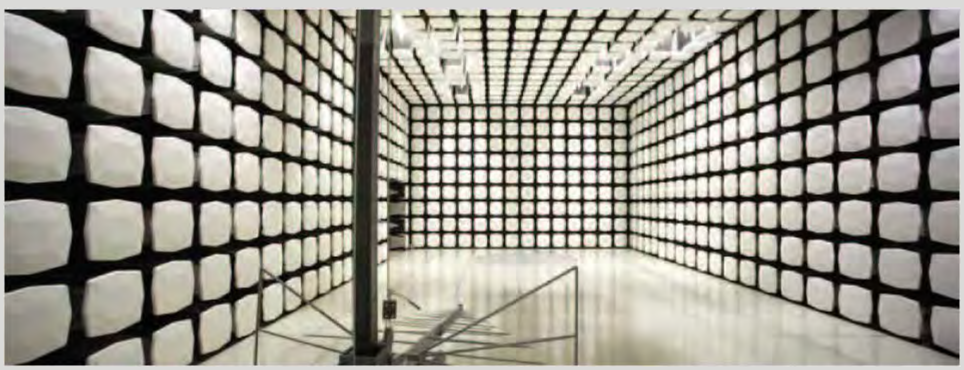
Masimo Corporation
RAD7A

SAR Evaluation Report #: MASI0204

Evaluated to the following SAR Specification:

FCC 2.1093:2014



Report Prepared By Northwest EMC Inc.

NORTHWEST EMC – (888) 364-2378 – www.nwemc.com

California – Minnesota – Oregon – New York – Washington

WTD 12.5.23

CERTIFICATE OF TEST

Last Date of Test: March 19, 2014
Masimo Corporation
Model: RAD7A

Applicable Standard

Test Description	Specification	Test Method	Pass/Fail
SAR Evaluation	FCC 2.1093:2014 FCC 15.247:2014	IEEE Std 1528:2003 FCC KDB 447498 D01 v05r02 FCC KDB 248227 D01 v01r02 FCC KDB 865664 D01 v01r03 and D02 v01r01	Pass

Highest SAR Values:

Frequency Bands (GHz)	Body (W/kg) 1g	Limit (W/kg) 1g	Exposure Environment
2.4	0.054	**1.6**	**General Population**
5.0	Excluded		

Deviations From Test Standards

None

Approved By:

Don Facteau, IS Manager

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.

REV 2012.08.02

REVISION HISTORY

Revision Number	Description	Date	Page Number
00	None		

Barometric Pressure

The recorded barometric pressure has been normalized to sea level.

NORTHWEST EMC

REV 2012.05.24

ACCREDITATIONS AND AUTHORIZATIONS

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

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.

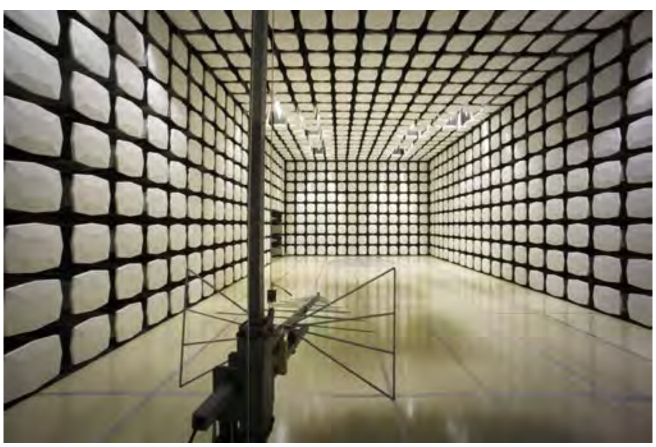
SCOPE

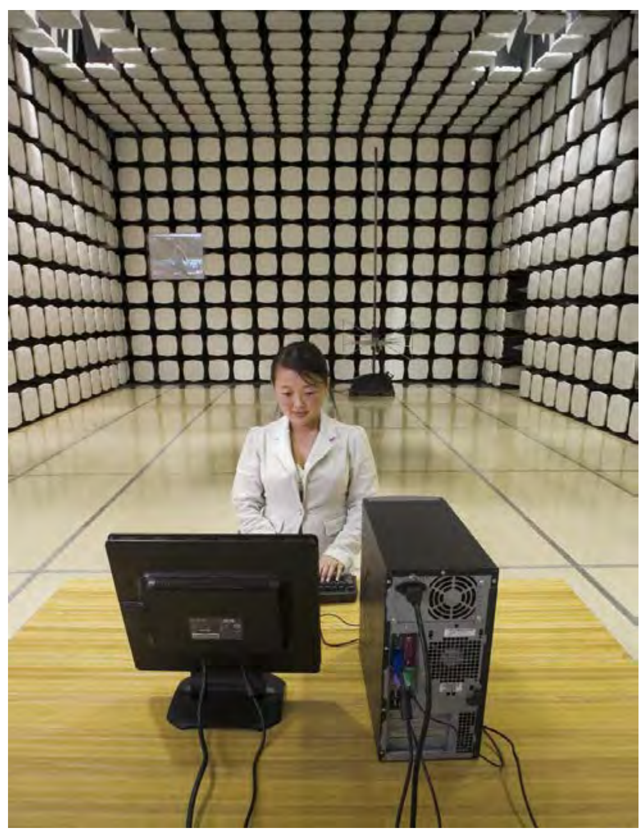
For details on the Scopes of our Accreditations, please visit:
http://www.nwemc.com/accreditations/

LOCATIONS

REV 2013.01.07

Oregon Labs EV01-12 22975 NW Evergreen Pkwy Hillsboro, OR 97124 (503) 844-4066	**California** Labs OC01-13 41 Tesla Irvine, CA 92618 (949) 861-8918	**New York** Labs WA01-04 4939 Jordan Rd. Elbridge, NY 13060 (315) 685-0796	**Minnesota** Labs MN01-08 9349 W Broadway Ave. Brooklyn Park, MN 55445 (763) 425-2281	**Washington** Labs NC01-05,SU02,SU07 19201 120th Ave. NE Bothell, WA 98011 (425) 984-6600
		VCCI		
A-0108	A-0029		A-0109	A-0110
		Industry Canada		
2834D-1, 2834D-*2*	2834B-1, 2834B-2, 2834B-3		2834E-1	2834C-1





WTD 12.5.23

PRODUCT DESCRIPTION

Client and Equipment Under Test (EUT) Information

Company Name:	Masimo Corporation
Address:	40 Parker
City, State, Zip:	Irvine, CA 92618
Test Requested By:	Michael Clark
Model:	RAD7A
First Date of Test:	February 26, 2014
Last Date of Test:	March 19, 2014
Receipt Date of Samples:	February 26, 2014
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 Masimo Model RAD7A Pulse CO-Oximeter containing an 802.11 a/b/g radio. The RAD7A is a handheld pulse CO-Oximeter with a LCD display. The radio interface allows wireless connection to Patient Safety Net and other wireless systems. The RAD7A is only used in a clinic or hospital environment. The hardware design limits wireless transmission to patient telemetry data only. No other type of data transmission is possible. Kirby Dotson, Manager Instrument Hardware at Masimo, attests that the maximum duty cycle is about 6%:

> "The software sends 120bytes @ 62.5 Hz for 7500 bytes per second or 60K bits/sec.
> Worst duty cycle will be when in 1.1Mbit/sec mode which is 60K/1.1M for a duty cycle of about 6%."

The RAD7A uses one Isolated Magnetic Dipole™ (IMD) trace antenna located in the center / top half of the unit (see EUT photos).

The frequency range of the 802.11a/b/g radio in the RAD7A:

- 2412 – 2462 MHz
- 5180 – 5240 MHz
- 5745 – 5825 MHz

In normal operation, the RAD7A can be placed in the Masimo Model RDS series docking station. This provides battery charging and wired connection to other devices. In this configuration, it will be used 20cm or greater from the user's head or torso and can be considered a mobile device. However, when removed from the RDS docking station, it can be used in a stand-alone configuration. Primarily, it will be used as a handheld device, but it is also possible for the RAD7A to be placed next to the patient's torso. No body worn accessories are sold or approved by Masimo, so a worst case spacing of 0 cm is used for this SAR evaluation. The RAD7A does not contain a microphone, nor would it be possible to install VOIP software on the device, so use near the head is not considered.

A patient cable will always be attached during use. A SP02 cable was connected to the RAD7A during the SAR evaluation.

When used in a stand-alone configuration, the RAD7A is powered by a lithium-ion battery, Model 32794.

WTD 12.5.23

PRODUCT DESCRIPTION

Testing Objective:

To demonstrate compliance with the SAR requirements of FCC 2.1093.

Scope

The SAR evaluation documented in this report is for the Masimo Model RAD7A, containing an 802.11a/b/g radio.

Per Section 4.3.1 of KDB 447498 D01 v05r02, the 5GHz bands are excluded from SAR testing, but not the 2.4 GHz band

Standalone SAR Test Exclusion

Conducted Output Power (mW)	Duty Cycle Corrected Output Power (mW)	Test Separation (mm)	Transmit Frequency (GHz)	Exclusion Threshold	Spec
101.00	6.06	5.00	5.73	2.90	<=3.0
26.83	1.61	5.00	5.24	0.74	<=3.0
218.02	13.08	5.00	2.46	4.11	<=3.0

CONFIGURATIONS

Configuration MASI0204- 1

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Radical 7 2012	Masimo Corporation	RAD7A	1000027554
Finger Sensor	Masimo Corporation	DCI-DC12	9H014
3.7V Rechargeable Li-Ion Battery	Masimo Corporation	23794	P1336000393
3.7V Rechargeable Li-Ion Battery	Masimo Corporation	23794	P1336002302
3.7V Rechargeable Li-Ion Battery	Masimo Corporation	23794	P1321001349

Configuration MASI0204- 2

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Radical 7 2012	Masimo Corporation	RAD7A	1000027554
Finger Sensor	Masimo Corporation	DCI-DC12	9H014
3.7V Rechargeable Li-Ion Battery	Masimo Corporation	23794	P1336000393
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3.7V Rechargeable Li-Ion Battery	Masimo Corporation	23794	P1321001349

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
SpO2	Yes	1.0	No	Radical 7 2012	Finger Sensor
PA = Cable is permanently attached to the device. Shielding and/or presence of ferrite may be unknown.					

