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426-5, Gasan-dong, Geumcheon-gu,
Seoul, 153-803, KoreaTEL: 82-2-867-3201
FAX: 82-2-867-3204**SAR Compliance Test Report****APPLICANT NAME & ADDRESS :**

SAMSUNG Electronics Co., Ltd

(Maetan dong) 129, Samsung-ro Yeongtong-gu,

Suwon-si, Gyeonggi-do 443-742, Korea

DATA & LOCATION OF TESTING

Dates of testing : 2013-03-20

Test Site : ESTECH Co., Ltd.

97-1, Hoeok-Ri, Majang-Myun, Icheon-City,
Kyonggi-Do, 467-811, Korea**Test Device :**

Model : SMT-W5120

FCC ID : A3LSMTW5120

TYPE : WLAN Phone

Test Report No. :

ESTSAR1303-001

Number of page :

21

Contact person :

Jong-deuk Kang /Principal Engineer

Responsible test Engineer :

In-Ki Hong

Testing has been
Carried out in
Accordance with :

IEEE 1528(2003)

Recommended Practice for Determining the Peak Spatial-Average Specific
Absorption Rate(SAR) in the Human Body Due to Wireless Communications
Device : Experimental Techniques

Applicant Type :

Certification

FCC CLASSIFICATION :

DTS-Part 15 Digital Transmitter System

FCC Rule Part(s) :

47CFR §2.1093; FCC/OET Bulletin 65 Supplement C ;ANSI/IEEE C95.1(1992)

Test results :

The Tested device complies with the requirements in respect of all
parameters subject to the test. The test results and statements relate
only to the items tested. The test report shall not be reproduced receipt in
full, without written approval of the laboratory.

Date and Signatures :

March 21, 2013

Report Prepared By :

Engineer/ In-Ki Hong

Engineering Manager/ Jin-Mo Yang

(Signature)

(Signature)

Test Report No. : ESTSAR1303-001

EST-QP-20-01(1)-(SAR)

Web : www. estech. co. kr

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1. SUMMARY FOR TEST REPORT

FCC ID	A3LSMTW5120
Date of test	2013-03-20
Measurement performed by	In-Ki Hong
Technical Reviewer	Jin-Mo Yang
EUT Type	WLAN Phone
Tx Frequency	802.11b/802.11g : 2412~2462 MHz
Rx Frequency	802.11b/802.11g : 2412~2462 MHz
Duty Cycle	100%
Max Power	20.11(802.11b,Ch6), 19.54(802.11g,Ch6)
Battery Type	DC 3.8 V(Lithum-ion Battery)

1.1 Head Worn Configuration (WLAN)

Max. SAR Measurement

Mode	Head Position	EUT Psition	Frequency (MHz)	Cannel	Power (dBm)	1g SAR (W/kg)
802.11g	Left	Cheek	2462	6	20.11	0.40

1.2 Body Worn Configuration (WLAN)

Max. SAR Measurement

Mode	Body Position	EUT Psition	Frequency (MHz)	Cannel	Power (dBm)	1g SAR (W/kg)
802.11b	—	LCD	2436	6	19.54	0.07

1.3 Measurement Uncertainty

Combine Standard Uncertainty	$\pm 11.00 (k=1)$
Extended Standard Uncertainty	$\pm 22.00 (k=2, 95\% \text{ CONFIDENCE LEVEL})$



2. INTRODUCTION

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

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

SAR Definition

Specific Absorption Rate (SAR) is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). it is also defined as the rate of rf energy absorption per unit mass at a point in an absorbing body (see Fig. 2.1.).

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

Figure 2.1 SAR Mathematical Equation

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

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

Where:

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

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3. DESCRIPTION OF THE DEVICE UNDER TEST

The FCC rules for evaluating portable devices for RF exposure compliance are contained in 47 CFR §2.1093. For purposes of RF exposure evaluation, a portable device is defined as a transmitting device designed to be used with any part of its radiating structure in direct contact with the user's body or within 20 cm of the body of a user or bystanders under normal operating conditions. This category of devices would include hand-held that incorporate the radiating antenna into the hand-piece and wireless transmitters that are carried next to the body. Portable devices are evaluated with respect to SAR limits for RF exposure. The applicable SAR limit for portable transmitters used by consumers is 1.6 W/kg, which is averaged over any one gram of tissue defined as a tissue volume in the shape of a cube.

2.1 Antenna Description

Type	Internal Antenna
Location	the top of the device
Radiator Material	Copper

2.2 Device Description

Serial numbers	NONE
Exposure environment	Uncontrolled exposure
Device category	Portable device
Mode(s) of Operation	DSSS, OFDM
Modulation Mode(s)	DSSS, OFDM
Duty Cycle	100%
Transmitting Frequency Range(s)	802.11b/802.11g : 2412~2462 MHz
test signal method	☐ Base station simulator ☒ Internal test code

2.3 Battery Options

☒ Standard ☐ Extended



4. TEST CONDITIONS

4.1 Ambient Conditions

Ambient Temperature (°C)	23
Tissue simulating liquid temperature (°C)	23
Humidity (% R.H.)	44

4.2 RF Characteristics of The Test Site

This measurement were performed in a fully enclosed RF Shielded environment

4.3 Test Signal, Frequencies, And Output Power

The Wireless Phone was placed into simulated call mode

In all operation bands the measurements were performed on lowest, middle and highest channels.

The phone was set to maximum power level during the all tests and at the beginning of the each test the battery was fully charged.

DASY4 system measures power drift during SAR testing by comparing e-field in the same location at the beginning and at the end of measurement. These records were used to monitor stability of power output.



Fig. 4.1 SAR Measurement System



5. DESCRIPTION OF THE TEST EQUIPMENT

An SAR measurement system usually consists of a small diameter isotropic electric field probe, a multiple axis probe positioning system, a test device holder, one or more phantom models, the field probe instrumentation, a computer and other electronic equipment for controlling the probe and making the measurements. Other supporting equipment, such as a network analyzer, power meters and RF signal generators, are also required to measure the dielectric parameters of the simulated tissue media and to verify the measurement accuracy of the SAR system.

5.1 Test System Specifications

Test Equipment	Model	Serial Number	Due Cal. Date
DAE	DAE4	551	2014-02-14
E-Field Probe	ET3DV3	3123	2014-01-22
Dipole validation kit	D2450V2	741	2014-02-23
Network analyzer	8753ES	US39173718	2013-10-17
Signal generator	83620B	3722A00463	2013-08-31
RF Power meter	EPM-442A	GB37170412	2014-01-27
Power Sensor	8481A	3318A87063	2014-01-27
Power Sensor	8481A	3318A96476	2014-01-27
Dielectric Probe	85070D	US01440154	-
Power Amplifier	BBS3K8CEM	NONE	2014-01-27
LP Filter	LA-30N	NONE	2013-09-26
Attenuator	8491B	21828	2014-01-27
Dual Directional Coupler	778D	17575	2014-01-27

5.2 SAR Measurement Setup

Measurement are performed using the DASY4 dosimetric assessment system. The DASY4 is made by Schmid & Partner Engineering AG(SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, Pentium IV computer, near-field probe, probe alignment sensor, and the SAM twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field(EMF) (see Fig. 5.1) A cell controller system contains the power supply, robot controller, teach pendant(Joystick), and a remote control used to drive the robot motors. The pc consists of the Intel Pentium IV 2.4 GHz computer with WindowsXP system and SAR measurement Software DASY4, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc.

5. DESCRIPTION OF THE TEST EQUIPMENT(continued)

Is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

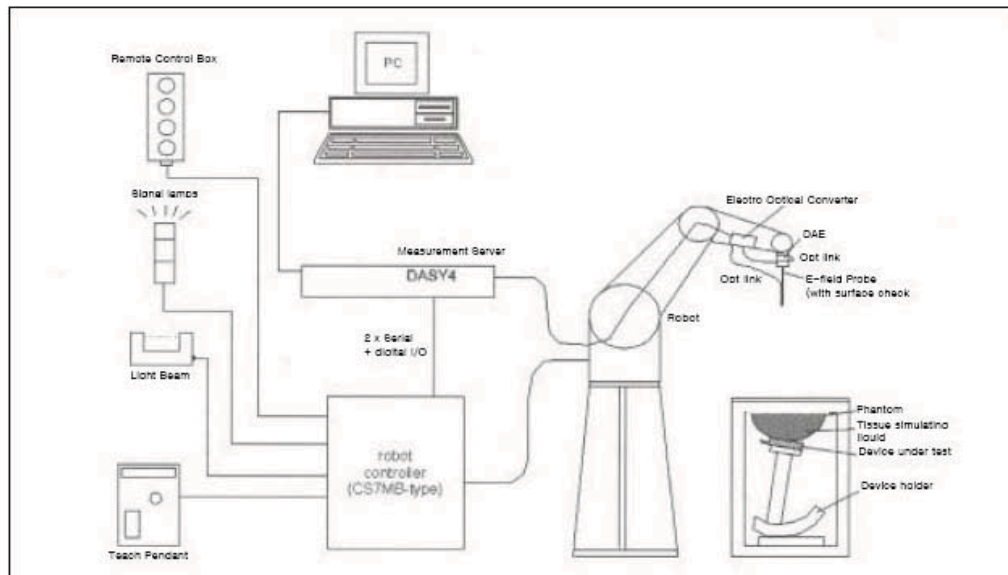


Fig. 5.1 SAR Measurement System Setup

The DAE4 consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gainswitching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the Ethernet Card is accomplished through an optical downlink for data and status

information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in.

5.3 DASY4 E-Field Probe System

The SAR measurements were conducted with the dosimetric probe ET3DV6, designed in the classical triangular configuration (see Fig.5.2) and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box in the robot arm and provides an automatic detection transmitter, the other half to a synchronized receiver.



5. DESCRIPTION OF THE TEST EQUIPMENT(continued)

As the probe approach the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches coupling is zero. The distance of the coupling maximum to the surface is probe angle. The DASY4 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting (see Fig. 5.2). The approach is stopped at reaching the maximum.

 Isotropic E-Field Probe	Isotropic E-Field Probe for Dosimetric Measurements	
	Construction	Symmetrical design with triangular core Interleafed sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycol)
	Calibration	In air from 10 MHz to 3 GHz In brain and muscle simulating tissue at frequencies of 450 MHz, 900 MHz and 1.8 GHz (accuracy $\pm 8\%$) Calibration for other liquids and frequencies upon request
	Frequency	10 MHz to > 6 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)
	Directivity	± 0.2 dB in brain tissue (rotation around probe axis) ± 0.3 dB in brain tissue (rotation normal to probe axis)
	Dynamic Range	5 μ W/g to > 100 mW/g; Linearity: ± 0.2 dB
	Dimensions	Overall length: 330 mm Tip length: 20 mm Body diameter: 12 mm Tip diameter: 3.9 mm Distance from probe tip to dipole centers: 2.7 mm

Fig. 5.2 Probe Specifications



5. DESCRIPTION OF THE TEST EQUIPMENT(continued)

5.4 Phantom & Equivalent Tissues

SAM Phantom

The SAM Twin Phantom V4.0 is constructed of the fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.

Head & Muscle simulation Mixture Characterization

The brain and muscle mixtures consist of a viscous gel using hydroxethylcellulose(HEC) gelling agent and saline solution (see Fig 5.3). Preservation with a bactericide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 have been specified in IEEE1528(2003) are derived from the issue dielectric parameters computed from the 4-Cole-Cole equations The mixture characterizations used for the brain and muscle tissue simulation liquids are according to the data by C. Gabriel and G. Hartagrove. (see Fig. 5.3)

Frequency	Head		Body	
(MHz)	ϵ_r	σ (S/m)	ϵ_r	σ (S/m)
150	52.3	0.76	61.9	0.8
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.9	55.2	0.97
900	41.5	0.97	55	1.05
915	41.5	0.98	55	1.06
1450	40.5	1.2	54	1.3
1610	40.3	1.29	53.8	1.4
1800-2000	40	1.4	53.3	1.52
2450	39.2	1.8	52.7	1.95
3000	38.5	2.4	52	2.73
5800	35.3	5.27	48.2	6

Fig.5.3 Head and body tissue parameters by the IEEE SCC-34/SC-2 in P1528



5. DESCRIPTION OF THE TEST EQUIPMENT(continued)

Ingredients (% by weight)	Frequency(MHz)											
	450		750		835		915		1 900		2 450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.2	51.7	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt(NaCl)	3.95	1.49	1.4	1.0	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	57	47.2	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	0.2	0.0	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.2	0.1	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7

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

Fig. 5.4 Composition of the Tissue Equivalent Matter

Device Holder for Transmitters

In combination with the SAM Twin Phantom V4.0, the Mounting Device enables the rotation of the accurately, and repeatably be positioned according to the FCC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

Note : A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produce infinite number of configurations [12]. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

6. DESCRIPTION OF THE TEST PROCEDURE

6.1 Definition of Reference Point

EAR Reference point

The point “M” is the reference point for the center of the mouth, “ERP” is the ear reference point. The ERP are 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown is figure 6.1. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) is perpendicular to the reference plane and passing through the ERP is called the Reference Pivoting Line (see Figure 6.1) B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning [5].

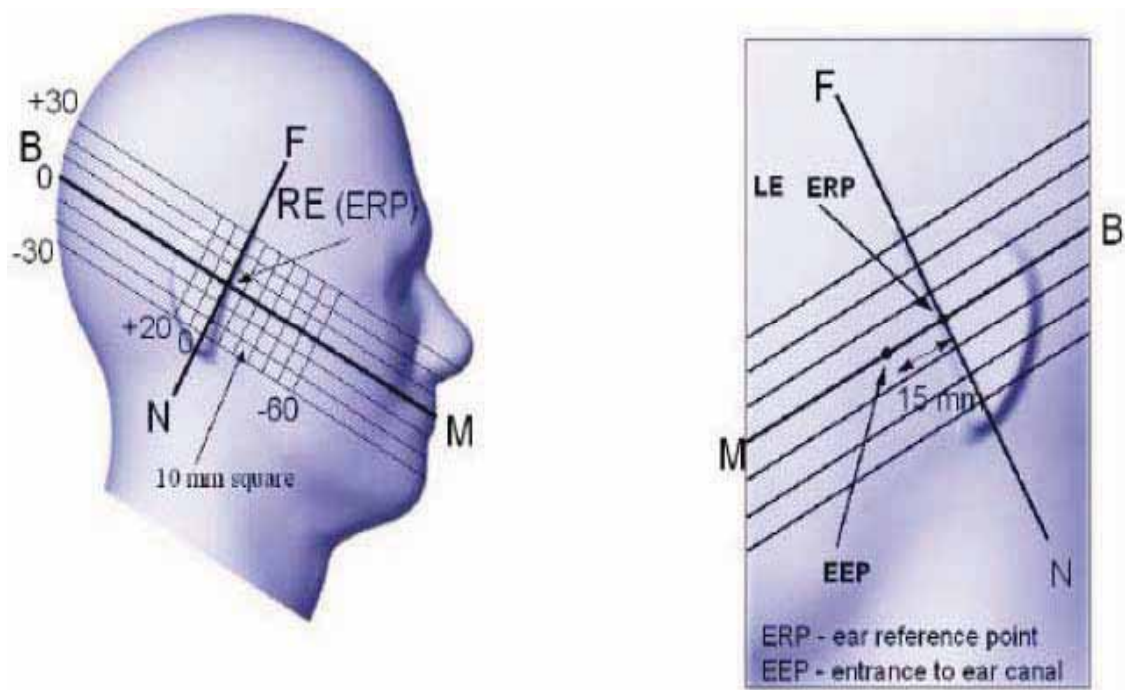


Figure 6.1 Close-up side view of ERP

Handset Reference Points

Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The test device was placed in a normal operating position with the “test device reference point” located along the “vertical centerline” on the front of the device aligned to the “ear reference point” (see Fig. 6.2). The “test device reference point” was then located at the same level as the center of the ear reference point. The test device was positioned so that the “vertical centerline” was bisecting the front surface of the handset at it’s top and bottom edges, positioning the “ear reference point” on the outer surface of the both the left and right head phantoms on the ear reference point” on the outer surface of the both the left and right head phantoms on the ear reference point.

