

EMC EMISSIONS - TEST REPORT (In-Part)

Test Report No.	3090365-1	Issue Date:	Tues. Jan. 31, 2006
Model / Serial No.	ES1501, ES1501-XL/ 01564224, 01564072		
Product Type	Water Meter Transmitters.		
Client	Inovonics Wireless Corp.		
Manufacturer	Inovonics Wireless Corp.		
License holder	Inovonics Wireless Corp.		
Address	315 CTC Blvd Louisville, CO 80027		
Test Criteria Applied	FCC CFR47 Part 15.247		
Test Result	PASS		
Test Project Number	3090365	Title 47 CFR 15: RADIO FREQUENCY DEVICES	
References			
Total Pages Including Appendices:	45		
	<i>Michael Spataro</i>	<i>Robert Creswell</i>	
Reviewed By :	Mike Spataro	Approved By :	

INTERNATIONAL APPROVALS LABORATORIES (IAL) reports apply only to the specific samples tested under stated test conditions. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. IAL have no liability for any deductions, inferences or generalizations drawn by the client or others from IAL issued reports.

This report is the confidential property of the client. As a mutual protection to our clients, the public and ourselves, extracts from the test report shall not be reproduced except in full without our written approval of IAL. This report shall not be used by the client to claim product endorsement by NVLAP (No. 200624-0) or any agency of the US government.

International Approval Laboratories and its professional staff hold government and professional organization certifications and are members of IEEE, NVLAP, and VCCI.



Lab Code:200264-0

The entity logos above are for reference only and may not apply to this test report.

DIRECTORY

Documentation	Page(s)
Test report	<u>1 - 45</u>
Directory	<u>2</u>
Test Regulations	<u>3</u>
General Remarks	<u>4-5</u>
Test-setup Photographs	<u>6 - 10</u>
Appendix A	
Test Data Sheets and Test Equipment Used	<u>11 - 30</u>
Appendix B	
Test Plan/Constructional Data Form	<u>31 - 40</u>
Appendix C	
Measurement Protocol/Test Procedures	<u>41 - 45</u>

STATEMENT OF MEASUREMENT UNCERTAINTY

The data and results referenced in this document are true and accurate. The measurement uncertainty for Conducted Emissions in the frequency range of 150kHz – 30MHz is calculated to be $\pm 2.30\text{dB}$ and for Radiated Emissions is calculated to be $\pm 3.60\text{dB}$ in the frequency range of 30MHz – 200MHz and $\pm 3.38\text{dB}$ in the frequency range of 200MHz – 1000MHz.

EUT Received Date: 5-Jan-2006

Testing Start Date: 5-Jan-2006

Testing End Date: 7-Jan-2006

The tests were performed according to following regulations :

- 1. FCC CFR47 Part 15.205
- 2. FCC CFR47 Part 15.207
- 3. FCC CFR47 Part 15.209
- 4. FCC CFR47 Part 15.247
- 5. ICES-003

Emission Test Results:

Conducted Emissions, Powerline (15.207) - Not Applicable

Test Result

Minimum limit margin NA dB at NA MHz

Maximum limit exceeding dB at MHz

Remarks: _____

Radiated Emissions (15.209) - PASS

Test Result

Minimum limit margin -5.4 dB at 1159.61 MHz

Maximum limit exceeding dB at MHz

Remarks: _____

Radiated Emissions (15.205)/(15.247) (c) - PASS

Test Result

Minimum limit margin -3.92 dB at 2744.28 MHz

Maximum limit exceeding dB at MHz

Remarks: Emissions is from model: ES1501 on the mid channel

Peak Output Power 15.247 (b)(2) - PASS

Test Result

Minimum limit margin -1.7 dB at 902.37 MHz

Maximum limit exceeding dB at MHz

Remarks: Emissions is from model: ES1501-XL on the low channel

GENERAL REMARKS:

The following remarks are to be considered as “where applicable“ and are taken into account while completing any FCC/IC/ETSI radio tests at Intertek, ETL Semko.

Testing was performed in 3 different orthogonal axis to determine the worst case emissions from the device. The worst case emissions measurements are shown in this report.

FCC CFR47 Part 15.31: Measurement Standards: In any case where the device is powered off a battery, a fresh battery was used during test. In cases where the device is powered off an AC supply, voltage was varied per Part 15.31 to find worst case emissions.

FCC CFR47 Part 15.35: Measurement Detector Functions and Bandwidths: FCC Part 15.35 was utilized when performing the measurements within this report.

This test report is in-part, Intertek, ETL Semko was asked to test only the field strength of the fundamental and harmonics as well as the unintentional radiated emissions and conducted emissions when applicable.

This report covers two models of the same family of products. Intentional emissions, fundamental and harmonics, was completed on each unit separately. Unintentional emissions were completed on the two units at the same time.

Modifications required to pass: None

Test Specification Deviations: Additions to or Exclusions from: None

Required Information In Accordance to FCC CFR 47 Part 2.1033:

<i>Rule Part 11, 15 & 18 Devices</i>	<i>Other Rule Part Devices</i>	<i>Description</i>	<i>Comments</i>
2.1033(b)(1)	2.1033(c)(1)	Manu. Contact	See Page 1 of this report
2.1033(b)(2)	2.1033(c)(2)	FCC Identifier	
2.1033(b)(3)	2.1033(c)(3)	Users Manual to include Operating, installation	Attached as Exhibit
	2.1033(c)(4)	Emissions Designator per 2.	
	2.1033(c)(5)	Frequency Range	Not Applicable to Part 15 Devcies
	2.1033(c)(6)	Power range and controls	Not Applicable to Part 15 Devcies
	2.1033(c)(7)	Maximum power ouput rating	Not Applicable to Part 15 Devcies
	2.1033(c)(8)	DC Voltage and Current suplying final RF stages	Not Applicable to Part 15 Devcies
2.1033(b)(3)	2.1033(c)(9)	Tune –up procedure	Please refer to the users manual for applicability
2.1033(b)(4&5)	2.1033(c)(10)	Complete Circuit Diagrams and circuit operation description	Attached as Exhibit
2.1033(b)(7)	2.1033(c)(11)	Photographs/drawings of the identification label & its location on the device	Attached as Exhibit
2.1033(b)(7)	2.1033(c)(12)	Photographs of the external and internal surfaces, and construction	Attached as Exhibit
	2.1033(c)(13)	Digital Modulation	Not Applicable
2.1033(b)(6)	2.1033(c)(14)	Report of Measurement Data Required by 2.1046 – 2.1057	See Data Below (This report consists of the testing required under Part 15.231)
2.1033(b)(8)		Description of publicly available support equipment used during test	Refer to Exhibit B of this report (Client Test Plan)
2.1033(b)(9)		Statement of Autorization to Part 15.37 of CFR47	The equipment herein is being authorized in accordance to 15.37 of the CFR47 Rules.
2.1033(b)(10)		Direct Sequence Spread Spectrum Devices (DSSS)	Exhibit of compliance to 15.247(e)
2.1033(b)(10)		Frequency Hopping Devices	Exhibit of compliance to 15.247(a)(1)
2.1033(b)(11)		Scanning receiver construction	Exhibit stating compliance to construction in accordance to 15.121.
15.31	15.31	Transmitter Supply Voltage	Testing herein was completed in accordance to FCC CFR47 Part 15.31

Exhibits Including (where applicable):

- | | |
|------------------------------------|---|
| 1. Users Manual | 7. Parts List |
| 2. Operation Description | 8. Tuning Procedure (if applicable) |
| 3. Block Diagram | 9. Test Setup Photograph |
| 4. Report of Measurement | 10. Label Drawings and or Photograpghs |
| 5. External & Internal Photographs | 11. Description of Support Equipment (where Applicable) |
| 6. Schematic | |

Required Information in Accordance to Industry Canada Regulations (In addition to the above):

<i>Information Required</i>	<i>Description</i>	<i>Comments</i>
Modulation Type	(i.e. ASK, NON, FSK, DSSS, FHSS, etc.)	
Emissions Designator	Per TRC-49	
In Country Representative	Contact Information	
99% Bandwidth Measurement	Per RSS-210	

Test-setup photo(s):
Conducted Emissions

Not Applicable



Test-setup photo(s):
Radiated Intentional Emissions: ES1501



Test-setup photo(s):
Radiated Intentional Emissions: ES1501



Test-setup photo(s):
Radiated Intentional Emissions: ES1501-XL



Test-setup photo(s):
Radiated Intentional Emissions: ES1501-XL



Appendix A

Test Data Sheets
and
Test Equipment Used



15.209 Test Data

Radiated Electromagnetic Emissions

Test Report #: **3090365**
 Test Method: FCC Part 15.209
 EUT Model #: ES1501, ES1501-XL
 EUT Serial #: 01564224, 01564072
 Manufacturer: Inovonics
 EUT Description: Water Meter Transmitter
 Notes: Two units tested in field simultaneously.
 Removable Battery(ES1501)
 Fixed Battery(ES1501-XL)

Test Area: Pinewood Site 1 (3m)
 Test Date: 07-Jan-2006
 EUT Power: 3 VDC

Temperature: 18.0 °C
 Relative Humidity: 26 %
 Air Pressure: 81 kPa

Page:

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dB/m) (dB)	(dBuV)	(m) (DEG)	15.209 <1GHz	15.209 >1GHz
Loop antenna is perpendicular to EUT.						
No significant emissions detected between 10 kHz and 30 MHz.						
The following are noise floor points.						
0.0100	66.1 Qp	0.0 / 18.5 / 0.0	84.6	V / 1.0 / 0.0	-43.0	N/A
0.254	43.1 Qp	0.1 / 10.5 / 0.0	53.7	V / 1.0 / 0.0	-45.8	N/A
0.446	38.2 Qp	0.1 / 10.4 / 0.0	48.7	V / 1.0 / 0.0	-45.9	N/A
4.80	28.9 Qp	0.2 / 10.2 / 0.0	39.2	V / 1.0 / 0.0	-30.3	N/A
19.45	25.4 Qp	0.4 / 10.3 / 0.0	36.2	V / 1.0 / 0.0	-33.3	N/A
11.16	23.7 Qp	0.2 / 10.5 / 0.0	34.5	V / 1.0 / 0.0	-35.0	N/A
Loop is parallel to EUT.						
0.103	60.6 Qp	0.1 / 11.0 / 0.0	71.7	H / 1.0 / 0.0	-35.6	N/A
0.184	43.2 Qp	0.1 / 10.7 / 0.0	54.0	H / 1.0 / 0.0	-48.3	N/A
0.369	40.8 Qp	0.1 / 10.4 / 0.0	51.2	H / 1.0 / 0.0	-45.1	N/A
2.26	25.4 Qp	0.1 / 10.2 / 0.0	35.7	H / 1.0 / 0.0	-33.8	N/A
11.16	30.6 Qp	0.2 / 10.5 / 0.0	41.3	H / 1.0 / 0.0	-28.2	N/A
29.75	29.8 Qp	0.5 / 8.5 / 0.0	38.9	H / 1.0 / 0.0	-30.6	N/A
Bicon Antenna						
No significant emissions detected between 30 - 200 MHz.						
The following are noise floor points.						
30.00	28.7 Qp	0.5 / 13.1 / 28.2	14.1	V / 1.0 / 0.0	-25.9	N/A
108.84	36.4 Qp	1.1 / 10.4 / 28.0	19.9	V / 1.0 / 0.0	-23.6	N/A
173.49	30.9 Qp	1.4 / 12.5 / 27.6	17.3	V / 1.0 / 0.0	-26.2	N/A
Horizontal						
50.12	35.9 Qp	0.7 / 10.3 / 28.2	18.6	H / 2.0 / 0.0	-21.4	N/A
120.20	26.9 Qp	1.2 / 11.7 / 27.9	11.8	H / 2.0 / 0.0	-31.7	N/A
190.20	27.4 Qp	1.4 / 13.5 / 27.5	14.8	H / 2.0 / 0.0	-28.7	N/A
Antenna: EMCO Log						
No significant emissions detected between 200 - 1000 MHz.						

