

FCC/ISED Test Report

Prepared for: KoreLock, Inc.

Address: 7100 E. Bellevue Ave. Suite 203
Greenwood Village, CO 80111 USA

Product: KIC Select series locks

Test Report No: R20240322-70-E1E

Approved by:


Fox Lane
EMC Test Engineer

DATE: August 12, 2024

Total Pages: 30

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REVISION PAGE

Rev. No.	Date	Description
0	28 June 2024	Issued by FLane Reviewed by FLane Prepared by ESchmidt
A	17 July 2024	Updated Address – FL
D	7 August 2024	Updated model/FCC ID's Removed FCCID of previous module - FL
E	12 August 2024	Updated model name - 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

APPLIED STANDARDS AND REGULATIONS		
Standard Section	Test Type	Result
FCC Part 15.209	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.247 (unrestricted)	Transmitter Radiated Emissions	Pass
FCC Part 15.209, 15.247(d)	Band Edge Measurement	Pass

These tests were completed with the intention of a Class 2 Permissive Change.



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2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	KIC Select series locks
FCC ID	2BBNS-KLKIC
EUT Received	23 April 2024
EUT Tested	28 May 2024 - 31 May 2024
Serial No.	011633 (NCEE Assigned Serial number)
Operating Band	2400 – 2483.5 MHz
Device Type	☐ GMSK ☐ GFSK ☐ BT BR ☐ BT EDR 2MB ☐ BT EDR 3MB ☒ 802.11x
Power Supply / Voltage	Internal Batteries 4xAA batteries

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 (26.5GHz)	N9038A	MY56400083	July 17, 2023	July 17, 2025
SunAR RF Motion	JB1	A091418	July 27, 2023	July 26, 2024
Agilent Preamp*	87405A	3207A01475	May 2, 2024	May 2, 2026
ETS Red Preamplifier (Orange)*	3115-PA	00218576	January 22, 2024	January 22, 2026
Trilithic High Pass Filter*	6HC330	23042	June 5, 2023	June 5, 2025
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	June 5, 2023	June 5, 2025
ETS-Lindgren Red Horn Antenna	3115	218576	July 31, 2023	July 30, 2024
ETS – Lindgren- VSWR on 10m Chamber	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	May 15, 2024	May 15, 2027
NCEE Labs-NSA on 10m Chamber*	10m Semi-anechoic chamber-NSA	NCEE-001	May 22, 2024	May 22, 2026
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

*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.

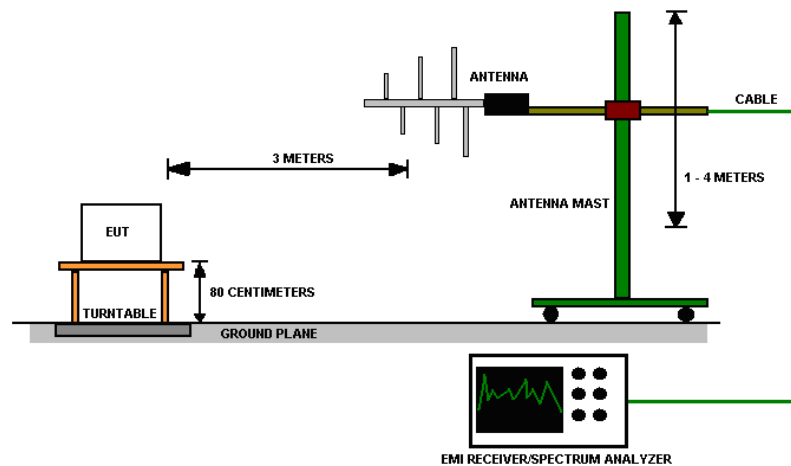


Figure 2 - Radiated Emissions Test Setup

4.0 RESULTS

4.1 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 (μ 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:

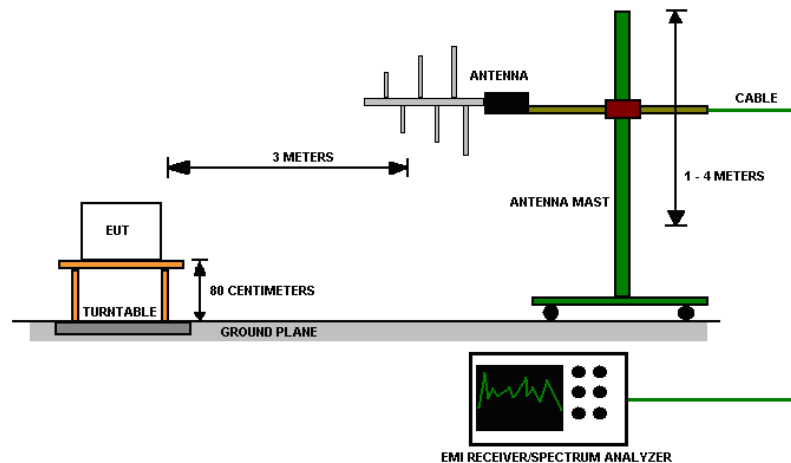


Figure 3 - Radiated Emissions Test Setup

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.

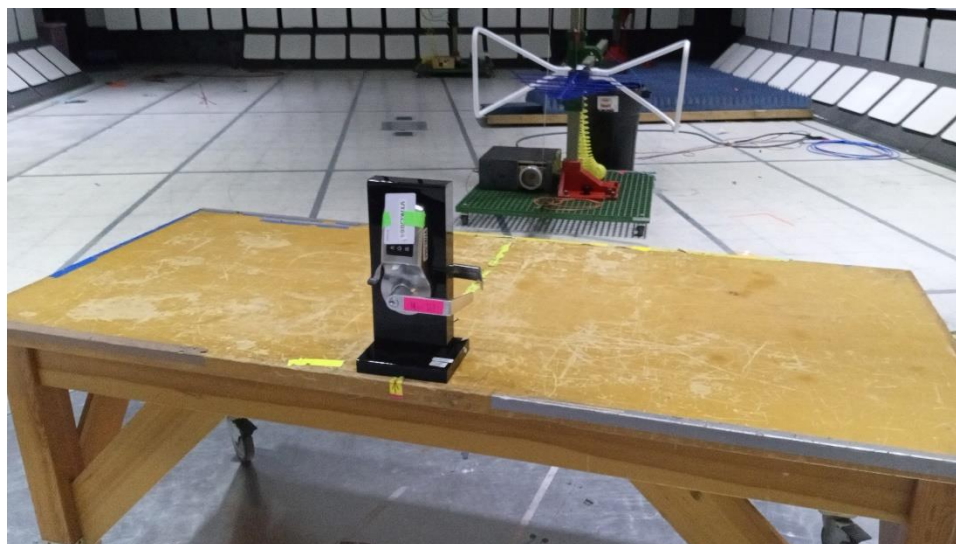


Figure 4 - Radiated Emissions Setup, 30M-1G

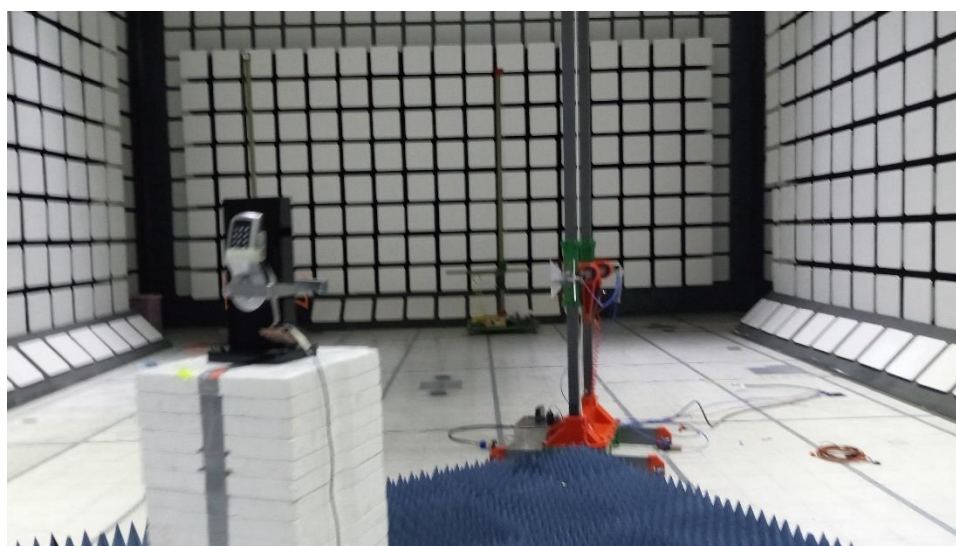


Figure 5 - Radiated Emissions Setup, > 1G

Test results:

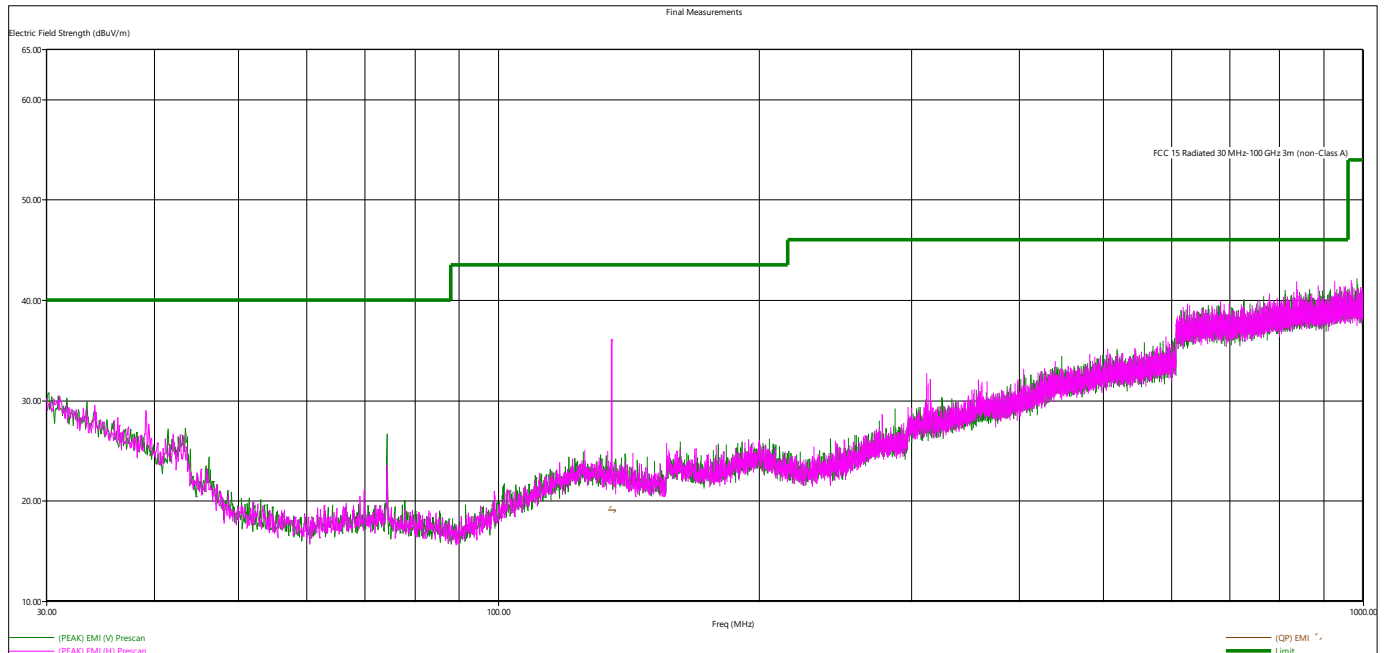


Figure 6 - Radiated Emissions Plot, RX (Packets)

