

# EMC TEST REPORT

## FULL COMPLIANCE

**Report Number:** 100315802ATL-001B  
**Project Number:** G100315802

**Report Issue Date:** March 1, 2016

**Model(s) Tested:** RFT-1

**Standards:** CFR47 FCC Part 15 Subpart C:2015 Section 15.35, 15.205, 15.209, 15.215, 15.247  
CFR47 FCC Part 15 Subpart B:2015 Section 15.109  
Industry Canada RSS-247 Issue 1 May 2015, Section 5  
Industry Canada RSS-GEN Issue 4 November 2014

Tested by:  
Intertek Testing Services NA, Inc.  
1950 Evergreen Blvd, Suite 100  
Duluth, GA 30096 USA

Client:  
TPI Corporation - REDD-i Division  
PO Box 4973  
114 Roscoe Fitz  
Johnson City, TN 37602-4973 USA

Report prepared by



Mary Sampson/Senior Project Engineer

Report reviewed by



Kouma Sinn/EMC Staff Engineer

*This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to permit copying or distribution of this report and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product, or service is or has ever been under an Intertek certification program.*

## Table of Contents

1	<b><i>Introduction and Conclusion</i></b> .....	3
2	<b><i>Test Summary</i></b> .....	3
3	<b><i>Client Information</i></b> .....	5
4	<b><i>Description of Equipment Under Test and Variant Models</i></b> .....	5
5	<b><i>System Setup and Method</i></b> .....	7
6	<b><i>AC Mains Conducted Emissions</i></b> .....	8
7	<b><i>Transmitter Antenna Port Conducted Spurious Emissions</i></b> .....	8
8	<b><i>Transmitter Spurious Radiated Emissions</i></b> .....	11
9	<b><i>Receiver Spurious Radiated Emissions</i></b> .....	17
10	<b><i>Carrier Frequency Separation</i></b> .....	21
11	<b><i>Number of Hopping Frequencies</i></b> .....	23
12	<b><i>Time of Occupancy (Dwell Time)</i></b> .....	25
13	<b><i>Conducted Peak Output Power</i></b> .....	27
14	<b><i>Bandedge</i></b> .....	30
15	<b><i>20dB and Occupied Bandwidth</i></b> .....	34
16	<b><i>RF Exposure Compliance</i></b> .....	37
17	<b><i>Duty Cycle</i></b> .....	38
18	<b><i>Revision History</i></b> .....	41

## 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. Intertek does not make any claims of compliance for samples or variants which were not tested.

## 2 Test Summary

Section	Test full name	Result
3	Client Information	--
4	Description of Equipment Under Test and Variant Models	--
5	System Setup and Method	--
-	AC Mains Conducted Emissions (CFR47 FCC Part 15 Subpart C:2015 Section 15.205, 15.209, 15.215, 15.247(d); Industry Canada RSS-247 Issue 1 May 2015, Section 5; Industry Canada RSS-GEN Issue 4 December 2014, Section 6.13) Battery operated device	N/A
6	Transmitter Antenna Port Conducted Spurious Emissions (CFR47 FCC Part 15 Subpart C:2015 Section 15.205, 15.209, 15.215, 15.247(d); Industry Canada RSS-247 Issue 1 May 2015, Section 5; Industry Canada RSS-GEN Issue 4 December 2014, Section 6.13)	Compliant
7	Transmitter Spurious Radiated Emissions (CFR47 FCC Part 15 Subpart C:2015 Section 15.205, 15.209, 15.215, 15.247(d); Industry Canada RSS-247 Issue 1 May 2015, Section 5; Industry Canada RSS-GEN Issue 3 December 2014, Section 6.13)	Compliant
8	Receiver Spurious Radiated Emissions (CFR47 FCC Part 15 Subpart B:2015 Section 15.109; Industry Canada RSS-GEN Issue 4 December 2014, Section 7.1)	Compliant
9	Carrier Frequency Separation (CFR47 FCC Part 15 Subpart C:2015 Section 15.247(a)(1); Industry Canada RSS-247 Issue 1 May 2015, Section 5)	Compliant
10	Number of Hopping Frequencies (CFR47 FCC Part 15 Subpart C:2015 Section 15.247(a)(1)(i); Industry Canada RSS-247 Issue 1 May 2015, Section 5)	Compliant
11	Time of Occupancy (Dwell Time) (CFR47 FCC Part 15 Subpart C:2015 Section 15.247(a)(1)(i); Industry Canada RSS-247 Issue 1 May 2015, Section 5)	Compliant

<b>Section</b>	<b>Test full name</b>	<b>Result</b>
12	Peak Output Power (CFR47 FCC Part 15 Subpart C:2015 Section 15.247(b)(2); Industry Canada RSS-247 Issue 1 May 2015, Section 5; Industry Canada RSS-GEN Issue 4 December 2014, Section 6.12)	Compliant
13	Bandedge (CFR47 FCC Part 15 Subpart C:2015 Section 15.205, 15.215, 15.247(d); Industry Canada RSS-247 Issue 1 May 2015, Section 5	Compliant
14	20dB and Occupied Bandwidth (CFR47 FCC Part 15 Subpart C:2015 Section 15.215; 15.247(a)(1)(i); Industry Canada RSS-247 Issue 1 May 2015, Section 5; Industry Canada RSS-GEN Issue 4 December 2014, Section 6.6)	Compliant
15	RF Exposure Compliance (CFR47 FCC Part 15 Subpart C:2014 Section 15.215; 15.247(i); Industry Canada RSS-GEN Issue 4 December 2014, Section 3.2)	Compliant
16	Duty Cycle	Compliant
17	Revision History	--

### 3 Client Information

This EUT was tested at the request of:

**Client:** TPI Corporation - REDD-i Division  
 PO Box 4973  
 114 Roscoe Fitz  
 Johnson City, TN 37602-4973  
 USA

**Contact:** Tim Maden  
**Telephone:** 423-477-4131  
**Fax:** 423-477-8201  
**Email:** [Tmaden@tpicorp.com](mailto:Tmaden@tpicorp.com)

### 4 Description of Equipment Under Test and Variant Models

**Manufacturer:** TPI Corporation - REDD-i Division  
 PO Box 4973  
 114 Roscoe Fitz  
 Johnson City, TN 37602-4973  
 USA

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
Relay Package	TPI Corporation	RFT-1	Intertek Assigned: ATL1507281024-002 – Radiated Sample
Relay Package	TPI Corporation	RFT-1	Intertek Assigned: ATL1509041002-001 – Conducted Sample

Receive Date:	07/28/2015 and 09/04/2015
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)	
The product is a wireless interface between a thermostat and a remotely located HVAC relay electronics using short-range radios operating in the 915MHz ISM band. The system is a point-to-point configuration with both ends located indoors. The thermostat end of the system is battery powered. The relay end of the communication link is typically located within 100 feet of the thermostat unit and is powered from wall current.	

#### Equipment Under Test Power Configuration

Rated Voltage	Rated Current	Rated Frequency	Number of Phases
3 Vdc	28 mA	N/A	N/A

#### Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Continuous Transmission with hopping function enabled
2	Continuous Transmission with hopping function disabled
3	Continuous Receiving

**Software used by the EUT:**

No.	Descriptions of EUT Exercising
1	SD (Setback On-Demand) Thermostat software

Radio/Receiver Characteristics	
<b>Frequency Band(s)</b>	914.0 to 926.6 MHz
<b>Modulation Type(s)</b>	F1D
<b>Maximum Output Power</b>	10 dBm
<b>Test Channels</b>	Low, Mid and High
<b>Occupied Bandwidth</b>	Low channel = 380 kHz; Mid channel and High channels = 375 kHz
<b>Frequency Hopper: Number of Hopping Channels</b>	64
<b>Frequency Hopper: Channel Dwell Time</b>	395 ms
<b>Frequency Hopper: Max interval between two instances of use of the same channel</b>	25.6 seconds
<b>MIMO Information (# of Transmit and Receive antenna ports)</b>	N/A
<b>Equipment Type</b>	Standalone
<b>ETSI LBT/Adaptivity</b>	N/A
<b>ETSI Adaptivity Type</b>	N/A
<b>ETSI Temperature Category (I, II, III)</b>	N/A
<b>ETSI Receiver Category (1, 2, 3)</b>	N/A
<b>Antenna Type and Gain</b>	50 Ohm inverted F type, 0.0 dBi

**5 System Setup and Method**

Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
None					

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
None			

**5.1 Method:**

Configuration as required by Configuration as required by ANSI C63.10: 2013 and FCC Public Notice DA 00-705 Released March 30, 2000: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

**5.2 EUT Block Diagram:**

## 6 Transmitter Antenna Port Conducted Spurious Emissions

### 6.1 Method

Tests are performed in accordance with CFR47 FCC Part 15 Subpart C: 2015 Section 15.205, 15.247(d); Industry Canada RSS-247 Issue 1 May 2015, Section 5; Industry Canada RSS-GEN Issue 4 December 2014 Section 8.8

**TEST SITE:** Shielded Room

**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.

### 6.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
211872;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer.	Omega	iBTHX-W	0240116	11/07/2014	11/07/2015
Borrowed;	EMC Analyzer	Agilent	E7405A	US3915014	08/03/2015	08/03/2016
None;	5 dB Attenuator	Mini-Circuits	VAT -5+	15542	VBU	Verified
None;	5 dB Attenuator	Mini-Circuits	VAT -5+	15542	VBU	Verified
E208;	RF Coax Cable	Megaphase	TM18-N1N1-120	14065201-002	05/07/2015	05/07/2016

### Software Utilized:

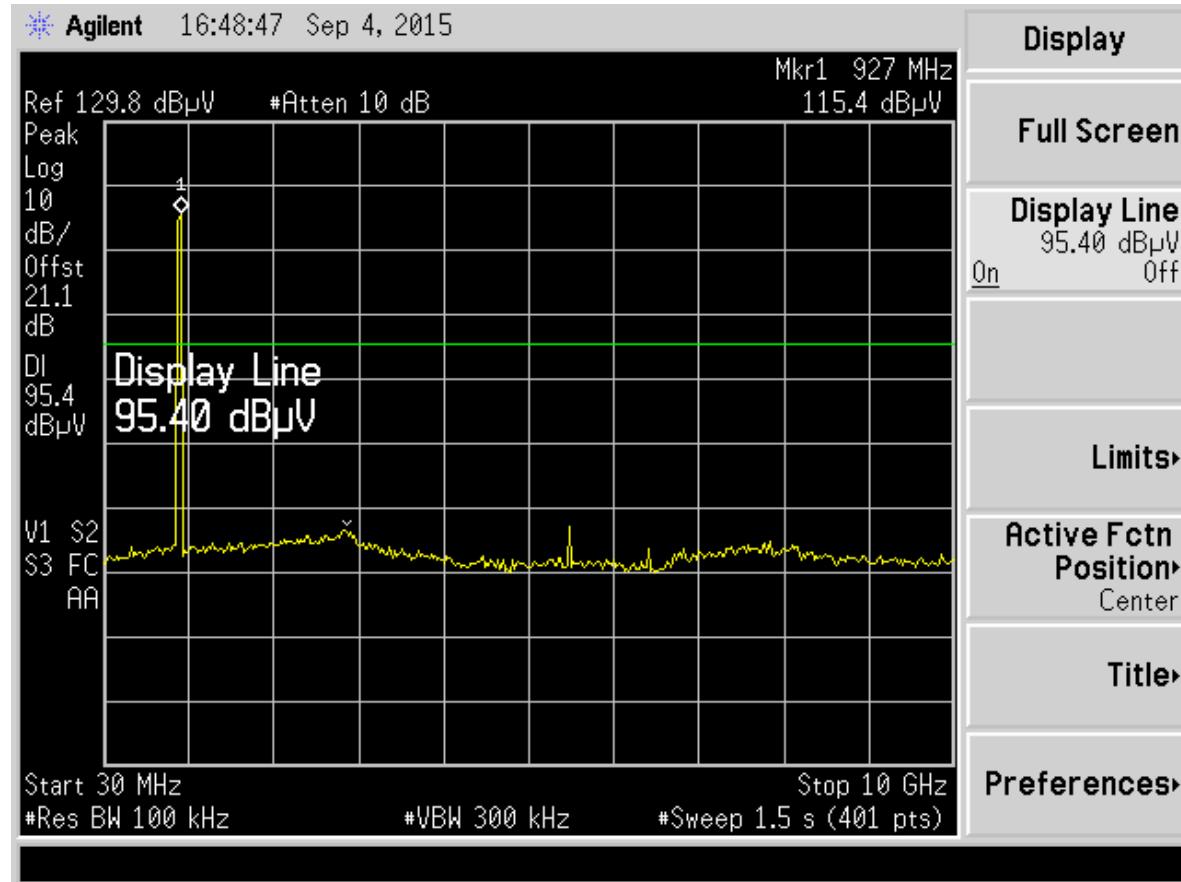
Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

