Electric Imp

Model: Imp

SAR Evaluation Report

Evaluated to the following SAR Specifications:

FCC 2.1093:2012
Health Safety Code 6:2009

Report No. ELIM0001

Report Prepared By

NORTHWEST EMC

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NORTHWEST EMC

22975 NW Evergreen Parkway
Suite 400
Hillsboro, Oregon 97124

Certificate of Evaluation

Last Date of Test: June 25, 2012
Electric Imp
Model: Imp

Applicable Standards			
Test Description	**Specification**	**Test Method**	**Pass/Fail**
SAR Evaluation	FCC 2.1093:2012 FCC 15.247:2012	FCC OET 65C:2001	**Pass**
		IEEE Std 1528:2003	
		FCC KDB 447498 D01 v04	
		FCC KDB 248227 D01 v01r02	
	Health Safety Code 6:2009	RSS-102, Issue 4:2010	**Pass**

Highest SAR Values				
Frequency Band (GHz)	**Head 1g (W/kg)**	**Body[1] 1g (W/kg)**	**Limit 1g (W/kg)**	**Exposure Environment**
2.4	N/A	0.392	**1.6**	General Population Uncontrolled

Note #1: The spacing used between the EUT and phantom was 1.1cm. Since the highest 1-g SAR is less than 0.4 W/kg, per FCC KDB 447498 D01 v04, Item 2(a)(i), the device may be used in portable exposure conditions with no restrictions on host platforms when the minimum spacing between the device and the user is 1.1cm or greater.

Modifications made to the product
See the Modifications section of this report

Test Facility

The measurement facility used to collect the data is located at:

Northwest EMC, Inc.
22975 NW Evergreen Parkway, Suite 400
Hillsboro, OR 97124

Phone: (503) 844-4066 Fax: 844-3826

Approved By:
Don Facteau, IS Manager

NVLAP

NVLAP Lab Code: 200630-0

This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government of the United States of America.

Product compliance is the responsibility of the client, therefore the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. This Report may only be duplicated in its entirety. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test.

Revision Number	Description	Date	Page Number
00			

Barometric Pressure

The recorded barometric pressure has been normalized to sea level.

Accreditations and Authorizations

Revision
02/21/2012

United States

FCC - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

A2LA - Accredited by A2LA to ISO / IEC Guide 65 as a product certifier. This allows Northwest EMC to certify transmitters to FCC and IC specifications.

NVLAP - Each laboratory is accredited by NVLAP to ISO 17025. The scope includes radio, ITE, and medical standards from around the world. See: http://www.nwemc.com/accreditations/

Canada

IC - Recognized by Industry Canada as a Certification Body (CB). Certification chambers and Open Area Test Sites are filed with IC.

European Union

European Commission – Validated by the European Commission as a Conformity Assessment Body (CAB) under the EMC directive and as a Notified Body under the R&TTE Directive.

Australia/New Zealand

ACMA - Recognized by ACMA as a CAB for the acceptance of test data.

Korea

KCC / RRA - Recognized by KCC's RRA as a CAB for the acceptance of test data.

Japan

VCCI - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

Taiwan

BSMI – Recognized by BSMI as a CAB for the acceptance of test data.

NCC - Recognized by NCC as a CAB for the acceptance of test data.

Singapore

IDA – Recognized by IDA as a CAB for the acceptance of test data.

Hong Kong

OFTA – Recognized by OFTA as a CAB for the acceptance of test data.

Vietnam

MIC – Recognized by MIC as a CAB for the acceptance of test data.

