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

October 24, 2013

C. E. Thermal, Care Of:
Dave Cameron
Hetronic International
3905 NW 36th St.
Oklahoma City, OK 73112
USA

Dear Dave:

Thank you for allowing Professional Testing (EMI), Inc. an opportunity to perform testing for Hetronic and C. E Thermal. Enclosed is the Wireless Certification Report for the Compact. This report can be used to demonstrate compliance with FCC requirements for wireless devices in the United States.

If you have any questions, please contact me.

Sincerely,

Jeffrey A. Lenk
President

Attachment

Project 14661-10

Compact

Wireless Certification Report

Prepared for:

Hetronic and C. E. Thermal

By

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

October 24, 2013

Reviewed by

Larry Finn
Product Development Engineer

Written by

Eric Lifsey
Test Engineer

Revision History

Revision Number	Description	Date
00	Initial Release	June 20, 2013
01	Revised per ACB Comments	July 12, 2013
02	Revised per ACB Comments	August 5, 2013
03	Revised per ACB Comments, legibility only.	August 16, 2013
04	Revised per ACB Comments	October 24, 2013

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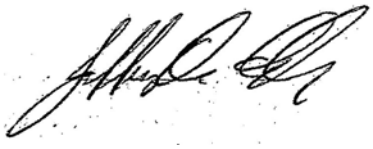
Certificate of Compliance

Applicant:	C. E. Thermal
Applicant's Address:	C. E. Thermal (Tom Reynolds) 7401 W. Wilson Chicago Illinois 60706 USA
FCC ID:	R3G-COMPACT
IC ID:	10571A-COMPACT
Model:	Compact
Project Number:	14661-15

The **Compact** by **C. E. Thermal**, was tested utilizing the following documents and found to be in compliance with the required criteria on the indicated test date.

47 CFR (USA), IC (Industry Canada)		
Section Reference	Parameter	Date
15.249(a), RSS-210 Issue 8	Fundamental Field Strength Limit 50 mV/m	2013-07-31
15.209, RSS-210 Issue 8	Harmonic & Spurious Emissions	2013-07-12
15.203, RSS-Gen Issue 3	Antenna Requirements	2013-06-20
RSS-210 Issue 8	Bandwidth	2013-05-20
2.1091	Maximum Permissible Exposure	2013-08-05

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



Jeffrey A. Lenk
President

This report has been reviewed and accepted by Hetronic. The undersigned is responsible for ensuring that the Compact by C. E. Thermal, will continue to comply with the applicable rules.

_____
Representative of C. E. Thermal

1.0 Introduction

1.1 Scope

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

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

1.2 EUT Description

The EUT is the **Compact** by **C. E. Thermal**. This device is a wireless remote control for a variety of industrial or commercial machine control applications ranging from horse walking systems to large material moving equipment. It is designed to be used with a companion 'receiver' which contains electrical relays that are actuated by wireless key-pressed commands from the Compact. The EUT as tested consisted of the following:

Table 1.2.1: Equipment Under Test

Manufacturer	Model	Serial #	Description
C. E. Thermal	Compact	6 0113 220016	Wireless machine controller.

The device is composed of a rectangular plastic box designed to be carried in the hand. One long side features eight recessed push button switches labeled with graphical direction arrows and a red button labeled in text as STOP. One end of the enclosure has a removable battery compartment cover which reveals the three AA size batteries used to power the device. There are no external ports or power connections of any kind. A single red/green LED at the keypad center serves as activity indicator.

The EUT measures approximately 28 x 70 x 124 cm. A front view of the EUT is provided below.

Photograph 1.2.1: EUT

1.3 EUT Operation

The EUT was exercised in a manner consistent with normal operations. As a hand held device, all three orthogonal orientations are tested for maximum emissions.

A sample was provided with firmware that allowed control of receive/transmit mode and channel selection for each mode. This software operated the transmitter in a continuous modulated mode.

An additional test sample, loaded with normal production software, was used to measure the transmit duty cycle.

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.

2.0 Applicable Documents and Clauses

This device operates on the 2.4 GHz ISM band, as such 47 CFR and relevant part(s) applies as shown below.

Table 2.0.1: Applicable Documents

Document #	Title/Description
47 CFR (USA)	Part 15 – Section 15.249
IC (Canada)	RSS-210 Issue 8, RSS-102 Issue 4, RSS-Gen Issue 3
ANSI C63.4 2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low Voltage Electrical and Electronic Equipment

Table 2.0.2: Applicable Clauses

Clause Subject	Section References	Required?	Result
Radiated Output Power	15.249, RSS210 A2.9(a)	Yes	Pass
Occupied Bandwidth, 20 dB	2.1049, RSS210-Gen 4.6.3	No, Yes	Informational
Field Strength of Radiated Spurious/Harmonic Emissions (30 MHz to 25 GHz)	15.249, 15.209, RSS-210 A2.9(a) and (b)	Yes	Pass
Antenna Construction	15.203, RSS-Gen 7.1.2	Yes	Pass
Maximum Permissible Exposure	2.1091, FCC 447498 D01 General RF Exposure Guidance v05, RSS-102	Yes	Pass

3.0 Fundamental Field Strength

Radiated peak output power measurements were made on the EUT.

3.1 Test Procedure

EUT is placed on a non-conductive surface 80 cm above a reference plane and measurements of emissions are made to find maximum emission level. As a hand-held device, three orthogonal orientations of the EUT were measured to find the maximum signal.

3.2 Test Criteria

Section Reference	Parameter	Date(s)
15.249, RSS210 A2.9(a)	Radiated Output Power, 50 mV/m @ 3 m Restated as 93.98 dBµV/m @ 3 m	2013-07-31

3.3 Test Results

The EUT was found to be in compliance with the applicable criteria. The maximum emission is presented below and compared to the limit.

Field Strength of Fundamental, **3** Meter Measurement Distance
Maximum Reported: Channel High, Oriented Flat, Vertical Antenna Polarity

Frequency GHz	EUT Direction degrees	Antenna Height meters	Measured Level dBµV	Amplifier Gain dB	Antenna Factor dB/m	Cable Loss dB	Corrected Level (Measured Peak Level) dBµV/m	Detector Mode
2.480	30	1	68.36	0.0	32.7	5.1	106.16	Peak

Resolution bandwidth 1 MHz. Video bandwidth 3 MHz. Detector mode is peak.

Average Limit at **3** meters dBµV/m	Corrected Level (Measured Peak Level) dBµV/m	Duty Cycle Factor dB	Corrected Level (Measured Peak Level less Duty Cycle Factor) dBµV/m	Margin dB
93.98	106.16	-20	86.16	-7.82

4.0 Transmitter Duty Cycle

Measurements of transmitter on time and intervals between transmissions were made to determine the duty cycle factor.

4.1 Test Procedure

EUT is placed into normal transmit operation to observe and record transmitter time domain performance.

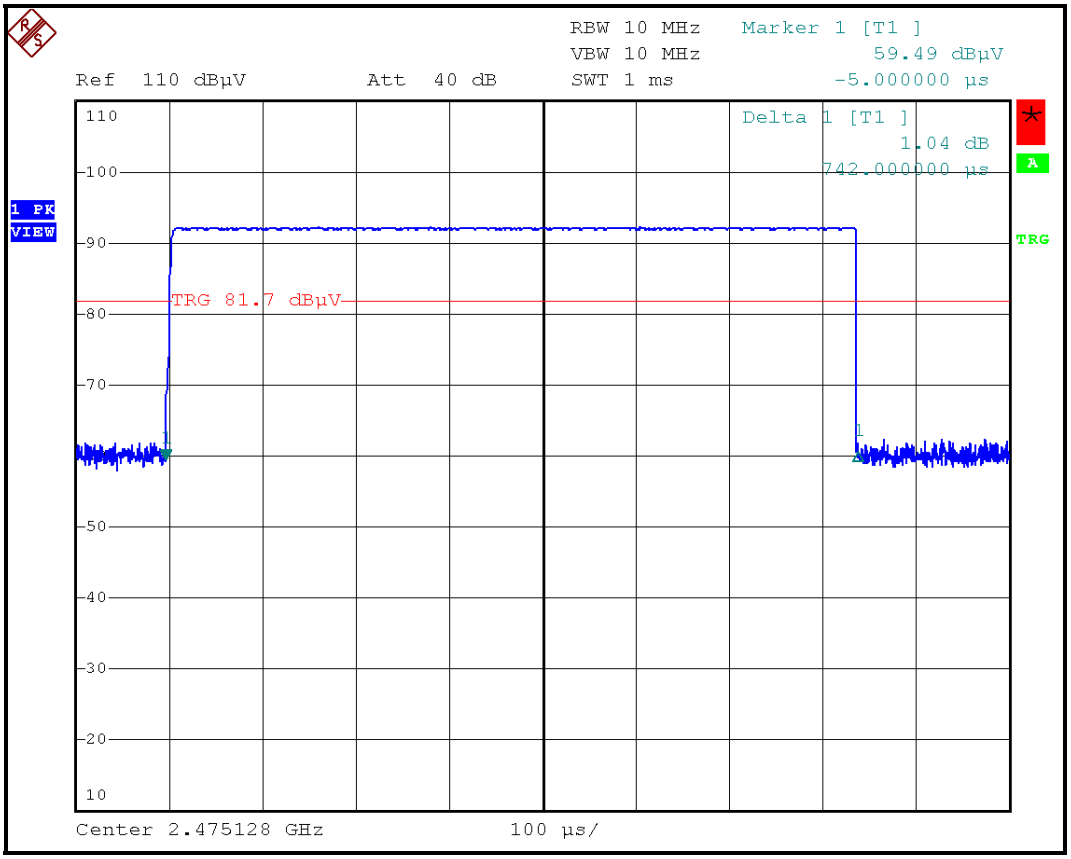
4.2 Test Criteria

Measurement is based on intervals not to exceed 100 msec. Maximum transmitter on time is divided by the lesser of 100 msec or the actual measured minimum transmitter interval time. The result is converted to dB and applied as needed to peak measurements of transmitter artifacts to determine average power. This is not a pass/fail measurement.

4.3 Test Results

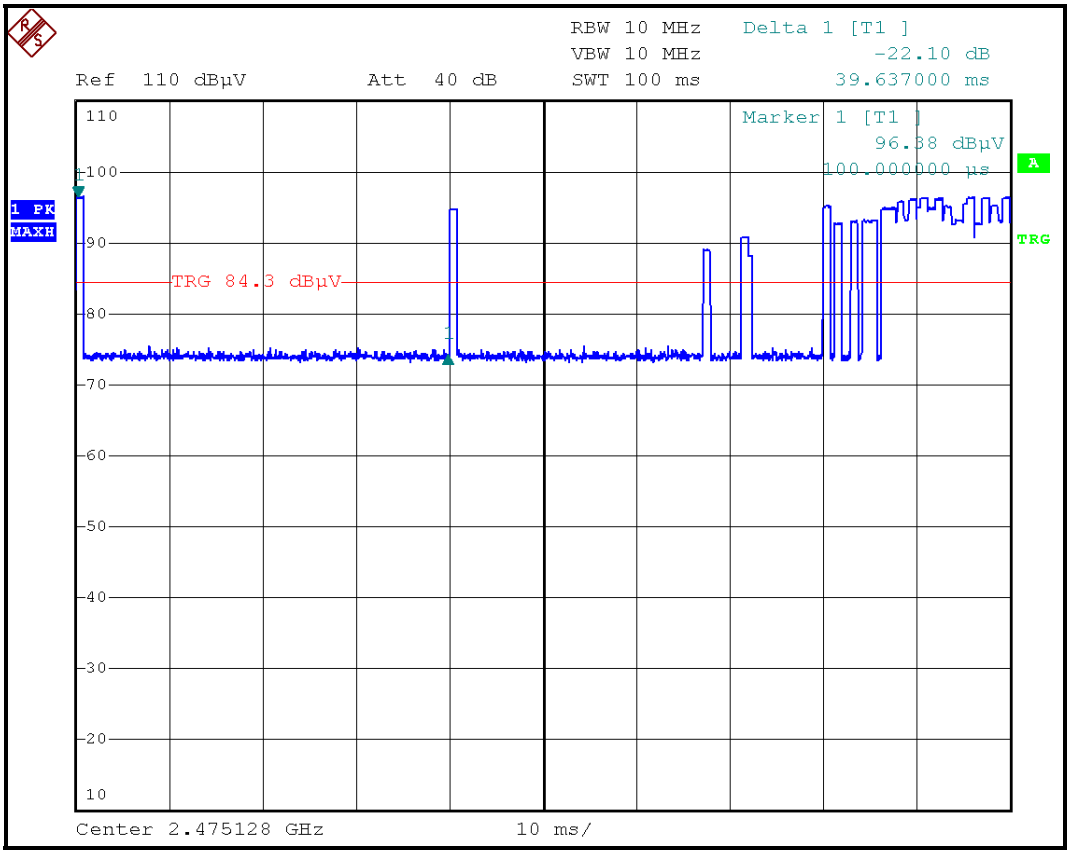
Measurements were performed on 2013-04-15 with the following results.

Plot 4.3.1 Transmit On Time



Measured maximum transmit time: 0.742 msec. Max hold recording was continued until no further change was observed.

Plot 4.3.2 Transmit Interval Time



Measured minimum transmit interval time: 39.637 msec.

Note that the transmit interval varies from the minimum captured above. This can be seen as the additional transmit events captured in max-hold mode on the right side of the plot. Max hold recording was continued until no additional events were observed. Therefore the smallest interval is represented above.

Table 4.3.1 Duty Cycle Factor Result

Measured On Time (msec)	Measured Time Interval (msec)	Duty Cycle Factor Calculation	Result (dB)	Duty Cycle Factor Allowed (dB)
0.742	39.637	= 20 * Log_{10} (0.742 msec / 39.637 msec)	-34.55	-20

The allowed duty cycle factor is applied to fundamental and harmonic signals as needed to determine average levels. If applicable, the Result factor above can be applied to exposure calculations.

Factor for exposure calculation: 10 * Log_{10} (0.742 msec / 39.637 msec) = -17.28 dB

5.0 Occupied Bandwidth

Occupied bandwidth measurement was made on the EUT.

5.1 Test Procedure

The EUT is configured for best signal/power and the bandwidth then is measured. A recording of the results is included.

