Electromagnetic Compatibility Test Report

Prepared in accordance with

FCC Part 15C, RSS-210 Issue 8, RSS-119 Issue 11

On

Hand-Held Interrogator

PI900

Elster Solutions, LLC
208 South Rogers Lane
Raleigh, NC 27610

Prepared by:

TUV Rheinland of North America, Inc.

Manufacturer's statement - attestation

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

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

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

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

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

JOHN HOLT
Printed name of official

John Holt
Signature of official

208 South Rogers Lane
Raleigh, NC 27610
Address

12 January 2012
Date

919-250-5575
Telephone number

John.Holt@us.elster.com
Email address of official

Client:	Elster Solutions, LLC 208 South Rogers Lane Raleigh, NC 27610	John Holt 919-250-5557 / 919-250-5486 John.Holt@us.elster.com	
Identification:	Hand-Held Interrogator	***Serial No.:***	Production Sample
Test item:	PI900	***Date tested:***	14 November 2011
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, RSS-119 Issue 11: FCC Part 15.207(a) and RSS-210 FCC Parts 15.205, 15.209, 15.215(c), RSS-210 FCC Part 15.247(a)(1)(i) and RSS-210 A1.1.3, FCC Part 15.247 and RSS-210 Annex 8, FCC Part 15.247(a)(1)(i), RSS-210, Section A8.1 and Section A1.1.3, FCC Part 15.247(a)(1) and RSS-210 A8.1(c), 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 Parts 15.109(a) and RSS-GEN and FCC Part 15.107(a) and ICES-003, FCC Part 15.247(i) 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
17 November 2011  ***Signature***	10 February 2012  ***Signature***
Other Aspects:	**None**

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

90552 and 100881	**NVLAP Lab Code (200094-0)**	**Industry Canada** **IC-2932H**

TABLE OF CONTENTS

1 General Information

1.1 Scope

This report is intended to document the status of conformance with the requirements of the FCC Part 15C, RSS-210 Issue 8, RSS-119 Issue 11 based on the results of testing performed on 14 November 2011 on the Hand-Held Interrogator , Model No. PI900, manufactured by Elster Solutions, LLC. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

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

1.3 Revision History

Revision	Date	Description of Revision
--	12 January 2012	Initial Release
Rev. A	26 January 2012	Addition of 451MHz data for Industry Canada; RSS-119
Rev. B	9 February 2012	Clean-up of descriptions, typos, and other editorial corrections.

1.4 *Summary of Test Results*

Applicant	Elster Solutions, LLC 208 South Rogers Lane Raleigh, NC 27610	**Tel**	919-250-5557	**Contact**	John Holt
		Fax	919-250-5486	**e-mail**	John.Holt@us.elster.com

Description	Hand-Held Interrogator	**Model Number**	PI900
Serial Number	Production Sample	**Test Voltage/Freq.**	7.2V DC Battery
Test Date Completed:	14 November 2011	**Test Engineer**	Mark Ryan

Standards	Description	Severity Level or Limit	Worst-Case	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**
RSS-119 Issue 11 Standard	Radio Transmitters and Receivers Operating in the Land Mobile and Fixed Services in the Frequency Range 27.41-960 MHz	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)	52.8 dBµV	Complies
FCC Part 15.207(a) and RSS-210	Conducted Emissions on Mains EUT in Transmit Mode	EUT is Battery opered only.	NA	Not Applicable
FCC Part 15.247 and RSS-210 Annex 8	Operation within the band 902-928 MHz	See called out basic standards below	--	Complies
FCC Part 15.247(a)(1)(i), RSS-210, Section A8.1	Channel Seperation	minimum 25kHz or 20dB Channel Band Width (which ever is greater)	400 kHz	Complies
FCC Part 15.247(a)(1) and RSS-210 A8.1(c)	Pseudorandom Hoppong Algorithm	25 hopping channels when the BW ≥ 250kHz	See operation description	Complies
FCC Part 15.247(a)(1)(i) and RSS-210 A1.1.3	Occupied Bandwidth	20dB ≤ 500 kHz 99% BW ≤ 500 kHz	459 kHz 463 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 0.25 Watts	0.21 W	Complies
FCC Part 15.247(g) and RSS-210 A8.1	Frequency Hopping Spread Spectrum (FHSS) Systems	Description of Hopping System	See operation description	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	Not Applicable
FCC Parts 15.109(a) and RSS-GEN	Radiated Emissions while EUT in Receive Mode	Below limit of section 15.109(a) Class B	32.93 dBµV	Complies
FCC Part 15.107(a) and ICES-003	Conducted Emissions EUT in Receive Mode	EUT is Battery opered only.	NA	Not Applicable
FCC Part 15.247(i) and RSS-102, Issue 4	RF Exposure	SAR or MPE Requirements	65.8 mW	Complies

2 Laboratory Information

2.1 Accreditations and Endorsements

2.1.1 US Federal Communications Commission

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

2.1.2 NIST / NVLAP

Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Standard 17025:2005 (Lab code: 200094-0). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Industry Canada

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

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. (Registration No. R-1174, R-1679, C-1790 and C-1791).

2.1.5 Sample Calculation – radiated & conducted emissions

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

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

Where: RAW = Measured level before correction (dBµV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

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

Sample radiated emissions calculation @ 30 MHz

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

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

2.2 Measurement Uncertainty Emissions

	U_{lab}	U_{cispr}
Radiated Disturbance @ 3m		
30 MHz – 1,000 MHz	4.52 dB	5.2 dB
Radiated Disturbance @ 10m		
30 MHz – 1,000 MHz	4.51 dB	5.2 dB
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	3.33 dB	3.6 dB
Disturbance Power		
30 MHz – 300 MHz	4.00 dB	4.5 dB

2.3 Calibration Traceability

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

2.4 Measurement Equipment Used

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal dd/mm/yy	Next Cal dd/mm/yy
Radiated Emissions (5 Meter Chamber and Bench top)					
Amplifier, preamp	Agilent Technologies	8449B	3008A01480	01-Feb-11	01-Feb-12
Antenna Horn 1-18GHz	EMCO	3115	2236	13-Dec10	13-Dec-12
Antenna Horn 1-18GHz	EMCO	3115	5770	18-Aug-10	18-Aug-12
Ant. BiconiLog	Chase	CBL6140A	1108	24-Aug-11	24-Aug-12
Receiver, EMI	Rohde & Schwarz	ESIB40	100043	01-Aug-11	01-Aug-12
Spectrum Analyzer	Agilent Tec.	E7405A	US39440157	06-Dec-10	06-Dec-11
Cable, Coax	MicroCaox	MKR300C-0-0-1200-500500	002	16-Dec-10	16-Dec-11
Cable, Coax	Andrew	FSJ1-50A	003	16-Dec-10	16-Dec-11
Cable, Coax	Andrew	FSJ1-50A	030	16-Dec-10	16-Dec-11
Cable, Coax	Andrew	FSJ1-50A	045	16-Dec-10	16-Dec-11
High Pass Filter	Micro-tronics	BRM50702	049	20-Jan-11	20-Jan-12
Conducted Emissions (AC/DC and Signal I/O)					
LISN 15-18 (NSLK 8126)	Schwarzbeck Mess-Electronik	NSLK 8126	003885	21-Jan-11	21-Jan-12
Transient Limiter	Schaffner	CFL-9206	1649	01-Aug-11	01-Aug-12
Receiver, EMI	Rohde & Schwarz	ESH 3	860905/005	15-Dec-10	15-Dec-11
Spectrum Analyzer	Agilent Tec.	E7405A	US39440157	06-Dec-10	06-Dec-11
Cable, Coax	Pasternack	RG-223	051	16-Dec-10	16-Dec-11
General Laboratory Equipment					
Generator, Noise	York University	CNE III	Ser/98/66	CNR II	CNR II
Meter, Multi	Fluke	179	90580752	06-Dec-10	06-Dec-11
Power Supply, AC	California Instruments	3001ix	53354	07-Dec-10	07-Dec-11
Meter, Temp/Humid/Barom	Davis Instruments	7400	PB00205A13	1-Jan-11	1-Jan-12

3 Product Information

3.1 Product Description

The EUT is a PCMCIA Transceiver Card for utility meter reading.

3.2 Class 2 Permissive Change Description

The purpose for the Class 2 Permissive Change was to add an external antenna to the product; external antenna is terminated with a unique connector. No changes were made to the printed wire board.

3.2.1 Device Type

The Internal PI900 is an intentional radiator and is classified as a Part 15.247 device. The critical specifications of the PI900 are listed in the following table:

3.3 Equipment Modifications

No modifications were needed to bring product into compliance.

4 Spurious Emissions

4.1 Spurious Emissions Outside the band – 902 MHz Band

In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power, based on either RF conducted or radiated measurements. Conducted antenna port measurements are provided in Section 5.1 of this report to show that the EUT meets these requirements at the band edges.

4.1.1 Over View of Test

Results	**Complies** (as tested per this report)					**Date**	14 November 2011
Standard	FCC Parts 15.205, 15.209, 15.215 and RSS-210						
Product Model	PI900			**Serial#**		Production Sample	
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	7.2V DC Battery	**Temp**	75º F	**Humidity**	43%	**Pressure**	1020 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 NVLAP 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

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

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.