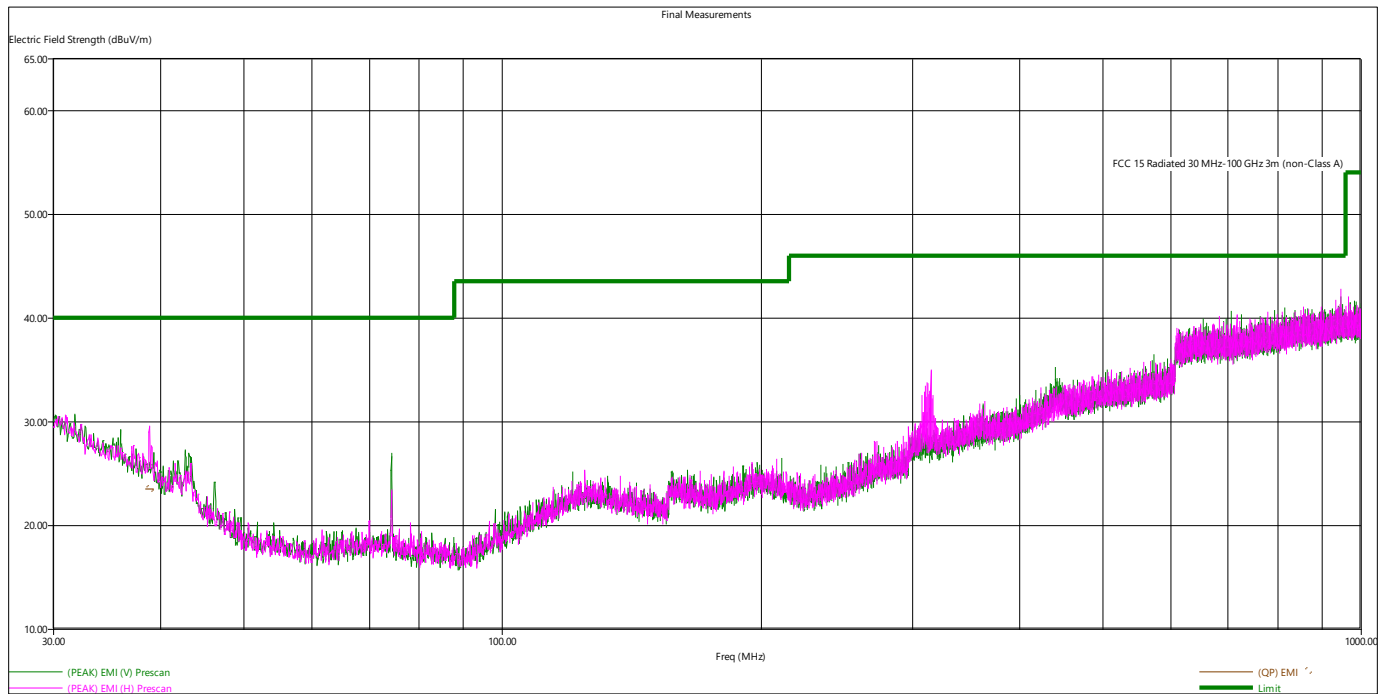


Figure 7 - Radiated Emissions Plot, 802.11b 1MB

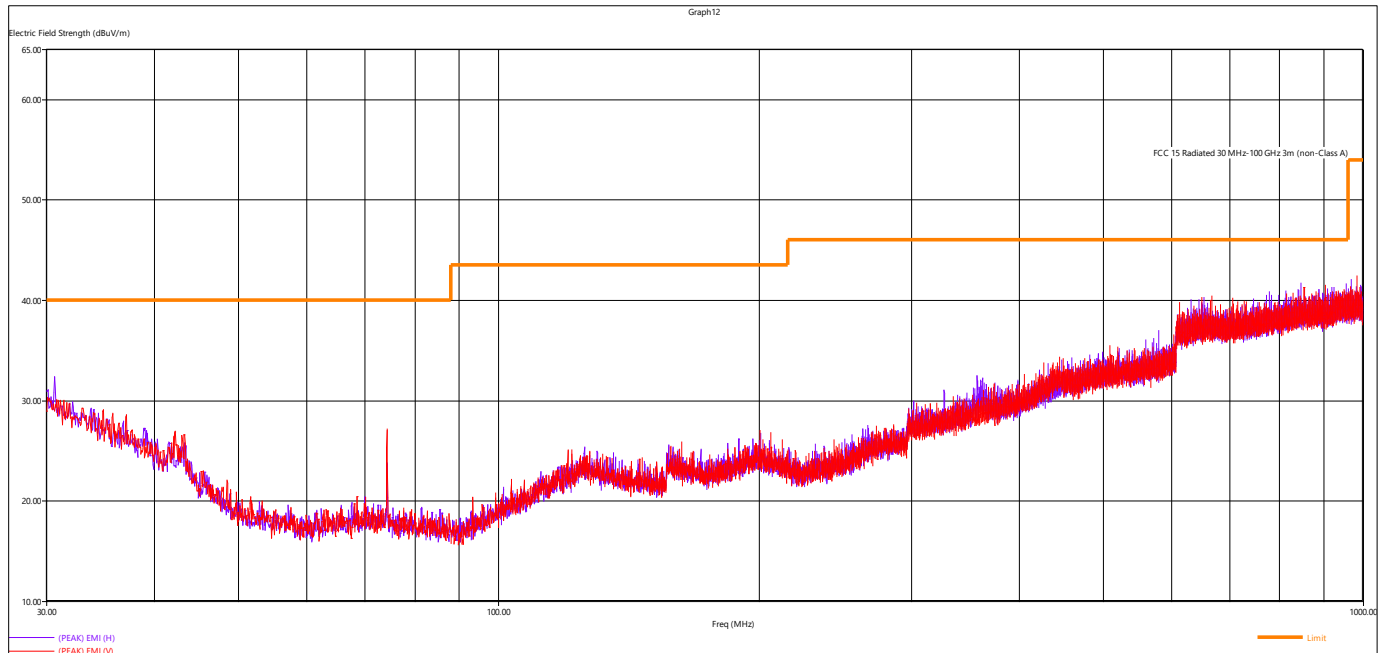


Figure 8 - Radiated Emissions Plot, 802.11b 11MB

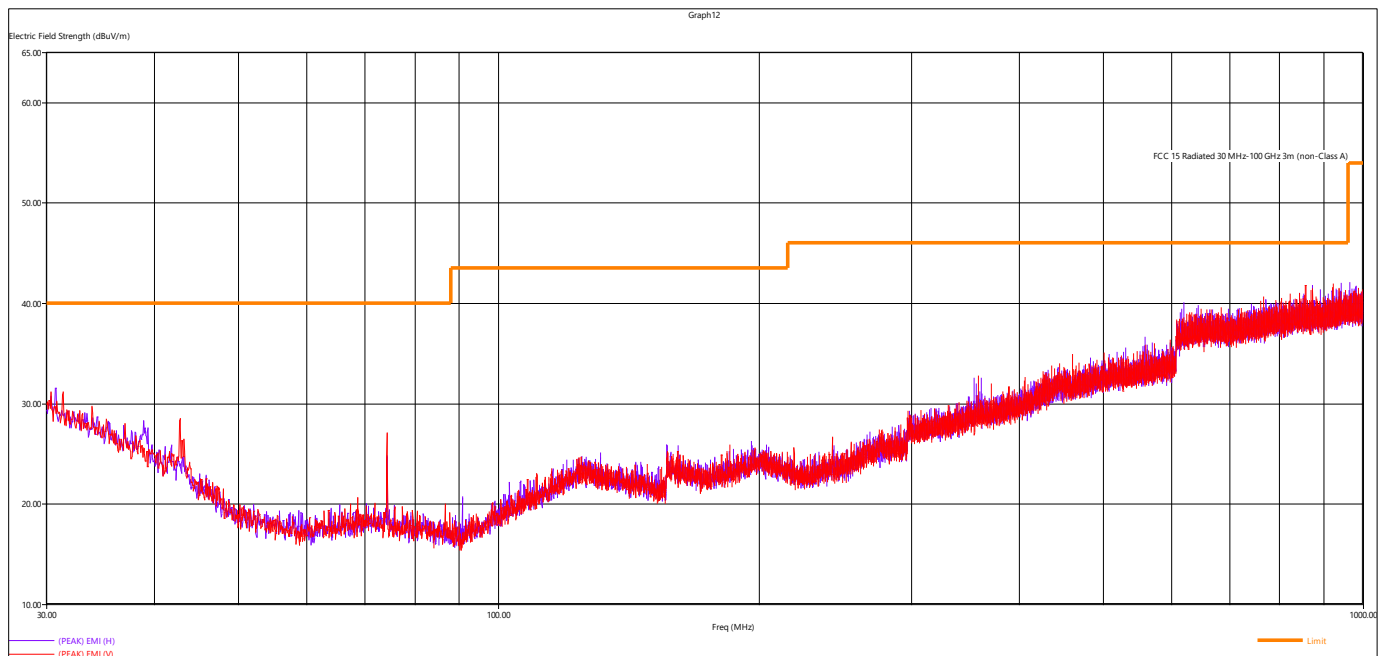


Figure 9 - Radiated Emissions Plot, 802.11g 6MB

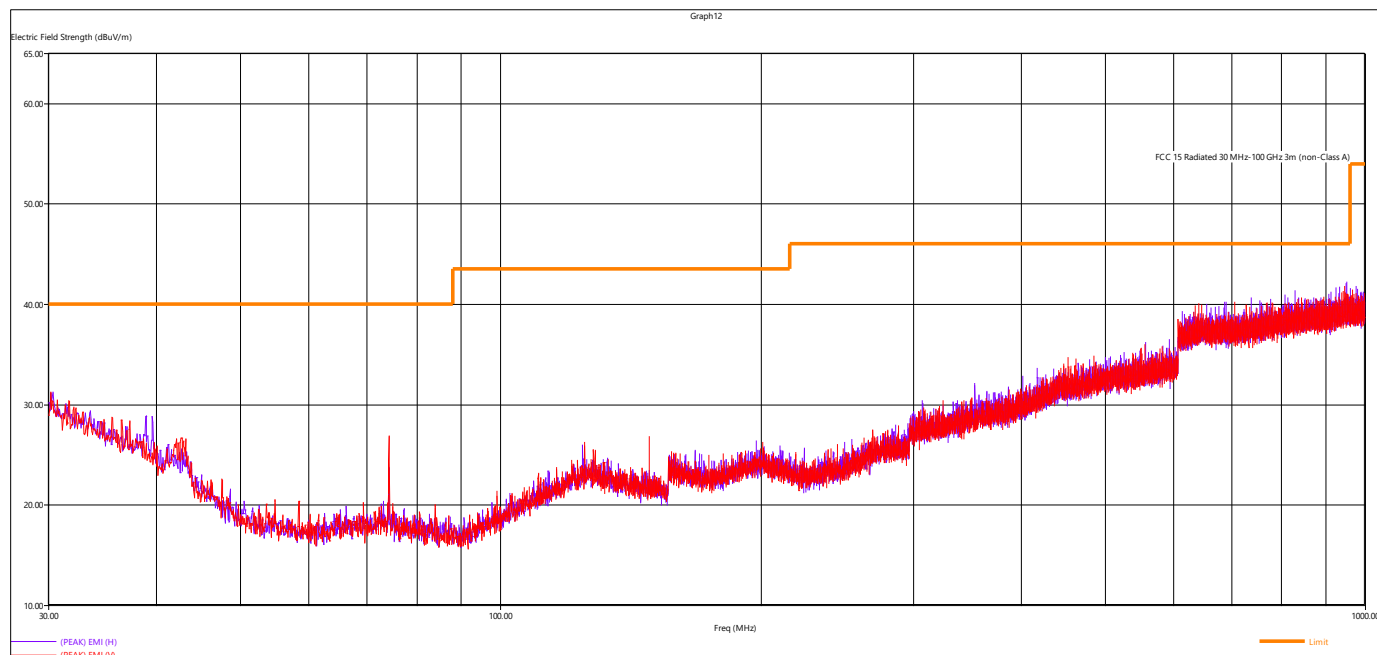


Figure 10 - Radiated Emissions Plot, 802.11g 54MB

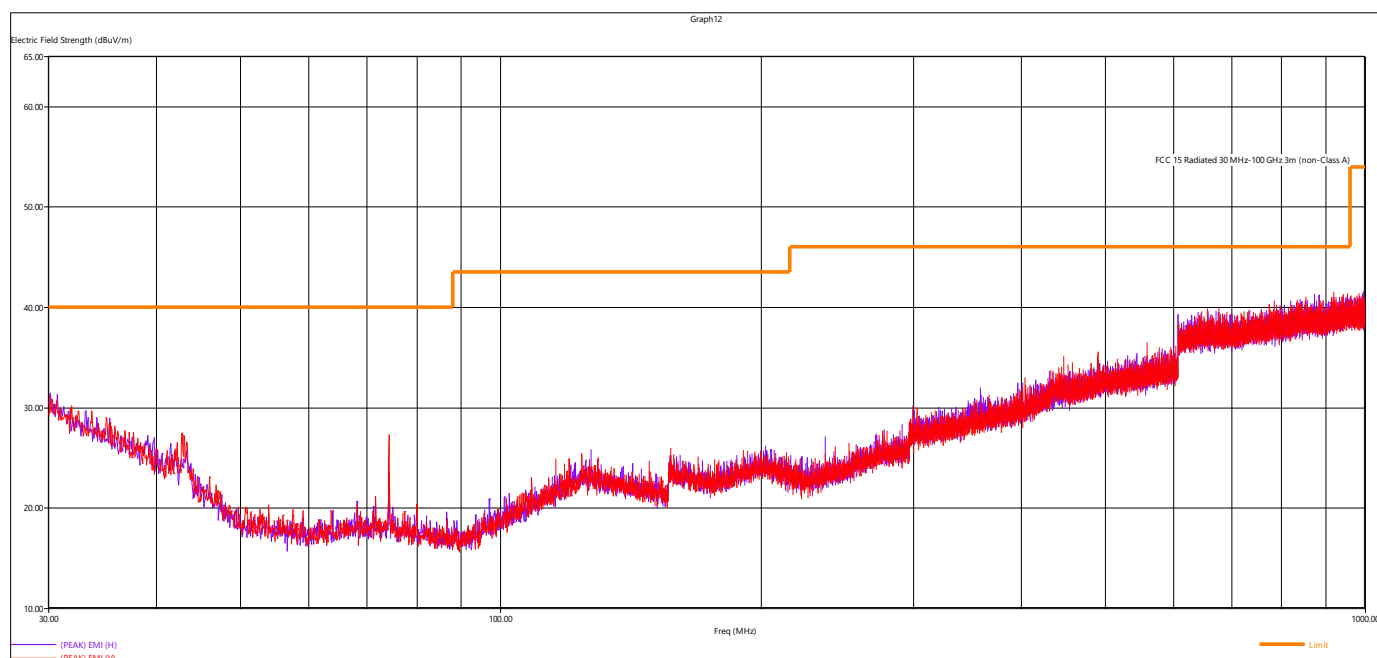


Figure 11 - Radiated Emissions Plot, 802.11n MCS0

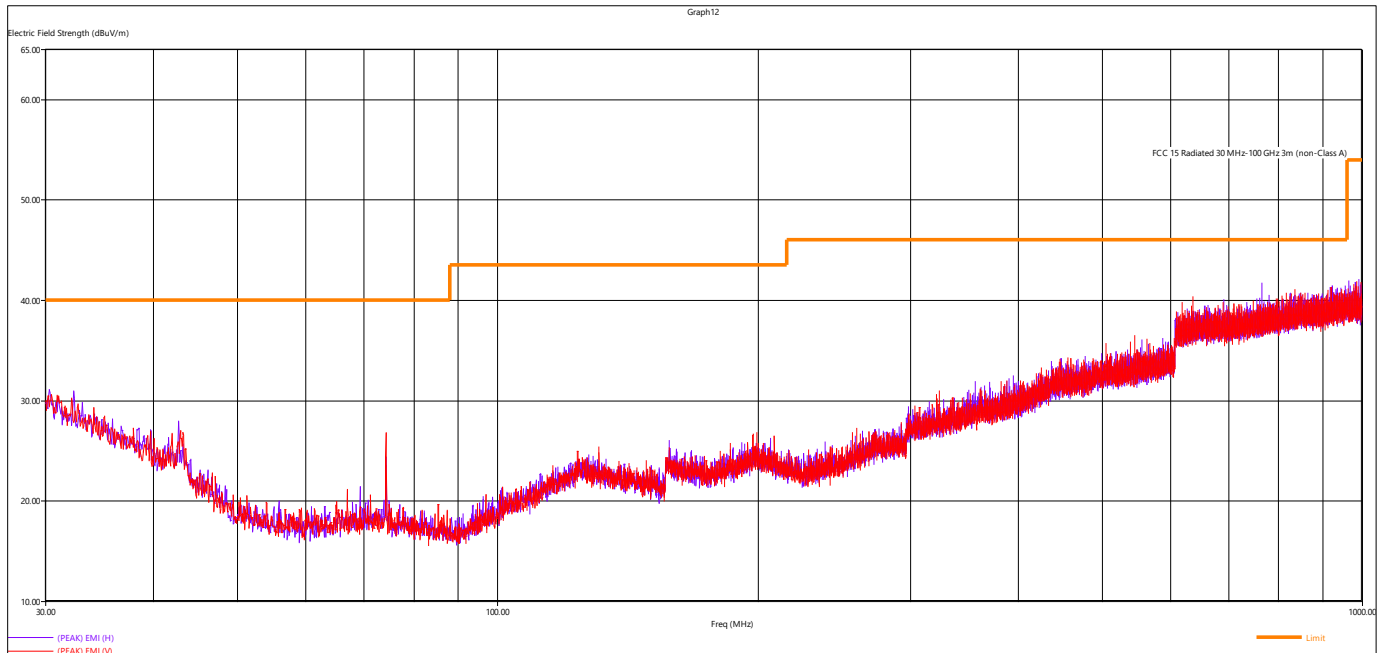


Figure 12 - Radiated Emissions Plot, 802.11n MCS7

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.			
38.889360	23.47	40.00	16.53	230.14	269.00	H	Mid	B 1MB
135.174960	19.13	43.52	24.39	349.97	298.75	H	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.			
2410.550000	113.97	N/A	N/A	145.97	180.50	H	Low	Wifi B 1MB
2411.624000	113.84	N/A	N/A	177.13	179.00	H	Low	Wifi B 11MB
2464.932000	111.13	N/A	N/A	137.07	182.75	H	High	Wifi G 6MB
2464.192000	107.48	N/A	N/A	136.05	182.75	H	High	Wifi G 54MB