5.2 Test Criteria

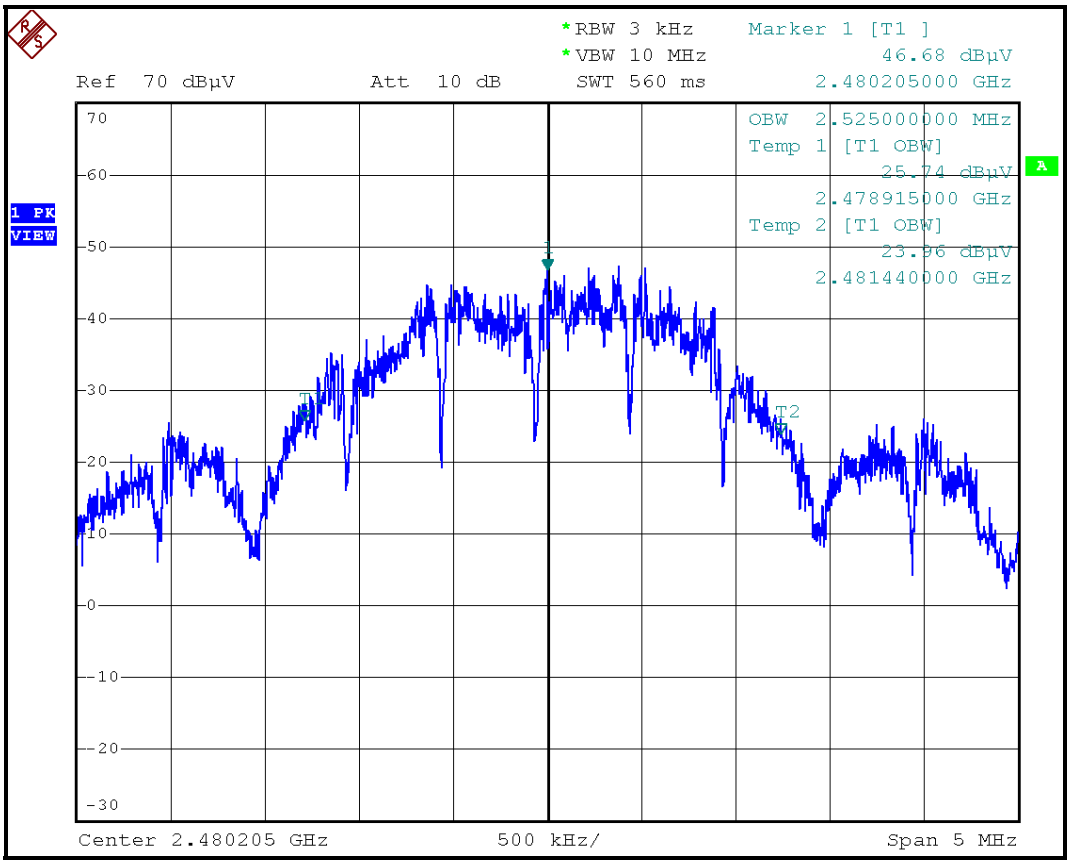
Section Reference	Parameter	Date(s)
2.1049, RSS210-Gen 4.6.3	Bandwidth, 20 dB	2013-05-20

5.3 Test Results

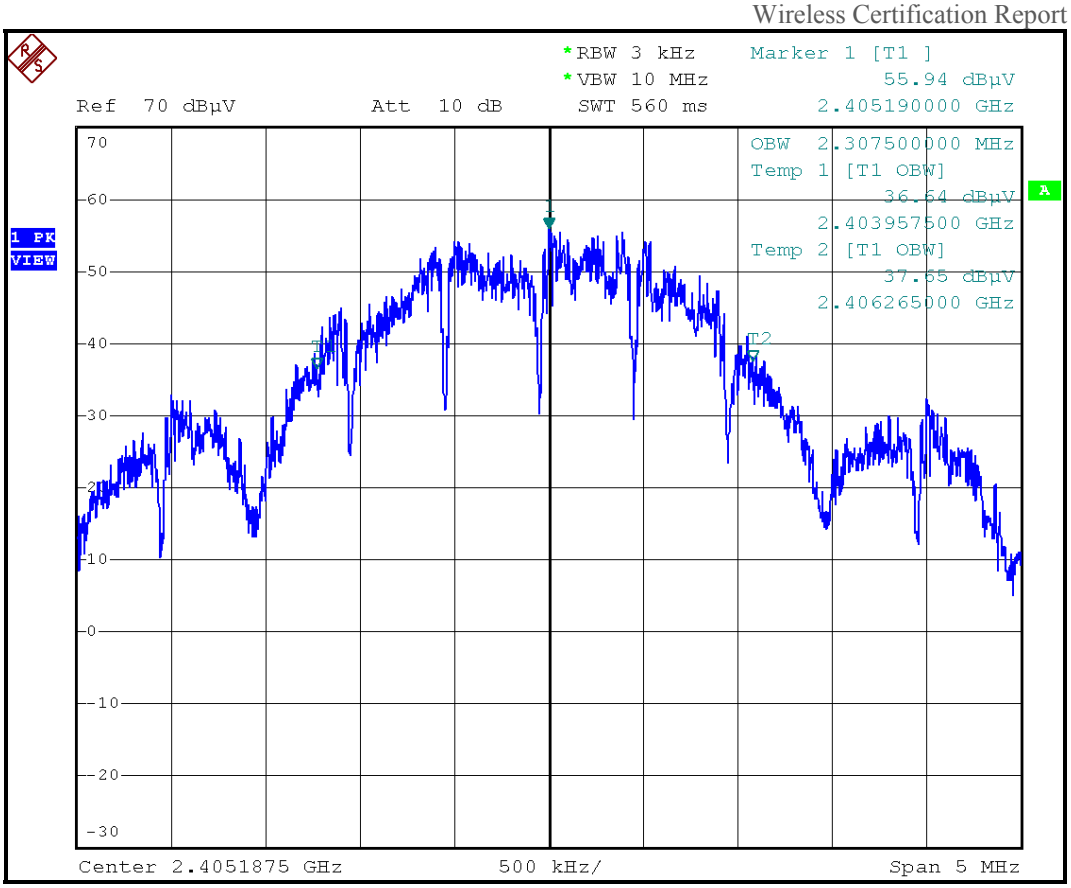
EUT was found to be in compliance with applicable requirements.

Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	**Maximum BW (kHz)**
2307.5	2235.0	2525.0	**2525.0**

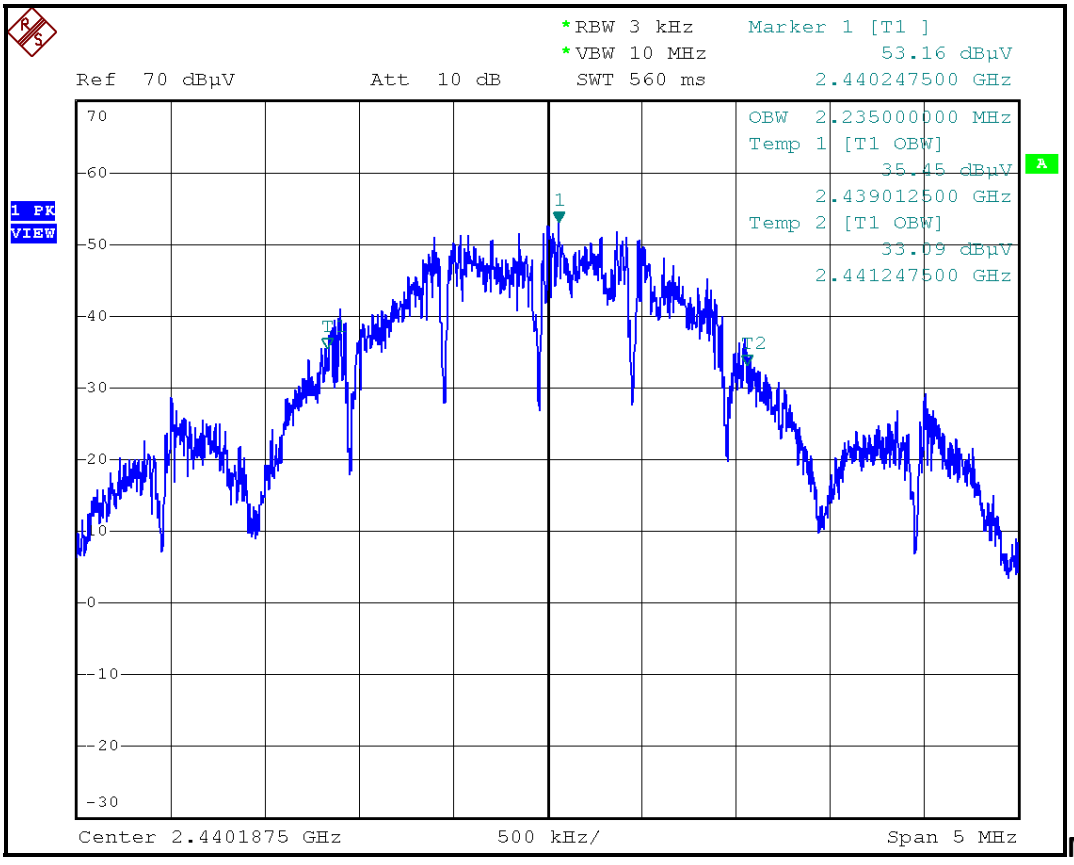
5.3.1 Bandwidth Plots



High Channel



Low Channel



Middle Channel

6.0 Band Edge

Measurements of transmitter emissions at the top and bottom band edge.

6.1 Test Procedure

EUT is placed into normal transmit operation on the nearest band edge channel and positioned for maximum emissions as determined during the power measurement. The spectrum analyzer is centered on the band edge frequency with span sufficient to include the peak of the adjacent fundamental signal. Measurement includes two standard bandwidths from the respective band edge. The relative difference in signal levels from fundamental to strongest signal at the band edge are then determined and compared to limits. If required, the band-edge marker-delta method of C63.4 is utilized.

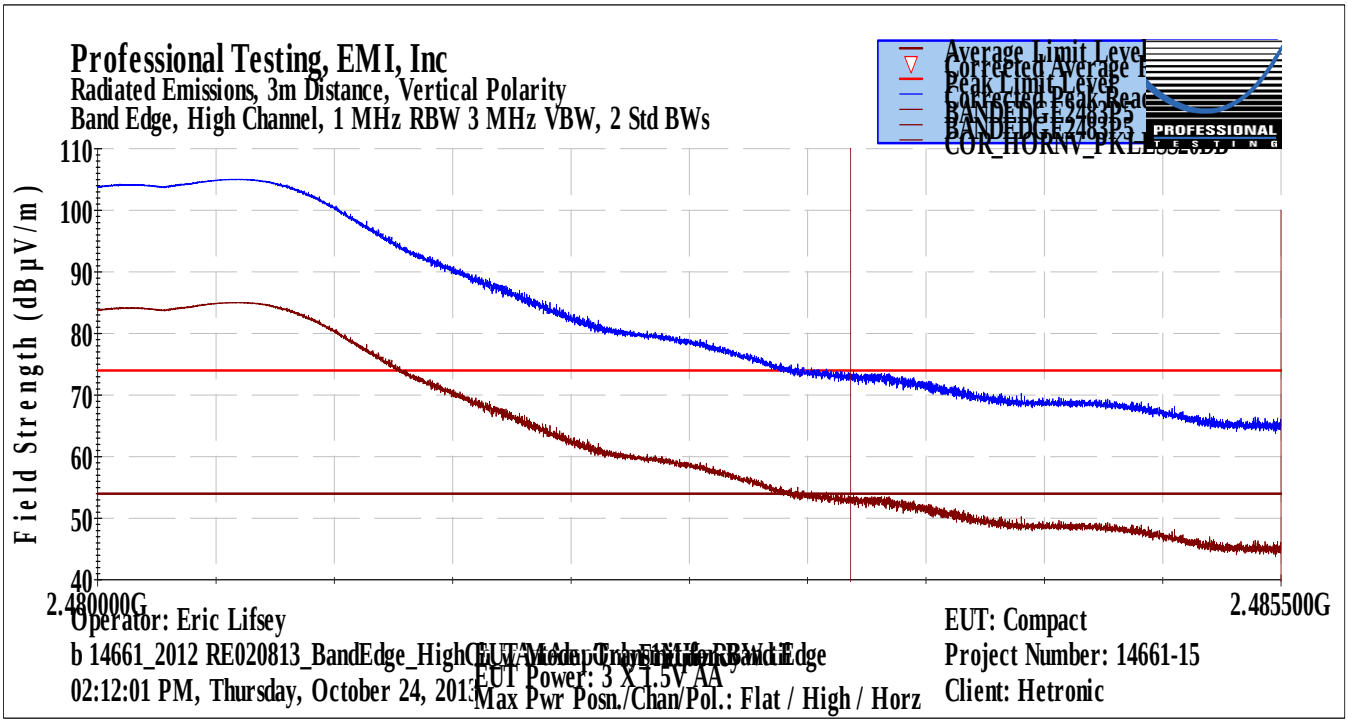
6.2 Test Criteria

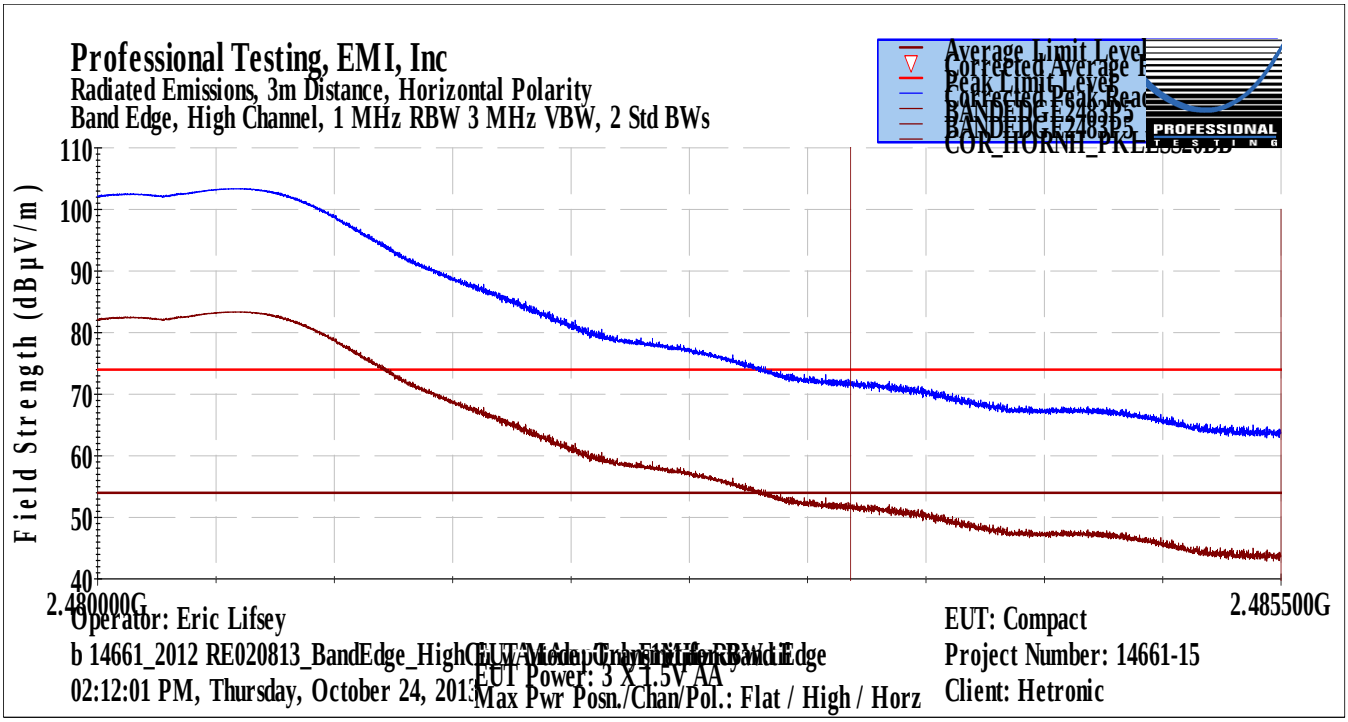
Section Reference	Parameter	Date(s)
15.205, 15.209	Emissions Outside Band	2013-08-03

6.3 Test Results

The EUT satisfied the criteria. Recorded data is presented below.

