PTI Project 19484

Exhibit Set 89FT6019

Motorola Solutions Inc
CB200-U

Paging Transmitter
452.000 to 470.000 MHz

Wireless Certification Report

FCC Part 90 and IC RSS-119

Prepared for:

Motorola Solutions Inc
8000 W. Sunrise Blvd.
Ft. Lauderdale FL 33322
USA

By

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

20 Nov 2017

Reviewed by

Larry Finn
Chief Technical Officer

Written by

Eric Lifsey
EMC Engineer

Revision History

Revision Number	Description	Date
01 DRAFT	Draft for review.	18 Oct 2017
02 DRAFT	Draft for review.	20 Oct 2017
Final04		22 Nov 2017

Corrections:

None.

Table of Contents

Certificate of Compliance

FCC MRA Designation Number: US5270
NVLAP Accreditation Number: 200062-0

Applicant	Device & Test Identification	
Motorola Solutions Inc 8000 W. Sunrise Blvd. Ft. Lauderdale FL 33322 Certificate Date: 20 Nov 2017	FCC ID: IC ID: Model(s): Laboratory Project ID:	AZ489FT6019 109U-89FT6019 CB200-U 19484-15

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 (B and D)	90.210, 2.1047	RSS-119 Issue 12, 5.8
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
Modulation; Frequency Response & Limiting	2.1047(a), (b)	
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

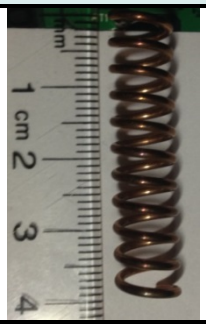
1.1 Scope

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

Table 1.2.1 Equipment Under Test		
Manufacturer & Description	**Basic Properties**	**Photo**
Alert Technologies Paging transmitter with user interface. Model CB200-U Revision F, Setting 504 Serial Number: none	Dimensions ~19 x 11 x 3 cm. Typically wall mounted. Powered internally by six AA batteries in series/parallel to provide 4.5 VDC maximum; nominally 4.0 VDC in operation. Photo at right shown with cosmetic cover in place and battery holder partially removed at bottom end.	

Table 1.2.2 Antenna Description	Photo
Shortened/helical quarter-wave monopole soldered to circuit board. It is positioned near the bottom edge of circuit board and becomes oriented vertically when EUT is wall mounted. Antenna is fully contained in the enclosure and cannot be touched or modified by the user. Length ~4 cm. Gain 0 dBi.	

1.3 EUT Operation

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

Table 1.3.1 Operating Frequency/Range (On licensed frequencies per localized regulations.)			
Lowest Frequency	**Center Frequency**	**Highest Frequency**	**Total Frequency Range**
452.000 MHz	461.000 MHz	470.000 MHz	18 MHz
The three channels were tested per customary practice for a frequency range exceeding 10 MHz.			

Emission designators that apply are 11K0F3E and 16K0F3E.

1.4 Modifications to Equipment

No modifications were made to the EUT during the performance of the test program. A simple connector was soldered to the microphone circuit terminals to allow modulation to be directly injected from a signal generator for the relevant tests.

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	18 Sep 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.

Table 2.3.1 Power, Peak, Conducted

Frequency (MHz)	Power (dBm)	Power (mW)
452	25.1	324
461	24.7	295
470	24.3	269

2.4 Emission Attenuation/Limits Beyond Authorized Bandwidth

Per 90.210(b) $\text{Attenuation}_{(dB)} = 43 + 10\ \text{Log}_{10}(0.324\ \text{W}) = 38.1\ \text{dB}$

$$\text{Limit}_{(dBm)} = \text{Fundamental\_Power}_{(dBm)} - \text{Attenuation}_{(dB)} = 25.1\ \text{dBm} - 38.1\ \text{dB} = -13\ \text{dBm}$$

Per 90.210(d) $\text{Attenuation}_{(dB)} = 50 + 10\ \text{Log}_{10}(0.324\ \text{W}) = 45.1\ \text{dB}$

$$\text{Limit}_{(dBm)} = \text{Fundamental\_Power}_{(dBm)} - \text{Attenuation}_{(dB)} = 25.1\ \text{dBm} - 45.1\ \text{dB} = -20\ \text{dBm}$$

3.0 Emission Mask

3.1 Procedure

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

3.2 Criteria

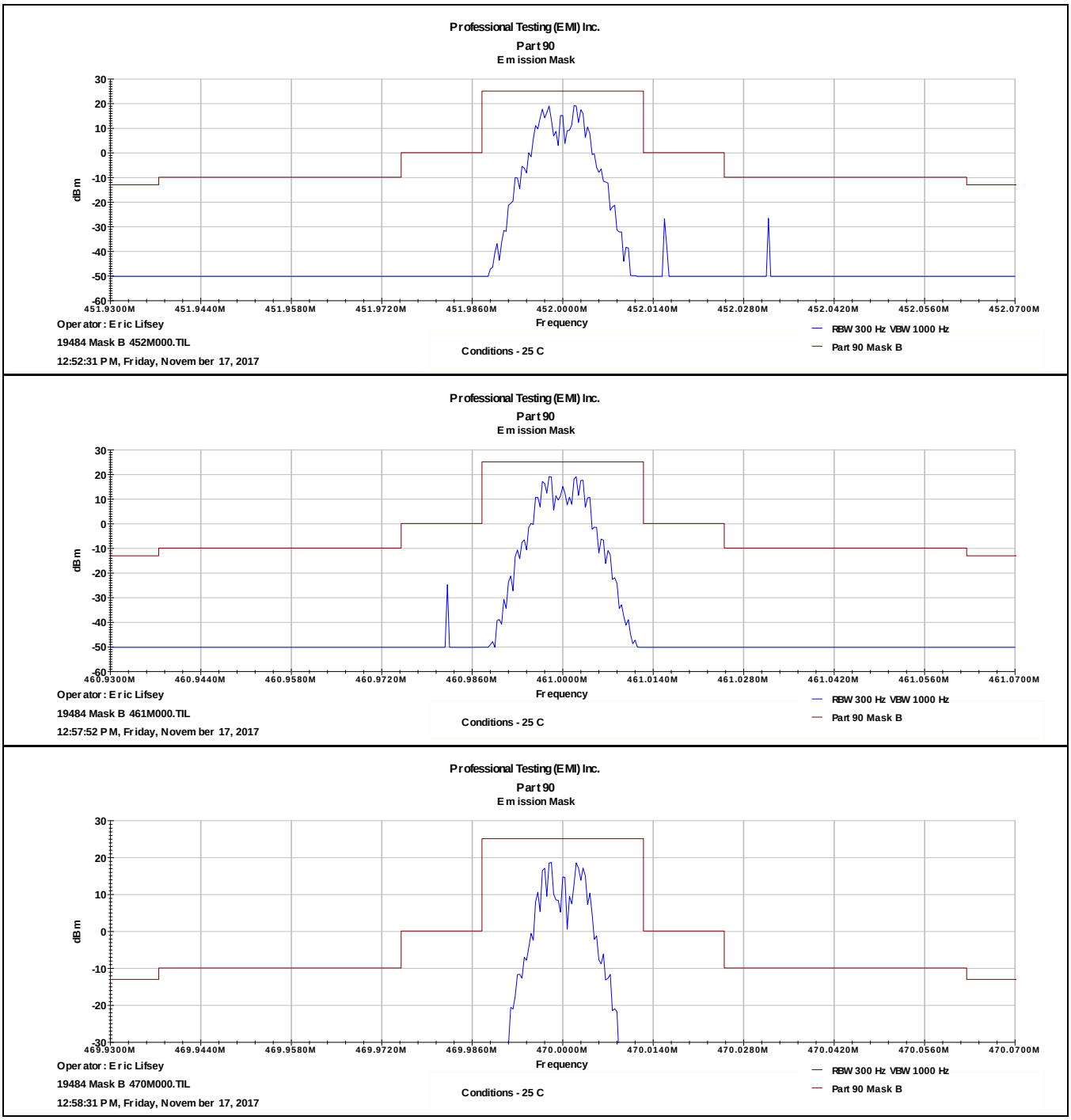
Parameter	Section Number	Date
Emissions at Antenna Terminals	90.210, 2.1047| RSS-119 Issue 12, 5.8	07, 17 Nov 2017

3.3 Results

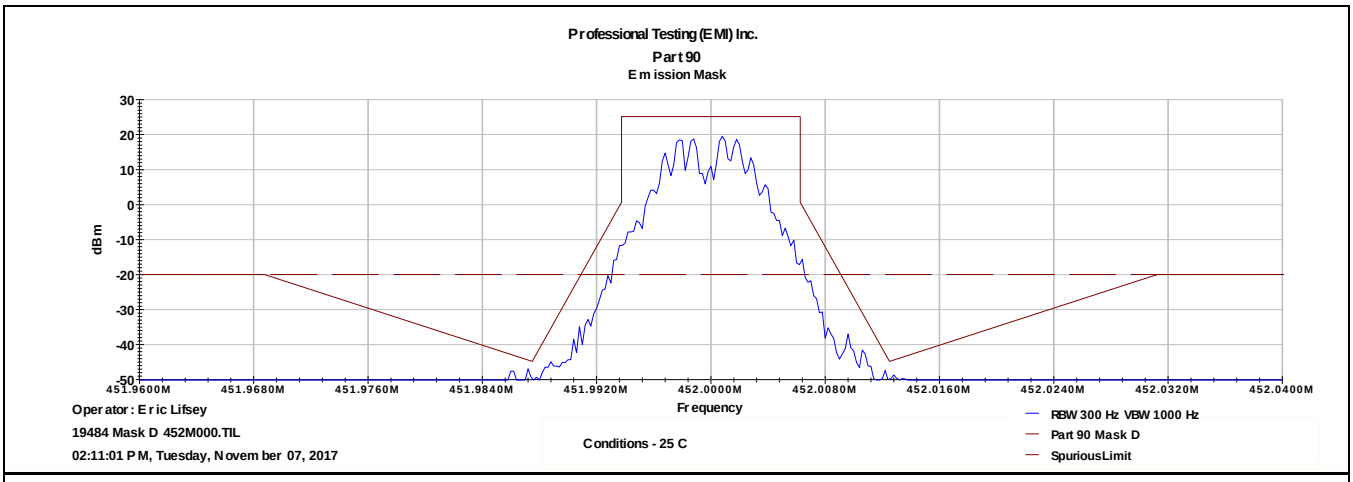
The emission was measured coupled directly to the analyzer without cabling.

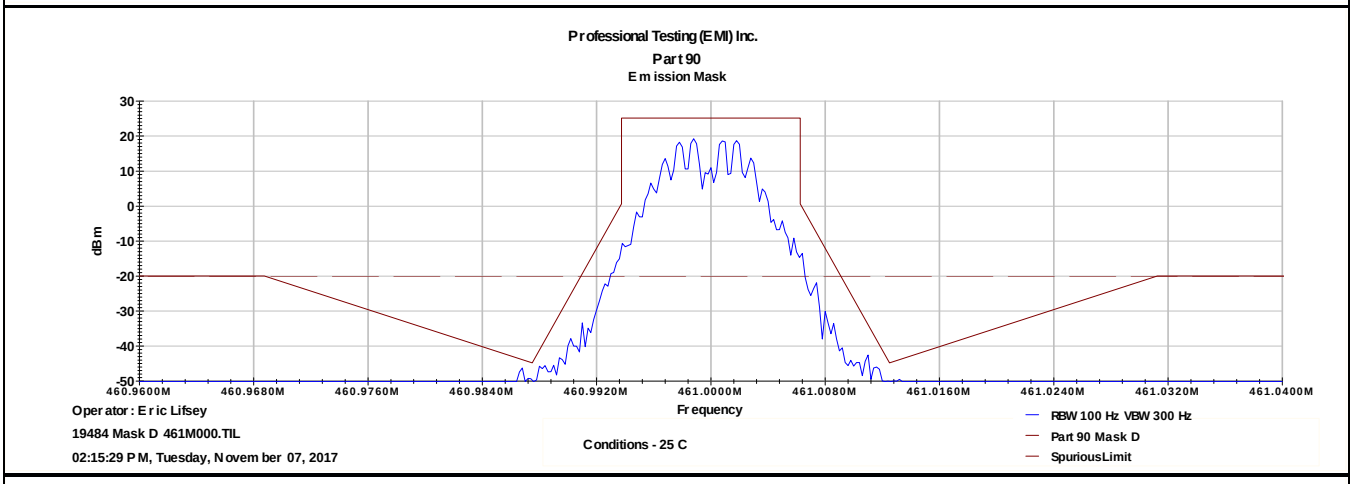
The EUT satisfied the requirement. Measurements appear below.