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. Conducted antenna port measurements are provided below to show that the EUT meets these requirements at the band edges.

Three orientations of the EUT investigated for highest emissions:

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	QP FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Orientation
CH 63:									
927.60	H	1.5	323	90.39	0.00	3.50	22.51	116.40	1
927.60	V	1.1	197	84.61	0.00	3.50	22.51	110.62	1
927.60	H	2.4	108	90.03	0.00	3.50	22.51	116.04	2
927.60	V	1.0	0	92.56	0.00	3.50	22.51	118.57	2
927.60	H	2.5	194	88.13	0.00	3.50	22.51	114.14	3
927.60	V	1	22	90.44	0.00	3.50	22.51	116.45	3

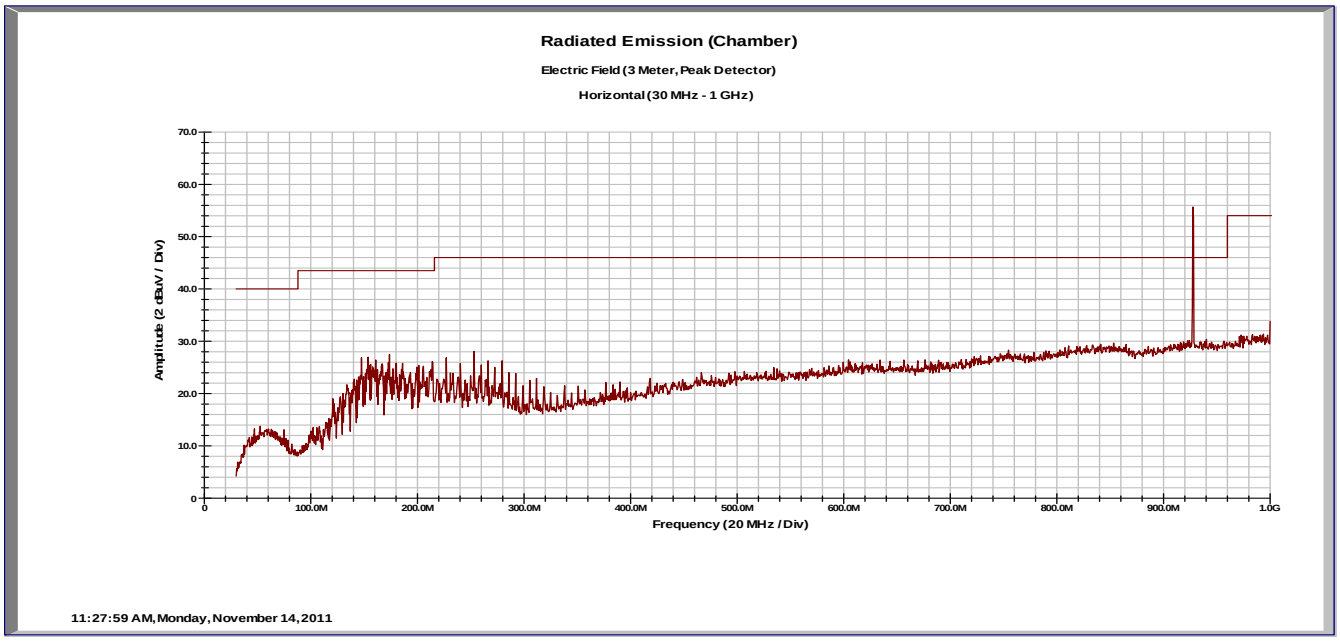
NOTE: Orientation 2 of CH 63 provided the highest harmonic emissions.

Red Emissions are Orientation 1, Green Emissions are Orientation 2, and Blue Emissions are Orientation 3

There are no changes in the circuit for this Class 2 Permissive Change. The addition of an external antenna is the only change. The Antenna chosen is not tuned to the 902 MHz band. The antenna acts as a negative gain antenna, typically -6 dBi in this frequency band.

Radiated Emissions – 30 MHz to 1000 MHz

Horizontal Ch 1



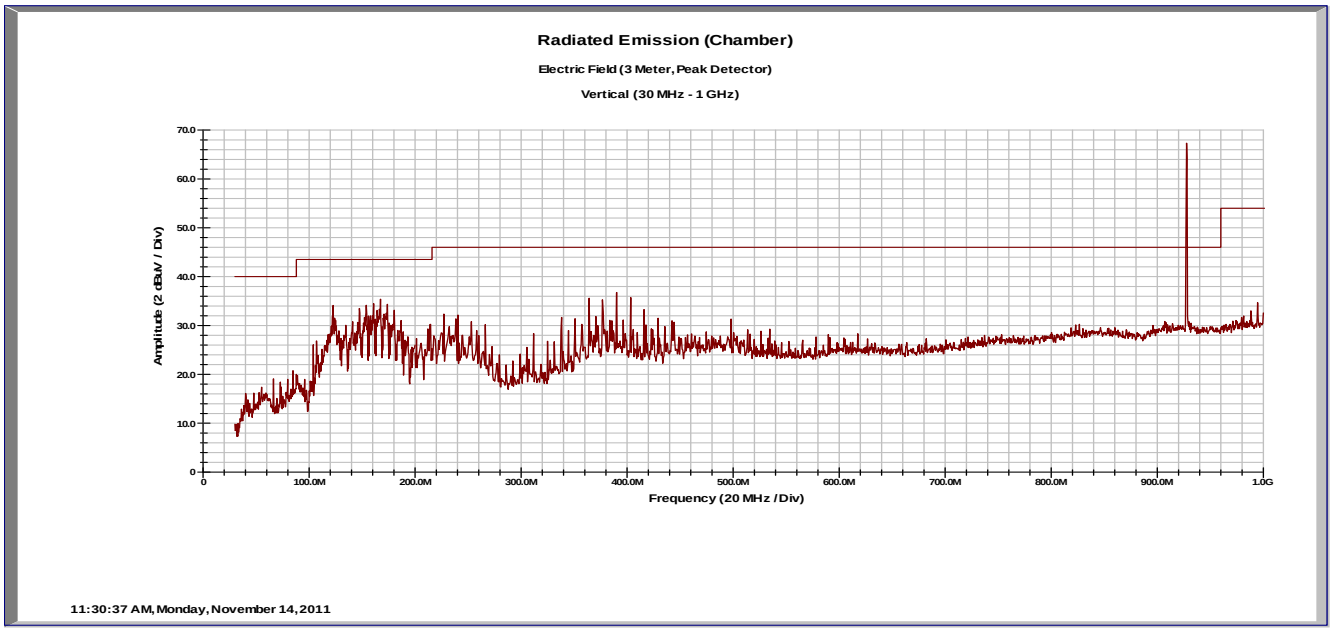
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)
927.60	H	1.5	323	90.03	0.00	3.50	22.51	116.04	NA	NA
927.60	H	1.5	323	89.32	0.00	3.50	22.51	115.33	NA	NA
927.60	H	1.5	323	83.51	0.00	3.50	22.51	109.52	NA	NA

Notes:
Except for the fundamental frequency, a notch filter was used for all measurements Using the QP detector.
All emissions except for the fundamental frequency is more than 20 dB below the limit

The Fundamental frequency was measured without the notch filter and used the **Pk**, **QP** and **Av** detectors.
These values are used as the reference level (-20dBc) for the harmonic measurements, not in a restricted band.

