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

April 22, 2014

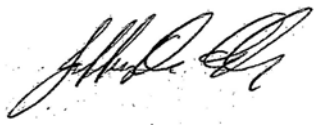
John Weber
Long Range Systems, LLC
4550 Excel Parkway Suite 200
Addison TX 75001

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-7470 LRS Paging 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-7470
LRS Paging 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

April 22, 2014

Reviewed by

Larry Finn
Regulatory Design Engineer

Written by

Eric Lifsey
Test Engineer

Revision History

Revision Number	Description	Date
00	Initial draft for review.	April 22, 2014
01	Revised per Larry Finn review.	April 22, 2014

Table of Contents

Certificate of Compliance

Applicant:	Long Range Systems, LLC (John Weber)
Applicant's Address:	Long Range Systems, LLC 4550 Excel Parkway Suite 200 Addison, Texas 75001
FCC ID:	2AB6O7470
Model(s):	TX-7470 and TX-7470-C232
Project Number:	15689-10

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

47 CFR, Part 90		
Clause Subject	**Section References**	**Date**
Conducted Output Power	90.210, 2.1046	March 20, 2014
Emission Mask	90.210, 2.1047	March 28, 2014
Conducted Spurious/Harmonic Emissions at Antenna Terminals	90.210, 2.1051	March 26, 2014
Field Strength of Radiated Spurious/Harmonic Emissions Fundamental to 5 GHz	90.210, 2.1053	March 19, 24-26, 2014
Transient Frequency Behavior	90.214, TIA/EIA-603C	March 21, 2014
Frequency Stability	90.213, 2.1055	March 21, 2014
Occupied Bandwidth, 20 dB	90.209, 2.1049	March 20, 2014
Radiated Emissions 30MHz – 6 GHz	15.109, ICES-003	March 19, 26, 2014
Mains Conducted Emissions, Class B	15.107, ICES-003	March 19, 2014
Maximum Permissible Exposure	Reported separately.	April 13, 2014

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 models 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 a plastic enclosure with optional 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-7470	None	467.75 MHz paging transmitter

Table 1.2.2 Other Model(s) Represented by EUT

Manufacturer	Model	Serial #	Description
Long Range Systems, LLC*	TX-7470-C232	N/A	467.75 MHz paging transmitter

*This is a sub-equipped model with same RF characteristics as the EUT but is solely controlled by a serial port. It has no display or keypad.

Photograph 1.3.1: EUT TX-7470

1.3 EUT Operation

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

1.4 Modifications to Equipment

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

1.5 Test Site

Measurements were made at the PTI semi-anechoic facility designated Site 45 (FCC 459644, IC 3036B-1) in Austin, Texas. The site is registered with the FCC under Section 2.948 and Industry Canada per RS-212, 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

This device operates on frequencies assigned to the Iridium satellite communication services, as such 47 CFR, Part 25, applies as shown below.

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	Yes	Pass
Emission Mask	90.210, 2.1047	Yes	Pass
Conducted Spurious/Harmonic Emissions at Antenna Terminals	90.210, 2.1051	Yes	Pass
Field Strength of Radiated Spurious/Harmonic Emissions Fundamental to 5 GHz	90.210, 2.1053	Yes	Pass
Transient Frequency Behavior	90.214, TIA/EIA-603C	Yes	Pass
Frequency Stability	90.213, 2.1055	Yes	Pass
Occupied Bandwidth, 20 dB	90.209, 2.1049	Yes	Pass
Radiated Emissions 30MHz – 6 GHz[1]	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

[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.

3.0 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 spectrum analyzer amplitude is offset to compensate for the attenuator calibrated power loss. 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	2014-03-20

3.3 Results

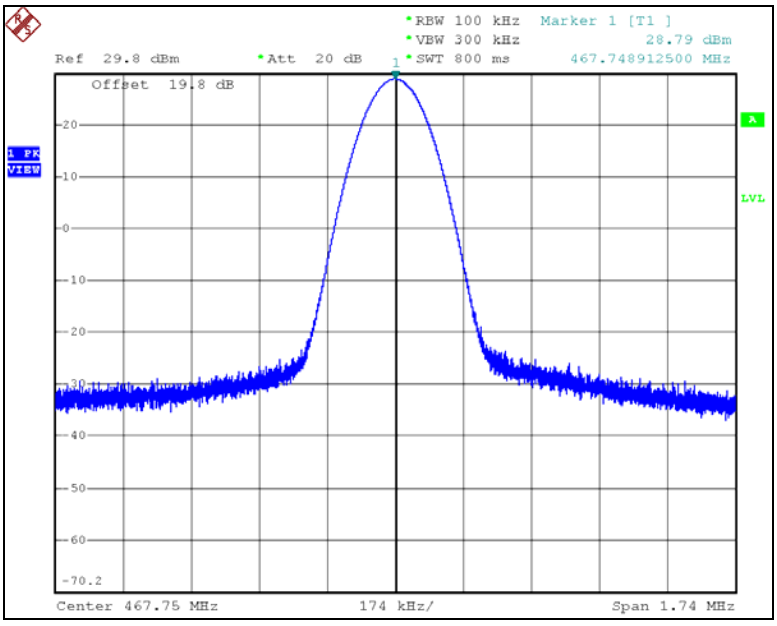
The EUT is in compliance with the applicable requirements. Plotted results are presented below.

Table 3.3.1 Equipment List

Asset #	Manufacturer	Model #	Description	Calibration Due
ALN-077	Rohde & Schwarz	FSP-30	Spectrum Analyzer	2015-01-29
A105	Narda	768A-20	20 Watt 20 dB Attenuator, DC to 11 GHz	2014-04-16

Table 3.3.2 Power, Conducted

Frequency	Measured Level
467.750 MHz	28.79 dBm (757 mW)



Peak Power, Conducted

4.0 Emission Mask [90.210(d)(1-3)]

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 spectrum analyzer amplitude is offset to compensate for the attenuator calibrated power loss. 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

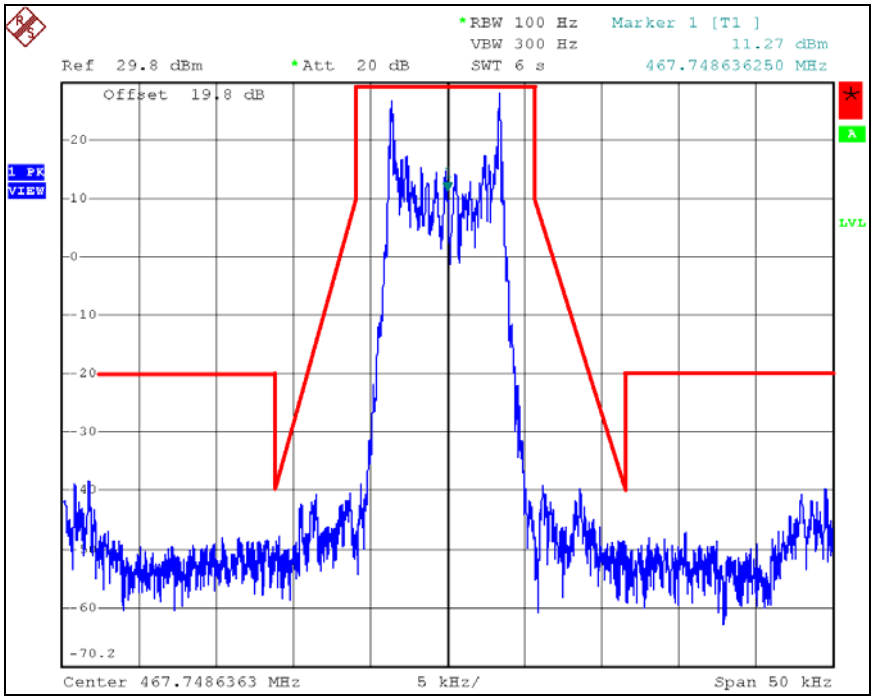
Guideline	Section Number	Date
Emissions at Antenna Terminals	90.210(d)(1-3), 2.1051	2014-03-28

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
A105	Narda	768A-20	20 Watt 20 dB Attenuator, DC to 11 GHz	2014-04-16

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



Modulated Emission with Superimposed Mask of 90.210(d)(1 to 3)

5.0 Spurious Emissions at Antenna Terminals [90.210(e)(3)]

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 spectrum analyzer amplitude is offset to compensate for the attenuator calibrated power loss. 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	90.210(e)(3), 2.1051	2014-03-26

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 90.210(e)(3) for emissions beyond 4.6 kHz from authorized bandwidth. (Note that paragraph 90.210(e)(3) selected as worse-case criteria for future bandwidth interest as the limit is 5 dB lower than section 90.210(e)(3).)