### 6.3 Results:

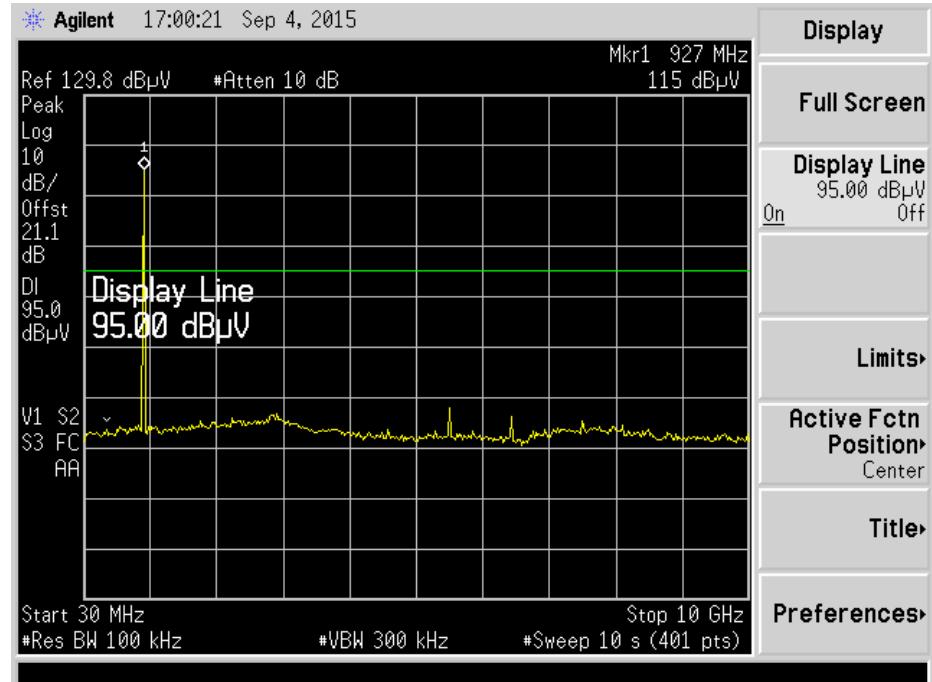
The sample tested was found to Comply. Testing was performed with hopping disabled and EUT transmitting on low, mid and high channels.

## 6.4 Plots/Data:

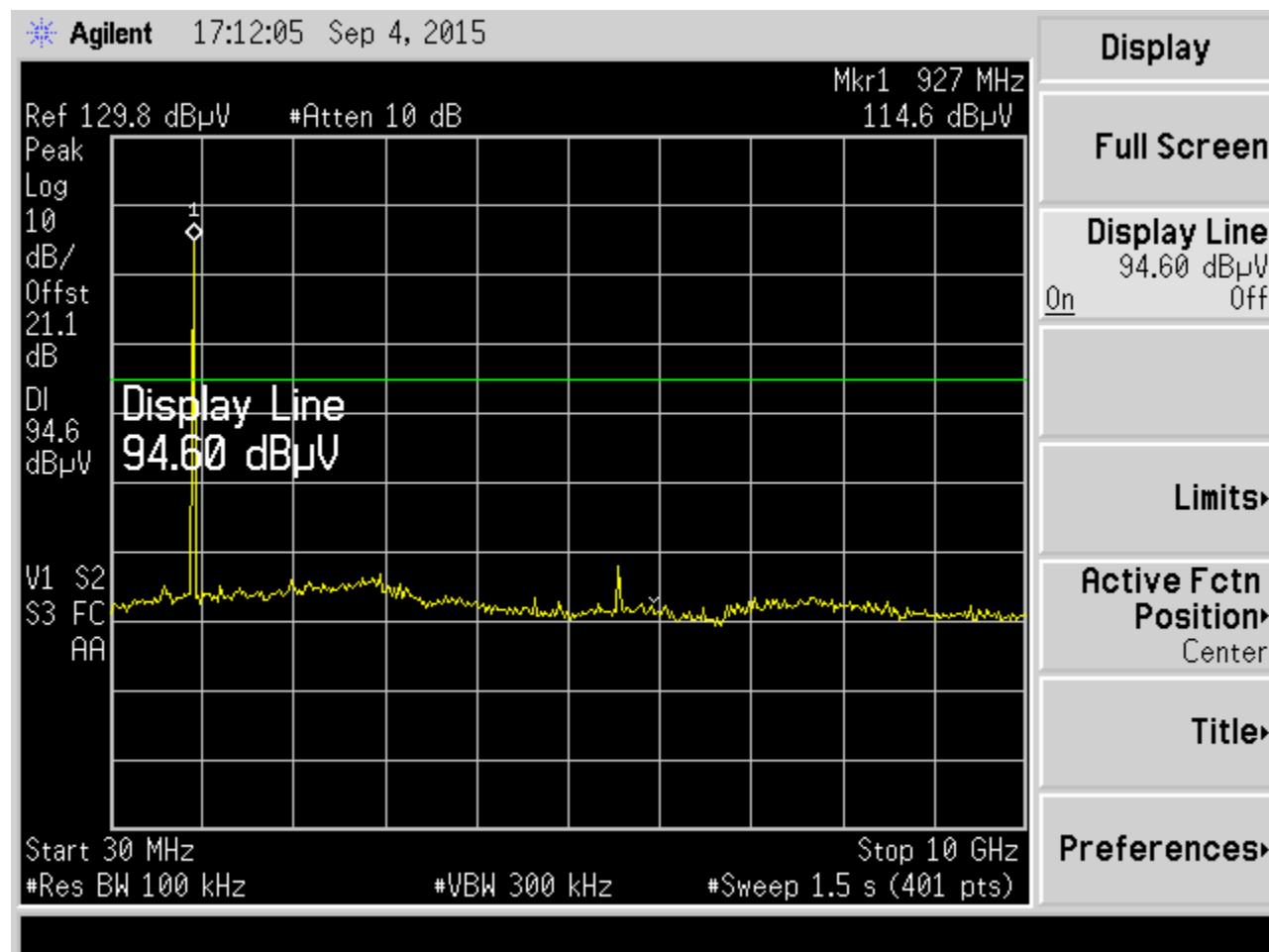
### Low Channel



### Middle Channel



## High Channel



Test Personnel: Mary Sampson MTS  
 Supervising/Reviewing  
 Engineer:  
 (Where Applicable) N/A  
 Product Standard: FCC 15.205, 15.209, 15.215,  
15.247, IC RSS-247, IC RSS-GEN  
 Input Voltage: 24Vac

Test Date: 09/04/2015  
 Limit Applied: 15..209, 15.215, 15.247,  
IC RSS-247  
 Ambient Temperature: 23.8 °C  
 Relative Humidity: 48.5 %  
 Atmospheric Pressure: 982.1 mbars

Deviations, Additions, or Exclusions: None

## 7 Transmitter Spurious Radiated Emissions

### 7.1 Method

Tests are performed in accordance with CFR47 FCC Part 15 Subpart C: 2015 Section 15.205, 15.209, 15.247(d); Industry Canada RSS-247 Issue 1 May 2015, Section 5; Industry Canada RSS-GEN Issue 4 December 2014.

**TEST SITE:** 10m Semi-Anechoic Chamber

**10 Meter Semi-Anechoic Chamber** The test site for radiated emissions is located at 1950 Evergreen Blvd, Suite 100, Duluth, Georgia 30096. It is a 10 meter semi-anechoic chamber manufactured by Panashield. Embedded in the floor is a 3 meter diameter turntable.

#### Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	3.6 dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	3.9 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.2 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	4.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.2 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.2 dB	5.5 dB

As shown in the table above our radiated emissions  $U_{lab}$  is less than the corresponding  $U_{CISPR}$  reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

**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  $\text{dB}\mu\text{V}/\text{m}$

RA = Receiver Amplitude (including preamplifier) in  $\text{dB}\mu\text{V}$

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  $\text{dB}\mu\text{V}$  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  $\text{dB}\mu\text{V}/\text{m}$ . This value in  $\text{dB}\mu\text{V}/\text{m}$  was converted to its corresponding level in  $\mu\text{V}/\text{m}$ .

$$RA = 52.0 \text{ dB}\mu\text{V}$$

$$AF = 7.4 \text{ dB}/\text{m}$$

$$CF = 1.6 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$FS = 32 \text{ dB}\mu\text{V}/\text{m}$$

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

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

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

**Example:**

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

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

## 7.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
211872; TT7;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer. RF Coax Cable	Omega Andrews	iBTHX-W FSJ2-50	0240116 A001827924	11/07/2014 06/10/2015	11/07/2015 06/10/2016
MP3;	Cable MP3, 18 GHz, N, 10m	Megaphase	G919-NKNK-394	MP3	05/07/2015	05/07/2016
E207;	RF Coax Cable	Megaphase	TM18-N1N1-120	14065201-001	05/07/2015	05/07/2016
E209;	RF Coax Cable	Megaphase	TM18-N1N1-120	14065201-003	05/07/2015	05/07/2016
200162;	EMI Receiver (20Hz-40GHz)	Rohde & Schwarz	ESU 40	100314	03/02/2015	03/02/2016
211386;	Antenna, BiLog, 20-2000MHz	Chase	CBL6112B	2622	12/18/2014	12/18/2015
200082;	Preamplifier, 20MHz to 2GHz, 40 dB	A.H. Systems	PAM-0202	203	03/13/2015	03/13/2016
213061;	Antenna, Horn, <18 GHz	EMCO	3115	9208-3919	07/27/2015	07/27/2016
200108;	Preamplifier, 20 MHz to 18 GHz, 40 dB	A.H. Systems	PAM-0118	199	12/03/2014	12/03/2015
211873;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer.	Omega	iBTHX-W	0240115	12/09/2014	12/09/2015
211897;	Digital Pocket Thermometer and Hydrometer	Mannix	SAM700BAR	none	01/07/2015	01/07/2016

## Software Utilized:

Name	Manufacturer	Version
Tile	Quantum Change	3.4.K.22

## 7.3 Results:

The sample tested was found to Comply. Testing was performed with EUT in X, Y, Z axis and transmitting on low, middle and high channels. Worst case data presented in section 8.5.

