

FCC/ISED Test Report

Prepared for: Amusement Connect

Address: 7050 Universal Avenue
Kansas City, MO 64120, USA

Product: MobileMech

Test Report No: R20240403-70-E1B

Approved by:



Fox Lane
EMC Test Engineer

DATE: July 17, 2024

Total Pages: 96

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REVISION PAGE

Rev. No.	Date	Description
0	28 June 2024	Issued by FLane Reviewed by FLane Prepared by ESchmidt
A	29 June 2024	Reformatted – FL
B	17 July 2024	Added Setup Diagram – FL



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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 3

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 3 Section 5.4(d)	Peak output power	Pass
FCC Part 15.247(a)(2) RSS-247 Issue 3 Section 5.2 (a)	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 3 Section 5.5, RSS-Gen Issue 5, Section 8.9	Transmitter Radiated Emissions	Pass
FCC Part 15.247(e) RSS-247 Issue 3 Section 5.2 (b)	Power Spectral Density	Pass
FCC Part 15.209, 15.247(d) RSS-247 Issue 3 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	MobileMech
FCC ID	2BA2JMMGEN1
IC	30456-MMGEN1
EUT Received	31 May 2024
EUT Tested	4 June 2024 - 18 June 2024
Serial No.	F412FA2E5640 (Radiated Measurements) F412FA2E2B58 (Radiated Measurements) F412FA2E3428 (Conducted Measurements)
Operating Band	2400 – 2483.5 MHz
Device Type	<input type="checkbox"/> GMSK <input type="checkbox"/> GFSK <input type="checkbox"/> BT BR <input type="checkbox"/> BT EDR 2MB <input type="checkbox"/> BT EDR 3MB <input checked="" type="checkbox"/> 802.11x
Power Supply / Voltage	12VDC AC to DC switching adapter: Model: GQ12-120100-CU

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 frequencies 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, Review, and Report
2	Blake Winter	Test Engineer	Testing
3	Ethan Schmidt	Test Engineer	Testing and Report

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
ComPower Hybrid Antenna	ACL-6000	10350002	April 29, 2024	April 29, 2025
ETS-Lindgren Red Horn Antenna	3115	218576	July 31, 2023	July 30, 2024
Com-Power LISN, Single Phase	LI-220C	20070017	July 17, 2023	July 17, 2025
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
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	NCEEBH1	June 5, 2023	June 5, 2025
N connector bulkhead (control room)	PE9128	NCEEBH2	June 5, 2023	June 5, 2025
TDK Emissions Lab Software	V11.25	700307	NA	NA
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

*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 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 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.

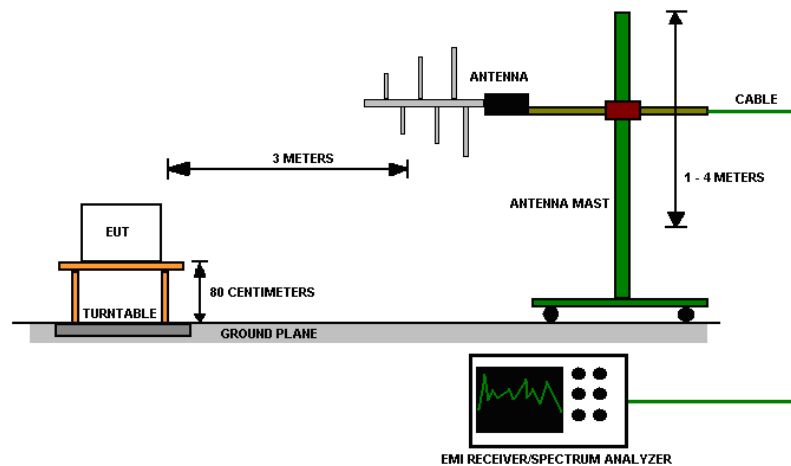


Figure 2 - Radiated Emissions Test Setup

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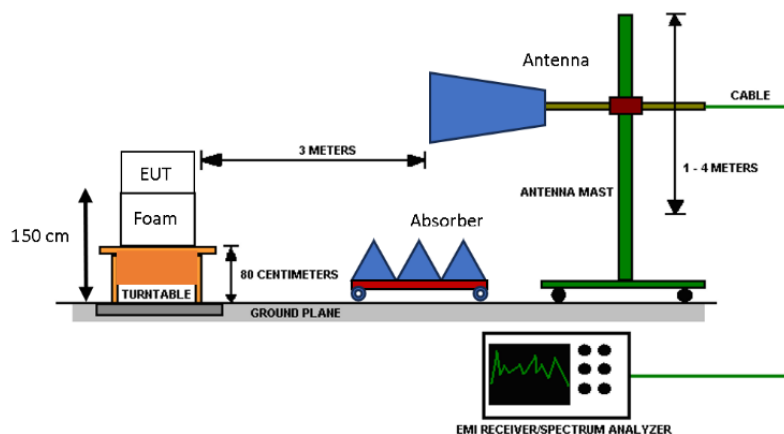


Figure 3 - Radiated Emissions Test Setup, >1GHz



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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	13.062	10.11	7.72	5.916	-14.178	PASS
Mid	802.11 b	13.044	9.536	5.27	3.365	-13.311	PASS
High	802.11 b	13.044	9.57	5.53	3.573	-13.589	PASS
Low	802.11 g	16.535	16.39	7.05	5.070	-14.767	PASS
Mid	802.11 g	16.519	16.39	4.52	2.831	-15.845	PASS
High	802.11 g	16.542	16.42	4.77	2.999	-14.953	PASS
Low	802.11 n	17.3	16.85	5.98	3.963	-15.407	PASS
Mid	802.11 n	17.306	16.81	3.38	2.178	-17.362	PASS
High	802.11 n	17.315	16.93	3.68	2.333	-17.63	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 (dBμV)	Relative Fundamental (dBμV)	Delta (dB)	Min Delta (dB)	Result
Low	802.11 b	2400.00	60.077	108.849	48.773	30.00	PASS
Low	802.11 g	2400.00	63.440	106.123	42.682	30.00	PASS
Low	802.11 n	2400.00	62.802	105.016	42.214	30.00	PASS
High	802.11 b	2483.50	55.299	109.517	54.218	30.00	PASS
High	802.11 g	2483.50	54.981	103.463	48.482	30.00	PASS
High	802.11 n	2483.50	54.170	102.771	48.601	30.00	PASS

Radiated Peak Restricted Band-Edge Low Data Rate

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBμV/m @ 3m)	Measurement Type	Limit (dBμV/m @ 3m)	Margin	Result
Low	802.11 b	2390.00	50.182	Peak	73.98	23.798	PASS
Low	802.11 g	2390.00	67.030	Peak	73.98	6.950	PASS
Low	802.11 n	2390.00	62.734	Peak	73.98	11.246	PASS
High	802.11 b	2483.50	57.500	Peak	73.98	16.480	PASS
High	802.11 g	2483.50	71.211	Peak	73.98	2.769	PASS
High	802.11 n	2483.50	67.408	Peak	73.98	6.572	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 (dB μ V/m @ 3m)	Measurement Type	Limit (dB μ V/m @ 3m)	Margin	Result
Low	802.11 b	2390.00	38.640	Average	53.98	15.340	PASS
Low	802.11 g	2390.00	48.711	Average	53.98	5.269	PASS
Low	802.11 n	2390.00	46.712	Average	53.98	7.268	PASS
High	802.11 b	2483.50	46.276	Average	53.98	7.704	PASS
High	802.11 g	2483.50	51.348	Average	53.98	2.632	PASS
High	802.11 n	2483.50	50.494	Average	53.98	3.486	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	13.017	9.151	7.74	5.943	-10.461	PASS
Mid	802.11 b	13.011	9.773	5.28	3.373	-13.228	PASS
High	802.11 b	13.002	8.984	5.53	3.573	-10.516	PASS
Low	802.11 g	16.539	16.49	see below tables for 802.11g/n High data rate tabulated power values		-17.376	PASS
Mid	802.11 g	16.524	16.48			-19.925	PASS
High	802.11 g	16.534	16.49			-19.944	PASS
Low	802.11 n	17.345	17.02			-17.259	PASS
Mid	802.11 n	17.355	17.01			-19.82	PASS
High	802.11 n	17.353	17.01			-19.893	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 (dBμV)	Relative Fundamental (dBμV)	Delta (dB)	Min Delta (dB)	Result
Low	802.11 b	2400.00	62.017	111.237	49.22	30.00	PASS
Low	802.11 g	2400.00	62.608	104.652	42.044	30.00	PASS
Low	802.11 n	2400.00	62.512	104.110	41.598	30.00	PASS
High	802.11 b	2483.50	54.074	108.767	54.693	30.00	PASS
High	802.11 g	2483.50	51.545	101.893	50.347	30.00	PASS
High	802.11 n	2483.50	52.111	101.444	49.334	30.00	PASS

Radiated Peak Restricted Band-Edge High Data Rate

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBμV/m @ 3m)	Measurement Type	Limit (dBμV/m @ 3m)	Margin	Result
Low	802.11 b	2390.00	55.569	Peak	73.98	18.411	PASS
High	802.11 b	2483.50	57.319	Peak	73.98	16.661	PASS

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

Radiated Average Restricted Band-Edge High Data Rate

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBμV/m @ 3m)	Measurement Type	Limit (dBμV/m @ 3m)	Margin	Result
Low	802.11 b	2390.00	43.947	Average	53.98	10.033	PASS
High	802.11 b	2483.50	45.677	Average	53.98	8.303	PASS

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



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DTS Power Measurements

CHANNEL	Transmitter	Raw Avg Output Power (dBm)	DCCF (dB) (for Power)**	Corrected Avg Output Power(dBm)	Corrected Avg Output Power(mW)	RESULT
Low	802.11 g	5.11	0.164	5.27	3.37	PASS
Mid	802.11 g	2.37	0.164	2.53	1.79	PASS
High	802.11 g	2.49	0.164	2.65	1.84	PASS
Low	802.11 n	4.50	0.173	4.67	2.93	PASS
Mid	802.11 n	1.86	0.173	2.03	1.60	PASS
High	802.11 n	1.98	0.173	2.15	1.64	PASS

**See Section 4.3 for more information regarding DCCF

Corrected Avg Power = DCCF + Raw Avg Power

Radiated Peak Restricted Band-Edge High Data Rate

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Detector	Limit (dBuV/m @ 3m)	Margin	Result
Low	802.11 g	2390.00	61.865	Average	73.98	12.115	PASS
High	802.11 g	2483.50	60.400	Average	73.98	13.58	PASS
Low	802.11 n	2390.00	62.495	Average	73.98	11.485	PASS
High	802.11 n	2483.50	58.734	Average	73.98	15.246	PASS

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

Radiated Average Restricted Band-Edge High Data Rate

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Avg Out of Band Level (dBuV/m @ 3m)	DCCF for Emissions (dB)**	Corrected Out of band level (dBuV/m @ 3m)	Meas. Type	Limit (dBuV/m @ 3m)	Margin	Result
Low	802.11 g	2390.00	49.377	0.327	49.704	Average	53.98	4.276	PASS
High	802.11 g	2390.00	47.539	0.327	47.866	Average	53.98	6.114	PASS
Low	802.11 n	2483.50	49.055	0.346	49.401	Average	53.98	4.579	PASS
High	802.11 n	2483.50	47.323	0.346	47.669	Average	53.98	6.311	PASS

Corrected Out of band level = Avg out of band level + DCCF for emissions

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

**See Section 4.3 for more information regarding DCCF



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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 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 purposes 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 Appendix C.
2. All the measurements were found to be compliant.
3. The measurements are listed in the tables in section 4.0.

4.3 DUTY CYCLE

Test Method:

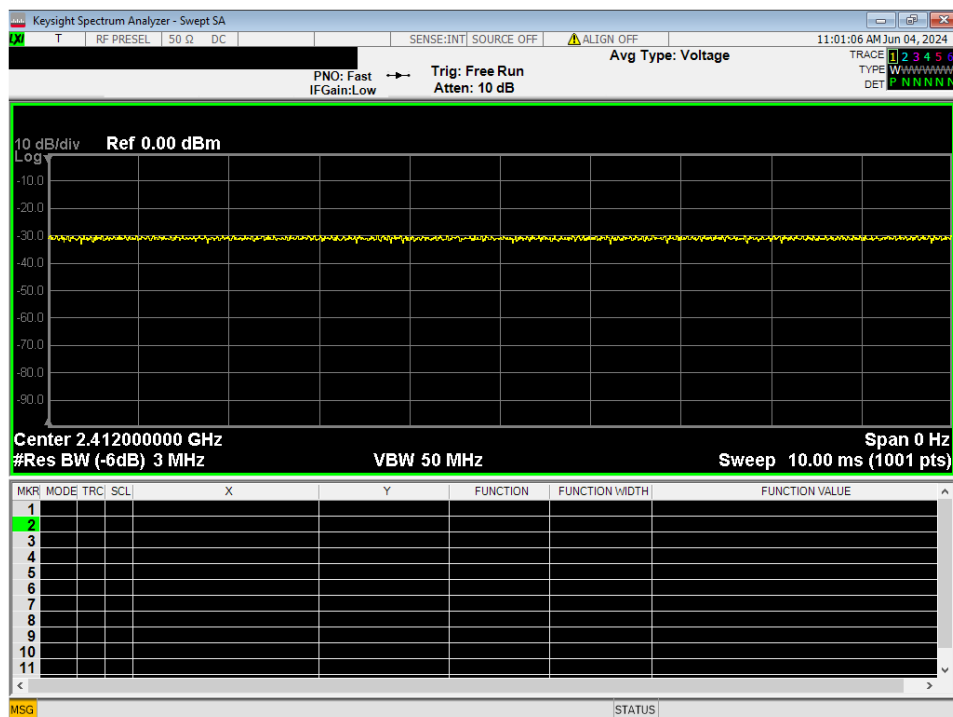


Figure 4 – Duty Cycle, Wifi B 1MB

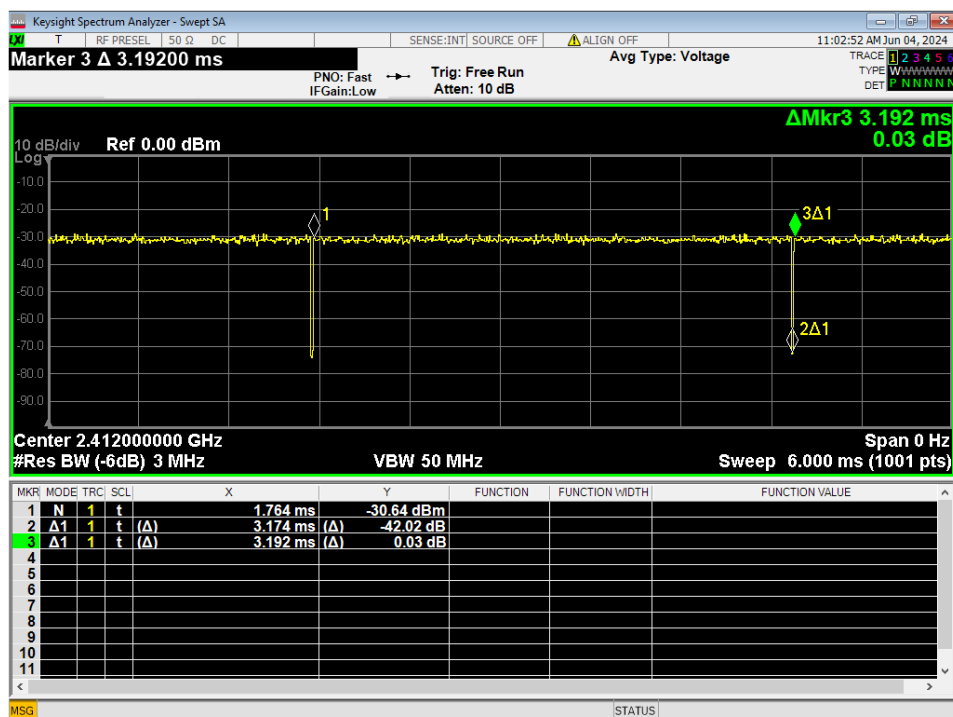


Figure 5 – Duty Cycle, Wifi B 11MB

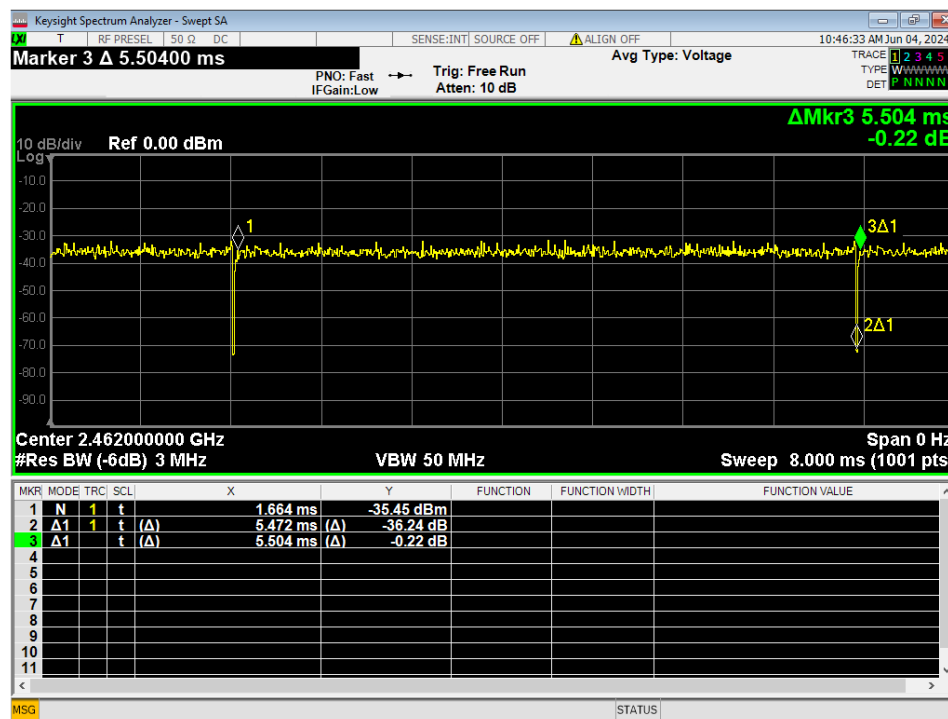


Figure 6 – Duty Cycle, Wifi G 6MB

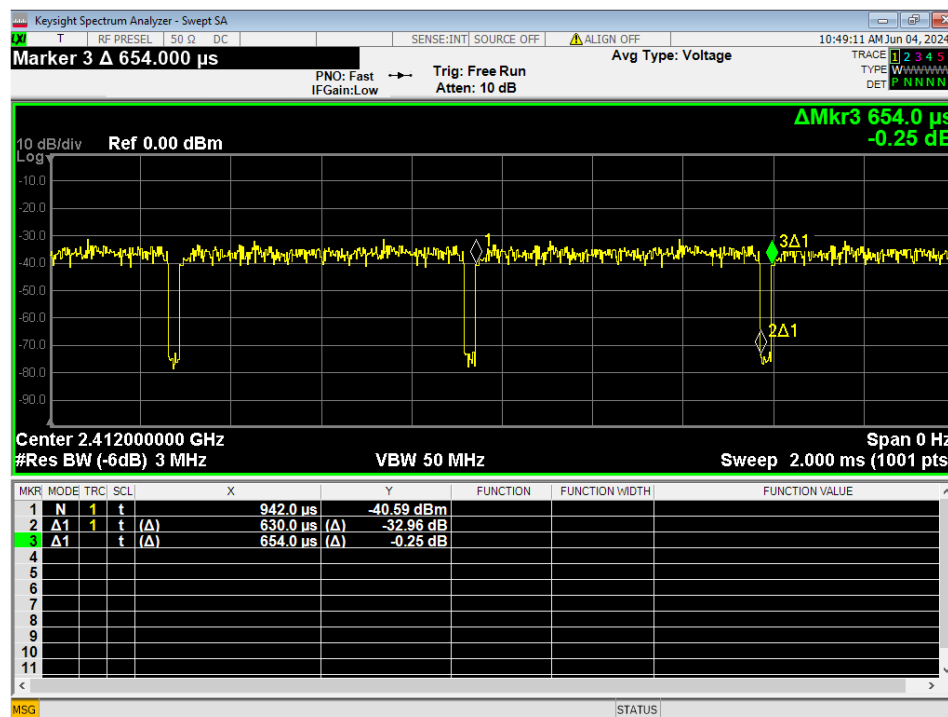


Figure 7 – Duty Cycle, Wifi G 54MB

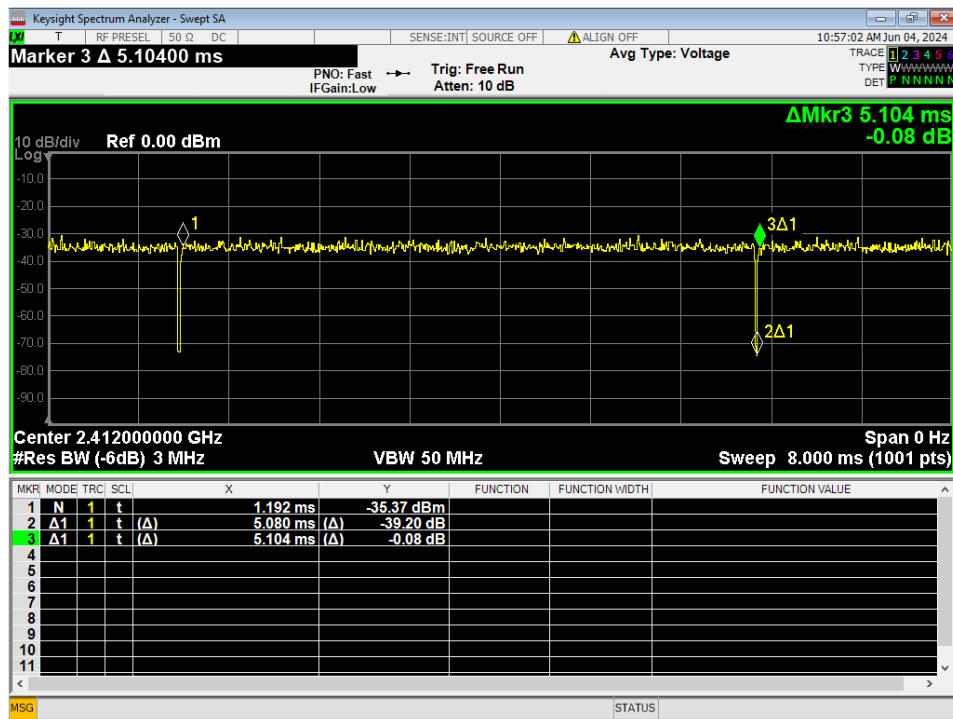


Figure 8 – Duty Cycle, Wifi N MCS0

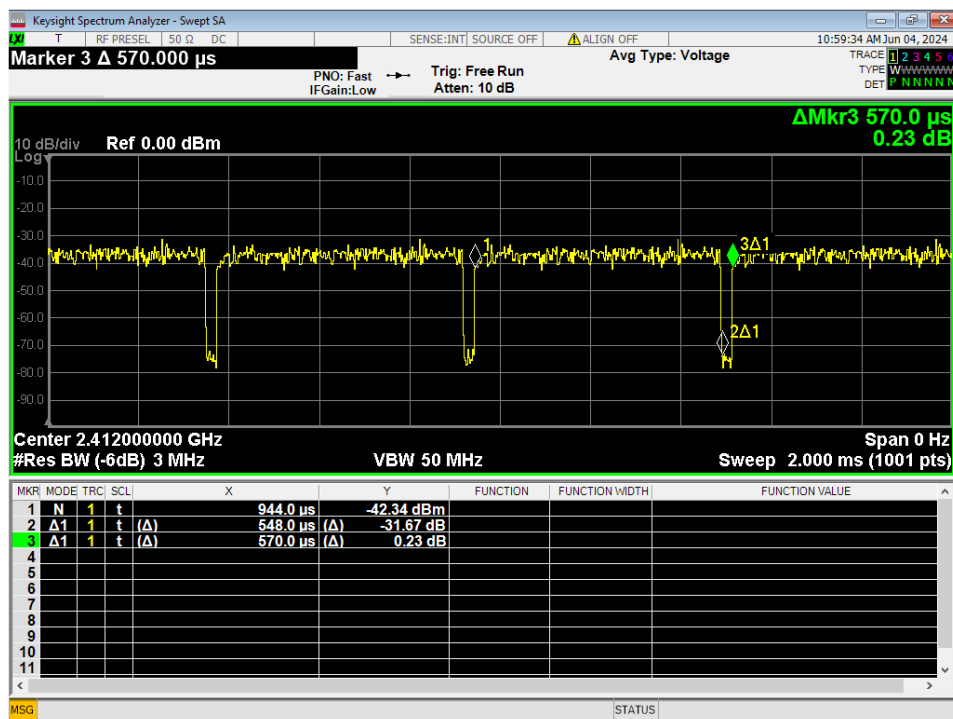


Figure 9 – Duty Cycle, Wifi N MCS7



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Modulation	DC	DCCF For Emissions	DCCF For Power
B 1MB	>98%	0	0
B 11MB	>98%	0	0
G 6MB	>98%	0	0
G 54MB	96.3	0.327	0.164
N MCS0	>98%	0	0
N MCS7	96.1	0.346	0.173

DC = ON Time / Period

DCCF For Emissions = $20 \cdot \log(1/DC)$ DCCF For Power = $10 \cdot \log(1/DC)$ **B 1MB:**

>98%

B 11MB:

DC = 3.174ms/3.192ms >98%

G 6MB:

DC = 5.472ms/5.504ms >98%

G 54MB:

DC = 630/654 = 0.963

DCCF For Emissions = $20 \cdot \log(1/0.963) = 0.327\text{dB}$ DCCF For Power = $10 \cdot \log(1/0.963) = 0.164\text{dB}$ **N MCS0:**

DC = 5.080ms/5.104 >98%

N MCS7:

DC = 548/570 = 0.961

DCCF For Emissions = $20 \cdot \log(1/0.961) = 0.346\text{dB}$ DCCF For Power = $10 \cdot \log(1/0.961) = 0.173\text{dB}$

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 worst-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:

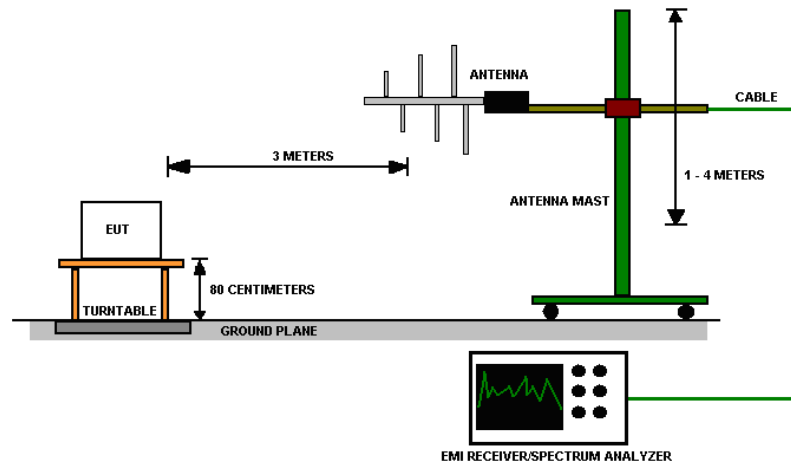


Figure 10 - Radiated Emissions Test Setup

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:

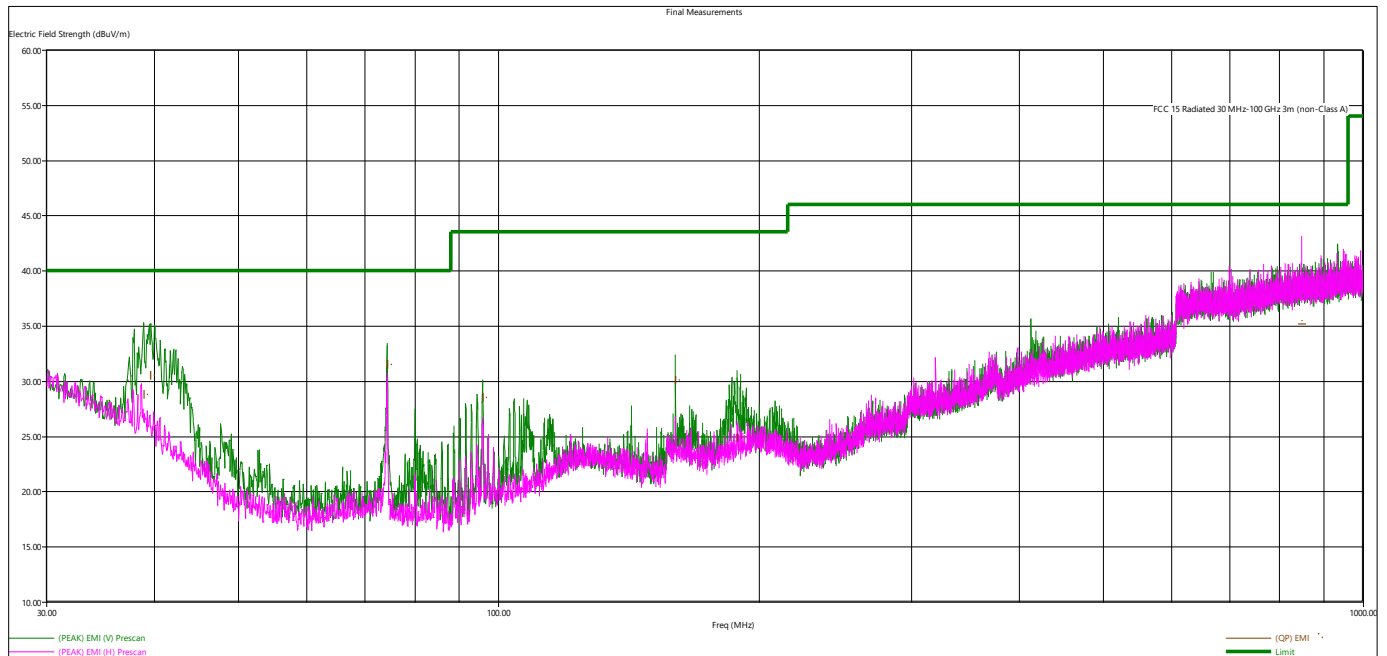


Figure 11 - Radiated Emissions Plot, RX (Packets)

