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FCC/ISED Test Report

Prepared for: **Hunter Douglas**

Address: **2550 W. Midway Blvd.**
Broomfield, CO 80020

Product: **LBEE5HY1MW**
802.11a

Test Report No: **R20200723-21-E3E**

Approved by:

Nic S. Johnson, NCE
Technical Manager
iNARTE Certified EMC Engineer #EMC-003337-NE

DATE: **11 July 2022**

Total Pages: **41**

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REVISION PAGE

Rev. No.	Date	Description
0	6 June 2022	Original – NJohnson Prepared by KVepuri/FLane
B	13 June 2022	Reported channels investigated Updated standard listings to sec 1.0 Updated peak/average limit where applicable Added comment to Sec 4.2 Showed which channels were investigated, Sec 2.2
C	30 June 2022	Clarified limits
D	5 July 2022	Clarified limits
E	11 July 2022	Clarified limits

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1.0 SUMMARY OF TEST RESULTS

The intention of this report is to determine, if the module in the EUT can be qualified as Class II permissive change. The EUT contains Murata module (with model number LBEE5HY1MW (FCC ID: VPYLBEE5HY1MW)). The manufacturer declared that they changed the antenna on the module. So, only the measurements that would be affected due to these changes are investigated in this report. The measurements that can be done in conducted manner are ignored as they won't be affected due to these changes. The worst-case measurements were reported in this report. Summary of test results presented in this report correspond to the following section:

FCC Part 15.407

The EUT has been tested according to the following specifications:

(1) US Code of Federal Regulations, Title 47, Part 15
(2) ISED RSS-Gen, Issue 5
(3) ISED 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	Complies
FCC Part 15.209 FCC Part 15.407(b)(5) RSS-Gen Issue 4, Section 7.1	Receiver Radiated Emissions	Complies
FCC Part 15.209 (restricted bands) FCC Part 15.407 (unrestricted), RSS-247, Issue 2	General Field Strength Limits(Restricted Bands and Radiated Emission Limits)	Complies
FCC Part 15.209 (restricted bands) FCC Part 15.407 (unrestricted), RSS-247, Issue 215.407 added	Band Edge Measurement	Complies

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

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

EUT	Gen3 Gateway
EUT Received	20 November 2020
EUT Tested	25 November 2020- 3 June 2022
Serial No.	00218 (radiated measurements); (NCEE Assigned Serial Number)
Operating Band	5180 - 5825 MHz (20 MHz Span), 5190 – 5795 MHz (40 MHz Span), 5210 – 5795 MHz (80 MHz Span)
Device Type	☒ 802.11a, ☒ 802.11n, ☒ 802.11ac
Power Supply / Voltage	TP-POE-48 SN:139049622D RC03

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

2.2 DESCRIPTION OF TEST MODES

The operating range of the EUT is dependent on the device type found in section 2.1:
See the operational description for a list of all channel frequencies tested.

Seen below are each of the channels investigated. Worst case channels were reported.

	Channel No.	Center Frequency (MHz)	Data Rate / MCS
802.11a, 802.11n-HT20 and 802.11ac-VHT20	36	5180	6 (6Mbps) or 0 (MCS0)
	44	5220	6 (6Mbps) or 0 (MCS0)
	48	5240	6 (6Mbps) or 0 (MCS0)
	52	5260	6 (6Mbps) or 0 (MCS0)
	60	5300	6 (6Mbps) or 0 (MCS0)
	64	5320	6 (6Mbps) or 0 (MCS0)
	100	5500	6 (6Mbps) or 0 (MCS0)
	116	5580	6 (6Mbps) or 0 (MCS0)
	120	5600	6 (6Mbps) or 0 (MCS0)
	140	5700	6 (6Mbps) or 0 (MCS0)
	144	5720	6 (6Mbps) or 0 (MCS0)
	149	5745	6 (6Mbps) or 0 (MCS0)
	157	5785	6 (6Mbps) or 0 (MCS0)
	165	5825	6 (6Mbps) or 0 (MCS0)
802.11n-HT40 and 802.11ac-VHT40	36 (38)	5190	MCS0 (BPSK,1/2)
	44 (46)	5230	MCS0 (BPSK,1/2)
	52 (54)	5270	MCS0 (BPSK,1/2)
	60 (62)	5310	MCS0 (BPSK,1/2)
	100 (102)	5510	MCS0 (BPSK,1/2)
	108 (110)	5550	MCS0 (BPSK,1/2)
	116 (118)	5590	MCS0 (BPSK,1/2)
	132 (134)	5670	MCS0 (BPSK,1/2)
	140 (142)	5710	MCS0 (BPSK,1/2)
	149 (151)	5755	MCS0 (BPSK,1/2)
	157 (159)	5795	MCS0 (BPSK,1/2)
802.11ac-VHT80	40 (42)	5210	MCS0 (BPSK,1/2)
	56 (58)	5290	MCS0 (BPSK,1/2)
	104 (106)	5530	MCS0 (BPSK,1/2)
	120 (122)	5610	MCS0 (BPSK,1/2)
	136 (138)	5690	MCS0 (BPSK,1/2)
	153 (155)	5775	MCS0 (BPSK,1/2)

2.3 DESCRIPTION OF SUPPORT UNITS

None

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 ± 4%
Temperature of 22 ± 3° Celsius

3.2 TEST PERSONNEL

No.	PERSONNEL	TITLE	ROLE
1	Nic Johnson	Technical Manager	Review/editing
2	Karthik Vepuri	Test Engineer	Testing and report
3	Fox Lane	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.

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 21, 2021	July 21, 2023^
Keysight MXE Signal Analyzer (26.5GHz)***	N9038A	MY56400083	May 5, 2020	May 5, 2023^
SunAR RF Motion	JB1	A091418	July 27, 2021	July 27, 2022^
EMCO Horn Antenna**	3115	6415	March 16, 2020	March 16, 2022
EMCO Horn Antenna	3115	6416	July 28, 2021	July 28, 2022
EMCO Horn Antenna**	3116	2576	March 9, 2020	March 9, 2022
Rohde & Schwarz Preamplifier**	TS-PR18	3545700803	March 21, 2022	March 21, 2024^
Trilithic High Pass Filter*	6HC330	23042	April 14, 2020	April 14, 2022
MiniCircuits 8400+ High Pass Filter	VHF-8400+	30807	May 30, 2022	May 30, 2024
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	December 1, 2021	December 1, 2023^
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3874	December 1, 2021	December 1, 2023^
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	December 1, 2021	December 1, 2023^
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	December 1, 2021	December 1, 2023^
N connector bulkhead (control room)*	PE9128	NCEEBH2	December 1, 2021	December 1, 2023^
TDK Emissions Lab Software	V11.25	700307	NA	NA

* Internal Verification
**2 Year Cal Cycle
***3 Year Cal Cycle
^Most up to date calibration reported, testing was also performed before last calibration date and returned in tolerance.

Notes:

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

3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMNTS

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.

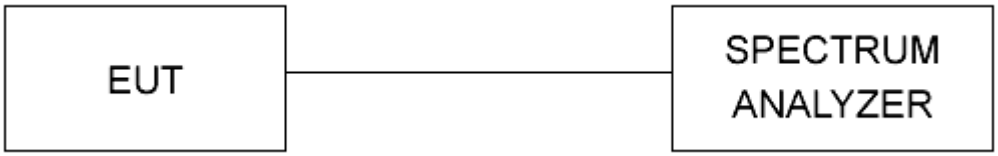


Figure 1 - Bandwidth Measurements Test Setup

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.

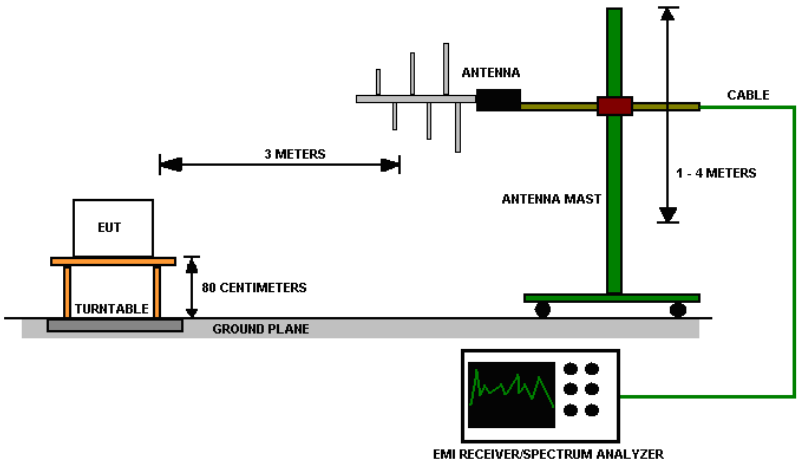


Figure 2 - Radiated Emissions Test Setup

4.0 RESULTS

Peak Restricted Band-Edge								
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)	Margin	Result	Span
100	a	5460.00	55.20	Peak	73.98	18.78	PASS	20
36	a	5150.00	60.21	Peak	73.98	13.77	PASS	20
100	n	5460.00	55.76	Peak	73.98	18.22	PASS	40
36	n	5150.00	59.46	Peak	73.98	14.52	PASS	40
104	ac	5460.00	56.07	Peak	73.98	17.91	PASS	80
40	ac	5150.00	61.91	Peak	73.98	12.07	PASS	80
64	a	5350.00	56.02	Peak	73.98	17.96	PASS	20
165	a	7250.00	58.61	Peak	73.98	15.37	PASS	20
60	n	5350.00	54.69	Peak	73.98	19.29	PASS	40
157	n	7250.00	60.10	Peak	73.98	13.88	PASS	40
56	ac	5350.00	58.65	Peak	73.98	15.33	PASS	80
153	ac	7250.00	58.95	Peak	73.98	15.04	PASS	80
*Limit shown is the peak limit taken from FCC Part 15.209								

All conducted output power measurements were repeated and found to be within the same as the original grant within measurement tolerance.

Average Restricted Band-Edge									
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Uncorrected Highest out of band level (dBuV/m @ 3m)	Corrected Highest out of band level (dBuV/m @ 3m)	Limit (dBuV/m @ 3m)	Correction Factor	Margin	Result	Span
100	a	5460.00	38.00	38.00	53.98	0	15.98	PASS	20
36	a	5150.00	43.10	43.10	53.98	0	10.88	PASS	20
100	n	5460.00	37.99	38.25	53.98	0.258	15.99	PASS	40
36	n	5150.00	47.29	47.55	53.98	0.258	6.69	PASS	40
104	ac	5460.00	41.08	41.59	53.98	0.508	12.90	PASS	80
40	ac	5150.00	49.54	50.04	53.98	0.508	4.44	PASS	80
64	a	5350.00	38.53	38.53	53.98	0	15.45	PASS	20
165	a	7250.00	42.48	42.48	53.98	0	11.50	PASS	20
60	n	5350.00	38.53	38.79	53.98	0.258	15.45	PASS	40
157	n	7250.00	41.87	42.13	53.98	0.258	12.11	PASS	40
56	ac	5350.00	40.22	40.73	53.98	0.508	13.76	PASS	80
153	ac	7250.00	42.84	43.35	53.98	0.508	11.14	PASS	80

Limit shown is the average limit taken from FCC Part 15.209
*Correction Factor has been added to the following average values as the duty cycle is found to be <98%, refer to section 4.2:
802.11n, 40 MHz Span = 0.258 dB
802.11ac, 40 MHz Span = 0.256 dB
802.11ac, 80 MHz Span = 0.508 dB
Correction factor is calculated with the following equation from C63.10-2013, Sec. 12.7.7.2: 20*log(1/D)
D = Duty Cycle
Uncorrected Highest out of band level (dBuV/m @ 3m) has antenna factor and cable loss included but does not account for correction factor
Corrected Highest out of band level (dBuV/m @ 3m) = Uncorrected Highest out of band level (dBuV/m @ 3m) + Correction Factor

4.1 DUTY CYCLE

Duty Cycle Calculations				
Modulation	**Span (MHz)**	**On Time (ms)**	**Period (ms)**	**Duty Cycle (%)**
a	20	1.428	1.448	98.619
n	20	1.336	1.356	98.525
ac	20	1.344	1.364	98.534
n	40	0.664	0.684	97.076
ac	40	0.668	0.688	97.093
ac	80	0.332	0.352	94.318

Duty Cycle Correction Factor (DCCF) = 20 * log(1 / Duty Cycle[DC])

WIFI n Span 40 = 20 * log(1 / 0.97076) = 0.258

WIFI ac Span 40 = 20 * log(1 / 0.97093) = 0.256

WIFI ac Span 80 = 20 * log(1 / 0.94318) = 0.508

4.2 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 and 15.407:

FREQUENCIES (MHz)	FIELD STRENGTH (µV/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

For 15.407, limit = -27 dBm EIRP/MHz = 68.20 dBuV/m at 3m, used for out-of-band spurious emissions in unrestricted bands.

