

SAR TEST REPORT

Franklin Technology Inc.

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Seoul, Korea

Date of Issue: October 01, 2014

Test Report No.: HCT-A-1410-F001

Test Site: HCT CO., LTD.

FCC ID:

XHG-R800

Equipment Type:
Model Name:
**Testing has been carried
out in accordance with:**

Mobile Router
MHS800L

47CFR §2.1093
ANSI/ IEEE C95.1 – 1992
IEEE 1528-2003

Date of Test:

September 15, 2014 ~ September 17, 2014

This device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in FCC KDB procedures and had been tested in accordance with the measurement procedures specified in FCC KDB procedures.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Tested By



Yun-Jeang Heo
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Reviewed By



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Technical Manager / SAR Team
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Revision History

Rev.	Issue DATE	DESCRIPTION
HCT-A-1410-F001	Oct. 01, 2014	Initial Issue

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1. INTRODUCTION

The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency radiation in ET Docket 93-62 on Aug. 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices.

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. The measurement procedure described in IEEE/ANSI C95.3-1992 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave is used for guidance in measuring SAR due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields," NCRP Report No. 86 NCRP, 1986, Bethesda, MD 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

SAR Definition

Specific Absorption Rate (SAR) is defined as the time derivative of the incremental electromagnetic energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body.

$$SAR = \frac{d}{dt} \left(\frac{dU}{dm} \right) = \frac{d}{dt} \left(\frac{dU}{\rho dV} \right)$$

Figure 1. SAR Mathematical Equation

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

$$SAR = \sigma E^2 / \rho$$

Where:

- σ = conductivity of the tissue-simulant material (S/m)
- ρ = mass density of the tissue-simulant material (kg/m³)
- E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relations to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC KDB Procedure, IEEE Standard 1528-2003 & IEEE 1528a-2005 and the following published KDB procedures.

- FCC KDB Publication 941225 D05 SAR for LTE Devices v02r03
- FCC KDB Publication 941225 D06 Hot Spot SAR v01r01
- FCC KDB Publication 248227 D01v01r02(SAR Considerationa for 802.11 Devices)
- FCC KDB Publication 447498 D01v05r02 (General SAR Guidance)
- FCC KDB Publication 865664 D01 SAR measurement 100 MHz to 6 GHz v01r03
- FCC KDB Publication 865664 D02 SAR Reporting v01r01

3. DESCRIPTION OF DEVICE

Environmental evaluation measurements of specific absorption rate (SAR) distributions in emulated human head and body tissues exposed to radio frequency (RF) radiation from wireless portable devices for compliance with the rules and regulations of the U.S. Federal Communications Commission (FCC).

EUT Type	Mobile Router		
FCC ID:	XHG-R800		
Model:	MHS800L		
Trade Name	Franklin Technology Inc.		
Application Type	Certification		
Tx. Frequency	782 MHz (LTE Band 13)		
	1 712.5 – 1 752.5 MHz (LTE Band 4)		
	2 412 - 2 462 (802.11b/g/n)		
Production Unit or Identical Prototype	Prototype		
Max. SAR	Band	Equipment Class	Reported 1g SAR (W/Kg) Body SAR
	LTE 13	PCB	1.11
	LTE 4	PCB	0.82
	802.11b	DTS	0.13
	Simultaneous SAR per KDB 690783 D01v01r03		1.19
Date(s) of Tests	Sep. 15, 2014 ~ Sep. 17, 2014		
Antenna Type	Integral Antenna		
Key Feature(s)	This device supports Mobile Hotspot.		

3.1 KDB 941225 LTE informatio

Frequency Range:	Band 4: 1 712.5 – 1 752.5 MHz, Band 13: 782 MHz																																																												
Channel Bandwidth:	Band 4: 5 MHz, 10 MHz, 15 MHz, 20 MHz, Band 13: 5MHz ,10 MHz																																																												
Channel Number & Frequency:	<table border="1"> <thead> <tr> <th colspan="8">Band 4</th> </tr> <tr> <th colspan="2">5 MHz</th> <th colspan="2">10 MHz</th> <th colspan="2">15 MHz</th> <th colspan="2">20 MHz</th> </tr> <tr> <th>Ch.</th> <th>Freq. (MHz)</th> <th>Ch.</th> <th>Freq. (MHz)</th> <th>Ch.</th> <th>Freq.(MHz)</th> <th>Ch.</th> <th>Freq.(MHz)</th> </tr> </thead> <tbody> <tr> <td>19975</td> <td>1 712.5</td> <td>20000</td> <td>1 715</td> <td>20025</td> <td>1 717.5</td> <td>20050</td> <td>1 720</td> </tr> <tr> <td>20175</td> <td>1 732.5</td> <td>20175</td> <td>1 732.5</td> <td>20175</td> <td>1 732.5</td> <td>20175</td> <td>1 732.5</td> </tr> <tr> <td>20375</td> <td>1 752.5</td> <td>20350</td> <td>1 750</td> <td>20325</td> <td>1 747.5</td> <td>20300</td> <td>1 745</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th colspan="3">Band 13</th> </tr> <tr> <th>BW</th> <th>Ch.</th> <th>Freq.(MHz)</th> </tr> </thead> <tbody> <tr> <td>5MHz</td> <td>23230</td> <td>782</td> </tr> <tr> <td>10MHz</td> <td>23230</td> <td>782</td> </tr> </tbody> </table>	Band 4								5 MHz		10 MHz		15 MHz		20 MHz		Ch.	Freq. (MHz)	Ch.	Freq. (MHz)	Ch.	Freq.(MHz)	Ch.	Freq.(MHz)	19975	1 712.5	20000	1 715	20025	1 717.5	20050	1 720	20175	1 732.5	20175	1 732.5	20175	1 732.5	20175	1 732.5	20375	1 752.5	20350	1 750	20325	1 747.5	20300	1 745	Band 13			BW	Ch.	Freq.(MHz)	5MHz	23230	782	10MHz	23230	782
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UE Category & Uplink Modulation	UE Category 3 QPSK, 16QAM																																																												
Power Class	UE Power Class 3																																																												
Description of the LTE Transmitter & antenna	<p>This model have two Tx antennas.</p> <ul style="list-style-type: none"> - Main Antenna :LTE Band 13/ LTE Band 4 - Wi-Fi Antenna : 802.11b/g/n <p>See section 11.1</p>																																																												
LTE voice/data requirements	Data Only																																																												
Identify if MPR is optional or mandatory	<p>The EUT incorporates MPR as per 3GPP TS36.101.</p> <p>The MPR is permanently built-in by design as a mandatory.</p> <p>A-MPR is not implemented.</p> <p>During SAR testing, A-MPR was disabled by setting NS=01 on the R&S CMW500.</p>																																																												
Maximum average conducted output power (dBm)	See section 10. RF conducted power measurement in the SAR report.																																																												
Identify all other U.S. wireless operating modes, device exposure configurations and frequency bands	- LTE Band 4, LTE Band 13 and WiFi 2.4 GHz : Body SAR is required																																																												
Simultaneous Transmission condition	<p>This device support simultaneous transmission.</p> <p>Main Antenna and Wi-Fi Antenna can transmit simultaneously.</p>																																																												
Power reduction explanation	This device doesn't implements power reduction.																																																												
Description of the test equipment, software, etc.	<p>LTE SAR Testing was performed using a CMW500.</p> <p>UE transmits with maximum output power during SAR testing.</p>																																																												

4. DESCRIPTION OF TEST EQUIPMENT

4.1 SAR MEASUREMENT SETUP

These measurements are performed using the DASY4 automated dosimetric assessment system. It is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland. It consists of high precision robotics system (Staubli), robot controller, Pentium III computer, near-field probe, probe alignment sensor, and the generic twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Figure.2).

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and remote control, is used to drive the robot motors. The PC consists of the HP Pentium IV 3.0 GHz computer with Windows XP system and SAR Measurement Software DASY4, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

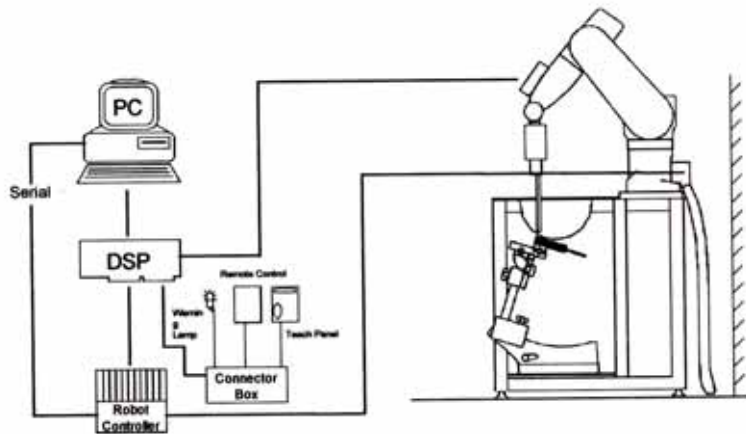


Figure 2. HCT SAR Lab. Test Measurement Set-up

The DAE4 consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in.

4.2 DASY E-FIELD PROBE SYSTEM

4.2.1 ET3DV6 Probe Specification

Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection System Built-in shielding against static charges
Calibration	In air from 10 MHz to 2.5 GHz In brain and muscle simulating tissue at Frequencies of 450 MHz, 900 MHz and 1.8 GHz (accuracy: 8 %)
Frequency	10 MHz to > 3 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)
Directivity	± 0.2 dB in brain tissue (rotation around probe axis) ± 0.4 dB in brain tissue (rotation normal probe axis)
Dynamic	5 μ W/g to > 100 mW/g;
Range Linearity:	± 0.2 dB
Surface Detection	± 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces.
Dimensions	Overall length: 330 mm Tip length: 16 mm Body diameter: 12 mm Tip diameter: 6.8 mm Distance from probe tip to dipole centers: 2.7 mm
Application	General dissymmetry up to 3 GHz Compliance tests of WCDMA/LTE Phones Fast automatic scanning in arbitrary phantoms



Figure 3. Photograph of the probe and the Phantom

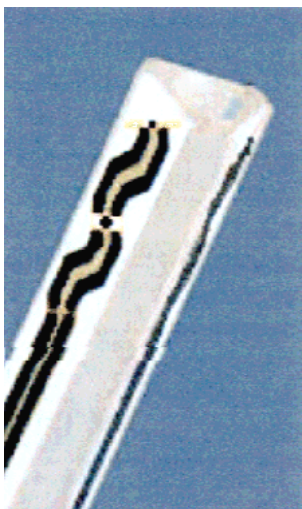


Figure 4. ET3DV6 E-field Probe

The SAR measurements were conducted with the dosimetric probe ET3DV6, designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches a maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.

4.2.2 EX3DV4 Probe Specification

Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	Basic Broad Band Calibration in air Conversion Factors (CF) for HSL 900 and HSL 1810 Additional CF for other liquids and frequencies upon request
Frequency	10 MHz to 4 GHz; Linearity: ± 0.2 dB (30 MHz to 4 GHz)
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: 330 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm
Application	General dosimetry up to 4 GHz Dosimetry in strong gradient fields Compliance tests of mobile phones



Figure 5. Photograph of the probe and the Phantom



Figure 6. EX3DV4 E-field Probe

The SAR measurements were conducted with the dosimetric probe EX3DV4, designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches a maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.

4.3 PROBE CALIBRATION PROCESS

4.3.1 E-Probe Calibration

Each probe is calibrated according to a dosimetric assessment procedure with an accuracy better than $\pm 10\%$. The spherical isotropy was evaluated with the proper procedure and found to be better than ± 0.25 dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe is tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a waveguide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C \frac{\Delta T}{\Delta t}$$

where:

Δt = exposure time (30 seconds),

C = heat capacity of tissue (brain or muscle),

ΔT = temperature increase due to RF exposure.

SAR is proportional to $\Delta T/\Delta t$, the initial rate of tissue heating, before thermal diffusion takes place.

Now it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E-field;

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

where:

σ = simulated tissue conductivity,

ρ = Tissue density (1.25 g/cm^3 for brain tissue)

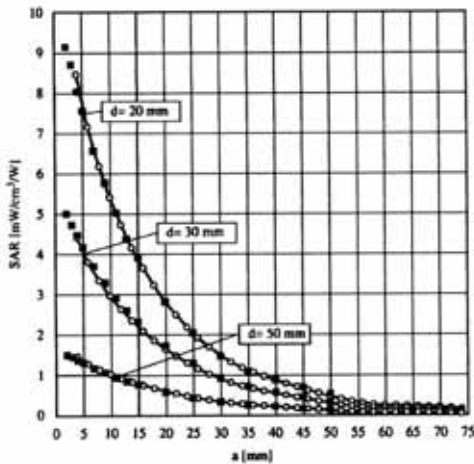


Figure 7. E-Field and Temperature measurements at 900 MHz

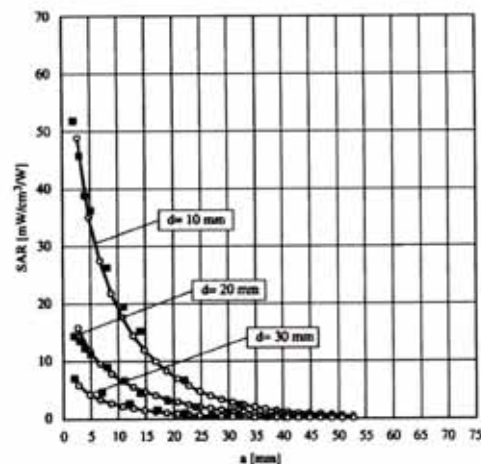


Figure 8. E-Field and temperature measurements at 1.8 GHz

4.3.2 Data Extrapolation

The DASY4 software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given like below;

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i} \quad \text{with} \quad \begin{array}{l} V_i = \text{compensated signal of channel } i \quad (i=x,y,z) \\ U_i = \text{input signal of channel } i \quad (i=x,y,z) \\ cf = \text{crest factor of exciting field} \quad (\text{DASY parameter}) \\ dcp_i = \text{diode compression poing} \quad (\text{DASY parameter}) \end{array}$$

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes: with

$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

V_i	= compensated signal of channel i	(i=x,y,z)
$Norm_i$	= sensor sensitivity of channel i	(i=x,y,z)
		$\mu\text{V}/(\text{V}/\text{m})^2$ for E-field probes
$ConvF$	= sensitivity of enhancement in solution	
E_i	= electric field strength of channel i	in V/m

The RSS value of the field components gives the total field strength (Hermetian magnitude):

$$E_{tot} = E_x^2 + E_y^2 + E_z^2$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000} \quad \text{with} \quad \begin{array}{l} SAR = \text{local specific absorption rate in W/g} \\ E_{tot} = \text{total field strength in V/m} \\ \sigma = \text{conductivity in [mho/m] or [Siemens/m]} \\ \rho = \text{equivalent tissue density in } g/\text{cm}^3 \end{array}$$

The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{3770} \quad \text{with} \quad \begin{array}{l} P_{pwe} = \text{equivalent power density of a plane wave in } w/\text{cm}^2 \\ E_{tot} = \text{total electric field strength in V/m} \end{array}$$

4.4 SAM Phantom

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.



