ncee labs
Product Compliance Solutions

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FCC Test Report

Prepared for:	**Fireboard Labs LLC**
Address:	**501 Charlotte St Kansas City, MO 64106**
Product:	**FBWP**
FCC ID: **IC ID:**	**2A29A-FBWP24** **27842-FBWP24**
Test Report No:	**R20220216-20-E1**
Approved by:	 **Blake Winter** **EMC Test Engineer** **iNARTE EMC-50662-E**
DATE:	**August 27, 2024**
Total Pages:	**34**

REVISION PAGE

Rev. No.	Date	Description
0	27 August 2024	Issued by BWinter Reviewed by KVepuri Prepared by BWinter

CONTENTS

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 15.247(b)(3)	Peak output power	Pass
FCC Part 15.247(a)(2)	Bandwidth	Pass
FCC Part 15.209	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.247 (unrestricted)	Transmitter Radiated Emissions	Pass
FCC Part 15.247(e)	Power Spectral Density	Pass
FCC Part 15.209, 15.247(d)	Band Edge Measurement	Pass
FCC Part 15.207	Conducted Emissions	Pass

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

Manufacturer	Fireboard Labs LLC
EUT	FBWP
EUT Received	12 July 2024
EUT Tested	15 July 2024- 26 July 2024
Serial No.	A1, NCEE 011943 (for the majority of the radiated measurements) A2, NCEE 011944 (for some harmonics and some radio measurements)
Operating Band	2400 – 2483.5 MHz
Device Type	DTS
Power Supply	USB Power Supply, Fireboard AD568, SN NCEE 011887

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

2.2 DESCRIPTION OF TEST MODES

The following channels were tested:

Channel	Frequency
Low	2402MHz
Mid	2426 MHz
High	2480 MHz

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

2.3 DESCRIPTION OF SUPPORT UNITS

USB Power Supply.

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.

3.2 TEST PERSONNEL

No.	PERSONNEL	TITLE	ROLE
1	Karthik Vepuri	Test Engineer	Review
2	Blake Winter	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 17, 2024	July 17, 2026
Keysight MXE Signal Analyzer (26.5GHz)**	N9038A	MY56400083	July 17, 2024	July 17, 2026
SunAR RF Motion	JB1	A091418	May 16, 2024	May 16, 2025
ETS EMCO Red Horn Antenna	3115	00218576	February 21, 2024	February 21, 2025
ETS EMCO Amplifier*	3115-PA	00218576	January 22, 2024	January 22, 2026
Trilithic High Pass Filter*	6HC330	23042	June 5, 2023	June 5, 2025
ETS – Lindgren- VSWR on 10m Chamber***	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	May 7, 2024	May 7, 2027
NCEE Labs-NSA on 10m Chamber*	10m Semi-anechoic chamber-NSA	NCEE-001	June 18, 2024	June 18, 2026
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)*	MFR-57500	90-195-040	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	01E3864	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

*Internal Characterization
**2 Year Cal Cycle
***3 Year Cal Cycle

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

3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO 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 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.

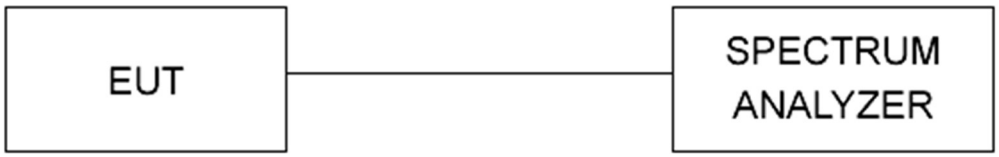


Figure 1 - Bandwidth Measurements Test Setup

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.

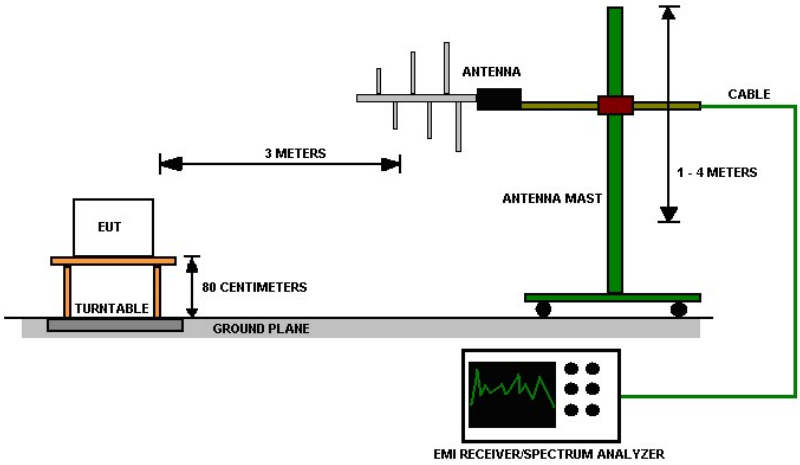


Figure 2 - Radiated Emissions Test Setup, 30MHz – 1GHz

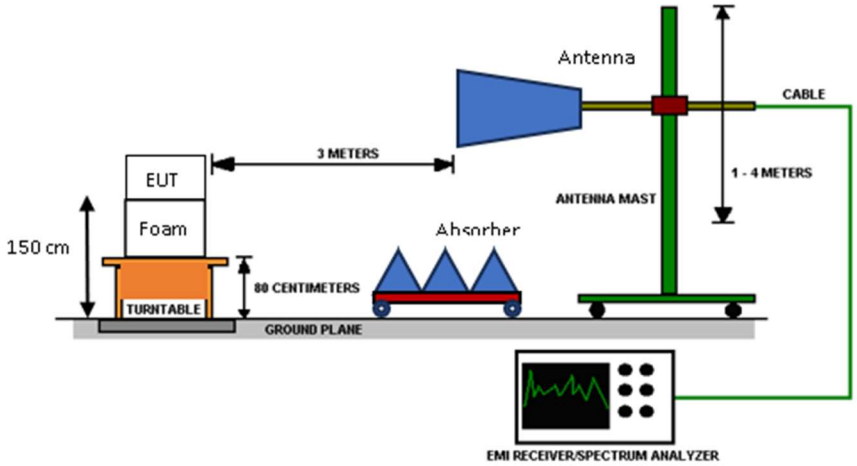


Figure 3 - Radiated Emissions Test Setup, 1GHz – 18GHz

4.0 RESULTS

DTS Radio Measurements							
CHANNEL	Occupied Bandwidth (MHz)	6 dB Bandwidth (kHz)	Peak OUTPUT Field Strength (dBuV/m)	Peak EIRP (dBm)	Peak EIRP (mW)	PSD EIRP (dBm)	RESULT
Low	1.484	726.7	89.82	-5.41	0.29	-20.78	PASS
Mid	1.538	702.2	89.31	-5.92	0.26	-19.85	PASS
High	2.128	709.1	85.29	-9.94	0.10	-25.25	PASS
Occupied Bandwidth = N/A; 6dB Bandwidth Limit = 500 kHz				Output Power Limit = 30 dBm; PSD Limit = 8 dBm			

