

SAR TEST REPORT

For

Handheld Rugged Terminal

Model Number: HRT500i

FCC ID: SX3-HRT500i

Report Number : WT158002881

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Test report declaration

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Manufacturer : Optima Klasik Sdn Bhd
Address : IRIS Smart Technology Complex,Technology Park Malaysia,Bukit Jalil,57000 Kuala Lumpur,Malaysia.
EUT Description : Handheld Rugged Terminal
Model No : HRT500i
Trade mark : 
Marketing name : /
FCC ID : : SX3-HRT500I

Test Standards:

IEEE 1528-2003 FCC KDB 865664 D01 v01r3

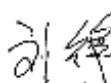
The EUT described above is tested by Shenzhen Academy of Metrology and Quality Inspection EMC Laboratory to determine the compliance of the applicable standards stated above.

Shenzhen Academy of Metrology and Quality Inspection EMC Laboratory is assumed full responsibility for the accuracy of the test results.

The results documented in this report only apply to the tested sample, under the conditions and modes of operation as described herein.

The test report shall not be reproduced in part without written approval of the laboratory.

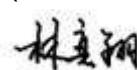
Project Engineer:



Date: Jun.19.2015

(Liu Zheng)

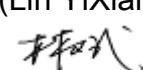
Checked by:



Date: Jun.19.2015

(Lin Yixiang)

Approved by:



Date: Jun.19.2015

(Lin Bin)

Revision History

No	Date	Reason
--	2015-06-19	Initial issue

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1. REPORTED SAR SUMMARY

The maximum results of Specific Absorption Rate (SAR) found during testing are as follows.

Highest Reported Standalone SAR Summary

Exposure Position	Frequency Band	Highest Reported 1g-SAR (W/kg)
Body-Hotspot(0mm Gap)	GSM850	0.022
Body-Hotspot(0mm Gap)	GSM1900	0.120
Body-Hotspot(0mm Gap)	WCDMA V	0.012
Body-Hotspot(0mm Gap)	Wi-Fi	0.006

2. GENERAL INFORMATION

2.1. Report information

This report is not a certificate of quality; it only applies to the sample of the specific product/equipment given at the time of its testing. The results are not used to indicate or imply that they are application to the similar items. In addition, such results must not be used to indicate or imply that SMQ approves recommends or endorses the manufacture, supplier or use of such product/equipment, or that SMQ in any way guarantees the later performance of the product/equipment.

The sample/s mentioned in this report is/are supplied by Applicant, SMQ therefore assumes no responsibility for the accuracy of information on the brand name, model number, origin of manufacture or any information supplied.

Additional copies of the report are available to the Applicant at an additional fee. No third part can obtain a copy of this report through SMQ, unless the applicant has authorized SMQ in writing to do so.

2.2. Laboratory Accreditation and Relationship to Customer

The testing report were performed by the Shenzhen Academy of Metrology and quality Inspection EMC Laboratory (Guangdong EMC compliance testing center), in their facilities located at Bldg. of Metrology & Quality Inspection, Longzhu Road, Nanshan District, Shenzhen, Guangdong, China. At the time of testing, Laboratory is accredited by the following organizations:

China National Accreditation Service for Conformity Assessment (CNAS) accredits the Laboratory for conformance to FCC standards, EMC international standards and EN standards. The Registration Number is CNAS L0579.

The Laboratory is listed in the United States of American Federal Communications Commission (FCC), and the registration number are 446246 806614 994606 (semi anechoic chamber).

The Laboratory is registered to perform emission tests with Industry Canada (IC), and the registration number is IC4174.

TUV Rhineland accredits the Laboratory for conformance to IEC and EN standards, the registration number is E2024086Z02.

3. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

3.1.DUT Description

Frequency Bands	GSM850; GSM1900; WCDMA Band V
Modulation Mode	: GPRS: GMSK EDGE: 8PSK WCDMA: QPSK
Antenna type	RFID:Integrated Antenna 0dBi BT:Chip Antenna 0dBi WiFi:PCB Antenna 0dBi GPS:Patch Antenna 0dBi 2G/3G:PCB Antenna 0dBi
Battery Model	Lithium Polymer 3600mAh
Battery Specification	7.4V/3600mAh
Hardware Revision	V1.0
Software Revision	Windows CE 6.0

Remark: This product is prototype.

3.2.RF output power Tune up limit

GSM/GPRS/EDGE850 (GMSK) :

1TXslot: 31 dBm[-1dB~~+1.0dB]

2TXslot: 31 dBm[-1dB~~+1.0dB]

3TXslot: 31 dBm[-1dB~~+1.0dB]

4TXslot: 31 dBm [-1dB~~+1.0dB]

EDGE850 (8PSK) :

1TXslot: 25 dBm[-1dB~~+1.0dB]

2TXslot: 25 dBm[-1dB~~+1.0dB]

3TXslot: 25 dBm[-1dB~~+1.0dB]

4TXslot: 25 dBm [-1dB~~+1.0dB]

PCS/GPRS/EDGE 1900 (GMSK) :

1TXslot: 29 dBm [-1dB~~+1.0dB]

2TXslot: 29 dBm [-1dB~~+1.0dB]

3TXslot: 29 dBm [-1dB~~+1.0dB]

4TXslot: 29 dBm[-1dB~~+1.0dB]

EDGE 1900 (8PSK) :

1TXslot: 25 dBm [-1dB~~+1.0dB]

2TXslot: 25 dBm [-1dB~~+1.0dB]

3TXslot: 25 dBm [-1dB~~+1.0dB]

4TXslot: 25 dBm [-1dB~~+1.0dB]

The UMTS Band 5 power adjust procedure

WCDMA: 22 dBm [-1dB~~+1dB]

HSDPA:

HSDPA Subtest 1: 21 dBm [-1dB~~+1.0dB]

HSDPA Subtest 2: 20 dBm [-1dB~~+1.0dB]

HSDPA Subtest 3: 20 dBm [-1dB~~+1.0dB]

HSDPA Subtest 4: 20 dBm [-1dB~~+1.0dB]

HSUPA:

HSUPA Subtest 1: 20 dBm [-1dB~~+1.0dB]

HSUPA Subtest 2: 20 dBm [-1dB~~+1.0dB]

HSUPA Subtest 3: 19.5 dBm [-1dB~~+1.0dB]

HSUPA Subtest 4: 21 dBm [-1dB~~+1.0dB]

HSUPA Subtest 5: 20.5 dBm [-1dB~~+1.0dB]

BT Average Power:

BT: 1dBm [-1dB~~+1.0dB]

The Wi-Fi RF test procedure

WIFI

Average Power:

11b: 11dBm[-1dB~~+1.0dB]

11g: 9dBm[-1dB~~+1.0dB]

3.3. Applied Standards

- **FCC 47 CFR Part 2 (2.1093)**
- **ANSI/IEEE C95.1-1992**
- **IEEE 1528-2003**
- **FCC KDB 447498 D01 v05r02**
- **FCC KDB 648474 D04v01r02**
- **FCC KDB 248227 D01 v01r02**
- **FCC KDB 941225 D01 v02**
- **FCC KDB 941225 D06 v01**
- **FCC KDB 865664 D01 v03**
- **FCC KDB 616217 D04v01**

3.4. SAR Limit

This device belongs to portable device category because its radiating structure is allowed to be used within 20 centimeters of the body of the user. Limit for General Population/Uncontrolled exposure should be applied for this device, it is 1.6 W/kg as averaged over any 1 gram of tissue.

4. TEST CONDITIONS

4.1. Temperature and Humidity

Ambient temperature (°C):	21-22
Ambient humidity (RH %):	59-60

4.2. Introduction of SAR

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for general public group.

SAR Definition:

$$SAR = \frac{d}{dt} \left(\frac{dW}{dm} \right) = \frac{d}{dt} \left(\frac{dW}{\rho dv} \right) \quad SAR = C \frac{\delta T}{\delta t} \quad SAR = \frac{\sigma |E|^2}{\rho}$$

In the first equation, the SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density ρ .

In the second equation, C is the specific heat capacity, δT is the temperature rise and δt is the exposure duration.

The last equation relates to the electrical field, where σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the rms electrical field strength. However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

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

4.3. Test Configuration

GSM Test Configuration

The tests for GSM850 and GSM1900, a communication link is set up with a System Simulator by air link. The Absolute Radio Frequency Channel Number (ARFCN) is allocated to 128, 190 and 251 respectively in the case of GSM850, to 512, 661 and

810 respectively in the case of GSM1900. The tests in the band of GSM850 and GSM1900 are performed in the mode of GPRS/EGPRS function. Since the GPRS class is 10 for this EUT, it has at most 2 timeslots in uplink and at most 4 timeslots in downlink, the maximum total timeslot is 5. The EGPRS class is 10 for this EUT, it has at most 2 timeslots in uplink, and at most 4 timeslots in downlink, the maximum total timeslot is 5. The device output power was set to maximum power level for all tests. Using CMU200 the power control level is set to “ 5” for GSM850, set to “ 0” for GSM1900.

WCDMA Test Configuration

The following tests were completed according to the test requirements outlined in section 5.2 of the 3GPP TS34.121-1 specification. The EUT supports power Class 3, which has a nominal maximum output power of 24 dBm (+1.7/-3.7).

	Mode	Rel99
	Subtest	---
WCDMA General Settings	Loopback Mode	Test Mode 1
	Rel99 RMC	12.2kbps RMC
	Power Control Algorithm	Algorithm2
	β_c / β_d	8/15

WiFi Test configuration

For the 802.11b/g/n SAR tests, a communication link is set up with the test mode software for WiFi mode test. The Absolute Radio Frequency Channel Number(ARFCN) is allocated to 1, 6 and 11 respectively in the case of 2450 MHz. During the test, at the each test frequency channel, the EUT is operated at the RF continuous emission mode. Each channel should be tested at the lowest data rate.

The distance between the DUT and the antenna of the System Simulator is larger than 50 cm. A fully charged battery was used for every test sequence.

For all the testing, measurements follow the EN 62209-1/-2 standards. The measurements were performed on the middle channel of both bands for each testing position. For the testing position with largest SAR result on each band, measurements of the lowest channel and highest channel were also performed.

The radiated output power of the device was measured by a separate test laboratory

on the same unit(s) as used for SAR testing.

The tests shall be performed, which is illustrated in figure as below.

5. DESCRIPTION OF THE TEST EQUIPMENTS

5.1. Measurement System and Components

No.	Equipment	Model No.	Manufacturer	Asset No.	Last Calibration Data	Period
1	SAR test system	TX60L	SPEAG	SB6810	---	---
2	SAR Probe	EX3DV4	SPEAG	SB6810/02	2014.07.22	1year
4	System Validation Dipole, 1900MHz	D1900V2	SPEAG	SB6810/05	2012.09.21	3year
6	Dielectric Probe Kit	85070E	SPEAG	SB6810/12	---	---
7	Dual-directional coupler, 0.10-2.0GHz	778D	Agilent	SB6810/07	---	---
8	Dual-directional coupler, 2.00-18GHz	772D	Agilent	SB6810/08		
9	Coaxial attenuator	8491A	Agilent	SB6810/09	---	---
10	Power Amplifier	ZHL42W	Agilent	SB6810/10	---	---
11	Signal Generator	SMR20	R&S	SB3438	2015.05.12	1year
12	Power Meter	NRVD	R&S	SB3437	2015.04.16	1year
13	Call Tester	CMU 200	R&S	SB3441	2015.01.07	1year
14	Data Acquisition Electronics	DAE4	SPEAG	SB6810/01	2015.03.09	1Year
15	Software	DASY52	SPEAG	SB6810/14	--	--
16	Network Analyzer	E5071C	Agilent	SB9011/01	2015.04.23	1Year

The measurements were performed using an automated near-field scanning system, DASY5, manufactured by Schmid & Partner Engineering AG (SPEAG) in Switzerland. The SAR extrapolation algorithm used in all measurements was the “ advanced extrapolation” algorithm.

5.2. Isotropic E-field Probe Type EX3DV4

Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., butyl diglycol)
Calibration	Calibration certificate in Appendix C
Frequency	10MHz to 4GHz (dosimetry); Linearity: $\pm 0.2\text{dB}$ (30MHz to 4GHz)
Directivity	$\pm 0.2\text{ dB}$ in HSL (rotation around probe axis) $\pm 0.3\text{ dB}$ in HSL (rotation normal to probe axis)
Dynamic Range	5 $\mu\text{W/g}$ to $> 100\text{mW/g}$; Linearity: $\pm 0.2\text{ dB}$
Dimensions	Overall length: 330 mm Tip length: 20 mm Body diameter: 12 mm Tip diameter: 3.9 mm Distance from probe tip to dipole centers: 2.0 mm
Application	General dosimetry up to 4 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms

5.3. Phantoms

The phantom used for all tests i.e. for both system checks and device testing, was the twin-headed "SAM Phantom", manufactured by SPEAG. The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region, where shell thickness increases to 6mm).

System checking was performed using the flat section, whilst Head SAR tests used the left and right head profile sections. Body SAR testing also used the flat section between the head profiles.



SAM Twin Phantom

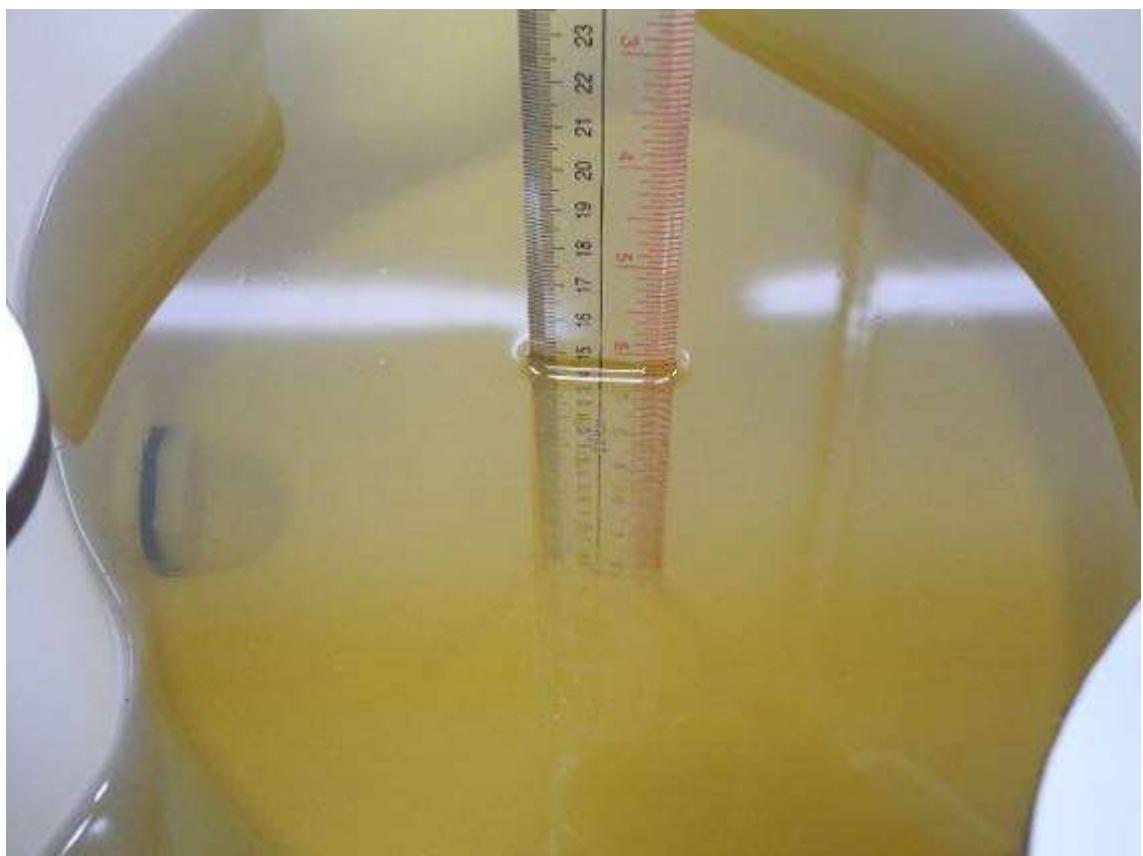
5.4. Tissue-equivalent Liquids

Tissue-equivalent liquids that are used for testing, which are made mainly of sugar, salt and water solution. All tests were carried out using tissue-equivalent liquids whose dielectric parameters were within $\pm 5\%$ of the recommended values. All tests were carried out within 24 hours of measuring the dielectric parameters.

The depth of the Tissue-equivalent liquid was 15.0 ± 0.5 cm measured from the ear reference point (ERP) during system checking and device measurements.

Tissue-equivalent liquid Recipes

The following recipe(s) were used for Head Tissue-equivalent liquid(s):



Ingredient (% by weight)	Frequency Band			
	800-900	1800-1900	800-900	1800-1900
Tissue Type	Head	Head	Body	Body
Water	40.6	56.1	50.8	68.9
Sugar	58.2	--	48.2	--
Salt	1.0	0.03	0.9	0.1
Preventol D-7	0.1	--	0.1	--
DGMBE	--	43.87	--	31
Cellulose	0.1	--	--	--
Ingredient (% by weight)	Frequency Band			
	2450	2450		
Tissue Type	Head	Body		
Water	54.8	68.4		
Sugar	--	--		
Salt	--	--		
Preventol D-7	--	--		
DGMBE	45.2	31.6		
Cellulose	--	--		

Tissue-equivalent liquids used in the Measurements

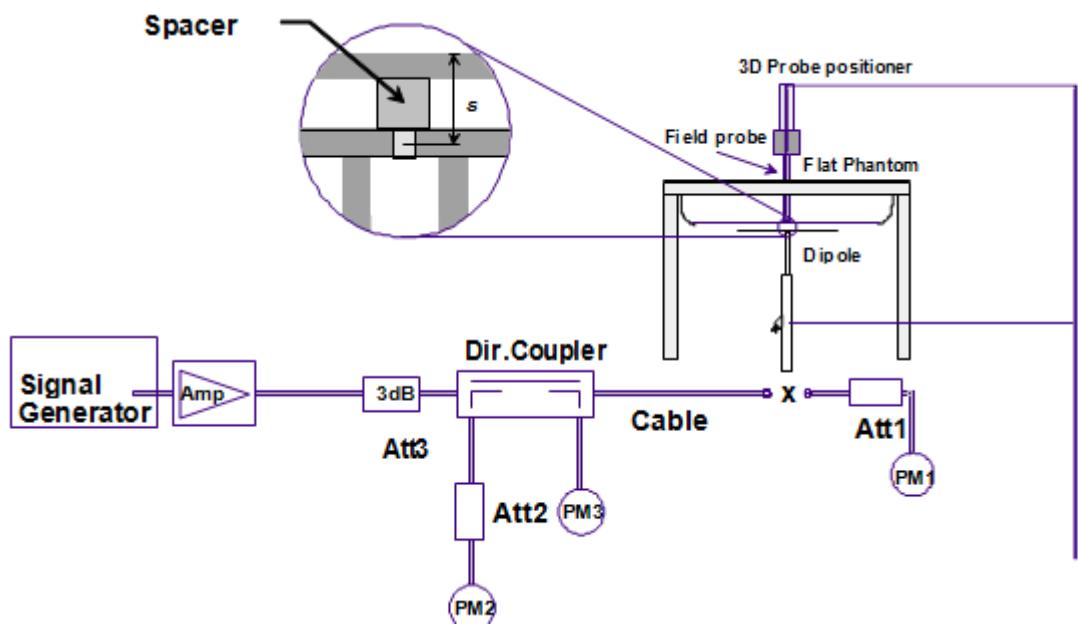
Dielectric parameters of the Tissue-equivalent liquids were measured before testing using the dielectric probe kit and the Network Analyzer. The measurement is carried out following the Agilent 85070 dielectric probe software instruction. A calibration of the probe open in air, probe with shorting block and probe in water is performed before measurement. After calibration, Insert the probe into the tissue liquid, trigger a measurement on software interface and record the data.

Body Tissue-equivalent liquid measurements:

f/MHz	Date Tested	Dielectric Parameters	Target	Delta(%)	Tolerance (%)	Temp (°C)
850	2015/06/15	$\epsilon_r = 55.87$	55.2	1.22	± 5	22
		$\sigma = 0.96$	0.97	-1.04		
1900	2015/06/15	$\epsilon_r = 52.80$	53.3	-0.94	± 5	22
		$\sigma = 1.45$	1.52	-4.61		
2450	2015/06/15	$\epsilon_r = 52.74$	50.71	4.0	± 5	22
		$\sigma = 2.03$	2.02	0.4		
ϵ_r = Relative permittivity, σ = Conductivity						

System Checking

The manufacturer calibrates the probes annually. A system check measurement was made following the determination of the dielectric parameters of the tissue-equivalent liquid, using the dipole validation kit. A power level of 250mW was supplied to the dipole antenna, which was placed under the flat section of the twin SAM phantom.



The system checking results (dielectric parameters and SAR values) are given in the table below.

