
Project 18446-15

**Hetronic
Proximity Detector Module**

Wireless Certification Report

Prepared for:

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

By

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

19 Mar 2017

Reviewed by

A handwritten signature in black ink, appearing to read 'Larry Finn'.

Larry Finn
Chief Technical Officer

Written by

A handwritten signature in black ink, appearing to read 'Eric Lifsey'.

Eric Lifsey
EMC Engineer

Revision History

Revision Number	Description	Date
DRAFT 1	Draft for review.	19 Apr 2017
Final 01	Finalized.	19 May 2017

Corrections:

Table of Contents

Revision History.....	2
Compliance Certificate.....	5
1.0 Introduction.....	6
1.1 Scope.....	6
1.2 EUT Description	6
1.3 EUT Operation.....	6
1.4 Modifications to Equipment.....	6
1.5 Test Site	7
1.6 Radiated Measurements	7
1.7 Applicable Documents and Clauses.....	7
2.0 Fundamental Power	8
2.1 Test Procedure	8
2.2 Test Criteria	8
2.3 Test Results, Peak Power.....	8
2.4 Test Results, Duty Cycle.....	9
3.0 Power Spectral Density.....	11
3.1 Test Procedure	11
3.2 Test Criteria	11
3.3 Test Results.....	11
4.0 Occupied Bandwidth.....	12
4.1 Test Procedure	12
4.2 Test Criteria	12
4.3 Test Results.....	12
4.3.1 Bandwidth Plots, 6 dB, Port A	13
4.3.2 Bandwidth Plots, 6 dB, Port B.....	14
4.3.3 Bandwidth Plots, 20 dB, Port A	15
4.3.4 Bandwidth Plots, 20 dB, Port B.....	16
5.0 Band Edge.....	17
5.1 Test Procedure	17
5.2 Test Criteria	17
5.3 Test Results.....	17
5.3.1 Low Channel Band Edge.....	18
5.3.2 High Channel Band Edge	18
6.0 Radiated Spurious Emissions, Receive Mode.....	19
6.1 Test Procedure	19
6.2 Test Criteria	19
6.3 Test Results.....	19
6.3.1 Up to 1 GHz	20
6.3.2 Up to 13 GHz	22
7.0 Radiated Spurious Emissions, Transmit Mode	24
7.1 Test Procedure	24
7.2 Test Criteria	24
7.3 Test Results.....	24
7.3.1 Hopping Up to 1 GHz.....	25
7.3.2 Hopping Up to 18 GHz.....	27
7.3.3 Hopping Up to 25 GHz.....	29
8.0 Antenna Construction Requirements	31
8.1 Procedure	31
8.2 Criteria	31
8.3 Results.....	31
9.0 Equipment.....	32
9.1 Radiated Emissions 30 MHz to 25 GHz	32
9.2 Power, Bandwidth, Duty Cycle, Band Edge, Conducted Spurious.....	33
10.0 Measurement Bandwidths.....	34
Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty	35
End of Report	36

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Compliance Certificate

Applicant	Device & Test Identification
Hetronic 3905 NW 36th St. Oklahoma City, OK 73112 USA Certificate Date: 14 Apr 2017	FCC ID: LW9-PDM Industry Canada ID: 2119-PDM Model(s): Proximity Detector Module Laboratory Project ID: 18446-15

The device named above was tested utilizing the following documents and found to be in compliance with the required criteria:

Requirement	Reference	Detail
FCC 47 CFR Part 15 C	15.247	Operation within the bands 902-928 MHz, <u>2400-2483.5 MHz</u> , and 5725-5850 MHz.
FCC 47 CFR Part 15 C	15.209	Radiated emission limits; general requirements.
FCC 47 CFR Part 15 C	15.205	Restricted Bands of Operation
KDB 558074 D01	DR01	DTS Measurement Guidance v03r02
KDB 412172	D01	Guidelines for Determining the ERP and EIRP of an RF Transmitting System
OET Bulletin 65*	Edition 97-01, and Supplement C, Ed. 01-01	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
RSS-247	Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-Gen	Issue 4	General Requirements and Information for the Certification of Radio Apparatus
RSS-102	Issue 5	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

*MPE is reported separately from this document. **Corresponding RSS references are listed in the body of the report.

I, Eric Lifsey, for Professional Testing (EMI), Inc., being familiar with the above requirements 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 the United States and Canada.

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.

1.2 EUT Description

Table 1.2.1: Equipment Under Test		
Manufacturer / Model	Serial #	Description
Hetronic Model: Remote	none	2400-2483.5 MHz DTS transceiver; using Zigbee style protocol.

Table 1.2.2: Support Equipment		
Manufacturer / Model	Serial #	Description
None		

This device is a module intended to be hosted in other products of the manufacturer. It provides an in/out range verification function as part of a larger system. This provides a true/false status per configured range setting and not a range measurement.

The device is powered by a DC source of 3 to 12 VDC; nominally 5 VDC in the final application as module is installed and powered within the manufacturers line of industrial control devices.

The EUT electronics are on a single circuit board which measures approximately 5.3 cm x 3.8 cm x 0.5 cm. In the final application the EUT fits inside a plastic enclosure of a host system where it obtains power. The battery powered applications use the low power setting (-17 dBm) while the fixed non-battery powered hosts use the high power setting (4 dBm).

The module board has two chip antennas and two U.FL connectors. In the battery powered application the chip antennas are used. In the fixed application external antennas are used.

1.3 EUT Operation

The EUT was exercised in a manner consistent with normal operations. The communication channels, which maintained the higher default power output, were used for measurement. The ranging channels, at and below the same power levels, were redundant to the communication channels.

1.4 Modifications to Equipment

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

1.5 Test Site

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

1.6 Radiated Measurements

Table 1.6 1 Measurement Corrections	
Parameter	From Sums Of
Radiated Field Strength	Raw Measured Level + Antenna Factor + Cable Losses – Amplifier Gain
Conducted Antenna Port	Raw Measured Level + Attenuator Factor + Cable Losses
Conducted Mains Port	Raw Measured Level + LISN Factor + Cable/Filter/Limiter Losses

Additionally, measurement distance extrapolation factors (such as $1/d$ above 30 MHz) are applied and documented where used.

1.7 Applicable Documents and Clauses

Table 1.7.1: Applicable Documents	
Document	Title
47 CFR	Part 15 – Radio Frequency Devices Subpart C -Intentional Radiators
RSS-247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-Gen Issue 4	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10:2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

Table 1.7.2: Applicable Clauses		
Parameter	FCC Part 15 Rule Paragraphs	IC RSS References
Transmitter Characteristics	15.247	RSS-247 5.2 (DTS) & 5.4, RSS-Gen
Bandwidth	15.247(a)(1), 2.1049, KDB 558074 D01	RSS-Gen 4.6
Spurious Emission	15.247, 15.209, 15.205	RSS-247 5.5, RSS-GEN 4.9, 4.10
Band Edge	15.247, 15.205	RSS-247 5.5, RSS-Gen 4.9
Antenna Requirement	15.247, 15.203	RSS-Gen 8.3

2.0 Fundamental Power

2.1 Test Procedure

Peak power is measured using conducted means and with modulation.

2.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
15.247(a)(3) // RSS-247 5.2	Fundamental Power Conducted Limits 1 W Limit Restated as Field: 125.23 dBμV/m @ 3 m	15 Mar 2017

2.3 Test Results, Peak Power

The EUT was measured for conducted power by connection directly to a spectrum analyzer.

Table 2.3.1 Power, Peak, Conducted, Port A

Frequency MHz	Measured Peak Power in dBm	Measured Peak Power in mW
2405	3.5	2.2
2440	3.4	2.2
2480	3.3	2.1

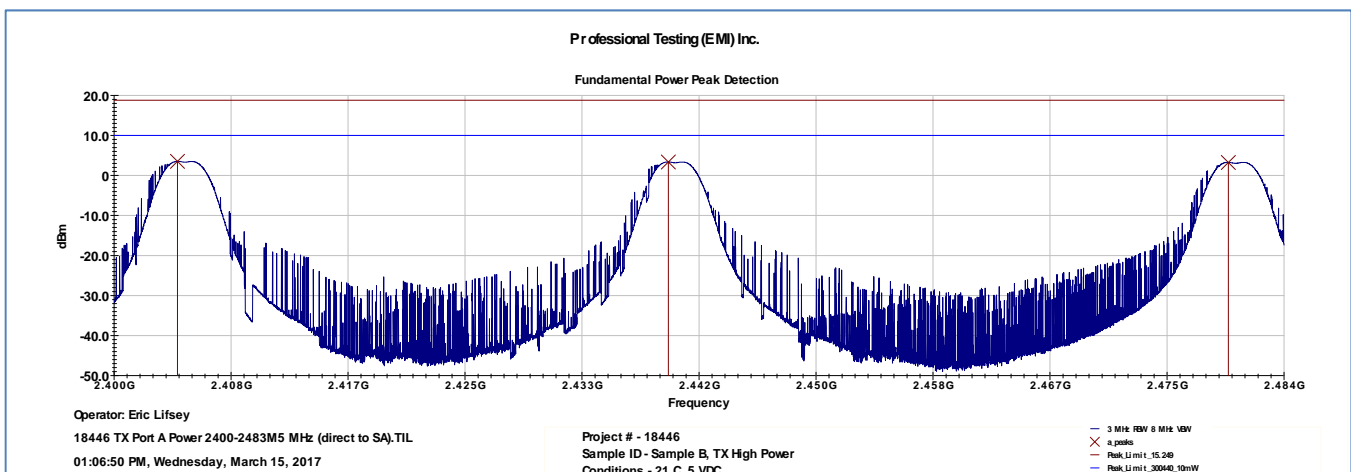
Measured in 3 MHz RBW, 8 MHz VBW.

