
Project 17649-15

**POD
2.4 GHz Movement Sensor**

Wireless Certification Report

Prepared for:

Virtuix
1826 Kramer Lane, Suite H
Austin, TX 78758

By

Professional Testing (EMI), Inc.
1601 North A.W. Grimes Blvd., Suite B
Round Rock, Texas 78665

9 Mar 2016

Reviewed by



Larry Finn
Chief Technical Officer

Written by



Eric Lifsey
EMC Engineer

Revision History

| Revision Number | Description | Date |
|------------------------|---------------------------|-------------|
| 00 | Draft Release for review. | 24 Feb 2016 |
| 01 | Revised. | 9 Mar 2016 |
| | | |
| | | |
| | | |

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Corrections:

None.



Certificate of Compliance

| Applicant | Device & Test Identification |
|---|---|
| Virtuix, Inc. (Doug Shuffield) 1826 Kramer Lane, Suite H Austin, TX 78758 Certificate Date: 9 Mar 2016 | FCC ID: 2AHSFN-PODV001 Industry Canada ID: 21168-PODV001 Model(s): POD Laboratory Project ID: 17649-15 |

The device model(s) listed above were tested utilizing the following documents and found to be in compliance with the required criteria.

| Requirement** | Reference | Detail |
|----------------------|--|--|
| FCC 47 CFR Part 15 C | 15.247 | Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz. |
| FCC 47 CFR Part 15 C | 15.209 | Radiated emission limits; general requirements. |
| FCC 47 CFR Part 15 C | 15.207 | Conducted emission limits. |
| FCC 47 CFR Part 15 C | 15.205 | Restricted Bands of Operation |
| KDB 558074 D01 | DR01 | DTS Measurement Guidance v03r02 |
| KDB 412172 | D01 | Guidelines for Determining the ERP and EIRP of an RF Transmitting System |
| OET Bulletin 65* | Edition 97-01, and Supplement C, Ed. 01-01 | Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields |
| RSS-247 | Issue 1 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |
| RSS-Gen | Issue 4 | General Requirements and Information for the Certification of Radio Apparatus |
| RSS-102 | Issue 4 | Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands) |

*MPE is reported separately from this document. **Corresponding RSS references are listed in the body of the report.

I, Eric Lifsey, for Professional Testing (EMI), Inc., being familiar with the above requirements have reviewed the test setup, measured data, and this report. I believe them to be true and accurate.

Eric Lifsey
EMC Engineer

This report has been reviewed and accepted by the Applicant. The undersigned is responsible for ensuring that this device will continue to comply with the requirements listed above.

Representative of Applicant

1.0 Introduction

1.1 Scope

This report describes the extent to which the equipment under test (EUT) conformed to the intentional radiator requirements of the United States and Canada.

Professional Testing (EMI), Inc., (PTI) follows the guidelines of National Institute of Standards and Technology (NIST) for all uncertainty calculations, estimates, and expressions thereof for electromagnetic compatibility testing.

1.2 EUT Description

The EUT is a part of a virtual reality system. It snaps onto custom shoes worn by the user to detect individual foot movement and position. It reports this data by wireless means to a companion aggregator board that occupies the base upon which the user stands and moves.

Table 1.2.1: Equipment Under Test

| Manufacturer / Model | Serial # | Description |
|----------------------|----------|--|
| Virtuix, Inc. POD | None | Wireless position sensor 2400-2483.5 transceiver |

The device employs a chip antenna. The EUT is powered by an internal rechargeable 3.7 V battery.

The EUT measures approximately 35 x 35 x 15 mm.

1.3 EUT Operation

The EUT was exercised in a manner consistent with normal operations.

1.4 Modifications to Equipment

No modifications were made to the EUT during the performance of the test program.

1.5 Test Site

Measurements were made at the PTI semi-anechoic facility designated Site 45 (FCC 459644, IC 3036B-1) in Austin, Texas. The site is registered with the FCC under Section 2.948 and Industry Canada per RSS-GEN, and is subsequently confirmed by laboratory accreditation (NVLAP). The test site is located at 11400 Burnet Road, Austin, Texas 78758, while the main office is located at 1601 North A.W. Grimes Boulevard, Suite B, Round Rock, Texas, 78665.

1.6 Radiated Measurements

Radiated levels are determined as follows:

$$\text{Raw Measured Level} + \text{Antenna Factor} + \text{Cable Losses} - \text{Amplifier Gain} = \text{Corrected Level}$$

Conducted RF levels are determined as follows:

Raw Measured Level + Attenuator Factor + Cable Losses = Corrected Level

Conducted mains levels are determined as follows:

Raw Measured Level + LISN Factor + Cable/Filter/Limiter Losses = Corrected Level

Additionally, measurement distance extrapolation factors are applied and documented where used.

1.7 Applicable Documents and Clauses

Table 1.7.1: Applicable Documents

| Document | Title |
|-----------------|---|
| 47 CFR | Part 15 – Radio Frequency Devices Subpart C -Intentional Radiators |
| RSS-247 Issue 1 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |
| RSS-Gen Issue 4 | General Requirements and Information for the Certification of Radio Apparatus |
| ANSI C63.4 2009 | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low Voltage Electrical and Electronic Equipment |

Table 1.7.2: Applicable Clauses

| Parameter | FCC Part 15 Rule Paragraphs | IC RSS References |
|-----------------------------|--------------------------------------|------------------------------------|
| Transmitter Characteristics | 15.247(a)(2) | RSS-247 5.2 (DTS) & 5.4, RSS-Gen 6 |
| Power Spectral Density | 15.247(e) | RSS-247 5.2 (DTS) |
| Bandwidth | 15.247(a)(2), 2.1049, KDB 558074 D01 | RSS-247 5.2 (DTS), RSS-Gen 6.6 |
| Spurious Emission | 15.247, 15.209, 15.205 | RSS-247 5.5, RSS-GEN 6.13, 7.1 |
| Band Edge | 15.247, 15.205 | RSS-247 5.5, RSS-Gen 6.13 |
| Antenna Requirement | 15.203 | RSS-Gen 8.3 |
| Conducted Emissions, Mains | 15.207 | RSS-Gen 8.8 |

2.0 Fundamental Power

2.1 Test Procedure

Bandwidth is first determined to select correct entire bandwidth for power measurement and the fundamental field strength is then measured.

2.2 Test Criteria

| 47 CFR (USA) // IC (Canada) | | |
|--------------------------------|---|-------------|
| Section Reference | Parameter | Date |
| 15.247(a)(2) // RSS-247 5.2 | Fundamental Power Conducted Limit: 1 Watt Desired Power Limit: 10 mW Restated as Radiated Limit @ 3 m: 105.23 dB μ V/m | 18 Jan 2016 |

2.3 Test Results

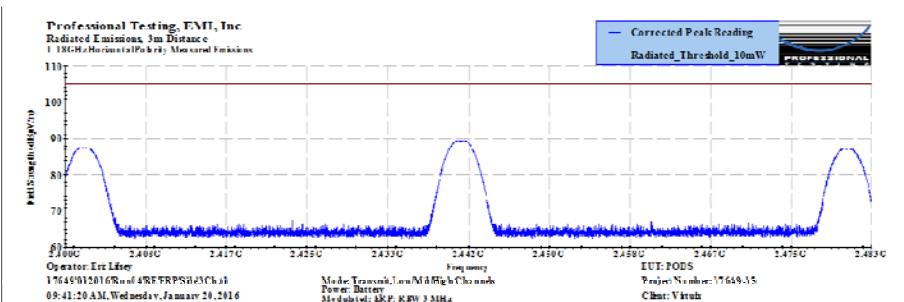
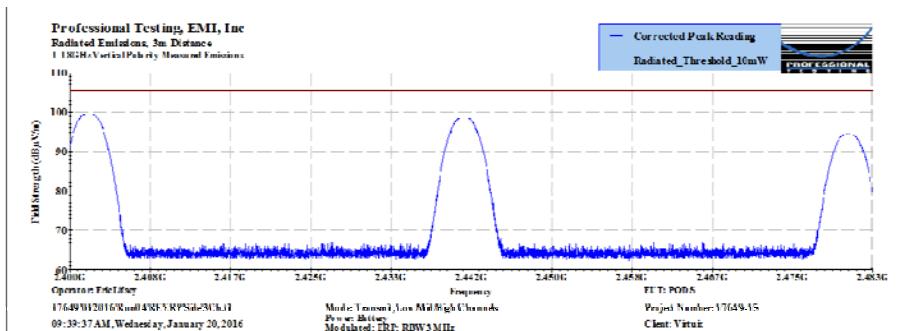
The EUT bandwidth was found to be between 1 MHz and 3 MHz, the measurement resolution bandwidth was set accordingly. Maximum polarity was vertical with EUT oriented in side position.

Table 2.3.1 Radiated Power at 3 meters, Maximum Polarity & Orientation

| Frequency MHz | Measured Radiated Peak Power dB μ V/m @ 3m |
|---------------|---|
| 2402 | 99.6 |
| 2441 | 98.6 |
| 2481 | 94.5 |

Measured in 3 MHz RBW, 3 MHz VBW.

The EUT satisfied the requirement. Note that the highest frequency channel has power reduced to satisfy band-edge emissions. Plotted measurements appears below.



3.0 Power Spectral Density

3.1 Test Procedure

The EUT fundamental field strength is measured a spectrum analyzer and is then adjusted to record in max-hold mode for an extended time sufficient to capture all transmit products.

3.2 Test Criteria

| 47 CFR (USA) // IC (Canada) | | |
|-----------------------------|---|-------------|
| Section Reference | Parameter | Date |
| 15.247(e) // RSS-247 5.2 | Power Spectral Density Conducted Limit: 8 dBm / 3 kHz Restated as Radiated Limit @ 3 m: 103.23 dB μ V/m | 18 Jan 2016 |

3.3 Test Results

The fundamental peak power in 3 MHz measured to be below the PSD power limit. Therefore EUT satisfied the PSD limit without need for measurement.

4.0 Transmitter Duty Cycle

4.1 Test Procedure

EUT is placed into worse-case transmit operation to observe and record transmitter time domain performance.

4.2 Test Criteria

| Section Reference | Parameter | Date(s) |
|---------------------------------|---------------------|-------------|
| 15.247 // RSS-247, RSS-Gen 6.10 | Transmit Duty Cycle | 24 Feb 2016 |

Measurement is based on intervals not to exceed 100 msec. Maximum transmitter on time is divided by the lesser of 100 msec or the actual measured minimum transmitter interval time. The result is converted to dB and applied as needed to peak measurements of transmitter artifacts to determine average power. This is not a pass/fail measurement.

