Electromagnetic Compatibility Test Report

Prepared in accordance with

CFR 47 Part 15C and RSS-210, Issue 8

Tested using the procedures of ANSI C63.10-2013

On

B-ware Beehive Monitoring System

SMART HIVE MONITOR

SolutionBee LLC
8112 Glenbrittle Way
Raleigh NC 27615 USA

Prepared by:

TUV Rheinland of North America, Inc.

Manufacturer's statement - attestation

The manufacturer; SolutionBee LLC, as the responsible party for the equipment tested, hereby affirms:

a) That he has reviewed and concurs that the test shown in this report are reflective of the operational characteristics of the device for which certification is sought;

b) That the device in this test report will be representative of production units;

c) That all changes (in hardware and software/firmware) to the subject device will be reviewed.

d) That any changes impacting the attributes, functionality or operational characteristics documented in this report will be communicated to the body responsible for approving (certifying) the subject equipment.

Rafael Cabrera	
Printed name of official	Signature of official
8112 Glenbrittle Way Raleigh NC 27615 USA	29 August 2014
Address	Date
919-607-3407	rafael.cabrera@solutionbee.com
Telephone number	Email address of official

Client:	SolutionBee LLC 8112 Glenbrittle Way Raleigh NC 27615 USA	Rafael Cabrera 919-607-3407 rafael.cabrera@solutionbee.com	
Identification:	B-ware Beehive Monitoring System	***Serial No.:***	NOT SERIALIZED
Test item:	SMART HIVE MONITOR	***Date tested:***	08 October 2014
Testing location:	TUV Rheinland of North America 762 Park Avenue Youngsville, NC 27596-9470 U.S.A.	Tel: (919) 554-3668 Fax: (919) 554-3542	
Test specification:	**Emissions:** FCC Part 15, Subpart C, RSS-210 Issue 8: FCC Part 15.207(a) and RSS-GEN 7.2 FCC Parts 15.247(d), 15.205, 15.209, 15.215(c) and RSS-210 A8.5 and RSS-GEN 7.2 FCC Part 15.247(a)(2) and RSS-210 A1.1.3, FCC Part 15.247 and RSS-210 Annex 8, FCC Part 15.247(b)(3) and RSS-210 A8.4(4), FCC Part 15.247(d) and RSS-210 2.2, FCC Parts 15.109(a), RSS-210 2.2, 2.5, and RSS-GEN 6.1 and		
Test Result	**The above product was found to be Compliant to the above test standard(s)**		
tested by: Mark Ryan		***reviewed by:*** Michael Moranha	
8 October 2014 ***Signature***		8 October 2014 ***Signature***	
Other Aspects:	**None**		

Abbreviations: OK, Pass, Compliant, Complies = passed
Fail, Not Compliant, Does Not Comply = failed
N/A = not applicable

90552 and 100881	**Testing Cert #3331.05**	**Industry Canada** **2932H-1 and 2932H-2**

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1 General Information

1.1 Scope

This report is intended to document the status of conformance with the requirements of the CFR 47 Part 15C and RSS-210, Issue 8 based on the results of testing performed on 08 October 2014 on the B-ware Beehive Monitoring System, Model No. SMART HIVE MONITOR, manufactured by SolutionBee LLC. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT (Equipment Under Test) in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

1.3 Revision History

Revision	Date	Description of Revision
--	02 Sept. 2014	Initial Release
A	18 Sept. 2014	Updated 99% PBW plots and corrected several typos
B	8 Oct 2014	Updated SolutionBee address and added restricted band measurements

1.4 *Summary of Test Results*

Applicant	SolutionBee LLC 8112 Glenbrittle Way Raleigh NC 27615 USA	**Tel**	919-607-3407	**Contact**	Rafael Cabrera
		Fax		**e-mail**	rafael.cabrera@solutionbee.com

Description	B-ware Beehive Monitoring System	**Model Number**	SMART HIVE MONITOR
Serial Number	NOT SERIALIZED	**Test Voltage/Freq.**	3.3 VDC (Battery operated)
Test Date Completed:	08 October 2014	**Test Engineer**	Mark Ryan

Standards	Description	Severity Level or Limit	Criteria	Test Result
FCC Part 15, Subpart C Standard	Radio Frequency Devices-Subpart C: Intentional Radiators	See called out parts below	See Below	**Complies**
RSS-210 Issue 8 Standard	Low-Power Licence-exempt Radiocommunication Devices Category I Equipment	See called out parts below	See Below	**Complies**
FCC Part 15.247 and RSS-210 Annex 8	Operation within the band 2400 to 2483.5 MHz	See called out parts below	Below Limit	Complies
FCC Parts 15.247(d), 15.205, 15.209, 15.215(c) and RSS-210 A8.5 and RSS-GEN 7.2	Out-of-Band Spurious and Harmonic Emissions (EUT in Transmit Mode)	Below the applicable limits	Below Limit	Complies
FCC Part 15.207(a) and RSS-GEN 7.2	Conducted Emissions on Mains EUT in Transmit Mode	Below limit of section 15.207(a)	Below Limit	Complies
FCC Part 15.247(d) and RSS-210 2.2	Band Edge Radiated Emission	Per requirements of the standard	Below Limit	Complies
FCC Part 15.247(b)(3) and RSS-210 A8.4(4)	Conducted Output Power	Shall not exceed 1.0 Watts (4W-eirp)	Below Limit	Complies
FCC Part 15.247(a)(2) and RSS-210 A1.1.3	Occupied Bandwidth	6 dB ≥ 500 kHz 99% BW ≤ 0.5% of center freq.	Below Limit	Complies
FCC Part 15.247(e) and RSS-210, Section A8.2(b)	Peak Power Spectrial Denesity	≤ 8 dBm in any 3 kHz	Below Limit	Complies
FCC Part 15.31(e) and RSS-GEN 4.7	Frequency Stablity	Battery Operated, using a fresh Battery	Below Limit	Complies
FCC Parts 15.203, 15.204 and RSS-GEN 2.5	Antenna Requirements	Per requirements of the standard	Below Limit	Complies
FCC Parts 15.109(a), RSS-210 2.2, 2.5, and RSS-GEN 6.1	Radiated Emissions while EUT in Receive Mode	Below limit of section 15.109(a) Class B	Below Limit	Complies
FCC Part 2.1093 and RSS-102, Issue 4	RF Exposure	SAR or MPE Requirements	0.63 mW	Complies

Notes: This device is battery operated only. As such, there are no conducted power-line tests included in this report.

Although the Apparatus also contains a Modular Certified BlueTooth device, the BT device is used only to configure the transmitter or to initiate a manual reading. In normal operation, both transmitters do not transmit at the same time.

2 Laboratory Information

2.1 Accreditations and Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America located at 762 Park Avenue, Youngsville, NC 27596-9470 is accredited by the commission for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (Registration No 90552 and 100881). The laboratory scope of accreditation includes: Title 47 CFR Part 15, and 18. The accreditation is updated every 3 years.

2.1.2 ILAC / A2LA

The laboratory has been assessed and accredited by A2LA in accordance with ISO Standard 17025:2005 (Certificate Number: 3331.05, Master Code: 134288). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Industry Canada

Registration No.: 2932H-1 The OATS has been accepted by Industry Canada to perform testing to 3 and to 10 meters, based on the test procedures described in ANSI C63.4-2009.

Registration No.: 2932H-2 The 5 meter chamber has been accepted by Industry Canada to perform testing to 3 meters, based on the test procedures described in ANSI C63.4-2009.

2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland at the 762 Park Ave. Youngsville, N.C 27596 address has been assessed and approved in accordance with the Regulations for Voluntary Control Measures. (Laboratory Registration No: A-0034).

2.1.5 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBµV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBµV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBµV/m)

25 dBµV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBµV/m

2.2 Expanded Measurement Uncertainty Emissions

Per CISPR 16-4-2:2011	**U_{lab}**	**U_{cispr}**
Radiated Disturbance @ 3m, 10m		
30 MHz – 1,000 MHz	Horz. 3m = 4.52, Horz. 10m = 4.51	5.2 dB
1.0 GHz – 6.0 GHz	3m = 4.25	5.2 dB
6.0 GHz – 18.0 GHz	3m = 4.93	5.5 dB
Conducted Disturbance @ Mains Terminals		
9 kHz – 150 kHz	2.84 dB	4.0 dB
150 kHz – 30 MHz	3.33 dB	3.6 dB
Disturbance Power		
30 MHz – 300 MHz	4.00 dB	4.5 dB
Harmonics and Flicker		
The estimated combined standard uncertainty for harmonic current and flicker measurements; PM6000 is ± 2.5%.		Per CISPR 16-4-2

2.2.1 Software Used

Manufacturer	Name	Version
Quantum Change/EMC Systems LLC.	Tile	3.2U
TUV	Alt "R"	1
TUV	Alt "C"	1

2.3 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2005. Equipment calibration records are kept on file at the test facility.

2.4 Measurement Equipment Used

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal dd/mm/yy	Next Cal dd/mm/yy
Radiated and Conducted RF Emissions (5 Meter Chamber)					
Amplifier, preamp	Agilent Technologies	8449B	3008A01480	14-Aug-13	14-Aug-15
Antenna Horn 1-18GHz	EMCO	3115	2236	13-Nov12	13-Nov-14
Receiver, EMI	Rohde & Schwarz	ESIB40	100043	19-Aug-14	19-Aug-15
Receiver, EMI	Rohde & Schwarz	ESCI 7	100917	19-Aug-14	19-Aug-15
Spectrum Analyzer	Agilent Tec.	E7405A	US39440157	06-Aug-14	06-Aug-15
Cable, Coax	MicroCaox	MKR300C-0-0-1200-500500	002	22-Aug-14	22-Aug-15
Cable, Coax	MicroCaox	MKR300C-0-1968-500310	005	22-Aug-14	22-Aug-15
Cable, Coax	MicroCaox	UFB29C-1-5905-50U-50U	009	22-Aug-14	22-Aug-15
Cable, Coax	Andrew	FSJ1-50A	045	22-Aug-14	22-Aug-15
High Pass Filter	Micro-tronics	BRM50702	049	14-Aug-13	14-Aug-15
General Laboratory Equipment					
Meter, Multi	Fluke	179	90580752	19-Aug-14	19-Aug-15
Meter, Temp/Humid/Barom	ExTech	SD700	Q677933	06-May-13	06-May-15
Meter, Temp/Humid/Barom	ExTech	SD700	Q677942	06-May-13	06-May-15

3 Product Information

3.1 Product Description

Each monitored hive in the field contains a long-life battery-operated B-ware™ Smart Hive Monitor that is placed under each beehive. It continuously gathers the hive's precise weight and ambient temperature.

3.2 Equipment Modifications

No modifications were needed to bring product into compliance.

4 Radiated Emissions

4.1 Radiated Field Strength of Fundamental Frequency,

This test is to determine the worst-case orientation for the remaining tests.

4.1.1 Final Graphs and Tabulated Data

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)
Orientation A								
2405.00	V	1.2	138	54.84	0.00	5.60	28.54	88.98
2405.00	V	1.2	138	60.80	0.00	5.60	28.54	94.94
2405.00	H	1.2	70	62.51	0.00	5.60	28.54	96.65
2405.00	H	1.2	70	68.35	0.00	5.60	28.54	102.49
Orientation B								
2405.00	V	1.1	311	62.26	0.00	5.60	28.54	96.40
2405.00	V	1.1	311	67.97	0.00	5.60	28.54	102.11
2405.00	H	1.2	341	57.45	0.00	5.60	28.54	91.59
2405.00	H	1.2	341	63.40	0.00	5.60	28.54	97.54
Orientation C								
2405.00	V	1.1	115	60.51	0.00	5.60	28.54	94.65
2405.00	V	1.1	115	66.34	0.00	5.60	28.54	100.48
2405.00	H	2.3	141	61.87	0.00	5.60	28.54	96.01
2405.00	H	2.3	141	67.72	0.00	5.60	28.54	101.86
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor								

Notes: The top emissions of each group are utilizing the average detector, and the bottom is utilizing the Peak detector with associated Limits.

4.2 Spurious Emissions Outside the band - FCC 15.247(d), RSS-210 A8.5

In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power, based on either RF conducted or radiated measurements. Conducted antenna port measurements are provided below to show that the EUT meets these requirements at the band edges.

4.2.1 Over View of Test

Results	**Complies** (as tested per this report)				**Date**	23 April 2014 & 26 June 2014	
Standard	FCC Parts 15.205, 15.209, 15.215(c), 15.247(d), RSS-210 A8.5, and RSS-GEN 7.2.1						
Product Model	SMART HIVE MONITOR			**Serial#**	NOT SERIALIZED		
Test Set-up	Per ANSI C63.10:2013						
EUT Powered By	3.3 VDC	**Temp**	74 ºF	**Humidity**	36%	**Pressure**	1000 mbar
Perf. Criteria	(Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

4.2.2 Test Procedure

Testing was performed in accordance with 47 CFR Part 15, ANSI C63.10:2013, RSS-GEN Issue 3. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

4.2.3 Deviations

The EUT is compliant to the standard(s).

