NVLAP Lab Code 200087-0

# Application Submittal Report
For
# FCC And Industry Canada Grant Of Certification

FOR

## Model: A1AVGB00
## 2402 - 2480 MHz Transmitter

## FCC ID: IPH-01925
## IC: 1792A-01925

FOR

## GARMIN INTERNATIONAL, INC.
1200 East 151st Street
Olathe, KS 66062

Test Report Number: 110621A

Authorized Signatory: Scot D Rogers
Scot D. Rogers

NVLAP Lab Code 200087-0


**ROGERS LABS, INC.**
4405 West 259th Terrace
Louisburg, KS 66053
Phone / Fax (913) 837-3214


# Engineering Test Report For Grant Of Certification Application Submittal

CFR47, Part 15C - Intentional Radiators Paragraph 15.249,
Industry Canada, RSS-210
Low Power Transmitter

For

## Garmin International, Inc.

1200 East 151st Street
Olathe, KS 66062
Phone: (913) 397-8200
Mr. Van Ruggles
Director of Quality Assurance

# Model: A1AVGB00

Frequency 2402 - 2480 MHz
FCC ID#: IPH-01925
IC: 1792A-01925

Test Date: June 21, 2011

Certifying Engineer: Scot D Rogers


Scot D. Rogers
Rogers Labs, Inc.
4405 West 259th Terrace
Louisburg, KS 66053
Telephone: (913) 837-3214

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## Forward

The following information is submitted for consideration in obtaining Grant of Certification for a license exempt low power intentional radiator operating under CFR47 Paragraph 15.249 and Industry Canada Spectrum Management and Telecommunications Radio Standard Specification RSS-210, Issue 8.

Name of Applicant: Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062
Model: A1AVGB00
FCC I.D.: IPH-01925 , IC: 1792A-01925, Frequency Range: 2402 - 2480 MHz
Operating Power: Average emission of 84.4 dBµV/m (3 meter radiated measurement), 99% Occupied Bandwidth 945.51 kHz, Receiver worst-case emission 35.6 dBµV/m

## Applicable Standards & Procedures

In accordance with the Federal Communications Code of Federal Regulations, dated October 1, 2010, 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 15.249, and Industry Canada Spectrum Management and Telecommunications Radio Standard Specification 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 C63.4-2009, RSS-210, and appropriate FCC documents DA00-1407 and DA00-705 and/or TIA/EIA 603-1.

## Opinion / Interpretation of Results

| Test Performed | Minimum Margin (dB) | Results |
|---|---|---|
| Antenna requirement per CFR 47 15.203 | N/A | Complies |
| Restricted Bands Emissions as per CFR 47 15.205 and RSS-210 2.2 | -16.7 | Complies |
| AC Line Conducted Emissions as per CFR 47 15.207 and RSS-210 2.5 | -12.8 | Complies |
| Radiated Emissions as per CFR 47 15.209 and RSS-210 2.5 | -14.6 | Complies |
| Radiated Emissions per CFR 47 15.249 and RSS-210 A2.9 | -9.6 | Complies |
| Receivers emissions per CFR 47 15.111 and RSS-210 and RSS-GEN | -18.4 | Complies |

## Application for Certification

(1) Manufacturer: Garmin International, Inc.
1200 East 151st Street
Olathe, KS 66062

(2) Identification: Model: A1AVGB00
FCC I.D.: IPH-01925 IC: 1792A-01925

(3) Instruction Book: Refer to Exhibit for Instruction Manual.

(4) Description of Circuit Functions: Refer to Operational Description Exhibit

(5) Block Diagram with Frequencies: Refer to Block Diagram Exhibit

(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) Peripheral equipment or accessories for the equipment. Optional equipment available for the EUT includes AC power supply, DC cigarette adapters for battery recharge, vehicle mounts, and USB cable for computer interface and connection to AC power adapter. The available configuration options were investigated for this and other reports in compliance with required standards with worst-case data presented.

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

(10) Equipment is not a scanning receiver and this section is not applicable.

(11) The equipment does not operate in the 59 – 64 GHz frequency band and this section is not applicable.

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

## Statement of Modifications and Deviations

No modifications to the EUT were required for the equipment to demonstrate compliance with CFR47 Part 15C, or RSS-210 Emission Requirements. There were no deviations or modification to the specifications.

## Equipment Tested

| Equipment | Model / PN | Serial Number |
|---|---|---|
| (EUT) | A1AVGB00 | 38255297183 |
| AC Adapter | 362-00072-01 | N/A |
| USB Cable | 320-00128-00/02 | N/A |
| DC CLA adapter | 320-00239-40 | N/A |
| Traffic Receiver | GTM26 / 011-02587-xx | N/A |
| Computer | Dell / Studio XPS | 921LBN1 |
| Printer | Dell / 0N5819 | 5D1SL61 |

Test results in this report relate only to the items tested.

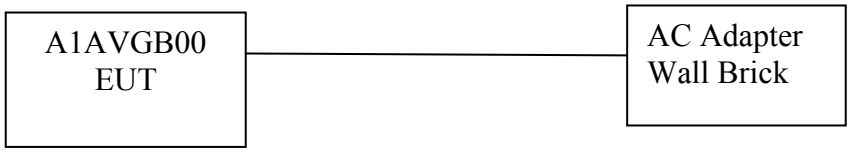
## Equipment Function and Testing Procedures

The EUT is a GPS receiver and display unit offering reception and display of location, navigation, and other information for the user incorporating a low power transmitter with operation capability in the 2402-2480 MHz frequency band (CFR 47 15.249 and RSS-210). The GPS design offers use as a hand-held, transportation mount or portable configuration for use in navigational applications. The equipment offers communication capability with other compliant 2402-2480 MHz equipment. Two samples were supplied for testing one production design and the other modified for testing purposes replacing integral antenna with RF connection port for this and other reports and documentation. Both samples offered test software enabling testing personnel ability to enable transmitter on defined channels. The antenna modification offered testing facility ability to connect transmitter antenna port to test equipment for transmitter antenna port conducted emissions testing. The EUT was arranged as typical user equipment configurations for testing purposes. The transmitter offers no other interface connections than those in the configuration options shown above. The unit operates from internal battery or external power received from external power supply options as shown in the configuration diagrams above. Some configurations shown above are not applicable for this report and have been tested and documented in other relevant documentation. As requested by the manufacturer and required by regulations, the equipment was tested for emissions compliance using the available configurations with the worst-case data presented. Test results in this report relate only to the products described in this report.

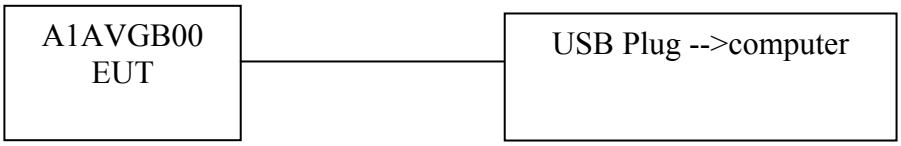
## Equipment and Cable Configurations

1. A1AVGB00 (GPN: 011-02737-XX / 011-02744-XX) connected to car cigarette lighter power cable assembly (GPN: 320-00239-40)

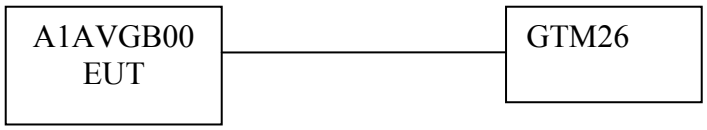

2. A1AVGB00 Li-Ion battery charged by the AC wall brick power supply (GPN: 362-00072-01/325-00128-00/02).




3. A1AVGB00 connected to computer through USB cable (GPN: 325-00128-00/02). The difference between the -00 and -02 is a paper tag attached.




4. A1AVGB00 connected to GTM26 cable assembly (011-02587-XX)



### *AC Line Conducted Emission Test Procedure*

Testing for the AC line-conducted emissions was performed as defined in sections 7.2.4 and 13.3 of ANSI C63.4-2009. The test setup, including the EUT, was arranged in the test configurations as shown above 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 photographs in exhibits for EUT placement used during testing.

### *Radiated Emission Test Procedure*

Testing for the radiated emissions was performed as defined in sections 8.3 and 13.4 of ANSI C63.4-2009. The EUT was arranged in the test configurations as shown above during testing. The test configuration 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. 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 final data was taken using a spectrum analyzer. Refer to photographs in exhibits for EUT placement used during testing.

## Environmental Conditions

| | |
|---|---|
| Ambient Temperature | 24.1° C |
| Relative Humidity | 54% |
| Atmospheric Pressure | 1012.0 mb |

## 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. |

## 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 FCC Site Registration Letter, # 90910, and Industry Canada Site Registration Letter, IC3041A-1.

## List of Test Equipment

A Rohde & Schwarz ESU40 and/or Hewlett Packard 8591EM Spectrum Analyzer was used as the measuring device for the emissions testing of frequencies below 1 GHz. A Rohde & 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.

| Analyzer Settings | | |
|---|---|---|
| AC Line Conducted Emissions: | | |
| RBW | AVG. BW | Detector Function |
| 9 kHz | 30 kHz | Peak/Quasi Peak |
| Radiated Emissions 30-1000 MHz | | |
| RBW | AVG. BW | Detector Function |
| 100 kHz | 100 kHz | Peak |
| 120 kHz | 300 kHz | Peak/Quasi Peak |
| Radiated Emissions Above 1000 MHz | | |
| RBW | Video BW | Detector Function |
| 1 MHz | 1 MHz | Peak / Average |

| Equipment | Manufacturer | Model | Calibration Date | Due |
|---|---|---|---|---|
| LISN | Comp. Design | FCC-LISN-2-MOD.CD | 10/10 | 10/11 |
| Antenna | ARA | BCD-235-B | 10/10 | 10/11 |
| Antenna | Sunol | JB6 | 10/10 | 10/11 |
| Antenna | EMCO | 3147 | 10/10 | 10/11 |
| Antenna | EMCO | 3143 | 5/11 | 5/12 |
| Analyzer | HP | 8591EM | 5/11 | 5/12 |
| Analyzer | HP | 8562A | 5/11 | 5/12 |
| Analyzer | Rohde & Schwarz | ESU40 | 5/11 | 5/12 |

# General Emissions (Unintentional Radiators)

## *AC Line Conducted EMI Procedure*

The EUT was arranged in typical equipment configurations as offered by manufacturer. Testing was performed with the EUT 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. Testing for the line-conducted emissions were the procedures of ANSI C63.4-2009 paragraphs 13.3 and 7.2.4. The AC adapter for the EUT was connected to the LISN for line-conducted emissions testing. 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 was 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 frequencies of each of the emissions, which demonstrated the highest amplitudes. 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 data was recorded with maximum conducted emissions levels. Refer to figures one and two showing plots of the worst-case AC Line conducted emissions of the AC Adapter while charging the EUT. Refer to figures three and four showing plots of the worst-case AC Line conducted emissions of the CPU AC Adapter while interfaced to computer through USB cable.

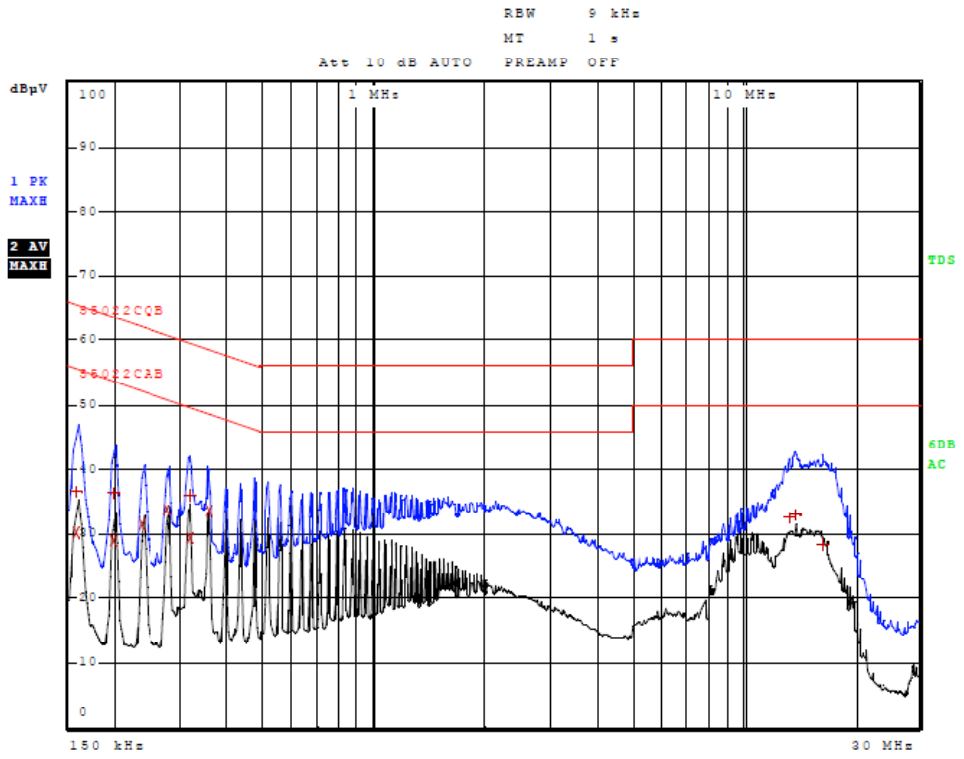



**Figure One AC Line Conducted emissions of EUT line 1 (EUT AC Adapter)**

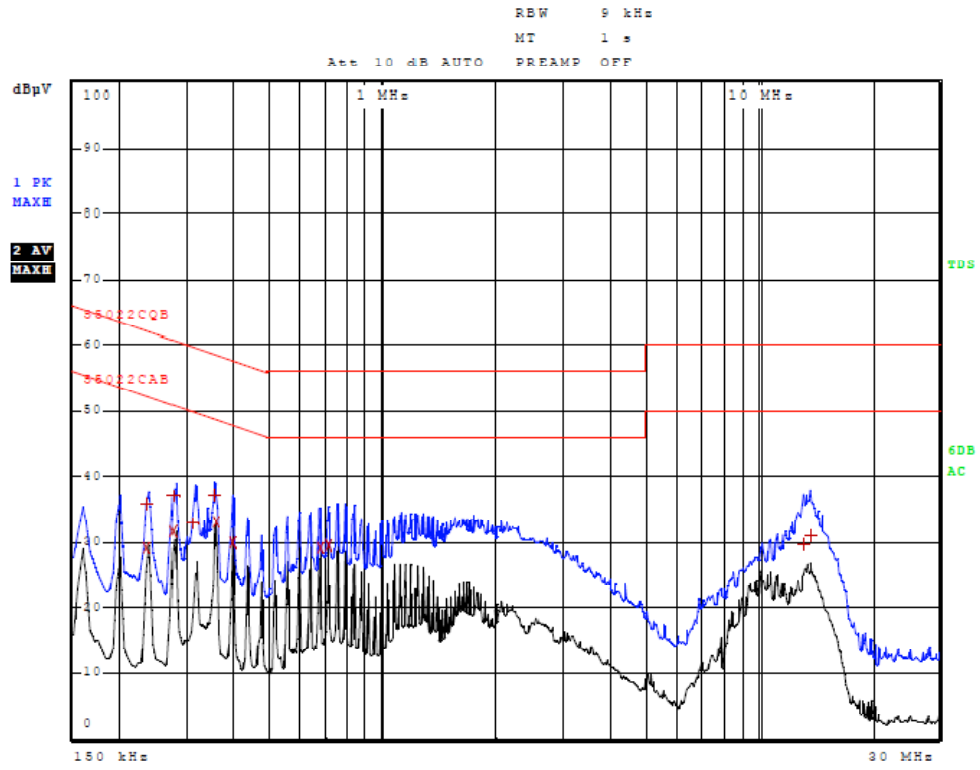



**Figure Two AC Line Conducted emissions of EUT line 2 (EUT AC Adapter)**

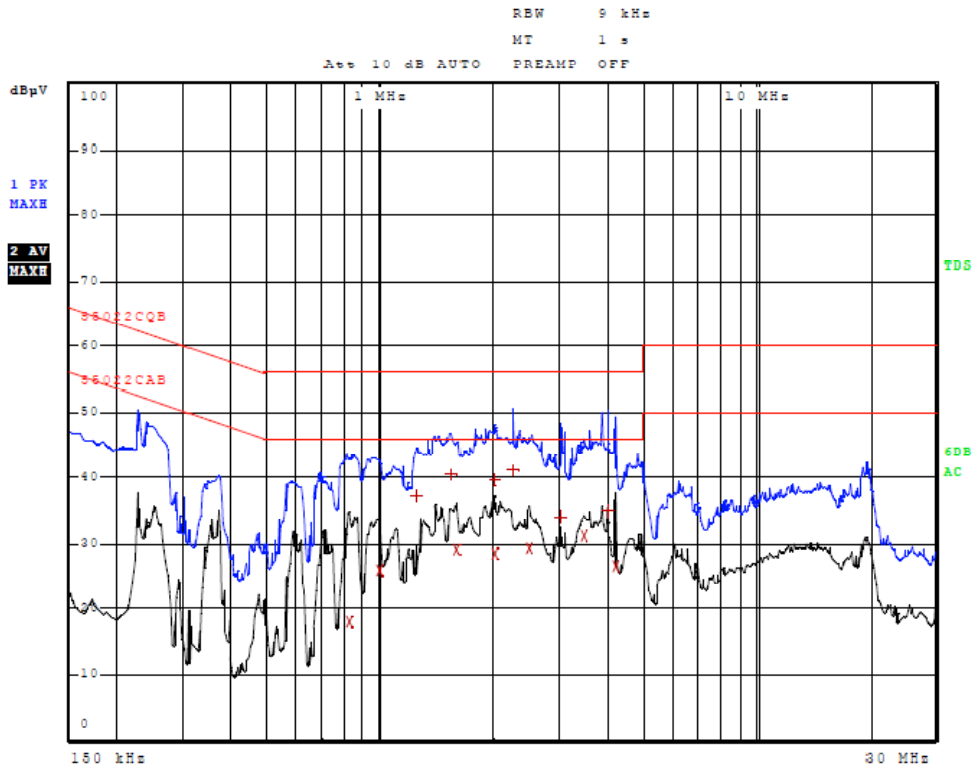



**Figure Three AC Line Conducted emissions of EUT line 1 (CPU AC Adapter / USB)**

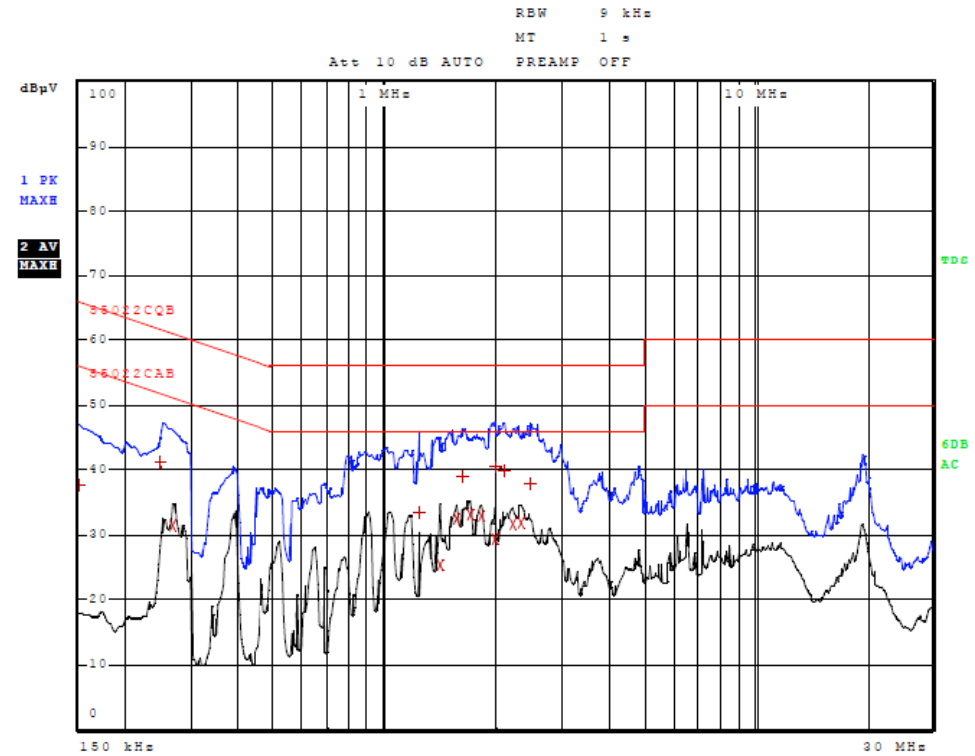



**Figure Four AC Line Conducted emissions of EUT line 2 (CPU AC Adapter / USB)**

**Data AC Line Conducted Emissions**

Line 1 (EUT AC Adapter)

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 2 | 158.000000000 kHz | 30.25 | Average | -25.32 |
| 1 | 158.000000000 kHz | 36.69 | Quasi Peak | -28.88 |
| 1 | 198.000000000 kHz | 36.41 | Quasi Peak | -27.28 |
| 2 | 198.000000000 kHz | 28.83 | Average | -24.87 |
| 2 | 238.000000000 kHz | 31.44 | Average | -20.72 |
| 2 | 278.000000000 kHz | 33.81 | Average | -17.07 |
| 2 | 318.000000000 kHz | 29.32 | Average | -20.44 |
| 1 | 318.000000000 kHz | 35.93 | Quasi Peak | -23.82 |
| 2 | 358.000000000 kHz | 33.56 | Average | -15.22 |
| 1 | 13.312000000 MHz | 32.52 | Quasi Peak | -27.48 |
| 1 | 13.712000000 MHz | 32.83 | Quasi Peak | -27.17 |
| 1 | 16.240000000 MHz | 28.33 | Quasi Peak | -31.67 |

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

Line 2 (EUT AC Adapter)

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 1 | 238.000000000 kHz | 35.77 | Quasi Peak | -26.39 |
| 2 | 238.000000000 kHz | 29.06 | Average | -23.11 |
| 2 | 278.000000000 kHz | 31.57 | Average | -19.31 |
| 1 | 278.000000000 kHz | 37.02 | Quasi Peak | -23.86 |
| 1 | 314.000000000 kHz | 32.89 | Quasi Peak | -26.97 |
| 1 | 354.000000000 kHz | 37.32 | Quasi Peak | -21.54 |
| 2 | 358.000000000 kHz | 33.14 | Average | -15.63 |
| 2 | 394.000000000 kHz | 30.02 | Average | -17.96 |
| 2 | 674.000000000 kHz | 29.13 | Average | -16.87 |
| 2 | 714.000000000 kHz | 29.50 | Average | -16.50 |
| 1 | 13.076000000 MHz | 29.72 | Quasi Peak | -30.28 |
| 1 | 13.560000000 MHz | 30.99 | Quasi Peak | -29.01 |

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

Line 1 (CPU AC Adapter / USB)

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 2 | 822.000000000 kHz | 18.05 | Average | -27.95 |
| 2 | 994.000000000 kHz | 25.98 | Average | -20.02 |
| 1 | 1.246000000 MHz | 37.34 | Quasi Peak | -18.66 |
| 1 | 1.542000000 MHz | 40.43 | Quasi Peak | -15.57 |
| 2 | 1.598000000 MHz | 29.03 | Average | -16.97 |
| 1 | 2.014000000 MHz | 39.59 | Quasi Peak | -16.41 |
| 2 | 2.014000000 MHz | 28.51 | Average | -17.49 |
| 1 | 2.242000000 MHz | 40.97 | Quasi Peak | -15.03 |
| 2 | 2.482000000 MHz | 29.23 | Average | -16.77 |
| 1 | 3.026000000 MHz | 34.13 | Quasi Peak | -21.87 |
| 2 | 3.510000000 MHz | 31.27 | Average | -14.73 |
| 1 | 4.010000000 MHz | 35.03 | Quasi Peak | -20.97 |
| 2 | 4.206000000 MHz | 26.52 | Average | -19.48 |

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

Line 2 (CPU AC Adapter / USB)

| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|---|---|---|---|---|
| 1 | 150.000000000 kHz | 37.63 | Quasi Peak | -28.37 |
| 1 | 250.000000000 kHz | 41.23 | Quasi Peak | -20.52 |
| 2 | 266.000000000 kHz | 31.43 | Average | -19.82 |
| 1 | 1.242000000 MHz | 33.46 | Quasi Peak | -22.54 |
| 2 | 1.402000000 MHz | 25.31 | Average | -20.69 |
| 2 | 1.558000000 MHz | 32.37 | Average | -13.63 |
| 1 | 1.610000000 MHz | 38.99 | Quasi Peak | -17.01 |
| 2 | 1.690000000 MHz | 33.16 | Average | -12.84 |
| 2 | 1.814000000 MHz | 32.98 | Average | -13.02 |
| 2 | 1.974000000 MHz | 29.21 | Average | -16.79 |
| 1 | 1.978000000 MHz | 40.50 | Quasi Peak | -15.50 |
| 1 | 2.102000000 MHz | 39.73 | Quasi Peak | -16.27 |
| 2 | 2.202000000 MHz | 31.65 | Average | -14.35 |
| 2 | 2.330000000 MHz | 31.77 | Average | -14.23 |
| 1 | 2.474000000 MHz | 37.94 | Quasi Peak | -18.06 |

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 AC Line Conducted Emissions requirements of CFR 47 Part 15B, RSS-GEN, and other applicable standards. The EUT worst-case configuration demonstrated a minimum margin of -12.8 dB below the limit. Other emissions were present with amplitudes at least 20 dB below the limit and worst-case amplitudes recorded.

### *Radiated EMI*

The EUT was arranged in typical equipment configurations and operated through all various modes. Preliminary testing was performed in a screen room with the EUT positioned 1 meter from the FSM. Radiated emissions measurements were performed to identify the frequencies, which produced the highest emissions. Plots were made of the worst-case radiated frequency spectrum from 30 MHz to 25,000 MHz for the preliminary testing. Refer to figures five through eleven showing plots of the worst-case radiated emissions spectrum taken in the screen room. Each radiated emission was then re-maximized at the OATS location before final radiated emissions measurements were performed. Final data was taken with the EUT located at the OATS at a distance of 3 meters between the EUT and the receiving antenna. The frequency spectrum from 30 MHz to 25,000 MHz was searched for radiated emissions. Measured emission levels were maximized by EUT placement on the table, rotating the turntable through 360 degrees, varying the antenna height between 1 and 4 meters above the ground plane and changing antenna position between horizontal and vertical polarization. Antennas used were Biconical, Broadband Biconilog, Log Periodic, and Double Ridge or Pyramidal Horns, notch filters and appropriate amplifiers were utilized.

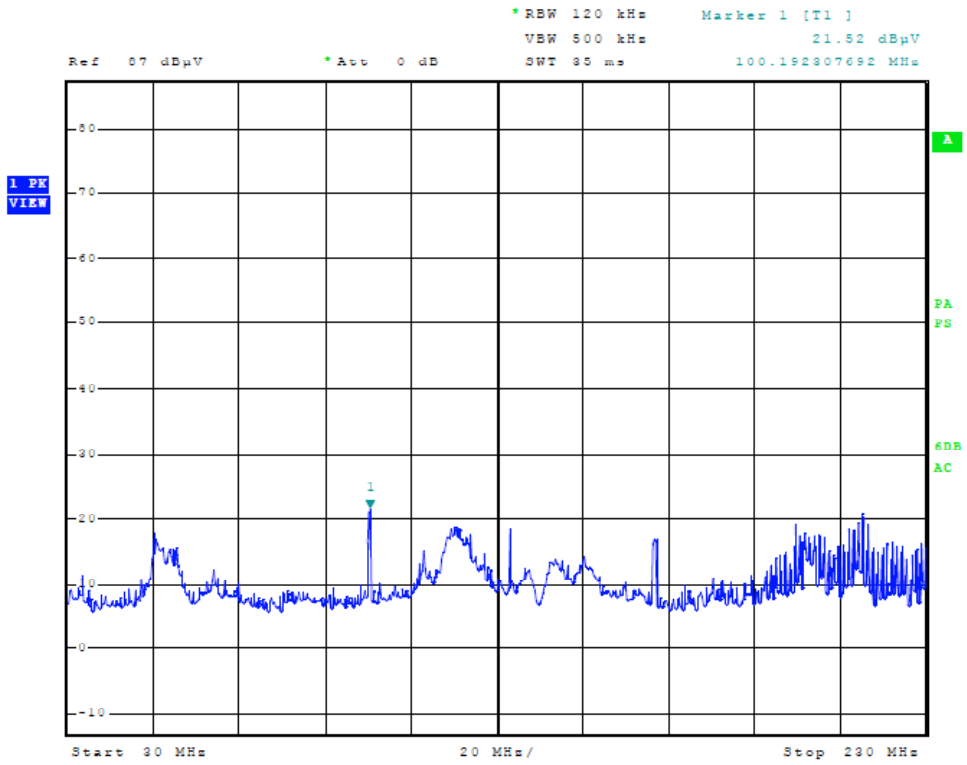



**Figure Five Plot of General Radiated Emissions (EUT CLA)**

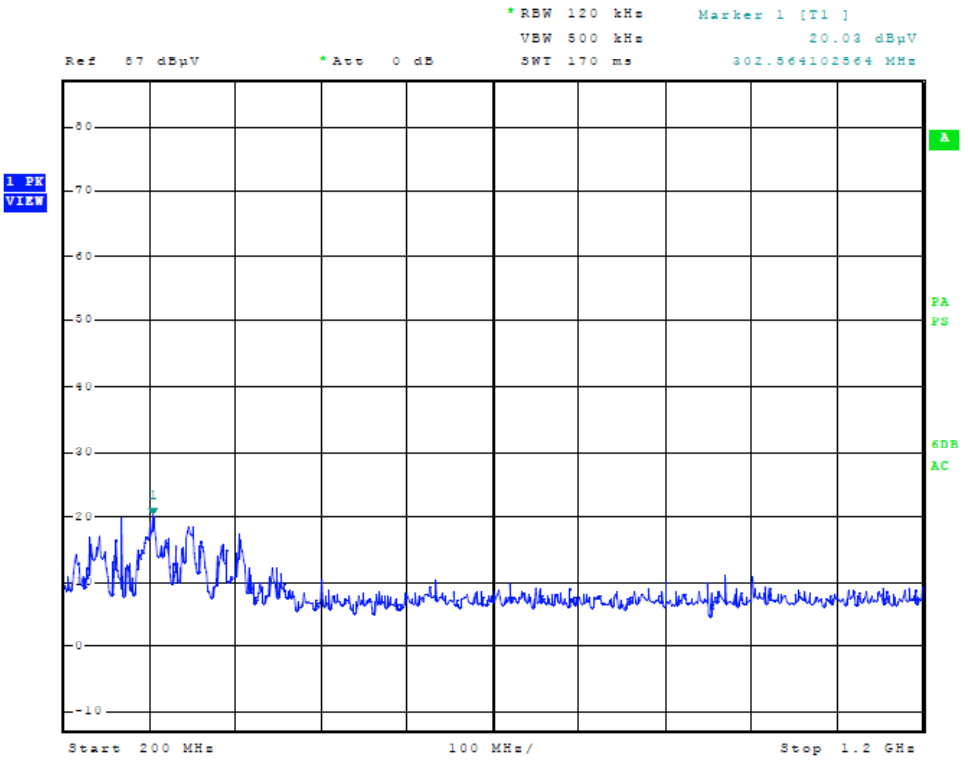



**Figure Six Plot of General Radiated Emissions (EUT CLA)**

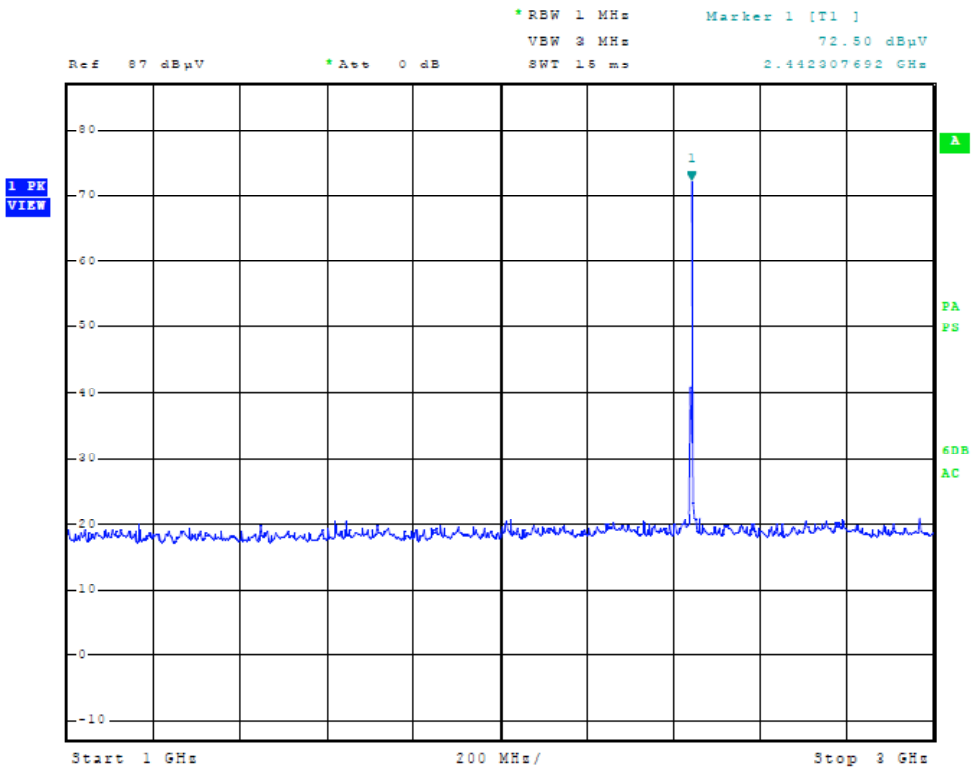



**Figure Seven Plot of General Radiated Emissions (EUT CLA)**

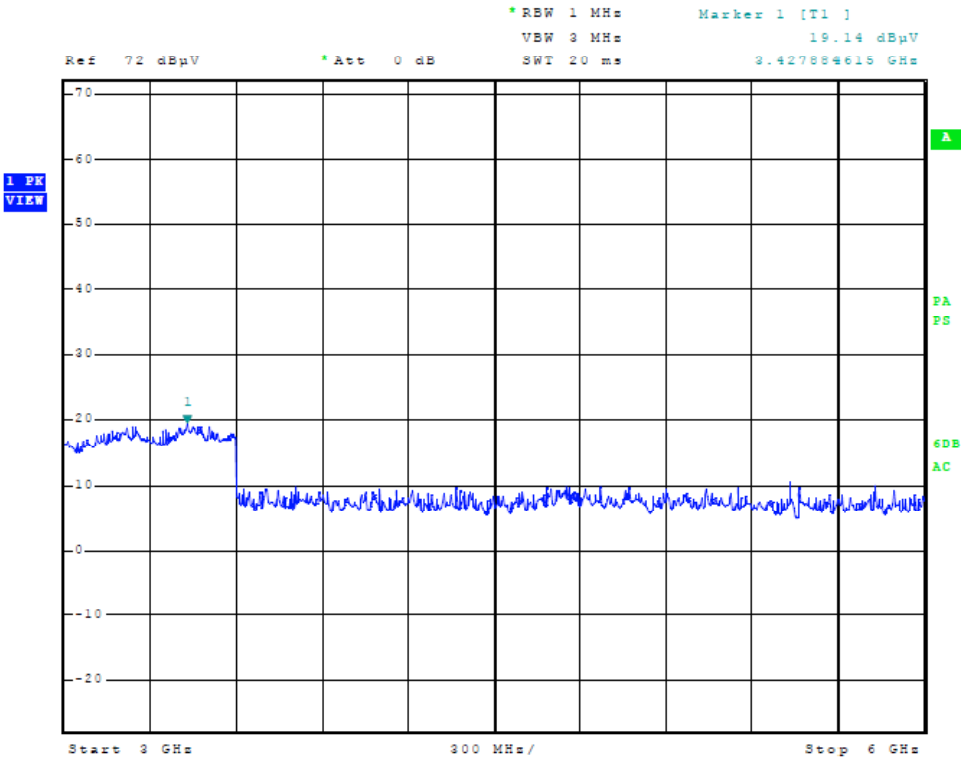



**Figure Eight Plot of General Radiated Emissions (EUT CLA)**

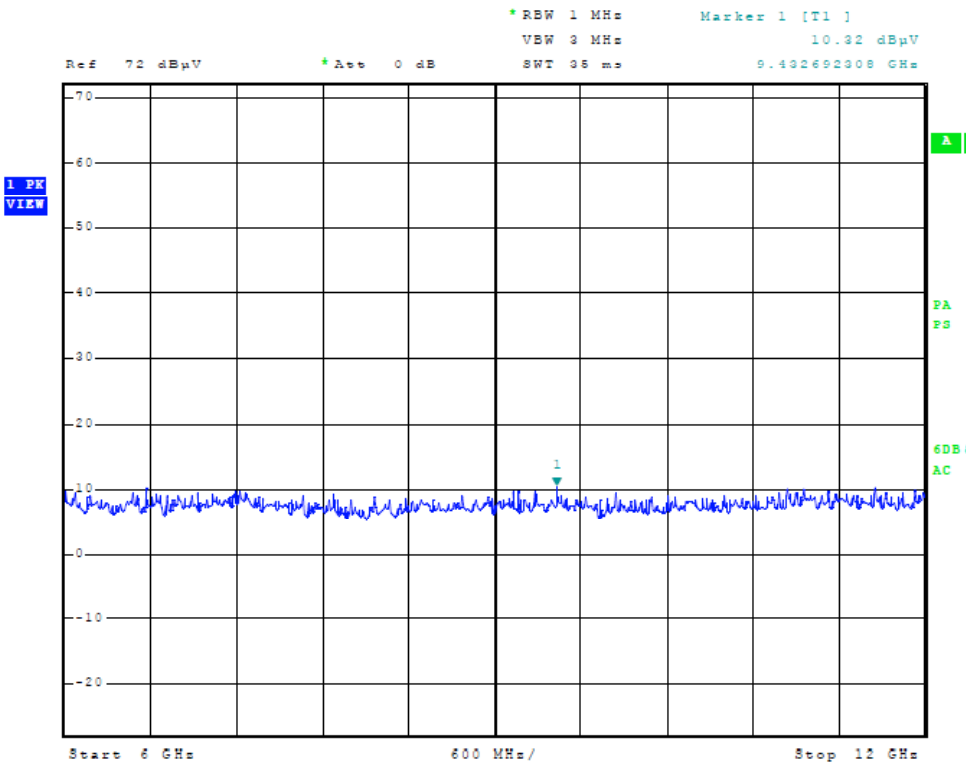



**Figure Nine Plot of General Radiated Emissions (EUT CLA)**

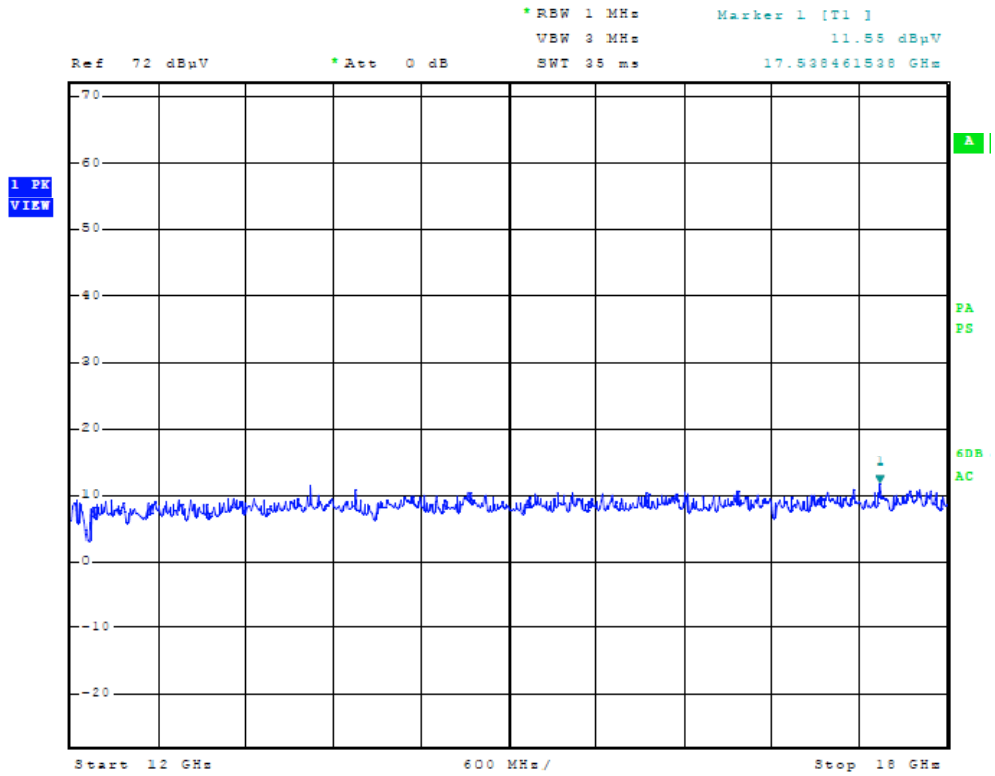



**Figure Ten Plot of General Radiated Emissions (EUT CLA)**

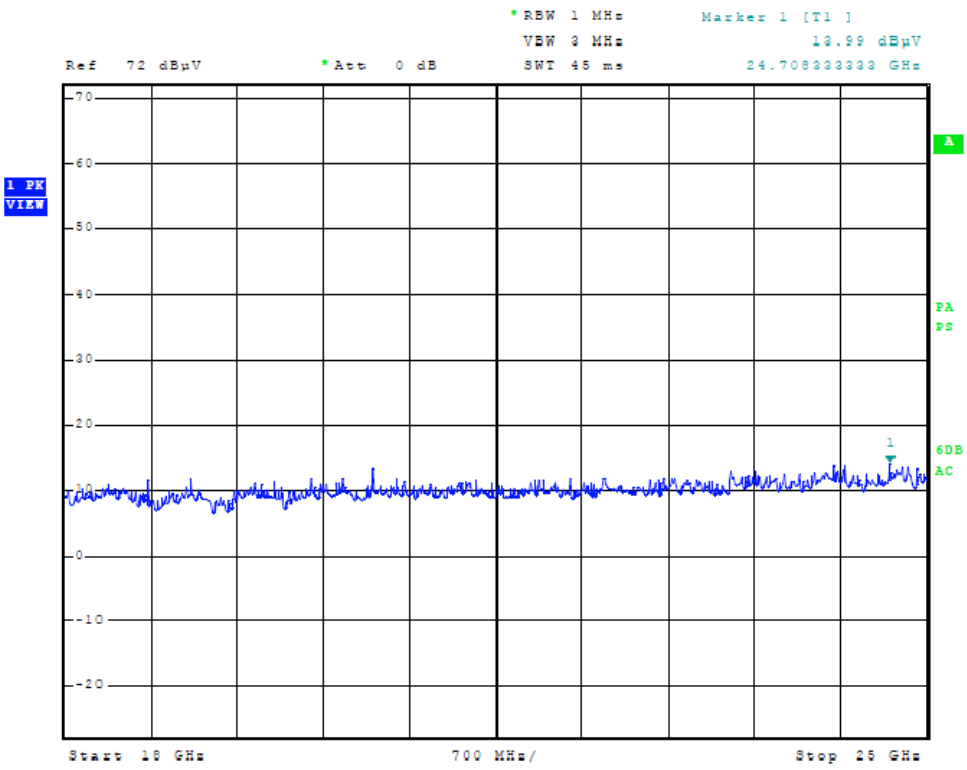



**Figure Eleven Plot of General Radiated Emissions (EUT CLA)**

### *General Radiated Emissions Data from EUT*

| Frequency in MHz | FSM Horz. (dBµV) | FSM Vert. (dBµV) | A.F. (dB/m) | Amp. Gain (dB) | RFS Horz. @ 3m (dBµV/m) | RFS Vert. @ 3m (dBµV/m) | Limit @ 3m (dBµV/m) |
|---|---|---|---|---|---|---|---|
| 99.8 | 48.6 | 42.5 | 10.3 | 30 | 28.9 | 22.8 | 43.5 |
| 150.0 | 38.4 | 30.9 | 13.0 | 30 | 21.4 | 13.9 | 43.5 |
| 193.3 | 33.5 | 29.2 | 12.2 | 30 | 15.7 | 11.4 | 43.5 |
| 303.8 | 43.6 | 42.1 | 14.1 | 30 | 27.7 | 26.2 | 46.0 |
| 304.7 | 45.3 | 41.0 | 14.1 | 30 | 29.4 | 25.1 | 46.0 |

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*

The EUT demonstrated compliance with requirements of CFR47, and Industry Canada requirements. The EUT demonstrated a minimum margin of -14.6 dB below requirements. Other emissions were present with amplitudes at least 20 dB below the limit.

# Intentional Radiators Emissions

As per CFR47 Part 15, Subpart C, paragraphs 15.203, 15.205, 15.209, 15.249 and RSS-210 the following information is submitted.

## *Antenna Requirements*

The unit is produced with a permanently attached transmitter antenna and has no provision for user service, replacement, or antenna modification. The requirements for unique antenna 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 at the OATS. The EUT utilizes frequency, determining circuitry, which generates harmonics falling in the restricted bands. Emissions were checked at the OATS, using appropriate antennas or pyramidal horns, amplification stages, and a spectrum analyzer. No other significant emission was observed which fell into the restricted bands of operation.

Sample Calculation:

RFS (dBμV/m @ 3m)= FSM (dBμV) + Antenna Factor (dB/m) - Amplifier Gain (dB)

**Radiated Emissions Data in Restricted Bands**

| Frequency in MHz | Horizontal Peak (dBµV) | Horizontal Quasi-Peak (dBµV) | Horizontal Average (dBµV) | Vertical Peak (dBµV) | Vertical Quasi-Peak (dBµV) | Vertical Average (dBµV) | Limit @ 3m (dBµV/m) |
|---|---|---|---|---|---|---|---|
| 150.0 | 25.1 | 21.4 | N/A | 21.1 | 13.9 | N/A | 43.5 |
| 2390.0 | 35.8 | N/A | 23.9 | 36.1 | N/A | 23.9 | 54.0 |
| 2483.5 | 46.0 | N/A | 33.2 | 52.8 | N/A | 33.6 | 54.0 |
| 4804.0 | 50.3 | N/A | 37.3 | 49.6 | N/A | 37.1 | 54.0 |
| 4882.0 | 48.4 | N/A | 35.6 | 47.9 | N/A | 35.6 | 54.0 |
| 4960.0 | 48.4 | N/A | 36.1 | 48.6 | N/A | 36.2 | 54.0 |
| 7206.0 | 46.8 | N/A | 33.7 | 45.7 | N/A | 33.5 | 54.0 |
| 7323.0 | 45.3 | N/A | 32.7 | 45.8 | N/A | 32.9 | 54.0 |
| 7440.0 | 45.9 | N/A | 32.3 | 45.1 | N/A | 32.3 | 54.0 |
| 12010.0 | 49.8 | N/A | 36.4 | 49.4 | N/A | 36.5 | 54.0 |
| 12205.0 | 47.8 | N/A | 35.2 | 48.4 | N/A | 35.0 | 54.0 |
| 12400.0 | 48.1 | N/A | 35.5 | 48.0 | N/A | 35.3 | 54.0 |

Other emissions present had amplitudes at least 20 dB below the limit.
Peak and Quasi-Peak amplitude emissions are recorded above for frequency range of 30-1000 MHz. Peak and 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 requirements of CFR47 15C, and Industry Canada RSS-210 requirements. The EUT demonstrated a minimum margin of -16.7 dB below requirements. Peak and Quasi-peak amplitudes of frequencies below 1000 MHz were measured and average and peak amplitudes of frequencies above 1000 MHz were measured for demonstration of compliance with the regulations. No other significant emissions where found in the restricted frequency bands. Other emissions were present with amplitudes at least 20 dB below the FCC Limits.

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

The power output was measured on an Open Area Test Site at a 3 meters distance. The EUT was placed on a wooden turntable 0.8 meters above the ground plane at a distance of 3 meters from the FSM antenna. The peak and average amplitude of emissions above 1000 MHz including spurious emissions were measured using a spectrum analyzer/receiver. Data was then recorded from the analyzer display. Emissions radiated outside of the specified bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in 15.209 (and/or RSS-210), whichever is the lesser attenuation. The amplitude of each emission was maximized by varying the FSM antenna height, polarization, and by rotating the turntable. Antennas used were Biconical, Broadband Biconilog, Log Periodic, and Double Ridge or Pyramidal Horns, notch filters and appropriate amplifiers. Emissions were measured in dBµV/m @ 3 meters. Refer to figures twelve through twenty-three showing the frequency and amplitude of emission displayed on the spectrum analyzer measured at the temporary test antenna port (performed on sample #2).

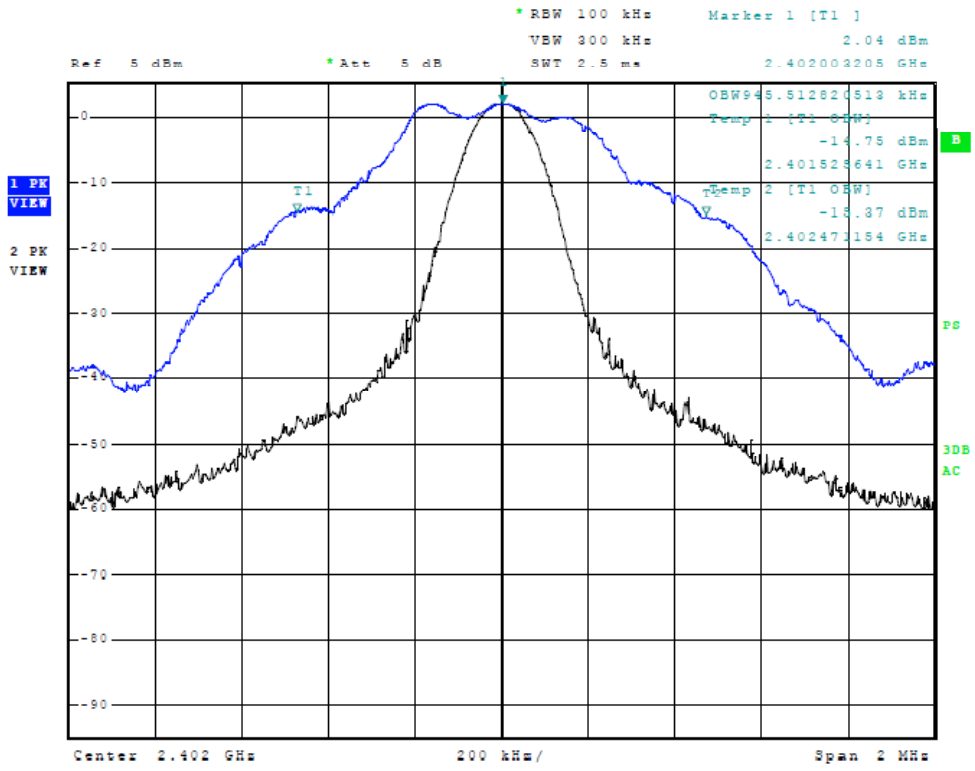



**Figure Twelve Plot of Occupied Bandwidth (Low channel)**

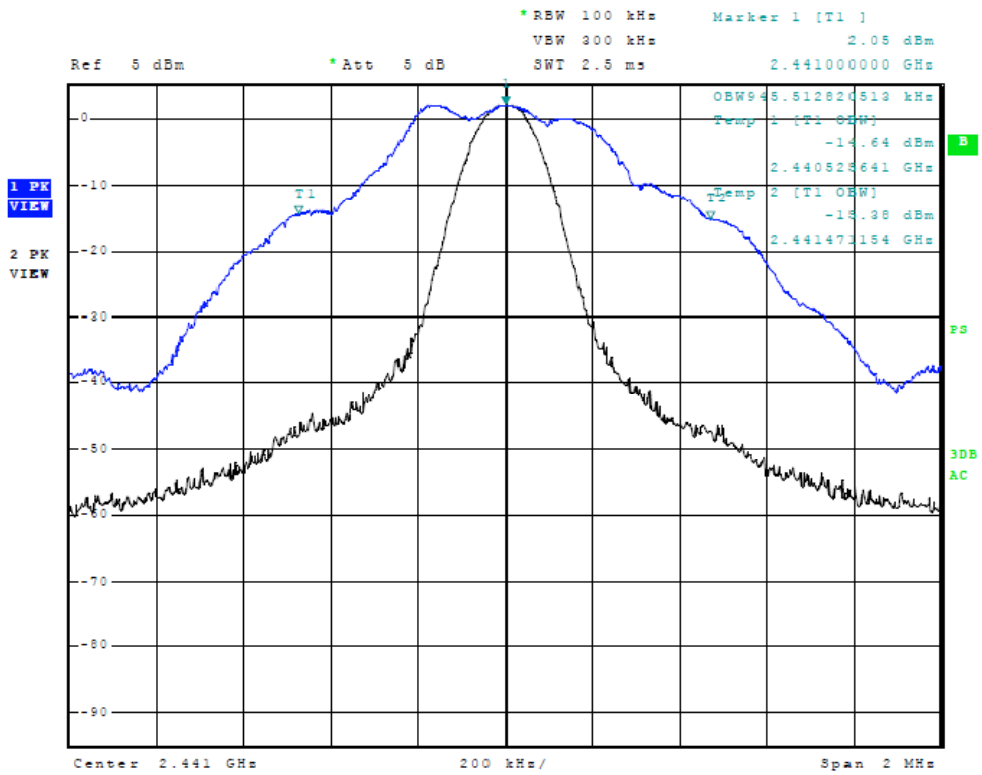



**Figure Thirteen Plot of Occupied Bandwidth (Middle channel)**

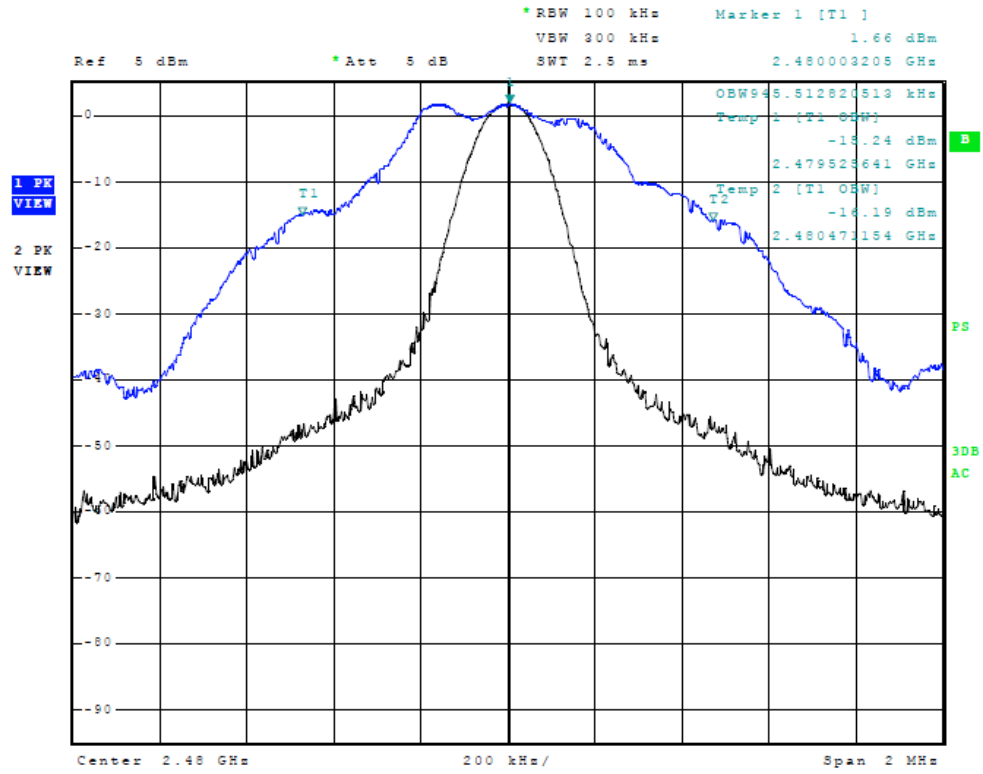



**Figure Fourteen Plot of Occupied Bandwidth (High channel)**

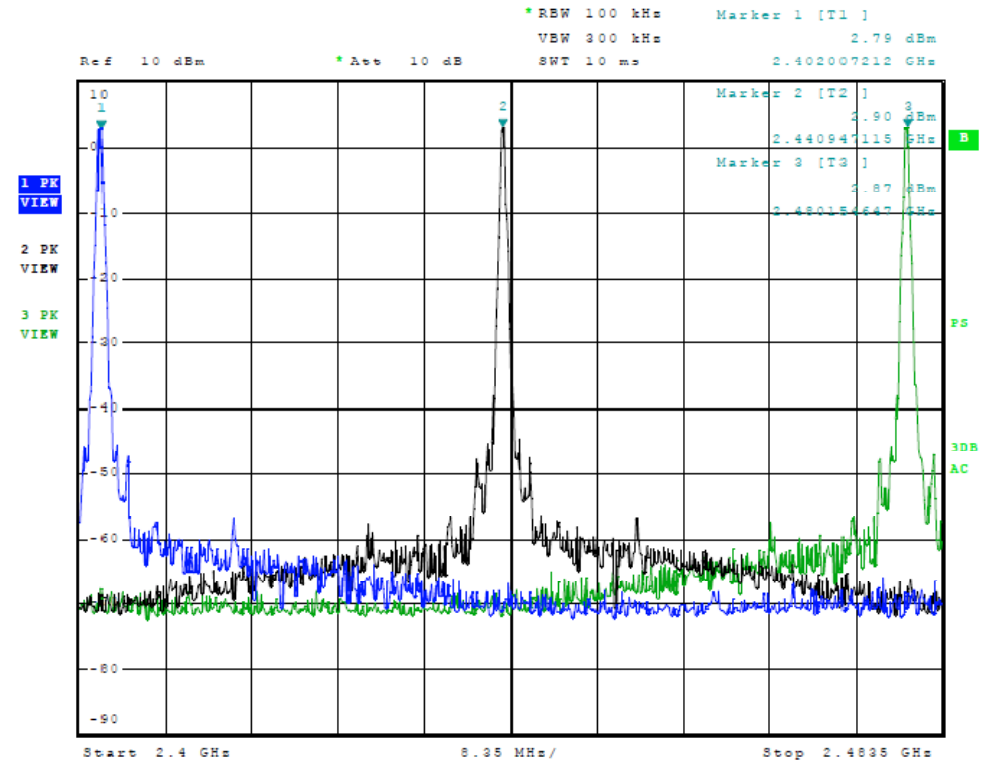



**Figure Fifteen Plot of Operation across frequency band**

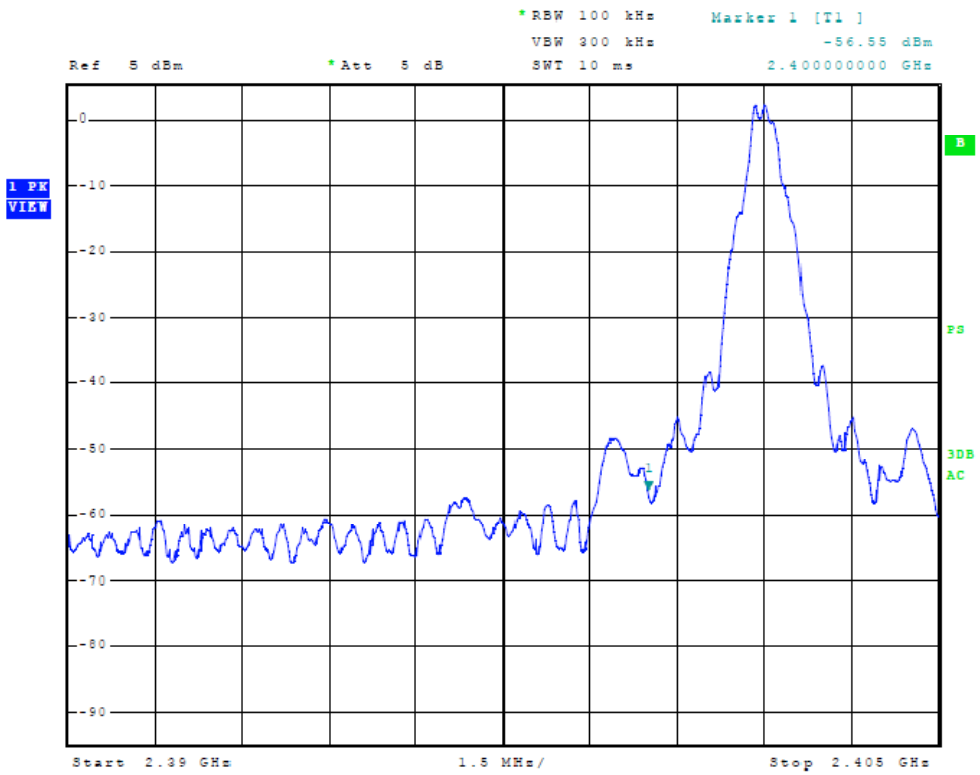



**Figure Sixteen Plot of Lower Frequency Band Edge**

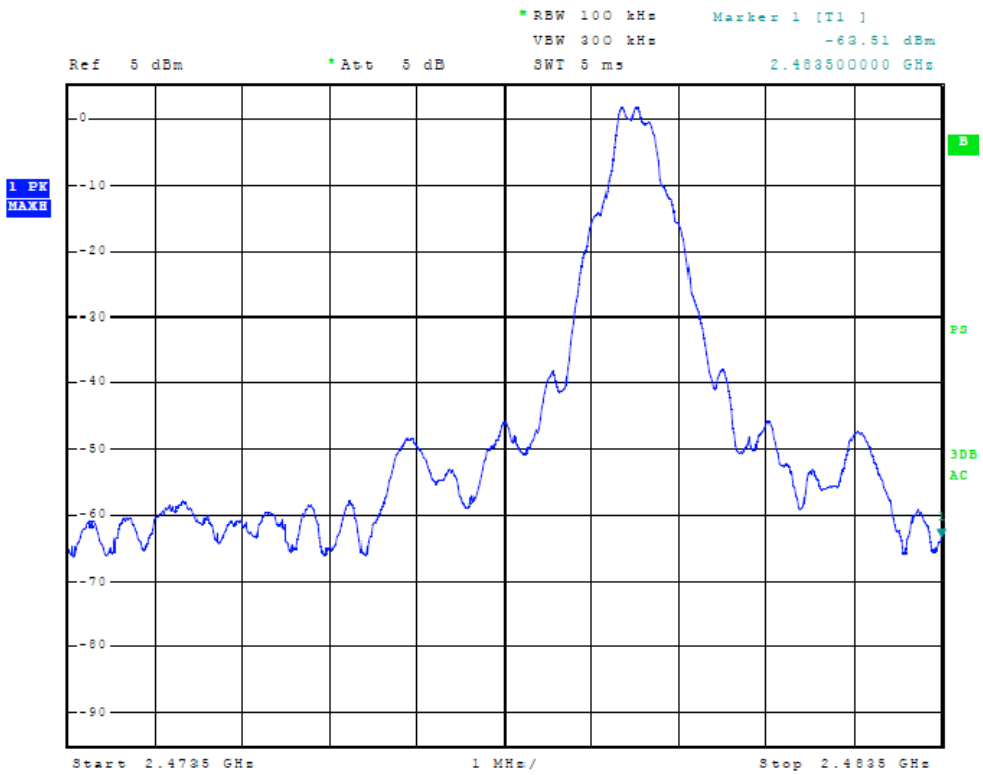



**Figure Seventeen Plot of Higher Frequency Band Edge**

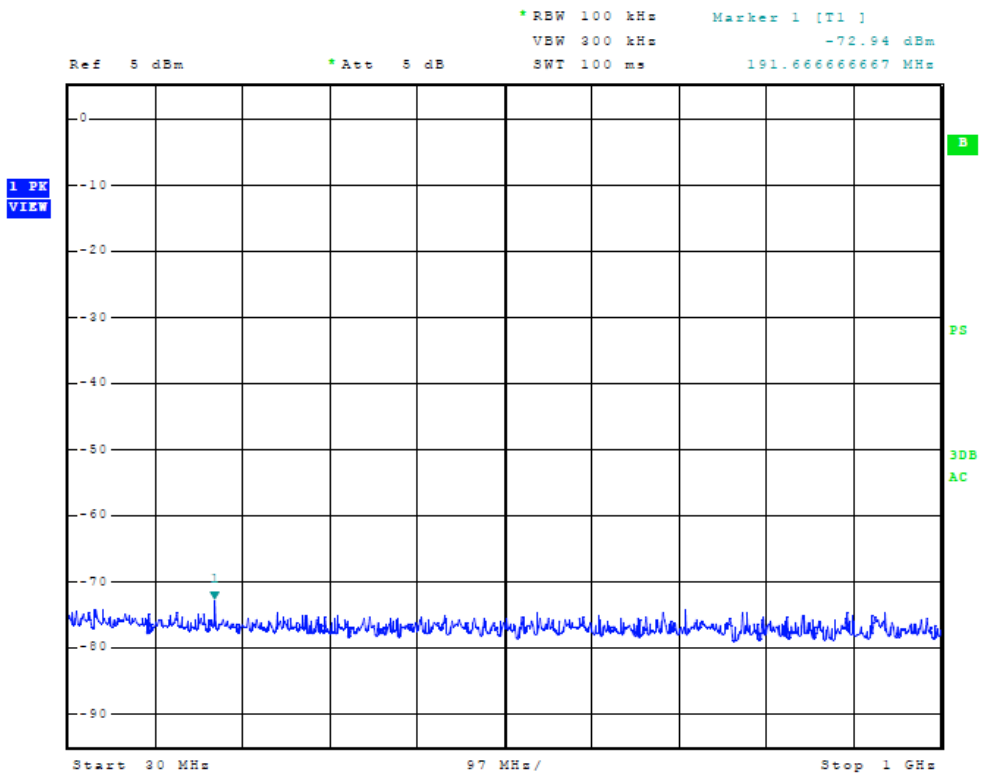



**Figure Eighteen Plot of Frequency Spectrum at Temporary Antenna Port**

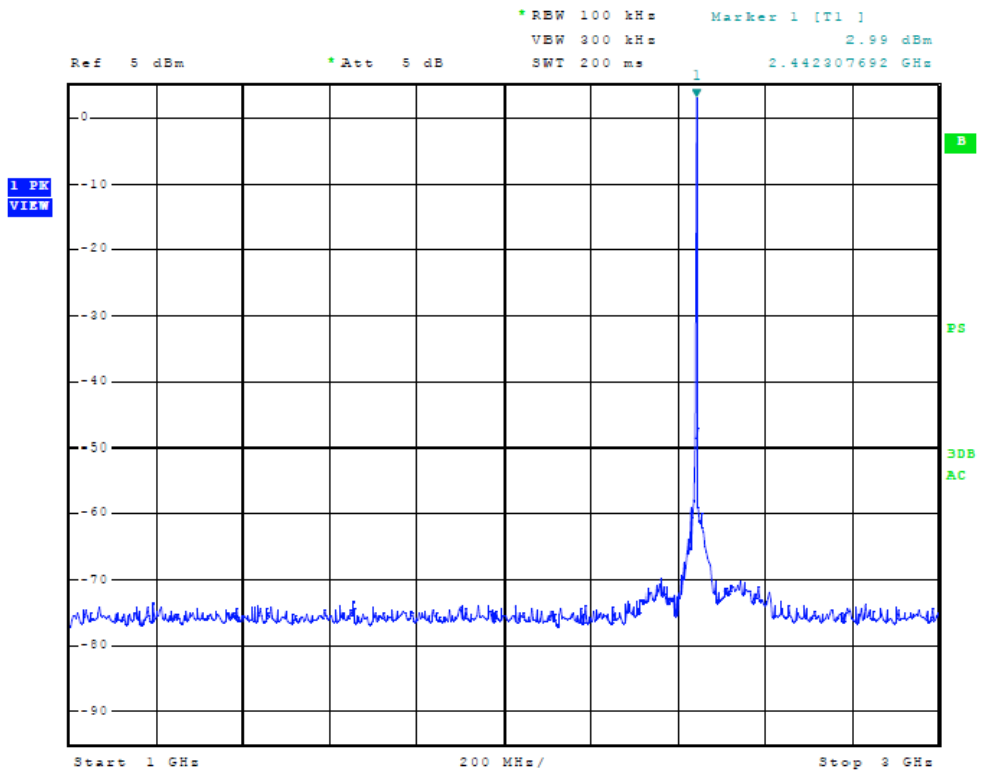



**Figure Nineteen Plot of Frequency Spectrum at Temporary Antenna Port**

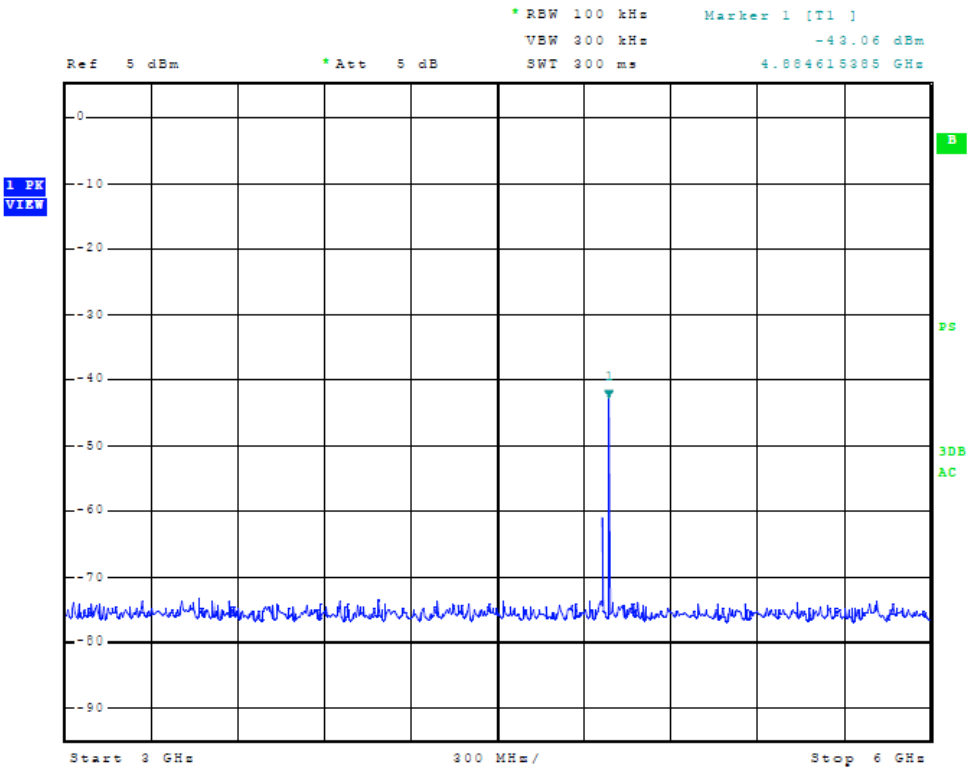



**Figure Twenty Plot of Frequency Spectrum at Temporary Antenna Port**

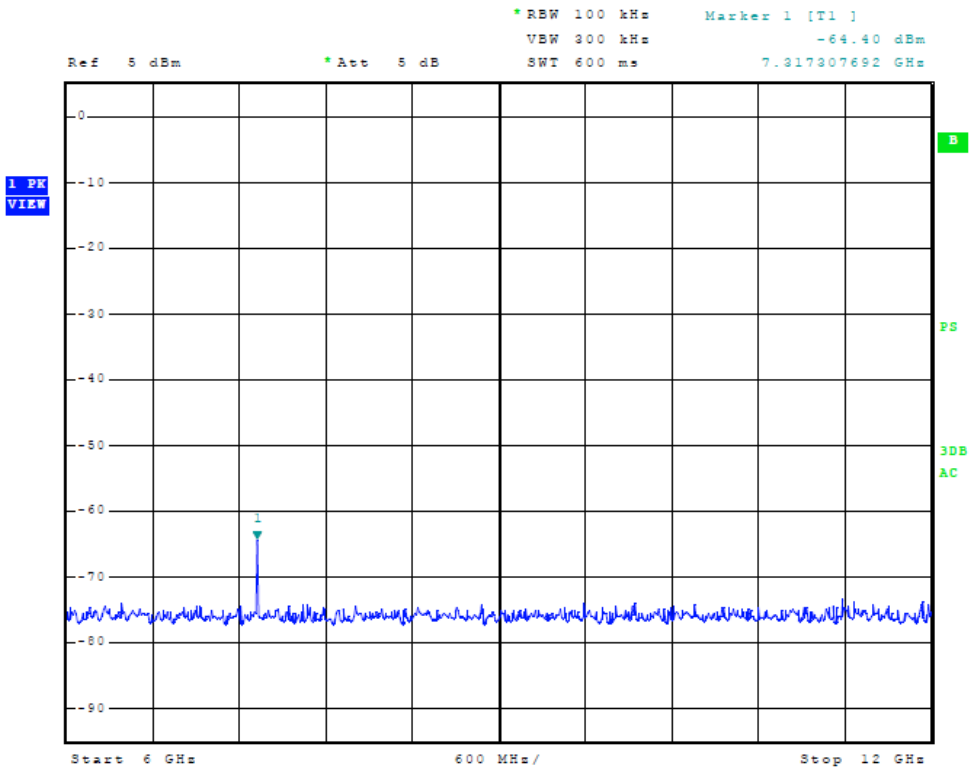



**Figure Twenty-One Plot of Frequency Spectrum at Temporary Antenna Port**

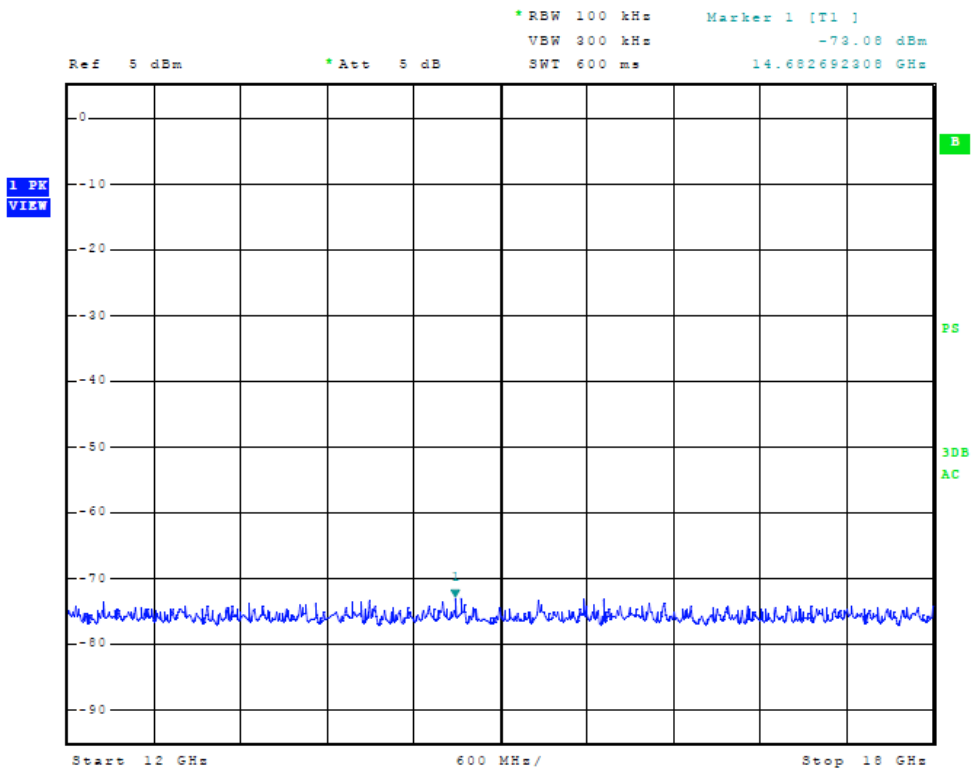



**Figure Twenty-Two Plot of Frequency Spectrum at Temporary Antenna Port**

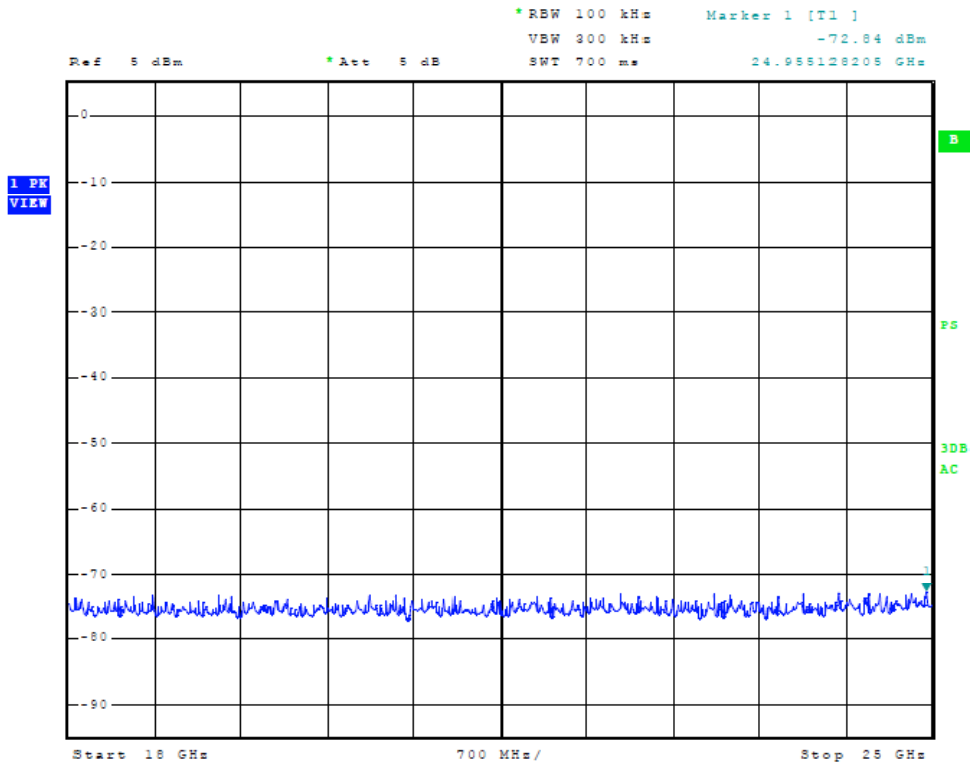



**Figure Twenty-Three Plot of Frequency Spectrum at Temporary Antenna Port**

## *Transmitter Emissions Data*

### Transmitter Antenna Port Conducted Emissions Data

| Frequency MHz | Antenna Conducted Output Power dBm | Occupied Bandwidth kHz |
|---|---|---|
| 2402.0 | 2.79 | 945.51 |
| 2441.0 | 2.90 | 945.51 |
| 2480.0 | 2.87 | 945.51 |

### Transmitter Radiated Emissions

| Frequency | FSM Hor Peak | FSM Hor Ave | FSM Vert Peak | FSM Vert Ave | AF | Amp Gain | RFS @ 3 m Hor Peak | RFS @ 3 m Hor Ave | RFS @ 3 m Vert Peak | RFS @ 3 m Vert Ave | Ave Limit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2402.0 | 94.5 | 76.9 | 94.5 | 78.8 | 30.6 | 25 | 100.1 | 82.5 | 100.1 | 84.4 | 94.0 |
| 4804.0 | 42.4 | 29.4 | 41.7 | 29.2 | 32.9 | 25 | 50.3 | 37.3 | 49.6 | 37.1 | 54.0 |
| 7206.0 | 35.8 | 22.7 | 34.7 | 22.5 | 36.0 | 25 | 46.8 | 33.7 | 45.7 | 33.5 | 54.0 |
| 9608.0 | 37.3 | 24.5 | 37.2 | 24.5 | 38.1 | 25 | 50.4 | 37.6 | 50.3 | 37.6 | 54.0 |
| 12010.0 | 34.8 | 21.4 | 34.4 | 21.5 | 40.0 | 25 | 49.8 | 36.4 | 49.4 | 36.5 | 54.0 |
| 2441.0 | 94.9 | 76.3 | 92.1 | 74.9 | 30.9 | 25 | 100.8 | 82.2 | 98.0 | 80.8 | 94.0 |
| 4882.0 | 42.0 | 29.2 | 41.5 | 29.2 | 31.4 | 25 | 48.4 | 35.6 | 47.9 | 35.6 | 54.0 |
| 7323.0 | 33.6 | 21.0 | 34.1 | 21.2 | 36.7 | 25 | 45.3 | 32.7 | 45.8 | 32.9 | 54.0 |
| 9764.0 | 36.3 | 23.7 | 35.3 | 23.4 | 38.4 | 25 | 49.7 | 37.1 | 48.7 | 36.8 | 54.0 |
| 12205.0 | 32.8 | 20.2 | 33.4 | 20.0 | 40.0 | 25 | 47.8 | 35.2 | 48.4 | 35.0 | 54.0 |
| 2480.0 | 92.3 | 74.6 | 92.3 | 74.3 | 31.4 | 25 | 98.7 | 81.0 | 98.7 | 80.7 | 94.0 |
| 4960.0 | 40.5 | 28.2 | 40.7 | 28.3 | 32.9 | 25 | 48.4 | 36.1 | 48.6 | 36.2 | 54.0 |
| 7440.0 | 34.2 | 20.6 | 33.4 | 20.6 | 36.7 | 25 | 45.9 | 32.3 | 45.1 | 32.3 | 54.0 |
| 9920.0 | 36.6 | 24.2 | 36.5 | 24.1 | 38.4 | 25 | 50.0 | 37.6 | 49.9 | 37.5 | 54.0 |
| 12400.0 | 32.3 | 19.7 | 32.2 | 19.5 | 40.8 | 25 | 48.1 | 35.5 | 48.0 | 35.3 | 54.0 |

Other emissions present had amplitudes at least 20 dB below the margin.
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.
Note: Levels measured @ 3-meter OATS site.

***Summary of Results for Transmitter Radiated Emissions***

The EUT demonstrated compliance with the requirements and specifications of CFR47 Part 15.249 and RSS-210 Intentional Radiators. The EUT demonstrated highest peak emission level of the fundamental of 100.8 dBµV/m, and average emission of 84.4 dBµV/m with a minimum margin of -9.6 dB, as measured at 3 meters. The EUT demonstrated a minimum margin of -10.4 dB below limits for the harmonic emissions. There were no other measurable emissions greater than 20 dB below requirements than those recorded in this report. There are no deviations or exceptions to the requirements.

## Receiver Spurious Emissions

Receivers which provide terminals for the connection of an external receiving antenna may be tested to demonstrate compliance with the antenna terminals shielded and terminated with a termination equal to the impedance specified for the antenna, provided these receivers also comply with the following: With the receiver antenna terminal connected to a resistive termination equal to the impedance specified or employed for the antenna, the power at the antenna terminal at any frequency within the range of measurements specified shall not exceed 2.0 nanowatts (-57 dBm). The EUT incorporates an integral antenna system in production equipment. A test sample was offered allowing connection to antenna port for antenna conducted emissions testing. The test antenna port was connected to a spectrum analyzer for testing the antenna-conducted emissions. Antenna port conduction testing was performed at temporary antenna test port connected to the spectrum analyzer through a short coaxial cable. The spectrum analyzer provided the 50-ohm load equivalent to the antenna. The frequency spectrum was investigated at the antenna port with the worst case data presented. Refer to figures twenty-four through twenty-nine showing the spectrum analyzer display of worst-case receiver antenna conduction emissions. Worst-case antenna port conducted emissions data presented. Worst-case (production design sample) receiver radiated emissions were tested at 3 meter OATS. Data presented below demonstrates compliance with regulations.

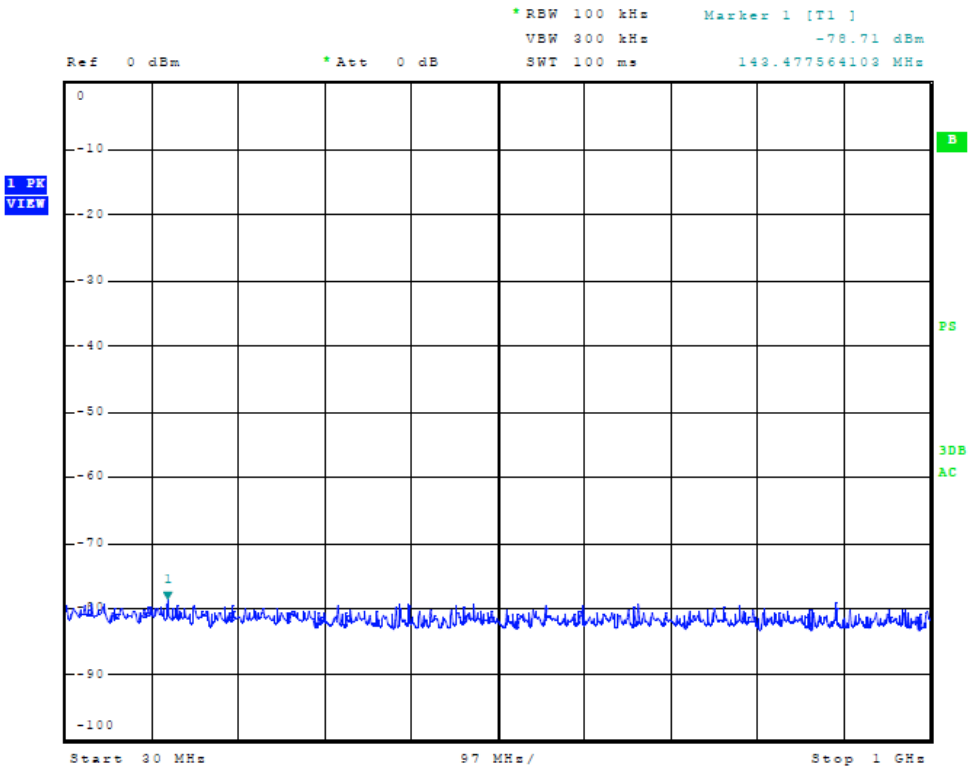



**Figure Twenty-Four Receiver Temporary Antenna Port Conducted Emissions**

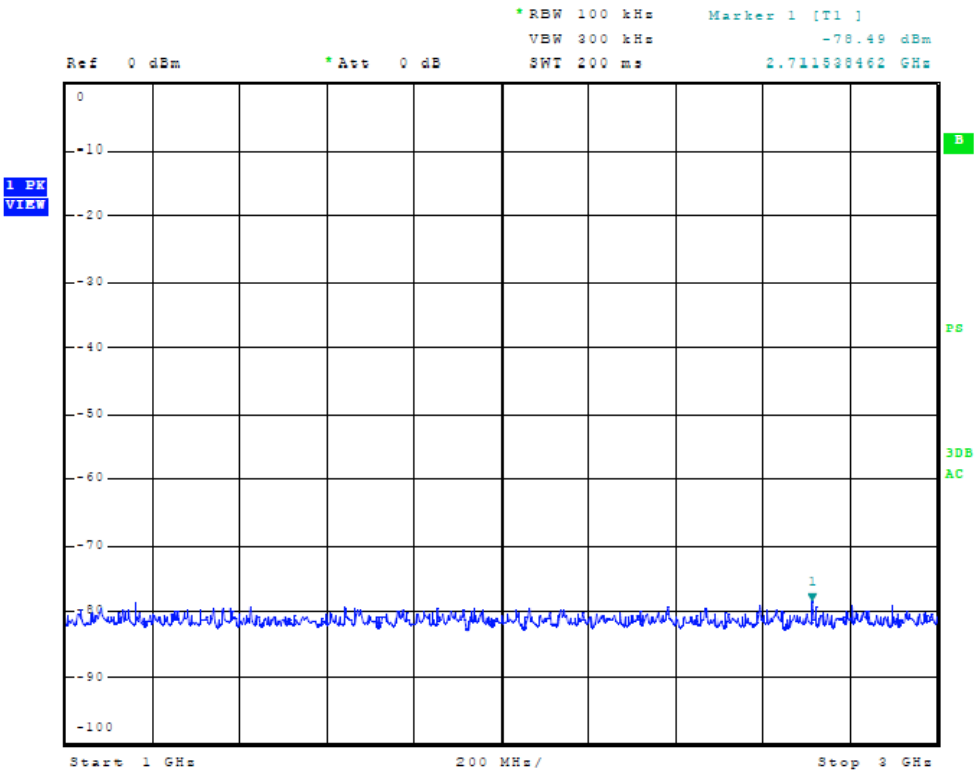



**Figure Twenty-Five Receiver Temporary Antenna Port Conducted Emissions**

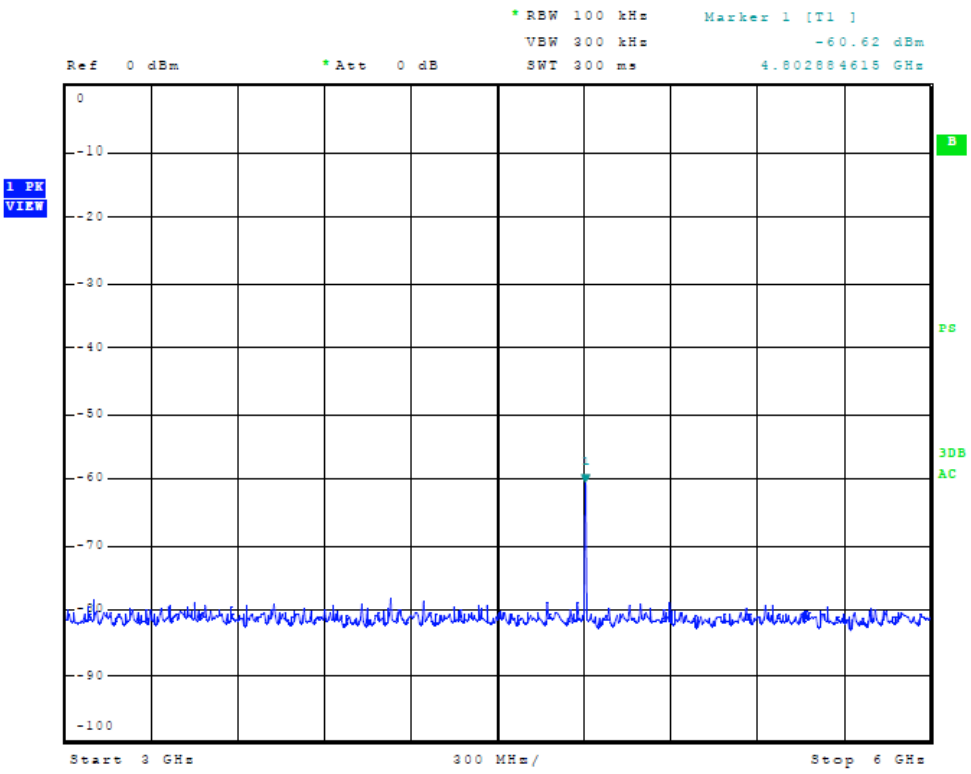



**Figure Twenty-Six Receiver Temporary Antenna Port Conducted Emissions**

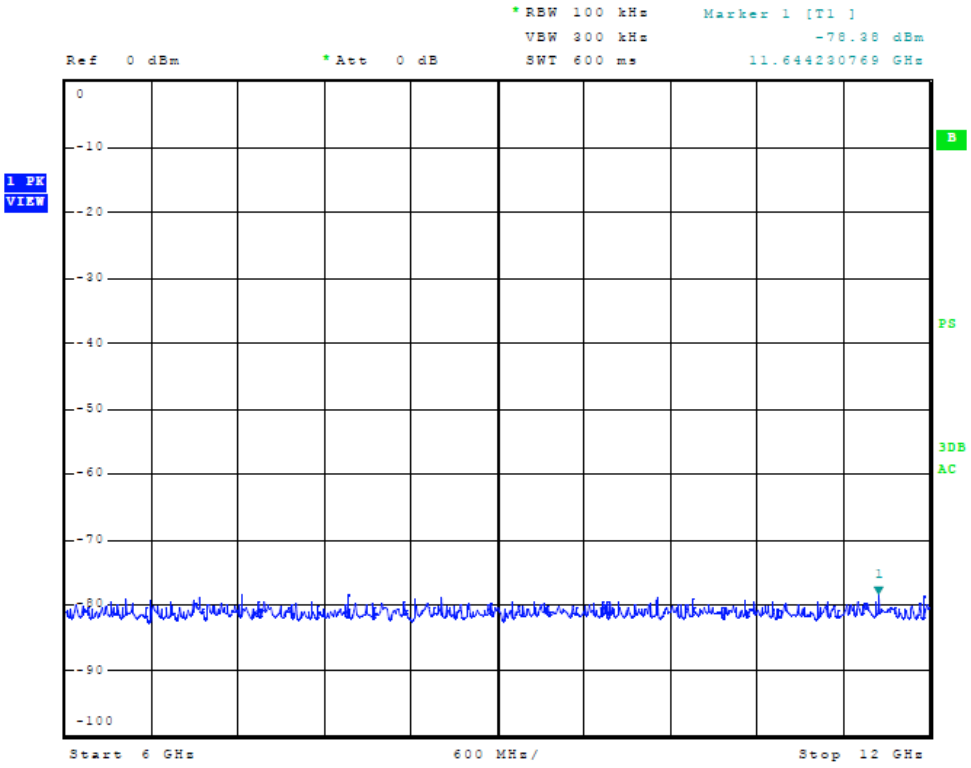



**Figure Twenty-Seven Receiver Temporary Antenna Port Conducted Emissions**

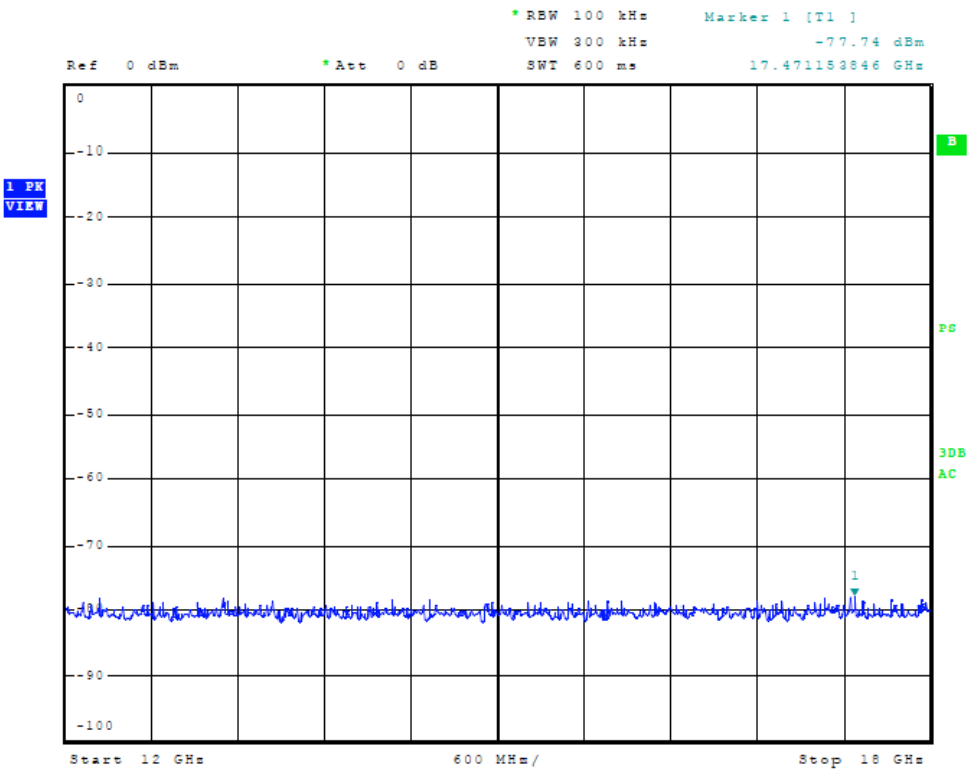



**Figure Twenty-Eight Receiver Temporary Antenna Port Conducted Emissions**

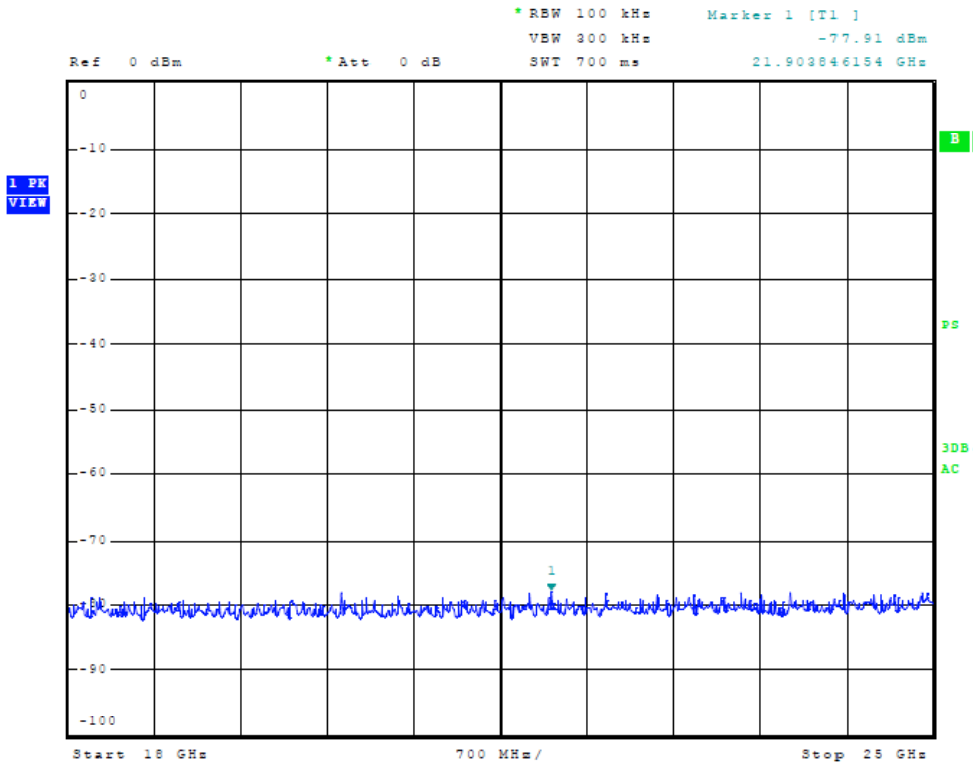



**Figure Twenty-Nine Receiver Temporary Antenna Port Conducted Emissions**

### *Receiver Antenna Conducted Emissions Data (Sample 2 temporary antenna port)*

| Frequency (MHz) | Emission Level (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|
| 4802.8 | -60.62 | -57.0 | -3.6 |
| 9605.6 | -80.07 | -57.0 | -23.1 |
| 14408.4 | -84.93 | -57.0 | -27.9 |
| 19211.2 | -83.73 | -57.0 | -26.7 |
| 24014.0 | -84.74 | -57.0 | -27.7 |
| 28816.8 | -86.70 | -57.0 | -29.7 |

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

### *Receiver Radiated Emissions Data*

| Frequency | FSM Hor Peak | FSM Hor Ave | FSM Vert Peak | FSM Vert Ave | AF | Amp Gain | RFS @ 3 m Hor Peak | RFS @ 3 m Hor Ave | RFS @ 3 m Vert Peak | RFS @ 3 m Vert Ave | Ave Limit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4802.0 | 42.2 | 24.3 | 42.3 | 24.4 | 32.9 | 25 | 50.1 | 32.2 | 50.2 | 32.3 | 54.0 |
| 9604.0 | 40.4 | 22.1 | 40.6 | 22.2 | 38.4 | 25 | 53.8 | 35.5 | 54.0 | 35.6 | 54.0 |

Other emissions present had amplitudes at least 20 dB below the margin.
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.
Note: Levels measured @ 3-meter OATS site.

### *Summary of Results for Receiver Emissions*

The EUT demonstrated compliance with the antenna conducted emissions requirements of CFR 47 Part 15B and RSS-GEN with an antenna port conducted minimum margin of -3.6 dB below requirements (measured at temporary test ant port). The EUT demonstrated compliance with the radiated emissions requirements of CFR 47 Part 15B and RSS-GEN with a minimum -18.4 dB margin below requirements. Other emissions were present with amplitudes at least 20 dB below the CFR 47 and RSS-GEN limits.

## Annex

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

## *Annex A Measurement Uncertainty Calculations*

*Radiated Emissions Measurement Uncertainty Calculation*

Measurement of vertically polarized radiated field strength over the frequency range 30 MHz to 1 GHz on an open area test site at 3m and 10m includes following uncertainty:

| Contribution | Probability Distribution | Uncertainty (dB) |
|---|---|---|
| Antenna factor calibration | normal (k = 2) | ±0.58 |
| Cable loss calibration | normal (k = 2) | ±0.2 |
| Receiver specification | rectangular | ±1.0 |
| Antenna directivity | rectangular | ±0.1 |
| Antenna factor variation with height | rectangular | ±2.0 |
| Antenna factor frequency interpolation | rectangular | ±0.1 |
| Measurement distance variation | rectangular | ±0.2 |
| Site Imperfections | rectangular | ±1.5 |

Combined standard uncertainty $u_c(y)$ is

$$U_c(y) = \pm \sqrt{\left[\frac{1.0}{2}\right]^2 + \left[\frac{0.2}{2}\right]^2 + \left[\frac{1.0^2 + 0.1^2 + 2.0^2 + 0.1^2 + 0.2^2 + 1.5^2}{3}\right]}$$

$U_c(y) = \pm 1.6$ dB

It is probable that $u_c(y) / s(q_k) > 3$, where $s(q_k)$ is estimated standard deviation from a sample of n readings unless the repeatability of the EUT is particularly poor, and a coverage factor of k = 2 will ensure that the level of confidence will be approximately 95%, therefore:

$$s(q_k) = \sqrt{\frac{1}{(n-1)} \sum_{k-1}^{n} (q_k - \bar{q})^2}$$

$U = 2\ U_c(y) = 2 \times \pm 1.6$ dB $= \pm 3.2$ dB

Notes:

1.1 Uncertainties for the antenna and cable were estimated, based on a normal probability distribution with k = 2.

1.2 The receiver uncertainty was obtained from the manufacturer's specification for which a rectangular distribution was assumed.

1.3 The antenna factor uncertainty does not take account of antenna directivity.

1.4 The antenna factor varies with height and since the height was not always the same in use as when the antenna was calibrated an additional uncertainty is added.

1.5 The uncertainty in the measurement distance is relatively small but has some effect on the received signal strength. The increase in measurement distance as the antenna height is increased is an inevitable consequence of the test method and is therefore not considered a contribution to uncertainty.

1.6 Site imperfections are difficult to quantify but may include the following contributions:
-Unwanted reflections from adjacent objects.
-Ground plane imperfections: reflection coefficient, flatness, and edge effects.
-Losses or reflections from "transparent" cabins for the EUT or site coverings.
-Earth currents in antenna cable (mainly effect Biconical antennas).

The specified limits for the difference between measured site attenuation and the theoretical value (± 4 dB) were not included in total since the measurement of site attenuation includes uncertainty contributions already allowed for in this budget, such as antenna factor.

*Conducted Measurements Uncertainty Calculation*

Measurement of conducted emissions over the frequency range 9 kHz to 30 MHz includes following uncertainty:

| Contribution | Probability Distribution | Uncertainty (dB) |
|---|---|---|
| Receiver specification | rectangular | ±1.5 |
| LISN coupling specification | rectangular | ±1.5 |
| Cable and input attenuator calibration | normal (k=2) | ±0.5 |

Combined standard uncertainty $u_c(y)$ is

$$U_c(y) = \pm \sqrt{\left[\frac{0.5}{2}\right]^2 + \frac{1.5^2 + 1.5^2}{3}}$$

$U_c(y) = \pm 1.2$ dB

As with radiated field strength uncertainty, it is probable that $u_c(y) / s(q_k) > 3$ and a coverage factor of k = 2 will suffice, therefore:

$U = 2\ U_c(y) = 2 \times \pm 1.2$ dB $= \pm 2.4$ dB

## *Annex B Rogers Labs Test Equipment List*

| List of Test Equipment | Calibration Date |
|---|---|
| Spectrum Analyzer: Rohde & Schwarz ESU40 | 5/11 |
| Spectrum Analyzer: HP 8562A, HP Adapters: 11518, 11519, and 11520 Mixers: 11517A, 11970A, 11970K, 11970U, 11970V, 11970W | 5/11 |
| Spectrum Analyzer: HP 8591EM | 5/11 |
| Antenna: EMCO Biconilog Model: 3143 | 5/11 |
| Antenna: Sunol Biconilog Model: JB6 | 10/10 |
| Antenna: EMCO Log Periodic Model: 3147 | 10/10 |
| Antenna: Antenna Research Biconical Model: BCD 235 | 10/10 |
| LISN: Compliance Design Model: FCC-LISN-2.Mod.cd, 50 µHy/50 ohm/0.1 µf | 10/10 |
| R.F. Preamp CPPA-102 | 10/10 |
| Attenuator: HP Model: HP11509A | 10/10 |
| Attenuator: Mini Circuits Model: CAT-3 | 10/10 |
| Attenuator: Mini Circuits Model: CAT-3 | 10/10 |
| Cable: Belden RG-58 (L1) | 10/10 |
| Cable: Belden RG-58 (L2) | 10/10 |
| Cable: Belden 8268 (L3) | 10/10 |
| Cable: Time Microwave: 4M-750HF290-750 | 10/10 |
| Cable: Time Microwave: 10M-750HF290-750 | 10/10 |
| Frequency Counter: Leader LDC825 | 2/11 |
| Oscilloscope Scope: Tektronix 2230 | 2/11 |
| Wattmeter: Bird 43 with Load Bird 8085 | 2/11 |
| Power Supplies: Sorensen SRL 20-25, SRL 40-25, DCR 150, DCR 140 | 2/11 |
| R.F. Generators: HP 606A, HP 8614A, HP 8640B | 2/11 |
| R.F. Power Amp 65W Model: 470-A-1010 | 2/11 |
| R.F. Power Amp 50W M185- 10-501 | 2/11 |
| R.F. Power Amp A.R. Model: 10W 1010M7 | 2/11 |
| R.F. Power Amp EIN Model: A301 | 2/11 |
| LISN: Compliance Eng. Model 240/20 | 2/11 |
| LISN: Fischer Custom Communications Model: FCC-LISN-50-16-2-08 | 2/11 |
| Antenna: EMCO Dipole Set 3121C | 2/11 |
| Antenna: C.D. B-101 | 2/11 |
| Antenna: Solar 9229-1 & 9230-1 | 2/11 |
| Antenna: EMCO 6509 | 2/11 |
| Audio Oscillator: H.P. 201CD | 2/11 |
| Peavey Power Amp Model: IPS 801 | 2/11 |
| ELGAR Model: 1751 | 2/11 |
| ELGAR Model: TG 704A-3D | 2/11 |
| ESD Test Set 2010i | 2/11 |
| Fast Transient Burst Generator Model: EFT/B-101 | 2/11 |
| Field Intensity Meter: EFM-018 | 2/11 |
| KEYTEK Ecat Surge Generator | 2/11 |
| 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. Work experience includes six years working 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.

NVLAP Lab Code 200087-0

## *Annex D FCC Test Site Registration Letter*

# FEDERAL COMMUNICATIONS COMMISSION

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

May 18, 2010

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: May 18, 2010

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 Test Site Registration Letter*

Industry Canada Industrie Canada

May 26, 2010

OUR FILE: 46405-3041
Submission No: 140719

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

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

Dear Sir/Madame:

The Bureau has received your application for the renewal of a 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 **( 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;

- Your primary code is: **3041**

- The company number 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 two 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,

Dalwinder Gill

Dalwinder Gill
For: Wireless Laboratory Manager
**Certification and Engineering Bureau**
3701 Carling Ave., Building 94
P.O. Box 11490, Station "H"
Ottawa, Ontario K2H 8S2
Email: dalwinder.gill@ic.gc.ca
Tel. No. (613) 998-8363
Fax. No. (613) 990-4752