

**ELECTROMAGNETIC COMPATIBILITY
TEST REPORT TO
CFR 47 FCC Part 15, Subpart C, Section 15.225**

Industry Canada RSS 210, Issue 8

Industry Canada RSS-Gen, Issue 3

**INTENTIONAL TRANSMITTER STANDARDS FOR LICENCE-EXEMPT RADIO
APPARATUS & INTENTIONAL RADIATORS OPERATING WITHIN THE BAND
13.110-14.010 MHz**

Report Number: E10531-1201
Issue: Revision 1.0
Date of Issue: January 29th, 2013
Number of Pages: 32

Testing Laboratory: Quality Auditing Institute
Address: #16 – 211 Schoolhouse Street, Coquitlam, BC, V3K 4X9, Canada

ISO 17025 Accreditation:



Standard Council of Canada: Accredited Laboratory No. 743

International Accreditation Service Inc.: Accredited Laboratory No. TL-239

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Applicant's Name:	BMI Technologies
Address:	#3 7317 12 Street SE, Calgary, AB, T2H 2S6
Phone:	(403) 244-3901
Fax:	
Primary Contact:	Clayton Johnson
E-mail:	clayton@bmitech.com
Test Specifications	
Standards:	Industry Canada RSS 210 Issue 8, Industry Canada RSS-Gen Issue 3, CFR 47 FCC Part 15 Subpart C Section 15.225.
Procedures:	As called by the standards above.
Non-Standard Test Methods:	NA
Test Item Description:	Vehicle RFID Card Reader
Trade Mark:	
	
Manufacturer:	BMI Technologies
Model Number:	RFVI-II
FCC ID #	SYXRFVI-II
IC ID #	6205A-VUI02



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Section I: EMC Test Description

Testing Location

Testing Laboratory: Quality Auditing Institute
Laboratory Address: #16 – 211 Schoolhouse Street, Coquitlam, BC, V3K 4X9, Canada
Associated EMC Laboratory: Quality Auditing Institute: Pitt Meadows & Maple Ridge Locations
Testing Location & Address: 19473 Fraser Way, Pitt Meadows, BC, V3Y 2V4, Canada
Phone Number: (604) 527-8378
FCC Test Site Registration Number: 10 Meter Open Air Test Site and 5 Meter Semi-Anechoic Chamber: 226383
Industry Canada Site Registration Number: 5 Meter SAC: 9543B-1
Industry Canada Test Site Registration Number: 10 Meter OATS: 9543C-1

EUT Receiving Details

Model Number: RFVI-II
Company: BMI Technologies
Received Date: October 16th, 2012
Received By: Simon Howkins
Test Sample Log: QAI Product Control Log: QM 1301 -Test Sample Inventory

Environmental Test Conditions: Indoors

Day 1: October 16 th , 2012	Temperature: 22°C	R.H.: 58%
Day 2: October 23 rd , 2012	Temperature: 22°C	R.H.: 60%
Day 3: October 30 th , 2012	Temperature: 23°C	R.H.: 55%
Day 4: November 19 th , 2012	Temperature: 22°C	R.H.: 45%
Day 5: November 23 rd , 2012	Temperature: 23°C	R.H.: 40%
Day 6: November 26 th , 2012	Temperature: 23°C	R.H.: 24%



EMC Test Summary

The following tests demonstrate testimony for the FCC & IC Marks for intentional transmitter / electromagnetic compatibility testing for the **RFVI-II** manufactured by **BMI Technologies**.

Test / Requirement Description	Deviations from:		Pass / Fail	Applicable FCC Rule Parts	Applicable Industry Canada Rule Parts
	Base Standard	Test Basis			
Radiated Emissions, 10 kHz to 30 MHz	No	No	Pass	FCC Subpart C 15.209 & 15.225	RSS-Gen Issue 3 7.2.5 & RSS-210 Issue 8 Annex A2.6
Radiated Emissions, 30 MHz to 1000 MHz	No	No	Pass	FCC Subpart C 15.209 & 15.225	RSS-Gen Issue 3 7.2.5 & RSS-210 Issue 8 Annex A2.6
Occupied Bandwidth (99% emissions bandwidth)	No	No	NA	N/A	RSS-Gen Issue 3 4.6.1
Transmitter Frequency Stability	No	No	Pass	FCC Subpart C 15.225 (e)	RSS-210 Issue 8 A2.6

X

Tested By & Report Written By
Simon Howkins, EMC Engineer

X

Reviewed By
David Johanson RF/ EMC Test Engineer

Tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with CFR 47 FCC Part 15 Subpart C Section 15.225, Industry Canada RSS 210 Issue 8 & Industry Canada RSS-Gen Issue 3: Intentional Transmitter Standards for Licence-Exempt Radio Apparatus & Intentional Radiators Operating within the Band 13.110-14.010 MHz. The manufacturer is responsible for the tested product configuration, continued product compliance with these standards listed, and for the appropriate auditing of subsequent products as required.



Revision History

Date	Report Number	Rev. #	Details	Author
Nov. 29 th , 2012	E10531-1201	0.0	Draft Test Report	Simon Howkins
Jan. 29 th , 2013	E10531-1201	1.0	Signed Test Report	Simon Howkins

All previous versions of this Report have been superseded by the latest dated Revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly.



Measurement Uncertainty

Radio Frequency:	$\pm 1.5 \times 10^{-5}$
Total RF Power: Conducted:	± 1 dB
RF Power Density: Conducted	± 2.75 dB
Spurious Emissions: Conducted	± 3 dB
All Emissions: Radiated	± 3.5 dB
Temperature	$\pm 1^{\circ}\text{C}$
Humidity	± 5 %
DC and Low Frequency Voltages	± 3 %

Test Equipment List

Semi-Anechoic Chamber Equipment List

Manufacturer	Model	Description	Serial No.	Last Cal	Cal Due Date
ETS Lindgren	2165	Turntable	00043677	N/A	N/A
ETS Lindgren	2125	Mast	00077487	N/A	N/A
Sunol Sciences	JB3	Antenna	A042004	31-Oct-2012	31-Oct-2014
Rohde & Schwarz	ESU40	EMI Receiver	100011	26-June-2012	26-June-2015
ETS Lindgren	S201	5 meter Semi-Anechoic Chamber	1030	N/A	N/A
EMCO	6502	Active Loop Antenna	2178	5-Feb-2011	5-Feb-2014

Measurement Software List

Manufacturer	Model	Version	Description
Rhode & Schwarz	EMC 32	6.20.0	Emissions Pre-scan Test Software

Temperature Chamber Equipment List

Manufacturer	Model	Description	Serial No.	Last Cal	Cal Due Date
Cincinnati Sub Zero	ZH-16-2-2-H/AC	Environmental Chamber	Z0013305	NA	NA
MadgeTech	PRHTemp2000	Temperature and Humidity Data Logger	N53053	26-July-2012	26-July-2013
EMCO	6502	Active Loop Antenna	2178	5-Feb-2011	5-Feb-2014
Rohde & Schwarz	ESCI	EMI Receiver	1000123	4-Mar-2011	29-Mar-2014
Samlex	PSA-305	Adjustable DC Power Supply	100073	NA	NA
Fluke	79III	Digital Multimeter	001883	14-July-2010	14-July-2013