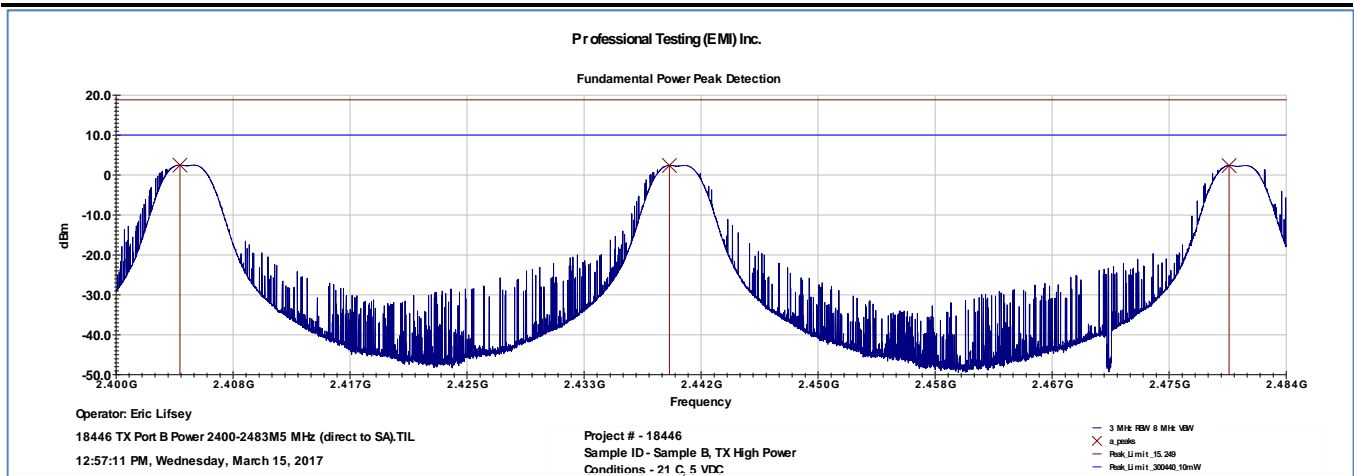
Table 2.3.1 Power, Peak, Conducted, Port B

Frequency MHz	Measured Peak Power in dBm	Measured Peak Power in mW
2405	2.5	1.8
2440	2.4	1.7
2480	2.4	1.7

Measured in 3 MHz RBW, 8 MHz VBW.

The EUT was satisfied the requirements.





2.4 Test Results, Duty Cycle

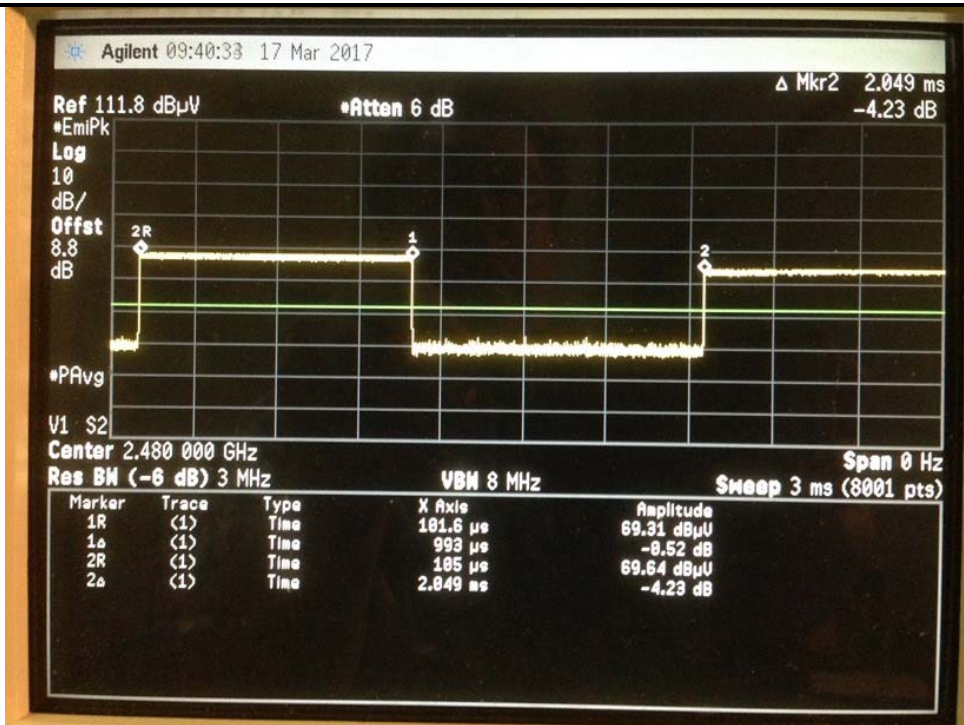
Measurement is based on intervals not to exceed 100 msec. Maximum transmitter on time is divided by the lesser of 100 msec or the actual measured minimum transmitter interval time. The result is converted to dB and applied as needed to peak measurements of transmitter artifacts to determine average power.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

Table 2.5.1 Duty Cycle Results and Average Duty Cycle Factor Result

Total Measured On Time (msec)	Measured Time Interval (msec)	Duty Cycle Factor Calculation	Result (dB)	Duty Cycle Factor Allowed (dB)
0.993	2.049	$= 20 * \log_{10} (0.993 \text{ msec} / 2.049 \text{ msec})$	-6.29	-6.29

The allowed duty cycle factor is applied to peak measured harmonic signals to find average levels.

Plotted results appear below.



Transmit Event & Time Interval

3.0 Power Spectral Density

3.1 Test Procedure

A spectrum analyzer is either connected directly to the EUT or used by radiated means to measure the fundamental emission. It is adjusted to measure the power spectral density in the specified resolution bandwidth.

3.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
15.247(e) // RSS-247, 5.2	Power Spectral Density, Conducted Limit: 8 dBm / 3 kHz Restated as field strength limit: 103.23 dB μ V/m at 3 m	NA

3.3 Test Results

The full bandwidth fundamental peak power measured below the limit for this test. The EUT satisfies the criteria without additional measurement.

4.0 Occupied Bandwidth

4.1 Test Procedure

Bandwidth is measured by radiated means. A recording of the results is included.

4.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
14.247(a)(2), 2.1049, KDB 558074 D01 // RSS-Gen 4.6	Bandwidth, 6 dB, 20 dB	15 Mar 2017

4.3 Test Results

The bandwidth measurement is used to verify DTS characteristics and/or for general reporting for agency application.

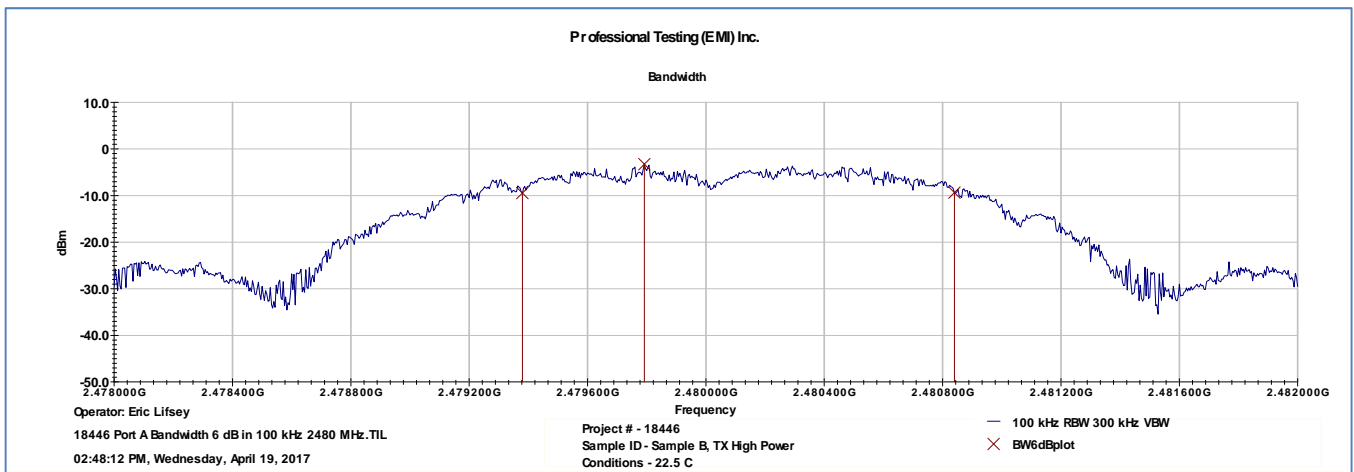
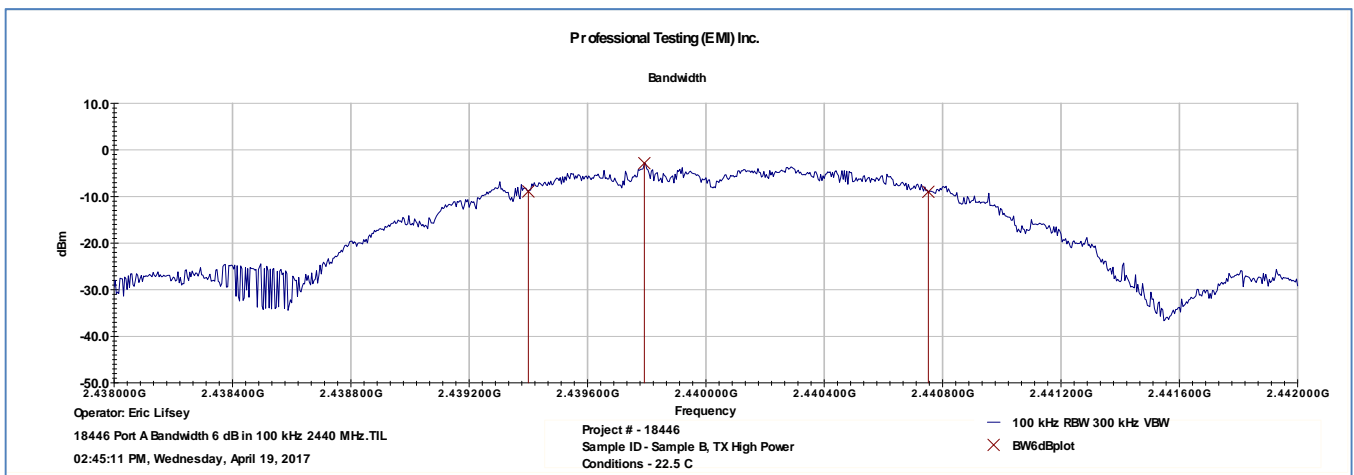
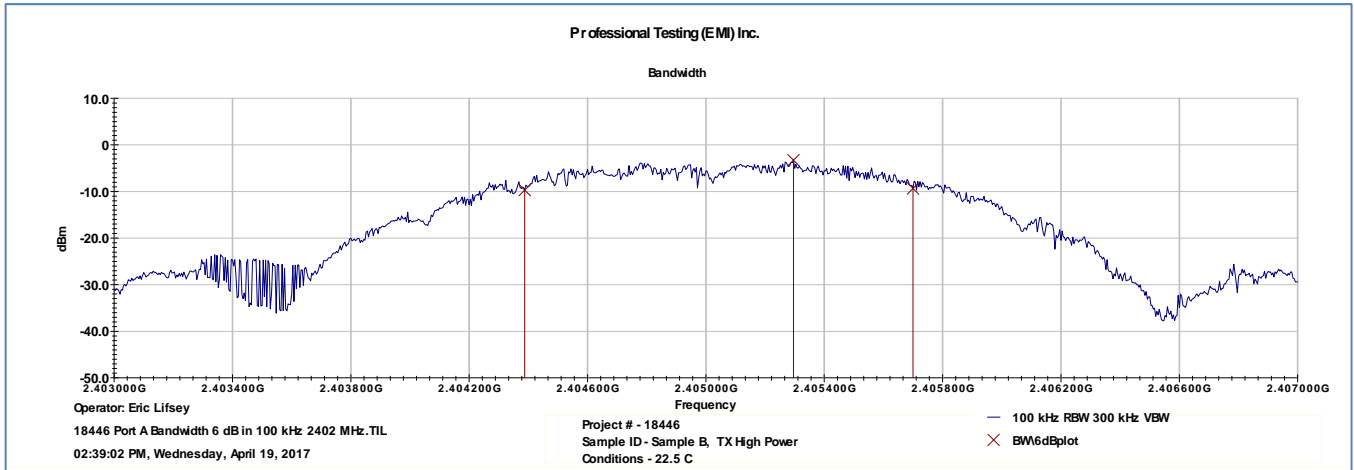
The EUT was found to be in compliance with applicable requirements.