**7.4 Setup Photographs:**

Below 1 GHz



Above 1 GHz



**7.5 Test Data:****Client:** TPI Corporation**Model Number:** RFT-1**Project Number:** G100315802**Tested By:** MTS**Date:** 10/16/2015**Frequency Range (MHz):** 30 to 1000**Input power:** 3 Vdc, 2 x AAA batteries**Receiver:** R&S ESU40**Antenna:** Chase 2622**Cables:** TT-7+TW2+E-207+E-209**Preamp:** PAM-0202**Test Distance (m):** 10**Limit:** FCC15 Class B-10m

NOTE: TX High ch, Z-Axis

**Modifications for compliance (y/n):** n

A	B	C	D	E	F	G	H	I	J
Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Net dB(uV/m)	10m Limit dB(uV/m)	Margin dB	Detectors / Bandwidths Det/RBW
H	926.600	88.3	21.2	5.9	41.2	74.3	114.0	-39.7	PK/120kHz
H	926.600	88.2	21.2	5.9	41.2	74.2	114.0	-39.8	QP/120kHz
H	30.970	38.0	17.9	1.1	40.8	16.2	29.5	-13.3	PK/120kHz
H	30.970	32.2	17.9	1.1	40.8	10.4	29.5	-19.1	QP/120kHz
H	643.137	37.6	18.9	4.9	40.7	20.7	35.5	-14.8	PK/120kHz
H	643.137	31.3	18.9	4.9	40.7	14.4	35.5	-21.1	QP/120kHz
H	972.549	37.9	21.6	6.1	41.2	24.3	43.5	-19.2	PK/120kHz
H	972.549	31.6	21.6	6.1	41.2	18.0	43.5	-25.5	QP/120kHz
V	826.079	37.6	20.1	5.5	41.0	22.1	35.5	-13.4	PK/120kHz
V	826.079	31.4	20.1	5.5	41.0	15.9	35.5	-19.6	QP/120kHz
V	996.023	38.1	21.4	6.2	41.3	24.5	43.5	-19.0	PK/120kHz
V	996.023	31.6	21.4	6.2	41.3	18.0	43.5	-25.5	QP/120kHz
<b>Calculations</b>		G=C+D+E-F		I=G-H					

**Client:** TPI Corporation  
**Model Number:** RFT-1  
**Project Number:** G100315802  
**Tested By:** MTS  
**Date:** 6/3/15

**Frequency Range (MHz):** 1000-10000

**Input power:** Battery

**Notes: TX mode @ 1.5m table height, Z-Axis**

**Receiver:** R&S ESU40  
**Antenna:** EMCO 3115  
**Cables:** MP8+MP3+E-207+E-209  
**Preamp:** HP8449B-213191  
**Limit:** FCC15 Class B-3m

**Test Distance (m):** 3

**Modifications for compliance (y/n):** n

A	B	C	D	E	F	G	H	I	J	K
Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Duty Cycle Factor dB	Net dB(uV/m)	3m Limit dB(uV/m)	Margin dB	Det/RBW
<b>Low Channel</b>										
V	1827.806	44.1	26.7	4.3	41.0	0.0	34.1	105.5	-71.4	PK/1MHz
V	1827.806	44.1	26.7	4.3	41.0	40.0	-5.9	85.5	-91.4	AVG/1MHz
V	2741.000	35.4	28.9	5.4	41.2	0.0	28.5	74.0	-45.5	PK/1MHz
V	2741.000	35.4	28.9	5.4	41.2	40.0	-11.5	54.0	-65.5	AVG/1MHz
V	3654.000	34.4	31.8	6.3	41.4	0.0	31.1	74.0	-42.9	PK/1MHz
V	3654.000	34.4	31.8	6.3	41.4	40.0	-8.9	54.0	-62.9	AVG/1MHz
V	9579.700	34.5	31.8	6.3	41.4	0.0	31.2	74.0	-42.8	PK/1MHz
V	9579.700	34.5	31.8	6.3	41.4	40.0	-8.8	54.0	-62.8	AVG/1MHz
<b>Mid Channel</b>										
H	1840.600	44.5	28.9	4.3	41.0	0.0	36.7	74.0	-37.3	PK/1MHz
H	1840.600	44.5	28.9	4.3	41.0	40.0	-3.3	54.0	-57.3	AVG/1MHz
H	3681.181	36.7	27.0	4.3	41.0	0.0	27.0	74.0	-47.0	PK/1MHz
H	3681.181	36.7	27.0	4.3	41.0	40.0	-13.0	54.0	-67.0	AVG/1MHz
<b>High Channel</b>										
H	1853.200	46.7	27.0	4.3	41.0	0.0	37.0	74.0	-37.0	PK/1MHz
H	1853.200	46.7	27.0	4.3	41.0	40.0	-3.0	54.0	-57.0	AVG/1MHz
H	1852.978	47.0	27.0	4.3	41.0	0.0	37.3	74.0	-36.7	PK/1MHz
H	1852.978	47.0	27.0	4.3	41.0	40.0	-2.7	54.0	-56.7	AVG/1MHz
<b>Calculations</b>	$H=C+D+E+F-G$				$J=I-H$					

**Test Personnel:** Mary Sampson *MTS*  
**Supervising/Reviewing**  
**Engineer:**  
**(Where Applicable)** N/A  
**Product Standard:** FCC 15.205, 15.209, 15.215,  
15.247, IC RSS-247  
**Input Voltage:** 3 Vdc  
**Pretest Verification w/**  
**Ambient Signals or**  
**BB Source:** BB Source

**Test Date:** 06/03 and 10/16/2015  
**Limit Applied:** FCC 15.205, 15.209, 15.215,  
15.247, IC RSS-247  
**Ambient Temperature:** 23.8 and 21.8 °C  
**Relative Humidity:** 46.8 and 45.8 %  
**Atmospheric Pressure:** 981.2 and 986.6 mbars

Deviations, Additions, or Exclusions: None

## 8 Receiver Spurious Radiated Emissions

### 8.1 Method

Tests are performed in accordance with in accordance with CFR 47 FCC Part 15 Subpart B: 2015 Section 15.109; Industry Canada RSS-GEN Issue 4 December 2014.

**TEST SITE: TEST SITE:** 10m Semi-Anechoic Chamber

**10 Meter Semi-Anechoic Chamber** The test site for radiated emissions is located at 1950 Evergreen Blvd, Suite 100, Duluth, Georgia 30096. It is a 10 meter semi-anechoic chamber manufactured by Panashield. Embedded in the floor is a 3 meter diameter turntable.

#### Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	3.6 dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	3.9 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.2 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	4.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.2 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.2 dB	5.5 dB

As shown in the table above our radiated emissions  $U_{lab}$  is less than the corresponding  $U_{CISPR}$  reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

### 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  $\text{dB}\mu\text{V}/\text{m}$

RA = Receiver Amplitude (including preamplifier) in  $\text{dB}\mu\text{V}$

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  $\text{dB}\mu\text{V}$  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  $\text{dB}\mu\text{V}/\text{m}$ . This value in  $\text{dB}\mu\text{V}/\text{m}$  was converted to its corresponding level in  $\mu\text{V}/\text{m}$ .

$$RA = 52.0 \text{ dB}\mu\text{V}$$

$$AF = 7.4 \text{ dB}/\text{m}$$

$$CF = 1.6 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$FS = 32 \text{ dB}\mu\text{V}/\text{m}$$

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

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

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

### Example:

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

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

### 8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
211872;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer.	Omega	iBTHX-W	0240116	11/07/2014	11/07/2015
TT7;	RF Coax Cable	Andrews	FSJ2-50	A001827924	06/10/2015	06/10/2016
MP3;	Cable MP3, 18 GHz, N, 10m	Megaphase	G919-NK NK-394	MP3	05/07/2015	05/07/2016
E207;	RF Coax Cable	Megaphase	TM18-N1N1-120	14065201-001	05/07/2015	05/07/2016
E209;	RF Coax Cable	Megaphase	TM18-N1N1-120	14065201-003	05/07/2015	05/07/2016
200162;	EMI Receiver (20Hz-40GHz)	Rohde & Schwarz	ESU 40	100314	03/02/2015	03/02/2016
211386;	Antenna, BiLog, 20-2000MHz	Chase	CBL6112B	2622	12/18/2014	12/18/2015
200082;	Preamplifier, 20MHz to 2GHz, 40 dB	A.H. Systems	PAM-0202	203	03/13/2015	03/13/2016
213061;	Antenna, Horn, <18 GHz	EMCO	3115	9208-3919	07/27/2015	07/27/2016
200108;	Preamplifier, 20 MHz to 18 GHz, 40 dB	A.H. Systems	PAM-0118	199	12/03/2014	12/03/2015

### Software Utilized:

Name	Manufacturer	Version
Tile	Quantum Change	3.4.K.22

### 8.3 Results:

The sample tested was found to Comply. Testing was performed with EUT in X,Y,Z axis in receive mode from 30 to 5000 MHz. Worst data presented in section 9.5.

**8.4 Setup Photographs:**

Below 1 GHz



Above 1 GHz



**8.5 Plots/Data:**

Client: TPI Corporation

Model Number: RFT-1

Project Number: G100315802

Tested By: MTS

Date: 10/16/2015

Frequency Range (MHz): 30 to 1000

Input power: 3 Vdc, 2 x AAA batteries

NOTE: RX, MID ch, Z-Axis

Modifications for compliance (y/n): n

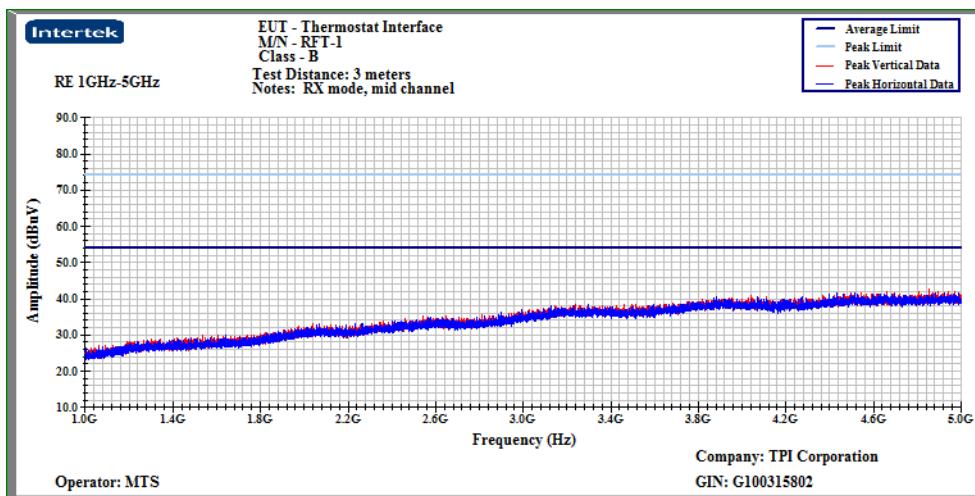
Receiver: R&amp;S ESU40

Antenna: Chase 2622

Cables: TT-7+TW2+E-207+E-209

Preamp: PAM-0202

A	B	C	D	E	F	G	H	I	J
Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Net dB(uV/m)	10m Limit dB(uV/m)	Margin dB	Detectors / Bandwidths Det/RBW
<b>Noise floor readings</b>									
V	30.097	31.9	19.0	1.1	40.9	11.2	29.5	-18.3	QP/120kHz
V	32.328	32.0	17.8	1.1	40.8	10.1	29.5	-19.4	QP/120kHz
V	113.323	31.5	12.1	2.1	40.7	5.0	33.0	-28.0	QP/120kHz
V	264.837	31.3	13.9	3.1	40.5	7.7	35.5	-27.8	QP/120kHz
V	890.875	31.3	20.2	5.7	41.1	16.2	35.5	-19.3	QP/120kHz
V	1000.000	31.4	21.5	6.2	41.3	17.9	43.5	-25.6	QP/120kHz
<b>Calculations</b>		$G=C+D+E-F$		$I=G-H$					



Test Personnel: Mary Sampson MTS  
 Supervising/Reviewing  
 Engineer:  
 (Where Applicable) N/A

Product Standard: FCC 15.109, IC RSS-GEN  
 Input Voltage: 3 Vdc

Pretest Verification w/  
 Ambient Signals or  
 BB Source: BB Source

Test Date: 10/16/2015

Limit Applied: FCC 15.109(a), IC RSS-GEN  
Section 6.1

Ambient Temperature: 21.8 °C  
 Relative Humidity: 45.8 %  
 Atmospheric Pressure: 986.6 mbars

Deviations, Additions, or Exclusions: None

## 9 Carrier Frequency Separation

### 9.1 Method

Tests are performed in accordance with CFR47 FCC Part 15 Subpart C: 2015 Section 15.247(a)(1); Industry Canada RSS-247 Issue 1 May 2015, Section 5; Industry Canada RSS-GEN Issue 4 December 2014.

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.

