

## EMC TEST REPORT

**Report Number:** 101761367BOX-001c

**Project Number:** G101761367

**Report Issue Date:** 11/12/2014

**Product Designation:** Z-Wave Radio

**Standards:** FCC 47CFR PT 15C:2014 15.249  
FCC 47CFR PT 15B:2014  
RSS-210 Issue 8 December 2010  
RSS-Gen Issue 3 December 2010  
ICES-003 Issue 5 August 2012

Tested by:  
Intertek Testing Services NA, Inc.  
70 Codman Hill Road  
Boxborough, MA 01719  
USA

Client:  
PowerHouse Dynamcis Inc  
1 Bridge Street  
3rd Floor, Suite 301  
Newton, MA 02458  
USA

Report prepared by Reviewer



Vathana F. Ven / Senior Project Engineer

Report reviewed by



Michael F. Murphy / Sr. Staff Engineer, EMC

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## 1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested.

## 2 Test Summary

Section	Test full name	Result
3	Client Information	
4	Description of Equipment Under Test	
5	System Setup and Method	
6	Transmitter Fundamental Power (FCC 47CFR PT 15.249(a), RSS-210 Issue 8 December 2010)	Pass
7	Transmitter Spurious Emissions (FCC 47CFR PT 15.249(d), RSS-210 Issue 8 December 2010)	Pass
8	Receiver Spurious Emissions (FCC 47CFR PT 15.209, RSS-Gen Issue 3 December 2010, ICES-003 Issue 5 August 2012)	Pass
9	Transmitter Bandwidth (FCC 47CFR PT 2.1049, RSS-Gen Issue 3 December 2010)	No limit
10	Transmitter Duty Cycle (FCC 47CFR PT 15.35(c), RSS-Gen Issue 3 December 2010)	No limit
11	AC Mains Conducted Emissions (FCC 47CFR PT 15.107, RSS-Gen Issue 3 December 2010, ICES-003 Issue 5 August 2012)	Pass
12	Revision History	

**3 Client Information**

This EUT was tested at the request of:

**Client:**

PowerHouse Dynamcis Inc  
 1 Bridge Street  
 3rd Floor, Suite 301  
 Newton, MA 02458  
 USA

**Contact:** Benjamin Sprachman  
**Telephone:** 617-340-6582  
**Fax:** N/A  
**Email:** ben@powerhousedynamics.com

**4 Description of Equipment Under Test**

**Manufacturer:**

PowerHouse Dynamcis Inc  
 1 Bridge Street  
 3rd Floor, Suite 301  
 Newton, MA 02458  
 USA

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
Z-Wave Radio	PowerHouse Dynamics	950-000018	AG0778814411221

Receive Date:	08/14/2014, 11/07/2014
Received Condition:	Good
Type:	Production

**Description of Equipment Under Test (provided by client)**

The device is a Z-Wave Radio

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
120VAC	N/L	50/60Hz	1

**Operating modes of the EUT:**

No.	Descriptions of EUT Exercising
1	Continuously transmit
2	Rx mode

**Software used by the EUT:**

No.	Descriptions of EUT Exercising
1	None

**5 System Setup and Method**

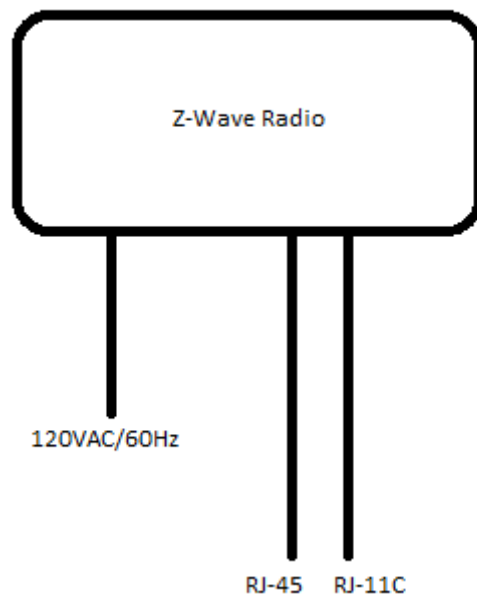
Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
1	AC cable	1	None	None	AC mains
2	RJ-45	5	None	None	Hub
3	RJ-11C	5	None	None	Unterminated

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Thermostat	PowerHouse Dynamics	N/A	N/A

**5.1 Method:**

Configuration as required by FCC Part 15C:2014, ANSI C63,4:2012.

**5.2 EUT Block Diagram:**



## 6 Transmitter Fundamental Power

### 6.1 Method

Tests are performed in accordance with FCC 47CFR Part 15 Subpart B Class B, FCC 47CFR Part 15 Subpart C Section 15.249, ANSI C63.10:2012, RSS-210, and ICES-003.

**TEST SITE:** 10m ALSE

**The 10m ALSE** is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

#### Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucisp
Radiated Emissions, 10m	30-1000 MHz	4.6	6.3
Radiated Emissions, 3m	30-1000 MHz	5.3	6.3
Radiated Emissions, 3m	1-6 GHz	4.5	5.2
Radiated Emissions, 3m	6-15 GHz	5.2	5.5
Radiated Emissions, 3m	15-18 GHz	5.0	5.5
Radiated Emissions, 3m	18-40 GHz	5.0	5.5

## Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB $\mu$ V/m
- RA = Receiver Amplitude (including preamplifier) in dB $\mu$ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB $\mu$ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB $\mu$ V/m. This value in dB $\mu$ V/m was converted to its corresponding level in  $\mu$ V/m.

RA = 52.0 dB $\mu$ V  
AF = 7.4 dB/m  
CF = 1.6 dB  
AG = 29.0 dB  
FS = 32 dB $\mu$ V/m

To convert from dB $\mu$ V to  $\mu$ V or mV the following was used:

$$UF = 10^{(NF / 20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$
$$NF = \text{Net Reading in dB}\mu\text{V}$$

### Example:

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$
$$UF = 10^{(32 \text{ dB}\mu\text{V} / 20)} = 39.8 \mu\text{V/m}$$

Alternately, when C5 Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". "AF" is the Antenna Factor; "PA+CL" are Preamp and Cable Loss. These are already accounted for in the "Level" column.

**6.2 Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV004	Weather Station	Davis Instruments	7400	PE80529A61A	10/06/2014	10/06/2015
145-410	Cables 145-400 145-403 145-405 145-406 145-407	Huber + Suhner	10m Track A Cables	multiple	10/04/2014	10/04/2015
145128	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/17/2014	03/17/2015
145145	Bilog Antenna (30MHz - 5GHz)	Sunol Sciences	JB5	A122313	01/07/2014	01/07/2015
145003	Preamplifier (150 KHz to 1.3 GHz)	Hewlett Packard	8447D	2443A04077	10/11/2014	10/11/2015

**Software Utilized:**

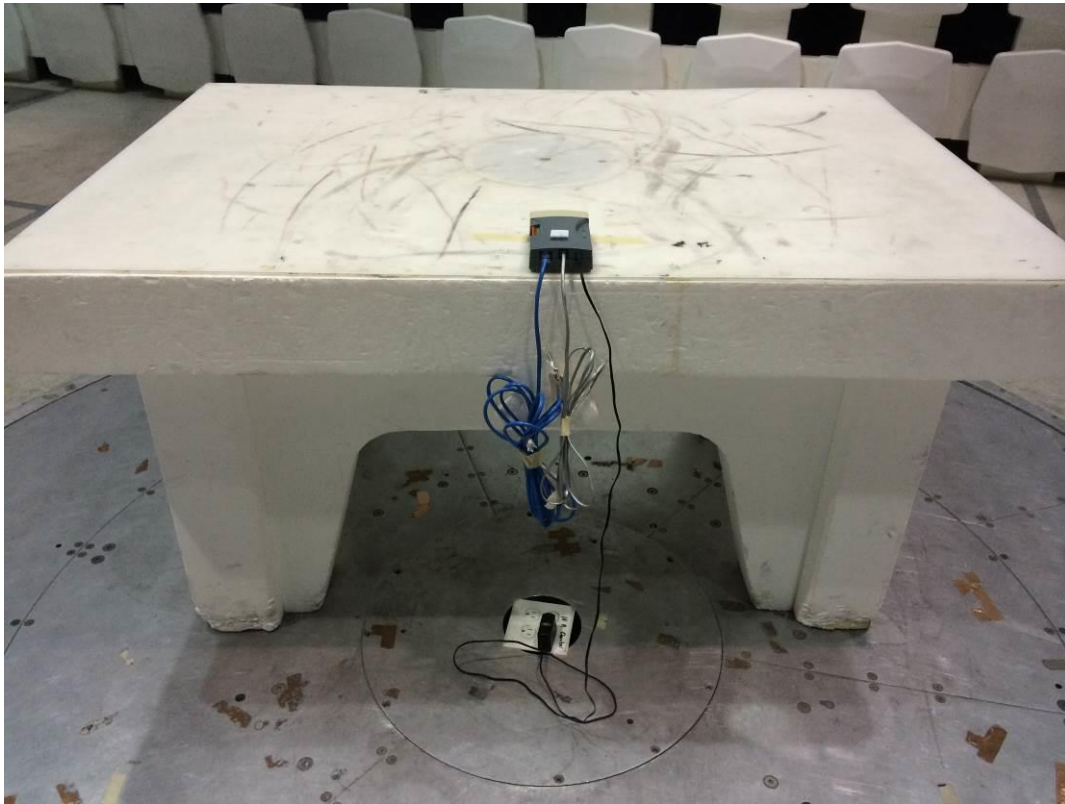
Name	Manufacturer	Version
C5	Teseq	5.26.46.46

**6.3 Results:**

The sample tested was found to Comply.

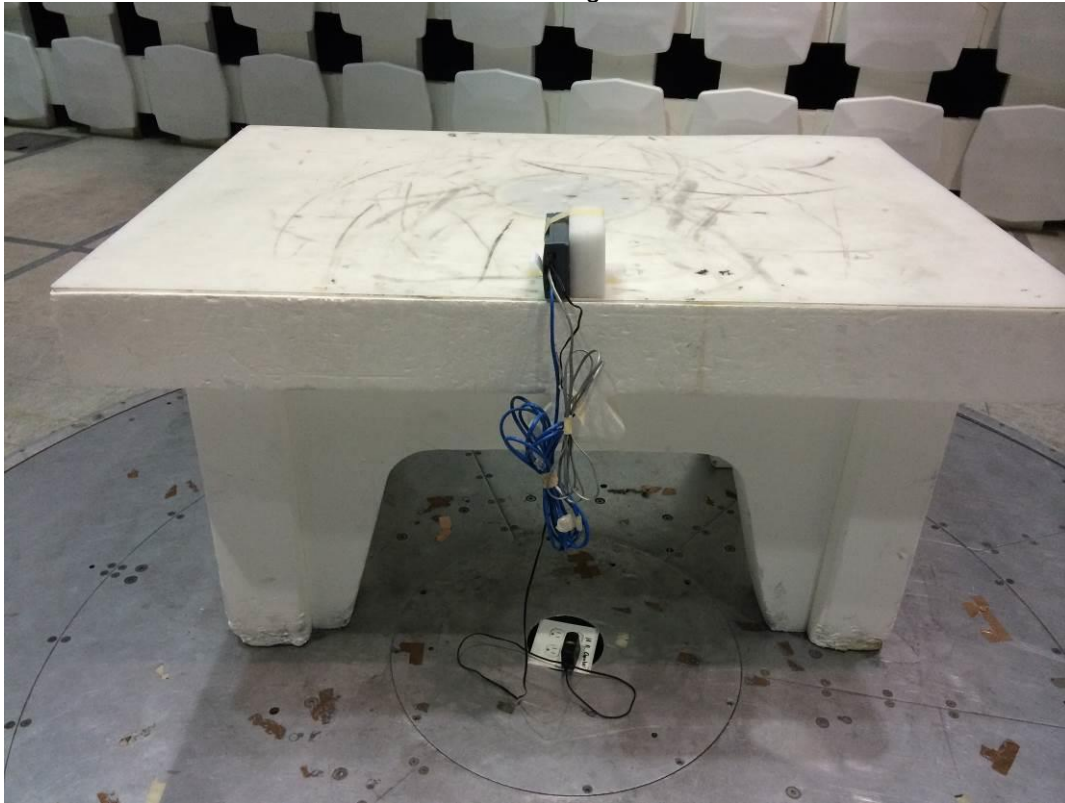
6.4 Setup Photographs:

EUT on its back





EUT on its long side



EUT on its short side



**6.5 Test Data:**

Company: PowerHouse Dynamics, Inc. Antenna & Cables: N Bands: N, LF, HF, SHF  
 Model #: Z-Wave Radio Antenna: 145106 V10m 10-01-2014.txt 145106 H10m 10-01-2014.txt  
 Serial #: 0 Cable(s): 145-410 10mTrkA 10-03-2014.txt NONE.  
 Engineers: Kouma Sinn Location: 10m chamber Barometer: DAV004 Filter: NONE  
 Project #: G101761367 Date(s): 08/14/14  
 Standard: FCC Part 15 Subpart C 15.249 Temp/Humidity/Pressure: 21C 51% 998mbar  
 Receiver: 145-128 Limit Distance (m): 3  
 PreAmp: NONE. Test Distance (m): 10  
 PreAmp Used? (Y or N): N Voltage/Frequency: 120VAC/60Hz Frequency Range: Fundamental Frequency  
 Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
Fundamental Limit = 50 milivolts/meter, or 50000 uV/m, or 20*log(50000), 93.98 dBuV/m at 3 meters											
Harmonic Limit = 500 uV/m, or 20*log(500), 53.98 dBuV/m at 3 meters											
Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.											
The Z-Wave radio was programmed to transmit continuous at 908.42 MHz											
EUT sits on its back, no pre-amp used											
MaxH PK	V	908.364	52.13	22.57	4.88	0.00	-10.46	90.03	113.98	-23.95	120/300 kHz
AVG	V	908.364	35.23	22.57	4.88	0.00	-10.46	73.13	93.98	-20.85	120/300 kHz
MaxH PK	H	908.360	48.98	22.17	4.88	0.00	-10.46	86.48	113.98	-27.50	120/300 kHz
AVG	H	908.360	32.08	22.17	4.88	0.00	-10.46	69.58	93.98	-24.40	120/300 kHz
EUT sits on its long side, no pre-amp used											
MaxH PK	V	908.364	47.40	22.57	4.88	0.00	-10.46	85.30	113.98	-28.68	120/300 kHz
AVG	V	908.364	30.50	22.57	4.88	0.00	-10.46	68.40	93.98	-25.58	120/300 kHz
MaxH PK	H	908.364	50.31	22.17	4.88	0.00	-10.46	87.81	113.98	-26.17	120/300 kHz
AVG	H	908.360	33.41	22.17	4.88	0.00	-10.46	70.91	93.98	-23.07	120/300 kHz
EUT sits on its short side, no pre-amp used											
MaxH PK	V	908.404	47.38	22.57	4.88	0.00	-10.46	85.28	113.98	-28.70	120/300 kHz
AVG	V	908.404	30.48	22.57	4.88	0.00	-10.46	68.38	93.98	-25.60	120/300 kHz
MaxH PK	H	908.360	52.32	22.17	4.88	0.00	-10.46	89.82	113.98	-24.16	120/300 kHz
AVG	H	908.360	35.42	22.17	4.88	0.00	-10.46	72.92	93.98	-21.06	120/300 kHz

Note that average factor of 16.9 dB was applied to the peak readings to obtain average readings

Test Personnel: <u>Kouma Sinn <i>KPS</i></u>	Test Date: <u>08/14/2014</u>
Supervising/Reviewing Engineer: <u>(Where Applicable) N/A</u>	
Product Standard: <u>FCC Part 15 Subpart 15.249, RSS-210</u>	Limit Applied: <u>Per Standard</u>
Input Voltage: <u>120VAC/60Hz</u>	
Pretest Verification w/ Ambient Signals or BB Source: <u>BB Source</u>	Ambient Temperature: <u>21 °C</u>
	Relative Humidity: <u>51 %</u>
	Atmospheric Pressure: <u>998 mbars</u>

Deviations, Additions, or Exclusions: None

## 7 Transmitter Spurious Emissions

### 7.1 Method

Tests are performed in accordance with FCC 47CFR Part 15 Subpart B Class B, FCC 47CFR Part 15 Subpart C Section 15.249, ANSI C63.10:2012, RSS-210, and ICES-003.

**TEST SITE:** 10m ALSE

**The 10m ALSE** is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

#### Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
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Radiated Emissions, 3m	30-1000 MHz	5.3	6.3
Radiated Emissions, 3m	1-6 GHz	4.5	5.2
Radiated Emissions, 3m	6-15 GHz	5.2	5.5
Radiated Emissions, 3m	15-18 GHz	5.0	5.5
Radiated Emissions, 3m	18-40 GHz	5.0	5.5

### Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB $\mu$ V/m
- RA = Receiver Amplitude (including preamplifier) in dB $\mu$ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB $\mu$ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB $\mu$ V/m. This value in dB $\mu$ V/m was converted to its corresponding level in  $\mu$ V/m.

RA = 52.0 dB $\mu$ V  
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To convert from dB $\mu$ V to  $\mu$ V or mV the following was used:

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$$NF = \text{Net Reading in dB}\mu\text{V}$$

#### Example:

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10^{(32 \text{ dB}\mu\text{V} / 20)} = 39.8 \mu\text{V/m}$$

Alternately, when C5 Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". "AF" is the Antenna Factor; "PA+CL" are Preamp and Cable Loss. These are already accounted for in the "Level" column.

