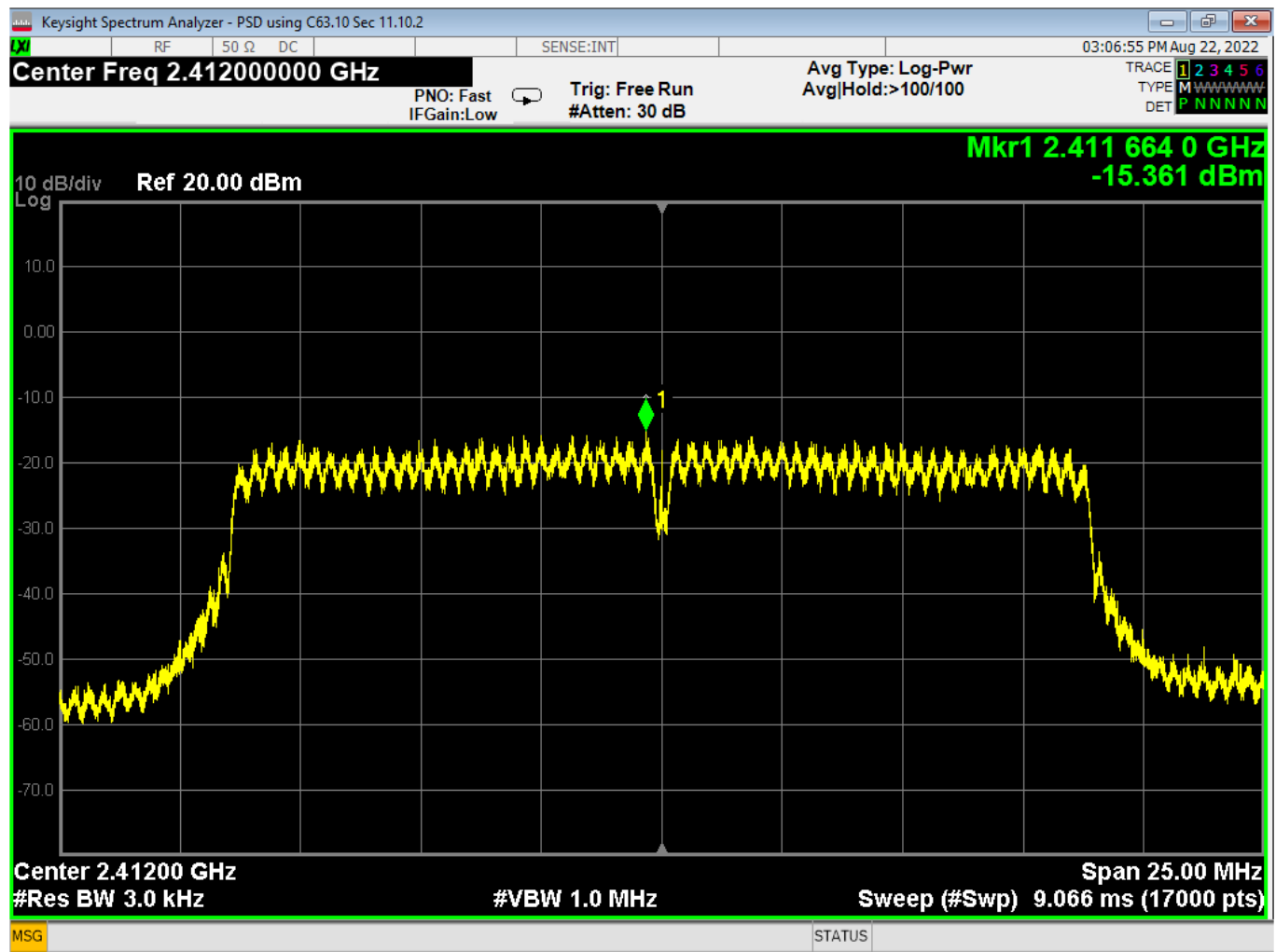
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71 6dB Bandwidth, High, Wifi N, High Data Rate



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72 PSD, Low, Wifi N, High Data Rate

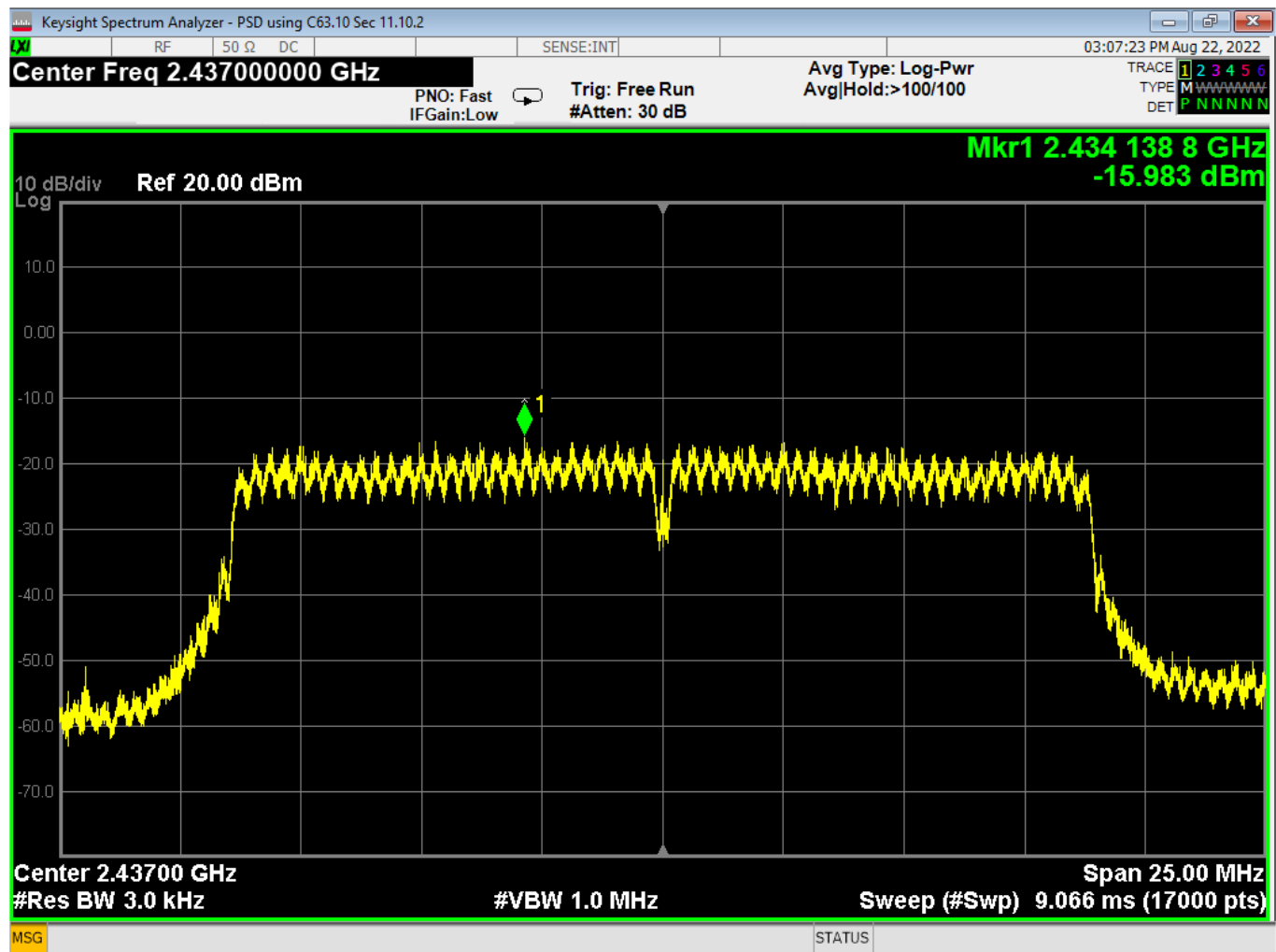


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73 PSD, Mid, Wifi N, High Data Rate

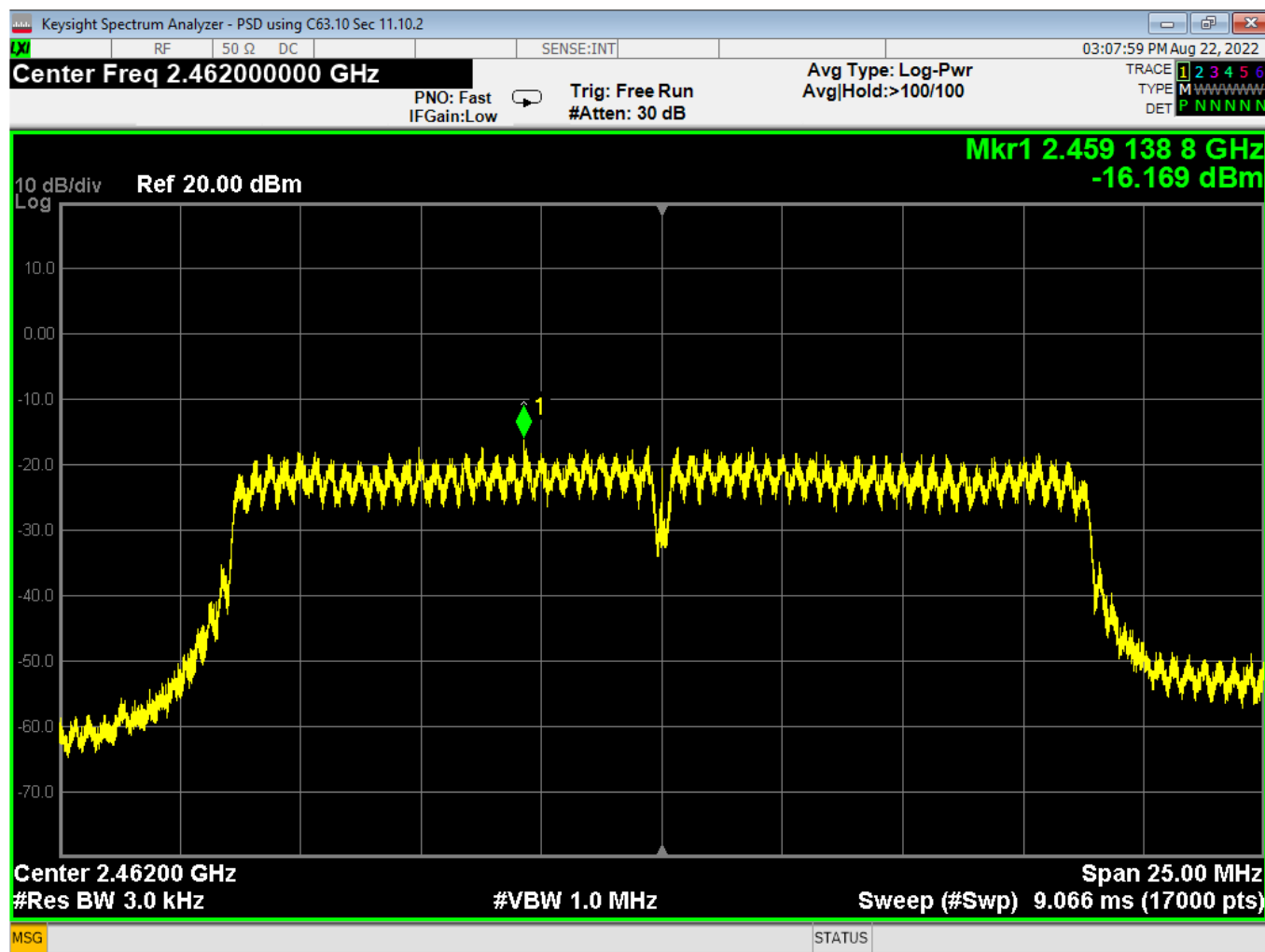


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74 PSD, High, Wifi N, High Data Rate

