RHEIN TECH LABORATORIES, INC.

Engineering Solutions & Electromagnetic Compatibility Services

FCC 15.231 & ISED RSS-210 Report

for

Connect+Pro 433.92 MHz

Alula, LLC
428 Minnesota Street
Suite 300
St. Paul, MN 55101 (USA)

Results: PASS

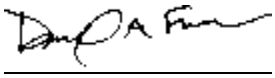
June 24, 2024

Standards Referenced for this Report	
FCC Part 15 (10-01-23)	Radio Frequency Devices
ISED RSS-210, Issue 10, 2019	Licence-Exempt Radio Apparatus: Category I Equipment
ANSI C63.10-2020	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

Report Prepared By: Daniel W. Baltzell

RTL Project/Document Number: 2024014

I, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this test report. No modifications were made to the equipment during testing in order to achieve compliance with these standards. Furthermore, there was no deviation from, additions to, or exclusions from the applicable parts of FCC Part 2, FCC Part 15, ANSI C63.10, ISED RSS-210, and RSS-Gen.

Signature:  Date: June 24, 2024

Typed/Printed Name: Desmond A. Fraser Position: President

This/these test(s) is/are accredited under Rhein Tech Laboratories, Inc. ISO/IEC 17025 accreditation issued by ANAB. Refer to certificate and scope of accreditation AT-1445.

Table of Contents

Table Index

Plot Index

Photograph Index

Appendix Index

1 General Information

1.1 Scope

This test report is prepared on behalf of Alula, LLC in accordance with the applicable FCC and ISED rules and regulations. The measurement procedure used was ANSI C63.10. The Equipment Under test (EUT) was the **Connect+Pro**.

The test results reported in this document relate only to the item(s) that was/were tested.

1.2 Test Facility

The open area test site (OATS) and conducted measurement facility used to collect the conducted and radiated data is located at 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170 (USA).

CAB ID: US0079

1.3 Deviations from Standards

There were no deviations from the test standards or methods.

1.4 Related Submitted(s)/Grants(s)

This is an original certification application for the Alula Connect+Pro, FCC ID: U5X-HUBPLUS; IC: 8310A-HUBPLUS. An SDoC report and a Collocation report is on file.

2 Test Information

2.1 Description of EUT

The Connect+Pro is a multi-transmitter residential wireless security system that manages other Alula alarm and security devices. It has two transmitting diversity antennas, antenna 1 and antenna 2.

The Connect+Pro has a 433 MHz TX and the following transmitter modules:

1. Espressif Wi-Fi; FCC ID: 2AC7Z-ESP32WROOM32E; IC: 21098-ESPWROOM32E)
2. Telit Cellular Modem; FCC ID: RI7ME310G1WW; IC: 5131A-ME310G1WW)
3. Alula Z-Wave; FCC ID: U5X-RE934Z; IC: 8310A-RE934Z

2.2 Exercising the EUT

For all testing, the EUT was set up to operate as intended in the field with the WiFi (802.11b/g/n) and cellular (LTE) modules transmitting simultaneously with the EUT per the Operational Description. The Connect+Pro was powered with a 12VDC AC Adapter provided by Alula.

For all tests, the EUT was operated in its most EMC-sensitive configuration.

2.3 Modification(s) to EUT

No modifications were made during testing.

2.4 Test Result Summary

Table 2-1: Test Result Summary

Test	FCC Reference	ISED Reference	Result
5 Second Timing	FCC 15.231(a)(1)	RSS-210 Issue 10 A1.1	PASS
Field Strength	FCC 15.231(b)(2)	RSS-210 Issue 10 A1.2	PASS
Restricted Band	FCC 15.205	RSS-Gen Issue 5 8.10	PASS
General Field Strength	FCC 15.209	RSS-Gen Issue 5 8.9	PASS
Bandwidth	FCC 15.231(c)	RSS-210 Issue 10 A1.3	PASS

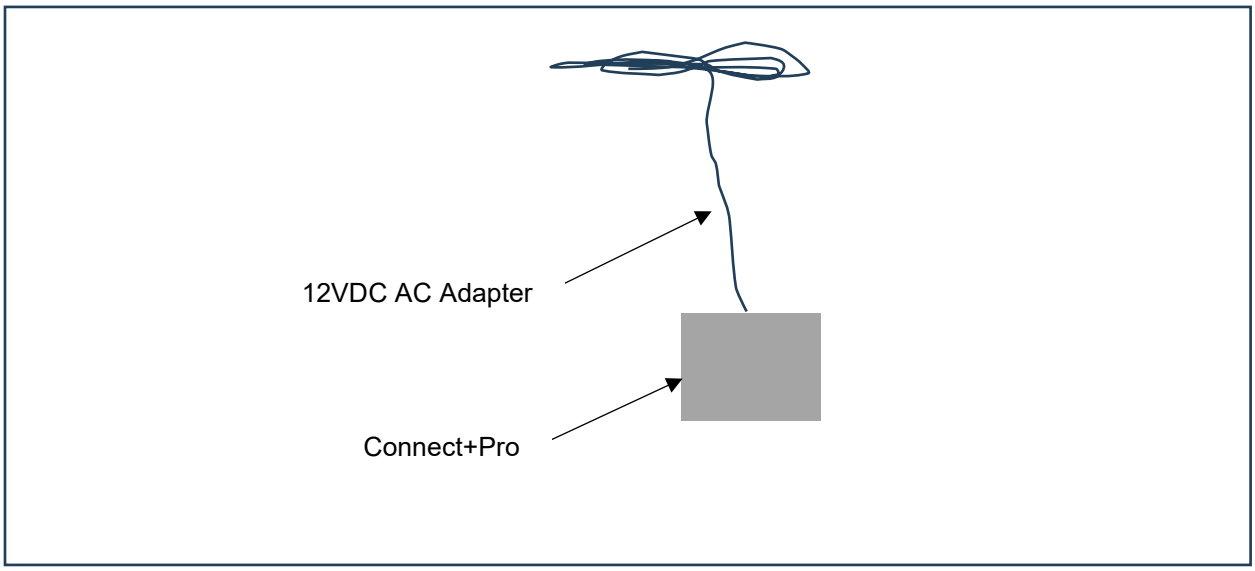
2.5 Test System Details

The test sample was received on February 16, 2024. The FCC identifiers for all applicable equipment, and cable descriptions used in the tested system, are listed in the following table.

