

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

**Client** **BACL**

## CALIBRATION CERTIFICATE

Object(s) **D5100V2 - SN:1001**

Calibration procedure(s) **QA CAL-05.v2**  
**Calibration procedure for dipole validation kits**

Calibration date: **August 18, 2003**


Condition of the calibrated item **In Tolerance (according to the specific calibration document)**

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
RF generator R&S SMT06	100058	23-May-01 (SPEAG, in house check May-03)	In house check: May-05
Power sensor E4412A	MY41495277	2-Apr-03 (METAS, No 252-0250)	Apr-04
Power sensor HP 8481A	MY41092180	18-Sep-02 (Agilent, No. 20020918)	Sep-03
Power meter EPM E4419B	GB41293874	2-Apr-03 (METAS, No 252-0250)	Apr-04
Network Analyzer HP 8753E	US37390585	18-Oct-01 (Agilent, No. 24BR1033101)	In house check: Oct 03
Fluke Process Calibrator Type 702	SN: 6295803	3-Sep-01 (ELCAL, No 2360)	Sep-03

	Name	Function	Signature
Calibrated by:	Fin Bomholt	R&D Director	

Approved by:	Katja Pokovic	Laboratory Director	
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Date issued: August 20, 2003

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

Schmid & Partner Engineering AG

**s p e a g**

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# DASY

## Dipole Validation Kit

Type: D5100V2

Serial: 1001

Manufactured: April 2, 2003

Calibrated: August 18, 2003

## 1. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with **head simulating solution** of the following electrical parameters:

Frequency:	<b>5200 MHz</b>	
Relative Dielectricity	<b>36.8</b>	$\pm 5\%$
Conductivity	<b>4.71 mho/m</b>	$\pm 5\%$
Frequency:	<b>5800 MHz</b>	
Relative Dielectricity	<b>35.5</b>	$\pm 5\%$
Conductivity	<b>5.32 mho/m</b>	$\pm 5\%$

The DASY3 System with a dosimetric E-field probe ES3DV2 - SN:3005 was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. Lossless spacer was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 5x5x5 fine cube was chosen for cube integration. The uncertainty of the dipole input power (forward power) was  $\pm 3\%$ . The results are normalized to 1W input power.

## 2. SAR Measurement with DASY System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured at **5200 MHz** with the dosimetric probe ES3DV2 SN:3005 and applying the advanced extrapolation are:

averaged over 1 cm <sup>3</sup> (1 g) of tissue:	<b>77.4 mW/g <math>\pm 21.7\%</math> (k=2)<sup>1</sup></b>
averaged over 10 cm <sup>3</sup> (10 g) of tissue:	<b>22.8 mW/g <math>\pm 20.6\%</math> (k=2)<sup>1</sup></b>

The resulting averaged SAR-values measured at **5800 MHz** with the dosimetric probe ES3DV2 SN:3005 and applying the advanced extrapolation are:

averaged over 1 cm <sup>3</sup> (1 g) of tissue:	<b>72.8 mW/g <math>\pm 21.7\%</math> (k=2)<sup>2</sup></b>
averaged over 10 cm <sup>3</sup> (10 g) of tissue:	<b>21.3 mW/g <math>\pm 20.6\%</math> (k=2)<sup>2</sup></b>

<sup>1</sup> validation uncertainty

<sup>2</sup> validation uncertainty

### **3. Dipole Transformation Parameters**

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint (please refer to the graphics attached to this document). The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay:	<b>1.204 ns</b>	(one direction)
Transmission factor:	<b>0.960</b>	(voltage transmission, one direction)

### **4. Measurement Conditions**

The measurements were performed in the flat section of the SAM twin phantom filled with **body simulating solution** of the following electrical parameters:

Frequency:	<b>5200 MHz</b>	
Relative Dielectricity	<b>49.9</b>	$\pm 5\%$
Conductivity	<b>5.21 mho/m</b>	$\pm 5\%$

Frequency:	<b>5800 MHz</b>	
Relative Dielectricity	<b>48.6</b>	$\pm 5\%$
Conductivity	<b>6.07 mho/m</b>	$\pm 5\%$

The DASY3 System with a dosimetric E-field probe ES3DV2 - SN:3005 was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. Lossless spacer was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 5x5x5 fine cube was chosen for cube integration. The uncertainty of the dipole input power (forward power) was  $\pm 3\%$ . The results are normalized to 1W input power.



## **5. SAR Measurement with DASY System**

Standard SAR-measurements were performed according to the measurement conditions described in section 4. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured at **5200 MHz** with the dosimetric probe ES3DV2 SN:3005 and applying the advanced extrapolation are:

averaged over 1 cm<sup>3</sup> (1 g) of tissue: **82.1 mW/g ± 21.7 % (k=2)<sup>3</sup>**

averaged over 10 cm<sup>3</sup> (10 g) of tissue: **24.2 mW/g ± 20.6 % (k=2)<sup>3</sup>**

The resulting averaged SAR-values measured at **5800 MHz** with the dosimetric probe ES3DV2 SN:3005 and applying the advanced extrapolation are:

averaged over 1 cm<sup>3</sup> (1 g) of tissue: **73.8 mW/g ± 21.7 % (k=2)<sup>4</sup>**

averaged over 10 cm<sup>3</sup> (10 g) of tissue: **21.8 mW/g ± 20.6 % (k=2)<sup>4</sup>**

## **6. Handling**

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

## **7. Design**

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.

Small end caps have been added to the dipole arms in order to increase frequency bandwidth at the position as explained in Sections 1 and 4.

## **8. Power Test**

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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<sup>3</sup> validation uncertainty

<sup>4</sup> validation uncertainty

08/18/03

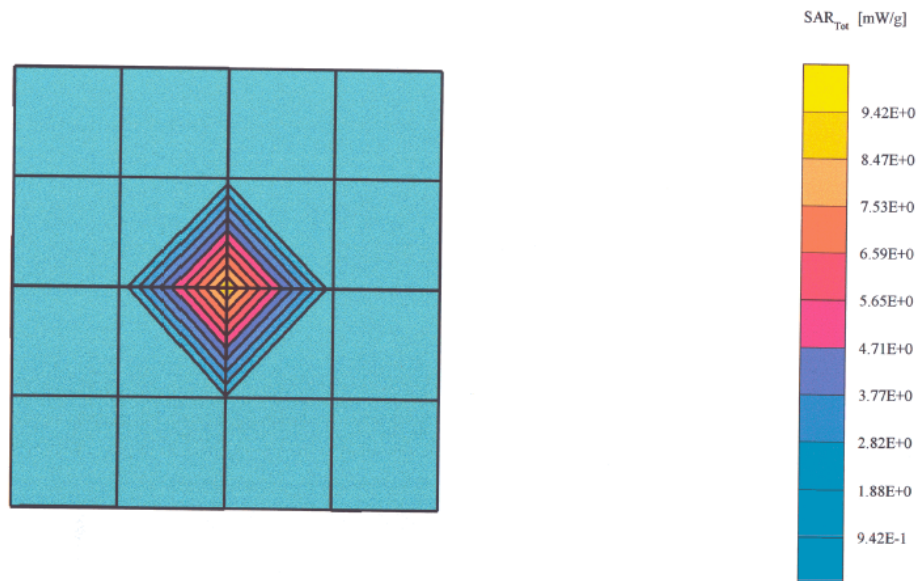
**Validation Dipole D5100V2 SN:1001, d = 10 mm**

Frequency: 5200 MHz; Antenna Input Power: 92.04 [mW]

Phantom Name: SAM, Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0

Probe: ES3DV2 - SN3005-Y2003; ConvF(2.80,2.80,2.80); Crest factor: 1.0; Head 5200 MHz:  $\sigma = 4.71 \text{ mho/m}$ ,  $\epsilon_r = 36.8$ ,  $\rho = 1.00 \text{ g/cm}^3$ Cubes (2): Peak: 21.2 mW/g  $\pm 0.09 \text{ dB}$ , SAR (1g): 7.12 mW/g  $\pm 0.04 \text{ dB}$ , SAR (10g): 2.10 mW/g  $\pm 0.03 \text{ dB}$ , (Advanced extrapolation)

Penetration depth: 2.6 (1.4, 3.9) [mm]

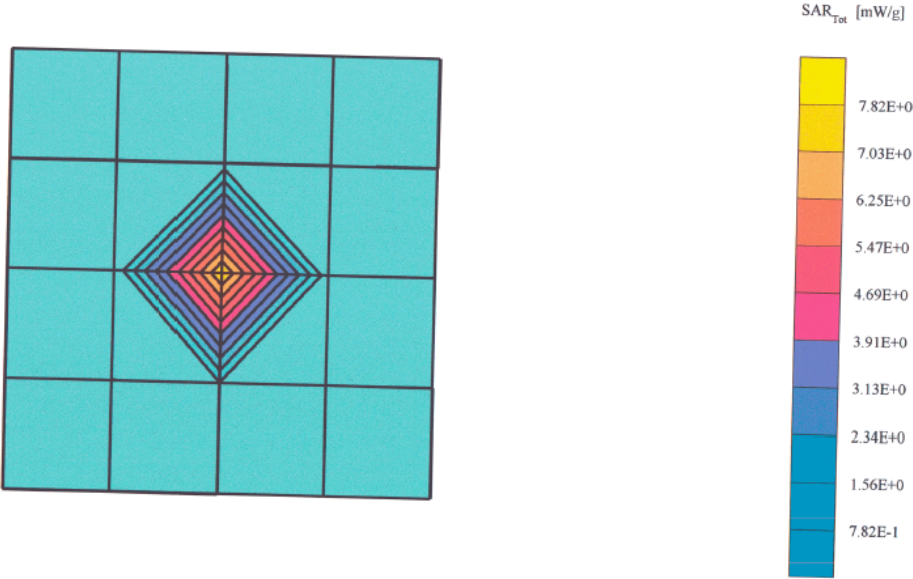


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Validation Dipole D5100V2 SN:1001, d = 10 mm

Frequency: 5800 MHz; Antenna Input Power: 79.43 [mW]  
Phantom Name: SAM, Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0  
Probe: ES3DV2 - SN3005-Y2003; ConvF(2.40,2.40,2.40); Crest factor: 1.0; Head 5800 MHz:  $\sigma = 5.32 \text{ mho/m}$   $\epsilon_r = 35.5$   $\rho = 1.00 \text{ g/cm}^3$   
Cubes (2): Peak: 17.9 mW/g  $\pm 0.11 \text{ dB}$ , SAR (1g): 5.78 mW/g  $\pm 0.06 \text{ dB}$ , SAR (10g): 1.69 mW/g  $\pm 0.02 \text{ dB}$ , (Advanced extrapolation)  
Penetration depth: 2.1 (0.2, 3.6) [mm]



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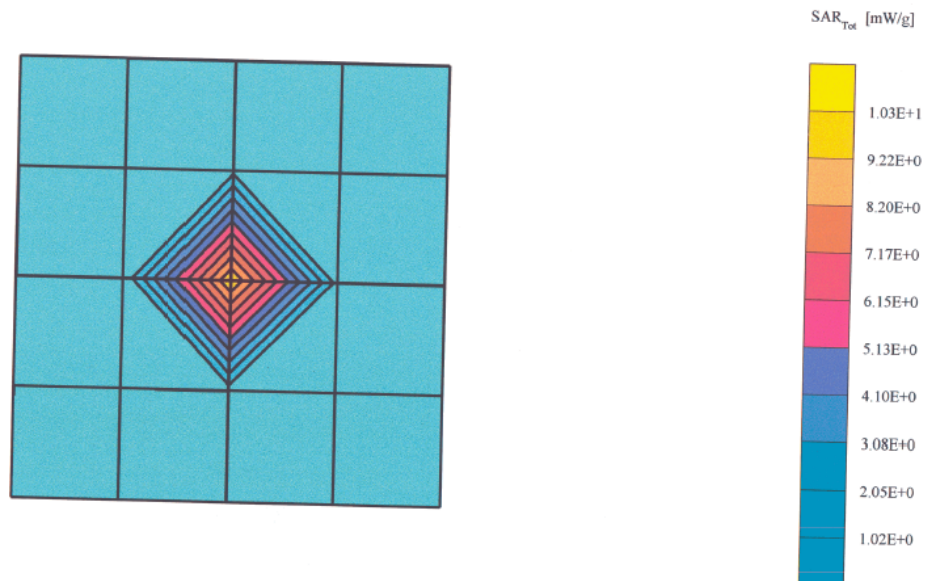
**Validation Dipole D5100V2 SN:1001, d = 10 mm**

Frequency: 5200 MHz; Antenna Input Power: 92.47 [mW]

Phantom Name: SAM, Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0

Probe: ES3DV2 - SN3005-Y2003; ConvF(1.75,1.75,1.75); Crest factor: 1.0; Body 5200 MHz:  $\sigma = 5.21$  mho/m  $\epsilon_r = 49.9$   $\rho = 1.00$  g/cm<sup>3</sup>Cubes (2): Peak: 21.8 mW/g  $\pm 0.18$  dB, SAR (1g): 7.59 mW/g  $\pm 0.10$  dB, SAR (10g): 2.24 mW/g  $\pm 0.02$  dB, (Advanced extrapolation)

Penetration depth: 3.1 (2.3, 4.1) [mm]



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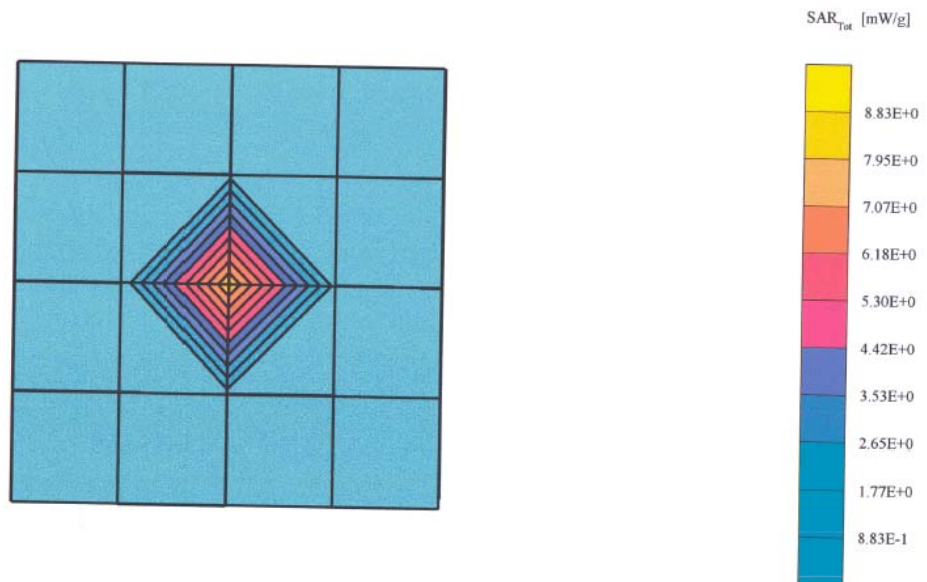
**Validation Dipole D5100V2 SN:1001, d = 10 mm**

Frequency: 5800 MHz, Antenna Input Power: 79.25 [mW]

Phantom Name: SAM, Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0

Probe: ES3DV2 - SN3005-Y2003, ConvF(1.40,1.40,1.40); Crest factor: 1.0; Body 5800 MHz:  $\sigma = 6.07$  mho/m  $\epsilon_r = 48.6$   $\rho = 1.00$  g/cm<sup>3</sup>Cubes (2): Peak: 17.3 mW/g  $\pm 0.14$  dB, SAR (1g): 5.85 mW/g  $\pm 0.08$  dB, SAR (10g): 1.73 mW/g  $\pm 0.03$  dB, (Advanced extrapolation)

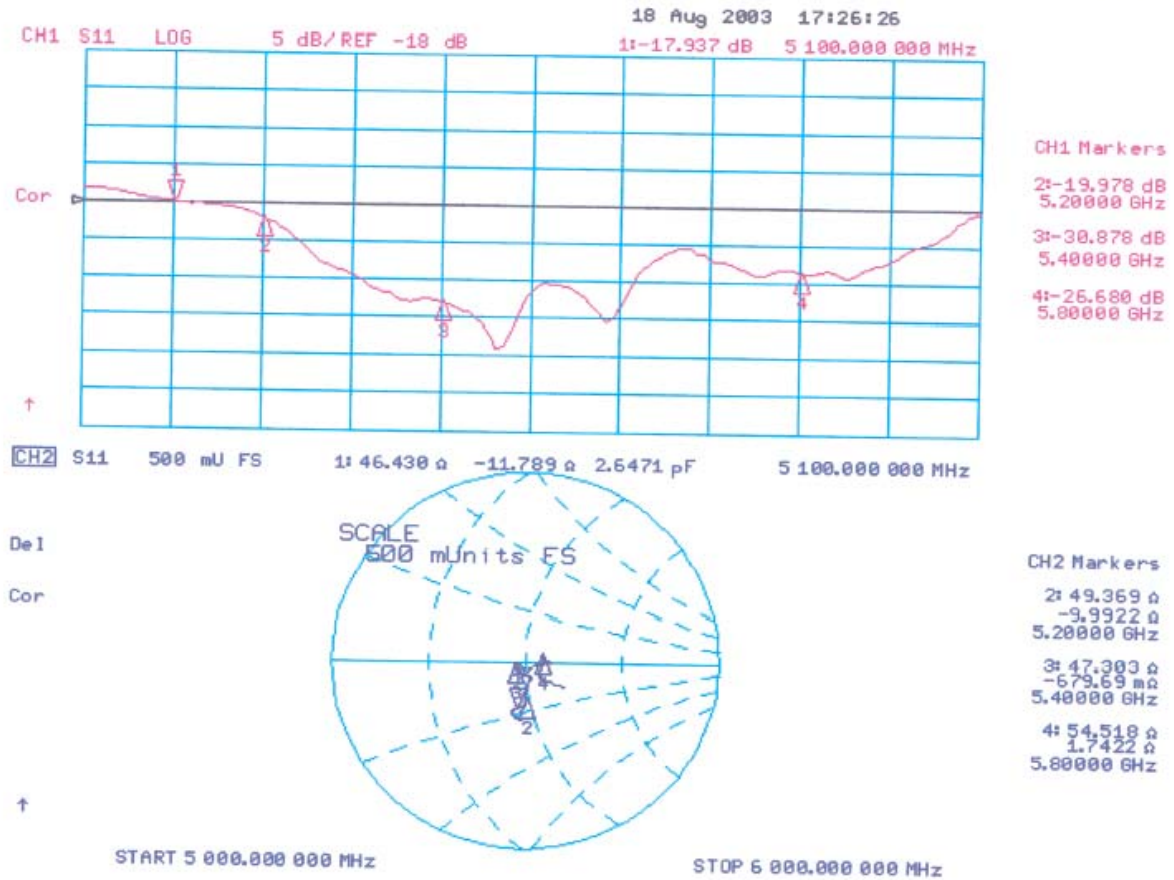
Penetration depth: 2.6 (1.3, 3.9) [mm]

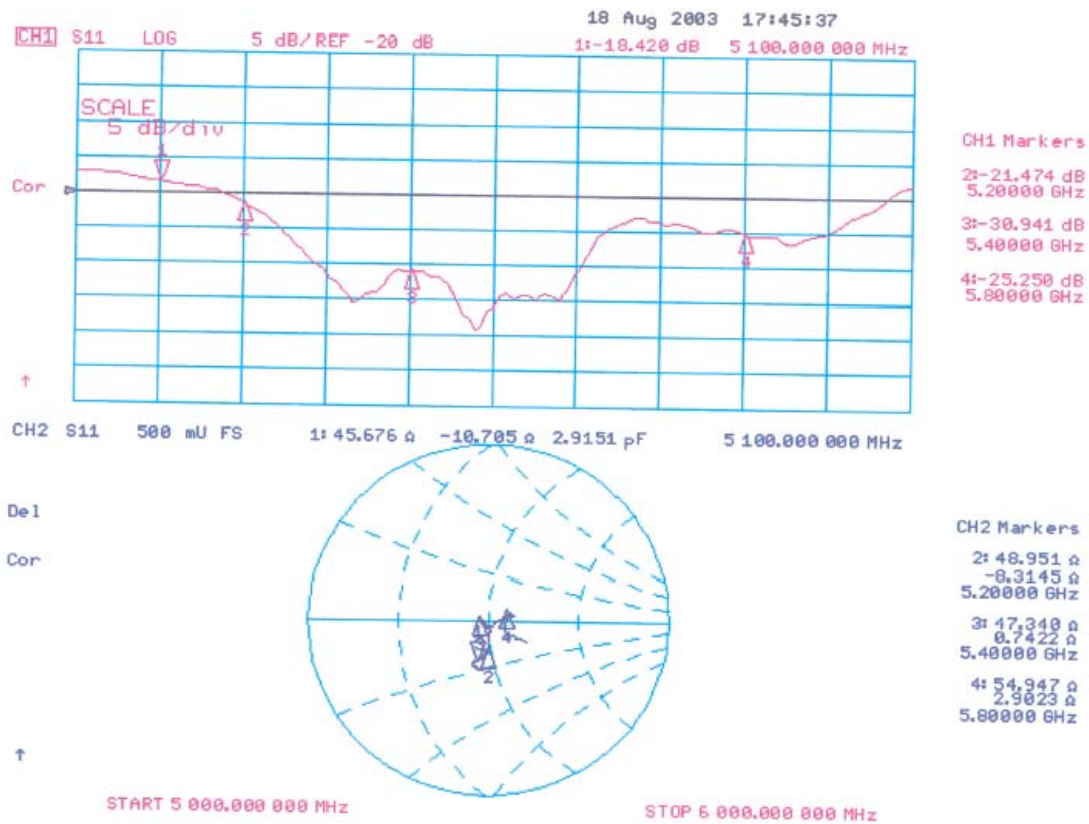


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100.

Head



1001  
Muscle

### 3 - EUT DESCRIPTION

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Transmitter Frequency:	5729.280 - 5808.128 MHz
Applicant:	LIONDA TECHNOLOGY COMPANY LIMITED
Product Description:	2.4GHz and 5.8GHz Cordless Phone, H/S Unit
FCC ID:	O63GH5850HDLD03
Maximum Output Power:	15.67 dBm (0.0369 W)
Dimension:	6.5"L x 2.0" W x 1.1" H
RF Exposure environment:	Population / Uncontrolled
Applicable Standard	FCC CFR 47, Part 15C
Application Type:	Certification

<sup>1</sup> Specific Absorption Rate (SAR) is a measure of the rate of energy absorption due to exposure to an RF transmitting source (wireless portable device).

<sup>2</sup> IEEE/ANSI Std. C95.1-1992 limits are used to determine compliance with FCC ET Docket 93-62.

Note: The test data was good for test sample only. It may have deviation for other test samples.

## **4 - SYSTEM TEST CONFIGURATION**

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### **4.1 Justification**

The system was configured for testing in a typical fashion (as normally used by a typical user).

### **4.2 EUT Exercise Procedure**

The EUT exercising program used during SAR testing was designed to exercise the various system components in a manner similar to a typical use.

### **4.3 Special Accessories**

All interface cables used for compliance testing are shielded. The EUT is featured shielded metal connectors.

### **4.4 Equipment Modifications**

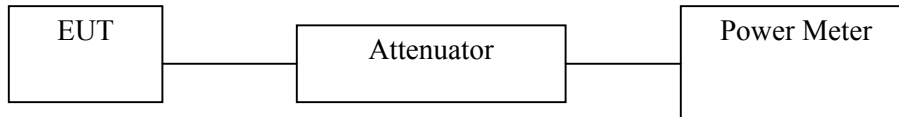
No modification(s) were made to ensure that the EUT complies with the applicable limits.



## 5 - CONDUCTED OUTPUT POWER MEASUREMENT

### 5.1 Measurement Procedure

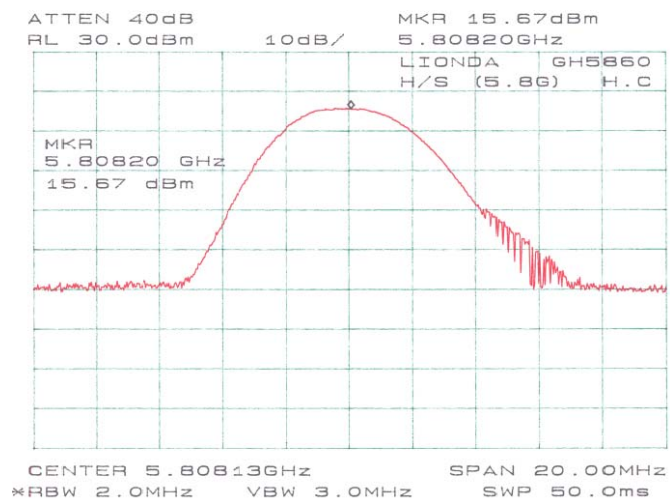
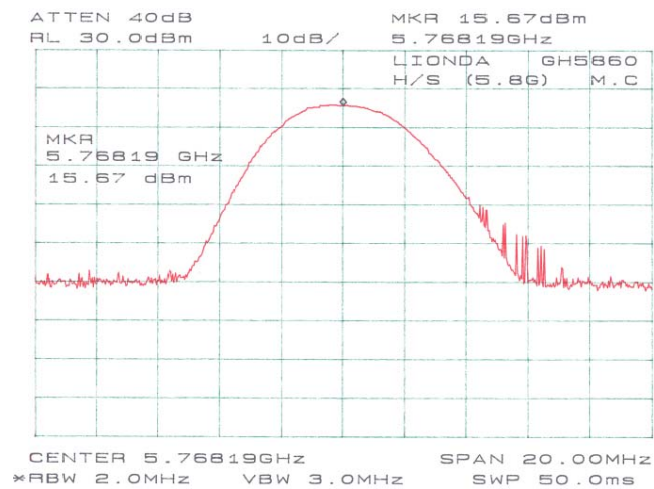
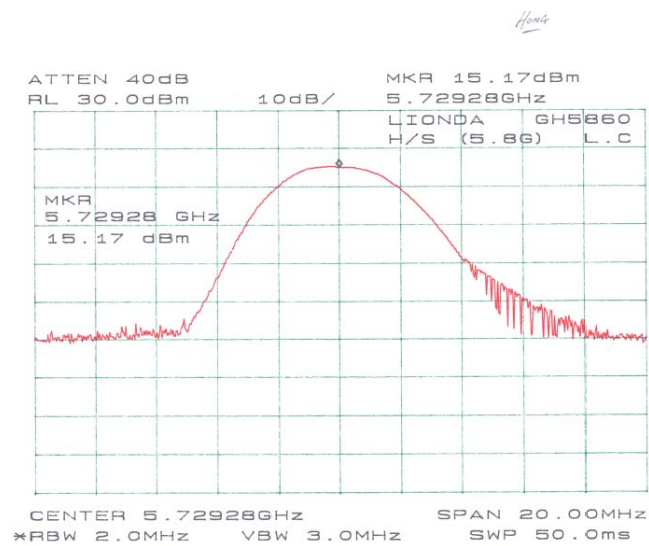
1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to a spectrum analyzer.
3. Add a correction factor to the display.



### 5.2 Test Results

Channel (MHz)	Output Power in dBm	Cable Loss dB	Corrected Output Power dBm	Output Power in W
5729.28	15.17	0.7	15.87	0.0386
5768.19	15.67	0.7	16.37	0.0434
5808.20	15.67	0.7	16.37	0.0434

Note: The power output may depend on the intended use of the EUT. For all tests, the EUT was set to maximum conditions.



## 6 - DOSIMETRIC ASSESSMENT SETUP

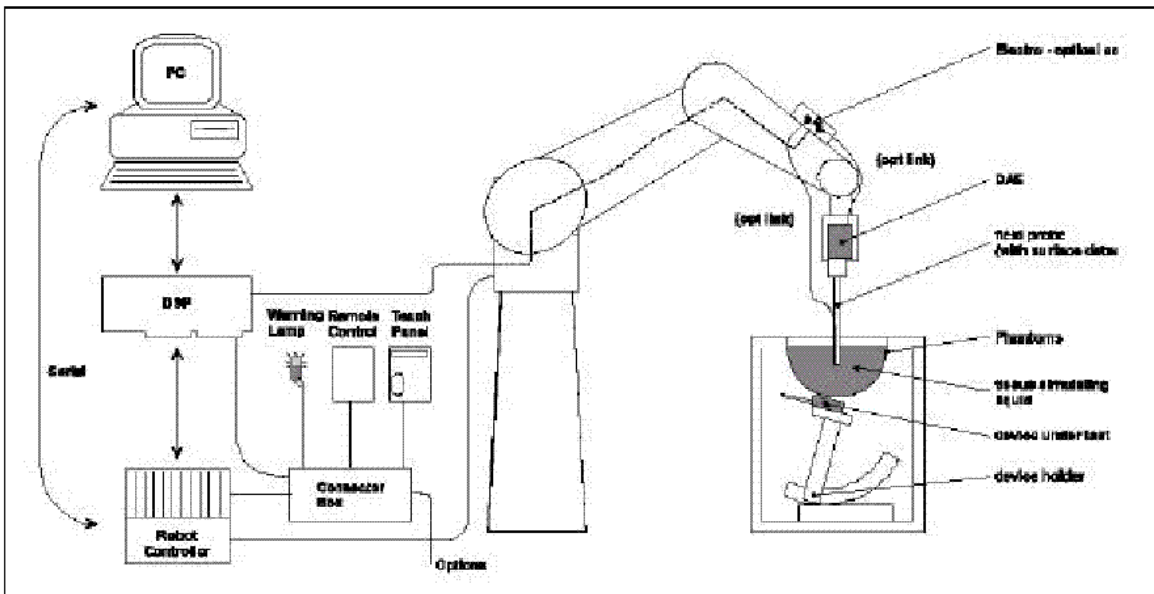
These measurements were performed with the automated near-field scanning system DASY3 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9m) which positions the probes with a positional repeatability of better than  $\pm 0.02\text{mm}$ . 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 to the data acquisition unit. The system is described in detail in [3].

The SAR measurements were conducted with the dosimetric probe ET3DV2 SN: 3019 (manufactured by SPEAG), designed in the classical triangular configuration [3] and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in [7] with accuracy of better than  $\pm 10\%$ . The spherical isotropy was evaluated with the procedure described in [8] and found to be better than  $\pm 0.25\text{dB}$ .

The phantom used was the "Generic Twin Phantom" described in [4]. The ear was simulated as a spacer of 4 mm thickness between the earpiece of the phone and the tissue simulating liquid. The Tissue simulation liquid used for each test is in according with the FCC OET65 supplement C as listed below.

Target Frequency (MHz)	Head		Body	
	$\epsilon_r$	$\sigma$ (S/m)	$\epsilon_r$	$\sigma$ (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

## 6.1 Measurement System Diagram



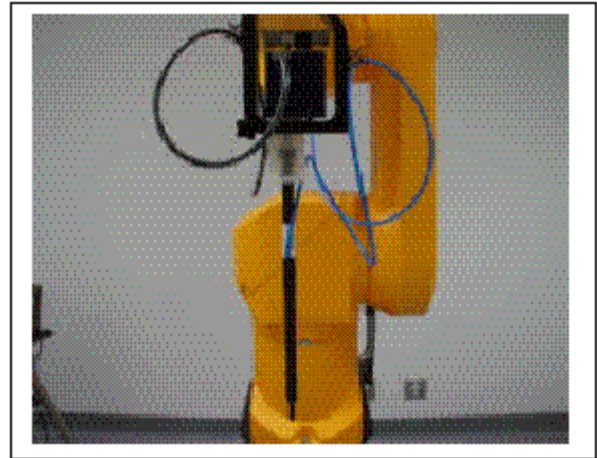
The DASY3 system for performing compliance tests consist of the following items:

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
2. An arm extension for accommodating the data acquisition electronics (DAE).
3. A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
4. A data acquisition electronic (DAE), which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
5. A unit to operate the optical surface detector, which is connected to the EOC. The Electro-optical coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the PC plug-in card. The functions of the PC plug-in card based on a DSP is to perform the time critical task such as signal filtering, surveillance of the robot operation fast movement interrupts.
6. A computer operating Windows 95 or larger
7. DASY3 software
8. Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling testing left-hand and right-hand usage.
10. The device holder for handheld EUT.
11. Tissue simulating liquid mixed according to the given recipes (see Application Note).
12. System validation dipoles to validate the proper functioning of the system.

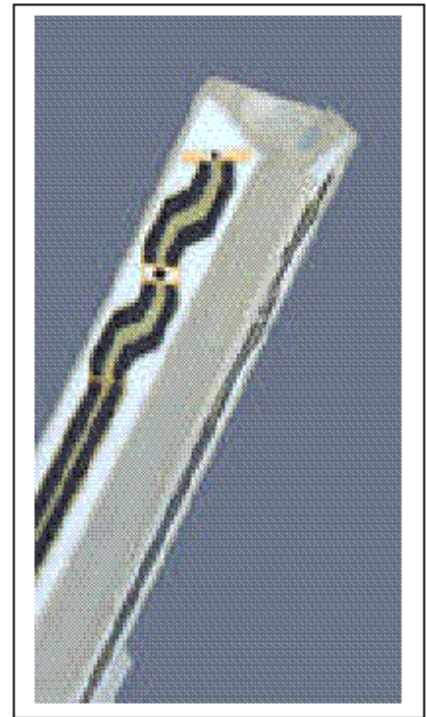
## 6.2 System Components

### ET3DV6 Probe Specification

Construction Symmetrical design with triangular core  
 Built-in optical fiber for surface detection System  
 Built-in shielding against static charges  
 Calibration In air from 10 MHz to 2.5 GHz  
 In brain and muscle simulating tissue at  
 Frequencies of 450 MHz, 900 MHz and  
 1.8 GHz (accuracy  $\pm 8\%$ )  
 Frequency 10 MHz to  $> 6$  GHz; Linearity:  $\pm 0.2$  dB  
 (30 MHz to 3 GHz)  
 Directivity  $\pm 0.2$  dB in brain tissue (rotation around  
 probe axis)  
 $\pm 0.4$  dB in brain tissue (rotation normal probe axis)  
 Dynamic 5 mW/g to  $> 100$  mW/g;  
 Range Linearity:  $\pm 0.2$  dB  
 Surface  $\pm 0.2$  mm repeatability in air and clear liquids  
 Detection over diffuse reflecting surfaces.  
 Dimensions Overall length: 330 mm  
 Tip length: 16 mm  
 Body diameter: 12 mm  
 Tip diameter: 6.8 mm  
 Distance from probe tip to dipole centers: 2.7 mm  
 Application General dosimetric up to 3 GHz  
 Compliance tests of mobile phones  
 Fast automatic scanning in arbitrary phantoms



Photograph of the probe



Inside view of  
ET3DV6 E-field Probe

The SAR measurements were conducted with the dosimetric probe ET3DV6 designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical 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 DASY3 software reads the reflection during a software approach and looks for the maximum using a 2<sup>nd</sup> order fitting. The approach is stopped when reaching the maximum.



## E-Field Probe Calibration Process

Each probe is calibrated according to a dosimetric assessment procedure described in [6] with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in [7] and found to be better than +/-0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a waveguide 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 then rotated 360 degrees.

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

## Data Evaluation

The DASY3 software 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 Parameter:	-Sensitivity	Norm <sub>i</sub> , a <sub>i0</sub> , a <sub>i1</sub> , a <sub>i2</sub>
	-Conversion Factor	ConvFi
	-Diode compression point	Dcp <sub>i</sub>
Device parameter:	-Frequency	f
	-Crest Factor	cf
Media parameter:	-Conductivity	σ
	-Density	ρ

These parameters must be set correctly in the software. They can either be found in the component documents or be imported into the software from the configuration files issued for the DASY3 components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

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

$$V_i = U_i + (U_i)^2 \text{ cf} / \text{dcp}_i$$

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)  
 $\text{dcp}_i$  = diode compression point (DASY parameter)

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

$$\begin{aligned} \text{E-field probes:} \quad E_i &= \sqrt{\frac{V_i}{\text{Norm}_i \cdot \text{ConvF}}} \\ \text{H-field probes:} \quad H_i &= \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f} \end{aligned}$$

With  $V_i$  = compensated signal of channel i (i=x, y, z)  
 $\text{Norm}_i$  = sensor sensitivity of channel i (i=x, y, z)  
 $\mu\text{V}/(\text{V/m})^2$  for E-field probes  
 $\text{ConvF}$  = 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  
 $H_i$  = diode compression point (DASY parameter)

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

$$E_{\text{tot}} = \text{Square Root} [(E_x)^2 + (E_y)^2 + (E_z)^2]$$

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

$$\text{SAR} = (E_{\text{tot}})^2 \cdot \sigma / (\rho \cdot 1000)$$

With  $\text{SAR}$  = local specific absorption rate in mW/g  
 $E_{\text{tot}}$  = total field strength in V/m  
 $\sigma$  = conductivity in [mho/m] or [Siemens/m]  
 $\rho$  = equivalent tissue density in  $\text{g/cm}^3$

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

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

$$P_{\text{pwe}} = (E_{\text{tot}})^2 / 3770 \text{ or } P_{\text{pwe}} = (H_{\text{tot}})^2 \cdot 37.7$$

With  $P_{\text{pwe}}$  = equivalent power density of a plane wave in mW/cm<sup>3</sup>  
 $E_{\text{tot}}$  = total electric field strength in V/m  
 $H_{\text{tot}}$  = total magnetic field strength in V/m

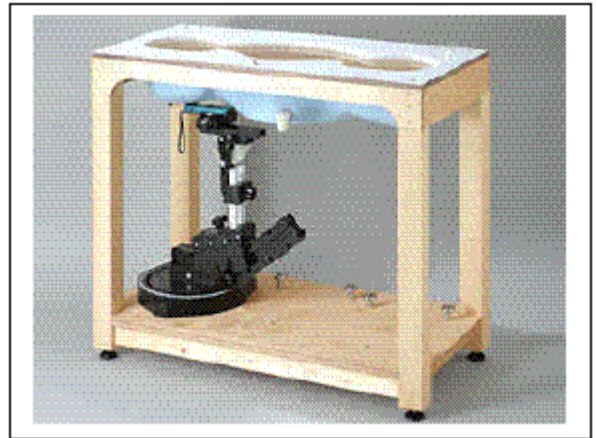
### Generic Twin Phantom

The Generic Twin Phantom is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users [9][10]. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the Phantom allows the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.

Shell Thickness  $2 \pm 0.1$  mm

Filling Volume Approx. 20 liters

Dimensions 810 x 1000 x 500 mm (H x L x W)

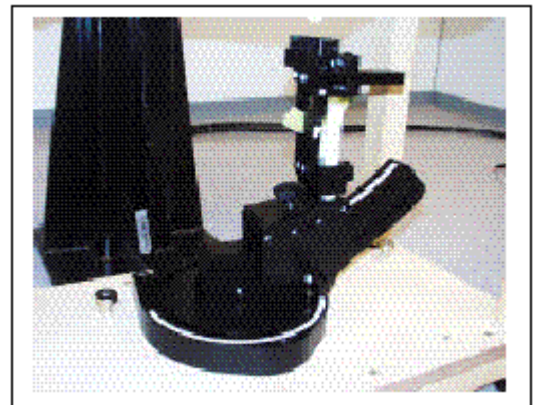


**Generic Twin Phantom**

### Device Holder

In combination with the Generic Twin Phantom V3.0, the Mounting Device enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening. The devices can be easily, accurately, and repeatedly positioned according to the FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

\* Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produced infinite number of configurations [10]. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.



**Device Holder**

### 6.3 Measurement Uncertainty

The uncertainty budget has been determined for the DASY3 measurement system according to the NIS81 [13] and the NIST1297 [14] documents and is given in the following Table.

Measurement Uncertainty Analysis per IEEE P1528-2002								
Description	Section	Reported Variance (%)	Probability Distributio n type	Divisor	Ci (1g)	Ui (1g)	Vi	welc/satt series term
Probe Calibration	E.2.1	4.80	N	1	1	4.80	1.00E+09	5.30842E-07
Axial isotropy	E.2.2	4.70	R	1.732	0.707107	1.92	1.00E+09	1.35563E-08
Hemispherical isotropy	E.2.2	9.60	R	1.732	0.707107	3.92	1.00E+09	2.35957E-07
Boundary effects	E.2.3	8.30	R	1.732	1	4.79	1.00E+09	5.27377E-07
Linearity	E.2.4	4.70	R	1.732	1	2.71	1.00E+09	5.4225E-08
System Detection Limit	E.2.5	1.00	R	1.732	1	0.58	1.00E+09	1.11124E-10
Readout Electronics	E.2.6	0.00	N	1	1	0.00	1.00E+09	0
Response time	E.2.7	0.00	R	1.732	1	0.00	1.00E+09	0
Integration time	E.2.8	0.00	R	1.732	1	0.00	1.00E+09	0
RF Ambient conditions	E.6.1	3.00	R	1.732	1	1.73	1.00E+09	9.00106E-09
Probe positioning mechanical tolerance	E.6.2	0.40	R	1.732	1	0.23	1.00E+09	2.84478E-12
Probe positioning wrt phantom shell	E.6.3	2.90	R	1.732	1	1.67	1.00E+09	7.8596E-09
Extra/inter-polation & integration algorithms for max SAR evaluation	E.5.2	3.90	R	1.732	1	2.25	1.00E+09	2.57079E-08
Test sample positioning	8, E.4.2	6.00	R	1.732	1	3.46	1.00E+09	1.44017E-07
Device holder distance tolerance	E.4.1	5.00	N	1	1	5.00	1.00E+09	0.000000625
Output power and SAR drift measurement	8, E.6.6.2	5.00	R	1.732	1	2.89	1.00E+09	6.94526E-08
Phantom uncertainty, shell thickness tolerance	E.3.1	4.00	R	1.732	1	2.31	1.00E+09	2.84478E-08
Liquid conductivity, deviation from target values	E.3.2	5.00	R	1.732	0.64	1.85	1.00E+09	1.16522E-08
Liquid conductivity, measurement uncertainty	E.3.3	5.00	N	1	0.64	3.20	5	20.97152
Liquid permittivity, deviation from target values	E.3.2	5.00	R	1.732	0.6	1.73	1.00E+09	9.00106E-09
Liquid permittivity, measurement uncertainty	E.3.3	5.00	N	1	0.6	3.00	5	16.2
								689
<b>Probe isotropy sensitivity coefficient</b>	<b>0.5</b>							
<b>Combined Standard Uncertainty</b>						<b>12.65 %</b>		
<b>Expanded Uncertainty, 95% confidence</b>		<b>k=</b>	<b>2.004</b>			<b>25.34 %</b>		

## 7 - SYSTEM EVALUATION

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### 7.1 Simulated Tissue Liquid Parameter Confirmation

The dielectric parameters were checked prior to assessment using the HP85070A dielectric probe kit. The dielectric parameters measured are reported in each correspondent section:

### 7.2 Evaluation Procedures

#### Maximum Search

The maximum search is automatically performed after each coarse scan measurement. It is based on splines in two or three dimensions. The procedure can find the maximum for most SAR distributions even with relatively large grid spacings. After the coarse scan measurement, the probe is automatically moved to a position at the interpolated maximum. The following scan can directly use this position for reference, e.g., for a finer resolution grid or the cube evaluations.

