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Project 19214-15

**Hetronic  
PA-1  
Amplifier Module**

**410.000 to 475.000 MHz**

**Wireless Certification Report**

**FCC Part 90 and IC RSS-119**

Prepared for:

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

By

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

15 Nov 2017

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Reviewed by



Larry Finn  
Chief Technical Officer

Written by



Eric Lifsey  
EMC Engineer

## Revision History

| Revision Number | Description       | Date        |
|-----------------|-------------------|-------------|
| DRAFT 01        | Draft for review. | 12 Jul 2017 |
| Final 01        |                   | 15 Nov 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<br>3905 NW 36th St.<br>Oklahoma City, OK 73112 USA<br>Certificate Date: 15 Nov 2017 | FCC ID:                      | LW9-PA1  |
|  | IC ID:                       | 2119-PA1 |
|  | Model(s):                    | PA-1     |
|  | Laboratory Project ID:       | 19214-15 |

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 (90.217 power below 120 mW)                                   | 90.217, 2.1047         | RSS-119 Issue 12, 5.10                              |
| 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, ANSI/TIA-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                           |
| Zone Enhancer   | N/A                    | RSS-131 Issue 3, 6.4                                |
| Operating frequency per licensed channel allocations of:                    | Part 90                | SRSP-510 Issue 5; 410 to 430 MHz and 450 to 460 MHz |

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 an amplifier module used in the manufacturer's systems that transmit and receive control codes with associated wireless devices in industrial environments. It receives power from the host system and RF/control from as associated radio module. The EUT supports external antennas, or a cable thereto, attached to the modules SMB connector.

| Table 1.2.1 Equipment Under Test                                    |       |          |
|---|-------|----------|
| Manufacturer & Description  | Model | Serial # |
| Hetronic<br>Amplifier and Transceiver<br>module for 410 to 475 MHz. | PA-1  | none     |

| Table 1.2.2 Options                     |         |   |
|---|---------|---|
| Manufacturer & Description              | Gain    | Notes   |
| Hetronic; ¼ wave SMB whip antenna       | 1 dBi   | For use directly on module in RF transparent hosts. |
| Hetronic; cable extension to TNC-F      | NA      | Extends modules to external antenna.                |
| Hetronic; ¼ wave TNC-M antenna          | 4 dBi   | External mobile antenna.                            |
| RFS 201-7N; fiberglass vertical antenna | 7.1 dBi | External fixed-mounted antenna; 450-470 MHz         |

### 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.

These modules are used as a transceiver and optional amplifier pair in portable battery or vehicular powered/fixed applications.

| 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.

## 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

| <b>Document #</b>      | <b>Title/Description</b>  |
|------------------------|---|
| 47 CFR                 | FCC Part 90   |
| IC RSS-119<br>Issue 12 | Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41-960 MHz                    |
| IC RSS-Gen<br>Issue 4  | General Requirements for Compliance of Radio Apparatus  |
| IC RSS-131<br>Issue 3  | Zone Enhancers  |
| ANSI C63.26-<br>2015   | American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services |
| ANSI/TIA-603-<br>E     | Land Mobile FM or PM Communications Equipment Measurement and Performance Standards               |

## 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 | 10 Jul 2017 |

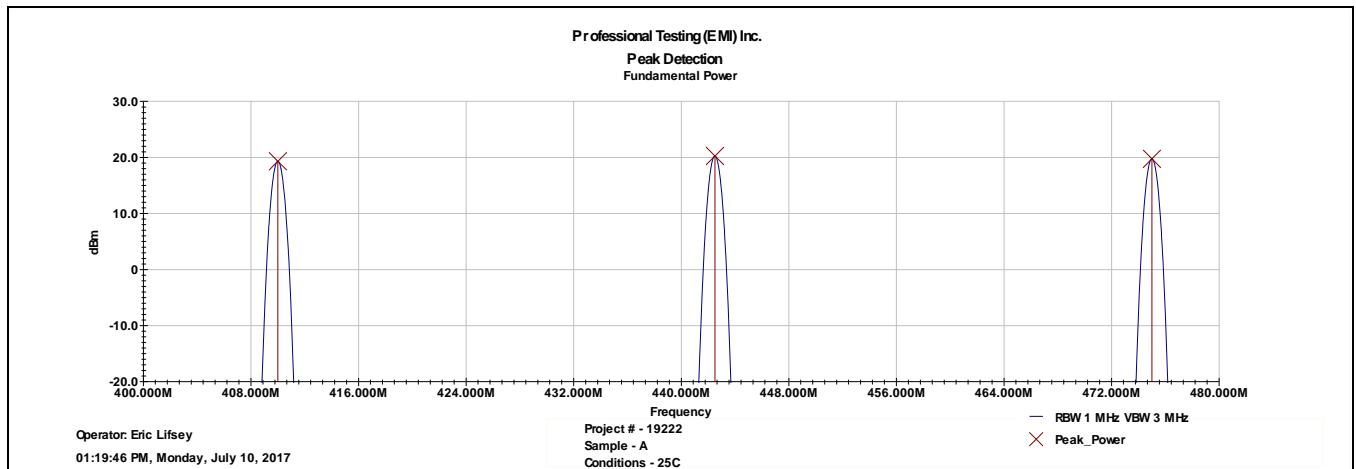
### 2.3 Results

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.

| Frequency (MHz) | Power (dBm) | Power (mW) |
|-----------------|-------------|------------|
| 410.000         | 19.3        | 85.1       |
| 442.500         | 20.3        | 107.2      |
| 475.000         | 19.7        | 93.3       |

The average of power over the channels is approximately 19.8 dBm and serves as the operating specification for other tests.





### 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 | 90.217(b), 2.1047   RSS-119 Issue 12, 5.10 | 10 Jul 2017 |

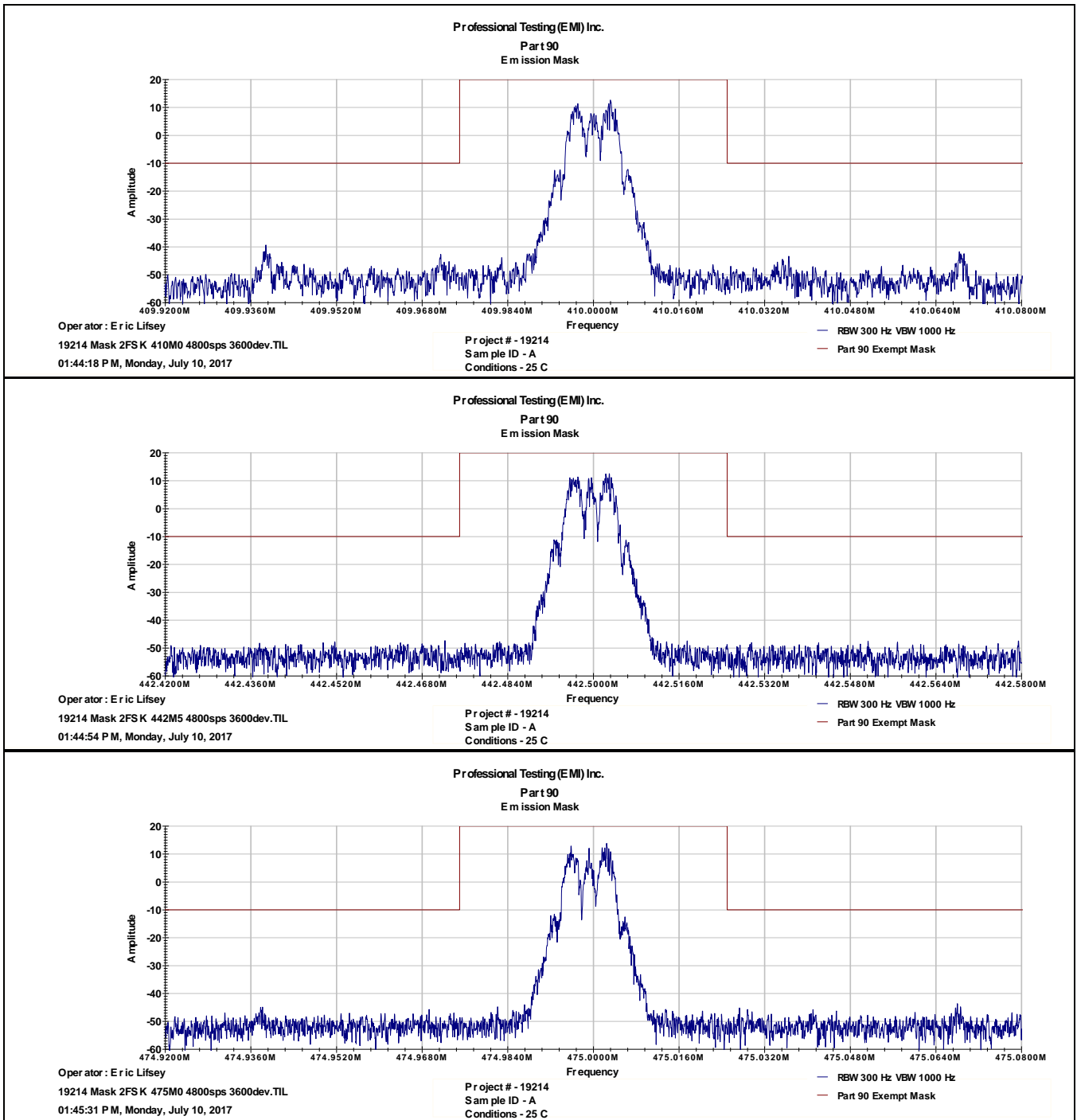
#### 3.3 Results

The emission was measured coupled directly to the analyzer without cabling. The EUT satisfied the requirement.

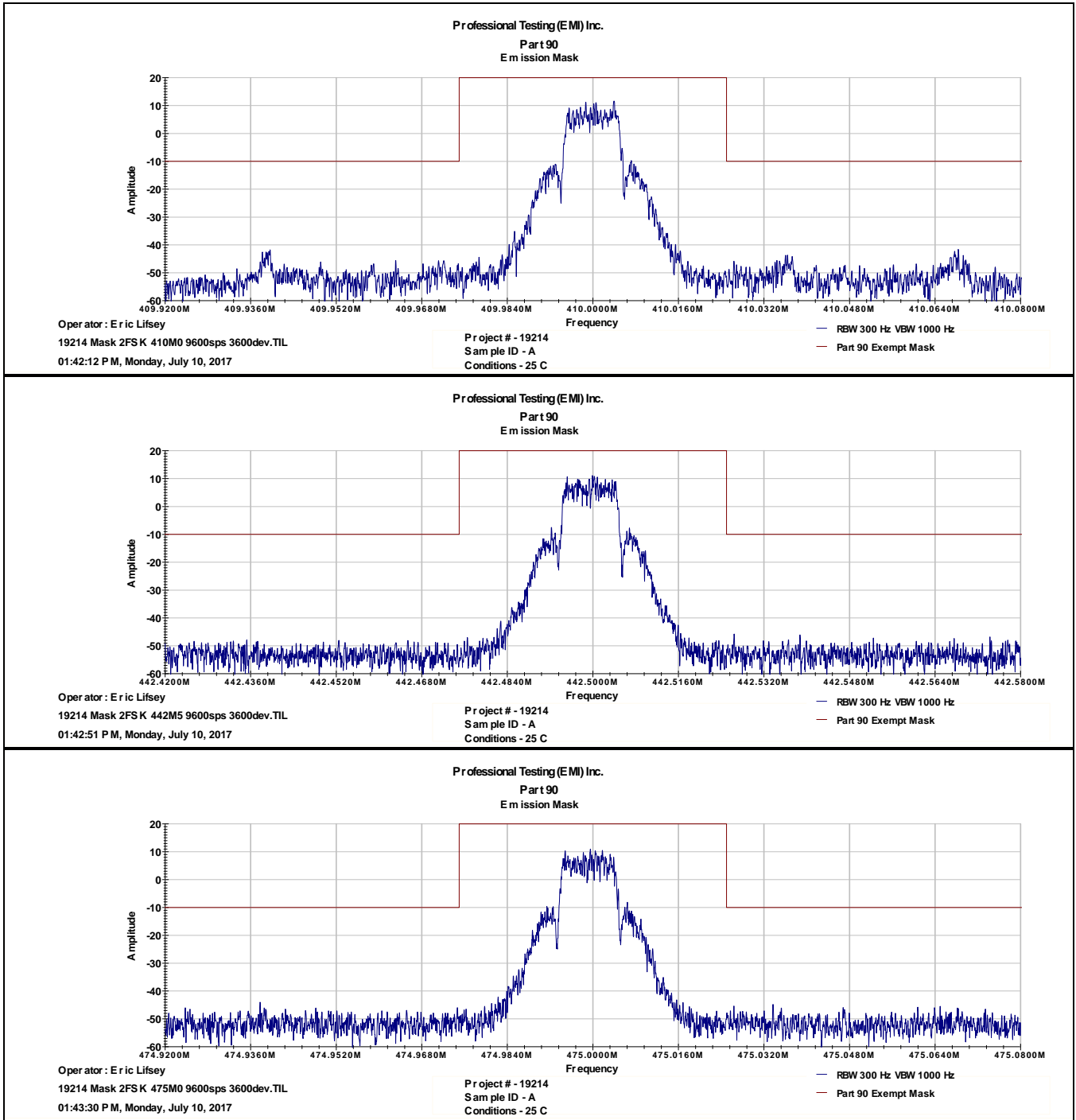
The peak power is below the exemption criteria of 120 mW, therefore the exemption mask of -30 dBc applies in all modulation modes.

Measurements appear on the following pages.

