



**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](http://www.nwemc.com)

California – Minnesota – Oregon – New York – Washington

**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<br>FCC 15.247:2014 | IEEE Std 1528:2003                       | Pass      |
|                  |                                    | FCC KDB 447498 D01 v05r02                |           |
|                  |                                    | FCC KDB 248227 D01 v01r02                |           |
|                  |                                    | FCC KDB 865664 D01 v01r03 and D02 v01r01 |           |

### Highest SAR Values:

| Frequency Bands (GHz) | Body (W/kg) | Limit (W/kg) | Exposure Environment |
|-----------------------|-------------|--------------|----------------------|
|                       | 1g          | 1g           |                      |
| 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.*

| Revision Number | Description | Date | Page Number |
|-----------------|-------------|------|-------------|
| 00              | None        |      |             |

## Barometric Pressure

The recorded barometric pressure has been normalized to sea level.

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## 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

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## Canada

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

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## 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.

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## Australia/New Zealand

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

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## Korea

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

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## Japan

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

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## 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.

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## Singapore

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

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## Hong Kong

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

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## Vietnam

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

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## Russia

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

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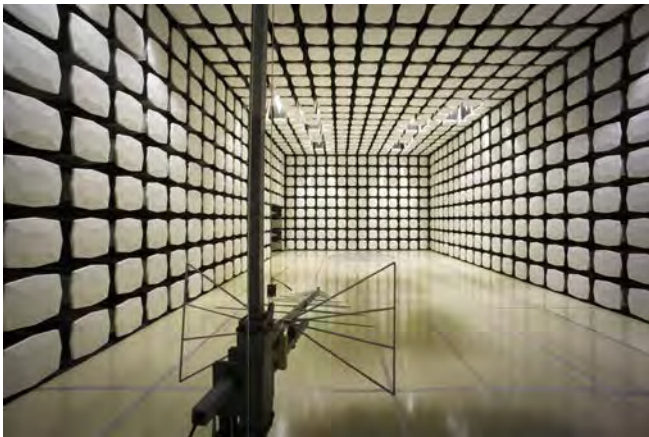
## SCOPE

For details on the Scopes of our Accreditations, please visit:

<http://www.nwemc.com/accreditations/>



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



**Client and Equipment Under Test (EUT) Information**

|                                 |                    |
|---------------------------------|--------------------|
| <b>Company Name:</b>            | Masimo Corporation |
| <b>Address:</b>                 | 40 Parker          |
| <b>City, State, Zip:</b>        | Irvine, CA 92618   |
| <b>Test Requested By:</b>       | Michael Clark      |
| <b>Model:</b>                   | RAD7A              |
| <b>First Date of Test:</b>      | February 26, 2014  |
| <b>Last Date of Test:</b>       | March 19, 2014     |
| <b>Receipt Date of Samples:</b> | February 26, 2014  |
| <b>Equipment Design Stage:</b>  | Production         |
| <b>Equipment Condition:</b>     | 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.

**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 |

**Configuration MASI0204- 1**

| <b>EUT</b>                       |                     |                          |                      |
|----------------------------------|---------------------|--------------------------|----------------------|
| <b>Description</b>               | <b>Manufacturer</b> | <b>Model/Part Number</b> | <b>Serial Number</b> |
| 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**

| <b>EUT</b>                       |                     |                          |                      |
|----------------------------------|---------------------|--------------------------|----------------------|
| <b>Description</b>               | <b>Manufacturer</b> | <b>Model/Part Number</b> | <b>Serial Number</b> |
| 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          |

| <b>Cables</b>     |               |                   |                |                     |                     |
|-------------------|---------------|-------------------|----------------|---------------------|---------------------|
| <b>Cable Type</b> | <b>Shield</b> | <b>Length (m)</b> | <b>Ferrite</b> | <b>Connection 1</b> | <b>Connection 2</b> |
| 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.**



## 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.                  |

**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<br>(MHz) | Head         |                | Body         |                |
|---------------------------|--------------|----------------|--------------|----------------|
|                           | $\epsilon_r$ | $\sigma$ (S/m) | $\epsilon_r$ | $\sigma$ (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           |

( $\epsilon_r$  = relative permittivity,  $\sigma$  = conductivity and  $\rho = 1000 \text{ kg/m}^3$ )

**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 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<br>(% 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<sup>+</sup>% Pure Sodium Chloride                      Sugar: 98<sup>+</sup>% Pure Sucrose  
 Water: De-ionized, 16 MΩ<sup>+</sup> resistivity                HEC: Hydroxyethyl Cellulose  
 DGBE: 99<sup>+</sup>% 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

|            |                        |                     |         |
|------------|------------------------|---------------------|---------|
| 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

| Frequency (MHz) | Actual Values         |              | Target Values         |              | Deviation (%)         |              |
|-----------------|-----------------------|--------------|-----------------------|--------------|-----------------------|--------------|
|                 | 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         |

## REQUIREMENT

Per IEEE 1528, Section 8.2.1, "System checks are performed prior to compliance tests and the results must always be within  $\pm 10\%$  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."

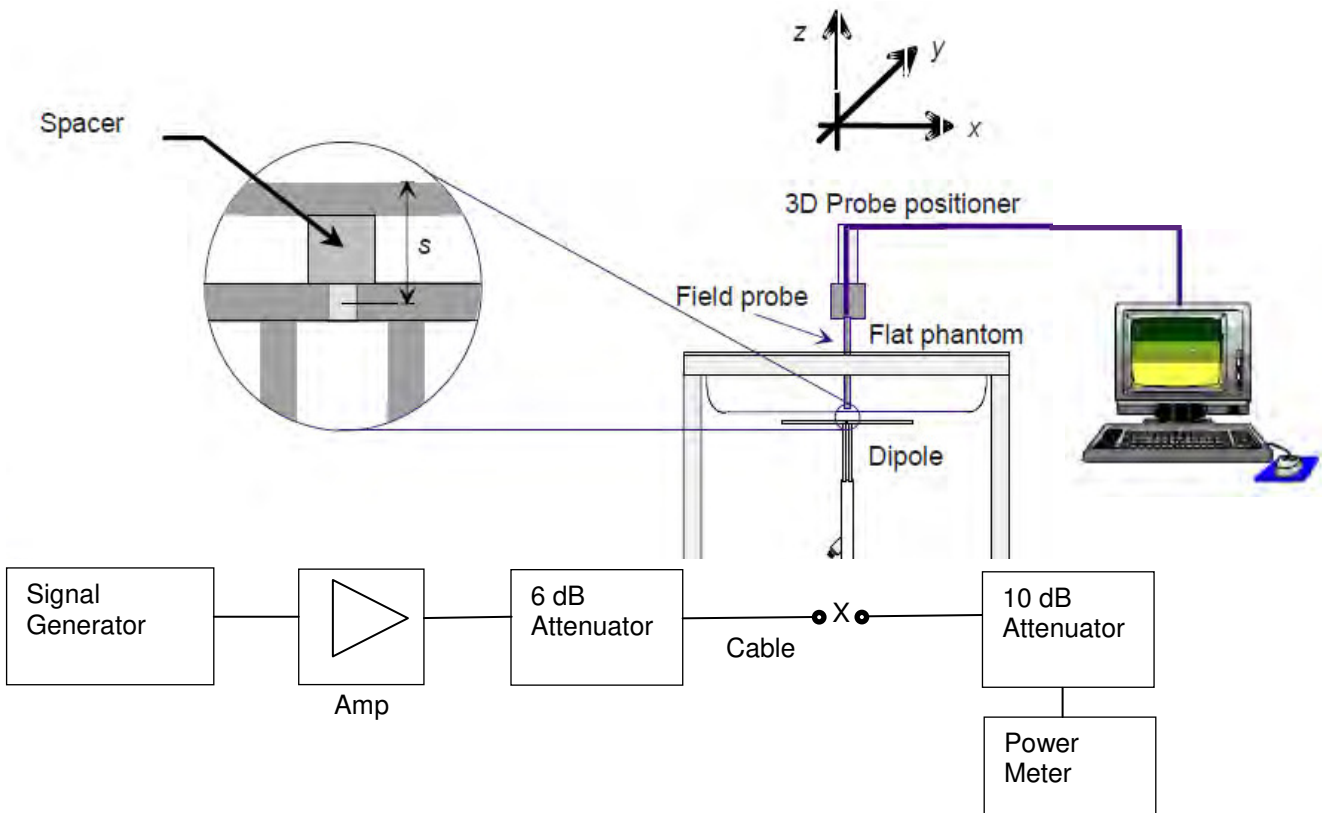
## TEST DESCRIPTION

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:

- $s = 15\text{mm}, \pm 0.2\text{mm}$  for  $300\text{MHz} \leq f \leq 1000 \text{ MHz}$ :
- $s = 10\text{mm}, \pm 0.2\text{mm}$  for  $1000\text{MHz} \leq f \leq 6000\text{MHz}$

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.