Table 4.3.1 Port A			
Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	Reported Minimum BW (kHz)
1312	1352	1460	1312
Bandwidth 20 dB, Measure and Report			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	Reported Maximum BW (kHz)
2564	2581	2580	2581

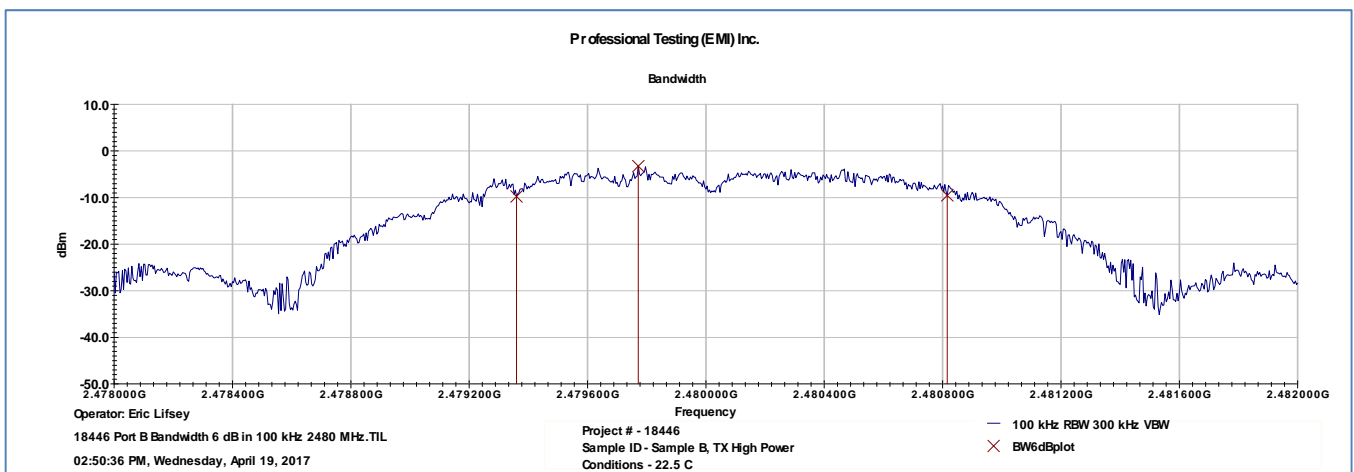
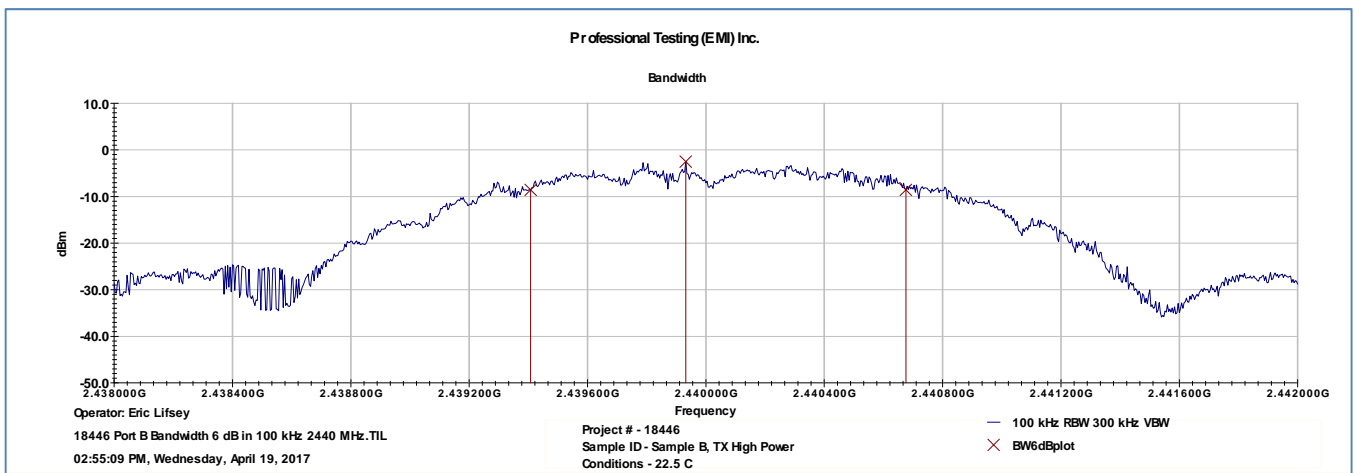
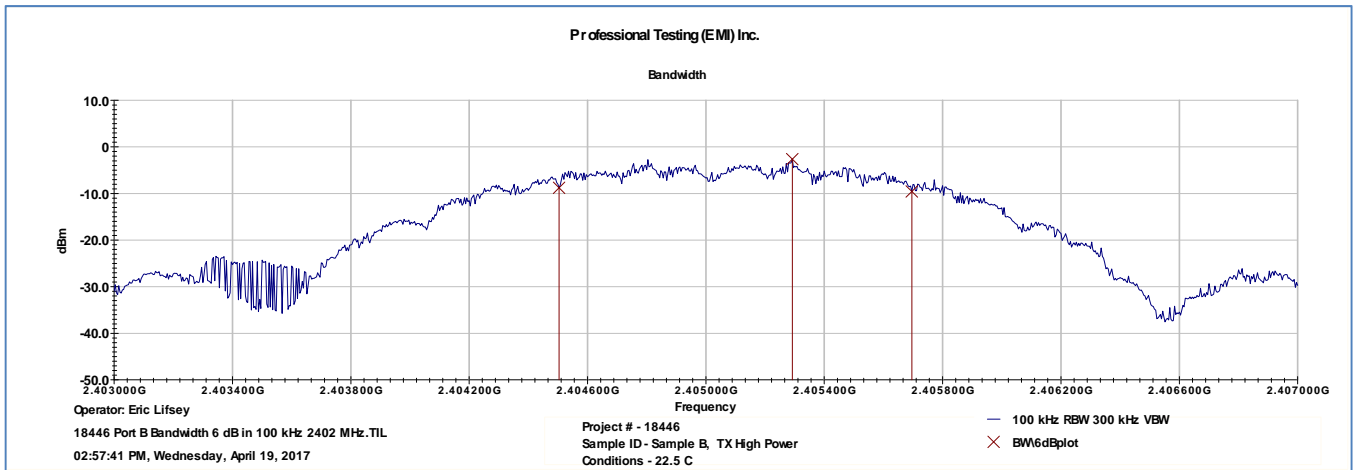
Table 4.3.2 Port B			
Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	Reported Minimum BW (kHz)
1192	1268	1456	1192
Bandwidth 20 dB, Measure and Report			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	Reported Maximum BW (kHz)
2584	2590	2578	2590

Plotted measurements appear on the following pages.

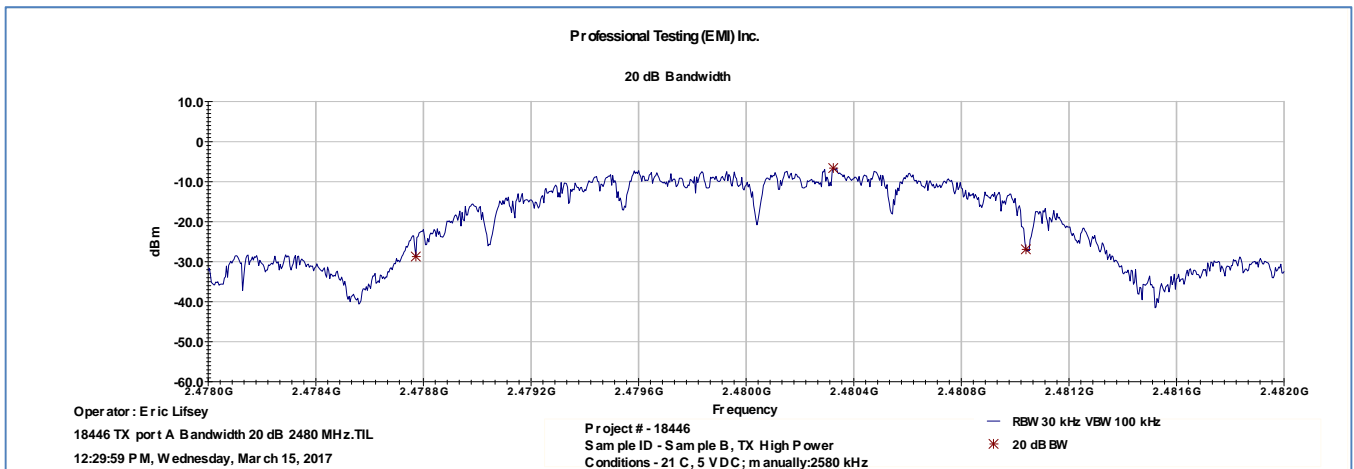
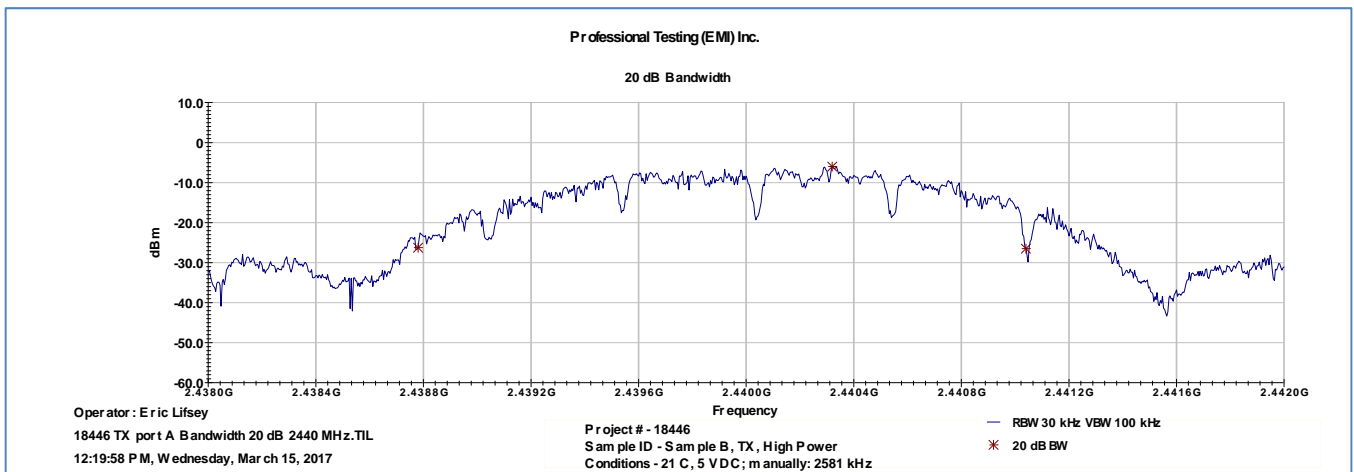
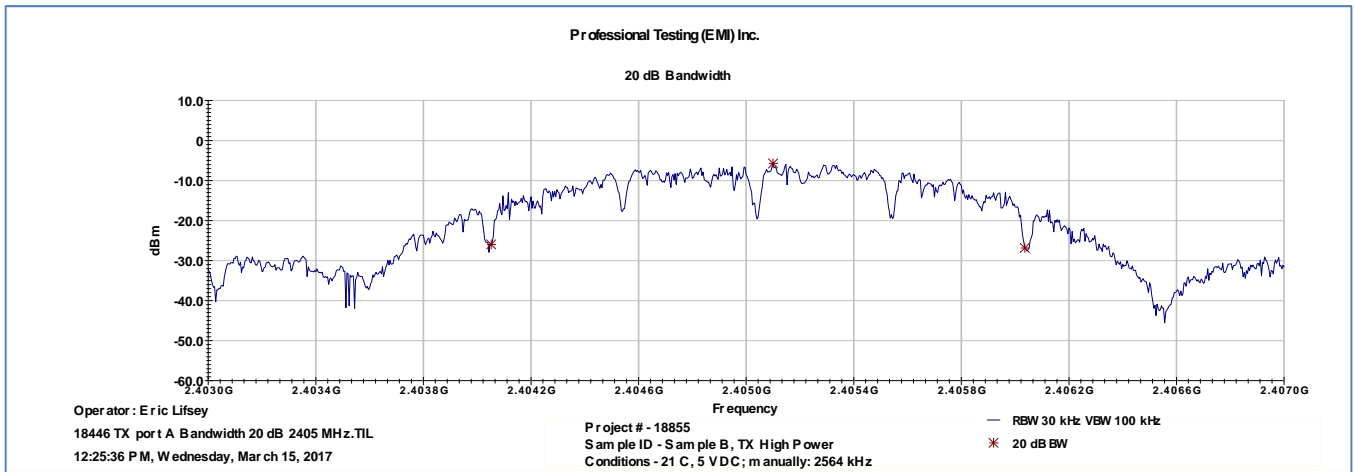
4.3.1 Bandwidth Plots, 6 dB, Port A



