

EMISSIONS TEST REPORT

Report Number: 101163191ATL-001

Project Number: G101163191

Report Issue Date: May 16, 2014

Report Revised Date: June 2, 2015

Product Designation: SDRF1001

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

A handwritten signature in black ink that reads "Mary Sampson".

Mary Sampson/Senior Project Engineer

Report reviewed by

A handwritten signature in black ink that reads "Vathana Ven".

Vathana Ven/Staff Engineer, EMC

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 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)	Pass
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)	Pass
8	Receiver Spurious Radiated Emissions (CFR47 FCC Part 15 Subpart C:2015 Section 15.109; Industry Canada RSS-GEN Issue 4 December 2014, Section 7.1)	Pass
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)	Pass
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)	Pass
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)	Pass
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)	Pass
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,	Pass

Section	Test full name	Result
	Section 5)	
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)	Pass
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)	Pass
16	Duty Cycle	Pass
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

4 Description of Equipment Under Test

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
RF Thermostat	TPI Corporation	SDRF1001	Intertek ID: ATL1502091431-002 – Continuous Transmission Sample, Antenna Port Tests
RF Thermostat	TPI Corporation	SDRF1001	Intertek ID: ATL1502091434-001 – Used for Continuous Transmission and Random Transmission, Radiated Tests
RF Thermostat	TPI Corporation	SDRF1001	Intertek ID: ATL1402071031-001- Continuous Receiving Sample

Receive Date:	02/07/2014 and 02/09/2015
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)

A wireless interface between a thermostat and a remotely located HVAC relay electronics using short range radios operating in the 915 MHz ISM band. The device operates in the range of 914 to 926.6 MHz. The communication mode is bi-directional and uses FHSS on 64 channels with an output power of +10 dBm. Antenna gain is 0.0 dBi.

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
4.8 to 2.4 Vdc	60 mA to 64 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

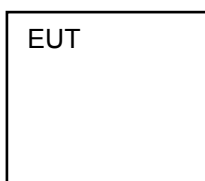
5 System Setup and Method

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 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, 15.209, 15.247(d); Industry Canada RSS-247 Issue 1 May 2015, Section 5, Annex 8; Industry Canada RSS-GEN Issue 4 December 2014.

TEST SITE: EMC Lab

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
200162;	EMI Receiver (20Hz-40GHz)	Rohde & Schwarz	ESU 40	100314	03/02/2015	03/02/2016

Software Utilized:

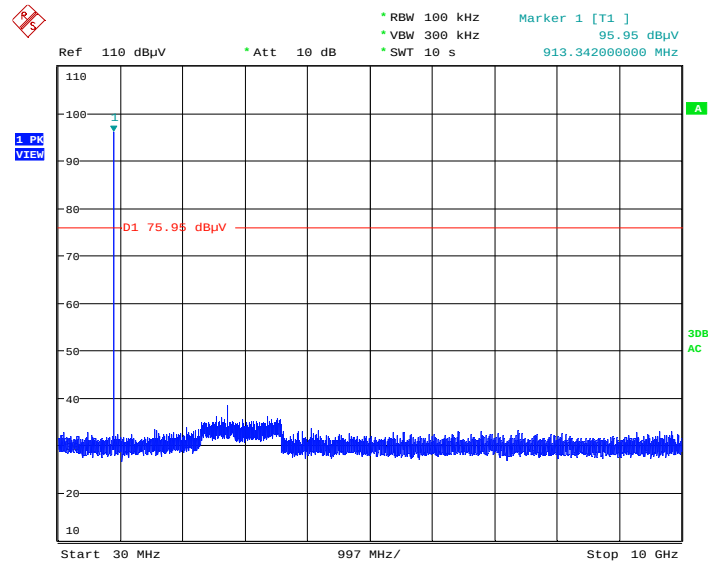
Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

6.3 Results:

The sample tested was found to Comply.

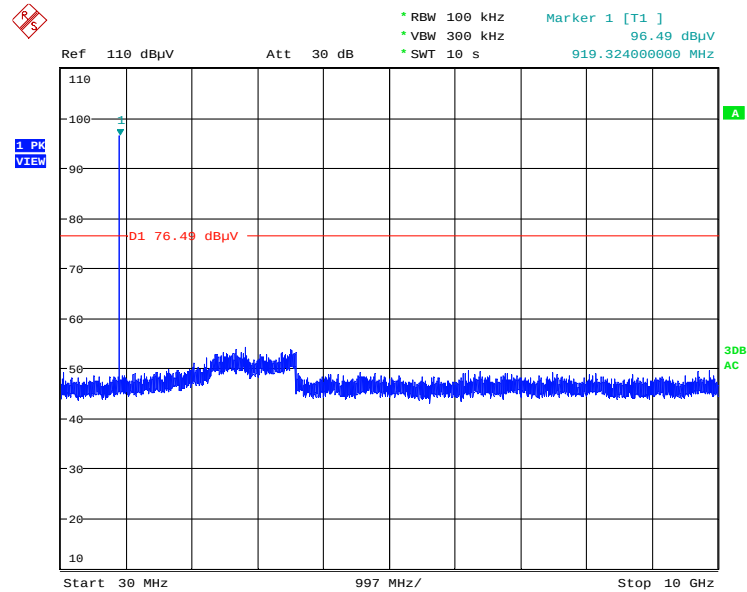
6.4 Plots/Data:

Low Channel



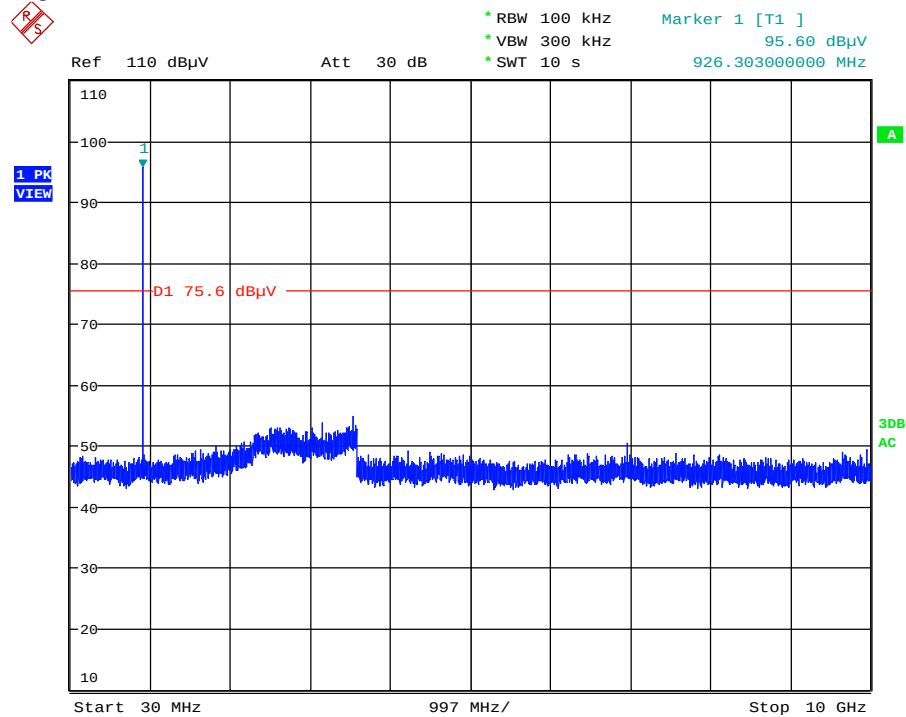
Date: 2.JUN.2015 11:05:42

Mid Channel



Date: 20.MAY.2015 09:37:47

High Channel



Date: 20.MAY.2015 09:39:05

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: 3 "AA" batteries

Test Date: 05/20 and 6/2/2015

Limit Applied: 15.209, 15.215, 15.247, IC RSS-247

Ambient Temperature: 24.0, 23.8 °C

Relative Humidity: 48.2, 50.8 %

Atmospheric Pressure: 982.3, 983.7 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, 15.215, 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

For radiated emissions, U_{lab} (3.9 dB at 3m and 3.6 dB at 10m below 1 GHz, and 4.2 dB at 3m above 1 GHz) $< U_{CISPR}$ (5.2 dB), which is the 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 dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ 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 μ 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 μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

RA = 52.0 dB μ V
 AF = 7.4 dB/m
 CF = 1.6 dB
 AG = 29.0 dB
 FS = 32 dB μ V/m

To convert from dB μ V to μ V or mV the following was used:

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

NF = Net Reading in dB μ V

Example:

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

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

7.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
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
213061;	Antenna, Horn, <18 GHz	EMCO	3115	9208-3919	07/22/2014	07/22/2015
TT-6	RF Coax Cable. Rated 9KHz to 2 GHz.	Andrews	Cable TT-6	TT6	06/18/2014	06/18/2015
MP3;	Cable MP3, 18 GHz, N, 10m	Megaphase	G919-NKNK-394	MP3	05/08/2014	05/08/2015
MP5;	RF Coax Cable	Megaphase	G919-N1N1-310	1GVT41411500102	08/26/2014	08/26/2015
E207;	RF Coax Cable	Megaphase	TM18-N1N1-120	14065201-001	05/07/2015	05/07/2016
200108;	Preamplifier, 20 MHz to 18 GHz, 40 dB	A.H. Systems	PAM-0118	199	12/03/2014	12/03/2015
E208;	RF Coax Cable	Megaphase	TM18-N1N1-120	14065201-002	05/08/2014	05/08/2015
E209;	RF Coax Cable	Megaphase	TM18-N1N1-120	14065201-003	05/08/2014	05/08/2015
ST-5;	7m Cable, 0.01-18GHz	Storm Products Co.	A81-0303-275.6	121-07-002	08/14/2014	08/14/2015
MP-HF-2;	Cable, 3-meters, 1-18GHz	Megaphase	EM18-N1N1-119	12090601002	08/26/2014	08/26/2015
200074;	Preamplifier, 10 MHz to 2000 MHz, 27 dB gain	Mini-Circuits	ZKL-2	D052005	10/02/2014	10/02/2015
213061;	Antenna, Horn, <18 GHz	EMCO	3115	9208-3919	07/22/2014	07/22/2015
211872;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer.	Omega	iBTHX-W	0240116	11/07/2014	11/07/2015

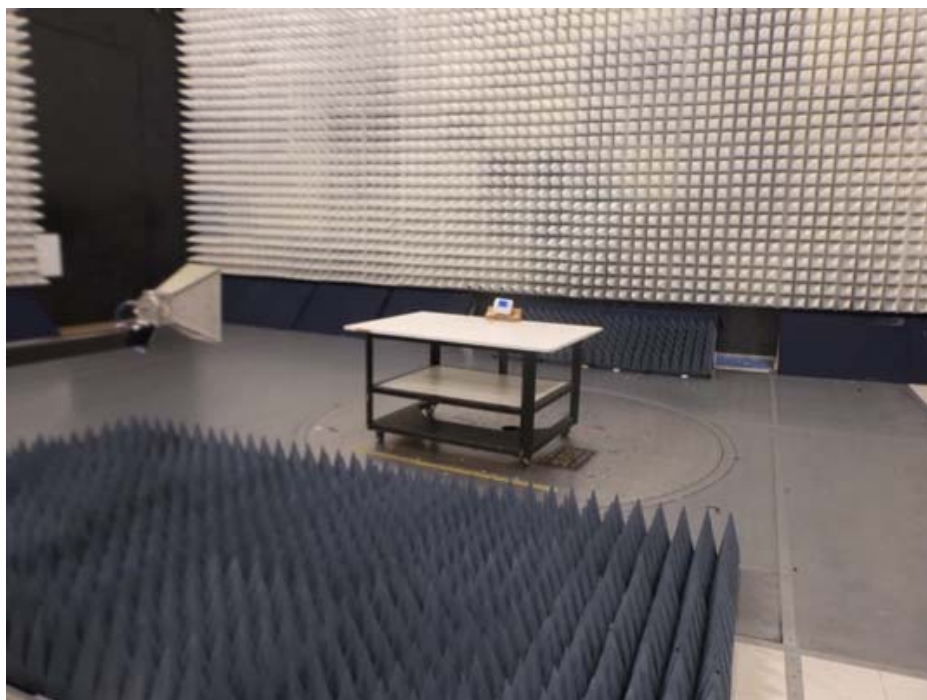
Software Utilized:

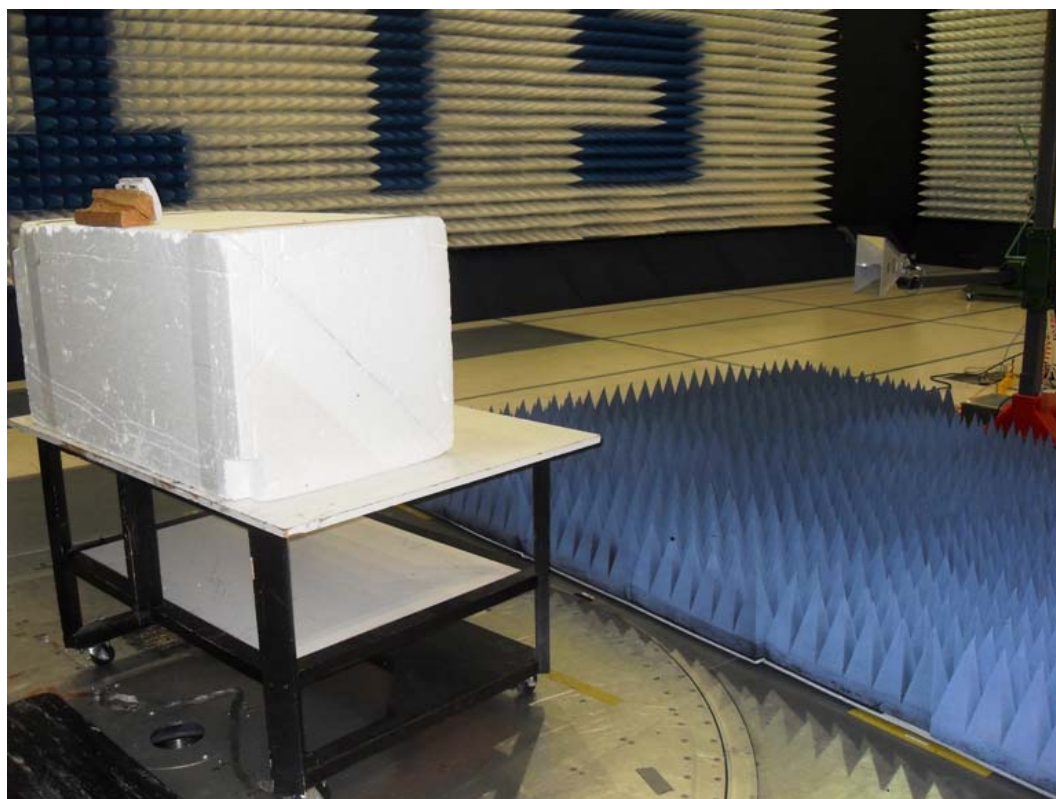
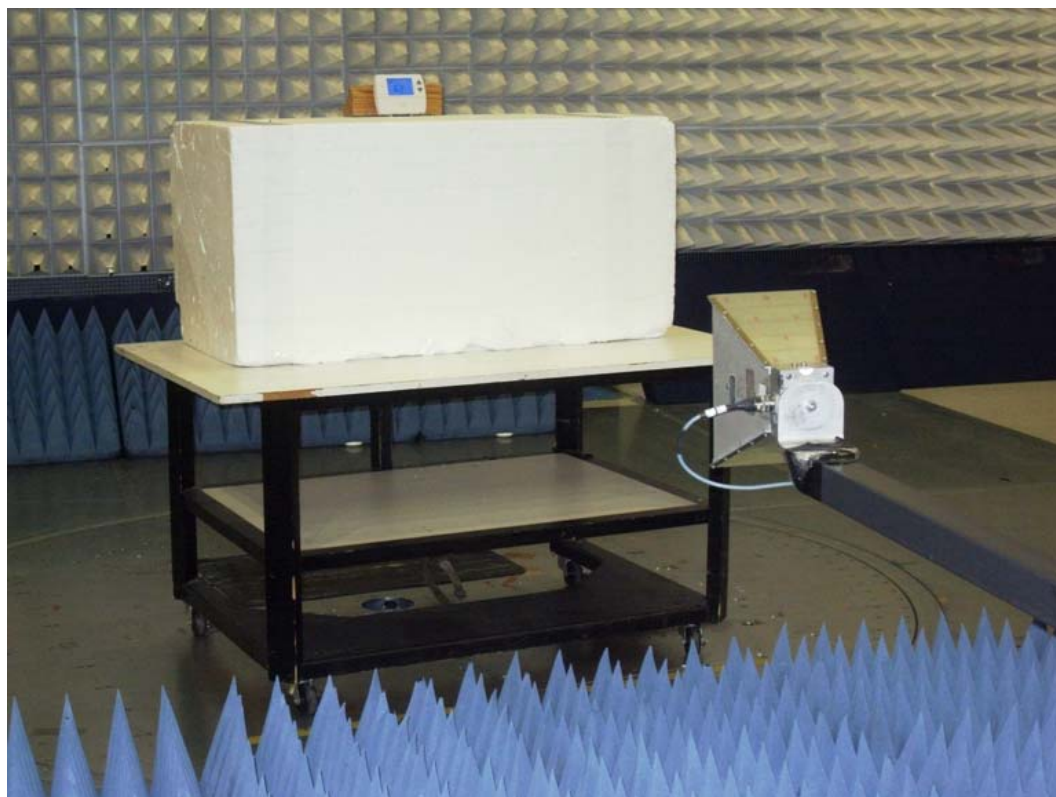
Name	Manufacturer	Version
Tile	Quantum Change	3.4.K.22

7.3 Results:

The sample tested was found to Comply.

