4740 Discovery Drive | Lincoln, NE 68521
tel- 402.323.6233 | tel -888.657.6860 | fax - 402.323.6238
info@nceelabs.com | http://nceelabs.com

FCC/ISED Test Report

Prepared for: Copper Labs

Address: 3015 STERLING CIR #200,
BOULDER, CO, 80301

Product: Ingot 2

Test Report No: R20200805-20-E1B

Approved by:

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

DATE: 1 February 2021

Total Pages: 41

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TESTING LABORATORY
CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
0	26 January 2021	Original – NJohnson Prepared by KVepuri/FLane
A	28 January 2021	Corrected tables in Section 4, Page 9
B	1 February 2021	Corrected tables in Section 4, Page 9

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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) 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	Pass
FCC Part 15.247(a)(1) RSS-247 Issue 2 Section 5.2	Peak output power	Pass
FCC Part 15.247(a)(1) RSS-247 Issue 2 Section 5.2	Bandwidth	Pass
FCC Part 15.209 RSS-Gen Issue 4, Section 7.1	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.247 (unrestricted) RSS-247 Issue 2 Section 5.5, RSS-Gen Issue 4, Section 8.9	Transmitter Radiated Emissions	Pass
FCC Part 15.247(a)(1) RSS-247 Issue 2 Section 5.2	Power Spectral Density	Pass
FCC Part 15.209, 15.247(d) RSS-247 Issue 2 Section 11.13	Band Edge Measurement	Pass
FCC Part 15.207 RSS-Gen Issue 4, Section 7.1	Conducted Emissions	Pass

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

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	Ingot 2
EUT Received	5 October 2020
EUT Tested	5 October 2020- 28 January 2021
Serial No.	00267; 00311; 00312; Serial numbers assigned by the test lab
Operating Band	2400 MHz – 2483.5 MHz
Device Type	Zig Bee
Voltage	120 VAC/ 60 Hz

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:

For Bluetooth Transmissions:

Channel	Frequency
Low	2405 MHz
Mid	2440 MHz
High	2480 MHz

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

2.3 DESCRIPTION OF SUPPORT UNITS

None

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	April 23, 2019	April 23, 2021
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	May 5, 2020	May 5, 2022
SunAR RF Motion	JB1	A091418	March 6, 2020	March 6, 2021
EMCO Horn Antenna	3115	6415	March 16, 2020	March 16, 2022
EMCO Horn Antenna	3116	2576	March 9, 2020	March 9, 2022
Com-Power LISN 50µH / 250µH - 50Ω	LI-220C	20070017	September 22, 2020	September 22, 2021
Rohde & Schwarz Preamplifier**	TS-PR18	3545700803	April 14, 2020	April 14, 2022
Trilithic High Pass Filter*	6HC330	23042	April 14, 2020	April 14, 2022
MiniCircuits High Pass Filter*	VHF-1320+	15542	April 14, 2020	April 14, 2022
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	April 14, 2020	April 14, 2022
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	April 14, 2020	April 14, 2022
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3874	April 14, 2020	April 14, 2022
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	April 14, 2020	April 14, 2022
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	April 14, 2020	April 14, 2022
N connector bulkhead (control room)*	PE9128	NCEEBH2	April 14, 2020	April 14, 2022
TDK Emissions Lab Software	V11.25	700307	NA	NA

*Internal Characterization

**2 year calibration cycle

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

3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO 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.

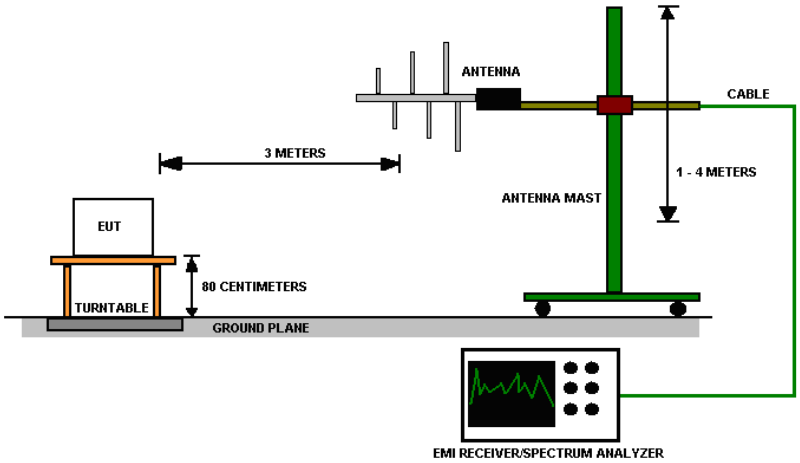


Figure 2 - Radiated Emissions Test Setup

4.0 RESULTS

Radio Measurements										
CHANNEL	Occupied Bandwidth (kHz)	6 dB Bandwidth (kHz)	Peak Corrected EIRP PSD (dBm)	Peak Corrected EIRP Output Power (dBm)	Peak Corrected EIRP Output Power (mW)	RESULT	Cable loss	Antenna Factor	Uncorrected PEAK Output Power (dBm)	Uncorrected PSD (dBm)
Low	2264.00	1647.00	-7.704	7.802	6.028	PASS	5.96	28.39	-38.317	-53.823
Mid	2277.00	1638.00	-5.193	10.899	12.300	PASS	5.89	28.30	-35.063	-51.155
High	2273.00	1637.00	-6.783	8.760	7.516	PASS	6.04	28.45	-37.500	-53.043
6 dB Bandwidth Limit => 500 kHz			Peak Output Power Limit = 30 dBm; PSD Limit = 8 dBm							
*EIRP Calculation = 107 - 95.23 + Corrected Level; Graphs show uncorrected measurements; Corrected EIRP=Uncorrected Level + Cable Loss + Antenna Factor										

Unrestricted Band-Edge									
CHANNEL	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level (dBm)	Relative Fundamental (dBm)	Measurement Type	Delta (dB)	Min Delta (dB)	Result	Cable loss	Antenna Factor
Low	2400.00	-61.92	-7.92	Peak	54.00	20.00	PASS	5.96	28.39
High	2483.50	-53.678*	-6.976*	Peak	46.70	20.00	PASS	6.04	28.45
*Converted from dBuV to dBm(dBm = dBuV - 107); Original plot shows the measurement in dBuV									
Peak and Average Restricted Band-Edge									
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)	Margin	Result	Cable loss	Antenna Factor
Low	ZigBee	2390.00	35.73	Average	53.98	18.25	PASS	5.96	28.39
High	ZigBee	2483.50	50.91	Average	53.98	3.08	PASS	6.04	28.45
Low	ZigBee	2390.00	50.77	Peak	73.98	23.21	PASS	5.96	28.39
High	ZigBee	2483.50	65.44	Peak	73.98	8.54	PASS	6.04	28.45
*Limit shown is the average limit taken from FCC Part 15.209									
**Duty cycle correction added to average levels									

4.1 OUTPUT POWER

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

Limits of power measurements:
For FCC Part 15.247 Device:
The maximum allowed peak output power is 30 dBm.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

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

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

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

4.2 BANDWIDTH

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

Limits of bandwidth measurements:

For FCC Part 15.247 Device:
The 99% occupied bandwidth is for informational purpose only. The 6dB bandwidth of the signal must be greater than 500 kHz.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

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

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

Test results:

Pass

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

4.3 DUTY CYCLE

Test Method:

Max MAC TX Duty Cycle (ON / TOTAL) (all long frames)	66.09%		Represents worst case ZigBee / MAC duty cycle (max on time) for a given frame size
Calculated duty cycle correction factor	3.597685	dB	

*Worst case Duty Cycle as declared by the manufacturer.

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 (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

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:

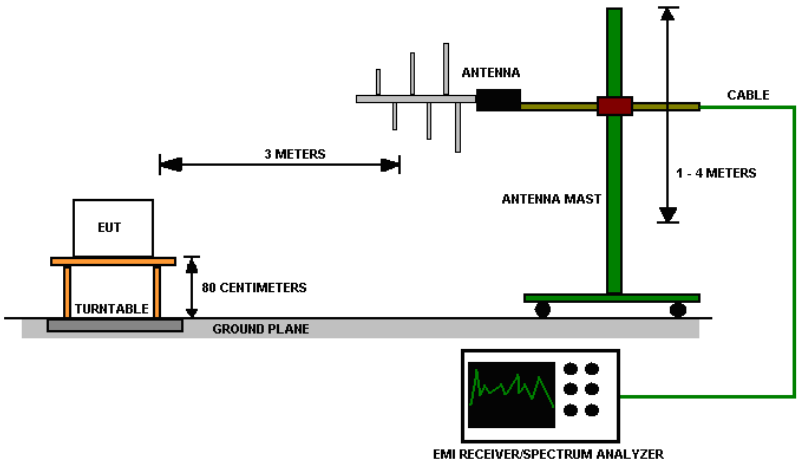


Figure 3 - Radiated Emissions Test Setup

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:

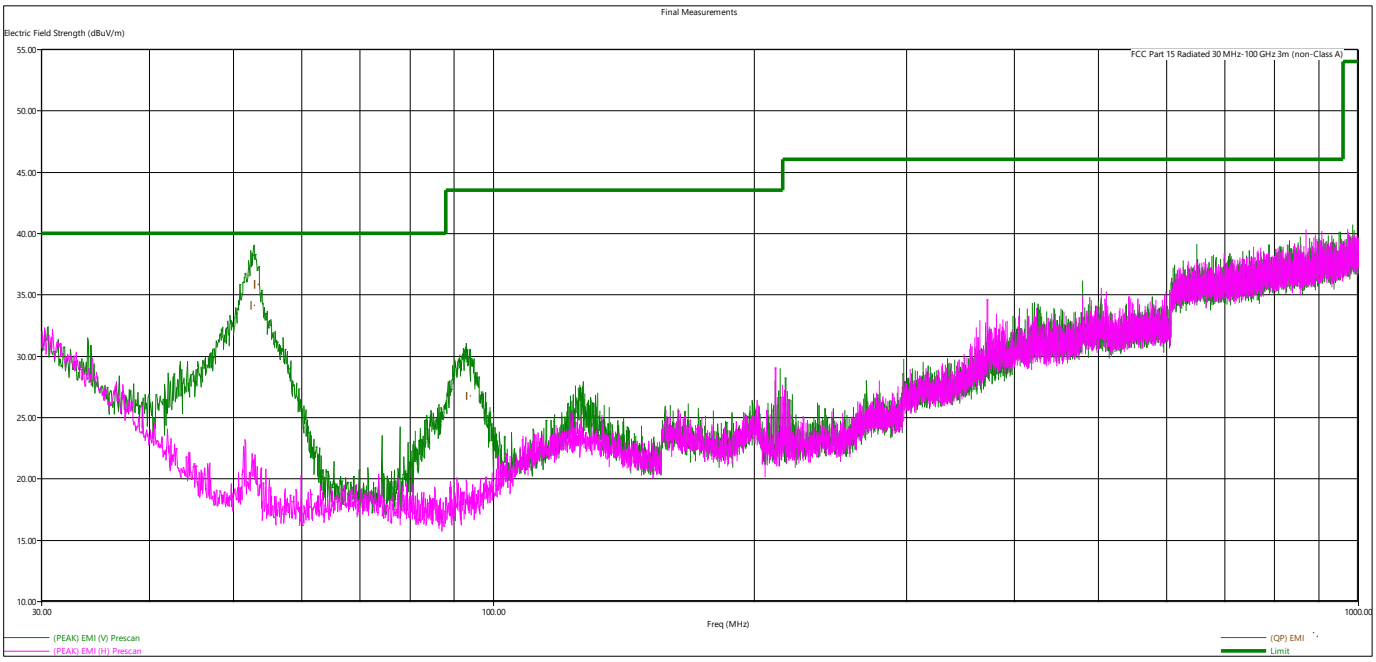


Figure 4 - Radiated Emissions Plot, Receive

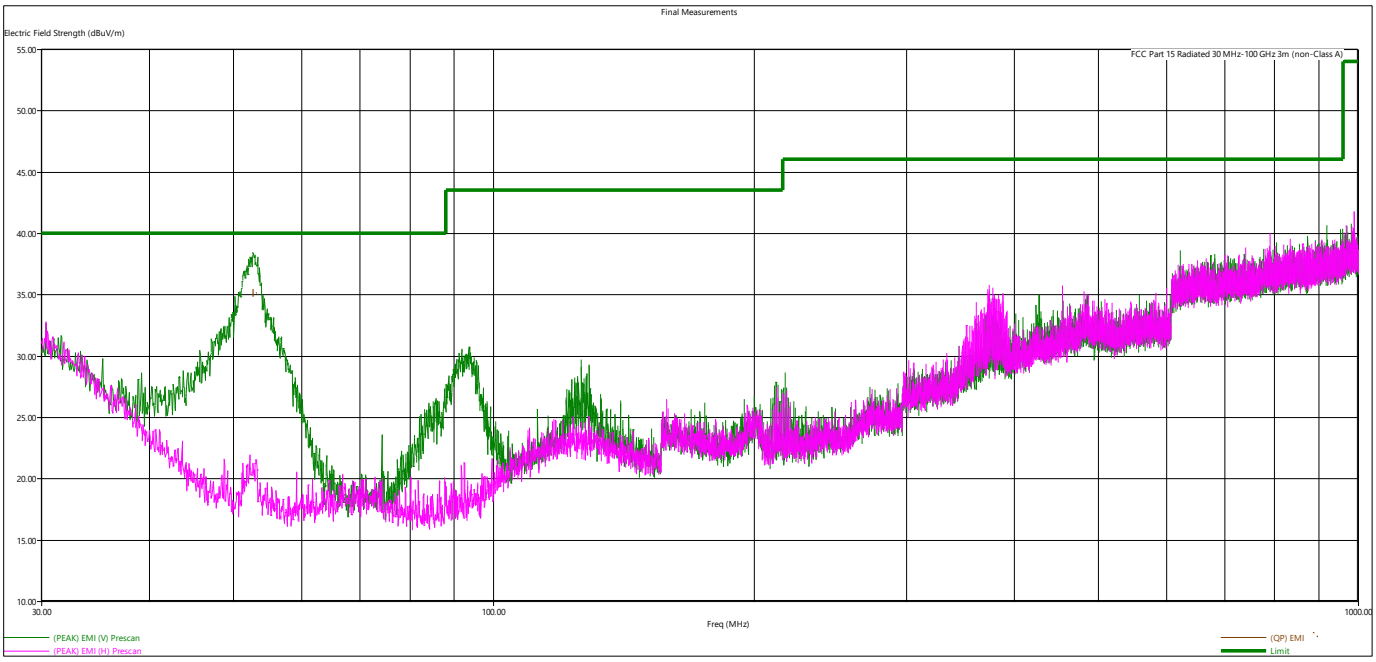


Figure 5 - Radiated Emissions Plot, Low Channel

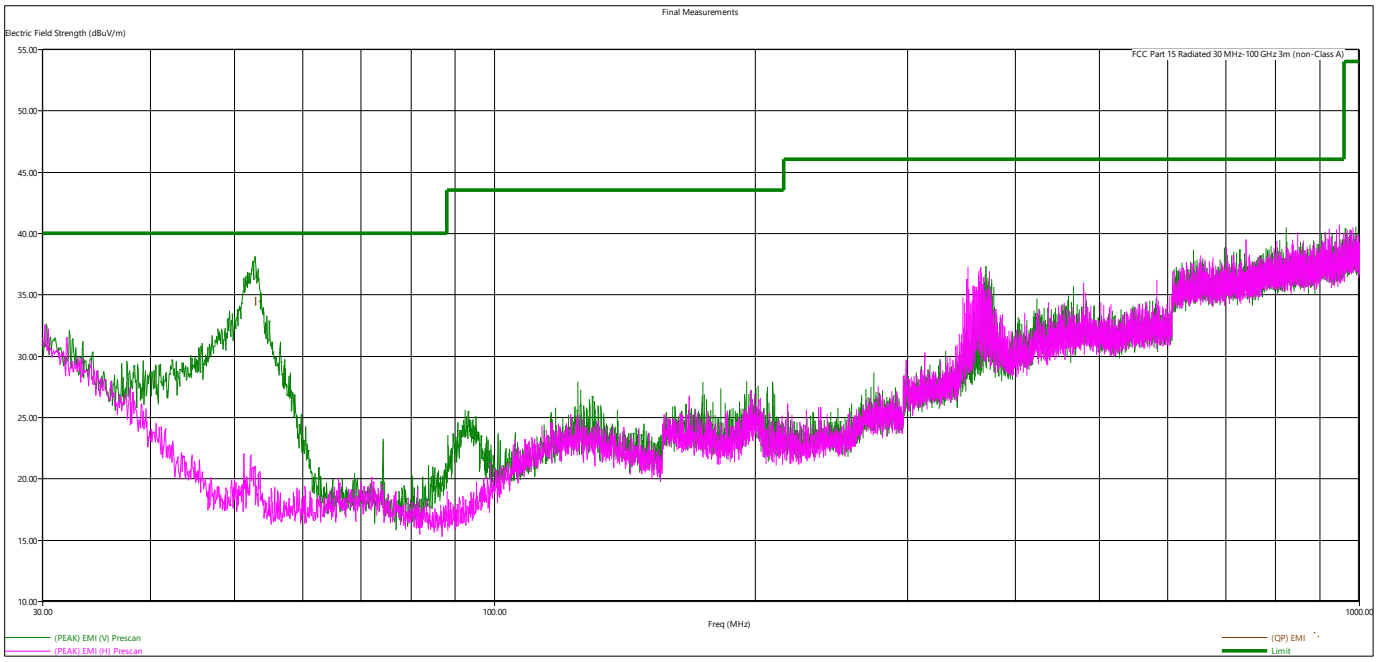


Figure 6 - Radiated Emissions Plot, Mid Channel

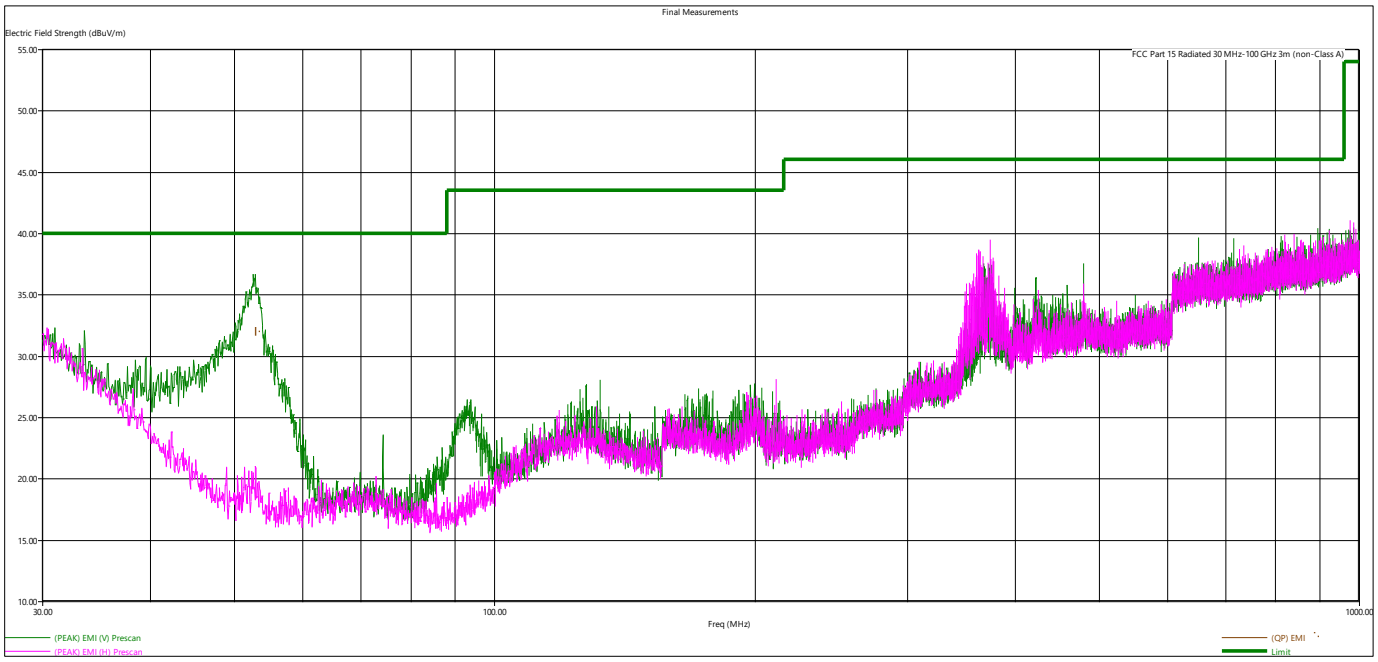


Figure 7 - Radiated Emissions Plot, High Channel

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, GMSK-GFSK								
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Mode
MHz	dBµV/m	dBµV/m	dB	cm.	deg.			
52.372080	34.10	40.00	5.90	109	182	V	Receive	ZigBee
52.850880	35.76	40.00	4.24	108	331	V	Receive	ZigBee
92.986080	26.70	43.52	16.82	112	358	V	Receive	ZigBee
52.705200	35.07	40.00	4.93	114	335	V	Low	ZigBee
52.748640	34.36	40.00	5.64	110	328	V	Mid	ZigBee
52.991520	31.96	40.00	8.04	109	148	V	High	ZigBee

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

Peak Measurements, 1 GHz -25 GHz								
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Mode
MHz	dBµV/m	dBµV/m	dB	cm.	deg.			
2405.468000	104.47	NA	NA	495	22	H	Low	ZigBee
2439.396000	106.48	NA	NA	550	21	H	Mid	ZigBee
2480.498000	109.58	NA	NA	462	24	H	High	ZigBee
4810.888000	62.38	73.98	11.60	161	305	H	Low	ZigBee
4880.950000	60.96	73.98	13.02	431	301	H	Mid	ZigBee
4961.014000	62.93	73.98	11.05	536	308	H	High	ZigBee

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

Average Measurements, 1 GHz -25 GHz								
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Mode
MHz	dBµV/m	dBµV/m	dB	cm.	deg.			
2405.468000	93.99	NA	NA	495	22	H	Low	ZigBee
2439.396000	96.79	NA	NA	550	21	H	Mid	ZigBee
2480.498000	98.06	NA	NA	462	24	H	High	ZigBee
4810.888000	52.36	53.98	1.62	161	305	H	Low	ZigBee
4880.950000	48.43	53.98	5.55	431	301	H	Mid	ZigBee
4961.014000	52.56	53.98	1.42	536	308	H	High	ZigBee

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Note that Duty cycle correction of 3.597 dB from section 4.3 is applied to the average detector measurement. Use of average detector is permitted as the duty cycle of the radio for these tests was 100 percent.

