



FCC SAR Test Report

Report No. : SA130301C21
Applicant : Senao Networks, Inc.
Address : 3F., No. 529, Chung Cheng Rd., Hsintien, New Taipei City, R.O.C
Product : Long Range Cordless Handset
FCC ID : U2M-SP922FH
Brand : EnGenius
Model No. : SP922FH
Standards : FCC 47 CFR Part 2 (2.1093) / IEEE C95.1:1991 / IEEE 1528:2003
FCC OET Bulletin 65 Supplement C (Edition 01-01)
KDB 447498 D01 v05 / KDB 648474 D04 v01
Date of Testing : Mar. 18, 2013 ~ Apr. 26, 2013

CERTIFICATION: The above equipment have been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch - Taiwan HwaYa Lab**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by TAF or any government agencies.

Prepared By : Evonne Liu
Evonne Liu / Specialist

Approved By : Roy Wu
Roy Wu / Manager



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Release Control Record

| Issue No. | Reason for Change | Date Issued |
|-----------|-------------------|---------------|
| R01 | Initial release | Apr. 26, 2013 |
| | | |
| | | |



1. Summary of Maximum SAR Value

| Equipment Class | Mode | Highest Reported Head SAR _{1g} (W/kg) | Highest Reported Body-Worn SAR _{1g} (1.5 cm Gap) (W/kg) |
|-----------------|--------------------------------------|--|--|
| PCE | Differentially Encoded MSK for ANT-1 | 0.25 | 0.54 |
| | Differentially Encoded MSK for ANT-2 | 0.37 | 0.27 |

Note:

1. The SAR limit (**Head & Body: SAR_{1g} 1.6 W/kg**) for general population / uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1991.



2. Description of Equipment Under Test

| | |
|---|-----------------------------|
| EUT Type | Long Range Cordless Handset |
| FCC ID | U2M-SP922FH |
| Brand Name | EnGenius |
| Model Name | SP922FH |
| Tx Frequency Bands (Unit: MHz) | 902.4 ~ 927.5 |
| Uplink Modulations | MSK |
| Maximum Tune-up Conducted Power (Unit: dBm) | 29.0 |
| Antenna Type | Fixed External Antenna |
| EUT Stage | Identical Prototype |

Note:

1. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

List of Accessory:

| | | |
|---------|--------------|-----------------|
| Battery | Brand Name | EnGenius |
| | Model Name | NA |
| | Power Rating | 3.7Vdc, 1100mAh |
| | Type | Li-ion |

3. SAR Measurement System

3.1 Definition of Specific Absorption Rate (SAR)

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

$$\text{SAR} = \frac{d}{dt} \left(\frac{dW}{dm} \right) = \frac{d}{dt} \left(\frac{dW}{\rho dv} \right)$$

SAR is expressed in units of Watts per kilogram (W/kg)

SAR measurement can be related to the electrical field in the tissue by

$$\text{SAR} = \frac{\sigma |E|^2}{\rho}$$

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

3.2 SPEAG DASY System

DASY system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY4/5 software defined. The DASY software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC.

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Fig-3.1 DASY System Setup

3.2.1 Robot

The DASY system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY4: CS7MB; DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ± 0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)



Fig-3.2 DASY4





Fig-3.3 DASY5

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3.2.2 Probes

The SAR measurement is conducted with the dosimetric probe. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.

| | | |
|----------------------|--|---|
| Model | EX3DV4 |  |
| Construction | Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE). | |
| Frequency | 10 MHz to 6 GHz Linearity: ± 0.2 dB | |
| Directivity | ± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis) | |
| Dynamic Range | 10 μ W/g to 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 μ W/g) | |
| Dimensions | Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm | |


| | | |
|----------------------|---|--|
| Model | ES3DV3 |  |
| Construction | Symmetrical design with triangular core. Interleaved sensors. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE). | |
| Frequency | 10 MHz to 4 GHz Linearity: ± 0.2 dB | |
| Directivity | ± 0.2 dB in HSL (rotation around probe axis) ± 0.3 dB in tissue material (rotation normal to probe axis) | |
| Dynamic Range | 5 μ W/g to 100 mW/g Linearity: ± 0.2 dB | |
| Dimensions | Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm | |


3.2.3 Data Acquisition Electronics (DAE)

| | | |
|-----------------------------|--|---|
| Model | DAE3, DAE4 |  |
| Construction | Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY4/5 embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop. | |
| Measurement Range | -100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV) | |
| Input Offset Voltage | < 5 μ V (with auto zero) | |
| Input Bias Current | < 50 fA | |
| Dimensions | 60 x 60 x 68 mm | |

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3.2.4 Phantoms


| | | |
|------------------------|---|---|
| Model | Twin SAM |  |
| Construction | The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot. | |
| Material | Vinylester, glass fiber reinforced (VE-GF) | |
| Shell Thickness | 2 ± 0.2 mm (6 ± 0.2 mm at ear point) | |
| Dimensions | Length: 1000 mm Width: 500 mm Height: adjustable feet | |
| Filling Volume | approx. 25 liters | |

| | | |
|------------------------|---|--|
| Model | ELI |  |
| Construction | Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles. | |
| Material | Vinylester, glass fiber reinforced (VE-GF) | |
| Shell Thickness | 2.0 ± 0.2 mm (bottom plate) | |
| Dimensions | Major axis: 600 mm Minor axis: 400 mm | |
| Filling Volume | approx. 30 liters | |


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3.2.5 Device Holder

| | | |
|---------------------|---|---|
| Model | Mounting Device |  |
| Construction | In combination with the Twin SAM Phantom or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). | |
| Material | POM | |

| | | |
|---------------------|---|---|
| Model | Laptop Extensions Kit |  |
| Construction | Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. | |
| Material | POM, Acrylic glass, Foam | |

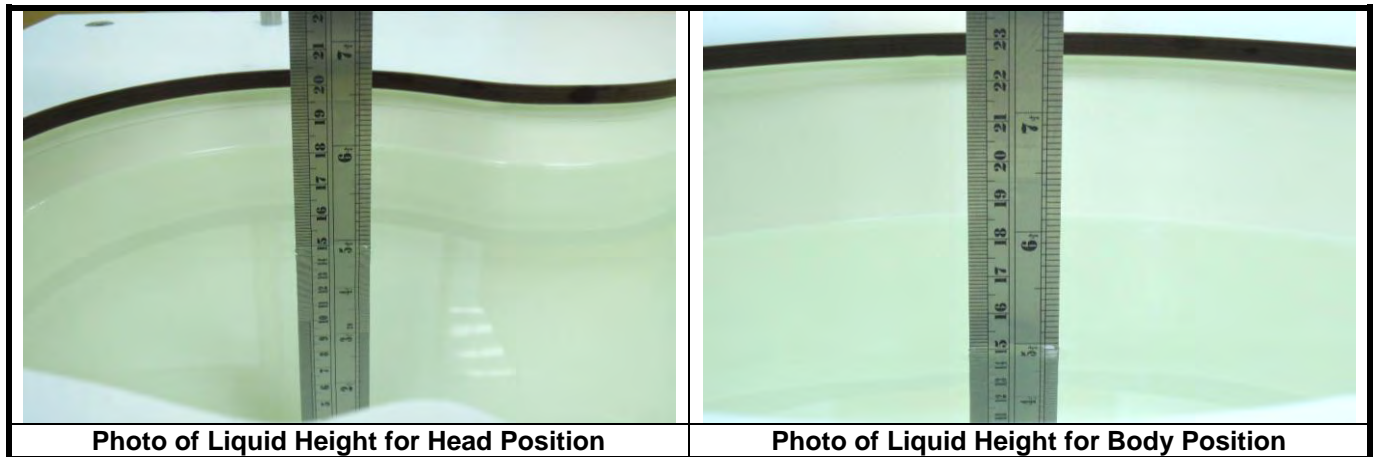
3.2.6 System Validation Dipoles

| | | |
|-------------------------|--|---|
| Model | D-Serial |  |
| Construction | Symmetrical dipole with 1/4 balun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions. | |
| Frequency | 750 MHz to 5800 MHz | |
| Return Loss | > 20 dB | |
| Power Capability | > 100 W (f < 1GHz), > 40 W (f > 1GHz) | |

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3.2.7 Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in Table-3.1.



The dielectric properties of the head tissue simulating liquids are defined in IEEE 1528 and FCC OET 65 Supplement C Appendix C. For the body tissue simulating liquids, the dielectric properties are defined in FCC OET 65 Supplement C Appendix C. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using an Agilent 85070D Dielectric Probe Kit and an Agilent Network Analyzer.

Table-3.1 Targets of Tissue Simulating Liquid

| Frequency (MHz) | Target Permittivity | Range of $\pm 5\%$ | Target Conductivity | Range of $\pm 5\%$ |
|-----------------|---------------------|--------------------|---------------------|--------------------|
| For Head | | | | |
| 900 | 41.5 | 39.4 ~ 43.6 | 0.97 | 0.92 ~ 1.02 |
| For Body | | | | |
| 900 | 55.0 | 52.3 ~ 57.8 | 1.05 | 1.00 ~ 1.10 |

The following table gives the recipes for tissue simulating liquids.

Table-3.2 Recipes of Tissue Simulating Liquid

| Tissue Type | Bactericide | DGBE | HEC | NaCl | Sucrose | Triton X-100 | Water | Diethylene Glycol Mono-hexylether |
|-------------|-------------|------|-----|------|---------|--------------|-------|-----------------------------------|
| H900 | 0.2 | - | 0.2 | 1.4 | 58.0 | - | 40.2 | - |
| B900 | 0.2 | - | 0.2 | 0.9 | 48.2 | - | 50.5 | - |

3.3 SAR System Verification

The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.

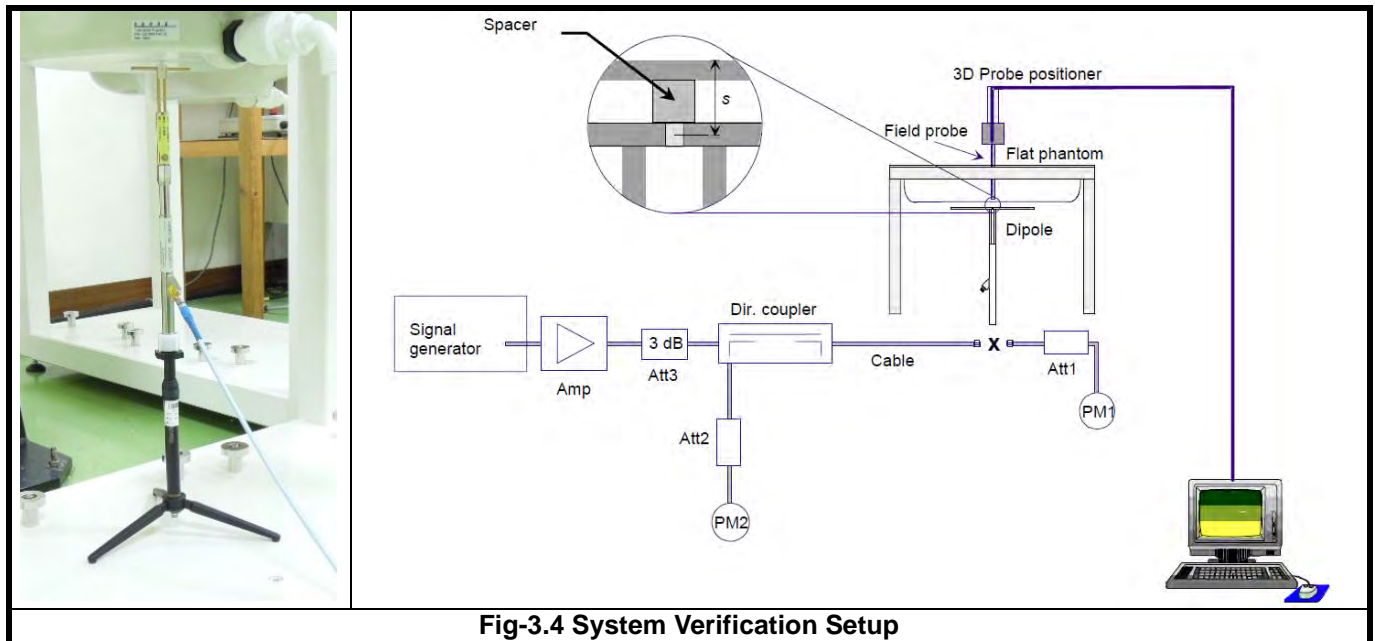


Fig-3.4 System Verification Setup

The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The power meter PM1 measures the forward power at the location of the system check dipole connector. The signal generator is adjusted for the desired forward power (250 mW is used for 700 MHz to 3 GHz, 100 mW is used for 3.5 GHz to 6 GHz) at the dipole connector and the power meter PM2 is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter PM2.

After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.

3.4 SAR Measurement Procedure

According to the SAR test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

- (a) Power reference measurement
- (b) Area scan
- (c) Zoom scan
- (d) Power drift measurement

The SAR measurement procedures for each of test conditions are as follows:

- (a) Make EUT to transmit maximum output power
- (b) Measure conducted output power through RF cable
- (c) Place the EUT in the specific position of phantom
- (d) Perform SAR testing steps on the DASY system
- (e) Record the SAR value

3.4.1 Area & Zoom Scan Procedure

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. According to KDB 865664D01v01, the resolution for Area and Zoom scan is specified in the table below.

| Items | <= 2 GHz | 2-3 GHz | 3-4 GHz | 4-5 GHz | 5-6 GHz |
|---------------------------------------|--------------------|----------------|----------------|----------------|----------------|
| Area Scan ($\Delta x, \Delta y$) | <= 15 mm | <= 12 mm | <= 12 mm | <= 10 mm | <= 10 mm |
| Zoom Scan ($\Delta x, \Delta y$) | <= 8 mm | <= 5 mm | <= 5 mm | <= 4 mm | <= 4 mm |
| Zoom Scan (Δz) | <= 5 mm | <= 5 mm | <= 4 mm | <= 3 mm | <= 2 mm |
| Zoom Scan Volume | >= 30 mm | >= 30 mm | >= 28 mm | >= 25 mm | >= 22 mm |

Note:

When zoom scan is required and report SAR is <= 1.4 W/kg, the zoom scan resolution of $\Delta x / \Delta y$ (2-3GHz: <= 8 mm, 3-4GHz: <= 7 mm, 4-6GHz: <= 5 mm) may be applied.