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2/26/2014	SAR Evaluation	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Northwest EMC following the test.
2	2/27/2014	SAR Evaluation	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Northwest EMC following the test.
3	3/19/2014	SAR Evaluation	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

TISSUE – EQUIVALENT LIQUID

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 the start 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 KDB 865664 D01 v01r01, Appendix A.1:

"The head tissue dielectric parameters recommended by IEEE Std 1528-2003 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 1528 are derived from tissue dielectric parameters computed from the 4-Cole-Cole equations described above and extrapolated according to the head parameters specified in 1528."

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)

TISSUE – EQUIVALENT LIQUID

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 IEEE 1528: 2003, Annex 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 $M\Omega^{+}$ 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

TISSUE – EQUIVALENT LIQUID

Date:	03/19/2014	Temperature:	22.8°C
Tissue:	Body, MSL2450, 2450MHz	Liquid Temperature:	21.1°C
Tested By:	Carl Engholm	Relative Humidity:	39%
Job Site:	EV08	Bar. Pressure:	1021 mb

TEST SPECIFICATIONS

Specification:	Method:
FCC 2.1093:2014	IEEE Std 1528:2003

RESULTS

	Actual Values		Target Values		Deviation (%)	
Frequency (MHz)	Relative Permittivity	Conductivity	Relative Permittivity	Conductivity	Relative Permittivity	Conductivity
2450	51.70	1.99	52.70	1.95	1.90	-2.05

Frequency (MHz)	Relative Permittivity	Conductivity
1900.00	53.10	5.60
1925.00	56.80	1.17
1950.00	57.10	1.02
1975.00	56.90	1.01
2000.00	56.80	1.03
2025.00	56.60	1.08
2050.00	56.40	1.13
2100.00	55.90	1.24
2125.00	55.60	1.31
2150.00	55.40	1.36
2175.00	55.10	1.42
2200.00	54.80	1.48
2225.00	54.50	1.54
2250.00	54.20	1.59
2300.00	53.60	1.70
2325.00	53.20	1.75
2350.00	52.90	1.80
2375.00	52.60	1.84
2400.00	52.30	1.89
2425.00	52.00	1.93
2450.00	51.70	1.99
2500.00	51.10	2.08
2525.00	50.80	2.13
2550.00	50.50	2.18
2575.00	50.20	2.23
2600.00	49.80	2.27
2625.00	49.50	2.31
2675.00	48.80	2.38
2700.00	48.50	2.41

SAR SYSTEM VERIFICATION

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.”

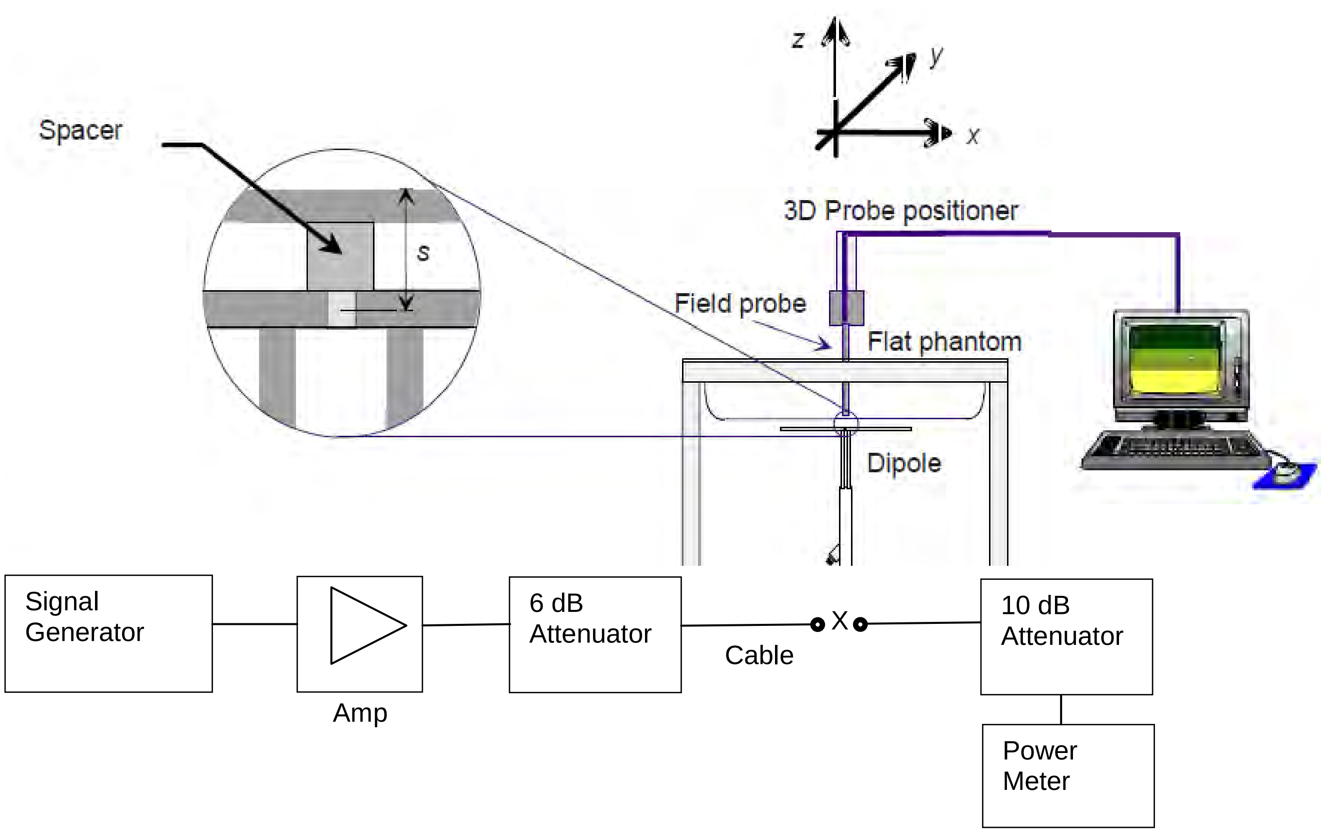
TEST DESCRIPTION

Within 24 hours of a measurement, then every 72 hours thereafter, 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 (X). 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.



SAR SYSTEM VERIFICATION

TEST SPECIFICATIONS

Specification:	Method:
FCC 2.1093:2014	IEEE Std 1528:2003 FCC KDB 865664 D01 v01r03 and D02 v01r01

RESULTS

Date	Liquid part number and frequency	Conducted Power into the Dipole (dBm)	Correction Factor	Measured		Normalized to 1W		Target (Normalized to 1W) Get from Dipole Calibration Certificate		% Difference	
				1g	10g	1g	10g	1g	10g	1g	10g
3/19/2014	MSL 2450 (2450 MHz)	19.95	10.12	4.75	2.21	48.07	22.37	50.40	23.70	-4.62	-5.61

WSSV.2013.09.09

SAR SYSTEM VERIFICATION

Tested By:	Carl Engholm	Room Temperature (°C):	22.3°C
Date:	3/19/2014	Liquid Temperature (°C):	21.4°C
Configuration:	Body	Humidity (%RH):	40%
		Bar. Pressure (mb):	1021 mb

MSL2450 System Check, 3-19-14
DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:855
Communication System: UID 10000, CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 2450 MHz; σ = 1.986 S/m; ε_r = 51.738; ρ = 1000 kg/m^3 , Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY Configuration:

- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

System Check/System Check/Area Scan (51x61x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 5.03 W/kg

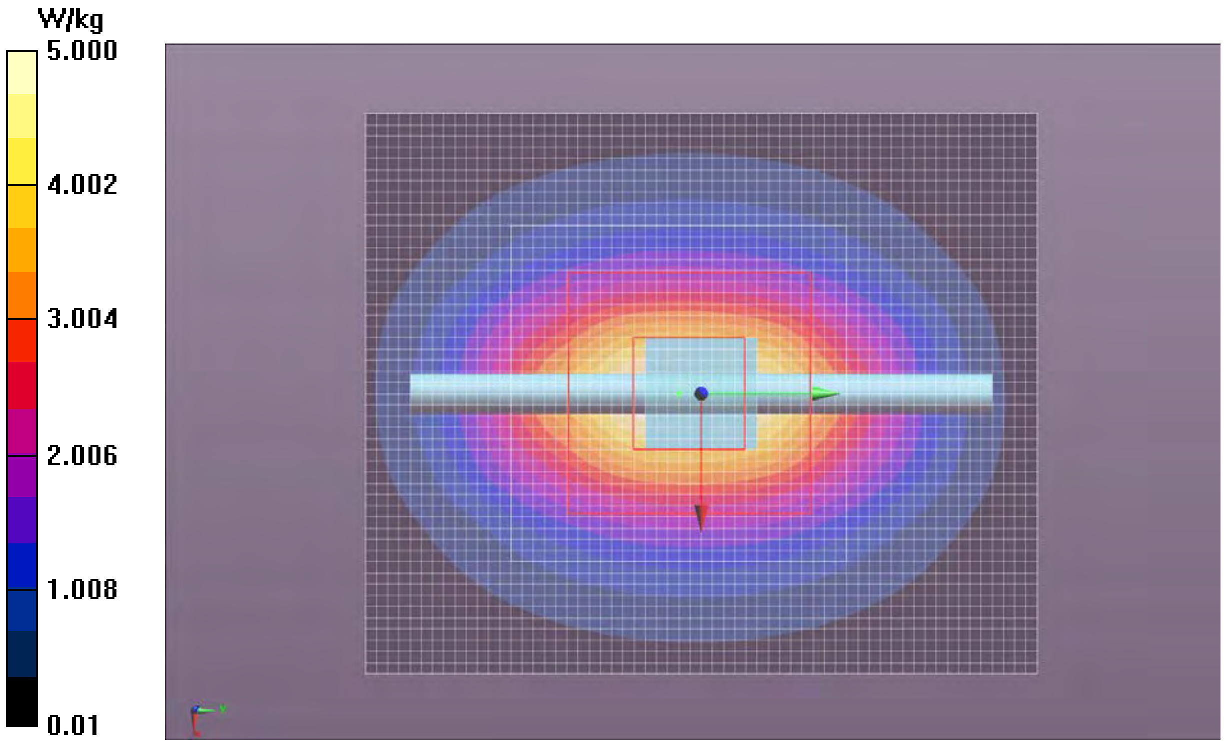
System Check/System Check/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of Total (measured) = 56.88 V/m

System Check/System Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 49.174 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 9.60 W/kg
SAR(1 g) = 4.75 W/kg; SAR(10 g) = 2.21 W/kg
Maximum value of SAR (measured) = 4.75 W/kg
Maximum value of SAR (measured) = 6.42 W/kg

Carl Engholm

Approved By

MSL2450 System Check, 3-19-14



OUTPUT POWER

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.