4.5 BAND EDGES

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

Limits of band-edge measurements:

For FCC Part 15.247 Device:
For emissions outside of the allowed band of operation (2400.0MHz – 2480.0MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

Test procedures:

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

Deviations from test standard:
No deviation.

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

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

Test results:
Pass

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

4.6 POWER SPECTRAL DENSITY

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

Limits of power measurements:

For FCC Part 15.247 Device:
The maximum PSD allowed is 8 dBm.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

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

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

Test results:

Pass

Comments:

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

4.7 CONDUCTED AC MAINS EMISSIONS

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

Limits for conducted emissions measurements:

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

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

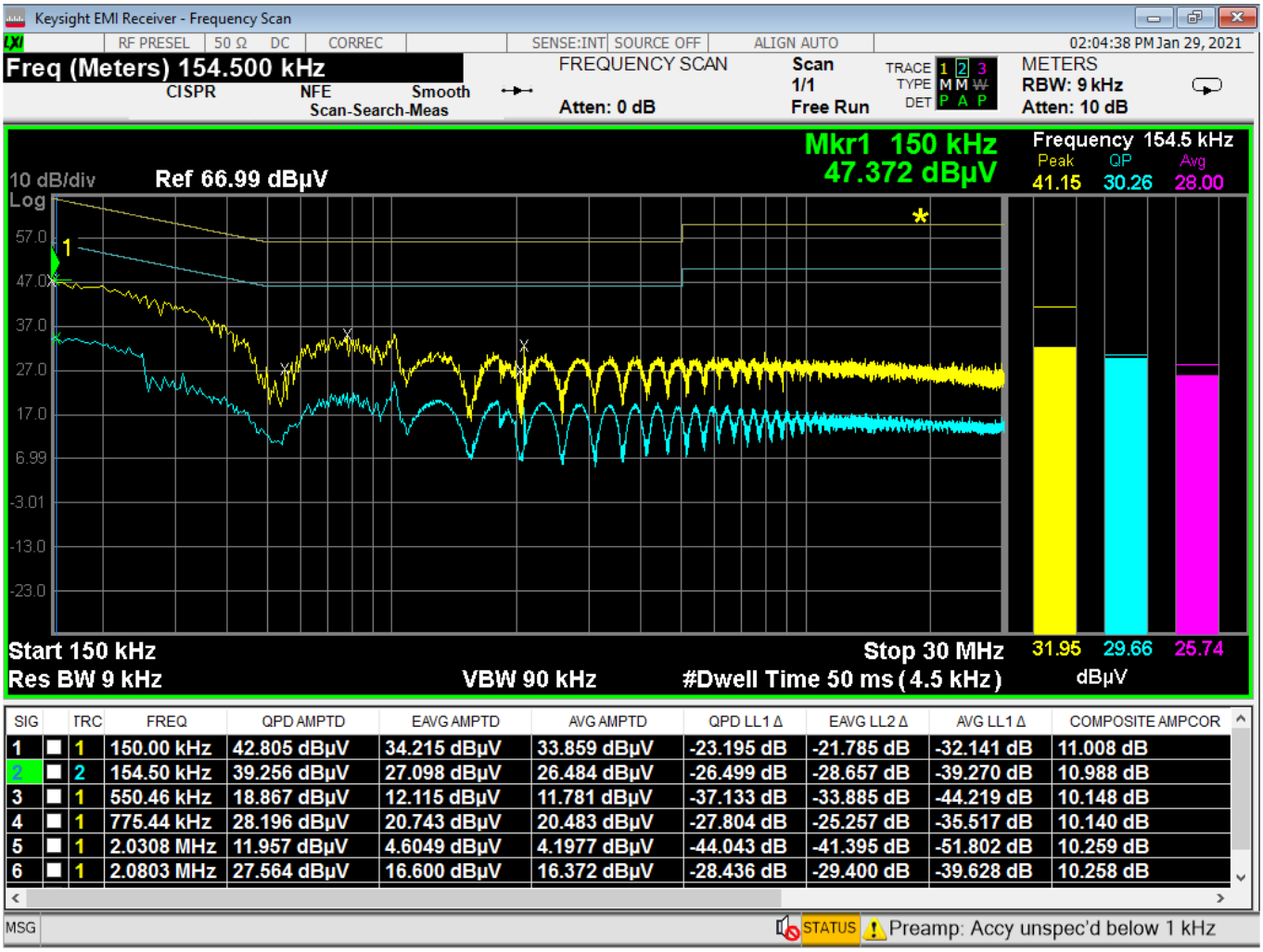
Test Procedures:

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

Deviation from the test standard:
No deviation

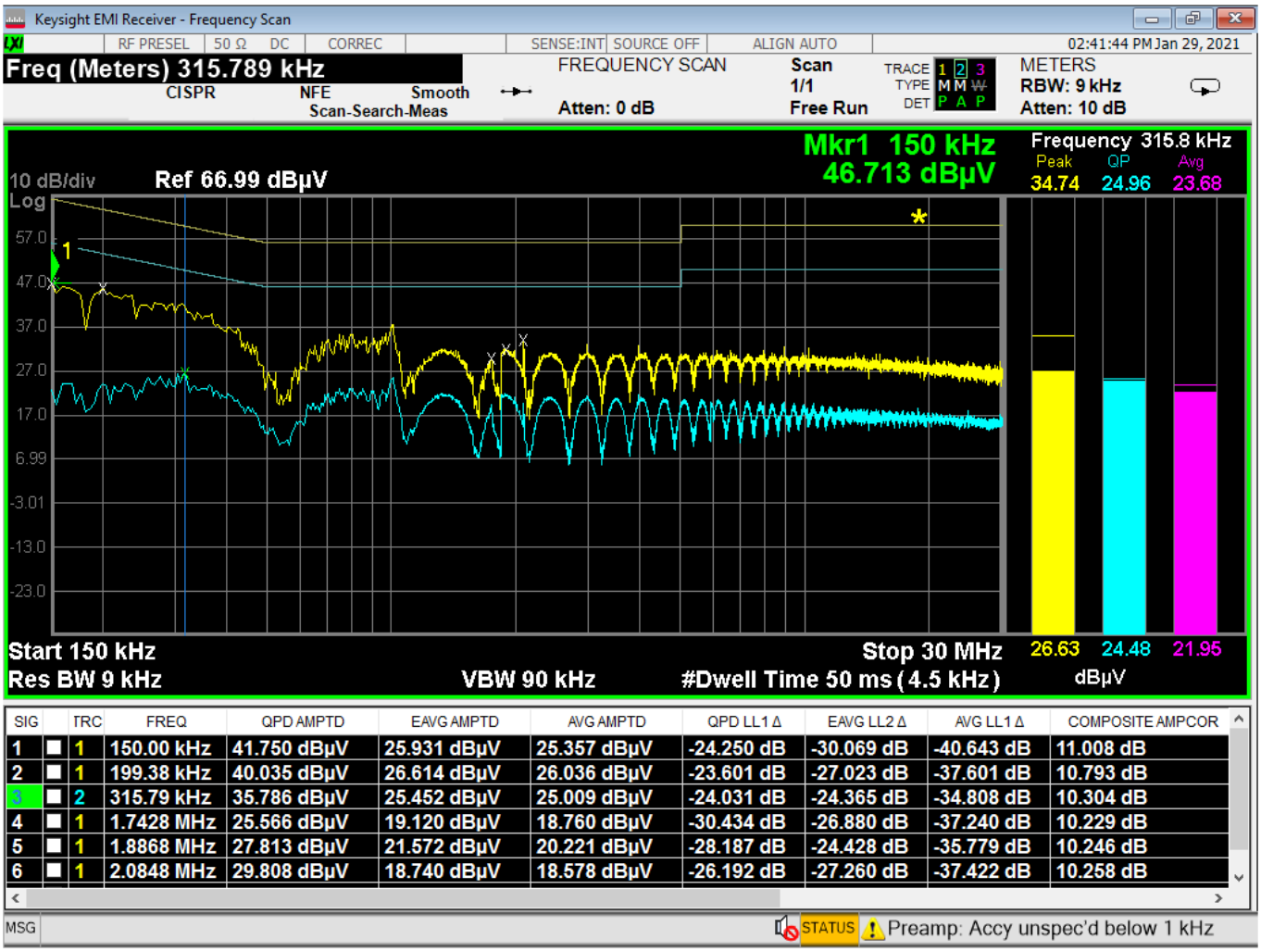
EUT operating conditions:
Details can be found in section 2.1 of this report.
.

Test Results:



SIG		TRC	FREQ	QPD AMPTD	EAVG AMPTD	AVG AMPTD	QPD LL1 Δ	EAVG LL2 Δ	AVG LL1 Δ	COMPOSITE AMPCOR
1	■	1	150.00 kHz	42.805 dBµV	34.215 dBµV	33.859 dBµV	-23.195 dB	-21.785 dB	-32.141 dB	11.008 dB
2	■	2	154.50 kHz	39.256 dBµV	27.098 dBµV	26.484 dBµV	-26.499 dB	-28.657 dB	-39.270 dB	10.988 dB
3	■	1	550.46 kHz	18.867 dBµV	12.115 dBµV	11.781 dBµV	-37.133 dB	-33.885 dB	-44.219 dB	10.148 dB
4	■	1	775.44 kHz	28.196 dBµV	20.743 dBµV	20.483 dBµV	-27.804 dB	-25.257 dB	-35.517 dB	10.140 dB
5	■	1	2.0308 MHz	11.957 dBµV	4.6049 dBµV	4.1977 dBµV	-44.043 dB	-41.395 dB	-51.802 dB	10.259 dB
6	■	1	2.0803 MHz	27.564 dBµV	16.600 dBµV	16.372 dBµV	-28.436 dB	-29.400 dB	-39.628 dB	10.258 dB

Figure 8 - Conducted Emissions Plot, Line



SIG		TRC	FREQ	QPD AMPTD	EAVG AMPTD	AVG AMPTD	QPD LL1 Δ	EAVG LL2 Δ	AVG LL1 Δ	COMPOSITE AMPCOR
1	■	1	150.00 kHz	41.750 dBµV	25.931 dBµV	25.357 dBµV	-24.250 dB	-30.069 dB	-40.643 dB	11.008 dB
2	■	1	199.38 kHz	40.035 dBµV	26.614 dBµV	26.036 dBµV	-23.601 dB	-27.023 dB	-37.601 dB	10.793 dB
3	■	2	315.79 kHz	35.786 dBµV	25.452 dBµV	25.009 dBµV	-24.031 dB	-24.365 dB	-34.808 dB	10.304 dB
4	■	1	1.7428 MHz	25.566 dBµV	19.120 dBµV	18.760 dBµV	-30.434 dB	-26.880 dB	-37.240 dB	10.229 dB
5	■	1	1.8868 MHz	27.813 dBµV	21.572 dBµV	20.221 dBµV	-28.187 dB	-24.428 dB	-35.779 dB	10.246 dB
6	■	1	2.0848 MHz	29.808 dBµV	18.740 dBµV	18.578 dBµV	-26.192 dB	-27.260 dB	-37.422 dB	10.258 dB

