**Amber Helm Development L.C.**
92723 Michigan Hwy-152
Sister Lakes, Michigan 49047 USA
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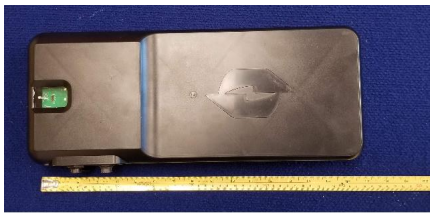
# EMC Test Report

**NIK-WR1915TX**
Issued: **October 10, 2019**

regarding

**USA: CFR Title 47, Part 15.247** (Emissions)
**Canada: IC RSS-247/GENe** (Emissions)

for



# 100-000A

**Category: Vero Transponder**

Judgments:
**FCC 15.247, ISED RSS-247v2 Compliant**
Testing Completed: October 9, 2019

TESTING
NVLAP LAB CODE 200129-0

Prepared for:

## Nikola Labs, Inc.

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Reviewed by: _____ Gordon Helm, EMC-002401-NE

Prepared by: _____ Dr. Joseph Brunett, EMC-002790-NE

Date of Issue: October 10, 2019

## Revision History

| Rev. No. | Date | Details | Revised By |
|---|---|---|---|
| r0 | October 10, 2019 | Initial Release. | J. Brunett |
| r1 | October 28, 2019 | Typographical and Photo corrections. | J. Brunett |

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# 1 Test Report Scope and Limitations

## 1.1 Laboratory Authorization

Test Facility description and attenuation characteristics are on file with the FCC Laboratory, Columbia, Maryland (FCC Reg. No: US5348 and US5356) and with ISED Canada, Ottawa, ON (File Ref. No: 3161A and 24249). Amber Helm Development L.C. holds accreditation under NVLAP Lab Code 200129-0.

## 1.2 Report Retention

For equipment verified to comply with the regulations herein, the manufacturer is obliged to retain this report with the product records for the life of the product, and no less than ten years. A copy of this Report will remain on file with this laboratory until November 2029.

## 1.3 Subcontracted Testing

This report does not contain data produced under subcontract.

## 1.4 Test Data

This test report contains data included within the laboratories scope of accreditation.

## 1.5 Limitation of Results

The test results contained in this report relate only to the item(s) tested. Any electrical or mechanical modification made to the test item subsequent to the test date shall invalidate the data presented in this report. Any electrical or mechanical modification made to the test item subsequent to this test date shall require reevaluation.

## 1.6 Copyright



## 1.7 Endorsements

This report shall not be used to claim product endorsement by any accrediting, regulatory, or governmental agency.

### 1.8 Test Location

The EUT was fully tested by **Amber Helm Development L.C.**, headquartered at 92723 Michigan Hwy-152, Sister Lakes, Michigan 49047 USA. Table 1 lists all sites employed herein. Specific test sites utilized are also listed in the test results sections of this report where needed.

Table 1: Test Site List.

| Description | Location | Quality Num. |
|---|---|---|
| OATS (3 meter) | 3615 E Grand River Rd., Williamston, Michigan 48895 | OATSC |

### 1.9 Traceability and Equipment Used

Pertinent test equipment used for measurements at this facility is listed in Table 2. The quality system employed at Amber Helm Development L.C. has been established to ensure all equipment has a clearly identifiable classification, calibration expiry date, and that all calibrations are traceable to the SI through NIST, other recognized national laboratories, accepted fundamental or natural physical constants, ratio type of calibration, or by comparison to consensus standards.

Table 2: Equipment List.

| Description | Manufacturer/Model | SN | Quality Num. | Last Cal By / Date Due |
|---|---|---|---|---|
| Spectrum Analyzer | R & S / FSV30 | 101660 | RSFSV30001 | RS / Apr-2021 |
| Spectrum Analyzer | R & S / FPC1500 | 101692 | RSFPC15001 | RS / May-2020 |
| LISN | Solar / 8012-50-R-24-BNC | 962138 | LISN7 | AHD / April-2021 |
| Biconical | EMCO / 93110B | 9802-3039 | BICEMCO01 | Keysight / Aug-2020 |
| Log Periodic Antenna | EMCO / 3146 | 9305-3614 | LOGEMCO01 | Keysight / Aug-2020 |
| BNC-BNC Coax | WRTL / RG58/U | 001 | CAB001-BLACK | AHD / Jul-2020 |
| BNC-BNC Coax | WRTL / RG58/U | 001 | CAB002-BLACK | AHD / Jul-2020 |
| 3.5-3.5MM Coax | PhaseFlex / PhaseFlex | 001 | CAB015-PURP | AHD / Jul-2020 |
| Quad Ridge Horn | Singer / A6100 | C35200 | HQR1TO18S01 | Keysight / Aug-2020 |
| K-Band Horn | JEF / NRL Std. | 001 | HRNK01 | AHD / Jul-2020 |

# 2 Test Specifications and Procedures

## 2.1 Test Specification and General Procedures

The goal of Nikola Labs, Inc. is to demonstrate that the Equipment Under Test (EUT) complies with the Rules and/or Directives below. Detailed in this report are the results of testing the Nikola Labs, Inc. 100-000A for compliance to:

| **Country/Region** | **Rules or Directive** | **Referenced Section(s)** |
|---|---|---|
| United States | Code of Federal Regulations | CFR Title 47, Part 15.247 |
| Canada | ISED Canada | IC RSS-247/GENe |

It has been determined that the equipment under test is subject to the rules and directives above at the date of this testing. In conjunction with these rules and directives, the following specifications and procedures are followed herein to demonstrate compliance (in whole or in part) with these regulations.

| | |
|---|---|
| ANSI C63.4:2014 | "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" |
| ANSI C63.10:2013 | "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices" |
| TP0102RA | "AHD Internal Document TP0102 - Radiated Emissions Test Procedure" |
| TP0106RC | "AHD Internal Document TP0106 - Emissions Measurement Procedures (above 40 GHz)" |
| ISED Canada | "The Measurement of Occupied Bandwidth" |
| ICES-003; Issue 6 (2016) | "Information Technology Equipment (ITE) - Limits and methods of measurement" |

# 3 Configuration and Identification of the Equipment Under Test

## 3.1 Description and Declarations

The EUT is a professionally installed fixed mounted DTS transceiver. The EUT is approximately 43 x 18 x 6 cm in dimension, and is depicted in Figure 1. It is powered by 115 VAC mains power. This product acts as a wireless power and communications interface for a sensor network. Table 3 outlines provider declared EUT specifications.


Figure 1: Photos of EUT.

Table 3: EUT Declarations.

| **General Declarations** | |
|---|---|
| **Equipment Type:** | Vero Transponder |
| **Country of Origin:** | USA |
| **Nominal Supply:** | 115 VAC |
| **Oper. Temp Range:** | not declared |
| **Frequency Range:** | 2402 – 2440 MHz |
| **Antenna Dimension:** | Integral |
| **Antenna Type:** | Integral Patch Array |
| **Antenna Gain:** | 12 dBi |
| **Number of Channels:** | 20(DTS) |
| **Channel Spacing:** | 2 MHz |
| **Alignment Range:** | Not Declared |
| **Type of Modulation:** | GFSK |
| | |
| **United States** | |
| **FCC ID Number:** | 2AUKSVEROTX2400 |
| **Classification:** | DTS |
| | |
| **Canada** | |
| **IC Number:** | 25467-VEROTX2400 |
| **Classification:** | Spread Spectrum (24002483.5 MHz) |

### 3.1.1 EUT Configuration

The EUT is configured for testing as depicted in Figure 2.