NORTHWEST EMC

OUTPUT POWER

EUT:	**BCM 4334/Azurewave AW-AH634**			**Work Order:**	**MASI0151**
Serial Number:	**36235C**			**Date:**	**01/29/14**
Customer:	**Masimo**			**Temperature:**	**24.3°C**
Attendees:	**Mike Clark**			**Humidity:**	**41%**
Project:	**None**			**Barometric Pres.:**	**1011**
Tested by:	**Jaemi Suh**	**Power:**	**110 VAC**	**Job Site:**	**OC13**

TEST SPECIFICATIONS	**Test Method**
FCC 2.1093:2014	IEEE Std 1528:2003
	FCC KDB 248227 D01 v01r02

COMMENTS

TX Power set to 90.

DEVIATIONS FROM TEST STANDARD

NONE

Configuration #	**1**	*Signature*

	Value	Limit	Result
2400 MHz - 2483.5 MHz Band			
802.11(b) 1 Mbps			
Low Channel 1, 2412 MHz	190.458 mW	< 1 W	Pass
Mid Channel 6, 2437 MHz	210.863 mW	< 1 W	Pass
High Channel 11, 2462 MHz	207.348 mW	< 1 W	Pass
802.11(b) 11 Mbps			
Low Channel 1, 2412 MHz	198.244 mW	< 1 W	Pass
Mid Channel 6, 2437 MHz	212.373 mW	< 1 W	Pass
High Channel 11, 2462 MHz	218.022 mW	< 1 W	Pass
802.11(g) 6 Mbps			
Low Channel 1, 2412 MHz	63.982 mW	< 1 W	Pass
Mid Channel 6, 2437 MHz	65.27 mW	< 1 W	Pass
High Channel 11, 2462 MHz	70.604 mW	< 1 W	Pass
802.11(g) 36 Mbps			
Low Channel 1, 2412 MHz	65.864 mW	< 1 W	Pass
Mid Channel 6, 2437 MHz	73.602 mW	< 1 W	Pass
High Channel 11, 2462 MHz	77.876 mW	< 1 W	Pass
802.11(g) 54 Mbps			
Low Channel 1, 2412 MHz	69.613 mW	< 1 W	Pass
Mid Channel 6, 2437 MHz	74.864 mW	< 1 W	Pass
High Channel 11, 2462 MHz	77.88 mW	< 1 W	Pass

TEST RESULTS

Test Configurations

In normal operation, the RAD7A can be placed in the Masimo Model RDS series docking station. This provides battery charging and wired connection to other devices. In this configuration, it will be used 20cm or greater from the user's head or torso and can be considered a mobile device. However, when removed from the RDS docking station, it can be used in a stand-alone configuration. Primarily, it will be used as a handheld device, but it is also possible for the RAD7A to be placed next to the patient's torso. No body worn accessories are sold or approved by Masimo, so a worst case spacing of 0 cm is used for this SAR evaluation. The RAD7A does not contain a microphone, nor would it be possible to install VOIP software on the device, so use near the head is not considered.

A patient cable will always be attached during use. A SP02 cable was connected to the RAD7A during the SAR evaluation.

When used in a stand-alone configuration, the RAD7A is powered by a lithium-ion battery, Model 32794.

Duty Factor

All testing was performed with the EUT configured in a worst-case configuration and operating mode to produce the highest SAR levels. The EUT used Masimo test software that permitted the selection of transmit channel, modulation type, and data rate. It operated continuously at 100% duty cycle.

In normal operation, the radio interface allows wireless connection to Patient Safety Net and other wireless systems. The RAD7A is only used in a clinic or hospital environment. The hardware design limits wireless transmission to patient telemetry data only. No other type of data transmission is possible. Kirby Dotson, Manager Instrument Hardware at Masimo, attests that the maximum duty cycle is about 6%:

> "The software sends 120bytes @ 62.5 Hz for 7500 bytes per second or 60K bits/sec. Worst duty cycle will be when in 1.1Mbit/sec mode which is 60K/1.1M for a duty cycle of about 6%."

Per KDB 248227, duty factor scaling was applied to data in the 2.4 GHz band. Since the highest measured SAR value (0.9 W/kg) was well below the limit, linearity of the measurement system was assumed. A scaling factor of 0.07 was applied to the SAR values measured at a 100% duty factor. Both measured and scaled SAR values are included in the test results.

Per Section 4.3.1 of KDB 447498 D01 v05r02, the 5GHz bands are excluded from SAR testing, but not the 2.4 GHz band

Standalone SAR Test Exclusion

Conducted Output Power (mW)	Duty Cycle Corrected Output Power (mW)	Test Separation (mm)	Transmit Frequency (GHz)	Exclusion Threshold	Spec
101.00	6.06	5.00	5.73	2.90	<=3.0
26.83	1.61	5.00	5.24	0.74	<=3.0
218.02	13.08	5.00	2.46	4.11	<=3.0

TEST RESULTS

Summary

The following tables summarize the measured SAR values.

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

WSTD.2013.09.09

SAR TEST DATA

EUT:	RAD7A	Work Order:	MASI0204
Customer:	Masimo Corporation	Job Site:	EV08
Attendees:	None	Customer Project:	None

TEST SPECIFICATIONS

Specification:	Method:
FCC 2.1093:2014 FCC 15.247:2014	IEEE Std 1528:2003 FCC KDB 447498 D01 v05r02 FCC KDB 248227 D01 v01r02 FCC 865664 D01 v01r03 and D02 v01r01

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

RESULTS

Test Configuration	Frequency Band	Transmit Frequency (MHz)	Transmit Channel	Data Rate (Mbps)	Modulation	Antenna Port	Accessory	EUT Position	Power Drift During Test (dB)	Measured 1g SAR Level (mW/g)	Scaled to 6% Duty Cycle[Note 1] (mW/g)	Test #
Body	2450	2462	11	1	BPSK	0	None	Front	-2.48	0.01	0.0006	1
Body	2450	2462	11	1	BPSK	0	Patient Leads	Back	-0.04	0.90	0.054	2

Note 1: Measured SAR multiplied by a duty cycle scale factor of 0.06

SAR TEST DATA

WSTD.2013.09.09

Tested By:	Carl Enghom	Room Temperature (°C):	22.8
Date:	3/19/2014	Liquid Temperature (°C):	21.1
Serial Number:	1000027554	Humidity (%RH):	39
Configuration:	MASI0204-1	Bar. Pressure (mb):	1021
Comments:	None		

Test 1
DUT: Handheld Wireless Device; Type: RAD7A; Serial: 1000027554
Communication System: UID 0, CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2462 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used (interpolated): f = 2462 MHz; σ = 2.01 S/m; ε_r = 51.594; ρ = 1000 kg/m^3 , Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY Configuration:

- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Body/Body/Zoom Scan (8x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.500 V/m; Power Drift = -2.48 dB
Peak SAR (extrapolated) = 0.0120 W/kg
SAR(1 g) = 0.00942 W/kg; SAR(10 g) = 0.00719 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.0121 W/kg

Body/Body/Area scan (51x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0113 W/kg

Body/Body/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of Total (measured) = 1.456 V/m

Body/Body/Reference scan (41x41x1): Interpolated grid: dx=3.000 mm, dy=3.000 mm

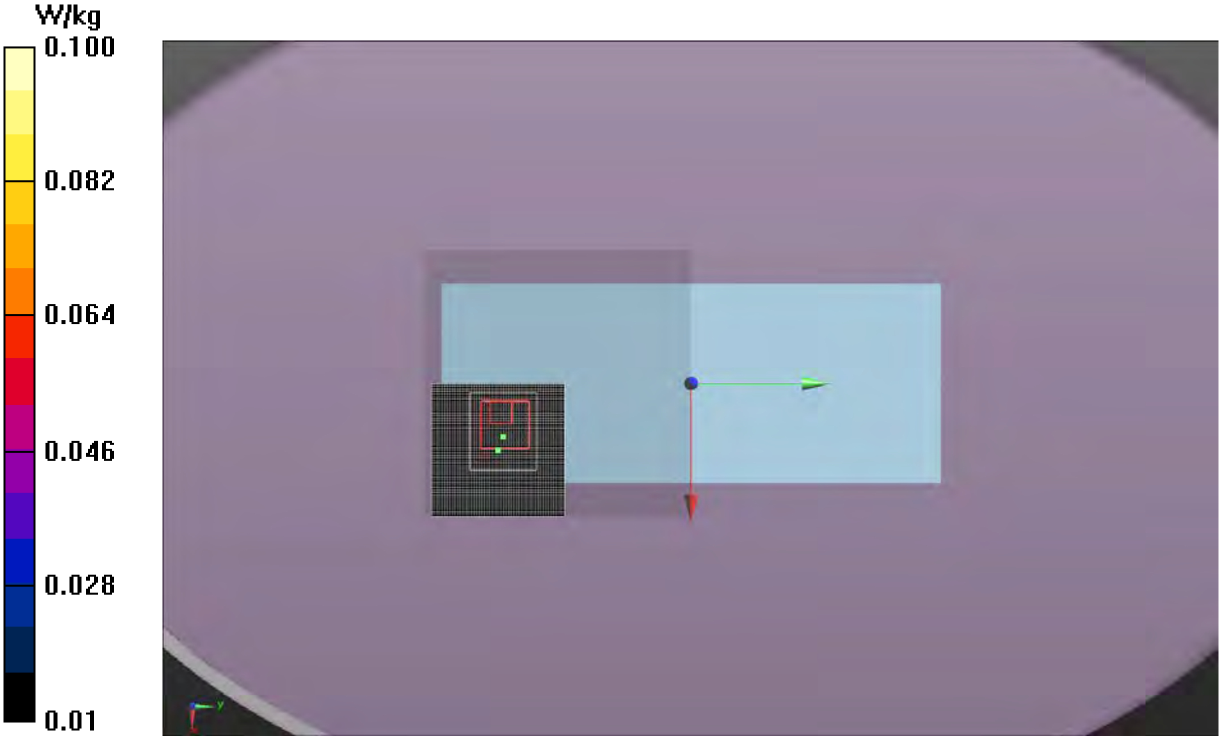
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0122 W/kg
Maximum value of SAR (measured) = 0.00426 W/kg