NOTE:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (µV/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.

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:

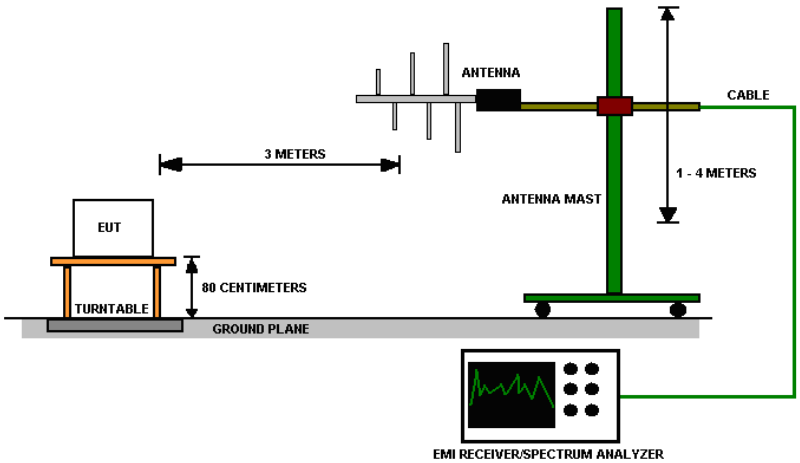


Figure 3 - Radiated Emissions Test Setup

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:

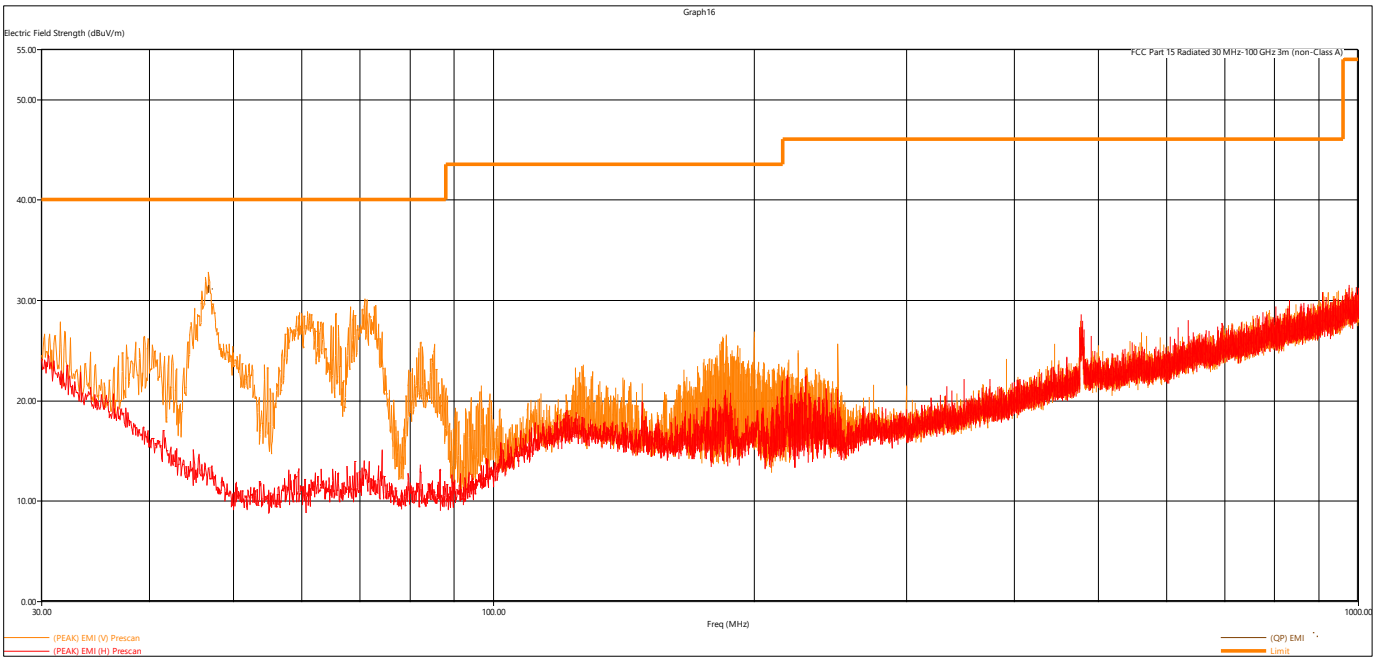


Figure 4 - Radiated Emissions Plot, Receive

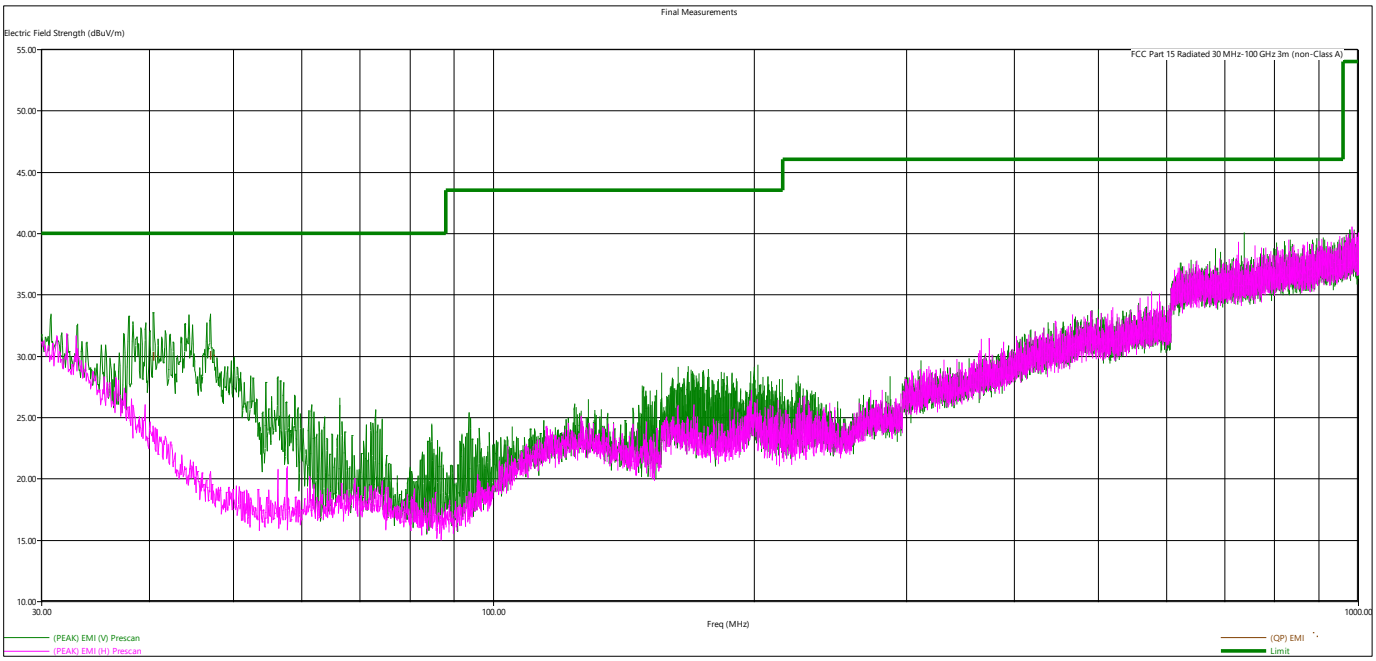


Figure 5 - Radiated Emissions Plot, CH36, 802.11a, 20 MHz span

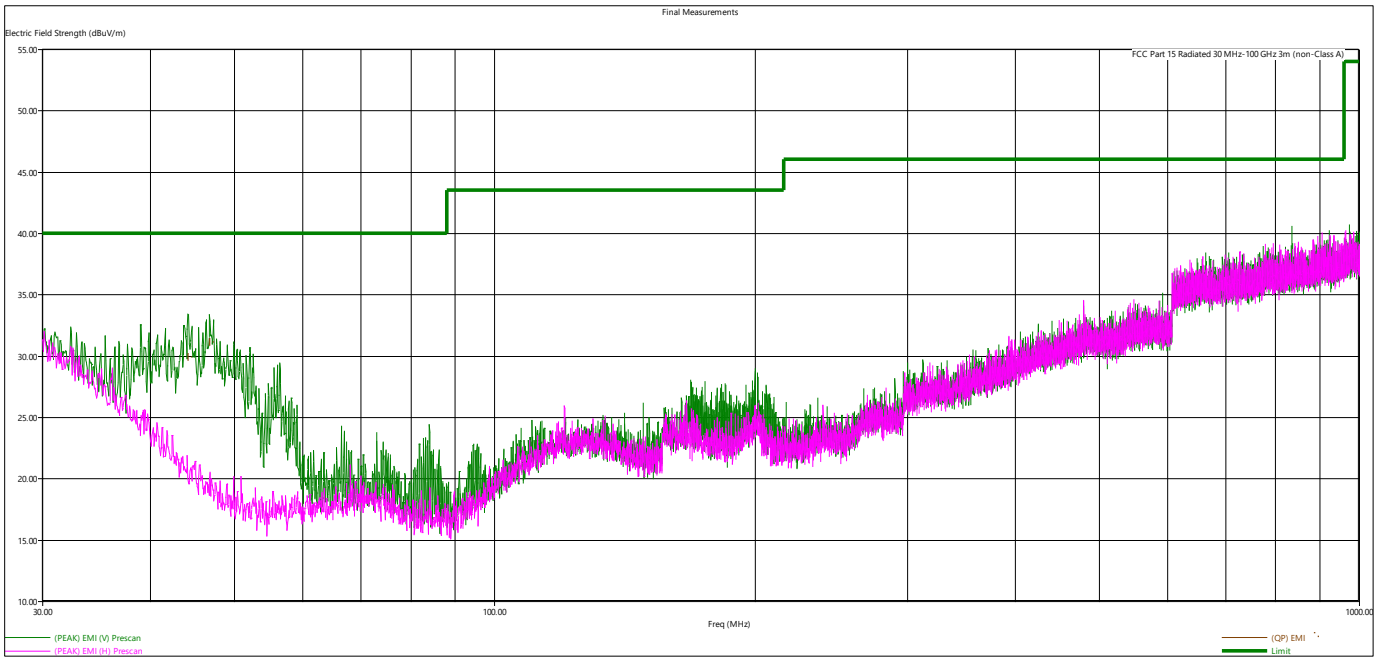


Figure 6 - Radiated Emissions Plot, CH36, 802.11n, 40 MHz span

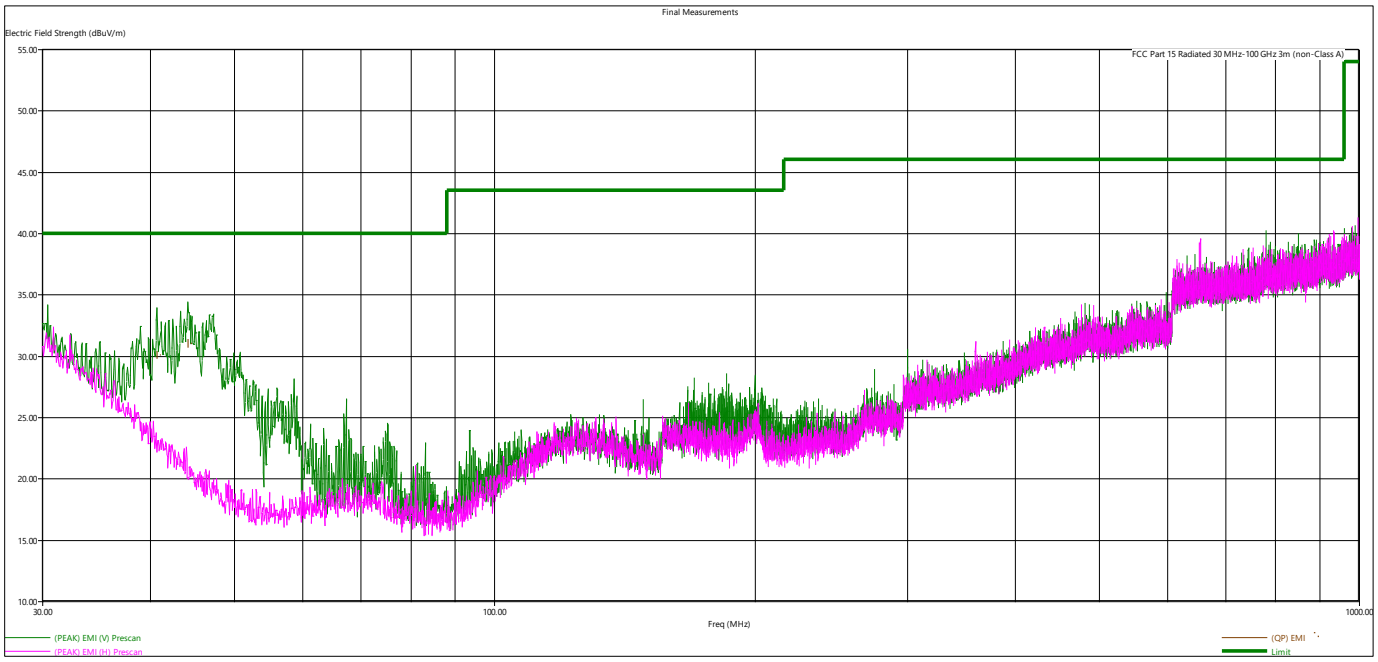


Figure 7 - Radiated Emissions Plot, CH40, 802.11ac, 80 MHz span

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 = Limit value - Emission level

Quasi-Peak Measurements, 802.11x									
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation	Bandwidth
MHz	dBµV/m	dBµV/m	dB	cm.	deg.				MHz
40.39752	29.92	40	10.08	104	84	V	36	802.11a	20
46.92024	29.97	40	10.03	106	163	V	36	802.11a	20
44.22528	29.85	40	10.15	117	284	V	36	802.11n	40
46.83072	31.08	40	8.92	105	275	V	36	802.11n	40
40.70496	30.06	40	9.94	106	297	V	40	802.11ac	80
44.14656	30.98	40	9.02	112	227	V	40	802.11ac	80
46.862400	31.09	40	8.91	106	8	V	Receive		NA

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

Peak Measurements, 802.11x									
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation	Span
MHz	dBµV/m	dBµV/m	dB	cm.	deg.				MHz
2460.738000	45.34	68.20	22.86	167.00	55.00	V	36	802.11a	20
5177.452000	104.41	NA	NA	465.00	69.00	H	36	802.11a	20
5180.000000	102.60	NA	NA	465.00	69.00	H	36	802.11a	20
5580.000000	102.57	NA	NA	465.00	69.00	H	116	802.11a	20
5825.000000	97.26	NA	NA	465.00	69.00	H	165	802.11a	20
5187.876000	99.10	NA	NA	280.00	56.00	H	36	802.11n	20
5180.000000	102.90	NA	NA	280.00	56.00	H	36	802.11n	20
5580.000000	103.00	NA	NA	280.00	56.00	H	116	802.11n	20
5825.000000	97.02	NA	NA	280.00	56.00	H	165	802.11n	20
5208.322000	96.76	NA	NA	383.00	74.00	H	36	802.11ac	20
5217.778000	93.21	NA	NA	345.00	50.00	V	36	802.11ac	20
5180.000000	102.90	NA	NA	383.00	74.00	V	36	802.11ac	20
5580.000000	102.20	NA	NA	383.00	74.00	V	116	802.11ac	20
5825.000000	97.76	NA	NA	383.00	74.00	V	165	802.11ac	20
5190.000000	98.66	NA	NA	280.00	56.00	H	36	802.11n	40
5550.000000	99.44	NA	NA	280.00	56.00	H	108	802.11n	40
5795.000000	92.86	NA	NA	280.00	56.00	H	157	802.11n	40
5190.000000	97.11	NA	NA	383.00	74.00	H	36	802.11ac	40
5550.000000	99.42	NA	NA	383.00	74.00	H	108	802.11ac	40
5795.000000	93.40	NA	NA	383.00	74.00	H	157	802.11ac	40
5210.000000	94.80	NA	NA	383.00	74.00	H	40	802.11ac	80
5530.000000	93.48	NA	NA	383.00	74.00	H	104	802.11ac	80
5775.000000	91.37	NA	NA	383.00	74.00	H	153	802.11ac	80
10360.000000	49.85	68.20	18.35	290.00	74.00	H	NA	802.11a	20
10440.000000	49.85	68.20	18.35	290.00	74.00	H	NA	802.11a	20
10480.000000	50.33	68.20	17.87	290.00	74.00	H	NA	802.11a	20
10520.000000	49.99	68.20	18.21	290.00	74.00	H	NA	802.11a	20
10600.000000	49.31	68.20	18.89	290.00	74.00	H	NA	802.11a	20
10640.000000	50.85	73.98	23.13	290.00	74.00	H	NA	802.11a	20
11000.000000	50.69	73.98	23.29	290.00	74.00	H	NA	802.11a	20
11160.000000	49.11	73.98	24.87	290.00	74.00	H	NA	802.11a	20
11200.000000	51.33	73.98	22.65	290.00	74.00	H	NA	802.11a	20
11400.000000	51.13	73.98	22.85	290.00	74.00	H	NA	802.11a	20
11440.000000	50.18	73.98	23.80	290.00	74.00	H	NA	802.11a	20

Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation	Span
MHz	dBµV/m	dBµV/m	dB	cm.	deg.				MHz
11490.000000	51.43	73.98	22.55	290.00	74.00	H	NA	802.11a	20
11570.000000	52.27	73.98	21.71	290.00	74.00	H	NA	802.11a	20
11650.000000	49.92	73.98	24.06	290.00	74.00	H	NA	802.11a	20
10380.000000	49.16	68.20	19.04	290.00	74.00	H	NA	802.11a	20
10460.000000	49.48	68.20	18.72	290.00	74.00	H	NA	802.11n	40
10540.000000	48.76	68.20	19.44	290.00	74.00	H	NA	802.11n	40
10620.000000	49.31	73.98	24.67	290.00	74.00	H	NA	802.11n	40
11020.000000	49.64	73.98	24.34	290.00	74.00	H	NA	802.11n	40
11100.000000	50.23	73.98	23.75	290.00	74.00	H	NA	802.11n	40
11180.000000	49.39	73.98	24.59	290.00	74.00	H	NA	802.11n	40
11340.000000	49.54	73.98	24.44	290.00	74.00	H	NA	802.11n	40
11420.000000	49.91	73.98	24.07	290.00	74.00	H	NA	802.11n	40
11510.000000	49.86	73.98	24.12	290.00	74.00	H	NA	802.11n	40
11590.000000	50.08	73.98	23.90	290.00	74.00	H	NA	802.11n	40
10420.000000	49.31	68.2	18.89	290.00	74.00	H	NA	802.11n	40
10580.000000	48.18	68.2	20.02	290.00	74.00	H	NA	802.11ac	80
11060.000000	49.88	73.98	24.10	290.00	74.00	H	NA	802.11ac	80
11220.000000	49.35	73.98	24.63	290.00	74.00	H	NA	802.11ac	80
11380.000000	49.72	73.98	24.26	290.00	74.00	H	NA	802.11ac	80
11550.000000	49.73	73.98	24.25	290.00	74.00	H	NA	802.11ac	80
15540.000000	55.81	73.98	18.17	290.00	74.00	H	NA	802.11a	20
15660.000000	56.51	73.98	17.47	290.00	74.00	H	NA	802.11a	20
15720.000000	56.79	73.98	17.19	290.00	74.00	H	NA	802.11a	20
15780.000000	56.55	73.98	17.43	290.00	74.00	H	NA	802.11a	20
15900.000000	57.14	73.98	16.84	290.00	74.00	H	NA	802.11a	20
15960.000000	56.55	73.98	17.43	290.00	74.00	H	NA	802.11a	20
16500.000000	57.42	68.20	10.78	290.00	74.00	H	NA	802.11a	20
16740.000000	59.35	68.20	8.85	290.00	74.00	H	NA	802.11a	20
16800.000000	58.63	68.20	9.57	290.00	74.00	H	NA	802.11a	20
17100.000000	59.3	68.20	8.90	290.00	74.00	H	NA	802.11a	20
17160.000000	59.19	68.20	9.01	290.00	74.00	H	NA	802.11a	20
17235.000000	60.63	68.20	7.57	290.00	74.00	H	NA	802.11a	20
17355.000000	61.00	68.20	7.20	290.00	74.00	H	NA	802.11a	20
17475.000000	62.51	68.20	5.69	290.00	74.00	H	NA	802.11a	20
15570.000000	54.7	73.98	19.28	290.00	74.00	H	NA	802.11a	20
15690.000000	56.41	73.98	17.57	290.00	74.00	H	NA	802.11n	40
15810.000000	57.68	73.98	16.30	290.00	74.00	H	NA	802.11n	40

Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation	Span
MHz	dBµV/m	dBµV/m	dB	cm.	deg.				MHz
15930.000000	56.91	73.98	17.07	290.00	74.00	H	NA	802.11n	40
16530.000000	59.15	68.20	9.05	290.00	74.00	H	NA	802.11n	40
16650.000000	59.4	68.20	8.80	290.00	74.00	H	NA	802.11n	40
16770.000000	58.4	68.20	9.80	290.00	74.00	H	NA	802.11n	40
17010.000000	59.18	68.20	9.02	290.00	74.00	H	NA	802.11n	40
17130.000000	59.82	68.20	8.38	290.00	74.00	H	NA	802.11n	40
17265.000000	60.28	68.20	7.92	290.00	74.00	H	NA	802.11n	40
17385.000000	60.03	68.20	8..17	290.00	74.00	H	NA	802.11n	40
15630.000000	55.69	73.98	18.29	290.00	74.00	H	NA	802.11n	40
15870.000000	54.49	73.98	19.49	290.00	74.00	H	NA	802.11ac	80
16590.000000	57.22	68.20	10.98	290.00	74.00	H	NA	802.11ac	80
16830.000000	58.91	68.20	9.29	290.00	74.00	H	NA	802.11ac	80
17070.000000	58.91	68.20	9.29	290.00	74.00	H	NA	802.11ac	80
17325.000000	61.16	68.20	7.04	290.00	74.00	H	NA	802.11ac	80