Table 2-2: Equipment Under Test

Part	Manufacturer	Model	Serial Number	Cable Description	RTL Bar Code
Connect+Pro	Alula, LLC	HUB-PLUS-AC-A	N/A	Unshielded	24312
Connect+Pro	Alula, LLC	HUB-PLUS-AC-A	N/A	Unshielded	24318
AC Adapter	Amigo	AMS135-1201000FU	22040341631	Unshielded	24317
AC Adapter	Amigo	AMS135-1201000FU	17120352206	Unshielded	24315

2.6 Configuration Setup



3 Transmitter Deactivation – FCC 15.231(a)(1), (a)(2); RSS-210

15.231(a)(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

15.231(a)(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

Table 3-1: Environmental Conditions

Temperature (°C)	Humidity (%)	Air Pressure (kPa)
31	33	105.5

Table 3-2: Deactivation Data

Frequency (MHz)	Deactivation Timing (s)	Limit (s)	Result (Pass / Fail)
433.92	2.5	5.0	Pass

A trigger was set on the analyzer at initiation of pulse, a marker was located to show deactivation.

Plot 3-1: Transmission Deactivation

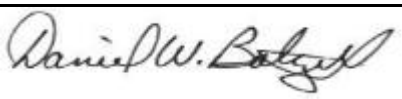
Measurement uncertainty: ±0.5 dB. This measurement uncertainty is an expanded uncertainty for 95% confidence level received with a coverage factor k=2.

Table 3-3: Deactivation Test Equipment

RTL Asset #	Part Type	Manufacturer	Model	Serial Number	Calibration Due Date
901773	Spectrum Analyzer	Rohde & Schwarz	FSW	101021	02/02/2025

Result: PASS

Test Personnel:

Daniel W. Baltzell		April 3, 2024
EMC Test Engineer	**Signature**	**Date of Test**

4 Occupied Bandwidth – FCC 15.231(c); RSS-210

4.1 Test Procedure

ANSI 63.10 §6.9

15.231(c): The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

Table 4-1: Environmental Conditions

Date	Temperature (°C)	Humidity (%)	Air Pressure (kPa)
March 11, 2024	22	25	99.8
April 3, 2024	24	30	99.2

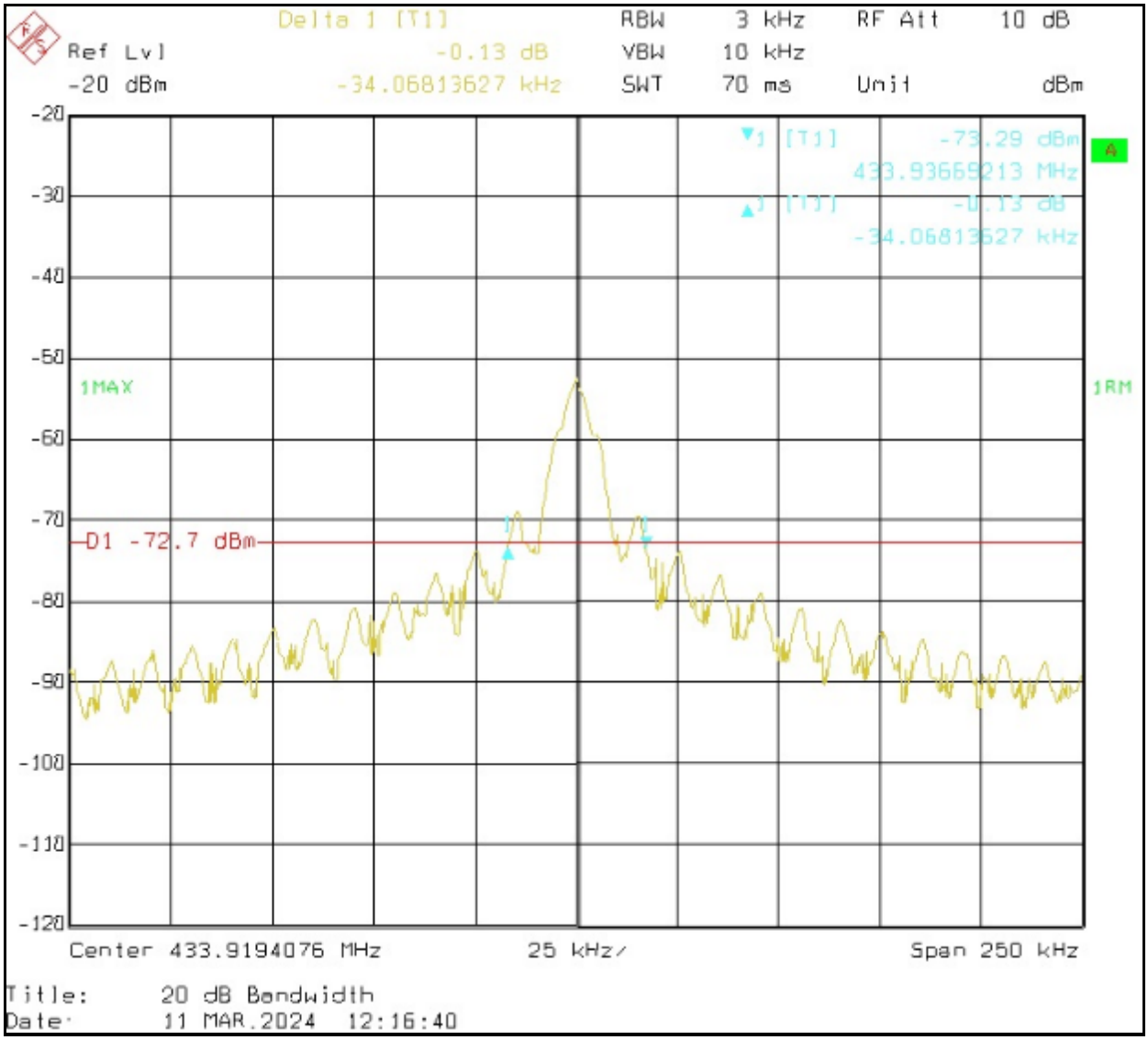
Table 4-2: Occupied Bandwidth Data

OBW 99% (kHz)	OBW 20 dB (kHz)	Limit (kHz)	Result (Pass / Fail)
86.7	34.1	1084.8	Pass