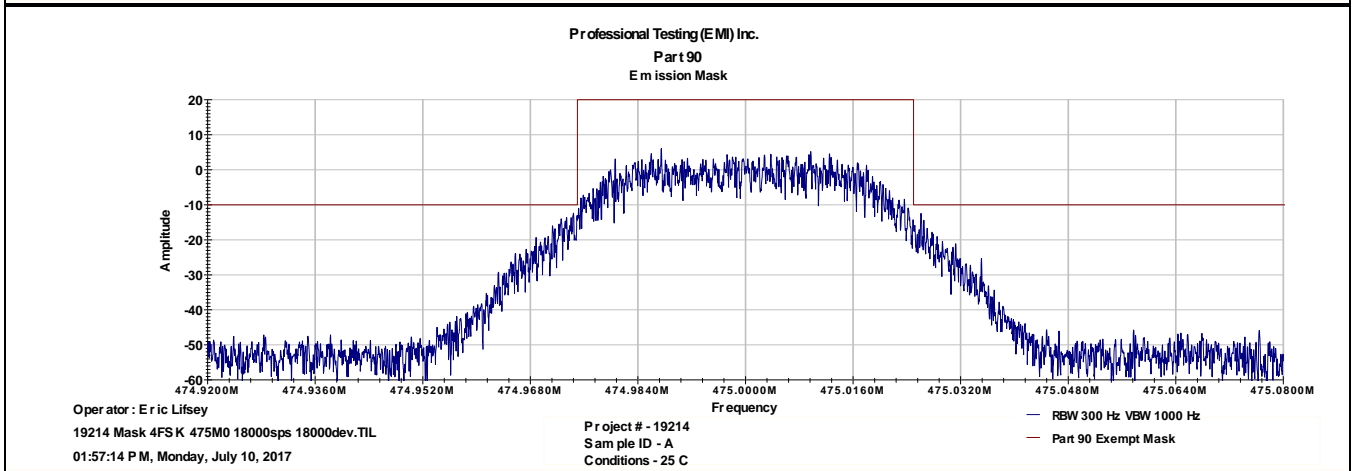
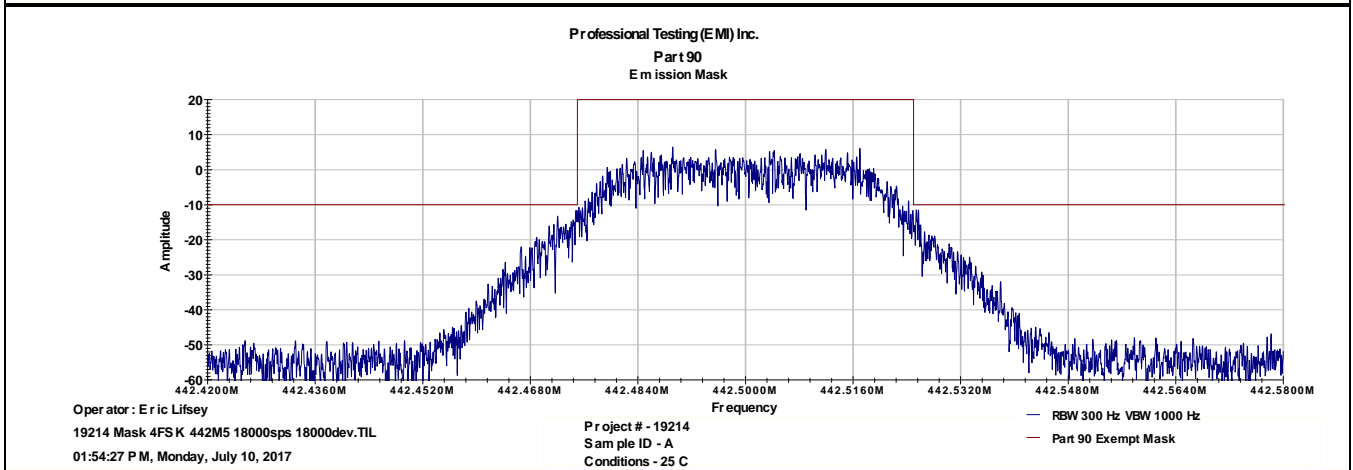
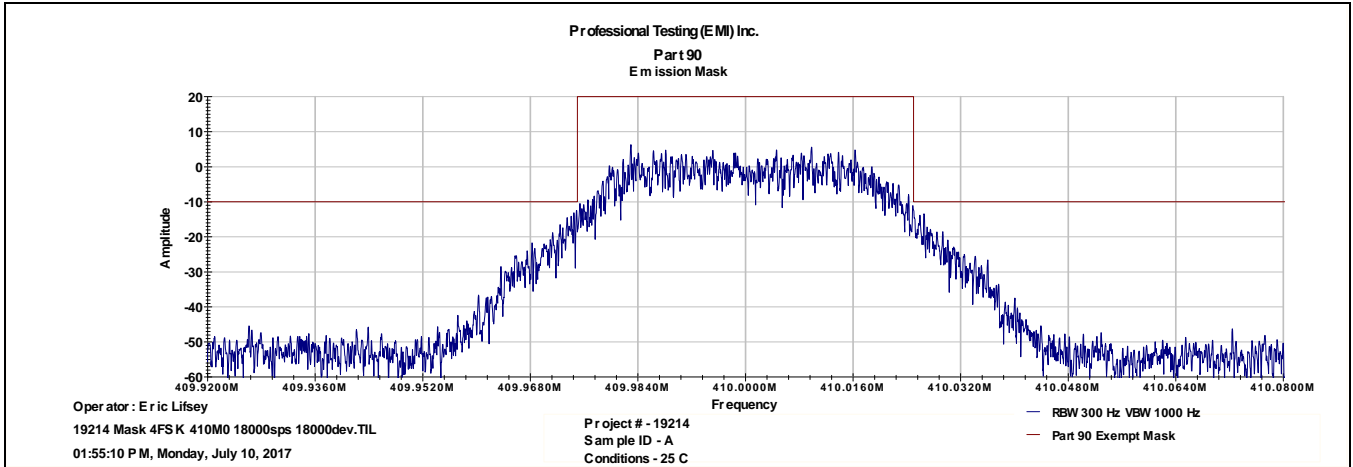
### 3.3.1 Modulation 2GFSK at 4800 Symbols per Second



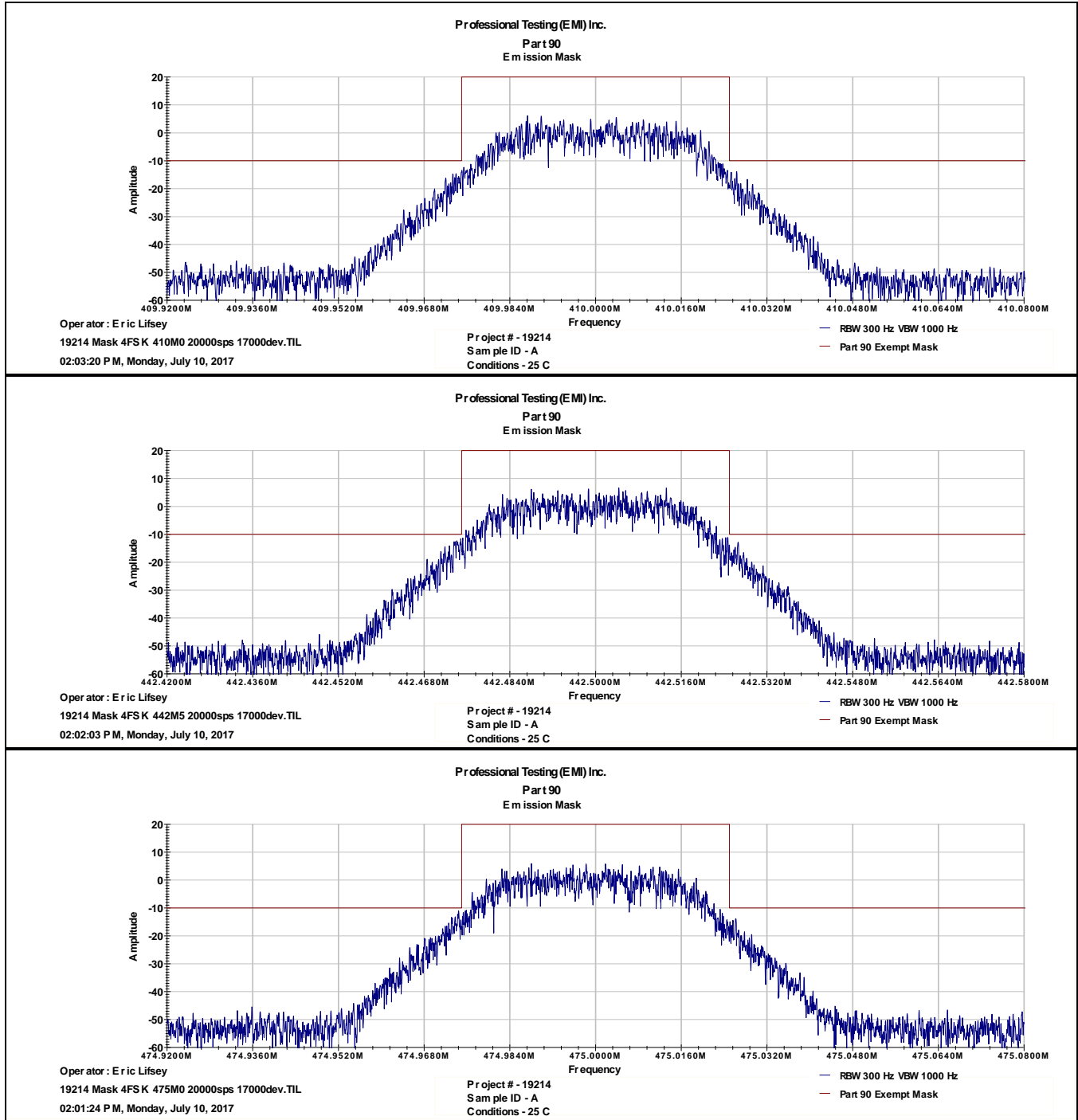
### 3.3.2 Modulation 2GFSK at 9600 Symbols per Second



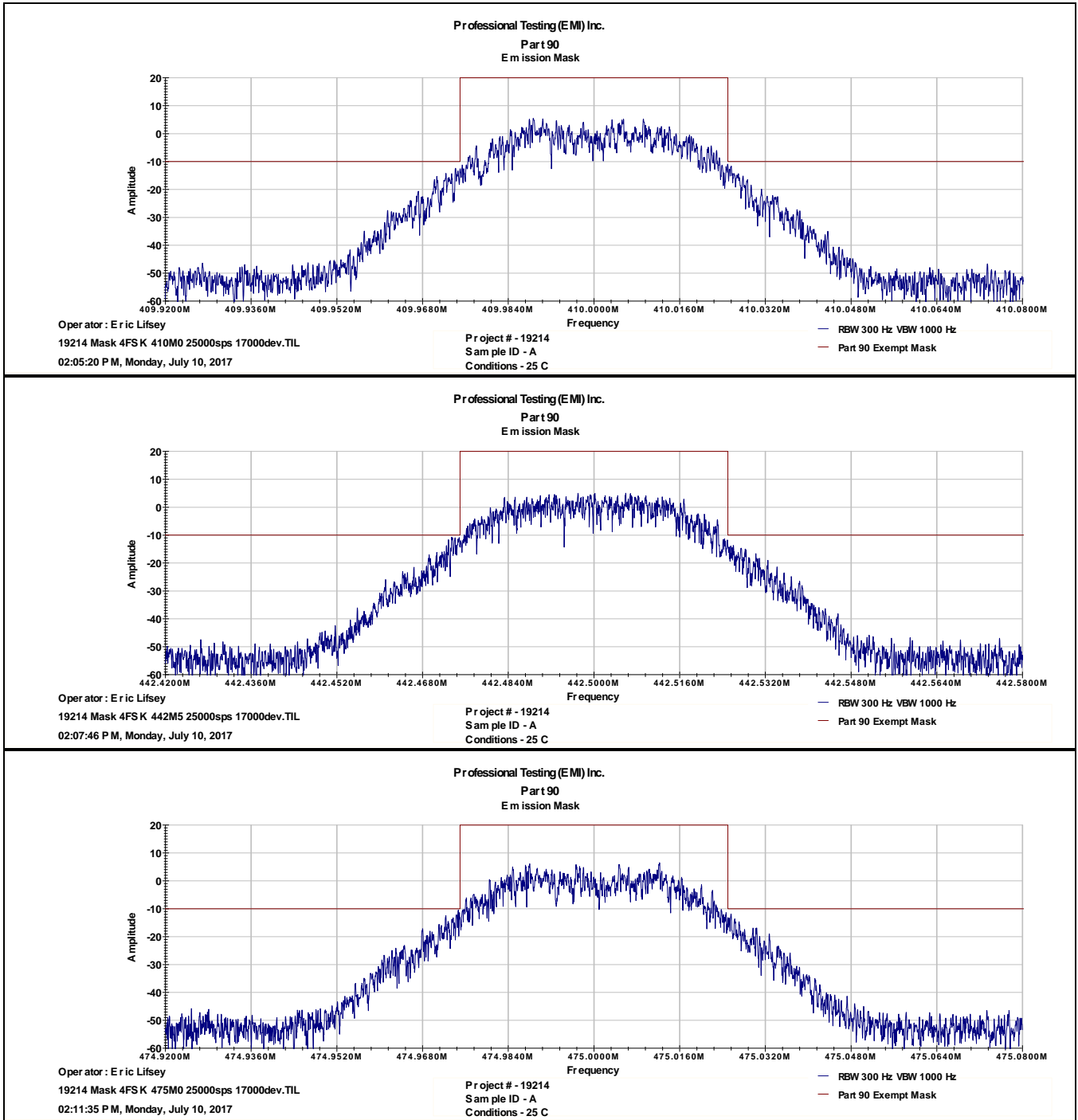
### 3.3.3 Modulation 4GFSK at 18000 Symbols per Second with 18000 Hz Deviation



### 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 | 10 Jul 2017 |

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

Per 90.210(c)(3)  $\text{Attenuation}_{(\text{dB})} = 43 + 10 \text{Log}_{10}(0.1072 \text{ W}) = 33.3 \text{ dB}$

$\text{Limit}_{(\text{dBm})} = \text{Fundamental\_Power}_{(\text{dBm})} - \text{Attenuation}_{(\text{dB})} = 20.3 \text{ dBm} - 33.3 \text{ dB} = -13 \text{ dBm}$

### 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.

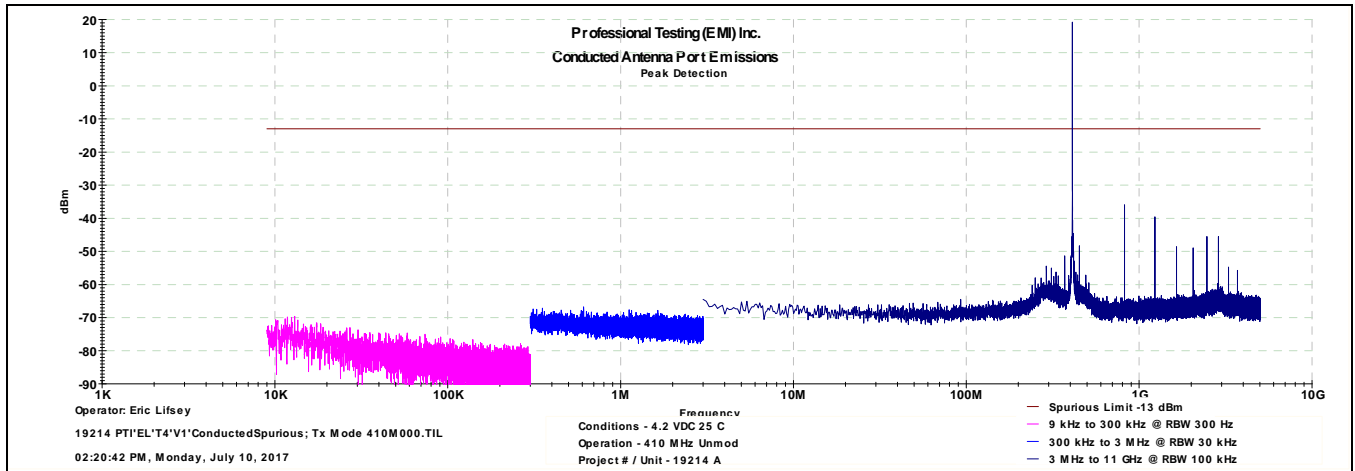
The EUT was found to be in compliance with applicable requirements.

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

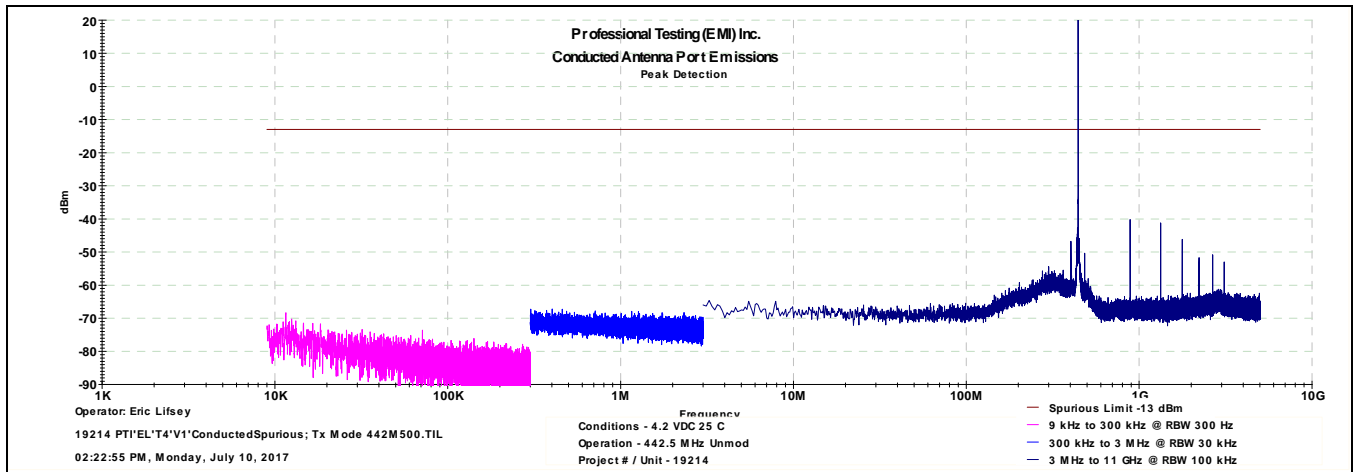
For receive mode the -41 dBm general emission limit is included as a dashed red line.