Radiated Emissions – 30 MHz to 1000 MHz

Vertical Ch 63



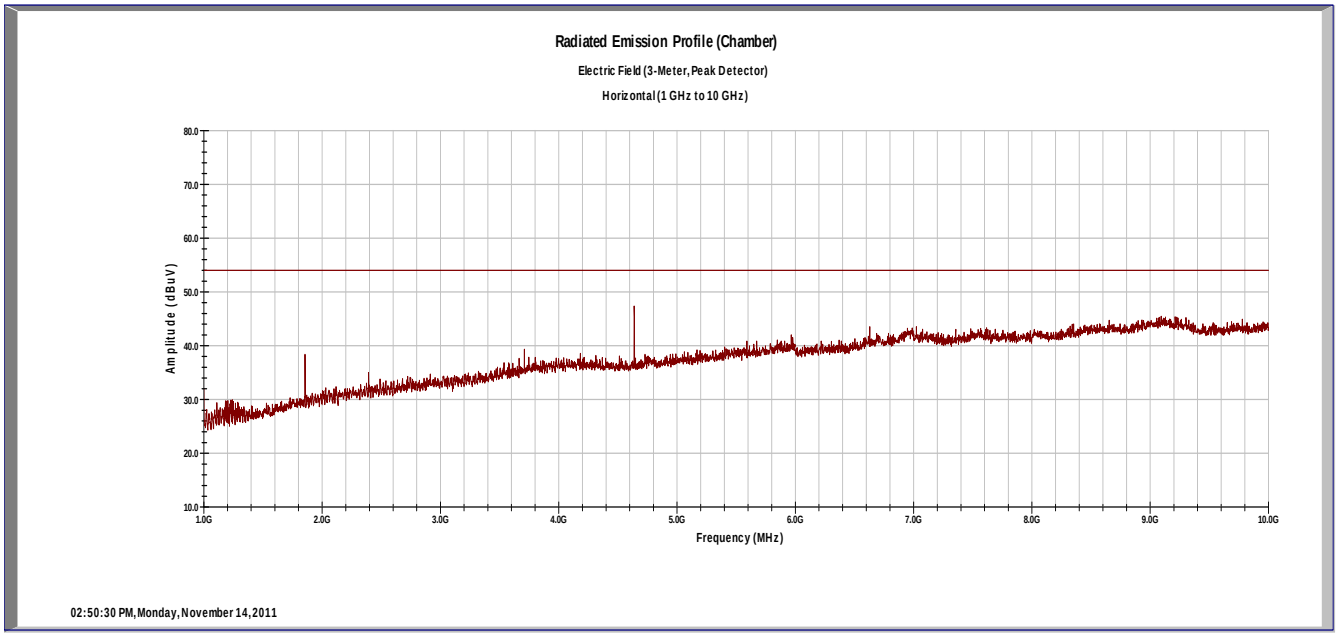
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)
512.00	V	1	3	10.56	0.00	2.51	17.89	30.97	47.00	-16.03
537.60	V	1	4	10.21	0.00	2.57	18.30	31.08	47.00	-15.92
927.60	V	1.0	0	92.56	0.00	3.50	22.51	118.57	NA	NA
927.60	V	1.0	0	92.37	0.00	3.50	22.51	118.38	NA	NA
927.60	V	1.0	0	86.51	0.00	3.50	22.51	112.52	NA	NA

Notes: The Plot was taken with a notch filter tuned at the fundamental frequency
Except for the fundamental frequency, a notch filter was used for all measurements Using the QP detector.

The Fundamental frequency was measured without the notch filter and used the **Pk**, **QP** and **Av** detectors.
These values are used as the reference level (-20dBc) for the harmonic measurements, not in a restricted band.

Radiated Emissions – 1 GHz to 10 GHz

Horizontal CH 63

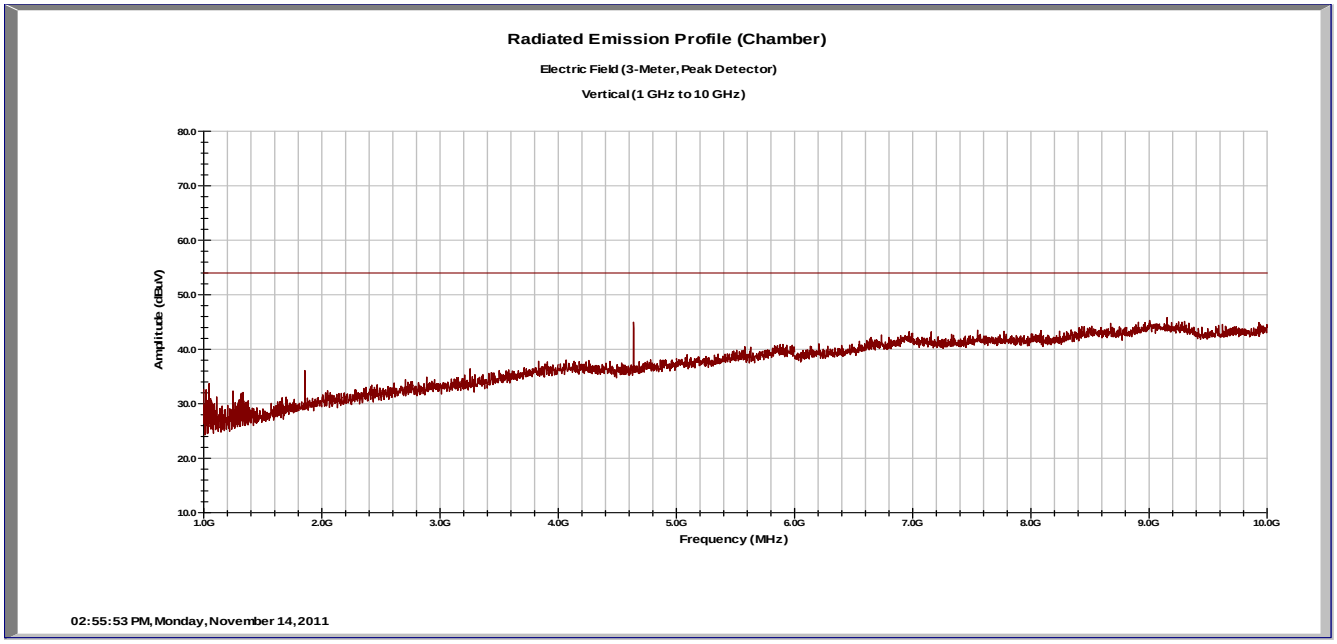


Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)
1855.20	H	1	302	53.36	34.74	6.84	27.30	52.76	54.00	-1.24
4638.00	H	1	288	28.78	34.57	10.48	32.37	37.06	54.00	-16.94
1855.20	H	1	302	59.01	34.74	6.84	27.30	58.41	74.00	-15.59
4638.00	H	1	288	39.55	34.57	10.48	32.37	47.83	74.00	-26.17

Notes: Notes: CH 63 – 927.6 MHz High Pass Filter used
Emissions shown in Green are using the Average Detector and shown in Blue are using the Peak Detector
Highlighted emission is worst case
Emissions not in the Restricted Bands are shown, the limit is -20dBc (88.01dBµV – 20dB = 68.01).
All spurious and harmonic emissions, including those inside the restricted bands, are below the Part 15.209 limits.

Radiated Emissions – Internal Antenna

Vertical CH 63



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)
1855.20	V	1.3	133	50.25	34.74	6.84	27.30	49.65	54.00	-4.35
4638.00	V	1	54	26.11	34.57	10.48	32.37	34.39	54.00	-19.61
1855.20	V	1.3	133	56.12	34.74	6.84	27.30	55.52	74.00	-18.48
4638.60	V	1	54	38.34	34.57	10.48	32.37	46.63	74.00	-27.37

Notes: Notes: CH 63 – 927.6 MHz High Pass Filter used
Emissions shown in Green are using the Average Detector and shown in Blue are using the Peak Detector
Emissions not in the Restricted Bands are shown, the limit is -20dBc (88.01dBµV – 20dB = 68.01).
All spurious and harmonic emissions, including those inside the restricted bands, are below the Part 15.209 limits.

4.2 Spurious Emissions Outside the band – 450 MHz Band

In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power, based on either RF conducted or radiated measurements. Conducted antenna port measurements are provided in Section 5.1 of this report to show that the EUT meets these requirements at the band edges.

4.2.1 Over View of Test

Results	**Complies** (as tested per this report)					**Date**	14 November 2011
Standard	RSS-119						
Product Model	PI900			**Serial#**	Production Sample		
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	7.2V DC Battery	**Temp**	75º F	**Humidity**	43%	**Pressure**	1020 mbar
Perf. Criteria	(Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

4.2.2 Test Procedure

Testing was performed in accordance with 47 CFR Part 15, ANSI C63.10:2009, RSS-GEN Issue 2. These test methods are listed under the laboratory's NVLAP Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

4.2.3 Deviations

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

4.2.4 Final Test

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

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

4.2.5 Final Test

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

The worst –case emissions are shown below.

Radiated Emissions
451 MHz Wake Up Tone Fundamental

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)
451.35	V	1.2	315	102.78	0.00	2.29	16.20	121.27	NA	NA
451.35	H	1	290	84.12	0.00	2.29	16.20	102.61	NA	NA