### 9.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
211873;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer.	Omega	iBTHX-W	0240115	12/09/2014	12/09/2015
Borrowed:	EMC Analyzer	Agilent	E7405A	US3915014	08/03/2015	08/03/2016
200008;	Attenuator, 20 dB, <18GHz	Weinschel Corp	2	BK2323	01/07/2015	01/07/2016
E208;	RF Coax Cable	Megaphase	TM18-N1N1-120	14065201-002	05/07/2015	05/07/2016

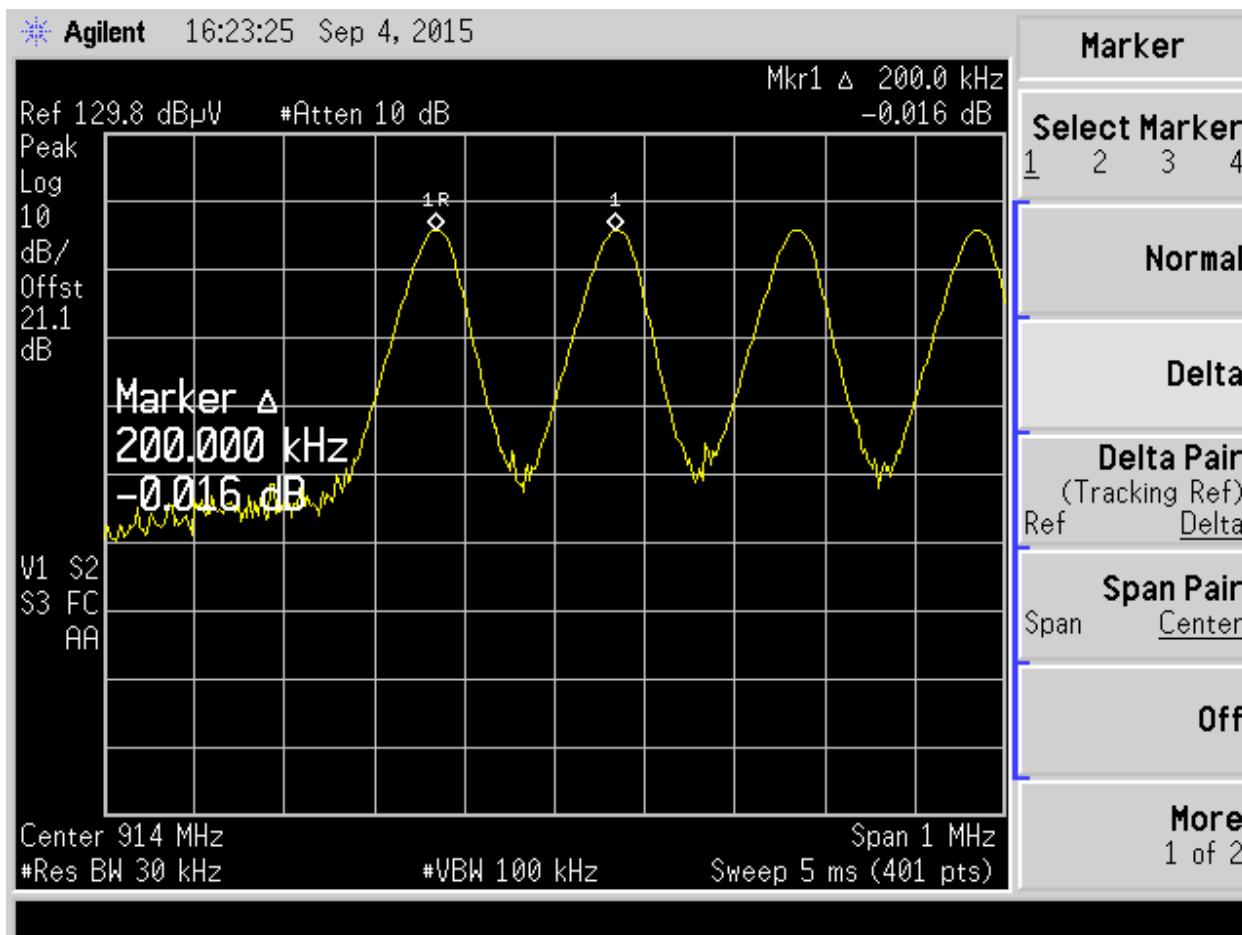
### Software Utilized:

Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

### 9.3 Results:

The sample tested was found to Comply. Carrier frequency separation is 200 kHz.

## 9.4 Plots/Data:



Test Personnel: Mary Sampson MTS  
 Supervising/Reviewing  
 Engineer:  
 (Where Applicable) N/A

Product Standard: FCC 15.247, IC RSS-247  
 Input Voltage: 3 Vdc

Test Date: 9/4/2015

Limit Applied: FCC 15.247(a)(1), RSS-247  
 Section 5.1(2)

Ambient Temperature: 23.8 °C  
 Relative Humidity: 48.5 %  
 Atmospheric Pressure: 982.1 mbars

Deviations, Additions, or Exclusions: None

## 10 Number of Hopping Frequencies

### 10.1 Method

Tests are performed in accordance with CFR47 FCC Part 15 Subpart C: 2015 Section 15.247(a)(1)(i); Industry Canada RSS-247 Issue 1 May 2015, Section 5.

**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.

### 10.2 Test Equipment Used:

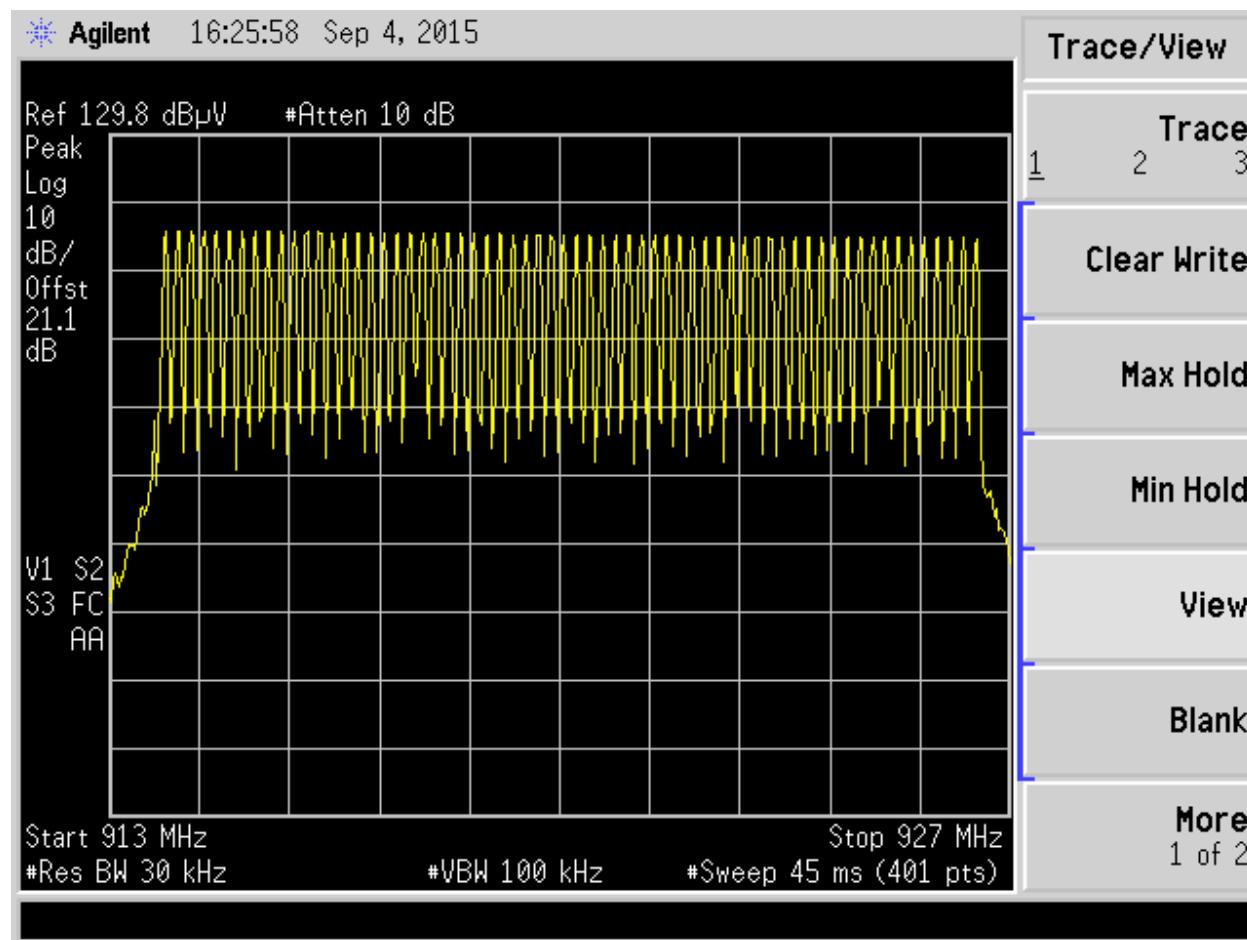
Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
211873;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer.	Omega	iBTHX-W	0240115	12/09/2014	12/09/2015
200008;	Attenuator, 20 dB, <18GHz	Weinschel Corp	2	BK2323	01/07/2015	01/07/2016
Borrowed:	EMC Analyzer	Agilent	E7405A	US3915014	08/03/2015	08/03/2016
E208;	RF Coax Cable	Megaphase	TM18-N1N1-120	14066201-002	05/07/2015	05/07/2016

### Software Utilized:

Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

### 10.3 Results:

The sample tested was found to Comply. Number of hopping channels is 64.

**10.4 Plots/Data:**

Number of Hopping Channels Measured = 64 channels

Test Personnel: Mary Sampson MTS  
Supervising/Reviewing  
Engineer:  
(Where Applicable) N/A  
Product Standard: FCC 15.247, IC RSS-247  
Input Voltage: 3 Vdc

Test Date: 09/04/2015  
Limit Applied: FCC 15.247(a)(1)(i), RSS-247  
Section 5.1(3)  
Ambient Temperature: 23.8 °C  
Relative Humidity: 48.5 %  
Atmospheric Pressure: 982.1 mbars

Deviations, Additions, or Exclusions: None

## 11 Time of Occupancy (Dwell Time)

### 11.1 Method

Tests are performed in accordance with CFR47 FCC Part 15 Subpart C: 2015 Section 15.247(a)(1)(i); Industry Canada RSS-247 Issue 1 May 2015, Section 5.1(3).

**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.

### 11.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
211873;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer.	Omega	iBTHX-W	0240115	12/09/2014	12/09/2015
200008;	Attenuator, 20 dB, <18GHz	Weinschel Corp	2	BK2323	01/07/2015	01/07/2016
Borrowed:	EMC Analyzer	Agilent	E7405A	US3915014	08/03/2015	08/03/2016
E208;	RF Coax Cable	Megaphase	TM18-N1N1-120	14066201-002	05/07/2015	05/07/2016

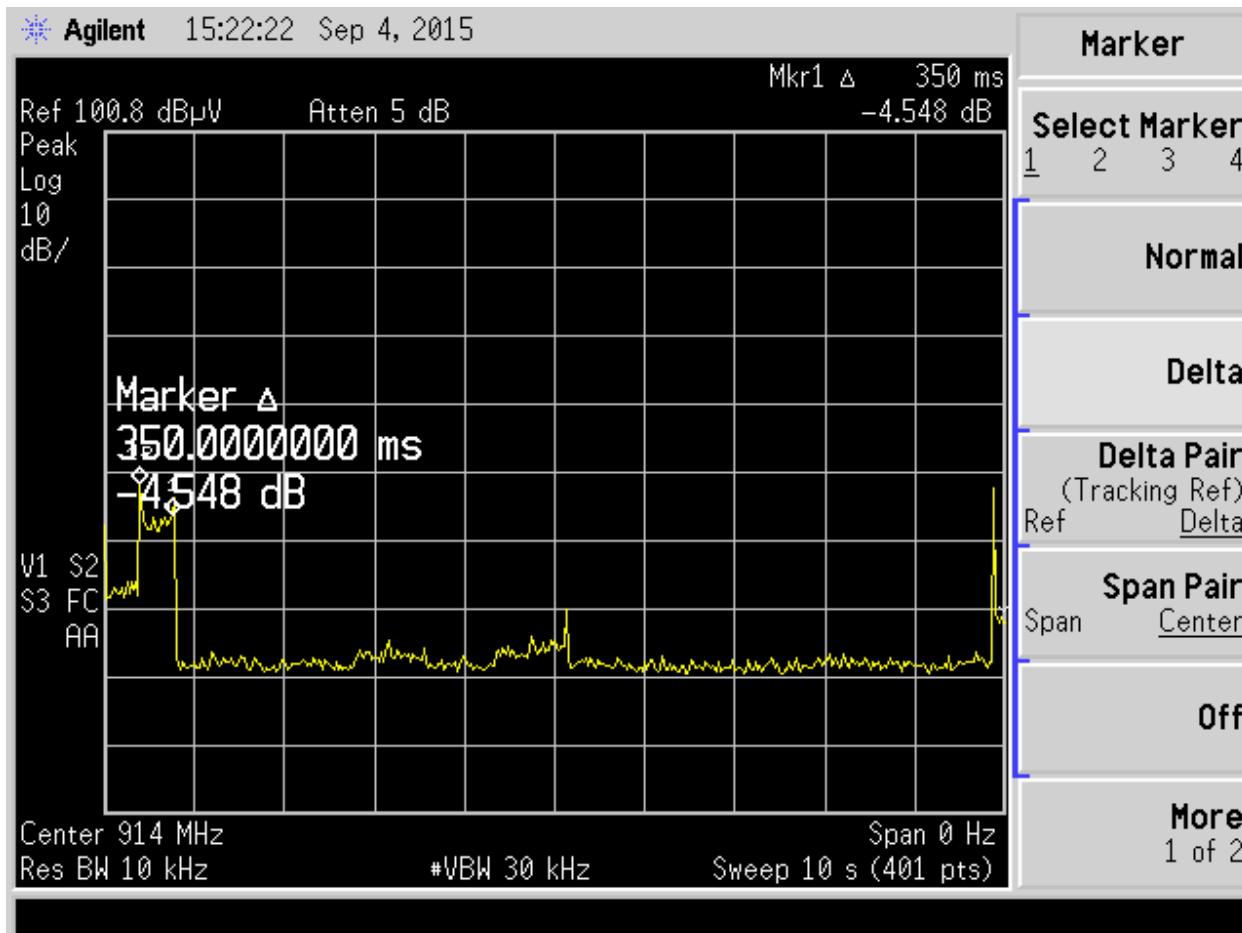
### Software Utilized:

Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

### 11.3 Results:

The sample tested was found to Comply. Time of occupancy is 350 ms out of 10 second period. Hopping was enabled.

