FCC SAR Test Report

APPLICANT	:	**Gluteen LLC**
EQUIPMENT	:	**Electronic Display Device**
MODEL NAME	:	**EY21**
FCC ID	:	**A8Y-1496**
STANDARD	:	**FCC 47 CFR Part 2 (2.1093)**
		IEEE C95.1-1991
		IEEE 1528-2003
		FCC OET Bulletin 65 Supplement C (Edition 01-01)

The product was received on Feb. 10, 2012 and completely tested on Feb. 21, 2012. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the procedures and shown the compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC., the test report shall not be reproduced except in full.

Reviewed by:

Jones Tsai

Jones Tsai / Manager

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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA1O0313-02	Rev. 01	Initial issue of report	Apr. 16, 2012
FA1O0313-02	Rev. 02	1. Revise the typo of WLAN channel number/frequency at page 29. 2. Add data rate versus power table at page 29	May. 17, 2012

1. *Statement of Compliance*

The maximum results of Specific Absorption Rate (SAR) found during testing for **Gluteen LLC Electronic Display Device EY21** are as follows.

Band	Position	SAR$_{1g}$ (W/kg)
802.11 b/g/n	**Bottom Face (0 cm Gap) for Ant. A**	**1.21**
	Bottom Face (0 cm Gap) for Ant. B	**1.18**

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1991, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2003 and FCC OET Bulletin 65 Supplement C (Edition 01-01).

2. <u>*Administration Data*</u>

2.1 <u>*Testing Laboratory*</u>

Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C. TEL: +886-3-327-3456 FAX: +886-3-328-4978

2.2 <u>*Applicant*</u>

Company Name	Gluteen LLC
Address	801 Adlai Stevenson Drive Springfield, IL 62703

2.3 <u>*Application Details*</u>

Date of Receipt of Application	Feb. 10, 2012
Date of Start during the Test	Feb. 10, 2012
Date of End during the Test	Feb. 21, 2012

3. *General Information*

3.1 *Description of Device Under Test (DUT)*

Product Feature & Specification	
DUT Type	Electronic Display Device
Model Name	EY21
FCC ID	A8Y-1496
Tx Frequency	2412 MHz ~ 2462 MHz
Rx Frequency	2412 MHz ~ 2462 MHz
Maximum Average Output Power to Antenna	802.11b: 14.42 dBm 802.11g: 14.24 dBm 802.11n (2.4GHz): 14.14 dBm (BW 20MHz)
Antenna Type	Fixed Internal Antenna
Type of Modulation	802.11b: DSSS (BPSK / QPSK / CCK) 802.11g/n: OFDM (BPSK / QPSK / 16QAM / 64QAM)
DUT Stage	Production Unit
Remark: The above DUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.	

3.2 *Product Photos*

Please refer to Appendix D

3.3 *Applied Standards*

The Specific Absorption Rate (SAR) testing specification, method and procedure for this device is in accordance with the following standards:

- FCC 47 CFR Part 2 (2.1093)
- IEEE C95.1-1991
- IEEE 1528-2003
- FCC OET Bulletin 65 Supplement C (Edition 01-01)
- FCC KDB 447498 D01 v04
- FCC KDB 616217 D03 v01
- FCC KDB 248227 D01 v01r02

3.4 *Device Category and SAR Limits*

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.

3.5 *Test Conditions*

3.5.1 Ambient Condition

Ambient Temperature	20 to 24 ℃
Humidity	< 60 %

3.5.2 Test Configuration

For WLAN SAR testing, WLAN engineering testing software installed on the DUT can provide continuous transmitting RF signal. This RF signal utilized in SAR measurement has almost 100% duty cycle and its crest factor is 1.

4. *Specific Absorption Rate (SAR)*

4.1 *Introduction*

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

4.2 *SAR Definition*

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

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

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

SAR measurement can be either related to the temperature elevation in tissue by

$$\mathbf{SAR} = \mathbf{C}\left(\frac{\boldsymbol{\delta}\mathbf{T}}{\boldsymbol{\delta}\mathbf{t}}\right)$$

Where: C is the specific heat capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

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

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.
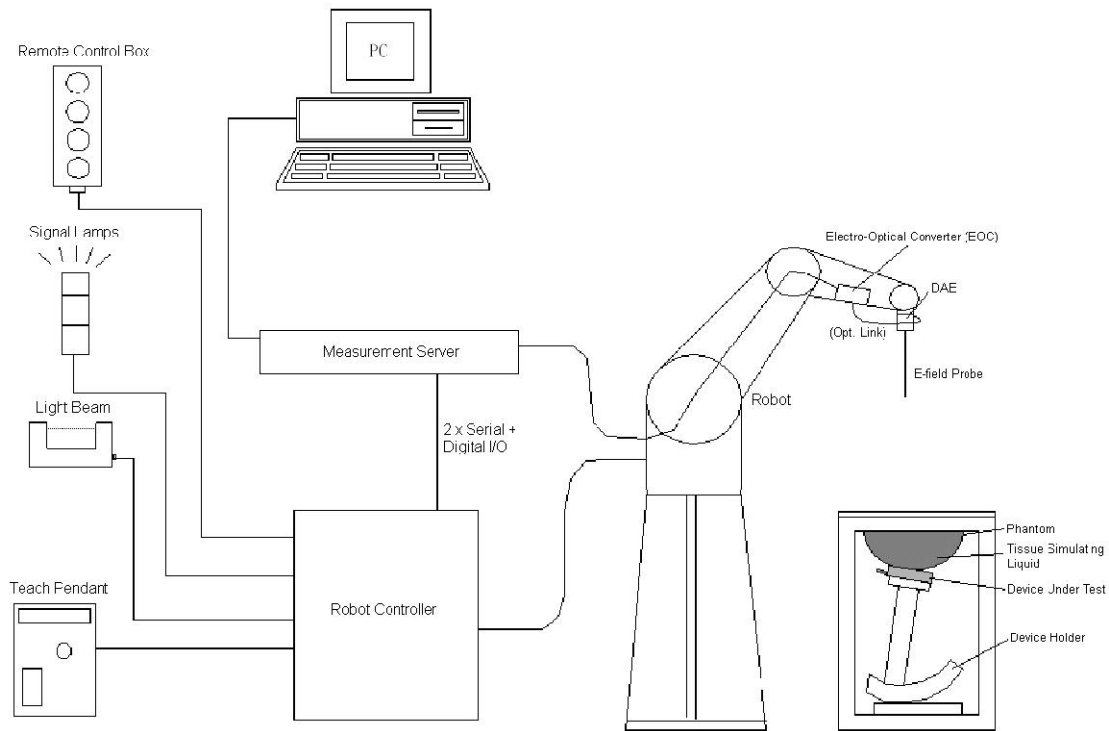
5. *SAR Measurement System*

Fig 5.1 SPEAG DASY System Configurations

The DASY system for performance compliance tests is illustrated above graphically. This system consists of the following items:

➢ A standard high precision 6-axis robot with controller, a teach pendant and software
➢ A data acquisition electronic (DAE) attached to the robot arm extension
➢ A dosimetric probe equipped with an optical surface detector system
➢ The electro-optical converter (ECO) performs the conversion between optical and electrical signals
➢ A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
➢ A probe alignment unit which improves the accuracy of the probe positioning
➢ A computer operating Windows XP
➢ DASY software
➢ Remove control with teach pendant and additional circuitry for robot safety such as warming lamps, etc.
➢ The SAM twin phantom
➢ A device holder
➢ Tissue simulating liquid
➢ Dipole for evaluating the proper functioning of the system

Some of the components are described in details in the following sub-sections.

5.1 E-Field Probe

The SAR measurement is conducted with the dosimetric probe (manufactured by SPEAG).The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. This probe has a built in optical surface detection system to prevent from collision with phantom.

5.1.1 E-Field Probe Specification

<ET3DV6 Probe >

Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection system. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz to 3 GHz; Linearity: ± 0.2 dB	
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.4 dB in HSL (rotation normal to probe axis)	
Dynamic Range	5 µW/g to 100 mW/g; Linearity: ± 0.2 dB	
Dimensions	Overall length: 330 mm (Tip: 16 mm) Tip diameter: 6.8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.7 mm	**Fig 5.2 Photo of ET3DV6**

<EX3DV4 Probe>

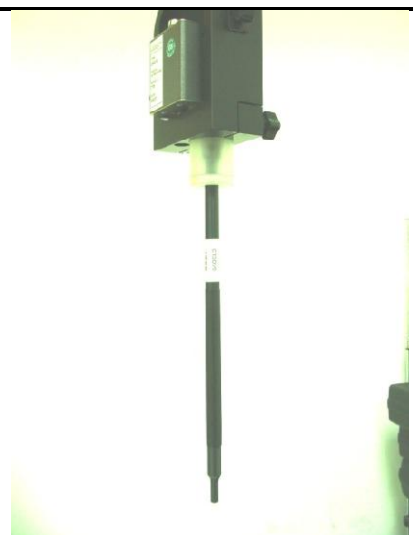|		
Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz to 6 GHz; Linearity: ± 0.2 dB	
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 µW/g to 100 mW/g; Linearity: ± 0.2 dB (noise: typically < 1 µW/g)	
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	**Fig 5.3 Photo of EX3DV4**

5.1.2 E-Field Probe Calibration

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than ± 10%. The spherical isotropy shall be evaluated and within ± 0.25 dB. The sensitivity parameters (NormX, NormY, and NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested. The calibration data can be referred to appendix C of this report.

5.2 *Data Acquisition Electronics (DAE)*

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

Fig 5.4   Photo of DAE

5.3 *Robot*

The SPEAG DASY system uses the high precision robots (DASY4: RX90BL; DASY5: TX90XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY4: CS7MB; DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

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

Fig 5.1   Photo of DASY4

Fig 5.2   Photo of DASY5

5.4 *Measurement Server*

The measurement server is based on a PC/104 CPU board with CPU (DASY4: 166 MHz, Intel Pentium; DASY5: 400 MHz, Intel Celeron), chipdisk (DASY4: 32 MB; DASY5: 128 MB), RAM (DASY4: 64 MB, DASY5: 128 MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all the real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operations.

Fig 5.1   Photo of Server for DASY4

Fig 5.2   Photo of Server for DASY5

5.5 *Phantom*

<SAM Twin Phantom>

Shell Thickness	2 ± 0.2 mm; Center ear point: 6 ± 0.2 mm	
Filling Volume	Approx. 25 liters	
Dimensions	Length: 1000 mm; Width: 500 mm; Height: adjustable feet	
Measurement Areas	Left Hand, Right Hand, Flat Phantom	 **Fig 5.3 Photo of SAM Phantom**
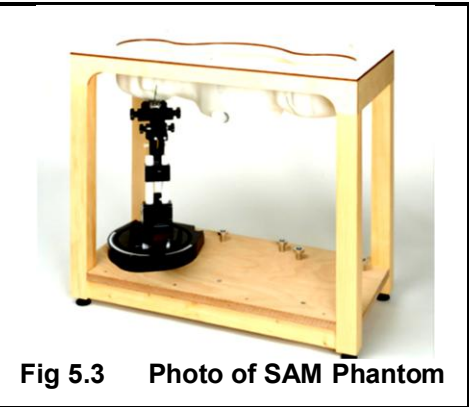
The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

<ELI4 Phantom>

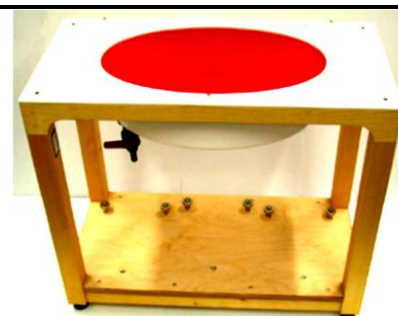|	
Shell Thickness	2 ± 0.2 mm (sagging: <1%)
Filling Volume	Approx. 30 liters
Dimensions	Major ellipse axis: 600 mm Minor axis: 400 mm

Fig 5.4   Photo of ELI4 Phantom

The ELI4 phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with standard and all known tissue simulating liquids.

5.6 *Device Holder*

<Device Holder for SAM Twin Phantom>

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5 mm distance, a positioning uncertainty of ± 0.5 mm would produce a SAR uncertainty of ± 20 %. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

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

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity ε = 3 and loss tangent δ = 0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

Fig 5.5   Device Holder

<Laptop Extension Kit>

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the mounting device in place of the phone positioned. The extension is fully compatible with the SAM Twin and ELI phantoms.
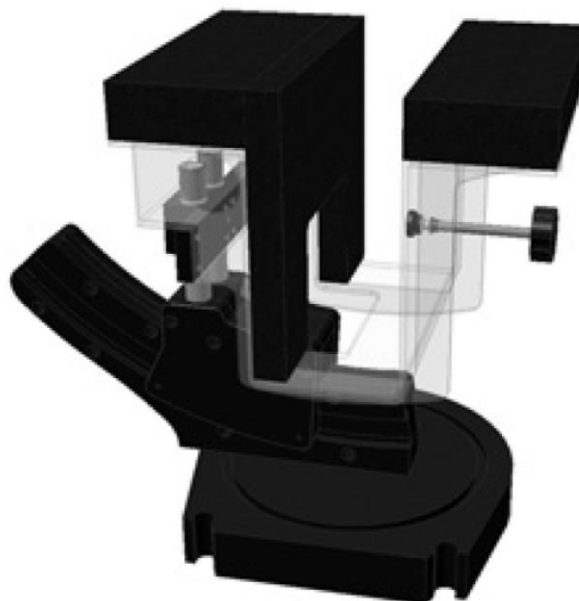

Fig 5.6   Laptop Extension Kit

5.7 *Data Storage and Evaluation*

5.7.1 Data Storage

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files. The post-processing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type (e.g., [V/m], [A/m], [mW/g]). Some of these units are not available in certain situations or give meaningless results, e.g., a SAR-output in a non-lose media, will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

5.7.2 Data Evaluation

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

Probe parameters：	- Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion factor	$ConvF_i$
	- Diode compression point	dcp_i
Device parameters：	- Frequency	f
	- Crest factor	cf
Media parameters：	- Conductivity	σ
	- Density	ρ

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

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power.

The formula for each channel can be given as：

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

with V_i = compensated signal of channel i, (i = x, y, z)
   U_i = input signal of channel i, (i = x, y, z)
   cf = crest factor of exciting field (DASY parameter)
   dcp_i = diode compression point (DASY parameter)

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

$$\text{E-field Probes：} E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$\text{H-field Probes：} H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

with V_i = compensated signal of channel i, (i = x, y, z)
   $Norm_i$ = sensor sensitivity of channel i, (i = x, y, z), $\mu V/(V/m)^2$ for E-field Probes
   ConvF = sensitivity enhancement in solution
   a_{ij} = sensor sensitivity factors for H-field probes
   f = carrier frequency [GHz]
   E_i = electric field strength of channel i in V/m
   H_i = magnetic field strength of channel i in A/m

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

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

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

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with SAR = local specific absorption rate in mW/g
   E_{tot} = total field strength in V/m
   σ = conductivity in [mho/m] or [Siemens/m]
   ρ = equivalent tissue density in g/cm^3

Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.

5.8 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Dosimetric E-Field Probe	ET3DV6	1787	May. 20, 2011	May. 19, 2012
SPEAG	Dosimetric E-Field Probe	ET3DV6	1788	Jan. 26, 2012	Jan. 25, 2013
SPEAG	Dosimetric E-Field Probe	EX3DV4	3792	Jun. 20, 2011	Jun. 19, 2012
SPEAG	2450MHz System Validation Kit	D2450V2	736	Jul. 25, 2011	Jul. 24, 2014
SPEAG	Data Acquisition Electronics	DAE3	577	Jun. 20, 2011	Jun. 19, 2012
SPEAG	Data Acquisition Electronics	DAE3	495	Apr. 28, 2011	Apr. 27, 2012
SPEAG	Device Holder	N/A	N/A	NCR	NCR
SPEAG	SAM Phantom	QD 000 P40 C	TP-1303	NCR	NCR
SPEAG	SAM Phantom	QD 000 P40 C	TP-1383	NCR	NCR
SPEAG	SAM Phantom	QD 000 P40 C	TP-1446	NCR	NCR
SPEAG	SAM Phantom	QD 000 P40 C	TP-1478	NCR	NCR
SPEAG	SAM Phantom	QD 000 P41 C	TP-1150	NCR	NCR
SPEAG	SAM Phantom	QD 000 P40 CD	TP-1644	NCR	NCR
SPEAG	SAM Phantom	SM 000 T01 DA	TP-1542	NCR	NCR
SPEAG	ELI4 Phantom	QD 0VA 001 BB	1026	NCR	NCR
SPEAG	ELI4 Phantom	QD 0VA 001 BA	1029	NCR	NCR
SPEAG	ELI4 Phantom	QD 0VA 002 AA	TP-1127	NCR	NCR
SPEAG	ELI4 Phantom	QD 0VA 002 AA	TP-1131	NCR	NCR
Agilent	ENA Series Network Analyzer	E5071C	MY46100746	Jun. 10, 2011	Jun. 09, 2012
Agilent	Mobile Wimax Test Set	E6651A	MY47310158	Oct. 07, 2011	Oct. 06, 2012
Agilent	ESG Vector Series Signal Generator	E4438C	MY49070755	Oct. 17, 2011	Oct. 16, 2012
Anritsu	Power Meter	ML2495A	932001	Sep. 21, 2011	Sep. 20, 2012
Anritsu	Radio Communication Analyzer	MT8820C	6201074414	Dec. 21, 2011	Dec. 20, 2012
Agilent	Wireless Communication Test Set	E5515C	MY48360820	Jan. 05, 2012	Jan. 04, 2014
Agilent	Wireless Communication Test Set	E5515C	GB46311322	Mar. 23, 2011	Mar. 22, 2013
Agilent	Wireless Communication Test Set	E5515C	MY50264370	Apr. 19, 2011	Apr. 18, 2013
Agilent	Wireless Communication Test Set	E5515C	US40260131	May. 17, 2011	May. 16, 2012
Agilent	Wireless Communication Test Set	E5515C	MY50266977	Nov. 13, 2011	Nov. 12, 2013
R&S	Universal Digital Radio communication Tester	CMU200	117995	Jul. 28, 2011	Jul. 27, 2012

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
Agilent	Dielectric Probe Kit	85070D	US01440205	NCR	NCR
Agilent	Dual Directional Coupler	778D	50422	NCR	NCR
AR	Power Amplifier	5S1G4M2	0328767	NCR	NCR
	Attentuator			NCR	NCR
R&S	Spectrum Analyzer	FSP7	101131	Jul. 29, 2011	Jul. 28, 2012
R&S	Spectrum Analyzer	FSP30	101329	May. 03, 2011	May. 02, 2012

Table 5.1 Test Equipment List

Note: The calibration certificate of DASY can be referred to appendix C of this report.