System checking, Body Tissue-equivalent liquid:

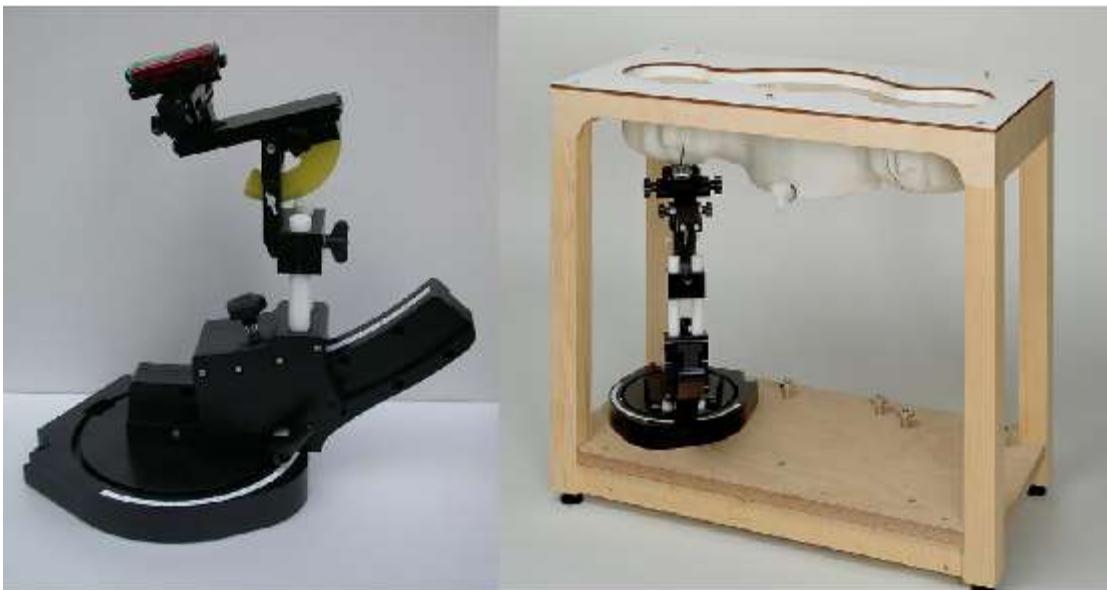
f/MHz	Date Tested	SAR(W/kg), 1g	Target	Delta(%)	Tolerance (%)	Temp (°C)
835	2015/06/15	9.92	9.46	4.86	±10	22
1900	2015/06/15	40.8	40.7	-0.25	±10	22
2450	2015/06/15	55.6	50.8	9.45	±10	22

Plots of the system checking scans are given in Appendix A.

5.5. Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SPEAG as an integral part of the DASY system.

The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.



Device holder supplied by SPEAG

5.6. Test Position

Against Phantom Head

The Mobile phone shall be tested in the “cheek” and “tilted” position on left and right sides of the phantom.

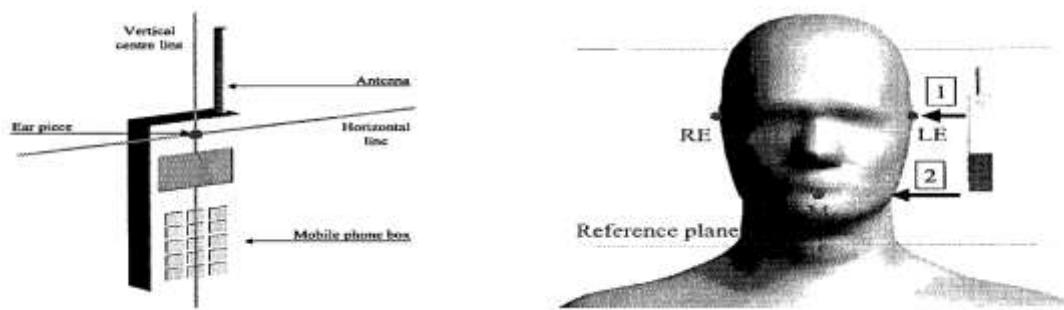
Define of the “cheek” position:

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

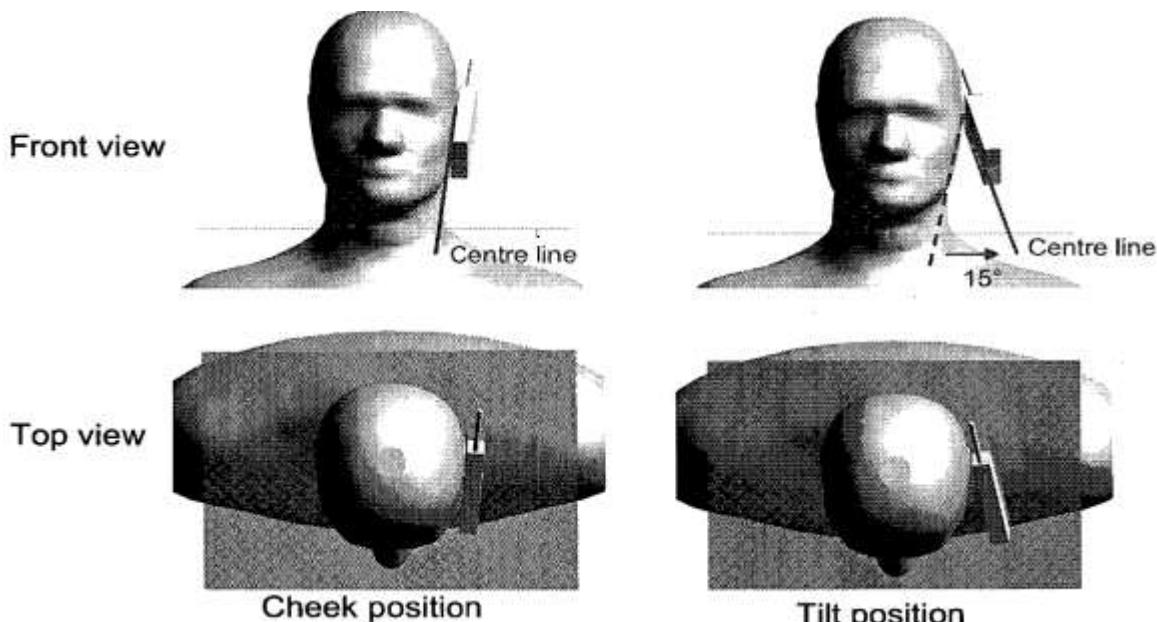
the cheek of the phantom or until contact with the ear is lost.

Define of the “ tilted” position:

- a) Position the device in the “ cheek” position described above.
- b) While maintaining the device the reference planes 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.



Define of the reference lines and points,
on the phone and on the phantom and initial position



“ Cheek” and “ tilted” position of the mobile phone on the left side

Body Worm Configuration

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. Devices with a headset output should be tested with a headset

connected to the device. The distance between of the device and the phantom was kept 15mm.

5.7. Scan Procedures

First, area scans were used for determination of the field distribution. Next, a zoom scan, a minimum of 5x5x7 points covering a volume of at least 30x30x30mm, was performed around the highest E-field value to determine the averaged SAR value. Drift was determined by measuring the same point at the start of the area scan and again at the end of the zoom scan.

5.8. SAR Averaging Methods

The DASY5 software includes all numerical procedures necessary to evaluate the spatial peak SAR values. The base for the evaluation is a “ cube” measurement in a volume of (30mm)³ (7x7x7 points). The maximum SAR value was averaged over the cube of tissue using interpolation and extrapolation.

The interpolation, extrapolation and maximum search routines within Dasy5 are all based on the modified Quadratic Shepard’ s method.

The interpolation scheme combines a least-square fitted function method with a weighted average method. A trivariate 3-D / bivariate 2-D quadratic function is computed for each measurement point and fitted to neighbouring points by a least-square method. For the zoom scan, inverse distance weighting is incorporated to fit distant points more accurately. The interpolating function is finally calculated as a weighted average of the quadratics.

In the zoom scan, the interpolation function is used to extrapolate the Peak SAR from the deepest measurement points to the inner surface of the phantom.

6. MEASUREMENT UNCERTAINTY

6.1. Uncertainty for SAR Test

Uncertainty Budget of DASY for frequency range 300 MHz to 3 GHz

Uncertainty Component	Tol. (%)	Prob Dist.	Div	ci (1g)	ci.ui(%) (1g)	vi
Measurement System						
Probe Calibration	±5.9	N	1	1	±5.9	∞
Axial Isotropy	±4.7	R	$\sqrt{3}$	0.7	±1.9	∞
Hemispherical Isotropy	±9.6	R	$\sqrt{3}$	0.7	±3.9	∞
Boundary Effect	±1.0	R	$\sqrt{3}$	1	±0.6	∞
Linearity	±4.7	R	$\sqrt{3}$	1	±2.7	∞
System Detection Limits	±1.0	R	$\sqrt{3}$	1	±0.6	∞
Readout Electronics	±0.3	N	1	1	±0.3	∞
Response Time	±0.8	R	$\sqrt{3}$	1	±0.5	∞
Integration Time	±2.6	R	$\sqrt{3}$	1	±1.5	∞
RF Ambient Conditions - Noise	±3.0	R	$\sqrt{3}$	1	±1.7	∞
RF Ambient Conditions - Reflections	±3.0	R	$\sqrt{3}$	1	±1.7	∞
Probe Positioner Mechanical Tolerance	±0.4	R	$\sqrt{3}$	1	±0.2	∞
Probe Positioning with respect to Phantom Shell	±2.9	R	$\sqrt{3}$	1	±1.7	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	±1.0	R	$\sqrt{3}$	1	±0.6	∞
Test Sample Related						
Test Sample Positioning	±2.9	N	1	1	±2.9	145
Device Holder Uncertainty	±3.6	N	1	1	±3.6	5
Output Power Variation - SAR drift measurement	±5.0	R	$\sqrt{3}$	1	±2.9	∞
Phantom and Tissue Parameters						
Phantom Uncertainty (shape and thickness tolerances)	±4.0	R	$\sqrt{3}$	1	±2.3	∞
Conductivity Target - tolerance	±5.0	R	$\sqrt{3}$	0.43	±1.2	∞
Conductivity - measurement uncertainty	±2.5	N	1	0.43	±1.1	∞
Permittivity Target - tolerance	±5.0	R	$\sqrt{3}$	0.49	±1.4	∞
Permittivity - measurement uncertainty	±2.5	N	1	0.49	±1.2	5
Combined Standard Uncertainty					±10.7	387
Expanded STD Uncertainty					±21.4	

6.2. Uncertainty for System Validation

Uncertainty Component	Uncert. value	Prob. Dist.	Div.	(ci) (1g)	Std. Unc. (1g)	(vi) v_{eff}
Probe Calibration	$\pm 6.55 \%$	N	1	1	$\pm 6.55 \%$	1
Axial Isotropy	$\pm 4.7 \%$	R	$\sqrt{3}$	1	$\pm 2.7 \%$	1
Hemispherical Isotropy	$\pm 9.6 \%$	R	$\sqrt{3}$	0	$\pm 0 \%$	1
Boundary Effects	$\pm 1.0 \%$	R	$\sqrt{3}$	1	$\pm 0.6 \%$	1
Linearity	$\pm 4.7 \%$	R	$\sqrt{3}$	1	$\pm 2.7 \%$	1
System Detection Limits	$\pm 1.0 \%$	R	$\sqrt{3}$	1	$\pm 0.6 \%$	1
Modulation Response	$\pm 0 \%$	R	$\sqrt{3}$	1	$\pm 0 \%$	1
Readout Electronics	$\pm 0.3 \%$	N	1	1	$\pm 0.3 \%$	1
Response Time	$\pm 0 \%$	R	$\sqrt{3}$	1	$\pm 0 \%$	1
Integration Time	$\pm 0 \%$	R	$\sqrt{3}$	1	$\pm 0 \%$	1
RF Ambient Noise	$\pm 1.0 \%$	R	$\sqrt{3}$	1	$\pm 0.6 \%$	1
RF Ambient Reactions	$\pm 1.0 \%$	R	$\sqrt{3}$	1	$\pm 0.6 \%$	1
Probe Positioner	$\pm 0.8 \%$	R	$\sqrt{3}$	1	$\pm 0.5 \%$	1
Probe Positioning	$\pm 6.7 \%$	R	$\sqrt{3}$	1	$\pm 3.9 \%$	1
Max. SAR Eval.	$\pm 2.0 \%$	R	$\sqrt{3}$	1	$\pm 1.2 \%$	1
Dipole Related						
Deviation of exp. dipole	$\pm 5.5 \%$	R	$\sqrt{3}$	1	$\pm 3.2 \%$	1
Dipole Axis to Liquid Dist.	$\pm 2.0 \%$	R	$\sqrt{3}$	1	$\pm 1.2 \%$	1
Input power & SAR drift	$\pm 3.4 \%$	R	$\sqrt{3}$	1	$\pm 2.0 \%$	1
Phantom and Setup						
Phantom Uncertainty	$\pm 4.0 \%$	R	$\sqrt{3}$	1	$\pm 2.3 \%$	1
SAR correction	$\pm 1.9 \%$	R	$\sqrt{3}$	0.84	$\pm 0.9 \%$	1
Liquid Conductivity (meas.)	$\pm 2.5 \%$	N	1	0.71	$\pm 1.8 \%$	1
Liquid Permittivity (meas.)	$\pm 2.5 \%$	N	1	0.26	$\pm 0.7 \%$	1
Temp. unc. -Conductivity	$\pm 1.7 \%$	R	$\sqrt{3}$	0.71	$\pm 0.7 \%$	1
Temp. unc. -Permittivity	$\pm 0.3 \%$	R	$\sqrt{3}$	0.26	$\pm 0.0 \%$	∞
Combined Std. Uncertainty					$\pm 10.1 \%$	
Expanded STD Uncertainty					$\pm 20.1 \%$	

MEASUREMENT RESULTS

Result:

Passed

Date of testing : 2015-05-15
 Ambient temperature : 20°C~22°C

Relative humidity : 50~68%

6.3. Conducted Power

For the measurements a Rohde & Schwarz Radio Communication Tester CMU 200 was used. SAR drift measured at the same position in liquid before and after each SAR test.

Note: CMU200 measures GSM peak and average output power for active timeslots. For SAR the time based average power is relevant. The difference in between depends on the duty cycle of the TDMA signal :

No. of timeslots	1	2	3	4
Duty Cycle	1:8.3	1:4.1	1:2.77	1:2.08
Time based avg. power compared to slotted avg. power	-9.19dB	-6.13dB	-4.42dB	-3.18dB

The signalling modes differ as follows:

mode	coding scheme	modulation
GPRS	CS1 to CS4	GMSK
EDGE	MCS1 to MCS4	GMSK
EDGE	MCS5 to MCS9	8PSK

Apart from modulation change (GMSK/8PSK) coding schemes differ in code rate without influence on the RF signal. Therefore one coding scheme per mode was selected for conducted power measurements.

HRT500i GSM Conducted Power Measurement Results

Band: GSM850	Burst Average Power (dBm)			Frame Average Power (dBm)		
Channel	128	190	251	128	190	251
Frequency (MHz)	824.2	836.6	848.8	824.2	836.6	848.8
GPRS/EDGE (GMSK, 1 Tx slot)	31.90	31.73	31.33	22.71	22.54	22.14
GPRS/EDGE (GMSK, 2 Tx slots)	31.80	31.64	31.29	25.67	25.51	25.16
GPRS/EDGE (GMSK, 3 Tx slots)	31.73	31.60	31.27	27.31	27.18	26.85
GPRS/EDGE (GMSK, 4 Tx slots)	31.72	31.59	31.24	28.54	28.41	28.06
EDGE (8PSK, 1 Tx slot)	25.58	25.08	25.10	16.39	15.89	15.91
EDGE (8PSK, 2 Tx slots)	25.54	25.06	25.09	19.41	18.93	18.96
EDGE (8PSK, 3 Tx slots)	25.52	25.05	25.08	21.1	20.63	20.66
EDGE (8PSK, 4 Tx slots)	25.51	25.04	25.07	22.33	21.86	21.89

Remark:

- 1) The conducted power of GSM850 is measured with RMS detector.
- 2) Frame-averaged output power was calculated from the measured burst-averaged output power by converting the slot powers into linear units and calculating the energy over 8 timeslots.
- 3) Per KDB941225 D01v03, the bolded GPRS 2Tx mode was selected as the primary mode for SAR testing according to the highest frame- averaged output power table.

HRT500i GSM Conducted Power Measurement Results

Band: GSM1900	Burst Average Power (dBm)			Frame Average Power (dBm)		
Channel	512	661	810	512	661	810
Frequency (MHz)	1850.2	1880	1909.8	1850.2	1880	1909.8

GPRS/EDGE (GMSK, 1 Tx slot)	28.86	29.38	29.14	19.67	20.19	19.95
GPRS/EDGE (GMSK, 2 Tx slots)	28.66	29.36	29.12	22.53	23.23	22.99
GPRS/EDGE (GMSK, 3 Tx slots)	28.63	29.35	29.11	24.21	24.93	24.69
GPRS/EDGE (GMSK, 4 Tx slots)	28.61	29.33	29.09	25.43	26.15	25.91
EGPRS (8PSK, 1 Tx slot)	25.16	25.79	25.98	15.97	16.6	16.79
EGPRS (8PSK, 2 Tx slots)	25.15	25.66	25.84	19.02	19.53	19.71
EGPRS (8PSK, 3 Tx slots)	25.13	25.62	25.76	20.71	21.2	21.34
EGPRS (8PSK, 4 Tx slots)	25.12	25.59	25.66	21.94	22.41	22.48

Remark:

- 1) The conducted power of GSM1900 is measured with RMS detector.
- 2) Frame-averaged output power was calculated from the measured burst-averaged output power by converting the slot powers into linear units and calculating the energy over 8 timeslots.
- 3) Per KDB941225 D01v03, the bolded GPRS 2Tx mode was selected as the primary mode for SAR testing according to the highest frame- averaged output power table.

HRT500i UMTS Conducted Power Measurement Results

Band		WCDMA Band V	
Channel	4,132	4,182	4,233
Frequency (MHz)	826.4	836.4	846.6
RMC 12.2K	23.33	22.90	22.47
RMC 64kbps	23.11	22.81	22.43
RMC 144kbps	23.08	22.78	22.47
RMC 384kbps	23.06	22.82	22.43
HSDPA Subtest-1	23.05	22.74	22.39
HSDPA Subtest-2	22.25	21.83	21.62
HSDPA Subtest-3	21.65	21.33	21.02
HSDPA Subtest-4	21.38	21.07	20.72
HSUPA Subtest-1	22.03	21.69	21.41
HSUPA Subtest-2	19.97	19.7	19.42
HSUPA Subtest-3	20.85	20.58	20.25
HSUPA Subtest-4	20.26	20.11	19.79
HSUPA Subtest-5	22.12	21.78	21.46
DC-HSDPA Subtest-1	21.31	21.25	21.33
DC-HSDPA Subtest-2	20.71	20.75	20.73
DC-HSDPA Subtest-3	20.43	20.50	20.43
DC-HSDPA Subtest-4	20.33	20.20	20.23

Remark:

- 1) The conducted power of UMTS Band V is measured with RMS detector
- 2) Per KDB 941225 D01v03, When the maximum output power and tune-up tolerance specified for production units in a secondary mode is ≤ 0.25 dB higher than the primary mode or when the highest reported SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode.

