
Project 17390A-15

**Hetronic
IP-Bridge RF1
Transceiver
410.000 to 475.000 MHz**

**Wireless Certification Report
(1 of 2)**

FCC Part 90 and IC RSS-119

Prepared for:

Hetronic
3905 NW 36th St.
Oklahoma City, OK 73112
USA

By

Professional Testing (EMI), Inc.
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17 Jul 2017

Reviewed by



Larry Finn
Chief Technical Officer

Written by



Eric Lifsey
EMC Engineer

Revision History

Revision Number	Description	Date
02	Draft for review.	17 Jul 2017
02	Final.	31 Jul 2017

Corrections:

None.

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NOTICE:

(1) This Report must not be used to claim product endorsement, by NVLAP, NIST, the FCC or any other Agency. This report also does not warrant certification by NVLAP or NIST.

(2) This report shall not be reproduced except in full, without the written approval of Professional Testing (EMI), Inc.

(3) The significance of this report is dependent on the representative character of the test sample submitted for evaluation and the results apply only in reference to the sample tested. The manufacturer must continuously implement the changes shown herein to attain and maintain the required degree of compliance.



Certificate of Compliance

Applicant	Device & Test Identification	
Hetronic 3905 NW 36th St. Oklahoma City, OK 73112 USA Certificate Date: 17 Nov 2017	FCC ID:	LW9-IPBRG
	IC ID:	2119-IPBRG
	Model(s):	IP-Bridge
	Radio Section:	RF1
	Laboratory Project ID:	17390A-15

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

47 CFR (USA) FCC, RSS IC(Industry Canada)		
Parameter	FCC	IC
Conducted Output Power	90.210, 2.1046	RSS-119 Issue 12, 5.4
Emission Mask (exempt < 120 mW)	90.217, 2.1047	RSS-119 Issue 12, 5.8.3
Conducted Spurious/Harmonic Emissions at Antenna Terminals	90.210, 2.1051	RSS-119 Issue 12, 5.8; RSS-Gen Issue 4
Field Strength of Radiated Spurious/Harmonic Emissions Fundamental to 5 GHz	90.210, 15.209, 2.1053	RSS-119 Issue 12, 5.8
Transient Frequency Behavior	90.214, TIA/EIA-603-E	RSS-119 Issue 12, 5.9
Frequency Stability	90.213, 2.1055	RSS-119 Issue 12, 5.3
Occupied Bandwidth, 20 dB, < 11.5 kHz	90.209, 2.1049	RSS-119 Issue 12, 5.5
Radiated Emissions 30 MHz – 5 GHz	15.109	RSS-Gen Issue 4, ICES-003

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

Eric Lifsey
EMC Engineer

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

Representative of Applicant

1.0 Introduction

1.1 Scope

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

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 methods of TIA/EIA-603 were applied unless specified otherwise in the associated agency rules and procedures.

1.2 EUT Description

The EUT is equipped with two identical 410-475 MHz radios etched into the board and includes an Ethernet port. This radio section reported herein is designated RF1. The companion radio on the same board is designated RF2 and is covered in a separate report.

Table 1.2.1 Equipment Under Test			
Manufacturer & Description	Model	Serial #	Photo
Hetronic Transceiver section RF1 for 410 to 475 MHz.	IP-Bridge	none	(Photo removed for confidentiality.) Appearance.

Table 1.2.2 Options		
Manufacturer & Description	Gain	Notes
Hetronic; ¼ wave SMB whip antenna	0 dBi	For use directly on module inside host.
Hetronic; cable extension to TNC-F	NA	Extends module to external antenna.
Hetronic; ¼ wave TNC-M antenna	0 dBi	External antenna.

1.3 EUT Operation

The EUT was exercised in a manner consistent with normal operations. It was tested alone with no additional shielding or filtering. It was powered by a linear DC power supply.

Table 1.3.1 Operating Frequency/Range			
Lowest Frequency	Center Frequency	Highest Frequency	Total Frequency Range
410.000 MHz	442.500 MHz	475.000 MHz	65 MHz
The three channels were tested per customary practice for a frequency range exceeding 10 MHz.			

1.4 Modifications to Equipment

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

In the final application, the EUT will be assembled into a RF transparent enclosure that offers no shielding or other effects on performance.

1.5 Test Site

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

1.6 Applicable Documents

Table 1.6.1: Applicable Documents		
Document #	Title/Description	Date
47 CFR	FCC Part 90	
IC RSS-119 Issue 12	Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41-960 MHz	2015
IC RSS-Gen Issue 4	General Requirements for Compliance of Radio Apparatus	2014
TIA/EIA-603-E	Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards	2016
ANSI C63.26	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services;	2015

2.0 Conducted Output Power

2.1 Procedure

The EUT is placed into continuous transmit mode without modulation for peak power measurement.

2.2 Criteria

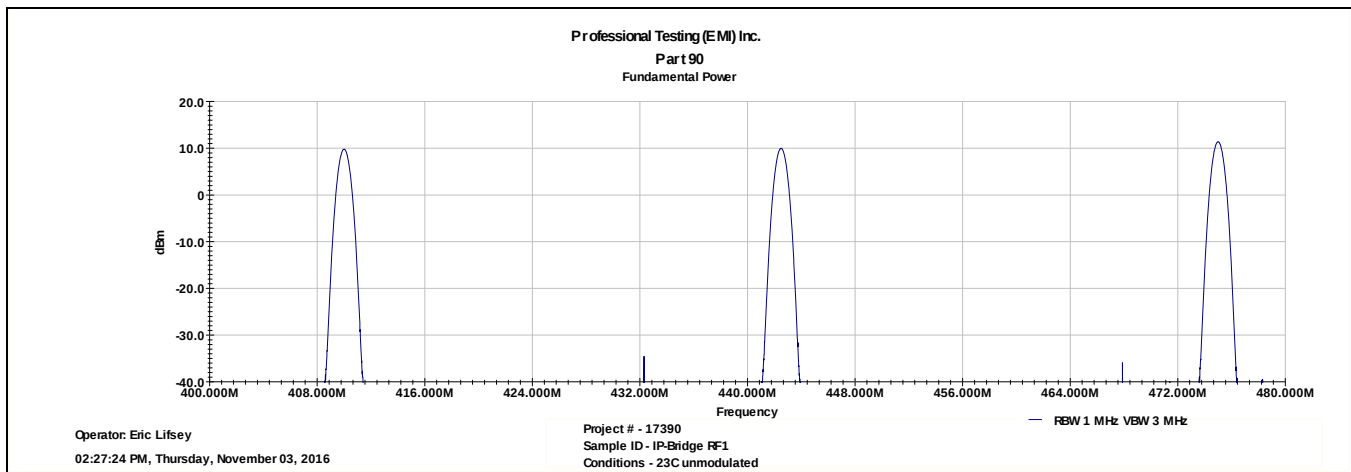
Parameter	Section Reference	Date
Conducted Output Power	90.210, 2.1046 RSS-119 Issue 12, 5.4	3 Nov 2016

2.3 Results

EUT antenna port was directly coupled to the spectrum analyzer without a cable so power was read directly with no factors required.

The EUT satisfied the requirement. Tabular results are presented below.

Table 2.3.1 Power, Peak, Conducted		
Frequency (MHz)	Power (dBm)	Power (mW)
410.000	9.8	9.6
442.500	10.0	10.0
475.000	11.4	13.8



3.0 Emission Mask

3.1 Procedure

Emissions are measured with peak detector with the mask superimposed on the graph.

3.2 Criteria

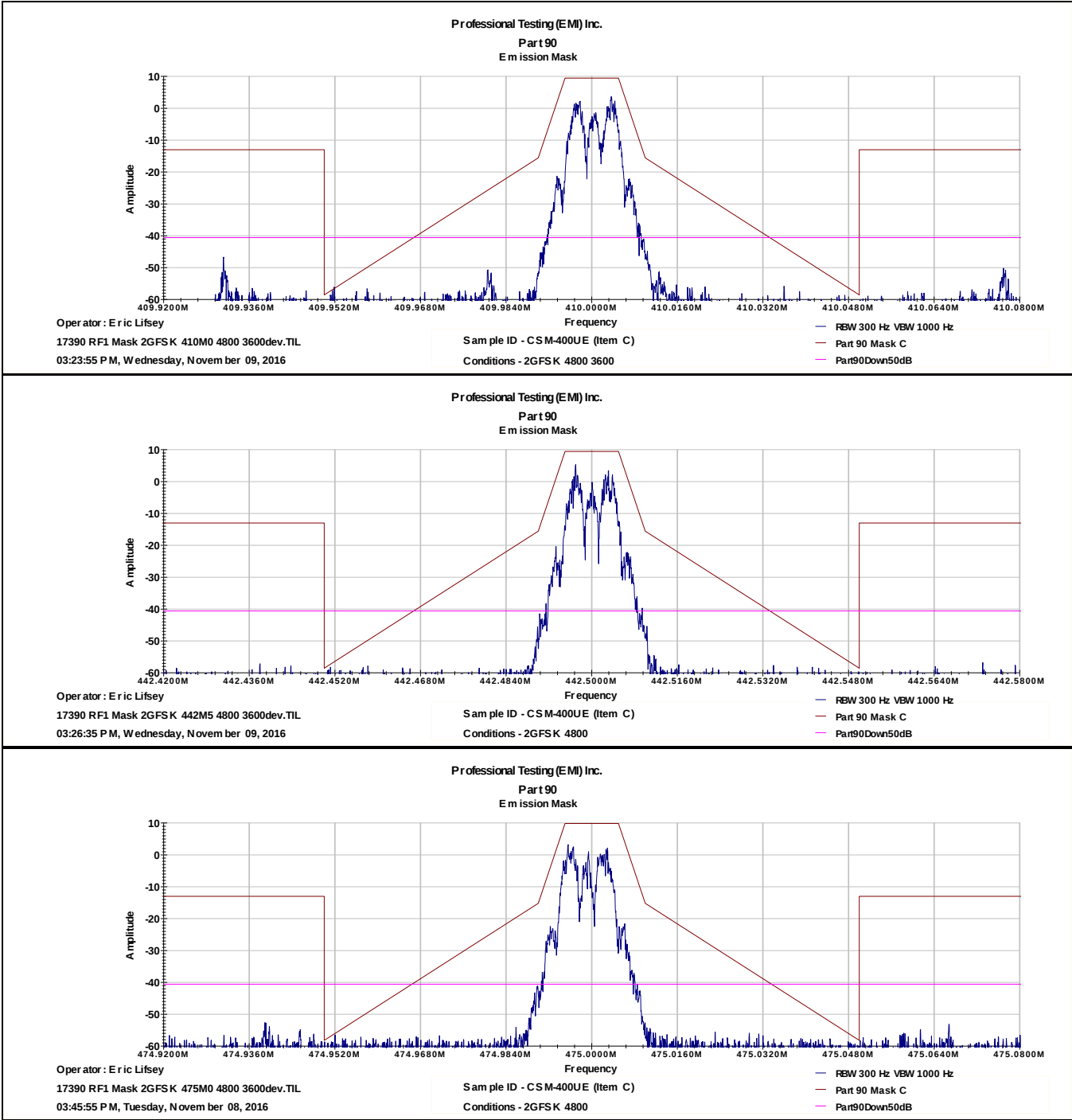
Parameter	Section Number	Date
Emissions at Antenna Terminals	90.210(c), 90.217(b), 2.1047 RSS-119 Issue 12, 5.8.3	9 Nov 2016 14 Jul 2017

3.3 Results

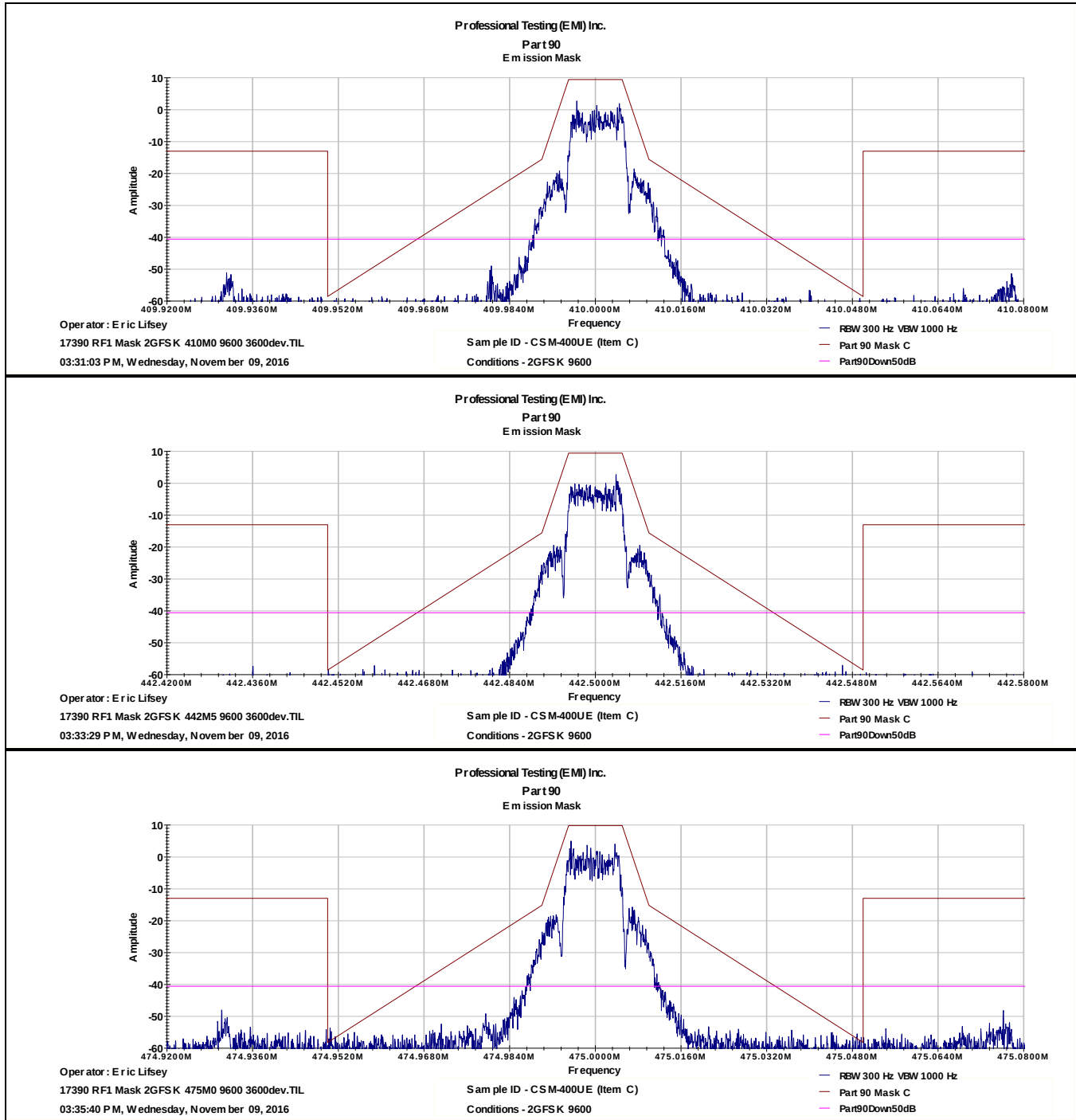
The emission was measured coupled directly to the analyzer without cabling. Low deviation modes were checked against the more restrictive Mask C though the 120 mW exemption clause applies in all cases.