Radiated Electromagnetic Emissions

Test Report #: **3090365**
 Test Method: **FCC Part 15.209**
 EUT Model #: **ES1501, ES1501-XL**
 EUT Serial #: **01564224, 01564072**
 Manufacturer: **Inovonics**
 EUT Description: **Water Meter Transmitter**
 Notes: **Two units tested in field simultaneously.**
Removable Battery(ES1501)
Fixed Battery(ES1501-XL)

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Jan-2006**
 EUT Power: **3 VDC**

Temperature: **18.0** °C
 Relative Humidity: **26** %
 Air Pressure: **81** kPa

Page:

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ (MHz)	LEVEL (dBuV)	CABLE / ANT / PREAMP (dB) (dB\m) (dB)	FINAL (dBuV)	POL / HGT / AZ (m) (DEG)	DELTA1 (dB) 15.209 <1GHz	DELTA2 (dB) 15.209 >1GHz
The following are noise floor points.						
200.00	21.9 Qp	1.5 / 11.5 / 27.4	7.5	V / 1.0 / 0.0	-36.0	N/A
275.00	18.2 Qp	1.8 / 13.4 / 27.0	6.4	V / 1.0 / 0.0	-39.6	N/A
350.00	17.8 Qp	2.1 / 15.2 / 27.3	7.7	V / 1.0 / 0.0	-38.3	N/A
425.00	19.4 Qp	2.3 / 16.6 / 28.0	10.3	V / 1.0 / 0.0	-35.7	N/A
500.00	20.1 Qp	2.6 / 18.8 / 28.4	13.1	V / 1.0 / 0.0	-32.9	N/A
575.00	19.9 Qp	2.8 / 19.4 / 28.4	13.7	V / 1.0 / 0.0	-32.3	N/A
650.00	19.4 Qp	3.0 / 20.2 / 28.4	14.2	V / 1.0 / 0.0	-31.8	N/A
725.00	19.2 Qp	3.2 / 21.4 / 28.2	15.6	V / 1.0 / 0.0	-30.4	N/A
800.00	18.3 Qp	3.3 / 21.7 / 28.0	15.3	V / 1.0 / 0.0	-30.7	N/A
875.00	19.1 Qp	3.5 / 23.0 / 27.7	17.8	V / 1.0 / 0.0	-28.2	N/A
975.01	18.6 Qp	3.7 / 23.8 / 27.4	18.7	V / 1.0 / 0.0	-35.3	N/A
Horizontal						
225.00	25.1 Qp	1.6 / 11.1 / 27.2	10.6	H / 2.0 / 0.0	-35.4	N/A
300.00	19.9 Qp	1.9 / 14.4 / 27.1	9.1	H / 2.0 / 0.0	-36.9	N/A
374.86	19.8 Qp	2.1 / 15.7 / 27.5	10.0	H / 2.0 / 0.0	-36.0	N/A
450.00	19.2 Qp	2.4 / 17.2 / 28.1	10.7	H / 2.0 / 0.0	-35.3	N/A
524.91	19.2 Qp	2.6 / 19.0 / 28.4	12.5	H / 2.0 / 0.0	-33.5	N/A
600.01	25.1 Qp	2.9 / 19.5 / 28.4	19.1	H / 2.0 / 0.0	-26.9	N/A
675.01	19.9 Qp	3.1 / 21.2 / 28.3	15.9	H / 2.0 / 0.0	-30.1	N/A
750.01	18.9 Qp	3.2 / 21.3 / 28.2	15.2	H / 2.0 / 0.0	-30.8	N/A
825.01	18.4 Qp	3.3 / 22.0 / 28.0	15.8	H / 2.0 / 0.0	-30.2	N/A
900.01	19.1 Qp	3.6 / 23.2 / 27.7	18.2	H / 2.0 / 0.0	-27.8	N/A
975.01	18.6 Qp	3.7 / 23.8 / 27.4	18.6	H / 2.0 / 0.0	-35.4	N/A
602.65	19.4 Qp	2.9 / 19.5 / 28.4	13.4	H / 2.0 / 0.0	-32.6	N/A
1 – 4 GHz						
1159.61	38.5 Av	2.4 / 22.5 / 16.7	46.8	V / 1.0 / 0.0	N/A	-7.2
Maximizing emission						
1159.61	40.3 Av	2.4 / 22.5 / 16.7	48.6	V / 1.0 / 115.0	N/A	-5.4

Radiated Electromagnetic Emissions

Test Report #: **3090365**
 Test Method: **FCC Part 15.209**
 EUT Model #: **ES1501, ES1501-XL**
 EUT Serial #: **01564224, 01564072**
 Manufacturer: **Inovonics**
 EUT Description: **Water Meter Transmitter**
 Notes: **Two units tested in field simultaneously.**
 Removable Battery(ES1501)
 Fixed Battery(ES1501-XL)

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Jan-2006**
 EUT Power: **3 VDC**

Temperature: **18.0** °C
 Relative Humidity: **26** %
 Air Pressure: **81** kPa

Page:

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ (MHz)	LEVEL (dBuV)	CABLE / ANT / PREAMP (dB) (dB\m) (dB)	FINAL (dBuV)	POL / HGT / AZ (m) (DEG)	DELTA1 (dB) 15.209 <1GHz	DELTA2 (dB) 15.209 >1GHz
Horizontal						
the following emission was maximized						
1159.61	39.0 Av	2.4 / 22.5 / 16.7	47.3	H / 1.2 / 326.0	N/A	-6.7
No other significant emissions detected the following are noise floor points.						
1250.00	35.0 Av	2.5 / 22.8 / 19.2	41.2	H / 1.0 / 0.0	N/A	-12.8
2000.00	33.0 Av	3.2 / 25.9 / 36.4	25.7	H / 1.0 / 0.0	N/A	-28.3
2750.00	35.4 Av	4.3 / 27.0 / 37.7	29.0	H / 1.0 / 0.0	N/A	-25.0
3500.00	34.3 Av	4.8 / 28.6 / 36.7	31.0	H / 1.0 / 0.0	N/A	-23.0
Vertical						
1000.00	33.2 Av	3.7 / 22.0 / 12.0	46.9	V / 1.0 / 0.0	N/A	-7.1
1750.00	35.2 Av	3.1 / 24.8 / 33.4	29.6	V / 1.0 / 0.0	N/A	-24.4
2500.00	33.7 Av	4.0 / 26.3 / 37.4	26.5	V / 1.0 / 0.0	N/A	-27.5
3250.00	34.2 Av	4.7 / 28.2 / 36.7	30.4	V / 1.0 / 0.0	N/A	-23.6
4000.00	35.2 Av	5.7 / 29.7 / 36.3	34.3	V / 1.0 / 0.0	N/A	-19.7
No significant emissions detected between 4 - 8 GHz.						
The following are noise floor points.						
4500.00	24.1 Av	6.6 / 30.1 / 40.5	20.3	H / 1.0 / 0.0	N/A	-33.7
5500.00	33.0 Av	6.7 / 32.0 / 40.3	31.4	H / 1.0 / 0.0	N/A	-22.6
6500.00	32.6 Av	8.5 / 32.0 / 40.3	32.8	H / 1.0 / 0.0	N/A	-21.2
7500.00	32.2 Av	8.2 / 34.2 / 39.9	34.7	H / 1.0 / 0.0	N/A	-19.3
Vertical						
5000.00	33.6 Av	7.6 / 31.4 / 40.4	32.2	V / 1.0 / 0.0	N/A	-21.8
6000.00	32.3 Av	7.7 / 32.2 / 39.6	32.6	V / 1.0 / 0.0	N/A	-21.4
7000.00	32.6 Av	8.1 / 33.1 / 40.5	33.3	V / 1.0 / 0.0	N/A	-20.7
8000.00	31.8 Av	8.3 / 34.3 / 40.6	33.8	V / 1.0 / 0.0	N/A	-20.2
No significant emissions detected between 8 - 10 GHz.						

Radiated Electromagnetic Emissions

Test Report #: **3090365**
 Test Method: FCC Part 15.209
 EUT Model #: ES1501, ES1501-XL
 EUT Serial #: 01564224, 01564072
 Manufacturer: Inovonics
 EUT Description: Water Meter Transmitter
 Notes: Two units tested in field simultaneously.
 Removable Battery(ES1501)
 Fixed Battery(ES1501-XL)

Test Area: Pinewood Site 1 (3m)
 Test Date: 07-Jan-2006
 EUT Power: 3 VDC

Temperature: 18.0 °C
 Relative Humidity: 26 %
 Air Pressure: 81 kPa

Page:

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ (MHz)	LEVEL (dBuV)	CABLE / ANT / PREAMP (dB) (dB\m) (dB)	FINAL (dBuV)	POL / HGT / AZ (m) (DEG)	DELTA1 (dB) 15.209 <1GHz	DELTA2 (dB) 15.209 >1GHz
The following are noise floor points.						
8500.00	42.5 Av	8.5 / 34.6 / 48.0	37.6	V / 1.0 / 0.0	N/A	-16.4
9500.00	40.1 Av	9.4 / 35.6 / 48.9	36.3	V / 1.0 / 0.0	N/A	-17.7
Horizontal						
10000.0	43.2 Av	9.5 / 35.4 / 48.6	39.6	H / 1.0 / 0.0	N/A	-14.4
9000.00	41.6 Av	8.5 / 35.1 / 48.6	36.6	H / 1.0 / 0.0	N/A	-17.4
End of Run						

Radiated Electromagnetic Emissions

Test Report #: **3090365**
 Test Method: **FCC Part 15.209**
 EUT Model #: **ES1501, ES1501-XL**
 EUT Serial #: **01564224, 01564072**
 Manufacturer: **Inovonics**
 EUT Description: **Water Meter Transmitter**
 Notes: **Two units tested in field simultaneously.**
 Removable Battery(ES1501)
 Fixed Battery(ES1501-XL)

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Jan-2006**
 EUT Power: **3 VDC**

Temperature: **18.0** °C
 Relative Humidity: **26** %
 Air Pressure: **81** kPa

Page:

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dB/m) (dB)	(dBuV)	(m) (DEG)	15.209 <1GHz	15.209 >1GHz
***** Measurement Summary *****						
1159.61	40.3 Av	2.4 / 22.5 / 16.7	48.6	V / 1.0 / 115.0	N/A	-5.4
1000.00	33.2 Av	3.7 / 22.0 / 12.0	46.9	V / 1.0 / 0.0	N/A	-7.1
1250.00	35.0 Av	2.5 / 22.8 / 19.2	41.2	H / 1.0 / 0.0	N/A	-12.8
10000.0	43.2 Av	9.5 / 35.4 / 48.6	39.6	H / 1.0 / 0.0	N/A	-14.4
8500.00	42.5 Av	8.5 / 34.6 / 48.0	37.6	V / 1.0 / 0.0	N/A	-16.4
9000.00	41.6 Av	8.5 / 35.1 / 48.6	36.6	H / 1.0 / 0.0	N/A	-17.4
9500.00	40.1 Av	9.4 / 35.6 / 48.9	36.3	V / 1.0 / 0.0	N/A	-17.7
7500.00	32.2 Av	8.2 / 34.2 / 39.9	34.7	H / 1.0 / 0.0	N/A	-19.3
4000.00	35.2 Av	5.7 / 29.7 / 36.3	34.3	V / 1.0 / 0.0	N/A	-19.7
8000.00	31.8 Av	8.3 / 34.3 / 40.6	33.8	V / 1.0 / 0.0	N/A	-20.2
7000.00	32.6 Av	8.1 / 33.1 / 40.5	33.3	V / 1.0 / 0.0	N/A	-20.7
6500.00	32.6 Av	8.5 / 32.0 / 40.3	32.8	H / 1.0 / 0.0	N/A	-21.2
50.12	35.9 Qp	0.7 / 10.3 / 28.2	18.6	H / 2.0 / 0.0	-21.4	N/A
6000.00	32.3 Av	7.7 / 32.2 / 39.6	32.6	V / 1.0 / 0.0	N/A	-21.4
5000.00	33.6 Av	7.6 / 31.4 / 40.4	32.2	V / 1.0 / 0.0	N/A	-21.8
5500.00	33.0 Av	6.7 / 32.0 / 40.3	31.4	H / 1.0 / 0.0	N/A	-22.6
3500.00	34.3 Av	4.8 / 28.6 / 36.7	31.0	H / 1.0 / 0.0	N/A	-23.0
108.84	36.4 Qp	1.1 / 10.4 / 28.0	19.9	V / 1.0 / 0.0	-23.6	N/A
3250.00	34.2 Av	4.7 / 28.2 / 36.7	30.4	V / 1.0 / 0.0	N/A	-23.6
1750.00	35.2 Av	3.1 / 24.8 / 33.4	29.6	V / 1.0 / 0.0	N/A	-24.4
2750.00	35.4 Av	4.3 / 27.0 / 37.7	29.0	H / 1.0 / 0.0	N/A	-25.0
30.00	28.7 Qp	0.5 / 13.1 / 28.2	14.1	V / 1.0 / 0.0	-25.9	N/A
173.49	30.9 Qp	1.4 / 12.5 / 27.6	17.3	V / 1.0 / 0.0	-26.2	N/A
2500.00	33.7 Av	4.0 / 26.3 / 37.4	26.5	V / 1.0 / 0.0	N/A	-27.5
900.01	19.1 Qp	3.6 / 23.2 / 27.7	18.2	H / 2.0 / 0.0	-27.8	N/A
11.16	30.6 Qp	0.2 / 10.5 / 0.0	41.3	H / 1.0 / 0.0	-28.2	N/A
875.00	19.1 Qp	3.5 / 23.0 / 27.7	17.8	V / 1.0 / 0.0	-28.2	N/A
2000.00	33.0 Av	3.2 / 25.9 / 36.4	25.7	H / 1.0 / 0.0	N/A	-28.3
190.20	27.4 Qp	1.4 / 13.5 / 27.5	14.8	H / 2.0 / 0.0	-28.7	N/A
675.01	19.9 Qp	3.1 / 21.2 / 28.3	15.9	H / 2.0 / 0.0	-30.1	N/A

Radiated Electromagnetic Emissions

Test Report #: **3090365**
 Test Method: **FCC Part 15.209**
 EUT Model #: **ES1501, ES1501-XL**
 EUT Serial #: **01564224, 01564072**
 Manufacturer: **Inovonics**
 EUT Description: **Water Meter Transmitter**
 Notes: **Two units tested in field simultaneously.**
 Removable Battery(ES1501)
 Fixed Battery(ES1501-XL)

Test Area: **Pinewood Site 1 (3m)**
 Test Date: **07-Jan-2006**
 EUT Power: **3 VDC**

Temperature: **18.0** °C
 Relative Humidity: **26** %
 Air Pressure: **81** kPa

Page:

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ (MHz)	LEVEL (dBuV)	CABLE / ANT / PREAMP (dB) (dB/m) (dB)	FINAL (dBuV)	POL / HGT / AZ (m) (DEG)	DELTA (dB)	
					15.209 <1GHz	15.209 >1GHz
825.01	18.4 Qp	3.3 / 22.0 / 28.0	15.8	H / 2.0 / 0.0	-30.2	N/A
4.80	28.9 Qp	0.2 / 10.2 / 0.0	39.2	V / 1.0 / 0.0	-30.3	N/A
725.00	19.2 Qp	3.2 / 21.4 / 28.2	15.6	V / 1.0 / 0.0	-30.4	N/A
29.75	29.8 Qp	0.5 / 8.5 / 0.0	38.9	H / 1.0 / 0.0	-30.6	N/A
800.00	18.3 Qp	3.3 / 21.7 / 28.0	15.3	V / 1.0 / 0.0	-30.7	N/A
750.01	18.9 Qp	3.2 / 21.3 / 28.2	15.2	H / 2.0 / 0.0	-30.8	N/A
120.20	26.9 Qp	1.2 / 11.7 / 27.9	11.8	H / 2.0 / 0.0	-31.7	N/A
650.00	19.4 Qp	3.0 / 20.2 / 28.4	14.2	V / 1.0 / 0.0	-31.8	N/A
575.00	19.9 Qp	2.8 / 19.4 / 28.4	13.7	V / 1.0 / 0.0	-32.3	N/A
602.65	19.4 Qp	2.9 / 19.5 / 28.4	13.4	H / 2.0 / 0.0	-32.6	N/A
500.00	20.1 Qp	2.6 / 18.8 / 28.4	13.1	V / 1.0 / 0.0	-32.9	N/A
19.45	25.4 Qp	0.4 / 10.3 / 0.0	36.2	V / 1.0 / 0.0	-33.3	N/A
524.91	19.2 Qp	2.6 / 19.0 / 28.4	12.5	H / 2.0 / 0.0	-33.5	N/A
4500.00	24.1 Av	6.6 / 30.1 / 40.5	20.3	H / 1.0 / 0.0	N/A	-33.7
2.26	25.4 Qp	0.1 / 10.2 / 0.0	35.7	H / 1.0 / 0.0	-33.8	N/A
450.00	19.2 Qp	2.4 / 17.2 / 28.1	10.7	H / 2.0 / 0.0	-35.3	N/A
975.01	18.6 Qp	3.7 / 23.8 / 27.4	18.7	V / 1.0 / 0.0	-35.3	N/A
225.00	25.1 Qp	1.6 / 11.1 / 27.2	10.6	H / 2.0 / 0.0	-35.4	N/A
0.103	60.6 Qp	0.1 / 11.0 / 0.0	71.7	H / 1.0 / 0.0	-35.6	N/A
425.00	19.4 Qp	2.3 / 16.6 / 28.0	10.3	V / 1.0 / 0.0	-35.7	N/A
200.00	21.9 Qp	1.5 / 11.5 / 27.4	7.5	V / 1.0 / 0.0	-36.0	N/A
374.86	19.8 Qp	2.1 / 15.7 / 27.5	10.0	H / 2.0 / 0.0	-36.0	N/A
300.00	19.9 Qp	1.9 / 14.4 / 27.1	9.1	H / 2.0 / 0.0	-36.9	N/A
350.00	17.8 Qp	2.1 / 15.2 / 27.3	7.7	V / 1.0 / 0.0	-38.3	N/A
275.00	18.2 Qp	1.8 / 13.4 / 27.0	6.4	V / 1.0 / 0.0	-39.6	N/A
0.0100	66.1 Qp	0.0 / 18.5 / 0.0	84.6	V / 1.0 / 0.0	-43.0	N/A
0.369	40.8 Qp	0.1 / 10.4 / 0.0	51.2	H / 1.0 / 0.0	-45.1	N/A
0.254	43.1 Qp	0.1 / 10.5 / 0.0	53.7	V / 1.0 / 0.0	-45.8	N/A
0.446	38.2 Qp	0.1 / 10.4 / 0.0	48.7	V / 1.0 / 0.0	-45.9	N/A
0.184	43.2 Qp	0.1 / 10.7 / 0.0	54.0	H / 1.0 / 0.0	-48.3	N/A

15.247 (b)(2), (c)/15.205 Test Data

ES1501

Field Strength Measurements Fundamental and Spurious of the Transmitter

Test Report #: 3090365	Test Area: Pinewood Site 1 (3m)	Temperature: 18.0 °C
Test Method: FCC Part 15.209	Test Date: 07-Jan-2006	Relative Humidity: 26 %
EUT Model #: ES1501	EUT Power: 3 VDC	Air Pressure: 81 kPa
EUT Serial #: 01564224		Page:
Manufacturer: Inovonics		
EUT Description: Water Meter Transmitter		
Notes: Removable Battery(ES1501)		

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Duty Cycle Correction	Final Corrected	Limit	DELTA
(MHz)	(dBuV)	(dB) (dBm) (dB)	(dBuV)	(m) (DEG)	(dB)	(dBuV/m)	(dBuV/m)	(dB)

The following duty cycle was declared by the manufacturer.
 "In this case, the maximum time that the carrier would dwell on any hopping channel is 18.8 mS in a 100 mS window. Therefore, the maximum Duty Factor correction factor of 14.52 dB was utilized in the calculations for the final measurement."

Averaging method for pulsed signals and calculation in accordance to FCC CFR47 Part 15.35 utilized to calculate field strength emissions.
 The testing performed in accordance to FCC CFR47 Part 15.205 (restricted bands of operation) and 15.247 emissions and delta limits were calculated as follows:
 Final Corrected Peak Measurement – Duty Cycle Correction Factor* = Final Calculated Emission
 The Final Calculated Emission was then compared to the Limits in CFR47 Part 15.209 and 15.247 and the emission/limit delta was calculated. the DTFC is calculated as follows $20 \cdot \log_{10}(\text{duty cycle in 100mS})$ "not to exceed 20dB"

Part 15.247 and 15.205 Respectively								
Determining worst case axis for EUT.								
Axis 1, EUT Flat on table								
Low Channel								
902.41	85.0 Pk	3.6 / 23.2 / 0.0	111.8	V / 1.0 / 152.0	0	111.8	119	-7.2
902.41	88.0 Pk	3.6 / 23.2 / 0.0	114.7	H / 1.0 / 40.0	0	114.7	119	-4.3
Mid Channel								
914.83	88.4 Pk	3.6 / 23.2 / 0.0	115.2	H / 1.0 / 51.0	0	115.2	119	-3.8
914.83	83.6 Pk	3.6 / 23.2 / 0.0	110.4	V / 1.1 / 242.0	0	110.4	119	-8.6
High Channel								
927.62	79.7 Pk	3.6 / 23.2 / 0.0	106.5	V / 1.1 / 240.0	0	106.5	119	-12.5
927.62	82.8 Pk	3.6 / 23.2 / 0.0	109.7	H / 1.1 / 42.0	0	109.7	119	-9.3
Axis 2, EUT on its side								
High Channel								
927.62	83.5 Pk	3.6 / 23.2 / 0.0	110.3	H / 1.5 / 210.0	0	110.3	119	-8.7
927.62	77.0 Pk	3.6 / 23.2 / 0.0	103.8	V / 1.0 / 22.0	0	103.8	119	-15.2
Mid Channel								
914.83	81.1 Pk	3.6 / 23.2 / 0.0	107.9	V / 1.0 / 46.0	0	107.9	119	-11.1
914.83	87.5 Pk	3.6 / 23.2 / 0.0	114.3	H / 1.0 / 337.0	0	114.3	119	-4.7
Low Channel								
902.41	90.0 Pk	3.6 / 23.2 / 0.0	116.8	H / 1.0 / 25.0	0	116.8	119	-2.2
902.41	83.2 Pk	3.6 / 23.2 / 0.0	110	V / 1.1 / 20.0	0	110.0	119	-9
Axis 3, EUT standing up								
Low Channel								
902.41	87.5 Pk	3.6 / 23.2 / 0.0	114.3	V / 1.1 / 0.0	0	114.3	119	-4.7
902.41	88.1 Pk	3.6 / 23.2 / 0.0	114.9	H / 1.1 / 112.0	0	114.9	119	-4.1

Field Strength Measurements Fundamental and Spurious of the Transmitter

Test Report #: 3090365	Test Area: Pinewood Site 1 (3m)	Temperature: 18.0 °C
Test Method: FCC Part 15.209	Test Date: 07-Jan-2006	Relative Humidity: 26 %
EUT Model #: ES1501	EUT Power: 3 VDC	Air Pressure: 81 kPa
EUT Serial #: 01564224		Page:
Manufacturer: Inovonics		
EUT Description: Water Meter Transmitter		
Notes: Removable Battery(ES1501)		

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Duty Cycle Correction	Final Corrected	Limit	DELTA
(MHz)	(dBuV)	(dB) (dBm) (dB)	(dBuV)	(m) (DEG)	(dB)	(dBuV/m)	(dBuV/m)	(dB)

The following duty cycle was declared by the manufacturer.
 "In this case, the maximum time that the carrier would dwell on any hopping channel is 18.8 mS in a 100 mS window. Therefore, the maximum Duty Factor correction factor of 14.52 dB was utilized in the calculations for the final measurement."