7.4 Setup Photographs:





7.5 Plots/Data:

Client: TPI Corporation Model Number: SDRF1001 Project Number: G101163191 Tested By: MTS Date: 04/02/2015 Frequency Range (MHz): 30-1000 Input power: 3 "AA" batteries	Receiver: R&S ESU Antenna: Chase 2622 Cables: TT-6+MP3+E-208+E-209 Preamp: ZKL-2 200074 Test Distance (m): 3 Limit: FCC15 Class B-3m
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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)	3m Limit dB(uV/m)	Margin dB	Detectors / Bandwidths Det/RBW/VBW
Channel 0, low channel									
H	30.388	36.3	18.2	1.1	31.7	23.9	40.0	-16.1	QP/120k
H	32.124	36.0	17.1	1.1	31.7	22.6	40.0	-17.4	QP/120k
Channel 3.1, mid channel									
V	30.776	36.1	19.4	1.1	31.7	25.0	40.0	-15.0	QP/120k
H	31.552	36.0	17.5	1.1	31.7	23.0	40.0	-17.0	QP/120k
Channel 6.2, high channel									
H	30.485	36.0	18.2	1.1	31.7	23.6	40.0	-16.4	QP/120k
V	31.940	35.8	18.7	1.1	31.7	24.0	40.0	-16.0	QP/120k
Calculations		G=C+D+E-F			I=G-H				

Client: TPI Corporation Model Number: SDRF1001 Project Number: G101163191 Tested By: MTS Date: 4/2/2015 Frequency Range (MHz): 1000-10000 Input power: 3 "AA" batteries	Receiver: R&S ESU40 Antenna: EMCO 3115 Cables: ST-5+MP3+MP-HF-2 Preamp: PAM-0118 Limit: FCC15 Class B-3m Test Distance (m): 3 Modifications for compliance (y/n): n
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Notes: TX mode, low channel

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	Net dB(uV/m)	3m Limit dB(uV/m)	Margin dB	Det/RBW/VBW
V	1827.913	50.2	26.9	22.0	38.9	0.0	60.2	105.5	-45.3	PK/1MHz/3MHz
V	1827.913	50.2	26.9	22.0	38.9	33.6	26.6	85.5	-58.9	AVG/1MHz/3MHz
H	2741.831	48.1	28.8	22.6	39.5	0.0	60.0	74.0	-14.0	PK/1MHz/3MHz
H	2741.831	48.1	28.8	22.6	39.5	33.6	26.4	54.0	-27.6	AVG/1MHz/3MHz
H	3655.802	46.0	31.5	23.0	39.6	0.0	60.9	74.0	-13.1	PK/1MHz/3MHz
H	3655.802	46.0	31.5	23.0	39.6	33.6	27.3	54.0	-26.7	AVG/1MHz/3MHz
Calculations		H=C+D+E+F-G			J=I-H					

Client: TPI Corporation
 Model Number: SDRF1001
 Project Number: G101163191
 Tested By: MTS
 Date: 4/2/2015
 Frequency Range (MHz): 1000-10000
 Input power: 3 "AA" batteries

Receiver: R&S ESU40
 Antenna: EMCO 3115
 Cables: ST-5+MP3+MP-HF-2
 Preamp: PAM-0118
 Limit: FCC15 Class B-3m
 Test Distance (m): 3
 Modifications for compliance (y/n): n

Notes: TX Mode

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/VBW
Mid Channel, 3.1										
V	1840.302	47.4	26.5	4.7	38.9	0.0	39.7	105.9	-66.1	PK/1MHz/3MHz
V	1840.302	47.4	26.5	4.7	38.9	36.6	3.1	95.9	-92.7	AVG/1MHz/3MHz
V	2760.434	49.4	28.9	21.7	39.0	0.0	61.0	74.0	-13.0	PK/1MHz/3MHz
V	2760.434	49.4	28.9	21.7	39.0	36.6	24.4	54.0	-29.6	AVG/1MHz/3MHz
High Channel, 6.2										
H	1852.687	47.8	27.0	21.3	38.9	0.0	57.2	104.3	-47.1	PK/1MHz/3MHz
H	1852.687	47.8	27.0	4.7	38.9	0.0	40.6	84.3	-43.7	AVG/1MHz/3MHz
H	2779.800	43.6	28.9	6.9	39.6	0.0	39.7	74.0	-34.3	PK/1MHz/3MHz
H	2779.800	43.6	28.9	6.9	39.6	36.6	3.1	54.0	-50.9	AVG/1MHz/3MHz
Calculations		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 "AA" batteries
 Pretest Verification w/ Ambient Signals or BB Source: BB Source

Test Date: 4/2/2015
 Limit Applied: FCC 15.209, 15.215, 15.247, IC RSS-247
 Ambient Temperature: 25.8 °C
 Relative Humidity: 36.3 %
 Atmospheric Pressure: 989.9 mbars

Client: TPI Corporation
 Model Number: SDRF1001
 Project Number: G101163191
 Tested By: LEM
 Date: 6/3/15

Receiver: R&S ESU40
 Antenna: EMCO 3115
 Cables: MP5+E-207
 Preamp: PAM-0118
 Limit: FCC15 Class B-3m

Frequency Range (MHz): 1000-10000

Test Distance (m): 3

Input power: Battery

Modifications for compliance (y/n): n

Notes: TX mode @1.5m table height

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/VBW
Low Channel										
H	1827.000	58.8	26.7	4.3	41.0	0.0	48.8	105.5	-56.7	PK/1MHz
H	1827.000	58.8	26.7	4.3	41.0	33.6	15.2	85.5	-70.3	AVG/1MHz
H	2741.000	66.1	28.9	5.4	41.2	0.0	59.2	74.0	-14.9	PK/1MHz
H	2741.000	66.1	28.9	5.4	41.2	33.6	25.6	54.0	-28.5	AVG/1MHz
H	3654.000	52.2	31.8	6.3	41.4	0.0	48.9	74.0	-25.2	PK/1MHz
H	3654.000	52.2	31.8	6.3	41.4	33.6	15.3	54.0	-38.8	AVG/1MHz
Mid Channel										
H	1836.000	57.4	26.8	4.3	41.0	0.0	47.5	105.9	-58.4	PK/1MHz
H	1836.000	57.4	26.8	4.3	41.0	33.6	13.9	95.9	-82.0	AVG/1MHz
H	2759.000	67.3	28.9	5.4	41.2	0.0	60.4	74.0	-13.6	PK/1MHz
H	2759.000	67.3	28.9	5.4	41.2	33.6	26.8	54.0	-27.2	AVG/1MHz
H	3684.000	51.3	31.9	6.3	41.4	0.0	48.1	74.0	-25.9	PK/1MHz
H	3684.000	51.3	26.9	22.0	39.2	33.6	27.3	54.0	-26.7	AVG/1MHz
High Channel										
H	1855.000	57.0	27.0	4.3	41.0	0.0	47.3	104.3	-57.0	PK/1MHz
H	1855.000	57.0	27.0	4.3	41.0	33.6	13.7	84.3	-70.6	AVG/1MHz
H	2778.000	66.4	28.8	5.4	41.2	0.0	59.4	74.0	-14.6	PK/1MHz
H	2778.000	66.4	28.8	5.4	41.2	33.6	25.8	54.0	-28.2	AVG/1MHz
V	3771.000	53.8	32.1	6.4	41.3	0.0	51.0	74.0	-23.0	PK/1MHz
V	3771.000	53.8	32.1	6.4	41.3	33.6	17.4	54.0	-36.6	AVG/1MHz
Calculations		H=C+D+E+F-G			J=I-H					

Test Personnel: Larry Miller
 Supervising/Reviewing Engineer:
 (Where Applicable) N/A
 Product Standard: FCC 15.205, 15.209, 15.215, 15.247, IC RSS-247
 Input Voltage: 3 "AA" batteries
 Pretest Verification w/ Ambient Signals or BB Source: BB Source

Test Date: 6/3/15

Limit Applied: FCC 15.209, 15.215, 15.247, IC RSS-247

Ambient Temperature: 24.4 °C
 Relative Humidity: 45.7 %
 Atmospheric Pressure: 982.4 mbars

For duty cycle calculation, reference Section 16

Deviations, Additions, or Exclusions: None

8 Receiver Spurious Radiated Emissions

8.1 Method

Tests are performed in accordance with CFR47 FCC Part 15 Subpart C:2015 Section 15.109; 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

For radiated emissions, U_{lab} (3.9 dB at 3m and 3.6 dB at 10m below 1 GHz, and 4.2 dB at 3m above 1 GHz) $< U_{CISPR}$ (5.2 dB), which is the 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 dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ 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 μ 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 μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

RA = 52.0 dB μ V
 AF = 7.4 dB/m
 CF = 1.6 dB
 AG = 29.0 dB
 FS = 32 dB μ V/m

To convert from dB μ V to μ 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:

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

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

8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
T006217;	THDX	Oregon Scientific	BA888	NSN	12/11/2013	12/11/2014
213061;	Antenna, Horn, <18 GHz	EMCO	3115	9208-3919	07/26/2013	07/26/2014
200162;	EMI Receiver (20Hz-40GHz)	Rohde & Schwarz	ESU 40	100314	11/21/2013	11/21/2014
ST-4;	7m Cable, 0.01-18GHz	Storm Products Co.	A81-0303-275.6	12-07-001	08/21/2013	08/21/2014
MP-HF-2;	Cable, 3-meters, 1-18GHz	Megaphase	EM18-N1N1-119	12090601002	07/17/2013	07/17/2014
200108;	Preamplifier, 20 MHz to 18 GHz, 40 dB	A.H. Systems	PAM-0118	199	02/10/2014	02/10/2015
211386;	Antenna, BiLog, 20-2000MHz	Chase	CBL6112B	2622	12/12/2013	12/12/2014
200074;	Preamplifier, 10 MHz to 2000 MHz, 27 dB gain	Mini-Circuits	ZKL-2	D052005	10/22/2013	10/22/2014
MP3;	Cable MP3, 18 GHz, N, 10m	Megaphase	G919-NKNK-394	MP3	05/13/2013	05/13/2014
E204;	Cable, N-N, 3 meters, 18GHz	Megaphase	TM18-NKNK-118	9053201 001	05/13/2013	05/13/2014
E206;	Cable, N-N, 3 meters, 18GHz	Megaphase	TM18-NKNK-118	9053201 004	05/13/2013	05/13/2014
211505;	EMI Receiver	Hewlett Packard	8546A	3650A00362	10/01/2013	10/01/2014
015762;	EMI Receiver, Preselector section	Hewlett Packard	85460A	3330A00158	04/05/2013	04/05/2014

Software Utilized:

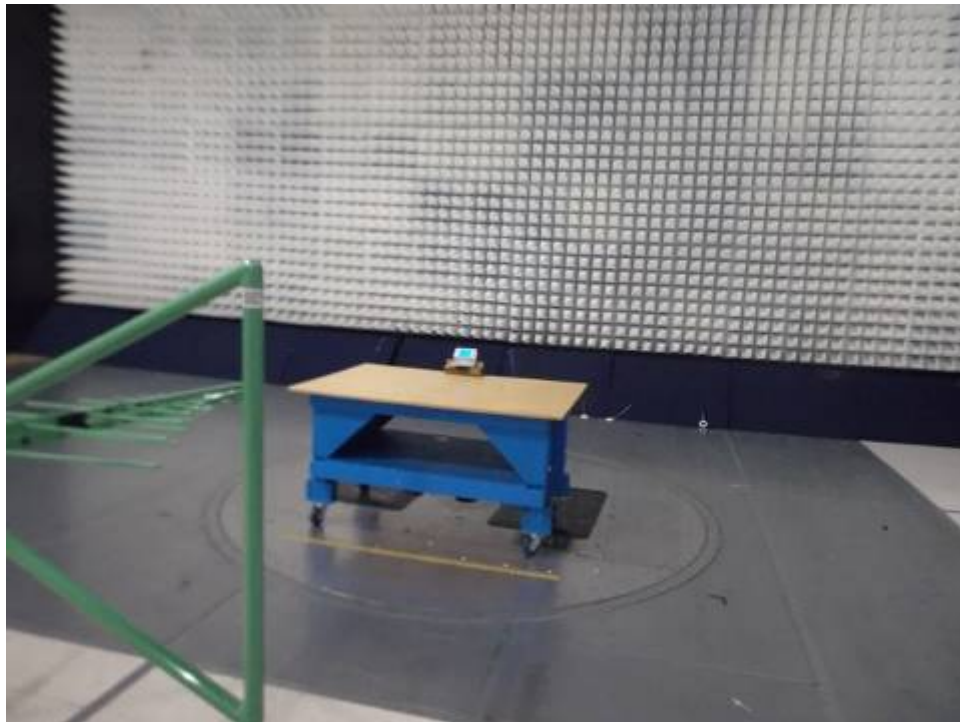
Name	Manufacturer	Version
Tile	Quantum Change	3.4.K.22

8.3 Results:

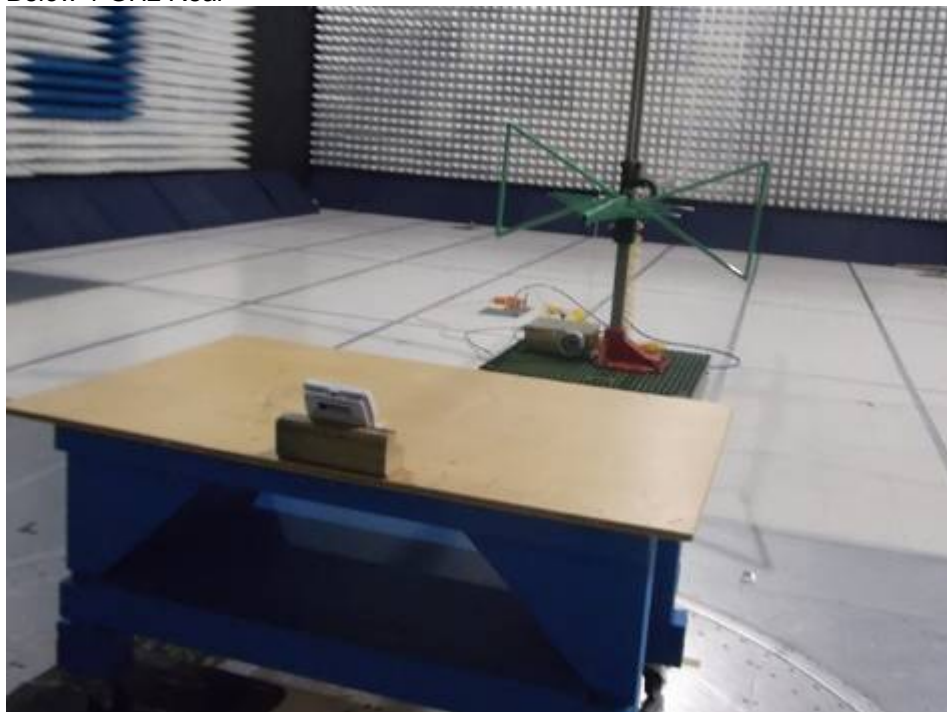
The sample tested was found to Comply.

8.4 Setup Photographs:

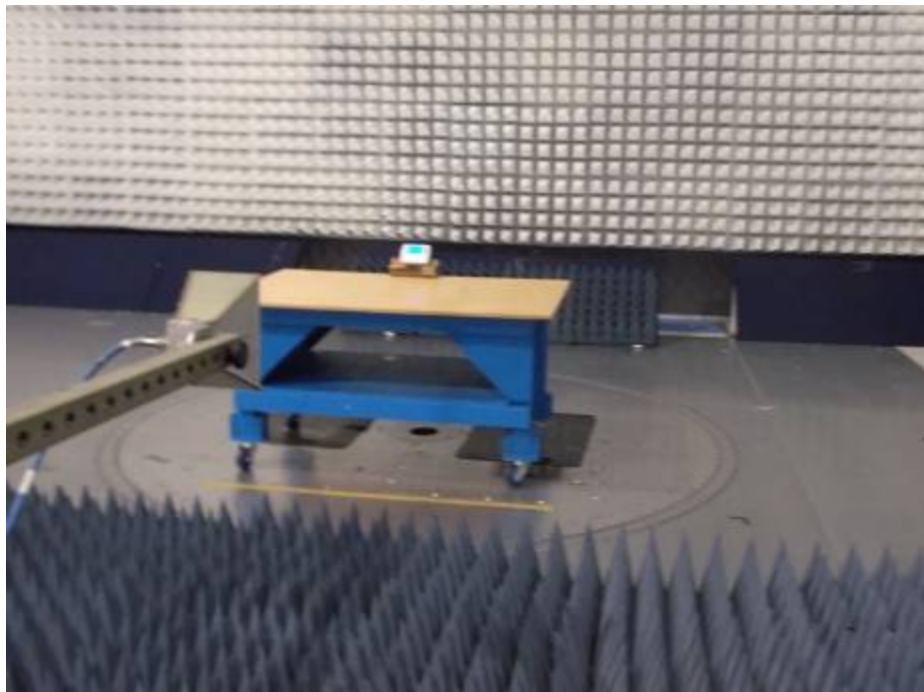
Below 1 GHz Front



Below 1 GHz Rear



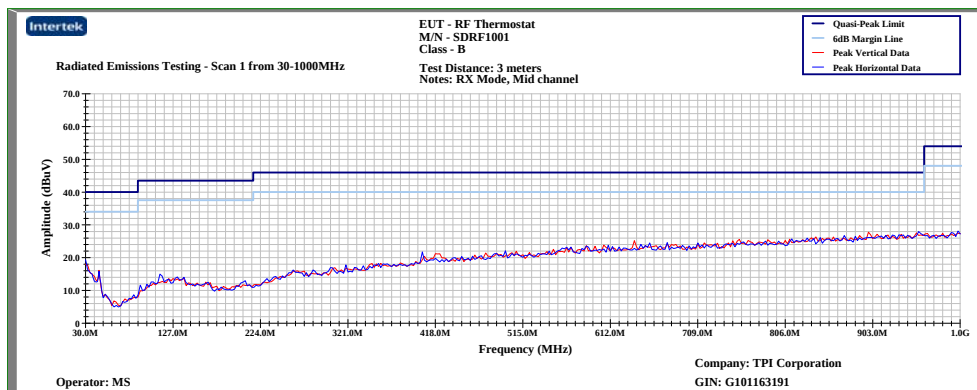
Above 1 GHz Front



Above 1 GHz Rear



8.5 Plots/Data:



Client: TPI Corporation
Model Number: SDRF1001
Project Number: G101163191
Tested By: MS
Date: 3/12/14
Frequency Range (MHz): 30-1000
Input power: 3 "AAA" batteries