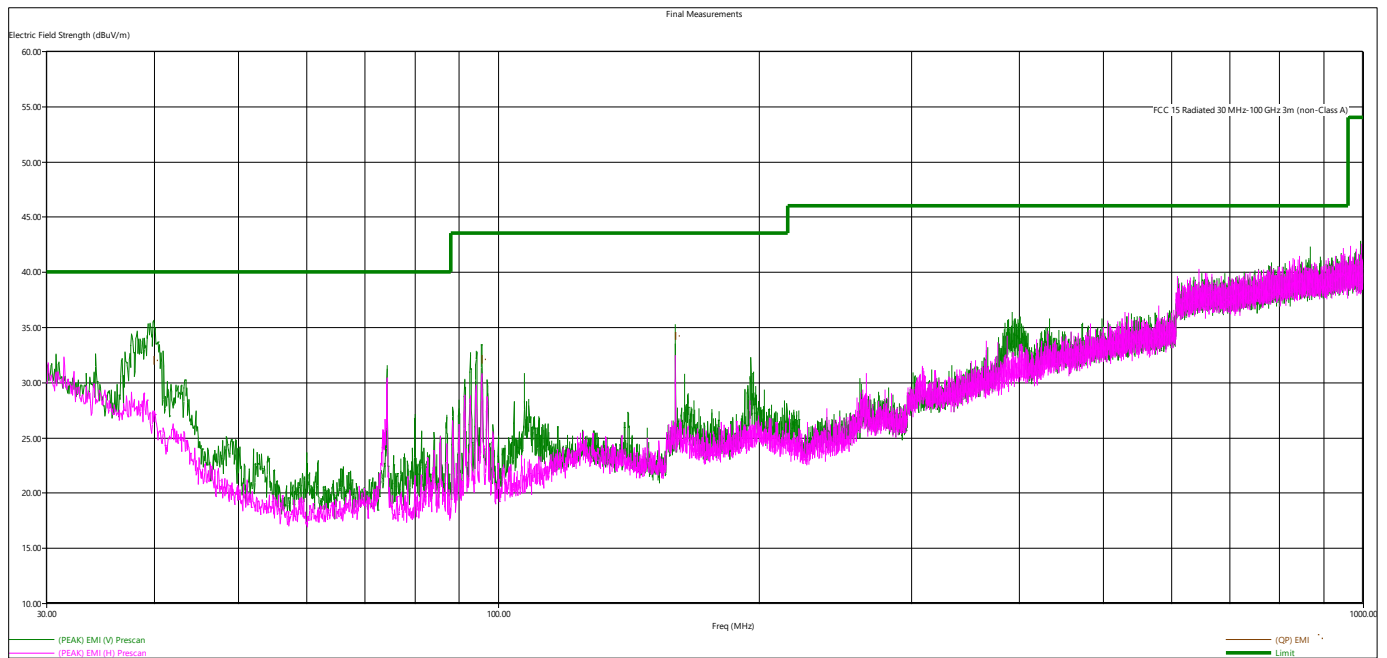


Figure 12 - Radiated Emissions Plot, 802.11b 1MB

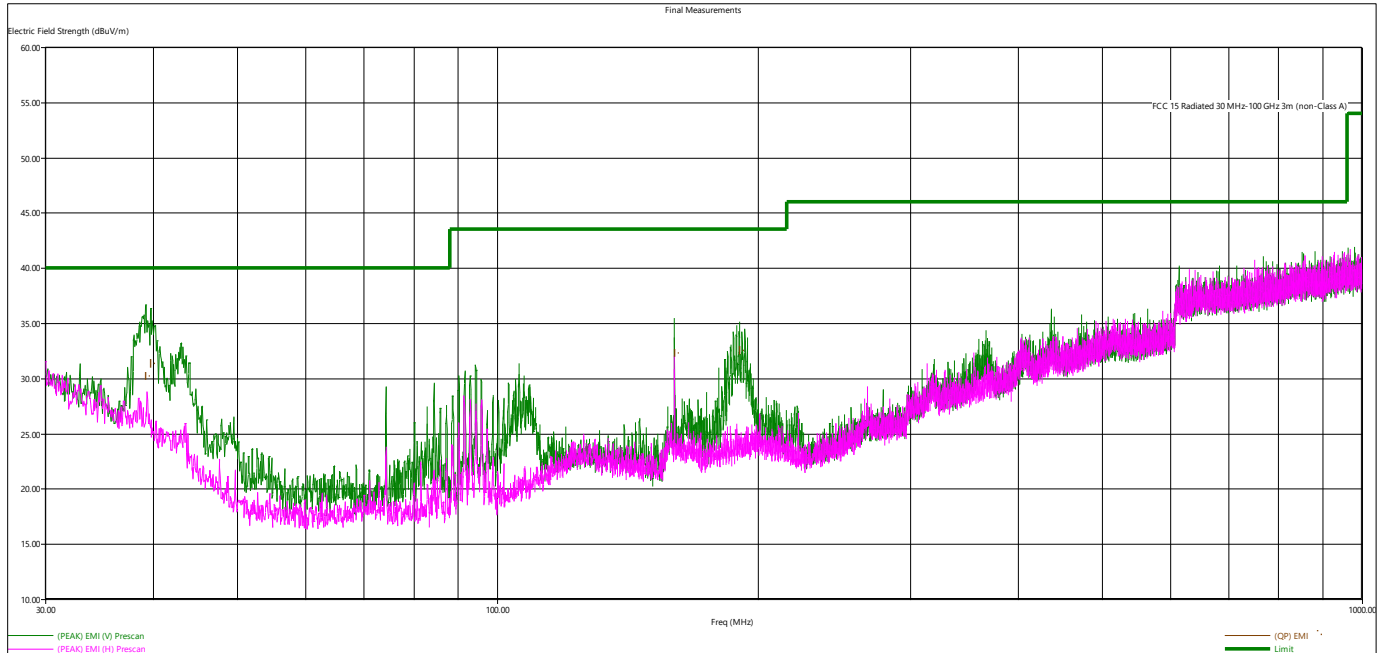


Figure 13 - Radiated Emissions Plot, 802.11b 11MB

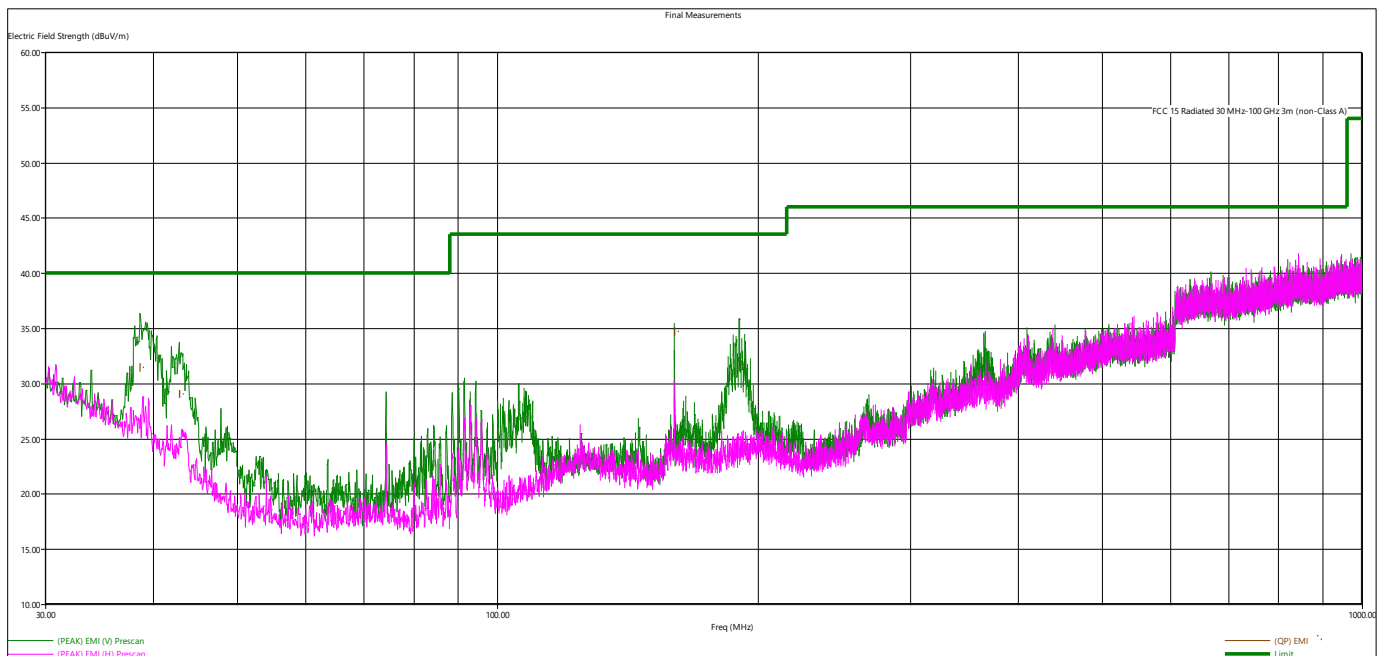


Figure 14 - Radiated Emissions Plot, 802.11g 6MB

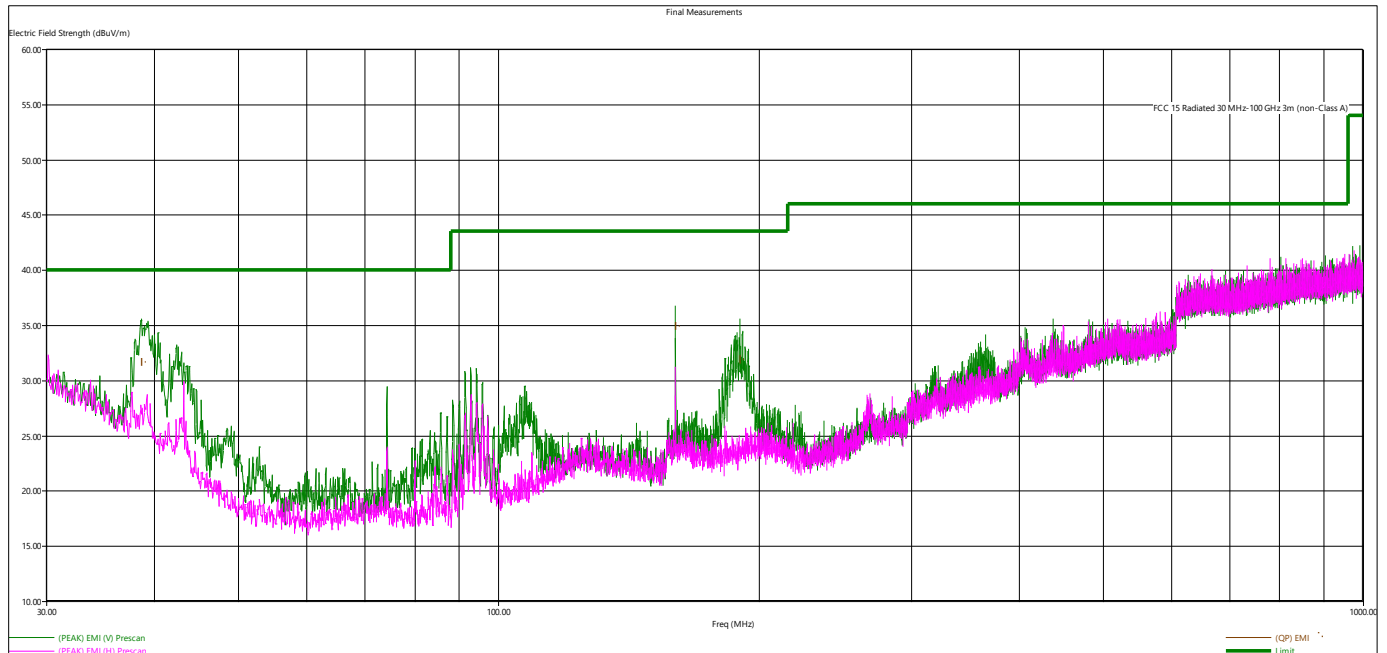


Figure 15 - Radiated Emissions Plot, 802.11g 54MB

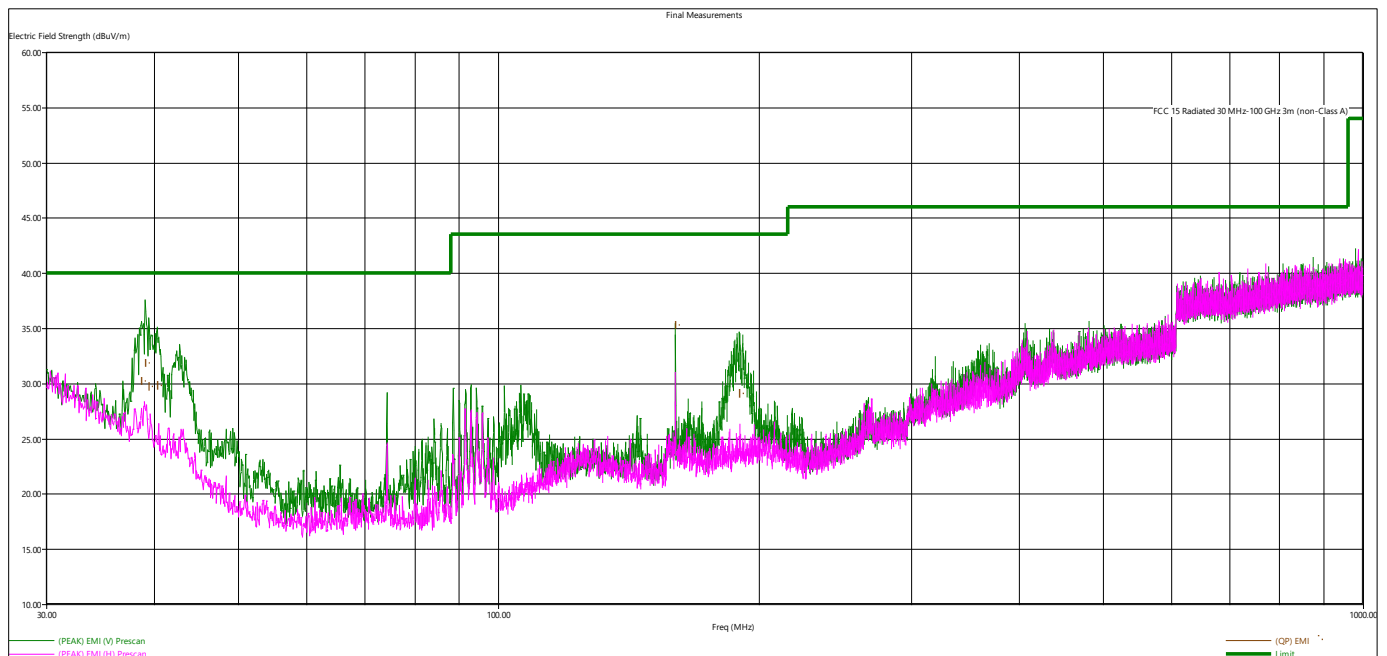


Figure 16 - Radiated Emissions Plot, 802.11n MCS0

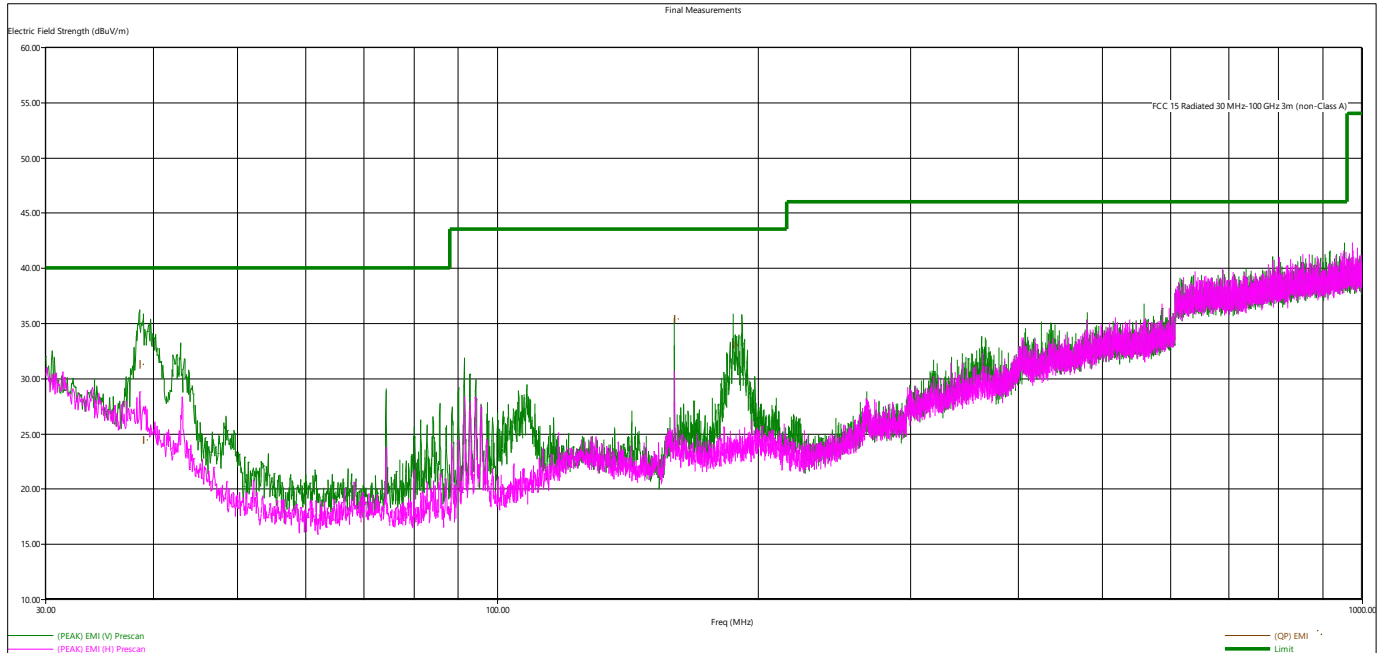


Figure 17 - Radiated Emissions Plot, 802.11n MCS7

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.			
40.028400	31.95	40.00	8.05	105.00	154.50	V	Low	B 1MB
95.583120	32.00	43.52	11.52	133.00	51.25	V	Low	B 1MB
160.024320	34.18	43.52	9.34	104.76	62.00	V	Low	B 1MB
39.206400	30.21	40.00	9.79	134.43	36.25	V	Mid	B 11MB
39.507600	31.27	40.00	8.73	108.22	194.50	V	Mid	B 11MB
160.038000	32.27	43.52	11.25	110.31	254.50	V	Mid	B 11MB
190.277040	32.45	43.52	11.07	104.46	47.25	V	Mid	B 11MB
38.529360	31.43	40.00	8.57	103.80	86.25	V	Mid	G 6MB
42.953040	29.02	40.00	10.98	107.62	306.00	V	Mid	G 6MB
160.021440	34.65	43.52	8.87	108.16	258.25	V	Mid	G 6MB
190.233360	31.65	43.52	11.87	110.19	32.25	V	Mid	G 6MB
38.684400	31.59	40.00	8.41	109.89	360.00	V	Mid	G 54MB
159.973920	34.85	43.52	8.67	104.70	279.25	V	Mid	G 54MB
189.923040	31.85	43.52	11.67	124.10	40.50	V	Mid	G 54MB



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38.606160	30.18	40.00	9.82	118.85	118.25	V	Mid	N MCS0
38.912880	31.80	40.00	8.20	98.07	69.75	V	Mid	N MCS0
39.403920	29.63	40.00	10.37	146.49	0.75	V	Mid	N MCS0
40.149600	29.77	40.00	10.23	105.83	338.50	V	Mid	N MCS0
160.006560	35.25	43.52	8.27	109.89	293.00	V	Mid	N MCS0
189.720000	29.10	43.52	14.42	108.04	166.25	V	Mid	N MCS0
38.534880	31.22	40.00	8.78	105.17	360.25	V	Mid	N MCS7
39.122400	24.40	40.00	15.60	343.26	282.25	V	Mid	N MCS7
159.989040	35.35	43.52	8.17	103.38	295.00	V	Mid	N MCS7
187.109280	32.97	43.52	10.55	105.53	41.75	V	Mid	N MCS7
848.175600	35.15	46.02	10.87	324.20	273.50	H	Receive	
38.682000	28.74	40.00	11.26	105.70	229.75	V	Receive	
39.711600	30.46	40.00	9.54	119.07	41.50	V	Receive	
74.263200	31.47	40.00	8.53	396.56	304.25	V	Receive	

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



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Peak Measurements, 802.11x

Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dBμV/m	dBμV/m	dB	cm.	deg.			
4823.678000	58.09	73.98	15.89	113.29	35.00	H	Low	B 1MB
4873.984	57.86	73.98	16.12	121.01	284.75	H	Mid	B 1MB
4923.944	56.24	73.98	17.74	187.76	284.75	H	High	B 1MB
4824.12	62.39	73.98	11.59	317.19	246.5	H	Low	B 11MB
4873.848	59.9	73.98	14.08	175.7	250.5	H	Mid	B 11MB
4923.662	56.55	73.98	17.43	290.44	246.75	H	High	B 11MB
4823.818	58.11	73.98	15.87	180.71	245.75	H	Low	G 6MB
4869.402	55.57	73.98	18.41	175.82	245.75	H	Mid	G 6MB
4917.844	54.41	73.98	19.57	210.92	245	H	High	G 6MB
4824.67	55.43	73.98	18.55	309.43	243.25	H	Low	G 54MB
4878.05	52.81	73.98	21.17	254.86	251.5	H	Mid	G 54MB
4915.486	50.99	73.98	22.99	248.77	250.5	H	High	G 54MB
4825.634	58.17	73.98	15.81	313.85	243.25	H	Low	N MCS0
4876.48	54.83	73.98	19.15	265.55	251	H	Mid	N MCS0
4920.146	53.05	73.98	20.93	304.23	257	H	High	N MCS0
4819.528	54.91	73.98	19.07	112.53	222.25	H	Low	N MCS7
4873.362	51.13	73.98	22.85	133.73	285	H	Mid	N MCS7
4925.968	48.31	73.98	25.67	119.28	284	H	High	N 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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Average Measurements, 802.11x

Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dBμV/m	dBμV/m	dB	cm.	deg.			
4823.678000	51.42	53.98	2.56	113.29	35.00	H	Low	B 1MB
4873.984	51.91	53.98	2.07	121.01	284.75	H	Mid	B 1MB
4923.944	50.08	53.98	3.90	187.76	284.75	H	High	B 1MB
4824.12	49.6	53.98	4.38	317.19	246.5	H	Low	B 11MB
4873.848	46.52	53.98	7.46	175.7	250.5	H	Mid	B 11MB
4923.662	44.24	53.98	9.74	290.44	246.75	H	High	B 11MB
4823.818	46.74	53.98	7.24	180.71	245.75	H	Low	G 6MB
4869.402	43.01	53.98	10.97	175.82	245.75	H	Mid	G 6MB
4917.844	40.17	53.98	13.81	210.92	245	H	High	G 6MB
4824.67	44.58	53.98	9.40	309.43	243.25	H	Low	G 54MB
4878.05	40.66	53.98	13.32	254.86	251.5	H	Mid	G 54MB
4915.486	36.72	53.98	17.26	248.77	250.5	H	High	G 54MB
4825.634	45.46	53.98	8.52	313.85	243.25	H	Low	N MCS0
4876.48	42.14	53.98	11.84	265.55	251	H	Mid	N MCS0
4920.146	39.08	53.98	14.9	304.23	257	H	High	N MCS0
4819.528	42.6	53.98	11.38	112.53	222.25	H	Low	N MCS7
4873.362	39.47	53.98	14.51	133.73	285	H	Mid	N MCS7
4925.968	36.76	53.98	17.22	119.28	284	H	High	N 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.

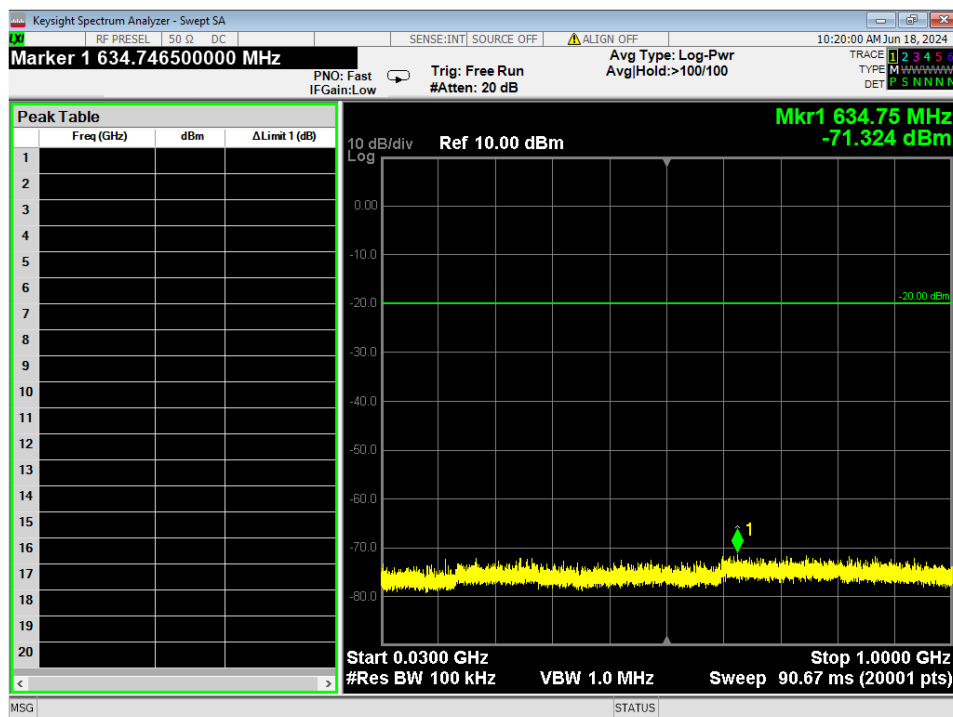


Figure 18 - Radiated Emissions Plot, WIFI 802.11b, 30M – 1G, Low

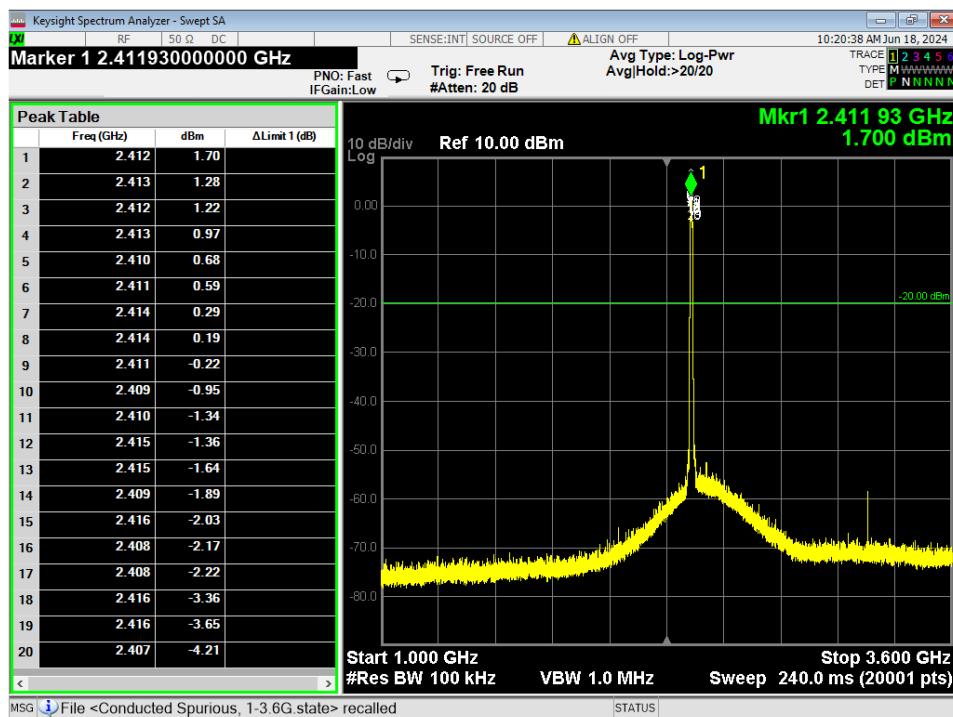



Figure 19 - Radiated Emissions Plot, WIFI 802.11b, 1G – 3.6G, Low

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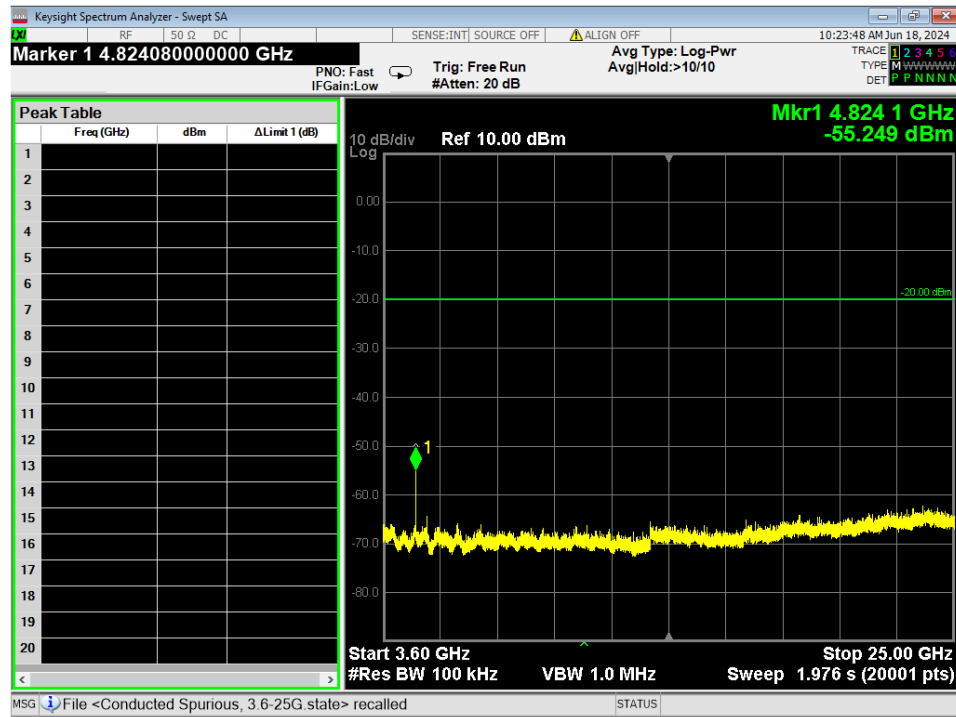


Figure 20 - Radiated Emissions Plot, WIFI 802.11b, 3.6G – 25G, Low

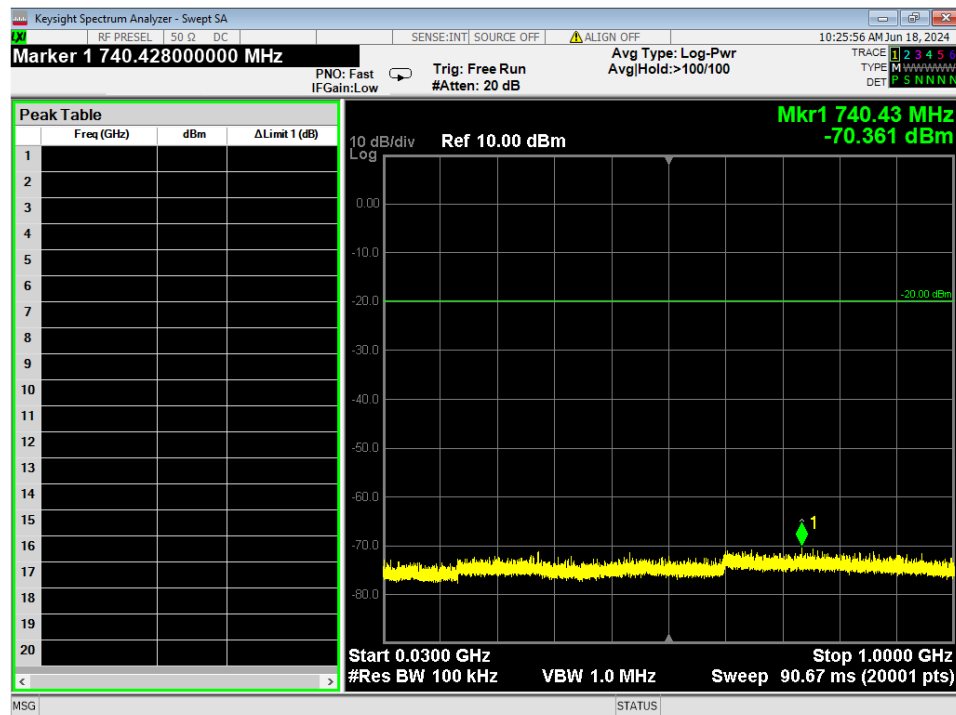


Figure 21 - Radiated Emissions Plot, WIFI 802.11g, 30M – 1G, Low

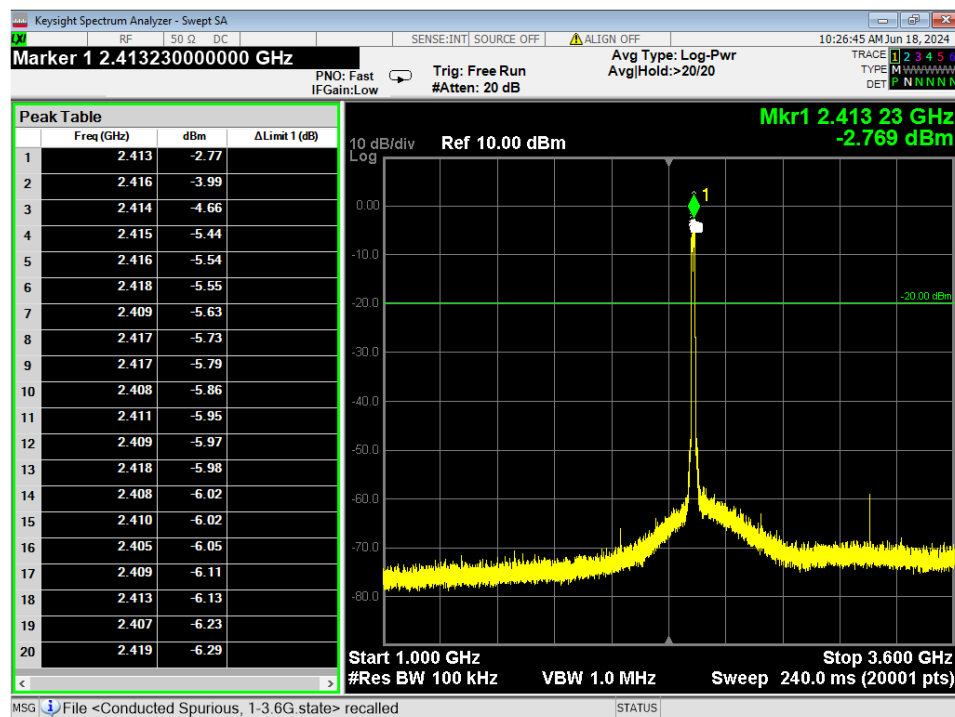


Figure 22 - Radiated Emissions Plot, WIFI 802.11g, 1G – 3.6G, Low

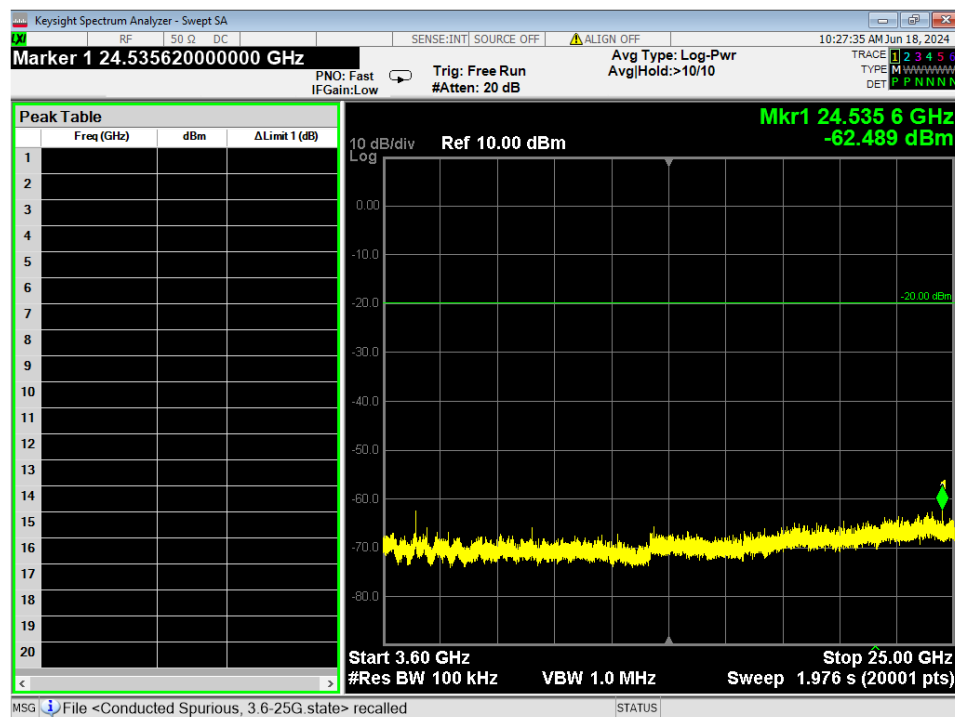


Figure 23 - Radiated Emissions Plot, WIFI 802.11g, 3.6G – 25G, Low

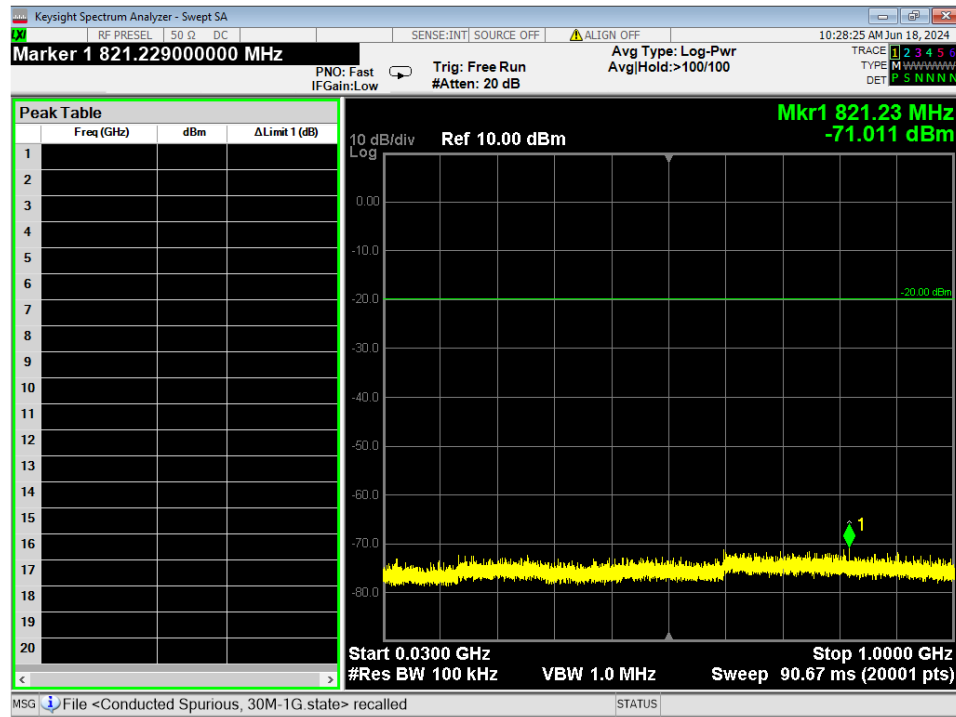


Figure 24 - Radiated Emissions Plot, WIFI 802.11n, 30M – 1G, Low

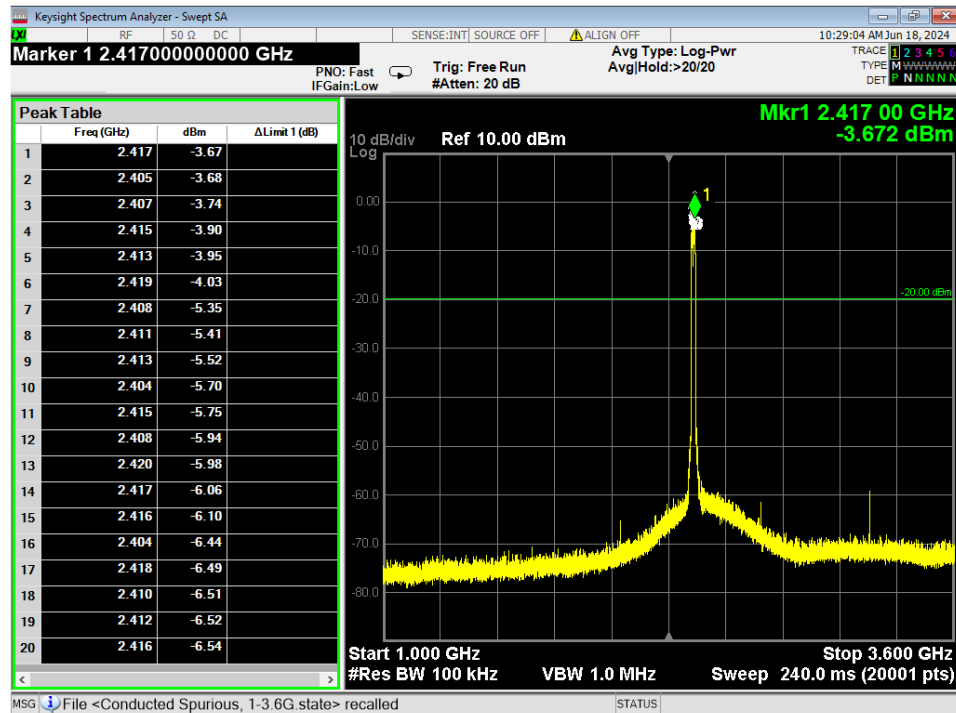


Figure 25 - Radiated Emissions Plot, WIFI 802.11n, 1G – 3.6G, Low

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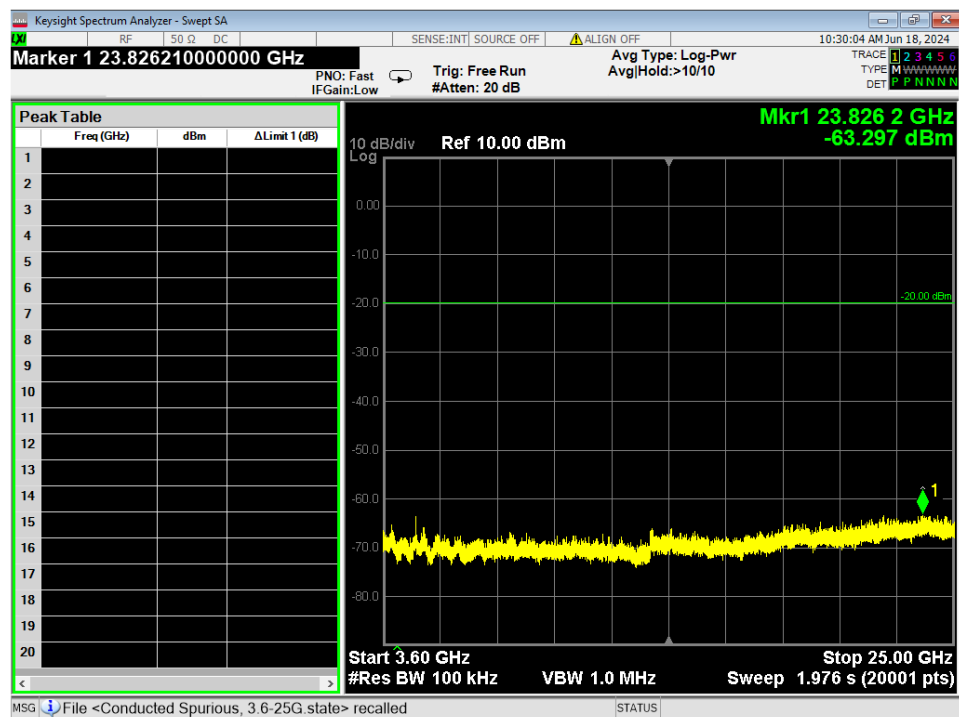


Figure 26 - Radiated Emissions Plot, WIFI 802.11n, 3.6G – 25G, Low



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4.6 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 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 it 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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4.7 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 Appendix C.
2. All the measurements were found to be compliant.
3. The measurements are listed in the tables in section 4.0.

4.8 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 (dB μ V)	
	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:

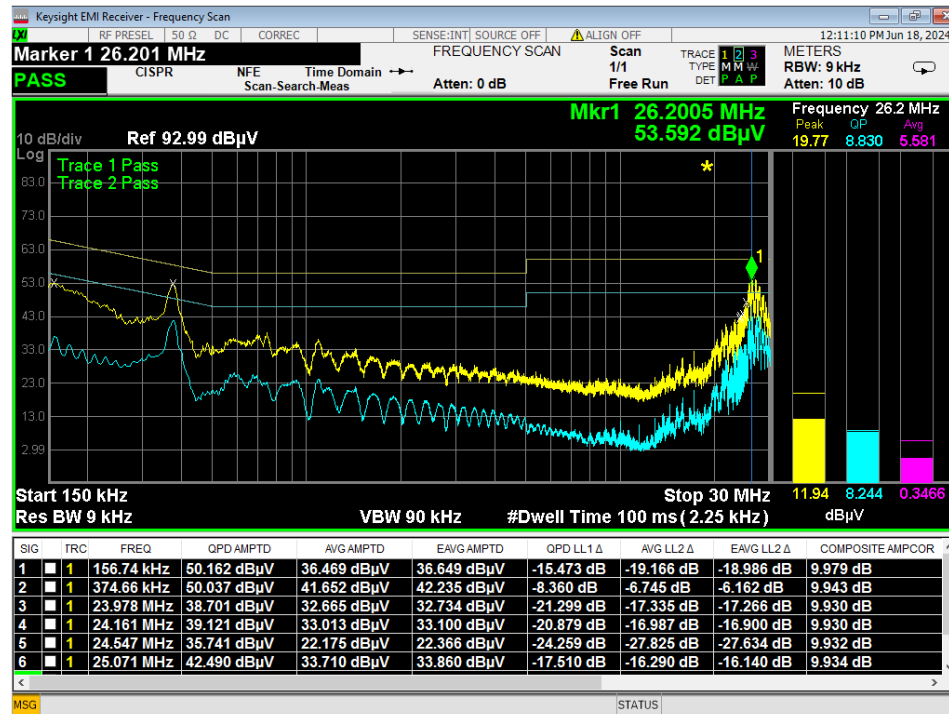


Figure 27 - Conducted Emissions Plot, Line, TX

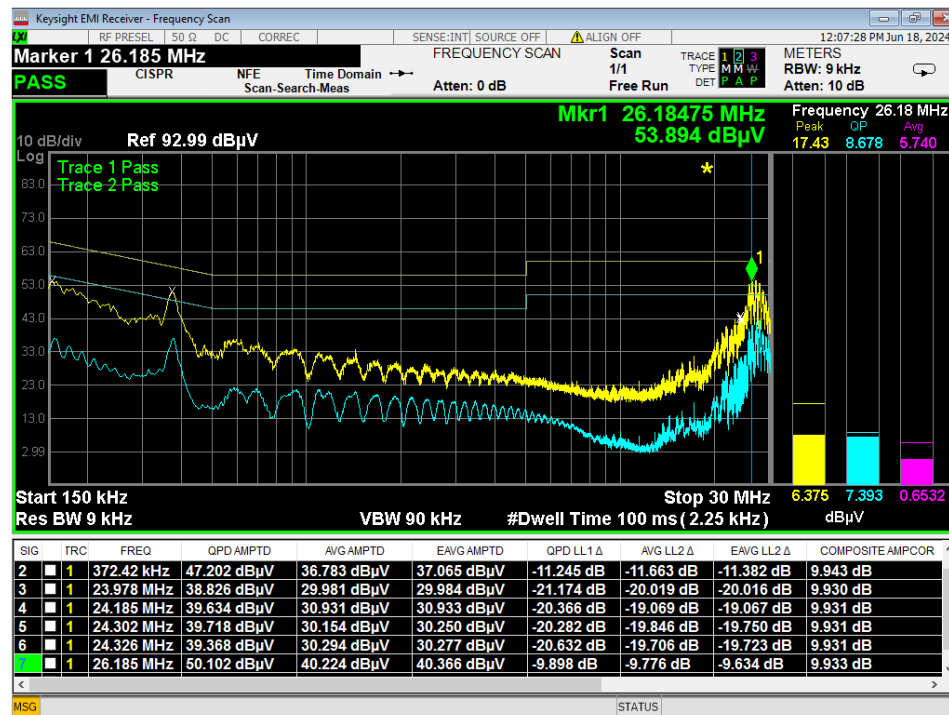


Figure 28 - Conducted Emissions Plot, Neutral, TX

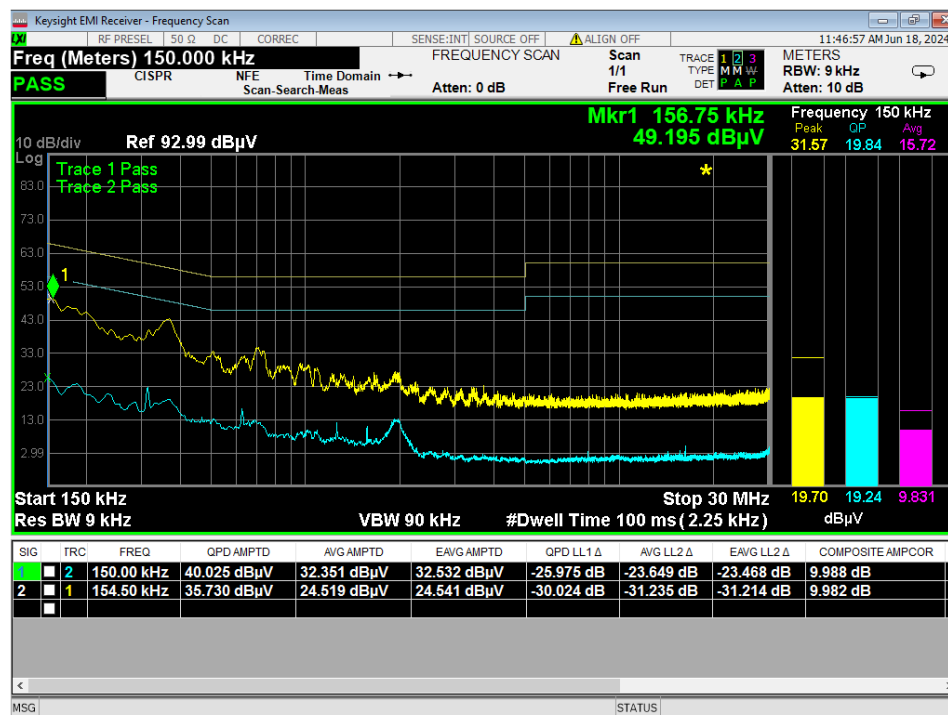


Figure 29 - Conducted Emissions Plot, Line, IDLE

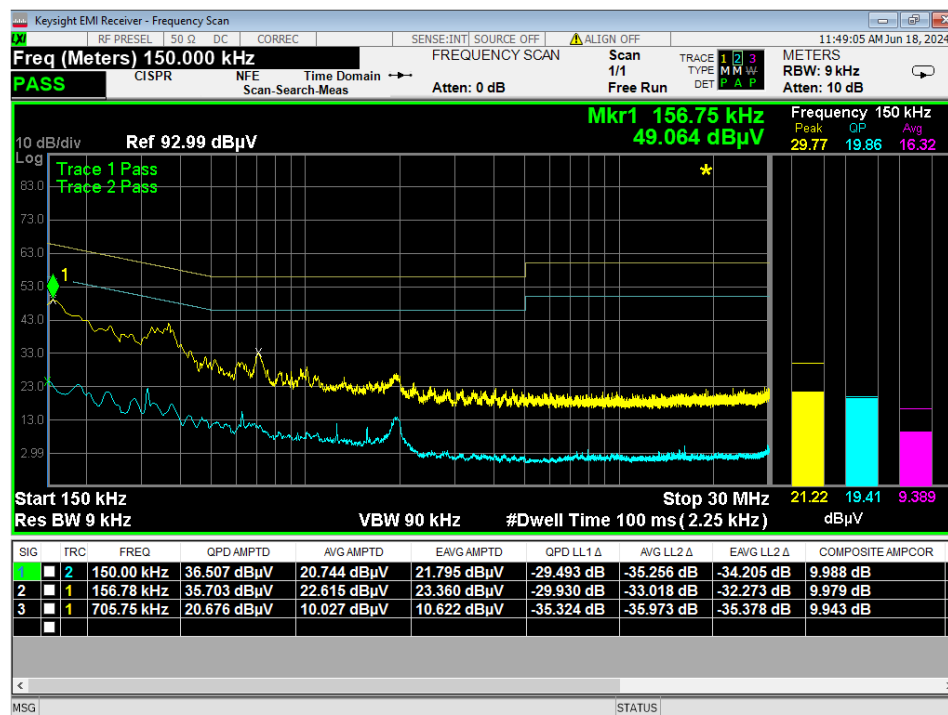


Figure 30 - Conducted Emissions Plot, Neutral, IDLE



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APPENDIX A: SAMPLE CALCULATION

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor, 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;

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

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

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

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


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

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

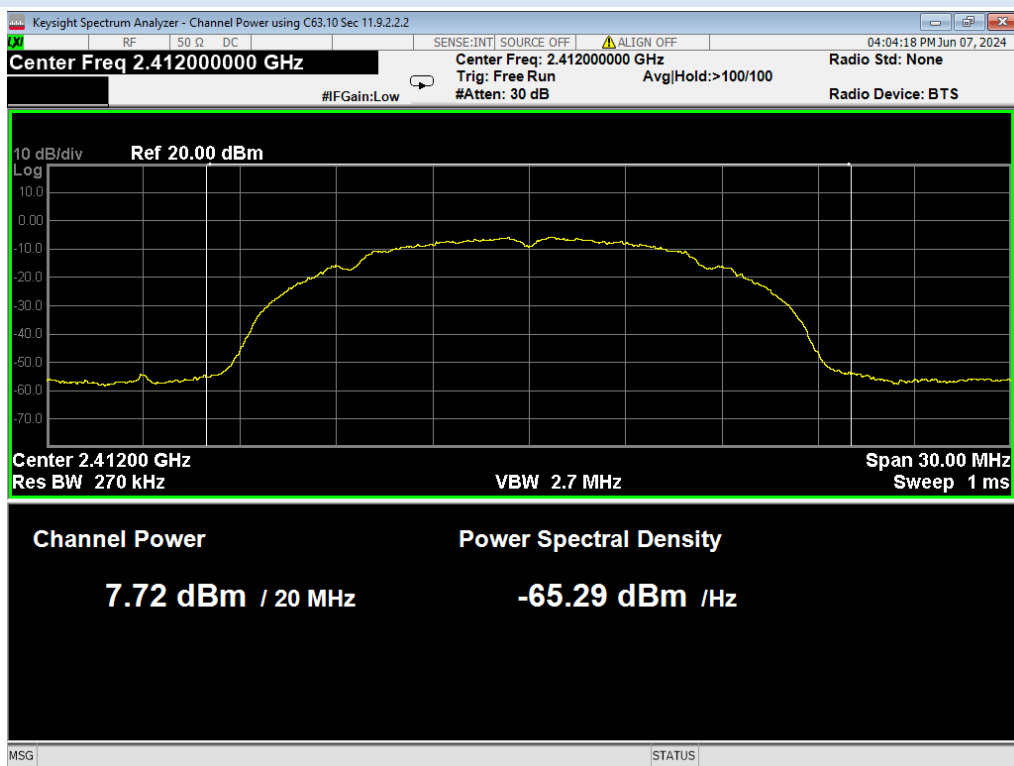
NCEE Labs does not add uncertainty to its measurements.