#### Extrapolation

The extrapolation can be used in z-axis scans with automatic surface detection. The SAR values can be extrapolated to the inner phantom surface. The extrapolation distance is the sum of the probe sensor offset, the surface detection distance and the grid offset. The extrapolation is based on fourth order polynomial functions. The extrapolation is only available for SAR values.

#### Boundary Corrections

The correction of the probe boundary effect in the vicinity of the phantom surface can be done in two different ways. In the standard (worse case) evaluation, the boundary effect is reduced by different weights for the lowest measured points in the extrapolation routine. The result is a slight overestimation of the extrapolated SAR values (2% to 8%) depending on the SAR distribution and gradient. The advanced evaluation makes a full compensation of the boundary effect before doing the extrapolation. This is only possible of probes with specifications on the boundary effect.

#### Peak Search for 1g and 10g cube averaged SAR

The 1g and 10g peak evaluations are only available for the predefined cube 4x4x7 and cube 5x5x7 scans. The routine are verified and optimized for the grid dimensions used in these cube measurements. The measured volume of 32x32x35mm contains about 35g of tissue. The first procedure is an extrapolation (incl. Boundary correction) to get the points between the lowest measured plane and the surface. The next step uses 3D interpolation get all points within the measured volume in a 1mm grid (35000 points). In the last step, a 1g cube is place numerically into the volume and its averaged SAR is calculated. This cube is the moved around until the highest averaged SAR is found. This last procedure is repeated for a 10g cube. If the highest SAR is found at the edge of the measured volume, the system will issue a warning,; higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.



### 7.3 System Accuracy Verification

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of  $\pm 10\%$ . The validation results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

#### Validation Dipole SAR Reference Test Result for Head (5800 MHz)

Validation Measurement	SAR @ 100 mW Input averaged over 1g	SAR @ 1W Input averaged over 1g	SAR @ 100 mW Input averaged over 10g	SAR @ 1W Input averaged over 10g
Test 1	7.70	77.0	2.28	22.8
Test 2	7.69	76.9	2.28	22.8
Test 3	7.68	76.8	2.28	22.8
Test 4	7.63	76.3	2.27	22.7
Test 5	7.65	76.5	2.27	22.7
Test 6	7.63	76.3	2.26	22.6
Test 7	7.62	76.2	2.26	22.6
Test 8	7.55	75.5	2.28	22.8
Test 9	7.67	76.7	2.28	22.8
Test 10	7.68	76.8	2.28	22.8
Average	7.65	76.5	2.274	22.74

#### Validation Dipole SAR Reference Test Result for Body (5800 MHz)

Validation Measurement	SAR @ 100 mW Input averaged over 1g	SAR @ 1W Input averaged over 1g	SAR @ 100 mW Input averaged over 10g	SAR @ 1W Input averaged over 10g
Test 1	7.40	74.0	2.10	21.0
Test 2	7.39	73.9	2.09	20.9
Test 3	7.36	73.6	2.09	20.9
Test 4	7.40	74.0	2.09	20.9
Test 5	7.41	74.1	2.10	21.0
Test 6	7.38	73.8	2.09	20.9
Test 7	7.40	74.0	2.10	21.0
Test 8	7.62	76.2	2.11	21.1
Test 9	7.65	76.5	2.12	21.2
Test 10	7.26	72.6	2.06	20.6
Average	7.427	74.27	2.095	20.95

## System validation result

11/14/03

Ambient Temperature (°C): 23.0

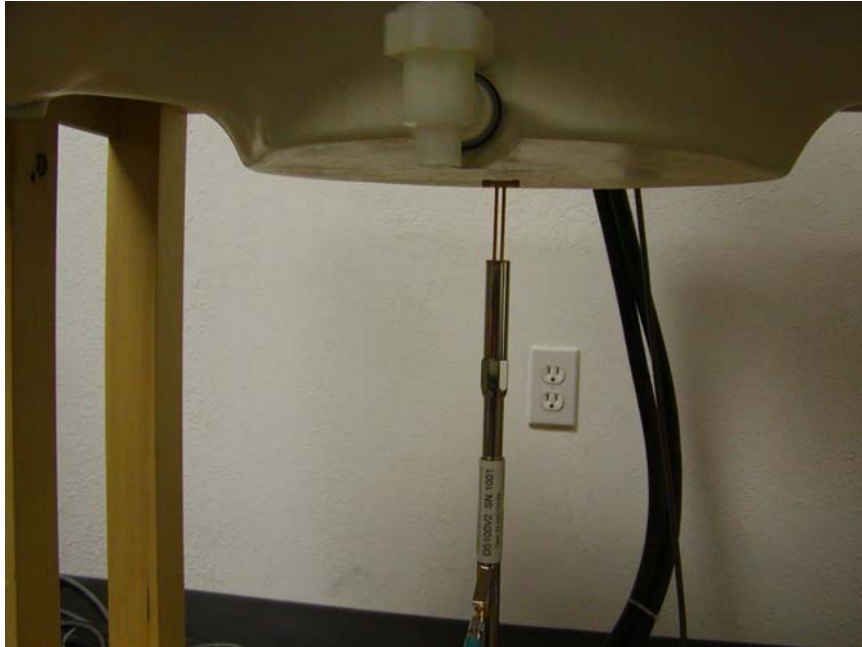
Relative Humidity (%): 49.3

Simulant	Freq [MHz]	Parameters	Liquid Temp [°C]	Target Value	Measured Value	Deviation [%]	Limits [%]
Body	5800	$\epsilon$	21	48.2	50.8	5.39	$\pm 5$
		$\sigma$	21	6.00	6.89	14.8	$\pm 5$
		1g SAR	21	74.27	72.55	-2.32	$\pm 10$
Head	5800	$\epsilon$	21	35.3	38.7	9.63	$\pm 5$
		$\sigma$	21	5.27	5.96	13.1	$\pm 5$
		1g SAR	21	76.5	75.49	-1.32	$\pm 10$

 $\epsilon$  = relative permittivity,  $\sigma$  = conductivity and  $\rho=1000\text{kg/m}^3$ 

Note: Forward power = 117mW

Forward Power = 102 mW

**System Validation Test Setup Photo**

## 5800 MHz Body Liquid System Validation (Ambit Temp = 23 Deg C, Liquid Temp = 21 Deg C, 11/14/2003)

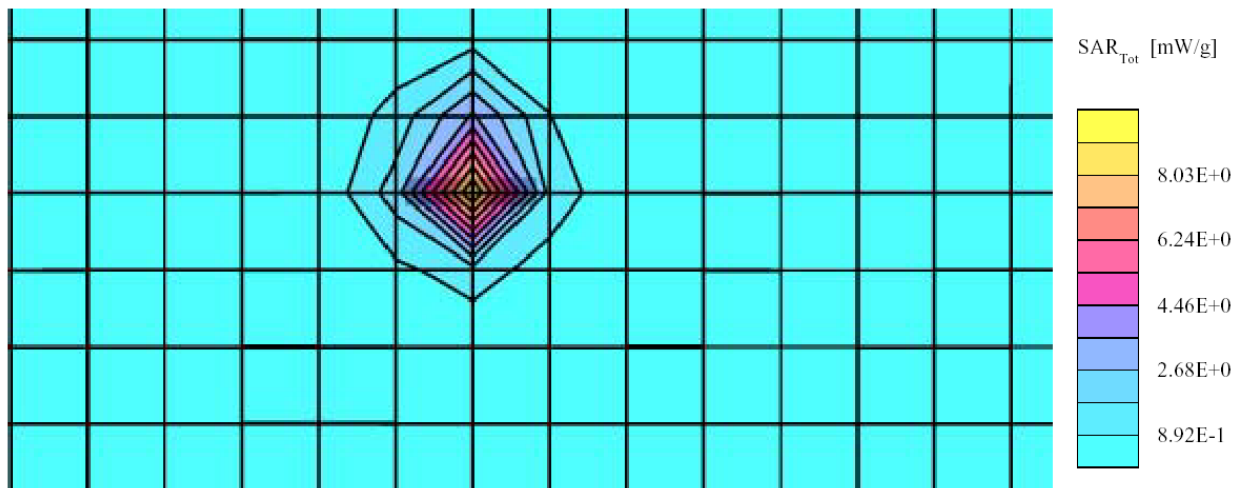
SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 5800 MHz

Probe: ES3DV2 - SN3019; ConvF(1.20,1.20,1.20); Crest factor: 1.0; 5800 MHz Head Liquid:  $\sigma = 6.89 \text{ mho/m}$   $\epsilon_r = 50.8$   $\rho = 1.00 \text{ g/cm}^3$

Cube 5x5x7: SAR (1g): 7.40 mW/g, SAR (10g): 2.10 mW/g, (Worst-case extrapolation)

Coarse: Dx = 12.0, Dy = 12.0, Dz = 10.0

Powerdrift: -0.05 dB



## 5800 MHz Head Liquid System Validation (Ambit Temp = 23 Deg C, Liquid Temp = 21 Deg C, 11/14/2003)

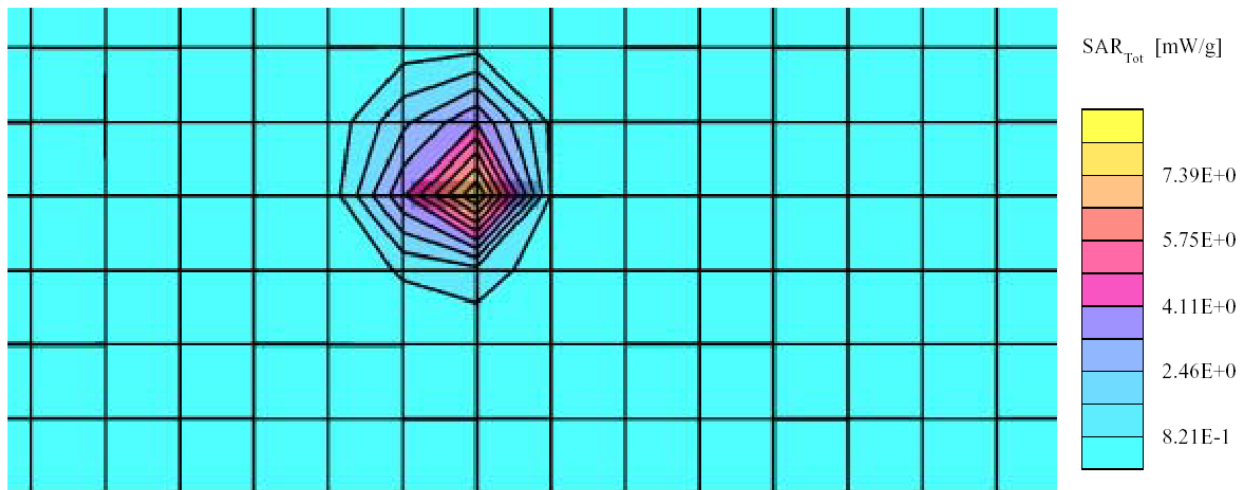
SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 5800 MHz

Probe: ES3DV2 - SN3019; ConvF(1.80,1.80,1.80); Crest factor: 1.0; 5800 MHz Head Liquid:  $\sigma = 5.96 \text{ mho/m}$   $\epsilon_r = 38.7$   $\rho = 1.00 \text{ g/cm}^3$

Cube 5x5x7: SAR (1g): 7.70 mW/g, SAR (10g): 2.28 mW/g, (Worst-case extrapolation)

Coarse: Dx = 12.0, Dy = 12.0, Dz = 10.0

Powerdrift: -0.02 dB





## 7.4 SAR Evaluation Procedure

- a. The evaluation was performed in the applicable area of the phantom depending on the type of device being tested. For device held to the head during normal operation, both the left and right ear positions were evaluated in accordance with FCC OET Bulletin 65, Supplement C (Edition 01-01) using the SAM phantom. For body-worn and face-held devices a planar phantom was used. The EUT in the test setup for body-worn and face-held devices was placed in three different positions (relative to the phantom): with belt clip, without belt clip and 2.5cm facing left head side and 2.5cm facing right head side.
- b. The SAR was determined by a pre-defined procedure within the DASY3 software. Upon completion of a reference and optical surface check, the exposed region of the phantom was scanned near the inner surface with a grid spacing of 20mm x 20mm.
- c. A 5x5x7 matrix was performed around the greatest special SAR distribution found during the area scan of the applicable exposed region. SAR values were then calculated using a 3-D spline interpolation algorithm and averaged over spatial volumes of 1 and 10 grams.
- d. The depth of the simulating tissue in the planar used for the SAR evaluation and system validation was no less than 15.0cm.
- e. For this particular evaluation, a stack of low-density, low-loss dielectric foamed polystyrene was used in place of the device holder.
- f. Re-measurement of the SAR value at the same location as in a. If the value changed by more than 5%, the evaluation was repeated.

## 7.5 Exposure Limits

Table 1: Limits for Occupational/Controlled Exposure (W/kg)

Whole-Body	Partial-Body	Hands. Wrists. Feet and Ankles
0.4	8.0	20.0

Table 2: Limits for General Population/Uncontrolled Exposure (W/kg)

Whole-Body	Partial-Body	Hands. Wrists. Feet and Ankles
0.08	1.6	4.0

*Note: Whole-body SAR is averaged over the entire body, partial-body SAR is averaged over any 1 gram of tissue defined as a tissue volume in the shape of a cube SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.*

Population/Uncontrolled Environments are defined as locations where there is the exposure of individual 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 people who are aware of the potential for exposure (i.e. as a result of employment or occupation).*

*Population/uncontrolled environments Partial-body limit 1.6W/kg applied to the EUT.*

## 8 - TEST RESULTS

This page summarizes the results of the performed dosimetric evaluation. The plots with the corresponding SAR distributions, which reveal information about the location of the maximum SAR with respect to the device could be found in the following pages.

According to the data in section 8.1, the EUT complied with the FCC 2.1093 RF Exposure standards, with worst case of **0.171mW/g**.

### 8.1 SAR Test Data

Ambient Temperature (°C): 23.0

Relative Humidity (%): 51.1

Worst case SAR reading

EUT position	Frequency (MHz)	Conducted Power (W)	Test Type	Liquid	Accessory	Phantom	Measured (mW/g)	Limit (mW/g)	Plot #
back in touch with phantom	5768	0.0434	Body worn	body	Headset	flat	0.0399	1.6	1
Right head cheek touching	5768	0.0434	Head	Head	/	flat	0.169	1.6	2
Right head tilt touching	5768	0.0434	Head	Head	/	flat	0.0887	1.6	3
Left head cheek touching	5768	0.0434	Head	Head	/	flat	0.171	1.6	4
Left head tilt touching	5768	0.0434	Head	Head	/	flat	0.0936	1.6	5

### 8.2 Plots of Test Result

The plots of test result were attached as reference.

Lionda Technology, Model Number: GH5800 (Back Touching to Flat Phantom with Headset, Mid Channel, Ambient Temp = 23 Deg C, Liquid Temp = 21 Deg C, 11/14/2003)

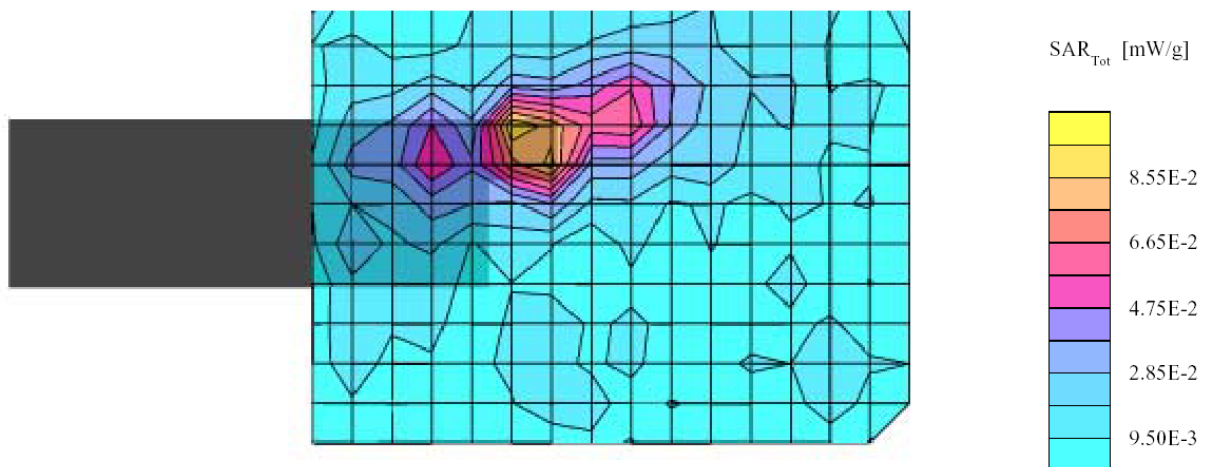
SAM Phantom; Flat Section; Position: (270°, 270°); Frequency: 5768 MHz

Probe: ES3DV2 - SN3019; ConvF(1.20, 1.20, 1.20); Crest factor: 1.0; 5800 MHz Head Liquid:  $\sigma = 6.89 \text{ mho/m}$   $\epsilon_r = 50.8$   $\rho = 1.00 \text{ g/cm}^3$

Cube 5x5x7: SAR (1g): 0.0955 mW/g, SAR (10g): 0.0399 mW/g, (Worst-case extrapolation)

Coarse: Dx = 12.0, Dy = 12.0, Dz = 10.0

Powerdrift: 0.05 dB



**Plot #1**

**Lionda Technology, Model Number: GH5800 (Right Head, Cheek, Mid Channel, Ambient  
Temp = 23 Deg C, Liquid Temp = 21 Deg C, 11/14/2003)**

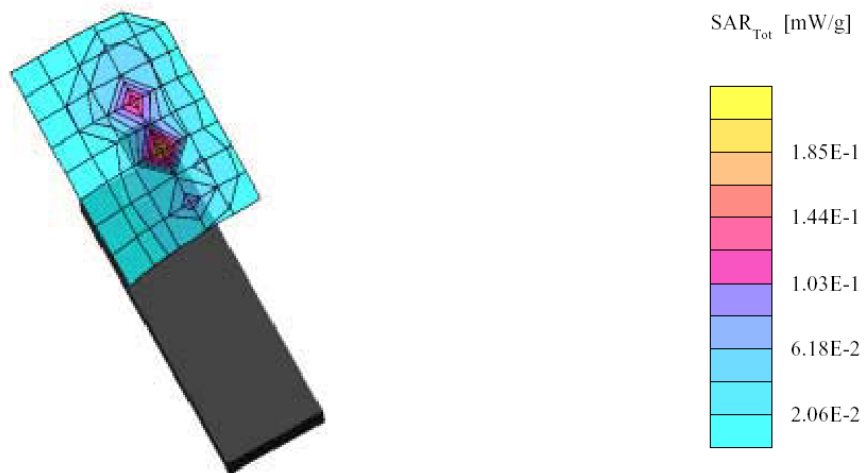
SAM Phantom; Righ Hand Section; Position: (60°,300°); Frequency: 5768 MHz

Probe: ES3DV2 - SN3019; ConvF(1.80,1.80,1.80); Crest factor: 1.0; 5800 MHz Head Liquid:  $\sigma = 5.96$  mho/m  $\epsilon_r = 38.7$   $\rho = 1.00$  g/cm<sup>3</sup>

Cube 5x5x7: SAR (1g): 0.169 mW/g, SAR (10g): 0.0564 mW/g, (Worst-case extrapolation)

Coarse: Dx = 15.0, Dy = 15.0, Dz = 10.0

Powerdrift: 0.01 dB



**Plot #2**

Lionda Technology, Model Number: GH5800 (Right Head, Tilted, Mid Channel, Ambient  
Temp = 23 Deg C, Liquid Temp = 21 Deg C, 11/14/2003)

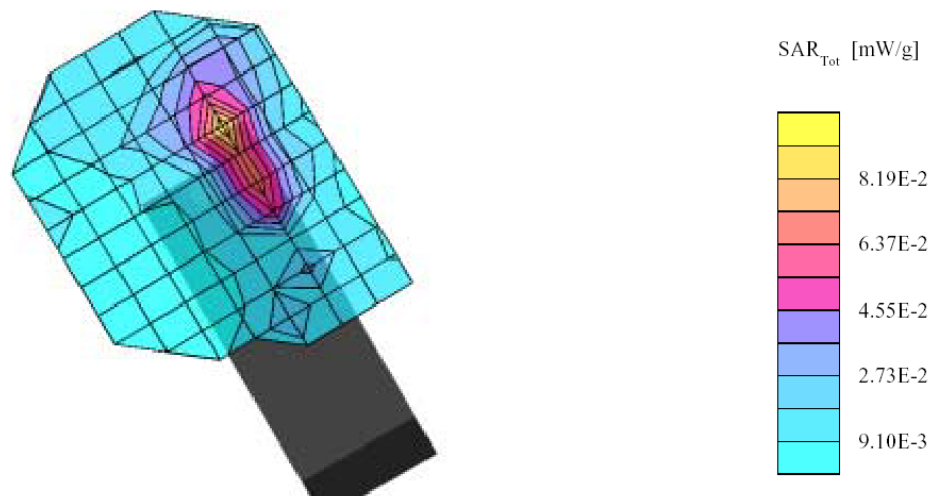
SAM Phantom; Righ Hand Section; Position: (60°, 300°); Frequency: 5768 MHz

Probe: ES3DV2 - SN3019; ConvF(1.80, 1.80, 1.80); Crest factor: 1.0; 5800 MHz Head Liquid:  $\sigma = 5.96 \text{ mho/m}$   $\epsilon_r = 38.7$   $\rho = 1.00 \text{ g/cm}^3$

Cube 5x5x7: SAR (1g): 0.0887 mW/g, SAR (10g): 0.0380 mW/g, (Worst-case extrapolation)

Coarse: Dx = 13.0, Dy = 16.0, Dz = 10.0

Powerdrift: 0.05 dB



**Plot #3**

Lionda Technology, Model Number: GH5800 (Left Head, Cheek, Mid Channel, Ambient  
Temp = 23 Deg C, Liquid Temp = 21 Deg C, 11/14/2003)

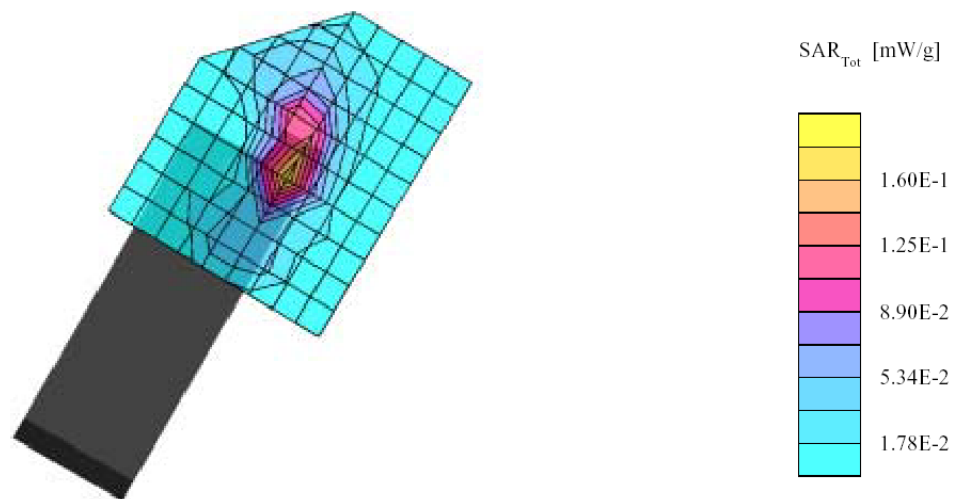
SAM Phantom; Left Hand Section; Position: (74°,60°); Frequency: 5768 MHz

Probe: ES3DV2 - SN3019; ConvF(1.80,1.80,1.80); Crest factor: 1.0; 5800 MHz Head Liquid:  $\sigma = 5.96 \text{ mho/m}$   $\epsilon_r = 38.7$   $\rho = 1.00 \text{ g/cm}^3$

Cube 5x5x7: SAR (1g): 0.171 mW/g, SAR (10g): 0.0585 mW/g, (Worst-case extrapolation)

Coarse: Dx = 12.0, Dy = 11.0, Dz = 10.0

Powerdrift: -0.04 dB



**Plot #4**



Lionda Technology, Model Number: GH5800 (Left Head, Tilted, Mid Channel, Ambient  
Temp = 23 Deg C, Liquid Temp = 21 Deg C, 11/14/2003)

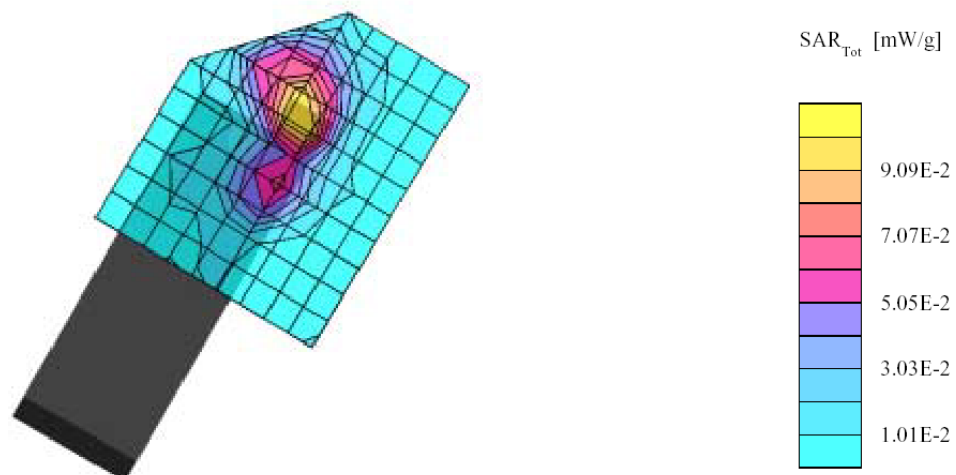
SAM Phantom; Left Hand Section; Position: (74°,60°); Frequency: 5768 MHz

Probe: ES3DV2 - SN3019; ConvF(1.80,1.80,1.80); Crest factor: 1.0; 5800 MHz Head Liquid:  $\sigma = 5.96 \text{ mho/m}$   $\epsilon_r = 38.7$   $\rho = 1.00 \text{ g/cm}^3$

Cube 5x5x7: SAR (1g): 0.0936 mW/g, SAR (10g): 0.0392 mW/g, (Worst-case extrapolation)

Coarse: Dx = 12.0, Dy = 11.0, Dz = 10.0

Powerdrift: -0.03 dB



**Plot #5**

## **EXHIBIT A - SAR SETUP PHOTOGRAPHS**

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### **Back in Touch with Phantom**



### **Right Head Cheek in Touch with Phantom**



### **Right Head Tilt in Touch with Phantom**



### **Left Head Cheek in Touch with Phantom**



### **Left Head Tilt in Touch with Phantom**



## EXHIBIT B - EUT PHOTOGRAPHS

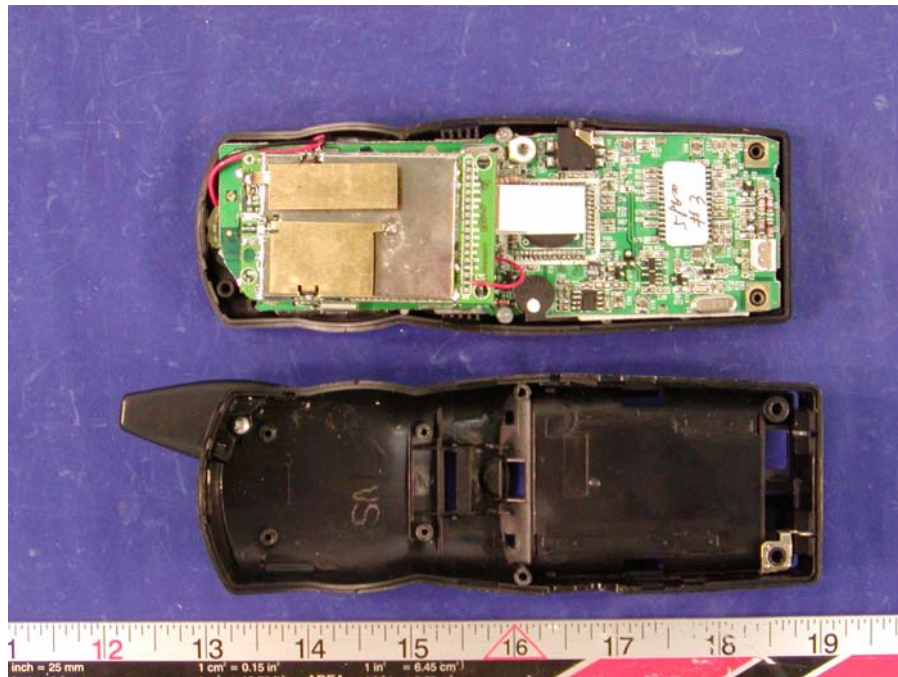
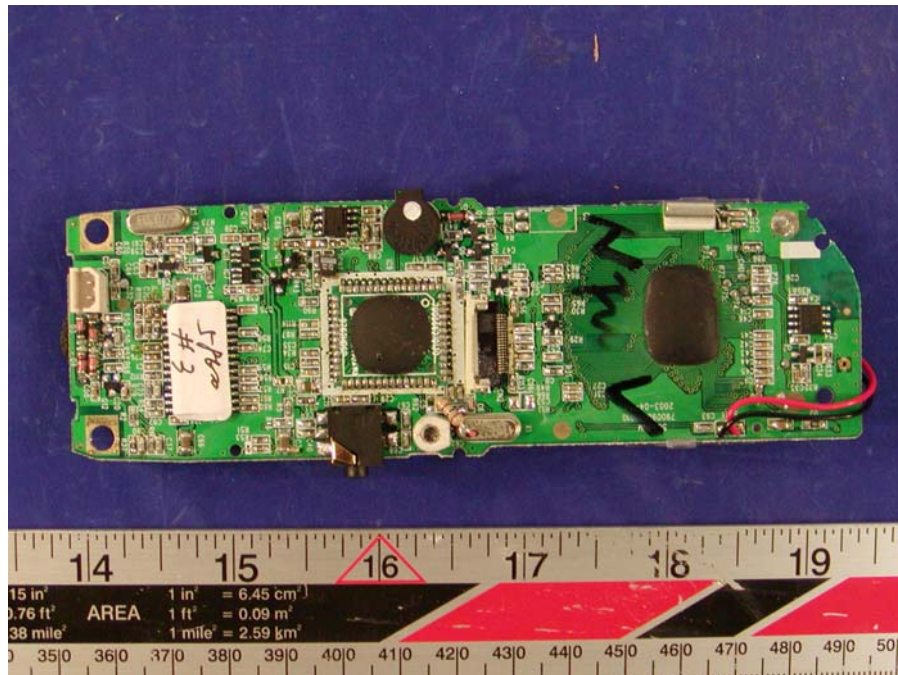
### Handset - Top View

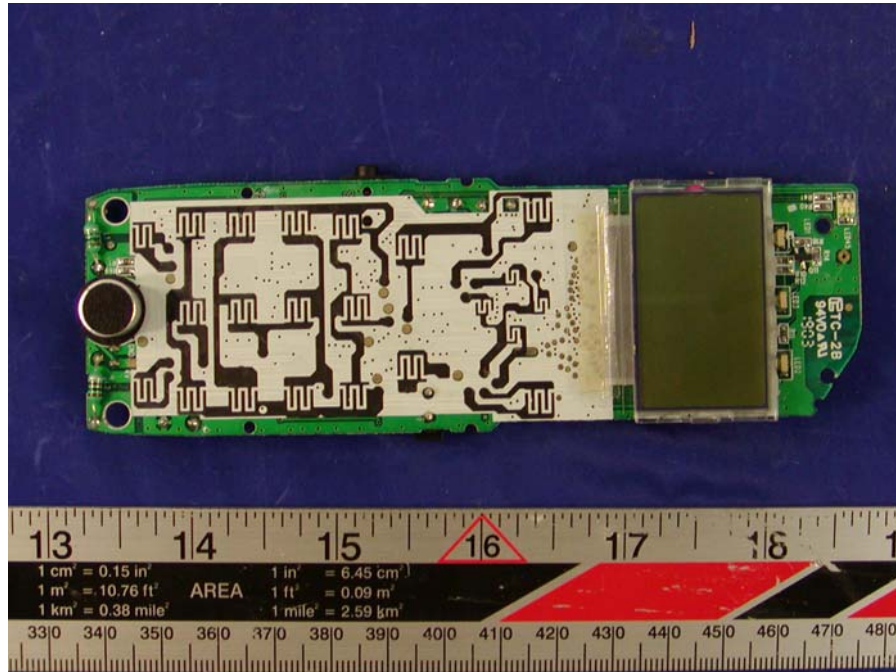
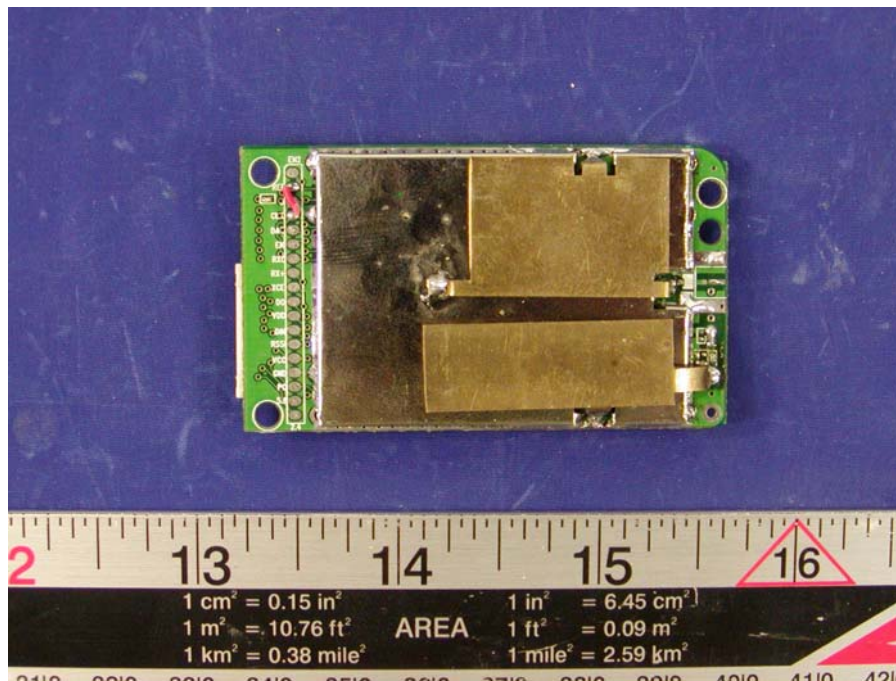


### Handset - Back View

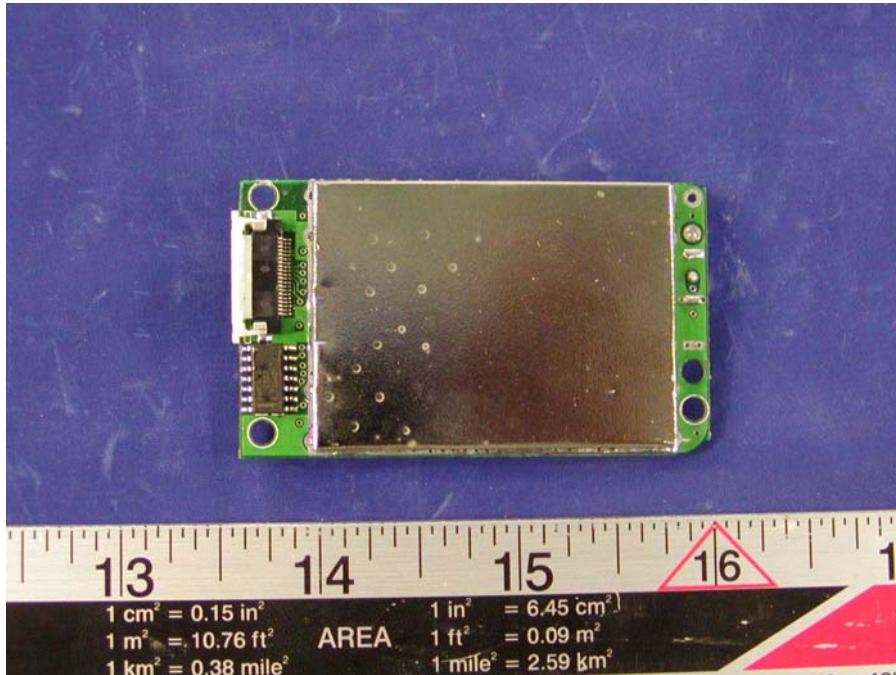
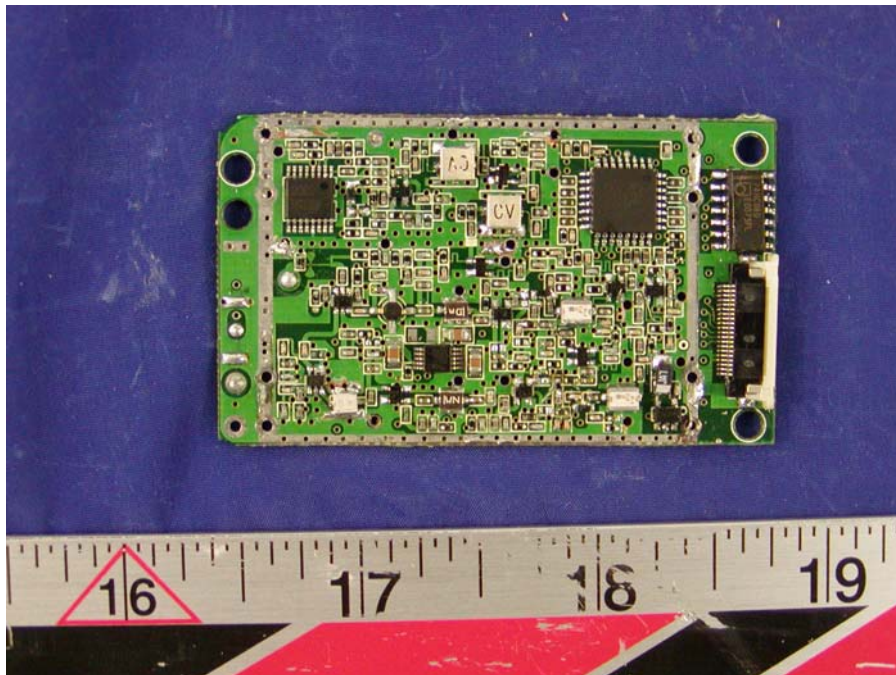


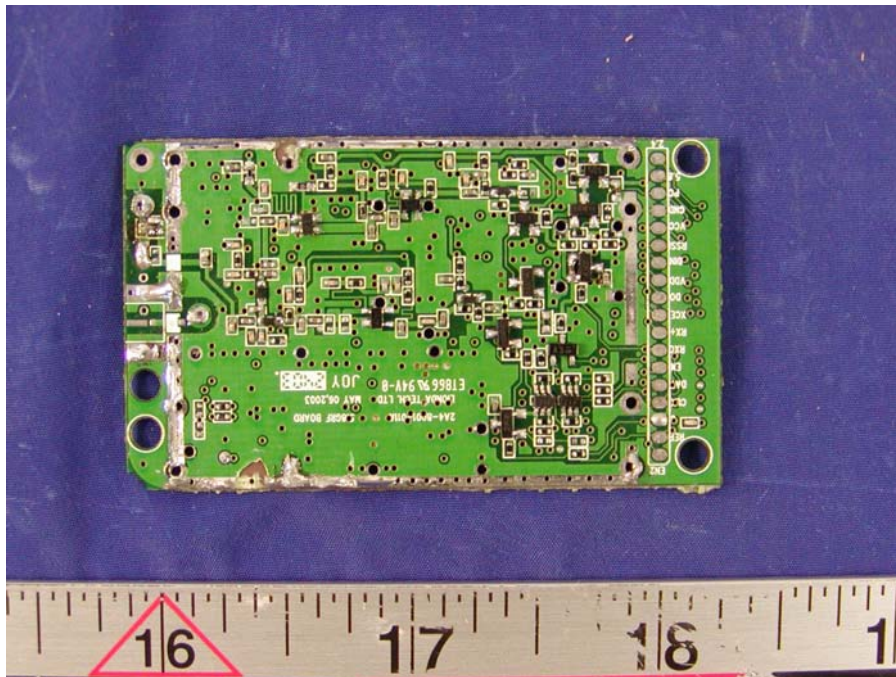


**Handset – Board and Housing View****Handset - Main Board Component View**

**Handset - Main Board Solder View****Handset - Transceiver Top Side View**



**Handset - Transceiver Bottom View****Handset - Transceiver Cover Removed Component View**

**Handset - Transceiver Cover Removed Solder View****Accessory- Headset**

**EXHIBIT C – Z-Axis**

Lionda Technology, Model Number: GH5800 (Left Head, Cheek, Mid Channel, Ambient  
Temp = 23 Deg C, Liquid Temp = 21 Deg C)

SAM Phantom; Section; Position: ; Frequency: 5768 MHz

Probe: ES3DV2 - SN3019; ConvF(1.80,1.80,1.80); Crest factor: 1.0; 5800 MHz Head Liquid:  $\sigma = 5.96 \text{ mho/m}$ ,  $\epsilon_r = 38.7$ ,  $\rho = 1.00 \text{ g/cm}^3$   
; , 0

Z-Axis: Dx = 0.0, Dy = 0.0, Dz = 2.0