4.2.4 Final Test

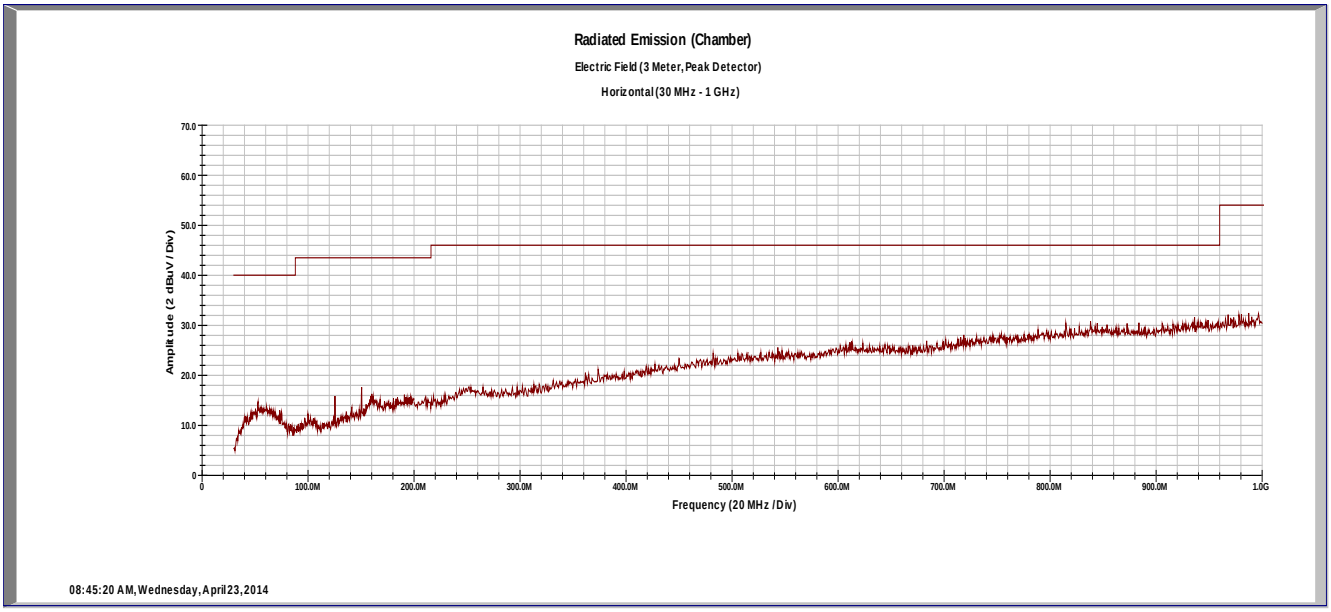
All final radiated spurious emissions measurements were below (in compliance) the limits.

The worst –case emissions are shown below. All other emissions are on file at TUV Rheinland.

4.2.4.1 Emissions Outside the Frequency Band

In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power, based on either RF conducted or radiated measurements. Conducted antenna port measurements are provided below to show that the EUT meets these requirements at the band edges.

Worst-Case Radiated Emissions 30MHz to 1000MHz
Horizontal

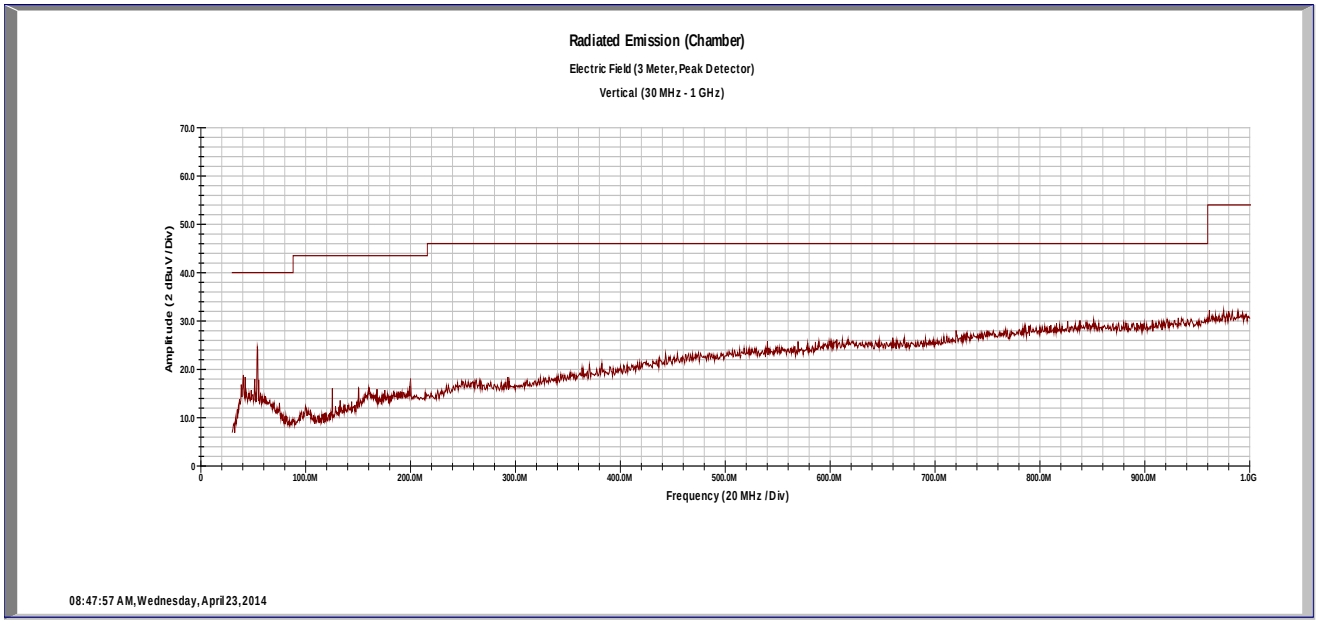


Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)

Notes: The spikes shown up to 200MHz are anomalies of the Preamp in the Receiver.
All emissions are at or below the noise floor of the receiver.

Worst-Case Radiated Emissions 30MHz to 1000MHz

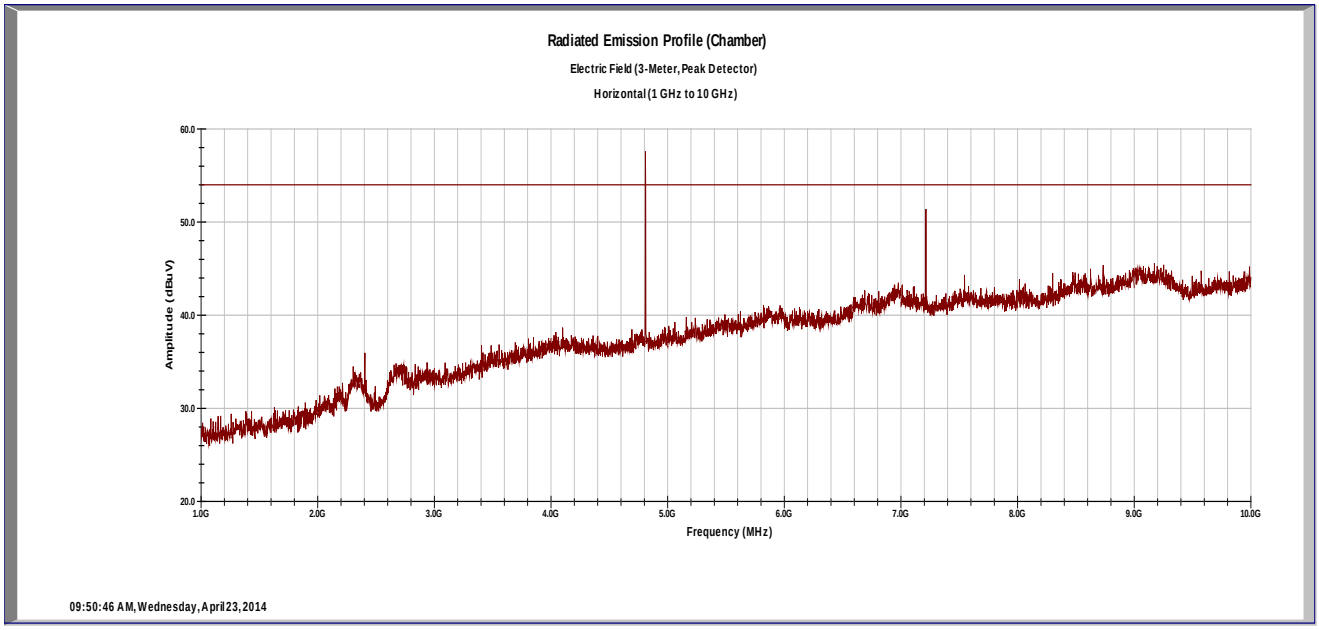
Vertical



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)

Notes: The spikes shown up to 200MHz are anomalies of the Preamp in the Receiver.
All emissions are at or below the noise floor of the receiver.

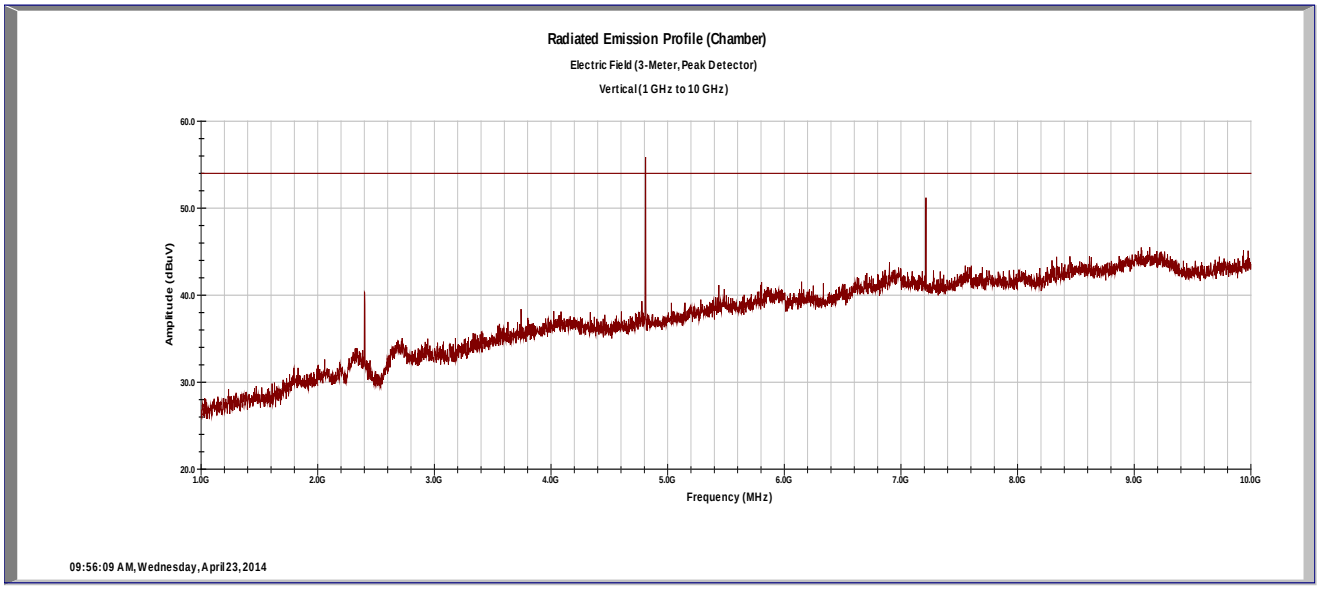
Worst-Case Radiated Emissions 1GHz to 10GHz
Horizontal



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)
4810.40	H	1.1	161	43.16	33.83	11.36	32.89	53.58	54.00	-0.42
4810.40	H	1.1	161	49.85	33.83	11.36	32.89	60.27	74.00	-13.73
7212.80	H	1.1	218	33.98	33.62	14.00	36.10	50.47	54.00	-3.53
7212.80	H	1.1	218	43.48	33.62	14.00	36.10	59.97	74.00	-14.03

Notes: The top emissions of each group is utilizing the average detector, and the bottom is utilizing the Peak.
The EUT is set to the lowest channel (Ch 11) – 2405MHz

Worst-Case Radiated Emissions 1GHz to 10GHz
Vertical

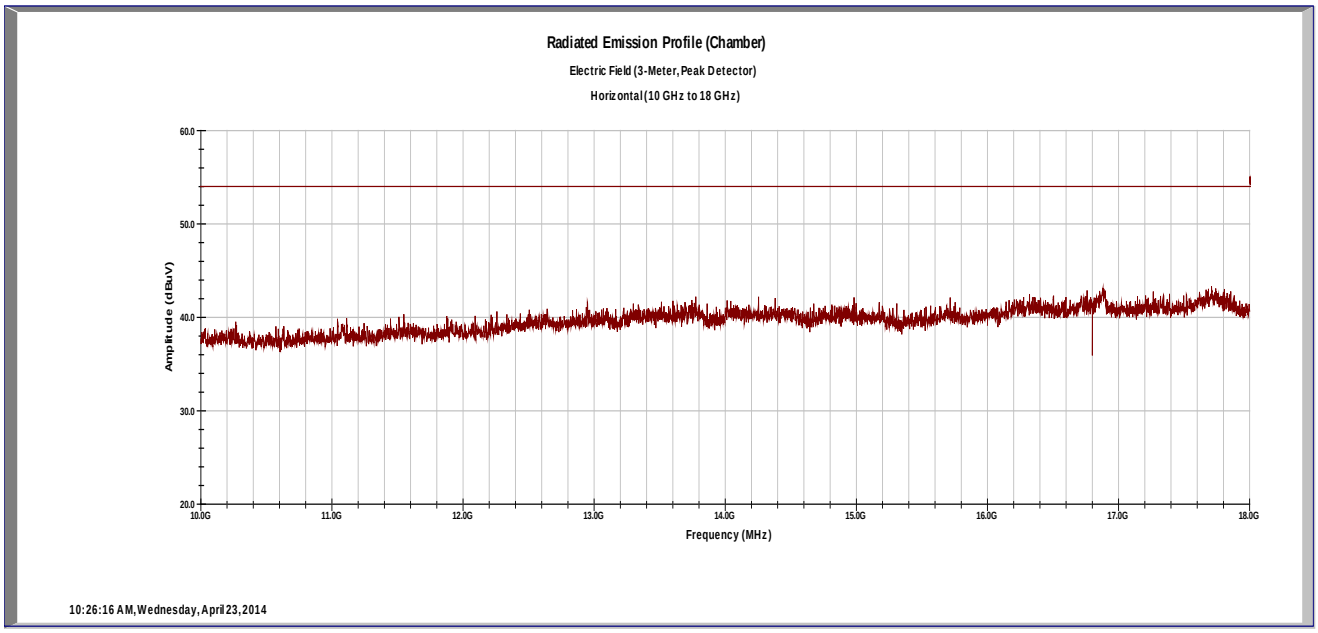


Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)
4810.40	V	1	228	37.31	33.83	11.36	32.89	47.73	54.00	-6.27
4810.40	V	1	228	45.32	33.83	11.36	32.89	55.74	74.00	-18.26
4810.40	V	1	228	39.07	33.83	11.36	32.89	49.49	54.00	-4.51
4810.40	V	1	228	46.19	33.83	11.36	32.89	56.61	74.00	-17.39
7212.80	V	1.3	145	34.33	33.62	14.00	36.10	50.82	54.00	-3.18
7212.80	V	1.3	145	43.86	33.62	14.00	36.10	60.35	74.00	-13.65