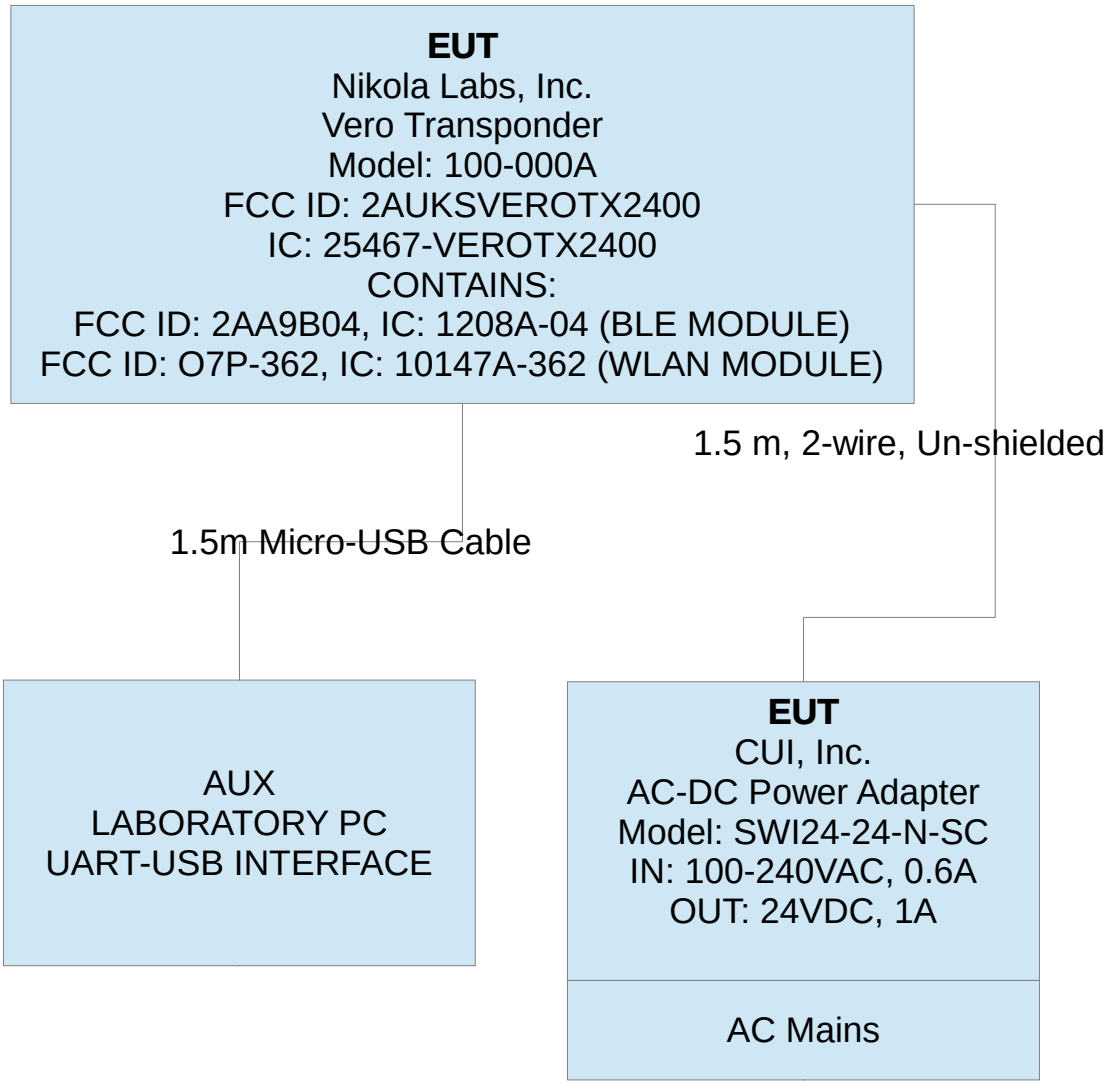



Figure 2: EUT Test Configuration Diagram.

### 3.1.2 Modes of Operation

The EUT employs a custom DTS transceiver with twenty (20) 2 MHz wide channels from 2402 MHz to 2440 MHz used to send both RF power and data to wireless sensors in its vicinity. This radio communicates through the integral 12 dBi patch antenna array. Also included in the EUT are two pre-certified modular transceivers operating in the 2.4 GHz frequency band: (FCC ID: 2AA9B04, IC: 1208A–4) a BLE transceiver and (FCC ID: O7P-362, IC: 10147A-362) a WLAN transceiver. Test samples were placed into worst-case continuous transmitting modes at the declared highest operating power settings of each channel using a PC serial UART-USB interface. The primary radio as well as the two pre-certified radio modules were active throughout testing. All three radios may be active at the same time in normal operation.

### 3.1.3 Variants

There is only a single variant of the EUT, as tested.

### 3.1.4 Test Samples

Two samples of the EUT were provided for emissions testing, one radiated sample and one sample for RF conducted measurements.

### 3.1.5 Functional Exerciser

EUT functionality was confirmed by measurement of transmitted signals.

### 3.1.6 Modifications Made

There were no modifications made to the EUT by this laboratory. However, in order to ensure device compliance, power settings for the radio and the selection of DTS radio operating channels was performed during pretesting at the laboratory. After pretesting, the manufacturer set the maximum power settings and channels used for testing.

### 3.1.7 Production Intent

The EUT appears to be a production ready sample.

### 3.1.8 Declared Exemptions and Additional Product Notes

None.

# 4 Emissions

## 4.1 General Test Procedures

### 4.1.1 Radiated Test Setup and Procedures

Radiated electromagnetic emissions from the EUT are first pre-scanned in our screen room. Spectrum and modulation characteristics of all emissions are recorded. Instrumentation, including spectrum analyzers and other test equipment as detailed in Section 1.8 are employed. After pre-scan, emission measurements are made on the test site of record. If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in relevant test standards are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 3. All intentionally radiating elements that are not fixed-mounted in use are placed on the test table lying flat, on their side, and on their end (3-axes) and the resulting worst case emissions are recorded. If the EUT is fixed-mounted in use, measurements are made with the device oriented in the manner consistent with installation and then emissions are recorded. If the EUT exhibits spurious emissions due to internal receiver circuitry, such emissions are measured with an appropriate carrier signal applied.

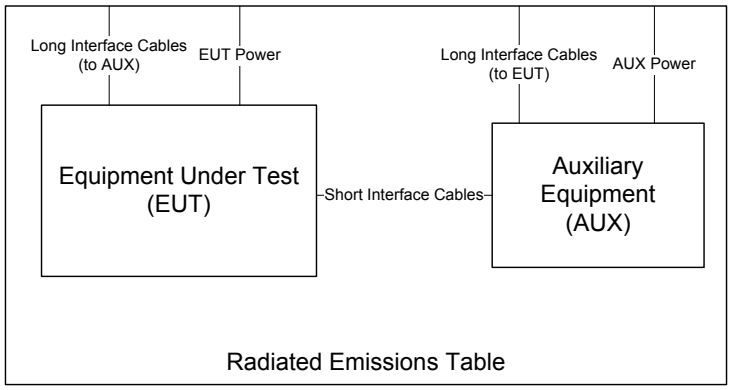



Figure 3: Radiated Emissions Diagram of the EUT.

For devices with intentional emissions below 30 MHz, a shielded loop antenna and/or E-field and H-Field broadband probes are used depending on the regulations. Shielded loops are placed at a 1 meter receive height at the desired measurement distance. For exposure in this band, the broadband probes employed are 10cm diameter single-axis shielded transducers and measurements are repeated and summed over three axes.

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. For both horizontal and vertical polarizations, the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected. The EUT is then rotated through $360^o$ in azimuth until the highest emission is detected. The test antenna is then raised and lowered one last time from 1 to 4 m and the worst case value is recorded. Emissions above 1 GHz are characterized using standard gain or broadband ridge-horn antennas on our OATS with a $4 \times 5$ m rectangle of ECCOSORB absorber covering the OATS ground screen and a 1.5m table height. Care is taken to ensure that test receiver resolution and video bandwidths meet the regulatory requirements, and that the emission bandwidth of the EUT is not reduced. Photographs of the test setup employed are depicted in Figure 4.

Where regulations allow for direct measurement of field strength, power values (dBm) measured on the test receiver / analyzer are converted to dB$\mu$V/m at the regulatory distance, using

$$E_{dist} = 107 + P_R + K_A - K_G + K_E - C_F$$

where $P_R$ is the power recorded on spectrum analyzer, in dBm, $K_A$ is the test antenna factor in dB/m, $K_G$ is the combined pre-amplifier gain and cable loss in dB, $K_E$ is duty correction factor (when applicable) in dB, and $C_F$ is a distance conversion (employed only if limits are specified at alternate distance) in dB. This field strength value is then compared with the regulatory limit. If effective isotropic radiated power (EIRP) is computed, it is computed as

$$EIRP(dBm) = E_{3m}(dB\mu V/m) - 95.2.$$

When presenting data at each frequency, the highest measured emission under all possible EUT orientations (3-axes) is reported.

Where regulations call for substitution method measurements, the EUT is replaced by a substitution antenna if field strength measurements indicate the emission is close to the regulatory limit. This antenna is co-polarized with the test antenna and tuned (when necessary) to the emission frequency, after which the test antenna height is again optimized. The substitution antenna's signal level is adjusted such that its emission is equal to the level measured from the EUT. The signal level applied to the substitution antenna is then recorded. Effective isotropic radiated power (EIRP) and effective radiated power (ERP) in dBm are formulated from

$$EIRP = P_T - G_A = ERP + 2.16, \tag{1}$$

where $P_T$ is the power applied to substitution antenna in dBm, including correction for cable loss, and $G_A$ is the substitution antenna gain, in dBi.

