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FCC/ISED Test Report

Prepared for:	**701x Inc.**
Address:	**700 Main Avenue** **Fargo, North Dakota 58103**
EUT:	**Ag Device xBASE**
Test Report No:	**R20230211-00-E1A**
Approved by:	**Nic Johnson, NCE** **Technical Manager** **iNARTE Certified EMC Engineer #EMC-003337-NE**
DATE:	**May 3, 2023**
Total Pages:	**38**

ilac-MRA A2LA ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
Original	30 March 2023	Issued by KVepuri Prepared by BWinter
A	26 April 2023	Rev A – NJohnson Prepared by BWinter 1. List details of reference offset in plots in 4.5 and 4.6. 2. Add FCC ID and contained FCC ID in 2.1.

CONTENTS

Revision Page 2

1.0 Summary of test results 4

2.0 EUT Description 5

2.1 Equipment under test 5

2.2 Description of test modes 6

2.3 Description of support units 6

3.0 Laboratory description 7

3.1 Laboratory description 7

3.2 Test personnel 7

3.3 Test equipment 8

3.4 General Test Procedure and Setup for Radio Measuremnts 9

4.0 Detailed results 10

4.1 Duty Cycle 11

4.2 Radiated emissions 12

4.3 Peak Output Power 20

4.4 Bandwidth 23

4.5 Bandedges 26

4.6 Power Spectral Density 30

4.6 Conducted AC Mains Emissions 33

Appendix A: Sample Calculation 36

Appendix B – Measurement Uncertainty 37

REPORT END 38

1.0 SUMMARY OF TEST RESULTS

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

ANSI C63.10-2013 was used as a test method, with guidance from KBD 558074 D01 v05

APPLIED STANDARDS AND REGULATIONS		
Standard Section	**Test Type**	**Result**
FCC Part 15.203	Unique Antenna Requirement	Internal Antenna
FCC Part 15.35 RSS Gen, Issue 5, Section 6.10	Duty Cycle	NA (100% duty cycle)
FCC Part 15.247(b)(3) RSS-247 Issue 2 Section 5.4(d)	Peak output power	Pass
FCC Part 15.247(a)(2) RSS-247 Issue 2 Section 5.2	Bandwidth	Pass
FCC Part 15.209 RSS-Gen Issue 5, Section 7.3	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.247 (unrestricted) RSS-247 Issue 2 Section 5.5, RSS-Gen Issue 5, Section 8.9	Transmitter Radiated Emissions	Pass
FCC Part 15.247(e) RSS-247 Issue 2 Section 5.2	Power Spectral Density	Pass
FCC Part 15.209, 15.247(d) RSS-247 Issue 2 Section 5.5	Band Edge Measurement	Pass
FCC Part 15.207 RSS-Gen Issue 5, Section 8.8	Conducted Emissions	Pass
KDB 996369 D04 Using ANSI C63.10-2013, Section 6.5, 6.6	Transmitter Radiated Emissions; Compare with Original Grant	Pass

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary
The Equipment Under Test (EUT) was Ag Device xBASE, a wireless receiver manufactured by 701x Inc. It has a Bluetooth Low Energy module that transmits and receives in the 2400 to 2483.5 MHz band, and it has a cellular module that is checked for modular integration.

EUT	701x xBASE
EUT Received	3/15/2023
EUT Tested	3/15/2023 - 3/16/2023
Serial No.	001 (NCEE 010973 assigned by NCEE)
Operating Band	2400 – 2483.5 MHz
FCC ID:	2AZT3-701XB01 Contains: XMR201912BG77
Device Type	DTS
Power Supply	120 VAC to DC power adapter, XP Power model VEL05US050-US-UB, 5 VDC output
Antenna	Internal Antenna

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

2.2 DESCRIPTION OF TEST MODES

The EUT operates on, and was tested at the frequencies below:

Channel	Frequency (MHz)
Low	2402
Middle	2440
High	2480

These are the only three 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.

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on the lowest, highest and one channel in the middle.

2.3 DESCRIPTION OF SUPPORT UNITS

None

3.0 LABORATORY 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 of Results
2	Blake Winter	Test Engineer	Testing and Report
3	Grace Larsen	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 19, 2022	July 19, 2024
Keysight MXE Signal Analyzer (26.5GHz)**	N9038A	MY56400083	July 19, 2022	July 19, 2024
Keysight EXA Signal Analyzer**	N9010A	MY56070862	July 20, 2021	July 20, 2023
SunAR RF Motion	JB1	A082918-1	July 26, 2022	July 26, 2023
ETS EMCO Red Horn Antenna	3115	00218655	July 21, 2022	July 21, 2023
Com-Power LISN, Single Phase**	LI-220C	20070017	July 18, 2022	July 18, 2024
8447F POT H64 Preamplifier*	8447F POT H64	3113AD4667	March 21, 2022	March 21, 2024
Rohde & Schwarz Preamplifier*	TS-PR18	3545700803	August 22, 2022	August 22, 2024
Trilithic High Pass Filter*	6HC330	23042	March 21, 2022	March 21, 2024
ETS – Lindgren- VSWR on 10m Chamber***	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	July 30, 2020	July 30, 2023
NCEE Labs-NSA on 10m Chamber*	10m Semi-anechoic chamber-NSA	NCEE-001	May 25, 2022	May 25, 2024
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)*	MFR-57500	90-195-040	August 22, 2022	August 22, 2024
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	September 24, 2021	September 24, 2023
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3864	September 24, 2021	September 24, 2023
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	September 24, 2021	September 24, 2023
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	September 24, 2021	September 24, 2023
N connector bulkhead (control room)*	PE9128	NCEEBH2	September 24, 2021	September 24, 2023

*Internal Calibration
**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 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.

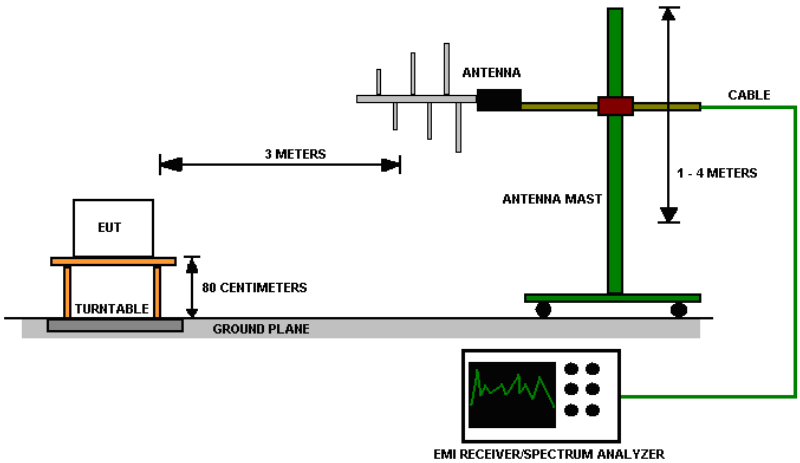


Figure 2 - Radiated Emissions Test Setup

4.0 DETAILED RESULTS

Radio Measurements						
CHANNEL	Occupied Bandwidth (kHz)	6 dB Bandwidth (kHz)	Conducted Peak Output Power (dBm)	Conducted Peak Output Power (mW)	PSD EIRP (dBm)	RESULT
Low	1087	676	3.96	2.49	-7.15	Pass
Mid	1113	716	3.53	2.25	-12.55	Pass
High	1096	666	3.02	2.01	-15.47	Pass
6 dB Bandwidth Limit >= 500 kHz			Peak Output Power Limit = 30 dBm; PSD Limit = 8 dBm			

Unrestricted Band-Edge							
CHANNEL	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level (dBuV)	Relative Fundamental (dBuV)	Measurement Type	Delta (dB)	Min Delta (dB)	Result
Low	2400	56.02	97.16	Peak	41.13	20	Pass
High	2483.5	41.49	92.04	Peak	50.55	20	Pass

Peak Limit- Restricted Band-Edge						
CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)*	Margin	Result
Low	2385.01	53.51	Peak	73.98	20.47	Pass
High	2499.62	53.50	Peak	73.98	20.48	Pass
*Limit shown is the peak limit taken from FCC Part 15.209.						

Average Limit- Restricted Band-Edge						
CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)*	Margin	Result
Low	2389.72	41.22	Average	53.98	12.76	Pass
High	2483.70	41.93	Average	53.98	12.05	Pass
*Limit shown is the average limit taken from FCC Part 15.209.						

4.1 DUTY CYCLE

Duty cycle is 100%. No correction factor is applied.

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 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.

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 form 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.

h. The orientation with the worst-case emissions was used for final measurements.

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.

