NVLAP Lab Code 200087-0

# Application Submittal Report

FOR
FCC And Industry Canada
Grant of Certification

FOR

## Model: RM024-10 Transmitter Module
## 2403-2467 MHz
## FHSS Transmission System

## **FCC ID: KQL-RM02410**
## **IC: 2268C-RM02410**

FOR

## **AeroComm Corporation**
11160 Thompson Avenue
Lenexa KS 66219

Test Report Number: 141212

Authorized Signatory: Scot D Rogers
Scot D. Rogers

NVLAP Lab Code 200087-0

**ROGERS LABS, INC.**

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Louisburg, KS 66053
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# Engineering Test Report
# For Application Submittal for
# Grant of Certification

FOR

CFR 47, PART 15C - Intentional Radiators Paragraph 15.247 and
Industry Canada, RSS-210
License Exempt Intentional Radiator

For

# AeroComm Corporation

11160 Thompson Avenue
Lenexa KS 66219

Model: RM024-10 Transmitter Module
FHSS Transmission System
Frequency Range 2403-2467 MHz
FCC ID#: KQL-RM02410
IC: 2268C-RM02410

Test Date: December 12, 2014

Certifying Engineer: Scot D Rogers

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# Table Of Contents

**TABLE OF CONTENTS** ..... 3

**REVISIONS** ..... 4

**FORWARD** ..... 5

**OPINION / INTERPRETATION OF RESULTS** ..... 5

**STATEMENT OF MODIFICATIONS AND DEVIATIONS** ..... 5

**EQUIPMENT TESTED** ..... 6

**EQUIPMENT FUNCTION AND CONFIGURATION** ..... 6

**Equipment Configuration** ..... 6

**APPLICATION FOR CERTIFICATION** ..... 7

**APPLICABLE STANDARDS & TEST PROCEDURES** ..... 8

**EQUIPMENT TESTING PROCEDURES** ..... 8

**AC Line Conducted Emission Test Procedure** ..... 8

**Radiated Emission Test Procedure** ..... 8

Diagram 1 Test arrangement for AC Line Conducted emissions ..... 9

Diagram 2 Test arrangement for radiated emissions of tabletop equipment ..... 10

Diagram 3 Test arrangement for radiated emissions tested on Open Area Test Site (OATS) ..... 11

**LIST OF TEST EQUIPMENT** ..... 12

**ENVIRONMENTAL CONDITIONS** ..... 13

**TEST SITE LOCATIONS** ..... 13

**UNITS OF MEASUREMENTS** ..... 13

**INTENTIONAL RADIATORS** ..... 13

**Antenna Requirements** ..... 14

**Restricted Bands of Operation** ..... 14

Table One Radiated Emissions in Restricted Bands Data General ..... 14

Table Two Radiated Emissions in Restricted Bands Data (chip Antenna) ..... 15

Table Three Radiated Emissions in Restricted Bands Data (2 dBi Diploe Antenna) ....16
**Summary of Results for Radiated Emissions in Restricted Bands ....16**
**AC Line Conducted Emissions Procedure ....17**
Figure One AC Line Conducted Emissions Line 1 ....18
Figure Two AC Line Conducted Emissions Line 2 ....18
Table Four AC Line Conducted Emissions Data (7 Highest Emissions) ....19
Table Five AC Line Conducted Emissions Data (7 Highest Emissions) ....19
**Summary of Results for AC Line Conducted Emissions ....19**
**General Radiated EMI Testing Procedure ....20**
Table Six General Radiated Emissions Data (worst-case all antennas) ....21
**Summary of Results for General Radiated Emissions ....21**
**Operation in the Band 2400 – 2483.5 MHz ....22**
Figure Three of Antenna Port Conducted Emissions (Frequency band) ....22
Figure Four of Antenna Port Conducted Emissions (Channel Separation) ....23
Figure Five of Antenna Port Conducted Emissions (Dwell Time on Channel) ....23
Figure Six of Antenna Port Conducted Emissions (number of Times on Channel) ....24
Figure Seven of Antenna Port Conducted Emissions (Occupied Bandwidth 2403) ....24
Figure Eight of Antenna Port Conducted Emissions (Occupied Bandwidth 2435) ....25
Figure Nine of Antenna Port Conducted Emissions (Occupied Bandwidth 2466) ....25
Figure Ten of Antenna Port Conducted Emissions (Low Band Edge) ....26
Figure Eleven of Antenna Port Conducted Emissions (High Band Edge) ....26
**Transmitter Emissions Data ....27**
Table Seven Transmitter Radiated Emission Data (Chip Antenna) ....27
Table Eight Transmitter Radiated Emission Data (2 dBi Dipole Antenna) ....28
Table Nine Transmitter Antenna Conducted Emissions Data ....29
**Summary of Results for Radiated Emissions of Intentional Radiator ....29**

**ANNEX ....30**

**Annex A Measurement Uncertainty Calculations ....31**
**Annex B Rogers Labs Test Equipment List ....32**
**Annex C Rogers Qualifications ....33**
**Annex D FCC Site Registration Letter ....34**
**Annex E Industry Canada Site Registration Letter ....35**

## Revisions

Revision 1 Issued December 18, 2014

## Forward

The following information is submitted for consideration in obtaining Grant of Certification for License Exempt FHSS Intentional Radiator operating under 47CFR Paragraph 15.247 and Industry Canada RSS-210.

Name of Applicant: AeroComm Corporation
11160 Thompson Avenue
Lenexa KS 66219
Model: RM024-10 Transmitter Module
FCC I.D.: KQL-RM02410 IC: 2268C-RM02410

Frequency Range: 2403.9-2466.9 MHz

Operating Power: 0.008 Watts, Occupied Bandwidth 1.017 MHz, Antennas supported (2 dBi Chip M/N: WIC2450-A and 2 dBi Dipole M/N: S181-6-PX-2450S)

## Opinion / Interpretation of Results

| Test Performed | Minimum Margin (dB) | Results |
|---|---|---|
| Antenna requirement per CFR 47 15.203 | N/A | Complies |
| Restricted Bands (General Emissions) from Support Equipment | -12.7 | Complies |
| Restricted Bands (Tx) Emissions as per CFR 47 15.205 and RSS-210 | -25.0 | Complies |
| AC Line Conducted Emissions as per CFR 47 15.207 | -27.4 | Complies |
| Radiated Emissions as per CFR 47 15.209 and RSS-210 | -6.2 | Complies |
| Radiated Emissions per CFR 47 15.247 and RSS-210 (harmonics) | -25.0 | Complies |

## Statement of Modifications and Deviations

No modifications to the EUT were required for the unit to demonstrate compliance with the 47CFR Part 15C or RSS-210 emissions requirements. There were no deviations or exceptions to the specifications.

## Equipment Tested

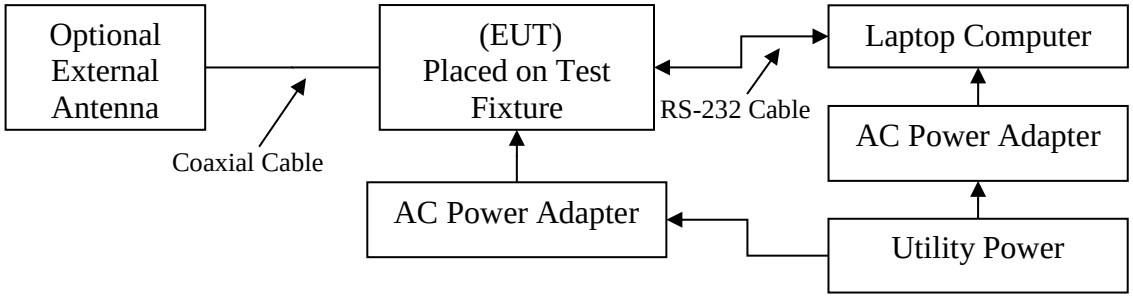
| Equipment | Model / PN | Serial Number | FCC Identifier | IC Identifier |
|---|---|---|---|---|
| EUT | RM024-10 | A | | |
| CPU | HP CRVSA-02T1-75 | TW24416178 | N/A | N/A |
| 2 dBi Chip | WIC2450-A | N/A | N/A | N/A |
| 2 dBi Dipole | S181-6-PX-2450S | N/A | N/A | N/A |

Test results in this report relate only to the items tested

## Equipment Function and Configuration

The EUT is a 2403.9-2466.9 MHz Frequency Hopping Spread Spectrum Transceiver Module used to transmit data in applications offering wireless connectivity. The design offers operation as a 43 hop set mode. The equipment is marketed for use to incorporate a wireless link to exchange data information from one point to another. The design offers two antenna options (PCB mounted chip antenna and u.fl connection). For testing purposes, the RM024 transceiver was connected to the manufacturer supplied test fixture, AC/DC power adapter, and communicating to the laptop computer allowing for data communications and operational control of the transmitter. The RM024 received power from the test fixture and offers no other provision for connection to other interface or power systems. Preliminary investigation was performed for all channel bandwidths and modes of operation. Testing of the RM024 and support equipment was performed with the EUT placed on the test fixture, powered from the AC/DC power adapter, and set to transmit in all available data modes and channels. Test results in this report relate only to the products described in this report.

### *Equipment Configuration*



## Application for Certification

(1) Manufacturer: AeroComm Corporation
11160 Thompson Avenue
Lenexa KS 66219

(2) Identification: Model: RM024-10 Transmitter Module
FCC I.D.: KQL-RM02410
IC: 2268C-RM02410

(3) Instruction Book:

Refer to Exhibit for Instruction Manual.

(4) Description of Circuit Functions:

Refer to Exhibit of Operational Description.

(5) Block Diagram with Frequencies:

Refer to Exhibit of Operational Description.

(6) Report of Measurements:

Report of measurements follows in this Report.

(7) Photographs: Construction, Component Placement, etc.:

Refer to Exhibit for photographs of equipment.

(8) List of Peripheral Equipment Necessary for operation. The equipment operates from power received from supporting circuitry. The module was placed on the support development board with communications to CPU through the RS-232 interface of the laptop computer during testing. Antenna configurations as documented were tested for Certification.

(9) Transition Provisions of 15.37 are not being requested.

(10) Not Applicable. The unit is not a scanning receiver.

(11) Not Applicable. The EUT does not operate in the 59 – 64 GHz frequency band.

(12) The equipment is not software defined and this section is not applicable.

## Applicable Standards & Test Procedures

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2013, Part 2, Subpart J, Paragraphs 2.907, 2.911, 2.913, 2.925, 2.926, 2.1031 through 2.1057, and applicable parts of paragraph 15, Part 15C Paragraph 15.247 and Industry Canada standard RSS-210 Issue 8 the following information is submitted. Test procedures used are the established Methods of Measurement of Radio-Noise Emissions as described in the ANSI C63.10-2013, FCC documents KDB 996369, KDB 996369 D01 v01r04, and DA00-705.