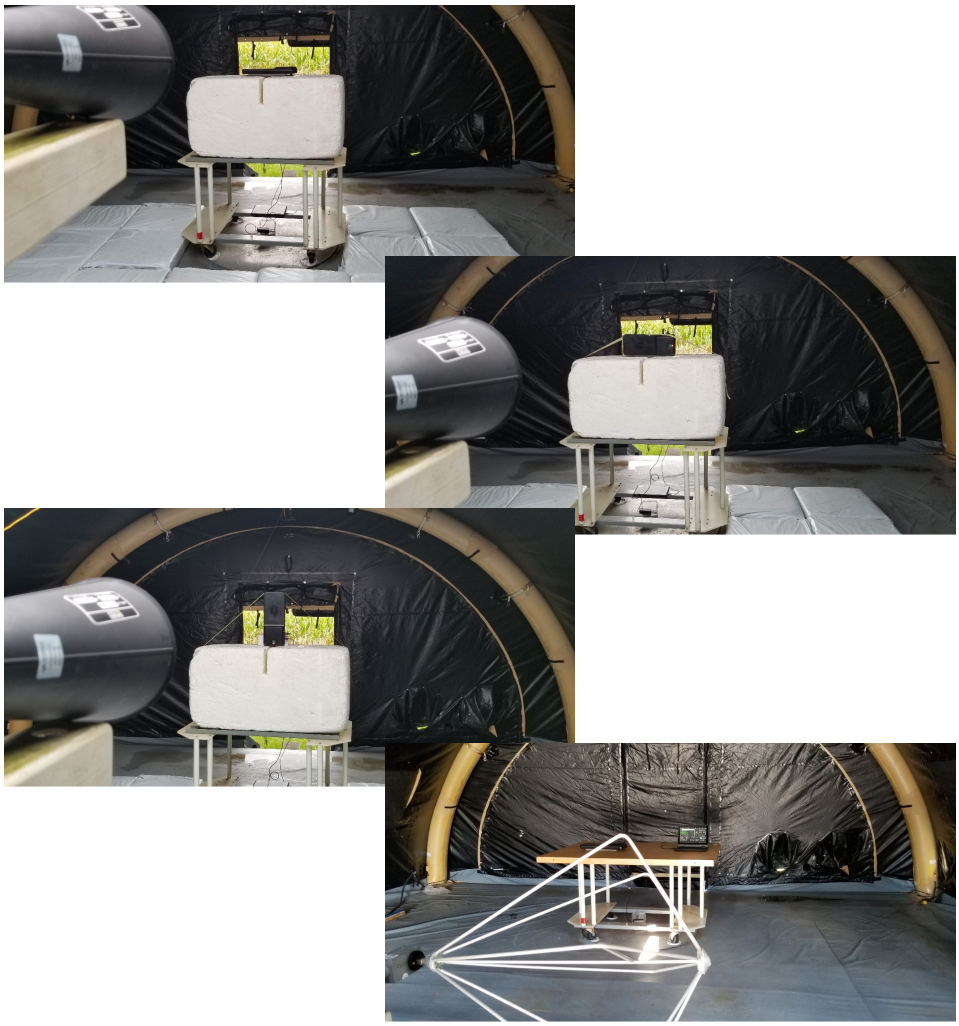


Figure 4: Radiated Emissions Test Setup Photograph(s).

### 4.1.2 Conducted Emissions Test Setup and Procedures

**Transmit Antenna Port Conducted Emissions** At least one sample EUT supplied for testing was provided with a 50Ω antenna port. Conducted transmit chain emissions measurements (where applicable) are made by connecting the EUT antenna port directly to the test receiver port. Photographs of the test setup employed are depicted in Figure 5.

Figure 5: Conducted RF Test Setup Photograph(s).

**AC Port Conducted Spurious** For this device, AC power line conducted emissions are measured in our screen room. If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 / CISPR 22 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 6.

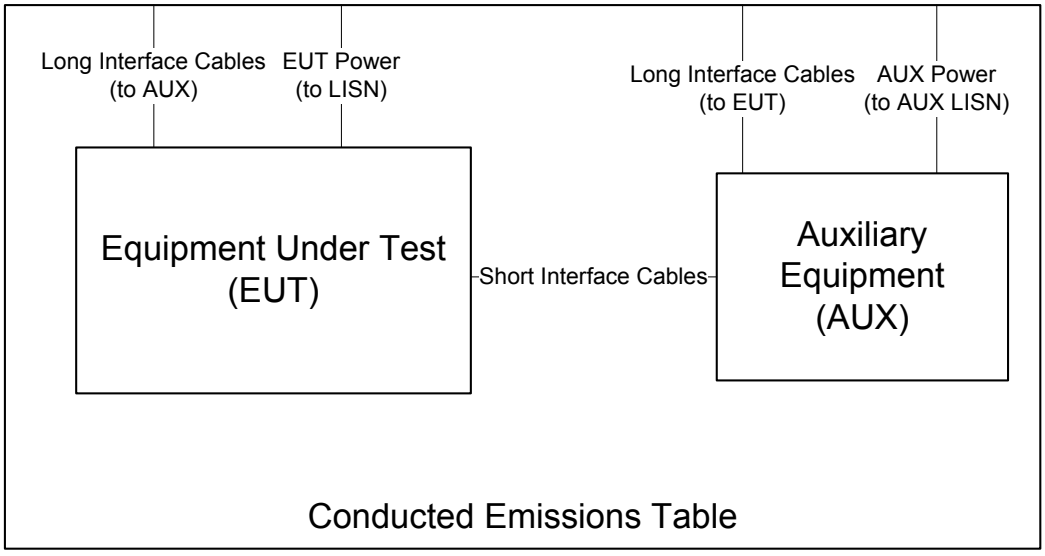



Figure 6: Conducted Emissions Setup Diagram of the EUT.

Conducted emissions are measured and recorded for each AC mains power source over the spectrum 0.15 MHz to 30 MHz for both the ungrounded (HI/PHASE) and grounded (LO/GND) conductors with the EUT placed in its highest current draw operating mode(s). The test receiver is set to peak-hold mode in order to record the

peak emissions throughout the course of functional operation. Only if an emission exceeds or is near the limit are quasi-peak and average detection applied. Photographs of the test setup employed are depicted in Figure 7.

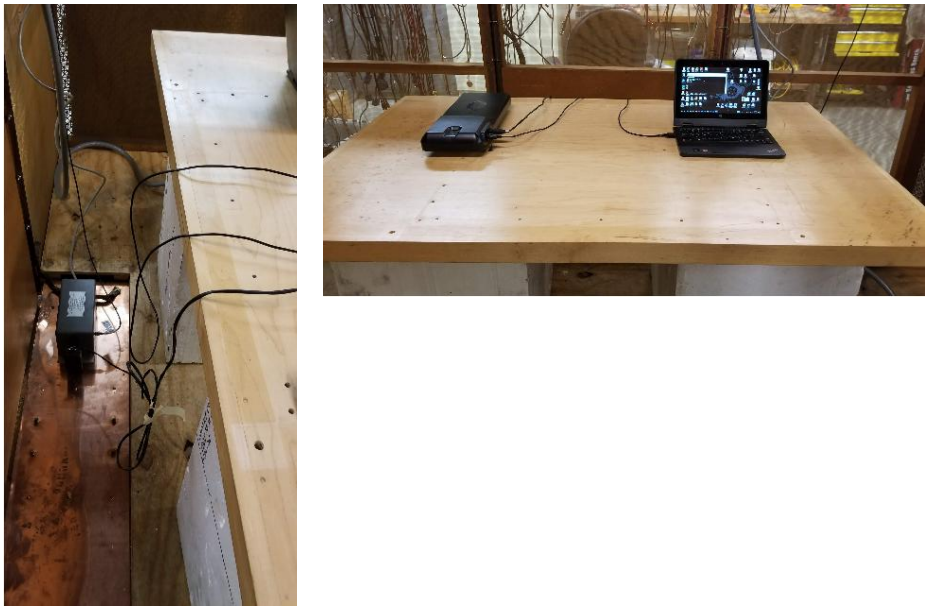


Figure 7: Conducted Emissions Test Setup Photograph(s).

### 4.1.3 Power Supply Variation

Tests at extreme supply voltages are made if required by the procedures specified in the test standard, and results of this testing are detailed in this report.

In the case of this EUT, measurements of the worst-case radiated emissions are performed with the supply voltage varied by no less than 85% and 115% of the nominal rated value for devices connecting to AC power mains.