## TEST SPECIFICATIONS

|                 |  |
|-----------------|--|
| Specification:  | Method:  |
| FCC 2.1093:2014 | IEEE Std 1528:2003<br>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<br>(Normalized to 1W)<br>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 |

|                |              |                          |         |
|----------------|--------------|--------------------------|---------|
| 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:  $f = 2450 \text{ MHz}$ ;  $\sigma = 1.986 \text{ S/m}$ ;  $\epsilon_r = 51.738$ ;  $\rho = 1000 \text{ kg/m}^3$ , Medium parameters used:  $\sigma = 0 \text{ S/m}$ ,  $\epsilon_r = 1$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- DASYS52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**System Check/System Check/Area Scan (51x61x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) = 5.03 W/kg

**System Check/System Check/Z Scan (1x1x21):** Measurement grid:  $dx=20\text{mm}$ ,  $dy=20\text{mm}$ ,  $dz=5\text{mm}$

Maximum value of Total (measured) = 56.88 V/m

**System Check/System Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

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**

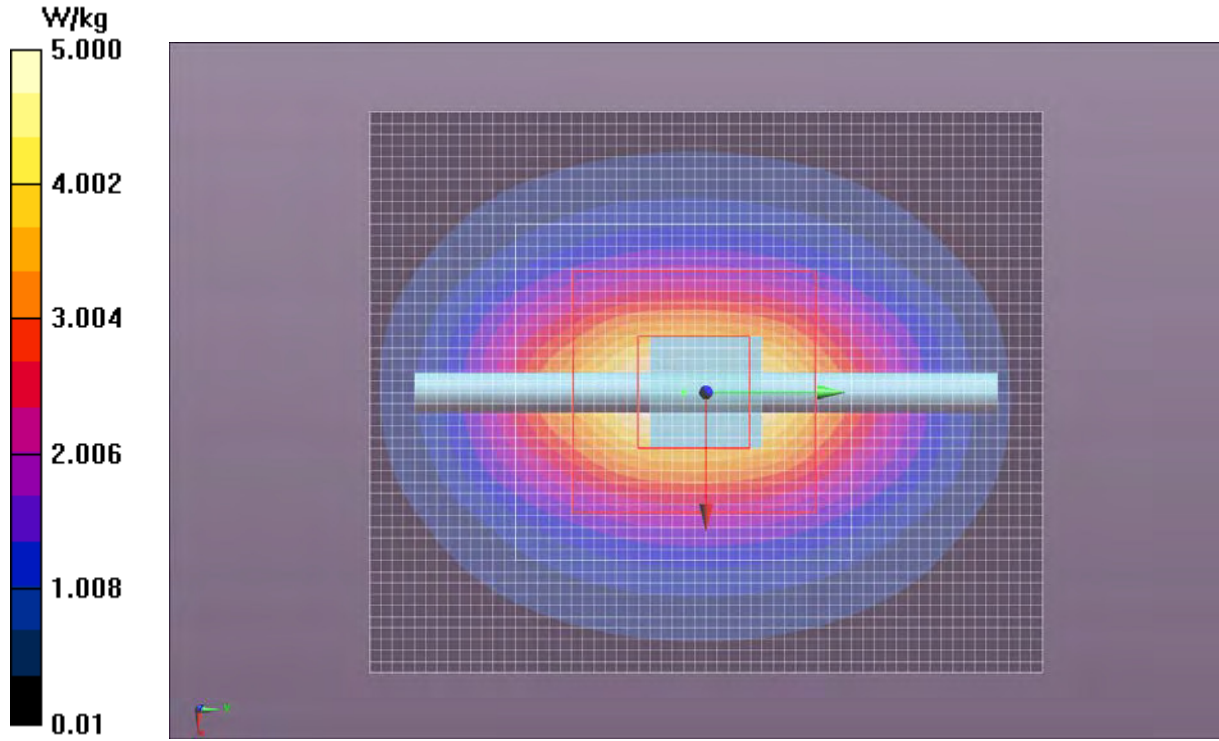
Maximum value of SAR (measured) = 4.75 W/kg

Maximum value of SAR (measured) = 6.42 W/kg



Approved By

## MSL2450 System Check, 3-19-14





## 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.

|                                     |                    |                           |
|-------------------------------------|--------------------|---------------------------|
| 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 |                           |
| COMMENTS                            |                    | FCC KDB 248227 D01 v01r02 |
| TX Power set to 90.                 |                    |                           |
| DEVIATIONS FROM TEST STANDARD       |                    |                           |
| NONE                                |                    |                           |
| Configuration #                     | 1                  | <i>Signature</i>          |
| <b>Value      Limit      Result</b> |                    |                           |
| 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 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 |

---

## 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.

---

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

**TEST SPECIFICATIONS**

|                                    |  |
|------------------------------------|--|
| Specification:                     | Method:  |
| FCC 2.1093:2014<br>FCC 15.247:2014 | IEEE Std 1528:2003<br>FCC KDB 447498 D01 v05r02<br>FCC KDB 248227 D01 v01r02<br>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 <sup>Note 1</sup> (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

|                |             |                          |      |
|----------------|-------------|--------------------------|------|
| 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;  $\sigma = 2.01$  S/m;  $\epsilon_r = 51.594$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASYS5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- DASYS52 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.](#)

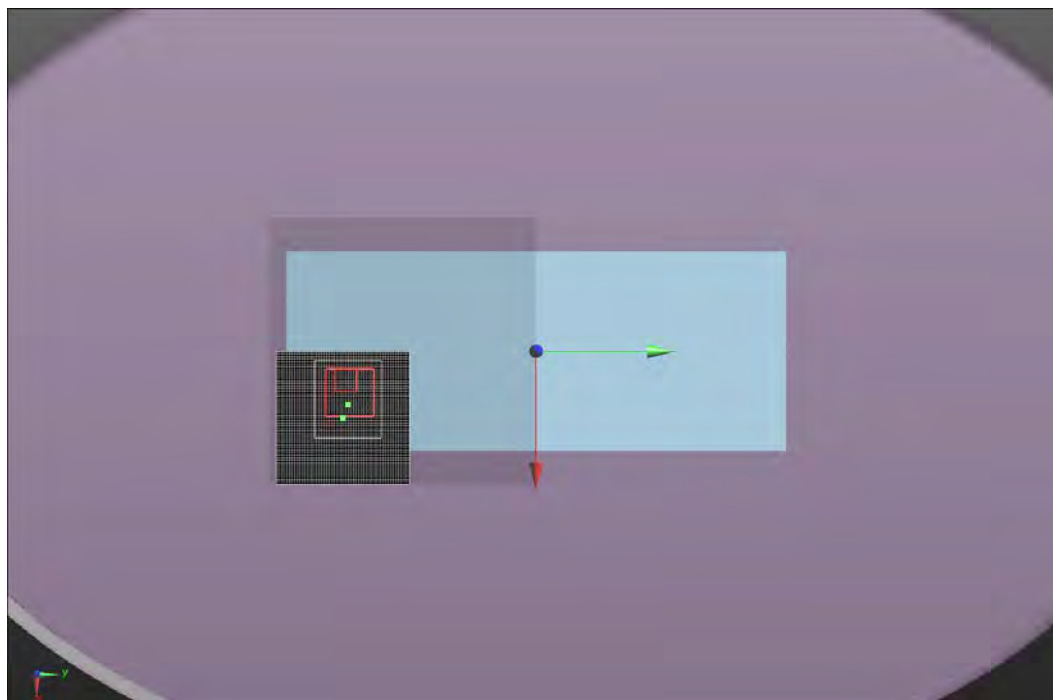
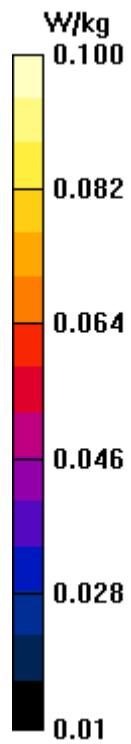
Maximum value of SAR (interpolated) = 0.0122 W/kg