6. _Tissue Simulating Liquids_

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 6.1. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 6.2.
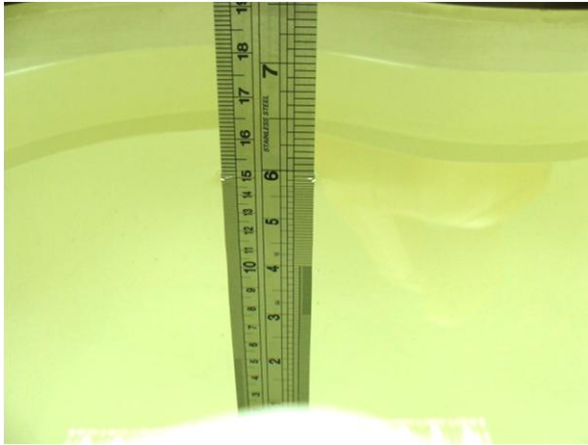
Fig 6.1 Photo of Liquid Height for Head SAR **Fig 6.2 Photo of Liquid Height for Body SAR**

The following table gives the recipes for tissue simulating liquid.

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (ε_r)
For Body								
2450	68.6	0	0	0	0	31.4	1.95	52.7

Table 6.1 Recipes of Tissue Simulating Liquid

The dielectric parameters of the liquids were verified prior to the SAR evaluation using an Agilent 85070D Dielectric Probe Kit and an Agilent Network Analyzer.

The following table shows the measuring results for simulating liquid.

Freq. (MHz)	Liquid Type	Temp. (℃)	Conductivity (σ)	Permittivity (εr)	Conductivity Target (σ)	Permittivity Target (εr)	Delta (σ) (%)	Delta (εr) (%)	Limit (%)	Date
2450	Body	21.5	1.965	52.764	1.95	52.7	0.77	0.12	±5	Feb. 10, 2012
2450	Body	21.5	1.96	52.9	1.95	52.7	0.51	0.38	±5	Feb. 11, 2012
2450	Body	21.5	1.965	53.842	1.95	52.7	0.77	2.17	±5	Feb. 21, 2012

Table 6.2 Measuring Results for Simulating Liquid

7. *Uncertainty Assessment*

The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type An evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience and knowledge of the behavior and properties of relevant materials and instruments, manufacture's specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in Table 7.1

Uncertainty Distributions	Normal	Rectangular	Triangular	U-Shape
Multi-plying Factor[a]	$1/k$[b]	$1/\sqrt{3}$	$1/\sqrt{6}$	$1/\sqrt{2}$

(a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity
(b) κ is the coverage factor

Table 7.1 Standard Uncertainty for Assumed Distribution

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual "root-sum-squares" (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is showed in Table 7.2.

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (1g)	Standard Uncertainty (1g)
Measurement System					
Probe Calibration	6.0	Normal	1	1	± 6.0 %
Axial Isotropy	4.7	Rectangular	√3	0.7	± 1.9 %
Hemispherical Isotropy	9.6	Rectangular	√3	0.7	± 3.9 %
Boundary Effects	1.0	Rectangular	√3	1	± 0.6 %
Linearity	4.7	Rectangular	√3	1	± 2.7 %
System Detection Limits	1.0	Rectangular	√3	1	± 0.6 %
Readout Electronics	0.3	Normal	1	1	± 0.3 %
Response Time	0.8	Rectangular	√3	1	± 0.5 %
Integration Time	2.6	Rectangular	√3	1	± 1.5 %
RF Ambient Noise	3.0	Rectangular	√3	1	± 1.7 %
RF Ambient Reflections	3.0	Rectangular	√3	1	± 1.7 %
Probe Positioner	0.4	Rectangular	√3	1	± 0.2 %
Probe Positioning	2.9	Rectangular	√3	1	± 1.7 %
Max. SAR Eval.	1.0	Rectangular	√3	1	± 0.6 %
Test Sample Related					
Device Positioning	2.9	Normal	1	1	± 2.9 %
Device Holder	3.6	Normal	1	1	± 3.6 %
Power Drift	5.0	Rectangular	√3	1	± 2.9 %
Phantom and Setup					
Phantom Uncertainty	4.0	Rectangular	√3	1	± 2.3 %
Liquid Conductivity (Target)	5.0	Rectangular	√3	0.64	± 1.8 %
Liquid Conductivity (Meas.)	2.5	Normal	1	0.64	± 1.6 %
Liquid Permittivity (Target)	5.0	Rectangular	√3	0.6	± 1.7 %
Liquid Permittivity (Meas.)	2.5	Normal	1	0.6	± 1.5 %
Combined Standard Uncertainty					± 11.0 %
Coverage Factor for 95 %					K = 2
Expanded Uncertainty					± 22.0 %

Table 7.2 Uncertainty Budget of DASY for frequency range 300 MHz to 3 GHz

8. *SAR Measurement Evaluation*

Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder.

8.1 *Purpose of System Performance check*

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

8.2 *System Setup*

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:
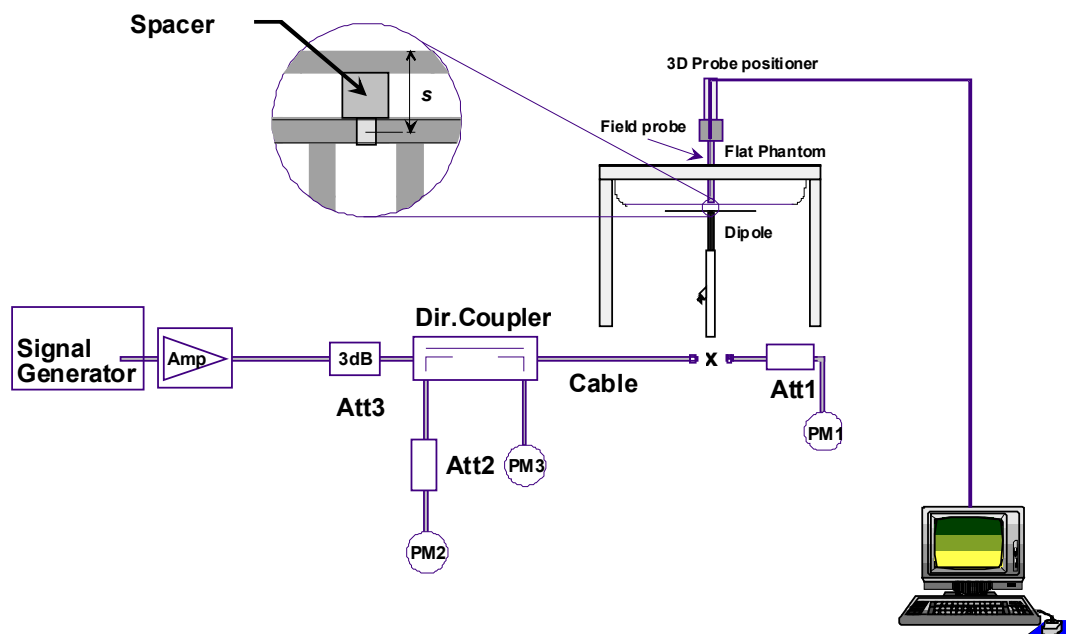

Fig 8.1 System Setup for System Evaluation

1. Signal Generator
2. Amplifier
3. Directional Coupler
4. Power Meter
5. Calibrated Dipole

The output power on dipole port must be calibrated to 24 dBm (250 mW) before dipole is connected.
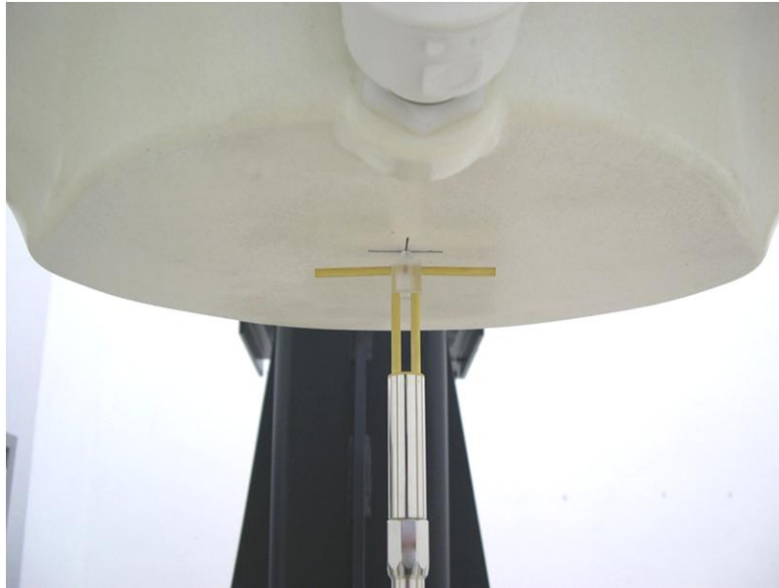

Fig 8.2 Photo of Dipole Setup

8.3 *Validation Results*

Comparing to the original SAR value provided by SPEAG, the validation data should be within its specification of 10 %. Table 8.1 shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

Measurement Date	Frequency (MHz)	Liquid Type	Targeted SAR_{1g} (W/kg)	Measured SAR_{1g} (W/kg)	Normalized SAR_{1g} (W/kg)	Deviation (%)
Feb. 10, 2012	2450	Body	52.3	13.7	54.80	4.78
Feb. 11, 2012	2450	Body	52.3	13.6	54.40	4.02
Feb. 21, 2012	2450	Body	52.3	13.3	53.20	1.72

Table 8.1 Target and Measurement SAR after Normalized

9. *DUT Testing Position*

This DUT was tested in two different positions. They are bottom face of DUT and Primary Portrait. In these positions, the surface of DUT is touching with phantom 0 cm gap. The device positioning in SAR measurement is included in "RF Exposure test setup photo" exhibit

10. _Measurement Procedures_

The measurement procedures are as follows:

(a) Use engineering software to transmit RF power continuously (continuous Tx) in the highest power channel.
(b) Keep DUT to radiate 100% duty factor.
(c) Measure output power through RF cable and power meter.
(d) Place the DUT in the positions as Appendix E demonstrates.
(e) Set scan area, grid size and other setting on the DASY software.
(f) Measure SAR results for the highest power channel on each testing position.
(g) Find out the largest SAR result on these testing positions of each band
(h) Measure SAR results for other channels in worst SAR testing position if the SAR of highest power channel is larger than 0.8 W/kg

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

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

10.1 _Spatial Peak SAR Evaluation_

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

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

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

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

10.2 _Area & Zoom Scan Procedures_

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan measures 5x5x7 points with step size 8, 8 and 5 mm for 300 MHz to 3 GHz, and 8x8x8 points with step size 4, 4 and 2.5 mm for 3 GHz to 6 GHz. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g.

10.3 *Volume Scan Procedures*

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the DUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing (step-size is 4, 4 and 2.5 mm). When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

10.4 *SAR Averaged Methods*

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

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

10.5 *Power Drift Monitoring*

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

11. SAR Test Results

11.1 Conducted Power (Unit: dBm)

Band	802.11b			802.11g		
Channel	1	6	11	1	6	11
Data rate	1M bps			6M bps		
Frequency (MHz)	2412	2437	2462	2412	2437	2462
Avg. Power (Ant. A)	14	14.42	13.64	13.36	14.24	13.9
Avg. Power (Ant. B)	11.68	12.45	11.37	11	12.49	11.66

Band	802.11n (BW 20MHz)		
Channel	1	6	11
MCS Index	MCS 0		
Frequency (MHz)	2412	2437	2462
Avg. Power (Ant. A)	13.27	14.14	13.32
Avg. Power (Ant. B)	10.04	12.46	10.91

Note:

1. Per 2010/10 TCB workshop and KDB 248227, choose the highest output power channel to test SAR and determine further SAR exclusion
2. Per KDB 248227, 11g and 11n output power is less than 1/4 dB higher than 11b mode, thus the SAR can be excluded.

<Power versus Data Rate >

Mode	Channel	Frequency(MHz)	Chain	Data Rate			
				1M bps	2M bps	5.5M bps	11M bps
802.11b	CH 01	2412 MHz	A	14	13.56	13.51	13.51
	CH 06	2437 MHz	A	14.42	14.32	14.31	14.37
	CH 11	2462 MHz	A	13.64	13.57	13.59	13.61

Mode	CH	Freq(MHz)	Chain	Data Rate							
				6M bps	9M bps	12M bps	18M bps	24M bps	36M bps	48M bps	54M bps
802.11g	CH 01	2412 MHz	A	13.36	13.32	13.28	13.31	12.45	12.42	12.33	12.32
	CH 06	2437 MHz	A	14.24	14.22	14.16	14.19	13.69	13.61	13.56	13.52
	CH 11	2462 MHz	A	13.9	13.82	13.7	13.74	13.41	13.13	13.07	12.99

Mode	CH	Freq(MHz)	Chain	Data Rate							
				MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11g(n20M)	CH 01	2412 MHz	A	13.27	13.19	13.11	12.48	12.87	12.81	12.73	12.72
	CH 06	2437 MHz	A	14.14	14.07	14.05	13.56	13.49	13.45	13.39	13.34
	CH 11	2462 MHz	A	13.32	13.16	13.18	12.55	12.46	12.41	12.41	12.38

Note:

1. Since same WLAN transceiver drives 2 chains, the higher power chain is chosen for verification.
2. For 802.11 bgn, lowest data rate results in highest power, and lowest data rate is selected for SAR testing.

11.2 *Test Records for Body SAR Test*

Plot No.	Band	Data Rate	Mode	Test Position	Separation Distance (cm)	Ch.	Ant.	SAR_{1g} (W/kg)
1	802.11b	1M bps	-	Bottom Face	0	6	A	1.2
2	802.11b	1M bps	-	Bottom Face	0	1	A	1.1
3	**802.11b**	1M bps	**-**	**Bottom Face**	**0**	**11**	**A**	**1.21**
4	802.11b	1M bps	-	Primary Portrait	0	6	A	0.795
5	802.11b	1M bps	-	Bottom Face	0	6	B	1.01
6	802.11b	1M bps	-	Bottom Face	0	1	B	0.816
7	**802.11b**	1M bps	**-**	**Bottom Face**	**0**	**11**	**B**	**1.18**
8	802.11b	1M bps	-	Primary Portrait	0	6	B	0.517

Note:
1. Per KDB447498, if the highest output channel SAR for each exposure position ≤ 0.8 W/kg other channels SAR tests are not necessary.
2. There is screen orientation limitation in DUT, thus secondary landscape/secondary portrait/primary landscape SAR can be excluded.

Test Engineer： Bevis Chang and Ted Sun and Angelo Chang

12. _References_

[1] FCC 47 CFR Part 2 "Frequency Allocations and Radio Treaty Matters; General Rules and Regulations"

[2] IEEE Std. C95.1-1991, "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz", 1991

[3] IEEE Std. 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003

[4] FCC OET Bulletin 65 (Edition 97-01) Supplement C (Edition 01-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", June 2001

[5] SPEAG DASY System Handbook

[6] FCC KDB 248227 D01 v01r02, "SAR Measurement Procedures for 802.11 a/b/g Transmitters", May 2007

[7] FCC KDB 447498 D01 v04, "Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies", November 2009

[8] FCC KDB 616217 D03 v01, "SAR Evaluation Considerations for Laptop/Notebook/Netbook and Tablet Computers", November 2009

[9] FCC KDB 941225 D03 v01, "Recommended SAR Test Reduction Procedures for GSM / GPRS / EDGE", December 2008

[10] FCC KDB 941225 D07 01, "SAR Evaluation Procedure for UMPC Mini-Tablet Devices", April 2011

Appendix A.　　Plots of System Performance Check

The plots are shown as follows.