Section II: Equipment Under Test Information

EUT Testing Information

Manufacturer	BMI Technologies Inc.
EUT Description	Vehicle RFID Reader
EUT Name	G Force Plus Vehicle Interface II
Model Number	RFVI-II RFID Reader
Serial Number	EMC Test Unit
Classification	Low Power Transmitter
Antenna	Integral
Modulation	ASK
Emissions Designator	118K8DCN
EUT Size (L x W x H) (cm)	11.4 x 6.4 x 4.0
Channels/Frequency Range	1 Channel, 13.56 MHz

Summary of On Board Frequencies

Frequency:	Module:	Signal:
500 kHz	Switching Regulator	System Clock
13.56 MHz	RFID Chip Reader	Microcontroller

Auxiliary Equipment

Description	Manufacturer	Model Number	Serial Number
Wiring Harness	BMI Technologies	VM+RF	EMC Test Unit
900 MHz Dipole Antenna	Unknown	Unknown	EMC Test Unit
Accelerometer	Unknown	Unknown	EMC Test Unit
12VDC Battery	Sure Start	10-3500-8	QAIBAT1
Adjustable DC Power Supply	Samlex	PSA-305	100073
RFID Card	BMI Technologies	G Force Plus RF Lock Out	0203

EUT Cabling Configuration

Description	Number of Lines	Length (m)	Connection Type	Load or Termination	Shielded	Ferrites
12VDC – Wiring Harness	2	2.1	Terminal Block	Yes	No	No
Wiring Harness – 900 MHz Dipole Antenna	2	3.2	SMA at Antenna RP-TNC at Wiring Harness	Yes	Yes	No
Wiring Harness - Accelerometer	6	3.0	Twist and Lock Connector	Yes	No	No
Wiring Harness – EUT	4	6.1	Twist and Lock Connector	Yes	Yes	No
Wiring Harness IO	10	2.1	Terminal Block	No	No	No



Appendix A: Report of Measurement Data and Plots

Radiated Emissions 10 kHz – 30 MHz

DATE: October 16th 2012, October 23rd 2012, October 30th 2012, November 19th 2012, November 23rd 2012.

BASE STANDARDS: FCC Part 15.225, 15.205 & 15.209
RSS-210 Issue 8, Annex A2.6
RSS-Gen Issue 3, 7.2.2 & 7.2.5

TEST METHOD: ANSI C63.4:2009 & ANSI C63.10:2009

TEST VOLTAGE: 12VDC

SPECIFICATIONS: **FCC Part 15.209 Limits**

Frequency MHz	Part 15.209 Limit		
	Quasi-Peak dBµV/m	Average dBµV/m	Distance m
0.009 – 0.090	NA	168.52 – 148.52 ¹	3
0.090 – 0.110	148.52 – 146.78 ¹	NA	3
0.110 – 0.490	NA	146.78 – 133.80 ¹	3
0.490 – 1.705	93.80 -82.97 ¹	NA	3
1.705 – 30.0	89.54	NA	3

Note 1 : Decrease with the logarithm of the frequency.

FCC Part 15.209 (d)

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

FCC Part 15.225 Operation within the band 13.110 – 14.010 MHz & RSS-210 Issue 8, Annex A2.6

- The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.
- Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.
- Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.
- The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in § 15.209.



FCC Part 15.205 & RSS-Gen 7.2.2 Restricted Bands of Operation

- (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:
- (b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in § 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in § 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in § 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in § 15.35 apply to these measurements.
- (d)(7) Devices operated pursuant to § 15.225 are exempt from complying with this section for the 13.36-13.41 MHz band only.

MHz	MHz
0.090–0.110	8.37625-8.38675
0.495-0.505	8.41425-8.41475
2.1735-2.1905	12.29-12.293
4.125-4.128	12.51975-12.52025
4.17725-4.17775	12.57675-12.57725
4.20725-4.20775	13.36-13.41
6.215-6.218	16.42–16.423
6.26775-6.26825	16.69475-16.69525
6.31175-6.31225	16.80425-16.80475
8.291-8.294	25.5-25.67
8.362-8.366	

TEST SETUP:

The EUT was setup in a 3 meter Semi-Anechoic Chamber. The auxiliary equipment was setup outside the anechoic chamber. The EUT's power and IO cable was fed out the chamber to the wiring harness. The EUT was powered up and an RFID card was placed on the EUT. This ensured that the EUT was exercising all its functional requirements. The radiated emissions of the EUT were checked in three orthogonal planes and the worst case results reported. The worst case was when the EUT was standing up on its bottom. See the pictures in Appendix B. An active loop antenna was used below 30 MHz and it was rotated about its vertical axis for each azimuth angle the EUT was tested at.

TEST RESULTS:

There were no emissions within 20dB of the applicable limit.

The EUT complies with CFR 47 FCC Part 15.205, 15.209, 15.225, Industry Canada RSS-210 Issue 8, Annex A2.6, and RSS-Gen Issue 3, 7.2.2 & 7.2.5

SAMPLE CALCULATIONS:

Correction Factor = Antenna Correction Factor + Cable Loss
Emission Level = Measured Value + Correction Factor
Margin = Limit – Emission Level
Limit (dBuV/m) = 20*Log(Limit (uV/m))
Limit (at 3 meters in dBuV/m) = Limit (at 30 meters in dBuV/m + 40 dB) For below 30 MHz ONLY

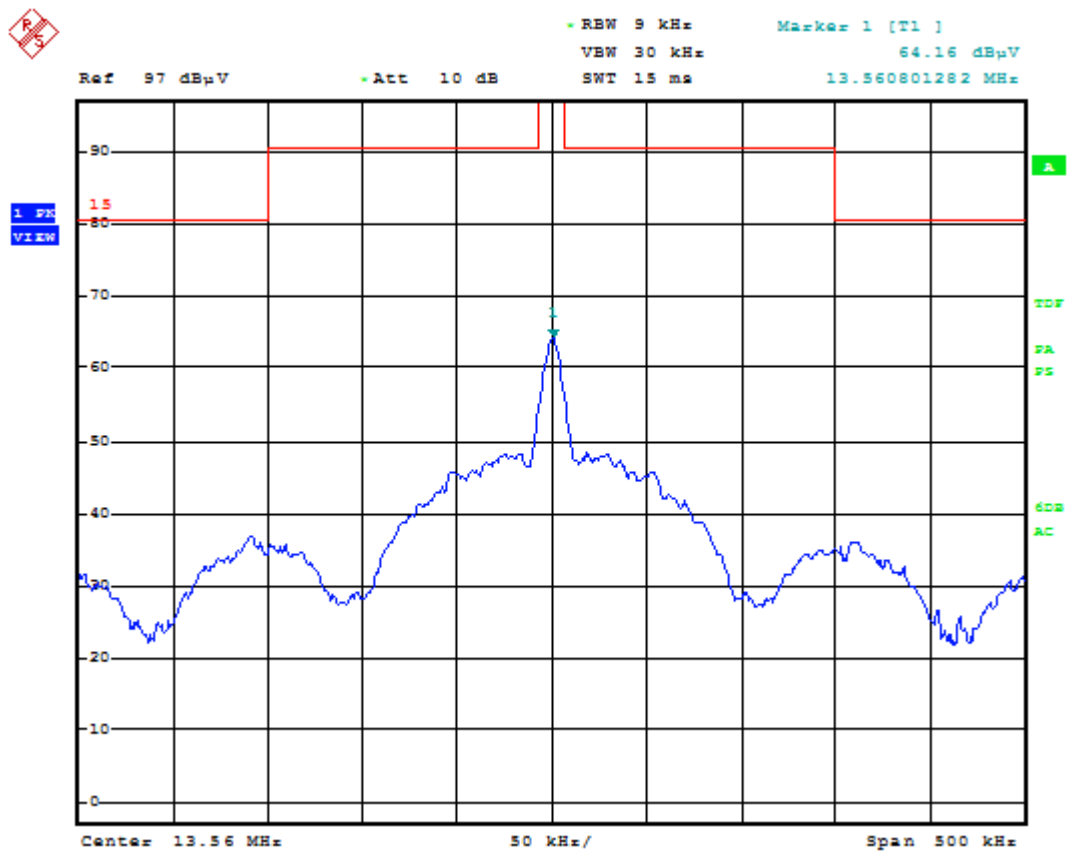


MEASUREMENT DATA AND PLOTS:

Carrier / Fundamental Emission

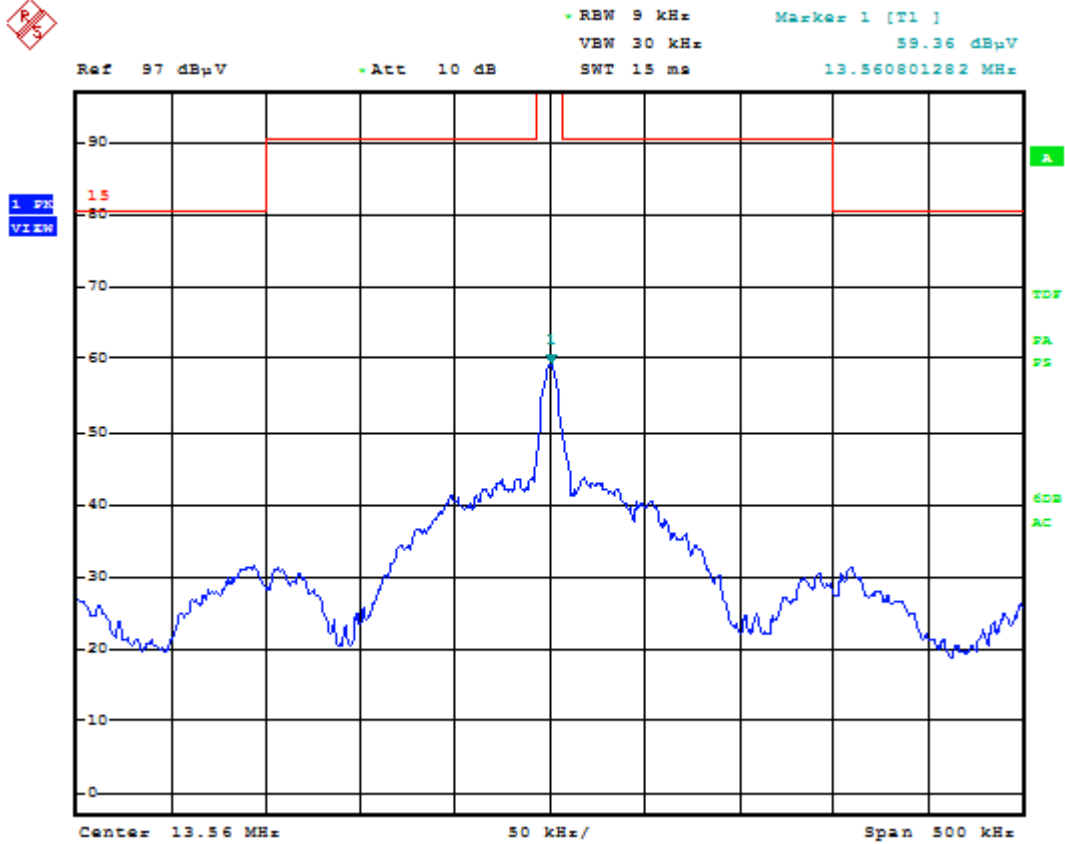
Loop Antenna Position	Frequency (MHz)	Measured Level (dBuV/m)	Measurement Detector	Correction Factors (dB)	Emission Level (dBuV/m)	Limit Line	Limit (dBuV/m)	Margin (dB)	Mast Height (cm)	Turntable Angle (degrees)
Vertical 90 degrees	13.56	53.76	Peak	10.4	64.16	QP	123.99	59.83	100	182
Vertical 0 degrees	13.56	48.61	Peak	10.4	59.01	QP	123.99	64.98	100	270