Notes: The top emissions of each group is utilizing the average detector, and the bottom is utilizing the Peak.
The EUT is set to the Lowest channel (Ch 11) – 2405MHz
The Emissions shown in BLUE is with the power setting at D5
The Emissions shown in RED is with the power setting at E5

Worst-Case Radiated Emissions 10GHz to 18GHz

Horizontal

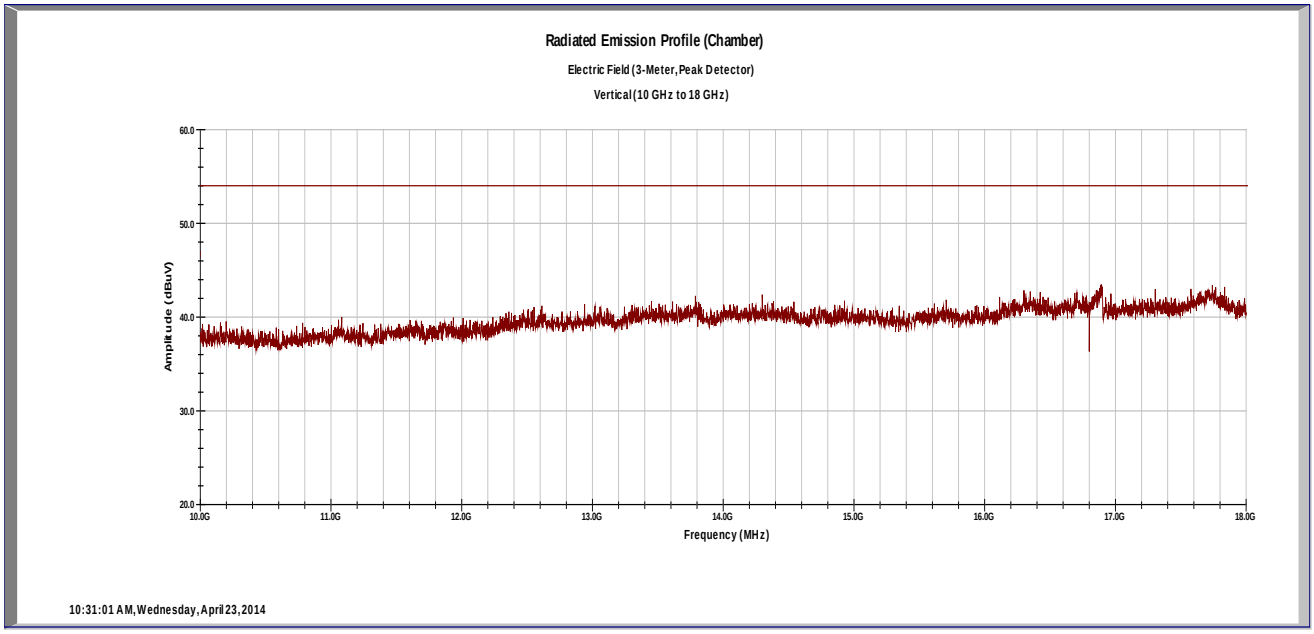


Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)

Notes: All emissions are at or below the noise floor of the receiver.
The EUT is set to the lowest channel (Ch 11) – 2405MHz

Worst-Case Radiated Emissions 10GHz to 18GHz

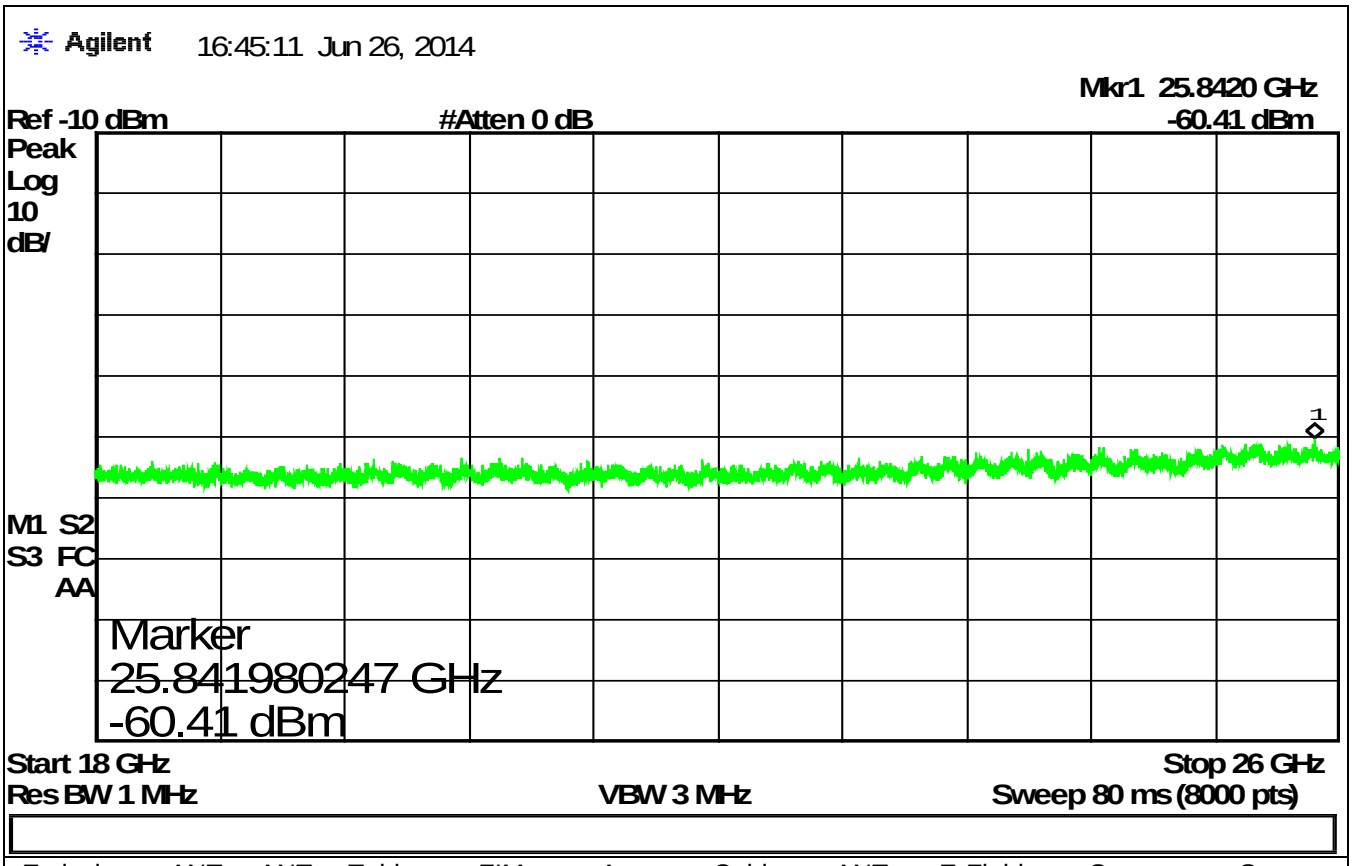
Vertical



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)

Notes: All emissions are at or below the noise floor of the receiver.
The EUT is set to the lowest channel (Ch 11) – 2405MHz

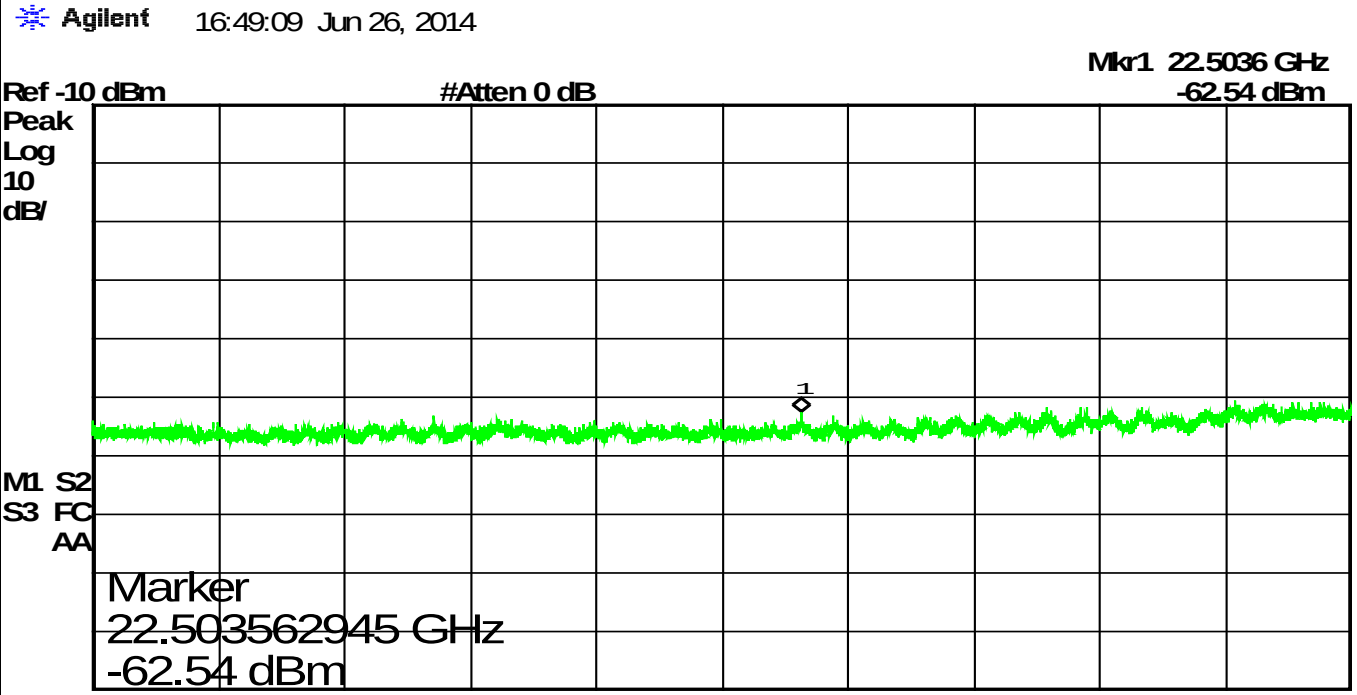
Worst-Case Radiated Emissions 18GHz to 25GHz
Horizontal



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)

Notes: All emissions were below the noise floor of the EMC Receiver.
The Trace shown above is raw data, without the application of correction factors.

Worst-Case Radiated Emissions 18GHz to 25GHz
Vertical



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)

Notes: All emissions were below the noise floor of the EMC Receiver.
The Trace shown above is raw data, without the application of correction factors.

4.3 Band Edge and Restricted Band

4.3.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	25 June 2014	
Standard	FCC Part 15.247(d), RSS 210 2.2						
Product Model	SMART HIVE MONITOR		**Serial#**	NOT SERIALIZED			
Test Set-up	Per ANSI C63.10:2013						
EUT Powered By	3.3 VDC	**Temp**	74º F	**Humidity**	32%	**Pressure**	1010mbar
Perf. Criteria	(Below Limit)		**Perf. Verification**	Readings Under Limit			
Mod. to EUT	None		**Test Performed By**	Mark Ryan			

4.3.2 Test Procedure

The EUT was using test software to allow the transmitter to transmit continuously. (Duty Cycle > 98%).

4.3.3 Deviations

There were no deviations from the test methodology listed.

4.3.4 Final Test

The EUT met the performance criteria requirement as specified in this report and in the standards.

4.3.4.1 Band Edge measurements:

The test methods of ANSI C63.10:2013, section 11.13 were used for band edge measurements.