**7.2 Test Equipment Used:**

Tested on 8/14/14 and on 10/30/2014

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV004	Weather Station	Davis Instruments	7400	PE80529A61A	10/06/2014	10/06/2015
145-410"	Cables 145-400 145-403 145-405 145-406 145-407	Huber + Suhner	10m Track A Cables	multiple	10/04/2014	10/04/2015
145128"	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/17/2014	03/17/2015
145106"	Bilog Antenna (30MHz - 5GHz)	Sunol Sciences	JB5	A111003	01/07/2014	01/07/2015
145003"	Preamplifier (150 KHz to 1.3 GHz)	Hewlett Packard	8447D	2443A04077	10/11/2014	10/11/2015
ETS001'	1-18GHz DRG Horn Antenna	ETS-Lindgren	3117	00143259	01/06/2014	01/06/2015
REA003'	1GHz High Pass Filter	Reactel, Inc	7HS-1G/10G-S11	06-1	12/30/2013	12/30/2015
145014'	Preamplifier (1 GHz to 26.5 GHz)	Hewlett Packard	8449B	3008A00232	12/19/2014	12/19/2015
145-416'	Cables 145-400 145-402 145-404 145-408	Huber + Suhner	3m Track B cables	multiple	10/04/2014	10/04/2015

**Software Utilized:**

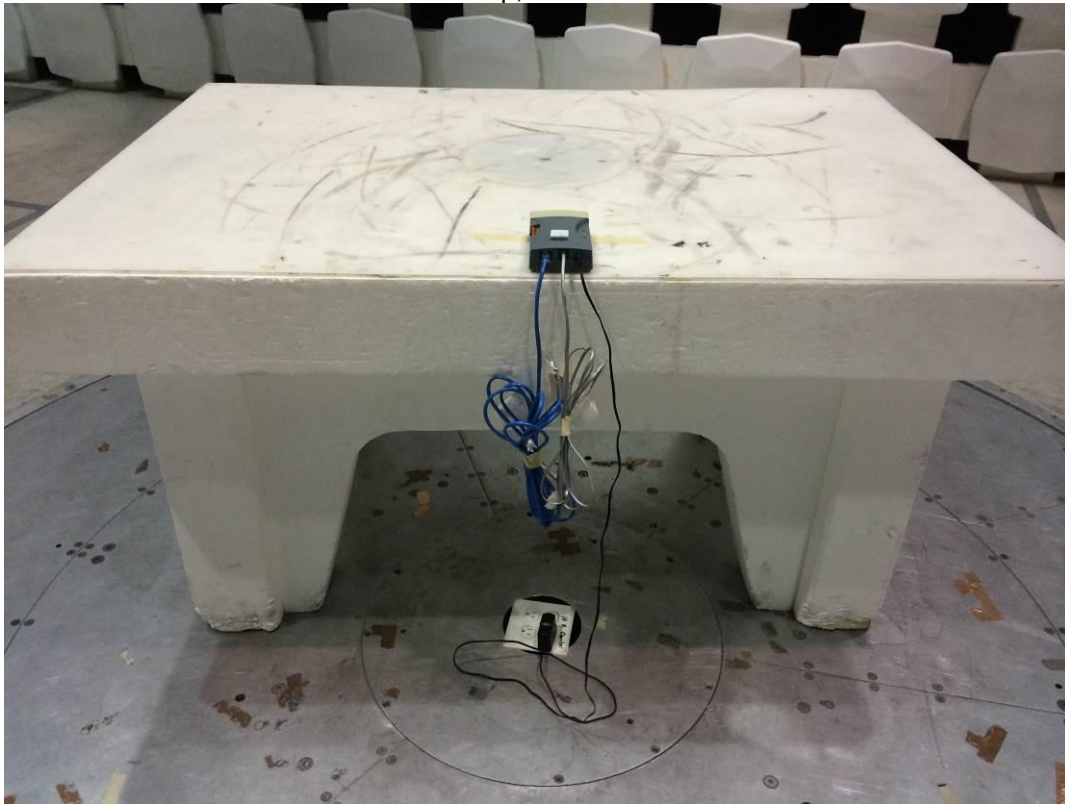
Name	Manufacturer	Version
C5	Teseq	5.26.46.46

**7.3 Results:**

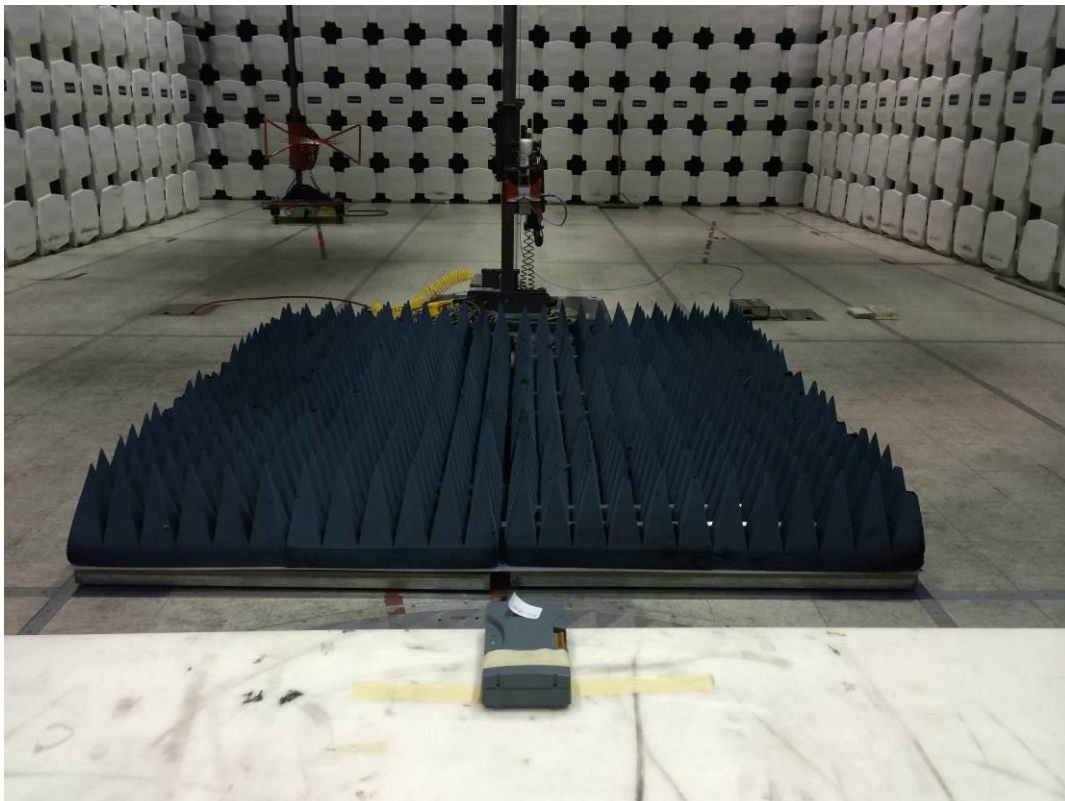
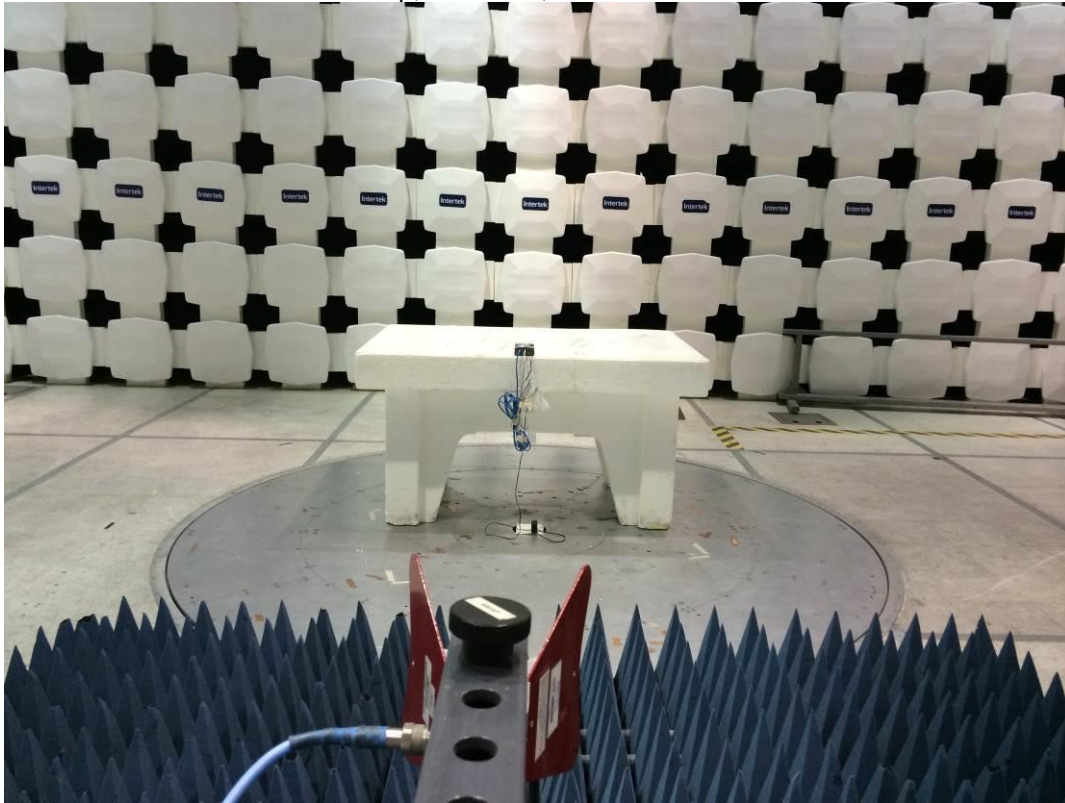
The sample tested was found to Comply.

7.4 Setup Photographs:

Test Setup, 30-1000 MHz

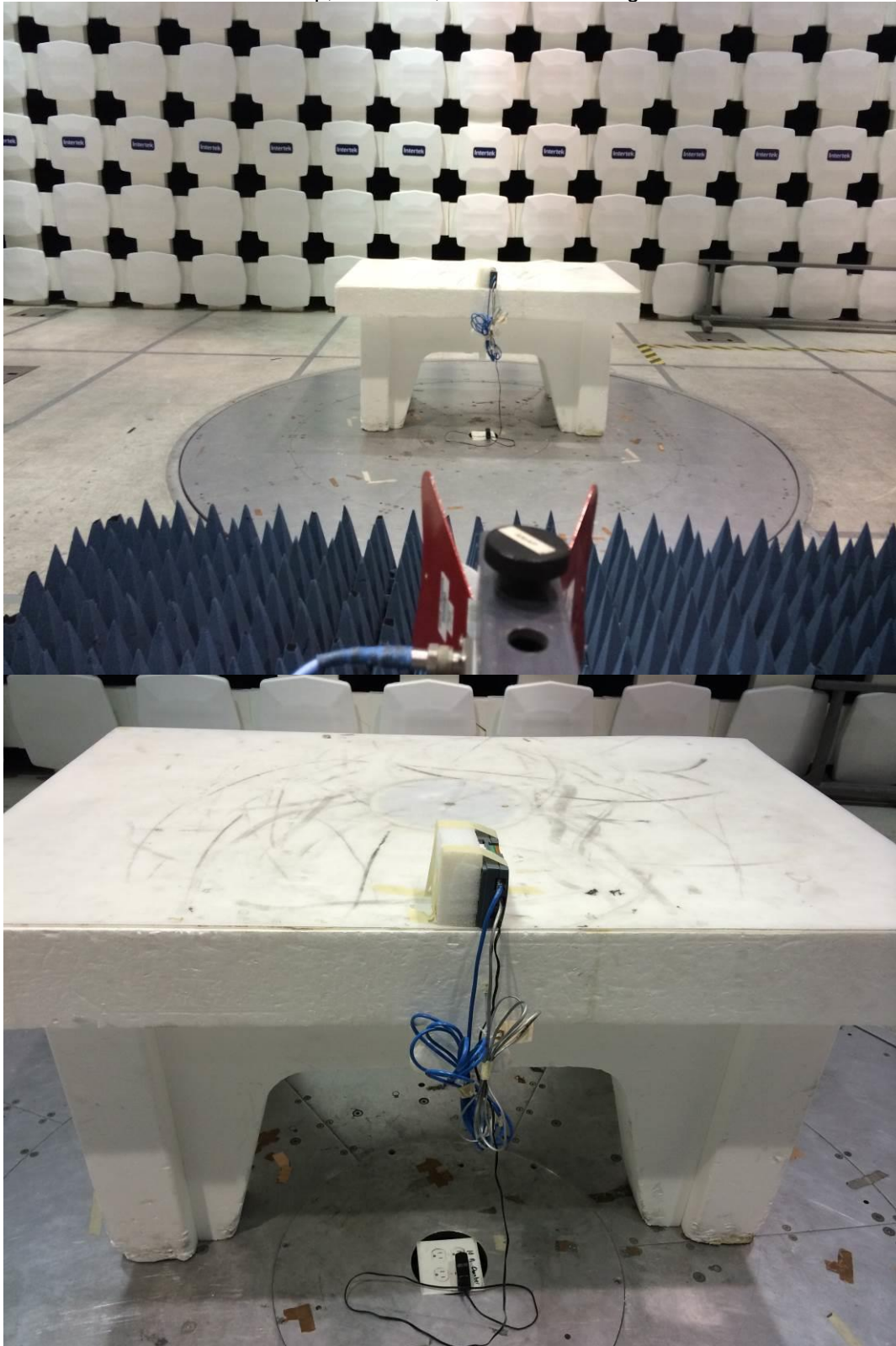


Test Setup, 1-10 GHz, EUT sits on its back

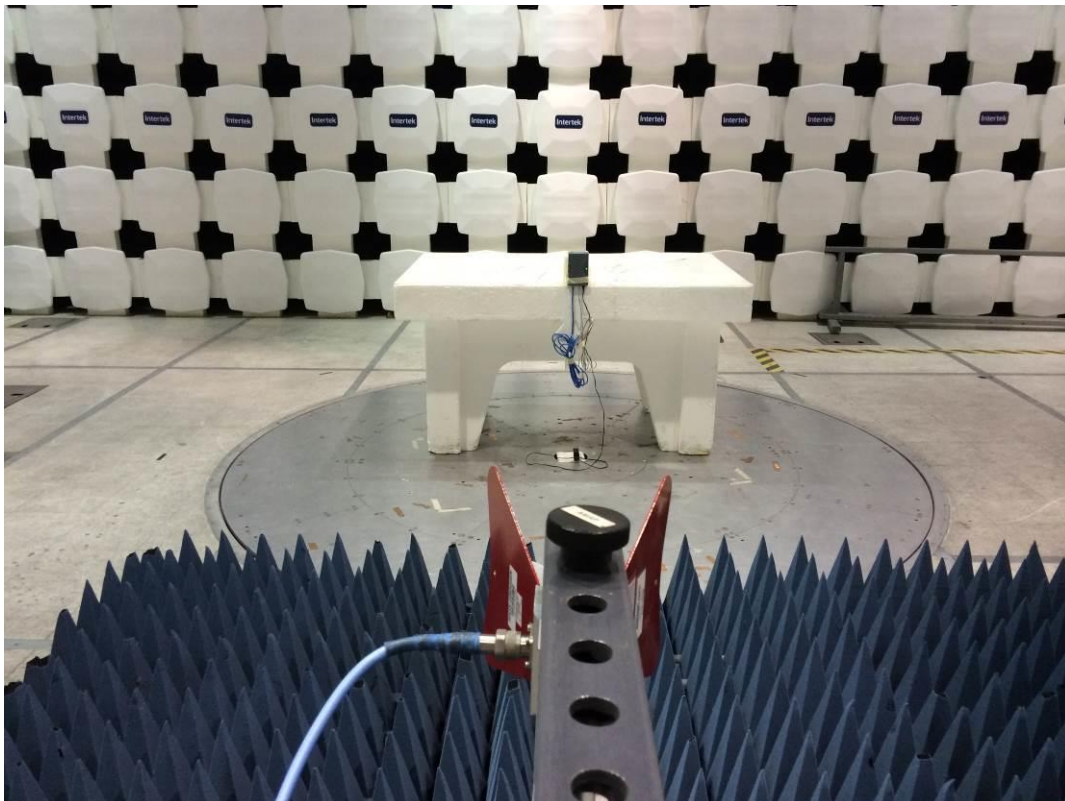




Test Setup, 1-10 GHz, EUT sits on its long side



Test Setup, 1-10 GHz, EUT sits on short side



7.5 Plots/Data:

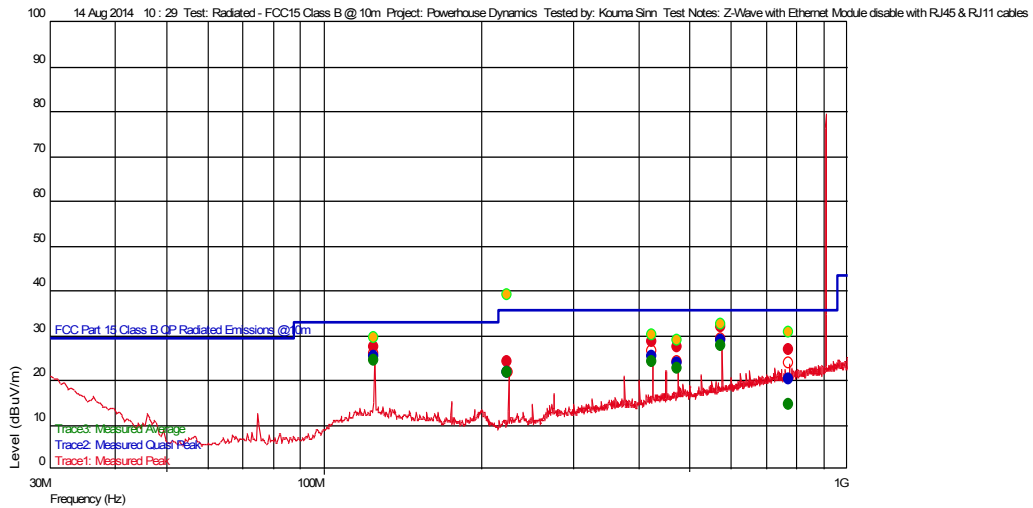
Transmit Mode, 30-1000 MHz

Test Information

Test Details User Entry  
 Test: Radiated - FCC15 Class B @ 10m  
 Project: Powerhouse Dynamics  
 Test Notes: Z-Wave with Ethernet Module disable with RJ45 & RJ11 cables  
 Temperature: 20%  
 Humidity: 68%, 997mbar  
 Tested by: Kouma Sinn  
 Test Started: 14 Aug 2014 10 : 29

Additional Information

Prescan Emission Graph



- Measured Peak Value
- Measured Quasi Peak Value
- Measured Average Value
- Maximum Value of Mast and Turntable
- Swept Peak Data
- Swept Quasi Peak Data
- Swept Average Data

Emissions Test Data

Trace1: Measured Peak

Frequency(Hz)	Level (dBuV/m)	AF	PA+CL	Limit(dBuV/m)	Margin(dBuV/m)	Hor ( -- ), Ver (   )	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
224.996793144 M	24.11	11.100	-23.810	--	--		276	1.05	120 k	
775.085571162 M	26.64	20.700	-23.355	--	--	--	164	3.73	120 k	
474.974749898 M	27.35	17.599	-24.510	--	--		40	1.25	120 k	
425.037474569 M	28.61	16.401	-24.155	--	--		8	1.16	120 k	
125.001803549 M	27.44	14.300	-25.365	--	--		239	2.52	120 k	
575.009418739 M	31.67	18.700	-24.290	--	--	--	281	1.87	120 k	

Trace2: Measured Quasi Peak

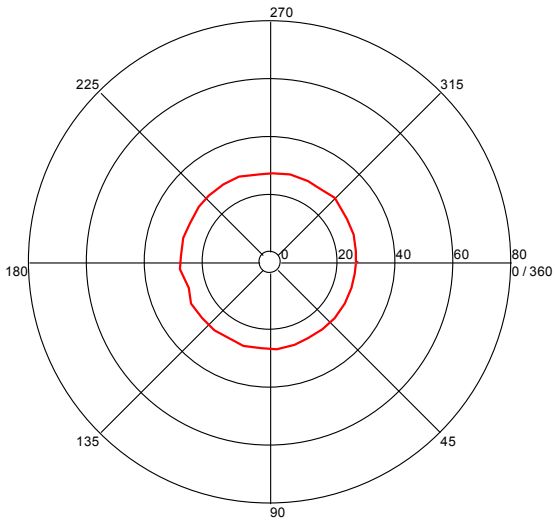
Frequency(Hz)	Level (dBuV/m)	AF	PA+CL	Limit(dBuV/m)	Margin(dBuV/m)	Hor ( -- ), Ver (   )	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
775.085571162 M	20.06	20.700	-23.355	35.540	-15.48	--	164	3.73	120 k	
224.996793144 M	21.66	11.100	-23.810	35.540	-13.88		276	1.05	120 k	
474.974749898 M	23.72	17.599	-24.510	35.540	-11.82		40	1.25	120 k	
425.037474569 M	25.28	16.401	-24.155	35.540	-10.26		8	1.16	120 k	
125.001803549 M	25.21	14.300	-25.365	33.040	-7.83		239	2.52	120 k	
575.009418739 M	28.95	18.700	-24.290	35.540	-6.59	--	281	1.87	120 k	

Notes: The big spike emission on the pre-scan plot is the fundamental frequency signal. It's not being measured.