3.4.2 Volume Scan Procedure

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

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3.4.3 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drift more than 5%, the SAR will be retested.

3.4.4 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

- (a) Extraction of the measured data (grid and values) from the Zoom Scan
- (b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
- (c) Generation of a high-resolution mesh within the measured volume
- (d) Interpolation of all measured values from the measurement grid to the high-resolution grid
- (e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
- (f) Calculation of the averaged SAR within masses of 1g and 10g

3.4.5 SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

4. SAR Measurement Evaluation

4.1 EUT Configuration and Setting

For SAR testing, the EUT has installed engineering testing software which can provide continuous transmitting RF signal. Since the worst duty cycle for this device is 13.3 %, the duty factor for SAR testing is set to 7.52. The setup steps for engineering mode are as below.

1. Turn the EUT power on
2. Press "Menu" key
3. Keyin **#, 00, 2, 12
4. Set the specific channel
5. RF single is transmitting

4.2 EUT Testing Position

According to KDB 648474 D04v01, handsets are tested for SAR compliance in head, body-worn accessory described in the following subsections.

4.2.1 Head Exposure Conditions

Head exposure is limited to next to the ear voice mode operations. Head SAR compliance is tested according to the test positions defined in IEEE Std 1528-2003 using the SAM phantom illustrated as below.

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1. Define two imaginary lines on the handset
 - (a) The vertical centerline passes through two points on the front side of the handset - the midpoint of the width w_t of the handset at the level of the acoustic output, and the midpoint of the width w_b of the bottom of the handset.
 - (b) The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output. The horizontal line is also tangential to the face of the handset at point A.
 - (c) The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output; however, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset, especially for clamshell handsets, handsets with flip covers, and other irregularly shaped handsets.

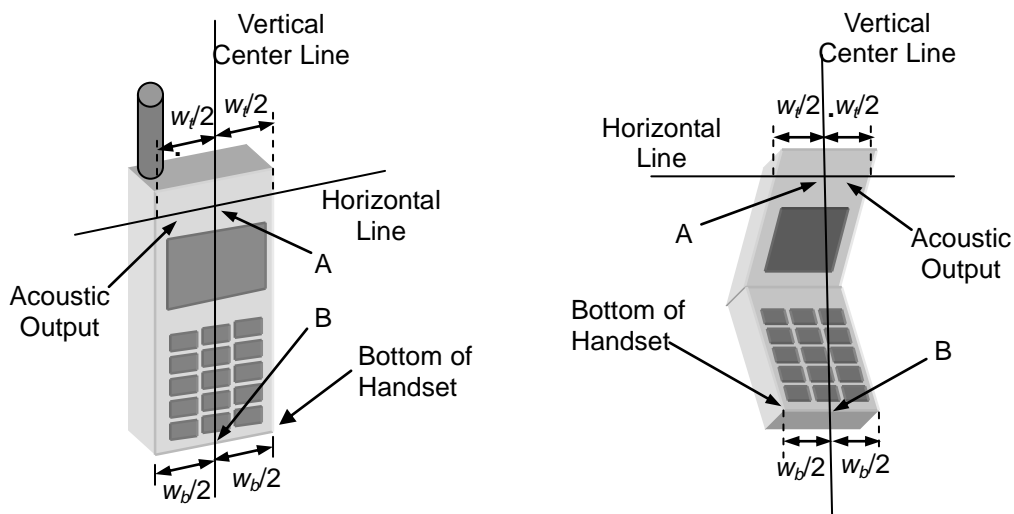


Fig-4.1 Illustration for Handset Vertical and Horizontal Reference Lines

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2. Cheek Position

- (a) To position the device with the vertical center line of the body of the device and the horizontal line crossing the center piece in a plane parallel to the sagittal plane of the phantom. While maintaining the device in this plane, align the vertical center line with the reference plane containing the three ear and mouth reference point (M: Mouth, RE: Right Ear, and LE: Left Ear) and align the center of the ear piece with the line RE-LE.
- (b) To move the device towards the phantom with the ear piece aligned with the line LE-RE until the phone touched the ear. While maintaining the device in the reference plane and maintaining the phone contact with the ear, move the bottom of the phone until any point on the front side is in contact with the cheek of the phantom or until contact with the ear is lost (see Fig-4.2).

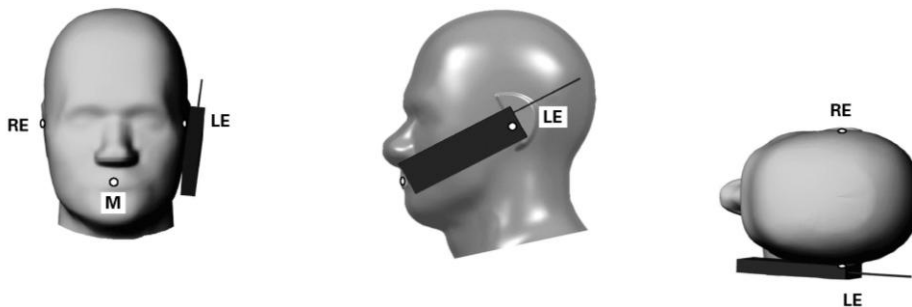


Fig-4.2 Illustration for Cheek Position

3. Tilted Position

- (a) To position the device in the "cheek" position described above.
- (b) While maintaining the device the reference plane described above and pivoting against the ear, moves it outward away from the mouth by an angle of 15 degrees or until contact with the ear is lost (see Fig-4.3).

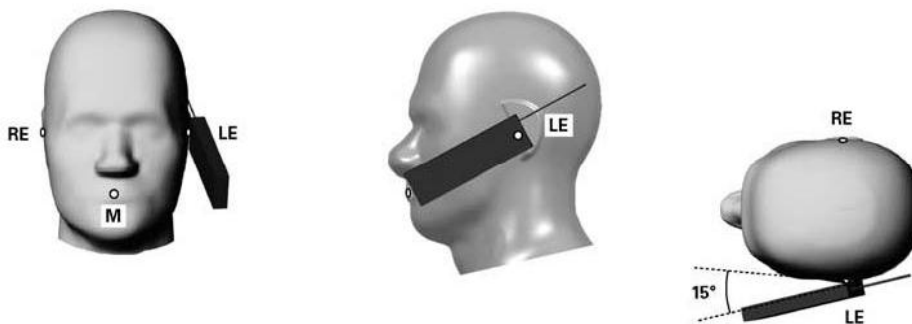


Fig-4.3 Illustration for Tilted Position

4.2.2 Body-Worn Accessory Exposure Conditions

Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in KDB 447498 are used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is $> 1.2 \text{ W/kg}$, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

Body-worn accessories that do not contain metallic or conductive components may be tested according to worst-case exposure configurations, typically according to the smallest test separation distance required for the group of body-worn accessories with similar operating and exposure characteristics. All body-worn accessories containing metallic components are tested in conjunction with the host device.

Body-worn accessory SAR compliance is based on a single minimum test separation distance for all wireless and operating modes applicable to each body-worn accessory used by the host, and according to the relevant voice and/or data mode transmissions and operations. If a body-worn accessory supports voice only operations in its normal and expected use conditions, testing of data mode for body-worn compliance is not required.

A conservative minimum test separation distance for supporting off-the-shelf body-worn accessories that may be acquired by users of consumer handsets is used to test for body-worn accessory SAR compliance. This distance is determined by the handset manufacturer, according to the requirements of Supplement C 01-01. Devices that are designed to operate on the body of users using lanyards and straps, or without requiring additional body-worn accessories, will be tested using a conservative minimum test separation distance $\leq 5 \text{ mm}$ to support compliance.

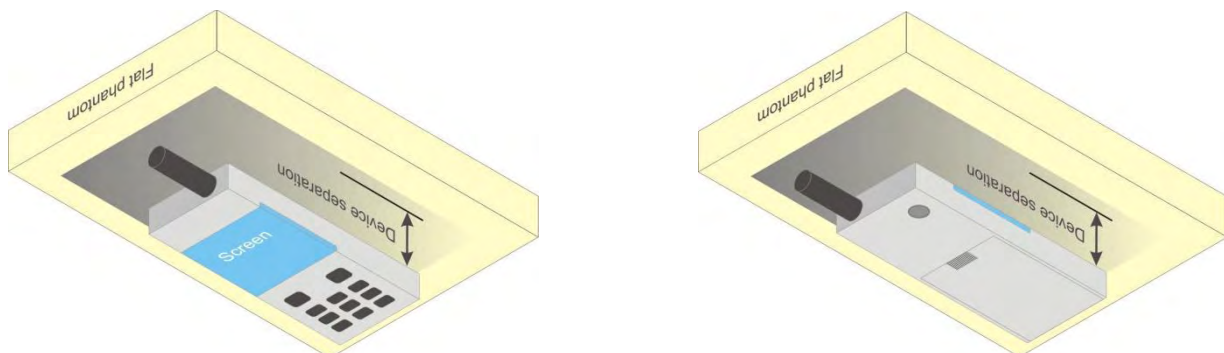


Fig-4.4 Illustration for Body Worn Position

Considering the body SAR setup issue caused by curved rear surface of this device and the length of antenna, we have discussed with FCC through KDB inquiry and positioned the EUT per FCC comment as below.

FCC response on 04/25/2013

Push the device all the way against the phantom (side touching the phantom), then slightly lower the device to 1.5 cm test set up position.

4.3 Tissue Verification

The measuring results for tissue simulating liquid are shown as below.

| Test Date | Tissue Type | Frequency (MHz) | Liquid Temp. (°C) | Measured Conductivity (σ) | Measured Permittivity (ϵ_r) | Target Conductivity (σ) | Target Permittivity (ϵ_r) | Conductivity Deviation (%) | Permittivity Deviation (%) |
|---------------|-------------|-----------------|-------------------|------------------------------------|--|----------------------------------|--------------------------------------|----------------------------|----------------------------|
| Mar. 18, 2013 | Head | 900 | 20.2 | 0.979 | 41.932 | 0.97 | 41.5 | 0.93 | 1.04 |
| Mar. 19, 2013 | Head | 900 | 20.5 | 0.952 | 41.585 | 0.97 | 41.5 | -1.86 | 0.20 |
| Apr. 26, 2013 | Body | 900 | 20.6 | 1.042 | 55.81 | 1.05 | 55.0 | -0.76 | 1.47 |

Note:

The dielectric properties of the tissue simulating liquid must be measured within 24 hours before the SAR testing and within $\pm 5\%$ of the target values. Liquid temperature during the SAR testing must be within $\pm 2^\circ\text{C}$.

4.4 System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01v01. The validation status in tabulated summary is as below.

| Test Date | Probe S/N | Calibration Point | | Measured Conductivity (σ) | Measured Permittivity (ϵ_r) | Validation for CW | | | Validation for Modulation | | |
|---------------|-----------|-------------------|-----|------------------------------------|--|-------------------|-----------------|----------------|---------------------------|-------------|-----|
| | | | | | | Sensitivity Range | Probe Linearity | Probe Isotropy | Modulation Type | Duty Factor | PAR |
| Mar. 18, 2013 | 3801 | Head | 900 | 0.979 | 41.932 | Pass | Pass | Pass | MSK | Pass | N/A |
| Mar. 19, 2013 | 3590 | Head | 900 | 0.952 | 41.585 | Pass | Pass | Pass | MSK | Pass | N/A |
| Apr. 26, 2013 | 3590 | Body | 900 | 1.042 | 55.81 | Pass | Pass | Pass | MSK | Pass | N/A |

4.5 System Verification

The measuring result for system verification is tabulated as below.

| Test Date | Mode | Frequency (MHz) | 1W Target SAR-1g (W/kg) | Measured SAR-1g (W/kg) | Normalized to 1W SAR-1g (W/kg) | Deviation (%) | Dipole S/N | Probe S/N | DAE S/N |
|---------------|------|-----------------|-------------------------|------------------------|--------------------------------|---------------|------------|-----------|---------|
| Mar. 18, 2013 | Head | 900 | 10.80 | 2.54 | 10.24 | -5.19 | 191 | 3801 | 1277 |
| Mar. 19, 2013 | Head | 900 | 10.80 | 2.55 | 10.20 | -5.56 | 191 | 3590 | 910 |
| Apr. 26, 2013 | Body | 900 | 10.70 | 2.72 | 10.88 | 1.68 | 191 | 3590 | 679 |

Note:

Comparing to the reference SAR value provided by SPEAG, the validation data should be within its specification of 10 %. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.