Unrestricted Band-Edge						
CHANNEL	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level (dB)	Relative Fundamental (dB)	Delta (dB)	Min Delta (dB)	Result
Low	2399.98	55.81	88.14	32.33	20.00	PASS
High	2483.5	17.98	45.30	27.32	20.00	PASS

Radiated Peak Restricted Band-Edge						
CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBµV /m @ 3m)	Measurement Type	Limit (dBµV/m @ 3m)	Margin	Result
Low	2389.8	60.41	Peak	73.98	13.57	PASS
High	2483.8	60.80	Peak	73.98	13.18	PASS

Radiated Average Restricted Band-Edge						
CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBµV /m @ 3m)	Measurement Type*	Limit (dBµV/m @ 3m)	Margin	Result
Low	2389.5	42.59	Average	53.98	11.39	PASS
High	2483.8	43.51	Average	53.98	10.47	PASS

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.

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

The manufacturer attests the maximum duty cycle is 60%.

Duty Cycle Correction Factor (DCCF) = 20 * log10 (0.6) = -4.44dB.

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 (dBμV/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.

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 6dB 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 6 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:

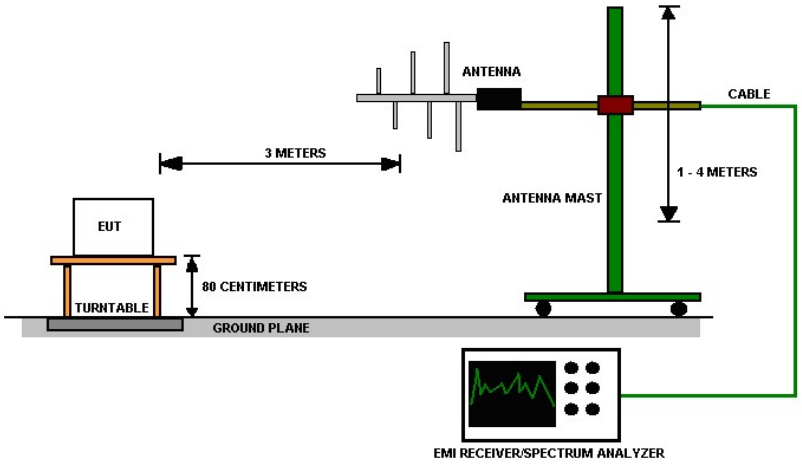


Figure 4 - Radiated Emissions Test Setup, 30MHz – 1GHz

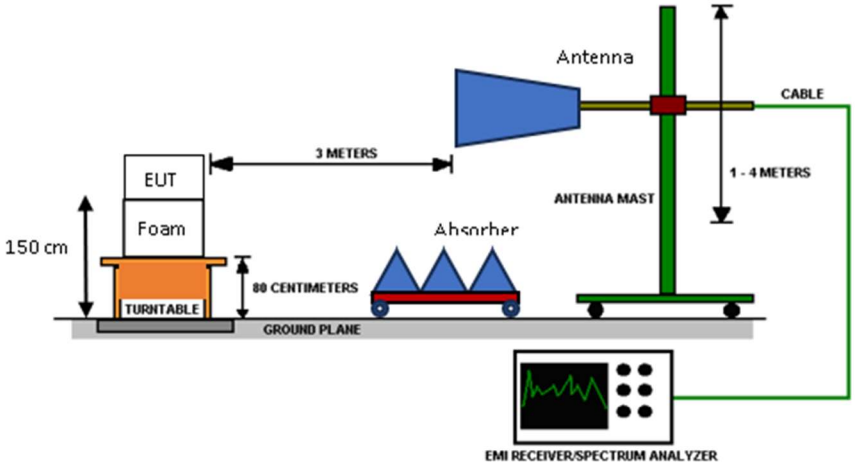


Figure 5 - Radiated Emissions Test Setup, 1GHz – 18GHz

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 was 1 MHz for all measurements and at frequencies above 1GHz, A peak and RMS 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:

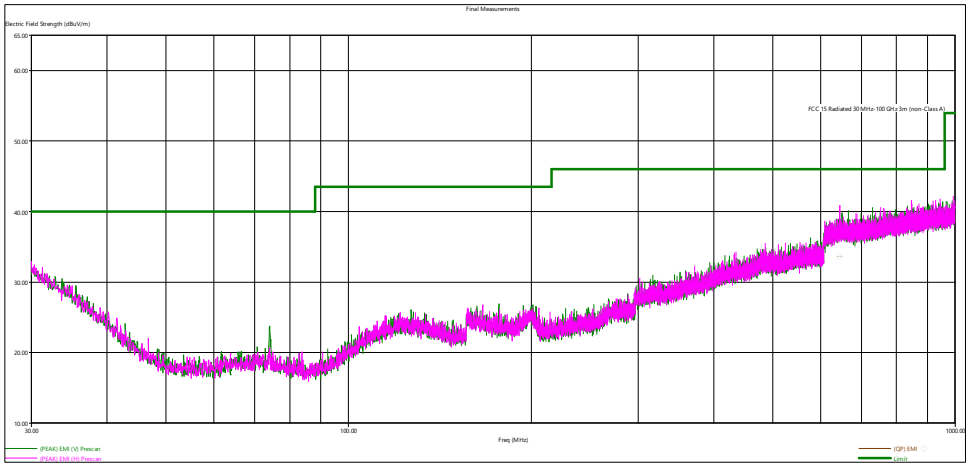


Figure 6 - Radiated Emissions Plot, Receive, A2 unit

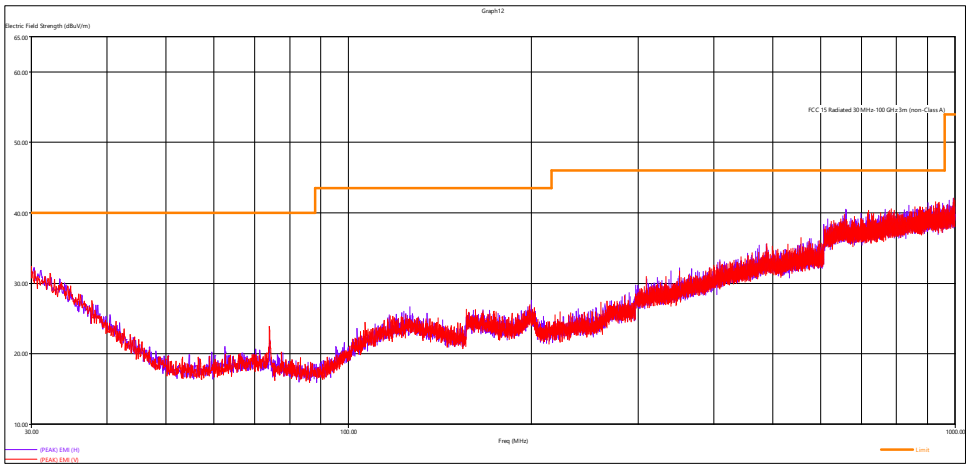


Figure 7 - Radiated Emissions Plot, Low Channel, 30M-1GHz

No peak emissions were within 6dB of the limit, and the emissions from this plot are not tabulated.

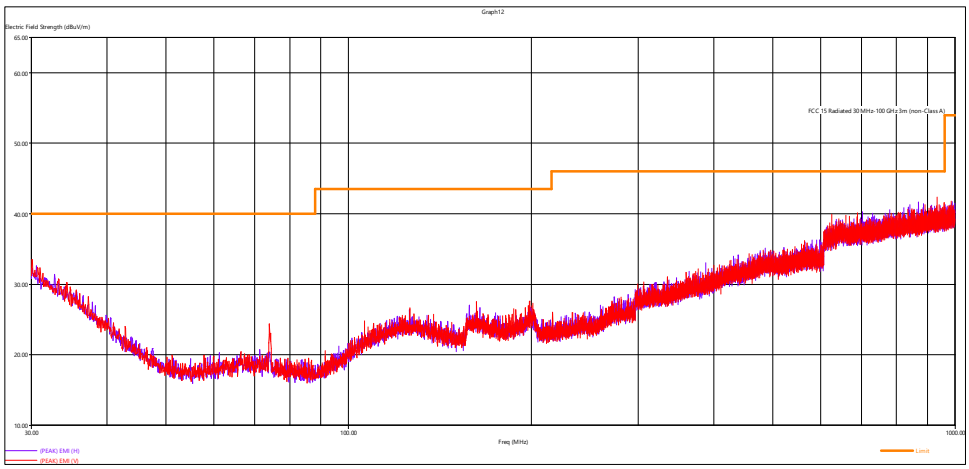


Figure 8 - Radiated Emissions Plot, Mid Channel, 30M-1GHz

No peak emissions were within 6dB of the limit, and the emissions from this plot are not tabulated.

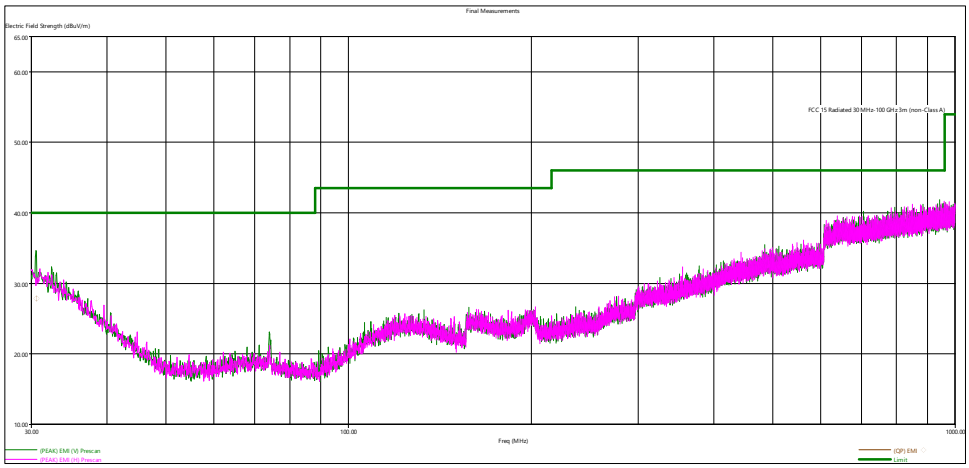


Figure 9 - Radiated Emissions Plot, High Channel, 30M-1GHz

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, 30 MHz – 1GHz, DTS							
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**		
644.769840	33.71	46.02	12.31	130.50	165.50	H	RX
30.337680	27.88	40.00	12.12	202.20	117.75	V	High

Peak Measurements, >1GHz, DTS								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**EUT SN**	**Channel**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			
2402.372000	89.68	NA	NA	303.52	223.25	H	A1	Low
2425.622000	89.24	NA	NA	498.68	262.00	V	A1	Mid
2480.002000	86.16	NA	NA	267.58	222.75	H	A1	High

The worst-case is shown in the plot and table above.
All other measurements were found to be at least 6 dB Below the limit.

Average Measurements, >1GHz, DTS									
Frequency	**Level***	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**DCCF**	**EUT SN**	**Ch.**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**		**dB**		
2402.372000	85.24	NA	NA	303.52	223.25	H	-4.44	A1	Low
2425.622000	84.8	NA	NA	498.68	262.00	V	-4.44	A1	Mid
2480.002000	81.72	NA	NA	267.58	222.75	H	-4.44	A1	High

The worst-case is shown in the table above.
All other measurements were found to be at least 6 dB Below the limit.
*Average level is Peak (PK) + Duty Cycle Correction Factor (DCCF).

4.5 BAND EDGES

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

Limits of band-edge measurements:
For FCC Part 15.247 Device:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c))

Test procedures:

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

Deviations from test standard:
No deviation.

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

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

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.

4.6 POWER SPECTRAL DENSITY

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

Limits of power measurements:

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

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

Deviations from test standard:
No deviation.

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

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

Test results:

Pass

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

4.7 CONDUCTED AC MAINS EMISSIONS

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

Limits for conducted emissions measurements:

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

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

Test Procedures:

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

Deviation from the test standard:
No deviation

EUT operating conditions:
Details can be found in section 2.1 of this report. USB power supply was used for AC Conducted Emissions.