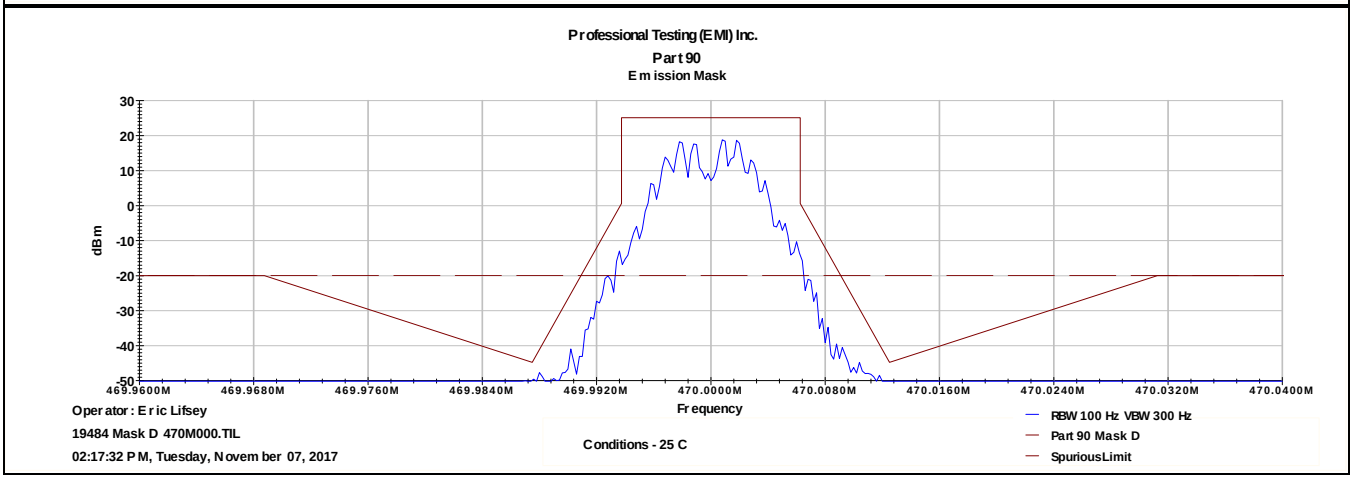
3.3.1 Mask B


Professional Testing (EMI) Inc.
Part 90
Emission Mask
dBm
30
20
10
0
-10
-20
-30
-40
-50
-60
451.9300M
451.9440M
451.9580M
451.9720M
451.9860M
452.0000M
452.0140M
452.0280M
452.0420M
452.0560M
452.0700M
Frequency
Operator: Eric Lifsey
19484 Mask B 452M000.TIL
12:52:31 PM, Friday, November 17, 2017
Conditions - 25 C
RBW 300 Hz VBW 1000 Hz
Part 90 Mask B
Professional Testing (EMI) Inc.
Part 90
Emission Mask
dBm
30
20
10
0
-10
-20
-30
-40
-50
-60
460.9300M
460.9440M
460.9580M
460.9720M
460.9860M
461.0000M
461.0140M
461.0280M
461.0420M
461.0560M
461.0700M
Frequency
Operator: Eric Lifsey
19484 Mask B 461M000.TIL
12:57:52 PM, Friday, November 17, 2017
Conditions - 25 C
RBW 300 Hz VBW 1000 Hz
Part 90 Mask B
Professional Testing (EMI) Inc.
Part 90
Emission Mask
dBm
30
20
10
0
-10
-20
-30
469.9300M
469.9440M
469.9580M
469.9720M
469.9860M
470.0000M
470.0140M
470.0280M
470.0420M
470.0560M
470.0700M
Frequency
Operator: Eric Lifsey
19484 Mask B 470M000.TIL
12:58:31 PM, Friday, November 17, 2017
Conditions - 25 C
RBW 300 Hz VBW 1000 Hz
Part 90 Mask B

3.3.2 Mask D


Professional Testing (EMI) Inc.
Part 90
Emission Mask
dBm
30
20
10
0
-10
-20
-30
-40
-50
451.9600M
451.9680M
451.9760M
451.9840M
451.9920M
452.0000M
452.0080M
452.0160M
452.0240M
452.0320M
452.0400M
Frequency
Operator: Eric Lifsey
19484 Mask D 452M000.TIL
02:11:01 PM, Tuesday, November 07, 2017
Conditions - 25 C
RBW 300 Hz VBW 1000 Hz
Part 90 Mask D
SpuriousLimit


Professional Testing (EMI) Inc.
Part 90
Emission Mask
dBm
30
20
10
0
-10
-20
-30
-40
-50
460.9600M
460.9680M
460.9760M
460.9840M
460.9920M
461.0000M
461.0080M
461.0160M
461.0240M
461.0320M
461.0400M
Frequency
Operator: Eric Lifsey
19484 Mask D 461M000.TIL
02:15:29 PM, Tuesday, November 07, 2017
Conditions - 25 C
RBW 100 Hz VBW 300 Hz
Part 90 Mask D
SpuriousLimit


Professional Testing (EMI) Inc.
Part 90
Emission Mask
dBm
30
20
10
0
-10
-20
-30
-40
-50
469.9600M
469.9680M
469.9760M
469.9840M
469.9920M
470.0000M
470.0080M
470.0160M
470.0240M
470.0320M
470.0400M
Frequency
Operator: Eric Lifsey
19484 Mask D 470M000.TIL
02:17:32 PM, Tuesday, November 07, 2017
Conditions - 25 C
RBW 100 Hz VBW 300 Hz
Part 90 Mask D
SpuriousLimit

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, 2.1047| RSS-119 Issue 12, 5.8	18 Aug 2017

Limit is determined from for emissions beyond the authorized bandwidth.

4.3 Results

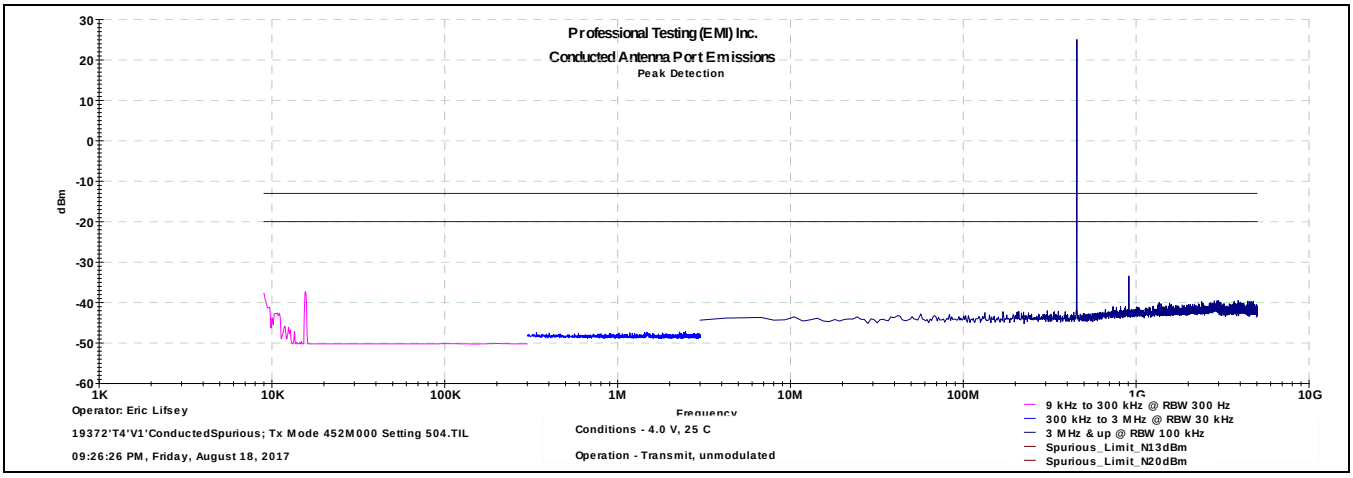
Measurements were performed with a direct connection to the spectrum analyzer such that no external losses or gains would apply. Measurement bandwidth is detailed in the graphs provided.

Spurious emission limits are -13 and -20 dBm.

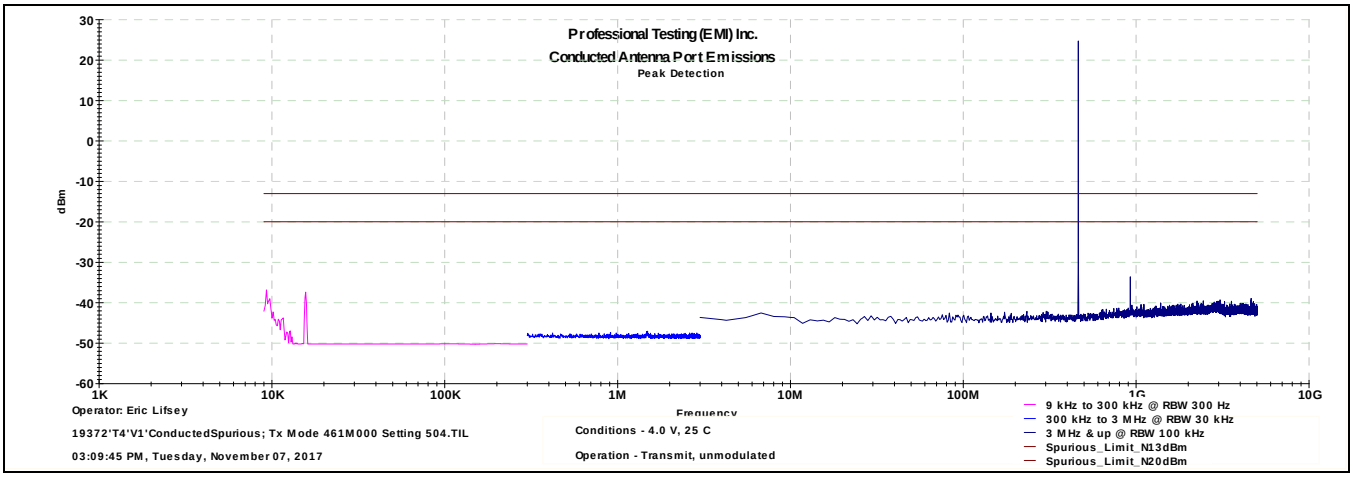
Highest emission recorded: -33.4 dBm at 904.96 MHz.

The EUT satisfied the requirement. Measurements appear below.

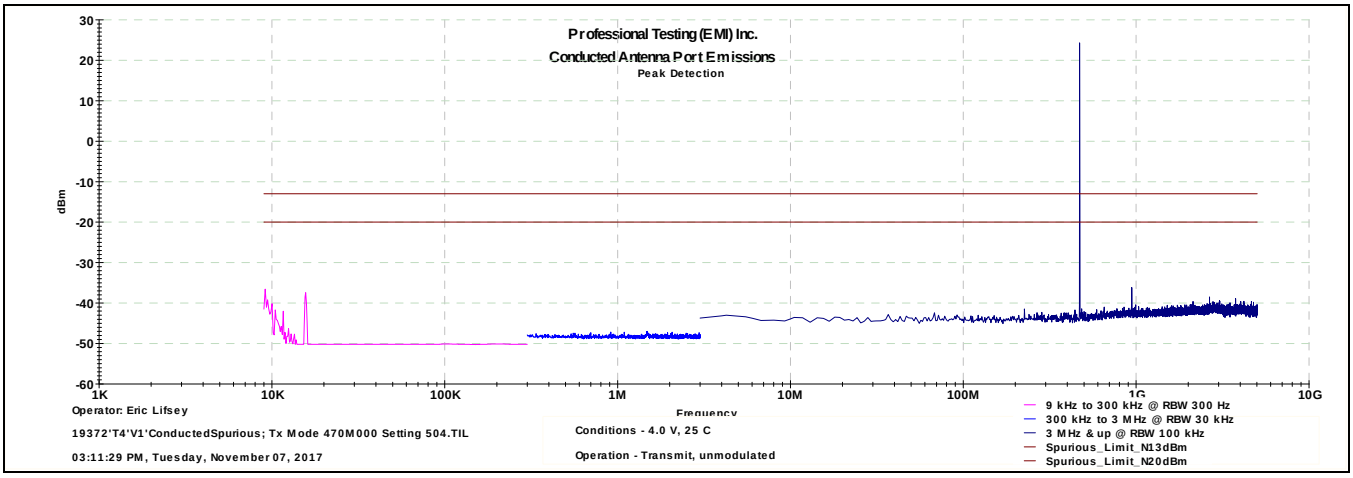
4.3.1 Transmit Mode, Bottom Channel



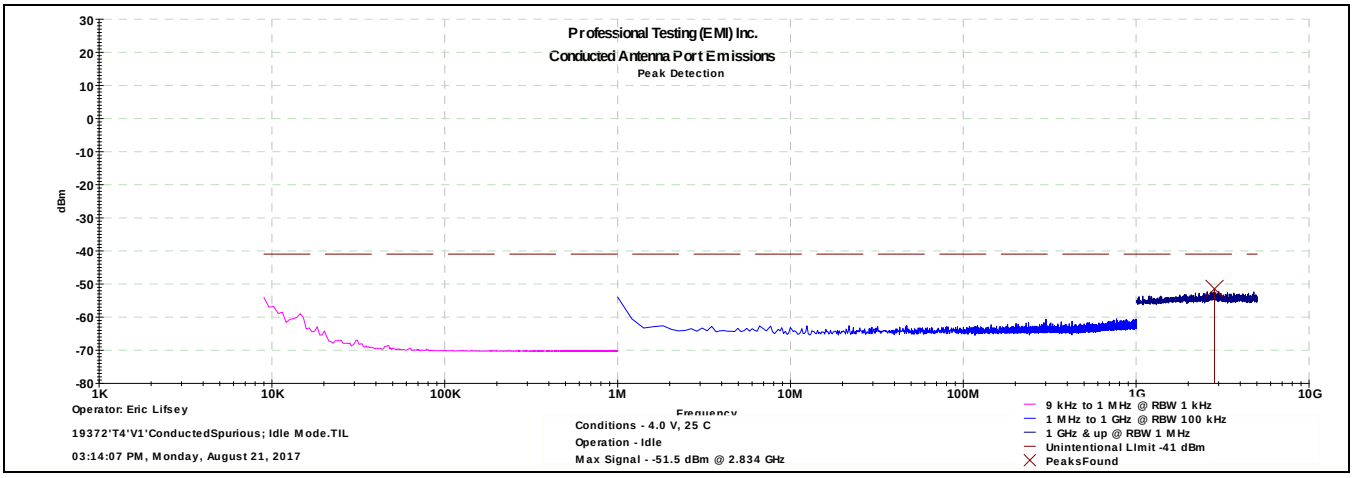
4.3.2 Transmit Mode, Middle Channel



4.3.3 Transmit Mode, Top Channel



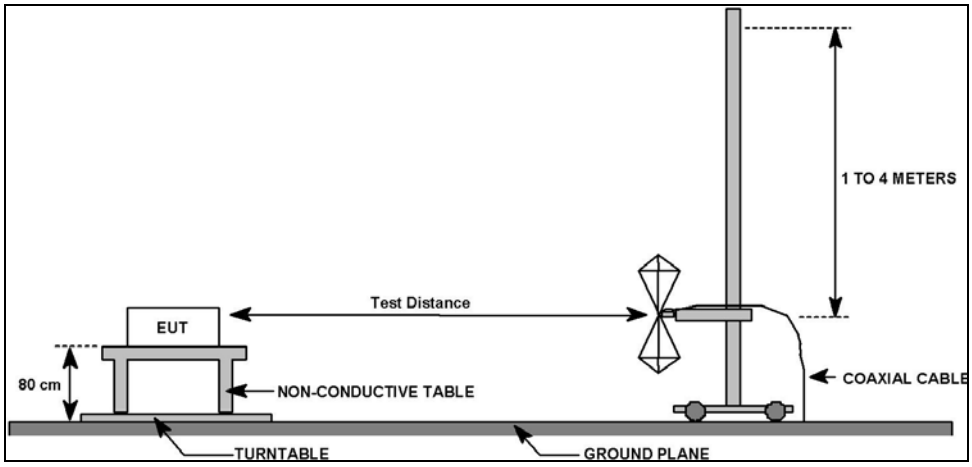
4.3.4 Receive/Idle Mode, Middle Channel



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.



Field Strength of Radiated Emissions Test Setup

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	18 Aug 2017

5.3 Results

Conducted limit is -25 dBm.

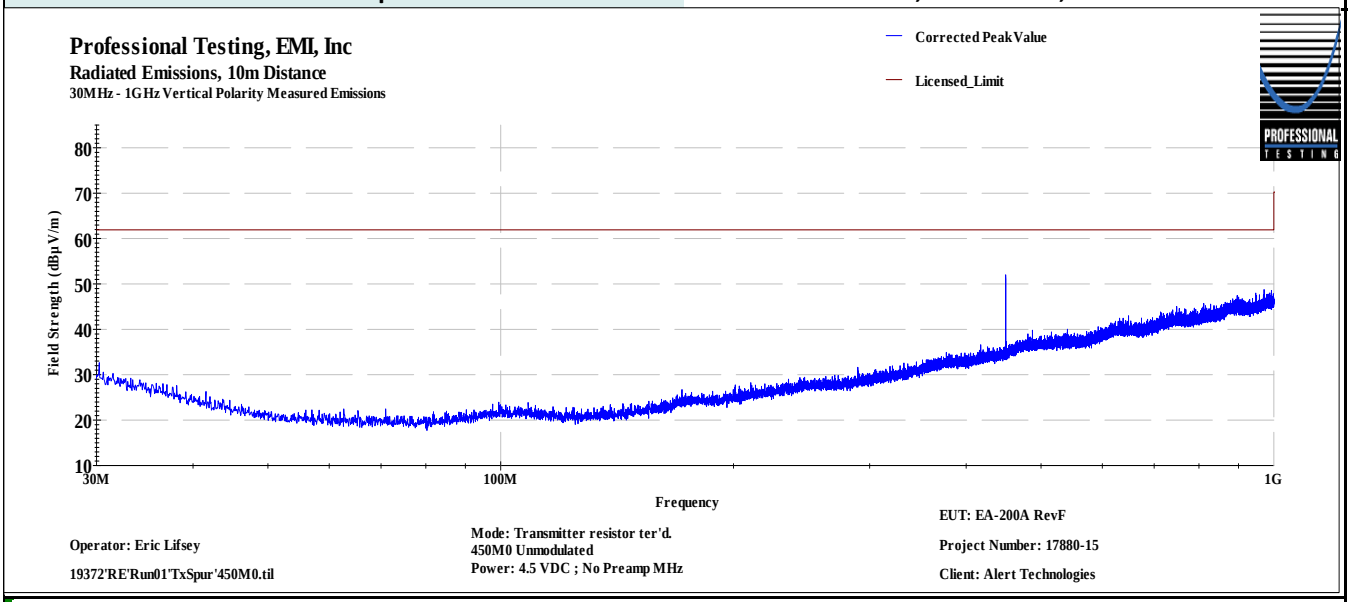
Highest recorded emission: 65.3 dBµV/m @ 3 m on 3.76 GHz.

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 C63.26, TIA/EIA-603-E. RSS-Gen		
In accordance with:	FCC Part 90; RSS-119		
Section:	Spurious		
Test Date(s):	9/7/2016	EUT Serial #:	Sample A
Project Number:	17880-15	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	EA-200A	Witness' Name:	None

Radiated Emissions Test Results Data Sheet			Page: 1 of 1		
EUT Line Voltage:	4.5	VDC	EUT Power Frequency:	0	N/A
Antenna Orientation:	Vertical		Frequency Range:	30MHz to 1GHz	
EUT Mode of Operation:			Transmit, terminated, low channel		



≤ 1GHz Vertical Antenna Polarity Measured Emissions

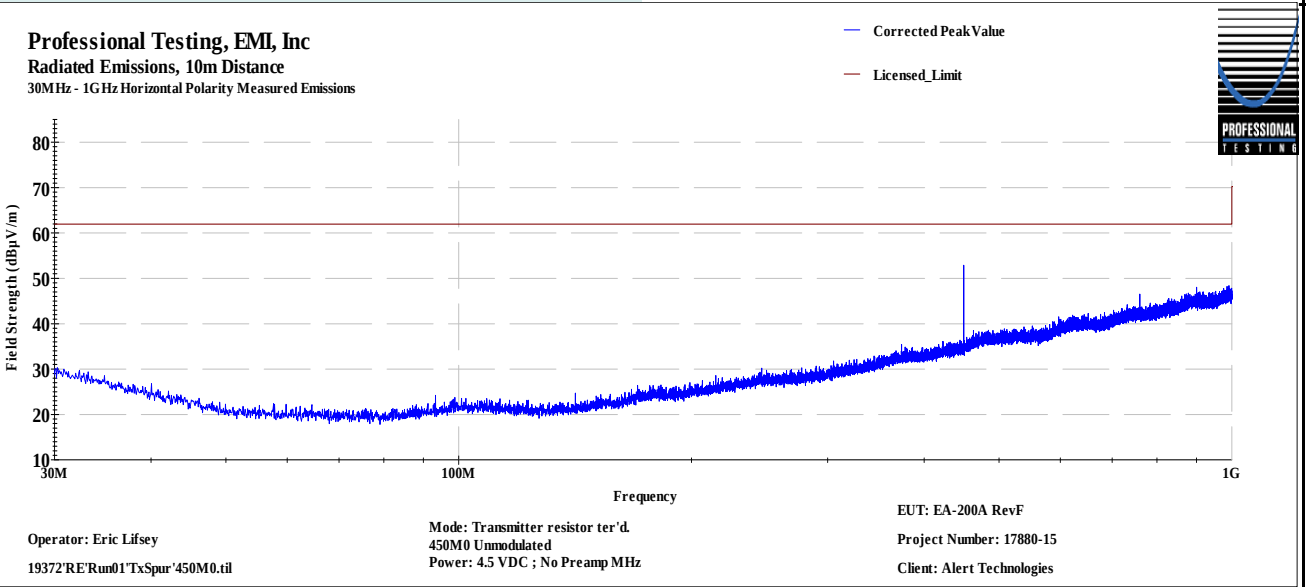
Professional Testing, EMI, Inc.

Test Method:	ANSI C63.26, TIA/EIA-603-E. RSS-Gen
In accordance with:	FCC Part 90; RSS-119
Section:	Spurious

Customer:	Alert Technologies	**EUT Part #:**	A130915 Rev F
Project Number:	17880-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	EA-200A	**Witness' Name:**	None

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

EUT Line Voltage:	4.5	VDC	**EUT Power Frequency:**	0	N/A
Antenna Orientation:	Horizontal		**Frequency Range:**	30MHz to 1GHz	
EUT Mode of Operation:	Transmit, terminated, low channel				

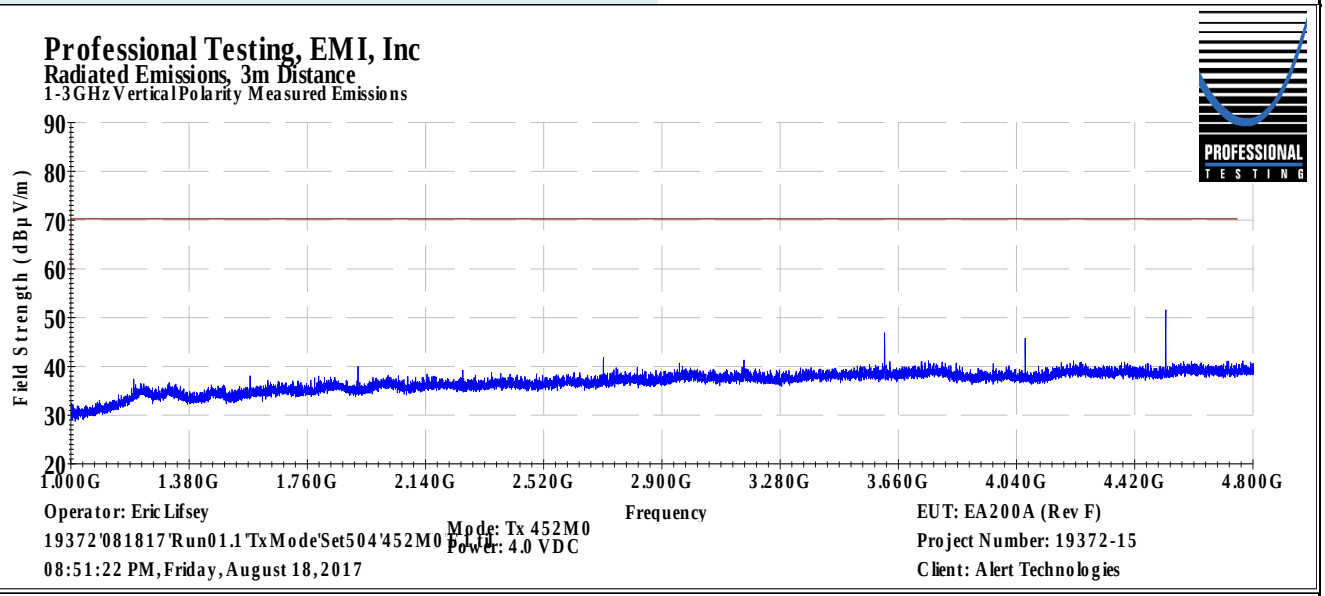


≤ 1GHz Horizontal Antenna Polarity Measured Emissions

5.3.2 Transmit Mode, Above 1 GHz, Bottom Channel

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.26, TIA/EIA-603-E. RSS-Gen		
In accordance with:	FCC Part 90; RSS-119		
Section:	Spurious		
Test Date(s):	8/18/2017	EUT Serial #:	Sample A
Project Number:	17880-15	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	EA-200A	Witness' Name:	None

Radiated Emissions Test Results Data Sheet			Page:	1	of	1
EUT Line Voltage:	4	VDC	EUT Power Frequency:	0	N/A	
Antenna Orientation:	Vertical		Frequency Range:	Above 1GHz		
EUT Mode of Operation:			Transmit, terminated, low channel			



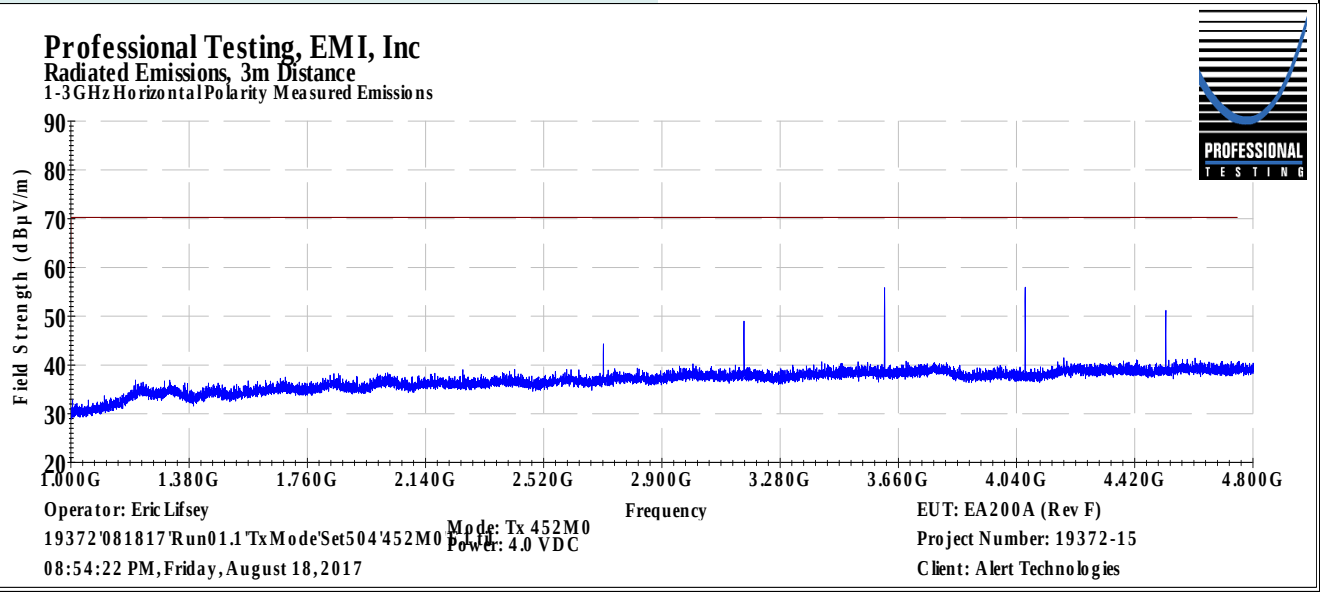
> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method:	ANSI C63.26, TIA/EIA-603-E. RSS-Gen		
In accordance with:	FCC Part 90; RSS-119		
Section:	Spurious		
Test Date(s):	8/18/2017	**EUT Serial #:**	Sample A
Project Number:	17880-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	EA-200A	**Witness' Name:**	None

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

EUT Line Voltage:	4	VDC	**EUT Power Frequency:**	0	N/A
Antenna Orientation:	Horizontal		**Frequency Range:**	Above 1GHz	
EUT Mode of Operation:	Transmit, terminated, low channel				

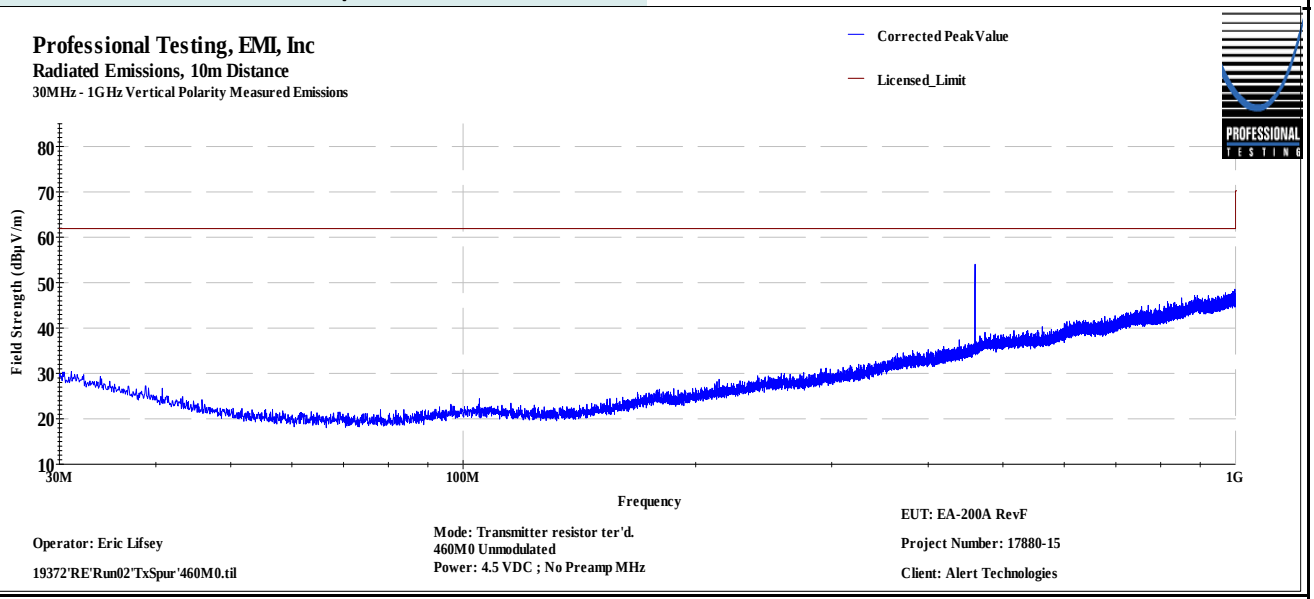


> 1GHz Horizontal Antenna Polarity Measured Emissions

5.3.3 Transmit Mode, Below 1 GHz, Middle Channel

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.26, TIA/EIA-603-E. RSS-Gen		
In accordance with:	FCC Part 90; RSS-119		
Section:	Spurious		
Test Date(s):	9/7/2016	EUT Serial #:	Sample A
Project Number:	17880-15	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	EA-200A	Witness' Name:	None

Radiated Emissions Test Results Data Sheet			Page:	1	of	1
EUT Line Voltage:	4.5	VDC	EUT Power Frequency:	0	N/A	
Antenna Orientation:	Vertical		Frequency Range:	30MHz to 1GHz		
EUT Mode of Operation:			Transmit, terminated, middle channel			



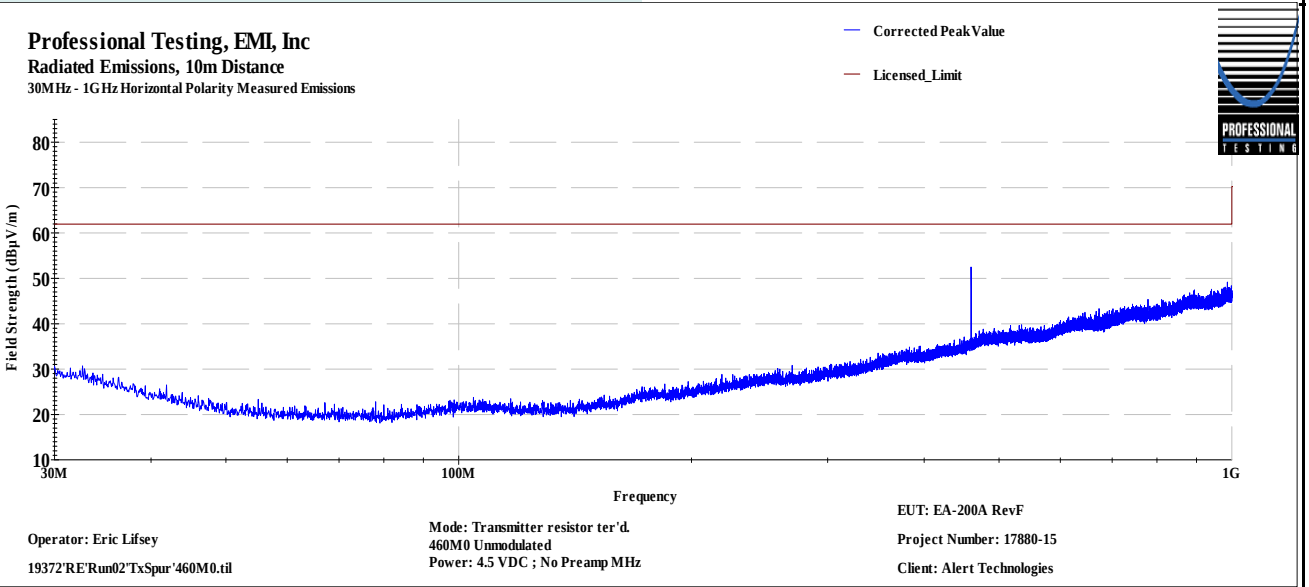
≤ 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method:	ANSI C63.26, TIA/EIA-603-E. RSS-Gen		
In accordance with:	FCC Part 90; RSS-119		
Section:	Spurious		
Test Date(s):	9/7/2016	**EUT Serial #:**	Sample A
Project Number:	17880-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	EA-200A	**Witness' Name:**	None

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

EUT Line Voltage:	4.5	VDC	**EUT Power Frequency:**	0	N/A
Antenna Orientation:	Horizontal		**Frequency Range:**	30MHz to 1GHz	
EUT Mode of Operation:			Transmit, terminated, middle channel		

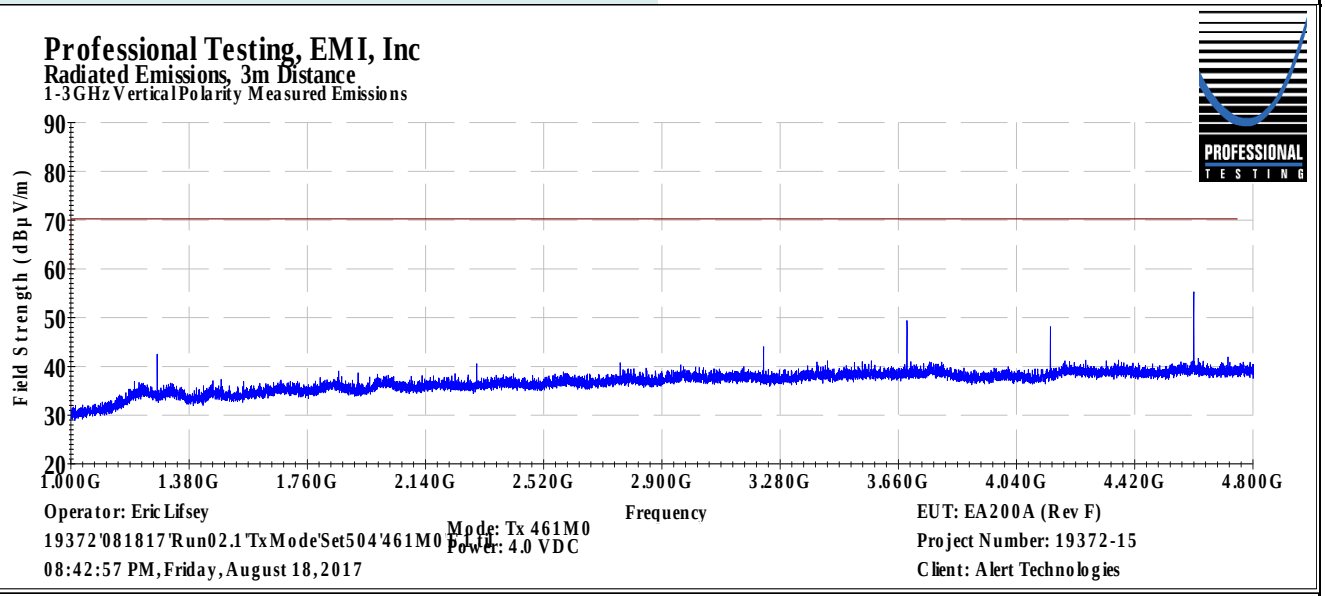


≤ 1GHz Horizontal Antenna Polarity Measured Emissions

5.3.4 Transmit Mode, Above 1 GHz, Middle Channel

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.26, TIA/EIA-603-E. RSS-Gen		
In accordance with:	FCC Part 90; RSS-119		
Section:	Spurious		
Test Date(s):	8/18/2017	EUT Serial #:	Sample A
Project Number:	17880-15	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	EA-200A	Witness' Name:	None

Radiated Emissions Test Results Data Sheet			Page:	1	of	1
EUT Line Voltage:	4	VDC	EUT Power Frequency:	0	N/A	
Antenna Orientation:	Vertical		Frequency Range:	Above 1GHz		
EUT Mode of Operation:			Transmit, terminated, middle channel			



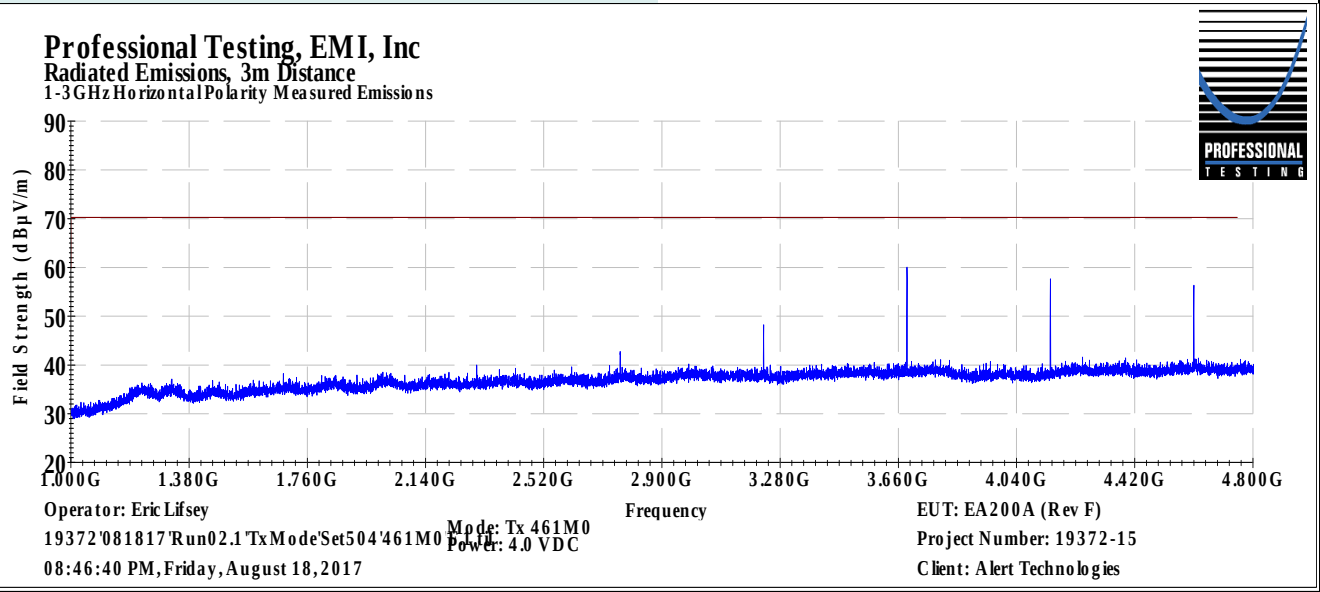
> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method:	ANSI C63.26, TIA/EIA-603-E. RSS-Gen		
In accordance with:	FCC Part 90; RSS-119		
Section:	Spurious		
Test Date(s):	8/18/2017	**EUT Serial #:**	Sample A
Project Number:	17880-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	EA-200A	**Witness' Name:**	None

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

EUT Line Voltage:	4	VDC	**EUT Power Frequency:**	0	N/A
Antenna Orientation:	Horizontal		**Frequency Range:**	Above 1GHz	
EUT Mode of Operation:	Transmit, terminated, middle channel				

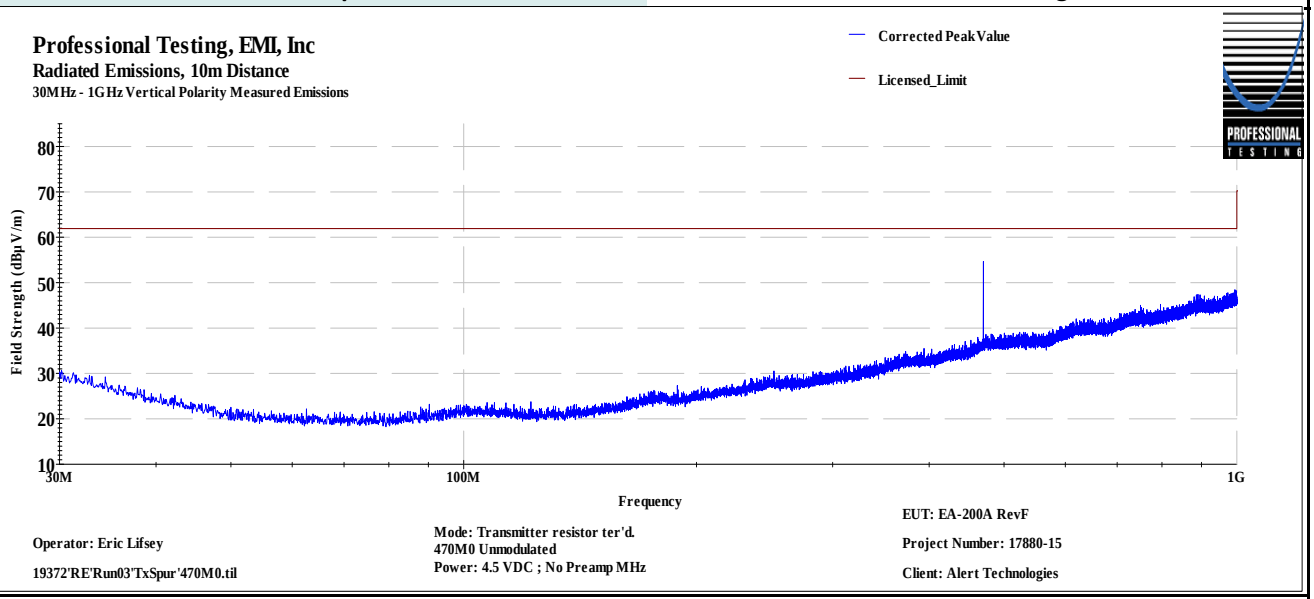


> 1GHz Horizontal Antenna Polarity Measured Emissions

5.3.5 Transmit Mode, Below 1 GHz, Top Channel

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.26, TIA/EIA-603-E. RSS-Gen		
In accordance with:	FCC Part 90; RSS-119		
Section:	Spurious		
Test Date(s):	9/7/2016	EUT Serial #:	Sample A
Project Number:	17880-15	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	EA-200A	Witness' Name:	None

Radiated Emissions Test Results Data Sheet			Page:	1	of	1
EUT Line Voltage:	4.5	VDC	EUT Power Frequency:	0	N/A	
Antenna Orientation:	Vertical		Frequency Range:	30MHz to 1GHz		
EUT Mode of Operation:			Transmit, terminated, high channel			



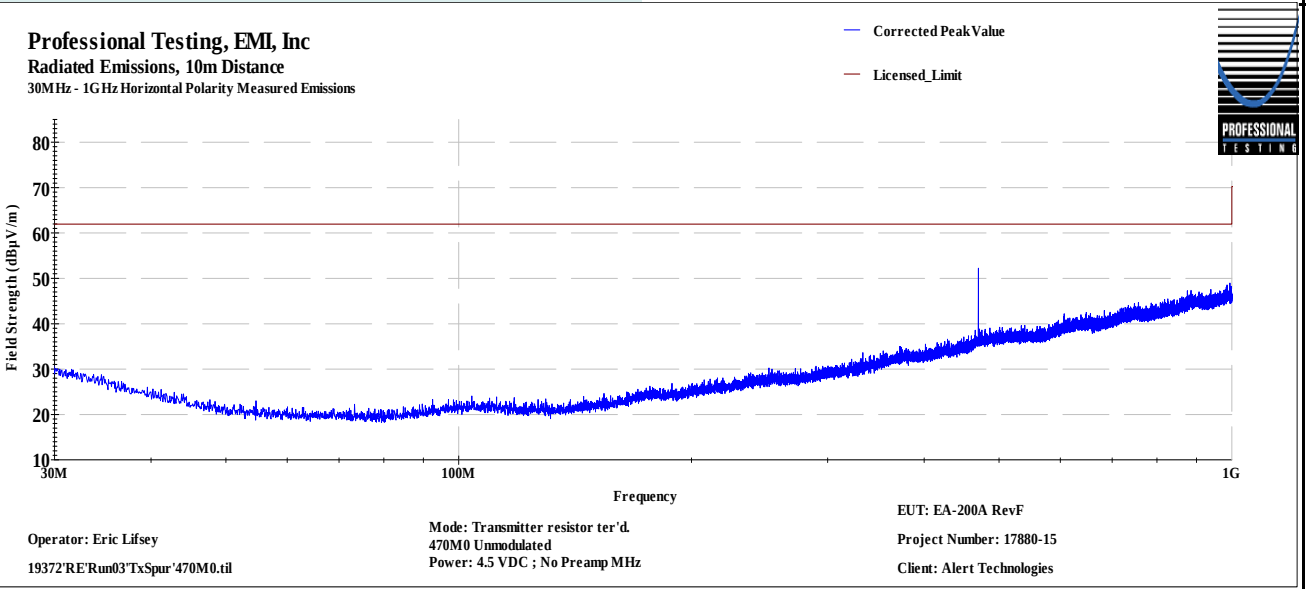
≤ 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method:	ANSI C63.26, TIA/EIA-603-E. RSS-Gen		
In accordance with:	FCC Part 90; RSS-119		
Section:	Spurious		
Test Date(s):	9/7/2016	**EUT Serial #:**	Sample A
Project Number:	17880-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	EA-200A	**Witness' Name:**	None

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

EUT Line Voltage:	4.5	VDC	**EUT Power Frequency:**	0	N/A
Antenna Orientation:	Horizontal		**Frequency Range:**	30MHz to 1GHz	
EUT Mode of Operation:	Transmit, terminated, high channel				

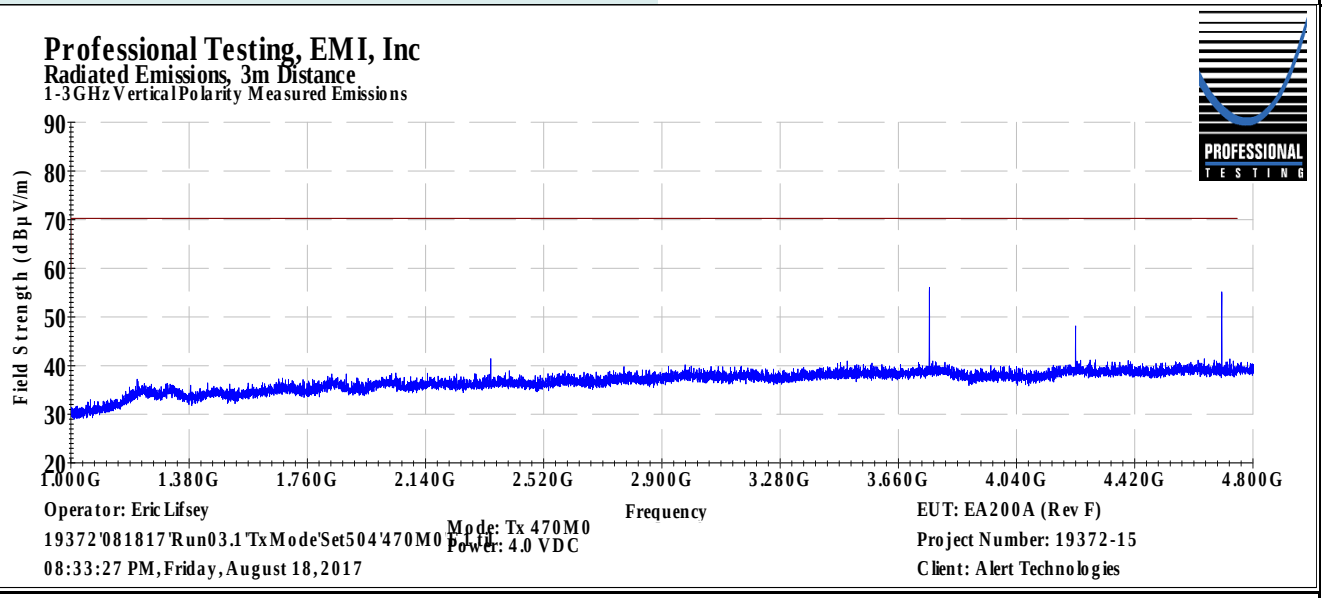


≤ 1GHz Horizontal Antenna Polarity Measured Emissions

5.3.6 Transmit Mode, Above 1 GHz, Top Channel

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.26, TIA/EIA-603-E. RSS-Gen		
In accordance with:	FCC Part 90; RSS-119		
Section:	Spurious		
Test Date(s):	8/18/2017	EUT Serial #:	Sample A
Project Number:	17880-15	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	EA-200A	Witness' Name:	None

Radiated Emissions Test Results Data Sheet			Page:	1	of	1
EUT Line Voltage:	4	VDC	EUT Power Frequency:	0	N/A	
Antenna Orientation:	Vertical		Frequency Range:	Above 1GHz		
EUT Mode of Operation:			Transmit, terminated, high channel			



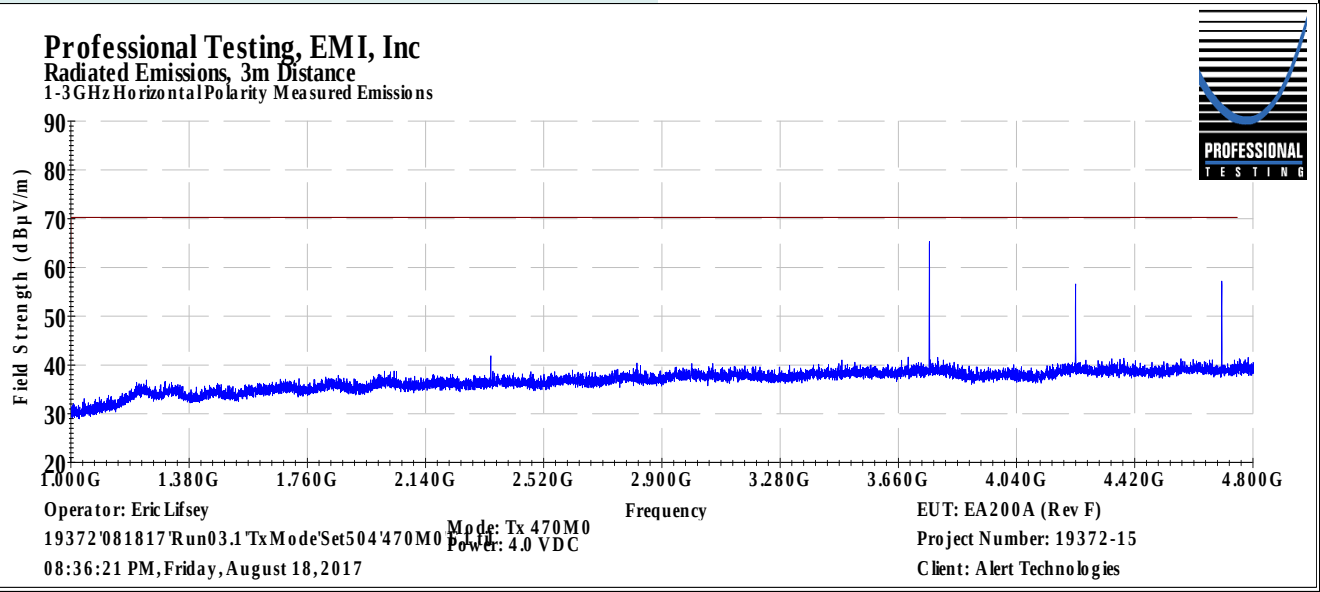
> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method:	ANSI C63.26, TIA/EIA-603-E. RSS-Gen		
In accordance with:	FCC Part 90; RSS-119		
Section:	Spurious		
Test Date(s):	8/18/2017	**EUT Serial #:**	Sample A
Project Number:	17880-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	EA-200A	**Witness' Name:**	None

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

EUT Line Voltage:	4	VDC	**EUT Power Frequency:**	0	N/A
Antenna Orientation:	Horizontal		**Frequency Range:**	Above 1GHz	
EUT Mode of Operation:	Transmit, terminated, high channel				



> 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	7 Aug 2017

Table 6.2.1 Frequency Tolerance
± 2.5 ppm

Table 6.2.2 Operating Voltages		
Low	**Nominal**	**High**
3.3	**4.5**	**5.2**

The operating frequency shall remain within the required tolerance.

6.3 Results

The highest deviation from frequency observed was -1070 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	450.000000	449.998943	-1057
-20	450.000000	449.999033	-967
-10	450.000000	449.999290	-710
0	450.000000	449.999583	-417
10	450.000000	449.999875	-125
20	450.000000	449.999865	-135
30	450.000000	449.999830	-170
40	450.000000	449.999718	-282
50	450.000000	449.999560	-440
Upper Deviation (Hz)			-125
Lower Deviation (Hz)			-1057

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	450.000000	449.999303	-697
Nominal	4.50	450.000000	449.999798	-202
High	5.20	450.000000	449.999808	-192

6.3.3 Middle Channel, Temperature

Condition	Frequency		Deviation
Temperature (C)	Reference Center Frequency (MHz)	Measured Frequency (MHz)	Calculated Deviation (Hz)
-30	460.000000	459.998953	-1047
-20	460.000000	459.998998	-1002
-10	460.000000	459.999223	-777
0	460.000000	459.999560	-440
10	460.000000	459.999808	-192
20	460.000000	459.999853	-147
30	460.000000	459.999820	-180
40	460.000000	459.999685	-315
50	460.000000	459.999528	-472
Upper Deviation (Hz)			-147
Lower Deviation (Hz)			-1047

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	460.000000	459.999268	-732
Nominal	4.50	460.000000	459.999830	-170
High	5.20	460.000000	459.999808	-192

6.3.5 Top Channel, Temperature

Condition	Frequency		Deviation
Temperature (C)	Reference Center Frequency (MHz)	Measured Frequency (MHz)	Calculated Deviation (Hz)
-30	470.000000	469.998930	-1070
-20	470.000000	469.998988	-1012
-10	470.000000	469.999218	-782
0	470.000000	469.999785	-215
10	470.000000	469.999775	-225
20	470.000000	469.999843	-157
30	470.000000	469.999798	-202
40	470.000000	469.999685	-315
50	470.000000	469.999470	-530
Upper Deviation (Hz)			-157
Lower Deviation (Hz)			-1070

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	470.000000	469.999290	-710
Nominal	4.50	470.000000	469.999785	-215
High	5.20	470.000000	469.999830	-170

7.0 Transient Frequency Behavior

The EUT was tested for transient frequency behavior using the test method outlined in TIA/EIA-603-E paragraph 2.2.19.3 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-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-E	13 Sep 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] t_{on} is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

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

t_2 is the time period immediately following t_1.

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

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

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

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

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

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

7.2 Results

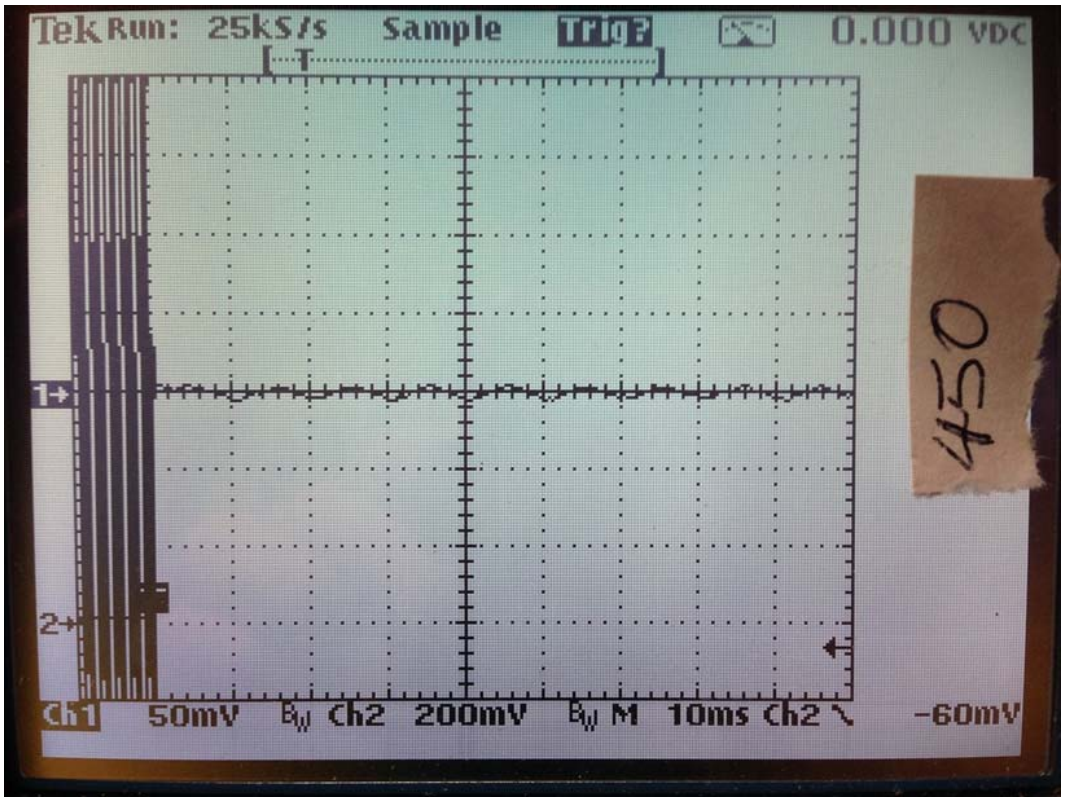
Plotted measurements appear on the following pages. The limits were not superimposed on the plots as the transmitter performance was clearly in compliance for any allowed channel scheme.

Since the frequency synthesis circuitry is identical for both channel spacing modes, one mode was measured and demonstrated stability for both modes.

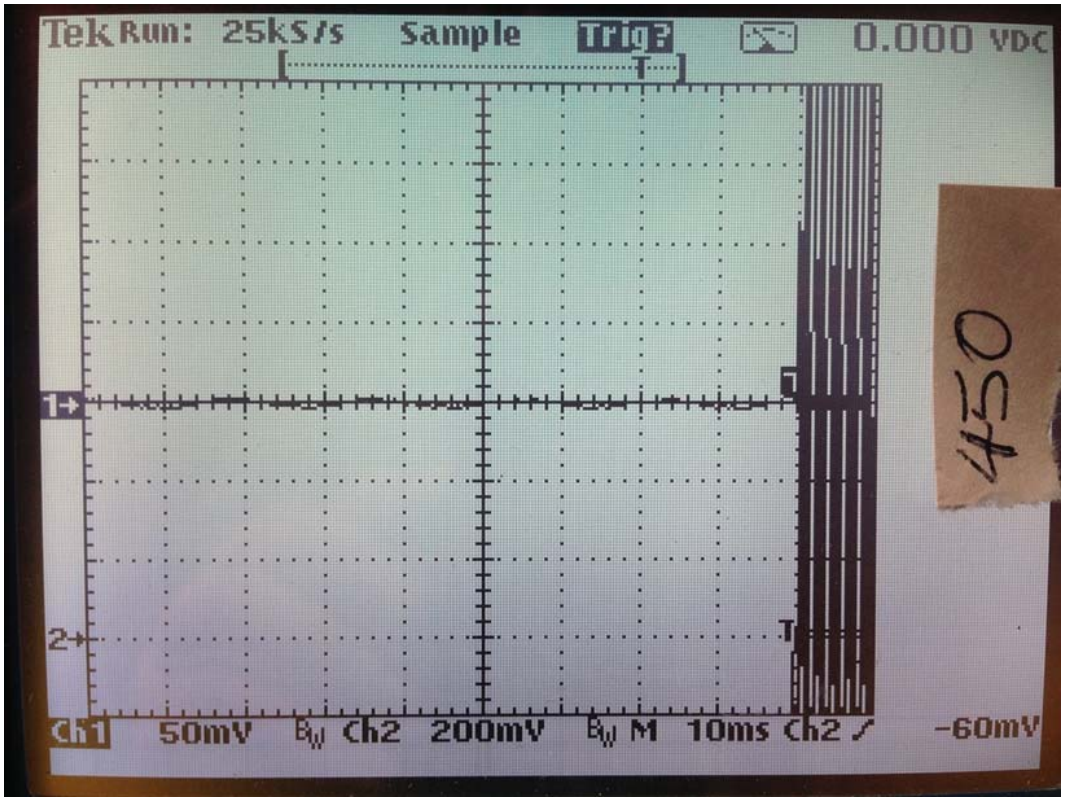
The sample tested utilized the same electrical design with regard to the radio module and associated circuitry.

The EUT satisfied the requirement. Measurements appear below.

7.2.1 Bottom Channel

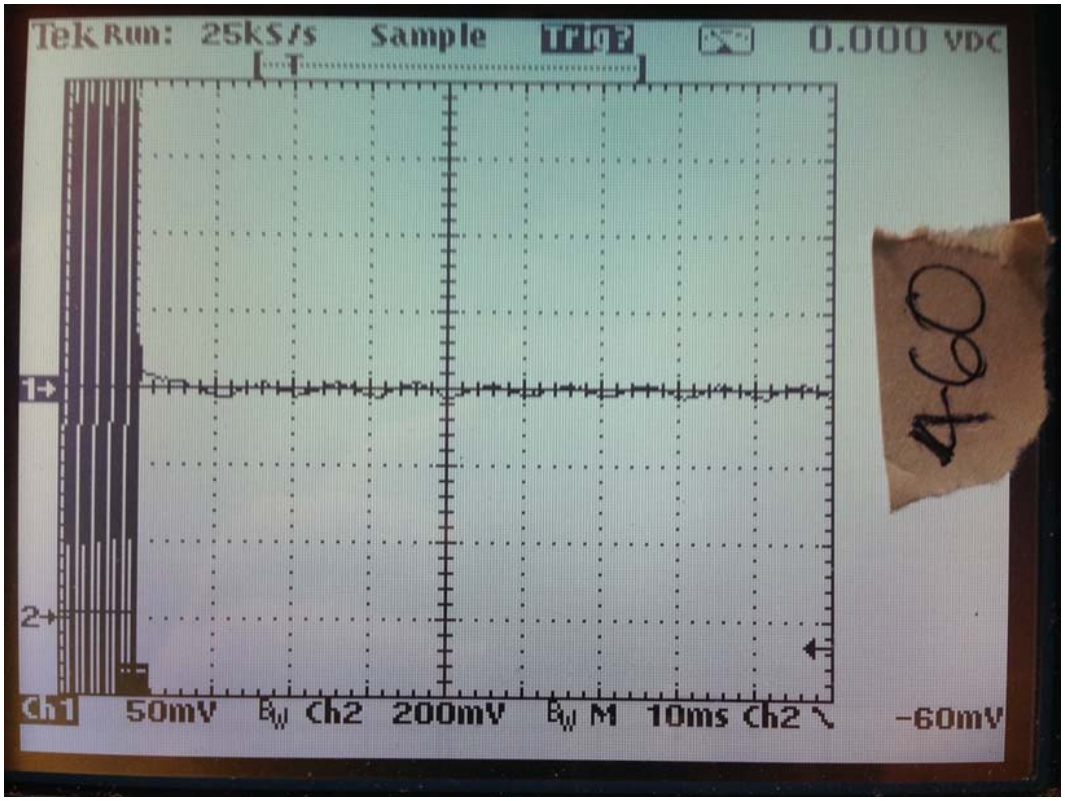


Attack

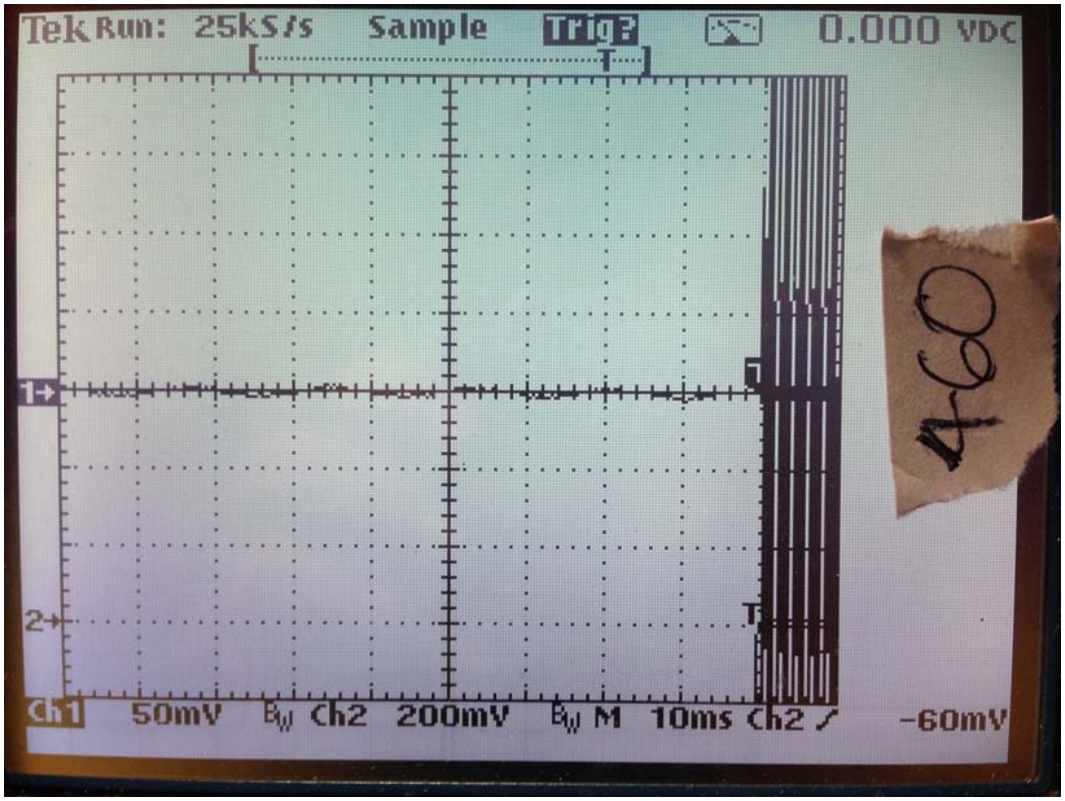


Release

7.2.2 Middle Channel

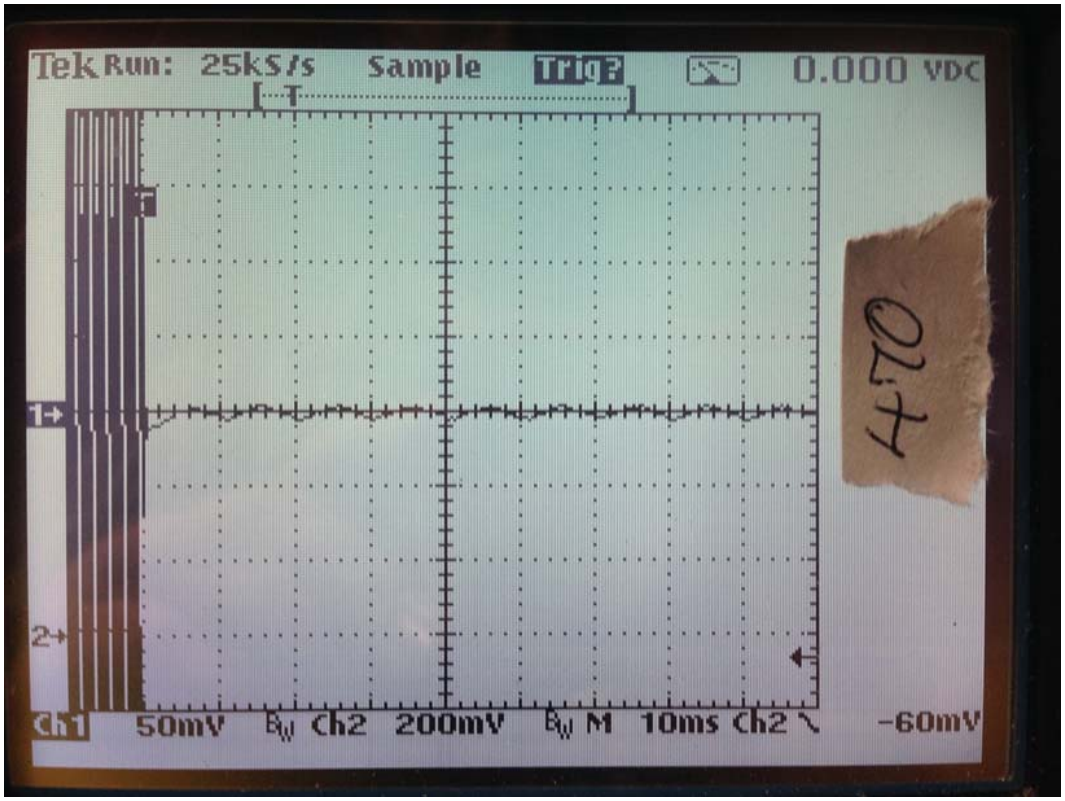


Attack

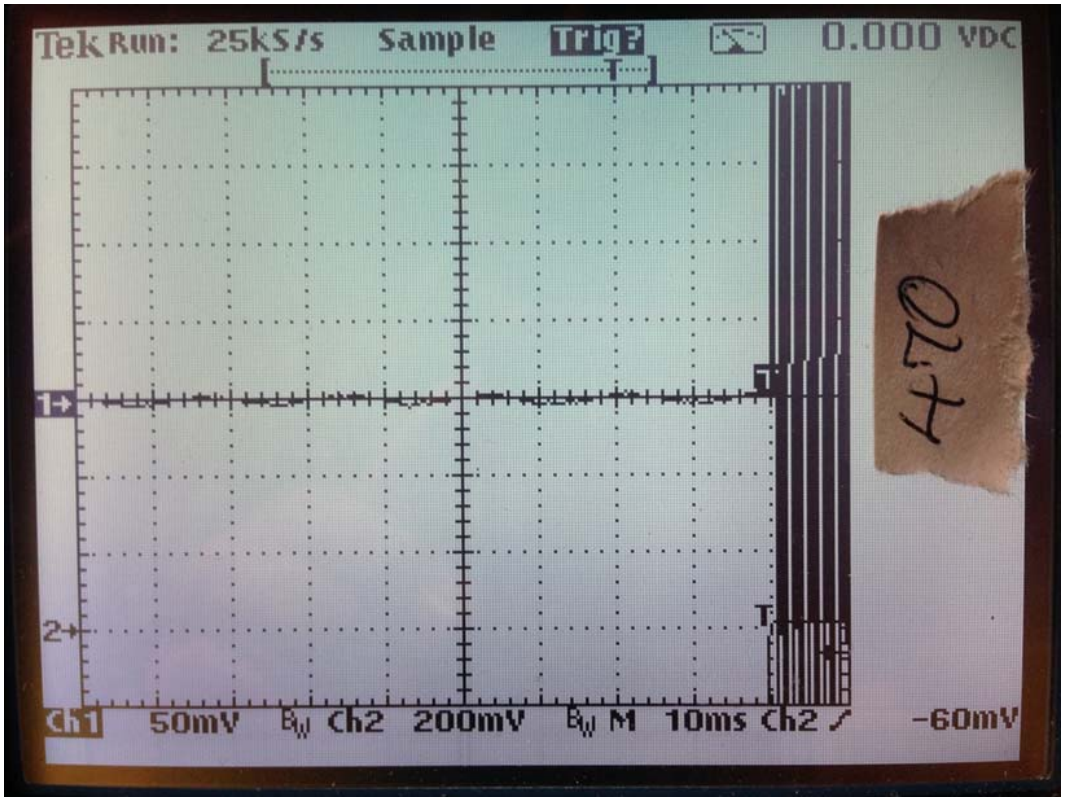


Release

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

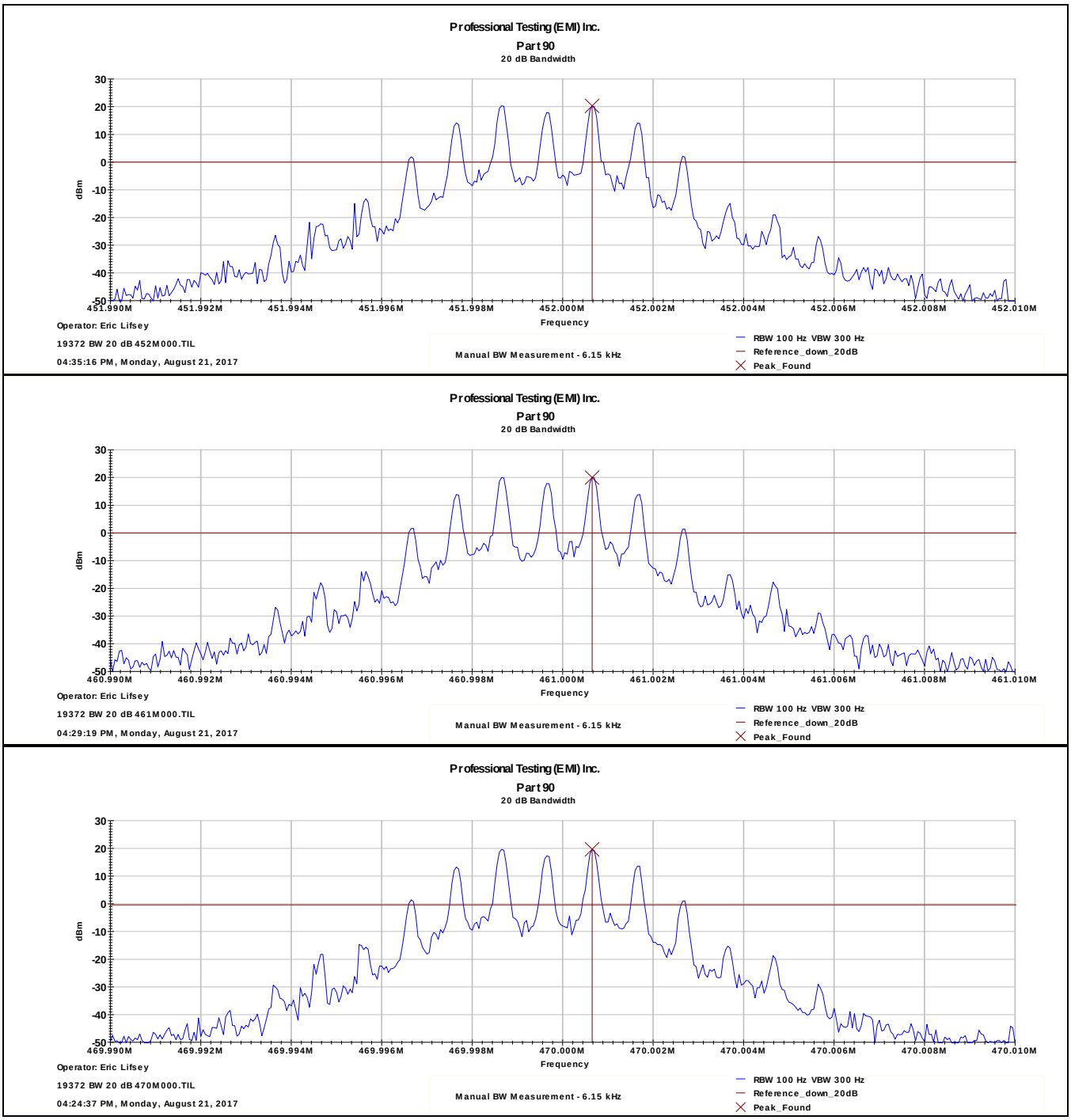
Parameter	Section Number	Date
20 dB Bandwidth for Reporting	90.210, 90.203(j)(3), 2.1049 | RSS-119 Issue 12, 5.5	7 Nov 2017

8.3 Results

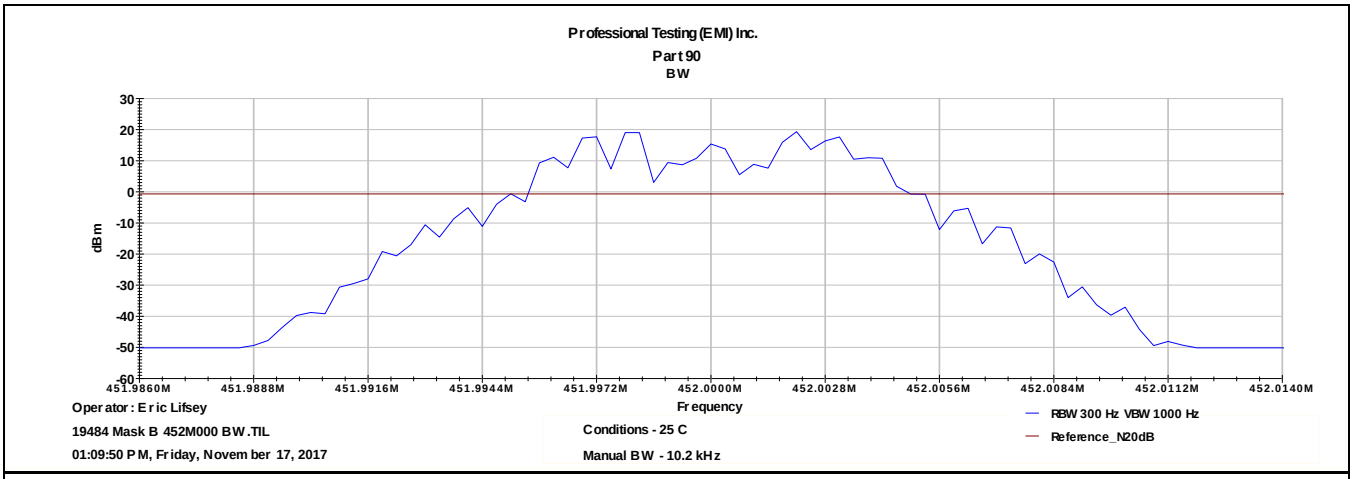
Table 8.3.1 Bandwidth 20 dB (kHz) Narrow Mode	
Frequency	**Measured Bandwidth kHz**
452.0 MHz	6.15
460.0 MHz	6.15
470.0 MHz	6.15

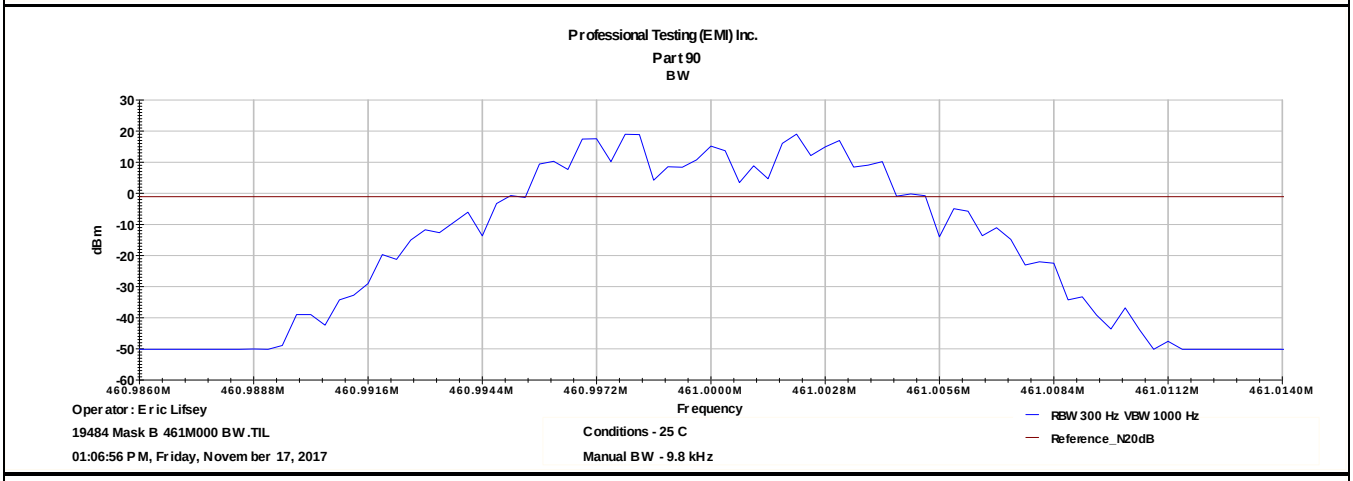
Table 8.3.2 Bandwidth 20 dB (kHz) Wide Mode	
Frequency	**Measured Bandwidth kHz**
452.0 MHz	9.8
460.0 MHz	9.8
470.0 MHz	10.2

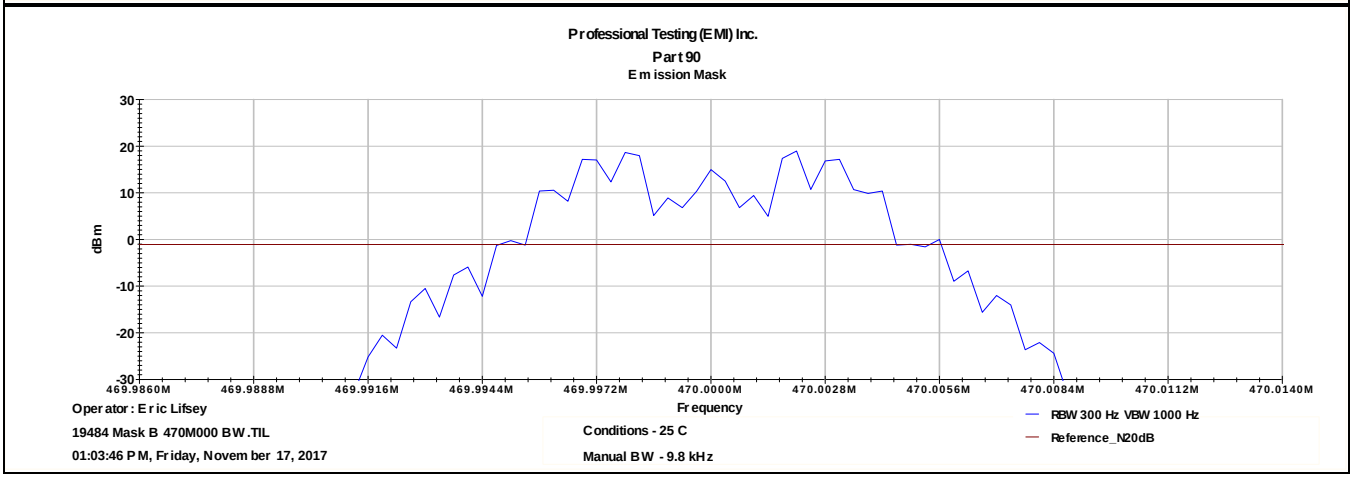
8.3.1 Narrow Mode



8.3.2 Wide Mode







9.0 Audio Frequency Response

9.1 Procedure

The EUT antenna port is coupled by radiated means to the modulation analyzer for measurement.

9.2 Criteria

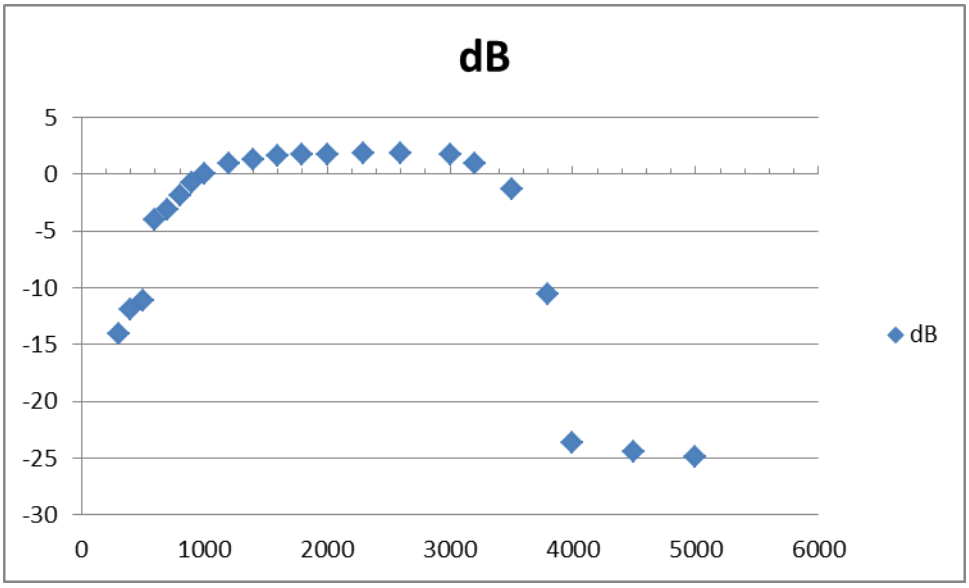
Parameter	Section Number	Date
Frequency Response	2.1047(a)	18 Oct 2017

9.3 Results

A high impedance injection probe was fabricated to apply audio modulation directly to the EUT. The probe consisted of two 9.8 k resistors on each leg of the microphone circuit. The microphone was covered with heavy tape to reduce ambient pickup and the EUT was placed in a test enclosure to further reduce ambient pick up. RF was sampled with a non-resonant antenna, feeding a preamplifier, then to the modulation analyzer input.

Table 9.3.1 Frequency Response (Relative from 1000 Hz.)

Frequency Hz	Measured Relative to 1000 Hz dB
300	-14.0
400	-11.9
500	-11.1
600	-4.0
700	-3.1
800	-1.9
900	-0.7
1000	0.0
1200	0.9
1400	1.3
1600	1.6
1800	1.7
2000	1.8
2300	1.9
2600	1.9
3000	1.7
3200	1.0
3500	-1.3
3800	-10.6
4000	-23.6
4500	-24.4
5000	-24.9



Plotted Frequency Response (Relative from 1000 Hz.)

10.0 Modulation Limiting

10.1 Procedure

The EUT antenna port is coupled by radiated means to the modulation analyzer for measurement. Modulation level is set to 60% deviation then a +20 dB level is applied and observed for instantaneous and steady state deviation.

10.2 Criteria

Parameter	Section Number	Date
Modulation Limiting	2.1047(b)	18 Oct 2017, 17 Nov 2017

10.3 Results

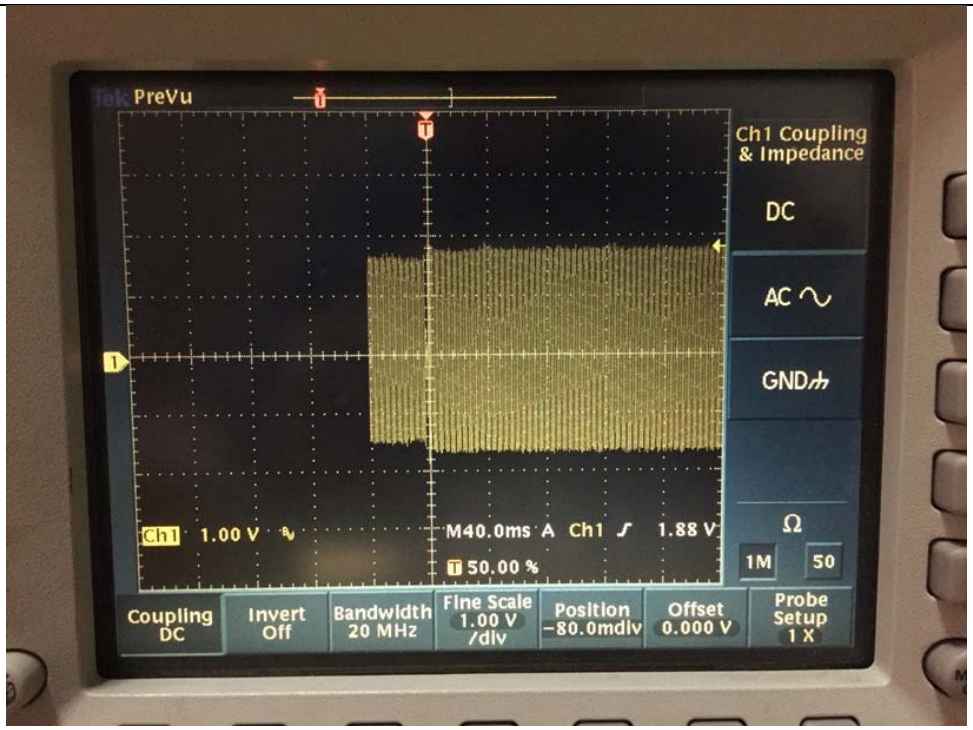
Table 10.3.1 Modulation Limiting, Narrow Mode

Audio Frequency Hz	Steady State Deviation (peak) kHz	Instantaneous Deviation (peak hold) kHz
300	1.0	2.2
1000	1.7	2.0
1500	1.7	1.9
3000	1.8	1.9

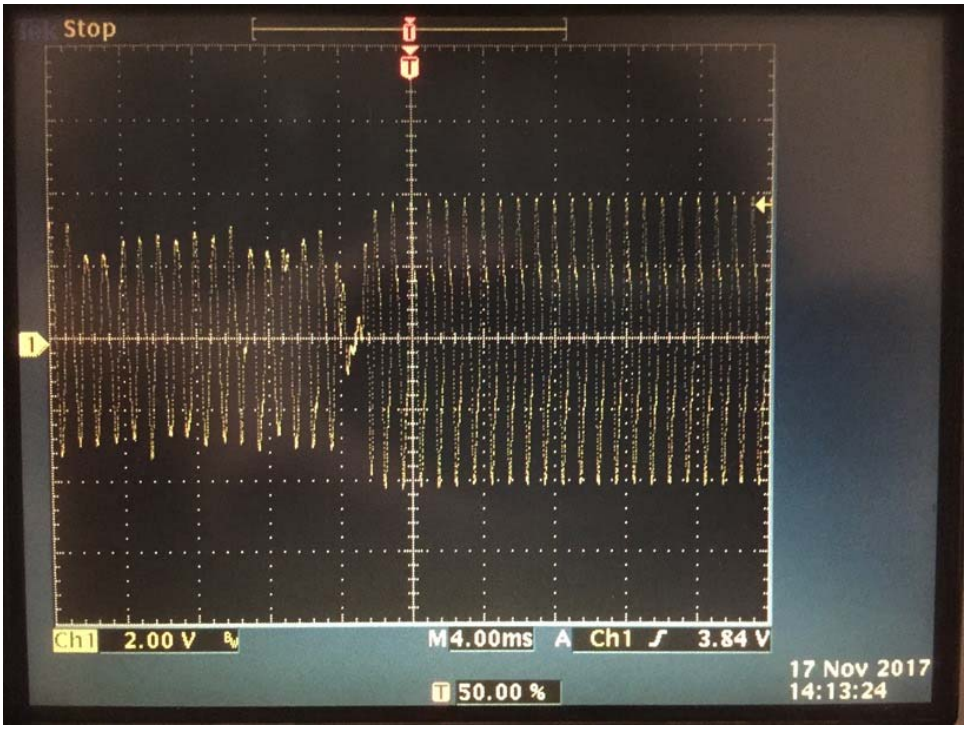
Table 10.3.2 Modulation Limiting, Wide Mode

Audio Frequency Hz	Steady State Deviation (peak) kHz	Instantaneous Deviation (peak hold) kHz
300	2.0	3.8
1000	3.3	4.0
1500	3.4	3.7
3000	2.7	2.9

The demodulated output was checked for +/- deviation symmetry on application of the +20 dB level with an oscilloscope and with the modulation analyzer. Setup was essentially the same as frequency response test but with the scope included to evaluate the modulation.



Time Domain and Deviation Check of +20 dB Modulation Event, Narrow Mode



Time Domain and Deviation Check of +20 dB Modulation Event, Wide Mode

11.0 Equipment Lists

11.1 Conducted Power, Conducted Spurious, Mask, and Bandwidth

Asset #	Manufacturer	Model #	Description	Calibration Due
2216	HP	8593E	Spectrum Analyzer	18 Jan 2019
2134	Tenny	TPS T2C	Temperature Chamber	12 Oct 2017
C241	Pasternack	RG type	Coaxial Cable, Low Loss, ~5m	21 Jan 2018
0472	Tektronix	THS730A	Scope/DMM	15 Nov 2017
1831	HP	6622A	DC Power Supply	CIU

11.2 Frequency Stability

Asset #	Manufacturer	Model #	Description	Calibration Due
2216	HP	8593E	Spectrum Analyzer	18 Jan 2019
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
1831	HP	6622A	DC Power Supply	CIU

11.3 Frequency Behavior

Asset #	Manufacturer	Model #	Description	Calibration Due
0836	Narda	3293-1	Broadband Directional Coupler	CNR
2228	Tektronix	TDS3034	Oscilloscope, Digital	19 Jul 2018
1678	HP	8921A	Cell Site Tester (as audio 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

11.4 Frequency Response and Modulation Limiting

Asset #	Manufacturer	Model #	Description	Calibration Due
2216	HP	8593E	Spectrum Analyzer	18 Jan 2019
1678	HP	8921A	Cell Site Tester (as audio signal generator)	CIU
0637	HP	8901A	Modulation Analyzer	10 Nov 2018
2228	Tektronix	TDS3034	Oscilloscope, Digital	19 Jul 2018
0742	HP	355C	Step Attenuator	CNR
0637	HP	8901A	Modulation Analyzer	CNR
None	PTI	N/A	Audio Injector Probe 2 x 9.8kΩ	CNR
2201	Agilent	E3632A	Adjustable DC Power Supply	CIU
None	Various	None	RG Type coaxial cables	CNR

11.5 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:		**2015 Rad Emissions_ClassA - LowPRF_072715.til or 2015 Rad Emissions_ClassB - LowPRF_072715.til**			
Asset #	**Manufacturer**	**Model**	**Equipment Nomenclature**	**Serial Number**	**Calibration Due Date**
1509A	Braden	TDK 10M	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	7/10/2019
1937	Agilent	E4440A	Spectrum Analyzer, 3 Hz - 26.5 GHz, 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	TDK 10M	TDK 10M Chamber, VSWR > 1 GHz	DAC-012915-005	6/23/2019
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	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

(This page intentionally left blank.)