Project 17687-15

Pruf Energy Controls
PEC915V10

Wireless Certification Report
Additional Antennas
Permissive Change

Prepared for:

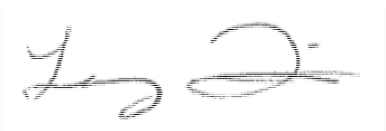
Pruf Energy Controls
100 Research Parkway
Suite 2265
Waco, TX 76704

By

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

11 Dec 2015

Reviewed by



Larry Finn
Chief Technical Officer

Written by

Eric Lifsey
EMC Engineer

Revision History

Revision Number	Description	Date
00	Draft for review.	9 Dec 2015
01	Revised per reviewer comments.	11 Dec 2015

Table of Contents

Revision History 2
Compliance Certificate 4
1.0 Introduction 5
1.1 Scope 5
1.2 EUT Description 5
1.3 EUT Operation 5
1.4 Modifications to Equipment 5
1.5 Test Site 5
1.6 Radiated Measurements 6
1.7 Applicable Documents and Clauses 6
2.0 Radiated Spurious Emissions, Receive Mode 7
2.1 Test Procedure 7
2.2 Test Criteria 7
2.3 Test Results 7
3.0 Radiated Spurious Emissions, Transmit Mode, Antenna 3 16
3.1 Test Procedure 16
3.2 Test Criteria 16
3.3 Test Results 16
4.0 Radiated Spurious Emissions, Transmit Mode, Antenna 4 21
4.1 Test Procedure 21
4.2 Test Criteria 21
4.3 Test Results 21
5.0 Antenna Construction Requirements 26
5.1 Procedure 26
5.2 Criteria 26
5.3 Results 26
6.0 Equipment and Bandwidths 29
6.1 Equipment for Spurious Radiated Emissions 29
6.2 Measurement Bandwidths, Radiated Emissions 30
Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty 31
End of Report 32

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Compliance Certificate

Applicant	Device & Test Identification	
Pruf Energy Controls	FCC ID:	2ACB8-PEC915V10
100 Research Parkway	Industry Canada ID:	11970A-PEC915V10
Suite 2265	Model(s):	PEC915V10
Waco, TX 76704	Part Number(s):	N/A
Certificate Date: 11 Dec 2015	Laboratory Project ID:	17687-15

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

Standard	Reference	Detail
FCC 47 CFR Part 15 C	15.247	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
FCC 47 CFR Part 15 C	15.209	Radiated emission limits; general requirements.
KDB 558074 D01	DR01	DTS Measurement Guidance v03r02
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-210	Issue 8	Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
RSS-Gen	Issue 3	General Requirements and Information for the Certification of Radio Apparatus
RSS-102	Issue 4	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. The procedures of ANSI C63.4: 2009 were used for making all radiated enclosure and mains emission measurements.

1.2 EUT Description

The EUT as tested consisted of the following module and the #3 and #4 antennas listed. Antennas #1 and #2 were listed in the original module report and are included here to form a complete list.

Table 1.2.1: Equipment Under Test

Manufacturer	Model	Serial #	Description
Pruf Energy Controls	PEC915V10	none	Wireless transmitter/receiver module for 902 – 928 MHz.

Table 1.2.2: Complete Antenna List

#	Manufacturer / Model	Type	Gain dBi	Description
1	Pulse / Model W3538	Printed multiband	2.8	Printed-circuit antenna with cable assembly
2	Pruf Energy Controls	Helical	0.0	Inductively-loaded helical wire
3	Pruf Energy Controls	Short Inverted-F "Badge"	0.0	Printed circuit antenna
4	Linx Antenna Factor / Model ANT-916-PML	Dipole	-0.4	Dipole antenna with cable assembly

The EUT is powered by a 3.3 Volts DC.

1.3 EUT Operation

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

The EUT internal software operated the transmitter in a continuous modulated mode.

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

Radiated levels are determined as follows:

Raw Measured Level + Antenna Factor + Cable Losses – Amplifier Gain = Corrected Level

Additionally, measurement distance extrapolation factors are applied where needed.

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 1	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 C63.4 2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low Voltage Electrical and Electronic Equipment

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
Spurious Emission	15.247, 15.209, 15.205	RSS-247 5.5, RSS-GEN 4.9, 4.10
Antenna Requirement	15.203	RSS-Gen 8.3

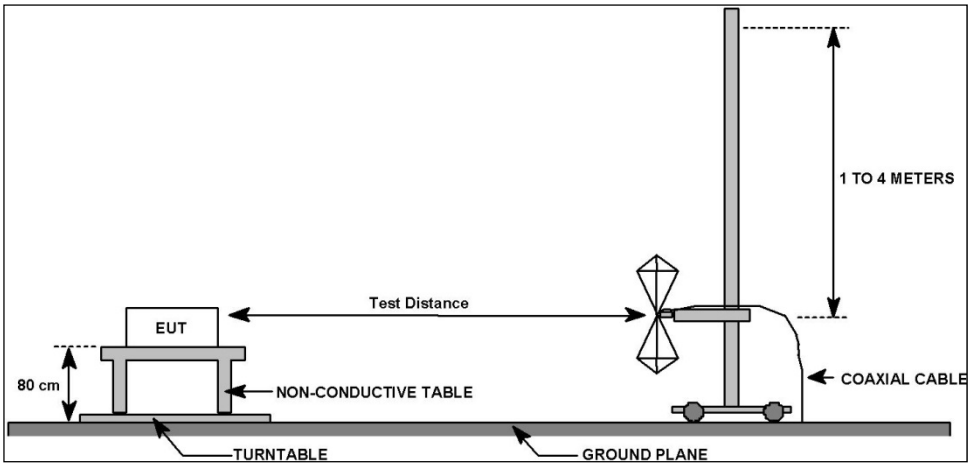
This report supplements test report 15590.

2.0 Radiated Spurious Emissions, Receive Mode

2.1 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. A diagram showing the test setup appears below.



2.2 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	4 Dec 2015

2.3 Test Results

Emission measurements of receiver spurious were taken for each of the added antennas. The EUT was tuned to the middle channel.

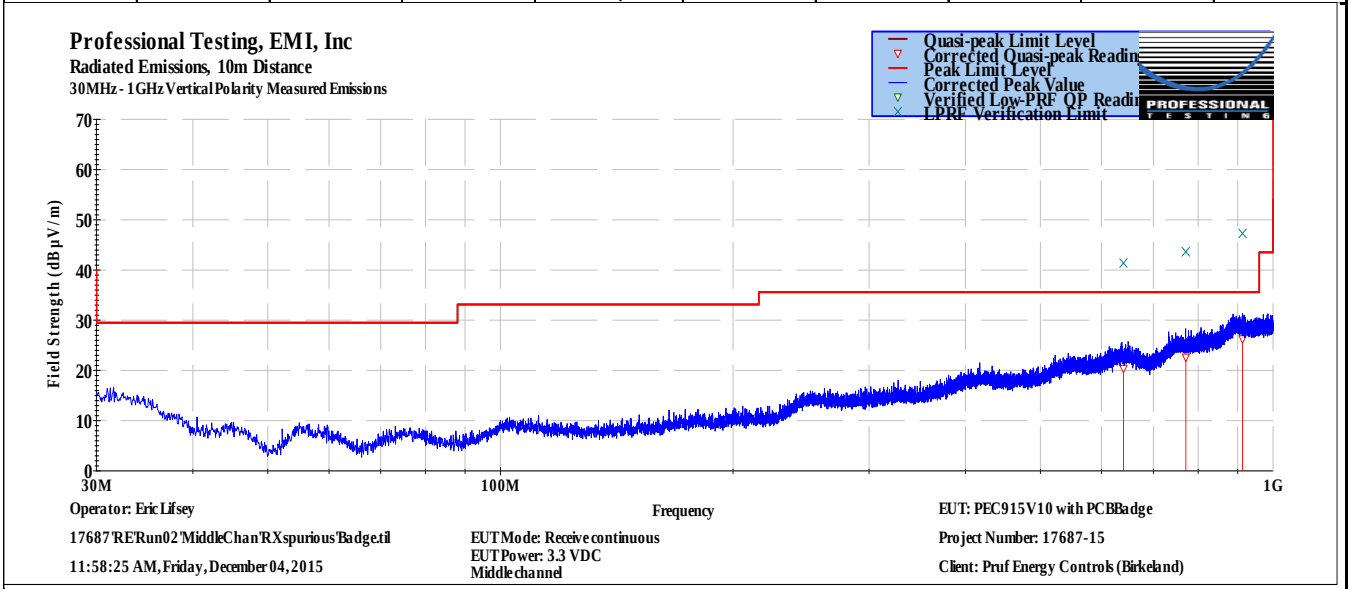
The EUT satisfied the criteria. Recorded data is presented below.