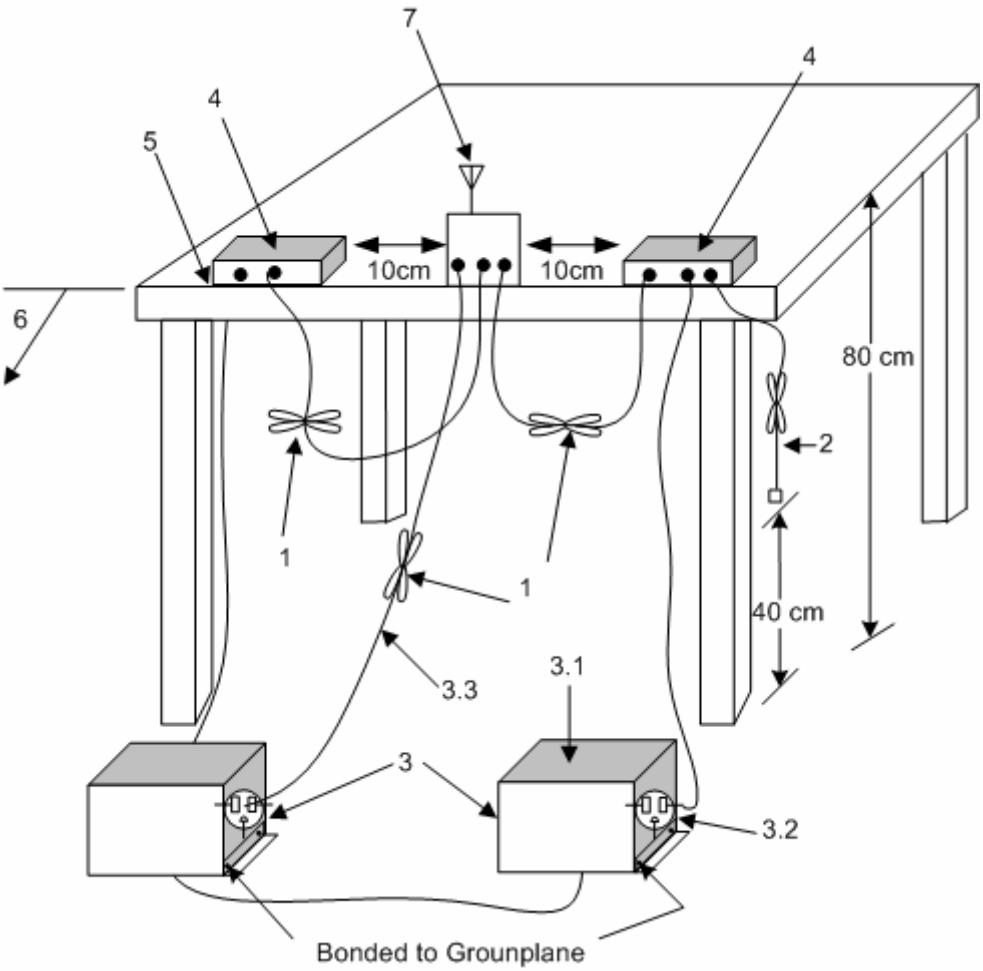
## Equipment Testing Procedures

### *AC Line Conducted Emission Test Procedure*

Testing for the AC line-conducted emissions was performed as defined in ANSI C63.10-2009. The EUT operates from DC power only received from host support equipment and must be connected to supporting circuitry for power and interface communications. For testing purposes, the manufacturer supplied AC/DC power adapter was used to power the EUT. The test setup, including the EUT, was arranged in the test configurations as presented during testing. The test configuration was placed on a 1 x 1.5-meter wooden bench, 0.8 meters high located in a screen room. The power lines of the system were isolated from the power source using a standard LISN with a 50-µHy choke. EMI was coupled to the spectrum analyzer through a 0.1 µF capacitor internal to the LISN. The LISN was positioned on the floor beneath the wooden bench supporting the EUT. The power lines and cables were draped over the back edge of the table. Refer to diagram 1 showing typical test arrangement and photographs in exhibits for EUT placement used during testing.

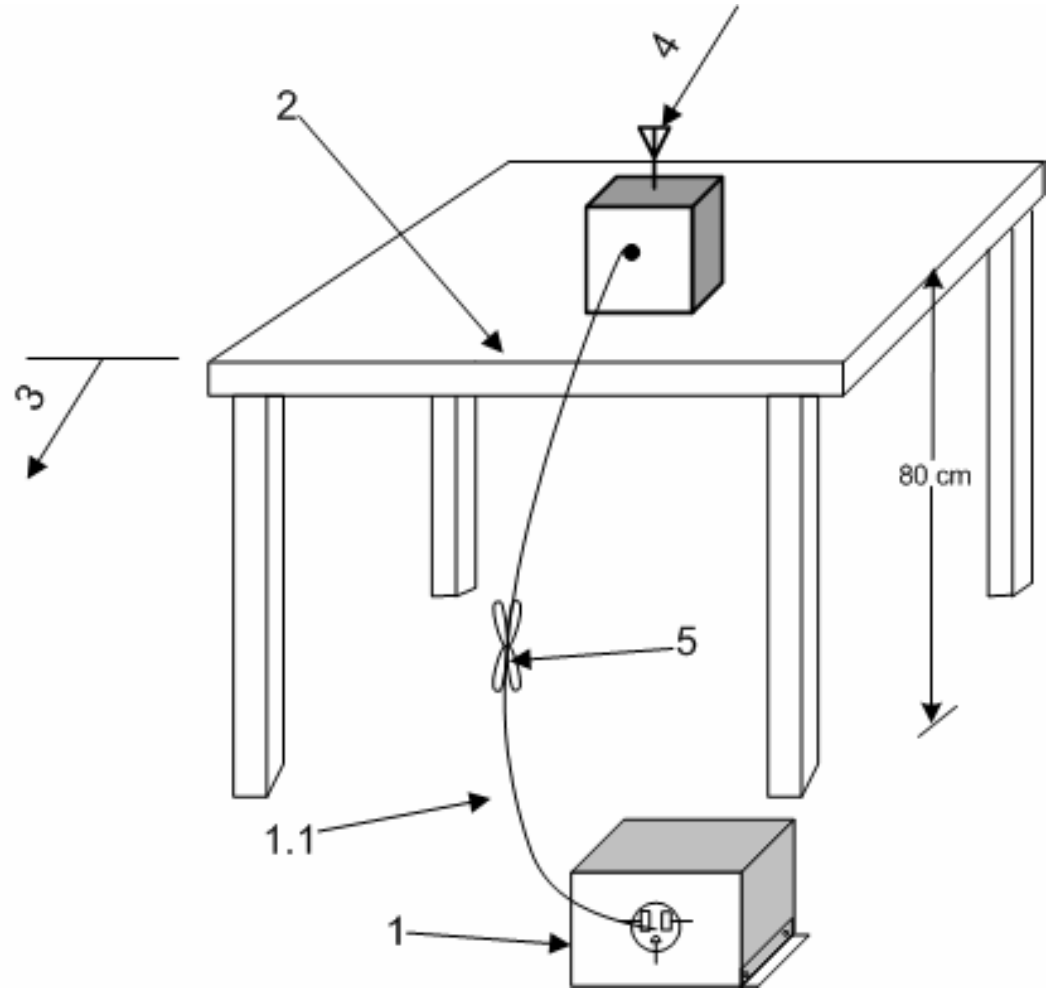
### *Radiated Emission Test Procedure*

The EUT was placed on a rotating 1 x 1.5-meter wooden platform, 0.8 meters above the ground plane at a distance of 3 meters from the FSM antenna. Radiated emissions testing were performed as required in CFR47 paragraph 15C, RSS-210 and as specified in sections 6 and 7 of ANSI C63.10-2009. EMI energy was maximized by equipment placement, raising and lowering the FSM antenna, changing the antenna polarization, and by rotating the turntable. Each emission was maximized before data was taken using a spectrum analyzer. The frequency spectrum from 9 kHz to 25,000 MHz was searched for during preliminary investigation. Refer to diagrams 2 and 3 showing typical test arrangement and photographs in the test setup exhibits for specific EUT placement during testing.



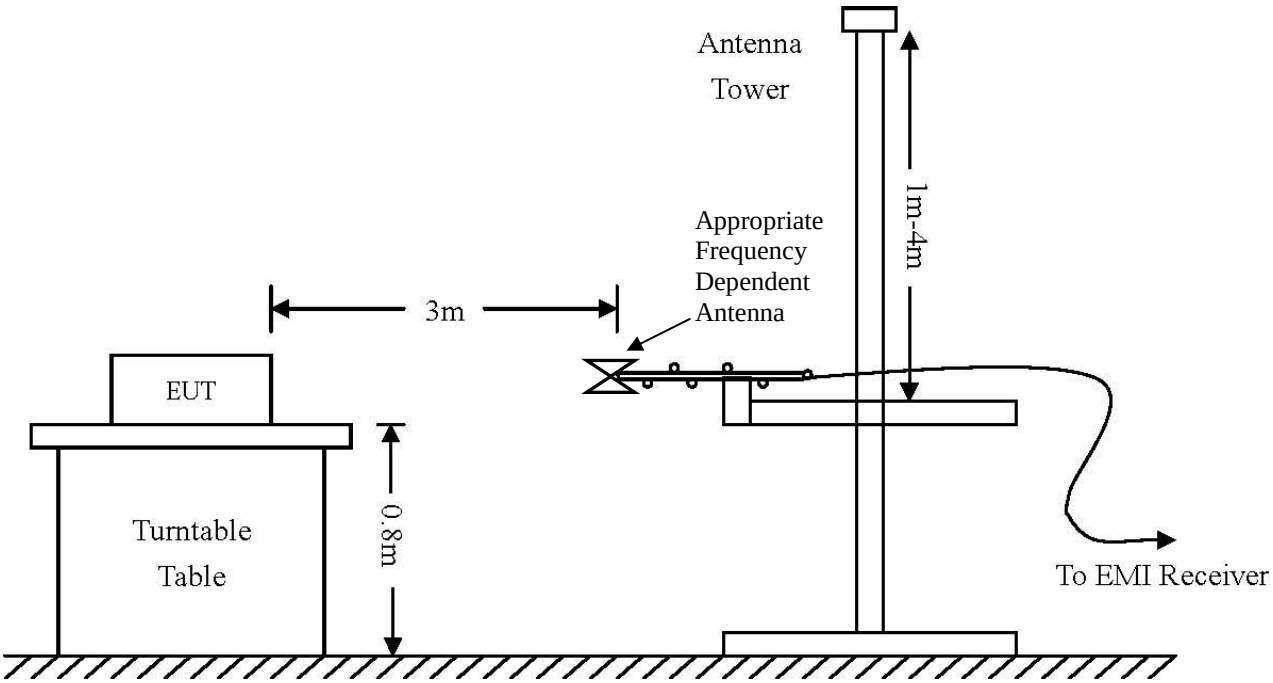

1. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long see (see 6.2.3.1).
2. I/O cables that are not connected to an accessory shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m (see 6.2.2).
3. EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. LISN can be placed on top of, or immediately beneath, reference ground plane (see 6.2.2 and 6.2.3).
   3.1 All other equipment powered from additional LISN(s).
   3.2 Multiple-outlet strip can be used for multiple power cords of non-EUT equipment.
   3.3 LISN at least 80 cm from nearest part of EUT chassis
4. Non-EUT components of EUT system being tested
5. Rear of EUT, including peripherals, shall all be aligned and flush with rear of tabletop (see 6.2.3.1).
6. Edge of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane (see 6.2.2 for options).
7. Antenna may be integral or detachable. If detachable, the antenna shall be attached for this test.

**Diagram 1 Test arrangement for AC Line Conducted emissions**




1. A LISN is optional for radiated measurements between 30 MHz to 1000 MHz, but not allowed for measurements below 30 MHz and above 1000 MHz (See 6.4.3, 6.5.1, and 6.6.3). If used, connect EUT to one LISN. Unused LISN measuring port connectors shall be terminated in 50Ω. LISN can be placed on top of, or immediately beneath, reference ground plane (see 6.2.2 and 6.2.3.1).
   1.1 LISN spaced at least 80 cm from nearest part of EUT chassis.
2. The EUT shall be placed in the center of the table to the extent possible (See 6.2.3.1 and 6.3.4).
3. A vertical conducting plane, if used for conducted tests per 6.2.2, shall be removed for radiated emission tests.
4. Antenna may be integral or detachable, depending on the EUT.
5. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long.

**Diagram 2 Test arrangement for radiated emissions of tabletop equipment**




| Frequency: 9 kHz-30 MHz | Frequency: 30 MHz- 1 GHZ | Frequency: Above 1 GHz |
|---|---|---|
| Loop Antenna | Broadband Biconilog | Horn |
| RBW = 9 kHz | RBW = 120 kHz | RBW = 1 MHz |
| VBW = 30 kHz | VBW = 500 kHz | VBW = 3 MHz |
| Sweep time = Auto | Sweep time = Auto | Sweep time = Auto |
| Detector = PK, QP | Detector = PK, QP | Detector = PK, AV |

**Diagram 3 Test arrangement for radiated emissions tested on Open Area Test Site (OATS)**

## List of Test Equipment

A Rohde and Schwarz ESU40 and/or Hewlett Packard 8591EM was used as the measuring device for the emissions testing of frequencies below 1 GHz. A Rohde and Schwarz ESU40 and/or Hewlett Packard 8562A Spectrum Analyzer was used as the measuring device for testing the emissions at frequencies above 1 GHz. The analyzer settings used are described in the following table. Refer to the appendix for a complete list of test equipment.

| AC Line Conducted Emissions (0.150 -30 MHz) | | |
|---|---|---|
| RBW | AVG. BW | Detector Function |
| 9 kHz | 30 kHz | Peak / Quasi Peak |
| Emissions (30-1000 MHz) | | |
| RBW | AVG. BW | Detector Function |
| 120 kHz | 300 kHz | Peak / Quasi Peak |
| Emissions (Above 1000 MHz) | | |
| RBW | Video BW | Detector Function |
| 100 kHz | 100 kHz | Peak |
| 1 MHz | 1 MHz | Peak / Average |

| Equipment | Manufacturer | Model (SN) | Band | Cal Date | Due |
|---|---|---|---|---|---|
| ☒ LISN | Comp. Design | FCC-LISN-2-MOD.CD (126) | .15-30MHz | 10/14 | 10/15 |
| ☒ Cable | Time Microwave | 750HF290-750 (L10M) | 9kHz-40 GHz | 10/14 | 10/15 |
| ☒ Cable | Belden | RG-58 (L1-CAT3-11509) | 9kHz-30 MHz | 10/14 | 10/15 |
| ☒ Cable | Belden | RG-58 (L2-CAT3-11509) | 9kHz-30 MHz | 10/14 | 10/15 |
| ☐ Antenna | ARA | BCD-235-B (169) | 20-350MHz | 10/14 | 10/15 |
| ☐ Antenna | EMCO | 3147 (40582) | 200-1000MHz | 10/14 | 10/15 |
| ☒ Antenna | Com Power | AH-118 (10110) | 1-18 GHz | 10/14 | 10/15 |
| ☒ Antenna | Com Power | AH-840 (101046) | 18-40 GHz | 5/14 | 5/15 |
| ☒ Antenna | EMCO | 6509 (9502-1374) | .001-30 MHz | 10/14 | 10/15 |
| ☒ Antenna | Sunol | JB-6 (A100709) | 30-1000 MHz | 10/14 | 10/15 |
| ☒ Antenna | Standard | FXRY638A (621786) | 10-18 GHz | 5/14 | 5/15 |
| ☐ Antenna | EMCO | 3143 (9607-1277) | 20-1200 MHz | 5/14 | 5/15 |
| ☐ Analyzer | HP | 8591EM (3628A00871) | 9kHz-1.8GHz | 5/14 | 5/15 |
| ☐ Analyzer | HP | 8562A (3051A05950) | 9kHz-110GHz | 5/14 | 5/15 |
| ☒ Analyzer | Rohde & Schwarz | ESU40 (100108) | 20Hz-40GHz | 5/14 | 5/15 |
| ☒ Amplifier | Com-Power | PA-010 (171003) | 100Hz-30MHz | 10/14 | 10/15 |
| ☒ Amplifier | Com-Power | CPPA-102 (01254) | 1-1000 MHz | 10/14 | 10/15 |
| ☒ Amplifier | Com-Power | PAM-118A (551014) | 0.5-18 GHz | 10/14 | 10/15 |

## Environmental Conditions

| | |
|---|---|
| Ambient Temperature | 22.8° C |
| Relative Humidity | 41% |
| Atmospheric Pressure | 1008.5 mb |

## Test Site Locations

| | |
|---|---|
| Conducted EMI | The AC power line conducted emissions testing performed in a shielded screen room located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS |
| Radiated EMI | The radiated emissions tests were performed at the 3 meters, Open Area Test Site (OATS) located at Rogers Labs, Inc., 4405 W. 259th Terrace, Louisburg, KS |
| Site Registration | Refer to Annex for Site Registration Letters |
| NVLAP Accreditation | Lab code 200087-0 |

## Units of Measurements

| | |
|---|---|
| Conducted EMI | Data is in dBµV; dB referenced to one microvolt |
| Radiated EMI | Data is in dBµV/m; dB/m referenced to one microvolt per meter |

Sample Calculation:

RFS = Radiated Field Strength, FSM = Field Strength Measured

A.F. = Receive antenna factor, Gain = amplification gains and/or cable losses

RFS (dBµV/m @ 3m) = FSM (dBµV) + A.F. (dB/m) - Gain (dB)

## Intentional Radiators

As per 47CFR, Subpart C, paragraph 15.247 and RSS-210 the following information is submitted.

### *Antenna Requirements*

The product is produced with U.FL antenna connector to be used with approved antenna structures or PCB mounted Chip antenna as described in accompanying documentation. The antenna connection point complies with the unique antenna connection requirements. The requirements are fulfilled and there are no deviations or exceptions to the specification.

### *Restricted Bands of Operation*

Spurious emissions falling in the restricted frequency bands of operation were measured at a distance of three meters on the OATS. The EUT utilizes frequency, determining circuitry, which generates harmonics falling in the restricted bands. Emissions were measured at the OATS, using appropriate antennas or pyramidal horns, amplification stages, and a spectrum analyzer. Emissions emanating from the support computer system in the restricted bands of operation are presented in Table 1. Emissions emanating from the transmitter module in restricted bands of operation are presented in Tables 2 and 3. Emissions No other significant emission was observed which fell into the restricted bands of operation.

**Table One Radiated Emissions in Restricted Bands Data General**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Quasi-Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Quasi-Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) |
|---|---|---|---|---|---|---|---|
| 132.0 | 36.1 | 30.8 | N/A | 32.7 | 27.4 | N/A | 43.5 |
| 133.2 | 35.3 | 28.9 | N/A | 33.8 | 27.7 | N/A | 43.5 |

Other emissions present had amplitudes at least 20 dB below the limit.
Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz.
Average amplitude emissions are recorded above for frequency range above 1000 MHz.

**Table Two Radiated Emissions in Restricted Bands Data (chip Antenna)**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Quasi-Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Quasi-Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) |
|---|---|---|---|---|---|---|---|
| 2390.0 | 38.4 | N/A | 6.6 | 44.5 | N/A | 8.5 | 54.0 |
| 2483.5 | 39.9 | N/A | 6.5 | 39.3 | N/A | 6.6 | 54.0 |
| 4801.4 | 42.2 | N/A | 11.6 | 43.8 | N/A | 12.1 | 54.0 |
| 4871.6 | 43.7 | N/A | 12.8 | 43.3 | N/A | 12.1 | 54.0 |
| 4941.8 | 42.3 | N/A | 11.5 | 43.6 | N/A | 12.5 | 54.0 |
| 7202.1 | 46.5 | N/A | 15.8 | 47.3 | N/A | 16.3 | 54.0 |
| 7307.4 | 46.7 | N/A | 16.3 | 46.4 | N/A | 15.9 | 54.0 |
| 7412.7 | 45.1 | N/A | 14.6 | 45.5 | N/A | 14.7 | 54.0 |
| 12003.5 | 53.1 | N/A | 22.9 | 53.3 | N/A | 22.9 | 54.0 |
| 12179.0 | 52.0 | N/A | 21.5 | 52.0 | N/A | 21.6 | 54.0 |
| 12354.5 | 54.8 | N/A | 24.2 | 53.6 | N/A | 23.5 | 54.0 |
| 14404.2 | 59.6 | N/A | 28.9 | 59.3 | N/A | 28.8 | 54.0 |

Other emissions present had amplitudes at least 20 dB below the limit. Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz. Average amplitude emissions are recorded above for frequency range above 1000 MHz.

**Table Three Radiated Emissions in Restricted Bands Data (2 dBi Diploe Antenna)**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Quasi-Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Quasi-Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) |
|---|---|---|---|---|---|---|---|
| 2390.0 | 39.2 | N/A | 6.5 | 52.1 | N/A | 10.1 | 54.0 |
| 2483.5 | 37.2 | N/A | 6.0 | 44.0 | N/A | 10.6 | 54.0 |
| 4801.4 | 43.8 | N/A | 13.4 | 45.1 | N/A | 14.3 | 54.0 |
| 4871.6 | 45.0 | N/A | 13.8 | 48.8 | N/A | 16.6 | 54.0 |
| 4941.8 | 42.9 | N/A | 12.2 | 47.0 | N/A | 17.6 | 54.0 |
| 7202.1 | 47.1 | N/A | 16.6 | 47.6 | N/A | 17.1 | 54.0 |
| 7307.4 | 44.9 | N/A | 14.3 | 45.8 | N/A | 15.6 | 54.0 |
| 7412.7 | 46.4 | N/A | 15.4 | 46.3 | N/A | 15.5 | 54.0 |
| 12003.5 | 53.3 | N/A | 22.8 | 53.5 | N/A | 22.7 | 54.0 |
| 12179.0 | 55.0 | N/A | 24.2 | 54.9 | N/A | 24.5 | 54.0 |
| 12354.5 | 55.3 | N/A | 24.6 | 55.2 | N/A | 24.2 | 54.0 |
| 14404.2 | 59.3 | N/A | 28.9 | 59.7 | N/A | 29.0 | 54.0 |

Other emissions present had amplitudes at least 20 dB below the limit. Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz. Average amplitude emissions are recorded above for frequency range above 1000 MHz.

### *Summary of Results for Radiated Emissions in Restricted Bands*

The EUT demonstrated compliance with the radiated emissions requirements of CFR 47 Part 15C and RSS-210 Intentional Radiators. The EUT transmitter demonstrated a minimum margin of –25.0 dB below the requirements. The EUT support computer system demonstrated a minimum margin of -12.7 dB below the requirements. Peak, Quasi-peak, and average amplitudes were checked for compliance with the regulations. Worst-case emissions are reported with other emissions found in the restricted frequency bands at least 20 dB below the requirements.

### *AC Line Conducted Emissions Procedure*

The EUT was arranged in a typical equipment configuration and placed on a 1 x 1.5-meter wooden bench 80 cm above the conducting ground plane, floor of a screen room. The bench was positioned 40 cm away from the wall of the screen room. The LISN was positioned on the floor of the screen room 80-cm from the rear of the EUT. The manufacturer supplied AC power adapter for the EUT test fixture was connected to the LISN. A second LISN was positioned on the floor of the screen room 80-cm from the rear of the supporting equipment of the EUT. All power cords except the EUT were then powered from the second LISN. EMI was coupled to the spectrum analyzer through a 0.1 μF capacitor, internal to the LISN. Power line conducted emissions testing were carried out individually for each current carrying conductor of the EUT. The excess length of lead between the system and the LISN receptacle was folded back and forth to form a bundle not exceeding 40 cm in length. The screen room, conducting ground plane, analyzer, and LISN were bonded together to the protective earth ground. Preliminary testing was performed to identify the frequency of each radio frequency emission displaying the highest amplitude. The cables were repositioned to obtain maximum amplitude of measured EMI level. Once the worst-case configuration was identified, plots were made of the EMI from 0.15 MHz to 30 MHz then the data was recorded with maximum conducted emissions levels. Refer to figures one and two for plots of the EUT test fixture AC Power Line conducted emissions.

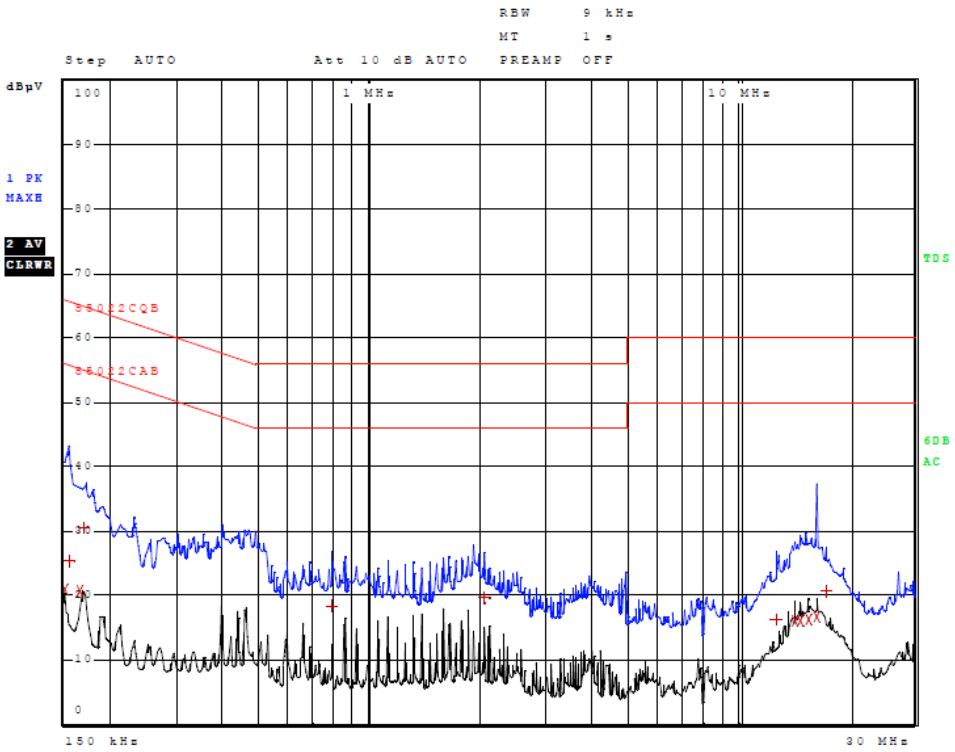



**Figure One AC Line Conducted Emissions Line 1**

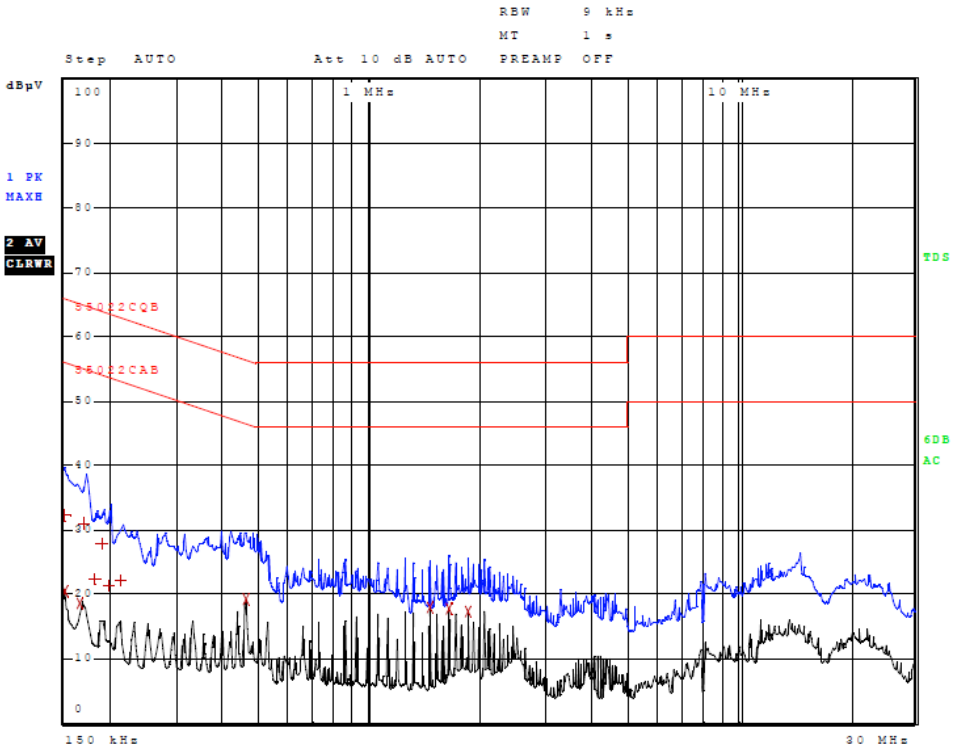



**Figure Two AC Line Conducted Emissions Line 2**

**Table Four AC Line Conducted Emissions Data (7 Highest Emissions)**

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 2 | 150.000000000 kHz | 20.82 | Average | -35.18 |
| 1 | 154.000000000 kHz | 25.35 | Quasi Peak | -40.43 |
| 2 | 166.000000000 kHz | 20.75 | Average | -34.41 |
| 1 | 170.000000000 kHz | 30.61 | Quasi Peak | -34.35 |
| 1 | 790.000000000 kHz | 18.40 | Quasi Peak | -37.60 |
| 1 | 2.046000000 MHz | 19.69 | Quasi Peak | -36.31 |
| 1 | 12.636000000 MHz | 16.25 | Quasi Peak | -43.75 |
| 2 | 14.224000000 MHz | 16.09 | Average | -33.91 |
| 2 | 14.728000000 MHz | 16.03 | Average | -33.97 |
| 2 | 15.496000000 MHz | 16.21 | Average | -33.79 |
| 2 | 16.292000000 MHz | 16.67 | Average | -33.33 |
| 1 | 17.252000000 MHz | 20.60 | Quasi Peak | -39.40 |

Other emissions present had amplitudes at least 20 dB below the limit.

**Table Five AC Line Conducted Emissions Data (7 Highest Emissions)**

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 2 | 150.000000000 kHz | 20.47 | Average | -35.53 |
| 1 | 150.000000000 kHz | 32.21 | Quasi Peak | -33.79 |
| 2 | 166.000000000 kHz | 18.66 | Average | -36.50 |
| 1 | 170.000000000 kHz | 31.06 | Quasi Peak | -33.90 |
| 1 | 182.000000000 kHz | 22.39 | Quasi Peak | -42.01 |
| 1 | 190.000000000 kHz | 27.75 | Quasi Peak | -36.28 |
| 1 | 198.000000000 kHz | 21.32 | Quasi Peak | -42.38 |
| 1 | 214.000000000 kHz | 22.14 | Quasi Peak | -40.91 |
| 2 | 462.000000000 kHz | 19.23 | Average | -27.42 |
| 2 | 1.450000000 MHz | 17.87 | Average | -28.13 |
| 2 | 1.646000000 MHz | 17.81 | Average | -28.19 |
| 2 | 1.846000000 MHz | 17.38 | Average | -28.62 |

Other emissions present had amplitudes at least 20 dB below the limit.

### *Summary of Results for AC Line Conducted Emissions*

The EUT demonstrated compliance with the conducted emissions requirements of 47CFR Part 15C and RSS-210 equipment. The EUT demonstrated minimum margin of -27.4 dB below the limit. Measurements were taken using the peak, quasi peak, and average, measurement function for each emissions amplitude and were below the limits stated in the specification. Other emissions were present with recorded data representing worst-case amplitudes.

### *General Radiated EMI Testing Procedure*

The EUT was arranged in the test fixture emulating worst-case equipment configuration and operated through all available modes with worst-case data recorded. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Investigations were performed to identify the frequencies, which produced the highest radiated emissions. Radiated emission investigations were performed from 9 kHz to 25,000 MHz with the EUT positioned in three orthogonal axes per regulations. Frequencies of interest were recorded for use during testing on the OATS. Each investigated emission was then maximized at the OATS site before final radiated emissions measurements were performed. Final data was taken with the EUT located at the open area test site at a distance of 3 meters between the EUT and the receiving antenna. Peak and average amplitudes of frequencies above 1000 MHz were compared to the required limits with worst-case data presented below. Measured emission levels were maximized by EUT placement on the table, changing cable location, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and changing antenna polarization between horizontal and vertical. Antennas used were Loop from 0.09 to 30 MHz, Broadband Biconical from 30 MHz to 200 MHz, Log Periodic from 200 MHz to 1 GHz, and/or Biconilog from 30 MHz to 1000 MHz, Double-Ridge, and/or Pyramidal Horns from 1 GHz to 25 GHz, and amplification stages.

**Table Six General Radiated Emissions Data (worst-case all antennas)**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Quasi-Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Quasi-Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) |
|---|---|---|---|---|---|---|---|
| 132.0 | 36.1 | 30.8 | N/A | 32.7 | 27.4 | N/A | 43.5 |
| 133.2 | 35.3 | 28.9 | N/A | 33.8 | 27.7 | N/A | 43.5 |
| 152.3 | 34.2 | 27.3 | N/A | 31.2 | 26.2 | N/A | 43.5 |
| 152.9 | 34.3 | 28.3 | N/A | 26.4 | 20.9 | N/A | 43.5 |
| 153.3 | 35.4 | 29.8 | N/A | 29.3 | 23.1 | N/A | 43.5 |
| 154.0 | 35.3 | 29.5 | N/A | 27.3 | 21.5 | N/A | 43.5 |
| 154.9 | 35.9 | 30.9 | N/A | 31.8 | 27.9 | N/A | 43.5 |
| 155.2 | 35.5 | 30.9 | N/A | 27.8 | 20.3 | N/A | 43.5 |
| 155.5 | 35.3 | 31.9 | N/A | 27.4 | 21.8 | N/A | 43.5 |
| 155.9 | 36.6 | 30.8 | N/A | 27.7 | 22.4 | N/A | 43.5 |
| 157.8 | 36.4 | 31.6 | N/A | 27.5 | 22.3 | N/A | 43.5 |
| 159.7 | 36.0 | 30.3 | N/A | 27.3 | 24.3 | N/A | 43.5 |
| 161.9 | 34.7 | 27.7 | N/A | 27.7 | 20.9 | N/A | 43.5 |
| 230.8 | 33.8 | 30.5 | N/A | 31.9 | 28.3 | N/A | 46.0 |
| 233.0 | 31.8 | 27.3 | N/A | 33.3 | 29.2 | N/A | 46.0 |
| 260.4 | 35.8 | 30.3 | N/A | 36.1 | 31.2 | N/A | 46.0 |
| 263.5 | 42.1 | 36.4 | N/A | 41.8 | 36.5 | N/A | 46.0 |
| 266.0 | 43.6 | 38.6 | N/A | 44.6 | 39.8 | N/A | 46.0 |
| 455.7 | 40.6 | 38.5 | N/A | 42.5 | 39.7 | N/A | 46.0 |
| 585.8 | 32.8 | 26.5 | N/A | 30.2 | 24.5 | N/A | 46.0 |
| 665.0 | 36.8 | 28.6 | N/A | 41.8 | 33.3 | N/A | 46.0 |
| 932.2 | 41.9 | 37.1 | N/A | 32.7 | 27.4 | N/A | 43.5 |

Other emissions present had amplitudes at least 20 dB below the limit.
Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz.
Average amplitude emissions are recorded above for frequency range above 1000 MHz.

### *Summary of Results for General Radiated Emissions*

The EUT demonstrated compliance with the general radiated emissions requirements of 47CFR Part 15.247 and RSS-210. The EUT demonstrated a minimum margin of -6.2 dB below general radiated emissions requirements. There are no other significantly measurable emissions in the restricted bands other than those recorded in this report. Other emissions were present with amplitudes at least 20 dB below the requirements.

### *Operation in the Band 2400 – 2483.5 MHz*

The power output was measured both at the antenna connection port and at the open area test site at a three-meter distance with the authorized antenna systems. Band edge and harmonic radiated emission measurements were taken while EUT was operated in both FHSS and test modes. Data presented below represents worst-case emissions from all modes investigated during testing. Harmonic emissions measurement data presented in table seven accounts for Duty Cycle correction Factor (DCF) reduction of -17.7 dB (as authorized in 47 CFR paragraph 15.35(b) and RSS –GEN paragraph 4.5). The DCF was calculated using the absolute maximum transmitter on time (13 mS) over a 100 millisecond period (20log[13/100] = -17.7). Figures three through eleven present antenna conducted emissions across the frequency spectrum.

Dwell Time on channel: The units resides on channel 32 times over 18 seconds, each time transmitting for 10.62 mS which equates to average time of occupancy of less than 340 mS demonstrating compliance with regulations.

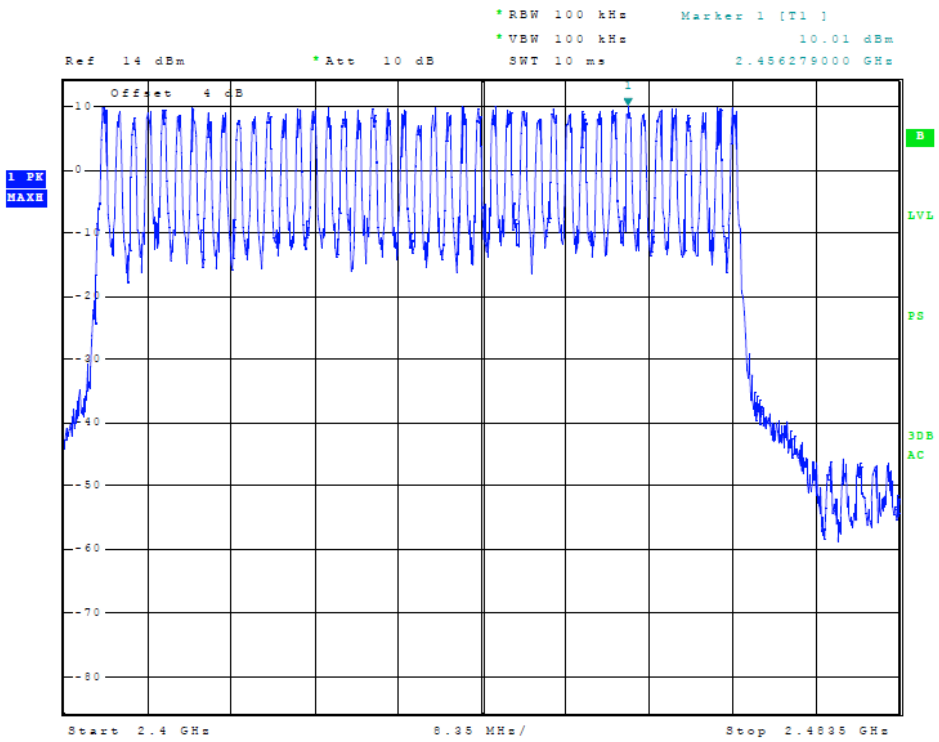



**Figure Three of Antenna Port Conducted Emissions (Frequency band)**

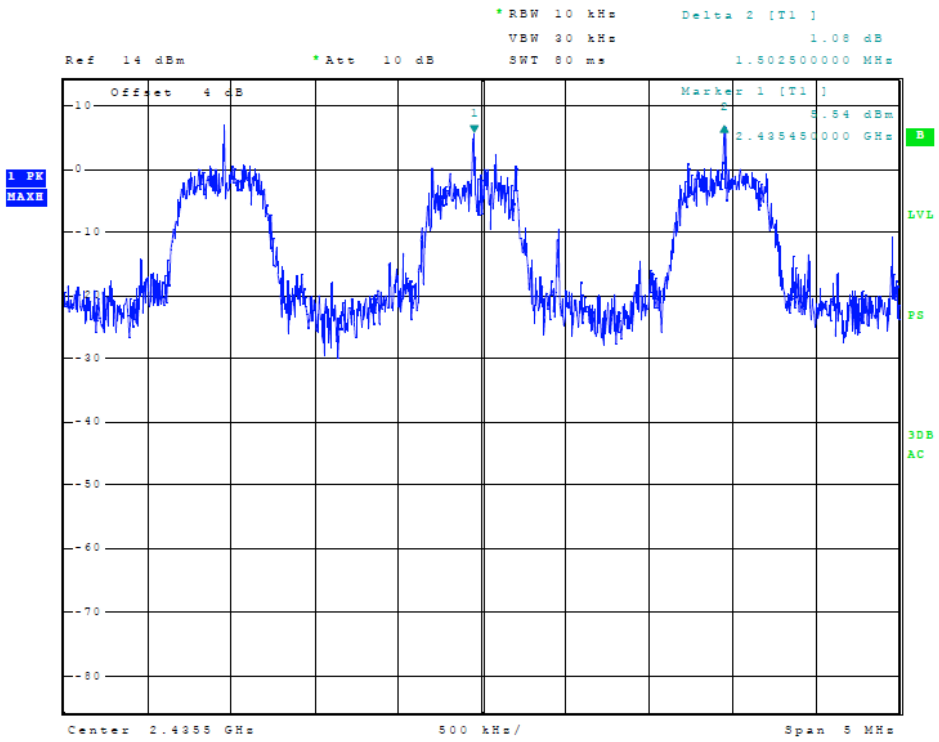



**Figure Four of Antenna Port Conducted Emissions (Channel Separation)**

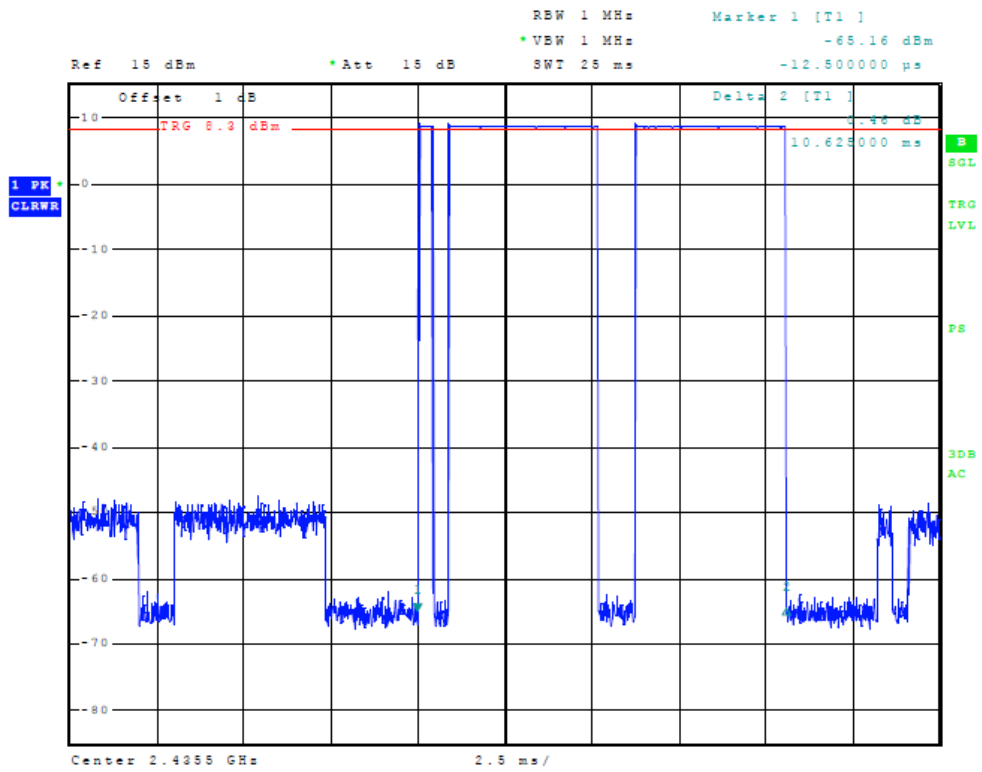



**Figure Five of Antenna Port Conducted Emissions (Dwell Time on Channel)**

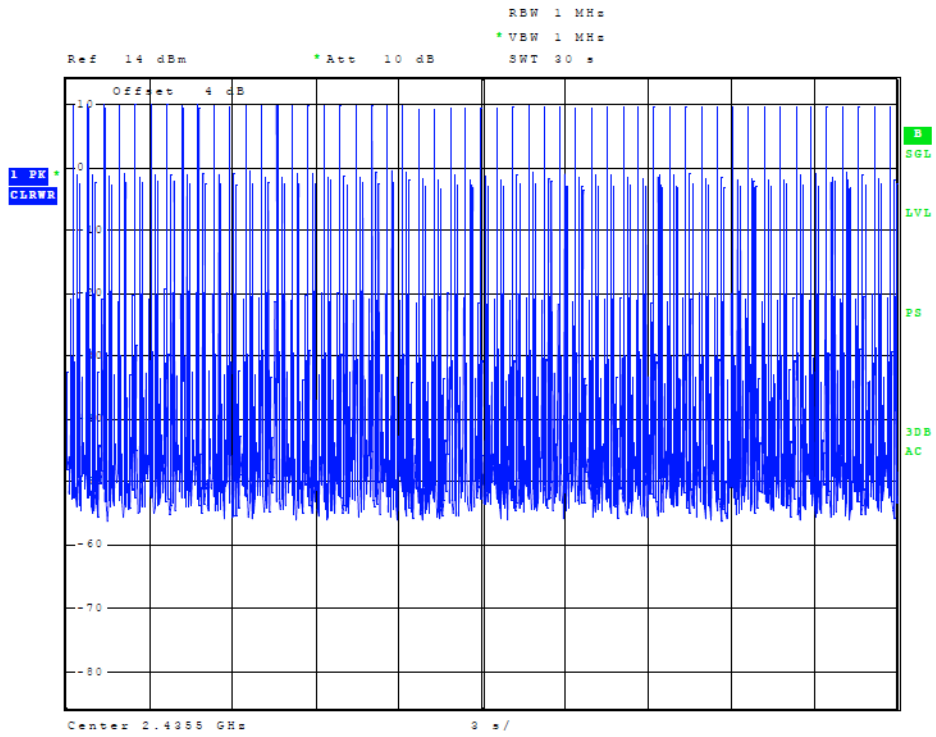



**Figure Six of Antenna Port Conducted Emissions (number of Times on Channel)**

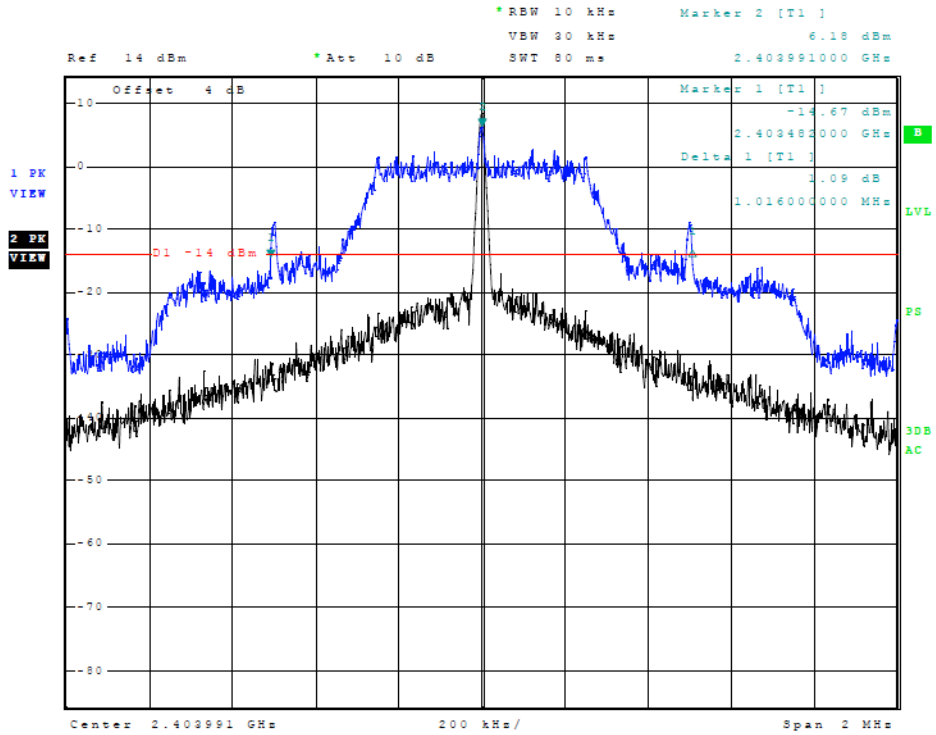



**Figure Seven of Antenna Port Conducted Emissions (Occupied Bandwidth 2403)**

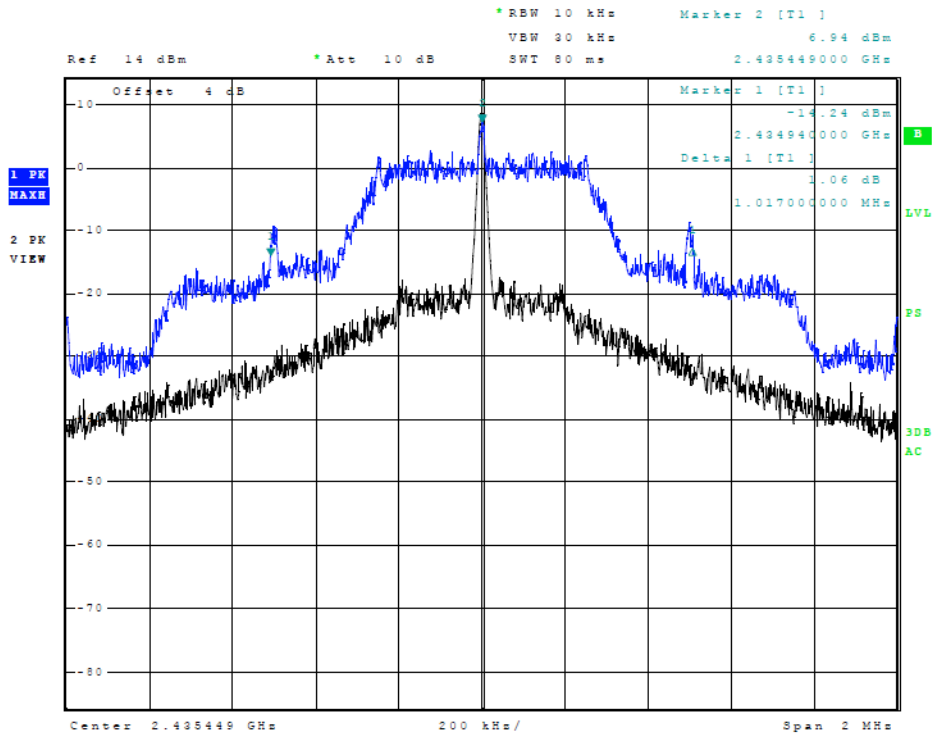



**Figure Eight of Antenna Port Conducted Emissions (Occupied Bandwidth 2435)**

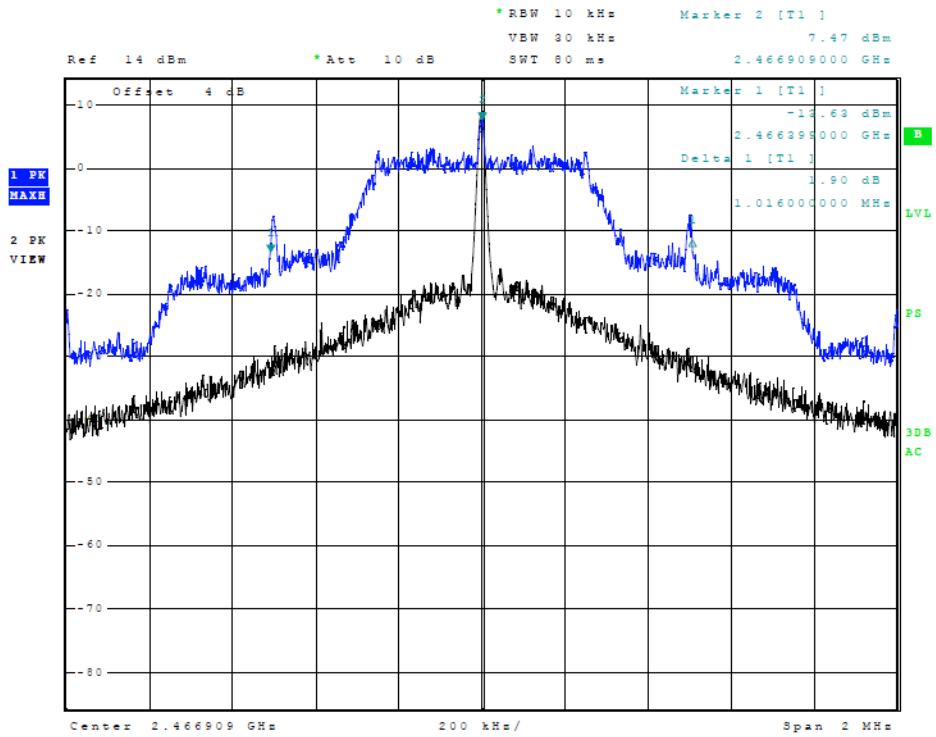



**Figure Nine of Antenna Port Conducted Emissions (Occupied Bandwidth 2466)**

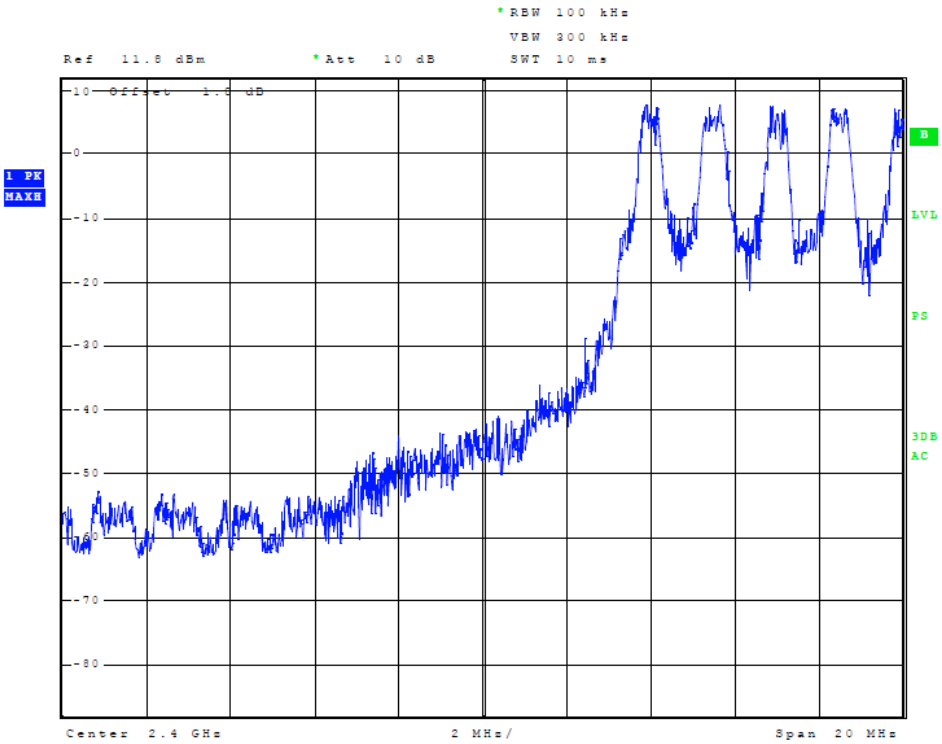



**Figure Ten of Antenna Port Conducted Emissions (Low Band Edge)**

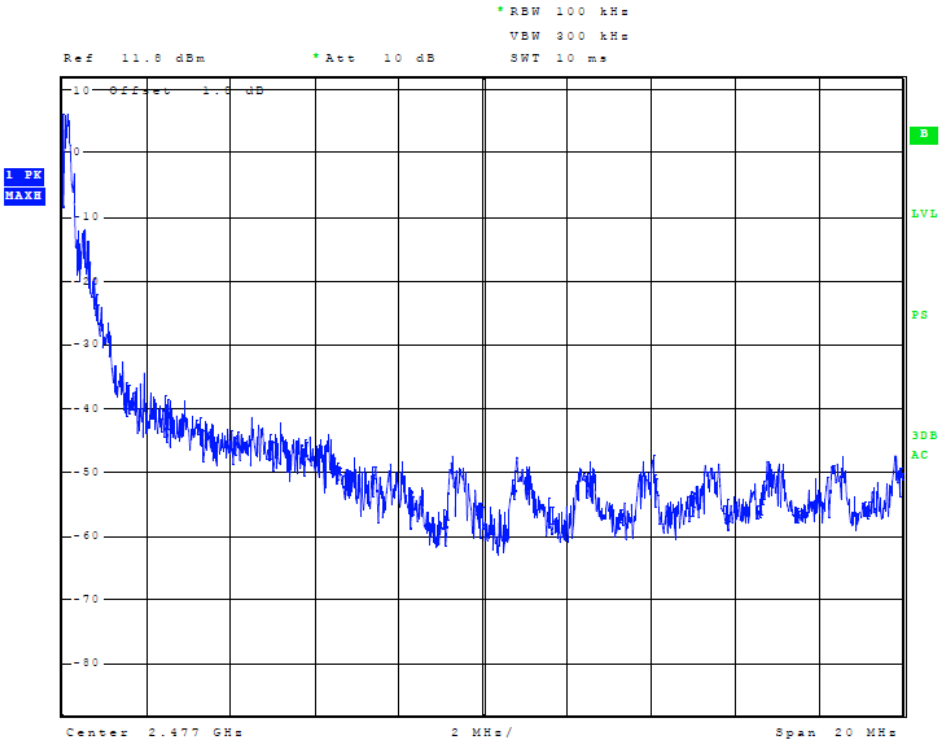



**Figure Eleven of Antenna Port Conducted Emissions (High Band Edge)**

## *Transmitter Emissions Data*

**Table Seven Transmitter Radiated Emission Data (Chip Antenna)**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Quasi-Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Quasi-Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) |
|---|---|---|---|---|---|---|---|
| 2404.0 | 100.0 | N/A | 74.7 | 100.3 | N/A | 75.2 | -- |
| 4808.0 | 42.2 | N/A | 11.6 | 43.8 | N/A | 12.1 | 54 |
| 7212.0 | 46.5 | N/A | 15.8 | 47.3 | N/A | 16.3 | 54 |
| 9616.0 | 45.9 | N/A | 19.4 | 49.7 | N/A | 19.5 | 54 |
| 12020.0 | 53.1 | N/A | 22.9 | 53.3 | N/A | 22.9 | 54 |
| 14424.0 | 59.6 | N/A | 28.9 | 59.3 | N/A | 28.8 | 54 |
| 2435.5 | 100.0 | N/A | 74.6 | 100.6 | N/A | 75.8 | -- |
| 4871.0 | 43.7 | N/A | 12.8 | 43.3 | N/A | 12.1 | 54 |
| 7306.5 | 46.7 | N/A | 16.3 | 46.4 | N/A | 15.9 | 54 |
| 9742.0 | 49.7 | N/A | 19.3 | 49.9 | N/A | 19.3 | 54 |
| 12177.5 | 52.0 | N/A | 21.5 | 52.0 | N/A | 21.6 | 54 |
| 14613.0 | 57.9 | N/A | 27.1 | 57.9 | N/A | 27.1 | 54 |