Measurements appear below.

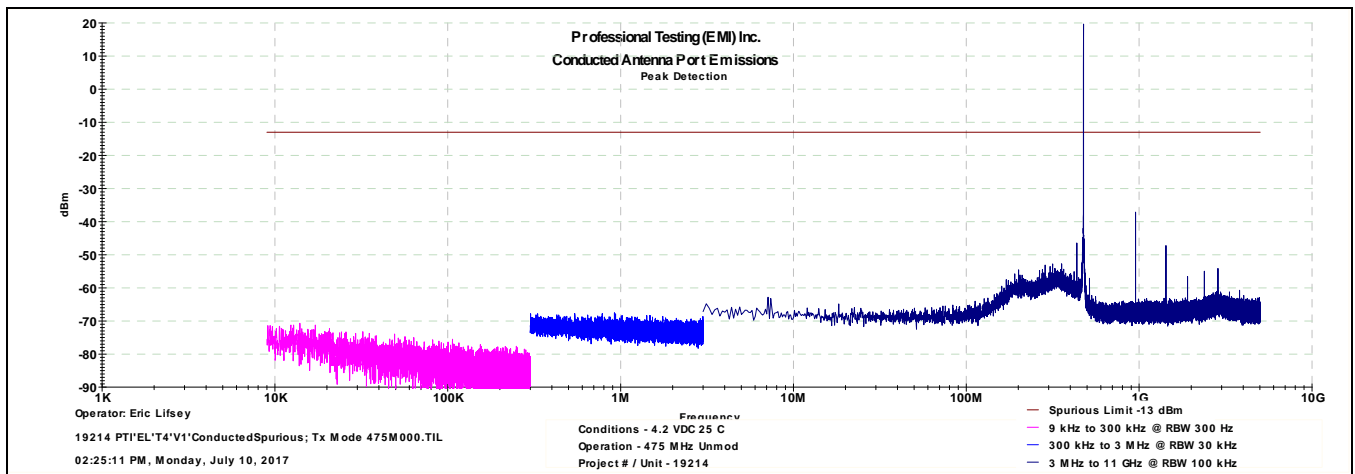
### 4.3.1 Transmit Mode, Bottom Channel



### 4.3.2 Transmit Mode, Middle Channel

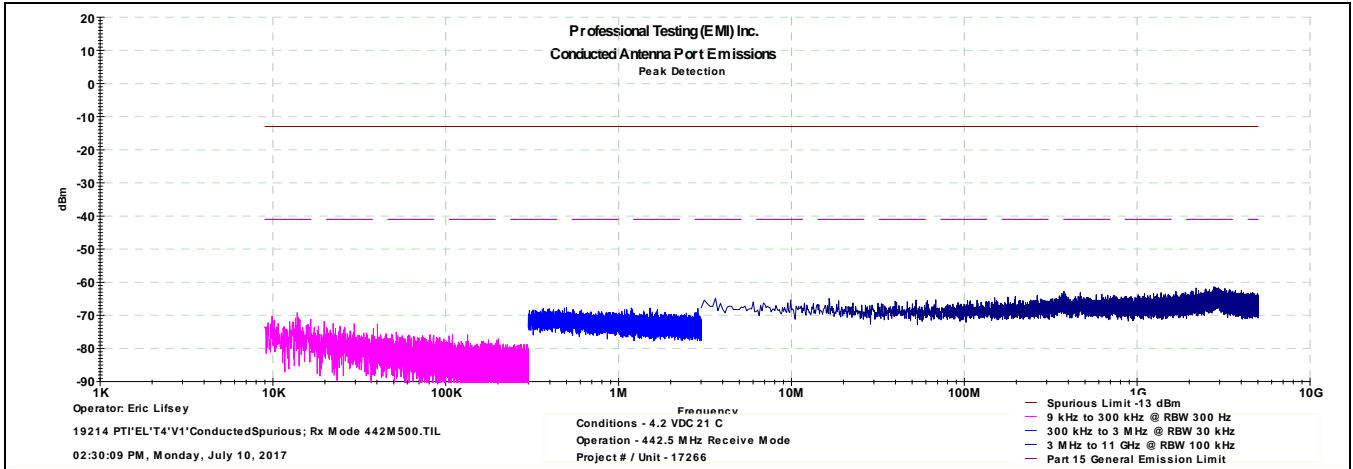


### 4.3.3 Transmit Mode, Top Channel





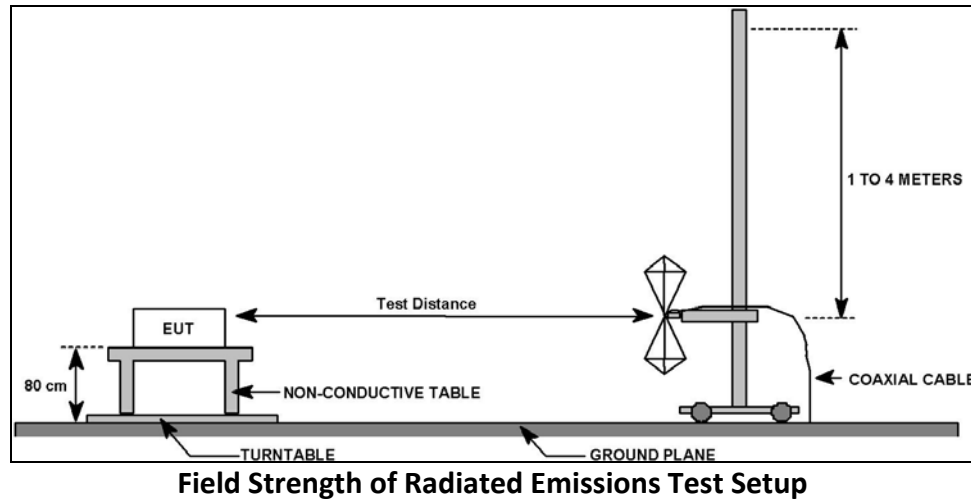
### 4.3.4 Receive Mode, Middle Channel



## 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<br>30 MHz to 5 GHz | 90.210, 15.209, 2.1053   RSS-119 Issue 12,<br>5.8; RSS-Gen Issue 4 | 30 Jun 2017 |

### 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)  $Attenuation_{(dB)} = 43 + 10 \text{ Log}_{10}(0.1072 \text{ W}) = 33.3 \text{ dB}$

$Limit_{(dBm)} = \text{Fundamental\_Power}_{(dBm)} - Attenuation_{(dB)} = 20.3 \text{ dBm} - 33.3 \text{ dB} = -13 \text{ dBm}$

Restated as radiated limits of: 73.9 dB $\mu$ V/m at 10 meters and 84.4 dB $\mu$ V/m at 3 meters.

The EUT satisfied the requirement. Measurements appear below.

### 5.3.1 Transmit Mode, Up to 1 GHz, All Channels

| Professional Testing, EMI, Inc. |   |                         |              |
|---------------------------------|---|-------------------------|--------------|
| <b>Test Method:</b>             | ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |                         |              |
| <b>In accordance with:</b>      | FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits   |                         |              |
| <b>Section:</b>                 | 15.109  |                         |              |
| <b>Test Date(s):</b>            | 6/30/2017   | <b>EUT Serial #:</b>    | None         |
| <b>Customer:</b>                | Hetronic  | <b>EUT Part #:</b>      | None         |
| <b>Project Number:</b>          | 19214-15  | <b>Test Technician:</b> | Bob Redoutey |
| <b>Purchase Order #:</b>        | N/A   | <b>Supervisor:</b>      | Lisa Arndt   |
| <b>Equip. Under Test:</b>       | PA-1 with CSM-400UE   | <b>Witness' Name:</b>   | None         |

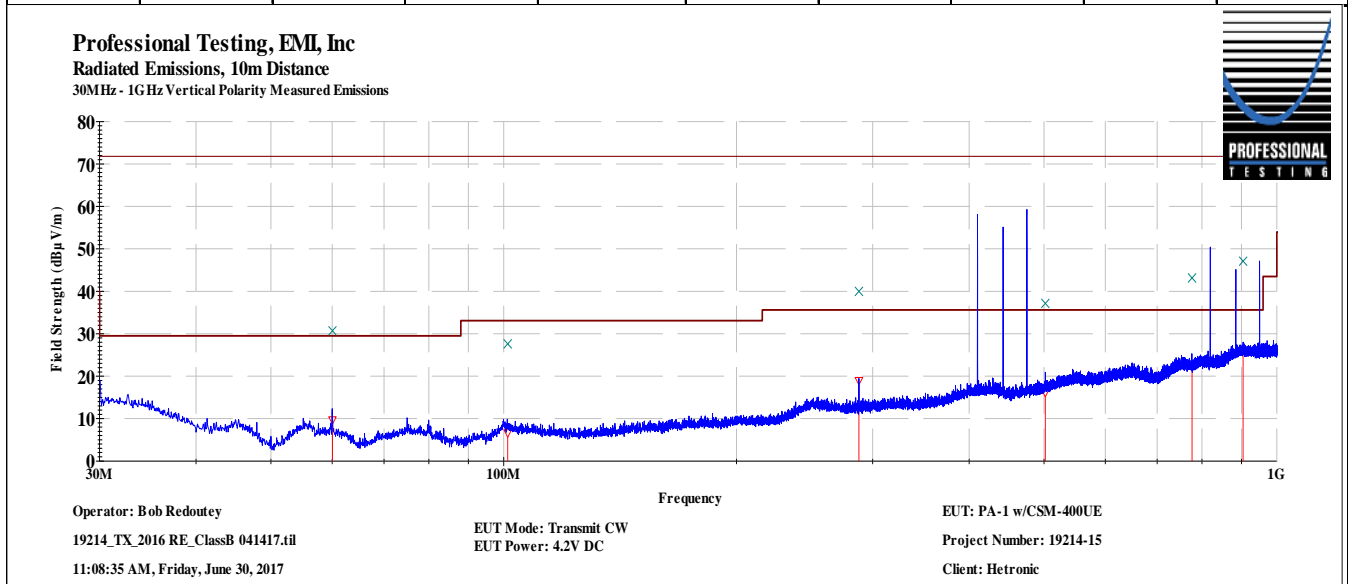
**Radiated Emissions Test Results Data Sheet** Page: 1 of 1

|                          |         |                             |       |
|--------------------------|---------|-----------------------------|-------|
| <b>EUT Line Voltage:</b> | 4.2 VDC | <b>EUT Power Frequency:</b> | - N/A |
|--------------------------|---------|-----------------------------|-------|

|                             |          |                         |               |
|-----------------------------|----------|-------------------------|---------------|
| <b>Antenna Orientation:</b> | Vertical | <b>Frequency Range:</b> | 30MHz to 1GHz |
|-----------------------------|----------|-------------------------|---------------|

|                               |             |
|-------------------------------|-------------|
| <b>EUT Mode of Operation:</b> | Transmit CW |
|-------------------------------|-------------|

| 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 |
|--------------------------|------------------------|-------------------------|-------------------------|-------------------|---------------------------|--------------------------|----------------------|-------------|--------------|
| 60.0336                  | 10                     | 161                     | 2.23                    | Quasi-peak        | 28                        | 9.683                    | 29.5                 | -19.8       | Pass         |
| 101.194                  | 10                     | 258                     | 3.01                    | Quasi-peak        | 23.1                      | 6.616                    | 33.1                 | -26.5       | Pass         |
| 288.03                   | 10                     | 37                      | 3.76                    | Quasi-peak        | 29.5                      | 18.955                   | 35.6                 | -16.6       | Pass         |
| 501.762                  | 10                     | 145                     | 2.49                    | Quasi-peak        | 22.4                      | 16.134                   | 35.6                 | -19.5       | Pass         |
| 776.605                  | 10                     | 122                     | 2.21                    | Quasi-peak        | 21.5                      | 22.129                   | 35.6                 | -13.5       | Pass         |
| 904.489                  | 10                     | 52                      | 3.31                    | Quasi-peak        | 21.2                      | 26.081                   | 35.6                 | -9.5        | Pass         |



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

## Professional Testing, EMI, Inc.

**Test Method:** ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

**In accordance with:** FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits

**Section:** 15.109

|   |                                      |
|---|--------------------------------------|
| <b>Test Date(s):</b> 6/30/2017                | <b>EUT Serial #:</b> None            |
| <b>Customer:</b> Hetronic                     | <b>EUT Part #:</b> None              |
| <b>Project Number:</b> 19214-15               | <b>Test Technician:</b> Bob Redoutey |
| <b>Purchase Order #:</b> N/A                  | <b>Supervisor:</b> Lisa Arndt        |
| <b>Equip. Under Test:</b> PA-1 with CSM-400UE | <b>Witness' Name:</b> None           |

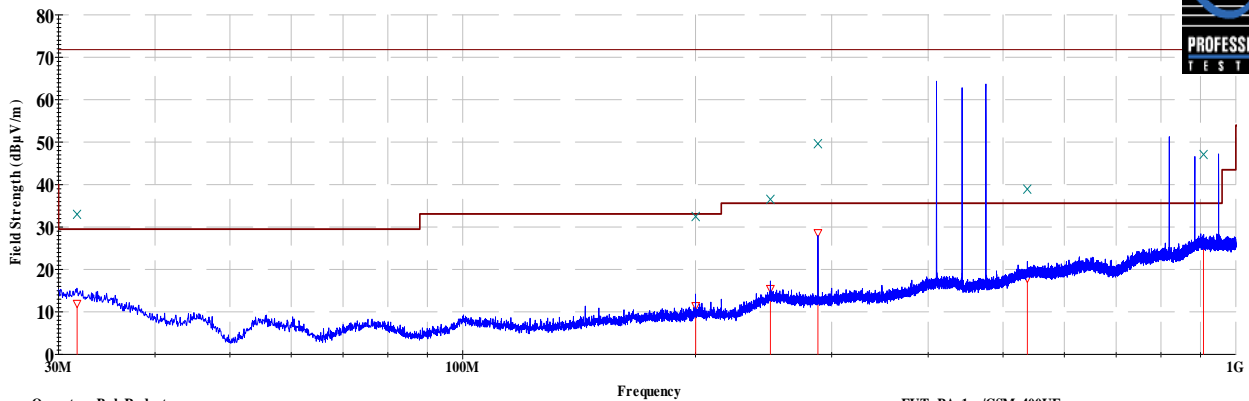
**Radiated Emissions Test Results Data Sheet** Page: 1 of 1

|  |                                       |
|--|---------------------------------------|
| <b>EUT Line Voltage:</b> 4.2 VDC       | <b>EUT Power Frequency:</b> - N/A     |
| <b>Antenna Orientation:</b> Horizontal | <b>Frequency Range:</b> 30MHz to 1GHz |

**EUT Mode of Operation:** Transmit CW

| 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 |
|--------------------------|------------------------|-------------------------|-------------------------|-------------------|---------------------------|--------------------------|----------------------|-------------|--------------|
| 31.7095                  | 10                     | 41                      | 1.07                    | Quasi-peak        | 24                        | 11.984                   | 29.5                 | -17.5       | Pass         |
| 200.109                  | 10                     | 323                     | 2.82                    | Quasi-peak        | 25.8                      | 11.463                   | 33.1                 | -21.6       | Pass         |
| 250.029                  | 10                     | 152                     | 2.66                    | Quasi-peak        | 25.5                      | 15.496                   | 35.6                 | -20.1       | Pass         |
| 288.034                  | 10                     | 296                     | 2.99                    | Quasi-peak        | 39.2                      | 28.631                   | 35.6                 | -7.0        | Pass         |
| 537.253                  | 10                     | 250                     | 3.71                    | Quasi-peak        | 22.2                      | 17.93                    | 35.6                 | -17.7       | Pass         |
| 908.4                    | 10                     | 110                     | 1.46                    | Quasi-peak        | 21.2                      | 26.078                   | 35.6                 | -9.5        | Pass         |