Table: Carrier / Fundamental Emission



Plot: Carrier Emission, Loop Antenna Vertical 90 degrees

Note: The correction factors have been applied internally to the receiver

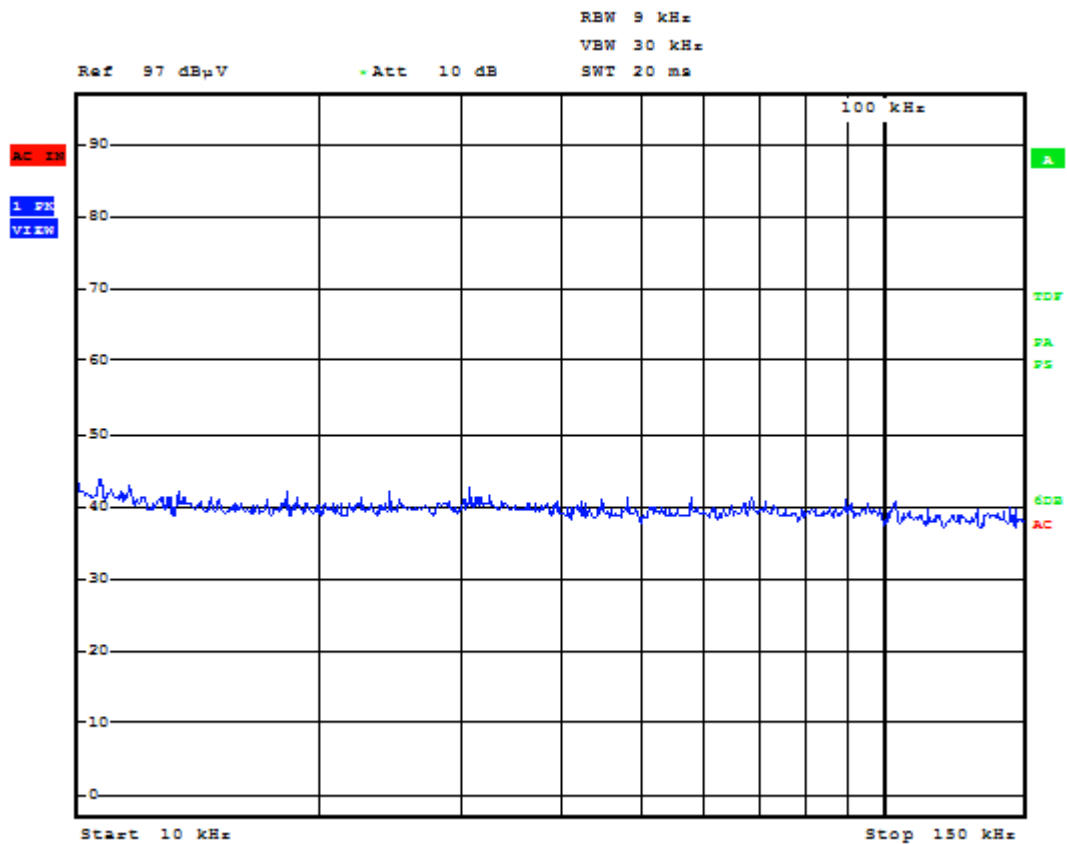


Plot: Carrier Emission, Loop Antenna Vertical 0 degrees

Note: The correction factors have been applied internally to the receiver

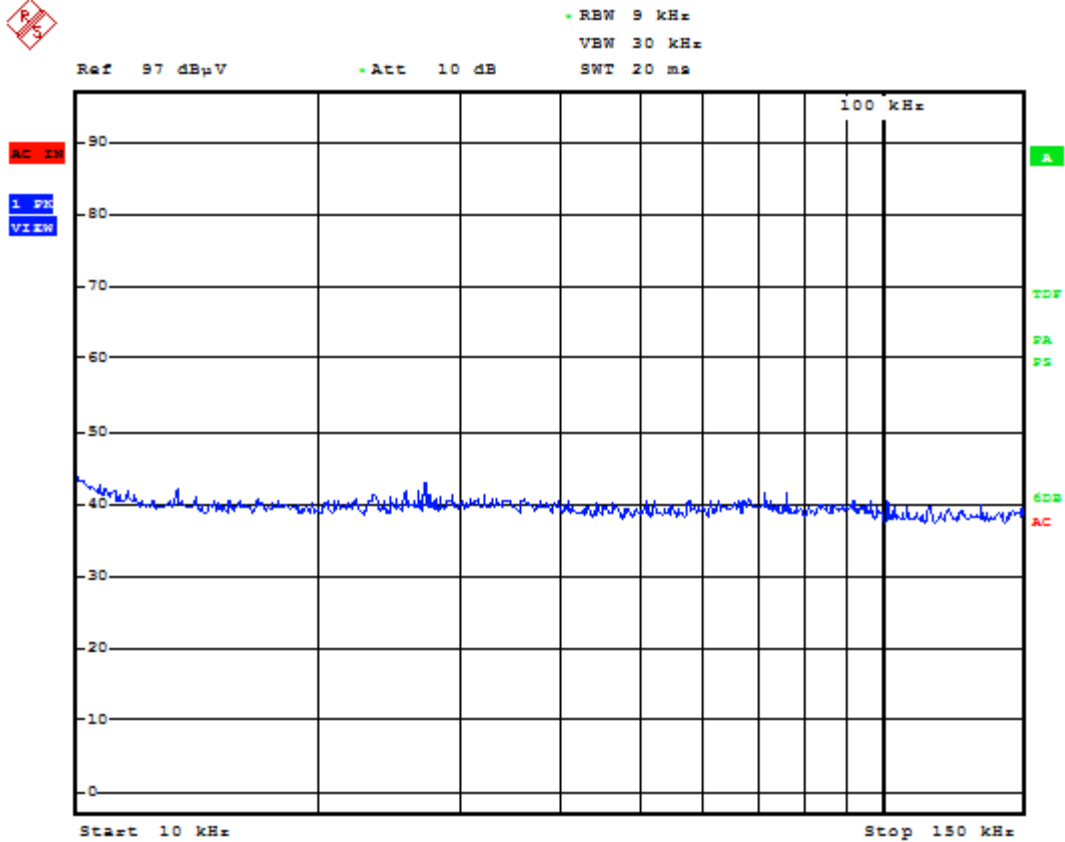


Radiated Emissions: 10 kHz – 150 kHz



Plot: Radiated Emissions 10 kHz – 150 kHz, Loop Antenna Vertical 0 degrees

Note: The correction factors have been applied internally to the receiver

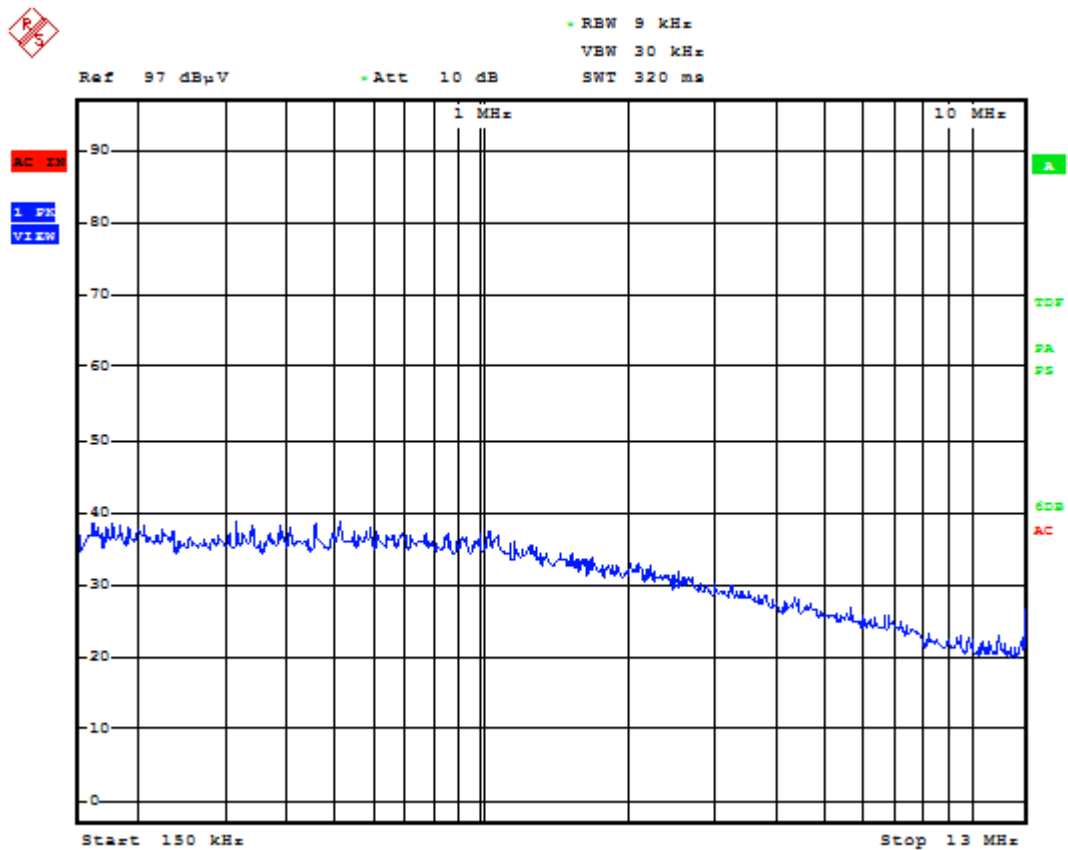