FCC SAR Test Report

4.6 Maximum Output Power

4.6.1 Nominal Conducted Power

The nominal conducted power (Unit: dBm) including tune-up tolerance is shown as below.

| Mode | Maximum Tune-up Power |
|----------------------------|-----------------------|
| Differentially Encoded MSK | 29.0 |

4.6.2 Measured Conducted Power Result

The measuring conducted power (Unit: dBm) is shown as below.

| Channel | 1 | 25 | 50 |
|----------------------------|--------|--------|--------|
| Frequency (MHz) | 902.38 | 914.92 | 927.47 |
| Differentially Encoded MSK | 28.88 | 28.79 | 28.76 |

4.7 SAR Testing Results

4.7.1 SAR Results for Head

| Plot No. | Test Position | Ch. | Antenna | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaled SAR-1g (W/kg) |
|----------|---------------|-----|---------|--------------------------|--------------------------------|----------------|------------------|------------------------|----------------------|
| | Right Cheek | 1 | 1 | 29.0 | 28.88 | 1.03 | -0.07 | 0.095 | 0.10 |
| | Right Tilted | 1 | 1 | 29.0 | 28.88 | 1.03 | -0.03 | 0.176 | 0.18 |
| | Left Cheek | 1 | 1 | 29.0 | 28.88 | 1.03 | -0.12 | 0.091 | 0.09 |
| 01 | Left Tilted | 1 | 1 | 29.0 | 28.88 | 1.03 | 0.07 | 0.243 | 0.25 |
| 02 | Right Cheek | 1 | 2 | 29.0 | 28.88 | 1.03 | -0.11 | 0.357 | 0.37 |
| | Right Tilted | 1 | 2 | 29.0 | 28.88 | 1.03 | 0.16 | 0.324 | 0.33 |
| | Left Cheek | 1 | 2 | 29.0 | 28.88 | 1.03 | -0.18 | 0.323 | 0.33 |
| | Left Tilted | 1 | 2 | 29.0 | 28.88 | 1.03 | 0.04 | 0.351 | 0.36 |

Note:

- SAR is performed on the highest power channel. When the reported SAR value of highest power channel is \leq 0.8 W/kg, SAR testing for optional channel is not required.

4.7.2 SAR Results for Body-Worn (Separation Distance is 1.5 cm)

| Plot No. | Test Position | Ch. | Antenna | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaled SAR-1g (W/kg) |
|----------|---------------|-----|---------|--------------------------|--------------------------------|----------------|------------------|------------------------|----------------------|
| | Front Face | 1 | 1 | 29.0 | 28.88 | 1.03 | 0.04 | 0.21 | 0.22 |
| 03 | Rear Face | 1 | 1 | 29.0 | 28.88 | 1.03 | -0.05 | 0.524 | 0.54 |
| 04 | Front Face | 1 | 2 | 29.0 | 28.88 | 1.03 | -0.07 | 0.266 | 0.27 |
| | Rear Face | 1 | 2 | 29.0 | 28.88 | 1.03 | -0.09 | 0.147 | 0.15 |

Note:

- SAR is performed on the highest power channel. When the reported SAR value of highest power channel is \leq 0.8 W/kg, SAR testing for optional channel is not required.

**4.7.3 SAR Measurement Variability**

According to KDB 865664 D01v01, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are ≤ 1.45 W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is ≤ 1.10 , the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

Since all the measured SAR are less than 0.8 W/kg, the repeated measurement is not required.

Test Engineer : Willy Chang, and Wayne Kang



5. Calibration of Test Equipment

| Equipment | Manufacturer | Model | SN | Cal. Date | Cal. Interval |
|------------------------------|--------------|----------------|------------|---------------|---------------|
| System Validation Kit | SPEAG | D900V2 | 191 | Feb. 15, 2013 | Annual |
| Dosimetric E-Field Probe | SPEAG | EX3DV4 | 3590 | Feb. 20, 2013 | Annual |
| Dosimetric E-Field Probe | SPEAG | EX3DV4 | 3801 | Jun. 22, 2012 | Annual |
| Data Acquisition Electronics | SPEAG | DAE4 | 679 | Jan. 16, 2013 | Annual |
| Data Acquisition Electronics | SPEAG | DAE4 | 910 | Dec. 05, 2012 | Annual |
| Data Acquisition Electronics | SPEAG | DAE4 | 1277 | Jul. 19, 2012 | Annual |
| SAM Phantom | SPEAG | QD000P40CD | TP-1485 | N/A | N/A |
| SAM Phantom | SPEAG | QD000P40CD | TP-1654 | N/A | N/A |
| ELI Phantom | SPEAG | QDOVA001B | TP-1043 | N/A | N/A |
| ENA Series Network Analyzer | Agilent | E5071C | MY46214281 | May 14, 2012 | Annual |
| MXG Analog Signal Generator | Agilent | N5181A | MY50143868 | May 06, 2012 | Annual |
| Power Meter | Anritsu | ML2495A | 1218009 | May 07, 2012 | Annual |
| Power Sensor | Anritsu | MA2411B | 1207252 | May 07, 2012 | Annual |
| EXA Spectrum Analyzer | Agilent | N9010A | MY52100136 | Apr. 23, 2012 | Annual |
| Dielectric Probe Kit | Agilent | 85070D | E2-020018 | May 14, 2012 | Annual |
| Thermometer | YFE | YF-160A | 110600361 | Feb. 20, 2013 | Annual |
| Directional Coupler | Woken | 0110A05602O-10 | 11122702 | Apr. 19, 2012 | Annual |
| Power Amplifier | AR | 5S1G4 | 0339656 | Apr. 23, 2012 | Annual |
| Attenuator | Woken | 00800A1G01L-03 | N/A | Apr. 19, 2012 | Annual |

6. Measurement Uncertainty

| Error Description | Uncertainty Value (±%) | Probability Distribution | Divisor | C _i (1g) | Standard Uncertainty (1g) | V _i |
|--------------------------------------|------------------------|--------------------------|---------|---------------------|---------------------------|----------------|
| Measurement System | | | | | | |
| Probe Calibration | 6.0 | Normal | 1 | 1 | ± 6.0 % | ∞ |
| Axial Isotropy | 4.7 | Rectangular | √3 | 0.7 | ± 1.9 % | ∞ |
| Hemispherical Isotropy | 9.6 | Rectangular | √3 | 0.7 | ± 3.9 % | ∞ |
| Boundary Effects | 1.0 | Rectangular | √3 | 1 | ± 0.6 % | ∞ |
| Linearity | 4.7 | Rectangular | √3 | 1 | ± 2.7 % | ∞ |
| System Detection Limits | 1.0 | Rectangular | √3 | 1 | ± 0.6 % | ∞ |
| Readout Electronics | 0.6 | Normal | 1 | 1 | ± 0.6 % | ∞ |
| Response Time | 0.0 | Rectangular | √3 | 1 | ± 0.0 % | ∞ |
| Integration Time | 1.7 | Rectangular | √3 | 1 | ± 1.0 % | ∞ |
| RF Ambient Noise | 3.0 | Rectangular | √3 | 1 | ± 1.7 % | ∞ |
| RF Ambient Reflections | 3.0 | Rectangular | √3 | 1 | ± 1.7 % | ∞ |
| Probe Positioner | 0.5 | Rectangular | √3 | 1 | ± 0.3 % | ∞ |
| Probe Positioning | 2.9 | Rectangular | √3 | 1 | ± 1.7 % | ∞ |
| Max. SAR Eval. | 2.3 | Rectangular | √3 | 1 | ± 1.3 % | ∞ |
| Test Sample Related | | | | | | |
| Device Positioning | 3.9 | Normal | 1 | 1 | ± 3.9 % | 31 |
| Device Holder | 2.7 | Normal | 1 | 1 | ± 2.7 % | 19 |
| Power Drift | 5.0 | Rectangular | √3 | 1 | ± 2.9 % | ∞ |
| Phantom and Setup | | | | | | |
| Phantom Uncertainty | 4.0 | Rectangular | √3 | 1 | ± 2.3 % | ∞ |
| Liquid Conductivity (Target) | 5.0 | Rectangular | √3 | 0.64 | ± 1.8 % | ∞ |
| Liquid Conductivity (Meas.) | 5.0 | Normal | 1 | 0.64 | ± 3.2 % | 29 |
| Liquid Permittivity (Target) | 5.0 | Rectangular | √3 | 0.6 | ± 1.7 % | ∞ |
| Liquid Permittivity (Meas.) | 5.0 | Normal | 1 | 0.6 | ± 3.0 % | 29 |
| Combined Standard Uncertainty | | | | | ± 11.7 % | |
| Expanded Uncertainty (K=2) | | | | | ± 23.4 % | |

Uncertainty budget for frequency range 300 MHz to 3 GHz



7. Information on the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Taiwan HwaYa EMC/RF/Safety/Telecom Lab:

Add: No. 19, Hwa Ya 2nd Rd, Wen Hwa Vil., Kwei Shan Hsiang, Taoyuan Hsien 333, Taiwan, R.O.C.
Tel: 886-3-318-3232
Fax: 886-3-327-0892

Taiwan LinKo EMC/RF Lab:

Add: No. 47, 14th Ling, Chia Pau Vil., Linkou Dist., New Taipei City 244, Taiwan, R.O.C.
Tel: 886-2-2605-2180
Fax: 886-2-2605-1924

Taiwan HsinChu EMC/RF Lab:

Add: No. 81-1, Lu Liao Keng, 9th Ling, Wu Lung Vil., Chiung Lin Township, Hsinchu County 307, Taiwan, R.O.C.
Tel: 886-3-593-5343
Fax: 886-3-593-5342

Email: service.adt@tw.bureauveritas.com

Web Site: www.adt.com.tw

The road map of all our labs can be found in our web site also.

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Appendix A. SAR Plots of System Verification

The plots for system verification are shown as follows.

System Check_H900_130318

DUT: Dipole 900 MHz; Type: D900V2; SN: 191

Communication System: CW; Frequency: 900 MHz; Duty Cycle: 1:1

Medium: H900_0318 Medium parameters used: $f = 900 \text{ MHz}$; $\sigma = 0.979 \text{ S/m}$; $\epsilon_r = 41.932$; $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature : $21.5 \text{ }^\circ\text{C}$; Liquid Temperature : $20.2 \text{ }^\circ\text{C}$

DASY5 Configuration:

- Probe: EX3DV4 - SN3801; ConvF(8.68, 8.68, 8.68); Calibrated: 2012/06/22;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2012/07/19
- Phantom: SAM Phantom_Front; Type: SAM V4.0; Serial: TP 1654
- Measurement SW: DASY52, Version 52.8 (4); SEMCAD X Version 14.6.8 (7028)

Pin=250mW/Area Scan (61x61x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$
Maximum value of SAR (interpolated) = 3.22 W/kg

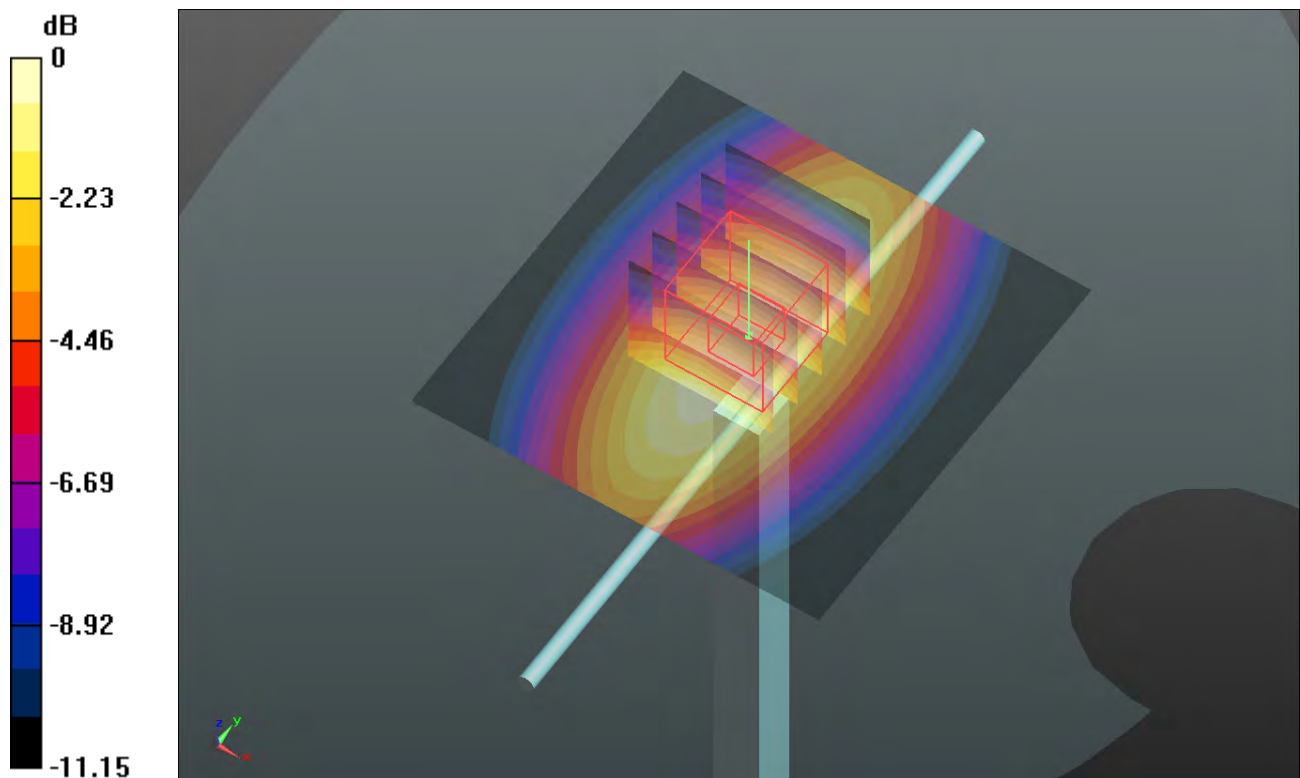
Pin=250mW/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 58.506 V/m ; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 3.85 W/kg

SAR(1 g) = 2.54 W/kg ; SAR(10 g) = 1.65 W/kg

Maximum value of SAR (measured) = 3.25 W/kg



System Check_H900_130319

DUT: Dipole 900 MHz; Type: D900V2; SN: 191

Communication System: CW; Frequency: 900 MHz; Duty Cycle: 1:1

Medium: H900_0319 Medium parameters used: $f = 900$ MHz; $\sigma = 0.952$ S/m; $\epsilon_r = 41.585$; $\rho = 1000$ kg/m³