4.3 Test Results

This measurement was not required due to the low fundamental power and spurious levels.

5.0 Occupied Bandwidth

5.1 Test Procedure

The EUT is directly connected to a spectrum analyzer and bandwidth then is measured. A recording of the results is included.

5.2 Test Criteria

| 47 CFR (USA) // IC (Canada) | | |
|---|--------------------------|-------------|
| Section Reference | Parameter | Date(s) |
| 14.247(a)(2), 2.1049 // RSS-Gen 5.2, RSS-Gen 6.6 | Bandwidth 6 dB, 20 dB | 19 Jan 2016 |

5.3 Test Results

EUT was found to be in compliance with applicable requirements.

Table 5.3.1 Bandwidth 6 dB, Minimum 500 kHz

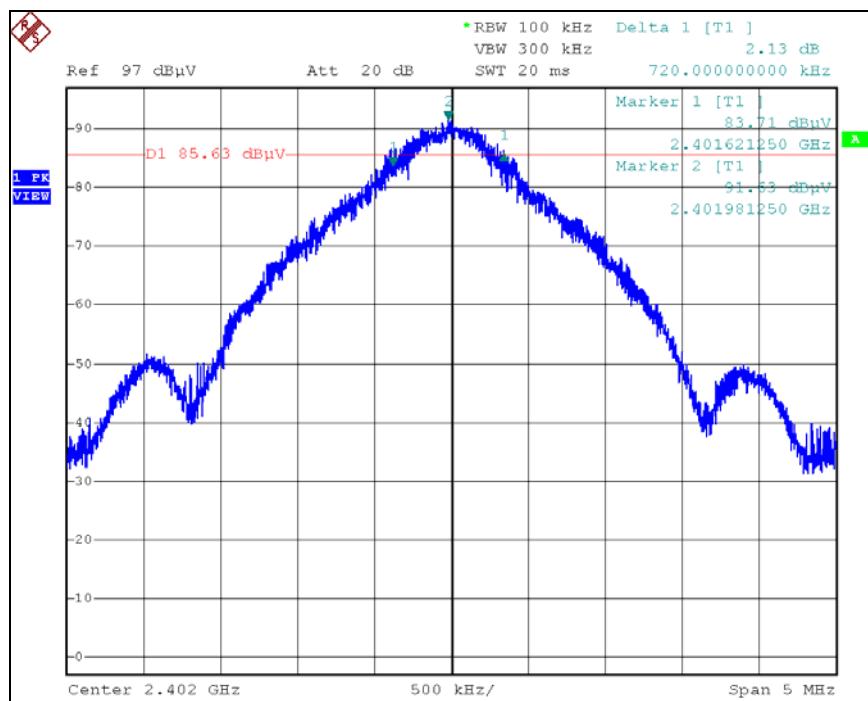
| Low Channel Measured BW (kHz) | Mid Channel Measured BW (kHz) | High Channel Measured BW (kHz) | Minimum BW (kHz) |
|-------------------------------------|-------------------------------------|--------------------------------------|-----------------------------|
| 720 | 720 | 770 | 720 |

Table 5.3.2 Bandwidth 20 dB, Measure and Report

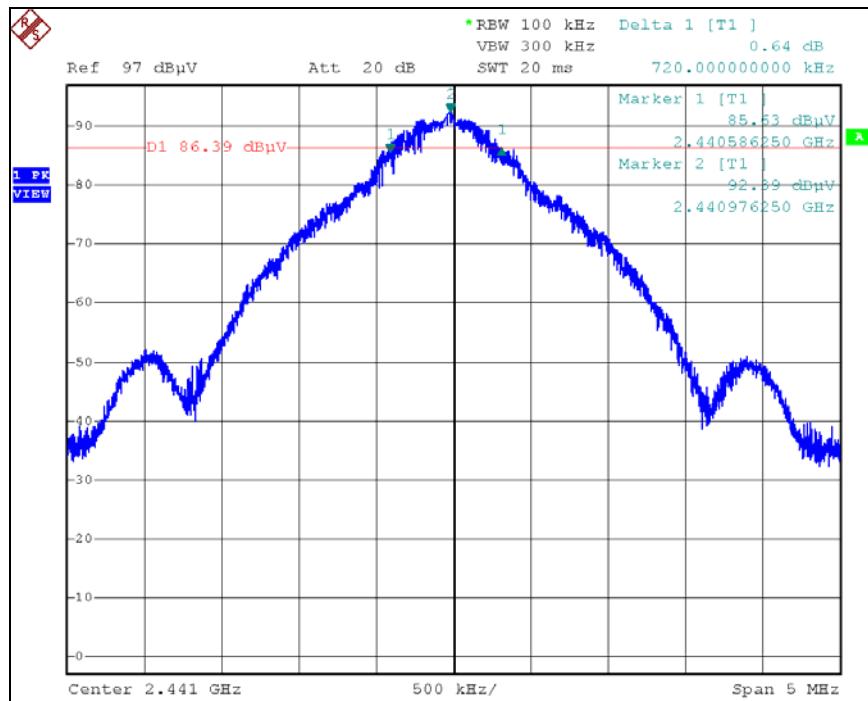
| Low Channel Measured BW (kHz) | Mid Channel Measured BW (kHz) | High Channel Measured BW (kHz) | Reported Maximum BW (kHz) |
|-------------------------------------|-------------------------------------|--------------------------------------|--|
| 1610 | 1590 | 1530 | 1610 |

Plotted measurements appear on the following pages.

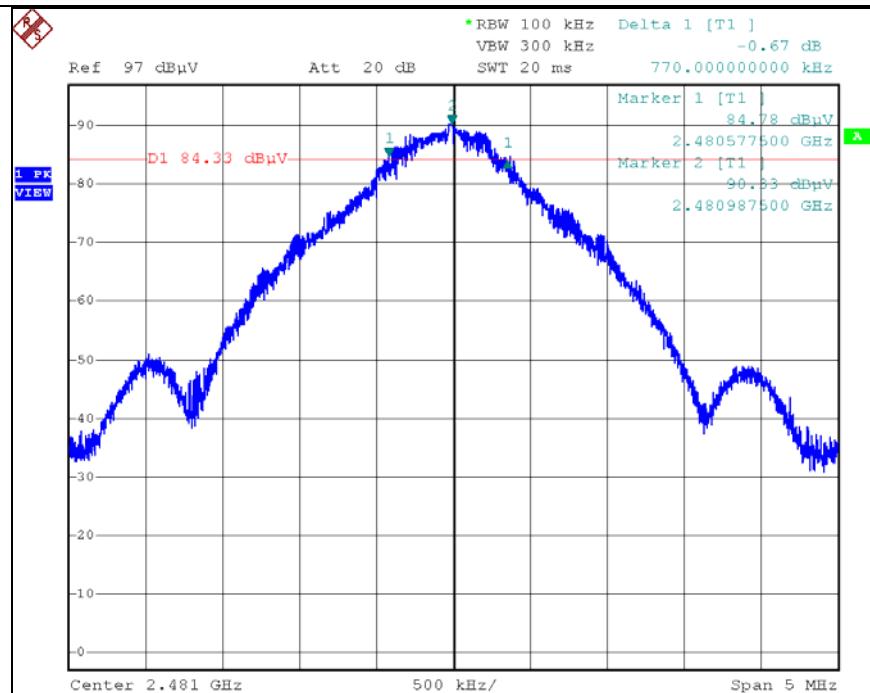
5.3.1 Bandwidth Plots, 6 dB



6 dB, Low Channel

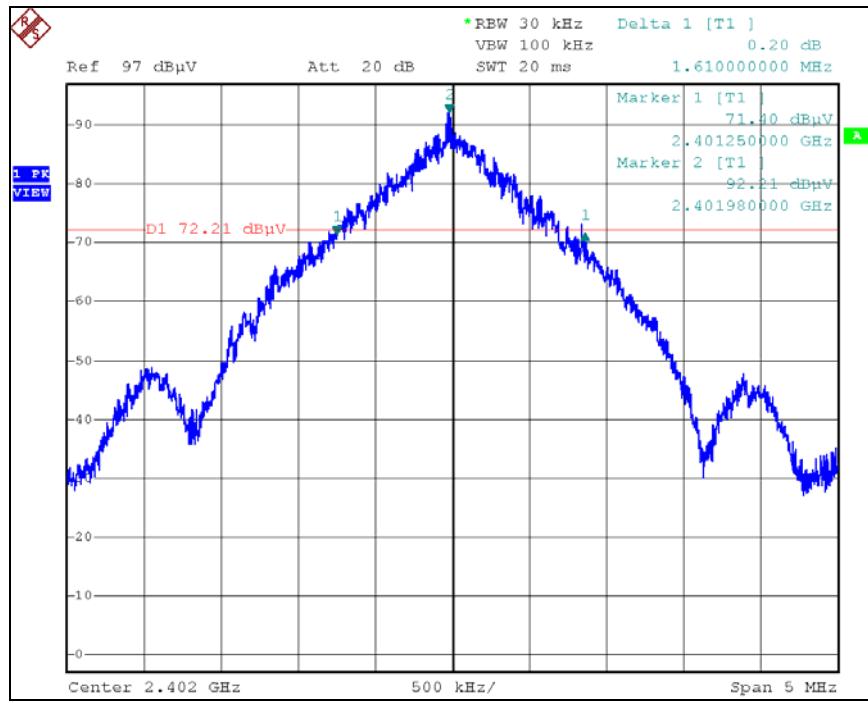


6 dB, Middle Channel

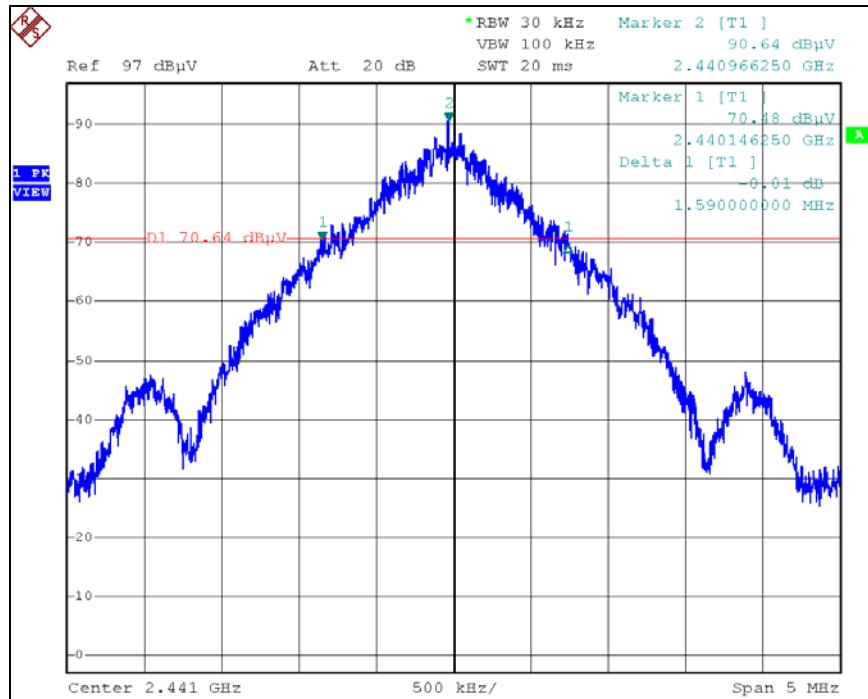


6 dB, High Channel

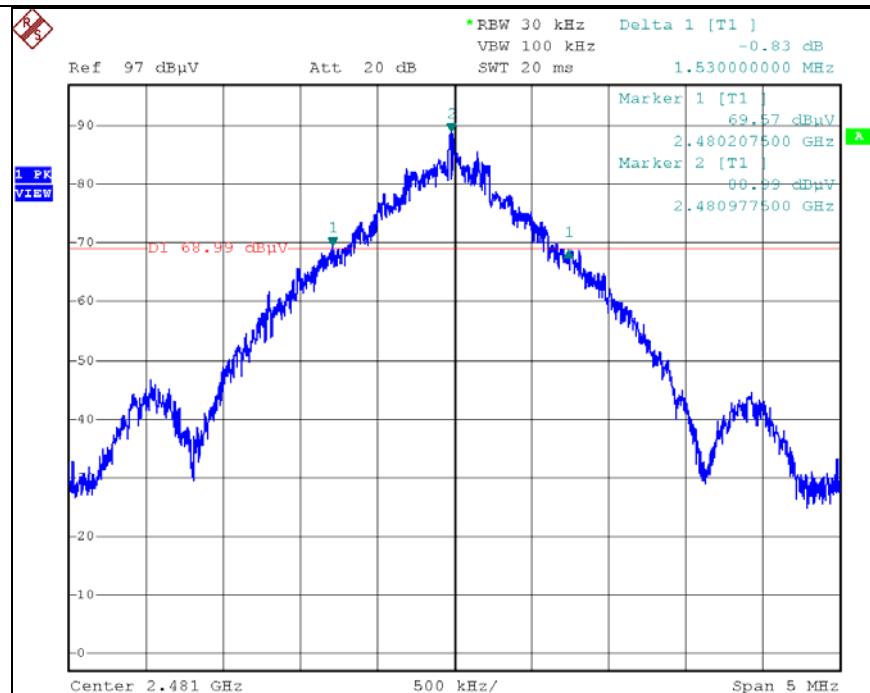
5.3.2 Bandwidth Plots, 20 dB



20 dB, Low Channel



20 dB, Middle Channel



6.0 Band Edge

6.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a rotating turntable at a distance of 3 meters from the measurement antenna.

EUT is placed into normal transmit operation on the nearest band edge channel. The spectrum analyzer is centered on the band edge frequency with span sufficient to include the peak of the adjacent fundamental signal. Using peak detection, the analyzer measured emissions in max-hold mode. The measurement range includes two standard bandwidths from the respective band edge and some beyond to see the emission profile clearly. If required, the band-edge marker-delta method of C63.4 is utilized.

6.2 Test Criteria

| 47 CFR (USA) // IC (Canada) | | |
|--|---|-------------|
| Section Reference | Parameter | Date(s) |
| 15.205, 15.209 // RSS-247 5.5, RSS-Gen 6.13 | Unwanted Emissions Adjacent to Authorized Band, Radiated | 18 Jan 2016 |

6.3 Test Results

Peak detection emissions at band edges were below the applicable general emission peak limits or the -20 dBc limit (shown in green).

The EUT satisfied the requirements.

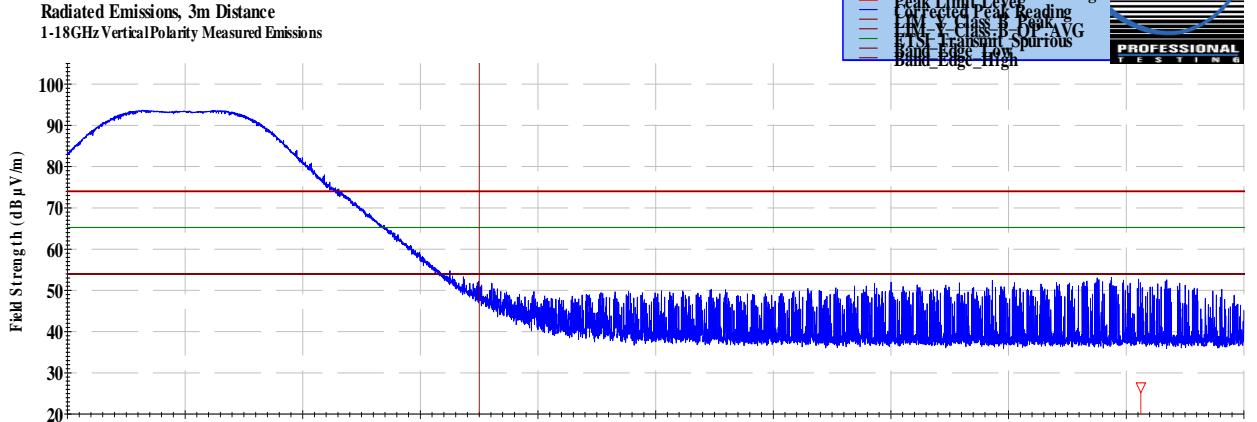
6.3.1 Low Channel Band Edge

| Professional Testing, EMI, Inc. | | | | | | | | | | | | | | | | | |
|---|--|-------------------------|-------------------------|-----------------------------|---|--------------------------------|----------------------------|-------------|--------------|--|--|--|--|--|--|--|--|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | | | | | | | | | | | |
| In accordance with: | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | | | | | | | | | | | | | | | |
| Section: | 15.209 | | | | | | | | | | | | | | | | |
| Test Date(s): | 1/18/2016 | | | EUT Serial #: | 0 | | | | | | | | | | | | |
| Customer: | Virtuix | | | EUT Part #: | 0 | | | | | | | | | | | | |
| Project Number: | 17649-15 | | | Test Technician: | Eric Lifsey | | | | | | | | | | | | |
| Purchase Order #: | NA | | | Supervisor: | Lisa Arndt | | | | | | | | | | | | |
| Equip. Under Test: | PODS | | | Witness' Name: | Brian Olinger, Patrick Herron | | | | | | | | | | | | |
| Radiated Emissions Test Results Data Sheet | | | | | | | | | | | | | | | | | |
| Page: 1 of 1 | | | | | | | | | | | | | | | | | |
| EUT Line Voltage: | 3.7 | | VDC | EUT Power Frequency: | | 0 | N/A | | | | | | | | | | |
| Antenna Orientation: | Vertical | | | Frequency Range: | | Above 1GHz | | | | | | | | | | | |
| EUT Side Position; Mode of Operation: | | | | | Transmit Mode, Modulated, 3 Channels/EUTs | | | | | | | | | | | | |
| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dB μ V) | Corrected Level (dB μ V/m) | Limit Level (dB μ V/m) | Margin (dB) | Test Results | | | | | | | | |
| 2395.12 | 10 | 63 | 1 | Peak | 45.4 | 36.747 | 63.5 | -26.8 | Pass | | | | | | | | |
| Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Vertical Polarity Measured Emissions | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| Band Edge, Lower | | | | | | | | | | | | | | | | | |

EUT Satisfies -20 dBc Criteria

Peak detection levels shown.

6.3.2 High Channel Band Edge

| Professional Testing, EMI, Inc. | | | | | | | | | | | | |
|---|--|-------------------------|-------------------------|-------------------------------|---|--------------------------------|----------------------------|--------------|--------------|--|--|--|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | | | | | | |
| In accordance with: | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | | | | | | | | | | |
| Section: | 15.209 | | | | | | | | | | | |
| Test Date(s): | 1/18/2016 | | EUT Serial #: | 0 | | | | | | | | |
| Customer: | Virtuix | | EUT Part #: | 0 | | | | | | | | |
| Project Number: | 17649-15 | | Test Technician: | Eric Lifsey | | | | | | | | |
| Purchase Order #: | NA | | Supervisor: | Lisa Arndt | | | | | | | | |
| Equip. Under Test: | PODS | | Witness' Name: | Brian Olinger, Patrick Herron | | | | | | | | |
| Radiated Emissions Test Results Data Sheet | | | | | | | | Page: | 1 of 1 | | | |
| EUT Line Voltage: | 3.7 | | VDC | EUT Power Frequency: | | 0 | N/A | | | | | |
| Antenna Orientation: | Horizontal | | | Frequency Range: | | Above 1GHz | | | | | | |
| EUT Side Position; Mode of Operation: | | | | | Transmit Mode, Modulated, 3 Channels/EUTs | | | | | | | |
| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dB μ V) | Corrected Level (dB μ V/m) | Limit Level (dB μ V/m) | Margin (dB) | Test Results | | | |
| 2489.13 | 10 | 320 | 1 | Peak | 43.3 | 34.926 | 65.2 | -30.3 | Pass | | | |
| Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Vertical Polarity Measured Emissions | | | | | | | | | | | | |
|  Field Strength (dB μ V/m) vs Frequency (GHz). The graph shows a sharp drop in field strength starting around 2.483 GHz. A red line indicates the average limit level, and a blue line shows the corrected peak reading. The x-axis ranges from 2.480 GHz to 2.490 GHz, and the y-axis ranges from 20 to 100 dB μ V/m. | | | | | | | | | | | | |
| Operator: Eric Lifsey 17649-12016\Run02\RETxBandEdgeMask\Upper.fil 11:07:31 AM, Wednesday, January 20, 2016 | | | | | | | | | | | | |
| Mode: Transmit, 2 Channels; low/high Power: Battery Modulated; band-edge and OOB domain | | | | | | | | | | | | |
| Project Number: 17649-15 Client: Virtuix | | | | | | | | | | | | |
| Band Edge, Upper | | | | | | | | | | | | |
| EUT Satisfies -20 dBc Criteria and General Emission 15.209 Criteria Above 2.4835 GHz | | | | | | | | | | | | |

Peak detection levels shown.

7.0 Radiated Spurious Emissions, Receive Mode (Charging)

7.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a rotating turntable. The measurement antenna is scanned from 1 to 4 meters in height.

Spurious emissions below 1 GHz were measured with peak and quasi-peak detection with a resolution bandwidth of 120 kHz at a distance of 10 meters. Above 1 GHz the measurement distance was 3 meters with resolution bandwidth of 1 MHz and using peak and average detection. A diagram showing the test setup is given in the figure below.

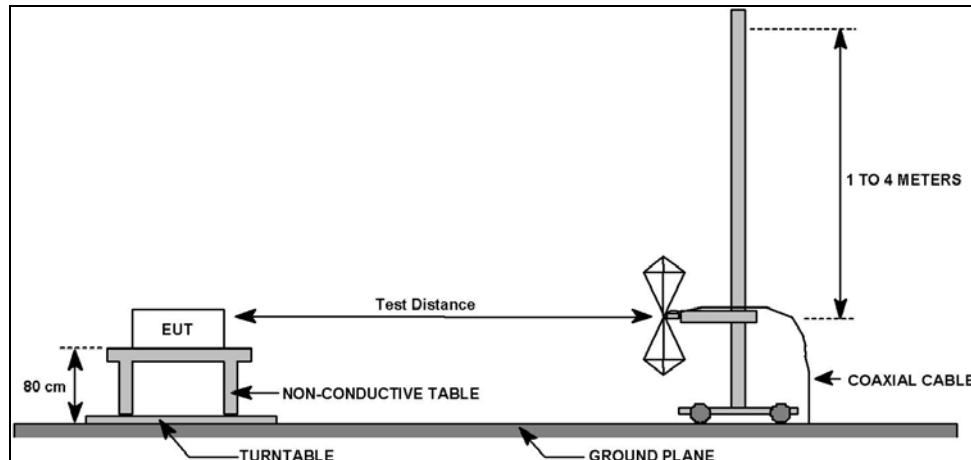


Figure 7.1.1: Field Strength of Spurious Emissions Test Setup

7.2 Test Criteria

| 47 CFR (USA) // IC (Canada) | | |
|---|---|-------------|
| Section Reference | Parameter | Date(s) |
| 15.247, 15.209 // RSS-247 5.5, RSS-Gen 7.1 | Field Strength of Radiated Spurious/Harmonic Emissions | 18 Jan 2016 |

7.3 Test Results

The EUT satisfied the criteria. Recorded data is presented below.

Table 7.3.1: Radiated Spurious Emissions, Receive Mode, Below 1 GHz, Vertical Polarity

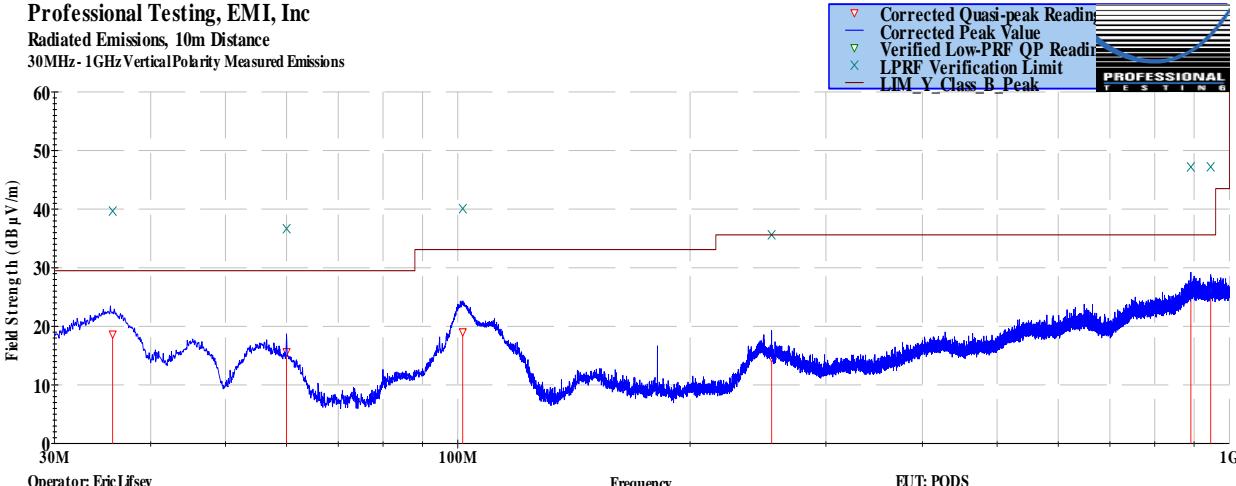
| Professional Testing, EMI, Inc. | | | | | | | | | | | | | |
|--|--|-------------------------|-----------------------------|-------------------------------|---------------------------------|--------------------------------|----------------------------|-------------|--------------|--|--|--|--|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | | | | | | | |
| In accordance with: | FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits | | | | | | | | | | | | |
| Section: | 15.109 | | | | | | | | | | | | |
| Test Date(s): | 1/18/2016 | | EUT Serial #: | 0 | | | | | | | | | |
| Customer: | Virtuix | | EUT Part #: | 0 | | | | | | | | | |
| Project Number: | 17649-15 | | Test Technician: | Eric Lifsey | | | | | | | | | |
| Purchase Order #: | NA | | Supervisor: | Lisa Arndt | | | | | | | | | |
| Equip. Under Test: | PODS | | Witness' Name: | Brian Olinger, Patrick Herron | | | | | | | | | |
| Radiated Emissions Test Results Data Sheet | | | | | | | | Page: | 1 of 1 | | | | |
| EUT Line Voltage: | 0 VDC | | EUT Power Frequency: | 0 | | N/A | | | | | | | |
| Antenna Orientation: | Vertical | | | Frequency Range: | 30MHz to 1GHz | | | | | | | | |
| EUT Mode of Operation: | | | | | Charging Mode | | | | | | | | |
| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dB μ V) | Corrected Level (dB μ V/m) | Limit Level (dB μ V/m) | Margin (dB) | Test Results | | | | |
| 35.709 | 10 | 154 | 1.61 | Quasi-peak | 31.1 | 18.659 | 29.5 | -10.8 | Pass | | | | |
| 60.0077 | 10 | 321 | 3.8 | Quasi-peak | 33.9 | 15.665 | 29.5 | -13.8 | Pass | | | | |
| 101.491 | 10 | 14 | 1.51 | Quasi-peak | 35.5 | 19.064 | 33.1 | -14.0 | Pass | | | | |
| 255.143 | 10 | 57 | 1.56 | Quasi-peak | 24.8 | 14.614 | 35.6 | -21.0 | Pass | | | | |
| 891.318 | 10 | 281 | 1.46 | Quasi-peak | 21.3 | 26.197 | 35.6 | -9.4 | Pass | | | | |
| 945.526 | 10 | 136 | 1.35 | Quasi-peak | 21 | 26.202 | 35.6 | -9.4 | Pass | | | | |
| Professional Testing, EMI, Inc Radiated Emissions, 10m Distance 30MHz - 1GHz Vertical Polarity Measured Emissions | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| Operator: Eric Lifsey 17649 Run06b'REChargeMode'standardUSBcableFCC+IC.til 11:49:21 AM, Monday, January 18, 2016 | | | | | | | | | | | | | |
| Mode: Charging Power: 230/50 Cable: Standard USB1 m | | | | | | | | | | | | | |
| Project Number: 17649-15 Client: Virtuix | | | | | | | | | | | | | |
| ≤ 1GHz Vertical Antenna Polarity Measured Emissions | | | | | | | | | | | | | |

Table 7.3.2: Radiated Spurious Emissions, Receive Mode, Below 1 GHz, Horizontal Polarity

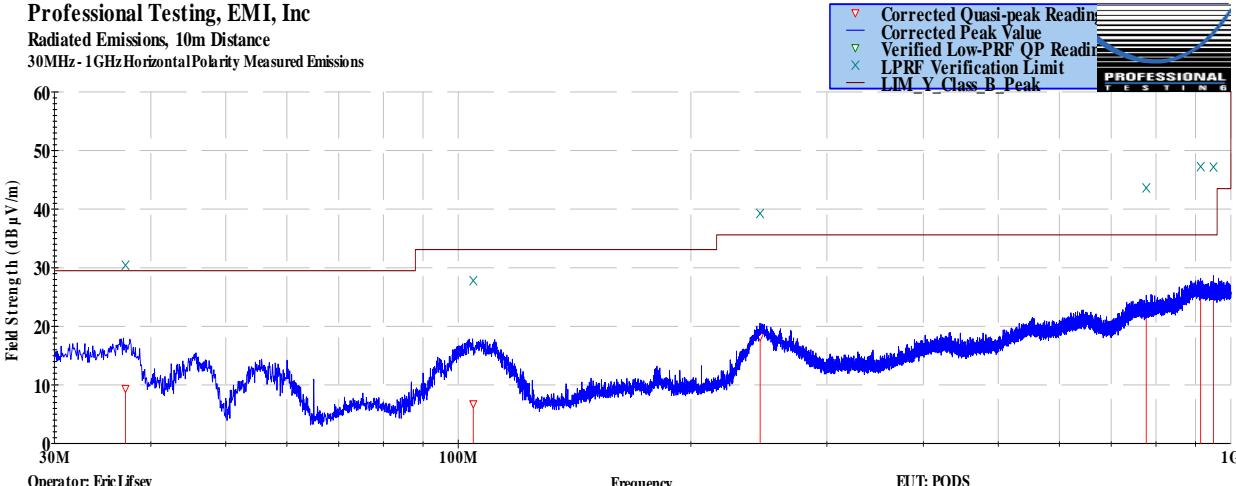
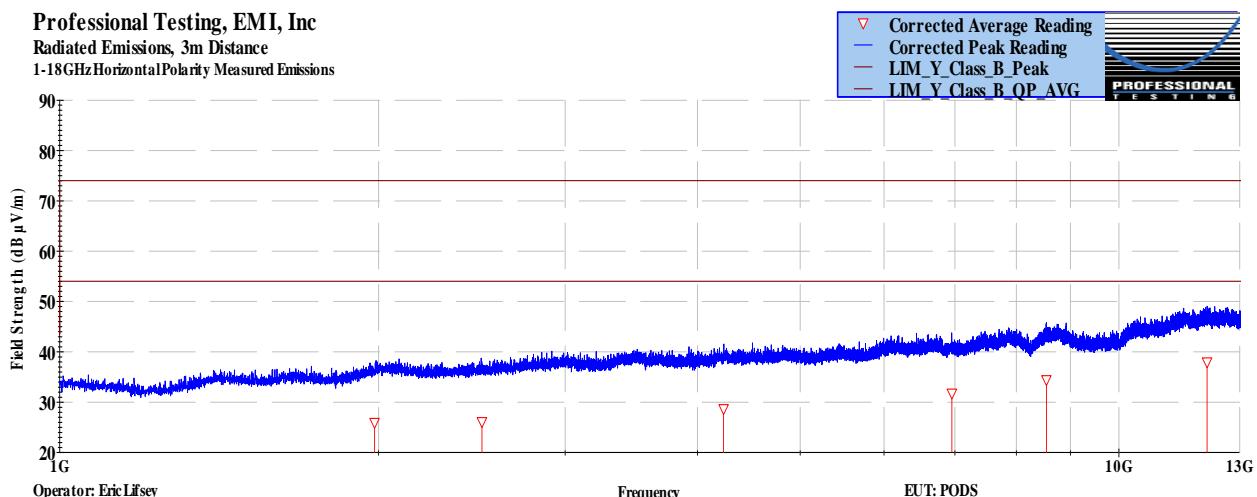
| Professional Testing, EMI, Inc. | | | | | | | | | | | |
|--|--|-------------------------|-------------------------|-----------------------------|---------------------------------|--------------------------------|----------------------------|-------------|--------------|--|--|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | | | | | |
| In accordance with: | FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits | | | | | | | | | | |
| Section: | 15.109 | | | | | | | | | | |
| Test Date(s): | 1/18/2016 | | | EUT Serial #: | 0 | | | | | | |
| Customer: | Virtuix | | | EUT Part #: | 0 | | | | | | |
| Project Number: | 17649-15 | | | Test Technician: | Eric Lifsey | | | | | | |
| Purchase Order #: | NA | | | Supervisor: | Lisa Arndt | | | | | | |
| Equip. Under Test: | PODS | | | Witness' Name: | Brian Olinger, Patrick Herron | | | | | | |
| Radiated Emissions Test Results Data Sheet | | | | | | | Page: | 1 | of 1 | | |
| EUT Line Voltage: | | 0 | VDC | EUT Power Frequency: | | | 0 | N/A | | | |
| Antenna Orientation: | | | Horizontal | Frequency Range: | | | 30MHz to 1GHz | | | | |
| EUT Mode of Operation: | | | | | Charging Mode | | | | | | |
| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dB μ V) | Corrected Level (dB μ V/m) | Limit Level (dB μ V/m) | Margin (dB) | Test Results | | |
| 37.0837 | 10 | 298 | 1.37 | Quasi-peak | 23.7 | 9.409 | 29.5 | -20.1 | Pass | | |
| 104.56 | 10 | 331 | 1.29 | Quasi-peak | 23.2 | 6.789 | 33.1 | -26.3 | Pass | | |
| 245.813 | 10 | 241 | 3.44 | Quasi-peak | 29.1 | 18.249 | 35.6 | -17.4 | Pass | | |
| 777.357 | 10 | 234 | 2.1 | Quasi-peak | 21.5 | 22.599 | 35.6 | -13.0 | Pass | | |
| 914.183 | 10 | 157 | 3.61 | Quasi-peak | 21.2 | 26.254 | 35.6 | -9.3 | Pass | | |
| 949.605 | 10 | 296 | 2.17 | Quasi-peak | 21 | 26.176 | 35.6 | -9.4 | Pass | | |
| Professional Testing, EMI, Inc Radiated Emissions, 10m Distance 30MHz - 1GHz Horizontal Polarity Measured Emissions | | | | | | | | | | | |
|  | | | | | | | | | | | |
| ≤ 1GHz Horizontal Antenna Polarity Measured Emissions | | | | | | | | | | | |

Table 7.3.3: Radiated Spurious Emissions, Receive Mode, Below 1 GHz, Middle Channel, Vertical Polarity

| Professional Testing, EMI, Inc. | | | | | | | | | |
|--|--|-------------------------|-----------------------------|-------------------------------|---------------------------------|--------------------------------|----------------------------|-------------|--------------|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | | | |
| In accordance with: | FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits | | | | | | | | |
| Section: | 15.109 | | | | | | | | |
| Test Date(s): | 1/18/2016 | | EUT Serial #: | 0 | | | | | |
| Customer: | Virtuix | | EUT Part #: | 0 | | | | | |
| Project Number: | 17649-15 | | Test Technician: | Eric Lifsey | | | | | |
| Purchase Order #: | NA | | Supervisor: | Lisa Arndt | | | | | |
| Equip. Under Test: | PODS | | Witness' Name: | Brian Olinger, Patrick Herron | | | | | |
| Radiated Emissions Test Results Data Sheet | | | | | | | Page: | 1 | of 1 |
| EUT Line Voltage: | 0 | VDC | EUT Power Frequency: | 0 | | | | | |
| Antenna Orientation: | Vertical | | | Frequency Range: | Above 1GHz | | | | |
| EUT Mode of Operation: | | | | | Charging Mode | | | | |
| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dB μ V) | Corrected Level (dB μ V/m) | Limit Level (dB μ V/m) | Margin (dB) | Test Results |
| 1946.03 | 3 | 173 | 1 | Average | 39.8 | 30.751 | 54.0 | -23.2 | Pass |
| 2110.9 | 3 | 3 | 1 | Average | 35.7 | 26.854 | 54.0 | -27.1 | Pass |
| 2465.6 | 3 | 28 | 1 | Average | 34.4 | 25.928 | 54.0 | -28.0 | Pass |
| 4140 | 3 | 106 | 1 | Average | 33.5 | 28.401 | 54.0 | -25.6 | Pass |
| 8561.42 | 3 | 111 | 1 | Average | 27 | 34.149 | 54.0 | -19.8 | Pass |
| 12626.8 | 3 | 183 | 1 | Average | 27.6 | 38.168 | 54.0 | -15.8 | Pass |
| Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Vertical Polarity Measured Emissions | | | | | | | | | |
| | | | | | | | | | |
| Operator: Eric Lifsey 17649 Run06b'RECChargeMode'standardUSBcableFCC+IC.til 12:43:43 PM, Monday, January 18, 2016 Frequency EUT: PODS Project Number: 17649-15 Client: Virtuix | | | | | | | | | |
| > 1GHz Vertical Antenna Polarity Measured Emissions | | | | | | | | | |

Table 7.3.4: Radiated Spurious Emissions, Receive Mode, Below 1 GHz, Middle Channel, Horizontal Polarity

| Professional Testing, EMI, Inc. | | | | | | | | | | | | | | | | | |
|---|--|-------------------------|-------------------------|-----------------------------|---------------------------------|--------------------------------|----------------------------|-------------|--------------|--|--|--|--|--|--|--|--|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | | | | | | | | | | | |
| In accordance with: | FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits | | | | | | | | | | | | | | | | |
| Section: | 15.109 | | | | | | | | | | | | | | | | |
| Test Date(s): | 1/18/2016 | | | EUT Serial #: | 0 | | | | | | | | | | | | |
| Customer: | Virtuix | | | EUT Part #: | 0 | | | | | | | | | | | | |
| Project Number: | 17649-15 | | | Test Technician: | Eric Lifsey | | | | | | | | | | | | |
| Purchase Order #: | NA | | | Supervisor: | Lisa Arndt | | | | | | | | | | | | |
| Equip. Under Test: | PODS | | | Witness' Name: | Brian Olinger, Patrick Herron | | | | | | | | | | | | |
| Radiated Emissions Test Results Data Sheet | | | | | | | | | | | | | | | | | |
| Page: 1 of 1 | | | | | | | | | | | | | | | | | |
| EUT Line Voltage: | | 0 | VDC | EUT Power Frequency: | | 0 | N/A | | | | | | | | | | |
| Antenna Orientation: | | Horizontal | | Frequency Range: | | Above 1GHz | | | | | | | | | | | |
| EUT Mode of Operation: | | | | | Charging Mode | | | | | | | | | | | | |
| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dB μ V) | Corrected Level (dB μ V/m) | Limit Level (dB μ V/m) | Margin (dB) | Test Results | | | | | | | | |
| 1982.37 | 3 | 99 | 1 | Average | 34.7 | 25.942 | 54.0 | -28.0 | Pass | | | | | | | | |
| 2503.65 | 3 | 245 | 1 | Average | 34.4 | 26.087 | 54.0 | -27.9 | Pass | | | | | | | | |
| 4233.61 | 3 | 138 | 1 | Average | 33.5 | 28.673 | 54.0 | -25.3 | Pass | | | | | | | | |
| 6953.51 | 3 | 292 | 1 | Average | 29.1 | 31.758 | 54.0 | -22.2 | Pass | | | | | | | | |
| 8538.54 | 3 | 246 | 1 | Average | 27.3 | 34.414 | 54.0 | -19.5 | Pass | | | | | | | | |
| 12109.4 | 3 | 259 | 1 | Average | 27.6 | 37.947 | 54.0 | -16.0 | Pass | | | | | | | | |
| Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| Operator: Eric Lifsey 17649 Run06b'RECChargeMode'standardUSBcableFCC+IC.til 12:43:43 PM, Monday, January 18, 2016 | | | | | | | | | | | | | | | | | |
| Frequency: 230.50 Mode: Charging Power: 230.50 Cable: Standard USB1 m | | | | | | | | | | | | | | | | | |
| EUT: PODS Project Number: 17649-15 Client: Virtuix | | | | | | | | | | | | | | | | | |
| > 1GHz Horizontal Antenna Polarity Measured Emissions | | | | | | | | | | | | | | | | | |

8.0 Radiated Spurious Emissions, Transmit Mode

8.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The EUT was centered on a rotating turntable.

Spurious emissions below 1 GHz were measured with peak and quasi-peak detection with a resolution bandwidth of 120 kHz at a distance of 10 meters. Above 1 GHz the measurement distance was 3 meters with resolution bandwidth of 1 MHz and using peak and average detection. A diagram showing the test setup is given in the figure below.