Figure 9 - Conducted Emissions Plot, Neutral

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

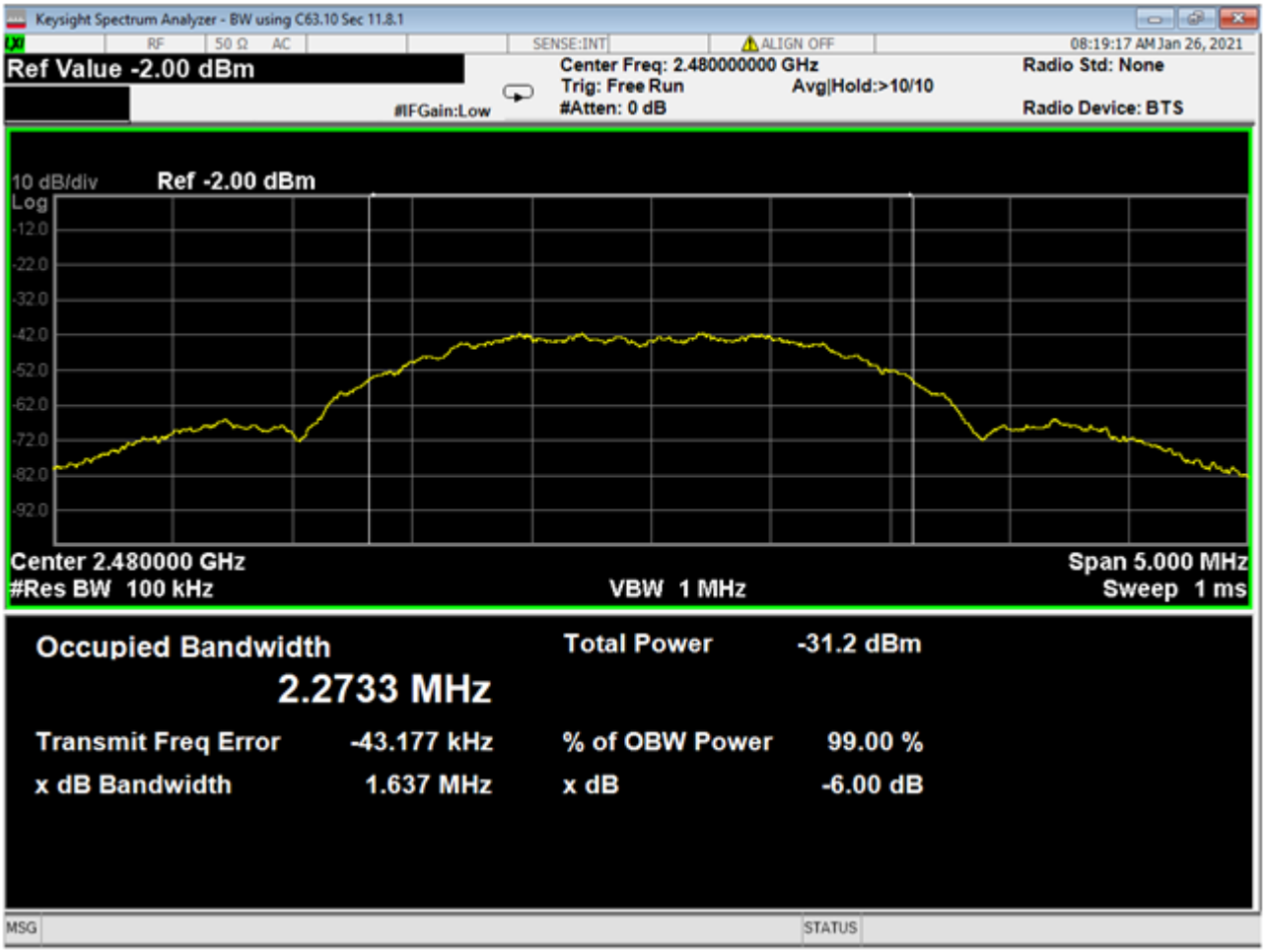
APPENDIX B – MEASUREMENT UNCERTAINTY

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

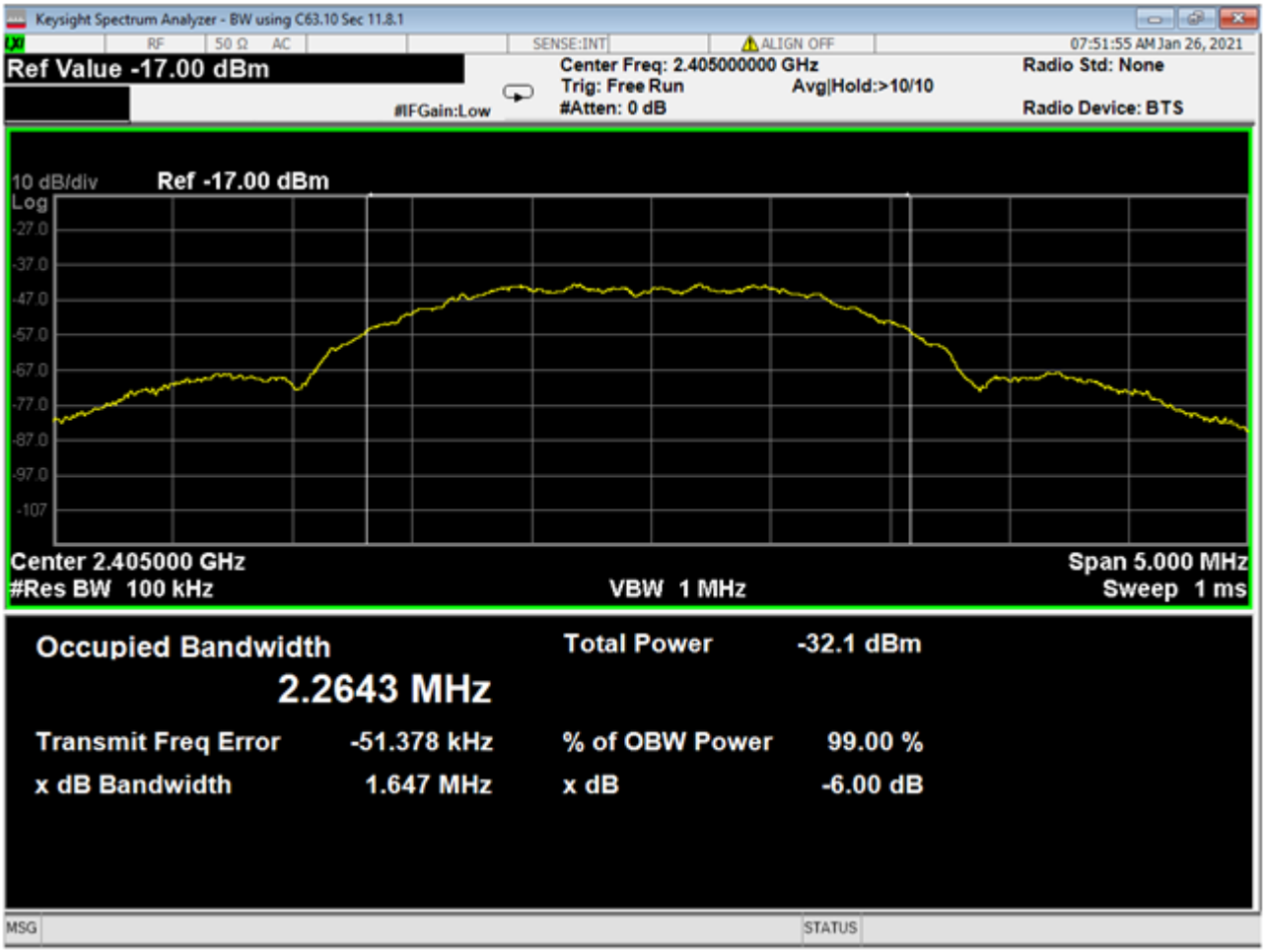
Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	3.82
Radiated Emissions, 3m	1GHz - 18GHz	4.44
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB

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

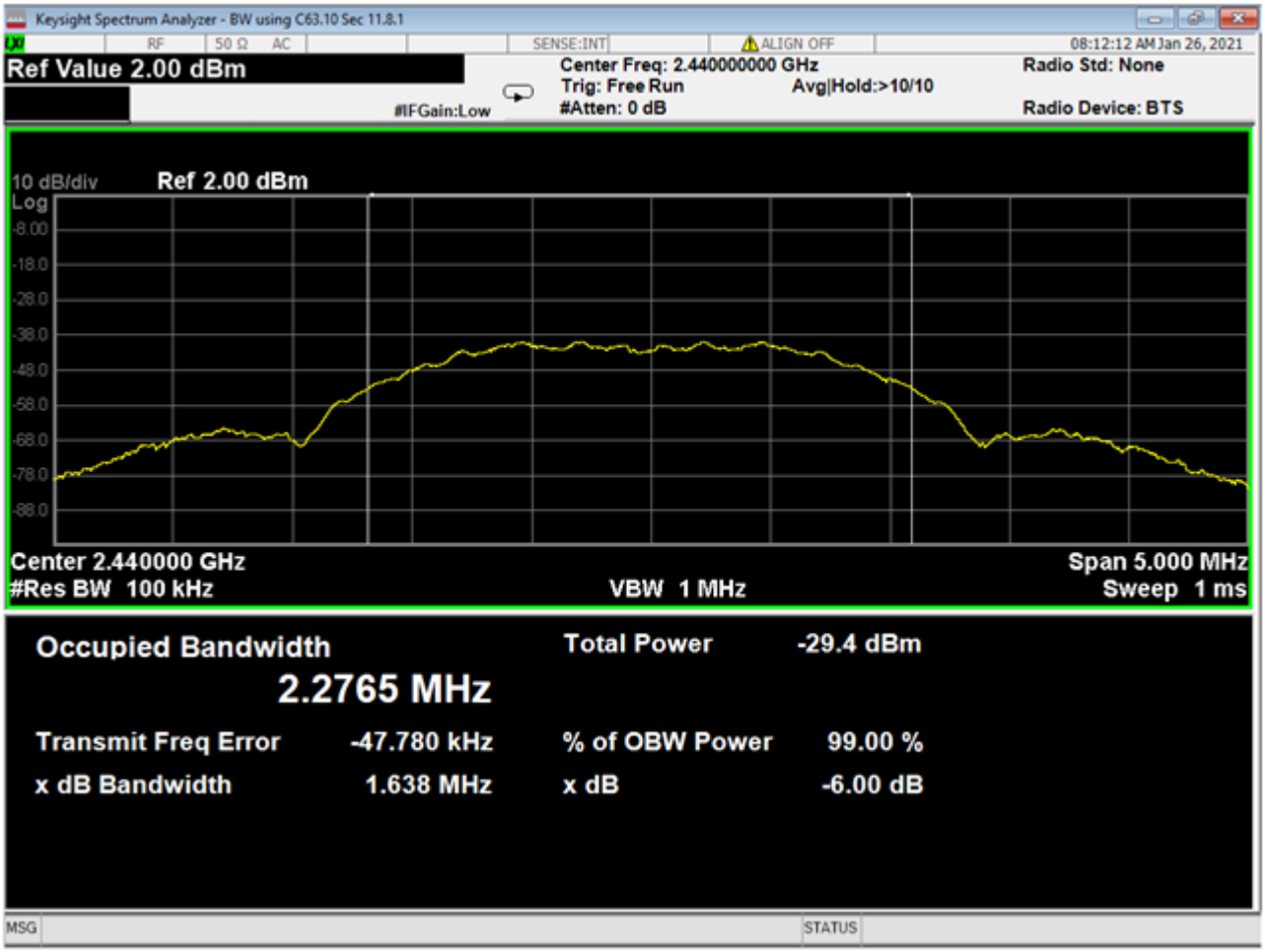
APPENDIX C – GRAPHS AND TABLES



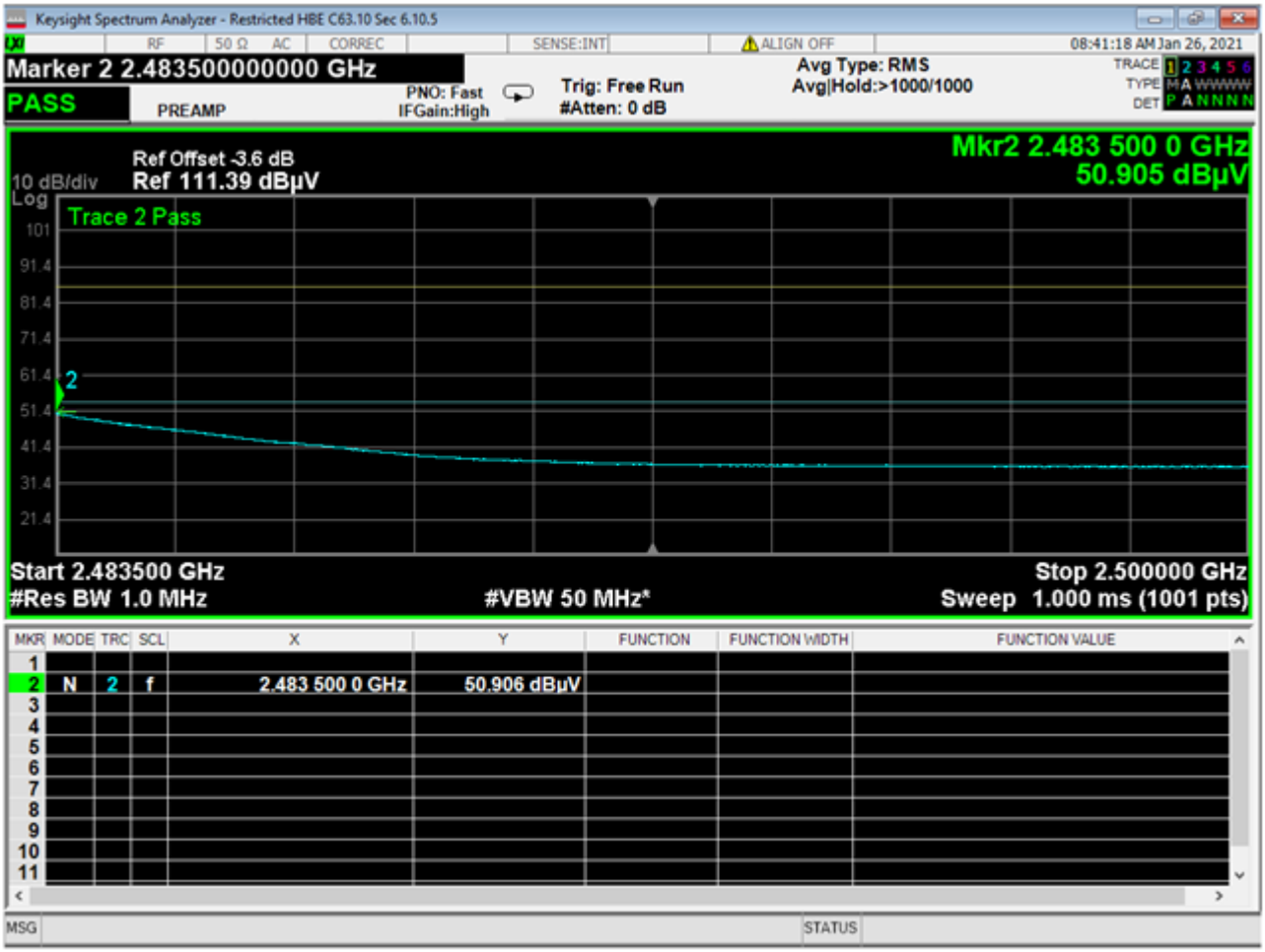
Bandwidth High Channel



Bandwidth Low Channel

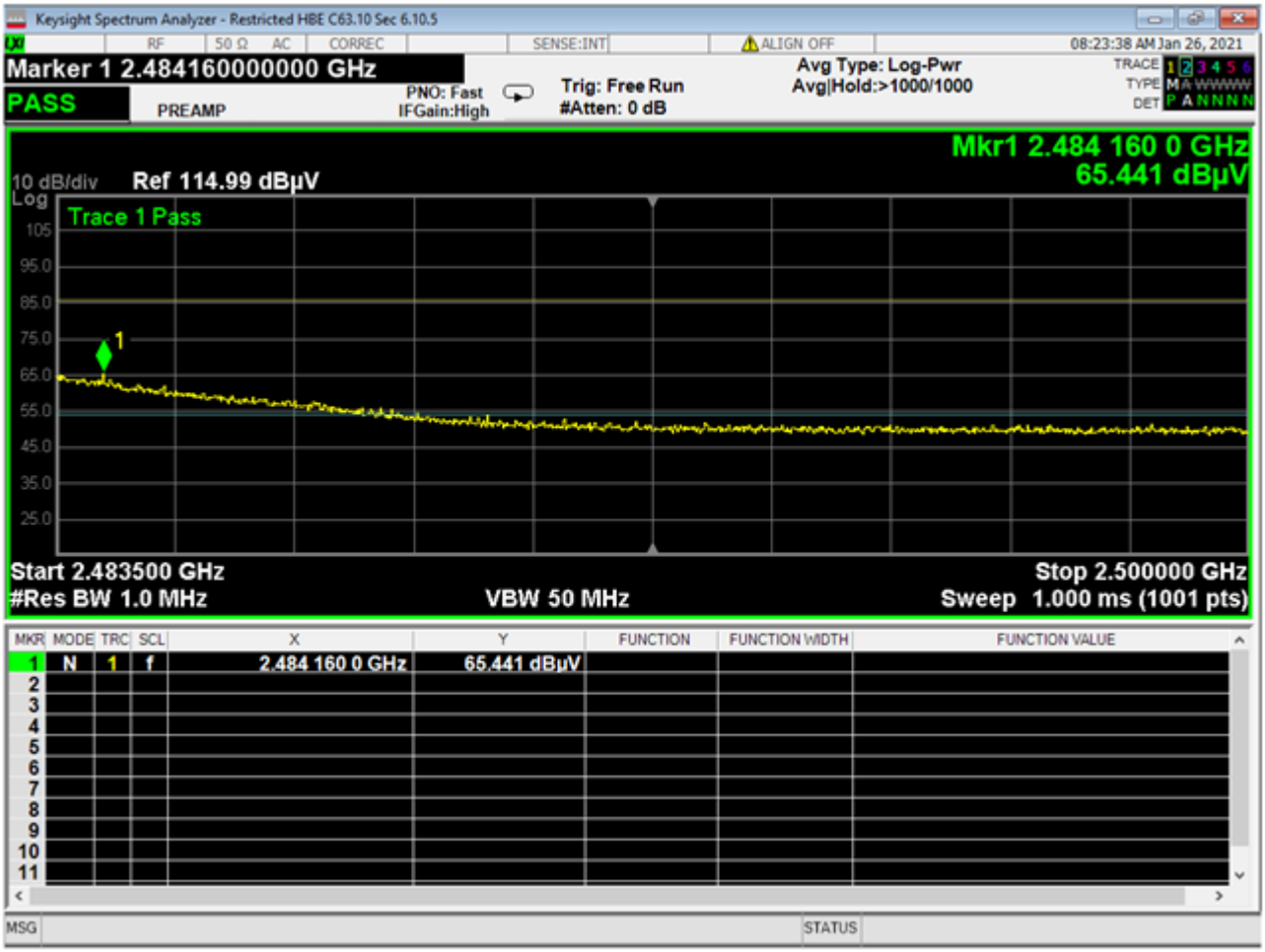


Bandwidth Mid Channel



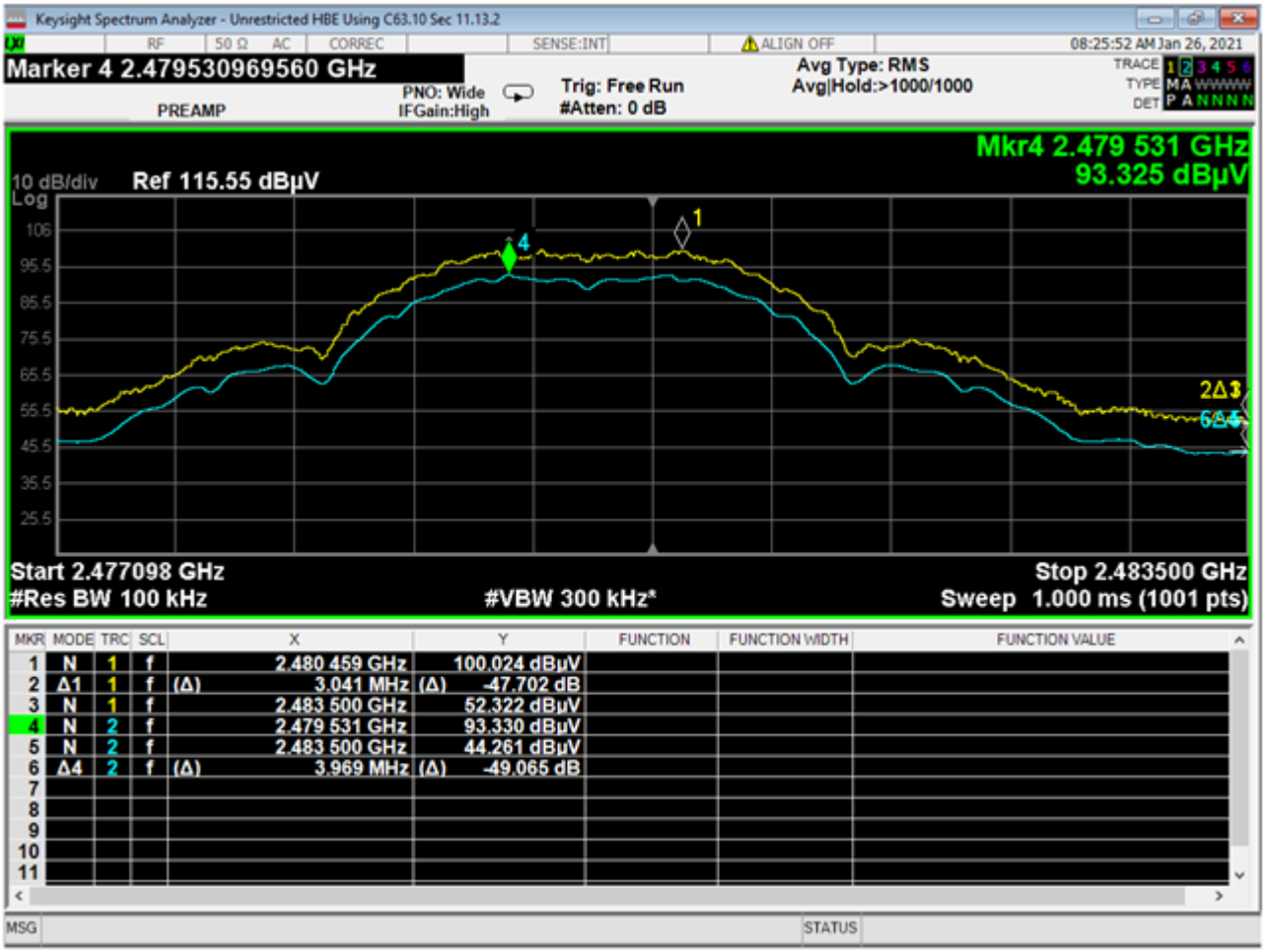
Higher Band Edge Restricted, Average

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Note that Duty cycle correction of 3.597 dB from section 4.3 is applied to the average detector measurement. Use of average detector is permitted as the duty cycle of the radio for these tests was 100 percent. Corrections are included in the graph.