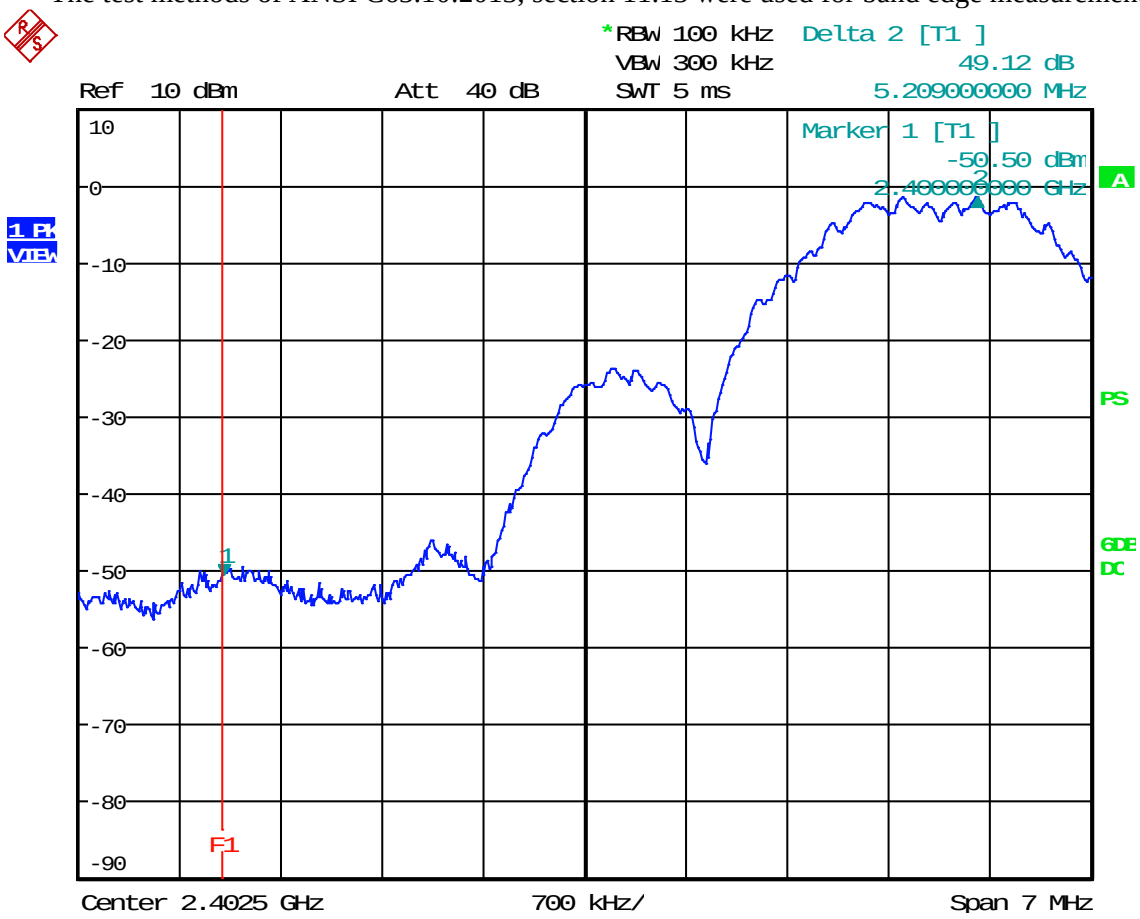
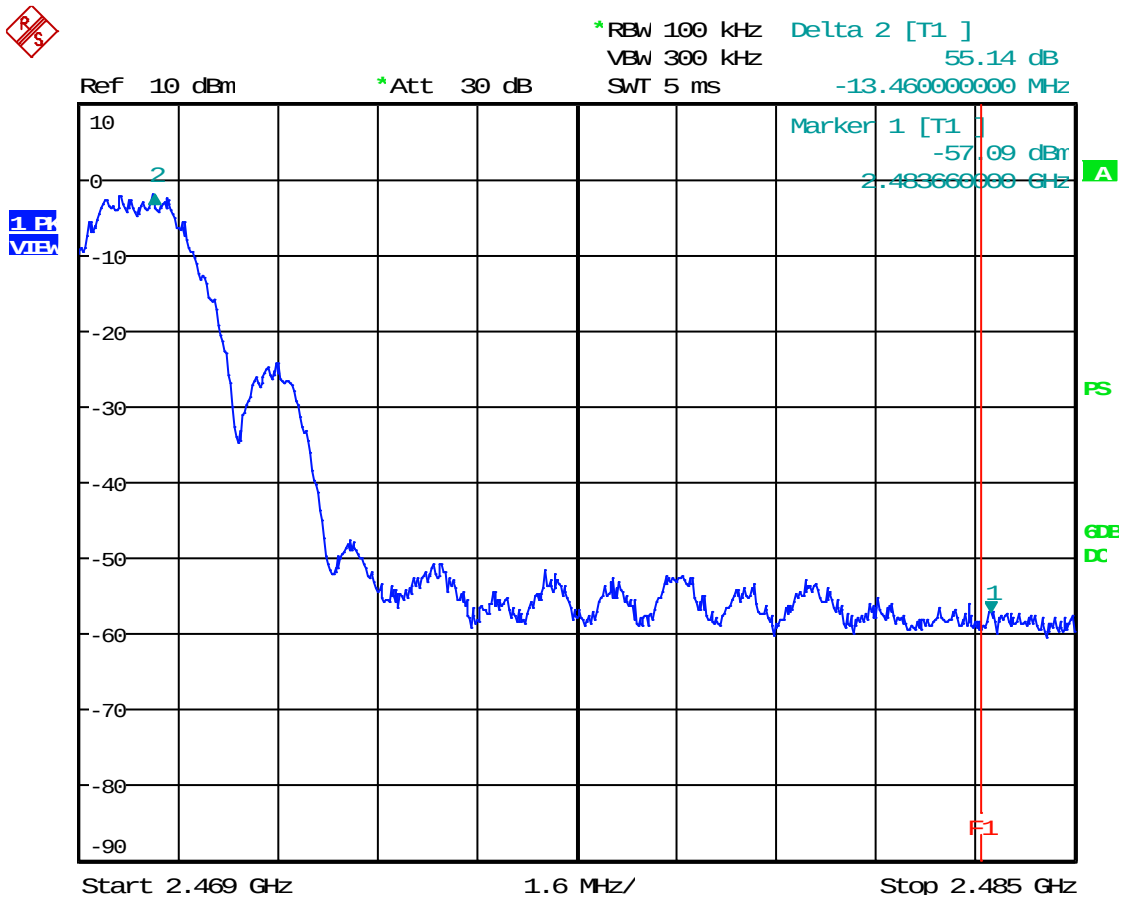


Figure 1: Lower Band Edge Measurement (Conducted Emission)

Note: Band Edge is at 2.4 GHz, and the nearest restricted band (2390MHz) is 10 MHz away

At the lowest channel, the highest emission at the band-edge at 2400 MHz is -49.12 dBc.

The EUT is compliant with the rules.



Date: 25.JUN.2014 11:22:12

Figure 2: Upper Band Edge Measurement (Conducted Emission)

Note: Band edge (F1) at 2483.5 MHz is also the start of a restricted band, so the rules of 15.205 apply.

The highest channel frequency is 2.47 GHz. The highest emission above the band edge is -55.14 dBc as the signal is gets lost in the noise floor of the receiver.

The EUT is compliant with the rules.

4.3.4.2 Restricted Band Edge measurements:

The test methods of ANSI C63.10:2013, section 6.10.5.2 were used for restricted band measurements.

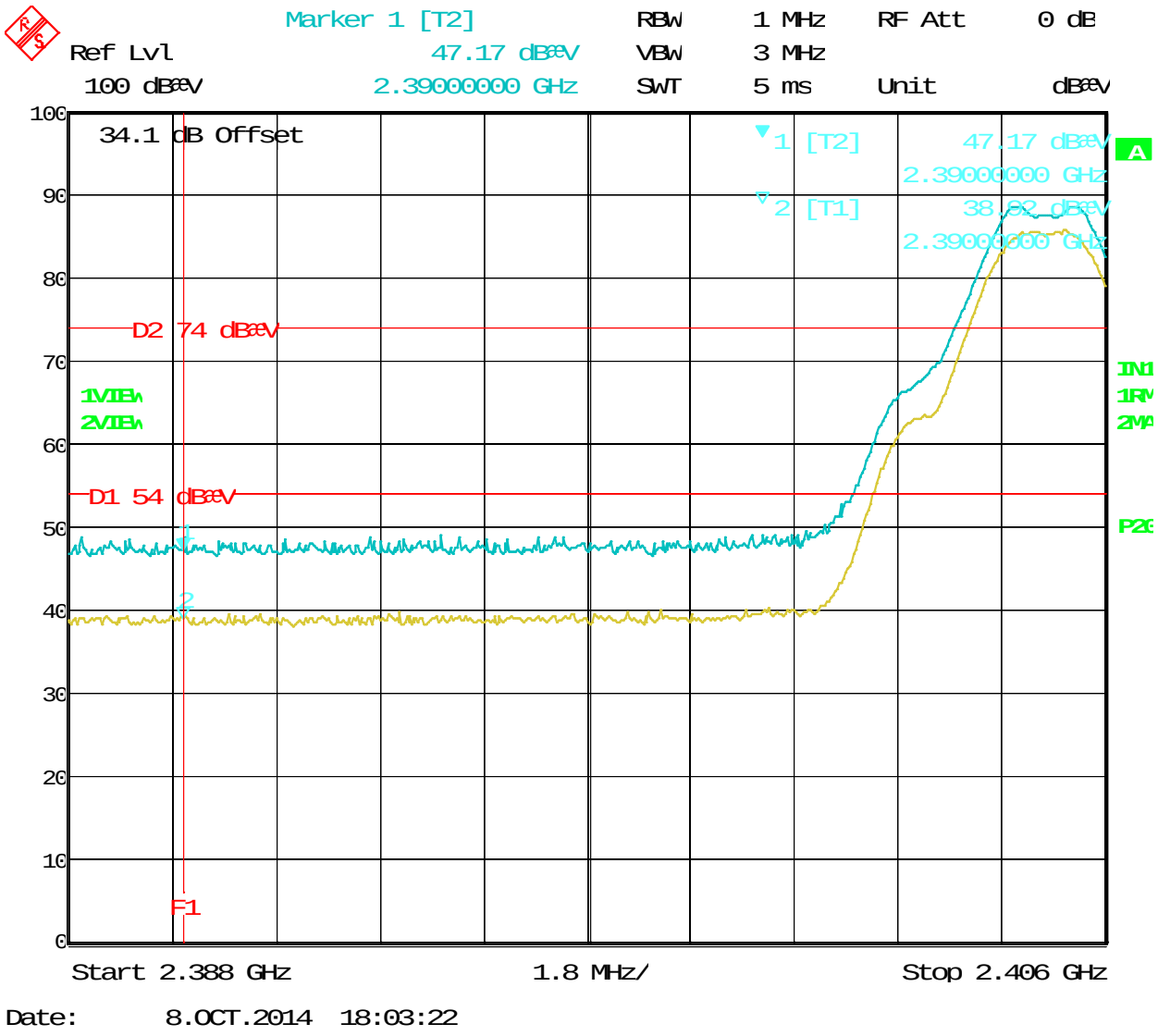


Figure 3: Lower Band Edge Measurement (Radiated Measurement)

Note: The Band Edge is at 2.4 GHz, and the nearest restricted band (Line F1at 2390MHz) is 10 MHz below the band edge.

The 38.92 dBuV/m field measured at the restricted Band (Line F1) is using the Average Detector.

The 47.17 dBuV/m field measured at the restricted Band (Line F1) is using the Peak Detector.

Line D1 is the average Limit and Line D2 is the Peak Limit.