HRT500i WLAN 2.4GHz Band Conducted Power

Wi-Fi 2450MHz	Channel	Average Power (dBm) for Data Rates (Mbps)							
		1	2	5.5	11	/	/	/	/
802.11b 2.4G(DSSS)	1(2412)	10.5	10.38	10.33	10.22	/	/	/	/
	6(2437)	11.5	10.76	10.29	10.84	/	/	/	/
	11(2462)	11.32	11.62	10.68	11.22	/	/	/	/
802.11g 2.4G(OFDM)	Channel	6	9	12	18	24	36	48	54
	1(2412)	6.5	5.75	5.8	5.72	5.64	5.52	5.3	5.18
	6(2437)	9.0	8.81	8.78	8.84	8.89	8.56	8.28	8.13
	11(2462)	9.4	9.23	9.18	8.98	9.03	8.93	8.55	8.41

HRT500i Bluetooth 2.4GHz Band Conducted Power

BT 2450	Average Conducted Power (dBm)		
	0CH	39CH	78CH
DH1	1.5	1.5	1.5
DH3	1.4	1.4	1.4
DH5	1.2	1.2	1.2
3DH1	-2.7	-2.7	-2.7
3DH3	-2.9	-2.9	-2.9
3DH5	-3.2	-3.2	-3.2

6.4. GSM850 SAR results

HRT500i GSM850 Body

Distance 0mm

Band	Mode	Test Position	Ch.	Freq. (MHz)	Burst Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Measured SAR (W/kg)	Reported SAR (W/kg)
GSM850	GPRS(4 Tx slots)	Front	190	836.6	--	--	--	--	--
GSM850	GPRS(4 Tx slots)	Back	190	836.6	31.59	32	1.099	0.0197	0.022

6.5. GSM1900 SAR results

HRT500i GSM1900 Body

Distance 0mm

Band	Mode	Test Position	Ch.	Freq. (MHz)	Burst Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Measured SAR (W/kg)	Reported SAR (W/kg)
GSM1900	GPRS(4 Tx slots)	Front	661	1880	--	--	--	--	--
GSM1900	GPRS(4 Tx slots)	Back	661	1880	29.33	30	1.167	0.103	0.12

6.6. WCDMA Band V SAR results

HRT500i WCDMA Band V Body

Distance 0mm

Band	Mode	Test Position	Ch.	Freq. (MHz)	Burst Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Measured SAR (W/kg)	Reported SAR (W/kg)
WCDMA Band V	RMC	Front	4182	836.4	--	--	--	--	--
WCDMA Band V	RMC	Back	4182	836.4	22.90	23	1.023	0.0115	0.012

6.7. Wifi SAR results

HRT500i Wifi 802.11b Body

Distance 0mm

Band	Mode	Test Position	Ch.	Freq. (MHz)	Burst Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Measured SAR (W/kg)	Reported SAR (W/kg)
Wifi	802.11b	Front	6	2437	--	--	--	--	--
Wifi	802.11b	Back	6	2437	11.5	12	1.122	0.00502	0.006

6.8.Repeated SAR results

Remark:

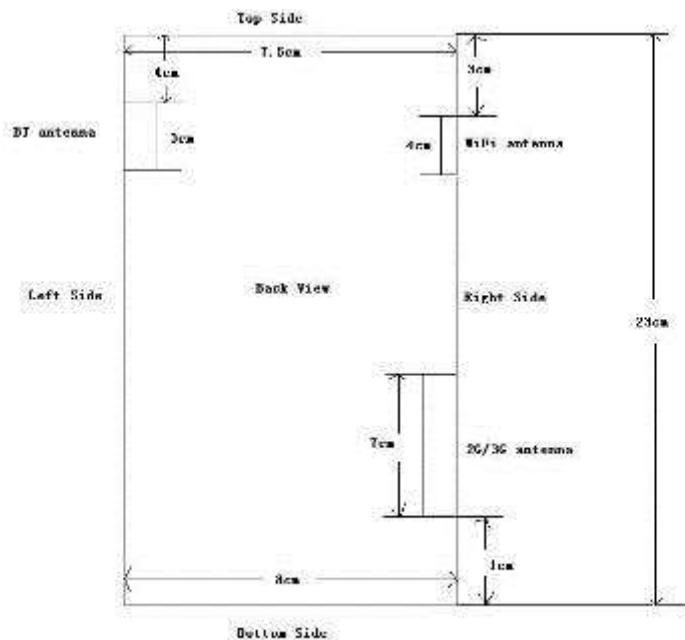
- 1 According to KDB 865664 D01v01r3, for each frequency band, repeated SAR measurement is required only when the measured SAR is $\geq 0.8\text{W/kg}$.
- 2 KDB 865664 D01v01r3, if the deviation among the repeated measurement is $\leq 20\%$ and the measured SAR $< 1.45\text{W/kg}$, only one repeated measurement is required.
- 3 The variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium.

Band	Mode	Test Position	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Measured SAR (W/kg)	Reported SAR (W/kg)	Ratio
--										
--										

Measured SAR of all frequency band are lower than 0.8W/kg, repeated SAR is not required .

7. SIMULTANEOUS TRANSMISSION SAR ANALYSIS

7.1. Multiple Transmitter Evaluation



Hotspot Mode is not support, only Body-Worn test configuration is tested.

7.2. Stand-alone SAR test exclusion

Per FCC KDB447498D01v05, the 1-g SAR and 10-g SAR test exclusion thresholds for 100MHz to 6GHz at test separation distances ≤ 50 mm are determined by:

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

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

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Mode	Position	P_{max} (dBm)	P_{max} (mW)	Distance (mm)	f(GHz)	Calculation result	SAR Exclusion threshold	SAR Test exclusion
BT	Body-worn	0	1	5	2.45	0.08	3	yes

Table 1 standalone SAR test exclusion for BT

Note:

1) *- maximum possible output power declared by manufacturer

2) Held to ear configurations are not applicable to Bluetooth for this device.

When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

$[(\text{max.power of channel, including tune-up tolerance, Mw})/(\text{min.test separation distance, mm})]^*[\sqrt{f(\text{GHz})/x}] \text{W/kg}$ for test separation distances $\leq 50\text{mm}$, where $x=7.5$ for 1-g SAR and $x=18.75$ for 10-g SAR.

When the minimum test separation distance is $<5\text{mm}$, a distance of 5 mm is applied to determine SAR test exclusion

Mode	Position	P_{max} (dBm)	P_{max} (mW)	Distance (mm)	f(GHz)	X	Estimated SAR(W/Kg)*
BT	Body-worn	0	1	5	2.45	7.5	0.611

Table 2: Estimated SAR calculation for BT

1) *- maximum possible output power declared by manufacturer

2) Held to ear configurations are not applicable to Bluetooth and therefore were not considered for simultaneous transmission.

7.3. Simultaneous Transmission Possibilities

The Simultaneous Transmission Possibilities of this device are as below:

No.	Configuration	Body-worn
1	GPRS/EDGE(DATA)+ WiFi2.4G	N/A
2	GPRS/EDGE(DATA)+ BT	N/A
3	UMTS(DATA)+ WiFi2.4G	N/A
4	UMTS(DATA)+ BT	N/A

Table 3: Simultaneous Transmission Possibilities

Note:

- 1) Wi-Fi 2.4G and Bluetooth share the same Tx antenna and can't transmit simultaneously.
- 2) 2G&3G can't transmit simultaneously.
- 3) Held to ear configurations are not applicable to Bluetooth and therefore were not considered for simultaneous transmission.
- 4) Hotspot mode is not supported and WIF is not considered for simultaneous transmission.

APPENDIX A: SYSTEM CHECKING SCANS

SystemPerformanceCheck-D835 Body

Date 2015.06.15.

DUT: Dipole 835 MHz D835V2; Type: D835V2;

Communication System: CW; Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.96 \text{ mho/m}$; $\epsilon_r = 55.87$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3203; ConvF(6.2, 6.2, 6.2); Calibrated: 2014.12.19.;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn876; Calibrated: 2015.03.09.
- Phantom: SAM 1; Type: QD000P40CC; Serial: TP:1504
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Body/Dipole835/Area Scan (61x131x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$
Reference Value = 55.902 V/m; Power Drift = -0.52 dB

Fast SAR: SAR(1 g) = 2.55 mW/g; SAR(10 g) = 1.67 mW/g

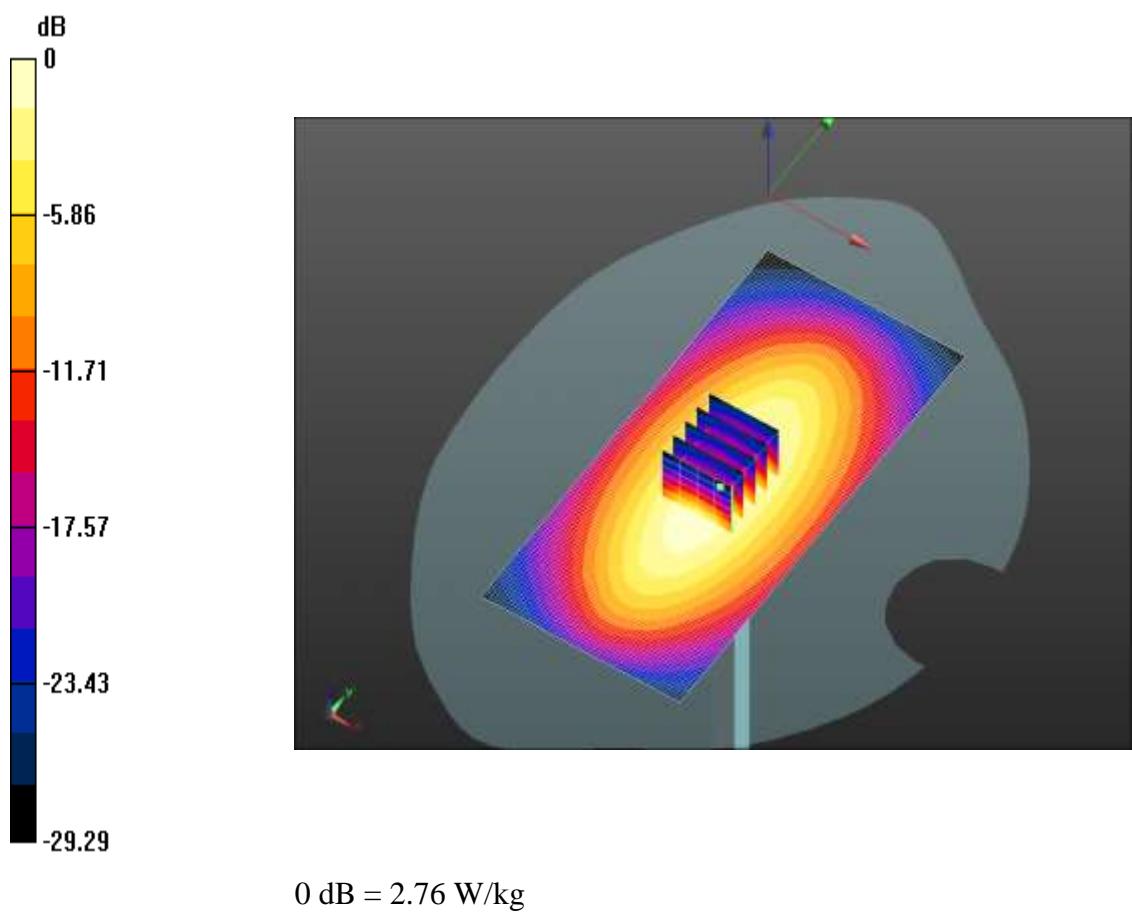
Maximum value of SAR (interpolated) = 2.76 W/kg

Body/Dipole835/Zoom Scan (5x5x7) /Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$
Reference Value = 55.902 V/m; Power Drift = -0.52 dB

Peak SAR (extrapolated) = 3.791 mW/g

SAR(1 g) = 2.48 mW/g; SAR(10 g) = 1.61 mW/g

Maximum value of SAR (measured) = 2.69 W/kg



Test Laboratory: SMQ SAR Test

SystemPerformanceCheck-D1900 Body

Date 2015.06.15.

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 – SN:5d162

Communication System: CW; Communication System Band: Not Specified; Frequency: 1900 MHz; Communication System PAR: 0 dB

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.45$ mho/m; $\epsilon_r = 52.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: EX3DV4 – SN3881; ConvF(8.25, 8.25, 8.25); Calibrated: 2014.07.22.
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn876; Calibrated: 2014.03.03.
- Phantom: SAM 1; Type: QD000P40CC; Serial: TP:1504
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

Pin=250mW/Area Scan (61x61x1): Interpolated grid: dx=15mm, dy=15mm

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

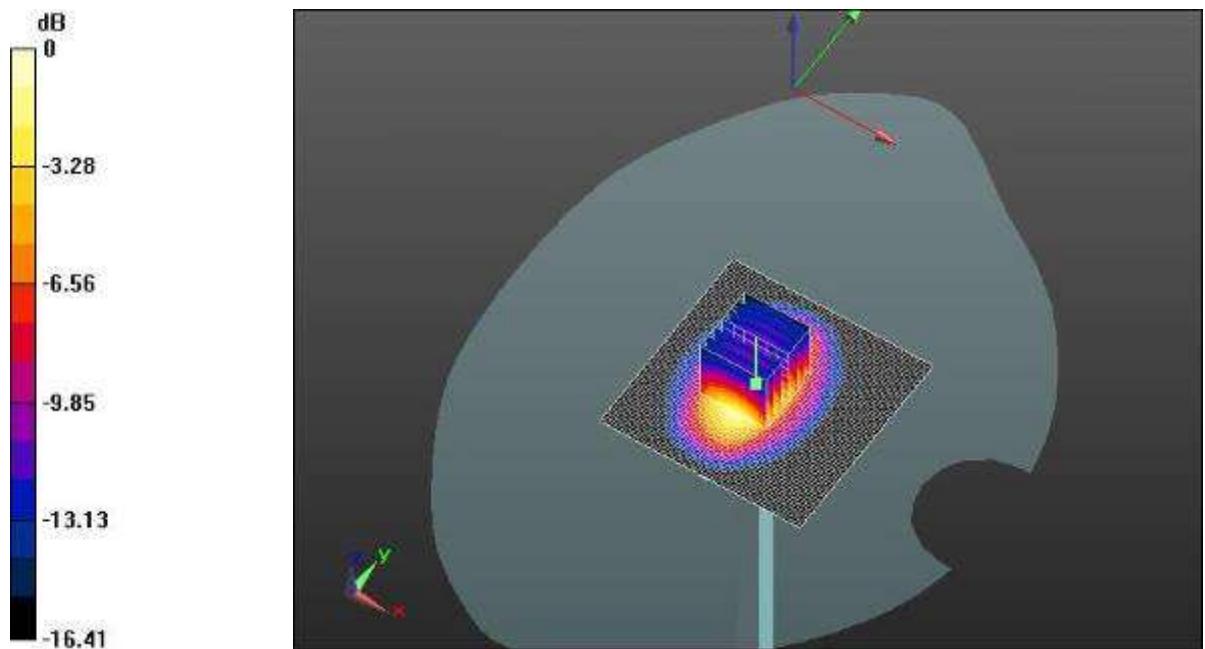
Pin=250mW/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 85.872 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 18.503 mW/g

SAR(1 g) = 10.2 mW/g; SAR(10 g) = 5.29 mW/g

Maximum value of SAR (measured) = 14.6 W/kg



$$0 \text{ dB} = 14.6 \text{ W/kg}$$

SystemPerformanceCheck-D2450-Body

Date: 2015.06.15

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2;

Communication System: CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450 \text{ MHz}$; $\sigma = 2.03 \text{ mho/m}$; $\epsilon_r = 50.74$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

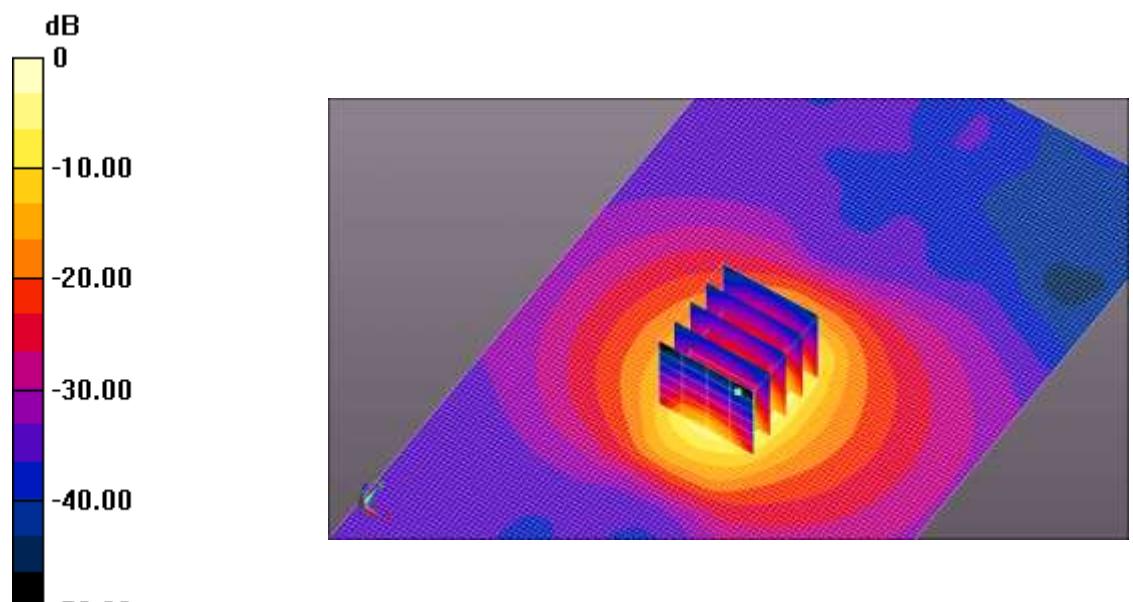
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3203; ConvF(4.55, 4.55, 4.55); Calibrated: 2014.12.19.;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn876; Calibrated: 2015.03.09.
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:xxxx
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Body/Dipole2450/Area Scan (91x161x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Reference Value = 92.292 V/m; Power Drift = 0.01 dB
Fast SAR: SAR(1 g) = 14.1 mW/g; SAR(10 g) = 6.22 mW/g
Maximum value of SAR (interpolated) = 17.3 W/kg

Body/Dipole2450/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 92.292 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 33.353 mW/g
SAR(1 g) = 13.9 mW/g; SAR(10 g) = 6.29 mW/g
Maximum value of SAR (measured) = 16.9 W/kg



$$0 \text{ dB} = 17.3 \text{ W/kg}$$

Test Laboratory: SMQ SAR Test

APPENDIX B: System Validation

Per KDB 865664 D02v01, SAR system validation status should be documented to confirm measurement accuracy. SAR measurement systems are validated according to procedures in KDB 865664 D01v01r3. The validation status is documented according to the validation date(s), measurement frequencies, SAR probe and tissue dielectric parameters. When multiple SAR system is used, the validation status of each SAR system is needed to be documented separately according to the associated system components.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probe and tissue dielectric parameters are shown as below.

Date	Probe S/N	Tested Freq MHz	Tissue	CW			Mod. Validation		
				Sensitivity	Linearity	Isotropy	Mod	Duty Factor	Peak to Average Power Ration
2015.06.15	3881	1900	body	pass	pass	pass	QPSK	pass	N/A
2015.06.15	3203	1900	Body	pass	pass	pass	QPSK	pass	N/A
2015.06.15	3881	850	Body	Pass	Pass	Pass	QPSK	Pass	N/A
2015.06.15	3203	850	Body	Pass	Pass	Pass	QPSK	Pass	N/A

APPENDIX C: MEASUREMENT SCANS

Date:
2015. 06. 15.

HRT500i GPRS850 Body Back Side Mid

Medium: MSL900

Communication System: GPRS 4 Tx slots; Communication System Band: GSM 850 (824.0 – 849.0 MHz); Frequency: 836.6 MHz; Duty Cycle: 1:2.08

Medium parameters used (interpolated): $f = 836.6 \text{ MHz}$; $\sigma = 0.96 \text{ mho/m}$; $\epsilon_r = 55.87$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5 Configuration: Probe: ES3DV3 – SN3203; ConvF(6.2, 6.2, 6.2); Calibrated: 2014.12.19.; Electronics: DAE4 Sn876; Calibrated: 2015.03.09.

GPRS 850_Facedown/Mid/Area Scan (51x51x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$

Reference Value = 3.904 V/m; Power Drift = 0.08 dB

Fast SAR: $\text{SAR}(1 \text{ g}) = 0.020 \text{ mW/g}$; $\text{SAR}(10 \text{ g}) = 0.013 \text{ mW/g}$

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (interpolated) = 0.0209 W/kg

GPRS 850_Facedown/Mid/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

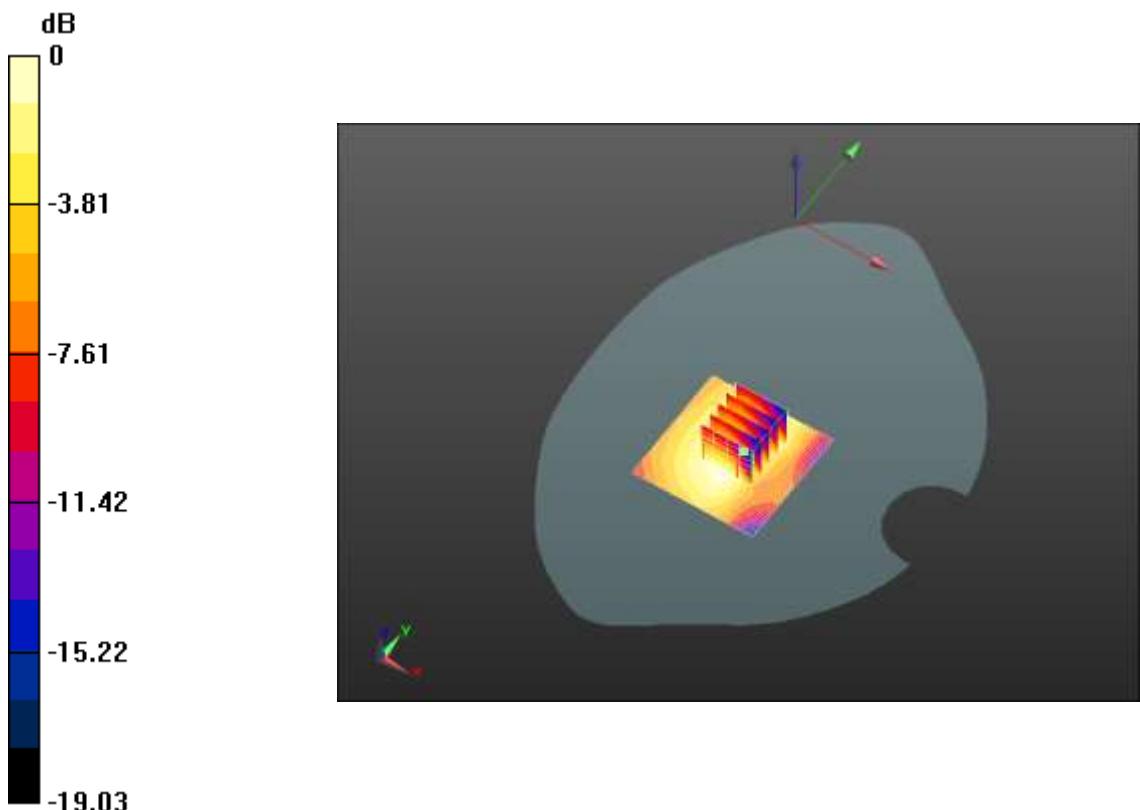
Reference Value = 3.904 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 0.025 mW/g

SAR(1 g) = 0.020 mW/g; SAR(10 g) = 0.015 mW/g

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.0209 W/kg



$$0 \text{ dB} = 0.0209 \text{ W/kg} = -33.58 \text{ dB W/kg}$$

Date:
2015. 06. 15.