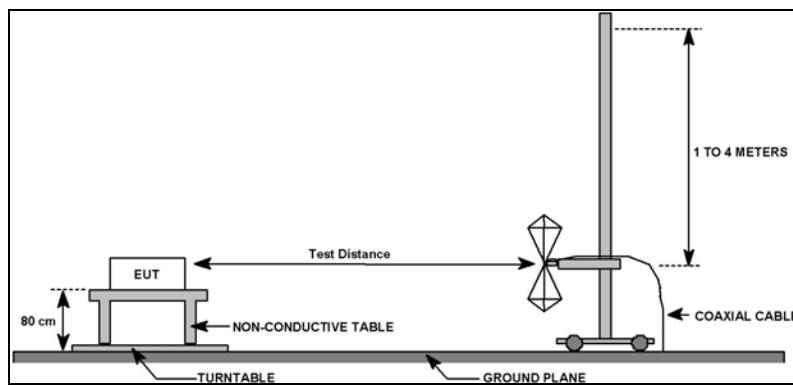


Figure 8.1.1: Field Strength of Spurious Emissions Test Setup

8.2 Test Criteria

| 47 CFR (USA) // IC (Canada) | | |
|--|--|-------------|
| Section Reference | Parameter | Date(s) |
| 15.247, 15.209 // RSS-247 5.5, RSS-Gen 6.13 | Field Strength of Radiated Spurious/Harmonic Emissions | 18 Jan 2016 |

8.3 Test Results

In all cases detector mode is peak, RBW 1 MHz, VBW 3 MHz. All peak emissions can be seen as being below the average or QP limits.

The EUT satisfied the criteria. Recorded data is presented below.

Table 8.3.1: Radiated Spurious Emissions, Transmit Mode, Below 1 GHz, Three Channels, Vertical Polarity

| Professional Testing, EMI, Inc. | | | | | | | | | |
|--|--|-------------------------|-----------------------------|-------------------------------|---|--------------------------------|----------------------------|-------------|--------------|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | | | |
| In accordance with: | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | | | | | | | |
| Section: | 15.209 | | | | | | | | |
| Test Date(s): | 1/18/2016 | | EUT Serial #: | 0 | | | | | |
| Customer: | Virtuix | | EUT Part #: | 0 | | | | | |
| Project Number: | 17649-15 | | Test Technician: | Eric Lifsey | | | | | |
| Purchase Order #: | NA | | Supervisor: | Lisa Arndt | | | | | |
| Equip. Under Test: | PODS | | Witness' Name: | Brian Olinger, Patrick Herron | | | | | |
| Radiated Emissions Test Results Data Sheet | | | | | | | Page: | 1 | of 1 |
| EUT Line Voltage: | 0 | VDC | EUT Power Frequency: | 0 | N/A | | | | |
| Antenna Orientation: | Vertical | | | Frequency Range: | 30MHz to 1GHz | | | | |
| EUT Mode of Operation: | | | | | Transmit Mode, Modulated, 3 Channels/EUTs | | | | |
| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dB μ V) | Corrected Level (dB μ V/m) | Limit Level (dB μ V/m) | Margin (dB) | Test Results |
| 31.0276 | 10 | 88 | 3.99 | Quasi-peak | 24.2 | 12.771 | 29.5 | -16.7 | Pass |
| 56.3039 | 10 | 198 | 2.78 | Quasi-peak | 24.6 | 6.791 | 29.5 | -22.7 | Pass |
| 60.0056 | 10 | 148 | 3.31 | Quasi-peak | 30.4 | 12.179 | 29.5 | -17.3 | Pass |
| 652.7 | 10 | 186 | 3.09 | Quasi-peak | 22 | 20.6 | 35.6 | -15.0 | Pass |
| 831.424 | 10 | 228 | 3.8 | Quasi-peak | 21.5 | 23.549 | 35.6 | -12.1 | Pass |
| 888.295 | 10 | 139 | 3.81 | Quasi-peak | 21.4 | 26.149 | 35.6 | -9.5 | Pass |
| <p>Professional Testing, EMI, Inc Radiated Emissions, 10m Distance 30MHz-1GHz Vertical Polarity Measured Emissions</p> <p>Field Strength (dBμV/m)</p> <p>Frequency</p> <p>Operator: Eric Lifsey</p> <p>17649Run08'RETxSpurious3Ch'hpfFCC.til</p> <p>02:39:31 PM, Monday, January 18, 2016</p> <p>Mode: Transmit, 3 Channels 2402/2440/2480 MHz</p> <p>Power: Battery</p> <p>Modulated</p> <p>EUT: PODS</p> <p>Project Number: 17649-15</p> <p>Client: Virtuix</p> | | | | | | | | | |
| ≤ 1GHz Vertical Antenna Polarity Measured Emissions | | | | | | | | | |

Table 8.3.2: Radiated Spurious Emissions, Transmit Mode, Below 1 GHz, Three Channels, Horizontal Polarity

| Professional Testing, EMI, Inc. | | | | | | | | | |
|--|--|-------------------------|-----------------------------|-------------------------------|---|--------------------------------|----------------------------|-------------|--------------|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | | | |
| In accordance with: | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | | | | | | | |
| Section: | 15.209 | | | | | | | | |
| Test Date(s): | 1/18/2016 | | EUT Serial #: | 0 | | | | | |
| Customer: | Virtuix | | EUT Part #: | 0 | | | | | |
| Project Number: | 17649-15 | | Test Technician: | Eric Lifsey | | | | | |
| Purchase Order #: | NA | | Supervisor: | Lisa Arndt | | | | | |
| Equip. Under Test: | PODS | | Witness' Name: | Brian Olinger, Patrick Herron | | | | | |
| Radiated Emissions Test Results Data Sheet | | | | | | | Page: | 1 | of 1 |
| EUT Line Voltage: | 0 | VDC | EUT Power Frequency: | 0 | | N/A | | | |
| Antenna Orientation: | Horizontal | | | Frequency Range: | 30MHz to 1GHz | | | | |
| EUT Mode of Operation: | | | | | Transmit Mode, Modulated, 3 Channels/EUTs | | | | |
| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dB μ V) | Corrected Level (dB μ V/m) | Limit Level (dB μ V/m) | Margin (dB) | Test Results |
| 34.6375 | 10 | 120 | 3.74 | Quasi-peak | 23.1 | 11.541 | 29.5 | -18.0 | Pass |
| 56.4334 | 10 | 278 | 1.41 | Quasi-peak | 23.7 | 5.834 | 29.5 | -23.7 | Pass |
| 761.369 | 10 | 207 | 1.98 | Quasi-peak | 21.7 | 22.647 | 35.6 | -13.0 | Pass |
| 796.307 | 10 | 281 | 2.81 | Quasi-peak | 21.5 | 23.038 | 35.6 | -12.6 | Pass |
| 943.059 | 10 | 254 | 2.63 | Quasi-peak | 21.1 | 26.214 | 35.6 | -9.4 | Pass |
| Professional Testing, EMI, Inc Radiated Emissions, 10m Distance 30MHz - 1GHz Horizontal Polarity Measured Emissions | | | | | | | | | |
| | | | | | | | | | |
| Operator: Eric Lifsey 17649 Run08'RETxSpurious3Ch'hpffCCTI 02:39:31 PM, Monday, January 18, 2016 | | | | | | | | | |
| Frequency: 2402/2440/2480 MHz Power: Battery Modulated EUT: PODS Project Number: 17649-15 Client: Virtuix | | | | | | | | | |
| ≤ 1GHz Horizontal Antenna Polarity Measured Emissions | | | | | | | | | |

Table 8.3.3: Radiated Spurious Emissions, Transmit Mode, 1 to 18 GHz, Three Channels, Vertical Polarity

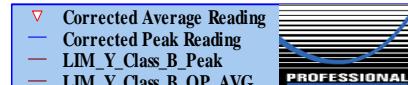
| Professional Testing, EMI, Inc. | | | | | | | | | |
|---|--|-------------------------|-------------------------|-----------------------------|---|--------------------------------|----------------------------|-------------|--------------|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | | | |
| In accordance with: | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | | | | | | | |
| Section: | 15.209 | | | | | | | | |
| Test Date(s): | 1/18/2016 | | | EUT Serial #: | 0 | | | | |
| Customer: | Virtuix | | | EUT Part #: | 0 | | | | |
| Project Number: | 17649-15 | | | Test Technician: | Eric Lifsey | | | | |
| Purchase Order #: | NA | | | Supervisor: | Lisa Arndt | | | | |
| Equip. Under Test: | PODS | | | Witness' Name: | Brian Olinger, Patrick Herron | | | | |
| Radiated Emissions Test Results Data Sheet | | | | | | | Page: | 1 | of 1 |
| EUT Line Voltage: | 0 | VDC | | EUT Power Frequency: | 0 | N/A | | | |
| Antenna Orientation: | Vertical | | | Frequency Range: | Above 1GHz | | | | |
| EUT Mode of Operation: | | | | | Transmit Mode, Modulated, 3 Channels/EUTs | | | | |
| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dB μ V) | Corrected Level (dB μ V/m) | Limit Level (dB μ V/m) | Margin (dB) | Test Results |
| 4877.19 | 3 | 165 | 0 | Average | 32.8 | 29.012 | 54.0 | -24.9 | Pass |
| 7326.79 | 3 | 186 | 0 | Average | 28.7 | 32.153 | 54.0 | -21.8 | Pass |
| 9756.6 | 3 | 172 | 0 | Average | 26.4 | 33.33 | 54.0 | -20.6 | Pass |
| 17071.1 | 3 | 124 | 0 | Average | 27.4 | 41.868 | 54.0 | -12.1 | Pass |
| | | | | | | | | | |
| Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Vertical Polarity Measured Emissions  Field Strength (dB μ V/m) vs Frequency (GHz) from 1G to 18G. The graph shows a blue line for corrected peak reading, a red line for LIM_Y Class B Peak, and a blue line for LIM_Y Class B QP AVG. The y-axis ranges from 20 to 90 dB μ V/m, and the x-axis ranges from 1G to 18G. The graph shows a sharp peak around 1.8 GHz and a noisy line between 10G and 18G. | | | | | | | | | |
| Operator: Eric Lifsey 17649Run08'RETxSpurious3Ch'hpFCC.til 03:46:20 PM, Monday, January 18, 2016 | | | | | | | | | |
| Mode: Transmit, 3 Channels 2402/2440/2480 MHz Power: Battery Modulated | | | | | | | | | |
| EUT: PODS Project Number: 17649-15 Client: Virtuix | | | | | | | | | |
| 1 to 18 GHz Vertical Antenna Polarity Measured Emissions | | | | | | | | | |

Table 8.3.4: Radiated Spurious Emissions, Transmit Mode, 1 to 18 GHz, Three Channels, Horizontal Polarity

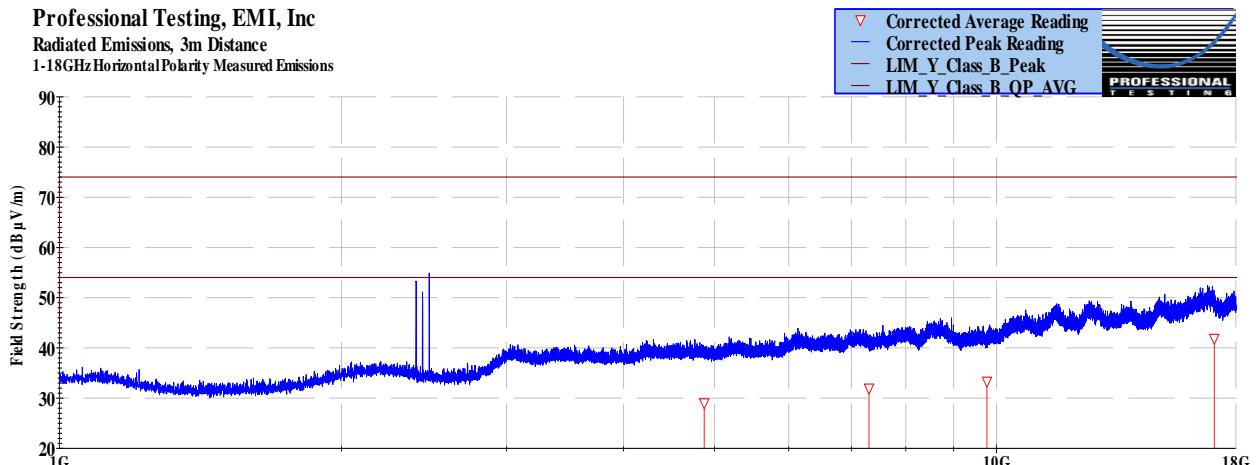
| Professional Testing, EMI, Inc. | | | | | | | | | | | | | |
|---|--|-------------------------|-------------------------|-----------------------------|---|--------------------------------|----------------------------|-------------|--------------|--|--|--|--|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | | | | | | | |
| In accordance with: | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | | | | | | | | | | | |
| Section: | 15.209 | | | | | | | | | | | | |
| Test Date(s): | 1/18/2016 | | | EUT Serial #: | 0 | | | | | | | | |
| Customer: | Virtuix | | | EUT Part #: | 0 | | | | | | | | |
| Project Number: | 17649-15 | | | Test Technician: | Eric Lifsey | | | | | | | | |
| Purchase Order #: | NA | | | Supervisor: | Lisa Arndt | | | | | | | | |
| Equip. Under Test: | PODS | | | Witness' Name: | Brian Olinger, Patrick Herron | | | | | | | | |
| Radiated Emissions Test Results Data Sheet | | | | | | | | | | Page: 1 of 1 | | | |
| EUT Line Voltage: | 0 VDC | | | EUT Power Frequency: | 0 | | | N/A | | | | | |
| Antenna Orientation: | Horizontal | | | | Frequency Range: | Above 1GHz | | | | | | | |
| EUT Mode of Operation: | | | | | Transmit Mode, Modulated, 3 Channels/EUTs | | | | | | | | |
| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dB μ V) | Corrected Level (dB μ V/m) | Limit Level (dB μ V/m) | Margin (dB) | Test Results | | | | |
| 4875.45 | 3 | 75 | 0 | Average | 32.8 | 29.014 | 54.0 | -24.9 | Pass | | | | |
| 7310.26 | 3 | 38 | 0 | Average | 28.5 | 31.948 | 54.0 | -22.0 | Pass | | | | |
| 9768.54 | 3 | 344 | 0 | Average | 26.4 | 33.316 | 54.0 | -20.6 | Pass | | | | |
| 17070.2 | 3 | 115 | 0 | Average | 27.4 | 41.863 | 54.0 | -12.1 | Pass | | | | |
| Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-18GHz Horizontal Polarity Measured Emissions | | | | | | | | | |  | | | |
| Operator: Eric Lifsey 17649Run08'RETxSpurious'3Ch'hpFCC.til 03:46:20 PM, Monday, January 18, 2016 | | | | | | | | | | Frequency EUT: PODS Project Number: 17649-15 Client: Virtuix | | | |
| 1 to 18 GHz Horizontal Antenna Polarity Measured Emissions | | | | | | | | | | | | | |

Table 8.3.5: Radiated Spurious Emissions, Transmit Mode, 18 to 26 GHz, Three Channels, Vertical Polarity

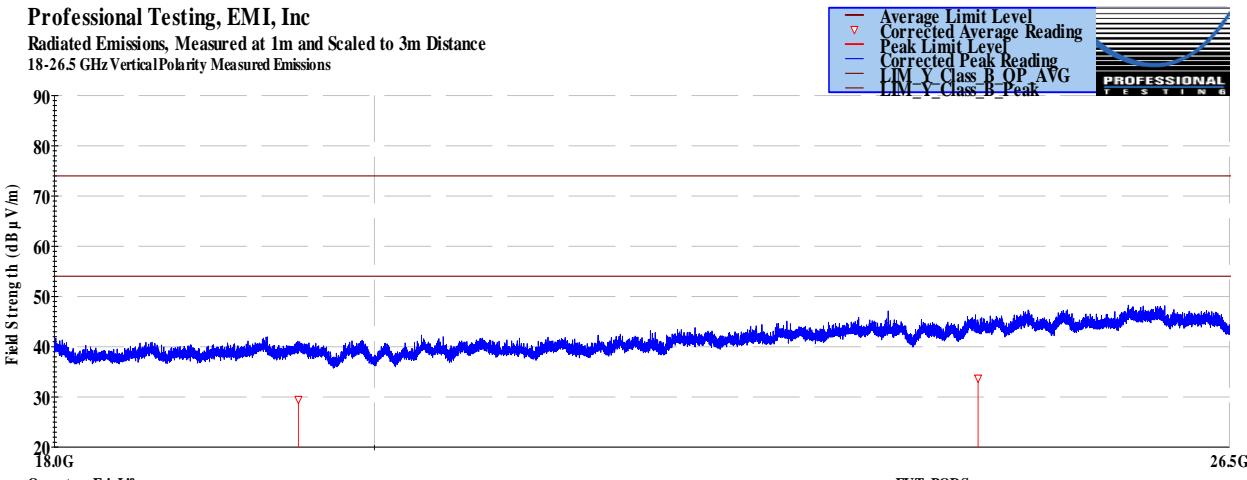
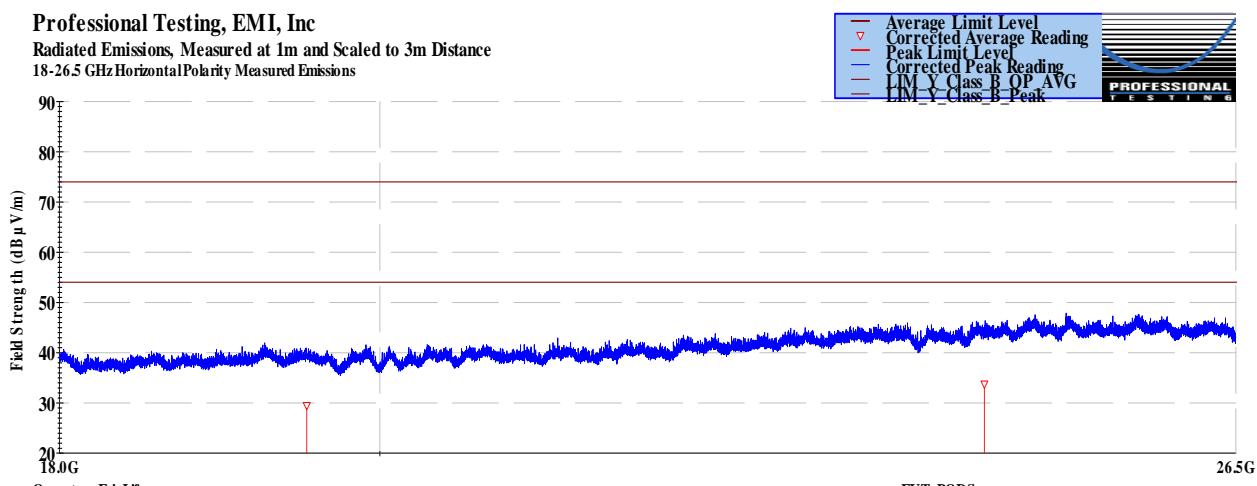
| Professional Testing, EMI, Inc. | | | | | | | | | | | | | | | | | |
|---|--|-------------------------|-------------------------|-----------------------------|---|--------------------------------|----------------------------|-------------|--------------|--|--|--|--|--|--|--|--|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | | | | | | | | | | | |
| In accordance with: | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | | | | | | | | | | | | | | | |
| Section: | 15.209 | | | | | | | | | | | | | | | | |
| Test Date(s): | 1/18/2016 | | | EUT Serial #: | 0 | | | | | | | | | | | | |
| Customer: | Virtuix | | | EUT Part #: | 0 | | | | | | | | | | | | |
| Project Number: | 17649-15 | | | Test Technician: | Eric Lifsey | | | | | | | | | | | | |
| Purchase Order #: | NA | | | Supervisor: | Lisa Arndt | | | | | | | | | | | | |
| Equip. Under Test: | PODS | | | Witness' Name: | Brian Olinger, Patrick Herron | | | | | | | | | | | | |
| Radiated Emissions Test Results Data Sheet | | | | | | | | | | | | | | | | | |
| Page: 1 of 1 | | | | | | | | | | | | | | | | | |
| EUT Line Voltage: | 0 | | VDC | EUT Power Frequency: | | 0 | N/A | | | | | | | | | | |
| Antenna Orientation: | Vertical | | | Frequency Range: | | Above 1GHz | | | | | | | | | | | |
| EUT Mode of Operation: | | | | | Transmit Mode, Modulated, 3 Channels/EUTs | | | | | | | | | | | | |
| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dB μ V) | Corrected Level (dB μ V/m) | Limit Level (dB μ V/m) | Margin (dB) | Test Results | | | | | | | | |
| 19505.9 | 3 | 26 | 1 | Average | 33.4 | 29.498 | 54.0 | -24.5 | Pass | | | | | | | | |
| 24396.6 | 3 | 319 | 1 | Average | 34.3 | 33.716 | 54.0 | -20.2 | Pass | | | | | | | | |
| Professional Testing, EMI, Inc Radiated Emissions, Measured at 1m and Scaled to 3m Distance 18-26.5 GHz Vertical Polarity Measured Emissions | | | | | | | | | | | | | | | | | |
|  Operator: Eric Lifsey 17649 Run08'RETxSpurious'3Ch'hpfFCC.til 04:31:01 PM, Monday, January 18, 2016 | | | | | | | | | | | | | | | | | |
| Frequency: 2402/2440/2480 MHz Power: Battery Modulated EUT: PODS Project Number: 17649-15 Client: Virtuix | | | | | | | | | | | | | | | | | |
| > 18 GHz Vertical Antenna Polarity Measured Emissions | | | | | | | | | | | | | | | | | |