The EUT satisfied the requirement. Measurements appear below.

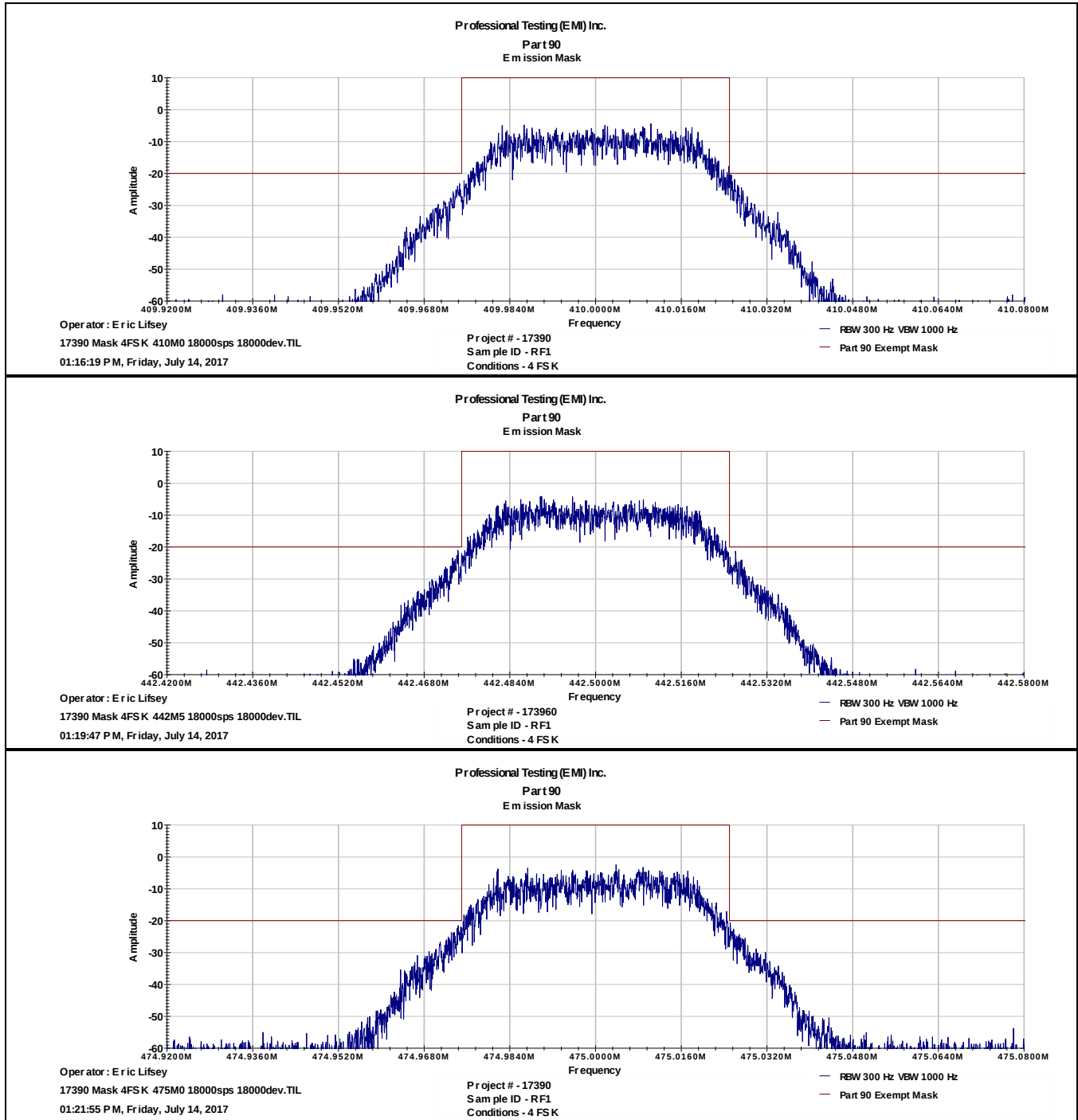
3.3.1 Modulation 2GFSK at 4800 Symbols per Second



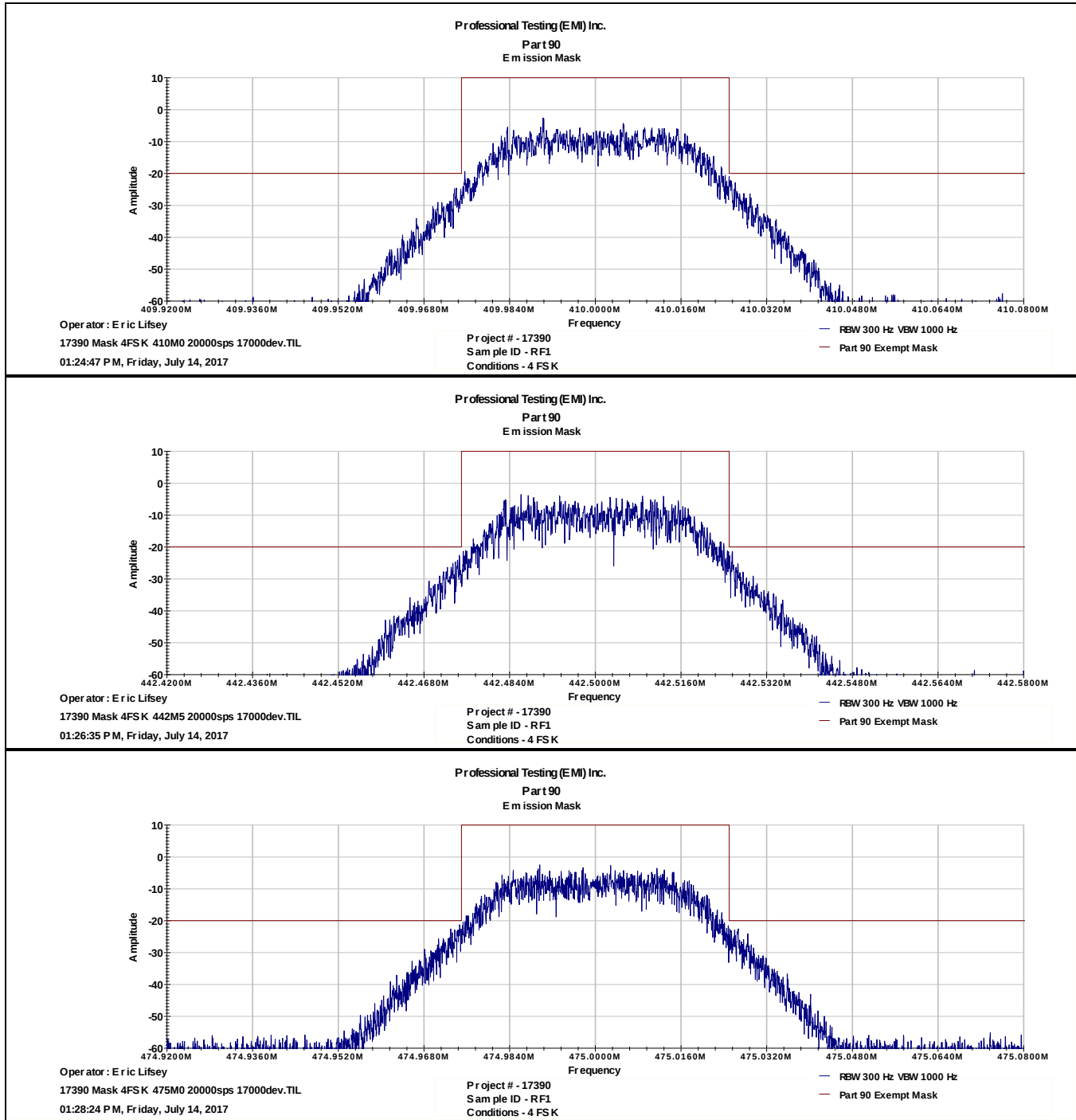
3.3.2 Modulation 2GFSK at 9600 Symbols per Second



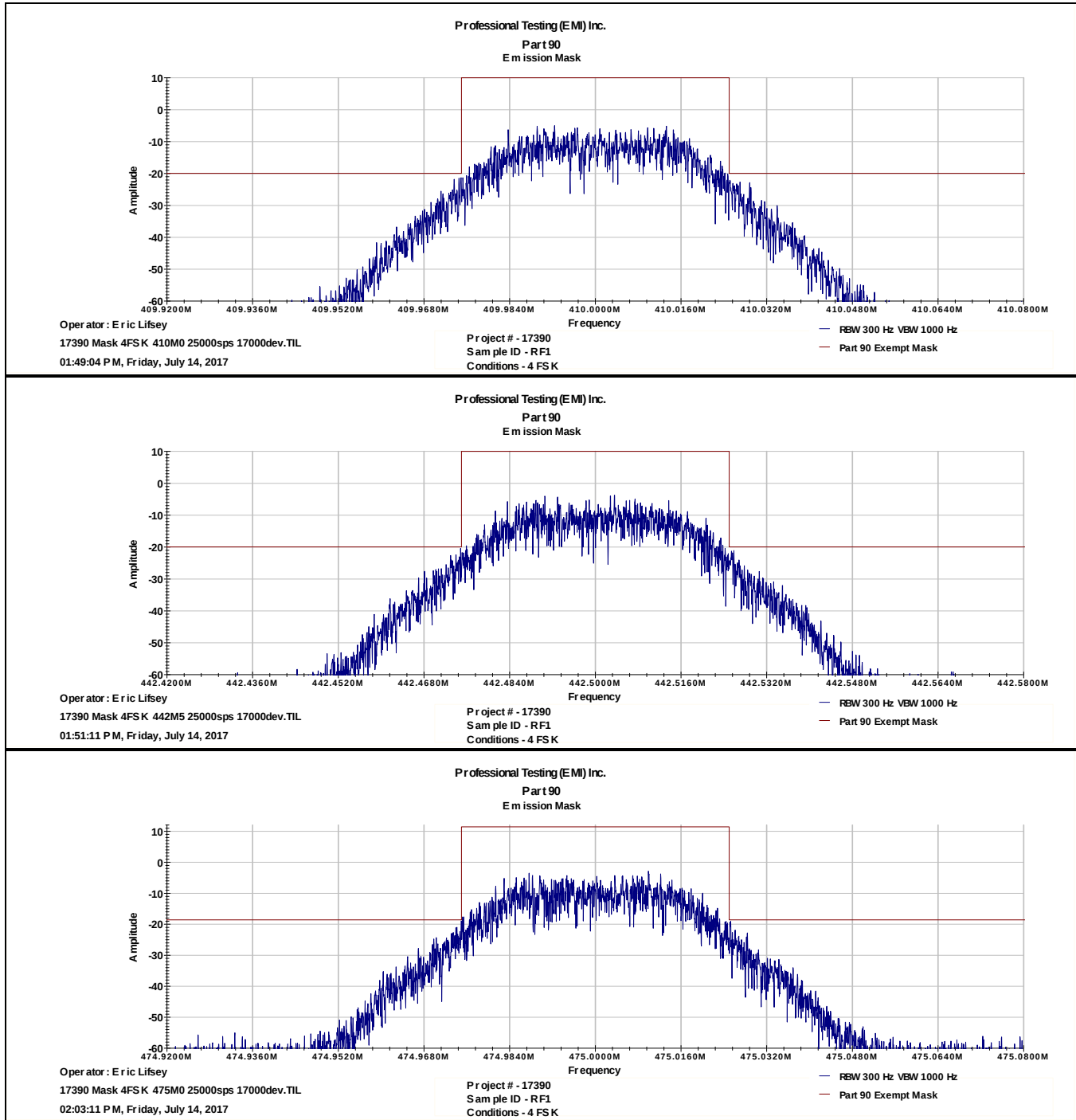
3.3.3 Modulation 4GFSK at 18000 Symbols per Second with 18000 Hz Deviation



3.3.4 Modulation 4GFSK at 20000 Symbols per Second with 17000 Hz Deviation



3.3.5 Modulation 4GFSK at 25000 Symbols per Second with 17000 Hz Deviation



4.0 Spurious Emissions at Antenna Terminals

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 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 a peak detector function from 9 kHz to 5 GHz to include the tenth harmonic 4.75 GHz.

4.2 Criteria

Parameter	Section Number	Date
Emissions at Antenna Terminals	90.210(b), 2.1047 RSS-119 Issue 12, 5.8	3/9 Nov 2016

Limit is determined from for emissions beyond 250% of authorized bandwidth.

Per 90.210(c)(3) $\text{Attenuation}_{\text{(dB)}} = 43 + 10 \log_{10}(0.0138 \text{ W}) = 24.4 \text{ dB}$

$\text{Limit}_{\text{(dBm)}} = \text{Fundamental_Power}_{\text{(dBm)}} - \text{Attenuation}_{\text{(dB)}} = 11.4 \text{ dBm} - 24.4 \text{ dB} = -13 \text{ dBm}$

4.3 Results

Measurements were performed with a direct connection to the spectrum analyzer such that no external losses or gains would apply. Measurement bandwidth is detailed in the graphs provided.