HRT500i GPRS1900 Body Back Side Mid

Medium: MSL1900

Communication System: GPRS 4 Tx slots; Communication System Band: PCS 1900 (1850.0 – 1910.0 MHz); Frequency: 1850.2 MHz; Duty Cycle: 1:2.08

Medium parameters used: $f = 1850.2 \text{ MHz}$; $\sigma = 1.45 \text{ mho/m}$; $\epsilon_r = 52.8$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5 Configuration: Probe: EX3DV4 – SN3881; ConvF(8.25, 8.25, 8.25); Calibrated: 2014. 07. 22.; Electronics: DAE4 Sn876; Calibrated: 2015. 03. 09.

1900_GPRS 0mm/GPRS1900 Facedown-Mid/Area Scan (61x61x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$

Reference Value = 4.983 V/m; Power Drift = 0.31 dB

Fast SAR: SAR(1 g) = 0.110 mW/g; SAR(10 g) = 0.062 mW/g

Maximum value of SAR (interpolated) = 0.128 W/kg

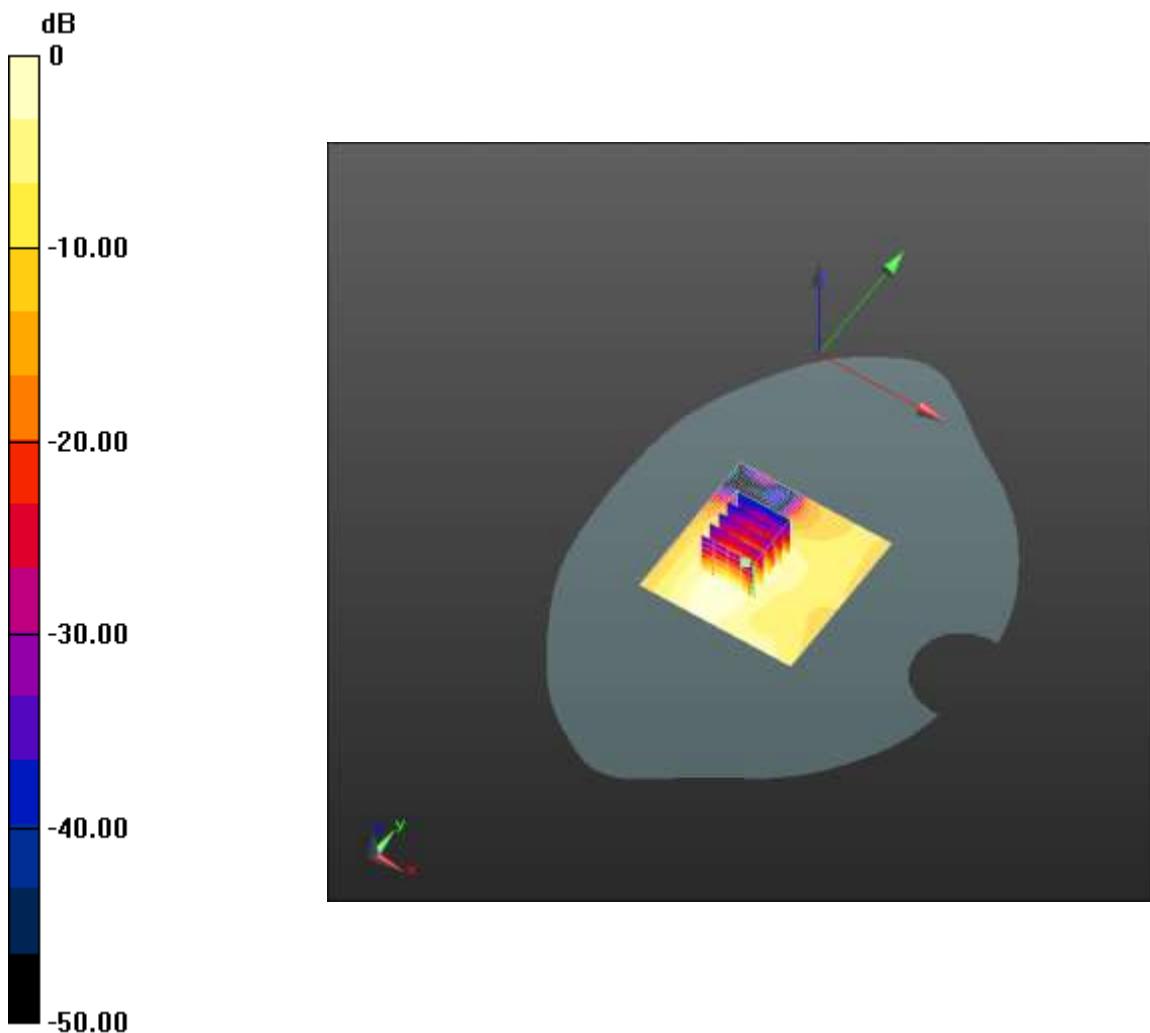
1900_GPRS 0mm/GPRS1900 Facedown-Mid/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 4.983 V/m; Power Drift = 0.11 dB

Peak SAR (extrapolated) = 0.160 mW/g

SAR(1 g) = 0.103 mW/g; SAR(10 g) = 0.064 mW/g

Maximum value of SAR (measured) = 0.111 W/kg



$$0 \text{ dB} = 0.128 \text{ W/kg} = -17.82 \text{ dB W/kg}$$

Date:
2015. 06. 15.

HRT500i WCDMA Body BAND5 Body Back Side Mid

Medium: MSL900

Communication System: UMTS-FDD; Communication System Band: Band 5, UTRA/FDD (824.0 – 849.0 MHz); Frequency: 836.6 MHz; Duty Cycle: 1:1.41

Medium parameters used (interpolated): $f = 836.6 \text{ MHz}$; $\sigma = 0.96 \text{ mho/m}$; $\epsilon_r = 55.87$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5 Configuration: Probe: ES3DV3 – SN3203; ConvF(6.2, 6.2, 6.2); Calibrated: 2014. 12. 19.; Electronics: DAE4 Sn876; Calibrated: 2015. 03. 09.

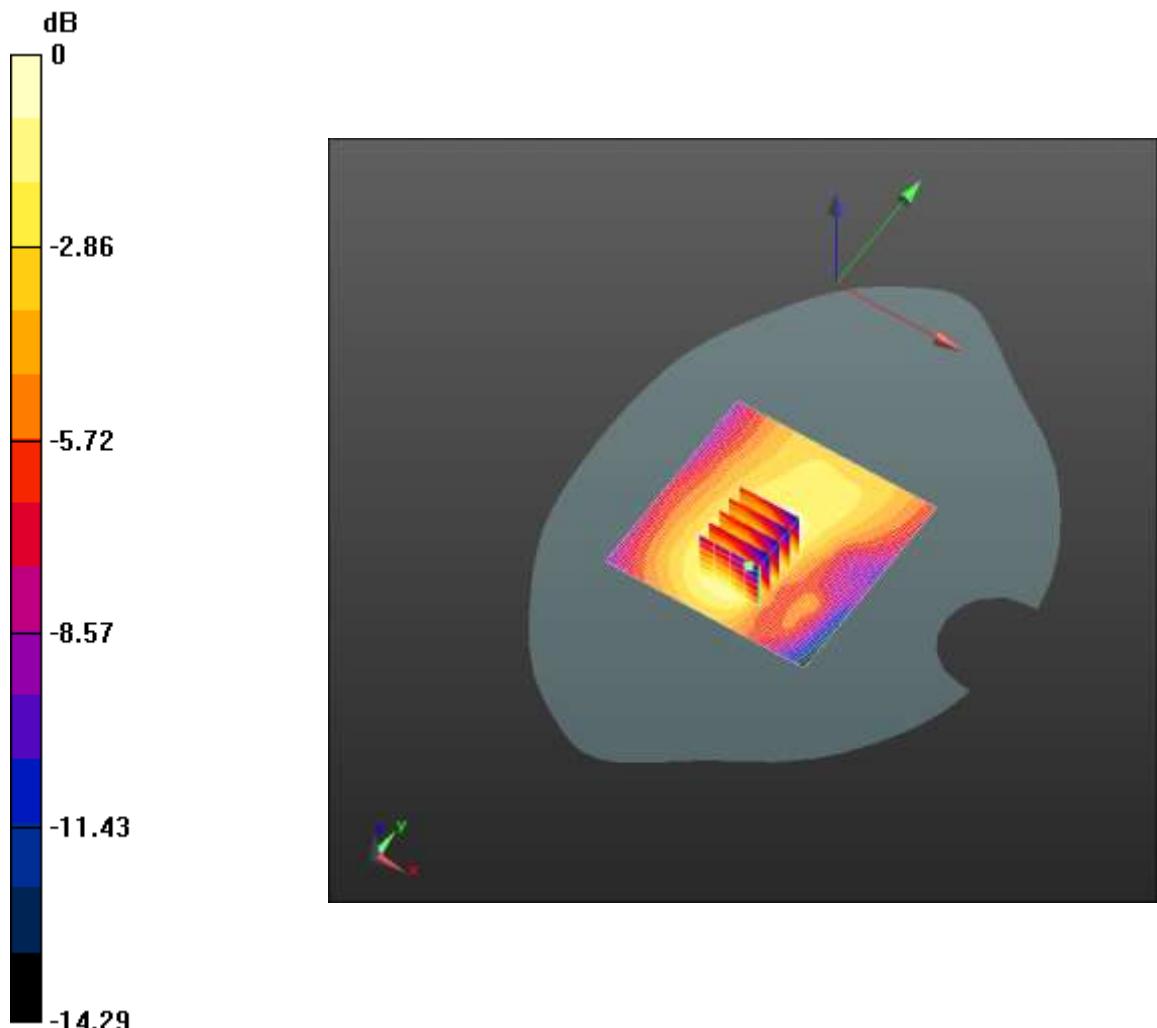
UMTS Band 5_body Back/Mid #3/Area Scan (71x71x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$
Reference Value = 2.961 V/m; Power Drift = 0.10 dB

Fast SAR: SAR(1 g) = 0.012 mW/g; SAR(10 g) = 0.00806 mW/g

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0128 W/kg

UMTS Band 5_body Back/Mid #3/Zoom Scan (5x5x7) /Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 2.961 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 0.015 mW/g
SAR(1 g) = 0.011 mW/g; SAR(10 g) = 0.00832 mW/g

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



$$0 \text{ dB} = 0.0128 \text{ W/kg} = -37.88 \text{ dB W/kg}$$

Date:
2015.06.15.

HRT500i WiFi 802.11b Body Back Side Mid

Medium: MSL2450

Communication System: 802.11b WiFi 2.4GHz (DSSS, 1Mbps); Communication System Band: 802.11b; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 2.03$ mho/m; $\epsilon_r = 52.74$; $\rho = 1000$ kg/m³
 Phantom section: Flat Section
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
 DASY5 Configuration: Probe: ES3DV3 – SN3203; ConvF(4.47, 4.47, 4.47); Calibrated: 2014.12.19.; Electronics: DAE4 Sn876; Calibrated: 2014.03.03.

802.11b-Left Head/Back Cheek-Mid/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Reference Value = 1.231 V/m; Power Drift = 0.25 dB

Fast SAR: SAR(1 g) = 0.00429 mW/g; SAR(10 g) = 0.0023 mW/g

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (interpolated) = 0.00476 W/kg

802.11b-Left Head/Back Cheek-Mid/Zoom Scan (5x5x7) /Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

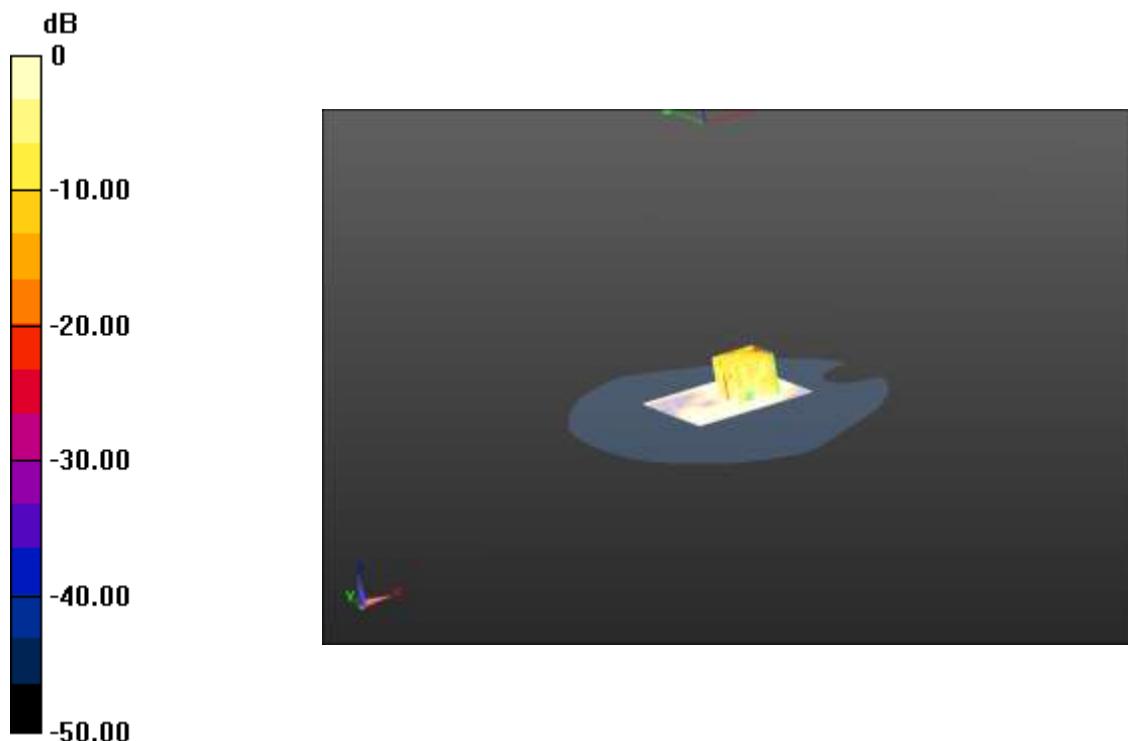
Reference Value = 1.231 V/m; Power Drift = 0.12 dB

Peak SAR (extrapolated) = 0.00803 mW/g

SAR(1 g) = 0.00502 mW/g; SAR(10 g) = 0.00299 mW/g

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.00560 W/kg



$$0 \text{ dB} = 0.00476 \text{ W/kg} = -46.45 \text{ dB W/kg}$$

**APPENDIX D: RELEVANT PAGES FROM PROBE CALIBRATION
REPORT(S)**

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 SMQ (Auden)

Certificate No: EX3-3881_Jul14

CALIBRATION CERTIFICATE

Object EX3DV4 - SN:3881

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

Calibration date: July 22, 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-13)	In house check: Oct-14

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

Issued: July 23, 2014

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

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**

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:

- $NORM_{x,y,z}$: 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 E^2 -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.
- $DCPx,y,z$: 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
- $A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}$; $VR_{x,y,z}$: 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).

Probe EX3DV4

SN:3881

Manufactured: April 30, 2012
Calibrated: July 22, 2014

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3881

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (μ V/(V/m)) ^A	0.18	0.37	0.53	\pm 10.1 %
DCP (mV) ^B	96.5	100.9	101.1	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu}$ V	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	133.4	\pm 4.1 %
		Y	0.0	0.0	1.0		131.0	
		Z	0.0	0.0	1.0		132.8	

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

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

^B Numerical linearization parameter: uncertainty not required.

^C 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:3881

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	10.60	10.60	10.60	0.18	1.80	± 13.3 %
835	41.5	0.90	9.41	9.41	9.41	0.49	0.70	± 12.0 %
1900	40.0	1.40	8.09	8.09	8.09	0.57	0.64	± 12.0 %

^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:3881

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)	Uncrt. (k=2)
450	56.7	0.94	10.75	10.75	10.75	0.10	1.50	± 13.3 %
835	55.2	0.97	9.34	9.34	9.34	0.30	1.03	± 12.0 %
1900	53.3	1.52	8.25	8.25	8.25	0.46	1.00	± 12.0 %

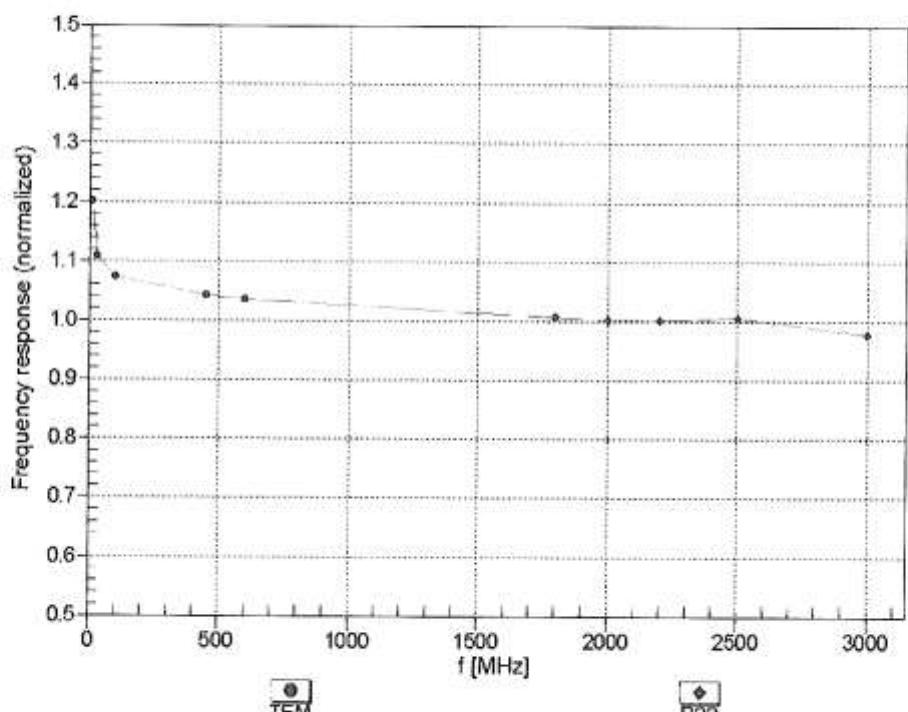
^C Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is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

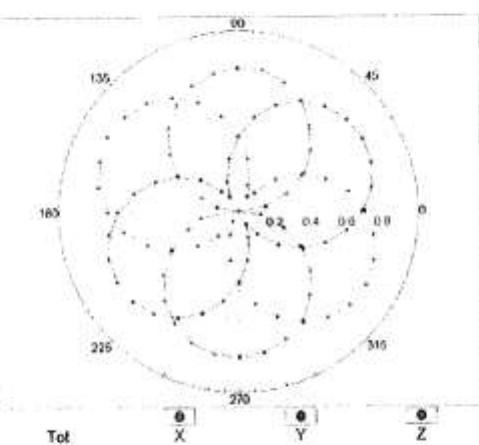
(TEM-Cell:ifi110 EXX, Waveguide: R22)



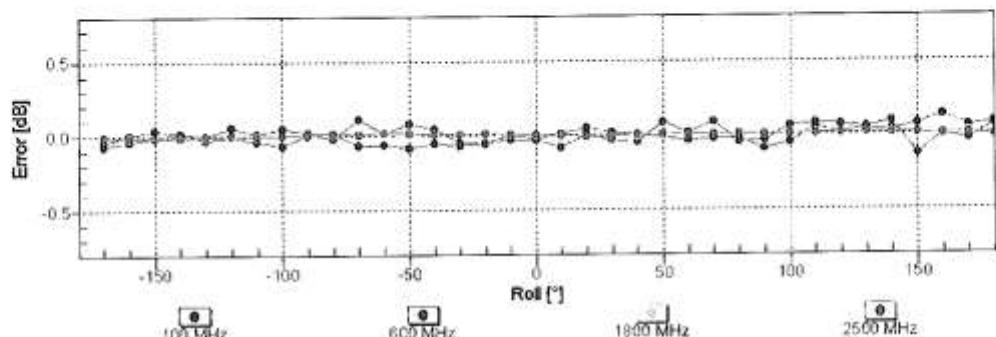
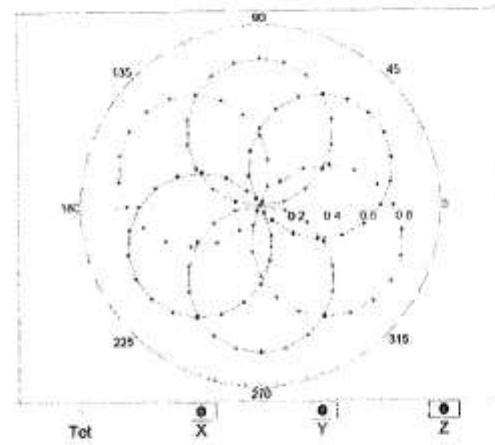
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