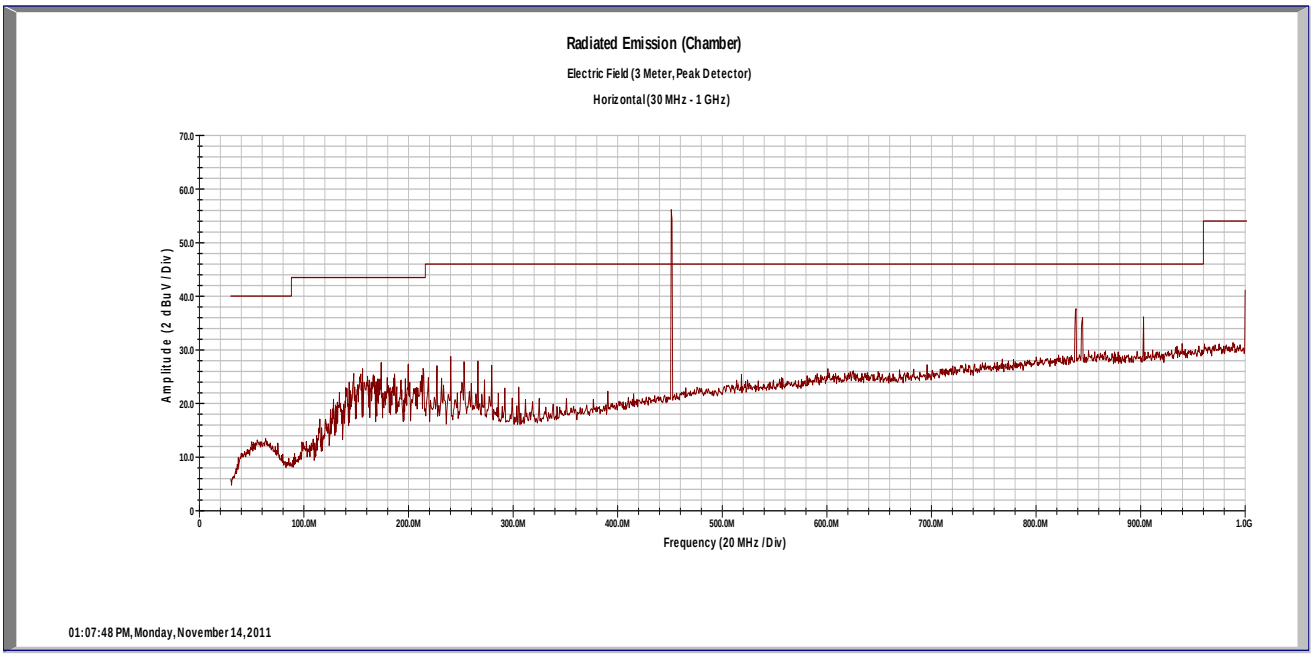
Notes: Wakeup tone at 451 MHz, Measured at 3m

Worst Case orientation

There are no changes in the circuit for this Class 2 Permissive Change. The addition of an external antenna is the only change. The Antenna chosen is tuned to the 450 MHz band. The antenna acts as a gain antenna, typically 3.12 dBi in this frequency band, per section 5.6.5, the gain of the antenna 3.12 dBi at 451 MHz.

As such, only the radiated spurs and harmonic emissions were investigated using the limits of RSS-GEN just to make sure no new radiated spurs or harmonics were generated. All other conditions have not changed from the original certification.

Radiated Emissions - 451 MHz Wake Up Tone
Vertical



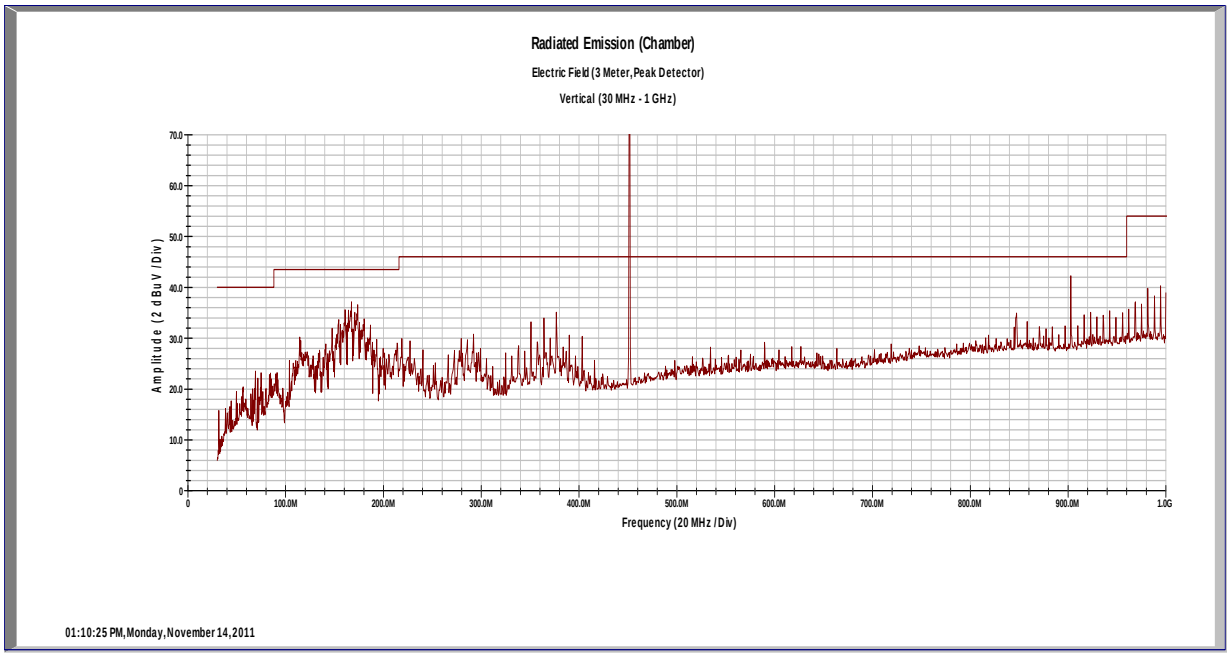
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
1000.00	H	1	4	14.77	0.00	3.49	23.90	42.16	54.00	-11.84

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

Combined Standard Uncertainty $u_c(y)$ = ± 2.26dB Expanded Uncertainty $U = 4.52\ ku_c(y)$ k = 2 for 95% confidence

Notes: The spike at 450 MHz is the fundamental frequency.
Notes: A tuned notch filter at the fundamental frequency was used in these measurements.

Radiated Emissions - 451 MHz Wake Up Tone
Horizontal



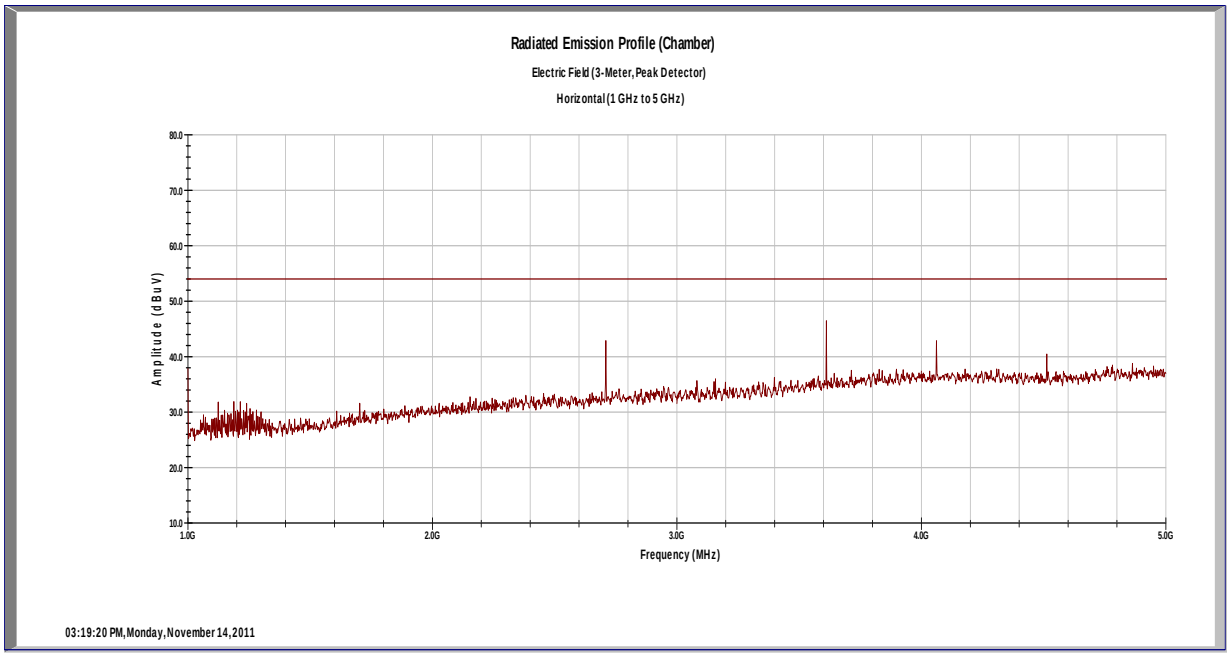
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
154.12	V	1	237	18.04	0.00	1.36	8.15	27.54	43.50	-15.96
363.96	V	1	0	15.17	0.00	2.10	14.80	32.07	46.00	-13.93
902.68	V	1.1	206	18.10	0.00	3.32	22.50	43.92	46.00	-2.08
994.48	V	1.2	355	9.91	0.00	3.48	23.90	37.29	54.00	-16.71

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

Combined Standard Uncertainty $u_c(y)$ = ± 2.26dB Expanded Uncertainty $U = 4.52\ ku_c(y)$ k = 2 for 95% confidence

Notes: The spike at 450 MHz is the fundamental frequency.
Notes: A tuned notch filter at the fundamental frequency was used in these measurements.