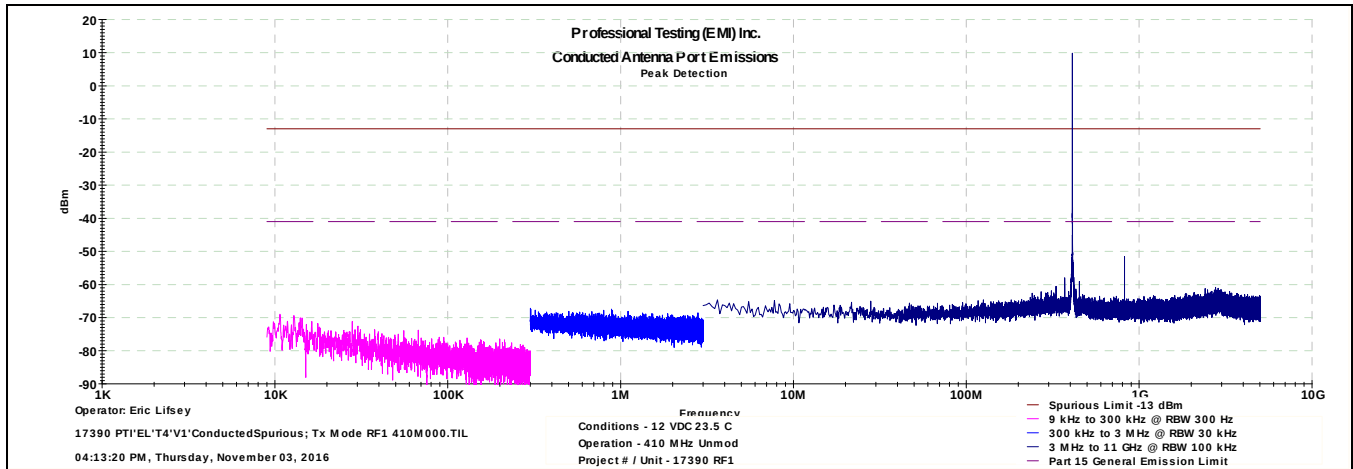
The EUT was found to be in compliance with applicable requirements.

In the plots the licensed emission limit is shown as a solid red line at -13 dBm.

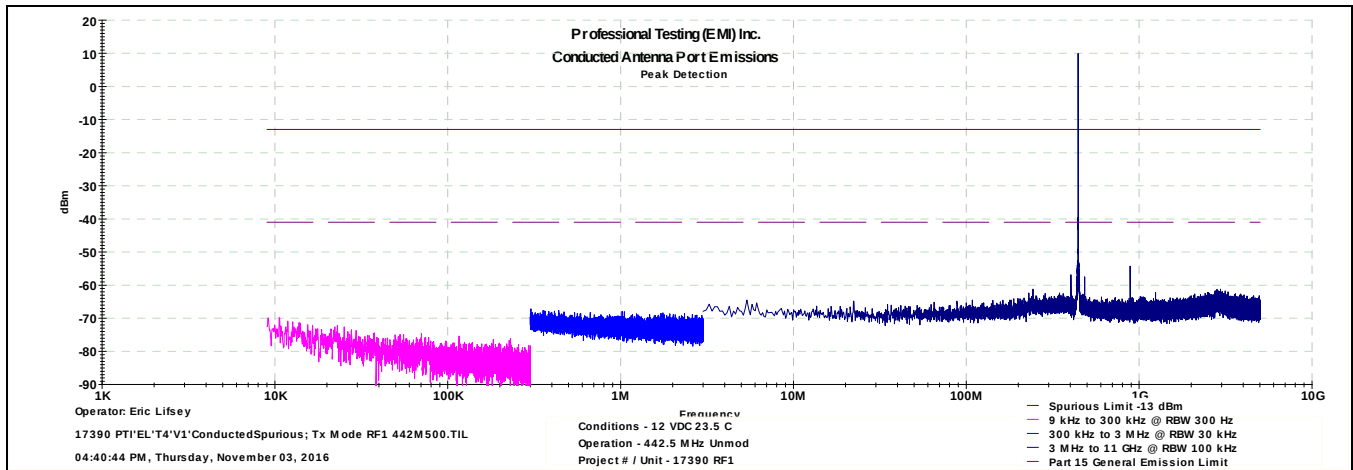
As supplemental information, the -41 dBm general emission limit was included as a dashed red line. It can be seen that both transmit and receive modes satisfy the general emission limit.

Measurements appear below.

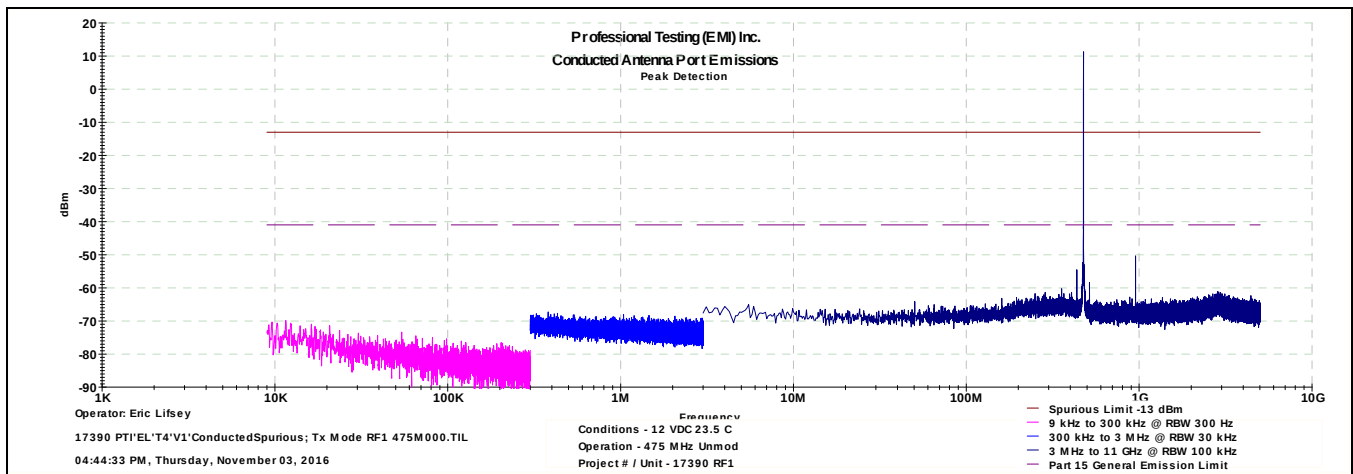
4.3.1 Transmit Mode, Bottom Channel



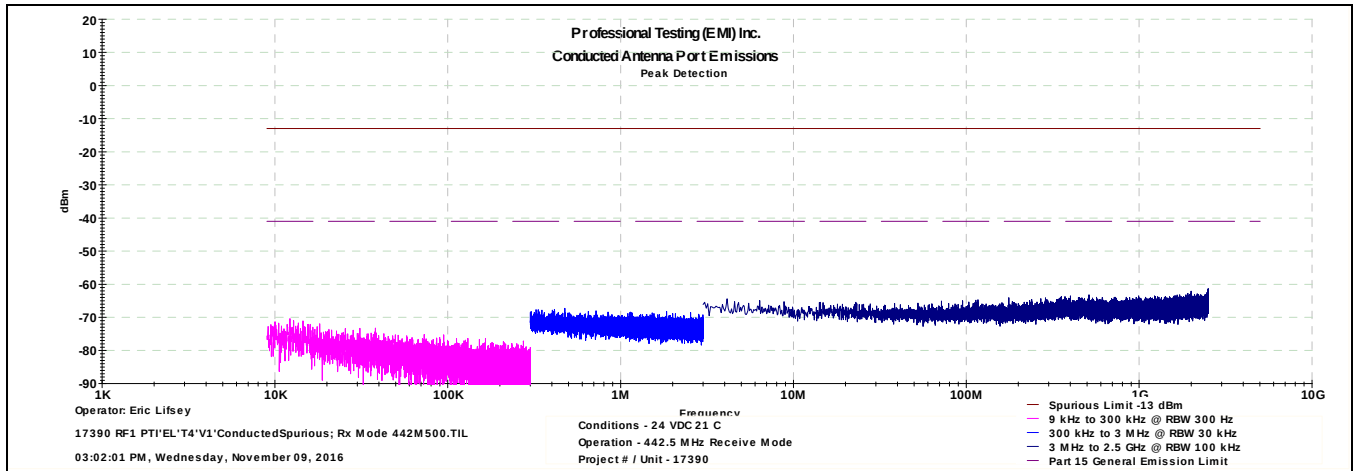
4.3.2 Transmit Mode, Middle Channel



4.3.3 Transmit Mode, Top Channel



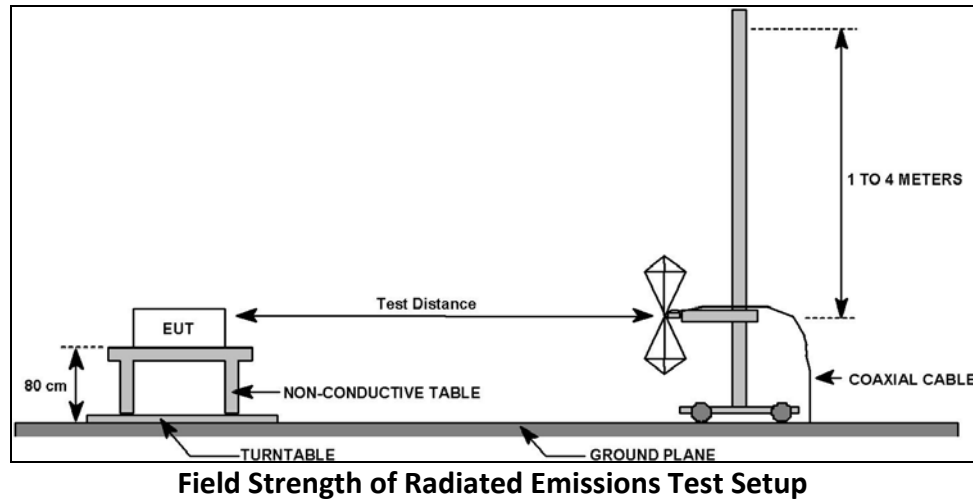
4.3.4 Receive Mode, Middle Channel



5.0 Field Strength of Radiated Spurious Emissions

5.1 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 removed and a resistive terminator substituted.



5.2 Criteria

Parameter	Section Number	Date
Field Strength of Radiated Emissions 30 MHz to 5 GHz	90.210, 15.209, 2.1053 RSS-119 Issue 12, 5.8; RSS-Gen Issue 4	31 Oct 2016

5.3 Results

The emission limits for the module were determined as follows:

Limit is determined from for emissions beyond 250% of authorized bandwidth.

Per 90.210(c)(3) $\text{Attenuation}_{\text{(dB)}} = 43 + 10 \log_{10}(0.0138 \text{ W}) = 24.4 \text{ dB}$

$\text{Limit}_{\text{(dBm)}} = \text{Fundamental_Power}_{\text{(dBm)}} - \text{Attenuation}_{\text{(dB)}} = 11.4 \text{ dBm} - 24.4 \text{ dB} = -13 \text{ dBm}$

The EUT satisfied the requirement. Measurements appear below.

5.3.1 Transmit Mode, Below 1 GHz, Bottom Channel

Professional Testing, EMI, Inc.			
Test Method: ANSI C63.10-2013, TIA/EIA-603C			
In accordance with: FCC Part 15, FCC Part 90			
Section: 15.209, 90.210			
Test Date(s): 10/31/2016		EUT Serial #: None	
Customer: Hetronic		EUT Part #: HI1511R06	
Project Number: 17390		Test Technician: Eric Lifsey	
Purchase Order #: 0		Supervisor: Lisa Arndt	
Equip. Under Test: IP Bridge (RF1)		Witness' Name: None	
Radiated Emissions Test Results Data Sheet			Page: 1 of 1
EUT Line Voltage: 12 VDC		EUT Power Frequency: 0 N/A	
Antenna Orientation: Vertical		Frequency Range: 30MHz to 1GHz	
EUT Mode of Operation:		Continuous Transmit; bottom channel	
Professional Testing, EMI, Inc Radiated Emissions, 10m Distance 30MHz - 1GHz Vertical Polarity Measured Emissions — Quasi-peak Limit Level — Corrected Quasi-peak Reading — Corrected Peak Value — Verified Low-PRF QP Reading — LPRF Verification Limit — Limit -13 dBm at 10m Operator: Eric Lifsey 17390 '103116'RE'RF1'Spurious'ChanBottom.til 02:16:41 PM, Monday, October 31, 2016 Frequency Transmitting unmodulated: 410.0 MHz; RF1 12 VDC Antenna port terminated. EUT: IP Bridge Project Number: 17390 Client: Hetronic			
≤ 1GHz Vertical Antenna Polarity Measured Emissions			

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013, TIA/EIA-603C

In accordance with: FCC Part 15, FCC Part 90

Section: 15.209, 90.210

Test Date(s): 10/31/2016

EUT Serial #: None

Customer: Hetronic

EUT Part #: HI1511R06

Project Number: 17390

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Lisa Arndt

Equip. Under Test: IP Bridge (RF1)

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 12 VDC

EUT Power Frequency: 0 N/A

Antenna Orientation: Horizontal

Frequency Range: 30MHz to 1GHz

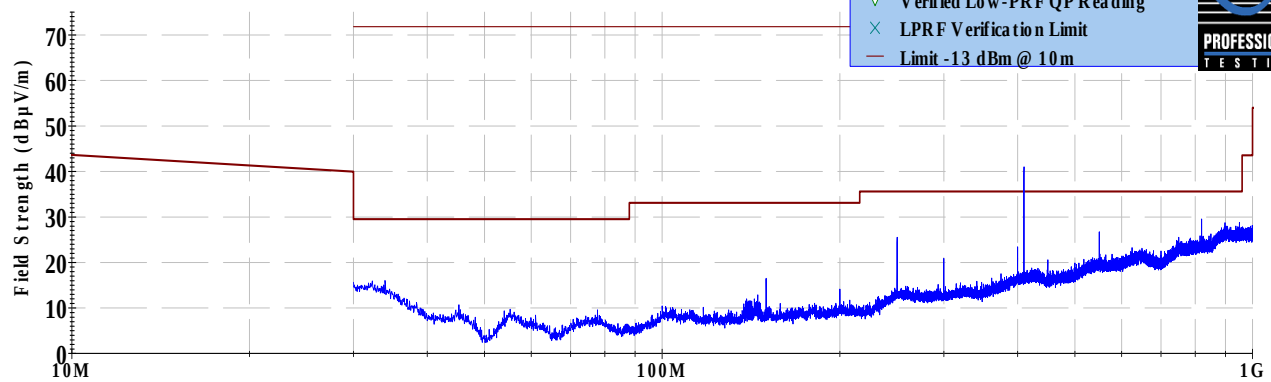
EUT Mode of Operation:

Continuous Transmit; bottom channel

Professional Testing, EMI, Inc

Radiated Emissions, 10m Distance

30MHz - 1GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

17390'103116'RE'RF1'Spurious'ChanBottom.til 12 VDC Transmitting unmodulated: 410.0 MHz; RF1

02:16:40 PM, Monday, October 31, 2016

Antenna port terminated.