Per 90.210(e)(3) $\text{Attenuation}_{(dB)} = 55 + \text{Log}_{10}(0.757\ W) = 54.88\ dB$

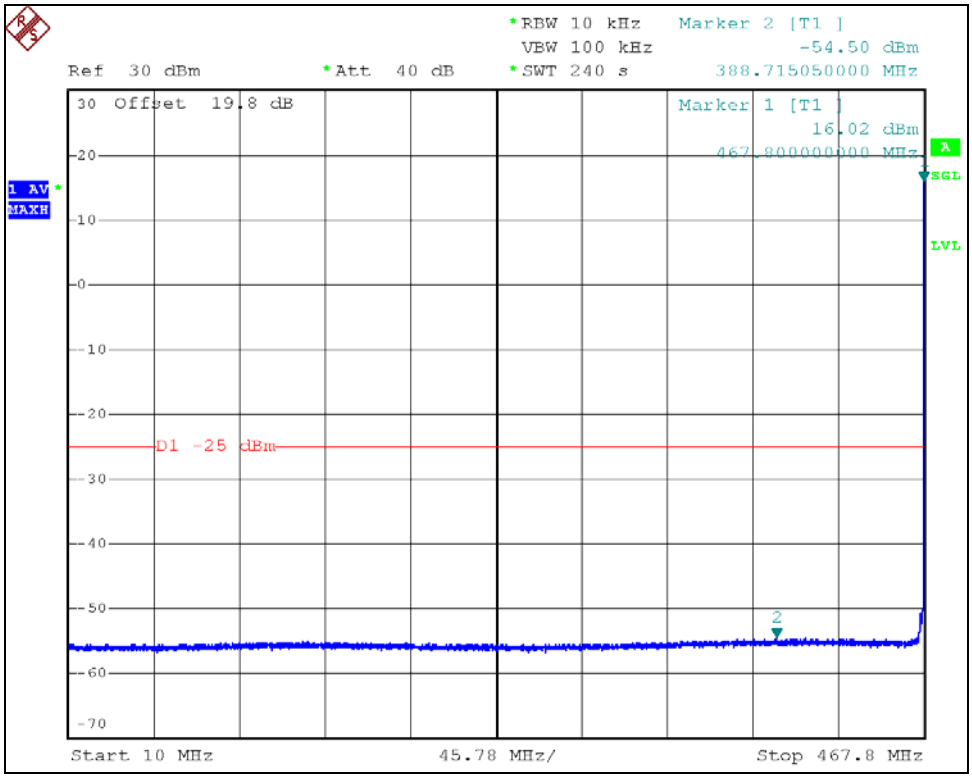
$\text{Limit}_{(dBm)} = \text{Fundamental\_Power}_{(dBm)} - \text{Attenuation}_{(dB)} = 28.79\ dBm - 54.88\ dB = -26.09\ dBm$

5.3 Results

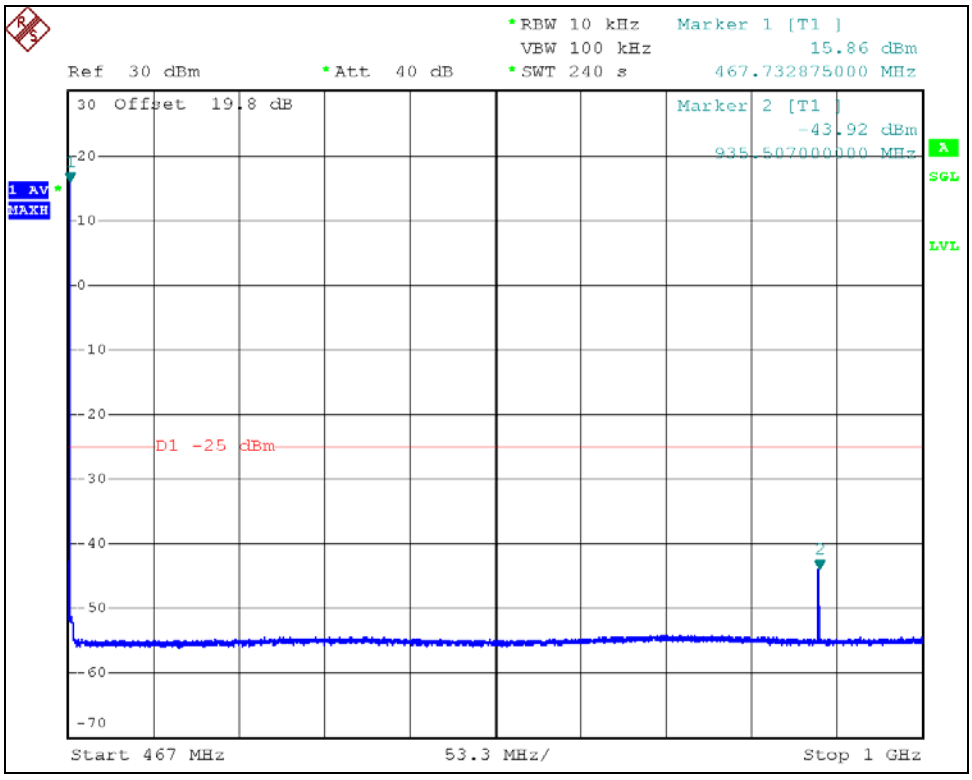
Table 5.3.1 Equipment List

Asset #	Manufacturer	Model #	Description	Calibration Due
ALN-077	Rohde & Schwarz	FSP-30	Spectrum Analyzer	2015-01-29
A105	Narda	768A-20	20 Watt 20 dB Attenuator, DC to 11 GHz	2014-04-16

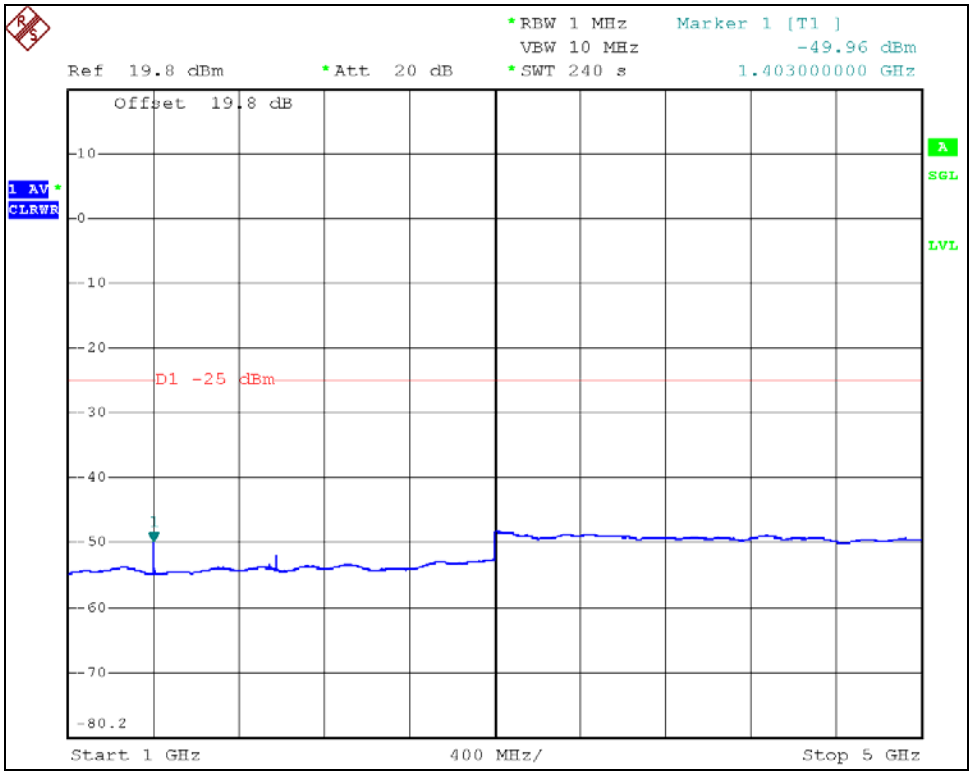
Highest spurious emission was found to be in excess of 17 dB below the limit. The EUT was found to be in compliance with applicable requirements for both current operating bandwidth and the future operating bandwidth. Plotted results are presented below.



Span: 10 MHz to Fundamental
(Fundamental visible on right edge of plot area.)
(Red line at -25 dBm, limit is 1.1 dB lower at -26.09 dBm.)



Span: Fundamental to 1 GHz
(Fundamental visible on left edge of plot.)
(Red line at -25 dBm, limit is 1.1 dB lower at -26.09 dBm.)



Span: 1 GHz to 5 GHz
(Red line at -25 dBm, limit is 1.1 dB lower at -26.09 dBm.)

6.0 Field Strength of Radiated Unintentional Emissions – Receive 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 receive 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.