Averaging method for pulsed signals and calculation in accordance to FCC CFR47 Part 15.35 utilized to calculate field strength emissions.

The testing performed in accordance to FCC CFR47 Part 15.205 (restricted bands of operation) and 15.247 emissions and delta limits were calculated as follows:

Final Corrected Peak Measurement – Duty Cycle Correction Factor* = Final Calculated Emission

The Final Calculated Emission was then compared to the Limits in CFR47 Part 15.209 and 15.247 and the emission/limit delta was calculated.

the DTCF is calculated as follows $20 \cdot \log_{10}(\text{duty cycle in 100mS})$ "not to exceed 20dB"

Part 15.247 and 15.205 Respectively

Mid Channel

914.83	87.2 Pk	3.6 / 23.2 / 0.0	114	H / 1.0 / 152.0	0	114.0	119	-5
914.83	86.0 Pk	3.6 / 23.2 / 0.0	112.7	V / 1.1 / 343.0	0	112.7	119	-6.3

High Channel

927.62	82.8 Pk	3.6 / 23.2 / 0.0	109.6	V / 1.1 / 88.0	0	109.6	119	-9.4
927.62	82.7 Pk	3.6 / 23.2 / 0.0	109.5	H / 1.1 / 155.0	0	109.5	119	-9.5

Axis 2 Determined to be worst case.

EUT placed in worst case position for remaining testing.

Low channel

1804.74	69.9 Pk	3.1 / 25.0 / 35.1	62.9	V / 1.0 / 197.0	-14.52	48.38	99	-50.62
1804.74	68.7 Pk	3.1 / 25.0 / 35.1	61.7	H / 1.0 / 189.0	-14.52	47.18	99	-51.82
2707.1	64.4 Pk	4.2 / 26.9 / 37.5	58	V / 1.0 / 197.0	-14.52	43.48	54	-10.52
2707.1	61.1 Pk	4.2 / 26.9 / 37.5	54.7	H / 1.1 / 191.0	-14.52	40.18	54	-13.82
3609.43	61.0 Pk	5.0 / 28.9 / 37.9	57	V / 1.0 / 346.0	-14.52	42.48	54	-11.52
3609.43	57.5 Pk	5.0 / 28.9 / 37.9	53.5	H / 1.9 / 146.0	-14.52	38.98	54	-15.02
4511.79	61.0 Pk	6.6 / 30.2 / 40.5	57.3	V / 1.2 / 20.0	-14.52	42.78	54	-11.22
4511.79	62.0 Pk	6.6 / 30.2 / 40.5	58.2	H / 1.6 / 75.0	-14.52	43.68	54	-10.32
5414.12	58.4 Pk	6.9 / 31.9 / 40.2	56.9	V / 1.2 / 331.0	-14.52	42.38	54	-11.62
5414.78	60.2 Pk	6.9 / 31.9 / 40.2	58.7	H / 1.5 / 128.0	-14.52	44.18	54	-9.82
6316.37	62.9 Pk	8.2 / 32.1 / 40.9	62.2	V / 1.1 / 300.0	-14.52	47.68	99	-51.32
6316.37	57.4 Pk	8.2 / 32.1 / 40.9	56.8	H / 1.4 / 210.0	-14.52	42.28	99	-56.72
7218.73	53.8 Pk	8.1 / 33.5 / 40.7	54.8	V / 1.3 / 260.0	-14.52	40.28	99	-58.72
7218.73	51.2 Pk	8.1 / 33.5 / 40.7	52.3	H / 1.7 / 97.0	-14.52	37.78	99	-61.22
8121.07	66.7 Pk	8.3 / 34.4 / 46.8	62.6	V / 1.8 / 203.0	-14.52	48.08	54	-5.92
8121.07	64.5 Pk	8.3 / 34.4 / 46.8	60.5	H / 1.6 / 332.0	-14.52	45.98	54	-8.02
9023.4	61.7 Pk	8.5 / 35.2 / 48.5	56.9	V / 1.5 / 193.0	-14.52	42.38	54	-11.62
9023.4	58.1 Pk	8.5 / 35.2 / 48.5	53.3	H / 1.5 / 70.0	-14.52	38.78	54	-15.22

Field Strength Measurements Fundamental and Spurious of the Transmitter

Test Report #: 3090365	Test Area: Pinewood Site 1 (3m)	Temperature: 18.0 °C								
Test Method: FCC Part 15.209	Test Date: 07-Jan-2006	Relative Humidity: 26 %								
EUT Model #: ES1501	EUT Power: 3 VDC	Air Pressure: 81 kPa								
EUT Serial #: 01564224	Page:									
Manufacturer: Inovonics	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Level Key</th> </tr> </thead> <tbody> <tr> <td>Pk – Peak</td> <td>Nb – Narrow Band</td> </tr> <tr> <td>Qp – QuasiPeak</td> <td>Bb – Broad Band</td> </tr> <tr> <td>Av - Average</td> <td></td> </tr> </tbody> </table>		Level Key		Pk – Peak	Nb – Narrow Band	Qp – QuasiPeak	Bb – Broad Band	Av - Average	
Level Key										
Pk – Peak	Nb – Narrow Band									
Qp – QuasiPeak	Bb – Broad Band									
Av - Average										
EUT Description: Water Meter Transmitter										
Notes: Removable Battery(ES1501)										

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Duty Cycle Correction	Final Corrected	Limit	DELTA
(MHz)	(dBuV)	(dB) (dBm) (dB)	(dBuV)	(m) (DEG)	(dB)	(dBuV/m)	(dBuV/m)	(dB)

The following duty cycle was declared by the manufacturer.

"In this case, the maximum time that the carrier would dwell on any hopping channel is 18.8 mS in a 100 mS window. Therefore, the maximum Duty Factor correction factor of 14.52 dB was utilized in the calculations for the final measurement."

Averaging method for pulsed signals and calculation in accordance to FCC CFR47 Part 15.35 utilized to calculate field strength emissions.

The testing performed in accordance to FCC CFR47 Part 15.205 (restricted bands of operation) and 15.247 emissions and delta limits were calculated as follows:

Final Corrected Peak Measurement – Duty Cycle Correction Factor* = Final Calculated Emission

The Final Calculated Emission was then compared to the Limits in CFR47 Part 15.209 and 15.247 and the emission/limit delta was calculated.

the DTCF is calculated as follows $20 \cdot \log_{10}(\text{duty cycle in 100mS})$ "not to exceed 20dB"

Part 15.247 and 15.205 Respectively

Mid Channel

1829.54	69.7 Pk	3.1 / 25.1 / 35.8	62.1	H / 1.2 / 331.0	-14.52	47.58	99	-51.42
1829.54	70.3 Pk	3.1 / 25.1 / 35.8	62.8	V / 1.2 / 332.0	-14.52	48.28	99	-50.72
2744.28	67.2 Pk	4.3 / 27.0 / 37.7	60.8	H / 1.9 / 342.0	-14.52	46.28	54	-7.72
2744.28	71.0 Pk	4.3 / 27.0 / 37.7	64.6	V / 1.1 / 337.0	-14.52	50.08	54	-3.92
3659.03	59.5 Pk	5.1 / 29.0 / 37.7	55.8	H / 1.9 / 142.0	-14.52	41.28	54	-12.72
3659.47	64.8 Pk	5.1 / 29.0 / 37.7	61.2	V / 1.2 / 331.0	-14.52	46.68	54	-7.32
4573.78	55.9 Pk	6.7 / 30.3 / 40.5	52.5	H / 1.9 / 110.0	-14.52	37.98	54	-16.02
4574.32	65.7 Pk	6.7 / 30.3 / 40.5	62.2	V / 1.2 / 348.0	-14.52	47.68	54	-6.32
5488.52	65.1 Pk	6.7 / 32.0 / 40.3	63.5	H / 1.7 / 215.0	-14.52	48.98	99	-50.02
5489.18	62.7 Pk	6.7 / 32.0 / 40.3	61.1	V / 2.1 / 222.0	-14.52	46.58	99	-52.42
6403.18	58.9 Pk	8.3 / 32.0 / 40.8	58.4	V / 1.4 / 293.0	-14.52	43.88	99	-55.12
6403.96	52.4 Pk	8.3 / 32.0 / 40.8	52	H / 1.4 / 134.0	-14.52	37.48	99	-61.52
7317.93	55.8 Pk	8.2 / 33.8 / 40.4	57.3	H / 1.5 / 160.0	-14.52	42.78	54	-11.22
7317.93	59.5 Pk	8.2 / 33.8 / 40.4	61	V / 1.0 / 220.0	-14.52	46.48	54	-7.52
8232.66	57.0 Pk	8.4 / 34.5 / 47.1	52.8	H / 1.7 / 320.0	-14.52	38.28	54	-15.72
8233.66	59.5 Pk	8.4 / 34.5 / 47.1	55.2	V / 1.6 / 240.0	-14.52	40.68	54	-13.32
9147.39	60.4 Pk	8.8 / 35.3 / 48.1	56.4	H / 1.6 / 176.0	-14.52	41.88	54	-12.12
9147.39	61.8 Pk	8.8 / 35.3 / 48.1	57.7	V / 2.1 / 305.0	-14.52	43.18	54	-10.82

High Channel

1855.13	69.1 Pk	3.1 / 25.3 / 35.8	61.7	H / 1.1 / 135.0	-14.52	47.18	99	-51.82
1855.15	71.8 Pk	3.1 / 25.3 / 35.8	64.4	V / 1.0 / 0.0	-14.52	49.88	99	-49.12
2782.68	63.1 Pk	4.3 / 27.1 / 37.7	56.8	H / 1.1 / 187.0	-14.52	42.28	54	-11.72
2782.69	68.3 Pk	4.3 / 27.1 / 37.7	62	V / 1.1 / 342.0	-14.52	47.48	54	-6.52
3710.23	64.8 Pk	5.2 / 29.1 / 37.5	61.7	V / 1.0 / 335.0	-14.52	47.18	54	-6.82
3710.23	56.6 Pk	5.2 / 29.1 / 37.5	53.4	H / 2.2 / 182.0	-14.52	38.88	54	-15.12
4637.77	60.7 Pk	6.9 / 30.5 / 40.4	57.6	V / 1.2 / 11.0	-14.52	43.08	54	-10.92
4637.77	56.5 Pk	6.9 / 30.5 / 40.4	53.4	H / 1.8 / 12.0	-14.52	38.88	54	-15.12