Plot: Radiated Emissions 10 kHz – 150 kHz, Loop Antenna Vertical 90 degrees

Note: The correction factors have been applied internally to the receiver



Radiated Emissions: 150 kHz – 13 MHz



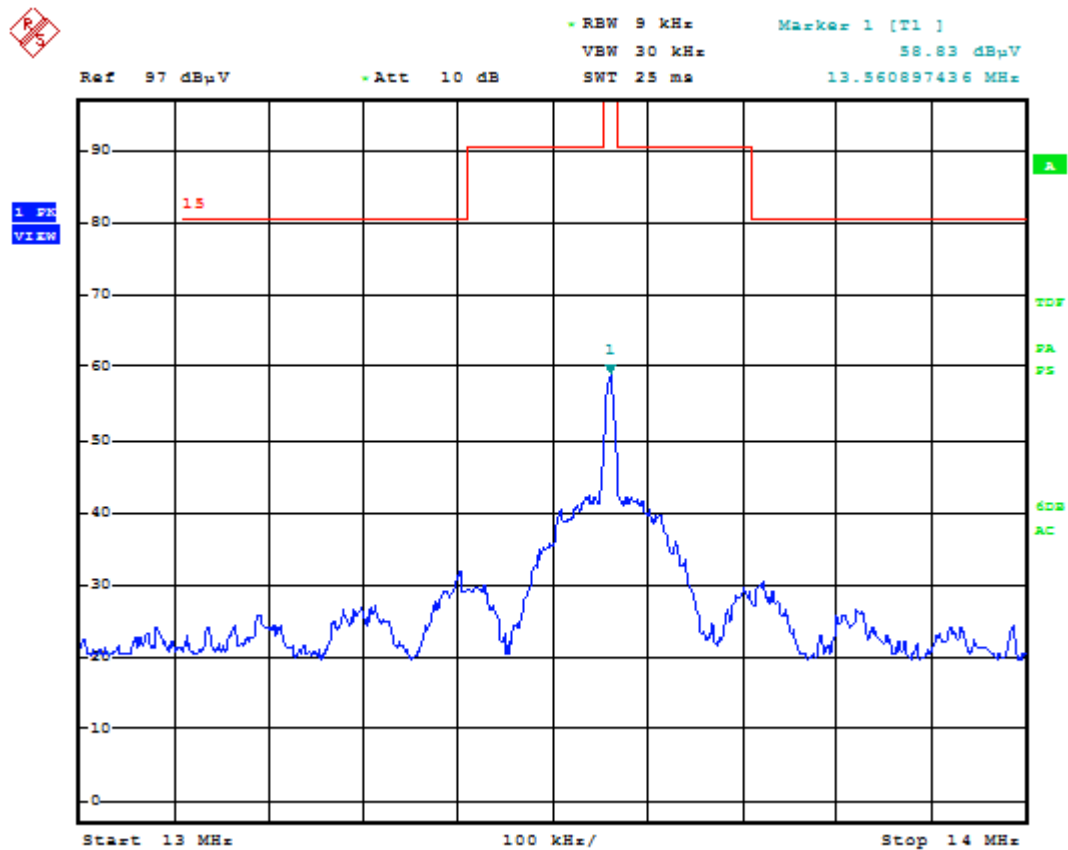
Plot: Radiated Emissions 150 kHz – 13 MHz, Loop Antenna Vertical 90 degrees

Note: The correction factors have been applied internally to the receiver





Radiated Emissions: 13 MHz – 14 MHz



Plot: Radiated Emissions 13 MHz – 14 MHz, Loop Antenna Vertical 0 degrees

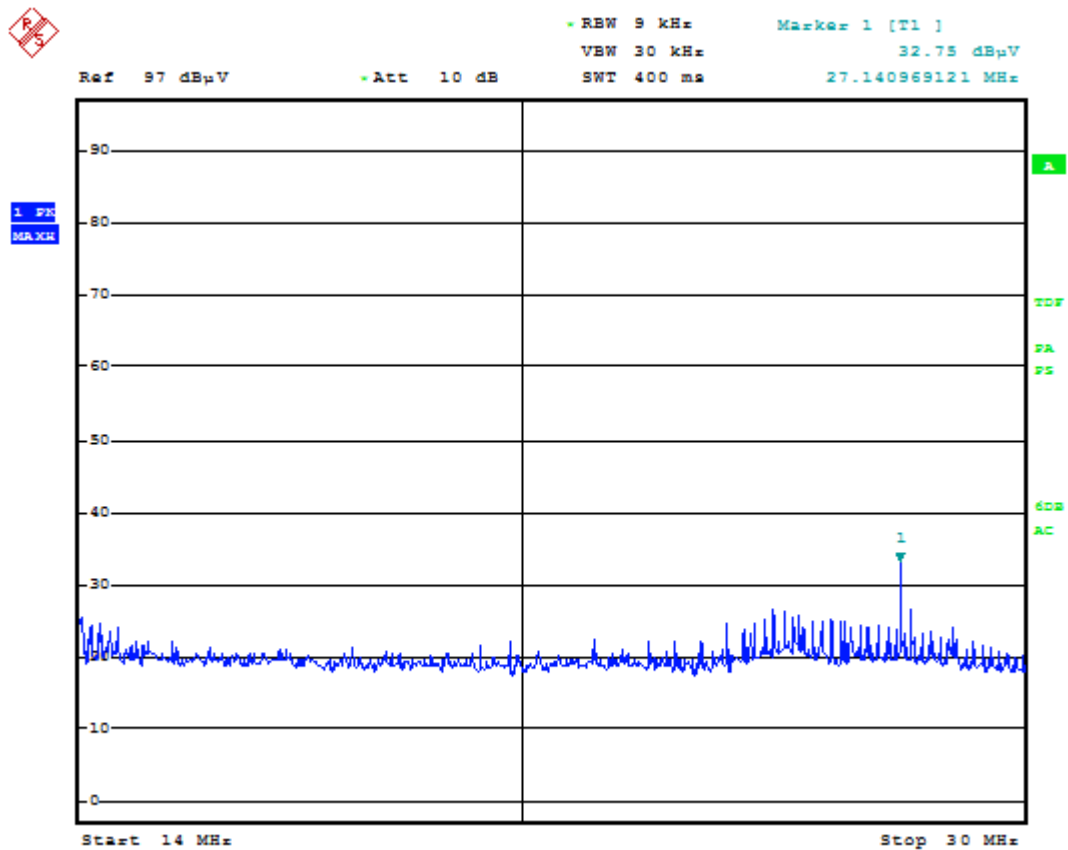
Note: The correction factors have been applied internally to the receiver