Average Measurements, 802.11									
Frequency	Corrected Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation	Span
MHz	dBµV/m	dBµV/m	dB	cm.	deg.				MHz
2460.738000	31.93	53.98	22.05	167.00	55.00	V	36	802.11a	20
5177.452000	94.13	NA	NA	465.00	69.00	H	36	802.11a	20
5180.000000	93.21	NA	NA	465.00	69.00	H	36	802.11a	20
5580.000000	92.55	NA	NA	465.00	69.00	H	116	802.11a	20
5825.000000	87.91	NA	NA	465.00	69.00	H	165	802.11a	20
5187.876000	89.29	NA	NA	280.00	56.00	H	36	802.11n	20
5180.000000	92.80	NA	NA	280.00	56.00	H	36	802.11n	20
5580.000000	92.00	NA	NA	280.00	56.00	H	116	802.11n	20
5825.000000	87.11	NA	NA	280.00	56.00	H	165	802.11n	20
5190.000000	88.63	NA	NA	280.00	56.00	H	36	802.11n	40
5550.000000	89.94	NA	NA	280.00	56.00	H	36	802.11n	40
5795.000000	82.66	NA	NA	280.00	56.00	H	36	802.11n	40
5208.322000	86.55	NA	NA	383.00	74.00	H	116	802.11ac	20
5217.778000	83.57	NA	NA	345.00	50.00	V	165	802.11ac	20
5180.000000	92.85	NA	NA	383.00	74.00	H	36	802.11ac	20
5580.000000	92.18	NA	NA	383.00	74.00	H	108	802.11ac	20
5825.000000	87.45	NA	NA	383.00	74.00	H	157	802.11ac	20
5190.000000	88.01	NA	NA	383.00	74.00	H	36	802.11ac	40
5550.000000	89.84	NA	NA	383.00	74.00	H	108	802.11ac	40
5795.000000	83.01	NA	NA	383.00	74.00	H	157	802.11ac	40
5210.000000	85.20	NA	NA	383.00	74.00	H	40	802.11ac	80
5530.000000	83.27	NA	NA	383.00	74.00	H	104	802.11ac	80
5775.000000	80.29	NA	NA	383.00	74.00	H	153	802.11ac	80
10360.000000	36.65	53.98	17.33	290.00	74.00	H	NA	802.11a	20
10440.000000	36.66	53.98	17.32	290.00	74.00	H	NA	802.11a	20
10480.000000	36.75	NA	NA	290.00	74.00	H	NA	802.11a	20
10520.000000	37.06	NA	NA	290.00	74.00	H	NA	802.11a	20
10600.000000	36.18	NA	NA	290.00	74.00	H	NA	802.11a	20
10640.000000	37.13	53.98	16.85	290.00	74.00	H	NA	802.11a	20
11000.000000	37.37	53.98	16.61	290.00	74.00	H	NA	802.11a	20
11160.000000	38.63	53.98	15.35	290.00	74.00	H	NA	802.11a	20
11200.000000	37.96	53.98	16.02	290.00	74.00	H	NA	802.11a	20
11400.000000	37.86	53.98	16.12	290.00	74.00	H	NA	802.11a	20
11440.000000	37.47	53.98	16.51	290.00	74.00	H	NA	802.11a	20
11490.000000	37.73	53.98	16.25	290.00	74.00	H	NA	802.11a	20

Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation	Span
MHz	dBµV/m	dBµV/m	dB	cm.	deg.				MHz
11570.000000	39.14	53.98	14.84	290.00	74.00	H	NA	802.11a	20
11650.000000	37.03	53.98	16.95	290.00	74.00	H	NA	802.11a	20
10380.000000	35.74	NA	NA	290.00	74.00	H	NA	802.11a	20
10460.000000	36.25	NA	NA	290.00	74.00	H	NA	802.11n	40
10540.000000	36.19	NA	NA	290.00	74.00	H	NA	802.11n	40
10620.000000	36.20	53.98	17.78	290.00	74.00	H	NA	802.11n	40
11020.000000	38.86	53.98	15.12	290.00	74.00	H	NA	802.11n	40
11100.000000	37.18	53.98	16.80	290.00	74.00	H	NA	802.11n	40
11180.000000	37.29	53.98	16.69	290.00	74.00	H	NA	802.11n	40
11340.000000	36.49	53.98	17.49	290.00	74.00	H	NA	802.11n	40
11420.000000	36.6	53.98	17.38	290.00	74.00	H	NA	802.11n	40
11510.000000	37.28	53.98	16.70	290.00	74.00	H	NA	802.11n	40
11590.000000	37.00	53.98	16.98	290.00	74.00	H	NA	802.11n	40
10420.000000	35.50	NA	NA	290.00	74.00	H	NA	802.11n	40
10580.000000	35.33	NA	NA	290.00	74.00	H	NA	802.11ac	80
11060.000000	36.71	53.98	17.27	290.00	74.00	H	NA	802.11ac	80
11220.000000	36.05	53.98	17.93	290.00	74.00	H	NA	802.11ac	80
11380.000000	36.73	53.98	17.25	290.00	74.00	H	NA	802.11ac	80
11550.000000	36.78	53.98	17.20	290.00	74.00	H	NA	802.11ac	80
15540.000000	42.92	53.98	11.06	290.00	74.00	H	NA	802.11a	20
15660.000000	42.27	53.98	11.71	290.00	74.00	H	NA	802.11a	20
15720.000000	43.40	53.98	10.58	290.00	74.00	H	NA	802.11a	20
15780.000000	43.11	53.98	10.87	290.00	74.00	H	NA	802.11a	20
15900.000000	44.12	53.98	9.86	290.00	74.00	H	NA	802.11a	20
15960.000000	43.21	53.98	10.77	290.00	74.00	H	NA	802.11a	20
16500.000000	44.44	NA	NA	290.00	74.00	H	NA	802.11a	20
16740.000000	46.60	NA	NA	290.00	74.00	H	NA	802.11a	20
16800.000000	45.01	NA	NA	290.00	74.00	H	NA	802.11a	20
17100.000000	47.07	NA	NA	290.00	74.00	H	NA	802.11a	20
17160.000000	46.24	NA	NA	290.00	74.00	H	NA	802.11a	20
17235.000000	48.31	53.98	5.67	290.00	74.00	H	NA	802.11a	20
17355.000000	49.98	53.98	4.00	290.00	74.00	H	NA	802.11a	20
17475.000000	48.33	53.98	5.65	290.00	74.00	H	NA	802.11a	20
15570.000000	41.41	53.98	12.57	290.00	74.00	H	NA	802.11a	20
15690.000000	43.79	53.98	10.19	290.00	74.00	H	NA	802.11n	40
15810.000000	43.96	53.98	10.02	290.00	74.00	H	NA	802.11n	40
15930.000000	44.23	53.98	9.75	290.00	74.00	H	NA	802.11n	40

Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation	Span
MHz	dBµV/m	dBµV/m	dB	cm.	deg.				MHz
16530.000000	45.12	NA	NA	290.00	74.00	H	NA	802.11n	40
16650.000000	45.94	NA	NA	290.00	74.00	H	NA	802.11n	40
16770.000000	45.85	NA	NA	290.00	74.00	H	NA	802.11n	40
17010.000000	46.70	NA	NA	290.00	74.00	H	NA	802.11n	40
17130.000000	47.32	NA	NA	290.00	74.00	H	NA	802.11n	40
17265.000000	47.50	53.98	6.48	290.00	74.00	H	NA	802.11n	40
17385.000000	48.40	53.98	5.58	290.00	74.00	H	NA	802.11n	40
15630.000000	42.92	53.98	11.06	290.00	74.00	H	NA	802.11n	40
15870.000000	42.13	53.98	11.85	290.00	74.00	H	NA	802.11ac	80
16590.000000	45.07	NA	NA	290.00	74.00	H	NA	802.11ac	80
16830.000000	46.18	NA	NA	290.00	74.00	H	NA	802.11ac	80
17070.000000	46.50	NA	NA	290.00	74.00	H	NA	802.11ac	80
17325.000000	48.48	53.98	5.50	290.00	74.00	H	NA	802.11ac	80

All other emissions were found to be below system noise floor, with at least 6 dB below the limit and were not reported.
*Since the duty cycle of the following modulations was found to be <98% a correction factor has been added to the following average values:
Corrected Level = Raw Average Level (corrections included but not DCCF) + DCCF
802.11n, 40 MHz Span = 0.258 dB
802.11ac, 40 MHz Span = 0.256 dB
802.11ac, 80 MHz Span = 0.508 dB
Correction factor is calculated with the following equation from C63.10-2013, Sec. 12.7.7.2: 20*log(1/D)
D = Duty Cycle
See Section 4.1 for more details

4.3 BAND EDGES

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

Limits of band-edge measurements:

For FCC Part 15.247 Device:
For emissions outside of the allowed band of operation, the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

Test procedures:

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

Deviations from test standard:
No deviation.

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

EUT operating conditions:
Details can be found in section 2.1 of this report.

Test results:
Pass

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

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 dBμV 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 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

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

EIRP Calculations

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

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

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

Voltage (dBµV) = Power (dBm) + 107 (for 50Ω measurement systems)

Field Strength (V/m) = 10^[Field Strength (dBµV/m) / 20] / 10^6

Gain = 1 (numeric gain for isotropic radiator)