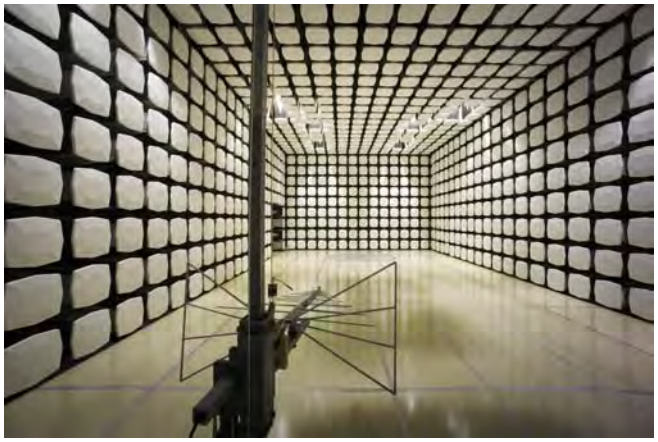
Russia

GOST – Accredited by Certinform VNIINMASH, CERTINFO, SAMTES, and Federal CHEC to perform EMC and Hygienic testing for Information Technology products to GOST standards.

Locations

Revision 2/23/12

Oregon Labs EV01-EV12 22975 NW Evergreen Pkwy, #400 Hillsboro, OR 97124 (503) 844-4066	**California** Labs OC01-OC13 41 Tesla Irvine, CA 92618 (949) 861-8918	**New York** Labs WA01-WA04 4939 Jordan Rd. Elbridge, NY 13060 (315) 685-0796	**Minnesota** Labs MN01-MN08 9349 W Broadway Ave. Brooklyn Park, MN 55445 (763) 425-2281	**Washington** Labs SU01-SU07 14128 339th Ave. SE Sultan, WA 98294 (360) 793-8675
VCCI				
C-1071, R-1025, G-84, C-2687, T-1658, R-2318	R-1943, G-85, C-2766, T-1659, G-548		R-3125, G-86, G-141, C-3464, T-1634	R-871, G-83, C-3265, T-1511
Industry Canada				
2834D-1, 2834D-*2*	2834B-1, 2834B-2, 2834B-3		2834E-1	2834C-1



Party Requesting the Test

Company Name:	Electric Imp
Address:	5050 El Camino Real, Ste 221
City, State, Zip:	Los Altos, CA 94022
Test Requested By:	Lolo Fong
Model:	Imp
First Date of Test:	June 15, 2012
Last Date of Test:	June 25, 2012
Receipt Date of Samples:	June 15, 2012
Equipment Design Stage:	Production
Equipment Condition:	No Damage

Information Provided by the Party Requesting the Test

Functional Description of the EUT (Equipment Under Test)

The EUT is the model Imp containing an 802.11 b/g/n radio with a single integral antenna. The Imp connects to an SD socket in a host device and provides wireless connection to the Internet. It uses WiFi and a cloud service to make it easier for vendors to internet-enable their products..

The Imp is very small - 32mm x 24mm x 2.1mm . In addition to the radio, it contains a Cortex-M3 core processor that gives great performance combined with low power consumption, allowing the Imp to deal with both maintaining a secure connection to the service and also executing the developer's code in a stable environment.

The Imp card has nine pins; two of which are used for power, and one is used to communicate with the ID chip that is in every device, leaving six pins for connection to peripherals. These six wired I/O pins are available for application use: UARTs, I2C, SPI, analog in and out, PWMs, GPIOs.

The Imp is limited by hardware to a maximum duty cycle of 77% as measured in this report.

The frequency range of the 802.11b/g/n radio in the Imp:

- 2412 – 2462 MHz

In normal operation, the Imp will be placed in a host device. Per FCC KDB 447498 D01 v04, Item 2(a)(i)

"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. When SAR evaluation is required, the most conservative exposure conditions for all expected operating configurations must be tested."

To provide the maximum flexibility, the Imp was tested at the most conservative (worst case) distance of 1.1cm as specified by the client, Electric Imp.

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Overview of the SAR Evaluation

Objective

To demonstrate compliance with the SAR requirements of FCC 2.1093 and Canada's Health Safety Code 6.

Scope

The SAR evaluation documented in this report is for the Electric Imp Model Imp, containing an 802.11b/g/n radio.