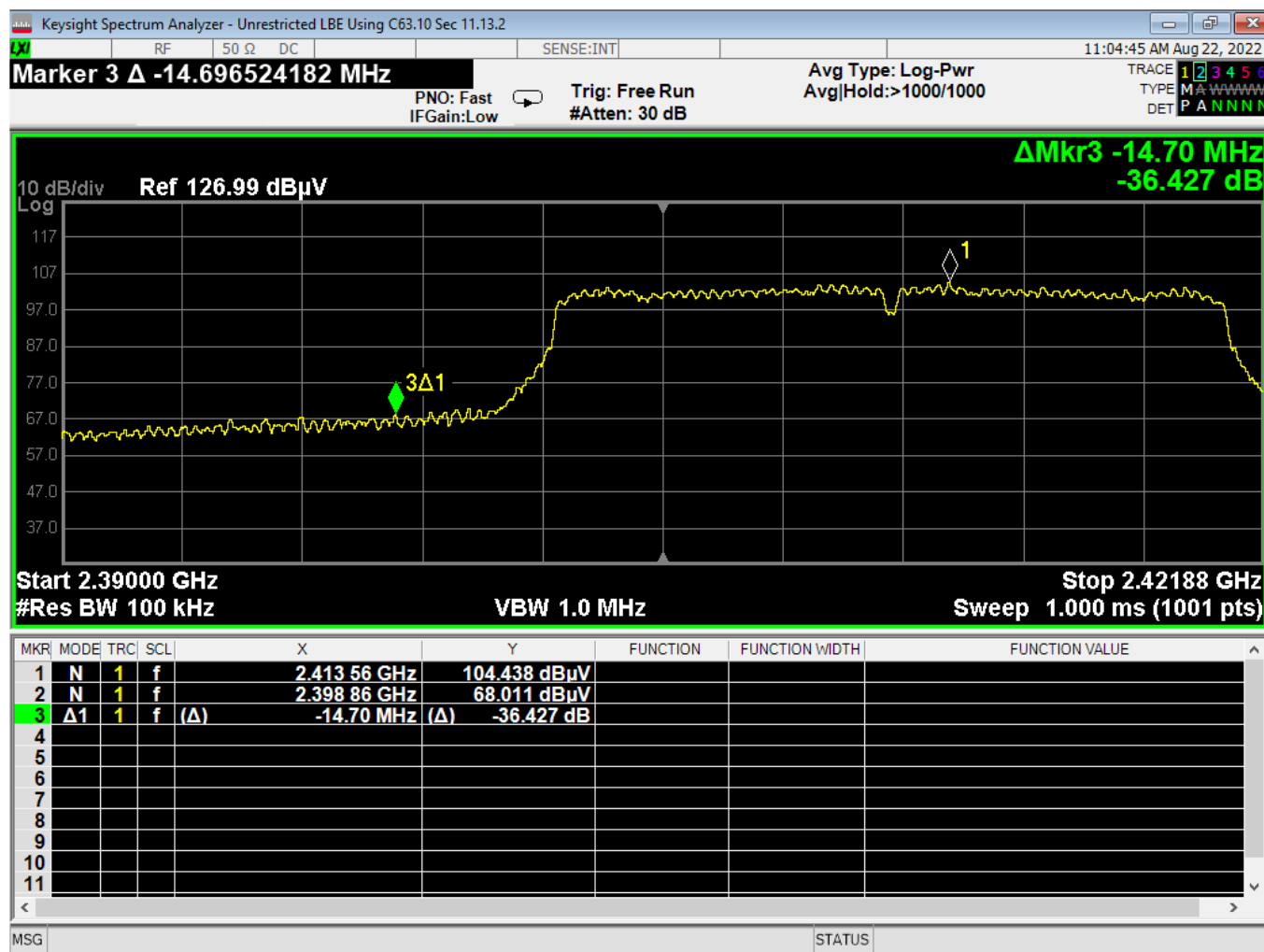


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75 Lower Bandedge, Unrestricted, Wifi N, High Data Rate



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76 Higher Bandedge, Unrestricted, Wifi N, High Data Rate

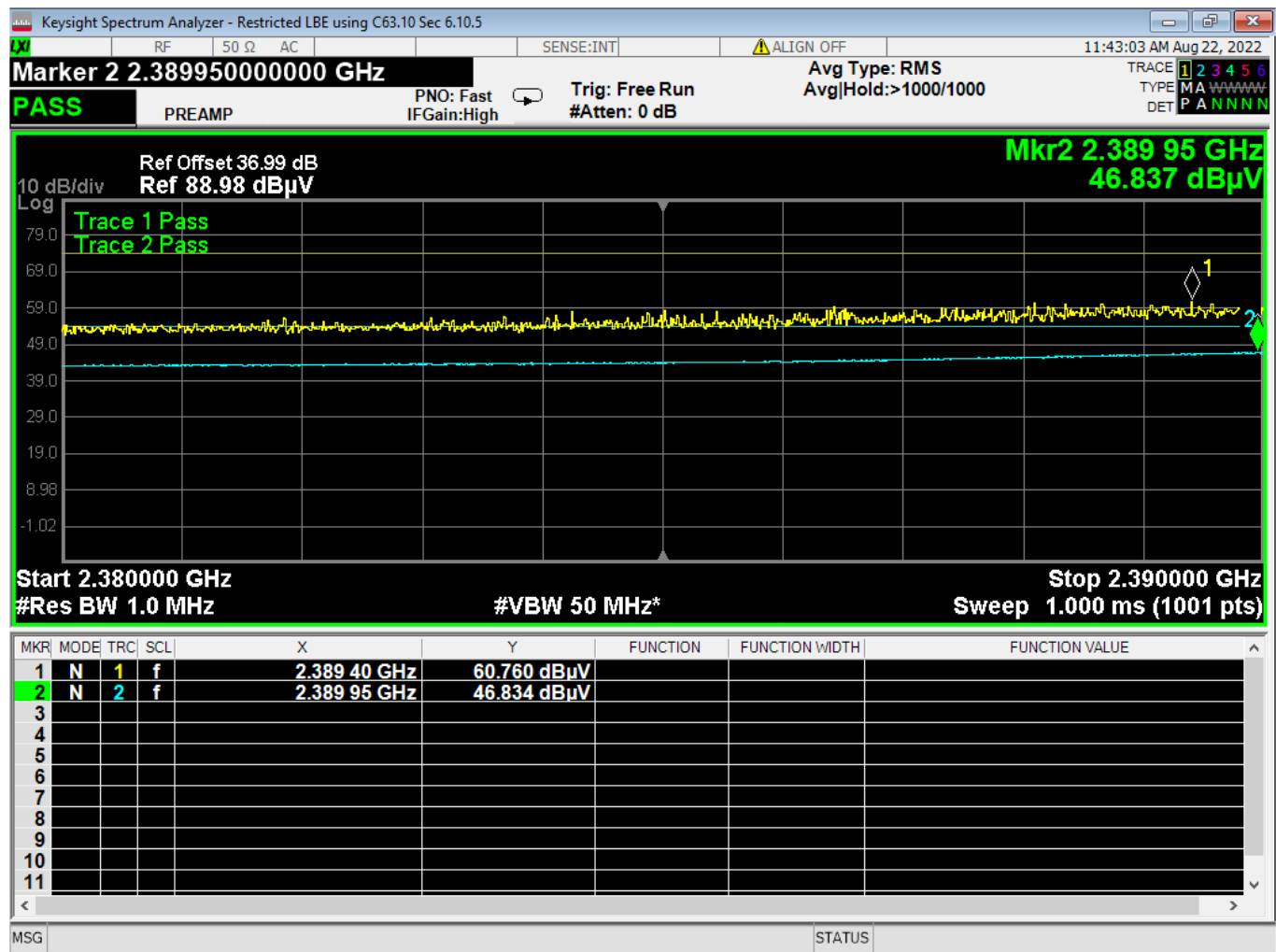


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77 Lower Bandedge, Restricted, Wifi N, High Data Rate

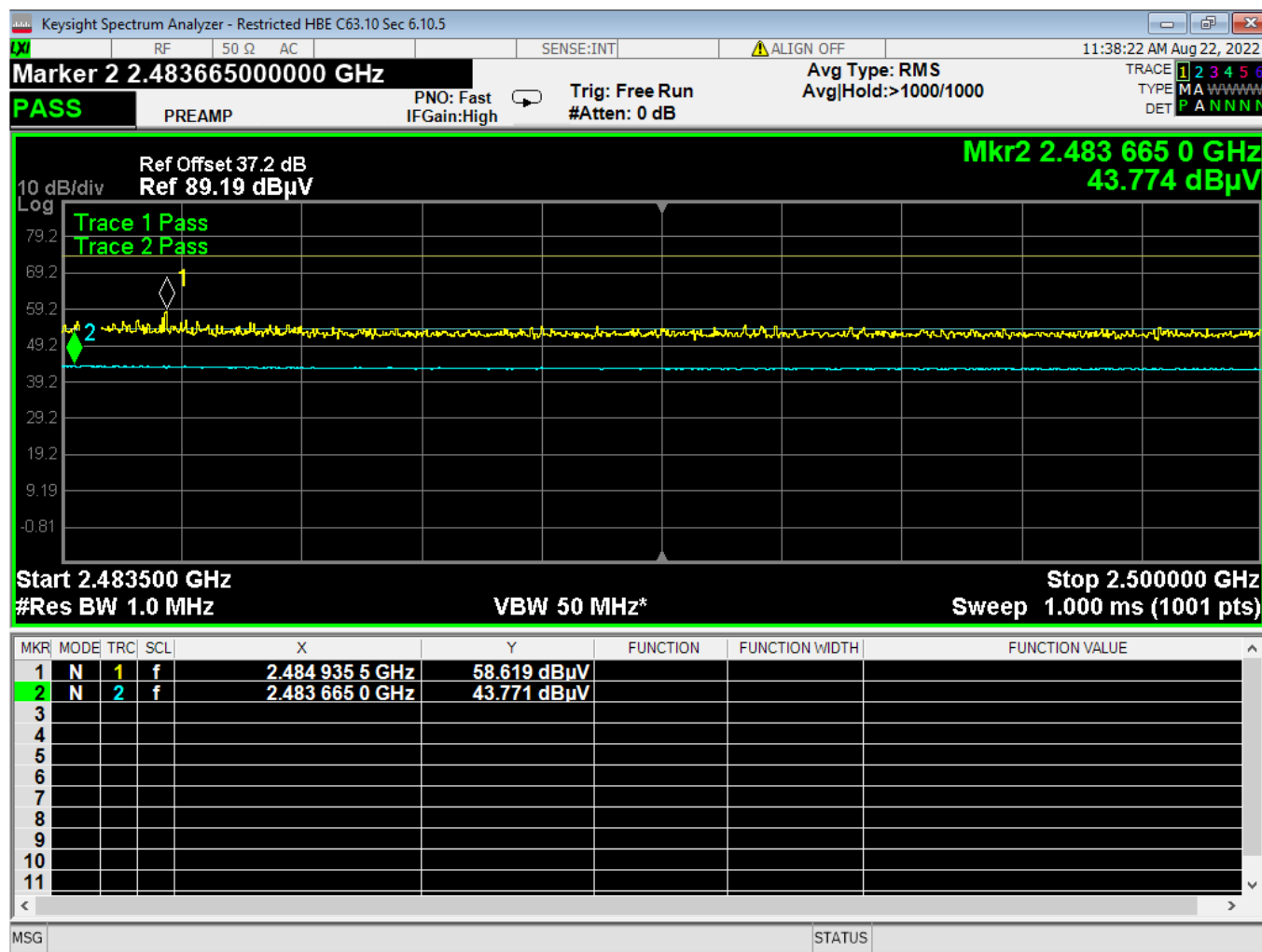


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78 Higher Bandedge, Restricted, Wifi N, High Data Rate