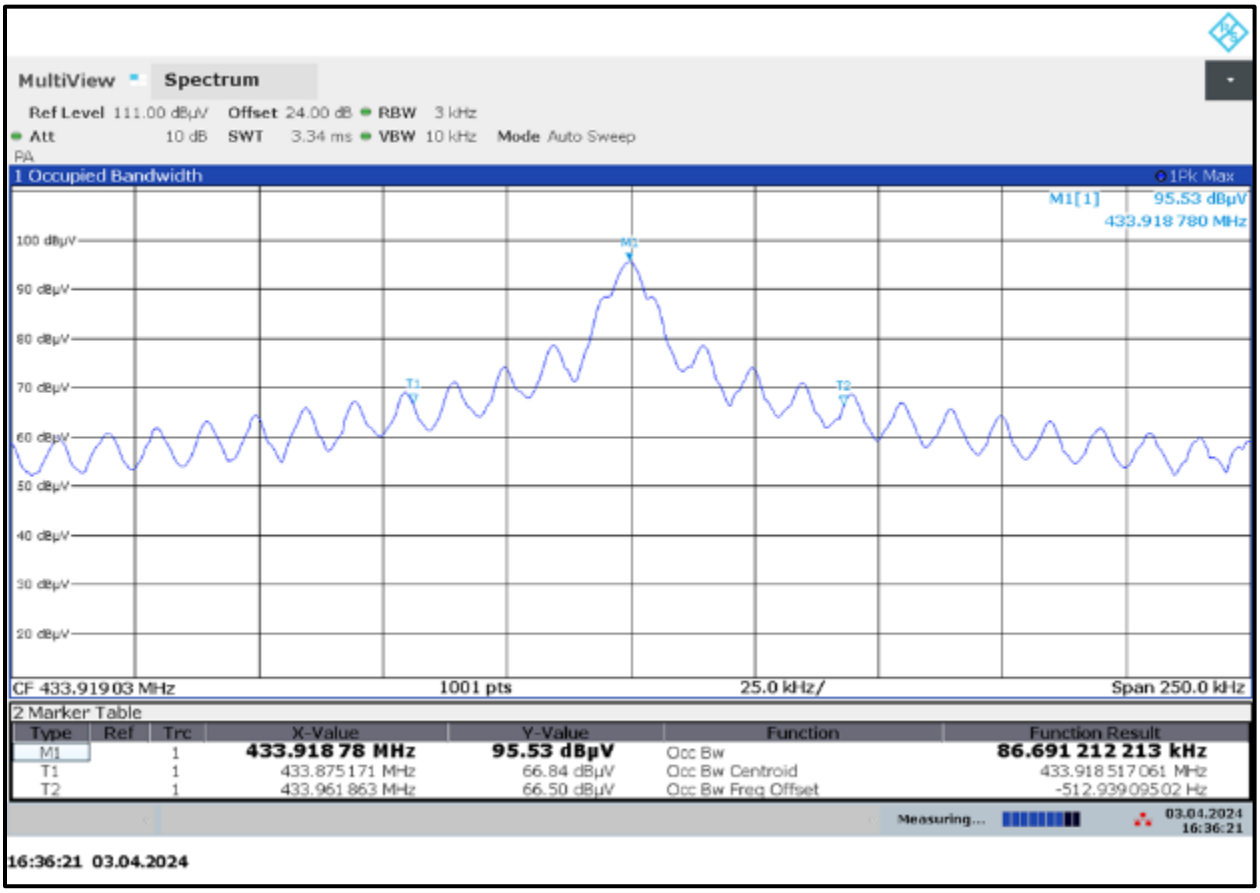
Limit = 433.92 MHz * 0.25% = 1.0848 MHz = 1084.8 kHz

OBW 99% = 86.7 kHz
OBW 20 dB = 34.1 kHz

Plot 4-1: 20 dB Bandwidth



Plot 4-2: 99% Bandwidth



Measurement uncertainty: ±0.5 dB. This measurement uncertainty is an expanded uncertainty for 95% confidence level received with a coverage factor k=2.

Table 4-3: Occupied Bandwidth Test Equipment

RTL Asset #	Part Type	Manufacturer	Model	Serial Number	Calibration Due Date
901672	Spectrum Analyzer	Rohde & Schwarz	FSEM30	FSEM30	03/29/2025
901773	Spectrum Analyzer	Rohde & Schwarz	FSW	101021	02/02/2025

Result: PASS

Test Personnel:

Daniel W. Baltzell		March 4 and 11, 2024
EMC Test Engineer	**Signature**	**Dates of Test**

5 Radiated Emissions – FCC 15.231(b)(2);15.205; 15.209; RSS-210; RSS-Gen

5.1 Radiated Emissions Test Procedure

ANSI C63.10 §6.3, 6.10

Radiated fundamental and spurious emissions were tested at 3 m. The EUT was tested in the three orthogonal planes with the receive antenna in both polarities. Before final measurements of radiated emissions were made on the OATS, the EUT was scanned indoors at 1 meter. This was done to determine its emissions spectrum signature. The physical arrangement of the test system and associated cabling was varied to determine the effect on the EUT's emissions in amplitude, direction, and frequency. process was repeated during final radiated emissions measurements on the OATS, at each frequency, to ensure that maximum amplitudes were attained. Final radiated emissions measurements were made on the OATS. The EUT was placed on a non-conductive turntable 80 cm high. At each frequency, the EUT was rotated 360°, and the antenna was raised and lowered between 1 and 4 meters to determine the emission's maximum level. Measurements were taken using both horizontal and vertical antenna polarization. For frequencies between 30 and 1000 MHz, the SA 6 dB bandwidth was set to 120 kHz, and the SA was operated in the CISPR QPK detection mode. For emissions above 1 GHz, measurements were taken using the AVG detector function with a minimum RBW of 1 MHz. The VBW was set to at least 3 times the RBW. The highest emission amplitudes relative to the appropriate limit were measured and recorded.

5.2 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:

$$FI(dB\mu V/m) = SAR(dB\mu V) + SCF(dB/m)$$

FI = Field Intensity
SAR = Spectrum Analyzer Reading
SCF = Site Correction Factor

The Site Correction Factor (SCF) used in the above equation is determined empirically, and is expressed in the following equation:

$$SCF(dB/m) = - PG(dB) + AF(dB/m) + CL(dB)$$

SCF = Site Correction Factor
PG = Pre-amplifier Gain
AF = Antenna Factor
CL = Cable Loss

The field intensity in microvolts per meter can then be determined according to the following equation:

$$FI(\mu V/m) = 10^{FI(dB\mu V/m)/20}$$

For example, assume a signal at a frequency of 125 MHz has a received level measured as 49.3 dBuV. The total Site Correction Factor (antenna factor plus cable loss minus preamplifier gain) for 125 MHz is -11.5 dB/m. The actual radiated field strength is calculated as follows:

$$49.3\ dB\mu V - 11.5\ dB = 37.8\ dB\mu V/m$$
$$10^{37.8/20} = 10^{1.89} = 77.6\ \mu V/m$$

5.3 Radiated Emissions Test Data

The data and limits presented in this report are for radiated emissions per 15.231(b)(2) which references 15.35(b), and peak limiting for restricted bands per 15.209(e), which again references 15.35(b)(2). No average data is presented in this report. Data (if applicable) is also presented for spurious, non-harmonic radiated emissions per 15.209.