Figure 9. SAM Phantom

Shell Thickness	2.0 mm ± 0.2 mm (6 ± 0.2 mm at ear point)
Filling Volume	about 25 L
Dimensions	810 mm x 1 000 mm x 500 mm (H x L x W)

Triple Modular Phantom consists of three identical modules which can be installed and removed separately without emptying the liquid. It includes three reference points for phantom installation. Covers prevent evaporation of the liquid. Phantom material is resistant to DGBE based tissue simulating liquids. The MFP V5.1 will be delivered including wooden support only (**non**-standard SPEAG support).

Applicable for system performance check from 700 MHz to 6 GHz (MFP V5.1C) or 800 MHz - 6 GHz (MFP V5.1A) as well as dosimetric evaluations for body-worn operation.

Shell Thickness	2.0 mm ± 0.2 mm
Filling Volume	approx. 9.2 L
Dimensions	830 mm x 500 mm (L x W)



Figure 10. MFP V5.1 Triple Modular Phantom

4.5 Device Holder for Transmitters

In combination with the SAM Phantom V 4.0, the Mounting Device (POM) enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening. The devices can be easily, accurately, and repeatably positioned according to the FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produce infinite number of configurations. To produce the Worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.



Figure 11. Device Holder

4.6 Tissue Simulating Mixture Characterization

The mixture is characterized to obtain proper dielectric constant (permittivity) and conductivity of the tissue of interest. The tissue dielectric parameters recommended in IEEE 1528 and IEC 62209 have been used as targets for the compositions, and are to match within 5%, per the FCC recommendations

Ingredients (% by weight)	Frequency (MHz)							
	750		1 800		2 450		5 200 - 5 800	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body
Water	41.1	51.7	55.2	70.2	55	68.8	65.52	78.66
Salt (NaCl)	1.4	0.9	0.3	0.4	0	0	0.0	0.0
Sugar	57.0	47.2	0.0	0	0.0	0.0	0.0	0.0
HEC	0.2	0	0.0	0	0.0	0.0	0.0	0.0
Bactericide	0.2	0.1	0.0	0	0.0	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0	0.0	17.24	10.67
DGBE	0.0	0.0	44.5	29.4	45	31.4	0.0	0.0
Diethylene glycol hexyl ether	-	-	-	-	-	-	17.24	10.67

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

Table 4.1 Composition of the Tissue Equivalent Matter

4.7 SAR TEST EQUIPMENT

Manufacturer	Type / Model	S/N	Calib. Date	Calib.Interval	Calib.Due
SPEAG	SAM Phantom	-	N/A	N/A	N/A
SPEAG	Triple Modular Phantom	-	N/A	N/A	N/A
Staubli	Robot RX90B L	F01/5K09A1/A/01	N/A	N/A	N/A
Staubli	Robot ControllerCS7MB	3403-91935	N/A	N/A	N/A
HP	Pavilion t000_puffer	KRJ51201TV	N/A	N/A	N/A
SPEAG	Light Alignment Sensor	265	N/A	N/A	N/A
Staubli	Teach Pendant (Joystick)	D221340.01	N/A	N/A	N/A
SPEAG	DAE3	446	Jan.22, 2014	Annual	Jan.22, 2015
SPEAG	E-Field Probe EX3DV4	3863	Jul. 24, 2014	Annual	Jul. 24, 2015
SPEAG	E-Field Probe EX3DV4	3968	Jan. 08, 2014	Annual	Jan. 08, 2015
SPEAG	Dipole D750V3	1014	Jul. 24, 2014	Annual	Jul. 24, 2015
SPEAG	Dipole D1800V2	2d006	Mar. 24, 2014	Annual	Mar. 24, 2015
SPEAG	Dipole D2450V2	743	Jul. 24, 2014	Annual	Jul. 24, 2015
Agilent	Power Meter(F) E4419B	MY41291386	Nov. 01, 2013	Annual	Nov. 01, 2014
Agilent	Power Sensor(G) 8481	MY41090680	Oct. 30, 2013	Annual	Oct. 30, 2014
Agilent	Dielectric Probe Kit 85070C	00721521	CBT		
HP	Dual Directional Coupler 778D	16072	Oct. 31, 2013	Annual	Oct. 31, 2014
Agilent	Base Station E5515C	GB44400269	Feb. 10, 2014	Annual	Feb. 10, 2015
HP	Signal Generator 8664A	3744A02069	Nov. 04, 2013	Annual	Nov. 04, 2014
Hewlett Packard	11636B/Power Divider	11377	Nov. 10. 2013	Annual	Nov. 10. 2014
Agilent	N9020A/ SIGNAL ANALYZER	MY50510407	Mar. 25, 2014	Annual	Mar. 25, 2015
TESCOM	TC-3000C / BLUETOOTH TESTER	3000C000276	Apr. 11, 2014	Annual	Apr. 11. 2015
HP	Network Analyzer 8753ES	JP39240221	Mar. 21, 2014	Annual	Mar. 21, 2015
R&S	Base Station CMW500	1201.0002K50_116858	Jan. 17, 2014	Annual	Jan. 17, 2015

NOTE:

1. The E-field probe was calibrated by SPEAG, by the waveguide technique procedure. Dipole Verification measurement is performed by HCT Lab. before each test. The brain/body simulating material is calibrated by HCT using the dielectric probe system and network analyzer to determine the conductivity and permittivity (dielectric constant) of the brain/body-equivalent material.

2. CBT(Calibrating Before Testing). Prior to testing, the dielectric probe kit was calibrated via the network analyzer, with the specified procedure(calibrated in pure water) and calibration kit(standard) short circuit, before the dielectric measurement. The specific procedure and calibration kit are provided by Agilent

5. SAR MEASUREMENT PROCEDURE

The evaluation was performed with the following procedure:

1. The SAR value at a fixed location above the ear point was measured and was used as a reference value for assessing the power drop.
2. The SAR distribution at the exposed side of the head was measured at a distance of 3.9 mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 15 mm x 15 mm. Based on this data, the area of the maximum absorption was determined by spline interpolation.
3. Around this point, a volume of 32 mm x 32 mm x 30 mm was assessed by measuring 5 x 5 x 7 points. On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure:
 - a. The data at the surface were extrapolated, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.
 - b. The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed using the 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y, and z directions. The volume was integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.
 - c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR value, at the same location as procedure #1, was re-measured. If the value changed by more than 5 %, the evaluation is repeated.

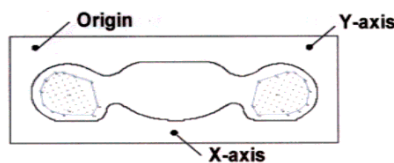


Figure 12. SAR Measurement Point in Area Scan

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 extend, 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 SASR-distribution over 10g. Area scan and zoom scan resolution setting follow KDB 865664 D01v01r03 quoted below.

		≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface		5 ± 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location		$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
Maximum area scan spatial resolution: $\Delta x_{Area}, \Delta y_{Area}$		≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
		When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be \leq the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: $\Delta x_{Zoom}, \Delta y_{Zoom}$		≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$	≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid $\Delta z_{Zoom}(1)$: between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
	$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z	≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm
<p>Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.</p> <p>* When zoom scan is required and the <i>reported</i> SAR from the area scan based <i>1-g SAR estimation</i> procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</p>			

6. MEASUREMENT UNCERTAINTY

Error Description	Tol (± %)	Prob. dist.	Div.	c_i	Standard Uncertainty (± %)	v_{eff}
1. Measurement System						
Probe Calibration	6.00	N	1	1	6.00	
Axial Isotropy	4.70	R	1.73	0.7	1.90	
Hemispherical Isotropy	9.60	R	1.73	0.7	3.88	
Boundary Effects	1.00	R	1.73	1	0.58	
Linearity	4.70	R	1.73	1	2.71	
System Detection Limits	1.00	R	1.73	1	0.58	
Readout Electronics	0.30	N	1.00	1	0.30	
Response Time	0.8	R	1.73	1	0.46	
Integration Time	2.6	R	1.73	1	1.50	
RF Ambient Conditions	3.00	R	1.73	1	1.73	
Probe Positioner	0.40	R	1.73	1	0.23	
Probe Positioning	2.90	R	1.73	1	1.67	
Max SAR Eval	1.00	R	1.73	1	0.58	
2. Test Sample Related						
Device Positioning	2.90	N	1.00	1	2.90	145
Device Holder	3.60	N	1.00	1	3.60	5
Power Drift	5.00	R	1.73	1	2.89	
3. Phantom and Setup						
Phantom Uncertainty	4.00	R	1.73	1	2.31	
Liquid Conductivity(target)	5.00	R	1.73	0.64	1.85	
Liquid Conductivity(meas.)	2.07	N	1	0.64	1.32	9
Liquid Permittivity(target)	5.00	R	1.73	0.6	1.73	
Liquid Permittivity(meas.)	5.02	N	1	0.6	3.01	9
Combine Standard Uncertainty					11.13	
Coverage Factor for 95 %					$k=2$	
Expanded STD Uncertainty					22.25	

Table 7.1 Uncertainty (700 MHz- 2 450 MHz)

7. ANSI/ IEEE C95.1 - 1992 RF EXPOSURE LIMITS

HUMAN EXPOSURE	UNCONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT Occupational (W/kg) or (mW/g)
SPATIAL PEAK SAR * (Brain)	1.60	8.00
SPATIAL AVERAGE SAR ** (Whole Body)	0.08	0.40
SPATIAL PEAK SAR *** (Hands / Feet / Ankle / Wrist)	4.00	20.00

Table 8.1 Safety Limits for Partial Body Exposure

NOTES:

- * The Spatial Peak value of the SAR averaged over any 1 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
- ** The Spatial Average value of the SAR averaged over the whole-body.
- *** The Spatial Peak value of the SAR averaged over any 10 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e.as a result of employment or occupation).

8. SAR SYSTEM VALIDATION

Per FCC KCB 865664 D02v01r01, SAR system validation status should be document to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in IEEE 1528-2003 and FCC KDB 865664 D01v01r03. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

SAR System #	Probe	Probe Type	Probe Calibration Point		Dipole	Date	Dielectric Parameters		CW Validation			Modulation Validation		
							Measured Permittivity	Measured conductivity	Sensitivity	Probe Linearity	Probe Isortopy	MOD. Type	Duty Factor	PAR
1	3968	EX3DV4	Body	750	1014	Aug. 01,2014	55.4	0.99	PASS	PASS	PASS	N/A	N/A	N/A
1	3863	EX3DV4	Body	1800	2d006	Aug.06,2014	53.5	1.52	PASS	PASS	PASS	N/A	N/A	N/A
1	3863	EX3DV4	Body	2450	743	Aug.06,2014	53.2	1.95	PASS	PASS	PASS	OFDM	N/A	PASS

SAR System Validation Summary

Note;

All measurement were performed using probes calibrated for CW signal only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01r03. SAR system were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (>5 dB), such as OFDM according to KDB 865664 D01v01r03.

9. SYSTEM VERIFICATION

9.1 Tissue Verification

Freq. [MHz]	Date	Liquid	Liquid Temp. [°C]	Parameters	Target Value	Measured Value	Deviation [%]	Limit [%]
750	Sep. 16 , 2014	Body	18.9	ϵr	55.5	54.5	- 1.80	± 5
				σ	0.96	0.98	+ 2.08	± 5
1 800	Sep. 15 , 2014	Body	19.9	ϵr	53.3	51.2	- 3.94	± 5
				σ	1.52	1.51	- 0.66	± 5
2 450	Sep. 17 , 2014	Body	20.4	ϵr	52.7	52.1	- 1.14	± 5
				σ	1.95	1.88	- 3.59	± 5

The Tissue dielectronic parameters were measured prior to the SAR evaluation using an 85070C Dielectronic Probe Kit and Network Analyzer.

9.2 System Verification

Prior to assessment, the system is verified to the ± 10 % of the specifications at 750 MHz, 1 800 MHz, 2 450 MHz by using the system Verification kit. (Graphic Plots Attached)

[System Verification Results]

Freq. [MHz]	Probe (SN)	Dipole (SN)	Date	Liquid	Liquid Temp. [°C]	1 W Target SAR _{1g} [mW/g]	Measured SAR _{1g} [mW/g]	1 W Normalized SAR _{1g} (mW/g)	Deviation [%]	Limit [%]
750	3968	1014	Sep. 16 , 2014	Body	18.9	8.63	0.860	8.57	- 0.35	± 10
1 800	3863	2d006	Sep. 15 , 2014	Body	19.9	38.1	3.84	38.4	+ 0.79	± 10
2 450	3863	743	Sep. 17 , 2014	Body	20.4	51.3	5	50	- 2.53	± 10

9.3 System Verification Procedure

SAR measurement was prior to assessment, the system is verified to the ± 10 % of the specifications at each frequency band by using the system Verification kit. (Graphic Plots Attached)

- Cabling the system, using the Verification kit equipments.
- Generate about 100 mW Input Level from the Signal generator to the Dipole Antenna.
- Dipole Antenna was placed below the Flat phantom.
- The measured one-gram SAR at the surface of the phantom above the dipole feed-point should be within 10 % of the target reference value.
- The results are normalized to 1 W input power.

Note;

SAR Verification was performed according to the FCC KDB 865664 D01v01r03.

10. RF CONDUCTED POWER MEASUREMENT

Power measurements were performed using a base station simulator under digital average power. The handset was placed into a simulated call using a base station simulator in a shielded chamber. Such test signals offer a consistent means for testing SAR and are recommended for evaluation SAR. SAR measurements were taken with a fully charged battery. In order to verify that the device was tested and maintained at full power, this was configured with the base station simulator. The SAR measurement Software calculates a reference point at the start and end of the test to check for power drifts. If conducted Power deviations of more than 5 % occurred, the tests were repeated.

10.1 Output Power Specifications.

LTE

Mode/Band	LTE Band 4	LTE Band 13
Target Power	21.7 dBm	23.3 dBm
Tune-up Tolerance : -1.5 dB/ +0.5 dB		

Wifi

Wifi (Average Power)	Mode / Band		
	2.4 GHz		
	802.11b	802.11g	802.11n
Target Power	13 dBm	13 dBm	13 dBm
Tune-up Tolerance : -1 dB/ +1 dB			

10.2 LTE

SAR testing was performed according to the FCC KDB 941225 D05v02r03 publication.

The RB2-U770 developed base on MPR. The MPR is mandatory.

The device will not operate with any other MPR setting than that stated in the table as indicated.

SAR Testing was performed using a CMW500. UE transmits with Maximum output power during SAR testing.

A-MPR has been disabled for all SAR tests by setting NS=01 on the R&S CMW500.