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

EIRP = [FS(V/m) x d^2]/30 = FS [0.3] for d = 3

EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = FS(dBµV/m) - 95.23

10log(10^9) is the conversion from micro to milli

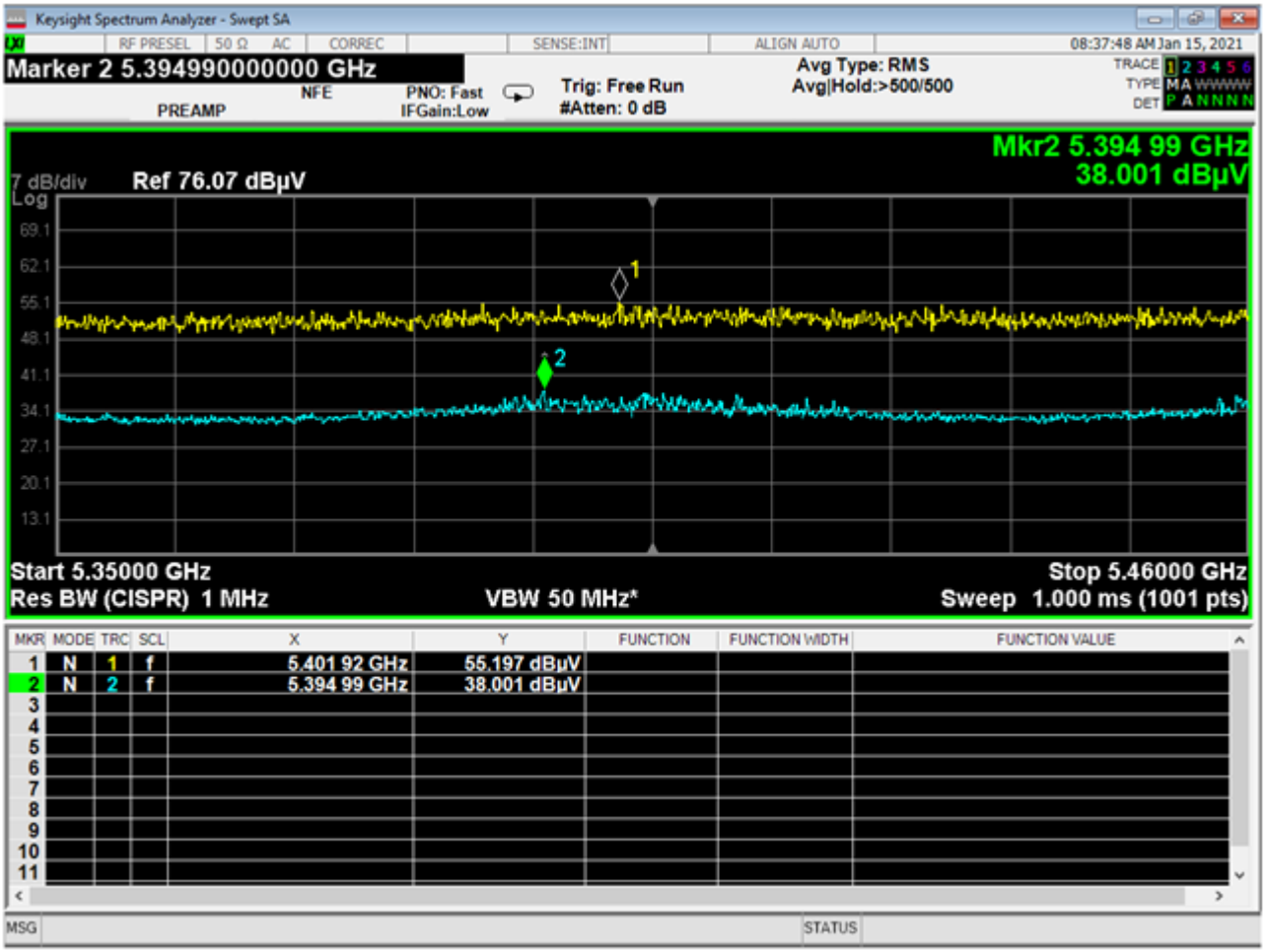
APPENDIX B – MEASUREMENT UNCERTAINTY

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

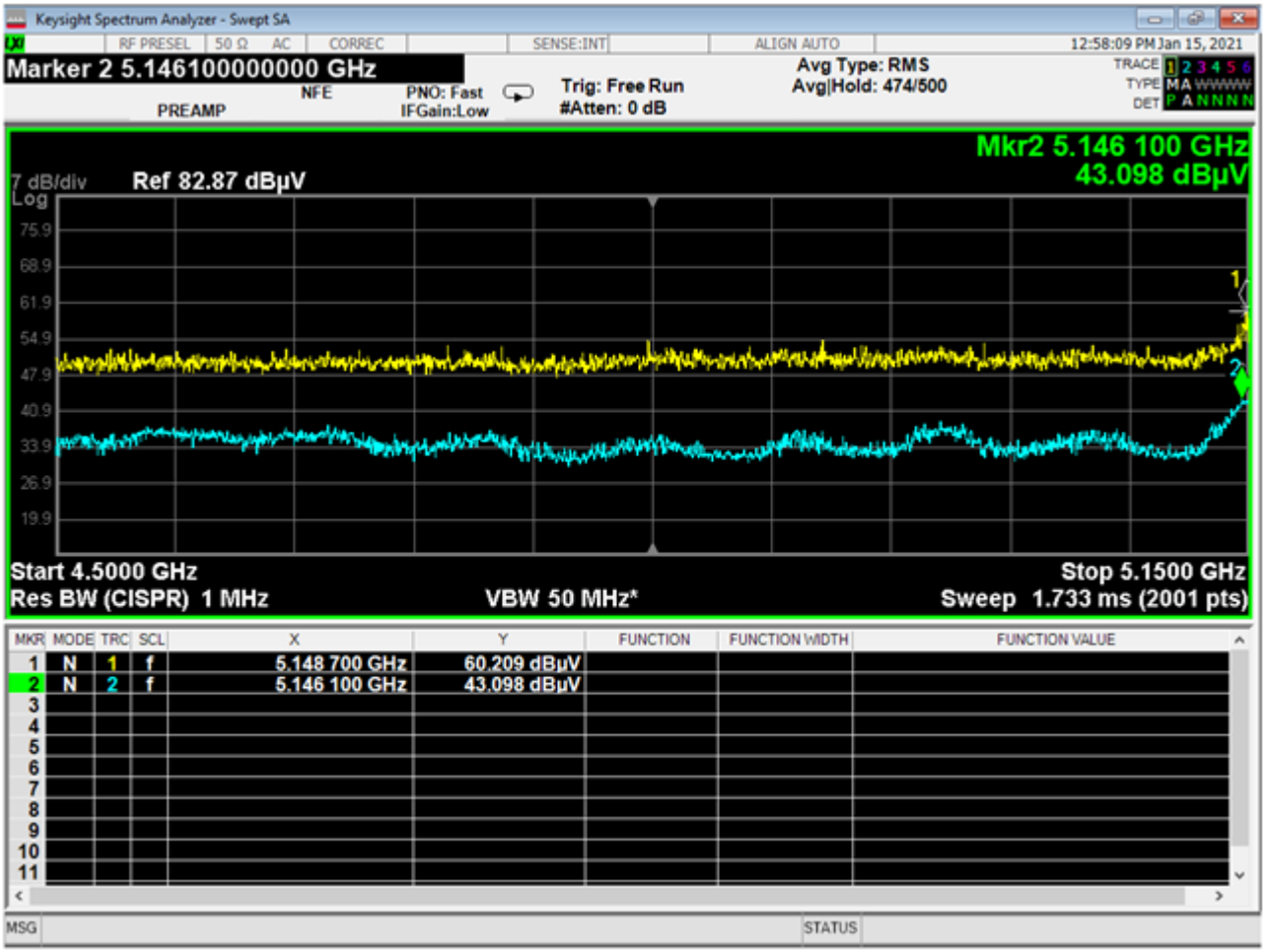
Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08
Emissions limits, conducted	30MHz – 18GHz	±3.03