Test setup:

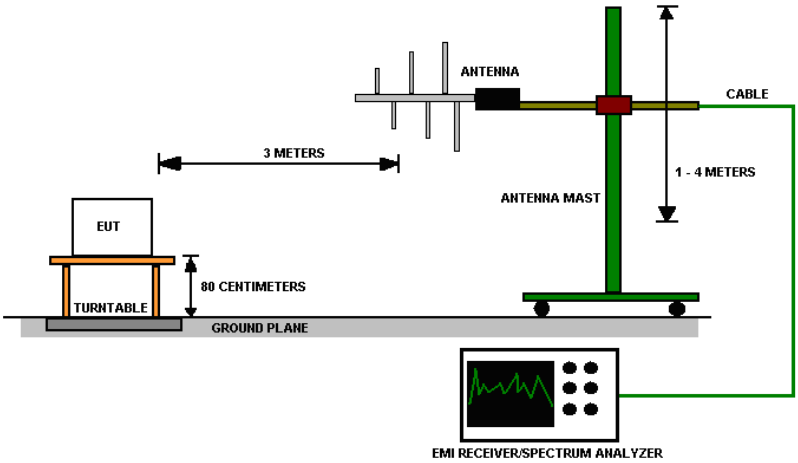


Figure 3 - Radiated Emissions Test Setup

EUT operating conditions
The EUT was powered by a 120 VAC to DC power adapter and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

Test results:

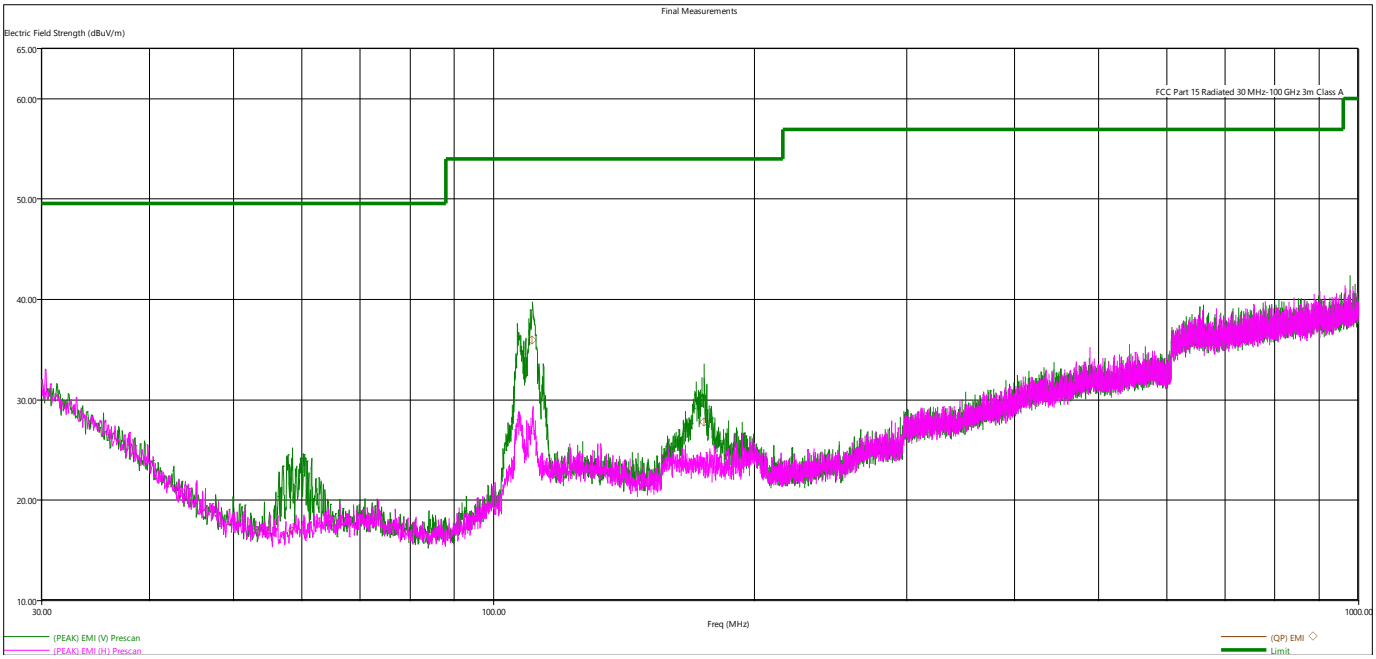


Figure 4 - Radiated Emissions Plot, 30 MHz-1 GHz Low Channel

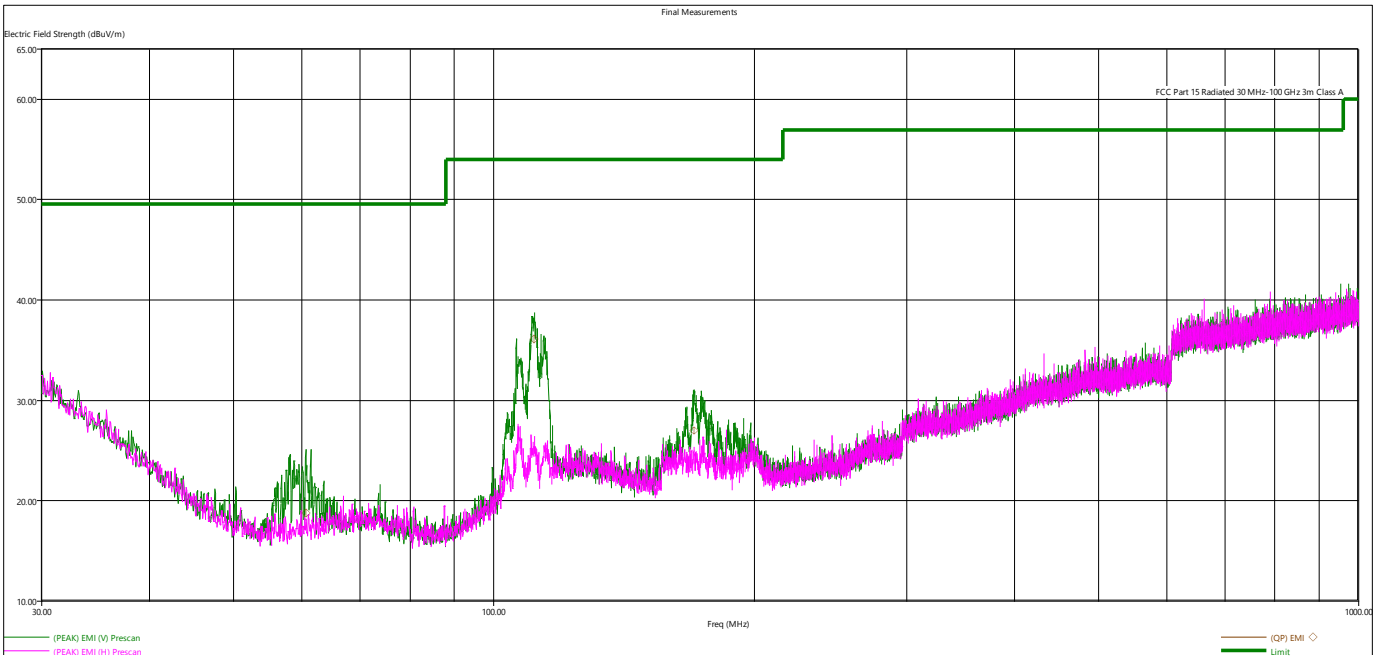


Figure 5 - Radiated Emissions Plot, 30 MHz-1 GHz, Mid Channel

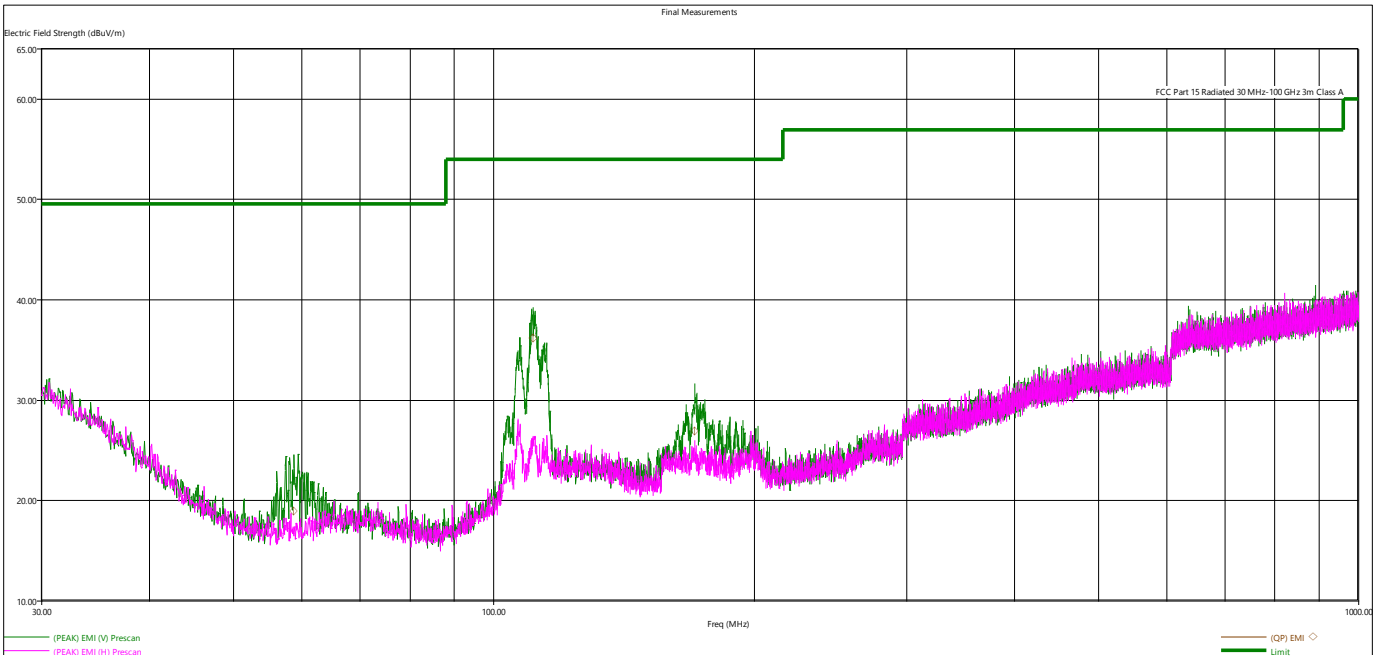


Figure 6 - Radiated Emissions Plot, 30 MHz-1 GHz High Channel

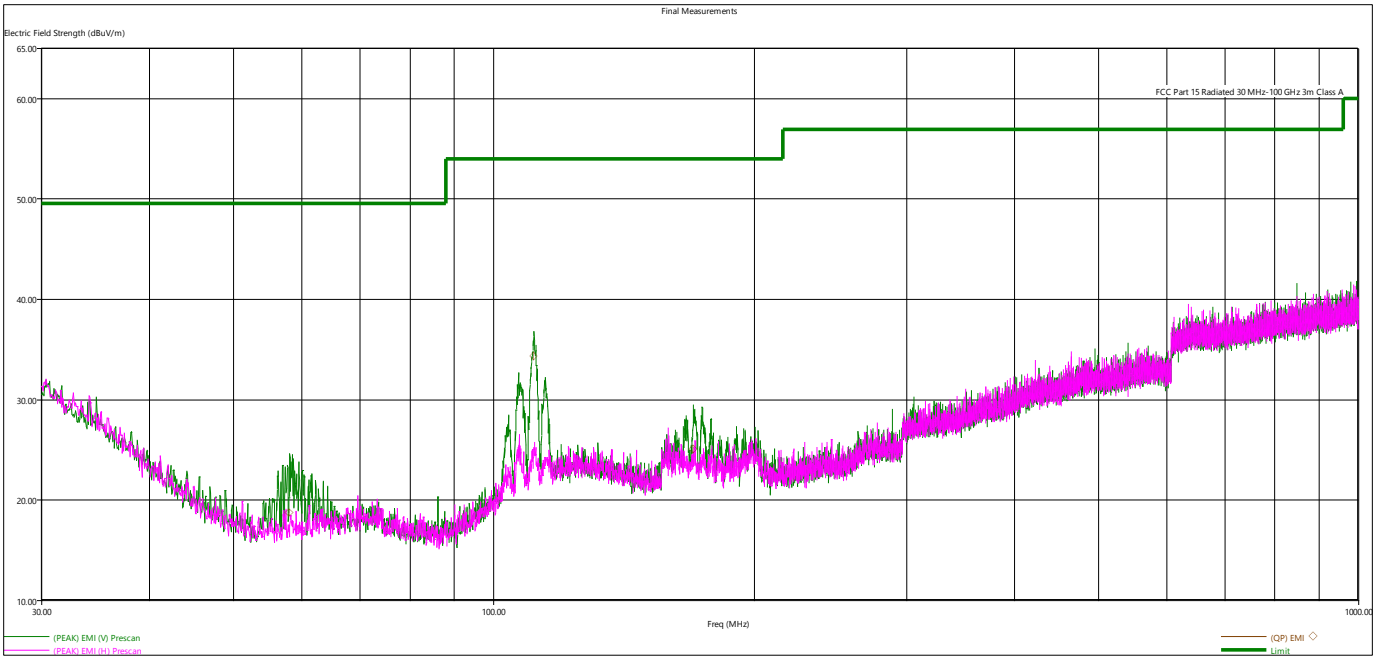


Figure 7 - Radiated Emissions Plot, 30 MHz-1 GHz, Receive Mode

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.
5. The EUT was measured in both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing.
6. FCC ID XMR201912BG77 cellular module emissions were compared with the results from the original grant are compliant.
7. Emissions from intermodulation products between the cellular module and the BLE module were compliant.

Quasi-Peak Measurements, 30 MHz -1 GHz, Low Channel						
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
58.559760	16.92	49.54	32.62	139.00	84.00	V
110.971680	35.89	53.98	18.09	129.00	173.00	V
175.244400	27.74	53.98	26.24	104.00	284.00	V

*All other measurements found to be at least 6dB below the limit line.

Quasi-Peak Measurements, 30 MHz -1 GHz, Mid Channel						
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
60.607920	18.71	49.54	30.83	105.00	345.00	V
111.406560	36.05	53.98	17.93	106.00	92.00	V
170.242080	26.95	53.98	27.03	108.00	136.00	V

*All other measurements found to be at least 6dB below the limit line.

Quasi-Peak Measurements, 30 MHz -1 GHz, High Channel						
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
58.873440	18.92	49.54	30.62	116.00	209.00	V
110.966400	36.13	53.98	17.85	115.00	51.00	V
170.634480	26.89	53.98	27.09	126.00	25.00	V

*All other measurements found to be at least 6dB below the limit line.

Quasi-Peak Measurements, 30 MHz -1 GHz, Receive Mode						
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
58.181760	18.77	49.54	30.77	112.00	202.00	V
111.261120	34.32	53.98	19.66	107.00	77.00	V
170.004480	25.07	53.98	28.91	134.00	142.00	V

*All other measurements found to be at least 6dB below the limit line.

Peak Measurements, 1 GHz - 10 GHz, Low Channel						
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
2401.708000	101.42	NA	NA	534.00	102.00	H
4803.724000	51.18	79.50	28.32	144.00	93.00	V

Peak Measurements, 1 GHz - 10 GHz, Mid Channel						
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
2440.280000	101.16	NA	NA	450.00	111.00	H
4879.508000	52.27	79.50	27.23	497.00	91.00	V

Peak Measurements, 1 GHz - 10 GHz, High Channel						
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
2480.166000	99.17	NA	NA	434.00	111.00	H
4960.512000	53.79	79.50	25.71	508.00	91.00	V

Peak Measurements, 1 GHz - 10 GHz, Receive Mode						
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
No peak emissions were within 6dB of the average limit.						

Average Measurements, 1 GHz- 10 GHz, Low Channel						
Frequency	**Average Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
2401.708000	98.72	NA	NA	534.00	102.00	H
4803.724000	44.14	59.50	15.36	144.00	93.00	V

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

Average Measurements, 1 GHz- 10 GHz, Mid Channel						
Frequency	**Average Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
2440.280000	98.06	NA	NA	450.00	111.00	H
4879.508000	43.95	59.50	15.55	497.00	91.00	V

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

Average Measurements, 1 GHz - 10 GHz, High Channel						
Frequency	**Average Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**	
2480.166000	97.16	NA	NA	434.00	111.00	H
4960.512000	45.70	59.50	13.80	508.00	91.00	V

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

4.3 PEAK OUTPUT POWER

Test Method: ANSI C63.10, Section(s) 7.8.5

Limits of bandwidth measurements:
For a DTS system, the output power is required to be less than 1000 mW or 30 dBm.

Conducted power was measured by connecting coax to the antenna port of the EUT and connecting to the analyzer.

Test procedure: Conducted.

Deviations from test standard:
No deviation.

Test setup:

See Section 3.4 and 4.2

EUT operating conditions:
The EUT was powered by a 120 VAC to DC power adapter and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

Test results:
Refer to section 4.0 for the results table.

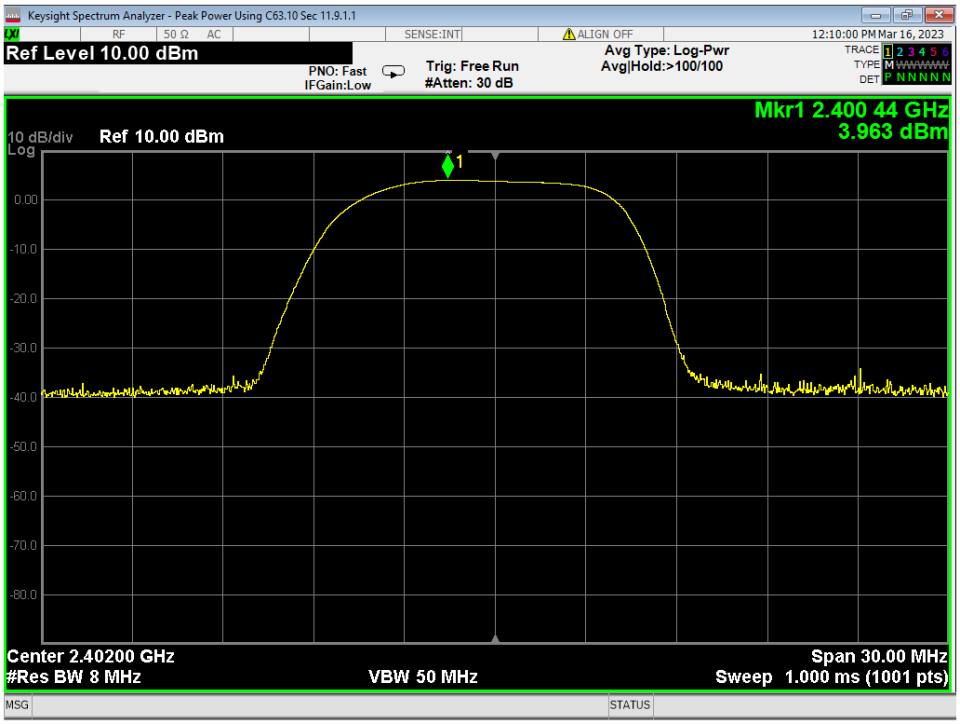


Figure 8 – Conducted Output Power, Low Channel.