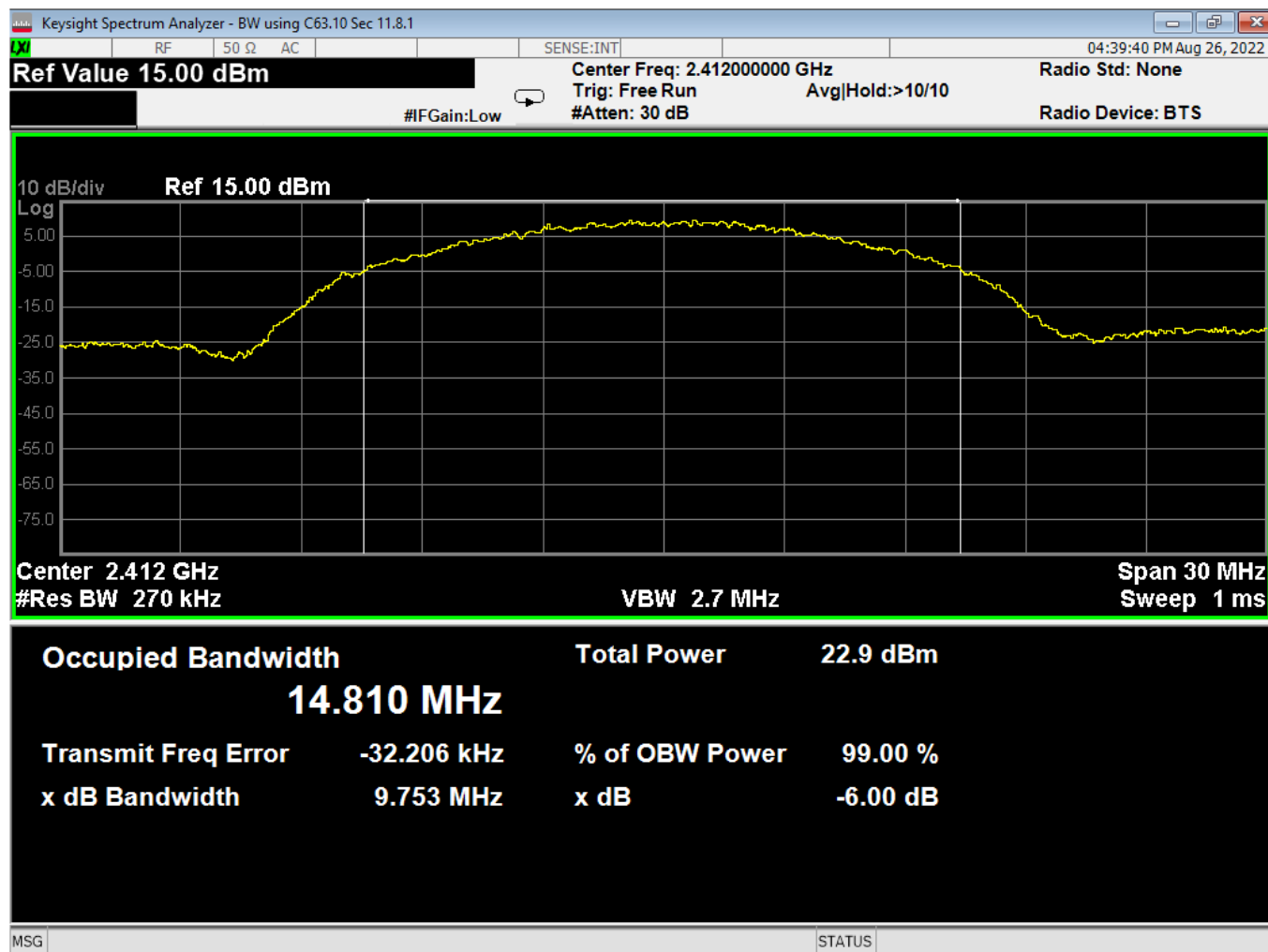


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79 6dB Bandwidth, Low, Wifi B, Low Data Rate

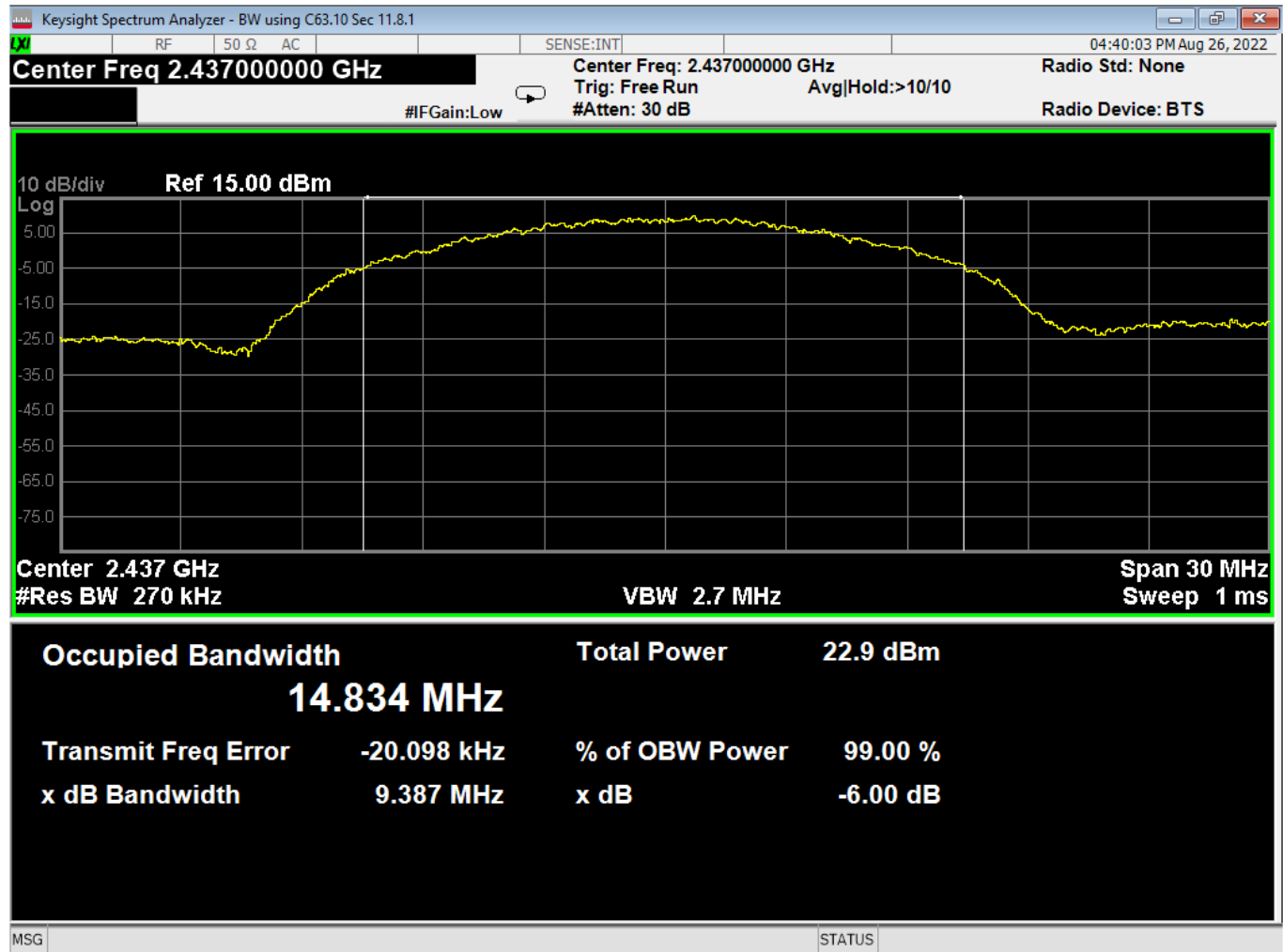


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80 6dB Bandwidth, Mid, Wifi B, Low Data Rate

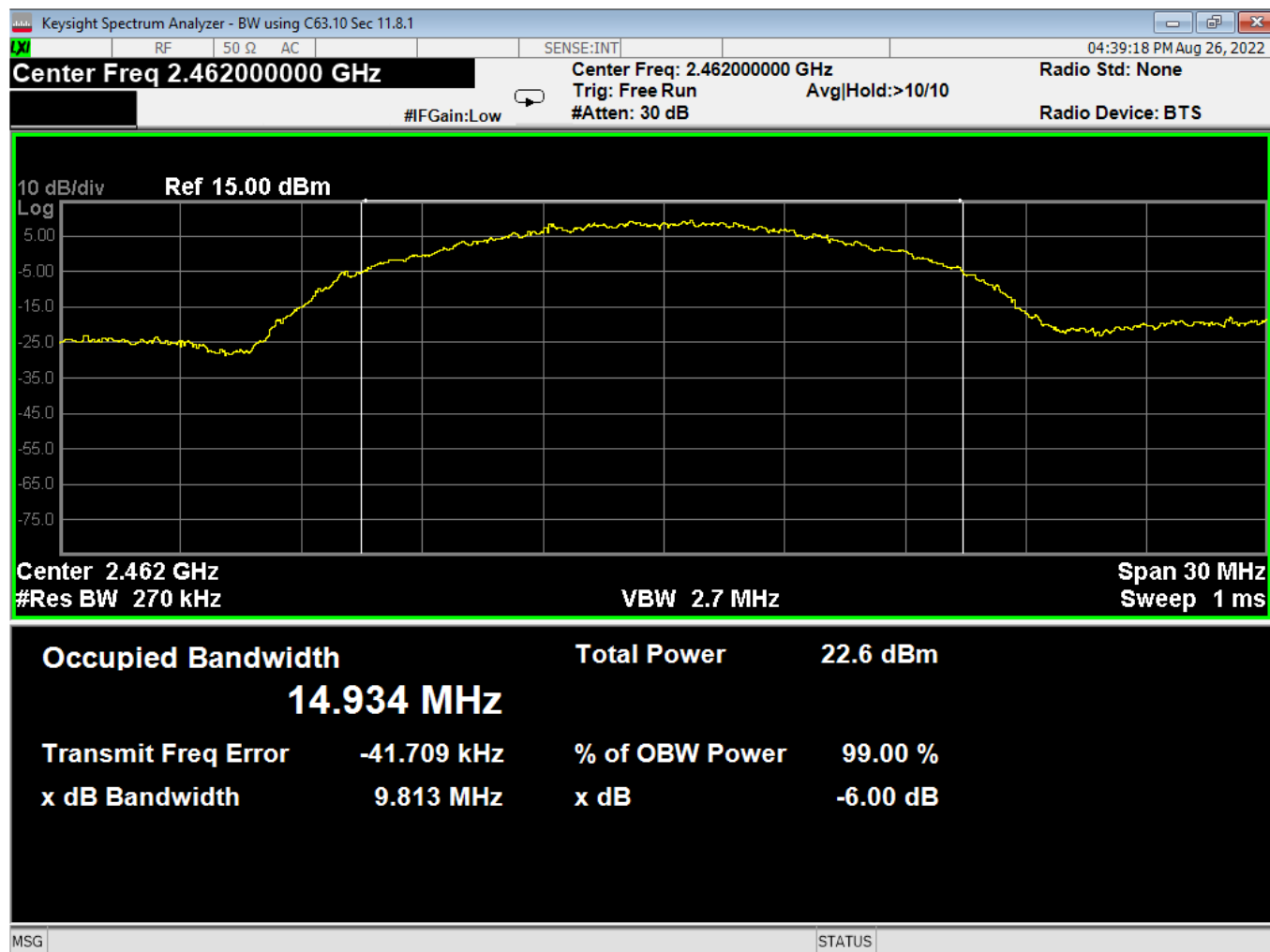


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81 6dB Bandwidth, High, Wifi B, Low Data Rate