Table 2.3.1: Radiated Spurious Emissions, Receive Mode, Below 1 GHz, Vertical Polarity Antenna 3

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):	12/4/2015	EUT Serial #:	0
Customer:	Pruf Energy Controls	EUT Part #:	PCBBadge Antenna
Project Number:	17687-15	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	PEC915V10 with PCBBadge	Witness' Name:	JD Holland

Radiated Emissions Test Results Data Sheet			Page:	1	of	1
EUT Line Voltage:	3.3	VDC	EUT Power Frequency:	0	N/A	
Antenna Orientation:	Vertical		Frequency Range:	30MHz to 1GHz		
EUT Mode of Operation:	Receive					

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
640.527	10	147	2.28	Quasi-peak	21.9	20.393	35.6	-15.2	Pass
771.206	10	221	1.8	Quasi-peak	21.6	22.614	35.6	-13.0	Pass
913.271	10	96	2.81	Quasi-peak	21.2	26.279	35.6	-9.3	Pass



≤ 1GHz Vertical Antenna Polarity Measured Emissions

Table 2.3.2: Radiated Spurious Emissions, Receive Mode, Below 1 GHz, Horizontal Polarity Antenna 3

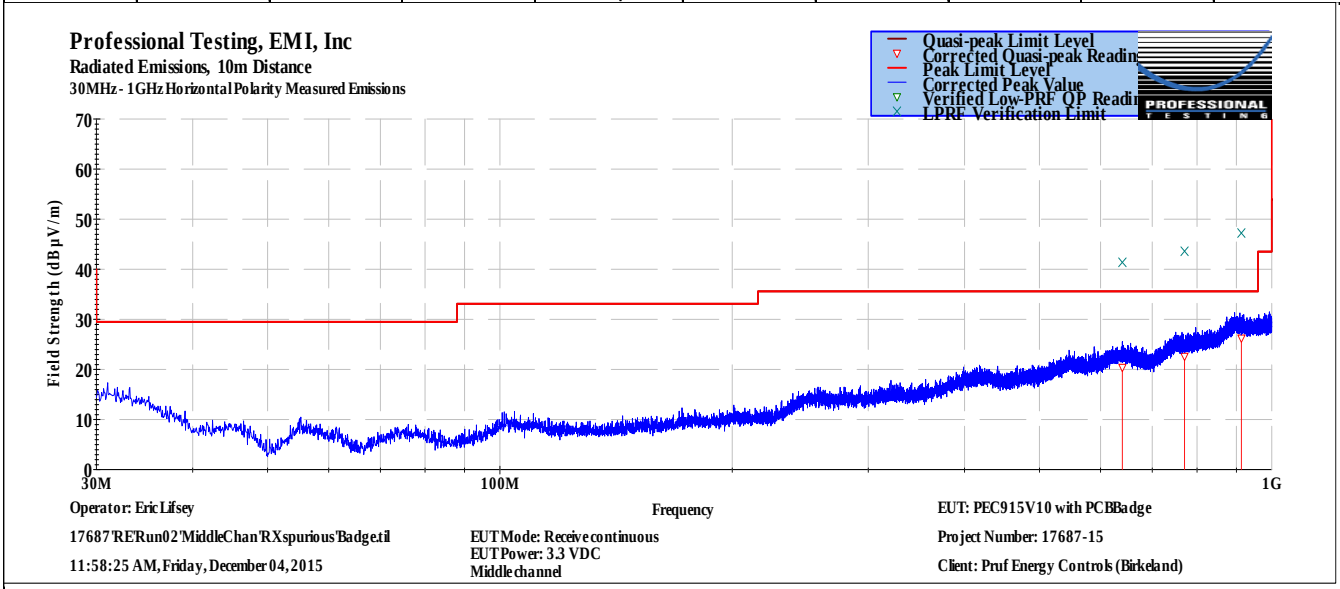
Professional Testing, EMI, Inc.

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):	12/4/2015	**EUT Serial #:**	0
Customer:	Pruf Energy Controls	**EUT Part #:**	PCBBadge Antenna
Project Number:	17687-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	PEC915V10 with PCBBadge	**Witness' Name:**	JD Holland

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

EUT Line Voltage:	3.3 VDC	**EUT Power Frequency:**	0 N/A
Antenna Orientation:	Horizontal	**Frequency Range:**	30MHz to 1GHz
EUT Mode of Operation:		Receive	

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
640.516	10	327	3.6	Quasi-peak	21.9	20.4	35.6	-15.2	Pass
770.942	10	82	2.96	Quasi-peak	21.6	22.609	35.6	-13.0	Pass
913.401	10	78	3.65	Quasi-peak	21.2	26.247	35.6	-9.4	Pass



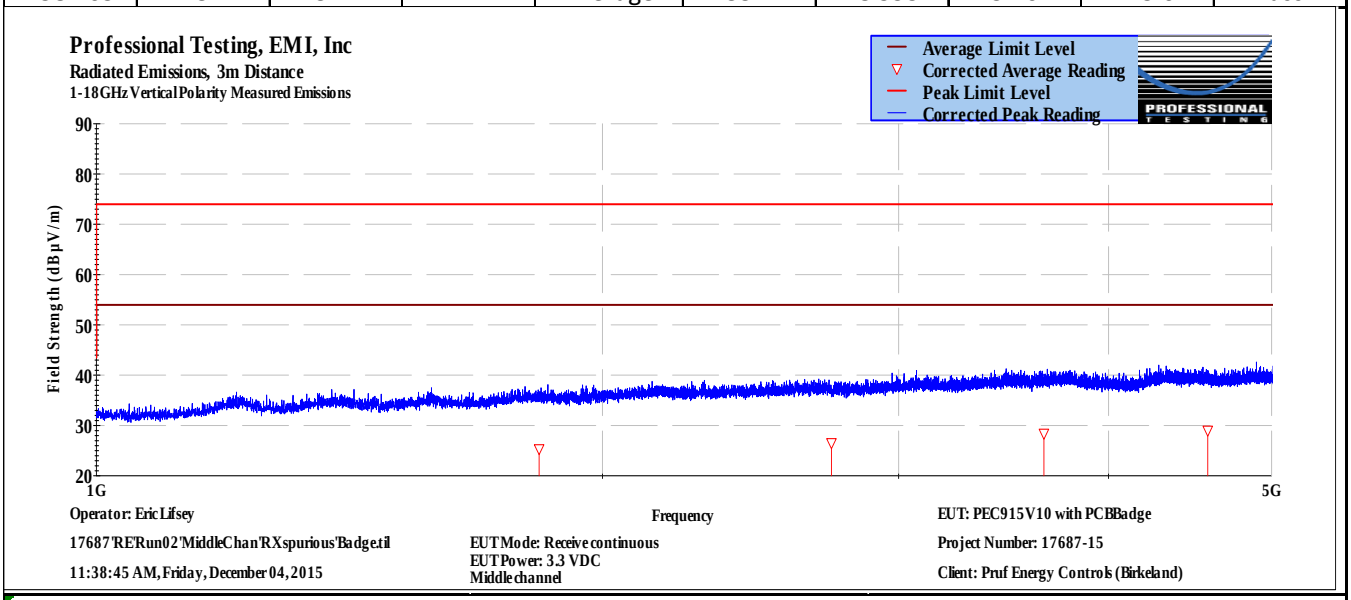
≤ 1GHz Horizontal Antenna Polarity Measured Emissions

Table 2.3.3: Radiated Spurious Emissions, Receive Mode, Above 1 GHz, Vertical Polarity Antenna 3

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):	12/4/2015	EUT Serial #:	0
Customer:	Pruf Energy Controls	EUT Part #:	PCBBadge Antenna
Project Number:	17687-15	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	PEC915V10 with PCBBadge	Witness' Name:	JD Holland

Radiated Emissions Test Results Data Sheet			Page:	1	of	1
EUT Line Voltage:	3.3	VDC	EUT Power Frequency:	0	N/A	
Antenna Orientation:	Vertical		Frequency Range:	Above 1GHz		
EUT Mode of Operation:			Receive			

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
1833.85	3	3	1	Average	35.1	25.335	54.0	-28.6	Pass
2736.43	3	10	1	Average	34.4	26.532	54.0	-27.4	Pass
3661.27	3	194	1	Average	34.5	28.424	54.0	-25.5	Pass
4581.65	3	342	1	Average	33.1	28.995	54.0	-25.0	Pass



> 1GHz Vertical Antenna Polarity Measured Emissions

Table 2.3.4: Radiated Spurious Emissions, Receive Mode, Above 1 GHz, Horizontal Polarity Antenna 3

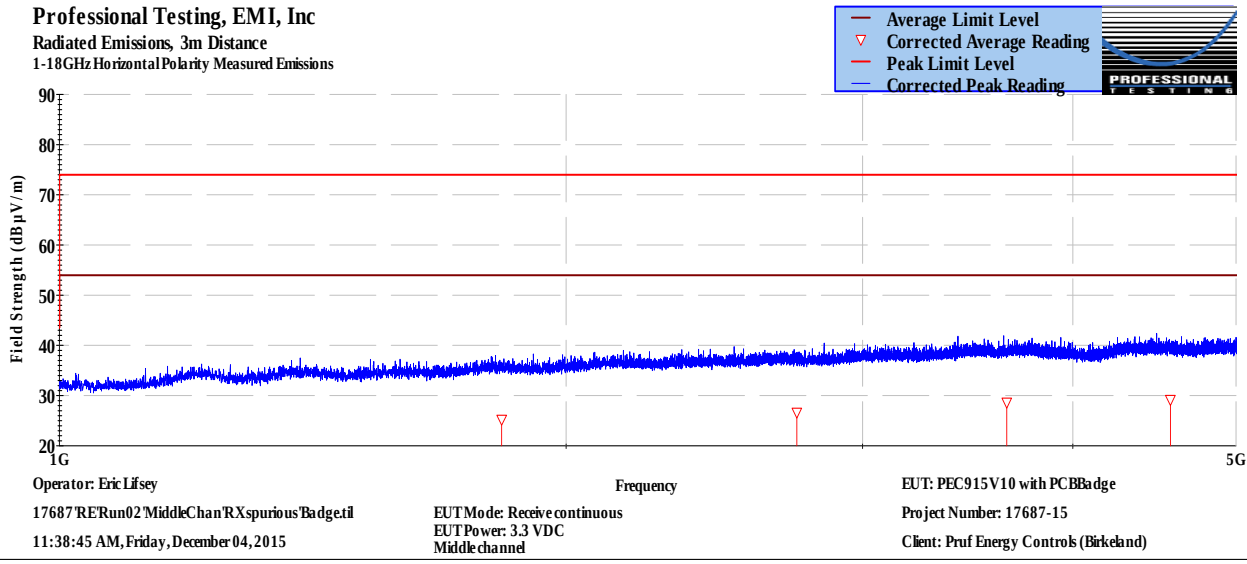
Professional Testing, EMI, Inc.