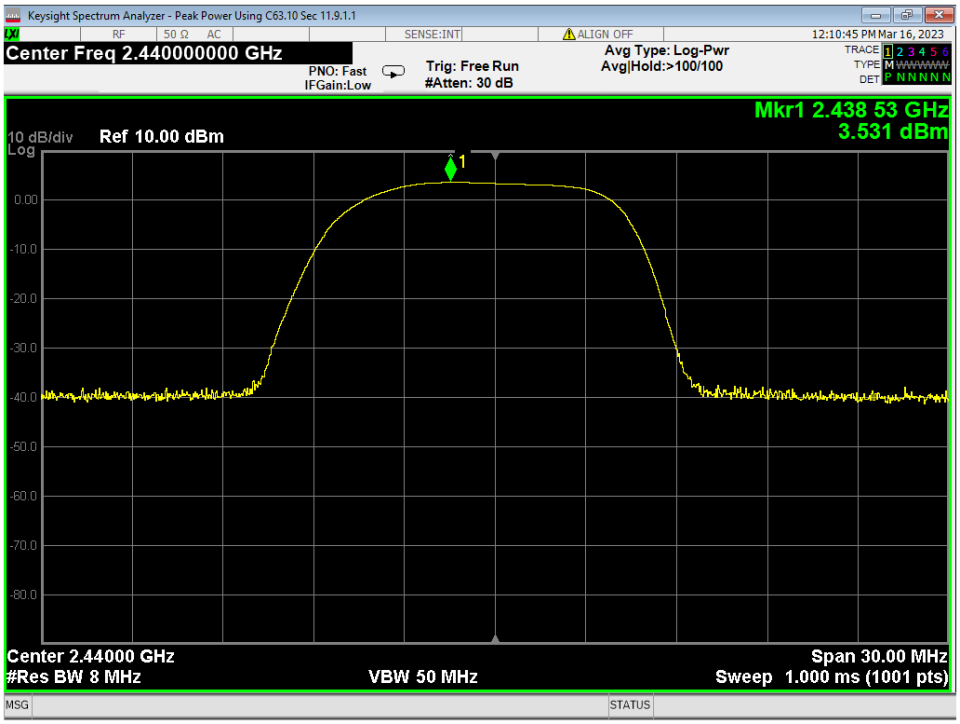


Figure 9 – Conducted Output Power, Mid Channel

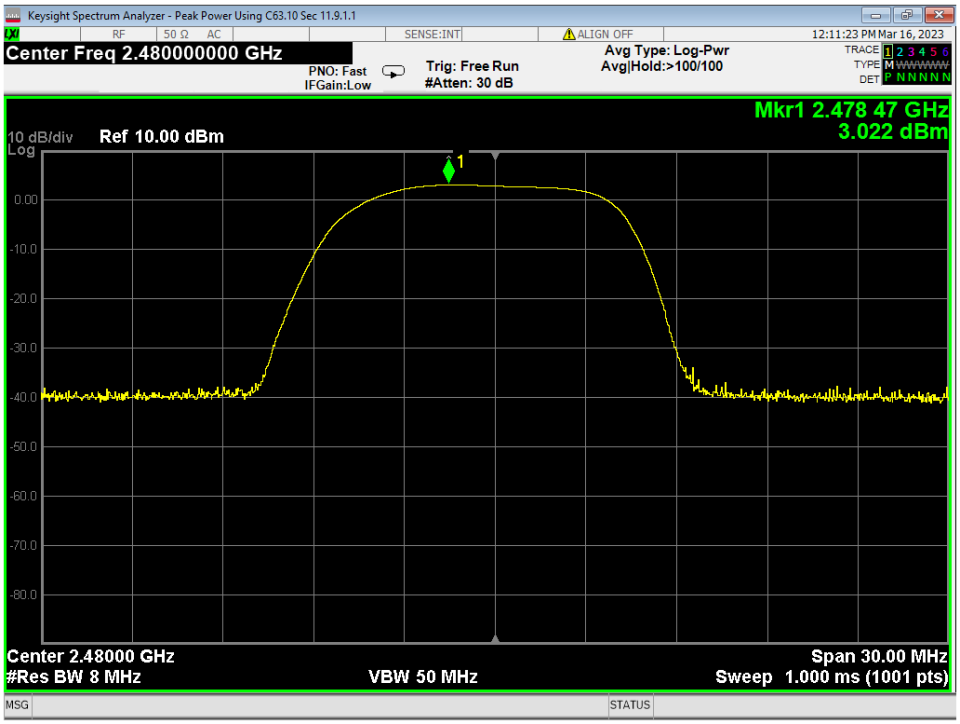


Figure 10 – Conducted Output Power, High Channel

4.4 BANDWIDTH

Test Method: ANSI C63.10, Section(s) 6.9.2 (6 dB BW)
ANSI C63.10, Section(s) 6.9.3 (99% BW)

Limits of bandwidth measurements:
From FCC Part 15.247 (1) (i) and RSS-247 5.1(c)

The minimum allowed 6 dB bandwidth of the DTS channel is 500 kHz.

Test procedures:
Bandwidth measurement was taken at a distance of 3m from the EUT. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 3 kHz RBW.

The 6dB bandwidth is defined as the bandwidth of which is higher than peak power minus 6dB.

The 99% occupied bandwidth was measured using the test receiver's occupied bandwidth function.

Test setup:

All the measurements were done at 3m test distance while operating at low, mid, and high channels. See Section 4.3 for more details.

Deviations from test standard:
No deviation.

Test setup:

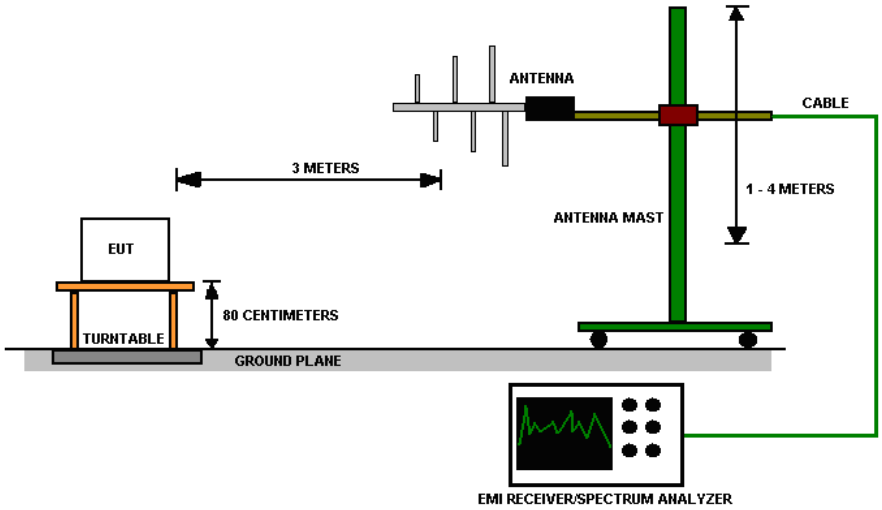


Figure 11 - Bandwidth Measurements Test Setup

EUT operating conditions:
The EUT was powered by internal battery unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

Test results:

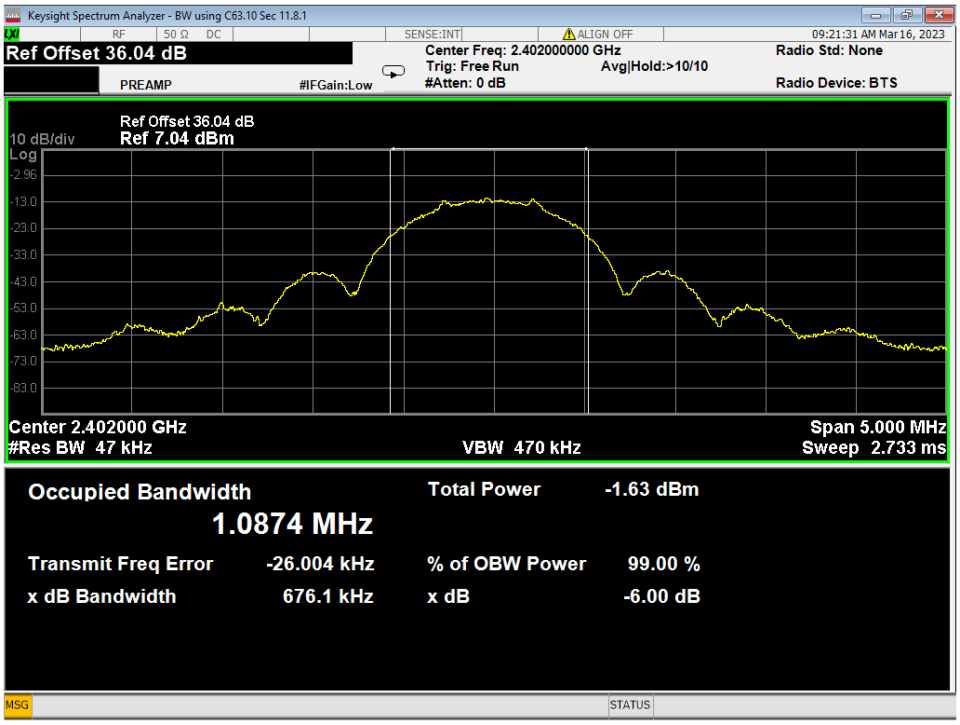


Figure 12 –Bandwidth, Low Channel

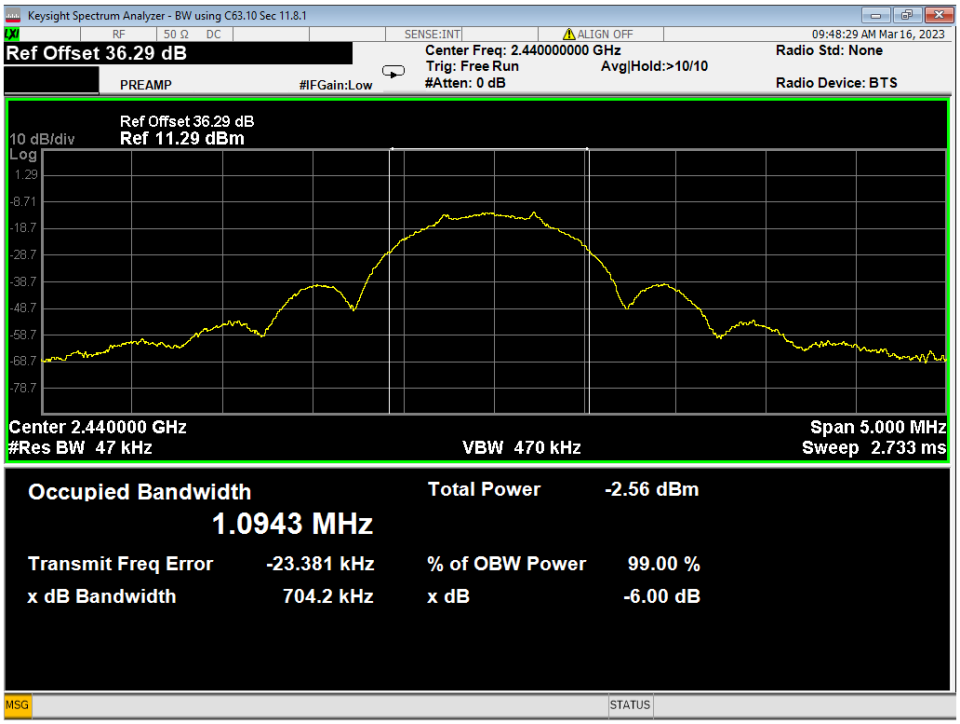


Figure 13 - Bandwidth, Mid Channel

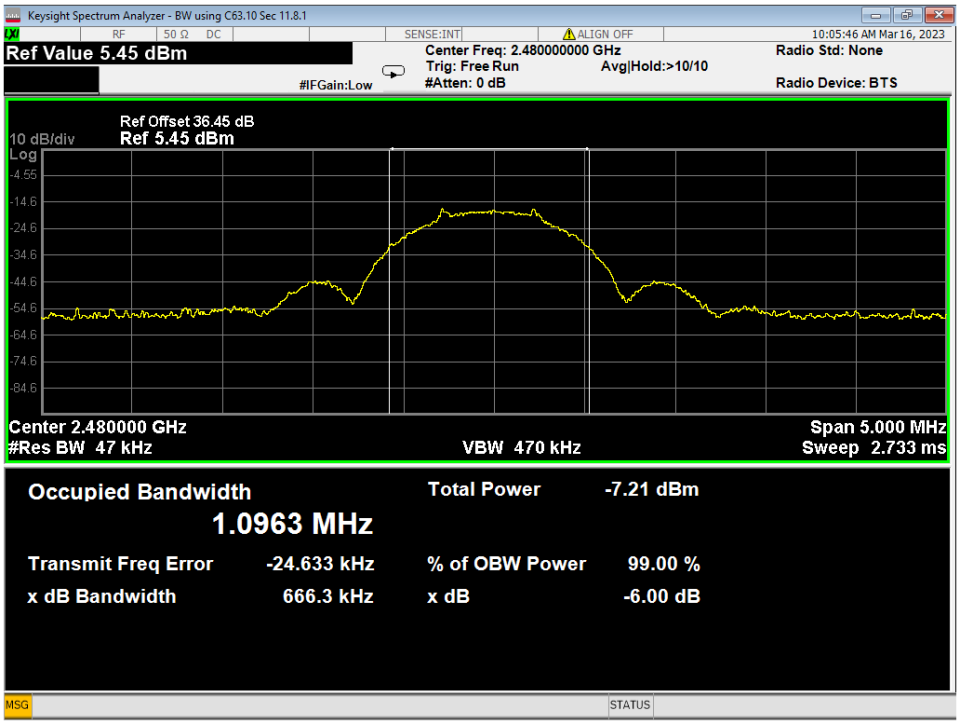


Figure 14 - Bandwidth, High Channel

4.5 BANDEDGES

Test Method: ANSI C63.10, Section(s) 6.10.6

Limits of bandedge measurements:
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:
All measurements were taken at a distance of 3m from the EUT.

The EUT was maximized in all 3 orthogonal positions in a similar manner as described in Section 4.2.

Deviations from test standard:
No deviation.

Test setup:
All the measurements were done at 3m test distance while operating on the highest and lowest channel depending on which band edge was investigated.

EUT operating conditions:
The EUT was powered by a 120 VAC to DC power adapter and set to transmit continuously on the lowest frequency channel and the highest frequency channel.

Test results:
Refer to section 4.0 for the results table.

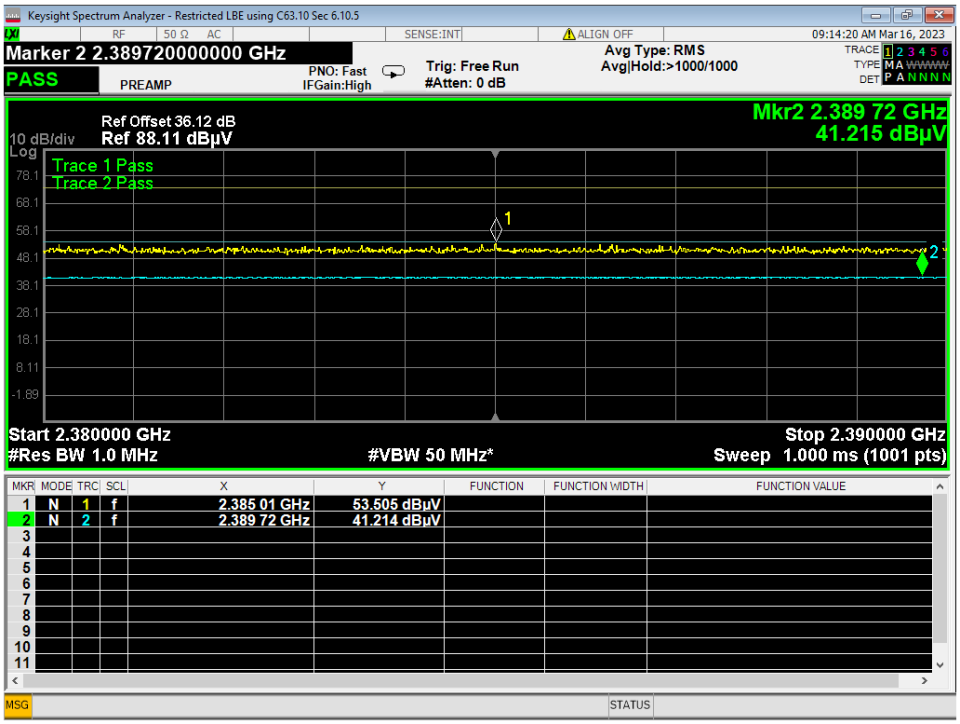


Figure 15 – Band-edge Measurement, Low Channel, Restricted Frequency

Reference Offset includes the cable loss (8.56dB) and the antenna factor (27.56dB)