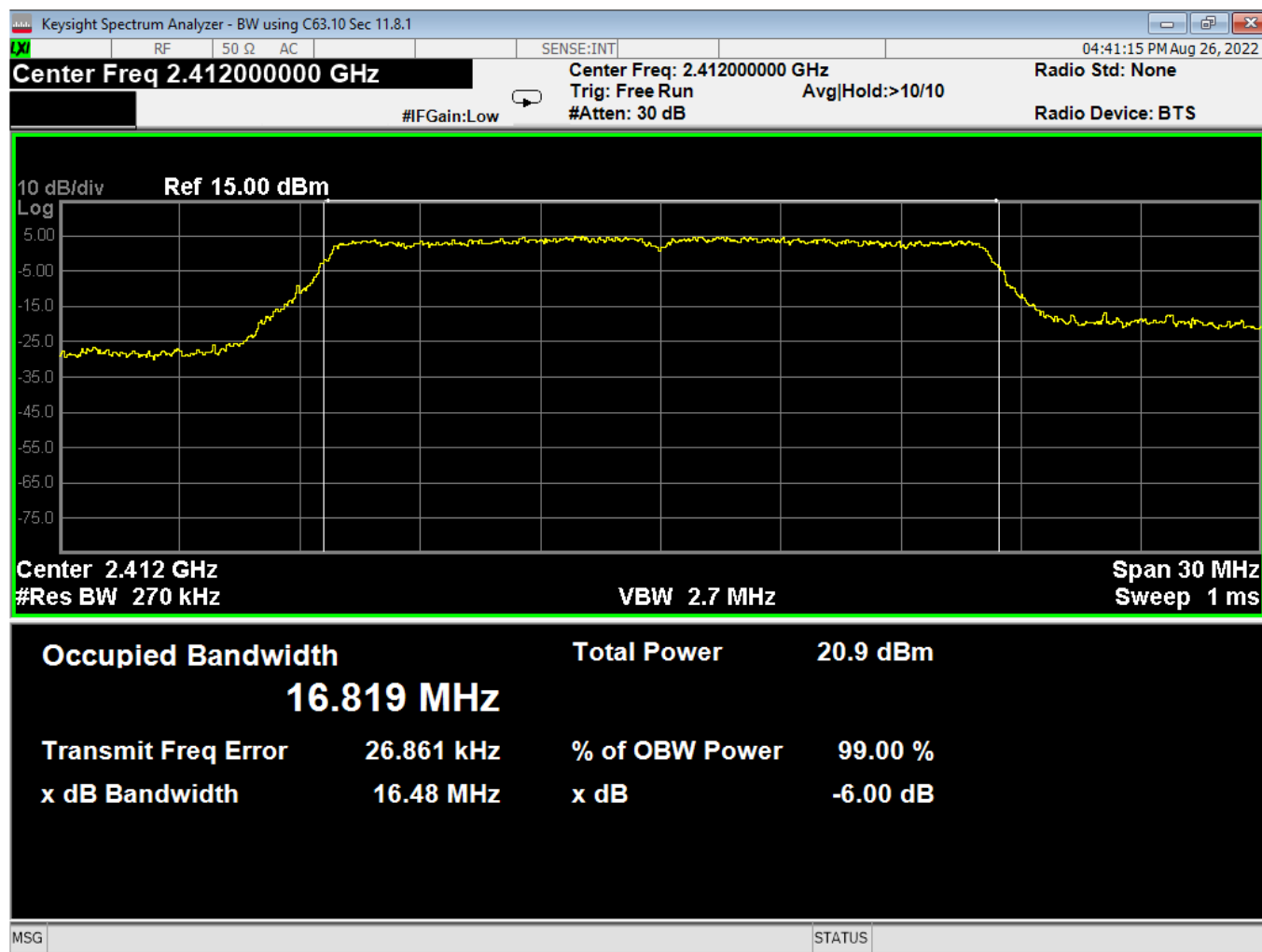


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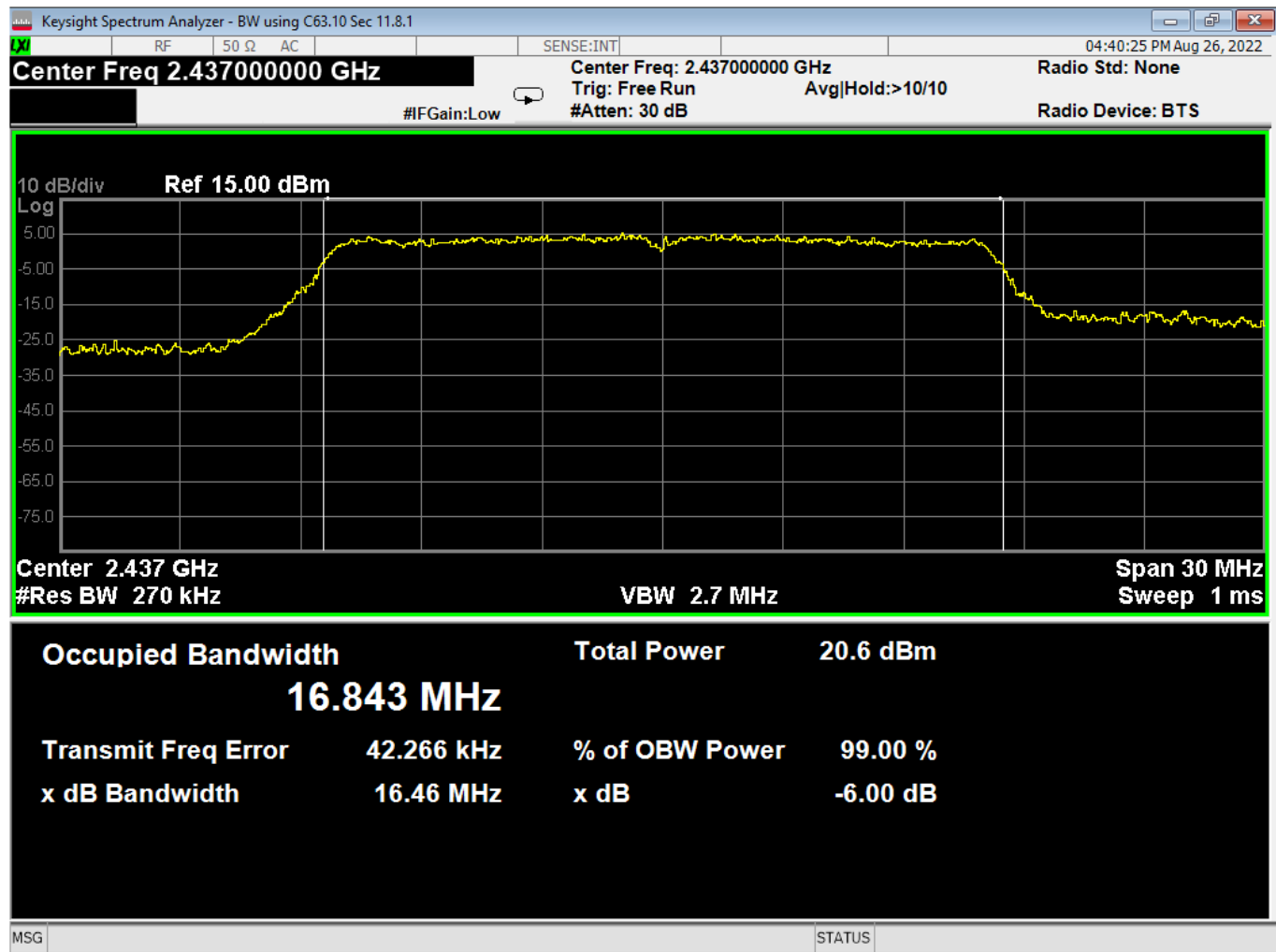
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82 6dB Bandwidth, Low, Wifi G, Low Data Rate



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83 6dB Bandwidth, Mid, Wifi G, Low Data Rate

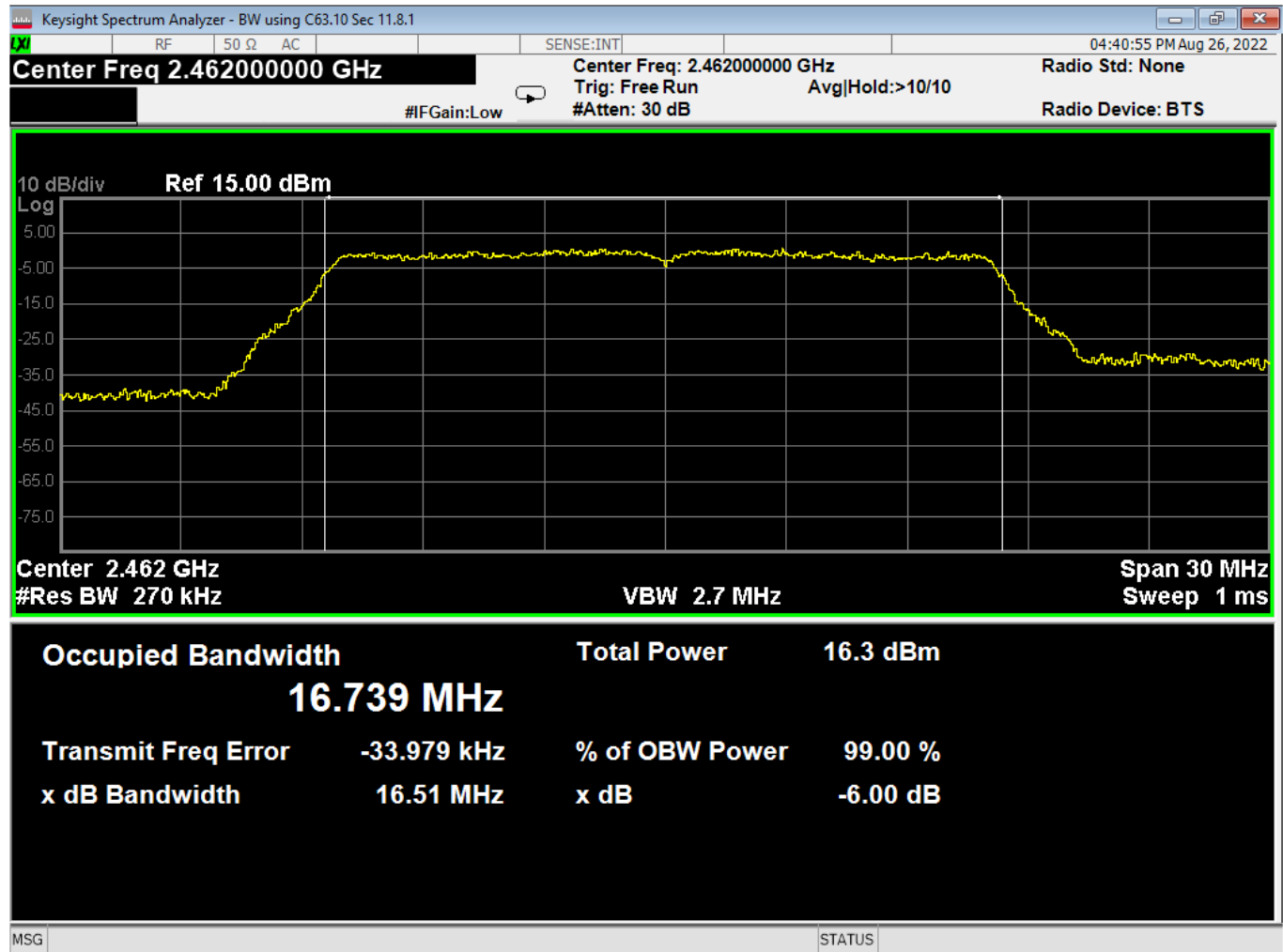


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Prepared for: Garmin International, Inc.



84 6dB Bandwidth, High, Wifi G, Low Data Rate

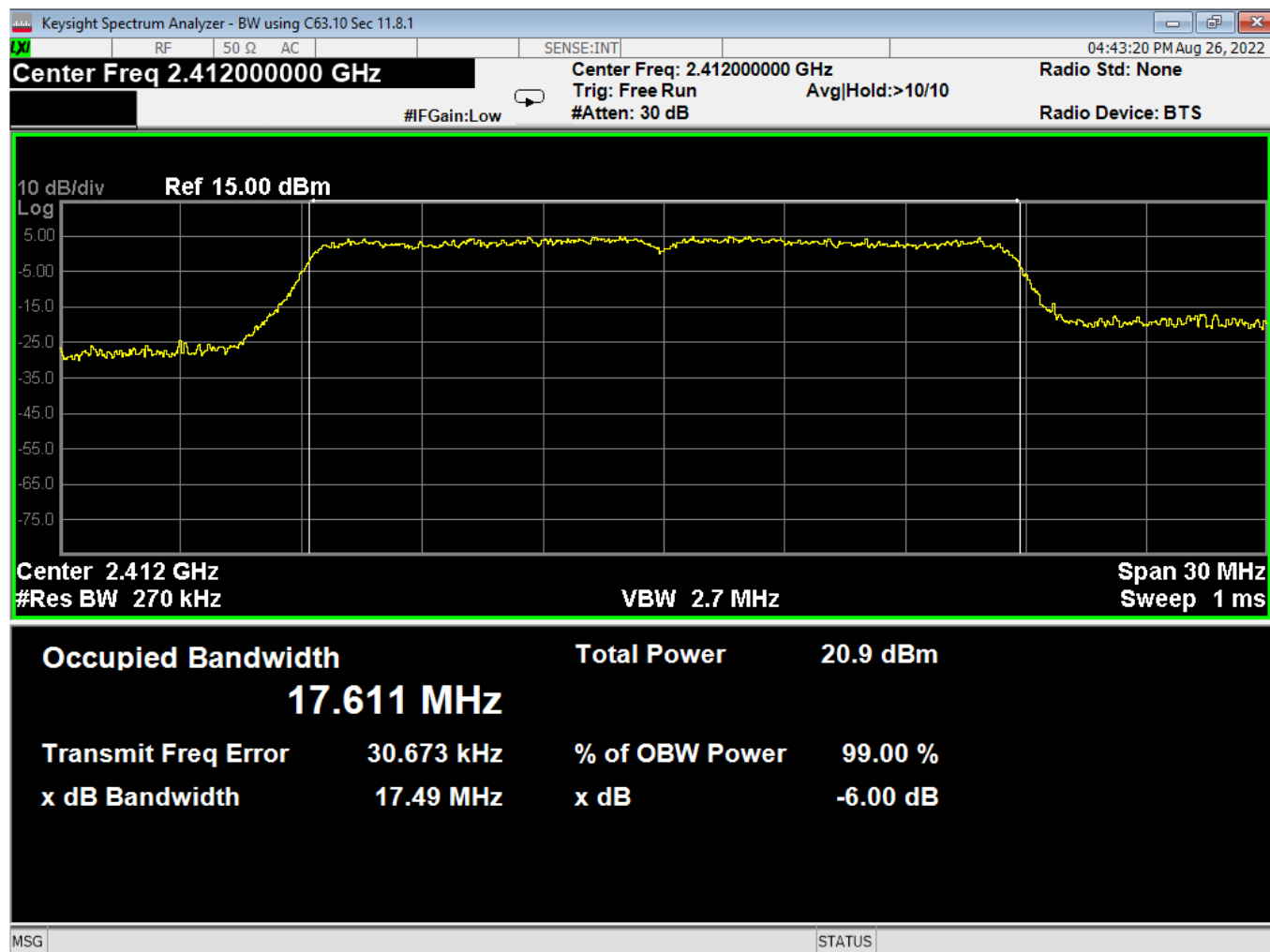


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Prepared for: Garmin International, Inc.



85 6dB Bandwidth, Low, Wifi N, Low Data Rate

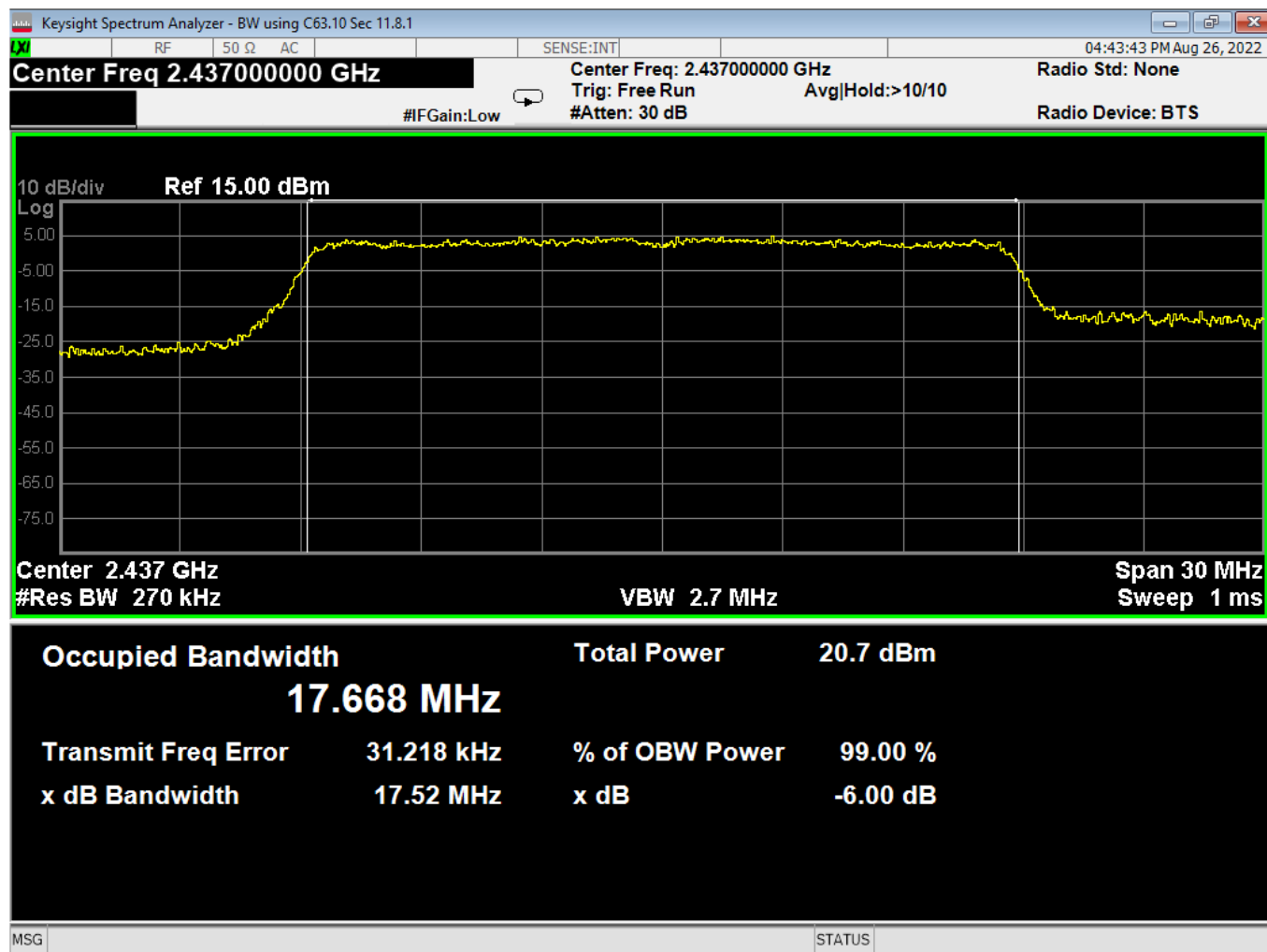


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86 6dB Bandwidth, Mid, Wifi N, Low Data Rate

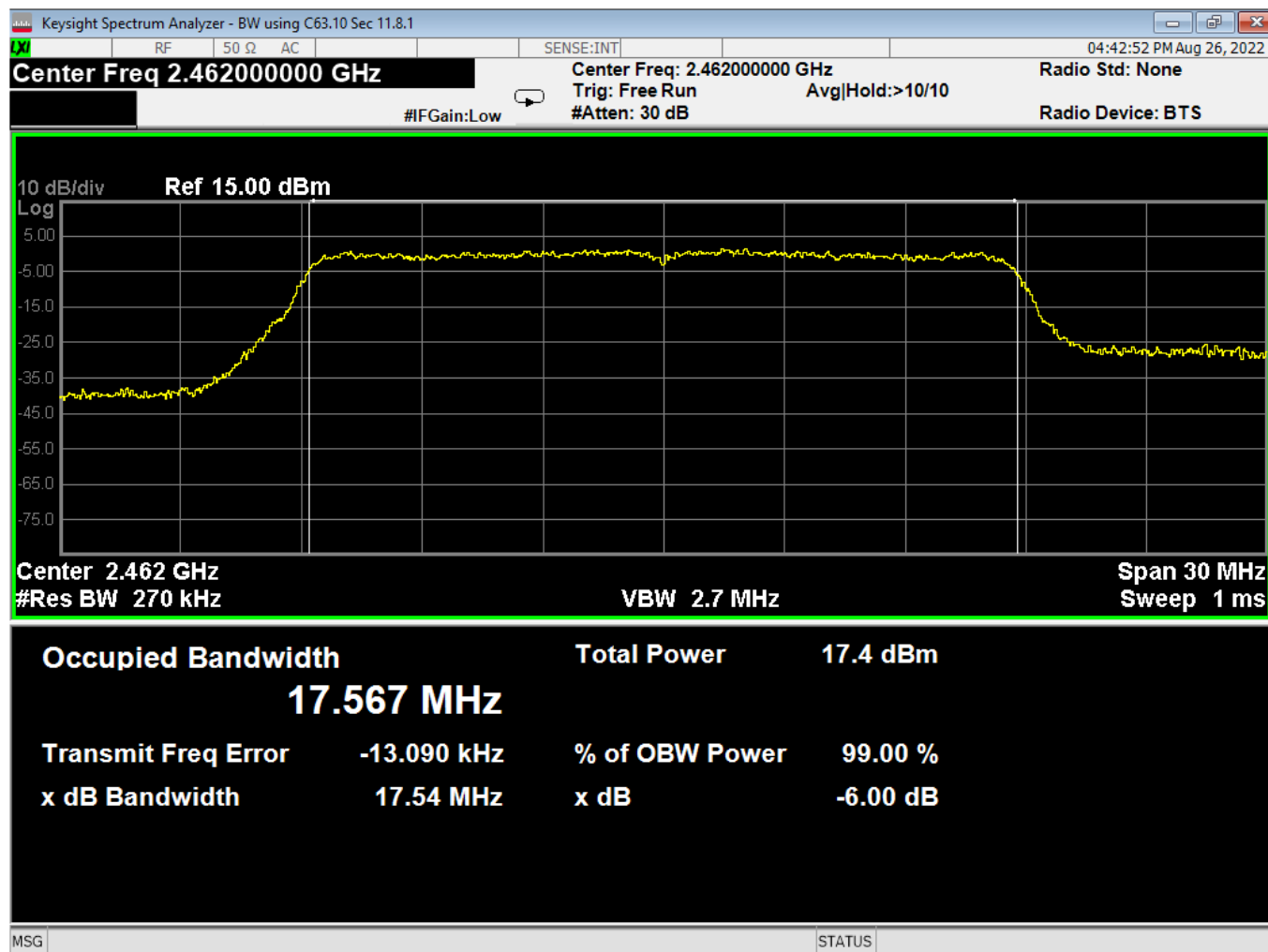


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87 6dB Bandwidth, High, Wifi N, Low Data Rate

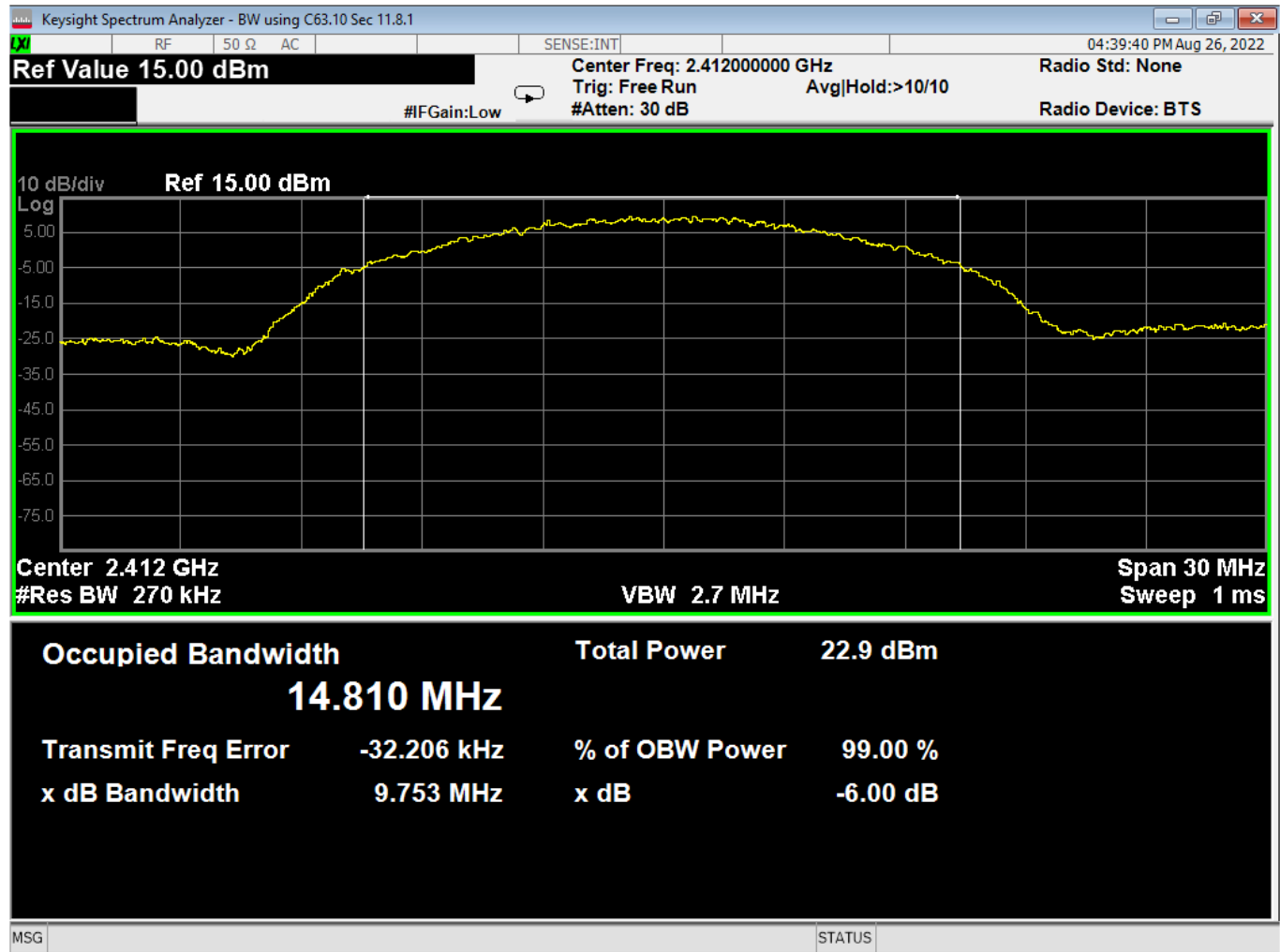


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88 6dB Bandwidth, Low, Wifi B, High Data Rate

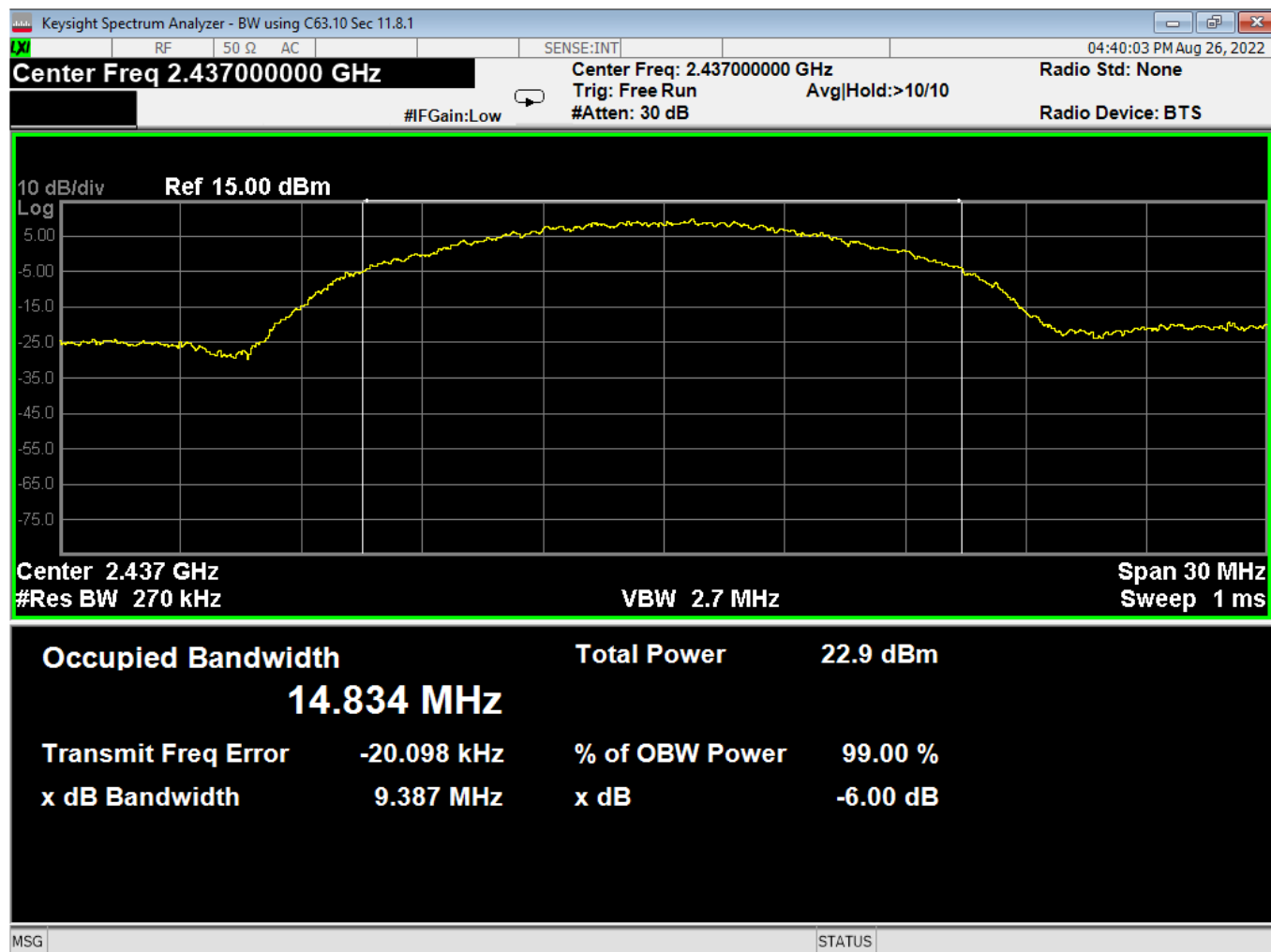


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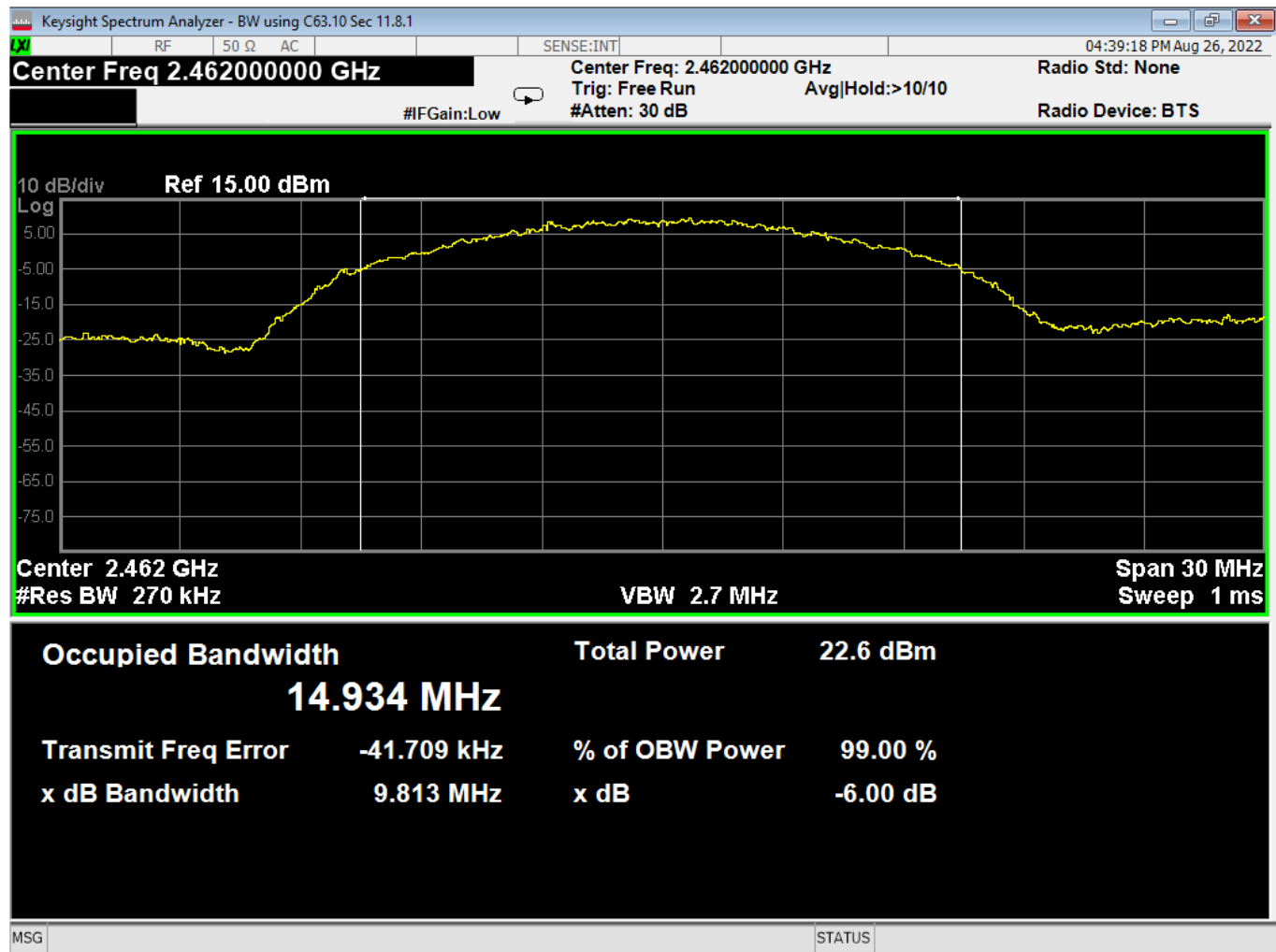
Prepared for: Garmin International, Inc.



89 6dB Bandwidth, Mid, Wifi B, High Data Rate



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90 6dB Bandwidth, High, Wifi B, High Data Rate

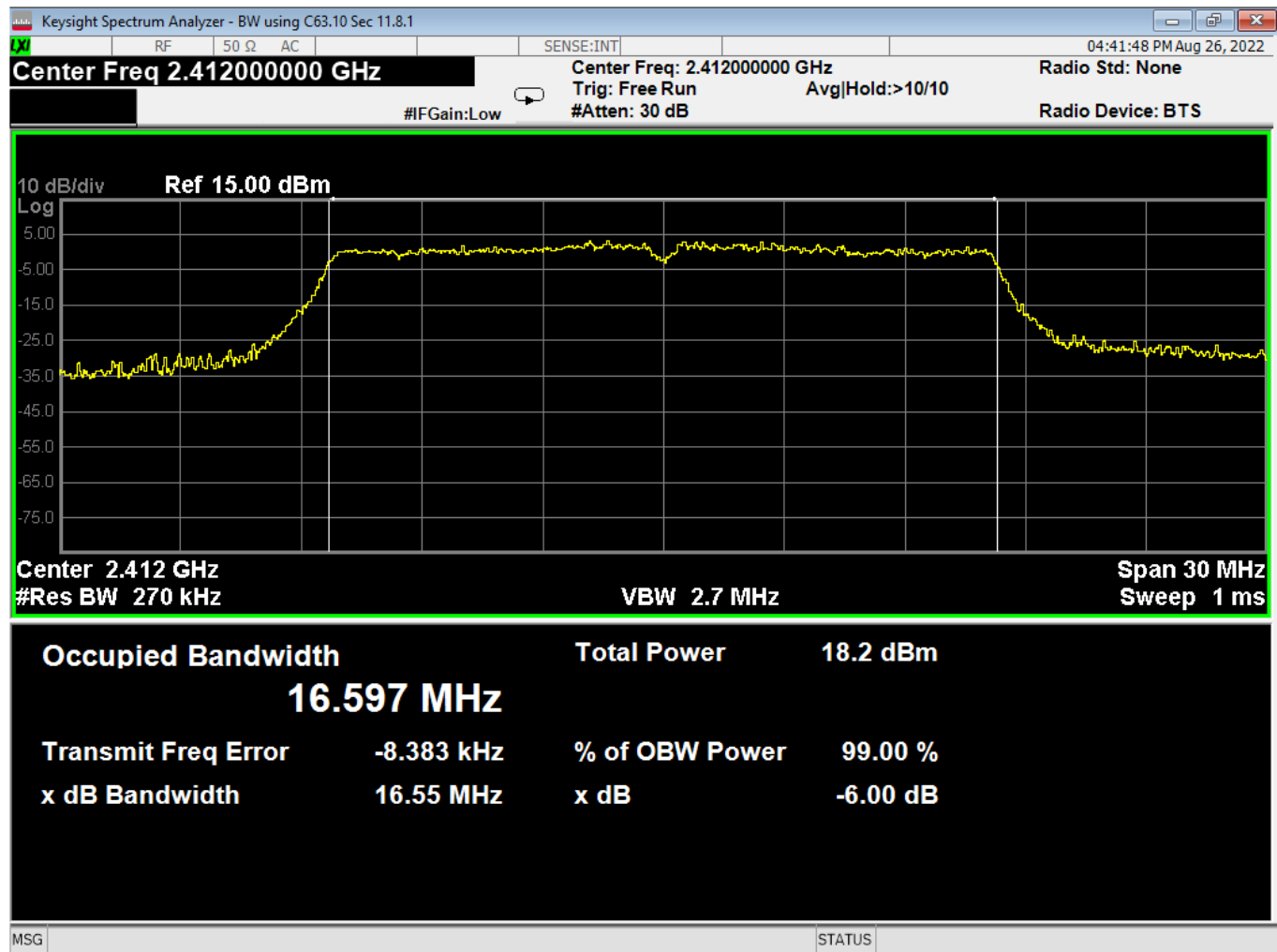


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91 6dB Bandwidth, Low, Wifi G, High Data Rate

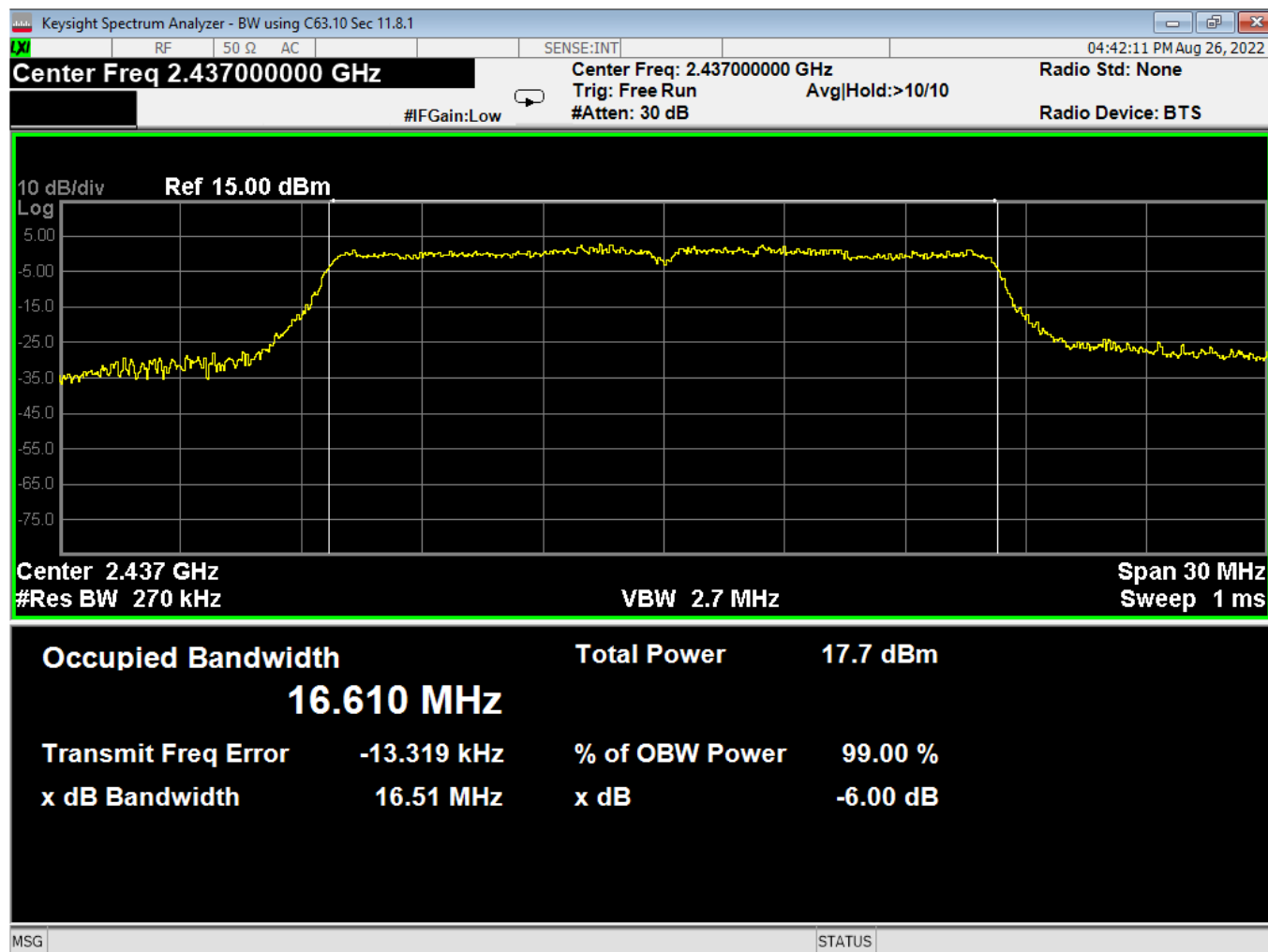


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92 dB Bandwidth, Mid, Wifi G, High Data Rate

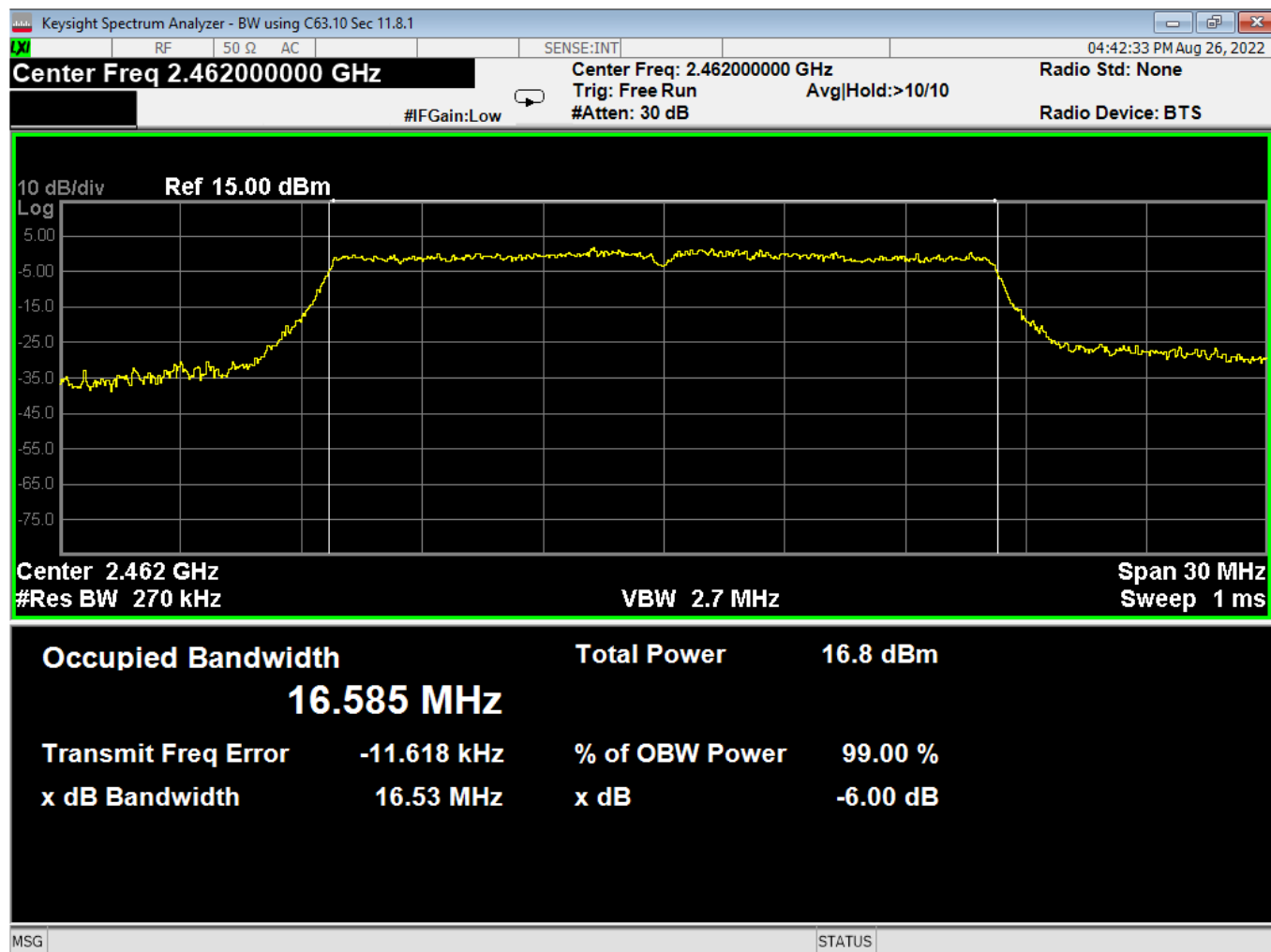


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93 6dB Bandwidth, High, Wifi G, High Data Rate

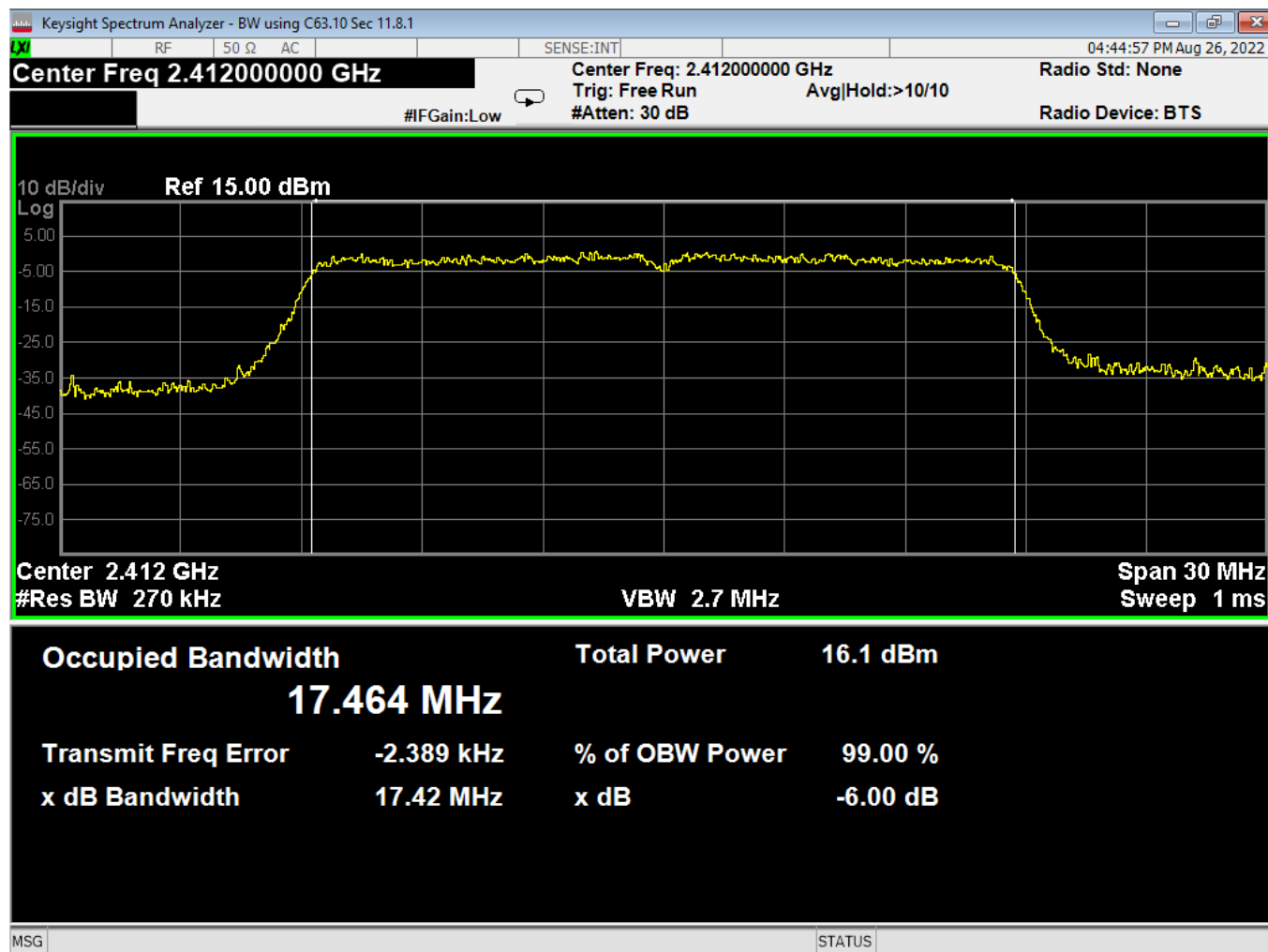


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94 6dB Bandwidth, Low, Wifi N, High Data Rate

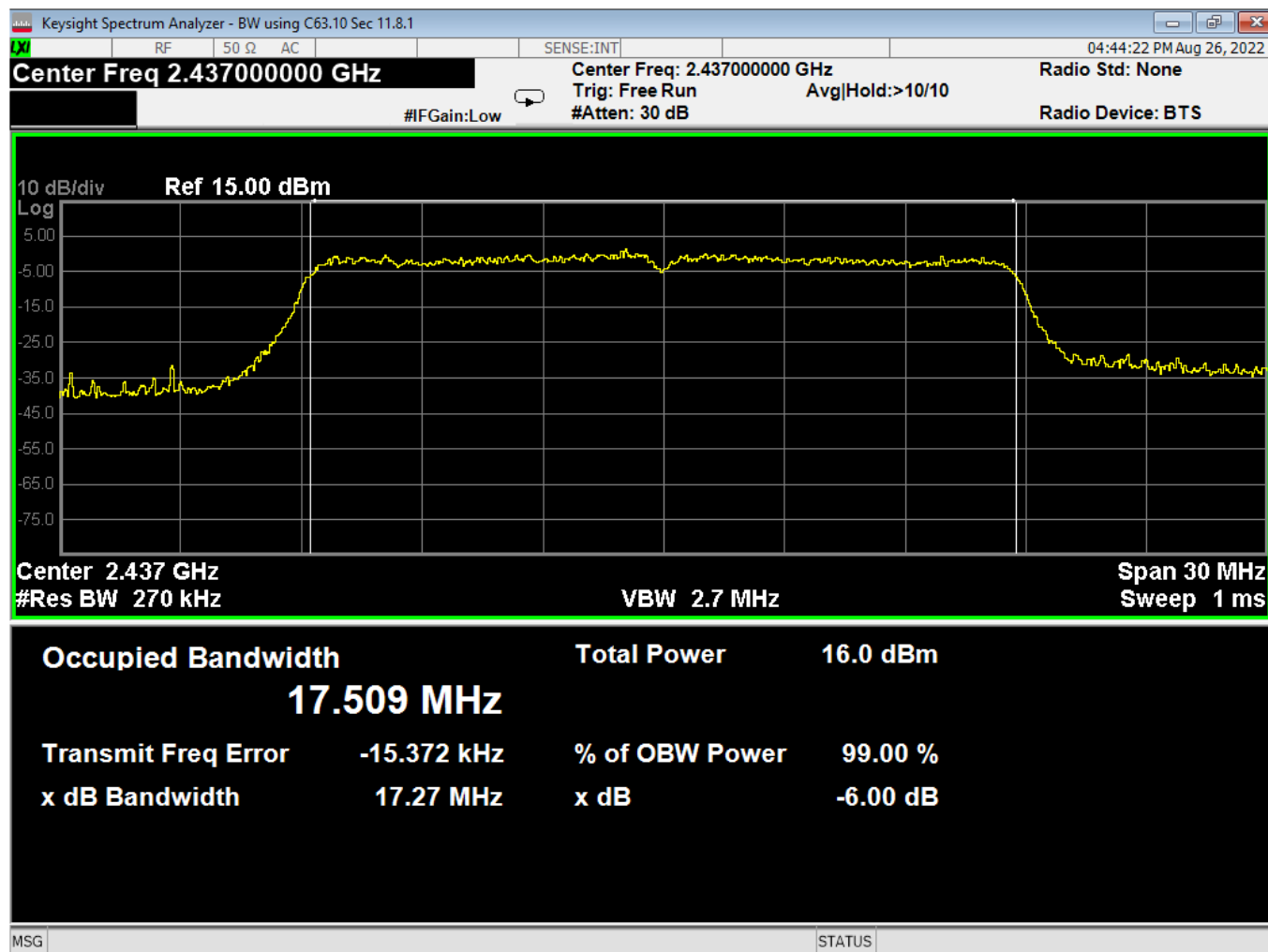


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95 6dB Bandwidth, Mid, Wifi N, High Data Rate

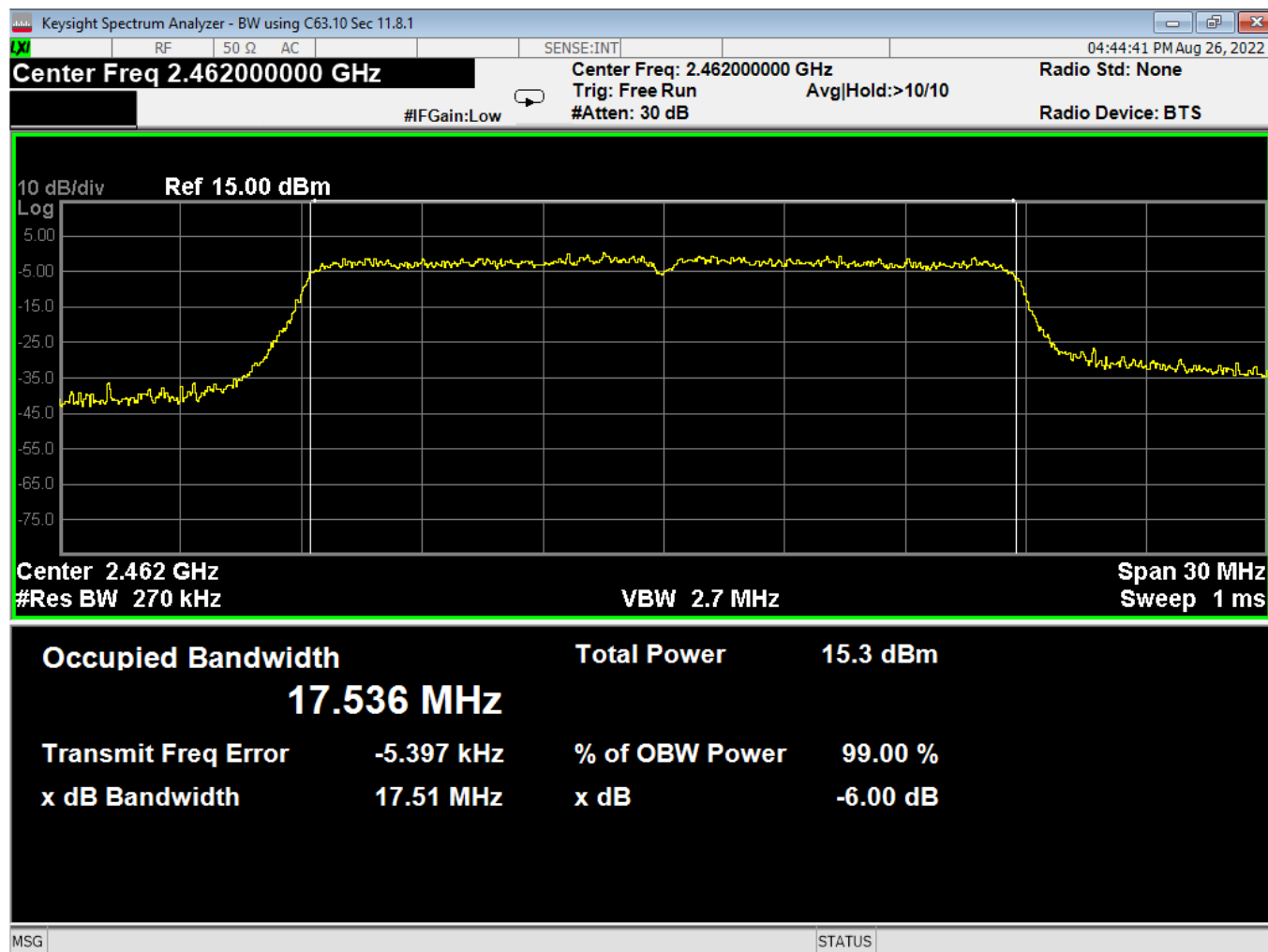


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96 6dB Bandwidth, High, Wifi N, High Data Rate



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REPORT END