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):	12/4/2015	**EUT Serial #:**	0
Customer:	Pruf Energy Controls	**EUT Part #:**	PCBBadge Antenna
Project Number:	17687-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	PEC915V10 with PCBBadge	**Witness' Name:**	JD Holland

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

EUT Line Voltage:	3.3 VDC	**EUT Power Frequency:**	0 N/A
Antenna Orientation:	Horizontal	**Frequency Range:**	Above 1GHz
EUT Mode of Operation:		Receive	

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
1831.18	3	17	1	Average	35.1	25.247	54.0	-28.7	Pass
2742.11	3	289	1	Average	34.5	26.647	54.0	-27.3	Pass
3654.44	3	161	1	Average	34.7	28.631	54.0	-25.3	Pass
4571.08	3	207	1	Average	33.2	29.177	54.0	-24.8	Pass



> 1GHz Horizontal Antenna Polarity Measured Emissions

Table 2.3.5: Radiated Spurious Emissions, Receive Mode, Below 1 GHz, Vertical Polarity Antenna 4

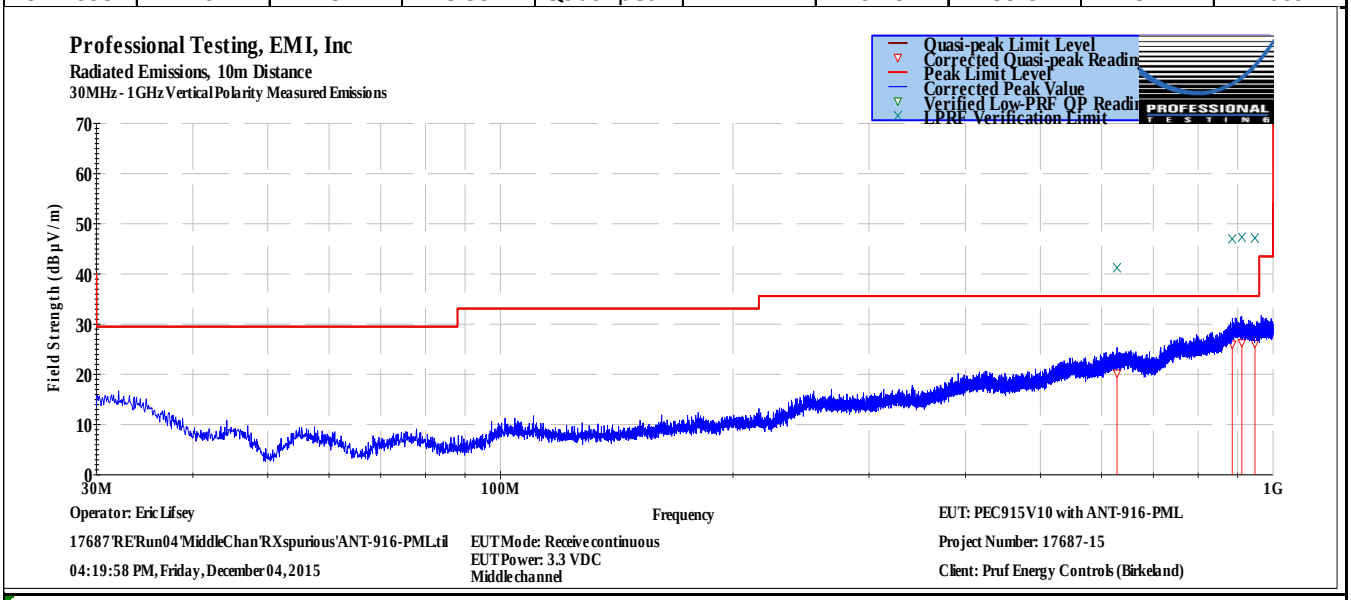
Professional Testing, EMI, Inc.

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):	12/4/2015	**EUT Serial #:**	0
Customer:	Pruf Energy Controls	**EUT Part #:**	ANT-916-PML Antenna
Project Number:	17687-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	PEC915V10 with ANT-916-PML	**Witness' Name:**	JD Holland

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

EUT Line Voltage:	3.3 VDC	**EUT Power Frequency:**	0 N/A
Antenna Orientation:	Vertical	**Frequency Range:**	30MHz to 1GHz
EUT Mode of Operation:		Receive	

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
628.483	10	250	3.84	Quasi-peak	22	20.249	35.6	-15.4	Pass
885.882	10	133	1.9	Quasi-peak	21.4	25.996	35.6	-9.6	Pass
911.391	10	186	1.75	Quasi-peak	21.2	26.304	35.6	-9.3	Pass
947.655	10	182	3.99	Quasi-peak	21	26.161	35.6	-9.4	Pass



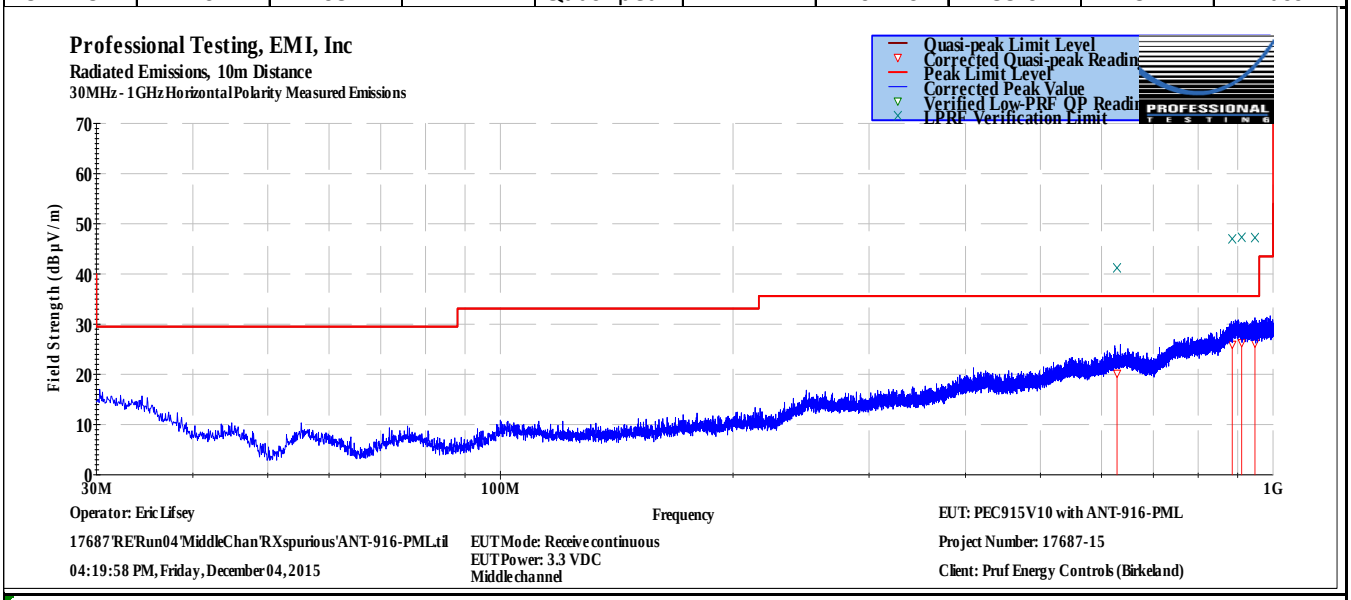
≤ 1GHz Vertical Antenna Polarity Measured Emissions

Table 2.3.6: Radiated Spurious Emissions, Receive Mode, Below 1 GHz, Horizontal Polarity Antenna 4

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):	12/4/2015	**EUT Serial #:**	0
Customer:	Pruf Energy Controls	**EUT Part #:**	ANT-916-PML Antenna
Project Number:	17687-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	PEC915V10 with ANT-916-PML	**Witness' Name:**	JD Holland

Radiated Emissions Test Results Data Sheet			Page: 1 of 1
EUT Line Voltage:	3.3 VDC	**EUT Power Frequency:**	0 N/A
Antenna Orientation:	Horizontal	**Frequency Range:**	30MHz to 1GHz
EUT Mode of Operation:		Receive	

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
628.527	10	198	1.25	Quasi-peak	22	20.204	35.6	-15.4	Pass
885.968	10	174	1.13	Quasi-peak	21.4	25.988	35.6	-9.6	Pass
911.195	10	14	2.18	Quasi-peak	21.2	26.3	35.6	-9.3	Pass
947.792	10	63	4	Quasi-peak	21	26.226	35.6	-9.4	Pass



≤ 1GHz Horizontal Antenna Polarity Measured Emissions

Table 2.3.7: Radiated Spurious Emissions, Receive Mode, Above 1 GHz, Vertical Polarity Antenna 4

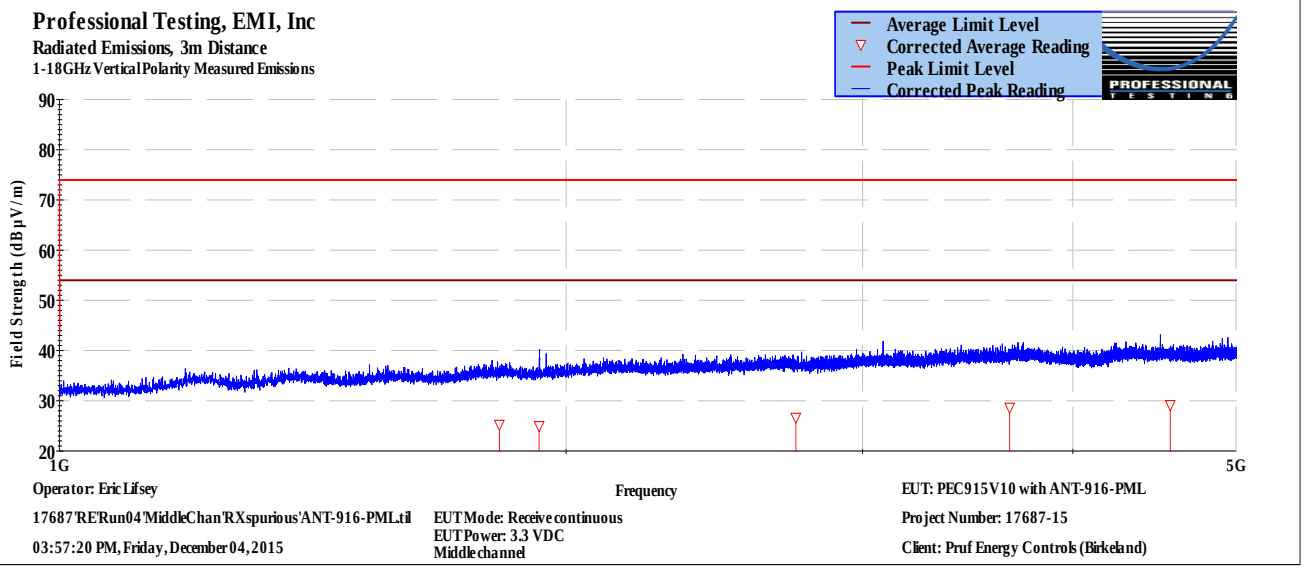
Professional Testing, EMI, Inc.