6. DESCRIPTION OF THE TEST PROCEDURE(continued)

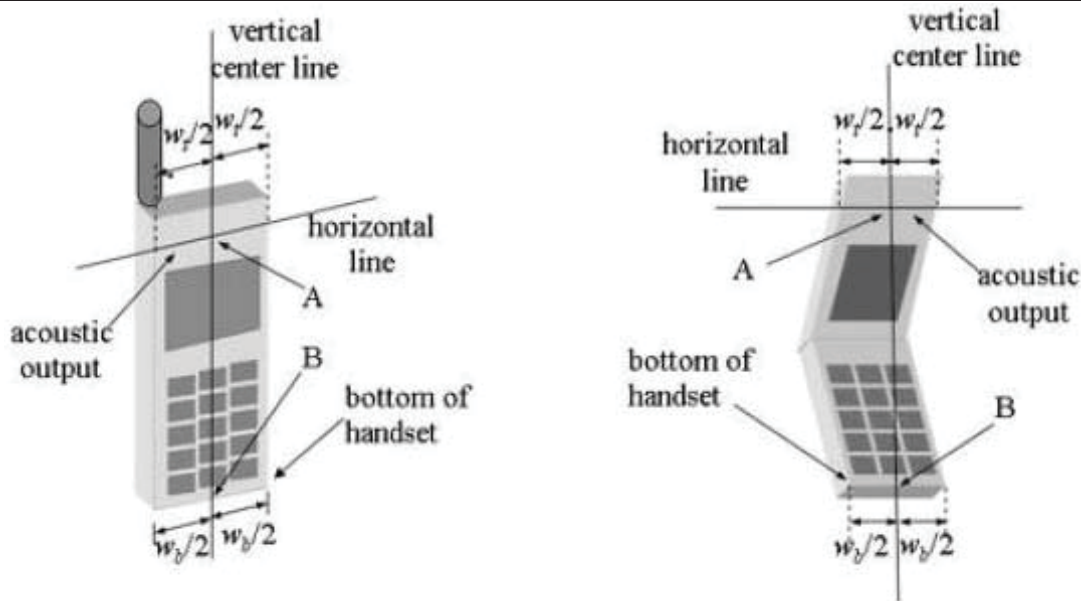


Figure 6.2 Handset Vertical Center & Horizontal Line Reference Points

6.2 Test Configuration Positions

Positioning for Cheek/Touch

- 1) Ready the handset for talk operation, if necessary. For example, for handsets with a cover piece, open the cover . (If the phone can also be used with the cover closed ,both configurations must be tested.)
- 2) Define two imaginary lines on the handset: the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset: the midpoint of the width w_t of the handset at the level of the acoustic output (point A on Figures 6.2), and the midpoint of the width w_b of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Figure 6.2). The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output. However, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset (see Figure 6.2), especially for clamshell handsets, handsets with lip pieces, and other irregularly-shaped handsets.
- 3) Position the handset close to the surface of the phantom touch that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 6.3), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom.

6. DESCRIPTION OF THE TEST PROCEDURE(continued)

- 4) Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the ear.
- 5) While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is in the plane normal to MB-NF including the line MB (called the reference plane).
- 6) Rotate the phone around the vertical centerline until the phone (horizontal line) is symmetrical with respect to the line NF.
- 7) While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, rotate the handset about the line NF until any point on the handset is in contact with a phantom point

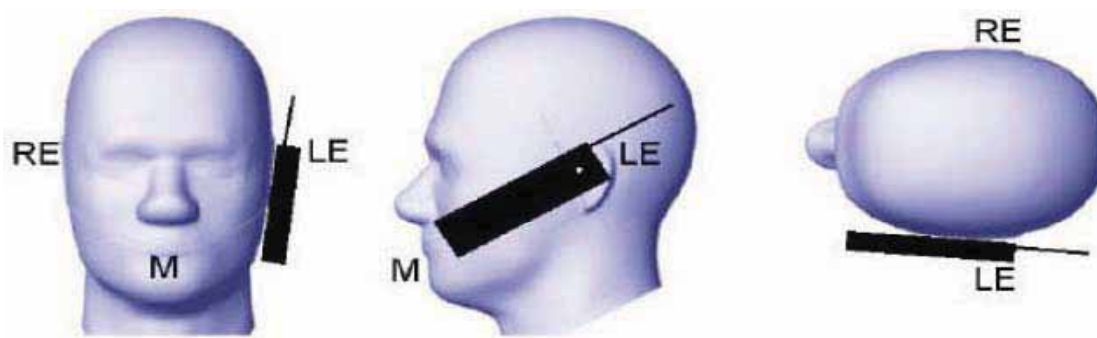


Figure 6.3 “Cheek” or “Touch” Position.

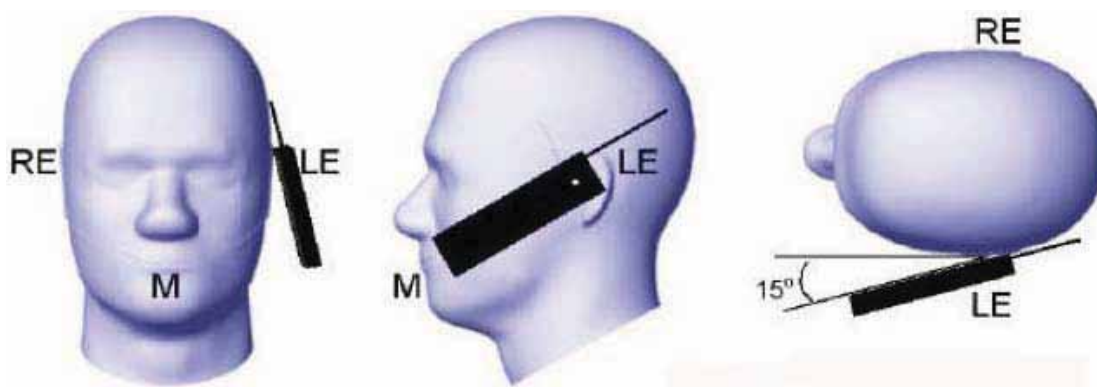


Figure 6.4 “Tilted” Position.



6. DESCRIPTION OF THE TEST PROCEDURE(continued)

Positioning for Ear / 15° Tilted

- 1) Repeat steps 1 to 7 of 6.2(Positioning for Cheek/Touch) to place the device in the “cheek position.”
- 2) While maintaining the orientation of the phone retract the phone parallel to the reference plane far enough to enable a rotation of the phone by 15 degree.
- 3) Rotate the phone around the horizontal line by 15 degree.
- 4) While maintaining the orientation of the phone, move the phone parallel to the reference plane until any part of the phone touches the head. (In this position, point A will be located on the line RE–LE). The tilted position is obtained when the contact is on the pinna. If the contact is at any location other than the pinna, the angle of the phone shall be reduced. The tilted position is obtained if any part of the phone is in contact of the ear as well as a second part of the phone is contact with the head.

Body Holder / Belt Clip Configurations

Body-worn operation configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration. A device with a headset output is tested with a headset connected to the device. Body dielectric parameters are used.

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are supplied with the device, the device is tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component (i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied of available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration where a separation distance between the back of the device and the flat phantom is used. All test position spacings are documented. Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance is tested with the accessory(ies), including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration. In all case SAR measurements are performed to investigate the worst case positioning. Worst-case positioning is then documented and used to perform Body SAR testing.

In order for users to be aware of the body-worn operation requirements for meeting RF exposure compliance, operation instructing instructions and cautions statements are included in the user's manual.



6. DESCRIPTION OF THE TEST PROCEDURE(continued)

6.3 Scan Procedures

First coarse scans are used for quick determination of the field distribution. Nest cube scan, 5x5x7 points; spacing between each point 5x5x5 mm, is performed around the highest E-field value to determine the averaged SAR-distribution over 1g.

6.4 SAR Averaging Methods

The maximum SAR value is averaged over its volume using interpolation and extrapolation.

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of three one-dimensional splines with the "Not a Knot" condition [W.Gander, Computermathematik, p. 141-150](x, y and z directions) [Numerical Recipes in C, Second Edition, p 123].

The extrapolation is based on least square algorithm [W.Gander, Computermathematik, p. 168-180]. Through the points in the first 30 mm in all z-axis, polynomials of order four are calculated. This polynomial is then used to evaluate the points between the surface and the probe tip. The points calculated from the surface, have a distance of 1mm from one another.



7. MEASUREMENT UNCERTAINTY

According to CENELEC [17], typical worst-case uncertainty of field measurements is 5 dB.

For well-defined modulation characteristics the uncertainty can be reduced to 3 dB.

ERROR Description	Uncertainty	Probability	Divisor	ci 1	Standard unc.	vi or
	value ±%	Distribution		1g	(1g)	Veff
MEASUREMENT SYSTEM						
Probe Calibration	± 11.7 %	normal	1	1	± 4.8 %	∞
Axial Isotropy	± 4.7	rectangular	√ 3	(1-cp) ^{1/2}	± 1.9%	∞
Hemispherical Isotropy	± 9.6	rectangular	√ 3	(cp) ^{1/2}	± 3.9%	∞
Boundary Effects	± 1.0	rectangular	√ 3	1	± 0.6%	∞
Linearity	± 4.7	rectangular	√ 3	1	± 2.7%	∞
System Detection Limits	± 1.0	rectangular	√ 3	1	± 0.6%	∞
Readout Electronics	± 1.0	normal	1	1	± 1.0%	∞
Response time	± 0.8	rectangular	√ 3	1	± 0.5%	∞
Integration time	± 2.6	rectangular	√ 3	1	± 1.5%	∞
RF Amnient Conditions	± 3.0	rectangular	√ 3	1	± 1.7%	∞
Probe Positioner Mechanical Tolerance	± 0.4	rectangular	√ 3	1	± 0.2%	∞
Probe Positioning with respect to Phantom Shell	± 2.9	rectangular	√ 3	1	± 1.7%	∞
Extrapolation, Interpolation and Integration Algorithms for Max. SAR Evaluation	± 1.0	rectangular	√ 3	1	± 0.6%	∞
Test Sample Related						
Test Sample Positioning	± 2.9	normal	1	1	± 2.97%	145
Device Holder Uncertainty	± 3.6	normal	0.84	1	± 3.69%	5
Output Power Validation – SAR drift measurement	± 5.0	rectangular	√ 3	1	± 2.9%	∞
Phantom and Tissue Parameters						
Phantom Uncertainty (shape and thickness tolerances)	± 4.0	rectangular	√ 3	1	± 2.3%	∞
Liquid conductivity Target – tolerance	± 5.0	rectangular	√ 3	0.64	± 1.8%	∞
Liquid Conductivity – measurement uncertainty	± 5.0	normal	1	0.64	± 3.2%	∞
Liquid permittivity Target – tolerance	± 5.0	rectangular	√ 3	0.6	± 1.7%	∞
Liquid Permittivity – measurement uncertainty	± 5.0	normal	1	0.6	± 3.0%	∞
Combined Standard Uncertainty					± 11.00 %	330
Coverage Factor for 95%				K = 2		
Expanded Standard Uncertainty					± 22.00 %	



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8. SYSTEM VERIFICATION

Tissue Verification

Table 8.1 Simulated Tissue Verification [5]

MEASURED TISSUE PARAMETERS										
Liquid Temperature (°C)		23		Liquid Depth(mm)		150				
Date	2013-03-20		2013-03-20							
Tissue	2450MHz Brain		2450MHz Body		835MHz Brain		835MHz Body			
	Target	Measured	Target	Measured	Target	Measured	Target	Measured	Target	Measured
Dielectric Constant: ϵ	39.2	38.5	52.7	51.9						
Conductivity: σ	1.8	1.78	1.95	1.92						
Deviation (%)	ϵ : -1.79% σ : -1.11%		ϵ : -1.52% σ : -1.54%							

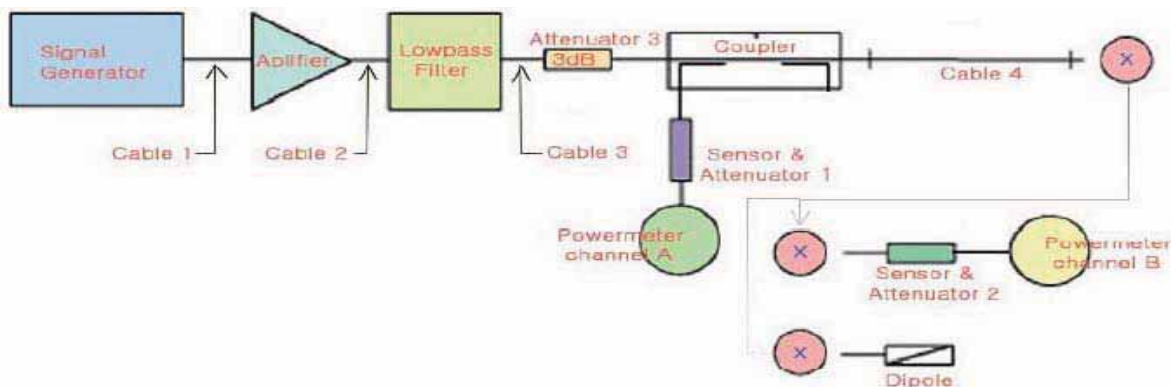
Test System Validation

- Prior to assessment, the system is verified to the $\pm 10\%$ of the specifications at 2450Hz (Graphic Plots Attached)
- The results are nominalized to 1W input power

Table 8.2 System Validation [5]

SYSTEM DIPOLE VALIDATION TARGET & MEASURED						
Tissue	System Validation Kit:	Forward Power (W)	Targeted SAR1g (mW/g)	Measured SAR1g (mW/g)	Deviation (%)	Test Date
2450MHz Head	D2450V2(S/N :741)	1.0	54	55.2	2.22%	2013-03-20

Tissue	System Validation Kit:	Forward Power (W)	Targeted SAR1g (mW/g)	Measured SAR1g (mW/g)	Deviation (%)	Test Date
2450MHz Body	D2450V2(S/N :741)	1.0	51.2	48.8	-4.69%	2013-03-20



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9. RESULTS(continued)

Ambient TEMPERATURE (C) : 23.0Relative HUMIDITY (%) : 44Mixture Type : 2450MHz HeadDielectric Constant : 38.5Conductivity: 1.78

Mode	Mbps	Average Power(dBm)		
		Low	Mid	High
802.11b	1	20.22	20.11	20.31
802.11g	6	19.28	19.54	19.13

Measurement Results (802.11b/g Head SAR)

ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population	1.6 W/kg (W/kg) averaged over 1 gram
---	---

MEASUREMENT RESULTS (802.11b/g Head SAR)

Mode	Head Position	EUT Position	Frequency (MHz)	Channel	Power (dBm)	Power Drift (dBm)	1g SAR (W/Kg)
802.11b	Right	Cheek	2437	6	20.11	-0.17	0.34
802.11b	Right	Tilt	2437	6	20.11	0.29	0.36
802.11b	Left	Cheek	2437	6	20.11	0.06	0.36
802.11b	Left	Tilt	2437	6	20.11	0.01	0.33
802.11g	Right	Cheek	2437	6	19.54	-0.07	0.40
802.11g	Right	Tilt	2437	6	19.54	0.01	0.26
802.11g	Left	Cheek	2437	6	19.54	0.93	0.34
802.11g	Left	Tilt	2437	6	19.54	0.26	0.28

Notes:

- 1 The test data reported are the worst-case SAR value according to test procedures specified in IEEE 1528(2003) FCC/OET Bulletin 65, Supplement C and FCC KDB Publication 447498 D01v05.
- 2 Batteries are fully charged at the beginning of the SAR measurements. A standard battery was used for all testing.
- 3 All modes of operation were investigated and the worst-case are reported. (worst case-11b:1 Mbps , 11g:6 Mbps)
- 4 Measured Depth of Simulating Tissue is 15.0 cm ± 0.2 cm.
- 5 Tissue parameters and temperatures are listed on the SAR plot.
- 6 For 2.4 GHz WLAN, Highest average power channel for the lowest data rate was selected for SAR evaluation base on KDB 248227. Other channels are not necessary because 1g-average SAR<0.8 W/kg and peak SAR < 1.6 W/kg per KDB 248227.

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9. RESULTS(continued)

Ambient TEMPERATURE (C) : 23.0Relative HUMIDITY (%) : 44Mixture Type : 2450MHz BodyDielectric Constant : 51.9Conductivity: 1.91

Measurement Results (802.11b/g BODY SAR)

ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population	1.6 W/kg (W/kg) averaged over 1 gram
---	---

MEASUREMENT RESULTS (802.11b/g BODY SAR)

Mode	Body Position	EUT Position	Frequency (MHz)	Channel	Power (dBm)	Power Drift (dBm)	1g SAR (W/Kg)
802.11b	–	LCD	2437	6	20.11	–0.44	0.07
802.11b	–	REAR	2437	6	20.11	0.07	0.07
802.11g	–	LCD	2437	6	19.54	–0.09	0.06
802.11g	–	REAR	2437	6	19.54	0.20	0.03

Notes:

- 1 The test data reported are the worst-case SAR value according to test procedures specified in IEEE 1528(2003) FCC/OET Bulletin 65, Supplement C and FCC KDB Publication 447498 D01v05.
- 2 Batteries are fully charged at the beginning of the SAR measurements. A standard battery was used for all testing.
- 3 All modes of operation were investigated and the worst-case are reported.(worst case–11b:1 Mbps , 11g:6 Mbps)
- 4 Measured Depth of Simulating Tissue is 15.0 cm ± 0.2 cm.
- 5 Tissue parameters and temperatures are listed on the SAR plot.
- 6 For 2.4 GHz WLAN, Highest average power channel for the lowest data rate was selected for SAR evaluation base on KDB 248227. Other channels are not necessary because 1g–average SAR<0.8 W/kg and peak SAR < 1.6 W/kg per KDB 248227.