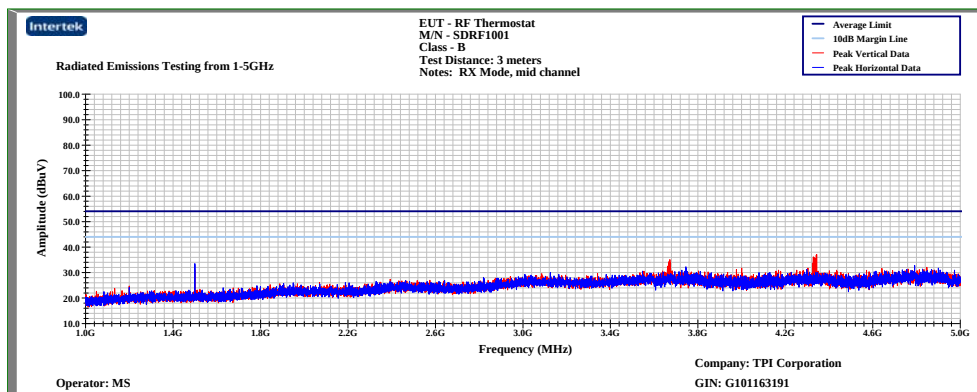
Receiver: HP 8546A
Antenna: Chase 2622
Cables: ST-4+MP3+E-204+E-206
Preamp: ZKL-2 200074

Test Distance (m): 3

Limit: FCC15 Class B-3m

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)	3m Limit dB(uV/m)	Margin dB	Detectors / Bandwidths Det/RBW/VBW
H	30.000	23.2	17.6	1.3	31.6	10.5	40.0	-29.5	QP/120K/300K
H	403.450	22.6	16.4	4.4	31.2	12.2	46.0	-33.8	QP/120K/300K
V	638.675	22.1	19.9	5.6	31.0	16.6	46.0	-29.4	QP/120K/300K
Calculations		G=C+D+E-F		I=G-H					



Client: TPI Corporation
Model Number: SDRF1001
Project Number: G101163191
Tested By: MS
Date: 3/12/14
Frequency Range (MHz): 1000-5000
Input power: 3 "AAA" batteries
Receiver: R&S ESU40
Antenna: EMCO 3115
Cables: ST-4+MP3+E-204+E-206
Preamp: PAM-0118
Test Distance (m): 3
Limit: FCC15 Class B-3m

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)	3m Limit dB(uV/m)	Margin dB	Detectors / Bandwidths Det/RBW/VBW
H	1499.600	50.9	25.6	10.4	40.9	46.0	74.0	-28.0	PK/1M/3M
H	1499.600	43.5	25.6	10.4	40.9	38.5	54.0	-15.5	AVG/1M/3M
V	3672.400	45.6	31.9	17.0	41.4	53.1	74.0	-20.9	PK/1M/3M
V	3672.400	38.8	31.9	17.0	41.4	46.4	54.0	-7.6	AVG/1M/3M
V	4343.600	47.1	32.0	20.3	41.4	58.0	74.0	-16.0	PK/1M/3M
V	4343.600	39.0	32.0	20.3	41.4	49.9	54.0	-4.1	AVG/1M/3M
Calculations		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 "AA" batteries
 Pretest Verification w/ Artifact: BB Source

Test Date: 3/12/14
 Limit Applied: FCC 15.109(a), IC RSS-GEN Section 6.1
 Ambient Temperature: 22.5 °C
 Relative Humidity: 28 %
 Atmospheric Pressure: 980 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-210 Issue 8 December 2010, Annex 8.1(b).

TEST SITE: EMC Lab Shielded Room

The EMC Lab has two Semi-anechoic Chambers 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
211872;	Barometer, Temperature, and Humidity sensor - Network based. Also marked as iServer MicroServer.	Omega	iBTHX-W	0240116	11/07/2014	11/07/2015
031690;	EMC Analyzer	Agilent	E7405A	US40240205	07/31/2014	07/31/2015

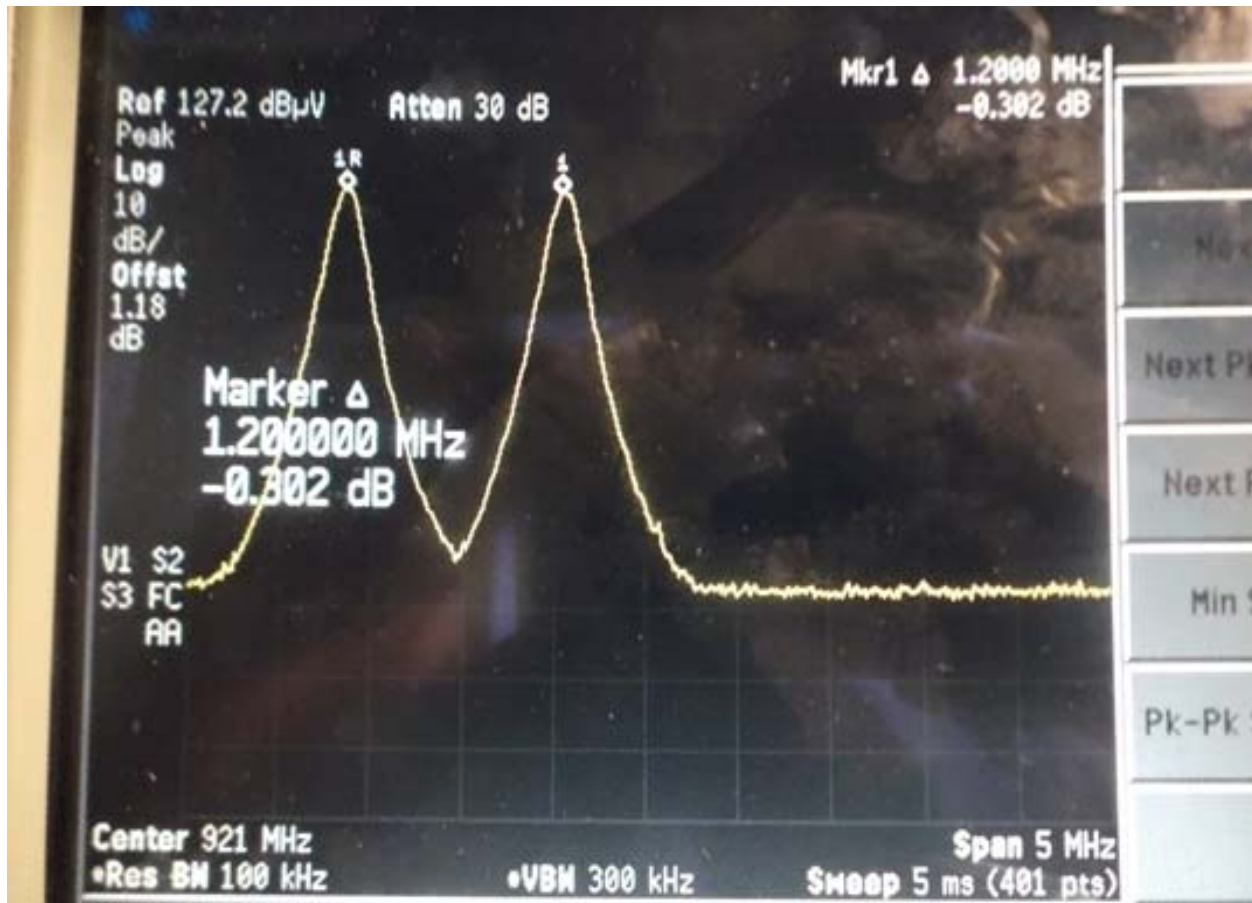
Software Utilized:

Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

9.3 Results:

The sample tested was found to Comply.

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 "AA" batteries

Test Date: 3/19/15

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

Ambient Temperature: 26.7 °C
Relative Humidity: 34.4 %
Atmospheric Pressure: 986.4 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.

TEST SITE: EMC Lab 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.

