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Report No.: SZEM150800520002
Rev.01
Page : 1 of 38

FCC SAR TEST REPORT

Application No: SZEM1508005200CR

Applicant: Mattel Asia Pacific Sourcing Ltd.

Manufacturer/Factory: Mattel Asia Pacific Sourcing Ltd.

Product Name: Hello Barbie

Model No.(EUT): DKF74

Add Model No.: DNR56, DNR57

Trade Mark: Mattel

FCC ID: PIYDKF74-15A5W

Standards: FCC 47CFR §2.1093

Date of Receipt: 2015-09-21

Date of Test: 2015-09-22

Date of Issue: 2015-09-22

Test Result : PASS *

* In the configuration tested, the EUT detailed in this report complied with the standards specified above.

Authorized Signature:



Jack Zhang
EMC Laboratory Manager

The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards. Any mention of SGS International Electrical Approvals or testing done by SGS International Electrical Approvals in connection with, distribution or use of the product described in this report must be approved by SGS International Electrical Approvals in writing.

The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government. All test results in this report can be traceable to National or International Standards.

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REVISION HISTORY

Revision Record				
Version	Chapter	Date	Modifier	Remark
01		2015-09-22		Original



Test Summary

Frequency Band	Test position	Test mode	Max Report SAR _{1g} (W/kg)	SAR limit (W/kg)	Verdict
WI-FI (2.4GHz)	Back Side 0mm	802.11b	0.08	1.6	PASS

Approved & Released by

Evan Mi

SAR Supervisor

Tested by

Eason Wang

SAR Engineer

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1 General Information

1.1 Details of Client

Applicant	Mattel Asia Pacific Sourcing Ltd.
Address:	13/F, South Tower, World Finance Centre, Tsimshatsui
Manufacturer	Mattel Asia Pacific Sourcing Ltd.
Address:	13/F, South Tower, World Finance Centre, Tsimshatsui
Factory	Mattel Asia Pacific Sourcing Ltd.
Address:	13/F, South Tower, World Finance Centre, Tsimshatsui

1.2 Test Location

Company: SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch E&E Lab
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Telephone: +86 (0) 755 2601 2053
Fax: +86 (0) 755 2671 0594
E-mail: ee.shenzhen@sgs.com



1.3 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **CNAS (No. CNAS L2929)**

CNAS has accredited SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC Lab to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories (CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence in the field of testing.

- **A2LA (Certificate No. 3816.01)**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 3816.01.

- **VCCI**

The 10m Semi-anechoic chamber and Shielded Room of SGS-CSTC Standards Technical Services Co., Ltd. have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: G-823, R-4188, T-1153 and C-2383 respectively.

- **FCC – Registration No.: 556682**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration No.: 556682.

- **Industry Canada (IC)**

The 3m Semi-anechoic chambers and the 10m Semi-anechoic chambers of SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC Lab have been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 4620C-2, 4620C-3.



1.4 General Description of EUT

Product Name:	Hello Barbie		
Model No.(EUT):	DKF74		
Trade Mark:	Mattel		
Product Phase:	production unit		
Device Type :	portable device		
Exposure Category:	uncontrolled environment / general population		
Hardware Version:	V4-1-1		
Software Version:	V1.1g		
Antenna Type:	Inner Antenna		
Device Operating Configurations :			
Modulation Mode:	WIFI:IEEE for 802.11b: DSSS(CCK,DQPSK,DBPSK) IEEE for 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK) IEEE for 802.11n(T20) : OFDM (64QAM, 16QAM, QPSK,BPSK)		
Frequency Bands:	Band	Tx (MHz)	Rx (MHz)
	WIFI	2412-2462	2412-2462
Battery Information:	Model10510		
	Normal Voltage :3.7V		
	Rated capacity :330mAh		
	Battery Type :Rechargeable Li-ion Battery		
Remark: Model No.: DKF74, DNR56, DNR57. Only the Model DKF74 was tested, since the electrical circuit design, layout, components used and internal wiring were identical for all above models. Only different on the doll body color and doll 's head.			

1.5 Test Specification

Identity	Document Title
FCC 47CFR §2.1093	Radiofrequency Radiation Exposure Evaluation: Portable Devices
IEEE Std C95.1 – 1991	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.
IEEE 1528-2003	Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
KDB447498 D01 v05r02	General RF Exposure Guidance
KDB447498 D03 v01	Supplement C Cross-Reference
KDB 248227 D01 v02r01	SAR Guidance For IEEE 802.11(Wi-Fi) Transmitters
KDB 865664 D01 v01r04	SAR Measurement 100 MHz to 6 GHz
KDB 865664 D02 v01r01	RF Exposure Reporting
Tracking Number	320351

1.6 RF exposure limits

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
Spatial Peak SAR* (Brain)	1.60 mW/g	8.00 mW/g
Spatial Average SAR** (Whole Body)	0.08 mW/g	0.40 mW/g
Spatial Peak SAR*** (Hands/Feet/Ankle/Wrist)	4.00 mW/g	20.00 mW/g

Notes:

* The Spatial Peak value of the SAR averaged over any 1 gram 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 grams 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.)



2 SAR Measurements System Configuration

2.1 The SAR Measurement System

This SAR Measurement System uses a Computer-controlled 3-D stepper motor system (SPEAG DASY5 professional system). A E-field probe is used to determine the internal electric fields. The SAR can be obtained from the equation $SAR = \sigma (|E|)^2 / \rho$ where σ and ρ are the conductivity and mass density of the tissue-Simulate.

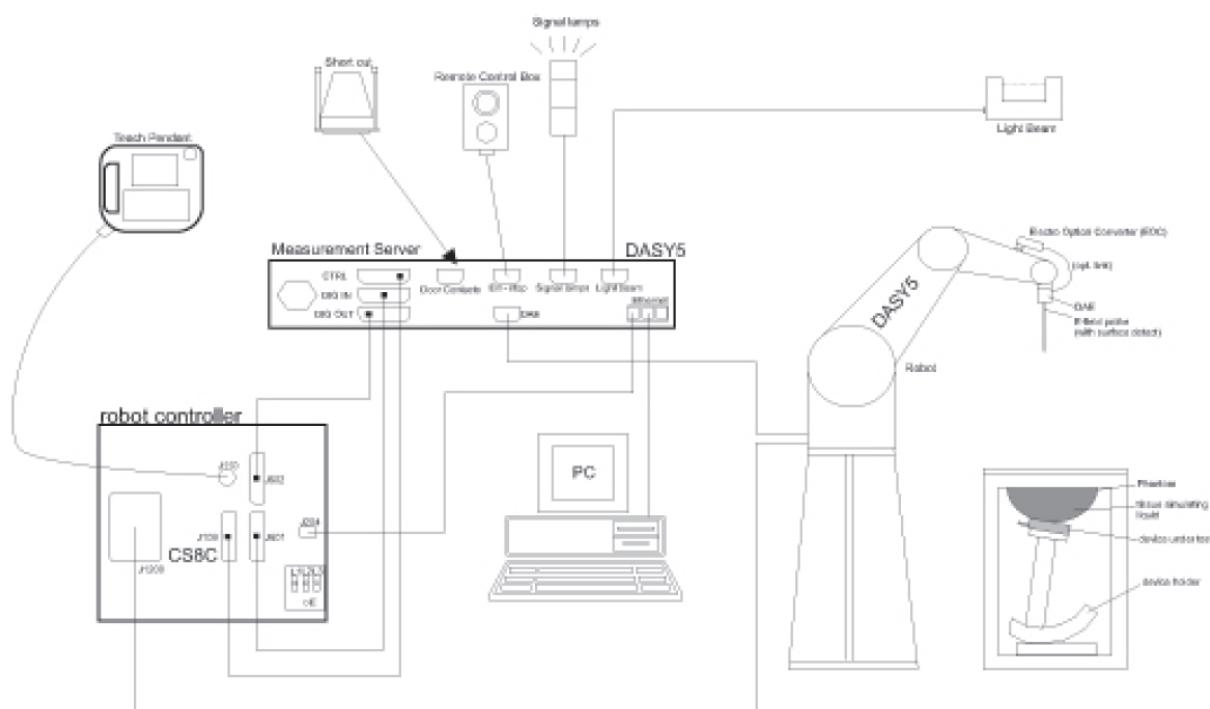
The DASY5 system for performing compliance tests consists of the following items:

A standard high precision 6-axis robot (Stabile RX family) with controller, teach pendant and software .An arm extension for accommodation the data acquisition electronics (DAE).

A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.

A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.



F-1. SAR Measurement System Configuration

- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7.
- DASY5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand, right-hand and Body Worn usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validating the proper functioning of the system.

2.2 Isotropic E-field Probe EX3DV4

	<p>Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)</p>
Calibration	ISO/IEC 17025 calibration service available.
Frequency	10 MHz to > 6 GHz Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.3 dB in TSL (rotation around probe axis) ± 0.5 dB in TSL (rotation normal to probe axis)
Dynamic Range	10 µW/g to > 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 µW/g)
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields); the only probe that enables compliance testing for frequencies up to 6 GHz with precision of better 30%.
Compatibility	DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI

2.3 Data Acquisition Electronics (DAE)

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



2.4 SAM Twin Phantom

Material	Vinylester, glass fiber reinforced (VE-GF)
Liquid Compatibility	Compatible with all SPEAG tissue simulating liquids (incl. DGBE type)
Shell Thickness	2 ± 0.2 mm (6 ± 0.2 mm at ear point)
Dimensions (incl. Wooden Support)	Length: 1000 mm Width: 500 mm Height: adjustable feet
Filling Volume	approx. 25 liters
Wooden Support	SPEAG standard phantom table



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.

Twin SAM V5.0 has the same shell geometry and is manufactured from the same material as Twin SAM V4.0, but has reinforced top structure.

2.5 ELI Phantom

Material	Vinylester, glass fiber reinforced (VE-GF)	
Liquid Compatibility	Compatible with all SPEAG tissue simulating liquids (incl. DGBE type)	
Shell Thickness	2.0 ± 0.2 mm (bottom plate)	
Dimensions	Major axis: 600 mm Minor axis: 400 mm	
Filling Volume	approx. 30 liters	
Wooden Support	SPEAG standard phantom table	

Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.

ELI V5.0 has the same shell geometry and is manufactured from the same material as ELI4, but has reinforced top structure.

2.6 Device Holder for Transmitters



F-2. Device Holder for Transmitters

- The DASY device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation centres for both scales are the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.
- The DASY device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity $\epsilon=3$ and loss tangent $\delta=0.02$. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

2.7 Measurement procedure

2.7.1 Scanning procedure

Step 1: Power reference measurement

The “reference” and “drift” measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure.

Step 2: Area scan

The SAR distribution at the exposed side of the head was measured at a distance of 4mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 15mm*15mm or 12mm*12mm or 10mm*10mm. Based on the area scan data, the area of the maximum absorption was determined by spline interpolation.

Step 3: Zoom scan

Around this point, a volume of 30mm*30mm*30mm (fine resolution volume scan, zoom scan) was assessed by measuring 5x5x7 points ($\leq 2\text{GHz}$) and 7x7x7 points ($\geq 2\text{GHz}$). On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure:

The data at the surface was extrapolated, since the centre of the dipoles is 2.0mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2mm. (This can be variable. Refer to the probe specification). 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. The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were computed using the 3D-Spline interpolation algorithm. The volume was integrated with the trapezoidal algorithm. One thousand points were interpolated to calculate the average. All neighbouring volumes were evaluated until no neighboring volume with a higher average value was found.

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements. Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std. 1528-2003.