System Check_Body_2450MHz_120210

DUT: Dipole 2450 MHz

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120210 Medium parameters used: f = 2450 MHz; σ = 1.965 mho/m; ε_r =

52.764; ρ = 1000 kg/m^3
Ambient Temperature：22.5 ℃；Liquid Temperature：21.5 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1787; ConvF(3.96, 3.96, 3.96); Calibrated: 2011/5/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP1127
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

Pin=250mW/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
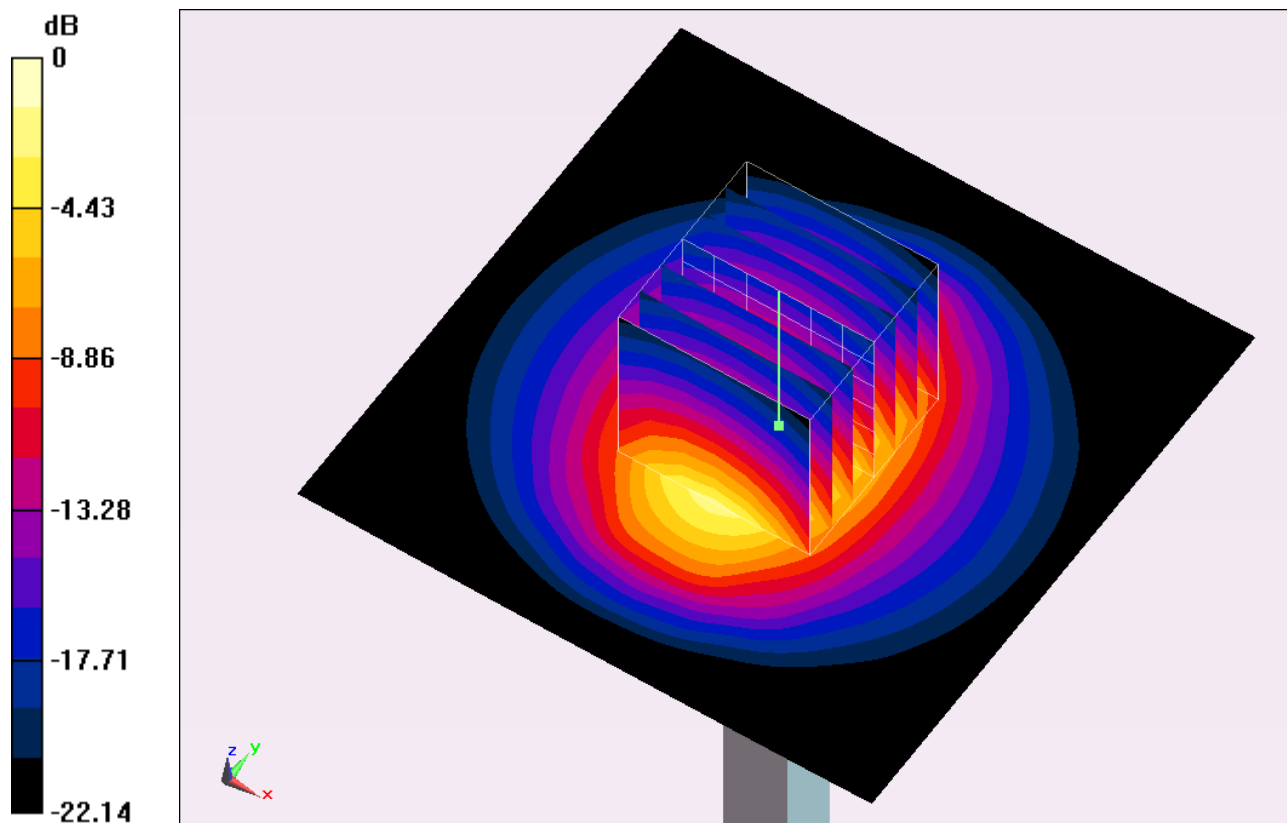Maximum value of SAR (interpolated) = 15.523 mW/g

Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 88.494 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 34.4480
SAR(1 g) = 13.7 mW/g; SAR(10 g) = 6.17 mW/g
Maximum value of SAR (measured) = 15.032 mW/g

0 dB = 15.030mW/g = 23.54 dB mW/g

System Check_Body_2450MHz_120211

DUT: Dipole 2450 MHz

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120211 Medium parameters used: f = 2450 MHz; σ = 1.96 mho/m; ε_r = 52.9; ρ

= 1000 kg/m^3
Ambient Temperature：22.4 ℃；Liquid Temperature：21.5 ℃

DASY4 Configuration:
- Probe: ET3DV6R - SN1788; ConvF(3.55, 3.55, 3.55); Calibrated: 2012/1/26
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 2008/11/12
- Phantom: ELI 4.0_Front; Type: QDOVA001BB; Serial: 1026
- Measurement SW: DASY5, V5.0 Build 120; Postprocessing SW: SEMCAD, V1.8 Build 186

Pin=250mW/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 15.3 mW/g

Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 87.3 V/m; Power Drift = -0.085 dB
Peak SAR (extrapolated) = 34.7 W/kg
SAR(1 g) = 13.6 mW/g; SAR(10 g) = 6.13 mW/g
Maximum value of SAR (measured) = 14.8 mW/g

0 dB = 14.8mW/g
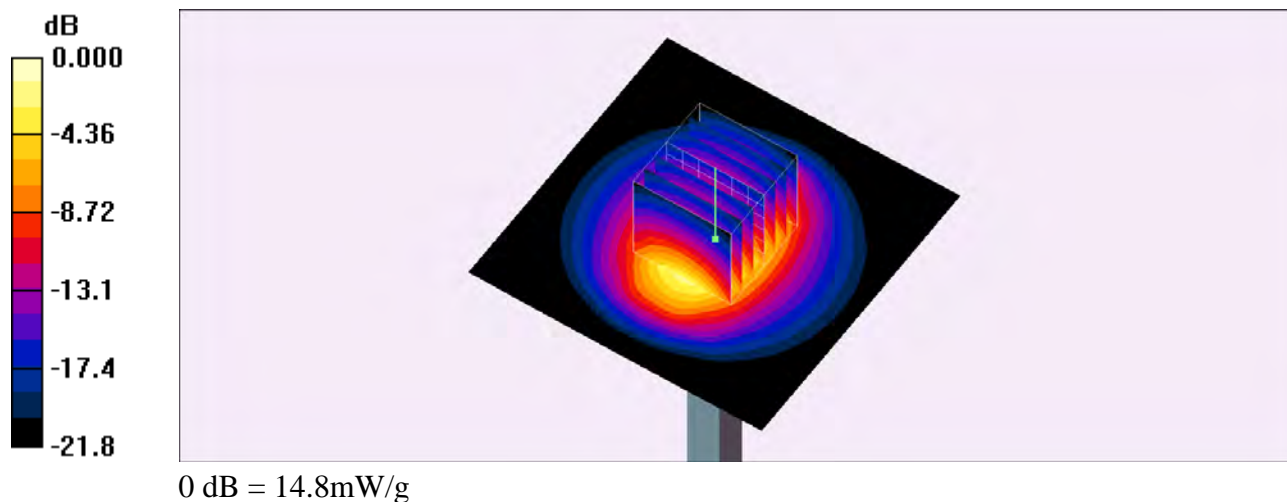
System Check_Body_2450MHz_120221

DUT: Dipole 2450 MHz

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120221 Medium parameters used: f = 2450 MHz; σ = 1.965 mho/m; ε$_r$ =

53.842; ρ = 1000 kg/m^3
Ambient Temperature：22.5 ℃； Liquid Temperature：21.5 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3792; ConvF(6.67, 6.67, 6.67); Calibrated: 2011/6/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 2011/6/20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP1127
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

Pin=250mW/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 15.130 mW/g
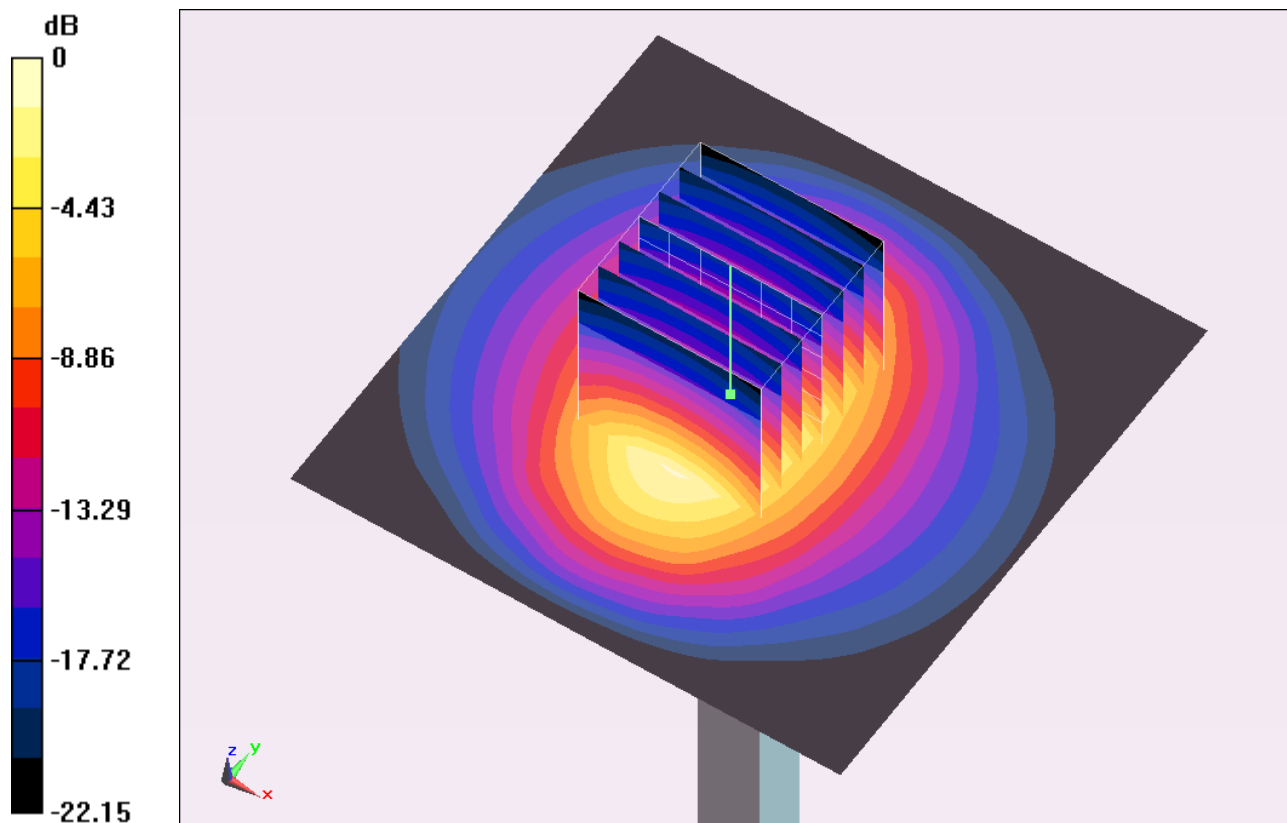
Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 85.030 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 29.1140
SAR(1 g) = 13.3 mW/g; SAR(10 g) = 6.32 mW/g
Maximum value of SAR (measured) = 14.751 mW/g

0 dB = 14.750mW/g = 23.38 dB mW/g

Appendix B.   *Plots of SAR Measurement*

The plots are shown as follows.

#01 802.11b_Bottom Face_0cm_Ch6_Ant A

DUT: 3Q2535/24

Communication System: 802.11b; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120221 Medium parameters used: f = 2437 MHz; σ = 1.946 mho/m; ε_r =

53.883; ρ = 1000 kg/m^3
Ambient Temperature：22.5 ℃；Liquid Temperature：21.5 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3792; ConvF(6.67, 6.67, 6.67); Calibrated: 2011/6/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 2011/6/20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP1127
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

Ch6/Area Scan (91x131x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.164 mW/g

Ch6/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 1.748 V/m; Power Drift = 0.129 dB
Peak SAR (extrapolated) = 2.6500
SAR(1 g) = 1.2 mW/g; SAR(10 g) = 0.458 mW/g
Maximum value of SAR (measured) = 1.147 mW/g

0 dB = 1.150mW/g = 1.21 dB mW/g
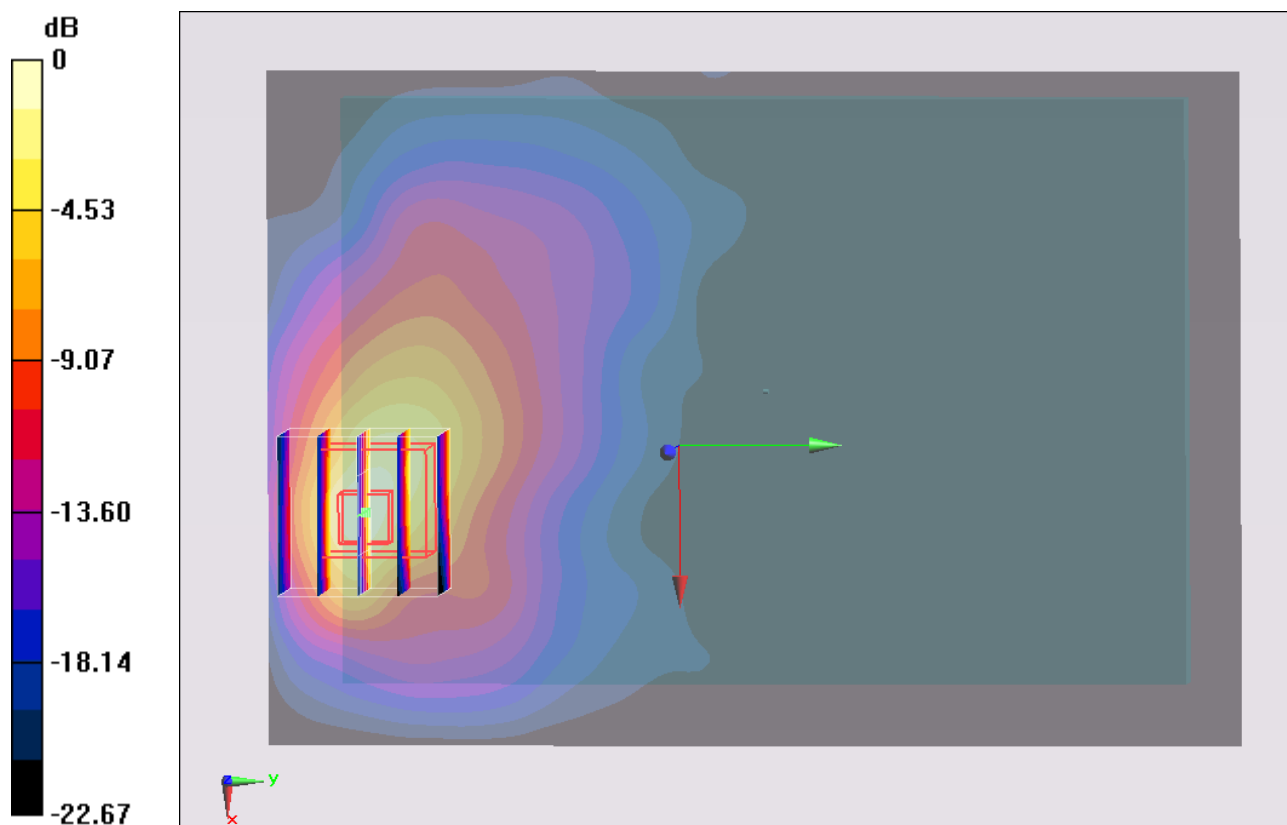
#02 802.11b_Bottom Face_0cm_Ch1_Ant A

DUT: 3Q2535/24

Communication System: 802.11b ; Frequency: 2412 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120211 Medium parameters used: f = 2412 MHz; σ = 1.91 mho/m; ε_r = 53;

ρ = 1000 kg/m^3
Ambient Temperature：22.4 ℃；Liquid Temperature：21.5 ℃

DASY4 Configuration:
- Probe: ET3DV6R - SN1788; ConvF(3.55, 3.55, 3.55); Calibrated: 2012/1/26
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 2011/6/20
- Phantom: ELI 4.0_Front; Type: QDOVA001BB; Serial: 1026
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch1/Area Scan (61x31x1): Measurement grid: dx=20mm, dy=20mm
Maximum value of SAR (interpolated) = 1.18 mW/g

Ch1/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 1.27 V/m; Power Drift = -0.191 dB
Peak SAR (extrapolated) = 3.34 W/kg
SAR(1 g) = 1.1 mW/g; SAR(10 g) = 0.465 mW/g
Maximum value of SAR (measured) = 1.20 mW/g

0 dB = 1.20mW/g
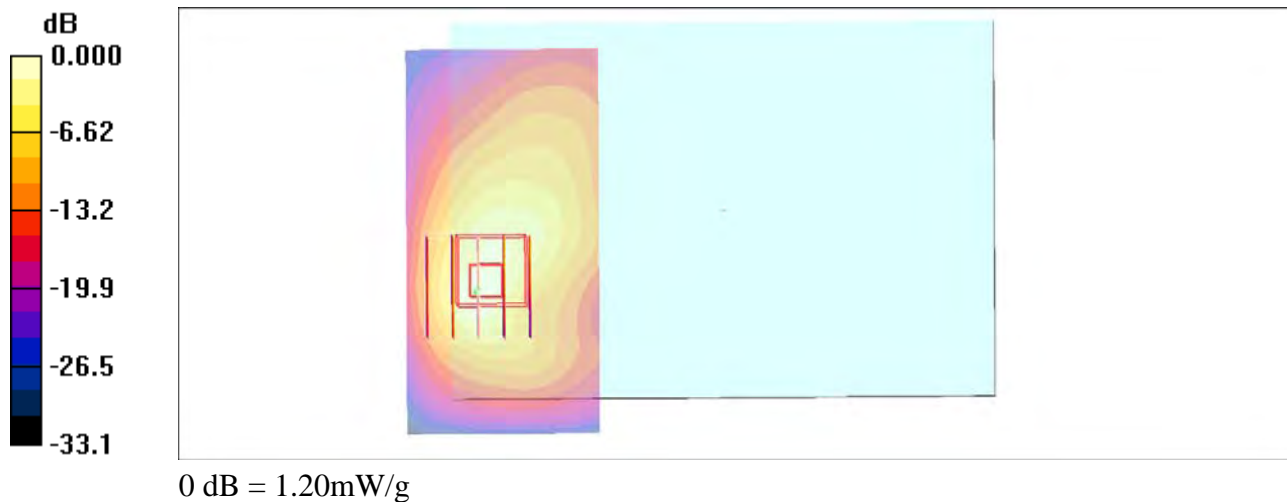
#03 802.11b_Bottom Face_0cm_Ch11_Ant A

DUT: 3Q2535/24

Communication System: 802.11b ; Frequency: 2462 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120211 Medium parameters used: f = 2462 MHz; σ = 1.98 mho/m; ε_r = 52.8;

ρ = 1000 kg/m^3
Ambient Temperature：22.4 ℃；Liquid Temperature：21.5 ℃

DASY4 Configuration:
- Probe: ET3DV6R - SN1788; ConvF(3.55, 3.55, 3.55); Calibrated: 2012/1/26
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 2011/6/20
- Phantom: ELI 4.0_Front; Type: QDOVA001BB; Serial: 1026
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch11/Area Scan (61x31x1): Measurement grid: dx=20mm, dy=20mm
Maximum value of SAR (interpolated) = 1.13 mW/g

Ch11/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 1.47 V/m; Power Drift = -0.019 dB
Peak SAR (extrapolated) = 3.78 W/kg
SAR(1 g) = 1.21 mW/g; SAR(10 g) = 0.505 mW/g
Maximum value of SAR (measured) = 1.25 mW/g

0 dB = 1.25mW/g

#03 802.11b_Bottom Face_0cm_Ch11_Ant A_2D

DUT: 3Q2535/24

Communication System: 802.11b ; Frequency: 2462 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120211 Medium parameters used: f = 2462 MHz; σ = 1.98 mho/m; ε_r = 52.8;

ρ = 1000 kg/m^3
Ambient Temperature：22.4 ℃；Liquid Temperature：21.5 ℃

DASY4 Configuration:
- Probe: ET3DV6R - SN1788; ConvF(3.55, 3.55, 3.55); Calibrated: 2012/1/26
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 2011/6/20
- Phantom: ELI 4.0_Front; Type: QDOVA001BB; Serial: 1026
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch11/Area Scan (61x31x1): Measurement grid: dx=20mm, dy=20mm
Maximum value of SAR (interpolated) = 1.13 mW/g

Ch11/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 1.47 V/m; Power Drift = -0.019 dB
Peak SAR (extrapolated) = 3.78 W/kg
SAR(1 g) = 1.21 mW/g; SAR(10 g) = 0.505 mW/g
Maximum value of SAR (measured) = 1.25 mW/g

#04 802.11b_Primary Portrait_0cm_Ch6_Ant A

DUT: 3Q2535/24

Communication System: 802.11b; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120221 Medium parameters used: f = 2437 MHz; σ = 1.946 mho/m; ε_r =