## 11.4 Plots/Data:



Test Personnel: Mary Sampson MTS  
 Supervising/Reviewing  
 Engineer:  
 (Where Applicable) N/A  
 Product Standard: FCC 15.247, IC RSS-247  
 Input Voltage: 24 Vac

Test Date: 09/4/2015  
 Limit Applied: FCC 15.247(a)(1), RSS-247  
 Section 5.1(3)  
 Ambient Temperature: 23.8 °C  
 Relative Humidity: 48.5 %  
 Atmospheric Pressure: 982.1 mbars

Deviations, Additions, or Exclusions: None

## 12 Conducted Peak Output Power

### 12.1 Method

Tests are performed in accordance with CFR47 FCC Part 15 Subpart C: 2015 Section 15.247(b)(2); Industry Canada RSS-247 Issue 1 May 2015, Section 5; Industry Canada RSS-GEN Issue 4 December 2014, Section 6.12.

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.

### 12.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
211873;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer.	Omega	iBTHX-W	0240115	12/09/2014	12/09/2015
200008;	Attenuator, 20 dB, <18GHz	Weinschel Corp	2	BK2323	01/07/2015	01/07/2016
Borrowed:	EMC Analyzer	Agilent	E7405A	US3915014	08/03/2015	08/03/2016
E208;	RF Coax Cable	Megaphase	TM18-N1N1-120	14065201-002	05/07/2015	05/07/2016

### Software Utilized:

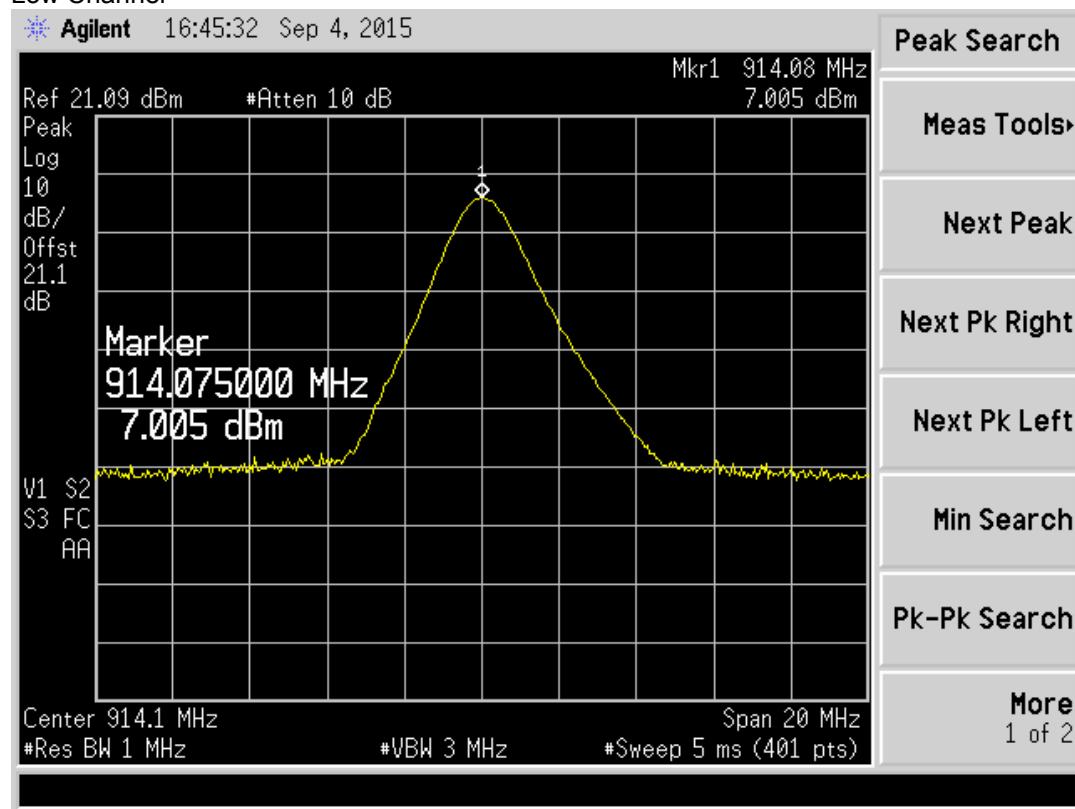
Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

### 12.3 Results:

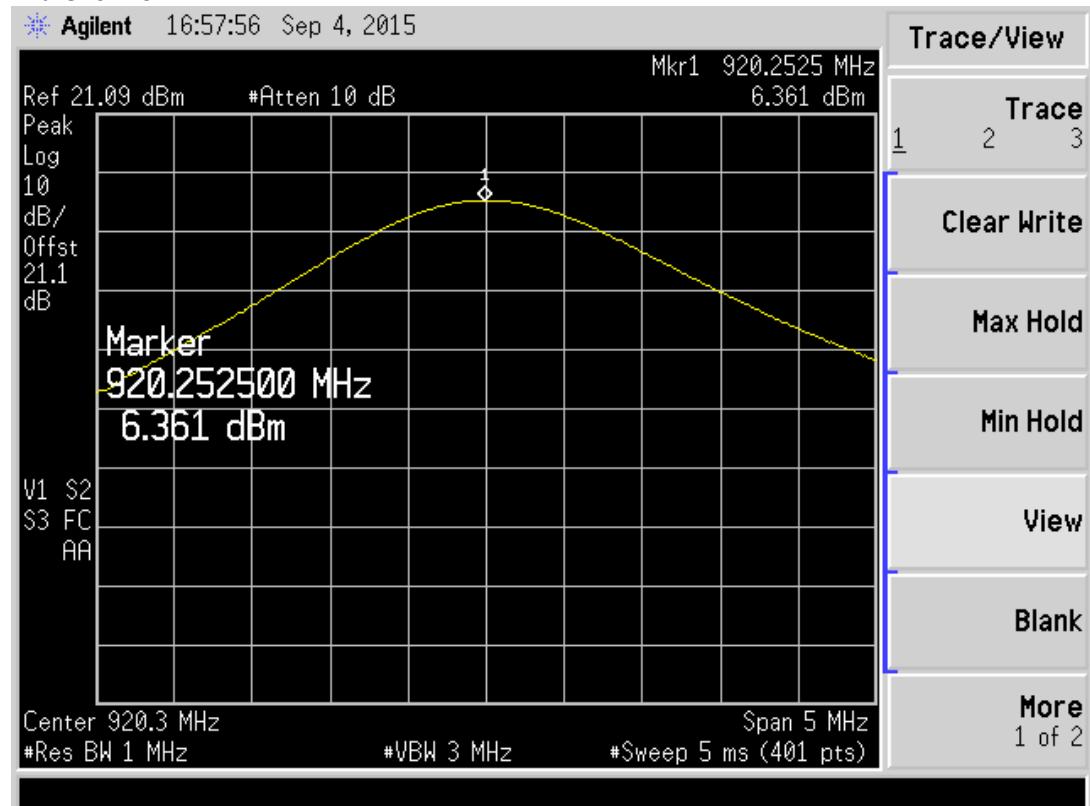
The sample tested was found to Comply. The highest conducted power measured was 7.005 dBm with device operating on low channel. Hopping was disabled.

## 12.4 Plots/Data:

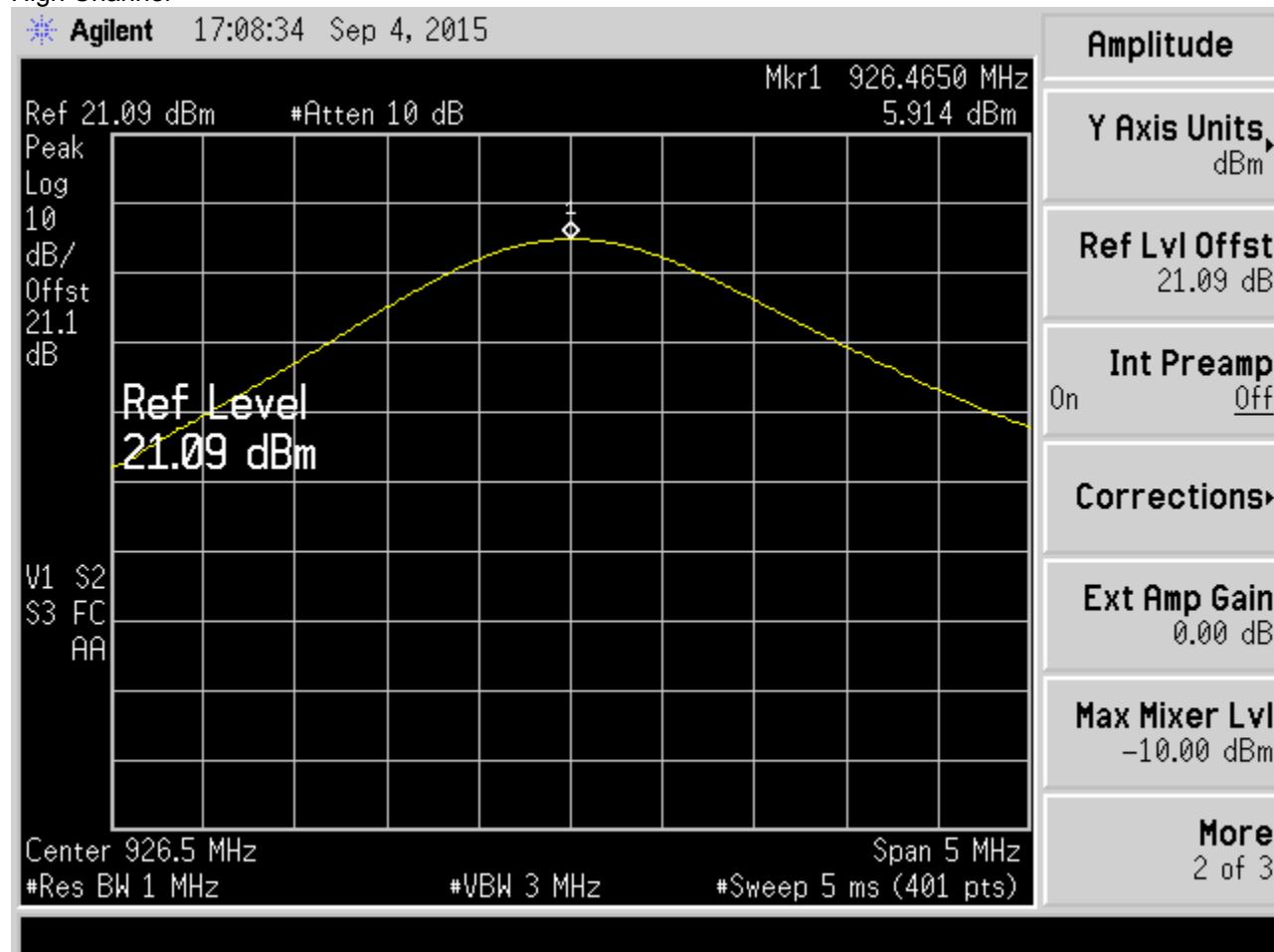
Low Channel



Mid Channel



High Channel



Test Personnel: Mary Sampson MTS  
 Supervising/Reviewing  
 Engineer:  
 (Where Applicable) N/A

Product Standard: FCC 15.247, IC RSS-247  
 Input Voltage: 3 Vdc

Test Date: 09/04/2015

Limit Applied: FCC 15.247(a)(1), RSS-247 Section 5

Ambient Temperature: 23.8 °C  
 Relative Humidity: 48.5 %  
 Atmospheric Pressure: 982.1 mbars

Deviations, Additions, or Exclusions: None

## 13 Bandedge

### 13.1 Method

Tests are performed in accordance with Tests are performed in accordance with CFR47 FCC Part 15 Subpart C: 2015 Section 15.247(a)(1); Industry Canada RSS-247 Issue 1 May 2015.