Maximum value of SAR (measured) = 0.00426 W/kg



Approved By

Test 1



|                |             |                          |      |
|----------------|-------------|--------------------------|------|
| 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;  $\sigma = 2.01$  S/m;  $\epsilon_r = 51.594$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASYS5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- DASYS52 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

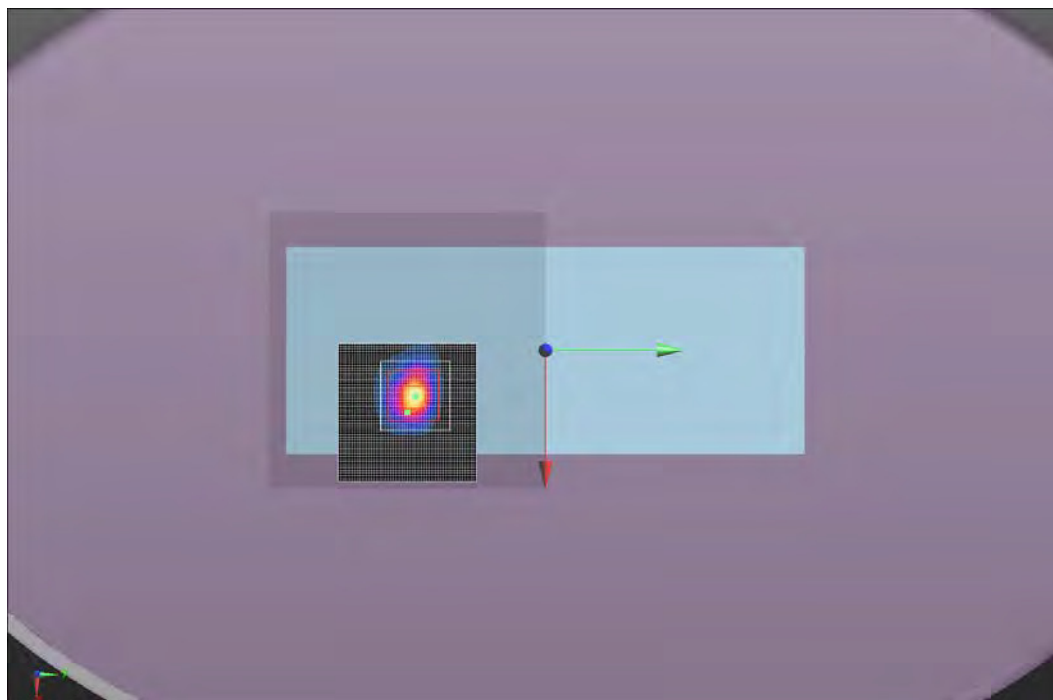
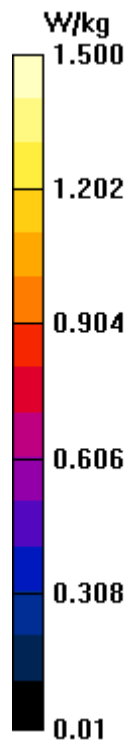
Maximum value of SAR (measured) = 0.655 W/kg