| 2466.9 | 100.8 | N/A | 75.2 | 100.8 | N/A | 75.6 | -- |
| 4933.8 | 42.3 | N/A | 11.5 | 43.6 | N/A | 12.5 | 54 |
| 7400.7 | 45.1 | N/A | 14.6 | 45.5 | N/A | 14.7 | 54 |
| 9867.6 | 49.4 | N/A | 18.9 | 49.5 | N/A | 18.7 | 54 |
| 12334.5 | 54.8 | N/A | 24.2 | 53.6 | N/A | 23.5 | 54 |
| 14801.4 | 57.8 | N/A | 27.2 | 57.5 | N/A | 27.1 | 54 |

Other emissions present had amplitudes at least 20 dB below the limit.
Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz.
Average amplitude emissions are recorded above for frequency range above 1000 MHz.

**Table Eight Transmitter Radiated Emission Data (2 dBi Dipole Antenna)**

| Frequency in MHz | Horizontal Peak (dBµV/m) | Horizontal Quasi-Peak (dBµV/m) | Horizontal Average (dBµV/m) | Vertical Peak (dBµV/m) | Vertical Quasi-Peak (dBµV/m) | Vertical Average (dBµV/m) | Limit @ 3m (dBµV/m) |
|---|---|---|---|---|---|---|---|
| 2404.0 | 101.5 | N/A | 76.4 | 109.0 | N/A | 83.5 | -- |
| 4808.0 | 43.8 | N/A | 13.4 | 45.1 | N/A | 14.3 | 54 |
| 7212.0 | 47.1 | N/A | 16.6 | 47.6 | N/A | 17.1 | 54 |
| 9616.0 | 48.7 | N/A | 18.2 | 54.5 | N/A | 22.9 | 54 |
| 12020.0 | 53.3 | N/A | 22.8 | 53.5 | N/A | 22.7 | 54 |
| 14424.0 | 59.3 | N/A | 28.9 | 59.7 | N/A | 29.0 | 54 |
| 2435.5 | 101.4 | N/A | 77.4 | 108.8 | N/A | 83.3 | -- |
| 4871.0 | 45.0 | N/A | 13.8 | 48.8 | N/A | 16.6 | 54 |
| 7306.5 | 44.9 | N/A | 14.3 | 45.8 | N/A | 15.6 | 54 |
| 9742.0 | 49.1 | N/A | 18.3 | 54.1 | N/A | 22.4 | 54 |
| 12177.5 | 55.0 | N/A | 24.2 | 54.9 | N/A | 24.5 | 54 |
| 14613.0 | 58.0 | N/A | 27.0 | 58.4 | N/A | 27.1 | 54 |
| 2466.9 | 100.5 | N/A | 77.1 | 108.8 | N/A | 82.7 | -- |
| 4933.8 | 42.9 | N/A | 12.2 | 47.0 | N/A | 17.6 | 54 |
| 7400.7 | 46.4 | N/A | 15.4 | 46.3 | N/A | 15.5 | 54 |
| 9867.6 | 49.3 | N/A | 19.2 | 53.1 | N/A | 19.5 | 54 |
| 12334.5 | 55.3 | N/A | 24.6 | 55.2 | N/A | 24.2 | 54 |
| 14801.4 | 57.9 | N/A | 27.1 | 57.4 | N/A | 27.1 | 54 |

Other emissions present had amplitudes at least 20 dB below the limit.
Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz.
Average amplitude emissions are recorded above for frequency range above 1000 MHz.