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

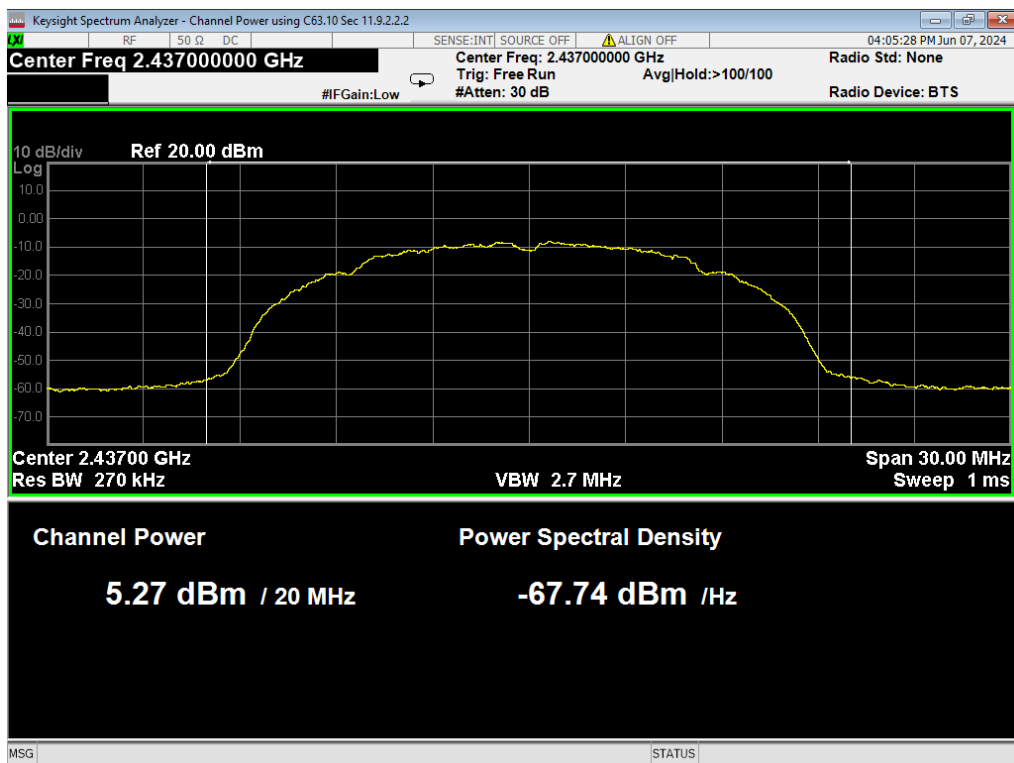
Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08
Emissions limits, conducted	30MHz – 18GHz	±3.03

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

APPENDIX C – GRAPHS AND TABLES

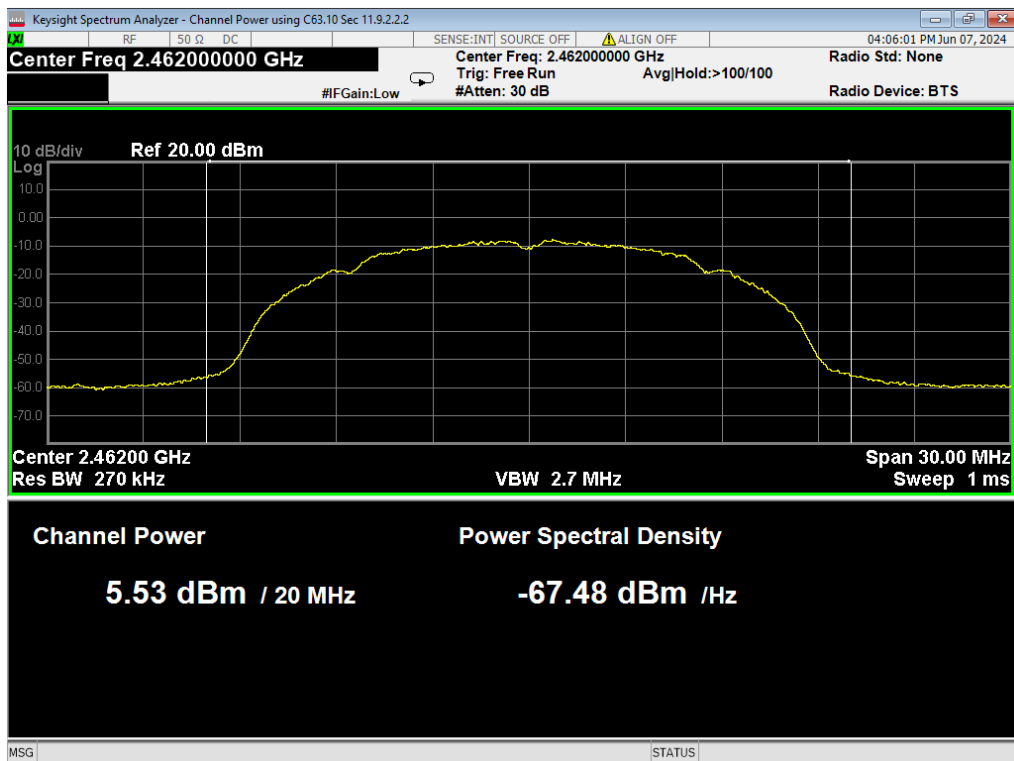


01 Average Power, Low Channel, Wifi B 1MB

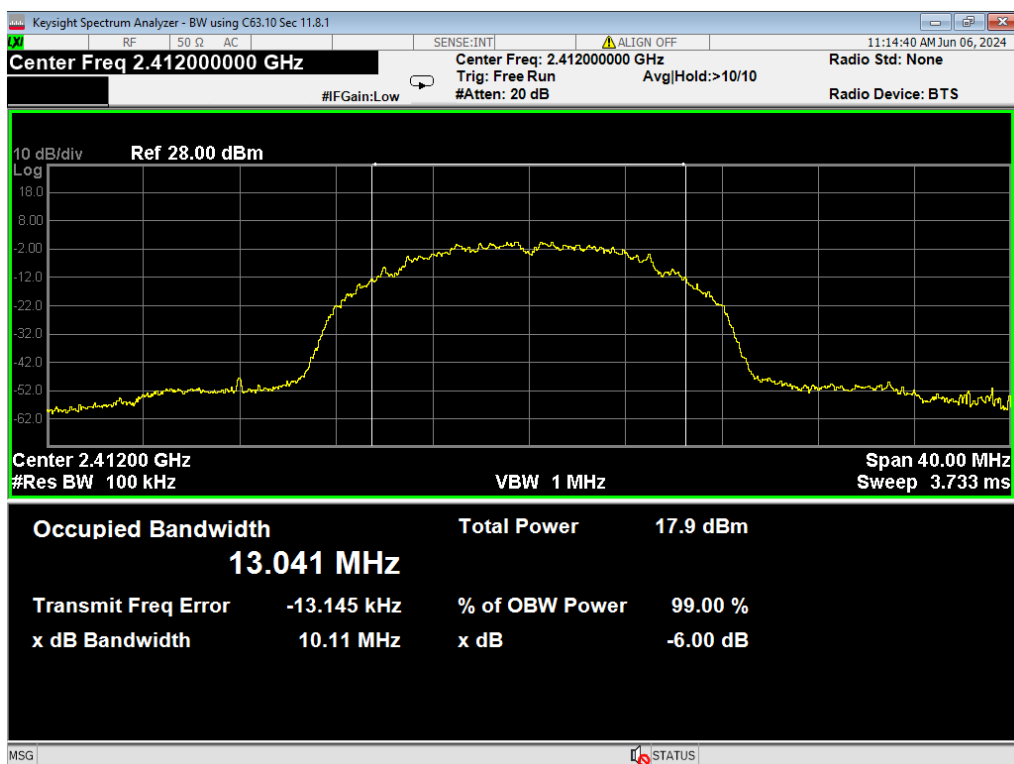


02 Average Power, Mid Channel, Wifi B 1MB


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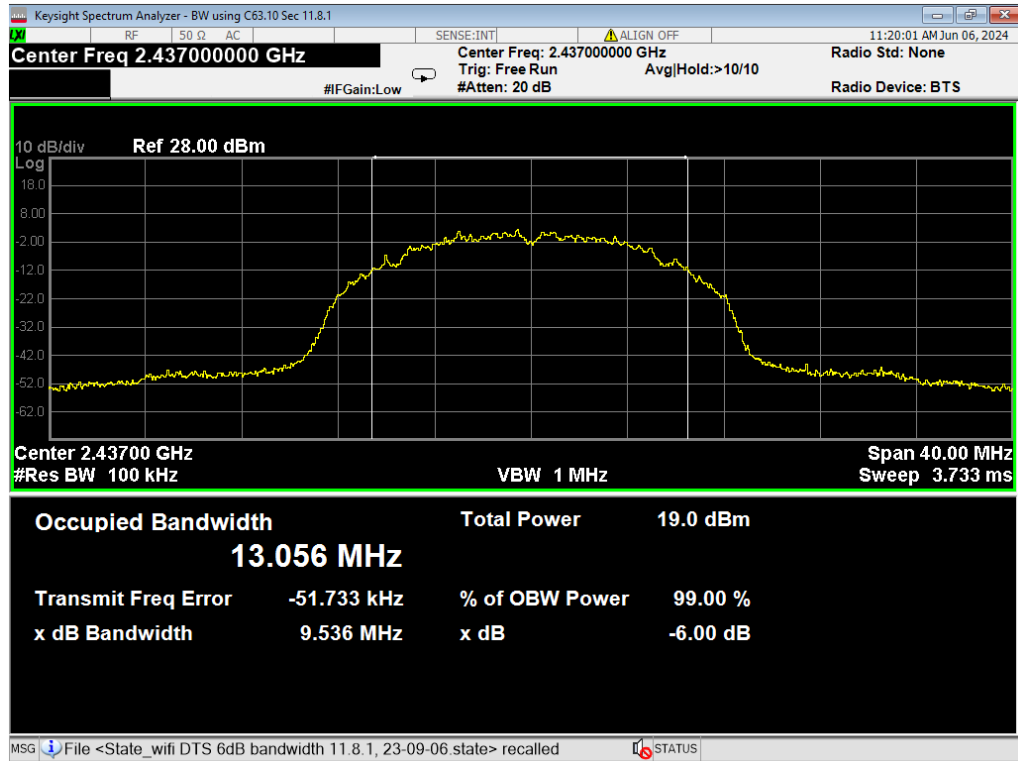


03 Average Power, High Channel, Wifi B 1MB

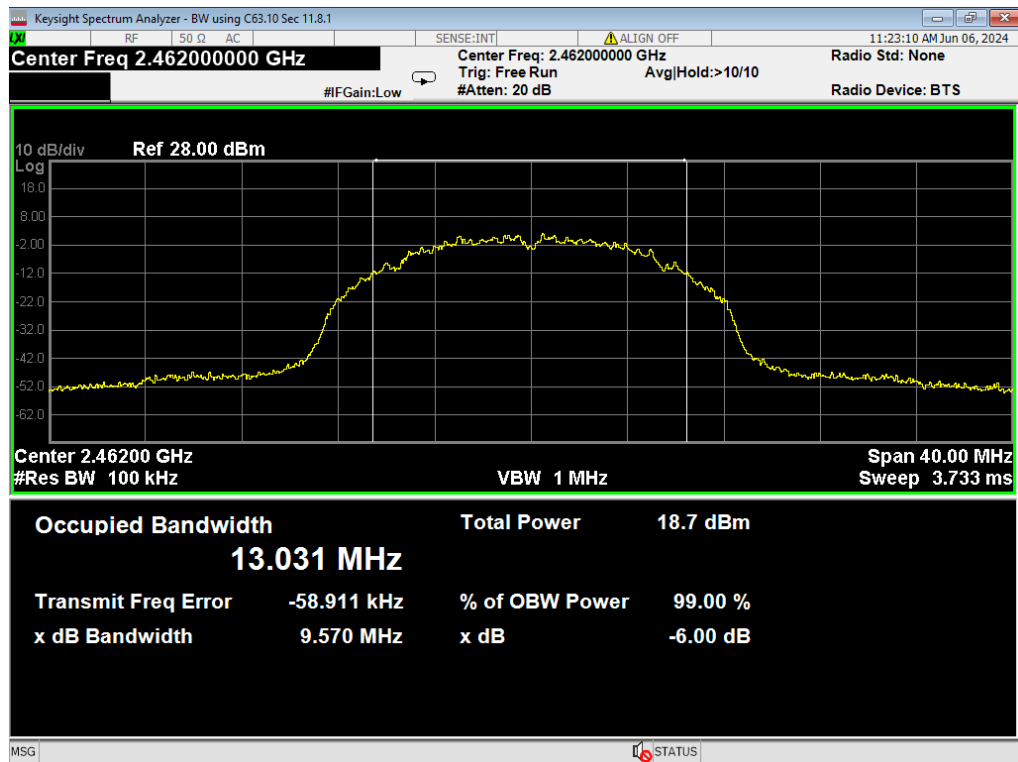


04 6dB Bandwidth, Low Channel, Wifi B 1MB

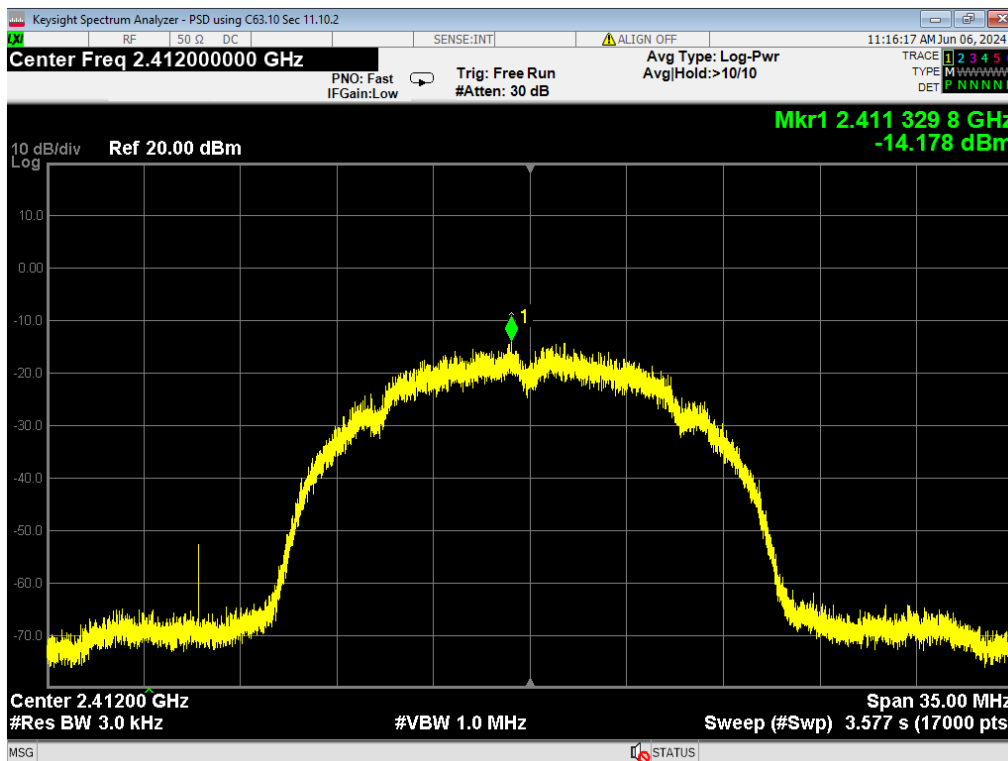
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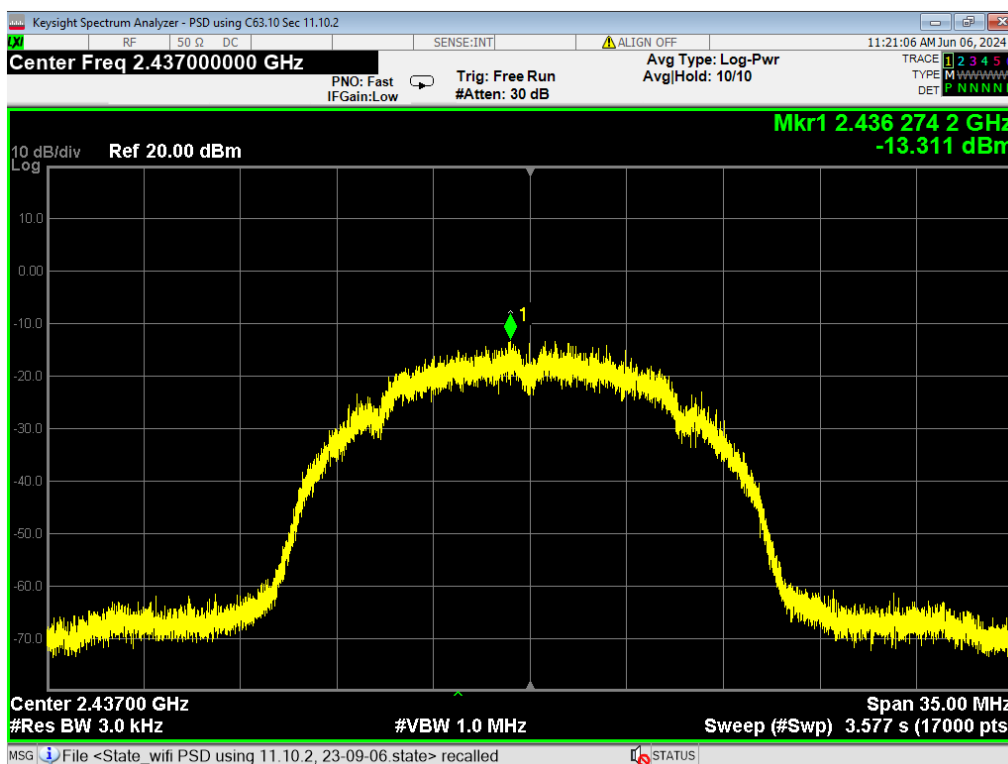
05 6dB Bandwidth, Mid Channel, Wifi B 1MB



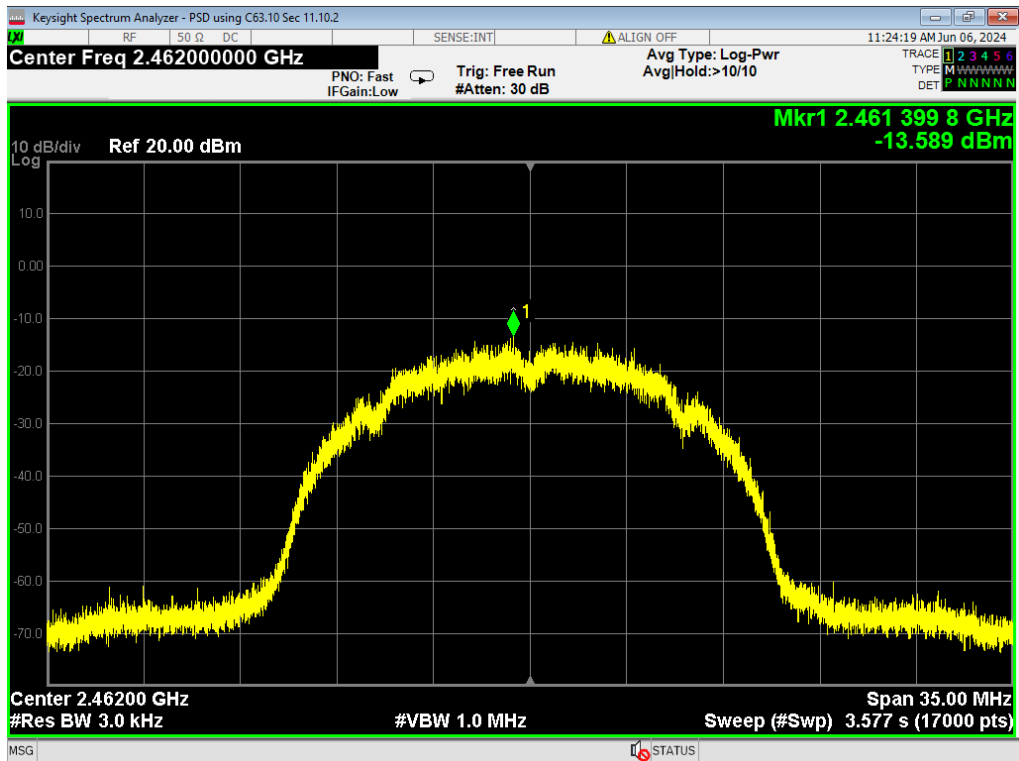
06 6dB Bandwidth, High Channel, Wifi B 1MB



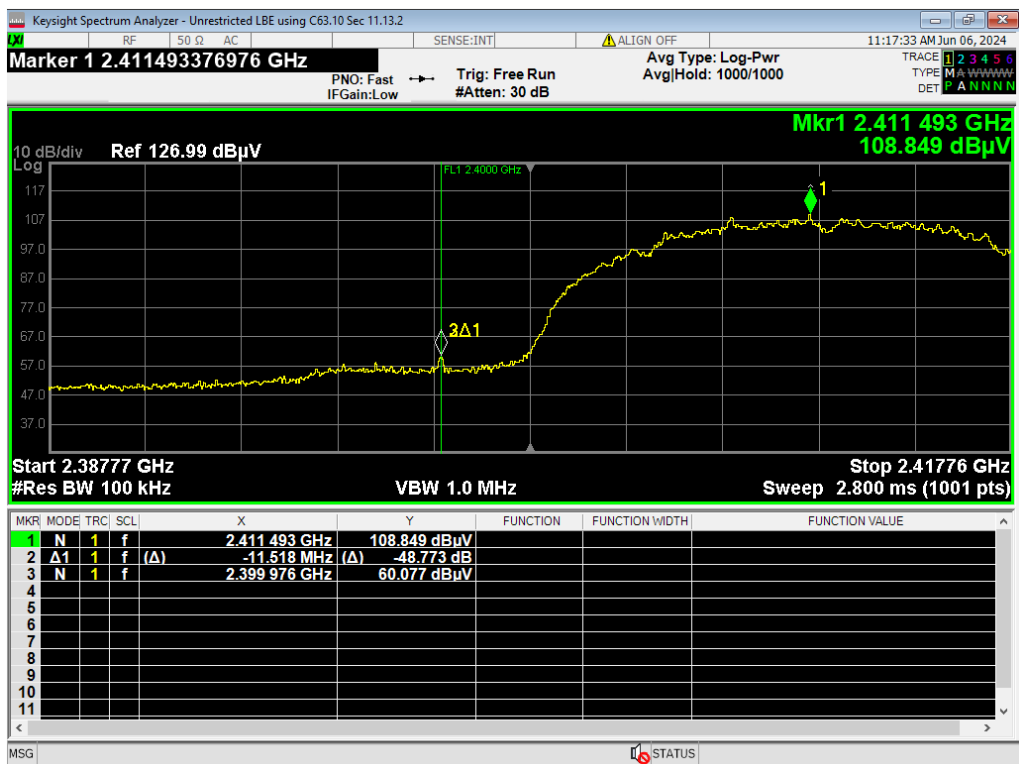
07 PSD, Low Channel, Wifi B 1MB



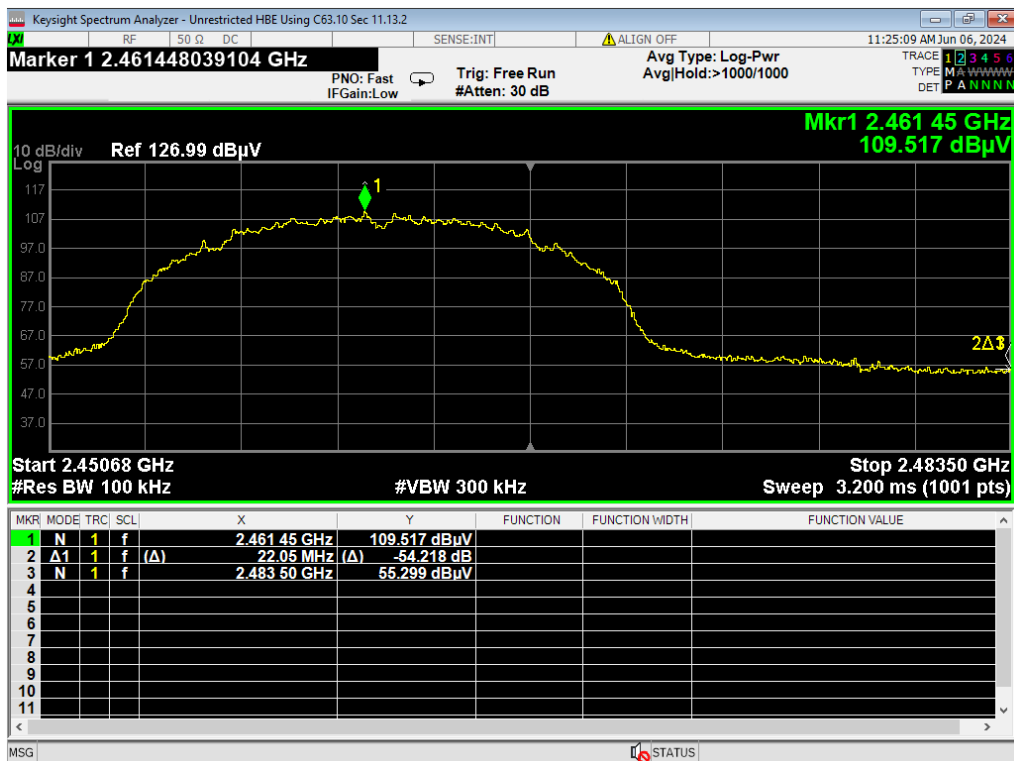
08 PSD, Mid Channel, Wifi B 1MB



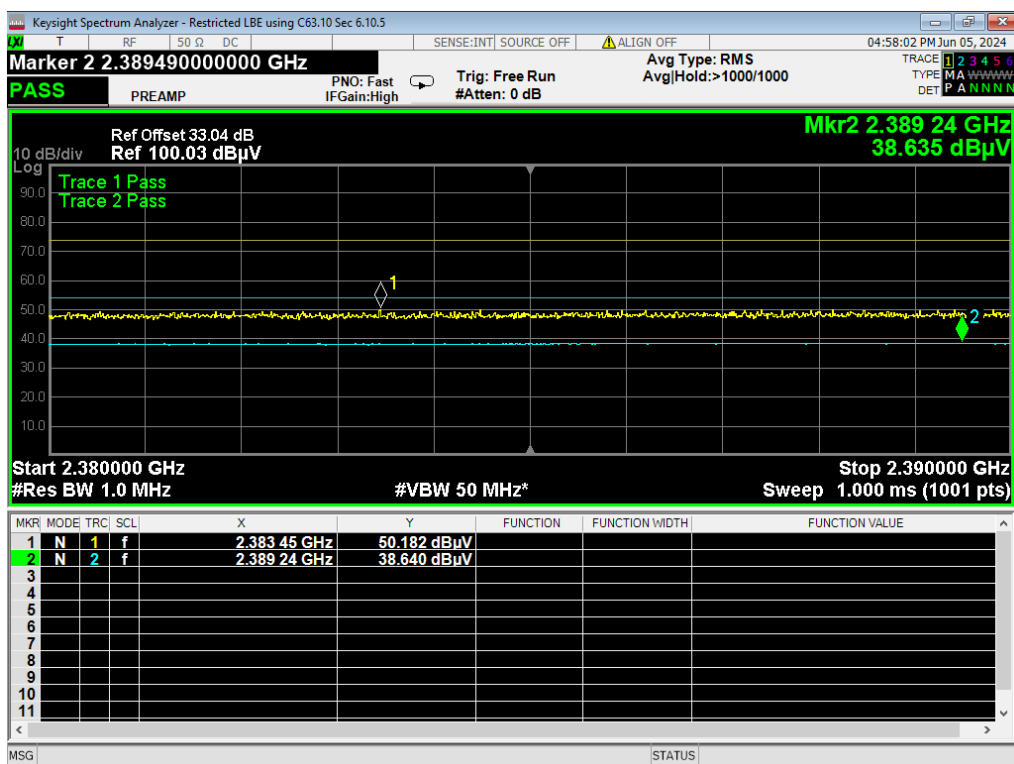
09 PSD, High Channel, Wifi B 1MB



10 LBE Unrestricted, Wifi B 1MB



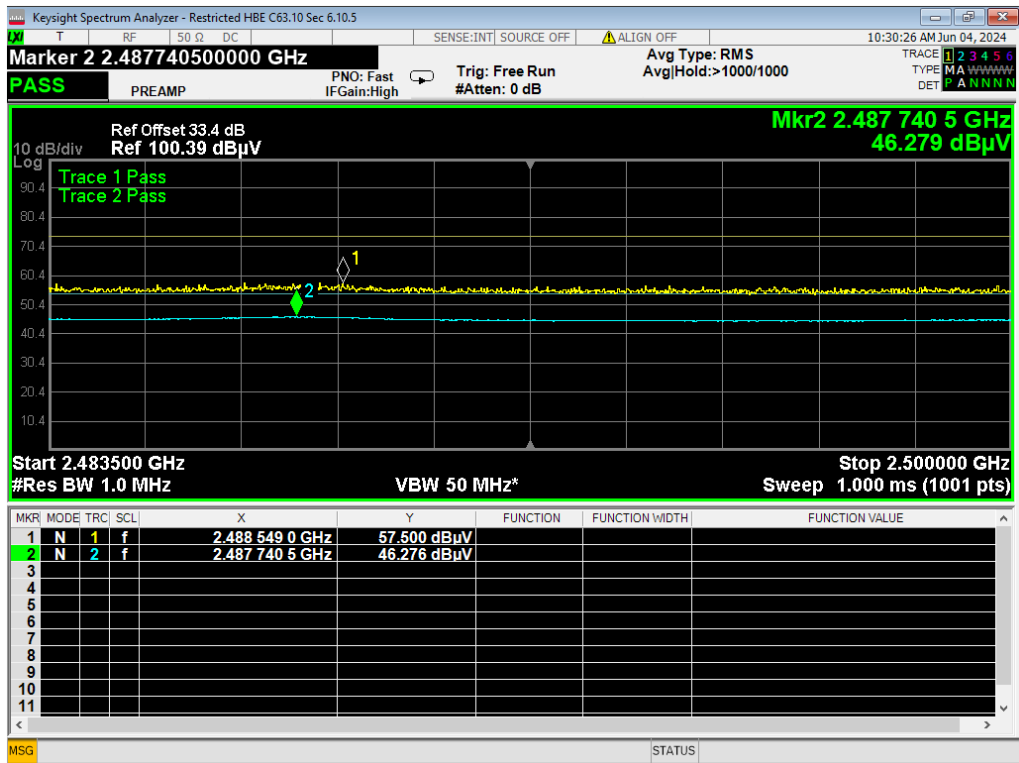
11 HBE Unrestricted, Wifi B 1MB



12 LBE Restricted, Wifi B 1MB

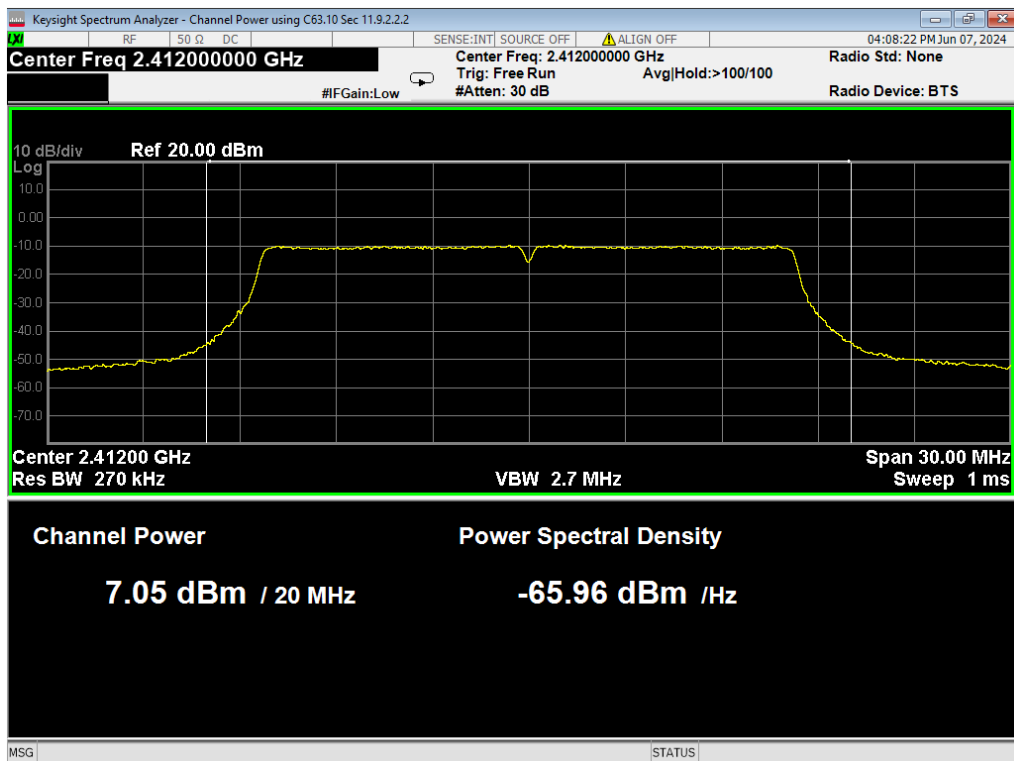


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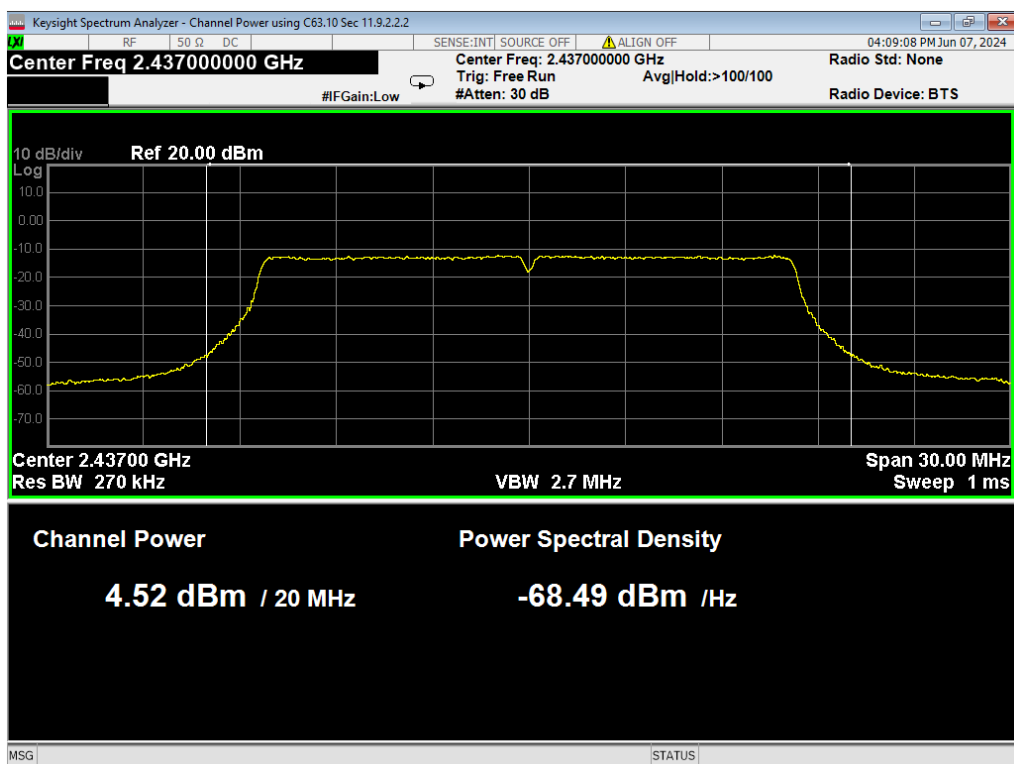


13 HBE Restricted, Wifi B 1MB

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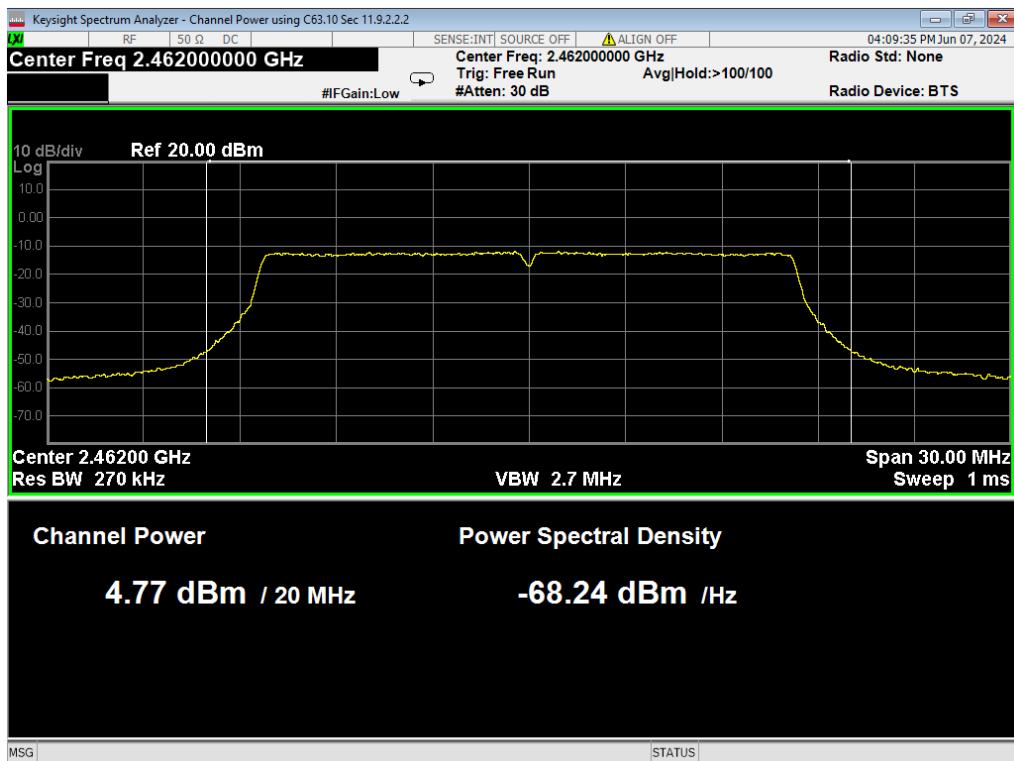