6.3.1 High Channel Band Edge

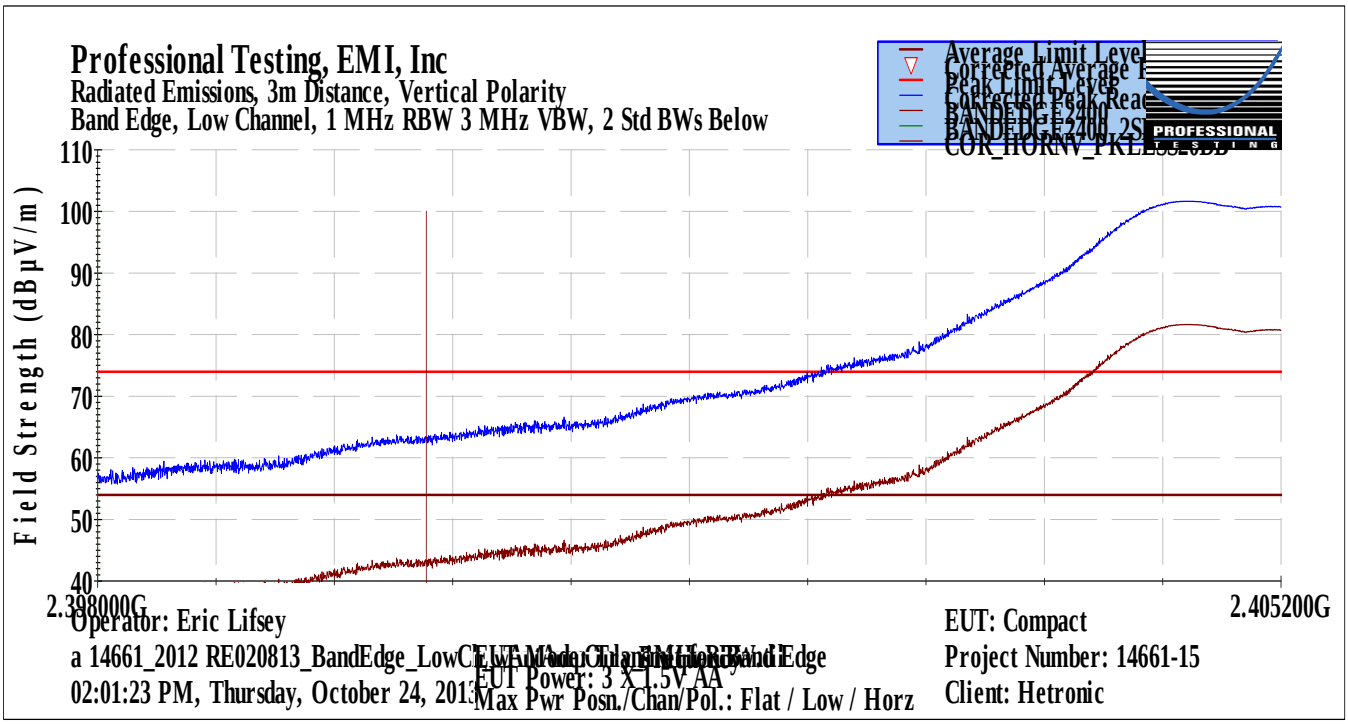


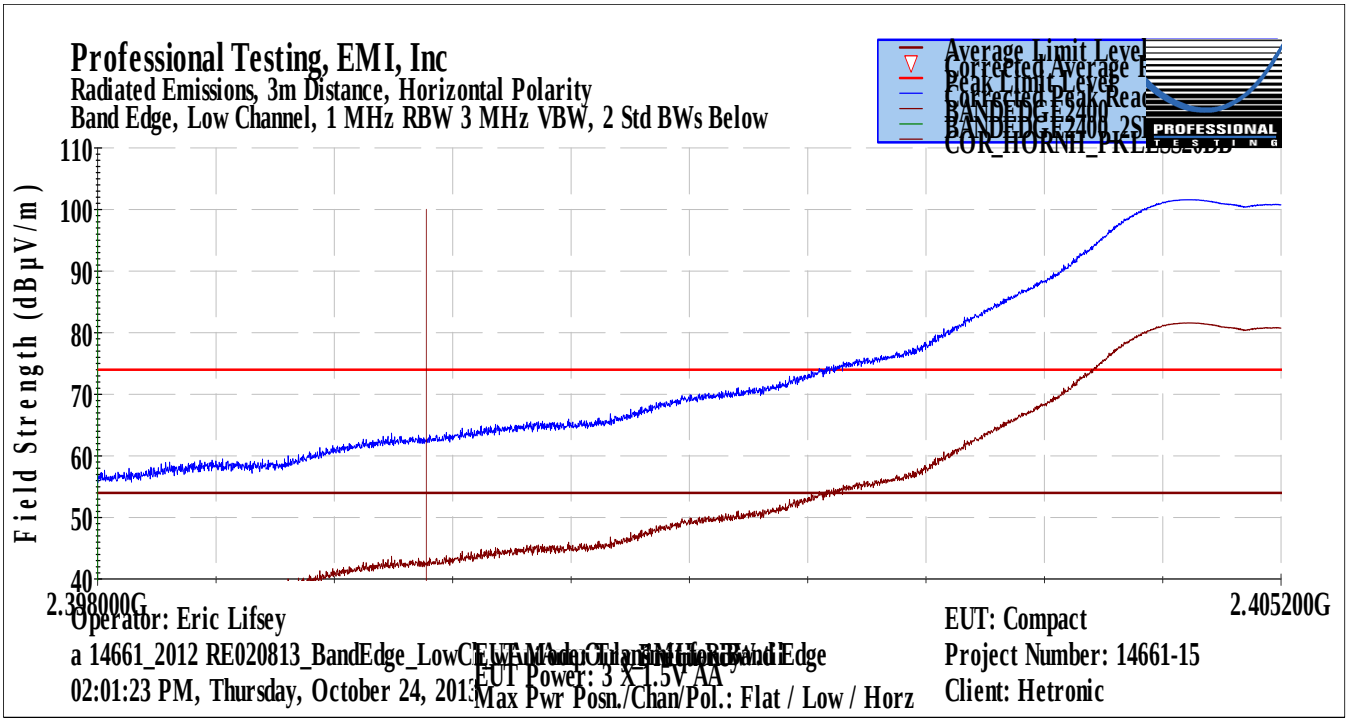


Measurements are of peak detection levels as the blue curve. The lower curve is calculated from peak by applying the duty cycle factor of -20 dB.

The curves are all under their respective limits with 1 MHz RBW. (0.1 dB margin worse case.) Consequently the delta procedure is not required.

6.3.2 Low Channel Band Edge





Measurements are of peak detection levels as the blue curve. The lower curve is calculated from peak by applying the duty cycle factor of -20 dB.

The curves are all under their respective limits with 1 MHz RBW. Consequently the delta procedure is not required.

7.0 Radiated Spurious Emissions Below 1 GHz

Out of band spurious/harmonic emissions measurements were performed on the EUT to determine compliance to 47 CFR, Part 15.

7.1 Test 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.

Spurious emissions below 1 GHz were measured with quasi-peak detection with a resolution bandwidth of 120 kHz. A diagram showing the test setup is given as Figure 6.1.1.

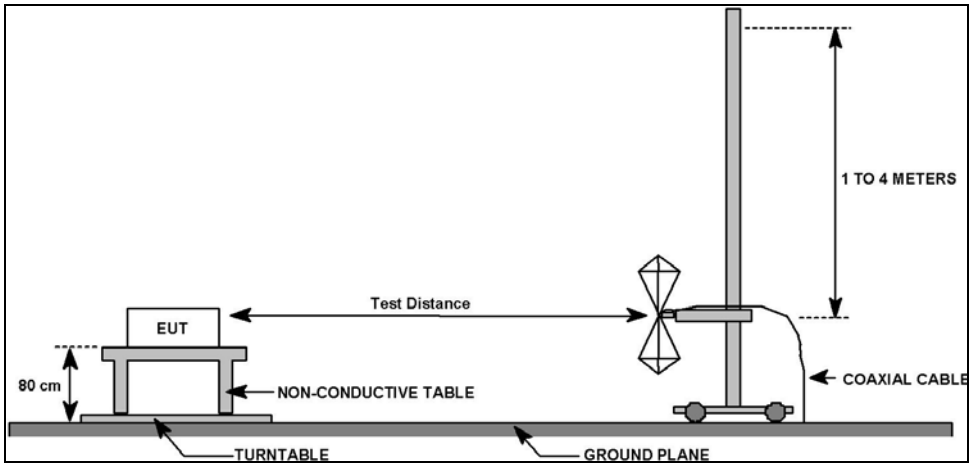


Figure 6.1.1: Field Strength of Spurious Emissions Test Setup

7.2 Test Criteria

Clause Subject	Section Number	Required?
Field Strength of Radiated Spurious/Harmonic Emissions	15.249, 15.209, RSS-210 A2.9(a) and (b)	Yes

7.3 Test Results

The EUT satisfied the criteria. Recorded data is presented below.

Table 7.3.1: Radiated Spurious Emissions, Below 1 GHz, Vertical Polarity

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38).		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	4/25/2013	EUT Serial #:	None
Customer:	Hetronic	EUT Part #:	None
Project Number:	14661-10	Test Technician:	Bob Redoutey
Purchase Order #:	None Listed	Supervisor:	Rob McCollough
Equip. Under Test:	Compact (2.4GHz)	Witness' Name:	None

Radiated Emissions Test Results Data Sheet									Page: 1 of 1
EUT Line Voltage:	4.5	VDC			EUT Power Frequency:	-	N/A		
Antenna Orientation:	Vertical				Frequency Range:	30MHz to 1GHz			
EUT Mode of Operation:					Transmit				
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
35.0491	10	173	1.93	Quasi-peak	23	9.82	29.5	-19.7	Pass
49.9843	10	24	3.61	Quasi-peak	23.7	3.932	29.5	-25.6	Pass
53.3503	10	17	4.09	Quasi-peak	23.7	3.586	29.5	-25.9	Pass
96.5815	10	318	1.89	Quasi-peak	27.5	7.986	33.1	-25.1	Pass
606.48	10	11	3.96	Quasi-peak	22.1	19.226	35.6	-16.4	Pass
893.748	10	102	2.21	Quasi-peak	21.4	24.635	35.6	-11.0	Pass

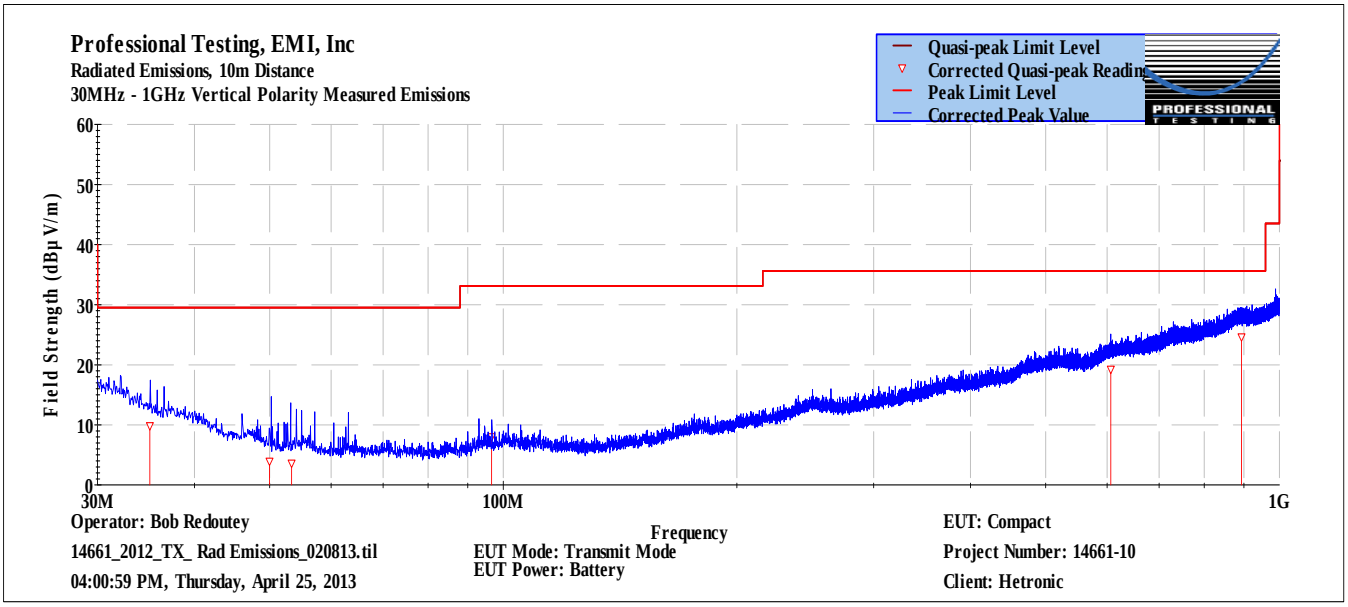
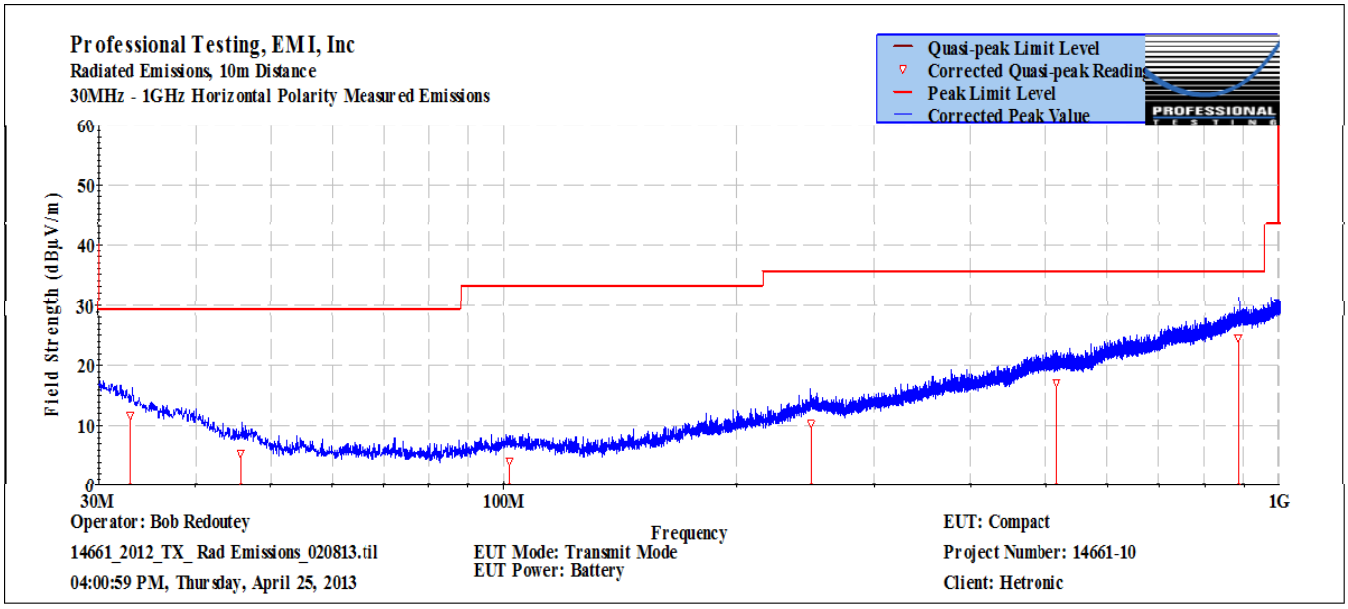


Table 7.3.2: Radiated Spurious Emissions, Below 1 GHz, Horizontal Polarity

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38).		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	4/25/2013	EUT Serial #:	None
Customer:	Hetronic	EUT Part #:	None
Project Number:	14661-10	Test Technician:	Bob Redoutey
Purchase Order #:	None Listed	Supervisor:	Rob McCollough
Equip. Under Test:	Compact (2.4GHz)	Witness' Name:	None

Radiated Emissions Test Results Data Sheet									Page: 1 of 1
EUT Line Voltage:	4.5 VDC				EUT Power Frequency:	- N/A			
Antenna Orientation:	Horizontal				Frequency Range:	30MHz to 1GHz			
EUT Mode of Operation:					Transmit				
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
32.9233	10	199	1.49	Quasi-peak	23.8	11.7	29.5	-17.8	Pass
45.6412	10	336	2.23	Quasi-peak	23.6	5.5	29.5	-24.0	Pass
101.598	10	240	1.38	Quasi-peak	23.3	4.2	33.1	-28.9	Pass
249.196	10	94	3.51	Quasi-peak	22.3	10.4	35.6	-25.2	Pass
517.27	10	176	2.38	Quasi-peak	22.3	17.2	35.6	-18.4	Pass
886.665	10	267	1.18	Quasi-peak	21.5	24.6	35.6	-11.0	Pass



8.0 Radiated Spurious Emissions Above 1 GHz

Out of band spurious/harmonic emissions measurements were performed on the EUT to determine compliance to 47 CFR, Part 15.