Test Results:

Figure 10 - Conducted Emissions, Line, Charging Only

Figure 11 - Conducted Emissions, Neutral, Charging Only

ANNEX A: MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels apply to tests performed in this test report:

Test	Frequency Range	NCEE Labs Uncertainty Value (dB)	Maximum Uncertainty Values per CISPR 16-4-2:2011/A1:2018
AC Line Conducted Emissions	150kHz - 30MHz	3.01	3.4
Radiated Emissions, 3m	30MHz - 1GHz	4.28	5.3
Radiated Emissions, 3m	1GHz – 6GHz	5.14	5.2
Radiated Emissions, 3m	6GHz – 18GHz	5.14	5.5

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

NCEE Labs meets the maximum uncertainty requirements per CISPR 16-4-2:2011/A1:2018, and therefore does not require a minimum passing margin to state that an EUT is less than the field strength limits of the applicable CISPR, IEC or EN limit per CISPR 16-4-2:2011/A1:2018, Section 4.1.

NCEE Labs employs tilting when testing at 3m test distance. The maximum uncertainty associated with this method is used.

Maximum uncertainty values show the worst-case of all test distances used.

ANNEX B: SAMPLE FIELD STRENGTH CALCULATION

Radiated Emissions

The field strength is calculated in decibels (dB) 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 = R + AF – (-CF + AG)

where FS = Field Strength

R = Receiver Amplitude Receiver reading in dBµV

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Preamplifier Amplifier Gain

Assume a receiver reading of 55.00 dBµV is obtained. The Antenna Factor of 12.00 and a Cable Factor of 1.10 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.10 dBµV/m.

FS = 55.00 + 12.00 – (-1.10 + 20.00) = 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

Conducted Emissions

Receiver readings are compared directly to the conducted emissions limits in decibels (dB) by adding the cable loss and LISN insertion loss to the receiver reading. The basic equations with a sample calculation is as follows;

FS = R + IL – (-CF)

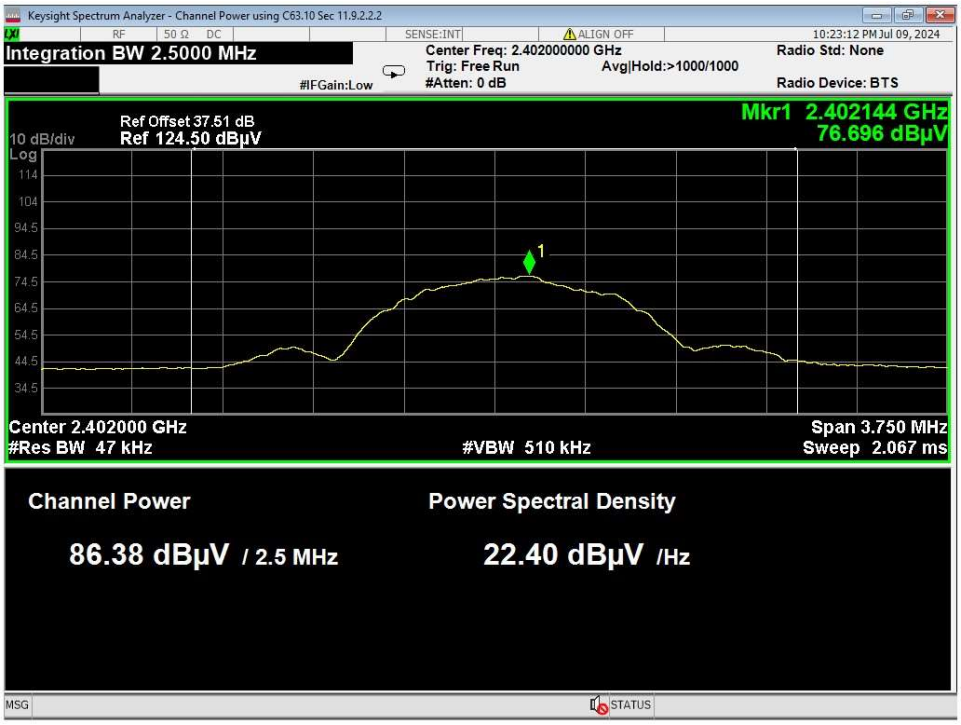
where V = Conducted Emissions Voltage Measurement