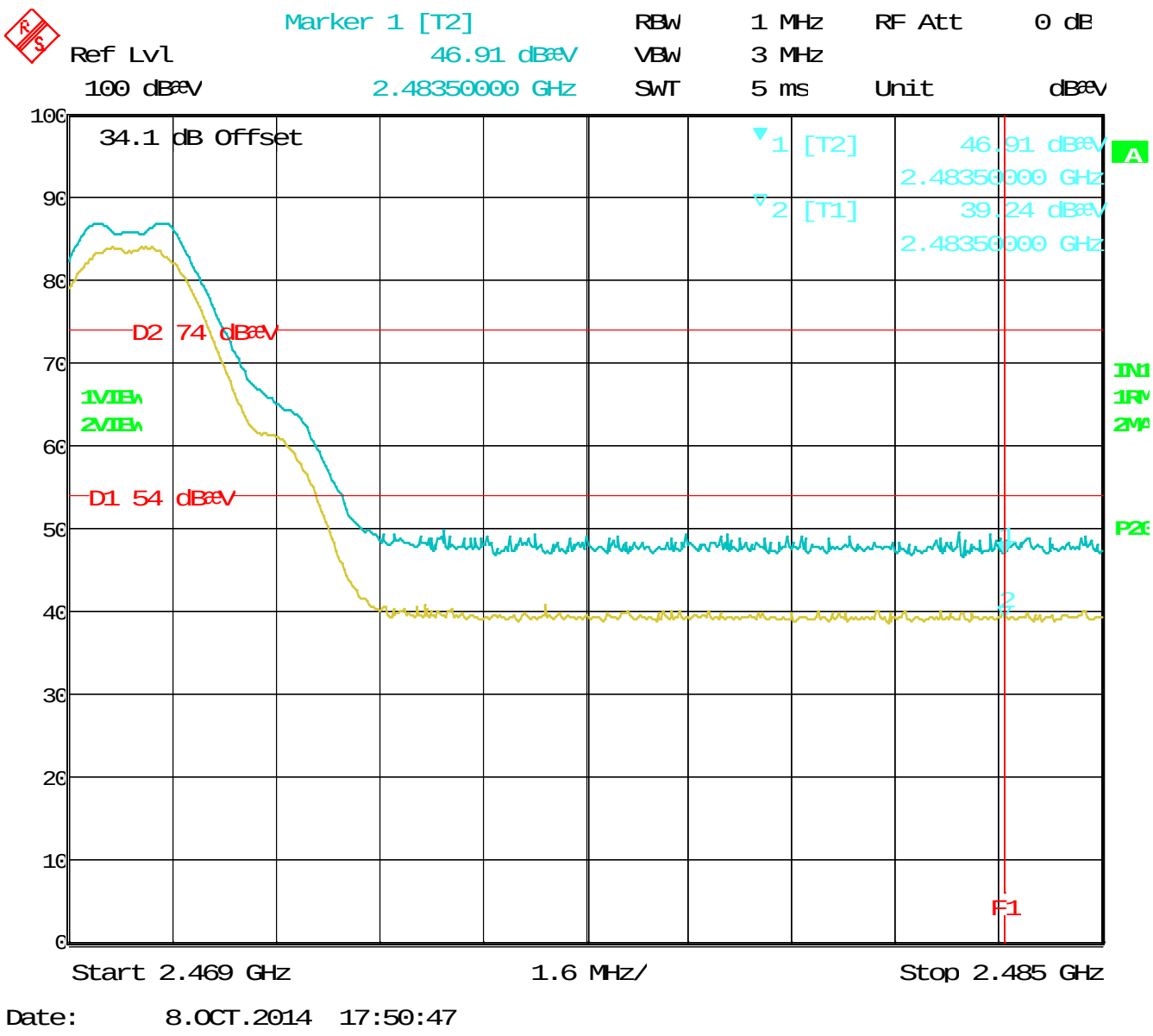


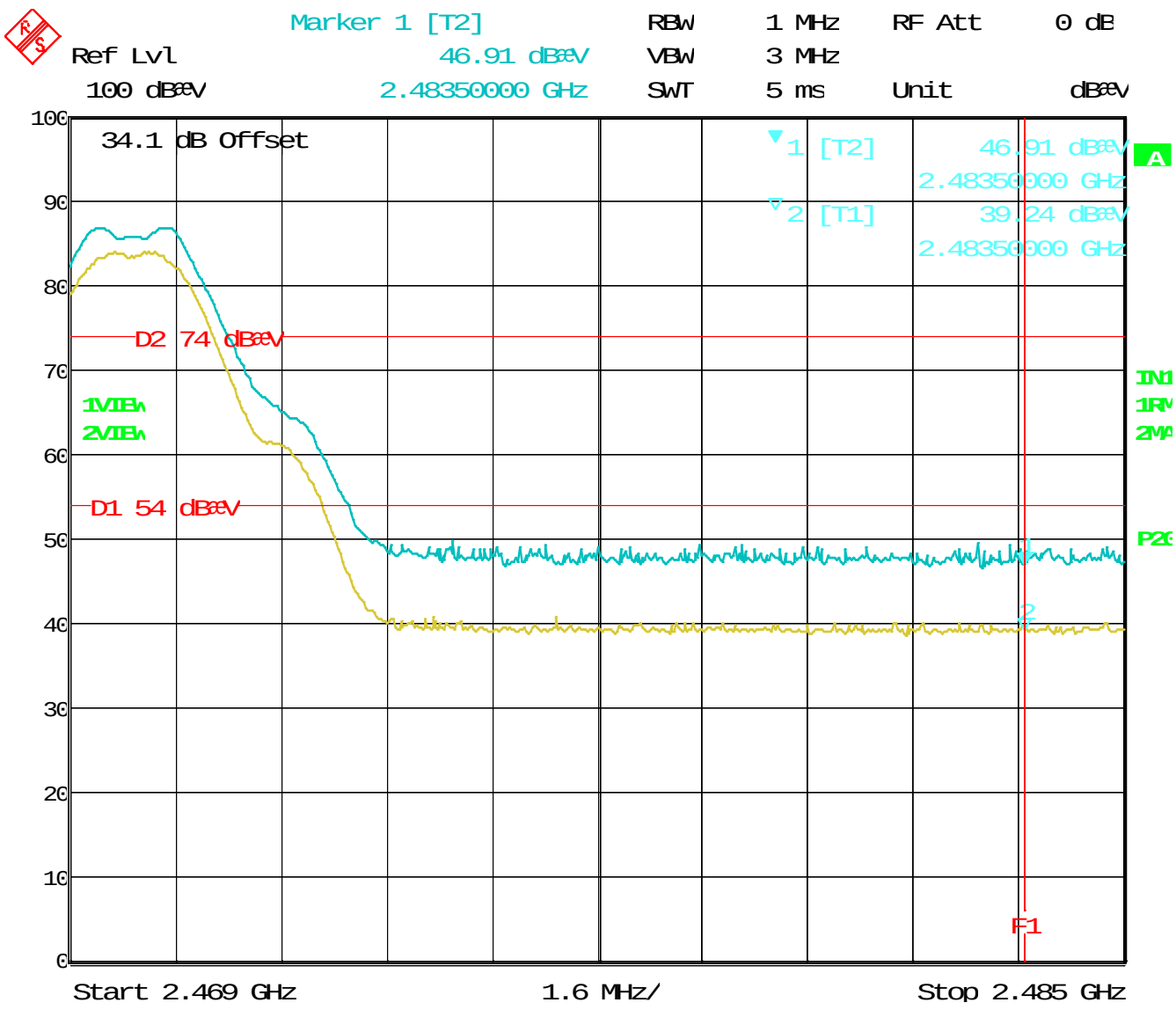
Figure 4: Upper Band Edge Measurement (Radiated Measurement)

Note: Band Edge starts at the restricted band (Line F1): 2483.5 MHz

The 39.24 dBuV/m field measured at the restricted Band (Line F1) is using the Average Detector.

The 46.91 dBuV/m field measured at the restricted Band (Line F1) is using the Peak Detector.

Line D1 is the Average Limit and line D2 is the Peak Limit.



Date: 8.OCT.2014 17:50:47

The 39.24 dBuV/m field measured at the restricted Band (Line F1) is using the Average Detector.

The 46.91 dBuV/m field measured at the restricted Band (Line F1) is using the Peak Detector.

Line D1 is the average Limit Line, D2 is the Peak Limit Line.

The EUT is compliant with the rules.

4.4 Conducted Emissions on AC Mains in Transmit mode

This test measures the electromagnet levels of spurious signals generated by the EUT on the AC power line that may affect the performance of other nearby electronic equipment.

4.4.1 Over View of Test

Results	**NA** (as tested per this report)				**Date**	NA	
Standard	FCC Part 15.207(a) and RSS-GEN 7.2						
Product Model	SMART HIVE MONITOR			**Serial#**	NOT SERIALIZED		
Test Set-up	Per ANSI C63.10:2013						
EUT Powered By	120VAC / 60 Hz	**Temp**	73º F	**Humidity**	25%	**Pressure**	1011 mbar
Frequency Range	150 kHz – 30 MHz						
Perf. Criteria	(Below Limit)	**Perf. Verification**	Readings Under Limit for L1 & Neutral				
Mod. to EUT	None	**Test Performed By**	Mark Ryan				

4.4.2 Test Procedure

The EUT is a battery operated device.

4.4.3 Final Test

Since the EUT is powered by 3.3VDC provided by the host device, this test is not applicable.

5 Antenna Port Conducted Emissions

For conducted tests, the emissions were measured at the antenna port.

Testing was performed in accordance with 47 CFR Part 15, ANSI C63.10:2013, RSP-100 Issue 9. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

5.1 Conducted Output Power, FCC 15.247(b)(3) and RSS-210 A8.4(4)

5.1.1 **For systems using digital modulation in the 2400–2483.5 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.**

5.1.2 Test Over View

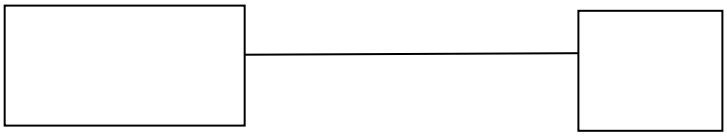
Results	**Complies** (as tested per this report)					**Date**	25 June 2014
Standard	FCC Part 15.247(b)(3) and RSS-210 A8.4(4)						
Product Model	SMART HIVE MONITOR			**Serial#**	NOT SERIALIZED		
Test Set-up	Per ANSI C63.10:2013						
EUT Powered By	3.3 VDC	**Temp**	74º F	**Humidity**	32%	**Pressure**	1010mbar
Perf. Criteria	(Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

5.1.3 Test Procedure

The EUT was using test software to allow the transmitter to transmit continuously. (Duty Cycle > 98%).

The test methods of ANSI C63.10:2013, section 11.9.2.2 were used.

Test Setup:



Spectrum Analyzer EUT RF Output connection

Note: The output of the EUT is low enough that an external attenuator was not necessary.

5.1.4 Deviations

There were no deviations from the test methodology.

5.1.5 Final Test

The EUT is compliant to the requirements of the standard.

5.1.6 Peak Power Output

Peak Output Conducted Channel Power Measurements

Emission Freq (MHz)	Corrected Value (dBm)	Spec Limit (dBm)	Spec Margin (dB)
2405.00 (f_H)	**0.57**	**+30.00**	**-29.43**
2440.00 (f_M)	0.20	+30.00	**-29.8**
2470.00 (f_H)	-0.11	+30.00	**-30.11**

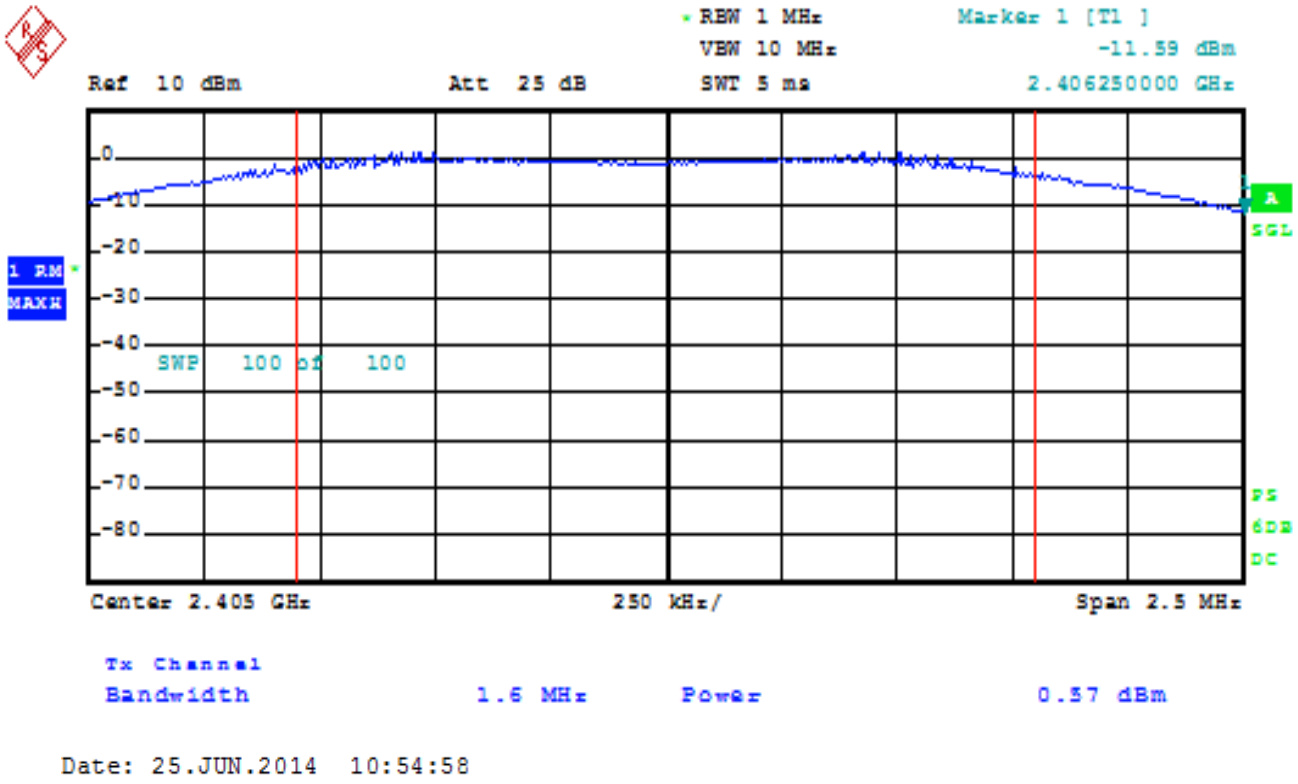


Figure 5 – Highest Peak Conducted Power Output for EUT highest frequency.

Graphs of the other frequencies are on file at the manufacturer and at TUV.

5.1.7 Antenna Gain

The antenna used on the product is a PC Board “Inverted-F” antenna that has a measured maximum gain of 3.54 dBi, which is below the 6 dBi maximum antenna gain requirement..

The EUT is also compliant to FCC Part 15.247(b)(4)

Results

As tested, the EUT was found to be compliant to the requirements of the test standard.

5.2 Maximum Power Spectral Density

5.2.1 Test Over View

Results	**Complies** (as tested per this report)					**Date**	25 June 2014
Standard	FCC Part 15.247(e) and RSS 210 A8.2(b)						
Product Model	SMART HIVE MONITOR			**Serial#**	NOT SERIALIZED		
Test Set-up	Per ANSI C63.10:2013						
EUT Powered By	3.3 VDC	**Temp**	74º F	**Humidity**	32%	**Pressure**	1010mbar
Perf. Criteria	Below Limit (10dBm)		**Perf. Verification**		≤8 dBm in any 3 kHz		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

5.2.2 Test Procedure

The EUT was using test software to allow the transmitter to transmit continuously. (Duty Cycle > 98%).

The test methods of ANSI C63.10:2013, section 11.10 were used.

5.2.3 Deviations

The output of the EUT is much less than the PSD limit, therefore the device is compliant by default.

However the measurements were made for informational use only.

RBW correction factor for 30kHz RBW: 10log(3/30) or -10dB.

5.2.4 Final Test

The EUT's total power (eirp) is well below 8 dBm. It is therefore compliant by default.

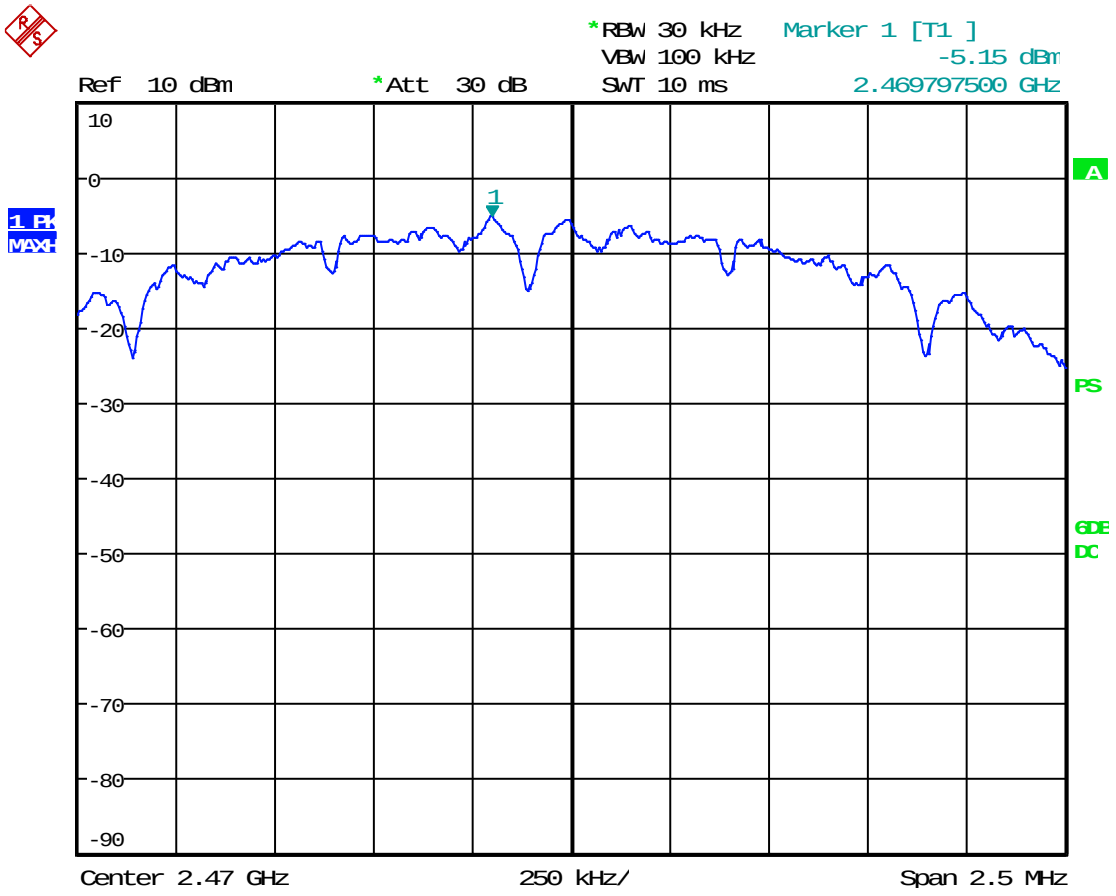
THE Power Spectral Density Measurements are shown below.

