A Test Lab Techno Corp.

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SAR EVALUATION REPORT

Test Report No.	:	1109FS16
Applicant	:	AEROMAX TECHNOLOGY CO., LTD.
Product Type	:	WiFi USB Dongle
Trade Name	:	Aeromax
Model Number	:	WU1112
Dates of Receive	:	Aug. 31, 2011
Dates of Test	:	Sep. 27, 2011
Date of Issued	:	Oct. 25, 2011
Test Environment	:	Ambient Temperature： 22 ±2°C
		Relative Humidity：40 - 70％
Standard	:	ANSI/IEEE C95.1-1999
		IEEE Std. 1528-2003
		47 CFR Part §2.1093
		FCC/OET Bulletin 65 Supplement C [July 2001]
		KDB 248227 D01 SAR meas for 802.11 a b g v01r02
		KDB 447498 "RF Exposure Procedures and Equipment Authorization Policies"
Max. SAR	:	0.098 W/kg Body SAR
Test Lab Location	:	Chang-an Lab
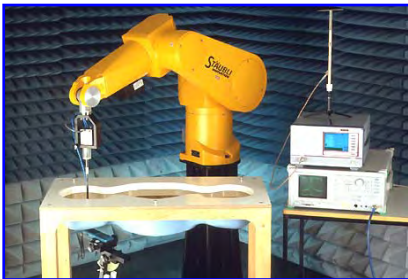
1. The test operations have to be performed with cautious behavior, the test results are as attached.
2. The test results are under chamber environment of A Test Lab Techno Corp. A Test Lab Techno Corp. does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples.
3. The measurement report has to be written approval of A Test Lab Techno Corp. It may only be reproduced or published in full. This report shall not be reproduced except in full, without the written approval of A Test Lab Techno Corp. The test results in the report only apply to the tested sample.

Approved By : _(Sam Chuang)_

Tested By : _(Alex Wu)_

Contents

1. Description of Equipment under Test (EUT)

Applicant	AEROMAX TECHNOLOGY CO., LTD.
Applicant Address	16F.-2, No.77, Sec. 1, Sintai 5th Rd., Sijhih Dist., New Taipei City, Taiwan 221
Manufacturer	AEROMAX TECHNOLOGY CO., LTD.
Manufacturer Address	16F.-2, No.77, Sec. 1, Sintai 5th Rd., Sijhih Dist., New Taipei City, Taiwan 221
Product Type	WiFi USB Dongle
Trade Name	Aeromax
Model Number	WU1112
FCC ID	Z6K-RT3070WU1112

Tx Frequency	Band	Operate Frequency (MHz)
	IEEE 802.11b / IEEE 802.11g	2412 - 2462
	Draft 802.11n 2.4GHz Standard-20MHz	2412 - 2462
	Draft 802.11n 2.4GHz Standard-40MHz	2422 - 2452

RF Conducted Power (Avg.)	Band	Power (W / dBm)
	IEEE 802.11b	0.019 / 12.87
	IEEE 802.11g	0.010 / 9.85
	Draft 802.11n 2.4GHz Standard-20MHz	0.008 / 8.92
	Draft 802.11n 2.4GHz Standard-40MHz	0.008 / 9.13

Max. SAR Measurement	0.098 W/kg Body SAR
Antenna Type	External Type
Antenna for Test	ARISTOTLE, RFA-25-T42-M62-1
Device Category	Portable Device
RF Exposure Environment	General Population / Uncontrolled
Application Type	Certification

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment / general population exposure limits specified in Standard C95.1-1999 and had been tested in accordance with the measurement procedures specified in IEEE Std. 1528-2003.

2. *Introduction*

The A Test Lab Techno Corp. has performed measurements of the maximum potential exposure to the user of **AEROMAX TECHNOLOGY CO., LTD.   Trade Name：Aeromax   Model(s)：WU1112.** The test procedures, as described in American National Standards, Institute C95.1-1999〔1〕, FCC/OET Bulletin 65 Supplement C [July 2001] were employed and they specify the maximum exposure limit of 1.6mW/g as averaged over any 1 gram of tissue for portable devices being used within 20cm between user and EUT in the uncontrolled environment. A description of the product and operating configuration, detailed summary of the test results, methodology and procedures used in the equipment used are included within this test report.

2.1   SAR Definition

Specific Absorption Rate (SAR) is defined as 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). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Figure 2).

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

Figure 2. SAR Mathematical Equation

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

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

Where：

σ =   conductivity of the tissue (S/m)

ρ =   mass density of the tissue (kg/m^3)

E =   RMS electric field strength (V/m)

＊Note：

The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relations to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane〔2〕
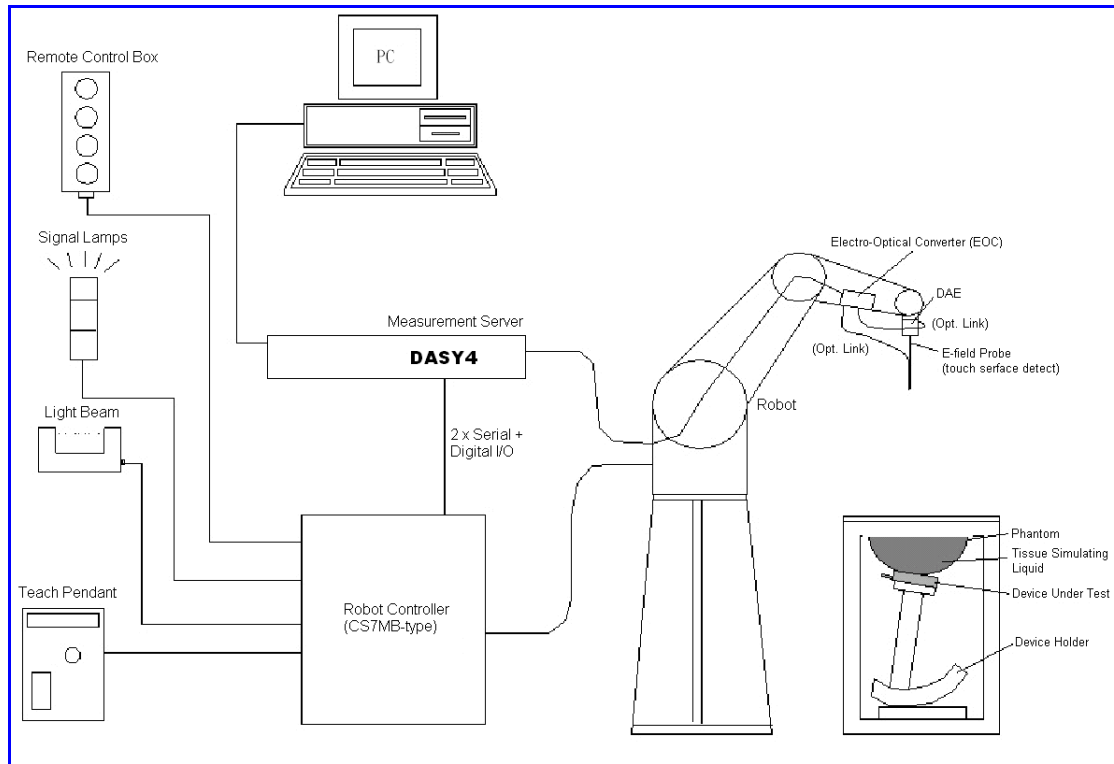
3. SAR Measurement Setup

These measurements were performed with the automated near-field scanning system DASY4 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9m) which positions the probes with a positional repeatability of better than $\pm$ 0.025mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines (length = 300mm) to the data acquisition unit.

A cell controller system contains the power supply, robot controller, teaches pendant (Joystick) and remote control, and is used to drive the robot motors. The Measurement Server is based on a PC/104 CPU board with a 166MHz low-power Pentium, 32MB chipdisk and 64MB RAM. The necessary circuits for communication with either the DAE3 electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY4 I/O-board, which is directly connected to the PC/104 bus of the CPU board. The PC consists of the Intel Pentium 4 2.4GHz computer with Windows XP system and SAR Measurement Software DASY4, Post Processor SEMCAD, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection…etc. is connected to the Electro-optical converter (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the Measurement Server.

The DAE4 (or DAE3) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in〔3〕.

Figure 1. SAR Lab Test Measurement Setup

3.1 DASY4 E-Field Probe System

The SAR measurements were conducted with the dosimetric probe EX3DV3 (manufactured by SPEAG), designed in the classical triangular configuration〔3〕and optimized for dosimetric evaluation. The probes is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped when reaching the maximum.

3.1.1 E-Field Probe Specification

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.q., glycol)

Calibration   In air from 10 MHz to 6 GHz

In brain and muscle simulating tissue at frequencies of 2450MHz (accuracy $\pm 8\%$)

Calibration for other liquids and frequencies upon request

Frequency ± 0.2 dB (30 MHz to 4 GHz) for EX3DV3

Directivity ± 0.3 dB in brain tissue (rotation around probe axis)

± 0.5 dB in brain tissue (rotation normal probe axis)

Dynamic Range 10μ W/g to $>$ 100mW/g; Linearity: ± 0.2dB

Dimensions   Overall length: 337mm

Tip length: 20mm

Body diameter: 12mm

Tip diameter: 3.9mm for EX3DV3

Distance from probe tip to dipole centers: 2.0mm for EX3DV3

Application   General dosimetry up to 6GHz

Compliance tests of mobile phones

Fast automatic scanning in arbitrary phantoms
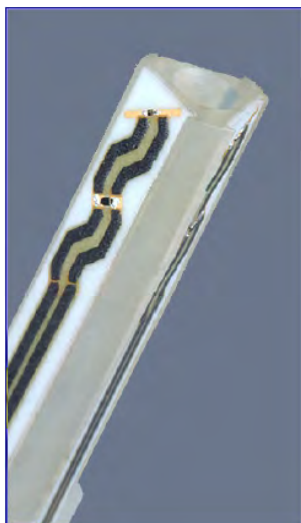
Figure 3. E-field Probe	**Figure 4. Probe setup on robot**

3.1.2 E-Field Probe Calibration process

Dosimetric Assessment Procedure

Each E-Probe/Probe Amplifier combination has unique calibration parameters.   A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm^2) using an RF Signal generator, TEM cell, and RF Power Meter.

Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber.   This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or other methodologies above 1 GHz for free space.   For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field.   The probe is rotated 360 degrees until the three channels show the maximum reading.   The power density readings equates to 1 mW/cm^2.

Temperature Assessment

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

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

Where：

$\boldsymbol{\Delta t}$　= Exposure time (30 seconds),

C　　= Heat capacity of tissue (head or body),

$\boldsymbol{\Delta T}$　= Temperature increase due to RF exposure.

Or　　**SAR =** $\dfrac{|\boldsymbol{E}|^2 \, \boldsymbol{\sigma}}{\boldsymbol{\rho}}$

Where：

$\boldsymbol{\sigma}$　　= Simulated tissue conductivity,

$\boldsymbol{\rho}$　　= Tissue density (kg/m^3).

3.2 Data Acquisition Electronic (DAE) System

Cell Controller

Processor： Intel Pentium 4

Clock Speed： 2.4GHz

Operating System： Windows XP Professional

Data Converter

Features： Signal Amplifier, multiplexer, A/D converter, and control logic

Software： DASY4 v4.7 (Build 80) & SEMCAD v1.8 (Build 186)

Connecting Lines： Optical downlink for data and status info

Optical uplink for commands and clock

3.3 Robot

Positioner： Stäubli Unimation Corp. Robot Model: RX90L

Repeatability： ±0.025 mm

No. of Axis： 6

3.4 Measurement Server

Processor： PC/104 with a 166MHz low-power Pentium

I/O-board： Link to DAE4 (or DAE3)

16-bit A/D converter for surface detection system

Digital I/O interface

Serial link to robot

Direct emergency stop output for robot

3.5 Device Holder

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.
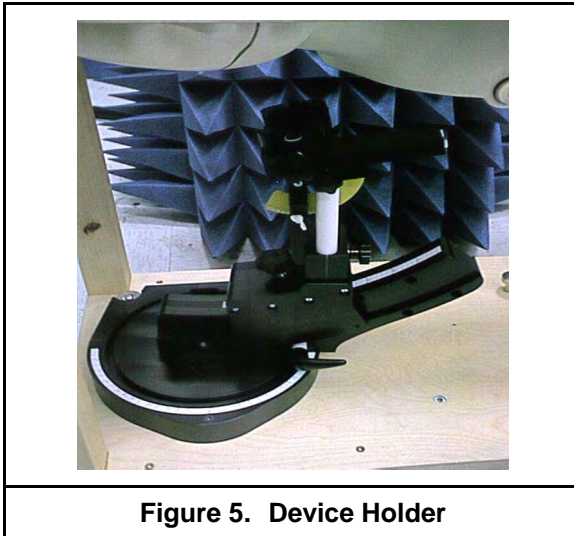
Figure 5. Device Holder

3.6 Phantom - SAM v4.0

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.

Shell Thickness	2 ±0.2 mm
Filling Volume	Approx. 25 liters
Dimensions	1000×500 mm (L×W)
Table 1. Specification of SAM v4.0	

Figure 6. SAM Twin Phantom

3.7   Oval Flat Phantom - ELI 4.0

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (Oval Flat) phantom defined in IEEE 1528-2003, CENELEC 50361 and IEC 62209. It enables the dosimetric evaluation of wireless portable device usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.

Shell Thickness	2 ±0.2 mm
Filling Volume	Approx. 30 liters
Dimensions	190×600×400 mm (H×L×W)
Table 2. Specification of ELI 4.0	
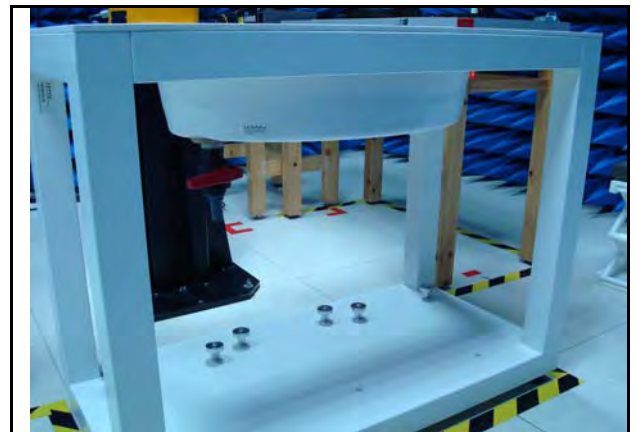
Figure 7. Oval Flat Phantom

3.8   Data Storage and Evaluation

3.8.1 Data Storage

The DASY4 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 with the extension .DA4. 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.

3.8.2 Data Evaluation

The DASY4 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   Normi, ai0, ai1, ai2

                     - Conversion factor   ConvFi

                     - Diode compression point   dcpi

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 multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

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

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

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：

E-field probes： $E_i = \sqrt{\dfrac{V_i}{Norm_i \cdot ConvF}}$

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)

           μ 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

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

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

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

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.

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

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

with P_{pwe} = equivalent power density of a plane wave in mW/cm^2

       E_{tot} = total electric field strength in V/m

       H_{tot} = total magnetic field strength in A/m

4. _Tissue Simulating Liquids_

The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the tissue. The dielectric parameters of the liquids were verified prior to the SAR evaluation using an 85070C Dielectric Probe Kit and an E5071B Network Analyzer.

IEEE SCC-34/SC-2 in 1528 recommended Tissue Dielectric Parameters

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in 1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in human head. Other head and body tissue parameters that have not been specified in 1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equation and extrapolated according to the head parameter specified in 1528.

Target Frequency	Head		Body	
(MHz)	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 - 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00
(ε_r = relative permittivity, σ = conductivity and ρ = 1000 kg/m^3)				

Table 3. Tissue dielectric parameters for head and body phantoms

4.1 Ingredients

The following ingredients are used:

- Water: deionized water (pure H_2O), resistivity ≥ 16 M Ω -as basis for the liquid
- Sugar: refied white sugar (typically 99.7 % sucrose, available as crystal sugar in food shops) -to reduce relative permittivity
- Salt: pure NaCl -to increase conductivity
- Cellulose: Hydroxyethyl-cellulose, medium viscosity (75-125 mPa.s, 2% in water, 20°C), CAS # 54290 -to increase viscosity and to keep sugar in solution.
- Preservative: Preventol D-7 Bayer AG, D-51368 Leverkusen, CAS # 55965-84-9 -to prevent the spread of bacteria and molds
- DGBE: Diethylenglycol-monobuthyl ether (DGBE), Fluka Chemie GmbH, CAS # 112-34-5 -to reduce relative permittivity

4.2 Recipes

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

Note: The goal dielectric parameters (at 22 ℃) must be achieved within a tolerance of ±5% for ε and ±5% for σ.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Salt: 99[+]% Pure Sodium Chloride   Sugar: 98[+]% Pure Sucrose

Water: De-ionized, 16 MΩ [+] resistivity   HEC: Hydroxyethyl Cellulose

DGBE: 99[+]% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]

Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

4.3 Liquid Confirmation

4.3.1 Parameters

Liquid Verify								
Ambient Temperature： 22 ± 2 ℃；Relative Humidity：40 -70%								
Liquid Type	Frequency	Temp (°C)	Parameters	Target Value	Measured Value	Deviation (%)	Limit (%)	Measured Date
2450MHz Body	2400MHz	22.0	εr	52.7	51.81	-1.69 %	± 5	09/27/2011
			σ	1.95	1.88	-3.59 %	± 5	
	2450MHz	22.0	εr	52.7	51.67	-1.95 %	± 5	
			σ	1.95	1.94	-0.51 %	± 5	
	2500MHz	22.0	εr	52.7	51.50	-2.28 %	± 5	
			σ	1.95	2.00	2.56 %	± 5	

Table 4. Measured Tissue dielectric parameters for head and body phantoms

4.3.2 Liquid Depth

The liquid level was during measurement 15cm ±0.5cm.