		≤ 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		$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
		≤ 2 GHz: ≤ 15 mm $2 - 3$ GHz: ≤ 12 mm	$3 - 4$ GHz: ≤ 12 mm $4 - 6$ GHz: ≤ 10 mm
Maximum area scan spatial resolution: Δx_{Area} , Δy_{Area}			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: Δx_{Zoom} , Δy_{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: $\Delta z_{\text{Zoom}}(n)$	≤ 5 mm	$3 - 4$ GHz: ≤ 4 mm $4 - 5$ GHz: ≤ 3 mm $5 - 6$ GHz: ≤ 2 mm
	graded grid	$\Delta z_{\text{Zoom}}(1)$: between 1 st two points closest to phantom surface $\Delta z_{\text{Zoom}}(n>1)$: between subsequent points	≤ 4 mm $\leq 1.5 \cdot \Delta z_{\text{Zoom}}(n-1)$
Minimum zoom scan volume	x, y, z	≥ 30 mm	$3 - 4$ GHz: ≥ 28 mm $4 - 5$ GHz: ≥ 25 mm $5 - 6$ GHz: ≥ 22 mm

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.

* When zoom scan is required and the reported SAR from the *area scan based 1-g SAR estimation* 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.

Step 4: Power reference measurement (drift)

The Power Drift Measurement job measures the field at the same location as the most recent power reference measurement job within the same procedure, and with the same settings. The indicated drift is mainly the variation of the DUT's output power and should vary max. $\pm 5\%$

2.7.2 Data Storage

The DASY software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension ".DAE3". The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated. The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [m W/g], [m W/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

2.7.3 Data Evaluation by SEMCAD

The SEMCAD software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	Normi, ai0, ai1, ai2
- Conversion factor	ConvFi	
- Diode compression point	Dcp <i>i</i>	
Device parameters:	- Frequency	f
- Crest factor	cf	
Media parameters:	- Conductivity	ε
- Density	ρ	

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

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 as:

$$V_i = U_i + U_i^2 \cdot c_f / d_c p_i$$

With V_i = compensated signal of channel i ($i = x, y, z$)

U_i = input signal of channel i ($i = x, y, z$)

c_f = crest factor of exciting field (DASY parameter)

$d_c p_i$ = diode compression point (DASY parameter)

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

E-field probes:

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$$E_i = (V_i / Norm_i \cdot ConvF)^{1/2}$$

H-field probes:

$$H_i = (V_i)^{1/2} \cdot (a_{i0} + a_{i1}f + a_{i2}f^2)/f$$

With V_i = compensated signal of channel i (i = x, y, z)

Norm_i = sensor sensitivity of channel i (i = x, y, z)

[mV/(V/m)2] for E-field Probes

ConvF = sensitivity enhancement in solution

aij = sensor sensitivity factors for H-field probes

f = carrier frequency [GHz]

Ei = electric field strength of channel i in V/m

Hi = magnetic field strength of channel i in A/m

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

$$E_{tot} = (E_x^2 + E_y^2 + E_z^2)^{1/2}$$

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

$$SAR = (E_{tot}^2 \cdot \sigma) / (\epsilon \cdot 1000)$$

with SAR = local specific absorption rate in mW/g

Etot = total field strength in V/m

σ = conductivity in [mho/m] or [Siemens/m]

ϵ = equivalent tissue density in g/cm³

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid. The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = E_{tot}^2 / 3770 \text{ or } P_{pwe} = H_{tot}^2 \cdot 37.7$$

with Ppwe = equivalent power density of a plane wave in mW/cm²

Etot = total electric field strength in V/m

Htot = total magnetic field strength in A/m

3 Description of Test Position

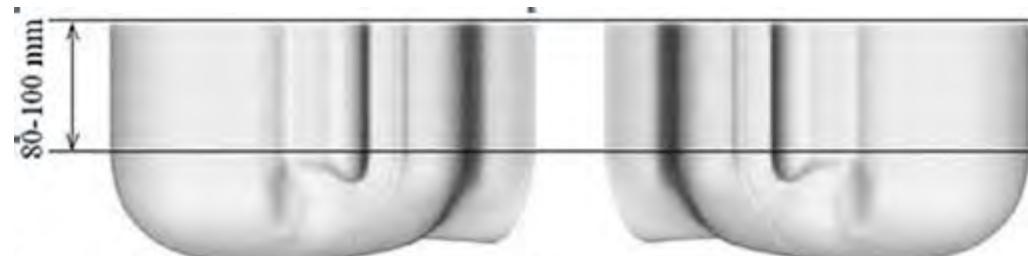
3.1 The Head Test Position

3.1.1 SAM Phantom Shape

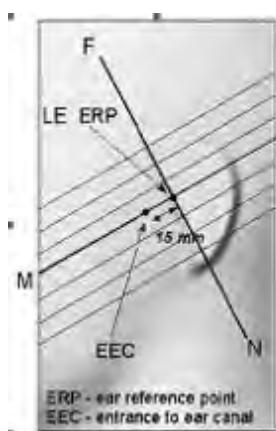


F-3. Front, back, and side views of SAM (model for the phantom shell). Full-head model is for illustration purposes only-procedures in this recommended practice are intended primarily for the phantom setup.

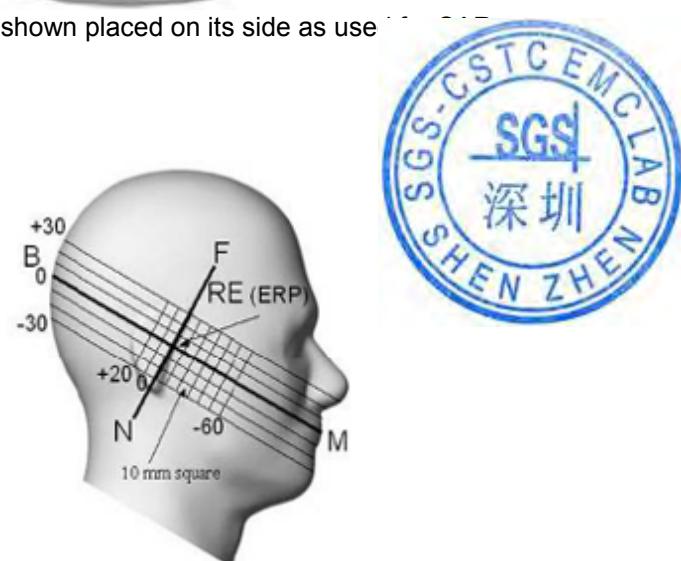
Note: The centre strip including the nose region has a different thickness tolerance.



F-4. Sagittally bisected phantom with extended perimeter (shown placed on its side as use measurements)

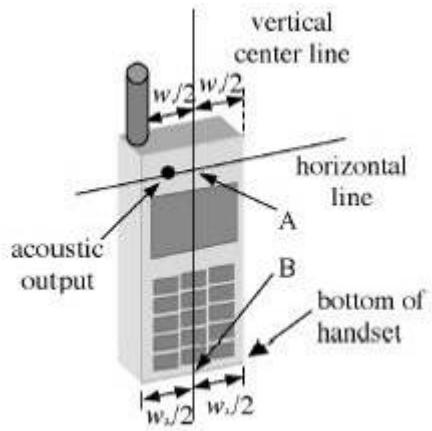


F-5. Close-up side view of phantom, showing the ear region, N-F and B-M lines, and seven cross-sectional plane locations

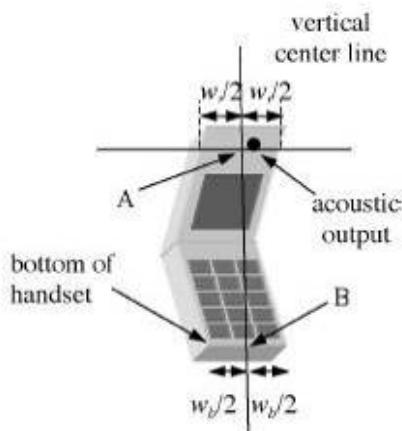


F-6. Side view of the phantom showing relevant markings and seven cross-sectional plane locations

3.1.2 EUT constructions



F-7. Handset vertical and horizontal reference lines - "fixed case"



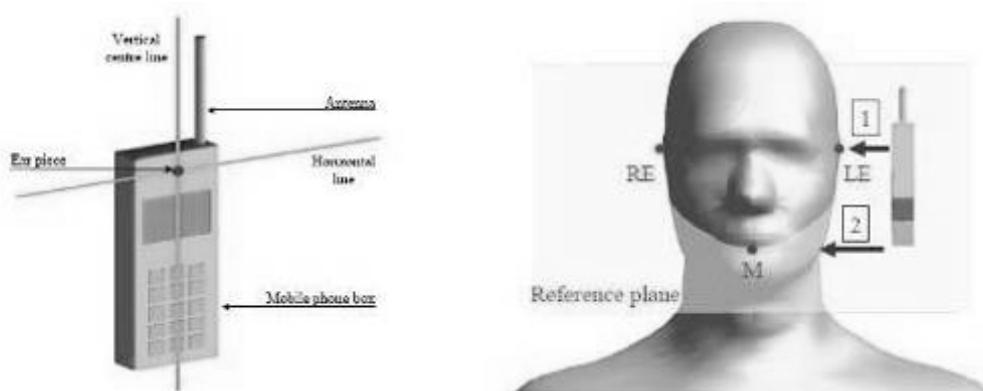
F-8. Handset vertical and horizontal reference lines - "clam-shell case"

3.1.3 Definition of the "cheek" position

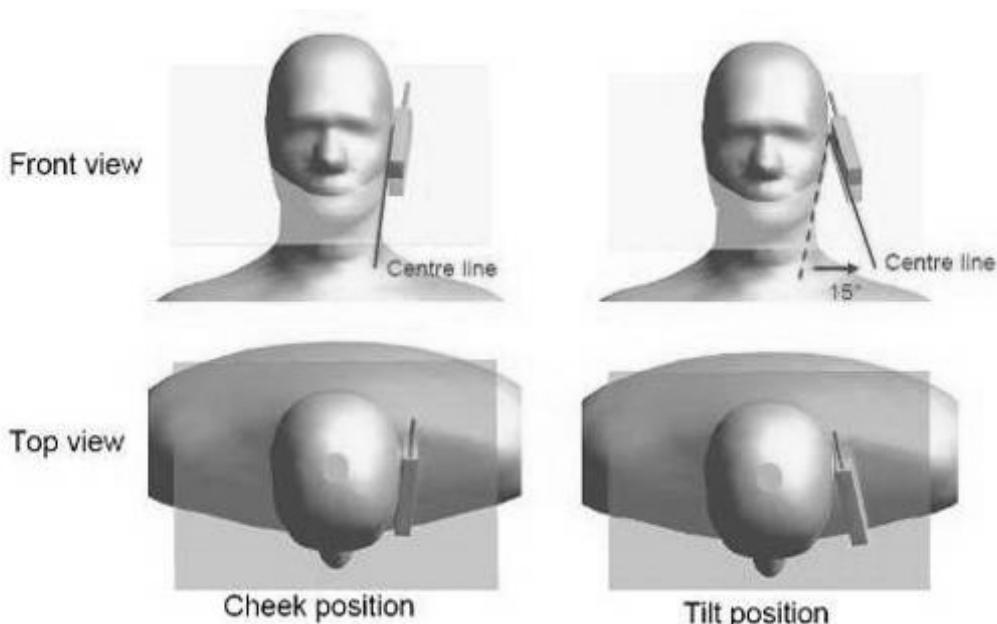
- Position the device with the vertical centre line of the body of the device and the horizontal line crossing the centre of the ear piece in a plane parallel to the sagittal plane of the phantom ("initial position"). While maintaining the device in this plane, align the vertical centre line with the reference plane containing the three ear and mouth reference points (M, RE and LE) and align the centre of the ear piece with the line RE-LE.
- Translate the mobile phone box towards the phantom with the ear piece aligned with the line LE-RE until telephone touches the ear. While maintaining the device in the reference plane and maintaining the phone contact with the ear, move the bottom of the box until any point on the front side is in contact with the cheek of the phantom or until contact with the ear is lost.