Maximum Power Spectral Density Measurements

Freq. (MHz)	Meas. (dBm)	CF (dB)	PSD (dBm)	Limit (dBm)	Margin (dB)
2405.00	-5.15	-10.00	-15.15	8.00	-23.15
2440.00	-5.19	-10.00	-15.19	8.00	-23.19
2470.00	-5.55	-10.00	-15.55	8.00	-23.55

Note: worst Case PSD measurement plot is shown below; the other plots are on file at TUV Rheinland.

5.2.5 Final Data



Date: 25.JUN.2014 11:31:19

Figure 6: Peak Reference Frequency

Spectrum Analyzer Parameters:
RBW= 30kHz
Span= 2.5MHz
VBW= 100kHz
LOG dB/div.= 10dB
Sweep = Auto
Detector = RMS detector, max hold

5.3 Occupied Bandwidth

For systems using digital modulation techniques shall have a minimum 6 dB bandwidth of at least 500 kHz.

5.3.1 Test Over View

Results	**Complies** (as tested per this report)					**Date**	25 June 2014
Standard	FCC Part 15.247(a)(2)						
Product Model	SMART HIVE MONITOR			**Serial#**	NOT SERIALIZED		
Test Set-up	Per ANSI C63.10:2013						
EUT Powered By	3.3 VDC	**Temp**	74º F	**Humidity**	32%	**Pressure**	1010mbar
Perf. Criteria	(Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

5.3.2 Test Procedure

The EUT was using test software to allow the transmitter to transmit continuously. (Duty Cycle > 98%).

The test methods of ANSI C63.10:2013, section 9.9.2 were used.

Both 6 dB and 20 Occupied Bandwidth measurements were made.

5.3.3 Deviations

No devieations

5.3.4 Final Test

All 6 dB bandwidth measurements are greater than 500 kHz.

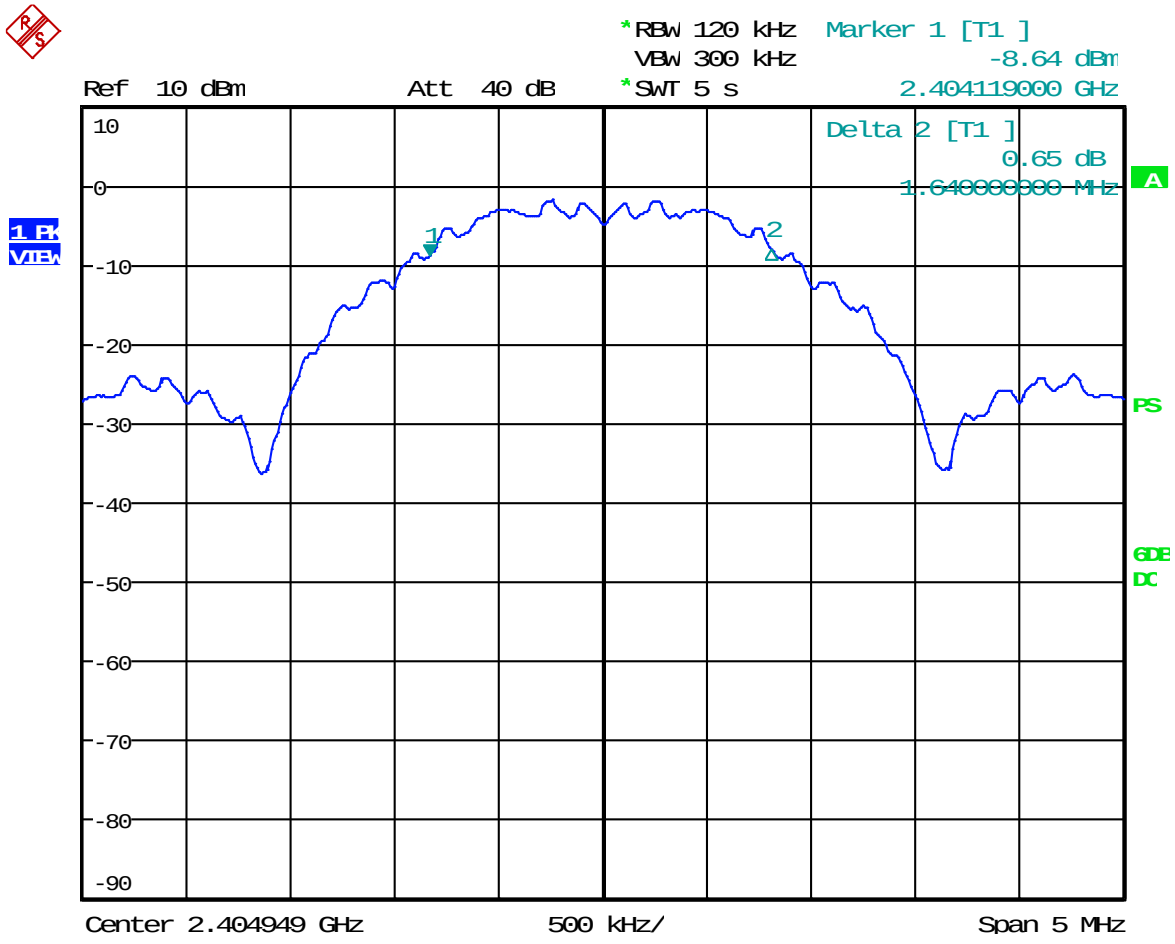
The EUT is compliant to the standard(s).

Occupied Bandwidth Measurements

Emission Freq (MHz)	OBW 6 dB (MHz)	OBW 20 dB (MHz)
2405.00 (f_H)	**1.64**	2.83
2440.00 (f_M)	1.62	**2.86**
2470.00 (f_H)	1.60	2.82

Note: worst Case 6 dB and 20 dB Occupied Bandwidth measurement plots are shown below; the other plots are on file at TUV Rheinland.

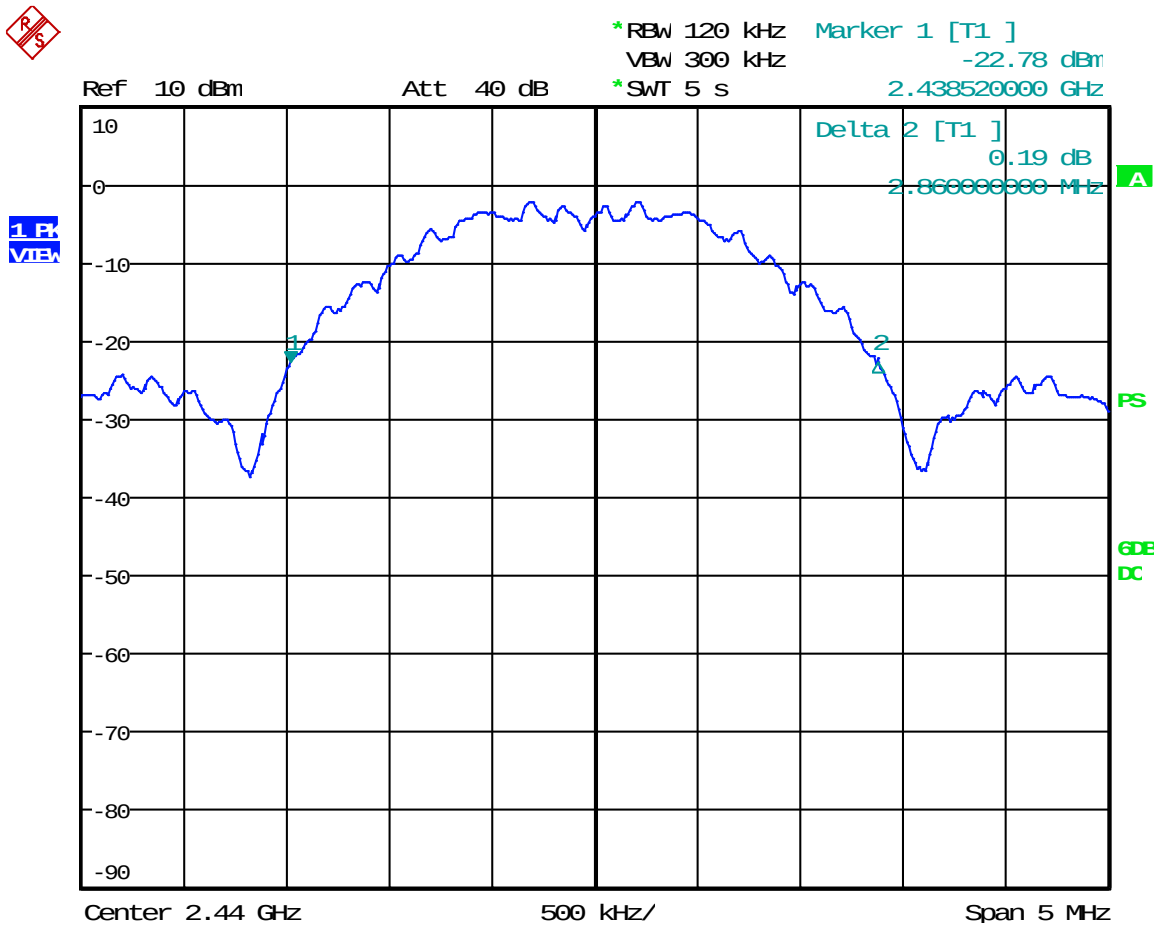
5.3.5 Final Data



Date: 25.JUN.2014 10:11:24

Figure 7: 6dB Occupied Bandwidth

6dB Band width is 1.64 MHz



Date: 25.JUN.2014 10:20:54

Figure 8: 20 dB Occupied Bandwidth

20dB Band width is 2.66 MHz

5.4 99% Power Bandwidth

For the purpose of Section A1.1, the 99% bandwidth shall be no wider than .25% of the center frequency for devices operating between 70-900MHz. Foe devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency.

5.4.1 Test Over View

Results	**Complies** (as tested per this report)					**Date**	25 June 2014
Standard	RSS-210 Section A1.1.3						
Product Model	SMART HIVE MONITOR			**Serial#**	NOT SERIALIZED		
Test Set-up	Per ANSI C63.10:2013						
EUT Powered By	3.3 VDC	**Temp**	74º F	**Humidity**	32%	**Pressure**	1010mbar
Perf. Criteria	(Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

5.4.2 Test Procedure

The EUT was using test software to allow the transmitter to transmit continuously. (Duty Cycle > 98%).

The test methods of RSS-GEN, Issue 3 section 4.6.1 were used.

5.4.3 Deviations

There were no deviations from the test methodology.

5.4.4 Final Test

For devices operating above 900 MHz, the 99% bandwidth shall be no wider than 0.5% of the center frequency.

The EUT met the requirement as specified in the standard.

99% Power Bandwidth Measurements

Emission Freq (MHz)	Maximum Bandwidth (MHz)	99% PBW (MHz)	Results
2405.00 (f_H)	12.03	2.42	PASS
2440.00 (f_M)	12.20	2.42	**PASS**
2470.00 (f_H)	**13.50**	**2.43**	**PASS**

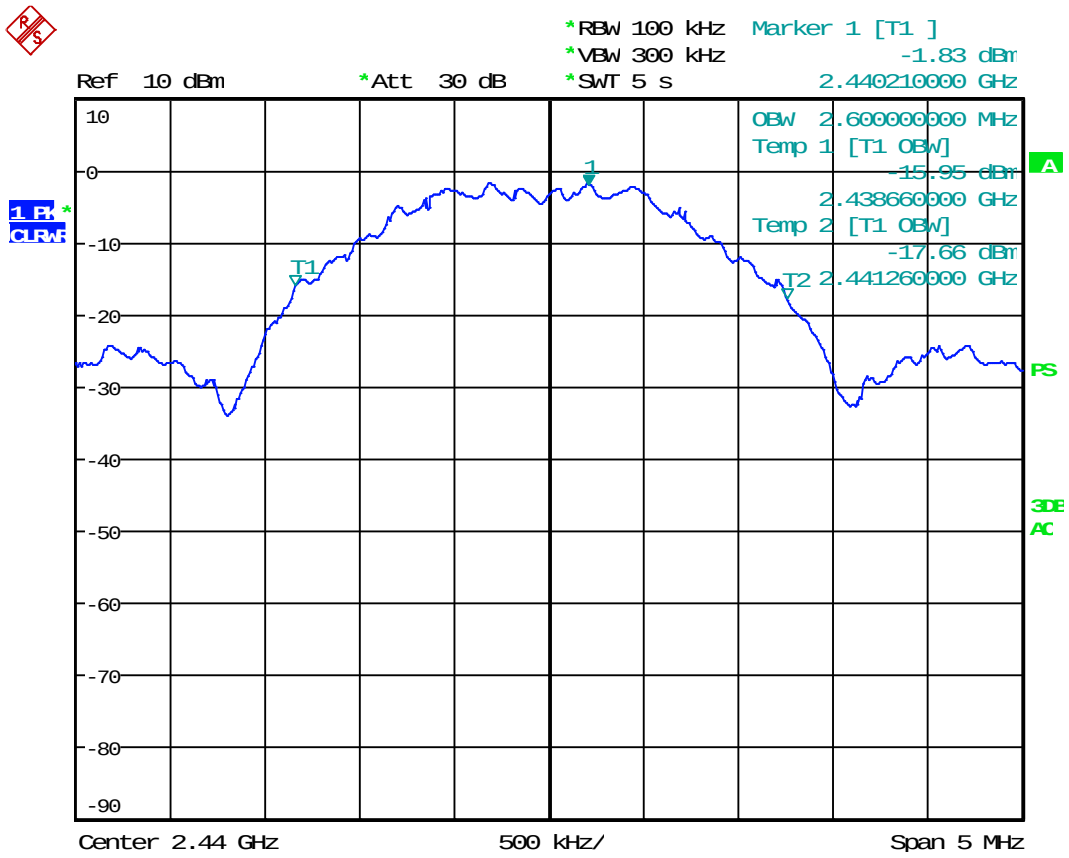


Figure 9 – 99% Power Bandwidth; verification scan

The Span was set to 5 MHz (approximately 2X PBW) to verify that the whole bandwidth will fall within a 3MHz span. It does, therefore refer to next plot for 1% BW to Span measurement.