R = Receiver reading in dBµV

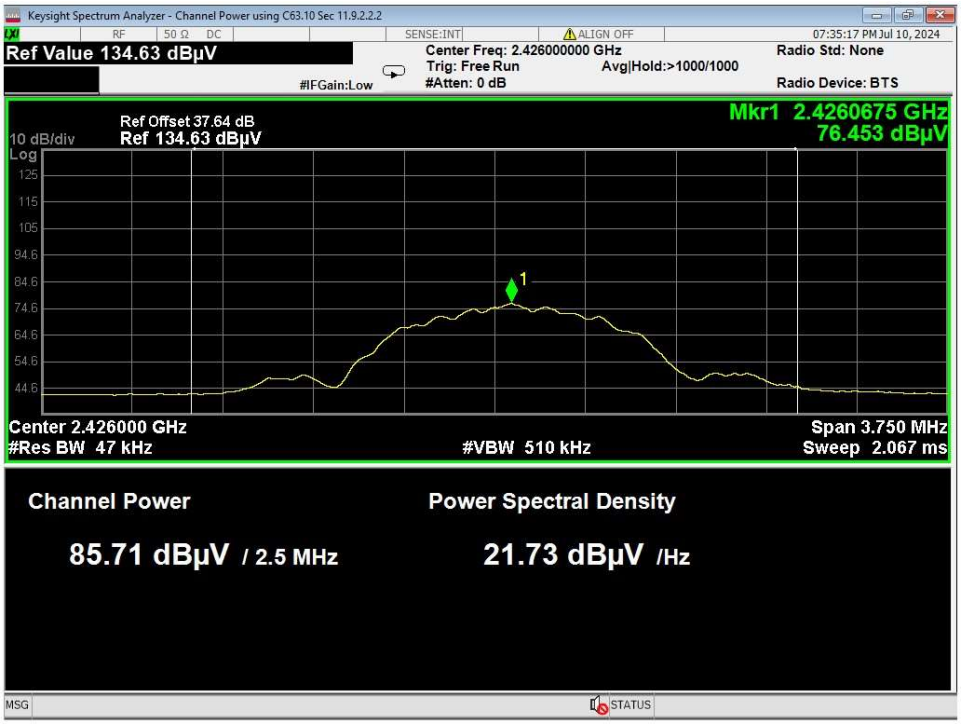
IL = LISN Insertion Loss

CF = Cable Attenuation Factor

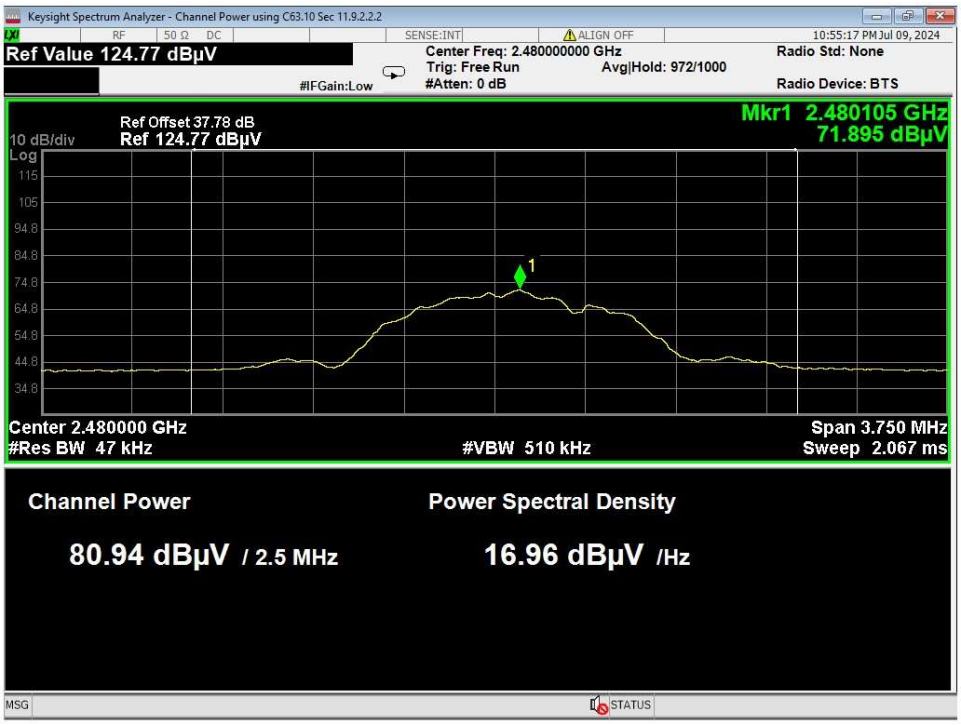
APPENDIX C – GRAPHS AND TABLES



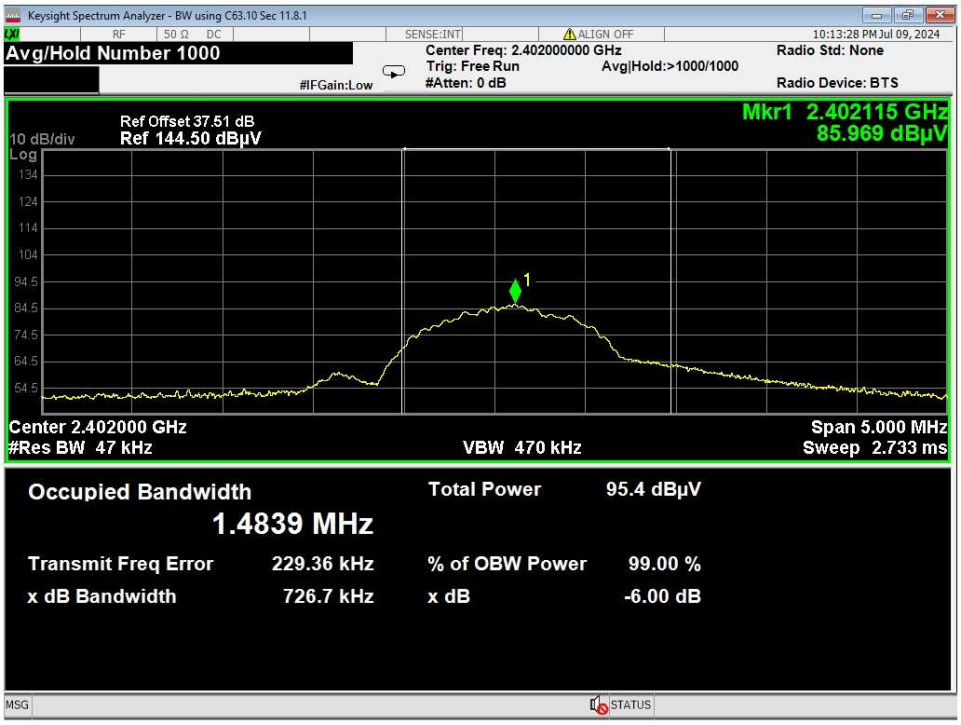
01 Peak Field Strength, Low, Radiated