- LTE Band 4

Bandwidth	Modulation	RB Size	RB Offset	Max.Average Power (dBm)		
				19975	20175	20375
				1712.5 MHz	1732.5 MHz	1752.5 MHz
5MHz	QPSK	1	0	21.97	22.07	22.04
		1	12	22.00	21.96	21.90
		1	24	21.94	21.82	21.85
		12	0	20.95	20.88	20.81
		12	6	20.97	20.86	20.80
		12	11	20.92	20.75	20.73
		25	0	20.90	20.81	20.78
	16QAM	1	0	21.12	21.26	21.18
		1	12	21.12	21.07	21.05
		1	24	21.15	21.03	21.02
		12	0	20.02	19.96	19.84
		12	6	20.03	19.92	19.84
		12	11	19.98	19.85	19.82
		25	0	20.04	19.92	19.89

Bandwidth	Modulation	RB Size	RB Offset	Max.Average Power (dBm)		
				20000	20175	20350
				1715 MHz	1732.5 MHz	1750 MHz
10MHz	QPSK	1	0	22.01	22.07	22.12
		1	24	22.01	21.97	21.99
		1	49	22.02	21.88	21.81
		25	0	20.95	20.96	20.98
		25	12	21.00	20.90	20.87
		25	24	21.04	20.80	20.79
		50	0	20.93	20.86	20.82
	16QAM	1	0	21.20	21.20	21.20
		1	24	21.19	21.07	21.14
		1	49	21.20	20.95	20.94
		25	0	20.05	20.02	20.02
		25	12	20.05	19.92	19.93
		25	24	20.09	19.87	19.83
		50	0	20.04	19.95	19.93

Bandwidth	Modulation	RB Size	RB Offset	Max.Average Power (dBm)		
				20025	20175	20325
				1717.5 MHz	1732.5 MHz	1747.5 MHz
15MHz	QPSK	1	0	22.04	22.18	22.03
		1	36	22.08	21.94	21.94
		1	74	21.21	21.69	21.69
		36	0	21.02	21.01	20.94
		36	18	21.01	20.85	20.93
		36	36	20.96	20.76	20.67
		75	0	20.91	20.79	20.80
	16QAM	1	0	21.20	21.20	21.20
		1	36	21.15	21.15	21.08
		1	74	21.10	20.8	20.86
		36	0	20.03	20.02	19.98
		36	18	20.05	19.89	19.94
		36	38	19.99	19.79	19.80
		75	0	20.04	19.94	19.89

Bandwidth	Modulation	RB Size	RB Offset	Max.Average Power (dBm)		
					20175	
					1732.5 MHz	
20MHz	QPSK	1	0		22.16	
		1	49		21.89	
		1	99		21.66	
		50	0		21.00	
		50	25		20.85	
		50	49		20.74	
		100	0		20.83	
	16QAM	1	0		21.20	
		1	49		21.18	
		1	99		21.06	
		50	0		20.06	
		50	25		19.91	
		50	49		19.78	
		100	0		19.91	

Note: LTE Band 4 (AWS) at 20 MHz Bandwidth does not support three non-overlapping channels. Per KDB 941225 D05v02r03, when a device supports overlapping channel assignment in a channel bandwidth configuration, the mid channel of the group of overlapping channels should be selected for testing.

- LTE Band 13

Bandwidth	Modulation	RB Size	RB Offset	Max.Average Power (dBm)		
					23230	
					782 MHz	
5MHz	QPSK	1	0		23.72	
		1	12		23.66	
		1	24		23.73	
		12	0		22.38	
		12	6		22.31	
		12	11		22.31	
		25	0		22.36	
	16QAM	1	0		22.56	
		1	12		22.71	
		1	24		22.78	
		12	0		21.33	
		12	6		21.37	
		12	11		21.31	
		25	0		21.31	

Bandwidth	Modulation	RB Size	RB Offset	Max.Average Power (dBm)		
					23230	
					782 MHz	
10MHz	QPSK	1	0		23.70	
		1	24		23.66	
		1	49		23.67	
		25	0		22.23	
		25	12		22.27	
		25	24		22.31	
		50	0		22.31	
	16QAM	1	0		22.54	
		1	24		22.71	
		1	49		22.74	
		25	0		21.29	
		25	12		21.23	
		25	24		21.26	
		50	0		21.18	

Note: LTE Band 13 at 5MHz/10MHz Bandwidth does not support three non-overlapping channels. Per KDB 941225 D05v02r03, when a device supports overlapping channel assignment in a channel bandwidth configuration, the mid channel of the group of overlapping channels should be selected for testing.

Note;

The EUT enables maximum power reduction in accordance with 3GPP 36.101. The MPR settings are configured during the manufacture process and are not configurable by the network, carrier, or end user.

10.3 WiFi

10.3.1 SAR Testing for 802.11b/g/n modes

General Device Setup

Normal Network operating configurations are not suitable for measuring the SAR of 802.11 a/b/g transmitters. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable.

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

Frequency Channel Configurations

802.11 a/b/g and 4.9 GHz operating modes are tested independently according to the service requirements in each frequency band. 802.11 b/g modes are tested on channels 1, 6 and 11. 802.11a is tested for UNII operations on channels 36 and 48 in the 5.15-5.25 GHz band; channels 52 and 64 in the 5.25-5.35 GHz band; Channels 104, 116, 124 and 136 in the 5.470-5.725 GHz band; and channels 149 and 161 in the 5.8 GHz band. When 5.8 GHz § 15.247 is also available, channels 149, 157 and 165 should be tested instead of the UNII channels. 4.9 GHz is tested on channels 1, 10 and 5 or 6, whichever has the higher output power, for 5 MHz channels; channels 11, 15 and 19 for 10 MHz channels; and channels 21 and 25 for 20 MHz channels. These are referred to as the “default test channels”. 802.11g mode was evaluated only if the output power was 0.25 dB higher than the 802.11b mode.

Mode	GHz	Channel	Turbo Channel	“Default Test Channels”		UNII	
				§15.247			
				802.11b	802.11g		
802.11b/g	2.412	1#		√			
	2.437	6	6	√			
	2.462	11#		√			
802.11a	5.18	36				√	
	5.20	40	42 (5.21 GHz)				*
	5.22	44					*
	5.24	48	50 (5.25 GHz)			√	
	5.26	52				√	
	5.28	56	58 (5.29 GHz)				*
	5.30	60					*
	5.32	64				√	
	5.500	100	Unknown				*
	5.520	104				√	
	5.540	108					*
	5.560	112					*
	5.580	116				√	
	5.600	120					*
	5.620	124				√	
	5.640	128					*
	5.660	132					*
	5.680	136					√
	5.700	140					*
	UNII or §15.247	5.745	149		√		√
5.765		153	152 (5.76 GHz)		*		*
5.785		157		√			*
5.805		161	160 (5.80 GHz)		*	√	
§15.247	5.825	165		√			

802.11 Test Channels per FCC Requirements

IEEE 802.11b Average RF Power

Mode	Freq. [MHz]	Channel	802.11b (2.4 GHz) Conducted Power [dBm]			
			Data Rate (Mbps)			
			1	2	5.5	11
802.11b	2412	1	13.20	13.29	13.20	13.20
	2437	6	12.35	12.45	12.43	12.56
	2462	11	12.56	12.55	12.56	12.54

IEEE 802.11g Average RF Power

Mode	Freq. [MHz]	Channel	802.11g (2.4 GHz) Conducted Power [dBm]							
			Data Rate (Mbps)							
			6	9	12	18	24	36	48	54
802.11g	2412	1	13.02	13.06	13.07	13.12	13.12	13.11	13.19	13.18
	2437	6	12.99	13.00	13.02	13.12	13.12	12.59	12.77	12.68
	2462	11	12.69	12.72	12.74	12.87	12.83	12.76	12.97	12.91

IEEE 802.11n Average RF Power

Mode	Freq. [MHz]	Channel	802.11n (2.4 GHz) Conducted Power [dBm]							
			Data Rate (Mbps)							
			6.5	13	19.5	26	39	52	58.5	65
802.11n (20MHz)	2412	1	12.91	12.93	13.07	13.11	13.26	13.25	13.30	13.38
	2437	6	13.06	13.00	13.23	13.19	12.93	12.91	12.88	12.94
	2462	11	12.81	12.82	13.02	13.01	13.15	13.14	13.03	12.83

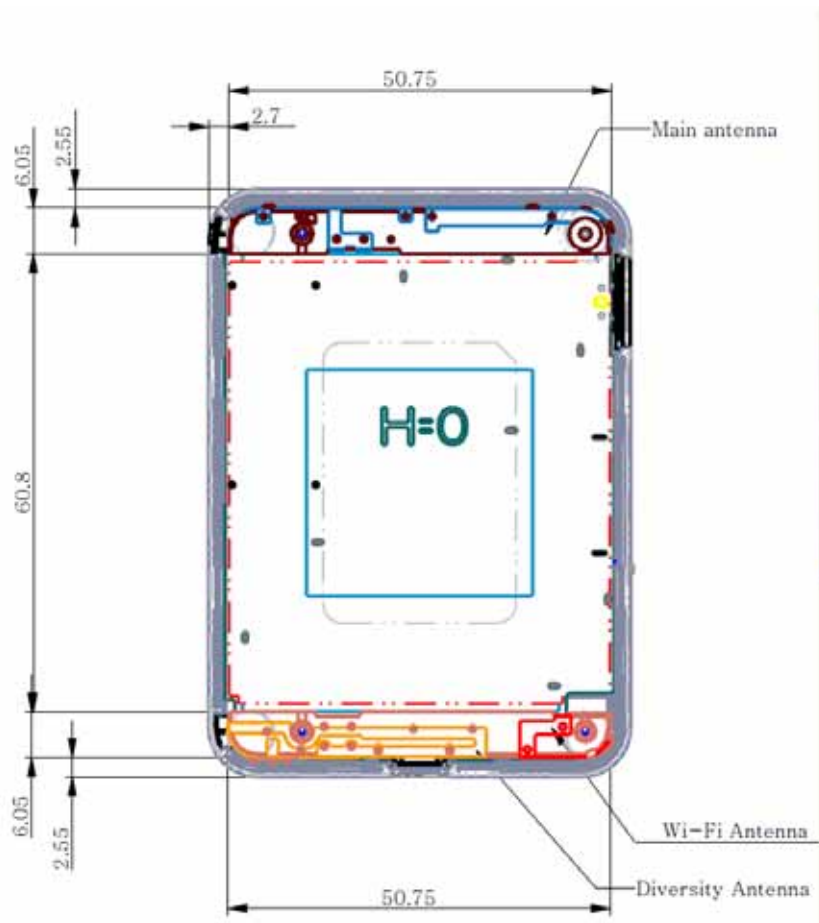
11. SAR Test configuration & Antenna information

11.1 Mobile Hotspot sides for SAR Testing configurations

Mode	Rear	Front	Left	Right	Bottom	Top
LTE Band 4	Yes	Yes	Yes	Yes	No	Yes
LTE Band 13	Yes	Yes	Yes	Yes	No	Yes
2.4 GHz WLAN	Yes	Yes	Yes	Yes	Yes	No

Note; All test configurations are based on front view.

11.2 Antenna and Device Information



Note;

1. Per FCC KDB Publication 941225 D06v01r01, we performed the SAR testing at 0.5 cm from the top & bottom surfaces and also from side edges with a transmitting antenna 2.5 cm from an edge.

*Please see the MHS800L_Antenna distance for further information

12. SAR TEST DATA SUMMARY

12.1 Measurement Results (LTE Band 4 20MHz Hotspot SAR)

Frequency		Mode	Power (dBm)		Power Drift (dB)	Configuration	RB Size	RB Offset	Separation Distance	Measured SAR (mW/g)	Scaling Factor	Scaled SAR (mW/g)	Plot No.
MHz	Ch.		Tune-Up Limit	Conducted Power									
1 732.5	20175	QPSK	22.2	22.16	0.010	Rear	1	0	0.5 cm	0.786	1.009	0.793	-
1 732.5	20175		21.2	21.00	0.080	Rear	50	0	0.5 cm	0.639	1.047	0.669	-
1 732.5	20175		22.2	22.16	-0.029	Front	1	0	0.5 cm	0.779	1.009	0.786	-
1 732.5	20175		21.2	21.00	-0.021	Front	50	0	0.5 cm	0.634	1.047	0.664	-
1 732.5	20175		22.2	22.16	-0.165	Left	1	0	0.5 cm	0.424	1.009	0.428	-
1 732.5	20175		21.2	21.00	-0.077	Left	50	0	0.5 cm	0.339	1.047	0.355	-
1 732.5	20175		22.2	22.16	-0.112	Right	1	0	0.5 cm	0.372	1.009	0.375	-
1 732.5	20175		21.2	21.00	-0.010	Right	50	0	0.5 cm	0.291	1.047	0.305	-
1 732.5	20175		22.2	22.16	-0.026	Top	1	0	0.5 cm	0.811	1.009	0.819	1
1 732.5	20175		21.2	21.00	-0.076	Top	50	0	0.5 cm	0.652	1.047	0.683	-
1 732.5	20175		21.2	20.83	-0.003	Top	100	0	0.5 cm	0.687	1.089	0.748	-
ANSI/ IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure/ General Population							Body 1.6 W/kg (mW/g) Averaged over 1 gram						

12.2 Measurement Results (LTE Band 13 10MHz Hotspot SAR)

Frequency		Mode	Power (dBm)		Power Drift (dB)	Configuration	RB Size	RB Offset	Separation Distance	Measured SAR (mW/g)	Scaling Factor	Scaled SAR (mW/g)	Plot No.	
MHz	Ch.		Tune-Up Limit	Conducted Power										
782	23230	QPSK	23.8	23.70	-0.018	Rear	1	0	0.5 cm	0.812	1.023	0.831	-	
782	23230		22.8	22.31	0.000	Rear	25	24	0.5 cm	0.617	1.119	0.691	-	
782	23230		22.8	22.31	0.009	Rear	50	0	0.5 cm	0.604	1.119	0.676	-	
782	23230		23.8	23.70	-0.124	Front	1	0	0.5 cm	1.08	1.023	1.105	2	
782	23230		22.8	22.31	0.032	Front	25	24	0.5 cm	0.772	1.119	0.864	-	
782	23230		22.8	22.31	0.014	Front	50	0	0.5 cm	0.763	1.119	0.854	-	
782	23230		23.8	23.70	-0.070	Left	1	0	0.5 cm	0.470	1.023	0.481	-	
782	23230		22.8	22.31	-0.024	Left	25	24	0.5 cm	0.345	1.119	0.386	-	
782	23230		23.8	23.70	-0.098	Right	1	0	0.5 cm	0.459	1.023	0.470	-	
782	23230		22.8	22.31	0.020	Right	25	24	0.5 cm	0.337	1.119	0.377	-	
782	23230		23.8	23.70	0.161	Top	1	0	0.5 cm	0.479	1.023	0.490	-	
782	23230		22.8	22.31	-0.051	Top	25	24	0.5 cm	0.368	1.119	0.412	-	
ANSI/ IEEE C95.1 1992 – Safety Limit Spatial Peak Uncontrolled Exposure/ General Population							Body 1.6 W/kg (mW/g) Averaged over 1 gram							

12.3 Measurement Results (WLAN Hotspot SAR)

Frequency		Mode	Power (dBm)		Power Drift (dB)	Configuration	Data Rate	Separation Distance	Measured SAR (mW/g)	Scaling Factor	Scaled SAR (mW/g)	Plot No.
MHz	Ch.		Tune-Up Limit	Conducted Power								
2412	1	802.11b	14	13.20	0.154	Rear	1Mbps	0.5 cm	0.106	1.202	0.127	-
			14	13.20	0.108	Front	1Mbps	0.5 cm	0.071	1.202	0.085	-
			14	13.20	0.103	Left	1Mbps	0.5 cm	0.110	1.202	0.132	3
			14	13.20	0.12	Right	1Mbps	0.5 cm	0.000367	1.202	0.000	-
			14	13.20	-0.035	Bottom	1Mbps	0.5 cm	0.071	1.202	0.085	-
ANSI/ IEEE C95.1 - 1992– Safety Limit Spatial Peak Uncontrolled Exposure/ General Population							Body 1.6 W/kg (mW/g) Averaged over 1 gram					

12.4 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2003, FCC KDB Procedure.
2. Batteries are fully charged at the beginning of the SAR measurements. A standard battery was used for all SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB 447498 D01v05r02.
6. Per FCC KDB 865664 D01v01r03, variability SAR tests were performed .Please see Section 13 for variability analysis information.
7. Device was tested using a fixed spacing for hotspot testing. A separation distance of 5 mm was considered because FCC KDB Publication 941225 D06v01r01 where SAR test consideration for devices(Lx W 9cm.x 5cm) are based on a composite test separation distance of 5 mm from the front, back and edges of the device containing transmitting antennas within 2.5cm of their edges.

LTE Notes:

1. LTE Considerations: LTE test configurations are determined according to SAR Evaluation Consideration for LTE Devices in FCC KDB 941225 D05v02r03.
2. According to FCC KDB 941225 D05v02r01:
 - i. When the reported SAR is ≤ 0.8 W/kg, testing of the 100%RB allocation and required test channels is not required. Otherwise, SAR is required for the remaining required test channels using the 1RB, 50%RB and 100%RB allocation with highest output power for that channel.
 - ii. Only one channel, and as reported SAR values for 1RB allocation and 50%RB allocation were less than 1.45W/Kg only the highest power RB offset for each allocation was required.
3. MPR is permanently implemented for this device by the manufacturer. The specific manufacturer target MPR is indicated alongside the SAR results. MPR is enabled for this device, according to target MPR is indicated alongside the SAR results.
4. A-MPR was disabled for all SAR tests by setting NS=01 on the base station simulator.
5. Pre-installed VOIP applications are considered.
6. SAR test reduction is applied using the following criteria:
 - Start with the largest channel bandwidth and measure SAR for QPSK with 1 RB, and 50% RB allocation, using the RB offset and required test channel combination with the highest maximum output power among RB offsets at the upper edge, middle and lower edge of each required test channel.
 - When the reported SAR is >0.8 W/kg, testing for other Channels is performed at the highest output power level for 1RB, and 50% RB configuration for that channel.
 - Testing for 100% RB configuration is performed at the highest output power level for 100% RB configuration across the Low, Mid and High Channel when the highest reported SAR for 1 RB and 50% RB are >0.8 W/kg, Testing for the remaining required channels is not needed because the reported SAR for 100% RB Allocation <1.45 W/kg.
 - Testing for 16-QAM modulation is not required because the reported SAR for QPSK is <1.45 W/kg and its output power is not more than 0.5 dB higher than that a QPSK.
 - Testing for the other channel bandwidths is not required because the reported SAR for the highest channel bandwidth is <1.45 W/kg and its output power is not more than 0.5 dB higher than that of the highest channel bandwidth.

WLAN Notes:

1. Justification for reduced test configurations for WIFI channels per KDB 248227 D01v01r02 and Oct. 2012 FCC/TCB Meeting Notes for 2.4 GHz WIFI: Highest average RF output power channel for the lowest data rate was selected for SAR evaluation in 802.11b. Other IEEE 802.11 modes (including 802.11 g/n) were not investigated since the average output powers over all channels and data rates were not more than 0.25 dB higher than the tested channel in the lowest data rate of IEEE 802.11b mode.
2. Since the maximum extrapolated peak SAR of the zoom scan for the maximum output channel was ≤ 1.6 W/kg and the reported 1g averaged SAR was < 0.8 W/kg, SAR testing on other default channels was not required.

13. SAR Measurement Variability and Uncertainty

In accordance with published RF Exposure KDB procedure 865664 D01v01r03 SAR measurement 100 MHz to 6 GHz. 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.

- 1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
- 2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
- 3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10 % from the 1-g SAR limit).
- 4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

Frequency		Modulation	Battery	Configuration	RB Size	RB Offset	Original SAR(mW/g)	Repeated SAR(mW/g)	Largest to Smallest SAR Ratio	Plot No.
MHz	Channel									
1 732.5	20175	LTE 4	Standard	Top	1	0	0.811	0.806	1.01	4
782	23230	LTE 13	Standard	Front	1	0	1.08	1.03	1.05	5

Note(s):

- 1) Second Repeated Measurement is not required since the ratio of the largest to smallest SAR for the original and first repeated measurement is not > 1.20.
- 2) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg.

14. SAR Summation Scenario

	Position	Applicable Combination	Note
Simultaneous Transmission	Body	LTE Band 4 + 2.4 GHz WiFi	Hotspot
		LTE Band 13 + 2.4 GHz WiFi	Hotspot

14.1 Simultaneous Transmission Summation for Hotspot

Simultaneous Transmission Summation with 2.4 GHz WIFI (0.5 cm)

Band	configuration	Scaled SAR (W/kg)	2.4 GHz WIFI Scaled SAR (W/kg)	Σ 1-g SAR (W/kg)
LTE Band 4	Rear	0.793	0.127	0.920
	Front	0.786	0.085	0.871
	Left	0.428	0.132	0.560
	Right	0.375	0.000	0.375
	Bottom		0.085	0.085
	Top	0.819		0.819
LTE Band 13	Rear	0.831	0.127	0.958
	Front	1.105	0.085	1.19
	Left	0.481	0.132	0.613
	Right	0.470	0.000	0.470
	Bottom		0.085	0.085
	Top	0.490		0.490

14.2 Simultaneous Transmission Conclusion

The above numerical summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit. And therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v05r02.

15. CONCLUSION

The SAR measurement indicates that the EUT complies with the RF radiation exposure limits of the ANSI/IEEE C95.1 1992.

These measurements are taken to simulate the RF effects exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests.

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Attachment 1. – SAR Test Plots

Test Laboratory: HCT CO., LTD
EUT Type: Mobile Router
Liquid Temperature: 19.9
Ambient Temperature: 20.1
Test Date: Sep.15, 2014
Plot No. 1

DUT: MHS800L

Communication System: LTE Band 4; Frequency: 1732.5 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 1732.5$ MHz; $\sigma = 1.44$ mho/m; $\epsilon_r = 51.4$; $\rho = 1000$ kg/m³
Phantom section: Center Section
Measurement Standard: DAS4 (High Precision Assessment)

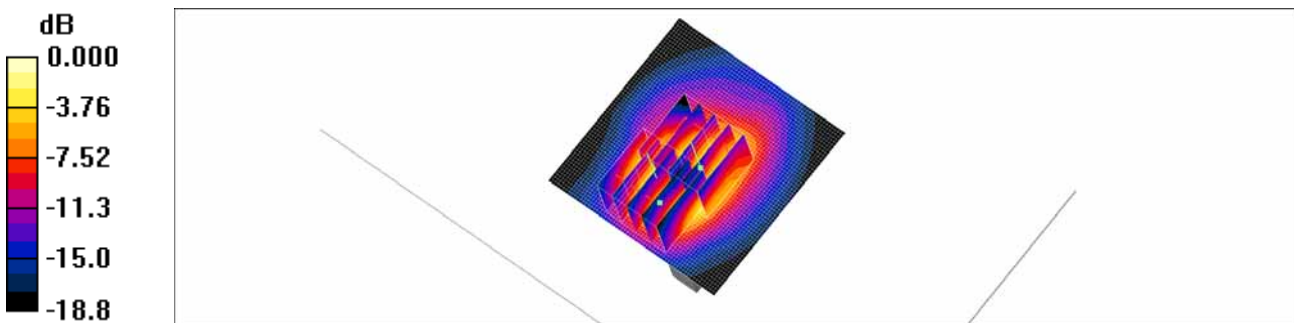
DASY4 Configuration:

- Probe: EX3DV4 - SN3863; ConvF(7.8, 7.8, 7.8); Calibrated: 2014-07-24
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2014-01-22
- Phantom: Triple Flat Phantom 5.1C_20120905; Type: QD 000 P51 CA;
- Measurement SW: DASY4, V4.7 Build 80;

LTE4 Body Top QPSK 20MHz 1RB 0offset 20175/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.13 mW/g

LTE4 Body Top QPSK 20MHz 1RB 0offset 20175/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 27.2 V/m; Power Drift = -0.026 dB
Peak SAR (extrapolated) = 1.33 W/kg
SAR(1 g) = 0.784 mW/g; SAR(10 g) = 0.449 mW/g
Maximum value of SAR (measured) = 1.05 mW/g

LTE4 Body Top QPSK 20MHz 1RB 0offset 20175/Zoom Scan (5x5x7)/Cube 1: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 27.2 V/m; Power Drift = -0.026 dB
Peak SAR (extrapolated) = 1.42 W/kg
SAR(1 g) = 0.811 mW/g; SAR(10 g) = 0.414 mW/g
Maximum value of SAR (measured) = 1.25 mW/g



0 dB = 1.25mW/g

Test Laboratory: HCT CO., LTD
 EUT Type: Mobile Router
 Liquid Temperature: 18.9
 Ambient Temperature: 19.1
 Test Date: Sep.16, 2014
 Plot No. 2

DUT: MHS800L; Type: bar

Communication System: LTE; Frequency: 782 MHz;Duty Cycle: 1:1
 Medium parameters used (interpolated): $f = 782 \text{ MHz}$; $\sigma = 1.01 \text{ mho/m}$; $\epsilon_r = 54.2$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Center Section
 Measurement Standard: DASY4 (High Precision Assessment)

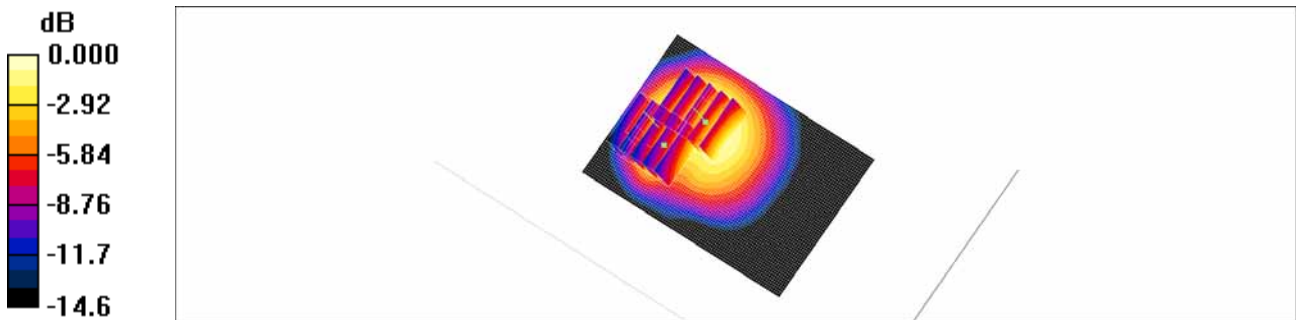
DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(9.74, 9.74, 9.74); Calibrated: 2014-01-08
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2014-01-22
- Phantom: Triple Flat Phantom 5.1C_20120905; Type: QD 000 P51 CA;
- Measurement SW: DASY4, V4.7 Build 80;

LTE13 Body Front QPSK 10MHz 1RB 0offset 23230/Area Scan (61x91x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$
 Maximum value of SAR (interpolated) = 1.44 mW/g

LTE13 Body Front QPSK 10MHz 1RB 0offset 23230/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$
 Reference Value = 27.9 V/m; Power Drift = -0.124 dB
 Peak SAR (extrapolated) = 1.64 W/kg
SAR(1 g) = 1.08 mW/g; SAR(10 g) = 0.700 mW/g
 Maximum value of SAR (measured) = 1.37 mW/g

LTE13 Body Front QPSK 10MHz 1RB 0offset 23230/Zoom Scan (5x5x7)/Cube 1: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$
 Reference Value = 27.9 V/m; Power Drift = -0.124 dB
 Peak SAR (extrapolated) = 1.64 W/kg
SAR(1 g) = 0.951 mW/g; SAR(10 g) = 0.546 mW/g
 Maximum value of SAR (measured) = 1.26 mW/g



0 dB = 1.26mW/g

Test Laboratory: HCT CO., LTD
EUT Type: Mobile Router
Liquid Temperature: 20.4
Ambient Temperature: 20.6
Test Date: Sep.17, 2014
Plot No. 3

DUT: MHS800L;

Communication System: 2450MHz FCC; Frequency: 2412 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 2412$ MHz; $\sigma = 1.83$ mho/m; $\epsilon_r = 52.3$; $\rho = 1000$ kg/m³
Phantom section: Center Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: EX3DV4 - SN3863; ConvF(6.97, 6.97, 6.97); Calibrated: 2014-07-24
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2014-01-22
- Phantom: Triple Flat Phantom 5.1C_20120905; Type: QD 000 P51 CA;
- Measurement SW: DASY4, V4.7 Build 80;

WiFi2450 Body Left 1ch 1Mbps/Area Scan (51x81x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.161 mW/g

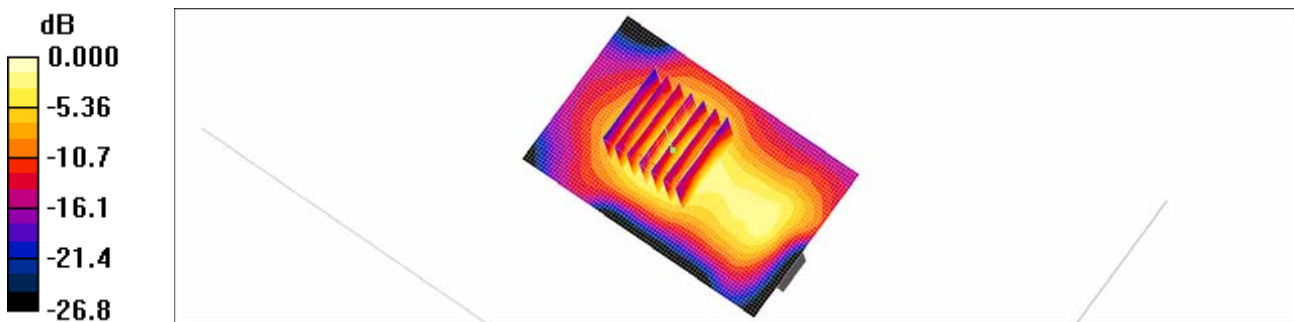
WiFi2450 Body Left 1ch 1Mbps/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 8.98 V/m; Power Drift = 0.103 dB

Peak SAR (extrapolated) = 0.214 W/kg

SAR(1 g) = 0.110 mW/g; SAR(10 g) = 0.055 mW/g

Maximum value of SAR (measured) = 0.161 mW/g



Test Laboratory: HCT CO., LTD
EUT Type: Mobile Router
Liquid Temperature: 19.9
Ambient Temperature: 20.1
Test Date: Sep.15, 2014
Plot No. 4

DUT: MHS800L;