2466.678000	109.17	N/A	N/A	136.41	182.75	H	High	Wifi N MCS0
2463.184000	106.29	N/A	N/A	163.88	181.25	H	High	Wifi N MCS7
4823.908000	47.73	73.98	26.25	124.29	289.25	V	Low	Wifi B 1MB
4874.026000	49.70	73.98	24.28	172.29	324.25	H	Mid	Wifi B 1MB
7310.026000	54.62	73.98	19.36	373.37	307.25	H	Mid	Wifi B 1MB
4923.864000	50.49	73.98	23.49	220.35	319.75	H	High	Wifi B 1MB
4823.660000	48.33	73.98	25.65	113.67	298.25	V	Low	Wifi B 11MB
7311.052000	52.56	73.98	21.42	228.77	12.00	H	Mid	Wifi B 11MB
4873.910000	48.10	73.98	25.88	183.22	289.50	V	Mid	Wifi B 11MB
4922.902000	38.58	73.98	35.40	462.02	60.50	H	High	Wifi B 11MB
7386.210000	46.28	73.98	27.70	559.34	273.00	V	High	Wifi B 11MB
4819.538000	46.71	73.98	27.27	110.38	299.00	V	Low	Wifi G 54MB
4880.432000	41.73	73.98	32.25	518.38	331.25	V	Mid	Wifi G 54MB
4824.024000	47.22	73.98	26.76	156.95	289.25	V	Low	Wifi N MCS0
4876.146000	46.82	73.98	27.16	205.49	324.50	H	Mid	Wifi N MCS0
4926.046000	45.69	73.98	28.29	207.58	326.50	H	High	Wifi N MCS0

The EUT was maximized for the low, mid, and high channels of each modulation.