8.1 Test 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 1 meter from the measurement antenna.

Harmonic emissions above 1 GHz peak were measured with peak detection, a resolution bandwidth of 3 MHz, and at a distance of 3 meters. If peak measurements exceeded average limits, the peak limit was applicable and duty cycle factor was then applied for average level calculation. Emissions were investigated up to the 10th harmonic of the transmitter fundamental.

Non-harmonic spurious emissions must satisfy the average limit and the peak limit (20 dB above average). A diagram showing the test setup is given as Figure 5.1.1.

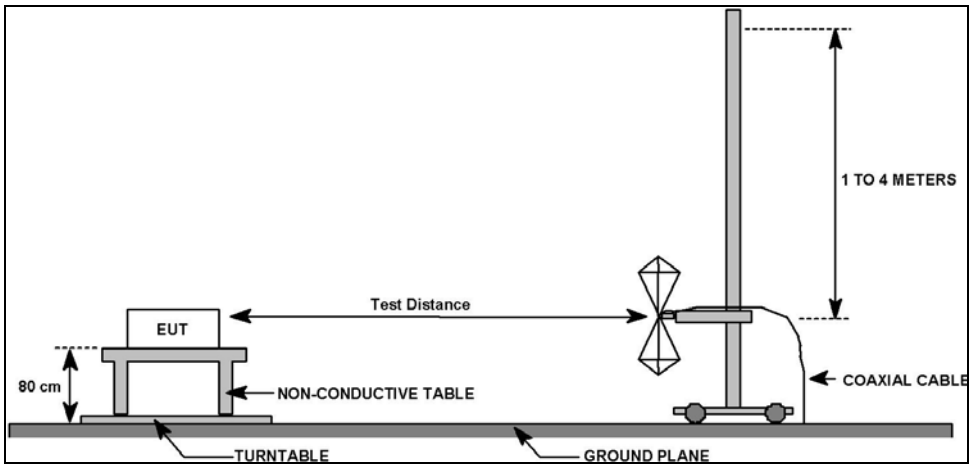


Figure 7.1.1: Field Strength of Spurious Emissions Test Setup

8.2 Test Criteria

Clause Subject	Section Number	Required?	Result
Field Strength of Radiated Spurious/Harmonic Emissions	15.249, 15.209	Yes	Pass

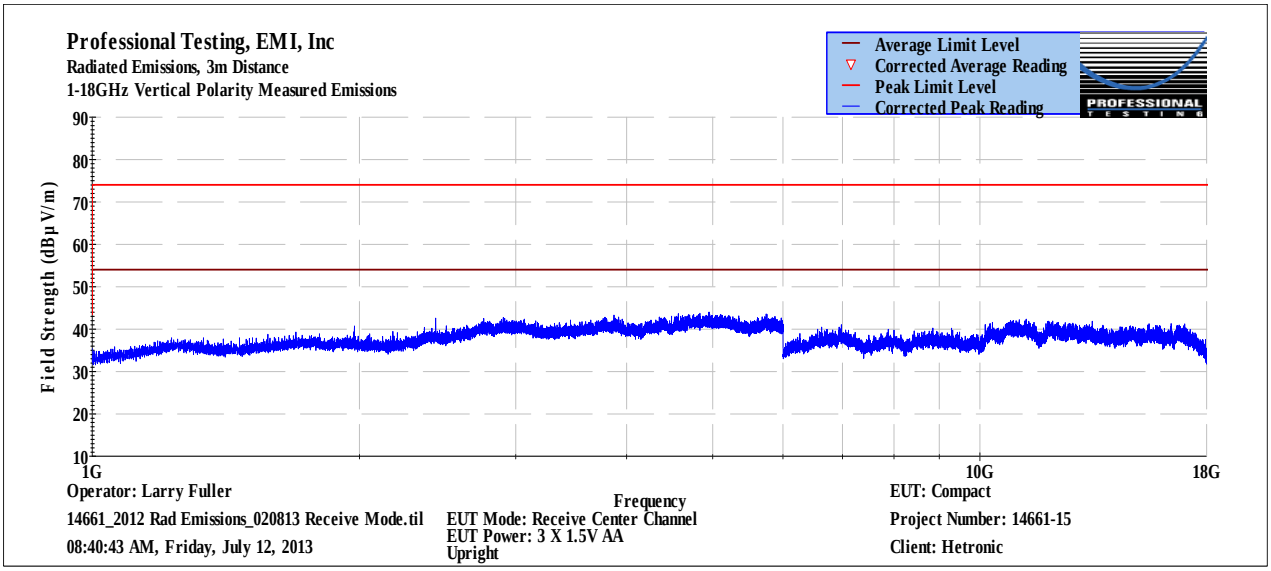
From timing measurements reported elsewhere in this report, the average level is -20 below the measured peak values. Therefore meeting the peak limit levels also complies with the average levels.

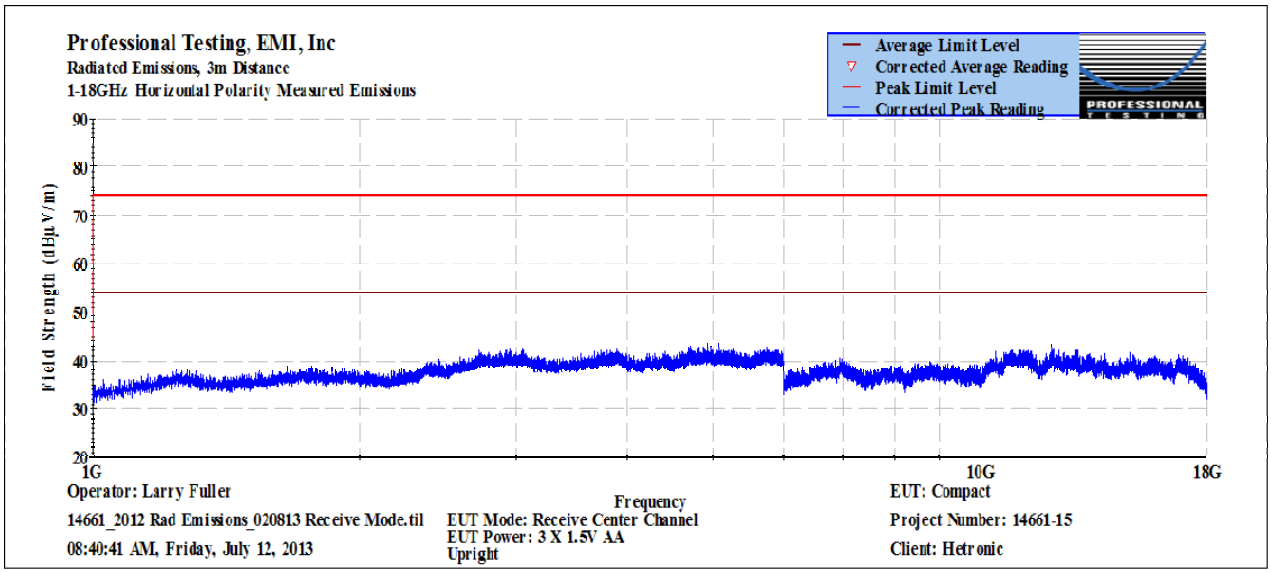
A pre-scan at 30 cm distance for 18 to 25 GHz found no signals to record.

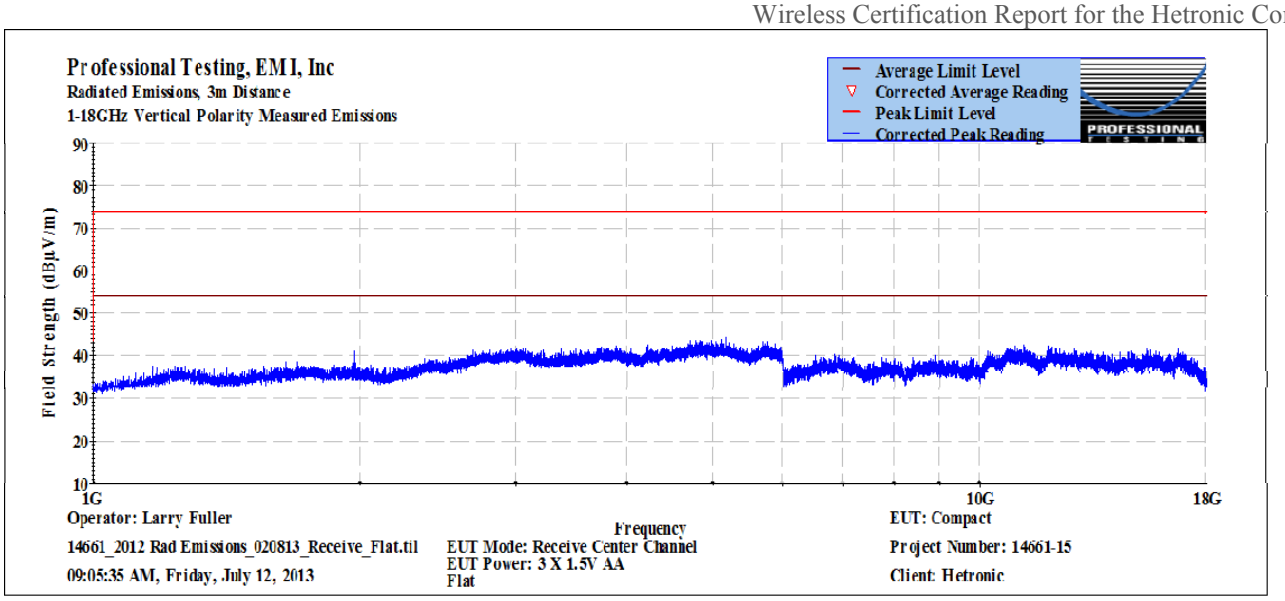
8.3 Test Results – Receive Mode

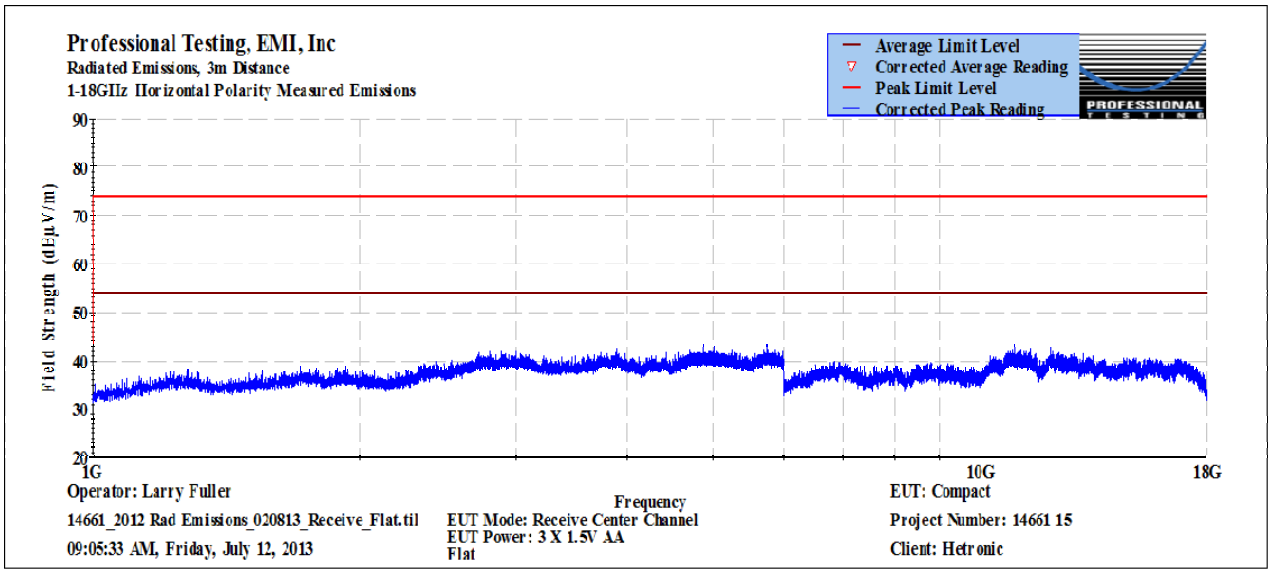
Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38).		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	7/12/2013	EUT Serial #:	Compact (2.4GHz)
Customer:	Hetronics	EUT Part #:	None
Project Number:	14661-10	Test Technician:	None
Purchase Order #:		Supervisor:	Larry Fuller
Equip. Under Test:	None Listed	Witness' Name:	Rob McCollough

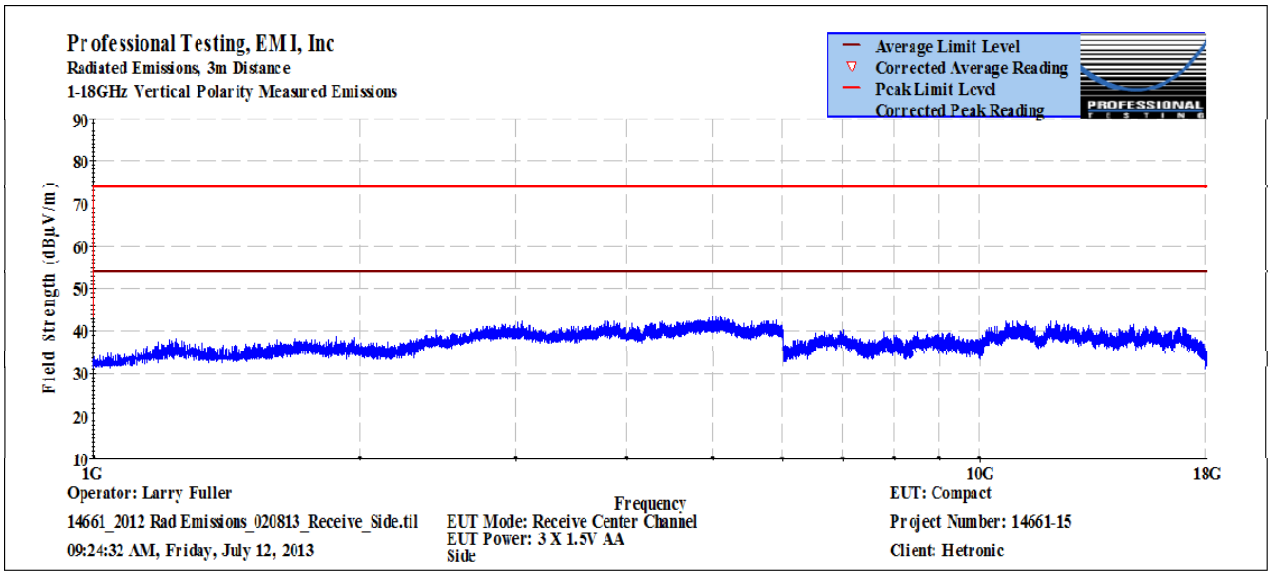
In the graphs below the detector mode is peak, resolution bandwidth 1 MHz, video bandwidth 3 MHz. The EUT was receiving on the center channel.