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):	12/4/2015	**EUT Serial #:**	0
Customer:	Pruf Energy Controls	**EUT Part #:**	ANT-916-PML Antenna
Project Number:	17687-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	PEC915V10 with ANT-916-PML	**Witness' Name:**	JD Holland

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

EUT Line Voltage:	3.3	VDC	**EUT Power Frequency:**	0	N/A
Antenna Orientation:	Vertical		**Frequency Range:**	Above 1GHz	
EUT Mode of Operation:	Receive				

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
1825.32	3	41	1	Average	35.1	25.281	54.0	-28.7	Pass
1927.63	3	151	1	Average	34.1	24.992	54.0	-29.0	Pass
2738.44	3	174	1	Average	34.6	26.679	54.0	-27.3	Pass
3668.77	3	357	1	Average	34.7	28.673	54.0	-25.3	Pass
4570.6	3	3	1	Average	33.2	29.169	54.0	-24.8	Pass



> 1GHz Vertical Antenna Polarity Measured Emissions

Table 2.3.8: Radiated Spurious Emissions, Receive Mode, Above 1 GHz, Horizontal Polarity Antenna 4

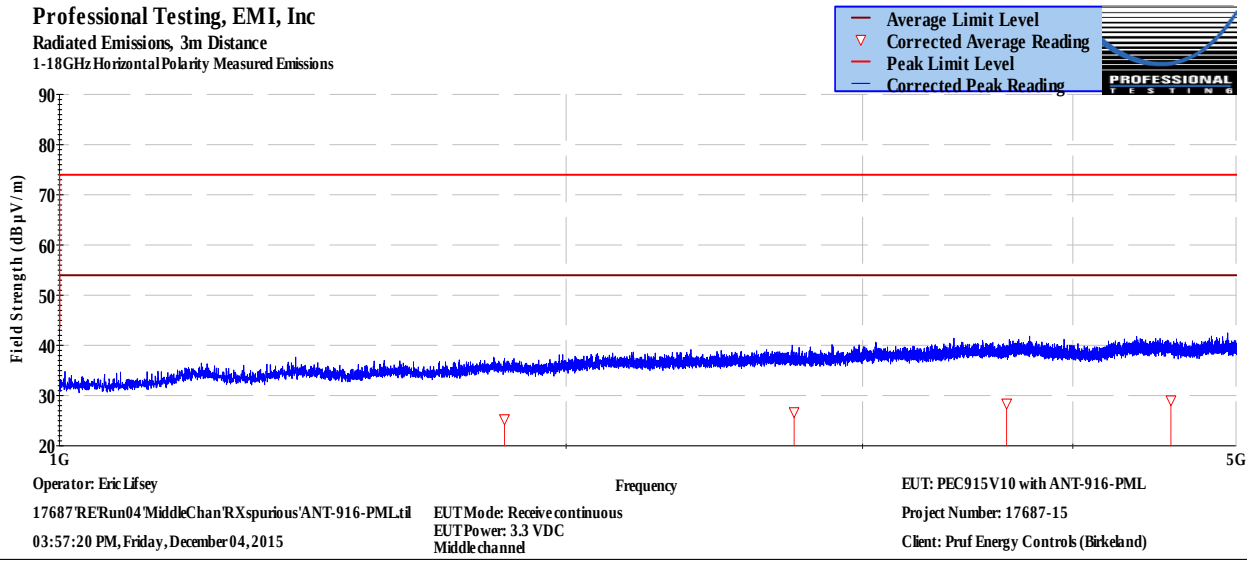
Professional Testing, EMI, Inc.

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):	12/4/2015	**EUT Serial #:**	0
Customer:	Pruf Energy Controls	**EUT Part #:**	ANT-916-PML Antenna
Project Number:	17687-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	PEC915V10 with ANT-916-PML	**Witness' Name:**	JD Holland

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

EUT Line Voltage:	3.3 VDC	**EUT Power Frequency:**	0 N/A
Antenna Orientation:	Horizontal	**Frequency Range:**	Above 1GHz
EUT Mode of Operation:		Receive	

Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
1838.18	3	332	1	Average	35.1	25.332	54.0	-28.6	Pass
2731.77	3	43	1	Average	34.7	26.756	54.0	-27.2	Pass
3653.68	3	230	1	Average	34.5	28.446	54.0	-25.5	Pass
4575.19	3	140	1	Average	33.2	29.106	54.0	-24.9	Pass



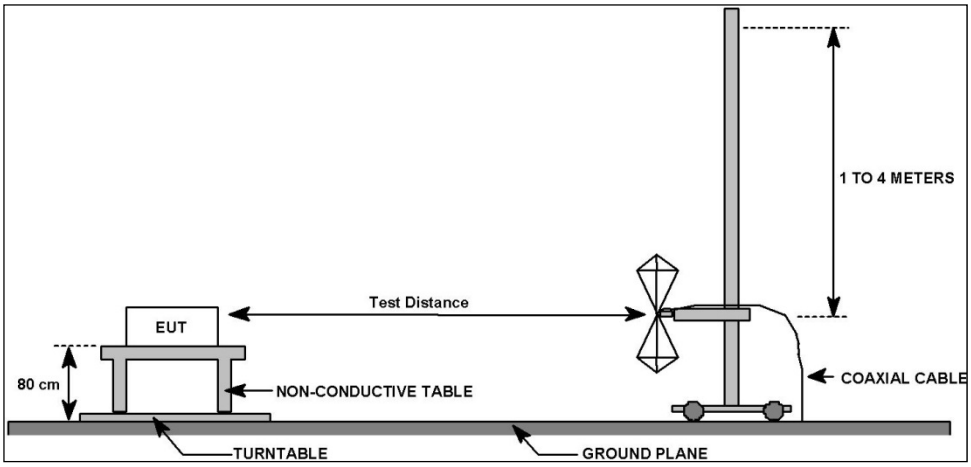
> 1GHz Horizontal Antenna Polarity Measured Emissions

3.0 Radiated Spurious Emissions, Transmit Mode, Antenna 3

3.1 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. A diagram showing the test setup appears below.



3.2 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	4 Dec 2015

3.3 Test Results

Three EUT and antenna samples were tested simultaneously to cover all three essential channels. Signals appear at wide enough intervals to be easily discerned.

The applicable duty cycle factor for averaging harmonics above 1 GHz is 0 dB. All peak emissions can be seen as falling below the average limit, meaning the average level would also be under the average limit.

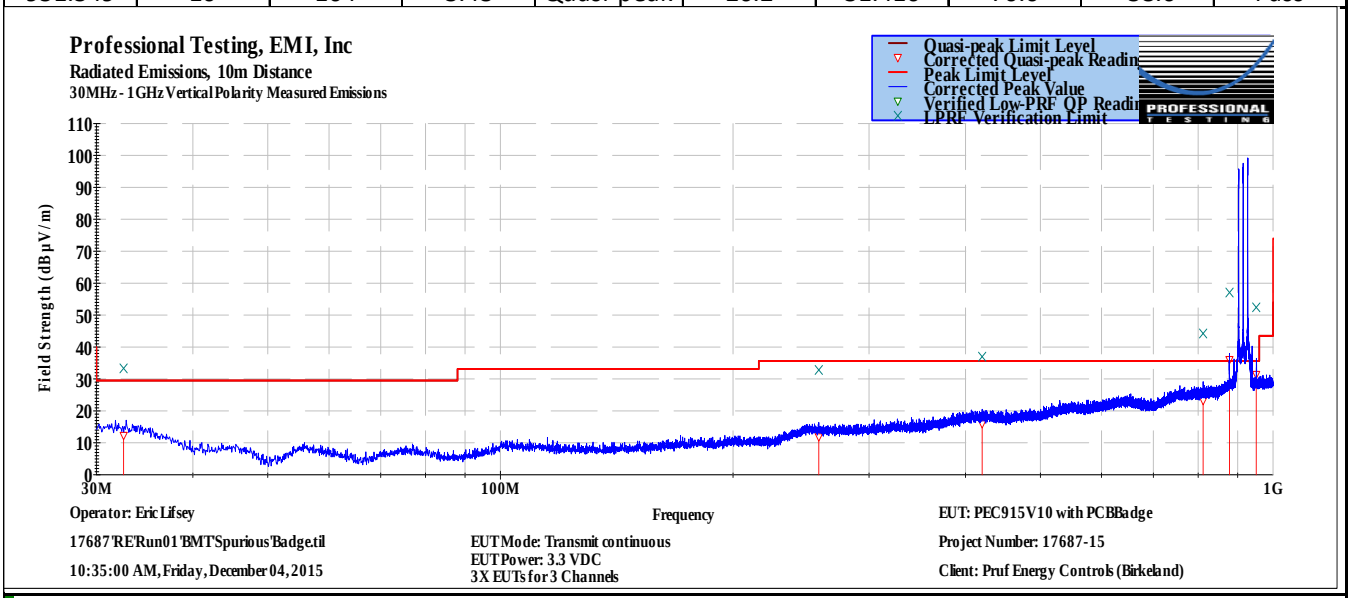
Also, certain harmonics, specifically the 2nd harmonic around 1.8 GHz, are outside of the restricted bands; as such the 15.247 -20 dBc criteria applies. Limit shown is conservative estimate using rounded-down to nearest 10 dB point then reduced 20 dB resulting in 70 dBµV/m limit.