CONFIGURATION 1 ELIM0001

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Wireless network node	Electric Imp	Imp	0c2a6900003f
Breakout Board	Electric Imp	April Rev 2	2012 Feb 29
Control	Electric Imp	Imp	0c2a6900003f
Remote Laptop	Dell	Inspiron 6000	DZ88H81

Cables					
Description	**Shielded**	**Ferrite**	**Length**	**Connection 1**	**Connection 2**
USB	Yes	No	1.8m	Breakout Board	Remote Laptop

Software	
Description	**Version**
WL.exe	Unknown

Equipment modifications					
Item	Date	Test	Modification	Note	Disposition of EUT
1	06/15/2012	SAR Evaluation	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

2.4 GHz Band

Per FCC KDB 248227, the conducted output power was measured at the “default test channels” and at the “required test channels” in each band. Measurements were made while the EUT transmitted at the lowest, middle and the highest data rates for each channel.

Per FCC KDB 248227, among the channels required for normal testing, SAR must be measured on the highest output channel (highlighted). When the SAR measured on the highest output channel is >0.8 W/kg, SAR evaluation for the other required test channels is necessary.

Output power measurements are on the following pages.

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Output Power

XMit 2011.01.18

EUT:	Imp			**Work Order:**	ELIM0001
Serial Number:	0c2a6900003f			**Date:**	06/15/12
Customer:	Electric Imp			**Temperature:**	21°C
Attendees:	Hugo Fiennes			**Humidity:**	45%
Project:	None			**Barometric Pres.:**	1021.8 mbar
Tested by:	Rod Peloquin	**EUT Power**	3.3 VDC	**Job Site:**	EV01

TEST SPECIFICATIONS	Test Method
FCC 2.1093:2012	FCC OET 65C:2001

COMMENTS

Conducted output power. 802.11b/g/n uses 800 ns guard interval

DEVIATIONS FROM TEST STANDARD

None

Configuration #	1	Signature

Conducted Power (Average)

Channel	Frequency (MHz)	Data Rate (Mbps)	Modulation	Antenna Port 1 dBm	Antenna Port 1 W
1	2412	1	BPSK	16.8	0.047
		11	CCK	16.6	0.045
		6	OFDM	13.4	0.022
		36	OFDM	12.0	0.016
		54	OFDM	11.6	0.014
		6.5 (MCS0)	OFDM	13.3	0.021
		65 (MCS7)	OFDM	11.8	0.015
6	2437	1	BPSK	16.7	0.047
		11	CCK	16.5	0.045
		6	OFDM	14.6	0.029
		36	OFDM	13.2	0.021
		54	OFDM	12.3	0.017
		6.5 (MCS0)	OFDM	14.6	0.029
		65 (MCS7)	OFDM	12.6	0.018
11	2462	1	BPSK	16.7	0.047
		11	CCK	16.6	0.046
		6	OFDM	14.5	0.028
		36	OFDM	13.2	0.021
		54	OFDM	12.3	0.017
		6.5 (MCS0)	OFDM	14.4	0.027
		65 (MCS7)	OFDM	12.6	0.018

Characterization of tissue-equivalent liquid dielectric properties

Per IEEE 1528: 2003, Section 5.2.2, the permittivity and conductivity of the tissue material should be measured at least within 24 hours of any full-compliance test. The measured values must be within +/- 5% of the target values. The temperature variation in the liquid during SAR measurements must be within +/- 2 degrees C of that recorded when the dielectric properties were measured.

The dielectric parameters of the tissue-equivalent liquids were measured within 24 hours of testing using the HP85070E dielectric probe kit. The dielectric measurements were made across the frequency range of the liquid. The attached data sheets show that the dielectric parameters of the liquid were within the required 5% tolerances.

Target values of dielectric parameters

Per FCC OET 65C, Appendix C:

"The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in P1528."

Target Frequency	Head		Body	
(MHz)	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

(ε_r = relative permittivity, σ = conductivity and ρ = 1000 kg/m^3)

Composition of Ingredients for Liquid Tissue Phantoms

Northwest EMC uses tissue-equivalent liquids prepared by SPEAG and confirmed by them to be within +/- 5% from the target values. Their recipes are based upon the following formulations as found in FCC OET 65C, Appendix C:

"The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation."