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	dB μ V/m	dB μ V/m	dB	cm.	deg.			
4823.908000	40.67	53.98	13.31	124.29	289.25	V	Low	Wifi B 1MB
4874.026000	43.51	53.98	10.47	172.29	324.25	H	Mid	Wifi B 1MB
7310.026000	45.28	53.98	8.70	373.37	307.25	H	Mid	Wifi B 1MB
4923.864000	44.21	53.98	9.77	220.35	319.75	H	High	Wifi B 1MB
4823.660000	34.83	53.98	19.15	113.67	298.25	V	Low	Wifi B 11MB
7311.052000	38.60	53.98	15.38	228.77	12.00	H	Mid	Wifi B 11MB
4873.910000	33.86	53.98	20.12	183.22	289.50	V	Mid	Wifi B 11MB
4922.902000	25.73	53.98	28.25	462.02	60.50	H	High	Wifi B 11MB
7386.210000	32.82	53.98	21.16	559.34	273.00	V	High	Wifi B 11MB
4819.538000	31.58	53.98	22.40	110.38	299.00	V	Low	Wifi G 54MB
4880.432000	27.28	53.98	26.70	518.38	331.25	V	Mid	Wifi G 54MB
4824.024000	34.13	53.98	19.85	156.95	289.25	V	Low	Wifi N MCS0
4876.146000	33.32	53.98	20.66	205.49	324.50	H	Mid	Wifi N MCS0
4926.046000	31.86	53.98	22.12	207.58	326.50	H	High	Wifi N MCS0

The EUT was maximized for the low, mid, and high channels of each modulation.

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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4.2 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. All measurements were found to be at least 6dB below the applicable line.
3. If the device falls under FCC Part 15.247 (Details can be found in summary of test results), compliance is shown in the unrestricted band edges by showing minimum delta of 20 dB between peak and the band edge.
4. The restricted band edge compliance is shown by comparing 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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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;

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

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

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

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

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

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

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

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

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



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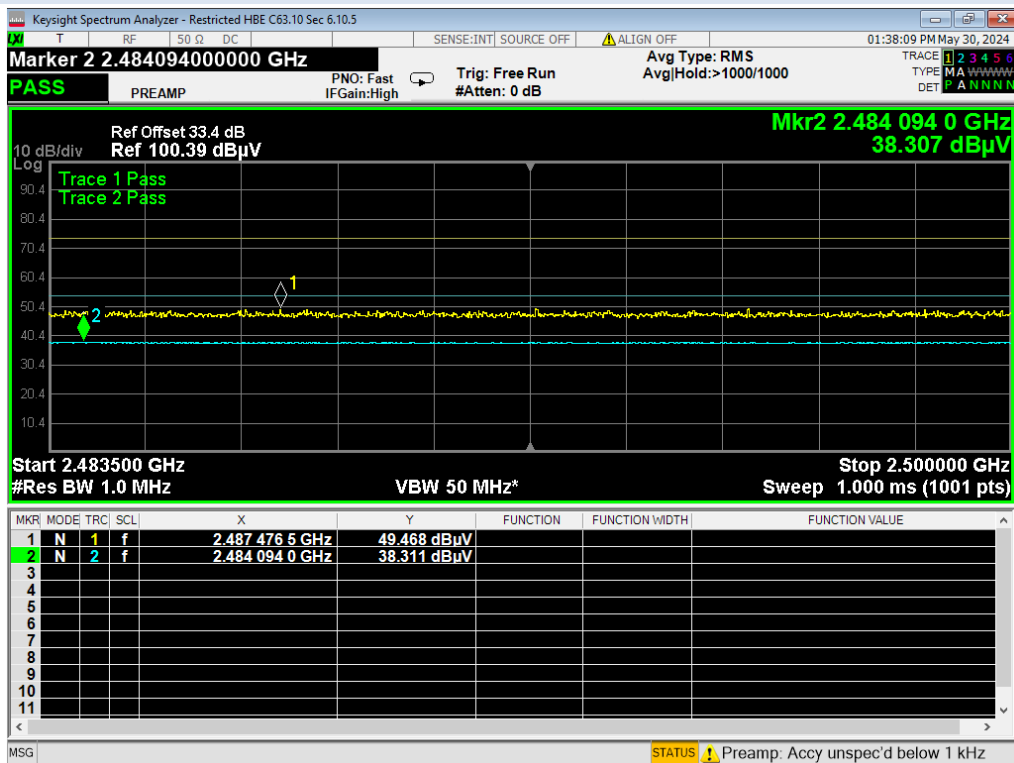
APPENDIX B – MEASUREMENT UNCERTAINTY

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

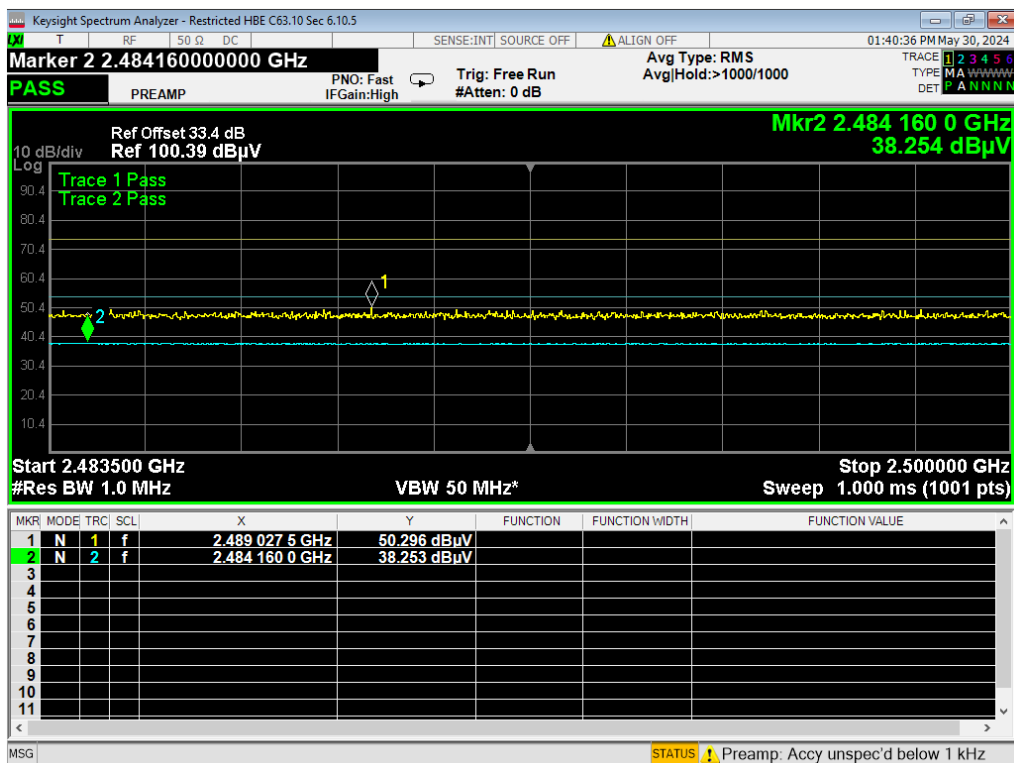
Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08
Emissions limits, conducted	30MHz – 18GHz	±3.03