3.1.4 Definition of the “tilted” position

- Position the device in the “cheek” position described above;
- While maintaining the device in the reference plane described above and pivoting against the ear, move it outward away from the mouth by an angle of 15 degrees or until contact with the ear is lost.



F-9. Definition of the reference lines and points, on the phone and on the phantom and initial position



F-10. “Cheek” and “tilt” positions of the mobile phone on the left side

3.2 The Body Test Position

3.2.1 Body-worn accessory exposure conditions

Body-worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations.

Based on the FCC inquiry, we test the toy at the follow position:

1. For the head position, per KDB 447498 D01v05r02 section 6.1, a test separation distance of 25 mm must be applied for in-front-of the face SAR test exclusion and SAR measurements
2. For the body position, I test the front and back sides of the toy and the separation distance is 0mm.

4 SAR System Verification Procedure

4.1 Tissue Simulate Liquid

4.1.1 Recipes for Tissue Simulate Liquid

The following tables give the recipes for tissue simulating liquids to be used in different frequency bands:

Ingredients (% by weight)	Frequency (MHz)							
	450		835		1800-2000		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	40.30	50.75	55.24	70.17	55.00	68.53
Salt (NaCl)	3.95	1.49	1.38	0.94	0.31	0.39	0.2	0.1
Sucrose	56.32	46.78	57.90	48.21	0	0	0	0
HEC	0.98	0.52	0.24	0	0	0	0	0
Bactericide	0.19	0.05	0.18	0.10	0	0	0	0
Tween	0	0	0	0	44.45	29.44	44.80	31.37

Table 1 : Recipe of Tissue Simulate Liquid

4.1.2 Measurement for Tissue Simulate Liquid

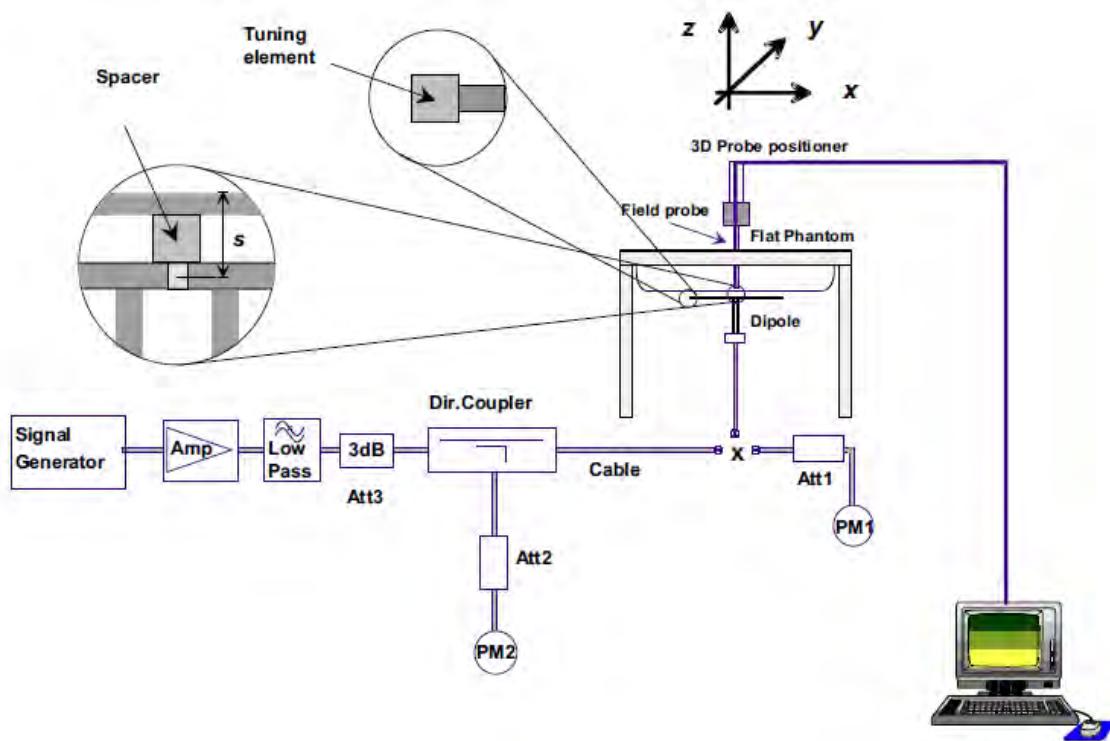
The dielectric properties for this Tissue Simulate Liquids were measured by using the Agilent Model 85070E Dielectric Probe in conjunction with Agilent E5071C Network Analyzer (300 KHz-8500 MHz). The Conductivity (σ) and Permittivity (ϵ_r) are listed in Table 1. For the SAR measurement given in this report. The temperature variation of the Tissue Simulate Liquids was $22\pm1^\circ\text{C}$.

Tissue Type	Measured Frequency (MHz)	Target Tissue ($\pm 5\%$)		Measured Tissue		Liquid Temp. (°C)	Measured Date
		ϵ_r	$\sigma(\text{S/m})$	ϵ_r	$\sigma(\text{S/m})$		
2450 Body	2450	52.70 (50.07~55.34)	1.95 (1.85~2.05)	51.999	1.952	22.01	2015/9/22

Table 2 : Measurement result of Tissue electric parameters

4.2 SAR System Validation

The microwave circuit arrangement for system verification is sketched in F-12. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within $\pm 10\%$ from the target SAR values. The tests were conducted on the same days as the measurement of the EUT. The obtained results from the system accuracy verification are displayed in the table 5 (A power level of 250mw was input to the dipole antenna). During the tests, the ambient temperature of the laboratory was in the range $22 \pm 1^\circ\text{C}$, the relative humidity was in the range 60% and the liquid depth above the ear reference points was above 15 cm in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.



F-11. the microwave circuit arrangement used for SAR system verification



4.2.1 Justification for Extended SAR Dipole Calibrations

- 1) Referring to KDB865664 D01 requirements for dipole calibration, instead of the typical annual calibration recommended by measurement standards, longer calibration intervals of up to three years may be considered when it is demonstrated that the SAR target, impedance and return loss of a dipole have remain stable according to the following requirements. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.
 - a) There is no physical damage on the dipole;
 - b) System check with specific dipole is within 10% of calibrated value;
 - c) Return-loss is within 10% of calibrated measurement;
 - d) Impedance is within 5Ω from the previous measurement.
- 2) Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.



4.2.2 Summary System Validation Result(s)

Validation Kit		Measured SAR 250mW	Normalized to 1w SAR	1W Target SAR (±10%)	Liquid Temp. (°C)	Measured date
		1g (W/kg)	1g (W/kg)	1g (W/kg)		
D2450V2	Body	12.7	50.8	51.3 (46.17~56.43)	22.01	2015/9/22

Table 3 : SAR System Validation Result

4.2.3 Detailed System Validation Results

Please see the Appendix A

5 Test results and Measurement Data

5.1 Operation Configurations

5.1.1 WiFi Test Configuration

A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement.

5.1.1.1 Initial Test Position SAR Test Reduction Procedure

DSSS and OFDM configurations are considered separately according to the required SAR procedures. SAR is measured in the initial test position using the 802.11 transmission mode configuration required by the DSSS procedure or initial test configuration and subsequent test configuration(s) according to the OFDM procedures. The initial test position procedure is described in the following:

- 1) . When the reported SAR of the initial test position is ≤ 0.4 W/kg, further SAR measurement is not required for the other (remaining) test positions in that exposure configuration and 802.11 transmission mode combinations within the frequency band or aggregated band. SAR is also not required for that exposure configuration in the subsequent test configuration(s).
- 2) . When the reported SAR of the initial test position is > 0.4 W/kg, SAR is repeated for the 802.11 transmission mode configuration tested in the initial test position using subsequent highest extrapolated or estimated 1-g SAR conditions determined by area scans or next closest/smallest test separation distance and maximum RF coupling test positions based on manufacturer justification, on the highest maximum output power channel, until the reported SAR is ≤ 0.8 W/kg or all required test positions (left, right, touch, tilt or subsequent surfaces and edges) are tested.
- 3) . For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required channels are tested. a) Additional power measurements may be required for this step, which should be limited to those necessary for identifying the subsequent highest output power channels.

5.1.1.2 Initial Test Configuration Procedures

An initial test configuration is determined for OFDM transmission modes according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. SAR is measured using the highest measured maximum output power channel. For configurations with the same specified or measured maximum output power, additional transmission mode and test channel selection procedures are required. SAR test reduction for subsequent highest output test channels is determined according to *reported* SAR of the initial test configuration.

For next to the ear, hotspot mode and UMC mini-tablet exposure configurations where multiple test positions are required, the initial test position procedure is applied to minimize the number of test positions required for SAR measurement using the initial test configuration transmission mode. For fixed exposure conditions that do not have multiple SAR test positions, SAR is measured in the transmission mode determined by the initial test configuration.

When the *reported* SAR of the initial test configuration is > 0.8 W/kg, SAR measurement is required for subsequent next highest measured output power channel(s) in the initial test configuration until *reported* SAR is ≤ 1.2 W/kg or all required channels are tested.

5.1.1.3 Subsequent Test Configuration Procedures

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units. The initial test position procedure is applied to next to the ear, UMPC mini-tablet and hotspot mode configurations.

When the same maximum output power is specified for multiple transmission modes, additional power measurements may be required to determine if SAR measurements are required for subsequent highest output power channels in a subsequent test configuration. The subsequent test configuration and SAR measurement procedures are described in the following.

- 1) . When SAR test exclusion provisions of KDB Publication 447498 are applicable and SAR measurement is not required for the initial test configuration, SAR is also not required for the next highest maximum output power transmission mode subsequent test configuration(s) in that frequency band or aggregated band and exposure configuration.
- 2) . When the highest *reported* SAR for the initial test configuration (when applicable, include subsequent highest output channels), according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.
- 3) . The number of channels in the initial test configuration and subsequent test configuration can be different due to differences in channel bandwidth. When SAR measurement is required for a subsequent test configuration and the channel bandwidth is smaller than that in the initial test configuration, all channels in the subsequent test configuration that overlap with the larger bandwidth channel tested in the initial test configuration should be used to determine the highest maximum output power channel. This step requires additional power measurement to identify the highest maximum output power channel in the subsequent test configuration to determine SAR test reduction.
 - a) SAR should first be measured for the channel with highest measured output power in the subsequent test configuration.
 - b) SAR for subsequent highest measured maximum output power channels in the subsequent test configuration is required only when the *reported* SAR of the preceding higher maximum output power channel(s) in the subsequent test configuration is > 1.2 W/kg or until all required channels are tested. i) For channels with the same measured maximum output power, SAR should be measured using the channel closest to the center frequency of the larger channel bandwidth channel in the initial test configuration.
- 4) . SAR measurements for the remaining highest specified maximum output OFDM transmission mode configurations that have not been tested in the initial test configuration (highest maximum output) or subsequent test configuration(s) (subsequent next highest maximum output power) is determined by recursively applying the subsequent test configuration procedures in this section to the remaining configurations according to the following:
 - a) replace "subsequent test configuration" with "next subsequent test configuration" (i.e., subsequent next highest specified maximum output power configuration)
 - b) replace "initial test configuration" with "all tested higher output power configurations"

5.1.1.4 2.4 GHz SAR Procedures

Separate SAR procedures are applied to DSSS and OFDM configurations in the 2.4 GHz band to simplify DSSS test requirements. For 802.11b DSSS SAR measurements, DSSS SAR procedure applies to fixed exposure test position and initial test position procedure applies to multiple exposure test positions. When SAR measurement is required for an OFDM configuration, the initial test configuration, subsequent test configuration and initial test position procedures are applied. The SAR test exclusion requirements for 802.11g/n OFDM configurations are described in following.

- **802.11b DSSS SAR Test Requirements**

SAR is measured for 2.4 GHz 802.11b DSSS using either a fixed test position or, when position procedure. SAR test reduction is determined according to the following:

- 1) . When the reported SAR of the highest measured maximum output power configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b configuration.
- 2) . When the reported SAR is > 0.8 W/kg, SAR is required for that exposure to highest measured output power channel. When any reported SAR is > 1.2 W/kg third channel; i.e., all channels require testing.

- **2.4 GHz 802.11g/n OFDM SAR Test Exclusion Requirements**



When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test



**SGS-CSTC Standards Technical Services Co., Ltd.
Shenzhen Branch**

Report No.: SZEM150800520002

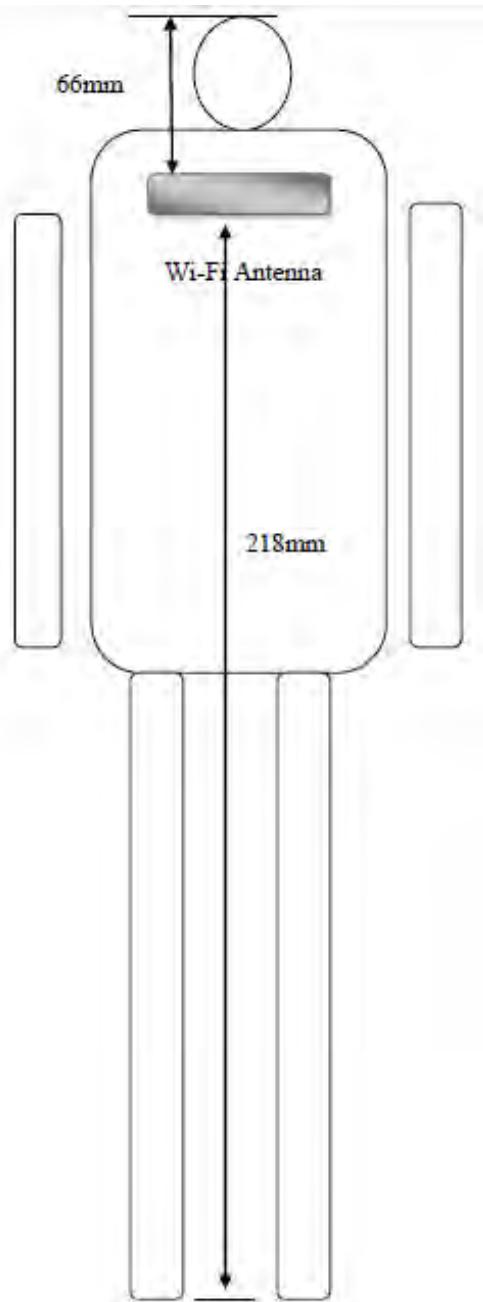
Rev.01

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reduction procedures for OFDM are applied (section 5.3, including sub-sections). SAR is not required for the following 2.4 GHz OFDM conditions.

- 1) . When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.
- 2) . When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is $\leq 1.2 \text{ W/kg}$.

5.1.2 DUT Antenna Locations



5.1.3 EUT side for SAR Testing

Per KDB 447498 D01v05r02, According to the FCC inquiry we can draw the conclusion that:

EUT Sides for SAR Testing						
Mode	Front	Back	Left	Right	Top	Bottom
Wi-Fi (2.4GHz)	Yes	Yes	No	No	No	No

Table 4: EUT Sides for SAR Testing

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5.1.4 Stand-alone SAR test evaluation

Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Test Exclusion Threshold condition is satisfied. These test exclusion conditions are based on source-based time-averaged maximum conducted output power of the RF channel requiring evaluation, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions.

Freq. Band	Frequency (GHz)	Position	Average Power		Test Separation (mm)	Calculate Value	Exclusion Threshold	Exclusion (Y/N)
			dBm	mW				
WiFi	2.450	Head	15	31.6	25	2.0	3.0	Y
WiFi	2.450	Body	15	31.6	0	9.9	3.0	N

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances \leq 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is \leq 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is $<$ 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

5.2 Measurement of RF conducted Power

5.2.1 Conducted Power Of WIFI

Wi-Fi 2450MHz	Average Power (dBm) for Data Rates (Mbps)									PK Output Power
	Channel	1	2	5.5	11	/	/	/	/	
802.11b	1	14.28	14.22	14.23	14.26	/	/	/	/	17.92
	6	14.58	14.57	14.51	14.28	/	/	/	/	18.66
	11	14.67	14.62	14.57	14.63	/	/	/	/	18.72
802.11g	Channel	6	9	12	18	24	36	48	54	6
	1	12.23	12.13	12.25	12.23	12.27	12.29	12.26	12.21	17.93
	6	12.41	12.42	12.44	12.43	12.46	12.47	12.43	12.49	18.35
	11	12.54	12.53	12.59	12.51	12.58	12.52	12.48	12.46	18.95
802.11n HT20	Channel	6.5	13	19.5	26	39	52	58.5	65	6.5
	1	12.15	12.14	12.18	12.16	12.13	12.17	12.13	12.16	17.39
	6	12.34	12.31	12.32	12.39	12.38	12.32	12.38	12.37	18.11
	11	12.48	12.44	12.42	12.47	12.44	12.46	12.45	12.42	18.61

Table 5: Conducted Power Of WIFI

5.3 Measurement of SAR Data

5.3.1 SAR Result Of WIFI

Test position	Test mode	Test Ch./Freq.	SAR (W/kg) 1-g	Power drift (dB)	Conducted power (dBm)	Tune up Limit (dBm)	Scaled factor	Scaled SAR (W/kg)	Liquid Temp.	SAR limit (W/kg)
Body Test data(Separate 0mm)										
Front side	802.11b	11/2462	0.03	-0.08	14.67	15	1.079	0.032	22.01	1.6
Back side	802.11b	11/2462	0.0737	0.18	14.67	15	1.079	0.080	22.01	1.6

Table 6: SAR of WIFI for Head and Body

Note:

- 1) Test positions of EUT(the distance between the EUT and the phantom is 0mm for all sides)
- 2) The maximum Scaled SAR value is marked in **bold**. Graph results refer to Appendix B
- 3) Per FCC KDB Publication 447498 D01v05r02, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is not required for such test configuration(s).
- 4) Each channel was tested at the lowest data rate.
- 5) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, 802.11g/n OFDM SAR Test is not required.



6 Equipment list

Test Platform		SPEAG DASY5 Professional			
Location		SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch E&E Lab			
Description		SAR Test System (Frequency range 300MHz-6GHz)			
Software Reference		DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)			
Hardware Reference					
Equipment		Model	Serial Number	Calibration Date	Due date of calibration
<input checked="" type="checkbox"/>	Robot	RX90L	F03/5V32A1/A01	NA	NA
<input type="checkbox"/>	Twin Phantom	SAM 1	TP-1283	NA	NA
<input checked="" type="checkbox"/>	Flat Phantom	ELI 5.0	1128	NA	NA
<input checked="" type="checkbox"/>	DAE	DAE3	569	2014-10-01	2015-09-30
<input checked="" type="checkbox"/>	E-Field Probe	EX3DV4	3962	2014-11-24	2015-11-23
<input type="checkbox"/>	Validation Kits	D835V2	4d015	2013-11-25	2016-11-24
<input type="checkbox"/>	Validation Kits	D1900V2	184	2013-11-27	2016-11-26
<input checked="" type="checkbox"/>	Validation Kits	D2450V2	733	2013-11-26	2016-11-25
<input checked="" type="checkbox"/>	Agilent Network Analyzer	E5071C	MY46523590	2015-03-02	2016-03-01
<input checked="" type="checkbox"/>	Dielectric Probe Kit	85070E	US01440210	NA	NA
<input checked="" type="checkbox"/>	R&S Universal Radio Communication Tester	CMU200	103633	2015-04-25	2016-04-25
<input checked="" type="checkbox"/>	RF Bi-Directional Coupler	ZABDC20-252H-N+	N989900825	2015-04-25	2016-04-25
<input checked="" type="checkbox"/>	Agilent Signal Generator	E4438C	MY42082326	2015-04-25	2016-04-25
<input checked="" type="checkbox"/>	Mini-Circuits Preamplifier	ZHL-42	QA0827002	2015-04-25	2016-04-25
<input checked="" type="checkbox"/>	Agilent Power Meter	E4416A	GB41292095	2015-04-25	2016-04-25
<input checked="" type="checkbox"/>	Agilent Power Sensor	8481H	MY41091234	2015-04-25	2016-04-25
<input checked="" type="checkbox"/>	R&S Power Sensor	NRP-Z92	100025	2015-04-25	2016-04-25
<input checked="" type="checkbox"/>	Attenuator	TS2-3dB	30704	2015-04-25	2016-04-25
<input checked="" type="checkbox"/>	Coaxial low pass filter	VLF-2500(+)	NA	2015-04-25	2016-04-25
<input checked="" type="checkbox"/>	50 Ω coaxial load	KARN-50+	00850	2015-04-25	2016-04-25
<input checked="" type="checkbox"/>	DC POWER SUPPLY	SK1730SL5A	NA	2015-04-25	2016-04-25

7 Measurement Uncertainty

Measurements and results are all in compliance with the standards listed in section 12 of this report. All measurements and results are recorded and maintained at the laboratory performing the tests and measurement uncertainties are taken into account when comparing measurements to pass/ fail criteria. The Expanded uncertainty (95% CONFIDENCE INTERVAL) is **21.36%**.

A	b1	c	d	e = f(d,k)	g	i = C*g/ e	k
Uncertainty Component	Section in P1528	Tol (%)	Prob . Dist.	Div.	Ci (1g)	$1g_{ui}$ (%)	Vi (Veff)
Probe calibration	E.2.1	6.3	N	1	1	6.30	∞
Axial isotropy	E.2.2	0.5	R	$\sqrt{3}$	$(1 - Cp)1/2$	0.20	∞
hemispherical isotropy	E.2.2	2.6	R	$\sqrt{3}$	\sqrt{Cp}	1.06	∞
Boundary effect	E.2.3	1.0	R	$\sqrt{3}$	1	0.58	∞
Linearity	E.2.4	0.6	R	$\sqrt{3}$	1	0.35	∞
System detection limit	E.2.5	0.25	R	$\sqrt{3}$	1	0.14	∞
Readout electronics	E.2.6	0.3	N	1	1	0.30	∞
Response time	E.2.7	0	R	$\sqrt{3}$	1	0.00	∞
Integration time	E.2.8	2.6	R	$\sqrt{3}$	1	1.50	∞
RF ambient Condition –Noise	E.6.1	3	R	$\sqrt{3}$	1	1.73	∞
RF ambient Condition - reflections	E.6.1	3	R	$\sqrt{3}$	1	1.73	∞
Probe positioning- mechanical tolerance	E.6.2	1.5	R	$\sqrt{3}$	1	0.87	∞
Probe positioning- with respect to phantom	E.6.3	2.9	R	$\sqrt{3}$	1	1.67	∞
Max. SAR evaluation	E.5.2	1	R	$\sqrt{3}$	1	0.58	∞
Test sample positioning	E.4.2	3.7	N	1	1	3.70	9
Device holder uncertainty	E.4.1	3.6	N	1	1	3.60	∞
Output power variation –SAR drift measurement	6.6.2	5	R	$\sqrt{3}$	1	2.89	∞
Phantom uncertainty (shape and thickness tolerances)	E.3.1	4	R	$\sqrt{3}$	1	2.31	∞
Liquid conductivity - deviation from target values	E.3.2	5	R	$\sqrt{3}$	0.64	1.85	∞
Liquid conductivity - measurement uncertainty	E.3.2	5.78	N	1	0.64	3.68	5



Liquid permittivity - deviation from target values	E.3.3	5	R	$\sqrt{3}$	0.6	1.73	∞
Liquid permittivity - measurement uncertainty	E.3.3	0.62	N	1	0.6	0.37 2	5
Combined standard uncertainty				RSS		10.6 8	430
Expanded uncertainty (95% CONFIDENCE INTERVAL)				K=2		21.3 6	

Table 7 : Measurement Uncertainty

8 Calibration certificate

Please see the Appendix C

9 Photographs

Please see the Appendix D



Appendix A : Detailed System Validation Results

Appendix B: Detailed Test Results

Appendix C Calibration certificate

Appendix D: Photographs

---END---



Appendix A

Detailed System Validation Results

1. System Performance Check for Body
System Performance Check 2450MHz Body

Test Laboratory: SGS-SAR Lab

System Performance Check 2450MHz Body

DUT: D2450V2; Type: D2450V2; Serial: 733

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: MSL2450; Medium parameters used: $f = 2450$ MHz; $\sigma = 1.952$ S/m; $\epsilon_r = 51.999$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY 5 Configuration:

- Probe: ES3DV3 - SN3071; ConvF(4.18, 4.18, 4.18); Calibrated: 2014-09-01;
- Sensor-Surface: 4mm (Mechanical Surface Detection), $z = 2.0, 32.0$
- Electronics: DAE3 Sn569; Calibrated: 2014-10-01
- Phantom: ELI V5.0; Type: ELI; Serial: 1128
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Body/d=10mm, Pin=250mW/Area Scan (8x11x1): Measurement grid: $dx=12$ mm, $dy=12$ mm
Maximum value of SAR (measured) = 13.4 W/kg

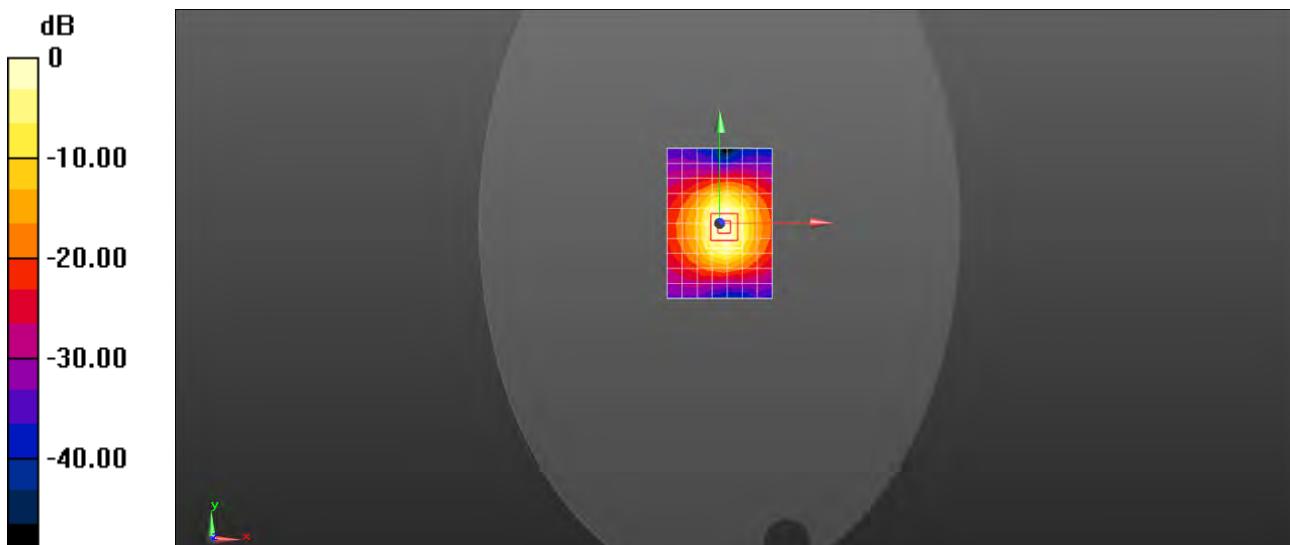
Body/d=10mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 82.21 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 25.4 W/kg

SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.94 W/kg

Maximum value of SAR (measured) = 14.5 W/kg





Appendix B

Detailed Test Results

1. WIFI
WIFI for Body

Test Laboratory: SGS-SAR Lab

LTS0804R WiFi 802.11b 11CH Back side 0mm

DUT: DKF47; Type: Hello Barbie; Serial: N/A

Communication System: UID 0, WI-FI(2.4GHz) (0); Frequency: 2462 MHz; Duty Cycle: 1:1

Medium: MSL2450; Medium parameters used: $f = 2462$ MHz; $\sigma = 1.967$ S/m; $\epsilon_r = 51.922$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY 5 Configuration:

- Probe: EX3DV4 - SN3962; ConvF(7.47, 7.47, 7.47); Calibrated: 2014-11-24;
- Sensor-Surface: 4mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE3 Sn569; Calibrated: 2014-10-01
- Phantom: ELI V5.0; Type: ELI; Serial: 1128
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Configuration/Body/Area Scan (8x11x1): Measurement grid: $dx=12$ mm, $dy=12$ mm

Maximum value of SAR (measured) = 0.0709 W/kg

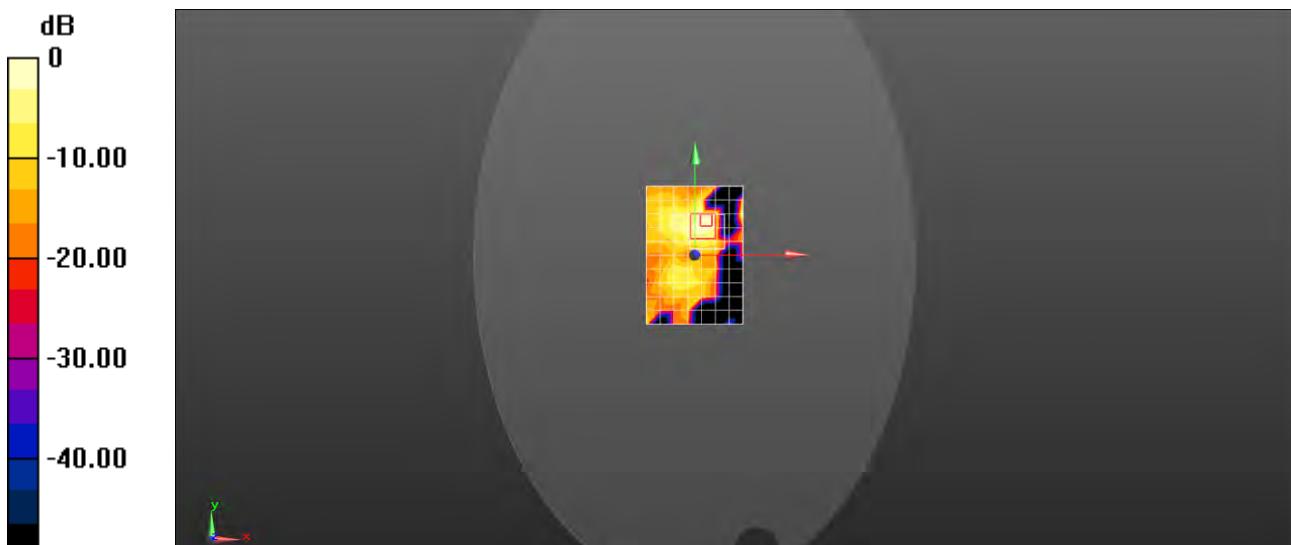
Configuration/Body/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 2.502 V/m; Power Drift = 0.18 dB

Peak SAR (extrapolated) = 0.161 W/kg

SAR(1 g) = 0.074 W/kg; SAR(10 g) = 0.026 W/kg

Maximum value of SAR (measured) = 0.150 W/kg





Appendix C

Calibration certificate

1. Dipole
D2450V2-SN733(2013-11-26)
2. DAE
DAE3-569(2014-10-01)
3. Probe
EX3DV4 - SN3962(2014-11-24)



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 Multilateral Agreement for the recognition of calibration certificates

Client **SGS-SZ (Auden)**

Accreditation No.: **SCS 108**

Certificate No: **D2450V2-733_Nov13**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 733**

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

Calibration date: **November 26, 2013**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^\circ\text{C}$ 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)	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	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
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-15
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

Calibrated by: **Name: Claudio Leubler Function: Laboratory Technician**

Signature:

Approved by: **Name: Katja Pokovic Function: Technical Manager**

Signature:

Issued: November 26, 2013

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



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Multilateral Agreement for the recognition of calibration certificates

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	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.7 ± 6 %	1.84 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.4 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.10 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.3 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	52.1 ± 6 %	2.02 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	12.6 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.4 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.81 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.0 W/kg ± 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$54.2 \Omega + 2.5 \text{ j} \Omega$
Return Loss	- 26.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$51.0 \Omega + 4.2 \text{ j} \Omega$
Return Loss	- 27.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.149 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	May 07, 2003

DASY5 Validation Report for Head TSL

Date: 26.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 733

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.84$ S/m; $\epsilon_r = 39.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- 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 (8x7x7)/Cube 0:

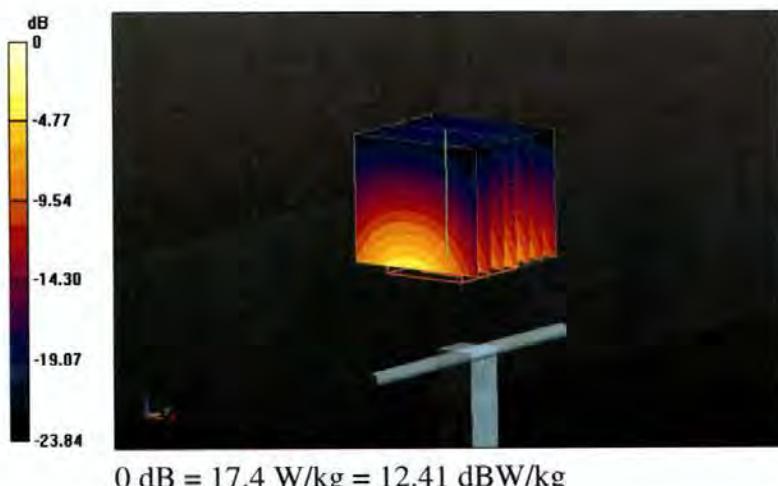
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.010 V/m; Power Drift = 0.09 dB

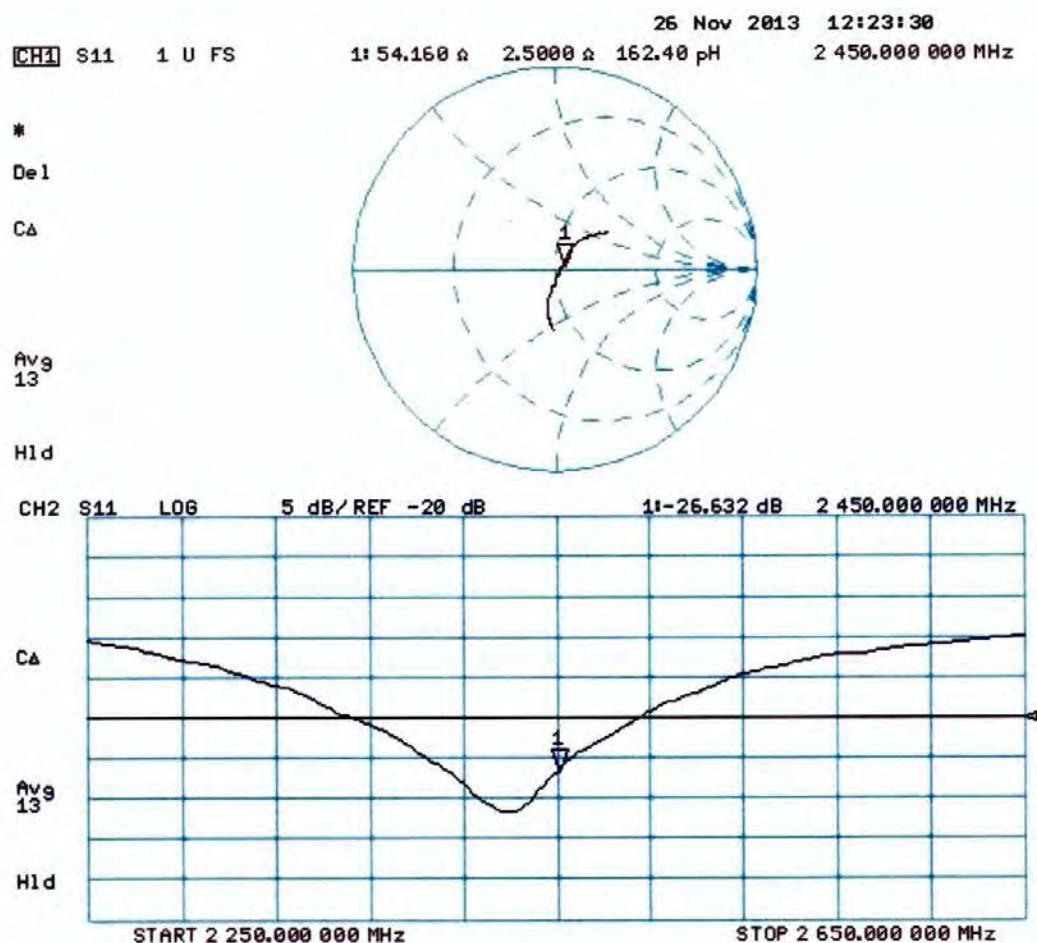
Peak SAR (extrapolated) = 27.4 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.1 W/kg

Maximum value of SAR (measured) = 17.4 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 26.11.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 733

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.02$ S/m; $\epsilon_r = 52.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- 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:

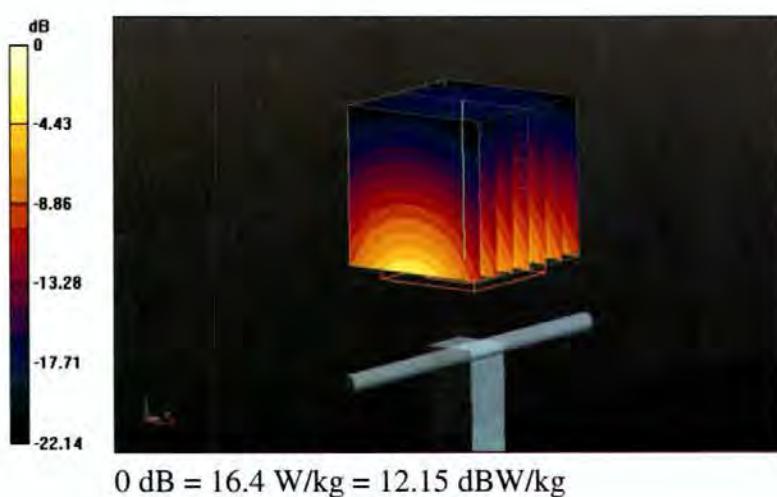
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.010 V/m; Power Drift = 0.02 dB

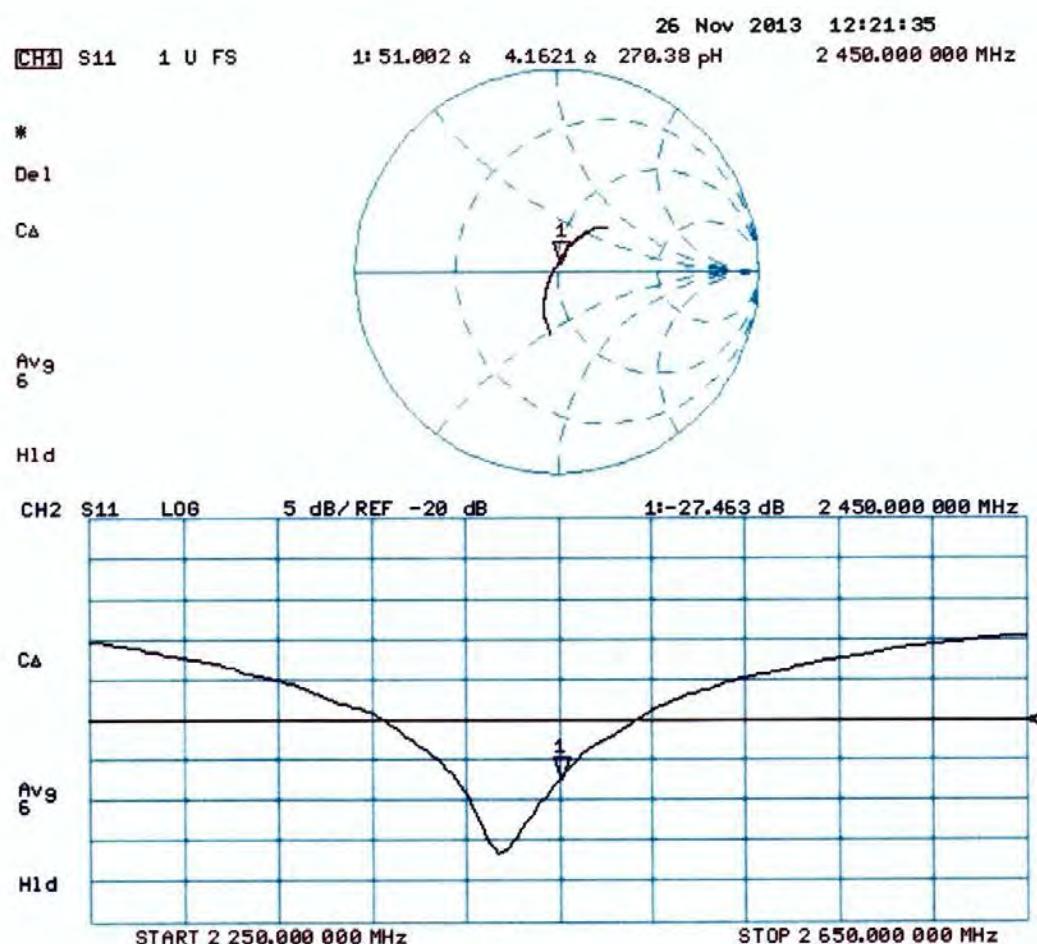
Peak SAR (extrapolated) = 26.1 W/kg

SAR(1 g) = 12.6 W/kg; SAR(10 g) = 5.81 W/kg

Maximum value of SAR (measured) = 16.4 W/kg



Impedance Measurement Plot for Body TSL

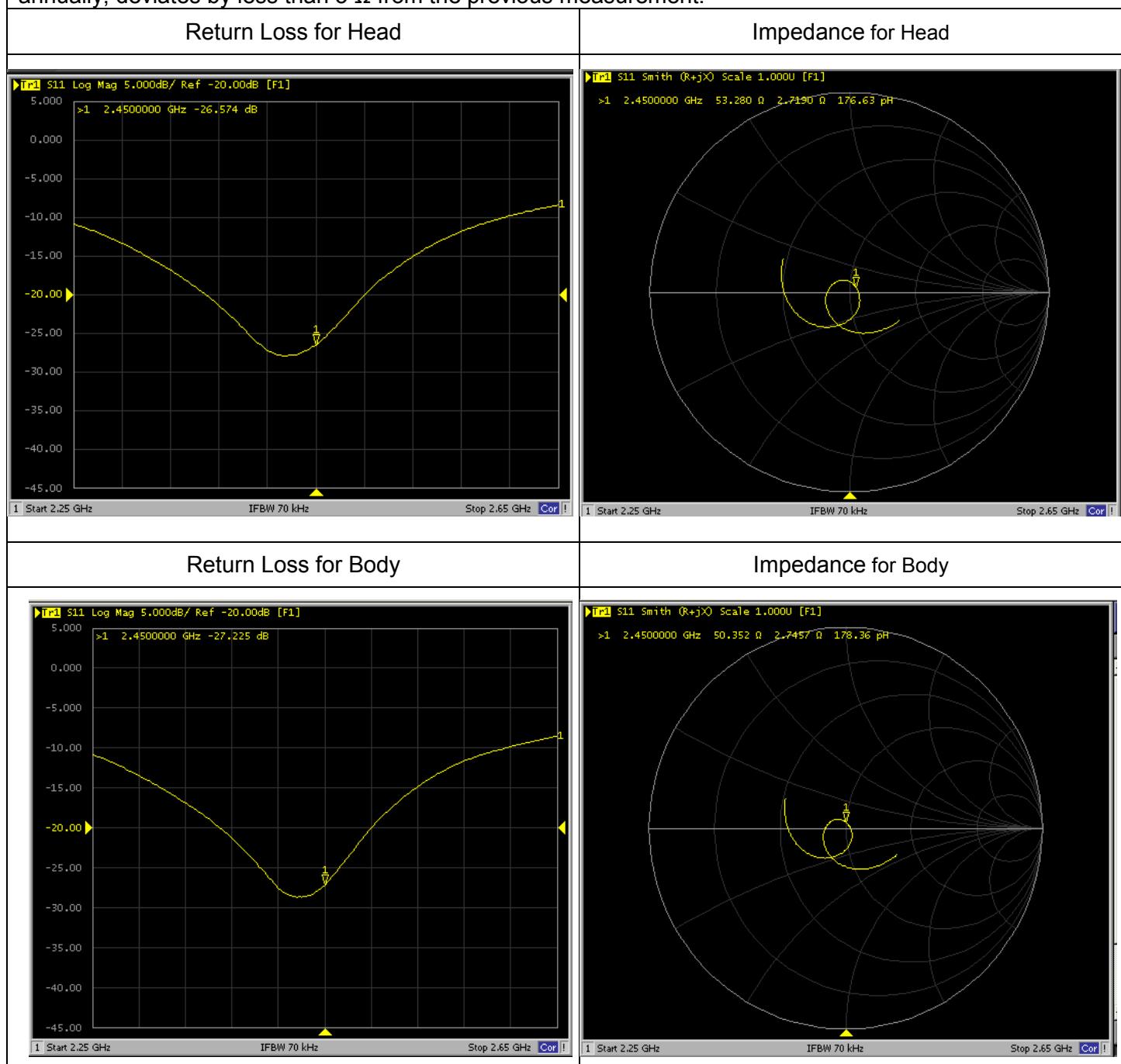


Dipole Calibration for Impedance and Return-loss

Model NO.:	D2450V2	Serial NO.:	733	Measurement Date:	2014-11-25
Liquid Type	Target Value:		Measured Value:		verdict
	Impedance	Return Loss	Impedance	Return Loss	
Head	54.2 Ω +2.5j Ω	-26.6dB	53.2 Ω +2.7j Ω	-26.6dB	Complied
Body	51.0 Ω +4.2j Ω	-27.5dB	50.4 Ω +2.7j Ω	-27.2dB	Complied

Remark: According to KDB 865664 D01, instead of the typical annual calibration recommended by measurement standards, longer calibration intervals of up to three years may be considered when it is demonstrated that the SAR target, impedance and return loss of a dipole have remain stable according to the following requirements:

- 1) The most recent return-loss result, measured at least annually, deviates by less than 20% from the previous measurement and meeting the required 20 dB minimum return-loss requirement.
- 2) The most recent measurement of the real and imaginary parts of the impedance, measured at least annually, deviates by less than 5 Ω from the previous measurement.



IMPORTANT NOTICE

USAGE OF THE DAE 3

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

Battery Exchange: The battery cover of the DAE3 unit is connected to a fragile 3-pin battery connector. Customer is responsible to apply outmost caution not to bend or damage the connector when changing batteries.

Shipping of the DAE: Before shipping the DAE to SPEAG for calibration the customer shall remove the batteries and pack the DAE in an antistatic bag. This antistatic bag shall then be packed into a larger box or container which protects the DAE from impacts transportation. The package shall be marked to indicate that a fragile instrument is inside.

E-Stop Failures: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, Customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

Repair: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

DASY Configuration Files: Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 M Ω is given in the corresponding configuration file.

Important Note:

Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.

Important Note:

Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.

Important Note:

To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.



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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **SGS-SZ (Auden)**

Certificate No: **DAE3-569_Oct14**

CALIBRATION CERTIFICATE

Object **DAE3 - SD 000 D03 AA - SN: 569**

Calibration procedure(s) **QA CAL-06.v28**
 Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **October 01, 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 $(22 \pm 3)^\circ\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	01-Oct-13 (No:13976)	Oct-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit Calibrator Box V2.1	SE UWS 053 AA 1001 SE UMS 006 AA 1002	07-Jan-14 (in house check) 07-Jan-14 (in house check)	In house check: Jan-15 In house check: Jan-15

Calibrated by:	Name Dominique Steffen	Function Technician	Signature
Approved by:	Fin Bomholt	Deputy Technical Manager	

Issued: October 1, 2014

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Accreditation No.: **SCS 108**

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement*: Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
 - *DC Voltage Measurement Linearity*: Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
 - *Common mode sensitivity*: Influence of a positive or negative common mode voltage on the differential measurement.
 - *Channel separation*: Influence of a voltage on the neighbor channels not subject to an input voltage.
 - *AD Converter Values with inputs shorted*: Values on the internal AD converter corresponding to zero input voltage
 - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
 - *Input Offset Current*: Typical value for information; Maximum channel input offset current, not considering the input resistance.
 - *Input resistance*: Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
 - *Low Battery Alarm Voltage*: Typical value for information. Below this voltage, a battery alarm signal is generated.
 - *Power consumption*: Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = $6.1\mu\text{V}$, full range = $-100\dots+300\text{ mV}$

Low Range: 1LSB = 61nV , full range = $-1\dots+3\text{mV}$

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	$402.924 \pm 0.02\% \text{ (k=2)}$	$403.325 \pm 0.02\% \text{ (k=2)}$	$403.500 \pm 0.02\% \text{ (k=2)}$
Low Range	$3.92577 \pm 1.50\% \text{ (k=2)}$	$3.96310 \pm 1.50\% \text{ (k=2)}$	$3.93738 \pm 1.50\% \text{ (k=2)}$

Connector Angle

Connector Angle to be used in DASY system	$251.5^\circ \pm 1^\circ$
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Appendix (Additional assessments outside the scope of SCS108)

1. DC Voltage Linearity

High Range		Reading (μ V)	Difference (μ V)	Error (%)
Channel X	+ Input	200035.22	-0.20	-0.00
Channel X	+ Input	20002.19	-1.76	-0.01
Channel X	- Input	-20006.97	-1.35	0.01
Channel Y	+ Input	200035.19	0.15	0.00
Channel Y	+ Input	20005.73	1.84	0.01
Channel Y	- Input	-20002.94	2.72	-0.01
Channel Z	+ Input	200036.78	2.05	0.00
Channel Z	+ Input	20000.85	-2.98	-0.01
Channel Z	- Input	-20003.49	2.25	-0.01

Low Range		Reading (μ V)	Difference (μ V)	Error (%)
Channel X	+ Input	2000.07	-0.52	-0.03
Channel X	+ Input	200.34	-0.24	-0.12
Channel X	- Input	-199.37	0.15	-0.07
Channel Y	+ Input	2000.14	-0.25	-0.01
Channel Y	+ Input	200.77	0.37	0.18
Channel Y	- Input	-200.33	-0.64	0.32
Channel Z	+ Input	1999.30	-1.02	-0.05
Channel Z	+ Input	199.21	-1.07	-0.53
Channel Z	- Input	-201.98	-2.27	1.13

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μ V)	Low Range Average Reading (μ V)
Channel X	200	-0.04	-1.94
	-200	3.39	1.76
Channel Y	200	4.71	4.96
	-200	-5.88	-6.27
Channel Z	200	-13.08	-13.58
	-200	11.57	11.33

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μ V)	Channel Y (μ V)	Channel Z (μ V)
Channel X	200	-	1.84	-2.31
Channel Y	200	9.77	-	2.55
Channel Z	200	7.06	7.64	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	16202	16482
Channel Y	16554	16428
Channel Z	15802	16416

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Input 10MΩ

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	-3.34	-4.82	-1.88	0.64
Channel Y	-1.07	-3.59	0.83	0.78
Channel Z	-0.53	-1.91	1.06	0.57

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

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



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

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Accreditation No.: **SCS 108**

Client **SGS-SZ (Auden)**

Certificate No: **EX3-3962_Nov14**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3962**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v4, QA CAL-23.v5,
 QA CAL-25.v6
 Calibration procedure for dosimetric E-field probes**

Calibration date: **November 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 $(22 \pm 3)^\circ\text{C}$ 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-14)	In house check: Oct-15

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

Issued: November 24, 2014

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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:

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

Methods Applied and Interpretation of Parameters:

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

Probe EX3DV4

SN:3962

Manufactured: September 30, 2013
Calibrated: November 24, 2014

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3962

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.38	0.47	0.43	$\pm 10.1\%$
DCP (mV) ^B	99.0	98.6	91.3	

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	157.1	$\pm 3.0\%$
		Y	0.0	0.0	1.0		153.4	
		Z	0.0	0.0	1.0		140.1	

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

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

^B Numerical linearization parameter: uncertainty not required.

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3962

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
450	43.5	0.87	10.94	10.94	10.94	0.20	1.40	± 13.3 %
850	41.5	0.92	9.89	9.89	9.89	0.80	0.50	± 12.0 %
1810	40.0	1.40	8.28	8.28	8.28	0.58	0.71	± 12.0 %
1900	40.0	1.40	8.14	8.14	8.14	0.63	0.67	± 12.0 %
2000	40.0	1.40	8.11	8.11	8.11	0.80	0.58	± 12.0 %
2450	39.2	1.80	7.32	7.32	7.32	0.63	0.68	± 12.0 %
5200	36.0	4.66	5.22	5.22	5.22	0.35	1.80	± 13.1 %
5300	35.9	4.76	5.03	5.03	5.03	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.75	4.75	4.75	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.66	4.66	4.66	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.68	4.68	4.68	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.

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3962

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)
450	56.7	0.94	11.11	11.11	11.11	0.12	1.20	± 13.3 %
850	55.2	0.99	10.07	10.07	10.07	0.80	0.50	± 12.0 %
1810	53.3	1.52	8.34	8.34	8.34	0.61	0.71	± 12.0 %
1900	53.3	1.52	8.07	8.07	8.07	0.44	0.77	± 12.0 %
2450	52.7	1.95	7.47	7.47	7.47	0.80	0.56	± 12.0 %
5200	49.0	5.30	4.27	4.27	4.27	0.50	1.90	± 13.1 %
5300	48.9	5.42	4.08	4.08	4.08	0.50	1.90	± 13.1 %
5500	48.6	5.65	3.85	3.85	3.85	0.55	1.90	± 13.1 %
5600	48.5	5.77	3.69	3.69	3.69	0.55	1.90	± 13.1 %
5800	48.2	6.00	3.89	3.89	3.89	0.55	1.90	± 13.1 %

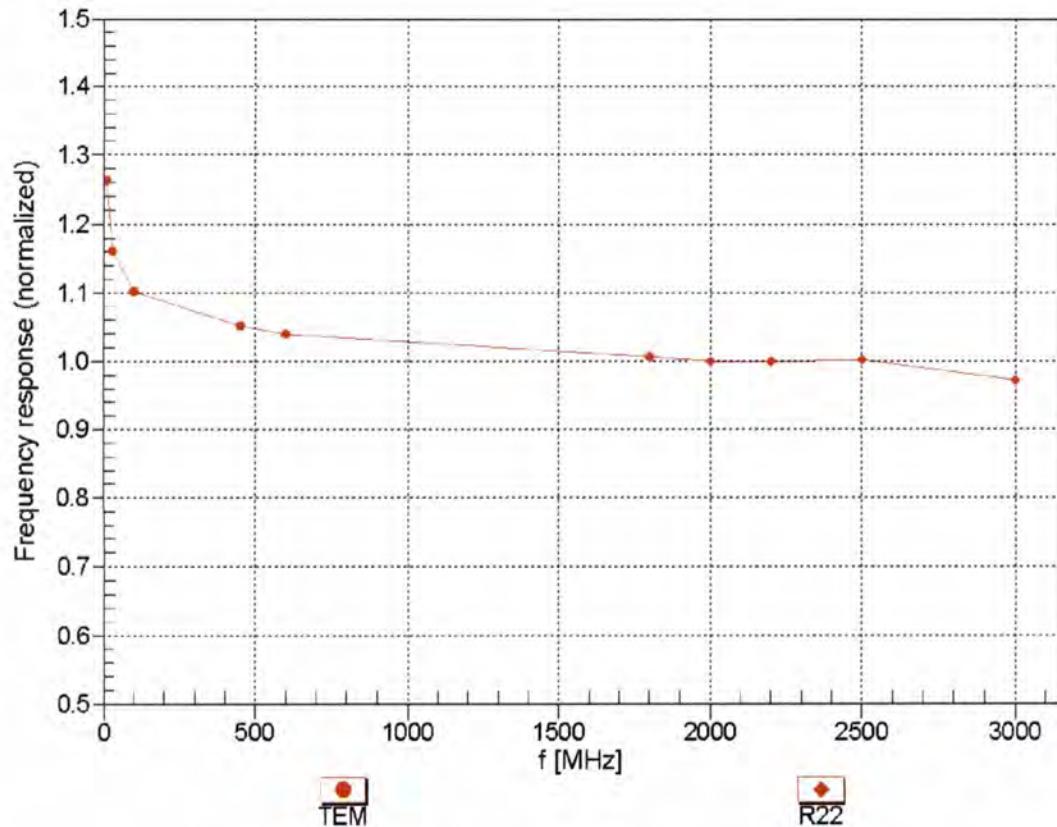
^C Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 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.

Frequency Response of E-Field

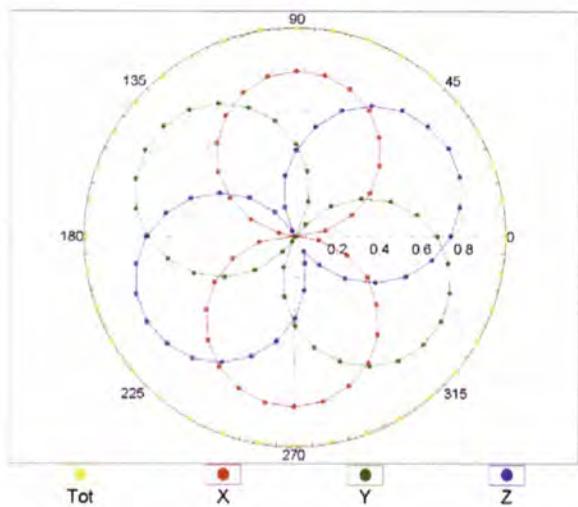
(TEM-Cell:ifi110 EXX, Waveguide: R22)



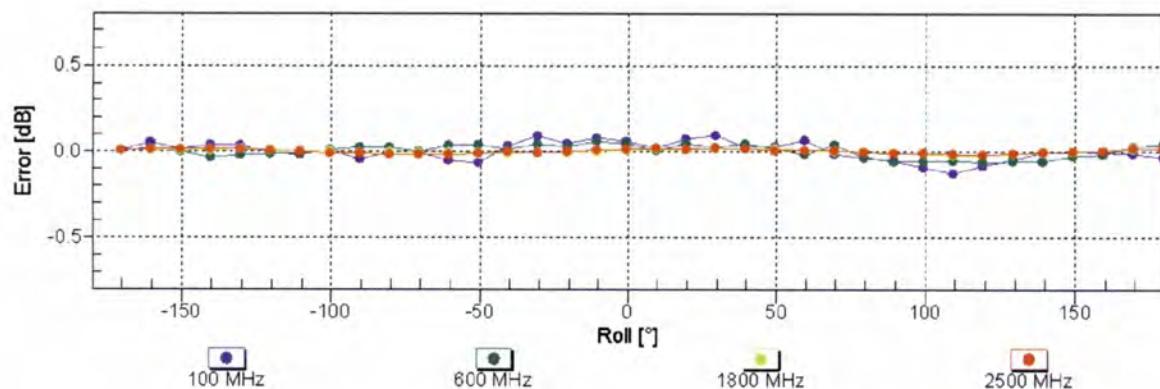
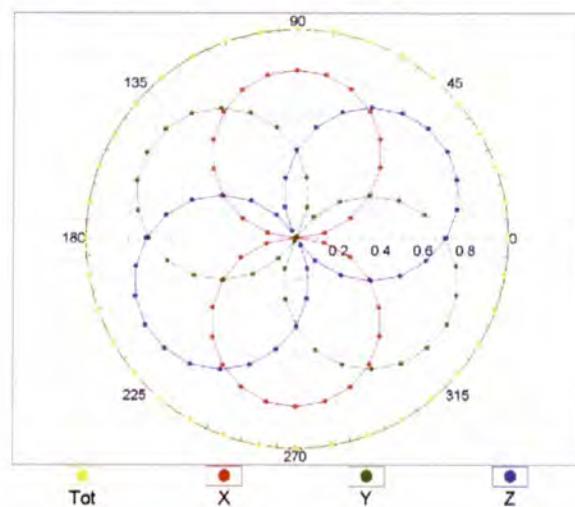
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz, TEM

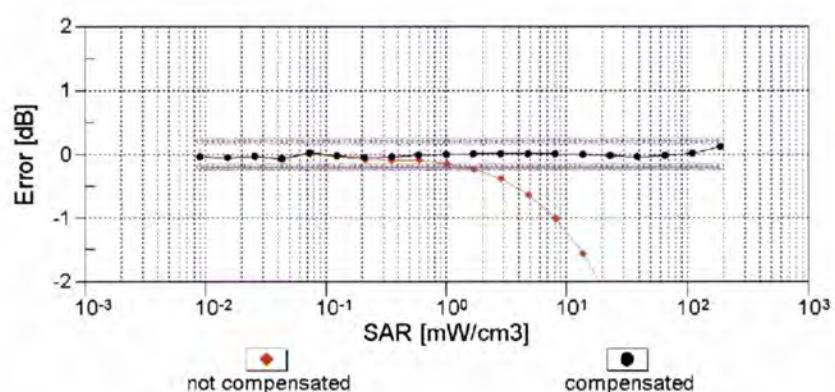
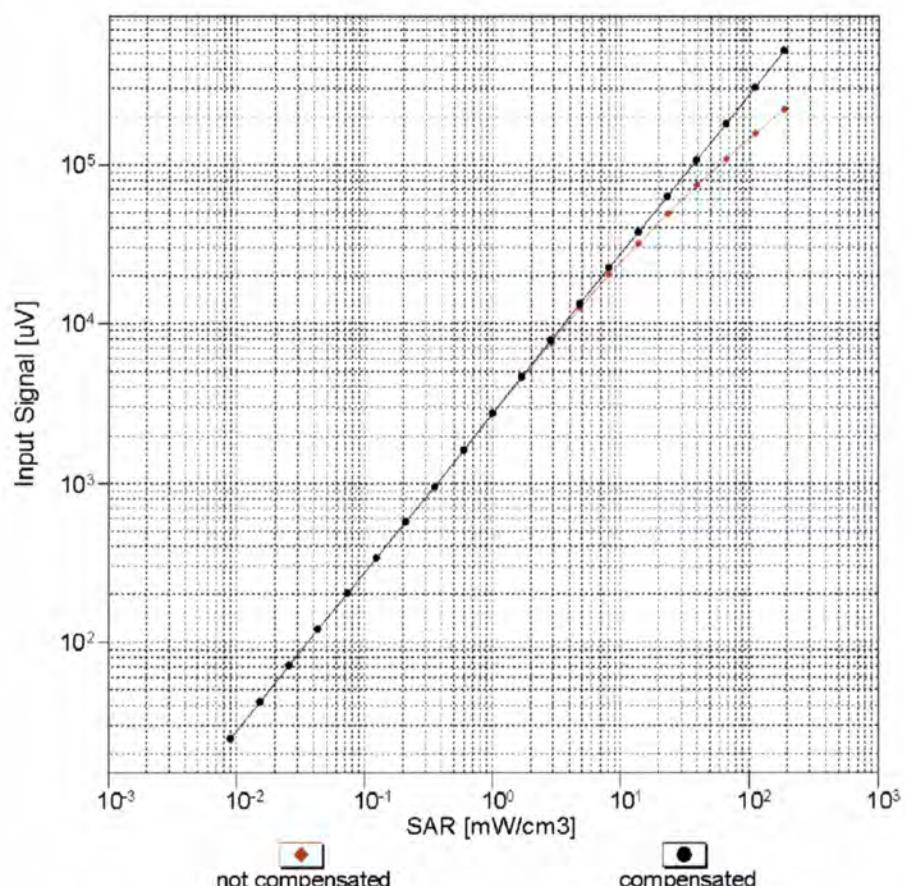


f=1800 MHz, R22



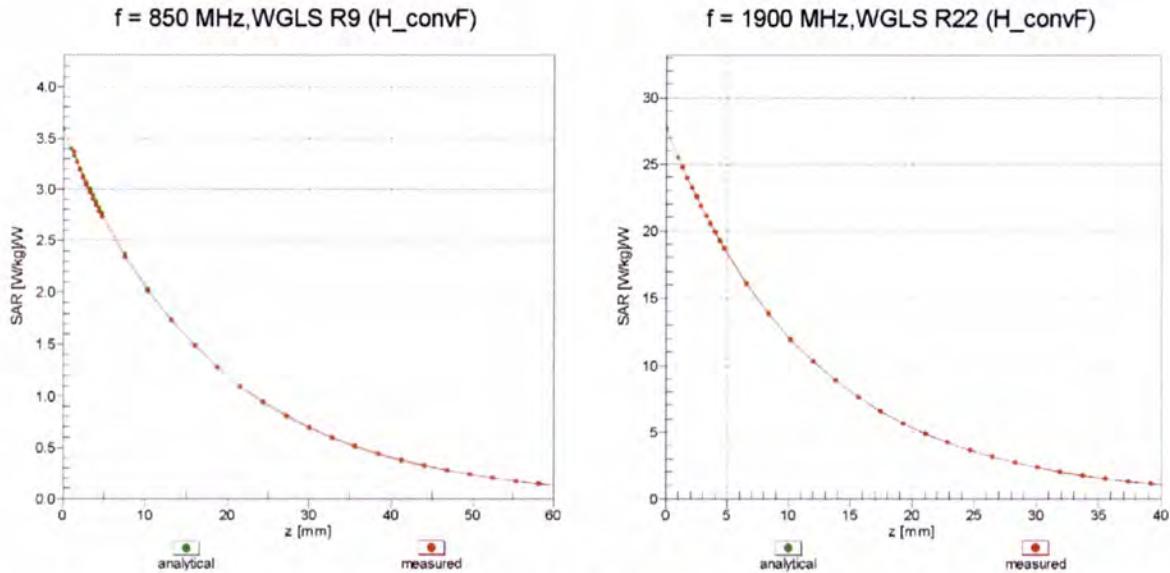
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

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

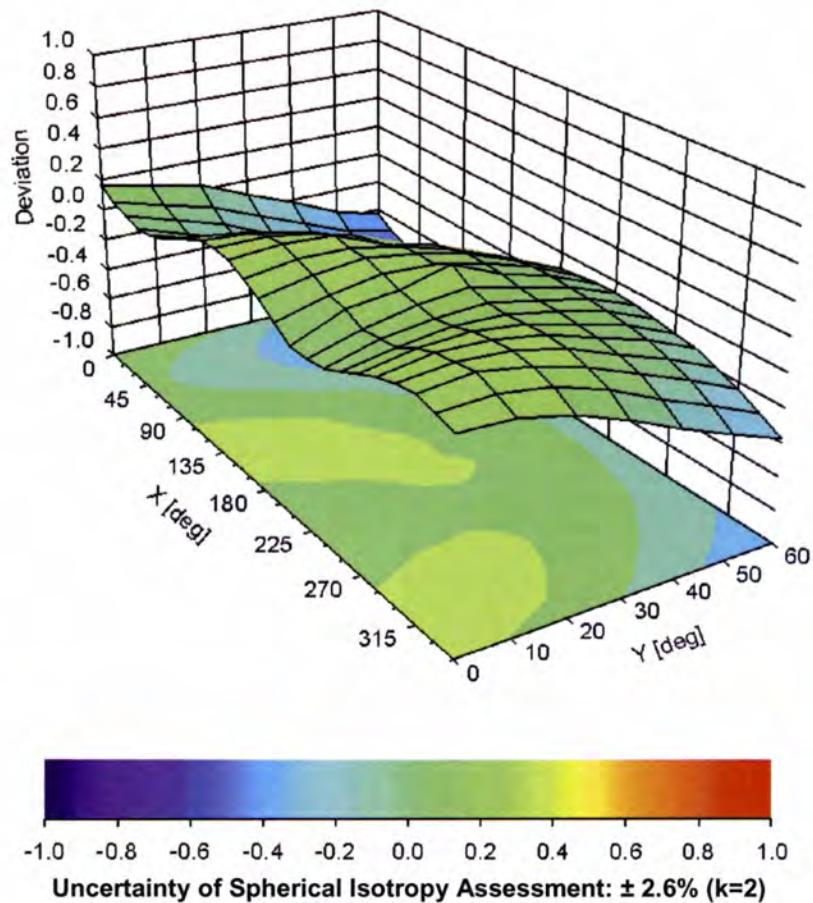


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



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



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3962

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-30.7
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



Appendix D

Photographs

1. SAR measurement System
2. Photographs of Tissue Simulate Liquid
3. Photographs of EUT test position
4. EUT Constructional Details

1. SAR measurement System:**2. Photographs of Tissue Simulate Liquid**

Photo 1: Tissue Simulant Liquid for Body 2450	NA
	NA

3. Photographs of EUT test position

Photo 2: Front side 0 mm	Photo 3: Back side 0 mm
	

4. EUT Constructional Details

Photo 4: Front View	Photo 5: Back View
	
Photo 6: Accessory	N/A
	N/A