## 4.2 Intentional Emissions

### 4.2.1 Duty and Transmission Cycle, Pulsed Operation

The details and results of testing the EUT for pulsed operation are summarized in Table 4. Plots showing the measurements made to obtain these values are provided in Figure 8.

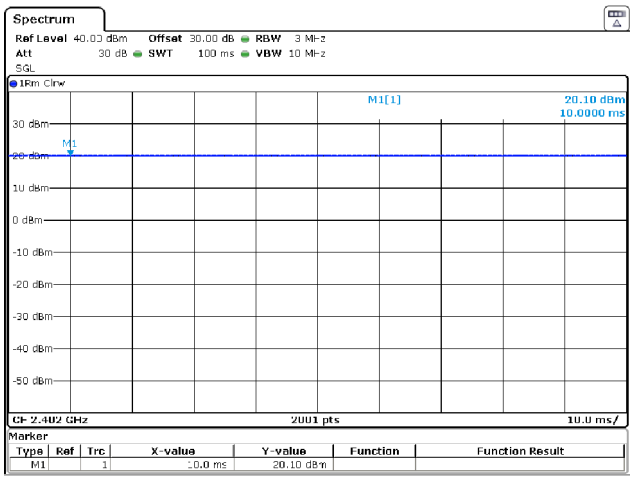
Table 4: Pulsed Emission Characteristics (Duty Cycle).

| Frequency Range | Det | IFBW | VBW | | |
|---|---|---|---|---|---|
| f > 1 000 MHz | Pk | 3 MHz | 10 MHz | **Test Date:** | 9-Oct-19 |
| | | | | **Test Engineer:** | Joseph Brunett |
| | | | | **EUT** | Nikola Vero 100-000A |
| | | | | **Meas. Distance:** | Conducted |

| Pulsed Operation / Duty Cycle | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Transmit Mode | Symbol Rate (Msym/s) | Data Rate (Mbps) | Voltage (Vac) | Oper. Freq (MHz) | Tx Cycle Time* (ms) | On-Time* (ms) | Duty Cycle (%) | Power Duty Correction (dB) |
| CM | - | - | 115.0 | 2402.0 | - | - | - | 0.0 |
| | - | - | 115.0 | 2420.0 | - | - | - | 0.0 |
| | - | - | 115.0 | 2440.0 | - | - | - | 0.0 |

* Duty cycle is not applied for demonstrating compliance for this device. EUT is capable of operating on a Contiously Modulated Transmission state during normal operation.

**20191009-NIKOLA-DUTY-CH02**

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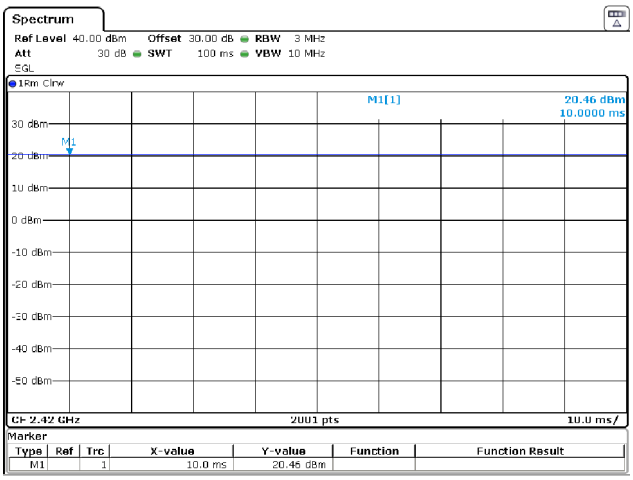


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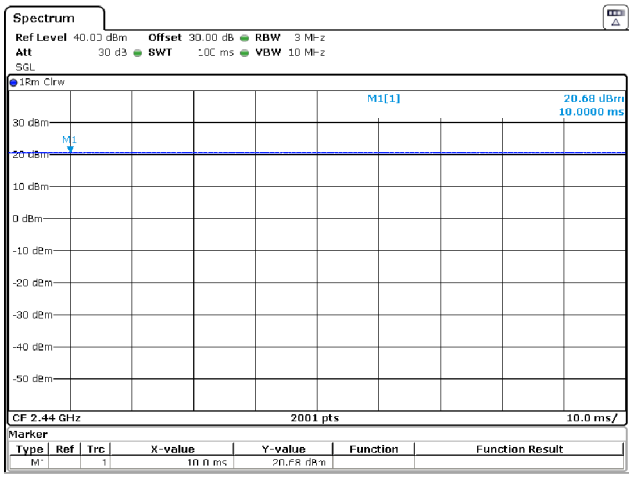



Figure 8: Pulsed Emission Characteristics (Duty Cycle).

### 4.2.2 Fundamental Emission Bandwidth

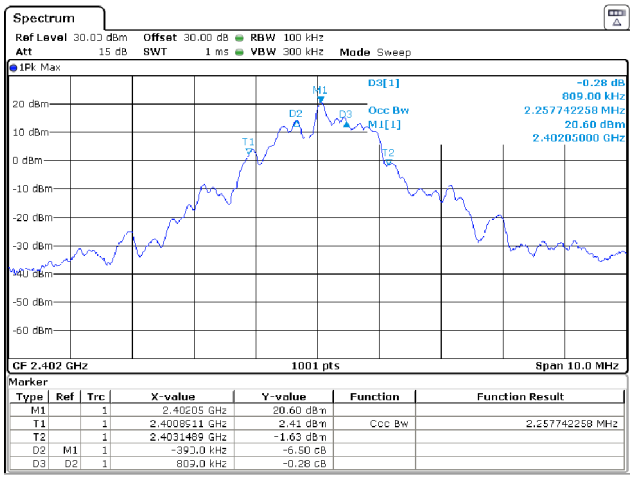
Emission bandwidth (EBW) of the EUT is measured with the device placed in the test mode(s) with the shortest available packet length and minimum packet spacing. Radiated emissions are recorded following the test procedures listed in Section 2.1. The 6 dB bandwidth is measured for the lowest, middle, and highest channels available. The 99% emission bandwidth per IC test procedures is also reported. The results of this testing are summarized in Table 5. Plots showing measurements employed obtain the emission bandwidths reported are provided in Figure 9.

Table 5: Intentional Emission Bandwidth.

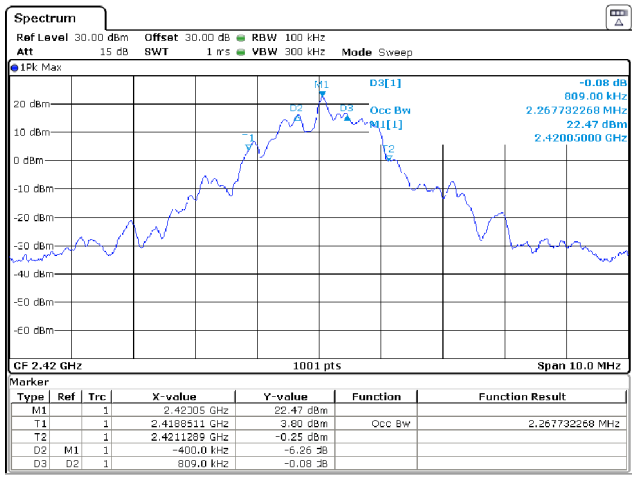
| **Frequency Range** | **Det** | **IFBW** | **VBW** | | |
|---|---|---|---|---|---|
| f > 1 000 MHz | Pk | 30 kHz | 1 MHz | **Test Date:** | 10/09/19 |
| | | | | **Test Engineer:** | Joseph Brunett |
| | | | | **EUT** | Nikola Vero 100-000A |
| | | | | **Meas. Distance:** | 30 cm |

| **Occupied Bandwidth** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Transmit Mode | Symbol Rate (Msym/s) | Data Rate (Mbps) | Voltage (V) | Oper. Freq (MHz) | 6 dB BW (kHz) | 6 dB BW Limit (MHz) | 99% OBW (MHz) | | Pass/Fail |
| Cont. Modulated | | | 115.0 | 2402.0 | 0.809 | 0.500 | 2.258 | | Pass |
| | | | | 2420.0 | 0.809 | 0.500 | 2.268 | | Pass |
| | | | | 2440.0 | 0.799 | 0.500 | 2.308 | | Pass |

**20191009-NIKOLA-OBW-CH02**




**20191009-NIKOLA-OBW-CH20**

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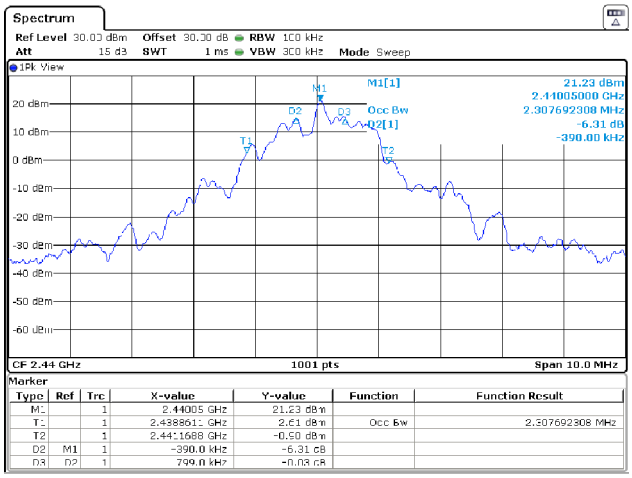



Figure 9: Intentional Emission Bandwidth.

### 4.2.3 Effective Isotropic Radiated Power

The EUT's radiated power is computed from antenna port conducted power measurements and the gain of the EUT antenna(s). Where the EUT is not sold with an antenna connector, a modified product has been provided including such. Peak conducted output power was measured directly from the EUT at the port where the antenna attaches. The test receiver bandwidth was set to be greater than the measured emission bandwidth of the EUT to capture the true peak. Antenna gain is either provided directly by the antenna manufacturer or measured by comparison between calculated EIRP and conducted output power. Table 6 details the results of these measurements. Plots showing conducted measurements made are depicted in Figure 10.

Table 6: Radiated Power Results.

**Test Date:** 9-Oct-19 **EUT:** Nikola Vero 100-000A
**Test Engineer:** J. Brunett **Meas. Distance:** 3m

FCC/IC

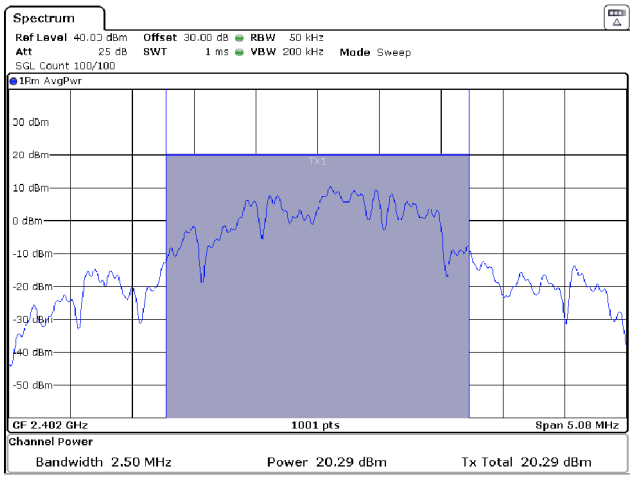
| # | Mode | Channel | Freq. MHz | Ant. Used | Ant. Pol. | Table Azim. deg | Ant Height m | Ka dB/m | Kg dB | Pout* (RMS) dBm | Pout (RMS) Limit dBm | Ant Gain dBi | FM Pwr Red dB | EIRP (RMS) dBm | EIRP (Avg) Limit dBm | Pass dB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CM | L | 2402.0 | HQR1TO18S01 | H/V | | COND | 30.5 | -0.3 | 20.3 | 30.0 | 12.0 | 2 | 32.3 | 40.0 | 7.7 |
| 2 | | M | 2420.0 | HQR1TO18S01 | H/V | | COND | 30.6 | -0.3 | 22.3 | 30.0 | 12.0 | 2 | 34.3 | 40.0 | **5.7** |
| 3 | | H | 2440.0 | HQR1TO18S01 | H/V | | COND | 30.7 | -0.3 | 21.1 | 30.0 | 12.0 | 2 | 33.1 | 40.0 | 6.9 |
| 4 | | | | | | | | | | | | | | | | |

| # | Mode | Channel | Freq. MHz | Supply Voltage | Ant. Pol. | Table Azim. deg | Ant Height m | Ka dB/m | Kg dB | Pout* (RMS) dBm |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | CM | M | 2420.0 | 132.3 | H/V | | COND | 30.6 | -0.3 | 22.3 |
| 6 | | | 2420.0 | 115.0 | H/V | | COND | 30.6 | -0.3 | 22.3 |
| 7 | | | 2420.0 | 97.8 | H/V | | COND | 30.6 | -0.3 | 22.3 |

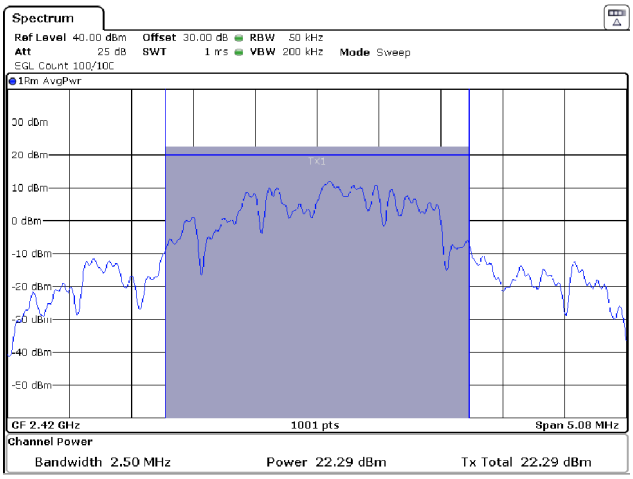
* Measured conducted from the radio using conducted test sample. RMS power measured per ANSI C63.10 11.9.2.2.2 AVGSA-1 Procedure. (See associated plots.)

** Measured radiated at 3 meter distance.

**20191009-NIKOLA-CONDPWR-CH02**




**20191009-NIKOLA-CONDPWR-CH20**

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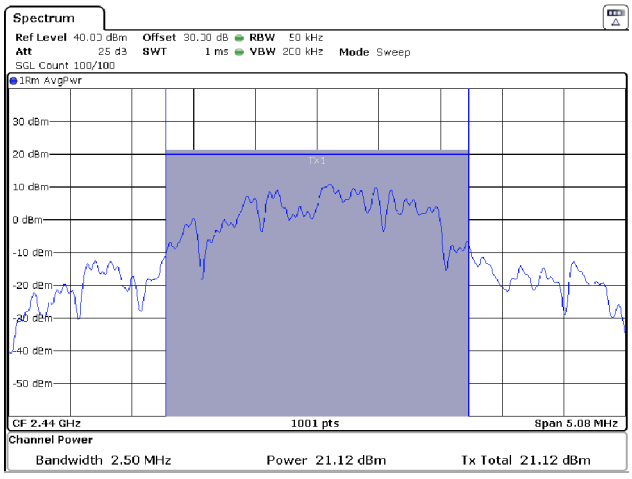



Figure 10: Conducted RF Power Plots

### 4.2.4 Power Spectral Density

For this test, the EUT was attached directly to the test receiver. Following FCC DTS measurement procedures, the emission spectrum is first scanned for maximum spectral peaks, the span and receiver bandwidth are then reduced until the power spectral density is measured in the prescribed receiver bandwidth. The results of this testing are summarized in Table 7. Plots showing how these measurements were made are depicted in Figure 11.

Table 7: Power Spectral Density Results.

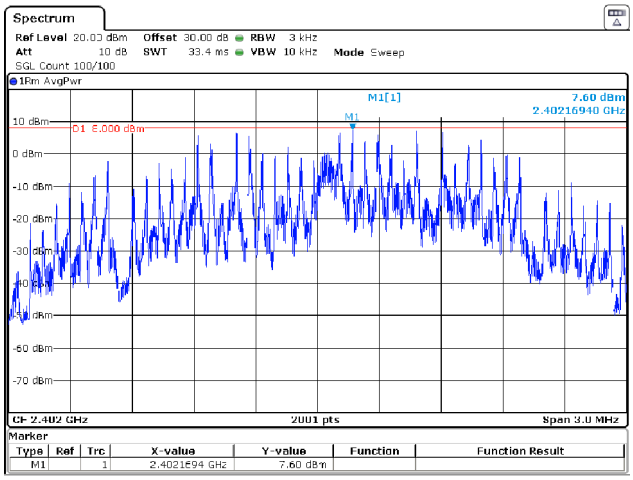
**Test Date:** 9-Oct-19 **EUT:** Nikola Vero 100-000A