Communication System: LTE Band 4; Frequency: 1732.5 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): $f = 1732.5$ MHz; $\sigma = 1.44$ mho/m; $\epsilon_r = 51.4$; $\rho = 1000$ kg/m³
Phantom section: Center Section
Measurement Standard: DASYS4 (High Precision Assessment)

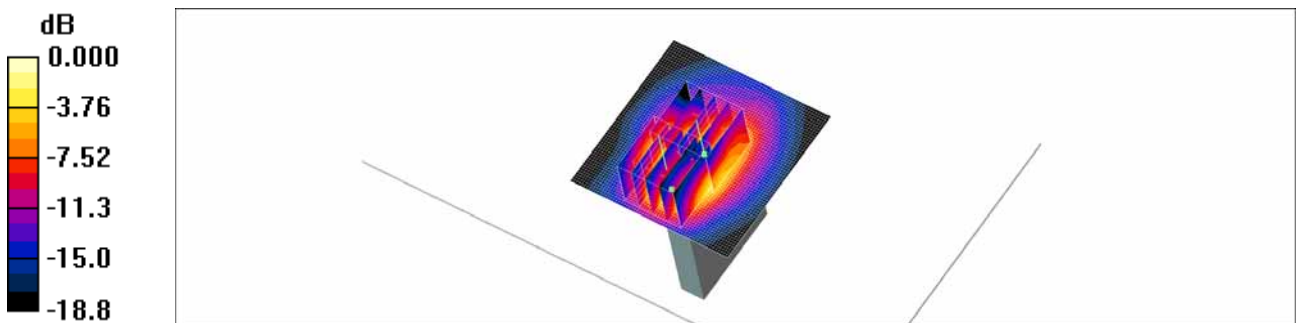
DASY4 Configuration:

- Probe: EX3DV4 - SN3863; ConvF(7.8, 7.8, 7.8); Calibrated: 2014-07-24
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2014-01-22
- Phantom: Triple Flat Phantom 5.1C_20120905; Type: QD 000 P51 CA;
- Measurement SW: DASYS4, V4.7 Build 80;

LTE4 Body Top QPSK 20MHz 1RB 0offset 20175/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.12 mW/g

LTE4 Body Top QPSK 20MHz 1RB 0offset 20175/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 27.2 V/m; Power Drift = -0.032 dB
Peak SAR (extrapolated) = 1.34 W/kg
SAR(1 g) = 0.787 mW/g; SAR(10 g) = 0.454 mW/g
Maximum value of SAR (measured) = 1.07 mW/g

LTE4 Body Top QPSK 20MHz 1RB 0offset 20175/Zoom Scan (5x5x7)/Cube 1: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 27.2 V/m; Power Drift = -0.032 dB
Peak SAR (extrapolated) = 1.42 W/kg
SAR(1 g) = 0.806 mW/g; SAR(10 g) = 0.412 mW/g
Maximum value of SAR (measured) = 1.24 mW/g



0 dB = 1.24mW/g

Test Laboratory: HCT CO., LTD
 EUT Type: Mobile Router
 Liquid Temperature: 18.9
 Ambient Temperature: 19.1
 Test Date: Sep.16, 2014
 Plot No. 5

DUT: MHS800L; Type: bar

Communication System: LTE; Frequency: 782 MHz; Duty Cycle: 1:1
 Medium parameters used (interpolated): $f = 782 \text{ MHz}$; $\sigma = 1.01 \text{ mho/m}$; $\epsilon_r = 54.2$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Center Section
 Measurement Standard: DASY4 (High Precision Assessment)

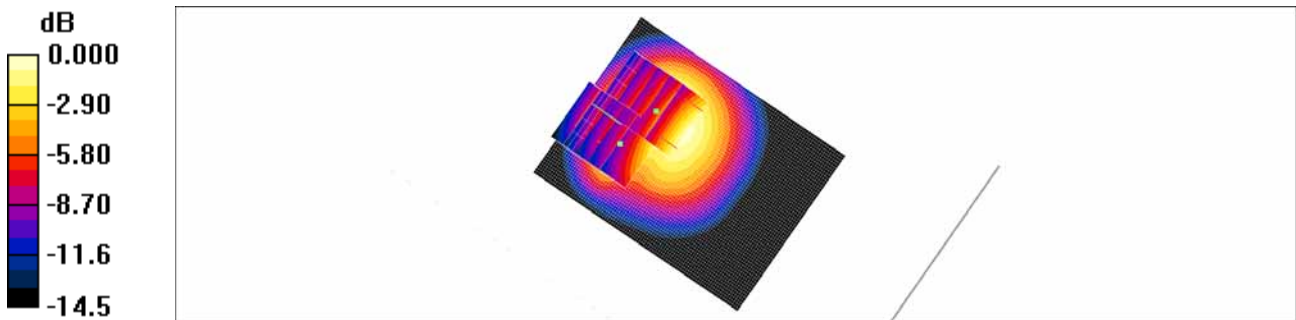
DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(9.74, 9.74, 9.74); Calibrated: 2014-01-08
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2014-01-22
- Phantom: Triple Flat Phantom 5.1C_20120905; Type: QD 000 P51 CA;
- Measurement SW: DASY4, V4.7 Build 80;

LTE13 Body Front QPSK 10MHz 1RB 0offset 23230/Area Scan (61x91x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$
 Maximum value of SAR (interpolated) = 1.37 mW/g

LTE13 Body Front QPSK 10MHz 1RB 0offset 23230/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$
 Reference Value = 27.2 V/m; Power Drift = 0.017 dB
 Peak SAR (extrapolated) = 1.68 W/kg
SAR(1 g) = 1.03 mW/g; SAR(10 g) = 0.673 mW/g
 Maximum value of SAR (measured) = 1.32 mW/g

LTE13 Body Front QPSK 10MHz 1RB 0offset 23230/Zoom Scan (5x5x7)/Cube 1: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$
 Reference Value = 27.2 V/m; Power Drift = 0.017 dB
 Peak SAR (extrapolated) = 1.59 W/kg
SAR(1 g) = 0.932 mW/g; SAR(10 g) = 0.537 mW/g
 Maximum value of SAR (measured) = 1.22 mW/g



0 dB = 1.22mW/g

Attachment 2. – Dipole Verification Plots

■ Verification Data (750 MHz Body)

Test Laboratory: HCT CO., LTD
 Input Power: 100 mW (20 dBm)
 Liquid Temp: 18.9
 Test Date: Sep. 16, 2014

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1014

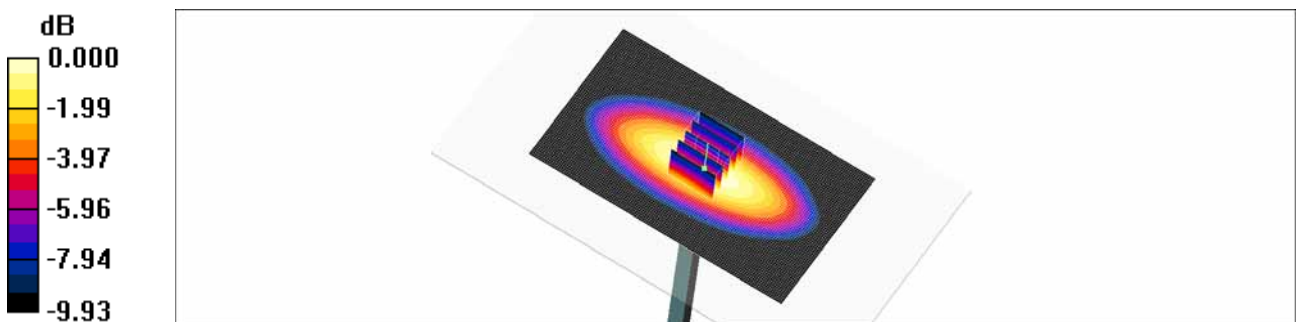
Communication System: CW; Frequency: 750 MHz; Duty Cycle: 1:1
 Medium parameters used: $f = 750 \text{ MHz}$; $\sigma = 0.98 \text{ mho/m}$; $\epsilon_r = 54.5$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Center Section
 Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: EX3DV4 - SN3968; ConvF(9.74, 9.74, 9.74); Calibrated: 2014-01-08
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2014-01-22
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA;
- Measurement SW: DASY4, V4.7 Build 80;

Verification 750 MHz/Area Scan (121x71x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$
 Maximum value of SAR (interpolated) = 0.921 mW/g

Verification 750 MHz/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$
 Reference Value = 30.9 V/m; Power Drift = -0.025 dB
 Peak SAR (extrapolated) = 1.26 W/kg
SAR(1 g) = 0.860 mW/g; SAR(10 g) = 0.572 mW/g
 Maximum value of SAR (measured) = 0.928 mW/g



0 dB = 0.928mW/g

■ Verification Data (1800 MHz Body)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 19.9
Test Date: Sep. 15, 2014

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN:2d006

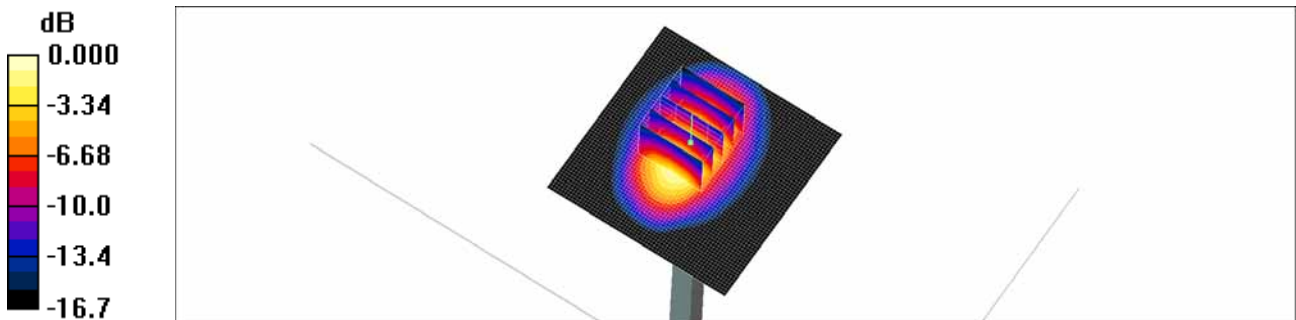
Communication System: CW; Frequency: 1800 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 1800 \text{ MHz}$; $\sigma = 1.51 \text{ mho/m}$; $\epsilon_r = 51.2$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Center Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: EX3DV4 - SN3863; ConvF(7.8, 7.8, 7.8); Calibrated: 2014-07-24
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2014-01-22
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA;
- Measurement SW: DASY4, V4.7 Build 80;

Verification 1800 MHz/Area Scan (61x61x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$
Maximum value of SAR (interpolated) = 4.72 mW/g

Verification 1800 MHz/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$
Reference Value = 48.5 V/m; Power Drift = -0.026 dB
Peak SAR (extrapolated) = 6.76 W/kg
SAR(1 g) = 3.84 mW/g; SAR(10 g) = 2.05 mW/g
Maximum value of SAR (measured) = 4.29 mW/g



0 dB = 4.29mW/g

■ Verification Data (2 450 MHz Body)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 20.4
Test Date: Sep. 17, 2014

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:743

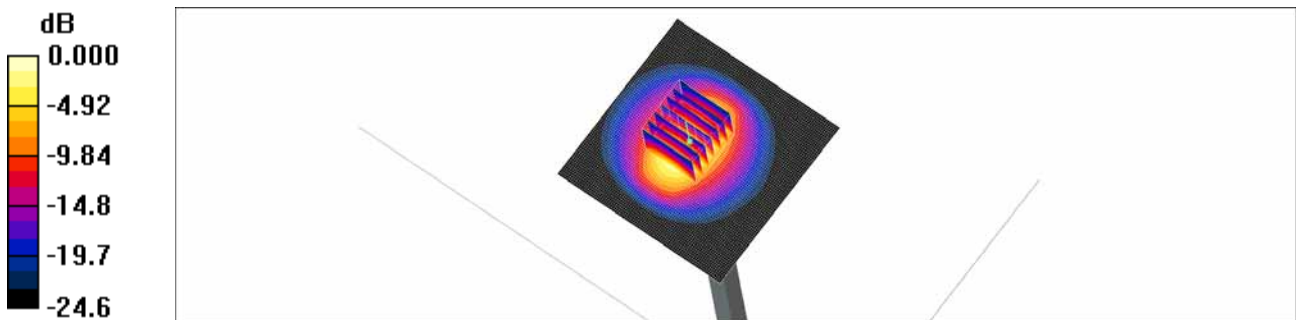
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.88$ mho/m; $\epsilon_r = 52.1$; $\rho = 1000$ kg/m³
Phantom section: Center Section
Measurement Standard: DASy4 (High Precision Assessment)

DASy4 Configuration:

- Probe: EX3DV4 - SN3863; ConvF(6.97, 6.97, 6.97); Calibrated: 2014-07-24
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn446; Calibrated: 2014-01-22
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA;
- Measurement SW: DASy4, V4.7 Build 80;

Verification 2450MHz/Area Scan (81x81x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 8.06 mW/g

Verification 2450MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 47.9 V/m; Power Drift = -0.084 dB
Peak SAR (extrapolated) = 11.2 W/kg
SAR(1 g) = 5 mW/g; SAR(10 g) = 2.22 mW/g
Maximum value of SAR (measured) = 7.93 mW/g



0 dB = 7.93mW/g

Attachment 3. – Probe Calibration Data

**Calibration Laboratory of
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Zeughausstrasse 43, 8004 Zurich, Switzerland



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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 **HCT (Dymstec)**

Certificate No: **EX3-3863_Jul14**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3863**

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: **July 24, 2014**

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	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-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-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: July 24, 2014

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

**Calibration Laboratory of
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Accredited by the Swiss Accreditation Service (SAS)
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Accreditation No.: **SCS 108**

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
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- **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.
- **Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

EX3DV4 – SN:3863

July 24, 2014

Probe EX3DV4

SN:3863

Manufactured: February 2, 2012
Calibrated: July 24, 2014

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

EX3DV4- SN:3863

July 24, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3863

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.37	0.35	0.45	± 10.1 %
DCP (mV) ^B	99.8	98.7	100.6	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√ μV	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	133.0	±2.5 %
		Y	0.0	0.0	1.0		131.3	
		Z	0.0	0.0	1.0		149.9	

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.

EX3DV4- SN:3863

July 24, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3863

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^f	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth ^h (mm)	Unct. (k=2)
835	41.5	0.90	9.50	9.50	9.50	0.80	0.50	± 12.0 %
900	41.5	0.97	9.21	9.21	9.21	0.59	0.71	± 12.0 %
1450	40.5	1.20	8.50	8.50	8.50	0.66	0.65	± 12.0 %
1750	40.1	1.37	8.38	8.38	8.38	0.75	0.58	± 12.0 %
1900	40.0	1.40	8.02	8.02	8.02	0.78	0.59	± 12.0 %
1950	40.0	1.40	7.71	7.71	7.71	0.56	0.70	± 12.0 %
2300	39.5	1.67	7.48	7.48	7.48	0.54	0.69	± 12.0 %
2450	39.2	1.80	7.15	7.15	7.15	0.70	0.59	± 12.0 %
2600	39.0	1.96	7.05	7.05	7.05	0.50	0.74	± 12.0 %
5200	36.0	4.66	4.98	4.98	4.98	0.40	1.80	± 13.1 %
5300	35.9	4.76	4.77	4.77	4.77	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.76	4.76	4.76	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.58	4.58	4.58	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.55	4.55	4.55	0.45	1.80	± 13.1 %

^c Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

^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.