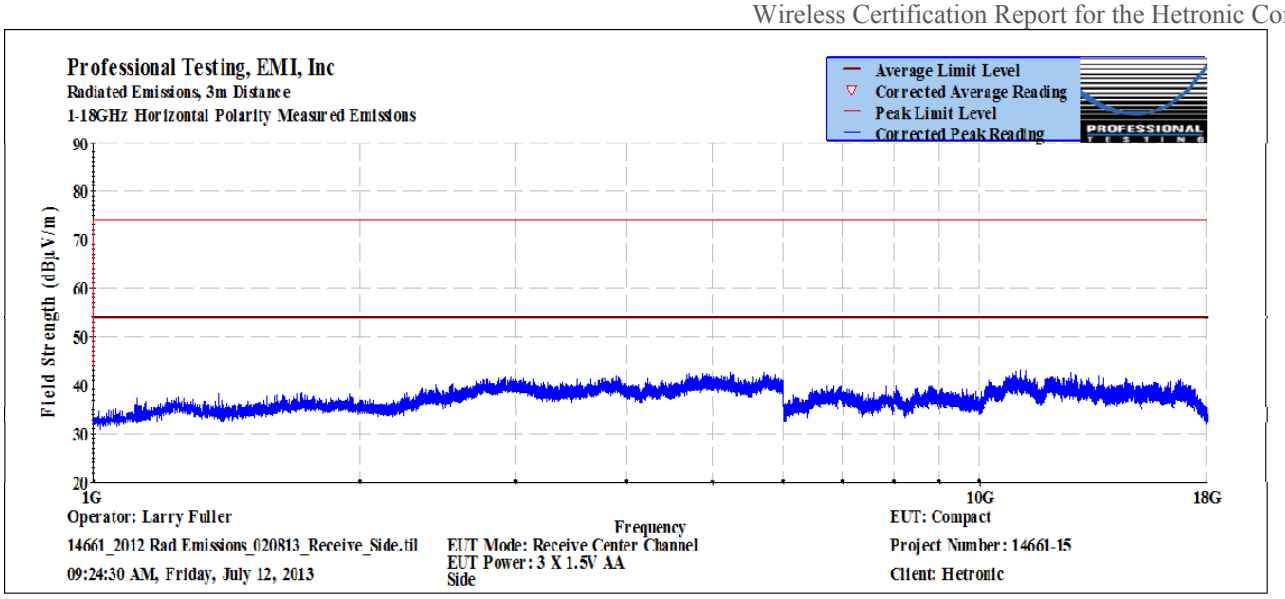





Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
1-18GHz Vertical Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL TESTING
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
10
1G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Receive_Flat.til
09:05:35 AM, Friday, July 12, 2013
EUT Mode: Receive Center Channel
EUT Power: 3 X 1.5V AA
Flat
EUT: Compact
Project Number: 14661-15
Client: Hetronic


Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
1-18GHz Horizontal Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL TESTING
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
1G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Receive_Flat.til
09:05:33 AM, Friday, July 12, 2013
EUT Mode: Receive Center Channel
EUT Power: 3 X 1.5V AA
Flat
EUT: Compact
Project Number: 14661 15
Client: Hetronic


Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
1-18GHz Vertical Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL TESTING
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
10
1G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Receive_Side.til
09:24:32 AM, Friday, July 12, 2013
EUT Mode: Receive Center Channel
EUT Power: 3 X 1.5V AA
Side
EUT: Compact
Project Number: 14661-15
Client: Hetronic

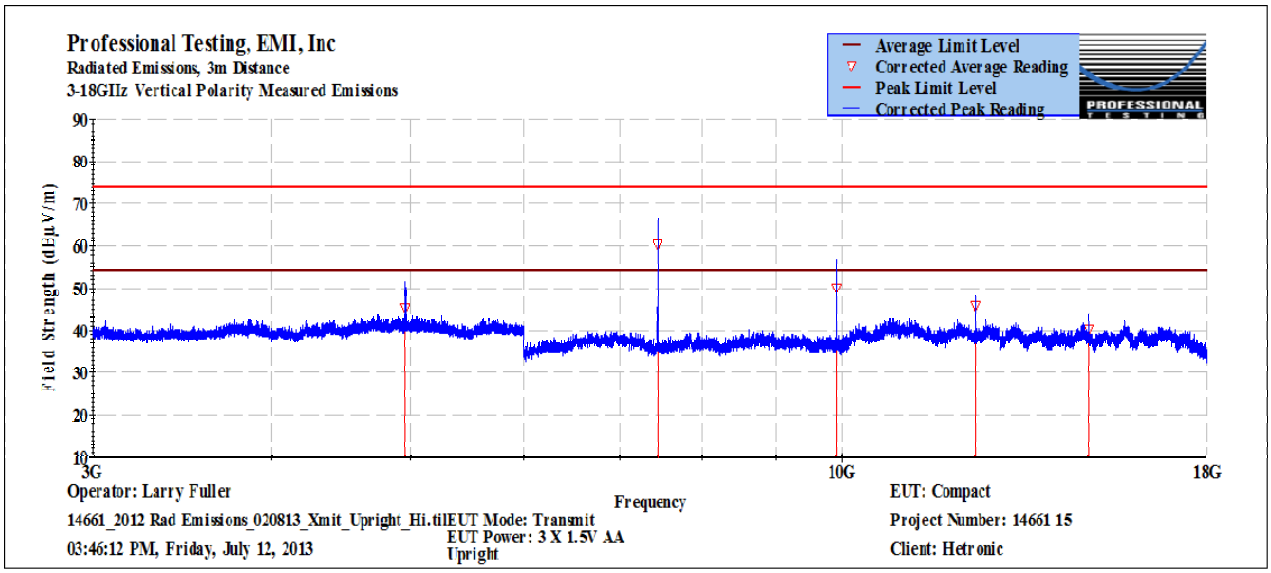

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
1-18GHz Horizontal Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL TESTING
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
1G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Receive_Side.til
09:24:30 AM, Friday, July 12, 2013
EUT Mode: Receive Center Channel
EUT Power: 3 X 1.5V AA
Side
EUT: Compact
Project Number: 14661-15
Client: Hetronic

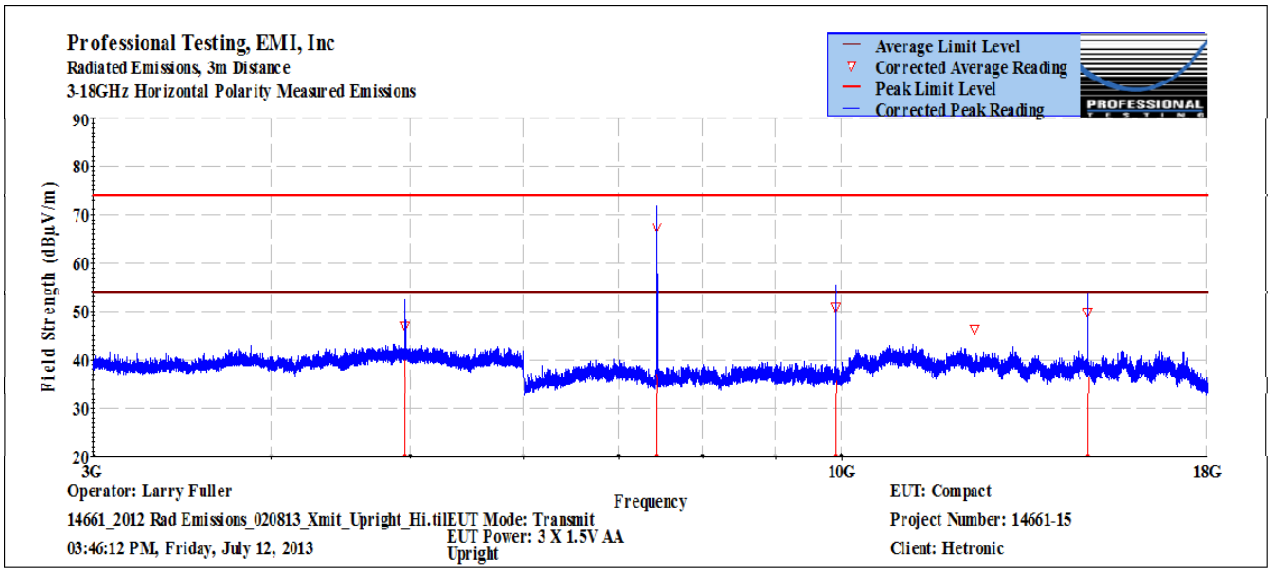
8.4 Test Results – Transmit Mode

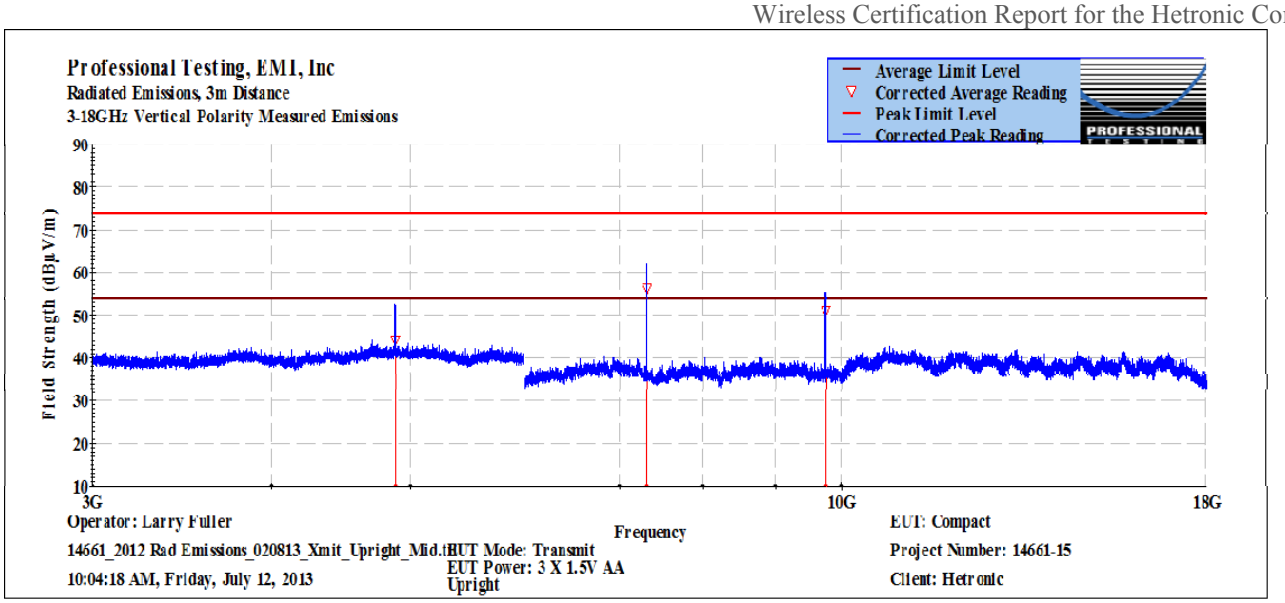
Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference, see §15.38).		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	7/12/2013	EUT Serial #:	Compact (2.4GHz)
Customer:	Hetronics	EUT Part #:	None
Project Number:	14661-10	Test Technician:	None
Purchase Order #:		Supervisor:	Larry Fuller
Equip. Under Test:	None Listed	Witness' Name:	Rob McCollough

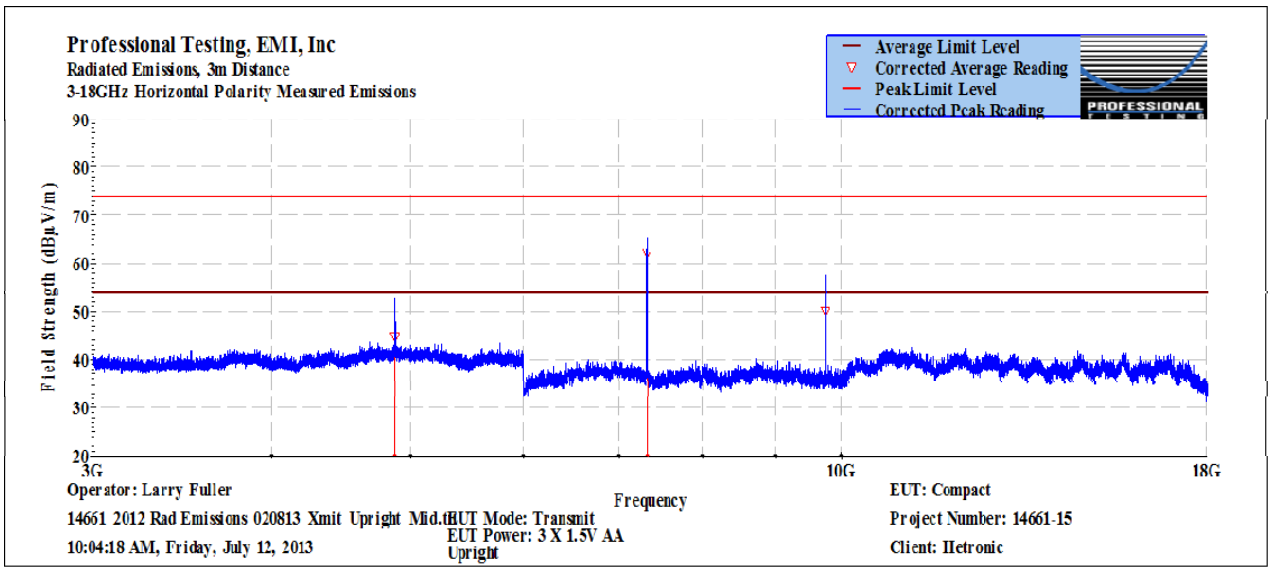
In all cases detector mode is peak, RBW 1 MHz, VBW 3 MHz. The applicable duty cycle factor for averaging is -20 dB. The EUT was transmitting on the indicated channel (Hi, Mid Lo).