53.883; ρ = 1000 kg/m^3
Ambient Temperature：22.5 ℃; Liquid Temperature：21.5 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3792; ConvF(6.67, 6.67, 6.67); Calibrated: 2011/6/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 2011/6/20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP1127
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

Ch6/Area Scan (41x101x1): Measurement grid: dx=15mm, dy=15mm
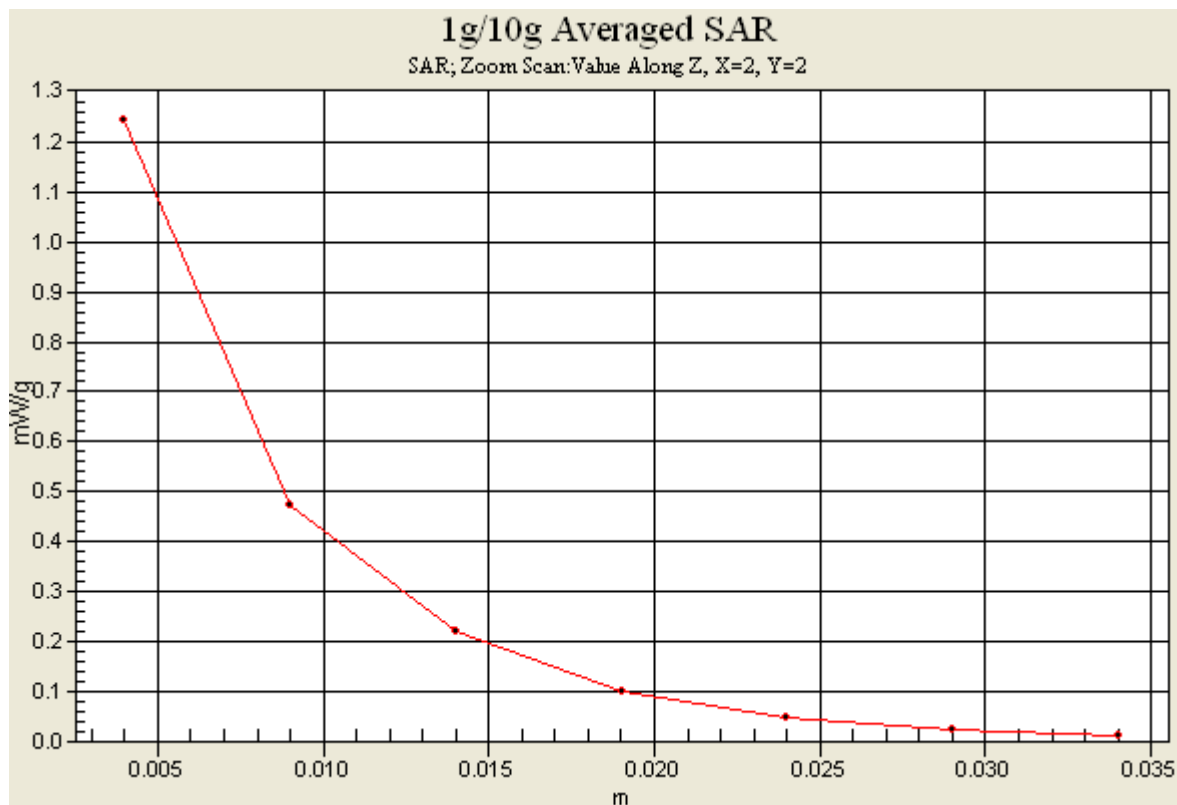Maximum value of SAR (interpolated) = 0.985 mW/g

Ch6/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 18.842 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 1.9270
SAR(1 g) = 0.795 mW/g; SAR(10 g) = 0.348 mW/g
Maximum value of SAR (measured) = 0.917 mW/g

0 dB = 0.920mW/g = -0.72 dB mW/g
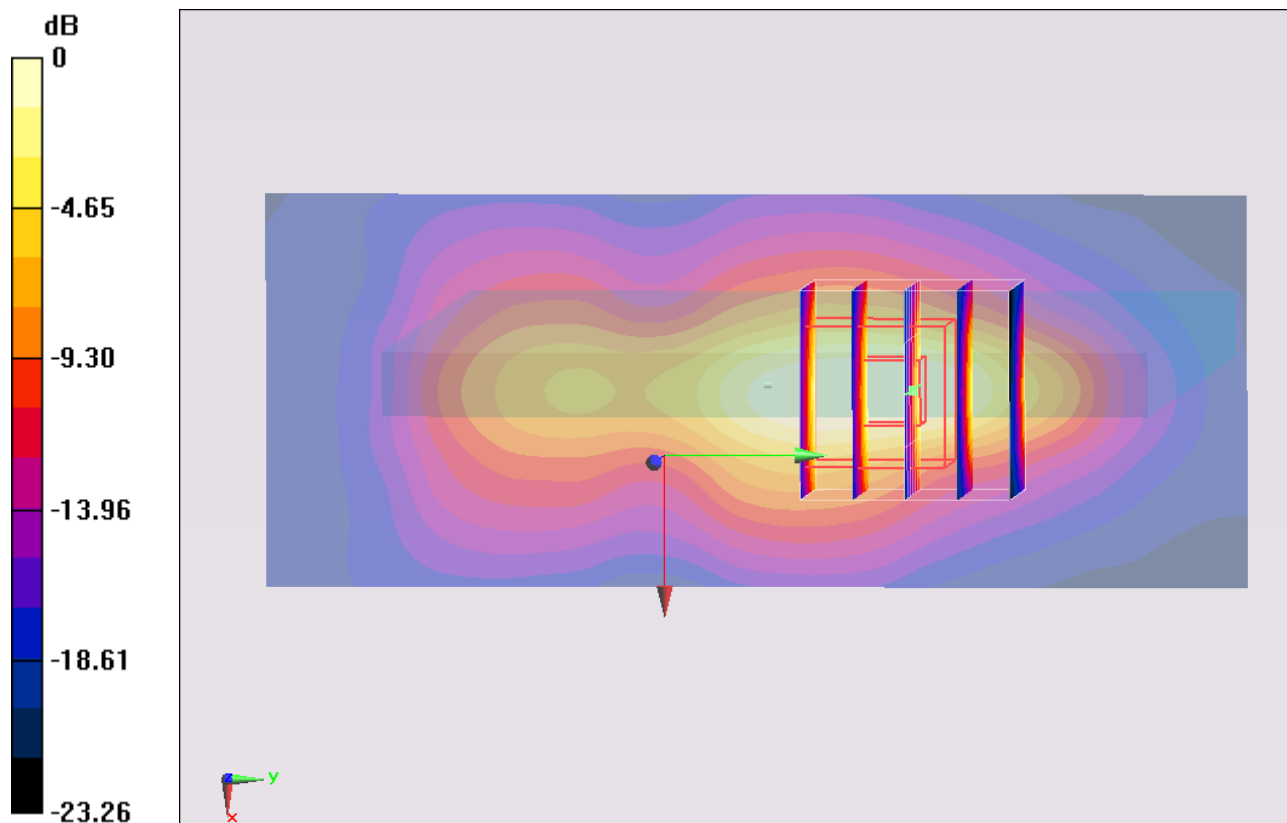
#05 802.11b_Bottom Face_0cm_Ch6_Ant B

DUT: 3Q2535/24

Communication System: 802.11b; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120221 Medium parameters used: f = 2437 MHz; σ = 1.946 mho/m; ε$_r$ =

53.883; ρ = 1000 kg/m^3
Ambient Temperature：22.5 ℃；Liquid Temperature：21.5 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3792; ConvF(6.67, 6.67, 6.67); Calibrated: 2011/6/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 2011/6/20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP1127
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

Ch6/Area Scan (91x131x1): Measurement grid: dx=15mm, dy=15mm
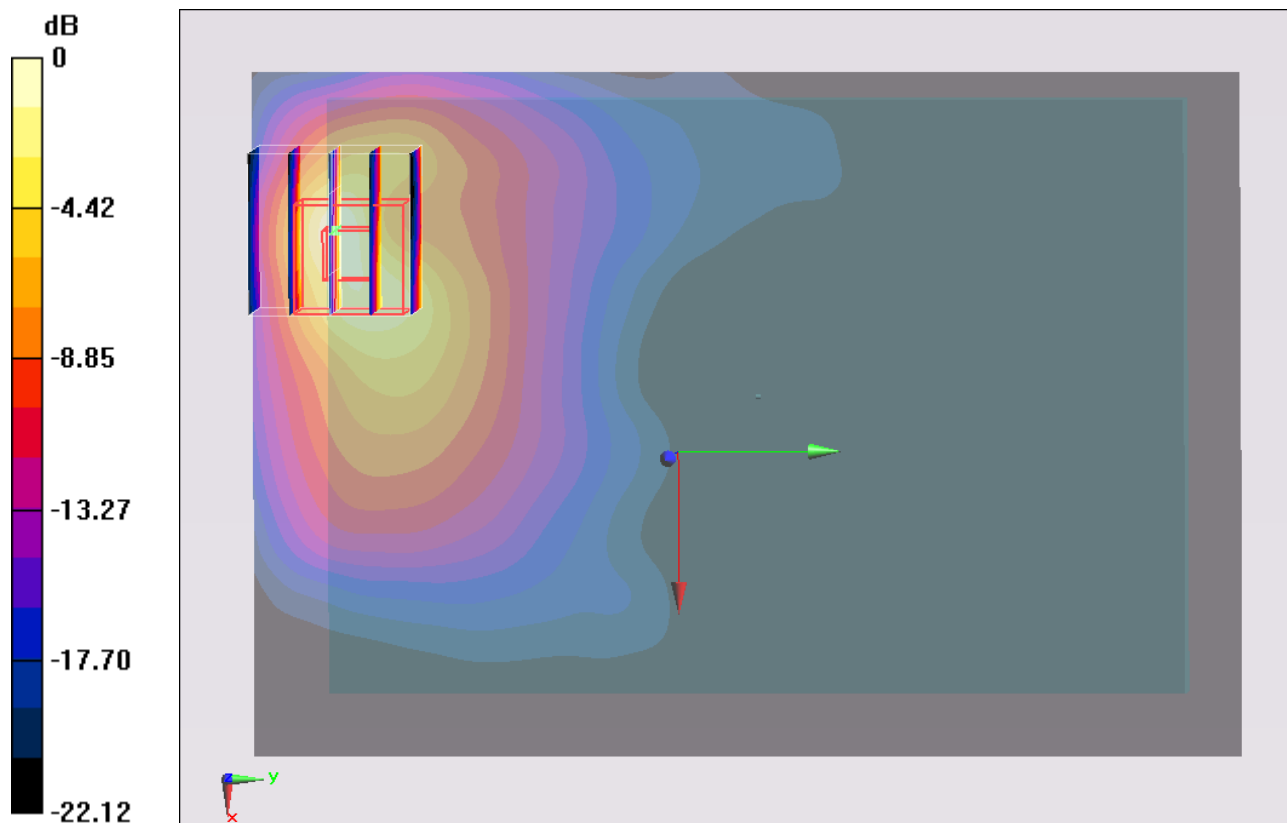Maximum value of SAR (interpolated) = 1.175 mW/g

Ch6/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 1.612 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 2.4790
SAR(1 g) = 1.01 mW/g; SAR(10 g) = 0.418 mW/g
Maximum value of SAR (measured) = 1.179 mW/g

0 dB = 1.180mW/g = 1.44 dB mW/g

#06 802.11b_Bottom Face_0cm_Ch1_Ant B

DUT: 3Q2535/24

Communication System: 802.11b; Frequency: 2412 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120210 Medium parameters used: f = 2412 MHz; σ = 1.915 mho/m; ε_r =

52.896; ρ = 1000 kg/m^3
Ambient Temperature：22.5 ℃；Liquid Temperature：21.5 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1787; ConvF(3.96, 3.96, 3.96); Calibrated: 2011/5/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP1127
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

Ch1/Area Scan (91x41x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.735 mW/g

Ch1/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 0.808 V/m; Power Drift = -0.136dB
Peak SAR (extrapolated) = 2.2050
SAR(1 g) = 0.816 mW/g; SAR(10 g) = 0.344 mW/g
Maximum value of SAR (measured) = 0.934 mW/g

0 dB = 0.930mW/g = -0.63 dB mW/g
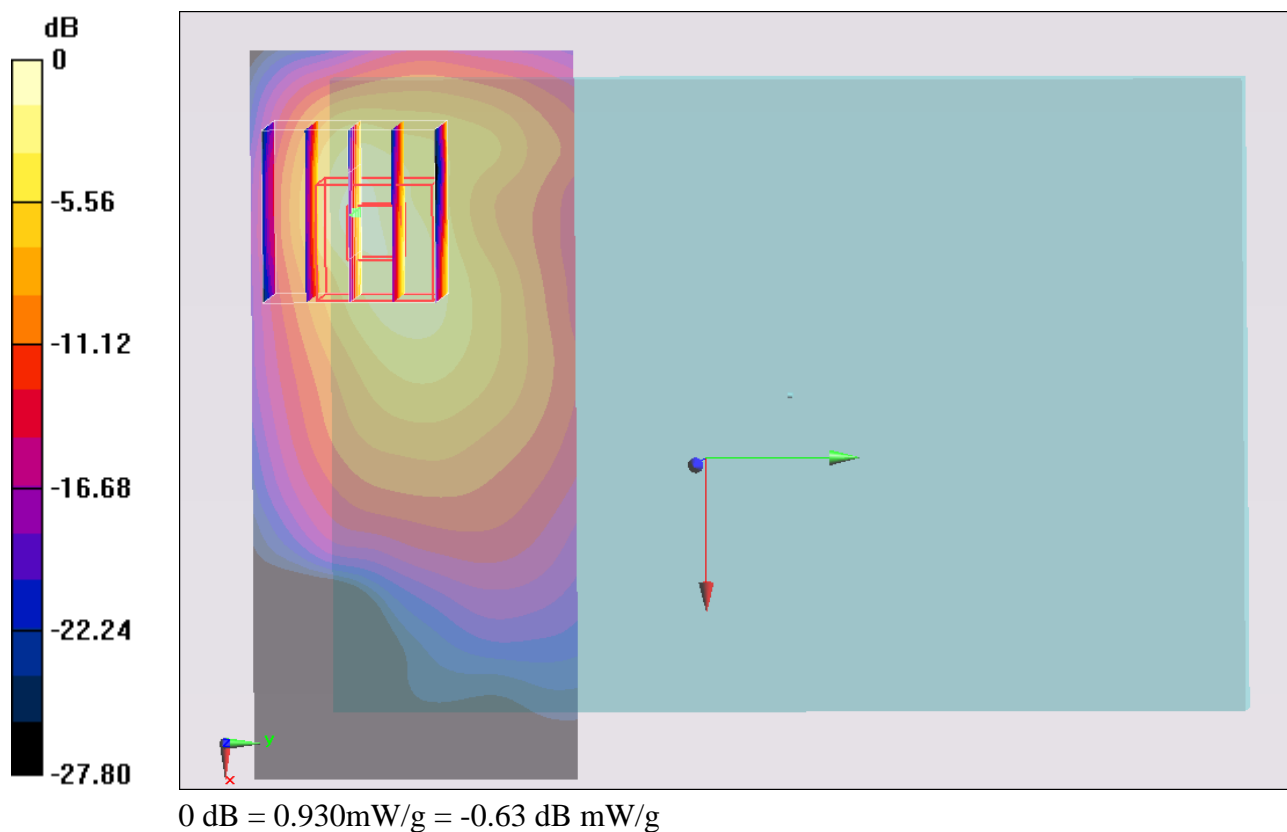
#07 802.11b_Bottom Face_0cm_Ch11_Ant B

DUT: 3Q2535/24

Communication System: 802.11b; Frequency: 2462 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120210 Medium parameters used: f = 2462 MHz; σ = 1.982 mho/m; ε_r =

52.719; ρ = 1000 kg/m^3
Ambient Temperature：22.5 ℃；Liquid Temperature：21.5 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1787; ConvF(3.96, 3.96, 3.96); Calibrated: 2011/5/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP1127
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

Ch11/Area Scan (91x41x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.370 mW/g

Ch11/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 0.723 V/m; Power Drift = -0.167 dB
Peak SAR (extrapolated) = 3.3930
SAR(1 g) = 1.18 mW/g; SAR(10 g) = 0.473 mW/g
Maximum value of SAR (measured) = 1.358 mW/g

0 dB = 1.360mW/g = 2.67 dB mW/g

#07 802.11b_Bottom Face_0cm_Ch11_Ant B_2D

DUT: 211923-01

Communication System: 802.11b; Frequency: 2462 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120210 Medium parameters used: f = 2462 MHz; σ = 1.982 mho/m; ε$_r$ =

52.719; ρ = 1000 kg/m^3
Ambient Temperature：22.5 ℃；Liquid Temperature：21.5 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1787; ConvF(3.96, 3.96, 3.96); Calibrated: 2011/5/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn495; Calibrated: 2011/4/28
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP1127
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