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



Operator: Bob Redoutey  
 19214\_TX\_2016\_RE\_ClassB 041417.4il  
 11:08:35 AM, Friday, June 30, 2017

EUT Mode: Transmit CW  
 EUT Power: 4.2V DC

EUT: PA-1 w/CSM-400UE  
 Project Number: 19214-15  
 Client: Hetronic

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

### 5.3.2 Transmit Mode, Above 1 GHz, All Channels

| Professional Testing, EMI, Inc. |   |                         |              |
|---------------------------------|---|-------------------------|--------------|
| <b>Test Method:</b>             | ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |                         |              |
| <b>In accordance with:</b>      | FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits   |                         |              |
| <b>Section:</b>                 | 15.109  |                         |              |
| <b>Test Date(s):</b>            | 6/30/2017   | <b>EUT Serial #:</b>    | None         |
| <b>Customer:</b>                | Hetronic  | <b>EUT Part #:</b>      | None         |
| <b>Project Number:</b>          | 19214-15  | <b>Test Technician:</b> | Bob Redoutey |
| <b>Purchase Order #:</b>        | N/A   | <b>Supervisor:</b>      | Lisa Arndt   |
| <b>Equip. Under Test:</b>       | PA-1 with CSM-400UE   | <b>Witness' Name:</b>   | None         |

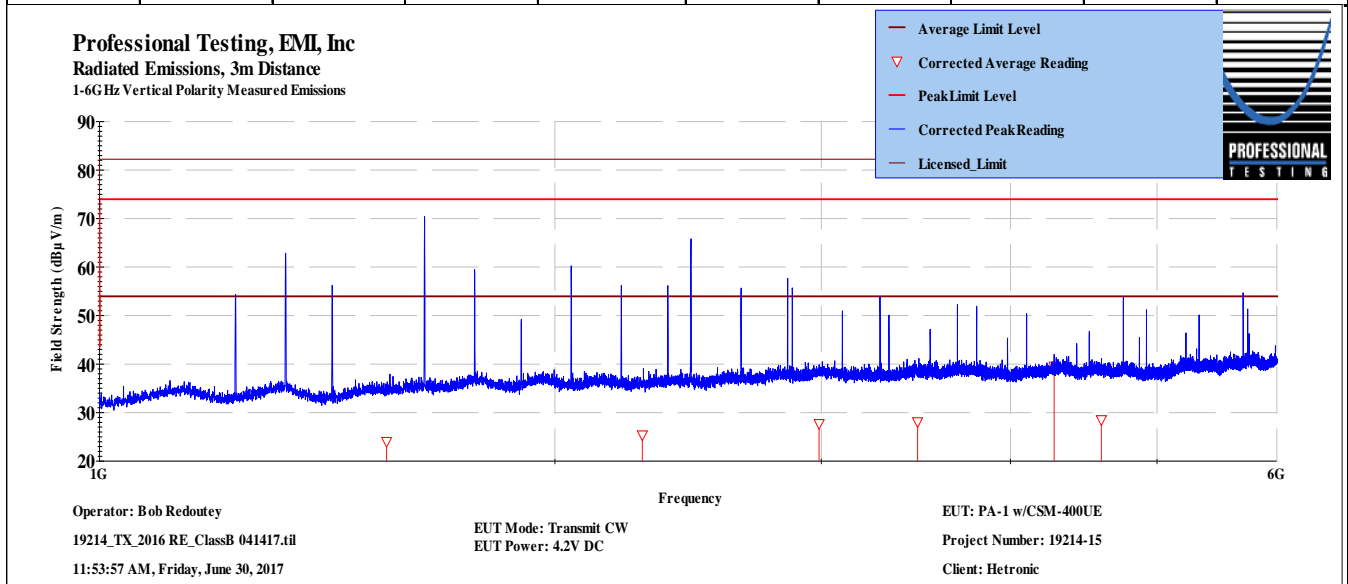
Radiated Emissions Test Results Data Sheet Page: 1 of 1

|                                  |                                   |
|----------------------------------|-----------------------------------|
| <b>EUT Line Voltage:</b> 4.2 VDC | <b>EUT Power Frequency:</b> - N/A |
|----------------------------------|-----------------------------------|

|                                      |                                    |
|--------------------------------------|------------------------------------|
| <b>Antenna Orientation:</b> Vertical | <b>Frequency Range:</b> Above 1GHz |
|--------------------------------------|------------------------------------|

|                               |                    |
|-------------------------------|--------------------|
| <b>EUT Mode of Operation:</b> | <b>Transmit CW</b> |
|-------------------------------|--------------------|

| 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 |
|--------------------------|------------------------|-------------------------|-------------------------|-------------------|---------------------------|--------------------------|----------------------|-------------|--------------|
| 1548.09                  | 3                      | 121                     | 2.55                    | Average           | 35.7                      | 24.007                   | 54.0                 | -30.0       | Pass         |
| 2284.57                  | 3                      | 303                     | 3.19                    | Average           | 34.9                      | 25.364                   | 54.0                 | -28.6       | Pass         |
| 2989.56                  | 3                      | 33                      | 1.98                    | Average           | 34.8                      | 27.713                   | 54.0                 | -26.2       | Pass         |
| 3473.01                  | 3                      | 315                     | 1.69                    | Average           | 35.2                      | 28.091                   | 54.0                 | -25.9       | Pass         |
| 4274.87                  | 3                      | 212                     | 2.14                    | Average           | 44.5                      | 39.564                   | 54.0                 | -14.4       | Pass         |
| 4593.31                  | 3                      | 258                     | 2.9                     | Average           | 32.9                      | 28.514                   | 54.0                 | -25.4       | Pass         |



## Professional Testing, EMI, Inc.

**Test Method:** ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

**In accordance with:** FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits

**Section:** 15.109

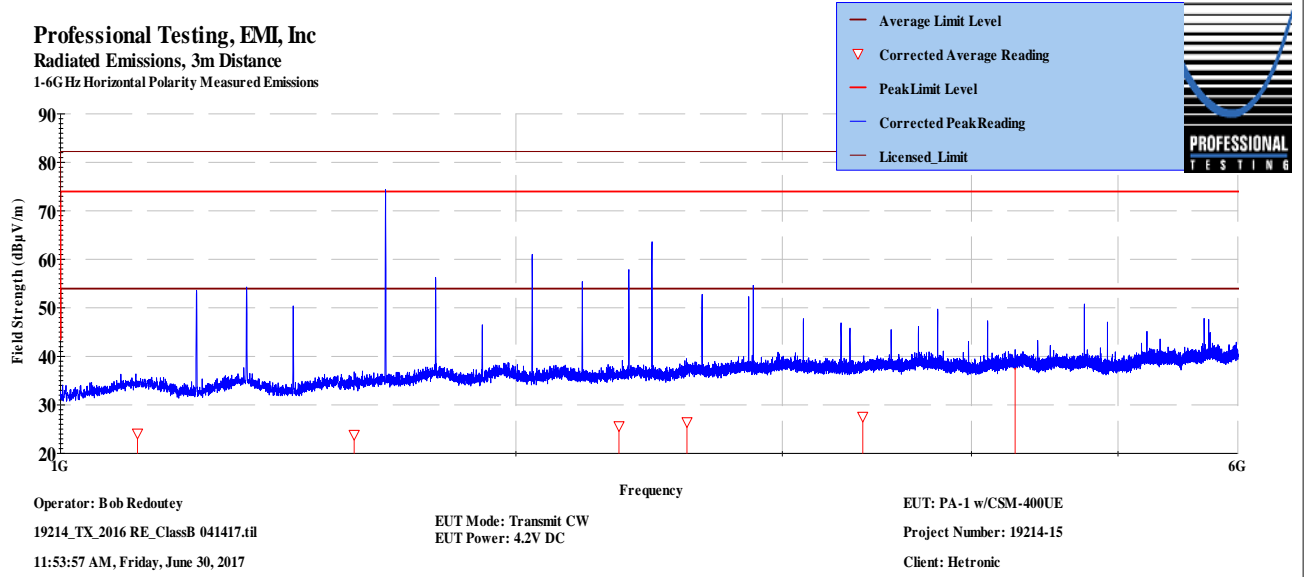
|   |                                      |
|---|--------------------------------------|
| <b>Test Date(s):</b> 6/30/2017                | <b>EUT Serial #:</b> None            |
| <b>Customer:</b> Hetronic                     | <b>EUT Part #:</b> None              |
| <b>Project Number:</b> 19214-15               | <b>Test Technician:</b> Bob Redoutey |
| <b>Purchase Order #:</b> N/A                  | <b>Supervisor:</b> Lisa Arndt        |
| <b>Equip. Under Test:</b> PA-1 with CSM-400UE | <b>Witness' Name:</b> None           |

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

|  |                                    |
|--|------------------------------------|
| <b>EUT Line Voltage:</b> 4.2 VDC       | <b>EUT Power Frequency:</b> - N/A  |
| <b>Antenna Orientation:</b> Horizontal | <b>Frequency Range:</b> Above 1GHz |

**EUT Mode of Operation:** Transmit CW

| 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 |
|--------------------------|------------------------|-------------------------|-------------------------|-------------------|---------------------------|--------------------------|----------------------|-------------|--------------|
| 1124.43                  | 3                      | 240                     | 1.82                    | Average           | 36.8                      | 24.13                    | 54.0                 | -29.8       | Pass         |
| 1563.38                  | 3                      | 212                     | 2.29                    | Average           | 35.5                      | 23.901                   | 54.0                 | -30.1       | Pass         |
| 2339.38                  | 3                      | 106                     | 3.24                    | Average           | 35                        | 25.657                   | 54.0                 | -28.3       | Pass         |
| 2594.62                  | 3                      | 284                     | 3.96                    | Average           | 35.1                      | 26.49                    | 54.0                 | -27.5       | Pass         |
| 3390.42                  | 3                      | 151                     | 3.05                    | Average           | 35.1                      | 27.607                   | 54.0                 | -26.4       | Pass         |
| 4274.95                  | 3                      | 225                     | 3.41                    | Average           | 43.4                      | 38.453                   | 54.0                 | -15.5       | Pass         |



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

5.3.3 Receive Mode, Up to 1 GHz

| Professional Testing, EMI, Inc. |   |                         |              |
|---------------------------------|---|-------------------------|--------------|
| <b>Test Method:</b>             | ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |                         |              |
| <b>In accordance with:</b>      | FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits   |                         |              |
| <b>Section:</b>                 | 15.109  |                         |              |
| <b>Test Date(s):</b>            | 6/30/2017   | <b>EUT Serial #:</b>    | None         |
| <b>Customer:</b>                | Hetronic  | <b>EUT Part #:</b>      | None         |
| <b>Project Number:</b>          | 19214-15  | <b>Test Technician:</b> | Bob Redoutey |
| <b>Purchase Order #:</b>        | N/A   | <b>Supervisor:</b>      | Lisa Arndt   |
| <b>Equip. Under Test:</b>       | PA-1 with CSM-400UE   | <b>Witness' Name:</b>   | None         |

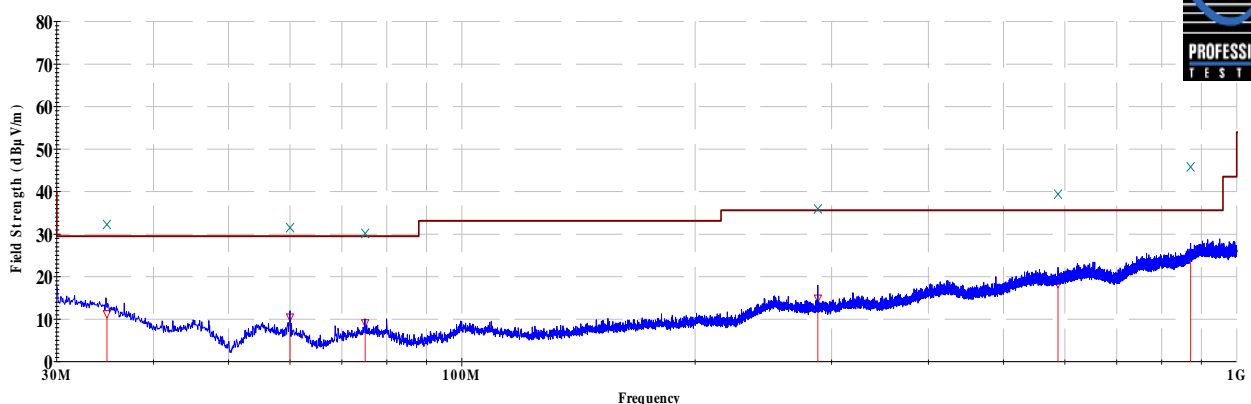
Radiated Emissions Test Results Data Sheet

Page: 1 of 1

| <b>EUT Line Voltage:</b>              | 4.2 VDC                | <b>EUT Power Frequency:</b> | - N/A                   |                   |                           |                          |                      |             |              |
|---------------------------------------|------------------------|-----------------------------|-------------------------|-------------------|---------------------------|--------------------------|----------------------|-------------|--------------|
| <b>Antenna Orientation:</b>           | Vertical               | <b>Frequency Range:</b>     | 30MHz to 1GHz           |                   |                           |                          |                      |             |              |
| <b>EUT Mode of Operation:</b> Receive |                        |                             |                         |                   |                           |                          |                      |             |              |
| 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 |
| 34.8237                               | 10                     | 62                          | 2.03                    | Quasi-peak        | 23                        | 11.245                   | 29.5                 | -18.3       | Pass         |
| 60.0211                               | 10                     | 84                          | 2.63                    | Quasi-peak        | 28.8                      | 10.493                   | 29.5                 | -19.0       | Pass         |
| 75.0231                               | 10                     | 255                         | 1.51                    | Quasi-peak        | 26.8                      | 9.125                    | 29.5                 | -20.4       | Pass         |
| 288.022                               | 10                     | 188                         | 2.96                    | Quasi-peak        | 25.5                      | 14.922                   | 35.6                 | -20.7       | Pass         |
| 587.912                               | 10                     | 42                          | 1.21                    | Quasi-peak        | 22.1                      | 18.382                   | 35.6                 | -17.2       | Pass         |
| 871.974                               | 10                     | 80                          | 3.49                    | Quasi-peak        | 21.3                      | 24.784                   | 35.6                 | -10.8       | Pass         |

Professional Testing, EMI, Inc

Radiated Emissions, 10m Distance  
30MHz - 1GHz Vertical Polarity Measured Emissions



Operator: Bob Redoutey

19214\_2016 RE-Rec\_ClassB\_Run01.fil

01:24:34 PM, Friday, June 30, 2017

EUT Mode: Receive Mode  
EUT Power: 4.2V DC

EUT: PA-1 w/CSM-400UE

Project Number: 19214-15

Client: Hetronic

≤ 1GHz Vertical Antenna Polarity Measured Emissions

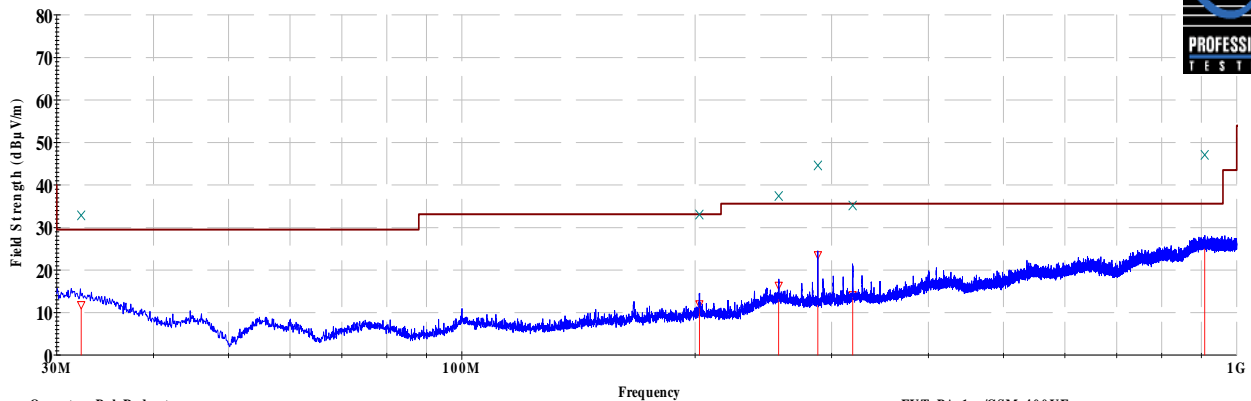
## Professional Testing, EMI, Inc.