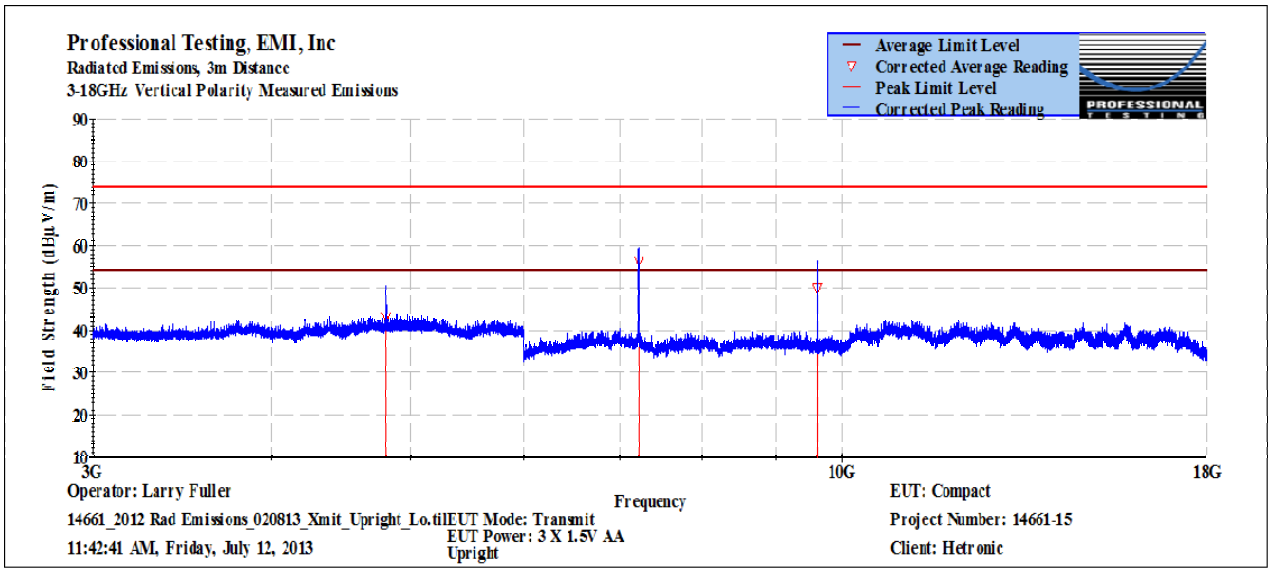
UPRIGHT:

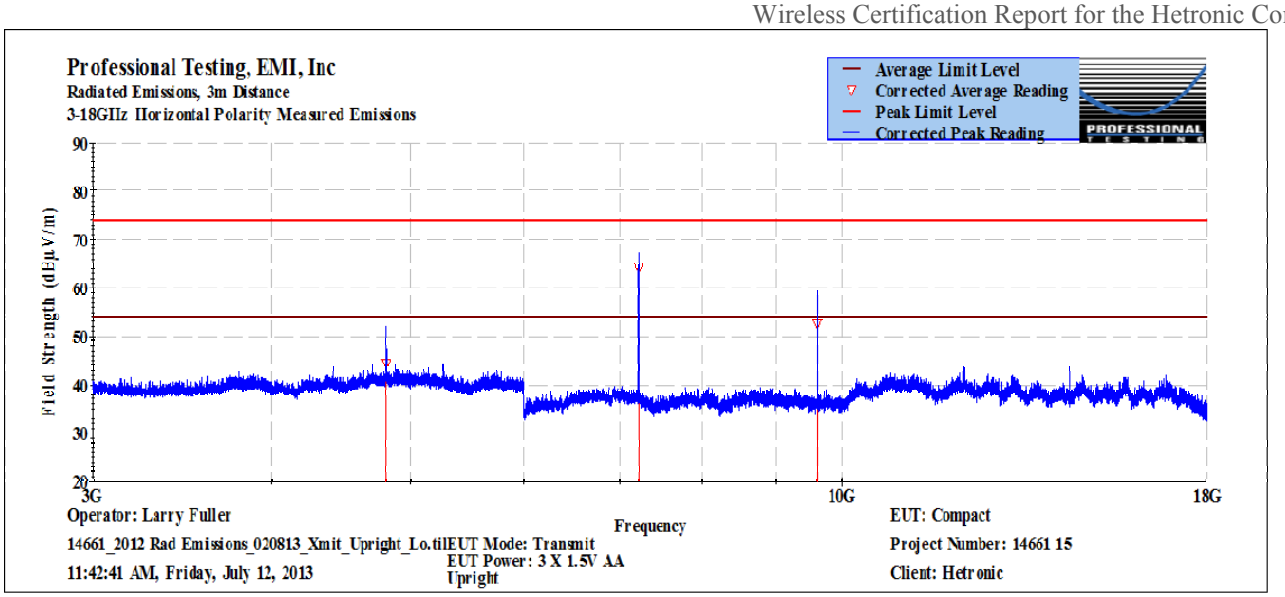




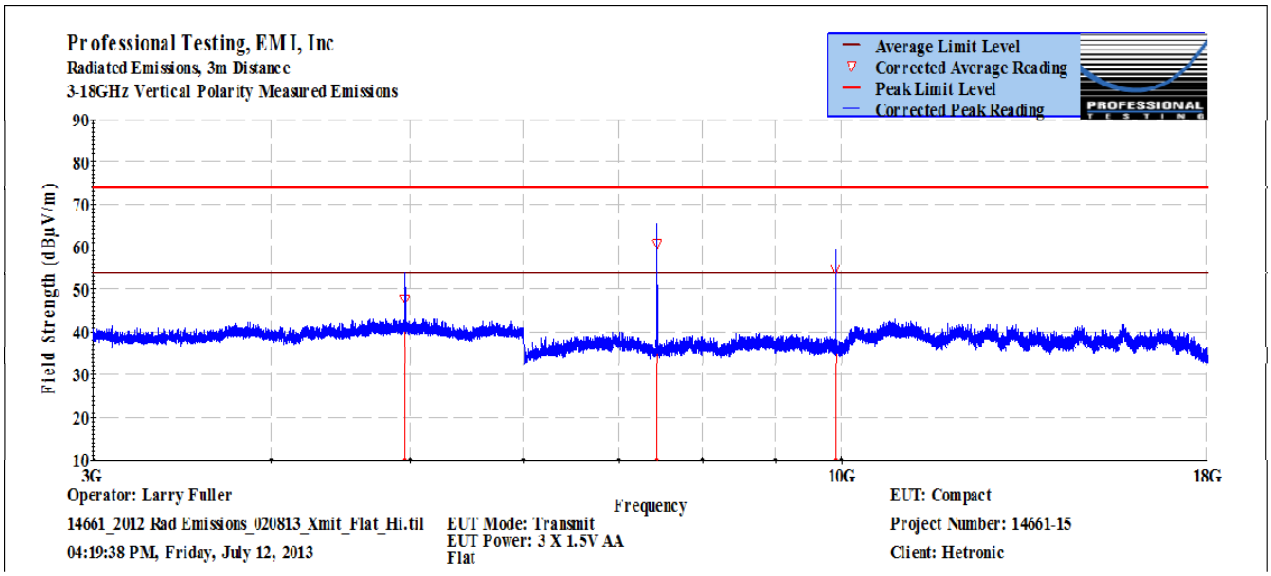

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Vertical Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
10
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Xmit_Upright_Mid.tl
10:04:18 AM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Upright
EUT: Compact
Project Number: 14661-15
Client: Hetronic

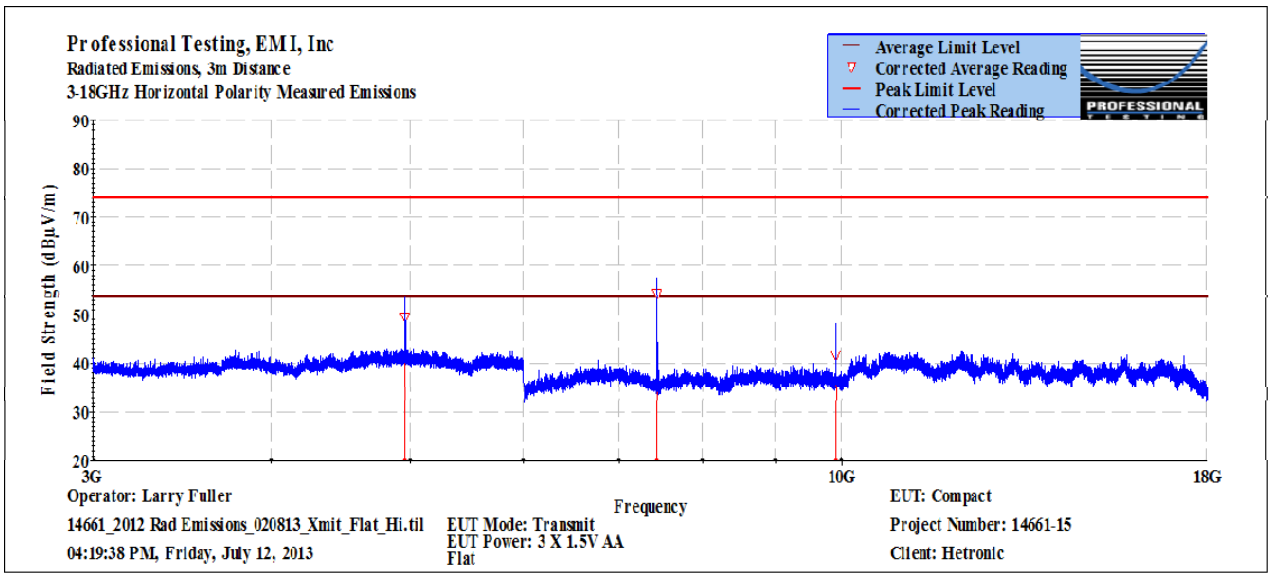

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Horizontal Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
3G
10G
18G
Frequency
Operator: Larry Fuller
14661 2012 Rad Emissions 020813 Xmit Upright Mid.tl
10:04:18 AM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Upright
EUT: Compact
Project Number: 14661-15
Client: Hetronic

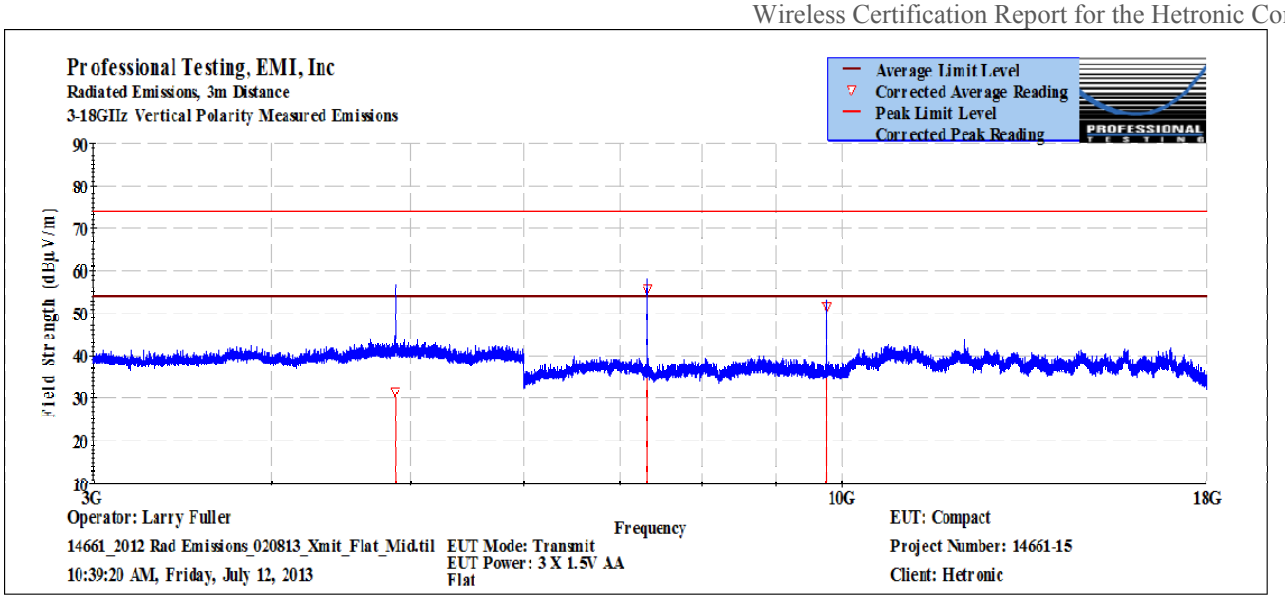

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Vertical Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
10
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Xmit_Upright_Lo.tl
11:42:41 AM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Upright
EUT: Compact
Project Number: 14661-15
Client: Hetronic

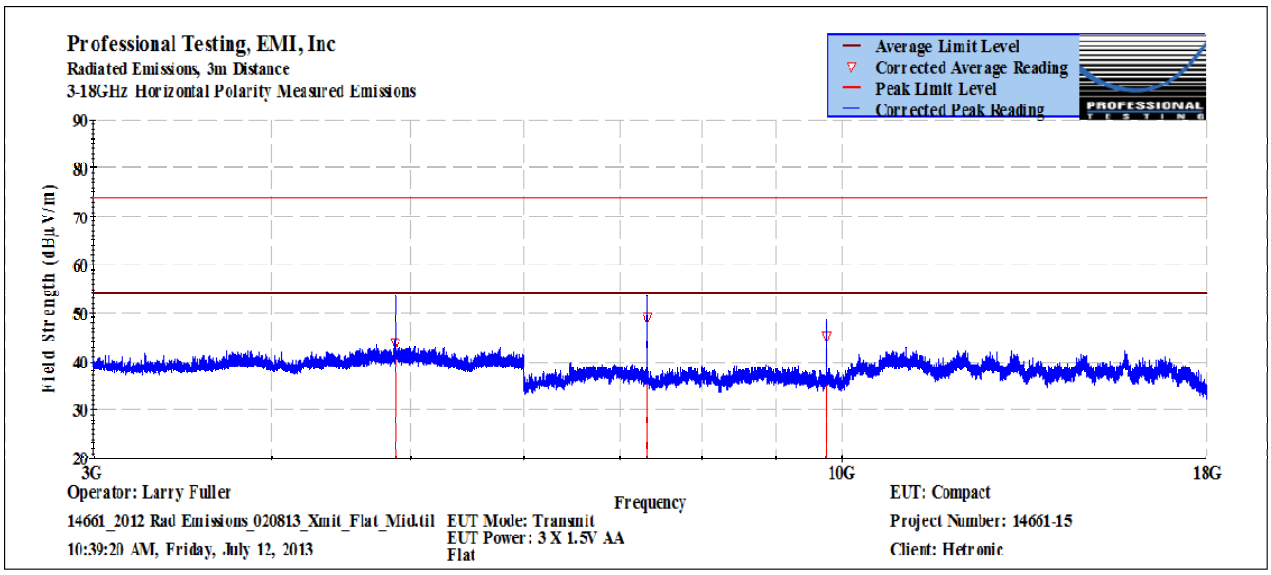

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Horizontal Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL TESTING
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Xmit_Upright_Lo.til
11:42:41 AM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Upright
EUT: Compact
Project Number: 14661 15
Client: Hetronic