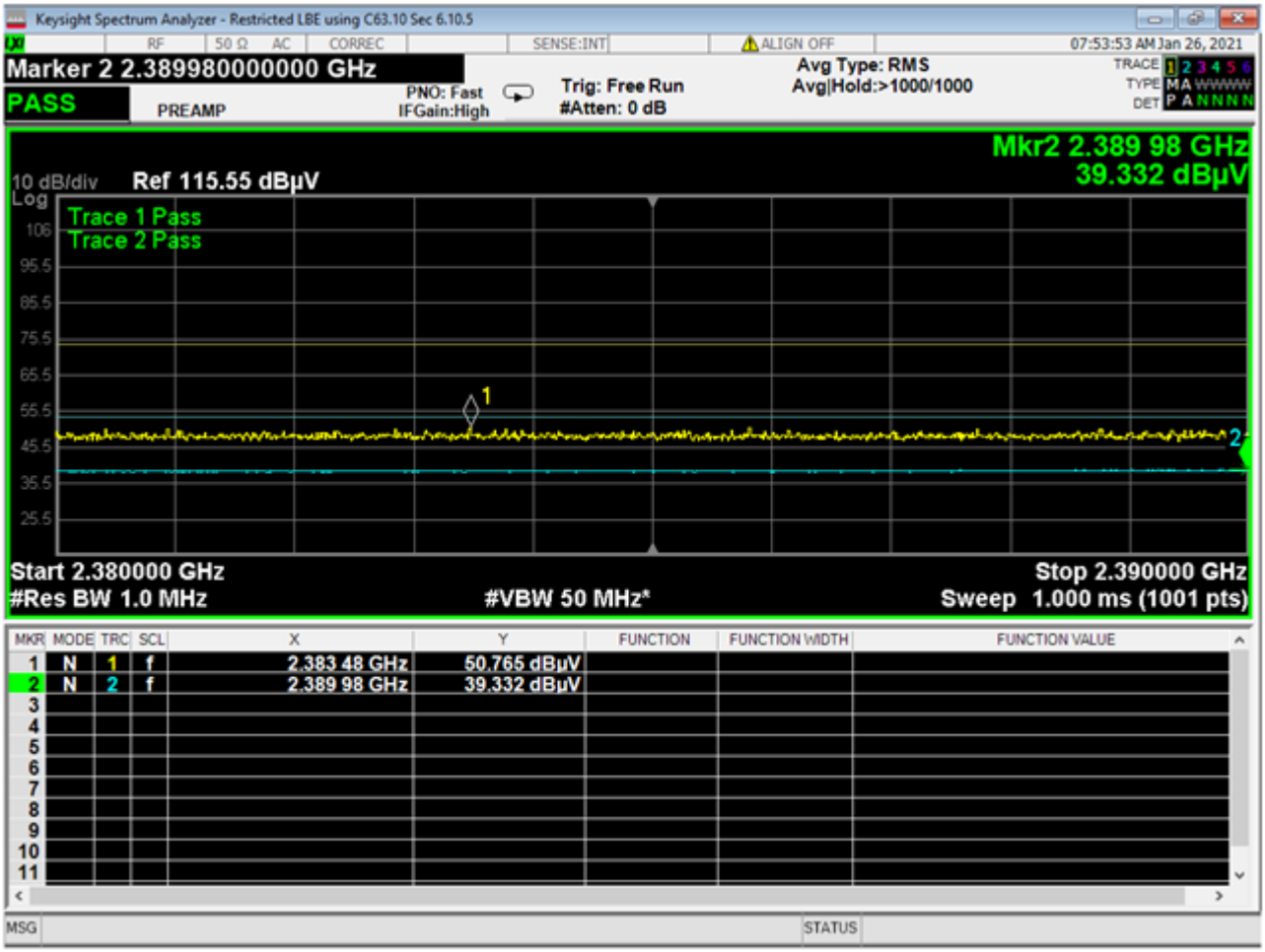
Higher Band Edge Restricted, Peak

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



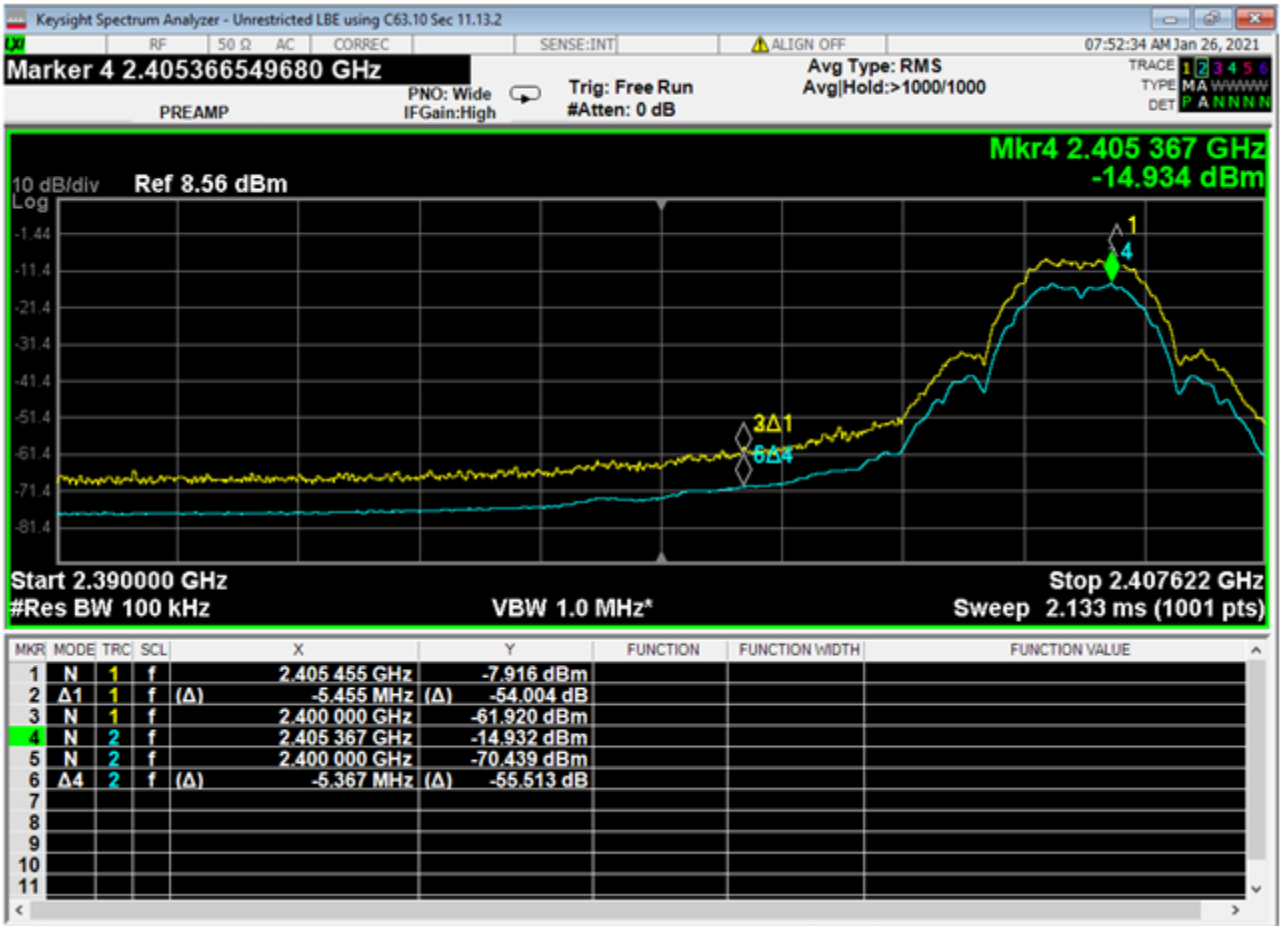
Higher Band Edge Unrestricted

Relative measurements only. Corrected value is shown in the graph.