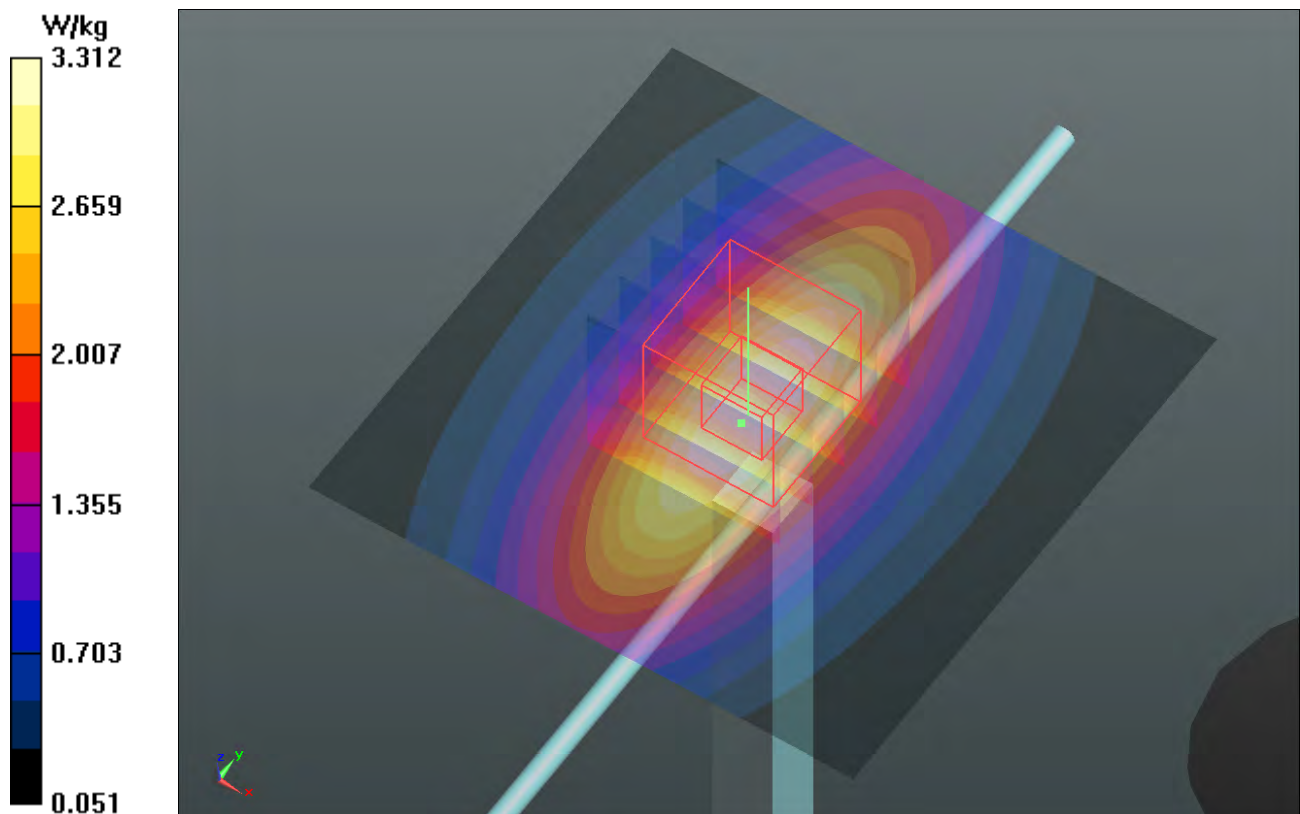
Ambient Temperature : 21.5 °C ; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3590; ConvF(10.53, 10.53, 10.53); Calibrated: 2013/02/20;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn910; Calibrated: 2012/12/05
- Phantom: SAM Phantom_Front; Type: SAM V4.0; Serial: TP 1485
- Measurement SW: DASY52, Version 52.8 (4); SEMCAD X Version 14.6.8 (7028)

Pin=250mW/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 3.31 W/kg

Pin=250mW/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 56.454 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 3.92 W/kg
SAR(1 g) = 2.55 W/kg; SAR(10 g) = 1.65 W/kg
Maximum value of SAR (measured) = 3.28 W/kg



System Check_B900_130426

DUT: Dipole 900 MHz; Type: D900V2; SN: 191

Communication System: CW; Frequency: 900 MHz; Duty Cycle: 1:1

Medium: B900_0426 Medium parameters used: $f = 900$ MHz; $\sigma = 1.042$ S/m; $\epsilon_r = 55.81$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.6 °C; Liquid Temperature : 20.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3590; ConvF(10.32, 10.32, 10.32); Calibrated: 2013/02/20;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn679; Calibrated: 2013/01/16
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY52, Version 52.8 (4); SEMCAD X Version 14.6.8 (7028)

Pin=250mW/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 3.51 W/kg

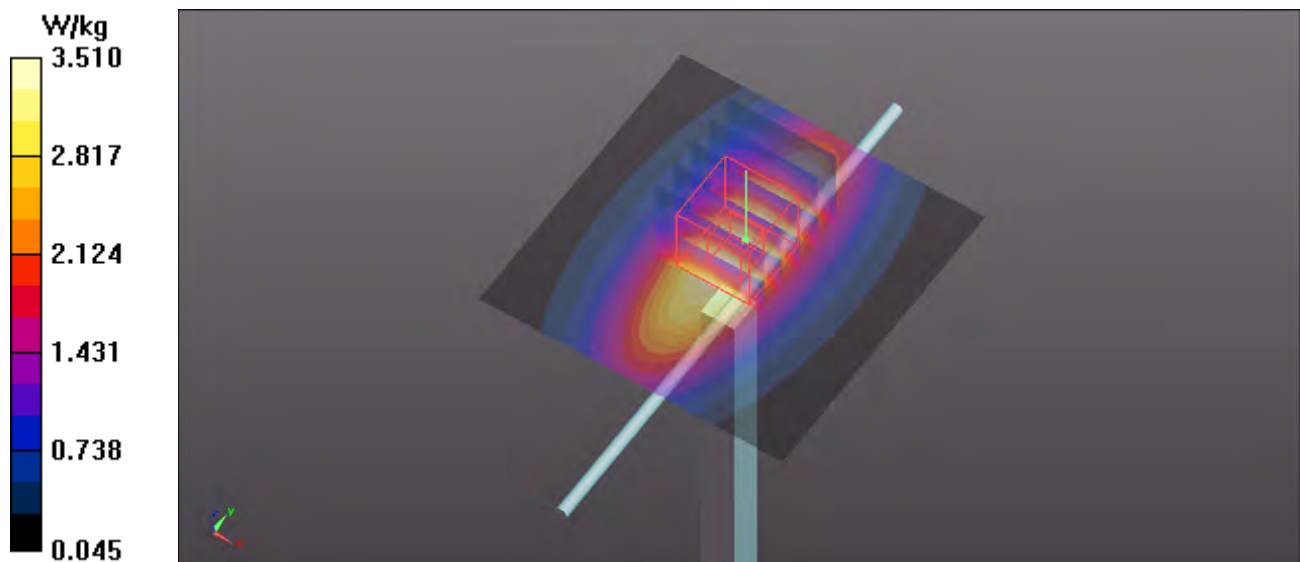
Pin=250mW/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 55.659 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 4.11 W/kg

SAR(1 g) = 2.72 W/kg; SAR(10 g) = 1.77 W/kg

Maximum value of SAR (measured) = 3.46 W/kg





Appendix B. SAR Plots of SAR Measurement

The SAR plots for highest measured SAR and measured SAR > 1.5 W/kg are shown as follows.

P01 Differentially Encoded MSK_Left Tilted_Ch1_APV/1

DUT: 130301C21

Communication System: MSK; Frequency: 902.38 MHz; Duty Cycle: 1:7.52

Medium: H900_0318 Medium parameters used: $f = 902.38$ MHz; $\sigma = 0.981$ S/m; $\epsilon_r = 41.903$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.5 °C ; Liquid Temperature : 20.2 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3801; ConvF(8.68, 8.68, 8.68); Calibrated: 2012/06/22;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2012/07/19
- Phantom: SAM Phantom_Front; Type: SAM V4.0; Serial: TP 1654
- Measurement SW: DASY52, Version 52.8 (4); SEMCAD X Version 14.6.8 (7028)

Ch1/Area Scan (81x211x1): Interpolated grid: dx=0.8000 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.301 W/kg

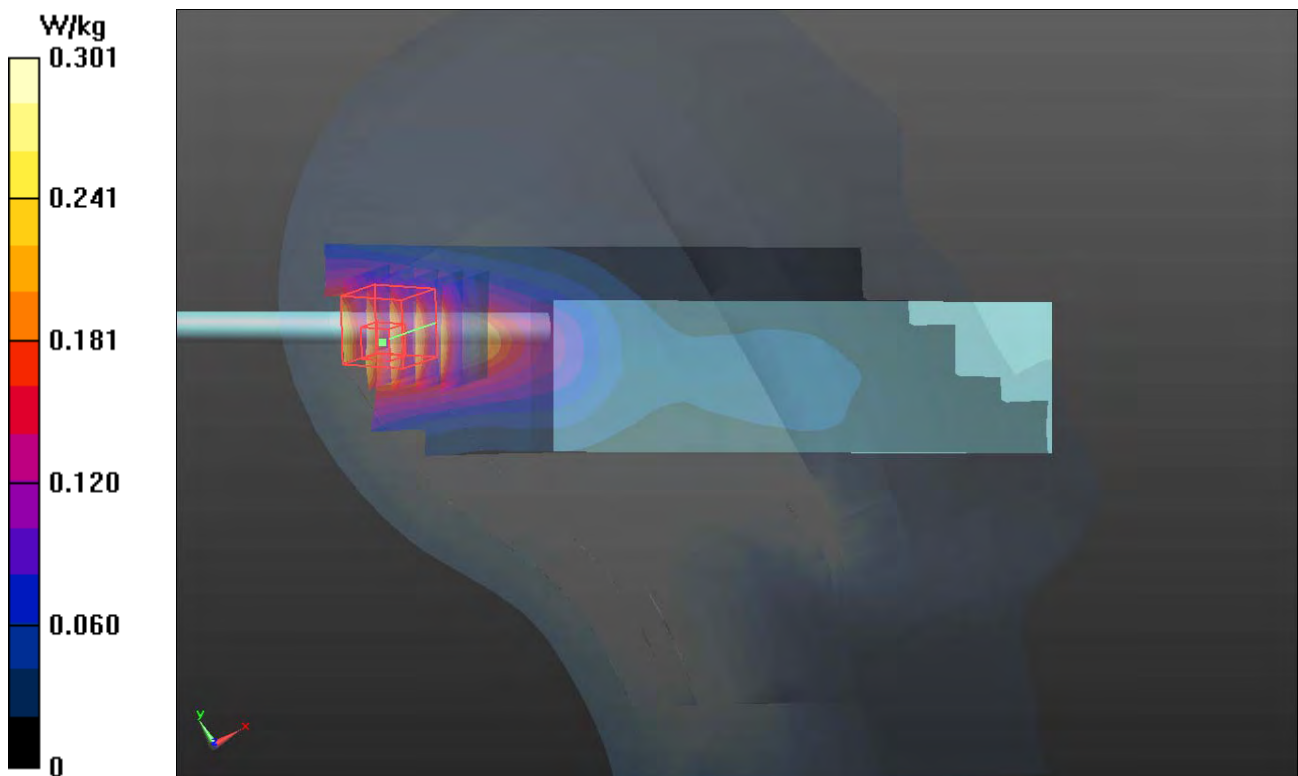
Ch1/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 6.360 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 0.330 W/kg

SAR(1 g) = 0.243 W/kg; SAR(10 g) = 0.167 W/kg

Maximum value of SAR (measured) = 0.291 W/kg



P02 Differentially Encoded MSK_Right Cheek_Ch1_APV/2

DUT: 130301C21

Communication System: MSK; Frequency: 902.38 MHz; Duty Cycle: 1:7.52

Medium: H900_0319 Medium parameters used: $f = 902.38$ MHz; $\sigma = 0.954$ S/m; $\epsilon_r = 41.564$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.5 °C; Liquid Temperature : 20.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3590; ConvF(10.53, 10.53, 10.53); Calibrated: 2013/02/20;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn910; Calibrated: 2012/12/05
- Phantom: SAM Phantom_Front; Type: SAM V4.0; Serial: TP 1485
- Measurement SW: DASY52, Version 52.8 (4); SEMCAD X Version 14.6.8 (7028)

Ch1/Area Scan (161x151x1): Interpolated grid: dx=0.4000 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.427 W/kg

Ch1/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 17.632 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 0.479 W/kg

SAR(1 g) = 0.357 W/kg; SAR(10 g) = 0.254 W/kg

Maximum value of SAR (measured) = 0.423 W/kg

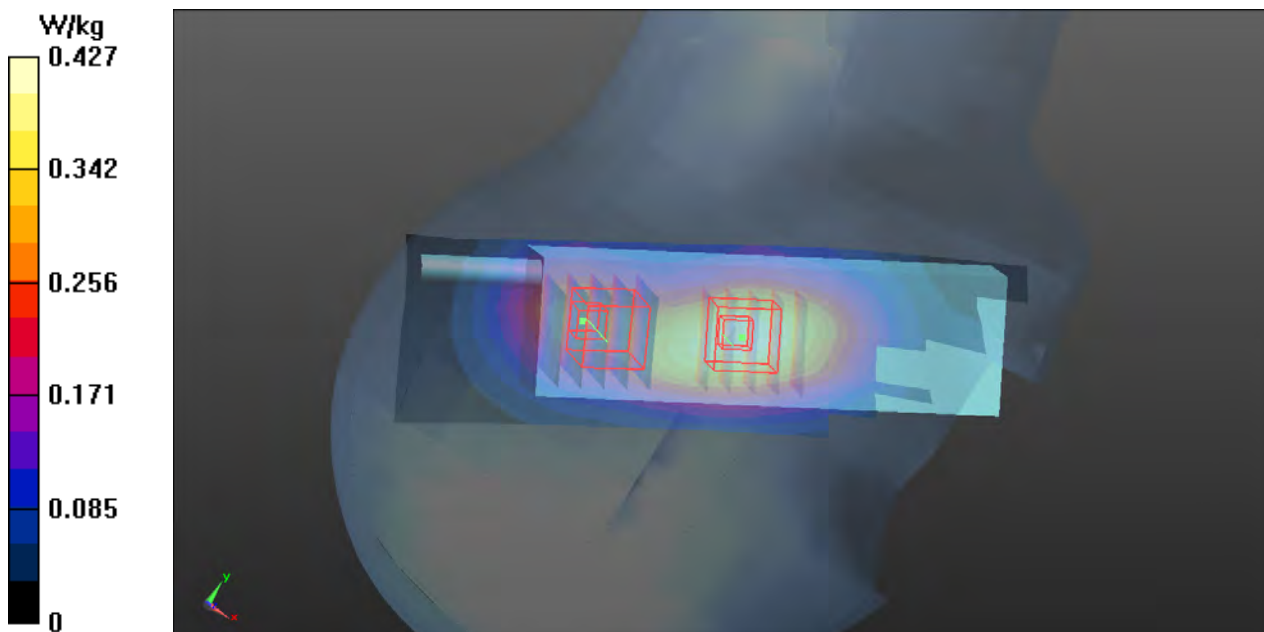
Ch1/Zoom Scan (5x5x7)/Cube 1: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 17.632 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 0.366 W/kg