Radiated Emissions - 451 MHz Wake Up Tone
Vertical



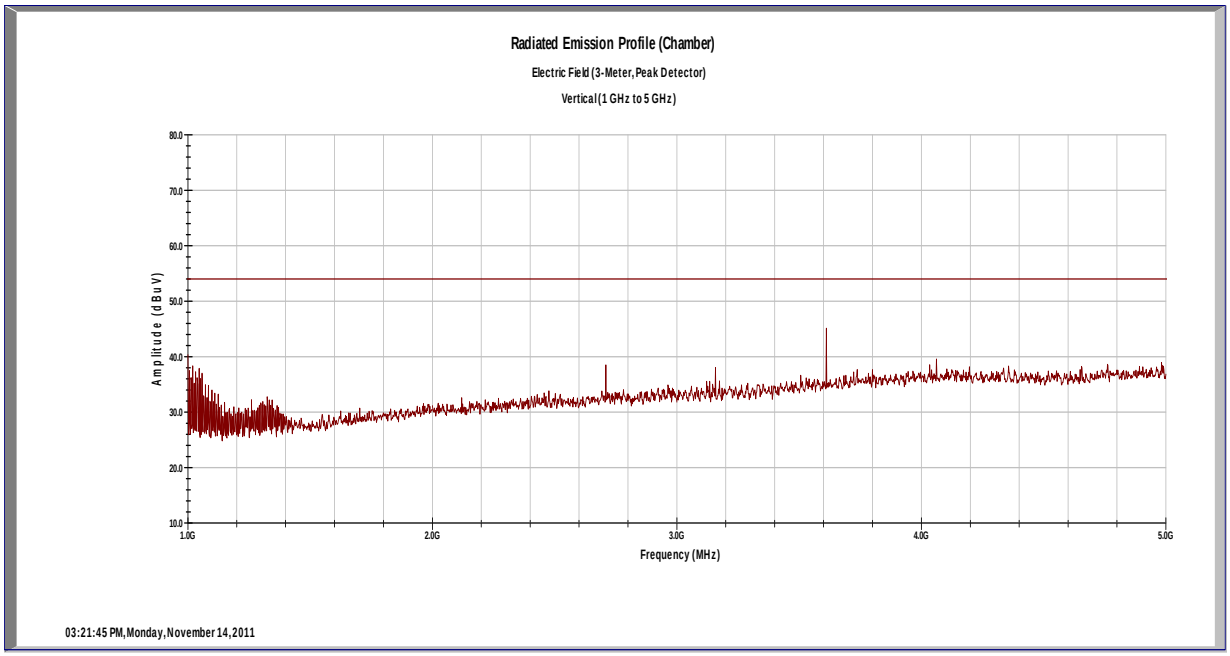
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
2708.40	H	1	223	44.36	34.65	7.54	28.94	46.19	74.00	-27.81
2708.40	H	1	223	37.22	34.65	7.54	28.94	39.05	54.00	-14.95
3610.80	H	1	262	44.50	34.59	8.85	31.63	50.40	74.00	-23.60
3610.80	H	1	262	39.56	34.59	8.85	31.63	45.46	54.00	-8.54
4062.00	H	1.1	222	41.20	34.22	9.76	32.30	49.04	74.00	-24.96
4062.00	H	1.1	222	32.40	34.22	9.76	32.30	40.24	54.00	-13.76

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

Combined Standard Uncertainty $u_c(y)$ = ± 2.26dB Expanded Uncertainty $U = 4.52\ ku_c(y)$ k = 2 for 95% confidence

Notes: A tuned notch filter at the fundamental frequency was used in these measurements.

Radiated Emissions - 451 MHz Wake Up Tone
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)
1078.40	V	1.3	0	50.75	35.82	4.69	24.71	44.33	74.00	-29.67
1078.40	V	1.3	0	42.86	35.82	4.69	24.71	36.44	54.00	-17.56
3610.80	V	1.2	218	43.57	34.59	8.85	31.63	49.47	74.00	-24.53
3610.80	V	1.2	218	28.09	34.59	8.85	31.63	33.99	54.00	-20.01

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

Combined Standard Uncertainty $u_c(y)$ = ± 2.26dB Expanded Uncertainty $U = 4.52\ ku_c(y)$ k = 2 for 95% confidence

Notes: Notes: A tuned notch filter at the fundamental frequency was used in these measurements.

4.3 Conducted Emissions in Transmit mode

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

4.3.1 Test Procedure

Conducted emissions tests were performed using the procedures of ANSI C63.4:2009. The frequency range from 150 kHz – 30 MHz was investigated for conducted emissions.

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

4.3.2 Deviations

The EUT is battery operated and has no means to connect to AC Mains.

4.3.3 Final Test

The EUT is battery operated only; therefore this test is not applicable.

4.4 Frequency Hopping Spread Spectrum (FHSS) Systems FCC Part 15.247(g)

Frequency hopping spread spectrum 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.

In constant transmit mode, the PI900 sends a packet nominally every 97.3 ms with a delay of 8 to 16 ms between packets. Each packet is sent on the next channel determined by the pseudo-random hop table. When presented with a continuous data stream, the EUT adheres to the 0.4 second dwell time for each 10 second window requirement. The EUT always distributes its transmissions across all 25 channels, and does not re-use a channel again until a transmission has occurred on each of the other 24 channels.

4.5 Incorporation of Intelligence within a FHSS System FCC Part 15.247(h)

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 hopsets 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 25 channels. A channel is not re-used until a transmission has occurred on each of the other 24 channels.

5 Antenna Port Conducted Emissions

Testing was performed in accordance with 47 CFR Part 15, ANSI C63.10:2009, RSP-100 Issue 9. These test methods are listed under the laboratory's NVLAP Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

5.1 Channel Separation

5.1.1 Deviations

There were no deviations from the original channels.

All channels are identical to the original application.

5.2 Pseudorandom Hopping Algorithm

5.2.1 Deviations

There were no deviations from the original channels and hopping algorithm. All channels and hopping algorithms are identical to the original application.

5.3 Occupied Bandwidth

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

5.3.1 Test Over View

Results	**Complies** (as tested per this report)					**Date**	14 November 2011
Standard	FCC Part 15.247(a)(1)(i)						
Product Model	PI900			**Serial#**	Production Sample		
Test Set-up	Direct Measurement from antenna port						
EUT Powered By	7.2V DC Battery	**Temp**	75º F	**Humidity**	43%	**Pressure**	1001 mbar
Perf. Criteria	(Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

5.3.2 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.

5.3.3 Deviations

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

5.3.4 Final Test

This Class two Permissive change will not affect the 6dB or 20dB Bandwidth measurements from the original filing.

5.4 99% Power Bandwidth

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

5.4.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	14 November 2011	
Standard	RSS-210 Section A1.1.3						
Product Model	PI900		**Serial#**	Production Sample			
Test Set-up	Direct Measurement from antenna port						
EUT Powered By	7.2V DC Battery	**Temp**	75º F	**Humidity**	43%	**Pressure**	1001 mbar
Perf. Criteria	(Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

5.4.2 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 or 4.58 MHz. The measured 99% power bandwidth is 463 kHz.

5.4.3 Deviations

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

5.4.4 Final Test

This Class two Permissive change will not affect the 99% Power Bandwidth measurements from the original filing.

5.5 Band Edge

5.5.1 Test Over View

Results	**Complies** (as tested per this report)					**Date**	14 November 2011
Standard	FCC Part 15.247(d), RSS 210 A8.1(c)						
Product Model	PI900			**Serial#**	Production Sample		
Test Set-up	Direct Measurement from antenna port						
EUT Powered By	7.2V DC Battery	**Temp**	75º F	**Humidity**	43%	**Pressure**	1012 mbar
Perf. Criteria	(Below Limit)			**Perf. Verification**	Readings Under Limit		
Mod. to EUT	None			**Test Performed By**	Mark Ryan		

5.5.2 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.