Field Strength Measurements Fundamental and Spurious of the Transmitter

Test Report #: 3090365	Test Area: Pinewood Site 1 (3m)	Temperature: 18.0 °C								
Test Method: FCC Part 15.209	Test Date: 07-Jan-2006	Relative Humidity: 26 %								
EUT Model #: ES1501	EUT Power: 3 VDC	Air Pressure: 81 kPa								
EUT Serial #: 01564224	Page:									
Manufacturer: Inovonics	<table border="0" style="width: 100%; text-align: center;"> <tr><td colspan="2">Level Key</td></tr> <tr><td>Pk – Peak</td><td>Nb – Narrow Band</td></tr> <tr><td>Qp – QuasiPeak</td><td>Bb – Broad Band</td></tr> <tr><td>Av - Average</td><td></td></tr> </table>		Level Key		Pk – Peak	Nb – Narrow Band	Qp – QuasiPeak	Bb – Broad Band	Av - Average	
Level Key										
Pk – Peak	Nb – Narrow Band									
Qp – QuasiPeak	Bb – Broad Band									
Av - Average										
EUT Description: Water Meter Transmitter										
Notes: Removable Battery(ES1501)										

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Duty Cycle Correction	Final Corrected	Limit	DELTA
(MHz)	(dBuV)	(dB) (dBm) (dB)	(dBuV)	(m) (DEG)	(dB)	(dBuV/m)	(dBuV/m)	(dB)

The following duty cycle was declared by the manufacturer.

"In this case, the maximum time that the carrier would dwell on any hopping channel is 18.8 mS in a 100 mS window. Therefore, the maximum Duty Factor correction factor of 14.52 dB was utilized in the calculations for the final measurement."

Averaging method for pulsed signals and calculation in accordance to FCC CFR47 Part 15.35 utilized to calculate field strength emissions.

The testing performed in accordance to FCC CFR47 Part 15.205 (restricted bands of operation) and 15.247 emissions and delta limits were calculated as follows:

Final Corrected Peak Measurement – Duty Cycle Correction Factor* = Final Calculated Emission

The Final Calculated Emission was then compared to the Limits in CFR47 Part 15.209 and 15.247 and the emission/limit delta was calculated.

the DTCCF is calculated as follows $20 \cdot \log_{10}(\text{duty cycle in 100mS})$ "not to exceed 20dB"

Part 15.247 and 15.205 Respectively

5565.31	69.5 Pk	6.8 / 32.0 / 40.6	67.8	V / 1.5 / 336.0	-14.52	53.28	99	-45.72
5565.31	67.0 Pk	6.8 / 32.0 / 40.6	65.3	H / 1.5 / 130.0	-14.52	50.78	99	-48.22
6492.77	54.0 Pk	8.5 / 32.0 / 40.3	54.2	V / 1.0 / 298.0	-14.52	39.68	99	-59.32
6492.77	50.8 Pk	8.5 / 32.0 / 40.3	50.9	H / 1.4 / 293.0	-14.52	36.38	99	-62.62
7420.31	56.2 Pk	8.2 / 34.0 / 40.0	58.4	V / 1.5 / 140.0	-14.52	43.88	54	-10.12
7420.31	52.3 Pk	8.2 / 34.0 / 40.0	54.5	H / 1.7 / 156.0	-14.52	39.98	54	-14.02
8347.86	62.8 Pk	8.4 / 34.5 / 47.6	58.2	V / 1.5 / 232.0	-14.52	43.68	54	-10.32
8347.86	60.2 Pk	8.4 / 34.5 / 47.6	55.6	H / 1.7 / 161.0	-14.52	41.08	54	-12.92
9275.4	52.9 Pk	9.0 / 35.4 / 48.5	48.8	V / 2.3 / 316.0	-14.52	34.28	99	-64.72
9276.5	52.2 Pk	9.0 / 35.4 / 48.5	48.2	H / 1.6 / 176.0	-14.52	33.68	99	-65.32

ES1501-XL

Field Strength Measurements Fundamental and Spurious of the Transmitter

Test Report #: 3090365	Test Area: Pinewood Site 1 (3m)	Temperature: 18.0 °C
Test Method: FCC Part 15.209	Test Date: 07-Jan-2006	Relative Humidity: 26 %
EUT Model #: ES1501-XL	EUT Power: 3 VDC	Air Pressure: 81 kPa
EUT Serial #: 01564027		Page:
Manufacturer: Inovonics		
EUT Description: Water Meter Transmitter		
Notes: Removable Battery(ES1501)		

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Duty Cycle Correction	Final Corrected	Limit	DELTA
(MHz)	(dBuV)	(dB) (dBm) (dB)	(dBuV)	(m) (DEG)	(dB)	(dBuV/m)	(dBuV/m)	(dB)

The following duty cycle was declared by the manufacturer.
 "In this case, the maximum time that the carrier would dwell on any hopping channel is 18.8 mS in a 100 mS window. Therefore, the maximum Duty Factor correction factor of 14.52 dB was utilized in the calculations for the final measurement."

Averaging method for pulsed signals and calculation in accordance to FCC CFR47 Part 15.35 utilized to calculate field strength emissions.
 The testing performed in accordance to FCC CFR47 Part 15.205 (restricted bands of operation) and 15.247 emissions and delta limits were calculated as follows:
 Final Corrected Peak Measurement – Duty Cycle Correction Factor* = Final Calculated Emission
 The Final Calculated Emission was then compared to the Limits in CFR47 Part 15.209 and 15.247 and the emission/limit delta was calculated. the DTFC is calculated as follows $20 \cdot \log_{10}(\text{duty cycle in 100mS})$ "not to exceed 20dB"

Part 15.247 and 15.205 Respectively								
Determining worst case position								
Axis 1, EUT Flat on table								
Low channel								
902.37	85.8 Pk	3.6 / 23.2 / 0.0	112.6	V / 1.7 / 115.0	0	112.6	119	-6.4
902.37	90.5 Pk	3.6 / 23.2 / 0.0	117.3	H / 1.0 / 44.0	0	117.3	119	-1.7
Mid Channel								
914.78	89.5 Pk	3.6 / 23.2 / 0.0	116.3	H / 1.0 / 44.0	0	116.3	119	-2.7
914.78	84.1 Pk	3.6 / 23.2 / 0.0	110.9	V / 2.1 / 120.0	0	110.9	119	-8.1
High Channel								
927.58	84.5 Pk	3.6 / 23.2 / 0.0	111.3	V / 1.2 / 120.0	0	111.3	119	-7.7
927.58	87.0 Pk	3.6 / 23.2 / 0.0	113.8	H / 1.0 / 46.0	0	113.8	119	-5.2
Axis 2, EUT on its side								
High Channel								
927.58	86.2 Pk	3.6 / 23.2 / 0.0	113	H / 1.0 / 39.0	0	113	119	-6
927.58	79.8 Pk	3.6 / 23.2 / 0.0	106.6	V / 1.3 / 123.0	0	106.6	119	-12.4
Mid Channel								
914.78	79.0 Pk	3.6 / 23.2 / 0.0	105.8	V / 1.3 / 25.0	0	105.8	119	-13.2
914.78	87.8 Pk	3.6 / 23.2 / 0.0	114.5	H / 1.0 / 46.0	0	114.5	119	-4.5
Low Channel								
902.37	89.5 Pk	3.6 / 23.2 / 0.0	116.3	H / 1.0 / 34.0	0	116.3	119	-2.7
902.37	82.8 Pk	3.6 / 23.2 / 0.0	109.6	V / 1.8 / 190.0	0	109.6	119	-9.4
Axis 3, EUT standing up								
Low Channel								
902.37	89.0 Pk	3.6 / 23.2 / 0.0	115.8	V / 1.0 / 125.0	0	115.8	119	-3.2
902.37	87.7 Pk	3.6 / 23.2 / 0.0	114.4	H / 1.0 / 50.0	0	114.4	119	-4.6

Field Strength Measurements Fundamental and Spurious of the Transmitter

Test Report #: 3090365	Test Area: Pinewood Site 1 (3m)	Temperature: 18.0 °C
Test Method: FCC Part 15.209	Test Date: 07-Jan-2006	Relative Humidity: 26 %
EUT Model #: ES1501-XL	EUT Power: 3 VDC	Air Pressure: 81 kPa
EUT Serial #: 01564027		
Manufacturer: Inovonics		
EUT Description: Water Meter Transmitter		
Notes: Removable Battery(ES1501)		

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Duty Cycle Correction	Final Corrected	Limit	DELTA
(MHz)	(dBuV)	(dB) (dBm) (dB)	(dBuV)	(m) (DEG)	(dB)	(dBuV/m)	(dBuV/m)	(dB)

The following duty cycle was declared by the manufacturer.

"In this case, the maximum time that the carrier would dwell on any hopping channel is 18.8 mS in a 100 mS window. Therefore, the maximum Duty Factor correction factor of 14.52 dB was utilized in the calculations for the final measurement."

Averaging method for pulsed signals and calculation in accordance to FCC CFR47 Part 15.35 utilized to calculate field strength emissions.

The testing performed in accordance to FCC CFR47 Part 15.205 (restricted bands of operation) and 15.247 emissions and delta limits were calculated as follows:

Final Corrected Peak Measurement – Duty Cycle Correction Factor* = Final Calculated Emission

The Final Calculated Emission was then compared to the Limits in CFR47 Part 15.209 and 15.247 and the emission/limit delta was calculated.

the DTCF is calculated as follows $20 \cdot \log_{10}(\text{duty cycle in 100mS})$ "not to exceed 20dB"

Part 15.247 and 15.205 Respectively

Mid Channel

914.78	88.4 Pk	3.6 / 23.2 / 0.0	115.2	H / 1.0 / 63.0	0	115.2	119	-3.8
914.78	89.2 Pk	3.6 / 23.2 / 0.0	116	V / 1.0 / 128.0	0	116	119	-3

High Channel

927.58	85.8 Pk	3.6 / 23.2 / 0.0	112.7	V / 1.0 / 128.0	0	112.7	119	-6.3
927.58	85.0 Pk	3.6 / 23.2 / 0.0	111.9	H / 1.0 / 50.0	0	111.9	119	-7.1

Axis 1 determined to be worst case. EUT now in Axis 1 for remaining testing.