**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.

### 13.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
211873;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer.	Omega	iBTHX-W	0240115	12/09/2014	12/09/2015
E208;	RF Coax Cable	Megaphase	TM18-N1N1-120	14065201-002	05/07/2015	05/07/2016
Borrowed;	EMC Analyzer	Agilent	E7405A	US3915014	08/03/2015	08/03/2016
200008;	Attenuator, 20 dB, <18GHz	Weinschel Corp	2	BK2323	01/07/2015	01/07/2016
213309;	RF Coax Cable - 10MHz to 18GHz, 1 ft.	Hasco, Inc.	HULL320-S1-S1-12	14045577	09/17/2015	09/17/2016
213310;	RF Coax Cable - 10MHz to 18GHz, 1.5 ft.	Hasco, Inc.	HULL320-S1-S1-18	13105554	09/17/2015	09/17/2016

### Software Utilized:

Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

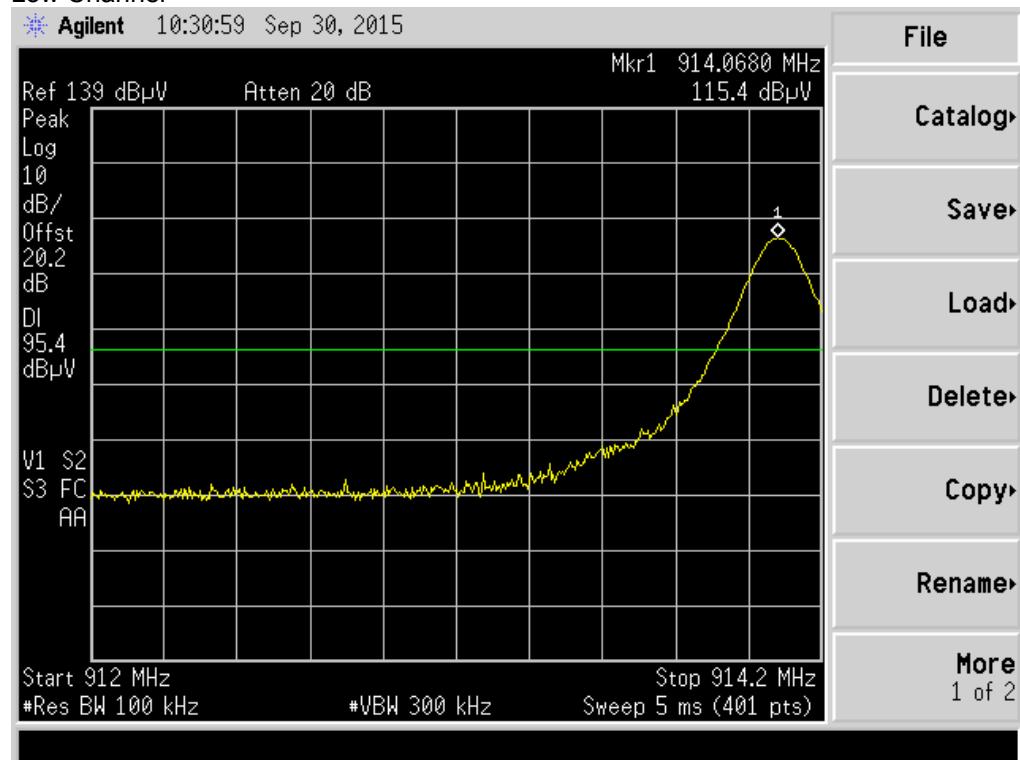
### 13.3 Results:

The sample tested was found to Comply.

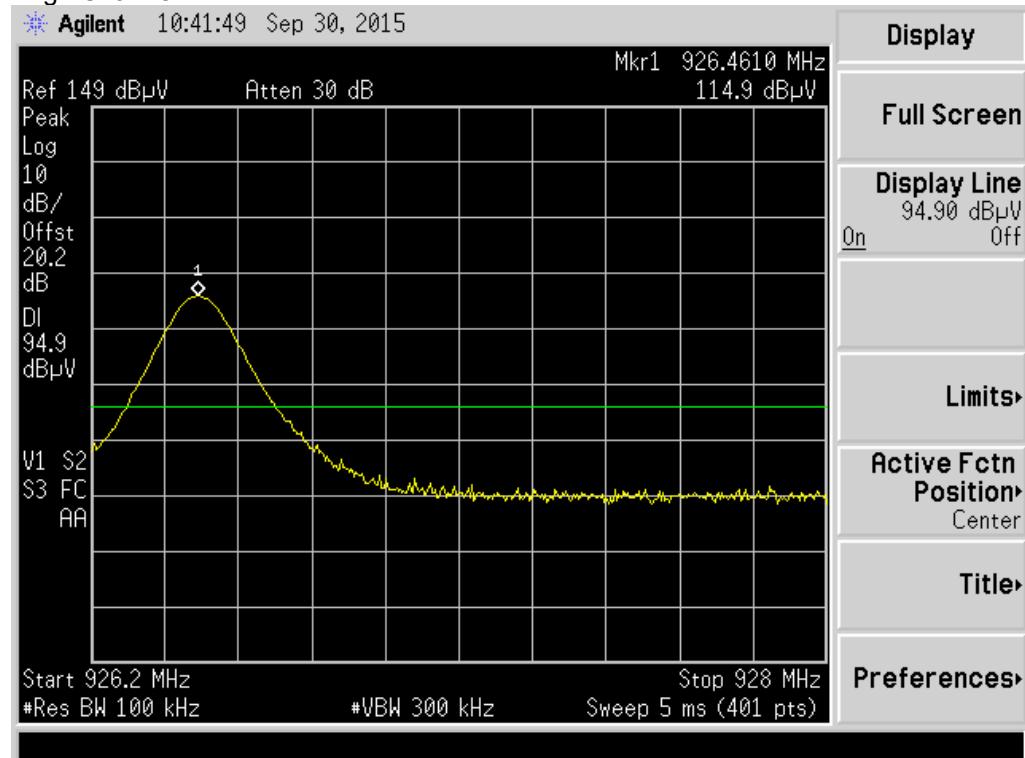
**13.4 Plots/Data:**

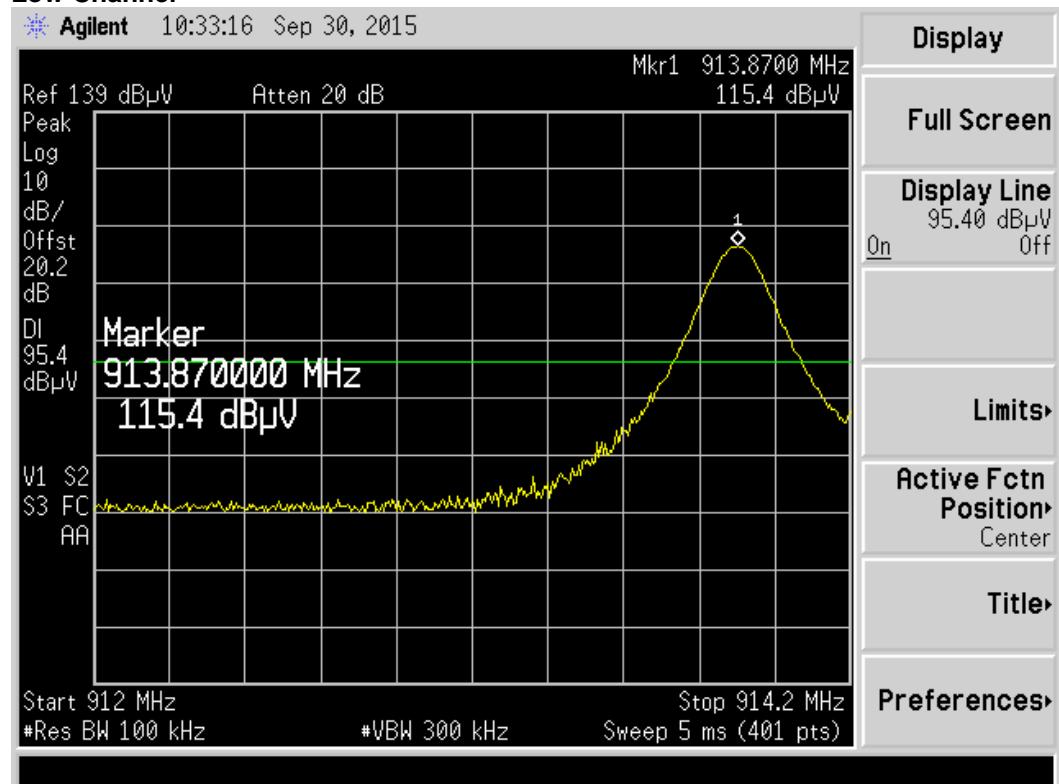
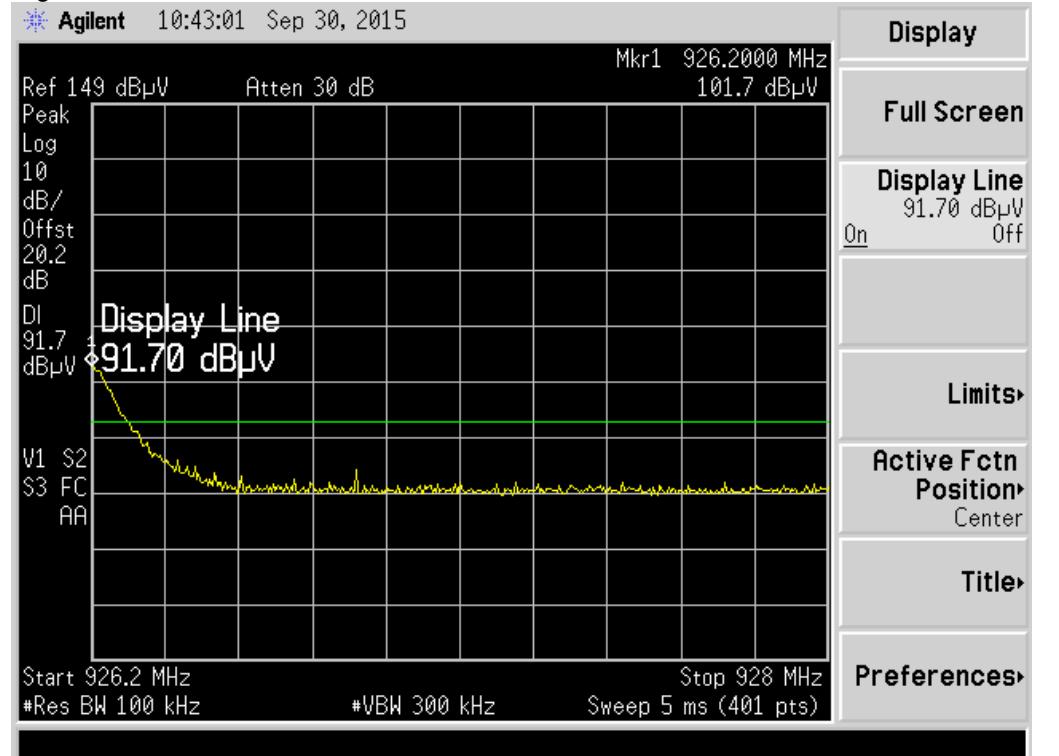
Hopping Disabled

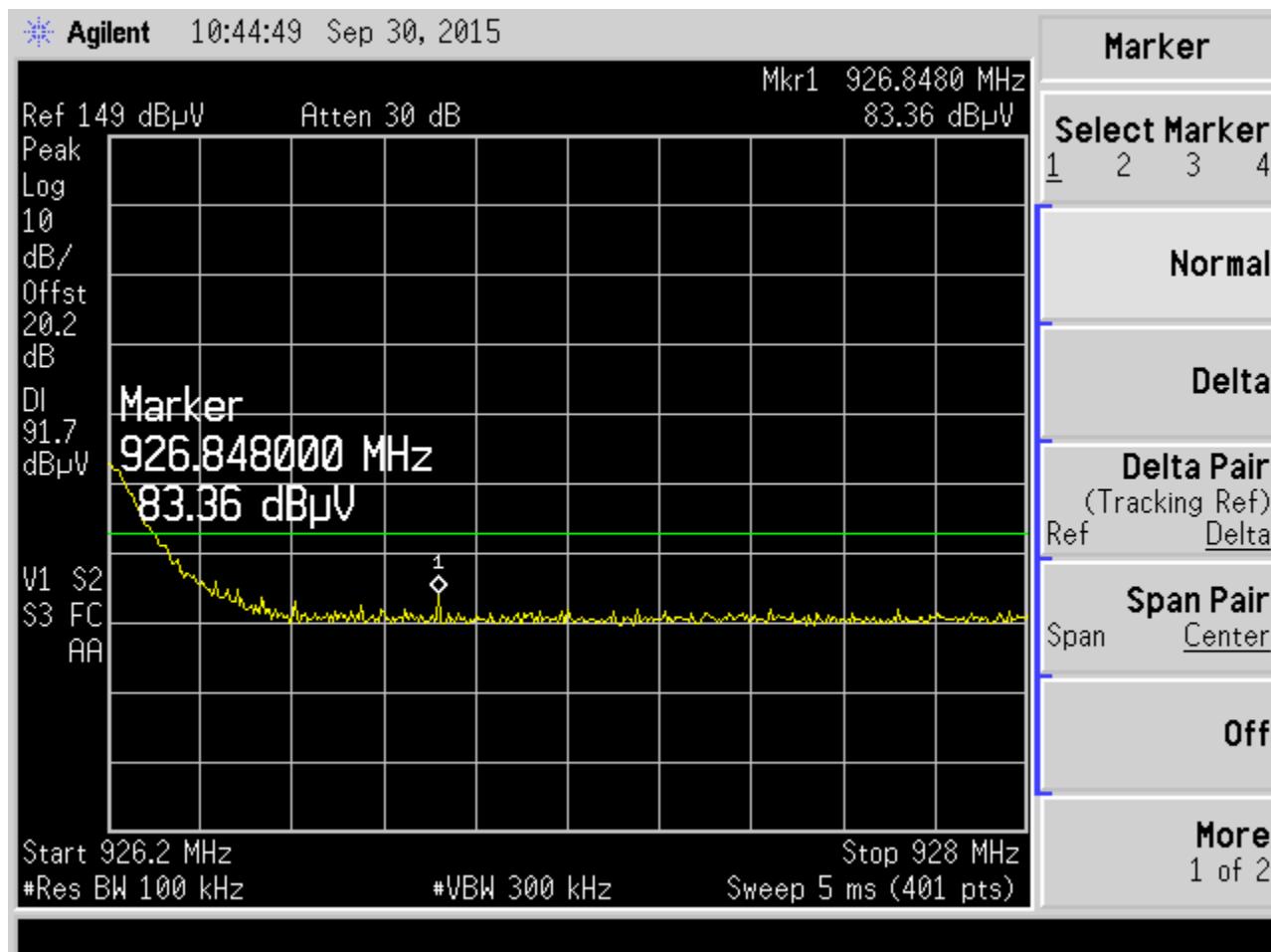
Low Channel



High Channel



**Hopping Enabled****Low Channel****High Channel**



Test Personnel: Mary Sampson MTS  
 Supervising/Reviewing  
 Engineer:  
 (Where Applicable) N/A

Product Standard: FCC 15.215, 15.247; RSS-247  
 Input Voltage: 3 Vdc

Test Date: 09/30/2015

Limit Applied: FCC 15.247(d); RSS-247, Section 5

Ambient Temperature: 24.2 °C  
 Relative Humidity: 49.6 %  
 Atmospheric Pressure: 976.0 mbars

## 14 20dB and Occupied Bandwidth

### 14.1 Method

Tests are performed in accordance with CFR47 FCC Part 15 Subpart C: 2015 Section 15.215; 15.247(a)(1)(i); Industry Canada RSS-247 Issue 1 May 2015, Section 5; Industry Canada RSS-GEN Issue 3 December 2014, Section 6.6.

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.

### 14.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
211873;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer.	Omega	iBTHX-W	0240115	12/09/2014	12/09/2015
E208;	RF Coax Cable	Megaphase	TM18-N1N1-120	14065201-002	05/07/2015	05/07/2016
Borrowed; 200008;	EMC Analyzer	Agilent	E7405A	US3915014	08/03/2015	08/03/2016
	Attenuator, 20 dB, <18GHz	Weinschel Corp	2	BK2323	01/07/2015	01/07/2016
213309;	RF Coax Cable - 10MHz to 18GHz, 1 ft.	Hasco, Inc.	HULL320-S1-S1-12	14045577	09/17/2015	09/17/2016
213310;	RF Coax Cable - 10MHz to 18GHz, 1.5 ft.	Hasco, Inc.	HULL320-S1-S1-18	13105554	09/17/2015	09/17/2016

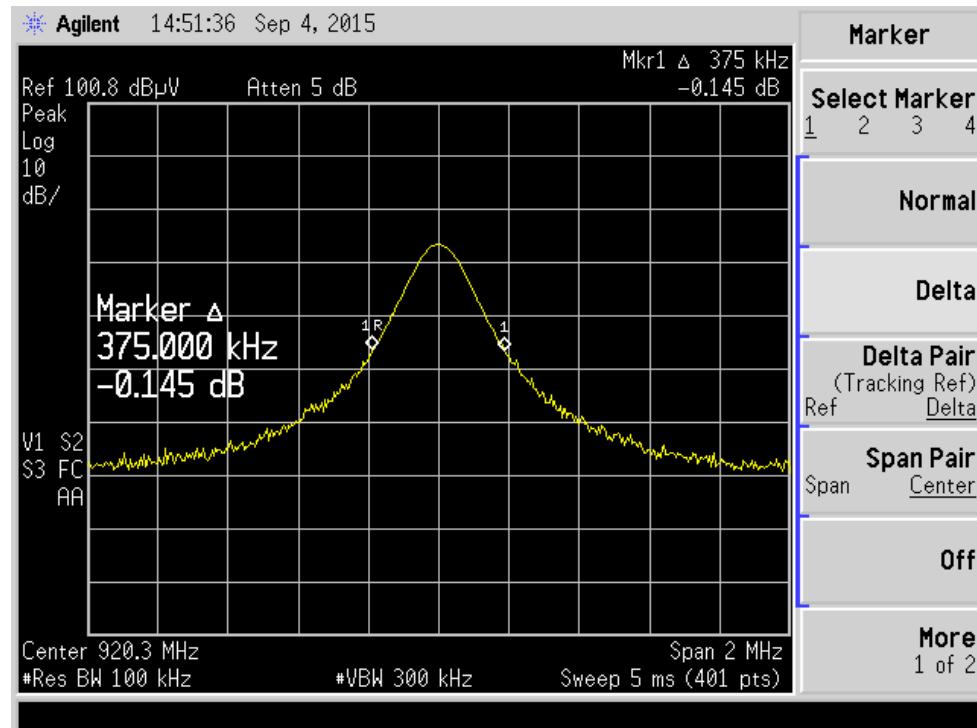
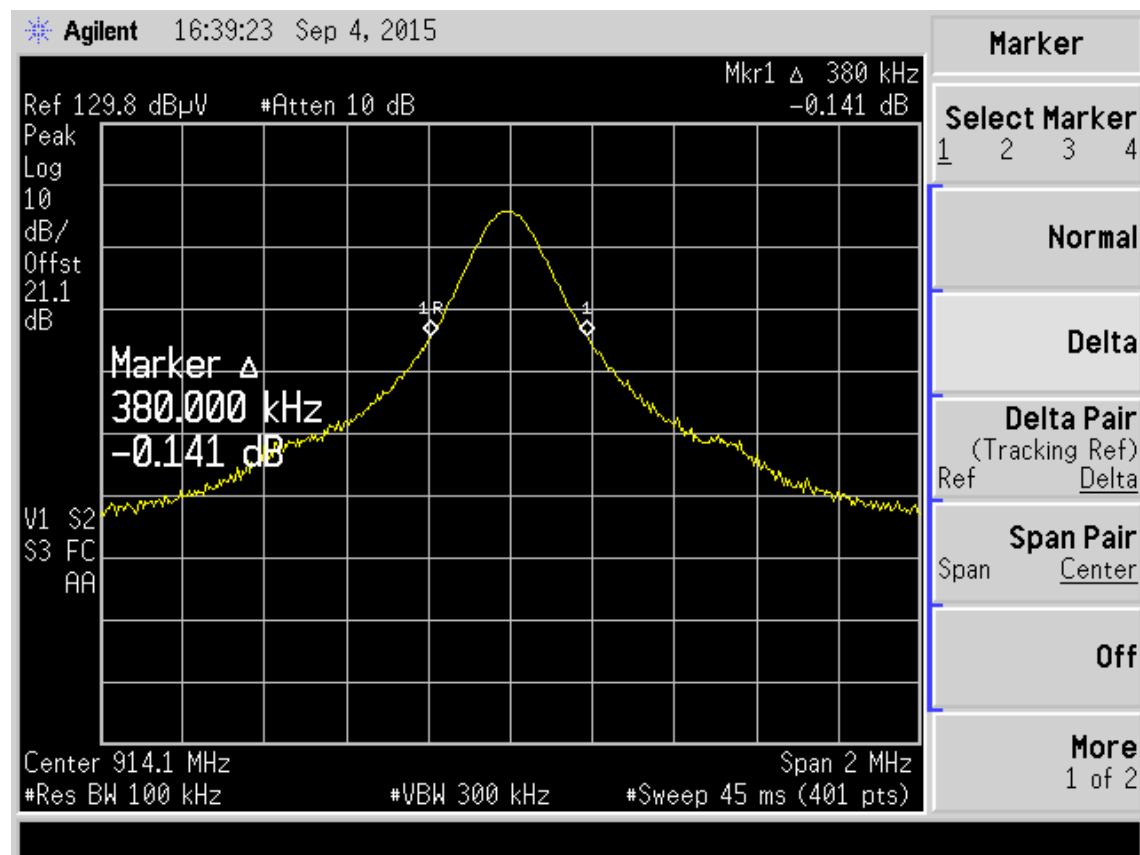
### Software Utilized:

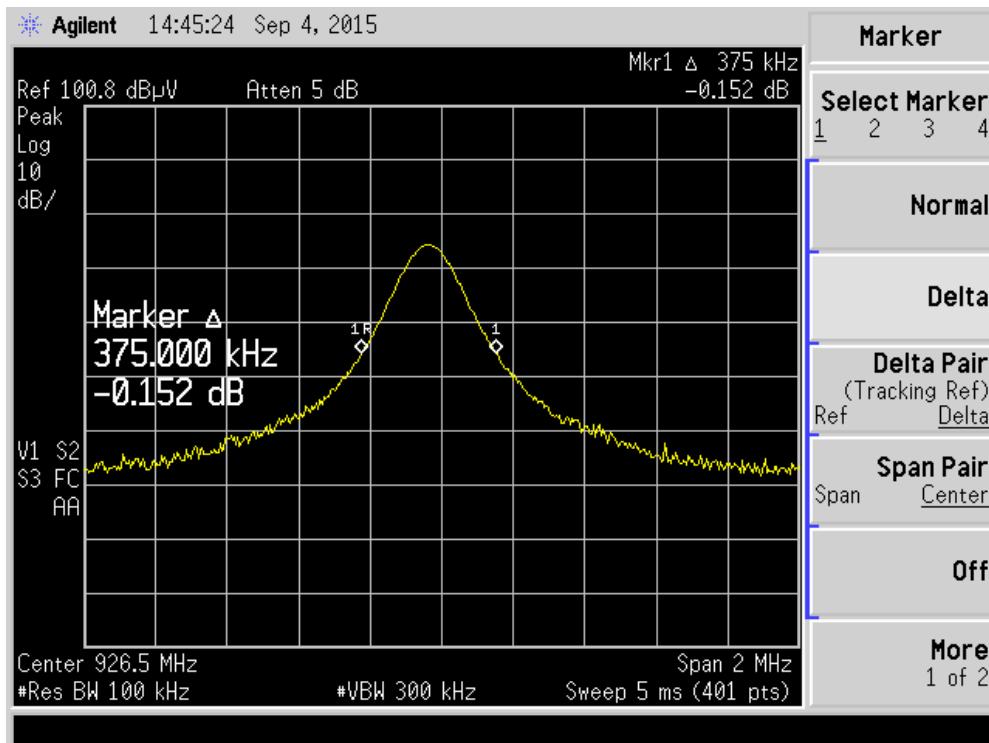
Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

### 14.3 Results:

The sample tested was found to Comply.