EUT: IP Bridge

Project Number: 17390

Client: Hetronic

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

5.3.2 Transmit Mode, Above 1 GHz, Bottom Channel

Professional Testing, EMI, Inc.			
Test Method:		ANSI C63.10-2013, TIA/EIA-603C	
In accordance with:		FCC Part 15, FCC Part 90	
Section:		15.209, 90.210	
Test Date(s):	10/31/2016	EUT Serial #:	None
Customer:	Hetronic	EUT Part #:	HI1511R06
Project Number:	17390	Test Technician:	Eric Lifsey
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	IP Bridge (RF1)	Witness' Name:	None
Radiated Emissions Test Results Data Sheet		Page: 1 of 1	
EUT Line Voltage:	12 VDC	EUT Power Frequency:	0 N/A
Antenna Orientation:	Vertical	Frequency Range:	Above 1GHz
EUT Mode of Operation:		Continuous Transmit; bottom channel	
Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-6 GHz Vertical Polarity Measured Emissions The graph displays field strength measurements from 1 GHz to 10 GHz. The y-axis ranges from 20 to 90 dBµV/m. A blue line represents the corrected peak reading, which fluctuates between approximately 35 and 45 dBµV/m. Three horizontal red lines indicate the limit levels: Average Limit Level at ~82 dBµV/m, Peak Limit Level at ~75 dBµV/m, and Limit -13 dBm at 3m at ~55 dBµV/m. A legend in the top right corner identifies these lines and the corrected average reading (red triangle) and corrected peak reading (blue line). PROFESSIONAL TESTING			
Operator: Eric Lifsey 17390'103116'RE'RF1'Spurious'ChanBottom.tif 02:33:19 PM, Monday, October 31, 2016 Frequency Transmitting unmodulated: 410.0 MHz; RF1 12 VDC Antenna port terminated. EUT: IP Bridge Project Number: 17390 Client: Hetronic			
> 1GHz Vertical Antenna Polarity Measured Emissions			

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013, TIA/EIA-603C

In accordance with: FCC Part 15, FCC Part 90

Section: 15.209, 90.210

Test Date(s): 10/31/2016

EUT Serial #: None

Customer: Hetronic

EUT Part #: HI1511R06

Project Number: 17390

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Lisa Arndt

Equip. Under Test: IP Bridge (RF1)

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 12 VDC

EUT Power Frequency: 0 N/A

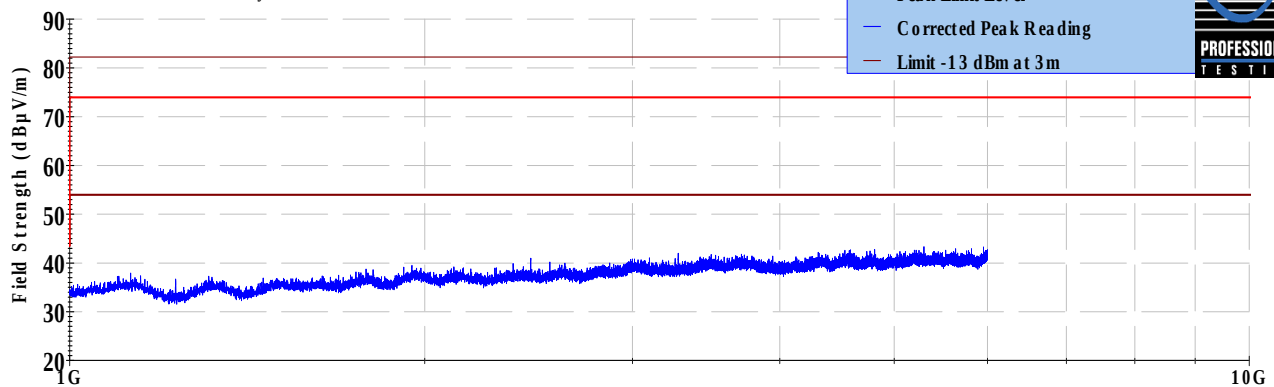
Antenna Orientation: Horizontal

Frequency Range: Above 1GHz

EUT Mode of Operation:

Continuous Transmit; bottom channel

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
1-6 GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

17390'103116'RE'RF1'Spurious'ChanBottom.til 12 VDC Transmitted unmodulated: 410.0 MHz; RF1

02:33:18 PM, Monday, October 31, 2016

Antenna port terminated.

EUT: IP Bridge

Project Number: 17390

Client: Hetronic

> 1GHz Horizontal Antenna Polarity Measured Emissions

5.3.3 Transmit Mode, Below 1 GHz, Middle Channel

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013, TIA/EIA-603C

In accordance with: FCC Part 15, FCC Part 90

Section: 15.209, 90.210

Test Date(s): 10/31/2016

EUT Serial #: None

Customer: Hetronic

EUT Part #: HI1511R06

Project Number: 17390

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Lisa Arndt

Equip. Under Test: IP Bridge (RF1)

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 12 VDC

EUT Power Frequency: 0 N/A

Antenna Orientation: Vertical

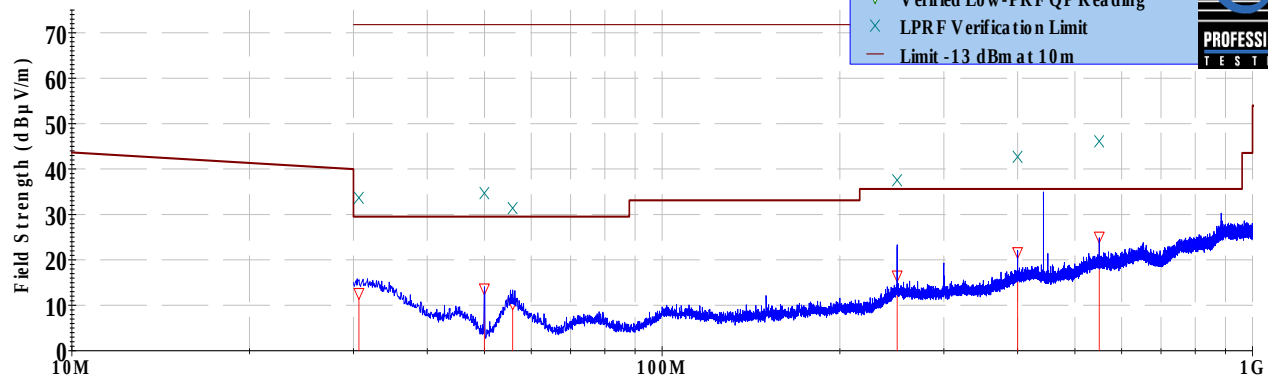
Frequency Range: 30MHz to 1GHz

EUT Mode of Operation:

Continuous Transmit; middle channel

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
30.6389	10	250	1.63	Quasi-peak	24	12.654	29.5	-16.8	Pass
49.9945	10	194	2.18	Quasi-peak	35.7	13.683	29.5	-15.8	Pass
55.8129	10	45	1.3	Quasi-peak	28.2	10.369	29.5	-19.1	Pass
250	10	61	4.12	Quasi-peak	26.7	16.524	35.6	-19.1	Pass
399.973	10	75	1.18	Quasi-peak	28.6	21.691	35.6	-13.9	Pass
550.001	10	75	4.11	Quasi-peak	28.6	25.104	35.6	-10.5	Pass

Professional Testing, EMI, Inc
Radiated Emissions, 10m Distance
30MHz - 1GHz Vertical Polarity Measured Emissions



Operator: Eric Lifsey

17390\103116\RE\RF1\SpuriousChanMid.ttl
12:17:13 PM, Monday, October 31, 2016

Transmitting unmodulated: 442.5 MHz; RF1
12 VDC
Antenna port terminated.

EUT: IP Bridge
Project Number: 17390
Client: Hetronic

≤ 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013, TIA/EIA-603C

In accordance with: FCC Part 15, FCC Part 90

Section: 15.209, 90.210

Test Date(s): 10/31/2016

EUT Serial #: None

Customer: Hetronic

EUT Part #: HI1511R06

Project Number: 17390

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Lisa Arndt

Equip. Under Test: IP Bridge (RF1)

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 12 VDC

EUT Power Frequency: 0 N/A

Antenna Orientation: Horizontal

Frequency Range: 30MHz to 1GHz

EUT Mode of Operation:

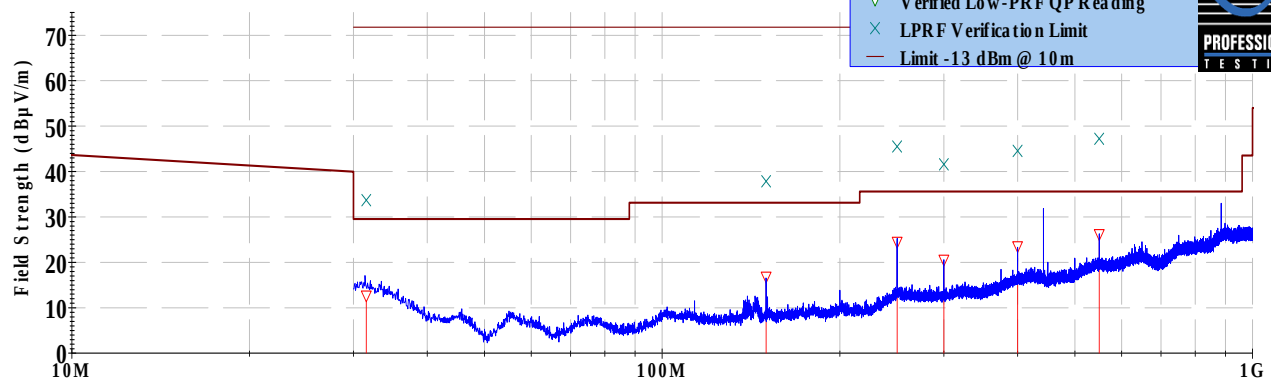
Continuous Transmit; middle channel

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
31.5388	10	316	1.67	Quasi-peak	24.1	12.664	29.5	-16.8	Pass
149.986	10	85	3.47	Quasi-peak	33.4	16.826	33.1	-16.3	Pass
250.022	10	260	3.33	Quasi-peak	34.7	24.502	35.6	-11.1	Pass
299.987	10	230	2.72	Quasi-peak	30.9	20.551	35.6	-15.0	Pass
399.993	10	99	1.42	Quasi-peak	30.4	23.516	35.6	-12.1	Pass
549.992	10	14	1.4	Quasi-peak	29.7	26.195	35.6	-9.4	Pass

Professional Testing, EMI, Inc

Radiated Emissions, 10m Distance

30MHz - 1GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

17390'103116'RE'RF1'Spurious'ChanMid.til

12:17:13 PM, Monday, October 31, 2016

Transmitting unmodulated: 442.5 MHz; RF1

12 VDC

Antenna port terminated.

EUT: IP Bridge

Project Number: 17390

Client: Hetronic

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

5.3.4 Transmit Mode, Above 1 GHz, Middle Channel

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013, TIA/EIA-603C

In accordance with: FCC Part 15, FCC Part 90

Section: 15.209, 90.210

Test Date(s): 10/31/2016

EUT Serial #: None

Customer: Hetronic

EUT Part #: HI1511R06

Project Number: 17390

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Lisa Arndt

Equip. Under Test: IP Bridge (RF1)

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 12 VDC

EUT Power Frequency: 0 N/A

Antenna Orientation: Vertical

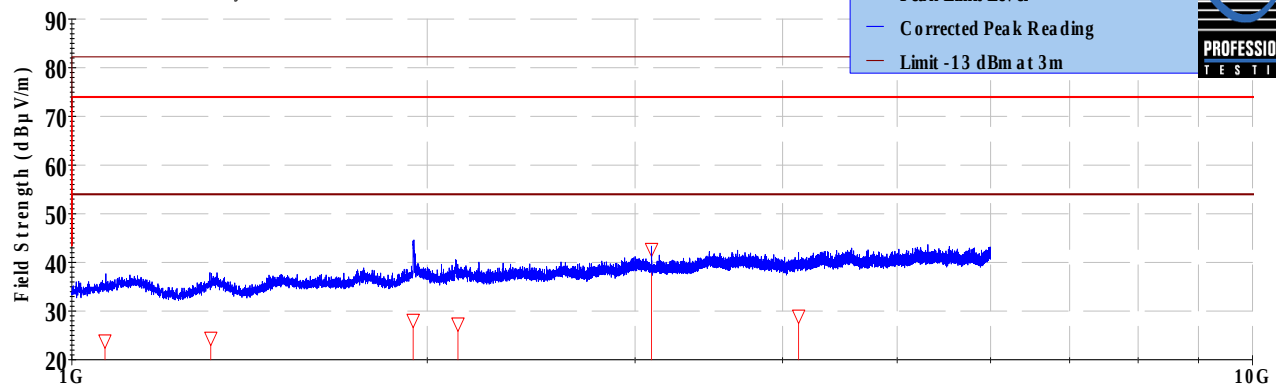
Frequency Range: Above 1GHz

EUT Mode of Operation:

Continuous Transmit; middle channel

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
1066.92	3	149	2.99	Average	35.5	23.926	54.0	-30.0	Pass
1311.66	3	120	2.22	Average	36.3	24.476	54.0	-29.5	Pass
1945.97	3	44	2.6	Average	37	28.153	54.0	-25.8	Pass
2123.41	3	44	1.09	Average	36.1	27.398	54.0	-26.6	Pass
3097.51	3	13	1.63	Average	49.3	42.745	54.0	-11.2	Pass
4126.88	3	140	1.45	Average	34.1	29.044	54.0	-24.9	Pass

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
1-6 GHz Vertical Polarity Measured Emissions



Operator: Eric Lifsey

17390\103116\RE\RF1\SpuriousChanMid.ttl
01:35:39 PM, Monday, October 31, 2016

Frequency
Transmitting unmodulated: 442.5 MHz; RF1
12 VDC
Antenna port terminated.

