



Engineering Solutions & Electromagnetic Compatibility Services

FCC Part 15.231 Test Data

345 MHz Sensor

Model: RE229

for

Alula

2340 Energy Park Drive, Suite 100

St. Paul, MN 55108 (USA)

Contact: Jake Peterson

Testing Conducted By:

Rhein Tech Laboratories, Inc.

360 Herndon Parkway, Suite 1400

Herndon, VA 20170

RTL Test Engineer: Khue Do

RTL Project/Report Number: 2019214

January 7, 2020

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, and ANSI C63.10.

Signature: 

Date: January 7, 2020

Typed/Printed Name: Desmond A. Fraser

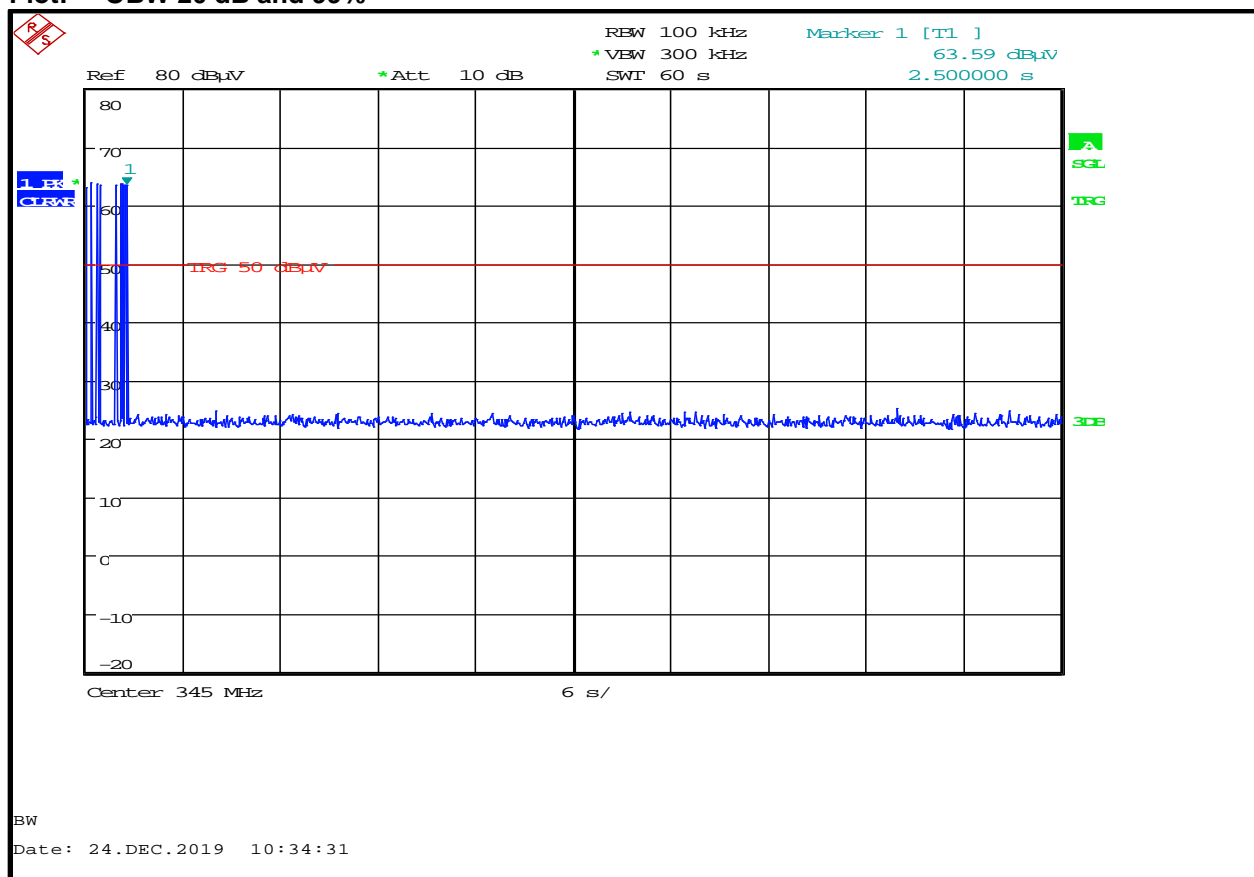
Position: President

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*These tests are accredited and meet the requirements of ISO/IEC 17025 as verified by ANAB.
Refer to certificate and scope of accreditation AT-1445. ISED#: 2956A*

| | | |
|------------------------|------------------|----------------------|
| 5 second timing | FCC 15.231(a)(1) | RSS-210 Issue 9 A1.1 |
| Field Strength | FCC 15.231(b)(2) | RSS-210 Issue 9 A1.2 |
| Restricted Band | FCC 15.205 | RSS-Gen Issue 5 8.10 |
| General Field Strength | FCC 15.209 | RSS-Gen Issue 5 8.9 |
| Bandwidth | FCC 15.231(c) | RSS-210 Issue 9 A1.3 |

| Frequency (MHz) | Deactivation Marker (s) | Limit (s) | Result (Pass / Fail) |
|-----------------|-------------------------|-----------|----------------------|
| 345.0 | 2.5 | 5.0 | Pass |



Measurement uncertainty: $\pm 1 \times 10^{-6}$ Hz. This measurement uncertainty is an expanded uncertainty for 95% confidence level received with a coverage factor $k=2$.

Deactivation Test Equipment

| RTL Asset # | Part Type | Manufacturer | Model | Serial Number | Calibration Due Date |
|-------------|---------------------------------------|--------------------|-------|---------------|----------------------|
| 901581 | Spectrum Analyzer (20 Hz – 50 GHz) | Rohde & Schwarz | FSU | 1166.1660.50 | 04/26/2021 |

Test Personnel:

| | | |
|-------------------|---|-------------------|
| Khue Do |  | December 24, 2019 |
| EMC Test Engineer | Signature | Date of Test |

Radiated Spurious Harmonics Emissions

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), as procured by Alula. 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

Test Procedure

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. The emissions were maximized; that is, the measurement antenna height was varied between 1 and 4 m, and the EUT was rotated through 360° on a rotating turntable until the maximum emissions were found. Both horizontal and vertical measurement antenna polarizations were used. A resolution bandwidth of 120 kHz was used for frequencies less than 1000 MHz, and a resolution bandwidth of 1 MHz was used for frequencies greater than or equal to 1000 MHz. The video bandwidth was set to a value at least three times greater than the resolution bandwidth.

EUT Disposition

The EUT was adapted to continuously transmit for testing purposes.

15.231 Radiated Spurious Emissions Test Data – Peak:

| 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) |
|-----------------|--------------------------|-----------------------|-------------------------------|-----------------------------|----------------|-------------|----------------------|
| 345.00 | H | 63.6 | 30.9 | 94.5 | 97.3 | -2.8 | Pass |
| 690.00 | H | 62.0 | -0.8 | 61.2 | 77.3 | -16.1 | Pass |
| 1035.00 | H | 49.2 | 4.8 | 54.0 | 74.0 | -20.0 | Pass |
| 1380.00 | H | 43.4 | 11.4 | 54.8 | 74.0 | -19.2 | Pass |
| 1725.00 | H | 42.4 | 19.2 | 61.6 | 77.3 | -15.7 | Pass |
| 2070.00 | H | 49.1 | 10.5 | 59.6 | 77.3 | -17.7 | Pass |
| 2415.00 | H | 49.4 | 11.0 | 60.4 | 77.3 | -16.9 | Pass |
| 2760.00 | H | 49.7 | 11.6 | 61.3 | 74.0 | -12.7 | Pass |
| 3105.00 | H | 49.0 | 12.4 | 61.4 | 77.3 | -15.9 | Pass |
| 3450.00 | H | 50.0 | 13.2 | 63.2 | 77.3 | -14.1 | Pass |

Measurement uncertainty: Measurement uncertainties shown for these tests are expanded uncertainties expressed at 95% confidence level using a coverage factor $k = 2$. ± 4.6 dB

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 | 05/17/2021 |
| 900772 | Horn Antenna (2 – 4 GHz) | EMCO | 3161-02 | 9804-1044 | 05/17/2021 |
| 900791 | Bilog Antenna (30 – 2000 MHz) | Chase | CBL6111B | N/A | 10/04/2020 |
| 900811 | Preamplifier (10 – 2000 MHz) | Rhein Tech Laboratories | PR-1040 | 1003 | 12/19/2020 |
| 900913 | RF Filter Section (100 kHz – 6.5 GHz) | Hewlett Packard | 85462A | 3325A00159 | 05/14/2021 |
| 900914 | EMI Receiver Section (9 kHz – 6.5 GHz) | Hewlett Packard | 85460A | 3330A00107 | 05/14/2021 |
| 901581 | Spectrum Analyzer (20 Hz – 50 GHz) | Rohde & Schwarz | FSU | 1166.1660.50 | 04/26/2021 |

Test Personnel:

| | | |
|-------------------|---|------------------------|
| Khue Do |  | December 23 – 24, 2019 |
| EMC Test Engineer | Signature | Date of Test |

Occupied Bandwidth

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.

OBW Data, RE229

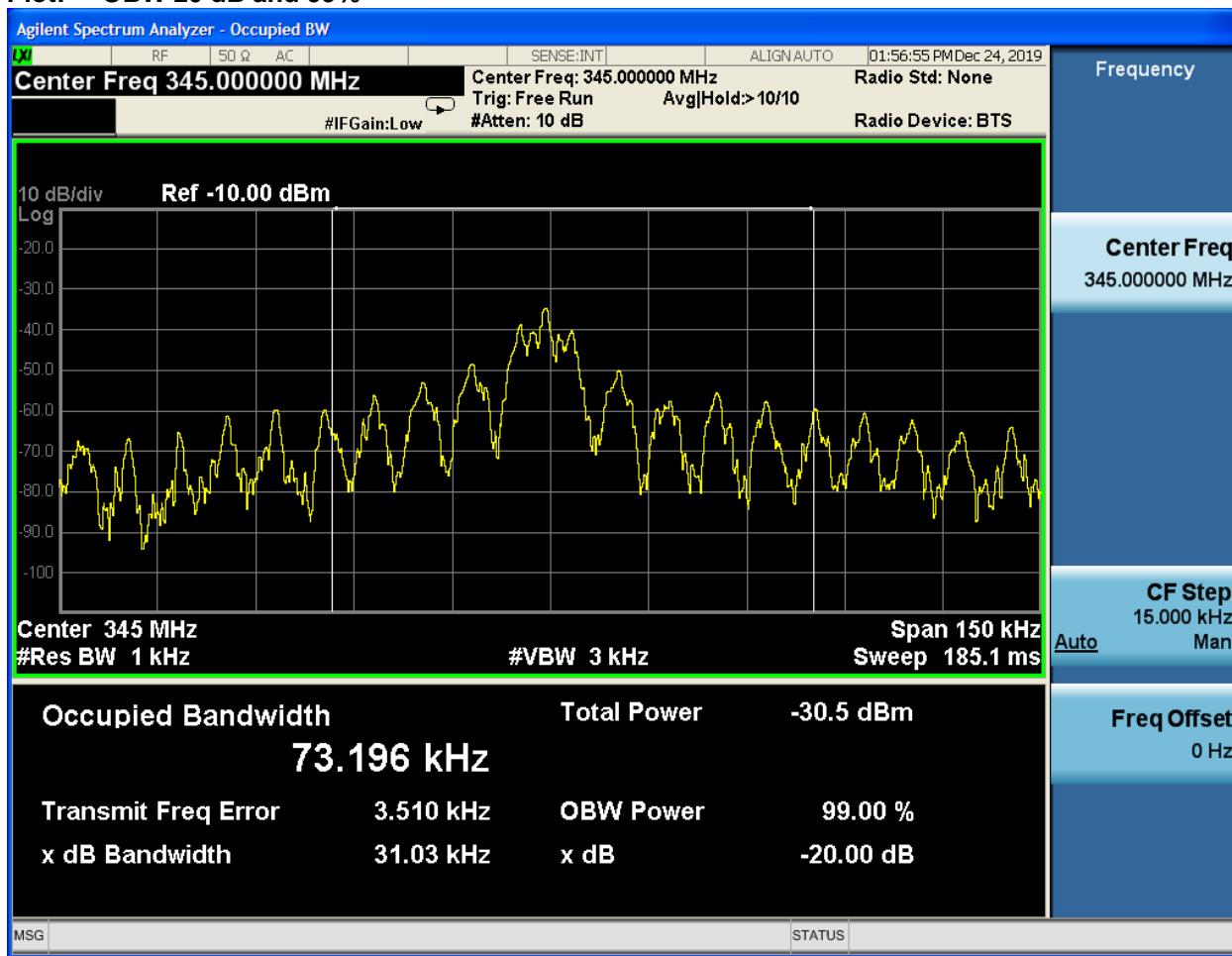
| OBW 99% (kHz) | OBW 20 dB (kHz) | Limit (kHz) | Result (Pass / Fail) |
|---------------|-----------------|-------------|----------------------|
| 73.20 | 31.03 | 862.50 | Pass |

Limit = 345 MHz * 0.25% = 0.8625 MHz = 862.50 kHz

OBW 99% = 73.20 kHz

OBW 20 dB = 31.03 kHz

Plot: OBW 20 dB and 99%



Measurement uncertainty: $\pm 1 \times 10^{-6}$ Hz. This measurement uncertainty is an expanded uncertainty for 95% confidence level received with a coverage factor $k=2$.

Occupied Bandwidth Test Equipment

| RTL Asset # | Part Type | Manufacturer | Model | Serial Number | Calibration Due Date |
|-------------|---------------------------------------|--------------|------------|---------------|----------------------|
| 901583 | Signal Analyzer (10 Hz – 26.5 GHz) | Agilent | EXA N9010A | MY51250846 | 02/06/2020 |

Test Personnel:

| | | |
|-------------------|---|-------------------|
| Khue Do |  | December 24, 2019 |
| EMC Test Engineer | Signature | Date of Test |

Test Configuration Photographs

Photograph: Radiated Emission, 30 MHz – 1 GHz, Front



Photograph: Radiated Emission, 30 MHz – 1 GHz, Rear



Photograph: Radiated Emission, Above 1 GHz, Front



Photograph: Radiated Emission, Above 1 GHz, Rear