14 Average Power, Low Channel, Wifi G 6MB

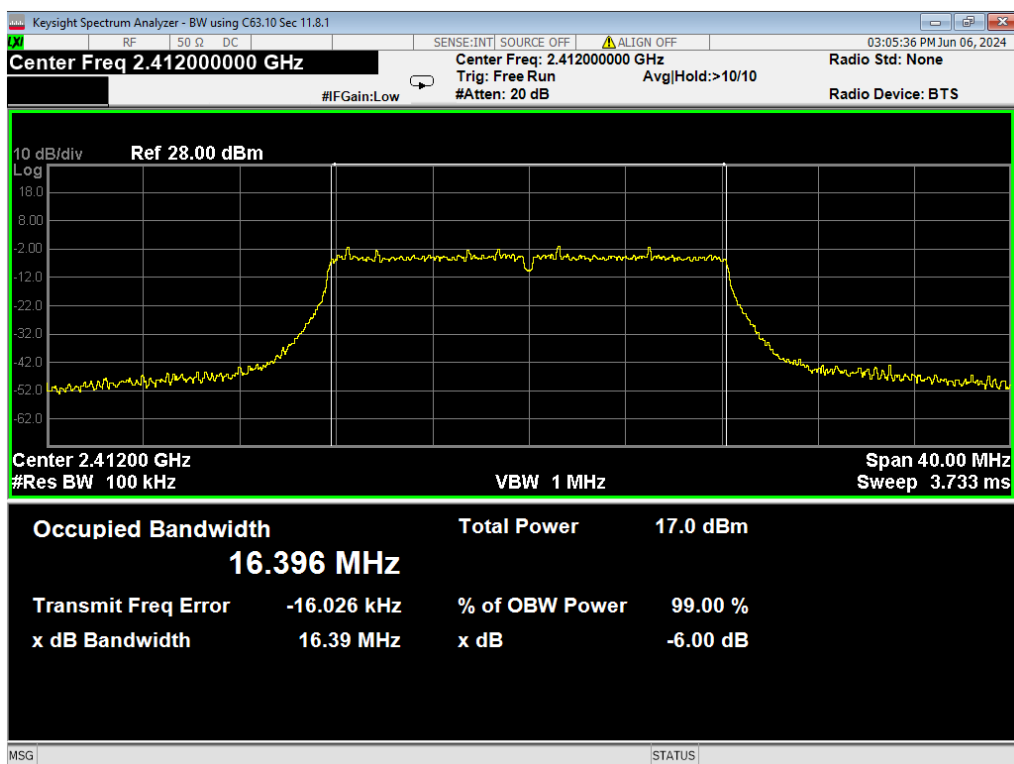


15 Average Power, Mid Channel, Wifi G 6MB


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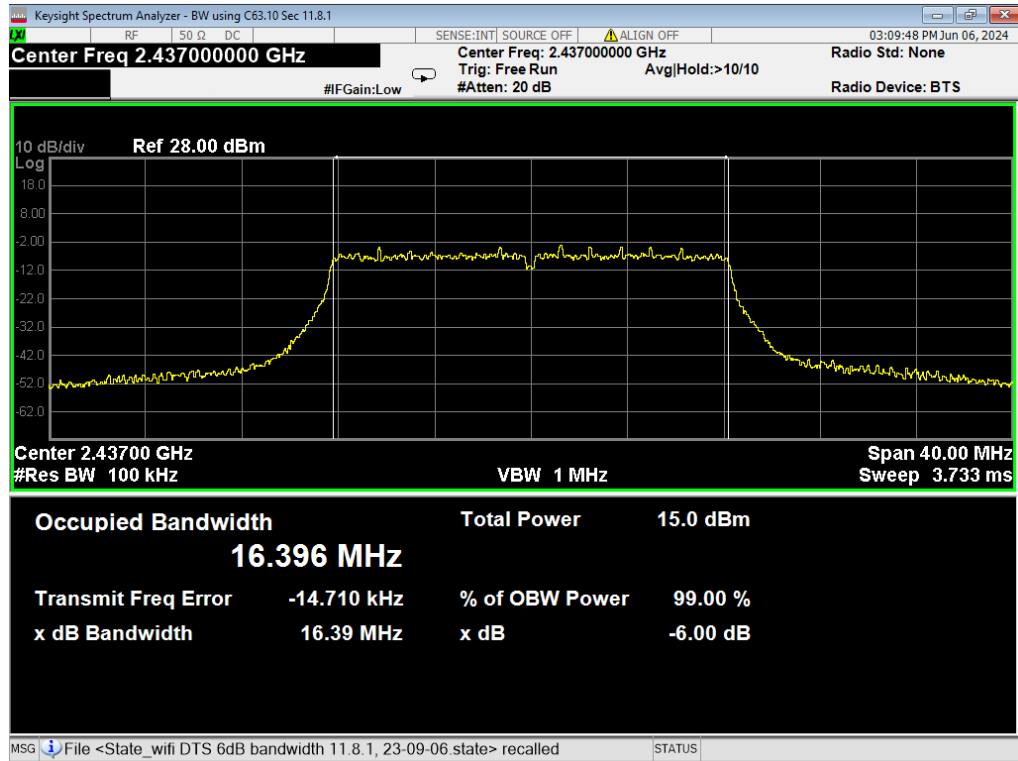


16 Average Power, High Channel, Wifi G 6MB

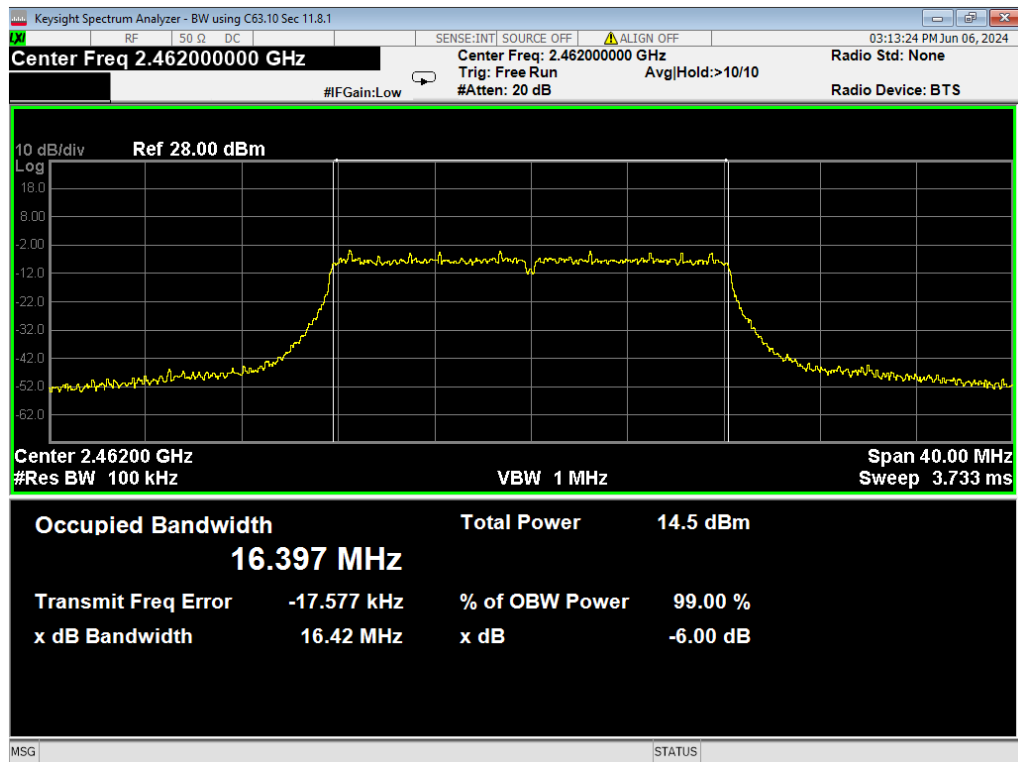


17 6dB Bandwidth, Low Channel, Wifi G 6MB

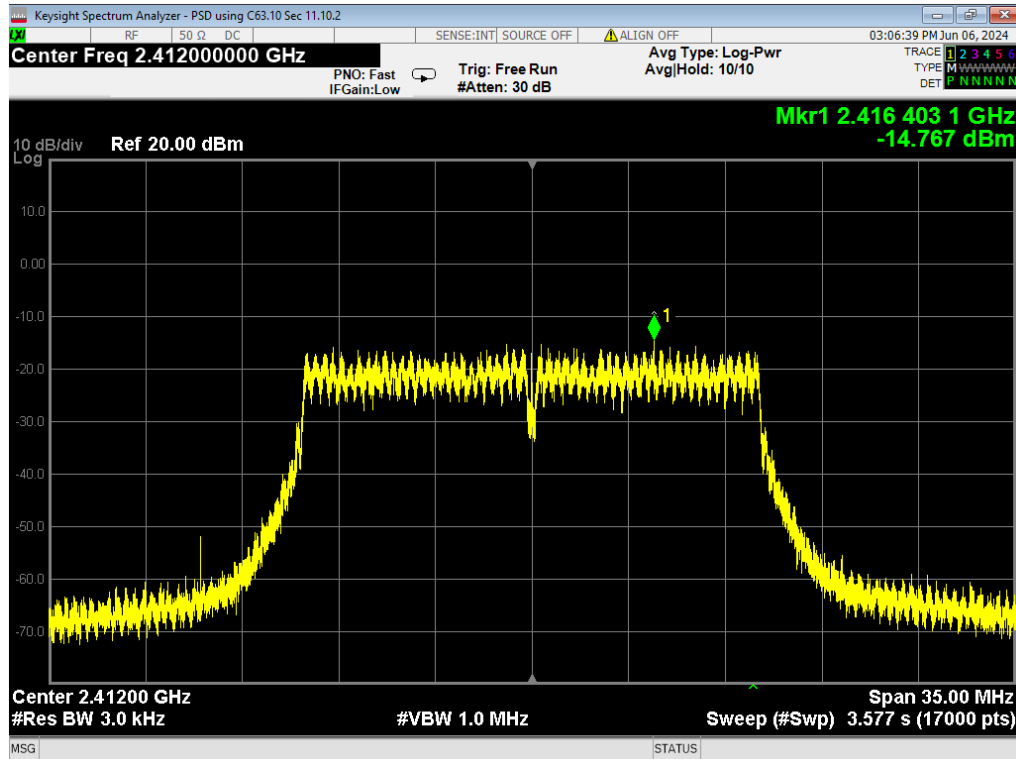
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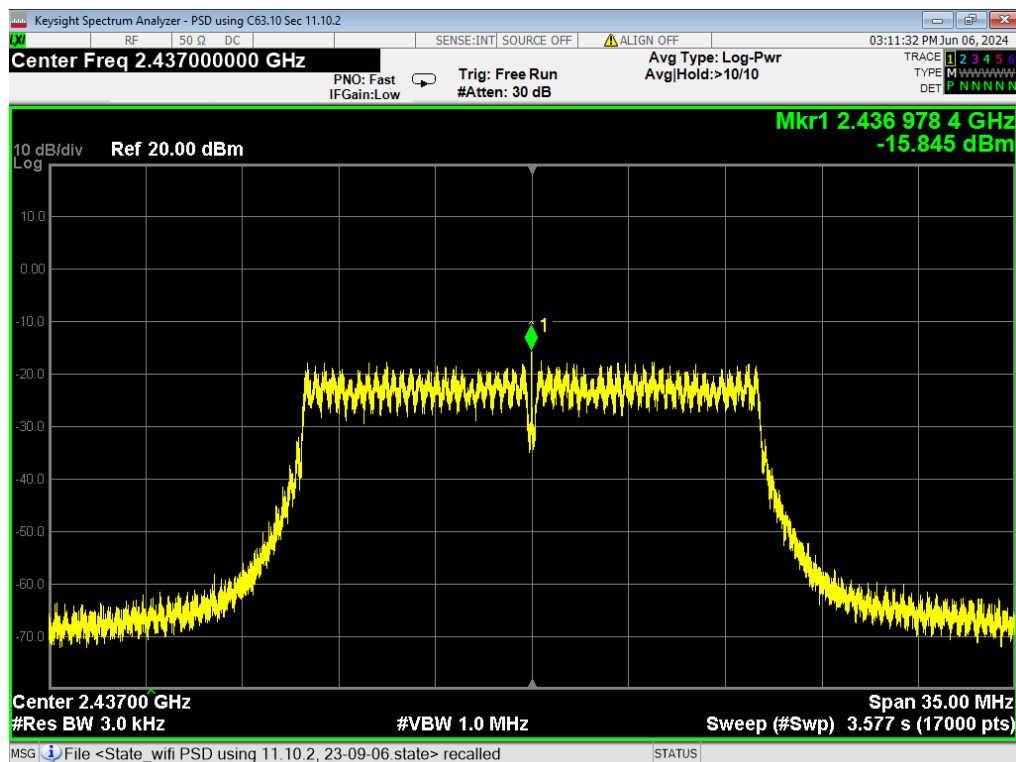
18 6dB Bandwidth, Mid Channel, Wifi G 6MB



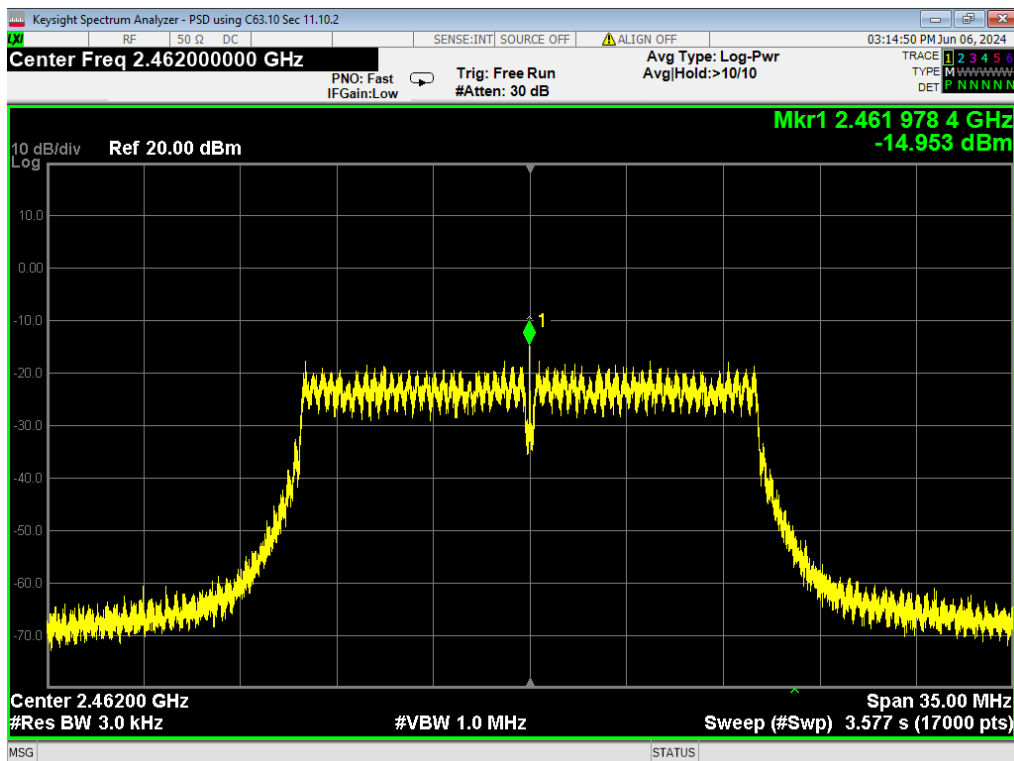
19 6dB Bandwidth, High Channel, Wifi G 6MB



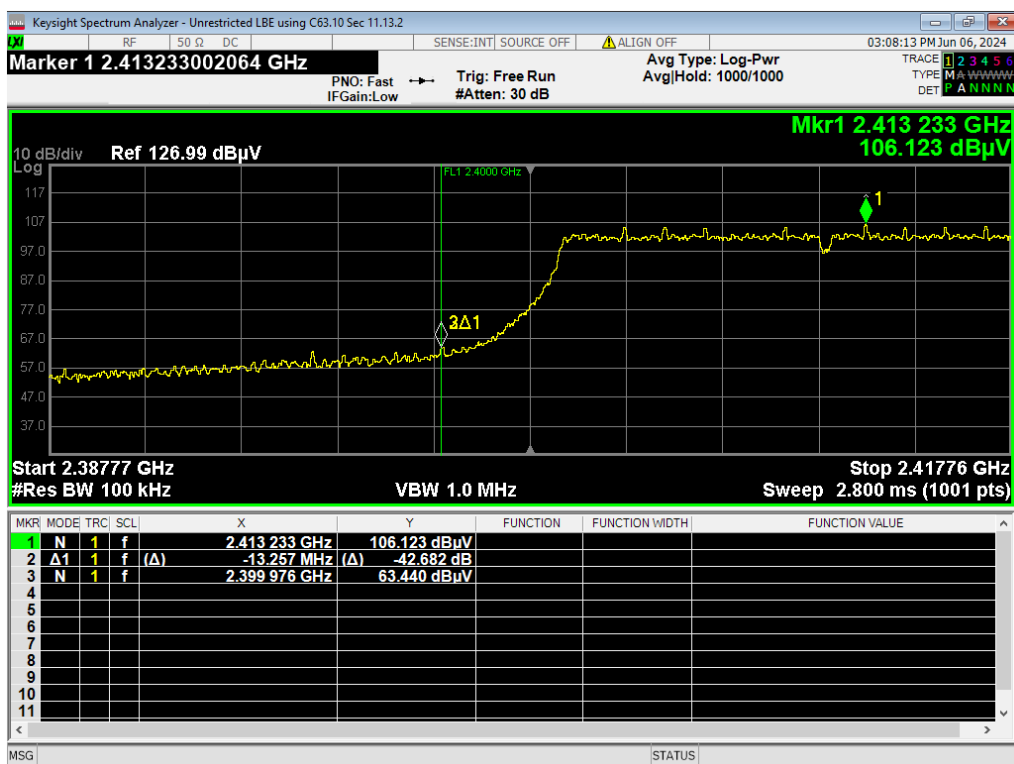
20 PSD, Low Channel, Wifi G 6MB



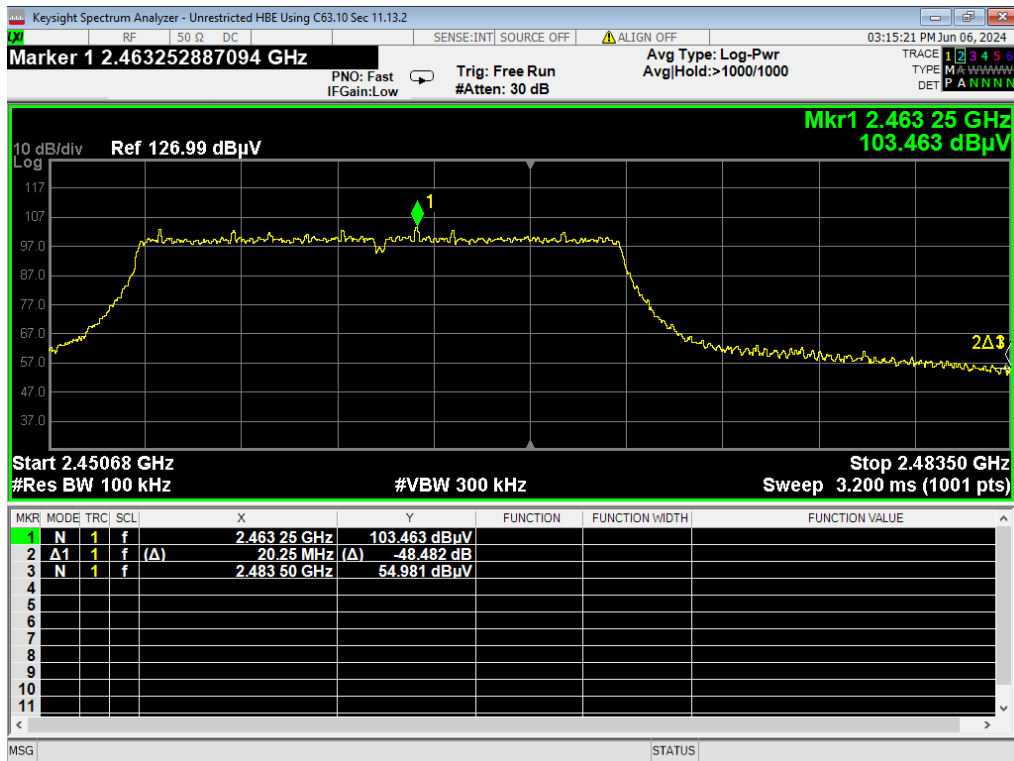
21 PSD, Mid Channel, Wifi G 6MB



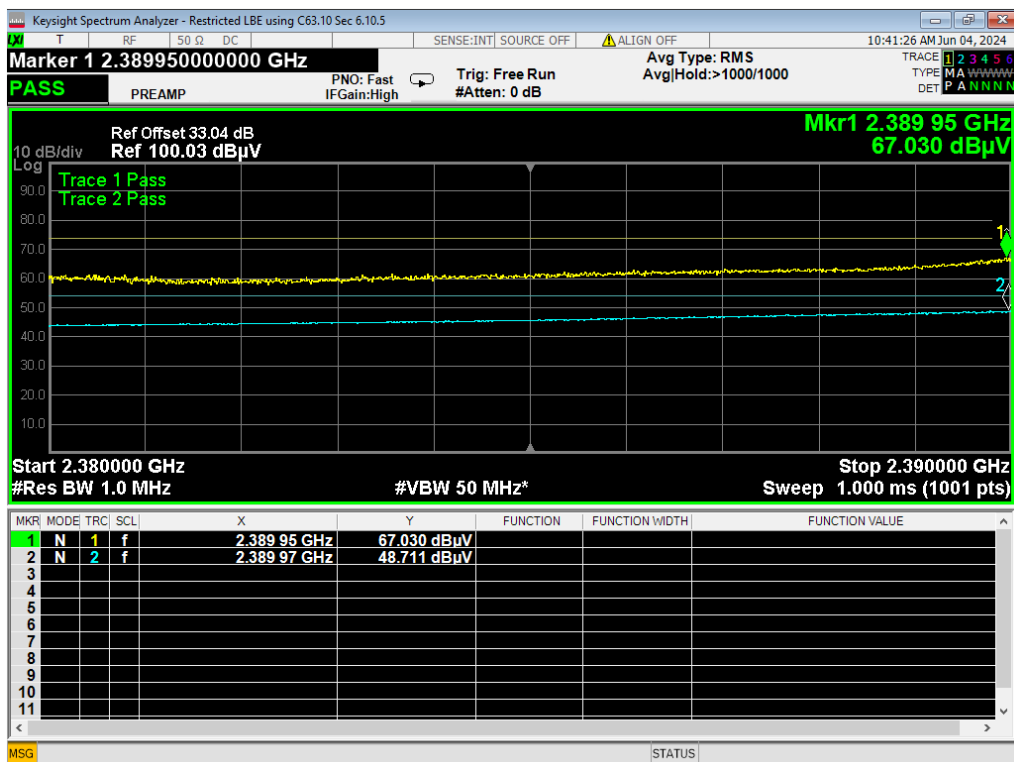
22 PSD, High Channel, Wifi G 6MB



23 LBE Unrestricted, Wifi G 6MB



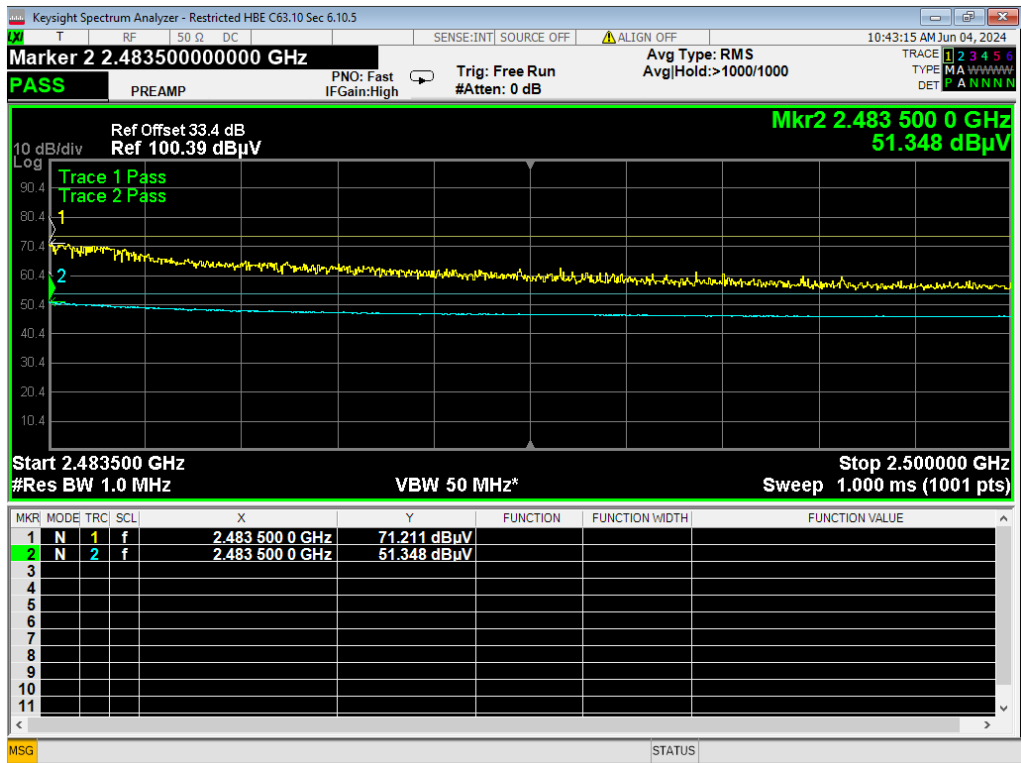
24 HBE Unrestricted, Wifi G 6MB



25 LBE Restricted, Wifi G 6MB

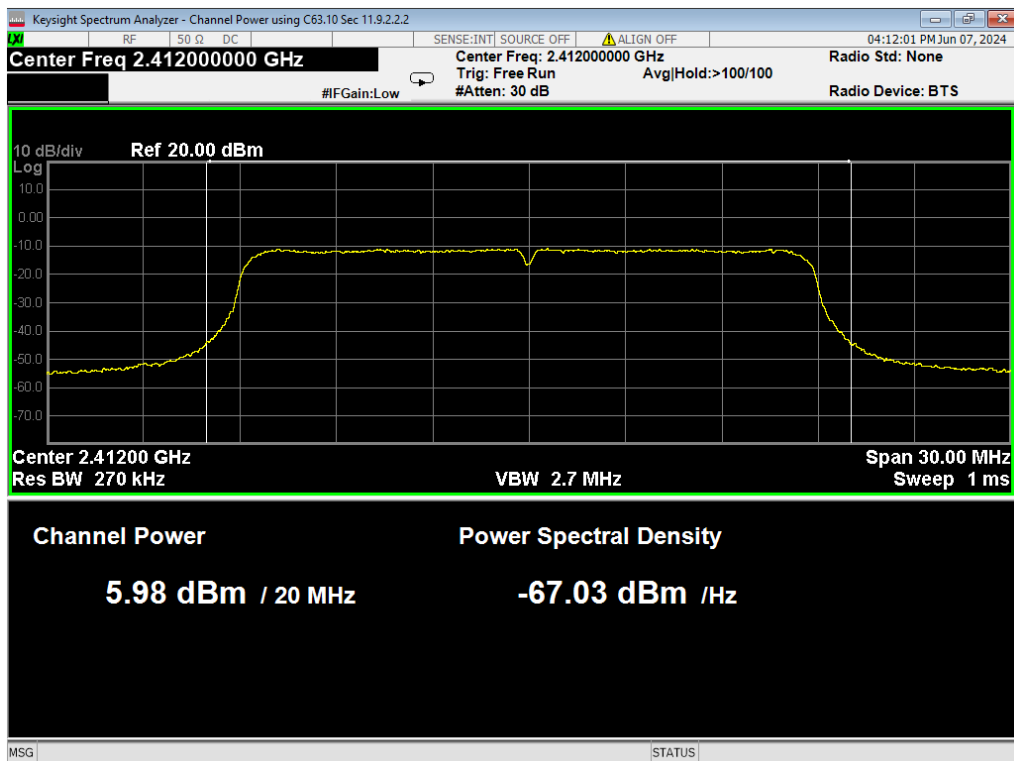


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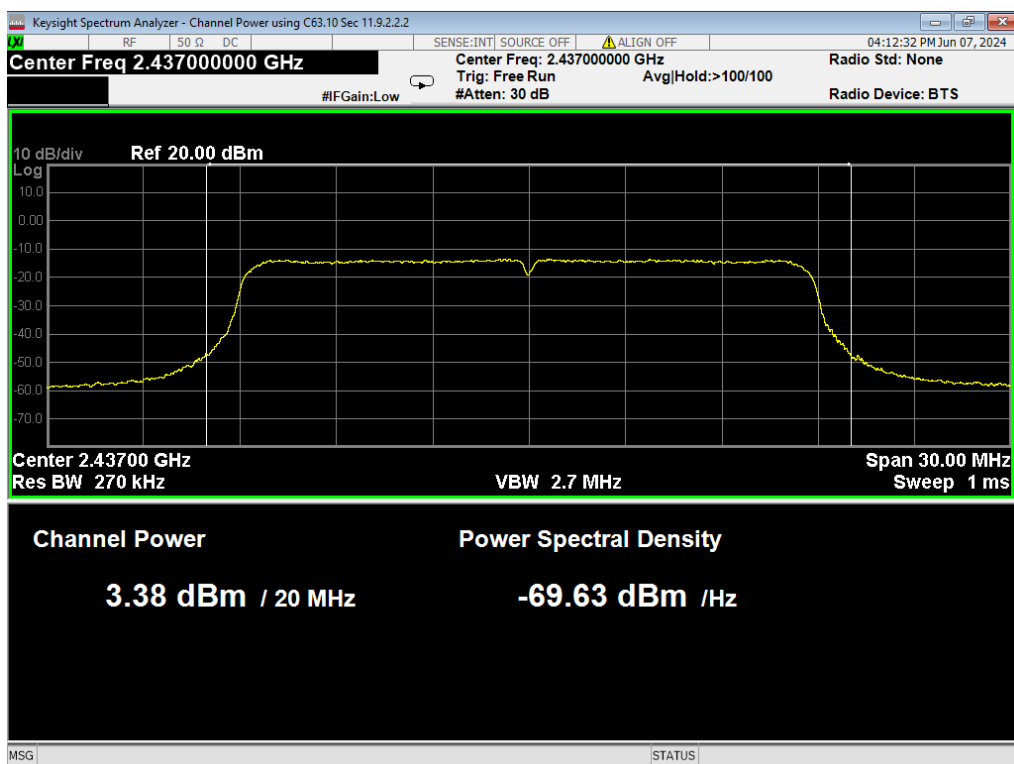


26 HBE Restricted, Wifi G 6MB

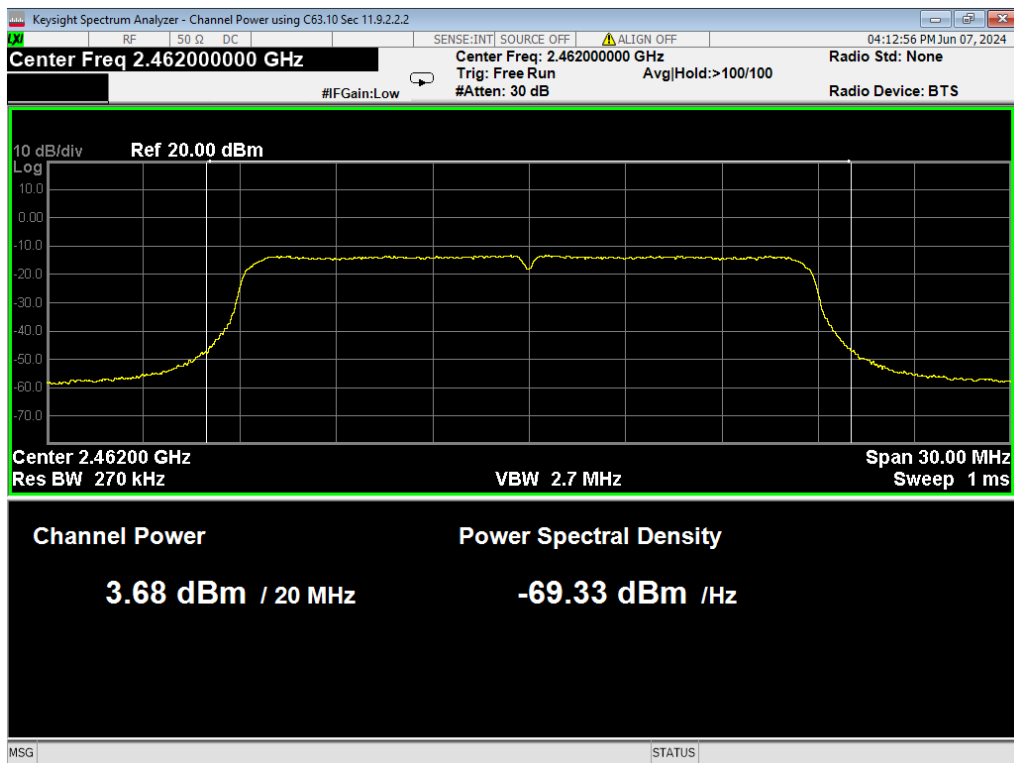
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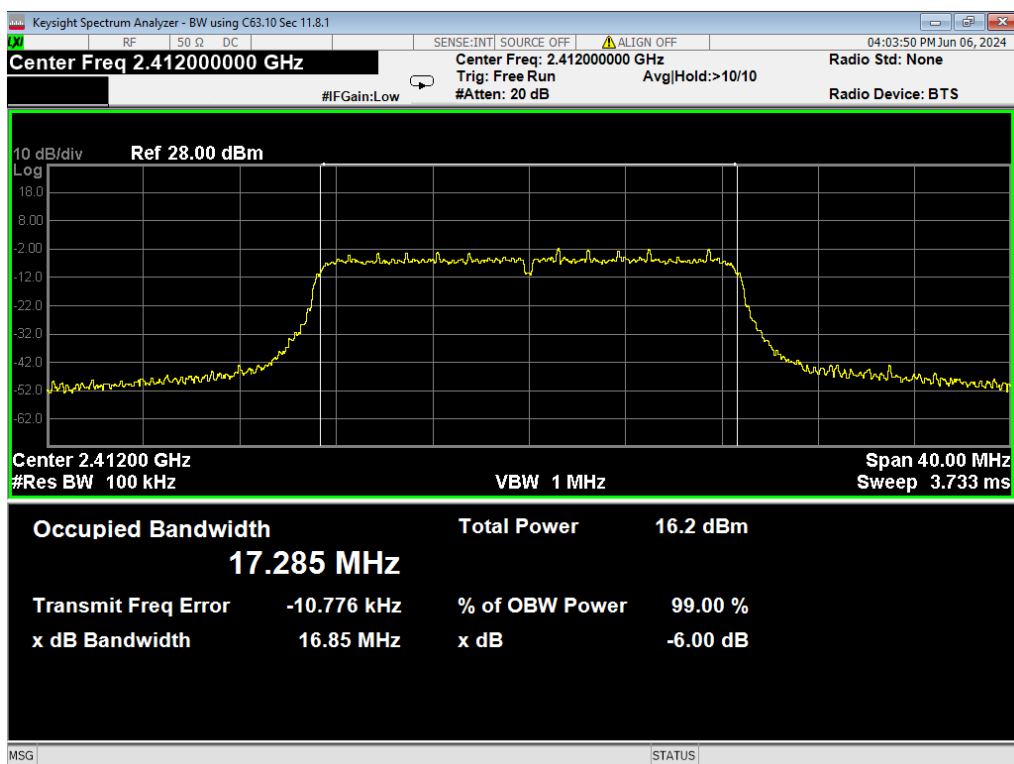
27 Average Power, Low Channel, Wifi N MCS0



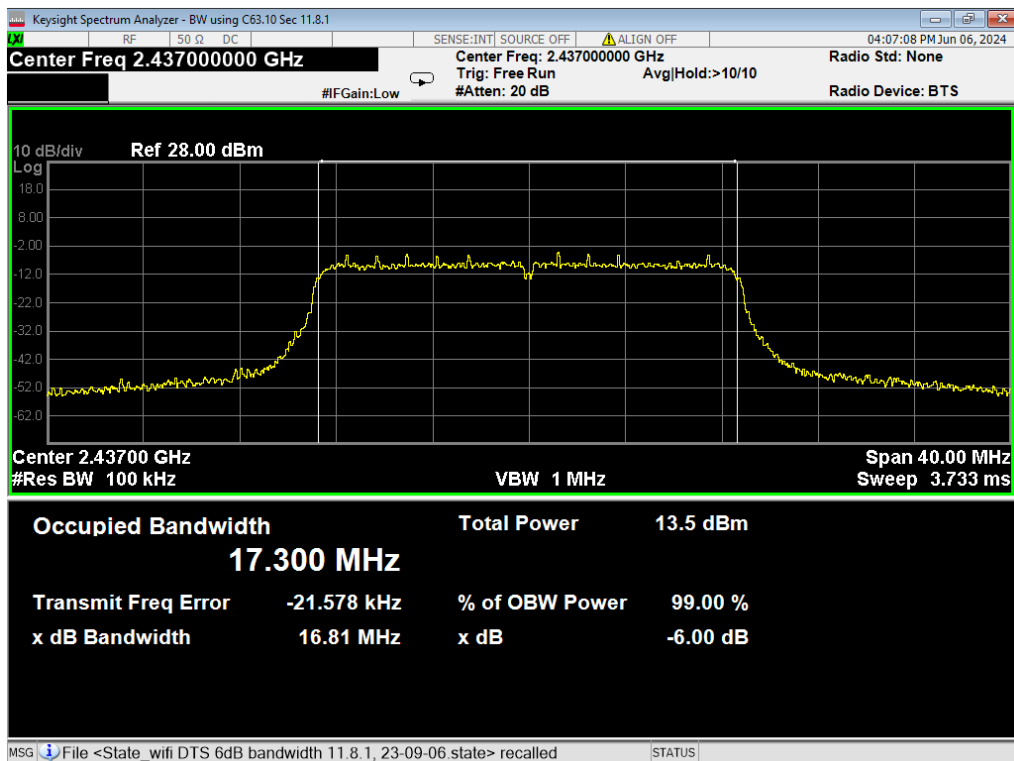
28 Average Power, Mid Channel, Wifi N MCS0



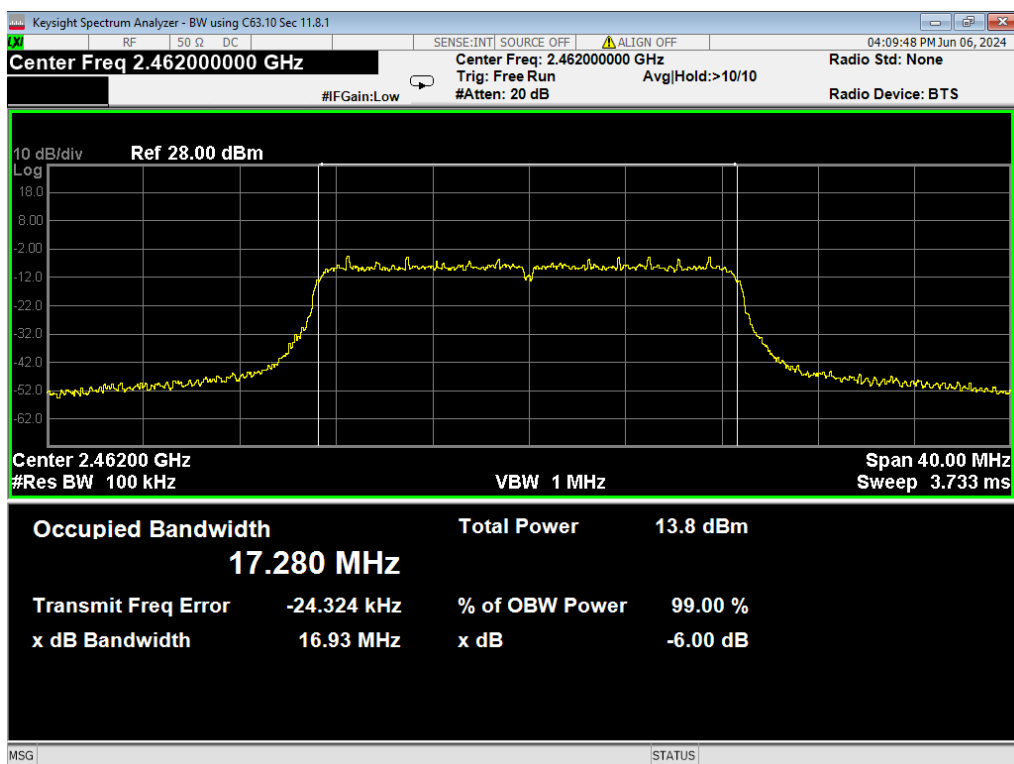
29 Average Power, High Channel, Wifi N MCS0