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

APPENDIX C – GRAPHS AND TABLES

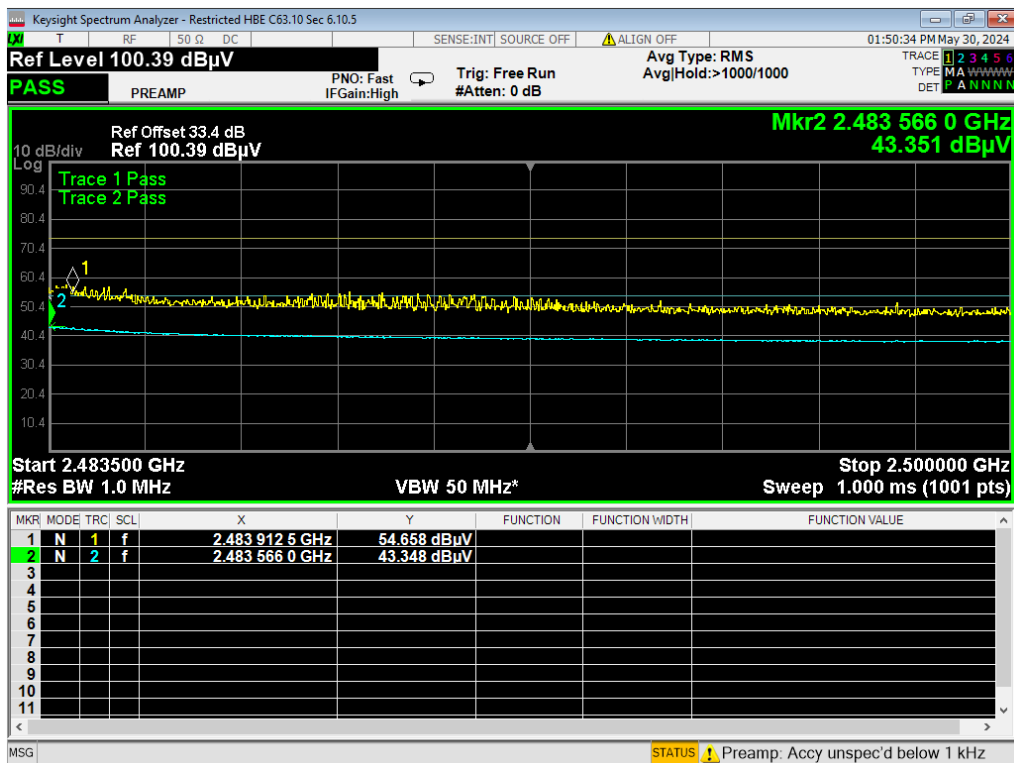


HBE Restricted, Wifi B 1MB

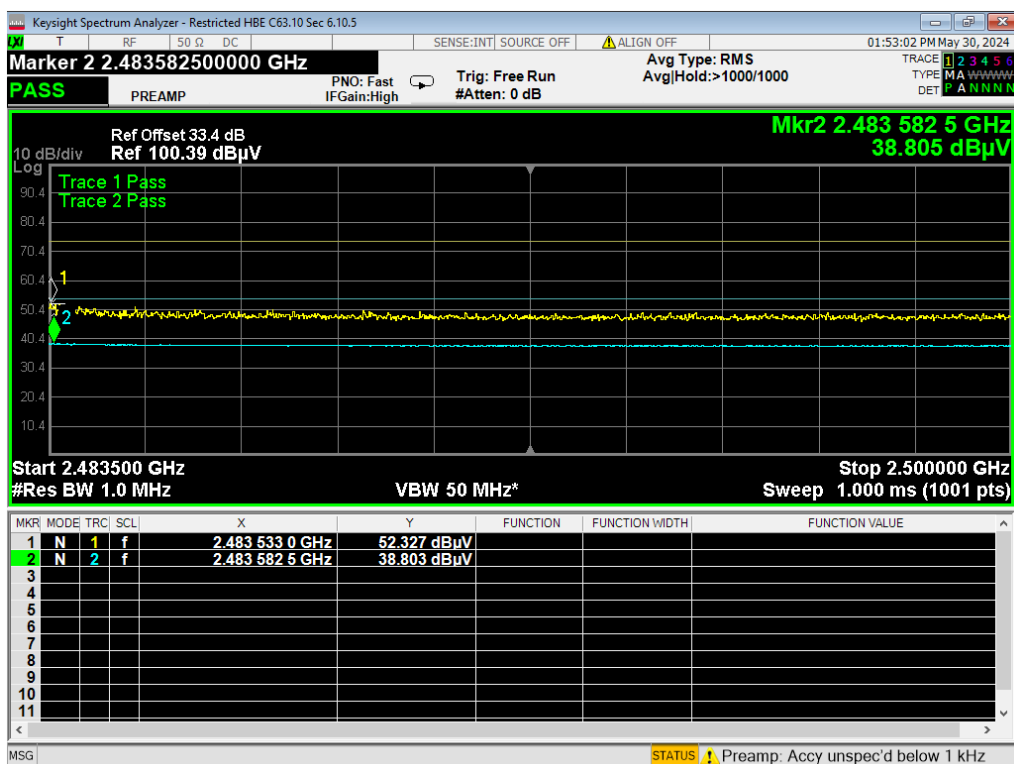


HBE Restricted, Wifi B 11MB

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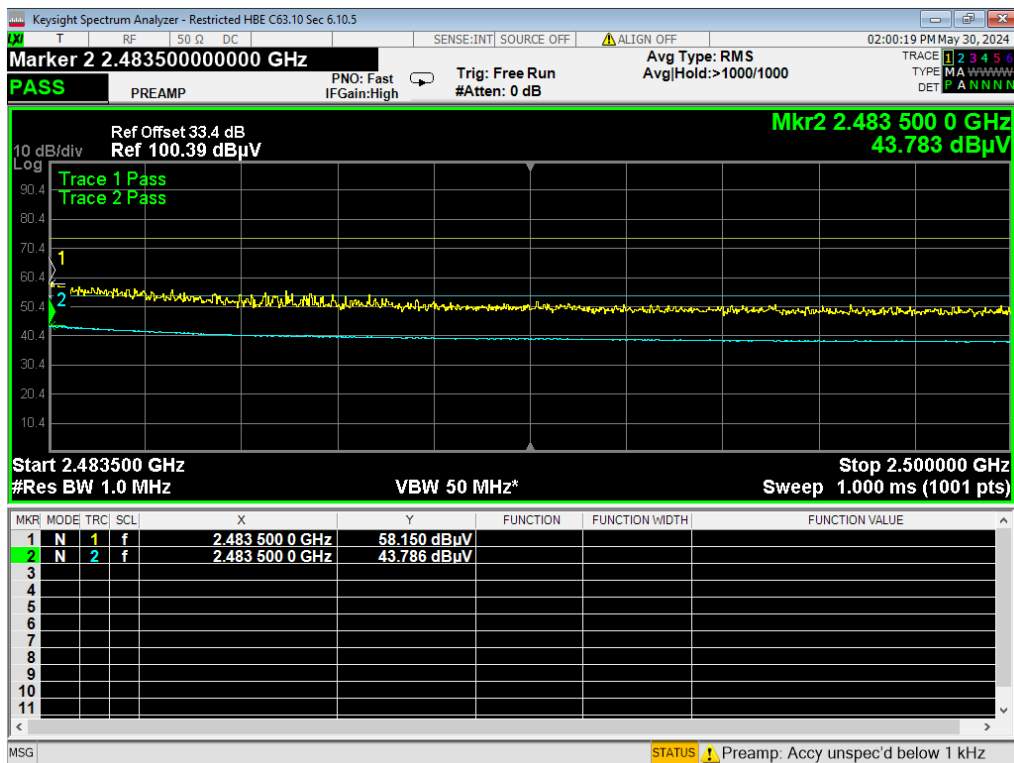