EUT: IP Bridge

Project Number: 17390
Client: Hetronic

> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013, TIA/EIA-603C

In accordance with: FCC Part 15, FCC Part 90

Section: 15.209, 90.210

Test Date(s): 10/31/2016

EUT Serial #: None

Customer: Hetronic

EUT Part #: HI1511R06

Project Number: 17390

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Lisa Arndt

Equip. Under Test: IP Bridge (RF1)

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 12 VDC

EUT Power Frequency: 0 N/A

Antenna Orientation: Horizontal

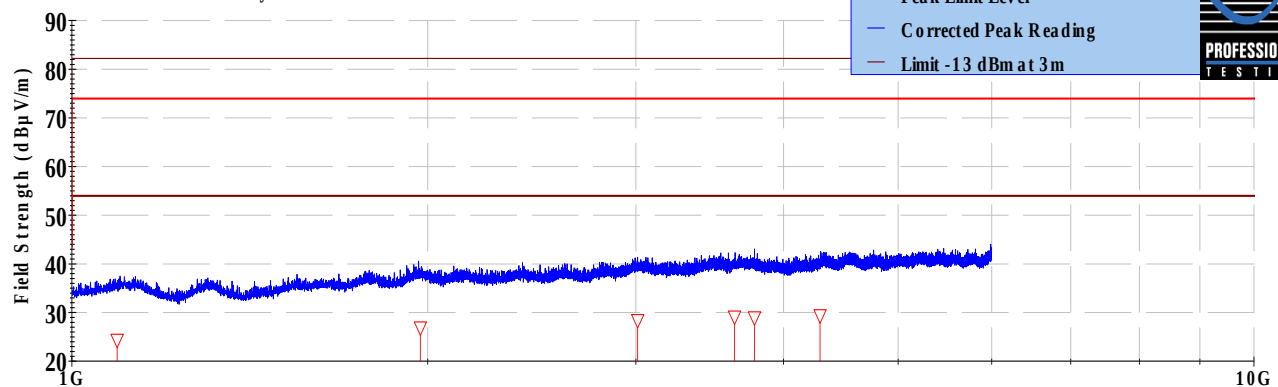
Frequency Range: Above 1GHz

EUT Mode of Operation:

Continuous Transmit; middle channel

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
1092.27	3	85	3.88	Average	36	24.338	54.0	-29.6	Pass
1971.82	3	133	3.69	Average	35.6	26.906	54.0	-27.1	Pass
3010.8	3	133	3.11	Average	34.8	28.412	54.0	-25.5	Pass
3636.49	3	298	2.73	Average	35	29.152	54.0	-24.8	Pass
3779.94	3	267	1.49	Average	34.6	28.952	54.0	-25.0	Pass
4295.61	3	240	3.86	Average	33.7	29.377	54.0	-24.6	Pass

Professional Testing, EMI, Inc. Radiated Emissions, 3m Distance 1-6 GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

17390'103116'RERF1'Spurious'ChanMid.til

01:35:39 PM, Monday, October 31, 2016

Transmitting unmodulated: 442.5 MHz; RF1
12 VDC
Antenna port terminated.

EUT: IP Bridge

Project Number: 17390

Client: Hetronic

> 1GHz Horizontal Antenna Polarity Measured Emissions

5.3.5 Transmit Mode, Below 1 GHz, Top Channel

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013, TIA/EIA-603C

In accordance with: FCC Part 15, FCC Part 90

Section: 15.209, 90.210

Test Date(s): 10/31/2016

EUT Serial #: None

Customer: Hetronic

EUT Part #: HI1511R06

Project Number: 17390

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Lisa Arndt

Equip. Under Test: IP Bridge (RF1)

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 12 VDC

EUT Power Frequency: 0 N/A

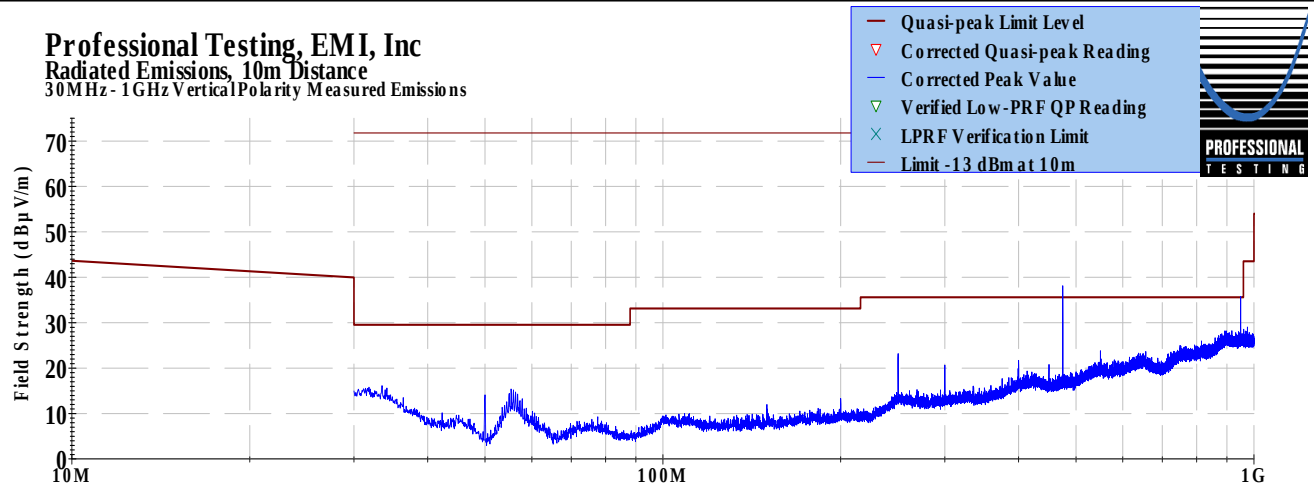
Antenna Orientation: Vertical

Frequency Range: 30MHz to 1GHz

EUT Mode of Operation:

Continuous Transmit; top channel

Professional Testing, EMI, Inc
Radiated Emissions, 10m Distance
30MHz - 1GHz Vertical Polarity Measured Emissions



Operator: Eric Lifsey

17390'103116'RE'RF1'Spurious'ChanTop.tif

03:08:11 PM, Monday, October 31, 2016

Frequency
Transmitting unmodulated: 475.0 MHz; RF1
12 VDC
Antenna port terminated.

EUT: IP Bridge

Project Number: 17390

Client: Hetronic

≤ 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013, TIA/EIA-603C

In accordance with: FCC Part 15, FCC Part 90

Section: 15.209, 90.210

Test Date(s): 10/31/2016

EUT Serial #: None

Customer: Hetronic

EUT Part #: HI1511R06

Project Number: 17390

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Lisa Arndt

Equip. Under Test: IP Bridge (RF1)

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 12 VDC

EUT Power Frequency: 0 N/A

Antenna Orientation: Horizontal

Frequency Range: 30MHz to 1GHz

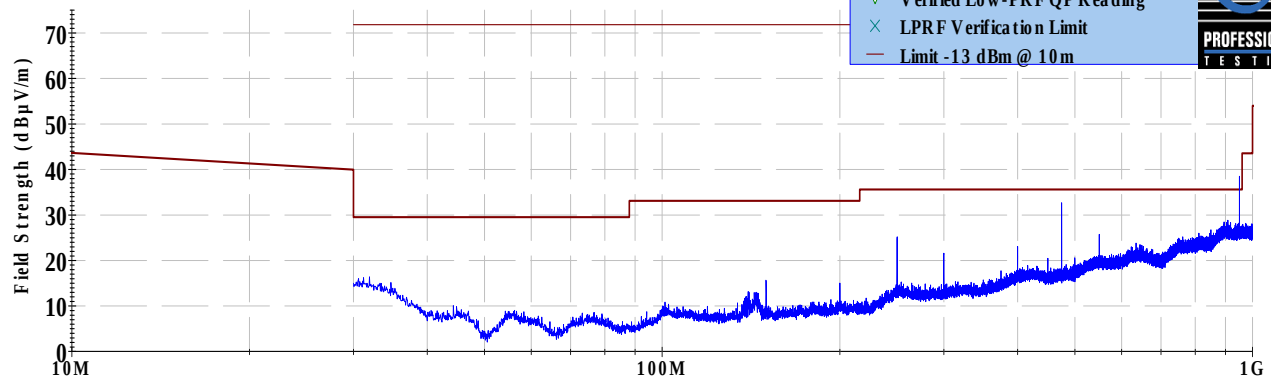
EUT Mode of Operation:

Continuous Transmit; top channel

Professional Testing, EMI, Inc

Radiated Emissions, 10m Distance

30MHz - 1GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

17390'103116'RE'RF1'Spurious'ChanTop.til

03:08:10 PM, Monday, October 31, 2016

Frequency

Transmitting unmodulated: 475.0 MHz; RF1

12 VDC

Antenna port terminated.

EUT: IP Bridge

Project Number: 17390

Client: Hetronic

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

5.3.6 Transmit Mode, Above 1 GHz, Top Channel

Professional Testing, EMI, Inc.			
Test Method:		ANSI C63.10-2013, TIA/EIA-603C	
In accordance with:		FCC Part 15, FCC Part 90	
Section:		15.209, 90.210	
Test Date(s):	10/31/2016	EUT Serial #:	None
Customer:	Hetronic	EUT Part #:	HI1511R06
Project Number:	17390	Test Technician:	Eric Lifsey
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	IP Bridge (RF1)	Witness' Name:	None
Radiated Emissions Test Results Data Sheet		Page: 1 of 1	
EUT Line Voltage:	12 VDC	EUT Power Frequency:	0 N/A
Antenna Orientation:	Vertical	Frequency Range:	Above 1GHz
EUT Mode of Operation:		Continuous Transmit; top channel	
Professional Testing, EMI, Inc Radiated Emissions, 3m Distance 1-6 GHz Vertical Polarity Measured Emissions The graph displays field strength measurements from 1 GHz to 10 GHz. The y-axis ranges from 20 to 90 dBµV/m. A blue line represents the corrected peak reading, which fluctuates between approximately 35 and 45 dBµV/m. Two horizontal red lines represent the average and peak limit levels at approximately 75 and 82 dBµV/m, respectively. A dashed blue line indicates the corrected average reading, and a solid blue line shows the limit at -13 dBm at 3m. — Average Limit Level ▽ Corrected Average Reading — Peak Limit Level — Corrected Peak Reading — Limit -13 dBm at 3m Operator: Eric Lifsey 17390'103116'RE'RF1'Spurious'ChanTop.tif 03:20:10 PM, Monday, October 31, 2016 Transmitting unmodulated: 475.0 MHz; RF1 12 VDC Antenna port terminated. EUT: IP Bridge Project Number: 17390 Client: Hetronic			
> 1GHz Vertical Antenna Polarity Measured Emissions			

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013, TIA/EIA-603C

In accordance with: FCC Part 15, FCC Part 90

Section: 15.209, 90.210

Test Date(s): 10/31/2016

EUT Serial #: None

Customer: Hetronic

EUT Part #: HI1511R06

Project Number: 17390

Test Technician: Eric Lifsey

Purchase Order #: 0

Supervisor: Lisa Arndt

Equip. Under Test: IP Bridge (RF1)

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 12 VDC

EUT Power Frequency: 0 N/A

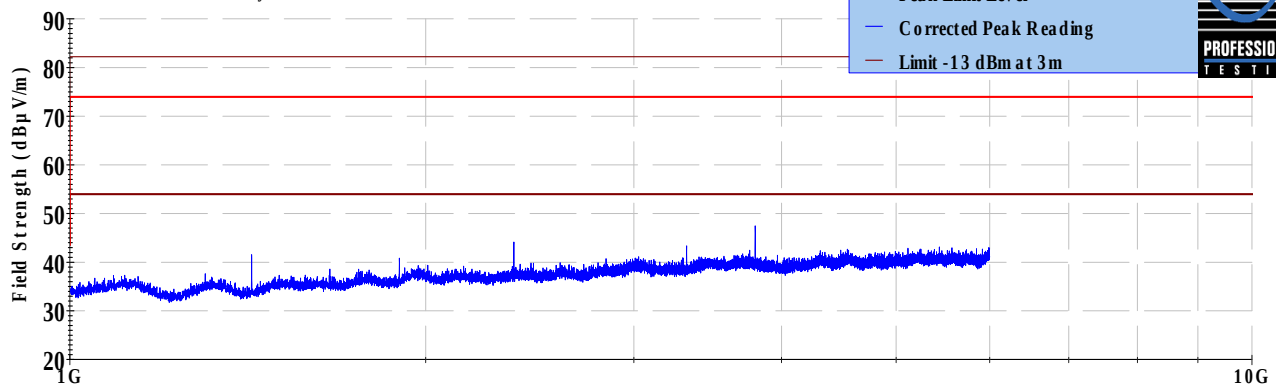
Antenna Orientation: Horizontal

Frequency Range: Above 1GHz

EUT Mode of Operation:

Continuous Transmit; top channel

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
1-6 GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

17390'103116'RE'RF1'Spurious'ChanTop.tif

03:20:09 PM, Monday, October 31, 2016

Frequency
Transmitting unmodulated: 475.0 MHz; RF1
12 VDC
Antenna port terminated.