5.4.5 Final Data

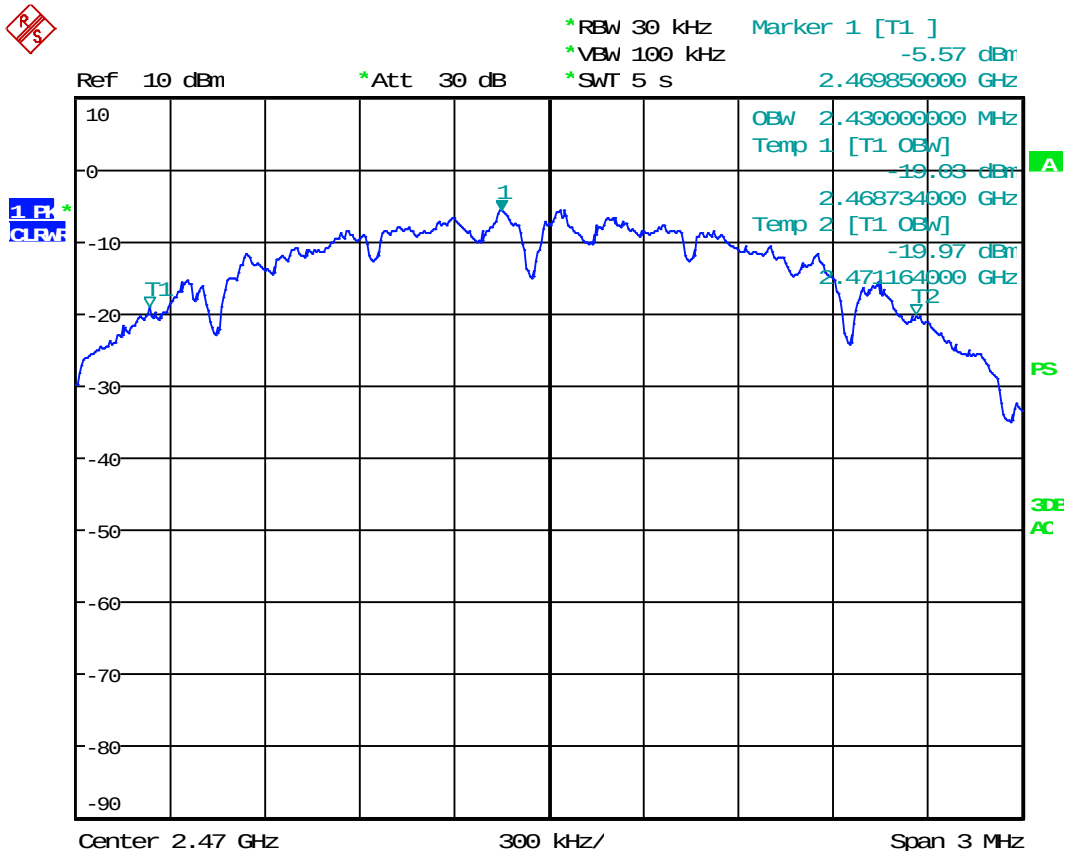


Figure 10 – Worst-case 99% Power Bandwidth = 2.430 MHz

The Bandwidth was changed to 30 kHz and Span to 3 MHz (1% BW to Span)

The EUT is compliant to the requirements of RSS-210 A1.1.3

5.5 Voltage Requirements FCC Part 15.31(e)

FCC Part 15.31 states that for intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

5.5.1 Over View of Test

Results	**Complies** (as tested per this report)	**Date**	25 June 2014
Standard	FCC Part 15.31(e) and RSS-GEN 4.7		
Product Model	SMART HIVE MONITOR	**Serial#**	NOT SERIALIZED
Test Set-up	Per ANSI C63.10:2013		
Perf. Criteria	(Below Limit)	**Perf. Verification**	Readings Under Limit
Mod. to EUT	None	**Test Performed By**	Mark Ryan

5.5.2 Test Procedure

The EUT is a battery-only operated device. A fresh battery was installed in the EUT for testing.

5.6 Antenna Requirements FCC Parts 15.203, 15.204 and RSS-GEN 7.1.4

FCC Part 15.31 states that for intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

5.6.1 Over View of Test

Results	**Complies** (as tested per this report)	**Date**	25 June 2014
Standard	FCC Part 15.203, 15.204 and RSS-GEN 714		
Product Model	SMART HIVE MONITOR	**Serial#**	NOT SERIALIZED

5.6.2 Test Procedure

The EUT was operates using only an internal printed circuit “Inverted – F” antenna.

The antenna has a maximum measured Gain of the antenna is 3.54 dBi or 2.26 (Linear scale).

Note: one apparatus was modified by bypassing the antenna and adding a coax cable with a connector to allow direct conducted RF measurements of the transmitter.

5.6.3 Final Test

The EUT was found to be compliant to the requirements of the test standard.

6 Emissions in Receive Mode.

6.1 Radiated Emissions

This test measures the electromagnetic levels of spurious signals generated by the EUT that radiated from the EUT and may affect the performance of other nearby electronic equipment.

6.1.1 Over View of Test

Results	**Complies** (as tested per this report)					**Date**	28 June 2014 & 29 July 2014
Standard	FCC Parts 15.109(a), RSS-210 2.2, 2.5, and RSS-GEN 6.1						
Product Model	SMART HIVE MONITOR			**Serial#**	NOT SERIALIZED		
Configuration	EUT set to receive mode						
Test Set-up	Per ANSI C63.10:2013						
EUT Powered By	3.3 VDC	**Temp**	74º F	**Humidity**	32%	**Pressure**	1010mbar
Frequency Range	30 MHz to 13 GHz @ 3m						
Perf. Criteria	(Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

6.1.2 Test Procedure

Radiated and FCC emissions tests were performed using the procedures of ANSI C63.4:2003 including methods for signal maximizations and EUT configuration. The photos included with the report show the EUT in its maximized configuration.

The frequency range from 30 MHz to 13 GHz was investigated for radiated emissions.

Radiated emission testing was performed at a distance of 3 meters in a 5 meter semi-anechoic chamber.

6.1.3 Deviations

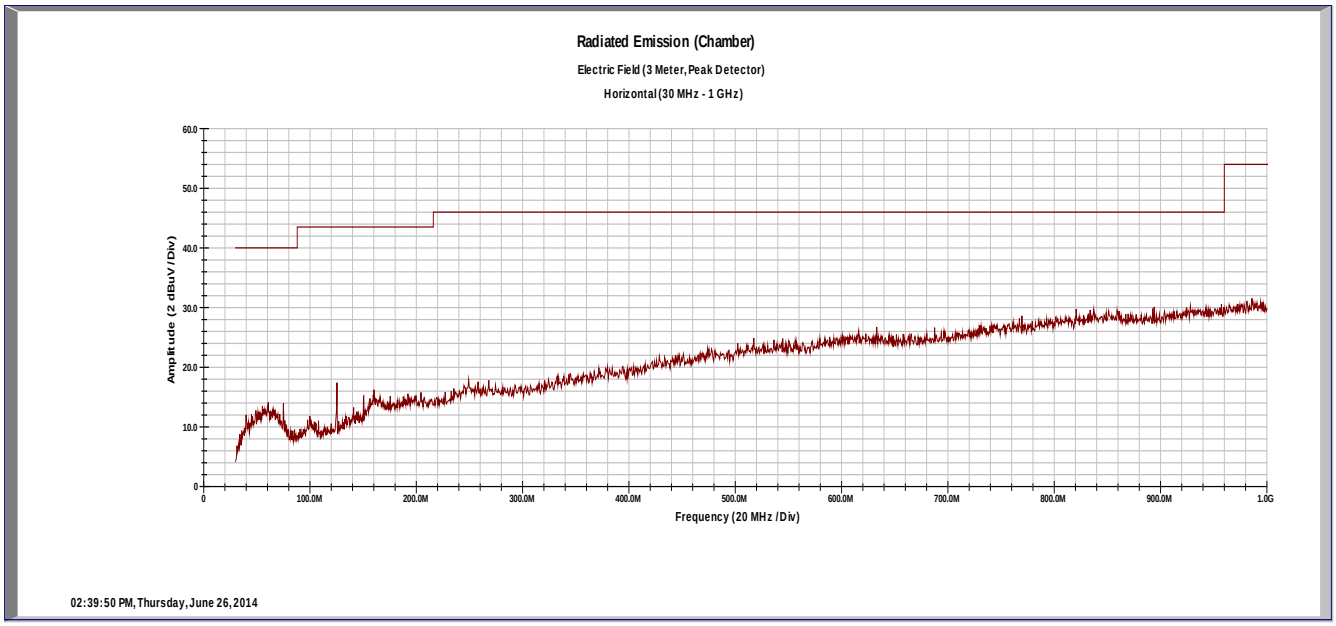
There were no deviations from the test methodology.

6.1.4 Final Test

All final radiated emissions measurements were below (in compliance) the limits.

6.1.5 Final Graphs and Tabulated Data

Radiated Emissions – Receive Mode – 30MHz to 1 GHz
Horizontal



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)

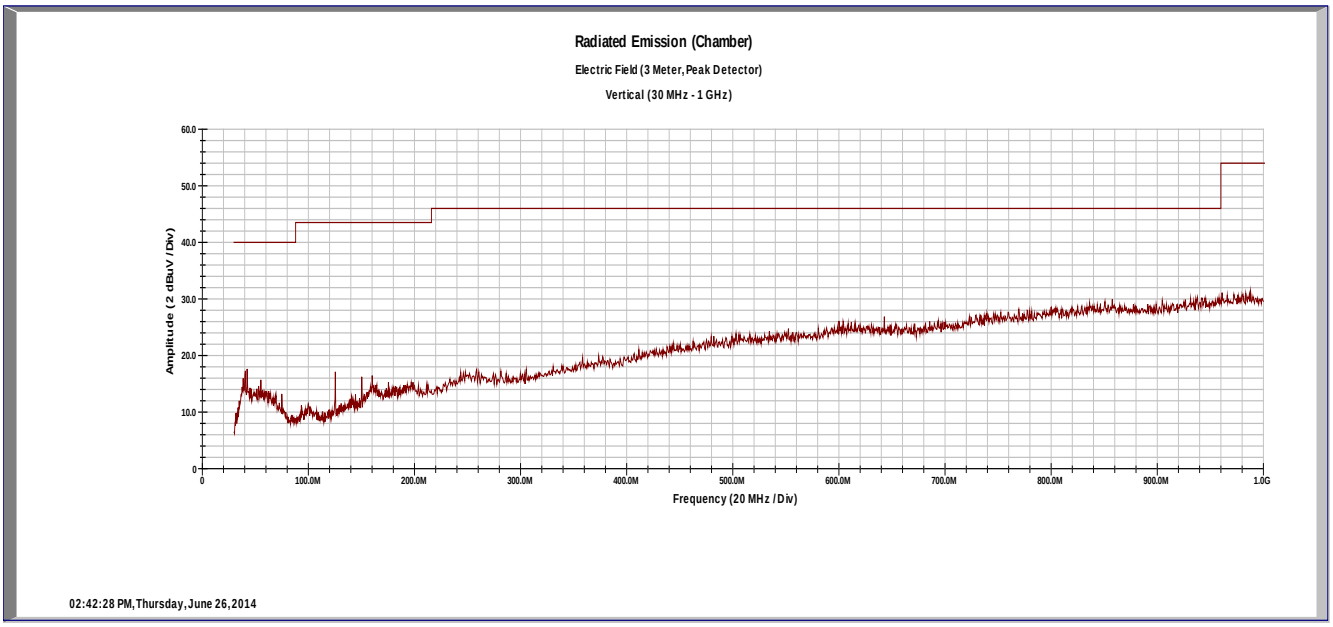
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: All emissions are either more than 20dB below the limit, or below the noise floor of the receiver.
The signals around 120MHz are anomalies in the receiver.

Radiated Emissions – Receive Mode – 30MHz to 1 GHz

Vertical



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)

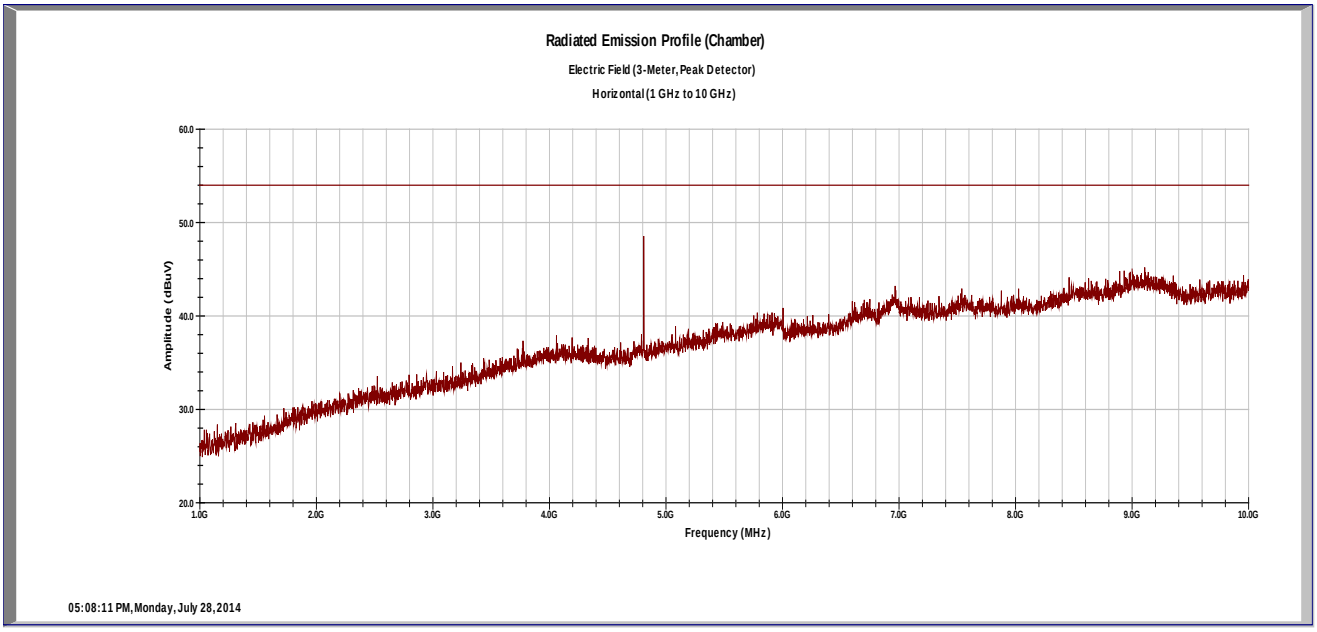
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: All emissions are either more than 20dB below the limit, or below the noise floor of the receiver.
The signals around 120MHz are anomalies in the receiver.