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

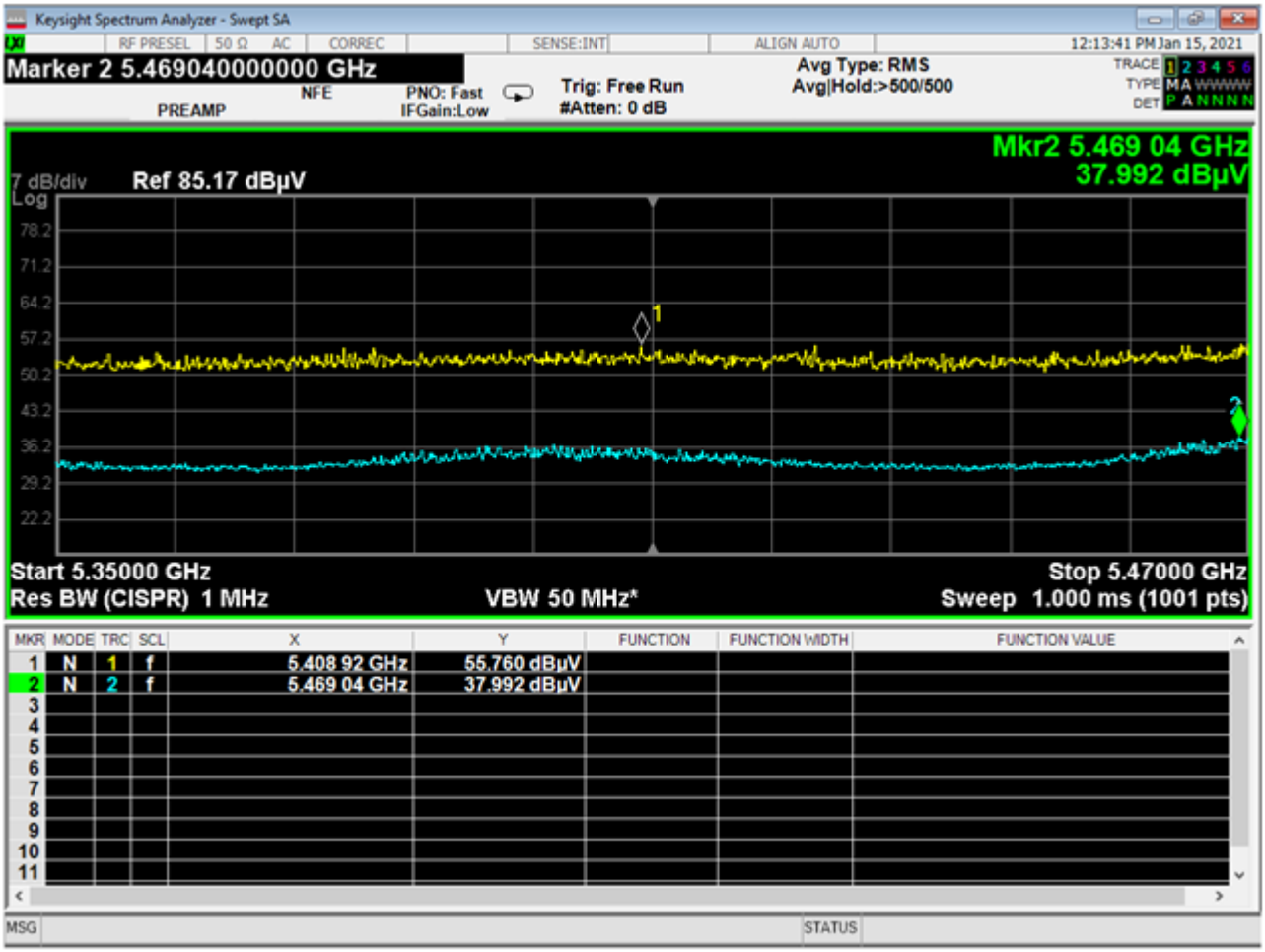
APPENDIX C – GRAPHS AND TABLES



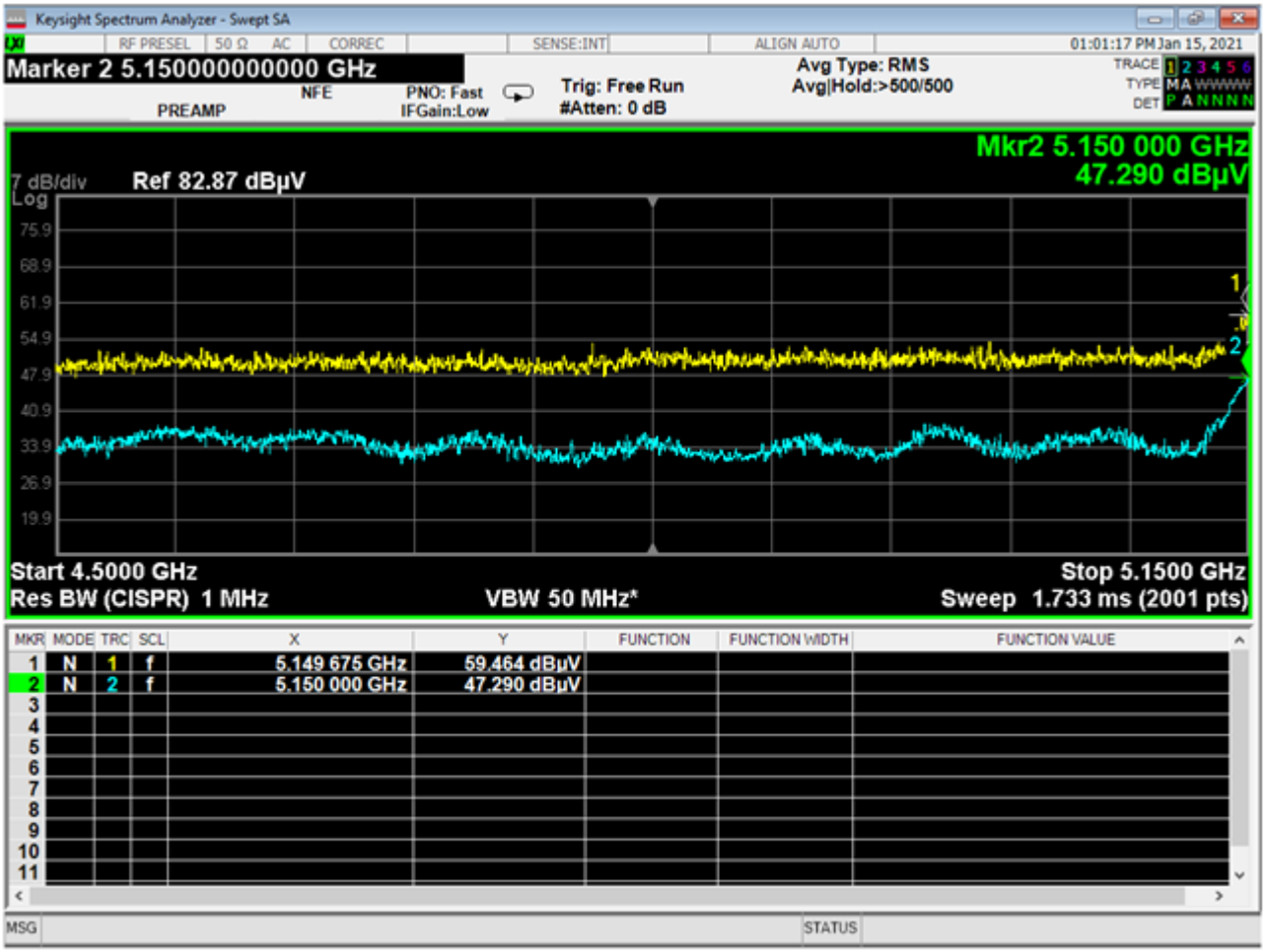
01. Lower Band Edge, Restricted, a, 20 Span, 5.35-5.46GHz, 100CH



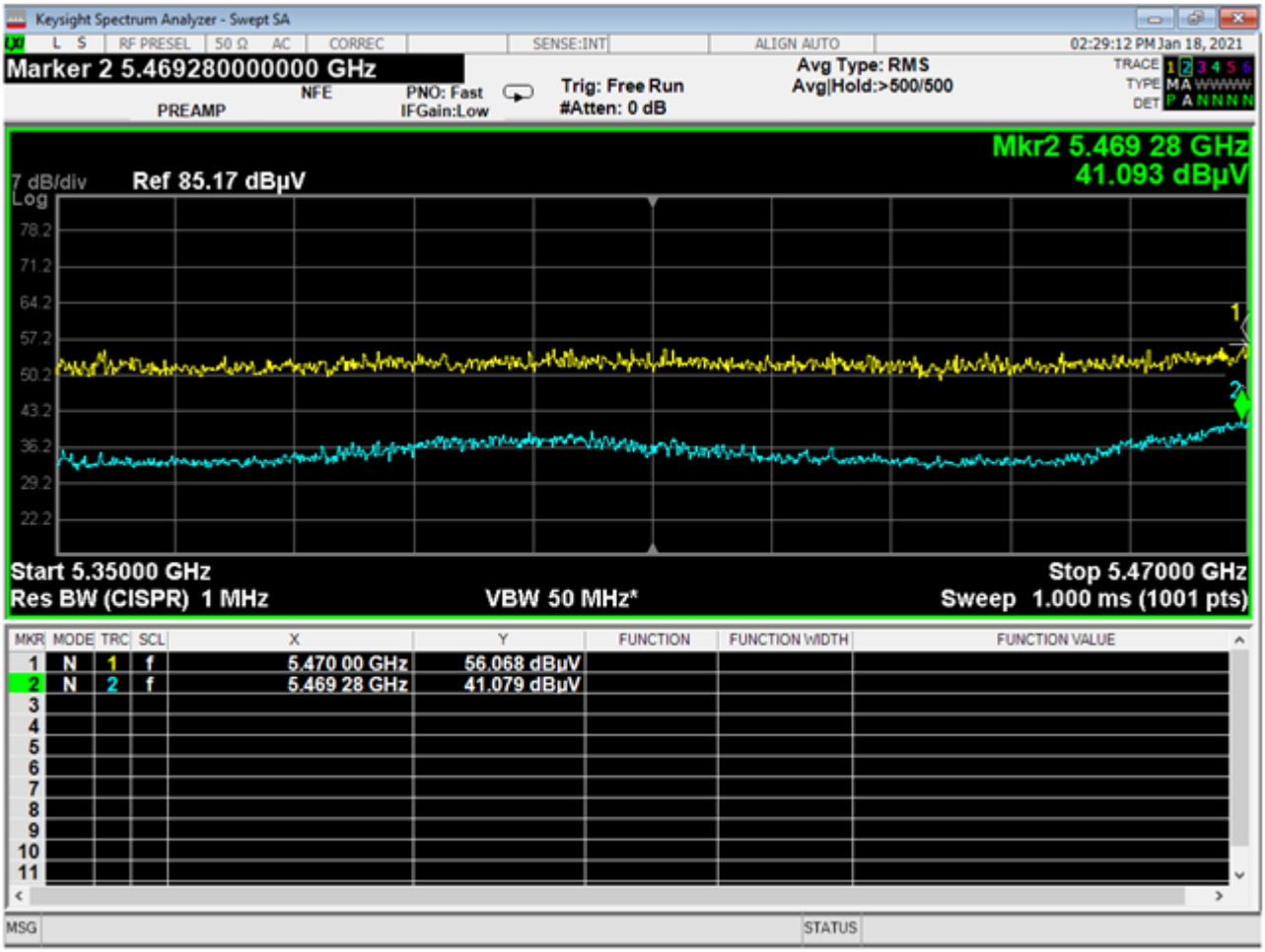
02. Lower Band Edge, Restricted, a, 20 Span, 4.5-5.15GHz, 36CH



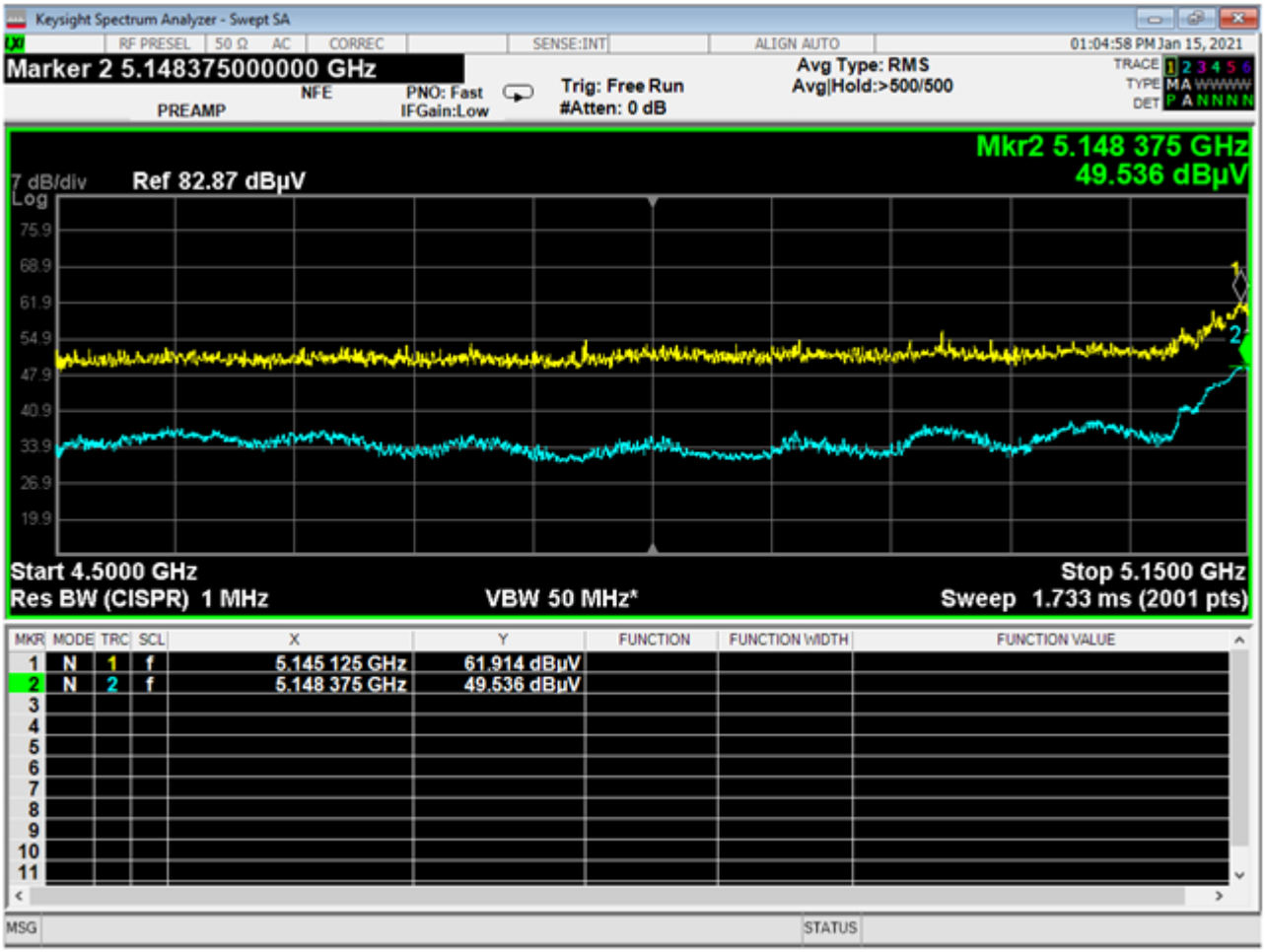
03. Lower Band Edge, Restricted, n, 40 Span, 5.35-5.47GHz, 100CH