15.231(b) In addition to the provisions of §15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

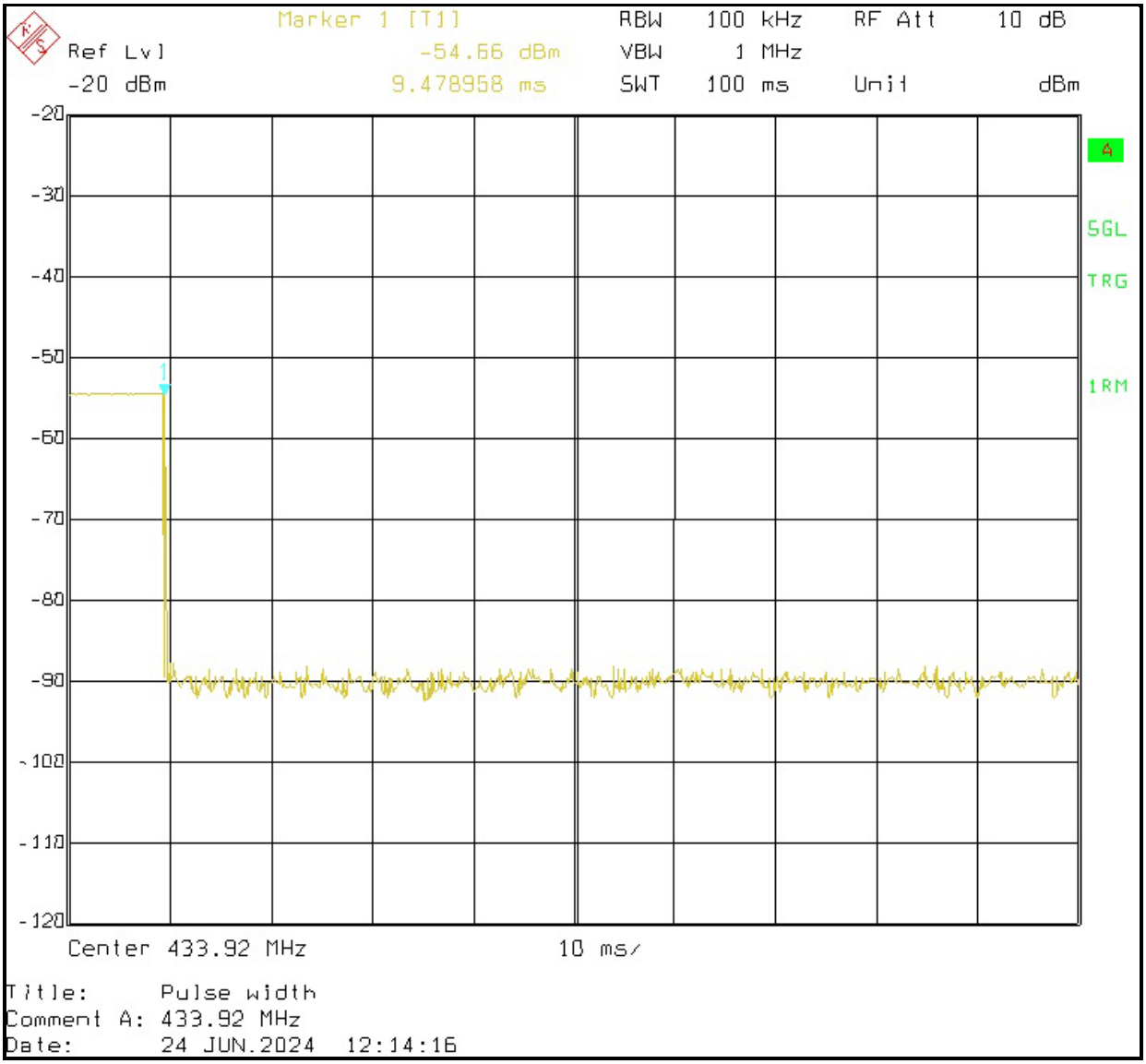
Fundamental Frequency (MHz)	Field Strength of Fundamental (µV/m)	Field Strength of Spurious Emissions (µV/m)
40.66 – 40.70	2 250	225
70 – 130	1 250	125
130 – 174	1 250 to 3 750	125 to 375
174 – 260	3 750	375
260 – 470	3 750 to 12 500[1]	375 to 1 250[1]
Above 470	12 500	1 250

[1] Linear Interpolation

Table 5-1: Environmental Conditions

Temperature (°C)	Humidity (%)	Air Pressure (kPa)
15	35	99.5

Plot 5-1: Duty Cycle Timing Plot



1- 9.5ms pulse per 100 ms

20log(.095)= -20.4 dB

Table 5-2: Radiated Spurious Emissions Test Data – Peak; Antenna #1

Frequency (MHz)	Antenna Polarity (H / V)	Raw Emission (dBµV/m)	Site Correction Factor (dB/m)	Corrected Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result (Pass / Fail)
433.92	V	77.1	23.5	100.6	100.8	-0.2	Pass
867.84	V	15.5	30.3	45.8	80.8	-35.0	Pass
1301.76	V	75.6	-3.9	71.7	74.0	-2.3	Pass
1735.68	H	67.3	0.4	67.7	80.8	-13.1	Pass
2169.60	H	66.0	2.8	68.8	80.8	-12.0	Pass
2603.52	V	71.1	4.9	76.0	80.8	-4.8	Pass
3037.44	V	61.8	10.0	71.8	80.8	-9.0	Pass
3471.36	H	53.6	9.4	63.0	80.8	-17.8	Pass
3905.28	H	45.9	11.3	57.2	74.0	-16.8	Pass

Table 5-3: Radiated Spurious Emissions Test Data – Average; Antenna #1

Frequency (MHz)	Antenna Polarity (H / V)	Raw Emission (dBµV/m)	Site Correction Factor (dB/m)	Corrected Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result (Pass / Fail)
433.92	V	56.7	23.5	80.2	80.8	-0.6	Pass
867.84	V	-4.9	30.3	25.4	60.8	-35.4	Pass
1301.76	V	55.2	-3.9	51.3	54	-2.7	Pass
1735.68	H	46.9	0.4	47.3	60.8	-13.5	Pass
2169.60	H	45.6	2.8	48.4	60.8	-12.4	Pass
2603.52	V	50.7	4.9	55.6	60.8	-5.2	Pass
3037.44	V	41.4	10	51.4	60.8	-9.4	Pass
3471.36	H	33.2	9.4	42.6	60.8	-18.2	Pass
3905.28	H	25.5	11.3	36.8	54	-17.2	Pass