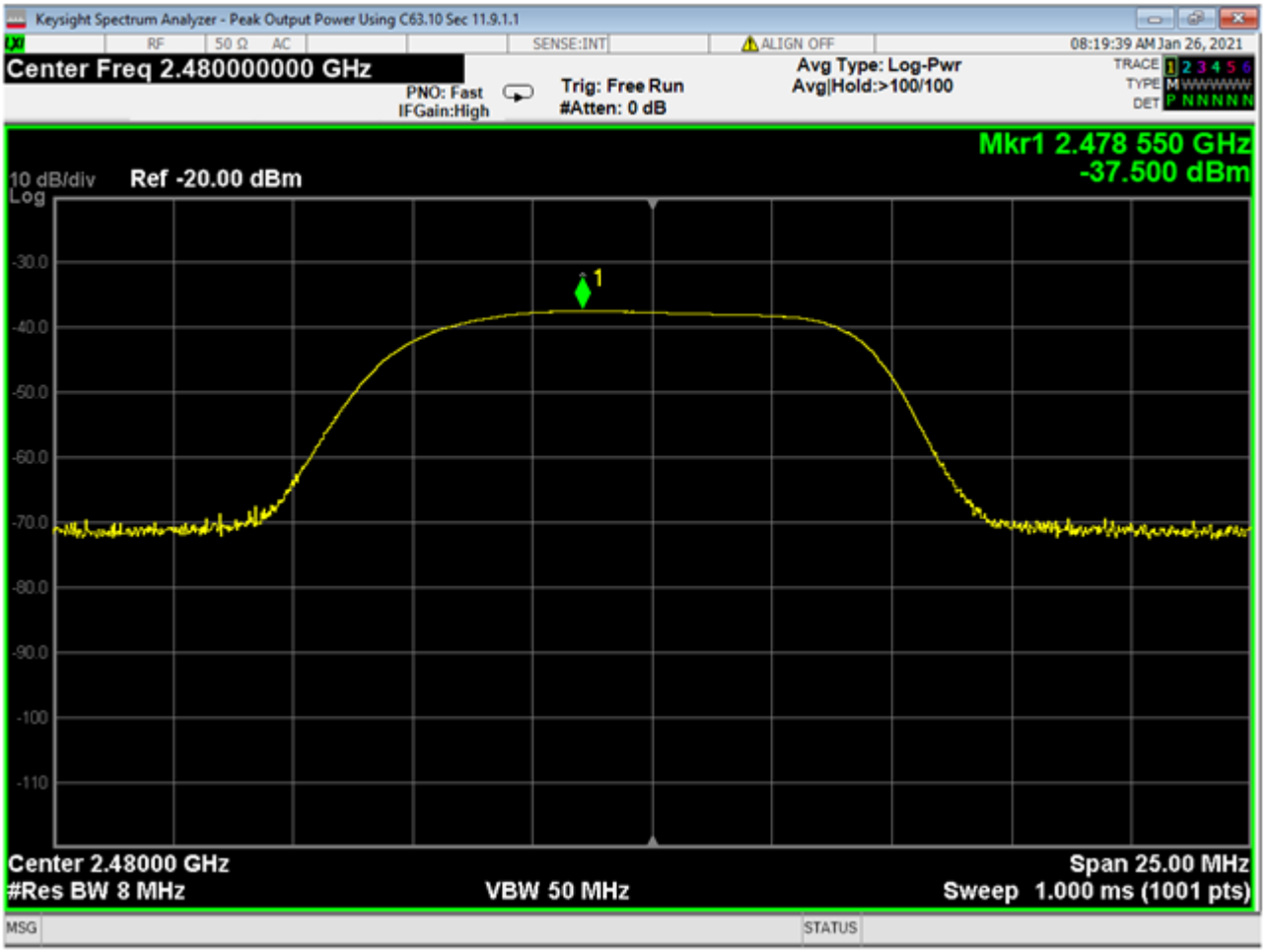
Lower Band Edge Restricted, Peak and Average

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Note that Duty cycle correction of 3.597 dB from section 4.3 is not applied to the average detector measurement. So a correction is applied and reported in section 4.0 Results. Use of average detector is permitted as the duty cycle of the radio for these tests was 100 percent. Corrections are included in the graph.



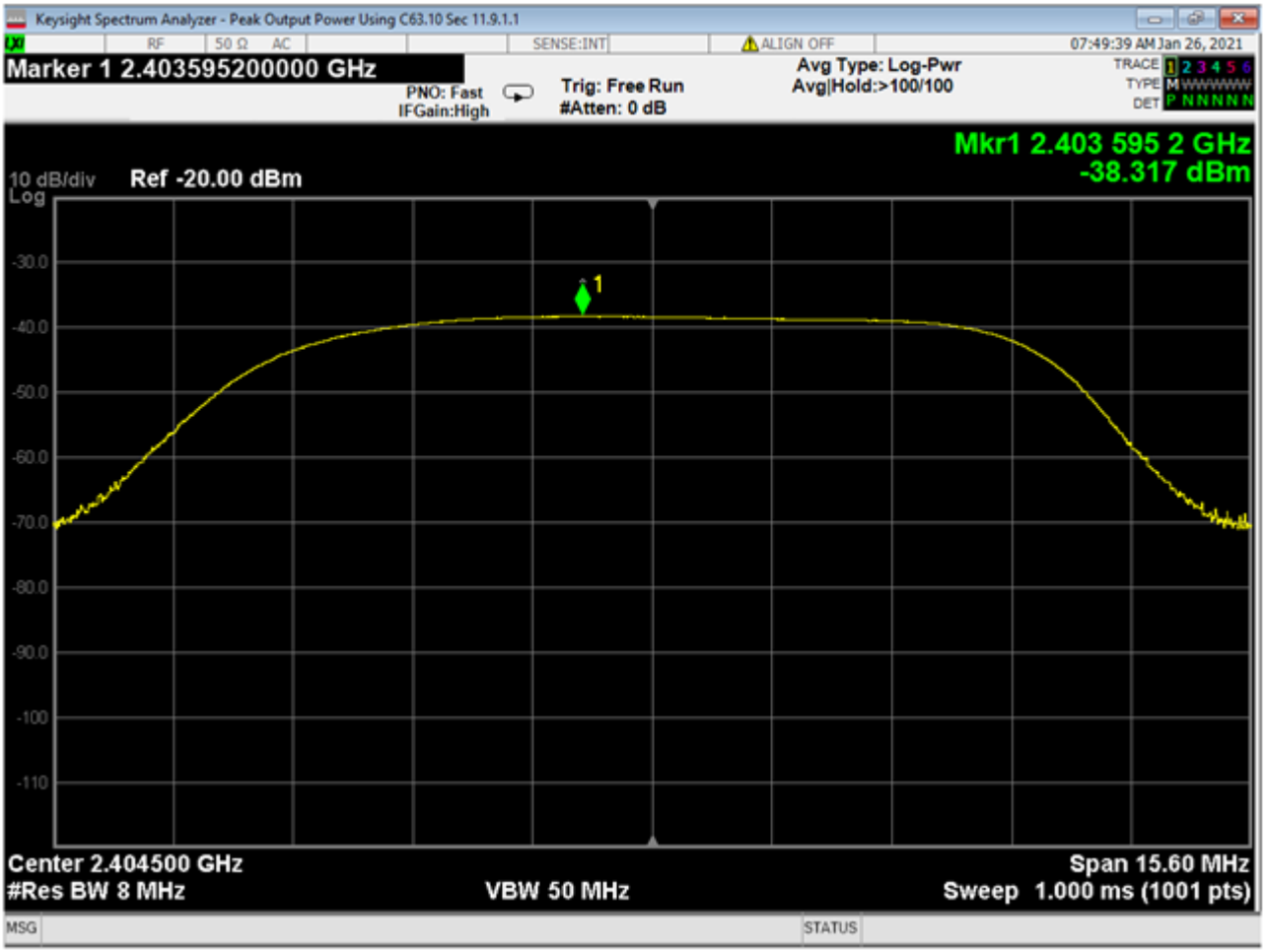
Lower Band Edge Unrestricted

Relative measurements only. Corrected value is shown in the graph.



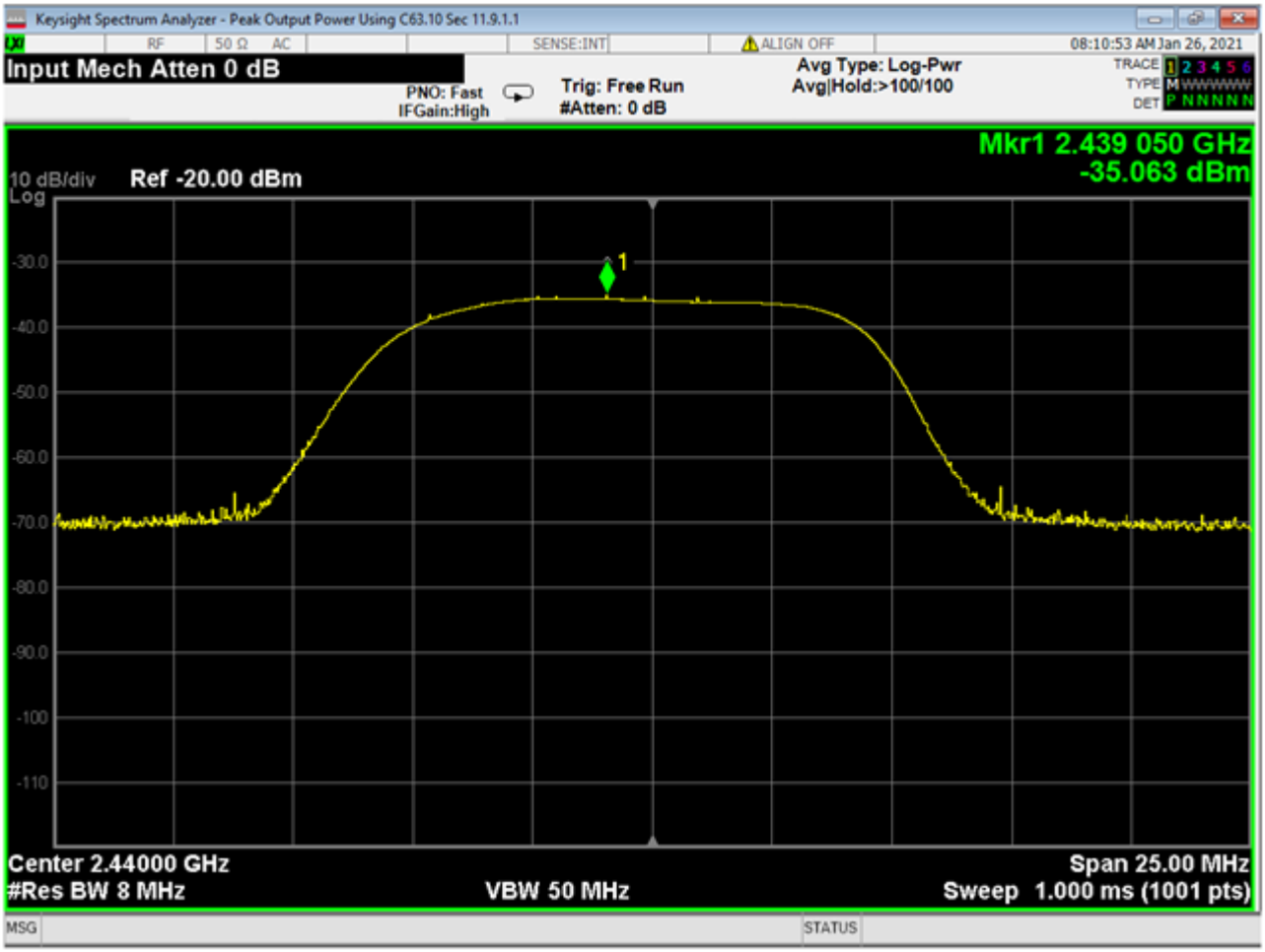
Power High Channel

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Uncorrected value is shown in the graph, corrections and corrected value can be found in section 4.0 of this report.