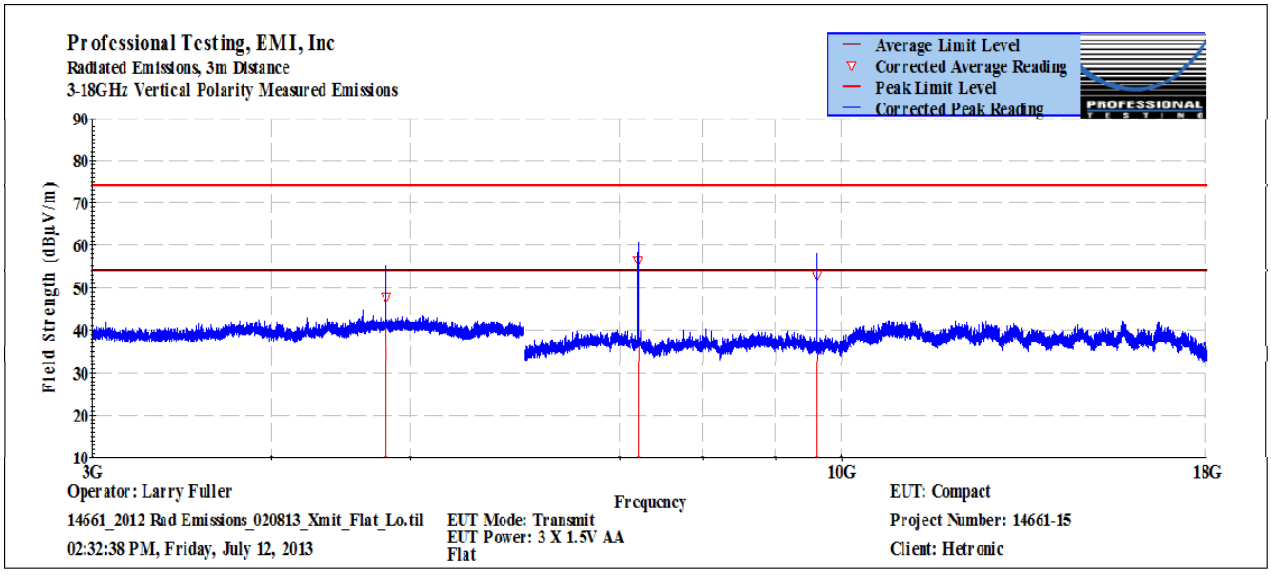
FLAT:

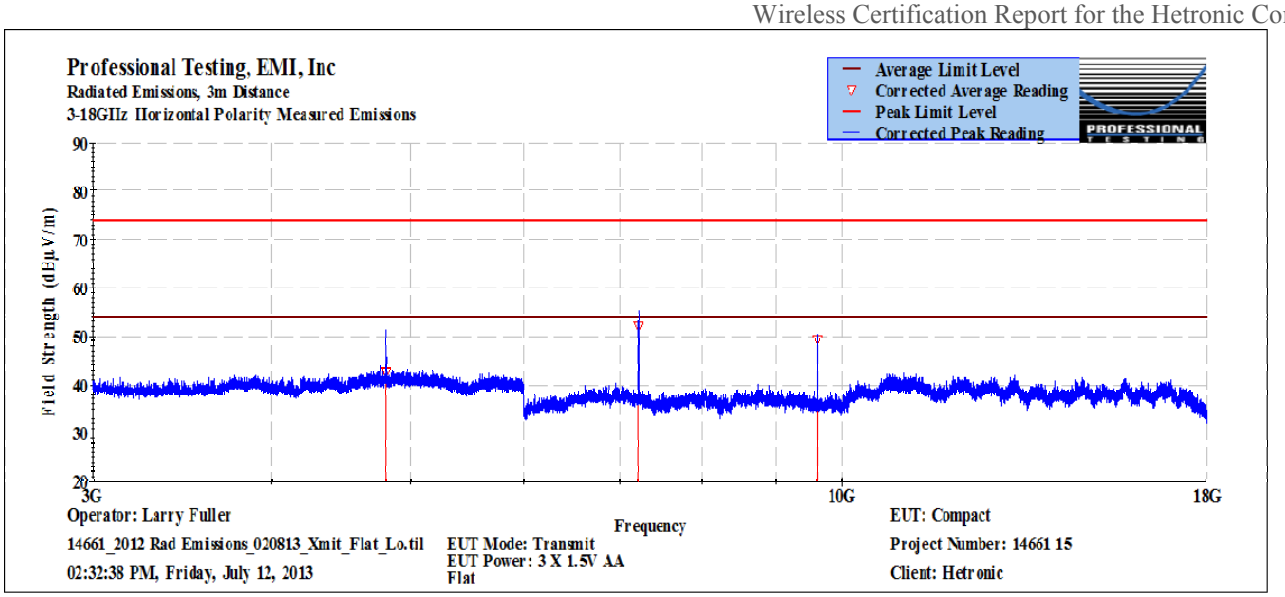

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Vertical Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL TESTING
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
10
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Xmit_Flat_Hi.til
04:19:38 PM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Flat
EUT: Compact
Project Number: 14661-15
Client: Hetronic


Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Horizontal Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL TESTING
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Xmit_Flat_Hi.til
04:19:38 PM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Flat
EUT: Compact
Project Number: 14661-15
Client: Hetronic

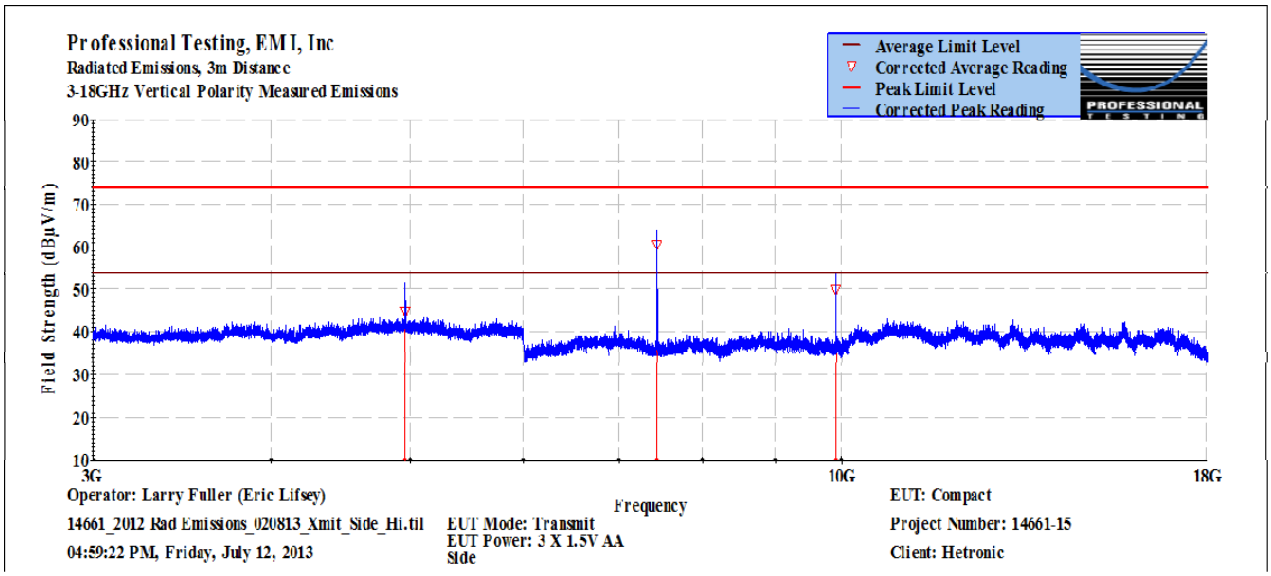

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Vertical Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
10
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions 020813_Xmit_Flat_Mid.til
10:39:20 AM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Flat
EUT: Compact
Project Number: 14661-15
Client: Hetronic

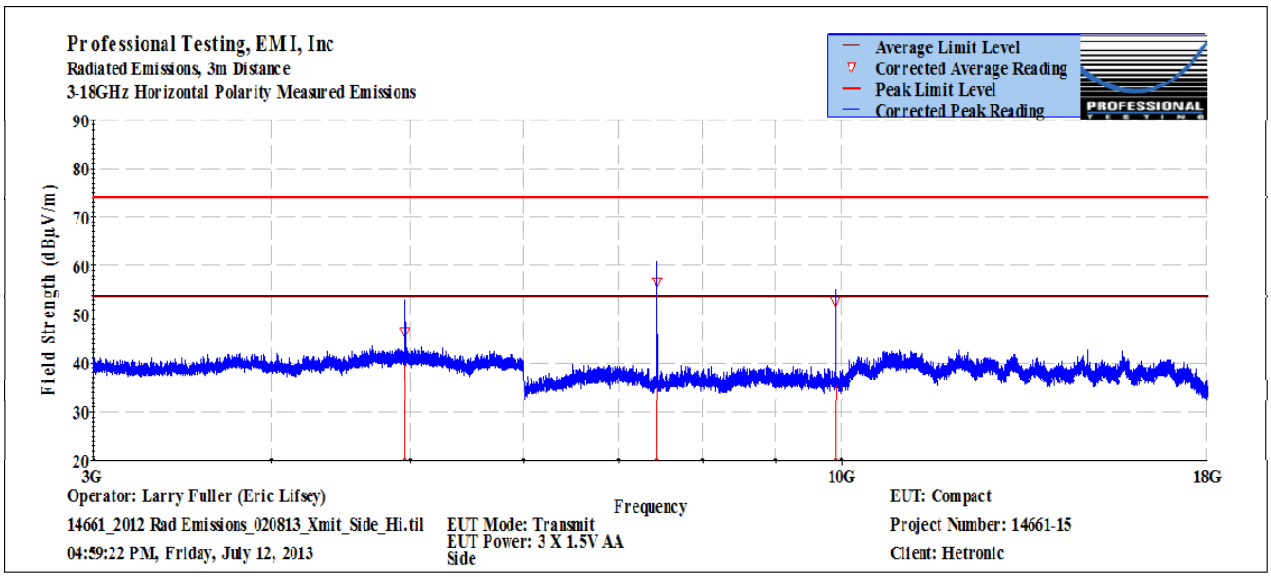

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Horizontal Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions 020813_Xmit_Flat_Mid.til
10:39:20 AM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Flat
EUT: Compact
Project Number: 14661-15
Client: Hetronic

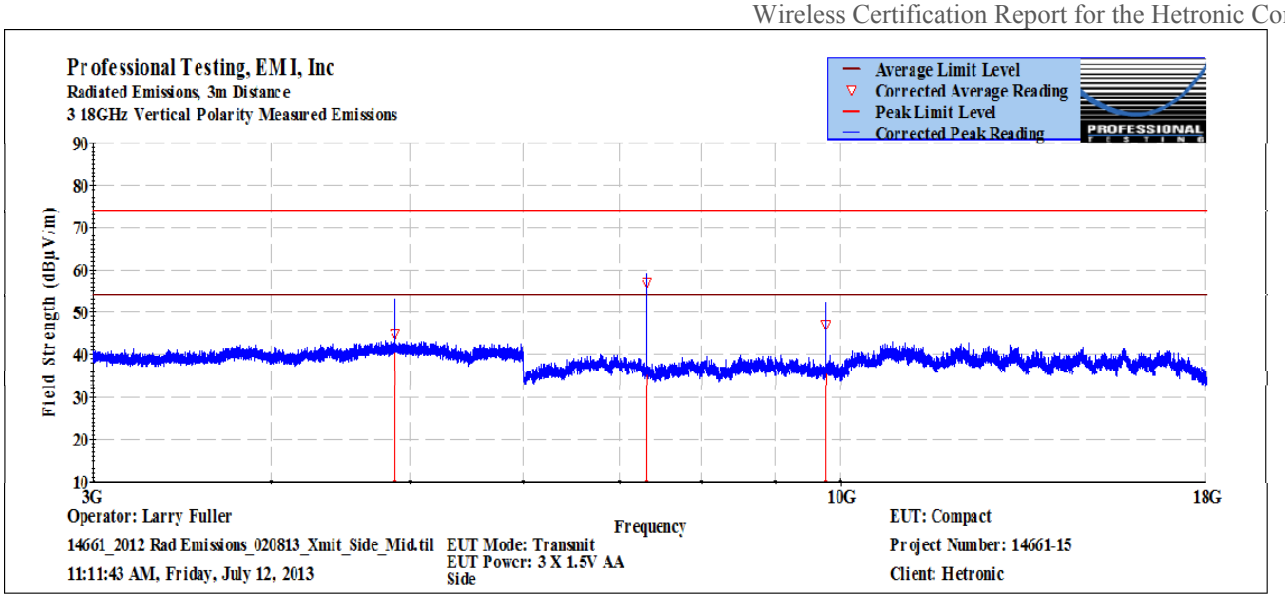

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Vertical Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
10
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions 020813_Xmit_Flat_Lo.til
02:32:38 PM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Flat
EUT: Compact
Project Number: 14661-15
Client: Hetronic

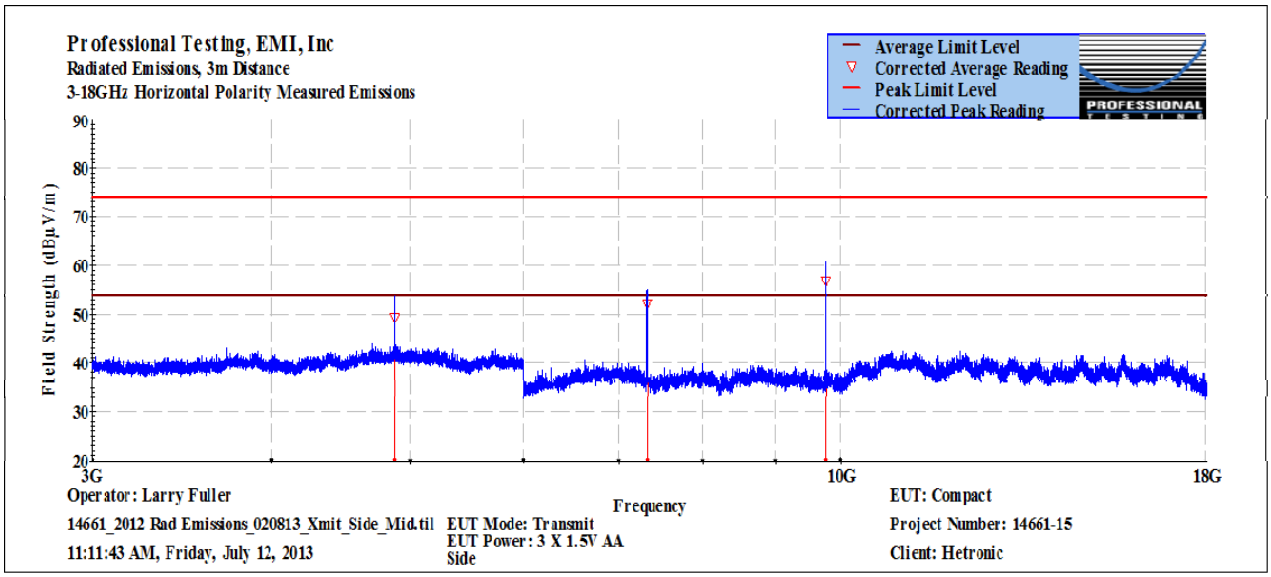

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Horizontal Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Xmit_Flat_Lo.til
02:32:38 PM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Flat
EUT: Compact
Project Number: 14661 15
Client: Hetronic

