Specific Absorption Rate (SAR) Test Report

for

QUALCOMM Incorporated

on the

CDMA2000, 1x/1x-EVDO, WCDMA/HSPA and GSM/GPRS/EDGE PCI Express^{TM} Mini Card

Report Number	**:**	**FA8O1007**
Model Name	**:**	**UNDP-1**
FCC ID	**:**	**J9CUNDP-1L**
IC ID	**:**	**2723A-UNDP1**
Date of Testing	**:**	**Oct. 02 ~ Oct. 09, 2008**
Date of Report	**:**	**Oct. 16, 2008**
Date of Review	**:**	**Oct. 16, 2008**

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- Report Version: Rev. 02

SPORTON INTERNATIONAL INC.

No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C.

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1. Statement of Compliance

The Specific Absorption Rate (SAR) maximum results found during testing for the QUALCOMM Incorporated CDMA2000, 1x/1x-EVDO, WCDMA/HSPA and GSM/GPRS/EDGE PCI Express™ Mini Card UNDP-1 are as follows (with expanded uncertainty 21.9%):

Position \ SAR	GSM850 SAR (W/kg)	CDMA2000 PCS SAR (W/kg)
Body	0.643	0.976

They are in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits specified in IC RSS-102 Issue 2, FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1999 and had been tested in accordance with the measurement methods and procedures specified in OET Bulletin 65 Supplement C (Edition 01-01).

Approved by

Roy Wu
Manager

2. Administration Data

2.1 Testing Laboratory

Company Name :	Sporton International Inc.
Address :	No.52, Hwa-Ya 1st RD., Hwa Ya Technology Park, Kwei-Shan Hsiang, TaoYuan Hsien, Taiwan, R.O.C.
Test Site :	SAR02-HY
Telephone Number :	886-3-327-3456
Fax Number :	886-3-328-4978

2.2 Applicant

Company Name :	QUALCOMM Incorporated
Address :	5775 Morehouse Drive

2.3 Manufacturer

Company Name :	Hong Fu Jin Precision Industry (Shenzhen) Co. Ltd.
Address :	No.2, 2nd Donghuan Rd., 10th Yousong Industrial District, Bao'an Longhua Town, Shenzhen, Guangdong, China

2.4 Application Details

Date of reception of application:	Oct. 02, 2008
Start of test :	Oct. 02, 2008
End of test :	Oct. 09, 2008

3. General Information

3.1 Description of Device Under Test (DUT)

Product Feature & Specification	
DUT Type :	CDMA2000, 1x/1x-EVDO, WCDMA/HSPA and GSM/GPRS/EDGE PCI Express™ Mini Card
Model Name :	UNDP-1
FCC ID :	J9CUNDP-1L
IC ID :	2723A-UNDP1
Tx Frequency :	GSM850 : 824 MHz ~ 849 MHz CDMA2000 PCS : 1850 MHz ~ 1910 MHz
Rx Frequency :	GSM850 : 869 MHz ~ 894 MHz CDMA2000 PCS : 1930 MHz ~ 1990 MHz
Maximum Output Power to Antenna :	GSM850 : 32.4 dBm CDMA2000 PCS : 24.05 dBm
Antenna Type :	External Antenna built in host PC units
Antenna Product Number :	Wistron NeWeb: 25.90667.001
HW Version :	P7
SW Version :	CDMA : 2151, UMTS : 4352
Host PC Model :	Lenovo, ThinkPad X200 Tablet Series
Type of Modulation :	GPRS : GMSK CDMA2000 : QPSK
DUT Stage :	Production Unit

3.2 Product Photos

Refer to Appendix D.

3.3 Applied Standards

The Specific Absorption Rate (SAR) testing specification, method and procedure for this CDMA2000, 1x/1x-EVDO, WCDMA/HSPA and GSM/GPRS/EDGE PCI Express™ Mini Card is in accordance with the following standards:

47 CFR Part 2 (2.1093),
IEEE C95.1-1999,
IEEE C95.3-2002,
IEEE P1528-2003, and
OET Bulletin 65 Supplement C (Edition 01-01)

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	20-24℃
Humidity	<60%

3.5.2 Test Configuration

The DUT was set from the emulator to radiate maximum output power during all tests.

The device was controlled by using a base station emulator R&S CMU200. Communication between the device and the emulator was established by air link. The distance between the DUT and the antenna of the emulator is larger than 50 cm and the output power radiated from the emulator antenna is at least 30 dB smaller than the output power of DUT.

Measurements were performed on the lowest, middle, and highest channel for each testing position. However, measurements were performed only on the middle channel if the SAR is below 3 dB of limit.

For SAR testing, EUT is in GPRS or CDMA link mode. In GPRS link mode, its crest factor is 4.3, because EUT is GPRS class 10 device (2 uplink slots). In CDMA2000 link mode, 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:

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

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

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

$$\textbf{SAR} = C\frac{\delta T}{\delta t}$$

, where C is the specific head capacity, δT is the temperature rise and δt the exposure duration,

or related to the electrical field in the tissue by

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

, 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 Setup

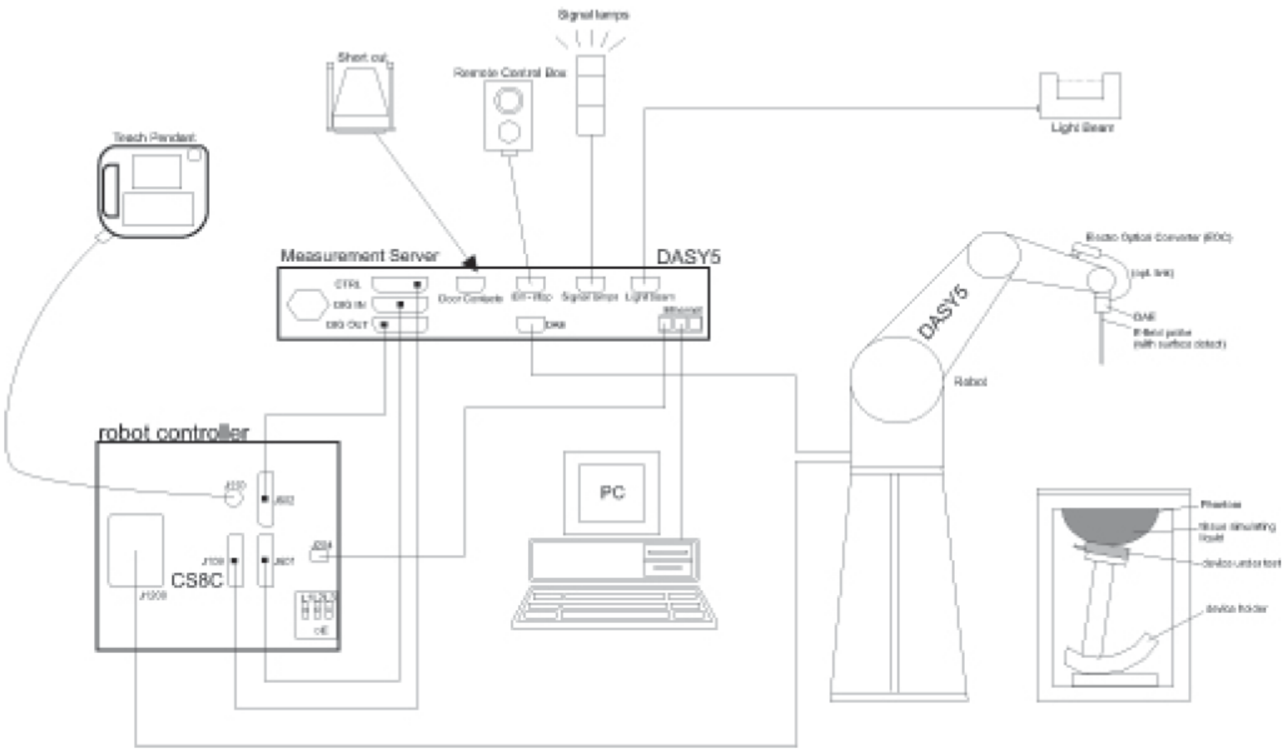


Fig. 5.1 DASY5 System

The DASY5 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
- DASY5 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 DASY5 E-Field Probe System

The SAR measurement is conducted with the dosimetric probe ET3DV6 (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 ET3DV6 E-Field Probe Specification

<ET3DV6>

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)
Frequency	10 MHz to 3 GHz
Directivity	± 0.2 dB in brain tissue (rotation around probe axis) ± 0.4 dB in brain tissue (rotation perpendicular to probe axis)
Dynamic Range	5 μ W/g to > 100mW/g; Linearity: ±0.2dB
Surface Detection	± 0.2 mm repeatability in air and clear liquids on reflecting surface
Dimensions	Overall length: 330mm Tip length: 16mm Body diameter: 12mm Tip diameter: 6.8mm Distance from probe tip to dipole centers: 2.7mm
Application	General dosimetry up to 3GHz Compliance tests for mobile phones and Wireless LAN Fast automatic scanning in arbitrary phantoms

Fig. 5.2 Probe Setup on Robot

5.1.2 ET3DV6 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 ± 0.25dB. 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 are as below:

➢ **ET3DV6 sn1787**

<table>
<tr><th>Sensitivity</th><td colspan="2">X axis : 1.63 µV</td><td>Y axis : 1.67 µV</td><td>Z axis : 2.18 µV</td></tr>
<tr><th>Diode compression point</th><td colspan="2">X axis : 90 mV</td><td>Y axis : 93 mV</td><td>Z axis : 92 mV</td></tr>
<tr><th rowspan="2">Conversion factor
(Head / Body)</th><th>Frequency
(MHz)</th><th>X axis</th><th>Y axis</th><th>Z axis</th></tr>
<tr><td>1850~2050</td><td>5.01 / 4.49</td><td>5.01 / 4.49</td><td>5.01 / 4.49</td></tr>
<tr><th rowspan="2">Boundary effect
(Head / Body)</th><th>Frequency
(MHz)</th><th>Alpha</th><th>Depth</th><td></td></tr>
<tr><td>1850~2050</td><td>0.59 / 0.68</td><td>1.96 / 1.95</td><td></td></tr>
</table>

➢ **ET3DV6 sn1788**

<table>
<tr><th>Sensitivity</th><td colspan="2">X axis : 1.73 µV</td><td>Y axis : 1.59 µV</td><td>Z axis : 1.72 µV</td></tr>
<tr><th>Diode compression point</th><td colspan="2">X axis : 95 mV</td><td>Y axis : 98 mV</td><td>Z axis : 91 mV</td></tr>
<tr><th rowspan="2">Conversion factor
(Head / Body)</th><th>Frequency
(MHz)</th><th>X axis</th><th>Y axis</th><th>Z axis</th></tr>
<tr><td>800~1000</td><td>6.55 / 6.34</td><td>6.55 / 6.34</td><td>6.55 / 6.34</td></tr>
<tr><th rowspan="2">Boundary effect
(Head / Body)</th><th>Frequency
(MHz)</th><th>Alpha</th><th>Depth</th><td></td></tr>
<tr><td>800~1000</td><td>0.44 / 0.50</td><td>2.65 / 2.48</td><td></td></tr>
</table>

NOTE: The probe parameters have been calibrated by the SPEAG.

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 mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

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

5.3 Robot

The DASY5 system uses the high precision robots TX90 XL type out of the newer series from Stäubli SA (France). For the 6-axis controller DASY5 system, the CS8C robot controller version from Stäubli is used. The XL robot series have many features that are important for our application:

- High precision (repeatability 0.02 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)
- 6-axis controller

5.4 Measurement Server

The DASY5 measurement server is based on a PC/104 CPU board with
400 MHz CPU
128 MB chipdisk and
128 MB RAM.

Communication with
the DAE electronic box
the 16-bit AD-converter system for optical detection and digital I/O interface.

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

5.5 SAM Twin Phantom

The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region where shell thickness increases to 6mm). It has three measurement areas:

- Left head
- Right head
- Flat 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.

The phantom can be used with the following tissue simulating liquids:
*Water-sugar based liquid
*Glycol based liquids

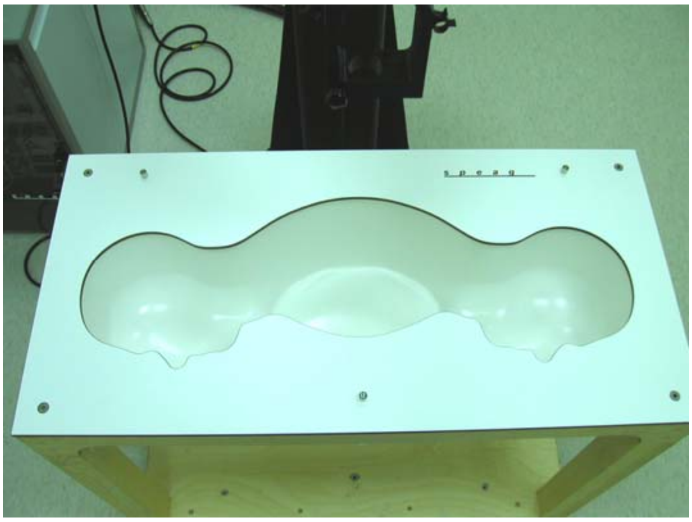


Fig. 5.3 Top View of Twin Phantom

Fig. 5.4 Bottom View of Twin Phantom

5.6 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 in 5 mm distance, a positioning uncertainty of ±0.5mm would produce a SAR uncertainty of ± 20%. An accurate device position is therefore crucial for accurate and repeatable measurement. The position in which the devices must be measured, are defined by the standards.

The DASY5 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 DASY5 device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity ε_r =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

5.7 Data Storage and Evaluation

5.7.1 Data Storage

The DASY5 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 .DA5. 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 DASY5 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 DASY5 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：

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

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： $E_i = \sqrt{\frac{V_i}{Norm_i ConvF}}$

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

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
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.

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

with ***SAR*** = local specific absorption rate in mW/g
Etot = total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
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.

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

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

5.8 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Dosimetric E-Filed Probe	ET3DV6	1787	Aug. 26, 2008	Aug. 25, 2009
SPEAG	Dosimetric E-Filed Probe	ET3DV6	1788	Sep. 23, 2008	Sep. 22, 2009
SPEAG	835MHz System Validation Kit	D835V2	499	Mar. 17, 2008	Mar. 16, 2010
SPEAG	1900MHz System Validation Kit	D1900V2	5d041	Mar. 28, 2008	Mar. 27, 2010
SPEAG	Data Acquisition Electronics	DAE3	393	Aug. 25, 2008	Aug. 24, 2009
SPEAG	Data Acquisition Electronics	DAE4	778	Sep. 22, 2008	Sep. 21, 2010
SPEAG	Device Holder	N/A	N/A	NCR	NCR
SPEAG	ELI4 Phantom	QD 0VA 001 BA	1029	NCR	NCR
Agilent	PNA Series Network Analyzer	E8358A	US40260131	Apr. 02, 2008	Apr. 01, 2009
Agilent	Wireless Communication Test Set	E5515C	GB46311322	Dec. 22, 2006	Dec. 21, 2008
R&S	Universal Radio Communication Tester	CMU200	103937	Oct. 19, 2007	Oct. 18, 2008
Agilent	Dielectric Probe Kit	85070D	US01440205	NCR	NCR
Agilent	Dual Directional Coupler	778D	50422	NCR	NCR
AR	Power Amplifier	5S1G4M2	0328767	NCR	NCR
R&S	Power Meter	NRVD	101394	Oct. 31, 2007	Oct. 30, 2008
R&S	Power Sensor	NRV-Z1	100130	Oct. 31, 2007	Oct. 30, 2008

Table 5.1 Test Equipment List

6. Tissue Simulating Liquids

For the measurement of the field distribution inside the SAM phantom with DASY5, the phantom must be filled with around 25 liters of homogeneous tissue simulating liquid. The liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is (head SAR)or from the flat phantom to the liquid top surface (body SAR) is 15.2cm.

The following ingredients for tissue simulating liquid are used:

- **Water**: deionized water (pure H_20), resistivity ≧16MΩ - as basis for the liquid
- **Sugar**: refined sugar in crystals, as available 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.
- **DGMBE**: Deithlenglycol-monobuthyl ether (DGMBE), Fluka Chemie GmbH, CAS#112-34-5 – to reduce relative permittivity.

Table 6.1 gives the recipes for one liter of body tissue simulating liquid for frequency band 850MHz and 1900 MHz.

Ingredient	MSL-850	MSL-1900
Water	631.68 g	716.56 g
Cellulose	0 g	0 g
Salt	11.72 g	4.0 g
Preventol D-7	1.2 g	0 g
Sugar	600.0 g	0 g
DGMBE	0 g	300.67 g
Total amount	1 liter (1.3 kg)	1 liter (1.0 kg)
Dielectric Parameters at 22°	f=835 MHz ε_r = 55.2±5%, σ= 0.97±5% S/m	f= 1900 MHz ε_r = 53.3±5 %, σ= 1.52±5% S/m

Table 6.1 Recipes for 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.

Table 6.2 shows the measuring results for muscle simulating liquid.

Band	Temperature (℃)	Frequency (MHz)	Conductivity (σ)	Permittivity (ε_r)	Measurement Date
GSM850	21.3	824.2	0.960	56.3	Oct. 09, 2008
		836.4	0.972	56.3	
		848.8	0.981	56.1	
CDMA2000 PCS	21.6	1850.2	1.460	55.4	Oct. 02, 2008
		1880.0	1.480	55.3	
		1909.8	1.540	54.6	

Table 6.2 Measuring Results for Simulating Liquid

The measuring data are consistent with $\varepsilon r = 55.2 \pm 5\%$ and $\sigma = 0.97 \pm 5\%$ for body GSM850 band and $\varepsilon r = 53.3 \pm 5\%$ and $\sigma = 1.52 \pm 5\%$ for body CDMA2000 PCS

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 A 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
Multiplying 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) k is the coverage factor

Table 7.1 Multiplying Factions for Various Distributions

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 DASY5 uncertainty Budget is showed in Table 7.2.

Error Description	Uncertainty Value ± %	Probability Distribution	Divisor	Ci (1g)	Standard Unc. (1g)	vi or Veff
Measurement Equipment						
Probe Calibration	±5.9 %	Normal	1	1	±5.9 %	∞
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	145
Device Holder	±3.6 %	Normal	1	1	±3.6	5
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					**±10.9**	**387**
Coverage Factor for 95 %		**K=2**				
Expanded uncertainty (Coverage factor = 2)					**±21.9**	

Table 7.2 Uncertainty Budget of DASY5

8. SAR Measurement Evaluation

Each DASY5 system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY5 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 which comes from a signal generator at frequency 835 MHz and 1900 MHz. 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:

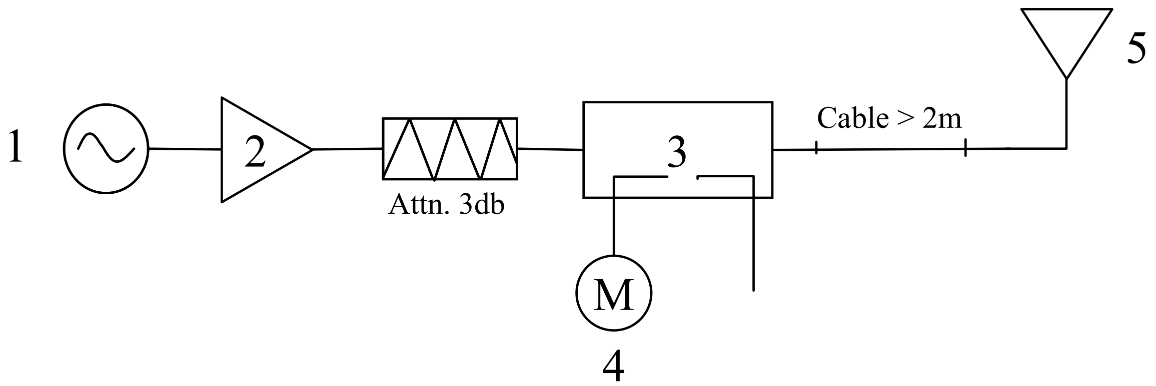


Fig. 8.1 System Setup for System Evaluation

1. Signal Generator
2. Amplifier
3. Directional Coupler
4. Power Meter
5. 835 MHz or 1900 MHz Dipole

The output power on dipole port must be calibrated to 20dBm (100mW) before dipole is connected.

Fig 8.2 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.

Frequency	SAR	Target (W/kg)	Measurement data (W/kg)	Variation	Measurement Date
835MHz	SAR (1g)	9.52	9.79	2.8 %	Oct. 09, 2008
	SAR (10g)	6.37	6.53	2.5 %	
1900MHz	SAR (1g)	40.1	40.9	2.0 %	Oct. 02, 2008
	SAR (10g)	21.3	21.7	1.9 %	

Table 8.1 Target and Measurement Data Comparison

The table above indicates the system performance check can meet the variation criterion.

9. Description for DUT Testing Position

This DUT was tested in two different positions. They are “Lap Held Position with Tablet Mode” and “Secondary Portrait Position with Tablet Mode”.

Remark: Please refer to Appendix E for the test setup photos.

10. Measurement Procedures

The measurement procedures are as follows:

- Linking DUT with base station emulator CMU200 in middle channel
- Setting CMU200 to allow DUT to radiate maximum output power
- Measuring output power through RF cable and power meter
- Placing the DUT in the positions described in the last section
- Setting scan area, grid size and other setting on the DASY5 software
- Taking data for the middle channel on each testing position
- Finding out the largest SAR result on these testing positions of each band
- Measuring output power and SAR results for the low and high channels in this worst case testing position

According to the IEEE P1528 draft standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

- Power reference measurement
- Area scan
- Zoom scan
- Power reference measurement

10.1 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the IEEE1528-2003 standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY5 software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

Base on the Draft: SCC-34, SC-2, WG-2-Computational Dosimetry, IEEE P1528/D1.2 (Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques), a new algorithm has been implemented. The spatial-peak SAR can be computed over any required mass.

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:

- extraction of the measured data (grid and values) from the Zoom Scan
- calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
- generation of a high-resolution mesh within the measured volume
- interpolation of all measured values form the measurement grid to the high-resolution grid
- extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
- calculation of the averaged SAR within masses of 1g and 10g

10.2 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. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 1 g.

10.3 SAR Averaged Methods

In DASY5, 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.

11. SAR Test Results

11.1 Conducted Power

Mode \ Channel \ Band	GSM 850 (dBm)		
	128	189	251
GPRS 8	32.32	32.34	32.40
GPRS 10	32.25	32.28	32.36

Mode \ Channel \ Band	CDMA2000 PCS (dBm)		
	25	600	1175
RTAP-9.6K	23.83	23.74	23.72
RTAP-38.4K	23.73	23.83	23.82
RTAP-153.6K	24.05	23.83	23.84

11.2 Test Records for Body SAR Test

Position	Band	Chan.	Freq. (MHz)	Modulation Type	Measured 1g SAR (W/kg)	Limit (W/kg)	Result
Lap Held Position with Tablet Mode	GSM850 (GPRS10)	128	824.2	GMSK	0.366	1.6	Pass
Lap Held Position with Tablet Mode	GSM850 (GPRS10)	190	836.6	GMSK	0.411	1.6	Pass
Lap Held Position with Tablet Mode	GSM850 (GPRS10)	251	848.8	GMSK	0.491	1.6	Pass
Secondary Portrait Position with Tablet Mode	GSM850 (GPRS10)	128	824.2	GMSK	0.53	1.6	Pass
Secondary Portrait Position with Tablet Mode	GSM850 (GPRS10)	190	836.6	GMSK	0.529	1.6	Pass
Secondary Portrait Position with Tablet Mode	**GSM850 (GPRS10)**	**251**	**848.8**	**GMSK**	**0.643**	**1.6**	**Pass**
Lap Held Position with Tablet Mode	CDMA1900 (RTAP153.6K)	25	1851.25	QPSK	0.191	1.6	Pass
Lap Held Position with Tablet Mode	CDMA1900 (RTAP153.6K)	600	1880.00	QPSK	0.19	1.6	Pass
Lap Held Position with Tablet Mode	CDMA1900 (RTAP153.6K)	1175	1908.75	QPSK	0.215	1.6	Pass
Secondary Portrait Position with Tablet Mode	**CDMA1900 (RTAP153.6K)**	**25**	**1851.25**	**QPSK**	**0.976**	**1.6**	**Pass**
Secondary Portrait Position with Tablet Mode	CDMA1900 (RTAP153.6K)	600	1880.00	QPSK	0.685	1.6	Pass
Secondary Portrait Position with Tablet Mode	CDMA1900 (RTAP153.6K)	1175	1908.75	QPSK	0.839	1.6	Pass

Remark: Test Engineer : Gordon Lin and A-Rod Chen

12. References

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

[2] IEEE Std. P1528-2003, “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”, April 21, 2003

[3] Supplement C (Edition 01-01) to OET Bulletin 65 (Edition 97-01), “Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to RF Emissions”, June 2001

[4] IEEE Std. C95.3-2002, “IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields-RF and Microwave”, 2002

[5] IEEE Std. C95.1-1999, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”, 1999

[6] 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

[7] DASY5 System Handbook

Appendix A - System Performance Check Data

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2008/10/9

System Check_Body_835MHz_20081009

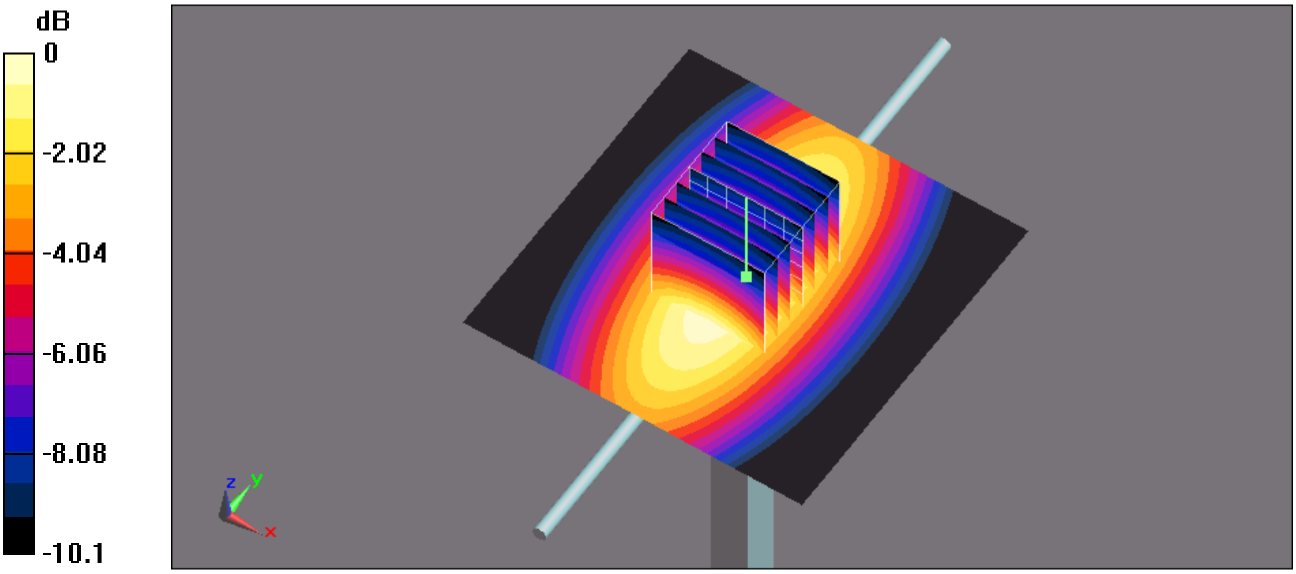
DUT: Dipole 835 MHz

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium: MSL_850 Medium parameters used: f = 835 MHz; σ = 0.971 mho/m; ε_r = 56.3; ρ = 1000 kg/m^3
Ambient Temperature : 22.6 ℃; Liquid Temperature : 21.3 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1788; ConvF(6.34, 6.34, 6.34); Calibrated: 2008/9/23
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn778; Calibrated: 2008/9/22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1029
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.2 Build 87

Pin=100mW/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.06 mW/g

Pin=100mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 34.8 V/m; Power Drift = -0.00939 dB
Peak SAR (extrapolated) = 1.33 W/kg
SAR(1 g) = 0.979 mW/g; SAR(10 g) = 0.653 mW/g
Maximum value of SAR (measured) = 1.06 mW/g



0 dB = 1.06mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2008/10/2

System Check_Body_1900MHz_20081002

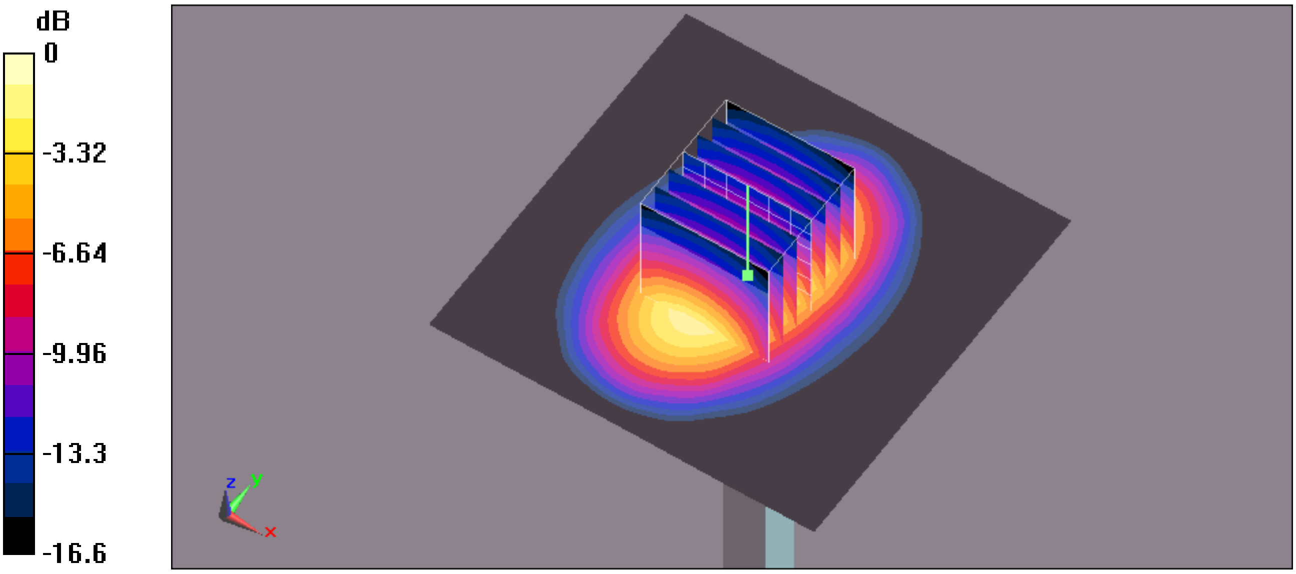
DUT: Dipole 1900 MHz

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: MSL_1900 Medium parameters used: f = 1900 MHz; σ = 1.51 mho/m; ε_r = 54.8; ρ = 1000 kg/m^3
Ambient Temperature：22.8 ℃; Liquid Temperature：21.6 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1787; ConvF(4.49, 4.49, 4.49); Calibrated: 2008/8/26
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn393; Calibrated: 2008/8/25
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1029
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.2 Build 87

Pin=100mW/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 4.68 mW/g

Pin=100mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 57.8 V/m; Power Drift = 0.016 dB
Peak SAR (extrapolated) = 7.38 W/kg
SAR(1 g) = 4.09 mW/g; SAR(10 g) = 2.17 mW/g
Maximum value of SAR (measured) = 4.6 mW/g



0 dB = 4.6mW/g

Appendix B - SAR Measurement Data

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2008/10/9

Body_GSM850 Ch251_Lap Held Position with Tablet Mode_GPRS10

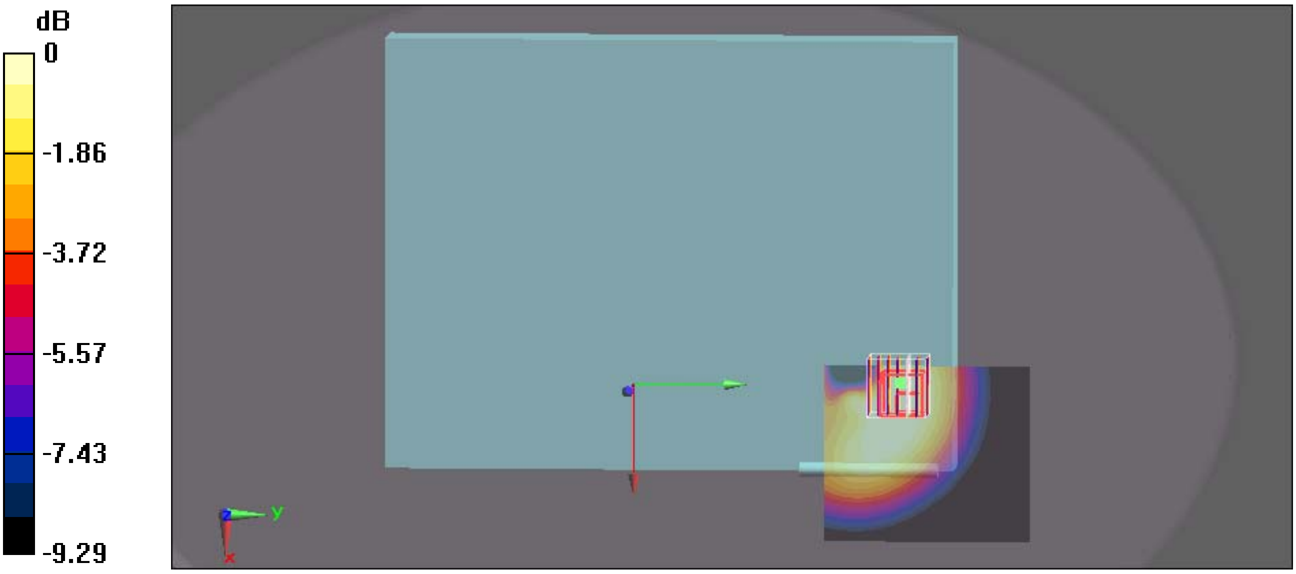
DUT: 8O1007

Communication System: GSM850; Frequency: 848.8 MHz;Duty Cycle: 1:4.3
Medium: MSL_850 Medium parameters used: f = 849 MHz; σ = 0.981 mho/m; ε_r = 56.1; ρ = 1000 kg/m^3
Ambient Temperature：22.6 ℃; Liquid Temperature：21.3 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1788; ConvF(6.34, 6.34, 6.34); Calibrated: 2008/9/23
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn778; Calibrated: 2008/9/22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1029
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.2 Build 87

Ch251/Area Scan (61x71x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.587 mW/g

Ch251/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.81 V/m; Power Drift = 0.090 dB
Peak SAR (extrapolated) = 0.650 W/kg
SAR(1 g) = 0.491 mW/g; SAR(10 g) = 0.348 mW/g
Maximum value of SAR (measured) = 0.520 mW/g



0 dB = 0.520mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2008/10/9

Body_GSM850 Ch251_Secondary Portrait with 0cm Gap_GPRS10

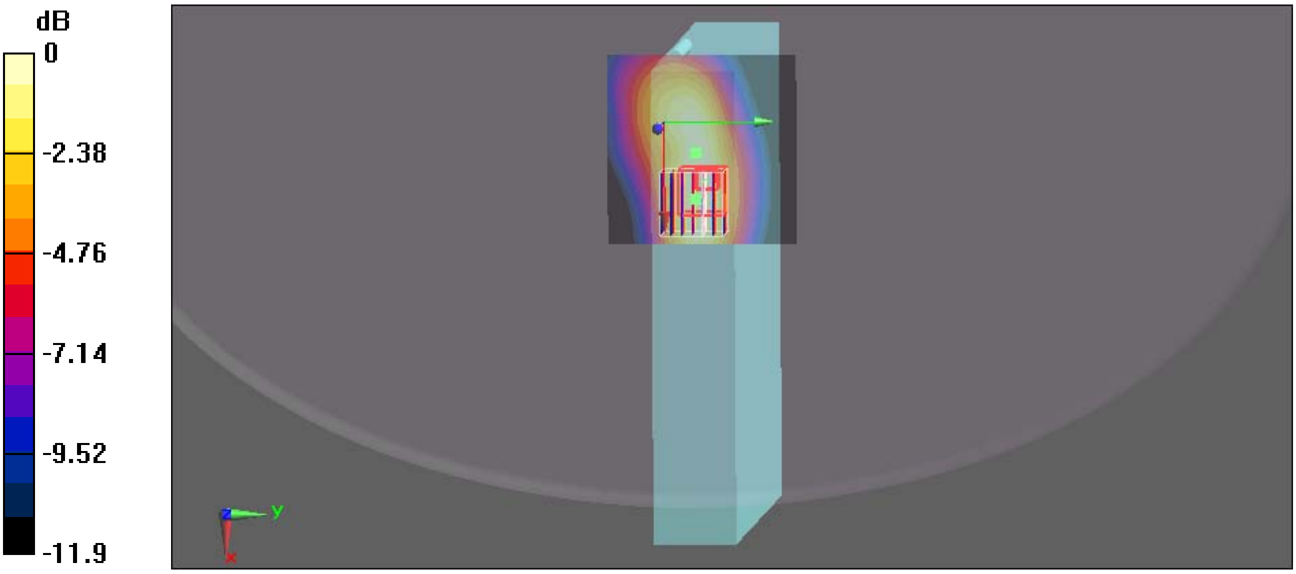
DUT: 8O1007

Communication System: GSM850; Frequency: 848.8 MHz;Duty Cycle: 1:4.3
Medium: MSL_850 Medium parameters used: f = 849 MHz; σ = 0.981 mho/m; ε_r = 56.1; ρ = 1000 kg/m^3
Ambient Temperature：22.6 ℃; Liquid Temperature：21.3 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1788; ConvF(6.34, 6.34, 6.34); Calibrated: 2008/9/23
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn778; Calibrated: 2008/9/22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1029
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.2 Build 87

Ch251/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.748 mW/g

Ch251/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 22.5 V/m; Power Drift = 0.016 dB
Peak SAR (extrapolated) = 1.01 W/kg
SAR(1 g) = 0.643 mW/g; SAR(10 g) = 0.401 mW/g
Maximum value of SAR (measured) = 0.740 mW/g



0 dB = 0.740mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2008/10/2

Body_CDMA1900 Ch1175_Lap Held Position with Tablet Mode_RTAP153.6K

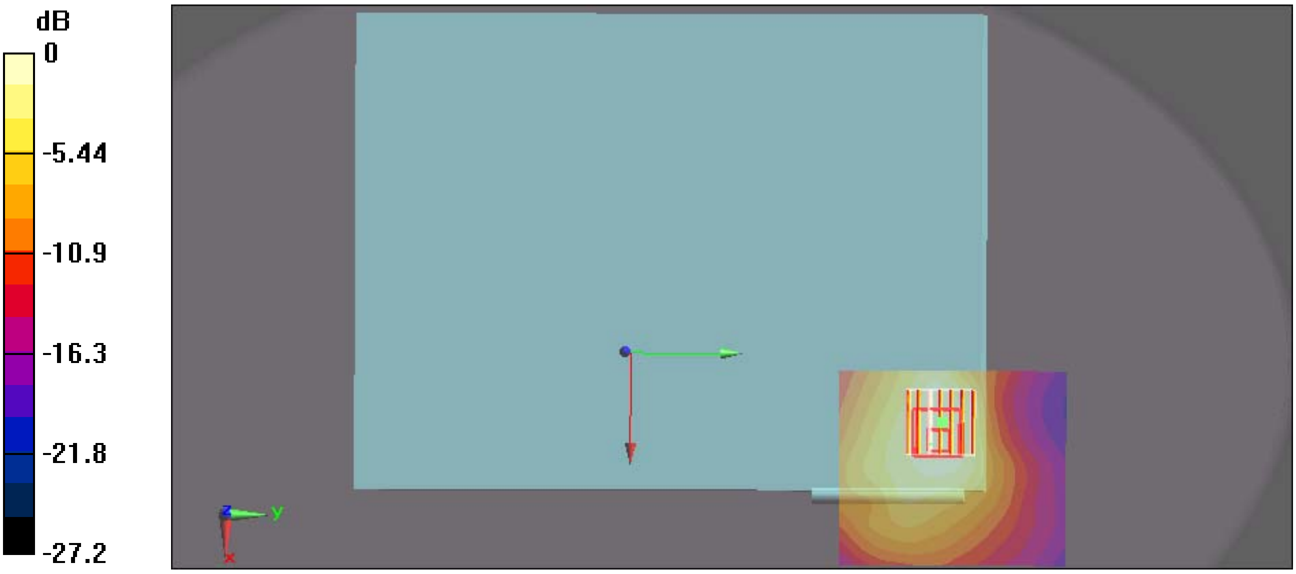
DUT: 8O1007

Communication System: CDMA ; Frequency: 1908.75 MHz;Duty Cycle: 1:1
Medium: MSL_1900 Medium parameters used: f = 1909 MHz; σ = 1.54 mho/m; ε_r = 54.6; ρ = 1000 kg/m^3
Ambient Temperature：22.9 ℃； Liquid Temperature：21.6 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1787; ConvF(4.49, 4.49, 4.49); Calibrated: 2008/8/26
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn393; Calibrated: 2008/8/25
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1029
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.2 Build 87

Ch1175/Area Scan (61x71x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.242 mW/g

Ch1175/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.08 V/m; Power Drift = 0.113 dB
Peak SAR (extrapolated) = 0.418 W/kg
SAR(1 g) = 0.215 mW/g; SAR(10 g) = 0.120 mW/g
Maximum value of SAR (measured) = 0.231 mW/g



0 dB = 0.231mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2008/10/2

Body_CDMA1900 Ch25_Secondary Portrait with 0cm Gap_RTAP153.6K

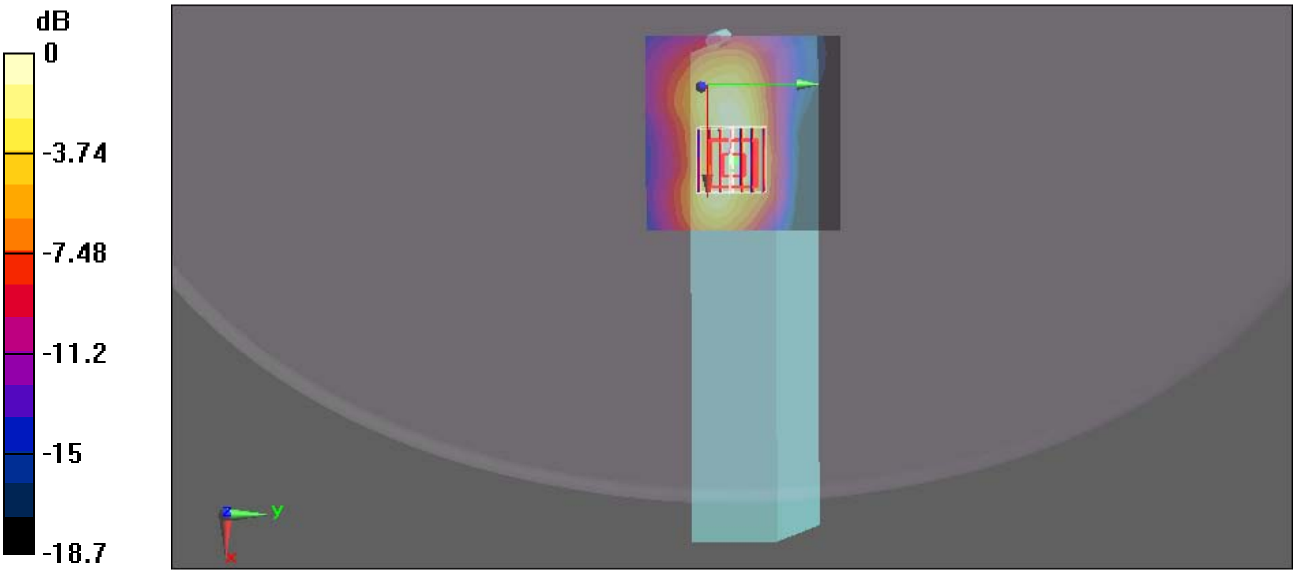
DUT: 8O1007

Communication System: CDMA ; Frequency: 1851.25 MHz;Duty Cycle: 1:1
Medium: MSL_1900 Medium parameters used: f = 1851.25 MHz; σ = 1.46 mho/m; ε_r = 55.4; ρ = 1000 kg/m^3
Ambient Temperature：23.0 ℃; Liquid Temperature：21.6 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1787; ConvF(4.49, 4.49, 4.49); Calibrated: 2008/8/26
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn393; Calibrated: 2008/8/25
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1029
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.2 Build 87

Ch25/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.13 mW/g

Ch25/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 19.3 V/m; Power Drift = -0.043 dB
Peak SAR (extrapolated) = 1.93 W/kg
SAR(1 g) = 0.976 mW/g; SAR(10 g) = 0.526 mW/g
Maximum value of SAR (measured) = 1.05 mW/g



0 dB = 1.05mW/g

Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2008/10/9

Body_GSM850 Ch251_Secondary Portrait with 0cm Gap_GPRS10_2D

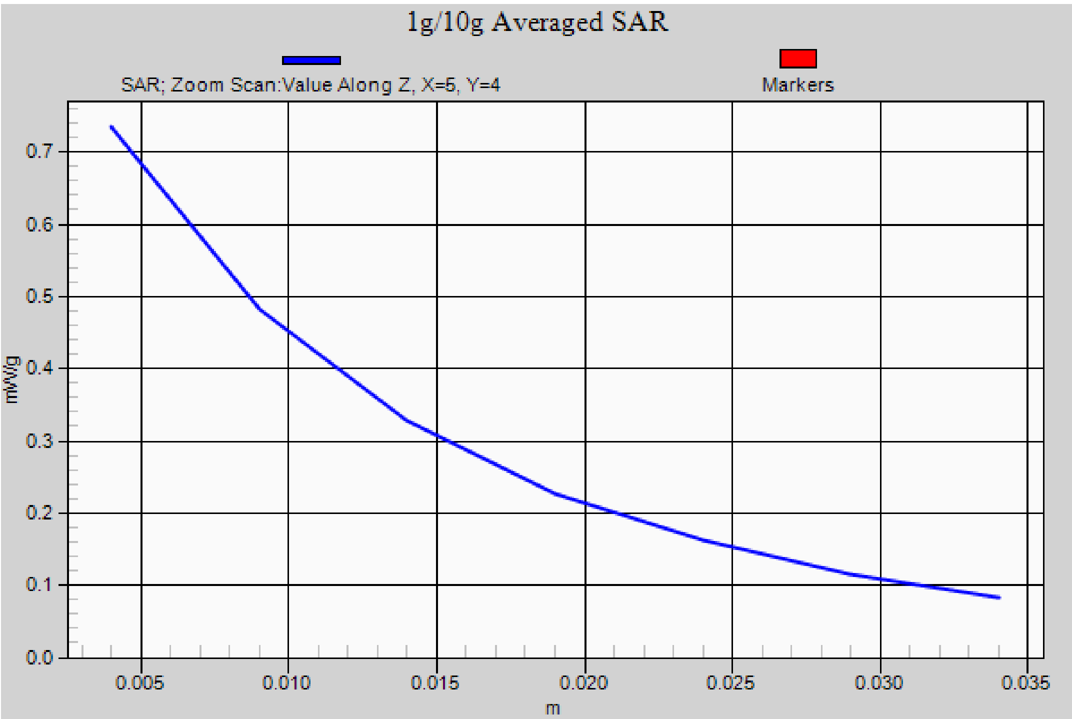
DUT: 816144

Communication System: GSM850; Frequency: 848.8 MHz;Duty Cycle: 1:4.3
Medium: MSL_850 Medium parameters used: f = 849 MHz; σ = 0.981 mho/m; ε_r = 56.1; ρ = 1000 kg/m^3
Ambient Temperature：22.6 ℃； Liquid Temperature：21.3 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1788; ConvF(6.34, 6.34, 6.34); Calibrated: 2008/9/23
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn778; Calibrated: 2008/9/22
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1029
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.2 Build 87

Ch251/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.748 mW/g

Ch251/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 22.5 V/m; Power Drift = 0.016 dB
Peak SAR (extrapolated) = 1.01 W/kg
SAR(1 g) = 0.643 mW/g; SAR(10 g) = 0.401 mW/g
Maximum value of SAR (measured) = 0.740 mW/g



Test Laboratory: Sporton International Inc. SAR/HAC Testing Lab Date: 2008/10/2

Body_CDMA1900 Ch25_Secondary Portrait with 0cm Gap_RTAP153.6K_2D

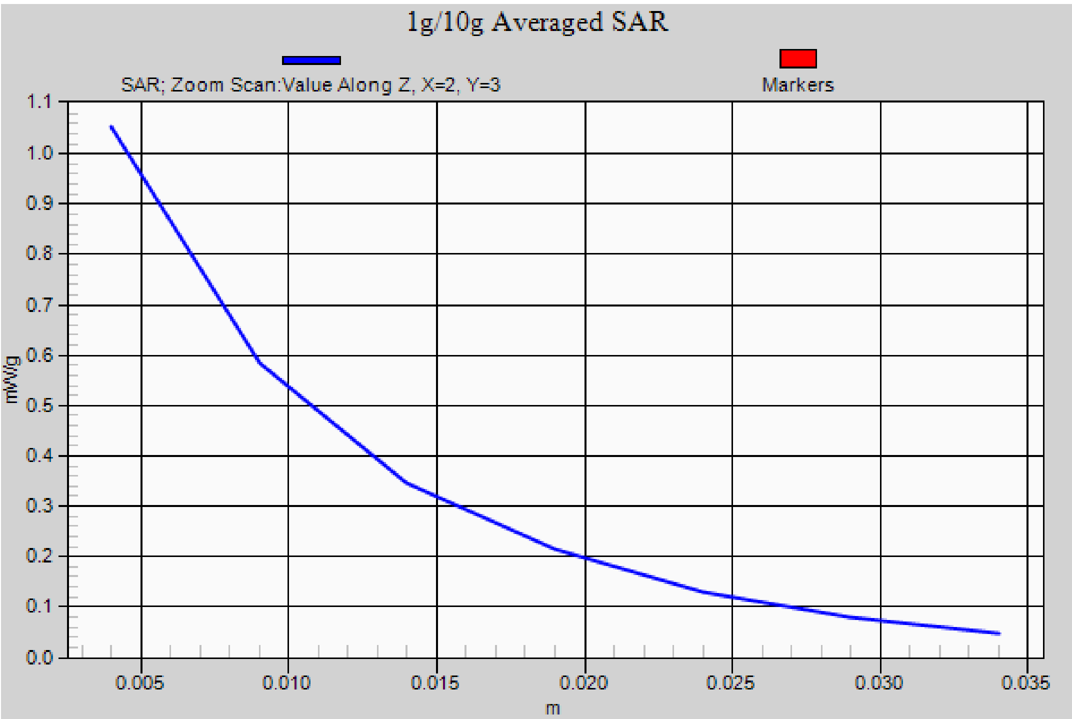
DUT: 816144

Communication System: CDMA ; Frequency: 1851.25 MHz;Duty Cycle: 1:1
Medium: MSL_1900 Medium parameters used : f = 1851.25 MHz; σ = 1.46 mho/m; ε_r = 55.4; ρ = 1000 kg/m^3
Ambient Temperature：23.0 ℃; Liquid Temperature：21.6 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1787; ConvF(4.49, 4.49, 4.49); Calibrated: 2008/8/26
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn393; Calibrated: 2008/8/25
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1029
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.2 Build 87

Ch25/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.13 mW/g

Ch25/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 19.3 V/m; Power Drift = -0.043 dB
Peak SAR (extrapolated) = 1.93 W/kg
SAR(1 g) = 0.976 mW/g; SAR(10 g) = 0.526 mW/g
Maximum value of SAR (measured) = 1.05 mW/g



Appendix C – Calibration Data

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

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

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: **D835V2-499_Mar08**

CALIBRATION CERTIFICATE

Object	D835V2 - SN: 499
Calibration procedure(s)	QA CAL-05.v7 Calibration procedure for dipole validation kits
Calibration date:	March 17, 2008
Condition of the calibrated item	In Tolerance

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	04-Oct-07 (METAS, No. 217-00736)	Oct-08
Power sensor HP 8481A	US37292783	04-Oct-07 (METAS, No. 217-00736)	Oct-08
Reference 20 dB Attenuator	SN: 5086 (20g)	07-Aug-07 (METAS, No 217-00718)	Aug-08
Reference Probe ES3DV2	SN: 3025	01-Mar-08 (SPEAG, No. ES3-3025_Mar08)	Mar-09
DAE4	SN 909	03-Sep-07 (SPEAG, No. DAE4-909_Sep07)	Sep-08

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (SPEAG, in house check Oct-07)	In house check: Oct-09
RF generator R&S SMT-06	100005	04-Aug-99 (SPEAG, in house check Oct-07)	In house check: Oct-09
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (SPEAG, in house check Oct-07)	In house check: Oct-08

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

Issued: March 17, 2008

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

Certificate No: D835V2-499_Mar08　　Page 1 of 9

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

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

Accredited by the Swiss Accreditation Service (SAS)
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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 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	DASY4	V4.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V4.9	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.5 ± 6 %	0.90 mho/m ± 6 %
Head TSL temperature during test	(22.0 ± 0.2) °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.29 mW / g
SAR normalized	normalized to 1W	9.16 mW / g
SAR for nominal Head TSL parameters [1]	normalized to 1W	**9.16 mW / g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.50 mW / g
SAR normalized	normalized to 1W	6.00 mW / g
SAR for nominal Head TSL parameters [1]	normalized to 1W	**6.00 mW / g ± 16.5 % (k=2)**

[1] Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	54.0 ± 6 %	1.00 mho/m ± 6 %
Body TSL temperature during test	(22.0 ± 0.2) °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.46 mW / g
SAR normalized	normalized to 1W	9.84 mW / g
SAR for nominal Body TSL parameters [2]	normalized to 1W	**9.52 mW / g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.63 mW / g
SAR normalized	normalized to 1W	6.52 mW / g
SAR for nominal Body TSL parameters [2]	normalized to 1W	**6.37 mW / g ± 16.5 % (k=2)**

[2] Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.9 Ω - 2.3 jΩ
Return Loss	- 28.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.2 Ω - 3.3 jΩ
Return Loss	- 29.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.392 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 10, 2003

DASY4 Validation Report for Head TSL

Date/Time: 17.03.2008 11:32:45

Test Laboratory: SPEAG, Zurich, Switzerland

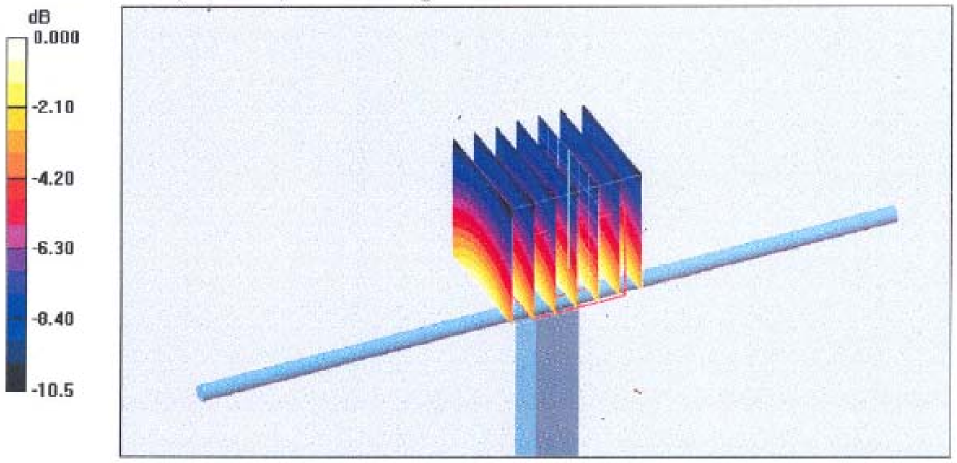
DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:499

Communication System: CW-835; Frequency: 835 MHz; Duty Cycle: 1:1
Medium: HSL 900 MHz;
Medium parameters used: f = 835 MHz; σ = 0.9 mho/m; ε_r = 41.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

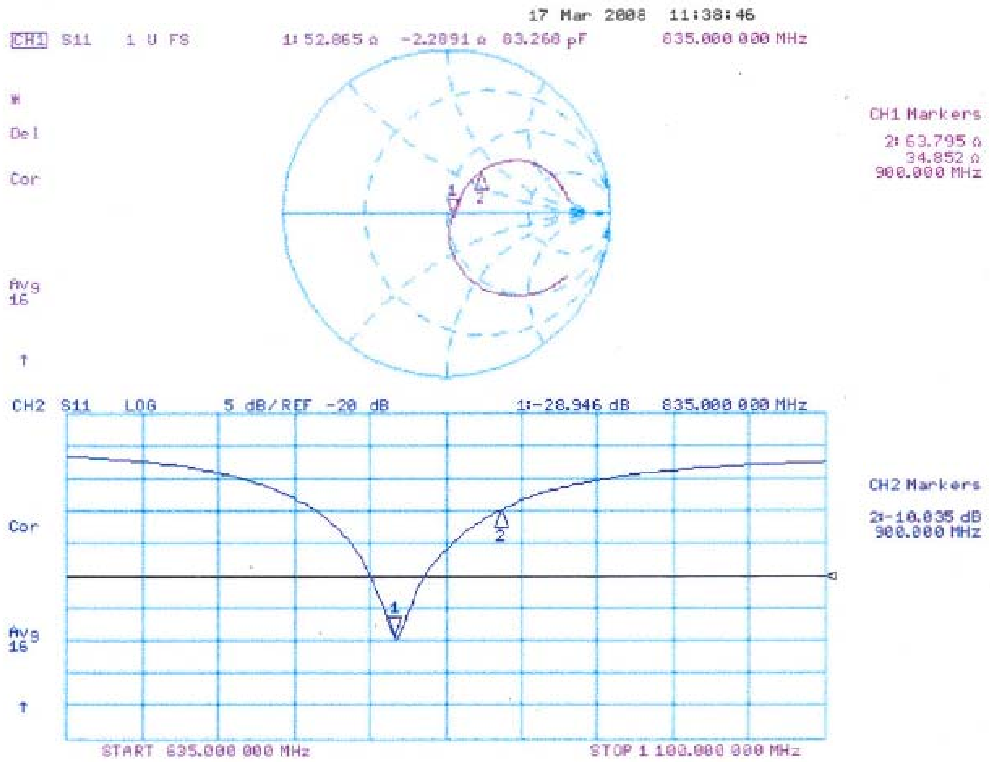
- Probe: ES3DV2 - SN3025; ConvF(6.09, 6.09, 6.09); Calibrated: 01.03.2008
- Sensor-Surface: 3.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 03.09.2007
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; ;
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 172

Unnamed procedure/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 54.9 V/m; Power Drift = -0.005 dB
Peak SAR (extrapolated) = 3.34 W/kg
SAR(1 g) = 2.29 mW/g; SAR(10 g) = 1.5 mW/g
Maximum value of SAR (measured) = 2.58 mW/g



0 dB = 2.58mW/g

Impedance Measurement Plot for Head TSL



DASY4 Validation Report for Body TSL

Date/Time: 10.03.2008 12:48:36

Test Laboratory: SPEAG, Zurich, Switzerland

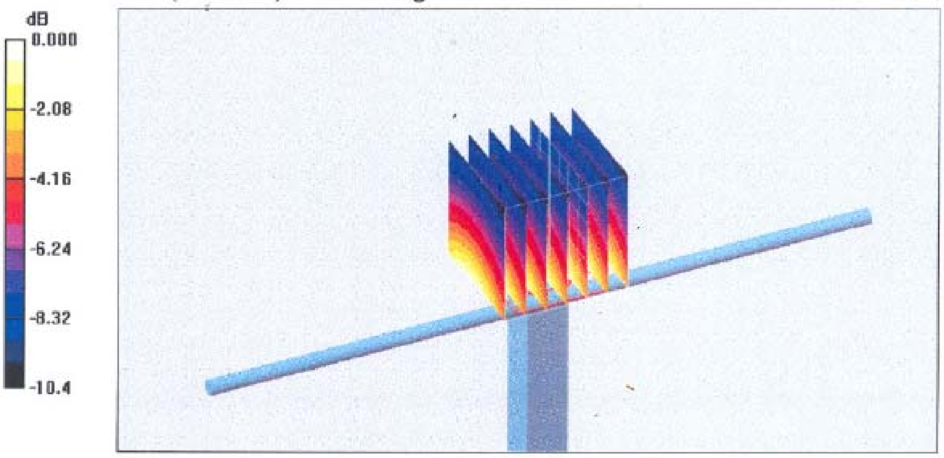
DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:499

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium: MSL900;
Medium parameters used: f = 835 MHz; σ = 1 mho/m; ε_r = 54; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

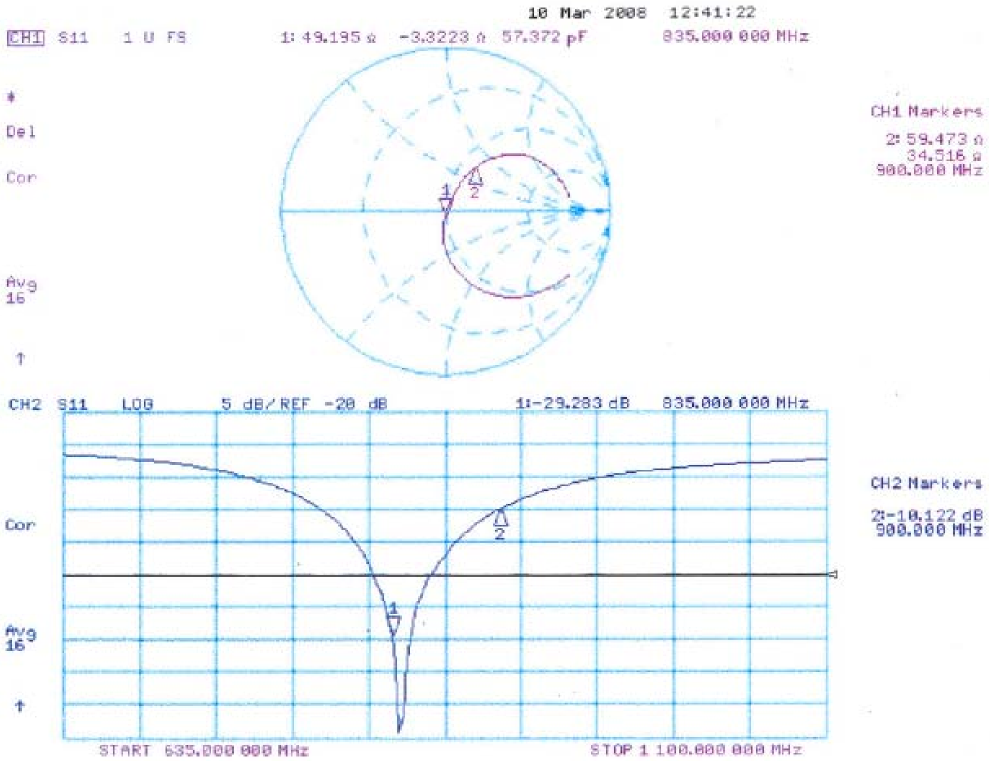
- Probe: ES3DV2 - SN3025; ConvF(5.85, 5.85, 5.85); Calibrated: 01.03.2008
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 03.09.2007
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; ;
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 172

Pin = 250mW, d = 15mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 51.8 V/m; Power Drift = 0.036 dB
Peak SAR (extrapolated) = 3.59 W/kg
SAR(1 g) = 2.46 mW/g; SAR(10 g) = 1.63 mW/g
Maximum value of SAR (measured) = 2.64 mW/g



0 dB = 2.64mW/g

Impedance Measurement Plot for Body TSL



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Accreditation No.: **SCS 108**

Client **Sporton (Auden)**

Certificate No: **D1900V2-5d041_Mar08**

CALIBRATION CERTIFICATE

Object	D1900V2 - SN: 5d041
Calibration procedure(s)	QA CAL-05.v7 Calibration procedure for dipole validation kits
Calibration date:	March 18, 2008
Condition of the calibrated item	In Tolerance

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	04-Oct-07 (METAS, No. 217-00736)	Oct-08
Power sensor HP 8481A	US37292783	04-Oct-07 (METAS, No. 217-00736)	Oct-08
Reference 20 dB Attenuator	SN: 5086 (20g)	07-Aug-07 (METAS, No 217-00718)	Aug-08
Reference 10 dB Attenuator	SN: 5047.2 (10r)	07-Aug-07 (METAS, No 217-00718)	Aug-08
Reference Probe ES3DV2	SN: 3025	01-Mar-08 (SPEAG, No. ES3-3025_Mar08)	Mar-09
DAE4	SN 909	3-Sep-08 (SPEAG, No. DAE4-909_Sep07)	Sep-07
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Power sensor HP 8481A	MY41092317	18-Oct-02 (SPEAG, in house check Oct-07)	In house check: Oct-08
RF generator R&S SMT-06	100005	4-Aug-99 (SPEAG, in house check Oct-07)	In house check: Oct-09
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (SPEAG, in house check Oct-07)	In house check: Oct-08
Power meter EPM-442A	GB37480704	04-Oct-07 (METAS, No. 217-00736)	Oct-08

	Name	Function	Signature
Calibrated by:	Marcel Fehr	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 18, 2008

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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) CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz), July 2001
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 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	DASY4	V4.7
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	1900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.2 ± 6 %	1.47 mho/m ± 6 %
Head TSL temperature during test	(21.1 ± 0.2) °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	condition	
SAR measured	250 mW input power	10.1 mW / g
SAR normalized	normalized to 1W	40.4 mW / g
SAR for nominal Head TSL parameters [1]	normalized to 1W	**39.5 mW / g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.20 mW / g
SAR normalized	normalized to 1W	20.8 mW / g
SAR for nominal Head TSL parameters [1]	normalized to 1W	**20.6 mW / g ± 16.5 % (k=2)**

[1] Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.6 ± 6 %	1.57 mho/m ± 6 %
Body TSL temperature during test	(21.4 ± 0.2) °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.4 mW / g
SAR normalized	normalized to 1W	41.6 mW / g
SAR for nominal Body TSL parameters [2]	normalized to 1W	**40.1 mW / g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.44 mW / g
SAR normalized	normalized to 1W	21.8 mW / g
SAR for nominal Body TSL parameters [2]	normalized to 1W	**21.3 mW / g ± 16.5 % (k=2)**

[2] Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.0 Ω + 5.1 jΩ
Return Loss	- 24.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.0 Ω + 6.1 jΩ
Return Loss	- 23.6 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 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 04, 2003

DASY4 Validation Report for Head TSL

Date/Time: 18.03.2008 12:05:10

Test Laboratory: SPEAG, Zurich, Switzerland

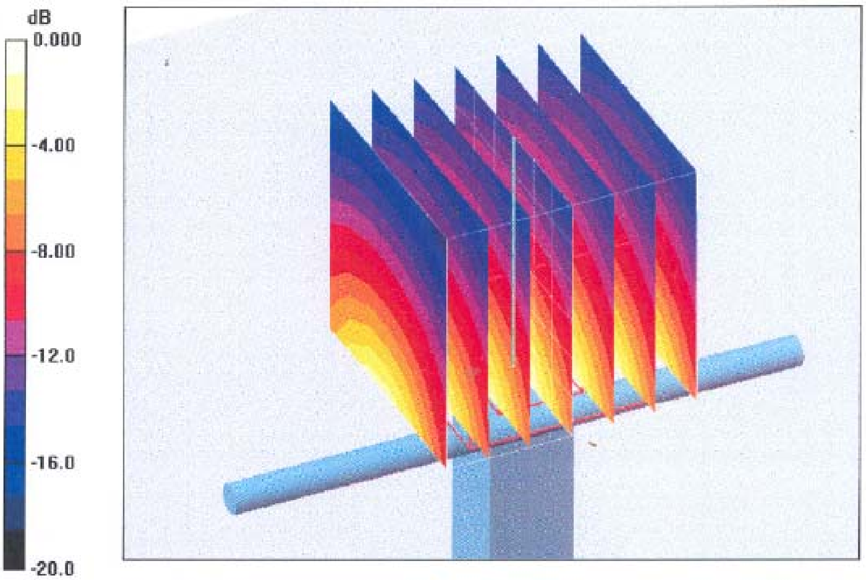
DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d041

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: HSL U10 BB;
Medium parameters used: f = 1900 MHz; σ = 1.47 mho/m; ε_r = 40.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

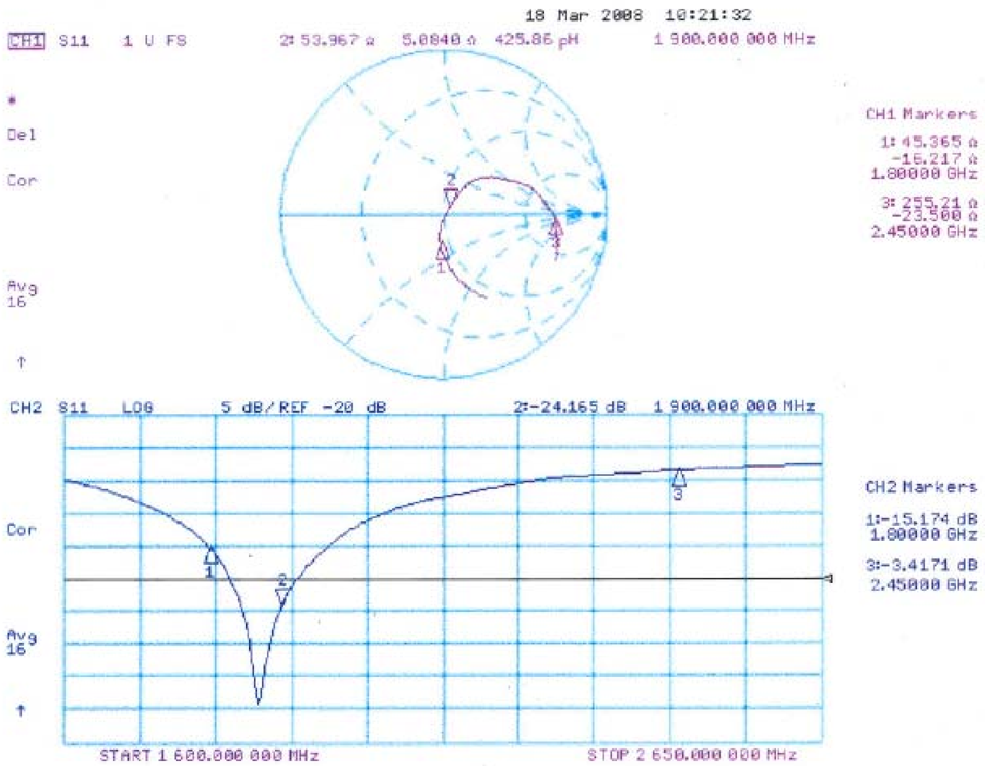
- Probe: ES3DV2 - SN3025; ConvF(4.9, 4.9, 4.9); Calibrated: 01.03.2008
- Sensor-Surface: 3.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 03.09.2007
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; ;
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 172

Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 91.7 V/m; Power Drift = 0.013 dB
Peak SAR (extrapolated) = 19.1 W/kg
SAR(1 g) = 10.1 mW/g; SAR(10 g) = 5.2 mW/g
Maximum value of SAR (measured) = 11.8 mW/g



0 dB = 11.8mW/g

Impedance Measurement Plot for Head TSL



DASY4 Validation Report for Body TSL

Date/Time: 14.03.2008 13:22:24

Test Laboratory: SPEAG, Zurich, Switzerland

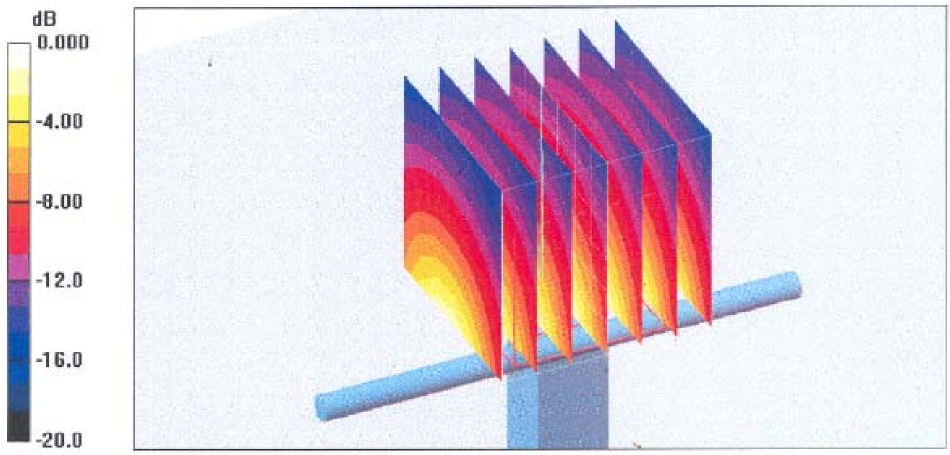
DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d041

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: MSL U10 BB;
Medium parameters used: f = 1900 MHz; σ = 1.57 mho/m; ε_r = 51.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

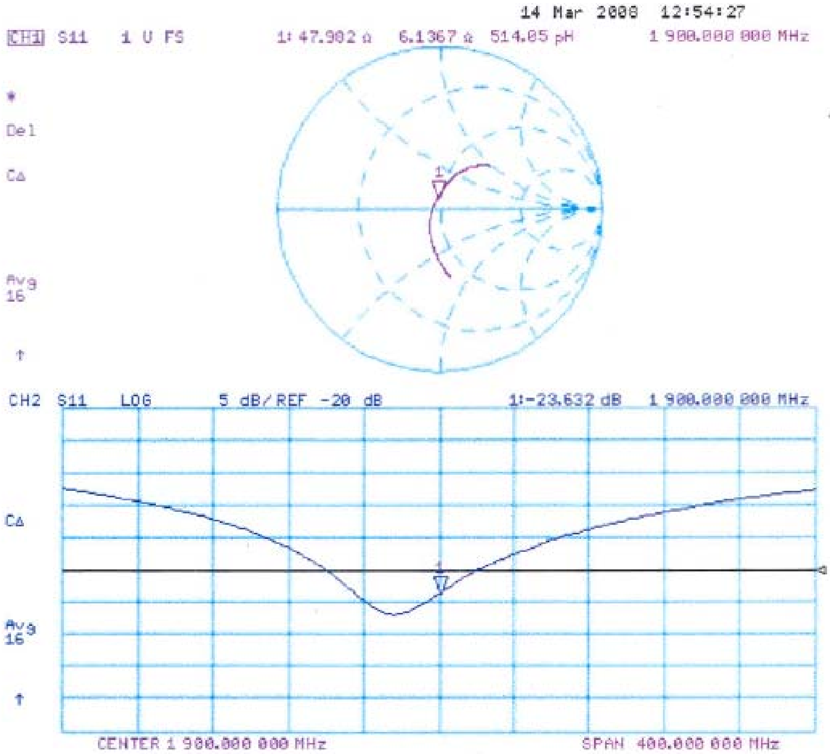
- Probe: ES3DV2 - SN3025; ConvF(4.5, 4.5, 4.5); Calibrated: 01.03.2008
- Sensor-Surface: 3.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn909; Calibrated: 03.09.2007
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; ;
- Measurement SW: DASY4, V4.7 Build 55; Postprocessing SW: SEMCAD, V1.8 Build 172

Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.7 V/m; Power Drift = 0.004 dB
Peak SAR (extrapolated) = 18.6 W/kg
SAR(1 g) = 10.4 mW/g; SAR(10 g) = 5.44 mW/g
Maximum value of SAR (measured) = 12.0 mW/g



0 dB = 12.0mW/g

Impedance Measurement Plot for Body TSL



Certificate No: D1900V2-5d041_Mar08 Page 9 of 9

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Accreditation No.: SCS 108

Client ATL (Auden) **Certificate No: DAE3-393_Aug08**

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AA - SN: 393
Calibration procedure(s)	QA CAL-06.v12 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	August 25, 2008
Condition of the calibrated item	In Tolerance

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
Fluke Process Calibrator Type 702	SN: 6295803	04-Oct-07 (No: 6467)	Oct-08
Keithley Multimeter Type 2001	SN: 0810278	03-Oct-07 (No: 6465)	Oct-08
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Calibrator Box V1.1	SE UMS 006 AB 1004	06-Jun-08 (in house check)	In house check: Jun-09

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

Issued: August 25, 2008

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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:* 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	403.922 ± 0.1% (k=2)	404.197 ± 0.1% (k=2)	404.112 ± 0.1% (k=2)
Low Range	3.99613 ± 0.7% (k=2)	3.96056 ± 0.7% (k=2)	3.96224 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	305 ° ± 1 °

Appendix

1. DC Voltage Linearity

High Range		Input (µV)	Reading (µV)	Error (%)
Channel X	+ Input	200000	200000.5	0.00
Channel X	+ Input	20000	20006.70	0.03
Channel X	- Input	20000	-19995.73	-0.02
Channel Y	+ Input	200000	200000.1	0.00
Channel Y	+ Input	20000	20003.14	0.02
Channel Y	- Input	20000	-19996.72	-0.02
Channel Z	+ Input	200000	200000.1	0.00
Channel Z	+ Input	20000	20000.43	0.00
Channel Z	- Input	20000	-20009.12	0.05

Low Range		Input (µV)	Reading (µV)	Error (%)
Channel X	+ Input	2000	2000	0.00
Channel X	+ Input	200	199.94	-0.03
Channel X	- Input	200	-199.74	-0.13
Channel Y	+ Input	2000	2000	0.00
Channel Y	+ Input	200	199.41	-0.30
Channel Y	- Input	200	-200.68	0.34
Channel Z	+ Input	2000	1999.9	0.00
Channel Z	+ Input	200	199.05	-0.47
Channel Z	- Input	200	-201.02	0.51

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	12.56	11.64
	- 200	-10.20	-11.30
Channel Y	200	9.63	9.29
	- 200	-10.67	-11.08
Channel Z	200	4.03	3.82
	- 200	-5.44	-5.95

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	-	3.90	1.05
Channel Y	200	1.67	-	5.27
Channel Z	200	-0.69	1.48	-

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	16160	16805
Channel Y	16023	16373
Channel Z	16458	17457

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	0.40	-0.62	1.30	0.25
Channel Y	-0.40	-0.88	0.29	0.22
Channel Z	-0.18	-1.74	2.11	0.48

6. Input Offset Current

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

7. Input Resistance

	Zeroing (MOhm)	Measuring (MOhm)
Channel X	0.2000	198.3
Channel Y	0.2000	198.2
Channel Z	0.2000	198.1

8. Low Battery Alarm Voltage (verified during pre test)

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

9. Power Consumption (verified during pre test)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.0	+6	+14
Supply (- Vcc)	–0.01	-8	-9