SAR(1 g) = 0.250 W/kg; SAR(10 g) = 0.169 W/kg

Maximum value of SAR (measured) = 0.313 W/kg



P03 Differentially Encoded MSK_Rear Face_1.5cm_Ch1_ANT-1

DUT: 130301C21

Communication System: MSK; Frequency: 902.38 MHz; Duty Cycle: 1:7.52

Medium: B900_0426 Medium parameters used: $f = 902.38 \text{ MHz}$; $\sigma = 1.045 \text{ S/m}$; $\epsilon_r = 55.791$; $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature : 21.6 °C ; Liquid Temperature : 20.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3590; ConvF(10.32, 10.32, 10.32); Calibrated: 2013/02/20;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn679; Calibrated: 2013/01/16
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY52, Version 52.8 (4); SEMCAD X Version 14.6.8 (7028)

Ch1/Area Scan (51x221x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) = 0.665 W/kg

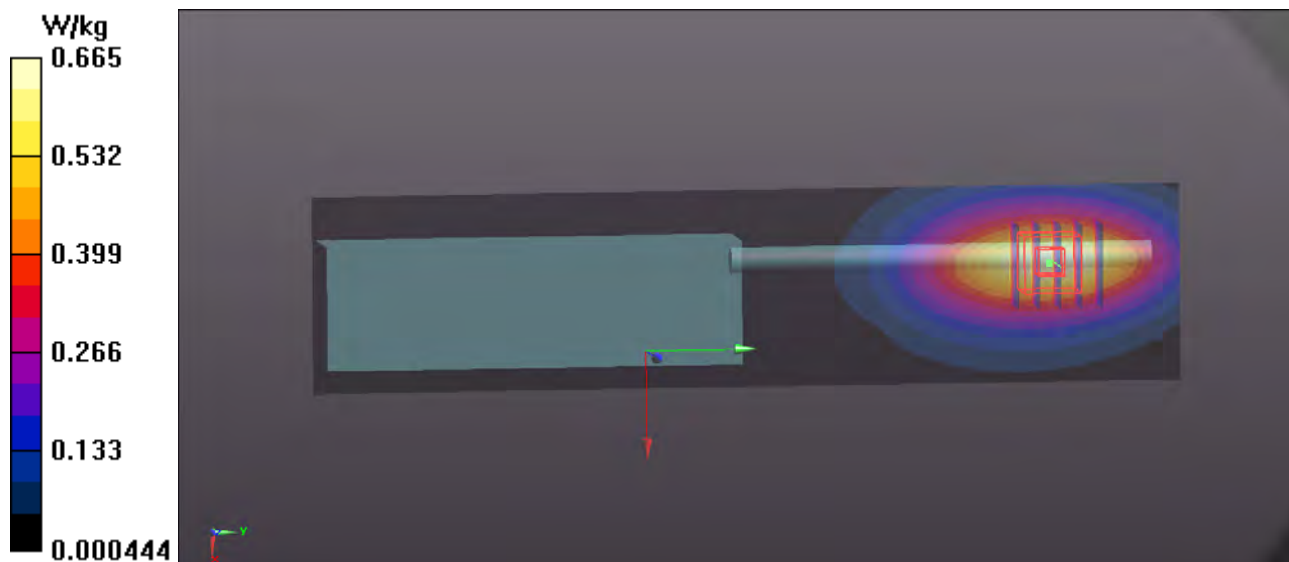
Ch1/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 5.338 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 0.757 W/kg

SAR(1 g) = 0.524 W/kg; SAR(10 g) = 0.353 W/kg

Maximum value of SAR (measured) = 0.652 W/kg



P04 Differentially Encoded MSK_Front Face_1.5cm_Ch1_ANT-2

DUT: 130301C21

Communication System: MSK; Frequency: 902.38 MHz; Duty Cycle: 1:7.52

Medium: B900_0426 Medium parameters used: $f = 902.38$ MHz; $\sigma = 1.045$ S/m; $\epsilon_r = 55.791$; $\rho = 1000$ kg/m³

Ambient Temperature : 21.6 °C; Liquid Temperature : 20.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN3590; ConvF(10.32, 10.32, 10.32); Calibrated: 2013/02/20;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn679; Calibrated: 2013/01/16
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BA; Serial: SN:1039
- Measurement SW: DASY52, Version 52.8 (4); SEMCAD X Version 14.6.8 (7028)

Ch1/Area Scan (161x151x1): Interpolated grid: dx=0.400 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.340 W/kg

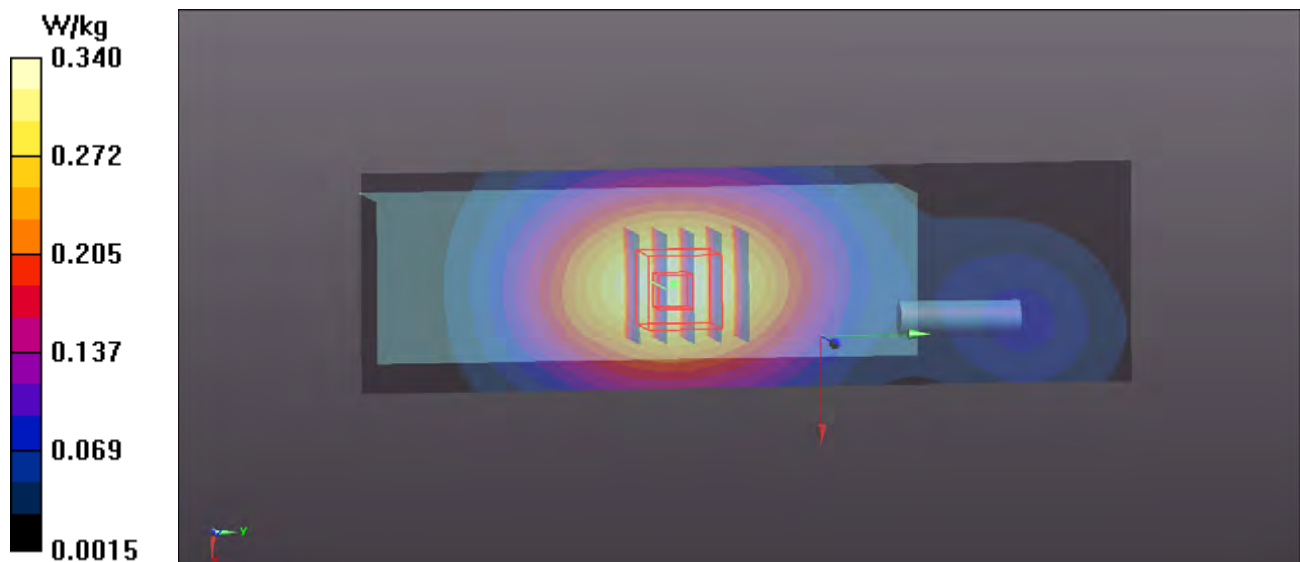
Ch1/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 17.670 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 0.354 W/kg

SAR(1 g) = 0.266 W/kg; SAR(10 g) = 0.192 W/kg

Maximum value of SAR (measured) = 0.313 W/kg





Appendix C. Calibration Certificate for Probe and Dipole

The SPEAG calibration certificates are shown as follows.



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 **B.V. ADT (Auden)**

Certificate No: **D900V2-191_Feb13**

CALIBRATION CERTIFICATE

Object **D900V2 - SN: 191**

Calibration procedure(s) **QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **February 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 EPM-442A | GB37480704 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Power sensor HP 8481A | US37292783 | 01-Nov-12 (No. 217-01640) | Oct-13 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 27-Mar-12 (No. 217-01530) | Apr-13 |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 27-Mar-12 (No. 217-01533) | Apr-13 |
| Reference Probe ES3DV3 | SN: 3205 | 28-Dec-12 (No. ES3-3205_Dec12) | Dec-13 |
| DAE4 | SN: 601 | 27-Jun-12 (No. DAE4-601_Jun12) | Jun-13 |
| 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-12) | In house check: Oct-13 |

| | | | |
|----------------|-------------------------------|--|--|
| Calibrated by: | Name Jeton Kastrati | Function Laboratory Technician | Signature  |
| Approved by: | Name Katja Pokovic | Function Technical Manager | Signature  |

Issued: February 15, 2013

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



Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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%.

Measurement Conditions

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

| | | |
|-------------------------------------|------------------------|-------------|
| DASY Version | DASY5 | V52.8.5 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Modular Flat Phantom | |
| Distance Dipole Center - TSL | 15 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 900 MHz \pm 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|---------------------|----------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 41.5 | 0.97 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 40.9 \pm 6 % | 0.96 mho/m \pm 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 2.69 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 10.8 W/kg \pm 17.0 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Head TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 1.72 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 6.91 W/kg \pm 16.5 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|---------------------|----------------|----------------------|
| Nominal Body TSL parameters | 22.0 °C | 55.0 | 1.05 mho/m |
| Measured Body TSL parameters | (22.0 \pm 0.2) °C | 54.6 \pm 6 % | 1.04 mho/m \pm 6 % |
| Body TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Body TSL

| SAR averaged over 1 cm³ (1 g) of Body TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 2.66 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 10.7 W/kg \pm 17.0 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Body TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 1.73 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 6.95 W/kg \pm 16.5 % (k=2) |

Appendix

Antenna Parameters with Head TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.8 Ω - 2.0 j Ω |
| Return Loss | - 33.5 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 47.2 Ω - 3.1 j Ω |
| Return Loss | - 27.4 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.409 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 | June 13, 2003 |

DASY5 Validation Report for Head TSL

Date: 15.02.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 191

Communication System: CW; Frequency: 900 MHz

Medium parameters used: $f = 900$ MHz; $\sigma = 0.96$ S/m; $\epsilon_r = 40.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.95, 5.95, 5.95); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

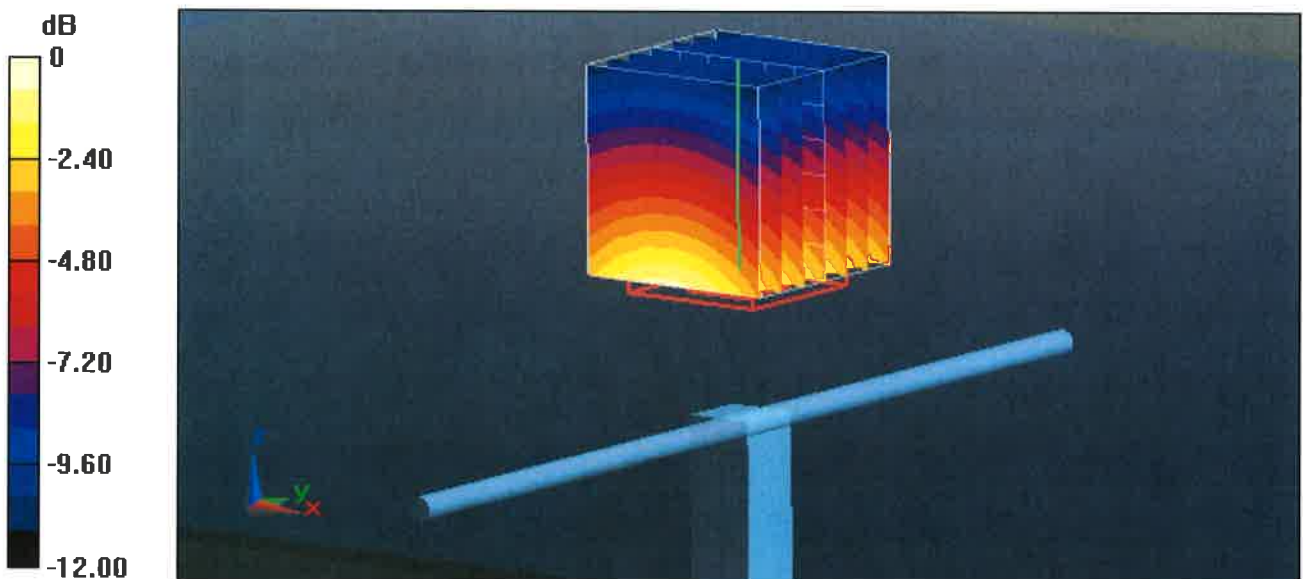
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.955 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 4.09 W/kg