Low Channel

1804.72	62.2 Pk	3.1 / 25.0 / 35.1	55.2	V / 1.4 / 170.0	-14.52	40.68	99	-58.32
1804.72	64.5 Pk	3.1 / 25.0 / 35.1	57.5	H / 1.0 / 79.0	-14.52	42.98	99	-56.02
2707.07	63.5 Pk	4.2 / 26.9 / 37.5	57.1	V / 1.0 / 68.0	-14.52	42.58	54	-11.42
2707.07	58.6 Pk	4.2 / 26.9 / 37.5	52.2	H / 1.6 / 34.0	-14.52	37.68	54	-16.32
3609.41	50.5 Pk	5.0 / 28.9 / 37.9	46.5	V / 1.2 / 195.0	-14.52	31.98	54	-22.02
3609.41	49.5 Pk	5.0 / 28.9 / 37.9	45.4	H / 1.8 / 355.0	-14.52	30.88	54	-23.12
4511.76	55.0 Pk	6.6 / 30.2 / 40.5	51.3	H / 1.0 / 353.0	-14.52	36.78	54	-17.22
4511.76	54.7 Pk	6.6 / 30.2 / 40.5	51	V / 2.2 / 152.0	-14.52	36.48	54	-17.52
5414.1	45.0 Pk	6.9 / 31.9 / 40.2	43.6	H / 1.9 / 328.0	-14.52	29.08	54	-24.92
5414.1	50.4 Pk	6.9 / 31.9 / 40.2	48.9	V / 1.0 / 339.0	-14.52	34.38	54	-19.62
6316.37	57.3 Pk	8.2 / 32.1 / 40.9	56.7	H / 1.9 / 291.0	-14.52	42.18	99	-56.82
6316.37	63.7 Pk	8.2 / 32.1 / 40.9	63.1	V / 1.0 / 340.0	-14.52	48.58	99	-50.42
7218.72	46.9 Pk	8.1 / 33.5 / 40.7	47.9	H / 1.4 / 192.0	-14.52	33.38	99	-65.62
7218.72	53.0 Pk	8.1 / 33.5 / 40.7	54	V / 1.6 / 346.0	-14.52	39.48	99	-59.52
8121.07	66.6 Pk	8.3 / 34.4 / 46.8	62.5	V / 1.3 / 0.0	-14.52	47.98	54	-6.02
8121.07	59.4 Pk	8.3 / 34.4 / 46.8	55.3	H / 1.0 / 286.0	-14.52	40.78	54	-13.22
9023.4	56.9 Pk	8.5 / 35.2 / 48.5	52	V / 1.2 / 354.0	-14.52	37.48	54	-16.52
9023.4	51.5 Pk	8.5 / 35.2 / 48.5	46.6	H / 1.4 / 125.0	-14.52	32.08	54	-21.92

Field Strength Measurements

Fundamental and Spurious of the Transmitter

Test Report #: 3090365	Test Area: Pinewood Site 1 (3m)	Temperature: 18.0 °C
Test Method: FCC Part 15.209	Test Date: 07-Jan-2006	Relative Humidity: 26 %
EUT Model #: ES1501-XL	EUT Power: 3 VDC	Air Pressure: 81 kPa
EUT Serial #: 01564027		
Manufacturer: Inovonics		
EUT Description: Water Meter Transmitter		
Notes: Removable Battery(ES1501)		

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Duty Cycle Correction	Final Corrected	Limit	DELTA
(MHz)	(dBuV)	(dB) (dBm) (dB)	(dBuV)	(m) (DEG)	(dB)	(dBuV/m)	(dBuV/m)	(dB)

The following duty cycle was declared by the manufacturer.

"In this case, the maximum time that the carrier would dwell on any hopping channel is 18.8 mS in a 100 mS window. Therefore, the maximum Duty Factor correction factor of 14.52 dB was utilized in the calculations for the final measurement."

Averaging method for pulsed signals and calculation in accordance to FCC CFR47 Part 15.35 utilized to calculate field strength emissions.

The testing performed in accordance to FCC CFR47 Part 15.205 (restricted bands of operation) and 15.247 emissions and delta limits were calculated as follows:

Final Corrected Peak Measurement – Duty Cycle Correction Factor* = Final Calculated Emission

The Final Calculated Emission was then compared to the Limits in CFR47 Part 15.209 and 15.247 and the emission/limit delta was calculated.

the DTCF is calculated as follows $20 \cdot \log_{10}(\text{duty cycle in 100mS})$ "not to exceed 20dB"

Part 15.247 and 15.205 Respectively

Mid Channel

1829.54	56.1 Pk	3.1 / 25.1 / 35.8	48.6	H / 1.3 / 21.0	-14.52	34.08	99	-64.92
1829.54	54.2 Pk	3.1 / 25.1 / 35.8	46.7	V / 1.0 / 115.0	-14.52	32.18	99	-66.82
2744.27	63.9 Pk	4.3 / 27.0 / 37.7	57.5	H / 1.1 / 235.0	-14.52	42.98	54	-11.02
2744.27	68.5 Pk	4.3 / 27.0 / 37.7	62	V / 1.0 / 108.0	-14.52	47.48	54	-6.52
3659.01	52.6 Pk	5.1 / 29.0 / 37.7	48.9	H / 1.8 / 357.0	-14.52	34.38	54	-19.62
3659.01	52.9 Pk	5.1 / 29.0 / 37.7	49.2	V / 2.3 / 13.0	-14.52	34.68	54	-19.32
4573.76	53.6 Pk	6.7 / 30.3 / 40.5	50.2	V / 1.0 / 343.0	-14.52	35.68	54	-18.32
4573.76	52.6 Pk	6.7 / 30.3 / 40.5	49.2	H / 1.0 / 238.0	-14.52	34.68	54	-19.32
5488.49	52.0 Pk	6.7 / 32.0 / 40.3	50.5	V / 1.7 / 359.0	-14.52	35.98	99	-63.02
5488.49	47.5 Pk	6.7 / 32.0 / 40.3	45.9	H / 1.0 / 354.0	-14.52	31.38	99	-67.62
6403.16	58.4 Pk	8.3 / 32.0 / 40.8	57.9	V / 1.1 / 346.0	-14.52	43.38	99	-55.62
6403.16	54.3 Pk	8.3 / 32.0 / 40.8	53.9	H / 1.0 / 112.0	-14.52	39.38	99	-59.62
7317.91	55.8 Pk	8.2 / 33.8 / 40.4	57.3	V / 1.8 / 323.0	-14.52	42.78	54	-11.22
7317.91	48.9 Pk	8.2 / 33.8 / 40.4	50.4	H / 1.5 / 119.0	-14.52	35.88	54	-18.12
8232.66	58.3 Pk	8.4 / 34.5 / 47.1	54	V / 1.5 / 0.0	-14.52	39.48	54	-14.52
8233.66	52.5 Pk	8.4 / 34.5 / 47.1	48.3	H / 1.1 / 271.0	-14.52	33.78	54	-20.22
9147.39	57.6 Pk	8.8 / 35.3 / 48.1	53.6	V / 2.2 / 45.0	-14.52	39.08	54	-14.92
9147.39	53.6 Pk	8.8 / 35.3 / 48.1	49.6	H / 1.6 / 148.0	-14.52	35.08	54	-18.92

High Channel

1855.13	62.5 Pk	3.1 / 25.3 / 35.8	55.1	V / 1.0 / 30.0	-14.52	40.58	99	-58.42
1855.13	61.7 Pk	3.1 / 25.3 / 35.8	54.3	H / 1.2 / 268.0	-14.52	39.78	99	-59.22
2782.67	63.8 Pk	4.3 / 27.1 / 37.7	57.4	V / 1.8 / 10.0	-14.52	42.88	54	-11.12
2782.67	64.5 Pk	4.3 / 27.1 / 37.7	58.1	H / 1.1 / 33.0	-14.52	43.58	54	-10.42
3710.22	51.7 Pk	5.2 / 29.1 / 37.5	48.5	V / 1.4 / 67.0	-14.52	33.98	54	-20.02
3710.22	52.8 Pk	5.2 / 29.1 / 37.5	49.6	H / 2.2 / 343.0	-14.52	35.08	54	-18.92
4637.77	54.0 Pk	6.9 / 30.5 / 40.4	50.9	H / 1.6 / 95.0	-14.52	36.38	54	-17.62
4637.77	53.9 Pk	6.9 / 30.5 / 40.4	50.8	V / 1.1 / 15.0	-14.52	36.28	54	-17.72

Field Strength Measurements Fundamental and Spurious of the Transmitter

Test Report #: 3090365	Test Area: Pinewood Site 1 (3m)	Temperature: 18.0 °C
Test Method: FCC Part 15.209	Test Date: 07-Jan-2006	Relative Humidity: 26 %
EUT Model #: ES1501-XL	EUT Power: 3 VDC	Air Pressure: 81 kPa
EUT Serial #: 01564027		
Manufacturer: Inovonics		
EUT Description: Water Meter Transmitter		
Notes: Removable Battery(ES1501)		

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Duty Cycle Correction	Final Corrected	Limit	DELTA
(MHz)	(dBuV)	(dB) (dBm) (dB)	(dBuV)	(m) (DEG)	(dB)	(dBuV/m)	(dBuV/m)	(dB)

The following duty cycle was declared by the manufacturer.

"In this case, the maximum time that the carrier would dwell on any hopping channel is 18.8 mS in a 100 mS window. Therefore, the maximum Duty Factor correction factor of 14.52 dB was utilized in the calculations for the final measurement."

Averaging method for pulsed signals and calculation in accordance to FCC CFR47 Part 15.35 utilized to calculate field strength emissions.

The testing performed in accordance to FCC CFR47 Part 15.205 (restricted bands of operation) and 15.247 emissions and delta limits were calculated as follows:

Final Corrected Peak Measurement – Duty Cycle Correction Factor* = Final Calculated Emission

The Final Calculated Emission was then compared to the Limits in CFR47 Part 15.209 and 15.247 and the emission/limit delta was calculated.

the DTCF is calculated as follows $20 \cdot \log_{10}(\text{duty cycle in 100mS})$ "not to exceed 20dB"

Part 15.247 and 15.205 Respectively

5565.28	54.4 Pk	6.8 / 32.0 / 40.6	52.7	V / 2.0 / 0.0	-14.52	38.18	99	-60.82
5565.31	52.5 Pk	6.8 / 32.0 / 40.6	50.7	H / 1.5 / 323.0	-14.52	36.18	99	-62.82
6492.77	50.9 Pk	8.5 / 32.0 / 40.3	51	H / 1.1 / 279.0	-14.52	36.48	99	-62.52
6493.52	53.0 Pk	8.5 / 32.0 / 40.3	53.1	V / 1.0 / 330.0	-14.52	38.58	99	-60.42
7420.31	46.6 Pk	8.2 / 34.0 / 40.0	48.8	H / 1.5 / 187.0	-14.52	34.28	54	-19.72
7420.31	55.3 Pk	8.2 / 34.0 / 40.0	57.5	V / 1.4 / 347.0	-14.52	42.98	54	-11.02
8347.86	59.6 Pk	8.4 / 34.5 / 47.6	55	H / 1.7 / 119.0	-14.52	40.48	54	-13.52
8347.86	63.8 Pk	8.4 / 34.5 / 47.6	59.2	V / 1.2 / 10.0	-14.52	44.68	54	-9.32
9275.41	48.0 Pk	9.0 / 35.4 / 48.5	43.9	H / 1.9 / 237.0	-14.52	29.38	99	-69.62
9275.41	52.3 Pk	9.0 / 35.4 / 48.5	48.2	V / 1.5 / 20.0	-14.52	33.68	99	-65.32