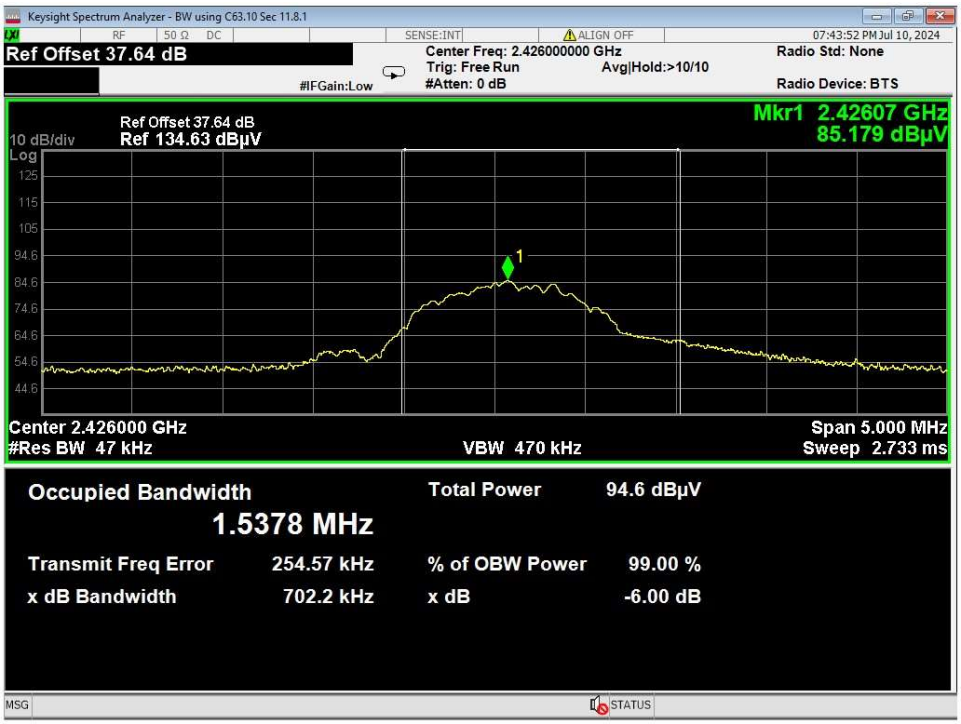
02 Peak Field Strength, Mid, Radiated



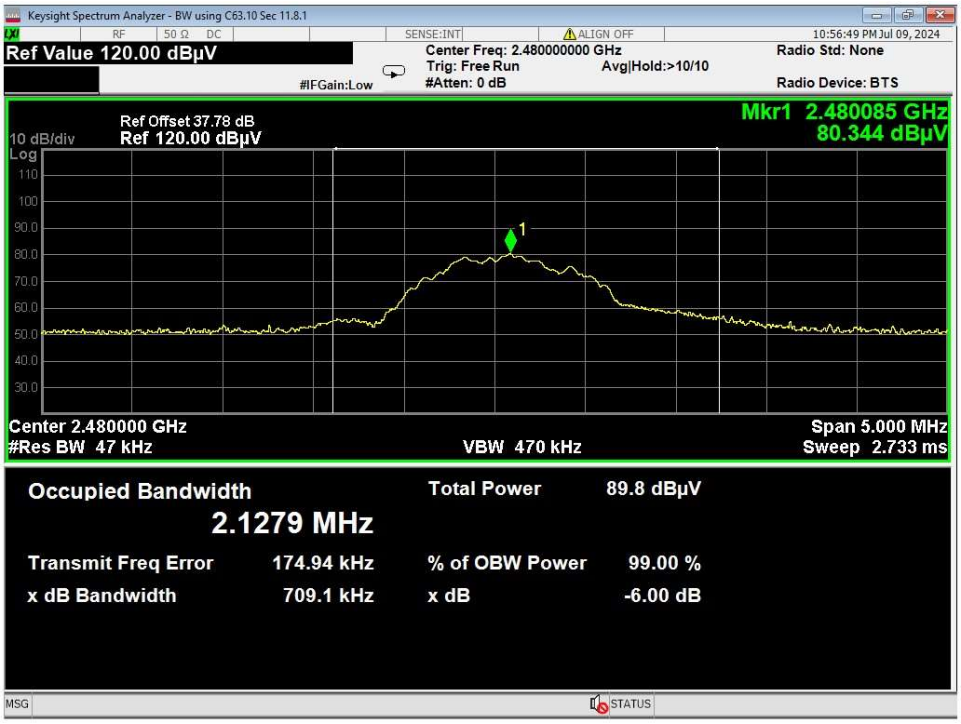
03 Peak Field Strength, High, Radiated



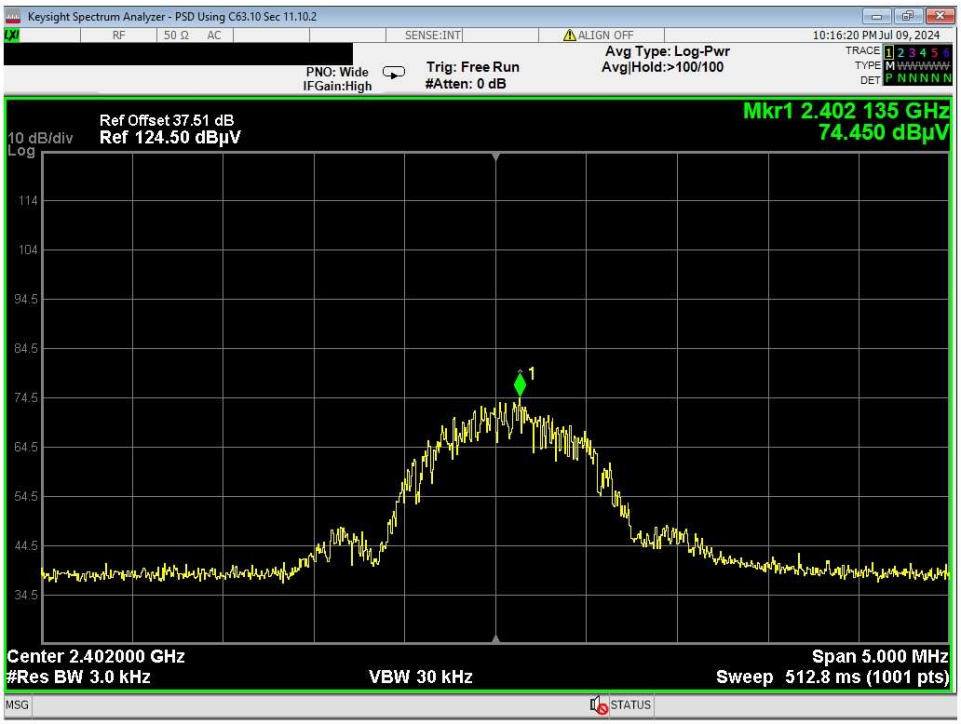
04 6dB Bandwidth, Low, Radiated