10. REFERENCE

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APPENDIX A : Validation Test Data of Tissue



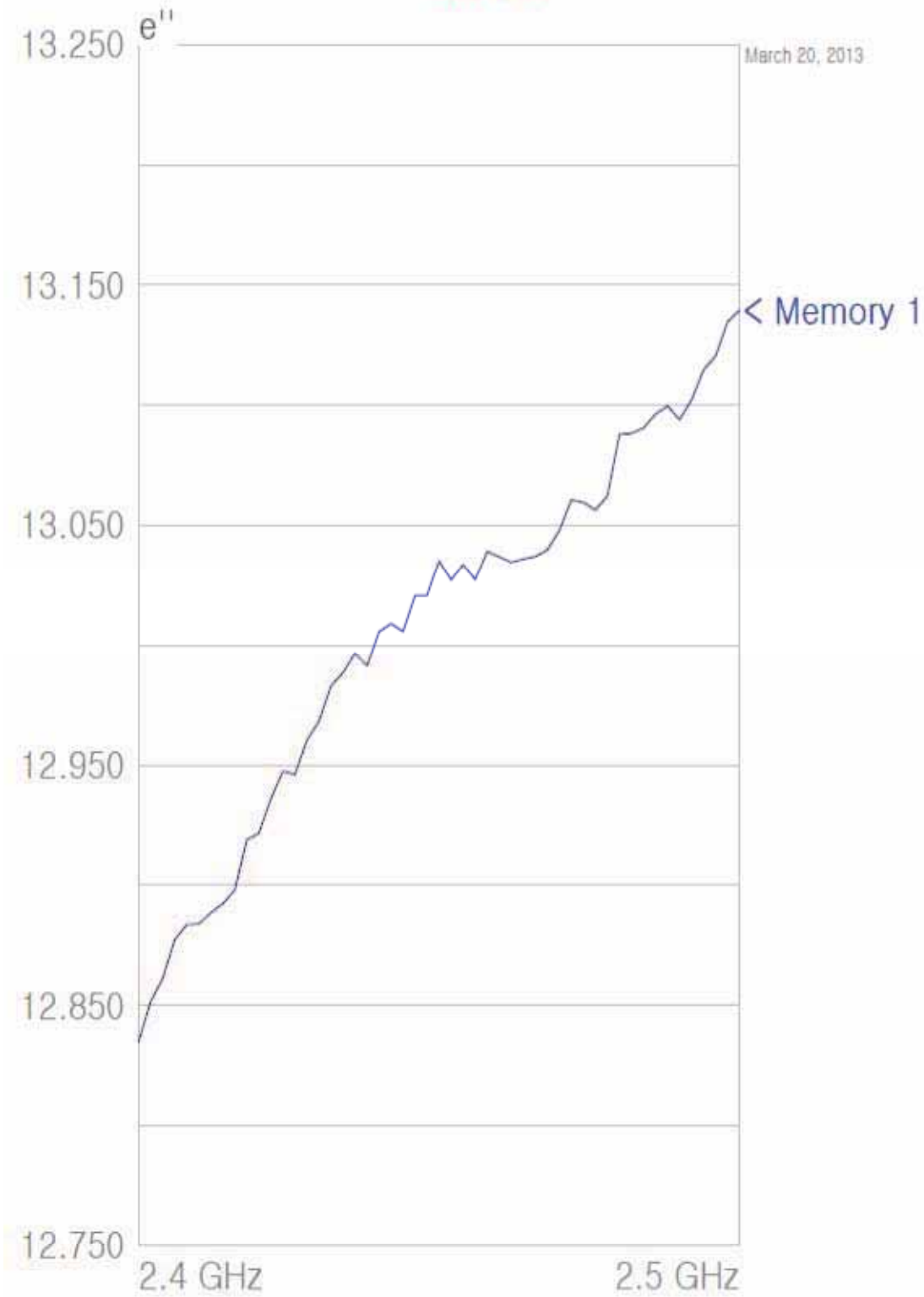
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- Head Tissue(2450MHz)

Title
SubTitle





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Title**SubTitle**

March 20, 2013

Frequency	e ¹	e ¹¹
2.400000000 GHz	38.6464	12.8348
2.401963461 GHz	38.6368	12.8514
2.403926921 GHz	38.6323	12.8610
2.405890382 GHz	38.6333	12.8772
2.407853843 GHz	38.6262	12.8835
2.409817303 GHz	38.6198	12.8838
2.411780795 GHz	38.6114	12.8884
2.413760288 GHz	38.6107	12.8922
2.415731780 GHz	38.5977	12.8979
2.417703272 GHz	38.6030	12.9188
2.419674764 GHz	38.5904	12.9215
2.421654321 GHz	38.5902	12.9358
2.423633878 GHz	38.5934	12.9474
2.425613435 GHz	38.5857	12.9460
2.427592991 GHz	38.5857	12.9603
2.429572548 GHz	38.5803	12.9681
2.431560202 GHz	38.5697	12.9828
2.433547856 GHz	38.5735	12.9884
2.435535511 GHz	38.5577	12.9966
2.437523165 GHz	38.5580	12.9913
2.439510819 GHz	38.5417	13.0055
2.441508604 GHz	38.5383	13.0089
2.443502388 GHz	38.5295	13.0057
2.445498173 GHz	38.5192	13.0204
2.447493958 GHz	38.5132	13.0205
2.449489743 GHz	38.5030	13.0351
2.451493891 GHz	38.5037	13.0268
2.453497640 GHz	38.4897	13.0336
2.455501589 GHz	38.4754	13.0270
2.457505537 GHz	38.4715	13.0391
2.459509486 GHz	38.4747	13.0369
2.461521632 GHz	38.4587	13.0346
2.463533778 GHz	38.4513	13.0359
2.465545923 GHz	38.4409	13.0370
2.467558069 GHz	38.4319	13.0397
2.469570215 GHz	38.4166	13.0478
2.471590592 GHz	38.4217	13.0606
2.473610968 GHz	38.4042	13.0596
2.475631345 GHz	38.3958	13.0564
2.477651722 GHz	38.3897	13.0622
2.479672098 GHz	38.3730	13.0679
2.481700739 GHz	38.3733	13.0883
2.483729380 GHz	38.3586	13.0905
2.485758021 GHz	38.3526	13.0963
2.487786662 GHz	38.3364	13.0997
2.489815303 GHz	38.3344	13.0940
2.491852243 GHz	38.3223	13.1022
2.493889182 GHz	38.3084	13.1147
2.495926121 GHz	38.3025	13.1205
2.497963061 GHz	38.2930	13.1347
2.500000000 GHz	38.2754	13.1395

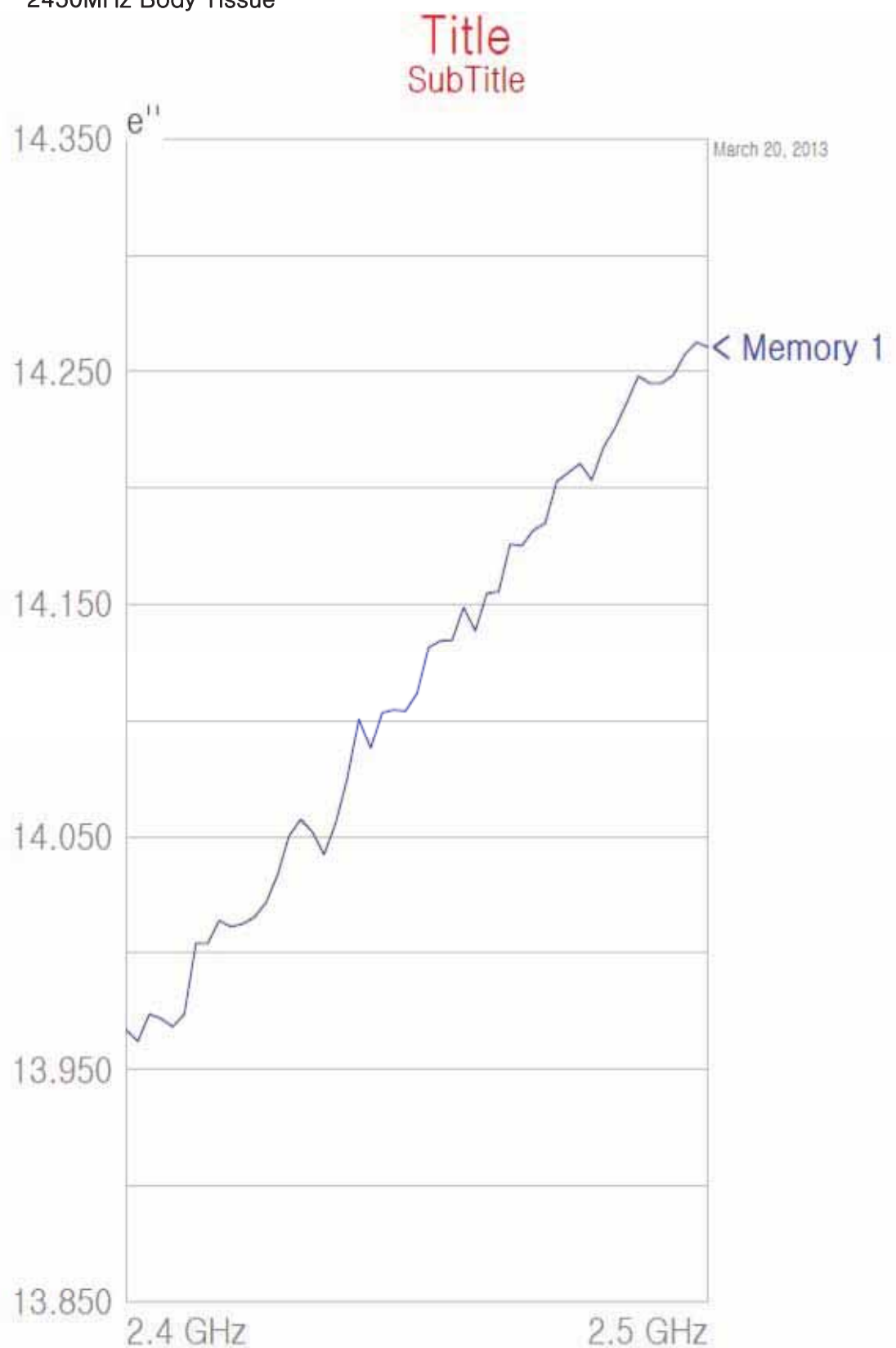


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– 2450MHz Body Tissue



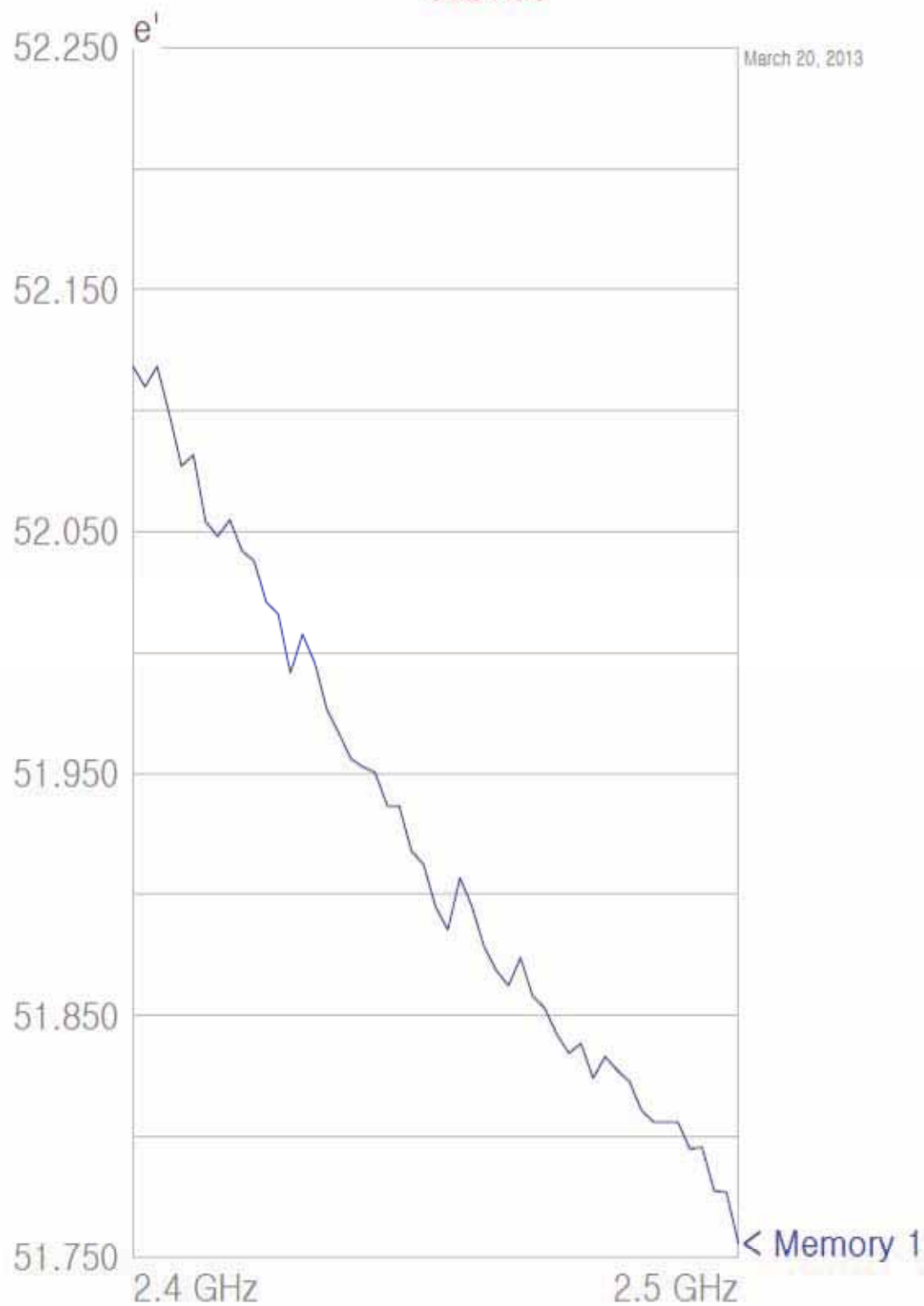
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Title

SubTitle

March 20, 2013

Frequency	e'	e''
2.40000000 GHz	52.1183	13.9668
2.401963461 GHz	52.1099	13.9620
2.403926921 GHz	52.1183	13.9736
2.405890382 GHz	52.0986	13.9717
2.407853843 GHz	52.0772	13.9683
2.409817303 GHz	52.0817	13.9736
2.411788795 GHz	52.0542	14.0041
2.413760288 GHz	52.0481	14.0040
2.415731780 GHz	52.0550	14.0139
2.417703272 GHz	52.0421	14.0112
2.419674764 GHz	52.0380	14.0124
2.421654321 GHz	52.0209	14.0152
2.423633878 GHz	52.0158	14.0214
2.425613435 GHz	51.9915	14.0333
2.427592991 GHz	52.0076	14.0503
2.429572548 GHz	51.9961	14.0573
2.431560202 GHz	51.9785	14.0520
2.433547856 GHz	51.9685	14.0422
2.435535511 GHz	51.9559	14.0557
2.437523165 GHz	51.9526	14.0749
2.439510819 GHz	51.9502	14.1006
2.441506604 GHz	51.9385	14.0880
2.443502388 GHz	51.9363	14.1034
2.445498173 GHz	51.9178	14.1046
2.447493958 GHz	51.9123	14.1041
2.449489743 GHz	51.8947	14.1117
2.451483691 GHz	51.8853	14.1315
2.453497640 GHz	51.9067	14.1343
2.455501589 GHz	51.8949	14.1346
2.457505537 GHz	51.8783	14.1487
2.459509486 GHz	51.8696	14.1387
2.461521632 GHz	51.8622	14.1548
2.463533778 GHz	51.8737	14.1554
2.465545923 GHz	51.8580	14.1759
2.467558069 GHz	51.8529	14.1752
2.469570215 GHz	51.8422	14.1819
2.471590592 GHz	51.8343	14.1849
2.473610968 GHz	51.8383	14.2028
2.475631345 GHz	51.8240	14.2066
2.477651722 GHz	51.8329	14.2106
2.479672098 GHz	51.8272	14.2034
2.481700739 GHz	51.8226	14.2174
2.483729380 GHz	51.8107	14.2258
2.485758021 GHz	51.8058	14.2365
2.487786662 GHz	51.8059	14.2481
2.489815303 GHz	51.8058	14.2451
2.491852243 GHz	51.7947	14.2451
2.493889182 GHz	51.7955	14.2484
2.495926121 GHz	51.7774	14.2575
2.497963061 GHz	51.7769	14.2626
2.500000000 GHz	51.7557	14.2606