SAR(1 g) = 2.69 W/kg; SAR(10 g) = 1.72 W/kg

Maximum value of SAR (measured) = 3.16 W/kg

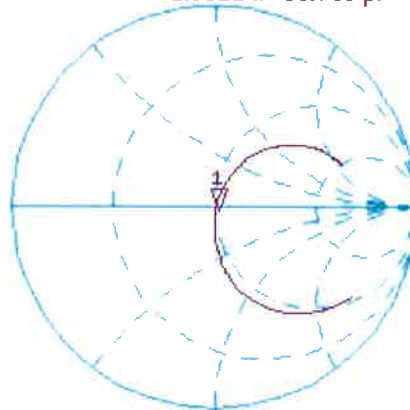


0 dB = 3.16 W/kg = 5.00 dBW/kg

Impedance Measurement Plot for Head TSL

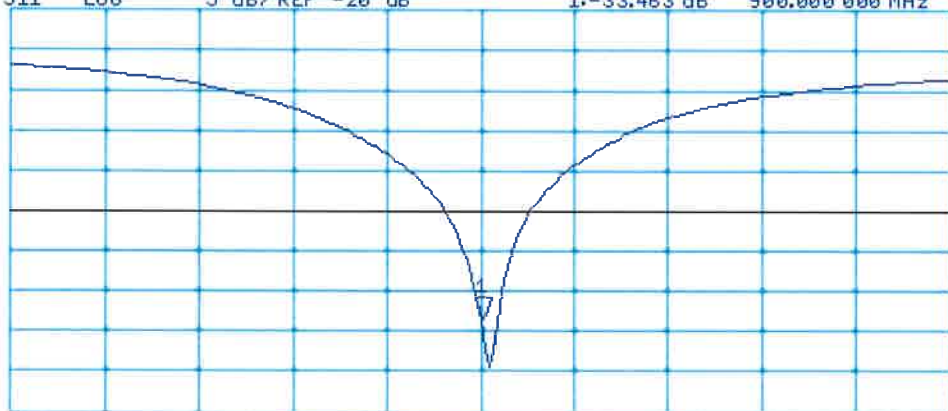
15 Feb 2013 09:38:16
CH1 S11 1 U FS 1: 50.775 Ω -1.9922 Ω 88.766 pF 900.000 000 MHz

*
De1
CA
Avg
16
H1d



CH2 S11 LOG 5 dB/REF -20 dB 1: -33.463 dB 900.000 000 MHz

CA
Avg
16
H1d



START 700.000 000 MHz STOP 1 100.000 000 MHz

DASY5 Validation Report for Body TSL

Date: 15.02.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 191

Communication System: CW; Frequency: 900 MHz

Medium parameters used: $f = 900$ MHz; $\sigma = 1.04$ S/m; $\epsilon_r = 54.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.95, 5.95, 5.95); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 56.379 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.93 W/kg

SAR(1 g) = 2.66 W/kg; SAR(10 g) = 1.73 W/kg

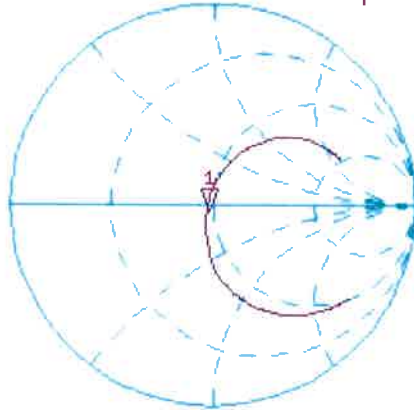
Maximum value of SAR (measured) = 3.10 W/kg



Impedance Measurement Plot for Body TSL

15 Feb 2013 16:42:41
CH1 S11 1 U FS 1: 47.246 Ω -3.1348 Ω 56.412 pF 900.000 000 MHz

*
De1
Cor



Avg
16

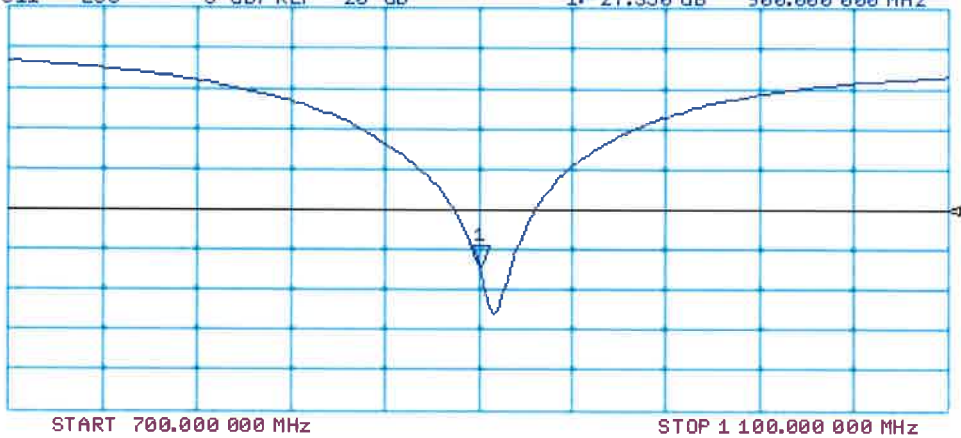
H1d

CH2 S11 LOG 5 dB/REF -20 dB 1:-27.350 dB 900.000 000 MHz

Cor

Avg
16

H1d





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **B.V. ADT (Auden)**

Certificate No: **EX3-3590_Feb13**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3590**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes**



Calibration date: **February 20, 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 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ES3DV2 | SN: 3013 | 28-Dec-12 (No. ES3-3013_Dec12) | Dec-13 |
| DAE4 | SN: 660 | 31-Jan-13 (No. DAE4-660_Jan13) | Jan-13 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-12) | In house check: Oct-13 |

| | | | |
|---|--------------------------------|--|--|
| Calibrated by: | Name Claudio Leubler | Function Laboratory Technician | Signature  |
| Approved by: | Name Katja Pokovic | Function Technical Manager | Signature  |
| | | | Issued: February 22, 2013 |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. | | | |



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Accreditation No.: **SCS 108**

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Multilateral Agreement for the recognition of calibration certificates

Glossary:

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

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

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}; A, B, C, D** are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ 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_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

Probe EX3DV4

SN:3590

Manufactured: March 23, 2009
Calibrated: February 20, 2013

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3590

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|-----------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.50 | 0.47 | 0.50 | ± 10.1 % |
| DCP (mV) ^B | 94.4 | 97.2 | 92.1 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 122.9 | ±3.0 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 144.4 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 120.3 | |

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

^A The uncertainties of NormX,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3590

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 41.9 | 0.89 | 10.91 | 10.91 | 10.91 | 0.31 | 0.89 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 10.52 | 10.52 | 10.52 | 0.48 | 0.75 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 10.53 | 10.53 | 10.53 | 0.63 | 0.62 | ± 12.0 % |
| 1450 | 40.5 | 1.20 | 9.08 | 9.08 | 9.08 | 0.17 | 1.62 | ± 12.0 % |
| 1640 | 40.3 | 1.29 | 9.10 | 9.10 | 9.10 | 0.55 | 0.66 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 8.89 | 8.89 | 8.89 | 0.54 | 0.67 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 8.70 | 8.70 | 8.70 | 0.67 | 0.61 | ± 12.0 % |
| 2000 | 40.0 | 1.40 | 8.67 | 8.67 | 8.67 | 0.73 | 0.59 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 8.32 | 8.32 | 8.32 | 0.55 | 0.67 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 7.88 | 7.88 | 7.88 | 0.46 | 0.74 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 7.69 | 7.69 | 7.69 | 0.28 | 1.02 | ± 12.0 % |
| 3500 | 37.9 | 2.91 | 7.75 | 7.75 | 7.75 | 0.57 | 0.81 | ± 13.1 % |
| 5200 | 36.0 | 4.66 | 5.79 | 5.79 | 5.79 | 0.35 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 5.61 | 5.61 | 5.61 | 0.32 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 5.20 | 5.20 | 5.20 | 0.36 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 5.05 | 5.05 | 5.05 | 0.40 | 1.80 | ± 13.1 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3590

Calibration Parameter Determined in Body Tissue Simulating Media

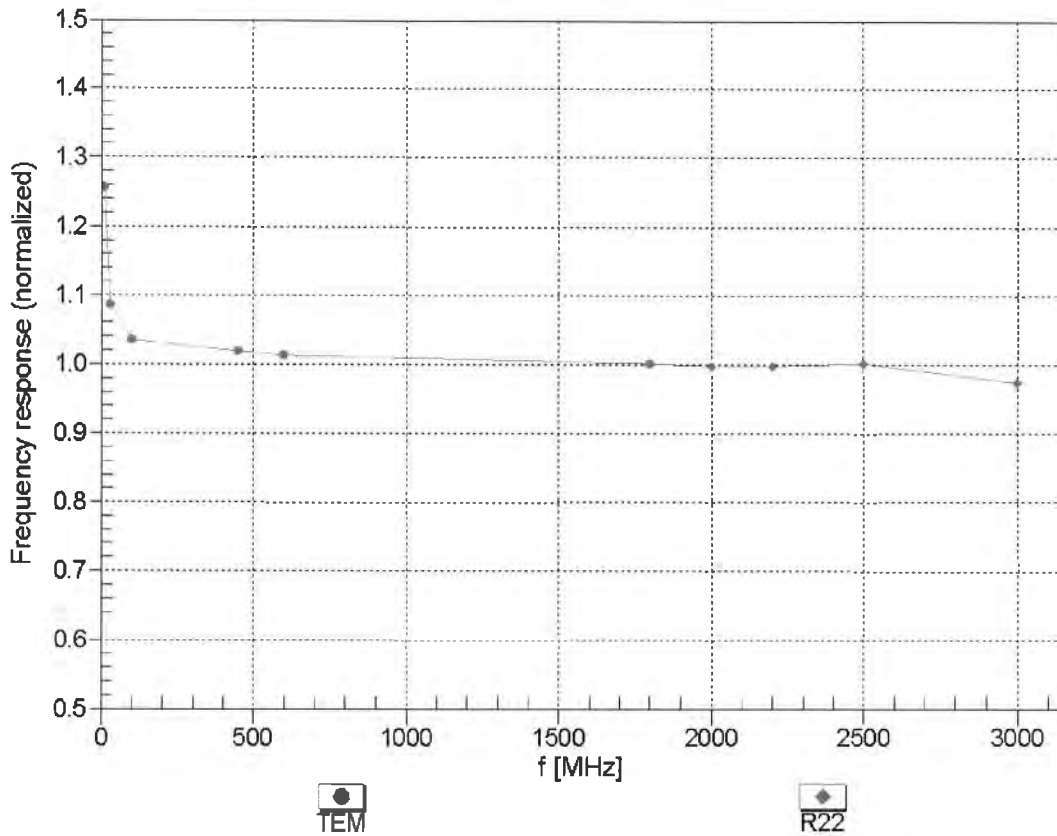
| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 55.5 | 0.96 | 10.60 | 10.60 | 10.60 | 0.80 | 0.62 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 10.43 | 10.43 | 10.43 | 0.60 | 0.71 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 10.32 | 10.32 | 10.32 | 0.69 | 0.66 | ± 12.0 % |
| 1450 | 54.0 | 1.30 | 9.03 | 9.03 | 9.03 | 0.76 | 0.55 | ± 12.0 % |
| 1640 | 53.8 | 1.40 | 9.42 | 9.42 | 9.42 | 0.62 | 0.68 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 8.63 | 8.63 | 8.63 | 0.44 | 0.82 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 8.39 | 8.39 | 8.39 | 0.34 | 0.86 | ± 12.0 % |
| 2000 | 53.3 | 1.52 | 8.55 | 8.55 | 8.55 | 0.32 | 0.87 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 8.20 | 8.20 | 8.20 | 0.69 | 0.60 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 8.08 | 8.08 | 8.08 | 0.76 | 0.57 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 7.83 | 7.83 | 7.83 | 0.58 | 0.50 | ± 12.0 % |
| 3500 | 51.3 | 3.31 | 7.38 | 7.38 | 7.38 | 0.55 | 0.88 | ± 13.1 % |
| 5200 | 49.0 | 5.30 | 5.15 | 5.15 | 5.15 | 0.40 | 1.90 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 4.94 | 4.94 | 4.94 | 0.40 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 4.57 | 4.57 | 4.57 | 0.46 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 4.46 | 4.46 | 4.46 | 0.40 | 1.90 | ± 13.1 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

Frequency Response of E-Field

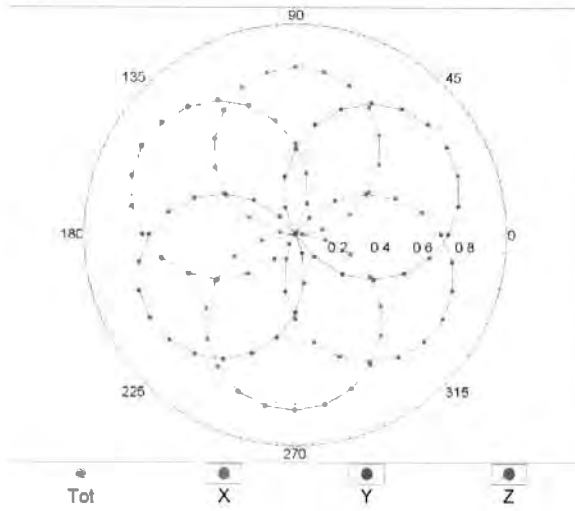
(TEM-Cell:ifi110 EXX, Waveguide: R22)