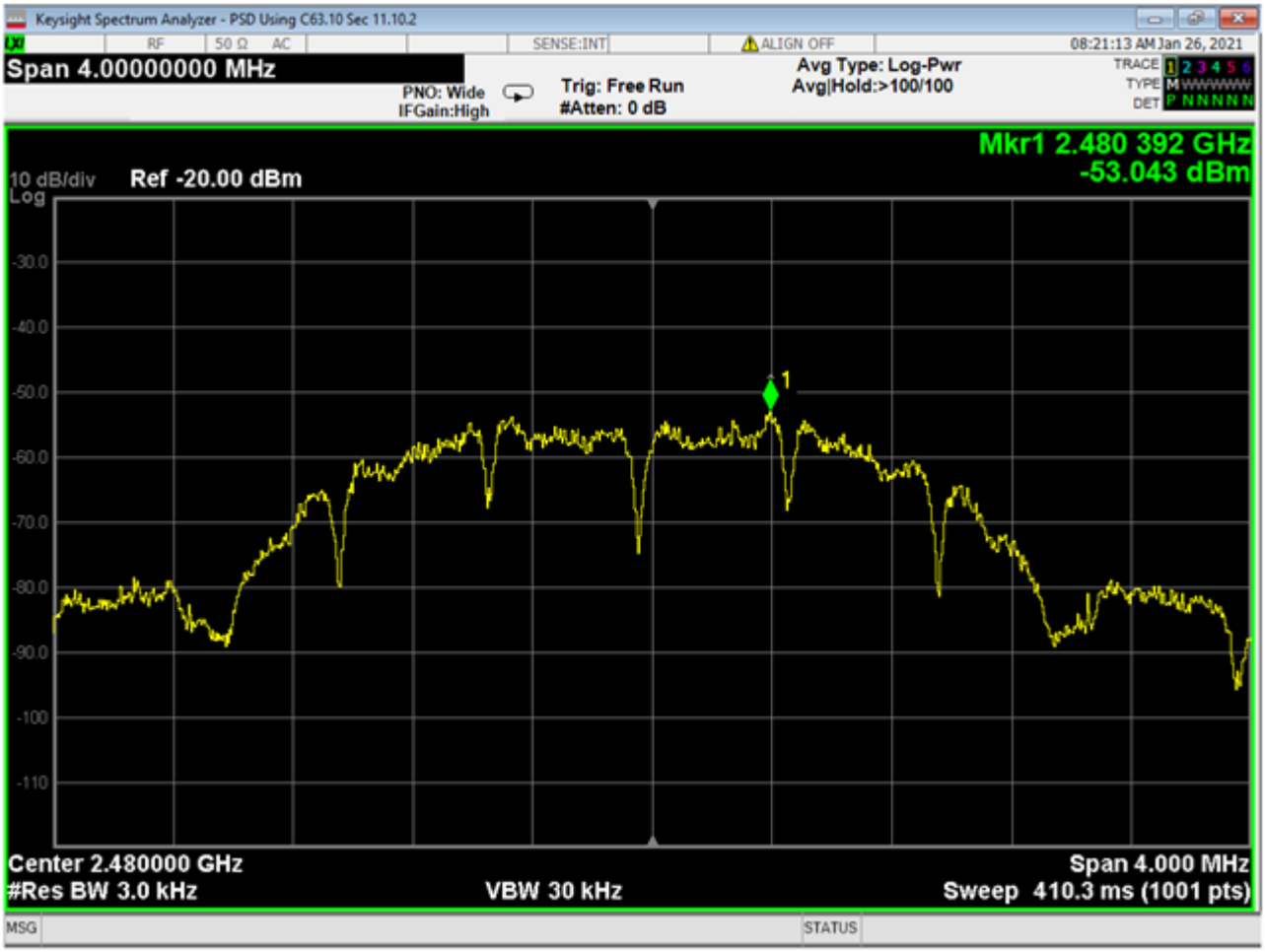
Power Low Channel

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Uncorrected value is shown in the graph, corrections and corrected value can be found in section 4.0 of this report.



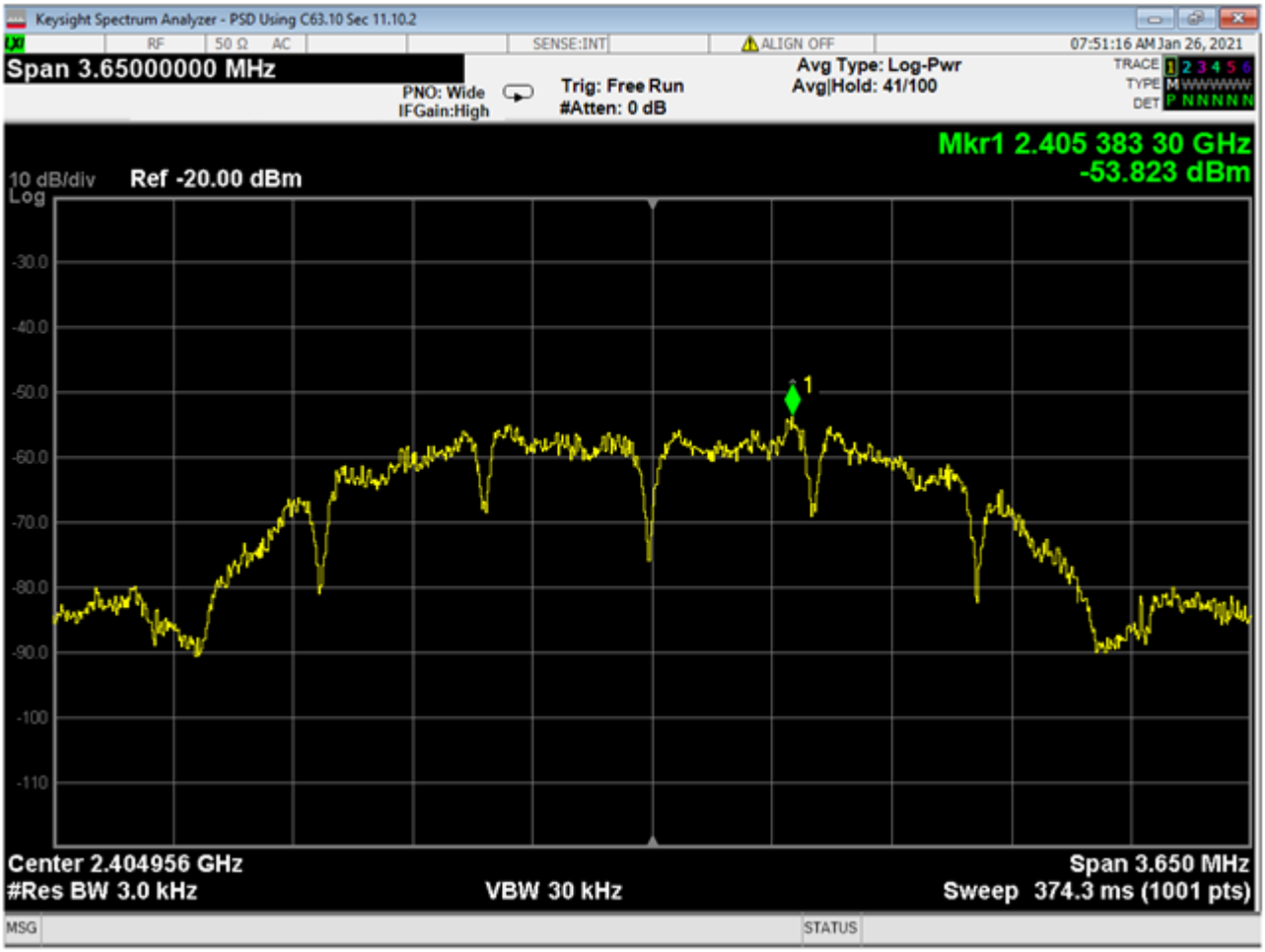
Power Mid Channel

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Uncorrected value is shown in the graph, corrections and corrected value can be found in section 4.0 of this report.



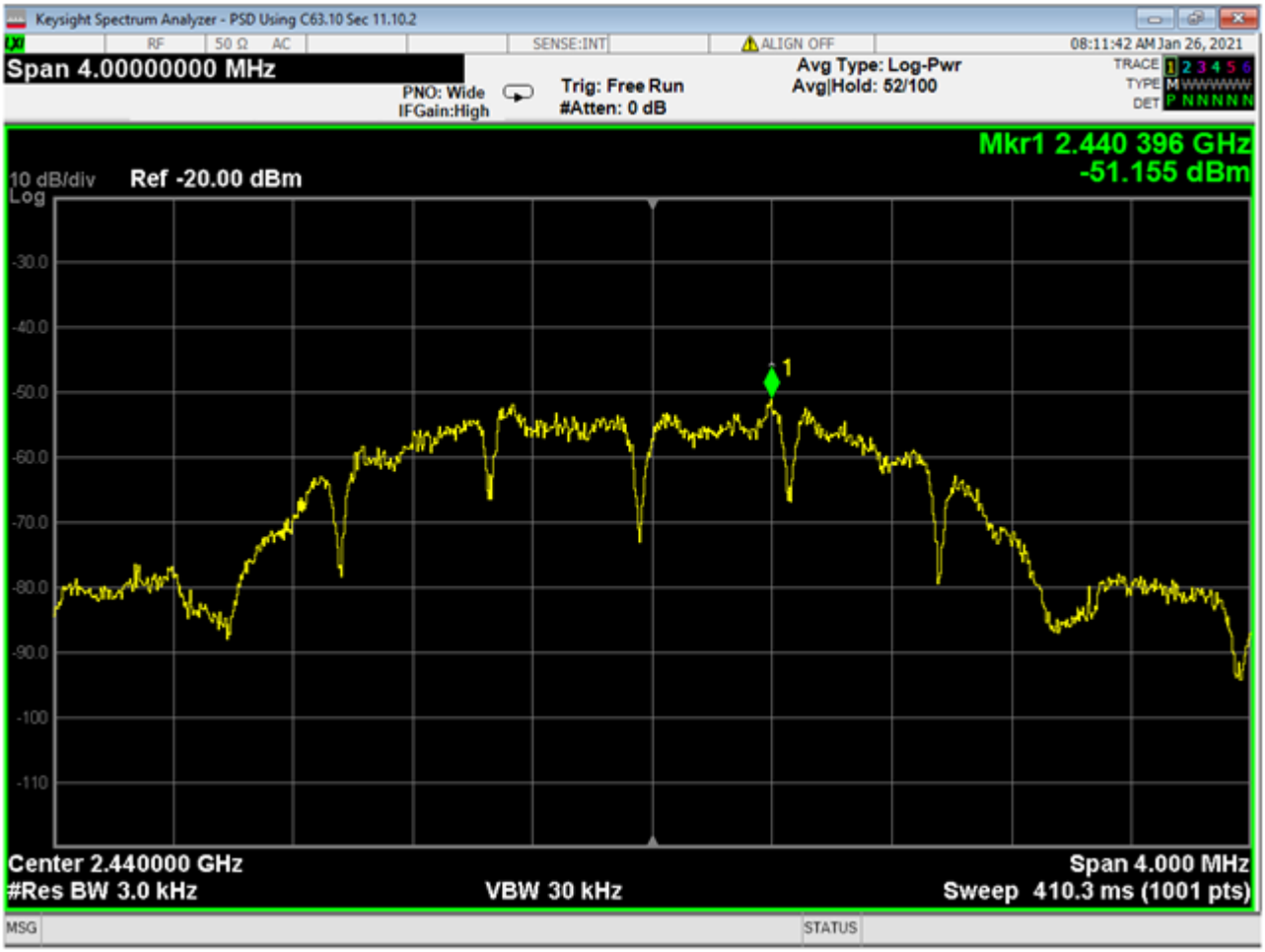
PSD High Channel

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Uncorrected value is shown in the graph, corrections and corrected value can be found in section 4.0 of this report.



PSD Low Channel

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Uncorrected value is shown in the graph, corrections and corrected value can be found in section 4.0 of this report.



PSD Mid Channel

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above. Uncorrected value is shown in the graph, corrections and corrected value can be found in section 4.0 of this report.

REPORT END