Project Report

Begin Date: 1/5/2006 End Date: 1/7/2006

Technician Mike Spataro

Project 3090365

Capital Asset ID	Manufacturer	Model #	Serial #	Description	Test Performed	Service Type	Service Date	Service Due
3	Hewlett-Packard	85650A	2811A01300	Q.P Adapter	R Radiated Emissions	For Cal	11/8/2005	11/8/2006
106	TENSOR	4105	2020	Ridged Guide Antenna 1-18GHz	R Radiated Emissions	For Cal	5/9/2005	5/9/2006
135	EMCO	3146	9402-3775	Log Periodic Antenna (200-1000MHz)	R Radiated Emissions	For Cal	9/30/2005	9/30/2006
138	EMC TEST SYSTEMS	3109	3142	Biconical Antenna 30-300MHz	R Radiated Emissions	For Cal	9/30/2005	9/30/2006
202	Avantek	AWT-18037	1002	RF Pre-Amplifier (8-18 GHz)	R Radiated Emissions	For Ver	4/4/2005	4/4/2006
203	Avantek	AFT97-8434-10F	1007	RF Pre-Amplifier (4-8 GHz)	R Radiated Emissions	For Ver	4/4/2005	4/4/2006
209	Hewlett-Packard	85662A	2403A08749	Display Section	R Radiated Emissions	For Cal	8/8/2005	8/8/2006
210	Hewlett-Packard	8566B	2410A00154	Spectrum Analyzer (dc-22 GHz)	R Radiated Emissions	For Cal	8/8/2005	8/8/2006
213	Mini-Circuits Lab	ZHL-42	N052792-2	Amplifier	R Radiated Emissions	For Ver	5/6/2005	5/6/2006
248	Hewlett-Packard	8447F	3113A05545	9 kHz- 1.3GHz Pre Amp	R Radiated Emissions	For Ver	5/6/2005	5/6/2006
259	Hewlett-Packard	E7405A	My44211889	Spectrum Analyzer	R Radiated Emissions	For Cal	12/14/2005	12/14/2006

Appendix B

Test Plan

and

Constructional Data Form

To be supplied by the customer

July 13, 2004

Todd Seeley
IA Labs
5451 Central Ave.
Boulder, CO 80301

Dear Todd,

Pursuant to section 15.247 of the FCC rules Inovonics transmitters are limited to 0.25 Watts maximum transmitted power. These devices contain integrated antennas and it is therefore impossible to measure the transmitted power in a conducted manner without significantly modifying the devices.

At the test lab the field strength is measured using an antenna located 3 meters from the device under test. The rules do not explicitly state the field strength at 3 meters corresponding to 0.25 Watts, so it must be calculated as follows:

The test facility measures the transmitted field strength, E, having units of Volts/meter, or the logarithmic equivalent. The transmitted power density as measured by the antenna is then $\frac{E^2}{\eta}$, where η is the intrinsic impedance of free space.

Assuming isotropic radiation from the product, the Effective Isotropic Radiated Power (EIRP) is found by multiplying the above power density by the area of a sphere having a radius of 3 meters,

$$P_{EIRP} = \frac{E^2}{\eta} 4\pi R^2 \quad (1)$$

Solving for E,

$$E = \frac{1}{2R} \left(\frac{\eta P_{EIRP}}{\pi} \right)^{1/2} \quad (2)$$

Given that $P_{EIRP} = 0.25$ Watts (FCC limit), $R = 3$ meters, and $\eta = 377$ Ohms, $E = 0.913$ V/m = 119.2 dB μ V/m.

Remember the above assumption of isotropic radiation- all real antennas have non-isotropic radiation patterns. Using the 119.2 dB μ V/m limit guarantees that the total RF power transmitted by the device is below the 0.25 Watt limit.

Also, according the part 15.35 we are allowed a relaxation of the general radiation limits found in 15.209 while using a peak detector, as applied to the harmonics of the fundamental. Inovonics EchoStream security transmitters have a transmission pulse duration of 20 ms, which corresponds to a duty cycle of 0.2 per 15.35(c). This duty cycle allows for a 14 dB relaxation of the general radiation limits from 54 dB μ V/m (500 μ V/m, per 15.209(a)) to 68 dB μ V/m for peak measurements.

Sincerely,



Steven Dunbar
RF Engineer

Request for Estimate & Test Plan

Laboratory/Agent Information:

Agent/Test Lab:	International Approvals Laboratories, LLC
Contact:	Todd Seeley
Title:	Principal Engineer (Services Development Focus)
Phone Number:	(303) 402-5272
Cell Number:	(303) 503-2491
Fax Number:	(303) 449-6160
Email Address:	todd@ialabs.com

Client Information:

License Holder:	Inovonics Wireless Corporation
Address:	315 CTC Boulevard, Louisville, CO 80027
Contact:	David Henke
Title:	Project Engineer
Phone Number:	303-209-7163
Fax Number:	303-939-8977
Email Address:	dave@inovonics.com

Please provide all pertinent information below and email this Form to Todd and Amy at todd@ialabs.com and Amy@ialabs.com for a quotation:

Estimates Requested:

EMC Testing	
<input type="checkbox"/> Requesting Estimate	<input checked="" type="checkbox"/> No Estimate Required
<input type="checkbox"/> Pre-Compliance Scans	<input type="checkbox"/> Engineering Test

Radio Device Testing and Certification	
<input checked="" type="checkbox"/> Requesting Estimate	<input type="checkbox"/> No Estimate Required
<input checked="" type="checkbox"/> FCC Certification	<input type="checkbox"/> Industry Canada Certification (Receivers required)
<input type="checkbox"/> Class 2 Notification Under the R&TTED	

Safety Testing and Certification	
<input type="checkbox"/> Requesting Estimate	<input checked="" type="checkbox"/> No Estimate Required
<input type="checkbox"/> NRTL Listing	<input type="checkbox"/> 1 Day Pre-Assessment (conducted at your facility)
<input type="checkbox"/> Letter of Findings	<input type="checkbox"/> CB Report Covering all country Deviations
<input type="checkbox"/> CE Report to Cover the LVD	<input type="checkbox"/> CB Report Covering - Specify Countries:
Please list all applicable standards that you would like your device certified under:	

General Product Information:

Product/Model Number(s):	ES1501, ES1501-XL, ES1210			
Description of product(s):	Frequency-hopping, spread-spectrum transmitters			
Intended Use:	<input type="checkbox"/> Household <input checked="" type="checkbox"/> Commercial <input type="checkbox"/> Industrial <input type="checkbox"/> Hospital <input type="checkbox"/> Life Supporting			
Intended Location:	<input checked="" type="checkbox"/> Dry <input checked="" type="checkbox"/> Damp <input type="checkbox"/> Wet <input type="checkbox"/> Hazardous Location			
Product Type:	<input checked="" type="checkbox"/> Prototype <input checked="" type="checkbox"/> Production Sample <input type="checkbox"/> Manufacturing Design Change: Please Describe			
If there is more than one product what are the differences?	ES1501 and ES1501-XL are used to monitor water meter usage and have inverted L antennas. ES1501-XL has a permanent battery; whereas, the ES1501 has a removable battery. ES1210 is used for security applications and has an inverted F antenna.			
Is the Product Enclosure:	<input type="checkbox"/> Metal <input checked="" type="checkbox"/> Plastic <input type="checkbox"/> Both			
Size:	Length:3.5 inches	Width:1.75 inches	Height:1 inches	Weight:2.0 ounces
What Voltages/Current does the EUT run at?	Rated Voltage:3VDC Rated Current:25maDC (when transmitting) # of Phases/Conductors:none # of Power Cords:none			
Are their multiple suppliers of power supplies?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes Please Describe:			
Are there Multiple Modes of Operation?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No If Yes Please Describe ES1501, ES1501-XL Normal Mode: Transmissions once per hour Rapid TX Mode: Transmissions once per minute Shipping Mode: No transmissions or microprocessor activity ES1210 Normal Mode: Transmissions once per three minutes and whenever alarm condition occurs			
Can all modes of operation be operated simultaneously?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Explain:			
In which countries will you be selling the product?	US			

EMC Information:

What EMC certifications are desired?	<input type="checkbox"/> FCC/ICES (US & Canada) <input type="checkbox"/> CE / EMC / MMD <input type="checkbox"/> BSMI (Taiwan) <input type="checkbox"/> VCCI (Japan) <input type="checkbox"/> SII (Israel) <input type="checkbox"/> AS/NZS (Australia/New Zealand) <input type="checkbox"/> Other: Please Specify
Highest frequency utilized for device operation:	
List of Clock Frequencies:	
What is the time that it takes for the device to complete a full cycle of operation? (time required to identify any degradation in performance)	
Total Number of I/O Cables: # Greater than 3m (9.75 feet) in Length # Greater than 30m (97.5 feet) in Length # of cables at a longer length (specify)	
Number of Dedicated Earth Equalization Ports	
Number of Ethernet and/or Telecommunications Ports	
When the device is a compilation of subsystems (in separate chassis) how many interconnecting I/O's are greater than 1 meter in length between the Subsystem chassis?	
For medical devices: Are there any coupled or direct patient contact points on the device?	<input type="checkbox"/> Yes <input type="checkbox"/> No Describe:

Radio Information:

What Radio certifications are desired?	<input checked="" type="checkbox"/> FCC (USA) (FCC Part 15, 15.249) <input type="checkbox"/> Industry Canada <input type="checkbox"/> ETSI (R&TTE) <input type="checkbox"/> Other: Please Specify
Operating Frequency:	902-928 MHZ (US ISM band)
RF Output Power:	17 dBm
Is there an RF Conducted Port?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Description:
Number of Antennas & Description: (Internal, External, Known Gain, etc.)	ES1501, ES1501-XL: Inverted L ES1210: Inverted F
Modulation Technique:	FSK
Number of Channels/Number of Discrete frequencies per Channel:	1/25
Can the device be operated in CW Mode?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No (But can put in CW mode for testing)
What is the lowest utilized frequency within the device?	902 MHz

Notes: Please ensure to bring a notch filter covering your fundamental operating frequency.

Safety Information:

<p>Has the device been tested and certified for product safety before?</p> <p>A. If it has been previously tested, to which standard and by which organization?</p> <p>B. Can you provide the test report?</p>	<p><input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> <p>Standard tested to:</p> <p>Organization tested by:</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>					
<p>Is the power supply</p>	<p><input type="checkbox"/> An approved off the shelf power supply</p> <p style="text-align: center;">OR</p> <p><input type="checkbox"/> A Custom Model that will need evaluation/ certification</p>					
<p>Does the device contain batteries?</p>	<p><input checked="" type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>What Type? Lithium</p> <p>How Many? One per transmitter</p>					
<p>What technology is used? (i.e., lasers, X Ray, etc.)</p>	<p>900 MHz RF</p>					
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%; padding: 2px;">If Laser:</td> <td style="width: 20%; padding: 2px;">Class:</td> <td style="width: 20%; padding: 2px;">Output Power:</td> <td style="width: 20%; padding: 2px;">Beam Divergence Angle:</td> <td style="width: 25%; padding: 2px;">Wavelength:</td> </tr> </table>	If Laser:	Class:	Output Power:	Beam Divergence Angle:	Wavelength:	
If Laser:	Class:	Output Power:	Beam Divergence Angle:	Wavelength:		
<p>Is the product a Medical Device?</p>	<p><input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p>					
<p>Is it an In Vitro Diagnostic Device?</p>	<p><input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p>					
<p>Testing location: (to be filled in by IALabs)</p>						

Additional Information:

This information is required to be filled in to act as a test plan and constructional data form required to be supplied as part of the test report in accordance to the required standards. This information is not required to obtain a quote.

Support Equipment:

IALabs requires our customers provide all support equipment necessary to fully operate the EUT. This includes any filters required for testing radio devices.

Item	Description	Manufacturer	Model No.
1	(We will bring filter that you have already characterized.)		
2			
3			
4			

Cabling Information:

Cable	Function*	Type of Shield	Length	Connectors	Connection**
1					
2					
3					
4					
5					
6					

* Function examples (Ethernet, RS232, USB, Analog, physiological parameter, etc.)

** Connection examples (Outside Plant, Patient Coupled, Ring Voltage, etc.)

Monitoring the EUT:

Please provide instructions below on how to observe the EUT to verify proper operation in all modes. (including software revision)

Any other information required: (Notes, Photos, Block Diagrams, Drawings, etc.)

A minimum of a block diagram showing the equipment under test and its support equipment.

For International Approvals Laboratories, Use Only.
Please do not fill in the following Information.

Quoting Engineer: todd		
Emissions Testing Required		
<input type="checkbox"/> Class A <input type="checkbox"/> Class B <input checked="" type="checkbox"/> Radio Device <input type="checkbox"/> Group 1 <input type="checkbox"/> Group 2		
<input checked="" type="checkbox"/> FCC Part 15	<input type="checkbox"/> ICES-003	<input type="checkbox"/> VCCI
<input type="checkbox"/> FCC Part 18	<input type="checkbox"/> BSMI	<input type="checkbox"/> CISPR 22/EN 55022
<input type="checkbox"/> CISPR 11/EN 55011	<input type="checkbox"/> IEC/EN 61326	<input type="checkbox"/> IEC/EN61000-6-3
<input type="checkbox"/> IEC/EN61000-6-4	<input type="checkbox"/> CNS13438	<input type="checkbox"/> AS/NZS 3548
<input type="checkbox"/> IEC/EN61000-3-2	<input type="checkbox"/> IEC/EN61000-3-3	<input type="checkbox"/> ETSI/EN 301 489
<input checked="" type="checkbox"/> Other: 15.247 only peak output power and Spurious emissions then 15.209 testing - pay attention to 15.205		
OATS Testing Voltages		
<input type="checkbox"/> 100VAC/50 Hz	<input type="checkbox"/> 120VAC/60Hz	<input type="checkbox"/> 230VAC/50Hz
<input type="checkbox"/> 110VAC/60Hz	<input type="checkbox"/> 220VAC/60Hz	<input type="checkbox"/> 240VAC/50Hz
<input type="checkbox"/> Other:		
Immunity Product Family Standard		
<input type="checkbox"/> CISPR24/EN 55024	<input type="checkbox"/> IEC/EN 61000-6-1	<input type="checkbox"/> IEC/EN 61000-6-2
<input type="checkbox"/> IEC/EN 60601-1-2 <input type="checkbox"/> Art. Hand.	<input type="checkbox"/> IEC/EN 61326	<input type="checkbox"/> CISPR14/ EN 55014-2
<input type="checkbox"/> ETSI/EN 301 489	<input type="checkbox"/> Add Israel Frequencies	
<input type="checkbox"/> Other:		
Immunity Methods		
<input type="checkbox"/> EN61000-4-2	<input type="checkbox"/> 4kV/8kV <input type="checkbox"/> 6kV/8kV	<input type="checkbox"/> 8kV <input type="checkbox"/> 12kV <input type="checkbox"/> 15kV
<input type="checkbox"/> EN61000-4-3	<input type="checkbox"/> 3V/m <input type="checkbox"/> 10V/m	<input type="checkbox"/> 1 kHz Modulation <input type="checkbox"/> 400 Hz Modulation <input type="checkbox"/> 2 Hz Modulation
<input type="checkbox"/> EN61000-4-4	<input type="checkbox"/> 0.5 kV <input type="checkbox"/> 1.0 kV	<input type="checkbox"/> 2.0 kV <input type="checkbox"/> Other:
<input type="checkbox"/> EN61000-4-5	<input type="checkbox"/> 0.5 kV <input type="checkbox"/> 1.0 kV	<input type="checkbox"/> 2.0 kV <input type="checkbox"/> 4.0 kV <input type="checkbox"/> Other:
<input type="checkbox"/> EN61000-4-6	<input type="checkbox"/> 3Vrms <input type="checkbox"/> 10Vrms	<input type="checkbox"/> 1 kHz Modulation <input type="checkbox"/> 400 Hz Modulation <input type="checkbox"/> 2 Hz Modulation <input type="checkbox"/> Other:
<input type="checkbox"/> EN61000-4-8	<input type="checkbox"/> 1A/m <input type="checkbox"/> 30A/m	<input type="checkbox"/> 400A/m <input type="checkbox"/> Other:
<input type="checkbox"/> EN61000-4-11	<input type="checkbox"/> >95% 0.5 Cycles <input type="checkbox"/> 30% 0.5 Cycles <input type="checkbox"/> 60% 5 Cycles <input type="checkbox"/> 60% 50 Cycles	<input type="checkbox"/> 30% 25 Cycles <input type="checkbox"/> >95% 250 Cycles <input type="checkbox"/> >95% 1 Cycle <input type="checkbox"/> Other:
Test Reports Requested		
<input type="checkbox"/> Emissions	<input type="checkbox"/> Engineering Data Only	<input type="checkbox"/> ETSI "Radio"
<input type="checkbox"/> Immunity	<input type="checkbox"/> FCC/Industry Canada "Radio"	<input type="checkbox"/> Other:
<input checked="" type="checkbox"/> Other/special notes: no report requested. start with intentional 3 orthogonal axis - follow setup in public release for peak output measurements go to spurious output - follow public announcement for spurious Set all transmitters on table and test for 15.209 - should be prescanned this afternoon for freq list - if no freq's - take 6 noise floor points per band up to 30M - 30-1000M and 1000-10000M		

Appendix C

Measurement Protocol

And

Test Procedures

MEASUREMENT PROTOCOL

GENERAL INFORMATION

Test Methodology

Conducted and radiated emission testing is performed according to the procedures in ANSI C63.4 & CNS13438.

Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral into its characteristic impedance or left unterminated. When appropriate, the cables are manually manipulated with respect to each other to obtain maximum emissions from the unit.

CONDUCTED EMISSIONS

The final level, expressed in dB μ V, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the applicable limit.

To convert between dB μ V and μ V, the following conversions apply:

- $\text{dB}\mu\text{V} = 20(\log \mu\text{V})$
- $\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$

RADIATED EMISSIONS

The final level, expressed in dB μ V/m, is arrived at by taking the reading from the spectrum analyzer (Level dB μ V) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has the applicable limit subtracted from it to provide the Delta which gives the tabular data as shown in the data sheets in Attachment B. The amplifier gain is automatically accounted for by using an analyzer offset.

Example: At a Test Frequency of 30 MHz, with a peak reading on the spectrum analyzer or measuring receiver of 14 dB μ V:

Measured Level		Transducer & Cable Loss factor		Corrected Reading	Specification Limit		Corrected Reading		Delta Specification
(dB μ V)	+	(dB)	=	(dB μ V/m)	(dB μ V/m)	-	(dB μ V/m)	=	
14.0		14.9		28.9	40.0		28.9		-11.1

DETAILS OF TEST PROCEDURES

General Standard Information

The test methods used comply with ANSI C63.4-1992 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."

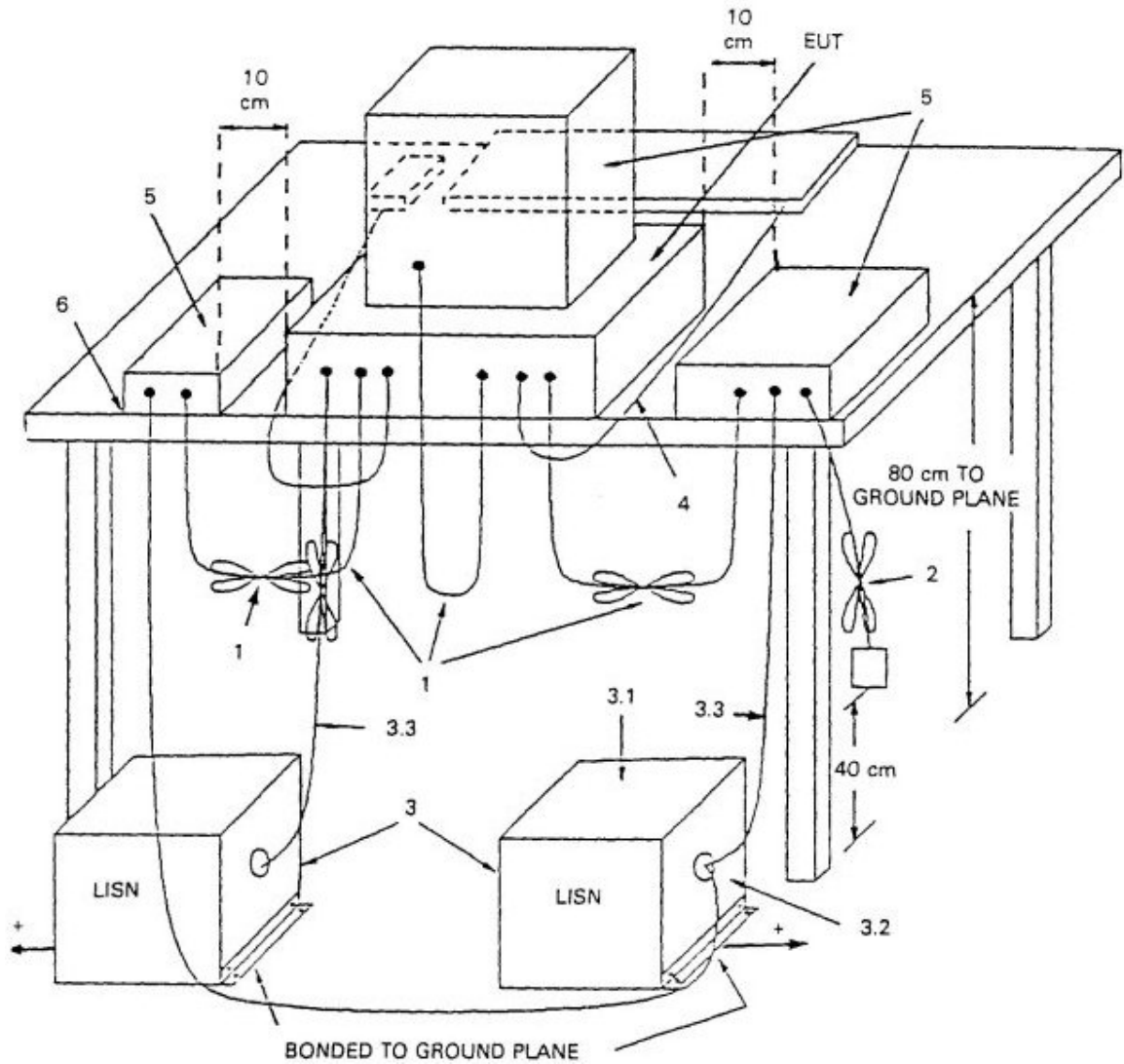
Conducted Emissions

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection, and a Line Impedance Stabilization Network (LISN), with 50 Ω /50 μ H (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimeters above the floor and is positioned 40 centimeters from the vertical ground plane (wall) of the screen room. In some cases, a pre-scan using a spectrum analyzer is initially performed on the units comprising the system under test to locate the highest emissions. If the minimum passing margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver or spectrum analyzer with quasi-peak and average detection and recorded on the data sheets.

Radiated Emissions

Radiated emissions from the EUT are measured in the frequency range of 30 to 22GHz using a spectrum analyzer and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection and measurements above 1000 MHz are made with a 1 MHz/6 dB bandwidth and peak detection. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimeters above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Interface cables that are closer than 40 centimeters to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimeters from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna is positioned 3, 10 or 30 meters horizontally from the EUT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 meters, measurement scans are made with both horizontal and vertical antenna polarizations and the EUT are rotated 360 degrees.

Conducted Emissions Diagram:



Radiated Emissions Diagram:

