



## ANSI/IEEE Std. C95.1-1992

In accordance with the requirements of FCC Report and Order:  
ET Docket 93-62 ; FCC 47 CFR Part 2 ( 2.1093)

## FCC SAR TEST REPORT

For

Product Name: Tablet

Brand Name : PCD

Model No.: Q PAD

Series Model: N/A

Test Report Number: C141224R01-SF

Issued for

Technology Brokers, INC

7412 SW 48ST Suite B, Miami, FL, 33133

Issued by

Compliance Certification Services Inc.

Kun shan Laboratory

No.10 Weiye Rd., Innovation park, Eco&Tec,  
Development Zone, Kunshan City, Jiangsu, China

TEL: 86-512-57355888

FAX: 86-512-57370818



TESTING CERT #2541.01

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## Revision History

Revision	REPORT NO.	Date	Page Revised	Contents
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## 1. CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

<b>Product Name:</b>	Tablet
<b>Brand Name:</b>	PCD
<b>Model Name.:</b>	Q PAD
<b>Series Model:</b>	N/A
<b>Devices supporting GPRS:</b>	Class B
<b>Description Test Modes(worst case ):</b>	SIM 1 and SIM2 is a chipset unit and tested as single chipset
<b>Device Category:</b>	PORTABLE DEVICES
<b>Exposure Category:</b>	GENERAL POPULATION/UNCONTROLLED EXPOSURE
<b>Date of Test:</b>	December 24, 2014 to December 26, 2014
<b>Applicant:</b>	<b>Technology Brokers, INC</b> 7412 SW 48ST Suite B, Miami, FL, 33133
<b>Manufacturer:</b>	<b>Technology Brokers, INC</b> 7412 SW 48ST Suite B, Miami, FL, 33133
<b>Application Type:</b>	Certification

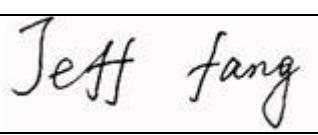
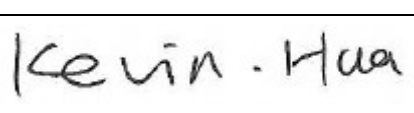
### APPLICABLE STANDARDS AND TEST PROCEDURES

STANDARDS AND TEST PROCEDURES	TEST RESULT
ANSI/IEEE C95.1-1992	No non-compliance noted

### Deviation from Applicable Standard

None
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The device was tested by Compliance Certification Services Inc. in accordance with the measurement methods and procedures specified in KDB 865664 The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

<b>Approved by:</b>	<b>Tested by:</b>
	
Jefffang RF Manager Compliance Certification Services Inc.	Kevin.hua Test Engineer Compliance Certification Services Inc.



## 2. EUT DESCRIPTION

<b>Product Name:</b>	Tablet	
<b>Brand Name:</b>	PCD	
<b>Model Name.:</b>	Q PAD	
<b>Series Model:</b>	N/A	
<b>Model Discrepancy:</b>	N/A	
<b>FCC ID:</b>	ZTP-QPAD	
<b>Power reduction:</b>	NO	
<b>DTM Description:</b>	N/A	
<b>Device Category:</b>	Production unit	
<b>Frequency Range:</b>	GSM 850: 824.2 ~ 848.8 MHz PCS1900: 1850.2 ~ 1909.8 MHz WCDMA Band II:1852.4~1907.6MHz WCDMA Band V:826.4~846.6 MHz WLAN 2.4GHz: 2412 ~ 2462 MHz Bluetooth: 2402 ~ 2480 MHz	
<b>Transmit Power(Average):</b>	GSM 850:32.82 dBm PCS 1900:29.52 dBm WCDMA Band II:23.24 dBm WCDMA Band V:22.98 dBm	802.11b: 16.41 dBm 802.11g: 13.22 dBm 802.11n HT20: 13.05 dBm 802.11n HT40: 11.39 dBm Bluetooth: 2.86 dBm BLE 4.0: -4.67 dBm
<b>Max. Reported SAR(1g):</b>	Head: GSM 850: 0.065 W/kg PCS 1900: 0.116 W/kg WCDMA Band II: 0.155 W/kg WCDMA Band V: 0.042 W/kg 802.11b: 0.347 W/kg	Body: GSM 850: 0.228 W/kg PCS 1900: 0.446 W/kg WCDMA Band II: 0.455 W/kg WCDMA Band V: 0.087 W/kg 802.11b: 0.695 W/kg
<b>Modulation Technique:</b>	GSM/GPRS: GMSK WCDMA:QPSK 802.11b: DSSS (CCK, DQPSK, DBPSK) 802.11g/n: OFDM (QPSK, BPSK, 16-QAM, 64-QAM) Bluetooth : GFSK + $\pi/4$ DQPSK+8DPSK BLE 4.0: GFSK	
<b>GPRS Level:</b>	Class12	
<b>Accessories:</b>	Battery(rating): Capacitance:3500 mAh Rated Voltage:3.7V	
<b>Antenna Specification:</b>	GSM/WCDMA: PIFA antenna WIFI/ Bluetooth: PIFA antenna	
<b>Operating Mode:</b>	Maximum continuous output	



### 3. REQUIREMENTS FOR COMPLIANCE TESTING DEFINED BY THE FCC

The US Federal Communications Commission has released the report and order "Guidelines for Evaluating the Environmental Effects of RF Radiation", ET Docket No. 93-62 in August 1996. The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 W/Kg for an uncontrolled environment and 8.0 W/Kg for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1-1992.

### 4. TEST METHODOLOGY

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

- ☒ FCC 47 CFR Part 2 ( 2.1093)
- ☒ ANSI/IEEE C95.1-1992
- ☒ KDB 248227 D01v01r02 SAR Measurement Procedures for 802.11 a/b/g Transmitters
- ☒ KDB 447498 D01v05r02 General RF Exposure Guidance
- ☒ KDB 616217 D04v01r01 SAR for laptop and tablets
- ☒ KDB 648474 D04v01r02 Handset SAR
- ☒ KDB 865664 D01v01r03 Measurement 100 MHz to 6 GHz
- ☒ KDB 865664 D02v01r01 RF Exposure Reporting
- ☒ KDB 941225 D01v03 3G SAR Procedures

### 5. TEST CONFIGURATION

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

During WLAN SAR testing EUT is configured with the WLAN continuous TX tool, and the transmission duty factor was monitored on the spectrum analyzer with zero-span setting

For WLAN SAR testing, WLAN engineering test software installed on the EUT can provide continuous transmitting RF signal.



## 6. DOSIMETRIC ASSESSMENT SETUP

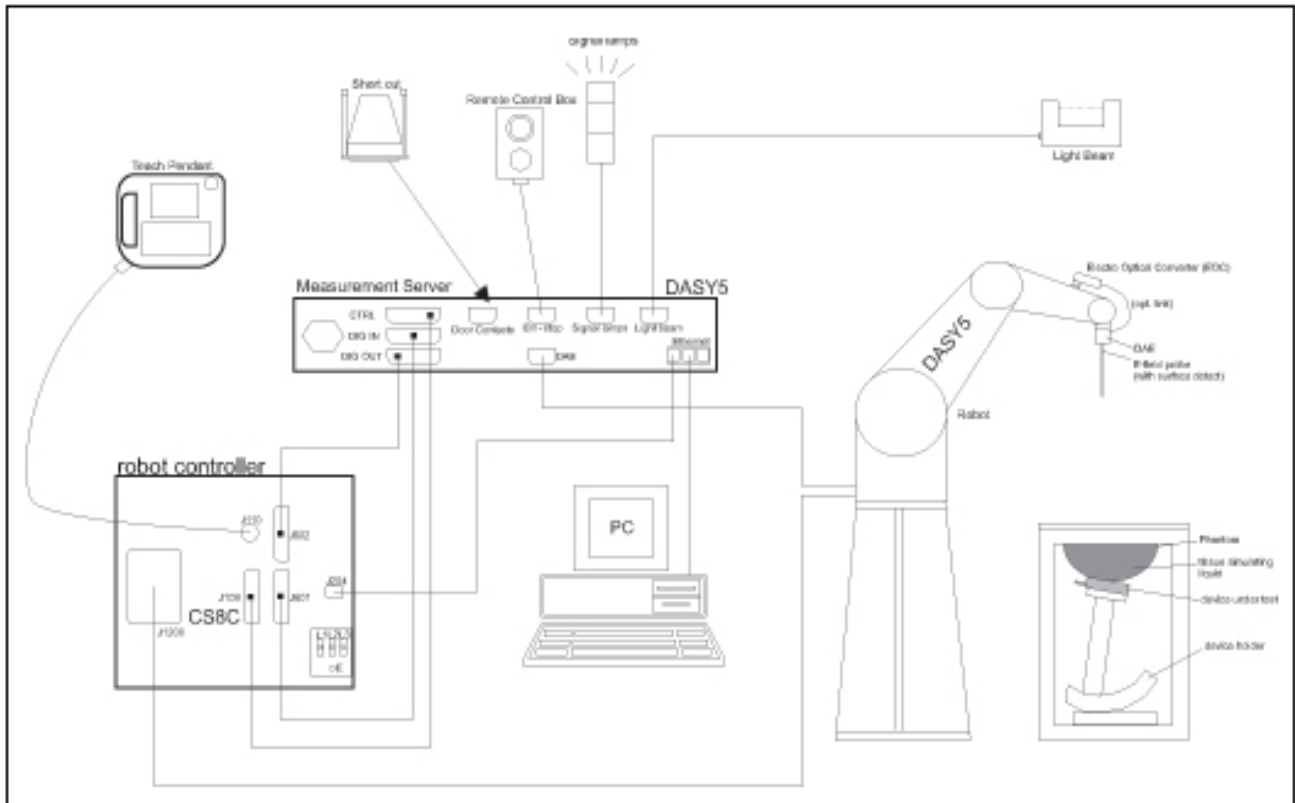
These measurements were performed with the automated near-field scanning system DASY 5 from ATTENNESSA. The system is based on a high precision robot (working range greater than 0.9 m), which positions the probes with a positional repeatability of better than  $\pm 0.02$  mm. Special E- and H-field probes 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 SAR measurements were conducted with the E-field PROBE EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration 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  $\pm 0.25$  dB. The phantom used was the SAM Twin Phantom as described in FCC supplement C, IEE P1528 and CENELEC EN 62209.

The following table gives the recipes for tissue simulating liquids.

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



## 6.1 MEASUREMENT SYSTEM DIAGRAM



### The DASYS5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- 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.
- A data acquisition electronics (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.
- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7.
- DASYS5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing validating the proper functioning of the system.



## 6.2 SYSTEM COMPONENTS



The DASY5 measurement server is based on a PC/104 CPU board with a 400MHz intel ULV celeron, 128MB chip-disk and 128 MB RAM. The necessary circuits for communication with either the DAE4(or DAE3) electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY5 I/O-board, which is directly connected to the PC/104 bus of the CPU board.

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



The PC-operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with two expansion slots which are reserved for future applications. Please note that the expansion slots do not have a standardized pinout and therefore only the expansion cards provided by SPEAG can be inserted. Expansion cards from any other supplier could seriously damage the measurement server. Calibration: No calibration required.

### Data Acquisition Electronics (DAE)



The data acquisition electronics (DAE4) 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 DAE4 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

### EX3DV4 Isotropic E-Field Probe for Dosimetric Measurements



**Construction:** Symmetrical design with triangular core

Built-in shielding against static charges

PEEK enclosure material (resistant to organic solvents, e.g., DGBE)

**Calibration:** Basic Broad Band Calibration in air: 10-3000 MHz.

Conversion Factors (CF) for HSL 900 and HSL 1800  
CF-Calibration for other liquids and frequencies upon request.

**Frequency:** 10 MHz to > 6 GHz; Linearity:  $\pm 0.2$  dB (30 MHz to 3 GHz)

**Directivity:**  $\pm 0.3$  dB in HSL (rotation around probe axis)  
 $\pm 0.5$  dB in HSL (rotation normal to probe axis)

**Dynamic Range:** 10  $\mu$ W/g to > 100 mW/g; Linearity:  $\pm 0.2$  dB  
(noise: typically < 1  $\mu$ W/g)



**Dimensions:** Overall length: 337 mm (Tip: 9 mm)  
Tip diameter: 2.5 mm (Body: 10 mm)  
Distance from probe tip to dipole centers:  
1 mm

**Application:** High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.



Interior of probe

## SAM Twin Phantom

### Construction:

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-200X, CENELEC 50360 and IEC 62209. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.



**Shell Thickness:**  $2 \pm 0.2$  mm

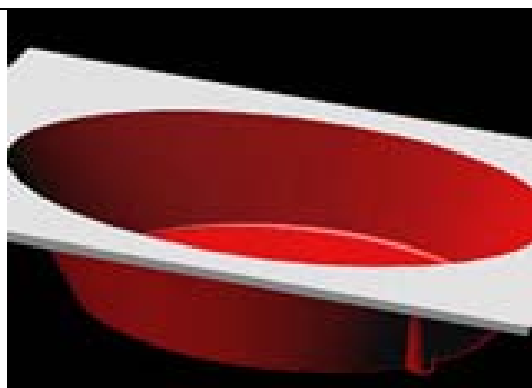
**Filling Volume:** Approx. 25 liters

**Dimensions:** Height: 850mm; Length: 1000mm; Width: 750mm

## SAM Phantom (ELI4 v4.0)

### Description Construction:

Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is supported by software version DASY4/DASY5.5 and higher and is compatible with all SPEAG dosimetric probes and dipoles



**Shell Thickness:**  $2.0 \pm 0.2$  mm (sagging: <1%)

**Filling Volume:** Approx. 25 liters

**Dimensions:** Major ellipse axis: 600 mm

**Minor axis:** 400 mm 500mm



## Device Holder for SAM Twin Phantom

**Construction:** In combination with the Twin SAM Phantom, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, and flat phantom).



## System Validation Kits for SAM Twin Phantom

**Construction:** Symmetrical dipole with 1/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

**Frequency:** 900, 1800, 2450, 5800 MHz

**ReTune loss:** > 20 dB at specified validation position

**Power capability:** > 100 W ( $f < 1\text{GHz}$ ); > 40 W ( $f > 1\text{GHz}$ )

**Dimensions:**

D835V2: dipole length: 161 mm; overall height: 340 mm

D1800V2: dipole length: 72.5 mm; overall height: 300 mm

D1900V2: dipole length: 67.7 mm; overall height: 300 mm

D2450V2: dipole length: 51.5 mm; overall height: 290 mm

D5GHzV2: dipole length: 20.6 mm; overall height: 300mm



## System Validation Kits for ELI4 phantom

**Construction:** Symmetrical dipole with 1/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

**Frequency:** 900, 1800, 2450, 5800 MHz

**ReTune loss:** > 20 dB at specified validation position

**Power capability:** > 100 W ( $f < 1\text{GHz}$ ); > 40 W ( $f > 1\text{GHz}$ )

**Dimensions:**

D835V2: dipole length: 161 mm; overall height: 340 mm

D1800V2: dipole length: 72.5 mm; overall height: 300 mm

D1900V2: dipole length: 67.7 mm; overall height: 300 mm

D2450V2: dipole length: 51.5 mm; overall height: 290 mm

D5GHzV2: dipole length: 20.6 mm; overall height: 300 mm





## 7. EVALUATION PROCEDURES

### DATA EVALUATION

The DASY 5 post processing 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 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	$\sigma$
	- Density	$\rho$

These parameters must be set correctly in the software. They can be found in the component documents or be imported into the software from the configuration files issued for the DASY 5 components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

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

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

with	$V_i$	= Compensated signal of channel i (i = x, y, z)
	$U_i$	= Input signal of channel i (i = x, y, z)
	$cf$	= Crest factor of exciting field (DASY 5 parameter)
	$dcp_i$	= Diode compression point (DASY 5 parameter)

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

E-field probes:

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

H-field probes:

$$H_i = \sqrt{V_i} \cdot \frac{a_{i10} + a_{i11}f + a_{i12}f^2}{f}$$

with	$V_i$	= Compensated signal of channel i (i = x, y, z)
	$Norm_i$	= Sensor sensitivity of channel i (i = x, y, z) $\mu V/(V/m)^2$ for E0field Probes
	$ConvF$	= Sensitivity enhancement in solution
	$a_{ij}$	= Sensor sensitivity factors for H-field probes
	$f$	= Carrier frequency (GHz)
	$E_i$	= Electric field strength of channel i in V/m
	$H_i$	= Magnetic field strength of channel i in A/m

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

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



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

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

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

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.

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

with  $P_{pwe}$  = Equivalent power density of a plane wave in mW/cm<sup>2</sup>  
 $E_{tot}$  = total electric field strength in V/m  
 $H_{tot}$  = total magnetic field strength in A/m



## **SAR EVALUATION PROCEDURES**

The procedure for assessing the peak spatial-average SAR value consists of the following steps:

- **Power Reference Measurement**

The reference and drift jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method.

- **Area Scan**

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a finer measurement around the hot spot. The sophisticated interpolation routines implemented in DASY 5 software can find the maximum locations even in relatively coarse grids. The scan area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the area scan's property sheet is brought-up, grid was at to 15 mm by 15 mm and can be edited by a user.

- **Zoom Scan**

Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default zoom scan measures 5 x 5 x 7 points within a cube whose base faces are centered around the maximum found in a preceding area scan job within the same procedure. If the preceding Area Scan job indicates more than one maximum, the number of Zoom Scans has to be enlarged accordingly (The default number inserted is 1).

- **Power Drift measurement**

The drift job measures the field at the same location as the most recent reference job within the same procedure, and with the same settings. The drift measurement gives the field difference in dB from the reading conducted within the last reference measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. In the properties of the Drift job, the user can specify a limit for the drift and have DASY 5 software stop the measurements if this limit is exceeded.