5.5.3 Deviations

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

5.5.4 Final Test

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

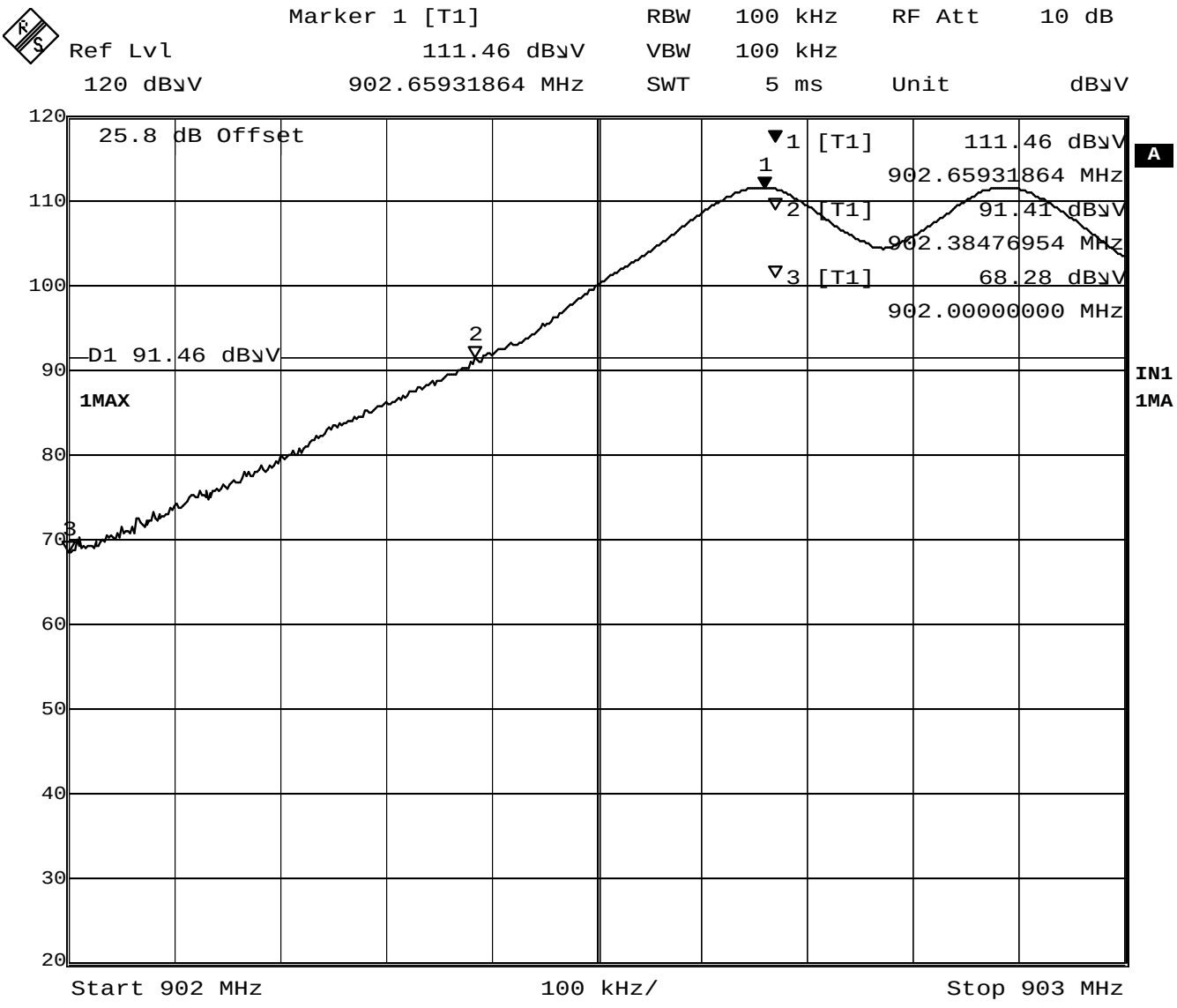


Figure 1: Lower Band Edge Measurement

Note: Band Edge is at 902 MHz

Channel Frequency is 902.8 MHz. The 20dB down point is at 902.38 MHz.

The EUT is compliant with the rules.

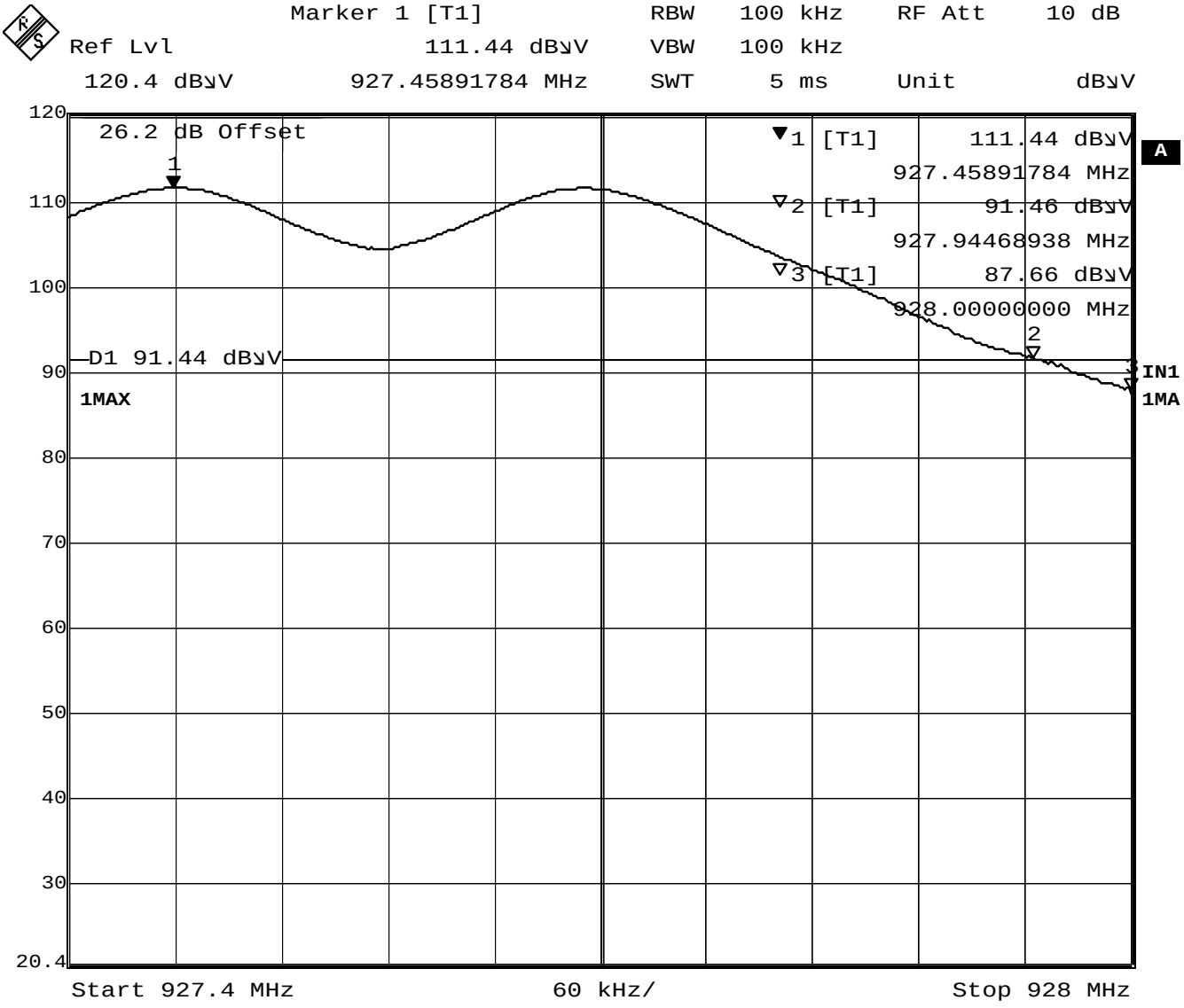


Figure 2: Upper Band Edge Measurement

Note: Band edge is at 928 MHz

Channel 63 Frequency is 927.6 MHz, The 20dB down point is at 927.94 MHz.

The EUT is compliant with the rules.

5.6 Peak Output Power

The maximum peak output power of the intentional radiator shall not exceed 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels. (Conducted Measurement)

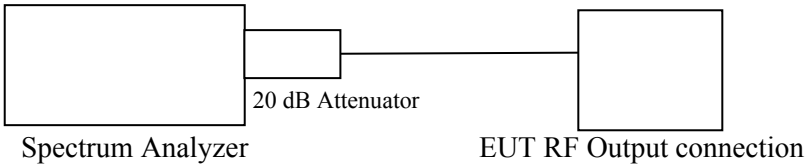
5.6.1 Test Over View

Results	**Complies** (as tested per this report)					**Date**	14 November 2011
Standard	FCC Part 15.247(b)(2) and RSS-210 A8.4(1)						
Product Model	PI900			**Serial#**	Production Sample		
Test Set-up	Direct Measurement from antenna port						
EUT Powered By	7.2V DC Battery	**Temp**	75º F	**Humidity**	43%	**Pressure**	1005 mbar
Perf. Criteria	(Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

5.6.2 Test Procedure

The peak output power was measured at CH01, CH34, CH48, and at CH63. 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:



5.6.3 Deviations

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

5.6.4 Final Test

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

5.6.5 Final Data - Peak Power Output

CH01: 902.8 MHz = 22.99 dBm or 199 mW

CH31: 914.8 MHz = 23.22 dBm or 210 mW – Highest Emissions Output

CH63: 927.6 MHz = 22.04 dBm or 160 mW.