Note: The correction factors have been applied internally to the receiver

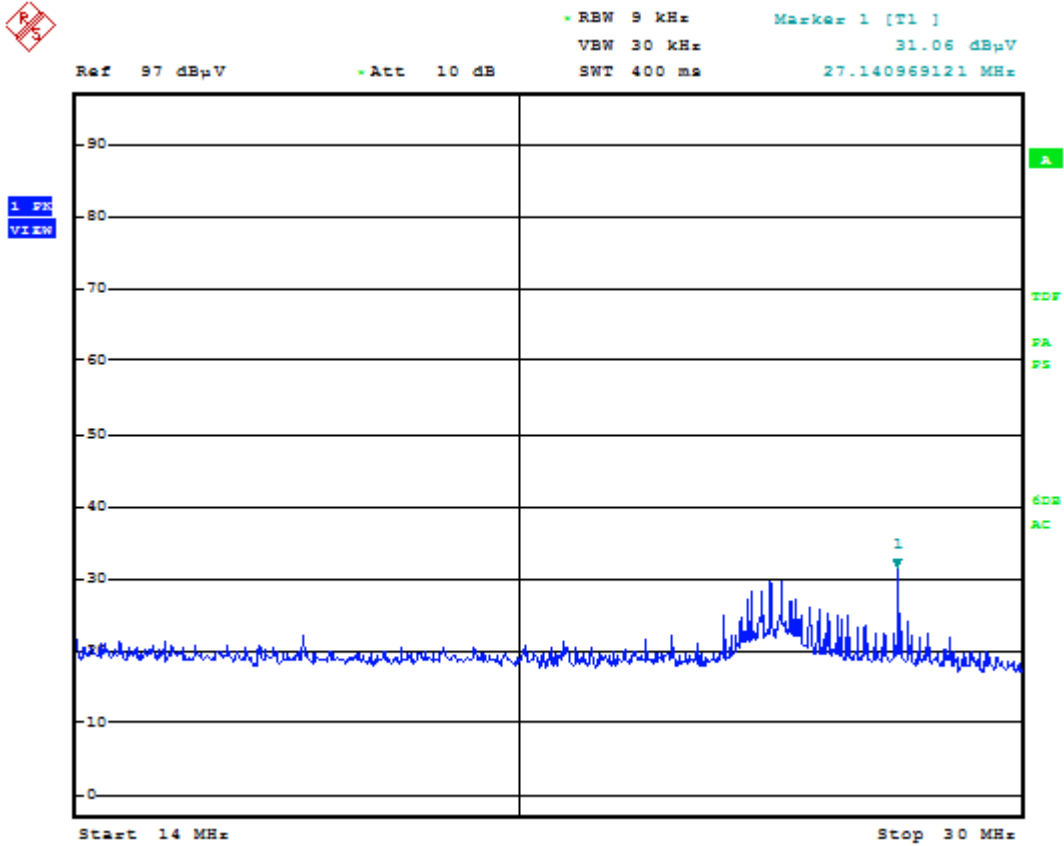


Radiated Emissions: 14 MHz – 30 MHz



Plot: Radiated Emissions 14 MHz – 30 MHz, Loop Antenna Vertical 90 degrees

Note: The correction factors have been applied internally to the receiver



Plot: Radiated Emissions 14 MHz – 30 MHz, Loop Antenna Vertical 0 degrees

Note: The correction factors have been applied internally to the receiver



Radiated Emissions 30 MHz – 1000 MHz

DATE: October 16th 2012, October 23rd 2012, October 30th 2012, November 19th 2012, November 23rd 2012.

BASE STANDARDS: FCC Part 15.109, 15.225, 15.205 & 15.209
RSS-Gen Issue 3, 7.2.2 & 7.2.5
ICES-003, Issue 5

TEST METHOD: ANSI C63.4:2009

TEST VOLTAGE: 12VDC

SPECIFICATIONS: **Part 15.209 Limit (Part 15.109 Class B)**

Frequency (MHz)	Field Strength	
	uV/m @ 3-m	dB μ V/m at 3m
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
960 - Above	500	54.0

FCC Part 15.209 (d)

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

FCC Part 15.225

(d) The field strength of any emissions appearing outside of the 13.110 – 14.010 MHz band shall not exceed the general radiated emission limits in 15.209.

FCC 15.205 and RSS-Gen Issue 3, 7.2.2

- (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:
- (b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in § 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in § 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in § 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in § 15.35 apply to these measurements.
- (d)(7) Devices operated pursuant to § 15.225 are exempt from complying with this section for the 13.36-13.41 MHz band only.

MHz	MHz
37.5-38.25	162.0125-167.17
73-74.6	167.72-173.2
74.8-75.2	240-285
108-121.94	322-335.4
123-138	399.9-410
149.9-150.05	608-614
156.52475-156.52525	960-1240
156.7-156.9	NA



TEST SETUP:

The EUT was setup in a 3 meter Semi-Anechoic Chamber. The auxiliary equipment was setup outside the anechoic chamber. The EUT's power and IO cable was fed out the chamber to the wiring harness. The EUT was powered up and an RFID card was placed on the EUT. This ensured that the EUT was exercising all its functional requirements. The radiated emissions of the EUT were checked in three orthogonal planes and the worst case results reported. The worst case was when the EUT was standing up on its bottom. See the pictures in Appendix B. A broadband hybrid antenna was used between 30 MHz and 1000 MHz. Emissions in both horizontal and vertical polarizations were measured while rotating the EUT on a turntable and raising and lowering the receiving antenna to maximize the emissions signal strength.

TEST RESULTS:

The EUT complies with CFR 47 FCC Part 15.109, 15.205, 15.209, 15.225, Industry Canada ICES-003 Issue 5, 6.2.1 & RSS-Gen Issue 3, 7.2.2 & 7.2.5

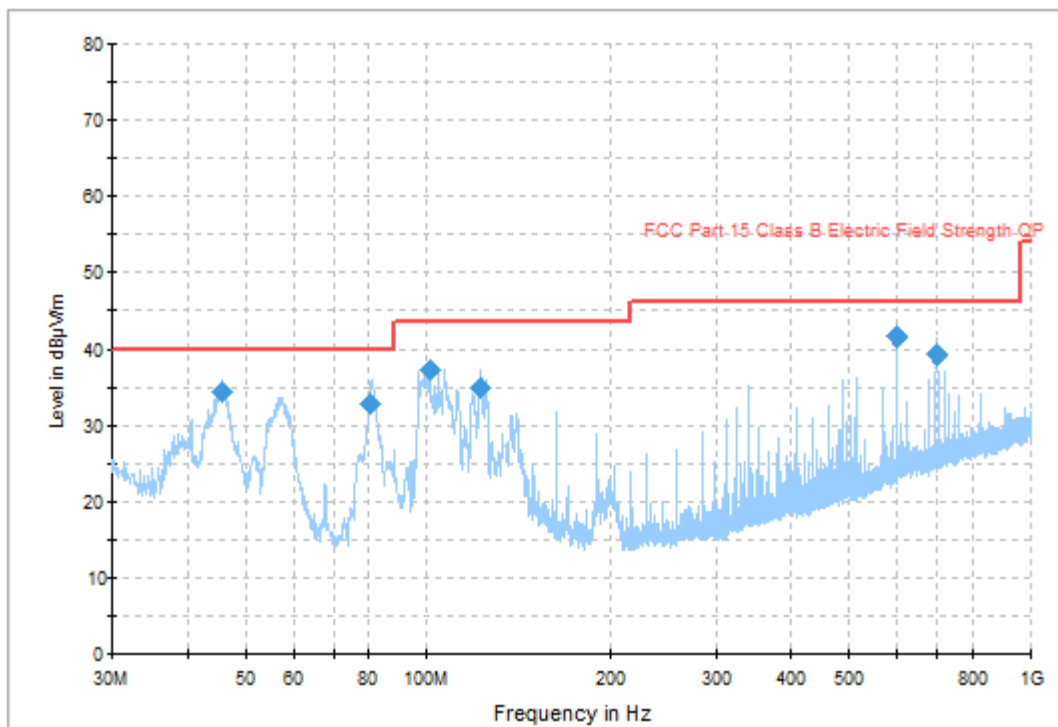
SAMPLE CALCULATIONS:

Correction Factor = Antenna Correction Factor + Cable Loss
Emission Level = Measured Value + Correction Factor
Margin = Limit – Emission Level
Limit (dBuV/m) = $20 \cdot \log(\text{Limit (uV/m)})$



MEASUREMENT DATA AND PLOTS:

Radiated Emissions: 30 MHz – 1000 MHz



Plot: Radiated Emissions 30 MHz – 1000 MHz

Note: The correction factors have been applied internally to the receiver

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
45.714360	34.4	1000.00	120.000	100.0	V	15.0	10.5	5.60	40.00
80.770520	33.0	1000.00	120.000	145.0	V	125.0	9.2	7.00	40.00
101.093320	37.3	1000.00	120.000	120.0	V	190.0	12.0	6.20	43.50
122.949680	35.1	1000.00	120.000	100.0	V	200.0	15.1	8.40	43.50
596.642560	41.6	1000.00	120.000	159.0	H	228.0	21.7	4.40	46.00
705.12261	39.1	1000.00	120.000	150.0	H	225.0	23.2	6.90	46.00