Ch11/Area Scan (91x41x1): Measurement grid: dx=15mm, dy=15mm
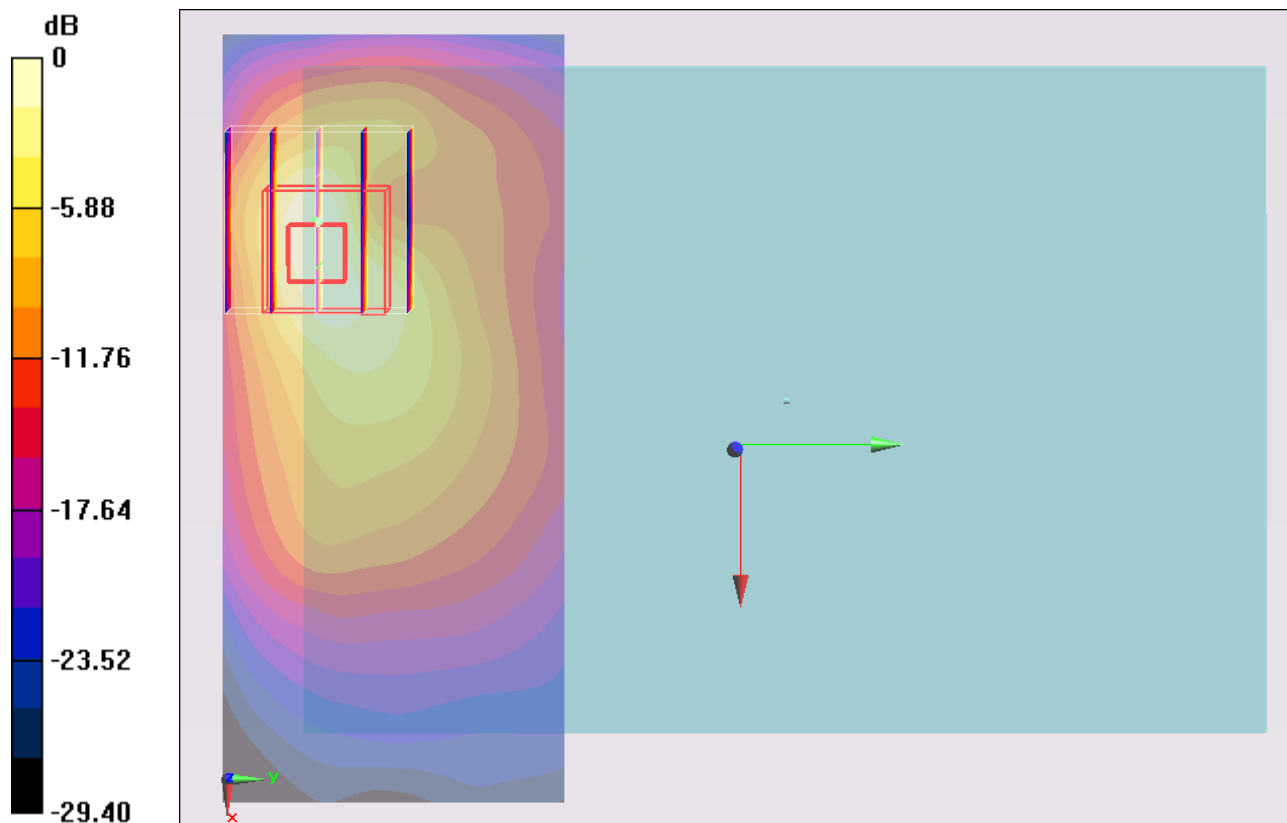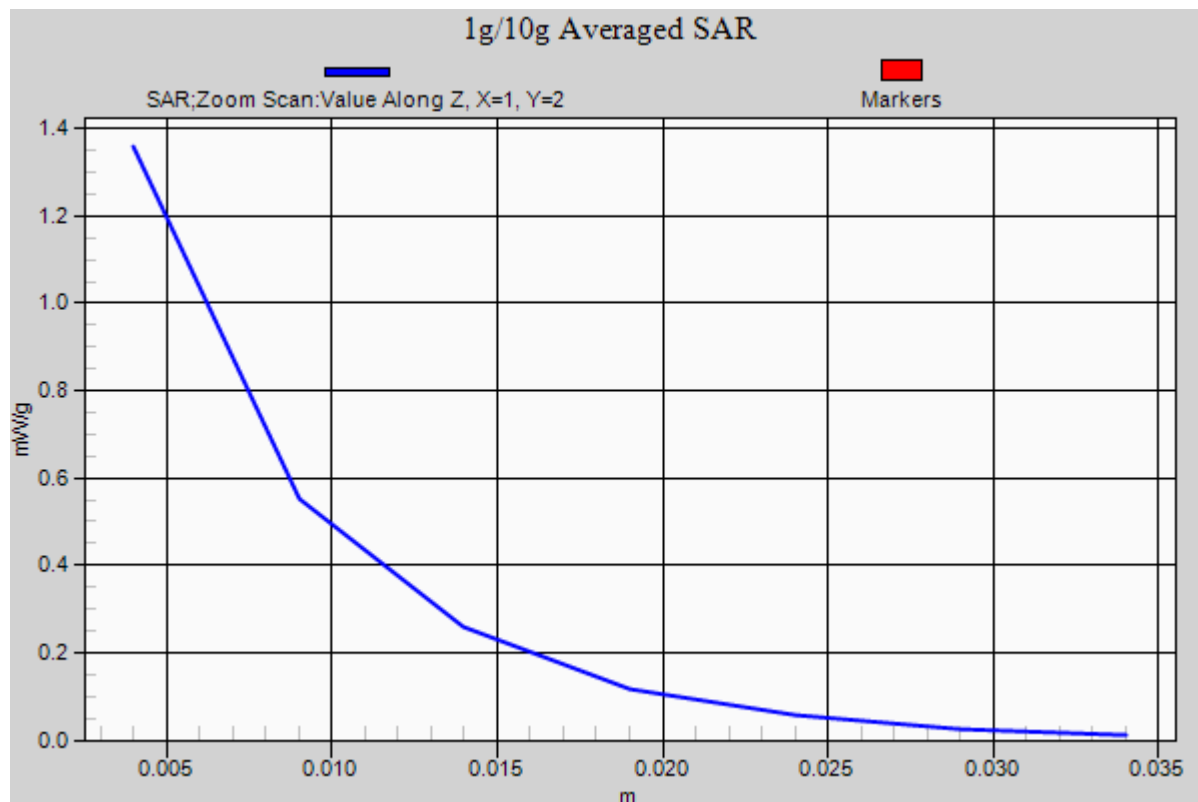Maximum value of SAR (interpolated) = 1.370 mW/g

Ch11/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 0.723 V/m; Power Drift = -0.167 dB
Peak SAR (extrapolated) = 3.3930
SAR(1 g) = 1.18 mW/g; SAR(10 g) = 0.473 mW/g
Maximum value of SAR (measured) = 1.358 mW/g

#08 802.11b_Primary Portrait_0cm_Ch6_Ant B

DUT: 3Q2535/24

Communication System: 802.11b; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium: MSL_2450_120221 Medium parameters used: f = 2437 MHz; σ = 1.946 mho/m; ε_r =

53.883; ρ = 1000 kg/m^3
Ambient Temperature：22.5 ℃；Liquid Temperature：21.5 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3792; ConvF(6.67, 6.67, 6.67); Calibrated: 2011/6/20
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 2011/6/20
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP1127
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

Configuration/Ch6/Area Scan (41x101x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.621 mW/g

Ch6/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 15.656 V/m; Power Drift = -0.005 dB
Peak SAR (extrapolated) = 1.1630
SAR(1 g) = 0.517 mW/g; SAR(10 g) = 0.225 mW/g
Maximum value of SAR (measured) = 0.573 mW/g

Ch6/Zoom Scan (5x5x7)/Cube 1: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 15.656 V/m; Power Drift = -0.005 dB
Peak SAR (extrapolated) = 1.2570
SAR(1 g) = 0.510 mW/g; SAR(10 g) = 0.198 mW/g
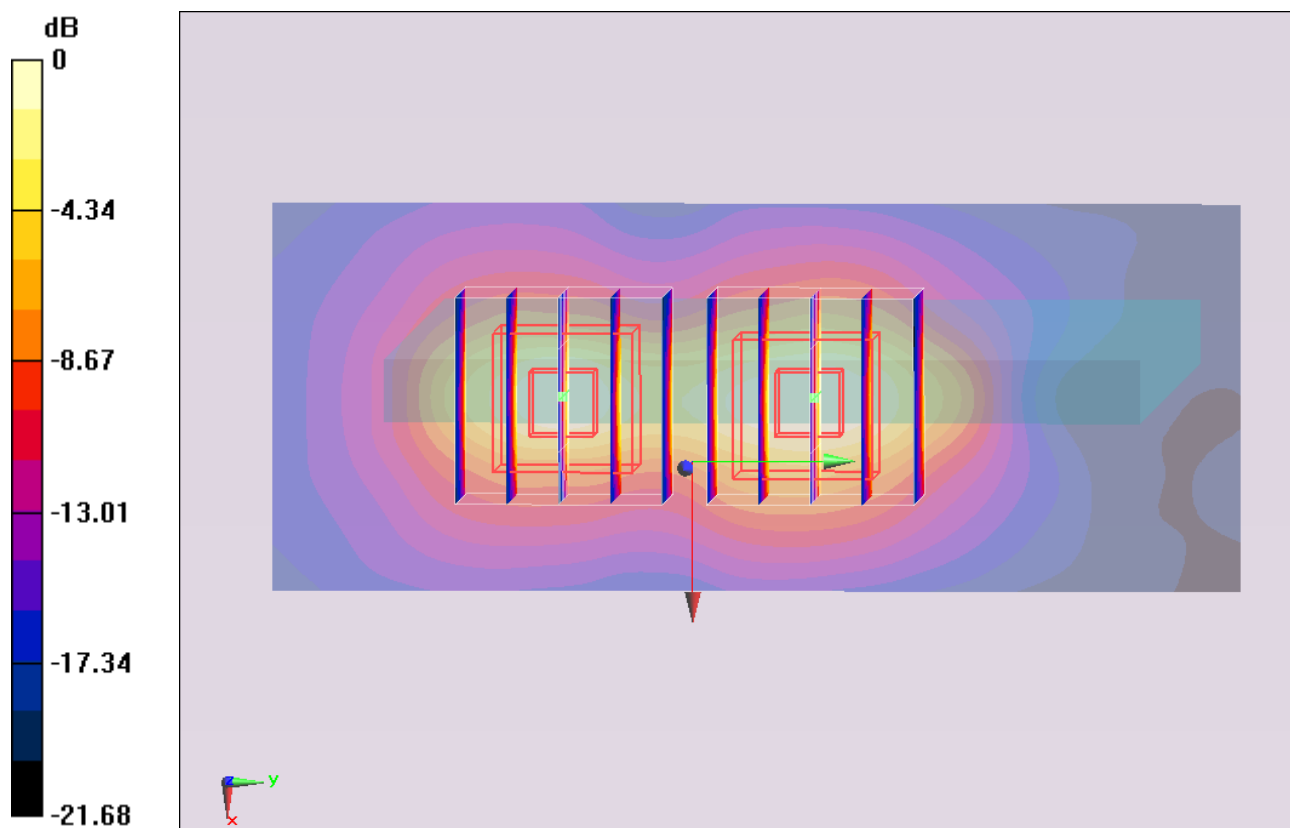Maximum value of SAR (measured) = 0.602 mW/g

0 dB = 0.570mW/g = -4.88 dB mW/g

Appendix C.   DASY Calibration Certificate

The DASY calibration certificates are shown as follows.

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

ilac-MRA

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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   **Sporton (Auden)**   Certificate No: **D2450V2-736_Jul11**

CALIBRATION CERTIFICATE

Object	**D2450V2 - SN: 736**
Calibration procedure(s)	**QA CAL-05.v8** **Calibration procedure for dipole validation kits above 700 MHz**
Calibration date:	**July 25, 2011**

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	06-Oct-10 (No. 217-01266)	Oct-11
Power sensor HP 8481A	US37292783	06-Oct-10 (No. 217-01266)	Oct-11
Reference 20 dB Attenuator	SN: S5086 (20b)	29-Mar-11 (No. 217-01367)	Apr-12
Type-N mismatch combination	SN: 5047.2 / 06327	29-Mar-11 (No. 217-01371)	Apr-12
Reference Probe ES3DV3	SN: 3205	29-Apr-11 (No. ES3-3205_Apr11)	Apr-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-09)	In house check: Oct-11
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-09)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-10)	In house check: Oct-11

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

Issued: July 25, 2011

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

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

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	V52.6.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.9 ± 6 %	1.85 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.9 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**54.8 mW /g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.44 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**25.6 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	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.7 ± 6 %	2.00 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	13.3 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**52.3 mW / g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.18 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**24.5 mW / g ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.4 Ω + 1.5 jΩ
Return Loss	- 27.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.8 Ω + 2.8 jΩ
Return Loss	- 30.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.159 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.
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	August 26, 2003

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 736

Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.85 mho/m; ε_r = 38.9; ρ = 1000 kg/m^3
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: 29.04.2011

- Sensor-Surface: 3mm (Mechanical Surface Detection)

- Electronics: DAE4 Sn601; Calibrated: 04.07.2011

- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001

- DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

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 = 98.095 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 28.615 W/kg
SAR(1 g) = 13.9 mW/g; SAR(10 g) = 6.44 mW/g
Maximum value of SAR (measured) = 18.121 mW/g

0 dB = 18.120mW/g

Impedance Measurement Plot for Head TSL

25 Jul 2011 11:54:16

CH1 S11   1 U FS   1: 54.398 Ω   1.4805 Ω 96.173 pH   2 450.000 000 MHz

✱

Del

Cor

Avg
16

Hld

CH2 S11   LOG   5 dB/ REF -20 dB   1:-27.042 dB   2 450.000 000 MHz

Cor

Avg
16

Hld

CENTER 2 450.000 000 MHz   SPAN 400.000 000 MHz

DASY5 Validation Report for Body TSL

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 736

Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2 mho/m; ε_r = 51.7; ρ = 1000 kg/m^3
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: 29.04.2011

- Sensor-Surface: 3mm (Mechanical Surface Detection)

- Electronics: DAE4 Sn601; Calibrated: 04.07.2011

- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002

- DASY52 52.6.2(482); SEMCAD X 14.4.5(3634)

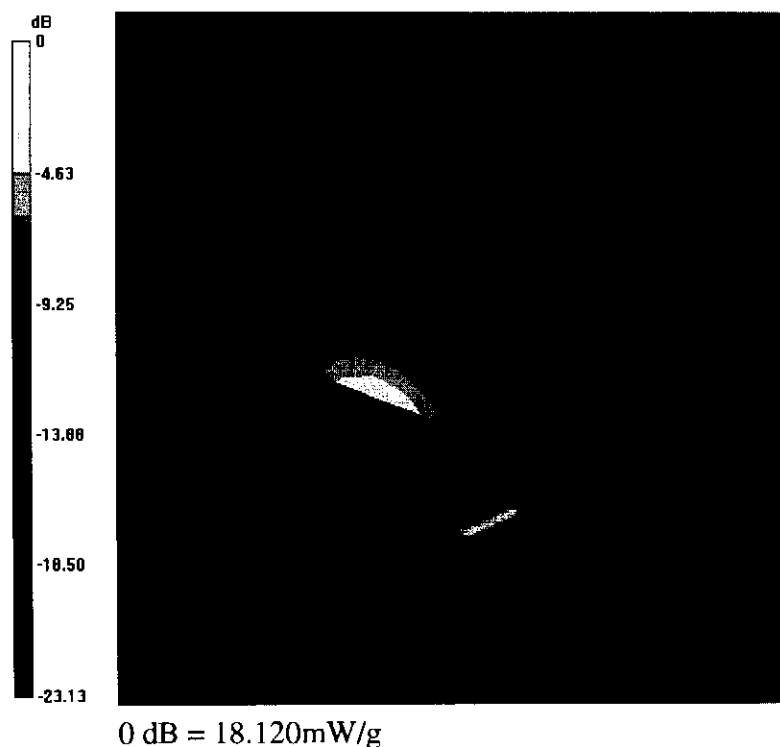## Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 96.550 V/m; Power Drift = 0.02 dB
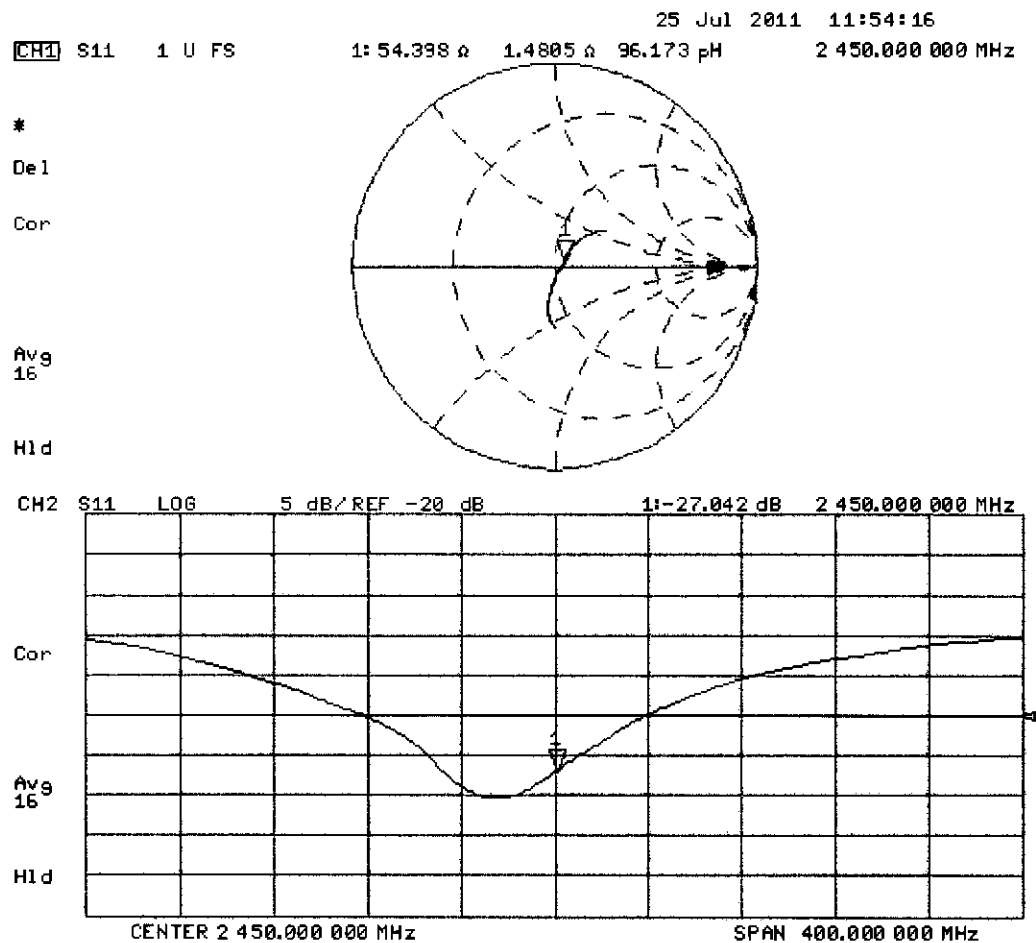Peak SAR (extrapolated) = 27.432 W/kg
SAR(1 g) = 13.3 mW/g; SAR(10 g) = 6.18 mW/g
Maximum value of SAR (measured) = 17.294 mW/g