## 14.4 Plots/Data:





Test Personnel: Mary Sampson MTS  
 Supervising/Reviewing  
 Engineer:  
 (Where Applicable) N/A  
 Product Standard: FCC 15.247, RSS-247, Section 5, RSS-GEN  
 Input Voltage: 3 Vdc

Test Date: 09/04/2015

Limit Applied: FCC 15.247(a)(1), RSS-247 Section 5.1(1)

Ambient Temperature: 24.2 °C  
 Relative Humidity: 49.6 %  
 Atmospheric Pressure: 976.0 mbars

Deviations, Additions, or Exclusions: None

## 15 RF Exposure Compliance

The maximum measured conducted power, P is 7.005 dBm.

The antenna gain, G is 0.0 dBi.

The maximum EIRP power = P+G

EIRP =  $7.005 + 0.0 = 7.005$  dBm or  $0.0050176457904$  W

The limits for Maximum Permissible Exposure (MPE) for transmitter operating at 902-928 MHz,

MPE is  $928/1500 = 0.619$  mW/cm<sup>2</sup> or 6.2W/m<sup>2</sup>.

The Power Density, S is related to EIRP with the equation:

$S = EIRP / 4\pi D^2$ , where D is the safe separation distance and = 0.2m, or 20cm

$S = 0.0050176457904 / 4\pi 0.2^2$ ,

$S = 0.0099$  W/m<sup>2</sup>

which is below the Maximum Permissible Exposure (MPE) of 6.2W/m<sup>2</sup>

## 16 Duty Cycle

### 16.1 Method

Tests are performed in accordance with CFR47 FCC Part 15 Subpart C: 2015 Section 15.247(a)(1); Industry Canada RSS-247 Issue 1 May 2015.

**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.

### 16.2 Test Equipment Used:

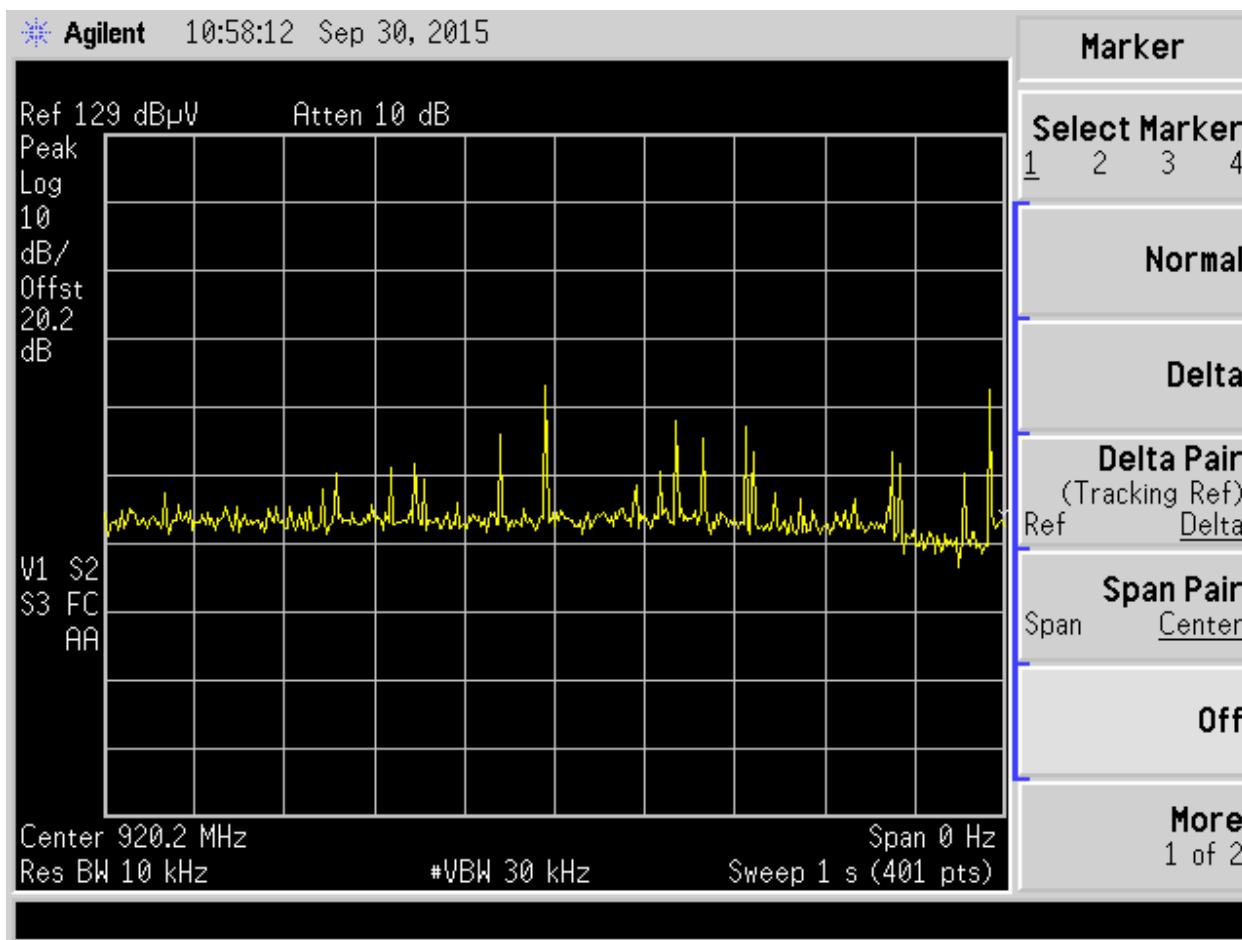
Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
211872;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer.	Omega	iBTHX-W	0240116	11/07/2014	11/07/2015
Borrowed; 200008;	EMC Analyzer	Agilent	E7405A	US3915014	08/03/2015	08/03/2016
	Attenuator, 20 dB, <18GHz	Weinschel Corp	2	BK2323	01/07/2015	01/07/2016
213310;;	RF Coax Cable - 10MHz to 18GHz, 1.5 ft.	Hasco, Inc.	HULL320-S1-S1-18	13105554	09/17/2015	09/17/2016
213309;	RF Coax Cable - 10MHz to 18GHz, 1 ft.	Hasco, Inc.	HULL320-S1-S1-12	14045577	09/17/2015	09/17/2016

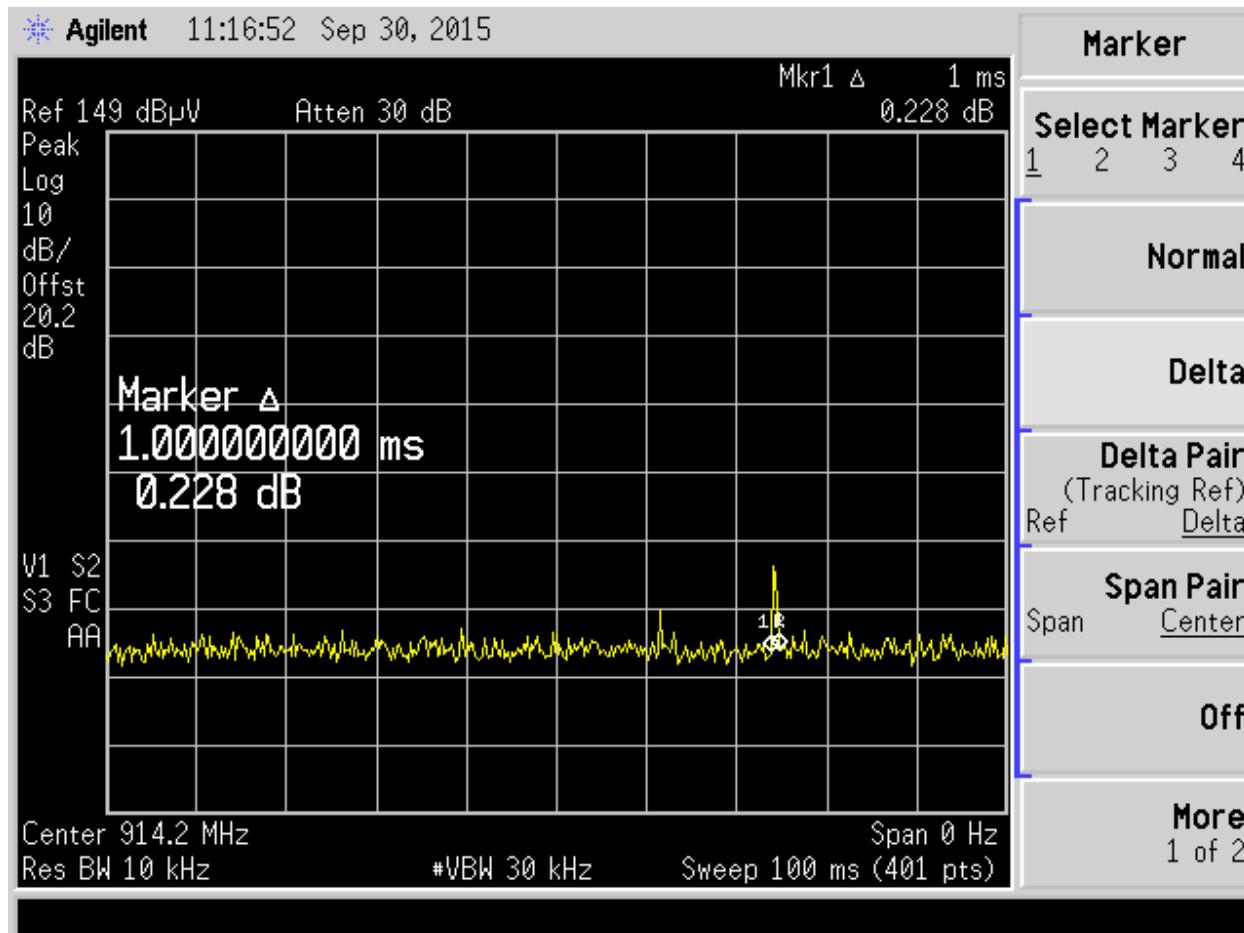
### Software Utilized:

Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

### 16.3 Results:

The sample tested was found to Comply.

**16.4 Plots/Data:**



The duty cycle = 1.0ms/100 ms = 0.1  
 Average factor =  $20 \cdot \text{LOG}(0.1) = -40 \text{ dB}$

Test Personnel: Mary Sampson MTS  
 Supervising/Reviewing  
 Engineer:  
 (Where Applicable) N/A  
 Product Standard: FCC 15.247, IC RSS-247  
 Input Voltage: 3 Vdc

Test Date: 09/30/2015  
 Limit Applied: FCC 15.247(a)(1), RSS-247 Section 5  
 Ambient Temperature: 24.2 °C  
 Relative Humidity: 49.6 %  
 Atmospheric Pressure: 976 mbars

Deviations, Additions, or Exclusions: None

**17 Revision History**

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	11/04/2015	100315802ATL-001A	MTS <i>MTS</i>	KPS <i>KPS</i>	Original Issue