Carl Enghom

Approved By

SAR TEST DATA

Test 1



SAR TEST DATA

WSTD.2013.09.09

Tested By:	Carl Enghom	Room Temperature (°C):	22.8
Date:	3/19/2014	Liquid Temperature (°C):	21
Serial Number:	1000027554	Humidity (%RH):	39
Configuration:	MASI0204-2	Bar. Pressure (mb):	1021
Comments:	None		

Test 2
DUT: Handheld Wireless Device; Type: RAD7A; Serial: 1000027554
Communication System: UID 0, CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2462 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used (interpolated): f = 2462 MHz; σ = 2.01 S/m; ε_r = 51.594; ρ = 1000 kg/m^3 , Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY Configuration:

- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Body/Body/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 25.654 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 2.34 W/kg
SAR(1 g) = 0.903 W/kg; SAR(10 g) = 0.326 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.57 W/kg

Body/Body/Area scan (51x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 1.50 W/kg

Body/Body/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of Total (measured) = 18.06 V/m

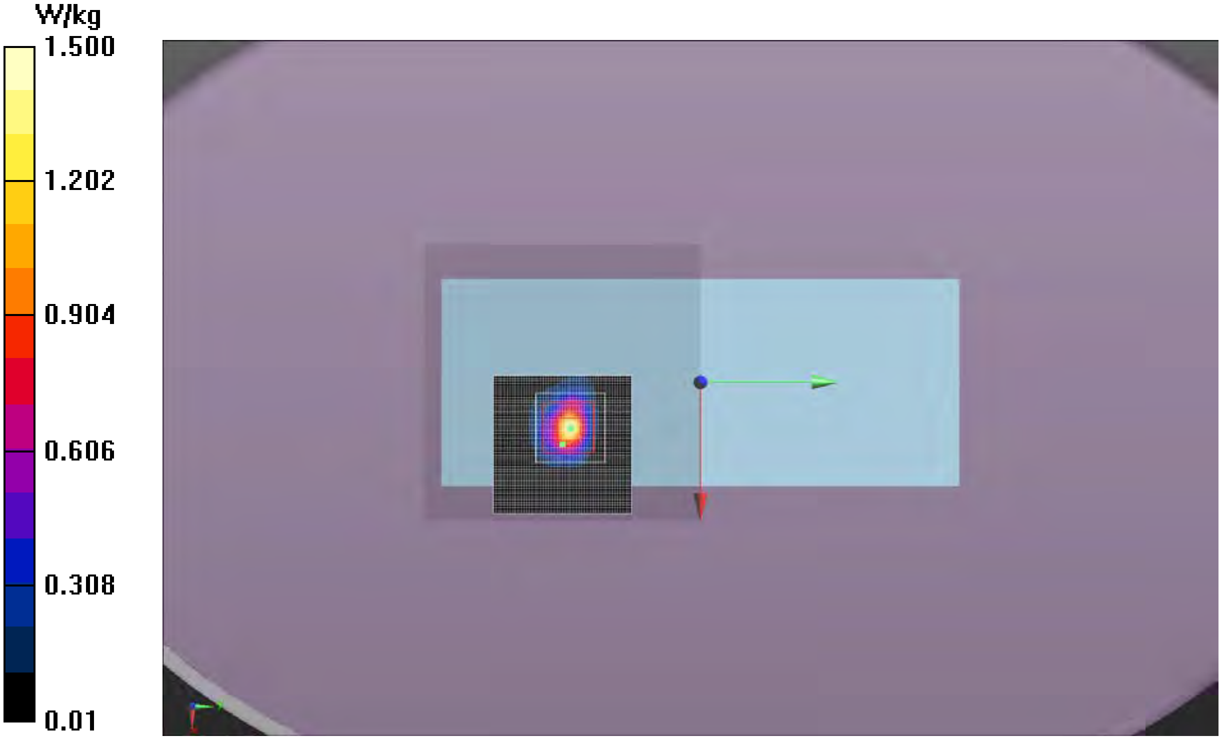
Body/Body/Reference scan (41x41x1): Interpolated grid: dx=3.000 mm, dy=3.000 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.880 W/kg
Maximum value of SAR (measured) = 0.655 W/kg