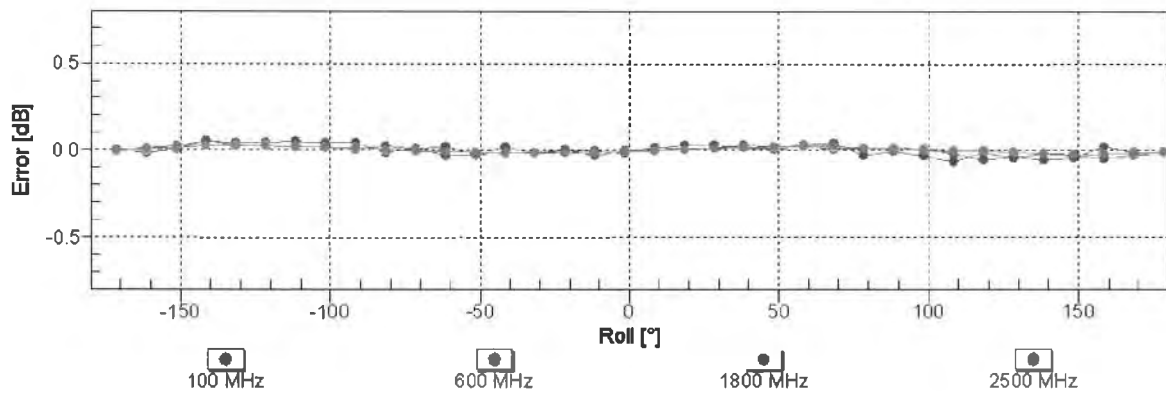
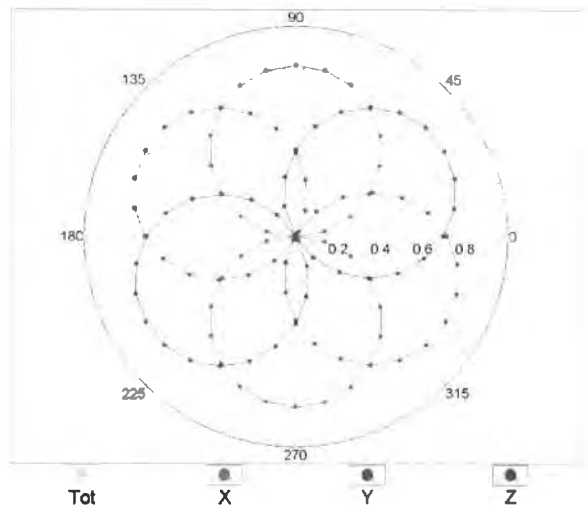
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

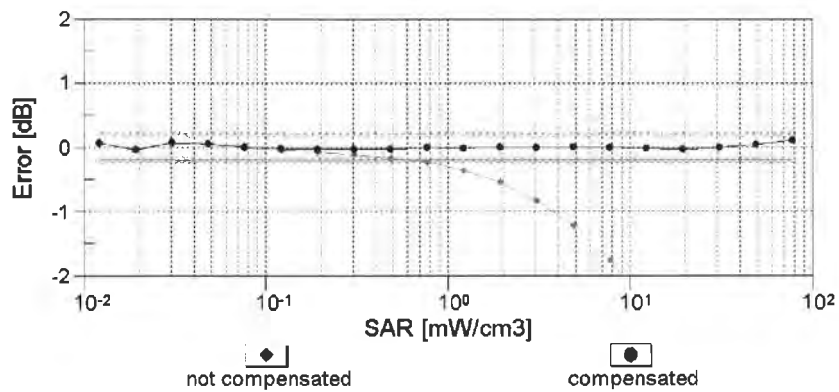
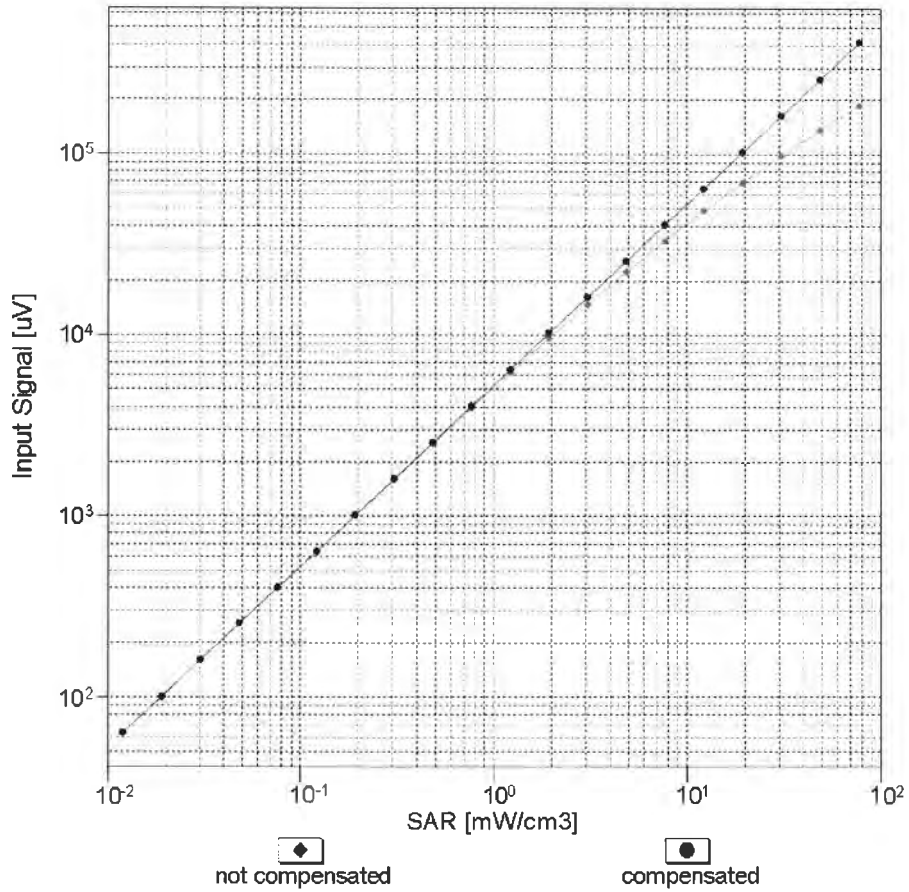


f=1800 MHz,R22



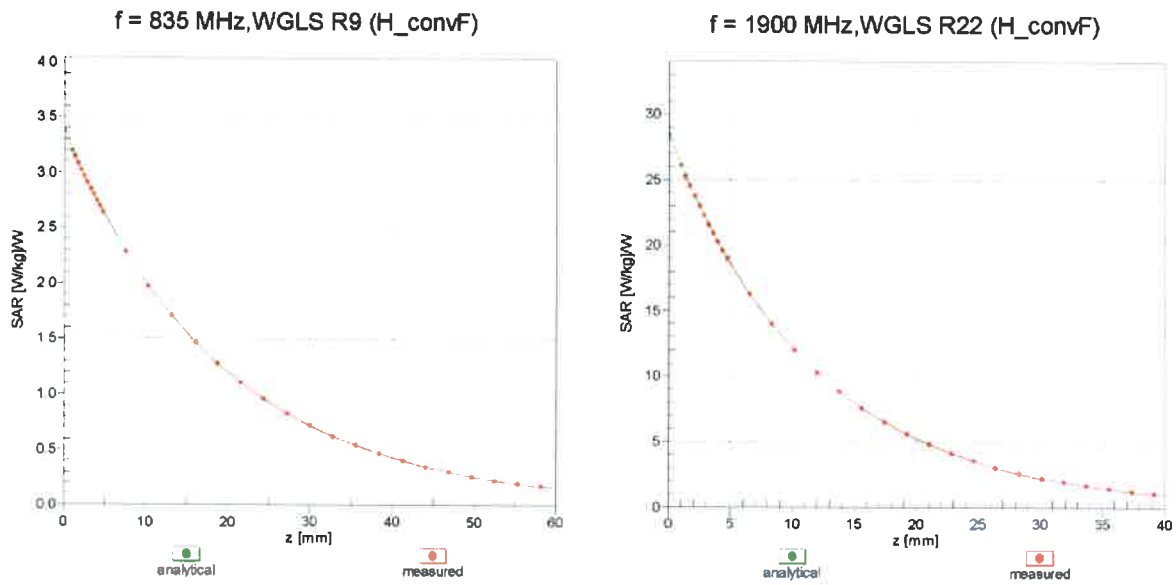
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

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

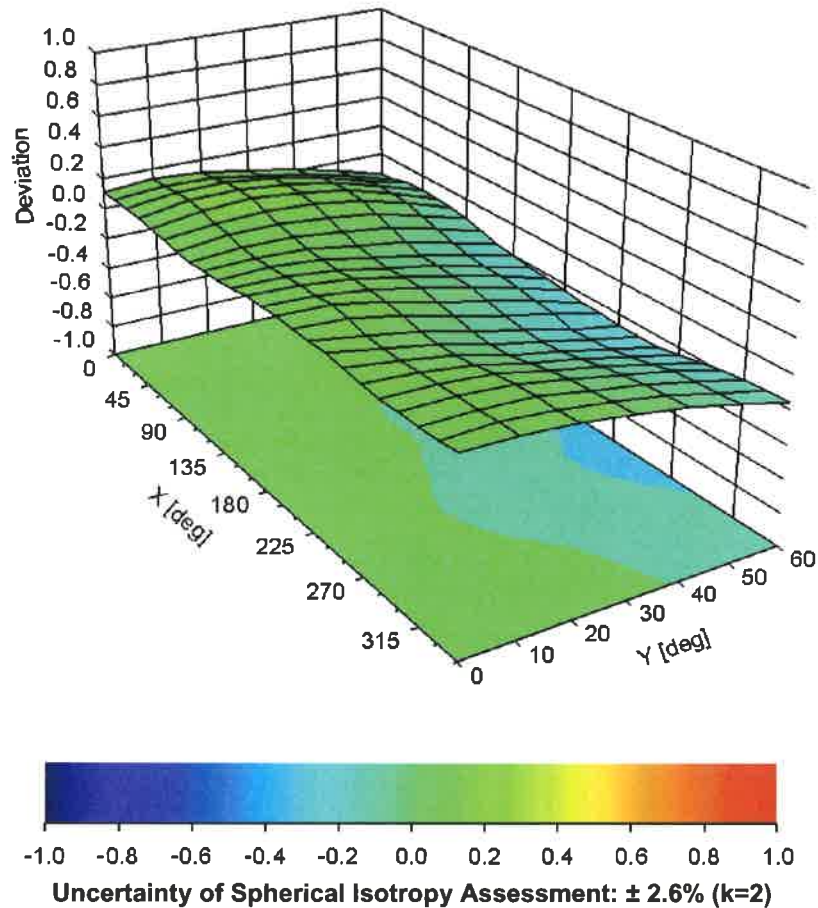


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, ϑ), f = 900 MHz



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3590

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 38.4 |
| 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 |



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Auden**

Certificate No: **EX3-3801_Jun12**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3801**

Calibration procedure(s) **QA CAL-01.v8, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes**

Calibration date: **June 22, 2012**

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 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Power sensor E4412A | MY41498087 | 29-Mar-12 (No. 217-01508) | Apr-13 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 27-Mar-12 (No. 217-01531) | Apr-13 |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 27-Mar-12 (No. 217-01529) | Apr-13 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 27-Mar-12 (No. 217-01532) | Apr-13 |
| Reference Probe ES3DV2 | SN: 3013 | 29-Dec-11 (No. ES3-3013_Dec11) | Dec-12 |
| DAE4 | SN: 660 | 10-Jan-12 (No. DAE4-660_Jan12) | Jan-13 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-11) | In house check: Apr-13 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-11) | In house check: Oct-12 |

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

Issued: June 22, 2012

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**

The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Glossary:

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

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

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z} = NORM_{x,y,z} * frequency_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,y,z}**: A, B, C 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_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

Probe EX3DV4

SN:3801

Manufactured: April 5, 2011
Calibrated: June 22, 2012

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3801

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|---------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.55 | 0.60 | 0.54 | $\pm 10.1 \%$ |
| DCP (mV) ^B | 98.6 | 101.4 | 102.0 | |

Modulation Calibration Parameters

| UID | Communication System Name | PAR | | A dB | B dB | C dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|------|---|---------|---------|---------|----------|---------------------------|
| 0 | CW | 0.00 | X | 0.00 | 0.00 | 1.00 | 177.5 | $\pm 3.8 \%$ |
| | | | Y | 0.00 | 0.00 | 1.00 | 184.0 | |
| | | | Z | 0.00 | 0.00 | 1.00 | 175.5 | |

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

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

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3801

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 41.9 | 0.89 | 9.09 | 9.09 | 9.09 | 0.80 | 0.61 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 8.71 | 8.71 | 8.71 | 0.42 | 0.82 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 8.68 | 8.68 | 8.68 | 0.63 | 0.73 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 7.70 | 7.70 | 7.70 | 0.35 | 1.02 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 7.42 | 7.42 | 7.42 | 0.35 | 1.01 | ± 12.0 % |
| 2000 | 40.0 | 1.40 | 7.37 | 7.37 | 7.37 | 0.60 | 0.74 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 6.70 | 6.70 | 6.70 | 0.41 | 0.93 | ± 12.0 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3801