10.2 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
031690;	EMC Analyzer	Agilent	E7405A	US40240205	07/31/2014	07/31/2015

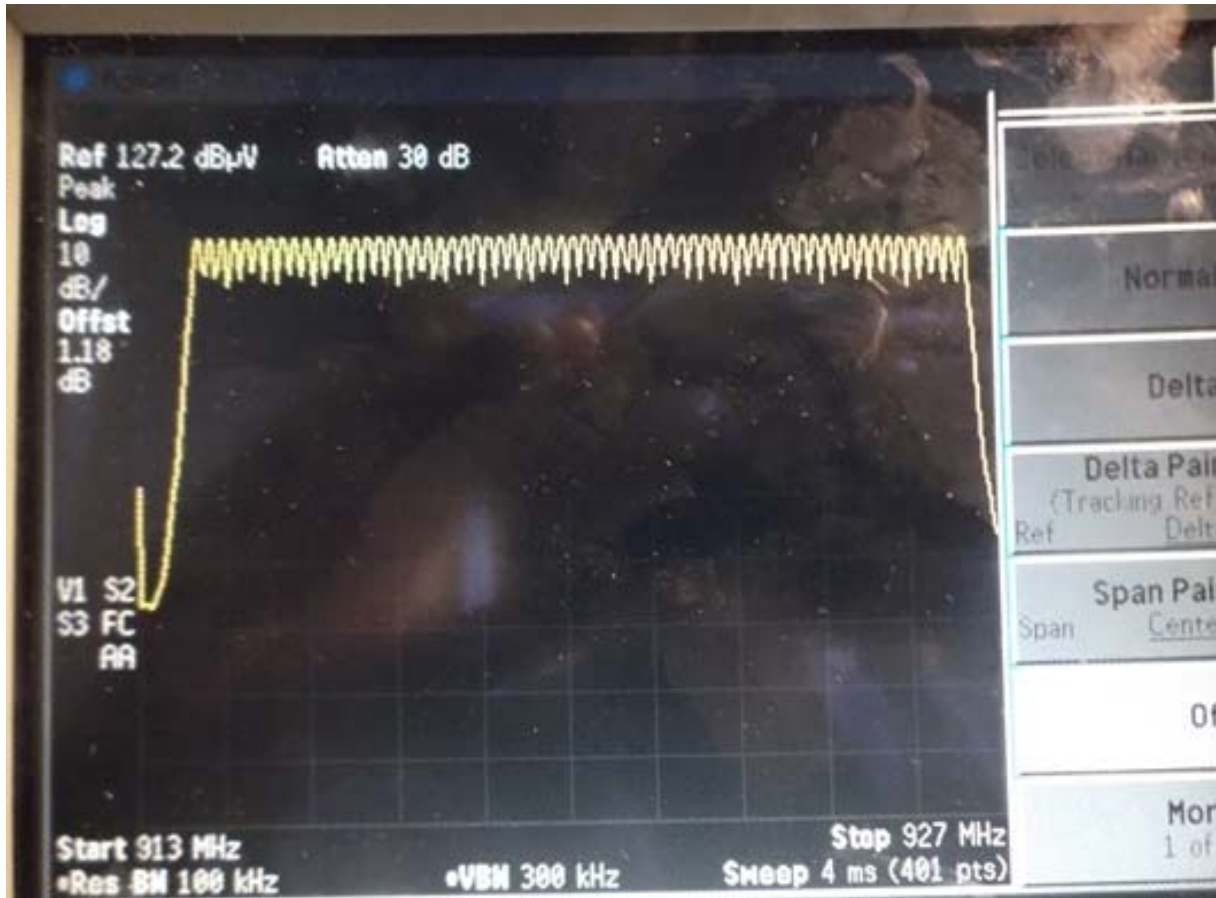
Software Utilized:

Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

10.3 Results:

The sample tested was found to Comply.

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 "AA" batteries

Test Date: 3/19/2015

Test Levels: FCC 15.247(a)(1)(i), RSS-247
Section 5

Ambient Temperature: 26.7 °C

Relative Humidity: 34.4 %

Atmospheric Pressure: 986.4 mbars

Deviations, Additions, or Exclusions: None

11 Time of Occupancy (Dwell Time)

11.1 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)(i); Industry Canada RSS-247 Issue 1 May 2015, Section 5

TEST SITE: EMC Lab 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.

11.2 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
200162	EMI Receiver (20Hz-40GHz)	Rohde & Schwarz	ESU 40	100314	03/02/2015	03/02/2016

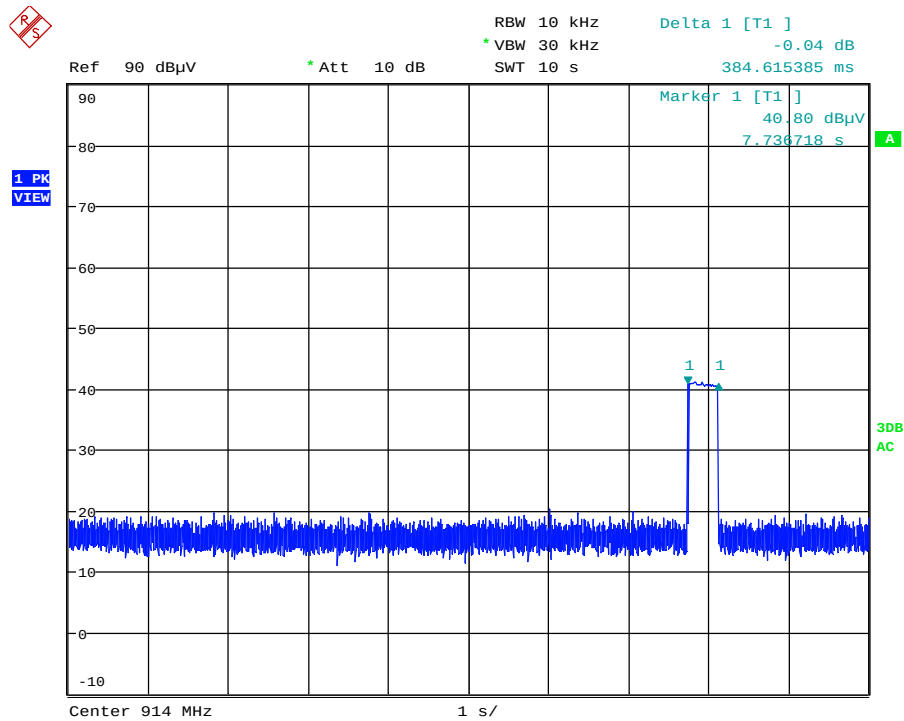
Software Utilized:

Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

11.3 Results:

The sample tested was found to Comply.

11.4 Plots/Data:



Date: 2.JUN.2015 14:36:02

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

Test Date: 06/02/2015Test Levels: FCC 15.247(a)(1)(i), RSS-247 Section 5Ambient Temperature: 23.8 °CRelative Humidity: 50.8 %Atmospheric Pressure: 983.7 mbars

Deviations, Additions, or Exclusions: None

12 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.

TEST SITE: EMC Lab 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.

12.2 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
031690;	EMC Analyzer	Agilent	E7405A	US40240205	07/31/2014	07/31/2015

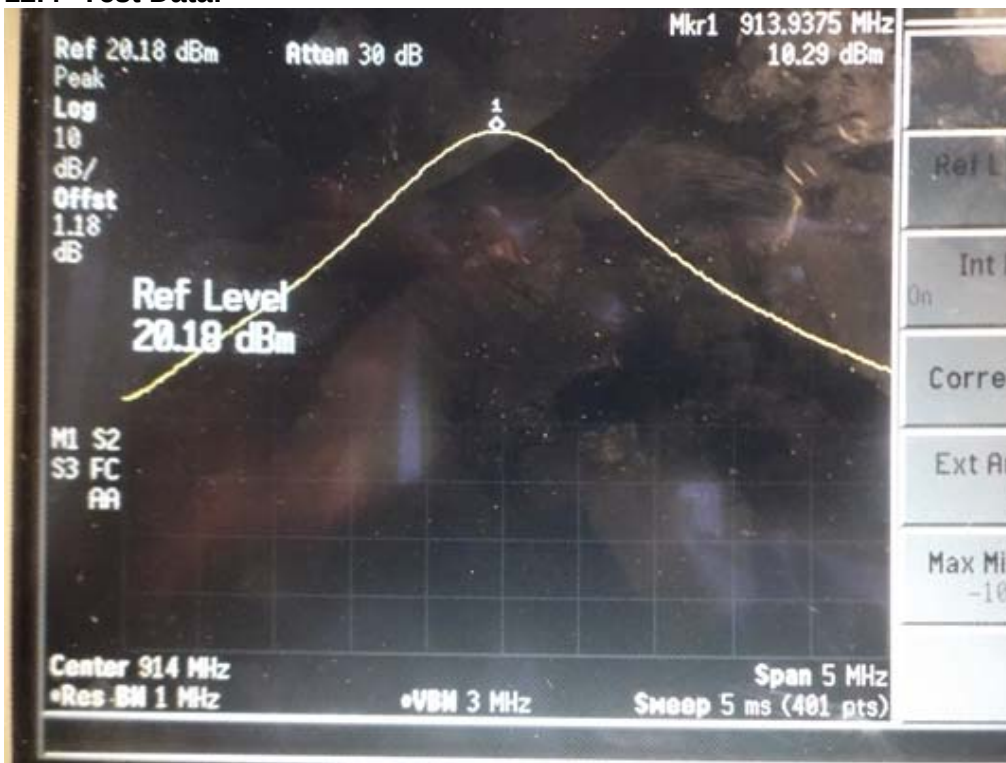
Software Utilized:

Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

12.3 Results:

The sample tested was found to Comply.

12.4 Test Data:





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

Test Date: 3/19/2015

Test Levels: FCC 15.247(B)(2); RSS-247
Section 5

Ambient Temperature: 26.7 °C
Relative Humidity: 34.4 %
Atmospheric Pressure: 986.4 mbars

Deviations, Additions, or Exclusions: None

13 Bandedge

13.1 Method

Tests are performed in accordance with 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.

TEST SITE: EMC Lab 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.