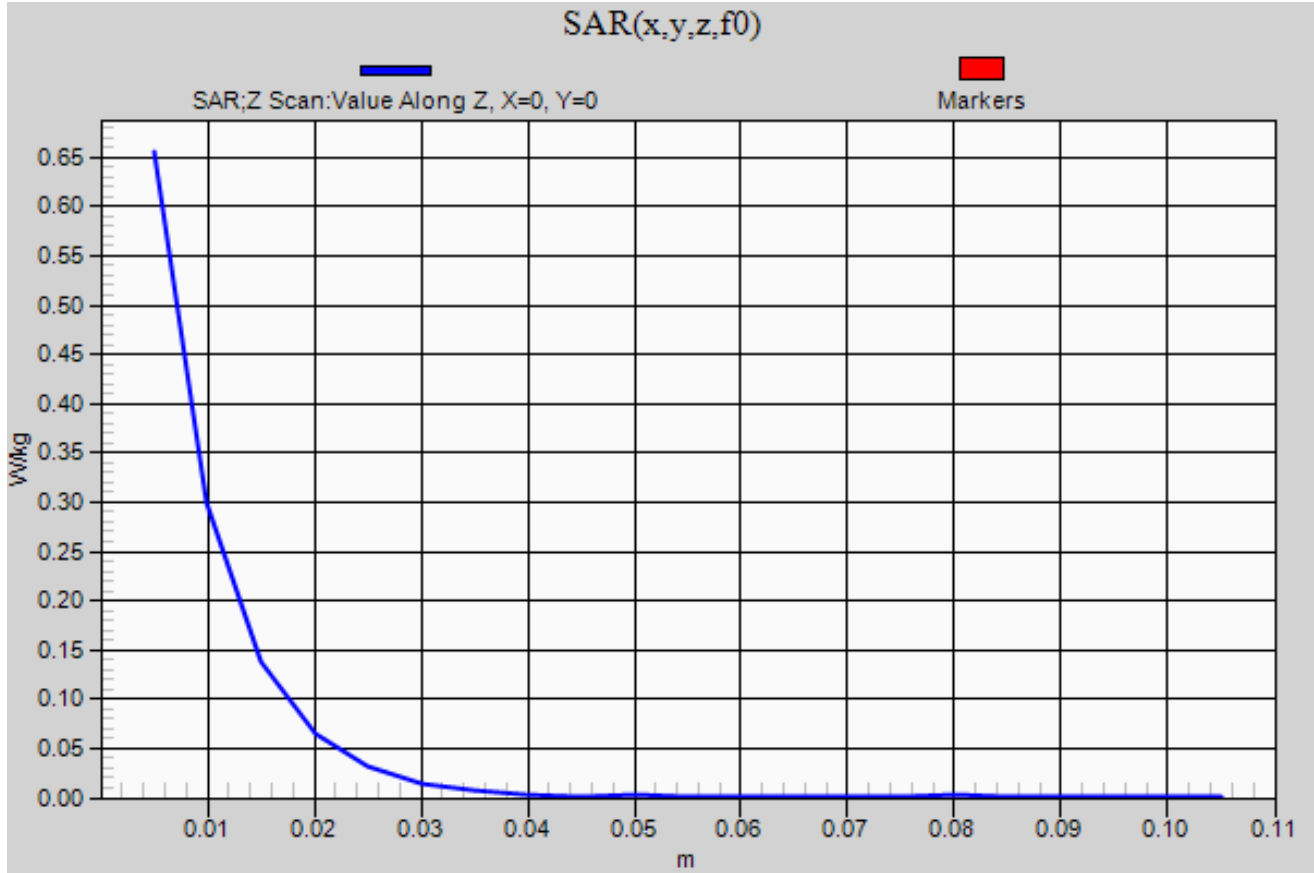
**Approved By**



## Test 2



## Test 2 – Z Scan

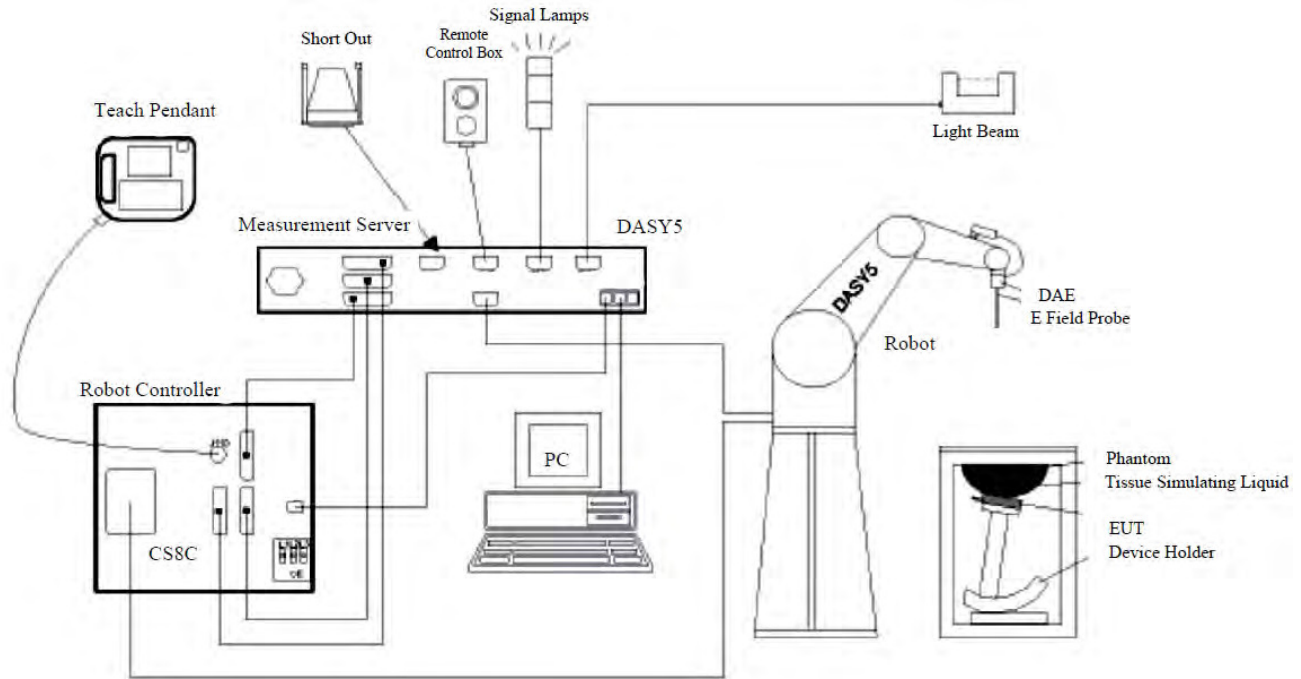


## SAR MEASUREMENT SYSTEM

### 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:



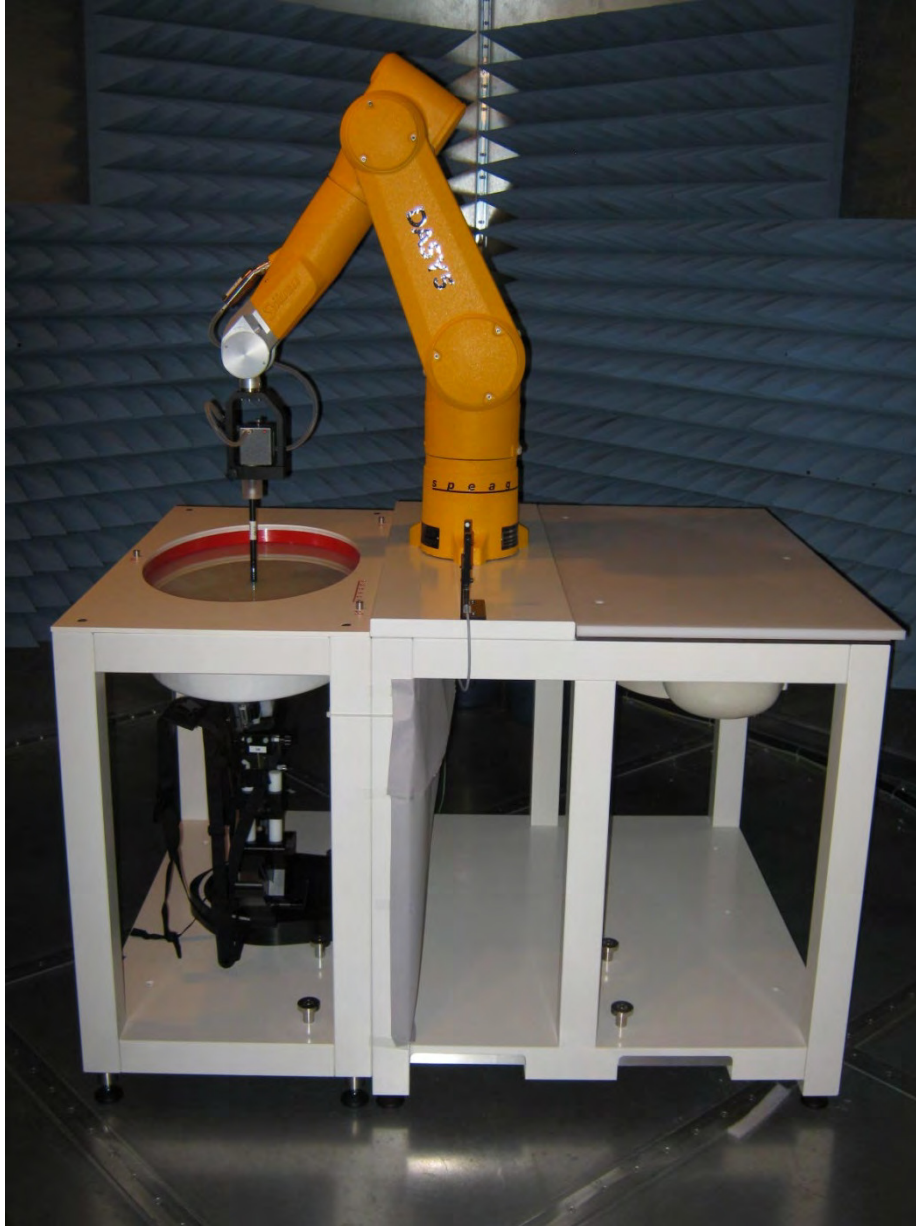
- A standard high precision 6-axis robot (Staubli TX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) 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