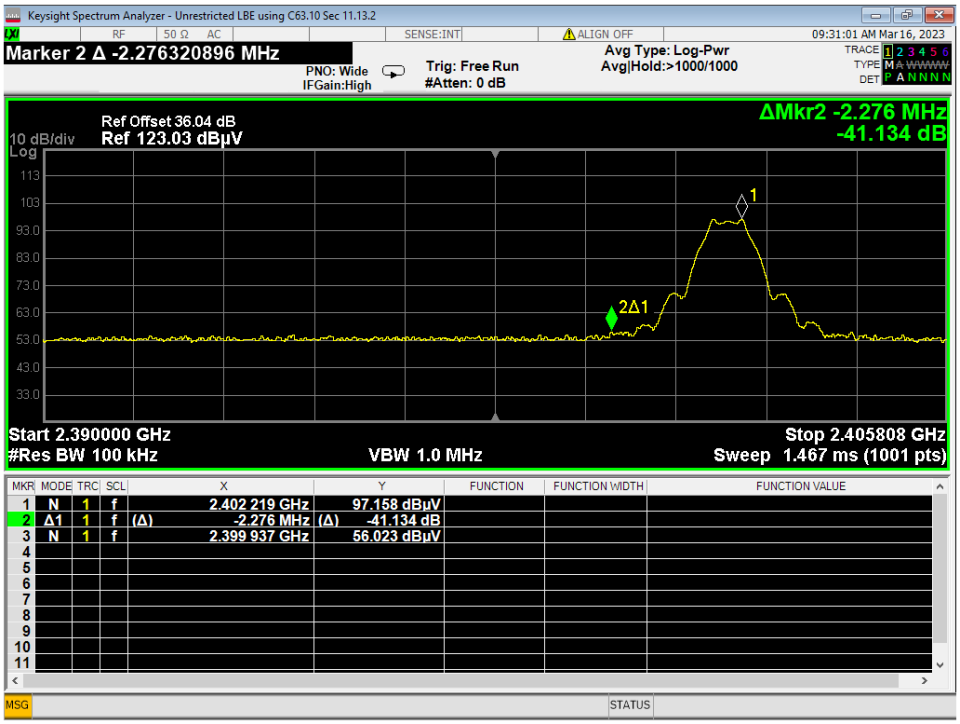


Figure 16 –Band-edge Measurement, Low Channel, Unrestricted Frequency

Reference Offset includes the cable loss (8.56dB) and the antenna factor (27.48dB)

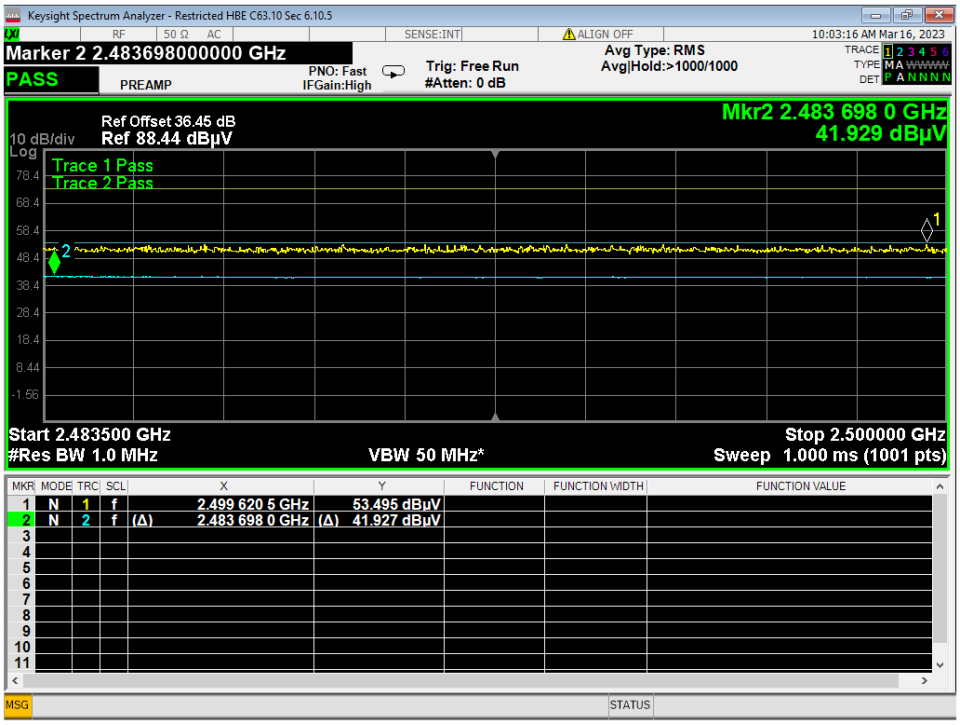


Figure 17 – Band-edge Measurement, High Channel, Restricted Frequency

Reference Offset includes cable loss (8.80dB) and antenna factor (27.67dB)

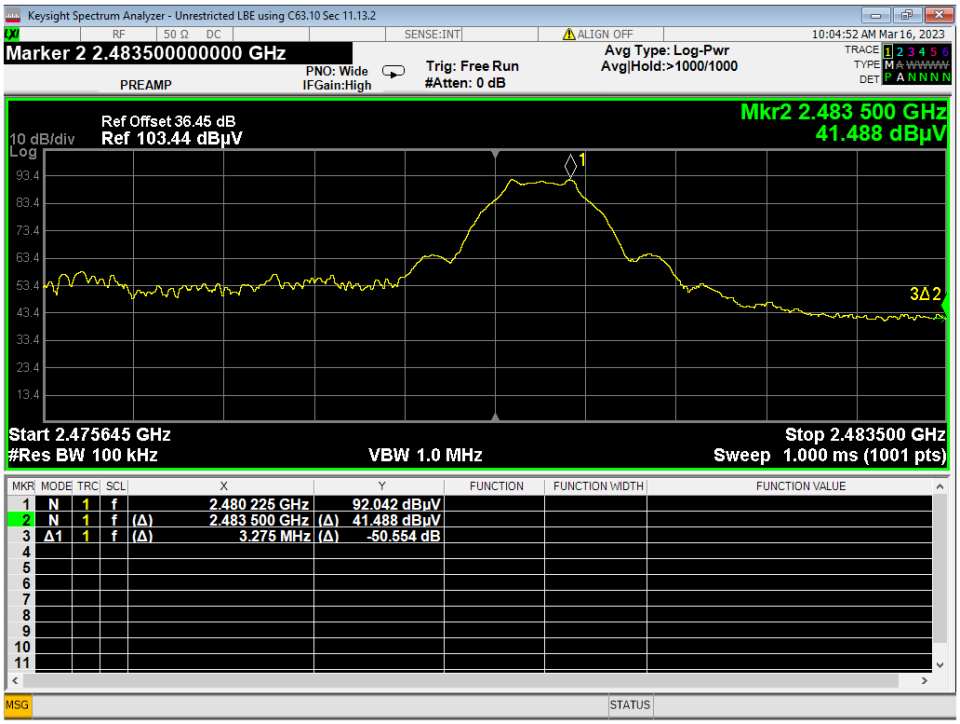


Figure 18 –Band-edge Measurement, High Channel, Unrestricted Frequency

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:
All measurements were taken at a distance of 3m from the EUT.

The EUT was maximized in all 3 orthogonal positions in a similar manner as described in Section 4.2.

Deviations from test standard:
No deviation.

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

EUT operating conditions:
The EUT was powered by a 120 VAC to DC power adapter and set to transmit mode.

Test results:
Pass
Comments:
1. All the measurements were found to be compliant.
2. Tabulated data is listed in section 4.0.

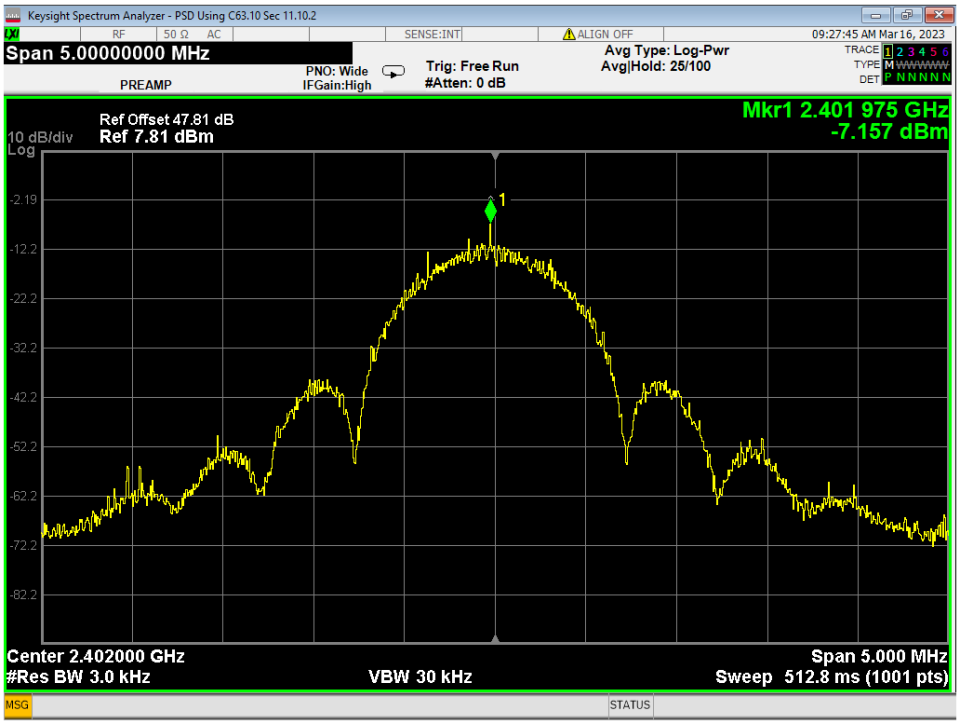


Figure 19 – Power Spectral Density, Low Channel

*EIRP radiated measurement. Reference Offset adds cable loss (8.57dB), antenna factor (27.47dB), and conversion from dBm to EIRP (11.77dB).

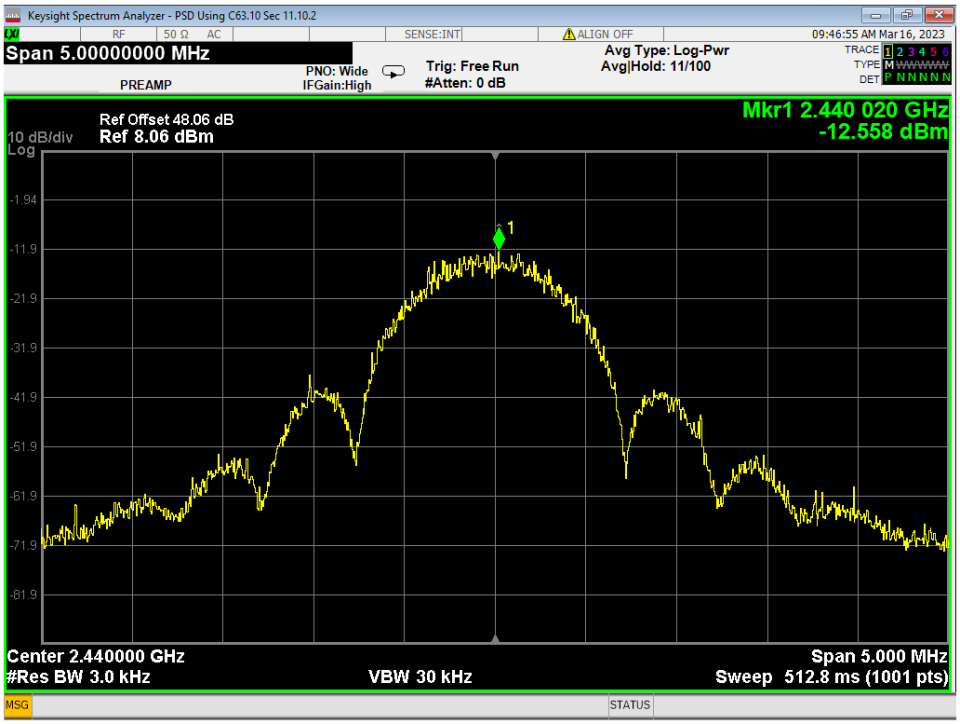


Figure 20 – Power Spectral Density, Mid Channel

*EIRP radiated measurement. Reference Offset adds cable loss (8.67dB), antenna factor (27.62dB), and conversion from dBm to EIRP (11.77dB).

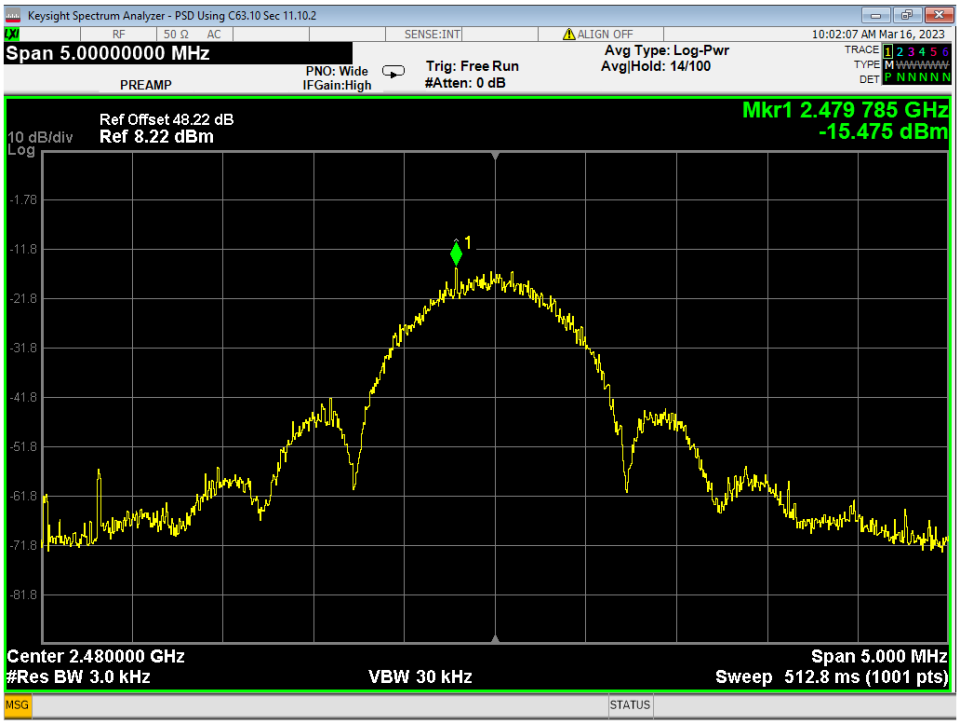


Figure 21 – Power Spectral Density, High Channel

* EIRP radiated measurement. Reference Offset adds cable loss (8.79dB), antenna factor (27.66dB), and conversion from dBm to EIRP (11.77dB).

4.6 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 0.5-5 5-30	66 to 56 56 60	56 to 46 46 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.

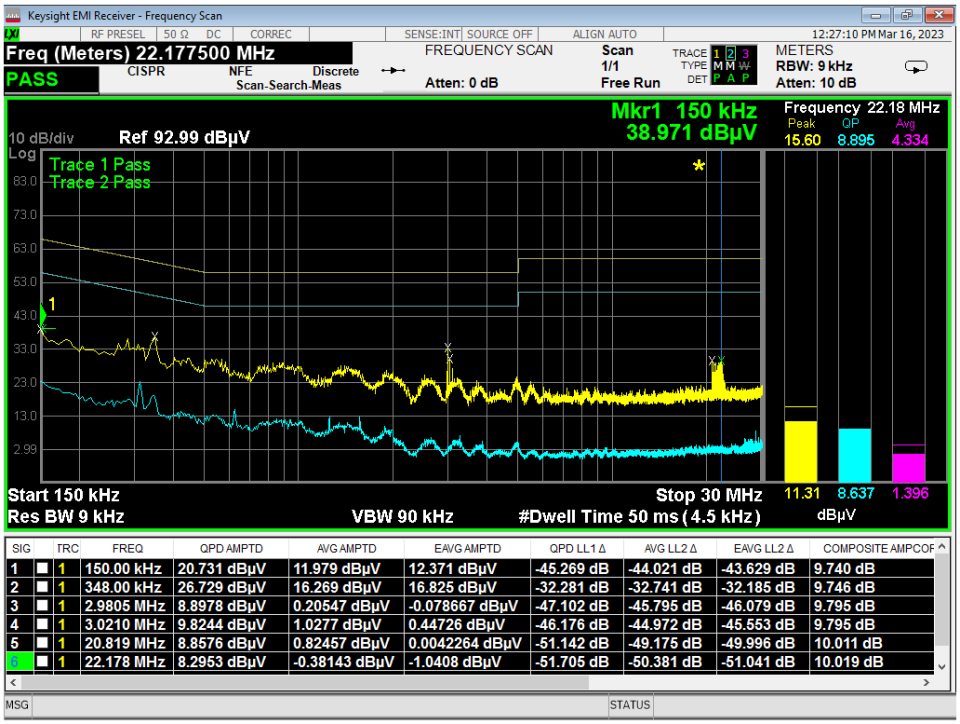
Test Procedures:

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room. A 120 VAC to DC power adapter was connected through a line impedance stabilization network (LISN) to the AC power mains. The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both the Line and Neutral of the AC power connected to the power supply through the LISN were checked for maximum conducted interference.
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