0 dB = 17.290mW/g
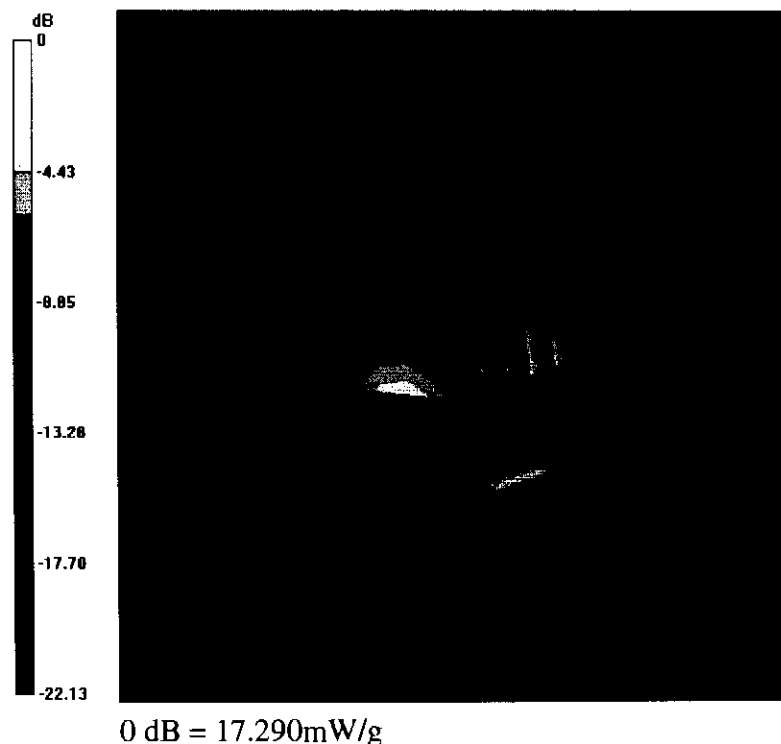
Impedance Measurement Plot for Body TSL
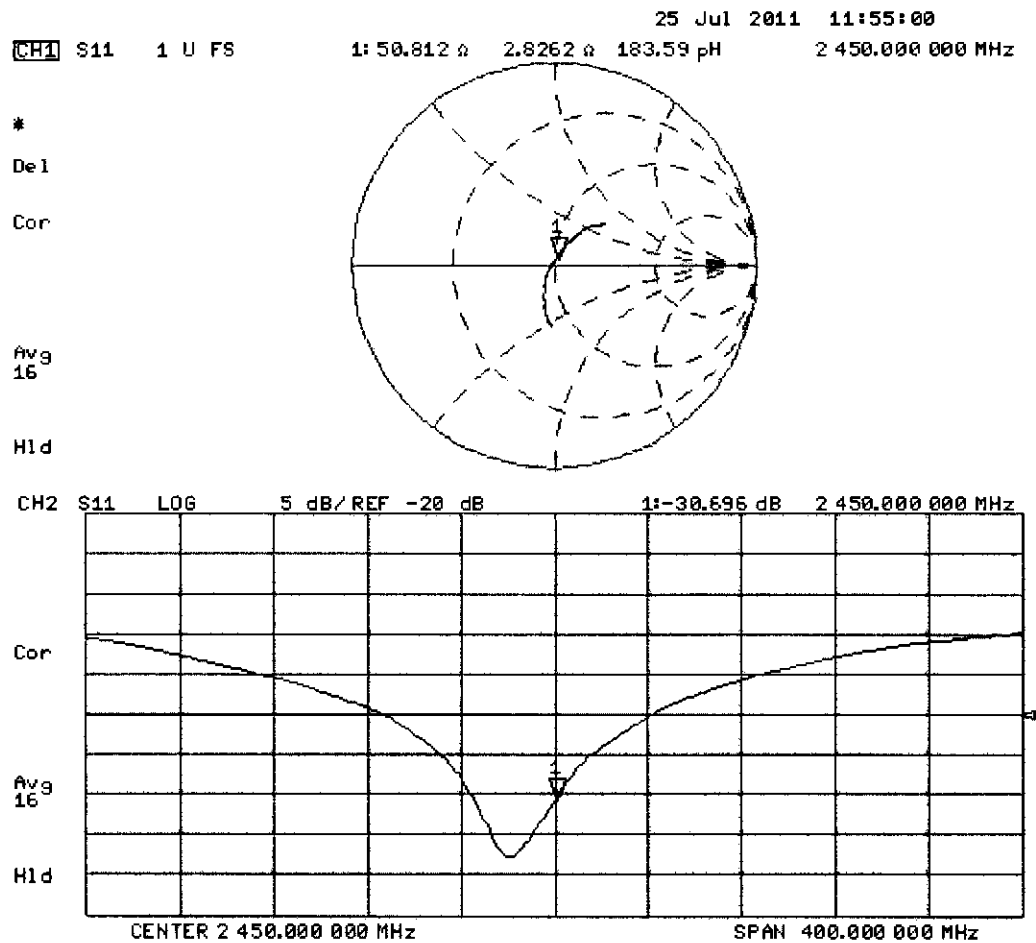
25 Jul 2011 11:55:00

CH1 S11 1 U FS   1: 50.812 Ω   2.8262 Ω 183.59 pH   2 450.000 000 MHz

*

Del

Cor

Avg
16

Hld

CH2 S11 LOG   5 dB/ REF -20 dB   1:-30.696 dB   2 450.000 000 MHz

Cor

Avg
16

Hld

CENTER 2 450.000 000 MHz   SPAN 400.000 000 MHz

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client   **Amphenol CN (Auden)**

Certificate No: **DAE3-495_Apr11**

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AD - SN: 495
Calibration procedure(s)	**QA CAL-06.v22** **Calibration procedure for the data acquisition electronics (DAE)**
Calibration date:	April 28, 2011

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	28-Sep-10 (No:10376)	Sep-11

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Calibrator Box V1.1	SE UMS 006 AB 1004	07-Jun-10 (in house check)	In house check: Jun-11

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	
Approved by:	Fin Bomholt	R&D Director	i.V.

Issued: April 28, 2011

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Multilateral Agreement for the recognition of calibration certificates

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 =   6.1µV ,   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	404.324 ± 0.1% (k=2)	405.291 ± 0.1% (k=2)	405.622 ± 0.1% (k=2)
Low Range	3.95043 ± 0.7% (k=2)	3.97613 ± 0.7% (k=2)	3.95159 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	227.5 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	199993.1	-2.74	-0.00
Channel X	+ Input	20001.66	1.46	0.01
Channel X	- Input	-19994.94	5.16	-0.03
Channel Y	+ Input	200006.0	1.16	0.00
Channel Y	+ Input	20002.16	1.86	0.01
Channel Y	- Input	-19997.98	2.02	-0.01
Channel Z	+ Input	200005.6	1.57	0.00
Channel Z	+ Input	20003.05	3.05	0.02
Channel Z	- Input	-19998.31	1.59	-0.01

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	2000.3	0.26	0.01
Channel X	+ Input	199.66	-0.24	-0.12
Channel X	- Input	-200.28	-0.38	0.19
Channel Y	+ Input	2001.0	1.06	0.05
Channel Y	+ Input	200.75	0.85	0.42
Channel Y	- Input	-202.12	-2.12	1.06
Channel Z	+ Input	1999.0	-1.13	-0.06
Channel Z	+ Input	198.35	-1.65	-0.82
Channel Z	- Input	-200.94	-1.04	0.52

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	2.91	1.12
	- 200	0.15	-1.40
Channel Y	200	-0.69	-0.74
	- 200	-0.12	-0.47
Channel Z	200	2.83	2.71
	- 200	-4.22	-4.44

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	-	2.33	0.36
Channel Y	200	2.17	-	4.08
Channel Z	200	3.22	-0.54	-

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	15791	16416
Channel Y	15742	16582
Channel Z	15883	16533

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	-1.87	-3.03	-0.77	0.45
Channel Y	-1.74	-2.98	-0.06	0.56
Channel Z	-1.44	-2.79	-0.14	0.61

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

IMPORTANT NOTICE

USAGE OF THE DAE 3

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

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

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

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

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

DASY Configuration Files: Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 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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Accreditation No.: **SCS 108**

Client   **Sporton TW (Auden)**

Certificate No: **DAE3-577_Jun11**

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AA - SN: 577

Calibration procedure(s)	QA CAL-06.v23 Calibration procedure for the data acquisition electronics (DAE)

Calibration date:	June 20, 2011

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	28-Sep-10 (No:10376)	Sep-11

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Calibrator Box V1.1	SE UMS 006 AB 1004	08-Jun-11 (in house check)	In house check: Jun-12

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	
Approved by:	Fin Bomholt	R&D Director	

Issued: June 20, 2011

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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 =   6.1μV ,   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	404.381 ± 0.1% (k=2)	403.844 ± 0.1% (k=2)	404.277 ± 0.1% (k=2)
Low Range	3.93296 ± 0.7% (k=2)	3.93560 ± 0.7% (k=2)	3.95800 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	101.5 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	199995.4	-2.24	-0.00
Channel X	+ Input	20003.13	3.03	0.02
Channel X	- Input	-19996.01	3.89	-0.02
Channel Y	+ Input	199996.5	-0.01	-0.00
Channel Y	+ Input	20000.48	0.58	0.00
Channel Y	- Input	-19998.50	2.10	-0.01
Channel Z	+ Input	199994.4	-1.15	-0.00
Channel Z	+ Input	20003.30	3.40	0.02
Channel Z	- Input	-19996.26	3.24	-0.02

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	2000.4	0.29	0.01
Channel X	+ Input	200.33	0.43	0.21
Channel X	- Input	-199.88	-0.08	0.04
Channel Y	+ Input	1999.9	-0.31	-0.02
Channel Y	+ Input	200.45	0.55	0.28
Channel Y	- Input	-200.38	-0.58	0.29
Channel Z	+ Input	1999.6	-0.23	-0.01
Channel Z	+ Input	199.26	-0.64	-0.32
Channel Z	- Input	-200.62	-0.82	0.41

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	15.32	13.45
	- 200	-13.16	-14.40
Channel Y	200	-5.58	-5.70
	- 200	4.51	4.52
Channel Z	200	-1.42	-1.57
	- 200	0.56	0.17

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	-	0.73	-0.43
Channel Y	200	3.10	-	4.07
Channel Z	200	0.93	-1.25	-

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	15973	16638
Channel Y	15856	15275
Channel Z	16211	16876

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	-0.94	-2.52	0.28	0.54
Channel Y	-1.05	-1.87	0.16	0.43
Channel Z	-0.85	-1.57	1.34	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   **Sporton (Auden)**

Certificate No: **ET3-1787_May11**

CALIBRATION CERTIFICATE

Object	ET3DV6 - SN:1787
Calibration procedure(s)	**QA CAL-01.v7, QA CAL-23.v4, QA CAL-25.v3** Calibration procedure for dosimetric E-field probes
Calibration date:	May 20, 2011

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	31-Mar-11 (No. 217-01372)	Apr-12
Power sensor E4412A	MY41498087	31-Mar-11 (No. 217-01372)	Apr-12
Reference 3 dB Attenuator	SN: S5054 (3c)	29-Mar-11 (No. 217-01369)	Apr-12
Reference 20 dB Attenuator	SN: S5086 (20b)	29-Mar-11 (No. 217-01367)	Apr-12
Reference 30 dB Attenuator	SN: S5129 (30b)	29-Mar-11 (No. 217-01370)	Apr-12
Reference Probe ES3DV2	SN: 3013	29-Dec-10 (No. ES3-3013_Dec10)	Dec-11
DAE4	SN: 654	3-May-11 (No. DAE4-654_May11)	May-12
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Oct-09)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-10)	In house check: Oct-11

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

Issued: May 23, 2011

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Accreditation No.: **SCS 108**

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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization $\vartheta = 0$ (f $\leq$ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).

- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.

- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.

- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics

- *Ax,y,z; Bx,y,z; Cx,y,z* are numerical linearization parameters in dB assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media.

- *VR:* VR is the validity range of the calibration related to the average diode voltage or DAE voltage in mV.

- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f $\leq$ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from $\pm$ 50 MHz to $\pm$ 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 ET3DV6

SN:1787

Manufactured: May 28, 2003
Calibrated: May 20, 2011

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

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1787

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	1.56	1.79	2.09	± 10.1 %
DCP (mV)^B	99.8	100.5	95.9	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc^E (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	131.5	±3.0 %
			Y	0.00	0.00	1.00	105.0	
			Z	0.00	0.00	1.00	114.9	

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

^{A} The uncertainties of NormX,Y,Z do not affect the 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: ET3DV6 - SN:1787

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [c]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	41.9	0.89	6.71	6.71	6.71	0.71	1.91	± 12.0 %
835	41.5	0.90	6.39	6.39	6.39	0.68	1.94	± 12.0 %
900	41.5	0.97	6.27	6.27	6.27	0.66	1.99	± 12.0 %
1450	40.5	1.20	5.58	5.58	5.58	0.51	2.57	± 12.0 %
1750	40.1	1.37	5.28	5.28	5.28	0.55	2.32	± 12.0 %
1900	40.0	1.40	5.03	5.03	5.03	0.51	2.44	± 12.0 %
2000	40.0	1.40	5.01	5.01	5.01	0.55	2.24	± 12.0 %
2450	39.2	1.80	4.41	4.41	4.41	0.71	1.83	± 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: ET3DV6- SN:1787

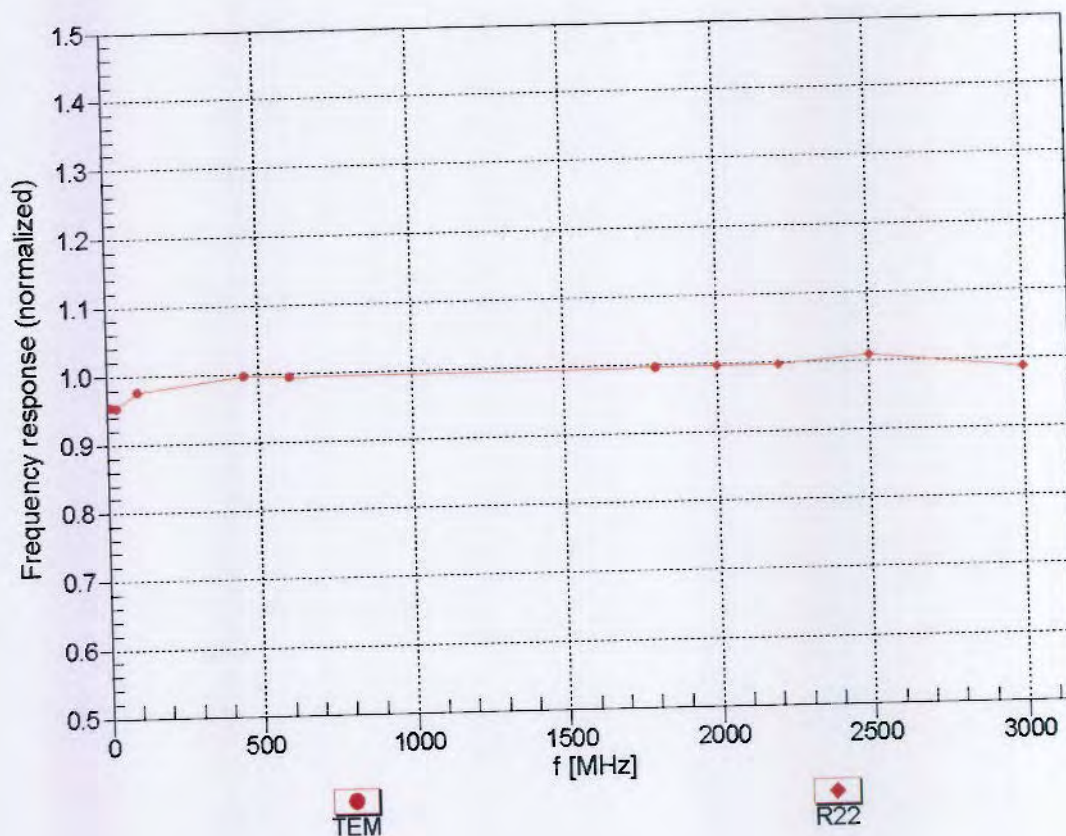## Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [c]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
750	55.5	0.96	6.35	6.35	6.35	0.76	1.83	± 12.0 %
835	55.2	0.97	6.22	6.22	6.22	0.67	2.02	± 12.0 %
900	55.0	1.05	6.17	6.17	6.17	0.72	1.87	± 12.0 %
1450	54.0	1.30	5.35	5.35	5.35	0.57	2.35	± 12.0 %
1750	53.4	1.49	4.74	4.74	4.74	0.56	2.86	± 12.0 %
1900	53.3	1.52	4.48	4.48	4.48	0.56	2.76	± 12.0 %
2000	53.3	1.52	4.50	4.50	4.50	0.60	2.47	± 12.0 %
2450	52.7	1.95	3.96	3.96	3.96	0.99	1.18	± 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.
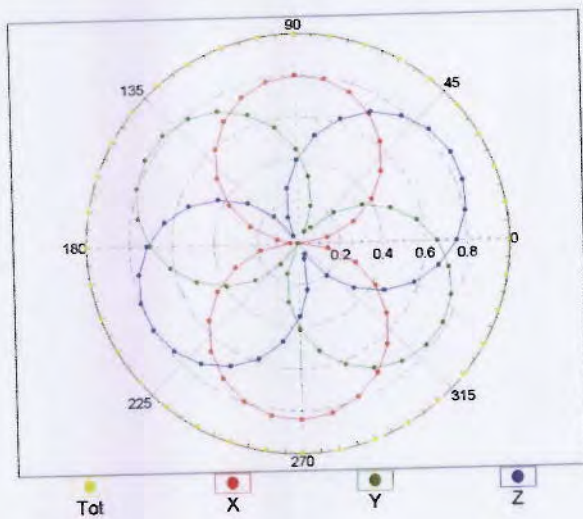
Frequency Response of E-Field
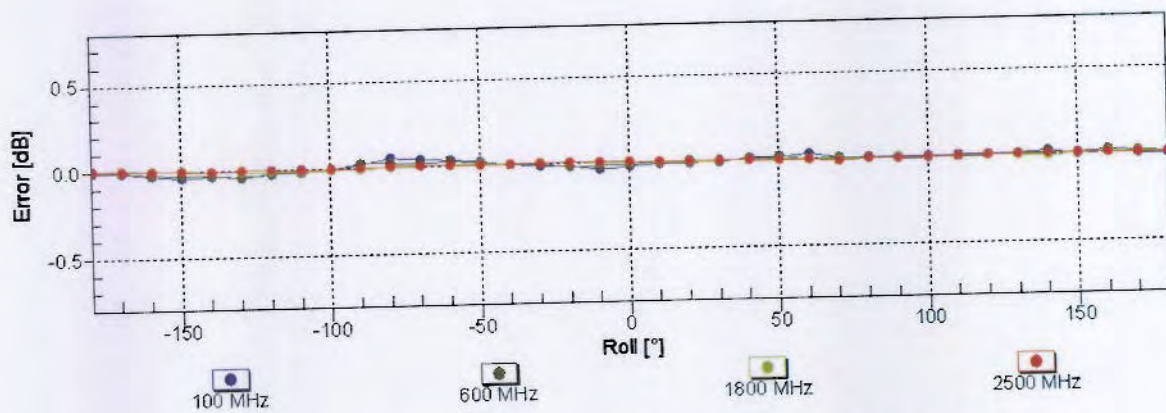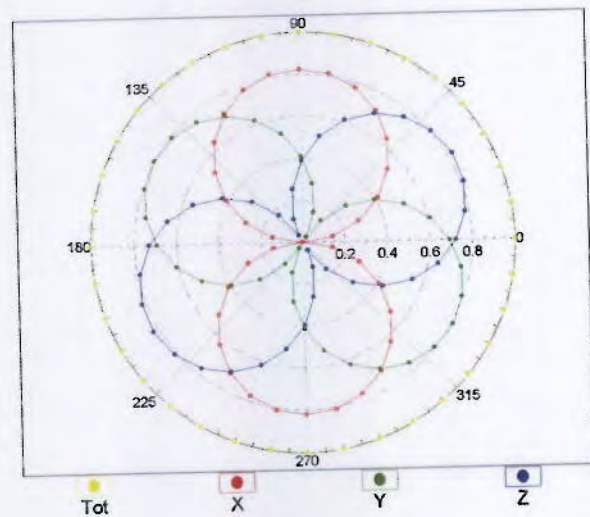## (TEM-Cell:ifi110 EXX, Waveguide: R22)

Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Receiving Pattern (ϕ), $\vartheta = 0°$

f=600 MHz,TEM

| Tot | X | Y | Z |

f=1800 MHz,R22
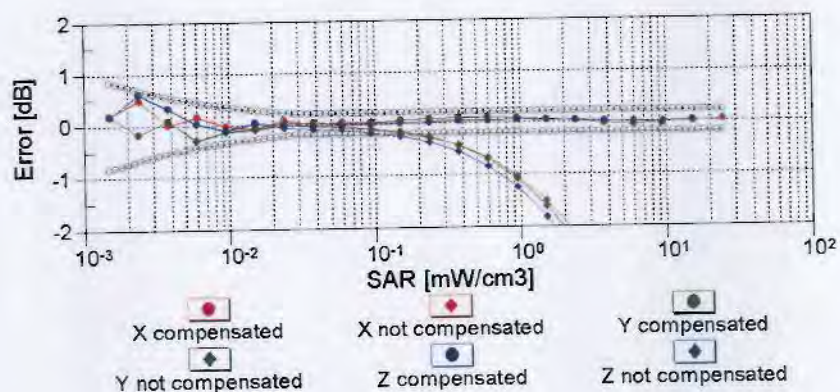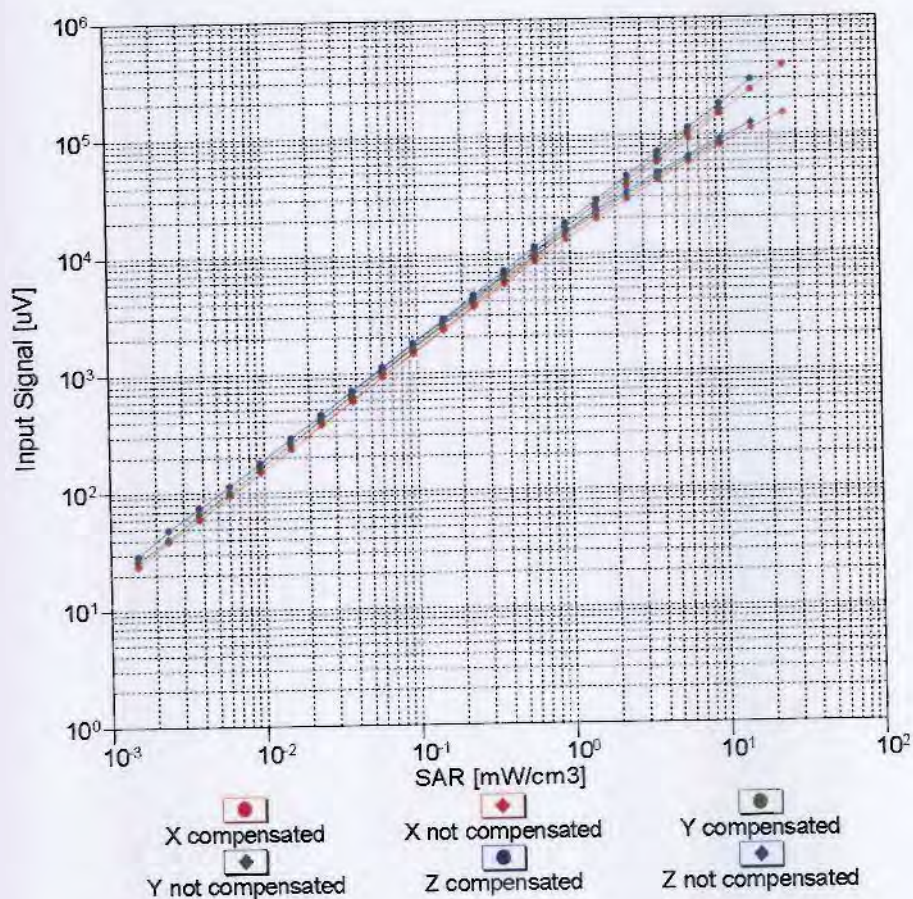

| Tot | X | Y | Z |

| 100 MHz | 600 MHz | 1800 MHz | 2500 MHz |

Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_head)
(TEM cell , f = 900 MHz)

X compensated   X not compensated   Y compensated
Y not compensated   Z compensated   Z not compensated

X compensated   X not compensated   Y compensated
Y not compensated   Z compensated   Z not compensated

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

Conversion Factor Assessment

f = 1900 MHz, WGLS R22 (H_convF)

f = 835 MHz, WGLS R9 (H_convF)

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

Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1787

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	Not applicable
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	6.8 mm
Probe Tip to Sensor X Calibration Point	2.7 mm
Probe Tip to Sensor Y Calibration Point	2.7 mm
Probe Tip to Sensor Z Calibration Point	2.7 mm
Recommended Measurement Distance from Surface	4 mm

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Accreditation No.: SCS 108

Client **Sporton (Auden)**

Certificate No: **ET3-1788_Jan12**

CALIBRATION CERTIFICATE

Object	ET3DV6R - SN:1788
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 26, 2012

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	31-Mar-11 (No. 217-01372)	Apr-12
Power sensor E4412A	MY41498087	31-Mar-11 (No. 217-01372)	Apr-12
Reference 3 dB Attenuator	SN: S5054 (3c)	29-Mar-11 (No. 217-01369)	Apr-12
Reference 20 dB Attenuator	SN: S5086 (20b)	29-Mar-11 (No. 217-01367)	Apr-12
Reference 30 dB Attenuator	SN: S5129 (30b)	29-Mar-11 (No. 217-01370)	Apr-12
Reference Probe ES3DV2	SN: 3013	29-Dec-11 (No. ES3-3013_Dec11)	Dec-12
DAE4	SN: 654	3-May-11 (No. DAE4-654_May11)	May-12
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

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

Issued: January 26, 2012

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SWISS CALIBRATION

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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization $\vartheta = 0$ (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).

- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.

- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.

- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics

- *Ax,y,z; Bx,y,z; Cx,y,z; 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 ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.

- *Spherical isotropy (3D deviation from isotropy):* in a field of low gradients realized using a flat phantom exposed by a patch antenna.

- *Sensor Offset:* The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

Probe ET3DV6R

SN:1788

Manufactured: May 28, 2003
Repaired   January 23, 2012
Calibrated: January 26, 2012

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

DASY/EASY - Parameters of Probe: ET3DV6R - SN:1788

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	2.07	1.99	2.05	± 10.1 %
DCP $(mV)^B$	98.4	99.3	99.0	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc^E (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	116.0	±2.7 %
			Y	0.00	0.00	1.00	118.0	
			Z	0.00	0.00	1.00	111.6	

> 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: ET3DV6R - SN:1788

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	5.80	5.80	5.80	0.31	3.00	± 12.0 %
900	41.5	0.97	5.65	5.65	5.65	0.29	3.00	± 12.0 %
1750	40.1	1.37	4.90	4.90	4.90	0.80	2.00	± 12.0 %
1900	40.0	1.40	4.68	4.68	4.68	0.80	2.02	± 12.0 %
2000	40.0	1.40	4.62	4.62	4.62	0.80	1.90	± 12.0 %
2450	39.2	1.80	3.99	3.99	3.99	0.80	1.67	± 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: ET3DV6R - SN:1788

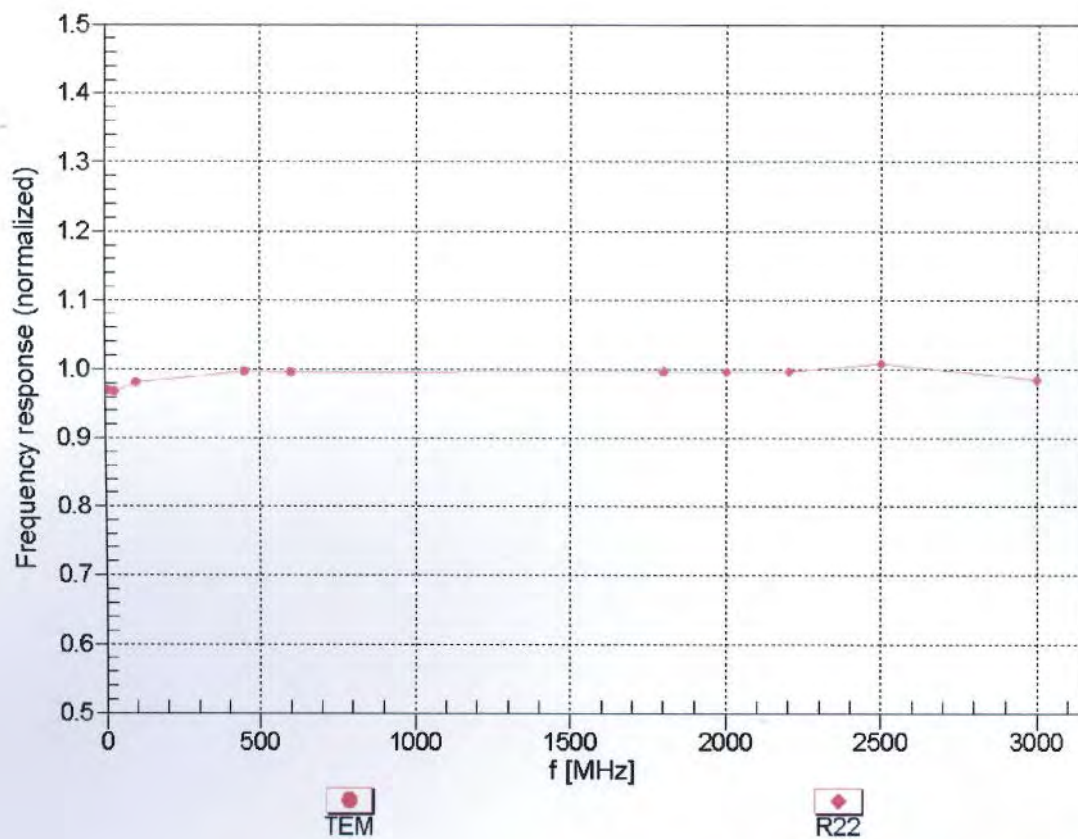## Calibration Parameter Determined in Body Tissue Simulating Media

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	5.75	5.75	5.75	0.29	3.00	± 12.0 %
900	55.0	1.05	5.66	5.66	5.66	0.35	2.71	± 12.0 %
1750	53.4	1.49	4.29	4.29	4.29	0.80	2.58	± 12.0 %
1900	53.3	1.52	4.06	4.06	4.06	0.80	2.40	± 12.0 %
2000	53.3	1.52	4.06	4.06	4.06	0.80	2.40	± 12.0 %
2450	52.7	1.95	3.55	3.55	3.55	0.64	1.17	± 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.
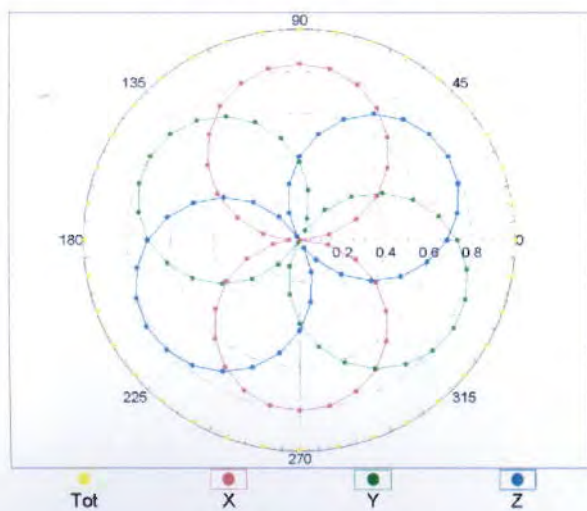
Frequency Response of E-Field
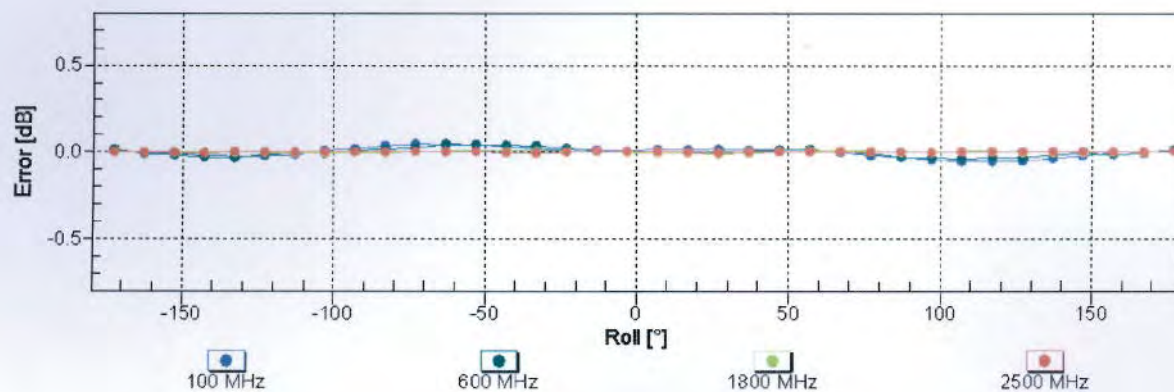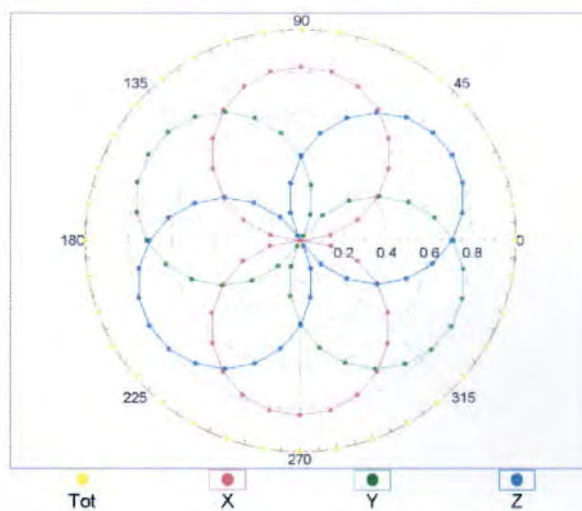## (TEM-Cell:ifi110 EXX, Waveguide: R22)

Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

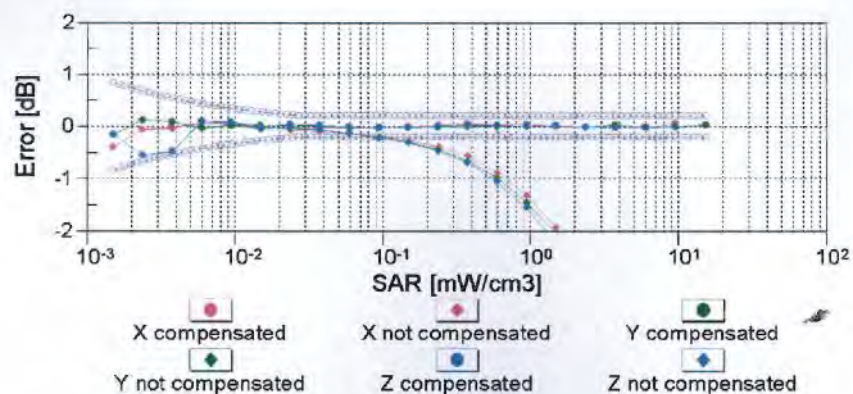# Receiving Pattern (ϕ), $\vartheta = 0°$

f=600 MHz,TEM

f=1800 MHz,R22

Tot   X   Y   Z

Tot   X   Y   Z

100 MHz   600 MHz   1800 MHz   2500 MHz

Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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

X compensated	X not compensated	Y compensated
Y not compensated	Z compensated	Z not compensated

X compensated	X not compensated	Y compensated
Y not compensated	Z compensated	Z not compensated

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

Conversion Factor Assessment

f = 900 MHz, WGLS R9 (H_convF)   f = 1900 MHz, WGLS R22 (H_convF)

analytical   measured   analytical   measured

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

-1.0   -0.8   -0.6   -0.4   -0.2   0.0   0.2   0.4   0.6   0.8   1.0

Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

DASY/EASY - Parameters of Probe: ET3DV6R - SN:1788

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	Not applicable
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	6.8 mm
Probe Tip to Sensor X Calibration Point	2.7 mm
Probe Tip to Sensor Y Calibration Point	2.7 mm
Probe Tip to Sensor Z Calibration Point	2.7 mm
Recommended Measurement Distance from Surface	4 mm

Calibration Laboratory of
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 Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client   **Sporton (Auden)**

Certificate No: **EX3-3792_Jun11**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3792
Calibration procedure(s)	QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4 Calibration procedure for dosimetric E-field probes
Calibration date:	June 20, 2011

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	31-Mar-11 (No. 217-01372)	Apr-12
Power sensor E4412A	MY41498087	31-Mar-11 (No. 217-01372)	Apr-12
Reference 3 dB Attenuator	SN: S5054 (3c)	29-Mar-11 (No. 217-01369)	Apr-12
Reference 20 dB Attenuator	SN: S5086 (20b)	29-Mar-11 (No. 217-01367)	Apr-12
Reference 30 dB Attenuator	SN: S5129 (30b)	29-Mar-11 (No. 217-01370)	Apr-12
Reference Probe ES3DV2	SN: 3013	29-Dec-10 (No. ES3-3013_Dec10)	Dec-11
DAE4	SN: 654	3-May-11 (No. DAE4-654_May11)	May-12
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Oct-09)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-10)	In house check: Oct-11

	Name	Function	Signature
Calibrated by:	Katja Pokovic	Technical Manager	
Approved by:	Niels Kuster	Quality Manager	

Issued: June 21, 2011

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Calibration Laboratory of

Schmid & Partner
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S   Swiss Calibration Service

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)
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Multilateral Agreement for the recognition of calibration certificates

Glossary:

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

Calibration is Performed According to the Following Standards:

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

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- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.