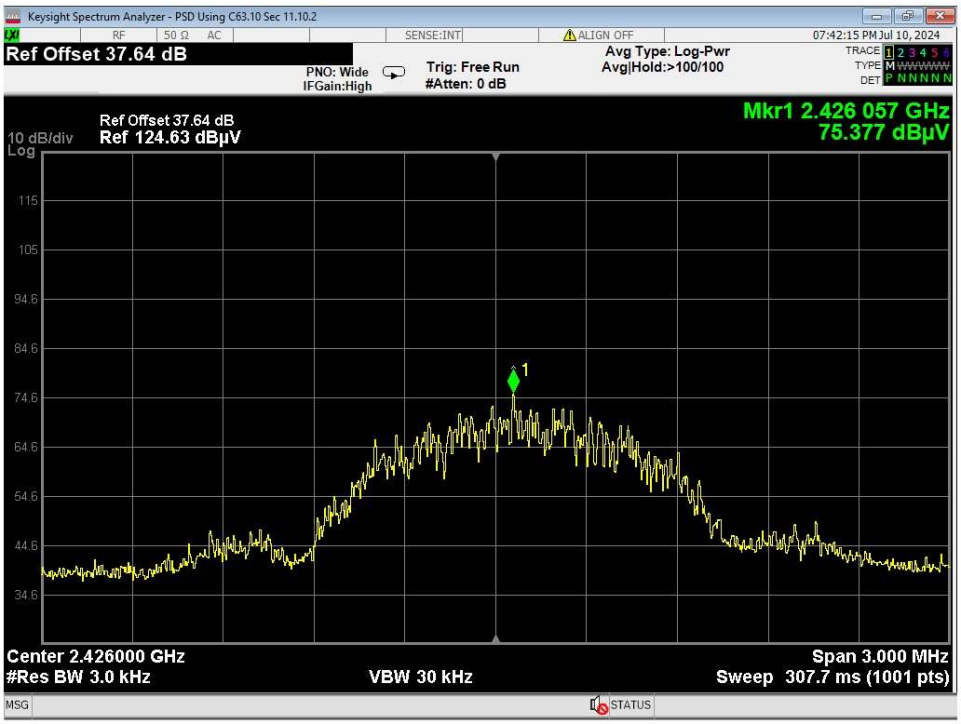
05 6dB Bandwidth, Mid, Radiated



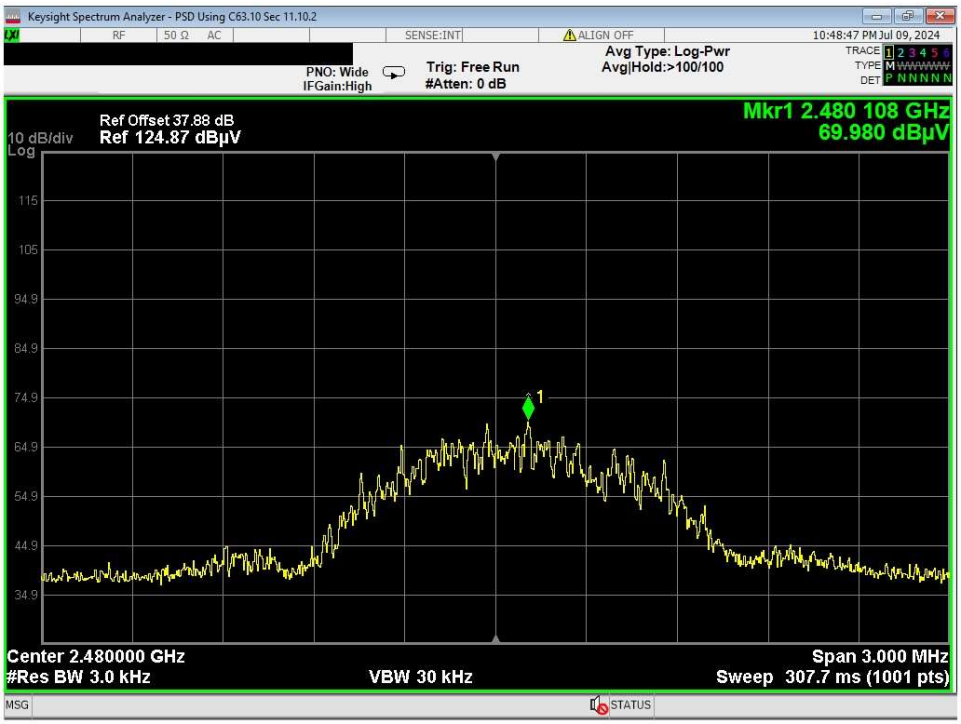
06 6dB Bandwidth, High, Conducted



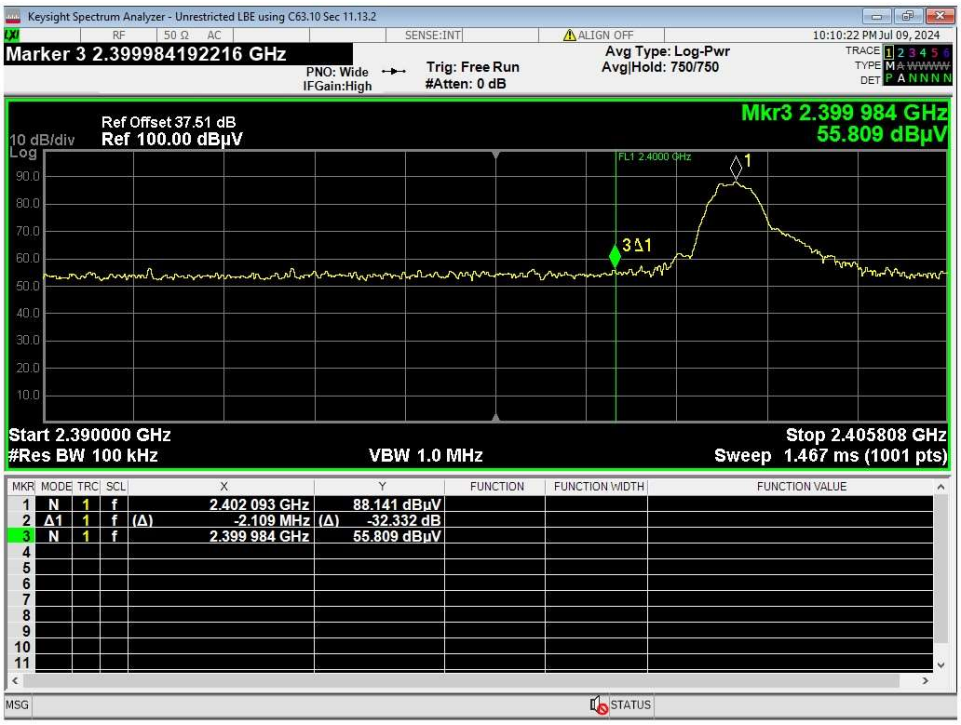
07 PSD, Low, Radiated, PSD (dBm) = Field Strength (dBuV/m) – 95.23 dB