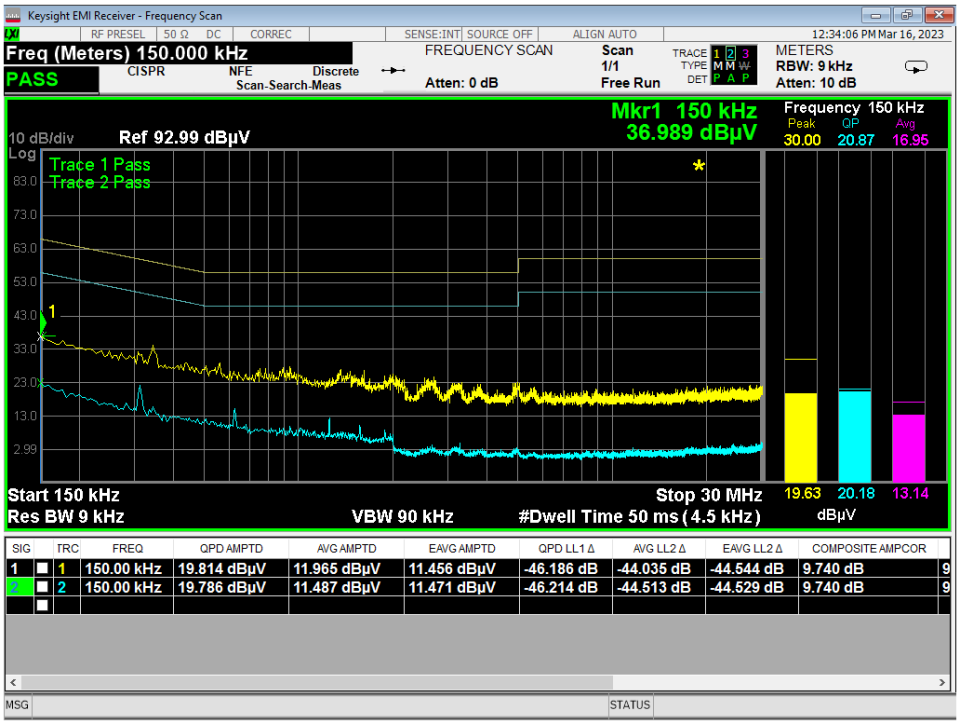
EUT operating conditions:
The EUT was powered by a 120 VAC to DC power adapter. The EUT was operating in transmit mode for one set of tests, and the EUT was operating in receive mode for another set of tests.

Test Results: PASS



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	EAVG AMPTD	QPD LL1 Δ	AVG LL2 Δ	EAVG LL2 Δ	COMPOSITE AMPCOR
1	1	150.00 kHz	20.731 dBµV	11.979 dBµV	12.371 dBµV	-45.269 dB	-44.021 dB	-43.629 dB	9.740 dB
2	1	348.00 kHz	26.729 dBµV	16.269 dBµV	16.825 dBµV	-32.281 dB	-32.741 dB	-32.185 dB	9.746 dB
3	1	2.9805 MHz	8.8978 dBµV	0.20547 dBµV	-0.078667 dBµV	-47.102 dB	-45.795 dB	-46.079 dB	9.795 dB
4	1	3.0210 MHz	9.8244 dBµV	1.0277 dBµV	0.44726 dBµV	-46.176 dB	-44.972 dB	-45.553 dB	9.795 dB
5	1	20.819 MHz	8.8576 dBµV	0.82457 dBµV	0.0042264 dBµV	-51.142 dB	-49.175 dB	-49.996 dB	10.011 dB
6	1	22.178 MHz	8.2953 dBµV	-0.38143 dBµV	-1.0408 dBµV	-51.705 dB	-50.381 dB	-51.041 dB	10.019 dB

Figure 22 - Conducted Emissions Plot, TX, Line



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	EAVG AMPTD	QPD LL1 Δ	AVG LL2 Δ	EAVG LL2 Δ	COMPOSITE AMPCOR
1	1	150.00 kHz	19.814 dBµV	11.965 dBµV	11.456 dBµV	-46.186 dB	-44.035 dB	-44.544 dB	9.740 dB
2	2	150.00 kHz	19.786 dBµV	11.487 dBµV	11.471 dBµV	-46.214 dB	-44.513 dB	-44.529 dB	9.740 dB

Figure 23 - Conducted Emissions Plot, TX, Neutral

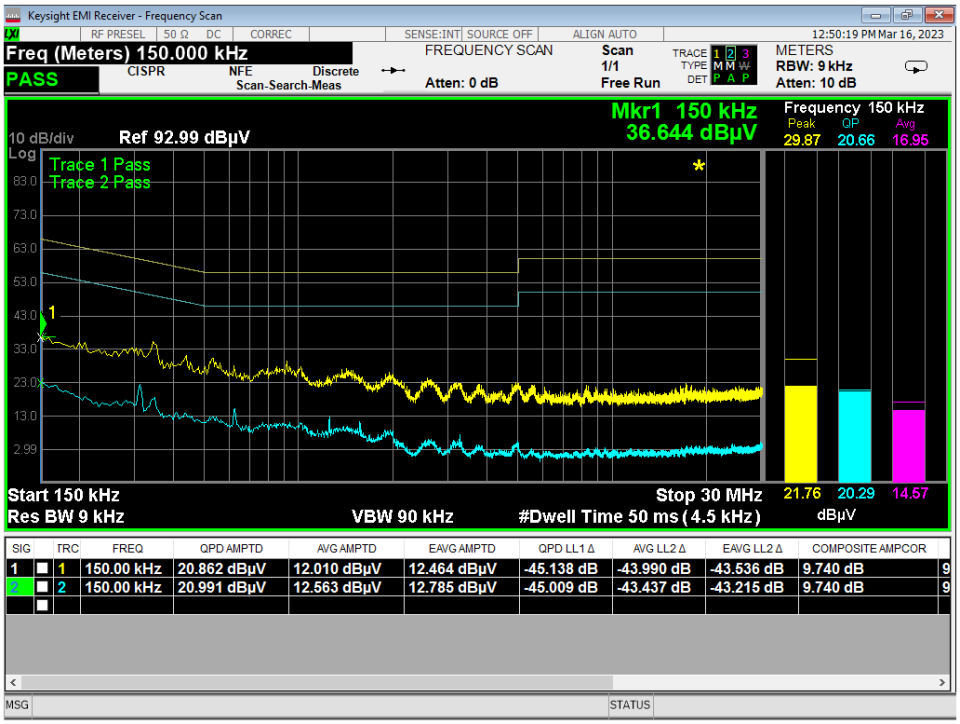


Figure 24 - Conducted Emissions Plot, RX, Line

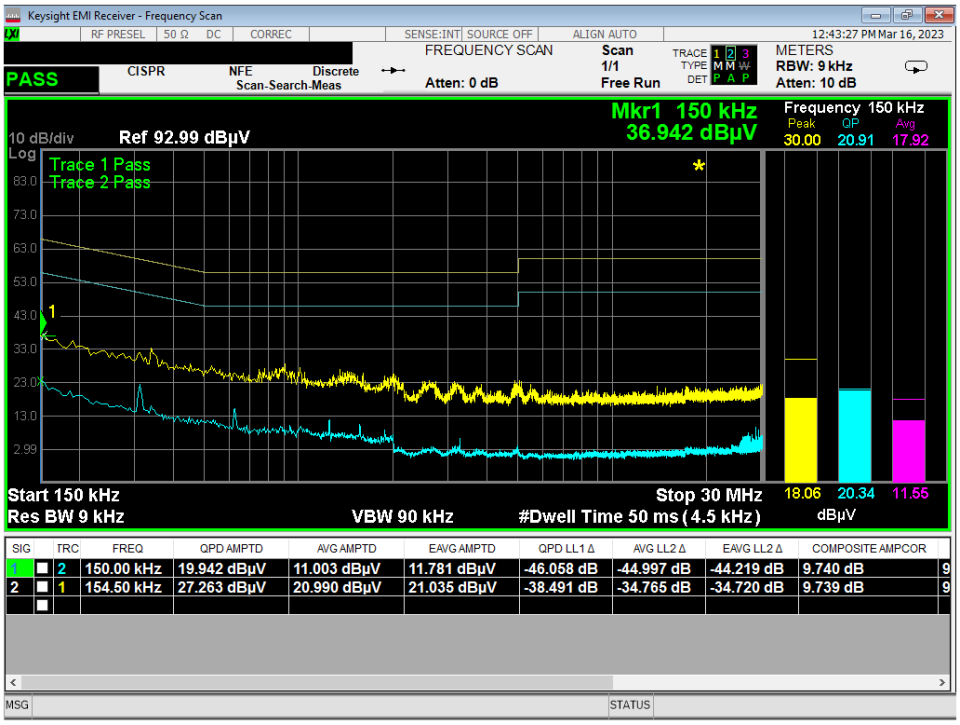


Figure 25 - Conducted Emissions Plot, RX, Line

APPENDIX A: SAMPLE 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 B – 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	3.03	3.60
Radiated Emissions, 3m	30MHz - 1GHz	4.19	5.34
Radiated Emissions, 3m	1GHz – 18GHz	5.08	5.48

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 worse-case of all test distances used.

REPORT END