

Report No.:

31252050.001

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Electromagnetic Compatibility Test Report

Prepared in accordance with

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

Multiple Parts

On

Firefly RFID Expansion Card

WIRELESS MODULAR DEVICE

**Firefly RFID Solutions
1521 Boone Trail Road
Sanford, NC 27330 USA**

Prepared by:

TUV Rheinland of North America, Inc.

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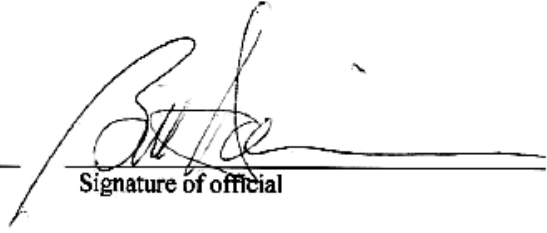
Manufacturer's statement / attestation

The manufacturer; Firefly RFID Solutions, 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.

BILL DAVIDSON

Printed name of official


Signature of official

1521 Boone Trail Road
Sanford, NC 27330

Address

MARCH 18, 2013

Date

919-460-1177 ext. 101

Telephone number

bill.davidson@rfdresolution.com

Email address of official

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Client:			Firefly RFID Solutions 1521 Boone Trail Road Sanford, NC 27330 USA	Ian Chalmers 919-460-1177 x111 / ian.chalmers@rfdiresolution.com
Identification:	WIRELESS MODULAR DEVICE		Serial No.:	PRODUCTION PROTOTYPE
Test item:	Firefly RFID Expansion Card		Date tested Completed:	8 March 2013
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, 7.2.2 FCC Parts 15.205, 15.209, 15.215(c), RSS-210 FCC Part 15.247(a)(1), RSS-210 A8.1(a), and RSS-GEN 4.6.1, FCC Part 15.247 and RSS-210 Annex 8, FCC Part 15.247(a)(1)(i), RSS-210, Section A8.1 FCC Part 15.247(b)(2) and RSS-210 A8.1(b), FCC Part 15.247(b)(2) and RSS-210 A8.4(1), FCC Part 15.247(g) and RSS-210 A8.1, FCC Part 15.247(h) and RSS-210 A8.1, FCC Part 15.31(e) FCC Part 15.231(a) and RSS-210, Annex 1, FCC Part 15.231(b) and RSS-210, A1.1 FCC Part 15.231(c) and RSS-210 A1.1.3 FCC Part 2.1093 and RSS-102, Issue 4			
Test Result	The above product was found to be Compliant to the above test standard(s)			
tested by: Mark Ryan			reviewed by: Michael Moranha	
 13 December 2010 Signature			 23 May 2013 Signature	
Other Aspects:	None			
Abbreviations: OK, Pass, Compliant, Complies = passed Fail, Not Compliant, Does Not Comply = failed N/A = not applicable				
				
Industry Canada				
90552 and 100881		Testing Cert #3331.05		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 8 March 2013 on the Firefly RFID Expansion Card , Model No. WIRELESS MODULAR DEVICE, manufactured by Firefly RFID Solutions. This report only applies to the specific samples tested under the stated test conditions for the only. 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
--	9 Apr 2013	Initial Release
A	23 May 2013	Clarifications of some descriptions

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1.4 Summary of Test Results

Applicant	Firefly RFID Solutions 1521 Boone Trail Road Sanford, NC 27330 USA	Tel	919-460-1177 x111	Contact	Ian Chalmers
		Fax		e-mail	ian.chalmers@rfidresolution.com
Description	Firefly RFID Expansion Card		Model Number	WIRELESS MODULAR DEVICE	
Serial Number	PRODUCTION PROTOTYPE		Test Voltage/Freq.	120VAC/60Hz	
Test Date Completed:	8 March 2013		Test Engineer	Mark Ryan	
Standards	Description	Severity Level or Limit		Results	Test Result
FCC Part 15, Subpart C Standard	Radio Frequency Devices- Subpart C: Intentional Radiators	See called out basic standards below		See Below	Complies
RSS-210 Issue 8 Standard	Low-Power Licence-exempt Radiocommunication Devices Category I Equipment	See called out basic standards below		See Below	Complies
FCC Parts 15.205, 15.209, 15.215(c), RSS-210	Radiated Emissions EUT in Transmit Mode	Below limit of sections 15.205, 15.209(a) and 15.215(c)		41.14 dBµV	Complies
FCC Part 15.207(a) and RSS-GEN, 7.2.2	Conducted Emissions on Mains EUT in Transmit Mode	15.207(a) limits, 150kHz - 30MHz		47.19 dBµV	Complies
FCC Part 15.247 and RSS-210 Annex 8	Frequency Hopping Operation within the band 902-928 MHz	See called out requirements below		--	Complies
FCC Part 15.247(a)(1)(i), RSS-210, Section A8.1	Channel Separation	Minimum 50 channels		0.5 MHz (50 channels)	Complies
FCC Part 15.247(b)(2) and RSS-210 A8.1(b)	Pseudorandom Hopping Algorithm	≥ 50 hopping channels		500 kHz	Complies
FCC Part 15.247(a)(1), RSS-210 A8.1(a), and RSS-GEN 4.6.1	Occupied Bandwidth	6dB ≥ 500 kHz 20dB (ref. for channel separation) 99% BW ≤ 500 kHz		43.2 kHz 71.6 kHz 66.0 kHz	Complies
FCC Part 15.247(d) and RSS-210 A8.5	Band Edge	Ensure 20dB bandwidth is Contained within the Frequency Band		>20dB BW is contained	Complies
FCC Part 15.247(b)(2) and RSS-210 A8.4(1)	Transmitter Output Power	Shall not exceed 1.0 Watts		0.65 W	Complies
FCC Part 15.247(g) and RSS-210 A8.1	Frequency Hopping Spread Spectrum (FHSS) Systems	Description of Hopping System		Firefly protocol	Complies
FCC Part 15.247(h) and RSS-210 A8.1	Incorporation of Intelligence within a FHSS System	Not Applicable: EUT does not incorporate hopping intelligence		NA	NA
FCC Part 15.31(e) and RSS-210, 2.1	Voltage Requirements	Output at 0.85% and 1.15% of Rated Voltage		Battery Operated	Complies
FCC Parts 15.109(a) and RSS-210 2.2, 2.6, A8.5, RSS-GEN 7.2.3.2	Radiated Emissions while EUT in Receive Mode	Below limit of section 15.109(a) Class B		37.45 dBµV	Complies
FCC Part 2.1093 and RSS-102, Issue 4	RF Exposure	SAR or MPE Requirements		See SAR report	Complies

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Standards	Description	Severity Level or Limit	Measured	Test Result
FCC Part 15.231 and RSS-210, Annex 1	Periodic operation in the band 40.66 - 40.70 MHz and above 70 MHz	See Basic Standards Below	See Below	Complies
FCC Parts 15.205, 15.209, 15.215(c), RSS-210	Radiated Emissions	30 MHz - 5 GHz	37.45 dBµV	Complies
FCC Part 15.207(a) and RSS-GEN, 7.2.2	Conducted Emissions on Mains EUT in Transmit Mode	15.207(a) limits, 150kHz - 30MHz	53.19 dBµV	Complies
FCC Part 15.231(a) and RSS-210, Annex 1	Deactivation of Transmitter	EUT is not Manually Operated	Not Required	Complies
FCC Part 15.231(b) and RSS-210, A1.1	Field Strength of Fundamental and Spurious Emissions	15.231(b) Table Peak Limit is 101.57 dBuV at 433.0 MHz	79.54 dBuV Peak Field Strength of Fundamental	Complies
FCC Part 15.231(c)	Bandwidth	Part 15.231(c) 1.08 MHz	519.0 kHz	Complies
RSS-210 A1.1.3	99% Occupied Bandwidth	No wider than 0.5% of the center frequency	Below Limit	Complies
FCC Part 2.1093 and RSS-102 Issue 4	RF Exposure	MPE or SAR Requirements (Mobile)	5 mW Max	Complies

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2 Laboratory Information

2.1 Accreditations

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).

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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:

$$\text{Field Strength (dB}\mu\text{V/m)} = \text{RAW} - \text{AMP} + \text{CBL} + \text{ACF}$$

Where: RAW = Measured level before correction (dBμV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

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

2.1.6 Sample radiated emissions calculation @ 30 MHz

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

$$25 \text{ dBuV/m} + 17.5 \text{ dB} - 20 \text{ dB} + 1.0 \text{ dB} = 23.5 \text{ dBuV/m}$$

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

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Measurement Uncertainty Immunity

The estimated combined standard uncertainty for ESD immunity measurements is $\pm 4.10\%$	Per IEC 61000-4-2
The estimated combined standard uncertainty for radiated immunity measurements is $\pm 2.05\text{dB}$	Per IEC 61000-4-3
The estimated combined standard uncertainty for conducted immunity measurements; CDN is $\pm 1.83\text{dB}$.	Per IEC 61000-4-6
The estimated combined standard uncertainty for harmonic current and flicker measurements; PM6000 is $\pm 2.5\%$.	Per CISPR 16-4-2

(Surge immunity is Per CISPR 16-4-2 methods)

The estimated combined standard uncertainty for EFT fast transient immunity measurements is $\pm 2.92\%$.
The estimated combined standard uncertainty for surge immunity measurements is $\pm 2.92\%$.

Measurement Uncertainty Immunity

The estimated combined standard uncertainty for power frequency magnetic field immunity measurements is $\pm 5.80\%$
The estimated combined standard uncertainty for voltage variation and interruption measurements is $\pm 1.74\%$

Expanded measurement uncertainty numbers are shown in the tables above. Compliance criteria are not based on measurement uncertainty. The expanded uncertainty at a level of 95% confidence is obtained by multiplying the combined standard uncertainty by a coverage factor of 2.

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.

2.3 Software Used

Manufacturer	Name	Version
Quantum Change/EMC Systems LLC.	Tile	3.2U
TopRudder	RadCon RF Immunity	1.1.13
TUV	Alt "R"	1
TUV	Alt "C"	1
VolTech Instruments	IEC61000-3 for PM6000	1.24.12
California Instruments	AC Source GUI 32	1.19
CTS	CTS 3.0	3.2.0.32
KeyTek ECAT	Surgeware	V5.31
KeyTek ECAT	Burstware	V5.31
Rohde & Schwarz	Click Rate Analyzer	1.7.0

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2.4 Measurement Equipment Used

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal dd/mm/yy	Next Cal dd/mm/yy
Radiated Emissions (5 Meter Chamber) and Conducted RF Measurements					
Receiver, EMI	Rohde & Schwarz	ESIB40	100043	04-Sep-12	04-Sep-13
Receiver, EMI	Rohde & Schwarz	ESCI 7	100917	05-Sep-12	05-Sep-13
Spectrum Analyzer	Agilent Tec.	E7405A	US39440161	28-Sep-12	28-Sep-13
Amplifier, preamp	Agilent Technologies	8449B	3008A01480	14-Nov-11	14-Nov-13
Ant. BiconiLog	Chase	CBL6140A	1108	24-Aug-11	24-Aug-13
Antenna Horn 1-18GHz	EMCO	3115	5770	26-Sep-12	26-Sep-14
Cable, Coax	MicroCaox	MKR300C-0-0-1200-500500	002	01-Sep-12	01-Sep-13
Cable, Coax	MicroCaox	MKR300C-0-1968-500310	005	01-Sep-12	01-Sep-13
Cable, Coax	MicroCaox	UFB29C-1-5905-50U-50U	009	01-Sep-12	01-Sep-13
Cable, Coax	Andrew	FSJ1-50A	045	01-Sep-12	01-Sep-13
1.5 GHz High Pass Filter	Bonn Elektronik	BHF 1500	025155	14-Nov-11	14-Nov-13
3.0 GHz High Pass Filter	Bonn Elektronik	BHF 3000	025155	14-Nov-11	14-Nov-13
High Pass Filter	Micro-tronics	BRM50702	049	14-Nov-11	14-Nov-13
Conducted Emissions (AC/DC and Signal I/O)					
Receiver, EMI	Rohde & Schwarz	ESCI 7	100917	05-Sep-12	05-Sep-13
Cable, Coax	Pasternack	RG-223	051	01-Sep-12	01-Sep-13
LISN 15-18 (NSLK 8126)	Schwarzbeck Mess-Elektronik	NSLK 8126	003885	11-Jan-12	11-Jan-14
Transient Limiter	Schaffner	CFL-9206	1649	01-Aug-11	01-Aug-13
General Laboratory Equipment					
Meter, Multi	Fluke	179	90580752	06-Sep-12	06-Sep-13
RFI (5m) Test System	TUV Rheinland	5 Meter		CNR	CNR
Meter, Temp/Humid/Barom	Davis	7400	PB00205A13	09-May-12	09-May-13
Meter, Temp/Humid/Barom	Davis	7400	PB00205A05	09-May-12	09-May-13

3 Product Information

3.1 Product Description

See Section Appendix A.

3.2 Equipment Modifications

No modifications were needed to bring product into compliance.

3.3 Test Plan

The EUT product information, test configuration, mode of operation, test types, test procedures, test levels, pass/failure criteria, in this report were carried out per the product test plan located in appendix A of this report

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4 900 MHz Transmitter Emission Measurements

4.1 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.

4.1.1 Over View of Test

Results	Complies (as tested per this report)					Date	4 March 2013	
Standard	FCC Parts 15.205, 15.209, 15.215(c), 15.247(d), RSS-210 A8.5, and RSS-GEN 7.2.3.2							
Product Model	FIREFLY RFID EXPANSION CARD			Serial#		PRODUCTION PROTOTYPE		
Test Set-up	Tested in a 5m Semi Anechoic chamber, placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane on a turn-table. See test plans for details							
EUT Powered By	120V 60Hz	Temp	70° F	Humidity	21%	Pressure	997 mbar	
Perf. Criteria	(Below Limit)			Perf. Verification		Readings Under Limit		
Mod. to EUT	None			Test Performed By		Mark Ryan		

4.1.2 Test Procedure

Testing was performed in accordance with 47 CFR Part 15, ANSI C63.10:2009, RSS-GEN Issue 2. 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.

4.1.3 Deviations

The EUT is intended to be used with rechargeable batteries; however these tests will drain the battery in a few minute. Therefore, a charging base was used to maintain the extended transmitter on time. This will be employed in all the following tests.

4.1.4 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.

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4.1.4.1 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. Radiated antenna emission measurements are provided below to show that the EUT meets these requirements including the cabinet radiation of the EUT.

Three orientations of the EUT investigated for highest emissions:

Emission Freq (MHz)	ANT Polar (H/V)	QP FIM Value (dBUV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBUV/m)
Orientation A:						
915.25	H	92.99	0.00	3.60	22.61	119.20
915.25	V	102.96	0.00	3.60	22.61	129.17
915.25	H	99.24	0.00	3.60	22.61	125.45
915.25	V	89.13	0.00	3.60	22.61	115.34
915.25	H	99.44	0.00	3.60	22.61	125.65
915.25	V	94.71	0.00	3.60	22.61	120.92
915.25	H	93.21	0.00	3.60	22.61	119.42
915.25	V	87.56	0.00	3.60	22.61	113.77
902.75	H	93.68	0.00	3.56	22.50	119.74
902.75	V	103.25	0.00	3.56	22.50	129.31
927.25	H	94.72	0.00	3.62	22.80	121.14
927.25	V	101.42	0.00	3.62	22.80	127.84
Orientation B:						
915.25	H	102.57	0.00	3.60	22.61	128.78
915.25	V	96.52	0.00	3.60	22.61	122.73
915.25	H	92.54	0.00	3.60	22.61	118.75
915.25	V	98.90	0.00	3.60	22.61	125.11
915.25	H	96.19	0.00	3.60	22.61	122.40
915.25	V	97.94	0.00	3.60	22.61	124.15
Orientation C:						
915.25	H	100.62	0.00	3.60	22.61	126.83
915.25	V	102.38	0.00	3.60	22.61	128.59
915.25	H	94.50	0.00	3.60	22.61	120.71
915.25	V	97.34	0.00	3.60	22.61	123.55
915.25	H	93.02	0.00	3.60	22.61	119.23
915.25	V	97.51	0.00	3.60	22.61	123.72

NOTE: Orientation A , on the low frequency produced the highest emission (see highlighted).