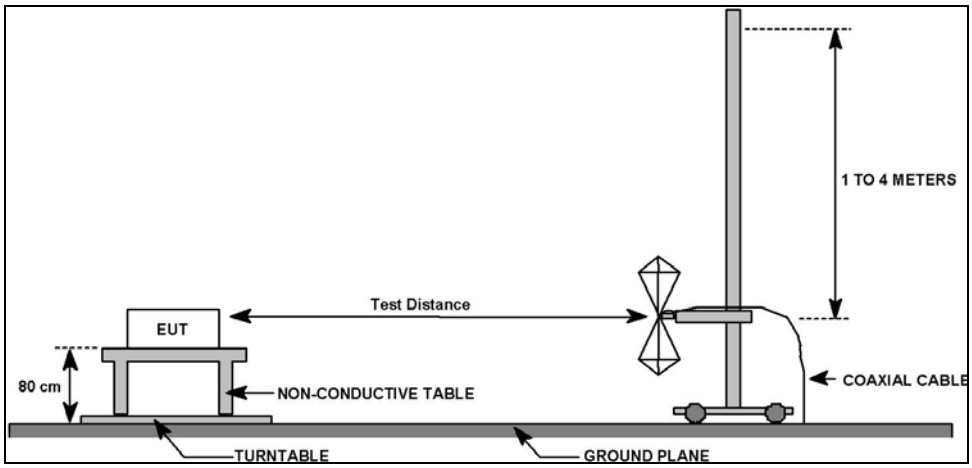


Figure 6.1.1: Field Strength of Radiated Emissions Test Setup

6.2 Criteria

Clause Subject	Section Number	Date
Field Strength of Radiated Unintentional Emissions 30 MHz to 5 GHz	15.109	2014-03-19

6.3 Results

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,**		
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):	**3/19/2014**	**EUT Serial #:**	**1**
Customer:	**Tenx Precision**	**EUT Part #:**	**None**
Project Number:	**15689-10**	**Test Technician:**	**Larry Fuller**
Purchase Order #:		**Supervisor:**	**Rob McCollough**
Equip. Under Test:	**TX-7470**	**Witness' Name:**	**Jason Gossiaux**

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 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 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits**		
Section:	**15.109**		
Test Date(s):	**3/19/2014**	**EUT Serial #:**	**1**
Customer:	**Tenx Precision**	**EUT Part #:**	**None**
Project Number:	**15689-10**	**Test Technician:**	**Larry Fuller**
Purchase Order #:		**Supervisor:**	**Rob McCollough**
Equip. Under Test:	**TX-7470**	**Witness' Name:**	**Jason Gossiaux**

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

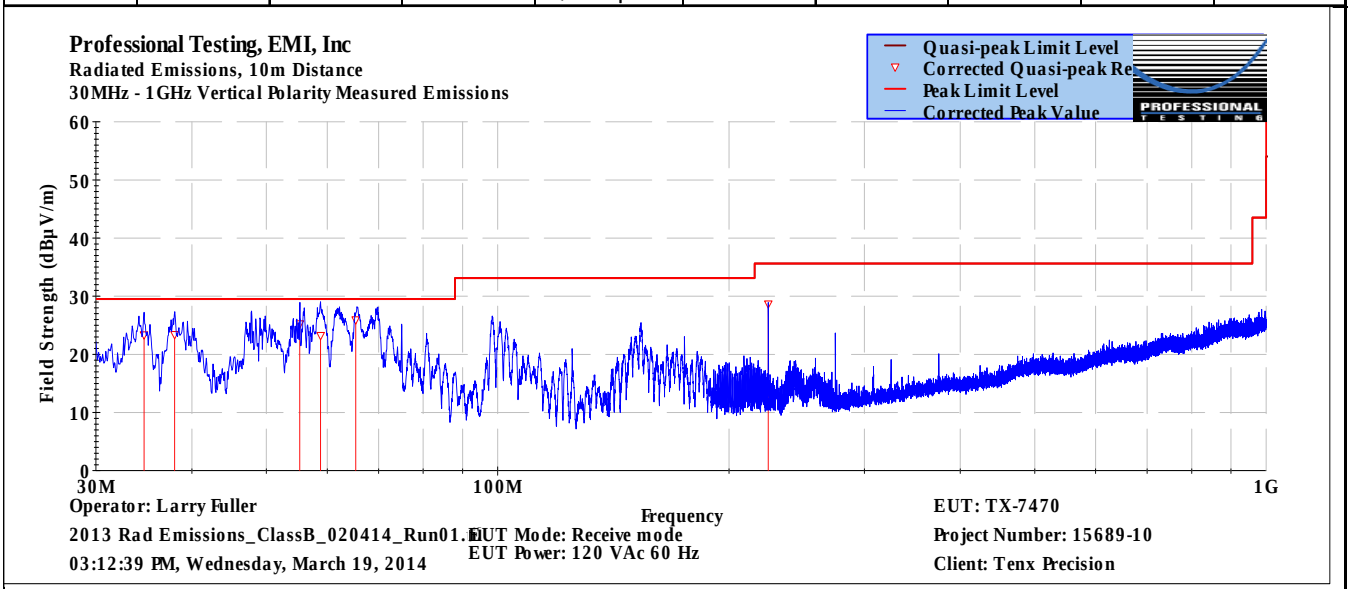
*Notes:
1. The settings above are specifically calculated for the E4440A series of spectrum analyzers, which have 8,000 data points per range.
2. The measurement receiver resolution bandwidth setting was 300 Hz for quasi-peak measurements from 9-150 kHz.
3. The measurement receiver resolution bandwidth 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):	3/19/2014	EUT Serial #:	1
Customer:	Tenx Precision	EUT Part #:	None
Project Number:	15689-10	Test Technician:	Larry Fuller
Purchase Order #:		Supervisor:	Rob McCollough
Equip. Under Test:	TX-7470	Witness' Name:	Jason Gossiaux

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:		Receive mode	

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
34.6567	10	341	1.42	Quasi-peak	36.9	23.332	29.5	-6.2	Pass
37.9823	10	35	1.61	Quasi-peak	38.8	23.381	29.5	-6.1	Pass
55.2732	10	256	3.74	Quasi-peak	46	25.209	29.5	-4.3	Pass
58.811	10	6	1.99	Quasi-peak	44.4	23.224	29.5	-6.3	Pass
65.3398	10	348	1.66	Quasi-peak	47.3	25.896	29.5	-3.6	Pass
225.01	10	270	1.23	Quasi-peak	44.2	28.644	35.6	-7.0	Pass



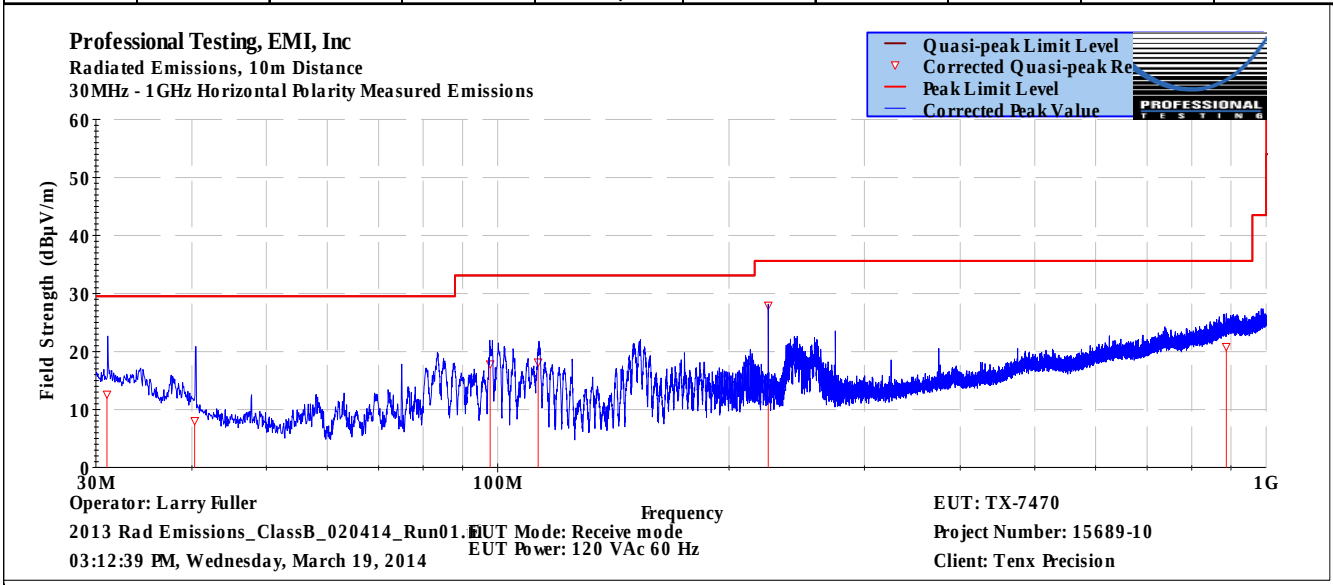
≤ 1GHz Vertical Antenna Polarity Measured Emissions

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):	3/19/2014	EUT Serial #:	1
Customer:	Tenx Precision	EUT Part #:	None
Project Number:	15689-10	Test Technician:	Larry Fuller
Purchase Order #:		Supervisor:	Rob McCollough
Equip. Under Test:	TX-7470	Witness' Name:	Jason Gossiaux