|                            |   |                         |              |
|----------------------------|---|-------------------------|--------------|
| <b>Test Method:</b>        | ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |                         |              |
| <b>In accordance with:</b> | FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits   |                         |              |
| <b>Section:</b>            | 15.109  |                         |              |
| <b>Test Date(s):</b>       | 6/30/2017   | <b>EUT Serial #:</b>    | None         |
| <b>Customer:</b>           | Hetronic  | <b>EUT Part #:</b>      | None         |
| <b>Project Number:</b>     | 19214-15  | <b>Test Technician:</b> | Bob Redoutey |
| <b>Purchase Order #:</b>   | N/A   | <b>Supervisor:</b>      | Lisa Arndt   |
| <b>Equip. Under Test:</b>  | PA-1 with CSM-400UE   | <b>Witness' Name:</b>   | None         |

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

| <b>EUT Line Voltage:</b>      |                        | 4.2 VDC                 |                         | <b>EUT Power Frequency:</b> |                           | - N/A                    |                      |             |              |
|-------------------------------|------------------------|-------------------------|-------------------------|-----------------------------|---------------------------|--------------------------|----------------------|-------------|--------------|
| <b>Antenna Orientation:</b>   |                        | Horizontal              |                         | <b>Frequency Range:</b>     |                           | 30MHz to 1GHz            |                      |             |              |
| <b>EUT Mode of Operation:</b> |                        |                         |                         | Receive                     |                           |                          |                      |             |              |
| 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 |
| 32.262                        | 10                     | 332                     | 2.93                    | Quasi-peak                  | 23.8                      | 11.846                   | 29.5                 | -17.7       | Pass         |
| 202.554                       | 10                     | 339                     | 3.77                    | Quasi-peak                  | 26.4                      | 12.048                   | 33.1                 | -21.1       | Pass         |
| 256.398                       | 10                     | 5                       | 3.08                    | Quasi-peak                  | 26.6                      | 16.396                   | 35.6                 | -19.2       | Pass         |
| 288.043                       | 10                     | 306                     | 3.53                    | Quasi-peak                  | 34.1                      | 23.585                   | 35.6                 | -12.0       | Pass         |
| 319.43                        | 10                     | 259                     | 3.69                    | Quasi-peak                  | 23.9                      | 14.155                   | 35.6                 | -21.4       | Pass         |
| 909.351                       | 10                     | 54                      | 1.06                    | Quasi-peak                  | 21.2                      | 26.059                   | 35.6                 | -9.5        | Pass         |

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



Operator: Bob Redoutey  
 19214\_2016 RE-Rec\_ClassB\_Run01.tif  
 01:24:34 PM, Friday, June 30, 2017

EUT Mode: Receive Mode  
 EUT Power: 4.2V DC

EUT: PA-1 w/CSM-400UE  
 Project Number: 19214-15  
 Client: Hetronic

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



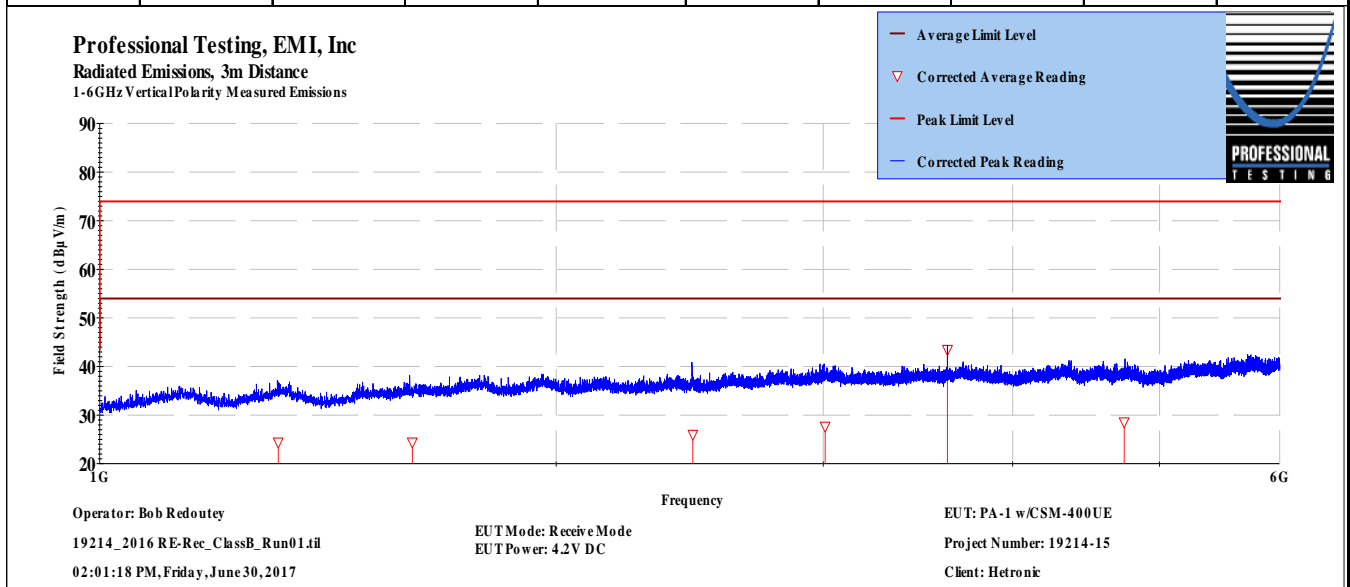
5.3.4 Receive Mode, Above 1 GHz

| Professional Testing, EMI, Inc. |   |                         |              |
|---------------------------------|---|-------------------------|--------------|
| <b>Test Method:</b>             | ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |                         |              |
| <b>In accordance with:</b>      | FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits   |                         |              |
| <b>Section:</b>                 | 15.109  |                         |              |
| <b>Test Date(s):</b>            | 6/30/2017   | <b>EUT Serial #:</b>    | None         |
| <b>Customer:</b>                | Hetronic  | <b>EUT Part #:</b>      | None         |
| <b>Project Number:</b>          | 19214-15  | <b>Test Technician:</b> | Bob Redoutey |
| <b>Purchase Order #:</b>        | N/A   | <b>Supervisor:</b>      | Lisa Arndt   |
| <b>Equip. Under Test:</b>       | PA-1 with CSM-400UE   | <b>Witness' Name:</b>   | None         |

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

| <b>EUT Line Voltage:</b>      | 4.2 VDC                | <b>EUT Power Frequency:</b> | - N/A                   |                   |                           |                          |                      |             |              |
|-------------------------------|------------------------|-----------------------------|-------------------------|-------------------|---------------------------|--------------------------|----------------------|-------------|--------------|
| <b>Antenna Orientation:</b>   | Vertical               | <b>Frequency Range:</b>     | Above 1GHz              |                   |                           |                          |                      |             |              |
| <b>EUT Mode of Operation:</b> |                        | <b>Receive</b>              |                         |                   |                           |                          |                      |             |              |
| 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 |
| 1311.36                       | 3                      | 137                         | 1.8                     | Average           | 36.3                      | 24.393                   | 54.0                 | -29.6       | Pass         |
| 1607.42                       | 3                      | 357                         | 2.9                     | Average           | 35.6                      | 24.401                   | 54.0                 | -29.6       | Pass         |
| 2461.15                       | 3                      | 154                         | 2.01                    | Average           | 35.1                      | 25.992                   | 54.0                 | -28.0       | Pass         |
| 3008.34                       | 3                      | 73                          | 1.92                    | Average           | 34.7                      | 27.662                   | 54.0                 | -26.3       | Pass         |
| 3622.76                       | 3                      | 228                         | 1.94                    | Average           | 50.4                      | 43.44                    | 54.0                 | -10.5       | Pass         |
| 4737.56                       | 3                      | 137                         | 1.65                    | Average           | 32.6                      | 28.558                   | 54.0                 | -25.4       | Pass         |



> 1GHz Vertical Antenna Polarity Measured Emissions

## Professional Testing, EMI, Inc.

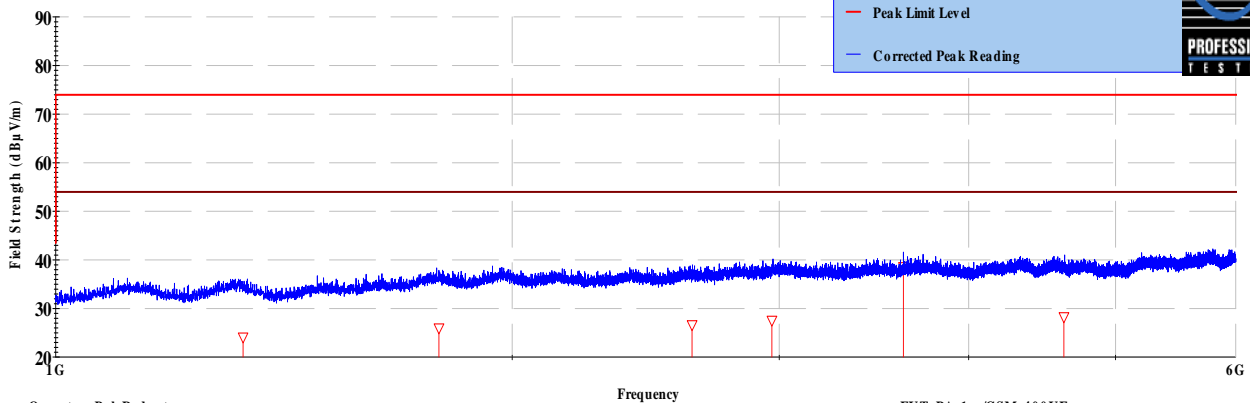
|                            |   |                         |              |
|----------------------------|---|-------------------------|--------------|
| <b>Test Method:</b>        | ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |                         |              |
| <b>In accordance with:</b> | FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits   |                         |              |
| <b>Section:</b>            | 15.109  |                         |              |
| <b>Test Date(s):</b>       | 6/30/2017   | <b>EUT Serial #:</b>    | None         |
| <b>Customer:</b>           | Hetronic  | <b>EUT Part #:</b>      | None         |
| <b>Project Number:</b>     | 19214-15  | <b>Test Technician:</b> | Bob Redoutey |
| <b>Purchase Order #:</b>   | N/A   | <b>Supervisor:</b>      | Lisa Arndt   |
| <b>Equip. Under Test:</b>  | PA-1 with CSM-400UE   | <b>Witness' Name:</b>   | None         |

### Radiated Emissions Test Results Data Sheet

Page: 1 of 1

| <b>EUT Line Voltage:</b>      |                        | 4.2 VDC                 |                         | <b>EUT Power Frequency:</b> |                           | - N/A                    |                      |             |              |
|-------------------------------|------------------------|-------------------------|-------------------------|-----------------------------|---------------------------|--------------------------|----------------------|-------------|--------------|
| <b>Antenna Orientation:</b>   |                        | Horizontal              |                         | <b>Frequency Range:</b>     |                           | Above 1GHz               |                      |             |              |
| <b>EUT Mode of Operation:</b> |                        |                         |                         | Receive                     |                           |                          |                      |             |              |
| 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 |
| 1329.02                       | 3                      | 117                     | 2.79                    | Average                     | 36                        | 24.073                   | 54.0                 | -29.9       | Pass         |
| 1789.47                       | 3                      | 330                     | 3.46                    | Average                     | 35.8                      | 25.971                   | 54.0                 | -28.0       | Pass         |
| 2628.36                       | 3                      | 290                     | 3.79                    | Average                     | 35                        | 26.61                    | 54.0                 | -27.3       | Pass         |
| 2966.99                       | 3                      | 164                     | 3.83                    | Average                     | 34.7                      | 27.532                   | 54.0                 | -26.4       | Pass         |
| 3622.71                       | 3                      | 57                      | 2.24                    | Average                     | 45.5                      | 38.573                   | 54.0                 | -15.4       | Pass         |
| 4622.33                       | 3                      | 290                     | 3.49                    | Average                     | 32.5                      | 28.248                   | 54.0                 | -25.7       | Pass         |

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



Operator: Bob Redoutey  
 19214\_2016 RE-Rec\_ClassB\_Run01.tif  
 02:01:18 PM, Friday, June 30, 2017

EUT Mode: Receive Mode  
 EUT Power: 4.2V DC

EUT: PA-1 w/CSM-400UE  
 Project Number: 19214-15  
 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 | 11 Jul 2017 |

**Table 6.2.1 Frequency Tolerance**

|  |
|--|
| $\pm 5$ ppm or restated as $\pm 2050$ Hz |
|--|

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

| Low        | Nominal    | High       |
|------------|------------|------------|
| <b>3.3</b> | <b>4.2</b> | <b>5.1</b> |

The operating frequency shall remain within the required tolerance.

### 6.3 Results

The highest deviation from frequency observed was -895 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                       | 409.999917               | -83                       |
| -20                | 410.000000                       | 409.999998               | -2                        |
| -10                | 410.000000                       | 410.000004               | 4                         |
| 0                  | 410.000000                       | 409.999906               | -94                       |
| 10                 | 410.000000                       | 409.999853               | -147                      |
| 20                 | 410.000000                       | 409.999881               | -119                      |
| 30                 | 410.000000                       | 409.999926               | -74                       |
| 40                 | 410.000000                       | 409.999894               | -106                      |
| 50                 | 410.000000                       | 409.999910               | -90                       |
| Max Deviation (Hz) |                                  |                          | 4                         |
| Min Deviation (Hz) |                                  |                          | -147                      |

### 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             | 3.30           | 410.000000                | 409.999926               | -74                       |
| Nominal         | 4.20           | 410.000000                | 409.999923               | -77                       |
| High            | 5.10           | 410.000000                | 409.999924               | -76                       |

### 6.3.3 Middle Channel, Temperature

| Condition          | Frequency                        |                          | Deviation                 |
|--------------------|----------------------------------|--------------------------|---------------------------|
| Temperature (C)    | Reference Center Frequency (MHz) | Measured Frequency (MHz) | Calculated Deviation (Hz) |
| -30                | 442.500000                       | 442.499557               | -443                      |
| -20                | 442.500000                       | 442.499640               | -360                      |
| -10                | 442.500000                       | 442.499641               | -359                      |
| 0                  | 442.500000                       | 442.499538               | -462                      |
| 10                 | 442.500000                       | 442.499478               | -522                      |
| 20                 | 442.500000                       | 442.499510               | -490                      |
| 30                 | 442.500000                       | 442.499560               | -440                      |
| 40                 | 442.500000                       | 442.499525               | -475                      |
| 50                 | 442.500000                       | 442.499544               | -456                      |
| Max Deviation (Hz) |                                  |                          | -359                      |
| Min Deviation (Hz) |                                  |                          | -522                      |

### 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             | 3.30           | 442.500000                | 442.499562               | -438                      |
| Nominal         | 4.20           | 442.500000                | 442.499561               | -439                      |
| High            | 5.10           | 442.500000                | 442.499561               | -439                      |

### 6.3.5 Top Channel, Temperature

| Condition          | Frequency                        |                          | Deviation                 |
|--------------------|----------------------------------|--------------------------|---------------------------|
| Temperature (C)    | Reference Center Frequency (MHz) | Measured Frequency (MHz) | Calculated Deviation (Hz) |
| -30                | 475.000000                       | 474.999190               | -810                      |
| -20                | 475.000000                       | 474.999286               | -714                      |
| -10                | 475.000000                       | 474.999278               | -722                      |
| 0                  | 475.000000                       | 474.999168               | -832                      |
| 10                 | 475.000000                       | 474.999105               | -895                      |
| 20                 | 475.000000                       | 474.999151               | -849                      |
| 30                 | 475.000000                       | 474.999193               | -807                      |
| 40                 | 475.000000                       | 474.999155               | -845                      |
| 50                 | 475.000000                       | 474.999174               | -826                      |
| Max Deviation (Hz) |                                  |                          | -714                      |
| Min Deviation (Hz) |                                  |                          | -895                      |

### 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             | 3.30           | 475.000000                | 474.999188               | -812                      |
| Nominal         | 4.20           | 475.000000                | 474.999188               | -812                      |
| High            | 5.10           | 475.000000                | 474.999189               | -811                      |

## 7.0 Transient Frequency Behavior

The EUT was tested for transient frequency behavior using the test method outlined in TIA/EIA-603-E paragraph on Alternate Method of Measurement (Using a Test Receiver).