EUT: IP Bridge

Project Number: 17390

Client: Hetronic

> 1GHz Horizontal Antenna Polarity Measured Emissions

6.0 Frequency Stability

6.1 Procedure

The EUT is placed into a temperature chamber with a cable coupling the transmitted signal to a spectrum analyzer. On reaching each set point temperature, the EUT is allowed to soak at least 10 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.

6.2 Criteria

Parameter	Section Number	Date
Frequency Stability	90.213 RSS-119 Issue 12, 5.3	4 Nov 2016

Table 6.2.1 Frequency Tolerance

± 5 ppm or restated as ± 2050 Hz
--

Table 6.2.2 Operating Voltages (From manufacturer's specifications.)

Low	Nominal	High
16	24	30

The operating frequency shall remain within the required tolerance.

6.3 Results

The highest deviation from frequency observed was 607 Hz. The EUT satisfied the requirement. Measurements appear below.

6.3.1 Bottom Channel, Temperature

Condition	Frequency		Deviation
Temperature (C)	Reference Center Frequency (MHz)	Measured Frequency (MHz)	Calculated Deviation (Hz)
-30	410.000000	410.000607	607
-20	410.000000	410.000508	508
-10	410.000000	410.000369	369
0	410.000000	410.000266	266
10	410.000000	410.000302	302
20	410.000000	410.000428	428
30	410.000000	410.000521	521
40	410.000000	410.000547	547
50	410.000000	410.000550	550
Max Deviation (Hz)			607
Min Deviation (Hz)			266

6.3.2 Bottom Channel, Operating Voltage

Condition	Voltage	Frequency		
Voltage Extreme	Voltage (V DC)	Reference Frequency (MHz)	Measured Frequency (MHz)	Calculated Deviation (Hz)
Low	16.00	410.000000	410.000475	475
Nominal	24.00	410.000000	410.000475	475
High	30.00	410.000000	410.000462	462

6.3.3 Middle Channel, Temperature

Condition	Frequency		Deviation
Temperature (C)	Reference Center Frequency (MHz)	Measured Frequency (MHz)	Calculated Deviation (Hz)
-30	442.500000	442.500216	216
-20	442.500000	442.500106	106
-10	442.500000	442.499960	-40
0	442.500000	442.499849	-151
10	442.500000	442.499888	-112
20	442.500000	442.499954	-46
30	442.500000	442.500125	125
40	442.500000	442.500150	150
50	442.500000	442.500148	148
Max Deviation (Hz)			216
Min Deviation (Hz)			-151

6.3.4 Middle Channel, Operating Voltage

Condition	Voltage	Frequency		
Voltage Extreme	Voltage (V DC)	Reference Frequency (MHz)	Measured Frequency (MHz)	Calculated Deviation (Hz)
Low	16.00	442.500000	442.500050	50
Nominal	24.00	442.500000	442.500051	51
High	30.00	442.500000	442.500051	51

6.3.5 Top Channel, Temperature

Condition	Frequency		Deviation
Temperature (C)	Reference Center Frequency (MHz)	Measured Frequency (MHz)	Calculated Deviation (Hz)
-30	475.000000	474.999819	-181
-20	475.000000	474.999707	-293
-10	475.000000	474.999546	-454
0	475.000000	474.999429	-571
10	475.000000	474.999474	-526
20	475.000000	474.999620	-380
30	475.000000	474.999724	-276
40	475.000000	474.999753	-247
50	475.000000	474.999752	-248
Max Deviation (Hz)			-181
Min Deviation (Hz)			-571

6.3.6 Top Channel, Operating Voltage

Condition	Voltage	Frequency		
Voltage Extreme	Voltage (V DC)	Reference Frequency (MHz)	Measured Frequency (MHz)	Calculated Deviation (Hz)
Low	16.00	475.000000	474.999642	-358
Nominal	24.00	475.000000	474.999641	-359
High	30.00	475.000000	474.999647	-353

7.0 Transient Frequency Behavior

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).

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

The EUT is terminated with a suitable resistive attenuator 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.

7.1 Criteria

Parameter	Section Reference	Date
Transient Frequency Behavior	90.214 RSS-119 Issue 12, 5.9 Procedure: TIA-603-C	7 Nov 2016

Table 7.1.1 Transient Frequency Limits			
Time intervals ^{1,2}	Maximum frequency difference ³	Frequency Range	
		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_{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.

²During 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.

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

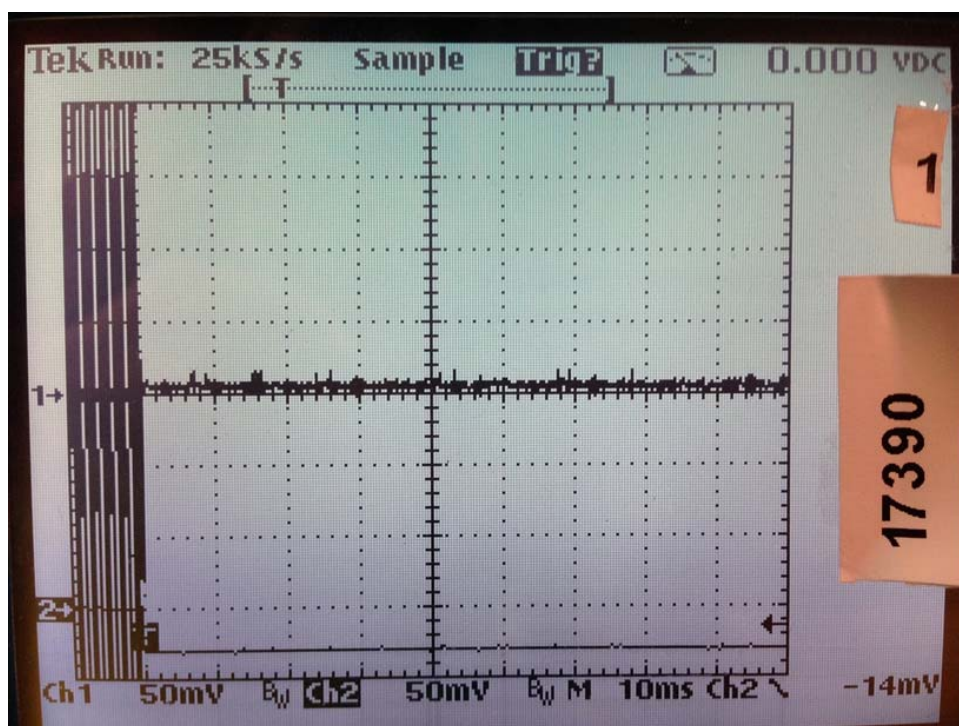
⁴If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

The measurement is performed for the lowest, middle, and highest operating frequency.

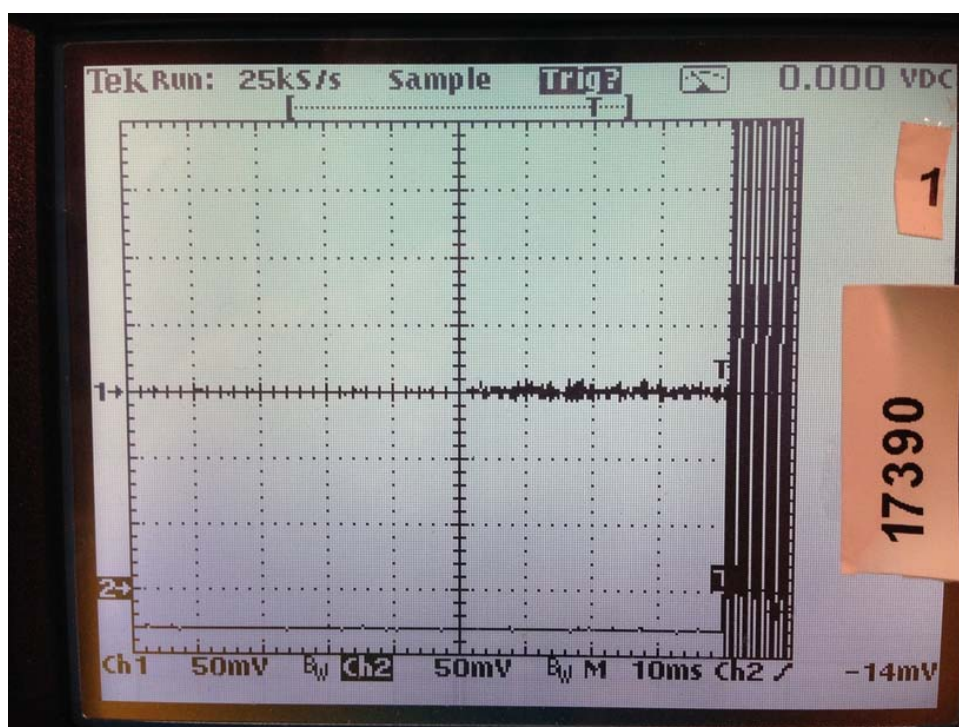
7.2 Results

The EUT satisfied the requirements. Plotted measurements appear on the following pages. The limits were not superimposed on the plots as the transmitter performance was clearly in compliance for any allowed channel scheme.