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APPENDIX B : Validation Test Data



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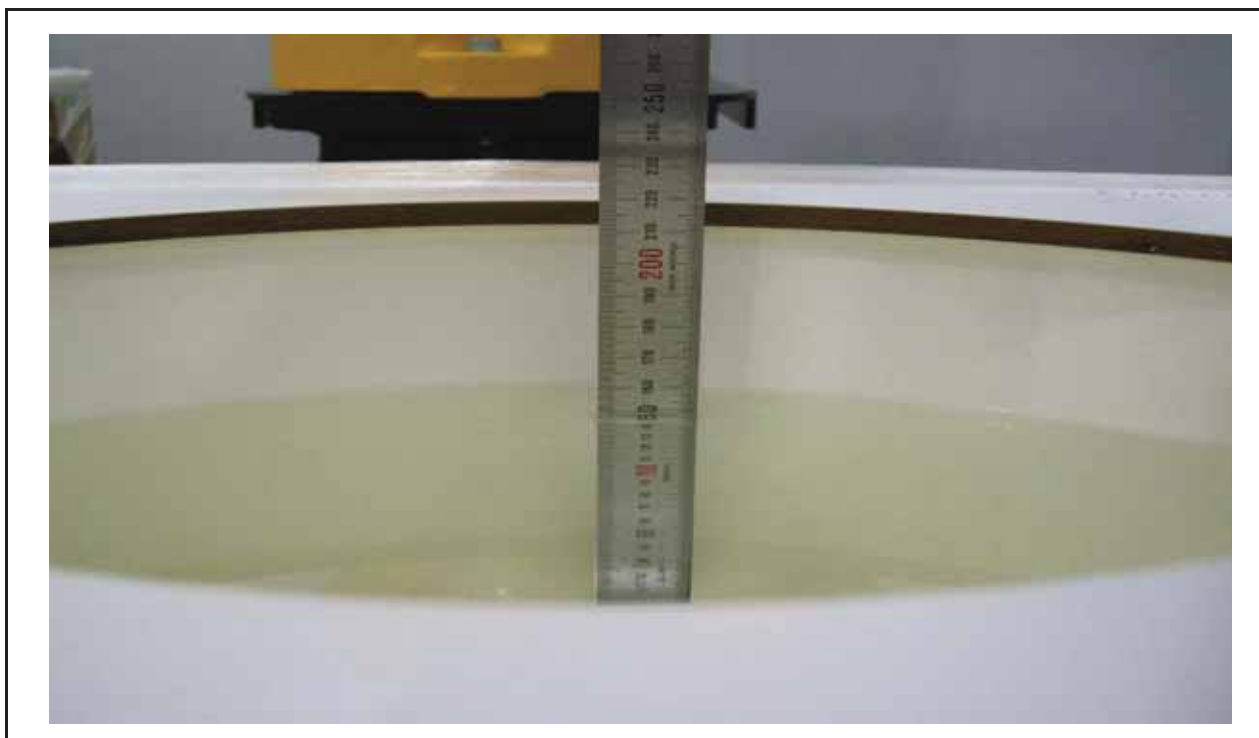
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Dipole Validation



Liquid depth



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– 2450MHz Validation (Head)

Date: 2013-03-20

Test Laboratory: ESTECH

VALIDATION

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

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.78$ mho/m; $\epsilon_r = 38.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.49, 4.49, 4.49); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900 12 03 23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (41x61x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 16.0 mW/g

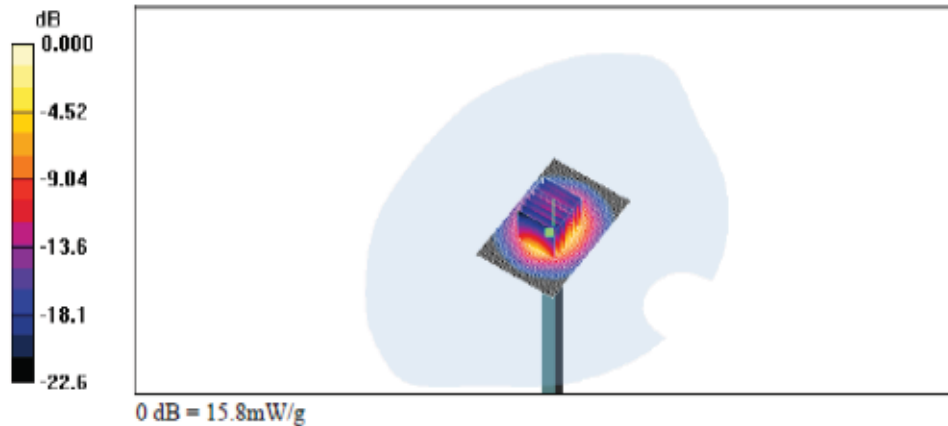
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.1 V/m; Power Drift = -0.054 dB

Peak SAR (extrapolated) = 28.6 W/kg

SAR(1 g) = 13.8 mW/g

Maximum value of SAR (measured) = 15.8 mW/g

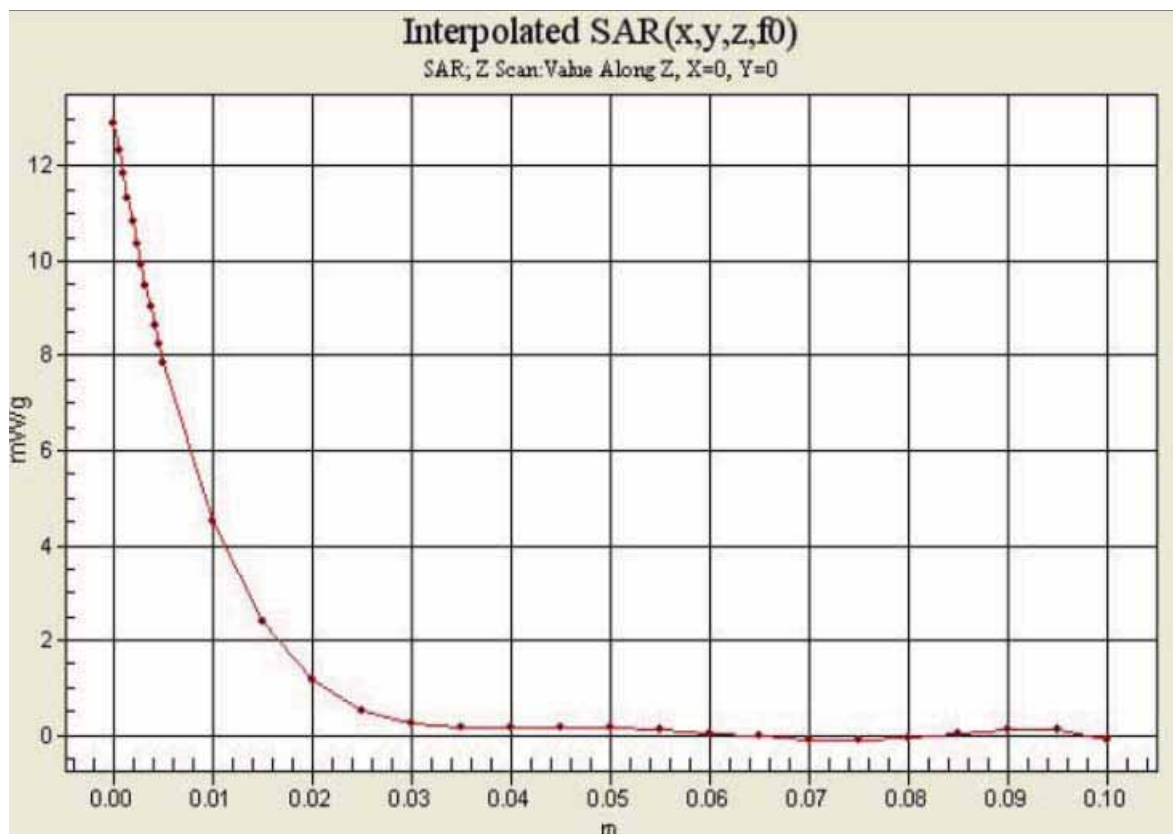




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– 2450MHz Validation (Body)

Date: 2013-03-20

Test Laboratory: ESTECH

VALIDATION BODY

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

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.92$ mho/m; $\epsilon_r = 51.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.25, 4.25, 4.25); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900 12_03_23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (41x61x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 14.2 mW/g

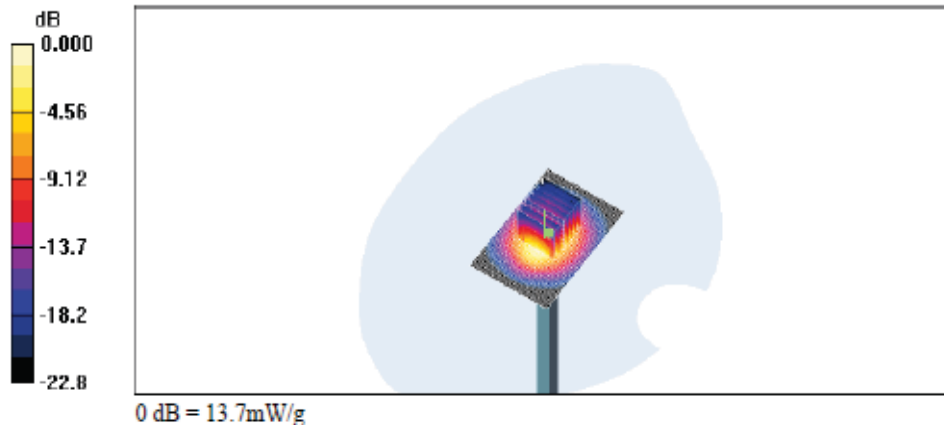
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 85.7 V/m; Power Drift = -0.033 dB

Peak SAR (extrapolated) = 26.3 W/kg

SAR(1 g) = 12.2 mW/g

Maximum value of SAR (measured) = 13.7 mW/g

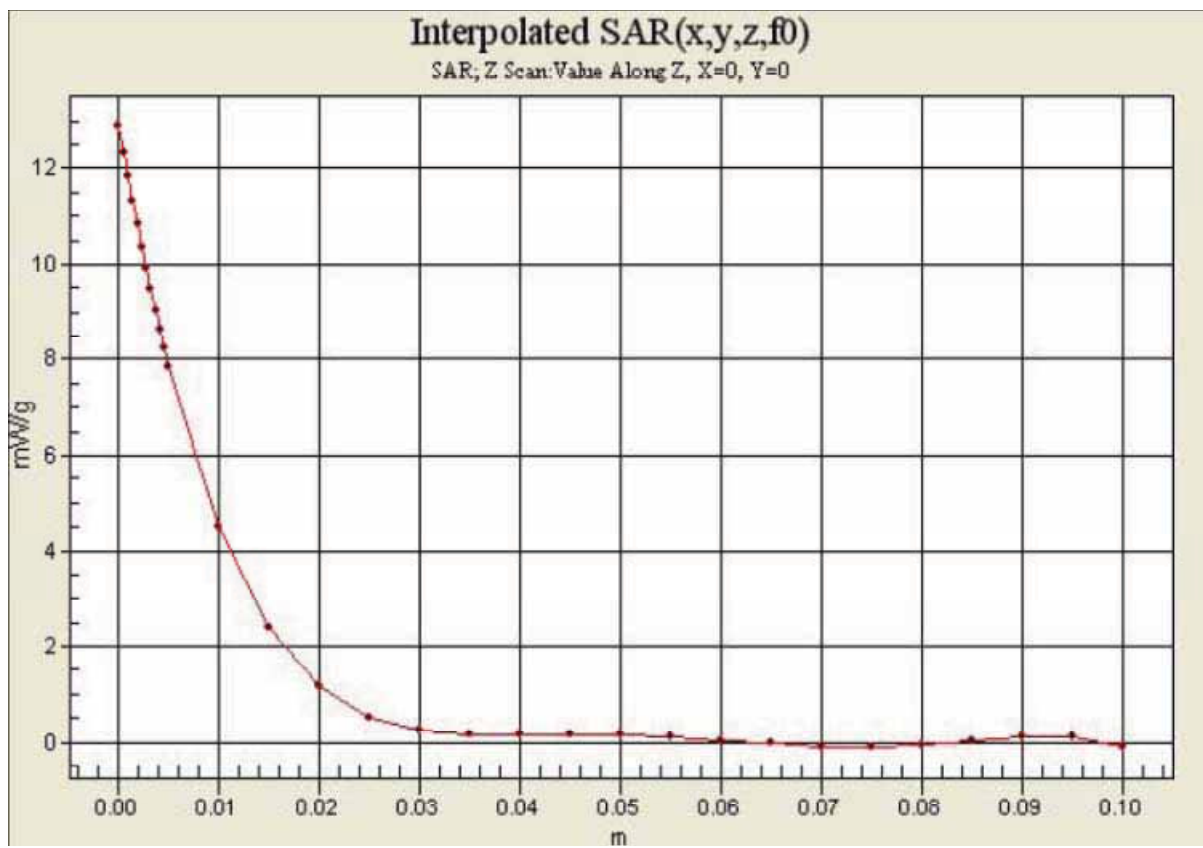




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APPENDIX C : SAR Test Data

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– 2437 MHz 802.11b Head

Date: 2013-03-20

Test Laboratory: ESTECH

RIGHT TOUCH 802.11b CH6

DUT: SMT-W5120; Type: BAR TYPE; Serial: XXXX

Communication System: Wireless; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.88$ mho/m; $\epsilon_r = 38$; $\rho = 1000$ kg/m³

Phantom section: Right Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.49, 4.49, 4.49); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900 12 03 23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (41x81x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.386 mW/g

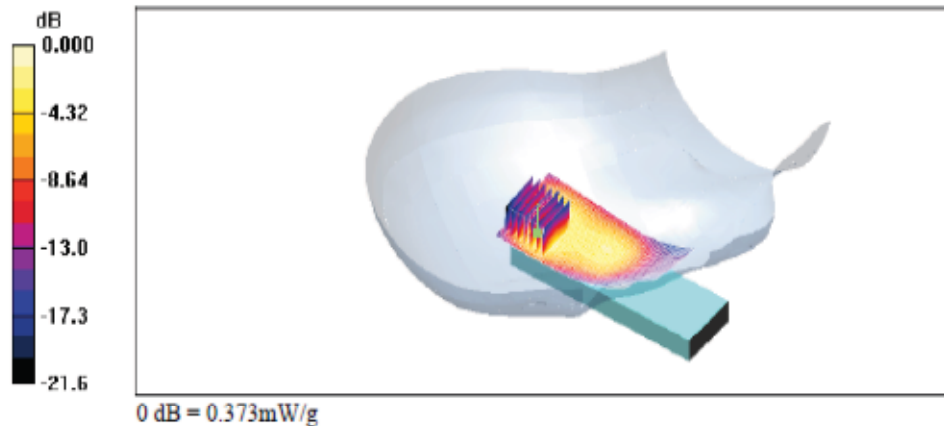
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 12.3 V/m; Power Drift = -0.165 dB

Peak SAR (extrapolated) = 0.629 W/kg

SAR(1 g) = 0.335 mW/g

Maximum value of SAR (measured) = 0.373 mW/g



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Date: 2013-03-20

Test Laboratory: ESTECH

RIGHT TILT 802.11b CH6

DUT: SMT-W5120; Type: BAR TYPE; Serial: XXXX

Communication System: Wireless; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.88$ mho/m; $\epsilon_r = 38$; $\rho = 1000$ kg/m³

Phantom section: Right Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.49, 4.49, 4.49); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900 12 03 23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (41x81x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.396 mW/g

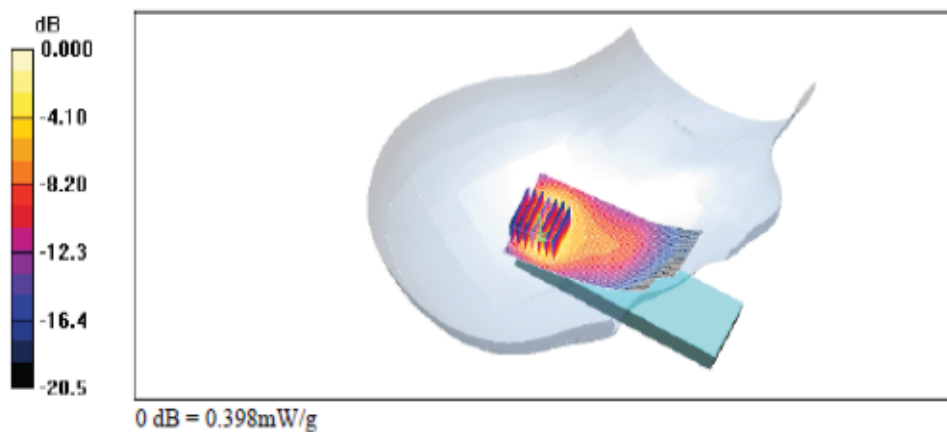
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 12.2 V/m; Power Drift = 0.285 dB