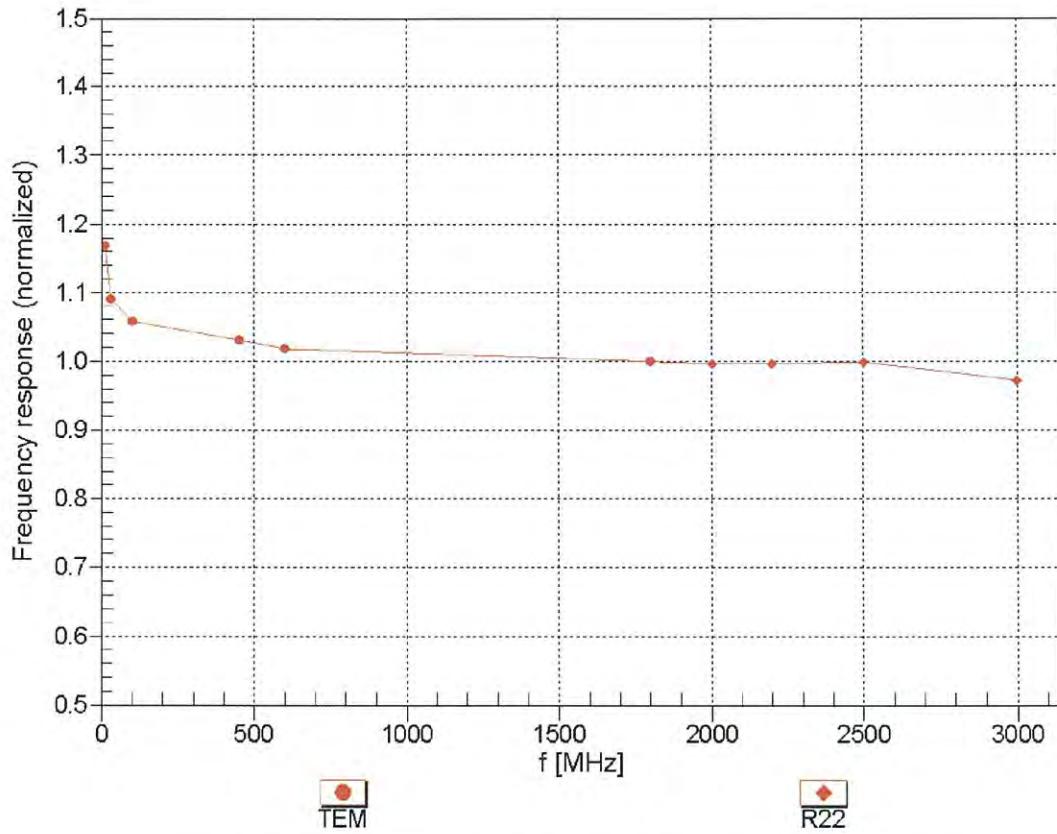
Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha | Depth (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|-------|------------|-------------|
| 750 | 55.5 | 0.96 | 9.00 | 9.00 | 9.00 | 0.80 | 0.66 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 8.82 | 8.82 | 8.82 | 0.53 | 0.78 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 8.72 | 8.72 | 8.72 | 0.80 | 0.61 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 7.50 | 7.50 | 7.50 | 0.77 | 0.68 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 7.13 | 7.13 | 7.13 | 0.51 | 0.79 | ± 12.0 % |
| 2000 | 53.3 | 1.52 | 7.13 | 7.13 | 7.13 | 0.70 | 0.68 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 6.59 | 6.59 | 6.59 | 0.80 | 0.59 | ± 12.0 % |

^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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

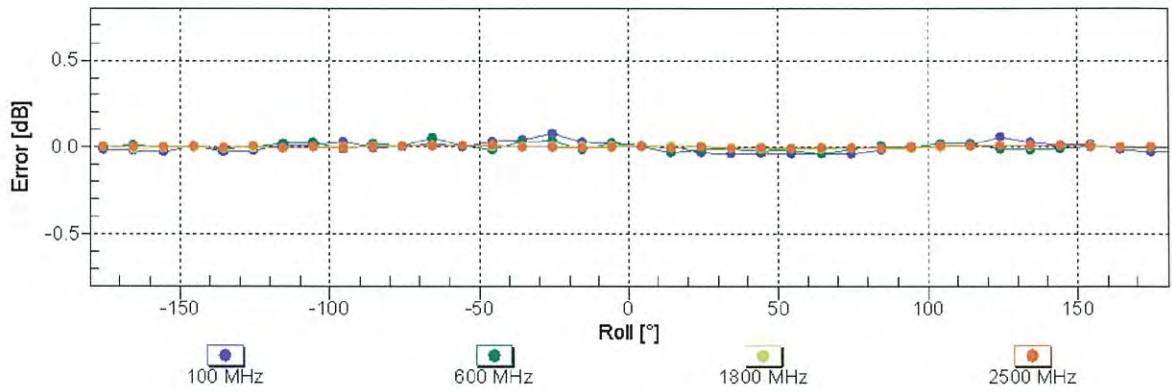
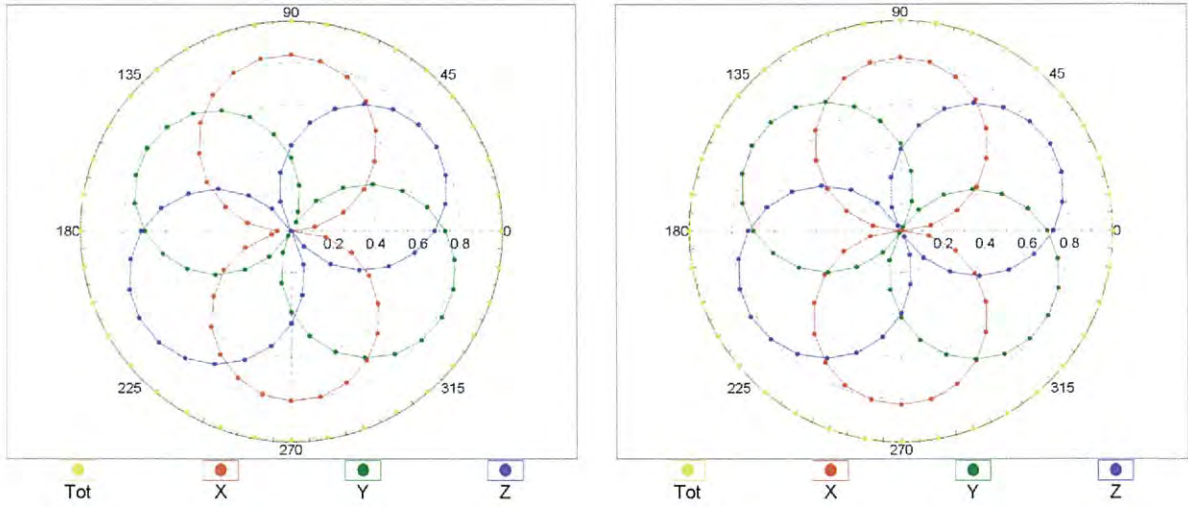


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

Receiving Pattern (ϕ), $\theta = 0^\circ$

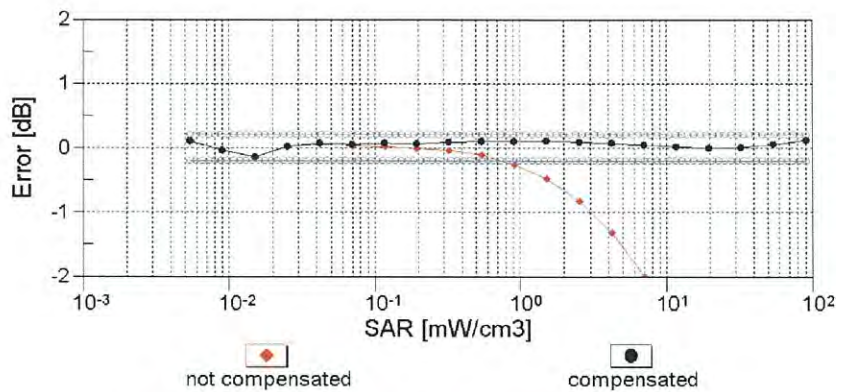
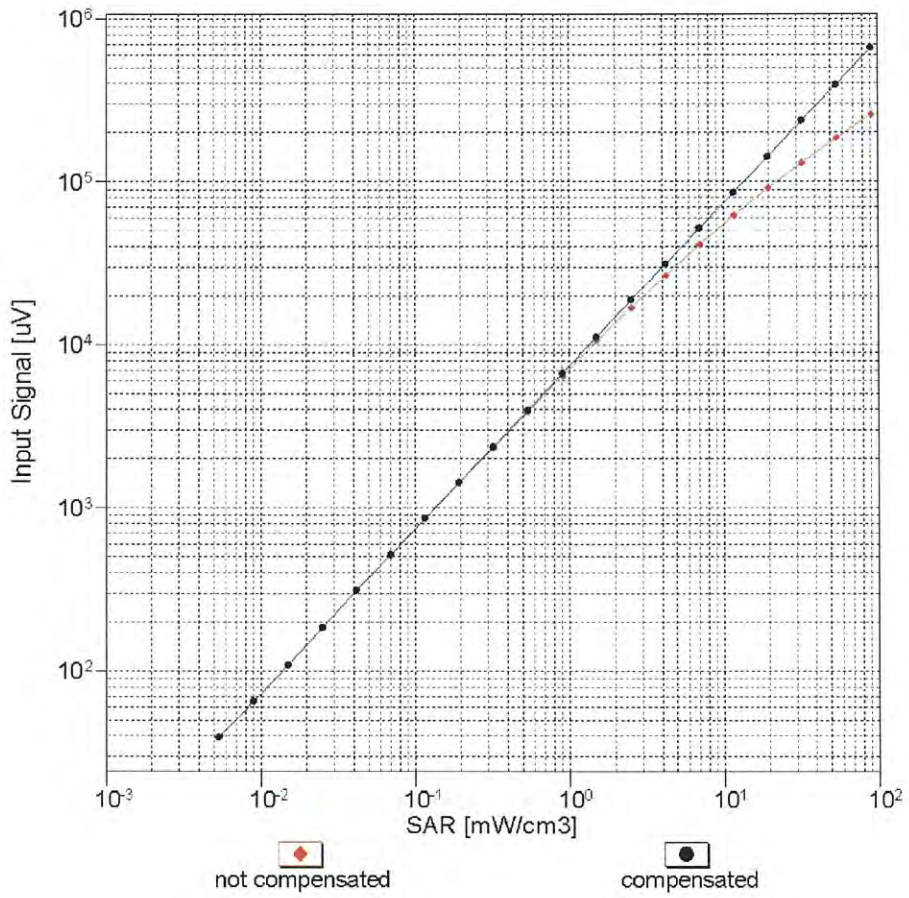
f=600 MHz,TEM

f=1800 MHz,R22



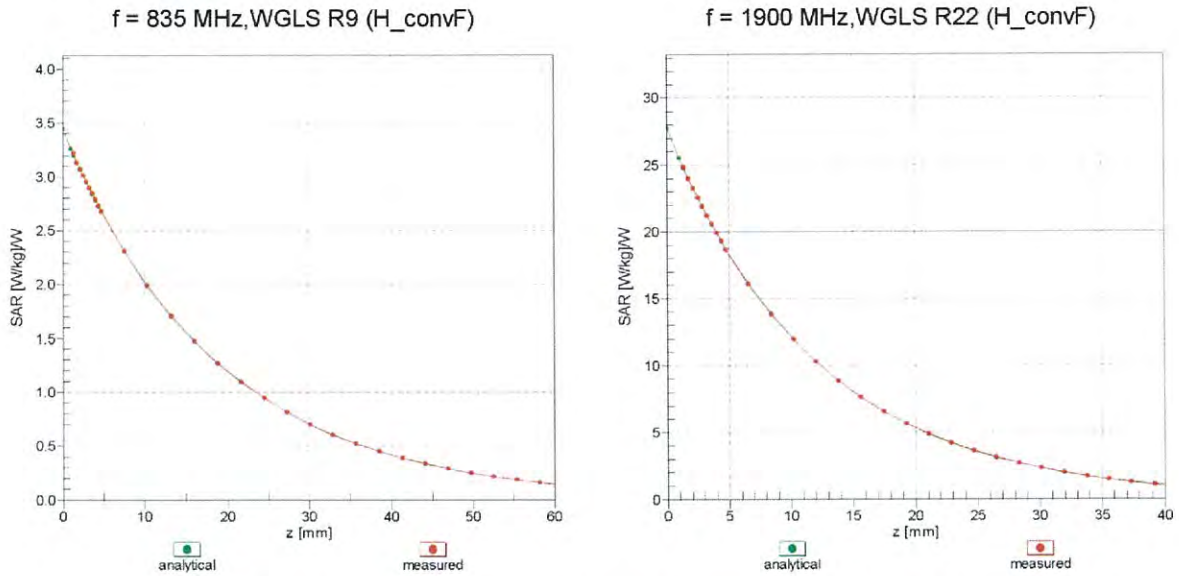
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

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



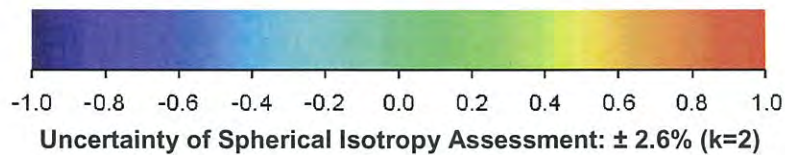
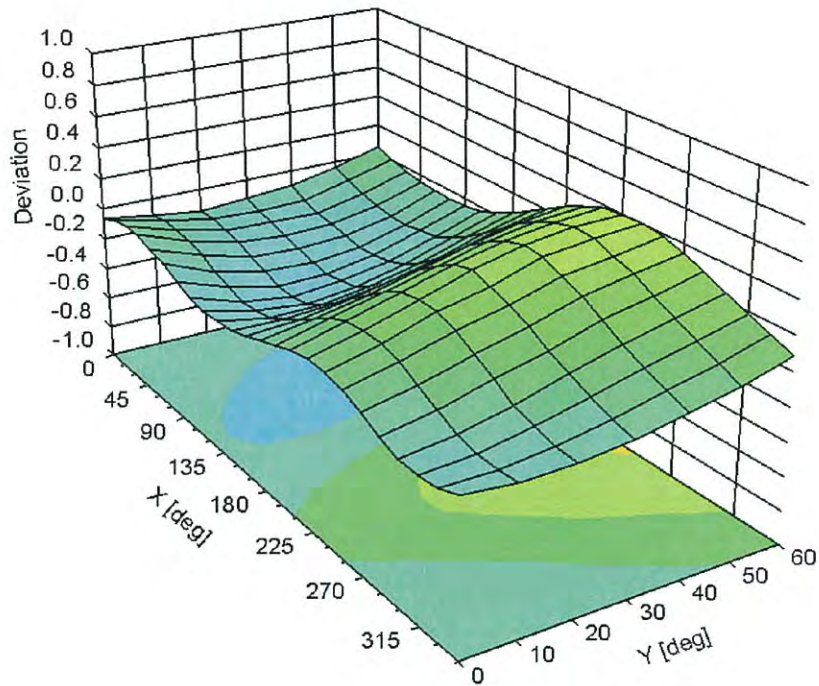
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), f = 900 MHz



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3801

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 124.4 |
| 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 |