7.2.1 Bottom Channel

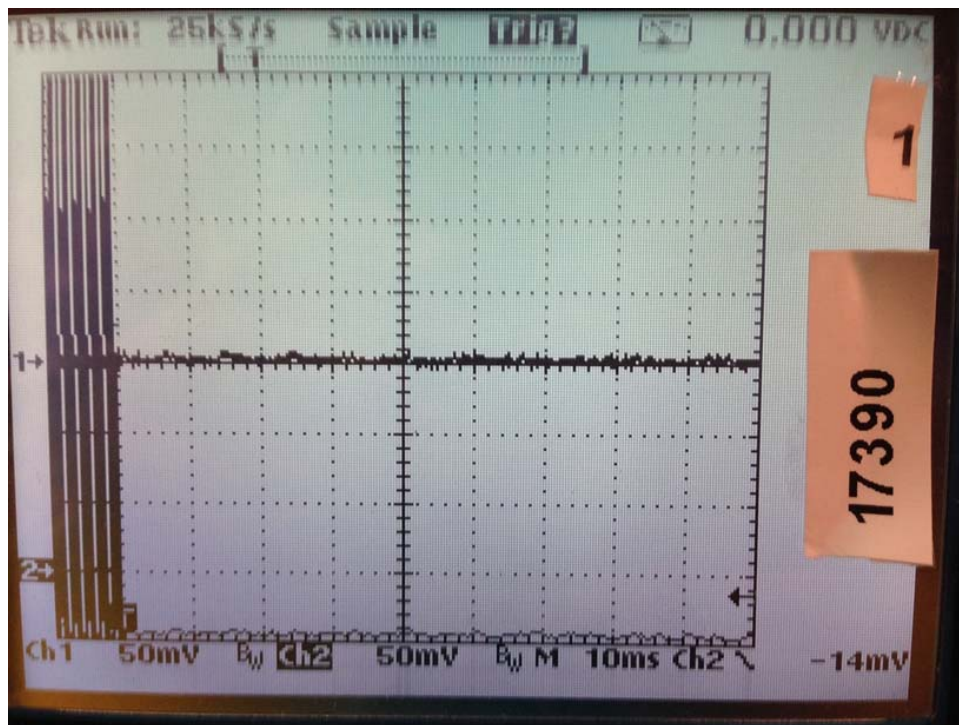


Attack

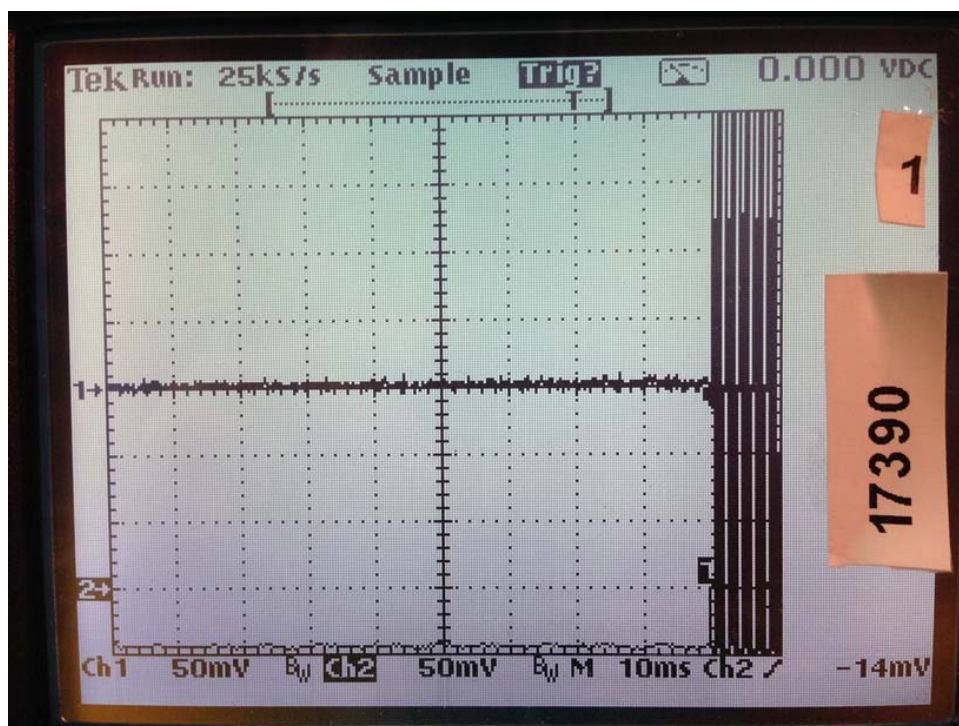


Release

7.2.2 Middle Channel

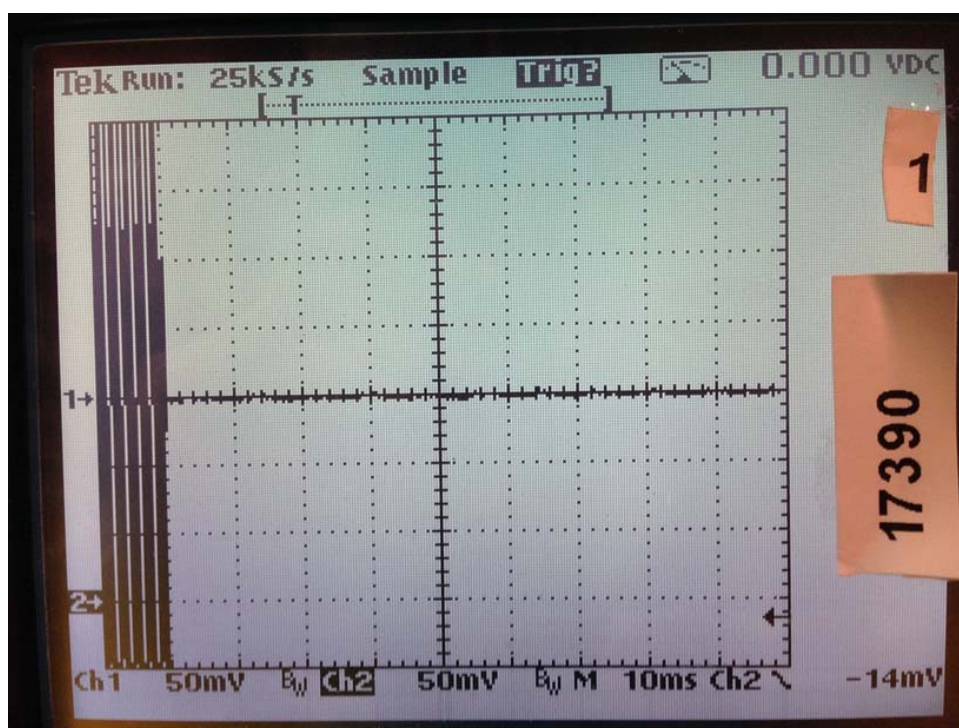


Attack

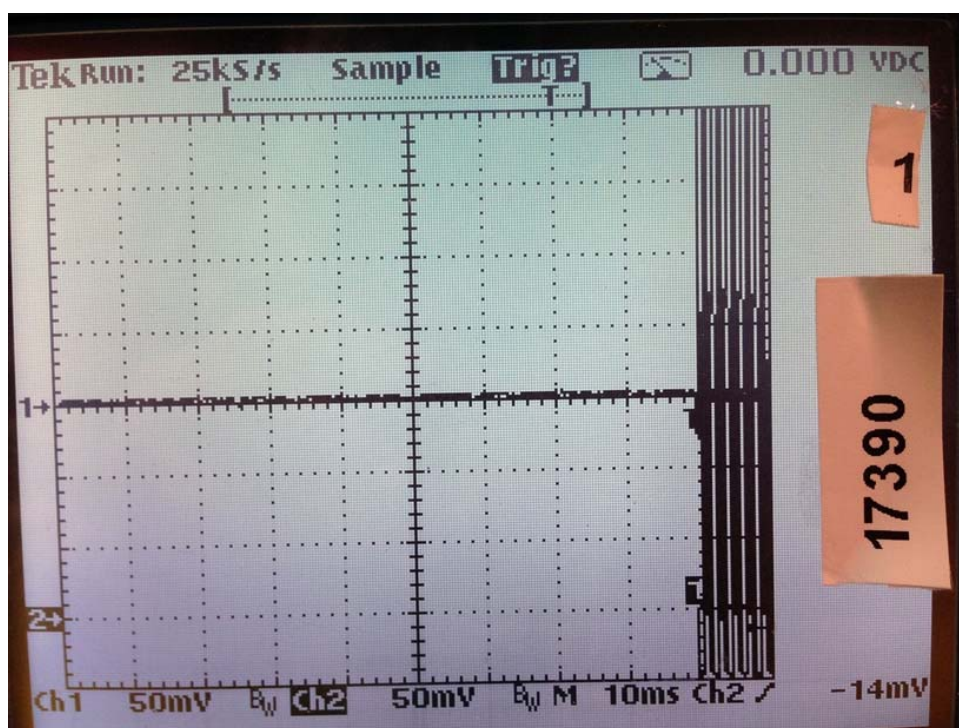


Release

7.2.3 Top Channel



Attack



Release

8.0 Emission Bandwidth

8.1 Procedure

The EUT antenna port is coupled direct to the spectrum analyzer for measurement.

8.2 Criteria

Parameter	Section Number	Date
90.210(c) Bandwidth < 12.5 kHz Or spectrum efficiency minimum 4800 baud per 6.25 kHz bandwidth per 90.203(j)(3).	90.210(c), 90.203(j)(3), 2.1049 RSS- 119 Issue 12, 5.5	9 Nov 2016 14 Jul 2017

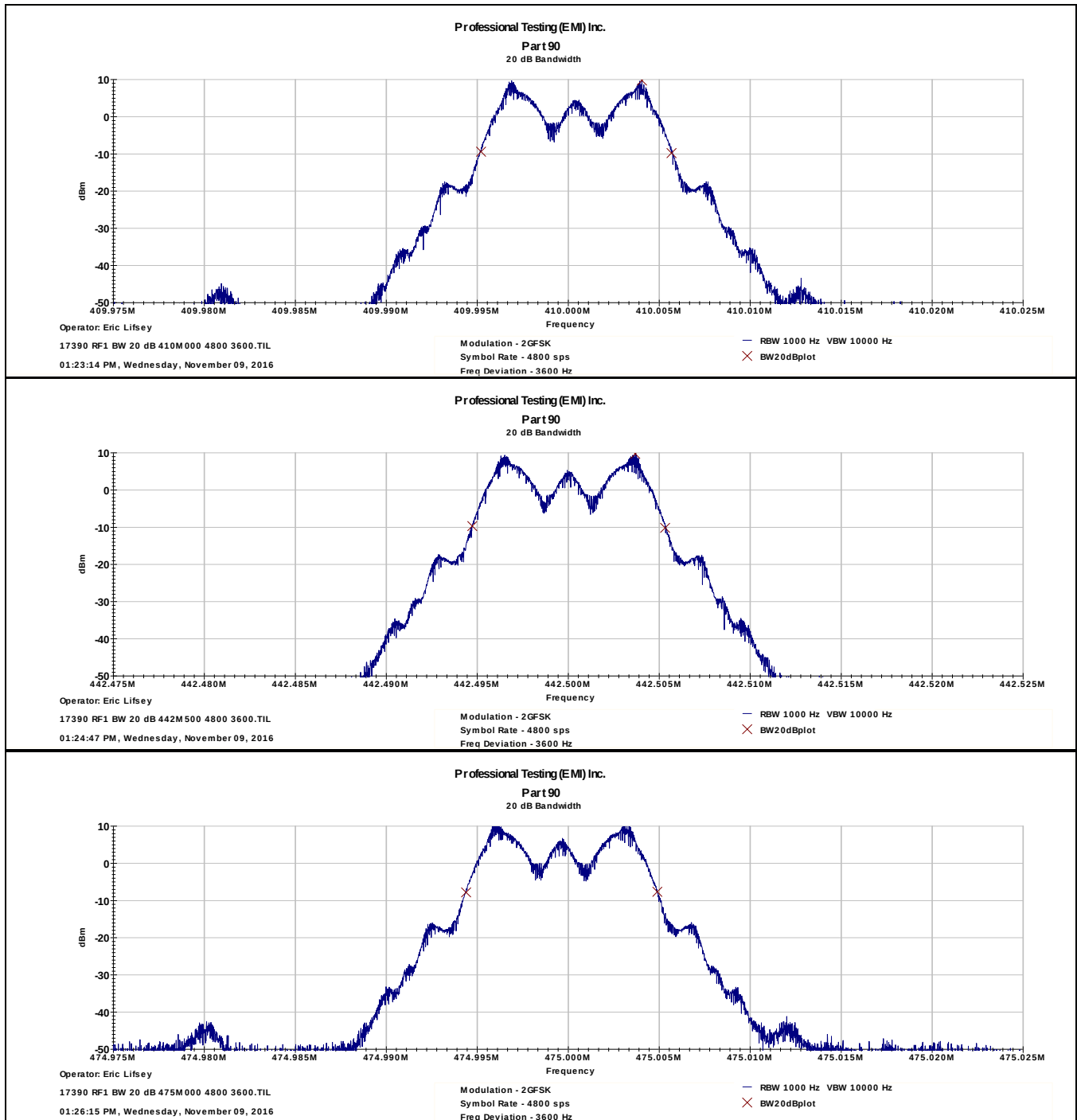
8.3 Results

Table 9.3.1 Bandwidth 20 dB (kHz)					
Frequency	2GFSK 4800 sps	2GFSK 9600 sps	4GFSK 18000 sps	4GFSK 20000 sps	4GFSK 25000 sps
410.0 MHz	10.64	11.25	19.96	21.16	20.03
442.5 MHz	10.65	11.34	20.08	21.24	20.10
475.0 MHz	10.66	11.24	20.05	21.45	19.70

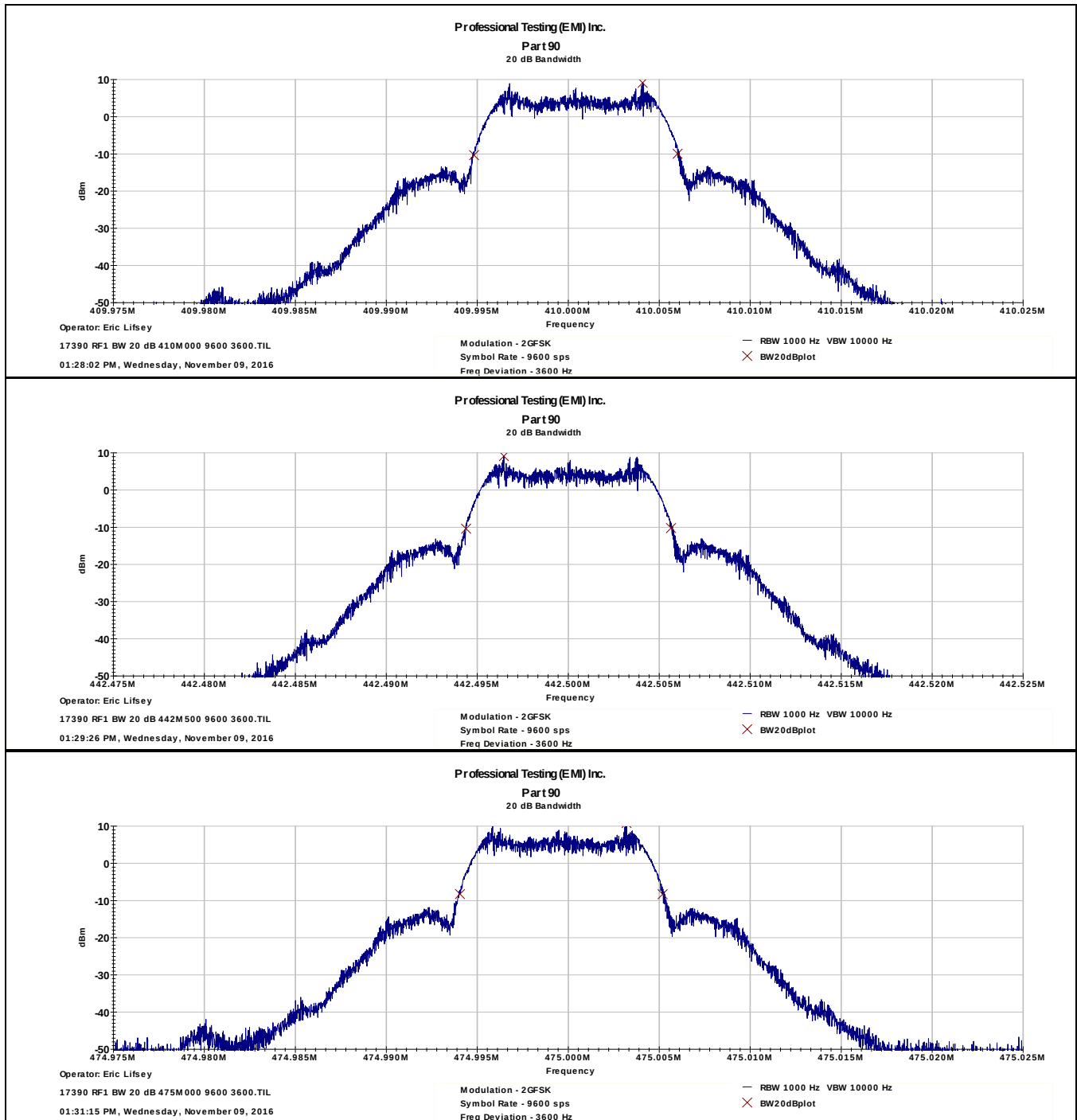
The emission satisfies the bandwidth criteria including the spectrum efficiency requirement at lower power than the threshold of 500 mW.

Plotted results appear on the following pages.