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:		Receive mode	

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
31.0108	10	45	3.71	Quasi-peak	24.2	12.637	29.5	-16.9	Pass
40.3331	10	237	1.26	Quasi-peak	24.7	8.065	29.5	-21.4	Pass
97.7865	10	79	3.94	Quasi-peak	38.1	17.838	33.1	-15.3	Pass
112.893	10	262	3.83	Quasi-peak	38.7	18.166	33.1	-14.9	Pass
225.024	10	57	3.81	Quasi-peak	43.5	27.955	35.6	-7.6	Pass
887.466	10	38	3.53	Quasi-peak	21.4	20.82	35.6	-14.8	Pass



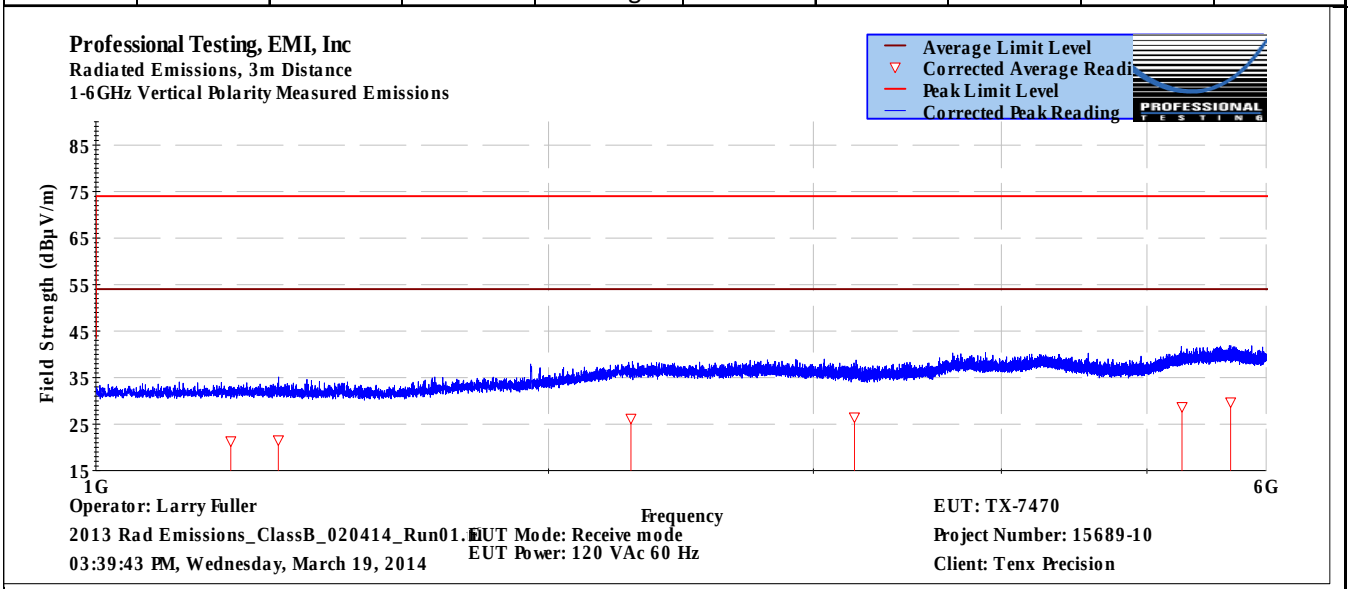
≤ 1GHz Horizontal Antenna Polarity Measured Emissions

Table 6.3.5: 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 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits		
Section:	15.109		
Test Date(s):	3/19/2014	EUT Serial #:	1
Customer:	Tenx Precision	EUT Part #:	None
Project Number:	15689-10	Test Technician:	Larry Fuller
Purchase Order #:		Supervisor:	Rob McCollough
Equip. Under Test:	TX-7470	Witness' Name:	Jason Gossiaux

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:		Receive mode	

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
1229.3	3	22	1	Average	33.8	21.385	54.0	-32.6	Pass
1322.3	3	53	1	Average	34.1	21.592	54.0	-32.4	Pass
2268.85	3	349	1	Average	35.1	26.252	54.0	-27.7	Pass
3194.61	3	13	1	Average	34	26.505	54.0	-27.5	Pass
5275.43	3	85	1	Average	32.2	28.757	54.0	-25.2	Pass
5683.38	3	179	1	Average	31.8	29.751	54.0	-24.2	Pass



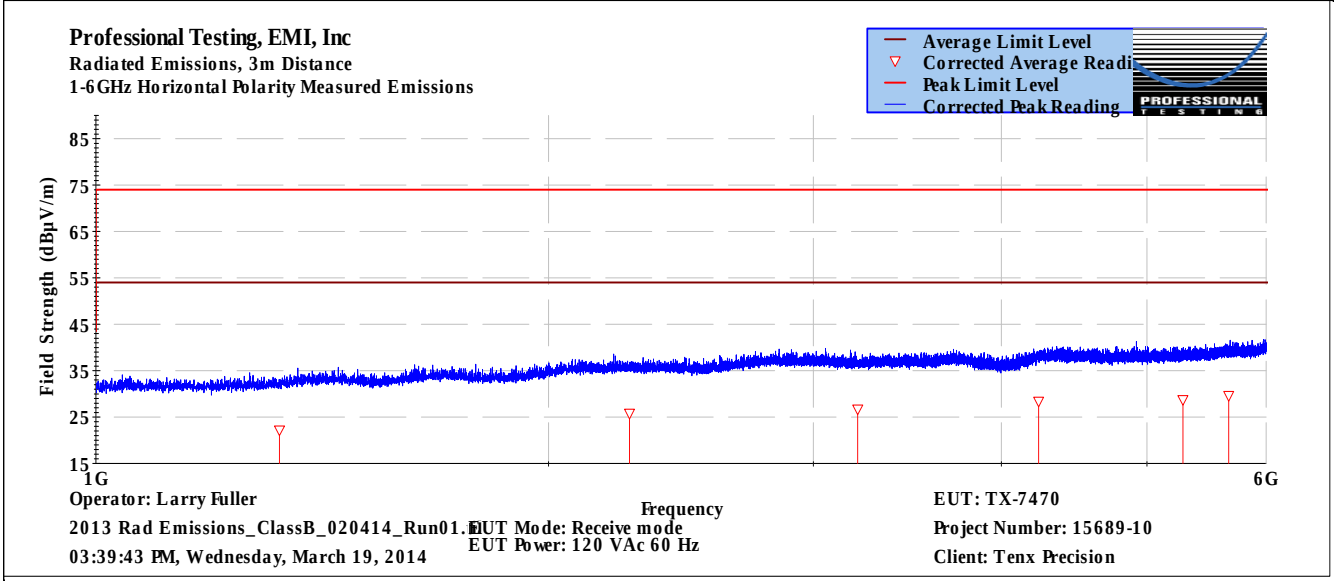
> 1GHz Vertical Antenna Polarity Measured Emissions

Table 6.3.6: 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 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits		
Section:	15.109		
Test Date(s):	3/19/2014	EUT Serial #:	1
Customer:	Tenx Precision	EUT Part #:	None
Project Number:	15689-10	Test Technician:	Larry Fuller
Purchase Order #:		Supervisor:	Rob McCollough
Equip. Under Test:	TX-7470	Witness' Name:	Jason Gossiaux

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:		Receive mode	

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
1324.48	3	178	1	Average	34.7	22.204	54.0	-31.8	Pass
2263.67	3	258	1	Average	34.7	25.801	54.0	-28.2	Pass
3210.49	3	201	1	Average	34.3	26.724	54.0	-27.2	Pass
4235.28	3	136	1	Average	33.8	28.42	54.0	-25.5	Pass
5281.82	3	45	1	Average	32.2	28.727	54.0	-25.2	Pass
5666.49	3	351	1	Average	31.8	29.619	54.0	-24.3	Pass



> 1GHz Horizontal Antenna Polarity Measured Emissions

7.0 Field Strength of Radiated Spurious Emissions – Transmit Mode [90.210(d)]

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.