Peak SAR (extrapolated) = 0.654 W/kg

SAR(1 g) = 0.356 mW/g

Maximum value of SAR (measured) = 0.398 mW/g



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Test Laboratory: ESTECH

LEFT TOUCH 802.11b CH6

DUT: SMT-W5120; Type: BAR TYPE; Serial: XXXX

Communication System: Wireless; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.88$ mho/m; $\epsilon_r = 38$; $\rho = 1000$ kg/m³

Phantom section: Left Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.49, 4.49, 4.49); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900 12_03_23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (41x81x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.469 mW/g

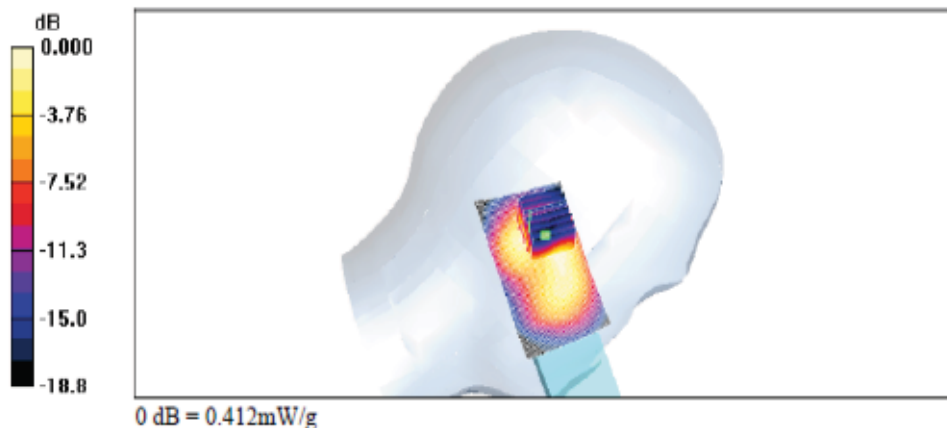
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 14.8 V/m; Power Drift = 0.064 dB

Peak SAR (extrapolated) = 0.757 W/kg

SAR(1 g) = 0.362 mW/g

Maximum value of SAR (measured) = 0.412 mW/g



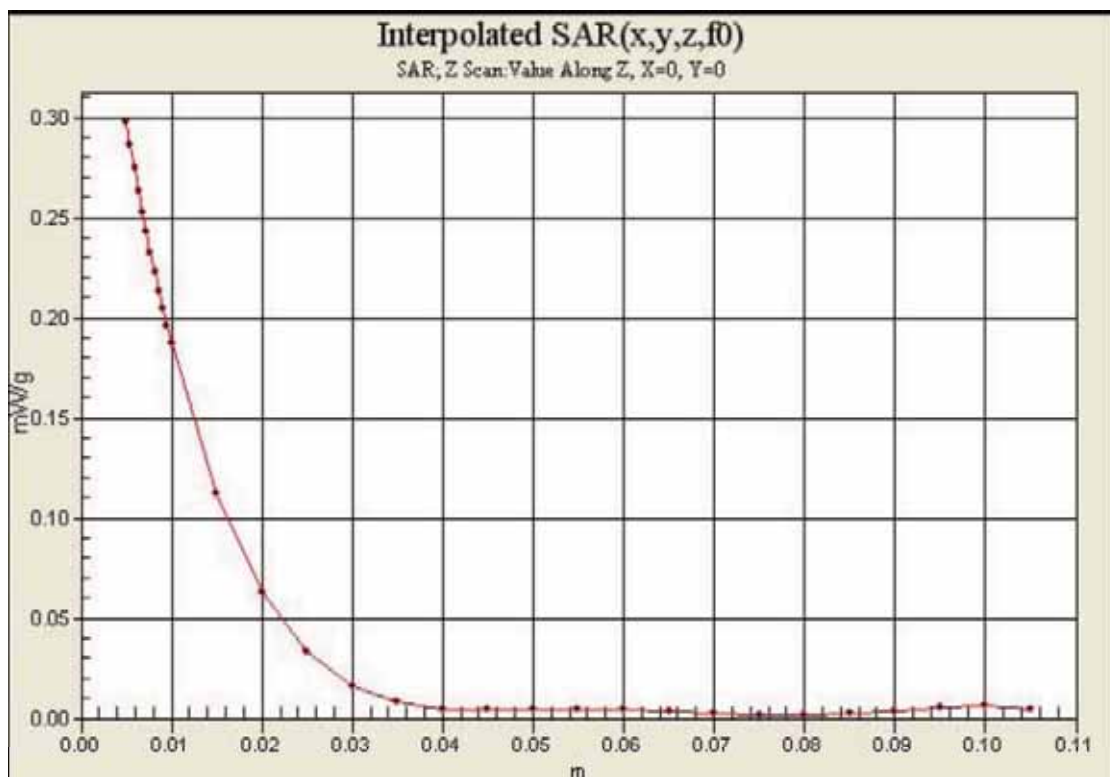


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Date: 2013-03-20

Test Laboratory: ESTECH

LEFT TILT 802.11b CH6

DUT: SMT-W5120; Type: BAR TYPE; Serial: XXXX

Communication System: Wireless; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.88$ mho/m; $\epsilon_r = 38$; $\rho = 1000$ kg/m³

Phantom section: Left Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.49, 4.49, 4.49); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900 12 03 23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (41x81x1): Measurement grid: $dx=15$ mm, $dy=15$ mm

Maximum value of SAR (interpolated) = 0.381 mW/g

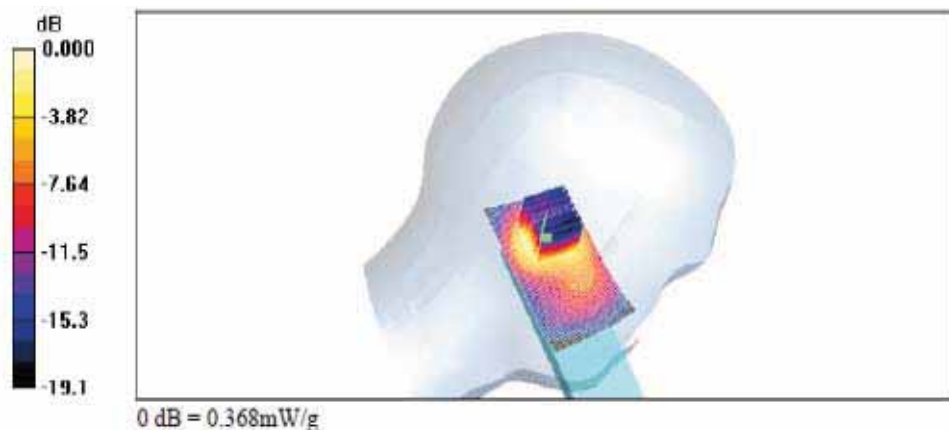
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 14.2 V/m; Power Drift = 0.009 dB

Peak SAR (extrapolated) = 0.619 W/kg

SAR(1 g) = 0.330 mW/g

Maximum value of SAR (measured) = 0.368 mW/g



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– 2437 MHz 802.11g Head

Date: 2013-03-20

Test Laboratory: ESTECH

RIGHT TOUCH 802.11G CH6

DUT: SMT-W5120; Type: BAR TYPE; Serial: XXXX

Communication System: Wireless; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.88$ mho/m; $\epsilon_r = 38$; $\rho = 1000$ kg/m³

Phantom section: Right Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.49, 4.49, 4.49); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900 12 03 23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (41x81x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.436 mW/g

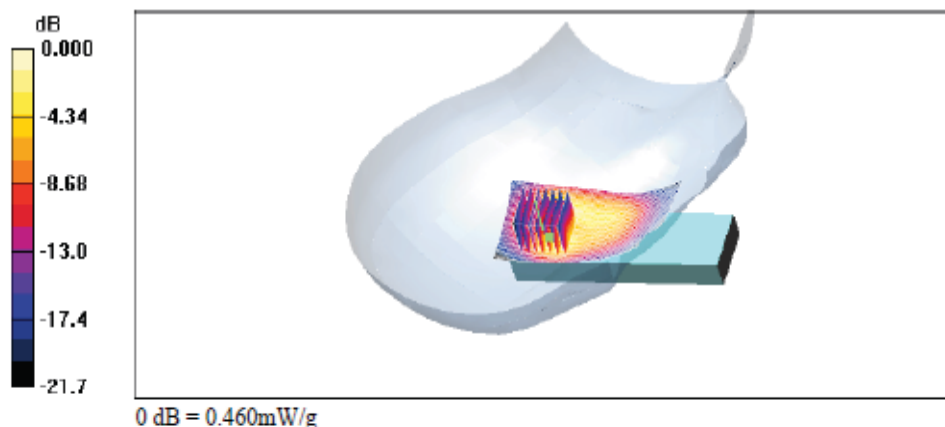
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 12.4 V/m; Power Drift = -0.068 dB

Peak SAR (extrapolated) = 0.848 W/kg

SAR(1 g) = 0.397 mW/g

Maximum value of SAR (measured) = 0.460 mW/g



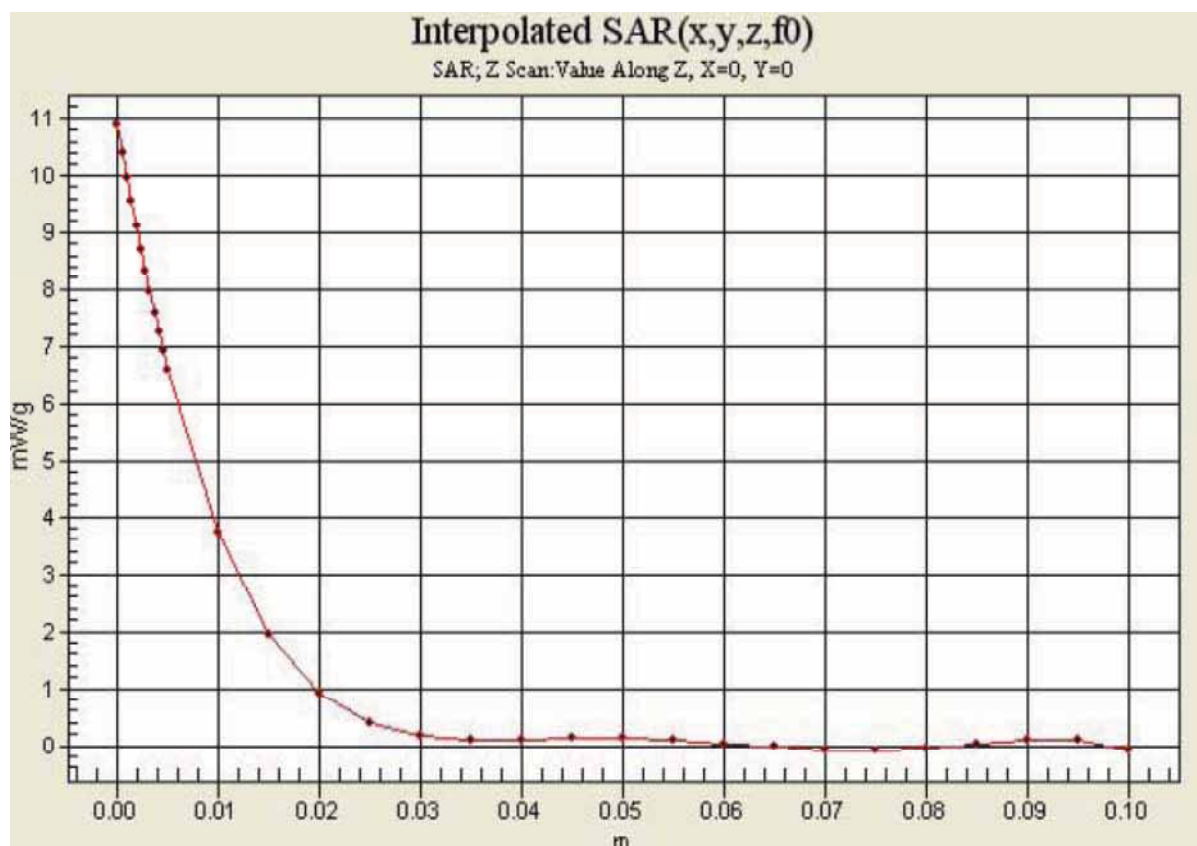


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Date: 2013-03-20

Test Laboratory: ESTECH

RIGHT TILT 802.11G CH6

DUT: SMT-W5120; Type: BAR TYPE; Serial: XXXX

Communication System: Wireless; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.88$ mho/m; $\epsilon_r = 38$; $\rho = 1000$ kg/m³

Phantom section: Right Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.49, 4.49, 4.49); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900_12_03_23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (41x81x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.298 mW/g

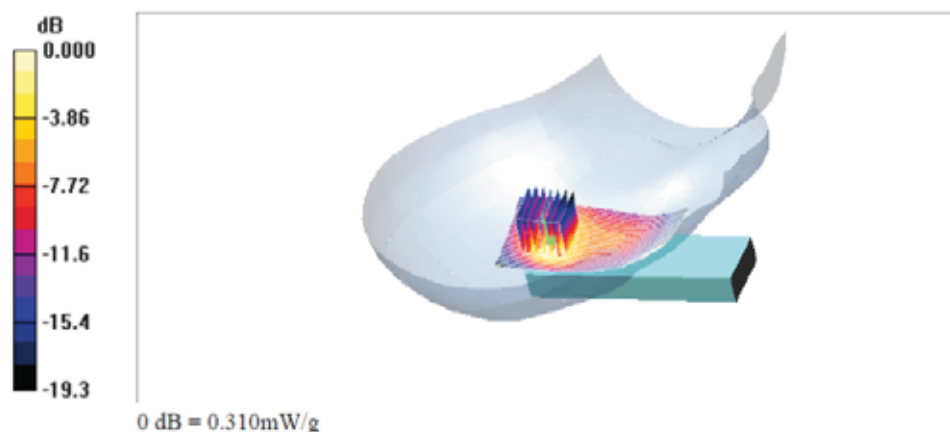
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 12.7 V/m; Power Drift = 0.013 dB

Peak SAR (extrapolated) = 0.584 W/kg

SAR(1 g) = 0.263 mW/g

Maximum value of SAR (measured) = 0.310 mW/g



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Date: 2013-03-20

Test Laboratory: ESTECH

LEF TOUCH 802.11G CH6

DUT: SMT-W5120; Type: BAR TYPE; Serial: XXXX

Communication System: Wireless; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.88$ mho/m; $\epsilon_r = 38$; $\rho = 1000$ kg/m³

Phantom section: Left Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.49, 4.49, 4.49); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900 12_03_23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (41x81x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.463 mW/g

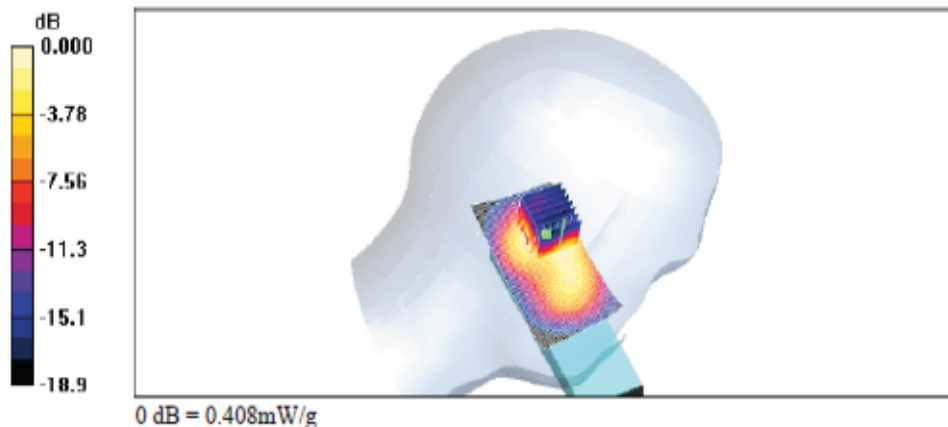
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 13.2 V/m; Power Drift = 0.933 dB

Peak SAR (extrapolated) = 0.803 W/kg

SAR(1 g) = 0.343 mW/g

Maximum value of SAR (measured) = 0.408 mW/g



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Date: 2013-03-20

Test Laboratory: ESTECH

LEF TILT 802.11G CH6

DUT: SMT-W5120; Type: BAR TYPE; Serial: XXXX

Communication System: Wireless; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.88$ mho/m; $\epsilon_r = 38$; $\rho = 1000$ kg/m³

Phantom section: Left Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.49, 4.49, 4.49); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900 12_03_23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (41x81x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.301 mW/g