Figure 8. Head-Tissue-Simulating-Liquid	Figure 9. Body-Tissue-Simulating-Liquid
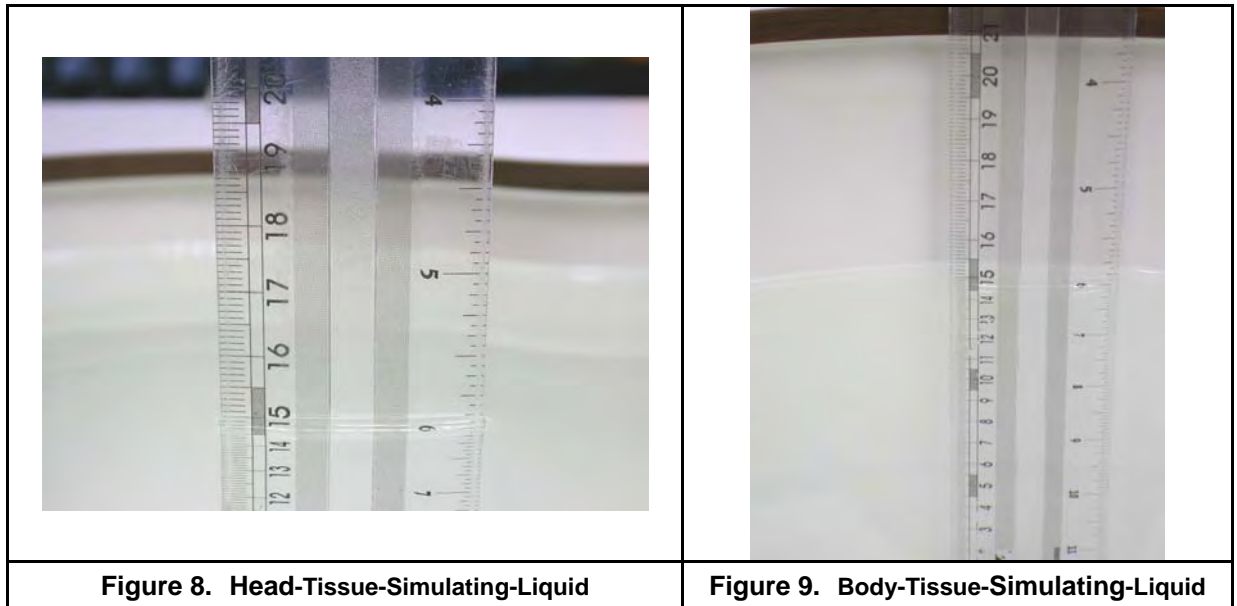
5.   *SAR Testing with RF Transmitters*

5.1   SAR Testing with 802.11 Transmitters

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

5.1.1   General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined

for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

5.1.2   Frequency Channel Configurations

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

802.11 Test Channels per FCC Requirement

Mode		GHz	Channel	Turbo Channel	Default Test "Channels" §15.247 802.11b	Default Test "Channels" §15.247 802.11g	UNII	
802.11 b/g		2412	1		✓	▽		
		2437	6	6	✓	▽		
		2462	11		✓	▽		
802.11a	UNII	5.18	36				✓	
		5.20	40	42 (5.21 GHz)				∗
		5.22	44					∗
		5.24	48	50 (5.25 GHz)				
		5.26	52				✓	
		5.28	56	58 (5.29 GHz)				∗
		5.30	60					∗
		5.32	64				✓	
		5.500	100	Unknown				∗
		5.520	104				✓	
		5.540	108					∗
		5.560	112					∗
		5.580	116				✓	
		5.600	120					∗
		5.620	124				✓	
		5.640	128					∗
		5.660	132					∗
		5.680	136				✓	
		5.700	140					∗
	UNII or §15.247	5.745	149		✓		✓	
		5.765	153	152 (5.76 GHz)		∗		∗
		5.785	157		✓			∗
		5.805	161	160 (5.80 GHz)		∗	✓	
	§15.247	5.825	165		✓			

5.2 Conducted Power

Band	Data Rate	CH	Frequency (MHz)	Average Power (dBm)
IEEE 802.11b	1M	1	2412.0	**12.87**
		6	2437.0	12.75
		11	2462.0	12.02
	2M	1	2412.0	12.76
		6	2437.0	12.67
		11	2462.0	12.06
	5.5M	1	2412.0	12.70
		6	2437.0	12.55
		11	2462.0	12.58
	11M	1	2412.0	12.75
		6	2437.0	12.41
		11	2462.0	12.86
IEEE 802.11g	6M	1	2412.0	**9.85**
		6	2437.0	9.05
		11	2462.0	9.59
	9M	1	2412.0	9.72
		6	2437.0	9.38
		11	2462.0	9.39
	12M	1	2412.0	9.66
		6	2437.0	9.08
		11	2462.0	9.35
	18M	1	2412.0	9.64
		6	2437.0	9.51
		11	2462.0	9.43
	24M	1	2412.0	9.77
		6	2437.0	9.75
		11	2462.0	9.34
	36M	1	2412.0	9.70
		6	2437.0	9.58
		11	2462.0	9.24
	48M	1	2412.0	9.55
		6	2437.0	9.47
		11	2462.0	9.20
	54M	1	2412.0	9.71
		6	2437.0	9.74
		11	2462.0	8.54
Draft 802.11n_HT20	6.5M	1	2412.0	**8.92**
		6	2437.0	8.32
		11	2462.0	8.44
	13M	1	2412.0	8.44
		6	2437.0	8.40
		11	2462.0	7.64

Band	Data Rate	CH	Frequency (MHz)	Average Power (dBm)
Draft 802.11n_HT20	19.5M	1	2412.0	8.70
		6	2437.0	8.09
		11	2462.0	7.70
	26M	1	2412.0	8.64
		6	2437.0	8.13
		11	2462.0	7.70
	39M	1	2412.0	8.87
		6	2437.0	8.30
		11	2462.0	7.86
	52M	1	2412.0	8.80
		6	2437.0	8.55
		11	2462.0	7.82
	58.5M	1	2412.0	8.80
		6	2437.0	8.40
		11	2462.0	7.63
	65M	1	2412.0	8.85
		6	2437.0	8.33
		11	2462.0	7.70
Draft 802.11n_HT40	13.5M	3	2422.0	**9.13**
		6	2437.0	8.71
		9	2452.0	8.37
	27M	3	2422.0	8.96
		6	2437.0	8.67
		9	2452.0	8.20
	40.5M	3	2422.0	8.98
		6	2437.0	8.50
		9	2452.0	8.07
	54M	3	2422.0	8.65
		6	2437.0	8.59
		9	2452.0	8.03
	81M	3	2422.0	8.68
		6	2437.0	8.66
		9	2452.0	7.99
	108M	3	2422.0	8.82
		6	2437.0	8.62
		9	2452.0	7.98
	121.5M	3	2422.0	8.93
		6	2437.0	8.57
		9	2452.0	7.73
	135M	3	2422.0	8.84
		6	2437.0	8.68
		9	2452.0	8.20

6.   *System Performance Check*

6.1   Symmetric Dipoles for System Validation

Construction   Symmetrical dipole with l/4 balun enables measurement of feed point impedance with NWA matched for use near flat phantoms filled with head simulating solutions Includes distance holder and tripod adaptor Calibration Calibrated SAR value for specified position and input power at the flat phantom in head simulating solutions.
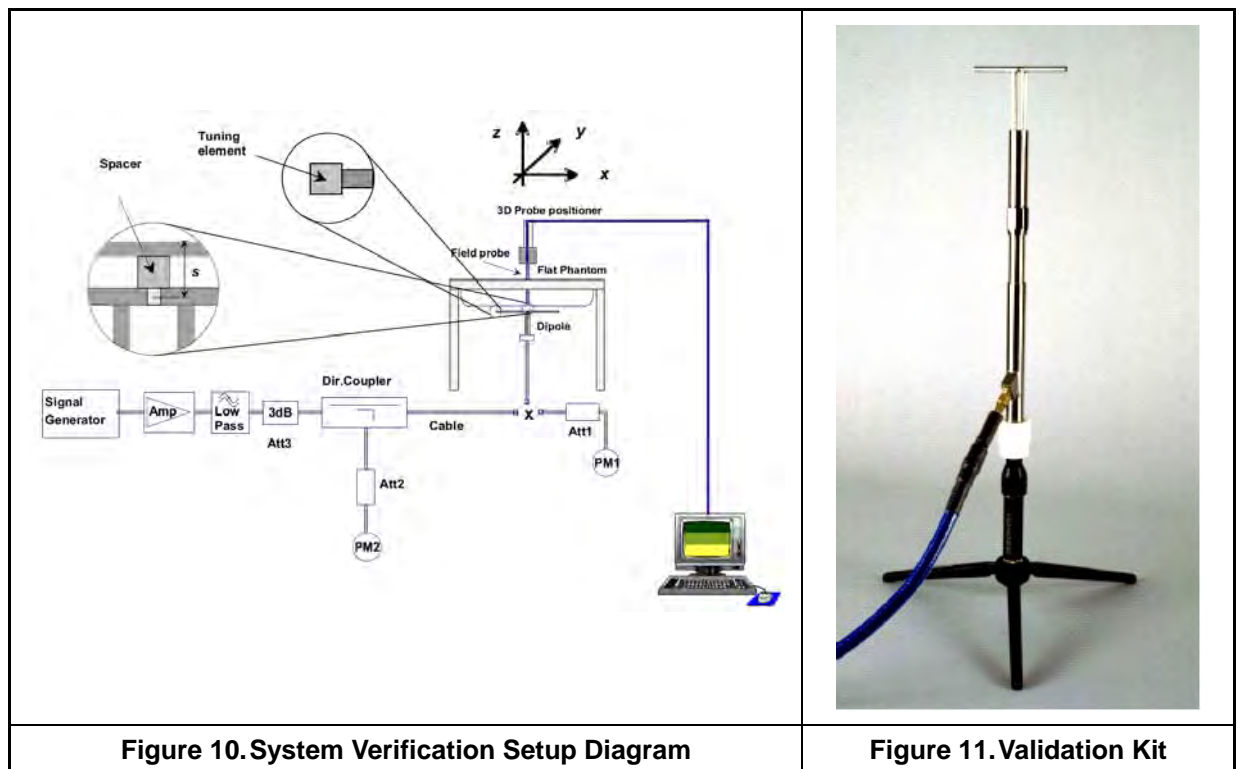
Frequency   2450 MHz

Return Loss > 20 dB at specified validation position

Power Capability > 100 W (f < 1GHz); > 40 W (f > 1GHz)