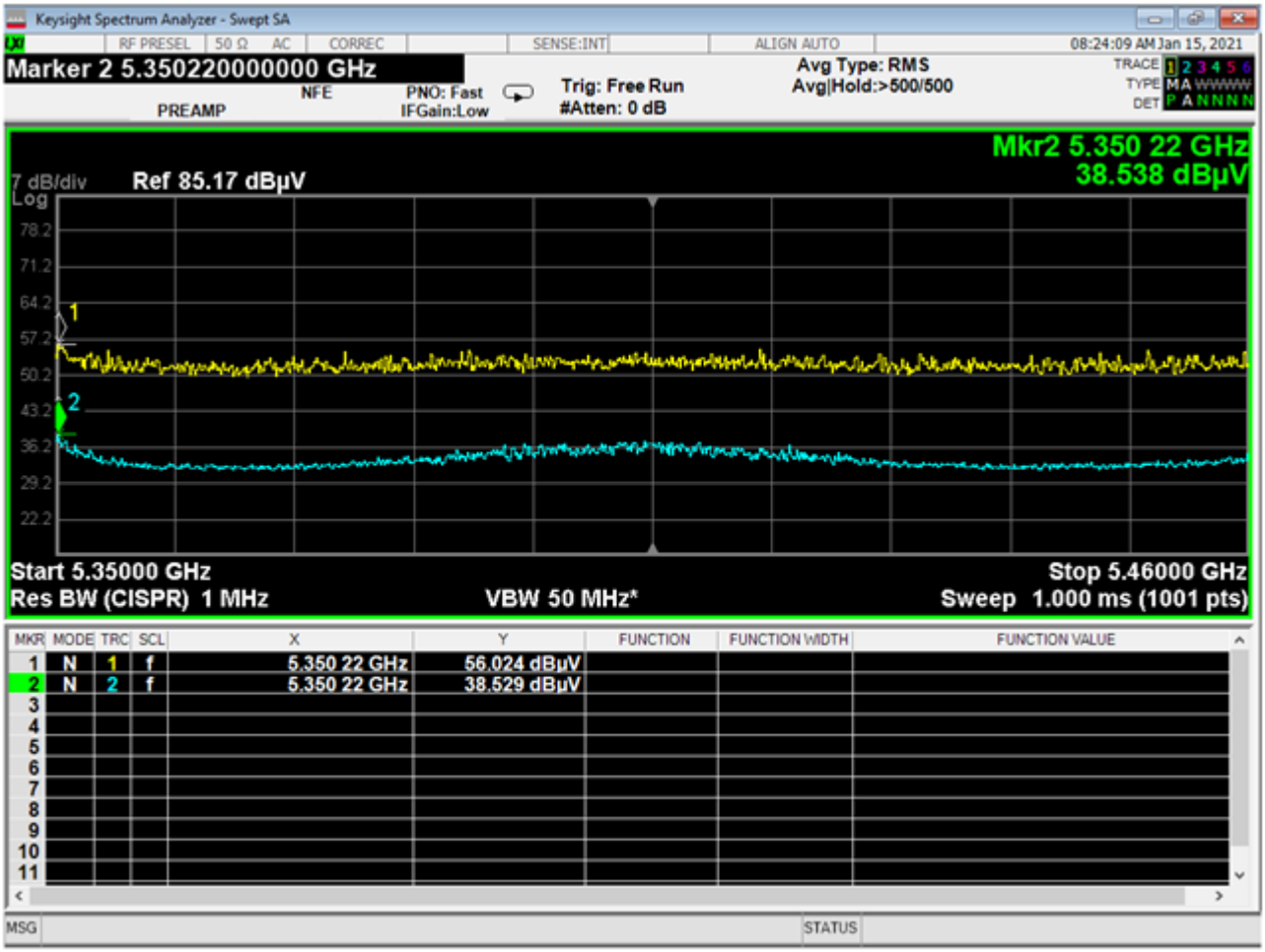
04. Lower Band Edge, Restricted, n, 40 Span, 4.5-5.15GHz, 36CH



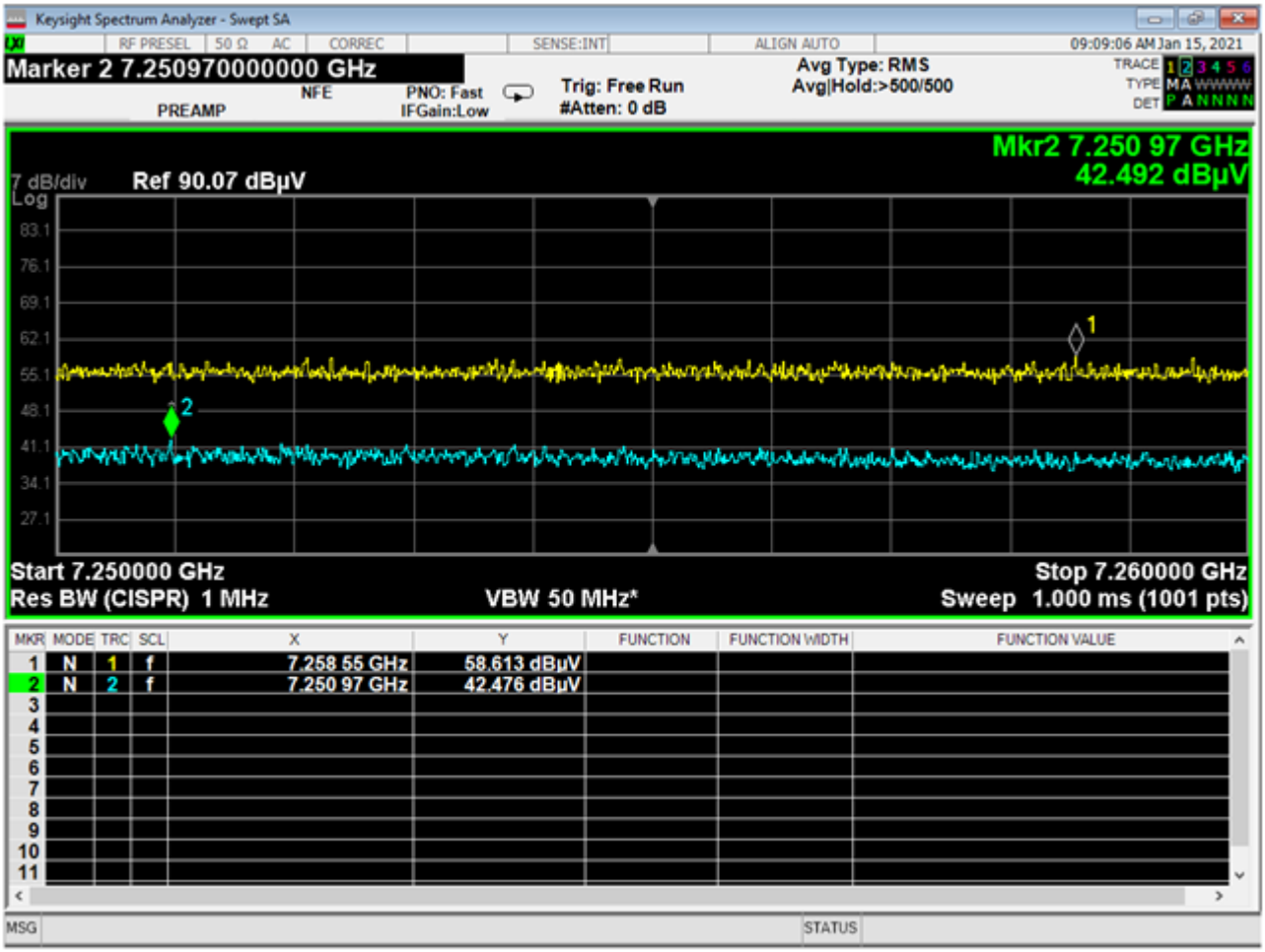
05. Lower Band Edge, Restricted, ac, 80 Span, 5.35-5.47GHz, 104CH



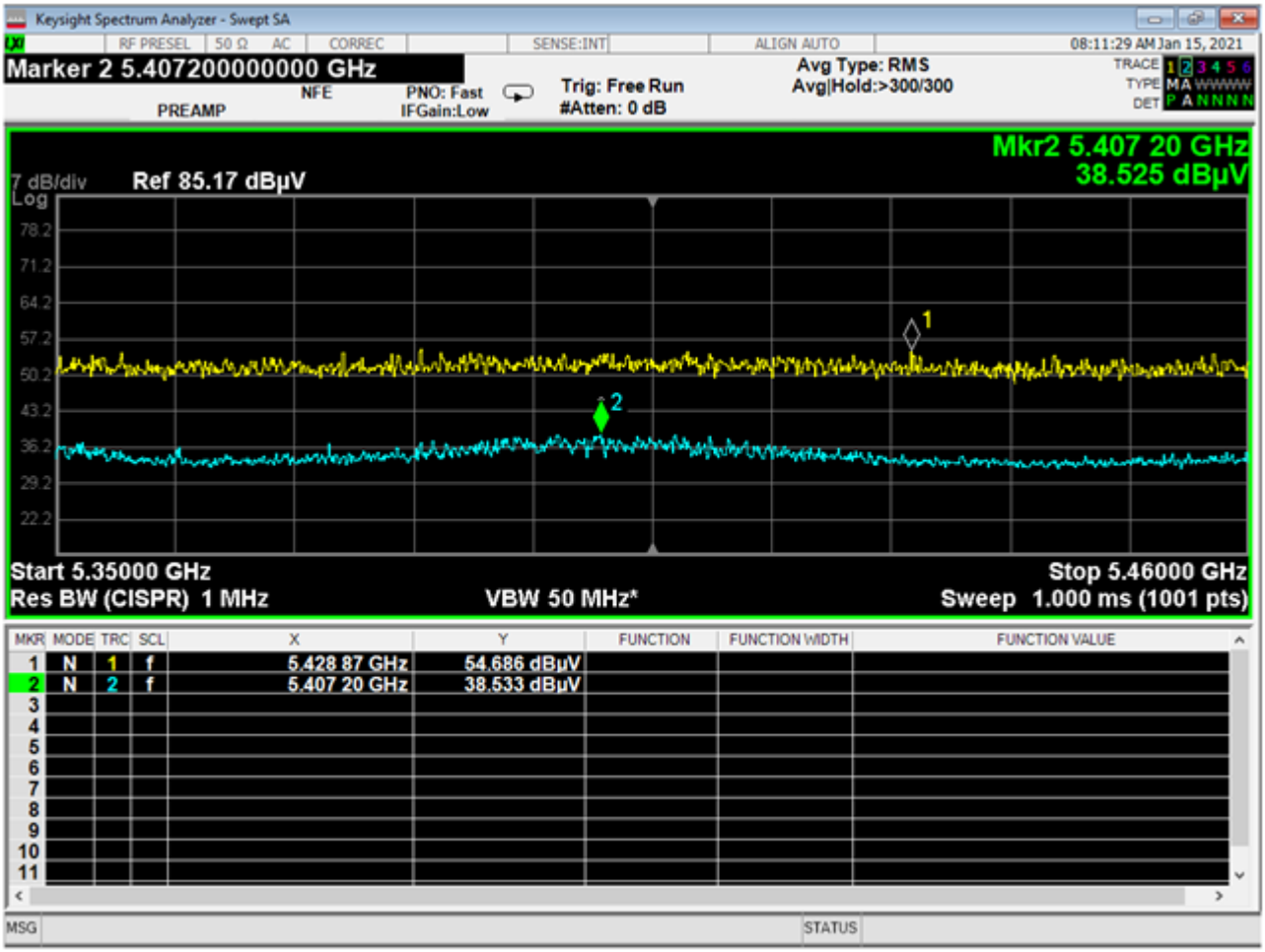
06. Lower Band Edge, Restricted, ac, 80 Span, 4.5-5.15GHz, 40CH