13.2 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
031690;	EMC Analyzer	Agilent	E7405A	US40240205	07/31/2014	07/31/2015

Software Utilized:

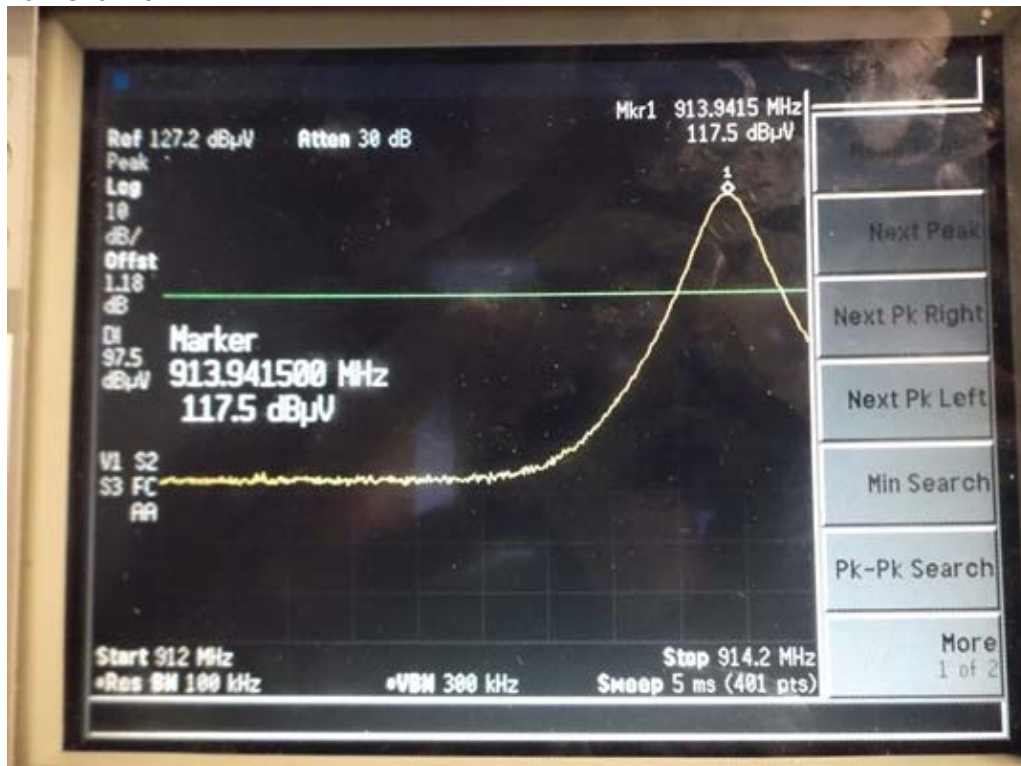
Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

13.3 Results:

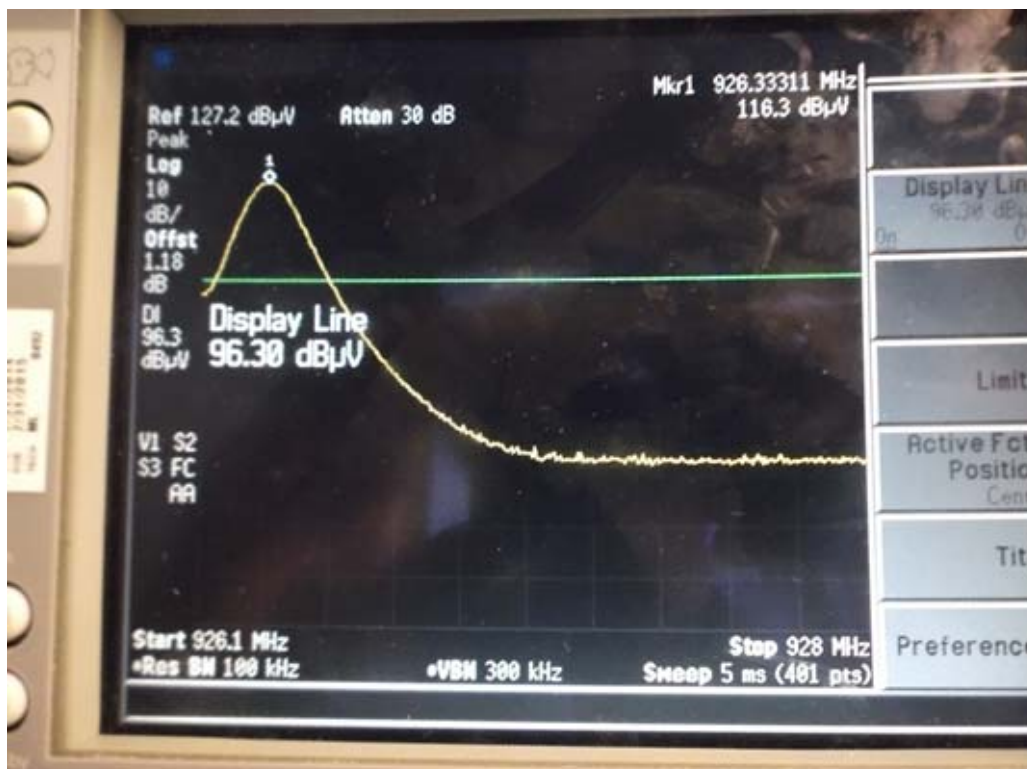
The sample tested was found to Comply.

13.4 Test Data:

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 Section 5
Input Voltage: 3 "AA" batteries

Test Date: 3/19/2015

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

Ambient Temperature: 26.7 °C

Relative Humidity: 34.4 %

Atmospheric Pressure: 986.4 mbars

Deviations, Additions, or Exclusions: None

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.

TEST SITE: EMC Lab 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.

14.2 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
031690	EMC Analyzer	Agilent	E7405A	US40240205	07/31/2014	07/31/2015

Software Utilized:

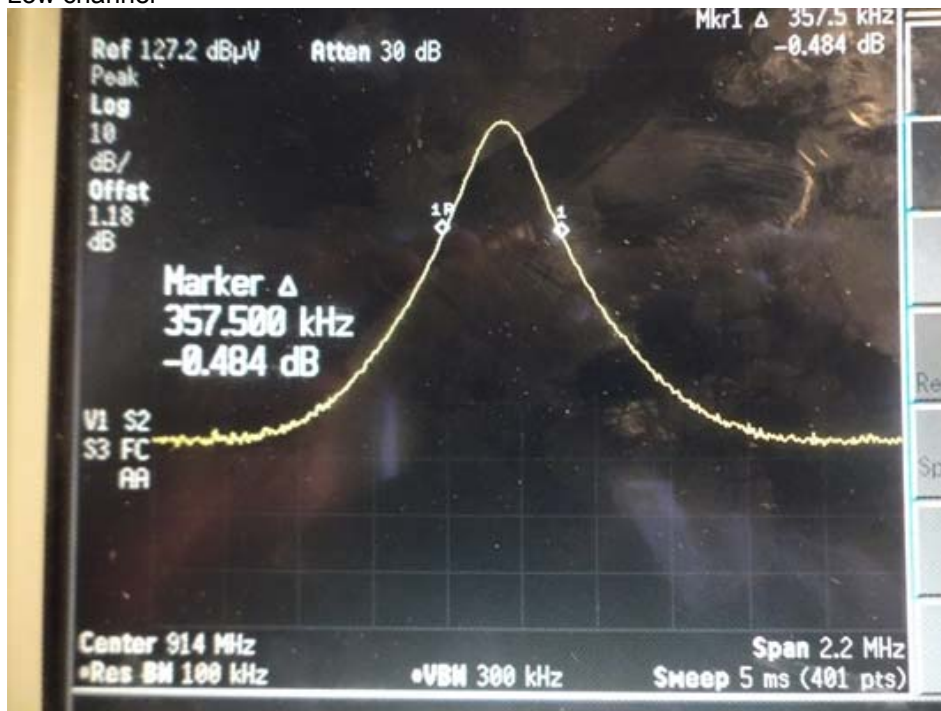
Name	Manufacturer	Version
None (Spectrum Analyzer Firmware)		

14.3 Results:

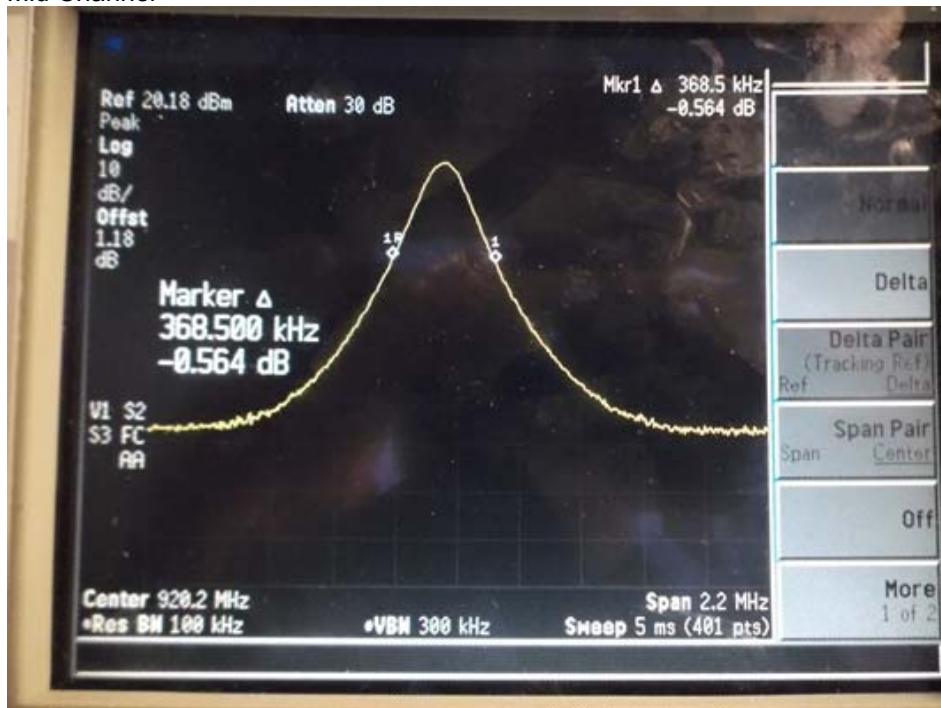
The sample tested was found to Comply.