Table 3.3.1: Radiated Spurious Emissions, TX Mode, Below 1 GHz, Vertical Polarity
Antenna 3

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):	12/4/2015	**EUT Serial #:**	0
Customer:	Pruf Energy Controls	**EUT Part #:**	PCBBadge Antenna
Project Number:	17687-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	PEC915V10 with PCBBadge	**Witness' Name:**	JD Holland

Radiated Emissions Test Results Data Sheet			Page: 1 of 1		
EUT Line Voltage:	3.3	VDC	**EUT Power Frequency:**	0	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
32.5312	10	148	3.4	Quasi-peak	23.8	12.301	29.5	-17.2	Pass
258.334	10	357	2.04	Quasi-peak	22.1	11.817	35.6	-23.8	Pass
420.398	10	138	1.25	Quasi-peak	22.2	15.977	35.6	-19.6	Pass
812.21	10	315	2.28	Quasi-peak	21.4	23.233	35.6	-12.4	Pass
878.437	10	289	3.43	Quasi-peak	31.9	36.042	70.0	-34.0	Pass
951.549	10	164	3.48	Quasi-peak	26.2	31.416	70.0	-38.6	Pass



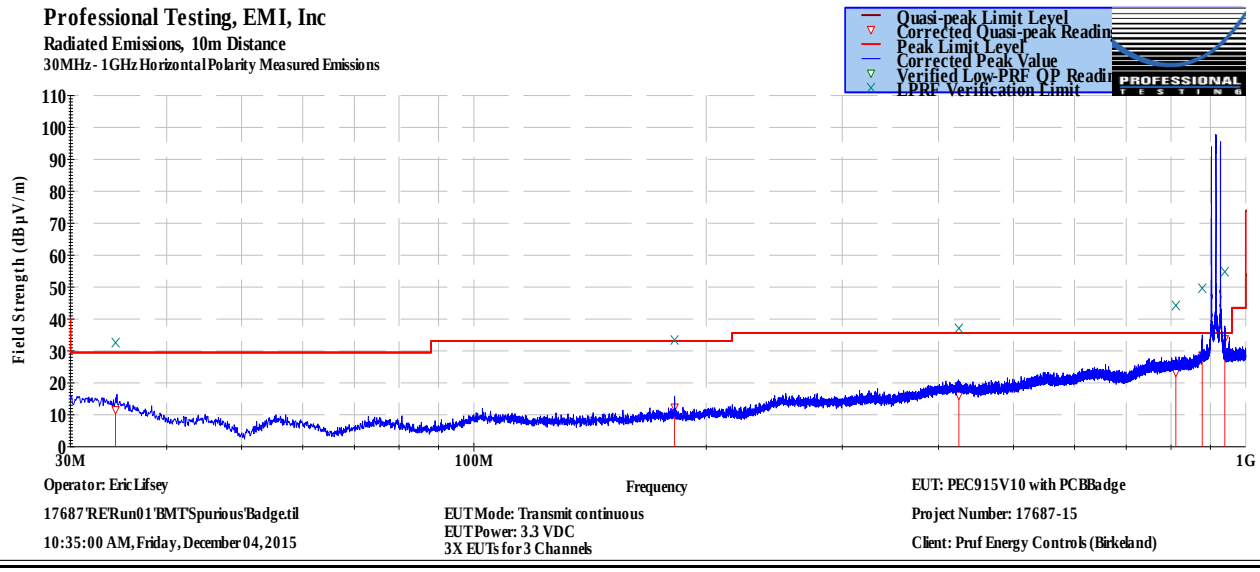
≤ 1GHz Vertical Antenna Polarity Measured Emissions

Table 3.3.2: Radiated Spurious Emissions, TX Mode, Below 1 GHz, Horizontal Polarity Antenna 3

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):	12/4/2015	EUT Serial #:	0
Customer:	Pruf Energy Controls	EUT Part #:	PCBBadge Antenna
Project Number:	17687-15	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	PEC915V10 with PCBBadge	Witness' Name:	JD Holland

Radiated Emissions Test Results Data Sheet			Page:	1	of	1
EUT Line Voltage:	3.3	VDC	EUT Power Frequency:	0	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
34.3375	10	180	1.53	Quasi-peak	23.1	11.602	29.5	-17.9	Pass
181.968	10	8	1.48	Quasi-peak	27.5	12.416	33.1	-20.7	Pass
424.818	10	237	1.21	Quasi-peak	22.2	16.091	35.6	-19.5	Pass
812.069	10	70	1.66	Quasi-peak	21.4	23.246	35.6	-12.4	Pass
878.453	10	60	1.43	Quasi-peak	24.5	28.651	70.0	-41.3	Pass
939.554	10	121	3.56	Quasi-peak	28.7	33.818	70.0	-36.2	Pass

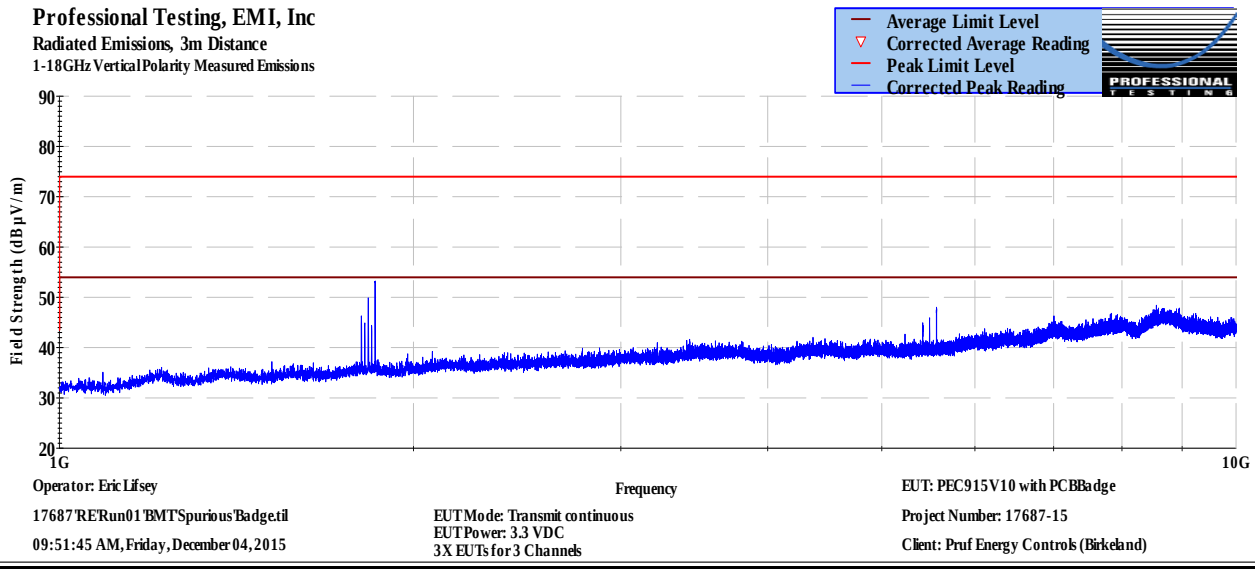


≤ 1GHz Horizontal Antenna Polarity Measured Emissions

Table 3.3.3: Radiated Spurious Emissions, TX Mode, Above 1 GHz, Vertical Polarity
Antenna 3

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):	12/4/2015	**EUT Serial #:**	0
Customer:	Pruf Energy Controls	**EUT Part #:**	PCBBadge Antenna
Project Number:	17687-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	PEC915V10 with PCBBadge	**Witness' Name:**	JD Holland

Radiated Emissions Test Results Data Sheet			Page: 1 of 1		
EUT Line Voltage:	3.3	VDC	**EUT Power Frequency:**	0	N/A
Antenna Orientation:	Vertical		**Frequency Range:**	Above 1GHz	
EUT Mode of Operation:	Transmit				



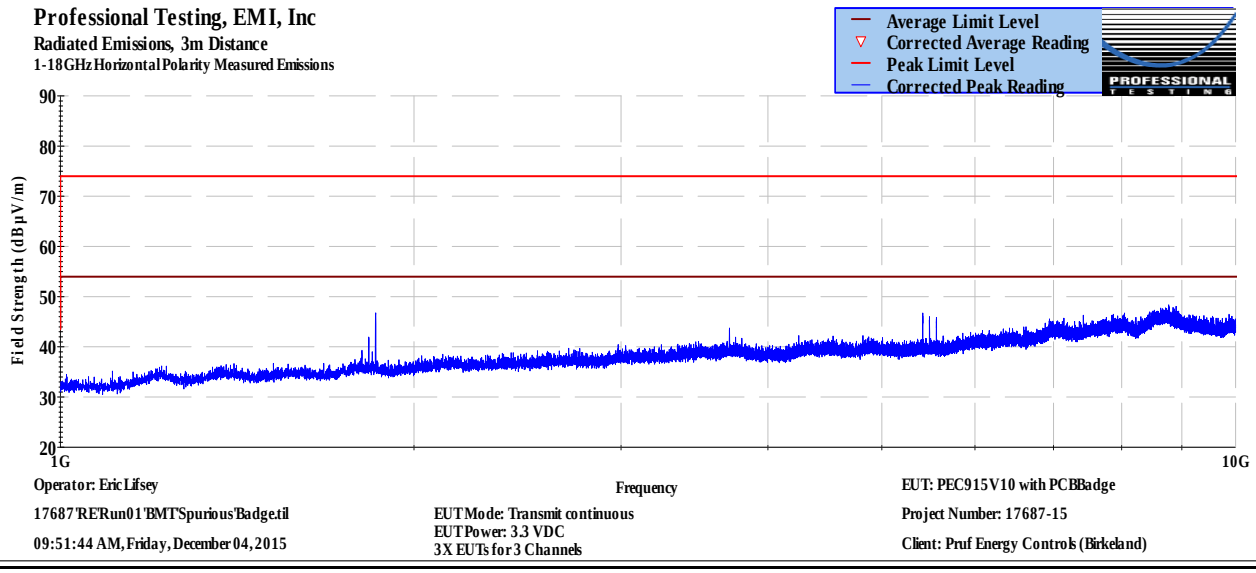
> 1GHz Vertical Antenna Polarity Measured Emissions

Note that the ~1.8 GHz harmonic emissions appearing above are subject to the 15.247 -20 dBc criteria with a limit of ~95 dBµV/m.