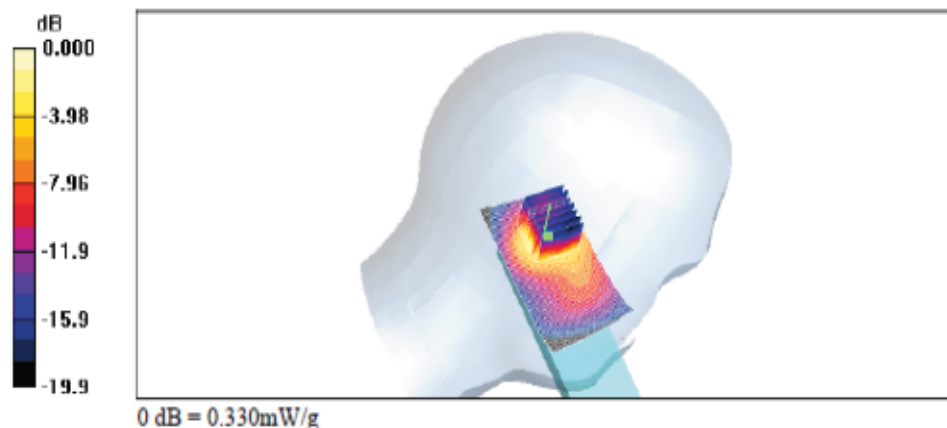
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 13.1 V/m; Power Drift = 0.256 dB

Peak SAR (extrapolated) = 0.564 W/kg

SAR(1 g) = 0.283 mW/g

Maximum value of SAR (measured) = 0.330 mW/g



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– 2450MHz 802.11b Body

Date: 2013-03-20

Test Laboratory: ESTECH

BODY LCD 802.11B CH6

DUT: SMT-W5120; Type: BAR TYPE; Serial: XXXX

Communication System: Wireless; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.91$ mho/m; $\epsilon_r = 52$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.25, 4.25, 4.25); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900 12 03 23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (51x81x1): Measurement grid: $dx=15$ mm, $dy=15$ mm

Maximum value of SAR (interpolated) = 0.083 mW/g

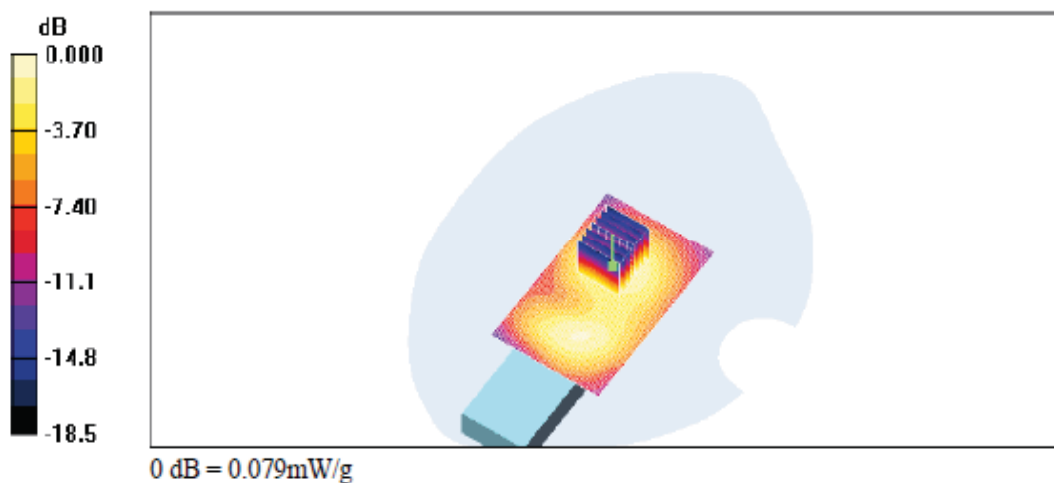
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 6.65 V/m; Power Drift = -0.441 dB

Peak SAR (extrapolated) = 0.132 W/kg

SAR(1 g) = 0.072 mW/g

Maximum value of SAR (measured) = 0.079 mW/g

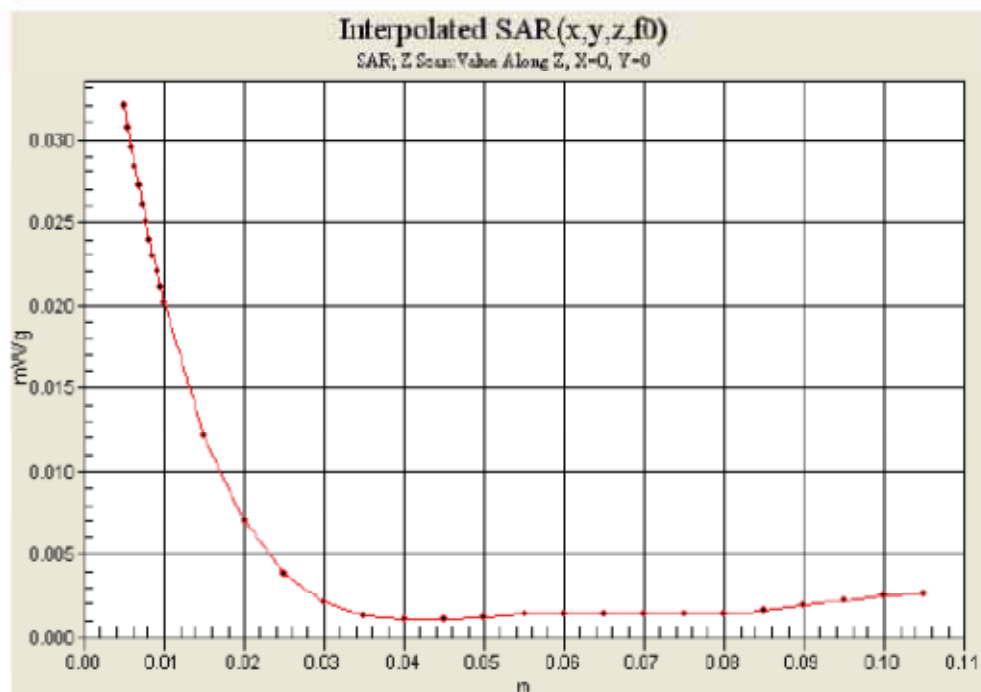




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Test Laboratory: ESTECH

BODY REAR 802.11B CH6

DUT: SMT-W5120; Type: BAR TYPE; Serial: XXXX

Communication System: Wireless; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.91$ mho/m; $\epsilon_r = 52$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.25, 4.25, 4.25); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900_12_03_23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (51x81x1): Measurement grid: $dx=15$ mm, $dy=15$ mm

Maximum value of SAR (interpolated) = 0.080 mW/g

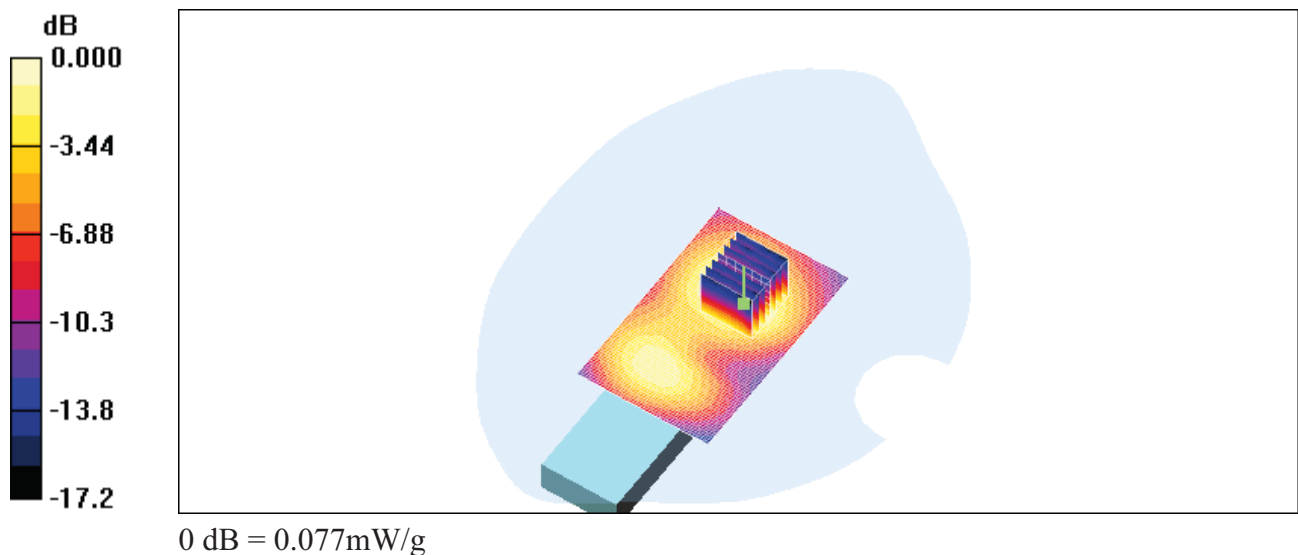
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 6.10 V/m; Power Drift = 0.070 dB

Peak SAR (extrapolated) = 0.130 W/kg

SAR(1 g) = 0.071 mW/g

Maximum value of SAR (measured) = 0.077 mW/g



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Date: 2013-03-20

Test Laboratory: ESTECH

BODY LCD 802.11G CH6

DUT: SMT-W5120; Type: BAR TYPE; Serial: XXXX

Communication System: Wireless; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.91$ mho/m; $\epsilon_r = 52$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.25, 4.25, 4.25); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900_12_03_23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (51x81x1): Measurement grid: $dx=15$ mm, $dy=15$ mm

Maximum value of SAR (interpolated) = 0.064 mW/g

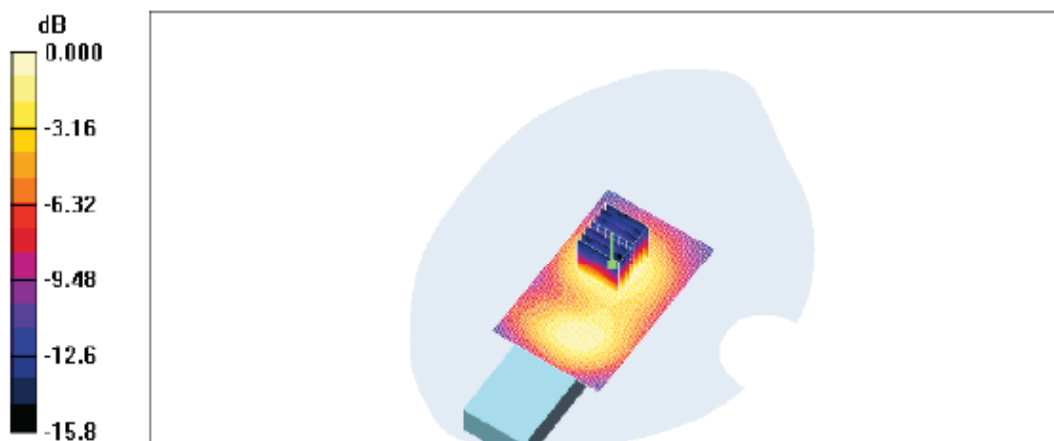
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 5.69 V/m; Power Drift = -0.085 dB

Peak SAR (extrapolated) = 0.105 W/kg

SAR(1 g) = 0.058 mW/g

Maximum value of SAR (measured) = 0.064 mW/g



0 dB = 0.064mW/g

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Date: 2013-03-20

Test Laboratory: ESTECH

BODY REAR 802.11G CH6

DUT: SMT-W5120; Type: BAR TYPE; Serial: XXXX

Communication System: Wireless; Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.91$ mho/m; $\epsilon_r = 52$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ES3DV3 - SN3123; ConvF(4.25, 4.25, 4.25); Calibrated: 2013-01-22
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn551; Calibrated: 2013-02-14
- Phantom: HSL1900_12_03_23; Type: TP-1263
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Area Scan (51x81x1): Measurement grid: $dx=15$ mm, $dy=15$ mm

Maximum value of SAR (interpolated) = 0.038 mW/g

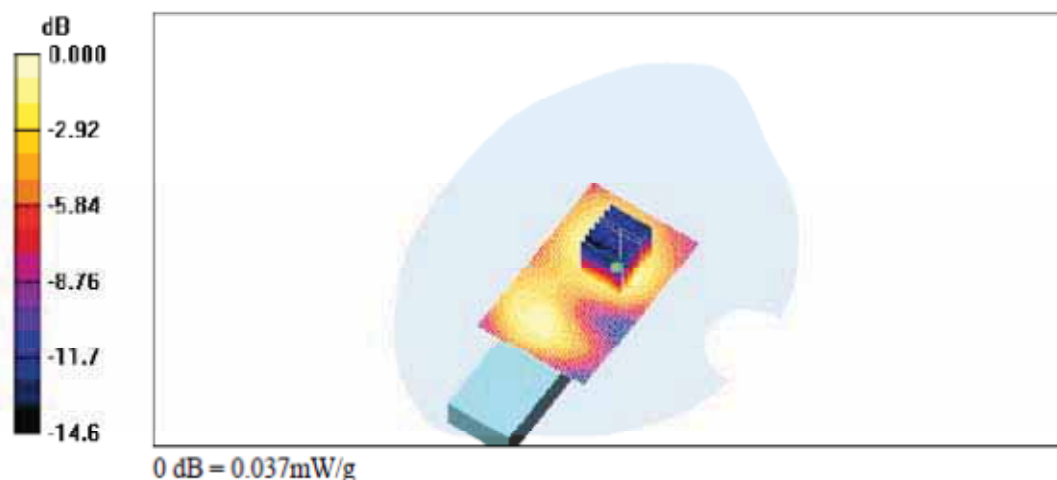
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 3.85 V/m; Power Drift = 0.204 dB

Peak SAR (extrapolated) = 0.068 W/kg

SAR(1 g) = 0.034 mW/g

Maximum value of SAR (measured) = 0.037 mW/g





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APPENDIX D : Calibration Certificates



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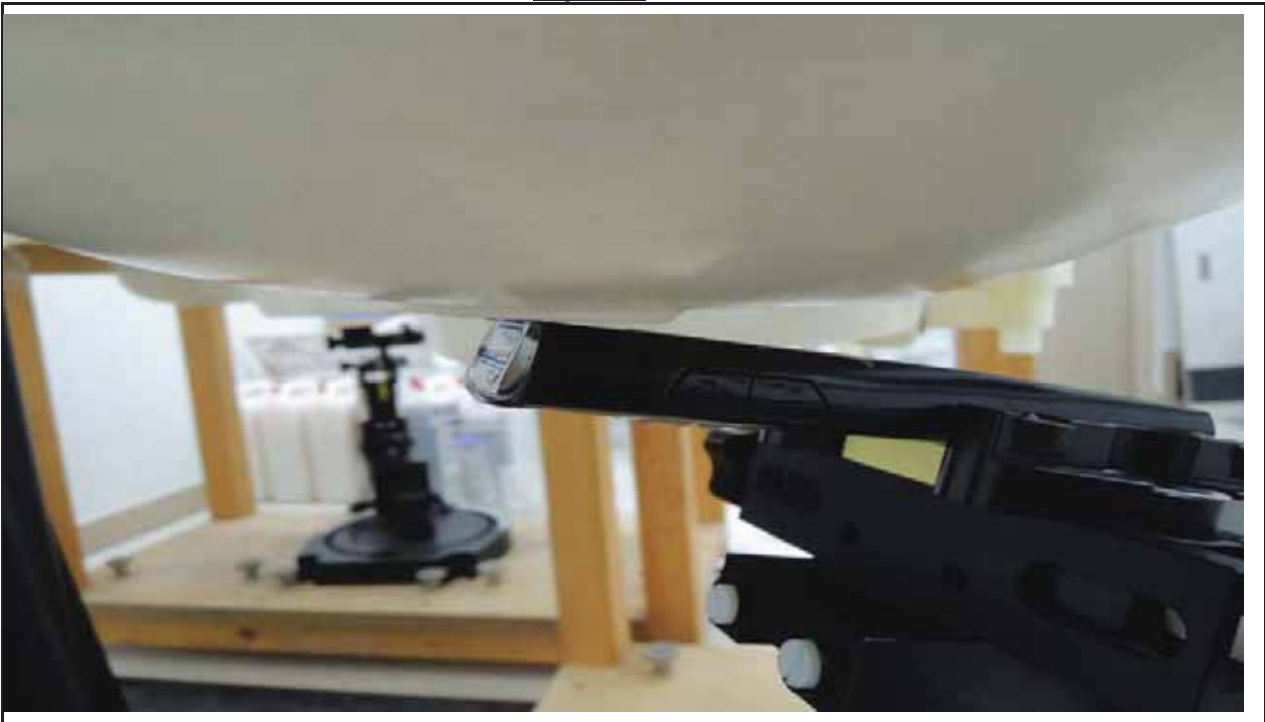
FAX: 82-2-867-3204