HBE Restricted, Wifi G 6MB

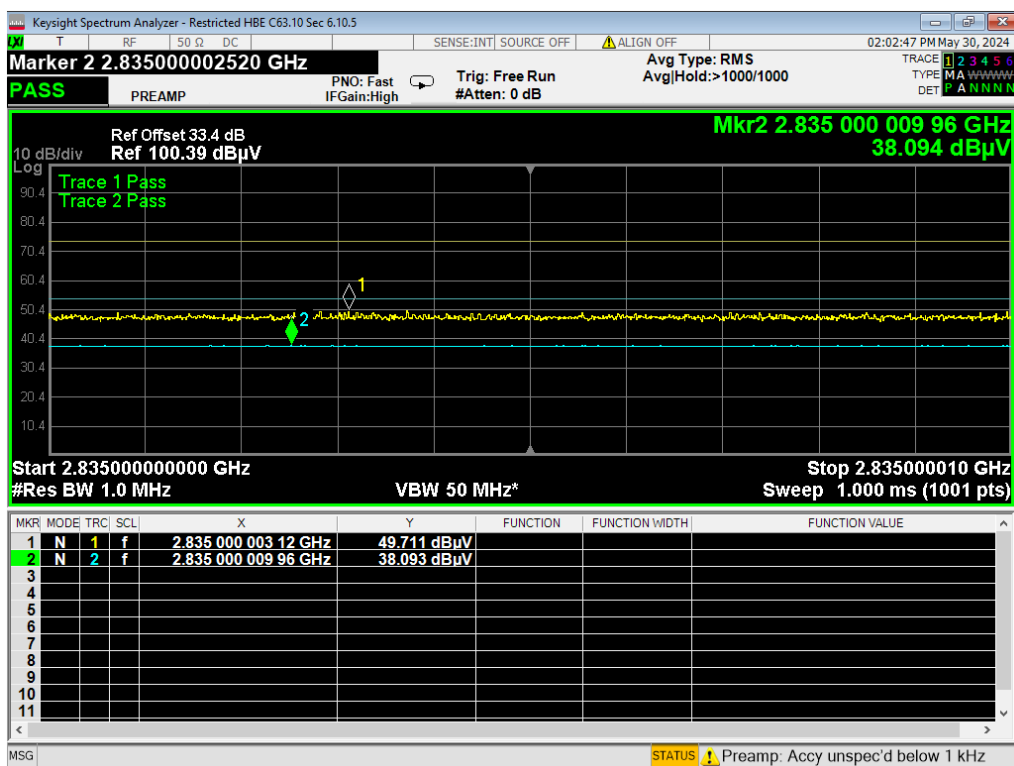


HBE Restricted, Wifi G 54MB

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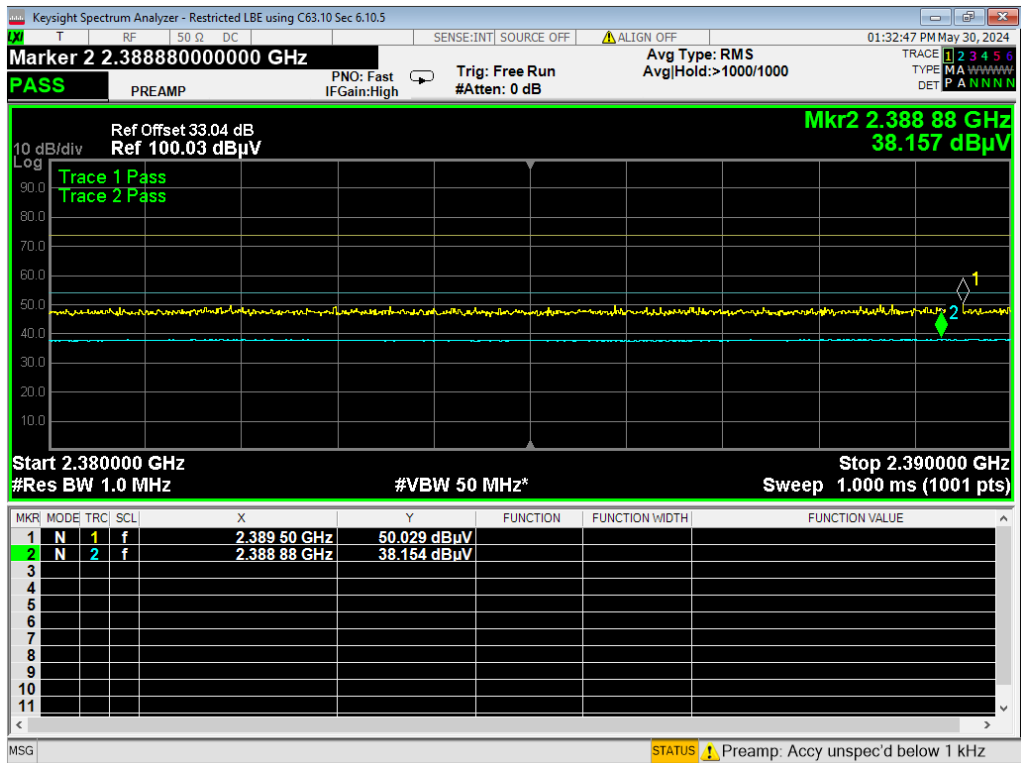
HBE Restricted, Wifi N MCS0