Table 3.3.4: Radiated Spurious Emissions, TX Mode, Above 1 GHz, Horizontal Polarity Antenna 3

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):	12/4/2015	EUT Serial #:	0
Customer:	Pruf Energy Controls	EUT Part #:	PCBBadge Antenna
Project Number:	17687-15	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	PEC915V10 with PCBBadge	Witness' Name:	JD Holland

Radiated Emissions Test Results Data Sheet			Page:	1	of	1
EUT Line Voltage:	3.3	VDC	EUT Power Frequency:	0	N/A	
Antenna Orientation:	Horizontal		Frequency Range:	Above 1GHz		
EUT Mode of Operation:			Transmit			



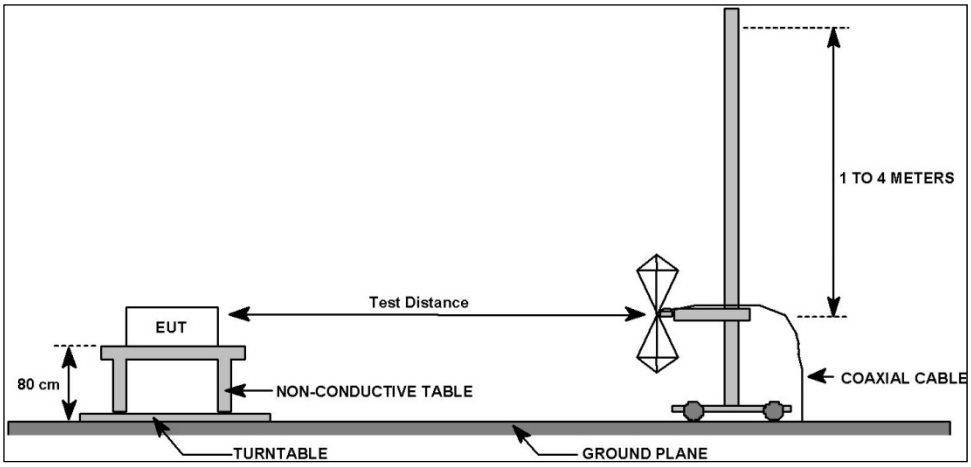
> 1GHz Horizontal Antenna Polarity Measured Emissions

4.0 Radiated Spurious Emissions, Transmit Mode, Antenna 4

4.1 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. A diagram showing the test setup appears below.



4.2 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	4 Dec 2015

4.3 Test Results

Three EUT and antenna samples were tested simultaneously to cover all three essential channels. Signals appear at wide enough intervals to be easily discerned.

The applicable duty cycle factor for averaging harmonics above 1 GHz is 0 dB. All peak emissions can be seen as falling below the average limit, meaning the average level would also be under the average limit. Also, certain harmonics, specifically the 2nd harmonic around 1.8 GHz, are outside of the restricted bands; as such the 15.247 -20 dBc criteria applies.

Table 4.3.1: Radiated Spurious Emissions, TX Mode, Below 1 GHz, Vertical Polarity
Antenna 4

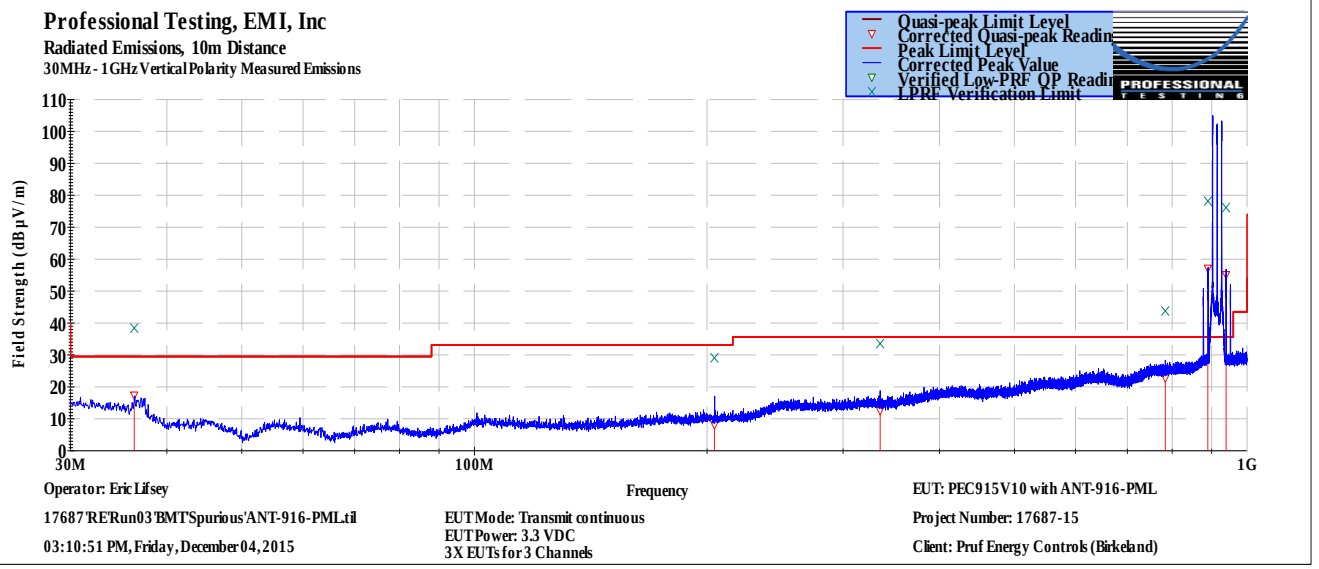
Professional Testing, EMI, Inc.

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):	12/4/2015	**EUT Serial #:**	0
Customer:	Pruf Energy Controls	**EUT Part #:**	ANT-916-PML Antenna
Project Number:	17687-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	PEC915V10 with ANT-916-PML	**Witness' Name:**	JD Holland

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

EUT Line Voltage:	3.3	VDC	**EUT Power Frequency:**	0	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
36.2881	10	188	3.04	Quasi-peak	30.6	17.392	29.5	-12.1	Pass
204.514	10	262	2.41	Quasi-peak	22.4	8.101	33.1	-25.0	Pass
335.099	10	305	1.28	Quasi-peak	22.1	12.542	35.6	-23.1	Pass
784.143	10	204	3.16	Quasi-peak	21.5	22.774	35.6	-12.8	Pass
890.293	10	6	3.21	Quasi-peak	52.3	57.169	70.0	-12.8	Pass
939.494	10	20	3.35	Quasi-peak	50.1	55.15	70.0	-14.9	Pass



≤ 1GHz Vertical Antenna Polarity Measured Emissions

Table 4.3.2: Radiated Spurious Emissions, TX Mode, Below 1 GHz, Horizontal Polarity
Antenna 4

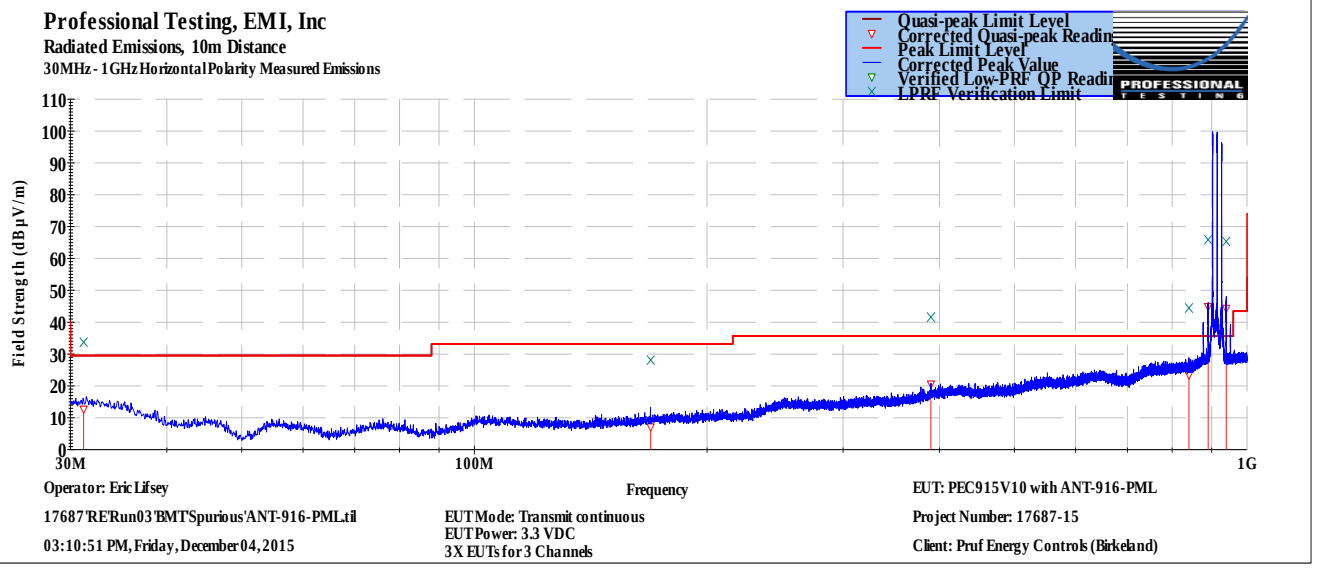
Professional Testing, EMI, Inc.