Carl Engholm

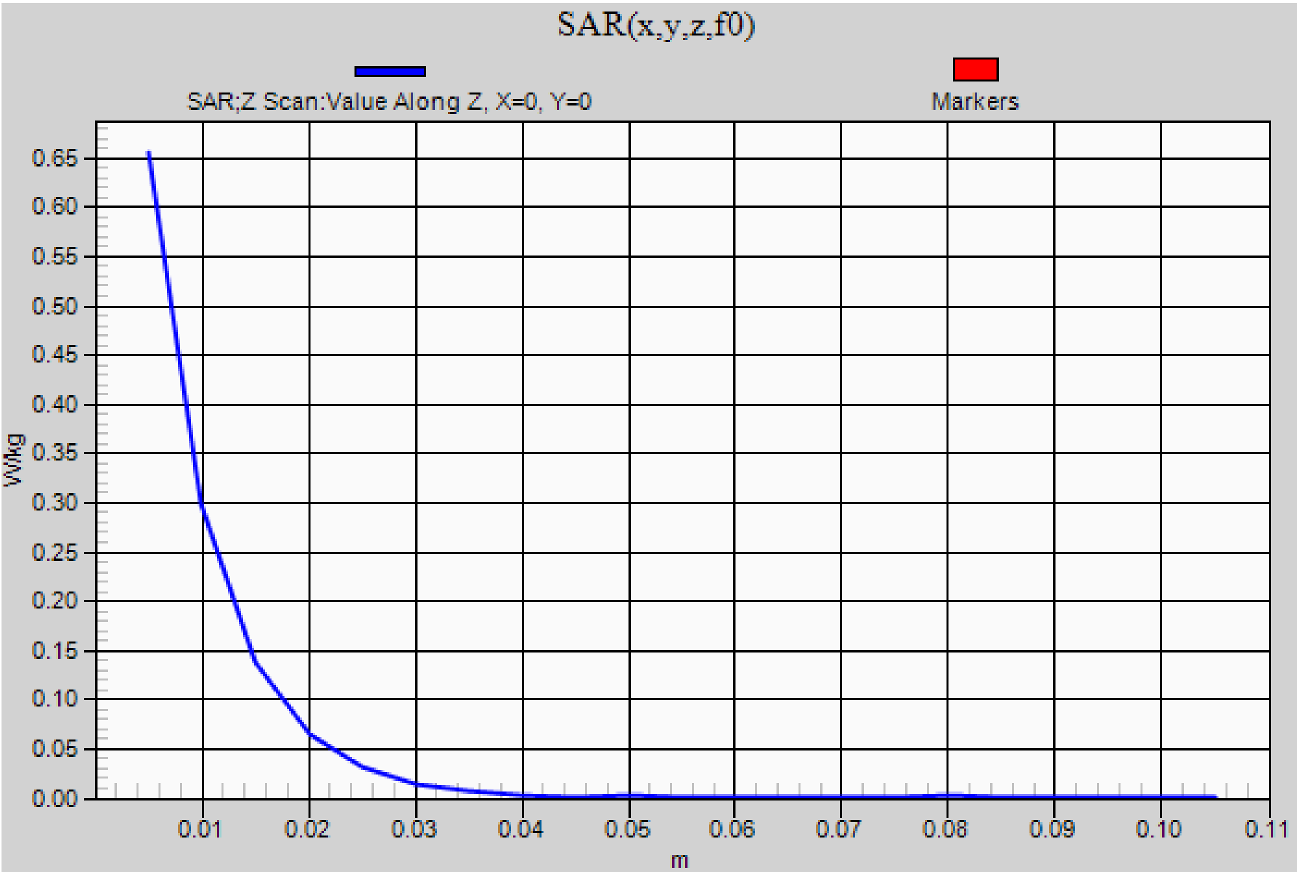
Approved By

Test 2



SAR TEST DATA

Test 2 – Z Scan

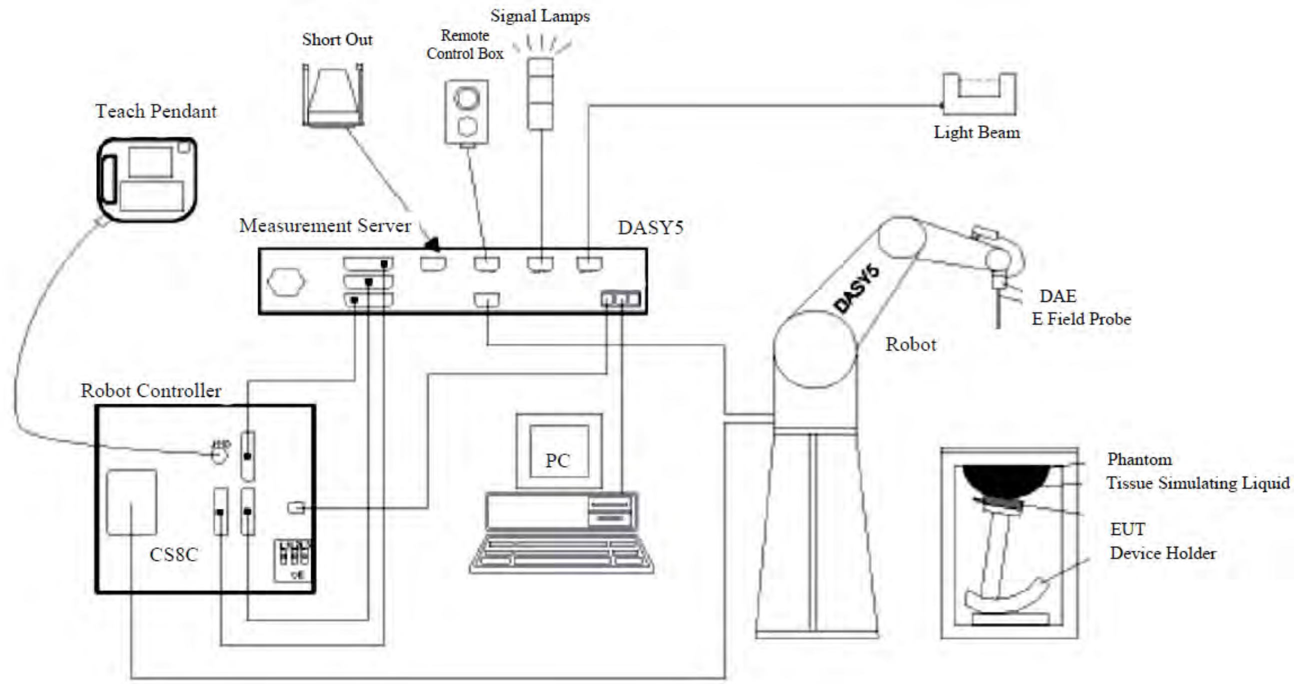


SAR MEASUREMENT SYSTEM

Schmid & Partner Engineering AG, DASY52

Northwest EMC selected the leader in SAR evaluation systems to provide the measurement tools for this evaluation. SPEAG's DASY52 is the fastest and most accurate scanner on the market. It is fully compatible with all world-wide standards for transmitters operating at the ear or within 20cm of the body. It provides full compatibility with IEC 62209-1, IEC 62209-2, IEEE 1528 as well as national adaptations such as FCC OET-65c and Korean Std. MIC #2000-93

The DASY52 system for performing compliance tests consists of the following items:



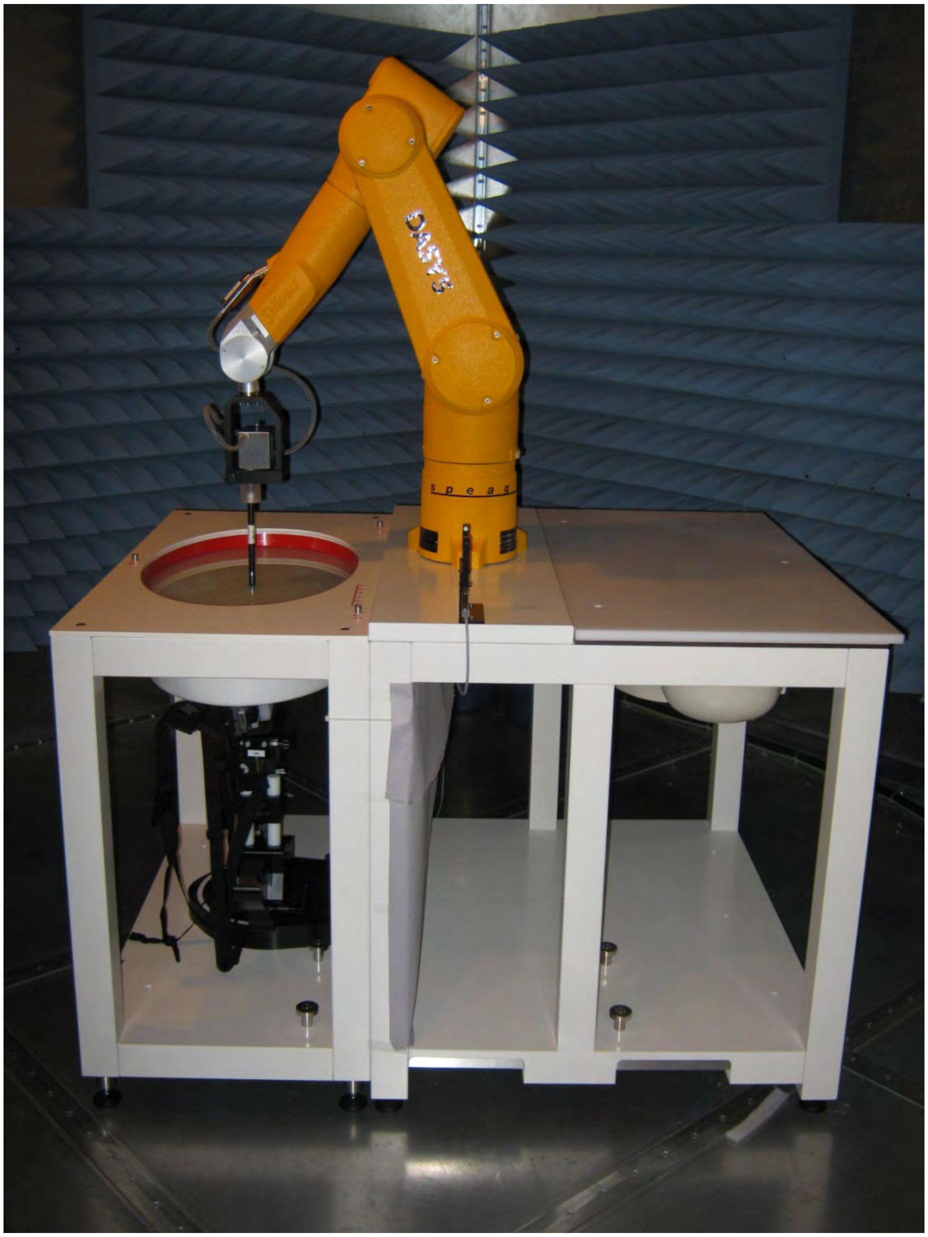
- A standard high precision 6-axis robot (Staubli TX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom, oval flat phantom, device holder, tissue simulating liquids, and validation dipole kits.

TEST SITE

Northwest EMC, Lab EV08

The SAR measurement system is located in a semi-anechoic chamber. This provides an ambient free environment that also eliminates reflections.

The chamber is 12 ft wide by 16 ft long x 8 ft high. A dedicated HVAC unit provides +/- 1 degree C temperature control.



TEST EQUIPMENT

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Amplifier	Mini Circuits	ZVE-3W-83+	TTA	NCR [1]	0 mo
Antenna, Dipole 2450MHz SAR	SPEAG	D2450V2	ADL	11/14/2013	12 mo
Body Solution	SPEAG	MSL 2450	SAM	At start of testing	
DAE	SPEAG	SD 000 D04 EJ	SAH	11/13/2013	12 mo
DASY5 Measurement Server	Staeubli	DAYS5	SAK	11/01/2013	36 mo
Device Holder	SPEAG	N/A	SAW	NCR	0 mo
Dielectric Probe Kit	Agilent	85070E	IPP	NCR	0 mo
Humidity Temperature Meter	Omegaette	HH311	DTY	03/29/2011	36 mo
Light Beam Unit	SPEAG	SE UKS 030 AA	SAD	NCR	0 mo
Network Analyzer	Hewlett Packard	N5230A	NAD	05/20/2013	12 mo
Phantom, 2mm Oval ELI4 (Body)	SPEAG	QD OVA 001 BB	SAC	NCR	0 mo
Power Meter	Agilent	N1913A	SQR	04/29/2013	36 mo
Power Sensor	Agilent	E9300H	SQO	04/29/2013	36 mo
RF Vector Signal Generator with associated cables and attenuators	Agilent	V2920A	TIH	NCR [1]	0 mo
Robot Arm	Staeubli	TX60LSPEAG	SAA	NCR	0 mo
Robot Chasis and power Supply	Staeubli	N/A	SAJ	NCR	0 mo
Robot Controller	Staeubli	CS8C	SAI	NCR	0 mo
SAR Probe	SPEAG	EX3DV4	SAG	11/15/2013	12 mo
Spectrum Analyzer	Aglient	E4446A	AAY	2/22/2013	24 mo

Note 1: The output of the signal generator / amplifier is verified with the calibrated power meter listed above.

MEASUREMENT UNCERTAINTY BUDGETS PER IEEE 1528:2003

300-3000 MHz Range

Uncertainty Component	Tolerance (+/- %)	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	u_i (1g) (+/-%)	u_i (10g) (+/-%)	v_i
Measurement System								
Probe calibration (k=1)	5.5	normal	1	1	1	5.5	5.5	∞
Axial isotropy	4.7	rectangular	1.732	0.707	0.707	1.9	1.9	∞
Hemispherical isotropy	9.6	rectangular	1.732	0.707	0.707	3.9	3.9	∞
Boundary effect	1.0	rectangular	1.732	1	1	0.6	0.6	∞
Linearity	4.7	rectangular	1.732	1	1	2.7	2.7	∞
System detection limits	1.0	rectangular	1.732	1	1	0.6	0.6	∞
Readout electronics	0.3	normal	1	1	1	0.3	0.3	∞
Response time	0.8	rectangular	1.732	1	1	0.5	0.5	∞
Integration time	2.6	rectangular	1.732	1	1	1.5	1.5	∞
RF ambient conditions - noise	1.7	rectangular	1.732	1	1	1.0	1.0	∞
RF Ambient Reflections	0.0	rectangular	1.732	1	1	0.0	0.0	∞
Probe positioner mechanical tolerance	0.4	rectangular	1.732	1	1	0.2	0.2	∞
Probe positioner with respect to phantom shell	2.9	rectangular	1.732	1	1	1.7	1.7	∞
Extrapolation, interpolation, and integration algorithms for max. SAR evaluation	1.0	rectangular	1.732	1	1	0.6	0.6	∞
Test Sample Related								
Device Positioning	2.9	normal	1	1	1	2.9	2.9	145
Device Holder	3.6	normal	1	1	1	3.6	3.6	5
Power Drift	5.0	rectangular	1.732	1	1	2.9	2.9	∞
Phantom and tissue parameters								
Phantom Uncertainty - shell thickness tolerances	4.0	rectangular	1.732	1	1	2.3	2.3	∞
Liquid conductivity - deviation from target values	5.0	rectangular	1.732	0.64	0.43	1.8	1.2	∞
Liquid conductivity - measurement uncertainty	6.5	normal	1	0.64	0.43	4.2	2.8	∞
Liquid permittivity - deviation from target values	5.0	rectangular	1.732	0.6	0.49	1.7	1.4	∞
Liquid permittivity - measurement uncertainty	3.2	normal	1	0.6	0.49	1.9	1.6	∞
Combined Standard Uncertainty		RSS				11.2	10.6	387
Expanded Measurement Uncertainty (95% Confidence/		normal (k=2)				22.5	21.2	

NORTHWEST EMC

WTD 12.5.23

PROBE CALIBRATION

Probe Calibration

Please see attached calibration data.