APPENDIX E : Test Setup Photo

Right Cheek



Right tilt





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FAX: 82-2-867-3204

Left Cheek



Left Tilt



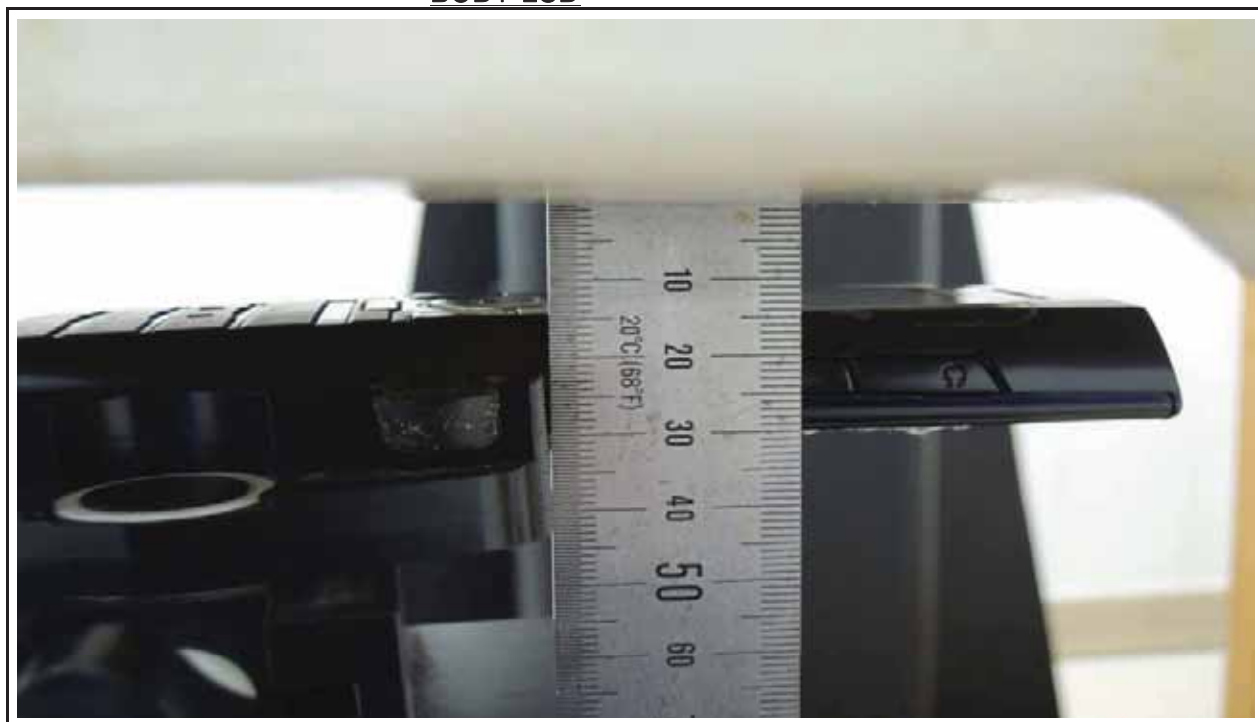


ESTECH Co., Ltd.

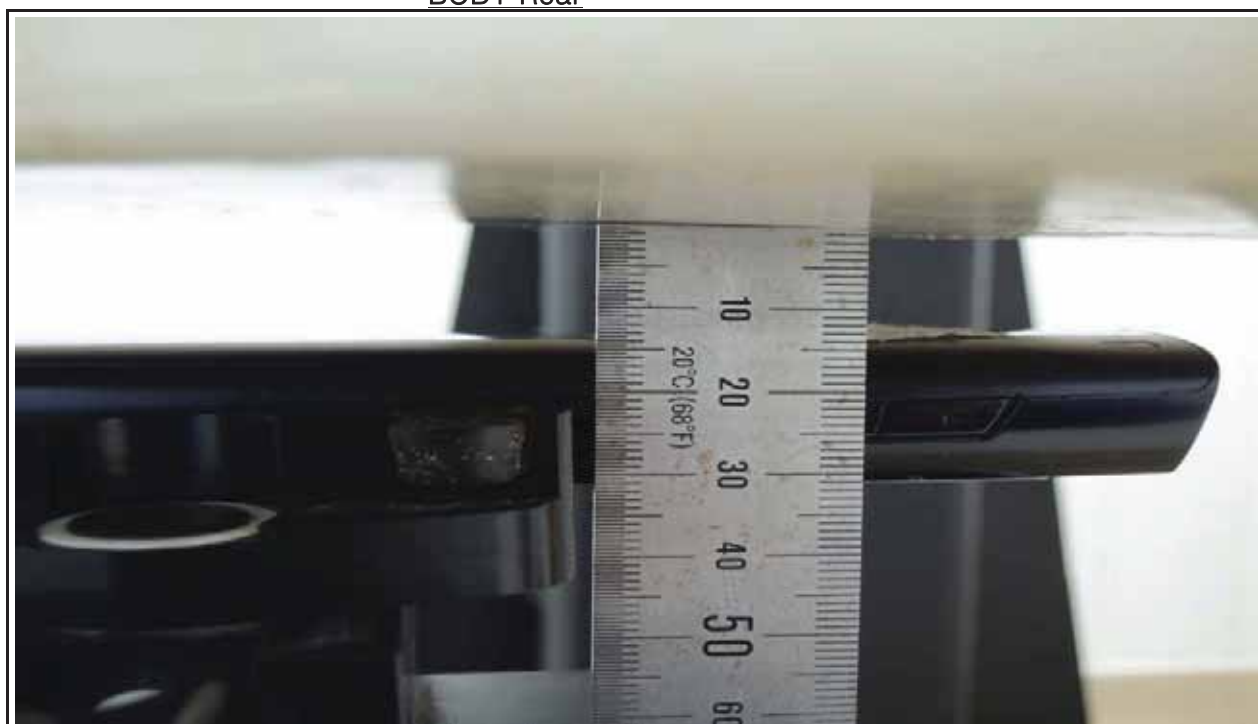
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BODY LCD



BODY Rear





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APPENDIX F : EUT Photo





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 **Estech (Dymstec)**

Certificate No: **ES3-3123_Jan13**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3123**

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

Calibration date: **January 22, 2013**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	29-Mar-12 (No. 217-01508)	Apr-13
Power sensor E4412A	MY41498087	29-Mar-12 (No. 217-01508)	Apr-13
Reference 3 dB Attenuator	SN: S5054 (3c)	27-Mar-12 (No. 217-01531)	Apr-13
Reference 20 dB Attenuator	SN: S5086 (20b)	27-Mar-12 (No. 217-01529)	Apr-13
Reference 30 dB Attenuator	SN: S5129 (30b)	27-Mar-12 (No. 217-01532)	Apr-13
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	20-Jun-12 (No. DAE4-660_Jun12)	Jun-13
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
			Issued: January 28, 2013
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Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

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

Probe ES3DV3

SN:3123

Manufactured: July 11, 2006
Calibrated: January 22, 2013

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3123

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.36	1.31	1.11	$\pm 10.1 \%$
DCP (mV) ^B	101.3	101.8	102.5	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	167.0	$\pm 3.0 \%$
		Y	0.0	0.0	1.0		165.1	
		Z	0.0	0.0	1.0		151.8	

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 E^2 -field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3123

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
835	41.5	0.90	6.28	6.28	6.28	0.39	1.66	± 12.0 %
900	41.5	0.97	6.22	6.22	6.22	0.39	1.59	± 12.0 %
1810	40.0	1.40	5.03	5.03	5.03	0.65	1.35	± 12.0 %
1900	40.0	1.40	5.10	5.10	5.10	0.79	1.26	± 12.0 %
2450	39.2	1.80	4.49	4.49	4.49	0.76	1.28	± 12.0 %

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

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3123

Calibration Parameter Determined in Body Tissue Simulating Media

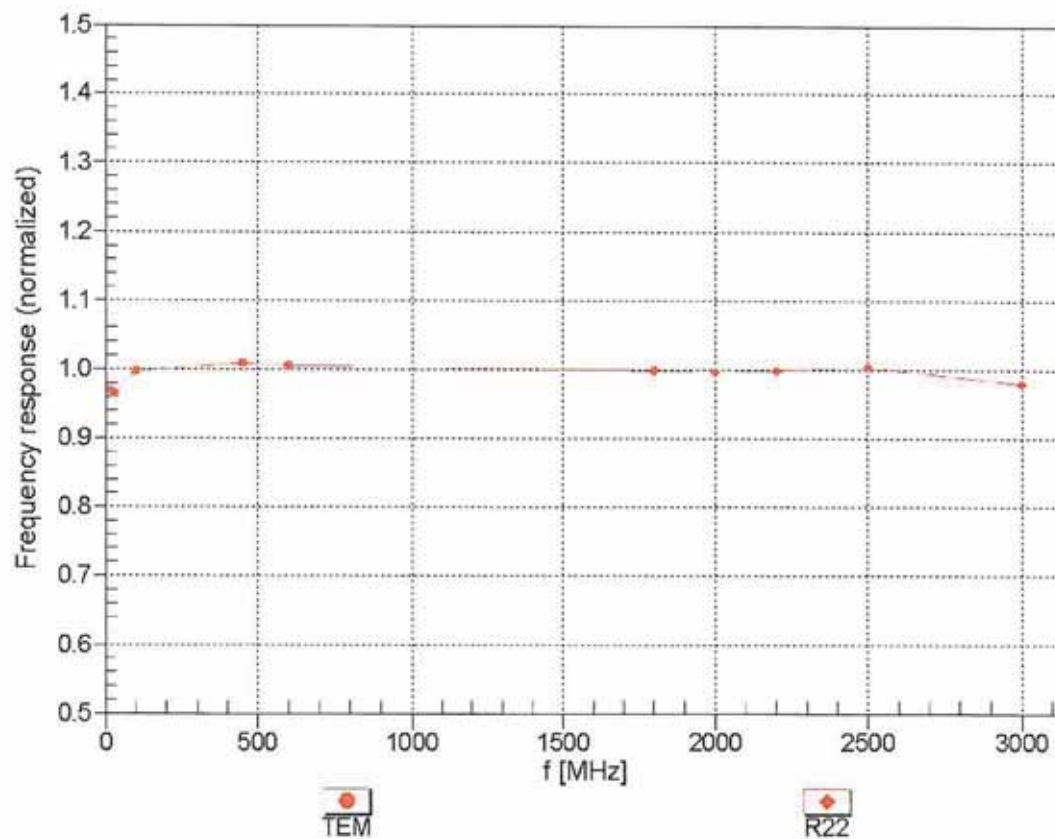
f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
835	55.2	0.97	6.05	6.05	6.05	0.41	1.64	± 12.0 %
900	55.0	1.05	6.05	6.05	6.05	0.80	1.18	± 12.0 %
1810	53.3	1.52	4.87	4.87	4.87	0.55	1.54	± 12.0 %
1900	53.3	1.52	4.68	4.68	4.68	0.62	1.41	± 12.0 %
2450	52.7	1.95	4.25	4.25	4.25	0.66	1.15	± 12.0 %

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

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

Frequency Response of E-Field

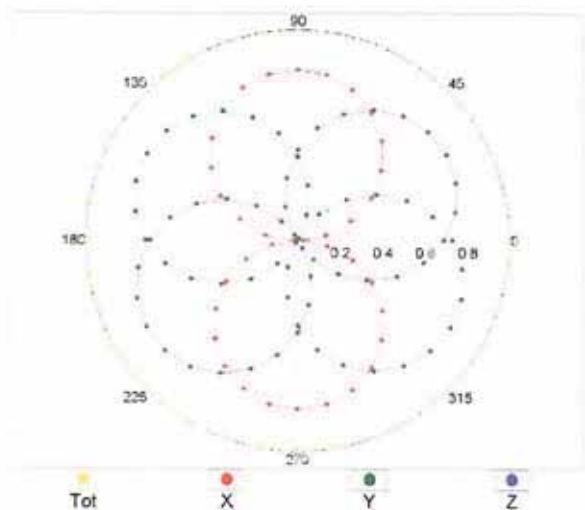
(TEM-Cell:ifi110 EXX, Waveguide: R22)



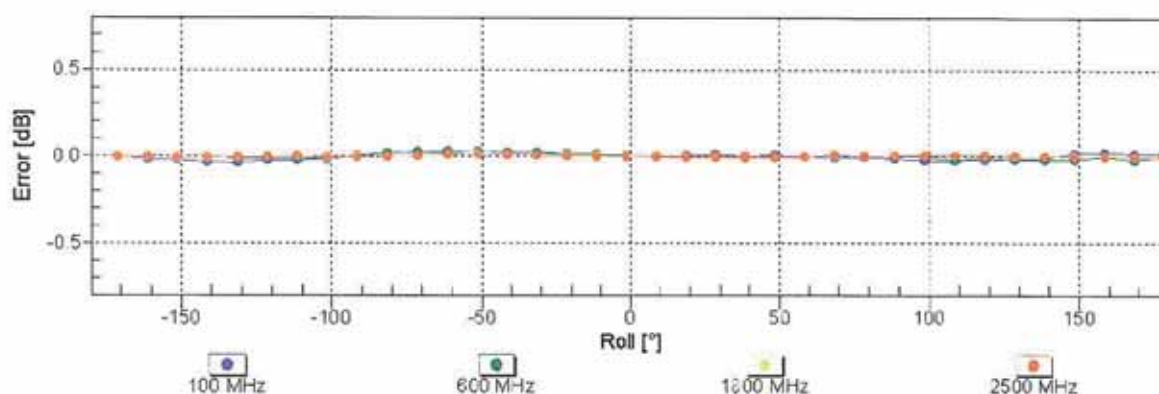
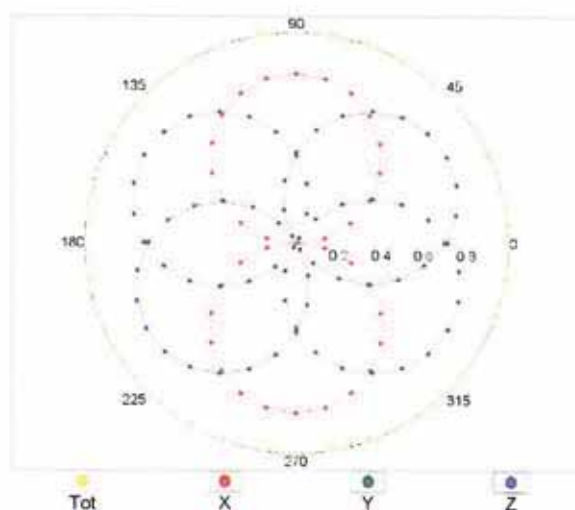
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