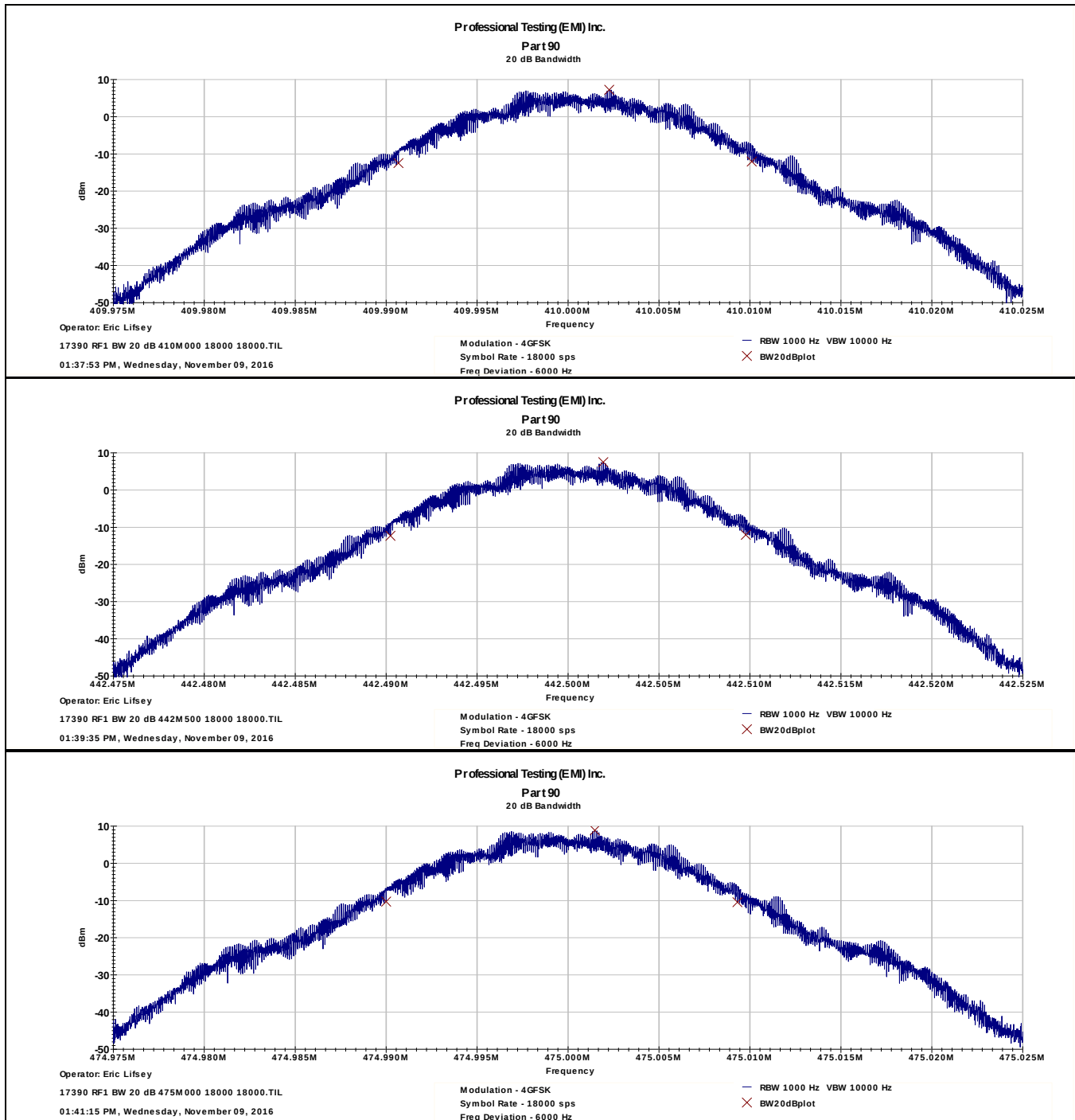
8.3.1 Modulation 2GFSK, 4800 Symbols Per Second



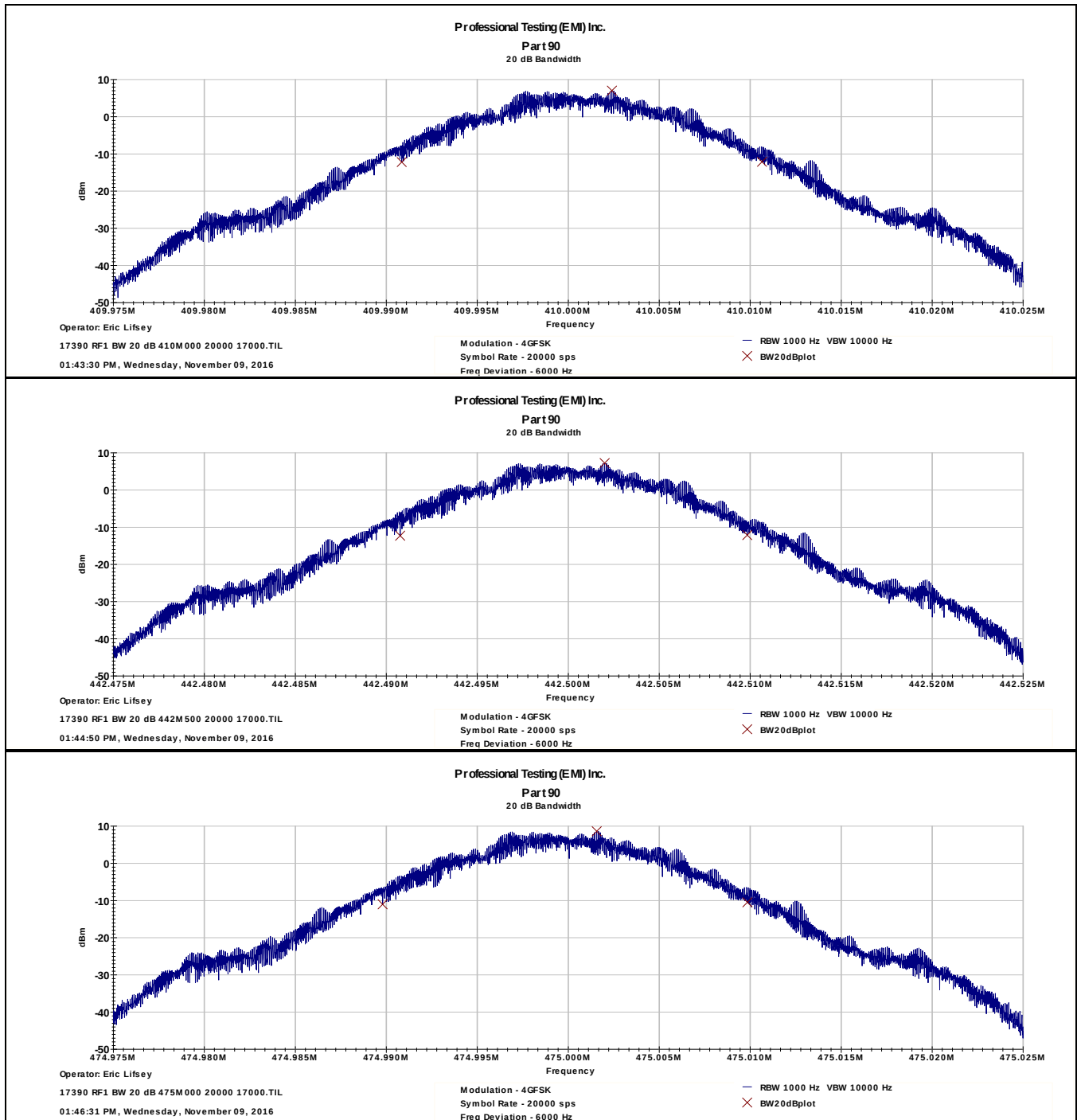
8.3.2 Modulation 2GFSK, 9600 Symbols Per Second



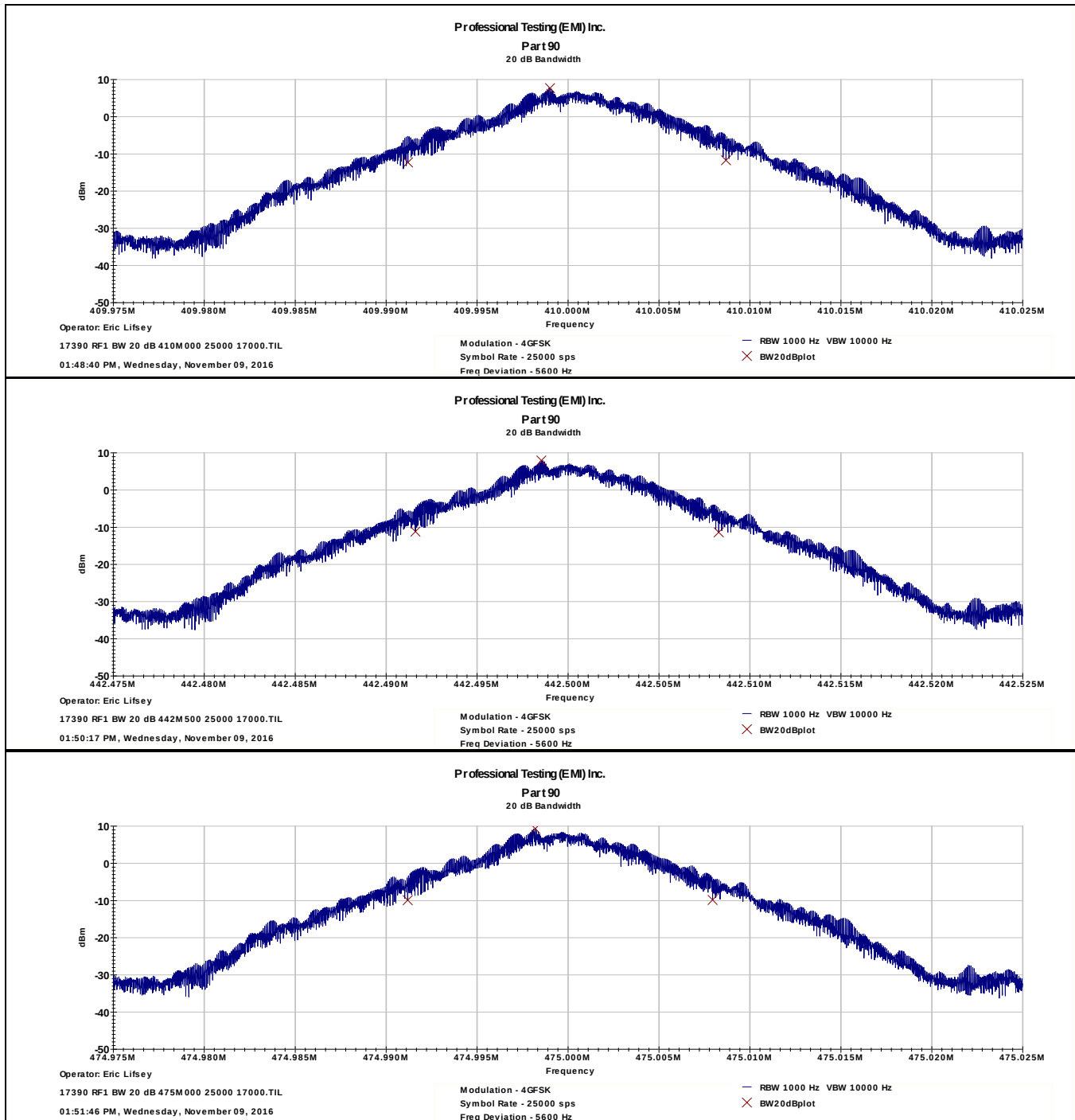
8.3.3 Modulation 4GFSK, 18000 Symbols Per Second



8.3.4 Modulation 4GFSK, 20000 Symbols Per Second



8.3.5 Modulation 4GFSK, 25000 Symbols Per Second



9.0 Equipment Lists

9.1 Conducted Power, Conducted Spurious, and Bandwidth

Asset #	Manufacturer	Model #	Description	Calibration Due
2295	Agilent	E4440A	Spectrum Analyzer	30 Sep 2017
0472	Tektronix	THS730A	Scope/DMM	15 Nov 2017
None	B&K	1710	Adjustable DC Power Supply	CIU
2201	Agilent	E3632A	Adjustable DC Power Supply	CIU

9.2 Frequency Stability

Asset #	Manufacturer	Model #	Description	Calibration Due
2295	Agilent	E4440A	Spectrum Analyzer	30 Sep 2017
2134	Tenny	TPS	Temperature Chamber	12 Oct 2017
C247	Pasternack	RG type	Coaxial Cable, double shielded	CNR
0472	Tektronix	THS730A	Scope/DMM	15 Nov 2017
None	B&K	1710	Adjustable DC Power Supply	CIU
2201	Agilent	E3632A	Adjustable DC Power Supply	CIU

9.3 Frequency Transient Behavior

Asset #	Manufacturer	Model #	Description	Calibration Due
0836	Narda	3293-1	Broadband Directional Coupler	CNR
0472	Tektronix	THS730A	Oscilloscope, Digital	15 Nov 2017
1678	HP	8921A	Cell Site Tester (as signal generator)	CIU
0742	HP	355C	Step Attenuator	CNR
0637	HP	8901A	Modulation Analyzer	CNR
None	Mini-Circuits	ZFRSC-43	3 Port Resistive Divider/Combiner SMA	CNR
0835	Narda	3293-1	Forward Power Coupler	CNR
None	Unknown	Unknown	10 dB SMA-SMA attenuator	CNR
A100	Narda	94455-1	Diode Detector	CNR
2201	Agilent	E3632A	Adjustable DC Power Supply	CIU
None	Various	None	RG Type coaxial cables	CNR

9.4 Radiated Spurious Transmit Mode and Receive Mode

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, FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators,			
In accordance with:		Radiated Emissions Limits			
Section:		15.209			
Test Date(s):		10/31/2016	EUT Serial #:	None	
Customer:		Hetronic	EUT Part #:	HI1511R06	
Project Number:		17390	Test Technician:	Eric Lifsey	
Purchase Order #:		0	Supervisor:	Lisa Arndt	
Equip. Under Test:		IP Bridge (RF1)	Witness' Name:	None	
Radiated Emissions Test Equipment List					
Tile! Software Version:		4.2.A, May 23, 2010, 08:38:52 AM			
Test Profile:		2016 RE_ClassA - Boresite+Mast_LowPRF_072616.til or 2016 RE_ClassB - Boresite+Mast_LowPRF_072616.til			
Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1509A	Braden	N/A	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	2/5/2017
1890	HP	8447F	Preamp/Amp, 9kHz-1300MHz, 28/25dB	3313A05298	2/1/2018
1937	Agilent	E4440A	Spectrum Analyzer, 3 Hz - 26.5 GHz, Opt. AYZ	MY44808298	12/15/2016
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz	135454	1/25/2017
C027D	PTI	None	Relay	none	N/A
1327	EMCO	1050	Controller, Antenna Mast	none	N/A
0942	EMCO	11968D	Turntable, 4ft.	9510-1835	N/A
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
1509B	Braden	N/A	TDK 10M Chamber, VSWR > 1 GHz	DAC-012915-005	3/14/2017
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, .1-18GHz	0	1/11/2018
C030	none	none	Cable Coax, N-N, 30m	none	10/1/2017
1325	EMCO	1050	Controller, Antenna Mast	9003-1461	N/A
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	110313	2/25/2017

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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