Table 8.3.6: Radiated Spurious Emissions, Transmit Mode, 18 to 26 GHz, Three Channels, Horizontal Polarity

| Professional Testing, EMI, Inc. | | | | | | | | | | | | | | | | | |
|---|--|-------------------------|-------------------------|-----------------------------|---|--------------------------------|----------------------------|-------------|--------------|--|--|--|--|--|--|--|--|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | | | | | | | | | | | |
| In accordance with: | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | | | | | | | | | | | | | | | |
| Section: | 15.209 | | | | | | | | | | | | | | | | |
| Test Date(s): | 1/18/2016 | | | EUT Serial #: | 0 | | | | | | | | | | | | |
| Customer: | Virtuix | | | EUT Part #: | 0 | | | | | | | | | | | | |
| Project Number: | 17649-15 | | | Test Technician: | Eric Lifsey | | | | | | | | | | | | |
| Purchase Order #: | NA | | | Supervisor: | Lisa Arndt | | | | | | | | | | | | |
| Equip. Under Test: | PODS | | | Witness' Name: | Brian Olinger, Patrick Herron | | | | | | | | | | | | |
| Radiated Emissions Test Results Data Sheet | | | | | | | | | | | | | | | | | |
| Page: 1 of 1 | | | | | | | | | | | | | | | | | |
| EUT Line Voltage: | 0 | | VDC | EUT Power Frequency: | | 0 | N/A | | | | | | | | | | |
| Antenna Orientation: | Horizontal | | | Frequency Range: | | Above 1GHz | | | | | | | | | | | |
| EUT Mode of Operation: | | | | | Transmit Mode, Modulated, 3 Channels/EUTs | | | | | | | | | | | | |
| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dB μ V) | Corrected Level (dB μ V/m) | Limit Level (dB μ V/m) | Margin (dB) | Test Results | | | | | | | | |
| 19524.8 | 3 | 78 | 1 | Average | 33.3 | 29.468 | 54.0 | -24.5 | Pass | | | | | | | | |
| 24398.1 | 3 | 156 | 1 | Average | 34.3 | 33.757 | 54.0 | -20.2 | Pass | | | | | | | | |
| Professional Testing, EMI, Inc Radiated Emissions, Measured at 1m and Scaled to 3m Distance 18-26.5 GHz Horizontal Polarity Measured Emissions | | | | | | | | | | | | | | | | | |
|  Field Strength (dB μ V/m) vs Frequency (GHz). The graph shows a blue line representing the measured data, which is mostly flat around 40 dB μ V/m with some noise. Two red vertical lines indicate the peak and average levels. A legend on the right shows: Average Limit Level (red line), Corrected Average Reading (red triangle), Peak Limit Level (red line), Corrected Peak Reading (blue line), LIM_X Class B OP AVG (red line), and LIM_Y Class B Peak (red line). The graph is titled "PROFESSIONAL TESTING". | | | | | | | | | | | | | | | | | |
| Operator: Eric Lifsey 17649 Run08'RETxSpurious'3Ch'hpFCC.tfl 04:31:01 PM, Monday, January 18, 2016 | | | | | | | | | | | | | | | | | |
| Frequency: 2402/2440/2480 MHz Power: Battery Modulated EUT: PODS Project Number: 17649-15 Client: Virtuix | | | | | | | | | | | | | | | | | |
| > 18 GHz Horizontal Antenna Polarity Measured Emissions | | | | | | | | | | | | | | | | | |

9.0 Antenna Construction Requirements

The design was investigated for meeting the antenna construction requirements of the applicable rules.

9.1 Procedure

A direct examination of the antenna construction is performed and compared to rule criteria that prevent wireless device antennas from being modified by end users in ways that would void their authorization to use the device.

9.2 Criteria

| 47 CFR (USA) // IC (Canada) | | |
|-----------------------------|----------------------|-------------|
| Section Reference | Parameter | Date(s) |
| 15.203 // RSS-Gen 8.3 | Antenna Construction | 18 Jan 2016 |

9.3 Results

| Table 9.3.1 Antenna Construction Details | |
|--|--|
| Antenna Manufacturer and Model | Specifications |
| Manufacturer: Johanson Technology, Inc. Model: P/N 2450AT18A100 | Chip antenna. Peak gain: 0.5 dBi* Average gain: -0.5 dBi* *The effect of gain is captured in the radiated measurements. |

- The antenna is internal only to the device.
- The antenna is soldered component on the circuit board.
- There is no antenna connector.

The antenna design above satisfies the requirements of the rules.

10.0 Equipment and Bandwidths

10.1 Equipment for Radiated Power, Band Edge and Spurious Emissions 30 MHz to 18 GHz

| Professional Testing, EMI, Inc. | | | | | | | |
|--|--|---|--|----------------|----------------------|--|--|
| Test Method: | ANSI C63.4-2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | | | | | |
| In accordance with: | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | | | | | |
| Section: | 15.209 | | | | | | |
| Test Date(s): | 1/18/2016 | EUT Serial #: | 0 | | | | |
| Customer: | Virtuix | EUT Part #: | 0 | | | | |
| Project Number: | 17649-15 | Test Technician: | Eric Lifsey | | | | |
| Purchase Order #: | NA | Supervisor: | Lisa Arndt | | | | |
| Equip. Under Test: | PODS | Witness' Name: | Brian Olinger, Patrick Herron | | | | |
| Radiated Emissions Test Equipment List | | | | | | | |
| Test Profile: | | 2015 Rad Emissions_ClassA - LowPRF_072715.til or 2015 Rad Emissions_ClassB - LowPRF_072715.til | | | | | |
| Asset # | Manufacturer | Model | Equipment Nomenclature | Serial Number | Calibration Due Date | | |
| 1509A | Braden | N/A | TDK 10M Chamber, NSA < 1 GHz | DAC-012915-005 | 2/5/2016 | | |
| 1890 | HP | 8447F | Preamp/Amp, 9kHz-1300MHz, 28/25dB | 3313A05298 | 2/6/2016 | | |
| 1937 | Agilent | E4440A | Spectrum Analyzer, 3 Hz - 26.5 GHz, Opt. AYZ | MY44808298 | 12/15/2016 | | |
| 1926 | ETS-Lindgren | 3142D | Antenna, Biconilog, 26 MHz - 6 GHz | 135454 | 1/25/2017 | | |
| C027D | none | RG214 | Cable Coax, N-N, 25m | none | 10/1/2016 | | |
| 1327 | EMCO | 1050 | Controller, Antenna Mast | none | N/A | | |
| 0942 | EMCO | 11968D | Turntable, 4ft. | 9510-1835 | N/A | | |
| 1969 | HP | 11713A | Attenuator/Switch Driver | 3748A04113 | N/A | | |
| | | | | | | | |
| 1509B | Braden | N/A | TDK 10M Chamber, VSWR > 1 GHz | DAC-012915-005 | 3/13/2016 | | |
| 2004 | Miteq | AFS44-00101800- 2S-10P-44 | Amplifier, 40dB, .1-18GHz | 0 | 1/11/2018 | | |
| C030 | none | none | Cable Coax, N-N, 30m | none | 10/1/2016 | | |
| 1325 | EMCO | 1050 | Controller, Antenna Mast | 9003-1461 | N/A | | |
| 1780 | ETS-Lindgren | 3117 | Antenna, Double Ridged Guide Horn, 1 - 18 GHz | 110313 | 2/25/2017 | | |
| | | | | | | | |
| 1735 | Pasternack | PE9850-20 | Antenna, horn, WR28 | N/A | N/A | | |
| 1974 | Agilent | 83017A | Amplifier, Microwave 0.5-26.5 GHz | MY39500684 | 12/17/2017 | | |

10.2 Equipment for Bandwidth and Timings

| Asset # | Manufacturer | Model # | Description | Calibration Due |
|---------|-----------------|---------|-------------------|-----------------|
| ALN-077 | Rohde & Schwarz | FSP-30 | Spectrum Analyzer | 16 Dec 2016 |

10.3 Measurement Bandwidths, Radiated

| Radiated Emissions Spectrum Analyzer Bandwidth and Measurement Time - Peak Scan | | | | |
|---|---------------------------|----------------------|-----------------------|----------------------------|
| Frequency Band Start (MHz) | Frequency Band Stop (MHz) | 6 dB Bandwidth (kHz) | Number of Ranges Used | Measurement Time per Range |
| 0.009 | 0.15 | 0.3 | 2 | Multiple Sweeps |
| 0.15 | 30 | 9 | 6 | Multiple Sweeps |
| 30 | 1000 | 120 | 2 | Multiple 800 mS Sweeps |
| 1000 | 6000 | 1000 | 2 | Multiple Sweeps |
| 6000 | 18000 | 1000 | 2 | Multiple Sweeps |
| 18000 | 26500 | 1000 | 2 | Multiple Sweeps |

*Notes:

1. The settings above are specifically calculated for the E4440A series of spectrum analyzers, which have 8,000 data points per range.
2. The measurement receiver resolution bandwidth setting was 300 Hz for quasi-peak measurements from 9-150 kHz.
3. The measurement receiver resolution bandwidth setting was 9 kHz for quasi-peak measurements from 0.15-30 MHz.
4. The measurement receiver resolution bandwidth setting was 120 kHz for quasi-peak measurements from 30-1000 MHz.
5. The measurement receiver resolution bandwidth setting was 1 MHz for average measurements from 1-18 GHz.

Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty

All uncertainty calculations, estimates and expressions thereof shall be in accordance with NIST policy. Since PTI operates in accordance with NIST (NVLAP) Handbook 150-11: 2007, all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by NIST Handbook 150-11.

1. Rationale and Summary of Expanded Uncertainty.

Each piece of instrumentation at PTI that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacturer's statements or specifications of the calibration tolerances, or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting stated uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations, but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a priori, or u-shaped) will be stated for each Type B evaluation.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of PTI measurements is shown as Table 1. These are the worst-case uncertainties considering all operative influence factors.

Table 1: Summary of Measurement Uncertainties for Site 45

| Type of Measurement | Frequency Range | Meas. Dist. | Expanded Uncertainty U, dB (k=2) |
|-----------------------------|-------------------|-------------|----------------------------------|
| Mains Conducted Emissions | 150 kHz to 30 MHz | N/A | 2.9 |
| Telecom Conducted Emissions | 150 kHz to 30 MHz | N/A | 2.8 |
| Radiated Emissions | 30 to 1,000 MHz | 10 m | 4.8 |
| | 1 to 18 GHz | 3 m | 5.7 |

End of Report

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