Red = Antenna 1, Blue = Antenna 2, Green = Antenna 3, Black = Antenna 4

Channel that produces the highest emissions:

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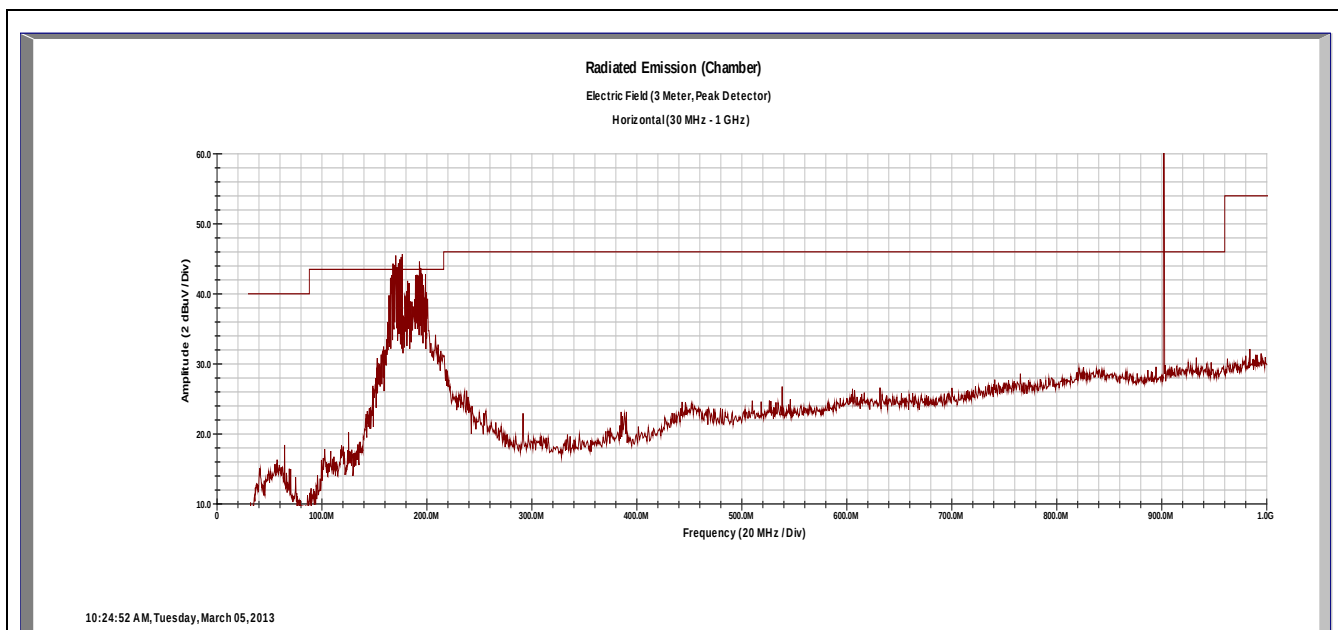
Report No.:

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Radiated Emissions - 30MHz to 1000 MHz

Horizontal



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
172.96	H	1.5	107	23.70	0.00	1.51	8.78	33.99	43.50	-9.51
192.00	H	1.1	113	22.89	0.00	1.61	10.28	34.78	43.50	-8.72

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

Combined Standard Uncertainty $u_c(y) = \pm 2.29\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: Worst Case emissions shown are in Orientation A on the low channel.

The emission at 902 MHz is the fundamental frequency.

A notch filter tuned to the fundamental was used.

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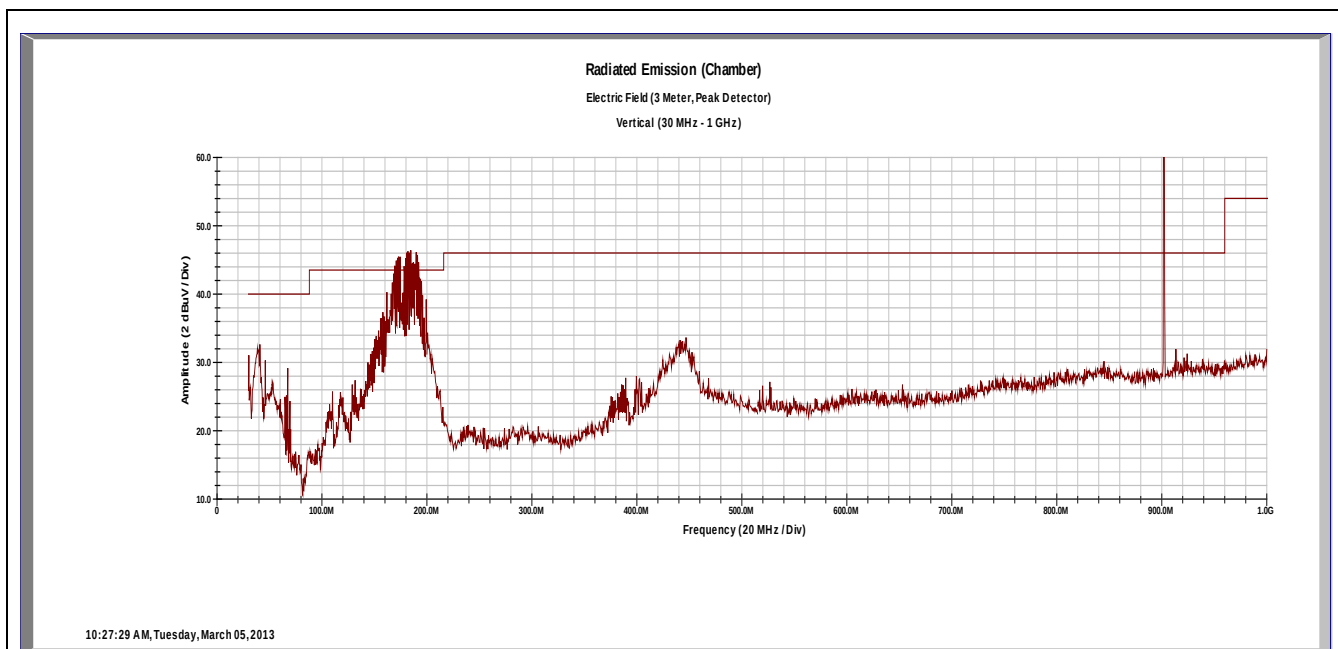
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Radiated Emissions - 30MHz to 1000 MHz

Vertical



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
36.76	V	1	337	20.54	0.00	0.69	8.06	29.29	40.00	-10.71
67.00	V	1	355	7.20	0.00	0.93	9.66	17.79	40.00	-22.21
177.96	V	1	311	25.72	0.00	1.54	9.20	36.45	43.50	-7.05
189.44	V	1	309	29.39	0.00	1.60	10.16	41.14	43.50	-2.36
445.96	V	1	328	10.96	0.00	2.46	16.32	29.74	46.00	-16.26

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

Combined Standard Uncertainty $u_c(y) = \pm 2.29\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: Worst Case emissions shown are in Orientation A on the low channel.

The emission at 902 MHz is the fundamental frequency.

A notch filter tuned to the fundamental was used.

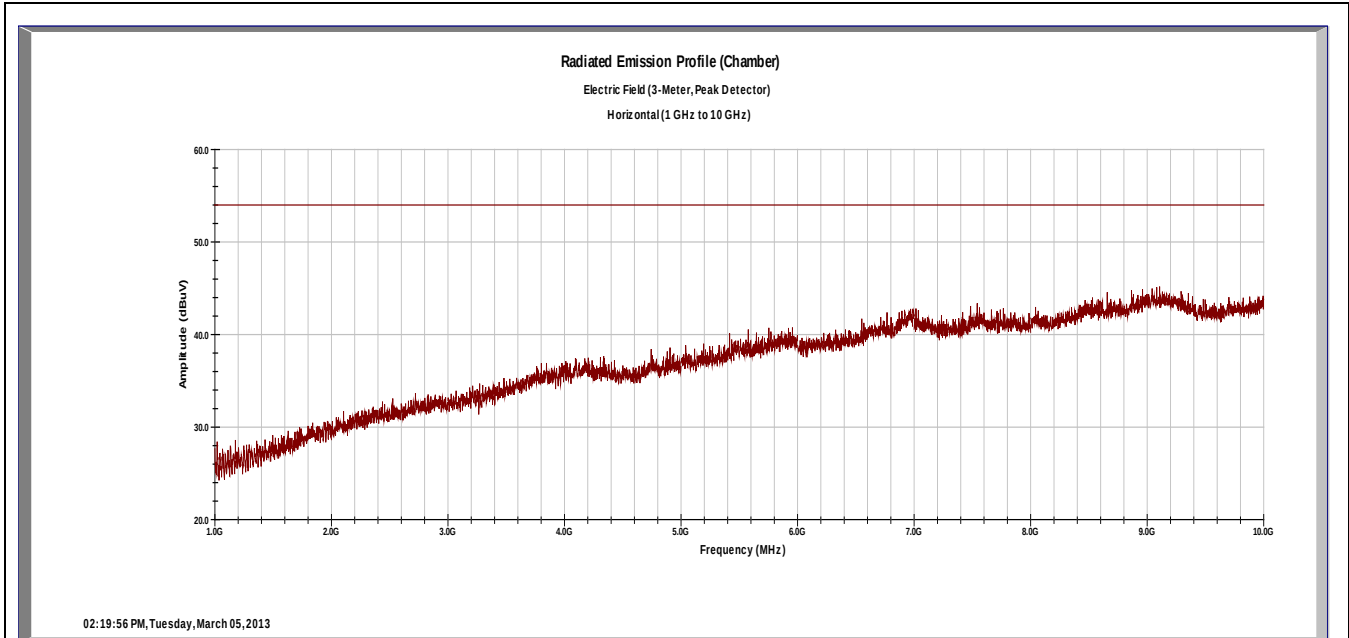
The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TUV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

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Radiated Emissions - 30MHz to 1000 MHz
Horizontal



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

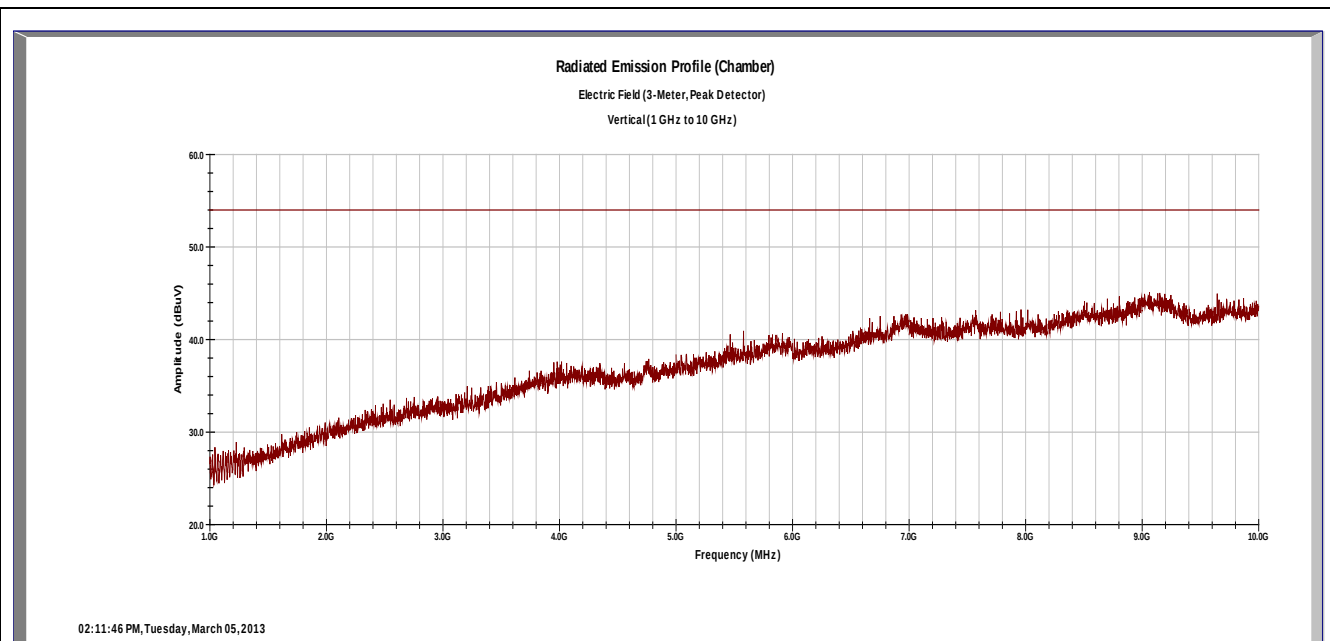
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y) = \pm 2.29\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: No detectable emissions

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Vertical

[illegible]
$$\text{Spec Margin} = \text{E-Field Value} - \text{Limit}, \quad \text{E-Field Value} = \text{FIM Value} - \text{Amp Gain} + \text{Cable Loss} + \text{ANT Factor} \pm \text{Uncertainty}$$

Combined Standard Uncertainty $u_c(y) = \pm 2.29\text{dB}$ Expanded Uncertainty $U = ku_c(y)$ $k = 2$ for 95% confidence

Notes: No detectable emissions

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4.2 Conducted Emissions FCC 15.207(a) and RSS-210

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.

4.2.1 Over View of Test

Results	Complies (as tested per this report)					Date	8 March 2013	
Standard	FCC Part 15.207(a) and RSS-GEN, 7.2.2							
Product Model	FIREFLY RFID EXPANSION CARD			Serial#	PRODUCTION PROTOTYPE			
Configuration	See test plan for details							
Test Set-up	Tested in shielded room. EUT placed on table, see test plans for details							
EUT Powered By	120VAC	Temp	72° F	Humidity	20%	Pressure	1007 mbar	
Frequency Range	150kHz - 30MHz							
Perf. Criteria	15.207(a) limits	Perf. Verification		Readings Under Limit for L1 & Neutral				
Mod. to EUT	None	Test Performed By		Mark Ryan				

4.2.2 Test Procedure

Conducted and FCC emissions tests were performed using the procedures of ANSI C63.4 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 150kHz - 30MHz was investigated for conducted emissions.

Conducted Emissions measurements were performed in the shielded room using procedures specified in the test plan and standard.

4.2.3 Deviations

There were no deviations from the test methodology listed in the test plan for the conducted emission test.

4.2.4 Final Test

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

The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TÜV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

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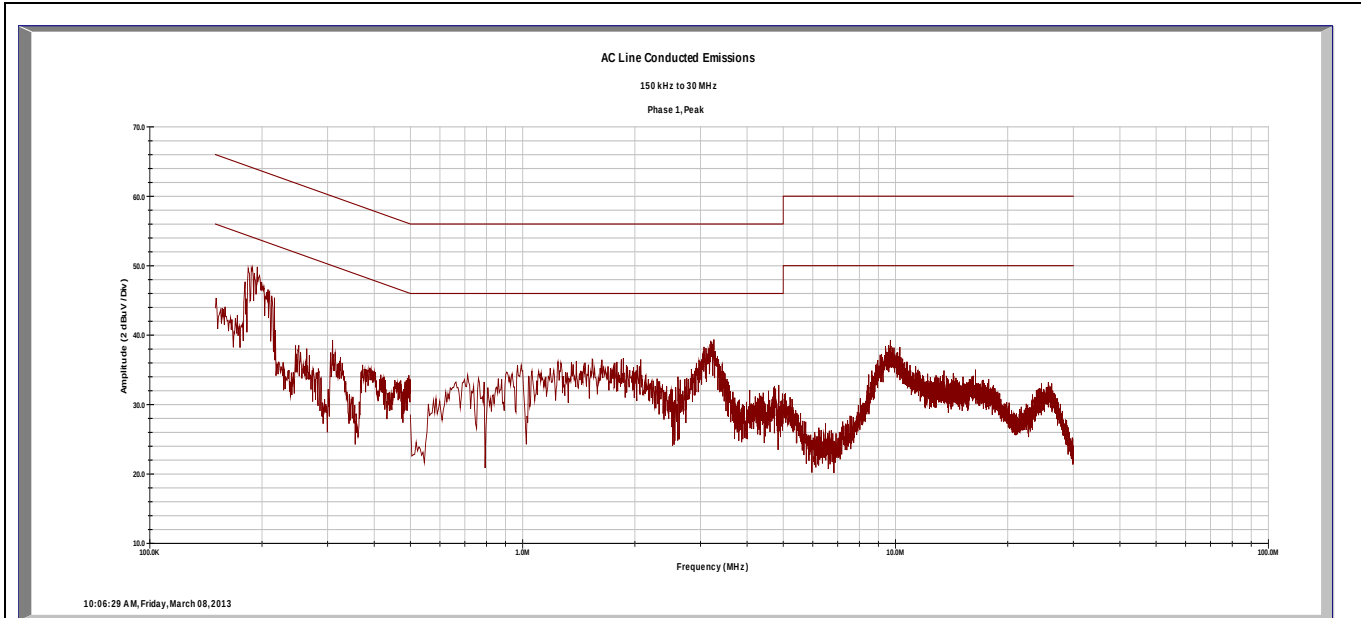
31252050.001

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4.2.5 Final Graphs and Tabulated Data

Conducted Emissions @ 120V/60Hz

Line 1



Freq (MHz)	ID (1,2,3,N)	Quasi (dBuV)	Ave (dBuV)	Loss (dB)	T Limiter (dB)	Limit (dBuV)	Limit (dBuV)	Margin (dB)	Margin (dB)
0.20	1	34.72	21.25	0.03	9.96	63.69	53.69	-18.99	-22.46
1.86	1	22.03	11.09	0.09	10.06	56.00	46.00	-23.83	-24.77
3.26	1	22.38	14.95	0.12	10.13	56.00	46.00	-23.38	-20.81
5.30	1	13.39	4.06	0.15	10.20	60.00	50.00	-36.26	-35.59
9.57	1	22.29	16.39	0.22	10.37	60.00	50.00	-27.12	-23.02
25.96	1	16.85	11.31	0.37	10.24	60.00	50.00	-32.54	-28.08

Quasi Spec Margin = Quasi FIM + Cable Loss + LISN CF - Quasi Limit $\pm$ Uncertainty

Ave Spec Margin = Ave FIM + Cable Loss + LISN CF - Ave Limit $\pm$ Uncertainty

Combined Standard Uncertainty $u_c(y) = \pm 1.66\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: 915MHz transmitter on

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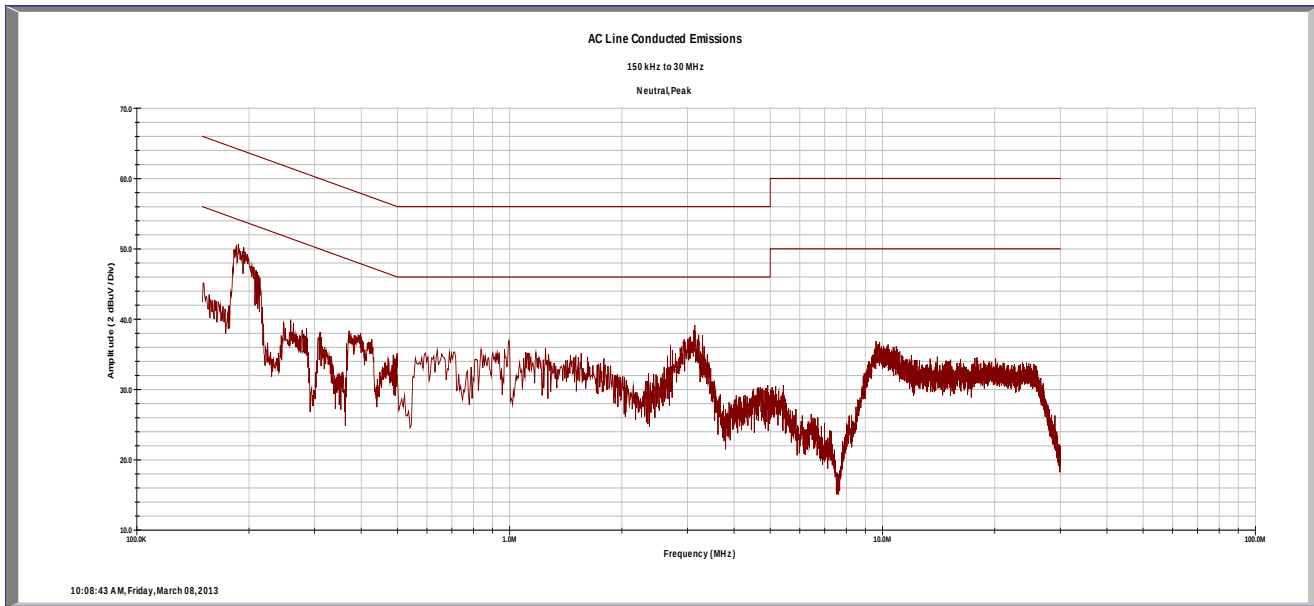
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Conducted Emissions @ 120V/60Hz

Neutral



Freq (MHz)	ID (1,2,3,N)	Quasi (dBuV)	Ave (dBuV)	Loss (dB)	T Limiter (dB)	Limit (dBuV)	Limit (dBuV)	Margin (dB)	Margin (dB)
0.19	N	37.19	21.81	0.03	9.97	64.21	54.21	-17.03	-22.41
1.18	N	20.58	8.69	0.07	10.01	56.00	46.00	-25.34	-27.23
3.12	N	22.12	13.69	0.11	10.11	56.00	46.00	-23.65	-22.08
4.90	N	13.98	4.12	0.15	10.20	56.00	46.00	-31.68	-31.54
9.77	N	21.05	14.93	0.22	10.42	60.00	50.00	-28.31	-24.43
21.52	N	18.08	12.56	0.33	10.54	60.00	50.00	-31.05	-26.57

Quasi Spec Margin = Quasi FIM + Cable Loss + LISN CF - Quasi Limit $\pm$ Uncertainty

Ave Spec Margin = Ave FIM + Cable Loss + LISN CF - Ave Limit $\pm$ Uncertainty

Combined Standard Uncertainty $u_c(y) = \pm 1.66\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: 915MHz transmitter on

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4.3 FHSS Systems FCC 15.247(g) and RSS-210, A8.1

Frequency Hopping Spread Spectrum (FHSS) systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

The FIREFLY RFID EXPANSION CARD utilizes proprietary protocols and pseudo-random hopping table.

4.4 Incorporation of Intelligence within a FHSS System FCC 15.247(h) and RSS-210, A8.1

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hop sets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

The EUT does not incorporate intelligence relating to the hopping pattern as described above. Rather, the EUT always distributes its transmissions across the same 50 channels. A channel is not re-used until a transmission has occurred on each of the other channels.

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4.5 Channel Separation

4.5.1 Test Over View

Results	Complies (as tested per this report)					Date	1 March 2013	
Standard	FCC Part 15.247(a)(1)(i), RSS 210 A8.1							
Product Model	FIREFLY RFID EXPANSION CARD			Serial#	PRODUCTION PROTOTYPE			
Test Set-up	Radiated emissions at 3m							
EUT Powered By	120VAC/60Hz	Temp	74° F	Humidity	32%	Pressure	1010mbar	
Perf. Criteria	(Below Limit)		Perf. Verification		Readings Under Limit			
Mod. to EUT	None		Test Performed By		Mark Ryan			

4.5.2 Test Procedure

Frequency hopping Systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Maximum allowed 20dB Bandwidth = 250 kHz

Min. Channel Separation = 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater

The channel separation is greater than the measured maximum 20 dB bandwidth. Therefore the EUT is compliant with this section.

4.5.3 Deviations

The test samples received were not modified with a direct measurement port. Therefore 3m radiated emissions were made for this measurement.

4.5.4 Final Test

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

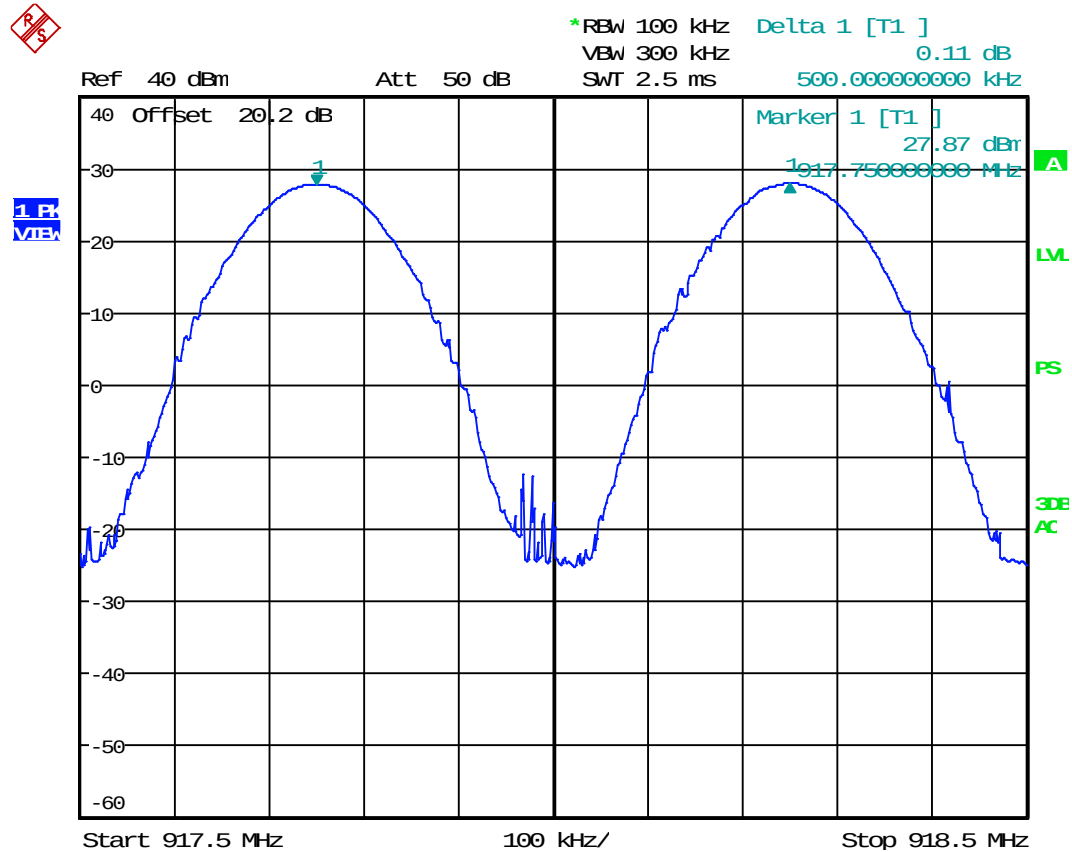
The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TUV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

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4.5.5 Final Data



Date: 1.MAR.2013 09:39:32

Figure 1: Channel Separation = 500 kHz

Spectrum Analyzer Parameters:

RBW=100kHz

Span=1 MHz

VBW= 30kHz

LOG dB/div.= 10dB

Sweep = Auto

Detector = peak detector, max hold

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4.6 Pseudorandom Hopping Algorithm

Frequency hopping systems in the 902 to 928 MHz band shall use at least 50 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20 second period.

4.6.1 Test Over View

Results	Complies (as tested per this report)					Date	1 March 2013	
Standard	FCC Part 15.247(b)(1) and RSS-210, A8.1(b)							
Product Model	FIREFLY RFID EXPANSION CARD				Serial#	PRODUCTION PROTOTYPE		
Test Set-up	Radiated Measurement from 3m							
EUT Powered By	120VAC/60Hz	Temp	77° F	Humidity	35%	Pressure	1004 mbar	
Perf. Criteria	(Below Limit)			Perf. Verification		Readings Under Limit		
Mod. to EUT	None			Test Performed By		Mark Ryan		

4.6.2 Test Procedure

The FIREFLY RFID EXPANSION CARD Transmitter would send a packet every 50 ms with a delay of 1 second between packets. Each packet is sent on the next channel as determined by the pseudo-random hop protocol.

4.6.3 Deviations

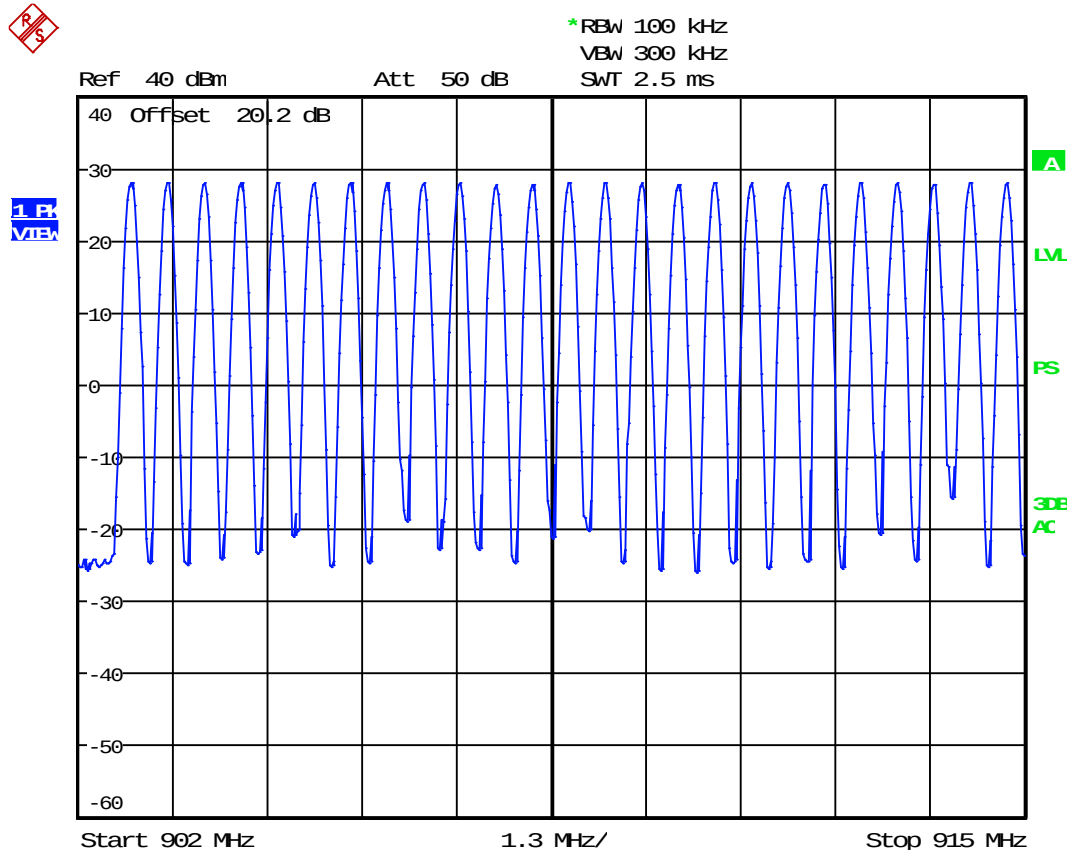
Tested on antenna port #3.

4.6.4 Final Test

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

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4.6.5 Final Data



Date: 1.MAR.2013 09:25:38

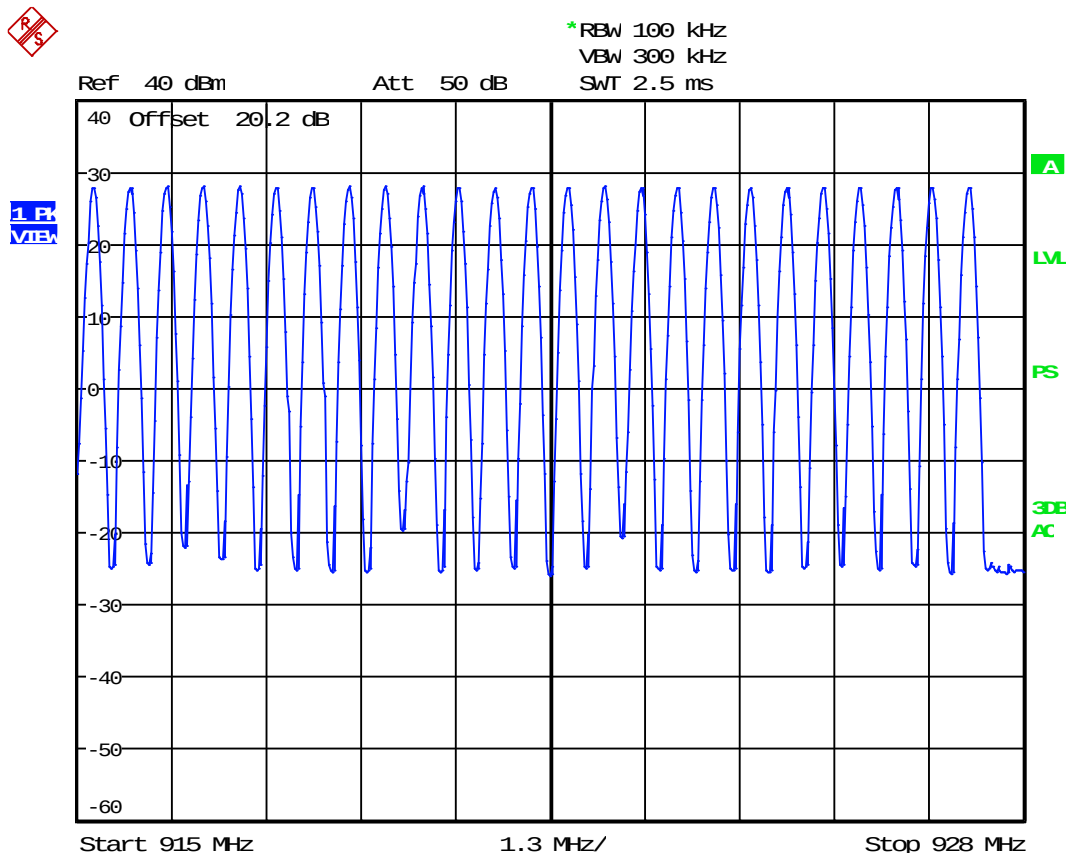
Figure 2: Plot of hopping Channels - 902 MHz to mid-band

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Date: 1.MAR.2013 09:28:28

Figure 3: Plot of hopping Channels from Mid-band to 928 MHz (50 hopping channels total)

Spectrum Analyzer Parameters:

RBW=100kHz

Span=14MHz

VBW= 100kHz

LOG dB/div.= 10dB

Sweep = Auto

Detector = peak detector, max hold

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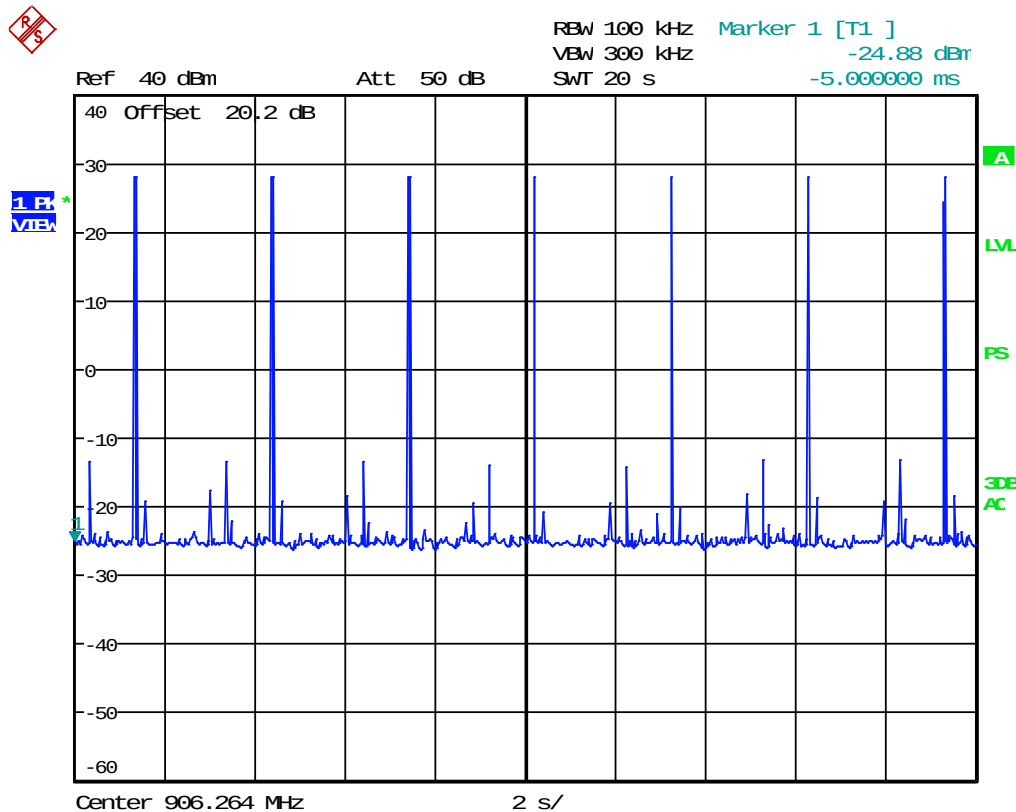
Time of Occupancy FCC Part 15.247(a)(1)(iii)

Frequency Band (MHz)	20 dB Bandwidth	Number of Hopping Channels	Average Time of Occupancy
902 to 928	≤250 kHz	50	≤ 0.4 sec. In (0.4 * 50) sec.

There were 7 hops at 38.7 milliseconds per hop for any 20 second period. Time of occupancy equals number of hops multiplied by the duration of one hop.

Time of Occupancy limit = 0.40 seconds in any (0.4*50) = 20 second period.

Calculated Time of Occupancy = 38.7 ms / hop x 7 hops = 0.28 seconds in any 20 second period



Date: 1.MAR.2013 13:13:46

Figure 4: 20 second sweep of 906.25 MHz shows 7 hops

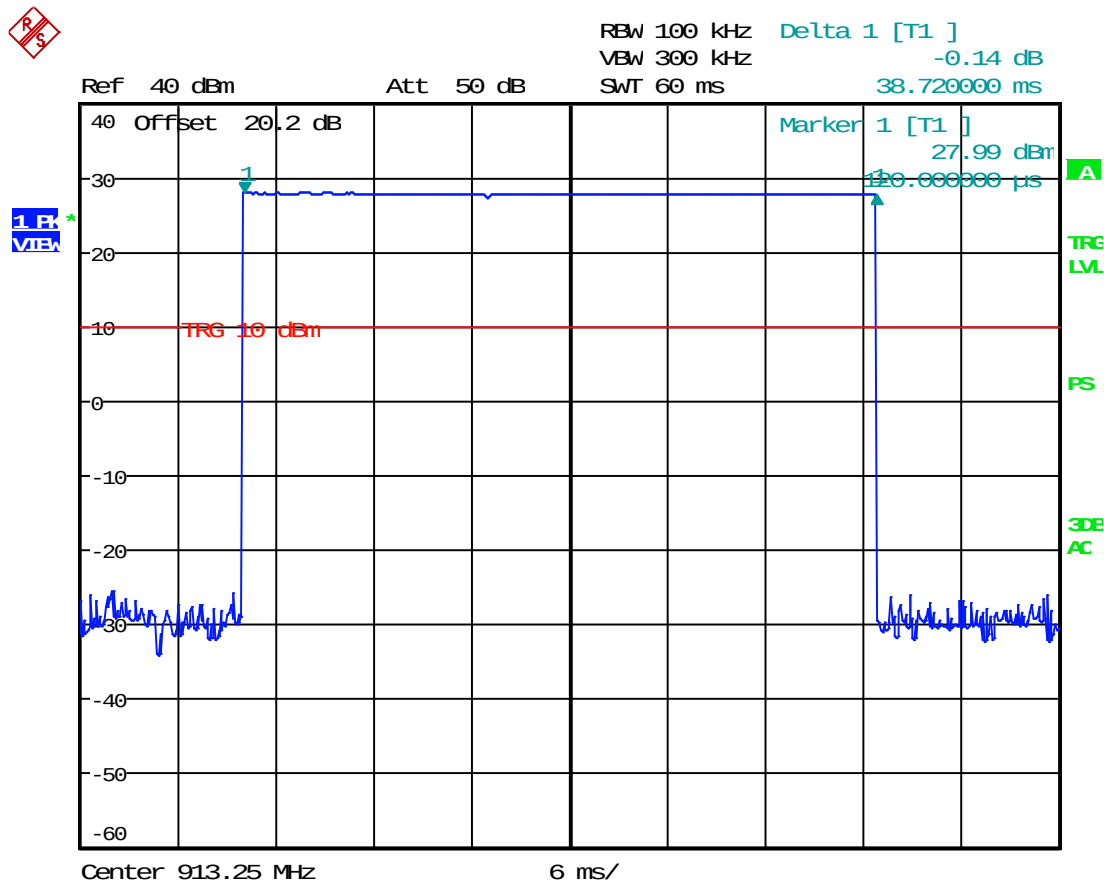
Note: The on-channel traces are the 7 highest peaks.

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Date: 1.MAR.2013 09:59:38

Figure 5: Measurement of 1 hop at 913.25 MHz

Time on Frequency = 38.7 ms

Spectrum Analyzer Parameters:

RBW=100kHz

Span=zero

VBW= 300kHz

LOG dB/div.= 10dB

Sweep = 60 ms

Detector = peak detector, max hold

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4.7 Occupied Bandwidth

The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

4.7.1 Test Over View

Results	Complies (as tested per this report)					Date	1 March 2013	
Standard	FCC Part 15.247(a)(1)(i) and RSS-210, A8.1(a)							
Product Model	FIREFLY RFID EXPANSION CARD			Serial#	PRODUCTION PROTOTYPE			
Test Set-up	Direct Measurement from antenna port							
EUT Powered By	120VAC/60Hz	Temp	74° F	Humidity	32%	Pressure	1010mbar	
Perf. Criteria	(Below Limit)			Perf. Verification		Readings Under Limit		
Mod. to EUT	None			Test Performed By		Mark Ryan		

4.7.2 Test Procedure

Frequency hopping Systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Maximum allowed 20dB Bandwidth = 500 kHz

Channel Separation = 25 kHz Min. or the 20 dB bandwidth of the hopping channel, whichever is greater

The channel separation is greater than the measured maximum 20 dB bandwidth. Therefore the EUT is compliant with this section.

4.7.3 Deviations

Tested on antenna port #3.

4.7.4 Final Test

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

4.7.5 Final Data

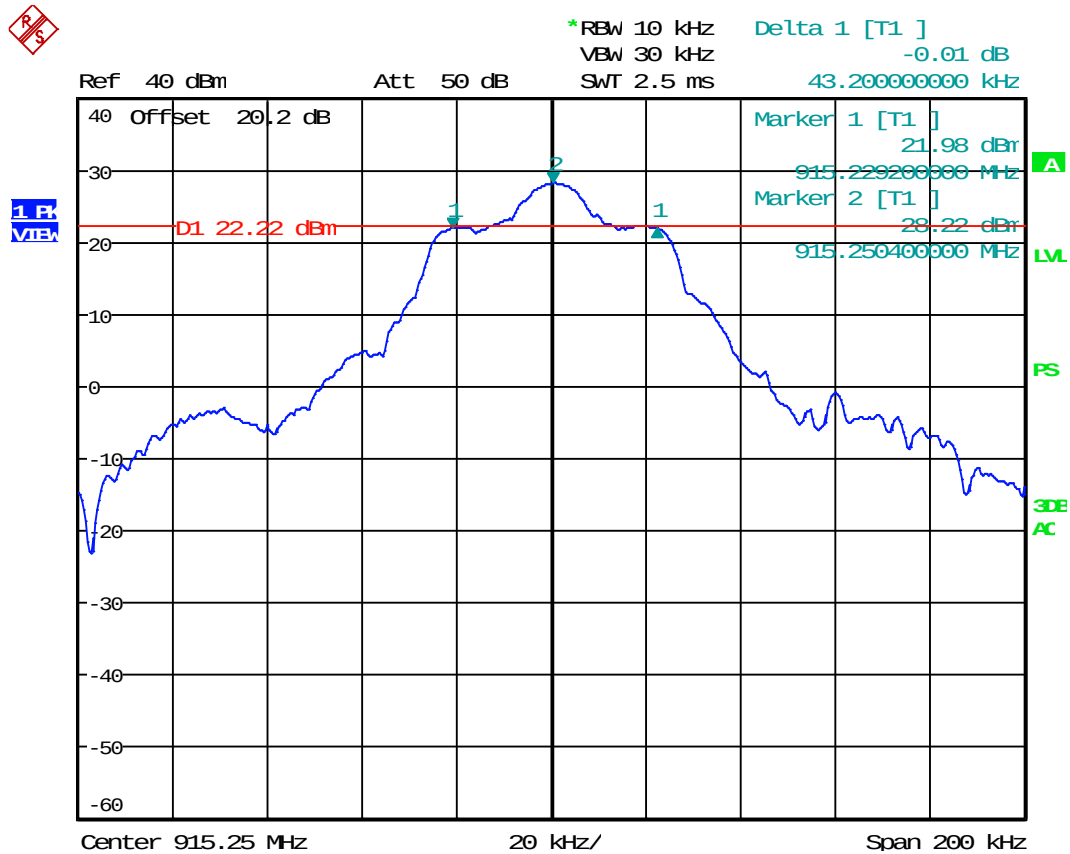
Frequency (MHz)	6 dB Band Width	20 dB Band width
902.75, f_L	42.4 kHz	70.4 kHz
915.25, f_m	43.2 kHz	69.6 kHz
927.25, f_h	41.6 kHz	71.6 kHz

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Date: 1.MAR.2013 11:27:17

Figure 6: 6 dB Occupied Bandwidth

Note: highest 6dB bandwidth shown. Plots for low and high band are on file at TUV Rheinland.

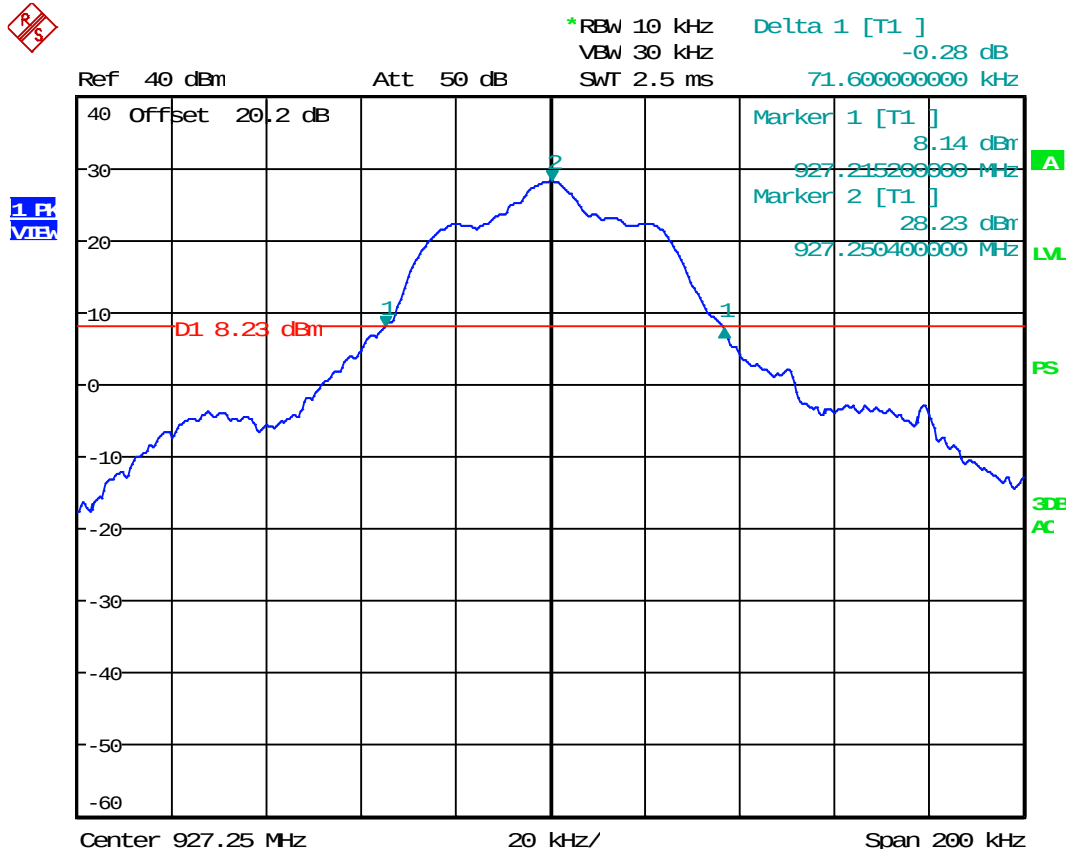
***BW = 43.2 KHZ**

The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TÜV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

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Date: 1.MAR.2013 12:59:21

Figure 7: 20 dB Occupied Bandwidth

Note: highest 20dB bandwidth shown. Plots for low and mid band are on file at TUV Rheinland..

***BW = 71.6 KHZ**

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

4.8.1 Test Over View

Results	Complies (as tested per this report)					Date	1 March 2013	
Standard	RSS-210, A8.1(a) and RSS-GEN.4.6.1							
Product Model	FIREFLY RFID EXPANSION CARD			Serial#	PRODUCTION PROTOTYPE			
Test Set-up	Direct Measurement from antenna port							
EUT Powered By	120VAC/60Hz	Temp	74° F	Humidity	32%	Pressure	1010mbar	
Perf. Criteria	(Below Limit)			Perf. Verification		Readings Under Limit		
Mod. to EUT	None			Test Performed By		Mark Ryan		

4.8.2 Test Procedure

Using the procedures of RSS-GEN section 4.6.1, the 10 kHz resolution bandwidth is 1% of the 1 MHz span. The Video bandwidth is 3 times that of the resolution bandwidth.

The limit of the bandwidth would be 0.5% of 916 MHz is 4.58 MHz. The measured 99% bandwidth is 326.7 kHz.

4.8.3 Deviations

Tested on antenna port #3.

4.8.4 Final Test

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

4.8.5 Final Data

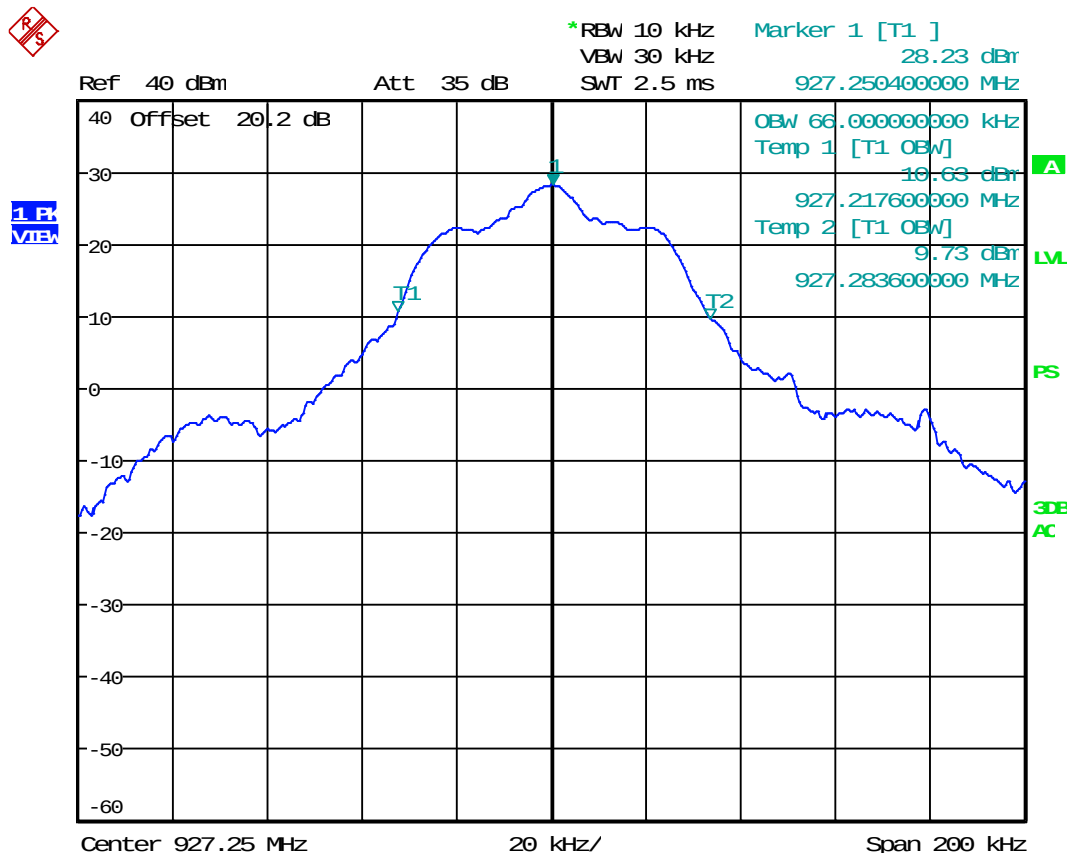
Frequency (MHz)	99% Power Band Width
902.75, f_L	64.4 kHz
915.25, f_m	64.0 kHz
927.25, f_h	66.0 kHz

The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TUV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

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Figure 8 – Worst case 99% Power Bandwidth = 66 kHz

Spectrum Analyzer Parameters:

RBW=10kHz

Span= 2 MHz

VBW= 30kHz

LOG dB/div.= 10dB

Sweep = Auto

Detector = peak detector, max hold

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

The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TUV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

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4.9 Band Edge

4.9.1 Test Over View

Results	Complies (as tested per this report)					Date	1 March 2013	
Standard	FCC Part 15.247(d), RSS 210 A8.5							
Product Model	FIREFLY RFID EXPANSION CARD			Serial#	PRODUCTION PROTOTYPE			
Test Set-up	Direct Measurement from antenna port							
EUT Powered By	120VAC/60Hz	Temp	74° F	Humidity	32%	Pressure	1010mbar	
Perf. Criteria	(Below Limit)			Perf. Verification		Readings Under Limit		
Mod. to EUT	None			Test Performed By		Mark Rvan		

4.9.2 Test Procedure

Intentional radiators operating under the alternative provisions to the general emission limits must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

4.9.3 Deviations

The test samples received were not modified with a direct measurement port. Therefore 3m radiated emissions were made for this measurement.

4.9.4 Final Test

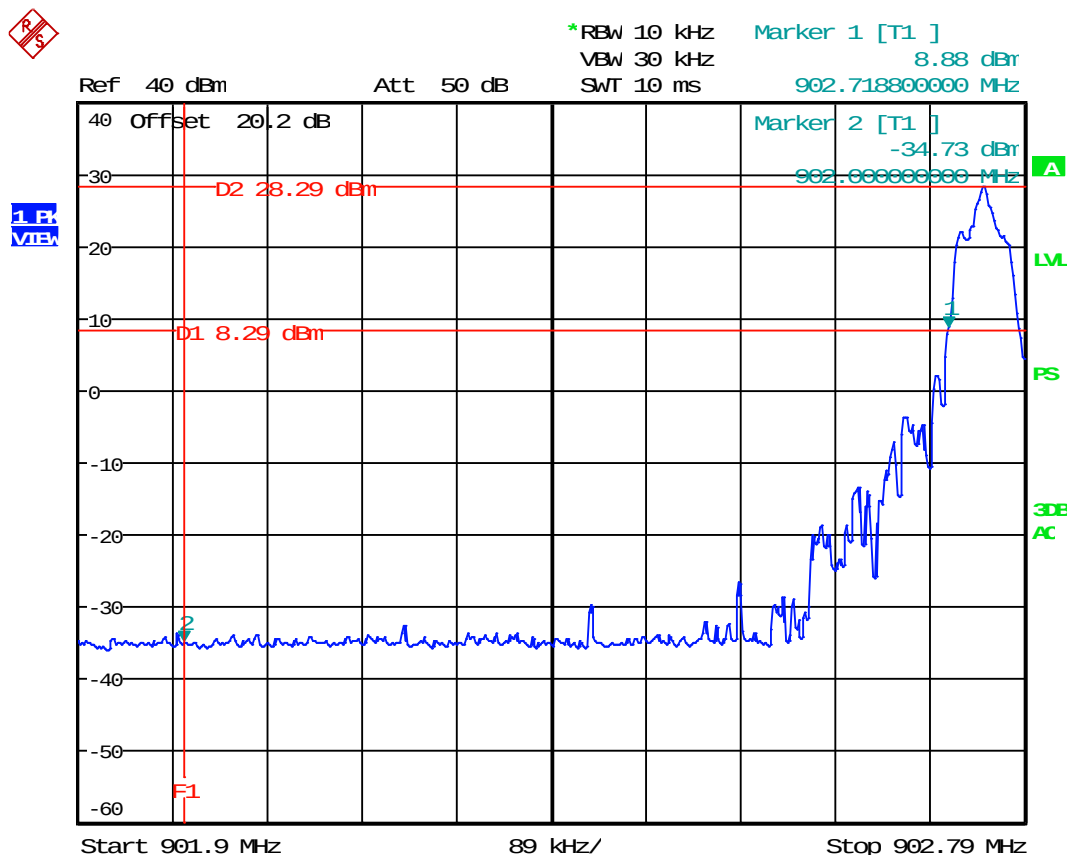
The EUT met the performance criteria requirement as specified in the test plan of this report and in the standards.

The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TUV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

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Date: 1.MAR.2013 13:56:24

Figure 9: Lower Band Edge Measurement

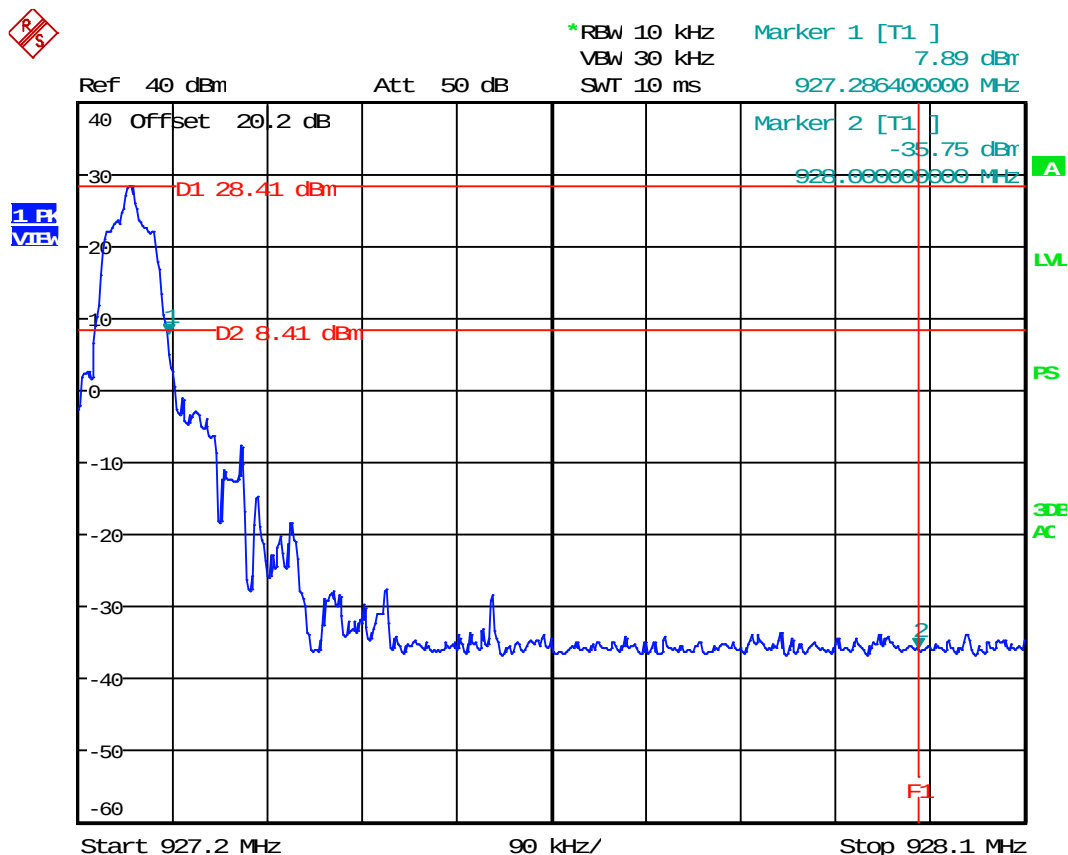
Note: Band Edge is at 902 MHz

Channel Frequency is 902.75 MHz,

The frequency at the -20dBc point is 902.72 MHz

The level at the 902 MHz band edge is -34.7 dBm (Noise floor of receiver) which is -63dBc

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Figure 10: Upper Band Edge Measurement

Note: Band edge is at 928 MHz

Channel Frequency is 928.25 MHz,

The frequency at the -20dBc point is 927.29 MHz

The level at the 902 MHz band edge is -35.7 dBm (Noise floor of receiver) which is -64 dBc

The EUT is compliant with the rules.

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4.10 Transmitter Output Power FCC part 15.247(b)(2) and RSS-210

For frequency hopping systems operating in the 902 to 928 MHz band employing at least 50 hopping channels: 1 watt.

4.10.1 Test Over View

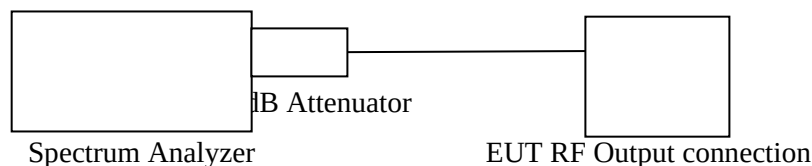
Results	Complies (as tested per this report)					Date	1 March 2013	
Standard	FCC Part 15.247(b)(2) and RSS-210 A8.4(2)							
Product Model	FIREFLY RFID EXPANSION CARD			Serial#	PRODUCTION PROTOTYPE			
Test Set-up	Direct Measurement from antenna port							
EUT Powered By	120VAC/60Hz	Temp	74° F	Humidity	32%	Pressure	1010mbar	
Perf. Criteria	(Below Limit)			Perf. Verification		Readings Under Limit		
Mod. to EUT	None			Test Performed By		Mark Ryan		

4.10.2 Test Procedure

The peak output power was measured at the low, mid and high band frequencies. The measurement was made using a direct connection between the RF output of the EUT and the spectrum analyzer. The cable loss and the attenuator was measured and added in the reference level offset in the spectrum analyzer. The spectrum analyzer's resolution bandwidth was greater than the 20dB bandwidth of the modulated carrier and the video bandwidth was equal to the resolution bandwidth.

The EUT was set with the modulation turned off for this measurement.

4.10.3 Test Setup:



4.10.4 Deviations

The test samples received were not modified with a direct measurement port. Therefore 3m radiated emissions were made for this measurement.

4.10.5 Final Test

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

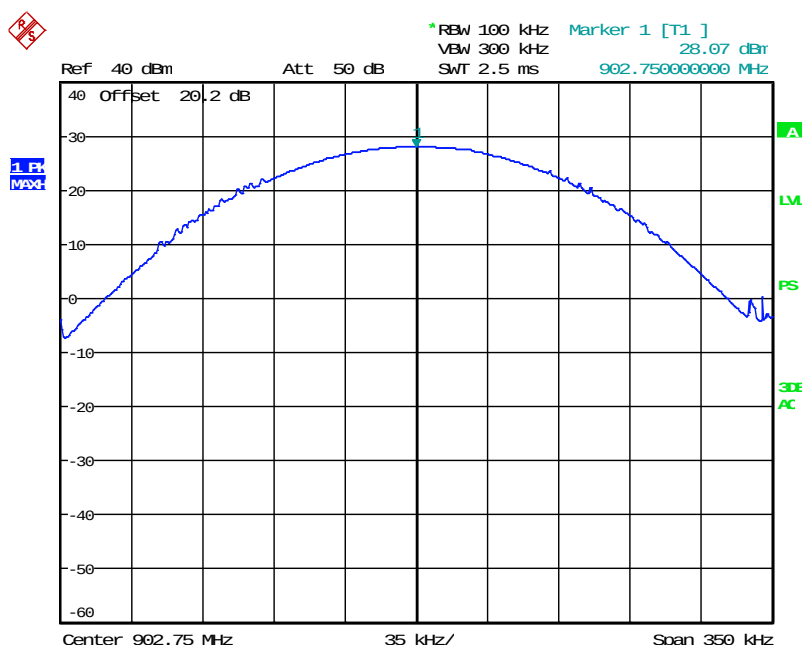
The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TUV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

4.10.6 Peak Power Output

Peak Output Calculated Power Measurements at TUV

Emission Freq (MHz)	Power Out (dBm)	Spec Limit (dBm)	Spec Margin (dB)
902.75, f_L	28.1	30	-1.9
915.25, f_m	28.0	30	-2.0
927.25, f_h	28.0	30	-2.0

Note: The spec limit Per FCC 15.247(b)(2) is 1.0 Watt (30 dBm)
The transmitter is rated at 1Watt Maximum output power.
1 Watt (0.988W) is represented in the SAR Report.
The transmitter submitted for testing produced an output of 65 mW (28.1 dBm).



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Figure 11 – Highest Peak Radiated Power Output shown.
Graphs of the other frequencies are on file at the manufacturer and at TUV.

4.10.7 Antenna Gain

The antenna gain data was supplied by the manufacturer with the following results provided:

Results: **Internal Antenna(s)**

Freq. (MHz)	Max. Peak Gain (dBi)	Max. Gain (Numeric)
902.0 – 928.0	3.0	2.0

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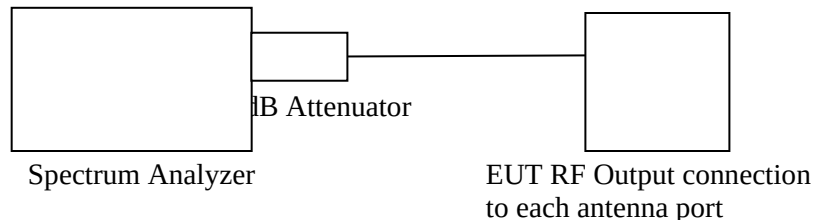
4.11 Operation with multiple antennas

The EUT employs the use of 4 antennas however, only one antenna at a time will be selected for transmission. This test verifies that the other antenna ports will produce similar results.

4.11.1 Test Procedure

The peak output power was measured at the mid band frequency at all four antenna ports. The measurements were made using a direct connection between the RF output of the EUT and the spectrum analyzer. The cable loss and the attenuator was measured and added in the reference level offset in the spectrum analyzer. The spectrum analyzer's resolution bandwidth was greater than the 20dB bandwidth of the modulated carrier and the video bandwidth was equal to the resolution bandwidth.

Test Setup:



4.11.2 Final Test

The EUT performed with very similar results on each of the antenna ports.

4.11.3 Peak Power Output

Peak Output Calculated Power Measurements

Antenna Freq (MHz)	Power Out (dBm)
1	28.03
2	28.20
3	28.07
4	28.06

Note: The antenna ports were within 0.20 dB of each other.

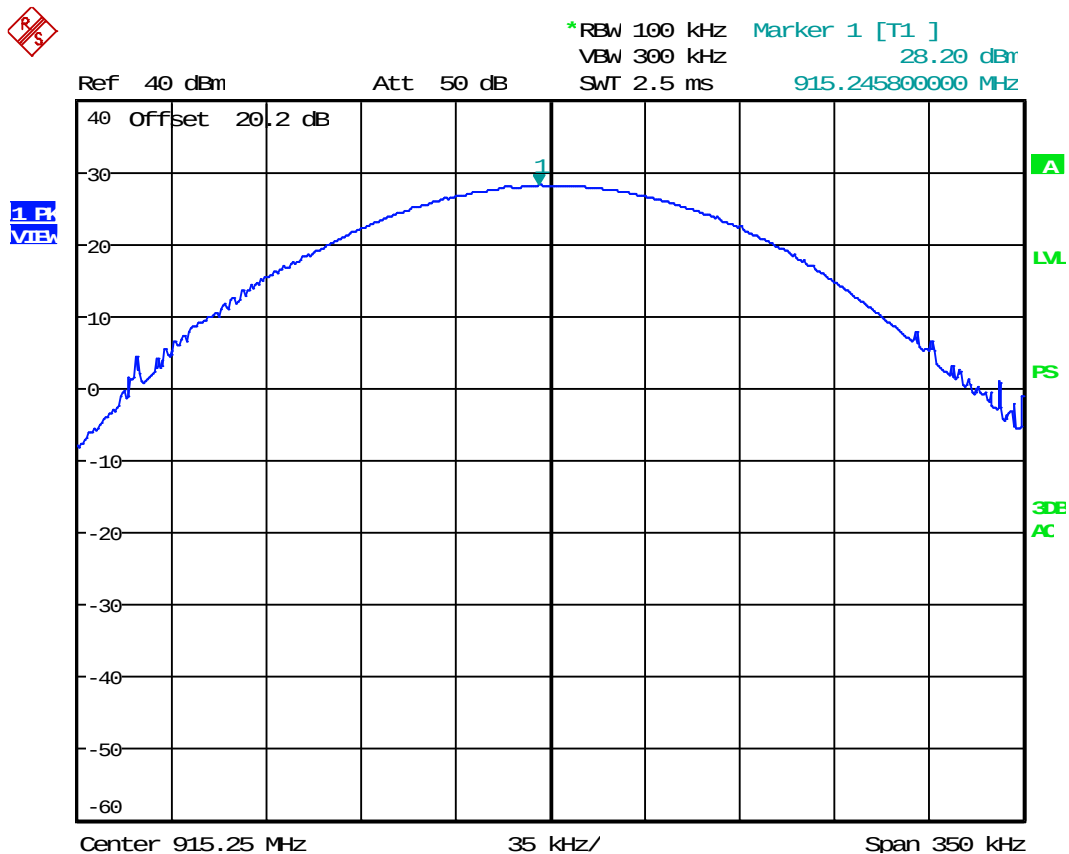
Plot on antenna 3 can be seen on page

The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TUV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

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Figure 12 – Highest Peak Radiated Power Output shown on antenna port 2.
Graphs of the other antenna ports are on file at the manufacturer and at TUV.

The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TUV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

4.12 900 MHz RF Exposure Evaluation

4.12.1 Exposure Requirements – FCC Part 2.1093 and RSS-102 Issue 4

FCC Part 15.247(d) states that SAR evaluation is not required if “Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See §1.1307(b)(1) of CFR 47.”

RSS-102 section 2.5.1 states that a device is exempt from SAR evaluation if the frequency is “above 2.2 GHz and up to 3 GHz inclusively, and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 20 mW for general public use...”.

4.12.2 Test Procedure

If the antenna is located > 20cm from the user, then an MPE calculation is acceptable.

If the antenna is located < 20cm (portable / mobile / hand-held device) from the user, then SAR evaluation is required.

4.12.3 Evaluation

The EUT is intended to be a hand held device. Therefore the transmitter antennas are located in close proximity (< 20cm) to humans. A SAR evaluation is required for the 900MHz portion of this device.

4.12.4 SAR Testing

SAR testing was performed at RF Exposure Lab, in San Marcos, CA. See the SAR Report in exhibits list. The SAR levels are compliant with both the FCC and Industry Canada rules

4.12.5 Evaluation for Industry Canada

RSS-102, Issue 4, section 1.1 states that a RF Exposure evaluation is the method used to evaluate the RF field strength levels generated by a device. RF exposure evaluation is required if the separation distance between the user and the device is greater than 20 cm.

RSS-102, Issue 4, section 1.1 states that a SAR evaluation is the method used to evaluate the SAR levels from a device by physical measurement or computational modeling techniques. SAR evaluation is required if the separation distance between the user or bystanders and the device is less than or equal to 20 cm.

4.12.6 Test Procedure

If the antenna is located > 20cm from the user, then an MPE calculation is acceptable.

If the antenna is located < 20cm (portable / mobile / hand-held device) from the user, then SAR evaluation is required.

4.12.7 Evaluation

The EUT is indented to be a hand held device. Therefore the transmitter antennas are located in close proximity (< 20cm) to humans. A SAR evaluation is required for the 900MHz portion of this device.

4.12.8 SAR Testing

SAR testing was performed at RF Exposure Lab, in San Marcos, CA. See the SAR Report in exhibits list. The SAR levels are compliant with both the FCC and Industry Canada rules.

5 433 MHz transmitter Emission Measurements

5.1 Fundamental Field Strength and Harmonic Emissions

This test evaluates the field strength of the fundamental and field strength of the spurious emissions.

5.1.1 Test Over View

Results	Complies (as tested per this report)					Date	4 March 2013	
Standard	FCC Part 15.247 and RSS-210 Annex 8and RSS-210, A1.1							
Product Model	FIREFLY RFID EXPANSION CARD				Serial#	PRODUCTUION PROTOTYPE		
Configuration	See test plan for details							
Test Set-up	Tested in anechoic chamber		EUT placed on table		See test plan for details			
EUT Powered By	120VAC/60Hz	Temp	72° F	Humidity	13%	Pressure	1000 mbar	
Perf. Criteria	15.231(b) Table (Below Limit)			Perf. Verification	Readings under Limit			
Mod to EUT	None			Test Performed By	Mark Ryan			

5.1.2 Test Procedure

The EUT was placed on a table 3 meters from the antenna and all 3 orthogonal positions were investigated for highest field strength and highest spurious emissions. The fundamental frequency of the EUT is 433.0 MHz, therefore in addition to the requirements of 15.205 the EUT was tested to meet the following requirements in 15.231(b)

Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)	Field strength of spurious emissions (microvolts/meter)
40.66-40.70.....	2,250.....	225
70-130.....	1,250.....	125
130-174.....	\1\ 1,250 to 3,750	\1\ 125 to 375
174-260.....	3,750.....	375
260-470.....	\1\ 3,750 to 12,500.	\1\ 375 to 1,250
Above 470.....	12,500.....	1,250

5.1.3 Deviations

There were no deviations from the test methodology listed in the test plan for the harmonic current emissions test.

The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TUV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

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5.1.4 Final Data

5.1.4.1 Three orientations of the EUT investigated for highest emissions:

433 MHz Orientation Data:

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
Orientation A										
433.00	H	1.9	189	51.74	0.00	2.42	16.20	70.36	100.79	-30.43
433.00	V	1	111	56.29	0.00	2.42	16.20	74.91	100.79	-25.88
433.00	H	1.9	189	45.85	0.00	2.42	16.20	64.47	80.79	-16.32
433.00	V	1	111	50.97	0.00	2.42	16.20	69.59	80.79	-11.20
433.00	H	1.9	189	17.71	0.00	2.42	16.20	36.33	80.79	-44.46
433.00	V	1	111	21.44	0.00	2.42	16.20	40.06	80.79	-40.73
Orientation B										
433.00	H	2.3	185	56.01	0.00	2.42	16.20	74.63	100.79	-26.16
433.00	V	1	104	54.83	0.00	2.42	16.20	73.45	100.79	-27.34
433.00	H	2.3	185	50.33	0.00	2.42	16.20	68.95	80.79	-11.84
433.00	V	1	104	49.35	0.00	2.42	16.20	67.97	80.79	-12.82
433.00	H	2.3	185	20.93	0.00	2.42	16.20	39.55	80.79	-41.24
433.00	V	1	104	20.17	0.00	2.42	16.20	38.79	80.79	-42.00
Orientation C										
433.00	H	1.9	339	65.56	0.00	2.42	16.20	84.18	100.79	-16.61
433.00	V	1	239	56.10	0.00	2.42	16.20	74.72	100.79	-26.07
433.00	H	1.9	339	60.92	0.00	2.42	16.20	79.54	80.79	-1.25
433.00	V	1	239	51.49	0.00	2.42	16.20	70.11	80.79	-10.68
433.00	H	1.9	339	28.03	0.00	2.42	16.20	46.65	80.79	-34.14
433.00	V	1	239	20.28	0.00	2.42	16.20	38.90	80.79	-41.89

Red = Pk, Blue = QP, Green = Ave

NOTE: Orientation "C" produced the highest emission (see highlighted).

The limit at 433MHz is 10958 μ V/m at 3m which is equivalent to 80.8 dB μ V/m at 3m

The worst-case emission employs the quasi-peak detector. Also note that this device passes without using a duty cycle correction factor.

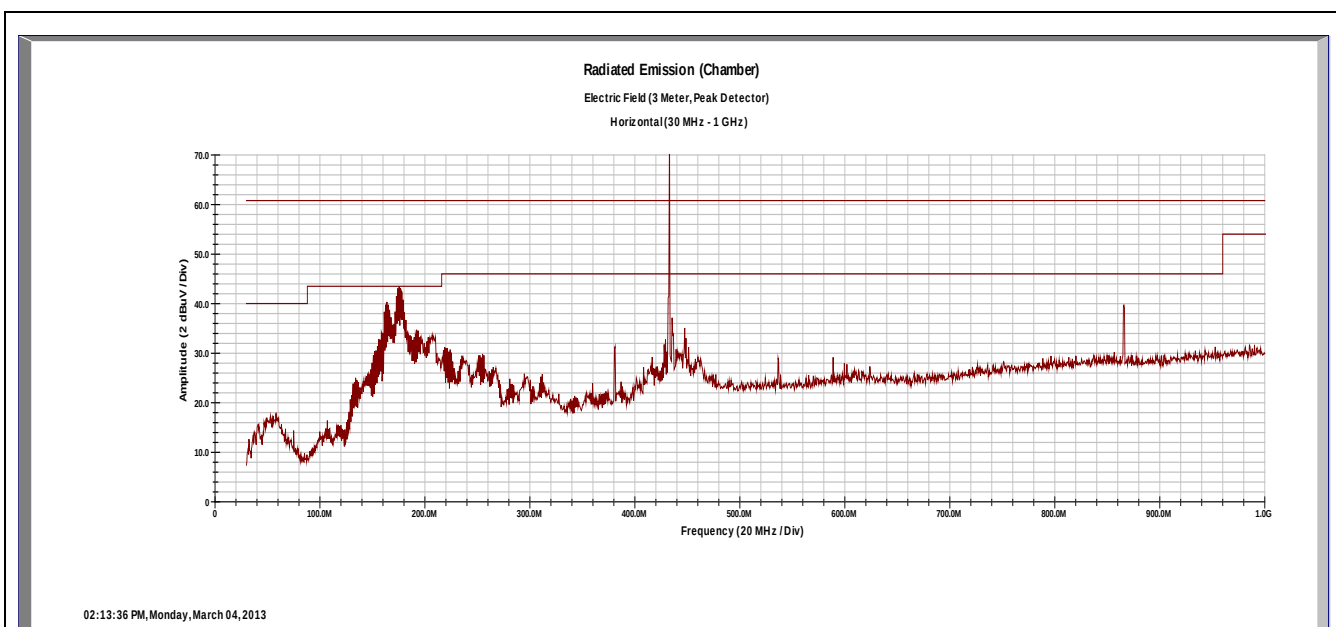
Note: Maximum conducted measurement peak output of the 433 MHz transmitter is 3.89 dBm = 2.5mW

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5.1.5 Final Graphs

Radiated Emissions – 30MHz to 1000 MHz

Horizontal



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
163.00	H	1.3	355	28.38	0.00	1.47	8.46	38.31	43.50	-5.19
173.68	H	1.9	5	31.71	0.00	1.51	8.82	42.04	43.50	-1.46
381.00	H	1	343	9.55	0.00	2.25	14.80	26.61	46.00	-19.39
447.00	H	2.2	351	17.91	0.00	2.46	16.34	36.71	46.00	-9.29
866.00	H	1	128	18.66	0.00	3.49	22.10	44.25	46.00	-1.75

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

Combined Standard Uncertainty $u_c(y) = \pm 2.29\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: Worst Case emissions shown are in Orientation C.

The emission at 433 MHz is the fundamental frequency.

The harmonic limits is 1096 $\mu\text{V/m}$ at 3m which is equivalent to 60.8 dB $\mu\text{V/m}$ at 3m (top limit line)

All emissions (including harmonics) are below the restricted-band limits (bottom limit line).

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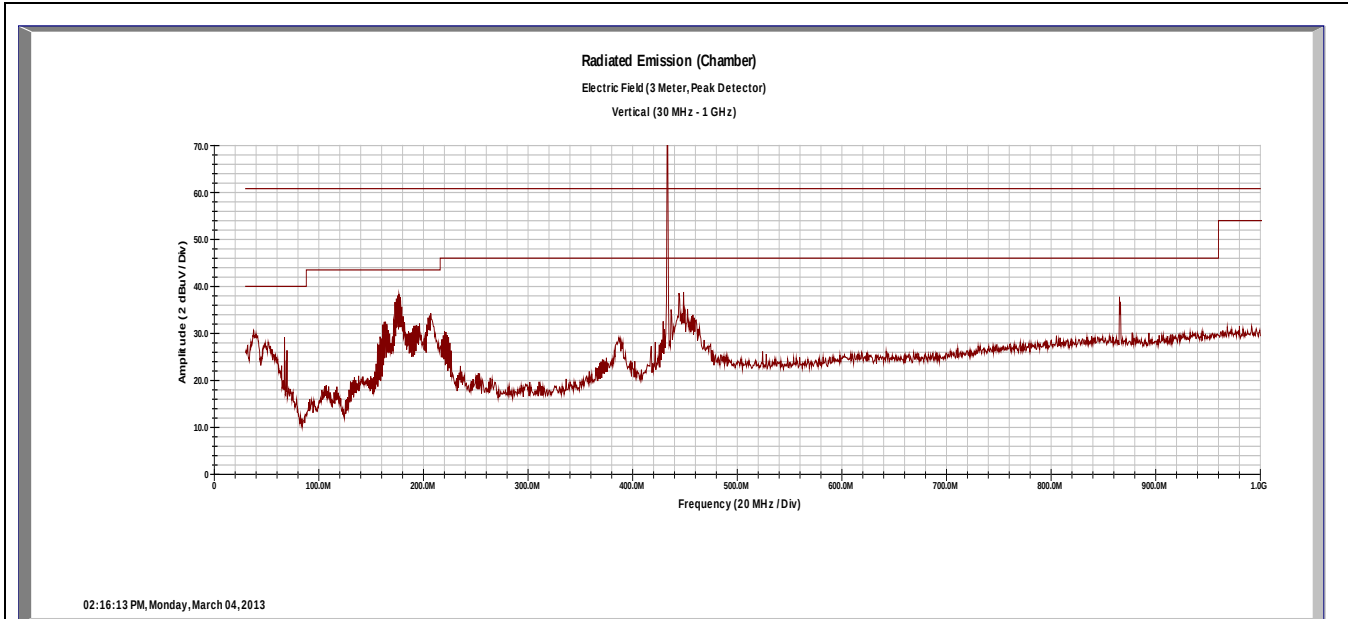
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Radiated Emissions – 30MHz to 1000 MHz

Vertical



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
32.04	V	1	4	19.43	0.00	0.65	5.78	25.86	40.00	-14.14
175.12	V	1.8	237	26.87	0.00	1.52	8.91	37.30	43.50	-6.20
206.08	V	2.3	250	18.95	0.00	1.65	10.42	31.03	43.50	-12.47
386.00	V	1.3	205	9.55	0.00	2.28	14.82	26.65	46.00	-19.35
448.44	V	1.1	243	0.00	0.00	2.47	16.37	18.83	46.00	-27.17
866.00	V	1.1	36	16.71	0.00	3.49	22.10	42.30	46.00	-3.70

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

Combined Standard Uncertainty $u_c(y) = \pm 2.29\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: Worst Case emissions shown are in Orientation C.

The emission at 433 MHz is the fundamental frequency.

The harmonic limits is 1096 $\mu\text{V/m}$ at 3m which is equivalent to 60.8 dB $\mu\text{V/m}$ at 3m (top limit line)

All emissions (including harmonics) are below the restricted-band limits (bottom limit line).

The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TUV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

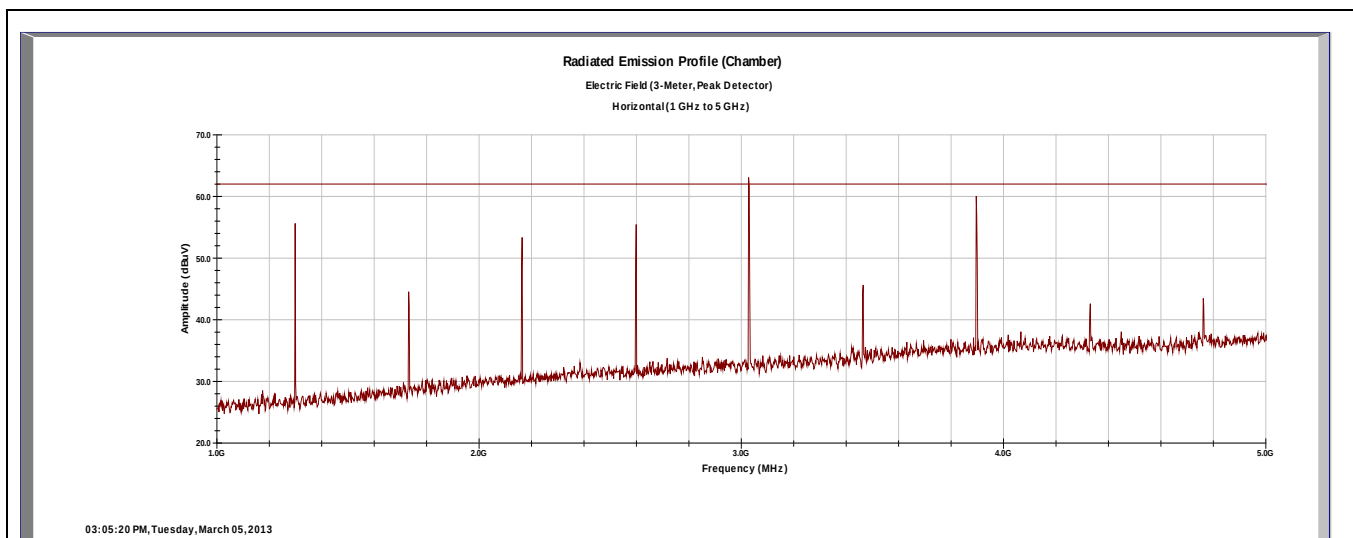
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Radiated Emissions – 1 GHz to 5 GHz

Horizontal



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
1299.00	H	1.2	209	55.75	34.81	5.72	25.49	52.15	84.00	-31.85
1299.00	H	1.2	209	29.06	34.81	5.72	25.49	25.46	64.00	-38.54
2165.00	H	1.2	105	61.58	34.29	7.44	27.86	62.59	84.00	-21.41
2165.00	H	1.2	105	30.34	34.29	7.44	27.86	31.35	64.00	-32.65
2598.00	H	1	198	54.73	34.15	8.15	29.03	57.76	84.00	-26.24
2598.00	H	1	198	26.50	34.15	8.15	29.03	29.53	64.00	-34.47
3031.00	H	1	50	64.16	34.19	8.83	30.50	69.30	84.00	-14.70
3031.00	H	1	50	29.76	34.19	8.83	30.50	34.90	64.00	-29.10
3897.00	H	1.1	43	51.96	-33.28	10.10	32.82	61.60	84.00	-22.40
3897.00	H	1.1	43	24.97	-33.28	10.10	32.82	34.61	64.00	-29.39

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

Combined Standard Uncertainty $u_c(y) = \pm 2.29\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

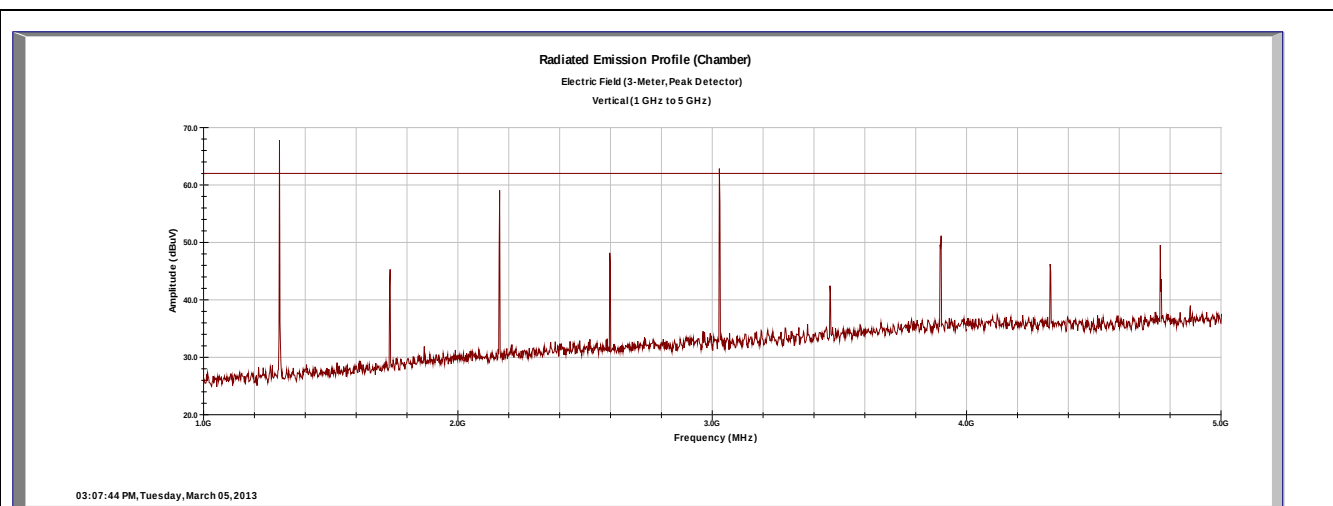
Notes: All Radiated Spurs and Harmonics are below the restricted-band limits

The Emissions shown in **BLUE** are using the Peak Detector and the Emissions shown in **GREEN** are using the Average Detector.

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Radiated Emissions – 1 GHz to 5 GHz
Vertical


Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
1299.00	V	1.2	344	63.44	34.81	5.72	25.49	59.84	84.00	-24.16
1299.00	V	1.2	344	32.70	34.81	5.72	25.49	29.10	64.00	-34.90
1732.00	V	1	217	55.53	34.38	6.67	26.87	54.69	84.00	-29.31
1732.00	V	1	217	30.33	34.38	6.67	26.87	29.49	64.00	-34.51
2165.00	V	1	225	62.64	34.29	7.44	27.86	63.65	84.00	-20.35
2165.00	V	1	225	32.63	34.29	7.44	27.86	33.64	64.00	-30.36
2598.00	V	1	239	52.72	34.15	8.15	29.03	55.75	84.00	-28.25
2598.00	V	1	239	27.39	34.15	8.15	29.03	30.42	64.00	-33.58
3031.00	V	1.2	170	63.71	34.19	8.83	30.50	68.85	84.00	-15.15
3031.00	V	1.2	170	29.96	34.19	8.83	30.50	35.10	64.00	-28.90
3897.00	V	1	70	51.81	33.28	10.10	32.82	61.45	84.00	-22.55
3897.00	V	1	70	26.76	33.28	10.10	32.82	36.40	64.00	-27.60
4330.00	V	1.1	158	41.55	33.59	10.76	32.16	50.88	84.00	-33.12
4330.00	V	1.1	158	23.40	33.59	10.76	32.16	32.73	64.00	-31.27

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

Combined Standard Uncertainty $u_c(y) = \pm 2.29\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: All Radiated Spurs and Harmonics are below the restricted-band limits

The Emissions shown in **BLUE** are using the Peak Detector and the

Emissions shown in **GREEN** are using the Average Detector.

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5.2 Bandwidth

This test measures the Bandwidth of the fundamental emission.

5.2.1 Test Over View

Results	Complies (as tested per this report)					Date	4 March 2013	
Standard	FCC Part 15.247(a)(1)(i), RSS-210, Section A8.1							
Product Model	FIREFLY RFID EXPANSION CARD			Serial#	PRODUCTUION PROTOTYPE			
Configuration	See test plan for details							
Test Set-up	Tested in an anechoic chamber EUT placed on table See test plan for details							
EUT Powered By	120VAC/60Hz	Temp	72° F	Humidity	13%	Pressure	1000 mbar	
Perf. Criteria	Part 15.231(c) (Below Limit)			Perf. Verification		Readings under Limit		
Mod to EUT	None			Test Performed By		Mark Rvan		

5.2.2 Test Procedure

Bandwidth measurements were made according to FCC part 15.31 and FCC part 15.231(c).

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

The Fundamental Frequency is 433.0 MHz therefore 0.25% of 433.0 MHz is 1.08 MHz

5.2.3 Deviations

There were no deviations from the test methodology.

5.2.4 Final Test

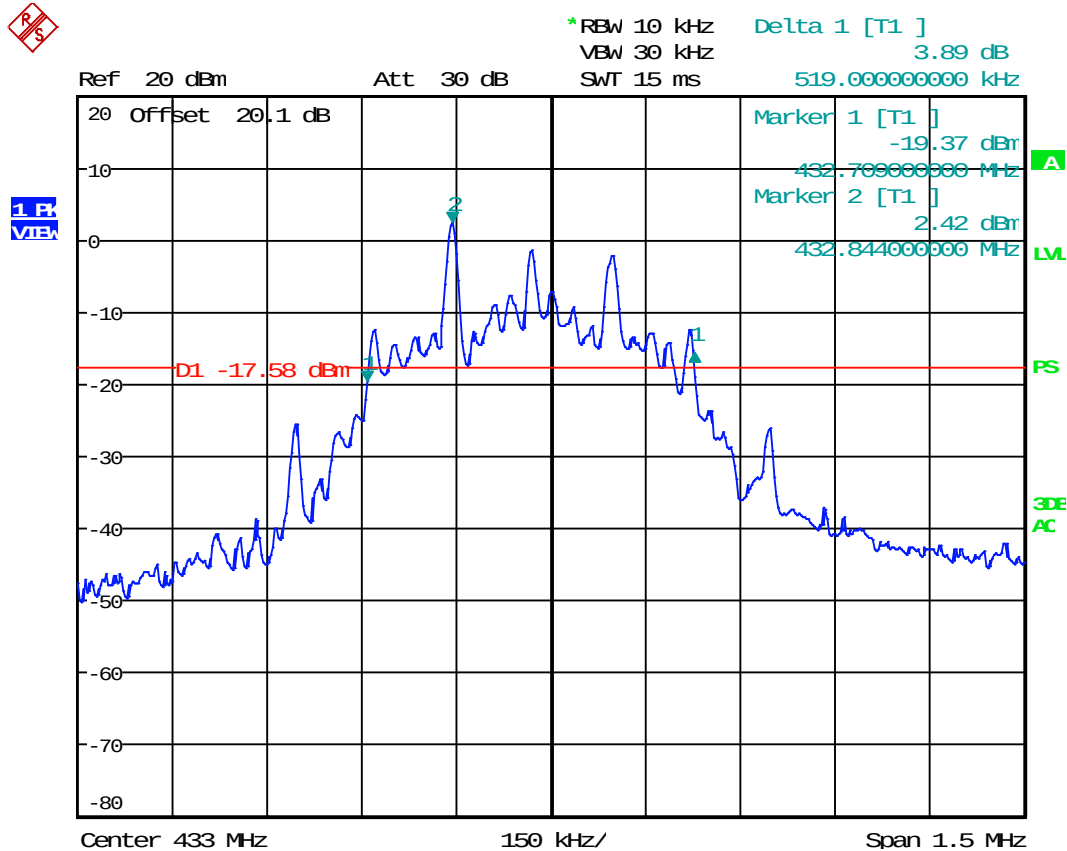
All final measurements were within (in compliance) the limits.

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Date: 4.MAR.2013 09:00:18

Figure 13 – 20 dB Bandwidth is 519.0 kHz

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

5.3.1 Test Over View

Results	Complies (as tested per this report)					Date	4 March 2013	
Standard	RSS-210 Section A1.1.3							
Product Model	BTA-1				Serial#	TS-1		
Test Set-up	Direct Measurement from antenna port							
EUT Powered By	Battery	Temp	72° F	Humidity	13%	Pressure	1000 mbar	
Perf. Criteria	(Below Limit)			Perf. Verification		Readings Under Limit		
Mod. to EUT	None			Test Performed By		Mark Ryan		

5.3.2 Test Procedure

Using the procedures of RSS-GEN section 4.6.1, the 1 kHz resolution bandwidth is 1% of the 1 MHz span. The Video bandwidth is 3 times that of the resolution bandwidth.

The limit of the bandwidth would be 0.5% of 433.0 MHz is 1.08 MHz. The measured 99% bandwidth is 513.0 kHz.

5.3.3 Deviations

There were no deviations from the test methodology listed in the test plan for the 99% Power bandwidth test.

5.3.4 Final Test

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

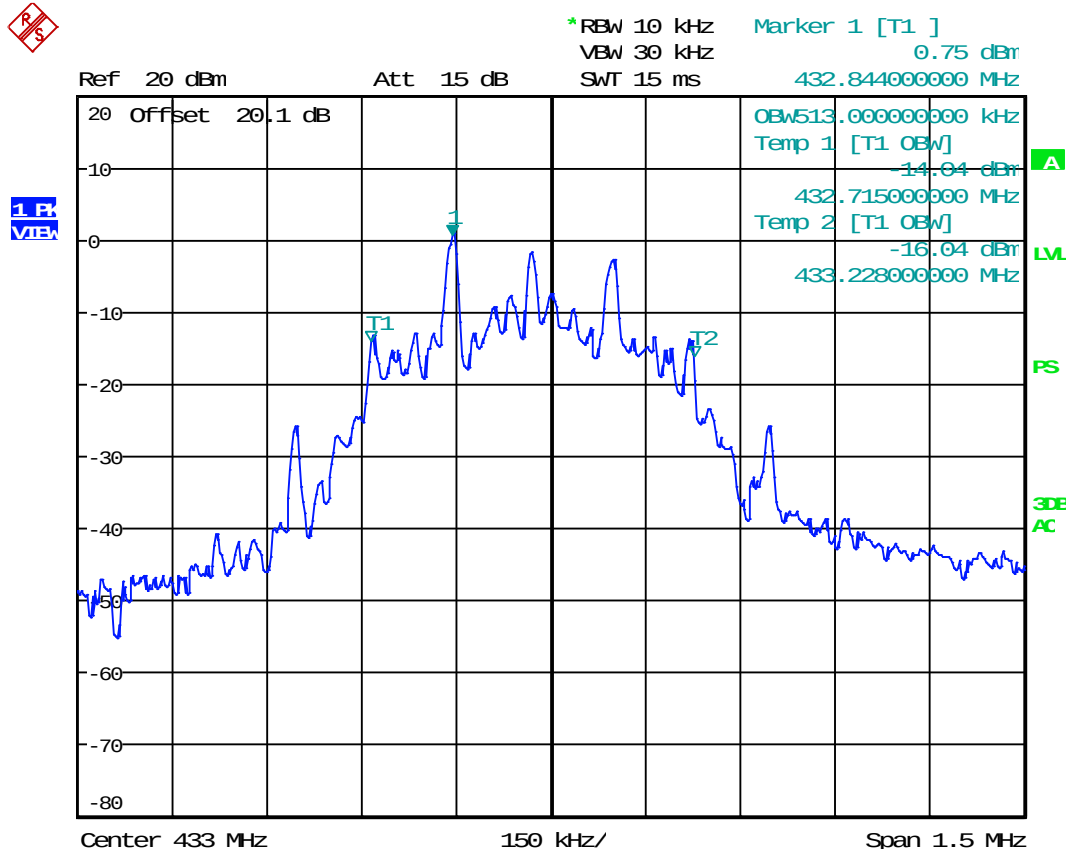
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5.3.5 Final Data



Date: 4.MAR.2013 09:02:00

Figure 14: 99% Bandwidth = 513.0 kHz

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5.4 433 MHz RF Exposure Evaluation

5.4.1 Exposure Requirements – FCC Part 2.1093 and RSS-102, Issue 4

FCC Part 15.247(d) states that SAR evaluation is not required if “Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See §1.1307(b)(1) of CFR 47.”

RSS-102 section 2.5.1 states that a device is exempt from SAR evaluation if the frequency is “above 2.2 GHz and up to 3 GHz inclusively, and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 20 mW for general public use...”.

5.4.2 Test Procedure

If the antenna is located > 20cm from the user, then an MPE calculation is acceptable.

If the antenna is located < 20cm (portable / mobile / hand-held device) from the user, then SAR evaluation is required.

5.4.3 Evaluation

The EUT is intended to be a hand held device. Therefore the transmitter antennas are located in close proximity (< 20cm) to humans. A SAR evaluation is required.

5.4.4 Evaluation for FCC to Part 2.1093

Refer to the SAR exhibit

FCC 447498 D01 Mobile Portable RF Exposure v05, Appendix A, provides a table for SAR Test Exclusion Thresholds for 100 MHz to 6 GHz and ≤ 50 mm.

The exclusion threshold for SAR testing at 430 MHz, 5 mm is 22mW.

The maximum power output of the 433MHz Transmitter plus maximum antenna gain

$$= 3.89 \text{ dBm} + 0 \text{ dBi} = 3.89 \text{ dBm, or } 2.5 \text{ mW EIRP. (at 100\% duty cycle)}$$

5.4.5 Conclusion

EiRP output of 5 mW is well below the 22 mW threshold.

The EUT is compliant, even without the duty cycle factor.

The 433MHz transmitter is excluded for SAR Testing.

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5.4.6 Evaluation for Industry Canada to RSS-102, Issue 4

RSS-102, Issue 4, section 1.1 states that a RF Exposure evaluation is the method used to evaluate the RF field strength levels generated by a device. RF exposure evaluation is required if the separation distance between the user and the device is greater than 20 cm.

RSS-102, Issue 4, section 1.1 states that a SAR evaluation is the method used to evaluate the SAR levels from a device by physical measurement or computational modeling techniques. SAR evaluation is required if the separation distance between the user or bystanders and the device is less than or equal to 20 cm.

5.4.7 Test Procedure

If the antenna is located > 20cm from the user, then an MPE calculation is acceptable.

If the antenna is located < 20cm (portable / mobile / hand-held device) from the user, then SAR evaluation is required.

5.4.8 Evaluation

2.5 mW output with a 0dBi Max. gain (numeric gain of 1) antenna. = a maximum EIRP output of 2.5 mW.

5.4.9 Conclusion

EIRP output of 2.5 mW is well below the 200 mW limit of RSS-102 section 2.5.1, for 3 kHz to 1 GHz.

The EUT is compliant, even without the duty cycle factor.

The 433MHz transmitter is exempted from SAR Testing.

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	8 March 2013	
Standard	FCC Parts 15.109(a) and RSS-210 2.2, 2.6,A8.5, RSS-GEN 7.2.3.2							
Product Model	FIREFLY RFID EXPANSION CARD			Serial#	PRODUCTION PROTOTYPE			
Configuration	See test plan for details							
Test Set-up	Tested in a 5m Semi Anechoic chamber, placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane on a turn-table. See test plans for details							
EUT Powered By	100VAC 60Hz	Temp	75 °F	Humidity	33%	Pressure	1001 mbar	
Frequency Range	30 MHz to 5 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 C63.4:2009 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 5 GHz was investigated for radiated emissions.

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

Both the 900 MHz Frequency hopper and the 433 MHz were set to receive mode.

6.1.3 Deviations

There were no deviations from the test methodology listed in the test plan for the radiated emission test.

6.1.4 Final Test

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

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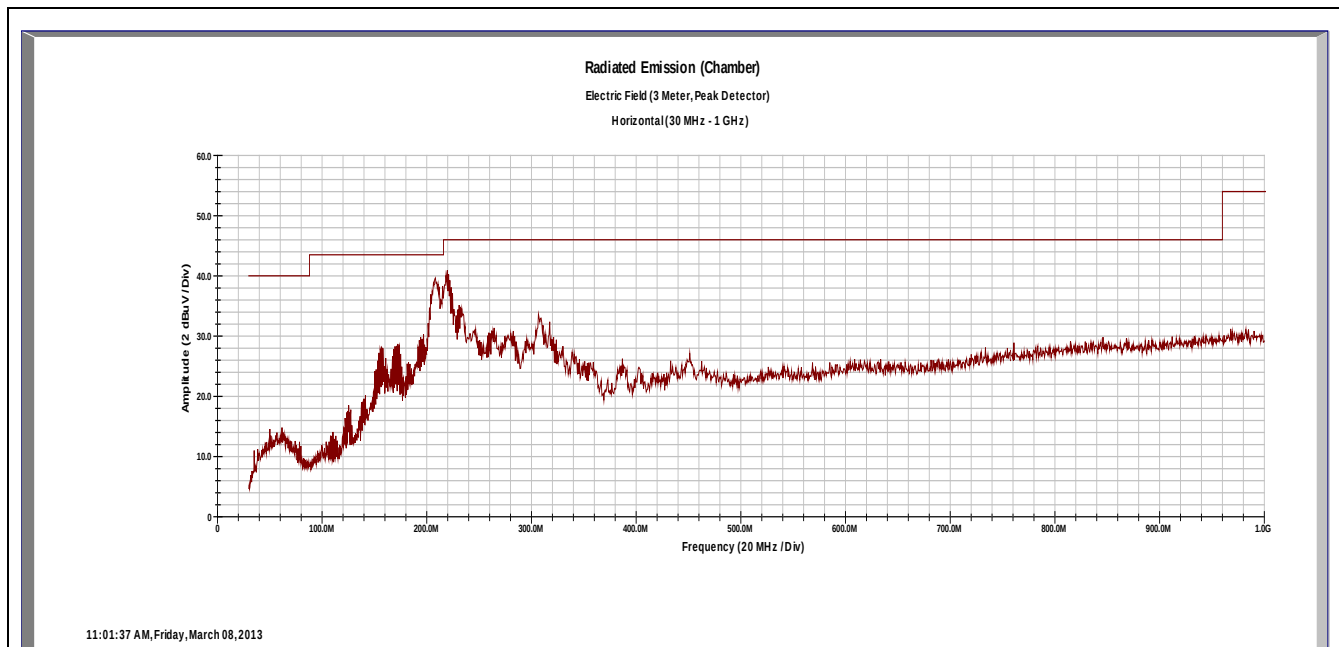
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6.1.5 Final Graphs and Tabulated Data

Radiated Emissions – 30MHz to 1000 MHz

Horizontal



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
156.00	H	1.7	80	15.66	0.00	1.43	8.30	25.39	43.50	-18.11
208.00	H	1	77	25.33	0.00	1.66	10.46	37.45	43.50	-6.05
306.00	H	1	81	15.83	0.00	2.02	12.96	30.81	46.00	-15.19

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

Combined Standard Uncertainty $u_c(y) = \pm 2.29\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: Frequency Hopper and 433MHz in Receive mode

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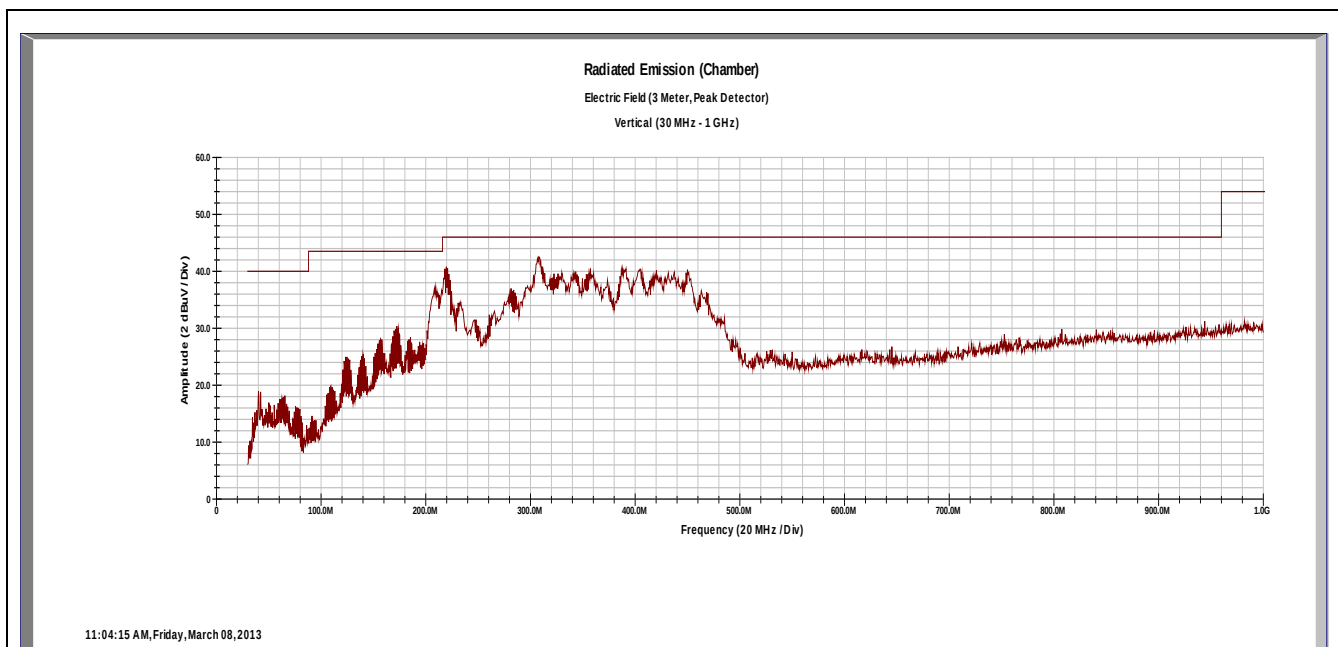
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Radiated Emissions – 30MHz to 1000 MHz

Vertical



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
172.00	V	1	0	17.73	0.00	1.50	8.72	27.95	43.50	-15.55
220.00	V	2	5	27.51	0.00	1.72	10.60	39.83	46.00	-6.17
307.00	V	1.4	94	24.79	0.00	2.02	12.92	39.73	46.00	-6.27
391.00	V	1	157	18.90	0.00	2.30	14.96	36.16	46.00	-9.84
450.00	V	1	136	16.41	0.00	2.47	16.40	35.28	46.00	-10.72

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

Combined Standard Uncertainty $u_c(y) = \pm 2.29\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: Frequency Hopper and 433MHz in Receive mode

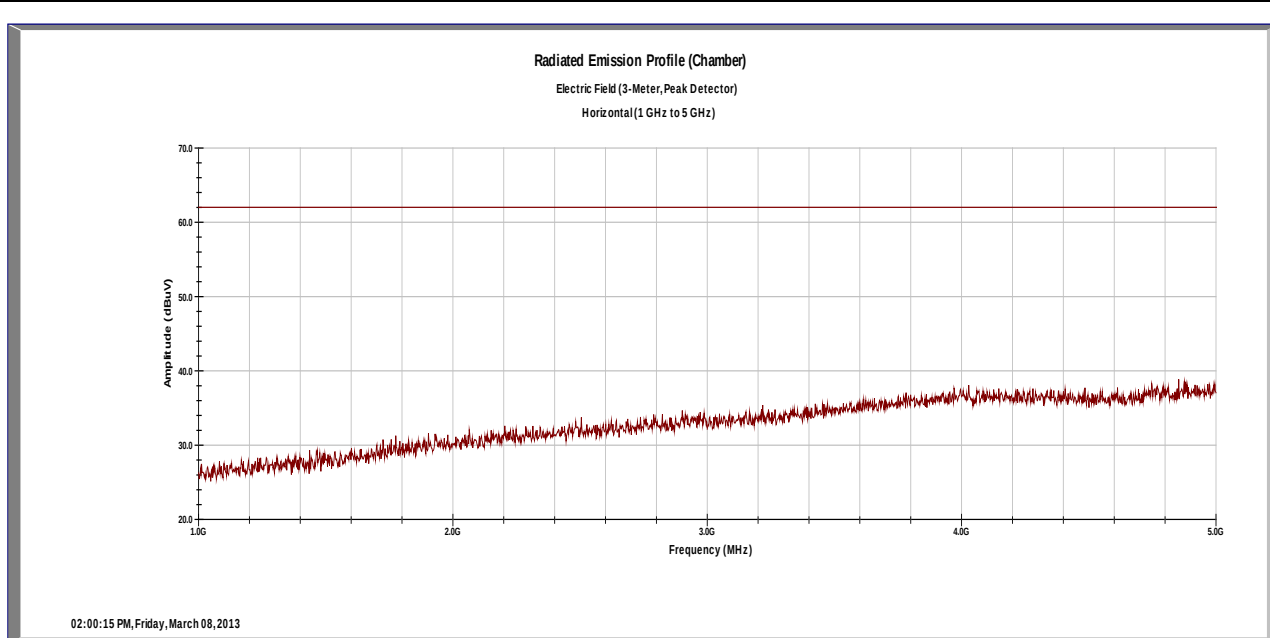
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Radiated Emissions – 1 GHz to 5 GHz
Horizontal



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

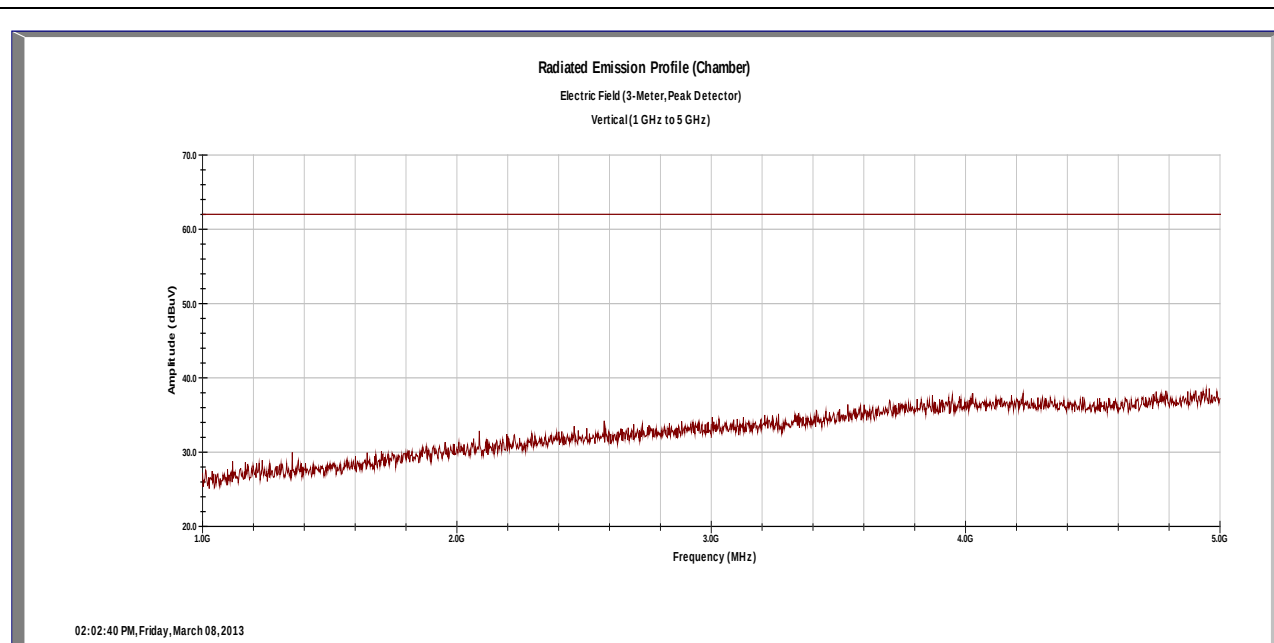
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y) = \pm 2.29\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: Frequency Hopper and 433MHz in Receive mode
No emissions detected

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Vertical

[illegible]
$$\text{Spec Margin} = \text{E-Field Value} - \text{Limit}, \quad \text{E-Field Value} = \text{FIM Value} - \text{Amp Gain} + \text{Cable Loss} + \text{ANT Factor} \pm \text{Uncertainty}$$

Combined Standard Uncertainty $u_c(y) = \pm 2.29\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: Frequency Hopper and 433MHz in Receive mode

No emissions detected

Appendix A

7 Test Plan

This test report is intended to follow this test plan outlined here in unless otherwise stated in this here report. The following test plan will give details on product information, standards to be used, test set ups and refer to TUV test procedures. The test procedures will give the steps to be taken when performing the stated test. The product information below came via client, product manual, product itself and or the internet.

7.2 General Information

Client	Firefly RFID Solutions
Address 1	1521 Boone Trail Road
Address 2	Sanford, NC 27330 USA
Contact Person	Ian Chalmers
Telephone	919-460-1177 x111
e-mail	ian.chalmers@rfidresolution.com

7.2 Model(s) Name

Firefly RFID Expansion Card

7.3 Type of Product

WIRELESS MODULAR DEVICE

7.4 Equipment Under Test (EUT) Description

This module is a full one watt conducted power passive RFID reader that can operate from a very low power source such as a battery operated device or power harvesting based devices such as remote solar or wind powered applications. The module uses power buffering to accumulate enough power to run the passive RFID radio at the full one watt conducted power on a duty cycle basis commensurate with the power available. The module also has a low power telemetry transceiver operating at 433 MHz to accommodate portable remote applications.

The device is initially to be used as an expansion card for the Psion Workabout Pro handheld terminal. This means it must physically fit inside and connect to the expansion card connector for that device. It must operate off the device's 3.8V battery source and limit the peak power draw to one amp or below so as not to reset the device. The expansion card interface supplies battery power, ttl serial line communications and an enable control line to the reader module.

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7.5 Modifications

No modifications were necessary to meet the requirements.

7.6 Product Environment

☐	Residential	☐	Hospital
☒	Light Industrial	☐	Small Clinic
☐	Industrial	☐	Doctor's office
☐	Other		

*Check all that apply

7.7 Countries

☒	USA
☒	Canada

*Check all that apply

7.8 Applicable Documents

Standards	Description
FCC Part 15.231 and RSS-210, Annex 1	Low-Power Licence-exempt Radiocommunication Devices Category I Equipment
FCC Part 15.247 and RSS-210 Annex 8	Frequency Hopping Operation within the band 902-928 MHz
FCC Parts 15.205, 15.209, 15.215(c), RSS-210	Radiated Emissions EUT in Transmit Modes

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7.9 EUT Modes of Operation

The Transmitter device is a module intended to be integrated with low-power and battery-powered devices to add RFID reading and programming capability to the host device. A typical application is for addition to a hand held battery powered terminal, such as the Psion Workabout-Pro as described in this document. The transmitting device must provide a sufficiently strong carrier to power up passive RFID devices, arbitrate with these passive RFID devices to form a communication link with one of the devices and then read back the ID from the passive RFID device which is done by the passive tag modulating our transmitting device's carrier in a backscatter scheme.

The Transmitter device only transmits on request from the host device. Usually a manual trigger which requests reading the ID's of all passive RFID devices in the field of view. This reading could also be triggered by an external sensor such as a light trip or motion sensor. The ISO-18000-6C protocol is used which takes roughly 1-2 mS per passive RFID device to arbitrate and read the ID. In no case will the internal firmware allow the Transmitter device to transmit packets more often than 0.4 seconds per channel in a 20 second period, per FCC Part 15.247(a)(1)(i).

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