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 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 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<br>Procedure: TIA-603-E | 10 Jul 2017 |

| Time intervals <sup>1,2</sup>   | Maximum frequency difference <sup>3</sup> | 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        |

<sup>1</sup>  $t_{on}$  is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.  
<sup>2</sup>  $t_1$  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.

<sup>2</sup>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.

<sup>3</sup>Difference between the actual transmitter frequency and the assigned transmitter frequency.

<sup>4</sup>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.

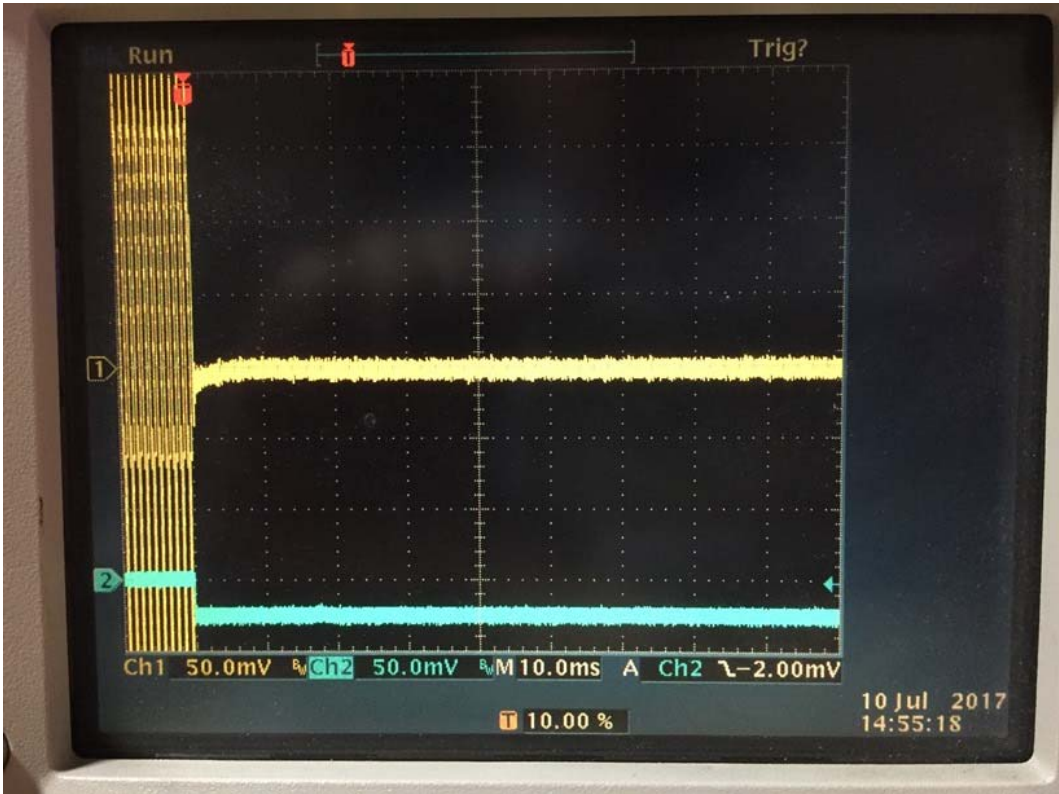
The measurement is performed for the lowest, middle, and highest operating frequency.

## 7.2 Results

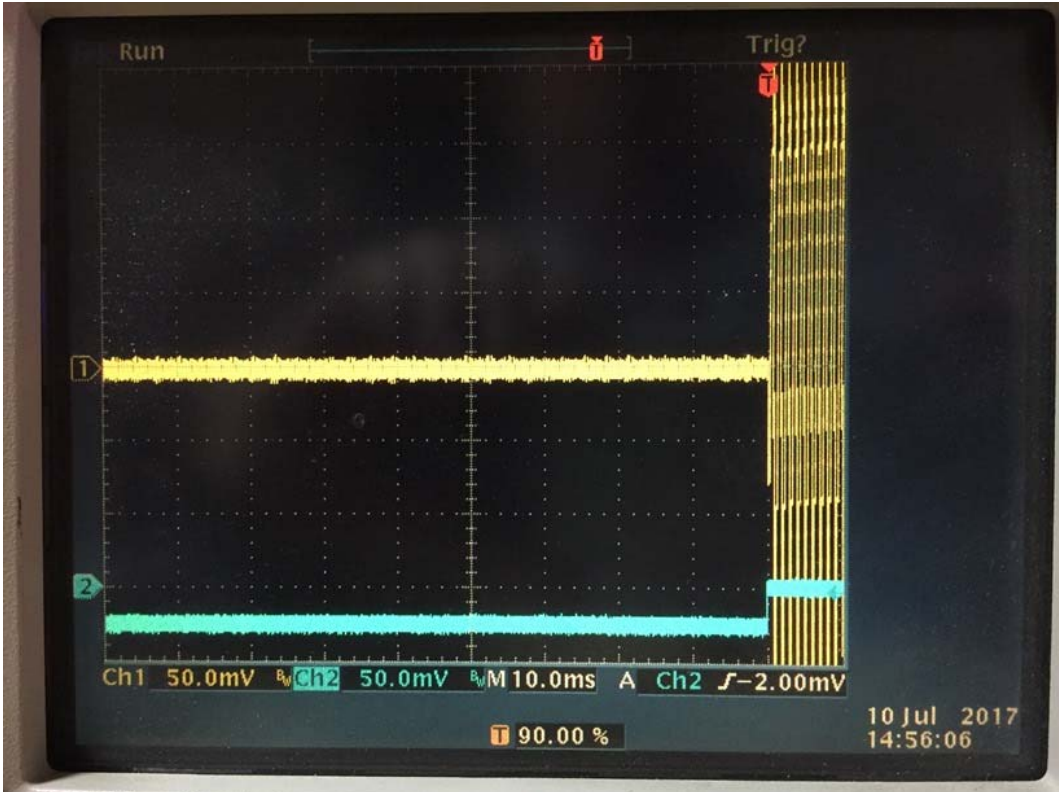
The EUT satisfied the requirements. Plotted measurements appear on the following pages. The limits were not superimposed on the plots as the transmitter performance was clearly in compliance for any allowed channel scheme.