**Table Nine Transmitter Antenna Conducted Emissions Data**

The antenna conducted output power and 20-dB bandwidth were measured while operating in available modes for the lowest, middle and highest available channels. The data reported below represents the worst-case operational conditions.

| Operational Mode | Frequency MHz | Antenna Conducted Output Power dBm | Antenna Conducted Output Power mW | Occupied Bandwidth kHz |
|---|---|---|---|---|
| 43 Hop Set | 2403.9 | 9.0 | 8 | 1016 |
| 43 Hop Set | 2435.5 | 9.0 | 8 | 1017 |
| 43 Hop Set | 2466.9 | 9.0 | 8 | 1016 |

## *Summary of Results for Radiated Emissions of Intentional Radiator*

The EUT demonstrated antenna conducted output power of 8 Milliwatts (0.008 Watts) at antenna port. The EUT presented in compliance with the radiated emissions requirements of 47CFR Part 15.247 and RSS-210 with highest radiated emission level measured of 109 dBµV/m @ 3m. The EUT demonstrated a minimum margin of -25.0 dB below the harmonic emissions requirements. The EUT demonstrated a minimum margin of -25.0 dB below the emissions requirements for restricted bands (transmitter emissions). The EUT and support equipment demonstrated a minimum margin of -12.7 dB below the emissions requirements in restricted bands (general emissions of support equipment). The EUT tested was observed in compliance with the radiated emissions requirements of 47CFR Part 15.247 and RSS-210 Intentional Radiators. There were no other significantly measurable emissions observed in restricted bands other than those recorded in this report. Other emissions were present with amplitudes at least 20 dB below the requirements. The EUT demonstrated compliance with the specifications of 47CFR 15.247 and RSS-210. There were no deviations or exceptions to the requirements.

## Annex

- Annex A Measurement Uncertainty Calculations
- Annex B Rogers Labs Test Equipment List
- Annex C Rogers Qualifications
- Annex D FCC Site Registration Letter
- Annex E Industry Canada Site Registration Letter

## *Annex A Measurement Uncertainty Calculations*

Measurement uncertainty calculations were made for the laboratory. Result of measurement uncertainty calculations are recorded below for AC line conducted and radiated emission measurements.

| Measurement Uncertainty | $U_{(E)}$ | $U_{(lab)}$ |
|---|---|---|
| 3 Meter Horizontal 30-200 MHz Measurements | 2.08 | 4.16 |
| 3 Meter Vertical 30-200 MHz Measurements | 2.16 | 4.33 |
| 3 Meter Vertical Measurements 200-1000 MHz | 2.99 | 5.97 |
| 10 Meter Horizontal Measurements 30-200 MHz | 2.07 | 4.15 |
| 10 Meter Vertical Measurements 30-200 MHz | 2.06 | 4.13 |
| 10 Meter Horizontal Measurements 200-1000 MHz | 2.32 | 4.64 |
| 10 Meter Vertical Measurements 200-1000 MHz | 2.33 | 4.66 |
| 3 Meter Measurements 1-6 GHz | 2.57 | 5.14 |
| 3 Meter Measurements 6-18 GHz | 2.58 | 5.16 |
| AC Line Conducted | 1.72 | 3.43 |

## *Annex B Rogers Labs Test Equipment List*

| List of Test Equipment | Calibration Date |
|---|---|
| Spectrum Analyzer: Rohde & Schwarz ESU40 | 5/14 |
| Spectrum Analyzer: HP 8562A, HP Adapters: 11518, 11519, and 11520 Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W | 5/14 |
| Spectrum Analyzer: HP 8591EM | 5/14 |
| Antenna: EMCO Biconilog Model: 3143 | 5/14 |
| Antenna: Sunol Biconilog Model: JB6 | 10/14 |
| Antenna: EMCO Log Periodic Model: 3147 | 10/14 |
| Antenna: Com Power Model: AH-118 | 10/14 |
| Antenna: Com Power Model: AH-840 | 10/14 |
| Antenna: Antenna Research Biconical Model: BCD 235 | 10/14 |
| Antenna: EMCO 6509 | 10/14 |
| LISN: Compliance Design Model: FCC-LISN-2.Mod.cd, 50 µHy/50 ohm/0.1 µf | 10/14 |
| R.F. Preamp CPPA-102 | 10/14 |
| Attenuator: HP Model: HP11509A | 10/14 |
| Attenuator: Mini Circuits Model: CAT-3 | 10/14 |
| Attenuator: Mini Circuits Model: CAT-3 | 10/14 |
| Cable: Belden RG-58 (L1) | 10/14 |
| Cable: Belden RG-58 (L2) | 10/14 |
| Cable: Belden 8268 (L3) | 10/14 |
| Cable: Time Microwave: 4M-750HF290-750 | 10/14 |
| Cable: Time Microwave: 10M-750HF290-750 | 10/14 |
| Frequency Counter: Leader LDC825 | 2/14 |
| Oscilloscope Scope: Tektronix 2230 | 2/14 |
| Wattmeter: Bird 43 with Load Bird 8085 | 2/14 |
| Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140 | 2/14 |
| R.F. Generators: HP 606A, HP 8614A, HP 8640B | 2/14 |
| R.F. Power Amp 65W Model: 470-A-1010 | 2/14 |
| R.F. Power Amp 50W M185- 10-501 | 2/14 |
| R.F. Power Amp A.R. Model: 10W 1010M7 | 2/14 |
| R.F. Power Amp EIN Model: A301 | 2/14 |
| LISN: Compliance Eng. Model 240/20 | 2/14 |
| LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08 | 2/14 |
| Antenna: EMCO Dipole Set 3121C | 2/14 |
| Antenna: C.D. B-101 | 2/14 |
| Antenna: Solar 9229-1 & 9230-1 | 2/14 |
| Audio Oscillator: H.P. 201CD | 2/14 |
| ELGAR Model: 1751 | 2/14 |
| ELGAR Model: TG 704A-3D | 2/14 |
| ESD Test Set 2010i | 2/14 |
| Fast Transient Burst Generator Model: EFT/B-101 | 2/14 |
| Field Intensity Meter: EFM-018 | 2/14 |
| KEYTEK Ecat Surge Generator | 2/14 |
| Shielded Room 5 M x 3 M x 3.0 M | |

## *Annex C Rogers Qualifications*

***Scot D. Rogers, Engineer***

**Rogers Labs, Inc.**

Mr. Rogers has approximately 17 years' experience in the field of electronics. Engineering experience includes six years in the automated controls industry and remaining years working with the design, development and testing of radio communications and electronic equipment.

Positions Held

| | | |
|---|---|---|
| Systems Engineer: | A/C Controls Mfg. Co., Inc. | 6 Years |
| Electrical Engineer: | Rogers Consulting Labs, Inc. | 5 Years |
| Electrical Engineer: | Rogers Labs, Inc. | Current |

Educational Background

1) Bachelor of Science Degree in Electrical Engineering from Kansas State University.

2) Bachelor of Science Degree in Business Administration Kansas State University.

3) Several Specialized Training courses and seminars pertaining to Microprocessors and Software programming.

Scot D Rogers

Scot D. Rogers

NVLAP Lab Code 200087-0

## *Annex D FCC Site Registration Letter*

# FEDERAL COMMUNICATIONS COMMISSION

**Laboratory Division**
**7435 Oakland Mills Road**
**Columbia, MD 21046**

June 28, 2013

Registration Number: 90910

Rogers Labs, Inc.
4405 West 259th Terrace,
Louisburg, KS 66053

Attention: Scot Rogers,

Re: Measurement facility located at Louisburg
3 & 10 meter site
Date of Renewal: June 28, 2013

Dear Sir or Madam:

Your request for renewal of the registration of the subject measurement facility has been received. The information submitted has been placed in your file and the registration has been renewed. The name of your organization will remain on the list of facilities whose measurement data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Please note that the file must be updated for any changes made to the facility and the registration must be renewed at least every three years.

Measurement facilities that have indicated that they are available to the public to perform measurement services on a fee basis may be found on the FCC website www.fcc.gov under E-Filing, OET Equipment Authorization Electronic Filing, Test Firms.

Sincerely,

Phyllis Parrish
Industry Analyst

NVLAP Lab Code 200087-0

## *Annex E Industry Canada Site Registration Letter*

Industry Canada Industrie Canada

June 19, 2013

OUR FILE: 46405-3041
Submission No: 168037

Rogers Labs Inc.
4405 West 259th Terrace
Louisburg
KS, USA
66053

***Attention***: Mr. Scot D. Rogers

Dear Sir:

The Bureau has received your application for the renewal of 3/10m OATS. Be advised that the information received was satisfactory to Industry Canada. The following number(s) is now associated to the site(s) for which registration / renewal was sought **(Site# 3041A-1).** Please reference the appropriate site number in the body of test reports containing measurements performed on the site. In addition, please keep for your records the following information;

- The company address code associated to the site(s) located at the above address is: **3041A**

Furthermore, to obtain or renew a unique site number, the applicant shall demonstrate that the site has been accredited to ANSI C63.4-2003 or later. A scope of accreditation indicating the accreditation by a recognized accreditation body to ANSI C63.4-2003 or later shall be accepted. Please indicate in a letter the previous assigned site number if applicable and the type of site (example: 3 metre OATS or 3 metre chamber). If the test facility is not accredited to ANSI C63.4-2003 or later, the test facility shall submit test data demonstrating full compliance with the ANSI standard. The Bureau will evaluate the filing to determine if recognition shall be granted.

The frequency for re-validation of the test site and the information that is required to be filed or retained by the testing party shall comply with the requirements established by the accrediting organization. However, in all cases, test site re-validation shall occur on an interval not to **exceed three years**. There is no fee or form associated with an OATS filing. OATS submissions are encouraged to be submitted electronically to the Bureau using the following URL;
http://strategis.ic.gc.ca/epic/internet/inceb-bhst.nsf/en/h_tt00052e.html.

If you have any questions, you may contact the Bureau by e-mail at certification.bureau@ic.gc.ca Please reference our file and submission number above for all correspondence.

Yours sincerely,

Bill Payn
For: Wireless Laboratory Manager
**Certification and Engineering Bureau**
3701 Carling Ave., Building 94
P.O. Box 11490, Station "H"
Ottawa, Ontario K2H 8S2
Email: Bill.Payn@ic.gc.ca
Tel. No. (613) 990-3639
Fax. No. (613) 990-4752