Equipment ID: SAG

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client **Northwest EMC**

Certificate No: EX3-3746_Nov13

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3746
Calibration procedure(s)	QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	November 15, 2013

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	4-Sep-13 (No. DAE4-660_Sep13)	Sep-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: November 16, 2013

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

Probe EX3DV4

SN:3746

Manufactured: March 26, 2010
Calibrated: November 15, 2013

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3746

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.49	0.47	0.50	± 10.1 %
DCP (mV)[B]	95.1	96.8	99.8	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	116.0	±2.5 %
		Y	0.0	0.0	1.0		114.4	
		Z	0.0	0.0	1.0		115.3	
10061-CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)	X	4.27	70.6	19.0	3.60	112.0	±0.7 %
		Y	3.46	70.3	19.5		146.7	
		Z	6.51	80.9	23.9		110.8	
10069-CAA	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps)	X	12.35	71.0	23.8	10.56	123.7	±3.8 %
		Y	10.65	68.7	22.9		104.8	
		Z	11.98	70.7	23.7		121.3	
10077-CAA	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps)	X	11.38	70.4	23.8	11.00	105.9	±3.5 %
		Y	10.68	71.0	24.7		131.5	
		Z	11.00	70.1	23.8		103.8	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of NormX,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3746

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
2450	39.2	1.80	6.74	6.74	6.74	0.49	0.93	± 12.0 %
2550	39.1	1.91	6.51	6.51	6.51	0.52	0.93	± 12.0 %
5200	36.0	4.66	4.92	4.92	4.92	0.35	1.80	± 13.1 %
5300	35.9	4.76	4.69	4.69	4.69	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.60	4.60	4.60	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.30	4.30	4.30	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.37	4.37	4.37	0.40	1.80	± 13.1 %

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

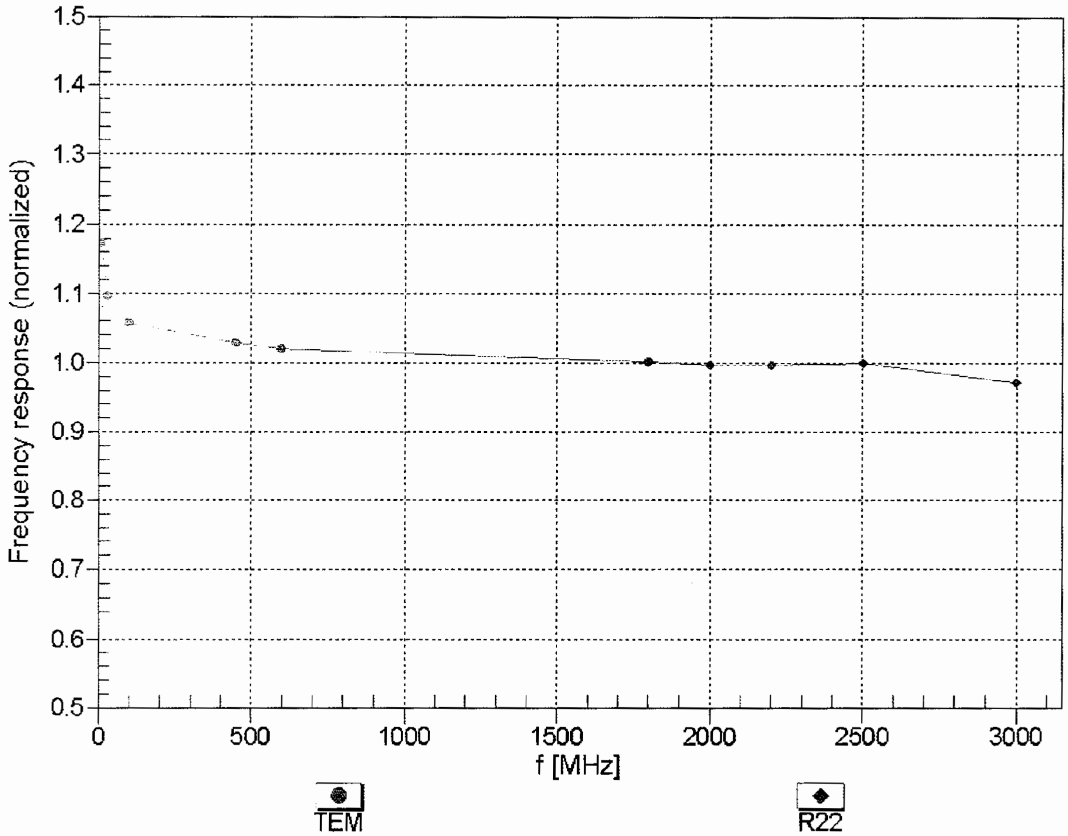
DASY/EASY - Parameters of Probe: EX3DV4 - SN:3746

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
2450	52.7	1.95	7.03	7.03	7.03	0.80	0.57	± 12.0 %
2550	52.6	2.09	6.78	6.78	6.78	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.25	4.25	4.25	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.04	4.04	4.04	0.45	1.90	± 13.1 %
5500	48.6	5.65	3.95	3.95	3.95	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.78	3.78	3.78	0.45	1.90	± 13.1 %
5800	48.2	6.00	4.16	4.16	4.16	0.45	1.90	± 13.1 %

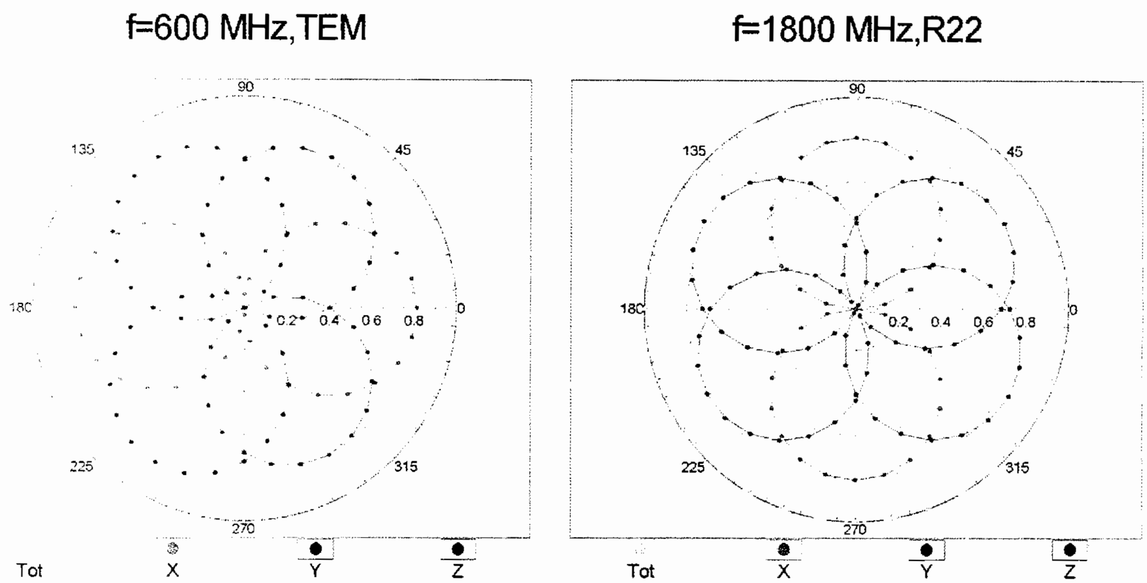
[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

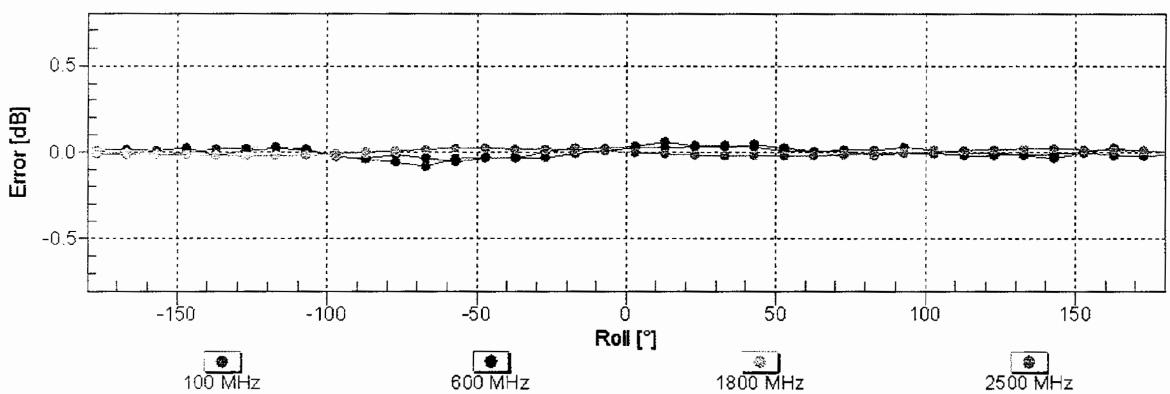
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

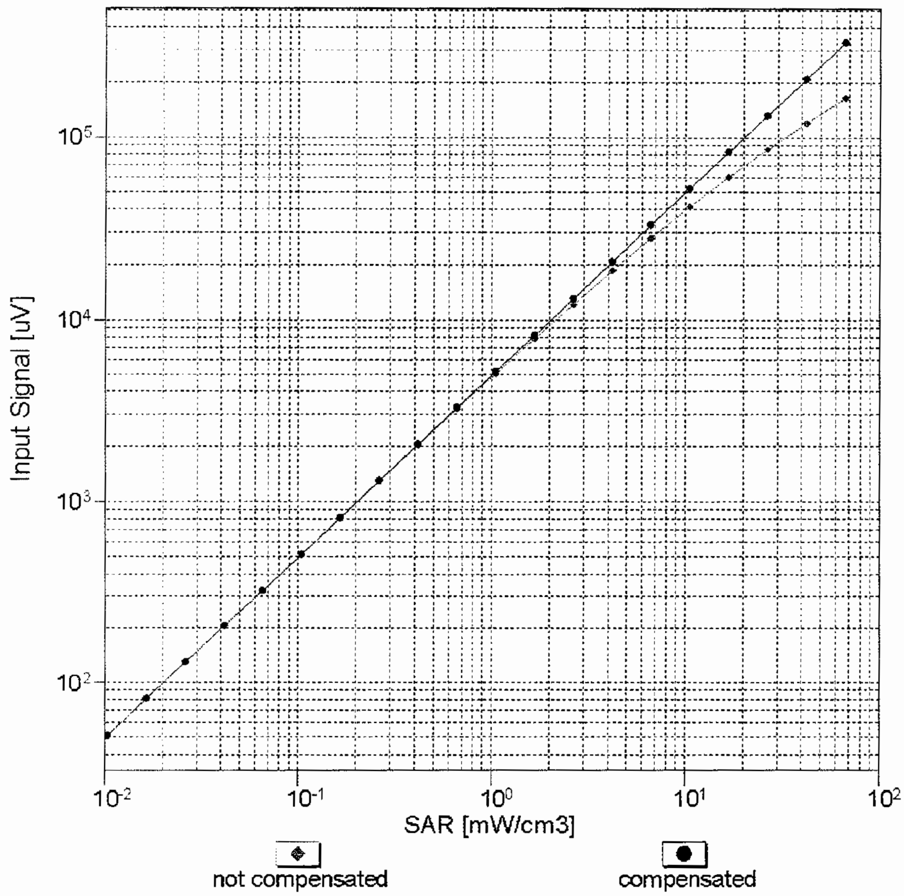
Receiving Pattern (ϕ), $\vartheta = 0°$

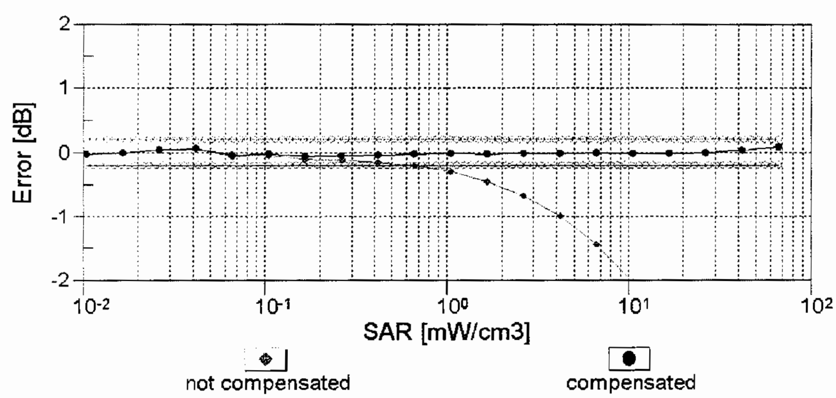




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

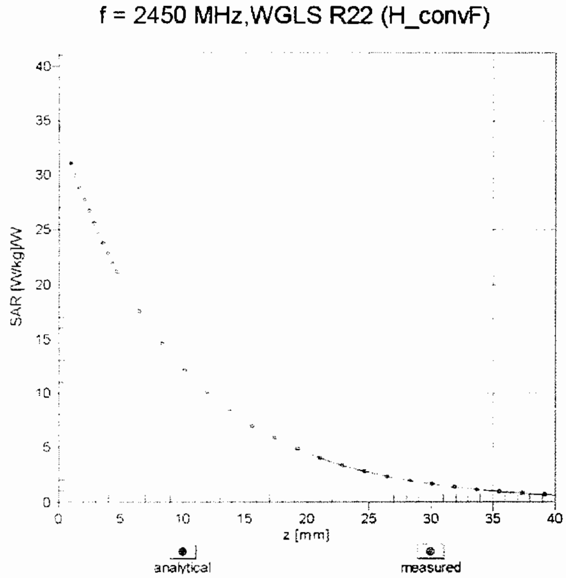
Dynamic Range f(SAR_{head})
(TEM cell , f = 900 MHz)

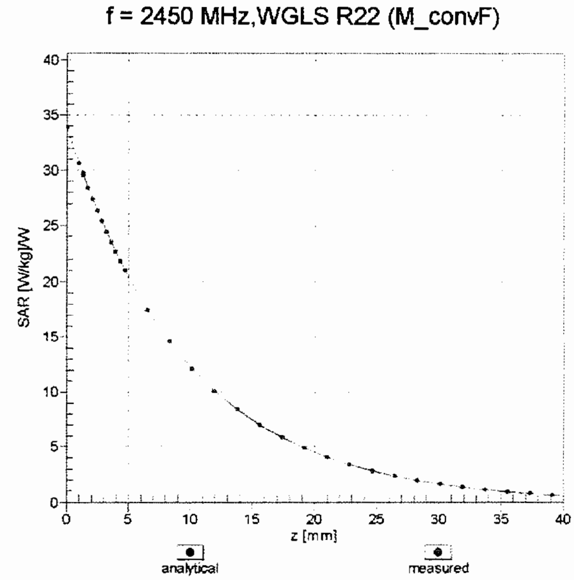




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

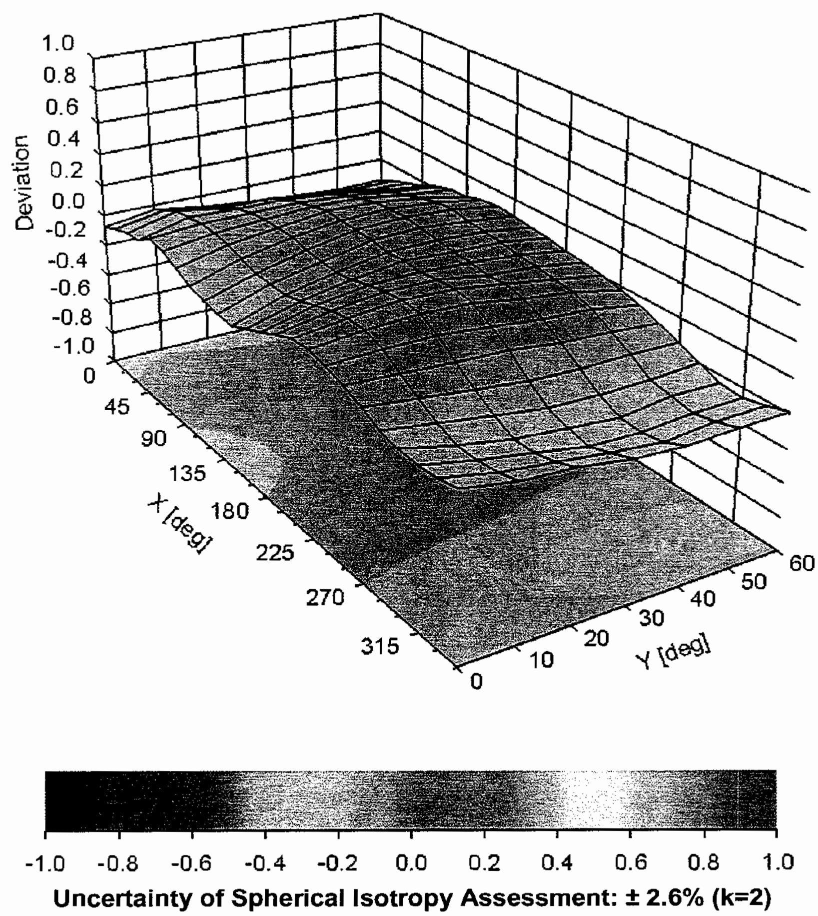
Conversion Factor Assessment





Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3746

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-137.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

DIPOLE CALIBRATION

Dipole Calibration

Key points:

1. Dipoles need to be sent to the manufacturer for calibration every 3 years.
2. For those years where they are not sent to the manufacturer the following two parameters are verified annually:

    a. The return-loss. If it deviates by more than 20% from the calibration data or does not meet the required -20 dB return-loss specification, then it fails the verification and must be sent to the manufacturer for repair and calibration.
    b. The real and imaginary parts of the impedance. If it deviates by more than 5 Ω from the calibration data, then it fails the verification and must be sent to the manufacturer for repair and calibration.

The return loss and complex impedance were verified to meet the FCC's criteria within one year of the manufacturer's calibration. The calibration data is used for the SAR system verification. The verification data shows that the dipole characteristics have not changed and the calibration data continues to be valid.

Please see attached calibration and verification data.

NORTHWEST
EMC

Calibration Certificate & Report

03/27/02dmt

Device	Dipole Antenna SPEAG SAR2450		
Equipment Code:	ADL	Cal Date:	111413
		Temperature:	23C
Customer:	Northwest EMC Tester: Varuzhan Kocharyan	Humidity:	40%
Certificate No.:	ADL 111413 Power: N/A	Job Site:	EV10

TEST SPECIFICATIONS

Specification:	Northwest EMC	Year:		Method:	FCC KDB 865664, Section 3.2.2

TEST PARAMETERS

Device Received In Tolerance:	Yes	Calibration Frequency :	2450MHz

Equipment Used to perform calibration

Item:	Network Analyzer	Identifier:	NAJ	Model:	Agilent E5061B	Calibration Date	3/24/2011
Item:	50 Ohm Termination	Identifier:	NAHA	Model:	Agilent 85032-60017	Calibration Date	5/6/2013
Item:	10dB Attenuator	Identifier:	RCD	Model:	SA6021-10	Calibration Date	4/15/2013
Item:	Head TSL	Identifier:	SAL	Model:	Head Solution	Calibration Date	9/23/2013
Item:	Body TSL	Identifier:	SAM	Model:	Body Solution	Calibration Date	9/23/2013

COMMENTS, OPINIONS and INTERPRETATIONS

Measurement Uncertainty

	Probability Distribution	Impedance (dB)	Return Loss (dB)		
Expanded uncertainty U (level of confidence = 95%)	normal (k=2)	TBD	TBD		

DEVIATIONS FROM TEST STANDARD

None

RESULTS

Pass

This measurement was a calibration verification. (Instrument parameters are within tolerances.)