Ingredients (% by weight)	**Frequency (MHz)**									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Salt: 99^{+}% Pure Sodium Chloride Sugar: 98^{+}% Pure Sucrose
Water: De-ionized, 16 MΩ^{+} resistivity HEC: Hydroxyethyl Cellulose
DGBE: 99^{+}% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]
Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

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Tissue - Equivalent Liquid

SAR 2011.02.21

EUT:	MSL2450			**Work Order:**	ELIM0001
Serial Number:	SAM			**Date:**	06/25/12
Customer:	Electric Imp			**Temperature (°C):**	23.0
Attendees:	none			**Humidity:**	44.2
Project:	none			**Barometric Pres. (mb):**	1010
Tested by:	Ethan Schoonover	**Power:**	None	**Job Site:**	EV08

TEST SPECIFICATIONS	Test Method
FCC 2.1093:2011	FCC OET 65C:2001

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

Configuration #	None	Signature

Tissue: MSL2450 Liquid Temperature (°C): 22

	Actual Values		Target Values		Deviation (%)	
Frequency (GHz)	**Relative Permittivity**	**Conductivity**	**Relative Permittivity**	**Conductivity**	**Relative Permittivity**	**Conductivity**
2450	**50.612**	**1.942**	**52.700**	**1.950**	**3.96**	**0.40**

1900.0	56.2	3.975
1925.0	55.7	0.951
1950.0	55.8	0.895
1975.0	55.7	0.920
2000.0	55.6	0.966
2025.0	55.4	1.016
2050.0	55.2	1.074
2075.0	55.0	1.132
2100.0	54.7	1.192
2125.0	54.5	1.250
2150.0	54.2	1.309
2175.0	53.9	1.366
2200.0	53.6	1.424
2225.0	53.3	1.482
2250.0	53.0	1.532
2275.0	52.6	1.590
2300.0	52.4	1.639
2325.0	52.0	1.686
2350.0	51.8	1.730
2375.0	51.5	1.786
2400.0	51.2	1.840
2425.0	50.9	1.891
2450.0	50.6	1.942
2475.0	50.3	1.989
2500.0	49.9	2.034
2525.0	49.6	2.075
2550.0	49.3	2.116
2575.0	49.0	2.160
2600.0	48.7	2.204
2625.0	48.4	2.249
2650.0	48.0	2.289
2675.0	47.7	2.325
2700.0	47.4	2.358

Requirement

Per IEEE 1528, Section 8.2.1, “System checks are performed prior to compliance tests and the results must always be within ± 10% of the target value corresponding to the test frequency, liquid, and the source used. The target values are 1 g or 10 g averaged SAR values measured on systems having current system validation and calibration status, and using the system check setup as shown in Figure 14. These target values should be determined using a standard source.”

Test Description

Within 24 hours of a measurement, Northwest EMC used the system validation kit (calibrated reference dipole) to test whether the system was operating within its specifications. The validation was performed in the indicated bands by making SAR measurements of the reference dipole with the phantom filled with the tissue-equivalent liquid. First, a signal generator and power amplifier were used to produce a 100mW level as measured with a power meter at the antenna terminals of the dipole. Then, the reference dipole was positioned below the bottom of the phantom and centered with its axis parallel to the longest side of the phantom. A low loss and low relative permittivity spacer was used to establish the correct distance between the center axis of the reference dipole and the liquid.

For the reference dipoles, the spacing distance s is given by:

s = 15mm, +/- 0.2mm for 300MHz ≤ f ≥ 1000 MHz:
s = 10mm, +/- 0.2mm for 1000MHz ≤ f ≥ 6000MHz

The measured 1 g and 10 g spatial average SAR values were normalized to a 1W dipole input power for comparison to the calibration data. The results are summarized in the attached table. The deviation is less than 10% in all cases, indicating that the system performance check was within tolerance.