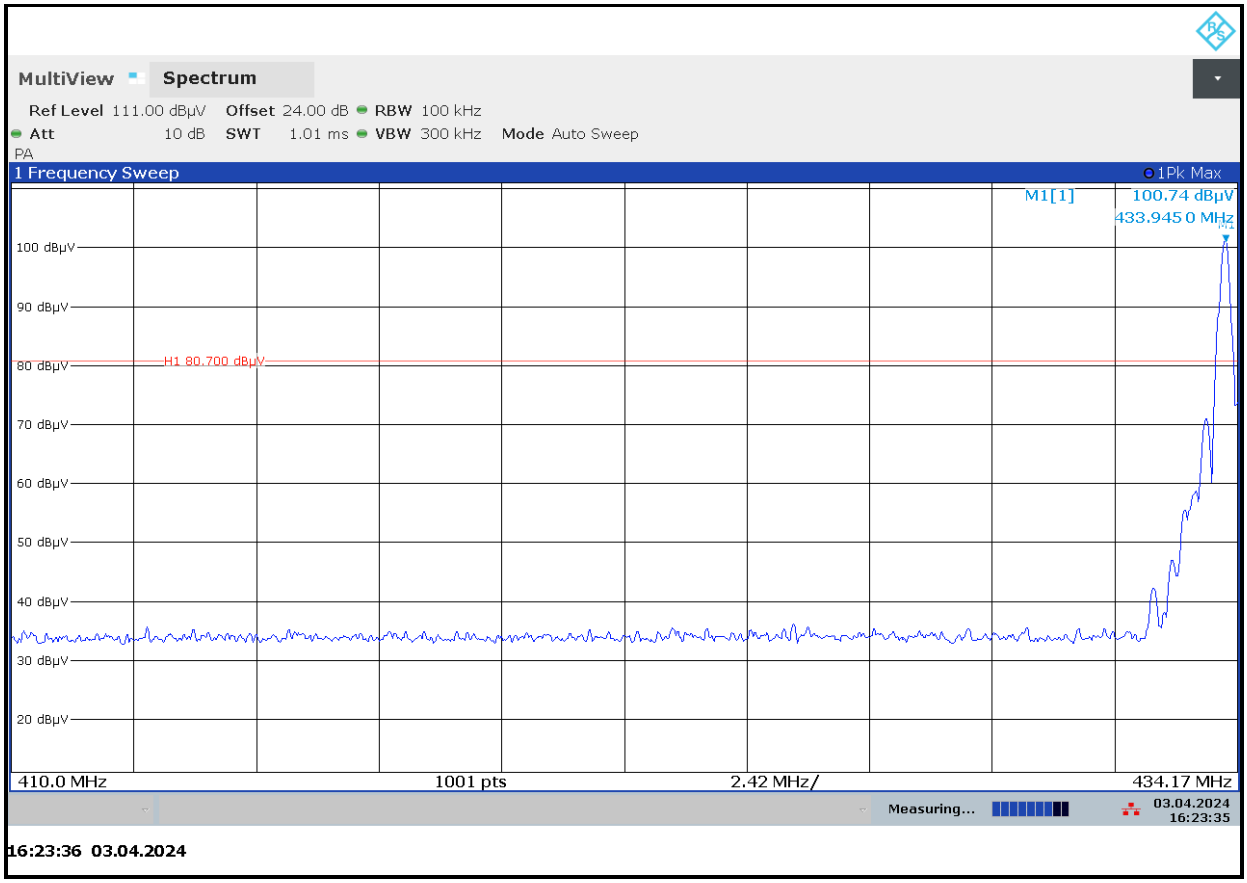
Table 5-4: Radiated Spurious Emissions Test Data – Peak; Antenna #2

Frequency (MHz)	Antenna Polarity (H / V)	Raw Emission (dBµV/m)	Site Correction Factor (dB/m)	Corrected Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result (Pass / Fail)
433.92	V	77.1	23.5	100.6	100.8	-0.2	Pass
867.84	V	24.1	30.3	54.4	80.8	-26.4	Pass
1301.76	H	33.7	33.6	67.3	74.0	-6.7	Pass
1735.68	H	56.5	0.4	56.9	80.8	-23.9	Pass
2169.60	H	57.5	2.8	60.3	80.8	-20.5	Pass
2603.52	V	68.1	4.9	73.0	80.8	-7.8	Pass
3037.44	H	61.0	10.0	71.0	80.8	-9.8	Pass
3471.36	H	53.5	9.4	62.9	80.8	-17.9	Pass
3905.28	V	44.3	11.3	55.6	74.0	-18.4	Pass
4339.20	V	45.9	14.9	60.8	74.0	-13.2	Pass

Table 5-5: Radiated Spurious Emissions Test Data – Average; Antenna #2

Frequency (MHz)	Antenna Polarity (H / V)	Raw Emission (dBµV/m)	Site Correction Factor (dB/m)	Corrected Emission (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result (Pass / Fail)
433.92	V	56.7	23.5	80.2	80.8	-0.6	Pass
867.84	V	3.7	30.3	34.0	60.8	-26.8	Pass
1301.76	H	13.3	33.6	46.9	54.0	-7.1	Pass
1735.68	H	36.1	0.4	36.5	60.8	-24.3	Pass
2169.60	H	37.1	2.8	39.9	60.8	-20.9	Pass
2603.52	V	47.7	4.9	52.6	60.8	-8.2	Pass
3037.44	H	40.6	10.0	50.6	60.8	-10.2	Pass
3471.36	H	33.1	9.4	42.5	60.8	-18.3	Pass
3905.28	V	23.9	11.3	35.2	54.0	-18.8	Pass
4339.20	V	25.5	14.9	40.4	54.0	-13.6	Pass

Plot 5-2: Restricted Band Edge - FCC 15.205



Measurement uncertainty: Measurement uncertainties shown for these tests are expanded uncertainties expressed at 95% confidence level using a coverage factor k = 2.

Radiated Emissions: +/- 4.6 dB

Table 5-6: Radiated Emissions Test Equipment

RTL Asset #	Part Type	Manufacturer	Model	Serial Number	Calibration Due Date
900321	Horn Antennas (4.0 – 8.2 GHz)	EMCO	3161-03	9508-1020	08/05/2024
900772	Horn Antenna (2 – 4 GHz)	EMCO	3161-02	9804-1044	08/05/2024
901669	Biconilog Antenna (30 MHz – 6000 MHz)	ETS-Lindgren	3142E	00166065	07/11/2025
900905	OATS 1 Preamplifier 40dB (30 MHz – 2 GHz)	Rhein Tech Laboratories	PR-1040	1006	01/30/2025
901727	SMK RF Cables 36”	Insulated Wire Inc.	KPS-1503-360-KPR	NA	11/30/2024
901729	SMK RF Cables 20’	Insulated Wire Inc.	KPS-1503-3150-KPR	NA	12/29/2024
901672	Spectrum Analyzer	Rohde & Schwarz	FSEM30	FSEM30	03/29/2025
900932	Preamplifier (1 - 26.5 GHz)	Hewlett Packard	8449B OPT H02	3008A00505	01/30/2025

Result: PASS

Test Personnel:

Daniel W. Baltzell		February 24-25, June 24, 2024
EMC Test Engineer	**Signature**	**Dates of Test**

6 AC Conducted Emissions - FCC Rules and Regulations §15.107

6.1 Test Methodology for Conducted Line Emissions Measurements

The power line conducted emission measurements were performed in a type shielded enclosure. The EUT was placed on a wooden table. Power was fed to the EUT through a 50-ohm/50 microhenry Line Impedance Stabilization Network (LISN). The EUT LISN was fed power through an AC filter box mounted on the shielded enclosure. The filter box and EUT LISN housing are bonded to the ground plane of the shielded enclosure. A second LISN, the peripheral LISN, provides isolation for the EUT's auxiliary equipment. This peripheral LISN was also fed AC power.

The spectrum analyzer was connected to the AC line through an isolation transformer. The 50-ohm output of the EUT LISN was connected to the spectrum analyzer input through a Solar 100 kHz high-pass filter. The filter is used to prevent overload of the spectrum analyzer from noise below 100 kHz. Conducted emission levels were measured on each current-carrying line with the spectrum analyzer operating in the CISPR quasi-peak mode (or peak mode if applicable). The analyzer's 6 dB bandwidth was set to 9 kHz. Video filter less than 10 times the resolution bandwidth is not used. Average measurements are performed in linear mode using a 10 kHz resolution bandwidth, a 1 Hz video bandwidth, by increasing
the sweep time in order to obtain a calibrated measurement. The emission spectrum was scanned from 150 kHz to 30 MHz.

Measurement Uncertainty: Measurement uncertainties shown for these tests are expanded uncertainties expressed at 95% confidence level using a coverage factor k = 2.

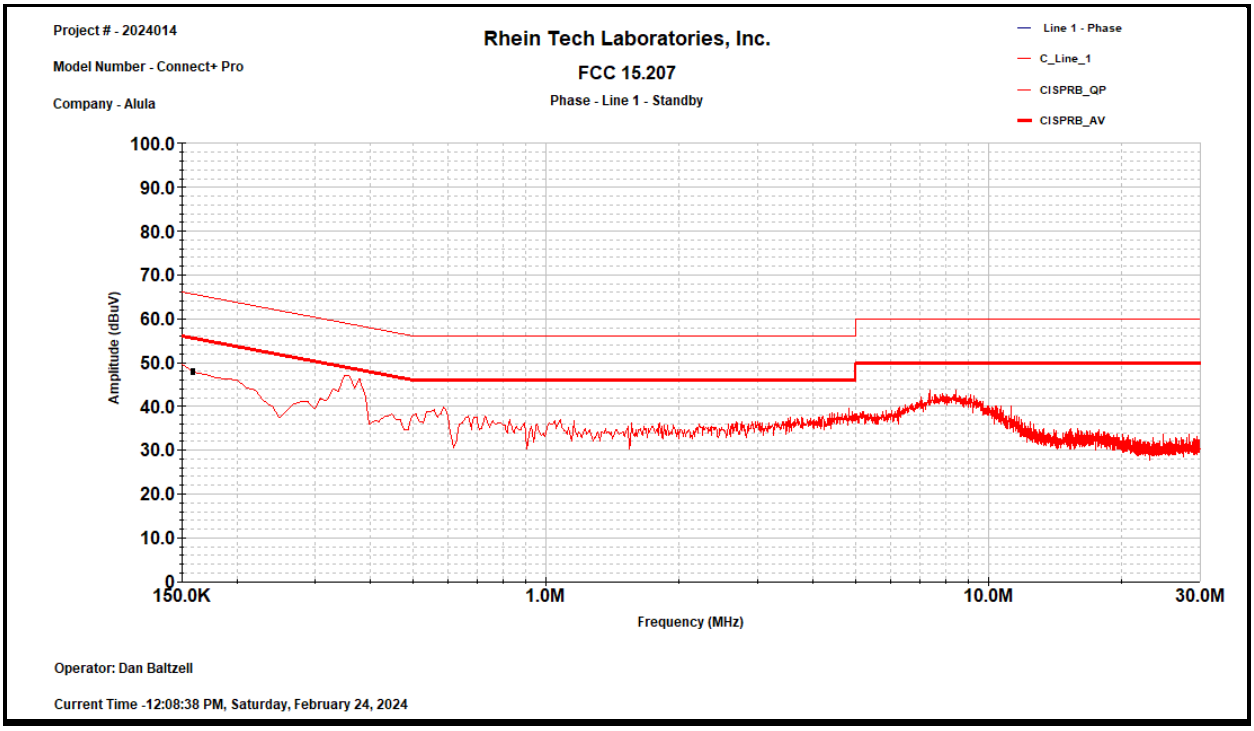
Conducted Emissions: +/-3.6 dB

Table 6-1: Environmental Conditions

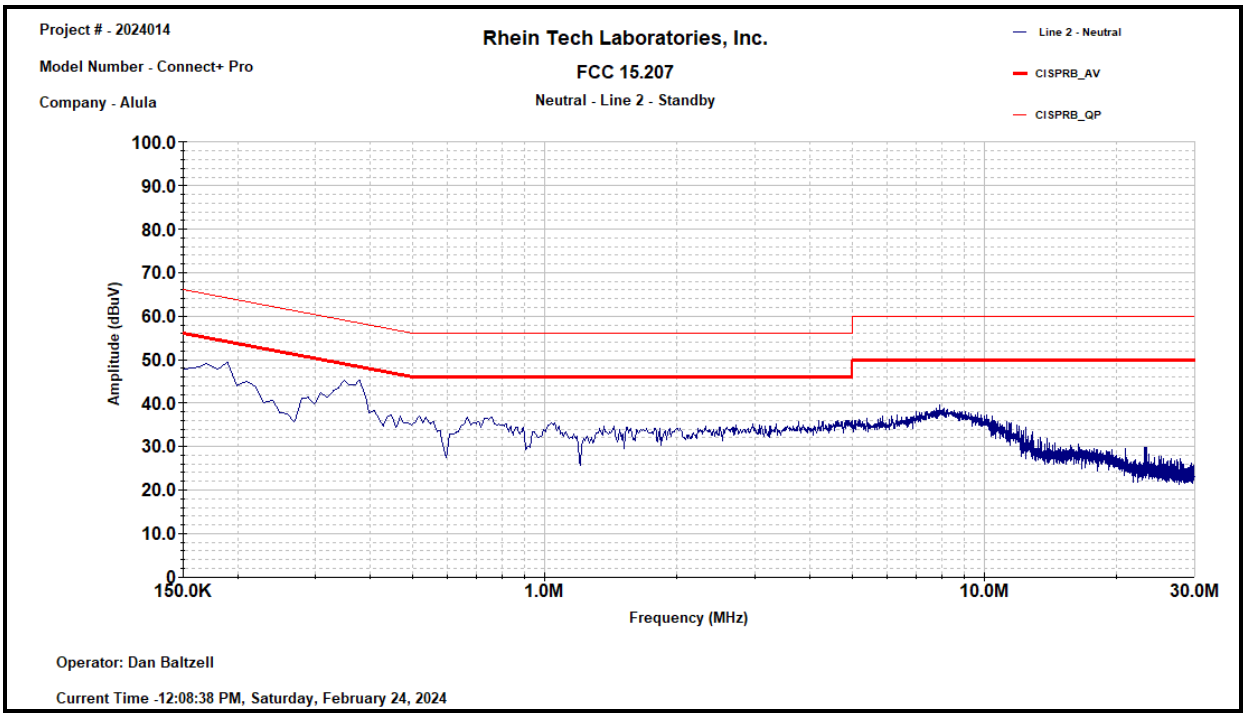
Temperature (°C)	Humidity (%)	Air Pressure (kPa)
22	29	100.3

6.2 Conducted Emissions Test Data

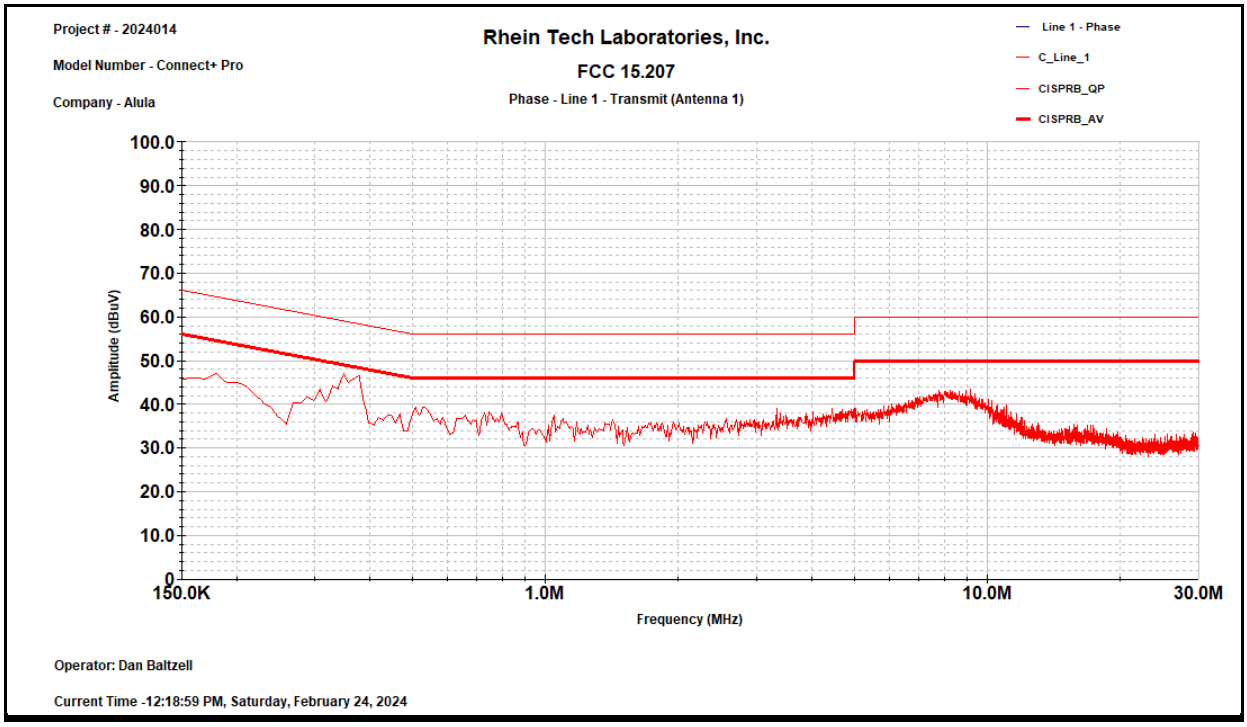
Plot 6-1 Phase (Standby)



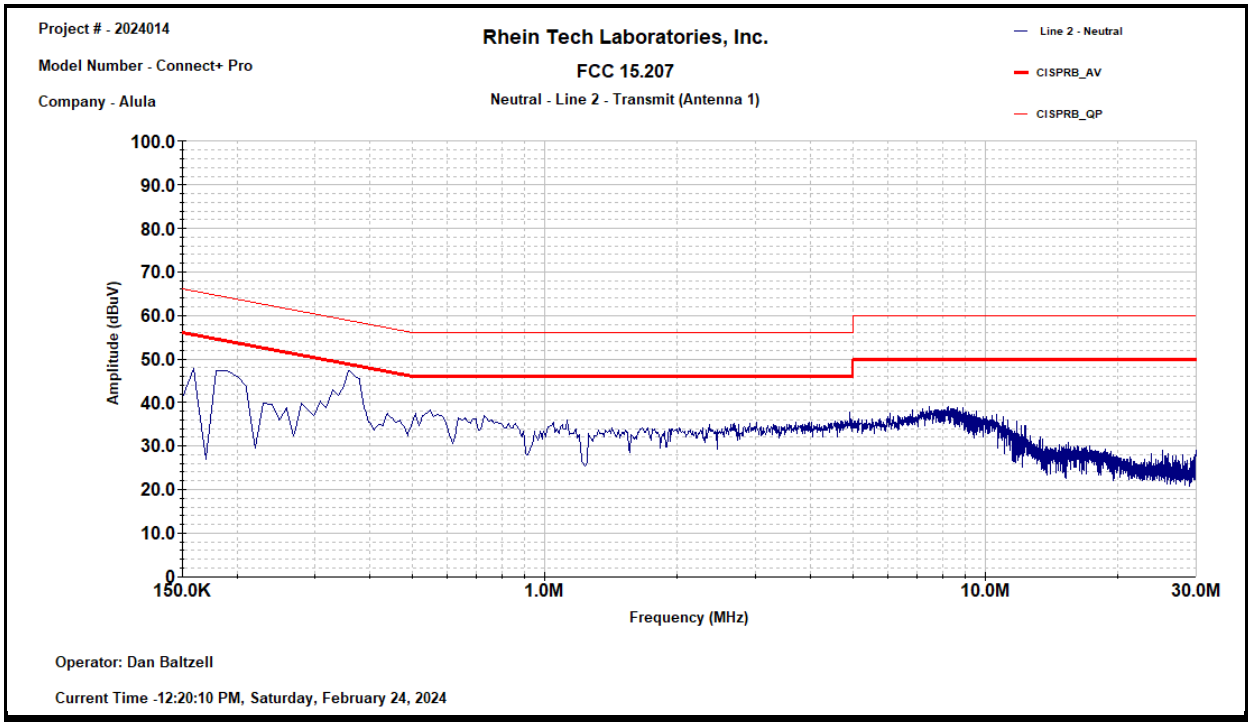
Plot 6-2: Neutral (Standby)