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):	12/4/2015	**EUT Serial #:**	0
Customer:	Pruf Energy Controls	**EUT Part #:**	ANT-916-PML Antenna
Project Number:	17687-15	**Test Technician:**	Eric Lifsey
Purchase Order #:	NA	**Supervisor:**	Lisa Arndt
Equip. Under Test:	PEC915V10 with ANT-916-PML	**Witness' Name:**	JD Holland

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

EUT Line Voltage:	3.3 VDC	**EUT Power Frequency:**	0 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
31.2059	10	174	3.73	Quasi-peak	24.1	12.679	29.5	-16.8	Pass
169.156	10	168	3.55	Quasi-peak	22.6	7.102	33.1	-26.0	Pass
389.971	10	292	2.84	Quasi-peak	28.1	20.554	35.6	-15.0	Pass
841.429	10	77	3.6	Quasi-peak	21.4	23.403	35.6	-12.2	Pass
890.629	10	69	1.23	Quasi-peak	40.1	44.9	70.0	-25.1	Pass
940.244	10	290	1.19	Quasi-peak	39.2	44.319	70.0	-25.7	Pass

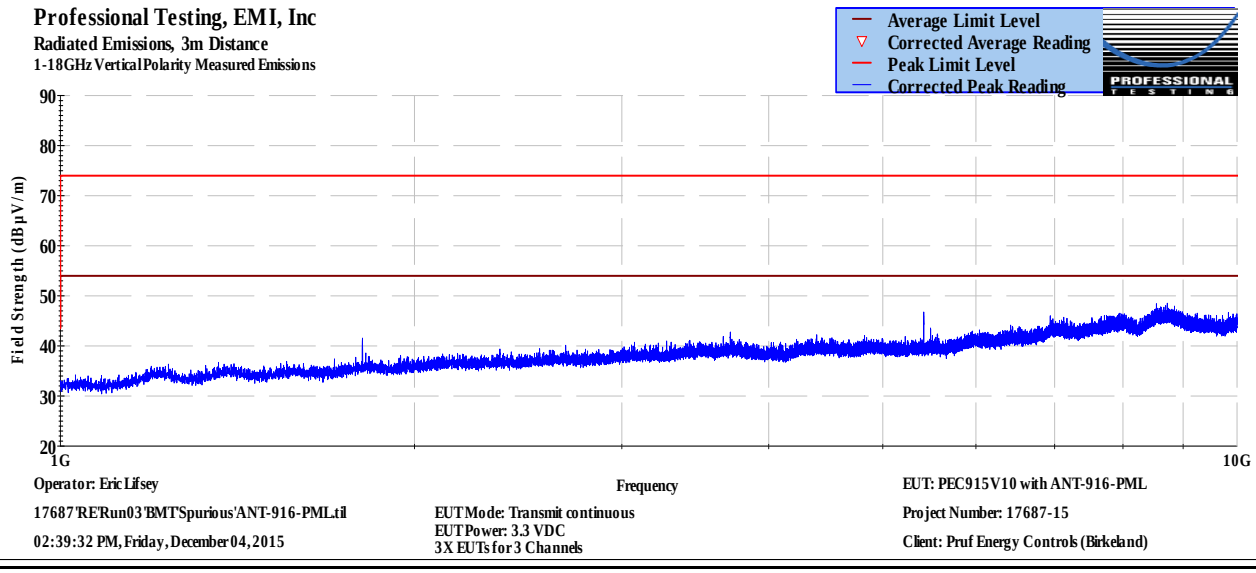


≤ 1GHz Horizontal Antenna Polarity Measured Emissions

Table 4.3.3: Radiated Spurious Emissions, TX Mode, Above 1 GHz, Vertical Polarity
Antenna 4

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):	12/4/2015	EUT Serial #:	0
Customer:	Pruf Energy Controls	EUT Part #:	ANT-916-PML Antenna
Project Number:	17687-15	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	PEC915V10 with ANT-916-PML	Witness' Name:	JD Holland

Radiated Emissions Test Results Data Sheet			Page:	1	of	1
EUT Line Voltage:	3.3	VDC	EUT Power Frequency:	0	N/A	
Antenna Orientation:	Vertical		Frequency Range:	Above 1GHz		
EUT Mode of Operation:			Transmit			

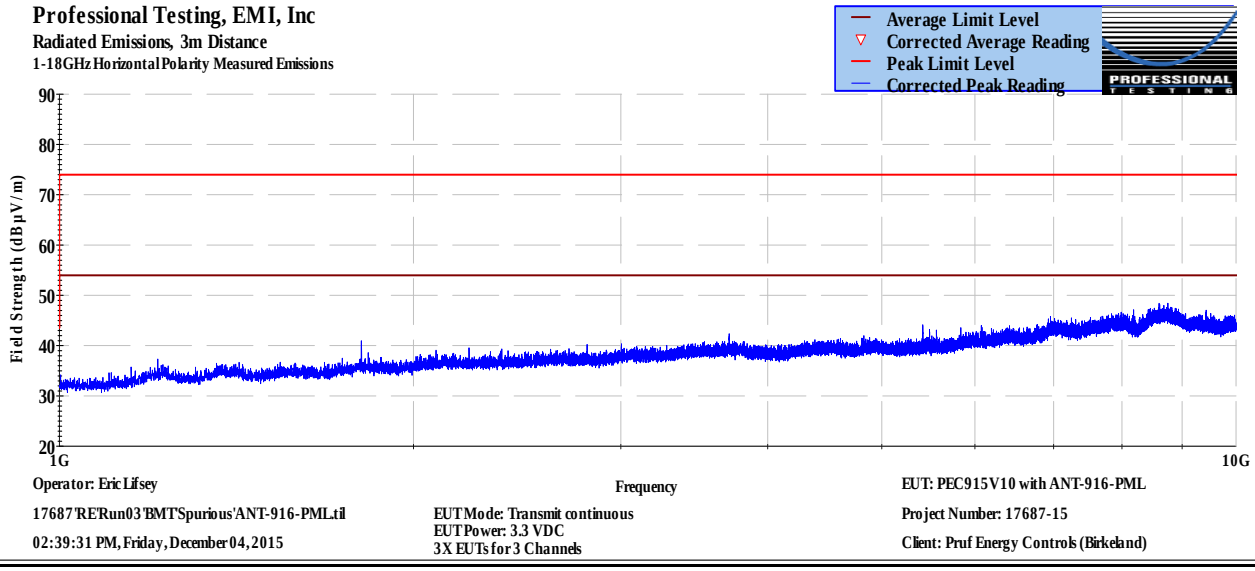


> 1GHz Vertical Antenna Polarity Measured Emissions

Table 4.3.4: Radiated Spurious Emissions, TX Mode, Above 1 GHz, Horizontal Polarity
Antenna 4

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):	12/4/2015	EUT Serial #:	0
Customer:	Pruf Energy Controls	EUT Part #:	ANT-916-PML Antenna
Project Number:	17687-15	Test Technician:	Eric Lifsey
Purchase Order #:	NA	Supervisor:	Lisa Arndt
Equip. Under Test:	PEC915V10 with ANT-916-PML	Witness' Name:	JD Holland

Radiated Emissions Test Results Data Sheet			Page:	1	of	1
EUT Line Voltage:	3.3	VDC	EUT Power Frequency:	0	N/A	
Antenna Orientation:	Horizontal		Frequency Range:	Above 1GHz		
EUT Mode of Operation:			Transmit			



> 1GHz Horizontal Antenna Polarity Measured Emissions

5.0 Antenna Construction Requirements

5.1 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 in ways that would void their authorization to use the device. Note that this device is supplied as a modular unit.

5.2 Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.203 // RSS-Gen 8.3	Antenna Construction	9 Dec 2015

5.3 Results

Antenna 1

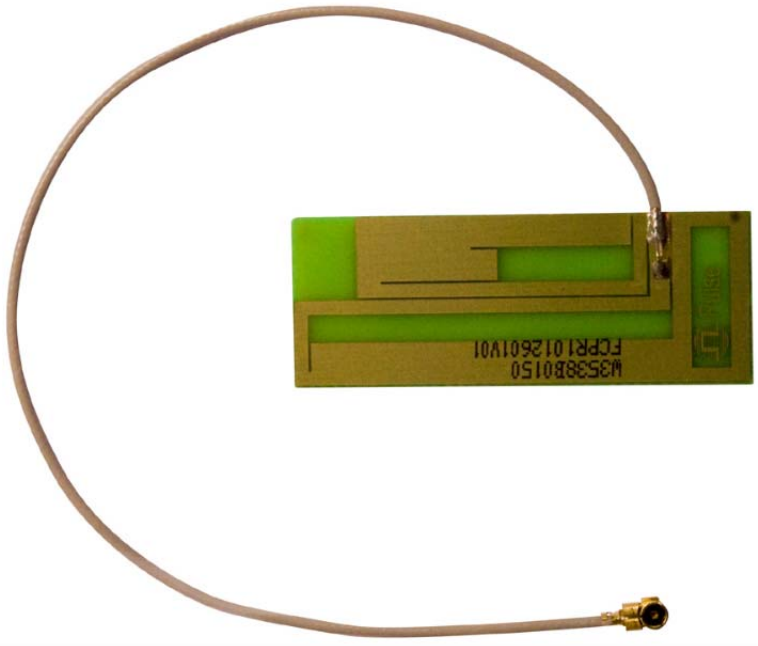
Antenna Manufacturer and Model	**Specifications**
Pulse Antenna USA 12220 World Trade Drive Sand Diego, CA 92128, USA	Printed circuit antenna

W3538B0200 / W3538E0200/ W3538M0200 / W3538T0200

Typical free space performance, measured in test unit mechanics (position1.)

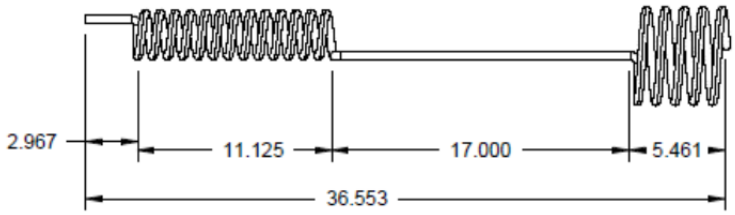
Frequency Range [MHz]	Max Gain [dBi]	Efficiency [%] / [dB]	Return loss min. [dB]	Impedance [Ω]	Operating Temperature [° C]
824 – 960	2,8 (peak) 0,5 (min)	70 / -1,6 (peak) 50 / -3,0 (min)	-6	50	-40 to +85

Appearance



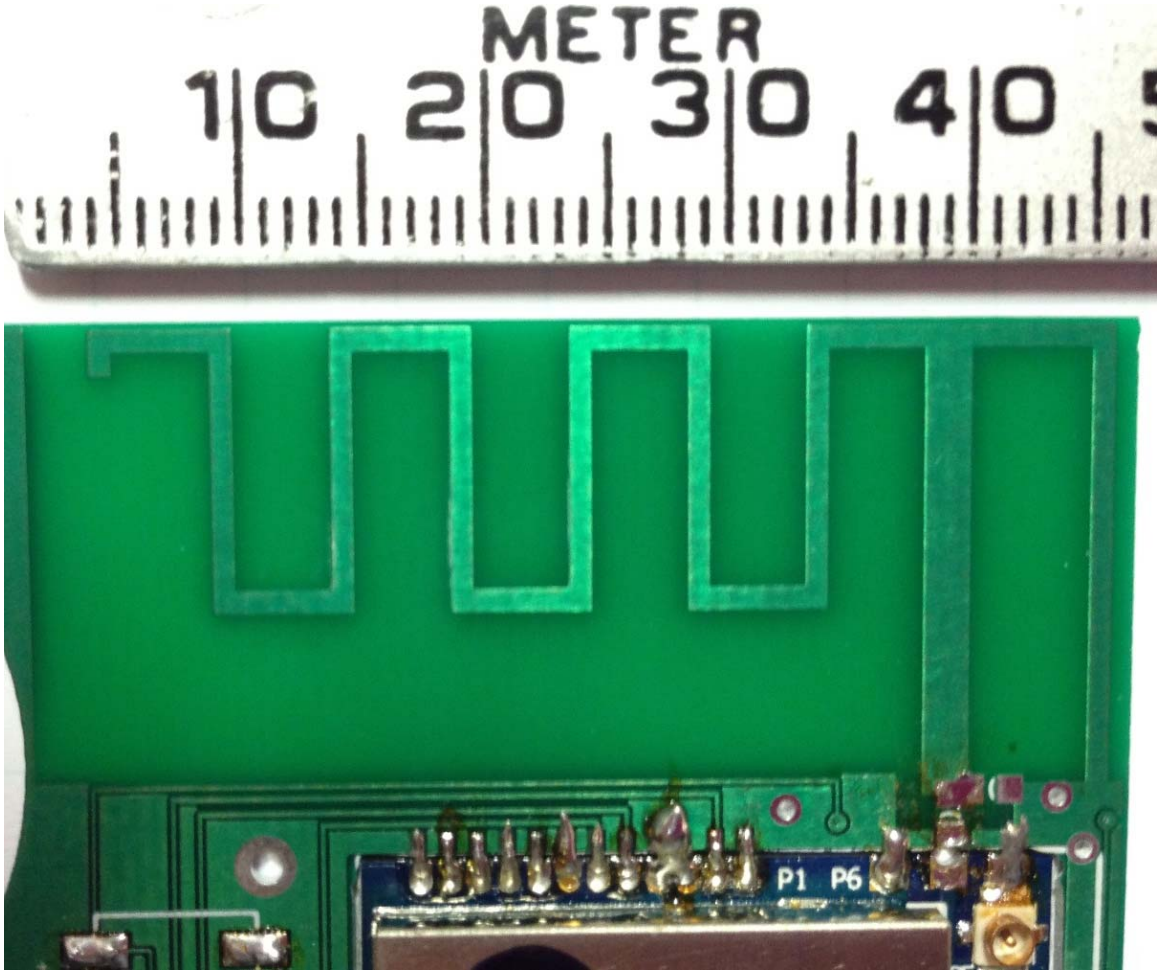
Antenna 2	
Antenna Manufacturer and Model	**Specifications**
Pruf Energy Controls PEC Drawing Number 34915-HELI	Helical Style (inductive loaded quarter-wave) Gain: 0 dBi Appearance:

Appearance

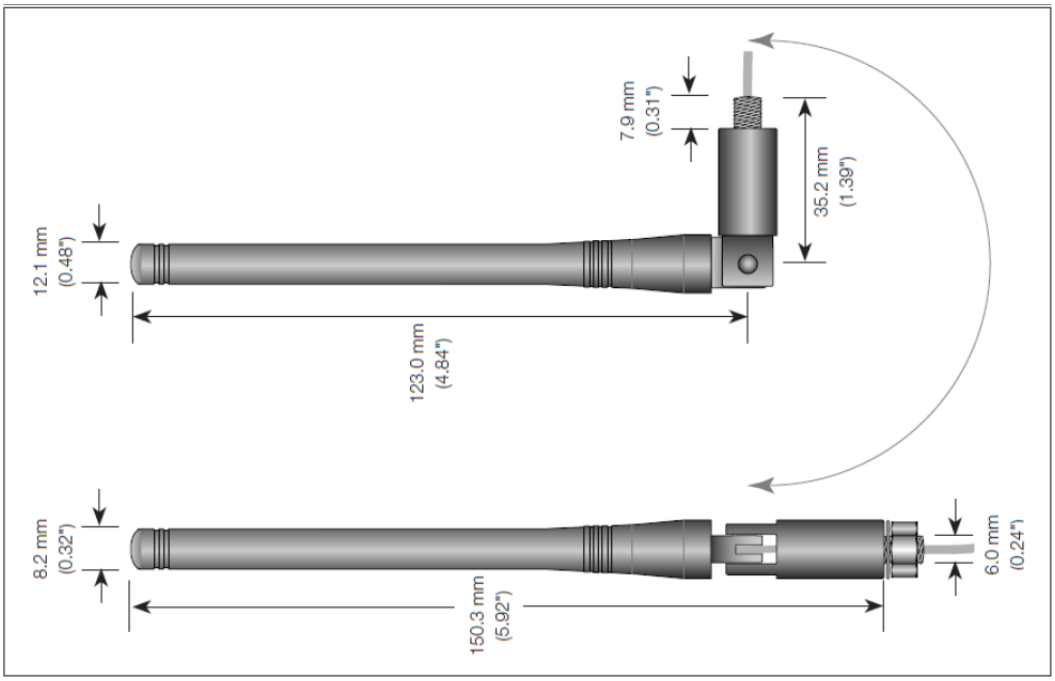


Antenna 3	
Antenna Manufacturer and Model	**Specifications**
Pruf Energy Controls PEC Drawing Number	Shortened inverted-F printed antenna (“Badge”) Gain: 0 dBi

Appearance (Units are cm)



Antenna 4	
Antenna Manufacturer and Model	**Specifications**
Linx Antenna Factor / Model ANT-916-PML	Dipole antenna with cable assembly Gain: -0.4 dBi:
Appearance	



- The final integrator is provided a list of antenna types and gains authorized for this device.
- Additional antennas, 3 and 4, are new types with gain of 0 dBi or lower.

The antenna designs above satisfy the requirements of the rules.

6.0 Equipment and Bandwidths

6.1 Equipment for Spurious Radiated Emissions

Radiated Emissions Test Equipment List					
Tile! Software Version:		**4.2.A, May 23, 2010, 08:38:52 AM**			
Test Profile:		**2015 Rad Emissions_ClassA - LowPRF_072715.til or 2015 Rad Emissions_ClassB - LowPRF_072715.til**			
Asset #	**Manufacturer**	**Model**	**Equipment Nomenclature**	**Serial Number**	**Calibration Due Date**
1509A	Braden	N/A	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	2/5/2016
1890	HP	8447F	Preamp/Amp, 9kHz-1300MHz, 28/25dB	3313A05298	2/6/2016
1937	Agilent	E4440A	Spectrum Analyzer, 3 Hz - 26.5 GHz	MY44303298	1/2/2016
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz	135454	1/25/2017
C027D	none	RG214	Cable Coax, N-N, 25m	none	10/1/2016
1327	EMCO	1050	Controller, Antenna Mast	none	N/A
0942	EMCO	11968D	Turntable, 4ft.	9510-1835	N/A
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
1509B	Braden	N/A	TDK 10M Chamber, VSWR > 1 GHz	DAC-012915-005	3/13/2016
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, .1-18GHz	0	12/29/2015
C030	none	none	Cable Coax, N-N, 30m	none	10/1/2016
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

6.2 Measurement Bandwidths, Radiated Emissions

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	300	2	Multiple Sweeps

*Notes:
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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