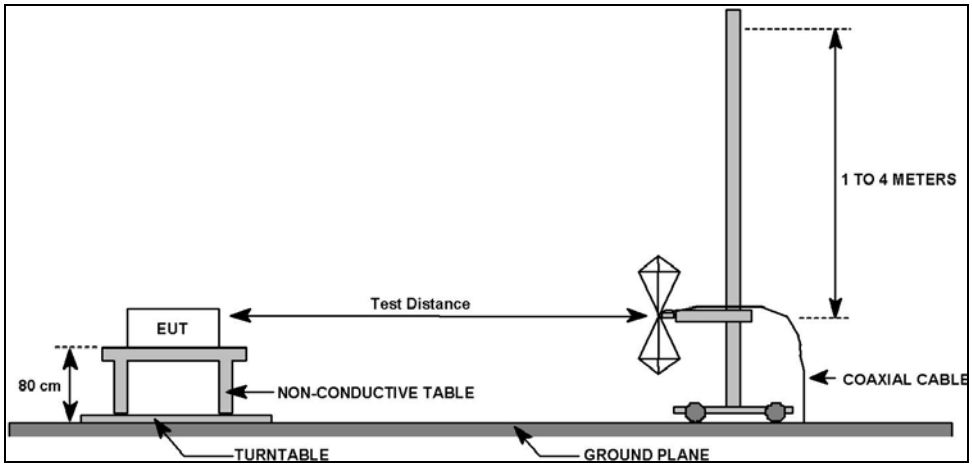


Figure 7.1.1: Field Strength of Spurious Emissions Test Setup

7.2 Criteria

Clause Subject	Section Number	Date
Field Strength of Radiated Spurious/Harmonic Emissions Fundamental to 5 GHz	90.210(d)	2014-03-24

7.3 Results

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:	**47 CFR Part 90**		
Section:	**90.210**		
Test Date(s):	**3/26/2014**	**EUT Serial #:**	**1**
Customer:	**Tenx Precision**	**EUT Part #:**	**None**
Project Number:	**15689-10**	**Test Technician:**	**Eric Lifsey**
Purchase Order #:		**Supervisor:**	**Rob McCollough**
Equip. Under Test:	**TX-7470**	**Witness' Name:**	**Jason Gossiaux**

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:	**47 CFR Part 90**		
Section:	**90.210**		
Test Date(s):	**3/26/2014**	**EUT Serial #:**	**1**
Customer:	**Tenx Precision**	**EUT Part #:**	**None**
Project Number:	**15689-10**	**Test Technician:**	**Eric Lifsey**
Purchase Order #:		**Supervisor:**	**Rob McCollough**
Equip. Under Test:	**TX-7470**	**Witness' Name:**	**Jason Gossiaux**

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

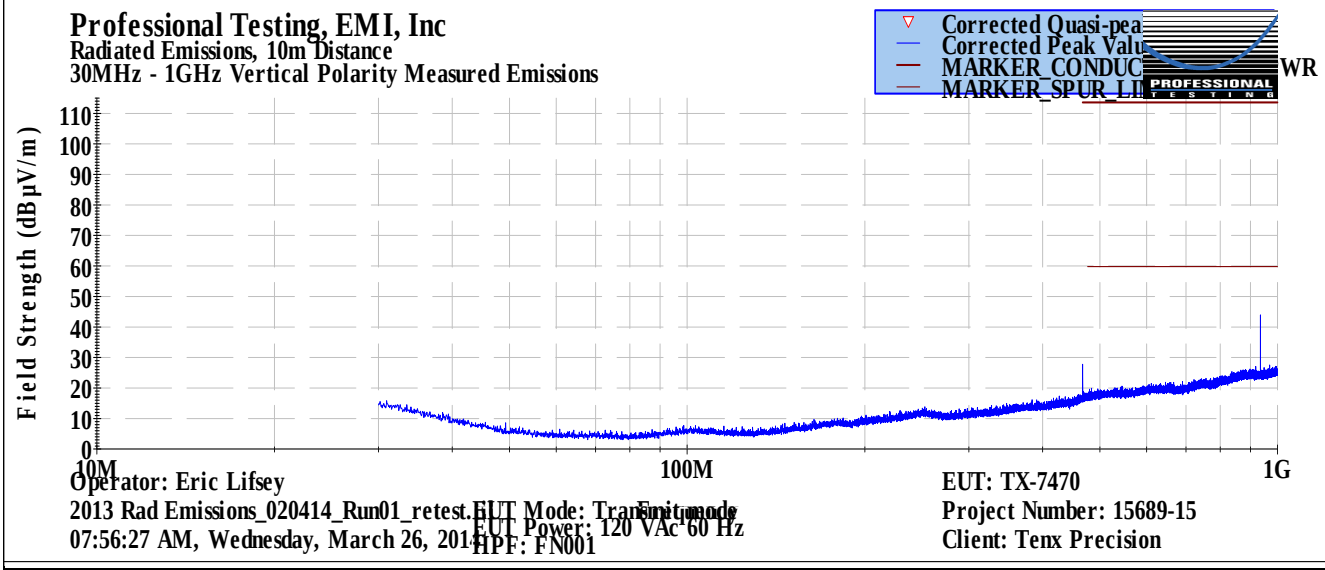
Professional Testing, EMI, Inc.

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,		
In accordance with:	47 CFR Part 90		
Section:	90.210		
Test Date(s):	3/26/2014	EUT Serial #:	1
Customer:	Tenx Precision	EUT Part #:	None
Project Number:	15689-10	Test Technician:	Eric Lifsey
Purchase Order #:		Supervisor:	Rob McCollough
Equip. Under Test:	TX-7470	Witness' Name:	Jason Gossiaux

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 mode	

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
935.495	10	170	2.96	Peak	47.6	47.6	59.8	-12.2	Pass



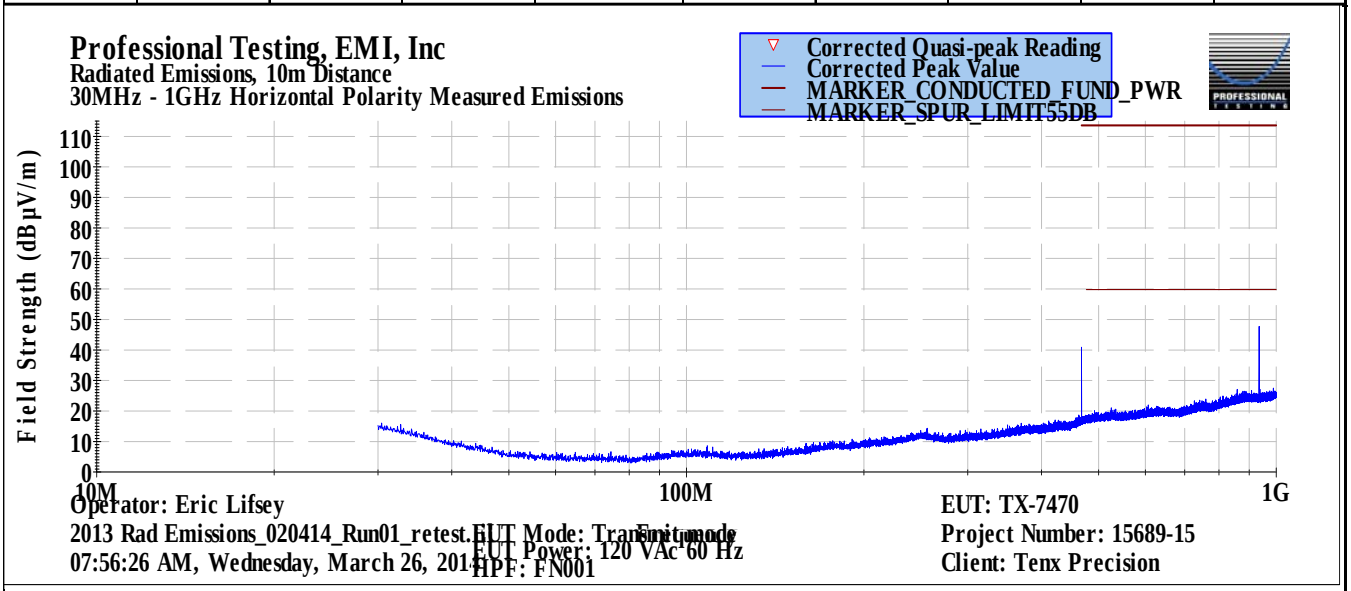
≤ 1GHz Vertical Antenna Polarity Measured Emissions

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,		
In accordance with:	47 CFR Part 90		
Section:	90.210		
Test Date(s):	3/26/2014	EUT Serial #:	1
Customer:	Tenx Precision	EUT Part #:	None
Project Number:	15689-10	Test Technician:	Eric Lifsey
Purchase Order #:		Supervisor:	Rob McCollough
Equip. Under Test:	TX-7470	Witness' Name:	Jason Gossiaux

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 mode				

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
935.496	10	268	1.71	Peak	47.6	47.6	59.8	-12.2	Pass