^h 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.

EX3DV4- SN:3863

July 24, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3863

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^f	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth ^g (mm)	Unct. (k=2)
835	55.2	0.97	9.43	9.43	9.43	0.80	0.61	± 12.0 %
1750	53.4	1.49	7.80	7.80	7.80	0.52	0.75	± 12.0 %
1900	53.3	1.52	7.36	7.36	7.36	0.26	1.18	± 12.0 %
2450	52.7	1.95	6.97	6.97	6.97	0.80	0.50	± 12.0 %
2600	52.5	2.16	6.87	6.87	6.87	0.63	0.50	± 12.0 %
5200	49.0	5.30	4.50	4.50	4.50	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.27	4.27	4.27	0.40	1.90	± 13.1 %
5500	48.6	5.65	4.01	4.01	4.01	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.83	3.83	3.83	0.45	1.90	± 13.1 %
5800	48.2	6.00	4.07	4.07	4.07	0.50	1.90	± 13.1 %

^c Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

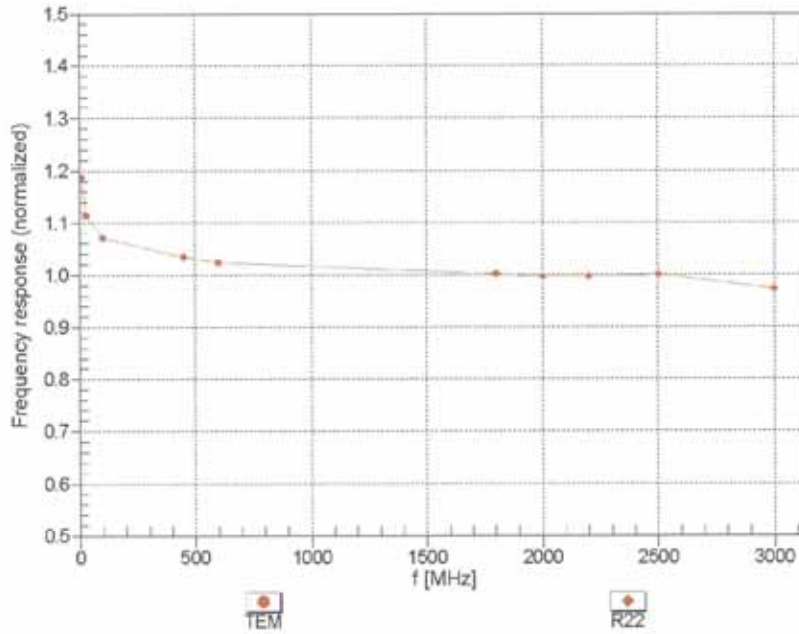
^f At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty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

^g Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:3863

July 24, 2014

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



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

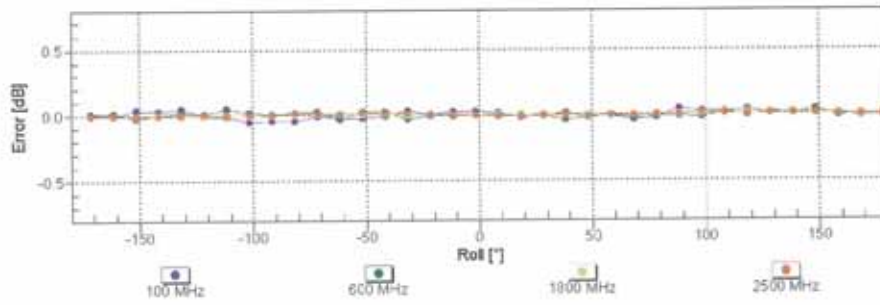
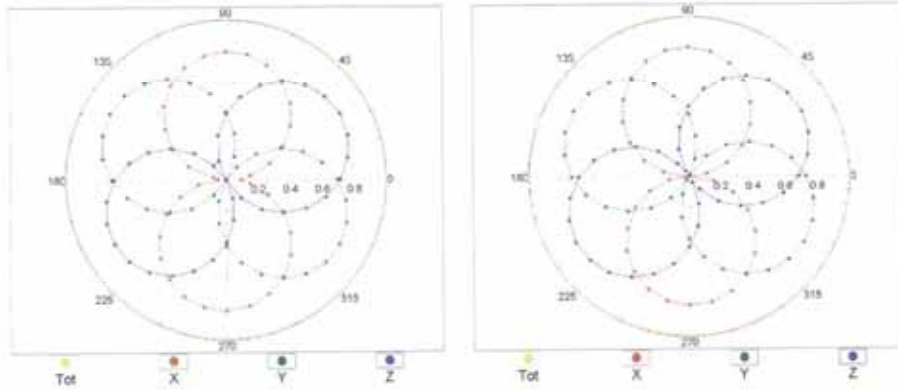
EX3DV4- SN:3863

July 24, 2014

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

f=600 MHz, TEM

f=1800 MHz, R22

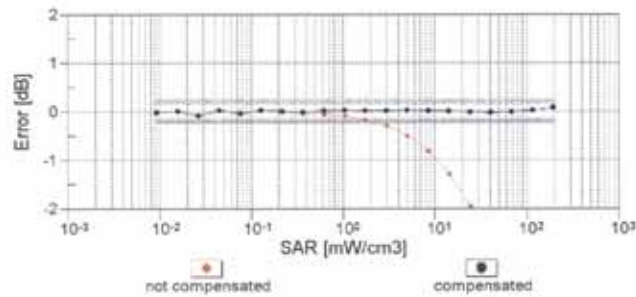
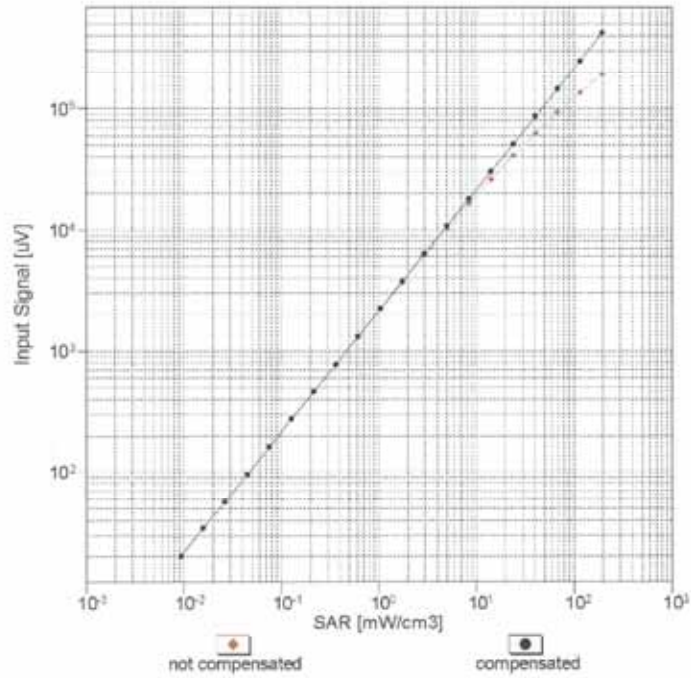


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

EX3DV4- SN:3863

July 24, 2014

Dynamic Range f(SAR_{head})
(TEM cell , f_{eval}= 1900 MHz)

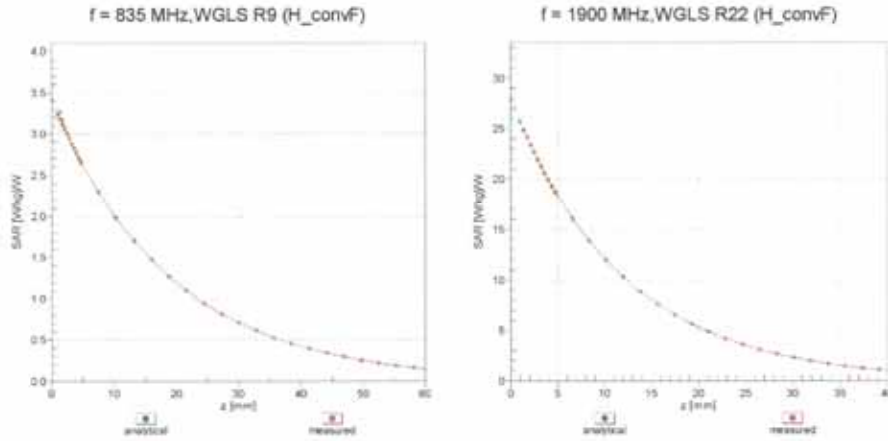


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

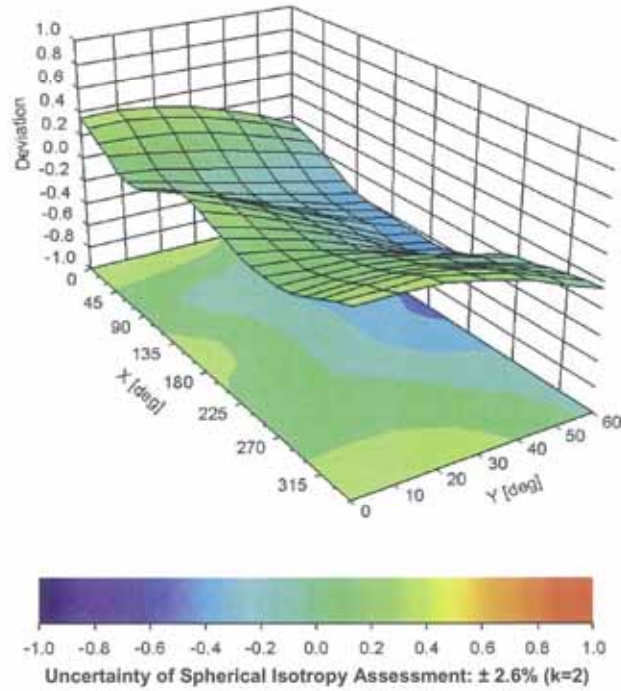
EX3DV4- SN:3863

July 24, 2014

Conversion Factor Assessment



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



EX3DV4- SN:3863

July 24, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3863**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-71.6
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	1.4 mm

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Accreditation No.: **SCS 108**

Client **HCT (Dymstec)**

Certificate No: **EX3-3968_Jan14**

CALIBRATION CERTIFICATE

Object: **EX3DV4 - SN:3968**

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: **January 8, 2014**

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	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-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-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	<i>Leif Klysner</i>
Approved by:	Katja Pokovic	Technical Manager	<i>Katja Pokovic</i>

Issued: January 8, 2014

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Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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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., $\theta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- **NORM_{x,y,z}**: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ 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.
- **Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).

EX3DV4 – SN:3968

January 8, 2014

Probe EX3DV4

SN:3968

Manufactured: September 30, 2013
Calibrated: January 8, 2014

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

EX3DV4- SN:3968

January 8, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3968

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.36	0.35	0.42	$\pm 10.1 \%$
DCP (mV) ^B	105.5	102.2	97.1	

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	133.2	$\pm 2.7 \%$
		Y	0.0	0.0	1.0		135.7	
		Z	0.0	0.0	1.0		142.2	

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.

EX3DV4- SN:3968

January 8, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3968

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^f	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth (mm) ^g	Unct. (k=2)
750	41.9	0.89	10.28	10.28	10.28	0.33	0.94	± 12.0 %
835	41.5	0.90	9.87	9.87	9.87	0.32	1.03	± 12.0 %
900	41.5	0.97	9.71	9.71	9.71	0.47	0.81	± 12.0 %
1450	40.5	1.20	8.58	8.58	8.58	0.68	0.64	± 12.0 %
1750	40.1	1.37	8.15	8.15	8.15	0.80	0.59	± 12.0 %
1900	40.0	1.40	7.91	7.91	7.91	0.76	0.59	± 12.0 %
1950	40.0	1.40	7.69	7.69	7.69	0.80	0.50	± 12.0 %
2450	39.2	1.80	7.10	7.10	7.10	0.39	0.81	± 12.0 %
2600	39.0	1.96	7.04	7.04	7.04	0.23	1.19	± 12.0 %
5200	36.0	4.66	5.14	5.14	5.14	0.40	1.80	± 13.1 %
5300	35.9	4.76	4.89	4.89	4.89	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.86	4.86	4.86	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.52	4.52	4.52	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.58	4.58	4.58	0.40	1.80	± 13.1 %

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

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

^g Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:3968

January 8, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3968

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth (mm) ^G	Unct. (k=2)
750	55.5	0.96	9.74	9.74	9.74	0.54	0.79	± 12.0 %
835	55.2	0.97	9.66	9.66	9.66	0.24	1.35	± 12.0 %
1750	53.4	1.49	7.93	7.93	7.93	0.63	0.68	± 12.0 %
1900	53.3	1.52	7.59	7.59	7.59	0.28	1.07	± 12.0 %
2450	52.7	1.95	7.31	7.31	7.31	0.76	0.56	± 12.0 %
2600	52.5	2.16	6.96	6.96	6.96	0.65	0.50	± 12.0 %
5200	49.0	5.30	4.66	4.66	4.66	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.28	4.28	4.28	0.50	1.90	± 13.1 %
5500	48.6	5.65	4.01	4.01	4.01	0.50	1.90	± 13.1 %
5600	48.5	5.77	4.17	4.17	4.17	0.40	1.90	± 13.1 %
5800	48.2	6.00	4.11	4.11	4.11	0.50	1.90	± 13.1 %

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

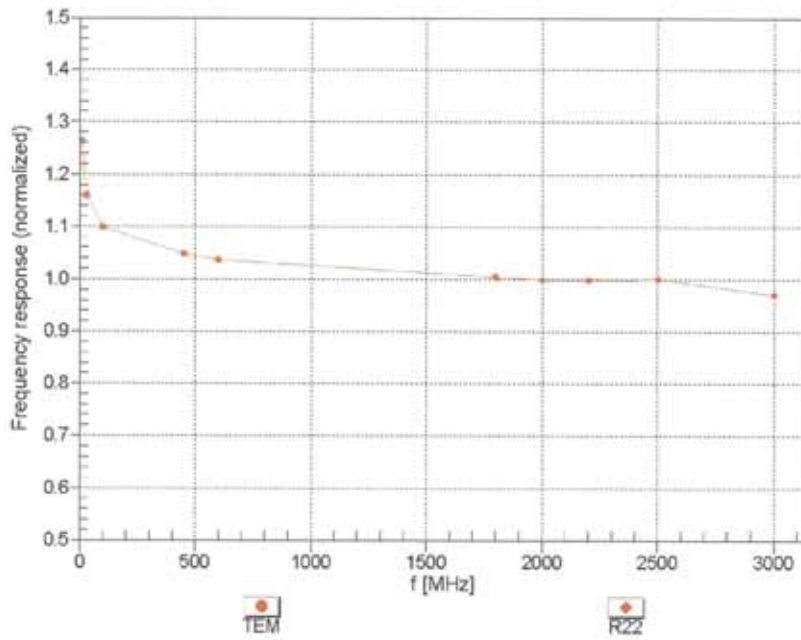
^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty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

^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:3968

January 8, 2014

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



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

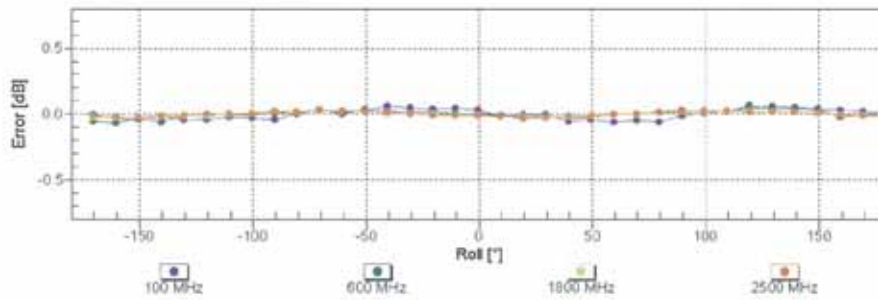
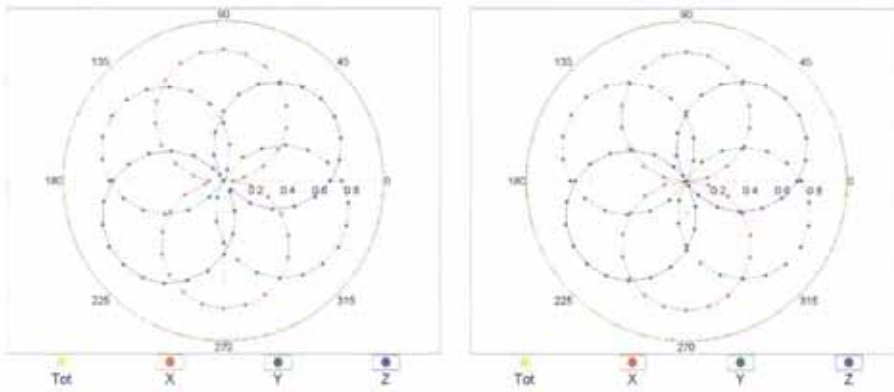
EX3DV4- SN:3968

January 8, 2014

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

f=600 MHz, TEM

f=1800 MHz, R22

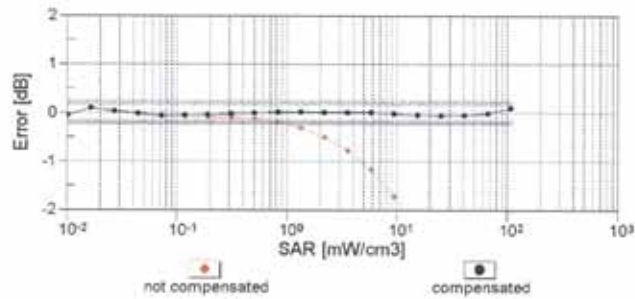
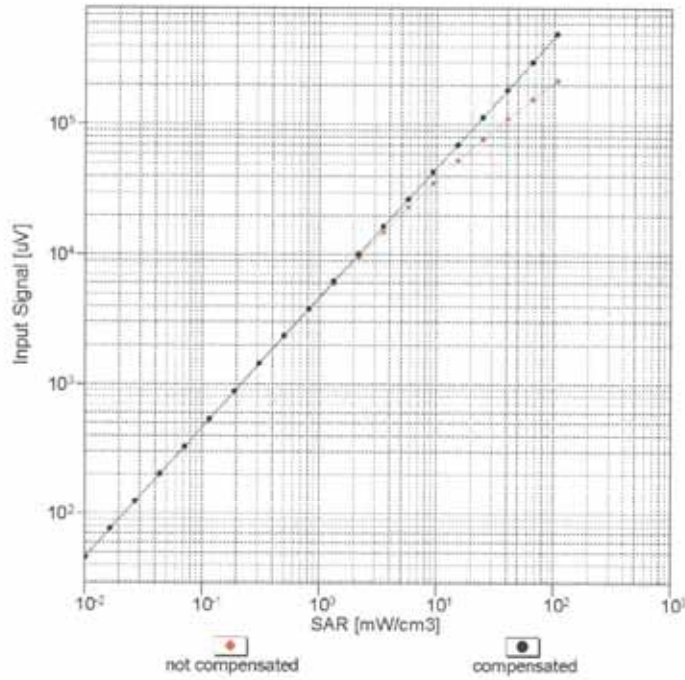


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

EX3DV4- SN:3968

January 8, 2014

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

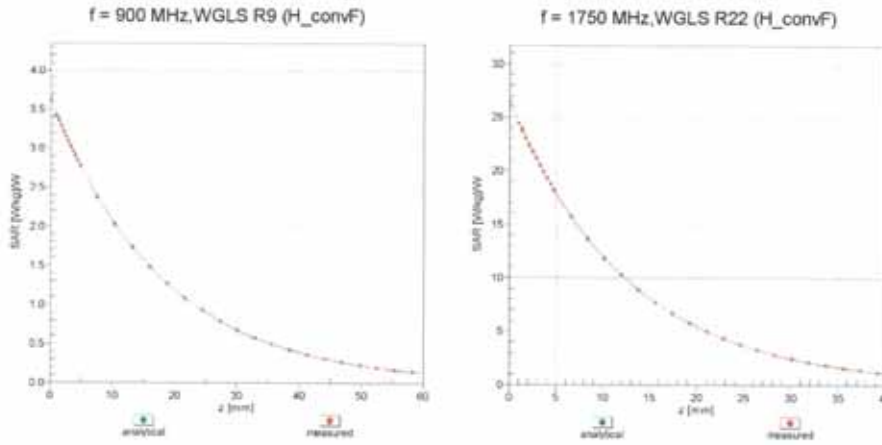


Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

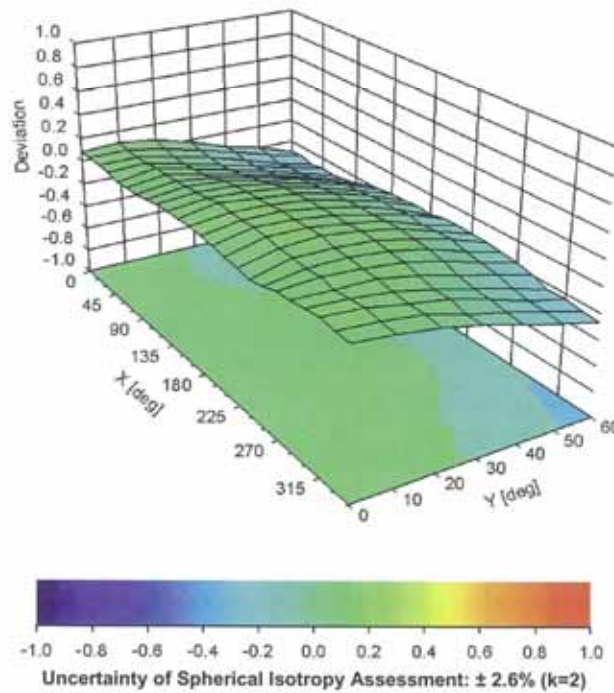
EX3DV4-- SN:3968

January 8, 2014

Conversion Factor Assessment



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



EX3DV4- SN:3968

January 8, 2014

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3968**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-120.5
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

Attachment 4. – Dipole Calibration Data

**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 **HCT (Dymstec)**

Certificate No: **D750V3-1014_Jul14**

CALIBRATION CERTIFICATE																																															
Object	D750V3 - SN: 1014																																														
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz																																														
Calibration date:	July 24, 2014																																														
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility; environment temperature (22 ± 3)°C and humidity < 70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p> <table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date (Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power meter EPM-442A</td> <td>GB37480704</td> <td>09-Oct-13 (No. 217-01827)</td> <td>Oct-14</td> </tr> <tr> <td>Power sensor HP 8481A</td> <td>US37282783</td> <td>09-Oct-13 (No. 217-01827)</td> <td>Oct-14</td> </tr> <tr> <td>Power sensor HP 8481A</td> <td>MY41092317</td> <td>09-Oct-13 (No. 217-01828)</td> <td>Oct-14</td> </tr> <tr> <td>Reference 20 dB Attenuator</td> <td>SN: 5058 (20k)</td> <td>03-Apr-14 (No. 217-01918)</td> <td>Apr-15</td> </tr> <tr> <td>Type-N mismatch combination</td> <td>SN: 5047.2 / 06327</td> <td>03-Apr-14 (No. 217-01921)</td> <td>Apr-15</td> </tr> <tr> <td>Reference Probe ES3DV3</td> <td>SN: 3205</td> <td>30-Dec-13 (No. ES3-3205_Dec13)</td> <td>Dec-14</td> </tr> <tr> <td>DAE4</td> <td>SN: 601</td> <td>30-Apr-14 (No. DAE4-601_Apr14)</td> <td>Apr-15</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Secondary Standards</th> <th>ID #</th> <th>Check Date (in house)</th> <th>Scheduled Check</th> </tr> </thead> <tbody> <tr> <td>RF generator R&S SMT-06</td> <td>100005</td> <td>04-Aug-99 (in house check Oct-13)</td> <td>In house check: Oct-16</td> </tr> <tr> <td>Network Analyzer HP 8753E</td> <td>US37390585 S4205</td> <td>18-Oct-01 (in house check Oct-13)</td> <td>In house check: Oct-14</td> </tr> </tbody> </table>				Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14	Power sensor HP 8481A	US37282783	09-Oct-13 (No. 217-01827)	Oct-14	Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14	Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15	Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15	Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14	DAE4	SN: 601	30-Apr-14 (No. DAE4-601_Apr14)	Apr-15	Secondary Standards	ID #	Check Date (in house)	Scheduled Check	RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16	Network Analyzer HP 8753E	US37390585 S4205	18-Oct-01 (in house check Oct-13)	In house check: Oct-14
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Calibrated by:	Name Claudio Leubler	Function Laboratory Technician	Signature 																																												
Approved by:	Name Katja Pokovic	Function Technical Manager	Signature 																																												
Issued: July 24, 2014																																															
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.																																															

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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 1528-2013, "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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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.

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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	750 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.9	0.89 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.2 ± 6 %	0.92 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.14 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.31 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.47 W/kg ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.5	0.96 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.9 ± 6 %	1.00 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.24 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	8.63 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.48 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	5.75 W/kg ± 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.2 Ω + 2.5 j Ω
Return Loss	- 26.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.4 Ω + 0.3 j Ω
Return Loss	- 43.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.037 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	March 22, 2010

DASY5 Validation Report for Head TSL

Date: 24.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1014

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used: $f = 750$ MHz; $\sigma = 0.92$ S/m; $\epsilon_r = 41.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.37, 6.37, 6.37); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

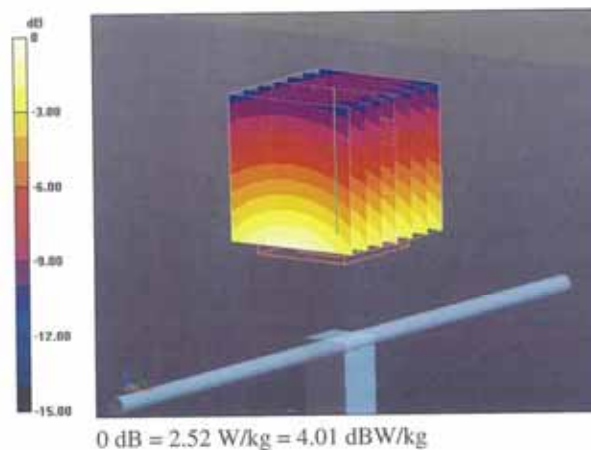
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 53.98 V/m; Power Drift = 0.01 dB

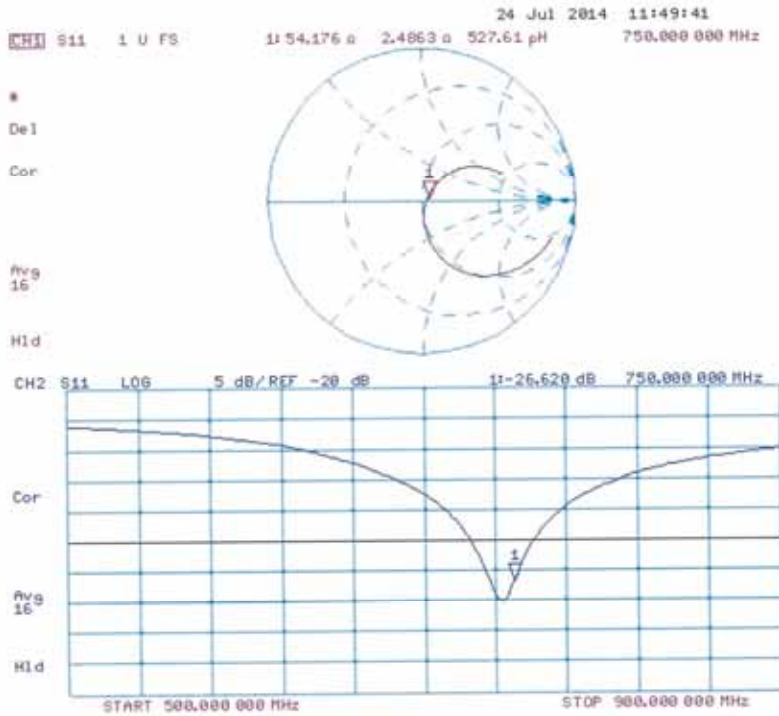
Peak SAR (extrapolated) = 3.23 W/kg

SAR(1 g) = 2.14 W/kg; SAR(10 g) = 1.4 W/kg

Maximum value of SAR (measured) = 2.52 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 17.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1014

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used: $f = 750$ MHz; $\sigma = 1$ S/m; $\epsilon_r = 53.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.13, 6.13, 6.13); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

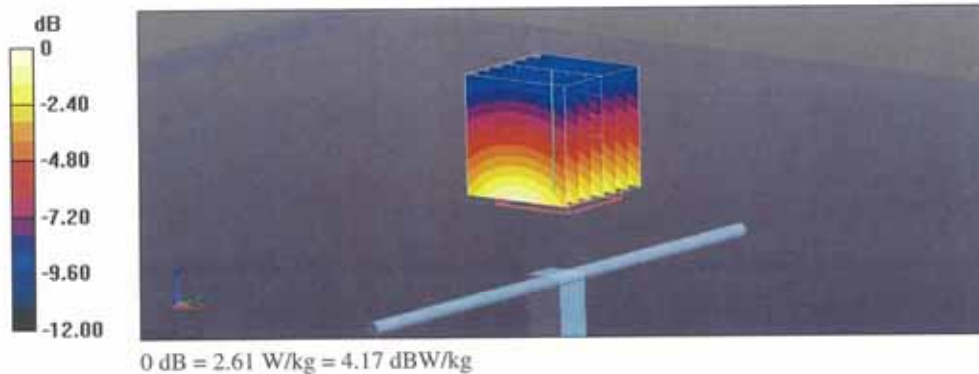
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 52.83 V/m; Power Drift = 0.01 dB

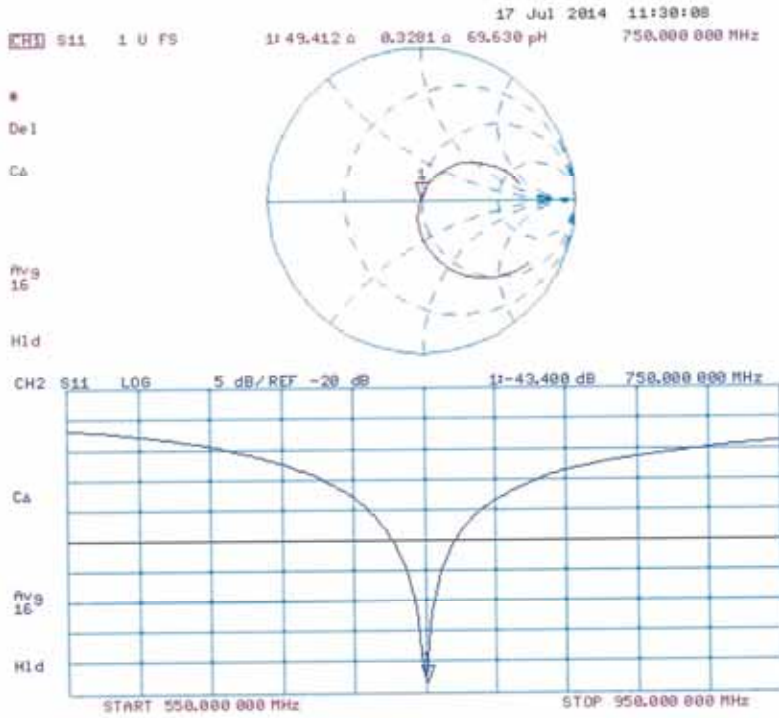
Peak SAR (extrapolated) = 3.28 W/kg

SAR(1 g) = 2.24 W/kg; SAR(10 g) = 1.48 W/kg

Maximum value of SAR (measured) = 2.61 W/kg



Impedance Measurement Plot for Body TSL



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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **HCT (Dymstec)**

Certificate No: **D1800V2-2d006_Mar14**

CALIBRATION CERTIFICATE			
Object	D1800V2 - SN: 2d006		
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz		
Calibration date:	March 24, 2014		
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p>			
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14
Calibrated by:	Name Israe El-Naouq	Function Laboratory Technician	Signature
Approved by:	Katja Pokovic	Technical Manager	
			Issued: March 24, 2014
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Zeughausstrasse 43, 8004 Zurich, Switzerland



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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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1800 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.7 ± 6 %	1.40 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.60 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	38.1 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.02 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.0 W/kg ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.5 ± 6 %	1.55 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.67 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	38.1 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.11 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.2 W/kg ± 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	47.7 Ω - 7.0 j Ω
Return Loss	- 22.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	43.7 Ω - 6.9 j Ω
Return Loss	- 20.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.208 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	July 23, 2001

DASY5 Validation Report for Head TSL

Date: 24.03.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN: 2d006

Communication System: UID 0 - CW; Frequency: 1800 MHz

Medium parameters used: $f = 1800$ MHz; $\sigma = 1.4$ S/m; $\epsilon_r = 38.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.09, 5.09, 5.09); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

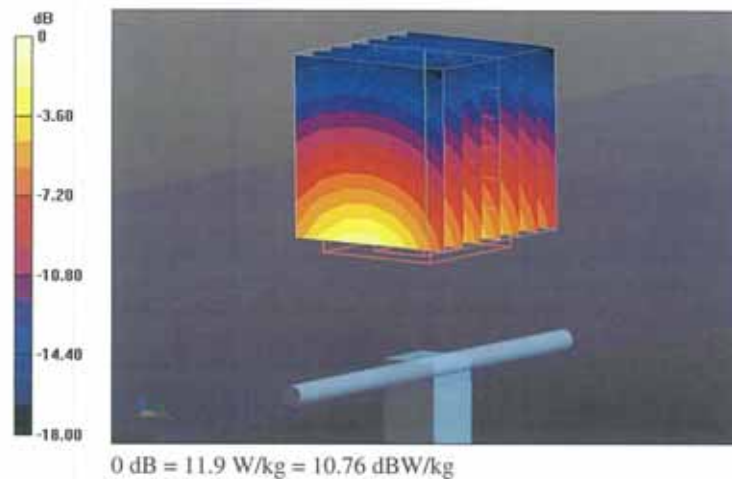
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.691 V/m; Power Drift = 0.04 dB

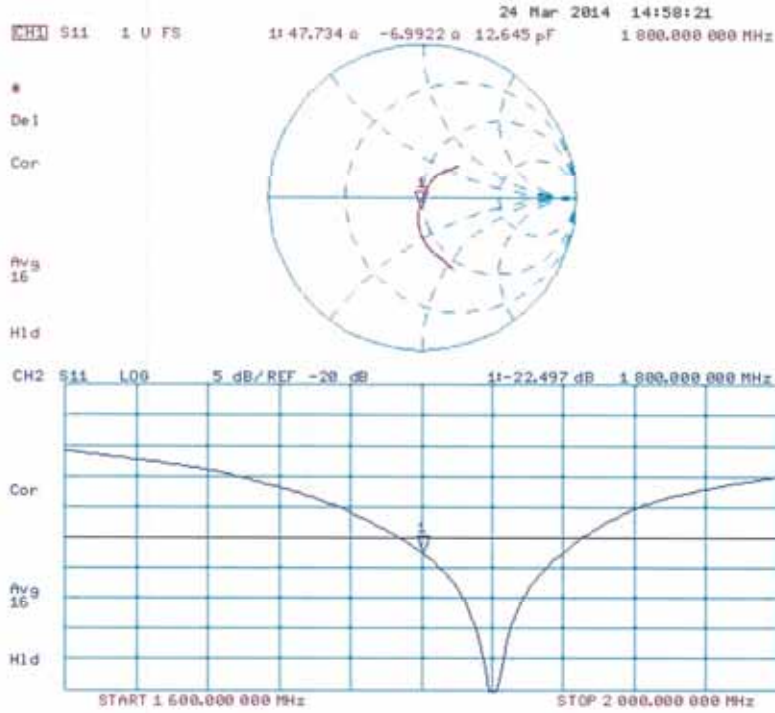
Peak SAR (extrapolated) = 17.7 W/kg

SAR(1 g) = 9.6 W/kg; SAR(10 g) = 5.02 W/kg

Maximum value of SAR (measured) = 11.9 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 24.03.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1800 MHz; Type: D1800V2; Serial: D1800V2 - SN: 2d006

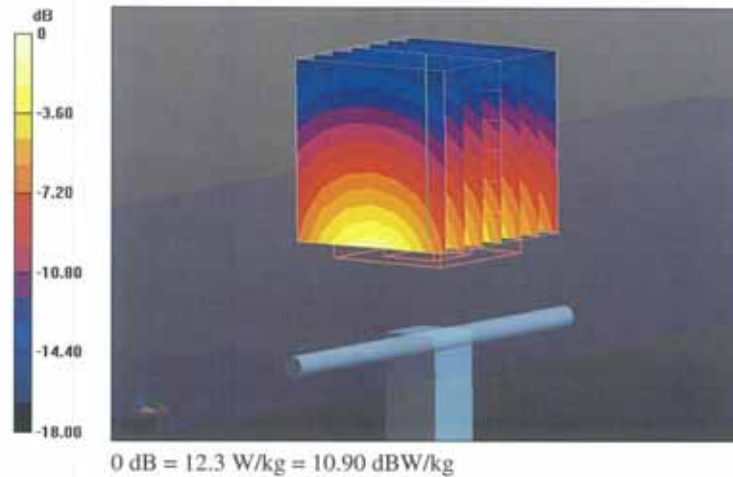
Communication System: UID 0 - CW; Frequency: 1800 MHz
 Medium parameters used: $f = 1800 \text{ MHz}$; $\sigma = 1.55 \text{ S/m}$; $\epsilon_r = 52.5$; $\rho = 1000 \text{ kg/m}^3$
 Phantom section: Flat Section
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

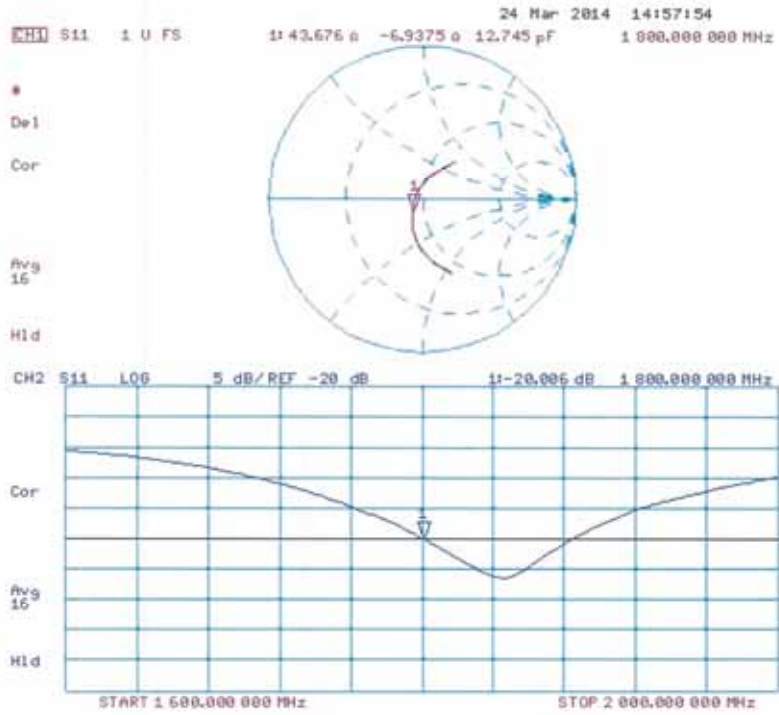
- Probe: ES3DV3 - SN3205; ConvF(4.86, 4.86, 4.86); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$
 Reference Value = 92.723 V/m; Power Drift = 0.01 dB
 Peak SAR (extrapolated) = 17.0 W/kg
SAR(1 g) = 9.67 W/kg; SAR(10 g) = 5.11 W/kg
 Maximum value of SAR (measured) = 12.3 W/kg



Impedance Measurement Plot for Body TSL



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Accreditation No.: **SCS 108**

Client **HCT (Dymstec)**

Certificate No: **D2450V2-743_Jul14**

CALIBRATION CERTIFICATE

Object: **D2450V2 - SN: 743**

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

Calibration date: **July 24, 2014**

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	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	30-Apr-14 (No. DAE4-601_Apr14)	Apr-15
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-09 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

Calibrated by: **Claudio Leubler** (Name), **Laboratory Technician** (Function), *[Signature]* (Signature)

Approved by: **Katja Pokovic** (Name), **Technical Manager** (Function), *[Signature]* (Signature)

Issued: July 25, 2014

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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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.8 ± 6 %	1.85 mho/m ± 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	13.6 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.2 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.8 W/kg ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	50.6 ± 6 %	2.03 mho/m ± 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	13.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	51.3 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.9 W/kg ± 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.2 Ω + 4.5 $\mu\Omega$
Return Loss	- 25.5 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.8 Ω + 6.3 $\mu\Omega$
Return Loss	- 24.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.160 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	December 01, 2003

DASY5 Validation Report for Head TSL

Date: 24.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 743

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.85$ S/m; $\epsilon_r = 37.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

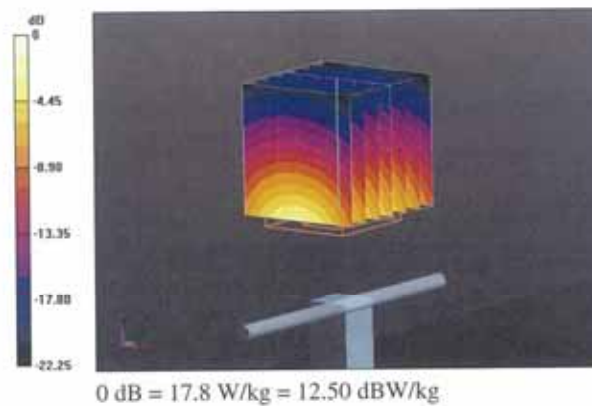
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 102.3 V/m; Power Drift = 0.01 dB

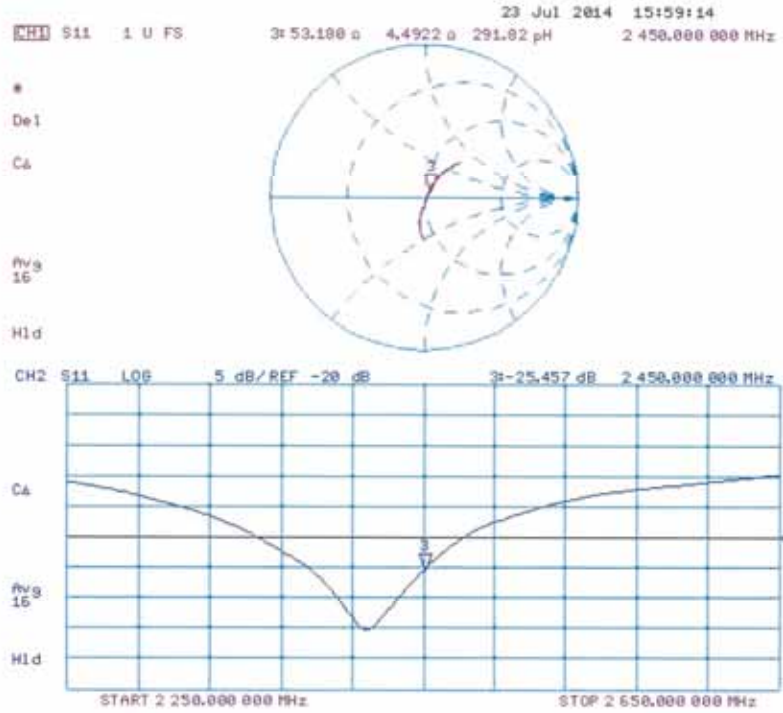
Peak SAR (extrapolated) = 28.0 W/kg

SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.28 W/kg

Maximum value of SAR (measured) = 17.8 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 16.07.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 743

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.03$ S/m; $\epsilon_r = 50.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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

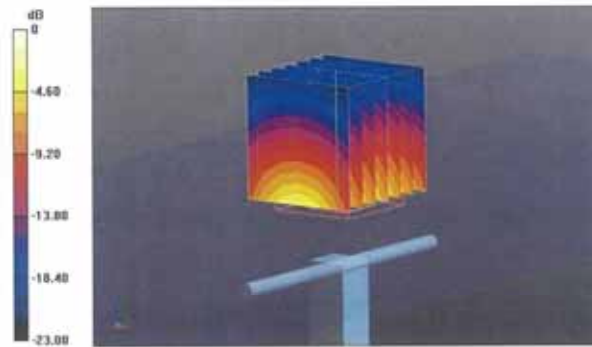
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.80 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 27.7 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.07 W/kg

Maximum value of SAR (measured) = 17.5 W/kg



0 dB = 17.5 W/kg = 12.43 dBW/kg

Impedance Measurement Plot for Body TSL