7.2.1 Bottom Channel

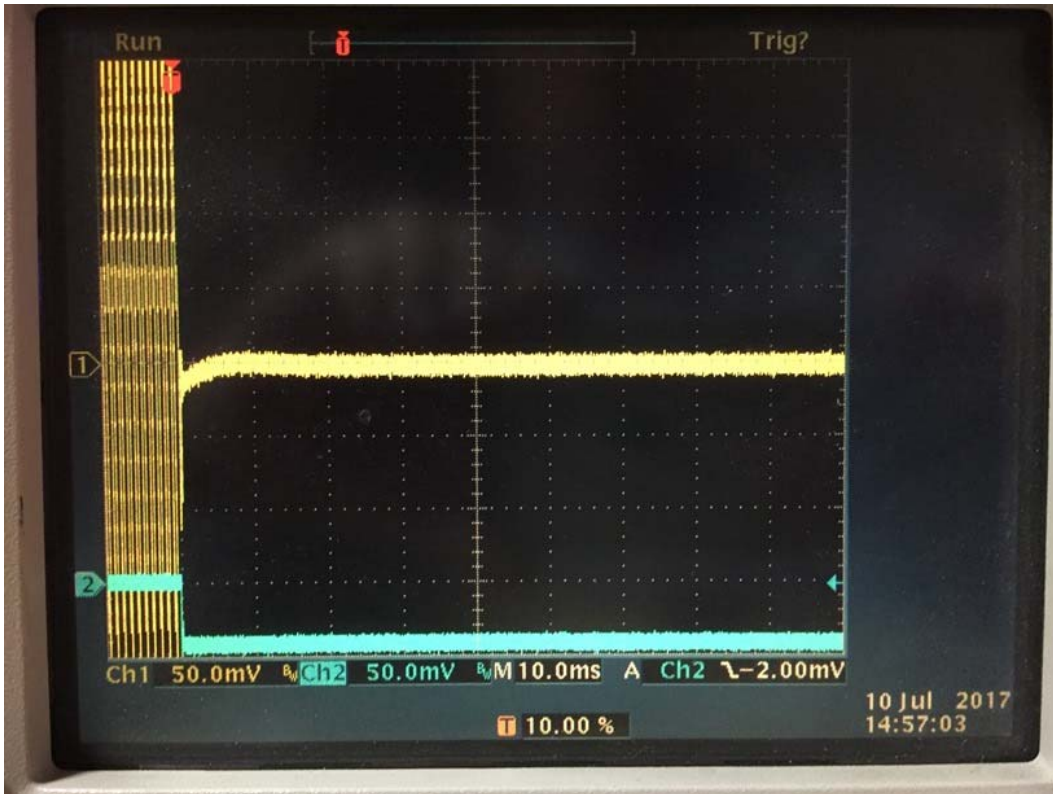


Attack

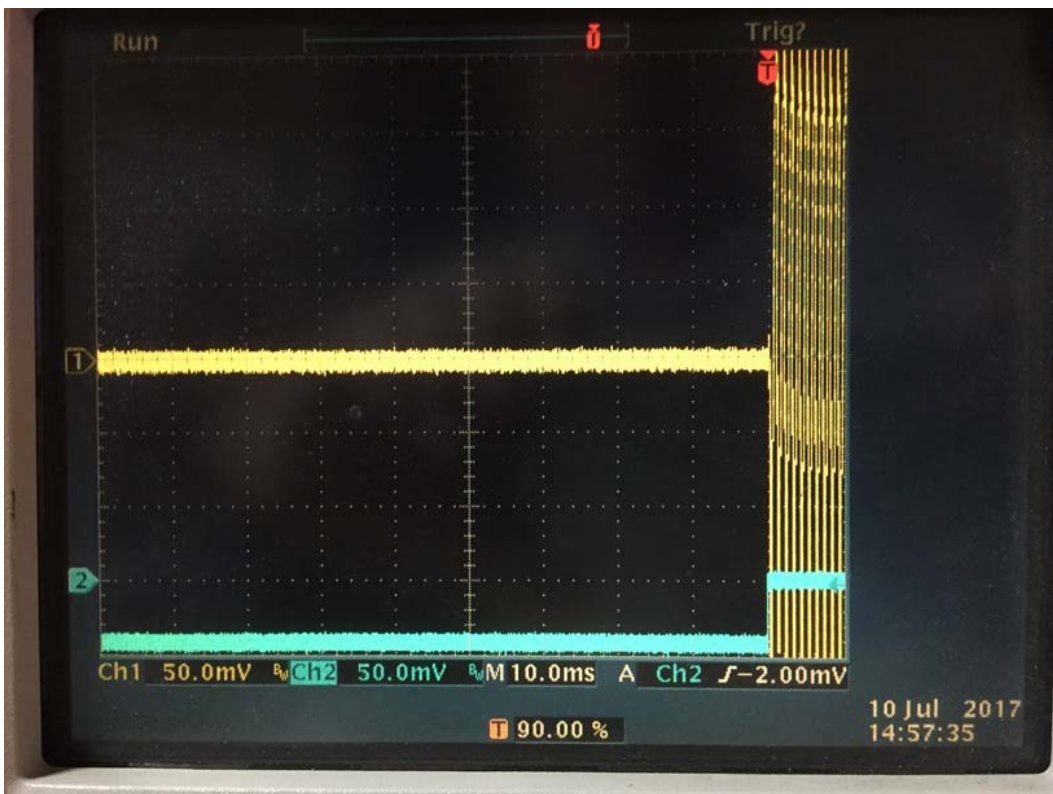


Release

### 7.2.2 Middle Channel

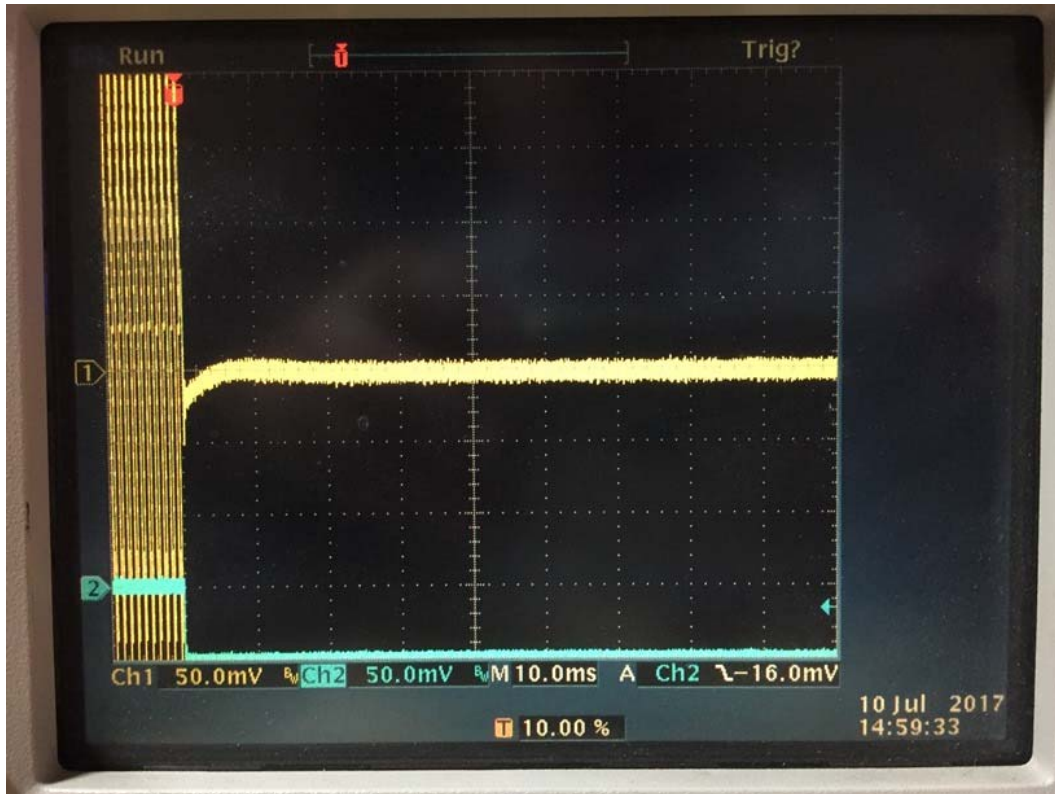


Attack

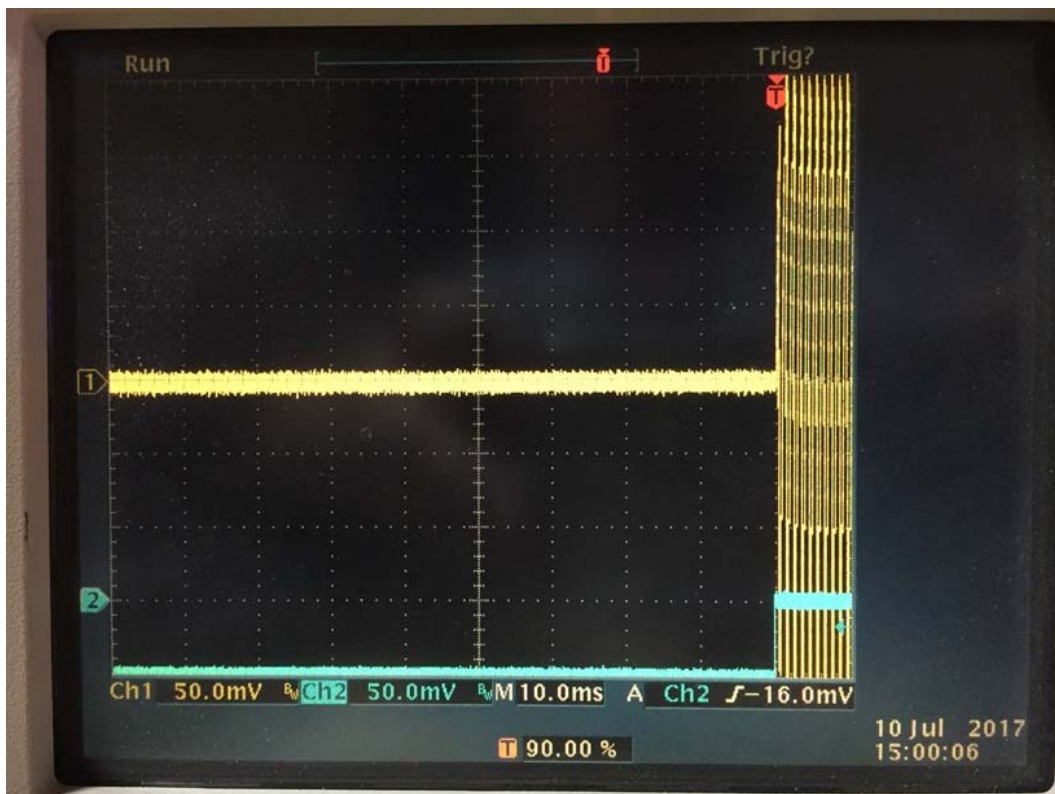


Release

### 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

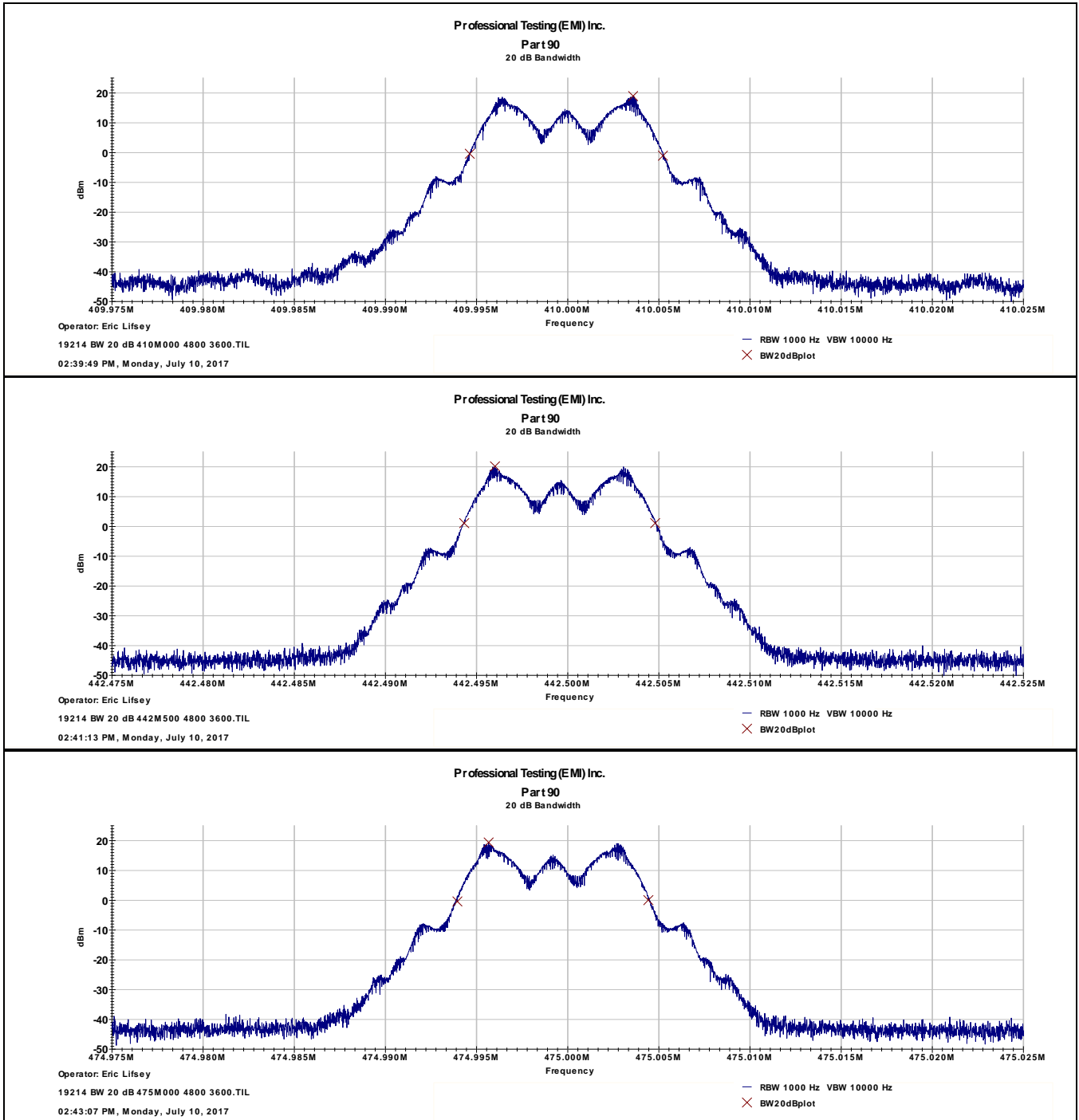
| Parameter   | Section Number  | Date        |
|---|---|-------------|
| 90.210(c) Bandwidth < 12.5 kHz<br>Or spectrum efficiency minimum 4800<br>baud per 6.25 kHz bandwidth per<br>90.203(j)(3). | 90.210(c), 90.203(j)(3), 2.1049   RSS-<br>119 Issue 12, 5.5 | 10 Jul 2017 |

### 8.3 Results

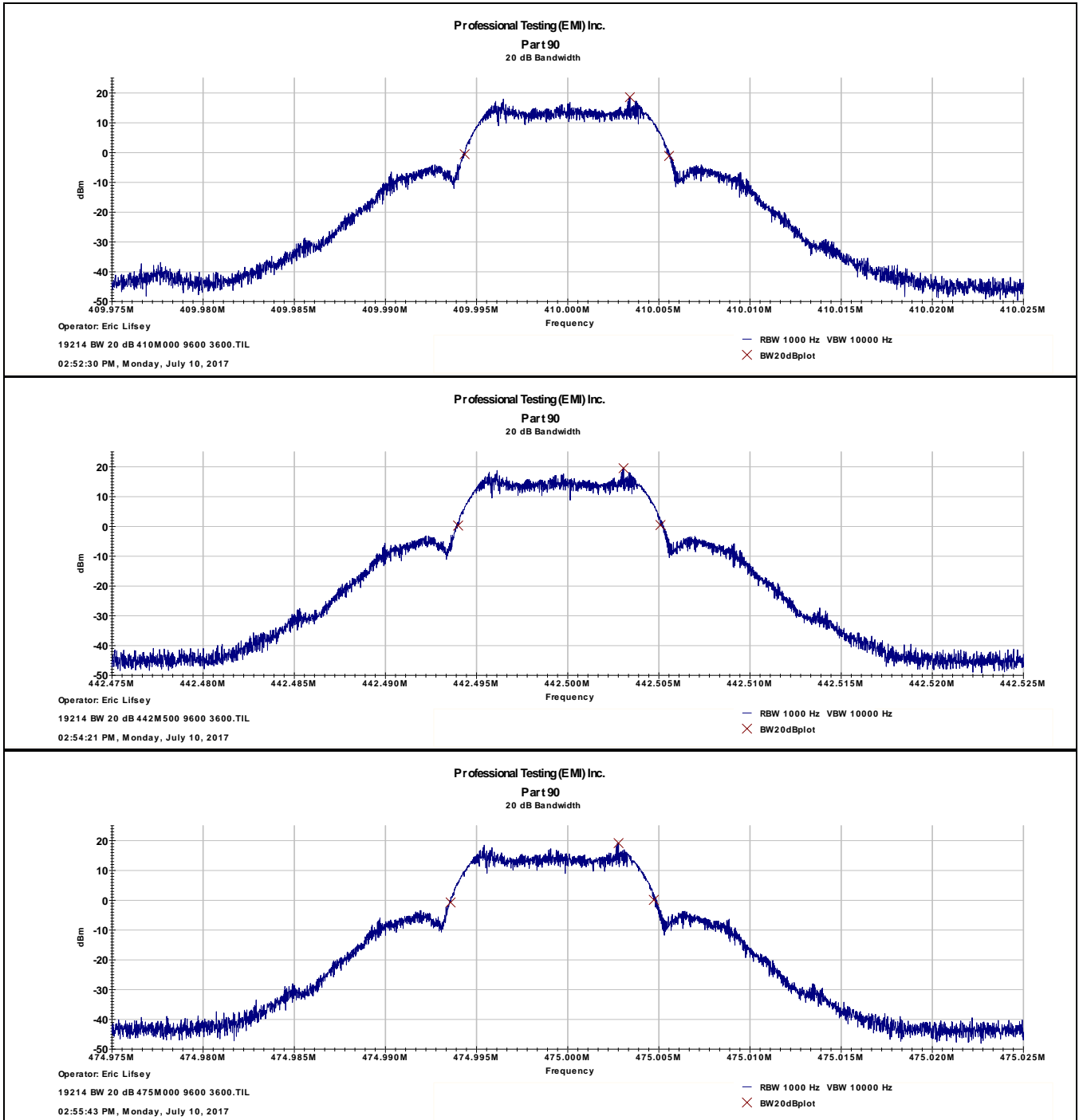
| Table 8.3.1 Bandwidth 20 dB (kHz) |                   |                   |                    |                    |                    |
|-----------------------------------|-------------------|-------------------|--------------------|--------------------|--------------------|
| Frequency                         | 2GFSK<br>4800 sps | 2GFSK<br>9600 sps | 4GFSK<br>18000 sps | 4GFSK<br>20000 sps | 4GFSK<br>25000 sps |
| 410.0 MHz                         | 10.65             | 11.34             | 48.54              | 45.26              | 50.42              |
| 442.5 MHz                         | 10.66             | 11.29             | 48.39              | 46.45              | 50.14              |
| 475.0 MHz                         | 10.66             | 11.30             | 48.47              | 45.33              | 50.42              |

The emission satisfies the bandwidth. Plotted results appear on the following pages.

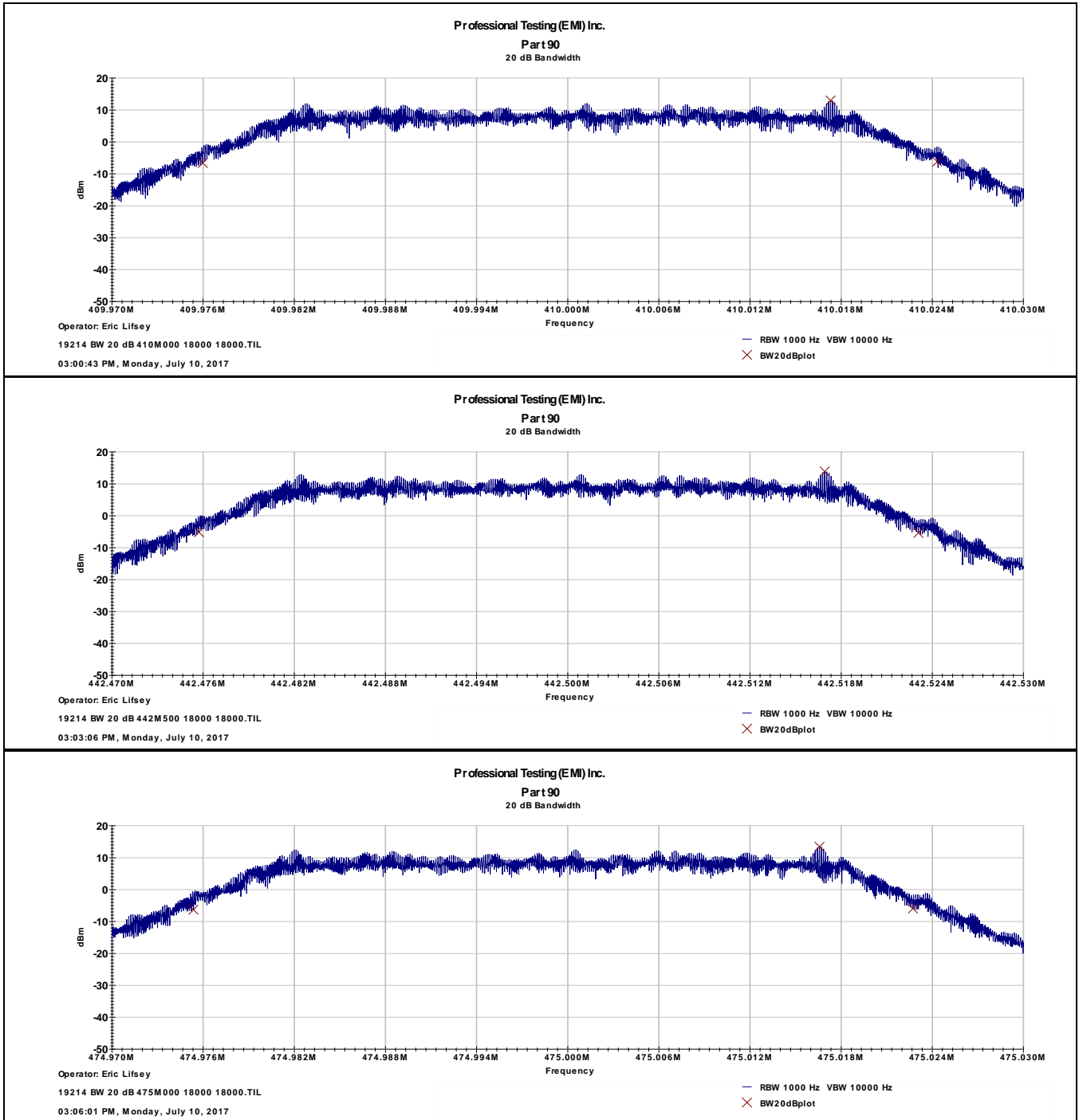
### 8.3.1 Modulation 2GFSK, 4800 Symbols Per Second



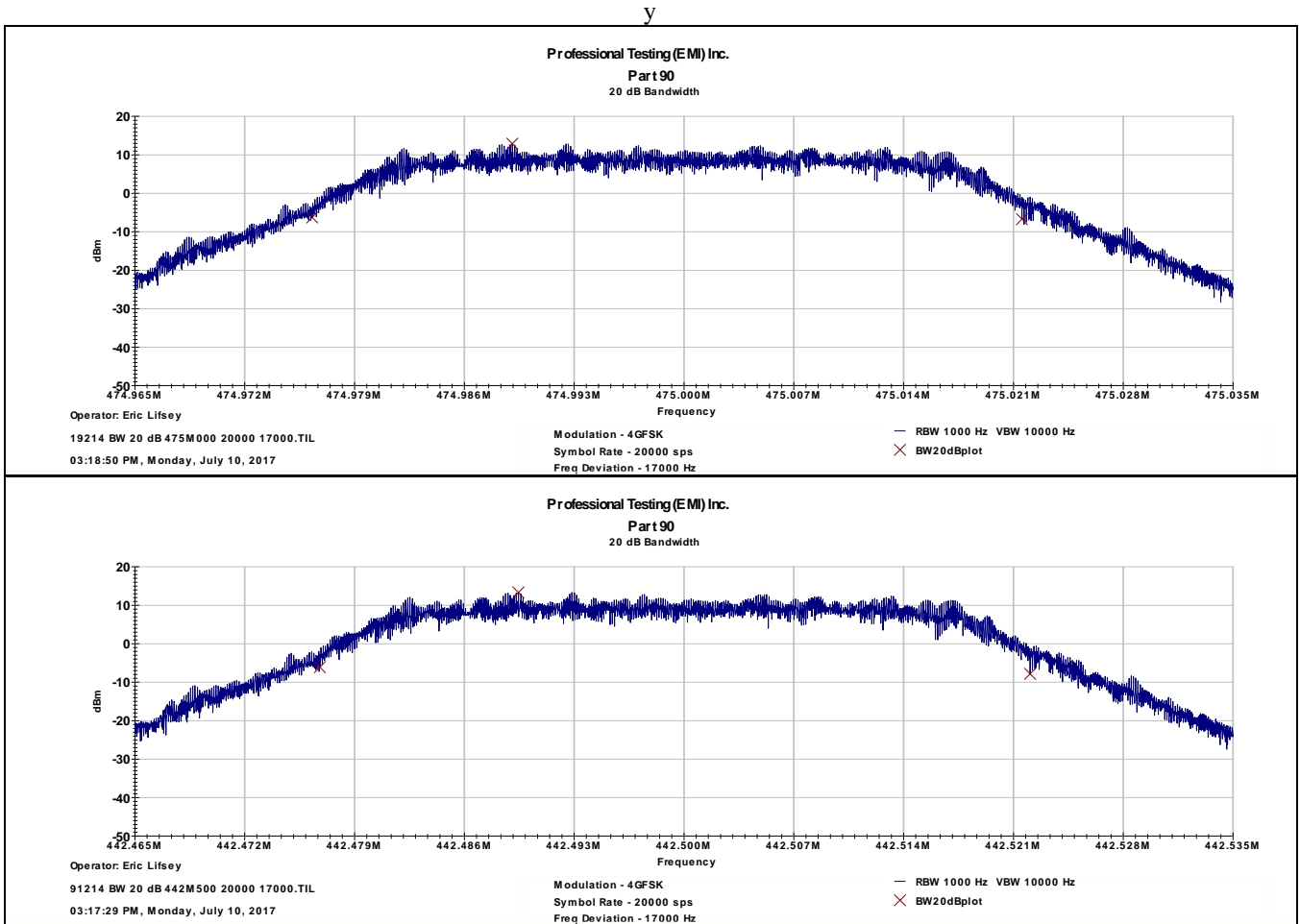
### 8.3.2 Modulation 2GFSK, 9600 Symbols Per Second



### 8.3.3 Modulation 4GFSK, 18000 Symbols Per Second

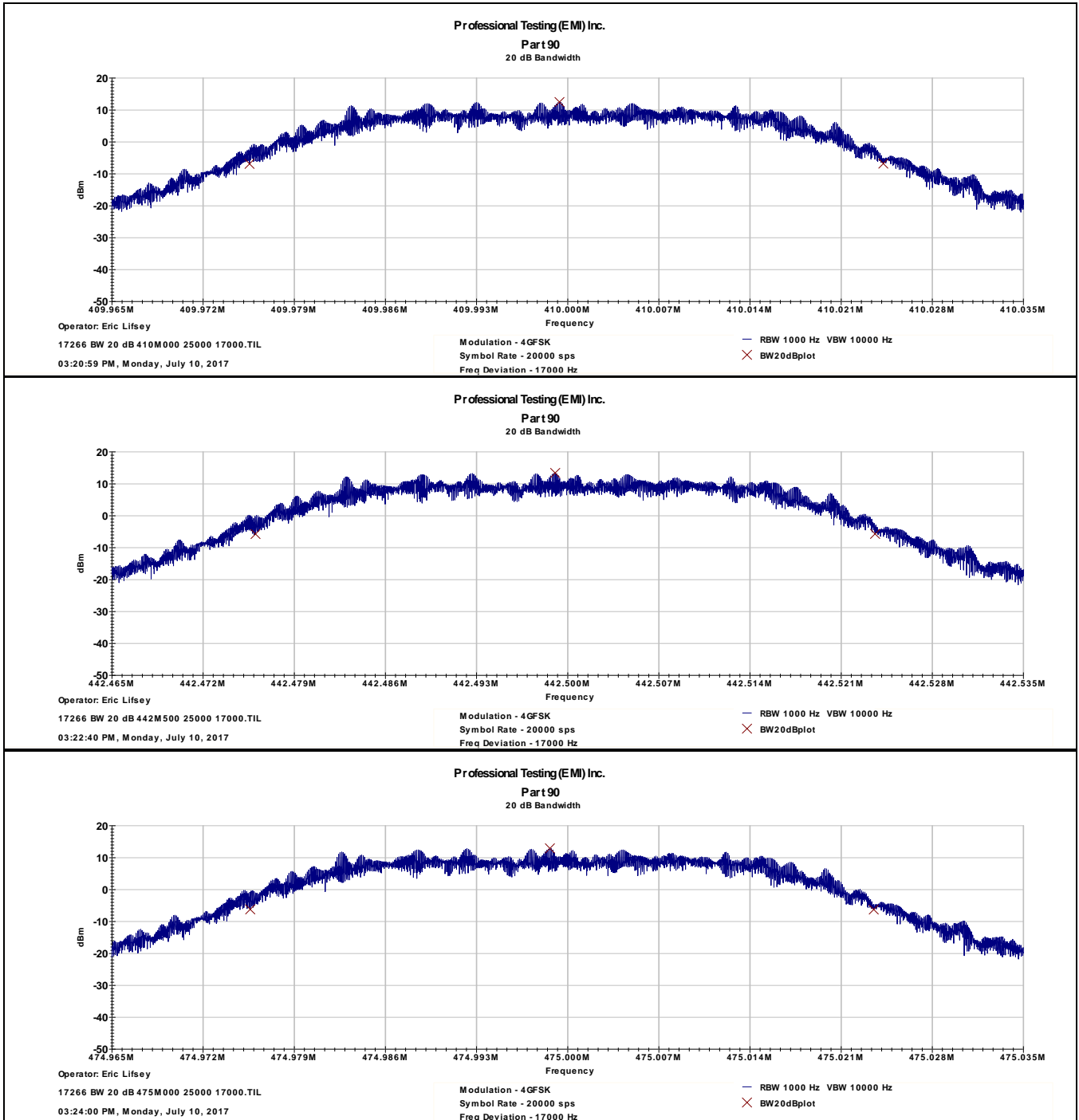


### 8.3.4 Modulation 4GFSK, 20000 Symbols Per Second





### 8.3.5 Modulation 4GFSK, 25000 Symbols Per Second



## 9.0 Noise Measurements (RSS-131)

### 9.1 Procedure

The EUT antenna port is coupled direct to the spectrum analyzer for measurement with input port terminated in the required impedance. This test is recommended though the amplifier is never operated as a zone enhancer for over-the-air signals.

### 9.2 Criteria

| Parameter   | Section Number           | Date        |
|---|--------------------------|-------------|
| Power +/- 1 dB of specification.<br>Intermodulation Products -30 dBm / 10 kHz.<br>Spurious emissions -13 dBm / 100 kHz.<br>In Band Emission < -43 dBm / 10 kHz.<br>Out Band Emission < -70 dBm / 10 kHz.<br>Noise figure shall not exceed 9 dB. | RSS-131 Iss. 3 Section 6 | 11 Jul 2017 |

### 9.3 Results

The EUT satisfied the requirements that apply. Results appear on the following pages.

#### 9.3.1 Power

Power varied 0.5 dB maximum from 19.8 dBm. This requirement is satisfied.

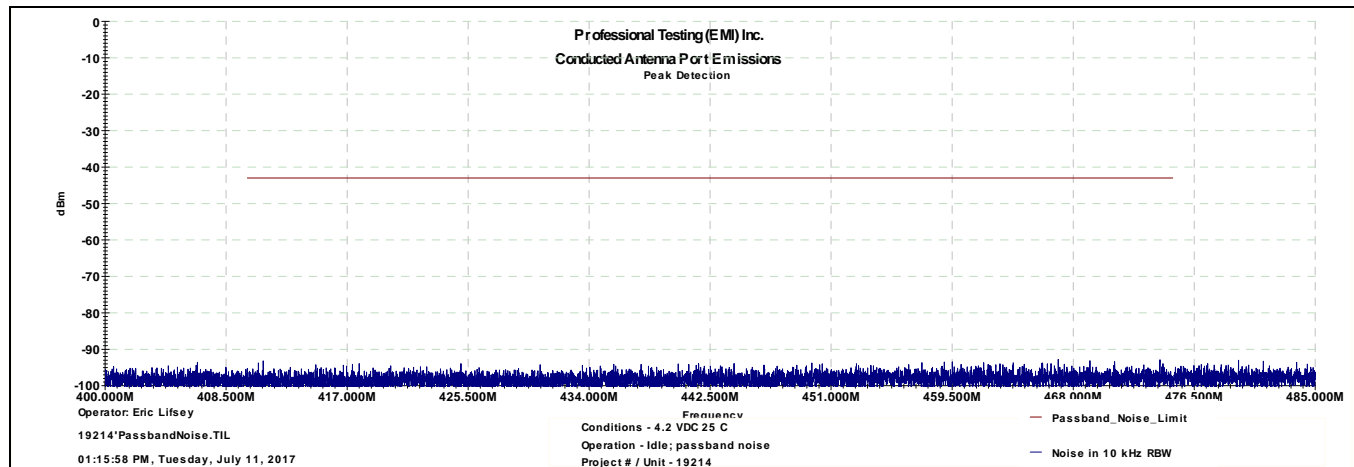
#### 9.3.2 Intermodulation Products

The amplifier is not used with multiple inputs and not used to amplify radiated signals. Only one signal source of one operating frequency is possible by direct connection. This measurement does not apply.

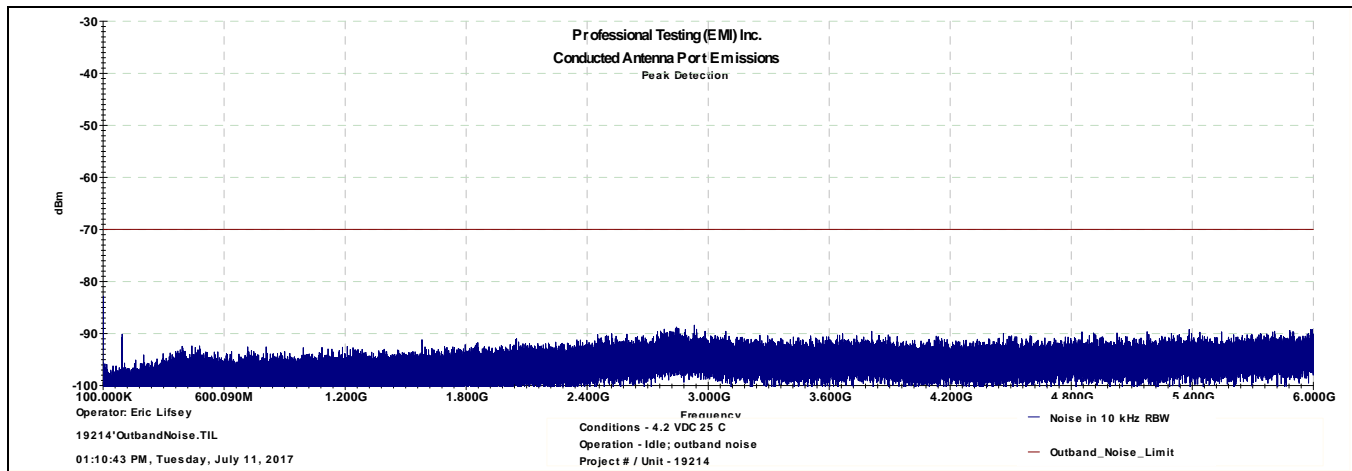
#### 9.3.3 Spurious Emission in 100 kHz

Compliance to this requirement is demonstrated by the conducted spurious measurements in section 4. The requirement is satisfied.

#### 9.3.4 Antenna Port In-band Noise, Transmit Mode



### 9.3.5 Antenna Port Out-band Noise, Transmit Mode



### 9.3.6 Noise Figure, Preamplifier

The noise figure of a zone enhancer shall not exceed 9 dB.

Determine or measure amplifier gain:

Preamplifier Gain = 20 dB +/- 10%

Measure noise output power with amplifier input terminated:

EUT powered: -94.0 dBm / MHz

EUT off: -94.0 dBm / MHz

No difference seen in measured noise on or off.

Subtracting worst-case gain 18 dB:  $-94 - 18 = -112$  dBm

Given the thermal noise floor is -114 dBm.

Difference is 2 dB above the thermal noise floor. EUT satisfies the requirement.

### 9.3.7 Noise Figure, Power Amplifier

The output power amplifier is always driven by the full input power signal of a directly connected single source and completely shut off when receiving. It does not amplify radiated signals from outside the system and the single-channel signal is generated by the attached radio module. Therefore this measurement does not apply.

## 10.0 Equipment Lists

### 10.1 Conducted Measurements of: Power, Spurious, Bandwidth, and Noise

| Asset # | Manufacturer | Model # | Description                | Calibration Due |
|---------|--------------|---------|----------------------------|-----------------|
| 2295    | Agilent      | E4440A  | Spectrum Analyzer          | 30 Sep 2017     |
| 0472    | Tektronix    | THS730A | Scope/DMM                  | 7 Dec 2017      |
| 2201    | Agilent      | E3632A  | Adjustable DC Power Supply | CIU             |

### 10.2 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                      | 7 Dec 2017      |
| None    | B&K          | 1710    | Adjustable DC Power Supply     | CIU             |
| 2201    | Agilent      | E3632A  | Adjustable DC Power Supply     | CIU             |

### 10.3 Frequency Transient Behavior

| Asset # | Manufacturer  | Model #  | Description                            | Calibration Due |
|---------|---------------|----------|--|-----------------|
| 0836    | Narda         | 3293-1   | Broadband Directional Coupler          | CNR             |
| 2228    | Tektronix     | TDS3034  | Oscilloscope, Digital                  | 19 Jul 2017     |
| 1678    | HP            | 8921A    | Cell Site Tester (as signal generator) | CIU             |
| 0742    | HP            | 355C     | Step Attenuator                        | CNR             |
| 0637    | HP            | 8901A    | Modulation Analyzer                    | 10 Nov 2018     |
| 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             |

## 10.4 Radiated Spurious Transmit Mode and Receive Mode

| 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_030617.til or<br>2016 RE_ClassB - Boresite+Mast_LowPRF_030617.til |  |                |                      |
| Asset #                                | Manufacturer | Model   | Equipment Nomenclature                           | Serial Number  | Calibration Due Date |
| 1509A                                  | Braden       | N/A   | TDK 10M Chamber, NSA < 1 GHz                     | DAC-012915-005 | 7/10/2017            |
| 1890                                   | HP           | 8447F   | Preamp/Amp, 9kHz-1300MHz,<br>28/25dB             | 3313A05298     | 2/1/2018             |
| 1937                                   | Agilent      | E4440A  | Spectrum Analyzer, 3 Hz - 26.5 GHz,<br>Opt. AYZ  | MY44808298     | 11/15/2017           |
| 1926                                   | ETS-Lindgren | 3142D   | Antenna, Biconilog, 26 MHz - 6 GHz               | 135454         | 3/7/2019             |
| 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 | 6/23/2019            |
| 2004                                   | Miteq        | AFS44-00101800-<br>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<br>Horn, 1 - 18 GHz | 110313         | 3/15/2019            |
|  |              |   |  |                |                      |

## 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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