| Description   | Manufacturer    | Model         | ID  | Last Cal.           | Interval |
|---|-----------------|---------------|-----|---------------------|----------|
| Amplifier   | Mini Circuits   | ZVE-3W-83+    | TTA | NCR <sup>1</sup>    | 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 <sup>1</sup>    | 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) (+/-%) | $v_i$    |
| <b>Measurement System</b>  |                   |                          |         |            |             |                   |                    |          |
| Probe calibration (k=1)  | 5.5               | normal                   | 1       | 1          | 1           | 5.5               | 5.5                | $\infty$ |
| Axial isotropy   | 4.7               | rectangular              | 1.732   | 0.707      | 0.707       | 1.9               | 1.9                | $\infty$ |
| Hemispherical isotropy   | 9.6               | rectangular              | 1.732   | 0.707      | 0.707       | 3.9               | 3.9                | $\infty$ |
| Boundary effect  | 1.0               | rectangular              | 1.732   | 1          | 1           | 0.6               | 0.6                | $\infty$ |
| Linearity  | 4.7               | rectangular              | 1.732   | 1          | 1           | 2.7               | 2.7                | $\infty$ |
| System detection limits  | 1.0               | rectangular              | 1.732   | 1          | 1           | 0.6               | 0.6                | $\infty$ |
| Readout electronics  | 0.3               | normal                   | 1       | 1          | 1           | 0.3               | 0.3                | $\infty$ |
| Response time  | 0.8               | rectangular              | 1.732   | 1          | 1           | 0.5               | 0.5                | $\infty$ |
| Integration time   | 2.6               | rectangular              | 1.732   | 1          | 1           | 1.5               | 1.5                | $\infty$ |
| RF ambient conditions - noise  | 1.7               | rectangular              | 1.732   | 1          | 1           | 1.0               | 1.0                | $\infty$ |
| RF Ambient Reflections   | 0.0               | rectangular              | 1.732   | 1          | 1           | 0.0               | 0.0                | $\infty$ |
| Probe positioner mechanical tolerance  | 0.4               | rectangular              | 1.732   | 1          | 1           | 0.2               | 0.2                | $\infty$ |
| Probe positioner with respect to phantom shell                                   | 2.9               | rectangular              | 1.732   | 1          | 1           | 1.7               | 1.7                | $\infty$ |
| Extrapolation, interpolation, and integration algorithms for max. SAR evaluation | 1.0               | rectangular              | 1.732   | 1          | 1           | 0.6               | 0.6                | $\infty$ |
| <b>Test Sample Related</b>   |                   |                          |         |            |             |                   |                    |          |
| 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                | $\infty$ |
| <b>Phantom and tissue parameters</b>   |                   |                          |         |            |             |                   |                    |          |
| Phantom Uncertainty - shell thickness tolerances                                 | 4.0               | rectangular              | 1.732   | 1          | 1           | 2.3               | 2.3                | $\infty$ |
| Liquid conductivity - deviation from target values                               | 5.0               | rectangular              | 1.732   | 0.64       | 0.43        | 1.8               | 1.2                | $\infty$ |
| Liquid conductivity - measurement uncertainty                                    | 6.5               | normal                   | 1       | 0.64       | 0.43        | 4.2               | 2.8                | $\infty$ |
| Liquid permittivity - deviation from target values                               | 5.0               | rectangular              | 1.732   | 0.6        | 0.49        | 1.7               | 1.4                | $\infty$ |
| Liquid permittivity - measurement uncertainty                                    | 3.2               | normal                   | 1       | 0.6        | 0.49        | 1.9               | 1.6                | $\infty$ |
| Combined Standard Uncertainty  | RSS               |                          |         |            |             | 11.2              | 10.6               | 387      |
| Expanded Measurement Uncertainty (95% Confidence/                                | normal (k=2)      |                          |         |            |             | 22.5              | 21.2               |          |

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**Probe Calibration**

Please see attached calibration data.

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**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 |

|                |                                |  |               |
|----------------|--------------------------------|--|---------------|
| Calibrated by: | Name<br><b>Claudio Leubler</b> | Function<br><b>Laboratory Technician</b> | Signature<br> |
| Approved by:   | Name<br><b>Katja Pokovic</b>   | Function<br><b>Technical Manager</b>     |               |

Issued: November 16, 2013

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





Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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Multilateral Agreement for the recognition of calibration certificates

### Glossary:

|                          |   |
|--------------------------|---|
| TSL                      | tissue simulating liquid  |
| NORM <sub>x,y,z</sub>    | sensitivity in free space   |
| ConvF                    | sensitivity in TSL / NORM <sub>x,y,z</sub>  |
| DCP                      | diode compression point   |
| CF                       | crest factor (1/duty_cycle) of the RF signal  |
| A, B, C, D               | modulation dependent linearization parameters   |
| Polarization $\varphi$   | $\varphi$ rotation around probe axis  |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center),<br>i.e., $\vartheta = 0$ 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:

- 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
- 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:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below *ConvF*).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* *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*.
- DCP<sub>x,y,z</sub>**: 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
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>; 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  $f \leq 800$  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 NORM<sub>x,y,z</sub> \* *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  $\pm 50$  MHz to  $\pm 100$  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 NORM<sub>x</sub> (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 ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 0.49     | 0.47     | 0.50     | ± 10.1 %  |
| DCP (mV) <sup>B</sup>                                     | 95.1     | 96.8     | 99.8     |           |

## Modulation Calibration Parameters

| UID           | Communication System Name                      |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C    | D<br>dB | VR<br>mV | Unc <sup>E</sup><br>(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-<br>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-<br>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-<br>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%.

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> 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) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (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 %    |

<sup>C</sup> 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.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) 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 ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> 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

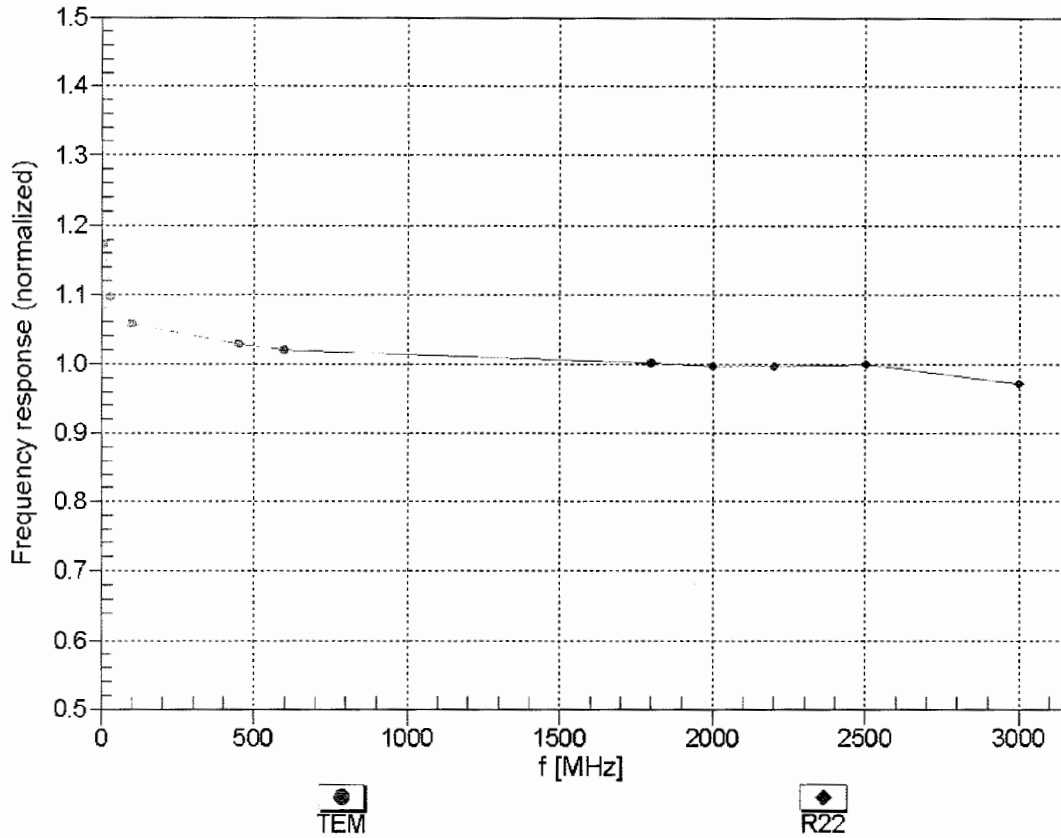
| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 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 %    |

<sup>C</sup> 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.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) 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 ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> 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.