Table: Radiated Emissions 30 MHz – 1000 MHz



Occupied Bandwidth

DATE: November 26th 2012

BASE STANDARD: RSS-Gen Issue 3, 4.6.1

TEST METHOD: RSS-Gen Issue 3, 4.6.1

TEST VOLTAGE: 12VDC

SPECIFICATIONS: When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

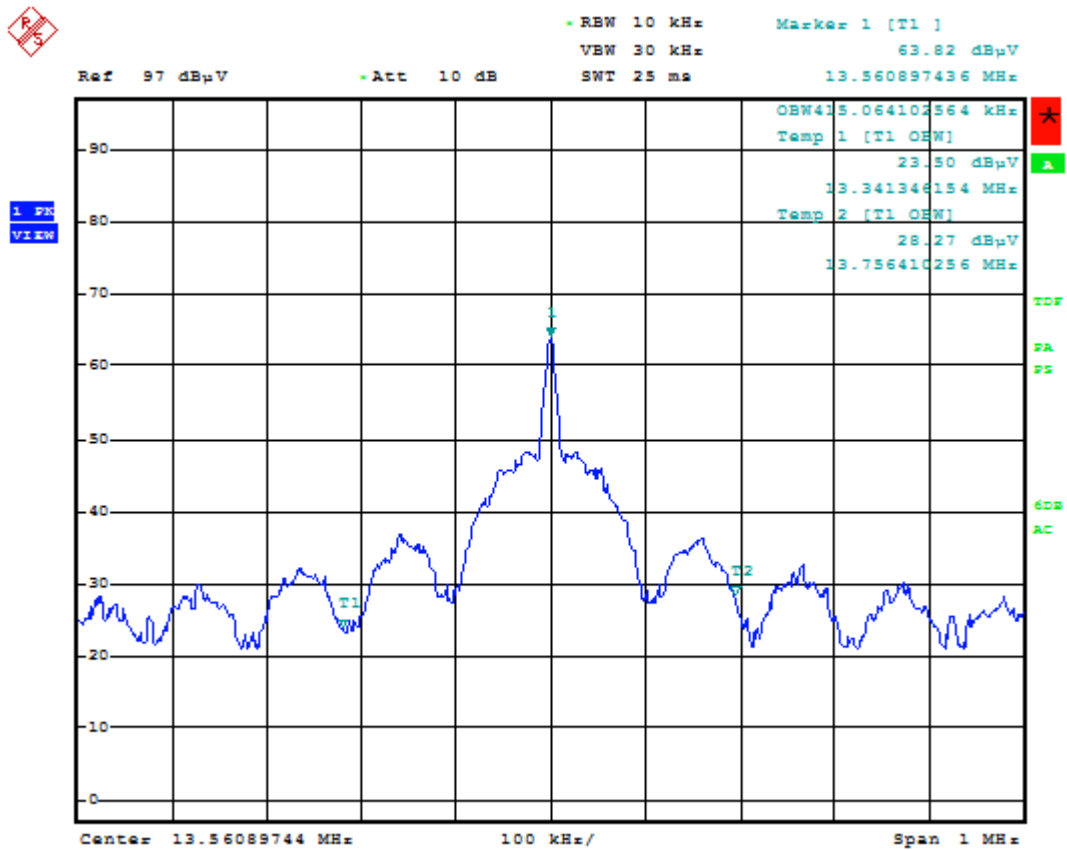
TEST SETUP: The EUT was setup in a 3 meter Semi-Anechoic Chamber. The auxiliary equipment was setup outside the anechoic chamber. The EUT's power and IO cable was fed out the chamber to the wiring harness. The EUT was powered up and an RFID card was placed on the EUT. This ensured that the EUT was exercising all its functional requirements. The radiated emissions of the EUT were checked in three orthogonal planes and the worst case results reported. The worst case was when the EUT was standing up on its bottom. See the pictures in Appendix B. An active loop antenna was used below 30 MHz and it was rotated about its vertical and horizontal axis for each azimuth angle the EUT was tested at.

TEST RESULTS:

Frequency (MHz)	Occupied Bandwidth (kHz)
13.56	415.064



MEASUREMENT DATA: See below for the 99% Occupied Bandwidth plot.





Transmitter Frequency Stability

DATE: November 26th, 2012

BASE STANDARDS: CFR 47 FCC Part 15.225 (e)
RSS-Gen Issue 3, 4.7
RSS-210 Issue 8, Annex A2.6

TEST METHOD: CFR 47 FCC Part 2.1055

TEST VOLTAGE: 12VDC

SPECIFICATIONS: 15.225 (e) The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of -20 degrees to $+50$ degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

RSS-Gen Issue 3, 4.7: With the transmitter installed in an environment test chamber, the unmodulated carrier frequency shall be measured under the conditions specified below. A sufficient stabilization period at each temperature shall be used prior to each frequency measurement. The following temperatures and supply voltage ranges apply, unless specified otherwise in the applicable RSS.

(a) at temperatures of -30°C , $+20^{\circ}\text{C}$ and $+50^{\circ}\text{C}$, and at the manufacturer's rated supply voltage; and

(b) at a temperature of $+20^{\circ}\text{C}$ and at ± 15 percent of the manufacturer's rated supply voltage.

TEST SETUP: The EUT was setup in an environmental chamber. The loop antenna and receiver were setup outside the chamber. The EUT was powered with an adjustable DC power supply and the frequency stability was measured.

TEST RESULTS: PASS: The EUT complies with CFR 47 FCC Part 15.225 (e), RSS-Gen Issue 3, 4.7, & RSS-210 Issue 8, Annex A2.6

SAMPLE CALCULATIONS: Frequency Shift = Measured Frequency – Reference Frequency



MEASUREMENT DATA:

Frequency Vs. Voltage at 20°C

Power Supply Voltage (VDC)	Measured Frequency (MHz)	Frequency Shift (MHz)	Maximum Allowed Frequency Shift (MHz)	Result
12.0	13.560132	REFERENCE	NA	NA
10.2	13.560144	+0.000012	±0.001356	PASS
13.8	13.560148	+0.000016	±0.001356	PASS