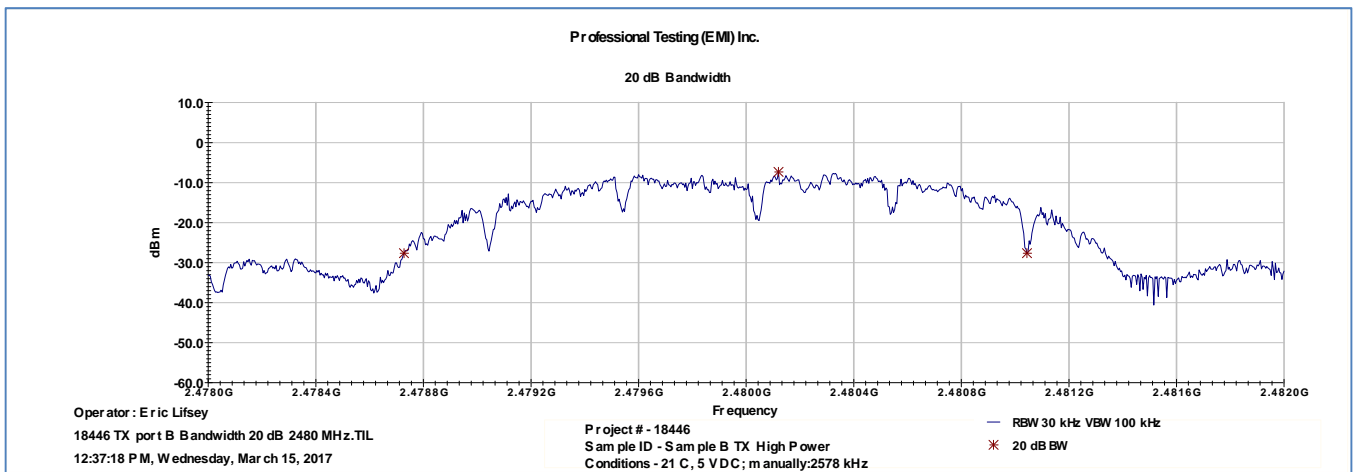
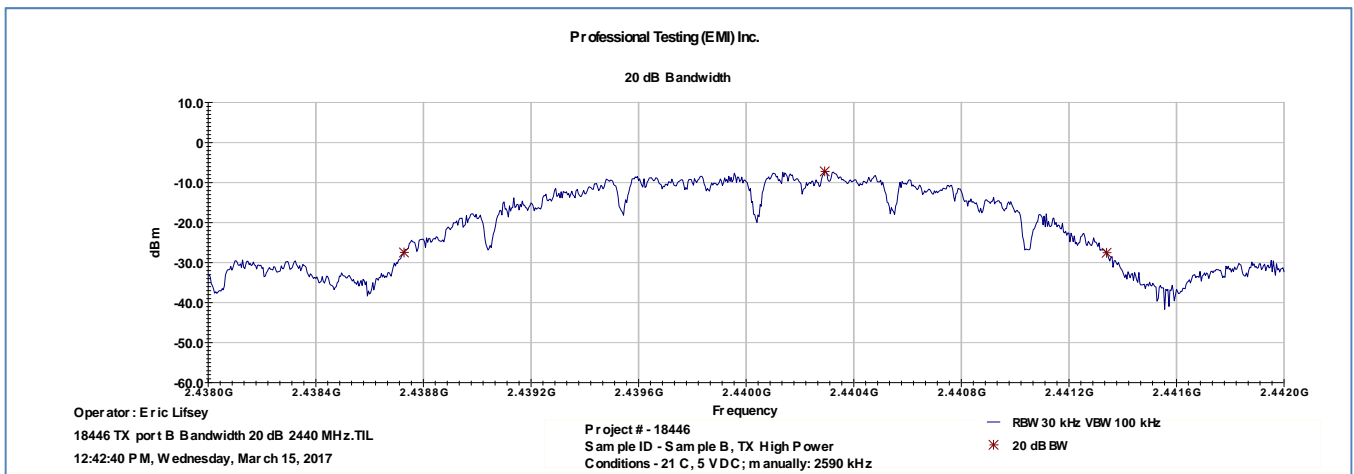
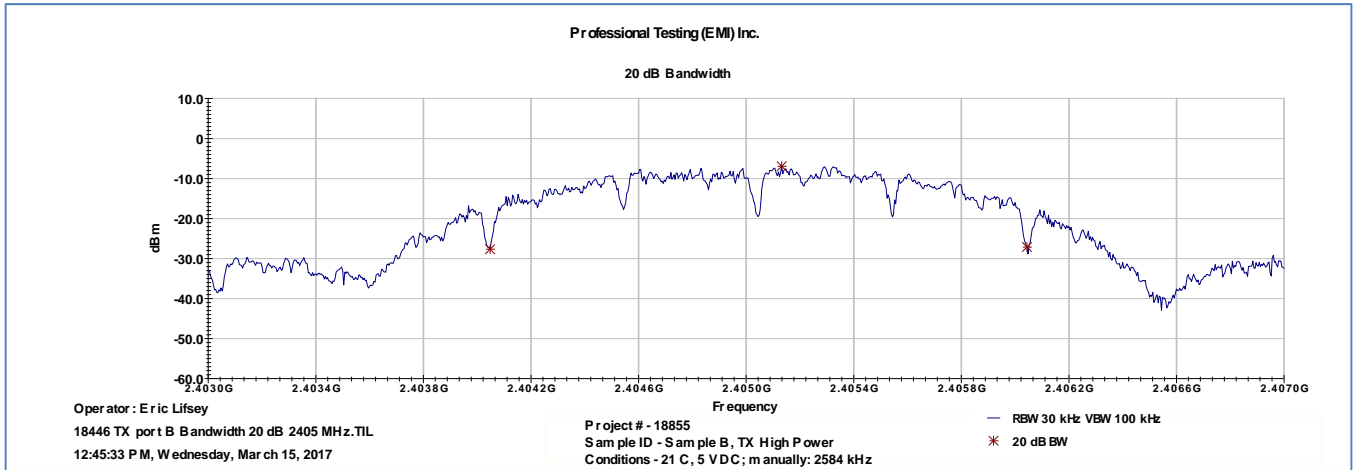
4.3.2 Bandwidth Plots, 6 dB, Port B



4.3.3 Bandwidth Plots, 20 dB, Port A



4.3.4 Bandwidth Plots, 20 dB, Port B



5.0 Band Edge

5.1 Test Procedure

EUT is placed into normal transmit operation on the nearest band edge channel. The spectrum analyzer is approximately centered on the band edge frequency with span sufficient to include the peak of the adjacent fundamental signal. Measurement includes at least two standard bandwidths from the respective band edge. If required, the band-edge marker-delta method is utilized.

5.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.205 // RSS-247 5.5, RSS-Gen 4.9	Unwanted Emissions Adjacent to Authorized Band	19 Apr 2017

5.3 Test Results

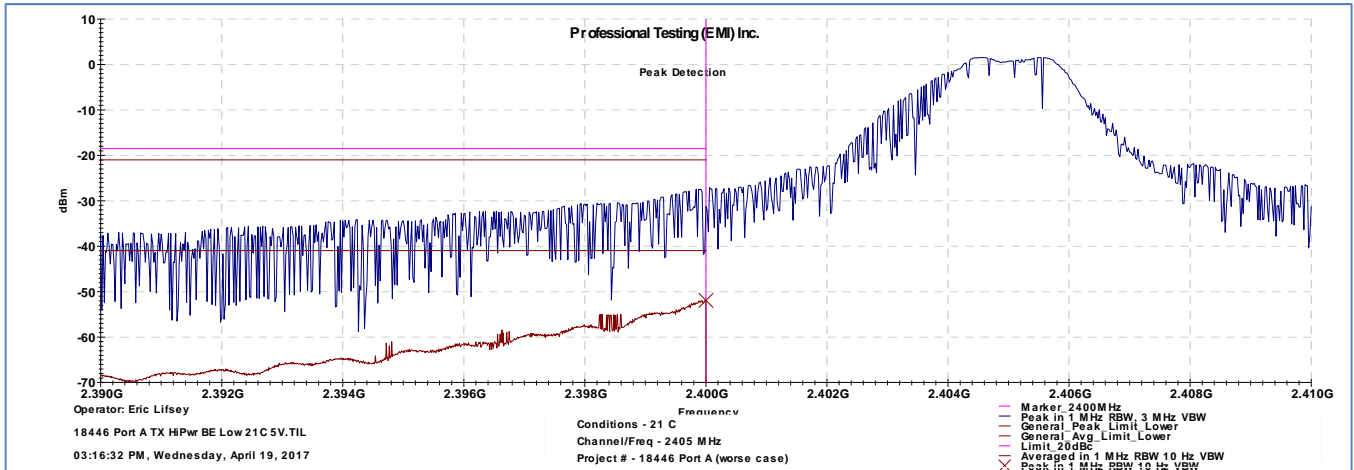
Measurements included fundamental and more than 2 standard bandwidths (standard bandwidth 1 MHz) beyond the band edges to provide a clear view of the fundamental and the declining emission levels.