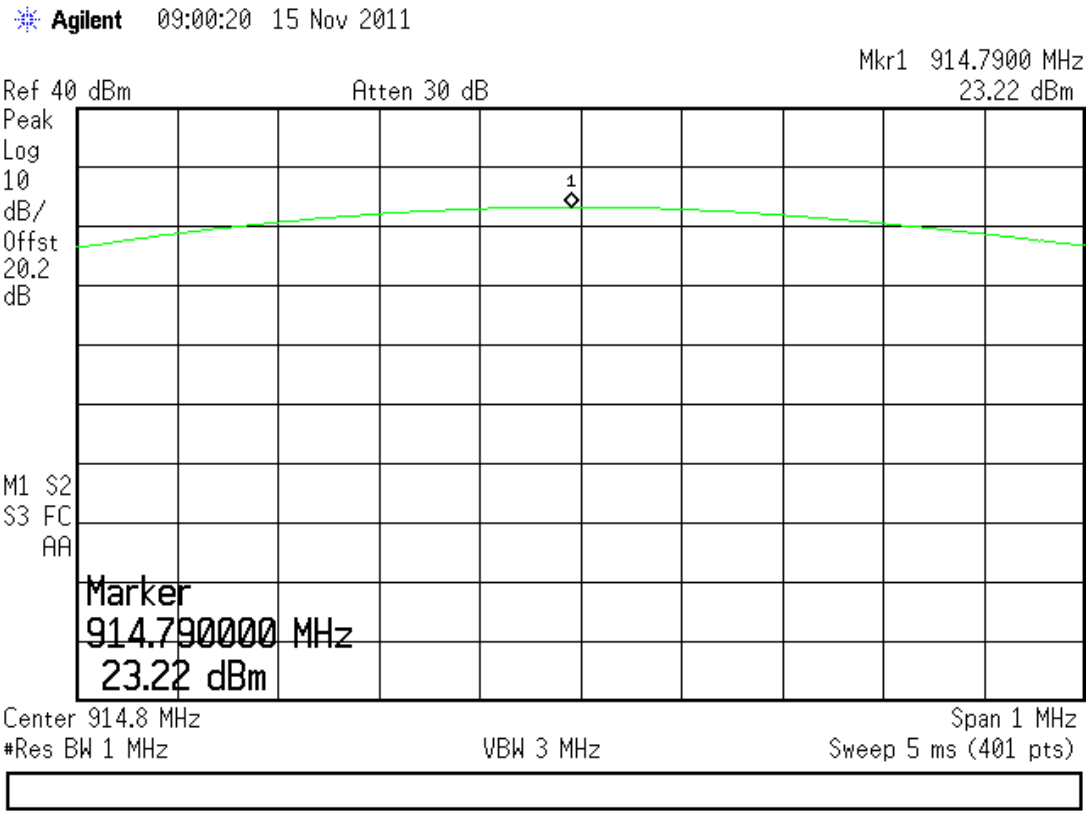


Figure 3: CH 34 (916.0 MHz) Peak Output Power - Worst Case Shown.

Plots of other channels are on file at TUV Rheinland.

Antenna Gain

The antenna gain data was measured/calculated in the lab with the following results provided:

Results; Internal Antenna

Freq. (MHz)	Peak (dBi)	Gain (Numeric)
902.0 – 928.0	-5.6	0.28
451.5	3.12	2.05

Note: The 450MHz gain is for the Part 90 section of this device reference G8JHHI04 / 4557C-HHI03

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**	08 June 2011	
Standard	FCC Parts 15.109(a) and RSS-GEN						
Product Model	PI900			**Serial#**	Production Sample		
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	7.2V DC Battery	**Temp**	75º F	**Humidity**	43%	**Pressure**	1012 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.

The EUT was set in Receive Mode for both the 902 MHz and 451MHz bands.

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

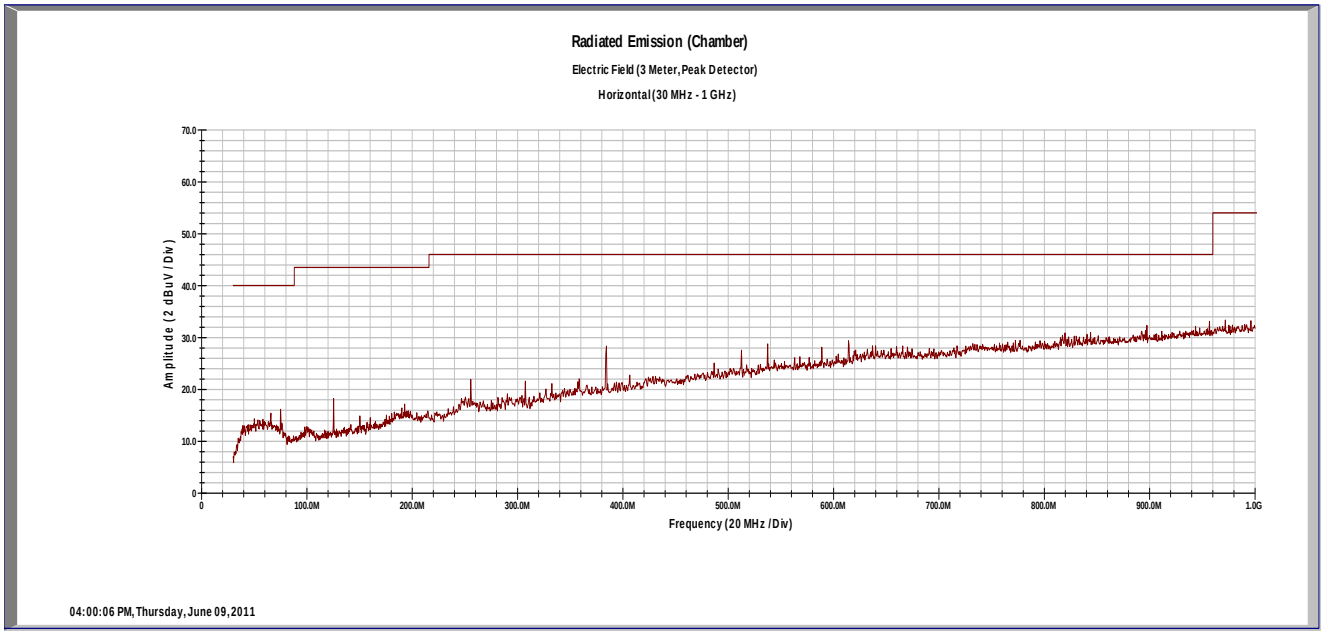
All final radiated emissions measurements were below (in compliance) the limits.

Note: These measurements were taken from the preliminary scans in June 2011.

There were no modifications made to the apparatus from this time to the final testing in November.

6.1.5 Final Graphs and Tabulated Data

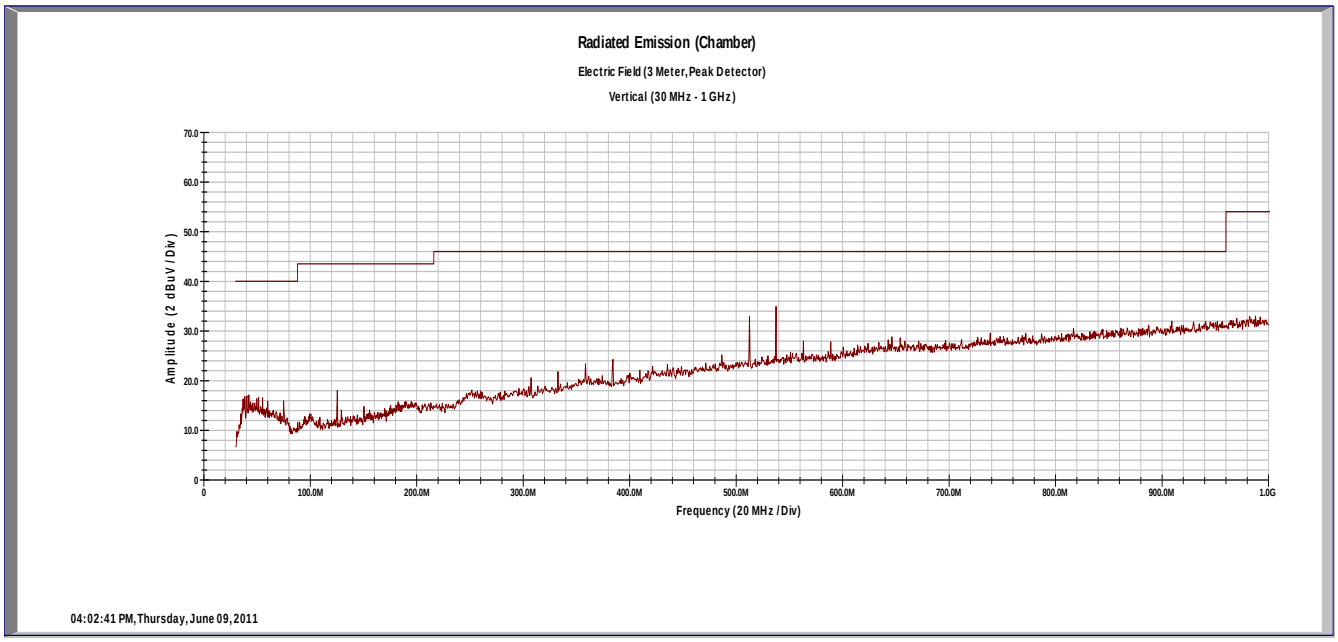
Radiated Emissions – External Antenna
Horizontal



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	QP FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)
384.00	H	2.2	300	15.05	0.00	2.15	15.31	32.51	47.00	-14.49

Notes: The low emissions below 200 MHz are anomalies of the receiver.

Radiated Emissions – External Antenna
Vertical

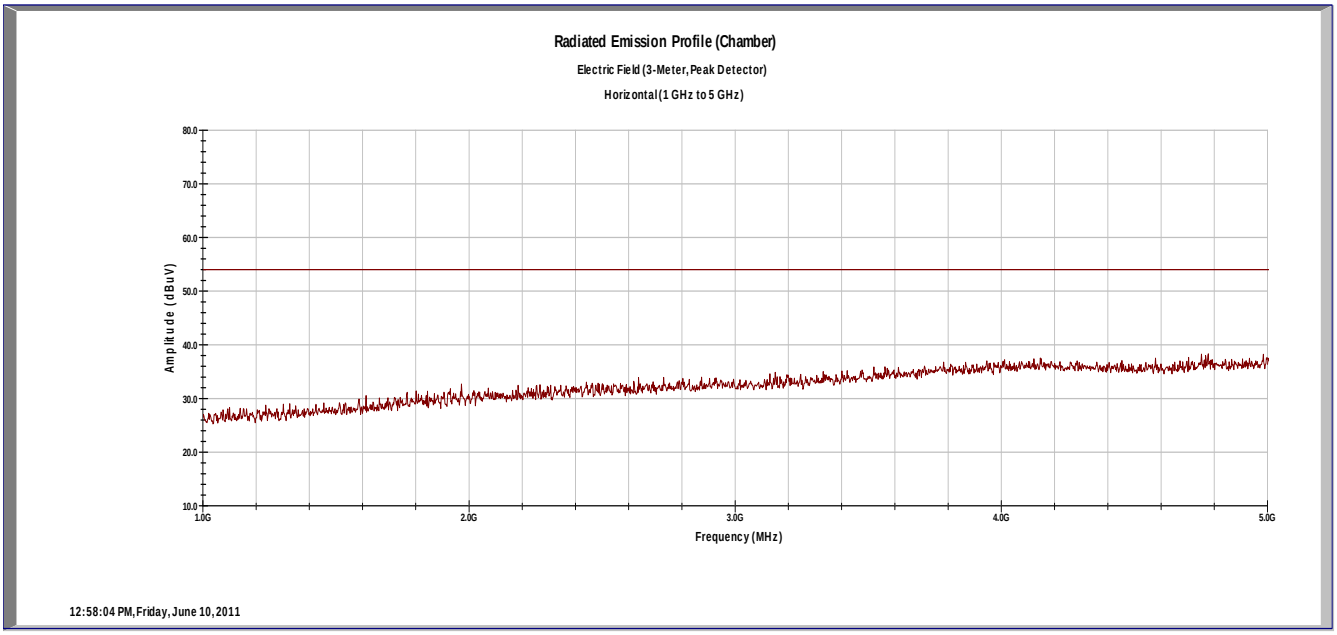


Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	QP FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Spec Limit (dBµV/m)	Spec Margin (dB)
512.00	V	1	13	12.52	0.00	2.51	17.89	32.93	47.00	-14.07
537.64	V	1	16	10.46	0.00	2.57	18.30	31.33	47.00	-15.67

Notes: The low emissions below 200 MHz are anomalies of the receiver.
Highlighted emission is worst case

Radiated Emissions – External Antenna

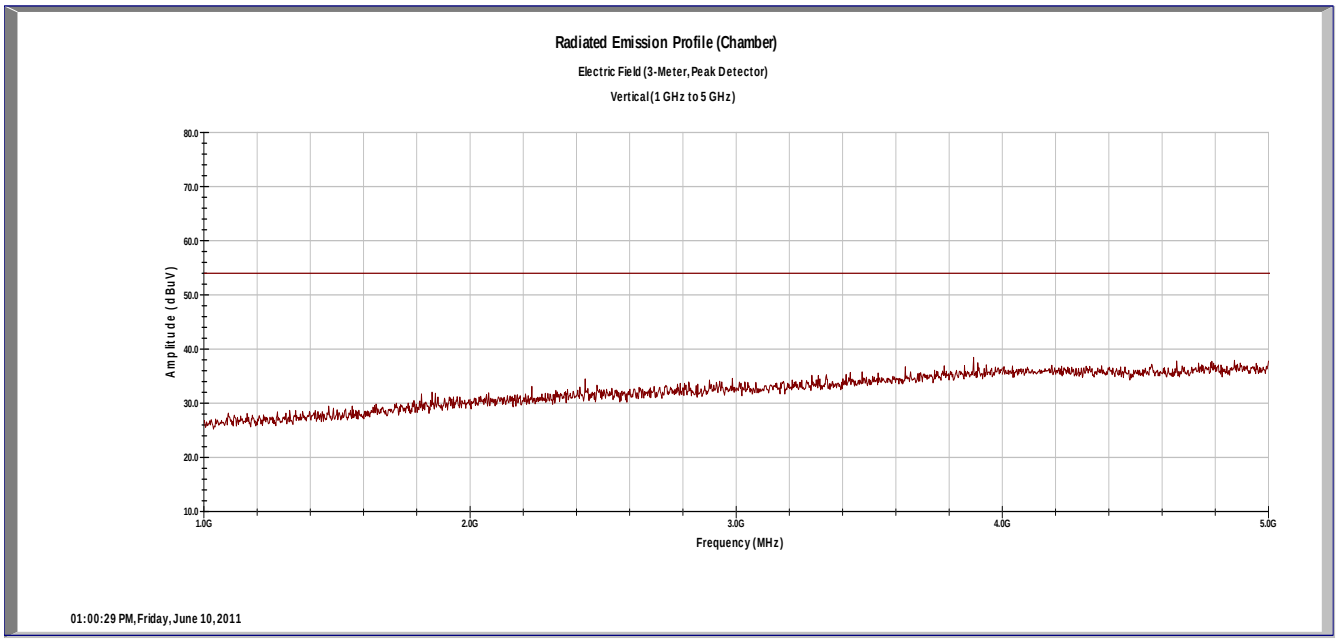
Horizontal



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

Notes: All emissions are either more than 20dB under the limit or below the noise floor of the spectrum analyzer.

Radiated Emissions – External Antenna
Vertical



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

Notes: All emissions are either more than 20dB under the limit or below the noise floor of the spectrum analyzer.

6.2 Conducted Emissions

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.

6.2.1 Over View of Test

Results	**NA** (as tested per this report)				**Date**	NA	
Standard	FCC Part 15.107(a) and ICES-003						
Product Model	PI900		**Serial#**	Production Sample			
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	7.2V DC Battery	**Temp**		**Humidity**		**Pressure**	
Frequency Range	150 kHz to 30 MHz						
Perf. Criteria	(Below Limit)	**Perf. Verification**	Readings Under Limit for L1 & Neutral				
Mod. to EUT	None	**Test Performed By**	Mark Ryan				

6.2.2 Test Procedure

Conducted 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 150 kHz to 30 MHz was investigated for conducted emissions.

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

6.2.1 Deviations

The EUT is battery operated and has no means to connect to AC Mains.

6.2.2 Final Test

The EUT is battery operated only; therefore this test is not applicable.

7 RF Exposure

7.1 Exposure Requirements – FCC Part 15.247(i) and RSS-102 Issue 4

FCC KDB # 447498 DO1 - Mobile and Portable Device RF Exposure and Procedures and Equipment Authorization Policies section 1) c) states that unless excluded by *specific FCC test procedures*, portable devices with output power > 60/$f_{(GHz)}$ mW shall include SAR data for equipment approval.

RSS-102 section 2.5.1 states that a device is exempt from SAR evaluation if the frequency is "from 3 kHz up to 1 GHz inclusively, and with output …power (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 200 mW for general public use…".

7.1.1 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.

7.1.2 Evaluation

The EUT is a hand-held portable device where the antenna can be located less than 20cm from the user, therefore SAR evaluation is required.

7.1.2.1 Evaluation for FCC for 902 MHz Band

FCC 447498 D01 Mobile Portable RF Exposure v04, Paragraph 2) section a) i) states:
"A device may be used in portable exposure conditions with no restrictions on host platforms when either the source-based time-averaged output power is ≤ 60/$f_{(GHz)}$ mW or all measured 1-g SAR are < 0.4 W/kg."

The minimum power that requires SAR is 60 / 0.902 GHz or 66.5 mW.

The maximum power output plus maximum antenna gain of the EUT is:

210 mW * 0.28 (numerical antenna gain) = 58.8 mW

The EUT is below the 66.5mW power level.

Note: this calculation does not include the time-averaged power factor(s).

7.1.2.2 Evaluation for Industry Canada for 902 MHz Band.

The maximum power output plus maximum antenna gain of the EUT is:

210 mW * 0.28 (numerical antenna gain) = 58.8 mW.

The EUT is well below the 200mW radiated power limit.

Note: this calculation does not include the time-averaged power factor(s).

7.1.2.3 Evaluation for Industry Canada for 451 MHz Band.

According to the manufacturer, the operation in this band is considered to be a PPT device. Per section 3.1 of RSS-102, a 50% duty cycle has been included with this calculation:

At 451 MHz, the antenna has a gain of 3.12 dBi, which is a numeric gain of 2.05.

The maximum power output plus maximum antenna gain of the EUT is:

193.8 mW (from original certification)* 2.05 (numerical antenna gain) * 0.5 (50% duty cycle) = 198 mW.

The EUT is below the 200mW power level.

Note: this calculation is based using peak power; the average power would be at least 3 dB lower.

7.1.3 Conclusion

SAR data is not required for either FCC or Industry Canada.