14.4 Test Data:

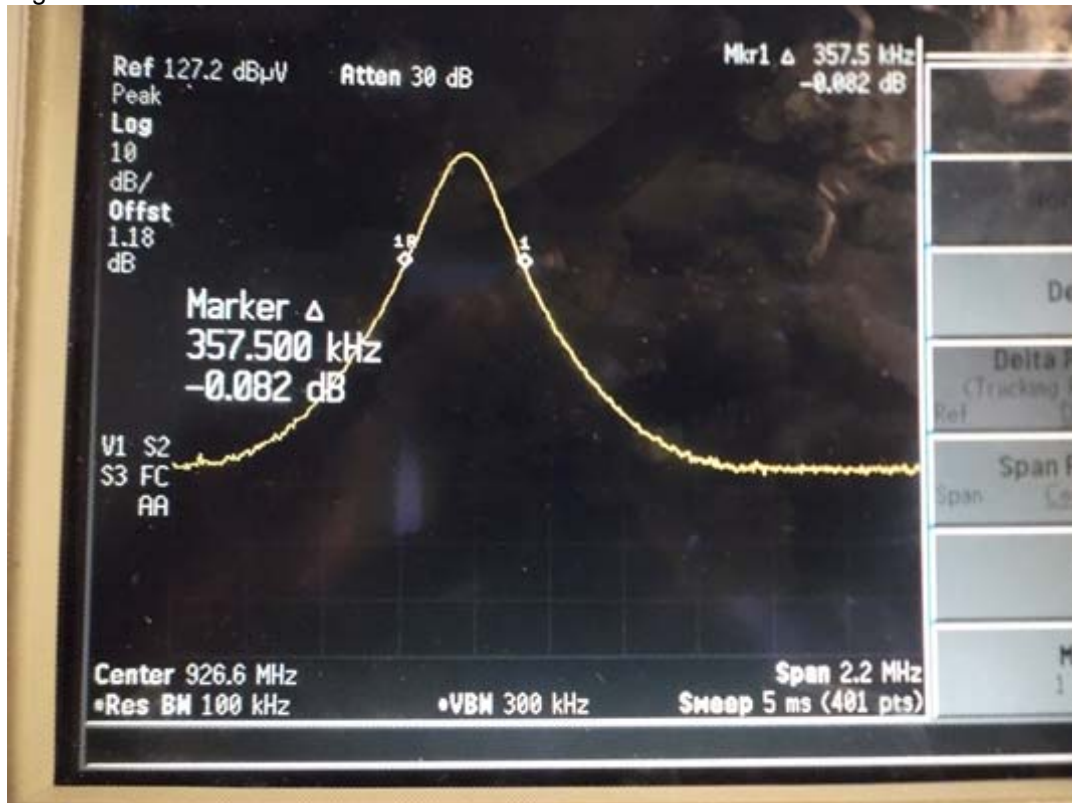
Low channel



Mid Channel



High Channel



Test Personnel: Mary Sampson *MTS*
Supervising/Reviewing
Engineer:
(Where Applicable) N/A
Product Standard: FCC 15.247, RSS-247, Section 5, RSS-GEN Annex 6.6
Input Voltage: 3 "AA" batteries

Test Date: 3/19/2015

Limits Applied: FCC 15.247(a)(1)(i); RSS-247, Section 5, RSS-GEN, Annex 6.6

Ambient Temperature: 26.7 °C
Relative Humidity: 34.4 %
Atmospheric Pressure: 986.4 mbars

Deviations, Additions, or Exclusions: None

15 RF Exposure Compliance

The maximum measured conducted power, P is 10.62 dBm.

The antenna gain, G is 0.0 dBi.

The maximum EIRP power = P+G

EIRP = 10.62 + 0.0 = 10.62 dBm or 0.011534532578 W

The limits for Maximum Permissible Exposure (MPE) for transmitter operating at 902-928 MHz, MPE is $928/1500 = 0.619 \text{ mW/cm}^2$ or 6.2 W/m^2 .

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

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

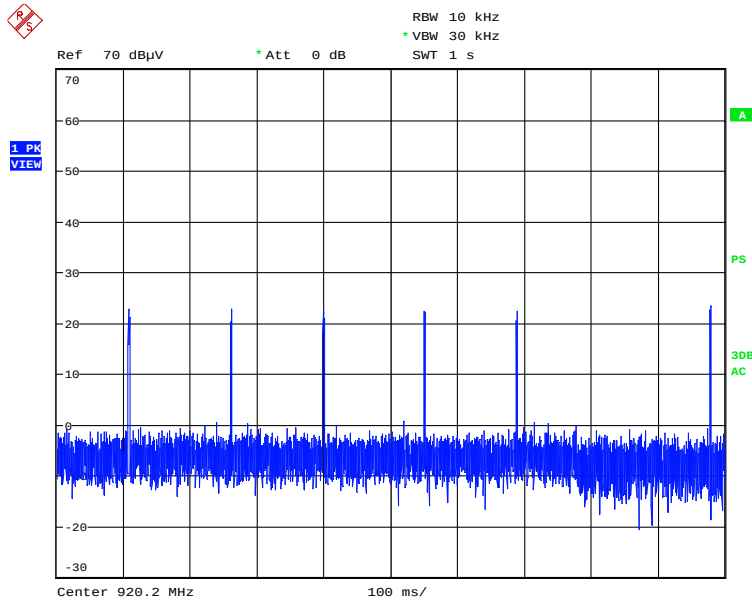
$S = \text{EIRP} / 4\pi D^2$, where D is the safe separation distance and = 0.2m, or 20cm

$S = 0.011534532578 / 4\pi 0.2^2$,

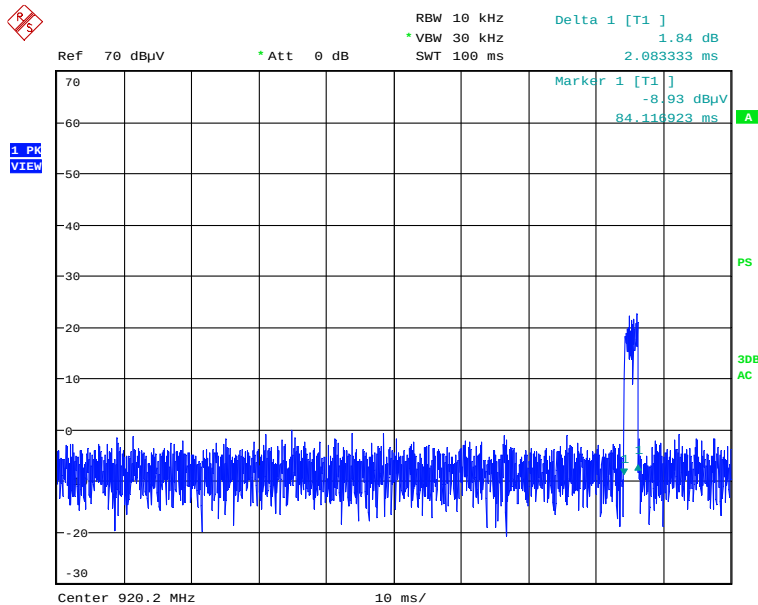
$S = 0.0229 \text{ W/m}^2$, or below the Maximum Permissible Exposure (MPE) of 6.2 W/m^2

16 Duty Cycle

Worst case duty cycle for typical EUT operation is shown below. The pulse train repeats over a larger than 100ms period.



Date: 24.APR.2014 12:41:41



Date: 24.APR.2014 12:43:41

The duty cycle = $2.083333\text{ms}/100\text{ms} = 0.02083333$
 Average factor = $20 \cdot \text{LOG}(0.02083333) = -33.6 \text{ dB}$

17 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	04/25/2014	101163191ATL-001	MTS <i>MTS</i>	KPS <i>KPS</i>	Original Issue
1	05/16/2014	101163191ATL-001	MTS <i>MTS</i>	KPS <i>KPS</i>	Corrected model number from RFLV4001 to SDRF1001.
2	06/02/2015	101163191ATL-001	MTS <i>MTS</i>	VFV <i>VFV</i>	Retest due to test data older than 1 year, RSE retest to satisfy 1.5 m table height and TCB Reviewers' comments.