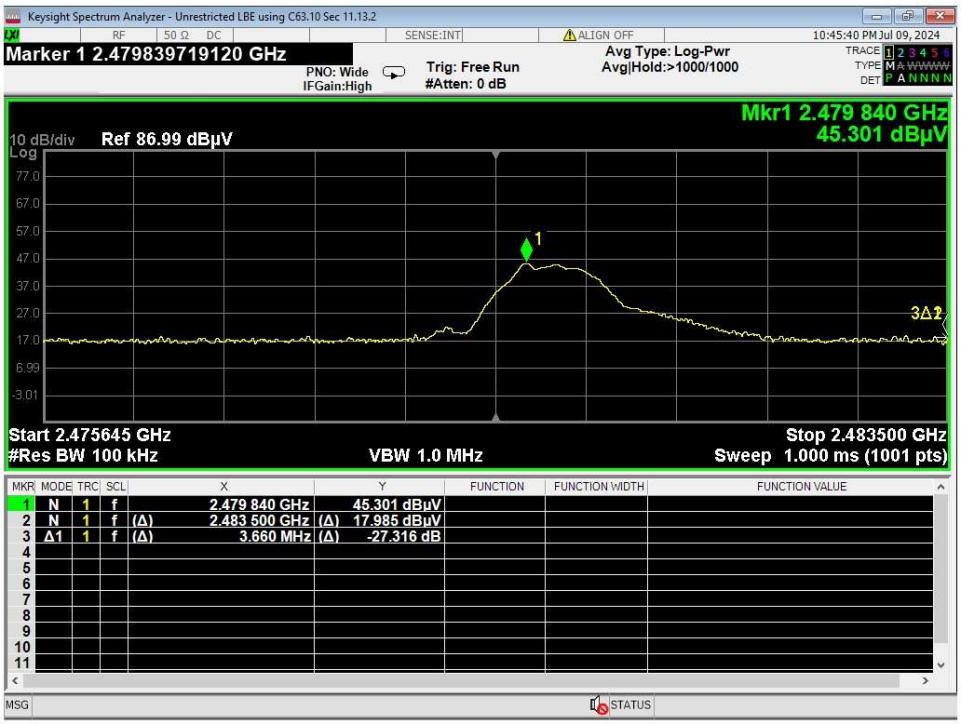
08 PSD, Mid, Radiated, PSD (dBm) = Field Strength (dBuV/m) – 95.23 dB



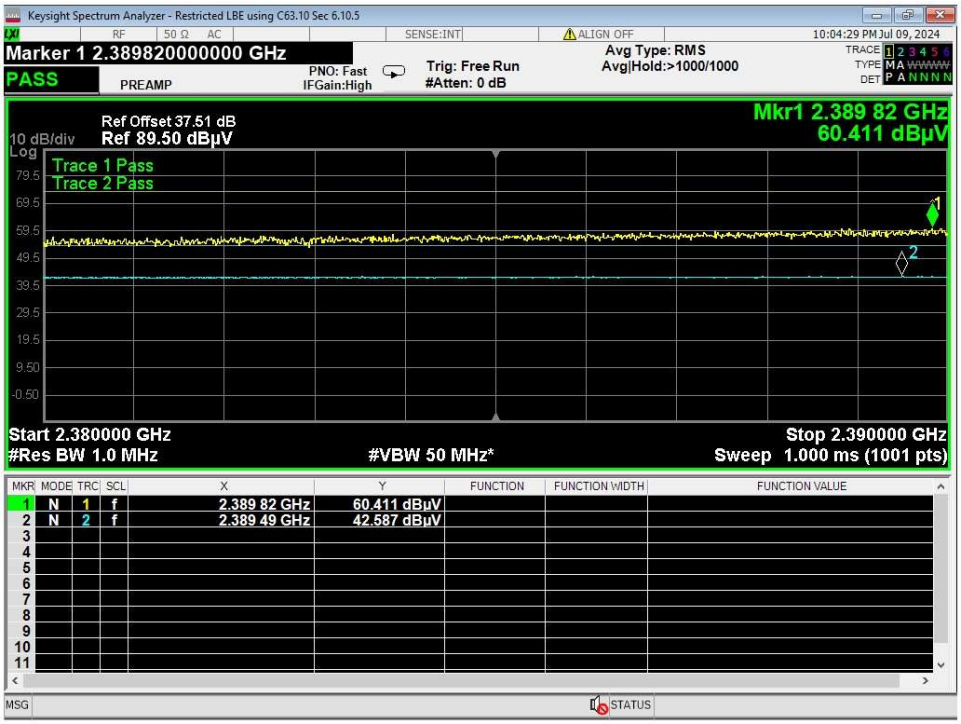
09 PSD, High, Radiated, PSD (dBm) = Field Strength (dBuV/m) – 95.23 dB



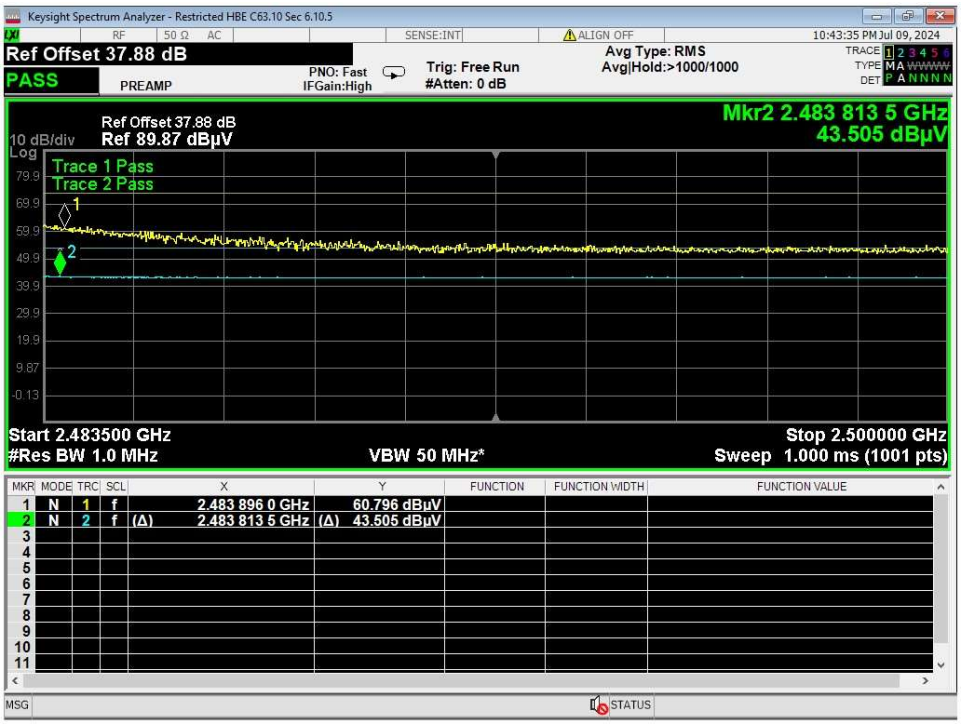
10 Lower Bandedge, Unrestricted, Radiated



11 Higher Bandedge, Unrestricted, Radiated



12 Lower Bandedge, Restricted, Radiated



13 Higher Bandedge, Restricted, Radiated

REPORT END