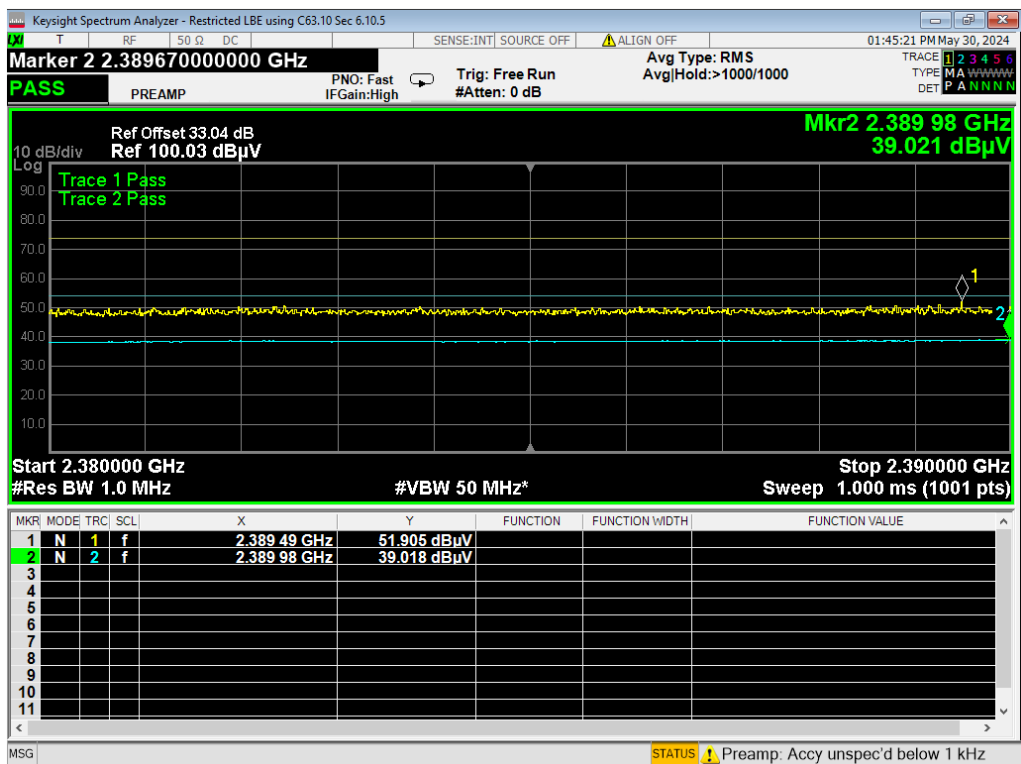
HBE Restricted, Wifi N MCS7



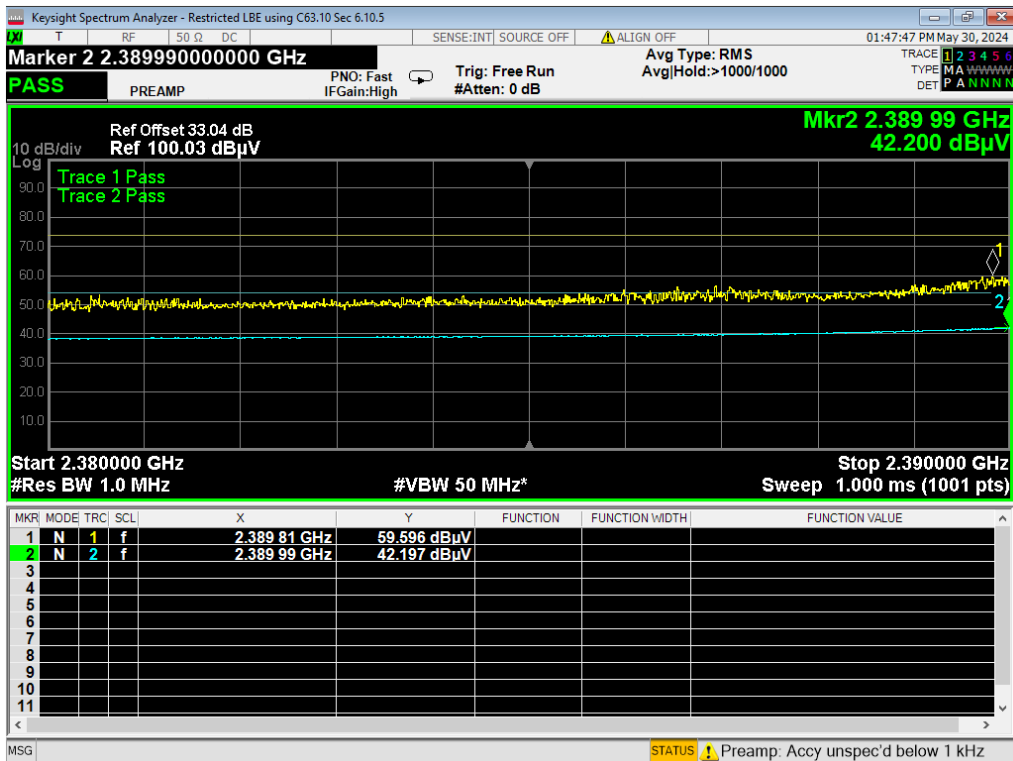
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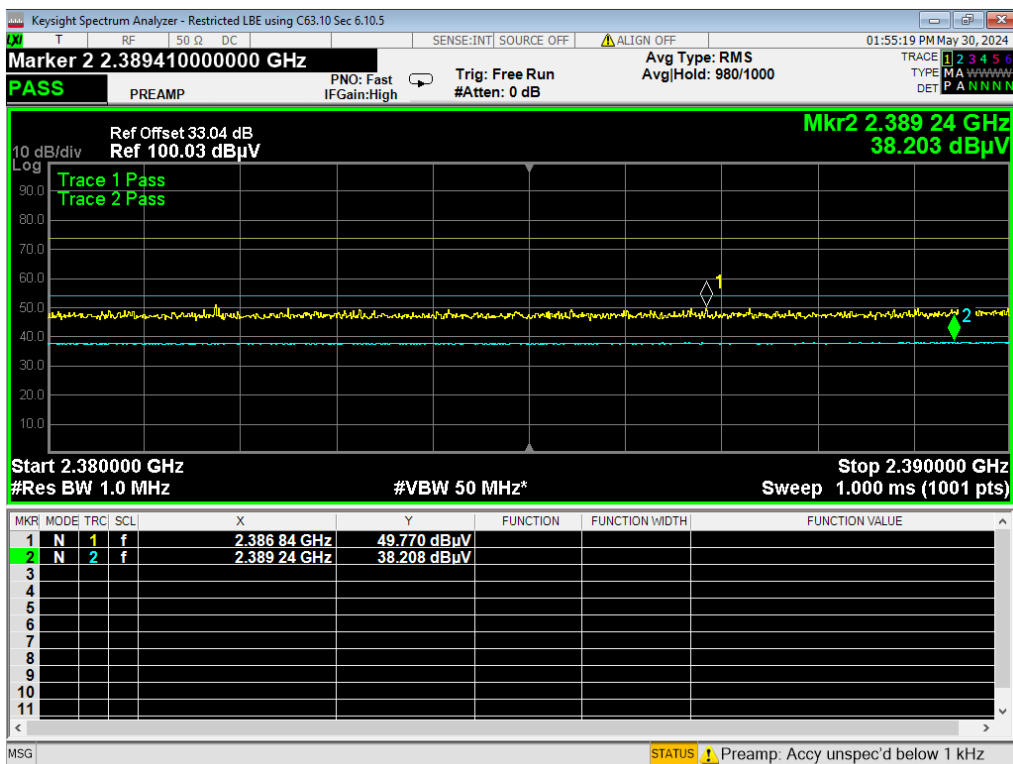
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LBE Restricted, Wifi B 11MB



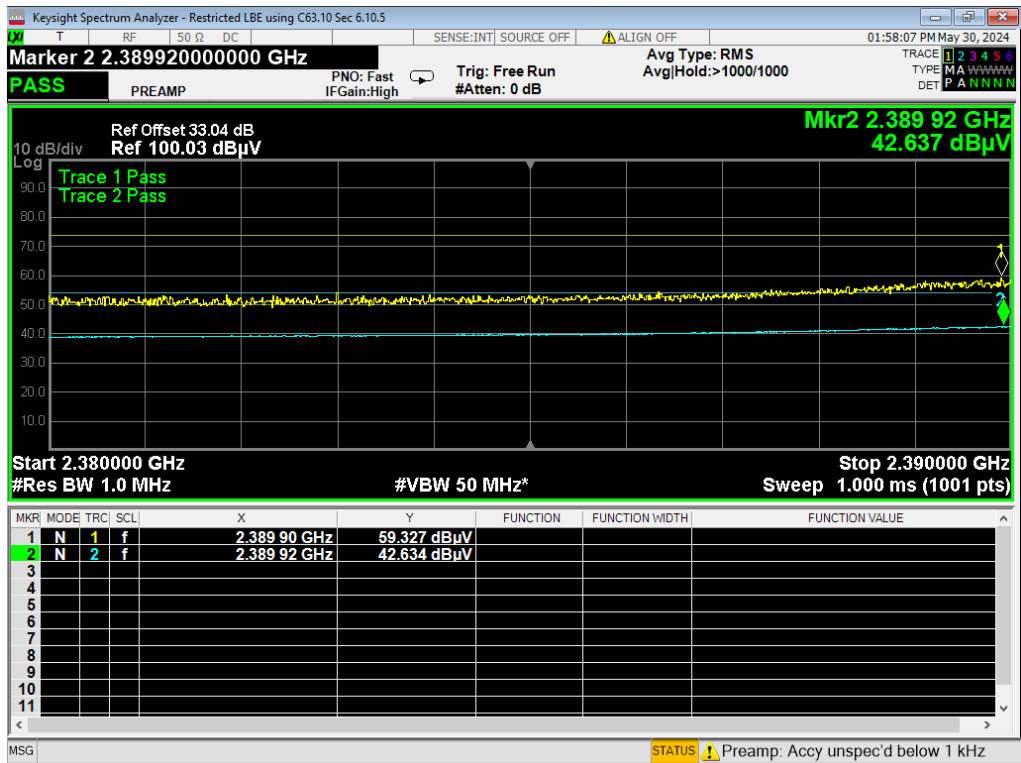
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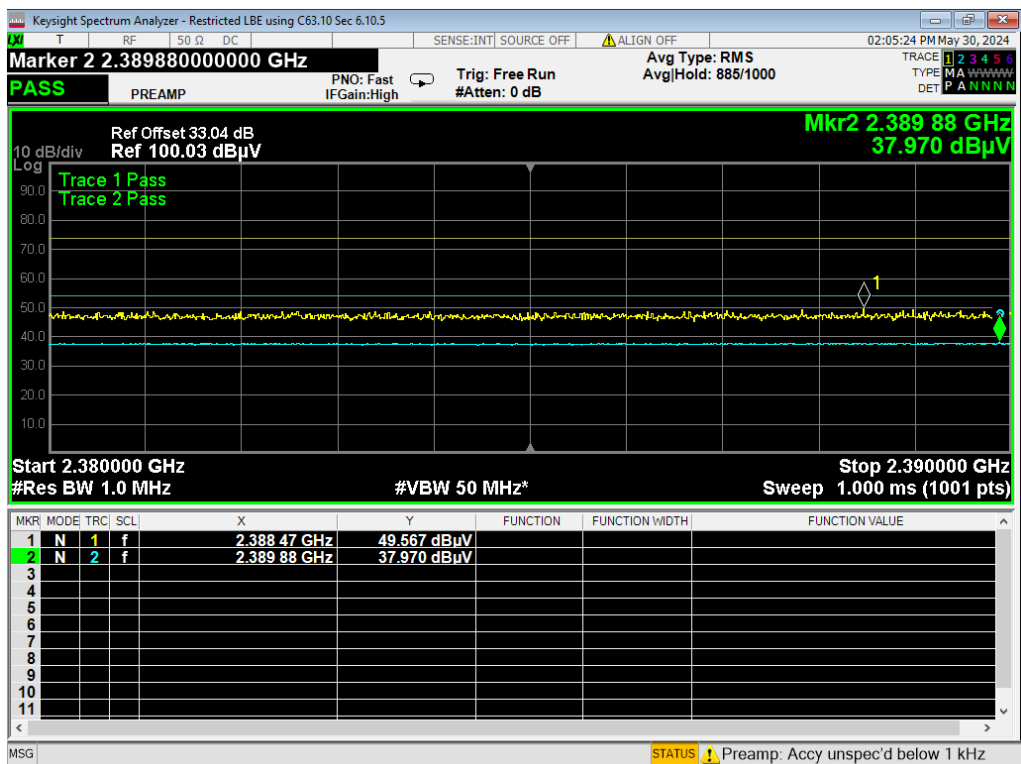
LBE Restricted, Wifi G 54MB



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LBE Restricted, Wifi N MCS7



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REPORT END