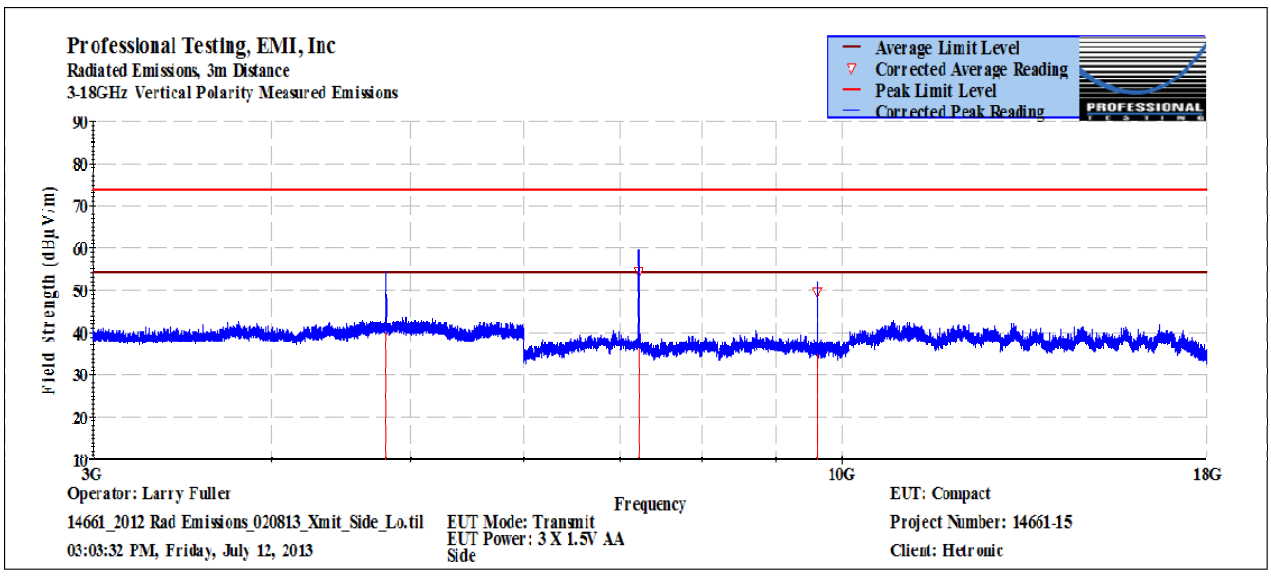
SIDE:

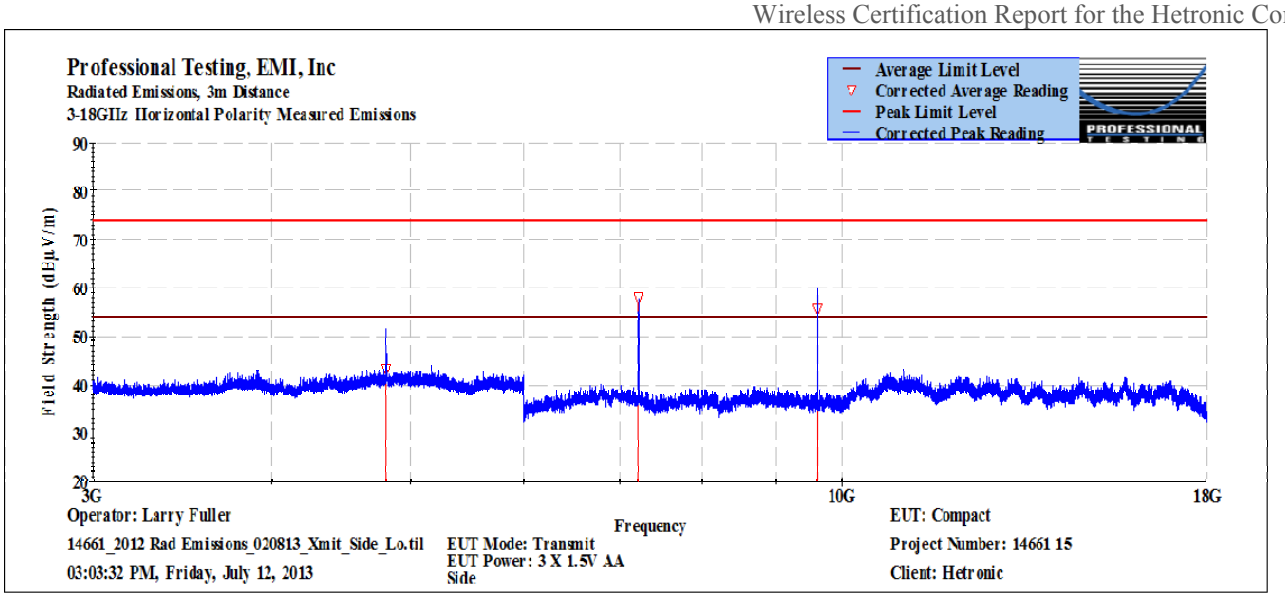

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Vertical Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
10
3G
10G
18G
Frequency
Operator: Larry Fuller (Eric Lifsey)
14661_2012 Rad Emissions_020813_Xmit_Side_Hi.til
04:59:22 PM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Side
EUT: Compact
Project Number: 14661-15
Client: Hetronic


Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Horizontal Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
3G
10G
18G
Frequency
Operator: Larry Fuller (Eric Lifsey)
14661_2012 Rad Emissions_020813_Xmit_Side_Hi.til
04:59:22 PM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Side
EUT: Compact
Project Number: 14661-15
Client: Hetronic


Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Vertical Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
10
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Xmit_Side_Mid.til
11:11:43 AM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Side
EUT: Compact
Project Number: 14661-15
Client: Hetronic


Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Horizontal Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Xmit_Side_Mid.til
11:11:43 AM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Side
EUT: Compact
Project Number: 14661-15
Client: Hetronic


Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Vertical Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
10
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions_020813_Xmit_Side_Lo.til
03:03:32 PM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Side
EUT: Compact
Project Number: 14661-15
Client: Hetronic


Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
3-18GHz Horizontal Polarity Measured Emissions
Average Limit Level
Corrected Average Reading
Peak Limit Level
Corrected Peak Reading
PROFESSIONAL
Field Strength (dBµV/m)
90
80
70
60
50
40
30
20
3G
10G
18G
Frequency
Operator: Larry Fuller
14661_2012 Rad Emissions 020813_Xmit_Side_Lo.til
03:03:32 PM, Friday, July 12, 2013
EUT Mode: Transmit
EUT Power: 3 X 1.5V AA
Side
EUT: Compact
Project Number: 14661 15
Client: Hetronic

9.0 Antenna Construction Requirements

The design was investigated for meeting the antenna construction requirements of the applicable rules.

9.1 Procedure

A direct examination of the antenna construction is performed and compared to rule criteria that prevents wireless device antennas from being modified by end users in ways that would void their authorization to use the device.

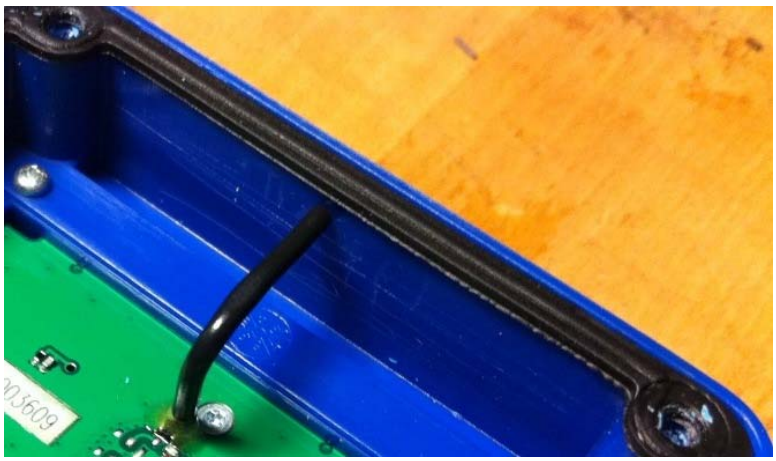
9.2 Criteria

Clause Subject	Section Number	Required?
Antenna Construction	15.203, RSS-Gen 7.1.2	Yes

9.3 Results

Antenna Manufacturer and Model	Specifications	
Hetronic Made from wire as specified in factory assembly instructions.	**Dimensions:**	D = 0.5 ~ 1.0 mm L = 25 mm Installed with gradual 90 degree bend at mid-point.

Antenna for this device is a 25 mm long insulated wire assembled into the device at the factory. It is located behind the Start and Stop button and oriented to the centerline from top to bottom of the enclosure. To fit the available space a 90 degree bend is applied at the center with the tip of the antenna touching the adjacent surface of the plastic enclosure. (When held upright this surface is the top.) The antenna is not exposed to the outside of the enclosure.



Antenna Construction Photo (Black wire from circuit board.)

- The antenna is internal only to the device.
- The antenna is a soldered-on factory made component on the transmitter circuit board.
- Antenna gain is estimated as 1.7 dBi (approximately ¼ wavelength radiator).
- There is no antenna connector.

The antenna design meets the requirements of the rules.

10.0 Equipment Lists

10.1 Equipment for Spurious Radiated Emissions below 1 GHz

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference,		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	4/25/2013	EUT Serial #:	None
Customer:	Hetronic	EUT Part #:	None
Project Number:	14661-10	Test Technician:	Bob Redoutey
Purchase Order #:	None Listed	Supervisor:	Rob McCollough
Equip. Under Test:	Compact (2.4GHz)	Witness' Name:	None

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

Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1509A	Braden	N/A	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	7/27/2013
1890	HP	8447F	Preamp/Amp, 9kHz-1300MHz, 28/25dB	3313A05298	1/8/2014
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz	00135454	7/24/2013
C027	N/A	RG214	Cable Coax, N-N, 25m	none	9/7/2013
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
Rental	Agilent	E4440A-239	Spectrum Analyzer, 3 Hz - 26.5 GHz	203523	11/19/2014
1509B	Braden	N/A	TDK 10M Chamber, VSWR > 1 GHz	DAC-012915-005	5/8/2013
1594	Miteq	AFS44-00102650	Amplifier, 1-26.5GHz, 42dB	none	10/15/2013
2004	Miteq	AFS44-00101800-25-10P-44	Amplifier, 40dB, .1-18GHz	0	11/26/2013
C030	N/A	0	Cable Coax, N-N, 30m	none	9/7/2013
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	00110313	2/4/2014
1325	EMCO	1050	Controller, Antenna Mast	9003-1461	N/A

10.2 Equipment for Spurious Radiated Emissions 1 GHz to 18 GHz

Professional Testing, EMI, Inc.			
Test Method:	**ANSI C63.4–2003: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" (incorporated by reference,**		
In accordance with:	**FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits**		
Section:	**15.209**		
Test Date(s):	**7/12/2013**	**EUT Serial #:**	**Compact (2.4GHz)**
Customer:	**Hetronics**	**EUT Part #:**	**None**
Project Number:	**14661-10**	**Test Technician:**	**None**
Purchase Order #:		**Supervisor:**	**Larry Fuller**
Equip. Under Test:	**None Listed**	**Witness' Name:**	**Rob McCollough**

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

Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1509A	HP	11970Q	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	7/27/2013
1890	HP	8447F	Preamp/Amp, 9kHz-1300MHz, 28/25dB	3313A05298	1/8/2014
Rental	Rohde	E4440A-239	Spectrum Analyzer, 3 Hz - 26.5 GHz	203523	11/19/2014
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz	00135454	7/29/2013
1327	EMCO	1050	Controller, Antenna Mast	none	N/A
C030	N/A	LMR-400	Cable Coax, N-N, 2m	none	N/A
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	00110313	1/30/2014
1325	EMCO	1050	Controller, Antenna Mast	9003-1461	N/A
1594	Miteq	AFS44-00102650	Amplifier, 1-26.5GHz, 42dB	none	10/15/2013
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, .1-18GHz	0	11/26/2013

10.3 Equipment for Timings, Bandwidth, and Spurious Pre-scan 18 to 25 GHz

The following equipment was used to measure transmitter timings, bandwidth, and pre-scan the radiated spurious emissions in the range of 18 to 25 GHz.

Asset #	Manufacturer	Model #	Description	Calibration Due
0582	EMCO	3115	Ridge Guide Antenna	2014-02-14
1594	Agilent	83017A	Microwave Preamplifier (preamp 1)	2014-09-24
1342	Rohde & Schwarz	FSP-30	Spectrum Analyzer	2015-01-29
C059	Pasternack		Cable	2014-02-06
C249	Pasternack		Cable	2014-02-06
C250	Pasternack		Cable	2014-02-06
1542	AH Systems	SAS-572	Horn Antenna, Standard Gain, 20 dB	Not Required

11.0 Maximum Permissible Exposure Evaluation

The results of power measurement and intended use/proximity are compared against the requirements for safety of RF exposure.

11.1 Criteria

Section Reference	Date
2.1091, FCC 447498 D01 General RF Exposure Guidance v05, RSS-102	2013-08-05

11.2 Procedure

Using measurement of peak power and intended application, determine the permissible exposure level or whether additional exposure tests (SAR) are indicated. Justify conclusion for selected exposure area and separation distance.

11.3 Results

Antenna for this device is a 25 mm long insulated wire assembled into the device at the factory. It is located behind the Start and Stop button and oriented to the centerline from top to bottom of the enclosure. To fit properly a 90 degree bend is applied at the center with the tip of the antenna touching the adjacent surface of the enclosure. (When held upright this surface is the top.) The antenna is not exposed to the outside of the enclosure.

The exposure is determined by taking the measured peak power level and subtracting the transmit duty cycle, based on power, then calculating the source power. Source power is then adjusted for antenna gain and compared to the exposure limit based on frequency and distance to user.

Corrected Level (Measured Peak Level)	Less the Power Based Duty Cycle Factor	Corrected Level (Measured Peak Level less Duty Cycle Factor)
106.16 dBµV/m	10 * Log_{10} (0.742 msec / 39.637 msec) = -17.28 dB	88.88 dBµV/m

Measured Field Strength	At Distance	Calculated Source Power	Wire Antenna Estimated Gain	Calculated ERP
88.88 dBµV/m	3 m	0.1413 mW	3.0 dBi*	0.2826 mW

* Applied a conservative 3 dB (vs. 1.7 dipole gain) representing double power, making the power calculation simpler.

FCC 447498 D01 General RF Exposure Guidance v05; Appendix A, Table Page 25, SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm	Distance Selected Column	Operating Frequency Row	SAR Exclusion Threshold From Table
For Operating Frequency: 2.4000 to 2.4835 GHz	5 mm	2450 MHz	10 mW

The transmitted average power is significantly below the SAR threshold and qualifies for the SAR exemption.

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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