The worse-case highest output power port was selected for this test. (Port A)

Average levels were measured outside the band using 10 Hz video bandwidth.

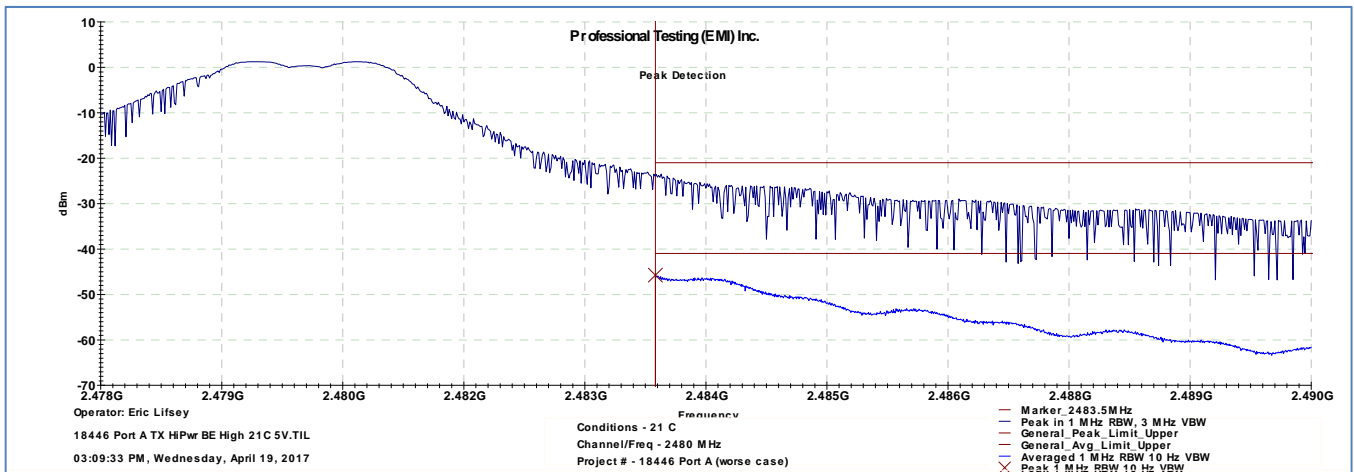
The EUT satisfied the criteria. Plotted results appear on the following pages.

5.3.1 Low Channel Band Edge



The 15.247 (-20 dBc) and general emission limits are shown.

5.3.2 High Channel Band Edge



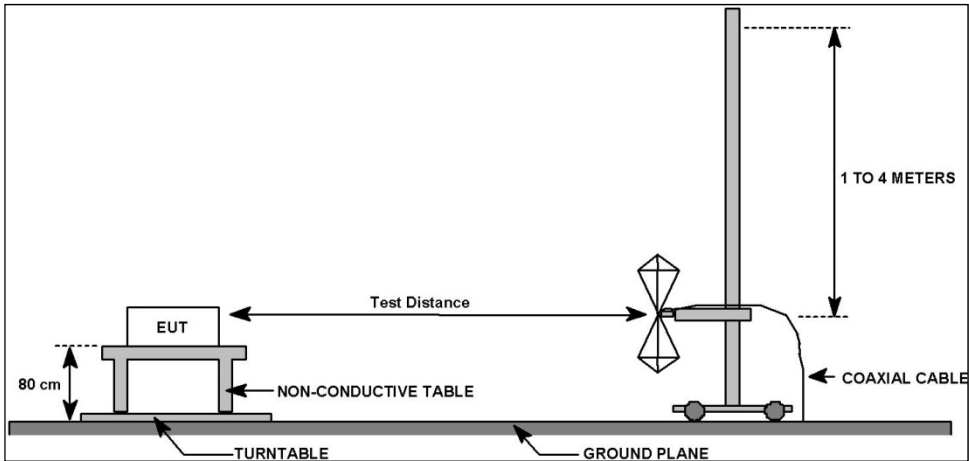
The general emission limit is shown.

6.0 Radiated Spurious Emissions, Receive Mode

6.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The EUT was centered on a rotating turntable. Measurements below 1 GHz were taken at a test distance of 10 meters from the measurement antenna. Above 1 GHz the measurement distance was 3 meters.

Spurious emissions below 1 GHz were measured with quasi-peak detection with a resolution bandwidth of 120 kHz. Above 1 GHz peak measurements were taken and average measured where appropriate and 1 MHz resolution bandwidth. A diagram showing the test setup appears below.



6.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.209 // RSS-247 5.5, RSS-Gen 4.9 & 4.10	Field Strength of Radiated Spurious/Harmonic Emissions Receive Mode	3 Apr 2017

6.3 Test Results

The EUT was tuned to the middle channel and placed in receive mode. The companion device was also included in this test.

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

6.3.1 Up to 1 GHz

Professional Testing, EMI, Inc.									
Test Method:		ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz							
In accordance with:		FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits							
Section:		15.109							
Test Date(s):		4/3/2017			EUT Serial #:		None		
Customer:		Hetronic			EUT Part #:		None		
Project Number:		18446			Test Technician:		Eric Lifsey		
Purchase Order #:		NA			Supervisor:		Lisa Arndt		
Equip. Under Test:		1: TX High Power; 2: TX Low			Witness' Name:		None		
Radiated Emissions Test Results Data Sheet									
Page: 1 of 1									
EUT Line Voltage:		1: 5VDC, 2: 3.6Vbatt			EUT Power Frequency:		0 N/A		
Antenna Orientation:		Vertical			Frequency Range:		30MHz to 1GHz		
EUT Mode of Operation:					Receive Mode				
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBμV)	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
29.9933	10	15	2.44	Quasi-peak	30	17.972	33.1	-15.1	Pass
174.439	10	255	4.09	Quasi-peak	26.5	10.919	33.1	-22.2	Pass
200.397	10	32	1.66	Quasi-peak	29	14.656	33.1	-18.4	Pass
892.528	10	346	3.57	Quasi-peak	21.3	25.793	35.6	-9.8	Pass
898.935	10	143	1.21	Quasi-peak	21.3	26.124	35.6	-9.5	Pass
953.991	10	50	3.09	Quasi-peak	21	25.98	35.6	-9.6	Pass
<div style="display: flex; justify-content: space-between;"> <div style="width: 60%;"> <p>Professional Testing, EMI, Inc Radiated Emissions, 10m Distance 30MHz - 1GHz Vertical Polarity Measured Emissions</p> <p>Operator: Eric Lifsey 18446 040317 PDM+RX 1mGHz RE Spurious Receive Model 09:56:35 AM, Monday, April 03, 2017</p> </div> <div style="width: 35%;"> <p>— Quasi-peak Limit Level — Corrected Quasi-peak Reading — Corrected Peak Value — Verified Low-PRF QP Reading — LPRF Verification Limit — LIM_ETSI_RX</p> <p>EUT: TX High Power & RX Low Power Project Number: 18446 Client: Hetronic</p> </div> </div>									
≤ 1GHz Vertical Antenna Polarity Measured Emissions									

Professional Testing, EMI, Inc.

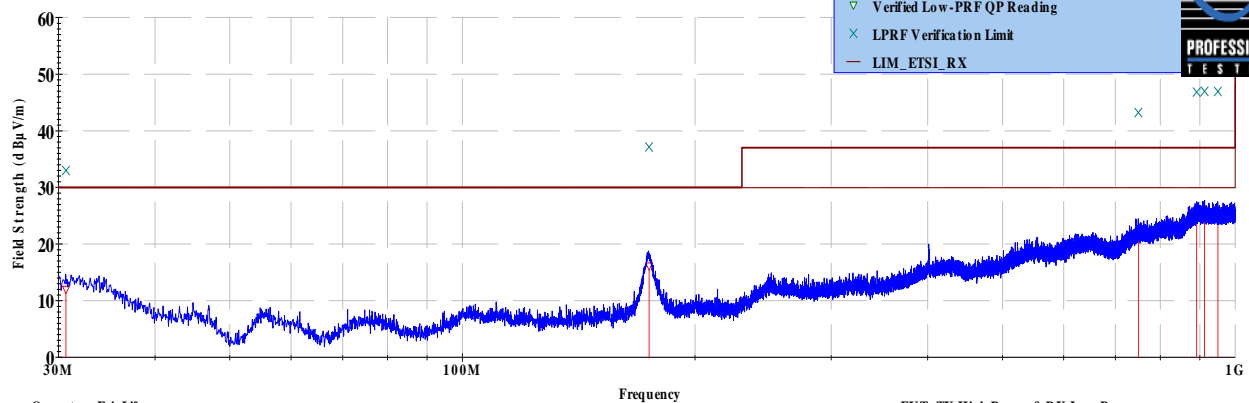
Test Method:	ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz		
In accordance with:	FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits		
Section:	15.109		
Test Date(s):	4/3/2017	EUT Serial #:	None
Customer:	Hetronic	EUT Part #:	None
Project Number:	18446	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	1: TX High Power; 2: TX Low	Witness' Name:	None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:		1:5VDC, 2:3.6Vbatt VDC			EUT Power Frequency:		0 N/A		
Antenna Orientation:		Horizontal			Frequency Range:		30MHz to 1GHz		
EUT Mode of Operation:					Receive Mode				
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBμV)	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
30.6867	10	37	3.71	Quasi-peak	24	11.986	29.5	-17.5	Pass
174.389	10	177	3.62	Quasi-peak	31.7	16.129	33.1	-17.0	Pass
749.564	10	164	1.35	Quasi-peak	21.7	22.21	35.6	-13.4	Pass
891.892	10	175	1.13	Quasi-peak	21.3	25.799	35.6	-9.8	Pass
912.902	10	128	2.28	Quasi-peak	21.1	25.971	35.6	-9.6	Pass
949.974	10	195	3.7	Quasi-peak	21	25.917	35.6	-9.7	Pass

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



Operator: Eric Lifsey

18446 040317 PDM+RX 1mGHz RE'Spurious'ReceiveMode.tif

09:56:35 AM, Monday, April 03, 2017

EUT1: Receive Mode; EUT2: Receive Mode
EUT1: Power: 5 VDC; EUT2: Battery 3.6V

EUT: TX High Power & RX Low Power

Project Number: 18446

Client: Hetronic

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

6.3.2 Up to 13 GHz

Professional Testing, EMI, Inc.