30 6dB Bandwidth, Low Channel, Wifi N MCS0

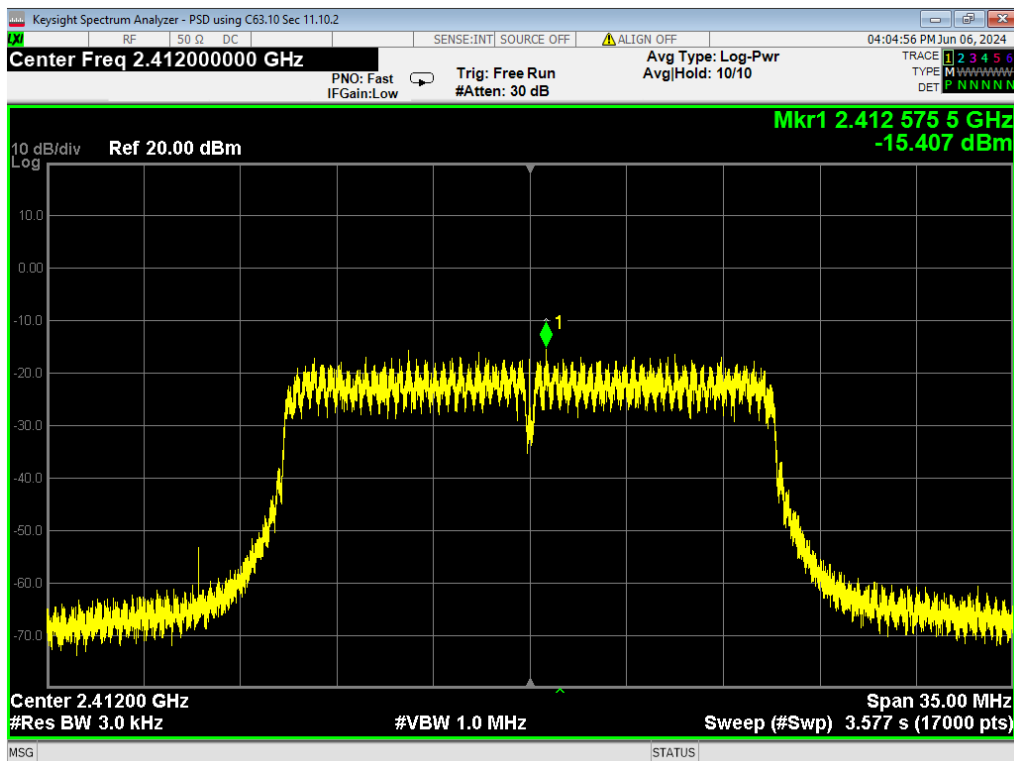


31 6dB Bandwidth, Mid Channel, Wifi N MCS0

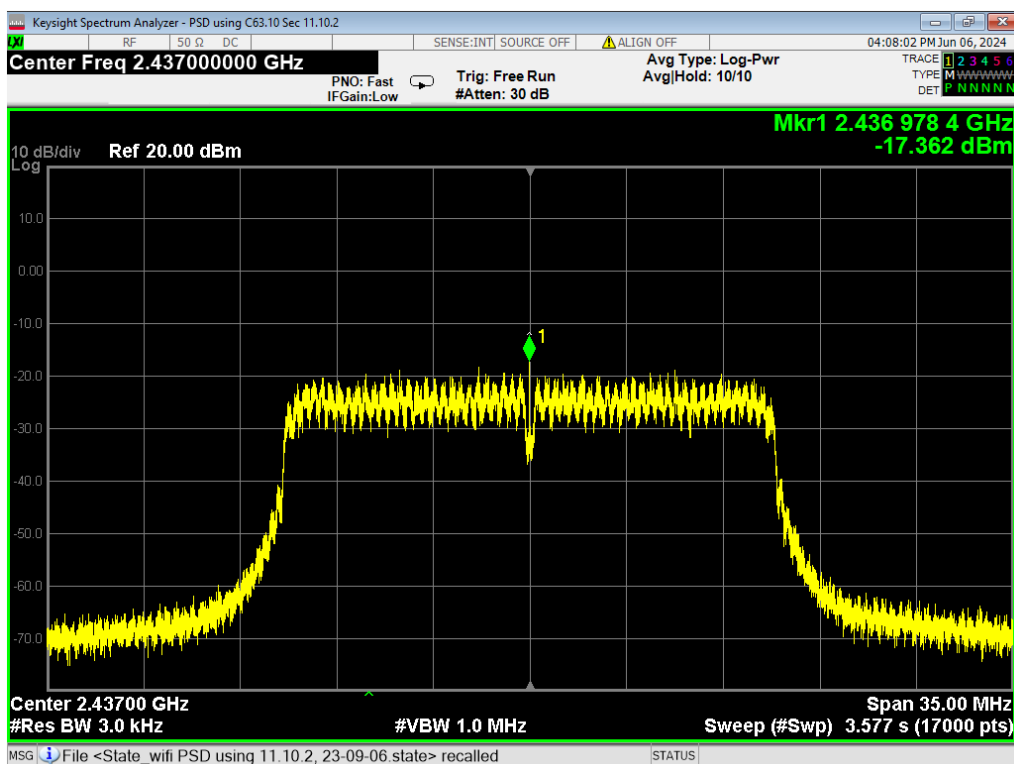


32 6dB Bandwidth, High Channel, Wifi N MCS0

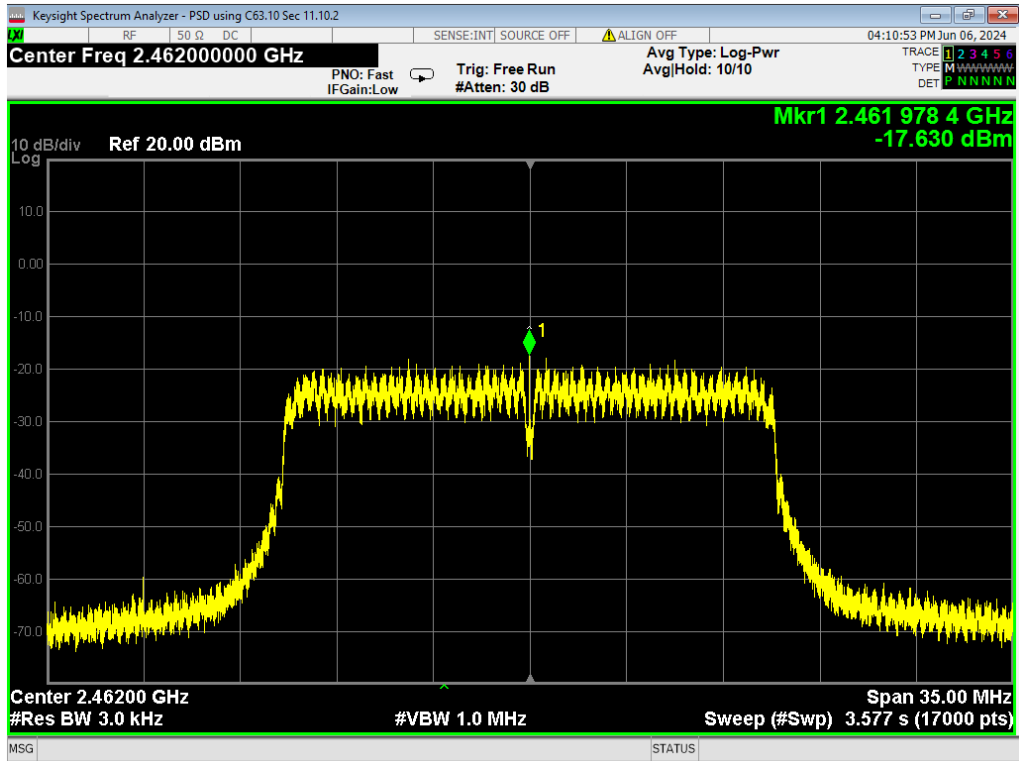
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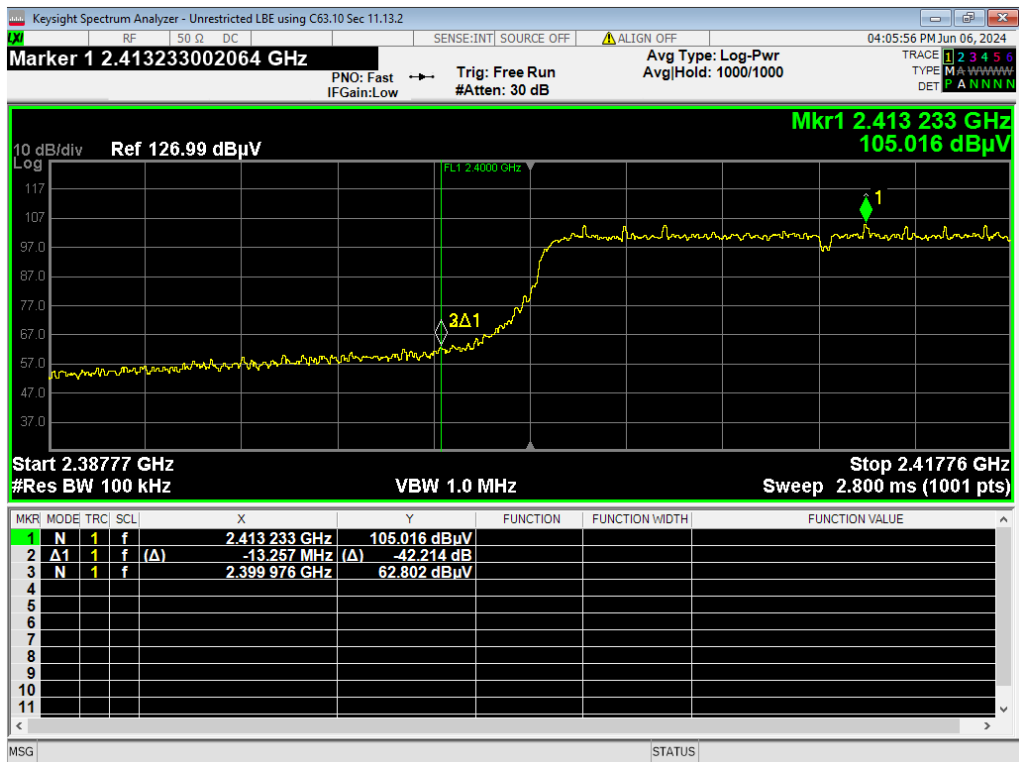
33 PSD, Low Channel, Wifi N MCS0



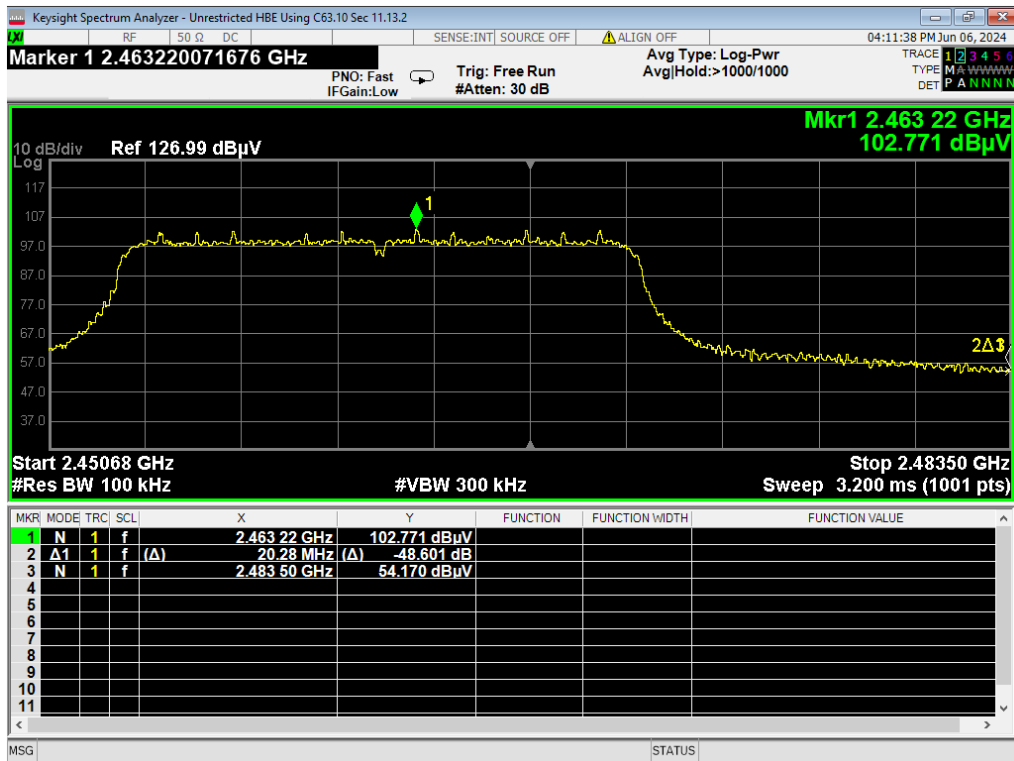
34 PSD, Mid Channel, Wifi N MCS0



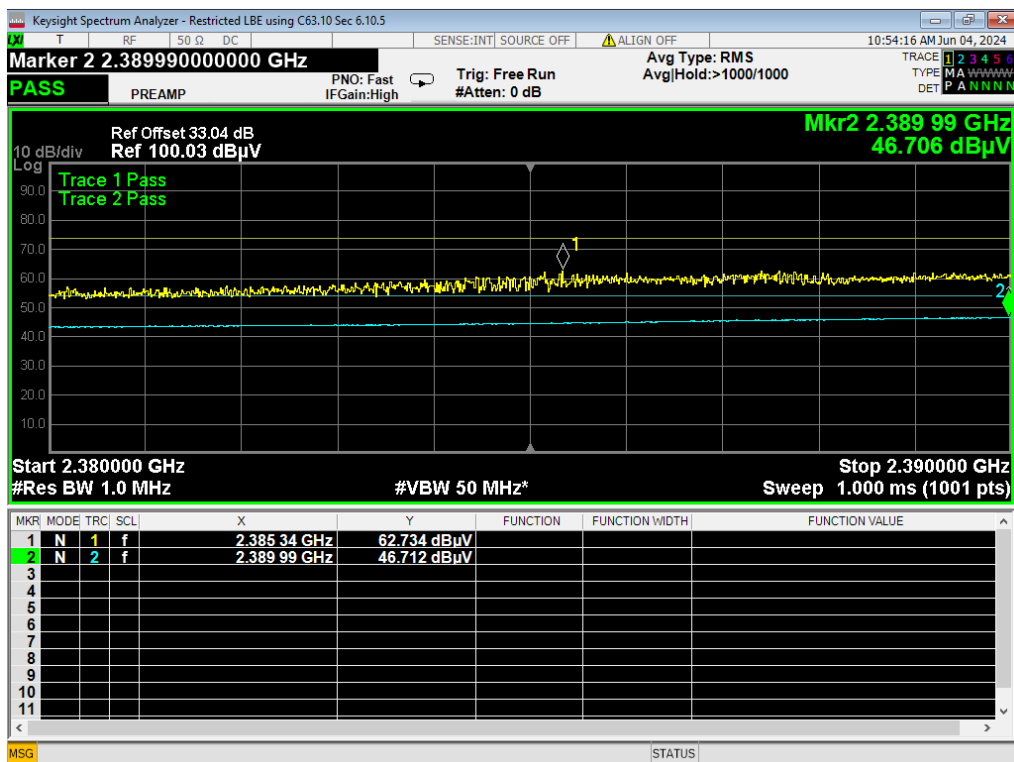
35 PSD, High Channel, Wifi N MCS0



36 LBE Unrestricted, Wifi N MCS0



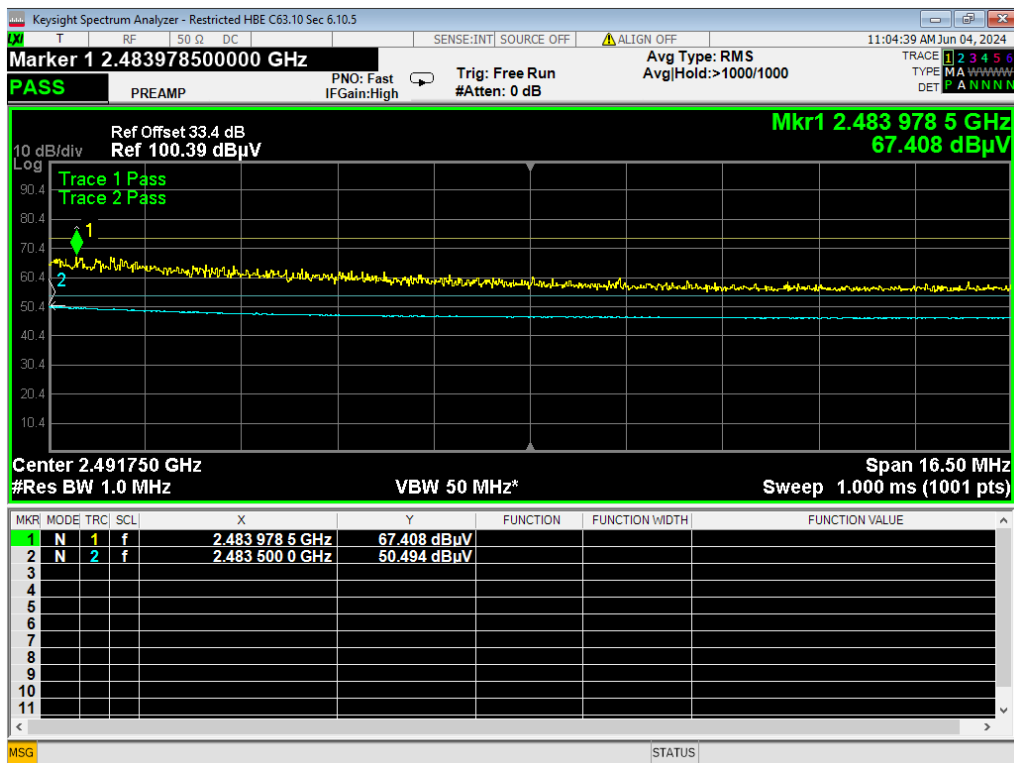
37 HBE Unrestricted, Wifi N MCS0



38 LBE Restricted, Wifi N MCS0

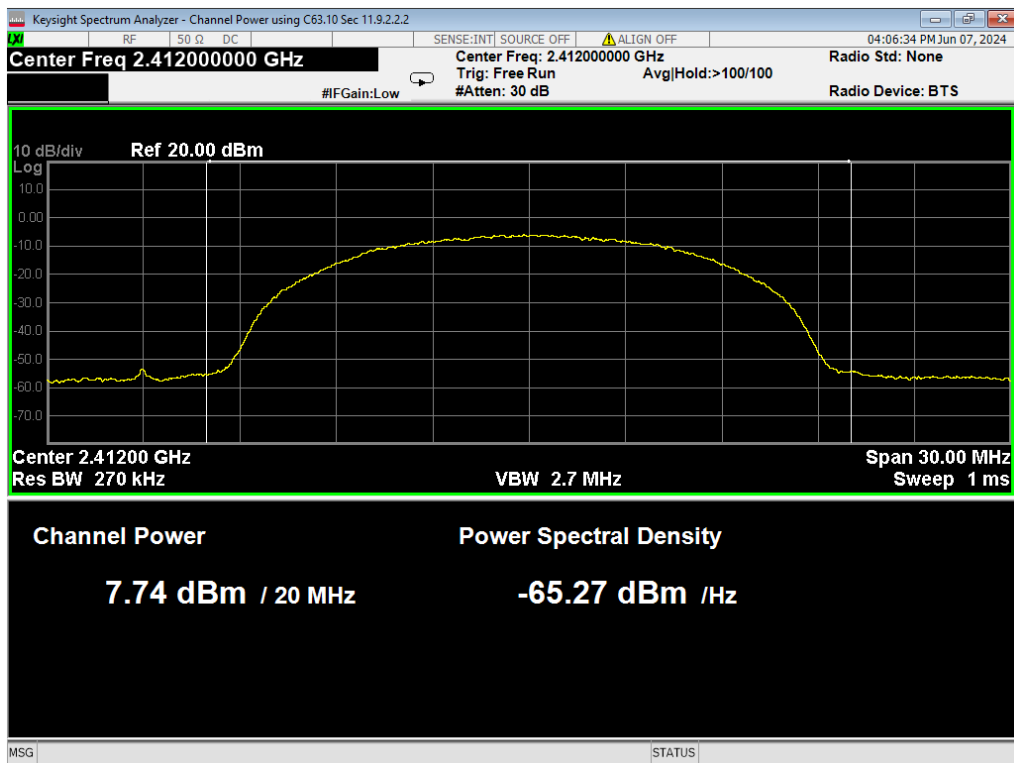


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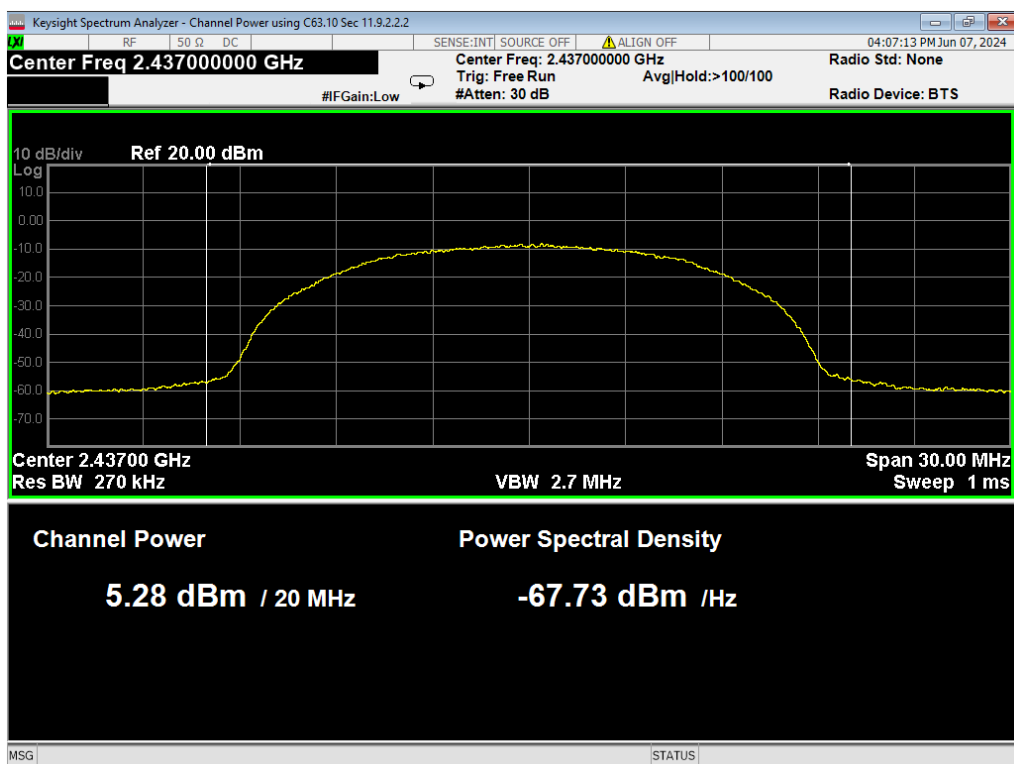


39 HBE Restricted, Wifi N MCS0

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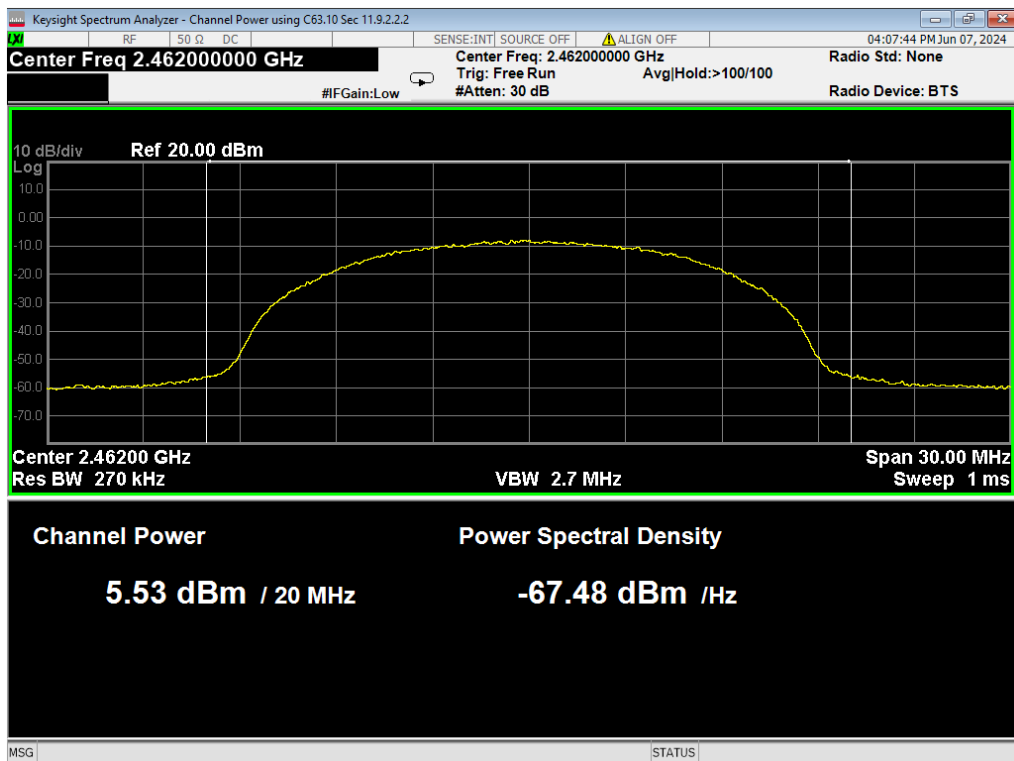


40 Average Power, Low Channel, Wifi B 11MB

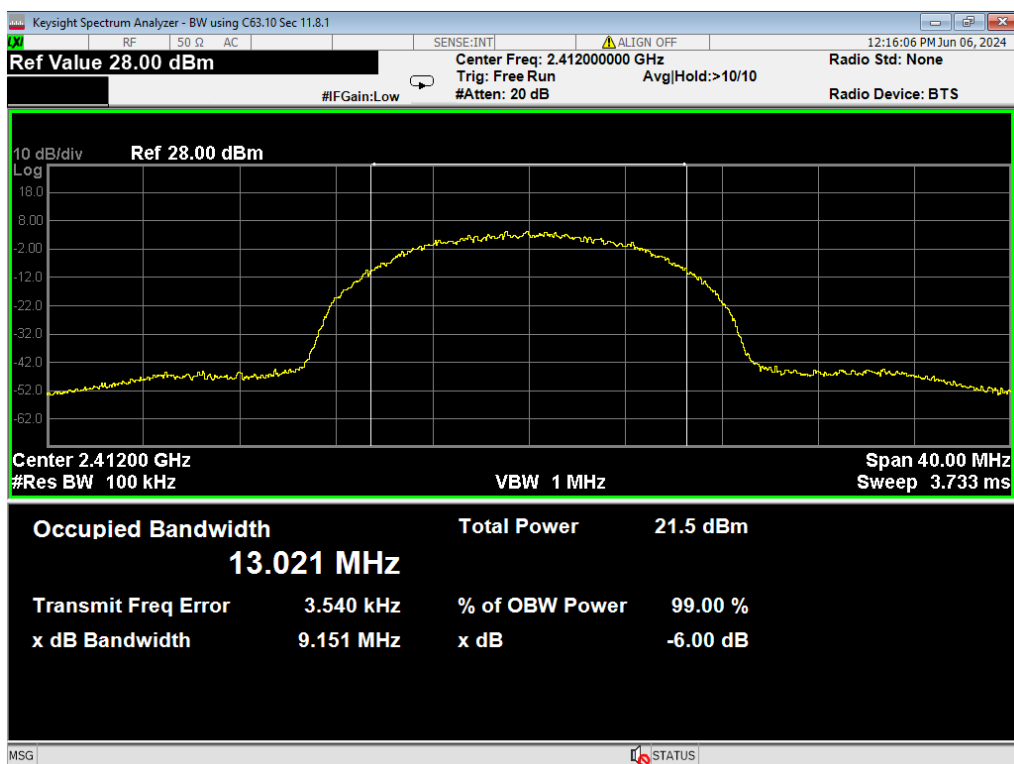


41 Average Power, Mid Channel, Wifi B 11MB

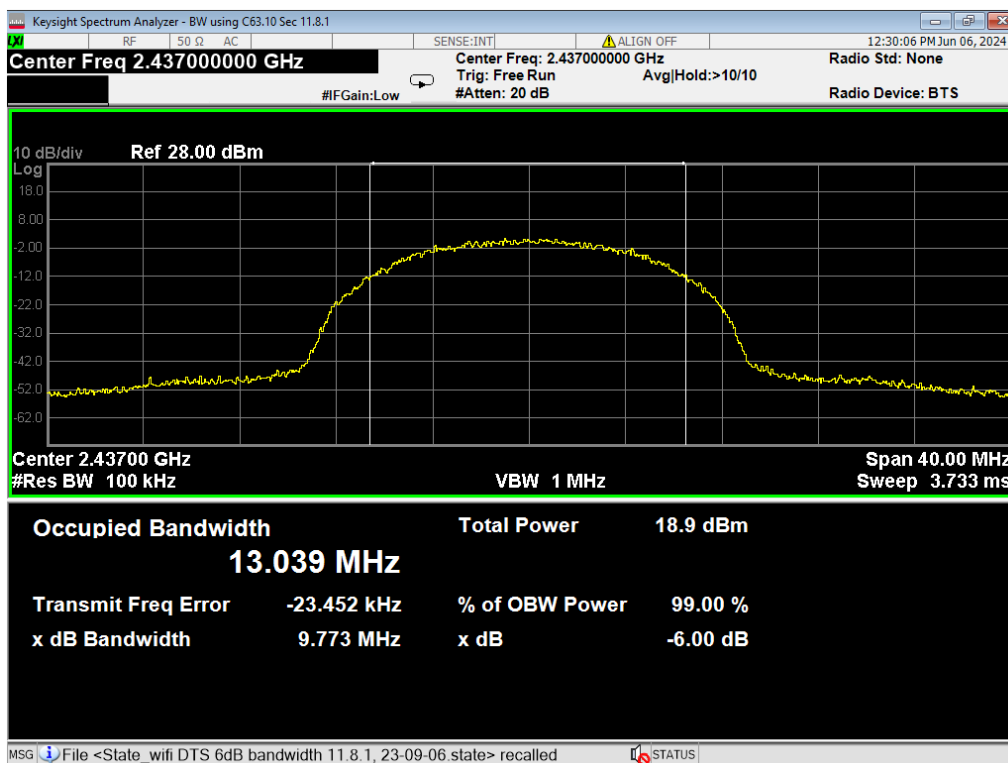
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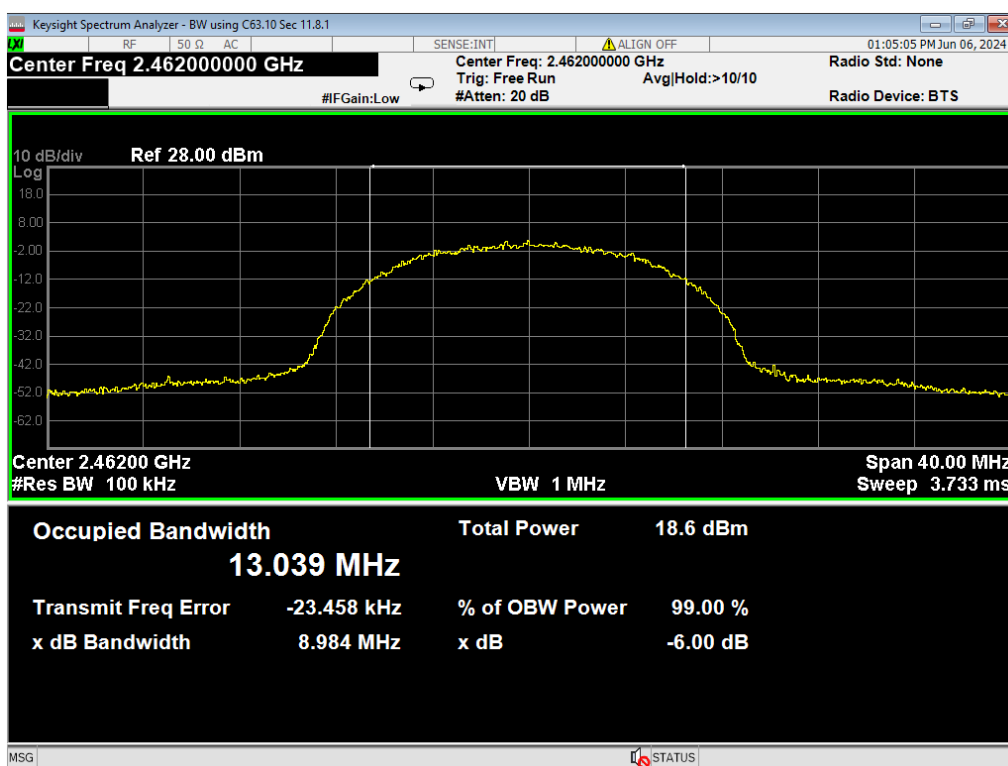
42 Average Power, High Channel, Wifi B 11MB



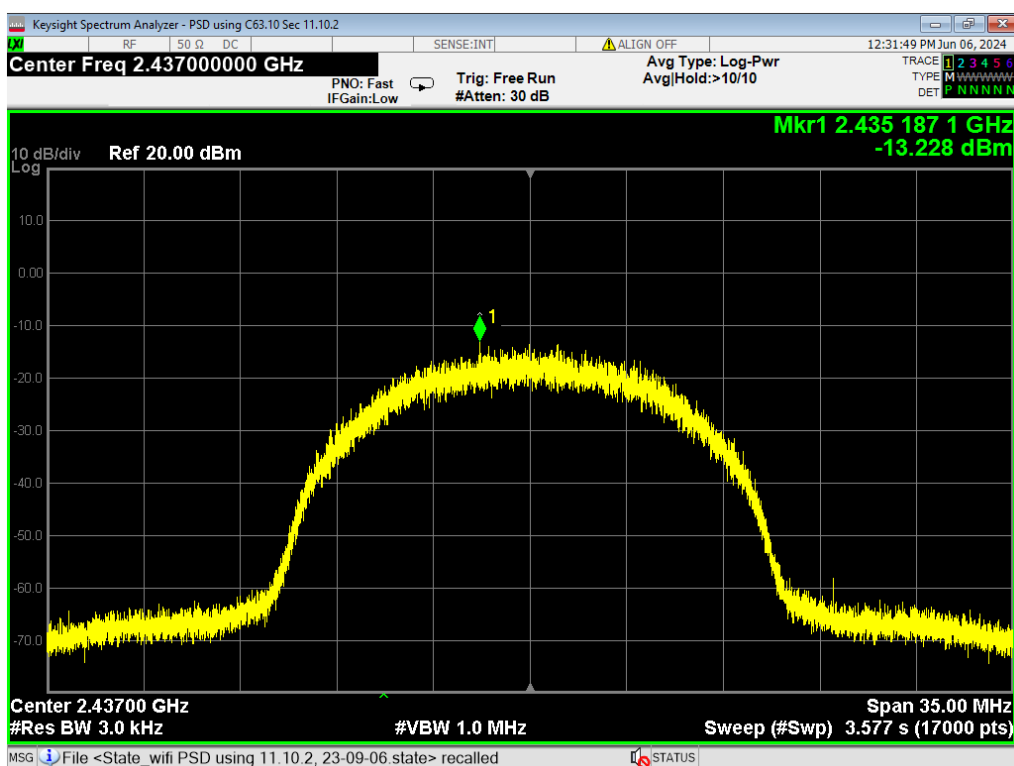
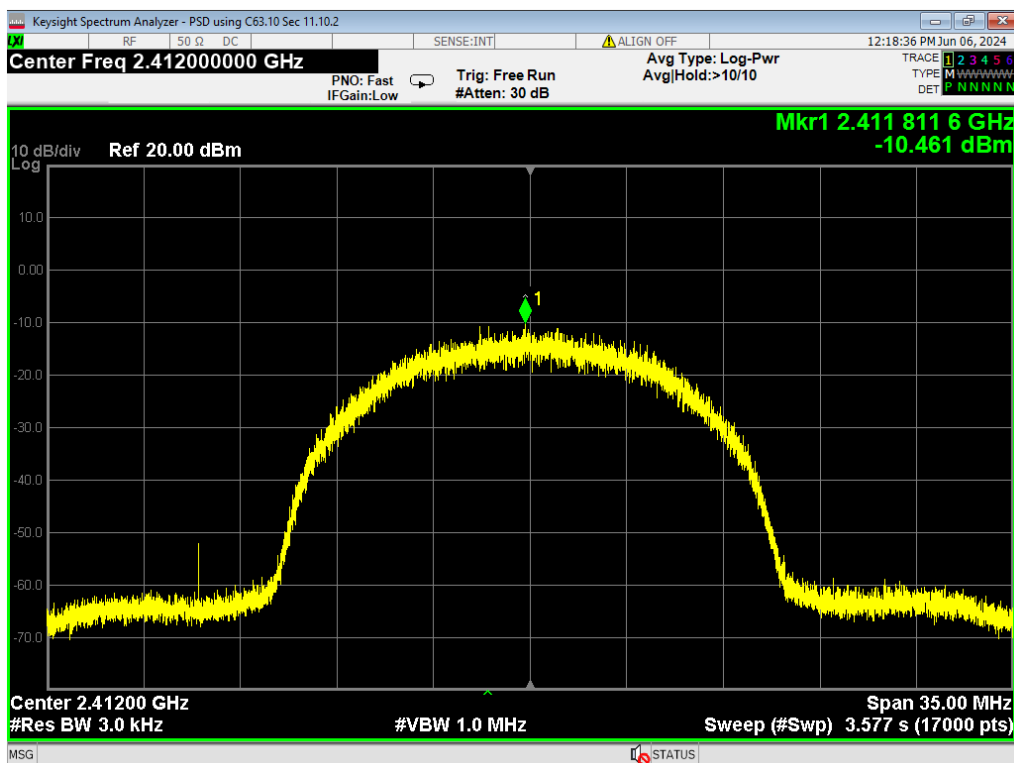
43 6dB Bandwidth, Low Channel, Wifi B 11MB