**Test Engineer:** Joseph Brunett **Meas. Distance:** Conducted

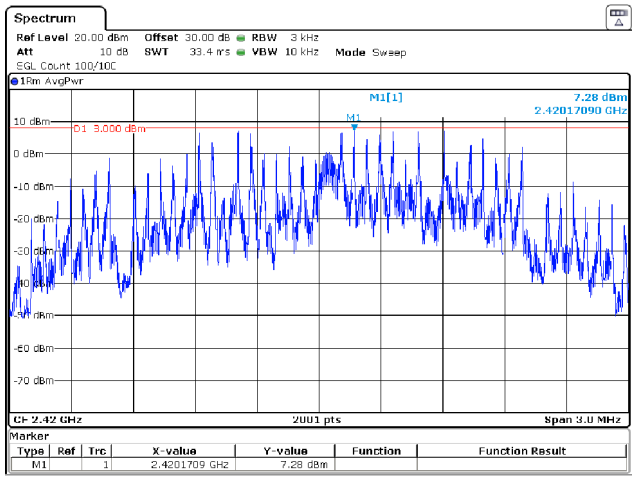
| | | | | | FCC/IC | |
|---|---|---|---|---|---|---|
| Mode | Channel | Frequency (MHz) | Ant. Used | PSDcond (meas)* (dBm/3kHz) | PSD Limit (dBm/3kHz) | Pass By (dB) |
| CM | L | 2402.0 | Cond. | 7.6 | 8.00 | 0.4 |
| | M | 2420.0 | Cond. | 7.3 | 8.00 | 0.7 |
| | H | 2440.0 | Cond. | 7.9 | 8.00 | **0.1** |

* PSD measured conducted out the the EUT antenna port following ANSI C63.10 11.10.3 AVGPSD-1 Procedure. (See assocated plots.)

**20191009-NIKOLA-PSD-CH02**




**20191009-NIKOLA-PSD-CH20**




**20191009-NIKOLA-PSD-CH40**

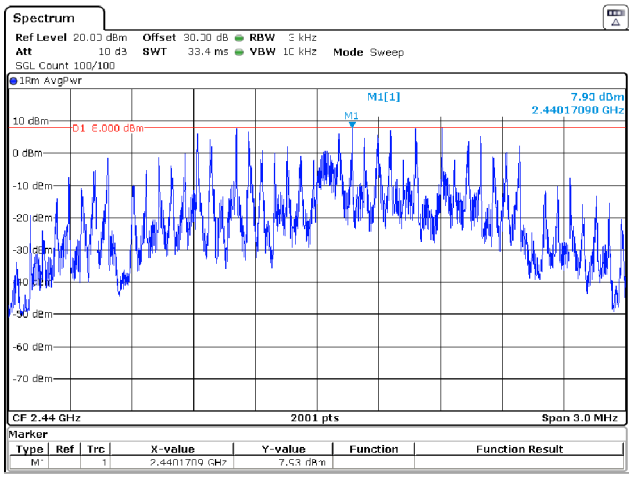



Figure 11: Power Spectral Density Plots.

## 4.3 Unintentional Emissions

### 4.3.1 Transmit Chain Spurious Emissions

The results for the measurement of transmit chain spurious emissions at the nominal voltage and temperature are provided in Table 8. Measurements are performed to 10 times the highest fundamental operating frequency.

Table 8: Transmit Chain Spurious Emissions.

**Test Date:** 7-Oct-19
**Test Engineer:** J. Brunett
**EUT:** Nikola Vero 100-000A
**Mode:** Cont. Modulated
**Meas. Distance:** 3m

| **Frequency Range** | **Det** | **IF Bandwidth** | **Video Bandwidth** |
|---|---|---|---|
| f > 1 000 MHz | Pk/Avg | 1 MHz | 3 MHz |

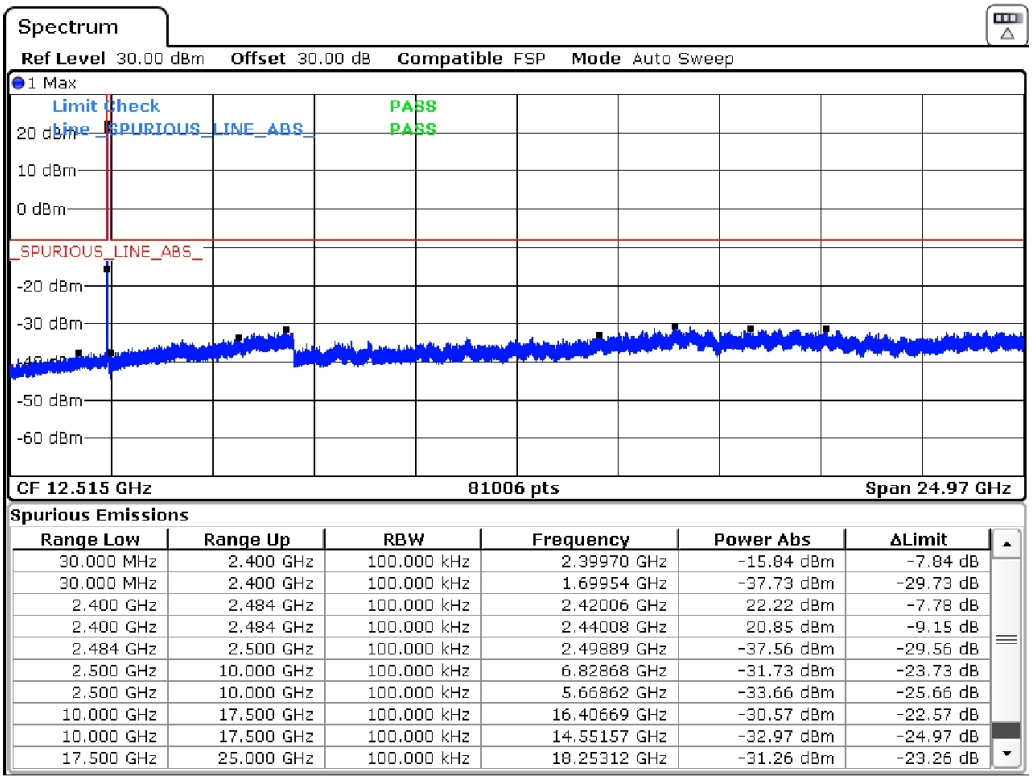
| Harmonic / Spurious Emissions** | | | | | | | | | | | | | | FCC/IC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | Freq. Start MHz | Freq. Stop MHz | Ant. Used | Ant. Pol. | Table Azim. deg | Ant Height m | Ka dB/m | Kg dB | E3(Pk) dBµV/m | E3 Pk Lim dBµV/m | E3(Avg) dBµV/m | E3 Avg Lim dBµV/m | Pass dB | Comments |
| 1 | 1000.0 | 2310.0 | HQR1TO18S01 | H/V | all | all | 30.2 | -0.3 | 47.2 | 74.0 | | 54.0 | 6.8 | max all, all active |
| 2 | 2310.0 | 2390.0 | HQR1TO18S01 | V | 0 | 1.5 | 30.5 | -0.3 | 55.7 | 74.0 | 47.7 | 54.0 | 6.3 | CH02 (L) |
| 3 | 2310.0 | 2390.0 | HQR1TO18S01 | V | 0 | 1.5 | 30.5 | -0.3 | 53.3 | 74.0 | 45.2 | 54.0 | 8.8 | CH20 (M) |
| 4 | 2310.0 | 2390.0 | HQR1TO18S01 | V | 0 | 1.5 | 30.5 | -0.3 | 53.3 | 74.0 | 45.3 | 54.0 | 8.7 | CH40 (H) |
| 5 | 2358.0 | 2358.0 | HQR1TO18S01 | H/V | 90 | 1.5 | 30.4 | -0.3 | 60.0 | 74.0 | 51.0 | 54.0 | 3.0 | ALL ACTIVE - WLAN MODULE SPURIOUS |
| 6 | 2483.5 | 2500.0 | HQR1TO18S01 | V | 0 | 1.5 | 30.8 | -0.3 | 56.7 | 74.0 | 48.6 | 54.0 | 5.4 | CH02 (L) |
| 7 | 2483.5 | 2500.0 | HQR1TO18S01 | V | 0 | 1.5 | 30.8 | -0.3 | 57.2 | 74.0 | 49.0 | 54.0 | 5.0 | CH20 (M) |
| 8 | 2483.5 | 2500.0 | HQR1TO18S01 | V | 0 | 1.5 | 30.8 | -0.3 | 57.9 | 74.0 | 49.1 | 54.0 | 4.9 | CH40 (H) |
| 9 | 2483.5 | 2500.0 | HQR1TO18S01 | H/V | 90 | 1.5 | 30.8 | -0.3 | 58.5 | 74.0 | 50.1 | 54.0 | 3.9 | ALL ACTIVE - WLAN MODULE SPURIOUS |
| 10 | 4804.0 | 4804.0 | HQR1TO18S01 | H/V | 320 | 1.8 | 32.3 | -0.5 | 57.2 | 74.0 | 51.2 | 54.0 | 2.8 | CH02 (L) |
| 11 | 4804.0 | 4805.0 | HQR1TO18S01 | H/V | 320 | 1.8 | 32.3 | -0.5 | 58.4 | 74.0 | 52.3 | 54.0 | 1.7 | CH20 (M) |
| 12 | 4840.0 | 4806.0 | HQR1TO18S01 | H/V | 320 | 1.8 | 32.3 | -0.5 | 59.0 | 74.0 | 53.0 | 54.0 | **1.0** | CH40 (H) |
| 13 | 4000.0 | 6000.0 | HQR1TO18S01 | H/V | all | all | 32.6 | -0.6 | 59.0 | 74.0 | 53.0 | 54.0 | 1.0 | all channels; max all |
| 14 | 7206.0 | 7206.0 | HQR1TO18S01 | H/V | 0 | 1.5 | 33.2 | -0.7 | 43.0 | 74.0 | 33.0 | 54.0 | 21.0 | CH02 (L) |
| 15 | 7206.0 | 7206.0 | HQR1TO18S01 | H/V | 0 | 1.5 | 33.2 | -0.7 | 46.6 | 74.0 | 36.6 | 54.0 | 17.4 | CH20 (M) |
| 16 | 7310.0 | 7310.0 | HQR1TO18S01 | H/V | 0 | 1.5 | 33.3 | -0.7 | 61.2 | 74.0 | 51.1 | 54.0 | 2.9 | ALL ACTIVE - WLAN MODULE SPURIOUS |
| 17 | 7260.0 | 7260.0 | HQR1TO18S01 | H/V | 0 | 1.5 | 33.3 | -0.7 | 42.8 | 74.0 | 32.8 | 54.0 | 21.2 | CH40 (H) |
| 18 | 6000.0 | 8400.0 | HQR1TO18S01 | H/V | all | all | 34.3 | -0.8 | 61.2 | 74.0 | 51.1 | 54.0 | 2.9 | all channels; max all |
| 19 | 8400.0 | 12500.0 | HQR1TO18S01 | H/V | all | all | 35.6 | -1.1 | 43.8 | 74.0 | | 54.0 | 10.2 | all channels; max all, noise |
| 20 | 12500.0 | 18000.0 | HQR1TO18S01 | H/V | all | all | 34.2 | -1.6 | 44.3 | 74.0 | | 54.0 | 9.7 | all channels; max all, noise |
| 21 | 18000.0 | 26500.0 | HRNK01 | H/V | all | all | 32.0 | 0.0 | 48.9 | 74.0 | | 54.0 | 5.1 | all channels; max all, noise |
| 22 | | | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | |

EUT measured in each of Flat, Side, End orientations. Worst case emission from all three orientations and both test antenna polarizations reported here.

** No other spurious emissions from the EUT were observed within 20 dB of the regulatory limit.

### 4.3.2 Relative Transmit Chain Spurious Emissions

The results for the measurement of transmit chain spurious emissions relative to the fundamental in a 100 kHz receiver bandwidth (at the nominal voltage and temperature) are provided in Figure 12 below.




| Range Low | Range Up | RBW | Frequency | Power Abs | ΔLimit |
|---|---|---|---|---|---|
| 30.000 MHz | 2.400 GHz | 100.000 kHz | 2.39970 GHz | -15.84 dBm | -7.84 dB |
| 30.000 MHz | 2.400 GHz | 100.000 kHz | 1.69954 GHz | -37.73 dBm | -29.73 dB |
| 2.400 GHz | 2.484 GHz | 100.000 kHz | 2.42006 GHz | 22.22 dBm | -7.78 dB |
| 2.400 GHz | 2.484 GHz | 100.000 kHz | 2.44008 GHz | 20.85 dBm | -9.15 dB |
| 2.484 GHz | 2.500 GHz | 100.000 kHz | 2.49889 GHz | -37.56 dBm | -29.56 dB |
| 2.500 GHz | 10.000 GHz | 100.000 kHz | 6.82868 GHz | -31.73 dBm | -23.73 dB |
| 2.500 GHz | 10.000 GHz | 100.000 kHz | 5.66862 GHz | -33.66 dBm | -25.66 dB |
| 10.000 GHz | 17.500 GHz | 100.000 kHz | 16.40669 GHz | -30.57 dBm | -22.57 dB |
| 10.000 GHz | 17.500 GHz | 100.000 kHz | 14.55157 GHz | -32.97 dBm | -24.97 dB |
| 17.500 GHz | 25.000 GHz | 100.000 kHz | 18.25312 GHz | -31.26 dBm | -23.26 dB |

Figure 12: Conducted Transmitter Emissions Measured.

### 4.3.3 General Radiated Spurious

The results for the measurement of general spurious emissions (emissions arising from digital circuitry) at the nominal voltage and temperature are provided in Table 9. Radiation from digital components are measured up to 1000 MHz or to the highest frequency required by the applied standards, whichever is greater.

Table 9: Radiated Digital Spurious Emissions.

| Frequency Range | Det | IF Bandwidth | Video Bandwidth | | |
|---|---|---|---|---|---|
| 25 MHz ≤ f ≤ 1 000 MHz | Pk/QPk | 120 kHz | 300 kHz | **Test Date:** | 8-Oct-18 |
| f > 1 000 MHz | Pk | 1 MHz | 3 MHz | **Test Engineer:** | Joseph Brunett |
| f > 1 000 MHz | Avg | 1 MHz | 3 MHz | **EUT:** | Nikola Vero 100-000A |
| | | | | **EUT Mode:** | Advertising |
| | | | | **Meas. Distance:** | 3 meters |

**Digital Spurious Emissions** FCC/IC + CE(CISPR)

| | Test | Test Setup | | | | | | E-Field @ 3m | | FCC/IC Class B | | CE Class B | | FCC/IC Class A | | CE Class A | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Freq. | Type | Test | Table Azim. | Ant Height | Ka | Kg | Pk | QPk/Avg | E3lim | Pass | E3lim | Pass | E3lim | Pass | E3lim | Pass | |
| # | MHz | Used | Pol. | deg | m | dB/m | dB | dBµV/m | dBµV/m | dBµV/m | dB | dBµV/m | dB | dBµV/m | dB | dBµV/m | dB | Comments |
| 1 | 70.6 | BICEMCO01 | H | 0.0 | 1.00 | 1.3 | -1.5 | 23.1 | | 40.0 | 16.9 | 40.5 | 17.4 | 49.5 | 26.4 | 50.5 | 27.4 | |
| 2 | 70.6 | BICEMCO01 | V | 180.0 | 1.00 | 1.3 | -1.5 | 24.8 | | 40.0 | 15.2 | 40.5 | 15.7 | 49.5 | 24.7 | 50.5 | 25.7 | |
| 3 | 121.5 | BICEMCO01 | H | 180.0 | 1.00 | 6.1 | -2.1 | 18.4 | | 43.5 | 25.1 | 40.5 | 22.1 | 54.0 | 35.6 | 50.5 | 32.1 | |
| 4 | 121.5 | BICEMCO01 | V | 180.0 | 1.00 | 6.1 | -2.1 | 20.9 | | 43.5 | 22.6 | 40.5 | 19.6 | 54.0 | 33.1 | 50.5 | 29.6 | |
| 5 | 173.2 | BICEMCO01 | H | 210.0 | 1.00 | 9.4 | -2.5 | 20.9 | | 43.5 | 22.6 | 40.5 | 19.6 | 54.0 | 33.1 | 50.5 | 29.6 | |
| 6 | 183.2 | BICEMCO01 | V | 210.0 | 1.25 | 9.9 | -2.6 | 38.2 | | 43.5 | **5.3** | 40.5 | 2.3 | 54.0 | 15.8 | 50.5 | 12.3 | |
| 7 | 290.0 | LOGEMCO01 | H | 0.0 | 1.50 | 13.5 | -3.6 | 21.5 | | 46.0 | 24.5 | 47.5 | 26.0 | 56.9 | 35.4 | 57.5 | 36.0 | |
| 8 | 290.0 | LOGEMCO01 | V | 0.0 | 1.25 | 13.5 | -3.6 | 29.3 | | 46.0 | 16.7 | 47.5 | 18.2 | 56.9 | 27.6 | 57.5 | 28.2 | |
| 9 | 321.4 | LOGEMCO01 | H | 0.0 | 1.50 | 14.2 | -3.8 | 38.2 | | 46.0 | 7.8 | 47.5 | 9.3 | 56.9 | 18.7 | 57.5 | 19.3 | |
| 10 | 321.4 | LOGEMCO01 | V | 180.0 | 1.50 | 14.2 | -3.8 | 39.1 | | 46.0 | 6.9 | 47.5 | 8.4 | 56.9 | 17.8 | 57.5 | 18.4 | |
| 11 | 394.5 | LOGEMCO01 | H | 180.0 | 1.25 | 15.6 | -4.3 | 39.2 | | 46.0 | 6.8 | 47.5 | 8.3 | 56.9 | 17.7 | 57.5 | 18.3 | |
| 12 | 394.5 | LOGEMCO01 | V | 180.0 | 1.50 | 15.6 | -4.3 | 40.2 | | 46.0 | 5.8 | 47.5 | 7.3 | 56.9 | 16.7 | 57.5 | 17.3 | |
| 13 | 443.0 | LOGEMCO01 | H | 180.0 | 1.25 | 16.5 | -4.6 | 30.1 | | 46.0 | 15.9 | 47.5 | 17.4 | 56.9 | 26.8 | 57.5 | 27.4 | |
| 14 | 443.0 | LOGEMCO01 | V | 180.0 | 1.50 | 16.5 | -4.6 | 29.0 | | 46.0 | 17.0 | 47.5 | 18.5 | 56.9 | 27.9 | 57.5 | 28.5 | |
| 15 | 704.0 | LOGEMCO01 | H | max all | 1.25 | 20.4 | -6.1 | 32.4 | | 46.0 | 13.6 | 47.5 | 15.1 | 56.9 | 24.5 | 57.5 | 25.1 | |
| 16 | 704.0 | LOGEMCO01 | V | max all | 1.25 | 20.4 | -6.1 | 33.9 | | 46.0 | 12.1 | 47.5 | 13.6 | 56.9 | 23.0 | 57.5 | 23.6 | |
| 17 | 747.0 | LOGEMCO01 | H | max all | 1.25 | 20.9 | -6.3 | 29.9 | | 46.0 | 16.1 | 47.5 | 17.6 | 56.9 | 27.0 | 57.5 | 27.6 | |
| 18 | 747.0 | LOGEMCO01 | V | max all | 1.00 | 20.9 | -6.3 | 35.0 | | 46.0 | 11.0 | 47.5 | 12.5 | 56.9 | 21.9 | 57.5 | 22.5 | |
| 19 | 875.0 | LOGEMCO01 | H | max all | 1.25 | 22.3 | -6.9 | 29.9 | | 46.0 | 16.1 | 47.5 | 17.6 | 56.9 | 27.0 | 57.5 | 27.6 | |
| 20 | 875.0 | LOGEMCO01 | V | max all | 1.00 | 22.3 | -6.9 | 36.0 | | 46.0 | 10.0 | 47.5 | 11.5 | 56.9 | 20.9 | 57.5 | 21.5 | |

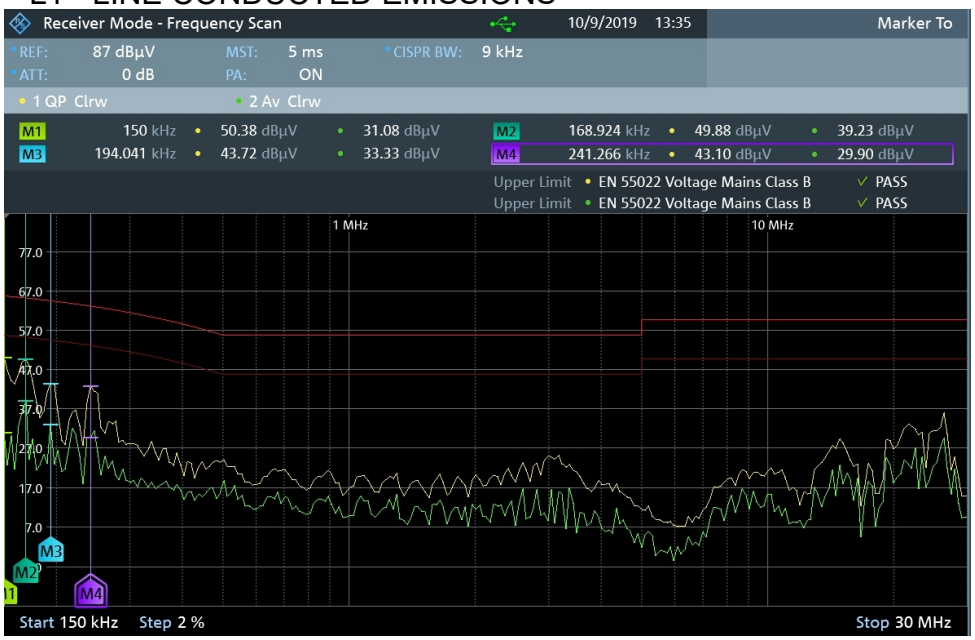
*QPk detection below 1 GHz, Avg detection at or above 1 GHz with receiver bandwidth as specified at top of table.

### 4.3.4 Conducted Emissions Test Results - AC Power Port(s)

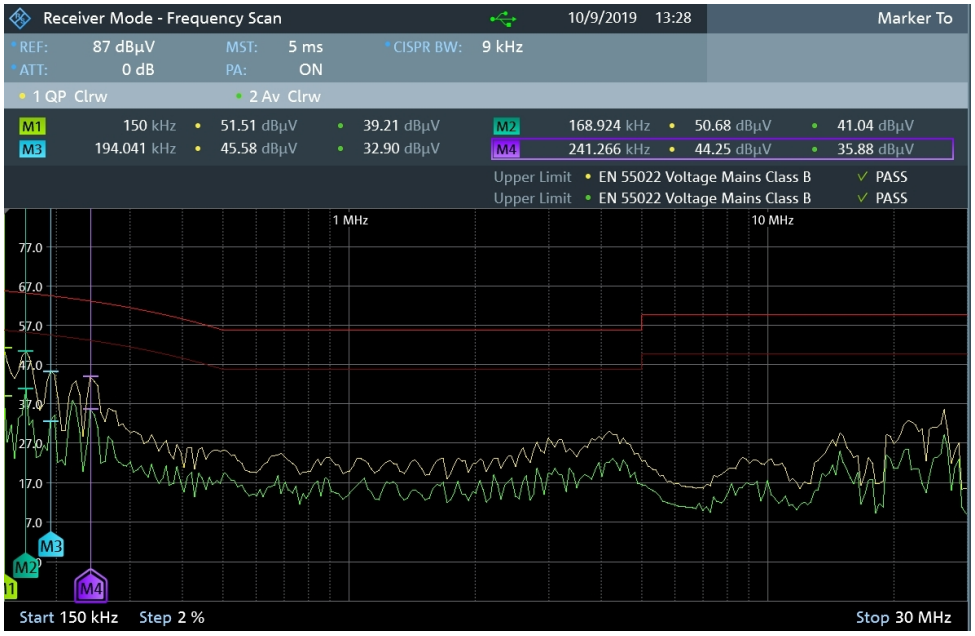
The results of emissions from the EUT's AC mains power port(s) are reported in Table 10.

Table 10: AC Mains Power Conducted Emissions Results.

L1 - LINE CONDUCTED EMISSIONS




L2 - LINE CONDUCTED EMISSIONS



## 5 Measurement Uncertainty and Accreditation Documents

The maximum values of measurement uncertainty for the laboratory test equipment and facilities associated with each test are given in the table below. This uncertainty is computed for a 95.45% confidence level based on a coverage factor of $k = 2$.

Table 11: Measurement Uncertainty.

| Measured Parameter | Measurement Uncertainty† |
|---|---|
| Radio Frequency | $\pm(f_{Mkr}/10^7 + RBW/10 + (SPN/(PTS-1))/2 + 1\,\text{Hz})$ |
| Conducted Emm. Amplitude | $\pm 1.9\,\text{dB}$ |
| Radiated Emm. Amplitude $(30 - 200\,\text{MHz})$ | $\pm 4.0\,\text{dB}$ |
| Radiated Emm. Amplitude $(200 - 1000\,\text{MHz})$ | $\pm 5.2\,\text{dB}$ |
| Radiated Emm. Amplitude $(f > 1000\,\text{MHz})$ | $\pm 3.7\,\text{dB}$ |

†Ref: CISPR 16-4-2:2011+A1:2014


United States Department of Commerce
National Institute of Standards and Technology

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**Electromagnetic Compatibility & Telecommunications**

*This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).*

2019-06-28 through 2020-06-30
*Effective Dates*

*For the National Voluntary Laboratory Accreditation Program*



Figure 13: Accreditation Documents