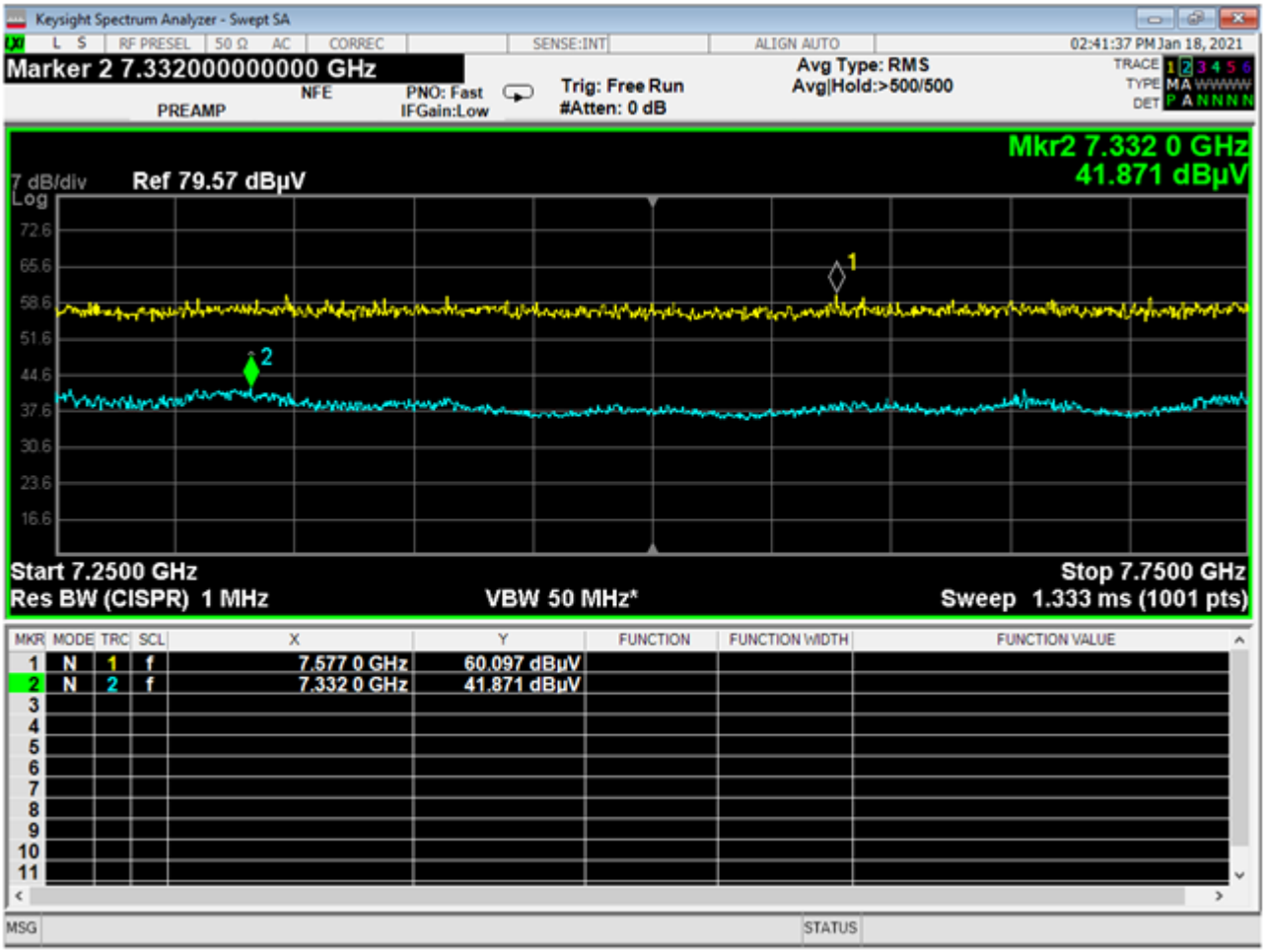
07. Higher Band Edge, Restricted, a, 20 Span, 5.35-5.46GHz, 64CH



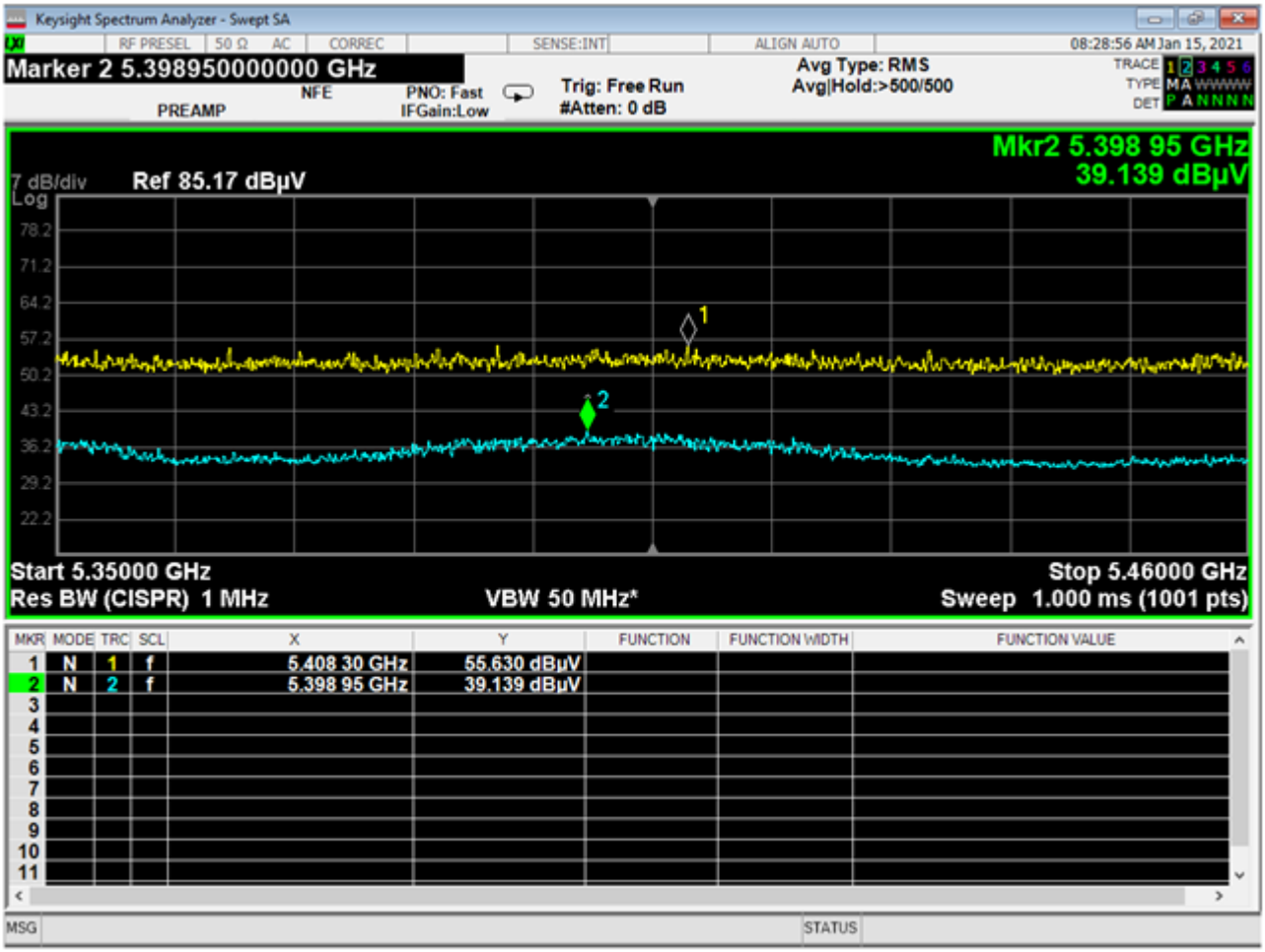
08. Higher Band Edge, Restricted, a, 20 Span, 7.25-7.26GHz, 165CH



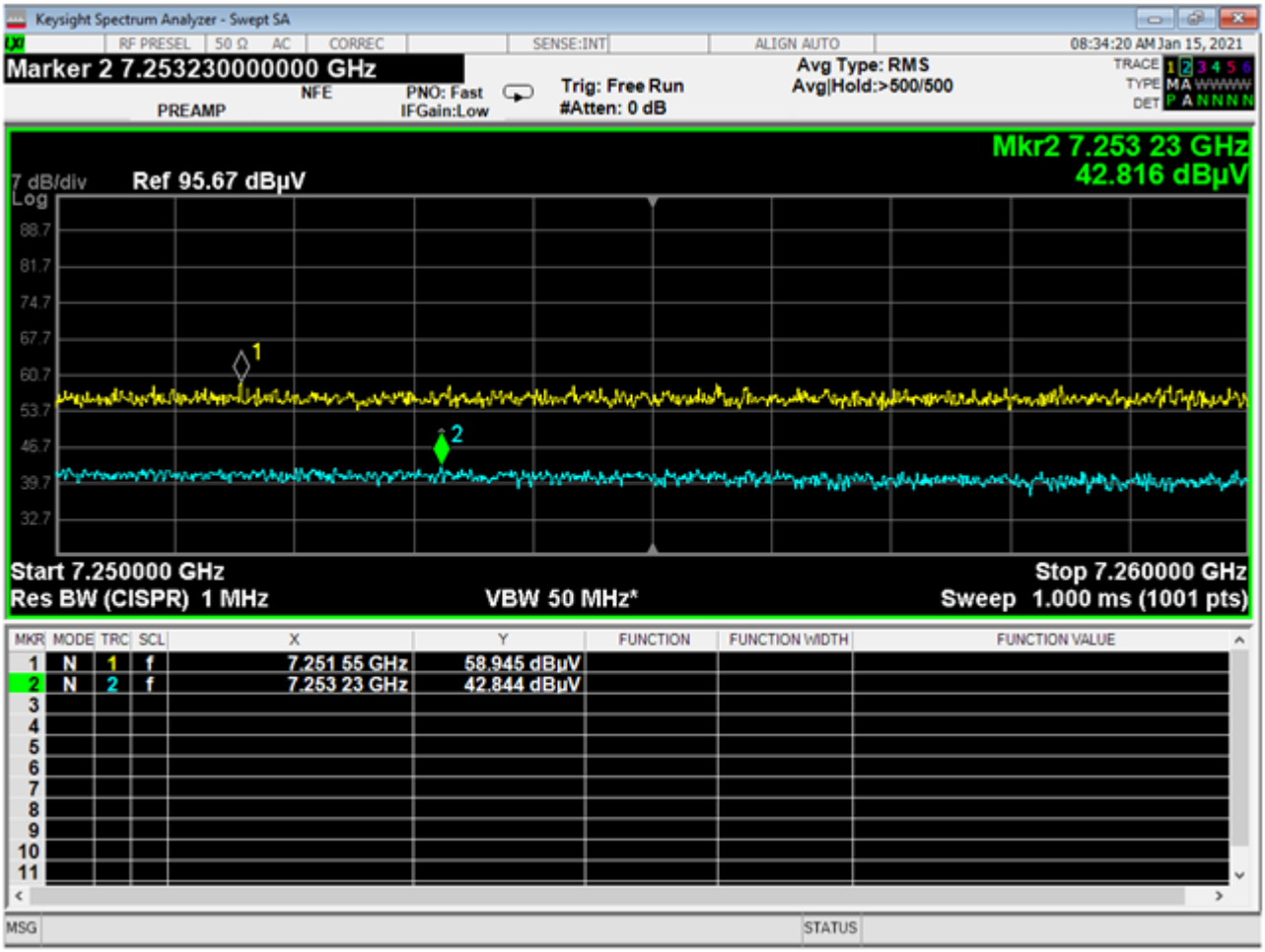
09. Higher Band Edge, Restricted, n, 40 Span, 5.35-5.46GHz, 60CH



10. Higher Band Edge, Restricted, n, 40 Span, 7.25-7.75GHz, 157CH



11. Higher Band Edge, Restricted, ac, 80 Span, 5.35-5.46GHz, 56CH



12. Higher Band Edge, Restricted, ac, 80 Span, 7.25-7.26GHz, 153CH

REPORT END