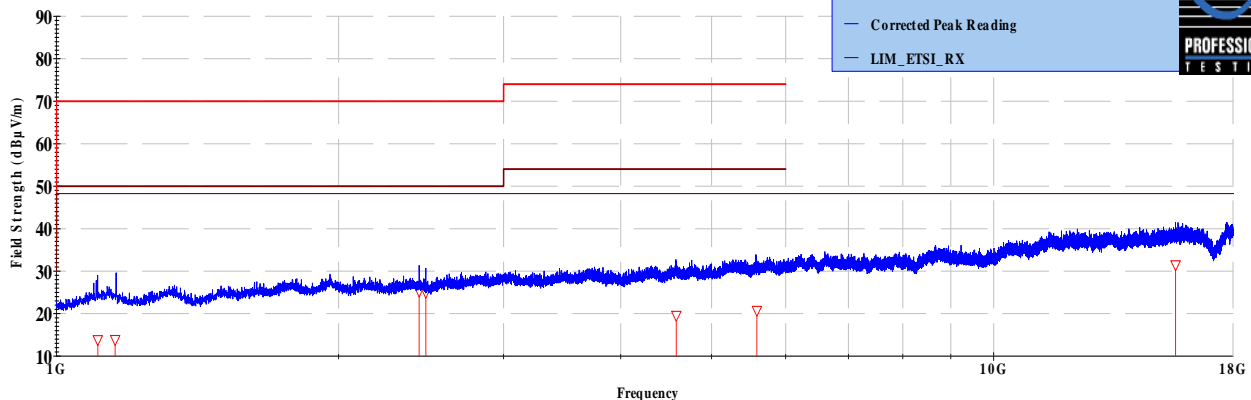
Test Method:	ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz		
In accordance with:	FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits		
Section:	15.109		
Test Date(s):	4/3/2017	EUT Serial #:	None
Customer:	Hetronic	EUT Part #:	None
Project Number:	18446	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	1: TX High Power; 2: TX Low	Witness' Name:	None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:			1:5VDC, 2:3.6Vbatt VDC		EUT Power Frequency:		0 N/A		
Antenna Orientation:			Vertical		Frequency Range:		Above 1GHz		
EUT Mode of Operation:					Receive Mode				
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBμV)	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
1107.04	3	299	1.44	Average	36.2	13.833	54.0	-40.1	Pass
1155.24	3	56	1.88	Average	35.9	13.849	54.0	-40.1	Pass
2438.04	3	9	1.41	Average	43.9	25.24	54.0	-28.7	Pass
2478	3	232	1.53	Average	43.6	24.996	54.0	-29.0	Pass
4585.61	3	274	2.67	Average	33.5	19.55	54.0	-34.4	Pass
5589.54	3	9	2.75	Average	32.4	20.736	54.0	-33.2	Pass
15634.3	3	91	2.57	Average	27.6	31.445	54.0	-22.5	Pass

Professional Testing, EMI, Inc
Radiated Emissions, 1m Distance, Restated for 3m
1-18GHz Vertical Polarity Measured Emissions



Operator: Eric Lifsey

18446\040317\PDM+RX\1mGHz\RE\Spurious\ReceiveMode.tif

11:04:21 AM, Monday, April 03, 2017

EUT1: Receive Mode; EUT2: Receive Mode
EUT1: Power: 5 VDC; EUT2: Battery 3.6V

EUT: TX High Power & RX Low Power

Project Number: 18446

Client: Hetronic

> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method:	ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz		
In accordance with:	FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits		
Section:	15.109		
Test Date(s):	4/3/2017	EUT Serial #:	None
Customer:	Hetronic	EUT Part #:	None
Project Number:	18446	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	1: TX High Power; 2: TX Low	Witness' Name:	None

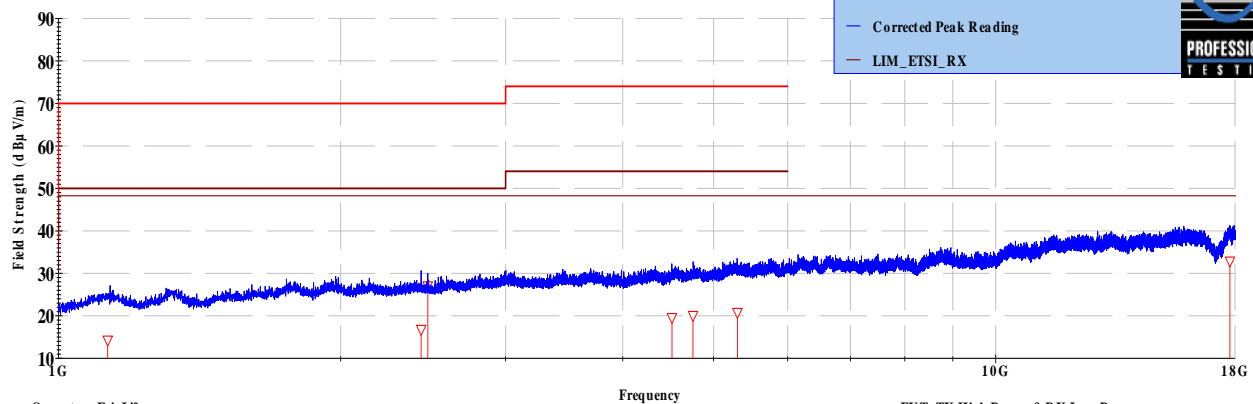
Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 1:5VDC, 2:3.6Vbatt VDC					EUT Power Frequency:		0 N/A		
Antenna Orientation:		Horizontal			Frequency Range:		Above 1GHz		
EUT Mode of Operation:					Receive Mode				
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBμV)	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
1128.9	3	18	3.3	Average	36.5	14.259	54.0	-39.7	Pass
2437.88	3	316	1.51	Average	35.4	16.755	54.0	-37.2	Pass
2478.04	3	147	1.52	Average	45.6	27.008	54.0	-26.9	Pass
4514.64	3	298	2.11	Average	33.6	19.528	54.0	-34.4	Pass
4754.42	3	15	3.55	Average	33.6	20.003	54.0	-34.0	Pass
5302.51	3	254	2.76	Average	32.9	20.751	54.0	-33.2	Pass
17779	3	205	1.14	Average	26.6	32.825	54.0	-21.1	Pass

Professional Testing, EMI, Inc

Radiated Emissions, 1m Distance, Restated for 3m
1-18GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

18446 040317 PDM+RX 1mGHz RESpurious Receive Model

11:04:21 AM, Monday, April 03, 2017

EUT1: Receive Mode; EUT2: Receive Mode
EUT1: Power: 5 VDC; EUT2: Battery 3.6V

EUT: TX High Power & RX Low Power

Project Number: 18446

Client: Hetronic

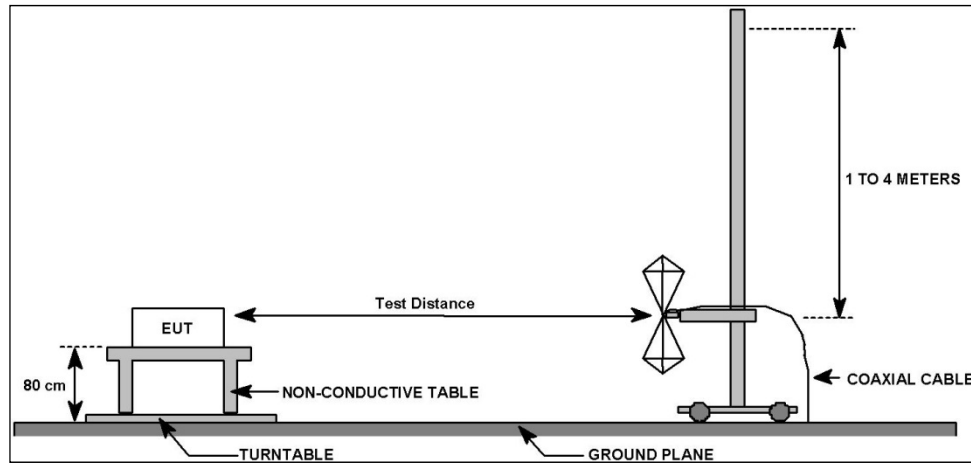
> 1GHz Horizontal Antenna Polarity Measured Emissions

7.0 Radiated Spurious Emissions, Transmit Mode

7.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The EUT was centered on a rotating turntable. Measurements below 1 GHz were taken at a test distance of 10 meters from the measurement antenna. Above 1 GHz the measurement distance was 3 meters.

Spurious emissions below 1 GHz were measured with quasi-peak detection with a resolution bandwidth of 120 kHz. Above 1 GHz peak measurements were taken and average measured where appropriate using 1 MHz resolution bandwidth. A diagram showing the test setup appears below.



7.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.209 // RSS-247 5.5, RSS-Gen 4.9 & 4.10	Field Strength of Radiated Spurious/Harmonic Emissions Transmit Mode	30 Jan 2017

7.3 Test Results

This device was simultaneously tested in both battery (low power) powered and fixed DC powered (high power) configurations and communicating normally.

Modulation and hopping was enabled for this test. The ranging operation occupied the lower channels including the bottom and middle channels, the communication channel was set to 2480 MHz to cover the top channel.