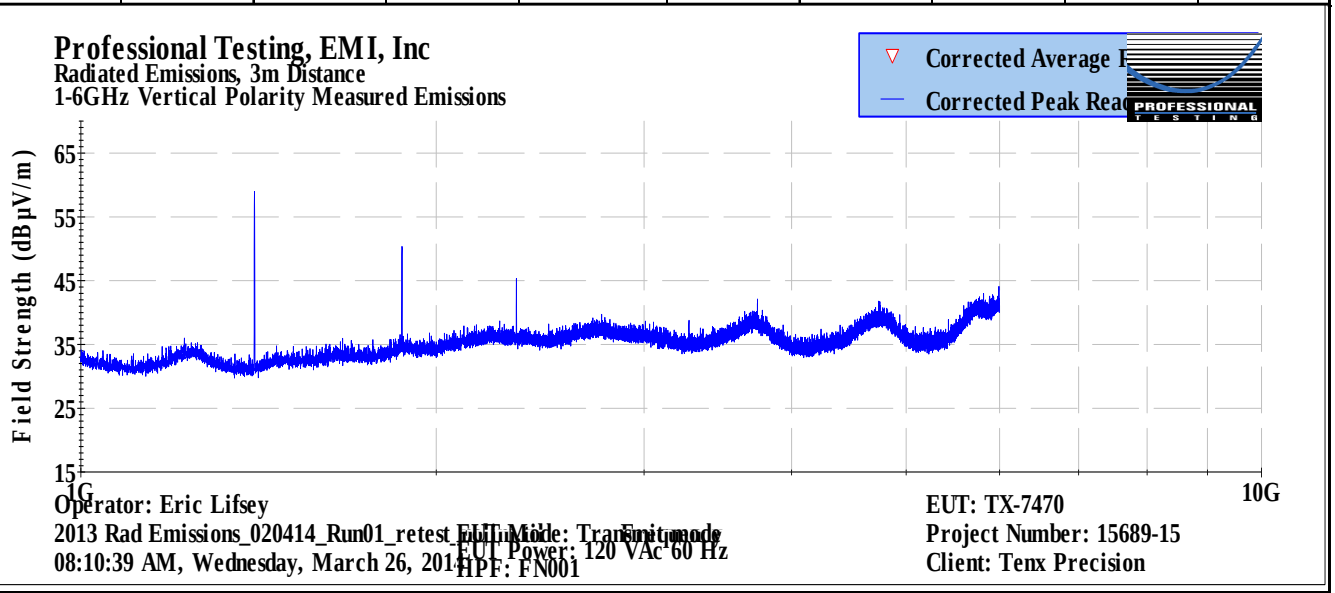
≤ 1GHz Horizontal Antenna Polarity Measured Emissions

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,		
In accordance with:	47 CFR Part 90		
Section:	90.210		
Test Date(s):	3/26/2014	EUT Serial #:	1
Customer:	Tenx Precision	EUT Part #:	None
Project Number:	15689-10	Test Technician:	Eric Lifsey
Purchase Order #:		Supervisor:	Rob McCollough
Equip. Under Test:	TX-7470	Witness' Name:	Jason Gossiaux

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 mode			

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
1403	3	22	1	Peak	59	59	70.2	-11.2	Pass



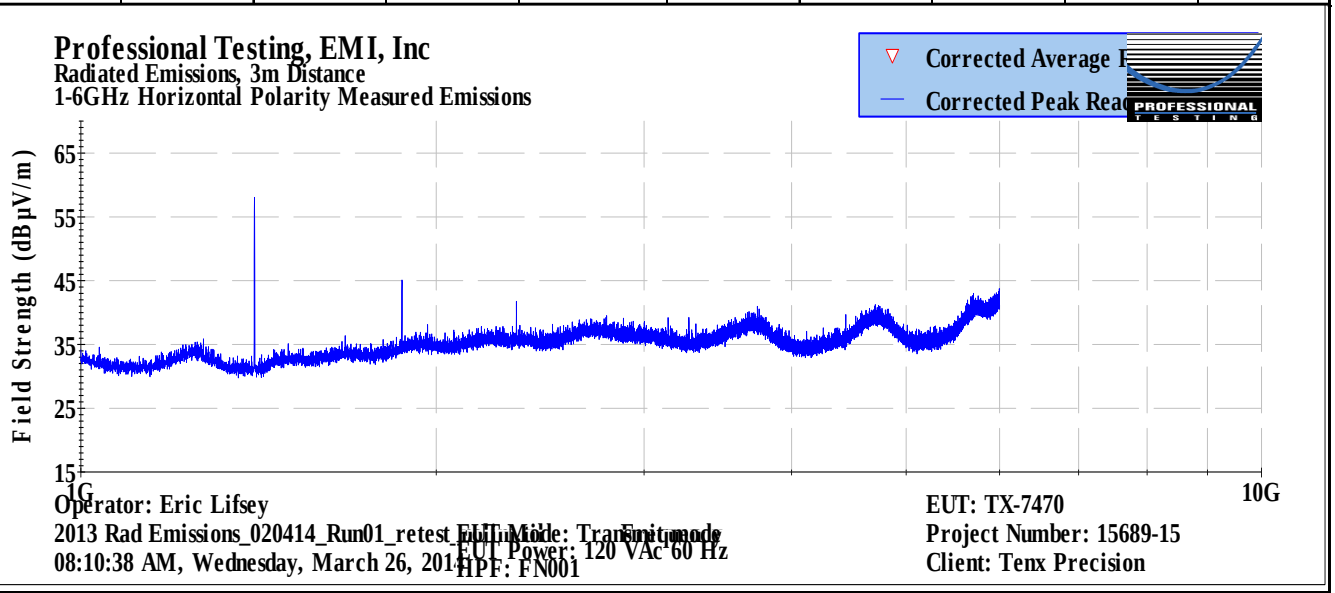
> 1GHz Vertical Antenna Polarity Measured Emissions

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,		
In accordance with:	47 CFR Part 90		
Section:	90.210		
Test Date(s):	3/26/2014	EUT Serial #:	1
Customer:	Tenx Precision	EUT Part #:	None
Project Number:	15689-10	Test Technician:	Eric Lifsey
Purchase Order #:		Supervisor:	Rob McCollough
Equip. Under Test:	TX-7470	Witness' Name:	Jason Gossiaux

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 mode	

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
1403	3	205	1	Peak	58	58	70.2	-12.2	Pass



> 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	2014-03-19

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):	**3/19/2014**	**EUT Serial #:**	**1**
Customer:	**Tenx Precision**	**EUT Part #:**	**None**
Project Number:	**15689-10**	**Test Technician:**	**Larry Fuller**
Purchase Order #:		**Supervisor:**	**Rob McCollough**
Equip. Under Test:	**TX-7470**	**Witness' Name:**	**Jason Gossiaux**

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	5/17/2014
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	6/5/2014
1173	PTI	100k HPF	Filter, High Pass, 100kHz	none	10/30/2014
1087	PTI	PTI-ALF3	Attenuator Limiter Filter	none	5/6/2014
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
C109	HP	none	Cable 19 inch BNC (grey)	none	7/10/2014
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):	**3/19/2014**	**EUT Serial #:**	**1**
Customer:	**Tenx Precision**	**EUT Part #:**	**None**
Project Number:	**15689-10**	**Test Technician:**	**Larry Fuller**
Purchase Order #:		**Supervisor:**	**Rob McCollough**
Equip. Under Test:	**TX-7470**	**Witness' Name:**	**Jason Gossiaux**

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

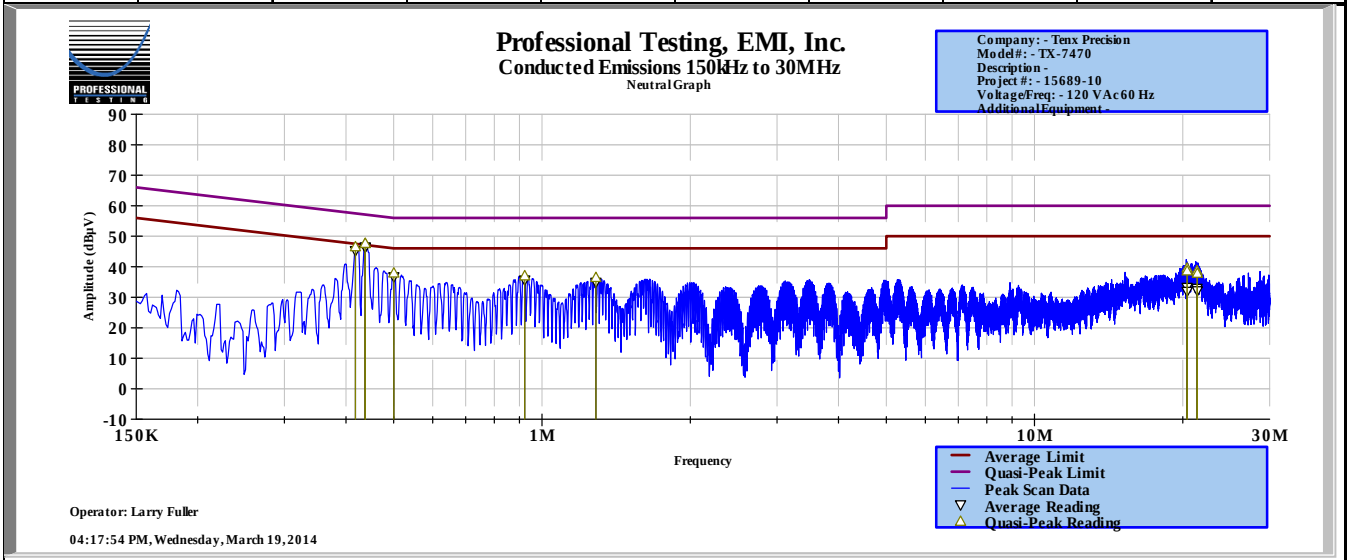
Professional Testing, EMI, Inc.