Azimuth Plots

Turntable Plot ( 125.001803549 MHz)

Level (dBuV/m)

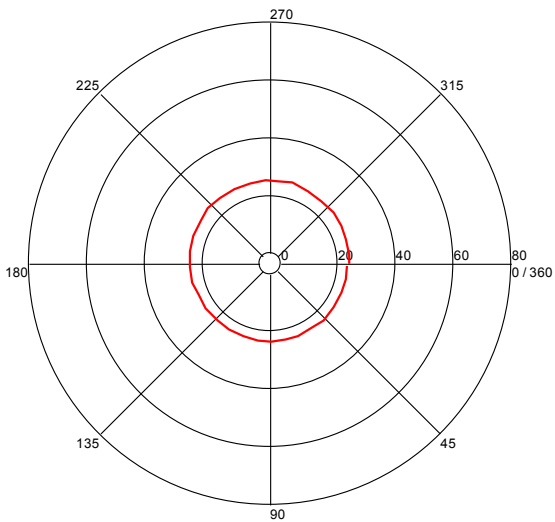


All Polarities

Azimuth (Degrees)

Turntable Plot ( 224.996793144 MHz)

Level (dBuV/m)

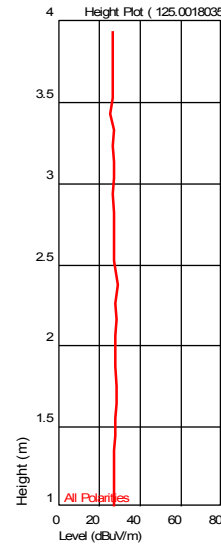


All Polarities

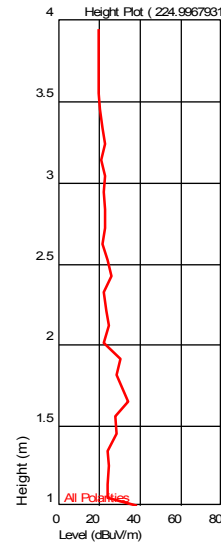
Azimuth (Degrees)

Turntable Plots

Height Plot ( 125.001803549 MHz)

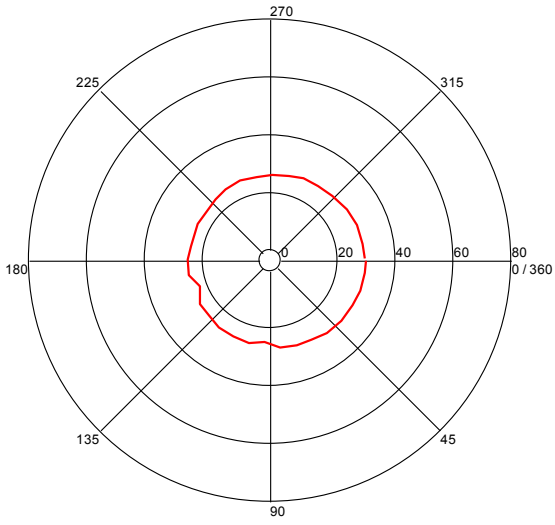


Height Plot ( 224.996793144 MHz)



Turntable Plot ( 425.037474569 MHz )

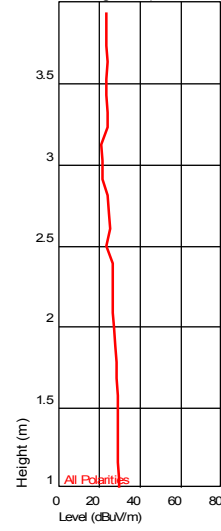
Level (dBuV/m)



All Polarities

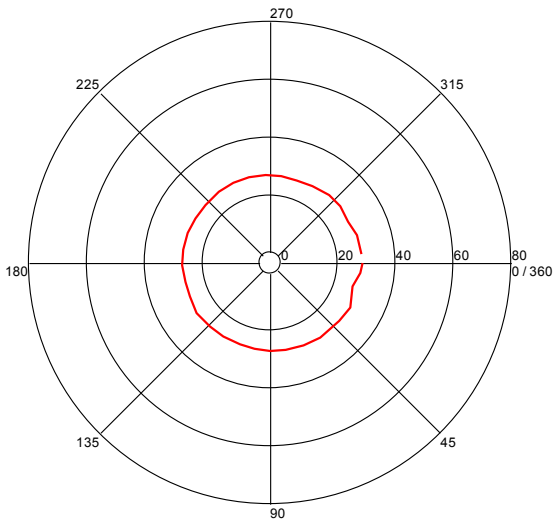
Azimuth (Degrees)

Height Plot ( 425.037474569 MHz )



Turntable Plot ( 474.974749898 MHz )

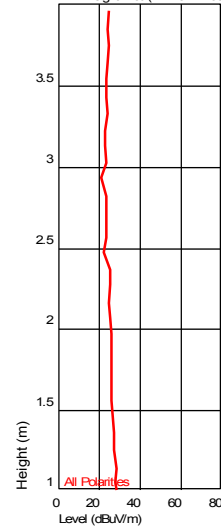
Level (dBuV/m)



All Polarities

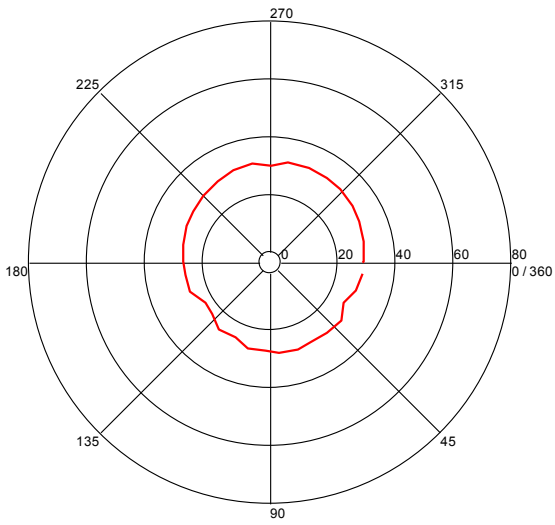
Azimuth (Degrees)

Height Plot ( 474.974749898 MHz )



Turntable Plot ( 575.009418739 MHz)

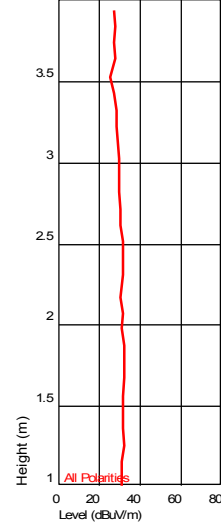
Level (dBuV/m)



All Polarities

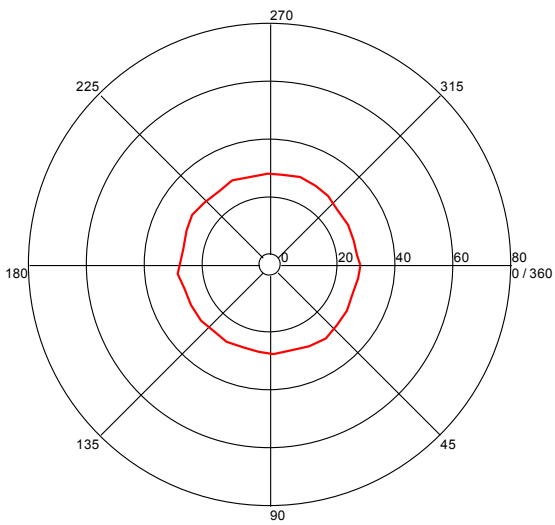
Azimuth (Degrees)

Height Plot ( 575.009418739 MHz)



Turntable Plot ( 775.085571162 MHz)

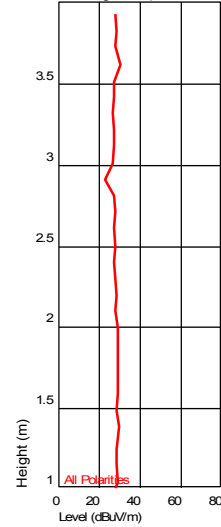
Level (dBuV/m)



All Polarities

Azimuth (Degrees)

Height Plot ( 775.085571162 MHz)



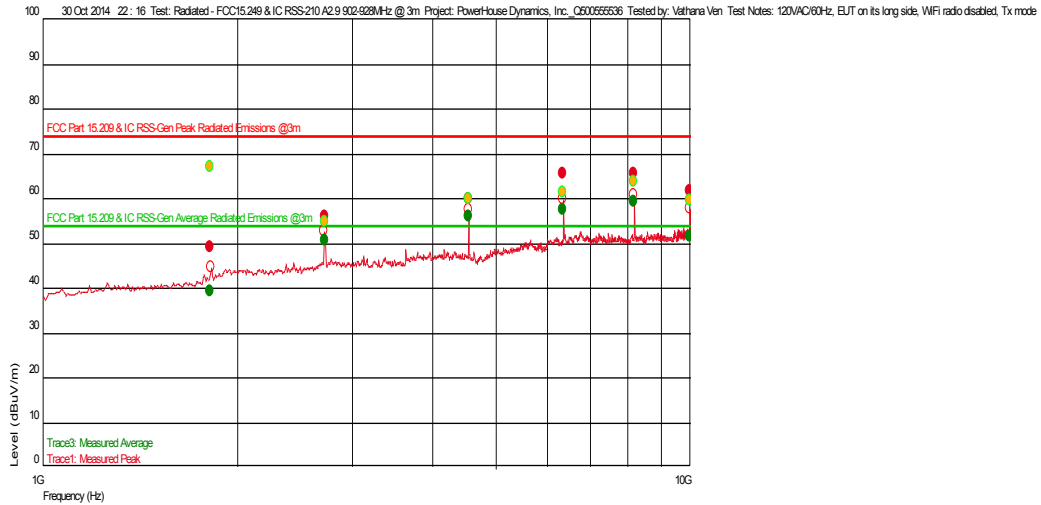
**Transmit Mode, EUT on its back side, 1-10 GHz**

**Test Information**

Test Details            User Entry  
 Test:                    Radiated - FCC15.249 & IC RSS-210 A2.9 902-928MHz @ 3m  
 Project:                PowerHouse Dynamics, Inc.\_Q50055536  
 Test Notes:            120VAC/60Hz, EUT on its long side, WiFi radio disabled, Tx mode  
 Temperature:         21 deg C  
 Humidity:             39%, 1003 mB  
 Tested by:             Vathana Ven  
 Test Started:         30 Oct 2014 22 : 16

Additional Information

**Prescan Emission Graph**



- Measured Peak Value
- Measured Quasi Peak Value
- Measured Average Value
- Maximum Value of Mast and Turntable
- Swept Peak Data
- Swept Quasi Peak Data
- Swept Average Data

**Emissions Test Data**

**Trace1: Measured Peak**

Frequency (Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin (dBuV/m)	Hor ( -- ), Ver (   )	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
1.816720107 G	48.97	30.290	-26.534	74.000	-25.03		284	1.64	1 M	
2.725103541 G	55.91	32.457	-25.430	74.000	-18.09		228	2.41	1 M	
4.541897127 G	59.90	34.260	-24.328	74.000	-14.10		228	2.65	1 M	
9.992625251 G	61.56	37.169	-20.824	74.000	-12.44	--	331	2.34	1 M	
8.175350701 G	65.44	35.973	-20.930	74.000	-8.56	--	251	2.09	1 M	
6.358643955 G	65.59	35.621	-20.874	74.000	-8.41		243	1.28	1 M	

**Trace3: Measured Average**

Frequency (Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin (dBuV/m)	Hor ( -- ), Ver (   )	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
1.816720107 G	32.07	30.290	-26.534	54.000	-21.93		284	1.64	1 M	
2.725103541 G	39.01	32.457	-25.430	54.000	-14.99		228	2.41	1 M	
9.992625251 G	43.00	37.169	-20.824	54.000	-11.00	--	331	2.34	1 M	
4.541897127 G	44.66	34.260	-24.328	54.000	-9.34		228	2.65	1 M	
6.358643955 G	48.54	35.621	-20.874	54.000	-5.46		243	1.28	1 M	
8.175350701 G	48.69	35.973	-20.930	54.000	-5.31	--	251	2.09	1 M	

Notes: Disregard the average readings on the pre-scan plot. The average readings on the table are the corrected average readings based on the duty cycle of the transmitter.

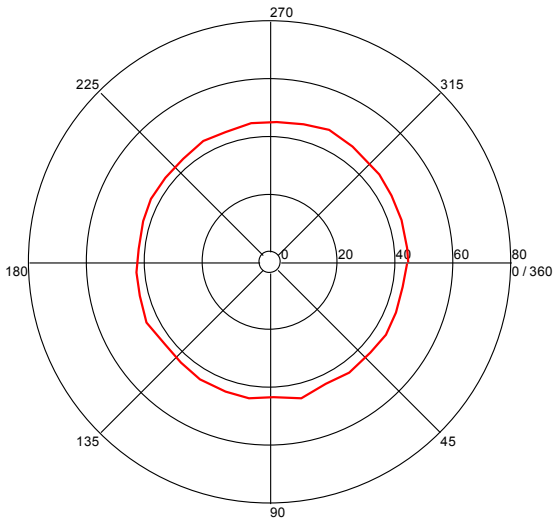
Average readings = Peak Readings - Average Factor

Average Factor was calculated to be 16.9 dB

Azimuth Plots

Turntable Plot ( 1.816720107 GHz )

Level (dBuV/m)

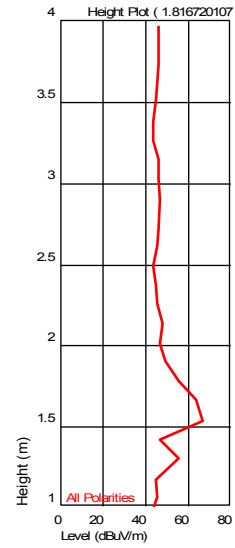


All Polarities

Azimuth (Degrees)

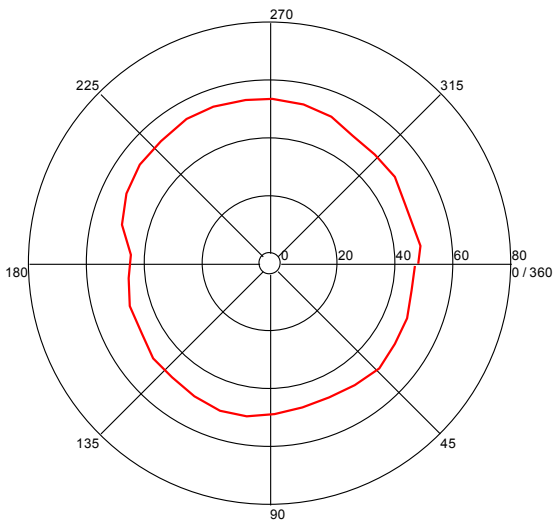
Turntable Plots

Height Plot ( 1.816720107 GHz )



Turntable Plot ( 2.725103541 GHz )

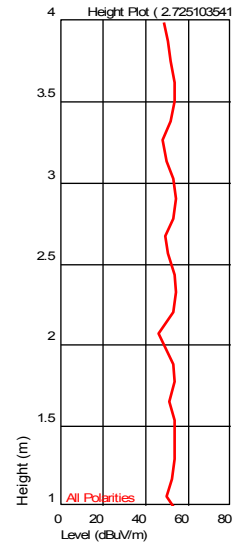
Level (dBuV/m)



All Polarities

Azimuth (Degrees)

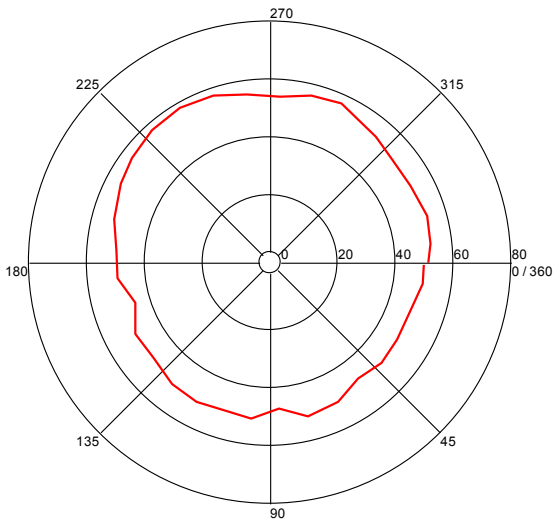
Height Plot ( 2.725103541 GHz )





Turntable Plot ( 4.541897127 GHz )

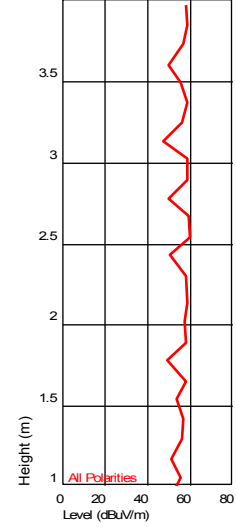
Level (dBuV/m)



All Polarities

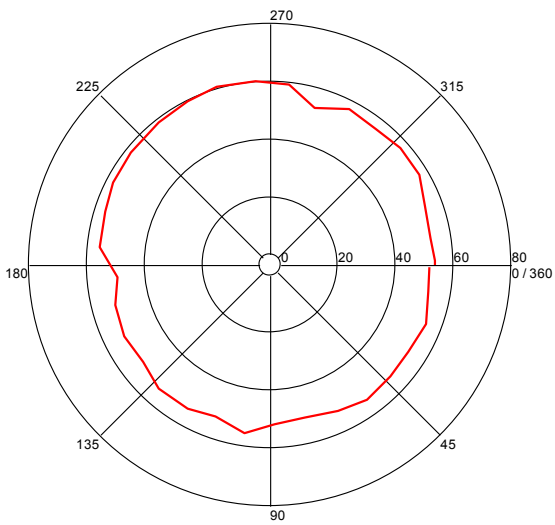
Azimuth (Degrees)

Height Plot ( 4.541897127 GHz )



Turntable Plot ( 6.358643955 GHz )

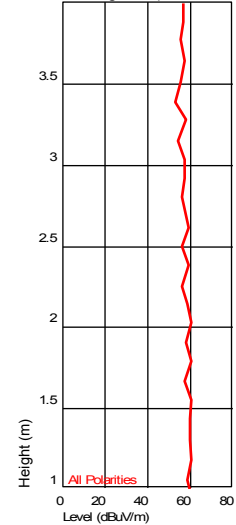
Level (dBuV/m)



All Polarities

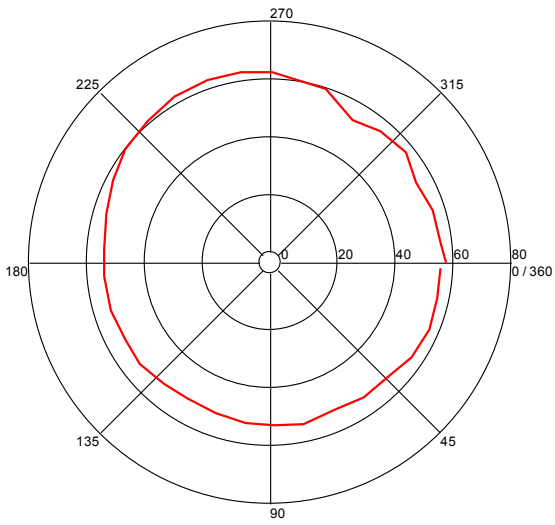
Azimuth (Degrees)

Height Plot ( 6.358643955 GHz )



Turntable Plot ( 8.175350701 GHz )

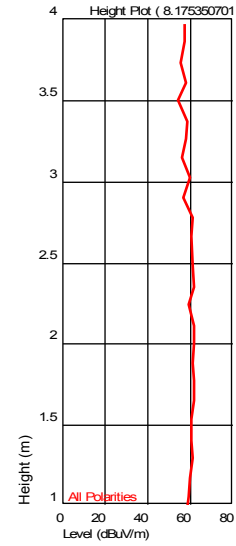
Level (dBuV/m)