7.3.1 Hopping Up to 1 GHz

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013

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): 1/30/2017

EUT Serial #: 1: none, 2: none

Customer: Hetronic

EUT Part #: 1: none, 2: none

Project Number: 18446

Test Technician: Eric Lifsey

Purchase Order #: NA

Supervisor: Lisa Arndt

Equip. Under Test: Proximity Detection Module

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 1: 5 VDC,
2: 3.6 V

EUT Power Frequency: 0 N/A

Antenna Orientation: Vertical

Frequency Range: 30MHz to 1GHz

EUT Mode of Operation:

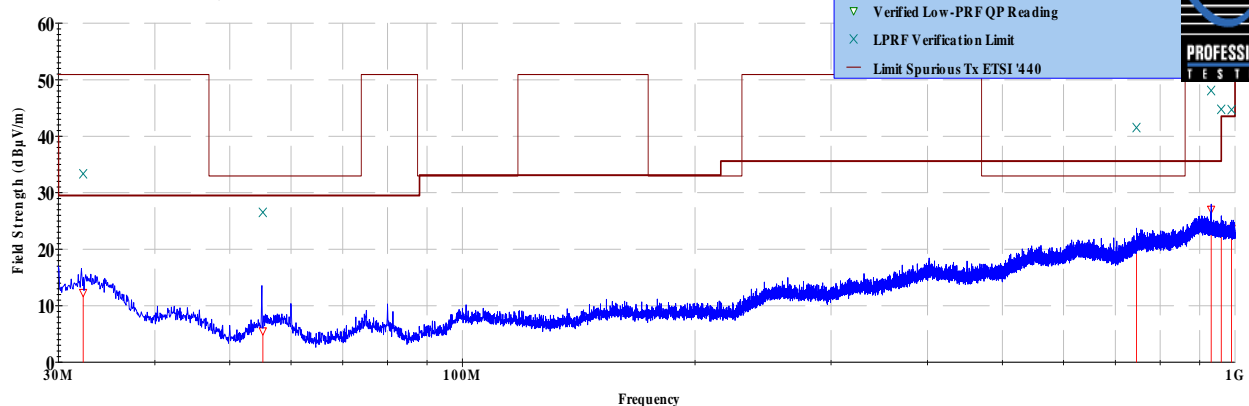
EUT 1 & 2 Transmit/Receive Hopping

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
32.2954	10	168	3.42	Quasi-peak	24.1	12.338	29.5	-17.2	Pass
55.1676	10	355	1.24	Quasi-peak	23.3	5.52	29.5	-24.0	Pass
745.714	10	338	1.98	Quasi-peak	21.7	20.508	35.6	-15.1	Pass
931.499	10	323	2.26	Quasi-peak	24.2	27.056	35.6	-8.5	Pass
959.876	10	195	3.84	Quasi-peak	21	23.748	35.6	-11.9	Pass
989.968	10	308	2.47	Quasi-peak	21	23.683	43.5	-19.8	Pass

Professional Testing, EMI, Inc

Radiated Emissions, 10m Distance

30MHz - 1GHz Vertical Polarity Measured Emissions



Operator: Eric Lifsey

18446'RERun01'PDM'EUT1+EUT2'Spurious'TX.4fl

04:28:43 PM, Monday, January 30, 2017

Mode: Both samples Tx/Rx, hopping

Sample 1: 5 VDC

Sample 2: 3.6 V Battery

EUT: Proximity Detector Module

Project Number: 18446

Client: Hetronic

≤ 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013

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): 1/30/2017

EUT Serial #: 1: none, 2: none

Customer: Hetronic

EUT Part #: 1: none, 2: none

Project Number: 18446

Test Technician: Eric Lifsey

Purchase Order #: NA

Supervisor: Lisa Arndt

Equip. Under Test: Proximity Detection Module

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 1: 5 VDC,
2: 3.6 V

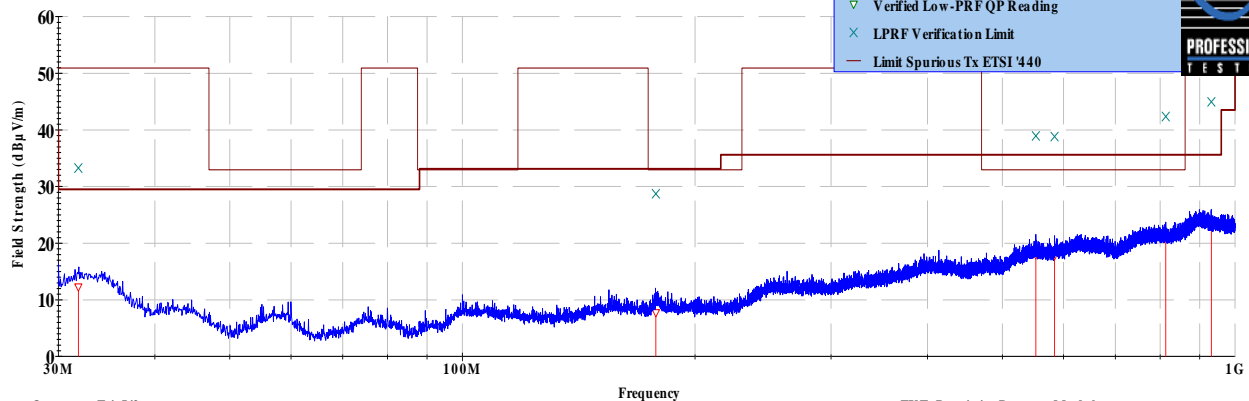
EUT Power Frequency: 0 N/A

Antenna Orientation: Horizontal

Frequency Range: 30MHz to 1GHz

EUT Mode of Operation:
EUT 1 & 2 Transmit/Receive Hopping

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBμV)	Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
31.8358	10	42	1.24	Quasi-peak	24	12.255	29.5	-17.2	Pass
178.021	10	40	3.66	Quasi-peak	22.9	7.701	33.1	-25.4	Pass
552.37	10	45	3.99	Quasi-peak	22.1	17.927	35.6	-17.7	Pass
584.159	10	18	3.01	Quasi-peak	22.1	17.809	35.6	-17.8	Pass
813.84	10	102	1.72	Quasi-peak	21.4	21.356	35.6	-14.2	Pass
932.078	10	321	1.98	Quasi-peak	21.1	23.934	35.6	-11.7	Pass

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

Operator: Eric Lifsey

18446 RERun01 PDM EUT1 + EUT2 Spurious TX.tif
04:28:43 PM, Monday, January 30, 2017
Mode: Both samples Tx/Rx, hopping

Sample 1: 5 VDC

Sample 2: 3.6 V Battery

EUT: Proximity Detector Module

Project Number: 18446

Client: Hetronic

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

7.3.2 Hopping Up to 18 GHz

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013

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): 1/30/2017

EUT Serial #: 1: none, 2: none

Customer: Hetronic

EUT Part #: 1: none, 2: none

Project Number: 18446

Test Technician: Eric Lifsey

Purchase Order #: NA

Supervisor: Lisa Arndt

Equip. Under Test: Proximity Detection Module

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 1: 5 VDC,
2: 3.6 V

EUT Power Frequency: 0 N/A

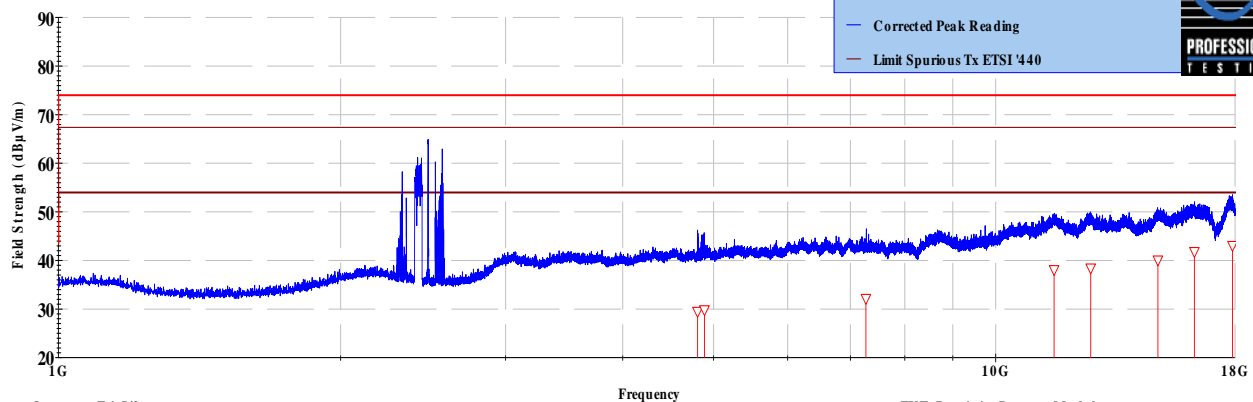
Antenna Orientation: Vertical

Frequency Range: Above 1GHz

EUT Mode of Operation:

EUT 1 & 2 Transmit/Receive Hopping

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
4807.81	3	332	3.35	Average	33.2	29.465	54.0	-24.5	Pass
4889.72	3	141	2.14	Average	33.3	29.788	54.0	-24.2	Pass
7269.97	3	13	1.21	Average	29.1	32.131	54.0	-21.8	Pass
11543.2	3	332	2.58	Average	27.2	38.061	54.0	-15.9	Pass
12630.1	3	191	2.21	Average	27.7	38.382	54.0	-15.6	Pass
14898.4	3	85	3.65	Average	28.4	40.024	54.0	-13.9	Pass
16294.2	3	257	2.99	Average	27.4	41.783	54.0	-12.2	Pass
17894	3	116	3.33	Average	26.8	43.028	54.0	-10.9	Pass

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
1-18GHz Vertical Polarity Measured Emissions

Operator: Eric Lifsey

18446'RERun01'PDM'EUT1+EUT2'Spurious'TX.tif

09:20:39 AM, Tuesday, January 31, 2017

Mode: Both samples Tx/Rx, hopping
Sample 1: 5 VDC
Sample 2: 3.6 V Battery

EUT: Proximity Detector Module

Project Number: 18446

Client: Hetronic

> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013

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): 1/30/2017

EUT Serial #: 1: none, 2: none

Customer: Hetronic

EUT Part #: 1: none, 2: none

Project Number: 18446

Test Technician: Eric Lifsey

Purchase Order #: NA

Supervisor: Lisa Arndt

Equip. Under Test: Proximity Detection Module

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 1: 5 VDC,
2: 3.6 V

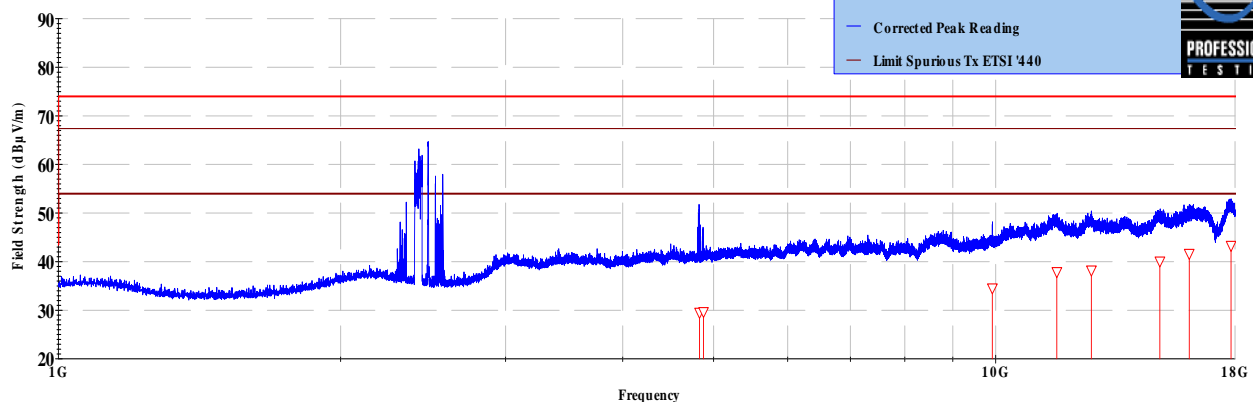
EUT Power Frequency: 0 N/A

Antenna Orientation: Horizontal

Frequency Range: Above 1GHz

EUT Mode of Operation:
EUT 1 & 2 Transmit/Receive Hopping

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
4831.64	3	182	3.4	Average	33.2	29.519	54.0	-24.4	Pass
4878.36	3	62	1.17	Average	33.2	29.67	54.0	-24.3	Pass
9919.63	3	120	3.98	Average	26.6	34.543	54.0	-19.4	Pass
11621.5	3	274	1.95	Average	27.4	37.882	54.0	-16.1	Pass
12650.8	3	204	1.63	Average	27.6	38.199	54.0	-15.8	Pass
14969.1	3	200	1.89	Average	28	40.048	54.0	-13.9	Pass
16088.3	3	75	2.79	Average	27.1	41.622	54.0	-12.3	Pass
17832	3	150	3.7	Average	27.2	43.29	54.0	-10.7	Pass

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
1-18GHz Horizontal Polarity Measured Emissions

Operator: Eric Lifsey

18446'RERun01'PDM'EUT1+EUT2'Spurious'TX.tif
09:20:39 AM, Tuesday, January 31, 2017
Mode: Both samples Tx/Rx, hopping

Sample 1: 5 VDC

Sample 2: 3.6 V Battery

EUT: Proximity Detector Module

Project Number: 18446

Client: Hetronic

> 1GHz Horizontal Antenna Polarity Measured Emissions

7.3.3 Hopping Up to 25 GHz

Professional Testing, EMI, Inc.									
Test Method:		ANSI C63.10-2013							
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):		2/6/2017		EUT Serial #:		1: none, 2: none			
Customer:		Hetronic		EUT Part #:		1: none, 2: none			
Project Number:		18446		Test Technician:		Eric Lifsey			
Purchase Order #:		NA		Supervisor:		Lisa Arndt			
Equip. Under Test:		Proximity Detection Module		Witness' Name:		None			
Radiated Emissions Test Results Data Sheet								Page: 1 of 1	
EUT Line Voltage:		1: 5 VDC, 2: 3.6 V		EUT Power Frequency:		0 N/A			
Antenna Orientation:		Vertical		Frequency Range:		Above 1GHz			
EUT Mode of Operation:				EUT 1 & 2 Transmit/Receive Hopping					
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
24030.1	3	99	1	Average	35.2	31.107	54.0	-22.9	Pass
24392.2	3	168	1	Average	35.6	31.654	54.0	-22.3	Pass
24800.2	3	262	1	Average	36.4	32.576	54.0	-21.4	Pass

Professional Testing, EMI, Inc
Radiated Emissions, Measured at 1m and Scaled to 3m Distance
18-26.5 GHz Vertical Polarity Measured Emissions

Operator: Eric Lifsey
18446'RERun01'PDM'EUT1+EUT2'SpuriousTX
11:28:54 AM, Monday, February 06, 2017

Mode: Both samples Tx/Rx, hopping
Sample 1: 5 VDC
Sample 2: 3.6 V Battery

EUT: Proximity Detector Module
Project Number: 18446
Client: Hetronic

> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

Test Method: ANSI C63.10-2013

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): 2/6/2017

EUT Serial #: 1: none, 2: none

Customer: Hetronic

EUT Part #: 1: none, 2: none

Project Number: 18446

Test Technician: Eric Lifsey

Purchase Order #: NA

Supervisor: Lisa Arndt

Equip. Under Test: Proximity Detection Module

Witness' Name: None

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage: 1: 5 VDC,
2: 3.6 V

EUT Power Frequency: 0 N/A

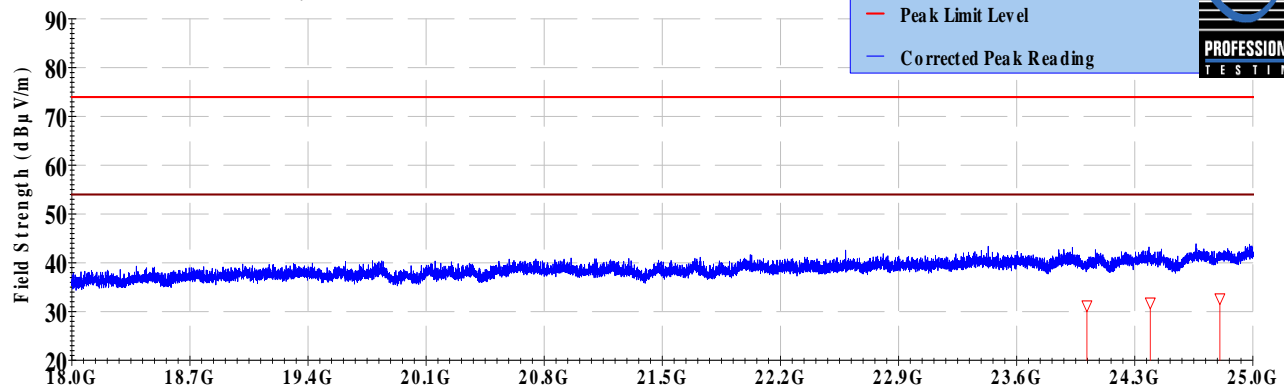
Antenna Orientation: Horizontal

Frequency Range: Above 1GHz

EUT Mode of Operation:
EUT 1 & 2 Transmit/Receive Hopping

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
24016.8	3	360	1	Average	35.4	31.242	54.0	-22.7	Pass
24392.3	3	476	1	Average	35.8	31.824	54.0	-22.1	Pass
24805.1	3	230	1	Average	36.5	32.669	54.0	-21.3	Pass

Professional Testing, EMI, Inc

 Radiated Emissions, Measured at 1m and Scaled to 3m Distance
 18-26.5 GHz Horizontal Polarity Measured Emissions


Operator: Eric Lifsey

18446'RERun01 PDM'EUT1+EUT2'SpuriousTXSet Mode: Both samples Tx/Rx, hopping

11:28:54 AM, Monday, February 06, 2017 Sample 1: 5 VDC Sample 2: 3.6 V Battery

EUT: Proximity Detector Module

Project Number: 18446

Client: Hetronic

> 1GHz Horizontal Antenna Polarity Measured Emissions

8.0 Antenna Construction Requirements

8.1 Procedure

A direct examination of the antenna construction is performed and compared to rule criteria that prevent wireless device antennas from being modified by end users.

8.2 Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.203, 15.247 // RSS-Gen 8.3	Antenna Construction	20 Apr 2017

8.3 Results

Table 8.3.1 Antenna Construction Details
On-Board Chip Antenna (2 antennas on board)
Manufacturer: Johanson Technology Model/PN: 2450AT45A100E Gain 2.2 dBi Soldered to circuit board, internal to system, and not subject to user modification.
External RP-TNC Dipole Antenna (2 used)
Manufacturer: Gainflex Model/PN: GK-442TF-R 2.4GHz TNC-Plug Rev. Polarity Length 154 mm Antenna gain 5 dBi. Uses reverse-polarized center pin to avoid user substitution.

The antenna system design above satisfies the requirements of the rules.

9.0 Equipment

9.1 Radiated Emissions 30 MHz to 25 GHz

Radiated Emissions Test Equipment List					
Tile! Software Version:		4.2.A, May 23, 2010, 08:38:52 AM			
Test Profile:		2016 RE_ClassA - Boresite+Mast_LowPRF_120516.til or 2016 RE_ClassB - Boresite+Mast_LowPRF_120516.til			
Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1509A	Braden	N/A	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	7/10/2017
1890	HP	8447F	Preamp/Amp, 9kHz-1300MHz, 28/25dB	3313A05298	2/1/2018
1937	Agilent	E4440A	Spectrum Analyzer, 3 Hz - 26.5 GHz, Opt. AYZ	MY44808298	11/15/2017
2172	ETS-Lindgren	3142C	Antenna, Biconilog, 26 MHz-3GHz	49383	11/27/2018
C027D	PTI	None	Relay	none	N/A
1327	EMCO	1050	Controller, Antenna Mast	none	N/A
0942	EMCO	11968D	Turntable, 4ft.	9510-1835	N/A
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
1509B	Braden	N/A	TDK 10M Chamber, VSWR > 1 GHz	DAC-012915-005	6/19/2017
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, .1-18GHz	0	1/11/2018
C030	none	none	Cable Coax, N-N, 30m	none	10/1/2017
1325	EMCO	1050	Controller, Antenna Mast	9003-1461	N/A
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	110313	2/25/2017
1443	HP	6216B	Power Supply, DC, 25V 400mA	1139A11716	N/A
524	EMCO	1060-1.211	Controller, Turntable	9111-1588	N/A
2295	Keysight	E4440A-AYZ	PSA Spectrum Analyzer	MY46186204	7/18/2017
1542	A.H. Systems	SAS-572	Antenna, Horn 18-26.5GHz, 20dB gain	225	11/20/2018
1974	Agilent	83017A	Amplifier, Microwave 0.5-26.5 GHz	MY39500684	11/17/2018

9.2 Power, Bandwidth, Duty Cycle, Band Edge, Conducted Spurious

Asset #	Manufacturer	Model #	Description	Calibration Due
2295	Agilent	E4440A	Spectrum Analyzer	30 Sep 2017
1831	HP	6622A	Power Supply	CIU
0472	Tektronix	THS730A	DMM/Scope	15 Nov 2017

10.0 Measurement Bandwidths

Radiated Emissions Spectrum Analyzer Bandwidth and Measurement Time - Peak Scan				
Frequency Band Start (MHz)	Frequency Band Stop (MHz)	6 dB Bandwidth (kHz)	Number of Ranges Used	Measurement Time per Range
0.009	0.15	0.3	2	Multiple Sweeps
0.15	30	9	6	Multiple Sweeps
30	1000	120	2	Multiple 800 mS Sweeps
1000	6000	1000	2	Multiple Sweeps
6000	18000	1000	2	Multiple Sweeps
18000	26500	1000	2	Multiple Sweeps
<p>*Notes:</p> <ol style="list-style-type: none"> 1. The settings above are specifically calculated for the E4440A series of spectrum analyzers, which have 8,000 data points per range. 2. The measurement receiver resolution bandwidth setting was 300 Hz for quasi-peak measurements from 9-150 kHz. 3. The measurement receiver resolution bandwidth setting was 9 kHz for quasi-peak measurements from 0.15-30 MHz. 4. The measurement receiver resolution bandwidth setting was 120 kHz for quasi-peak measurements from 30-1000 MHz. 5. The measurement receiver resolution bandwidth setting was 1 MHz for average measurements from 1-18 GHz. 				

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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