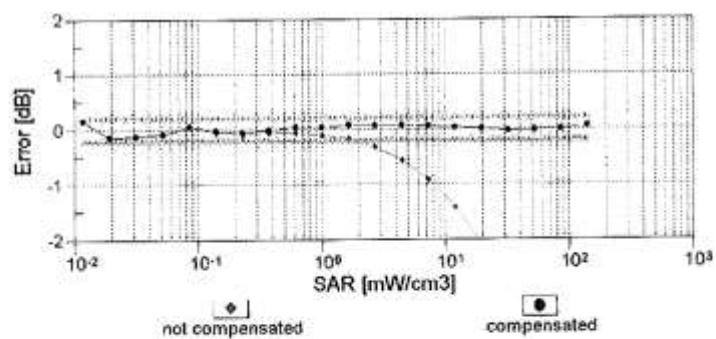
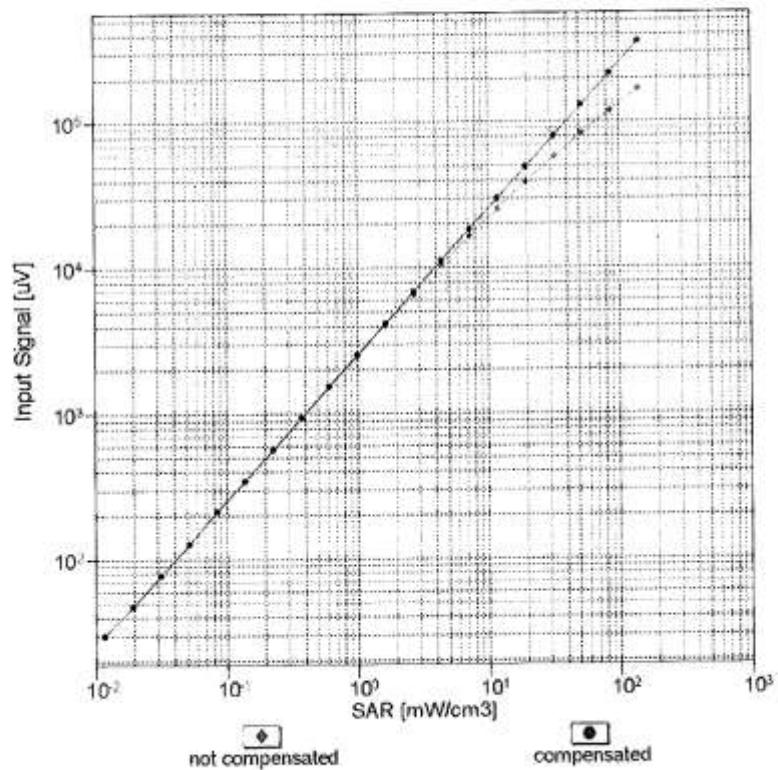
f=600 MHz, TEM



f=1800 MHz, R22

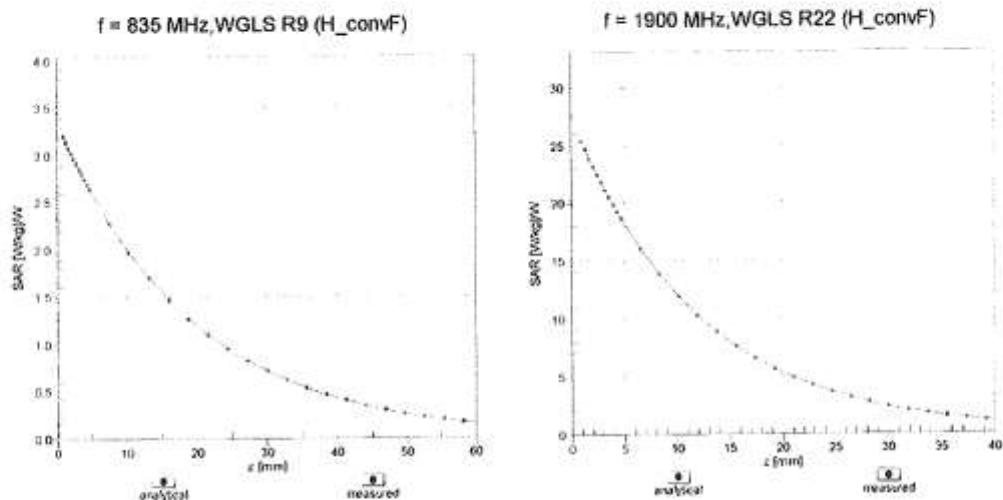
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Dynamic Range $f(\text{SAR}_{\text{head}})$
(TEM cell, $f_{\text{eval}} = 1900$ MHz)



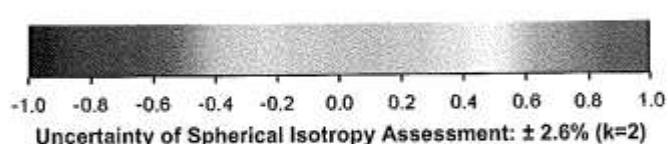
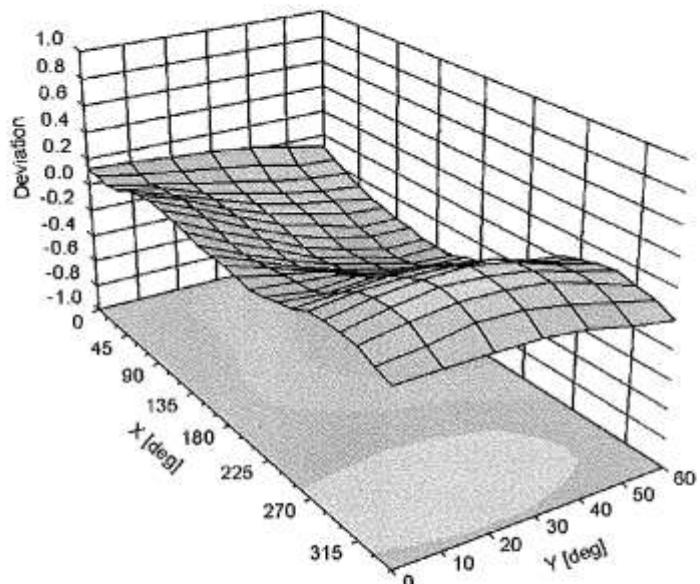
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), $f = 900$ MHz



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3881

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-10.2
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

**Acceptable Conditions for SAR Measurements Using Probes and Dipoles
Calibrated under the SPEAG-TMC Dual-Logo Calibration Program to
Support FCC Equipment Certification**

The acceptable conditions for SAR measurements using probes, dipoles and DAEs, calibrated by TMC (*Telecommunication Metrology Center of MITT in Beijing, China*), under the Dual-Logo Calibration Certificate program and quality assurance (QA) protocols established between SPEAG (*Schmid & Partner Engineering AG, Switzerland*) and TMC, to support FCC (*U.S. Federal Communications Commission*) equipment certification are defined and described in the following.

- 1) The agreement established between SPEAG and TMC is only applicable to calibration services performed by TMC where its clients (companies and divisions of such companies) are headquartered in the Greater China Region, including Taiwan and Hong Kong. This agreement is subject to renewal at the end of each calendar year between SPEAG and TMC. TMC shall inform the FCC of any changes or early termination to the agreement.
- 2) Only a subset of the calibration services specified in the SPEAG-TMC agreement, while it remains valid, are applicable to SAR measurements performed using such equipment for supporting FCC equipment certification. These are identified in the following.
 - a) Calibration of dosimetric (SAR) probes EX3DVx, ET3DVx and ES3DVx.
 - i) Free-space E-field and H-field probes, including those used for HAC (hearing aid compatibility) evaluation, temperature probes, other probes or equipment not identified in this document, when calibrated by TMC, are excluded and cannot be used for measurements to support FCC equipment certification.
 - ii) Signal specific and bundled probe calibrations based on PMR (probe modulation response) characteristics are handled according to the requirements of KDB 865664; that is, "Until standardized procedures are available to make such determination, the applicability of a signal specific probe calibration for testing specific wireless modes and technologies is determined on a case-by-case basis through KDB inquiries, including SAR system verification requirements."
 - b) Calibration of SAR system validation dipoles, excluding HAC dipoles.
 - c) Calibration of data acquisition electronics DAE3Vx, DAE4Vx and DAEasyVx.
 - d) For FCC equipment certification purposes, the frequency range of SAR probe and dipole calibrations is limited to 700 MHz - 6 GHz and provided it is supported by the equipment identified in the TMC QA protocol (a separate attachment to this document).
 - e) The identical system and equipment setup, measurement configurations, hardware, evaluation algorithms, calibration and QA protocols, including the format of calibration certificates and reports used by SPEAG shall be applied by TMC.
 - f) The calibrated items are only applicable to SPEAG DASY 4 and DASY 5 or higher version systems.

- 3) The SPEAG-TMC agreement includes specific protocols identified in the following to ensure the quality of calibration services provided by TMC under this SPEAG-TMC Dual-Logo calibration agreement are equivalent to the calibration services provided by SPEAG. TMC shall, upon request, provide copies of documentation to the FCC to substantiate program implementation.
 - a) The Inter-laboratory Calibration Evaluation (ILCE) stated in the TMC QA protocol shall be performed between SPEAG and TMC at least once every 12 months. The ILCE acceptance criteria defined in the TMC QA protocol shall be satisfied for the TMC, SPEAG and FCC agreements to remain valid.
 - b) Check of Calibration Certificate (CCC) shall be performed by SPEAG for all calibrations performed by TMC. Written confirmation from SPEAG is required for TMC to issue calibration certificates under the SPEAG-TMC Dual-Logo calibration program. Quarterly reports for all calibrations performed by TMC under the program are also issued by SPEAG.
 - c) The calibration equipment and measurement system used by TMC shall be verified before each calibration service according to the specific reference SAR probes, dipoles, and DAB calibrated by SPEAG. The results shall be reproducible and within the defined acceptance criteria specified in the TMC QA protocol before each actual calibration can commence. TMC shall maintain records of the measurement and calibration system verification results for all calibrations.
 - d) Quality Check of Calibration (QCC) certificates shall be performed by SPEAG at least once every 12 months. SPEAG shall visit TMC facilities to verify the laboratory, equipment, applied procedures and plausibility of randomly selected certificates.
- 4) A copy of this document, to be updated annually, shall be provided to TMC clients that accept calibration services according to the SPEAG-TMC Dual-Logo calibration program, which should be presented to a TCB (*Telecommunication Certification Body*), to facilitate FCC equipment approval.
- 5) TMC shall address any questions raised by its clients or TCBs relating to the SPEAG-TMC Dual-Logo calibration program and inform the FCC and SPEAG of any critical issues.

Change Note: Revised on June 26 to clarify the applicability of PMR and Bundled probe calibrations according to the requirements of KDB 865664.



In Collaboration with
s p e a g
 CALIBRATION LABORATORY

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 Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
 E-mail: cttl@chinattl.com <http://www.chinattl.cn>



CALIBRATION
No. L0570

Client **AUDEN**

Certificate No: Z14-97164

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3203**

Calibration Procedure(s) **TMC-OS-E-02-195**
 Calibration Procedures for Dosimetric E-field Probes

Calibration date: **December 19, 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(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	01-Jul-14 (CTTL, No.J14X02146)	Jun-15
Power sensor NRP-Z91	101547	01-Jul-14 (CTTL, No.J14X02146)	Jun-15
Power sensor NRP-Z91	101548	01-Jul-14 (CTTL, No.J14X02146)	Jun-15
Reference10dBAttenuator	18N50W-10dB	13-Mar-14(TMC, No.JZ14-1103)	Mar-16
Reference20dBAttenuator	18N50W-20dB	13-Mar-14(TMC, No.JZ14-1104)	Mar-16
Reference Probe EX3DV4	SN 3617	28-Aug-14(SPEAG, No.EX3-3617_Aug14)	Aug-15
DAE4	SN 1331	23-Jan-14 (SPEAG, DAE4-1331_Jan14)	Jan-15
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
SignalGeneratorMG3700A	6201052605	01-Jul-14 (CTTL, No.J14X02145)	Jun-15
Network Analyzer E6071C	MY46110673	15-Feb-14 (TMC, No.JZ14-781)	Feb-15

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Qi Dianyuan	SAR Project Leader	
Approved by:	Lu Bingsong	Deputy Director of the laboratory	

Issued: December 20, 2014

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



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com <http://www.chinattl.com>

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 $\theta=0$ 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 300MHz to 3GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}: Assessed for E-field polarization $\theta=0$ (f \leq 900MHz in TEM-cell; f $>$ 1800MHz: waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not effect the E^2 -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.
- DCPx,y,z: DCP are numerical linearization parameters assessed based on the data of power sweep (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; VRx,y,z; A,B,C are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f \leq 800MHz) and inside waveguide using analytical field distributions based on power measurements for f $>$ 800MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued 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 NORMx (no uncertainty required).



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Probe ES3DV3

SN: 3203

Calibrated: December 19, 2014

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)



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E-mail: cttl@chinatll.com <http://www.chinatll.com>

DASY/EASY – Parameters of Probe: ES3DV3 - SN: 3203

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm(μ V/(V/m) ²) ^A	1.39	1.37	1.19	±10.8%
DCP(mV) ^B	103.9	100.8	104.3	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB/ μ V	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	298.4	±2.3%
		Y	0.0	0.0	1.0		292.8	
		Z	0.0	0.0	1.0		272.7	

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 Norm X, Y, Z do not affect the E²-field uncertainty inside TSL (see Page 5 and Page 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.



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DASY/EASY – Parameters of Probe: ES3DV3 - SN: 3203

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)
900	41.5	0.97	6.55	6.55	6.55	0.32	1.66	±12%
1810	40.0	1.40	5.20	5.20	5.20	0.67	1.27	±12%
2450	39.2	1.80	4.55	4.55	4.55	0.90	1.10	±12%

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

^F At frequency 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 the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



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DASY/EASY – Parameters of Probe: ES3DV3 - SN: 3203

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)
900	55.0	1.05	6.20	6.20	6.20	0.55	1.38	± 12%
1810	53.3	1.52	4.88	4.88	4.88	0.46	1.60	± 12%
2450	52.7	1.95	4.47	4.47	4.47	0.59	1.55	± 12%

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

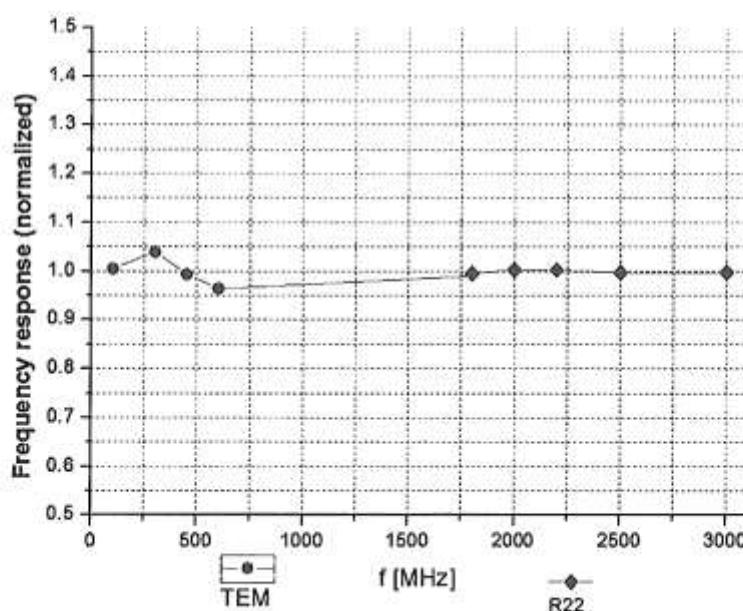
^f At frequency below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty 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 the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



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



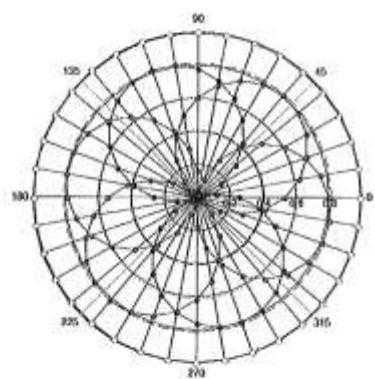
Uncertainty of Frequency Response of E-field: $\pm 7.5\%$ ($k=2$)



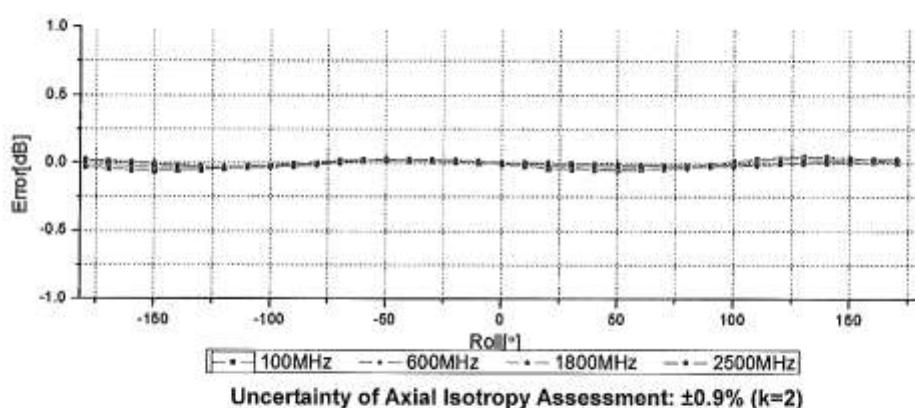
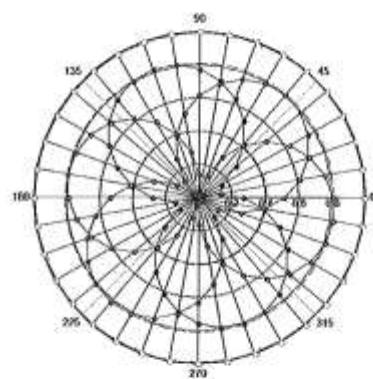
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Receiving Pattern (Φ), $\theta=0^\circ$

$f=600$ MHz, TEM

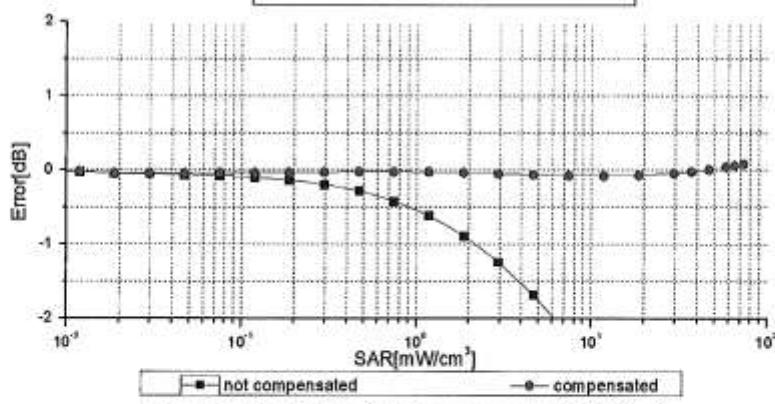
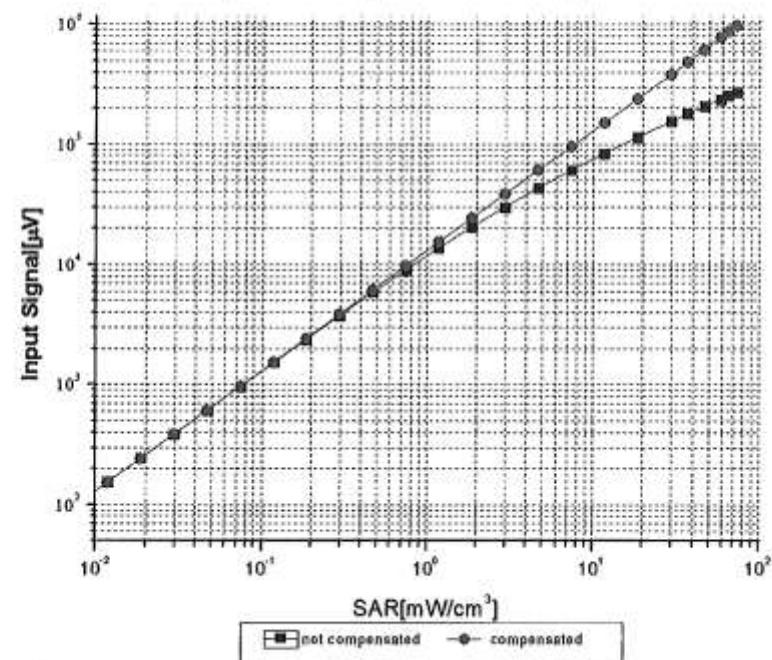


$f=1800$ MHz, R22



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



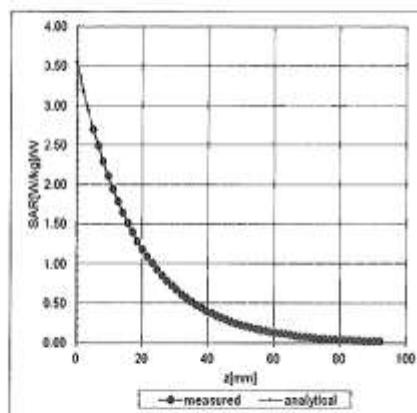
Uncertainty of Linearity Assessment: $\pm 0.9\% (k=2)$



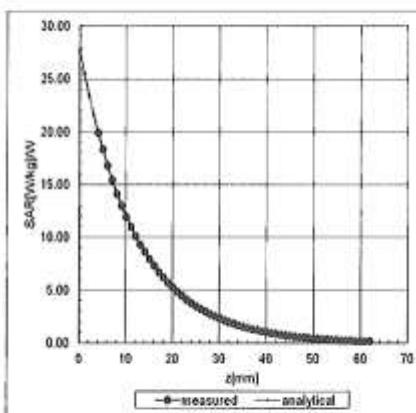
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Conversion Factor Assessment

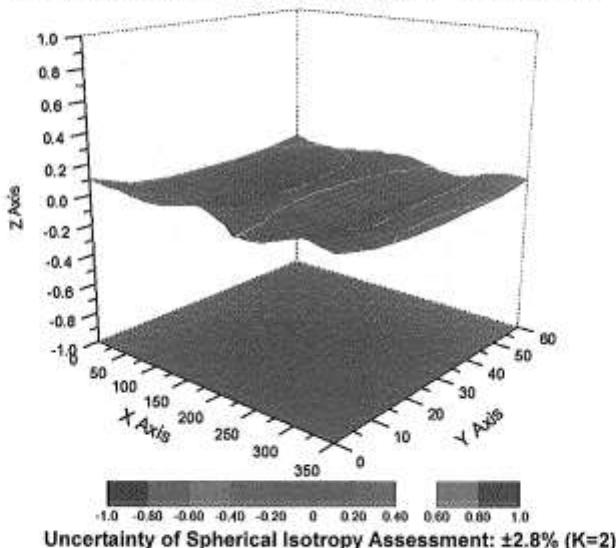
f=900 MHz, WGLS R9(H_convF)



f=1810 MHz, WGLS R22(H_convF)



Deviation from Isotropy in Liquid



Uncertainty of Spherical Isotropy Assessment: $\pm 2.8\%$ (K=2)



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DASY/EASY – Parameters of Probe: ES3DV3 - SN: 3203

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	175.2
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disable
Probe Overall Length	337mm
Probe Body Diameter	10mm
Tip Length	10mm
Tip Diameter	4mm
Probe Tip to Sensor X Calibration Point	2mm
Probe Tip to Sensor Y Calibration Point	2mm
Probe Tip to Sensor Z Calibration Point	2mm
Recommended Measurement Distance from Surface	3mm

APPENDIX E: RELEVANT PAGES FROM DIPOLE VALIDATION KIT

REPORT(S)

CLB /0364/01

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Accreditation No.: SCS 108

Client: SMQ (Auden)

Certificate No: D835V2-4d141_Sep12

CALIBRATION CERTIFICATE

Object: D835V2 - SN: 4d141
Calibration procedure(s): QA CAL-05.v8
Calibration procedure for dipole validation kits above 700 MHz
Calibration date: September 24, 2012

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	05-Oct-11 (No. 217-01451)	Oct-12
Power sensor HP 8481A	US37292783	05-Oct-11 (No. 217-01451)	Oct-12
Reference 20 dB Attenuator	SN: 5058 (20k)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.2 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	30-Dec-11 (No. ES3-3205_Dec11)	Dec-12
DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	Jun-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

Calibrated by: Name: Israe El-Naouq Function: Laboratory Technician

Signature:

Approved by: Name: Katja Pokovic Function: Technical Manager

Signature:

Issued: September 24, 2012

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Certificate No: D835V2-4d141_Sep12

Page 1 of 8

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

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.3 ± 6 %	0.90 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	2.34 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	9.35 mW / g ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.53 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	6.12 mW / g ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.2 ± 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	2.44 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	9.46 mW / g ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.60 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	6.25 mW / g ± 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.6 Ω - 2.7 $\mu\Omega$
Return Loss	- 28.7 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.1 Ω - 1.9 $\mu\Omega$
Return Loss	- 34.6 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.391 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 27, 2012

DASY5 Validation Report for Head TSL

Date: 24.09.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d141

Communication System: CW; Frequency: 835 MHz

Medium parameters used: $f = 835$ MHz; $\sigma = 0.9$ mho/m; $\epsilon_r = 41.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.07, 6.07, 6.07); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm 2/Zoom Scan (7x7x7)/Cube 0:

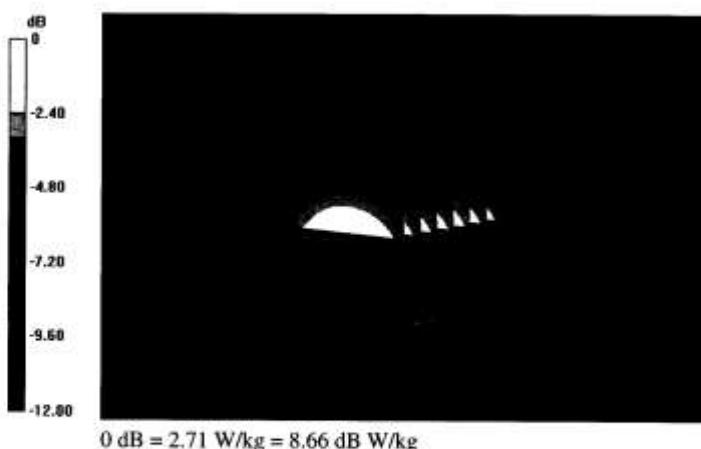
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.647 V/m; Power Drift = 0.03 dB

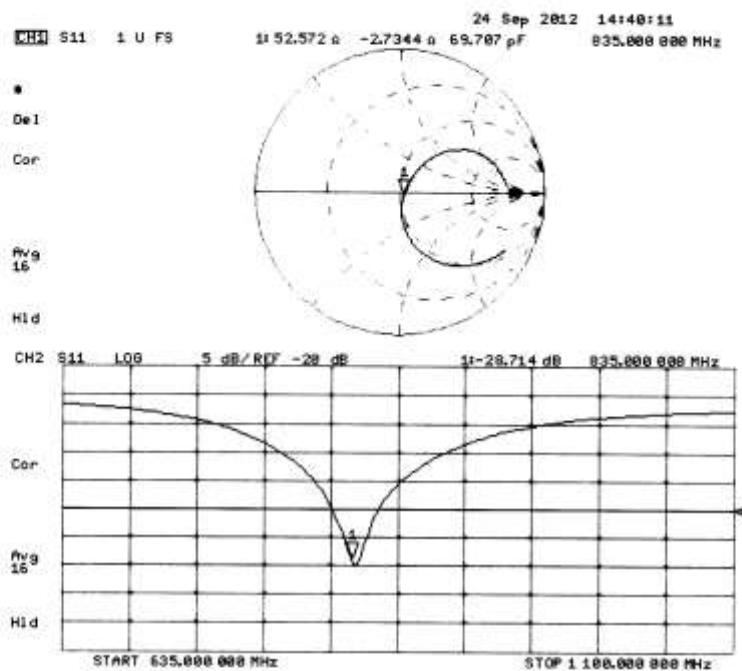
Peak SAR (extrapolated) = 3.447 mW/g

SAR(1 g) = 2.34 mW/g; SAR(10 g) = 1.53 mW/g

Maximum value of SAR (measured) = 2.71 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 24.09.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d141

Communication System: CW; Frequency: 835 MHz

Medium parameters used: $f = 835$ MHz; $\sigma = 1$ mho/m; $\epsilon_r = 53.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.02, 6.02, 6.02); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

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

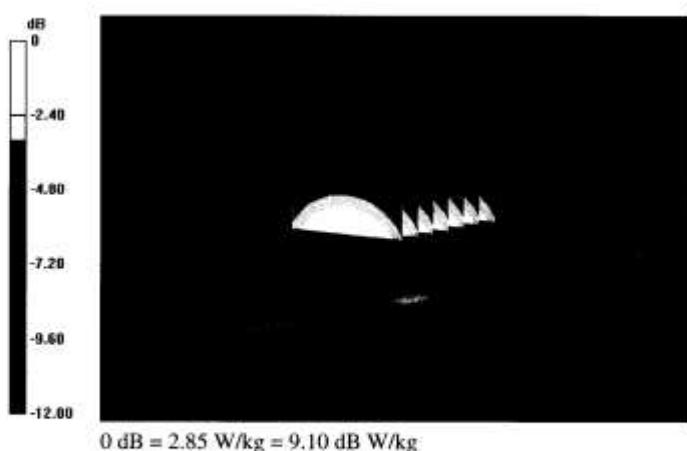
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 55.345 V/m; Power Drift = 0.02 dB

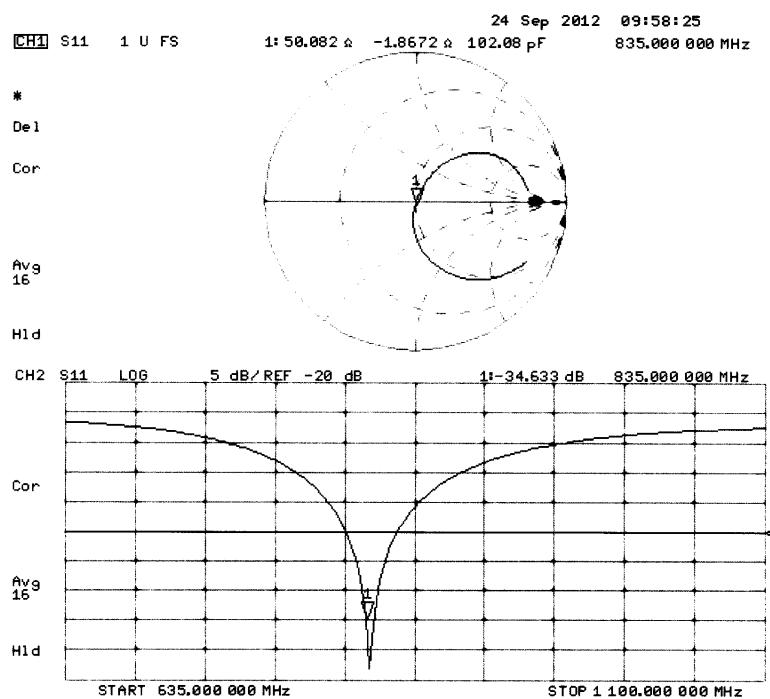
Peak SAR (extrapolated) = 3.541 mW/g

SAR(1 g) = 2.44 mW/g; SAR(10 g) = 1.6 mW/g

Maximum value of SAR (measured) = 2.85 W/kg



Impedance Measurement Plot for Body TSL



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Client SMQ (Auden)

Certificate No: D1900V2-5d162_Sep12

CALIBRATION CERTIFICATE

Object D1900V2 - SN: 5d162

Calibration procedure(s) QA CAL-05.v8
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: September 21, 2012

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	05-Oct-11 (No. 217-01451)	Oct-12
Power sensor HP 8481A	US37292783	05-Oct-11 (No. 217-01451)	Oct-12
Reference 20 dB Attenuator	SN: 5058 (20K)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.2 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	30-Dec-11 (No. ES3-3205_Dec11)	Dec-12
DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	Jun-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

Calibrated by: Name Israe El-Naouq Function Laboratory Technician

Signature

Approved by: Name Katja Pekovic Function Technical Manager

Issued: September 21, 2012

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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:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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	V52.8.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz \pm 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 \pm 0.2) °C	40.6 \pm 6 %	1.37 mho/m \pm 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	9.69 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	39.4 mW / g \pm 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.13 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	20.7 mW / g \pm 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	52.5 \pm 6 %	1.54 mho/m \pm 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	10.3 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	40.7 mW / g \pm 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.45 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	21.6 mW / g \pm 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$53.2 \Omega + 4.0 \text{ j}\Omega$
Return Loss	- 26.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$49.2 \Omega + 5.0 \text{ j}\Omega$
Return Loss	- 25.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.197 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 20, 2011

DASY5 Validation Report for Head TSL

Date: 21.09.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d162

Communication System: CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.37$ mho/m; $\epsilon_r = 40.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.01, 5.01, 5.01); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

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

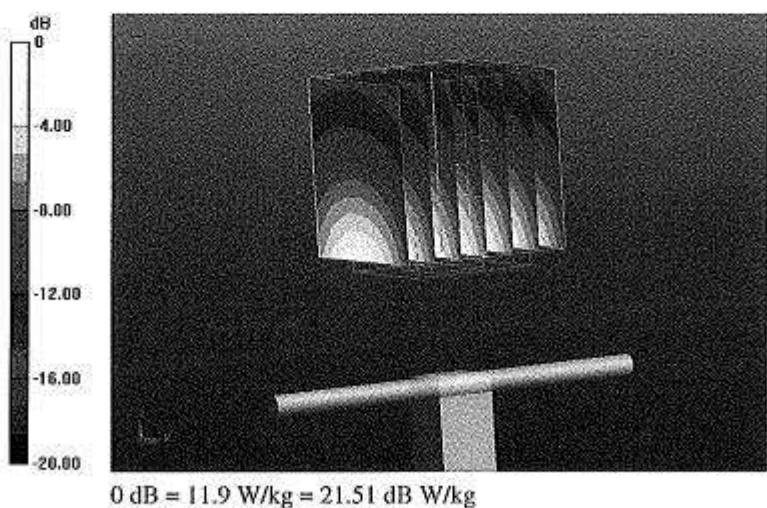
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.423 V/m; Power Drift = 0.04 dB

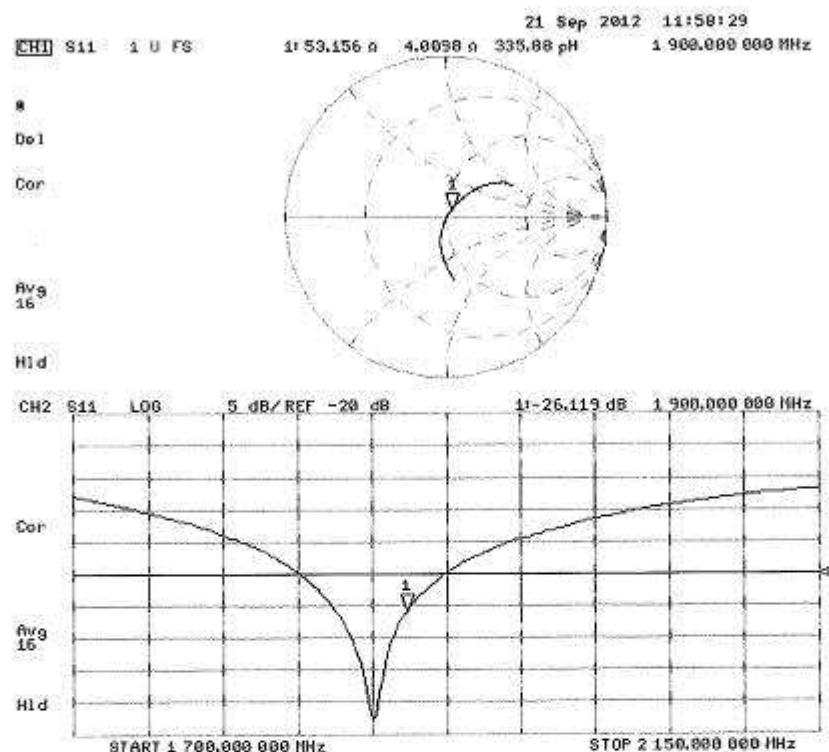
Peak SAR (extrapolated) = 17.236 mW/g

SAR(1 g) = 9.69 mW/g; SAR(10 g) = 5.13 mW/g

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



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 21.09.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d162

Communication System: CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.54$ mho/m; $\epsilon_r = 52.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.62, 4.62, 4.62); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAB4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

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

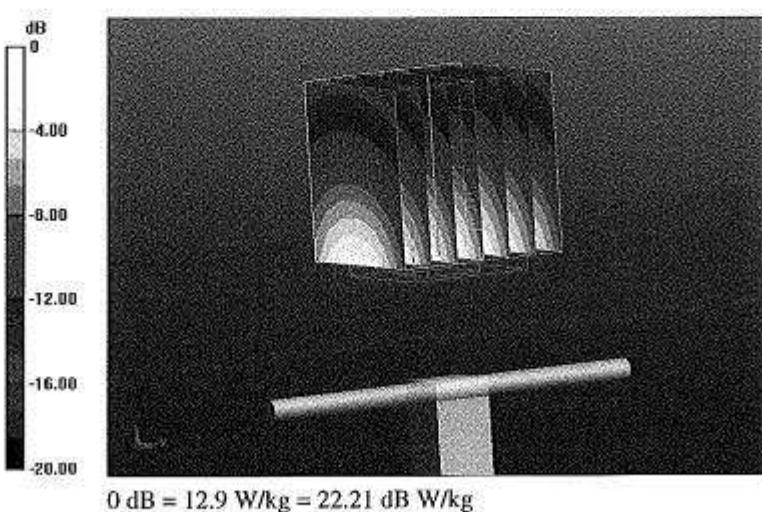
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.423 V/m; Power Drift = 0.02 dB

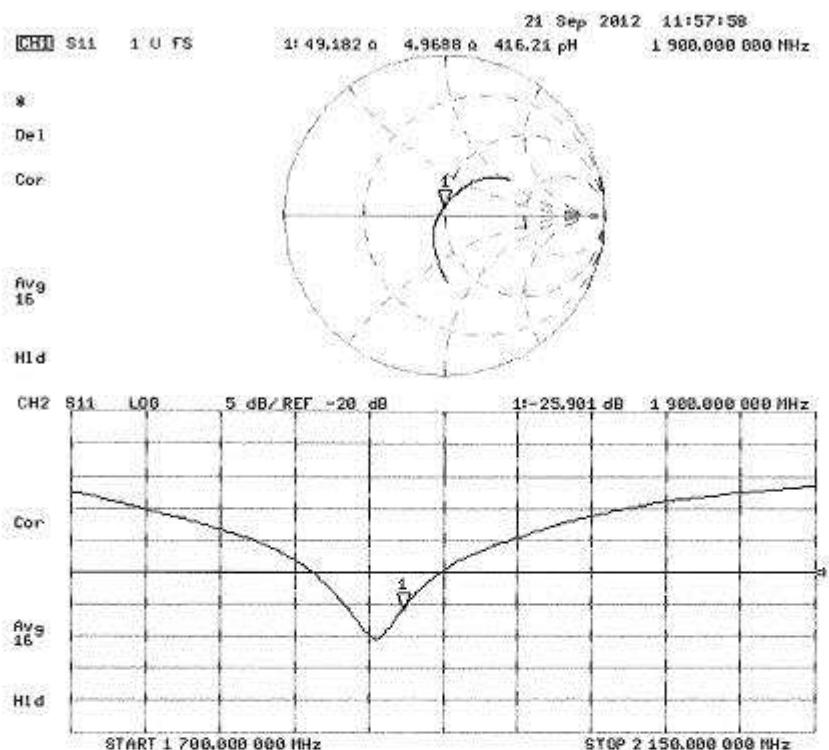
Peak SAR (extrapolated) = 17.979 mW/g

SAR(1 g) = 10.3 mW/g; SAR(10 g) = 5.45 mW/g

Maximum value of SAR (measured) = 12.9 W/kg



Impedance Measurement Plot for Body TSL



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 SMQ (Auden)

Certificate No: D2450V2-818_Oct12

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 818
Calibration procedure(s)	QA CAL-05.v8 Calibration procedure for dipole validation kits above 700 MHz
Calibration date	October 18, 2012

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

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

Calibration Equipment used (M&TE critical for calibration):

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	05-Oct-11 (No. 217-01451)	Oct-12
Power sensor HP 8481A	US37292783	05-Oct-11 (No. 217-01451)	Oct-12
Reference 20 dB Attenuator	SN: 5058 (20K)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.2 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	30-Dec-11 (No. ES3-3205_Dec11)	Dec-12
DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	Jun-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 54206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

Calibrated by:	Name: Israe El-Naouq	Function: Laboratory Technician	Signature:
Approved by:	Katja Pokovic	Technical Manager	

Issued: October 18, 2012

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

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**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASYS	V52.8.3
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 \pm 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 \pm 0.2) °C	38.4 \pm 6 %	1.85 mho/m \pm 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	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.3 W/kg \pm 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.19 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.5 W/kg \pm 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied:

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	51.0 \pm 6 %	2.02 mho/m \pm 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.8 W/kg \pm 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.03 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.8 W/kg \pm 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.0 Ω + 2.5 $j\Omega$
Return Loss	- 28.4 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.1 Ω + 4.4 $j\Omega$
Return Loss	- 27.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.165 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 11, 2008

DASY5 Validation Report for Head TSL

Date: 18.10.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 818

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.85$ mho/m; $\epsilon_r = 38.4$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.3(988); SEMCAD X 14.6.7(6848)

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

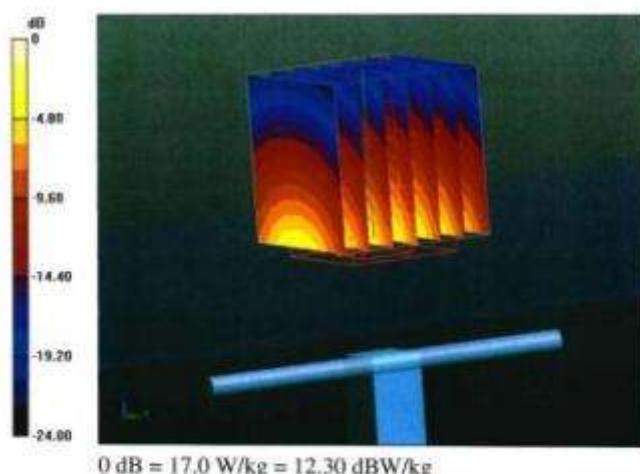
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.551 V/m; Power Drift = 0.07 dB

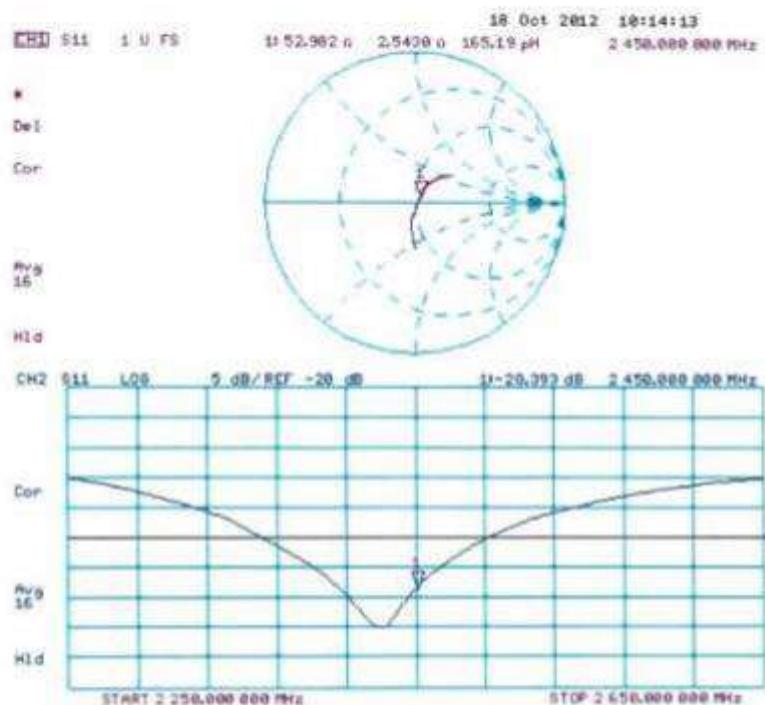
Peak SAR (extrapolated) = 27.4 W/kg

SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.19 W/kg

Maximum value of SAR (measured) = 17.0 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 18.10.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 818

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.02$ mho/m; $\epsilon_r = 51$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.3(988); SEMCAD X 14.6.7(6848)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm 2/Zoom Scan (7x7x7)/Cube 0:

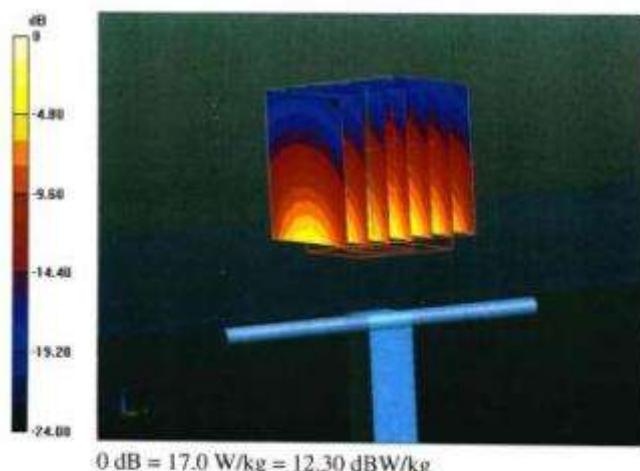
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.079 V/m; Power Drift = 0.02 dB

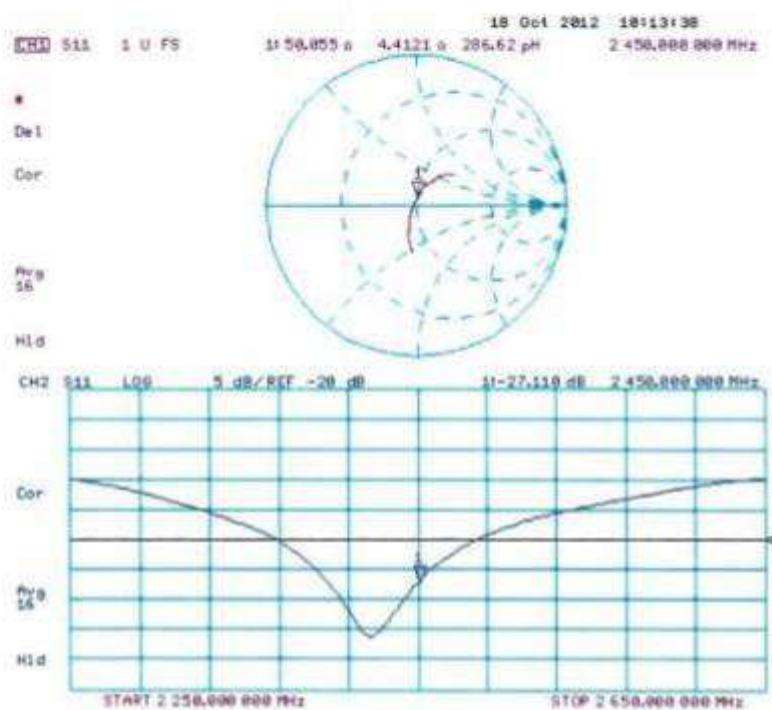
Peak SAR (extrapolated) = 26.9 W/kg

SAR(1 g) = 13 W/kg; SAR(10 g) = 6.03 W/kg

Maximum value of SAR (measured) = 17.0 W/kg



Impedance Measurement Plot for Body TSL





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APPROVED

Add: No.52 Huayuanbei Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: Info@emcite.com Http://www.emcite.com

Client : **SMQ**

Certificate No: Z14-97008

CALIBRATION CERTIFICATE

Object	DAE4 - SN: 876					
Calibration Procedure(s)	TMC-OS-E-01-198 Calibration Procedure for the Data Acquisition Electronics (DAEx)					
Calibration date:	March 03, 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(Calibrated by, Certificate No.)	Scheduled Calibration			
Documenting Process Calibrator 753	1971018	01-July-13 (TMC, No:JW13-049)	July-14			
Calibrated by:	Name Zhao Jing	Function SAR Test Engineer	Signature 			
Reviewed by:	Qi Dianyuan	SAR Project Leader				
Approved by:	Lu Bingsong	Deputy Director of the laboratory	 Issued: March 04, 2014			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.						

Certificate No: Z14-97008

Page 1 of 3



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Add: No.52 Huayuanbei Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: Info@emcite.com [Http://www.emcite.com](http://www.emcite.com)

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 report provide only calibration results for DAE, it does not contain other performance test results.

Note:

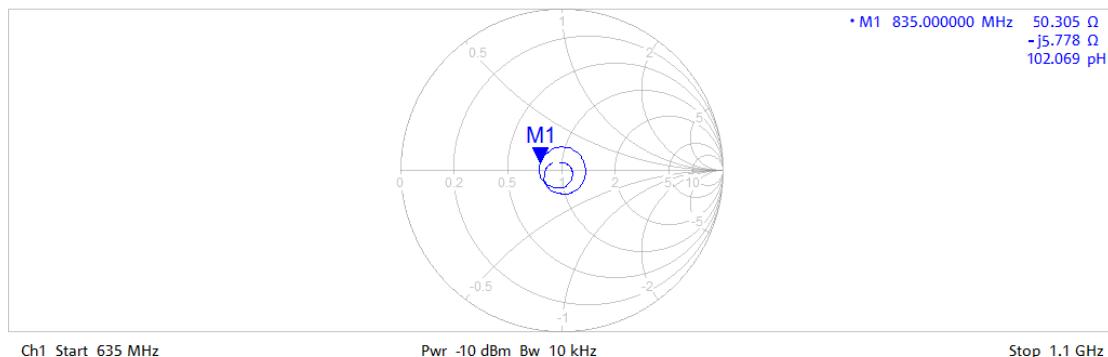
- 1) Per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three-year extended

calibration interval. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix D.

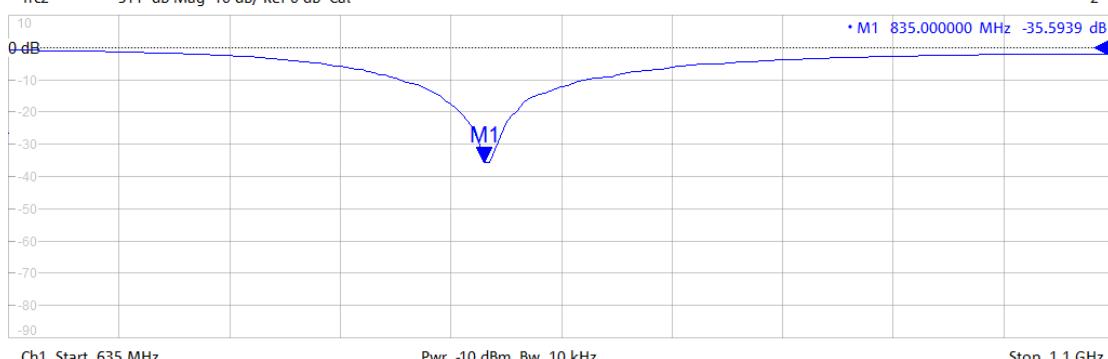
a) There is no physical damage on the dipole;

- b) System check with specific dipole is within 10% of calibrated value;
- c) The most recent return-loss result, measured at least annually, deviates by no more than 20% from the previous measurement.
- d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal



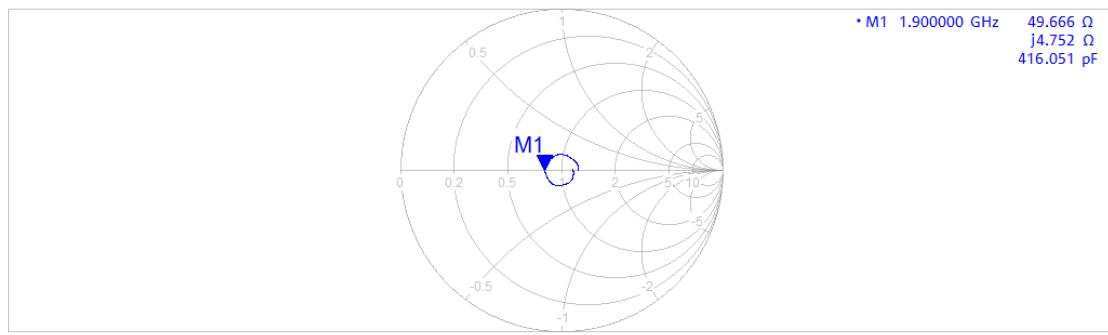
Trc2 — S11 dB Mag 10 dB/ Ref 0 dB Cal



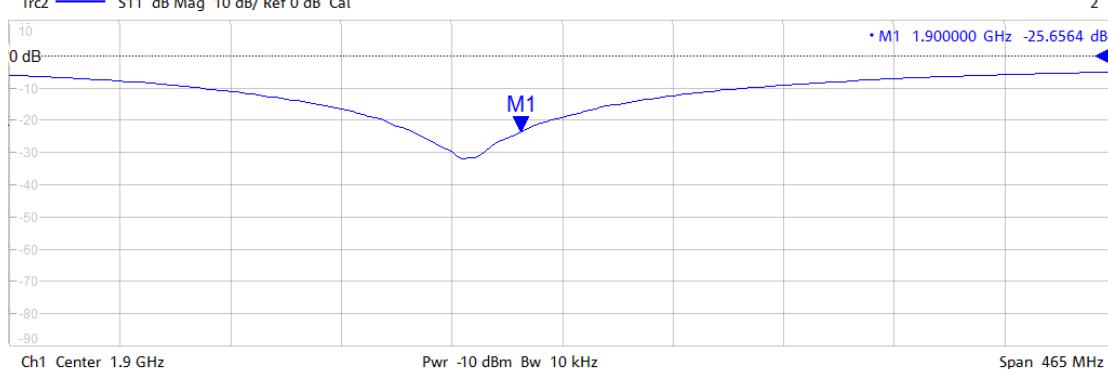
835MHz Dipole Body
D835V2, serial No. 4d141 Extended Dipole Calibrations

835 Head					
Date of Measurement	Return-Loss (dB)	Delta(%)	Real Impedance(ohm)	Delta (ohm)	
2012-9-24	-28.714		52.572		
2014-9-24	-29.594	-2.97	53.084	0.51	
835 Body					
	Return-Loss (dB)	Delta(%)	Real Impedance(ohm)	Delta (ohm)	
2012-9-24	-34.633		50.082		
2014-9-24	-35.594	-2.70	50.305	0.22	

Trc1 — S11 Smith 200 mU/ Ref 1 U Cal



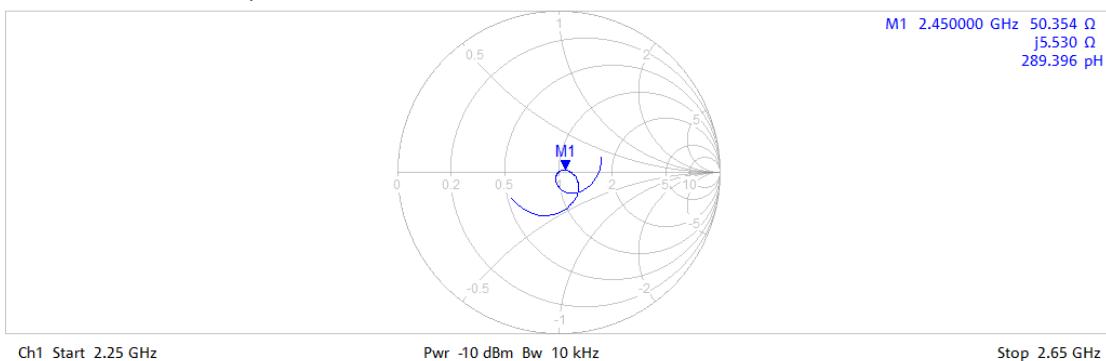
Trc2 — S11 dB Mag 10 dB/ Ref 0 dB Cal



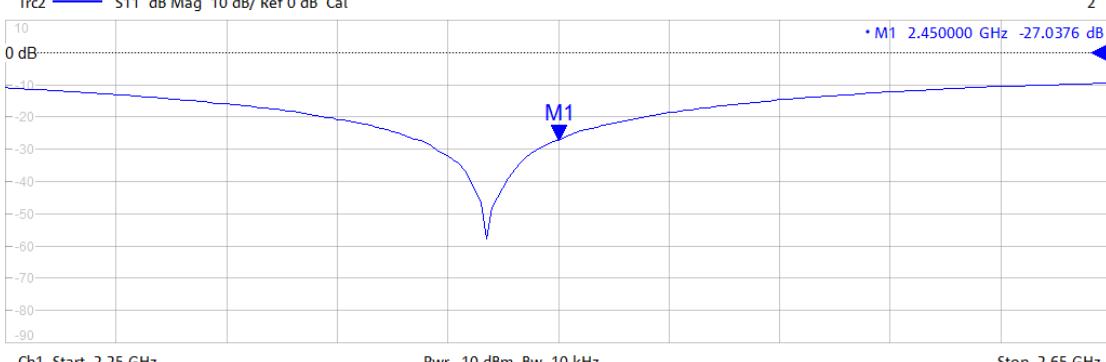
D1900V2, serial No. 5d162 Extended Dipole Calibrations
1900MHz Body

1900 Head					
Date of Measurement	Return-Loss (dB)	Delta(%)	Real Impedance(ohm)	Delta (ohm)	
2012-9-21	-26.119		53.156		
2014-9-24	-26.656	-2.02	53.666	0.51	
1900 Body					
	Return-Loss (dB)	Delta(%)	Real Impedance(ohm)	Delta (ohm)	
2012-9-21	-28.393		52.982		
2014-9-24	-25.656	0.11	49.666	-3.32	

Trc1 — S11 Smith 200 mU/Ref 1 U Cal



Trc2 — S11 dB Mag 10 dB/Ref 0 dB Cal



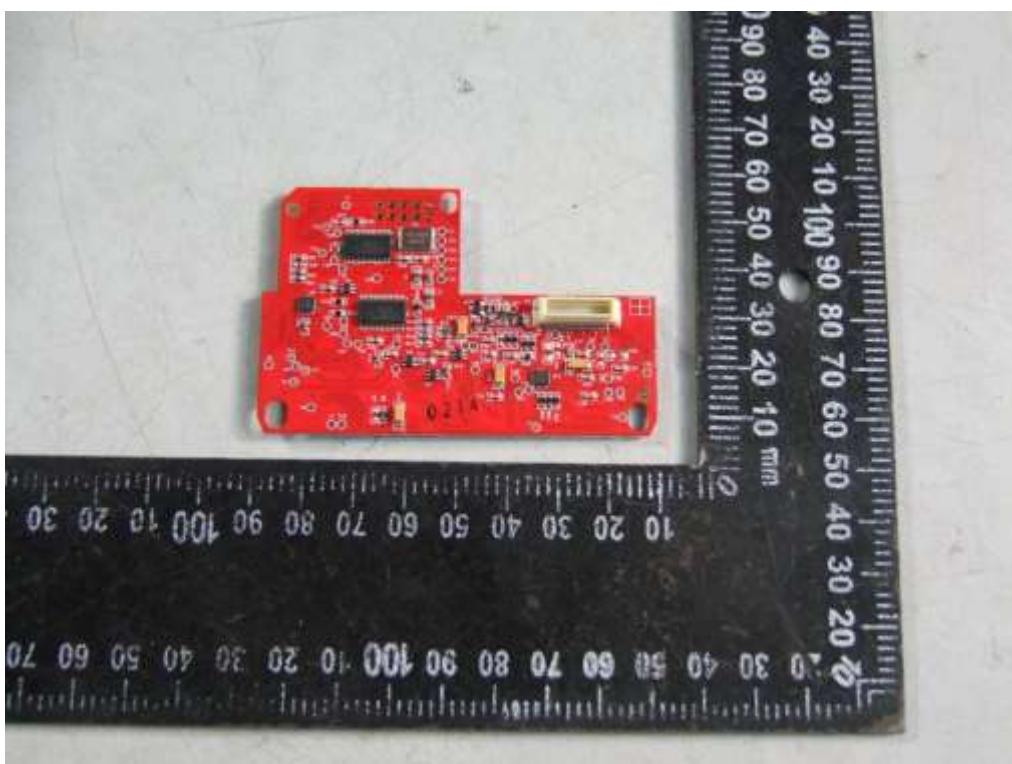
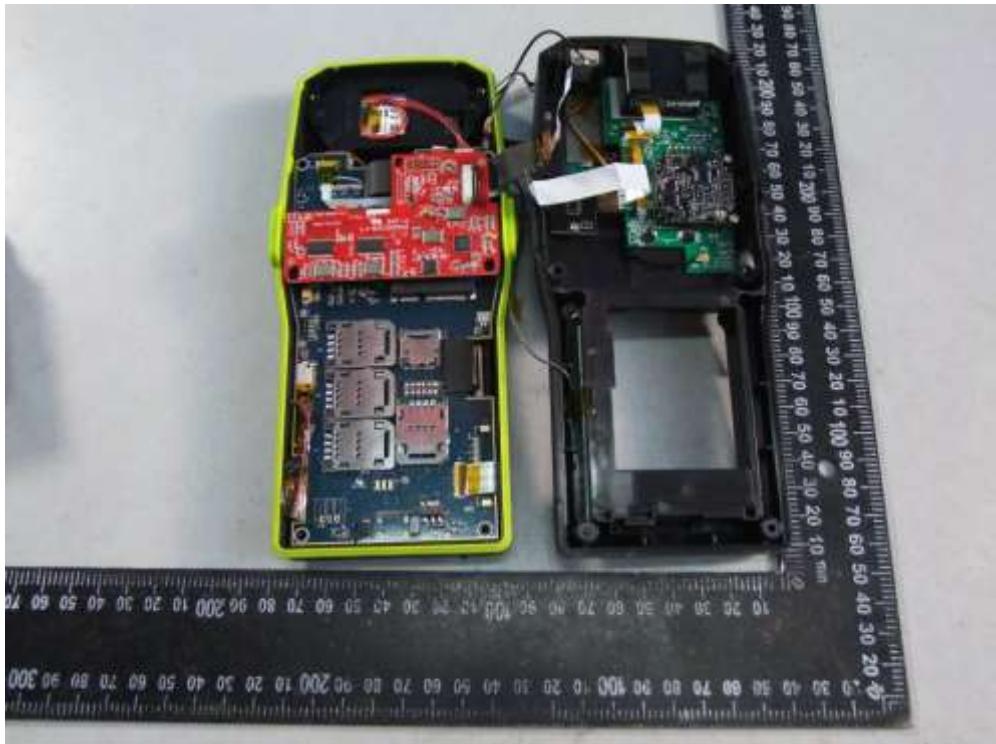
**D2450V2, serial No. 818 Extended Dipole Calibrations
2450MHz Dipole Body**

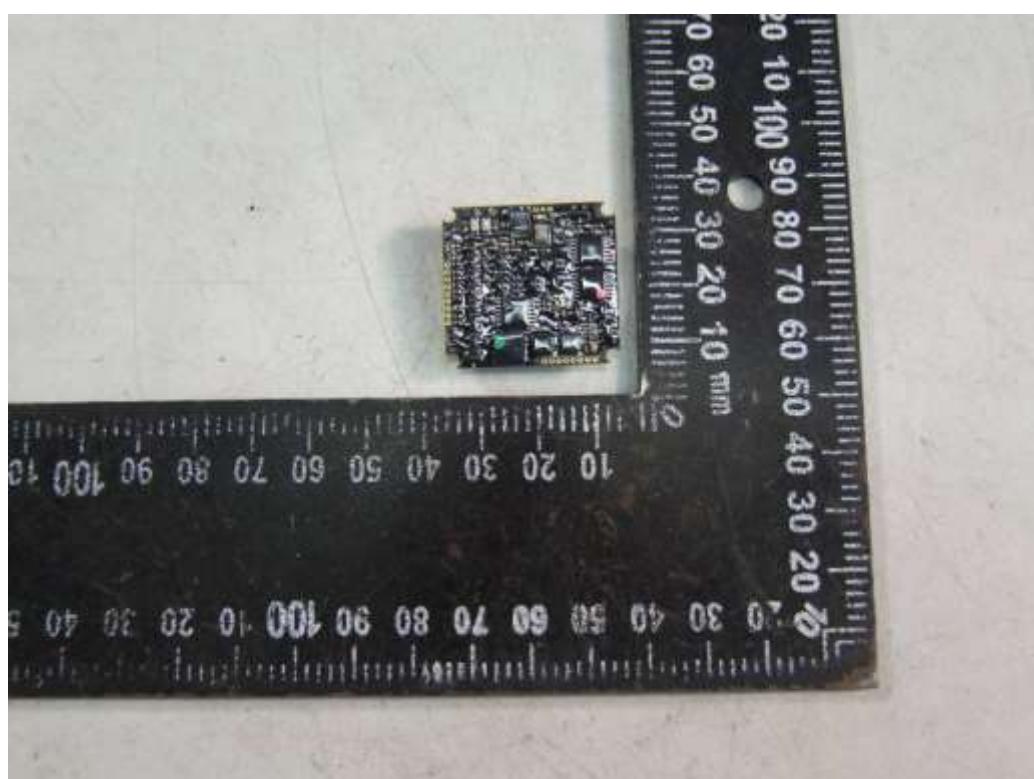
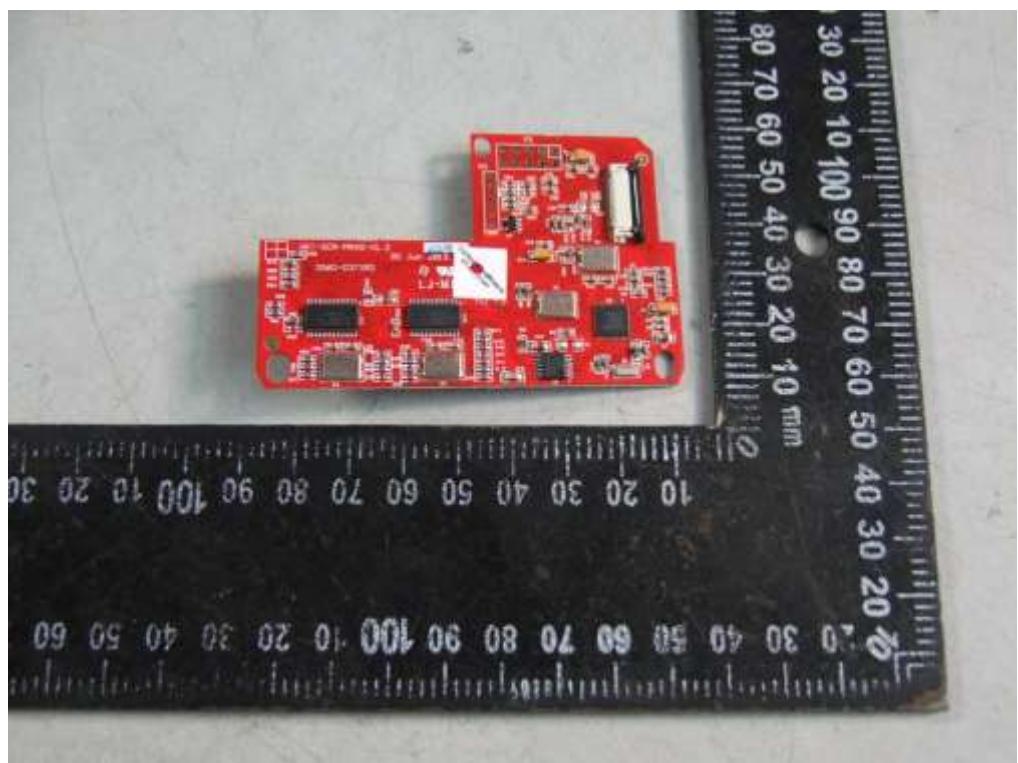
2450 Head					
Date of Measurement	Return-Loss (dB)	Delta(%)	Real Impedance(ohm)	Delta (ohm)	
2012-10-18	-28.393		52.982		
2014-10-18	-28.088	1.09	52.354	-0.63	
2450 Body					
	Return-Loss (dB)	Delta(%)	Real Impedance(ohm)	Delta (ohm)	
2012-10-18	-27.110		50.055		
2014-10-18	-27.038	0.27	50.354	0.30	

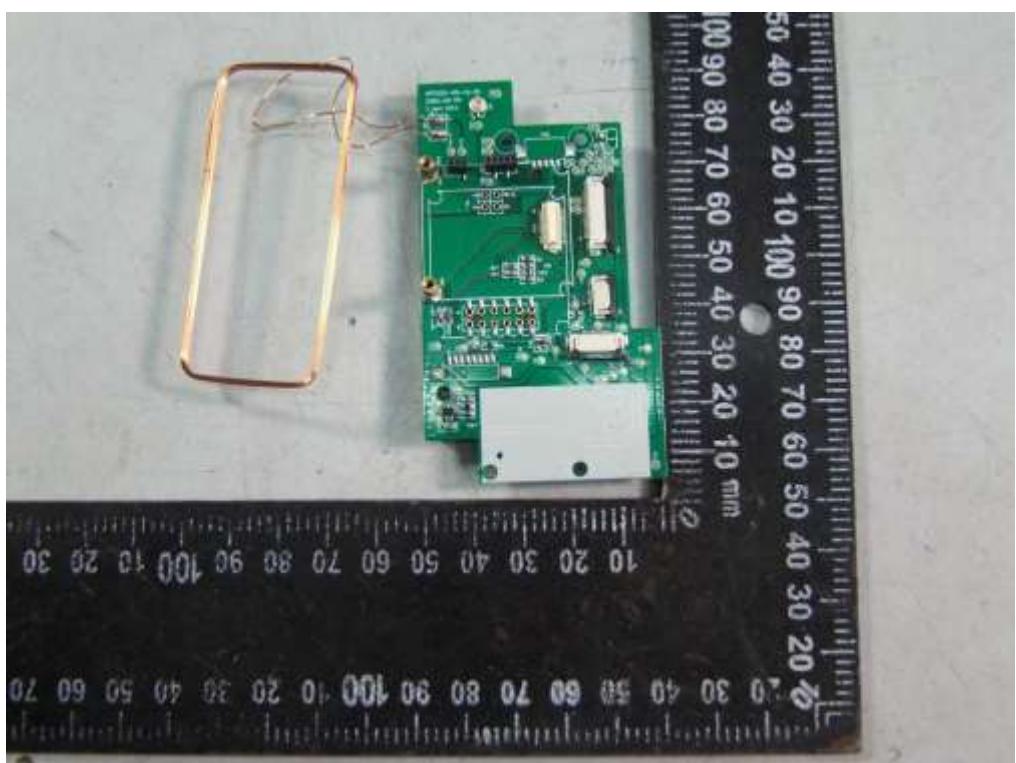
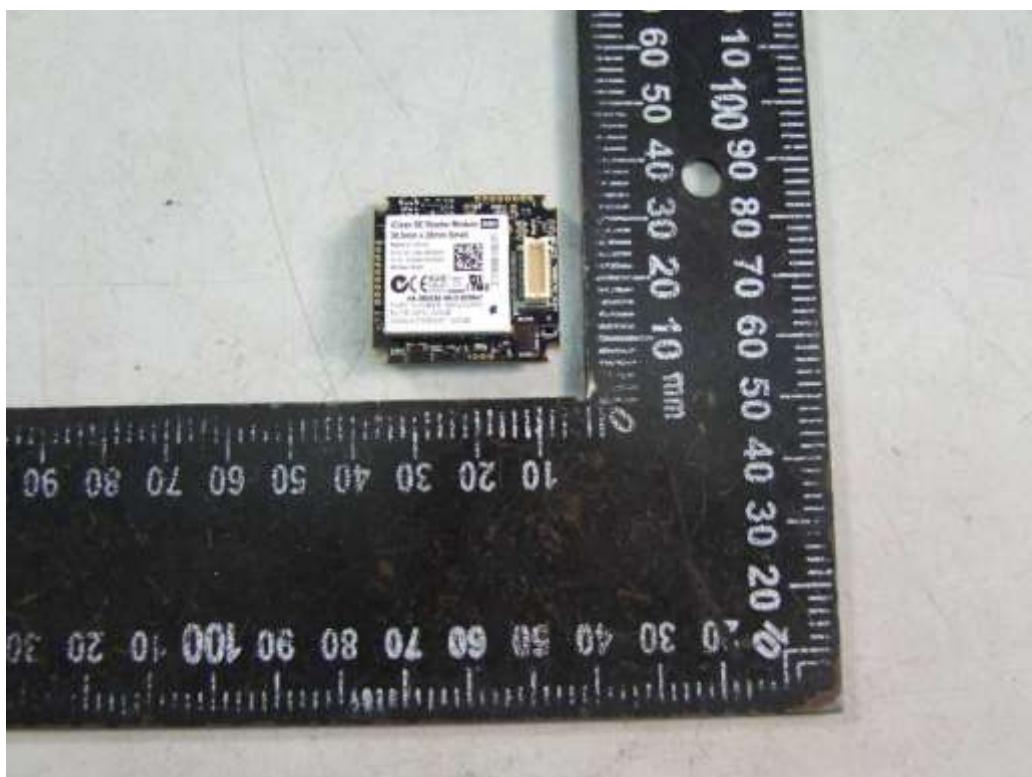
APPENDIX E: DUT Photos

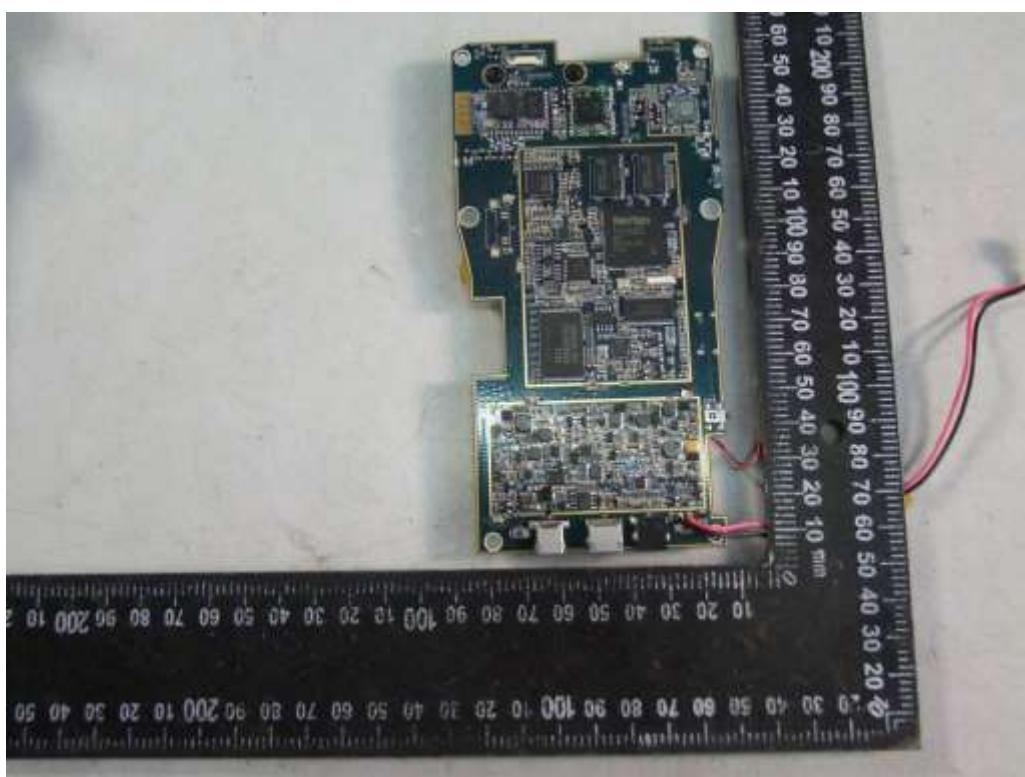
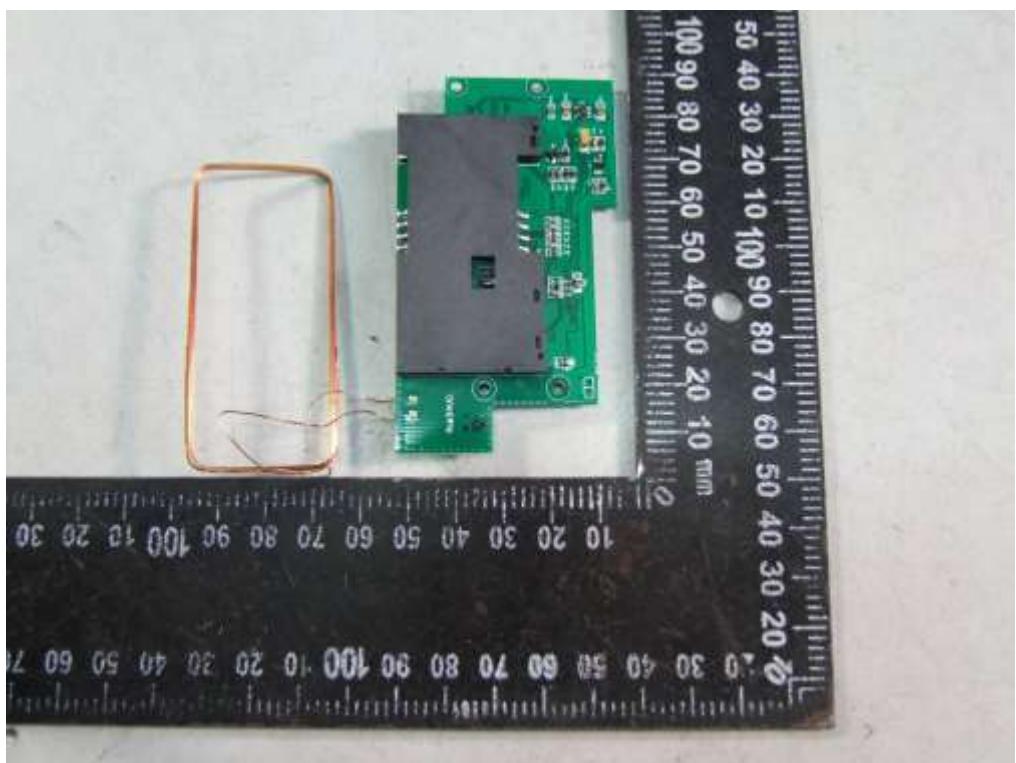


Internal photos





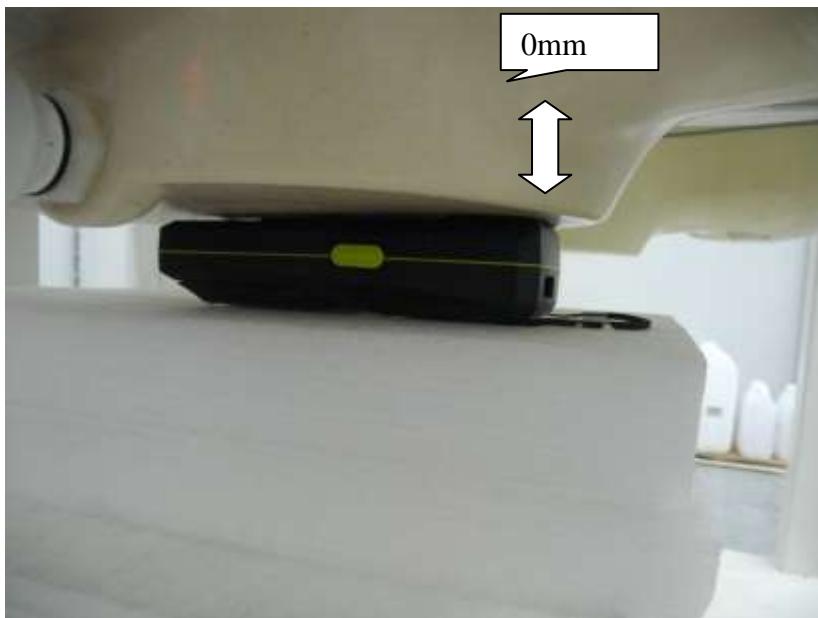




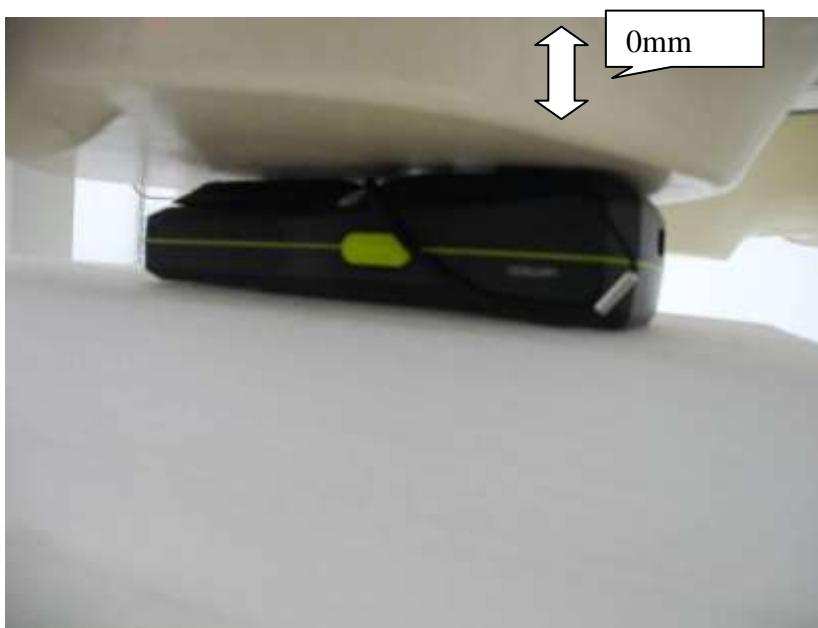
APPENDIX F: Test Position Photos

HRT500i

Front position 0mm



Back position 0mm



APPENDIX G: Laboratory Accreditation Certificate



China National Accreditation Service for Conformity Assessment

LABORATORY ACCREDITATION CERTIFICATE

(Registration No. CNAS L0579)

Shenzhen Academy of Metrology & Quality Inspection

Middle Section of Longzhu Avenue, Nanshan District, Shenzhen, Guangdong, China

is accredited 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 of testing and calibration.

The scope of accreditation is detailed in the attached appendices bearing the same registration number as above. The appendices form an integral part of this certificate.

Date of Issue: 2012-12-10

Date of Expiry: 2015-12-09

Date of Initial Accreditation: 1998-11-30

Date of Update: 2012-12-10

A handwritten signature in black ink, appearing to read '李玉华' (Li Yu-hua), is placed over the accreditation details.

Signed on behalf of China National Accreditation Service
for Conformity Assessment

China National Accreditation Service for Conformity Assessment (CNAS) is authorized by Certification and Accreditation Administration of the People's Republic of China (CNCA) to operate the national accreditation schemes for conformity assessment. CNAS is the signatory to International Laboratory Accreditation Cooperation Multilateral Recognition Arrangement (ILAC MRA) and Asia Pacific Laboratory Accreditation Cooperation Multilateral Recognition Arrangement (APLAC MRA).

No.CNAS AL 2

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