Options   Dipoles for other frequencies or solutions and other calibration conditions are available upon request

Dimensions   D2450V2：dipole length 51.5 mm; overall height 300 mm

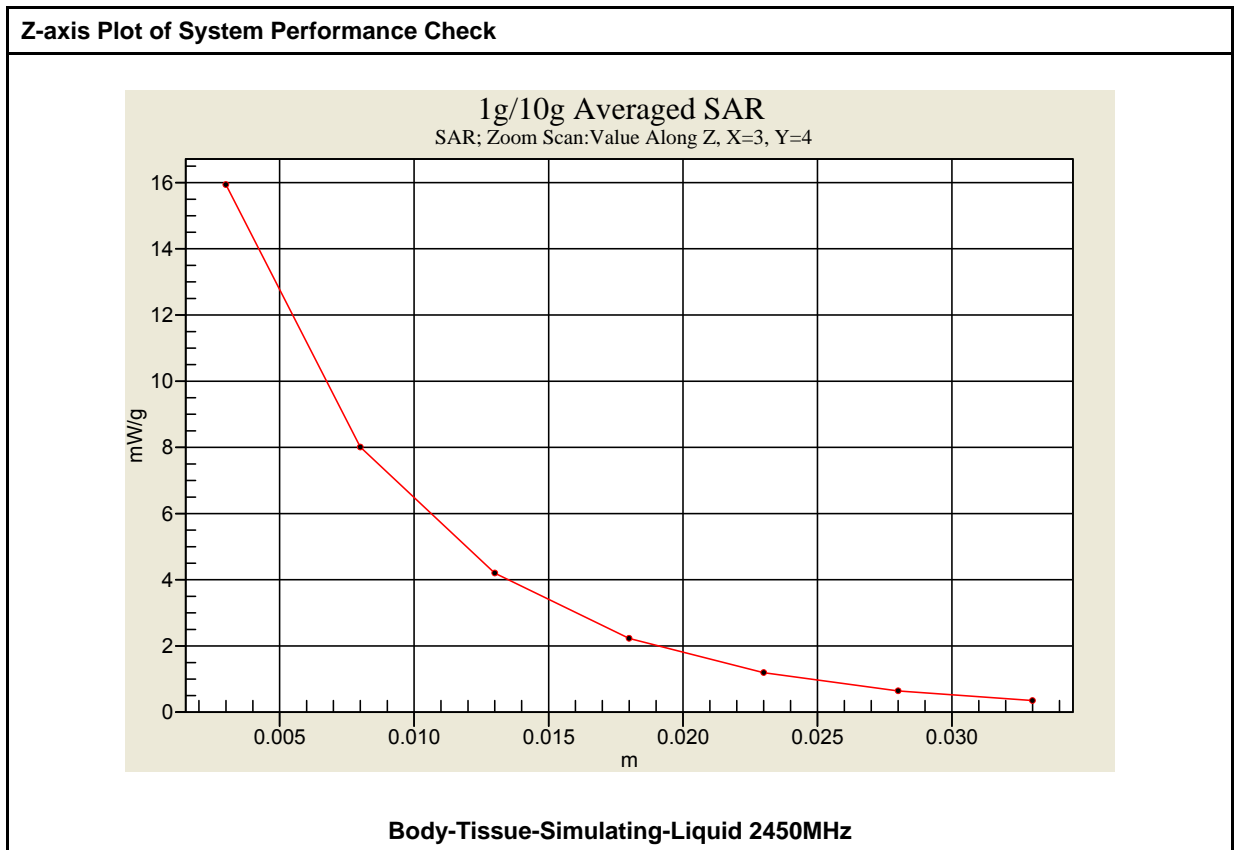| Figure 10. System Verification Setup Diagram	Figure 11. Validation Kit

6.2   Validation

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of $\pm$ 7%. The validation was performed at 2450 MHz.

Validation kit		Mixture Type	SAR$_{1g}$ [mW/g]		SAR$_{10g}$ [mW/g]		Date of Calibration
D2450V2-SN712		Body	50.4		23.3		02/23/2011
Frequency (MHz)	Power (dBm)	SAR$_{1g}$ (mW/g)	SAR$_{10g}$ (mW/g)	Drift (dB)	Difference percentage		Date
					1g	10g	
2450 (Body)	250mW	12.1	5.68	0.020	-4.0 %	-2.5 %	09/27/2011
	Normalize to 1 Watt	48.4	22.72				

Z-axis Plot of System Performance Check

1g/10g Averaged SAR
SAR; Zoom Scan:Value Along Z, X=3, Y=4

Body-Tissue-Simulating-Liquid 2450MHz

7. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Dosimetric E-Field Probe	EX3DV3	3519	02/25/2011	02/25/2012
SPEAG	2450MHz System Validation Kit	D2450V2	712	02/23/2011	02/23/2012
SPEAG	Data Acquisition Electronics	DAE4	541	07/21/2011	07/21/2012
SPEAG	Measurement Server	SE UMS 011 AA	1025	NCR	
SPEAG	Device Holder	N/A	N/A	NCR	
SPEAG	Phantom	SAM V4.0	TP-1150	NCR	
SPEAG	Robot	Staubli TX90XL	F07/564ZA1/C/01	NCR	
SPEAG	Software	DASY4 V4.7 Build 80	N/A	NCR	
SPEAG	Software	SEMCAD V1.8 Build 186	N/A	NCR	
Agilent	Dielectric Probe Kit	85070C	US99360094	NCR	
Agilent	ENA Series Network Analyzer	E5071B	MY42404655	04/14/2010	04/14/2012
R&S	Power Sensor	NRP-Z22	100179	05/27/2011	05/27/2012
Agilent	MXG Vector Signal Generator	N5182A	MY47420962	05/16/2011	05/16/2012
Agilent	Dual Directional Coupler	778D	50334	NCR	
Mini-Circuits	Power Amplifier	ZHL-42W-SMA	D111103#5	NCR	
Mini-Circuits	Power Amplifier	ZVE-8G-SMA	D042005 671800514	NCR	

Table 5.   Test Equipment List

8. *Measurement Uncertainty*

Measurement uncertainties in SAR measurements are difficult to quantify due to several variables including biological, physiological, and environmental. However, we estimate the measurement uncertainties in SAR to be less than ±20.10 ％〔8〕.

According to Std. C95.3〔9〕, the overall uncertainties are difficult to assess and will vary with the type of meter and usage situation. However, accuracy's of ±1 to 3 dB can be expected in practice, with greater uncertainties in near-field situations and at higher frequencies (shorter wavelengths), or areas where large reflecting objects are present. Under optimum measurement conditions, SAR measurement uncertainties of at least ±2dB can be expected.

According to CENELEC〔10〕, typical worst-case uncertainty of field measurements is ±5 dB. For well-defined modulation characteristics the uncertainty can be reduced to ±3 dB.

Item	Uncertainty Component	Uncertainty Value	Prob. Dist	Div.	c_i (1g)	c_i (10g)	Std. Unc. （1-g）	Std. Unc. （10-g）	v_i or V_{eff}
Measurement System									
u1	Probe Calibration (*k*=1)	±5.5%	Normal	1	1	1	±5.5%	±5.5%	∞
u2	Probe Isotropy	±7.6%	Rectangular	$\sqrt{3}$	0.7	0.7	±3.1%	±3.1%	∞
u3	Boundary Effect	±1.0%	Rectangular	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
u4	Linearity	±4.7%	Rectangular	$\sqrt{3}$	1	1	±2.7%	±2.7%	∞
u5	System Detection Limit	±1.0%	Rectangular	$\sqrt{3}$	1	1	±0.58%	±0.58%	∞
u6	Readout Electronics	±0.3%	Normal	1	1	1	±0.3%	±0.3%	∞
u7	Response Time	±0.8%	Rectangular	$\sqrt{3}$	1	1	±0.5%	±0.5%	∞
u8	Integration Time	±2.6%	Rectangular	$\sqrt{3}$	1	1	±1.5%	±1.5%	∞
u9	RF Ambient Conditions	±0%	Rectangular	$\sqrt{3}$	1	1	±0%	±0%	∞
u10	RF Ambient Reflections	±0%	Rectangular	$\sqrt{3}$	1	1	±0%	±0%	∞
u11	Probe Positioner Mechanical Tolerance	±0.4%	Rectangular	$\sqrt{3}$	1	1	±0.2%	±0.2%	∞
u12	Probe Positioning with respect to Phantom Shell	±2.9%	Rectangular	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
u13	Extrapolation, interpolation and integration Algorithms for Max. SAR Evaluation	±1.0%	Rectangular	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Test sample Related									
u14	Test sample Positioning	±3.6%	Normal	1	1	1	±3.6%	±3.6%	89
u15	Device Holder Uncertainty	±3.5%	Normal	1	1	1	±3.5%	±3.5%	5
u16	Output Power Variation - SAR drift measurement	±5.0%	Rectangular	$\sqrt{3}$	1	1	±2.9%	±2.9%	∞
Phantom and Tissue Parameters									
u17	Phantom Uncertainty (shape and thickness tolerances)	±4.0%	Rectangular	$\sqrt{3}$	1	1	±2.3%	±2.3%	∞
u18	Liquid Conductivity - deviation from target values	±5.0%	Rectangular	$\sqrt{3}$	0.64	0.43	±1.8%	±1.2%	∞
u19	Liquid Conductivity - measurement uncertainty	±1.93%	Normal	1	0.64	0.43	±1.24%	±0.83%	69
u20	Liquid Permittivity - deviation from target values	±5.0%	Rectangular	$\sqrt{3}$	0.6	0.49	±1.7%	±1.4%	∞
u21	Liquid Permittivity - measurement uncertainty	±1.4%	Normal	1	0.6	0.49	±0.84%	±1.69%	69
Combined standard uncertainty			RSS				±10.05%	±9.98%	313
Expanded uncertainty (95% CONFIDENCE LEVEL)			*k*=2				±20.10%	±19.96%	

Table 6.   Uncertainty Budget of DASY

9. *Measurement Procedure*

The measurement procedures are as follows:

1. For WLAN function, engineering testing software installed on Notebook can provide continuous transmitting signal.
2. Measure output power through RF cable and power meter
3. Set scan area, grid size and other setting on the DASY software
4. Find out the largest SAR result on these testing positions of each band
5. 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:

1. Power reference measurement
2. Area scan
3. Zoom scan
4. Power drift measurement

9.1 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

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

9.2 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 7x7x9 points with step size 5, 5 and 3 mm for 300 MHz to 3 GHz, and 7x7x9 points with step size 5, 5 and 3 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.