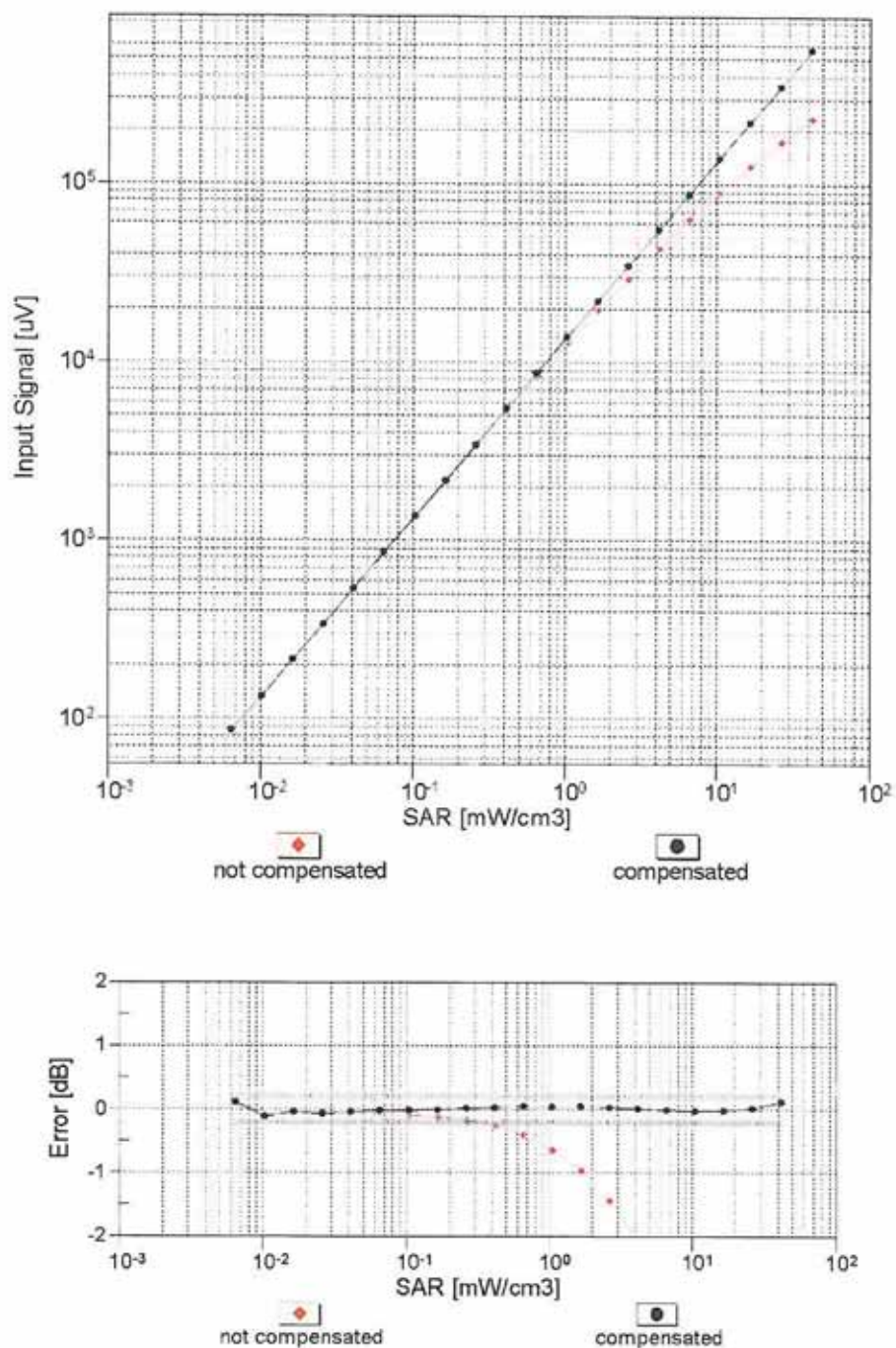


f=1800 MHz,R22



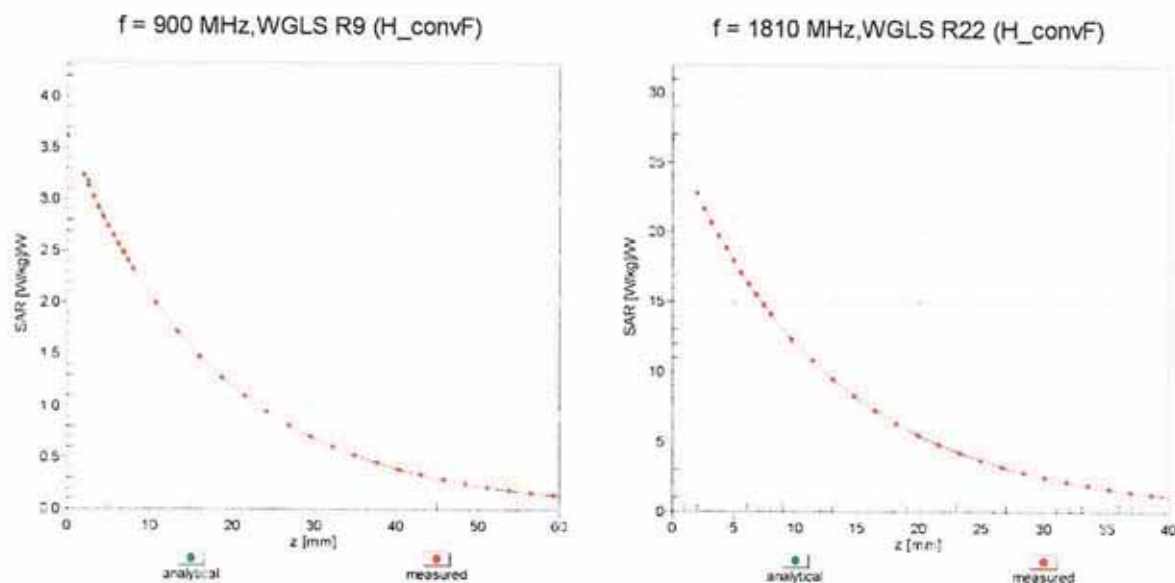
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

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



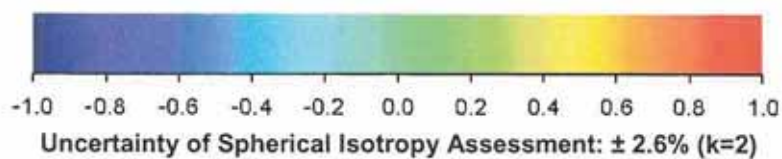
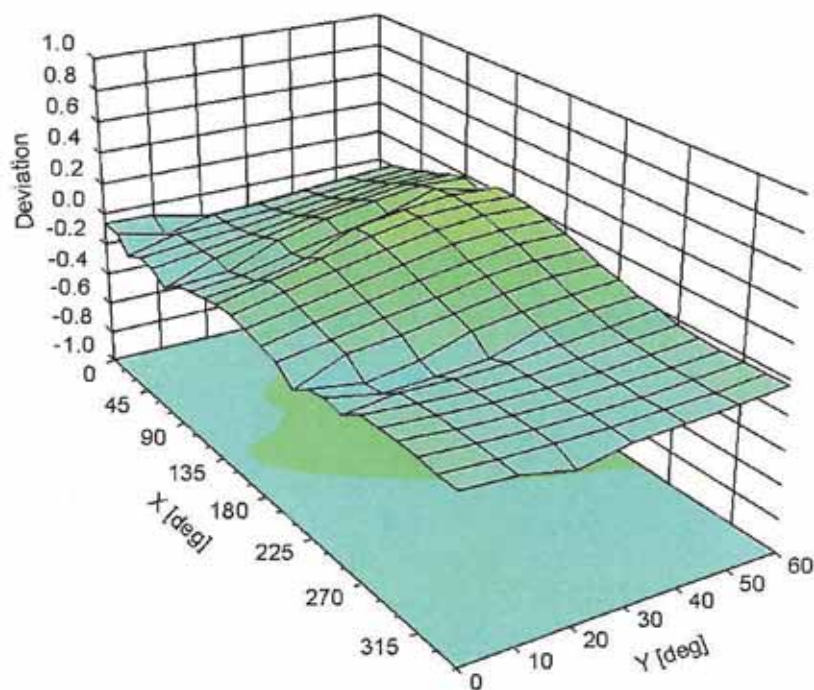
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ , θ), $f = 900 \text{ MHz}$



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3123

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	68.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

IMPORTANT NOTICE

USAGE OF THE DAE 4

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

Battery Exchange: The battery cover of the DAE4 unit is closed using a screw, over tightening the screw may cause the threads inside the DAE to wear out.

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

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

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

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

Important Note:

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

Important Note:

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

Important Note:

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Estech (Dymstec)**

Certificate No: **DAE4-551_Feb13**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BJ - SN: 551**

Calibration procedure(s) **QA CAL-06.v25**
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **February 14, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	02-Oct-12 (No:12728)	Oct-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-13 (in house check)	In house check: Jan-14
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-13 (in house check)	In house check: Jan-14

Calibrated by:	Name	Function	Signature
	R Mayoraz	Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	

Issued: February 14, 2013

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Accreditation No.: **SCS 108**

Glossary

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

Methods Applied and Interpretation of Parameters

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

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 μ V , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.....+3mV

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

Calibration Factors	X	Y	Z
High Range	404.021 $\pm$ 0.02% (k=2)	404.284 $\pm$ 0.02% (k=2)	403.991 $\pm$ 0.02% (k=2)
Low Range	3.95719 $\pm$ 1.55% (k=2)	3.94883 $\pm$ 1.55% (k=2)	3.90758 $\pm$ 1.55% (k=2)

Connector Angle

Connector Angle to be used in DASY system	137.5 ° $\pm$ 1 °
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Appendix

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199995.03	0.68	0.00
Channel X	+ Input	20003.46	3.81	0.02
Channel X	- Input	-19993.89	7.62	-0.04
Channel Y	+ Input	199995.26	1.03	0.00
Channel Y	+ Input	19999.50	-0.19	-0.00
Channel Y	- Input	-20001.69	-0.03	0.00
Channel Z	+ Input	199995.48	1.06	0.00
Channel Z	+ Input	19994.99	-4.51	-0.02
Channel Z	- Input	-20007.17	-5.44	0.03

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2000.13	0.32	0.02
Channel X	+ Input	200.34	0.06	0.03
Channel X	- Input	-199.63	-0.10	0.05
Channel Y	+ Input	1999.83	0.03	0.00
Channel Y	+ Input	200.30	-0.11	-0.05
Channel Y	- Input	-199.88	-0.29	0.14
Channel Z	+ Input	1999.54	-0.25	-0.01
Channel Z	+ Input	199.69	-0.70	-0.35
Channel Z	- Input	-200.54	-0.91	0.45

2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	4.88	2.41
	- 200	-1.80	-3.59
Channel Y	200	-0.61	-0.98
	- 200	0.36	0.00
Channel Z	200	9.72	9.54
	- 200	-11.58	-11.39

3. Channel separation

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

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	7.08	1.22
Channel Y	200	7.86	-	7.34
Channel Z	200	5.84	5.91	-

4. AD-Converter Values with inputs shorted

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

	High Range (LSB)	Low Range (LSB)
Channel X	15946	15716
Channel Y	16705	16671
Channel Z	16581	16195

5. Input Offset Measurement

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

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	1.12	0.51	2.35	0.36
Channel Y	0.34	-0.59	1.30	0.36
Channel Z	-0.03	-1.04	1.36	0.39

6. Input Offset Current

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

7. Input Resistance (Typical values for information)

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

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

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

9. Power Consumption (Typical values for information)

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



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Accreditation No.: SCS 108

Client **Estech (Dymstec)**

Certificate No: **D2450V2-741_Feb12**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 741**

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

Calibration date: **February 23, 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: 5086 (20g)	29-Mar-11 (No. 217-01368)	Apr-12
Type-N mismatch combination	SN: 5047.2 / 06327	29-Mar-11 (No. 217-01371)	Apr-12
Reference Probe ES3DV3	SN: 3205	30-Dec-11 (No. ES3-3205_Dec11)	Dec-12
DAE4	SN: 601	04-Jul-11 (No. DAE4-601_Jul11)	Jul-12
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

Calibrated by: **Israe El-Naouq** **Laboratory Technician**

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

Signature

Israe El-Naouq
Katja Pokovic

Issued: February 23, 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:

- 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.

Measurement Conditions

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

DASY Version	DASY5	V52.8.0
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	38.9 $\pm$ 6 %	1.86 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	13.5 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	53.1 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	6.24 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	24.7 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	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	52.3 $\pm$ 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	12.8 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	50.3 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	5.99 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	23.7 mW / g $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$54.4 \Omega + 5.1 j\Omega$
Return Loss	- 23.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$50.3 \Omega + 5.8 j\Omega$
Return Loss	- 24.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.158 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	December 01, 2003

DASY5 Validation Report for Head TSL

Date: 23.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 741

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.86$ mho/m; $\epsilon_r = 38.9$; $\rho = 1000$ 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: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

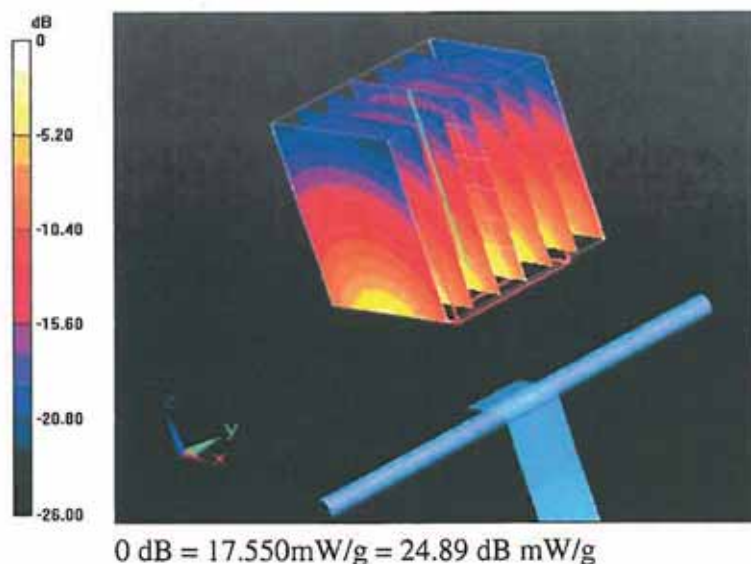
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 100.6 V/m; Power Drift = 0.0038 dB

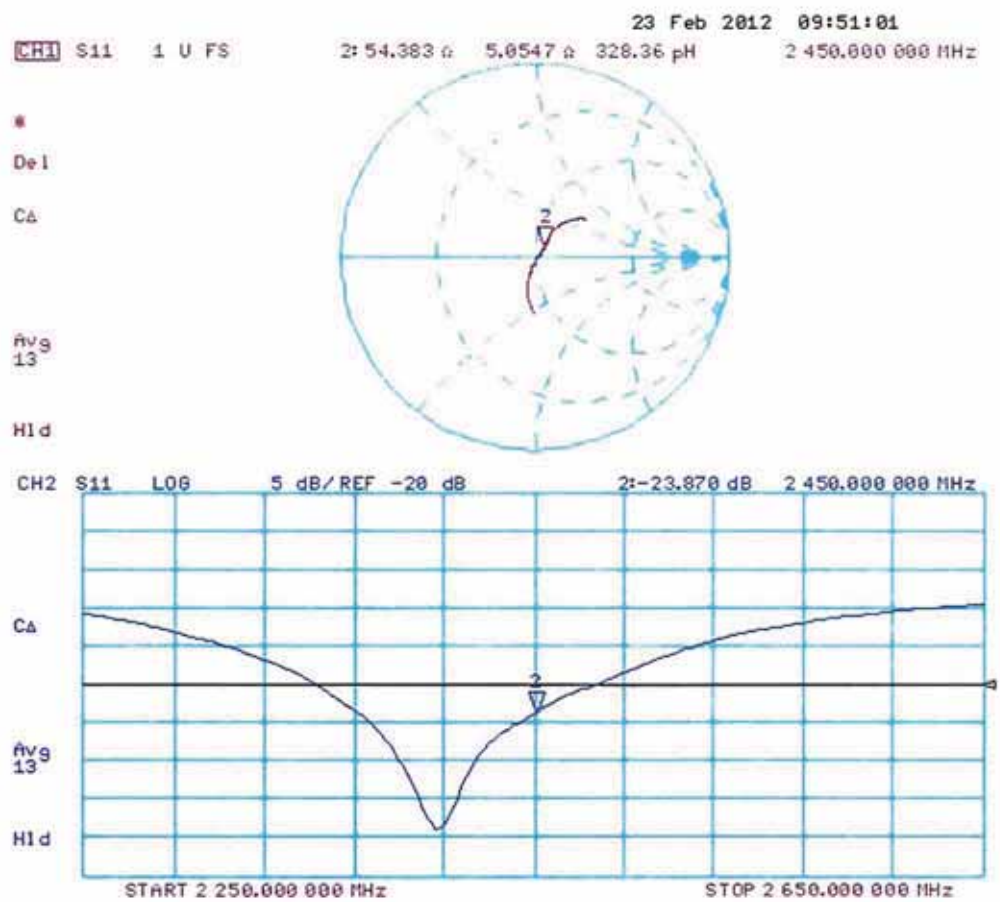
Peak SAR (extrapolated) = 27.9690

SAR(1 g) = 13.5 mW/g; SAR(10 g) = 6.24 mW/g

Maximum value of SAR (measured) = 17.554 mW/g



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 23.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 741

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.02$ mho/m; $\epsilon_r = 52.3$; $\rho = 1000$ 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: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

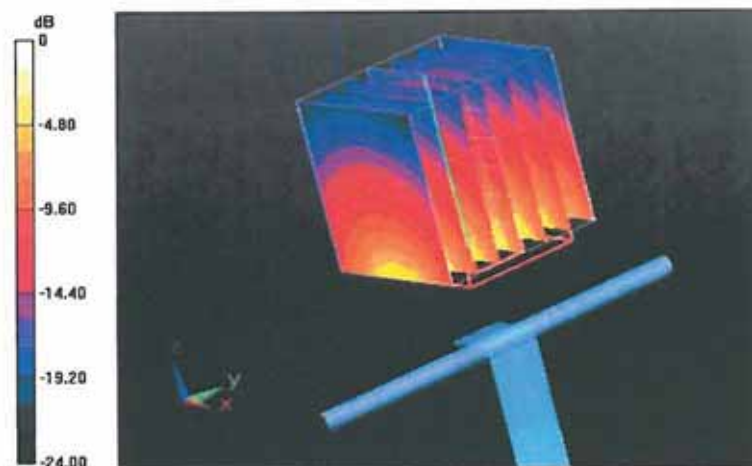
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.705 V/m; Power Drift = 0.006 dB

Peak SAR (extrapolated) = 26.2510

SAR(1 g) = 12.8 mW/g; SAR(10 g) = 5.99 mW/g

Maximum value of SAR (measured) = 16.879 mW/g



0 dB = 16.880mW/g = 24.55 dB mW/g

Impedance Measurement Plot for Body TSL