Radiated Emissions – Receive Mode – 1 GHz to 10 GHz

Horizontal



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)

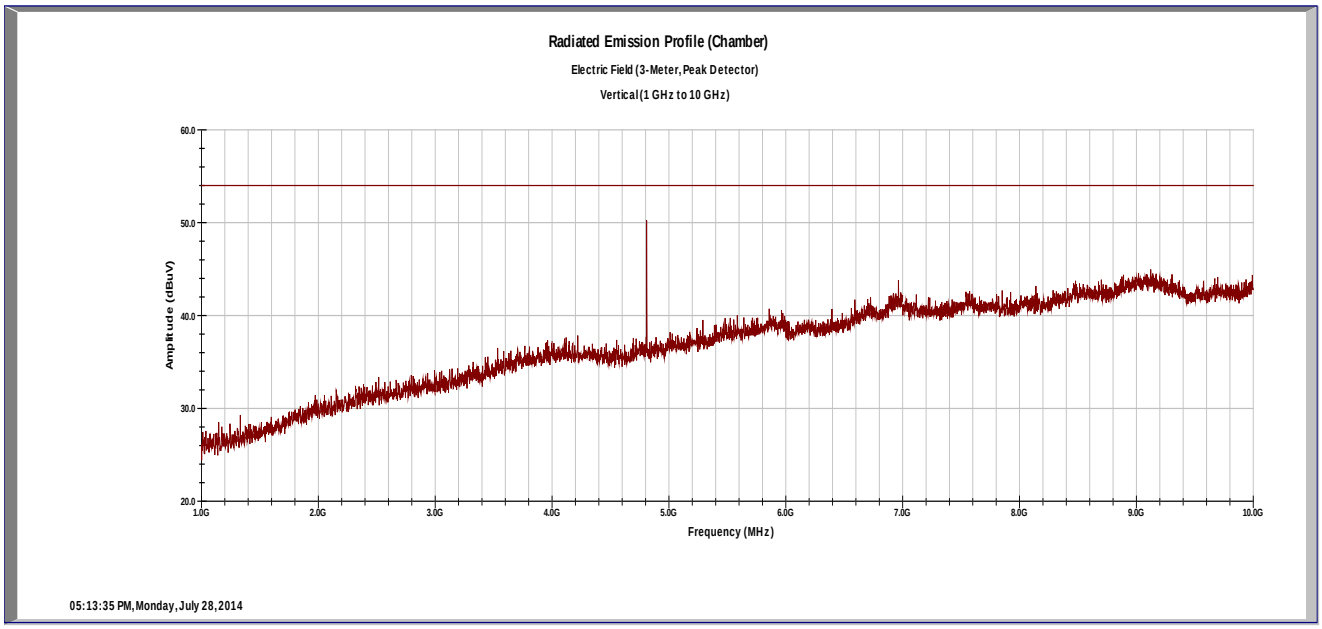
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: RX – Low
The Low receive channel produced the highest spurs and harmonic emissions.
The highest emission was observed in the Vertical Polarity.

Radiated Emissions – Receive Mode – 1 GHz to 10 GHz

Vertical



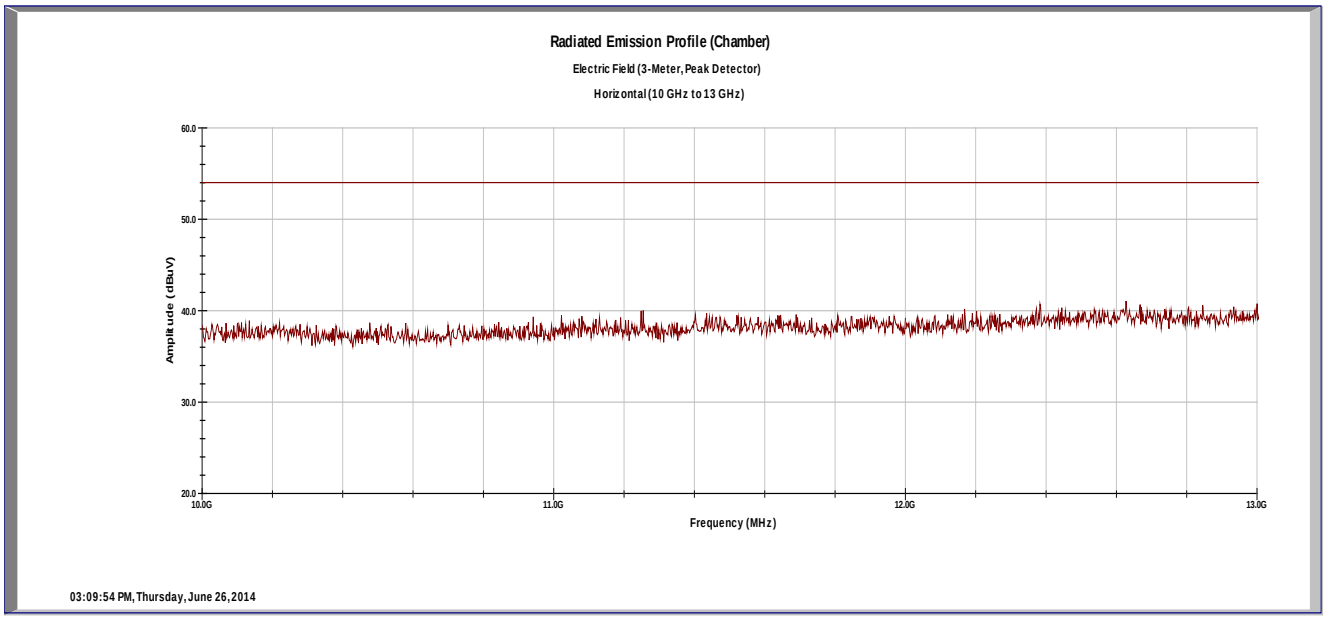
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)
4810.00	V	1.1	36	38.92	33.83	11.36	32.89	49.33	54.00	-4.67
4810.00	V	1.1	36	43.40	33.83	11.36	32.89	53.81	74.00	-20.19

Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Notes: RX – Low
The Low receive channel in the vertical polarity produced the highest spurs and harmonic emission.
The **Green** emission is measured using the average detector to the average limit.
The **Blue** emission is measured using the Peak detector to the Peak limit.

Radiated Emissions – Receive Mode – 10GHz to 13GHz

Horizontal



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)

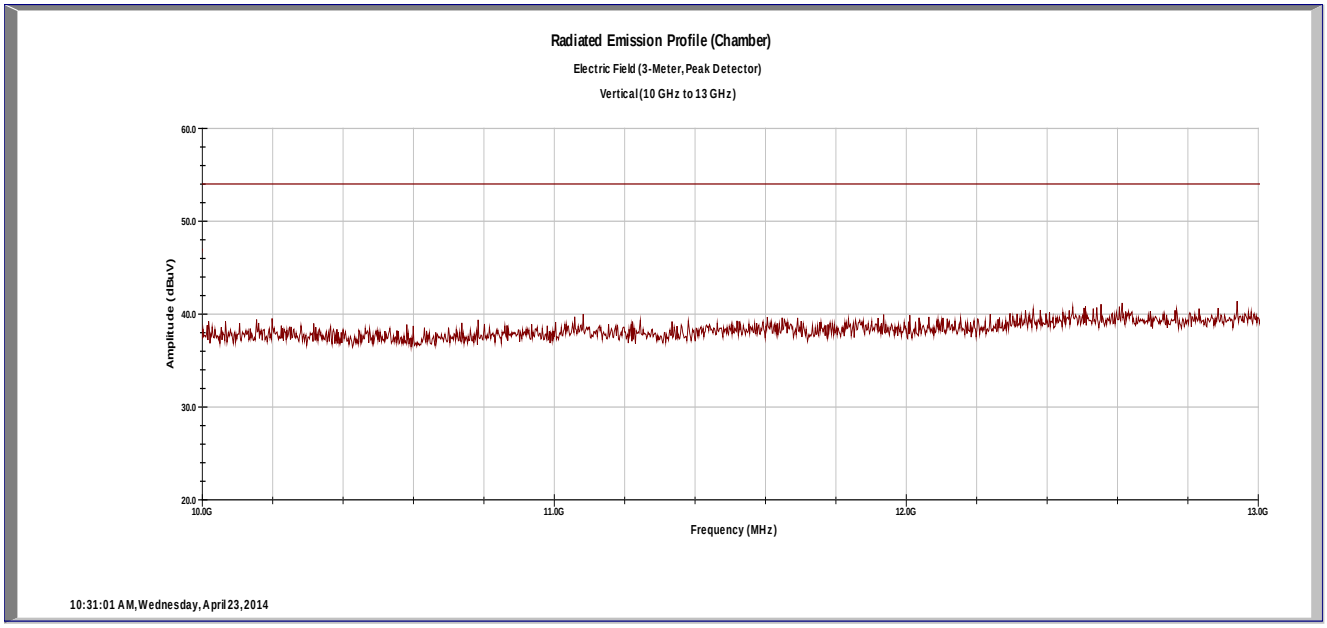
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: All emissions are either more than 20dB below the limit, or below the noise floor of the receiver.

Radiated Emissions – Receive Mode – 10GHz to 13GHz

Vertical



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)

Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: All emissions are either more than 20dB below the limit, or below the noise floor of the receiver.

7 RF Exposure Measurement (Mobile Device) 15.247(i)

7.1 Test Methodology

In this document, we try to prove the safety of radiation harmfulness to the human body for our product. The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. The Gain of the antenna used in this product is measured in a Semi-Anechoic Chamber, and also the maximum total power input to the antenna is measured. Through the Friis transmission formula (see section 4.9.6) and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

Although the Friis transmission formula is a far field assumption, the calculated result of that is an over-prediction for near field power density. We will take that as the worst case to specify the safety range.

7.2 RF Exposure Limit

According to FCC 1.1310 table 1: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b)

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A)Limits For Occupational / Control Exposures				
300-1500	…	…	F/300	6
1500-100,000	…	…	5	6
(B)Limits For General Population / Uncontrolled Exposure				
300-1500	…	…	f /1500	6
1500-100,000	…	…	**1.0**	30

f = Frequency in MHz

7.3 EUT Operating condition

The software provided by Manufacturer enabled the EUT to transmit data at lowest, middle and highest channel individually.

7.4 Classification

The antenna of the product, under normal use condition, is at least 20cm away from the body of the user. Warning statement to the user for keeping at least 20cm or more separation distance with the antenna should be included in the user's manual. Therefore, this device is classified as a **Mobile Device**.

7.5 FCC Test Results

7.5.1 Antenna Gain

The antenna has a maximum measured Gain of the antenna of 3.54 dBi or 2.26 (Linear scale).

7.5.2 Output Power into Antenna & RF Exposure value at distance 20cm:

Calculations for this report are based on highest power measurement and the highest gain of the antenna. Limit for MPE (from FCC part 1.1310 table 1) is **1.0 mW/cm^2**

Highest Pout is 0.57dBm = 1.14 mW, highest antenna gain (in linear scale) is 2.26, R is 20cm, and f = 2400 MHz

Pd = (1.14*2.26) / (1600π) = **0.0005 mW/cm^2**, which is 0.9995 mW/cm^2 below to the 1 mW/cm^2 limit.

Neither the Exposure time of 30 Minutes nor duty cycle were included nor required for this calculation.

7.5.3 Sample Calculation

The Friis transmission formula: $Pd = (Pout*G) / (4*\pi*R^2)$

Where;

Pd = power density in mW/cm2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
$\pi \approx 3.1416$
R = distance between observation point and center of the radiator in cm

Ref. : David K. Cheng, *Field and Wave Electromagnetics*, Second Edition, Page 640, Eq. (11-133).

7.6 Industry Canada Test Results

7.6.1 Antenna Gain

The antenna has a maximum measured Gain of the antenna of 3.54 dBi or 2.26 (Linear scale).

7.6.2 Output Power into Antenna & RF Exposure value at distance of 0.2 m:

Calculations for this report are based on highest power measurement and the highest gain of the antenna. Per the table in section 4.2 of RSS-102, the RF Field Exposure Limit is **10.0 W/m^2**

Highest Pout is 0.57dBm = 1.14 mW, highest antenna gain (in linear scale) is 2.26, R is 20cm, and f = 2400 MHz

Pd = (0.0114*2.26) / (0.16π) = **0.005 W/m^2**, which is 9.995 W/m^2 below to the 10 W/m^2 limit.

Neither the Exposure time of 6 Minutes nor duty cycle were included nor required for this calculation.

7.6.3 Sample Calculation

The Friis transmission formula: $Pd = (Pout*G) / (4*\pi*R^2)$

Where;

Pd = power density in W/m^2
Pout = output power to antenna in W
G = gain of antenna in linear scale
$\pi \approx 3.1416$
R = distance between observation point and center of the radiator in cm

Ref. : David K. Cheng, *Field and Wave Electromagnetics*, Second Edition, Page 640, Eq. (11-133).

7.7 MPE Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s) for both the FCC and Industry Canada.