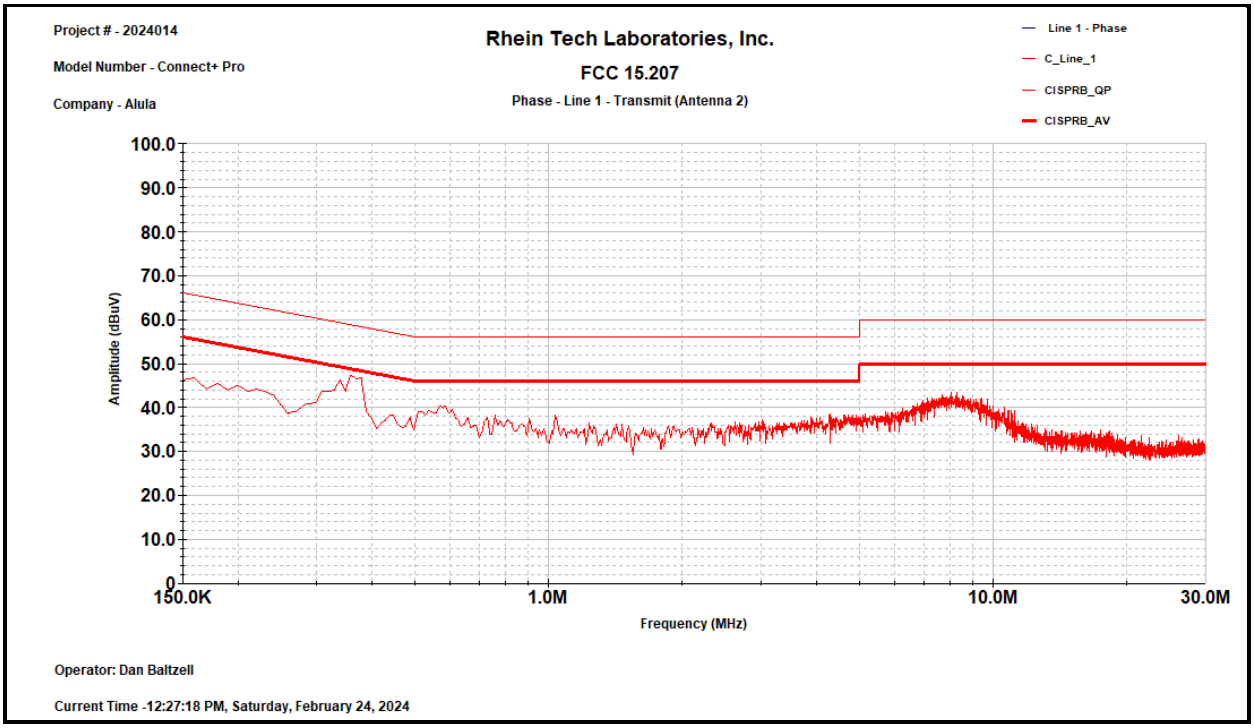
Plot 6-3: Phase (Transmit – Antenna 1)



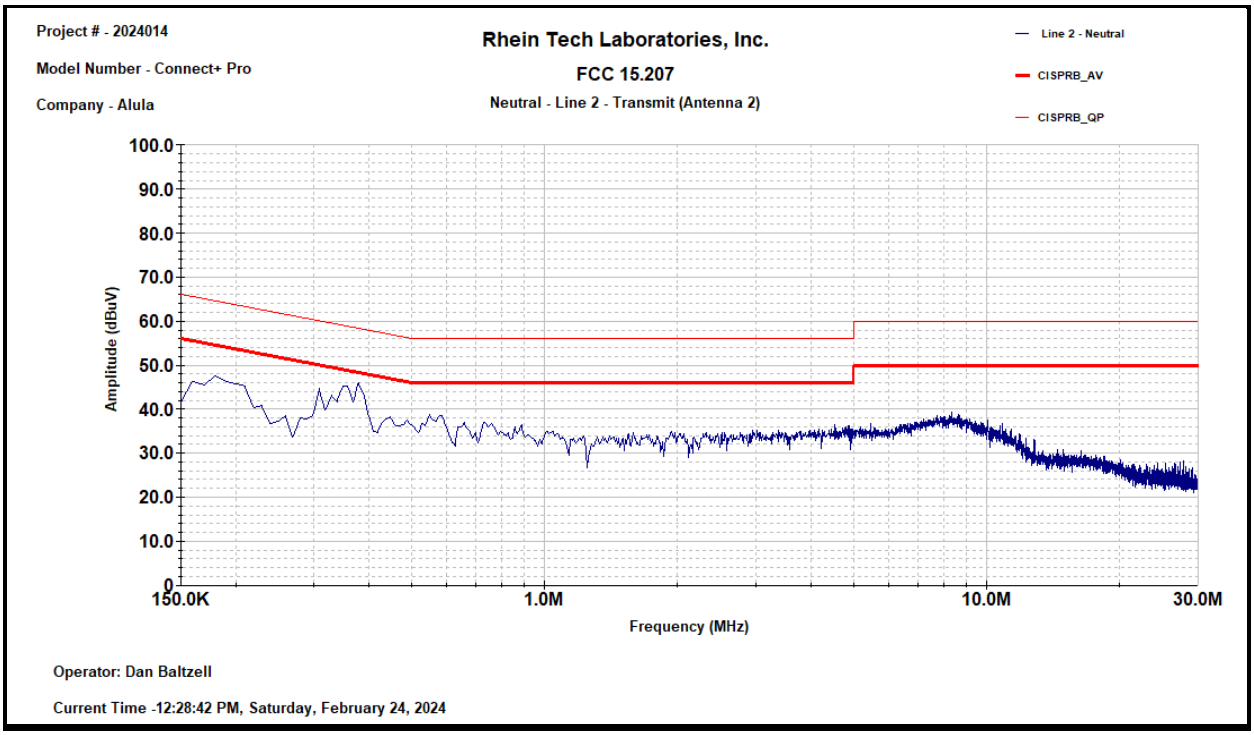
Plot 6-4: Neutral (Transmit – Antenna 1)



Plot 6-5: Phase (Transmit – Antenna 2)



Plot 6-6: Neutral (Transmit – Antenna 2)



Result: Pass

Test Personnel:

Daniel W. Baltzell		February 24, 2024
EMC Test Engineer	**Signature**	**Date of Test**

6.3 Conducted Emissions Test Equipment

Table 6-2: Conducted Emissions Test Equipment

Part	Manufacturer	Model	Serial Number	RTL Bar Code	Calibration Due Date
Quasi-Peak Adapter	Hewlett Packard	85650A	2521A00743	900339	09/16/2024
Spectrum Analyzer Display	Hewlett Packard	85662A 067	3144A20839	900930	02/26/2025
Spectrum Analyzer RF Section (100 Hz – 22 GHz)	Hewlett Packard	8566B	2138A07771	900931	02/26/2025
16A LISN	AFJ International	LS16/110VAC	16010020080	901083	02/16/2025
Filter	Solar	Type 8130-7.0	N/A	900728	05/08/2026
RF Current Probe (10 kHz - 500 MHz)	Fischer Custom Communications	F-52	130484	901636	05/05/2024
Test Software	ETS-Lindgren	Tile!	7.1.3.20	N/A	N/A

7 Conclusion

The data presented in this report shows that the EUT as tested, **Connect+Pro**, complies with the applicable requirements of FCC Rules and Regulations Parts 2 and 15 and ISED RSS-210.