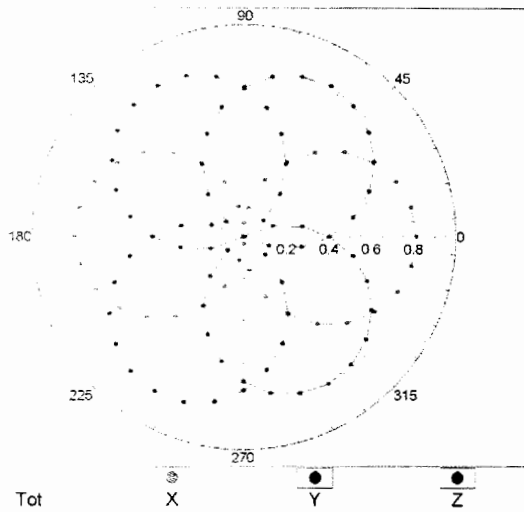
# Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



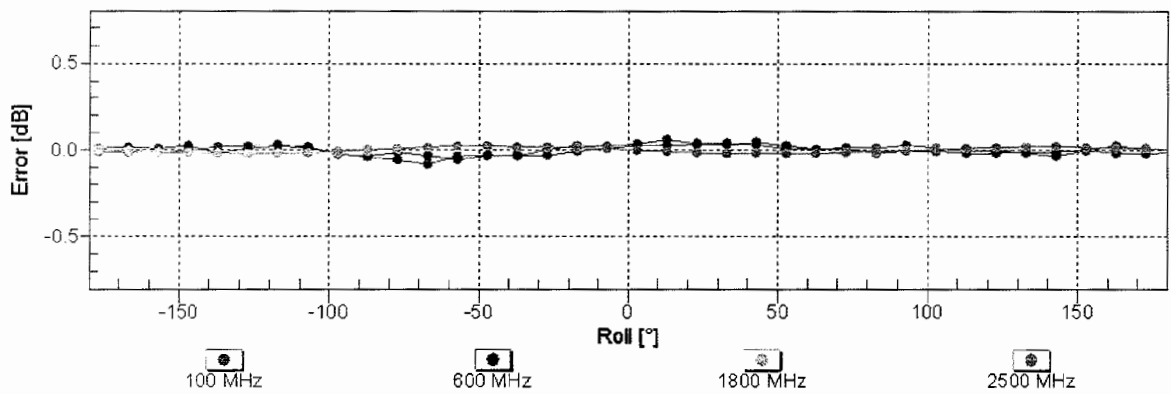
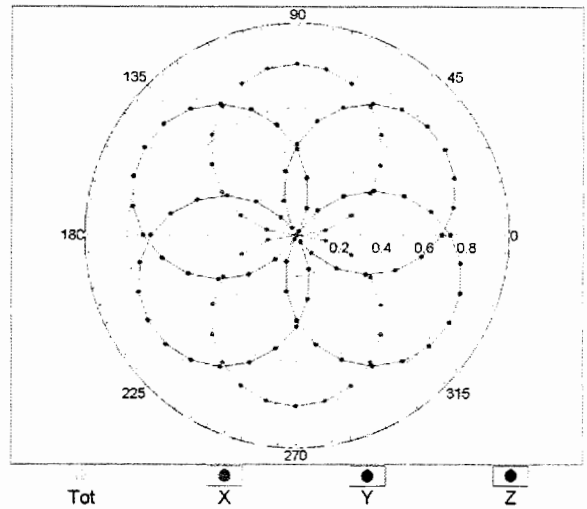
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

# Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$

f=600 MHz,TEM

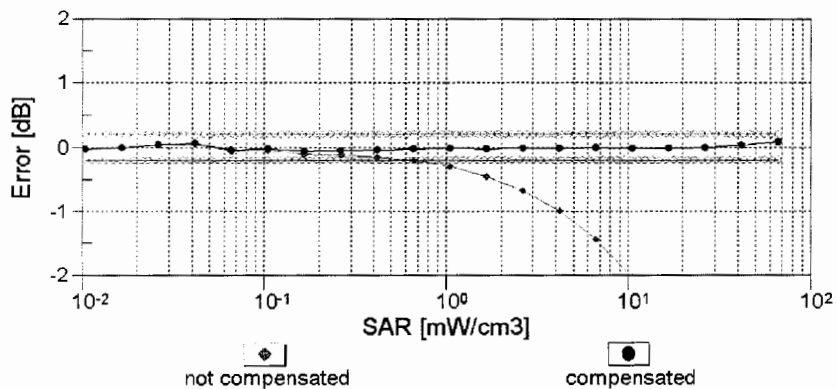
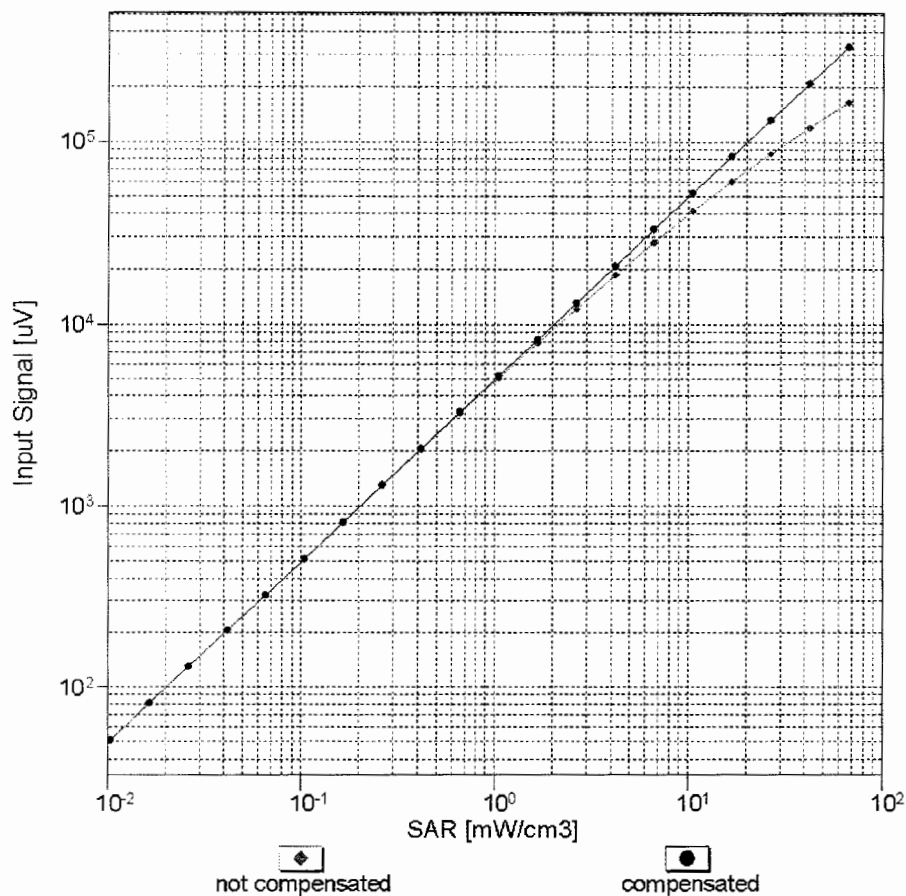


f=1800 MHz,R22



**Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)**

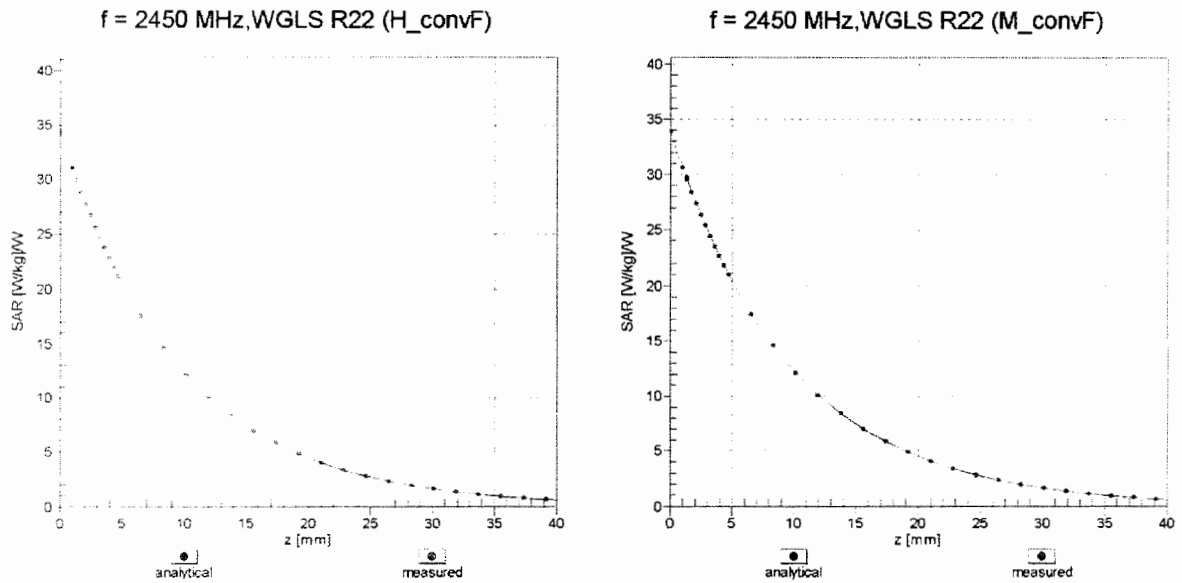
## Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f = 900 \text{ MHz}$ )



**Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )**

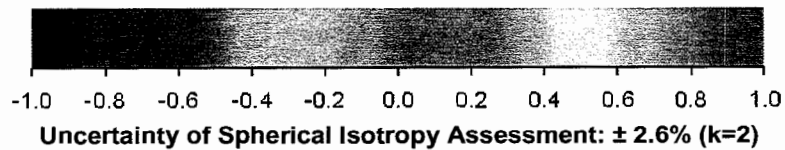
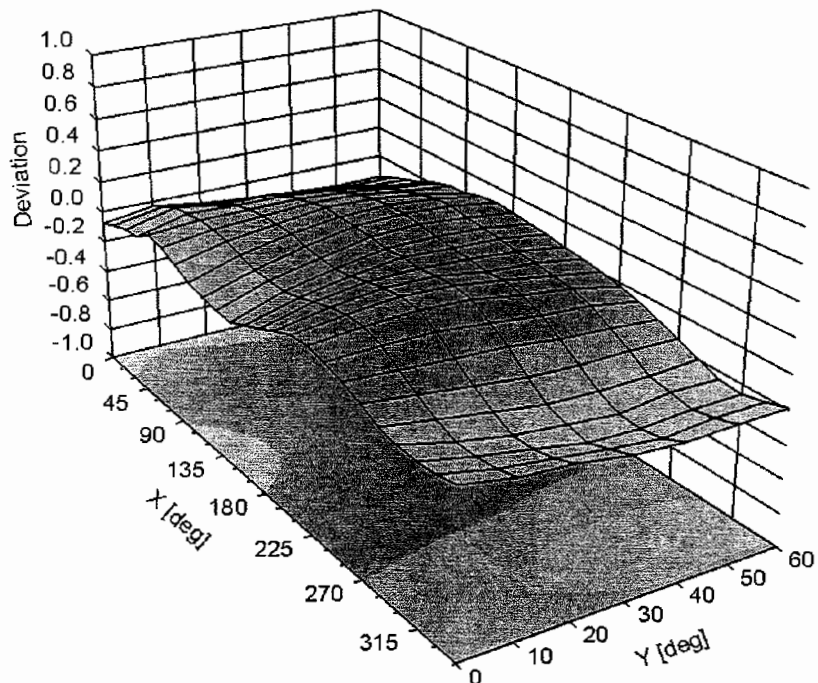


# Conversion Factor Assessment



## Deviation from Isotropy in Liquid

Error ( $\phi, \vartheta$ ), f = 900 MHz



## 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



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  $\Omega$  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<br><b>EMC</b>  |                    |                          |  |                |                        |                  | Calibration Certificate & Report  |  |                  |           | 03/27/03dmt                   |  |  |  |
|--|--------------------|--------------------------|--|----------------|------------------------|------------------|---|--|------------------|-----------|-------------------------------|--|--|--|
| 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   |                    |                          |  |                |                        |                  |   |  |                  |           |                               |  |  |  |
| <p>This measurement was a calibration verification. (Instrument parameters are within tolerances.)</p> |                    |                          |  |                |                        |                  |   |  |                  |           |                               |  |  |  |
|                     |                    |                          |  |                |                        |                  |  |  |                  |           |                               |  |  |  |
| Approved By  |                    |                          |  |                |                        |                  | Tested By   |  |                  |           |                               |  |  |  |
| CALIBRATION DATA ATTACHED  |                    |                          |  |                |                        |                  |   |  |                  |           |                               |  |  |  |

Verification Data

**EUT** Dipole Antenna  
Model SAR2450  
S/N ADL  
Manufacturer SPEAG  
Date 111413  
  
Temperature 23C  
Humidity 40%  
  
Operator Varuzhan Kocharyan

**Antenna Parameters with Head TSL**  
Impedance 50.26 +j5.77 49.71+6.52  
Return Loss -28.7 dB

**Antenna Parameters with Body TSL**  
Impedance, Ohms 49.82+j2.87  
Return Loss, dB -27.5 dB

# 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  
**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**

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 |

|                |                    |                              |                  |
|----------------|--------------------|------------------------------|------------------|
|                | <b>Name</b>        | <b>Function</b>              | <b>Signature</b> |
| Calibrated by: | <b>Dimce Iliev</b> | <b>Laboratory Technician</b> |                  |

|              |                      |                          |                  |
|--------------|----------------------|--------------------------|------------------|
|              | <b>Name</b>          | <b>Function</b>          | <b>Signature</b> |
| Approved by: | <b>Katja Pokovic</b> | <b>Technical Manager</b> |                  |

Issued: December 9, 2011  
47/54



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:

- 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
- 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
- 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:

- 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.

|                                     |                        |             |
|-------------------------------------|------------------------|-------------|
| <b>DASY Version</b>                 | DASY5                  | V52.8.0     |
| <b>Extrapolation</b>                | Advanced Extrapolation |             |
| <b>Phantom</b>                      | Modular Flat Phantom   |             |
| <b>Distance Dipole Center - TSL</b> | 10 mm                  | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm      |             |
| <b>Frequency</b>                    | 2450 MHz $\pm$ 1 MHz   |             |

## Head TSL parameters

The following parameters and calculations were applied.

|  | Temperature         | Permittivity   | Conductivity         |
|--|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 39.2           | 1.80 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 39.5 $\pm$ 6 % | 1.87 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | < 0.5 °C            | ---            | ---                  |

## SAR result with Head TSL

| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 13.7 mW / g                                      |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>53.9 mW / g <math>\pm</math> 17.0 % (k=2)</b> |

| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 6.38 mW / g                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>25.3 mW / g <math>\pm</math> 16.5 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

|  | Temperature         | Permittivity   | Conductivity         |
|--|---------------------|----------------|----------------------|
| <b>Nominal Body TSL parameters</b>             | 22.0 °C             | 52.7           | 1.95 mho/m           |
| <b>Measured Body TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 50.7 $\pm$ 6 % | 2.04 mho/m $\pm$ 6 % |
| <b>Body TSL temperature change during test</b> | < 0.5 °C            | ---            | ---                  |

## SAR result with Body TSL

| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 13.0 mW / g                                      |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>50.4 mW / g <math>\pm</math> 17.0 % (k=2)</b> |

| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 6.02 mW / g                                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>23.7 mW / g <math>\pm</math> 16.5 % (k=2)</b> |

## Appendix

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.9 $\Omega$ + 4.5 j $\Omega$ |
| Return Loss                          | - 25.7 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.4 $\Omega$ + 5.3 j $\Omega$ |
| 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;  $\sigma = 1.87$  mho/m;  $\epsilon_r = 39.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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:

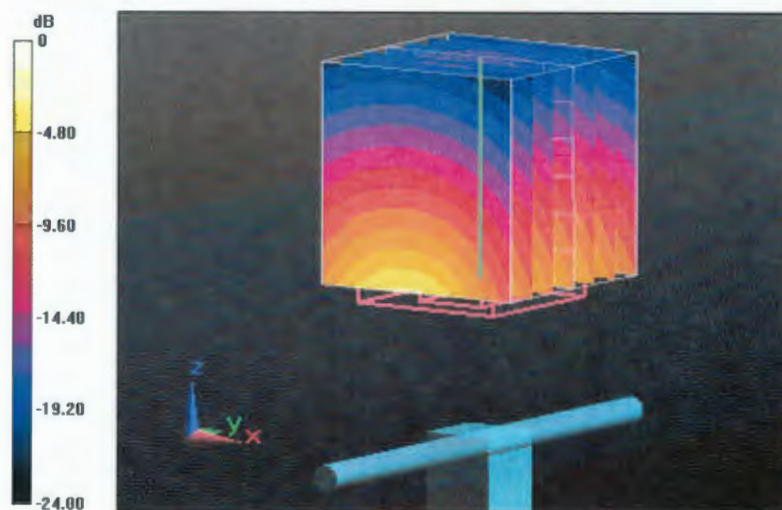
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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



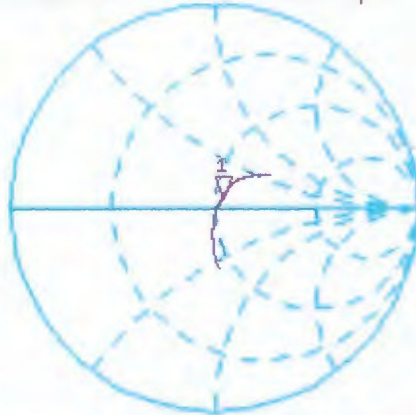
0 dB = 17.680mW/g = 24.95 dB mW/g

# Impedance Measurement Plot for Head TSL

9 Dec 2011 13:32:30

CH1 S11 1 U FS 1: 52.912  $\Omega$  4.5527  $\Omega$  295.75  $\mu$ H 2 450.000 000 MHz

\*  
Del  
Cor



Avg  
16

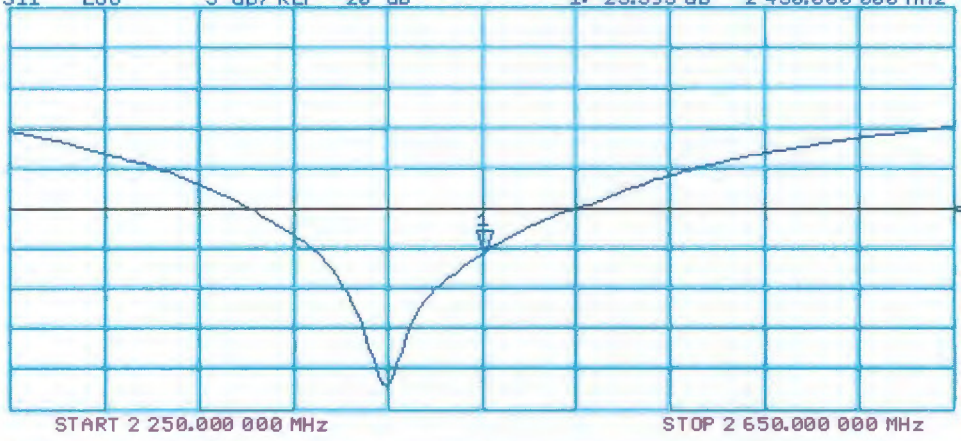
↑

CH2 S11 LOG 5 dB/REF -20 dB 1:-25.595 dB 2 450.000 000 MHz

Cor

Avg  
16

↑



# 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;  $\sigma = 2.04$  mho/m;  $\epsilon_r = 50.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

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:

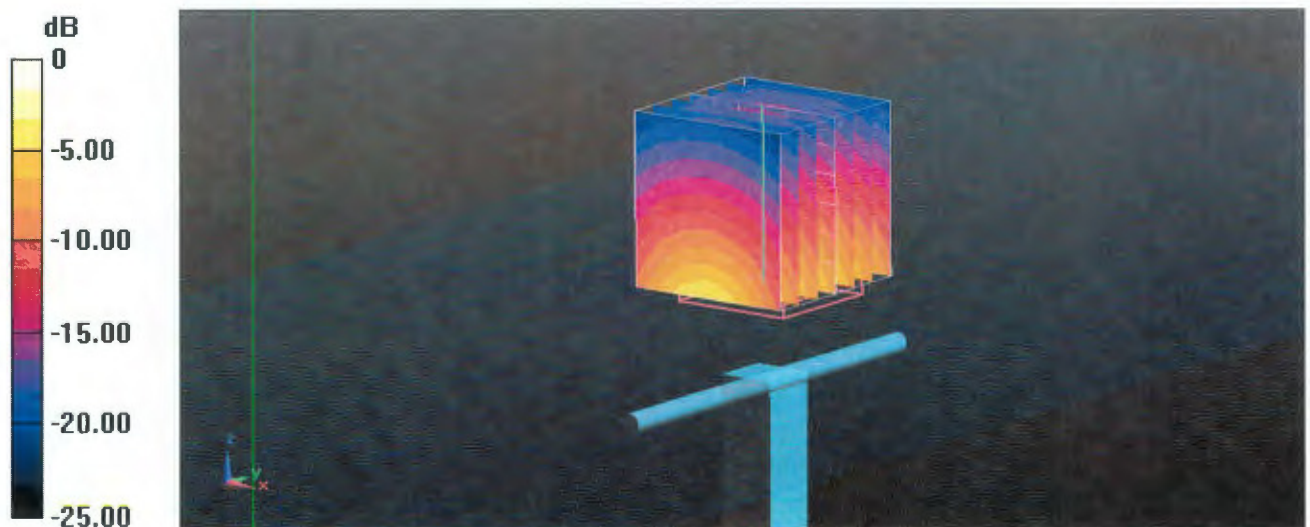
Measurement grid: dx=5mm, dy=5mm, dz=5mm

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



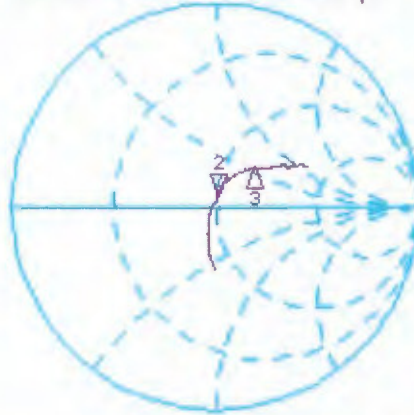
0 dB = 17.190mW/g = 24.71 dB mW/g

# Impedance Measurement Plot for Body TSL

8 Dec 2011 11:09:43

CH1 S11 1 U FS 2: 50.367  $\Omega$  5.3594  $\Omega$  348.12 pF 2 450.220 000 MHz

\*  
De1  
CA

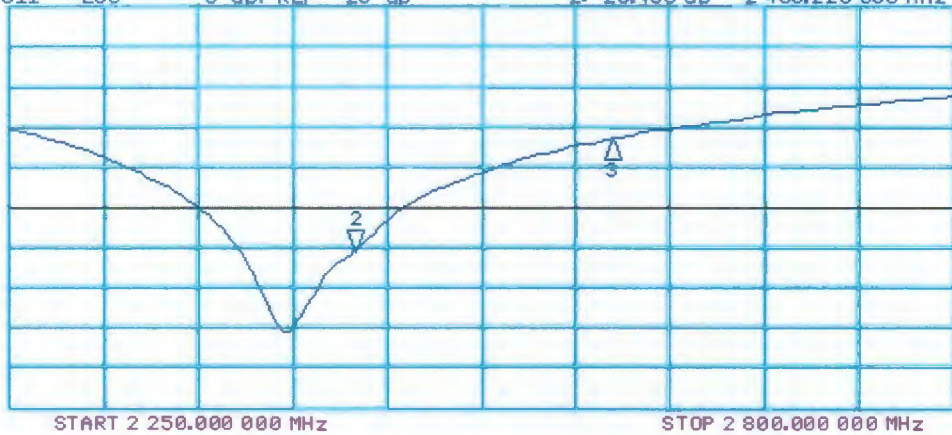


CH1 Markers  
1: 65.660  $\Omega$   
2: 27.344  $\Omega$   
3: 2.60000 GHz

H1d

CH2 S11 LOG 5 dB/REF -20 dB 2: -25.455 dB 2 450.220 000 MHz

CA  
Avg  
16  
H1d



CH2 Markers  
1: -11.515 dB  
2: 2.60000 GHz