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):	3/19/2014	**EUT Serial #:**	1
Customer:	Tenx Precision	**EUT Part #:**	None
Project Number:	15689-10	**Test Technician:**	Larry Fuller
Purchase Order #:		**Supervisor:**	Rob McCollough
Equip. Under Test:	TX-7470	**Witness' Name:**	Jason Gossiaux

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
0.41796	46.8	46.5	57.5	-11	PASS	45.3	47.5	-2.2	PASS
0.43759	47.8	47.6	57.1	-9.5	PASS	46.4	47.1	-0.7	PASS
0.43763	47.9	47.6	57.1	-9.5	PASS	46.5	47.1	-0.6	PASS
0.500019	38.4	37.9	56	-18.1	PASS	36.7	46	-9.3	PASS
0.9223	37.4	37	56	-19	PASS	35.7	46	-10.3	PASS
1.2866	36.6	36.4	56	-19.6	PASS	35	46	-11	PASS
20.3943	42.2	39.5	60	-20.5	PASS	33.3	50	-16.7	PASS
20.4003	43.2	38.6	60	-21.4	PASS	32	50	-18	PASS
21.3661	41.9	38.6	60	-21.4	PASS	32.9	50	-17.1	PASS
21.4028	42.1	37.8	60	-22.2	PASS	32.1	50	-17.9	PASS



Measured Conducted Emissions - Neutral Lead

Table 8.3.4: Mains Conducted Emissions, Phase Line

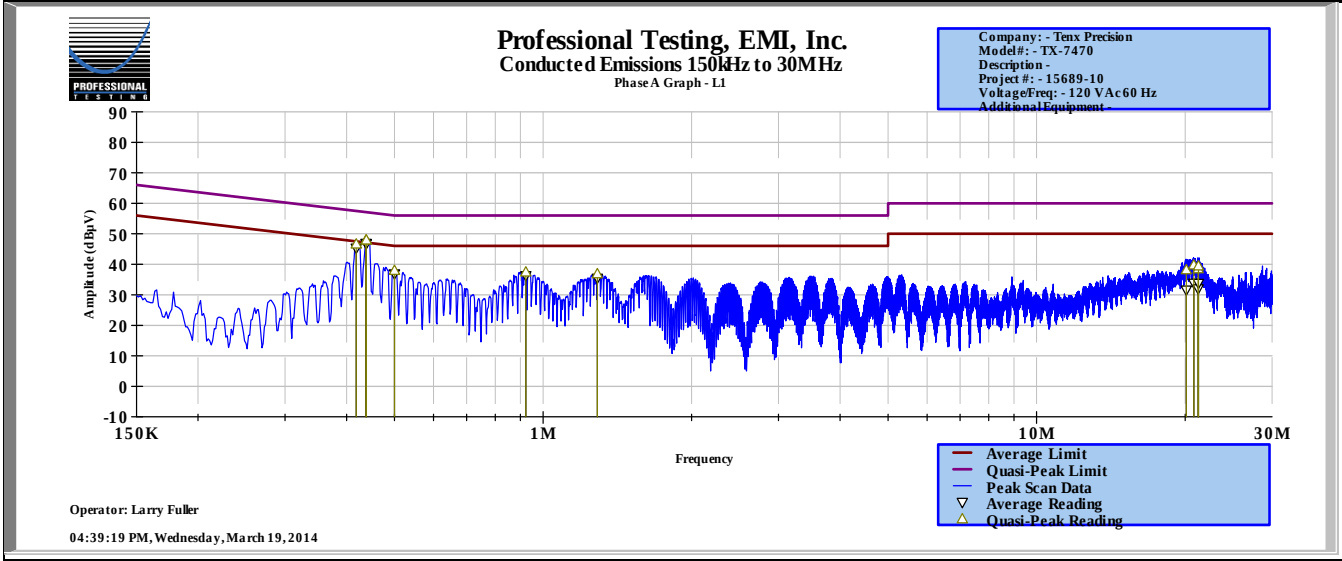
Professional Testing, EMI, Inc.

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):	3/19/2014	**EUT Serial #:**	1
Customer:	Tenx Precision	**EUT Part #:**	None
Project Number:	15689-10	**Test Technician:**	Larry Fuller
Purchase Order #:		**Supervisor:**	Rob McCollough
Equip. Under Test:	TX-7470	**Witness' Name:**	Jason Gossiaux

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
0.4185	47.1	46.6	57.5	-10.9	PASS	45.3	47.5	-2.1	PASS
0.43801	48.1	47.9	57.1	-9.2	PASS	46.9	47.1	-0.2	PASS
0.43828	48.2	47.9	57.1	-9.2	PASS	46.8	47.1	-0.3	PASS
0.500045	38.5	38	56	-18	PASS	36.9	46	-9.1	PASS
0.9231	37.7	37.5	56	-18.5	PASS	36.3	46	-9.7	PASS
1.2879	37	36.8	56	-19.2	PASS	35.4	46	-10.6	PASS
20.1039	41.5	38.2	60	-21.8	PASS	31.6	50	-18.4	PASS
20.82	42.7	39.7	60	-20.3	PASS	33.8	50	-16.2	PASS
21.254	42.7	38.5	60	-21.5	PASS	32	50	-18	PASS
21.2844	42.5	39.4	60	-20.6	PASS	33.8	50	-16.2	PASS



Measured Conducted Emissions - Phase Lead (Line 1)

9.0 Frequency Stability [90.213]

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 +/- 5 ppm 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
A105	Narda	768A-20	20 Watt 20 dB Attenuator, DC to 11 GHz	2014-04-16
2087	Fluke	189	DMM	2015-03-06
0428	Powerstat	146	Variac, 120V 30A	Not Required
	Tenny		Temperature Chamber	2014-11-19

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:	Continuous
Test Date(s):	3/21/2014	EUT Serial #:	None
Customer:	Tenx Precision (for LRS)	EUT Part #:	None
Project Number:	15689-15	Test Technician:	Eric Lifsey
Purchase Order #:	N/A	Supervisor	Rob McCollough
Equipment Under Test:	7470	Witness' Name:	Justin Gossiaux

Mobile Criteria: +/- 5 ppm

Condition	Frequency			Deviation	Soak Time	
Temperature (C)	Reference Frequency (MHz)	Measured Frequency (MHz)	Calculated Deviation (Hz)	Calculated Deviation (ppm)	Power-Off (min)	Power-On (min)
-30	467.750000	467.749341250	-658.750000014	-1.408337787	20	12
-20	467.750000	467.750612750	612.750000016	1.309994655	20	7
-10	467.750000	467.750989625	989.624999988	2.115713522	20	6
0	467.750000	467.750830625	830.624999992	1.775788348	20	7
10	467.750000	467.750299250	299.250000012	0.639764832	20	9
20	467.750000	467.749843250	-156.749999974	-0.335114912	20	11
30	467.750000	467.749604750	-395.249999997	-0.845002672	20	8
40	467.750000	467.749596100	-403.899999981	-0.863495457	20	6
50	467.750000	467.750307500	307.500000019	0.657402459	20	11

Condition	Frequency			Deviation	Voltage
Voltage Extreme	Reference Frequency (MHz)	Measured Frequency (MHz)	Calculated Deviation (Hz)	Calculated Deviation (ppm)	Measured Voltage (V AC)
-15%	467.750000	467.749688000	-312.000000008	-0.667022982	97.61
Nominal	467.750000	467.749642250	-357.749999978	-0.764831641	115.00
+15%	467.750000	467.749625375	-374.625000006	-0.800908605	143.95

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

Final tolerance displayed was +/- 1.77 ppm.

10.0 Transmit Transient [90.214]

The EUT was tested for transient frequency behavior using the test method outlined in TIA/EIA-603C paragraph 2.2.19.3 Alternate Method of Measurement (Using a Test Receiver). The 12.5 kHz requirement applies.

10.1 Procedure

Refer to diagram of TIA-603-C page 99 and the procedure of 2.2.19.3.

The EUT is terminated in a resistive attenuator of 20 dB with the output connected to a forward power coupler. The coupler forward output (-10 dB) is run through a detector diode then to the trigger input port of a digital oscilloscope. The RF pass-through output of the coupler is then run to a 3 port resistive power combining network; the #2 port of the combiner is connected to the output of a RF signal generator, the #3 port is used as output and connected to a test receiver (modulation analyzer). The detected output of the modulation analyzer is connected to the vertical input of the digital oscilloscope.

The RF generator is set to the fundamental operating frequency, set to modulate with a 1 kHz tone at +/- 25 kHz FM deviation, and at a relatively low but usable level where the modulation analyzer is able to demodulate the signal. The modulation analyzer is configured to use the high and low pass filter settings as called out in the TIA-603-C procedure. The modulation analyzer is then dialed via front panel keypad to the fundamental operating frequency for best sensitivity.

The transmitter is keyed as needed and adjustments are made to the instruments to trigger appropriately and render the measurement as required by the TIA-603-C standard. The essential technique is the signal generator provides a reference frequency captured by the modulation analyzer. When the EUT is keyed, at many dB above the signal generator level, the modulation analyzer locks to the EUT signal and deviation from center frequency can be observed and recorded on the digital oscilloscope.

10.2 Criteria

Transmitters for 150–174 MHz and 421–512 MHz frequency bands must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time intervals[1,2]	Maximum frequency difference[3]	All equipment	
		150 to 174 MHz	421 to 512 MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels			
t_1[4]	±25.0 kHz	5.0 ms	10.0 ms
t_2	±12.5 kHz	20.0 ms	25.0 ms
t_3[4]	±25.0 kHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels			
t_1[4]	±12.5 kHz	5.0 ms	10.0 ms
t_2	±6.25 kHz	20.0 ms	25.0 ms
t_3[4]	±12.5 kHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels			
t_1[4]	±6.25 kHz	5.0 ms	10.0 ms

t_2	±3.125 kHz	20.0 ms	25.0 ms
t_3[4]	±6.25 kHz	5.0 ms	10.0 ms

[1] t_{on} is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

t_1 is the time period immediately following t_{on}.

t_2 is the time period immediately following t_1.

t_3 is the time period from the instant when the transmitter is turned off until t_{off}.

t_{off} is the instant when the 1 kHz test signal starts to rise.

[2] During the time from the end of t_2 to the beginning of t_3, the frequency difference must not exceed the limits specified in §90.213.

[3] Difference between the actual transmitter frequency and the assigned transmitter frequency.

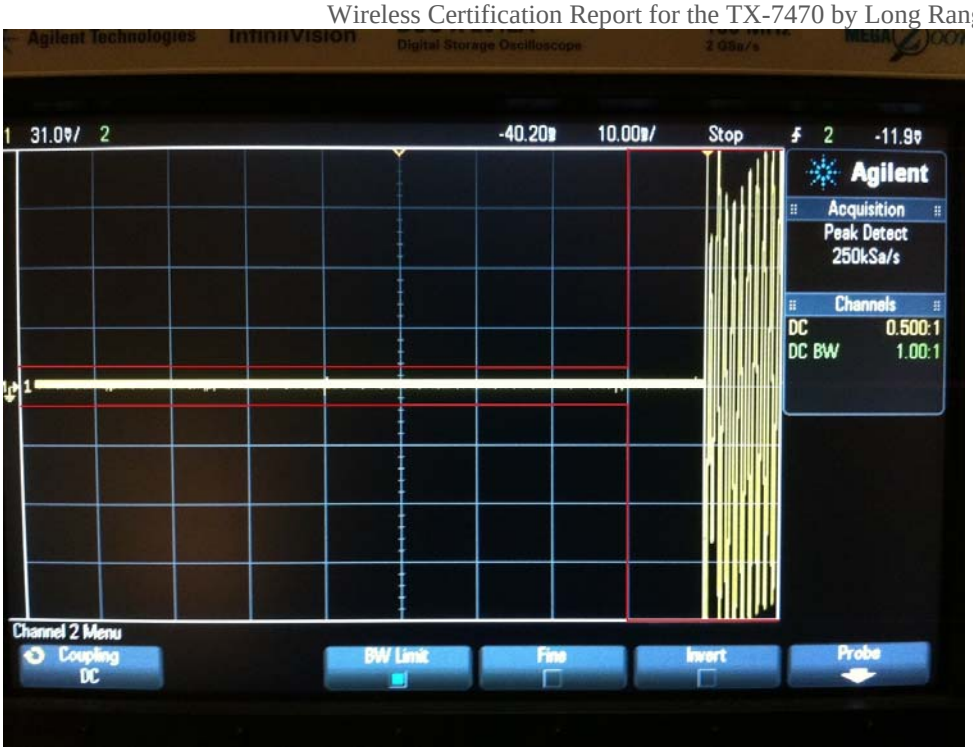
[4] If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

10.3 Results

Transient frequency behavior was found to be in compliance with applicable requirements.

Table 9.3.1 Equipment List				
Asset #	**Manufacturer**	**Model #**	**Description**	**Calibration Due**
1924	Agilent	DSO X-2012	Oscilloscope, Digital	2015-06-11
0718	HP	8656A	Signal Generator	2014-09-18
0637	HP	8901A	Modulation Analyzer	Not Required
0835	Narda	3293-1	Forward Power Coupler	Not Required
A105	Narda	768A-20	20 Watt 20 dB Attenuator, DC to 11 GHz	2014-04-16
A100	Narda	94455-1	Diode Detector	Not Required

Response For Transmit Initiation – Limits Superimposed in Red



Response For Transmit Cessation – Limits Superimposed in Red

11.0 Emission Bandwidth [90.210(d)]

11.1 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 spectrum analyzer amplitude is offset to compensate for the attenuator calibrated power loss. 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.

11.2 Criteria

Clause Requirement	Section Number	Date
90.210(d) Bandwidth < 12. 5 kHz	90.210(d)(1), 2.1051	2014-03-20

11.3 Results

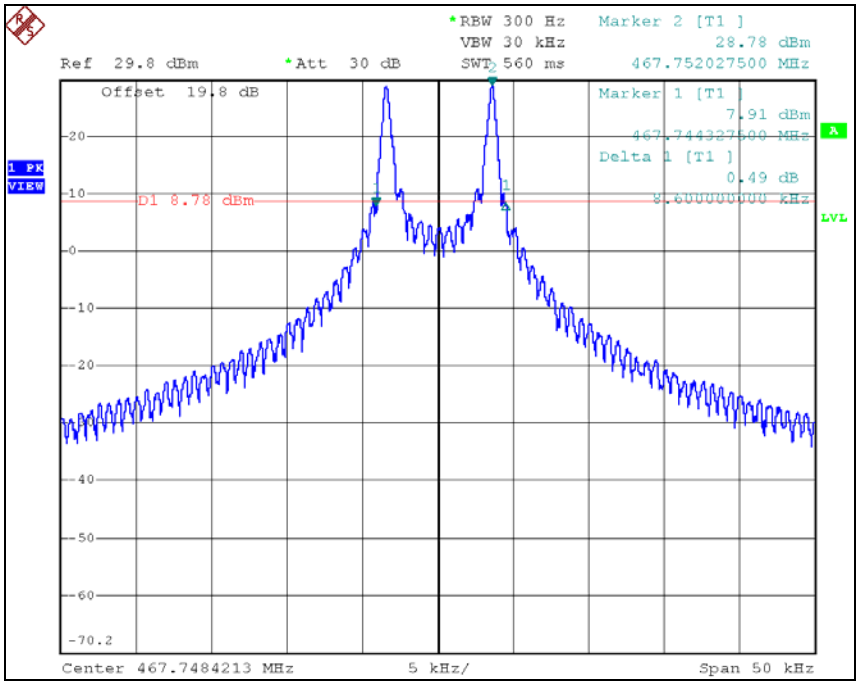
Table 11.3.1 Equipment List

Asset #	Manufacturer	Model #	Description	Calibration Due
ALN-077	Rohde & Schwarz	FSP-30	Spectrum Analyzer	2015-01-29
A105	Narda	768A-20	20 Watt 20 dB Attenuator, DC to 11 GHz	2014-04-16

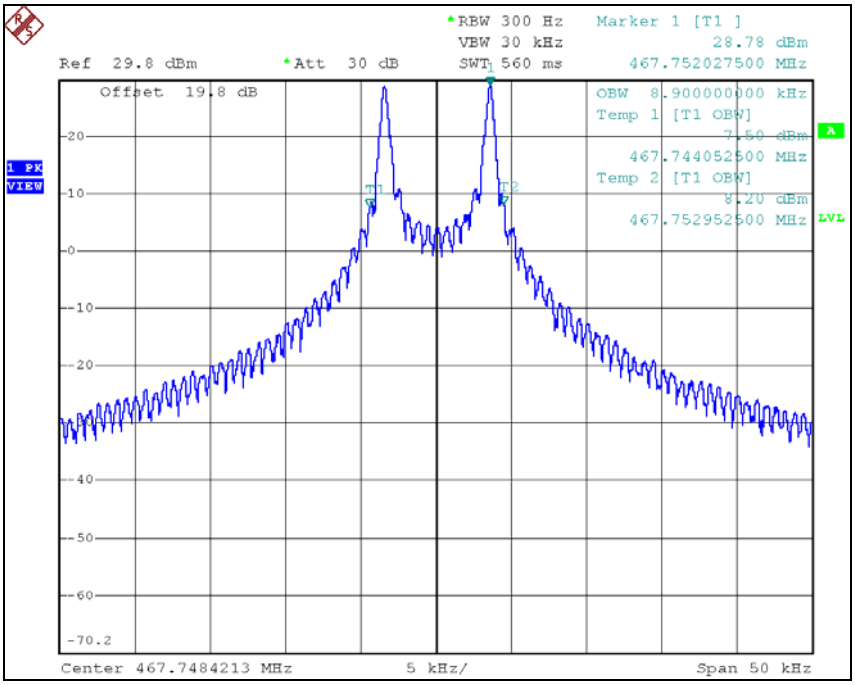
Table 11.3.2 Bandwidth

Bandwidth Measurement Method	Measured Bandwidth
20 dB	8.6 kHz
OBW Instrument Measurement	8.9 kHz

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



Bandwidth, 20 dB, 8.6 kHz



Bandwidth, OBW 8.9 kHz

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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