9.3 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.

9.4 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.

9.5   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.

10. *SAR Test Results Summary*

10.1 Body SAR

Measurement Results								
Frequency		Band	Power (dBm)	Test Position	Antenna	Spacing (mm)	SAR$_{1g}$ [mW/g]	Power Drift (dB)	Remark
MHz	CH								
2412	01	IEEE 802.11b Rate 1M	12.87	Horizontal Up	straight	5	**0.09800**	0.108	with USB Cable
2412	01	IEEE 802.11b Rate 1M	12.87	Horizontal Down	straight	5	0.07300	0.130	with USB Cable
2412	01	IEEE 802.11b Rate 1M	12.87	Horizontal Up	bent at 90 degrees	5	0.00258	0.031	with USB Cable
Std. C95.1-1999 - Safety Limit Spatial Peak Uncontrolled Exposure/General Population							**1.6 W/kg (mW/g) Averaged over 1 gram**	

Notes:

1. The test data reported are the worst-case SAR value with the position set in a typical

   configuration. Test procedures used were according to FCC/OET Bulletin 65, Supplement C [June 2001],

   IEEE1528-2003.

2. All modes of operation were investigated, and worst-case results are reported.

3. Tissue parameters and temperatures are listed on the SAR plots.

4. If the Channel's SAR 1g of maximum conducted power is > 0.8 mW/g, low, middle and high channel are

   supposed to be tested.

5. If the conducted power of (802.11g or 802.11n) is higher than 802.11b 0.25dB, (802.11g or 802.11n) is supposed

   to be tested.

6. The test procedure refers to Inquiry Tracking Number 213341.

10.2 Std. C95.1-1999 RF Exposure Limit

Human Exposure	Population Uncontrolled Exposure (W/kg) or (mW/g)	Occupational Controlled Exposure (W/kg) or (mW/g)
Spatial Peak SAR* (head)	1.60	8.00
Spatial Peak SAR** (Whole Body)	0.08	0.40
Spatial Peak SAR*** (Partial-Body)	1.60	8.00
Spatial Peak SAR**** (Hands / Feet / Ankle / Wrist)	4.00	20.00

Table 7.   Safety Limits for Partial Body Exposure

Notes：

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

(defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

**   The Spatial Average value of the SAR averaged over the whole – body.

***   The Spatial Average value of the SAR averaged over the partial – body.

****   The Spatial Peak value of the SAR averaged over any 10 grams of tissue.

(defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

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

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

11. Conclusion

The SAR test values found for the portable mobile phone **AEROMAX TECHNOLOGY CO., LTD. Trade Name：Aeromax Model(s)：WU1112** is below the maximum recommended level of 1.6 W/kg (mW/g).

12. References

[1] Std. C95.1-1999, "*American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 300KHz to 100GHz",* New York.

[2] NCRP, National Council on Radiation Protection and Measurements, "*Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields",* NCRP report NO. 86, 1986.

[3] T. Schmid, O. Egger, and N. Kuster, "*Automatic E-field scanning system for dosimetric assessments*", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp, 105-113, Jan. 1996.

[4] K. Pokoviċ, T. Schmid, and N. Kuster, "*Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequency*", in ICECOM'97, Dubrovnik, October 15-17, 1997, pp.120-124.

[5] K. Pokoviċ, T. Schmid, and N. Kuster, "*E-field probe with improved isotropy in brain simulating liquids*", in Proceedings of the ELMAR, Zadar, Croatia, 23-25 June, 1996, pp.172-175.

[6] N. Kuster, and Q. Balzano, "*Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300MHz*", IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.

[7] Robert J. Renka, "*Multivariate Interpolation Of Large Sets Of Scattered Data*", University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988 , pp. 139-148.

[8] N. Kuster, R. Kastle, T. Schmid, *Dosimetric evaluation of mobile communications equipment with known precision*, IEEE Transaction on Communications, vol. E80-B, no. 5, May 1997, pp. 645-652.

[9] Std. C95.3-1991, "*IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave,* New York: IEEE, Aug. 1992.

[10] CENELEC CLC/SC111B, European Prestandard (prENV 50166-2), *Human Exposure to Electromagnetic Fields High-frequency*: 10KHz-300GHz, Jan. 1995.

[11] KDB 248227 D01 SAR meas for 802 11 a b g v01r02.

[12] KDB 447498 D01 v04

Appendix A -   System Performance Check

Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2011/9/27 PM 12:02:47

System Performance Check at 2450MHz_20110927_Body

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:712

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.94 mho/m; ε_r = 51.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
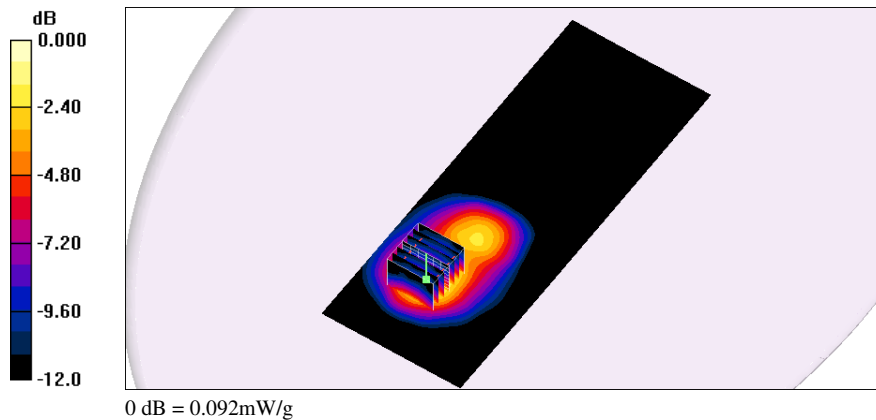Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within:2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV3 - SN3519; ConvF(8.17, 8.17, 8.17); Calibrated: 2011/2/25
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn541; Calibrated: 2011/7/21
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1003
- Measurement SW: DASY4, V4.7 Build 80;Postprocessing SW: SEMCAD, V1.8 Build 186

System Performance Check at 2450MHz/Area Scan (61x61x1):
Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 16.4 mW/g

System Performance Check at 2450MHz/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 90.4 V/m; Power Drift = 0.020 dB
Peak SAR (extrapolated) = 24.9 W/kg
SAR(1 g) = 12.1 mW/g; SAR(10 g) = 5.68 mW/g
Maximum value of SAR (measured) = 15.9 mW/g

0 dB = 15.9mW/g
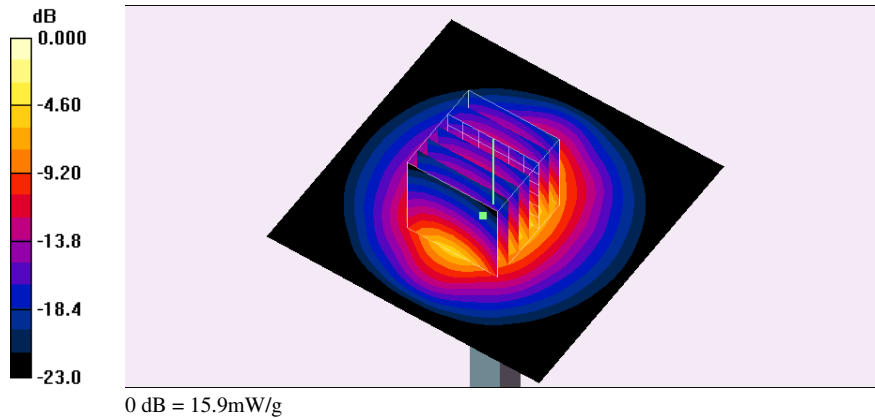
Appendix B - SAR Measurement Data

Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2011/9/27 PM 04:45:16

Flat_802.11b CH1_1M_Horizontal Up with USB Cable_antenna straight mode_5mm

DUT: WU1112; Type: WiFi USB Dongle; FCC ID: Z6K-RT3070WU1112

Communication System: IEEE 802.11b; Frequency: 2412 MHz;Duty Cycle: 1:1

Medium parameters used: f = 2412 MHz; σ = 1.89 mho/m; ε_r = 51.8; ρ = 1000 kg/m^3

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within:2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV3 - SN3519; ConvF(8.17, 8.17, 8.17); Calibrated: 2011/2/25
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn541; Calibrated: 2011/7/21
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1003
- Measurement SW: DASY4, V4.7 Build 80;Postprocessing SW: SEMCAD, V1.8 Build 186

Flat/Area Scan (61x161x1):

Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.130 mW/g

Flat/Zoom Scan (7x7x9)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=3mm

Reference Value = 0.964 V/m; Power Drift = 0.108 dB

Peak SAR (extrapolated) = 0.194 W/kg

SAR(1 g) = 0.098 mW/g; SAR(10 g) = 0.048 mW/g

Maximum value of SAR (measured) = 0.127 mW/g

0 dB = 0.127mW/g
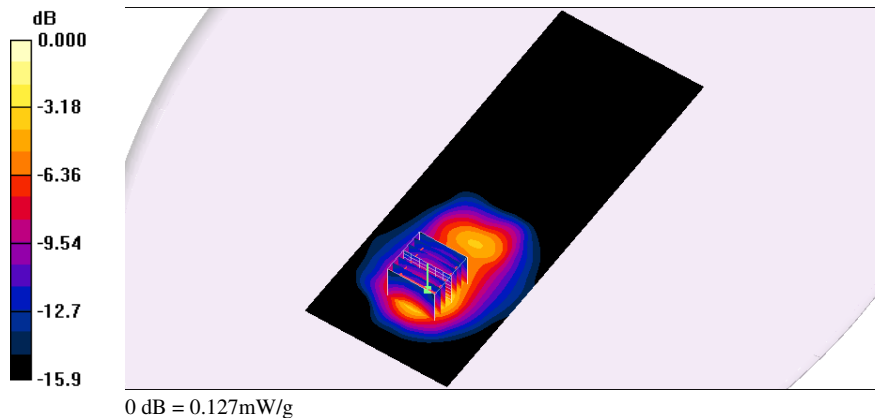
Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2011/9/27 PM 03:54:12

Flat_802.11b CH1_1M_Horizontal Down with USB Cable_antenna straight mode_5mm

DUT: WU1112; Type: WiFi USB Dongle; FCC ID: Z6K-RT3070WU1112

Communication System: IEEE 802.11b; Frequency: 2412 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2412 MHz; σ = 1.89 mho/m; ε_r = 51.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within:2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV3 - SN3519; ConvF(8.17, 8.17, 8.17); Calibrated: 2011/2/25
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn541; Calibrated: 2011/7/21
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1003
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Flat/Area Scan (61x161x1):
Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.099 mW/g

Flat/Zoom Scan (7x7x9)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=3mm
Reference Value = 1.49 V/m; Power Drift = 0.130 dB
Peak SAR (extrapolated) = 0.138 W/kg
SAR(1 g) = 0.073 mW/g; SAR(10 g) = 0.038 mW/g
Maximum value of SAR (measured) = 0.092 mW/g

0 dB = 0.092mW/g

Test Laboratory: A Test Lab Techno Corp.

Date/Time: 2011/9/27 PM 05:19:02

Flat_802.11b CH1_1M_Horizontal Up with USB Cable_antenna bent at 90 degrees_5mm

DUT: WU1112; Type: WiFi USB Dongle; FCC ID: Z6K-RT3070WU1112

Communication System: IEEE 802.11b; Frequency: 2412 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2412 MHz; σ = 1.89 mho/m; ε_r = 51.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Area Scan setting - Find Secondary Maximum Within:2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV3 - SN3519; ConvF(8.17, 8.17, 8.17); Calibrated: 2011/2/25
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn541; Calibrated: 2011/7/21
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1003
- Measurement SW: DASY4, V4.7 Build 80;Postprocessing SW: SEMCAD, V1.8 Build 186

Flat/Area Scan (61x161x1):
Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.005 mW/g

Flat/Zoom Scan (7x7x9)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=3mm
Reference Value = 0.968 V/m; Power Drift = 0.031 dB
Peak SAR (extrapolated) = 0.006 W/kg
SAR(1 g) = 0.00258 mW/g; SAR(10 g) = 0.00219 mW/g
Maximum value of SAR (measured) = 0.004 mW/g

0 dB = 0.004mW/g
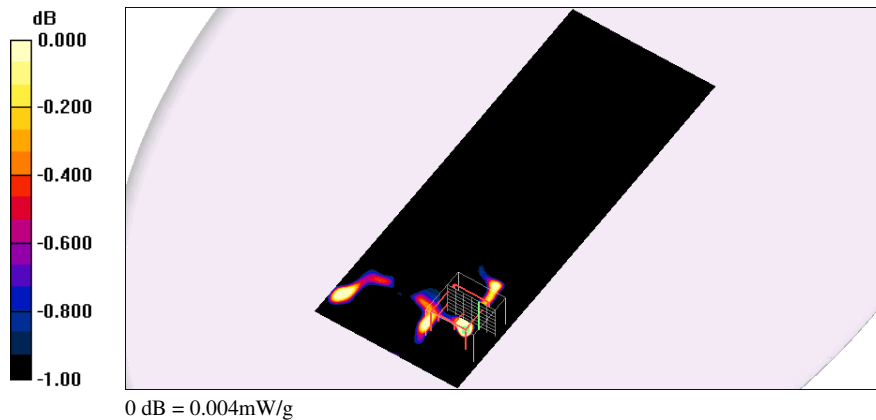
Appendix C - Calibration

All of the instruments Calibration information are listed below.

- Dipole _ D2450V2 SN:712 Calibration No.D2450V2-712_Feb11
- Probe _ EX3DV3 SN:3519 Calibration No.EX3-3519_Feb11
- DAE _ DAE4 SN:541 Calibration No.DAE4-541_Jul11

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Accreditation No.: **SCS 108**

Client	**ATL (Auden)**	Certificate No:	**D2450V2-712_Feb11**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 712
Calibration procedure(s)	QA CAL-05.v8 Calibration procedure for dipole validation kits
Calibration date:	February 23, 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: 5086 (20g)	30-Mar-10 (No. 217-01158)	Mar-11
Type-N mismatch combination	SN: 5047.2 / 06327	30-Mar-10 (No. 217-01162)	Mar-11
Reference Probe ES3DV3	SN: 3205	30-Apr-10 (No. ES3-3205_Apr10)	Apr-11
DAE4	SN: 601	10-Jun-10 (No. DAE4-601_Jun10)	Jun-11

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	4-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:	Dimce Iliev	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 24, 2011

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Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.

- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.

- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.

- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.

- *SAR measured:* SAR measured at the stated antenna input power.

- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.

- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

Certificate No: D2450V2-712_Feb11   Page 2 of 9

Measurement Conditions

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

DASY Version	DASY5	V52.6
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.1 ± 6 %	1.73 mho/m ± 6 %
Head TSL temperature during test	(21.2 ± 0.2) °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.0 mW / g
SAR normalized	normalized to 1W	52.0 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	52.9 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.08 mW / g
SAR normalized	normalized to 1W	24.3 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	24.5 mW /g ± 16.5 % (k=2)

Certificate No: D2450V2-712_Feb11   Page 3 of 9

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.2 ± 6 %	1.94 mho/m ± 6 %
Body TSL temperature during test	(21.8 ± 0.2) °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.6 mW / g
SAR normalized	normalized to 1W	50.4 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	50.4 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.83 mW / g
SAR normalized	normalized to 1W	23.3 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	23.3 mW / g ± 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.3 Ω + 1.7 jΩ
Return Loss	- 27.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.8 Ω + 5.5 jΩ
Return Loss	- 25.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.146 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	July 05, 2002

DASY5 Validation Report for Head TSL

Date/Time: 23.02.2011 12:42:01

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:712

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: HSL U12 BB
Medium parameters used: f = 2450 MHz; σ = 1.73 mho/m; ε_r = 39.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.04.2010

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

- Electronics: DAE4 Sn601; Calibrated: 10.06.2010

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

- Measurement SW: DASY52, V52.6.1 Build (408)

- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)

Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement
grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 101.5 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 26.439 W/kg
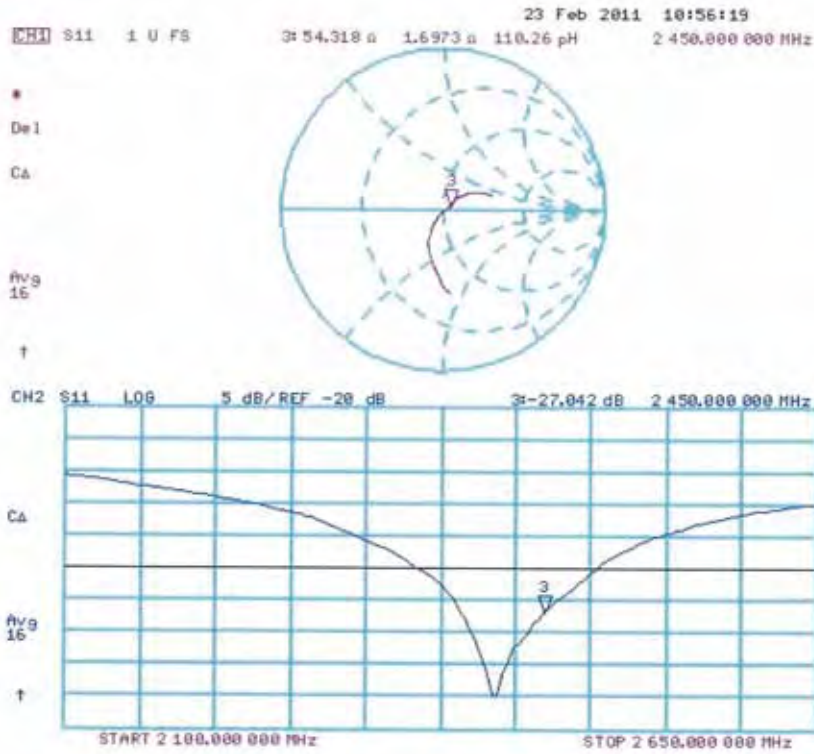**SAR(1 g) = 13 mW/g; SAR(10 g) = 6.08 mW/g**
Maximum value of SAR (measured) = 16.525 mW/g

0 dB = 16.530mW/g

Certificate No: D2450V2-712_Feb11   Page 6 of 9

Impedance Measurement Plot for Head TSL

DASY5 Validation Report for Body TSL

Date/Time: 18.02.2011 14:36:14

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:712

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: MSL U12 BB
Medium parameters used: f = 2450 MHz; σ = 1.94 mho/m; ε_r = 52.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.31, 4.31, 4.31); Calibrated: 30.04.2010

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

- Electronics: DAE4 Sn601; Calibrated: 10.06.2010

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

- Measurement SW: DASY52, V52.6.1 Build (408)

- Postprocessing SW: SEMCAD X, V14.4.2 Build (2595)
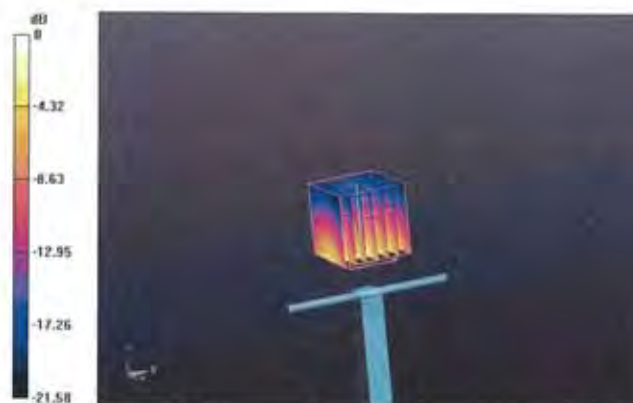
Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0: Measurement
grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.420 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 26.751 W/kg
SAR(1 g) = 12.6 mW/g; SAR(10 g) = 5.83 mW/g
Maximum value of SAR (measured) = 16.714 mW/g

0 dB = 16.710mW/g

Certificate No: D2450V2-712_Feb11   Page 8 of 9

Impedance Measurement Plot for Body TSL
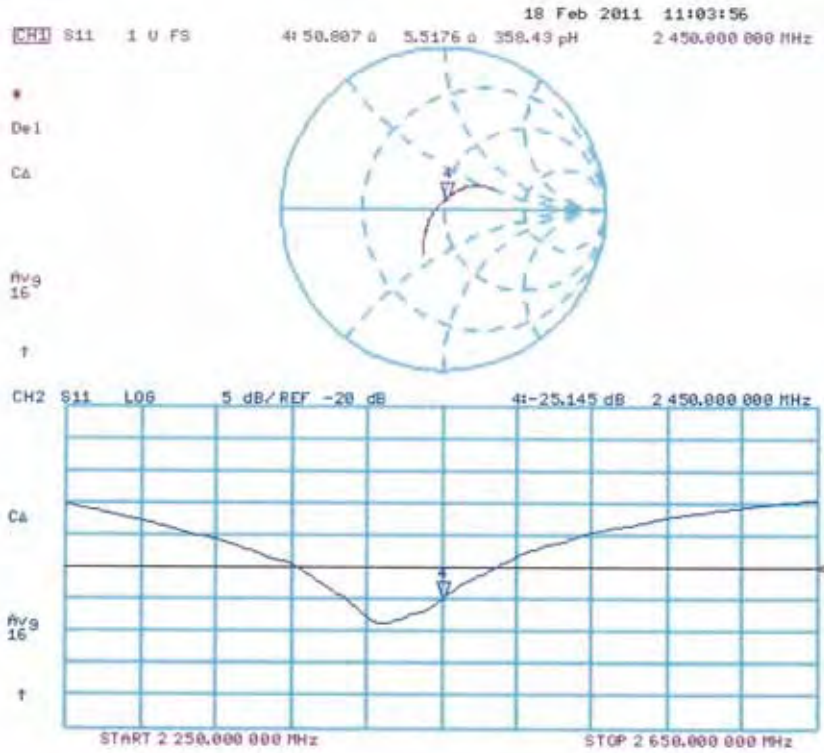
18 Feb 2011 11:03:56

CH1 S11 1 U FS 4: 50.807 Ω 5.5176 Ω 358.43 pH 2 450.000 000 MHz

Del

CA

Avg
16

↑

CH2 S11 LOG 5 dB/REF -20 dB 4:-25.145 dB 2 450.000 000 MHz

CA

Avg
16

↑

START 2 250.000 000 MHz STOP 2 650.000 000 MHz

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</table>

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Accreditation No.: **SCS 108**

Client **ATL (Auden)**   Certificate No: **EX3-3519_Feb11**

CALIBRATION CERTIFICATE

Object	EX3DV3 - SN:3519
Calibration procedure(s)	QA CAL-01.v7, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v3 Calibration procedure for dosimetric E-field probes
Calibration date:	February 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 E4419B	GB41293874	01-Apr-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41495277	01-Apr-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41498087	01-Apr-10 (No. 217-01136)	Apr-11
Reference 3 dB Attenuator	SN: S5054 (3c)	30-Mar-10 (No. 217-01159)	Mar-11
Reference 20 dB Attenuator	SN: S5086 (20b)	30-Mar-10 (No. 217-01161)	Mar-11
Reference 30 dB Attenuator	SN: S5129 (30b)	30-Mar-10 (No. 217-01160)	Mar-11
Reference Probe ES3DV2	SN: 3013	29-Dec-10 (No. ES3-3013_Dec10)	Dec-11
DAE4	SN: 654	23-Apr-10 (No. DAE4-654_Apr10)	Apr-11

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: February 25, 2011

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Certificate No: EX3-3519_Feb11   Page 1 of 11

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Accreditation No.: **SCS 108**

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., ϑ = 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 ϑ = 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* 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 ≤ 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.

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Probe EX3DV3

SN:3519

Manufactured: March 8, 2004
Calibrated: February 25, 2011

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

DASY/EASY - Parameters of Probe: EX3DV3 - SN:3519

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	0.82	0.71	0.72	± 10.1 %
DCP $(mV)^B$	99.0	98.5	100.8	

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	107.3	±1.9 %
			Y	0.00	0.00	1.00	110.4	
			Z	0.00	0.00	1.00	136.5	

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

^{A} The uncertainties of NormX,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).
^{B} Numerical linearization parameter: uncertainty not required.
^{E} Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV3 - SN:3519

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)
2000	40.0	1.40	9.25	9.25	9.25	0.53	0.78	± 12.0 %
5200	36.0	4.66	5.08	5.08	5.08	0.30	1.80	± 13.1 %
5500	35.6	4.96	4.60	4.60	4.60	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.13	4.13	4.13	0.50	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: EX3DV3- SN:3519

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)
2000	53.3	1.52	9.31	9.31	9.31	0.72	0.68	± 12.0 %
2300	52.9	1.81	8.67	8.67	8.67	0.69	0.67	± 12.0 %
2450	52.7	1.95	8.17	8.17	8.17	0.79	0.58	± 12.0 %
2600	52.5	2.16	7.75	7.75	7.75	0.79	0.54	± 12.0 %
3500	51.3	3.31	7.11	7.11	7.11	0.31	1.34	± 13.1 %
5200	49.0	5.30	4.36	4.36	4.36	0.52	1.95	± 13.1 %
5300	48.9	5.42	4.14	4.14	4.14	0.55	1.95	± 13.1 %
5500	48.6	5.65	3.88	3.88	3.88	0.55	1.95	± 13.1 %
5600	48.5	5.77	3.56	3.56	3.56	0.65	1.95	± 13.1 %
5800	48.2	6.00	3.94	3.94	3.94	0.58	1.95	± 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.
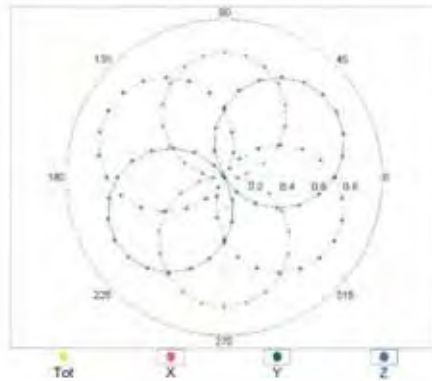
Certificate No: EX3-3519_Feb11   Page 6 of 11

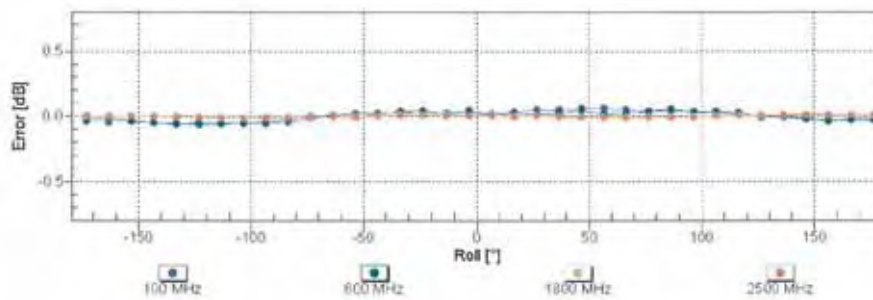## Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)
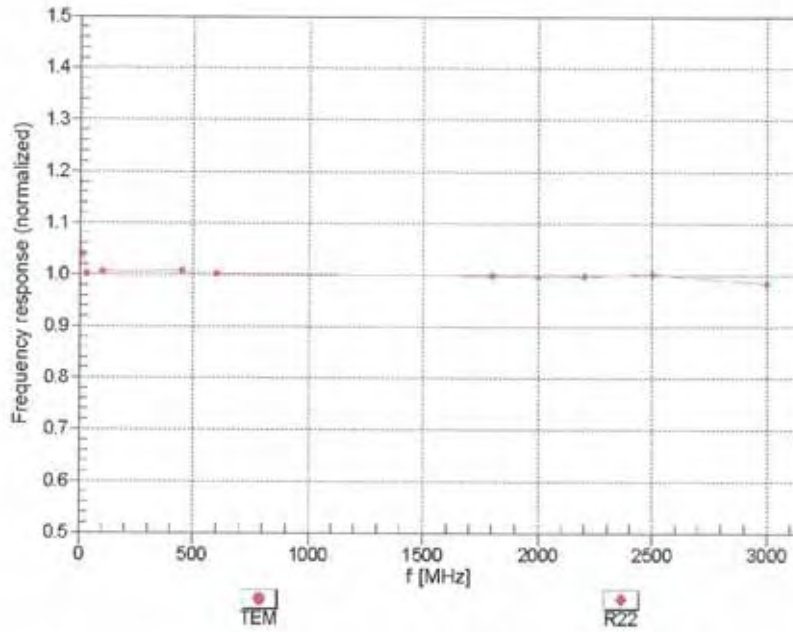
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Receiving Pattern (φ), ϑ = 0°

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

Tot   X   Y   Z   Tot   X   Y   Z
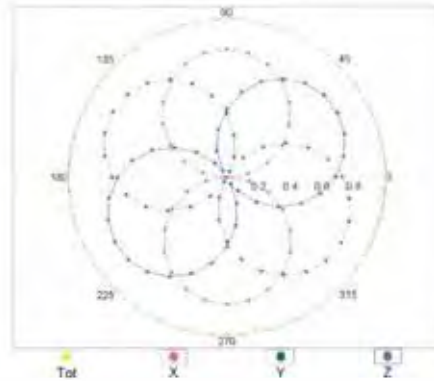
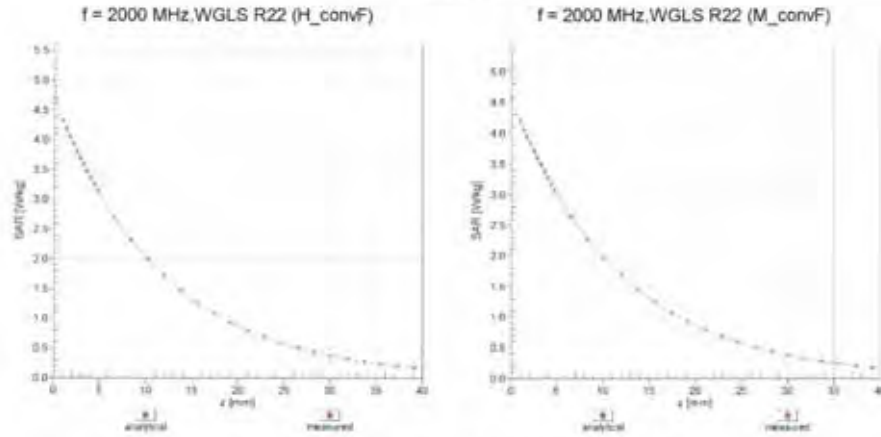**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

Dynamic Range f(SAR$_{head}$)
(TEM cell , f = 900 MHz)
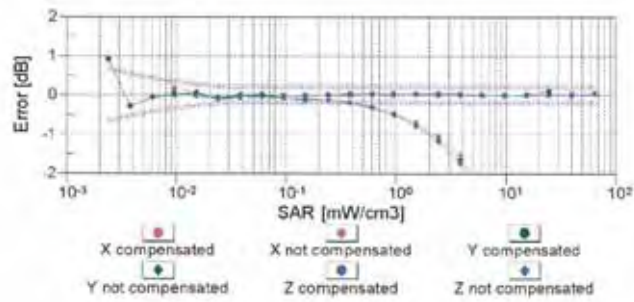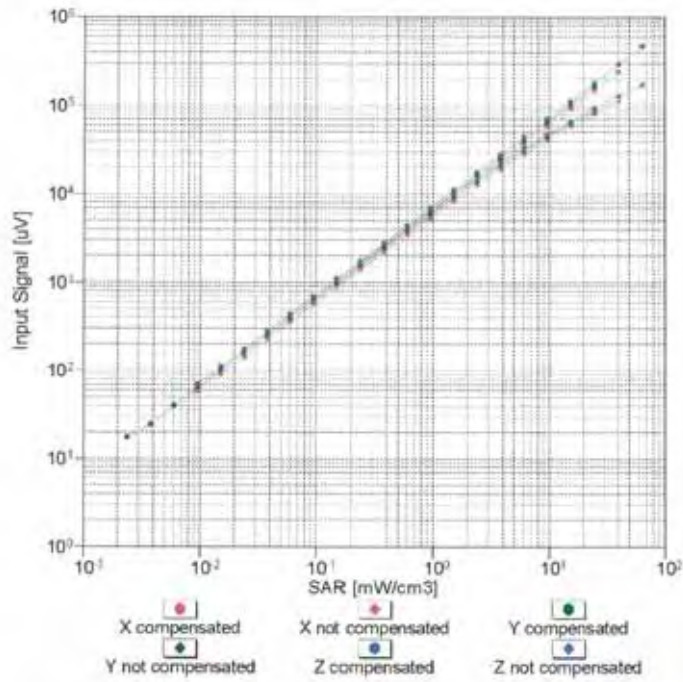
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 2000 MHz, WGLS R22 (H_convF)　　　　　f = 2000 MHz, WGLS R22 (M_convF)

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

Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)
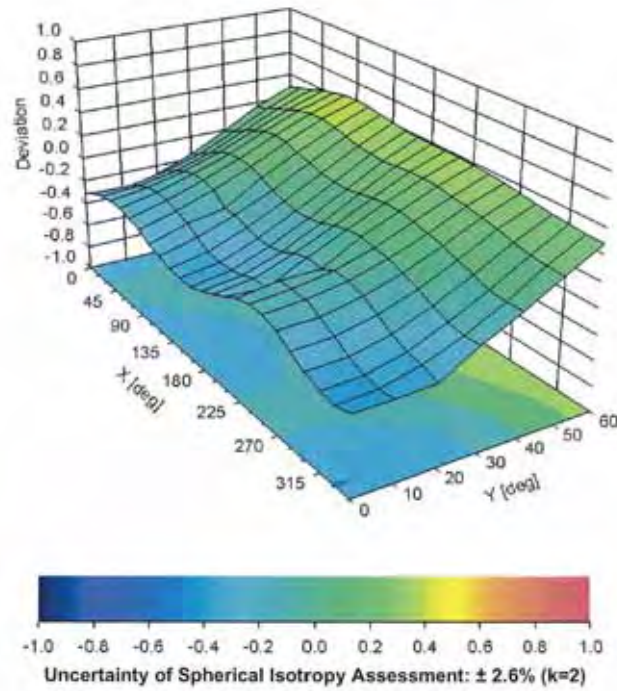
DASY/EASY - Parameters of Probe: EX3DV3 - SN:3519

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

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **ATL (Auden)**

Certificate No: **DAE4-541_Jul11**

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BJ - SN: 541
Calibration procedure(s)	QA CAL-06.v23 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	July 21, 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:	Andrea Guntli	Technician	
Approved by:	Fin Bomholt	R&D Director	

Issued: July 21, 2011

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

Certificate No: DAE4-541_Jul11

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Accreditation No.: **SCS 108**

Glossary

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

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.

- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.

- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.

  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.

  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.

  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.

  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage

  - *Input Offset Measurement:* Output voltage and statistical results over a large number of zero voltage measurements.

  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.

  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.

  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.

  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

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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	404.582 ± 0.1% (k=2)	404.459 ± 0.1% (k=2)	404.224 ± 0.1% (k=2)
Low Range	3.96870 ± 0.7% (k=2)	3.93611 ± 0.7% (k=2)	3.97524 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	289.5 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200008.1	-0.88	-0.00
Channel X	+ Input	20002.50	3.10	0.02
Channel X	- Input	-19996.27	4.53	-0.02
Channel Y	+ Input	199996.8	-1.55	-0.00
Channel Y	+ Input	19997.00	-2.30	-0.01
Channel Y	- Input	-19998.95	1.65	-0.01
Channel Z	+ Input	199999.3	1.60	0.00
Channel Z	+ Input	20001.15	1.75	0.01
Channel Z	- Input	-19996.29	3.21	-0.02

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2000.5	0.58	0.03
Channel X	+ Input	200.06	-0.04	-0.02
Channel X	- Input	-200.23	-0.23	0.11
Channel Y	+ Input	2000.2	0.25	0.01
Channel Y	+ Input	199.49	-0.51	-0.25
Channel Y	- Input	-200.76	-0.76	0.38
Channel Z	+ Input	2000.0	-0.07	-0.00
Channel Z	+ Input	198.95	-0.95	-0.47
Channel Z	- Input	-200.96	-0.76	0.38

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	12.21	10.17
	- 200	-8.92	-10.93
Channel Y	200	1.33	1.31
	- 200	-3.20	-2.56
Channel Z	200	1.32	0.71
	- 200	-1.57	-2.26

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	-	2.77	-0.01
Channel Y	200	1.35	-	4.90
Channel Z	200	0.02	0.12	-

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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	16012	16048
Channel Y	15790	15279
Channel Z	15978	16594

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	-0.14	-1.06	0.50	0.27
Channel Y	-0.69	-2.35	0.18	0.36
Channel Z	-0.84	-1.32	-0.29	0.23

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