All Polarities

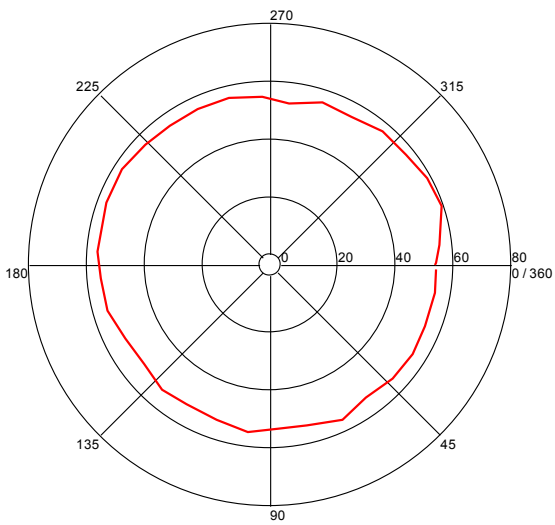
Azimuth (Degrees)

Height Plot ( 8.175350701 GHz )



Turntable Plot ( 9.992625251 GHz )

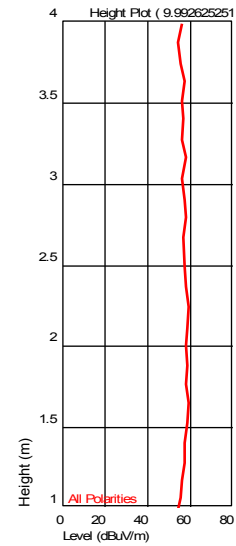
Level (dBuV/m)



All Polarities

Azimuth (Degrees)

Height Plot ( 9.992625251 GHz )

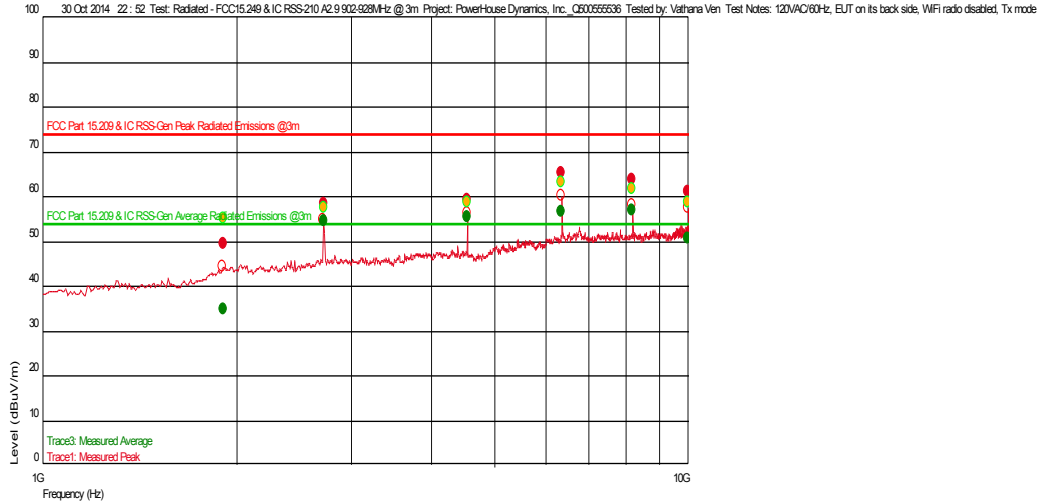


Test Information

Test Details  
Test: Radiated - FCC15.249 & IC RSS-210 A2.9 902-928MHz @ 3m  
Project: PowerHouse Dynamics, Inc.\_Q50055536  
Test Notes: 120VAC/60Hz, EUT on its back side, WiFi radio disabled, Tx mode  
Temperature: 21 deg C  
Humidity: 39%, 1003 mB  
Tested by: Vathana Ven  
Test Started: 30 Oct 2014 22 : 52

Additional Information

Prescan Emission Graph



- Measured Peak Value — Swept Peak Data
- Measured Quasi Peak Value — Swept Quasi Peak Data
- Measured Average Value — Swept Average Data
- Maximum Value of Mast and Turntable

**Emissions Test Data**

**Trace1: Measured Peak**

Frequency (Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin (dBuV/m)	Hor ( -- ), Ver (   )	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
1.907107548 G	49.26	31.402	-26.262	74.000	-24.74	--	127	1.89	1 M	
2.72504342 G	58.41	32.457	-25.430	74.000	-15.59	--	94	2.10	1 M	
4.542010688 G	59.36	34.260	-24.329	74.000	-14.64	--	276	2.48	1 M	
9.99258517 G	61.15	37.169	-20.824	74.000	-12.85		100	1.53	1 M	
8.175290581 G	63.80	35.973	-20.930	74.000	-10.20	--	188	2.89	1 M	
6.358603875 G	65.29	35.621	-20.874	74.000	-8.71		277	1.86	1 M	

**Trace3: Measured Average**

Frequency (Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin (dBuV/m)	Hor ( -- ), Ver (   )	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
1.907107548 G	32.36	31.402	-26.262	54.000	-21.64	--	127	1.89	1 M	
9.99258517 G	41.51	37.169	-20.824	54.000	-12.49		100	1.53	1 M	
2.72504342 G	42.46	32.457	-25.430	54.000	-11.54	--	94	2.10	1 M	
4.542010688 G	44.25	34.260	-24.329	54.000	-9.75	--	276	2.48	1 M	
6.358603875 G	46.90	35.621	-20.874	54.000	-7.10		277	1.86	1 M	
8.175290581 G	48.39	35.973	-20.930	54.000	-5.61	--	188	2.89	1 M	

Notes: Disregard the average readings on the pre-scan plot. The average readings on the table are the corrected average readings based on the duty cycle of the transmitter.

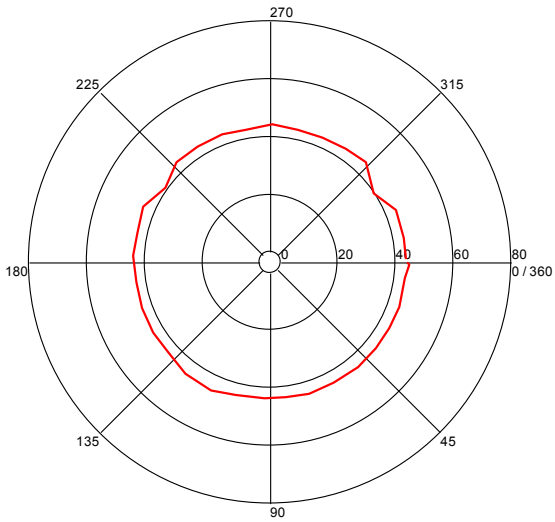
Average readings = Peak Readings - Average Factor

Average Factor was calculated to be 16.9 dB

Azimuth Plots

Turntable Plot ( 1.907107548 GHz )

Level (dBuV/m)

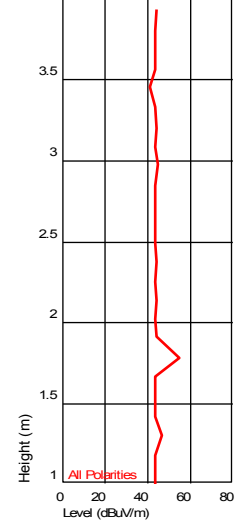


All Polarities

Azimuth (Degrees)

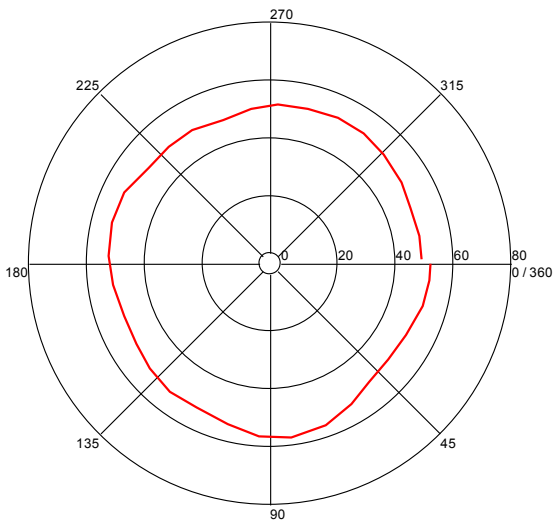
Turntable Plots

Height Plot ( 1.907107548 GHz )



Turntable Plot ( 2.72504342 GHz )

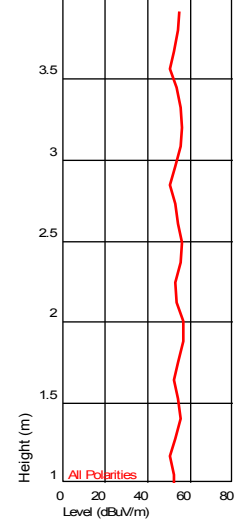
Level (dBuV/m)



All Polarities

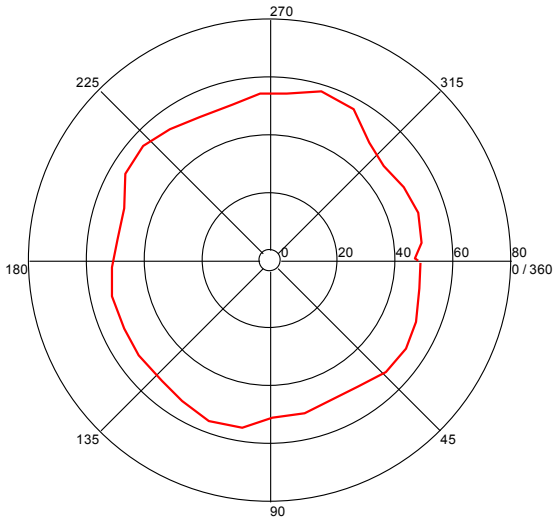
Azimuth (Degrees)

Height Plot ( 2.72504342 GHz )



Turntable Plot ( 4.542010688 GHz )

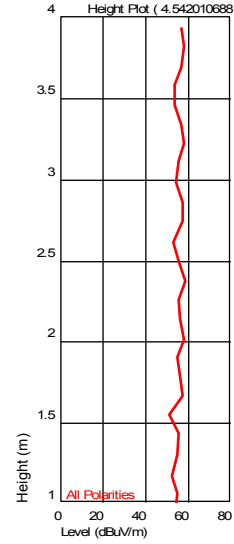
Level (dBuV/m)



All Polarities

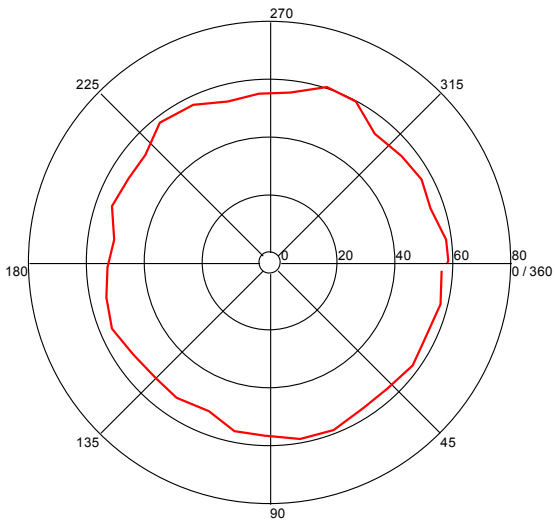
Azimuth (Degrees)

Height Plot ( 4.542010688 GHz )



Turntable Plot ( 6.358603875 GHz )

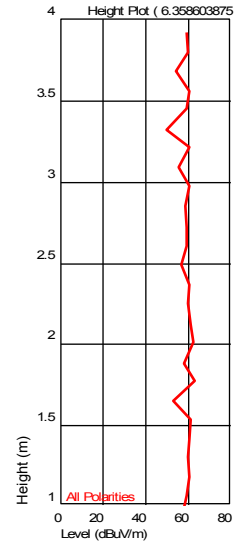
Level (dBuV/m)



All Polarities

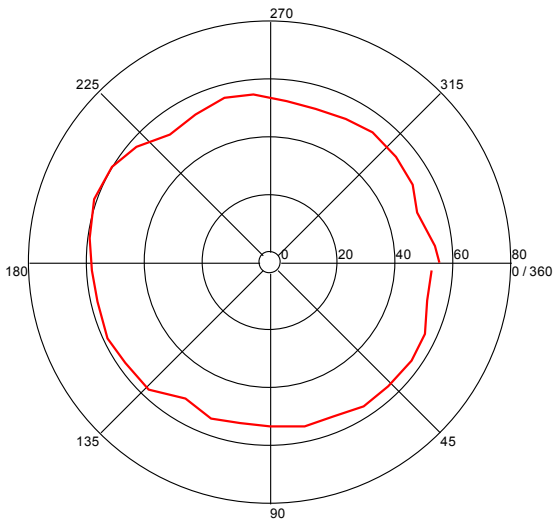
Azimuth (Degrees)

Height Plot ( 6.358603875 GHz )



Turntable Plot ( 8.175290581 GHz )

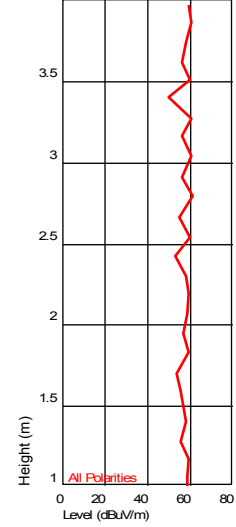
Level (dBuV/m)



All Polarities

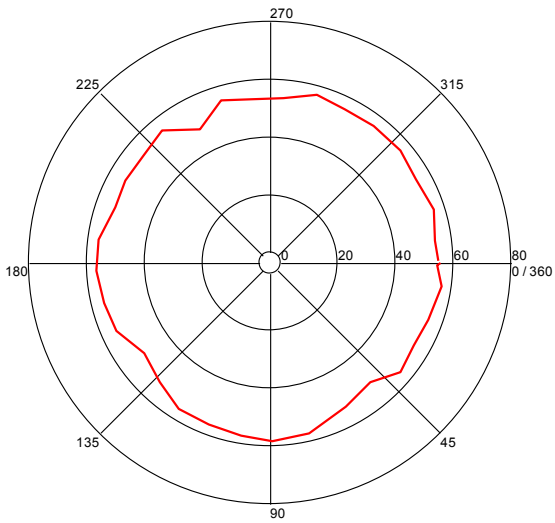
Azimuth (Degrees)

Height Plot ( 8.175290581 GHz )



Turntable Plot ( 9.99258517 GHz )

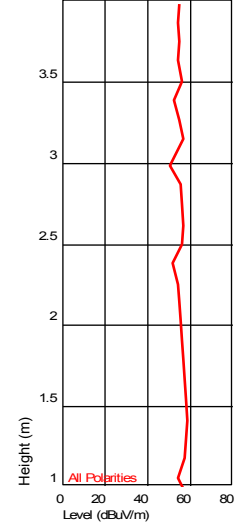
Level (dBuV/m)



All Polarities

Azimuth (Degrees)

Height Plot ( 9.99258517 GHz )

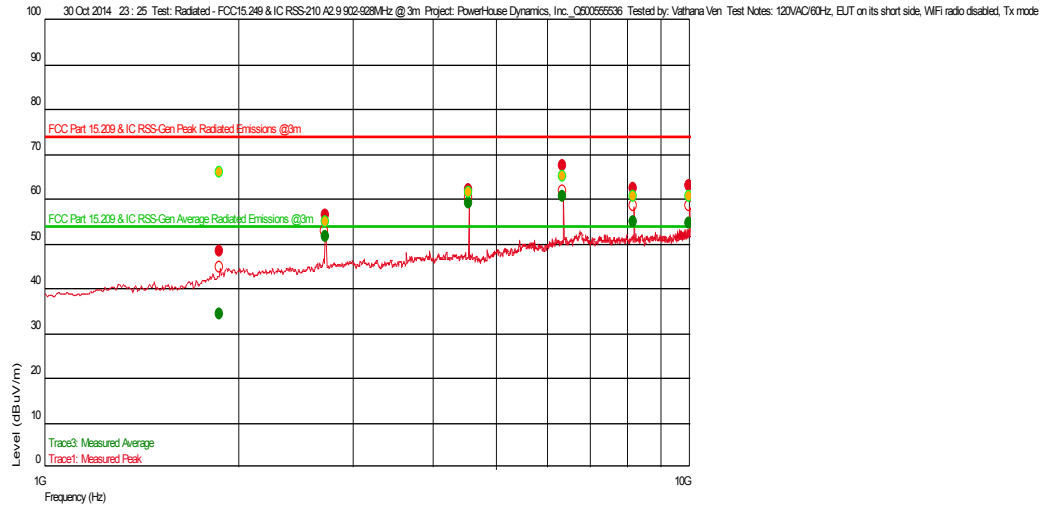


Test Information

Test Details User Entry  
 Test: Radiated - FCC15.249 & IC RSS-210 A2.9 902-928MHz @ 3m  
 Project: PowerHouse Dynamics, Inc.\_Q500555536  
 Test Notes: 120VAC/60Hz, EUT on its short side, WiFi radio disabled, Tx mod  
 Temperature: 21 deg C  
 Humidity: 39%, 1003 mB  
 Tested by: Vathana Ven  
 Test Started: 30 Oct 2014 23 : 25

Additional Information

Prescan Emission Graph



- Measured Peak Value
- Measured Quasi Peak Value
- Measured Average Value
- Maximum Value of Mast and Turntable
- Swept Peak Data
- Swept Quasi Peak Data
- Swept Average Data

Emissions Test Data

Trace1: Measured Peak

Frequency (Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin (dBuV/m)	Hor ( -- ), Ver (   )	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
1.870848363 G	48.12	30.994	-26.462	74.000	-25.88		89	1.64	1 M	
2.725156981 G	56.19	32.457	-25.430	74.000	-17.81	--	288	2.00	1 M	
4.542044088 G	61.83	34.260	-24.329	74.000	-12.17	--	161	1.53	1 M	
8.175671342 G	62.17	35.973	-20.932	74.000	-11.83		233	2.23	1 M	
9.992177689 G	62.82	37.169	-20.824	74.000	-11.18	--	232	1.40	1 M	
6.358537074 G	67.32	35.621	-20.875	74.000	-6.68		242	3.30	1 M	

Trace3: Measured Average

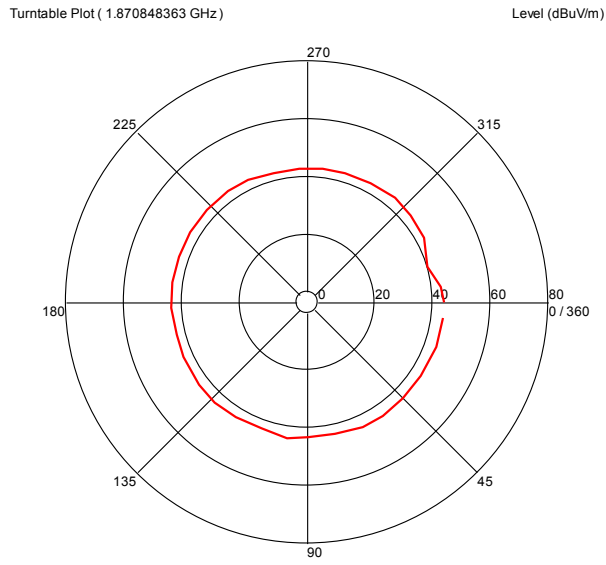
Frequency (Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin (dBuV/m)	Hor ( -- ), Ver (   )	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
1.870848363 G	31.22	30.994	-26.462	54.000	-22.78		89	1.64	1 M	
2.725156981 G	39.29	32.457	-25.430	54.000	-14.71	--	288	2.00	1 M	
9.992177689 G	44.93	37.169	-20.824	54.000	-9.07	--	232	1.40	1 M	
8.175671342 G	45.27	35.973	-20.932	54.000	-8.73		233	2.23	1 M	
4.542044088 G	45.92	34.260	-24.329	54.000	-8.08	--	161	1.53	1 M	
6.358537074 G	50.42	35.621	-20.875	54.000	-3.58		242	3.30	1 M	

Notes: Disregard the average readings on the pre-scan plot. The average readings on the table are the corrected average readings based on the duty cycle of the transmitter.

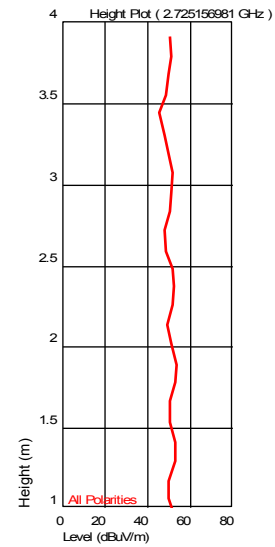
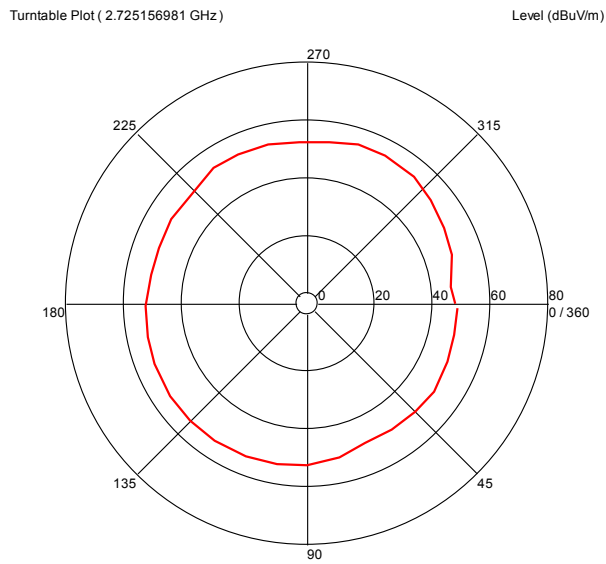
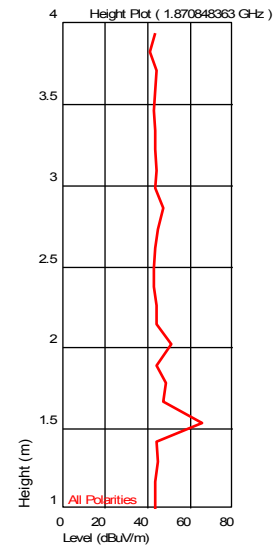
Average readings = Peak Readings - Average Factor

Average Factor was calculated to be 16.9 dB

Azimuth Plots



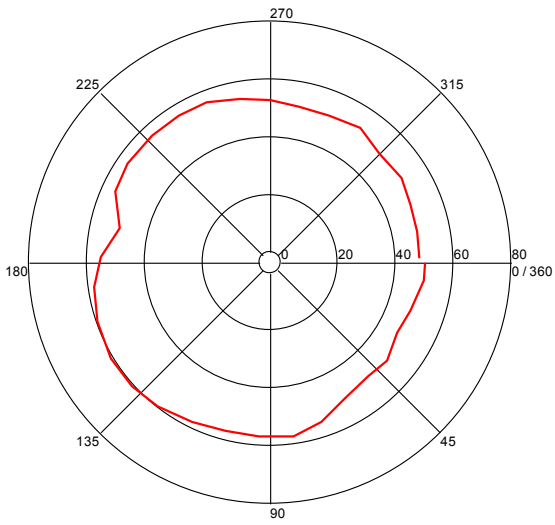
Turntable Plots





Turntable Plot ( 4.542044088 GHz )

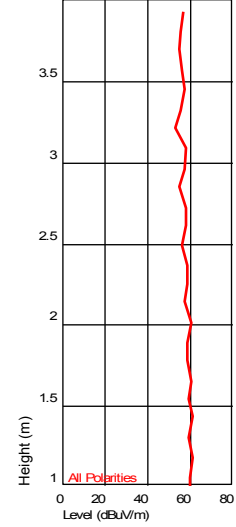
Level (dBuV/m)



All Polarities

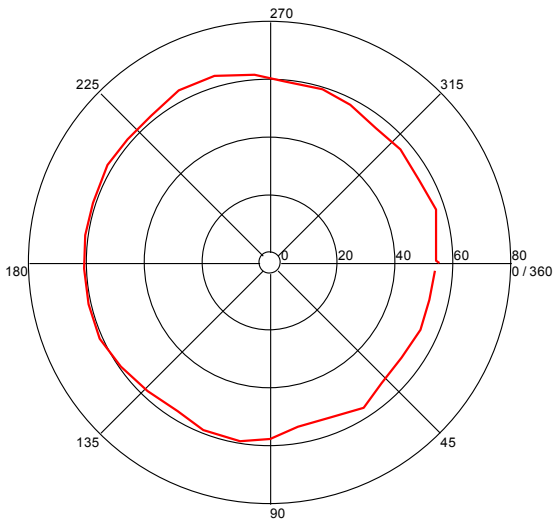
Azimuth (Degrees)

Height Plot ( 4.542044088 GHz )



Turntable Plot ( 6.358537074 GHz )

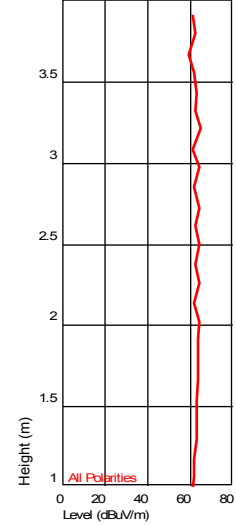
Level (dBuV/m)



All Polarities

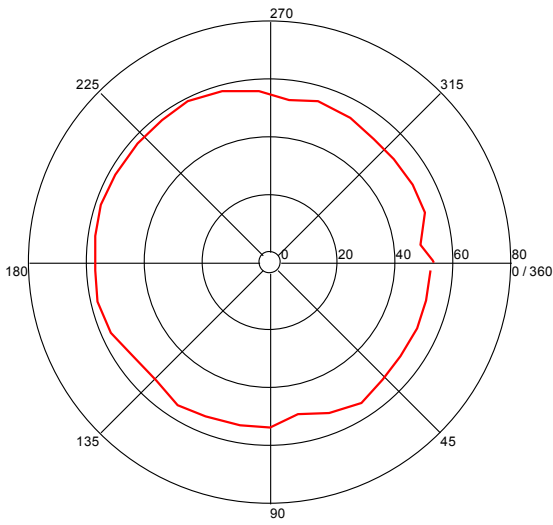
Azimuth (Degrees)

Height Plot ( 6.358537074 GHz )



Turntable Plot ( 8.175671342 GHz)

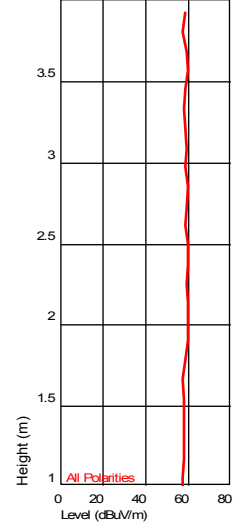
Level (dBuV/m)



All Polarities

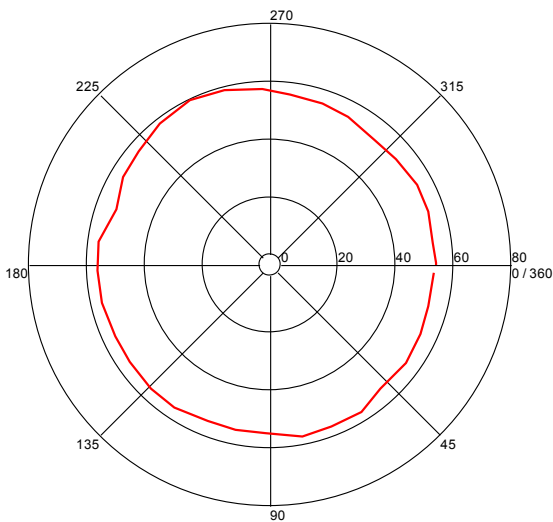
Azimuth (Degrees)

Height Plot ( 8.175671342 GHz )



Turntable Plot ( 9.992177689 GHz)

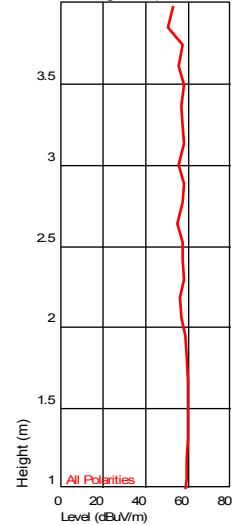
Level (dBuV/m)



All Polarities

Azimuth (Degrees)

Height Plot ( 9.992177689 GHz )



Test Personnel: Kouma Sinn *kps*  
 Supervising/Reviewing: Vathana Ven *VJV*  
 Engineer: N/A  
 (Where Applicable)  
 Product Standard: FCC Part 15 Subpart 15.249, RSS-210  
 Input Voltage: 120VAC/60Hz  
 Pretest Verification w/  
 Ambient Signals or  
 BB Source: BB Source

Test Date: 08/14/2014, 10/30/2014

Limit Applied: Per Standard  
 Ambient Temperature: 20, 21 °C  
 Relative Humidity: 68, 39 %  
 Atmospheric Pressure: 997, 1003 mbars

Deviations, Additions, or Exclusions: None

## 8 Receiver Spurious Emissions

### 8.1 Method

Tests are performed in accordance with FCC 47CFR Part 15 Subpart B Class B, ANSI C63.4:2009, and ICES-003.

**TEST SITE:** 10m ALSE

**The 10m ALSE** is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

#### Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6	6.3
Radiated Emissions, 3m	30-1000 MHz	5.3	6.3
Radiated Emissions, 3m	1-6 GHz	4.5	5.2
Radiated Emissions, 3m	6-15 GHz	5.2	5.5
Radiated Emissions, 3m	15-18 GHz	5.0	5.5
Radiated Emissions, 3m	18-40 GHz	5.0	5.5

### Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB $\mu$ V/m
- RA = Receiver Amplitude (including preamplifier) in dB $\mu$ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB $\mu$ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB $\mu$ V/m. This value in dB $\mu$ V/m was converted to its corresponding level in  $\mu$ V/m.

RA = 52.0 dB $\mu$ V  
 AF = 7.4 dB/m  
 CF = 1.6 dB  
 AG = 29.0 dB  
 FS = 32 dB $\mu$ V/m

To convert from dB $\mu$ V to  $\mu$ V or mV the following was used:

$$UF = 10^{(NF / 20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

$$NF = \text{Net Reading in dB}\mu\text{V}$$

#### Example:

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10^{(32 \text{ dB}\mu\text{V} / 20)} = 39.8 \mu\text{V/m}$$

Alternately, when C5 Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". "AF" is the Antenna Factor; "PA+CL" are Preamp and Cable Loss. These are already accounted for in the "Level" column.

**8.2 Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV004	Weather Station	Davis Instruments	7400	PE80529A61A	10/06/2014	10/06/2015
145-410"	Cables 145-400 145-403 145-405 145-406 145-407	Huber + Suhner	10m Track A Cables	multiple	10/04/2014	10/04/2015
145128"	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/17/2014	03/17/2015
145106"	Bilog Antenna (30MHz - 5GHz)	Sunol Sciences	JB5	A111003	01/07/2014	01/07/2015
145003"	Preamplifier (150 KHz to 1.3 GHz)	Hewlett Packard	8447D	2443A04077	10/11/2014	10/11/2015
ETS001'	1-18GHz DRG Horn Antenna	ETS-Lindgren	3117	00143259	01/06/2014	01/06/2015
145014'	Preamplifier (1 GHz to 26.5 GHz)	Hewlett Packard	8449B	3008A00232	12/19/2014	12/19/2015
145-416'	Cables 145-400 145-402 145-404 145-408	Huber + Suhner	3m Track B cables	multiple	10/04/2014	10/04/2015

**Software Utilized:**

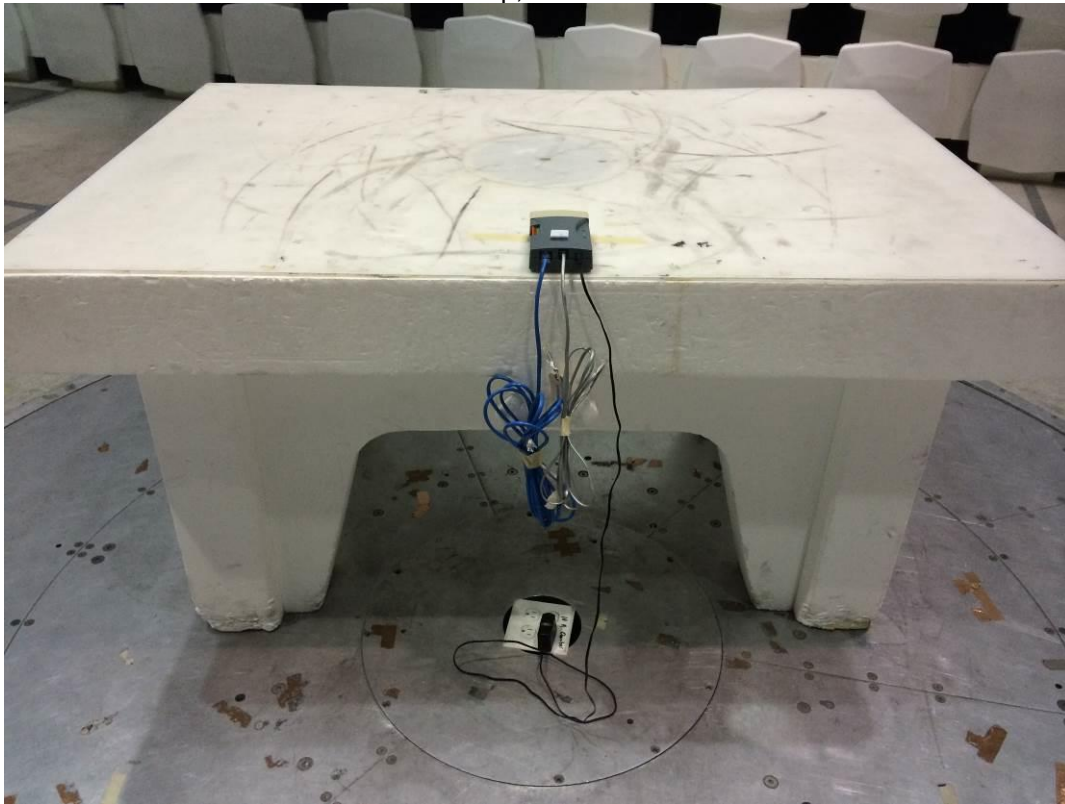
Name	Manufacturer	Version
C5	Teseq	5.26.46.46

**8.3 Results:**

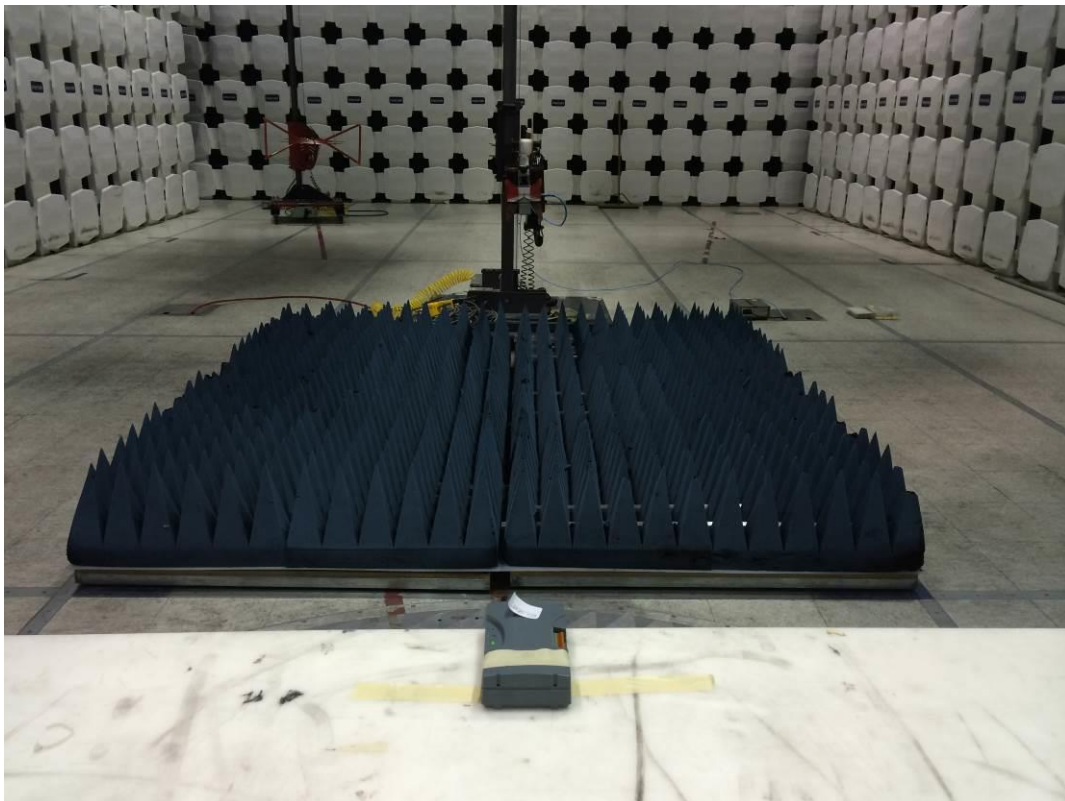
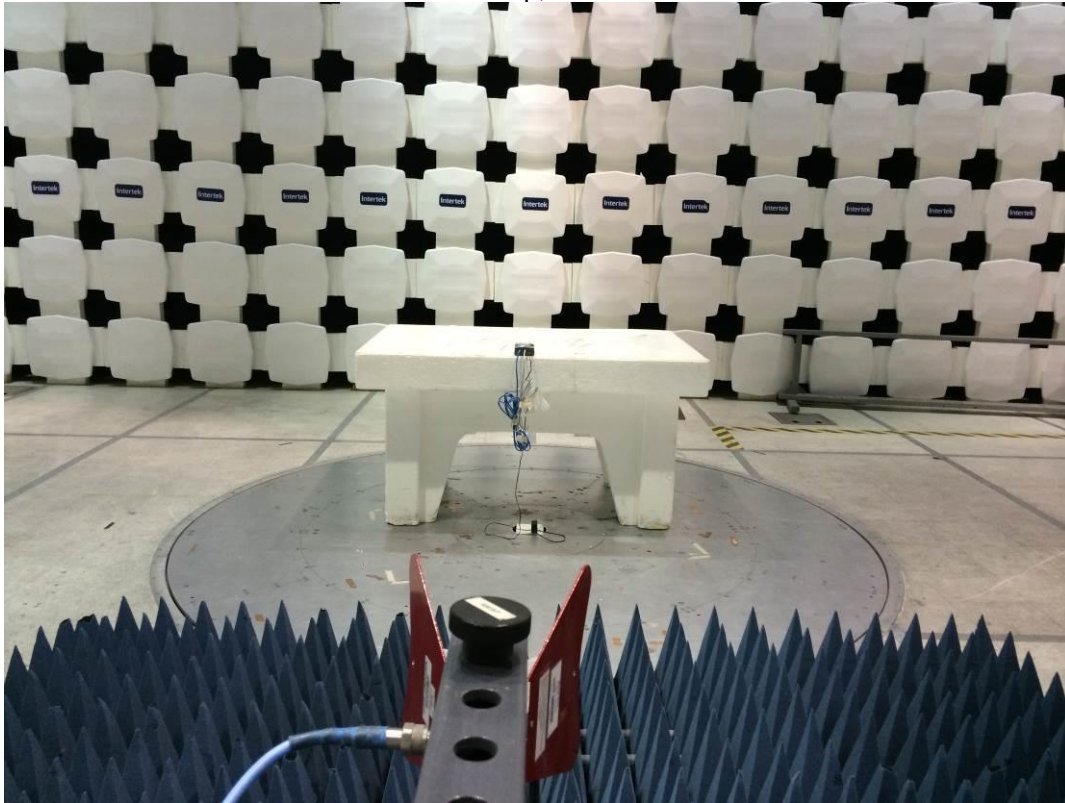
The sample tested was found to Comply.

8.4 Setup Photographs:

Test Setup, 30-1000 MHz



Test Setup, 1-10 GHz



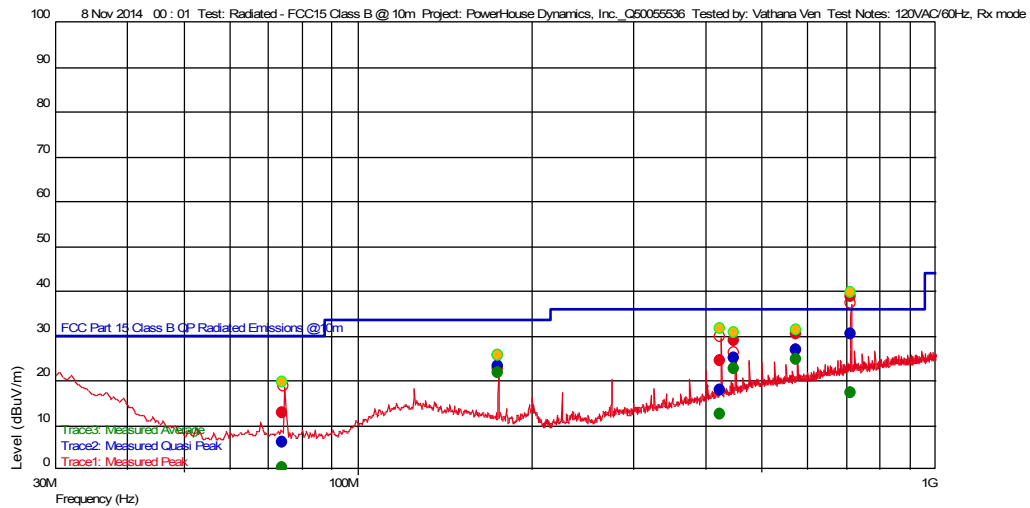
**8.5 Plots/Data:**

**Receive Mode, 30-1000 MHz**

**Test Information**

Test Details	User Entry	Additional Information
Test:	Radiated - FCC15 Class B @ 10m	
Project:	PowerHouse Dynamics, Inc._Q50055536	
Test Notes:	120VAC/60Hz, Rx mode	
Temperature:	20 deg C	
Humidity:	31%, 998mB	
Tested by:	Vathana Ven	
Test Started:	8 Nov 2014 00 : 01	

**Prescan Emission Graph**



- Measured Peak Value — Swept Peak Data
- Measured Quasi Peak Value — Swept Quasi Peak Data
- Measured Average Value — Swept Average Data
- Maximum Value of Mast and Turntable

**Emissions Test Data**

**Trace2: Measured Quasi Peak**

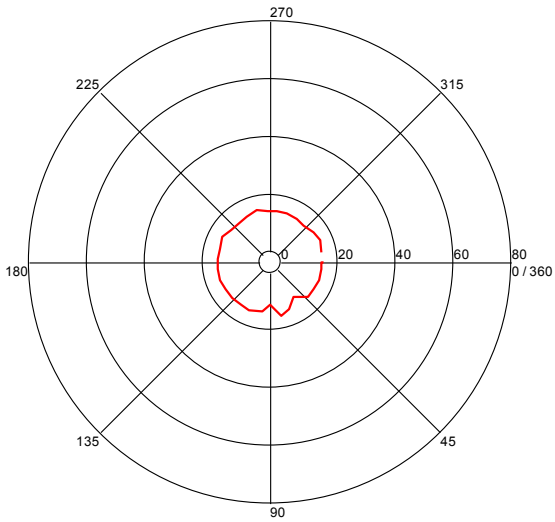
Frequency (Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin (dBuV/m)	Hor ( - ), Ver (   )	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
74.227655473 M	5.99	7.900	-24.515	30.000	-24.01		219	2.28	120 k	
425.128857335 M	17.87	16.403	-22.884	36.020	-18.15		311	1.27	120 k	
450.025651784 M	24.81	16.801	-22.705	36.020	-11.21		32	1.27	120 k	
174.991382543 M	23.01	11.600	-23.808	33.520	-10.51		340	1.04	120 k	
575.00701393 M	26.61	18.700	-22.103	36.020	-9.41	--	44	2.16	120 k	
712.980761417 M	30.34	20.419	-21.515	36.020	-5.68	--	151	1.87	120 k	



Azimuth Plots

Turntable Plot ( 74.227655473 MHz )

Level (dBuV/m)

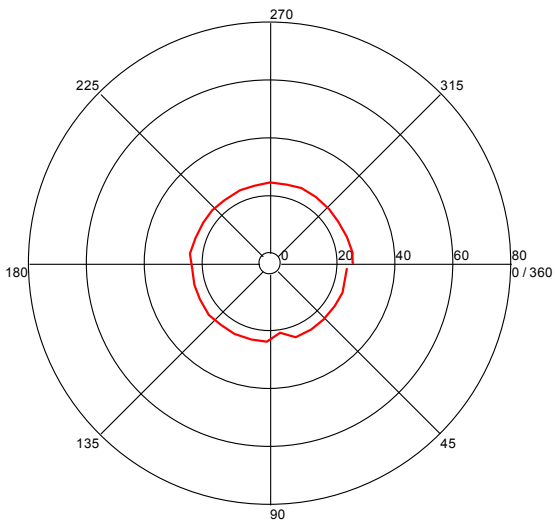


All Polarities

Azimuth (Degrees)

Turntable Plot ( 174.991382543 MHz )

Level (dBuV/m)

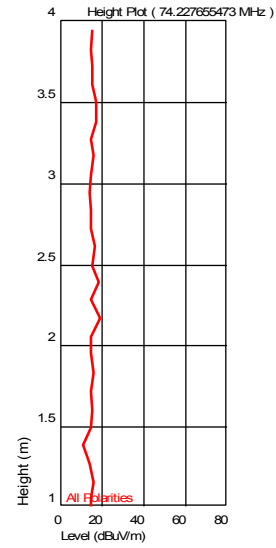


All Polarities

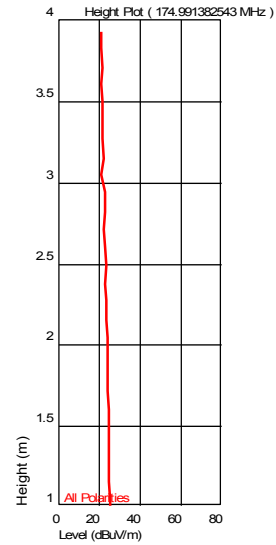
Azimuth (Degrees)

Turntable Plots

Height Plot ( 74.227655473 MHz )

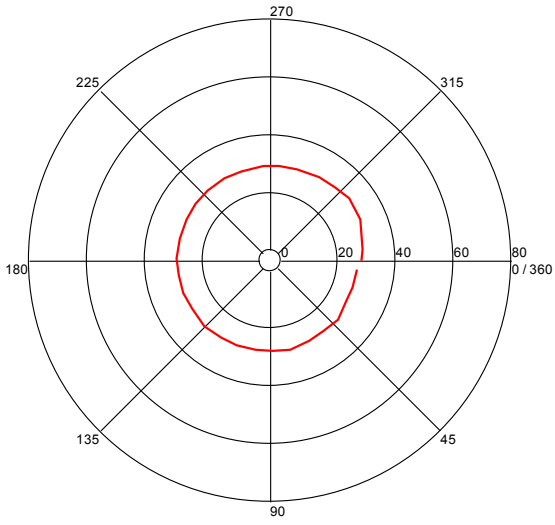


Height Plot ( 174.991382543 MHz )



Turntable Plot ( 425.128857335 MHz)

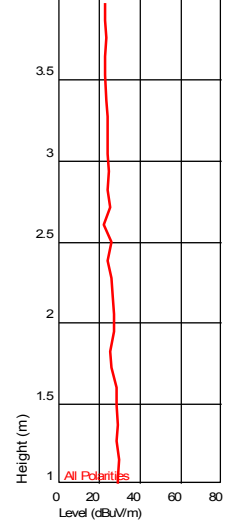
Level (dBuV/m)



All Polarities

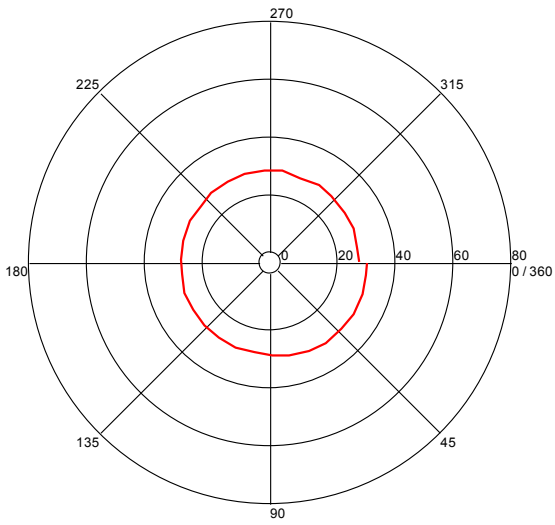
Azimuth (Degrees)

Height Plot ( 425.128857335 MHz )



Turntable Plot ( 450.025651784 MHz)

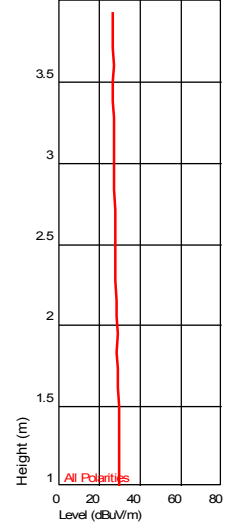
Level (dBuV/m)



All Polarities

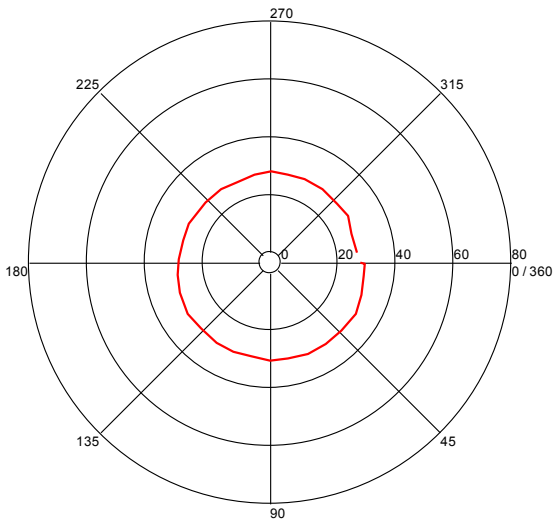
Azimuth (Degrees)

Height Plot ( 450.025651784 MHz )



Turntable Plot ( 575.00701393 MHz )

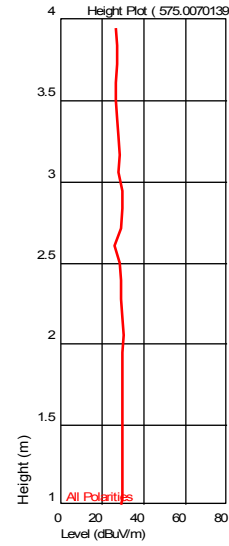
Level (dBuV/m)



All Polarities

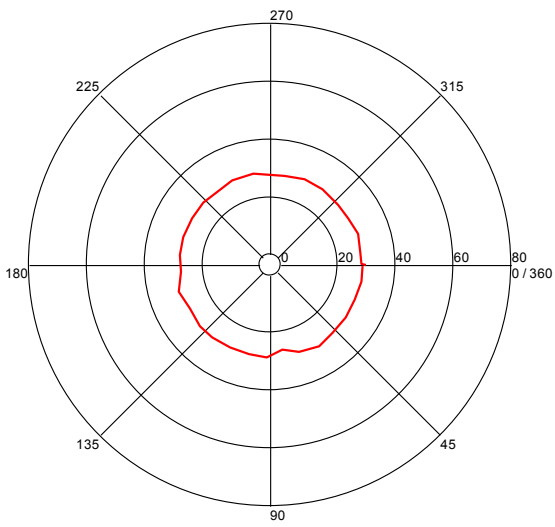
Azimuth (Degrees)

Height Plot ( 575.00701393 MHz )



Turntable Plot ( 712.980761417 MHz )

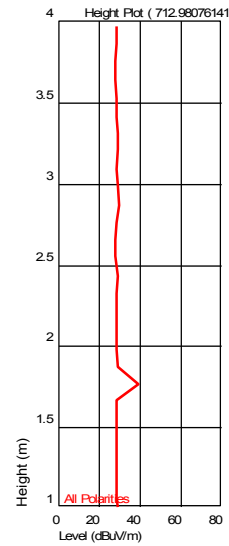
Level (dBuV/m)



All Polarities

Azimuth (Degrees)

Height Plot ( 712.980761417 MHz )



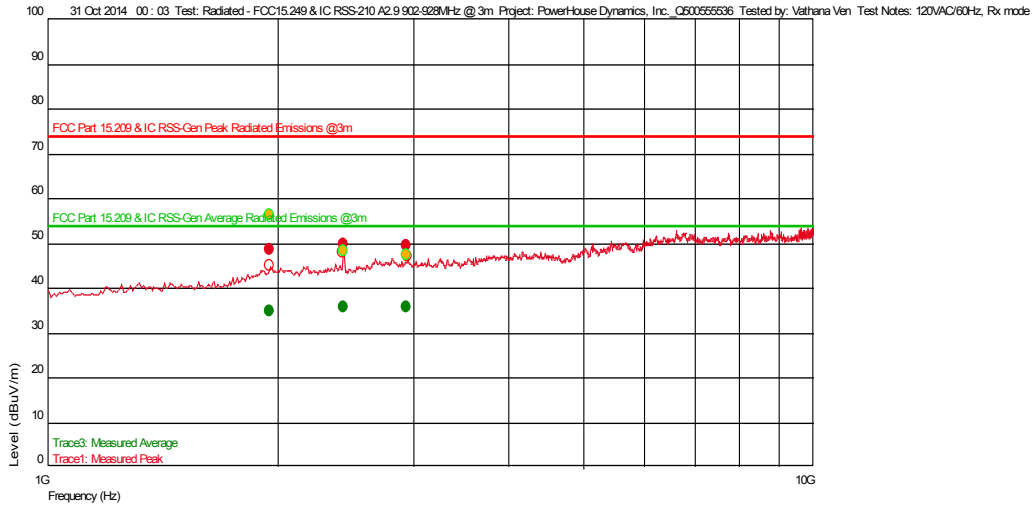
**Receive Mode, Above 1 GHz**

**Test Information**

Test Details            User Entry  
 Test:                    Radiated - FCC15.249 & IC RSS-210 A2.9 902-928MHz @ 3m  
 Project:                PowerHouse Dynamics, Inc.\_Q50055536  
 Test Notes:            120VAC/60Hz, Rx mode  
 Temperature:         21 deg C  
 Humidity:             39%, 1003 mB  
 Tested by:            Vathana Ven  
 Test Started:         31 Oct 2014 00 : 03

Additional Information

**Prescan Emission Graph**



- Measured Peak Value
- Measured Quasi Peak Value
- Measured Average Value
- Maximum Value of Mast and Turntable
- Swept Peak Data
- Swept Quasi Peak Data
- Swept Average Data

**Emissions Test Data**

**Trace1: Measured Peak**

Frequency (Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin (dBuV/m)	Hor ( -- ), Ver (   )	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
1.949271878 G	48.62	31.572	-26.048	74.000	-25.38		118	1.81	1 M	
2.947688711 G	49.30	32.722	-25.167	74.000	-24.70	--	360	1.50	1 M	
2.436392785 G	49.78	32.192	-25.883	74.000	-24.22		40	1.16	1 M	

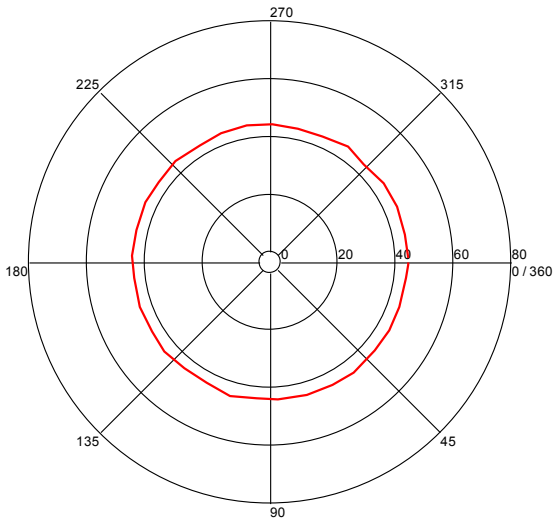
**Trace3: Measured Average**

Frequency (Hz)	Level (dBuV/m)	AF	PA+CL	Limit (dBuV/m)	Margin (dBuV/m)	Hor ( -- ), Ver (   )	Azimuth (deg)(Deg)	Mast Height(m)	RBW(Hz)	Comment
1.949271878 G	34.92	31.572	-26.048	54.000	-19.08		118	1.81	1 M	
2.436392785 G	35.55	32.192	-25.883	54.000	-18.45		40	1.16	1 M	
2.947688711 G	35.79	32.722	-25.167	54.000	-18.21	--	360	1.50	1 M	

Azimuth Plots

Turntable Plot ( 1.949271878 GHz )

Level (dBuV/m)

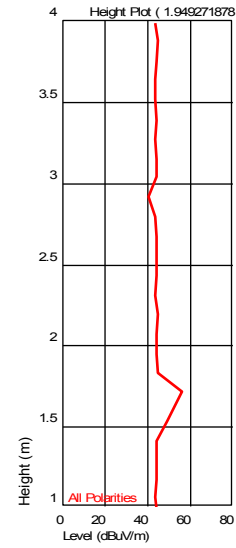


All Polarities

Azimuth (Degrees)

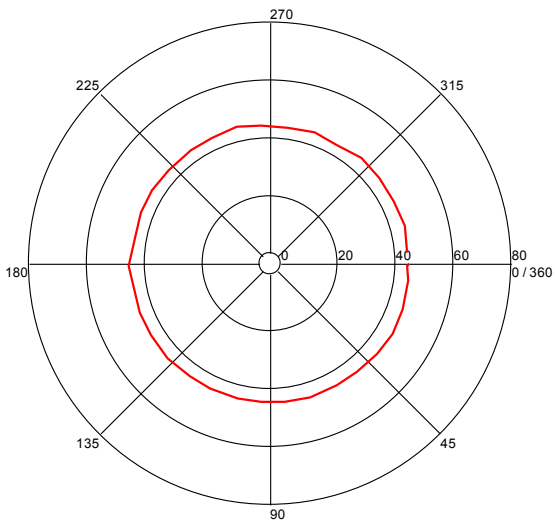
Turntable Plots

Height Plot ( 1.949271878 GHz )



Turntable Plot ( 2.436392785 GHz )

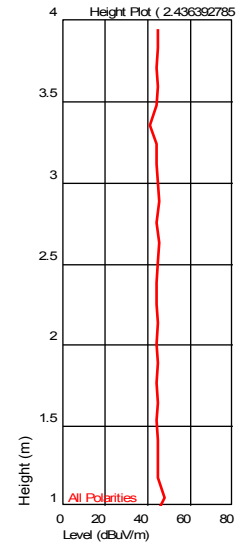
Level (dBuV/m)



All Polarities

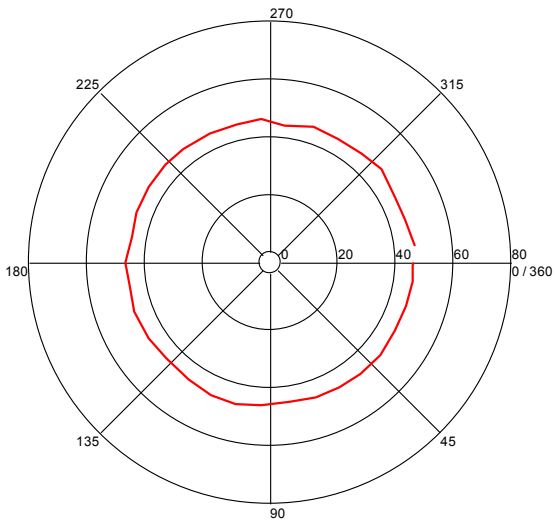
Azimuth (Degrees)

Height Plot ( 2.436392785 GHz )



Turntable Plot ( 2.947688711 GHz )

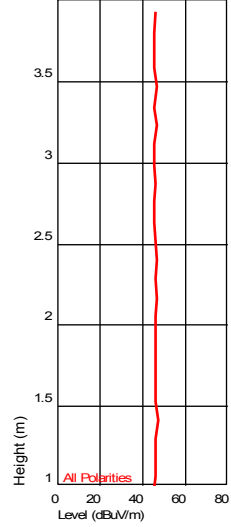
Level (dBuV/m)



All Polarities

Azimuth (Degrees)

Height Plot ( 2.947688711 GHz )



Height (m)

Level (dBuV/m)

Test Personnel: Vathana Ven *VSV*  
Supervising/Reviewing Engineer: N/A  
(Where Applicable) FCC Part 15 Subpart 15.249, RSS-210  
Product Standard: 120VAC/60Hz  
Input Voltage: BB Source  
Pretest Verification w/ Ambient Signals or BB Source: BB Source

Test Date: 10/31/2014, 11/08/2014

Limit Applied: Per Standard

Ambient Temperature: 20, 21 °C

Relative Humidity: 31, 31 %

Atmospheric Pressure: 998, 1003 mbars

Deviations, Additions, or Exclusions: None

## 9 Transmitter Bandwidth

### 9.1 Method

Tests are performed in accordance with FCC 47CFR Part 15 Subpart B Class B, FCC 47CFR Part 15 Subpart C Section 15.249, ANSI C63.10:2012, RSS-210, and ICES-003.

**TEST SITE:** 10m ALSE

**The 10m ALSE** is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

### Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6	6.3
Radiated Emissions, 3m	30-1000 MHz	5.3	6.3
Radiated Emissions, 3m	1-6 GHz	4.5	5.2
Radiated Emissions, 3m	6-15 GHz	5.2	5.5
Radiated Emissions, 3m	15-18 GHz	5.0	5.5
Radiated Emissions, 3m	18-40 GHz	5.0	5.5

### Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB $\mu$ V/m
- RA = Receiver Amplitude (including preamplifier) in dB $\mu$ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB $\mu$ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB $\mu$ V/m. This value in dB $\mu$ V/m was converted to its corresponding level in  $\mu$ V/m.

RA = 52.0 dB $\mu$ V  
 AF = 7.4 dB/m  
 CF = 1.6 dB  
 AG = 29.0 dB  
 FS = 32 dB $\mu$ V/m

To convert from dB $\mu$ V to  $\mu$ V or mV the following was used:

$$UF = 10^{(NF / 20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

$$NF = \text{Net Reading in dB}\mu\text{V}$$

#### Example:

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10^{(32 \text{ dB}\mu\text{V} / 20)} = 39.8 \mu\text{V/m}$$

Alternately, when C5 Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". "AF" is the Antenna Factor; "PA+CL" are Preamp and Cable Loss. These are already accounted for in the "Level" column.



**9.2 Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV004	Weather Station	Davis Instruments	7400	PE80529A61A	10/06/2014	10/06/2015
145-410"	Cables 145-400 145-403 145-405 145-406 145-407	Huber + Suhner	10m Track A Cables	multiple	10/04/2014	10/04/2015
145128"	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/17/2014	03/17/2015
145106"	Bilog Antenna (30MHz - 5GHz)	Sunol Sciences	JB5	A111003	01/07/2014	01/07/2015

**Software Utilized:**

Name	Manufacturer	Version
None		

**9.3 Results:**

The sample tested was found to Comply.

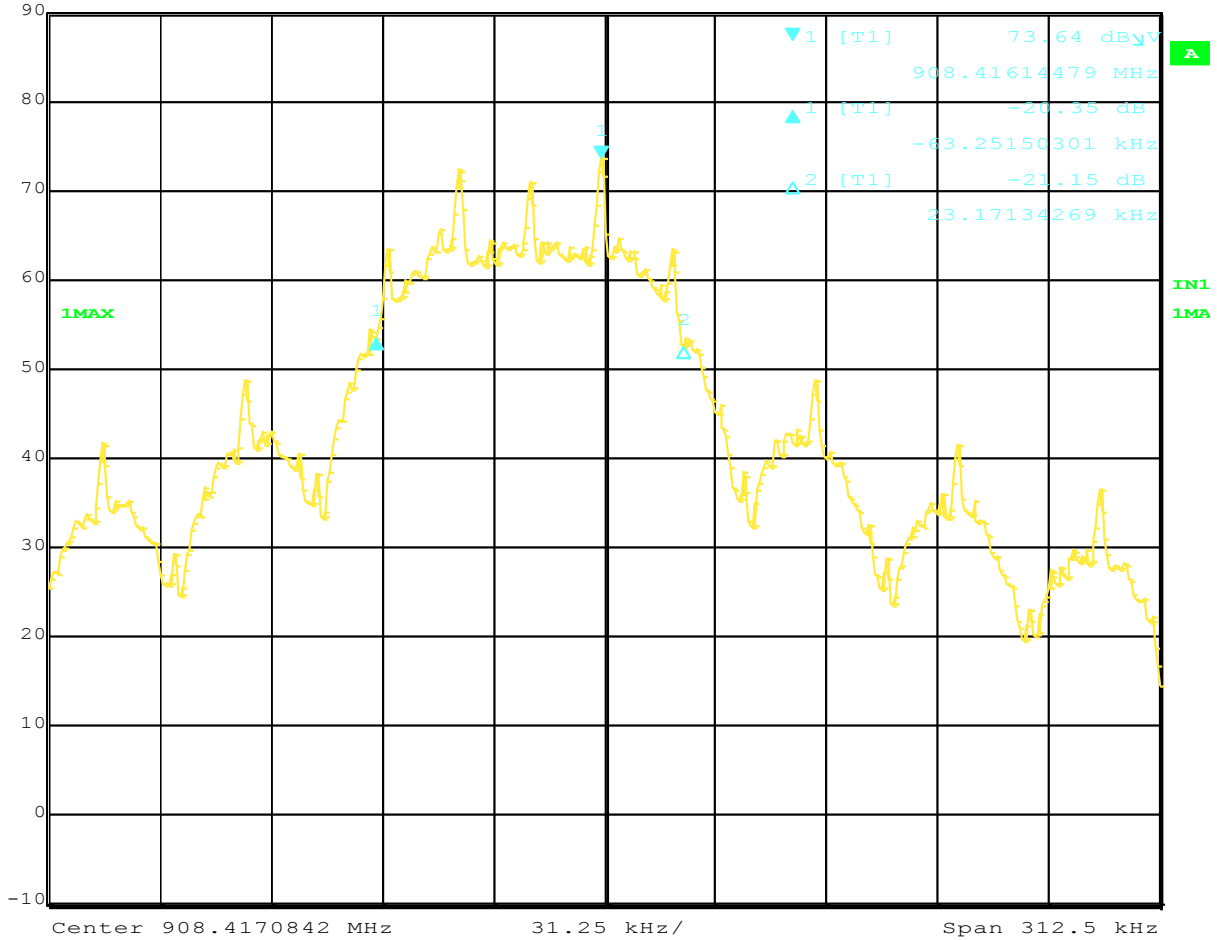
**9.4 Setup Photographs:**



9.5 Test Data:



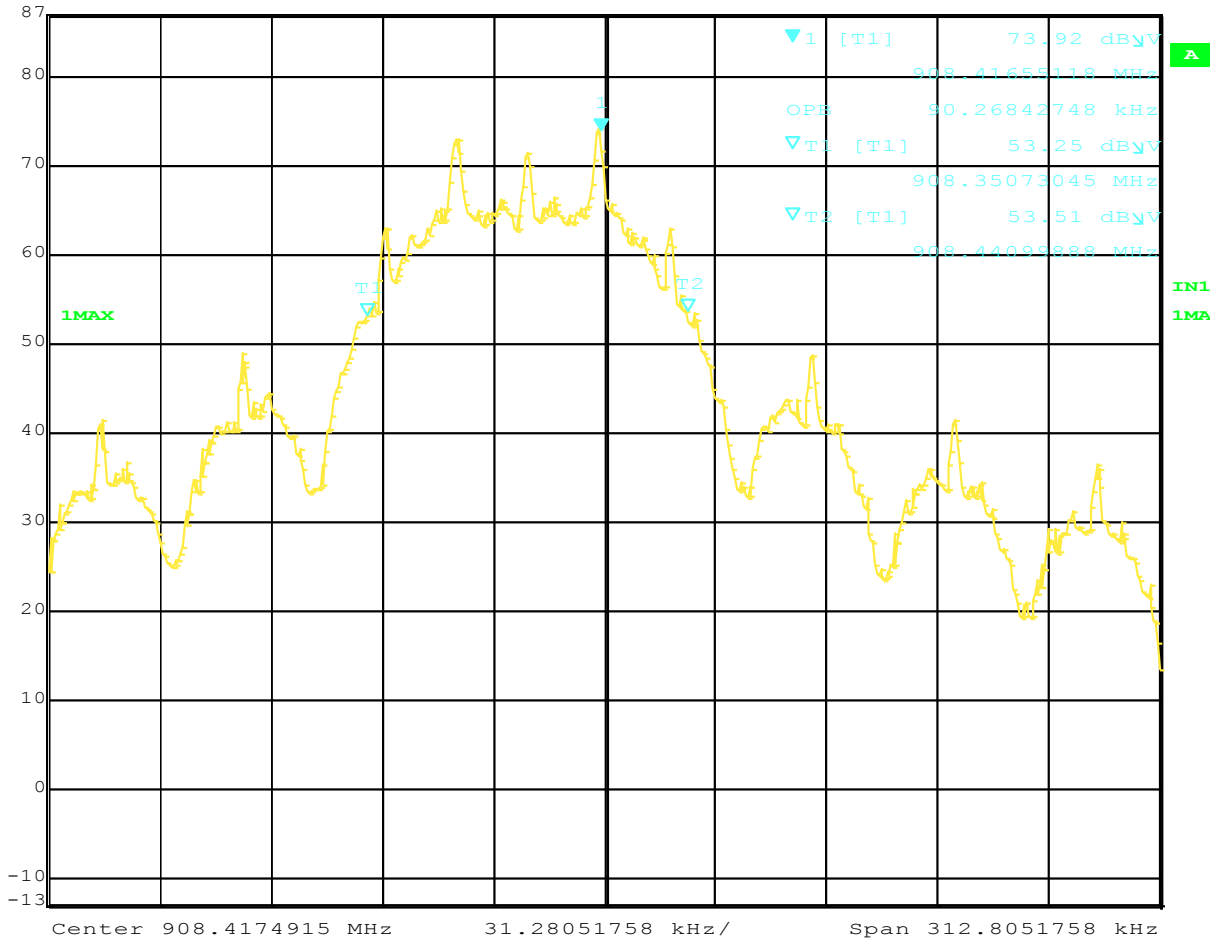
Ref Lvl	Delta 1 [T1]	RBW	2 kHz	RF Att	0 dB
90 dBμV	-20.35 dB	VBW	10 kHz		
	-63.25150301 kHz	SWT	300 ms	Unit	dBμV



Date: 14.AUG.2014 18:21:33



Ref Lvl	Marker 1 [T1]	RBW	2 kHz	RF Att	10 dB
87 dBμV	73.92 dBμV	VBW	10 kHz		
	908.41655118 MHz	SWT	5 s	Unit	dBμV



Date: 14.AUG.2014 18:27:23

Test Personnel: Vathana Ven *VSV*  
 Supervising/Reviewing Engineer: \_\_\_\_\_  
 (Where Applicable) N/A  
 Product Standard: FCC Part 15 Subpart 15.249, RSS-210  
 Input Voltage: 120VAC/60Hz  
 Pretest Verification w/ Ambient Signals or BB Source: Yes

Test Date: 11/11/2014  
 Limit Applied: Per Standard  
 Ambient Temperature: 20 °C  
 Relative Humidity: 31 %  
 Atmospheric Pressure: 998 mbars

Deviations, Additions, or Exclusions: None

## 10 Transmitter Duty Cycle

### 10.1 Method

Tests are performed in accordance with FCC 47CFR Part 15 Subpart B Class B, FCC 47CFR Part 15 Subpart C Section 15.249, ANSI C63.4:2009, RSS-210, and ICES-003.

**TEST SITE:** 10m ALSE

**The 10m ALSE** is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

### 10.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV004	Weather Station	Davis Instruments	7400	PE80529A61A	10/06/2014	10/06/2015
145-410"	Cables 145-400 145-403 145-405 145-406 145-407	Huber + Suhner	10m Track A Cables	multiple	10/04/2014	10/04/2015
145128"	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/17/2014	03/17/2015
145106"	Bilog Antenna (30MHz - 5GHz)	Sunol Sciences	JB5	A111003	01/07/2014	01/07/2015

#### Software Utilized:

Name	Manufacturer	Version
None		

### 10.3 Results:

The sample tested was found to Comply.

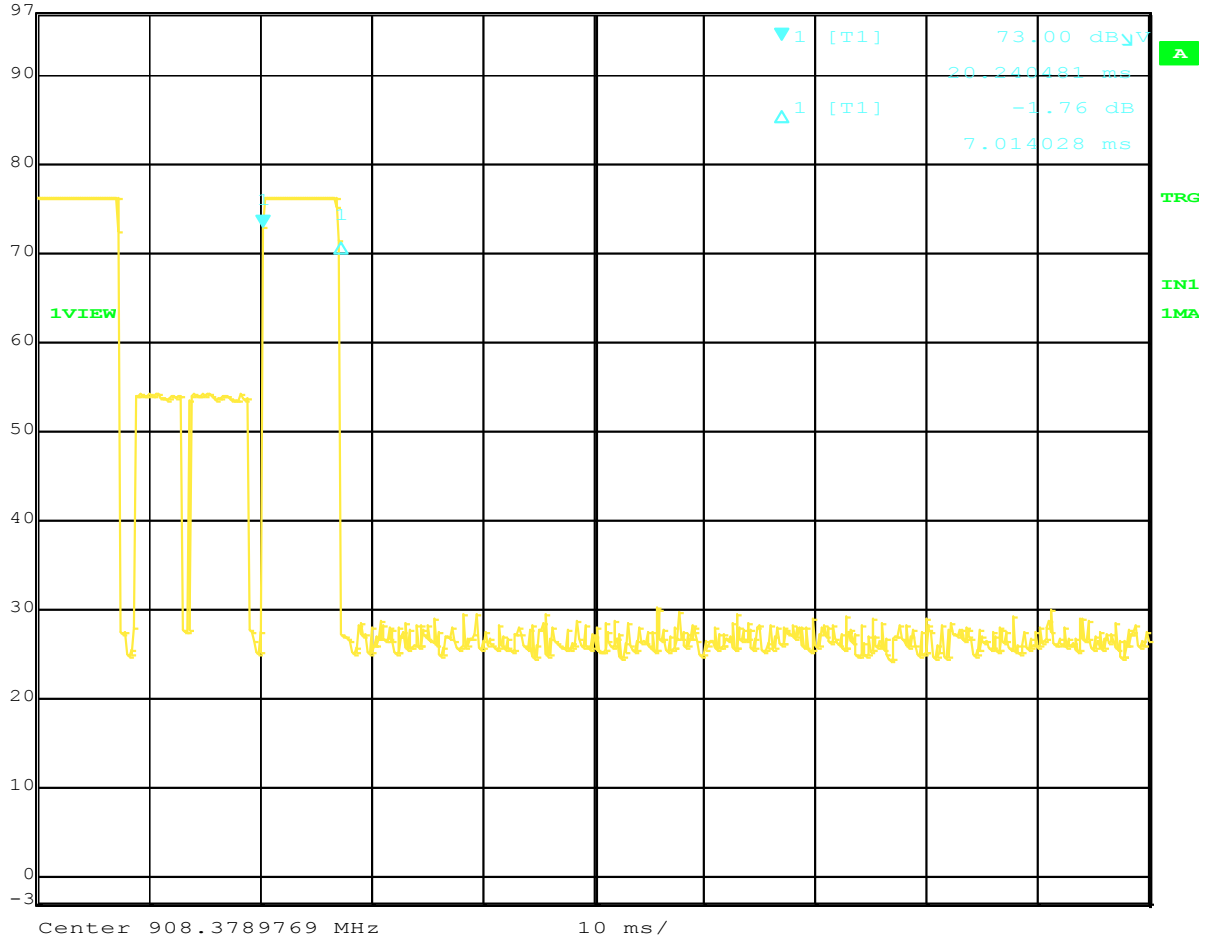
**10.4 Setup Photographs:**



10.5 Test Data:



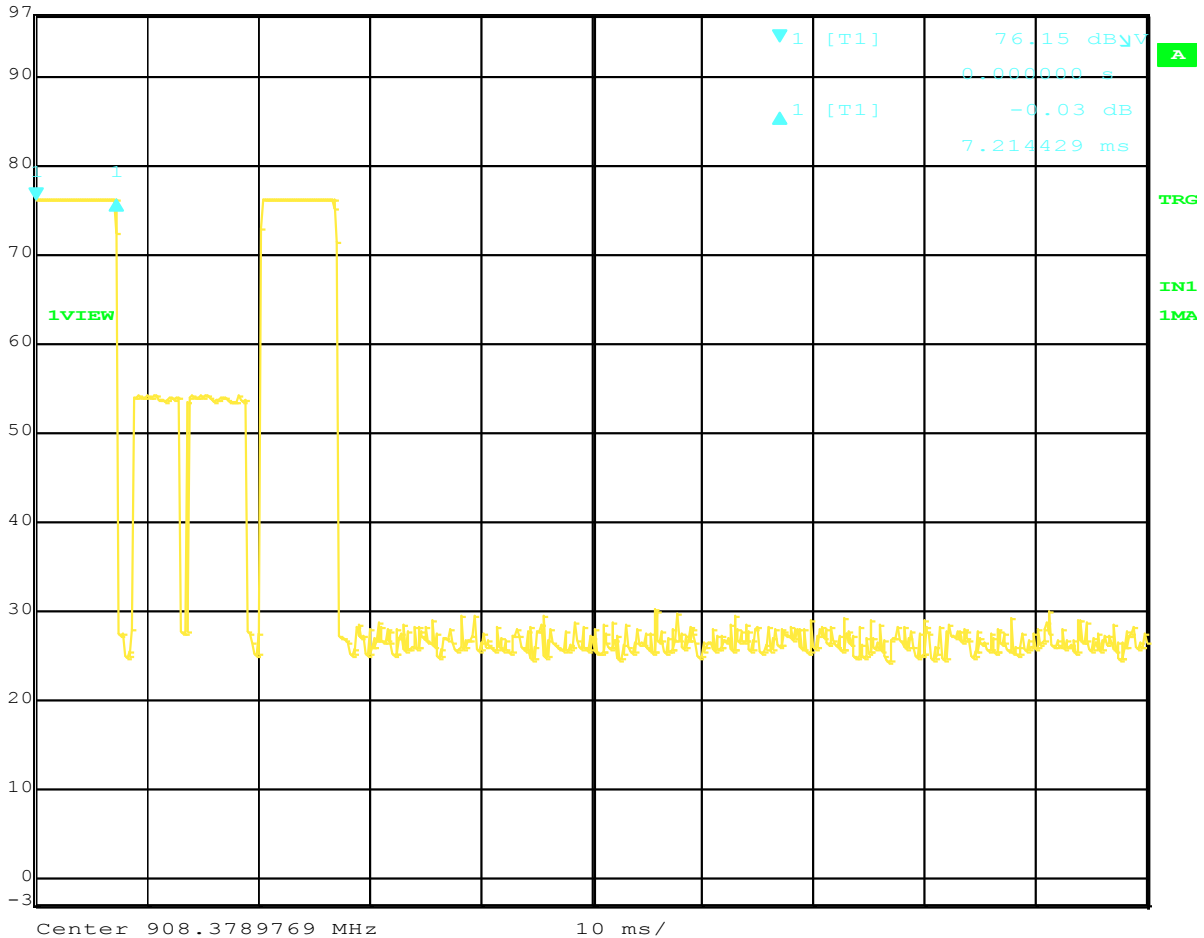
Ref Lvl	73.00 dB $\mu$ V	RBW	100 kHz	RF Att	10 dB
97 dB $\mu$ V	20.240481 ms	VBW	300 kHz		
		SWT	100 ms	Unit	dB $\mu$ V



Date: 14.AUG.2014 22:49:02



	Delta 1 [T1]	RBW	100 kHz	RF Att	10 dB
Ref Lvl	-0.03 dB	VBW	300 kHz		
97 dBμV	7.214429 ms	SWT	100 ms	Unit	dBμV



Date: 14.AUG.2014 22:46:48

Note that the two smaller pulses were from the thermostat (support equipment)

Average factor =  $20 \cdot \text{LOG}((7.214+7.014)/100) = 16.9$

Test Personnel: <u>Vathana Ven <i>VSV</i></u>	Test Date: <u>08/14/2014</u>
Supervising/Reviewing Engineer: <u>(Where Applicable) N/A</u>	
Product Standard: <u>FCC Part 15 Subpart 15.249, RSS-210</u>	Limit Applied: <u>Per Standard</u>
Input Voltage: <u>120VAC/60Hz</u>	Ambient Temperature: <u>20 °C</u>
Pretest Verification w/ Ambient Signals or BB Source: <u>Yes</u>	Relative Humidity: <u>31 %</u>
	Atmospheric Pressure: <u>998 mbars</u>

Deviations, Additions, or Exclusions: None



## 11 AC Mains Conducted Emissions

### 11.1 Method

Tests are performed in accordance with FCC 47CFR Part 15 Subpart B Class B, ICES-003..

#### TEST SITE: 10m ALSE

**The EMC Lab** has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

**The 10m ALSE** is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. A Styrofoam table 80 cm high is used for table-top equipment.

#### Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
AC Line Conducted Emissions	150 kHz - 30 MHz	2.8	3.4
Telco Port Emissions	150 kHz - 30 MHz	3.2	5

#### Sample Calculations

The following is how net line-conducted readings were determined:

$$NF = RF + LF + CF + AF$$

Where NF = Net Reading in dB $\mu$ V

RF = Reading from receiver in dB $\mu$ V

LF = LISN or ISN Correction Factor in dB

CF = Cable Correction Factor in dB

AF = Attenuator Loss Factor in dB

To convert from dB $\mu$ V to  $\mu$ V or mV the following was used:

$$UF = 10^{(NF / 20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

$$NF = \text{Net Reading in dB}\mu\text{V}$$

#### Example:

$$NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 \text{ dB}\mu\text{V}$$

$$UF = 10^{(49.1 \text{ dB}\mu\text{V} / 20)} = 285.1 \mu\text{V/m}$$

Alternately, when C5 Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". "TF" is the Transducer Factor; in this case LISN or ISN loss.

**11.2 Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV004'	Weather Station	Davis Instruments	7400	PE80529A61 A	10/06/2014	10/06/2015
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/17/2014	03/17/2015
DS27'	Attenuator, 20dB	Mini Circuits	20dB, 50 ohm	DS27	10/01/2014	10/01/2015
CBLBNC7'	30 ft 50 ohm coax, BNC - BNC	ITT Pomona	RG 58 C/U	CBLBNC7	02/04/2014	02/04/2015
LISN32'	CISPR 16 LISN	Com-Power	LI-215A	191955	02/26/2014	02/26/2015

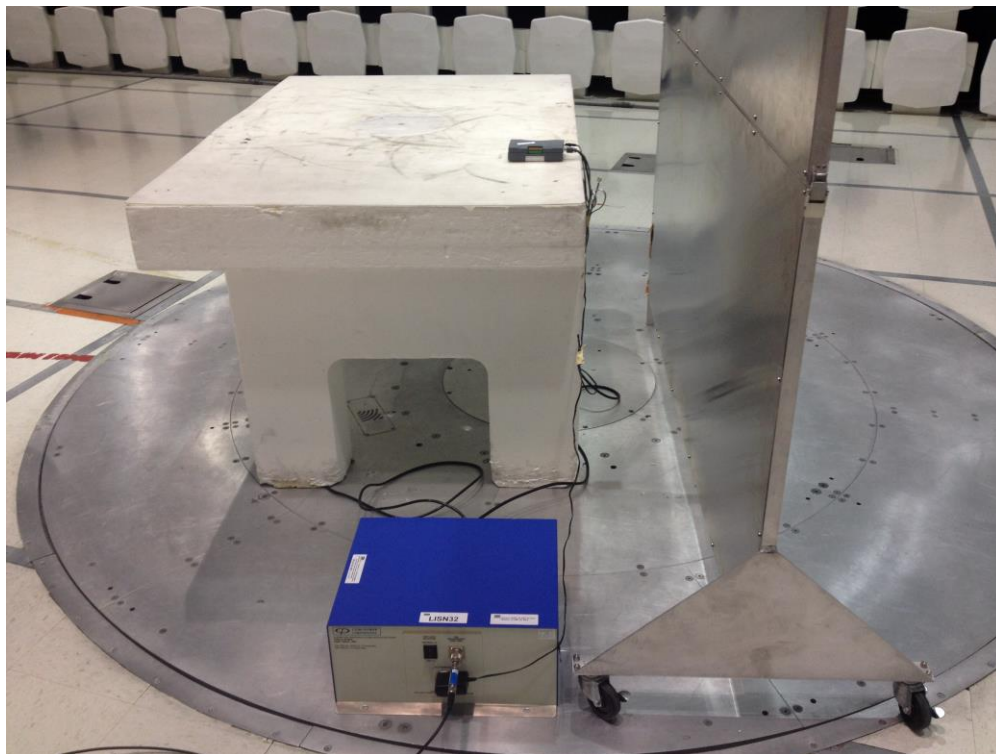
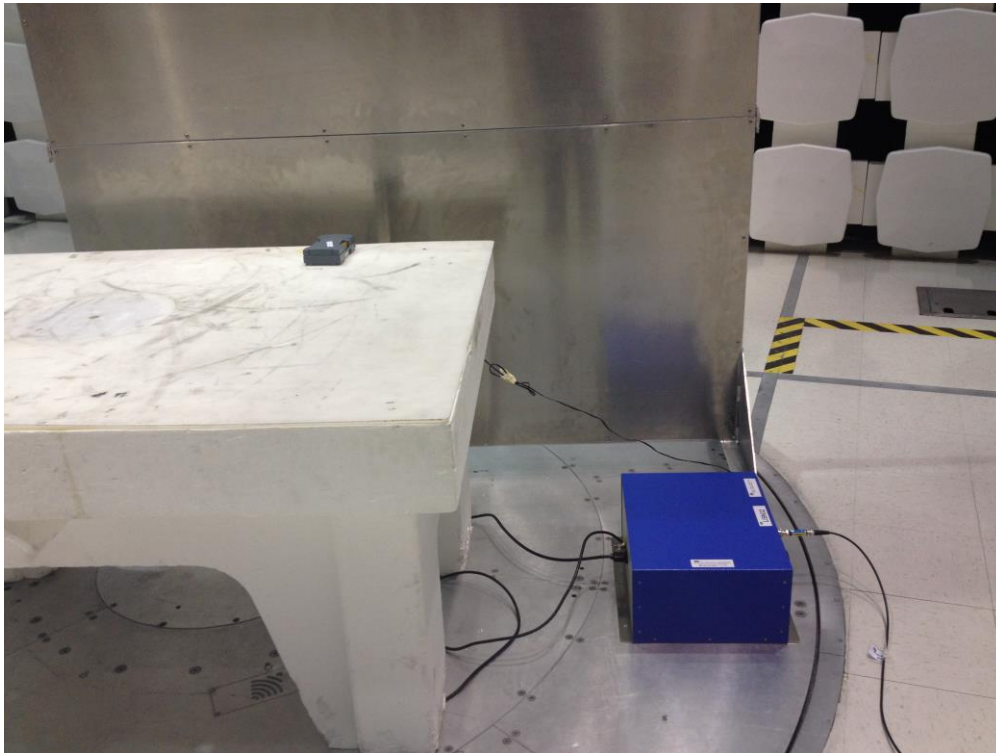
**Software Utilized:**

Name	Manufacturer	Version
C5	Teseq	5.26.46.46

**11.3 Results:**

The sample tested was found to Comply.

11.4 Setup Photographs:



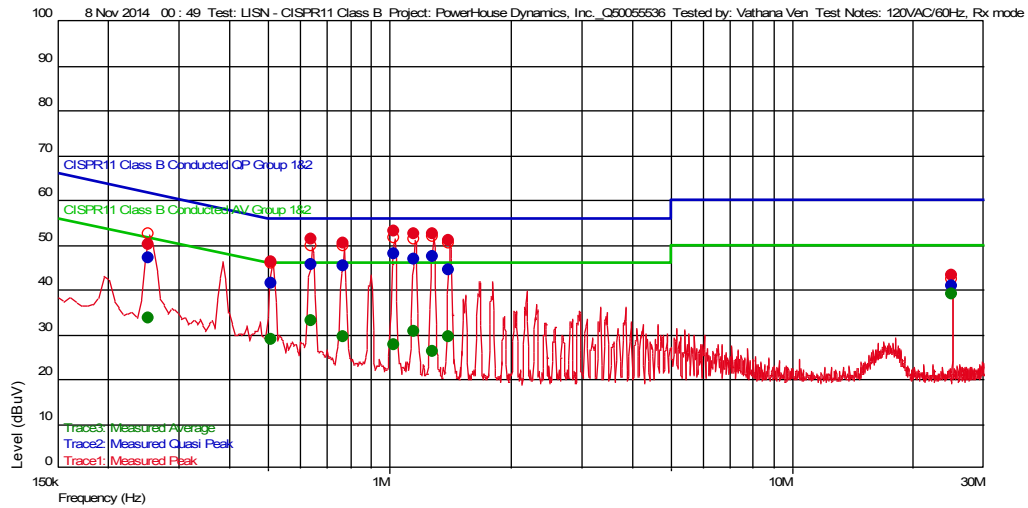
11.5 Plots/Data:

Test Information

Test Details User Entry  
 Test: LISN - CISPR11 Class B  
 Project: PowerHouse Dynamics, Inc.\_Q50055536  
 Test Notes: 120VAC/60Hz, Rx mode  
 Temperature: 20 deg C  
 Humidity: 31%, 998mB  
 Tested by: Vathana Ven  
 Test Started: 8 Nov 2014 00 : 49

Additional Information

Prescan Emission Graph



- Measured Peak Value
- Measured Quasi Peak Value
- Measured Average Value
- Maximum Value of Mast and Turntable
- Swept Peak Data
- Swept Quasi Peak Data
- Swept Average Data

Emissions Test Data

Trace2: Measured Quasi Peak

Frequency(Hz)	Level(dBuV)	TF	PA+CL	Limit(dBuV)	Margin(dBuV)	RBW(Hz)	Comment	LINE
25.000240481 M	40.83	0.084	21.240	60.000	-19.17	9 k		N
509.819639279 k	41.32	0.073	20.591	56.000	-14.68	9 k		N
252.805611222 k	47.09	0.080	20.552	61.664	-14.57	9 k		N
1.412224449 M	44.43	0.090	20.625	56.000	-11.57	9 k		N
772.54509018 k	45.21	0.090	20.606	56.000	-10.79	9 k		N
641.182364729 k	45.52	0.070	20.604	56.000	-10.48	9 k		N
1.155210421 M	46.80	0.090	20.616	56.000	-9.20	9 k		N
1.286573146 M	47.30	0.090	20.628	56.000	-8.70	9 k		N
1.029559118 M	47.79	0.097	20.610	56.000	-8.21	9 k		N

Trace3: Measured Average

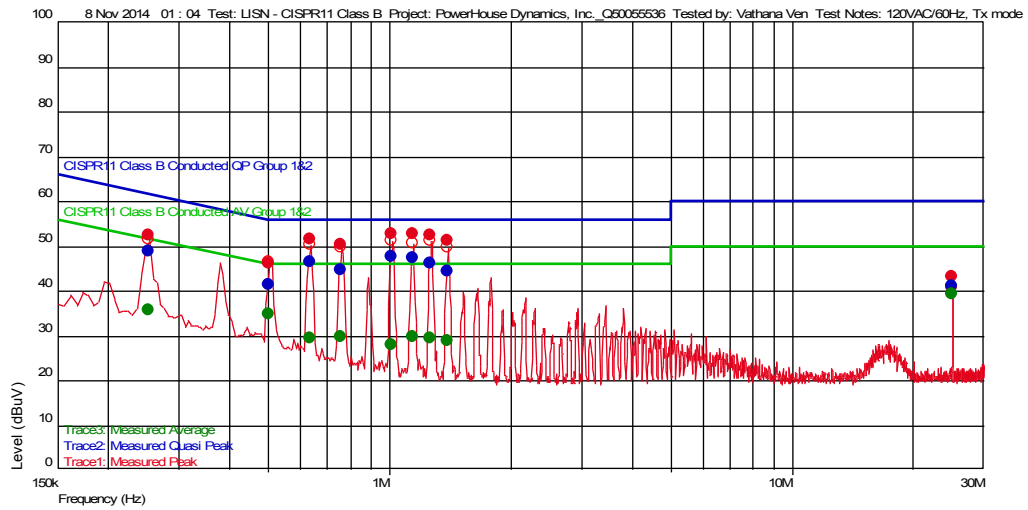
Frequency(Hz)	Level(dBuV)	TF	PA+CL	Limit(dBuV)	Margin(dBuV)	RBW(Hz)	Comment	LINE
1.286573146 M	26.21	0.090	20.628	46.000	-19.79	9 k		N
1.029559118 M	27.49	0.097	20.610	46.000	-18.51	9 k		N
252.805611222 k	33.53	0.080	20.552	51.664	-18.13	9 k		N
509.819639279 k	28.79	0.073	20.591	46.000	-17.21	9 k		N
772.54509018 k	29.48	0.090	20.606	46.000	-16.52	9 k		N
1.412224449 M	29.55	0.090	20.625	46.000	-16.45	9 k		N
1.155210421 M	30.53	0.090	20.616	46.000	-15.47	9 k		N
641.182364729 k	32.89	0.070	20.604	46.000	-13.11	9 k		N
25.000240481 M	39.07	0.084	21.240	50.000	-10.93	9 k		N

Test Information

Test Details User Entry  
 Test: LISN - CISPR11 Class B  
 Project: PowerHouse Dynamics, Inc.\_Q50055536  
 Test Notes: 120VAC/60Hz, Tx mode  
 Temperature: 20 deg C  
 Humidity: 31%, 998mB  
 Tested by: Vathana Ven  
 Test Started: 8 Nov 2014 01:04

Additional Information

Prescan Emission Graph



- Measured Peak Value
- Measured Quasi Peak Value
- Measured Average Value
- Maximum Value of Mast and Turntable
- Swept Peak Data
- Swept Quasi Peak Data
- Swept Average Data

Emissions Test Data

Trace2: Measured Quasi Peak

Frequency(Hz)	Level(dBuV)	TF	PA+CL	Limit(dBuV)	Margin(dBuV)	RBW(Hz)	Comment	LINE
25.000240481 M	40.97	0.084	21.240	60.000	-19.03	9 k		N
504.108216433 k	41.37	0.072	20.589	56.000	-14.63	9 k		N
252.805611222 k	48.72	0.080	20.552	61.664	-12.95	9 k		N
1.39509018 M	44.22	0.090	20.628	56.000	-11.78	9 k		N
761.122244489 k	44.61	0.090	20.609	56.000	-11.39	9 k		N
1.269438878 M	46.08	0.090	20.628	56.000	-9.92	9 k		N
635.470941884 k	46.44	0.070	20.606	56.000	-9.56	9 k		N
1.143787575 M	47.45	0.090	20.609	56.000	-8.55	9 k		N
1.018136273 M	47.74	0.099	20.619	56.000	-8.26	9 k		N

Trace3: Measured Average

Frequency(Hz)	Level(dBuV)	TF	PA+CL	Limit(dBuV)	Margin(dBuV)	RBW(Hz)	Comment	LINE
1.018136273 M	27.95	0.099	20.619	46.000	-18.05	9 k		N
1.39509018 M	28.73	0.090	20.628	46.000	-17.27	9 k		N
635.470941884 k	29.41	0.070	20.606	46.000	-16.59	9 k		N
1.269438878 M	29.45	0.090	20.628	46.000	-16.55	9 k		N
761.122244489 k	29.64	0.090	20.609	46.000	-16.36	9 k		N
1.143787575 M	29.69	0.090	20.609	46.000	-16.31	9 k		N
252.805611222 k	35.77	0.080	20.552	51.664	-15.89	9 k		N
504.108216433 k	34.70	0.072	20.589	46.000	-11.30	9 k		N
25.000240481 M	39.18	0.084	21.240	50.000	-10.82	9 k		N

Test Personnel: Vathana Ven *VSV*  
Supervising/Reviewing  
Engineer:  
(Where Applicable)  
Product Standard: FCC Part 15 Subpart B,  
ICES-003  
Input Voltage: 120VAC/60Hz  
Pretest Verification w/  
Ambient Signals or  
BB Source: Yes

Test Date: 11/08/2014  
Limit Applied: Class B  
Ambient Temperature: 20 °C  
Relative Humidity: 31 %  
Atmospheric Pressure: 998 mbars

Deviations, Additions, or Exclusions: None

**12 Revision History**

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	11/12/2014	101761367BOX-001c	VJV	MFM	Original Issue