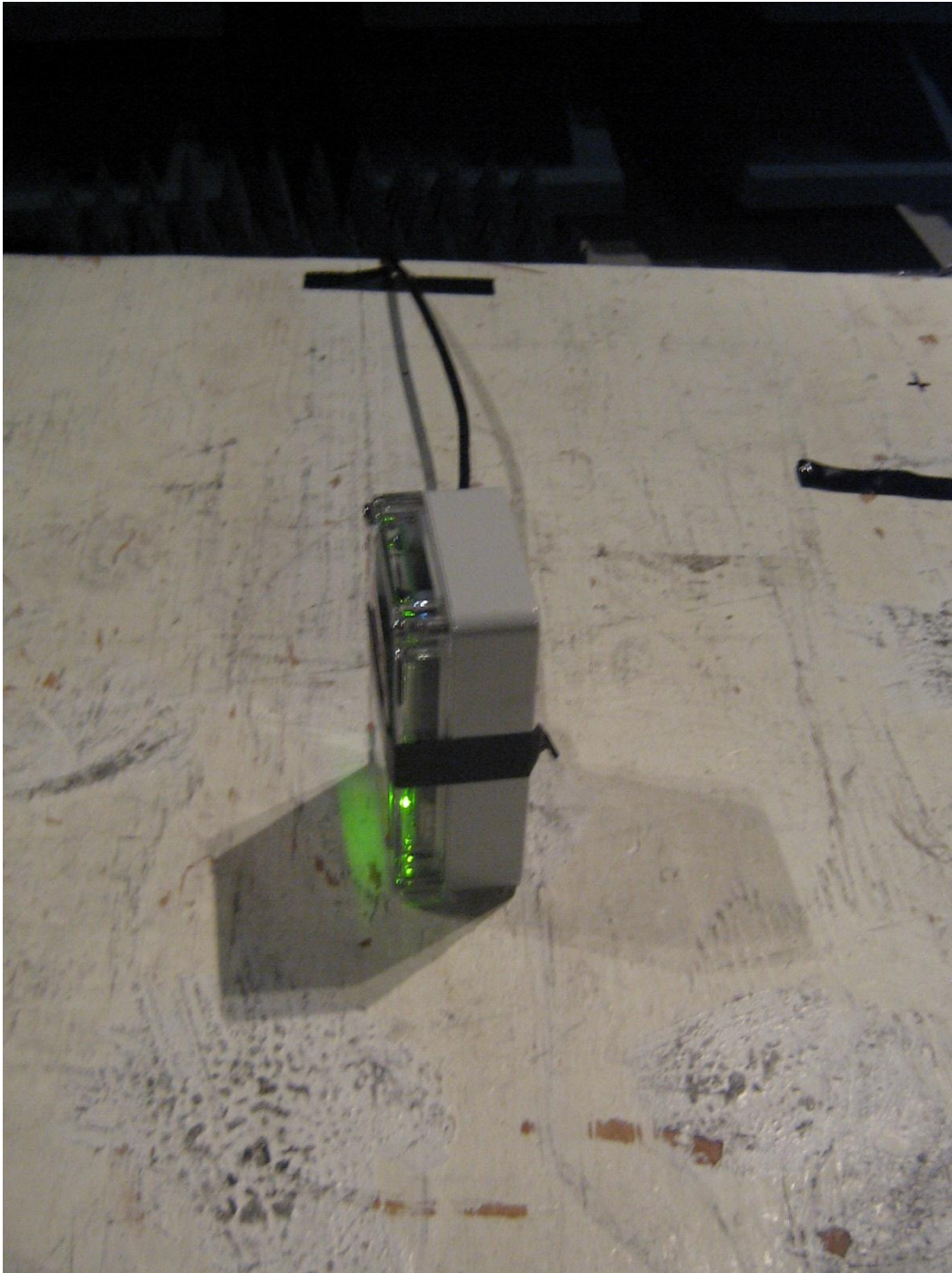
Frequency Vs. Temperature

Temperature (°C)	Measured Frequency (MHz)	Frequency Shift (MHz)	Maximum Allowed Frequency Shift (MHz)	Result
-30	13.560016	-0.000116	±0.001356	PASS
-20	13.560024	-0.000108	±0.001356	PASS
-10	13.560100	-0.000032	±0.001356	PASS
0	13.560124	-0.000008	±0.001356	PASS
10	13.560152	+0.000020	±0.001356	PASS
20	13.560132	REFERENCE	NA	NA
30	13.560124	-0.000008	±0.001356	PASS
40	13.560128	-0.000004	±0.001356	PASS
50	13.560128	-0.000004	±0.001356	PASS

Appendix B: EUT Photos During EMC Testing



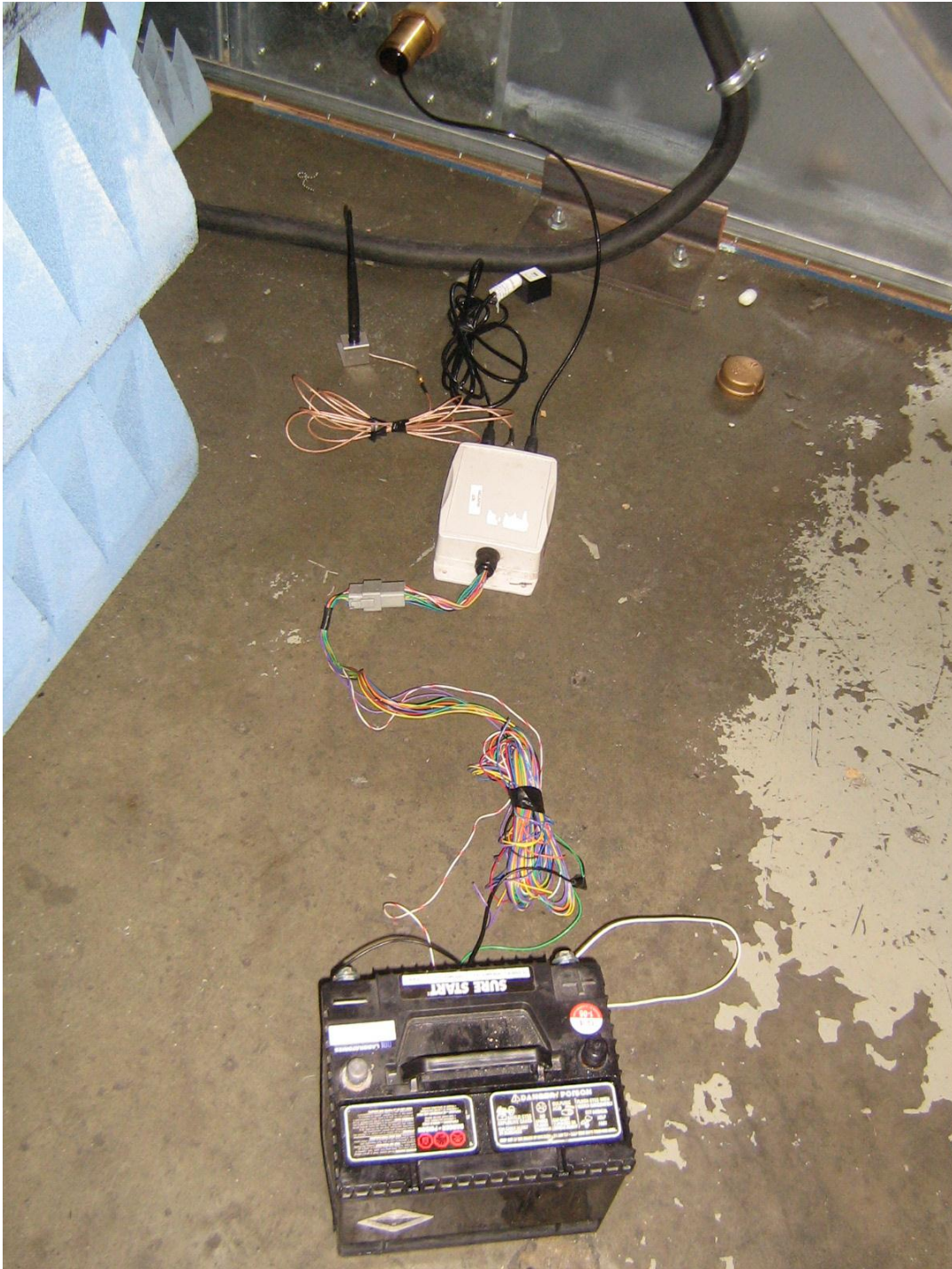
Radiated Emission Test Setup in the Semi-Anechoic Chamber



Radiated Emissions Test Set-Up in the Semi-Anechoic Chamber



Frequency Stability Test in Environmental Chamber



Auxiliary Equipment Located outside the Semi Anechoic Chamber