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- *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 $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.

- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.

- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

Probe EX3DV4

SN:3792

Manufactured: April 5, 2011
Calibrated: June 20, 2011

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3792

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (μV/(V/m)^2)^A	0.64	0.54	0.54	± 10.1 %
DCP (mV)^B	97.9	98.9	99.8	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc^E (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	134.2	±2.7 %
			Y	0.00	0.00	1.00	123.8	
			Z	0.00	0.00	1.00	122.9	

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

^{A} The uncertainties of NormX,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).
^{B} Numerical linearization parameter: uncertainty not required.
^{E} Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3792

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	8.93	8.93	8.93	0.80	0.67	± 12.0 %
900	41.5	0.97	8.69	8.69	8.69	0.75	0.71	± 12.0 %
1750	40.1	1.37	8.06	8.06	8.06	0.75	0.62	± 12.0 %
1900	40.0	1.40	7.76	7.76	7.76	0.76	0.60	± 12.0 %
2000	40.0	1.40	7.68	7.68	7.68	0.80	0.57	± 12.0 %
2300	39.5	1.67	7.27	7.27	7.27	0.73	0.61	± 12.0 %
2450	39.2	1.80	6.92	6.92	6.92	0.70	0.62	± 12.0 %
2600	39.0	1.96	6.85	6.85	6.85	0.62	0.68	± 12.0 %
3500	37.9	2.91	6.74	6.74	6.74	0.34	1.03	± 13.1 %
5200	36.0	4.66	4.95	4.95	4.95	0.35	1.80	± 13.1 %
5300	35.9	4.76	4.71	4.71	4.71	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.66	4.66	4.66	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.23	4.23	4.23	0.45	1.80	± 13.1 %
5800	35.3	5.27	4.42	4.42	4.42	0.43	1.80	± 13.1 %

[c] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

DASY/EASY - Parameters of Probe: EX3DV4- SN:3792

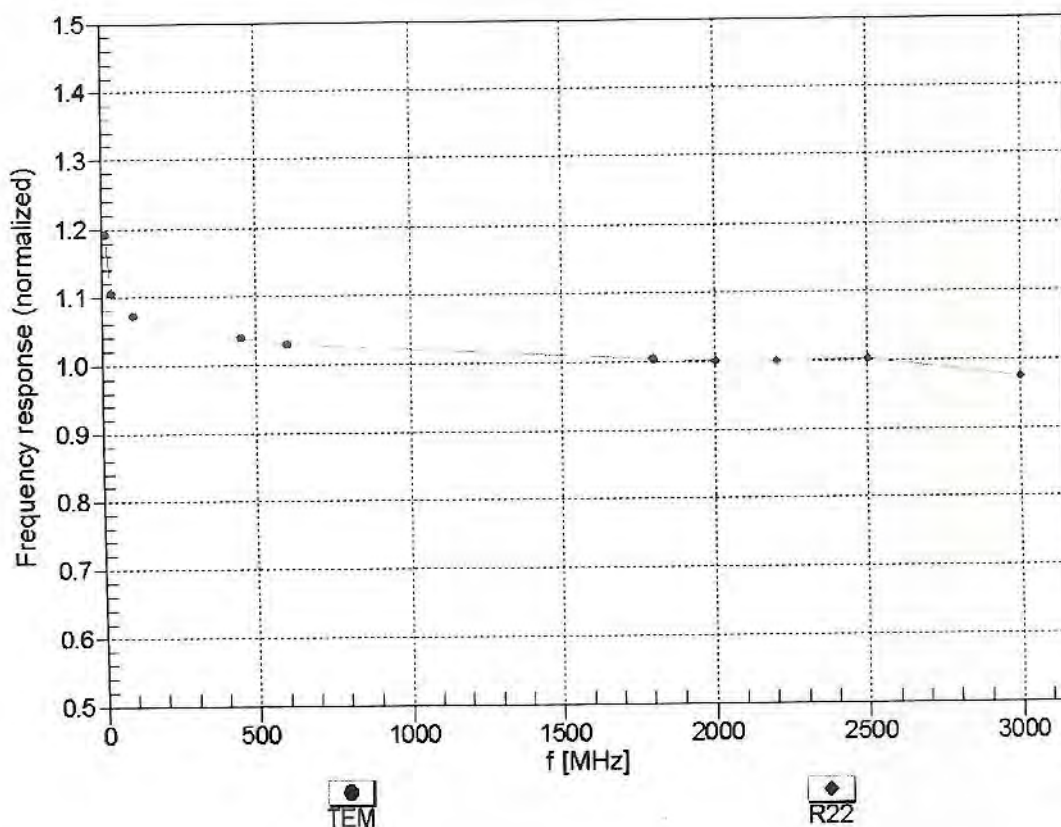## Calibration Parameter Determined in Body Tissue Simulating Media

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	9.02	9.02	9.02	0.80	0.72	± 12.0 %
900	55.0	1.05	8.91	8.91	8.91	0.80	0.71	± 12.0 %
1750	53.4	1.49	7.62	7.62	7.62	0.80	0.69	± 12.0 %
1900	53.3	1.52	7.17	7.17	7.17	0.80	0.64	± 12.0 %
2000	53.3	1.52	7.15	7.15	7.15	0.80	0.63	± 12.0 %
2300	52.9	1.81	6.90	6.90	6.90	0.80	0.61	± 12.0 %
2450	52.7	1.95	6.67	6.67	6.67	0.80	0.59	± 12.0 %
2600	52.5	2.16	6.53	6.53	6.53	0.80	0.60	± 12.0 %
3500	51.3	3.31	6.08	6.08	6.08	0.29	1.48	± 13.1 %
5200	49.0	5.30	4.22	4.22	4.22	0.50	1.90	± 13.1 %
5300	48.9	5.42	3.93	3.93	3.93	0.55	1.90	± 13.1 %
5500	48.6	5.65	3.76	3.76	3.76	0.55	1.90	± 13.1 %
5600	48.5	5.77	3.53	3.53	3.53	0.60	1.90	± 13.1 %
5800	48.2	6.00	3.78	3.78	3.78	0.60	1.90	± 13.1 %

[c] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
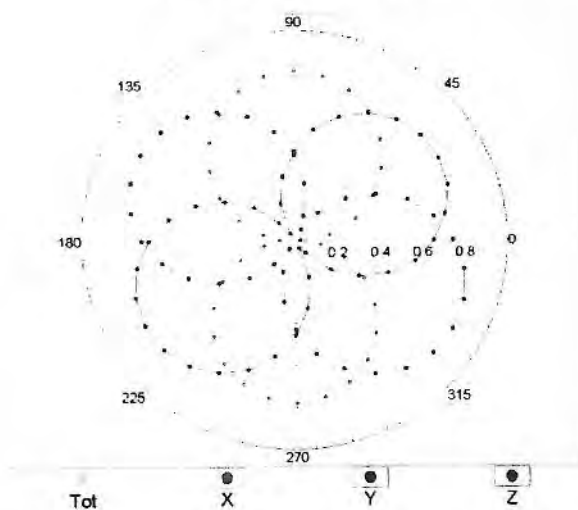
Frequency Response of E-Field
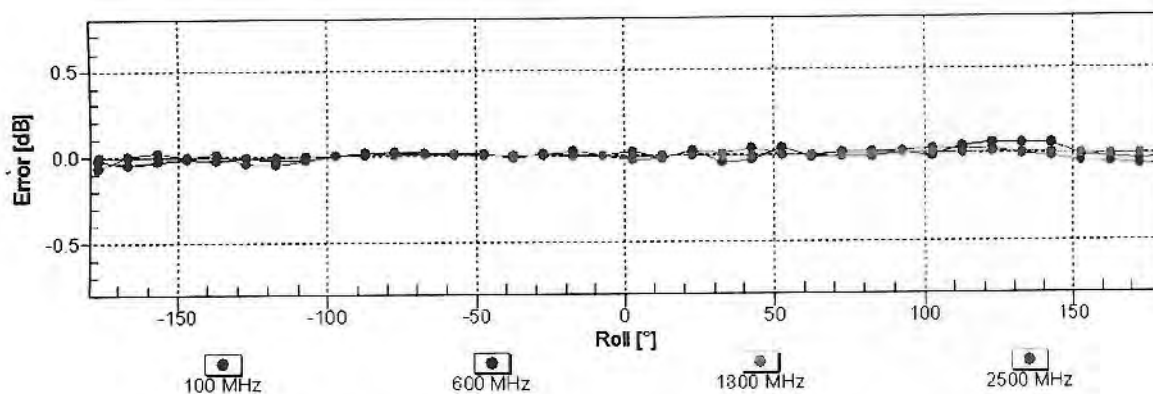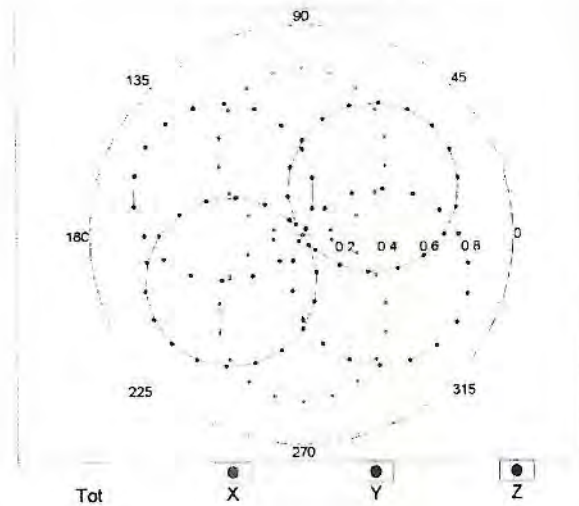## (TEM-Cell:ifi110 EXX, Waveguide: R22)

Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Receiving Pattern (φ), ϑ = 0°

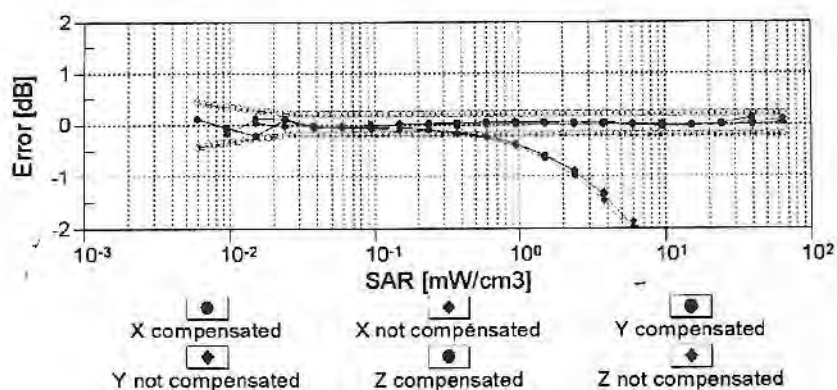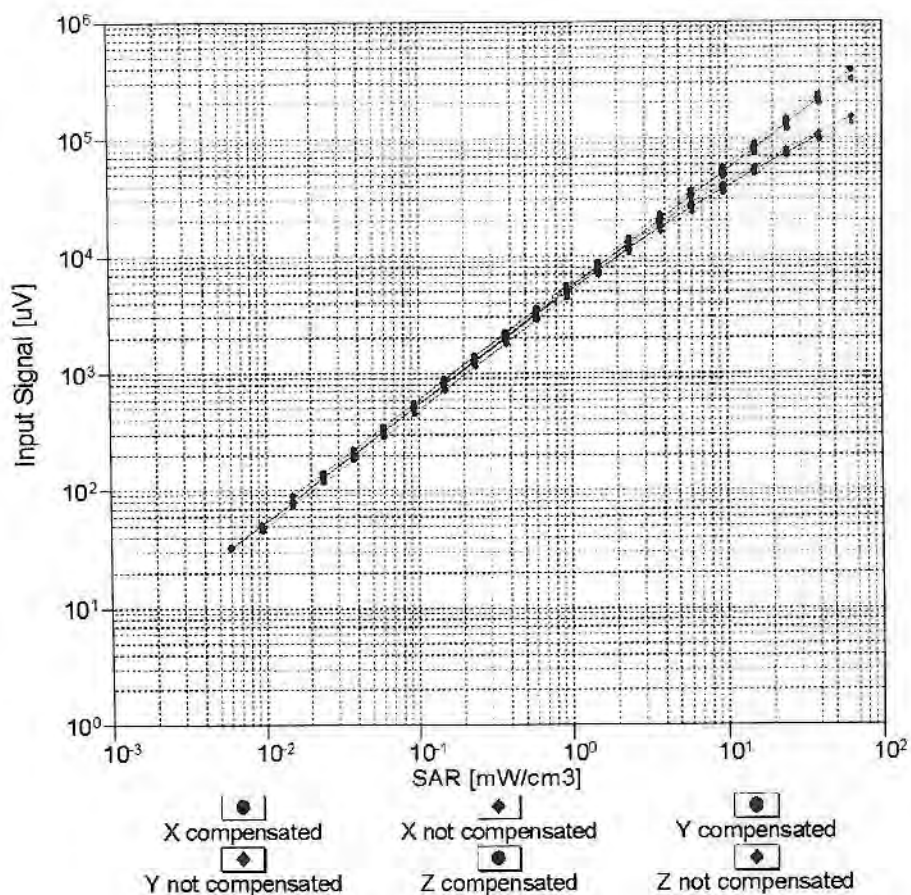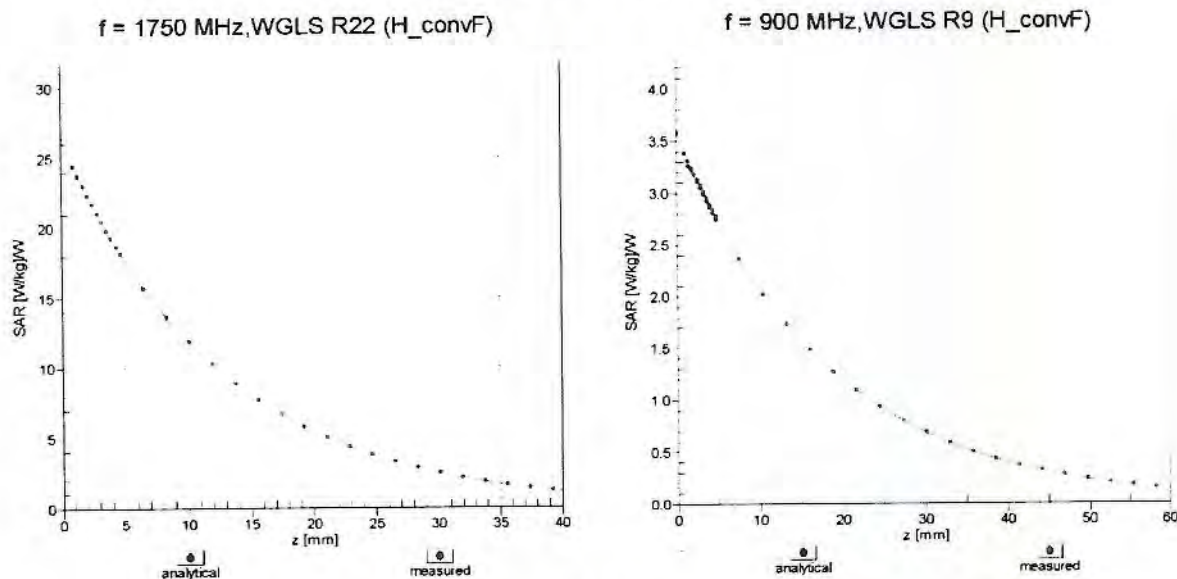## f=600 MHz,TEM   f=1800 MHz,R22

Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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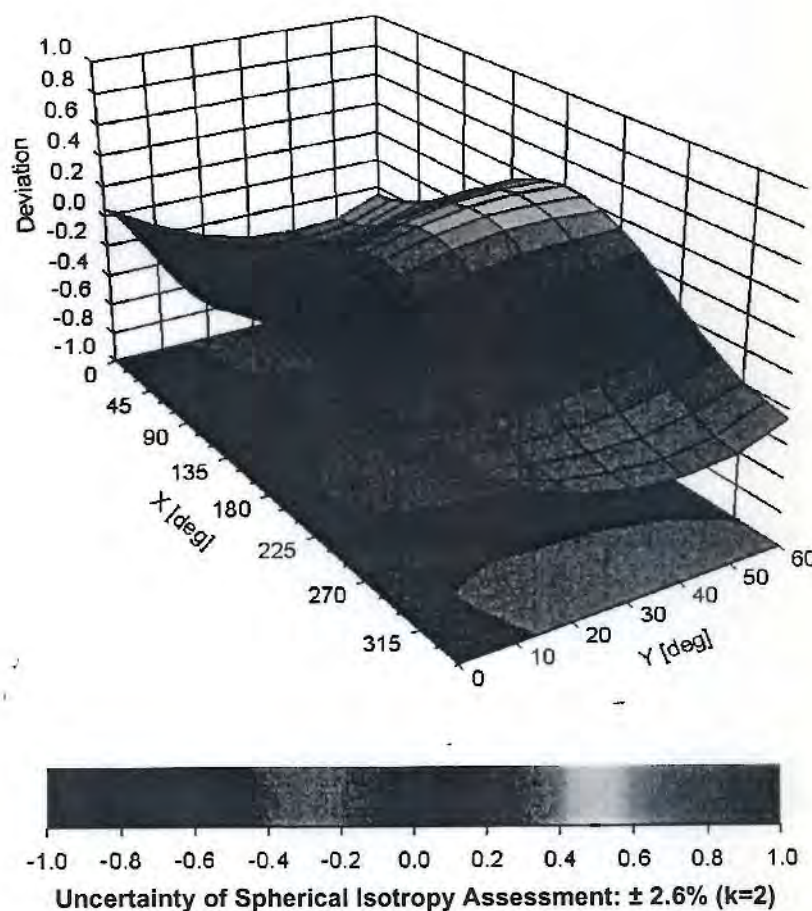## (TEM cell , f = 900 MHz)

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

Conversion Factor Assessment

f = 1750 MHz,WGLS R22 (H_convF)

f = 900 MHz,WGLS R9 (H_convF)

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

Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3792

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	Not applicable
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm