1601 North A.W. Grimes Blvd., Suite B
Round Rock, TX 78665
e-mail: info@ptitest.com
(512) 244-3371 Fax: (512) 244-1846

June 25, 2014

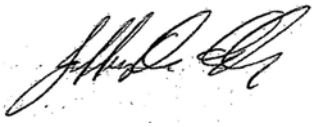
John Weber
Long Range Systems, LLC
4550 Excel Parkway Suite 200
Addison TX 75001

Dear John:

Thank you for allowing Professional Testing (EMI), Inc. an opportunity to perform testing for Long Range Systems, LLC. Enclosed is the Wireless Certification Report for the TX-9601 Paging System Transmitter. This report can be used to demonstrate compliance with FCC requirements for wireless devices in the United States.

If you have any questions, please contact me.

Sincerely,



Jeffrey A. Lenk
President

Attachment

Project 15689-10

**TX-9601 Paging System Transmitter**

**Wireless Certification Report**

Prepared for:

Long Range Systems, LLC

By

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

June 25, 2014

Reviewed by

Larry Finn
Regulatory Design Engineer

Written by

Eric Lifsey
Test Engineer

## Revision History

| Revision Number | Description | Date |
|---|---|---|
| 00 | Reviewed and released. | June 25, 2014 |
| | | |
| | | |
| | | |

# Table of Contents

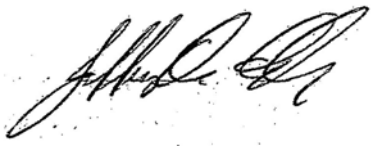
# Certificate of Compliance

| Applicant | Device & Test Identification | |
|---|---|---|
| Long Range Systems, LLC (John Weber)<br>4550 Excel Parkway Suite 200<br>Addison, Texas 75001<br>Certificate Date: June 25, 2014 | FCC ID:<br>Model(s):<br>Part Number(s):<br>Laboratory Project #: | 2AB6OTX9601<br>TX-9601 Paging System Transmitter<br>N/A<br>16005-15 |

The models listed above were tested utilizing the following documents and found to be in compliance with the required criteria.

| 47 CFR, Part 90 | |
|---|---|
| **Clause Subject** | **Section References** |
| Conducted Output Power | 90.210, 2.1046, 90.217(b) |
| Emission Mask | 90.217(b), 2.1047 |
| Conducted Spurious/Harmonic Emissions at Antenna Terminals | 90.217(b), 2.1051 |
| Field Strength of Radiated Spurious/Harmonic Emissions Fundamental to 5 GHz | 90.217(b), 2.1053 |
| Frequency Stability | 90.217(b), 2.1055 |
| Occupied Bandwidth, 20 dB | 90.209, 2.1049 |
| Radiated Emissions 30MHz – 1 GHz, Class B | 15.109, ICES-003 |
| Mains Conducted Emissions, Class B | 15.107, ICES-003 |
| Maximum Permissible Exposure | Reported separately. |

I, Jeffrey A. Lenk, for Professional Testing (EMI), Inc., being familiar with the FCC rules and test procedures, have reviewed the test setup, measured data, and this report. I believe them to be true and accurate.



Jeffrey A. Lenk
President

This report has been reviewed and accepted by Long Range Systems, LLC. The undersigned is responsible for ensuring that the model(s) listed above will continue to comply with the applicable rules.

_____
Representative of Long Range Systems, LLC

# 1.0 Introduction

## 1.1 Scope

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

Professional Testing (EMI), Inc., (PTI) follows the guidelines of National Institute of Standards and Technology (NIST) for all uncertainty calculations, estimates, and expressions thereof for electromagnetic compatibility testing. The procedures of ANSI C63.4: 2009 were used for making all radiated enclosure and mains emission measurements.

## 1.2 EUT Description

The EUT transmits alert codes to receivers held by patrons at restaurants to page them to host for seating or similar purposes in the establishment.

The EUT is housed in an extruded aluminum enclosure with a small LCD display and integral keypad. It receives external power from an AC to DC adapter. The EUT employs a BNC connector where a quarter-wave antenna is attached and positioned vertically.

**Table 1.2.1 Equipment Under Test**

| Manufacturer | Model | Serial # | Description |
|---|---|---|---|
| Long Range Systems, LLC | TX-9601 | None | 467.75 MHz paging transmitter |


**Photograph 1.3.1: EUT**

## 1.3 EUT Operation

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

The EUT does not contain a receiver but was tested in both idle and transmit modes where applicable.

## 1.4 Modifications to Equipment

To reduce unwanted radiated emissions below 1 GHz a ferrite was added inside the EUT as a common-mode choke on the DC power line. Ferrite manufactured by Laird, part number 28A2025-0A2. To reduce unwanted conducted port harmonic emissions the output RF filter was modified by changing filter section capacitors.

## 1.5 Test Site

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

# 2.0 Applicable Documents and Clauses

| Table 2.0.1: Applicable Documents | | |
|---|---|---|
| **Document #** | **Title/Description** | **Date** |
| 47 CFR | Part 90 | |
| ANSI C63.4 | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low Voltage Electrical and Electronic Equipment | 2009 |
| TIA/EIA-603C | Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards | 2004 |

| Table 2.0.2: Applicable Clauses | | | |
|---|---|---|---|
| **Clause Subject** | **Section References** | **Required?** | **Result** |
| Conducted Output Power | 90.210, 2.1046, 90.217(b) | Yes | Pass |
| Emission Mask[3] | 90.217(b), 2.1047 | Yes | Pass |
| Conducted Spurious/Harmonic Emissions at Antenna Terminals[3] | 90.217(b), 2.1051 | Yes | Pass |
| Field Strength of Radiated Spurious/Harmonic Emissions Fundamental to 5 GHz[3] | 90.217(b), 2.1053 | Yes | Pass |
| Transient Frequency Behavior[3] | 90.214, TIA/EIA-603C | No[3] | N/A |
| Frequency Stability[3] | 90.217(b), 2.1055 | Yes | Pass |
| Occupied Bandwidth, 20 dB | 90.209, 2.1049 | Yes | Pass |
| Radiated Emissions 30MHz – 1 GHz[1, 3] | 15.109, ICES-003 | Yes | Pass |
| Mains Conducted Emissions, Class B[1] | 15.107, ICES-003 | Yes | Pass |
| Maximum Permissible Exposure[2] | Reported separately. | Yes | Pass |
| Application Report Requirements | 2.1033(c) | Yes | N/A |
| Exemption From Technical Standards[3] | 90.217(b) | Yes | Pass |

[1]This device generates and uses RF energy in the form of a switching power supply, such that 47 CFR, Part 15, applies. Therefore unintentional radiated and conducted emissions were measured to Part 15 limits.
[2]Exposure is reported in a supplemental document.
[3]The transmit power of this device is below 120 mW and as such the exemptions of 90.217 apply to the noted paragraphs.

# 3.0 Conducted Output Power [90.205]

## 3.1 Procedure

The EUT antenna port is coupled through a power attenuator to a spectrum analyzer and then is placed into continuous transmit mode without modulation. The connection is direct and no cables are used. Power is then measured directly with no additional calculation required.

## 3.2 Criteria

| Section Reference | Parameter | Date(s) |
|---|---|---|
| 90.205, 2.1046 | Conducted Output Power | 2014-06-13 |

## 3.3 Results

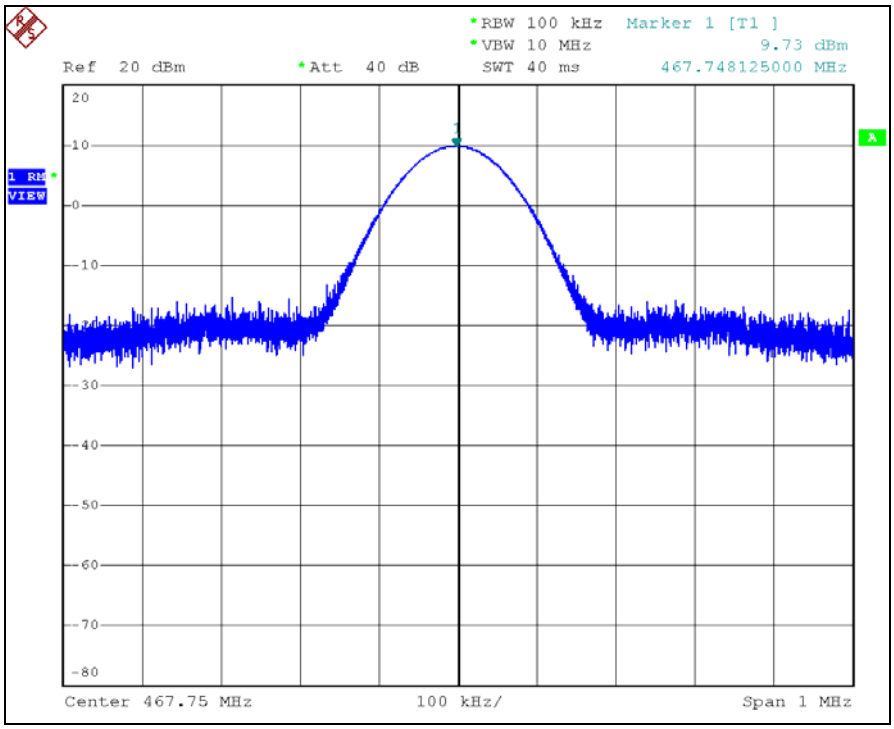
The EUT is in compliance with the applicable requirements. Plotted results are presented below.

**Table 3.3.1 Equipment List**

| Asset # | Manufacturer | Model # | Description | Calibration Due |
|---|---|---|---|---|
| ALN-077 | Rohde & Schwarz | FSP-30 | Spectrum Analyzer | 2015-01-29 |

**Table 3.3.2 Power, Conducted**

| Frequency | Measured Level |
|---|---|
| 467.750 MHz | 9.73 dBm, 9.40 mW |




Peak Power, Conducted

# 4.0 Emission Mask [90.217(b)]

## 4.1 Procedure

The EUT antenna port is coupled through a power attenuator to a spectrum analyzer and then is placed into continuous transmit mode with modulation. The connection is direct and no cables are used. Spurious signals are then measured directly with no additional calculation required. Emissions are measured with average detector. The frequency span is the inner mask area including the fundamental and out to +/- 25 kHz from center frequency of signal. The mask was selected to match the emission bandwidth in use.

## 4.2 Criteria

| Guideline | Section Number | Date |
|---|---|---|
| Emissions at Antenna Terminals | 90.217(b)*, 2.1051 | 2014-06-13 |

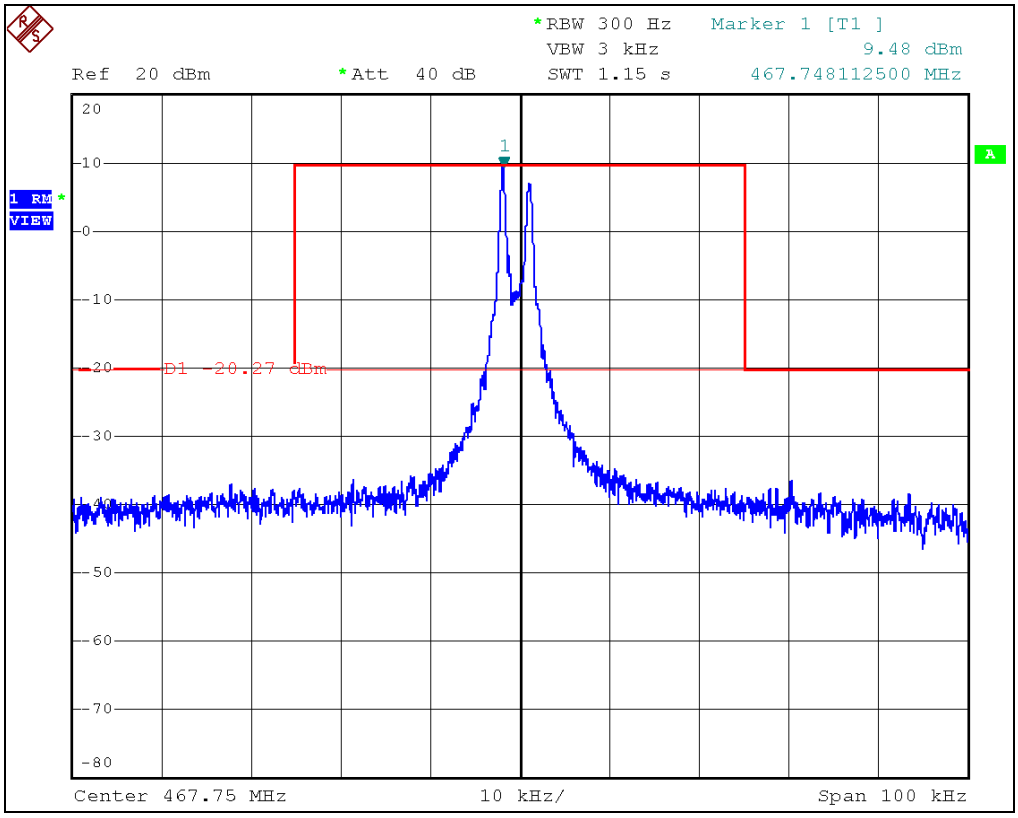
*Emission outside +/- 25 kHz of allocated channel center must be 30 dB or more below the fundamental.

## 4.3 Results

**Table 4.3.1 Equipment List**

| Asset # | Manufacturer | Model # | Description | Calibration Due |
|---|---|---|---|---|
| ALN-077 | Rohde & Schwarz | FSP-30 | Spectrum Analyzer | 2015-01-29 |

The emission measured within the mask as shown in the plot below. The EUT satisfied the criteria.




Modulated Emission with Superimposed Mask of 90.217(b)

# 5.0 Spurious Emissions at Antenna Terminals [90.217(b)]

## 5.1 Procedure

The EUT antenna port is coupled through a power attenuator to a spectrum analyzer and then is placed into continuous transmit mode without modulation. The connection is direct and no cables are used. Spurious signals are then measured directly with no additional calculation required. Emissions are measured with average detector function from lowest operating frequency (12 MHz) to tenth harmonic (4.67750 GHz). Selected range is 10 MHz to 5 GHz in three sub-ranges.

## 5.2 Criteria

| Guideline | Section Number | Date |
|---|---|---|
| Spurious/Harmonic Emissions at Antenna Terminals | 90.217(b), 2.1051 | 2014-06-13 |

Per procedures of TIA/EIA-603, below 1 GHz measurement resolution bandwidth is 10 KHz with video bandwidth set higher at 100 kHz. Above 1 GHz measurement resolution bandwidth is 1 MHz with video bandwidth higher at 10 MHz.

Reference peak power level is 28.79 dBm. Limit is determined from 90.217(b) for emissions beyond 25 kHz from authorized bandwidth.

Per 90.217(b) $\text{Attenuation}_{(dB)} = 30$ dB

$\text{Limit}_{(dBm)} = \text{Fundamental\_Power}_{(dBm)} - \text{Attenuation}_{(dB)} = 9.73 \text{ dBm} - 30 \text{ dB} = -20.27 \text{ dBm}$

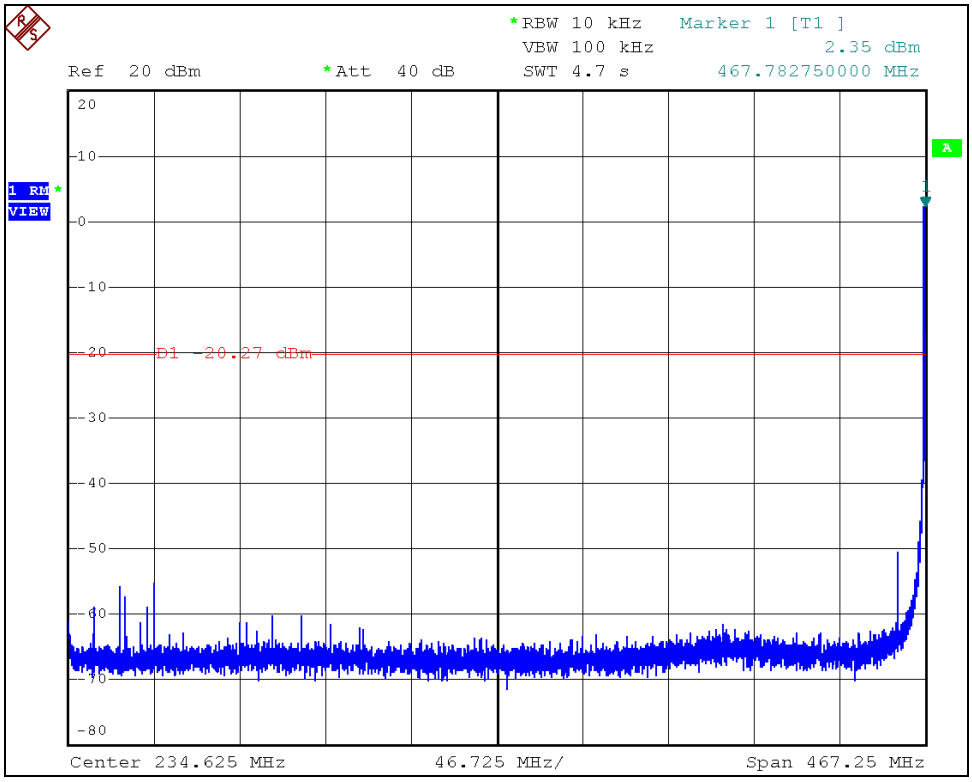
## 5.3 Results

**Table 5.3.1 Equipment List**

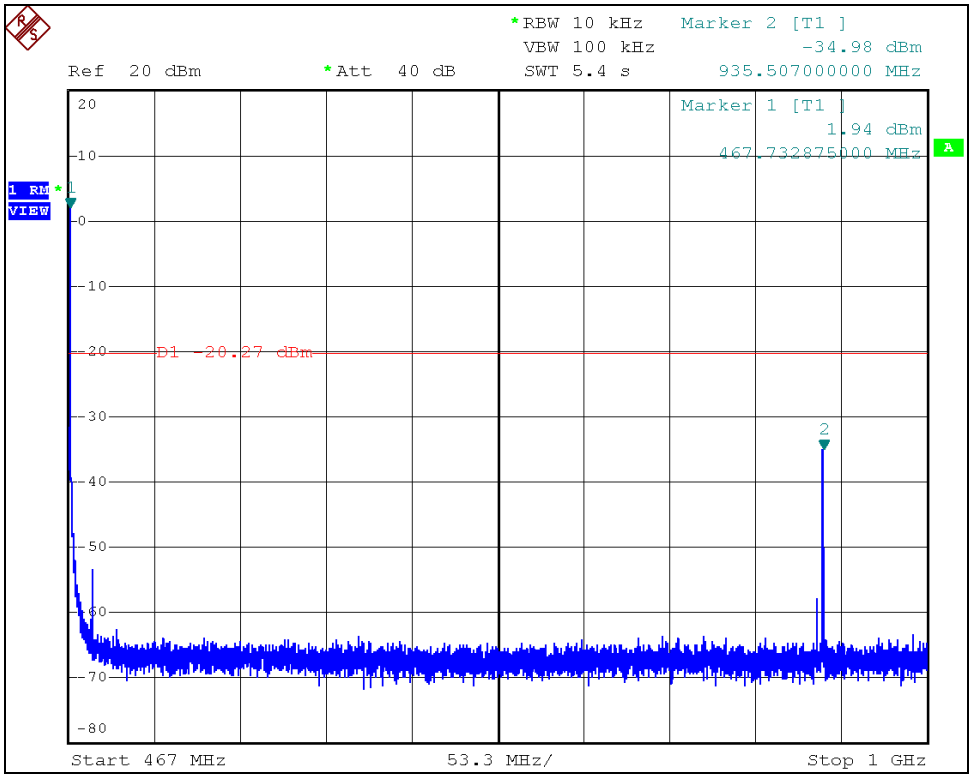
| Asset # | Manufacturer | Model # | Description | Calibration Due |
|---|---|---|---|---|
| ALN-077 | Rohde & Schwarz | FSP-30 | Spectrum Analyzer | 2015-01-29 |

Measurements were performed with a direct connection to the spectrum analyzer such that no external losses or gains would apply.

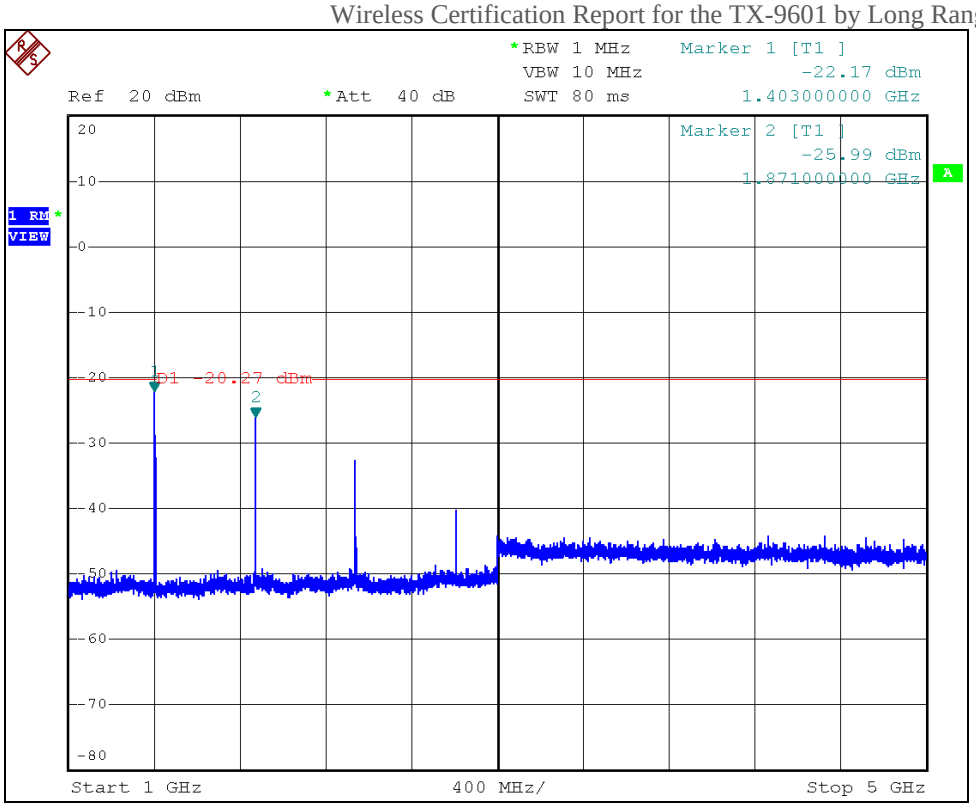
Highest spurious emission was found to be 1.9 dB below the limit at 1.403 GHz. The EUT was found to be in compliance with applicable requirements. Plotted results are presented below. In the plots the emission limit is marked with the red line at -20.27 dBm.




Span: 10 MHz to Fundamental
(Fundamental visible on right edge of plot area.)




Span: Fundamental to 1 GHz
(Fundamental visible on left edge of plot.)




Span: 1 GHz to 5 GHz

# 6.0 Field Strength of Radiated Unintentional Emissions – Idle Mode [15.109]

## 6.1 Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a rotating turntable at a distance of 10 meters from the measurement antenna. The EUT was placed into its idle mode with the antenna attached.

Spurious/harmonic emissions below 1 GHz were measured with quasi-peak detection at a distance of 10 meters. Spurious/harmonic emissions above 1 GHz peak were measured with average and peak detection with a resolution bandwidth of 1 MHz and measured at a distance of 3 meters. Average detection was used to determine compliance of the EUT if the peak did not meet the average limit. Non-harmonic emissions must satisfy the average limit and the peak limit (20 dB above average). A diagram showing the test setup is given as Figure 6.1.1.

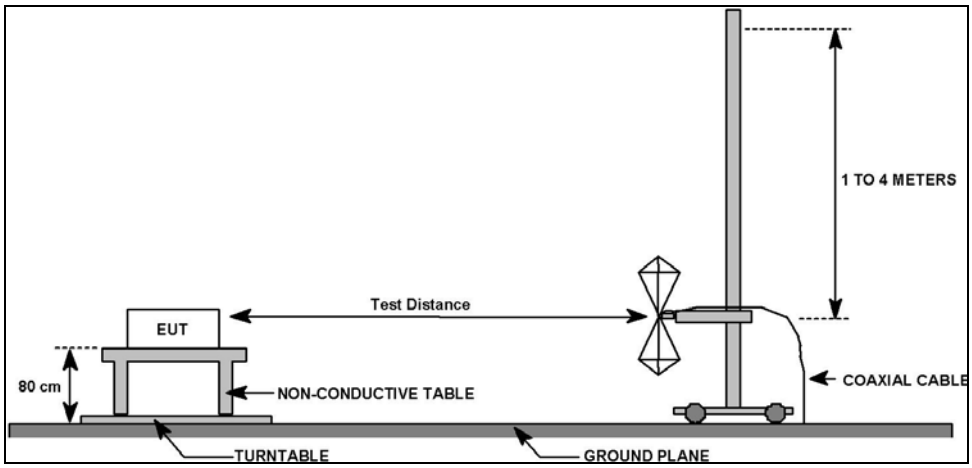



**Figure 6.1.1: Field Strength of Radiated Emissions Test Setup**

## 6.2 Criteria

| Clause Subject | Section Number | Date |
|---|---|---|
| Field Strength of Radiated Unintentional Emissions 30 MHz to 1 GHz | 15.109 | 2014-06-13 |

## 6.3 Results

Note that the EUT is not totally idle, in that once per minute a brief transmission is made and can be seen in the recorded data.

**Table 6.3.1: Equipment List**

| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| **Test Method:** | **ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38).** | | |
| **In accordance with:** | **FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits** | | |
| **Section:** | **15.109** | | |
| **Test Date(s):** | **6/13/2014** | **EUT Serial #:** | **Sample B** |
| **Customer:** | **Long Range Systems LLC** | **EUT Part #:** | **TX-9601** |
| **Project Number:** | **16005-15** | **Test Technician:** | **Eric Lifsey** |
| **Purchase Order #:** | **N/A** | **Supervisor:** | **Rob McCollough** |
| **Equip. Under Test:** | **TX-9601** | **Witness' Name:** | **Mike Williams** |

| Radiated Emissions Test Equipment List | |
|---|---|
| **Tile! Software Version:** | **4.2.A, May 23, 2010, 08:38:52 AM** |
| **Test Profile:** | **Radiated Emissions_Profile Version October 12, 2011** |

| Asset # | Manufacturer | Model | Equipment Nomenclature | Serial Number | Calibration Due Date |
|---|---|---|---|---|---|
| 1509A | Braden | N/A | TDK 10M Chamber, NSA < 1 GHz | DAC-012915-005 | 7/29/2014 |
| 1890 | HP | 8447F | Preamp/Amp, 9kHz-1300MHz, 28/25dB | 3313A05298 | 1/22/2015 |
| 1937 | Agilent | E4440A | Spectrum Analyzer, 3 Hz - 26.5 GHz | MY44303298 | 12/2/2015 |
| 1926 | ETS-Lindgren | 3142D | Antenna, Biconilog, 26 MHz - 6 GHz | 00135454 | 7/29/2014 |
| C027 | N/A | RG214 | Cable Coax, N-N, 25m | none | 9/26/2014 |
| 1327 | EMCO | 1050 | Controller, Antenna Mast | none | N/A |
| 0942 | EMCO | 11968D | Turntable, 4ft. | 9510-1835 | N/A |
| 1969 | HP | 11713A | Attenuator/Switch Driver | 3748A04113 | N/A |

**Table 6.3.2: Measurement Bandwidth**

| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| **Test Method:** | **ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference,** | | |
| **In accordance with:** | **FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits** | | |
| **Section:** | **15.209** | | |
| **Test Date(s):** | **6/13/2014** | **EUT Serial #:** | **None (Sample B)** |
| **Customer:** | **Long Range Systems LLC** | **EUT Part #:** | **TX-9601** |
| **Project Number:** | **16005-15** | **Test Technician:** | **Eric Lifsey** |
| **Purchase Order #:** | **N/A** | **Supervisor:** | **Rob McCollough** |
| **Equip. Under Test:** | **TX-9601** | **Witness' Name:** | **Mike Williams** |

**Radiated Emissions Spectrum Analyzer Bandwidth and Measurement Time - Peak Scan**

| Frequency Band Start (MHz) | Frequency Band Stop (MHz) | 6 dB Bandwidth (kHz) | Number of Ranges Used | Measurement Time per Range |
|---|---|---|---|---|
| 0.009 | 0.15 | 0.3 | 2 | Multiple Sweeps |
| 0.15 | 30 | 9 | 6 | Multiple Sweeps |
| 30 | 1000 | 120 | 2 | Multiple 800 mS Sweeps |
| 1000 | 6000 | 1000 | 2 | Multiple Sweeps |
| 6000 | 18000 | 300 | 2 | Multiple Sweeps |

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

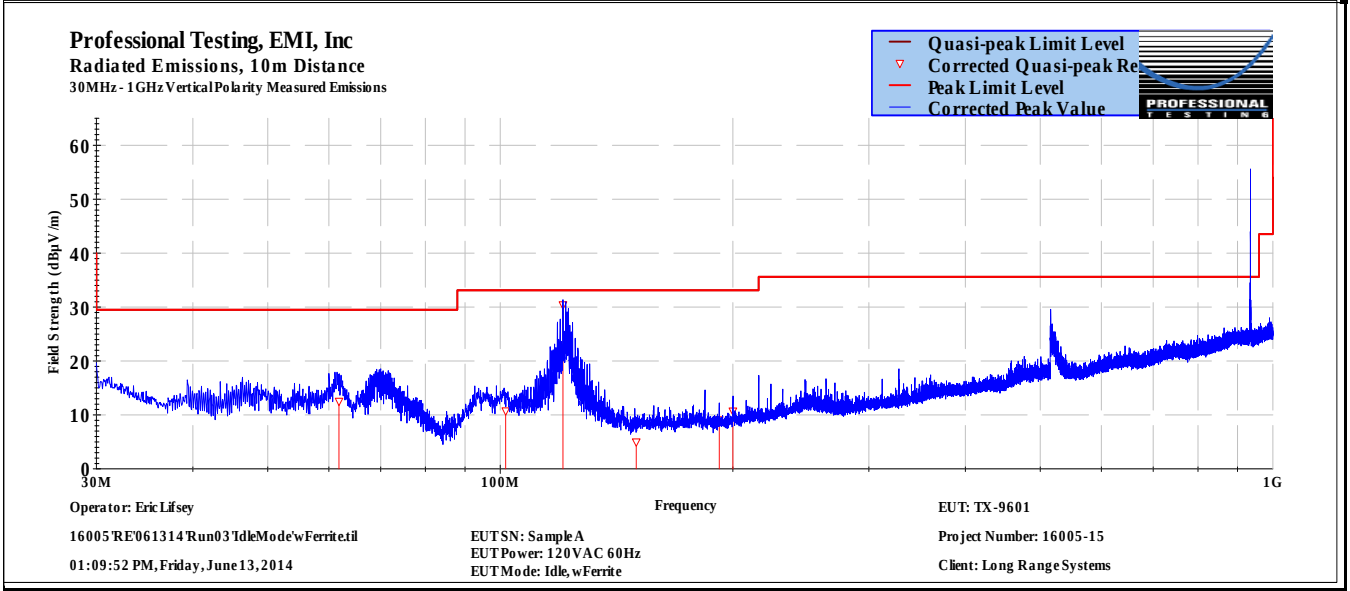
**Table 6.3.3: Field Strength of Spurious Emissions, Below 1 GHz, Vertical Polarity**

| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| **Test Method:** | ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | |
| **In accordance with:** | FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits | | |
| **Section:** | 15.109 | | |
| **Test Date(s):** | 6/13/2014 | **EUT Serial #:** | Sample B |
| **Customer:** | Long Range Systems LLC | **EUT Part #:** | TX-9601 |
| **Project Number:** | 16005-15 | **Test Technician:** | Eric Lifsey |
| **Purchase Order #:** | N/A | **Supervisor:** | Rob McCollough |
| **Equip. Under Test:** | TX-9601 | **Witness' Name:** | Mike Williams |

**Radiated Emissions Test Results Data Sheet** — **Page: 1 of 1**

| | | | |
|---|---|---|---|
| **EUT Line Voltage:** | 120 VAC | **EUT Power Frequency:** | 60 Hz |
| **Antenna Orientation:** | Vertical | **Frequency Range:** | 30MHz to 1GHz |
| **EUT Mode of Operation:** | | Idle, not transmitting | |

| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dBµV) | Corrected Level (dBµV/m) | Limit Level (dBµV/m) | Margin (dB) | Test Results |
|---|---|---|---|---|---|---|---|---|---|
| 61.8263 | 10 | 319 | 1.57 | Quasi-peak | 33.9 | 12.483 | 29.5 | -17.0 | Pass |
| 101.64 | 10 | 312 | 2.32 | Quasi-peak | 30.7 | 10.711 | 33.1 | -22.4 | Pass |
| 120.54 | 10 | 215 | 1.35 | Quasi-peak | 51.3 | 30.363 | 33.1 | -2.7 | Pass |
| 149.927 | 10 | 194 | 3.46 | Quasi-peak | 24.6 | 4.962 | 33.1 | -28.1 | Pass |
| 192.039 | 10 | 30 | 1.2 | Quasi-peak | 26.6 | 9.04 | 33.1 | -24.1 | Pass |
| 200.012 | 10 | 186 | 2.08 | Quasi-peak | 27.5 | 10.695 | 33.1 | -22.4 | Pass |




≤ 1GHz Vertical Antenna Polarity Measured Emissions

**Table 6.3.4: Field Strength of Spurious Emissions, Below 1 GHz, Horizontal Polarity**

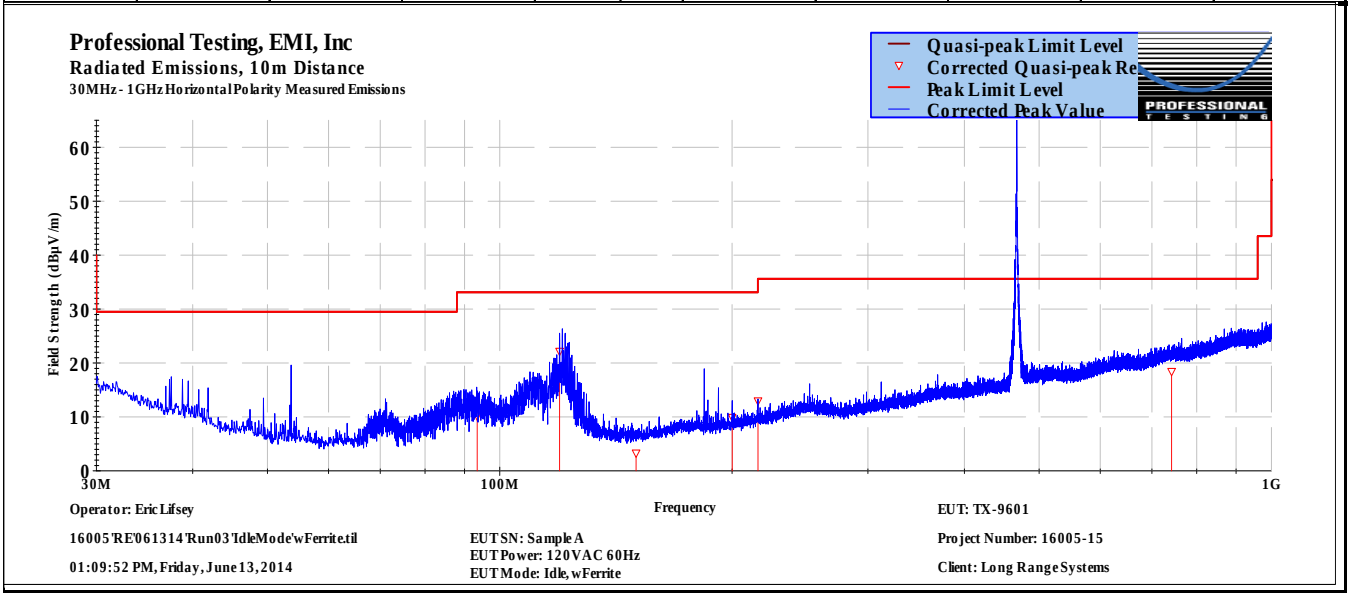
## Professional Testing, EMI, Inc.

| | | | |
|---|---|---|---|
| **Test Method:** | ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | |
| **In accordance with:** | FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits | | |
| **Section:** | 15.109 | | |
| **Test Date(s):** | 6/13/2014 | **EUT Serial #:** | Sample B |
| **Customer:** | Long Range Systems LLC | **EUT Part #:** | TX-9601 |
| **Project Number:** | 16005-15 | **Test Technician:** | Eric Lifsey |
| **Purchase Order #:** | N/A | **Supervisor:** | Rob McCollough |
| **Equip. Under Test:** | TX-9601 | **Witness' Name:** | Mike Williams |

**Radiated Emissions Test Results Data Sheet** — **Page: 1 of 1**

| | | | |
|---|---|---|---|
| **EUT Line Voltage:** | 120 VAC | **EUT Power Frequency:** | 60 Hz |
| **Antenna Orientation:** | Horizontal | **Frequency Range:** | 30MHz to 1GHz |
| **EUT Mode of Operation:** | | Idle, not transmitting | |

| Frequency Measured (MHz) | Test Distance (Meters) | EUT Direction (Degrees) | Antenna Height (Meters) | Detector Function | Recorded Amplitude (dBµV) | Corrected Level (dBµV/m) | Limit Level (dBµV/m) | Margin (dB) | Test Results |
|---|---|---|---|---|---|---|---|---|---|
| 93.5082 | 10 | 268 | 3.7 | Quasi-peak | 30.8 | 10.102 | 33.1 | -23.0 | Pass |
| 119.547 | 10 | 47 | 3.63 | Quasi-peak | 43 | 22.132 | 33.1 | -11.0 | Pass |
| 150.17 | 10 | 323 | 3.67 | Quasi-peak | 22.9 | 3.258 | 33.1 | -29.8 | Pass |
| 200.103 | 10 | 250 | 3.88 | Quasi-peak | 26.7 | 9.895 | 33.1 | -23.2 | Pass |
| 216.066 | 10 | 215 | 3.58 | Quasi-peak | 29 | 12.942 | 35.6 | -22.7 | Pass |
| 742.402 | 10 | 160 | 3.99 | Quasi-peak | 21.7 | 18.405 | 35.6 | -17.2 | Pass |




**≤ 1GHz Horizontal Antenna Polarity Measured Emissions**

# 7.0 Field Strength of Radiated Spurious Emissions – Transmit Mode [90.217(b)]

## 7.1 Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The table was centered on a rotating turntable at a distance of 10 meters from the measurement antenna. The EUT was placed into transmit mode with the antenna replaced by a non-radiating load.

Spurious/harmonic emissions below 1 GHz were measured with quasi-peak detection at a distance of 10 meters. Spurious/harmonic emissions above 1 GHz peak were measured with average and peak detection with a resolution bandwidth of 1 MHz and measured at a distance of 3 meters. Average detection was used to determine compliance of the EUT if the peak did not meet the average limit. Non-harmonic emissions must satisfy the average limit and the peak limit (20 dB above average). A high pass filter was employed to reduce the fundamental signal to allow measurement of the harmonics. A diagram showing the test setup is given as Figure 7.1.1.

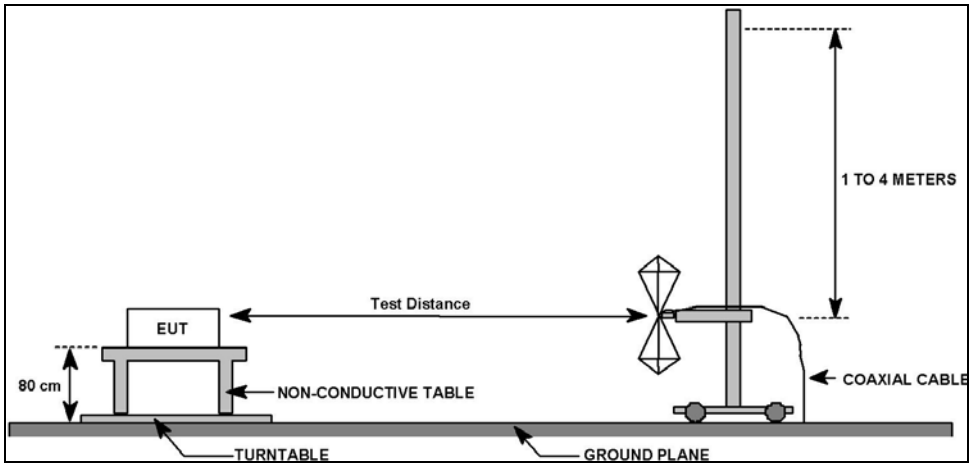



**Figure 7.1.1: Field Strength of Spurious Emissions Test Setup**

## 7.2 Criteria

| Clause Subject | Section Number | Date |
|---|---|---|
| Field Strength of Radiated Spurious/Harmonic Emissions Fundamental to 5 GHz | 90.217(b) | 2014-06-13<br>2014-06-25 |

## 7.3 Results

The EUT satisfied the requirements.

**Table 7.3.1: Equipment List**

| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| **Test Method:** | **ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference,** | | |
| **In accordance with:** | **FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits** | | |
| **Section:** | **15.209** | | |
| **Test Date(s):** | **6/13/2014** | **EUT Serial #:** | **None (Sample B)** |
| **Customer:** | **Long Range Systems LLC** | **EUT Part #:** | **TX-9601** |
| **Project Number:** | **16005-15** | **Test Technician:** | **Eric Lifsey** |
| **Purchase Order #:** | **N/A** | **Supervisor:** | **Rob McCollough** |
| **Equip. Under Test:** | **TX-9601** | **Witness' Name:** | **Mike Williams** |

| Radiated Emissions Test Equipment List | |
|---|---|
| **Tile! Software Version:** | **4.2.A, May 23, 2010, 08:38:52 AM** |
| **Test Profile:** | **Radiated Emissions_Profile Version October 12, 2011** |

| Asset # | Manufacturer | Model | Equipment Nomenclature | Serial Number | Calibration Due Date |
|---|---|---|---|---|---|
| 1509A | Braden | N/A | TDK 10M Chamber, NSA < 1 GHz | DAC-012915-005 | 7/29/2014 |
| 1890 | HP | 8447F | Preamp/Amp, 9kHz-1300MHz, 28/25dB | 3313A05298 | 1/22/2015 |
| 1937 | Agilent | E4440A | Spectrum Analyzer, 3 Hz - 26.5 GHz | MY44303298 | 12/2/2015 |
| 1926 | ETS-Lindgren | 3142D | Antenna, Biconilog, 26 MHz - 6 GHz | 00135454 | 7/29/2014 |
| C027 | N/A | RG214 | Cable Coax, N-N, 25m | none | 9/26/2014 |
| 1327 | EMCO | 1050 | Controller, Antenna Mast | none | N/A |
| 0942 | EMCO | 11968D | Turntable, 4ft. | 9510-1835 | N/A |
| 1969 | HP | 11713A | Attenuator/Switch Driver | 3748A04113 | N/A |
| | | | | | |
| 1509B | Braden | N/A | TDK 10M Chamber, VSWR > 1 GHz | DAC-012915-005 | 7/16/2014 |
| 2004 | Miteq | AFS44-00101800-2S-10P-44 | Amplifier, 40dB, .1-18GHz | 0 | 11/19/2014 |
| C030 | N/A | 0 | Cable Coax, N-N, 30m | none | 9/26/2014 |
| Loaner-ETS | ETS-Lindgren | 3117 | Antenna, Double Ridged Guide Horn, 1 - 18 GHz | 135203 | 1/14/2015 |
| 1325 | EMCO | 1050 | Controller, Antenna Mast | 9003-1461 | N/A |

**Table 7.3.2: Measurement Bandwidth**

| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| **Test Method:** | **ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference,** | | |
| **In accordance with:** | **FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits** | | |
| **Section:** | **15.209** | | |
| **Test Date(s):** | **6/13/2014** | **EUT Serial #:** | **None (Sample B)** |
| **Customer:** | **Long Range Systems LLC** | **EUT Part #:** | **TX-9601** |
| **Project Number:** | **16005-15** | **Test Technician:** | **Eric Lifsey** |
| **Purchase Order #:** | **N/A** | **Supervisor:** | **Rob McCollough** |
| **Equip. Under Test:** | **TX-9601** | **Witness' Name:** | **Mike Williams** |

**Radiated Emissions Spectrum Analyzer Bandwidth and Measurement Time - Peak Scan**

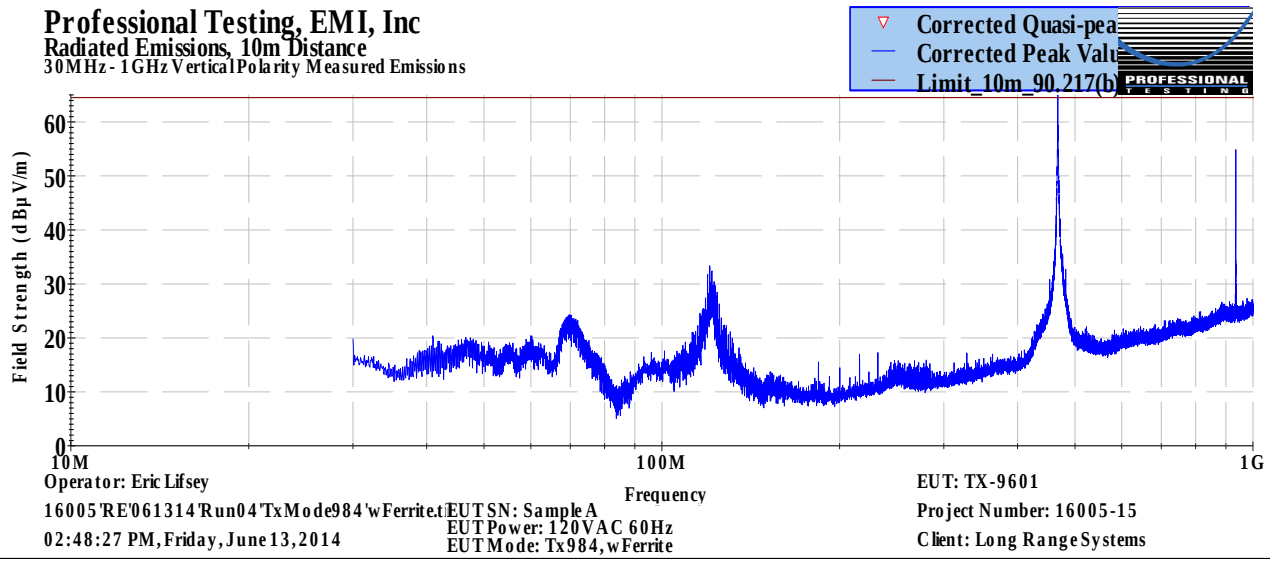
| Frequency Band Start (MHz) | Frequency Band Stop (MHz) | 6 dB Bandwidth (kHz) | Number of Ranges Used | Measurement Time per Range |
|---|---|---|---|---|
| 0.009 | 0.15 | 0.3 | 2 | Multiple Sweeps |
| 0.15 | 30 | 9 | 6 | Multiple Sweeps |
| 30 | 1000 | 120 | 2 | Multiple 800 mS Sweeps |
| 1000 | 6000 | 1000 | 2 | Multiple Sweeps |
| 6000 | 18000 | 300 | 2 | Multiple Sweeps |

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

**Table 7.3.3: Field Strength of Spurious Emissions, Below 1 GHz, Vertical Polarity**

| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| Test Method: | ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | |
| In accordance with: | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | |
| Section: | 15.209 | | |
| Test Date(s): | 6/13/2014 | EUT Serial #: | None (Sample B) |
| Customer: | Long Range Systems LLC | EUT Part #: | TX-9601 |
| Project Number: | 16005-15 | Test Technician: | Eric Lifsey |
| Purchase Order #: | N/A | Supervisor: | Rob McCollough |
| Equip. Under Test: | TX-9601 | Witness' Name: | Mike Williams |

| Radiated Emissions Test Results Data Sheet | | | Page: | 1 | of | 1 |
|---|---|---|---|---|---|---|
| EUT Line Voltage: | 120 VAC | EUT Power Frequency: | 60 Hz | | | |
| Antenna Orientation: | Vertical | Frequency Range: | 30MHz to 1GHz | | | |
| EUT Mode of Operation: | | Transmit | | | | |



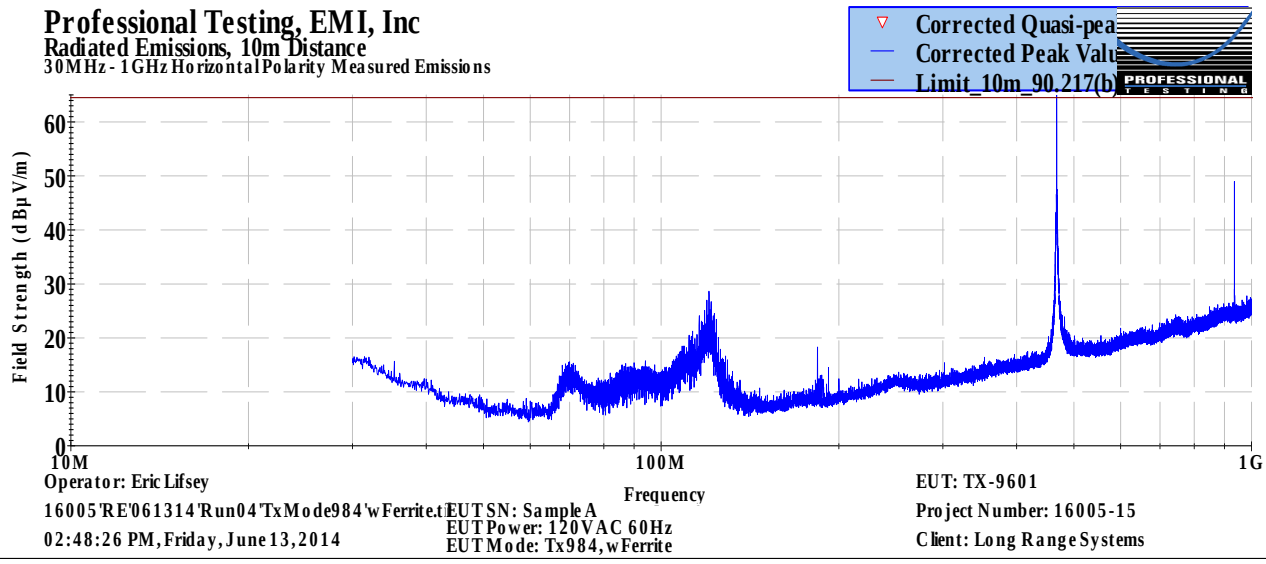

≤ 1GHz Vertical Antenna Polarity Measured Emissions

Note that the signal crossing the red limit line is the fundamental.

**Table 7.3.4: Field Strength of Spurious Emissions, Below 1 GHz, Horizontal Polarity**

| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| Test Method: | ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | |
| In accordance with: | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | |
| Section: | 15.209 | | |
| Test Date(s): | 6/13/2014 | EUT Serial #: | None (Sample B) |
| Customer: | Long Range Systems LLC | EUT Part #: | TX-9601 |
| Project Number: | 16005-15 | Test Technician: | Eric Lifsey |
| Purchase Order #: | N/A | Supervisor: | Rob McCollough |
| Equip. Under Test: | TX-9601 | Witness' Name: | Mike Williams |

| Radiated Emissions Test Results Data Sheet | | | Page: 1 of 1 | | |
|---|---|---|---|---|---|
| EUT Line Voltage: | 120 | VAC | EUT Power Frequency: | 60 | Hz |
| Antenna Orientation: | Horizontal | | Frequency Range: | 30MHz to 1GHz | |
| EUT Mode of Operation: | | | Transmit | | |

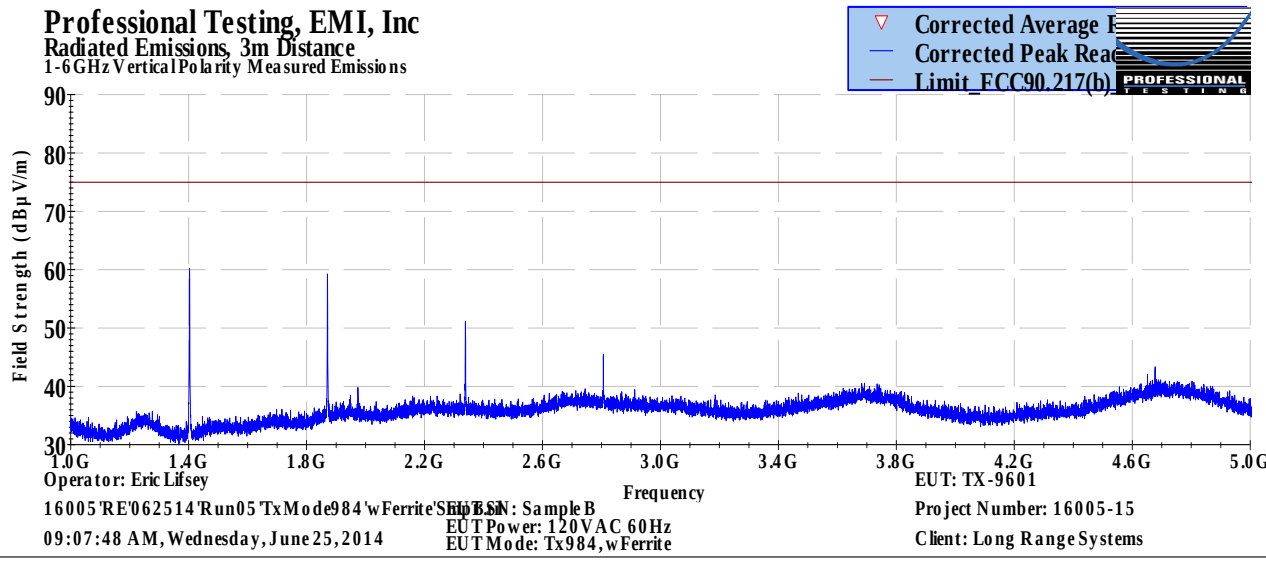



≤ 1GHz Horizontal Antenna Polarity Measured Emissions

Note that the signal crossing the red limit line is the fundamental.

**Table 7.3.5: Field Strength of Spurious Emissions, 1 GHz to 5 GHz, Vertical Polarity**

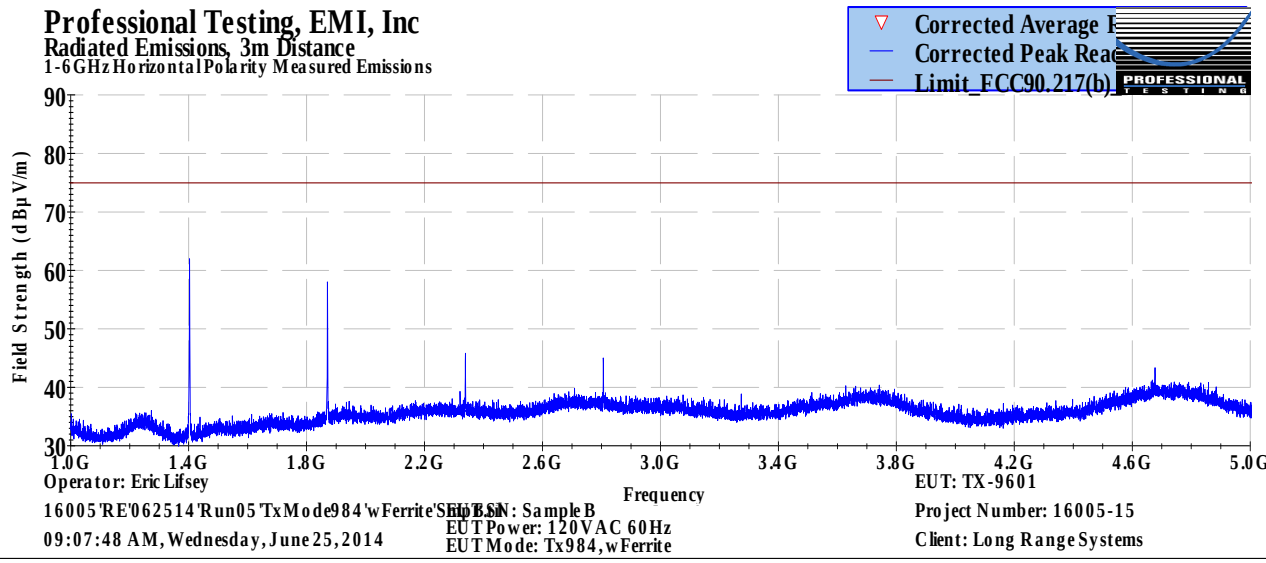
| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| **Test Method:** | ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | |
| **In accordance with:** | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | |
| **Section:** | 15.209 | | |
| **Test Date(s):** | 6/25/2014 | **EUT Serial #:** | None (Sample B) |
| **Customer:** | Long Range Systems LLC | **EUT Part #:** | TX-9601 |
| **Project Number:** | 16005-15 | **Test Technician:** | Eric Lifsey |
| **Purchase Order #:** | N/A | **Supervisor:** | Rob McCollough |
| **Equip. Under Test:** | TX-9601 | **Witness' Name:** | N/A |
| **Radiated Emissions Test Results Data Sheet** | | **Page:** | 1 of 1 |
| **EUT Line Voltage:** | 120 VAC | **EUT Power Frequency:** | 60 Hz |
| **Antenna Orientation:** | Vertical | **Frequency Range:** | Above 1GHz |
| **EUT Mode of Operation:** | | Transmit | |




**> 1GHz Vertical Antenna Polarity Measured Emissions**

**Table 7.3.6: Field Strength of Spurious Emissions, 1 GHz to 5 GHz, Horizontal Polarity**

| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| **Test Method:** | ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38). | | |
| **In accordance with:** | FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits | | |
| **Section:** | 15.209 | | |
| **Test Date(s):** | 6/25/2014 | **EUT Serial #:** | None (Sample B) |
| **Customer:** | Long Range Systems LLC | **EUT Part #:** | TX-9601 |
| **Project Number:** | 16005-15 | **Test Technician:** | Eric Lifsey |
| **Purchase Order #:** | N/A | **Supervisor:** | Rob McCollough |
| **Equip. Under Test:** | TX-9601 | **Witness' Name:** | N/A |
| **Radiated Emissions Test Results Data Sheet** | | **Page:** | 1 of 1 |
| **EUT Line Voltage:** | 120 VAC | **EUT Power Frequency:** | 60 Hz |
| **Antenna Orientation:** | Horizontal | **Frequency Range:** | Above 1GHz |
| **EUT Mode of Operation:** | | Transmit | |




**> 1GHz Horizontal Antenna Polarity Measured Emissions**

# 8.0 Mains Conducted Emissions [15.107 Class B]

Measurements of mains conducted emissions were taken on the EUT to determine the compliance to CFR 47, Part 15.

## 8.1 Procedure

The EUT was placed on a non-conductive table 0.8 meters above the floor and 0.4 meters from the conductive reference plane (wall). The EUT is powered through a line impedance stabilization network (LISN) that provides a measurement tap and a termination approximating 50 Ohms in the measurement range of 150 kHz to 30 MHz. A spectrum analyzer is connected, in turn, to each mains line measurement tap and software is employed to measure the radio frequency noise generated by the EUT.

## 8.2 Criteria

| Clause Subject | Section Number | Date |
|---|---|---|
| Mains Conducted Emissions, Class B | 15.107 | 2014-06-13 |

## 8.3 Results

**Table 8.3.1: Mains Conducted Emissions, Equipment List**

| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| Test Method: | ANSI C63.4–2009: Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (incorporated by reference, | | |
| In accordance with: | FCC Part 15.107 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Conducted Emissions Limits | | |
| Section: | 15.107 | | |
| Test Date(s): | 6/13/2014 | EUT Serial #: | None (Sample B) |
| Customer: | Long Range Systems | EUT Part #: | N/A |
| Project Number: | 16005-15 | Test Technician: | Eric Lifsey |
| Purchase Order #: | N/A | Supervisor: | Rob McCollough |
| Equip. Under Test: | TX-9601 | Witness' Name: | Mike Williams |

| Conducted Emissions Test Equipment List | |
|---|---|
| Tile! Software Version: | 4.1.A.0, April 14, 2009, 11:01:00PM |
| Test Profile: | Profile#: CE_2010.til, dated December 16, 2010 |

| Asset # | Manufacturer | Model | Equipment Nomenclature | Serial Number | Calibration Due Date |
|---|---|---|---|---|---|
| 1842 | HP | 8568B | Spectrum Analyzer | 2732A03633 | 6/17/2014 |
| 0045 | HP | 85662A | Spec Anal Dsply for AN1842 | 2816A16413 | N/A |
| 0990 | HP | 85685A | RF Preselector | 3010A01119 | 8/29/2014 |
| 1281 | HP | 85650A | Quasi Peak Adapter | 2043A00063 | 7/5/2014 |
| 1173 | PTI | 100k HPF | Filter, High Pass, 100kHz | none | 10/30/2014 |
| 1086 | PTI | PTI-ALF2 | Attenuator Limiter Filter | none | 5/7/2015 |
| C107 | Pomona | RG-223 | Cable 9 ft BNC RG-223 (black) | none | 7/10/2014 |
| C108 | Pomona | RG-223 | Cable 5.5 ft BNC RG-223 (black) | none | 7/10/2014 |
| 0939 | EMCO | 3825/2 | LISN, 10kHz-100MHz | 9603-2521 | 10/31/2014 |
| 1132 | AilTech | 91550-1M | Probe, Current, 10kHz-100MHz | 1856 | 1/8/2015 |
| 0936 | FCC | FCC-TLISN-T2 | TLISN-T2, 9kHz-30MHz, CISPR 22 | 20152 | 2/12/2015 |
| 0935 | FCC | FCC-TLISN-T4 | TLISN-T4, 9kHz-30MHz, CISPR 22 | 20153 | 2/12/2015 |
| 1683 | Teseq | ISN T800 | ISN-T8, Impedance Stabilization Network | 27091 | 4/16/2015 |
| 1185 | EMCO | 3825/2 | LISN, 10kHz-100MHz | 1235 | 10/31/2014 |

**Table 8.3.2: Mains Conducted Emissions, Measurement Bandwidths**

| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| **Test Method:** | **ANSI C63.4–2009: Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (incorporated by reference,** | | |
| **In accordance with:** | **FCC Part 15.107 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Conducted Emissions Limits** | | |
| **Section:** | **15.107** | | |
| **Test Date(s):** | **6/13/2014** | **EUT Serial #:** | **None (Sample B)** |
| **Customer:** | **Long Range Systems** | **EUT Part #:** | **N/A** |
| **Project Number:** | **16005-15** | **Test Technician:** | **Eric Lifsey** |
| **Purchase Order #:** | **N/A** | **Supervisor:** | **Rob McCollough** |
| **Equip. Under Test:** | **TX-9601** | **Witness' Name:** | **Mike Williams** |

| Conducted Emissions Spectrum Analyzer Bandwidth and Measurement Time | | | | |
|---|---|---|---|---|
| **Frequency Band Start (MHz)** | **Frequency Band Stop (MHz)** | **6 dB Bandwidth (kHz)** | **Number of Ranges Used** | **Measurement Time per Range** |
| 0.01 | 0.15 | 0.3 | 7 | Five 1 second sweeps |
| 0.15 | 30 | 9 | 20 | Five 1 second sweeps |

*Notes:
1. The settings above are specifically calculated for the HP856X series of spectrum analyzers, which have 1,000 data points per range.
2. The measurement receiver resolution bandwidth setting was 300 Hz for quasi-peak measurements from 10-150 kHz.
3. The measurement receiver resolution bandwidth setting was 9 kHz for quasi-peak measurements from 0.15-30 MHz.

**Table 8.3.3: Mains Conducted Emissions, Neutral Line**

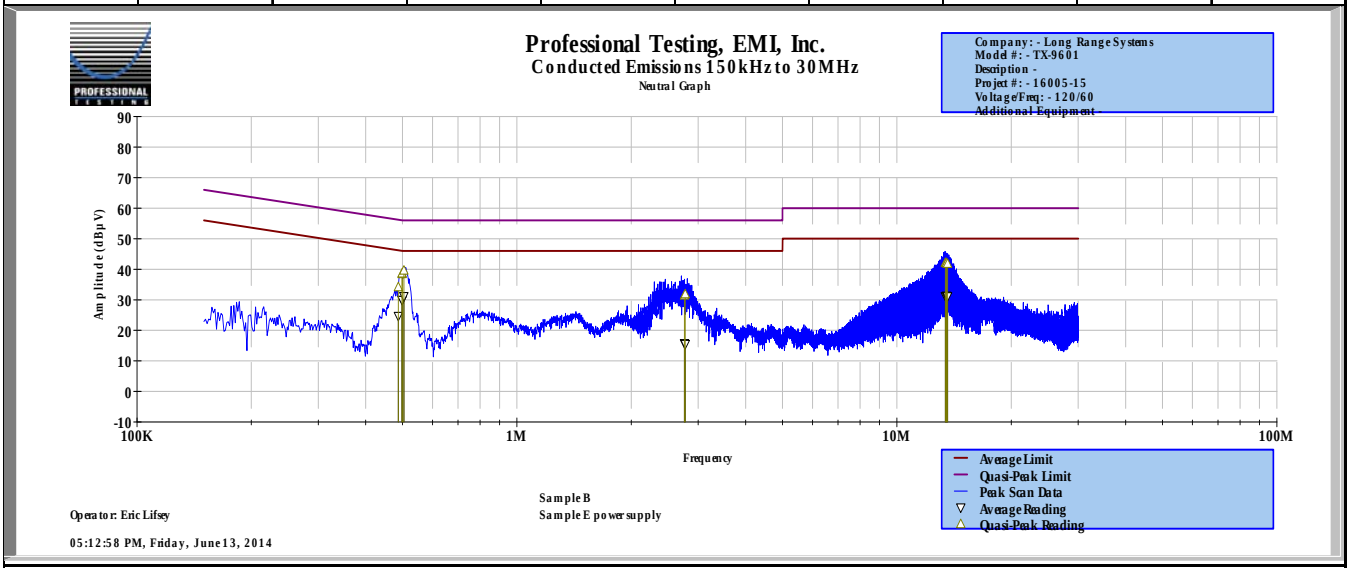
## Professional Testing, EMI, Inc.

| | | | |
|---|---|---|---|
| **Test Method:** | ANSI C63.4–2009: Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (incorporated by reference, see §15.38). | | |
| **In accordance with:** | FCC Part 15.107 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Conducted Emissions Limits | | |
| **Section:** | 15.107 | | |
| **Test Date(s):** | 6/13/2014 | **EUT Serial #:** | None (Sample B) |
| **Customer:** | Long Range Systems | **EUT Part #:** | N/A |
| **Project Number:** | 16005-15 | **Test Technician:** | Eric Lifsey |
| **Purchase Order #:** | N/A | **Supervisor:** | Rob McCollough |
| **Equip. Under Test:** | TX-9601 | **Witness' Name:** | Mike Williams |

**Conducted Emissions Test Results Data Sheet - Neutral Lead** **Page: 1 of 2**

| **EUT Line Voltage:** | **120** | **VAC** | **EUT Line Frequency:** | **60** | **Hz** |
|---|---|---|---|---|---|

| Frequency Measured (MHz) | Peak Detector Reading (dBµV) | Quasi-peak Detector Reading (dBµV) | Quasi-peak Detector Limit (dBµV) | Quasi-peak Detector Margin (dB) | Quasi-peak Detector Test Results | Average Detector Reading (dBµV) | Average Detector Limit (dBµV) | Average Detector Margin (dB) | Average Detector Test Results |
|---|---|---|---|---|---|---|---|---|---|
| 0.48719 | 36.1 | 34.1 | 56.2 | -22.1 | PASS | 24.7 | 46.2 | -21.5 | PASS |
| 0.498632 | 41.4 | 38.4 | 56 | -17.6 | PASS | 29.9 | 46 | -16.1 | PASS |
| 0.49878 | 40.2 | 38.6 | 56 | -17.5 | PASS | 29.9 | 46 | -16.1 | PASS |
| 0.504103 | 41.7 | 39.5 | 56 | -16.5 | PASS | 31.2 | 46 | -14.8 | PASS |
| 2.759 | 38.1 | 31.3 | 56 | -24.7 | PASS | 15.8 | 46 | -30.2 | PASS |
| 2.7717 | 38.4 | 31.8 | 56 | -24.2 | PASS | 15.5 | 46 | -30.5 | PASS |
| 13.4062 | 45.5 | 42 | 60 | -18 | PASS | 31.2 | 50 | -18.8 | PASS |
| 13.4648 | 46.1 | 42 | 60 | -18 | PASS | 31.2 | 50 | -18.8 | PASS |
| 13.5078 | 45.8 | 41.9 | 60 | -18.1 | PASS | 31.3 | 50 | -18.7 | PASS |
| 13.594 | 45.5 | 41.7 | 60 | -18.3 | PASS | 31.2 | 50 | -18.8 | PASS |




**Measured Conducted Emissions - Neutral Lead**

**Table 8.3.4: Mains Conducted Emissions, Phase Line**

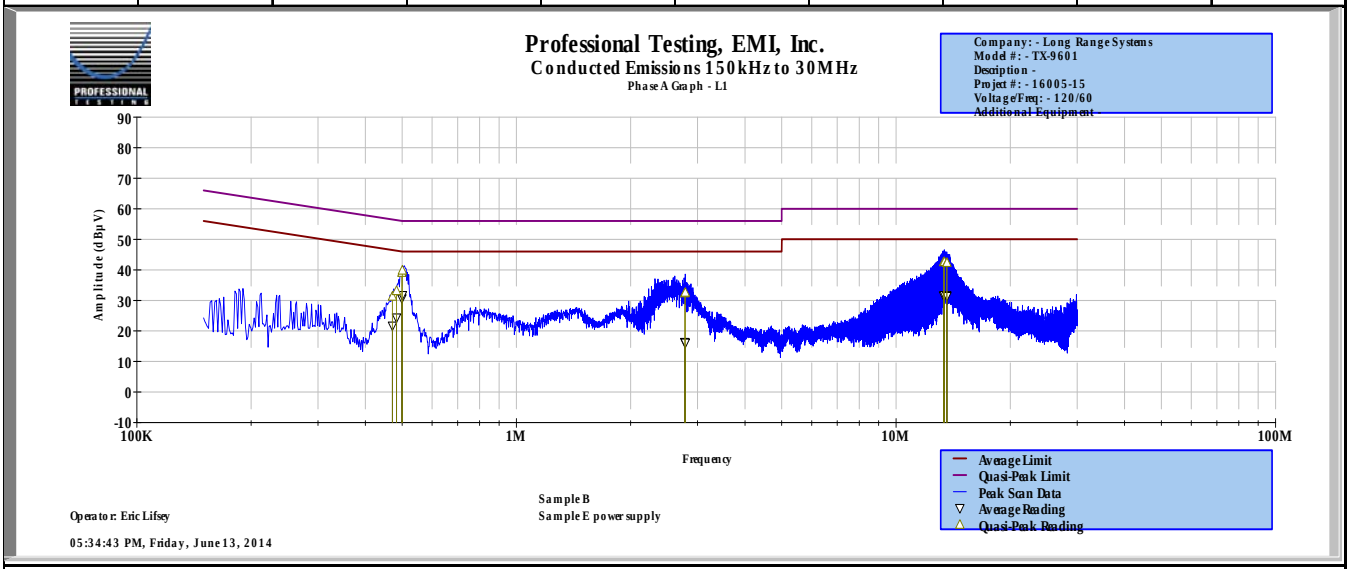
## Professional Testing, EMI, Inc.

| | | | |
|---|---|---|---|
| **Test Method:** | ANSI C63.4–2009: Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (incorporated by reference, see §15.38). | | |
| **In accordance with:** | FCC Part 15.107 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Conducted Emissions Limits | | |
| **Section:** | 15.107 | | |
| **Test Date(s):** | 6/13/2014 | **EUT Serial #:** | None (Sample B) |
| **Customer:** | Long Range Systems | **EUT Part #:** | N/A |
| **Project Number:** | 16005-15 | **Test Technician:** | Eric Lifsey |
| **Purchase Order #:** | N/A | **Supervisor:** | Rob McCollough |
| **Equip. Under Test:** | TX-9601 | **Witness' Name:** | Mike Williams |

**Conducted Emissions Test Results Data Sheet - Phase Lead (Line 1)** **Page: 2 of 2**

| EUT Line Voltage: | 120 | VAC | EUT Line Frequency: | 60 | Hz |
|---|---|---|---|---|---|

| Frequency Measured (MHz) | Peak Detector Reading (dBµV) | Quasi-peak Detector Reading (dBµV) | Quasi-peak Detector Limit (dBµV) | Quasi-peak Detector Margin (dB) | Quasi-peak Detector Test Results | Average Detector Reading (dBµV) | Average Detector Limit (dBµV) | Average Detector Margin (dB) | Average Detector Test Results |
|---|---|---|---|---|---|---|---|---|---|
| 0.47148 | 33.9 | 31.2 | 56.5 | -25.2 | PASS | 21.7 | 46.5 | -24.8 | PASS |
| 0.48306 | 34.7 | 33.1 | 56.3 | -23.2 | PASS | 24.4 | 46.3 | -21.9 | PASS |
| 0.49893 | 41 | 39 | 56 | -17 | PASS | 30.7 | 46 | -15.4 | PASS |
| 0.500725 | 42.3 | 39.8 | 56 | -16.2 | PASS | 31.7 | 46 | -14.3 | PASS |
| 2.7762 | 38.6 | 32.3 | 56 | -23.7 | PASS | 16.3 | 46 | -29.7 | PASS |
| 2.7839 | 39.6 | 32.5 | 56 | -23.5 | PASS | 16.2 | 46 | -29.8 | PASS |
| 13.3414 | 46.3 | 42.5 | 60 | -17.5 | PASS | 31.6 | 50 | -18.4 | PASS |
| 13.4023 | 46.5 | 42.6 | 60 | -17.4 | PASS | 31.7 | 50 | -18.3 | PASS |
| 13.5965 | 46.2 | 42.2 | 60 | -17.8 | PASS | 31.7 | 50 | -18.3 | PASS |
| 13.6154 | 46.5 | 42.2 | 60 | -17.8 | PASS | 31.4 | 50 | -18.6 | PASS |




**Measured Conducted Emissions - Phase Lead (Line 1)**

# 9.0 Frequency Stability [90.217(b)]

The EUT operating frequency is measured under conditions of ambient operating temperatures, then for conditions of operating mains voltage.

## 9.1 Procedure

The EUT is placed into a temperature chamber with a small dipole to pass the transmitted signal to a spectrum analyzer. On reaching each set point temperature, the EUT is allowed to soak at least 20 minutes without power applied. After soak time was satisfied, the EUT is powered on in transmit mode and the frequency is observed until it becomes stable; then the measurement of frequency is taken. The time required to become stable is also recorded.

Operating voltage stability was also measured for extremes of +/- 15% from nominal. In this case the power source is the AC mains.

## 9.2 Criteria

The operating frequency shall remain within +/- 25 kHz of the assigned channel.

## 9.3 Results

**Table 9.3.1 Equipment List**

| Asset # | Manufacturer | Model # | Description | Calibration Due |
|---|---|---|---|---|
| ALN-077 | Rohde & Schwarz | FSP-30 | Spectrum Analyzer | 2015-01-29 |
| 2087 | Fluke | 189 | DMM | 2015-03-06 |
| 0428 | Powerstat | 146 | Variac, 120V 30A | Not Required |
| 0881 | Thermotron | S-1.2C | Temperature Chamber | 2014-09-13 |
| C144 | Unspecified | RG-223 | Coaxial Cable, Double Shielded | Not Required |

| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| Test Method: | TIA-603-C-2004 Land Mobile FM or PM - Communications Equipment - Measurement and Performance Standards | | |
| Section: | 3.2.2 [FCC 2.1055(a)(1)] | EUT Typical Operation Mode: | Unmod. TX, FSK Shifted Down |
| Test Date(s): | 6/18/2014 | EUT Serial #: | None |
| Customer: | Long Range Systems | EUT Part #: | TX-9601 |
| Project Number: | 16005-15 | Test Technician: | Eric Lifsey |
| Purchase Order #: | N/A | Supervisor | Rob McCollough |
| Equipment Under Test: | TX-9601 | Witness' Name: | None |

**Mobile Criteria (per exemption paragraph): +/- 25 kHz at -30 dBc**

| Condition | Frequency | | Deviation | | Soak Time | |
|---|---|---|---|---|---|---|
| Temperature (C) | Reference Center Frequency (MHz) | Measured Frequency (MHz) | Calculated Deviation (Hz) | Deviation Increased by 50% of Channel BW (Hz) | Power-Off (min) | Power-On (min) |
| -30 | 467.750000 | 467.742640000 | -7360.0000000 | -13610.00000001 | 15 | 10 |
| -20 | 467.750000 | 467.745420000 | -4580.0000000 | -10829.99999998 | 15 | 5 |
| -10 | 467.750000 | 467.747060000 | -2940.0000000 | -9190.00000002 | 15 | 5 |
| 0 | 467.750000 | 467.747840000 | -2160.0000000 | -8410.00000000 | 15 | 4 |
| 10 | 467.750000 | 467.748060000 | -1940.0000000 | -8189.99999999 | 15 | 4 |
| 20 | 467.750000 | 467.748020000 | -1980.0000000 | -8230.00000000 | 15 | 4 |
| 30 | 467.750000 | 467.748300000 | -1700.0000000 | -7950.00000003 | 15 | 5 |
| 40 | 467.750000 | 467.748840000 | -1160.0000000 | -7410.00000003 | 15 | 5 |
| 50 | 467.750000 | 467.749640000 | -360.0000000 | -6610.00000000 | 15 | 15 |

EUT lower FSK frequency spur measured. EUT plus worse case channel BW remained within 25 kHz of center frequency.

| Professional Testing, EMI, Inc. | | | |
|---|---|---|---|
| Test Method: | TIA-603-C-2004 Land Mobile FM or PM - Communications Equipment - Measurement and Performance Standards | | |
| Section: | 3.3.1 [FCC 2.1055(d)(1)] | EUT Typical Operation Mode: | Unmod. TX, FSK Shifted Down |
| Test Date(s): | 6/18/2014 | EUT Serial #: | None |
| Customer: | Long Range Systems | EUT Part #: | TX-9601 |
| Project Number: | 16005-15 | Test Technician: | Eric Lifsey |
| Purchase Order #: | N/A | Supervisor | Rob McCollough |
| Equipment Under Test: | TX-9601 | Witness' Name: | None |

| Condition | Frequency | | | Deviation | Voltage |
|---|---|---|---|---|---|
| Voltage Extreme | Reference Frequency (MHz)* | Measured Frequency (MHz) | Calculated Deviation (Hz) | Calculated Deviation (ppm) | Measured Voltage (V AC) |
| -15% | 467.748320 | 467.748300000 | -20.000000006 | -0.042758037 | 106.26 |
| Nominal | 467.748320 | 467.748320000 | 0.000000000 | 0.000000000 | 125.20 |
| +15% | 467.748320 | 467.748280000 | -39.999999956 | -0.085516074 | 143.75 |

Note that the +15% mains voltage was calculated from a nominal assumed as 125 VAC.

# 10.0 Emission Bandwidth [90.210(d)]

## 10.1 Procedure

The EUT antenna port is coupled through a power attenuator to a spectrum analyzer and then is placed into continuous transmit mode with modulation. The connection is direct and no cables are used. The modulated signal is then measured directly in a manner consistent with power measurement. Resolution bandwidth is typically ~1-3 percent of the bandwidth of ~12 kHz max where that range is 120 Hz to 360 Hz; 300 Hz RBW is selected for measurement.

## 10.2 Criteria

| Clause Requirement | Section Number | Date |
|---|---|---|
| 90.210(d) Bandwidth < 12. 5 kHz | 90.210(d)(1), 2.1051 | 2014-06-13 |

## 10.3 Results

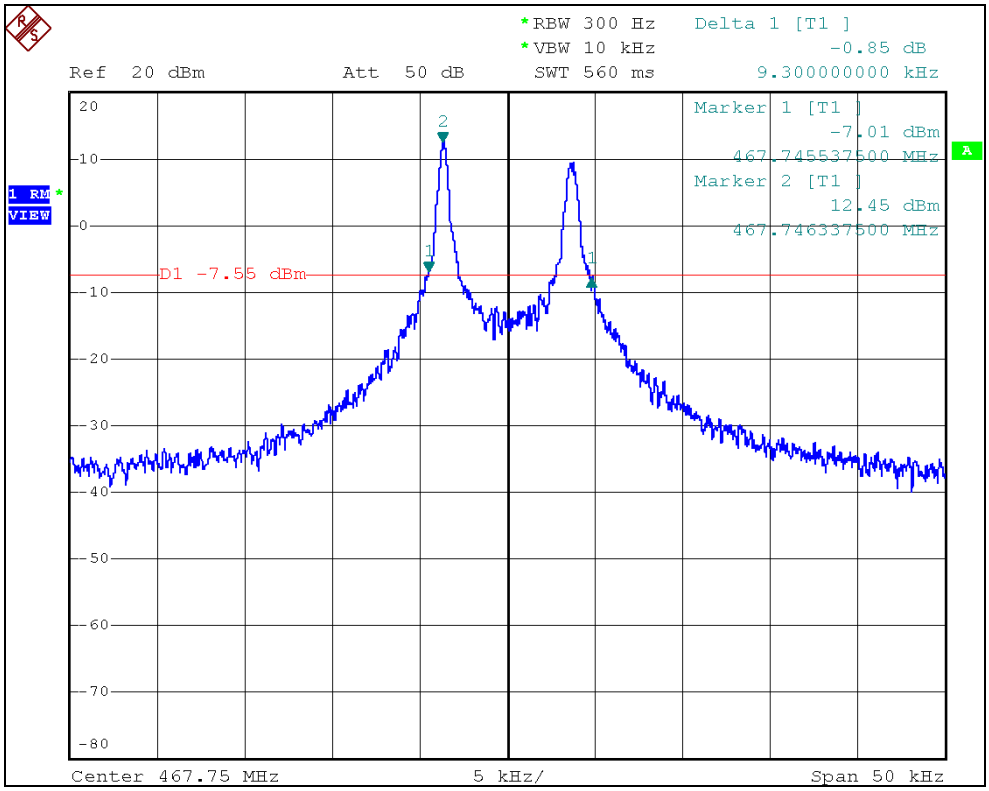
**Table 11.3.1 Equipment List**

| Asset # | Manufacturer | Model # | Description | Calibration Due |
|---|---|---|---|---|
| ALN-077 | Rohde & Schwarz | FSP-30 | Spectrum Analyzer | 2015-01-29 |

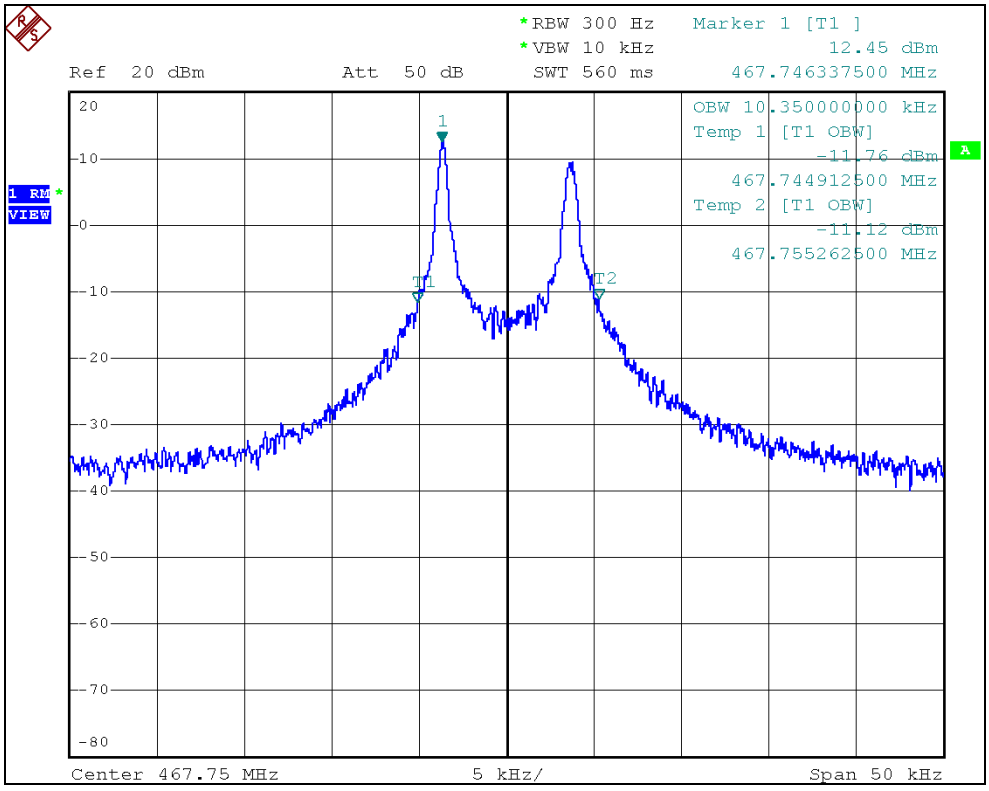
**Table 11.3.2 Bandwidth**

| Bandwidth Measurement Method | Measured Bandwidth |
|---|---|
| 20 dB | 9.3 kHz |
| OBW Instrument Measurement | 10.35 kHz |

The emission satisfies the bandwidth criteria. Plotted results appear below.




Bandwidth, 20 dB




Bandwidth, OBW

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

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

## 1. Rationale and Summary of Expanded Uncertainty.

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

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

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

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

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

**Table 1: Summary of Measurement Uncertainties for Site 45**

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

## End of Report

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