Approved By

Tested By

CALIBRATION DATA ATTACHED

Verification Data

EUT	Dipole Antenna			
Model	**SAR2450**	**Antenna Parameters with Head TSL**		
S/N	**ADL**	Impedance	50.26 +j5.77	49.71+6.52
Manufacturer	SPEAG	Return Loss	-28.7 dB	
Date	111413			
		Antenna Parameters with Body TSL		
Temperature	23C	Impedance, Ohms	49.82+j2.87	
Humidity	40%	Return Loss, dB	-27.5 dB	
Operator	Varuzhan Kocharyan			

Dipole Calibration

Performed by SPEAG (the manufacturer)

ADL

ADL

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client **Northwest EMC**

Certificate No: **D2450V2-855_Dec11**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 855
Calibration procedure(s)	QA CAL-05.v8 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	December 09, 2011

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	05-Oct-11 (No. 217-01451)	Oct-12
Power sensor HP 8481A	US37292783	05-Oct-11 (No. 217-01451)	Oct-12
Reference 20 dB Attenuator	SN: 5086 (20g)	29-Mar-11 (No. 217-01368)	Apr-12
Type-N mismatch combination	SN: 5047.2 / 06327	29-Mar-11 (No. 217-01371)	Apr-12
Reference Probe ES3DV3	SN: 3205	29-Apr-11 (No. ES3-3205_Apr11)	Apr-12
DAE4	SN: 601	04-Jul-11 (No. DAE4-601_Jul11)	Jul-12

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

	Name	Function	Signature
Calibrated by:	Dimce Iliev	Laboratory Technician	D. Iliev
Approved by:	Katja Pokovic	Technical Manager	

Issued: December 9, 2011

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.5 ± 6 %	1.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.7 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**53.9 mW /g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.38 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**25.3 mW /g ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	50.7 ± 6 %	2.04 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**50.4 mW / g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.02 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**23.7 mW / g ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.9 Ω + 4.5 jΩ
Return Loss	- 25.7 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.4 Ω + 5.3 jΩ
Return Loss	- 25.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.157 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	November 10, 2009

DASY5 Validation Report for Head TSL

Date: 09.12.2011

Test Laboratory: SPEAG, Zurich, Switzerland

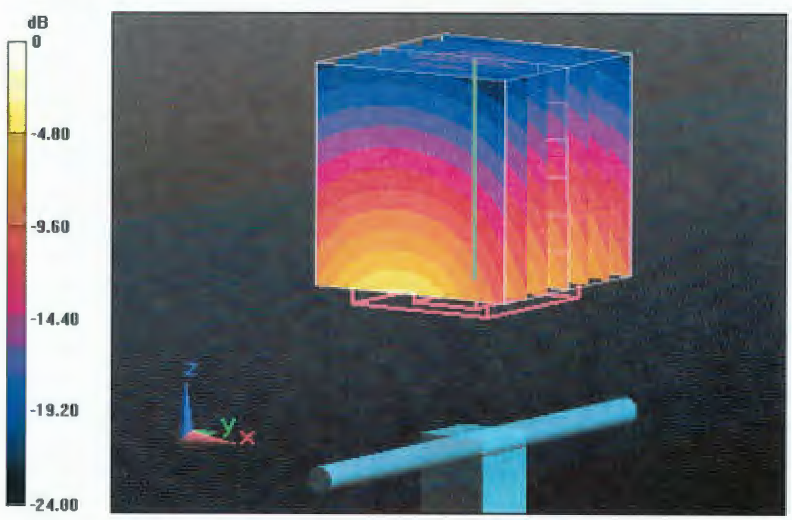
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 855

Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.87 mho/m; ε_r = 39.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

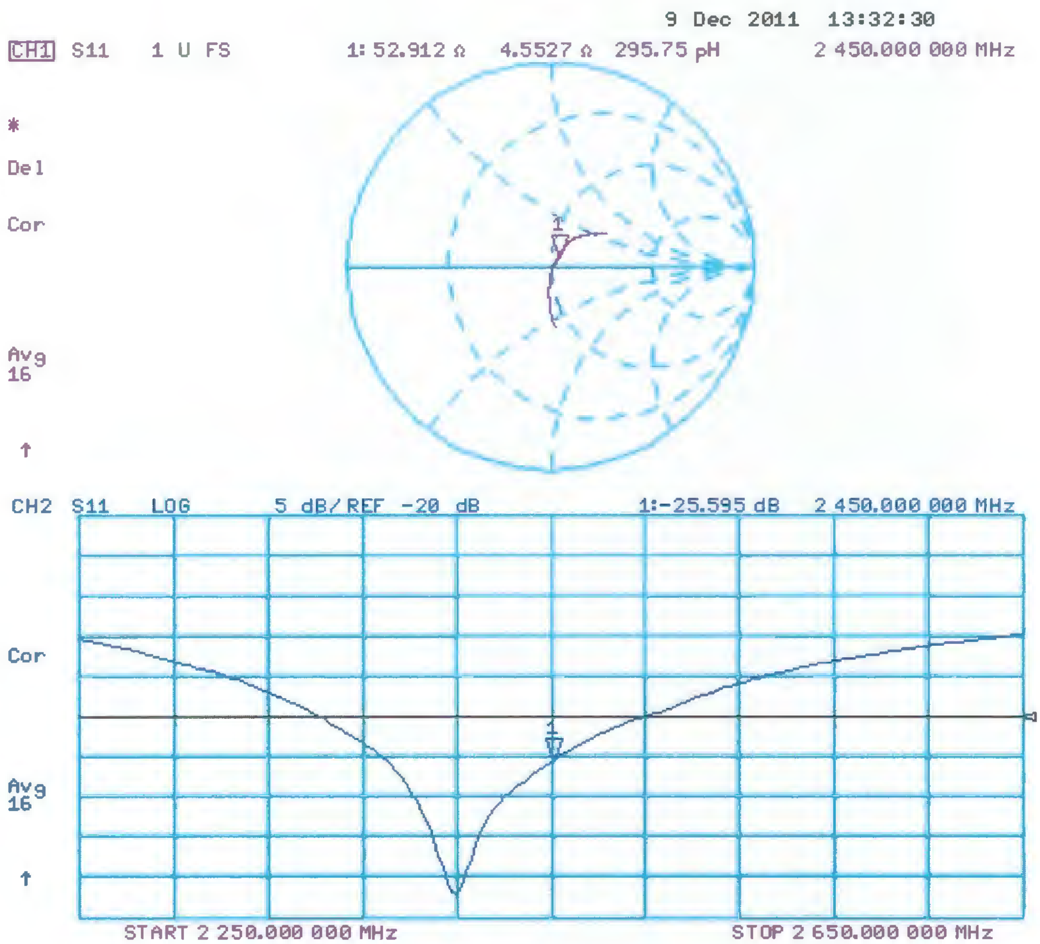
- Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 29.04.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 100.7 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 28.3310
SAR(1 g) = 13.7 mW/g; SAR(10 g) = 6.38 mW/g
Maximum value of SAR (measured) = 17.684 mW/g



0 dB = 17.680mW/g = 24.95 dB mW/g

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 08.12.2011

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 855

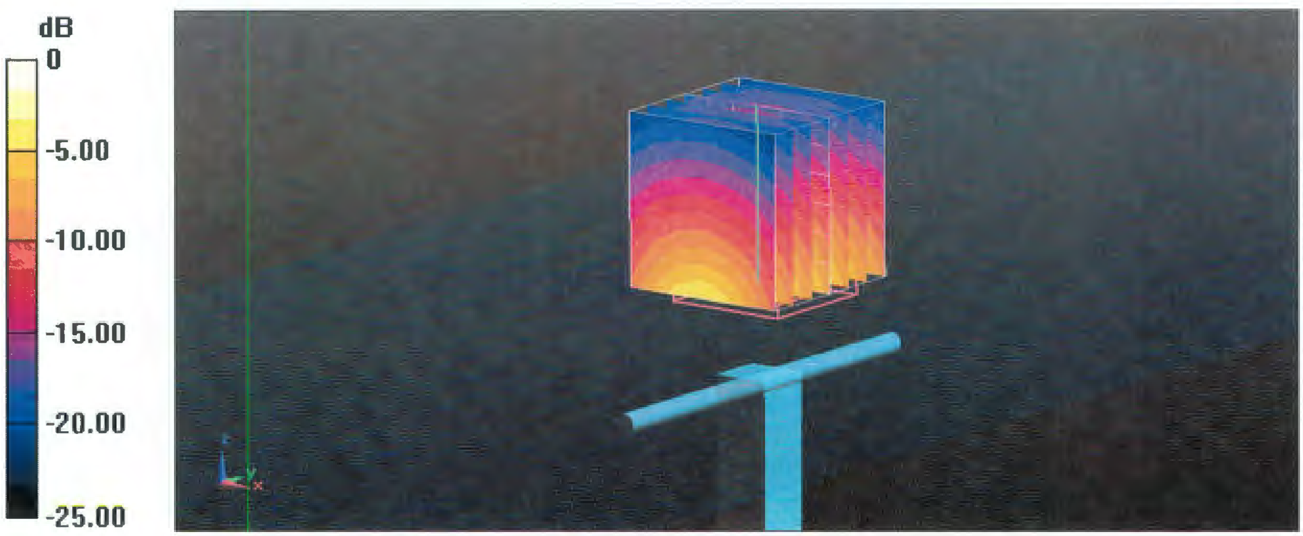
Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.04 mho/m; ε_r = 50.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 29.04.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.074 V/m; Power Drift = -0.0092 dB
Peak SAR (extrapolated) = 27.0840
SAR(1 g) = 13 mW/g; SAR(10 g) = 6.02 mW/g
Maximum value of SAR (measured) = 17.188 mW/g



0 dB = 17.190mW/g = 24.71 dB mW/g

Impedance Measurement Plot for Body TSL