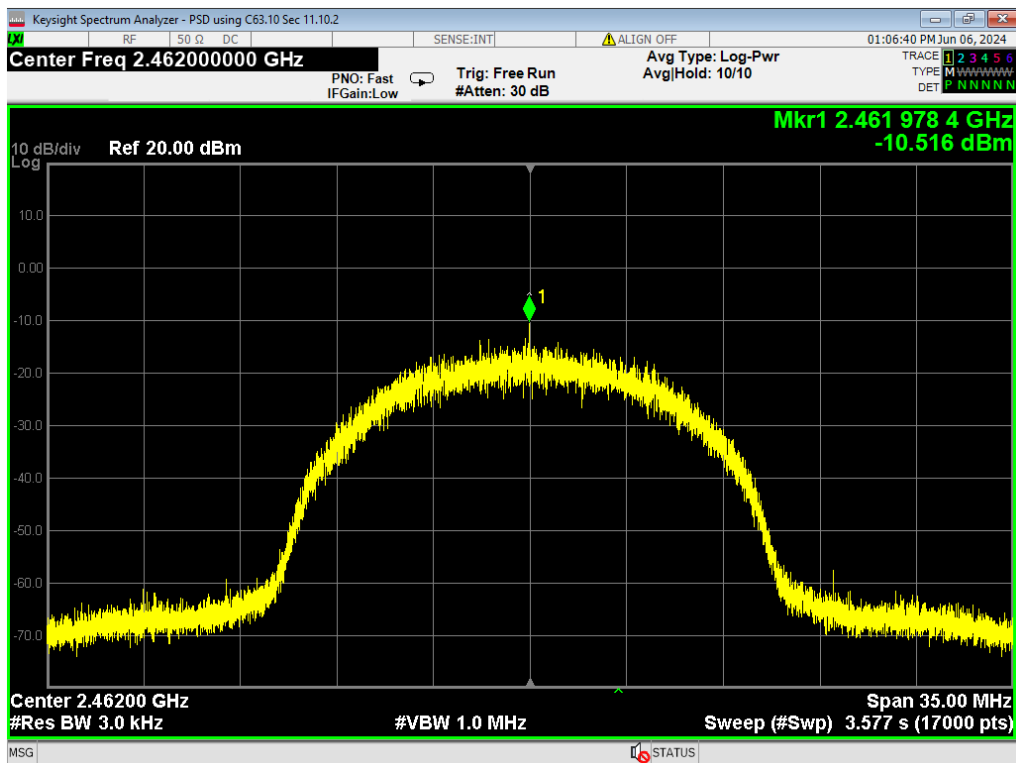


44 6dB Bandwidth, Mid Channel, Wifi B 11MB

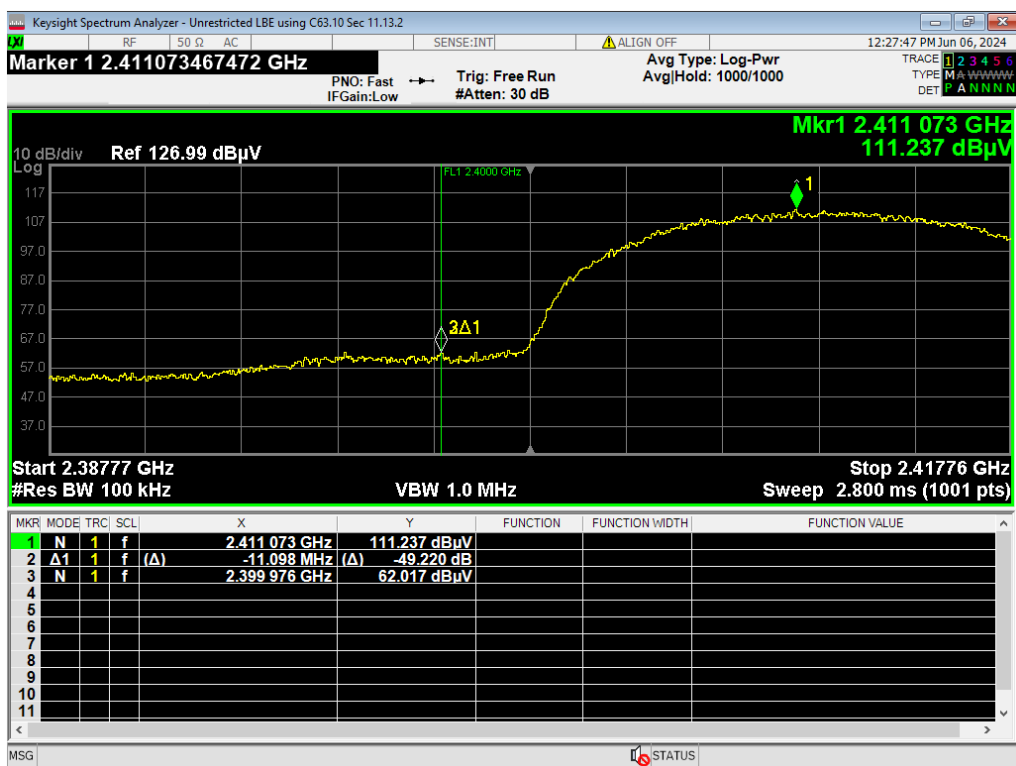


45 6dB Bandwidth, High Channel, Wifi B 11MB

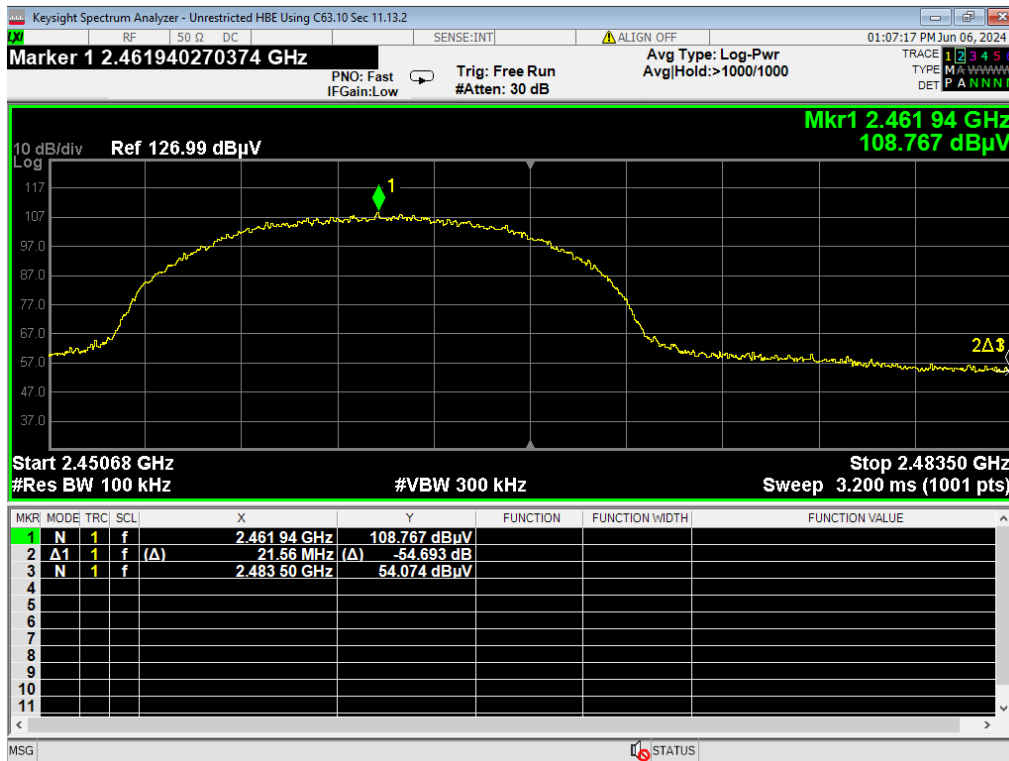




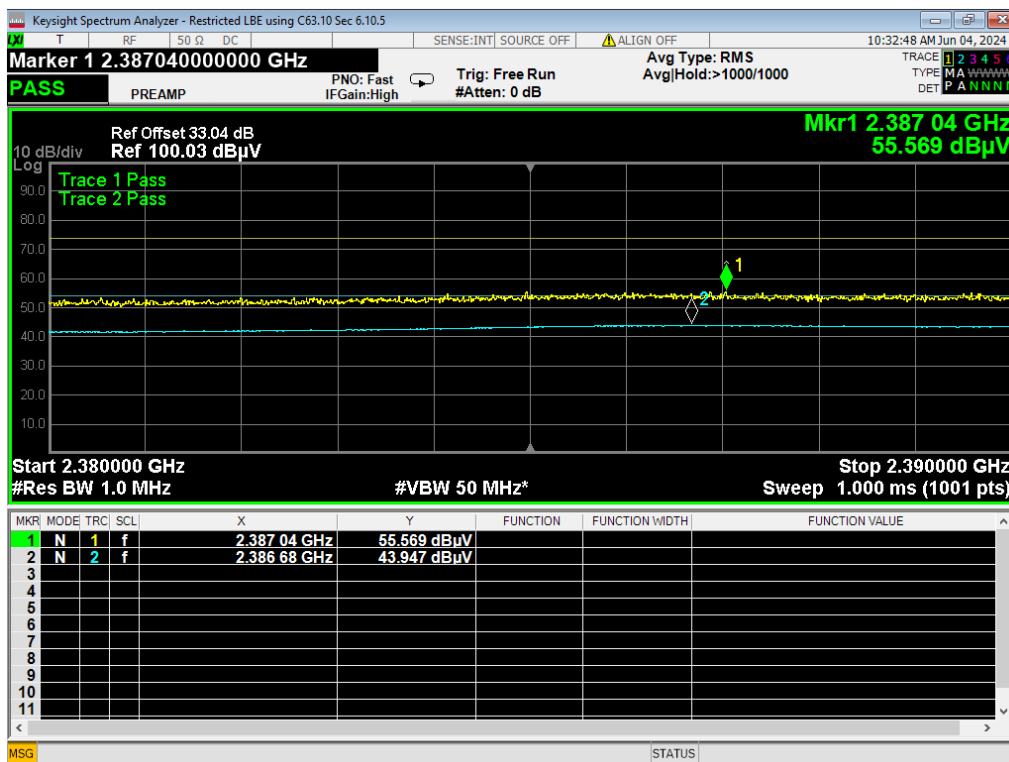
48 PSD, High Channel, Wifi B 11MB



49 LBE Unrestricted, Wifi B 11MB



50 HBE Unrestricted, Wifi B 11MB



51 LBE Restricted, Wifi B 11MB



Report Number:

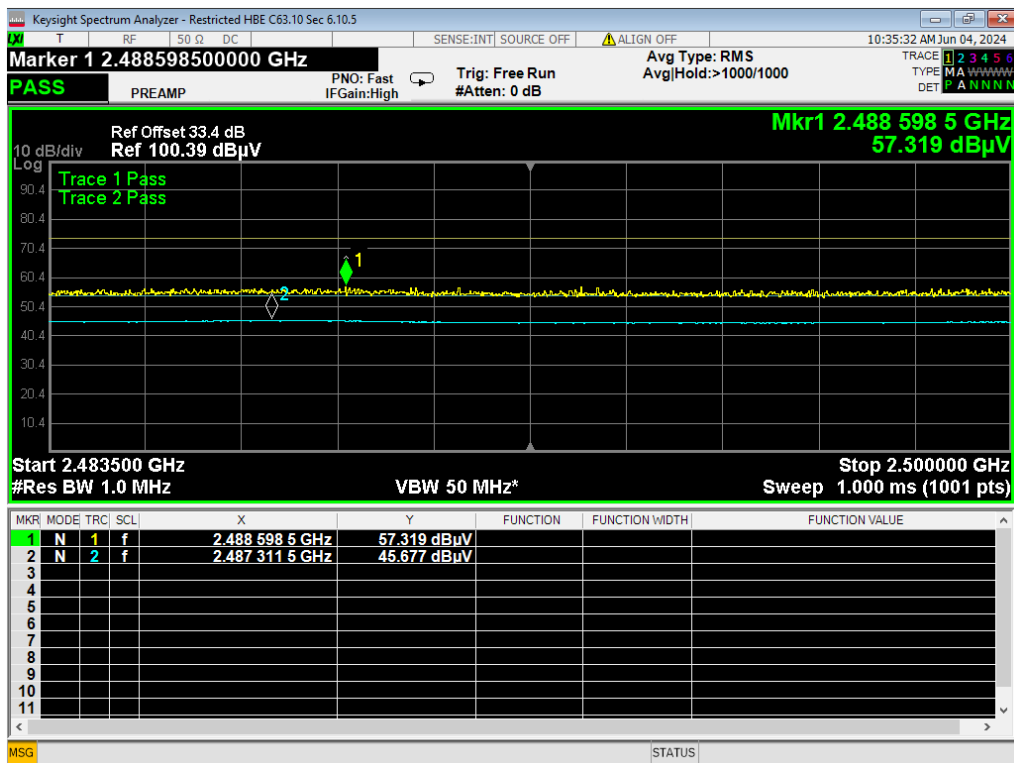
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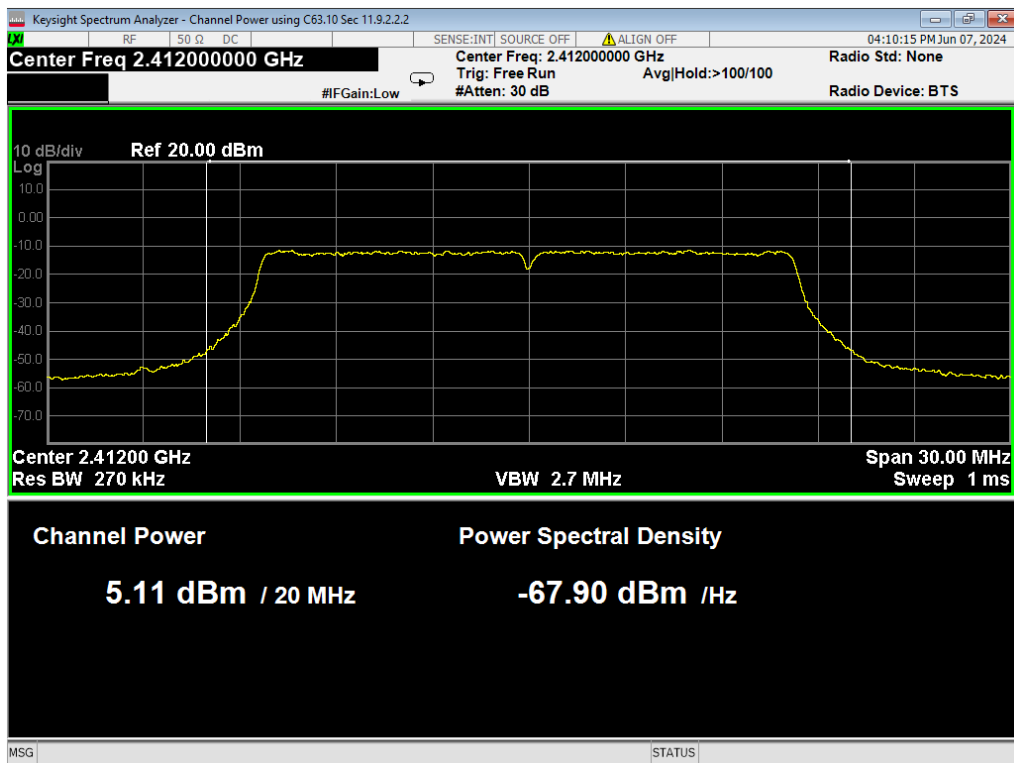
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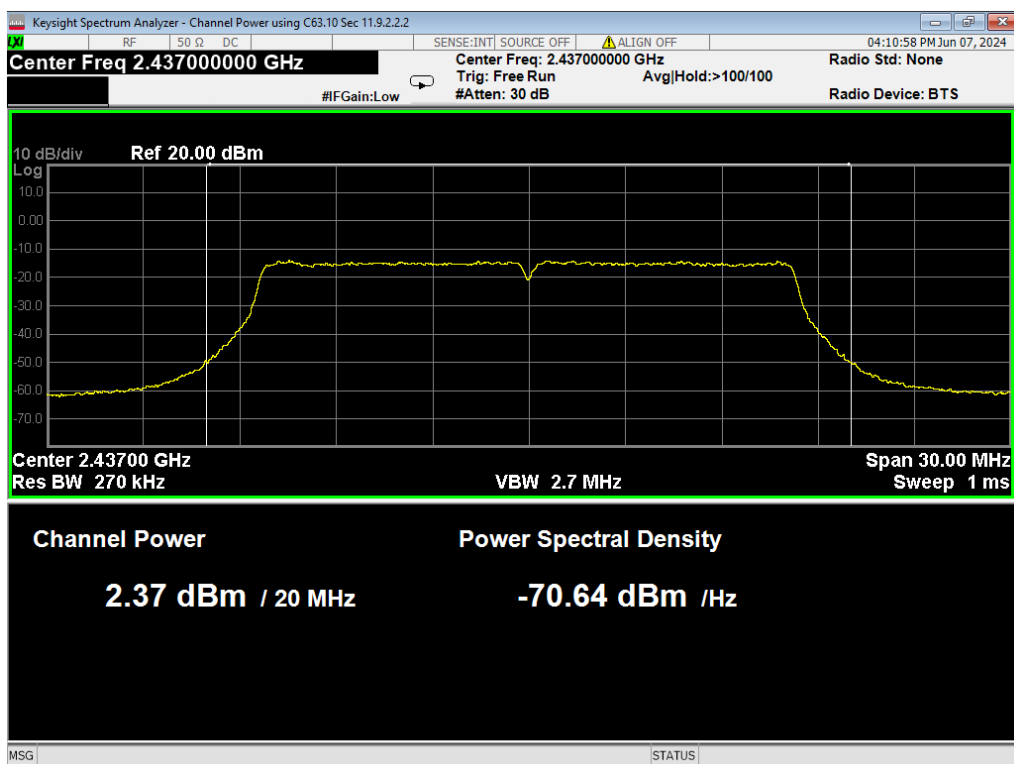


52 HBE Restricted, Wifi B 11MB

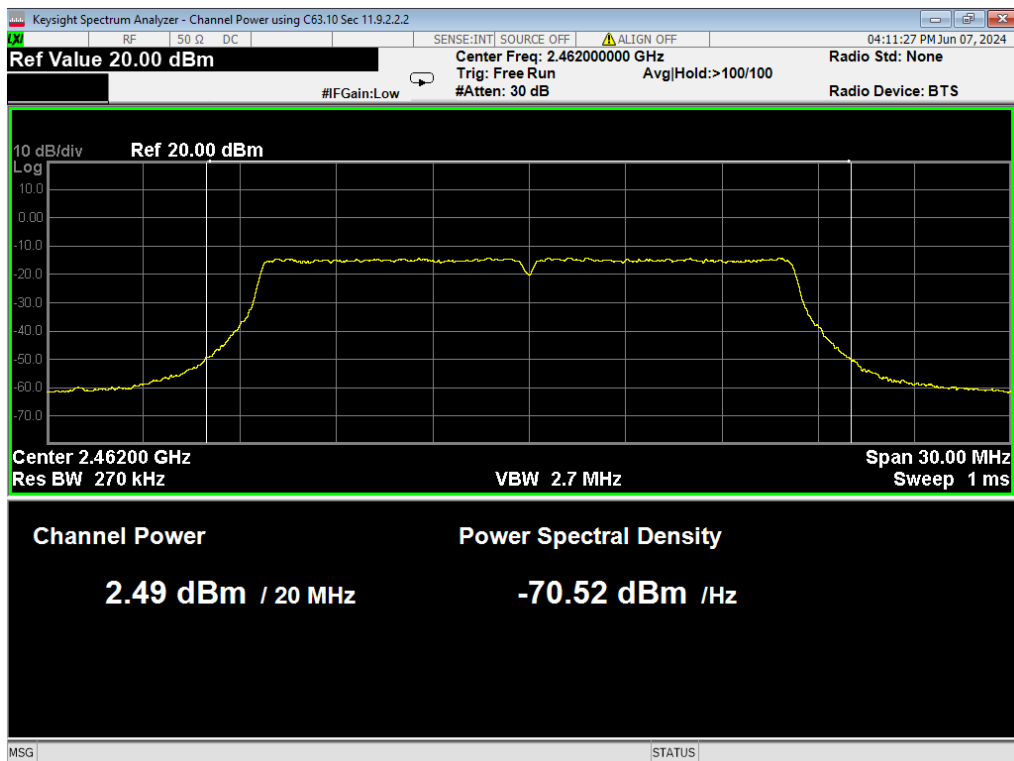
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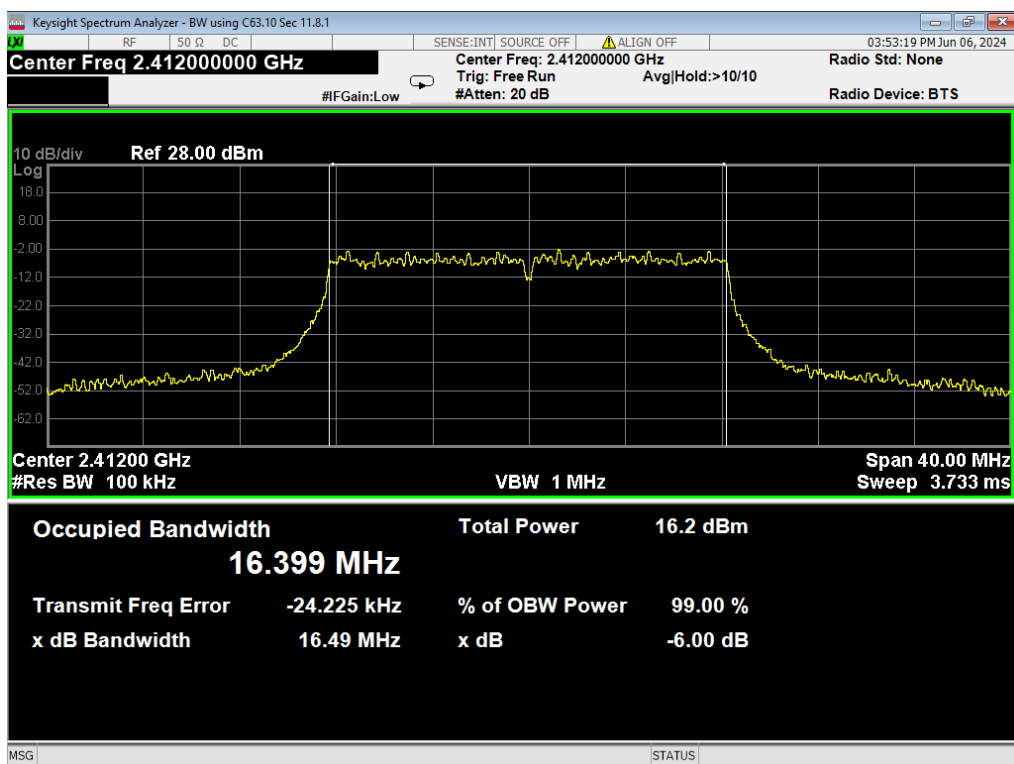
53 Average Power, Low Channel, Wifi G 54MB



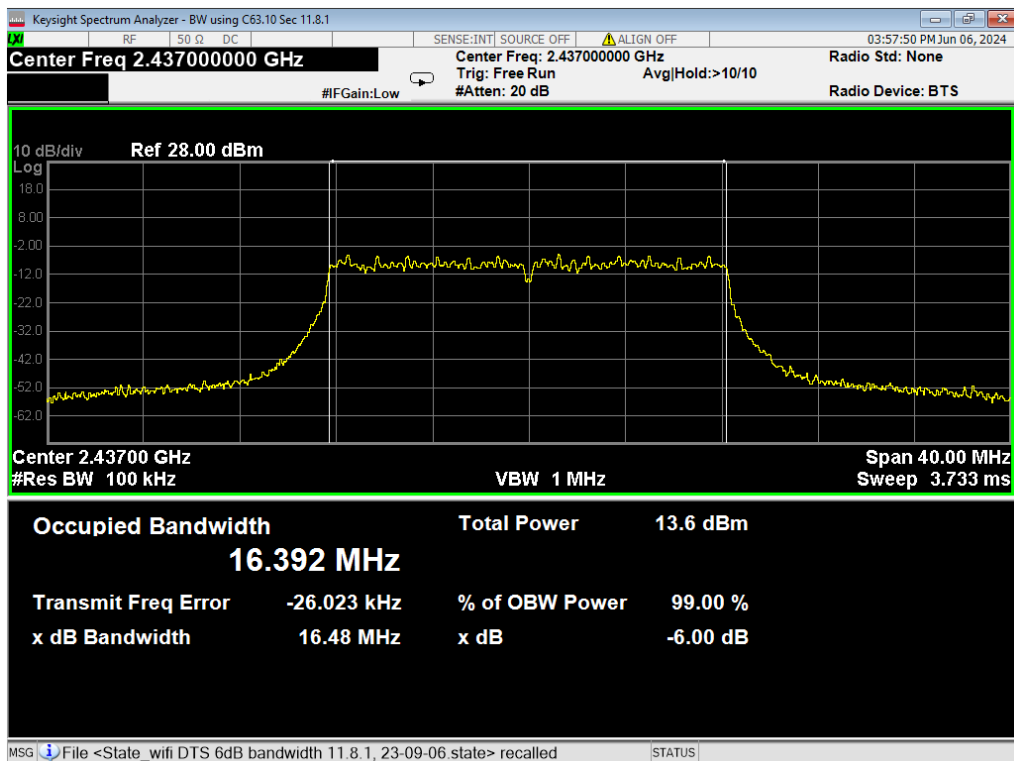
54 Average Power, Mid Channel, Wifi G 54MB



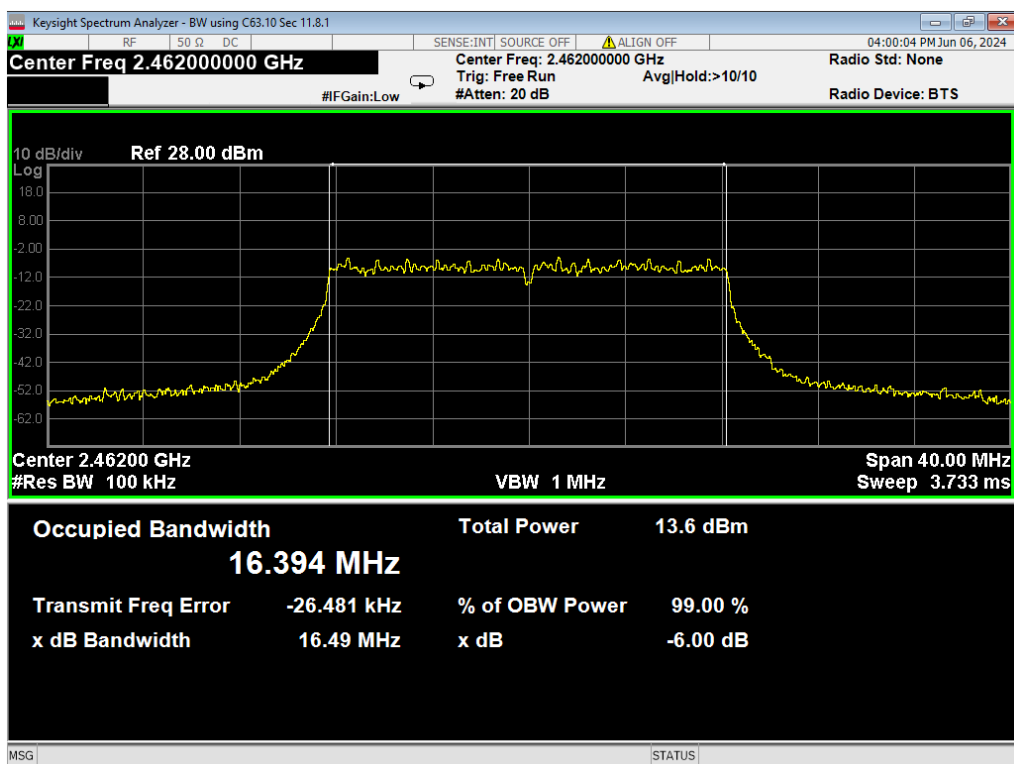
55 Average Power, High Channel, Wifi G 54MB




56 6dB Bandwidth, Low Channel, Wifi G 54MB

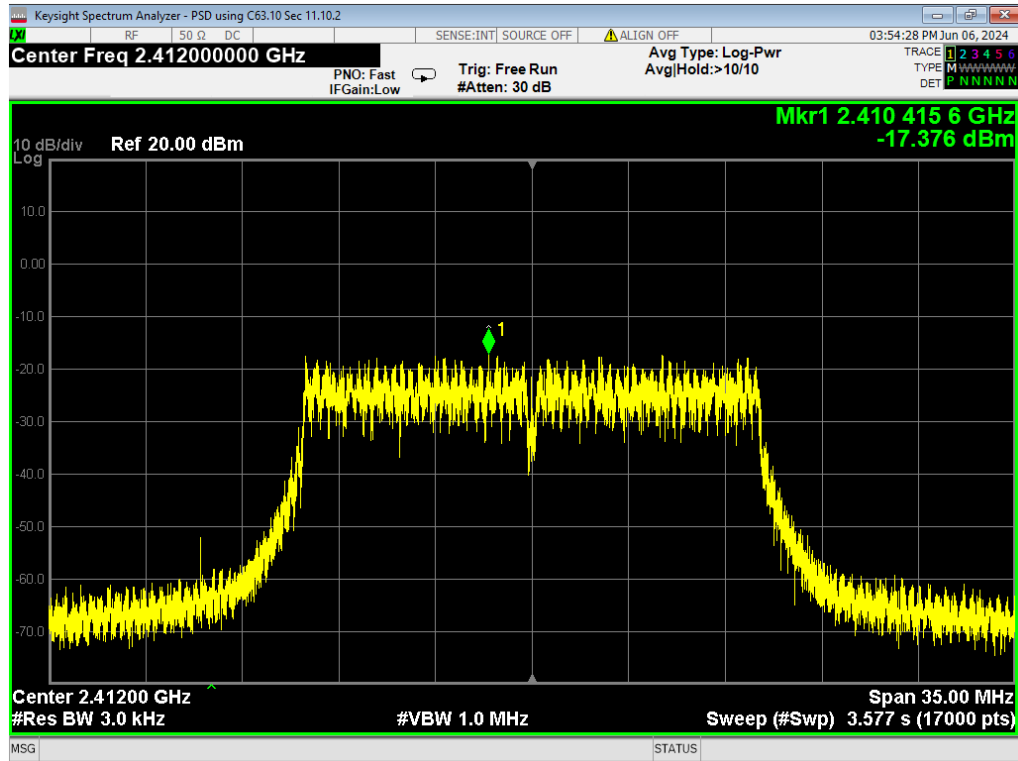


57 6dB Bandwidth, Mid Channel, Wifi G 54MB

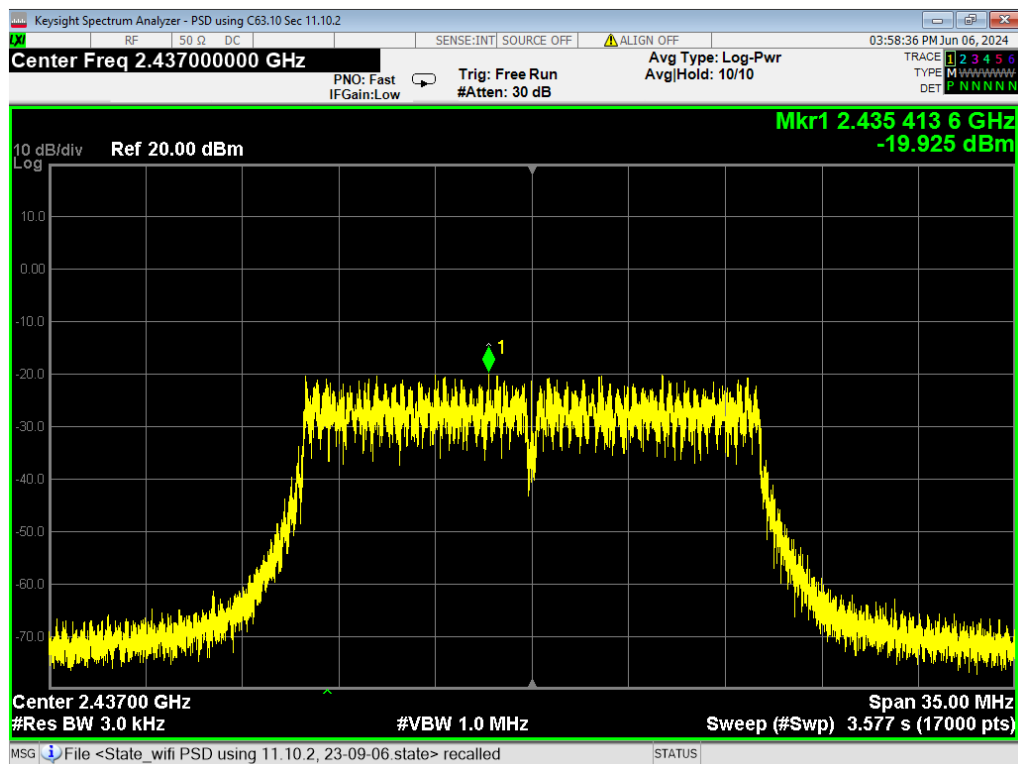


58 6dB Bandwidth, High Channel, Wifi G 54MB

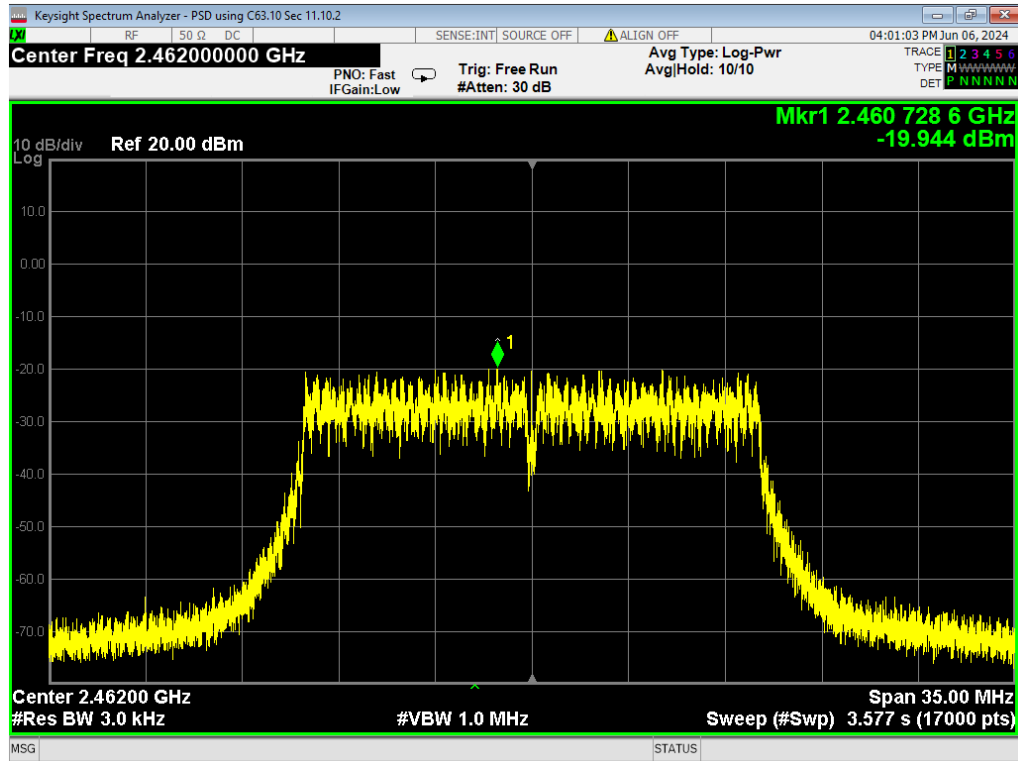
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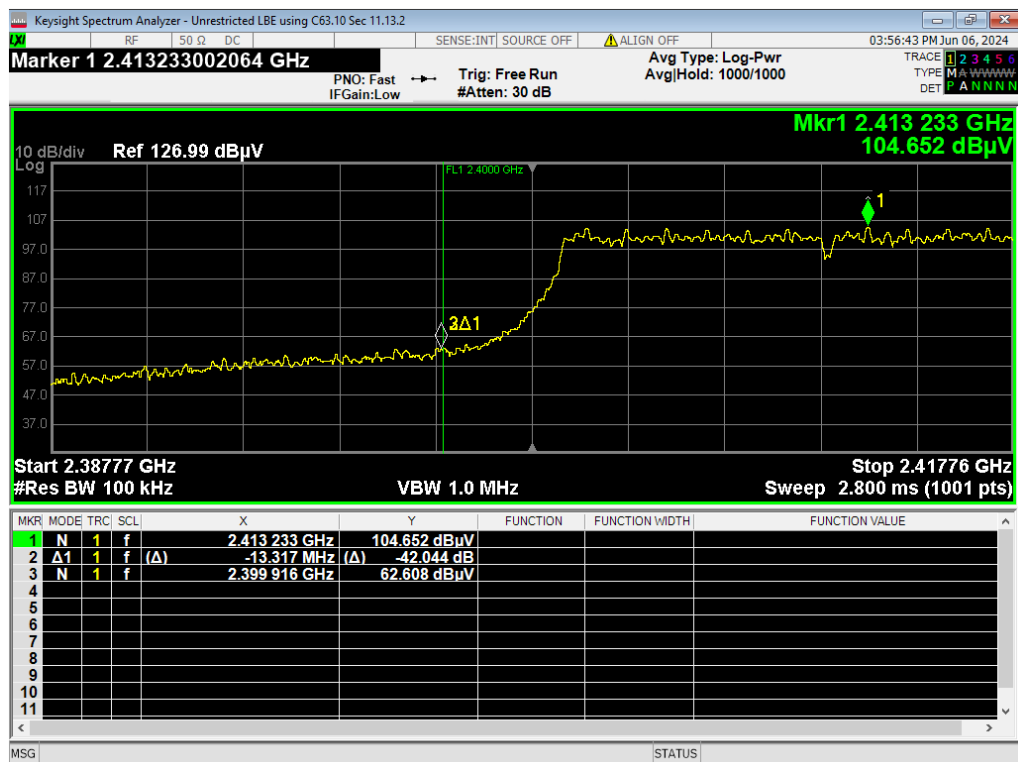
59 PSD, Low Channel, Wifi G 54MB



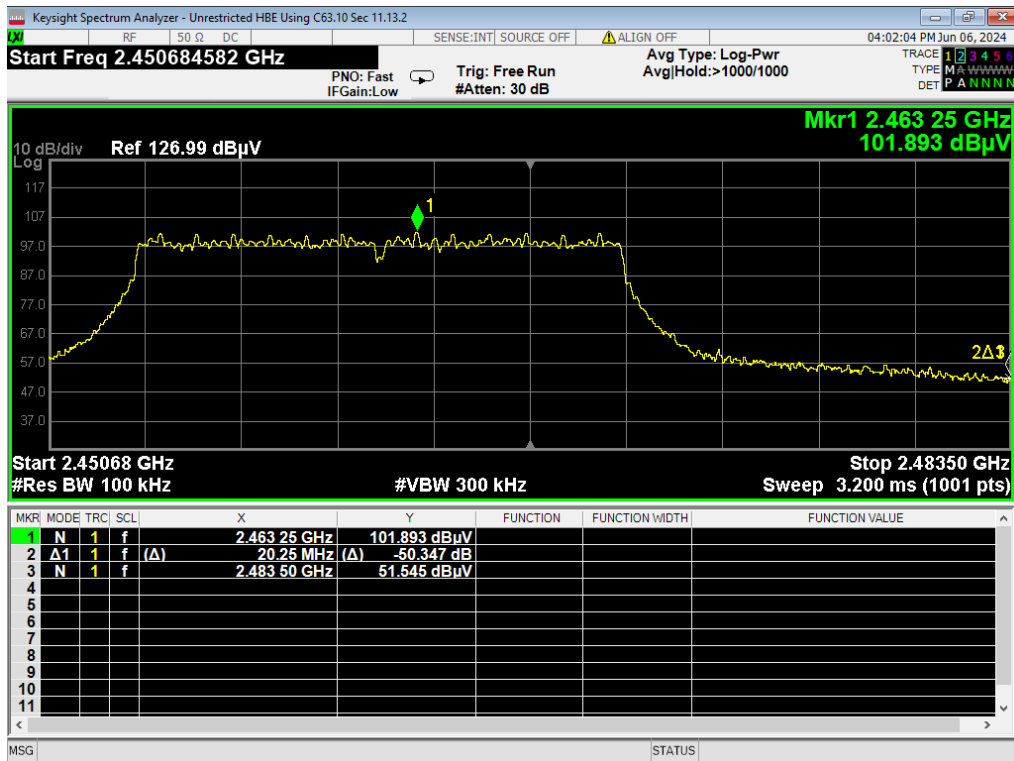
60 PSD, Mid Channel, Wifi G 54MB



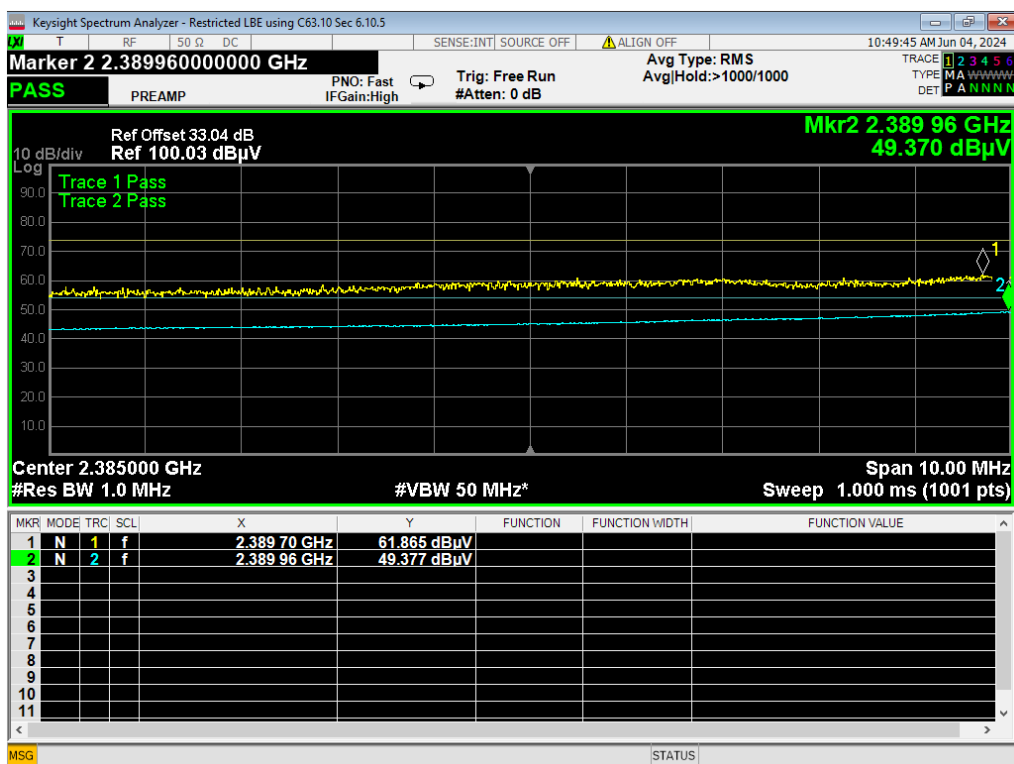
61 PSD, High Channel, Wifi G 54MB



62 LBE Unrestricted, Wifi G 54MB



63 HBE Unrestricted, Wifi G 54MB



64 LBE Restricted, Wifi G 54MB

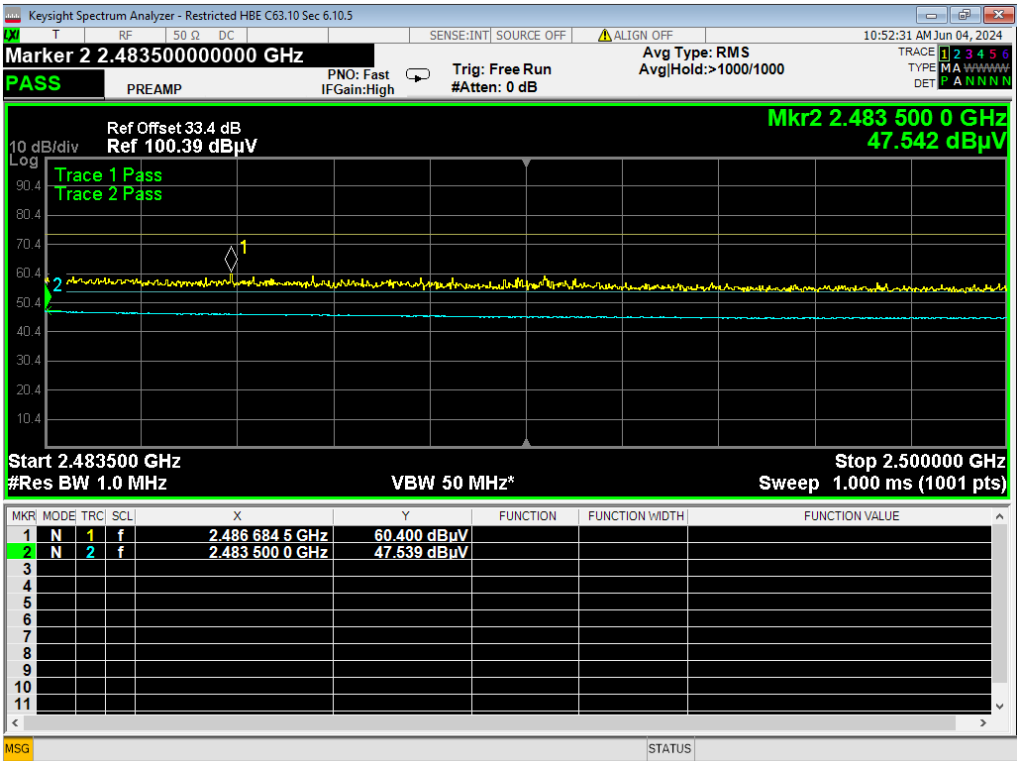


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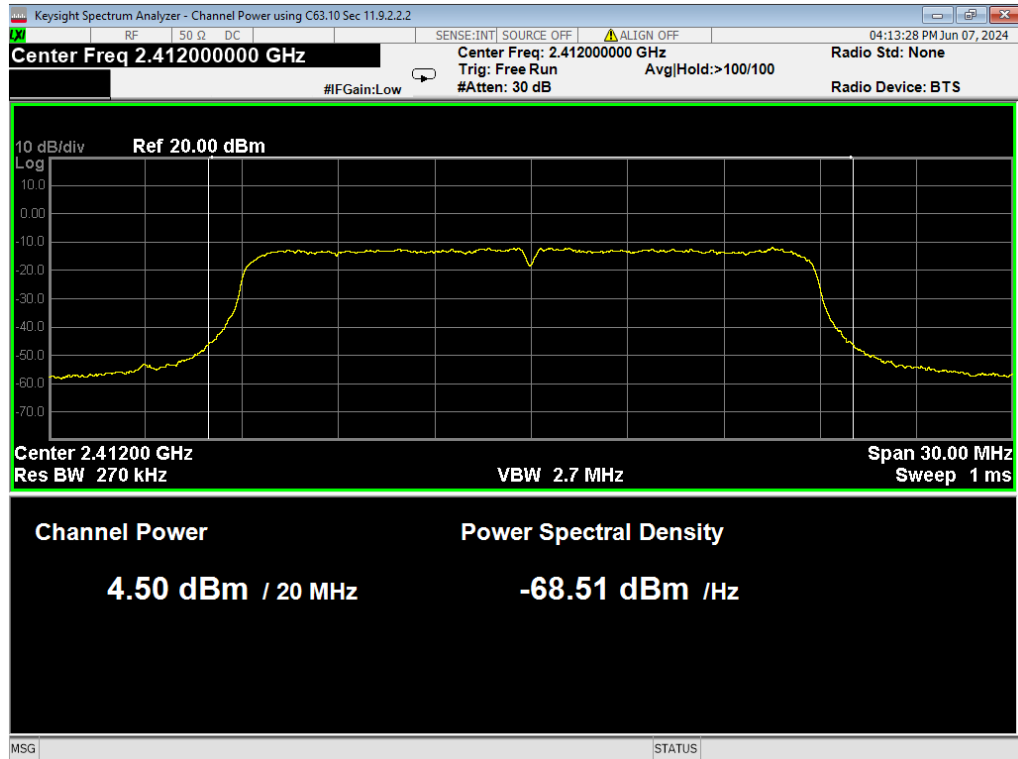
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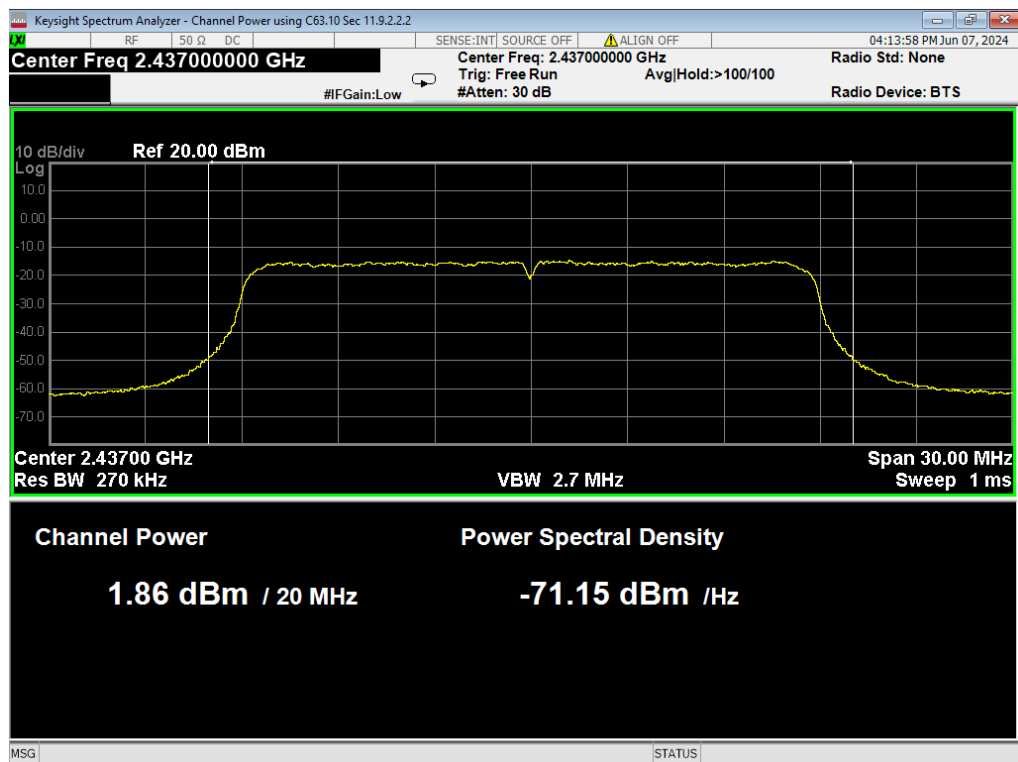


65 HBE Restricted, Wifi G 54MB

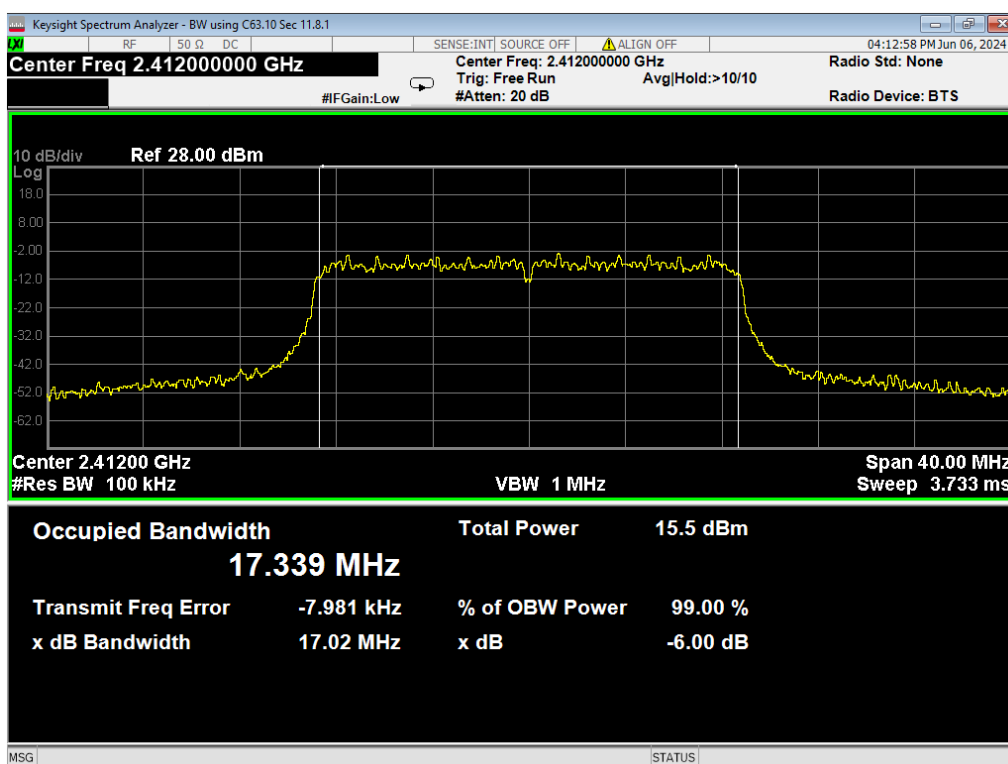
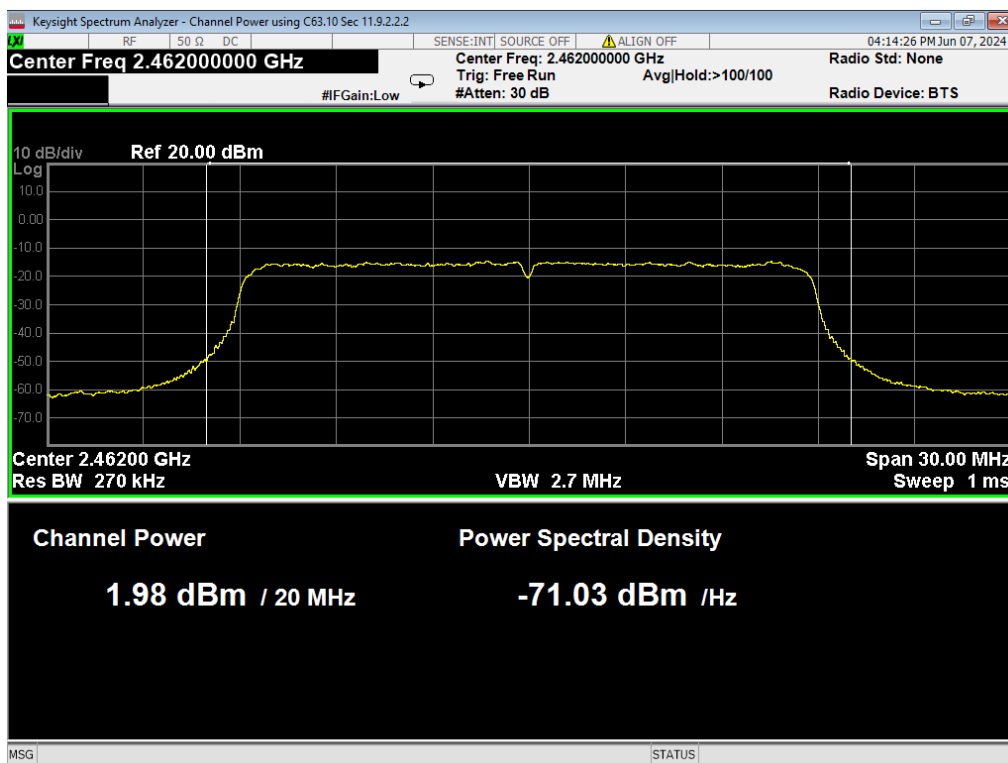
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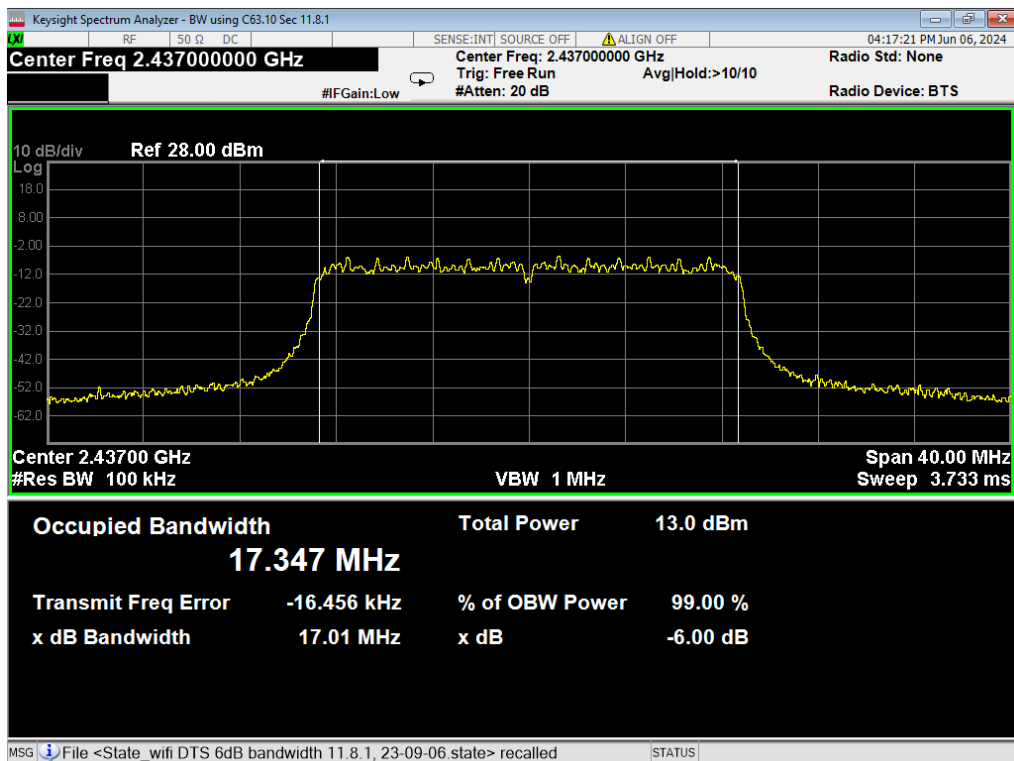


66 Average Power, Low Channel, Wifi N MCS7

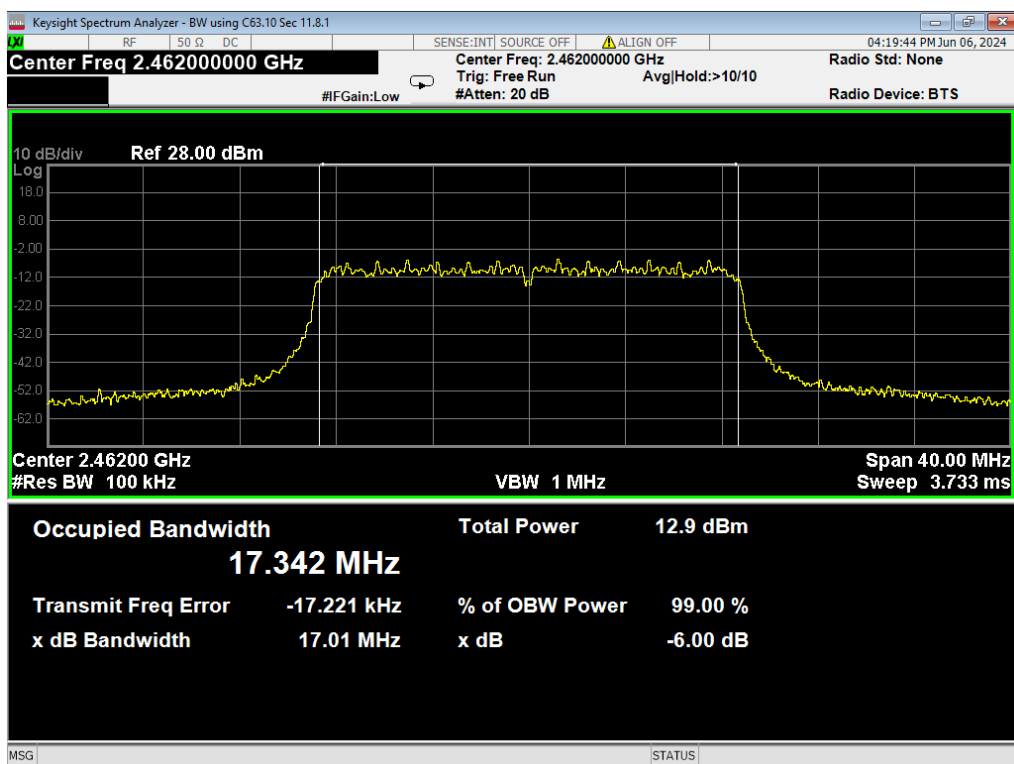


67 Average Power, Mid Channel, Wifi N MCS7

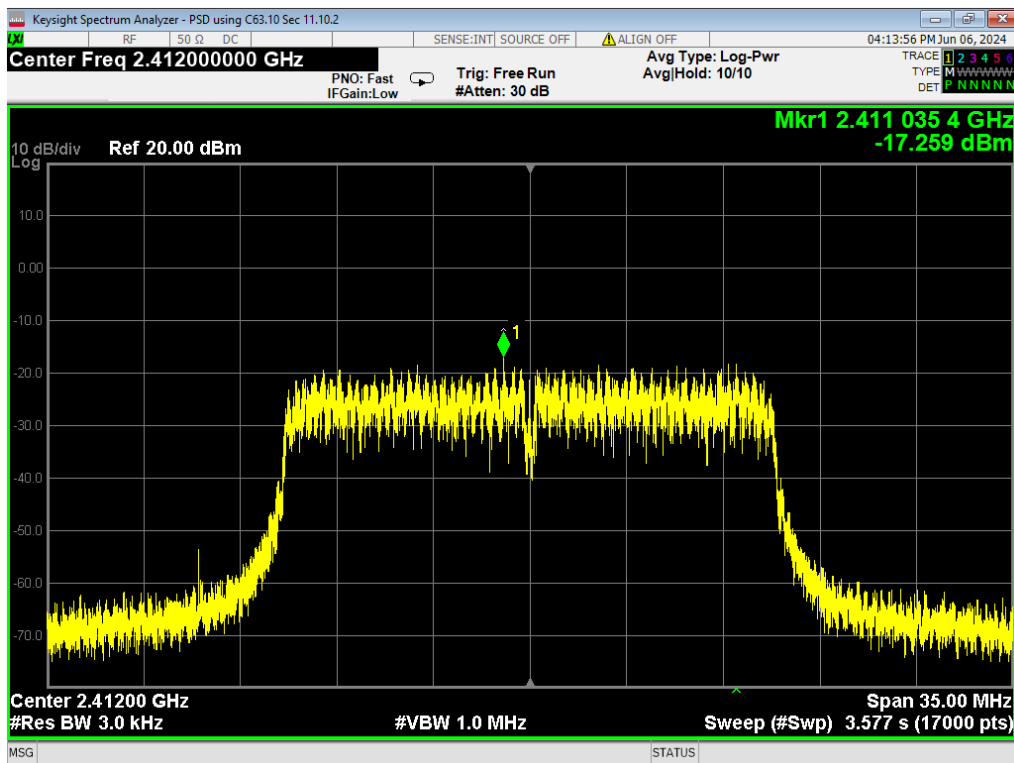




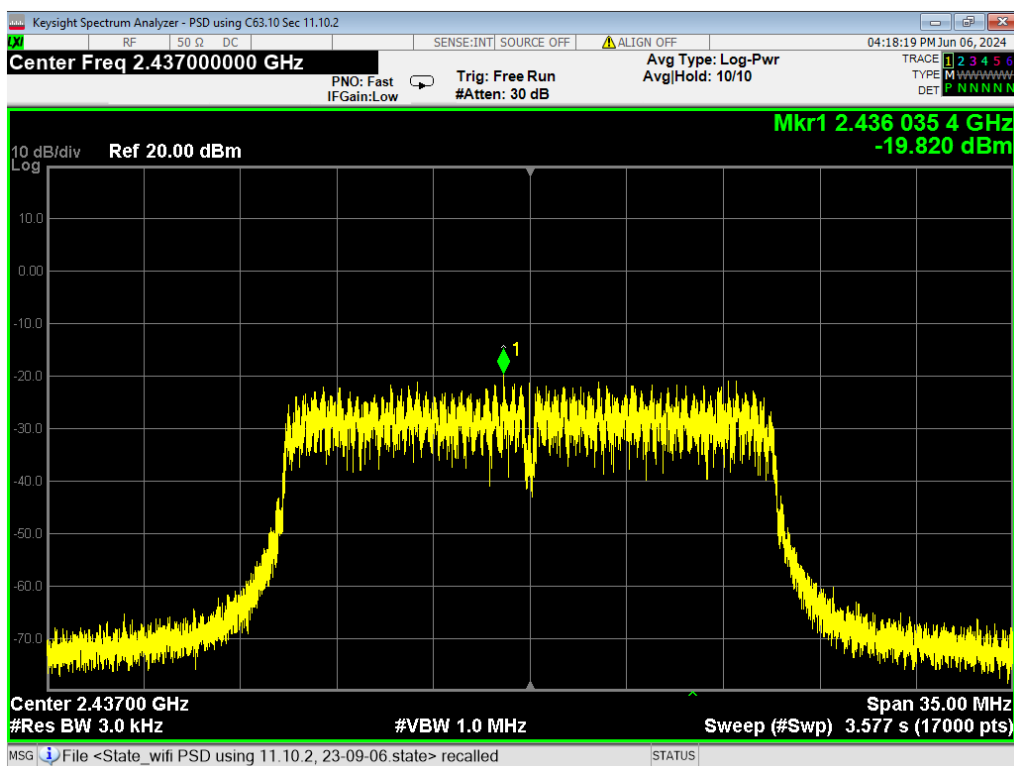
70 dB Bandwidth, Mid Channel, Wifi N MCS7



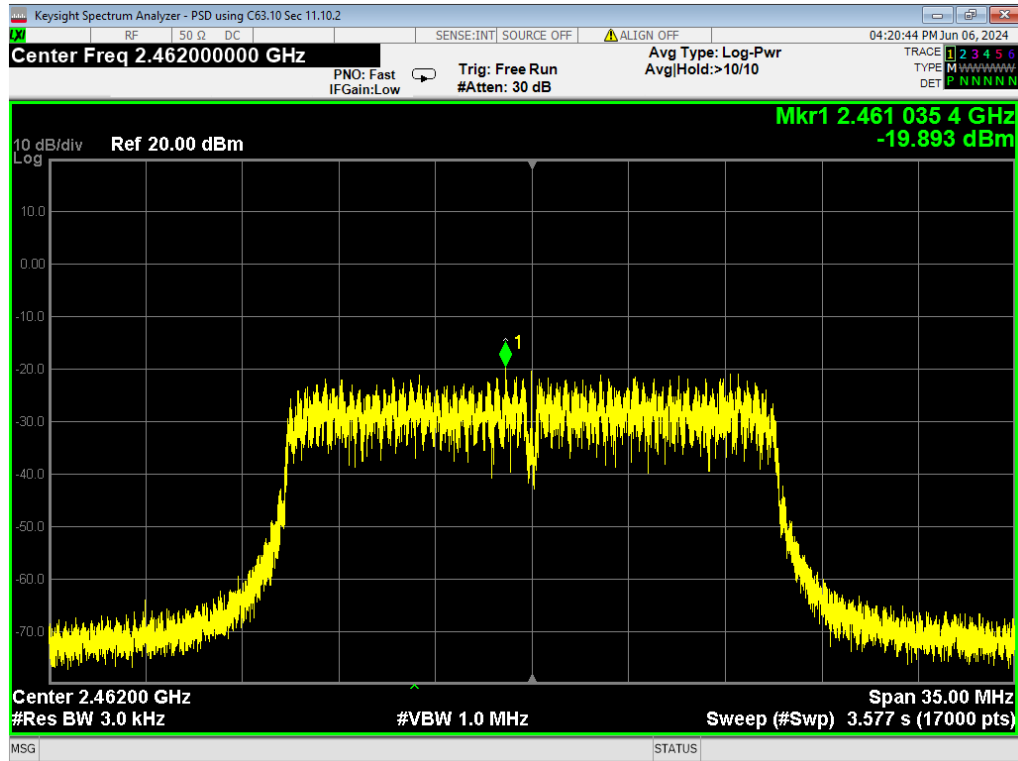
71 dB Bandwidth, High Channel, Wifi N MCS7



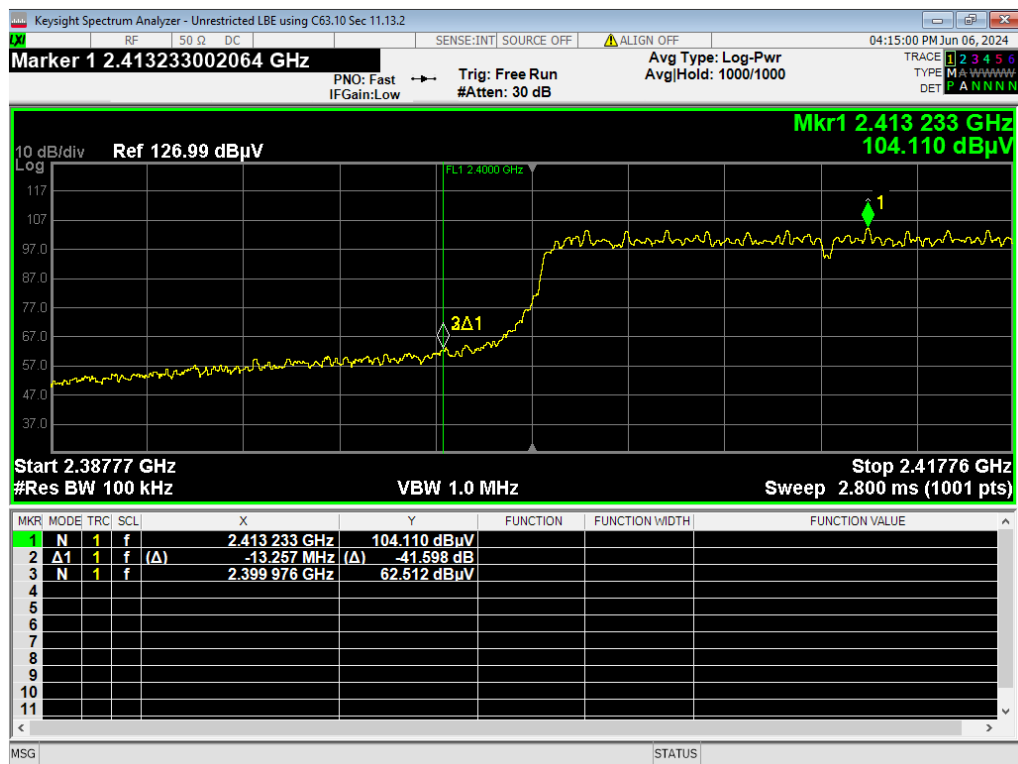
72 PSD, Low Channel, Wifi N MCS7



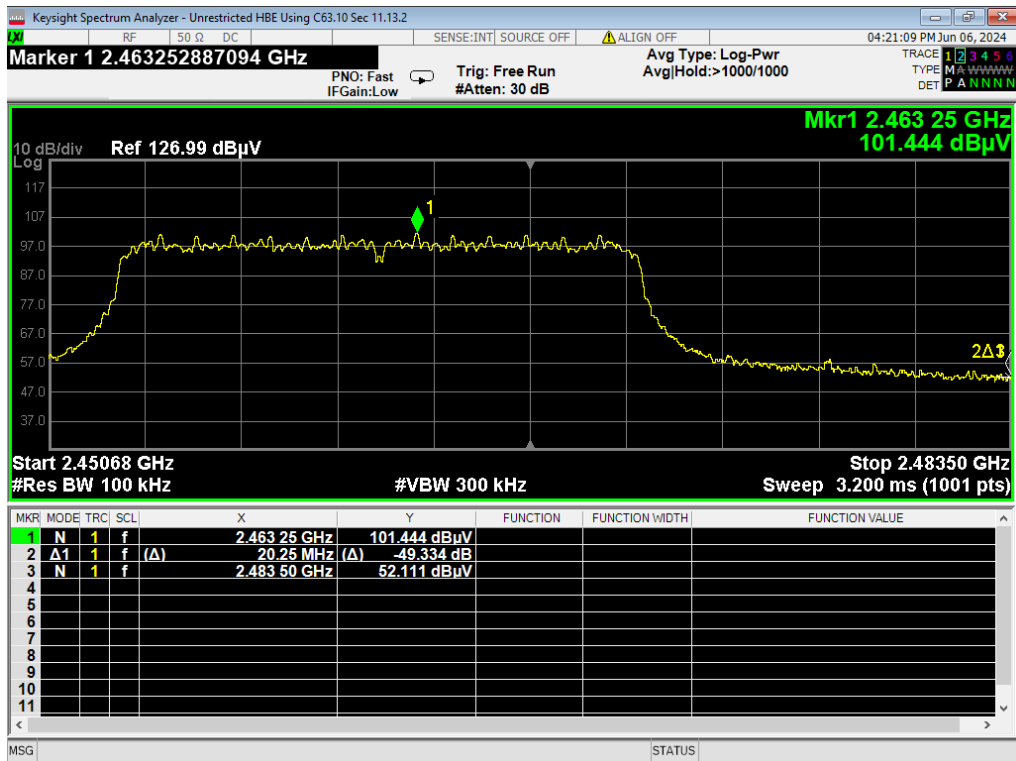
73 PSD, Mid Channel, Wifi N MCS7



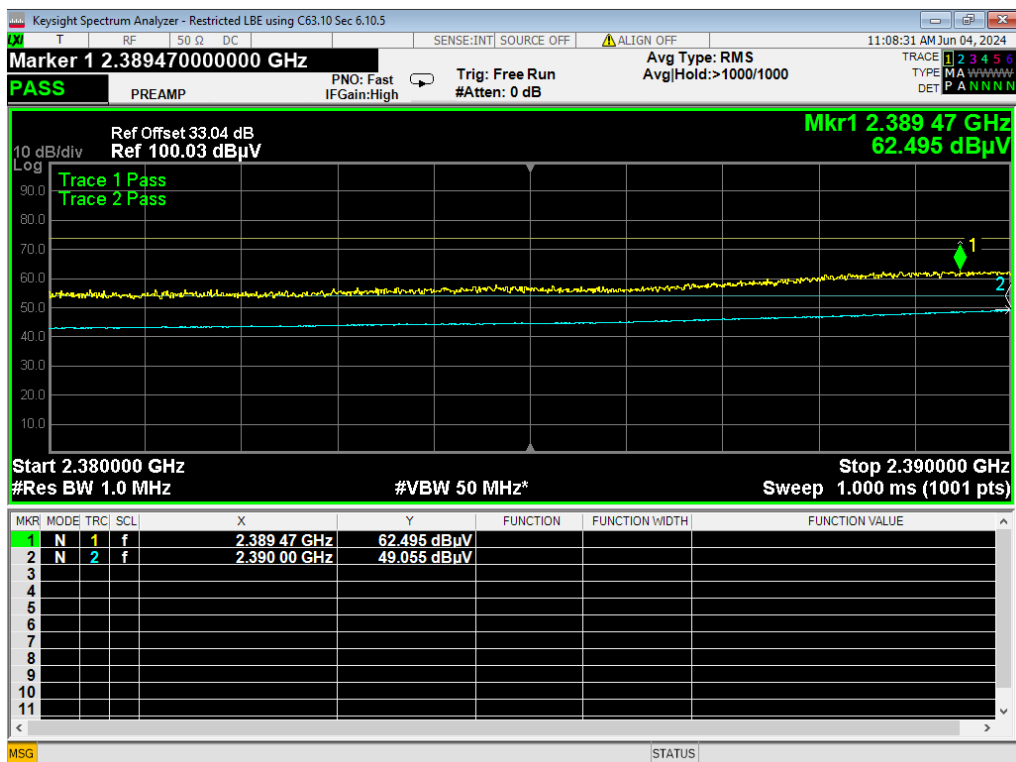
74 PSD, High Channel, Wifi N MCS7



75 LBE Unrestricted, Wifi N MCS7



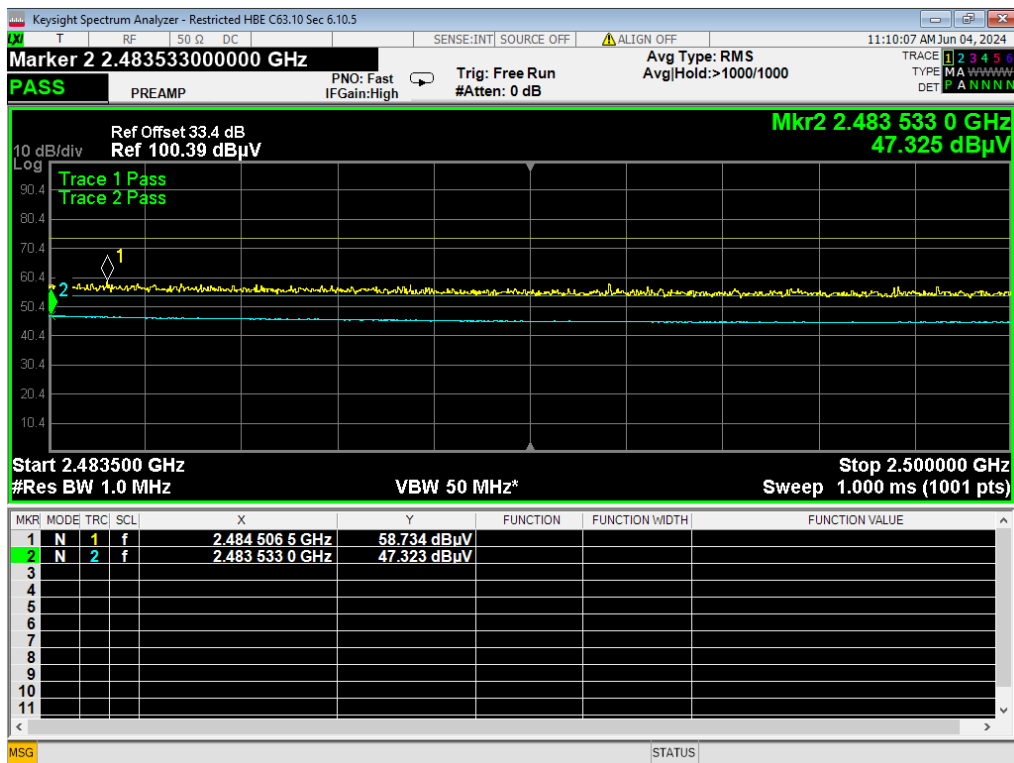
76 HBE Unrestricted, Wifi N MCS7



77 LBE Restricted, Wifi N MCS7

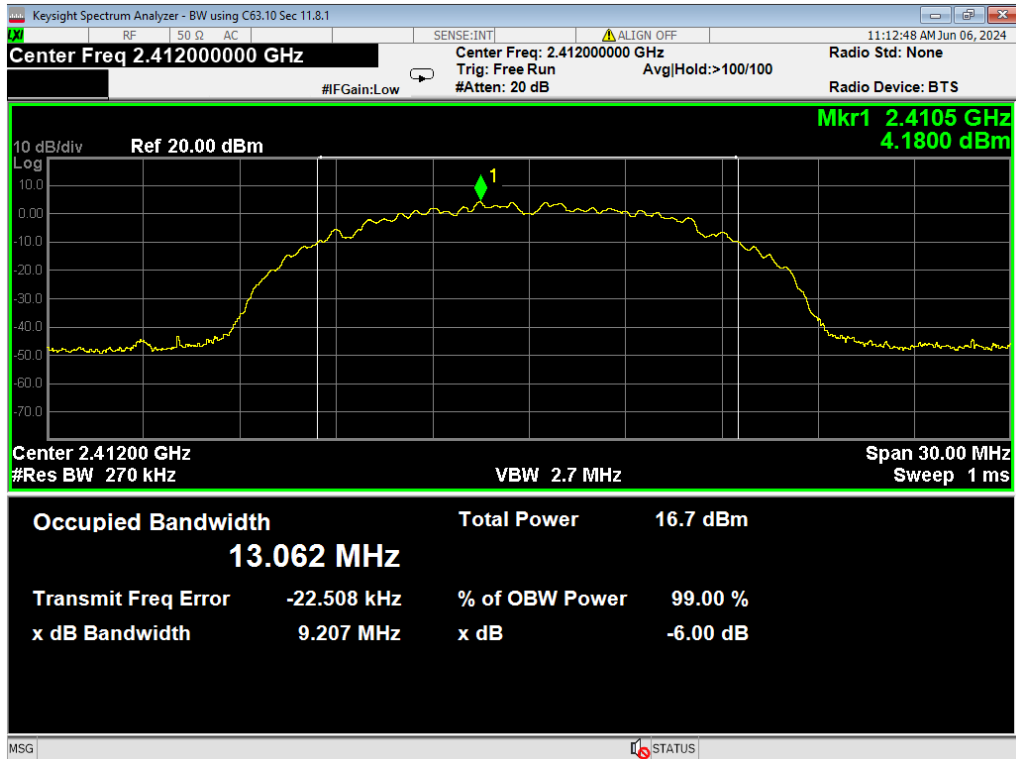


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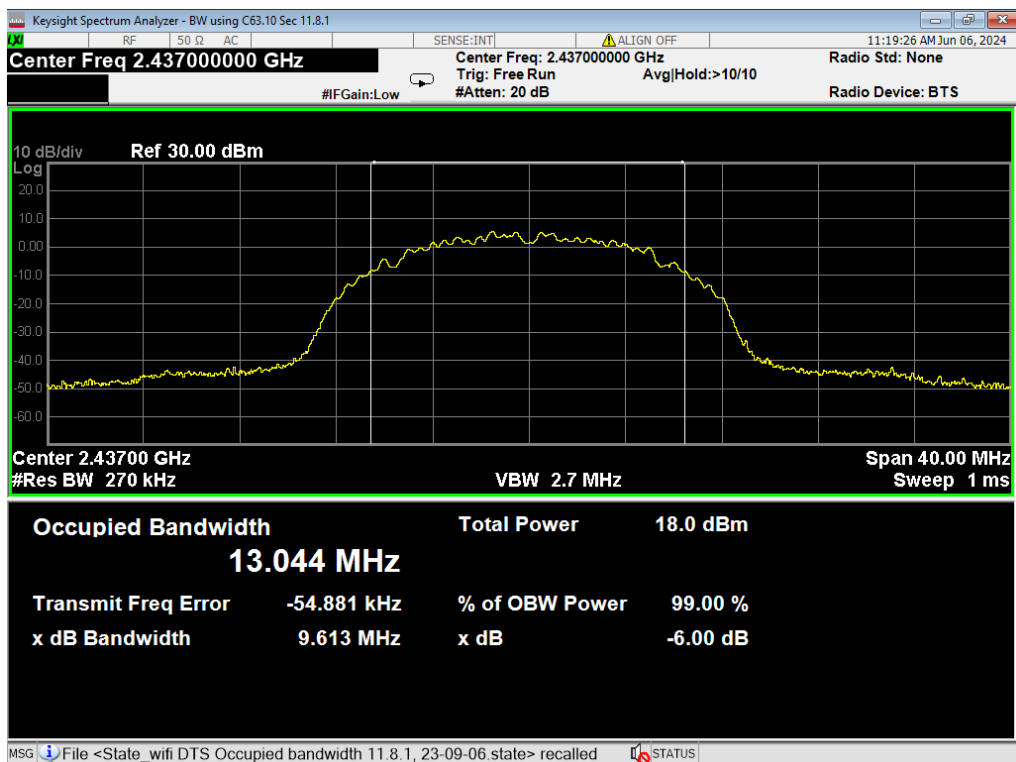


78 HBE Restricted, Wifi N MCS7

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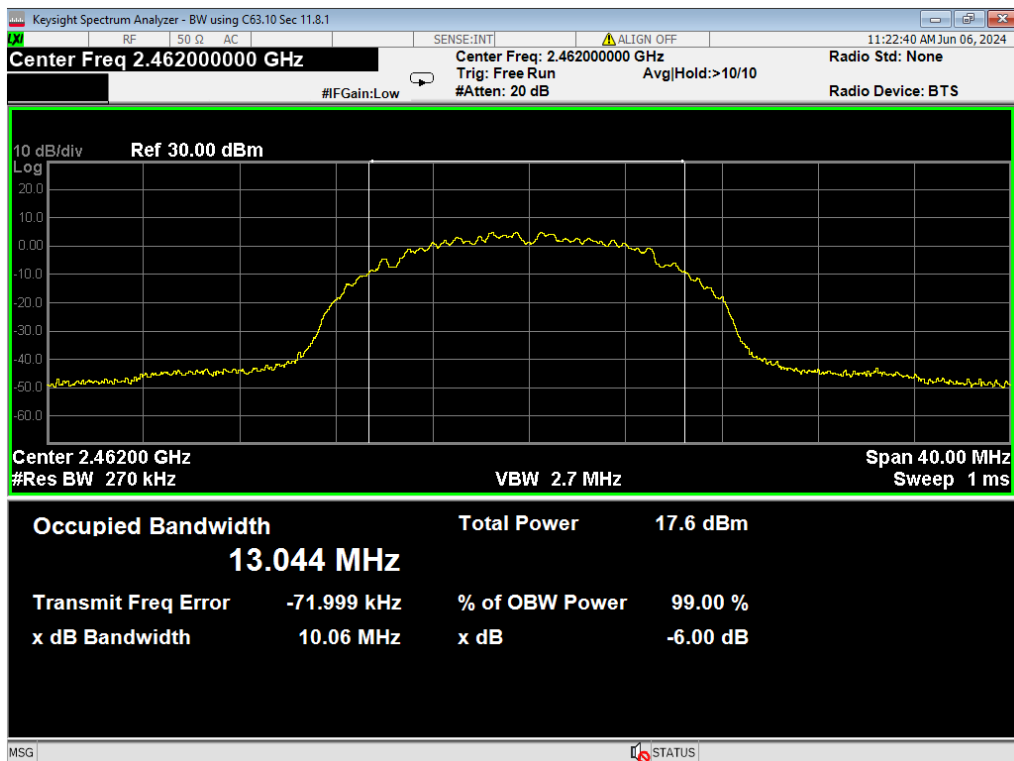


79 Occupied Bandwidth, Low Channel, Wifi B 1MB

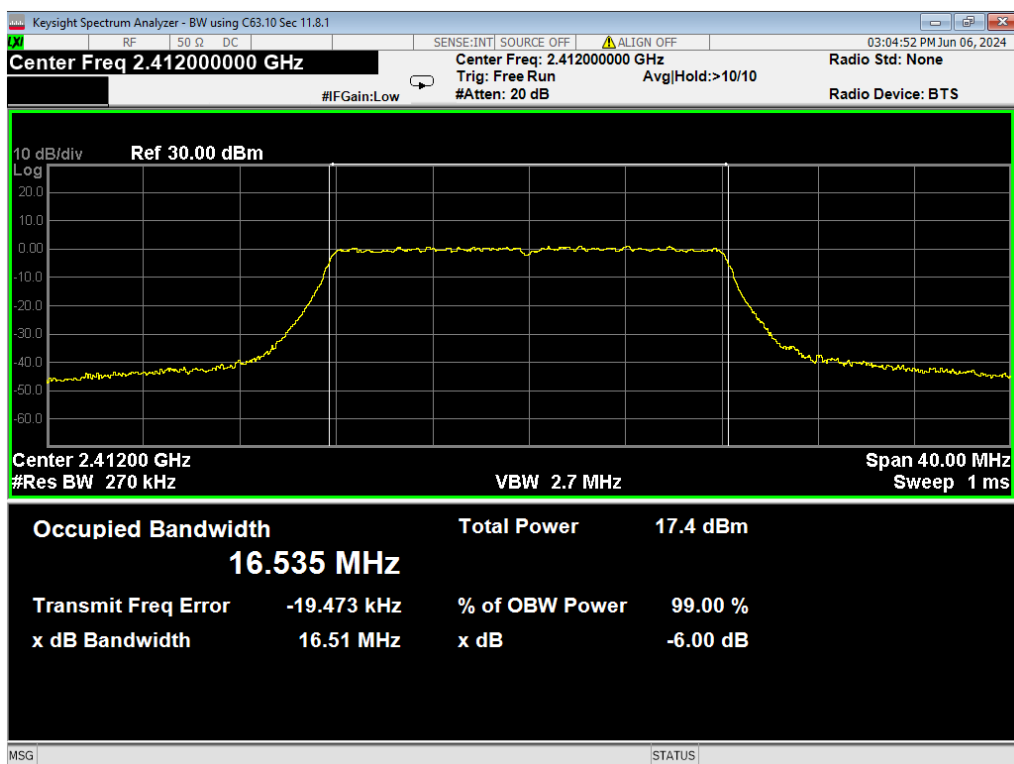


80 Occupied Bandwidth, Mid Channel, Wifi B 1MB


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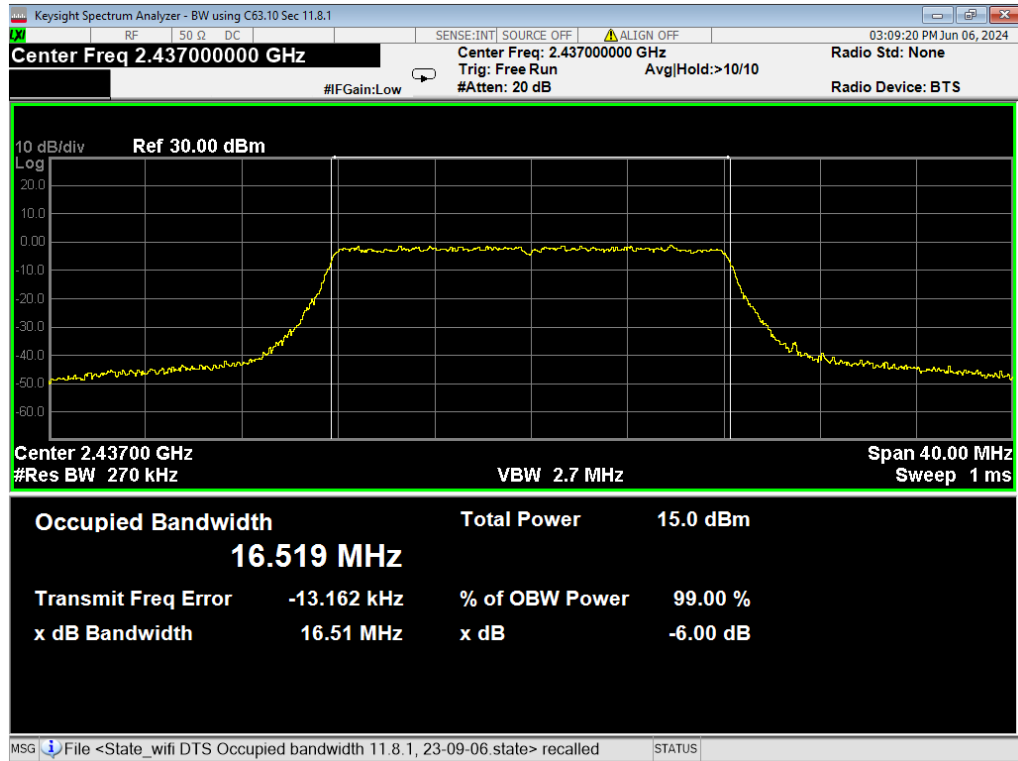


81 Occupied Bandwidth, High Channel, Wifi B 1MB

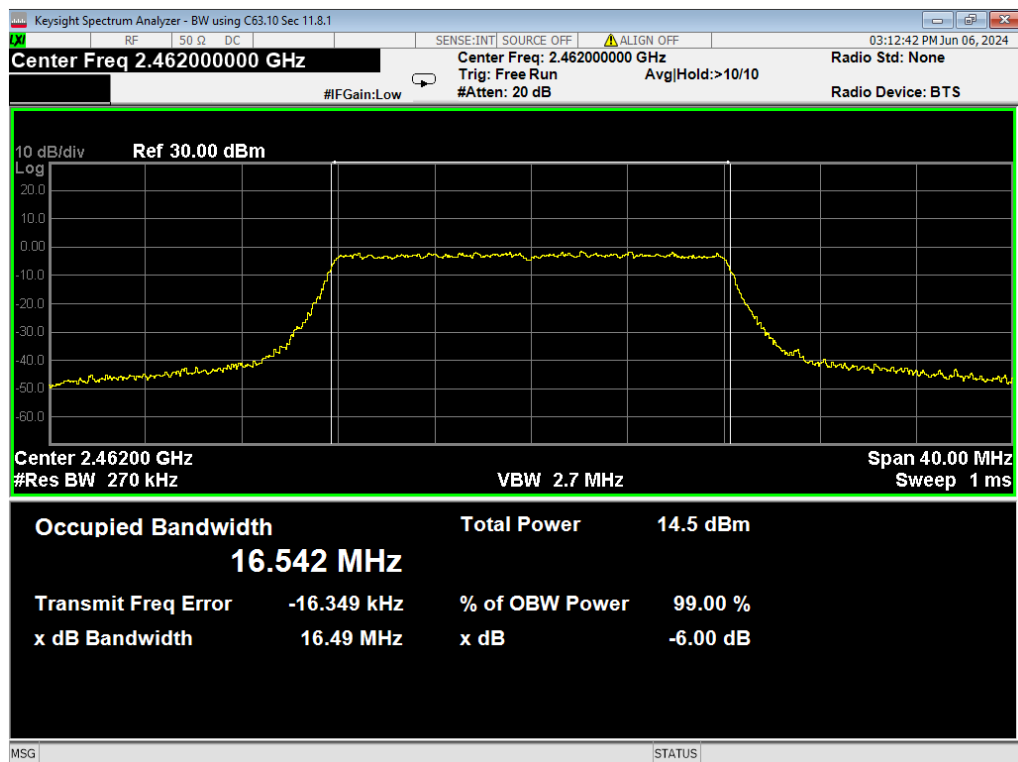


82 Occupied Bandwidth, Low Channel, Wifi G 6MB


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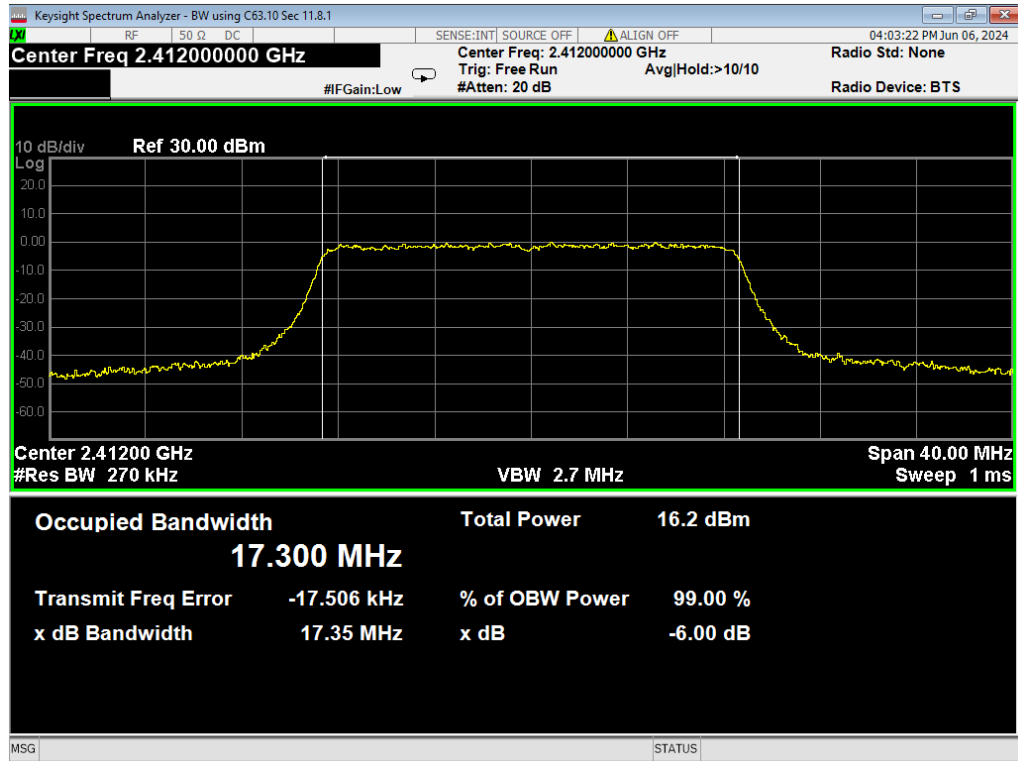


83 Occupied Bandwidth, Mid Channel, Wifi G 6MB

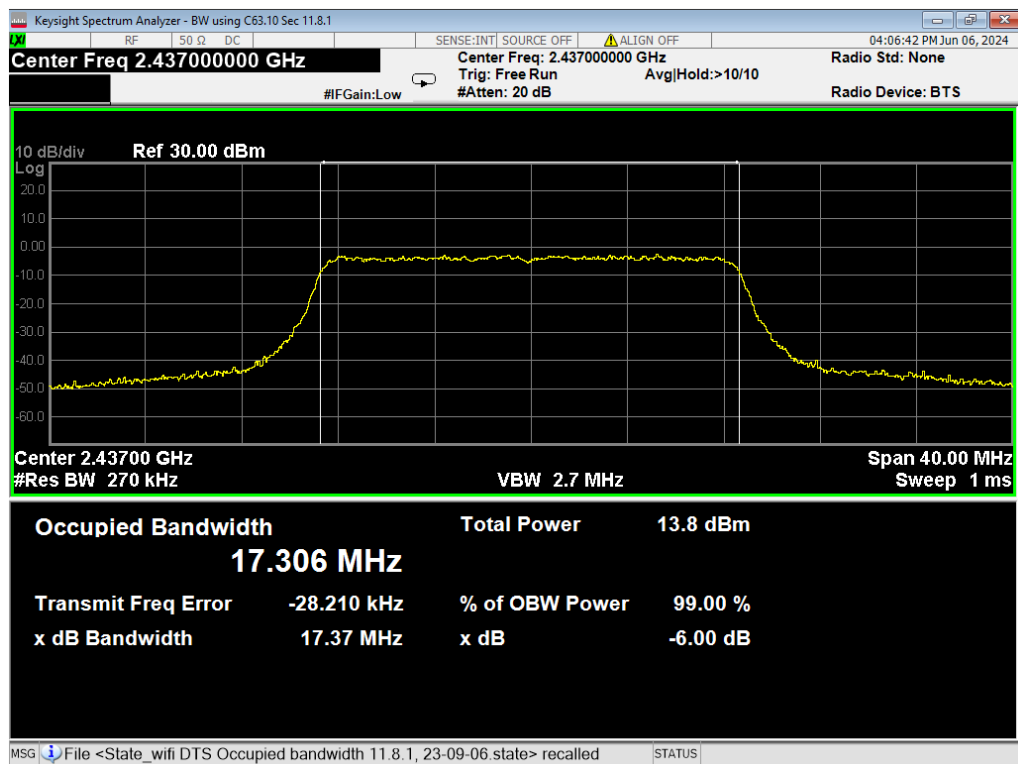


84 Occupied Bandwidth, High Channel, Wifi G 6MB


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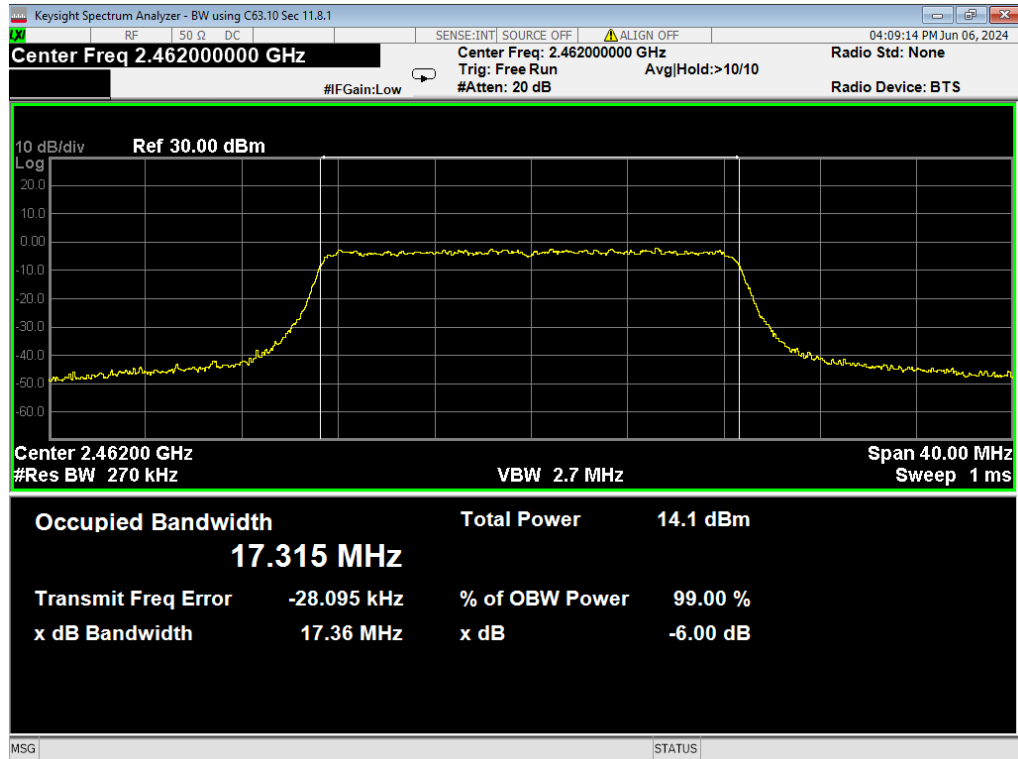


85 Occupied Bandwidth, Low Channel, Wifi N MCS0

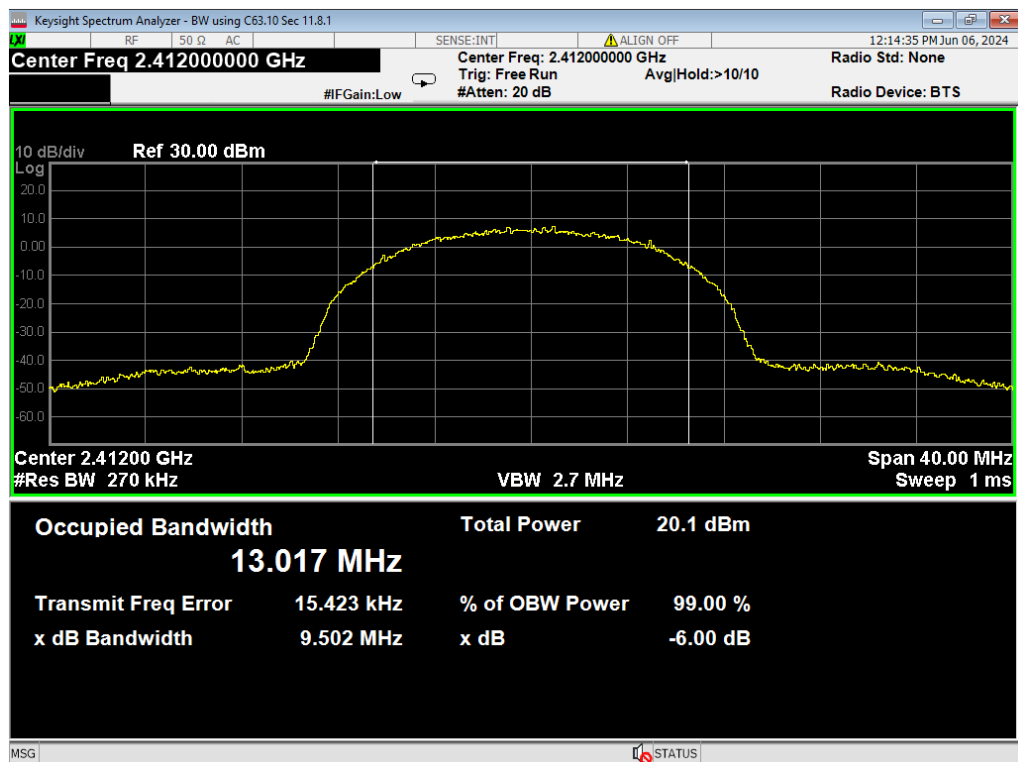


86 Occupied Bandwidth, Mid Channel, Wifi N MCS0


	Report Number:	R20240403-70-E1B	Rev	B
	Prepared for:	Amusement Connect		

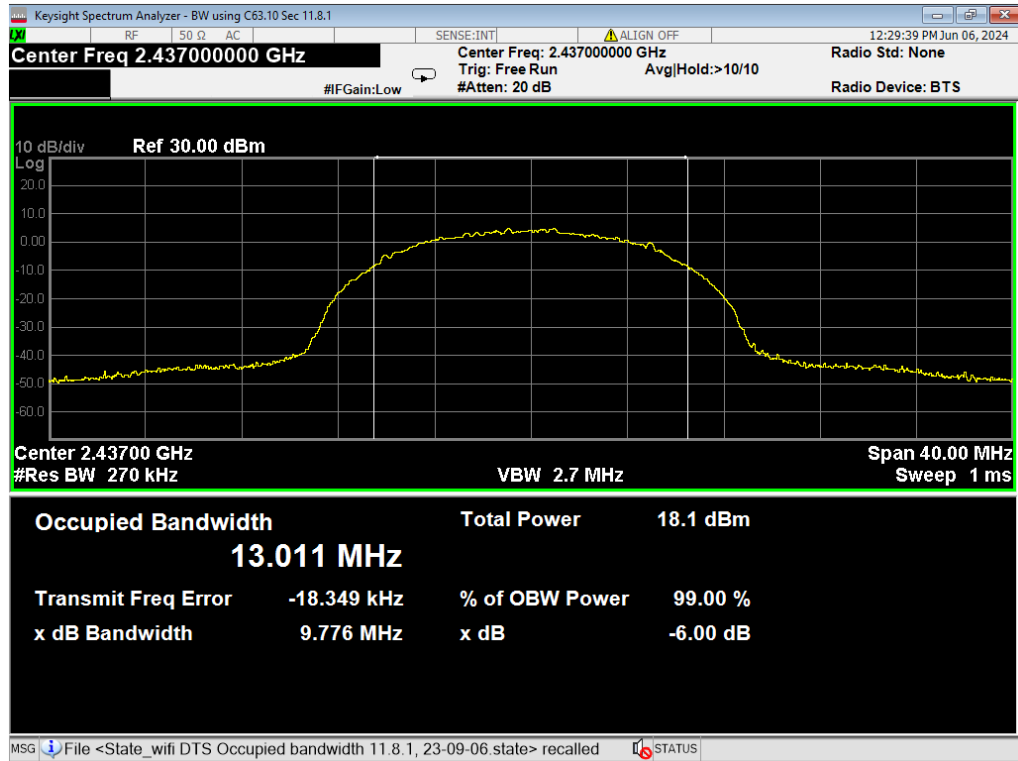


87 Occupied Bandwidth, High Channel, Wifi N MCS0

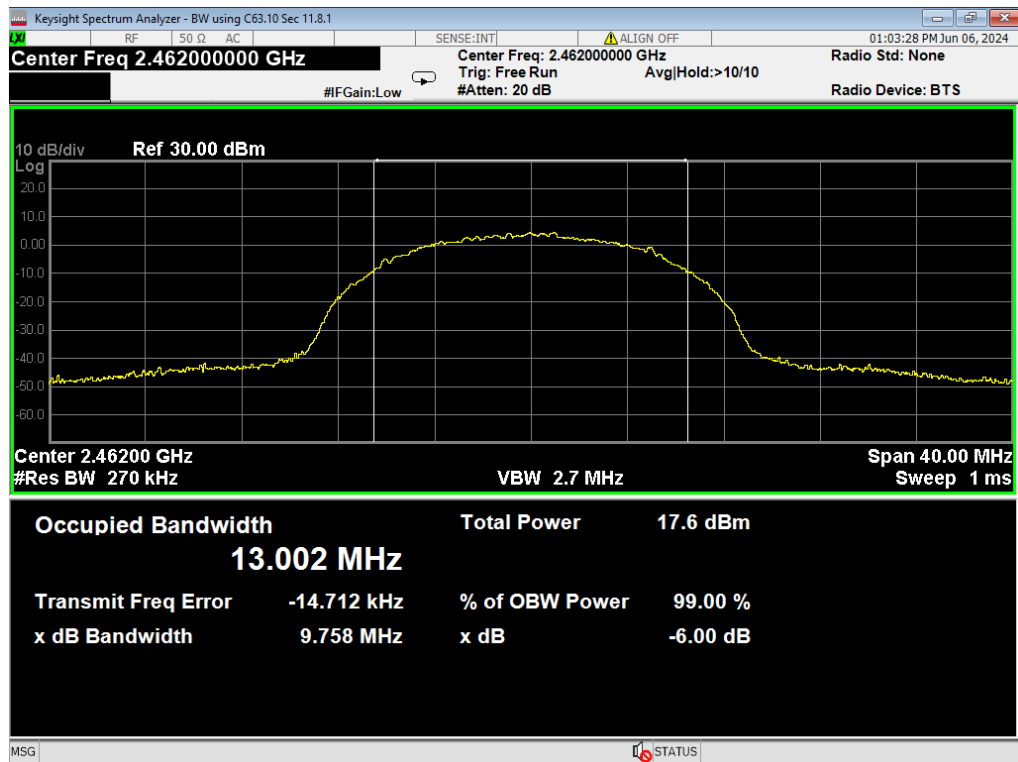


88 Occupied Bandwidth, Low Channel, Wifi B 11MB


	Report Number:	R20240403-70-E1B	Rev	B
	Prepared for:	Amusement Connect		

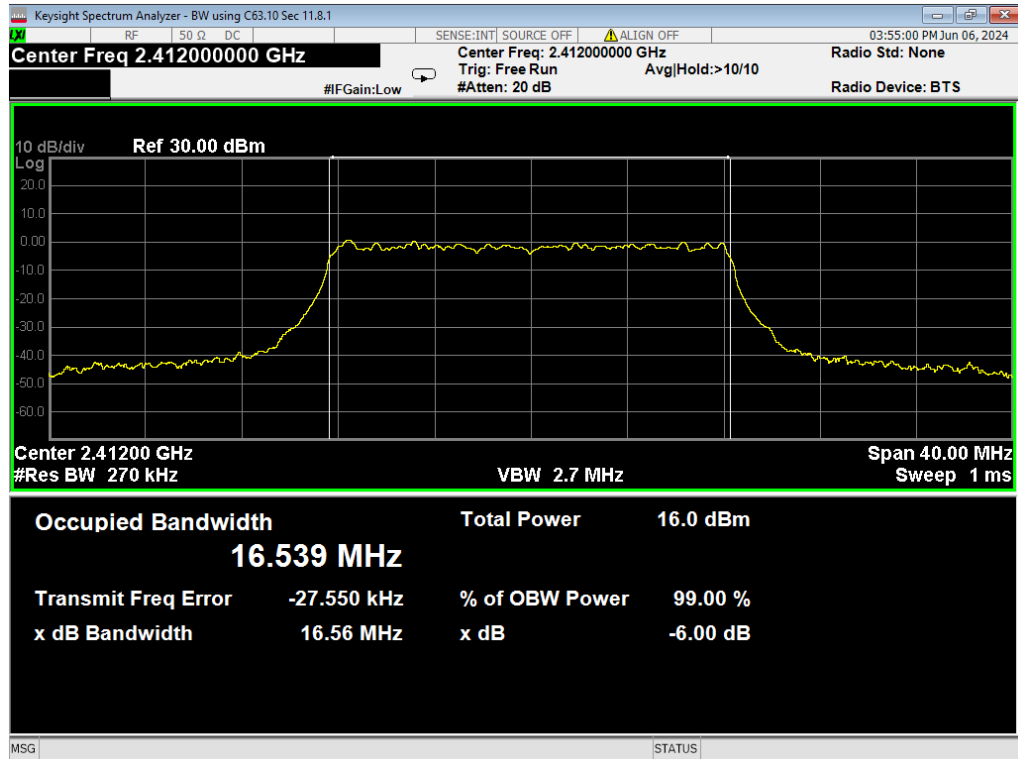


89 Occupied Bandwidth, Mid Channel, Wifi B 11MB

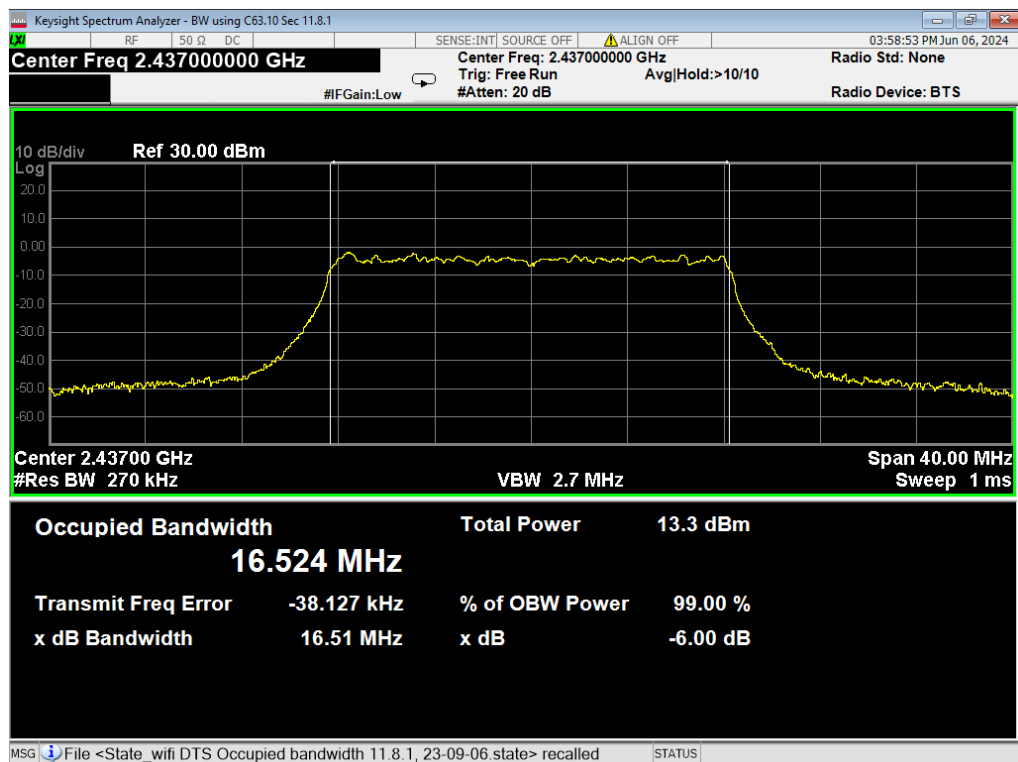


90 Occupied Bandwidth, High Channel, Wifi B 11MB

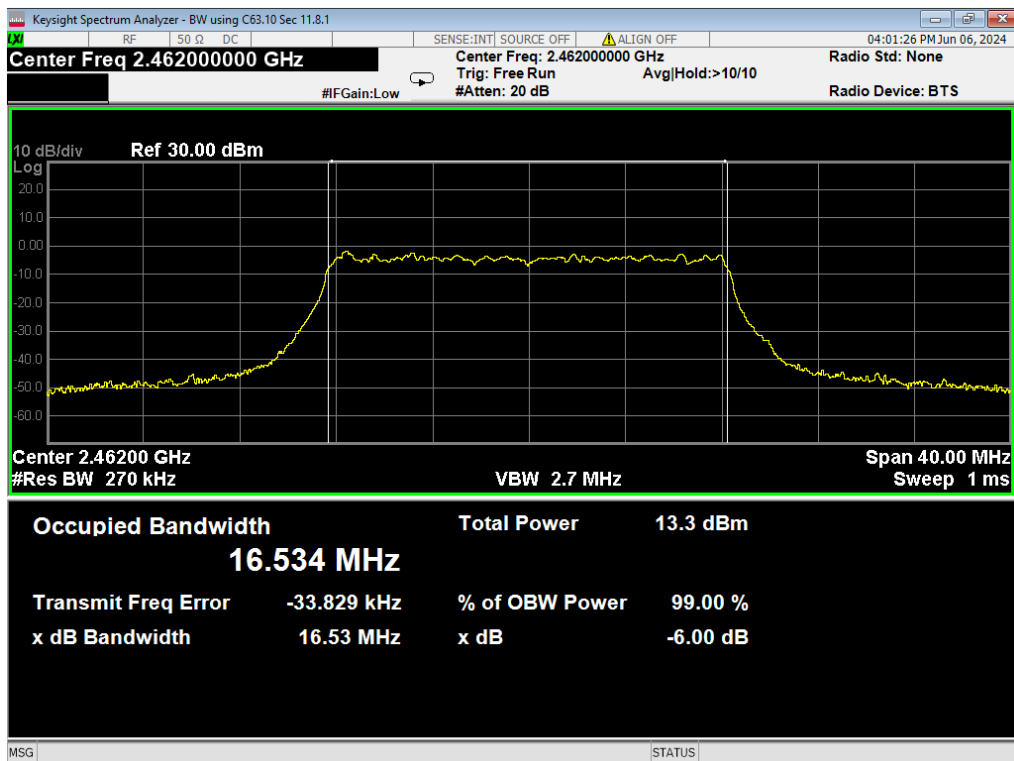
	Report Number:	R20240403-70-E1B	Rev	B
	Prepared for:	Amusement Connect		



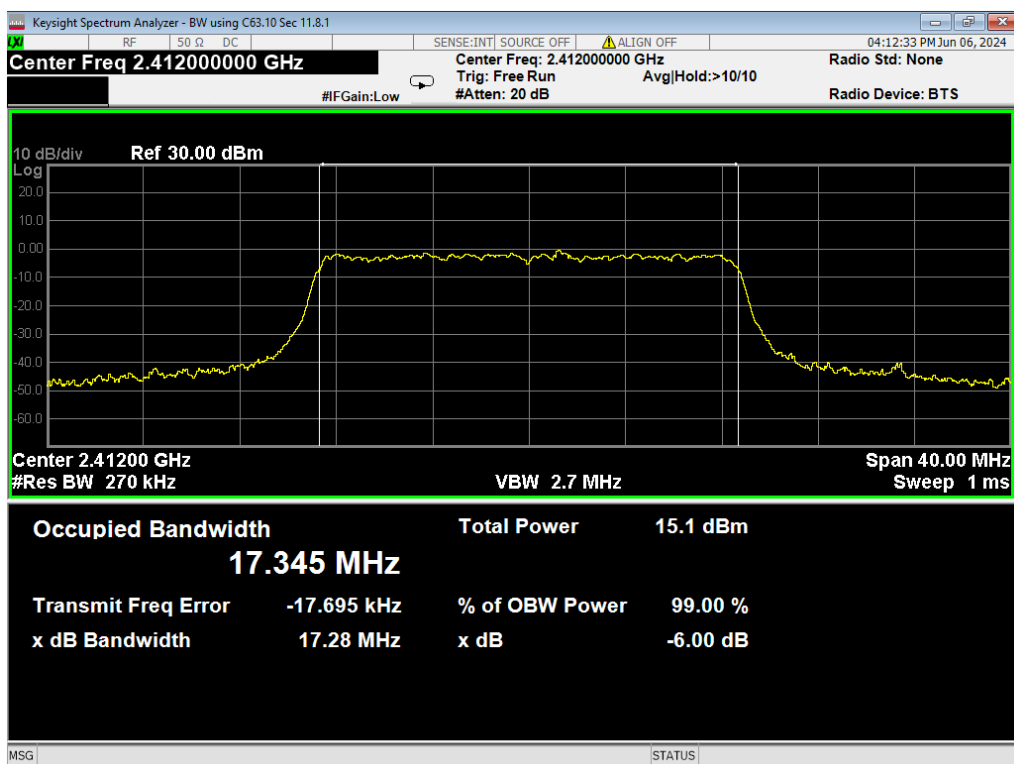
91 Occupied Bandwidth, Low Channel, Wifi G 54MB



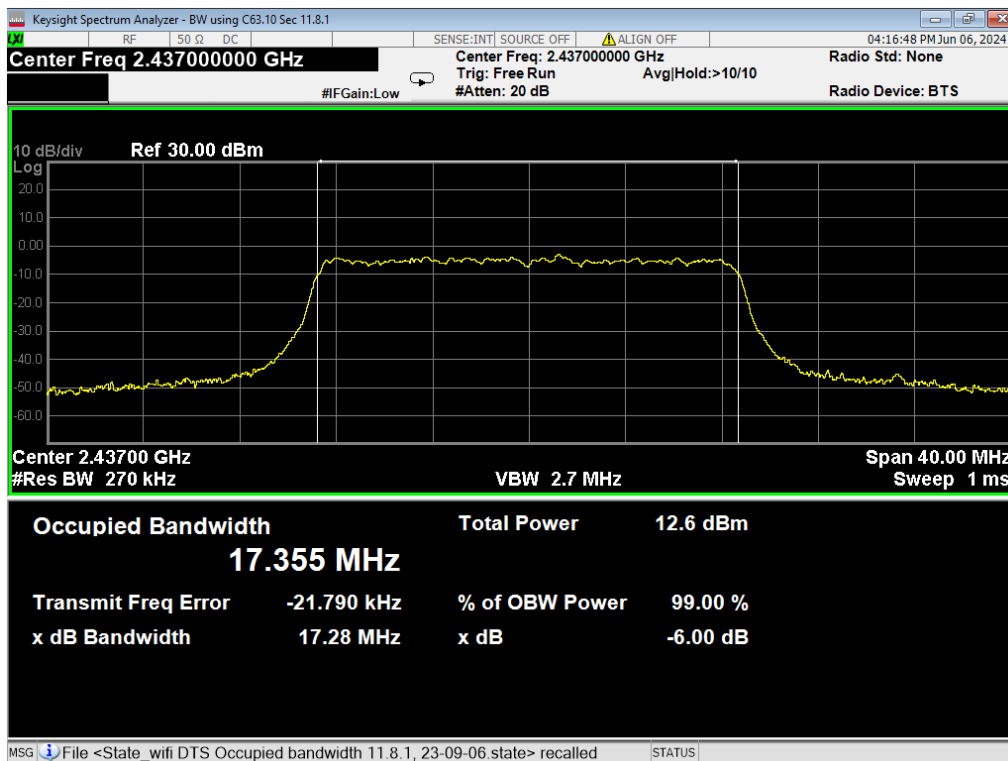
92 Occupied Bandwidth, Mid Channel, Wifi G 54MB



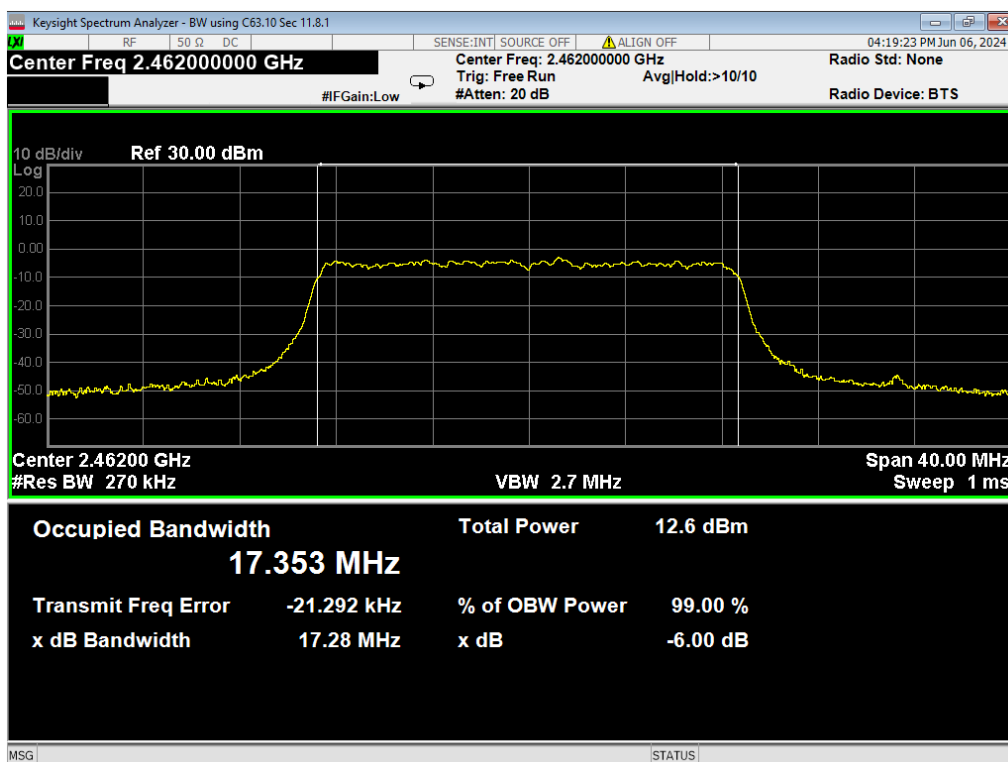
93 Occupied Bandwidth, High Channel, Wifi G 54MB



94 Occupied Bandwidth, Low Channel, Wifi N MCS7



95 Occupied Bandwidth, Mid Channel, Wifi N MCS7



96 Occupied Bandwidth, High Channel, Wifi N MCS7



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REPORT END