- **Z-Scan**

The Z Scan job measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. A user can anchor the grid to the current probe location. As with any other grids, the local Z-axis of the anchor location establishes the Z-axis of the grid.



## SPATIAL PEAK SAR EVALUATION

The procedure for spatial peak SAR evaluation has been implemented according to the IEEE1529 standard. It can be conducted for 1 g and 10 g.

The DASY 5 system allows evaluations that combine measured data and robot positions, such as:

- maximum search
- extrapolation
- boundary correction
- peak search for averaged SAR

During a maximum search, global and local maximum searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard's method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

### Extrapolation

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. Several measurements at different distances are necessary for the extrapolation.

Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Cube Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard's method for extrapolation. For a grid using 5x5x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1 g and 10 g cubes.

### Boundary effect

For measurements in the immediate vicinity of a phantom surface, the field coupling effects between the probe and the boundary influence the probe characteristics. Boundary effect errors of different dosimetric probe types have been analyzed by measurements and using a numerical probe model. As expected, both methods showed an enhanced sensitivity in the immediate vicinity of the boundary. The effect strongly depends on the probe dimensions and disappears with increasing distance from the boundary. The sensitivity can be approximately given as:

$$S \approx S_o + S_b \exp\left(-\frac{z}{a}\right) \cos\left(\pi \frac{z}{\lambda}\right)$$

Since the decay of the boundary effect dominates for small probes ( $a \ll \lambda$ ), the cos-term can be omitted. Factors  $S_b$  (parameter Alpha in the DASY 5 software) and  $a$  (parameter Delta in the DASY 5 software) are assessed during probe calibration and used for numerical compensation of the boundary effect. Several simulations and measurements have confirmed that the compensation is valid for different field and boundary configurations.

This simple compensation procedure can largely reduce the probe uncertainty near boundaries. It works well as long as:

- the boundary curvature is small
- the probe axis is angled less than 30° to the boundary normal
- the distance between probe and boundary is larger than 25% of the probe diameter
- the probe is symmetric (all sensors have the same offset from the probe tip)

Since all of these requirements are fulfilled in a DASY 5 system, the correction of the probe boundary effect in the vicinity of the phantom surface is performed in a fully automated manner via the measurement data extraction during post processing.



## 8. MEASUREMENT UNCERTAINTY

Measurement uncertainty for 30 MHz to 3 GHz averaged over 1 gram

Uncertainty Component	Uncertainty	Prob.	Div.	$C_i (1g)$	Std. Unc.(1-g)	$V_i$ or $V_{eff}$
Measurement System						
Probe Calibration ( $k=1$ )	6.00	Normal	1	1	6.00	$\infty$
Probe Isotropy	4.70	Rectangular	$\sqrt{3}$	0.7	1.90	$\infty$
Modulation Response	2.40	Rectangular	$\sqrt{3}$	1	1.39	$\infty$
Hemispherical Isotropy	9.60	Rectangular	$\sqrt{3}$	0.7	3.88	$\infty$
Boundary Effect	2.00	Rectangular	$\sqrt{3}$	1	1.15	$\infty$
Linearity	4.70	Rectangular	$\sqrt{3}$	1	2.71	$\infty$
System Detection Limit	1.00	Rectangular	$\sqrt{3}$	1	0.58	$\infty$
Readout Electronics	0.30	Normal	1	1	0.30	$\infty$
Response Time	0.80	Rectangular	$\sqrt{3}$	1	0.46	$\infty$
Integration Time	2.60	Rectangular	$\sqrt{3}$	1	1.50	$\infty$
RF Ambient Noise	3.00	Rectangular	$\sqrt{3}$	1	1.73	$\infty$
RF Ambient Reflections	3.00	Rectangular	$\sqrt{3}$	1	1.73	$\infty$
Probe Positioner	0.40	Rectangular	$\sqrt{3}$	1	0.23	$\infty$
Probe Positioning	2.90	Rectangular	$\sqrt{3}$	1	1.67	$\infty$
Max. SAR Evaluation	2.00	Rectangular	$\sqrt{3}$	1	1.15	$\infty$
<b>Test sample Related</b>						
Test sample Positioning	2.9	Normal	1	1	2.9	145
Device Holder Uncertainty	3.6	Normal	1	1	3.6	5
Power drift	5	Rectangular	$\sqrt{3}$	1	2.89	$\infty$
Power Scaling	0	Rectangular	$\sqrt{3}$	1	0.00	$\infty$
<b>Phantom and Tissue Parameters</b>						
Phantom Uncertainty	6.1	Rectangular	$\sqrt{3}$	1	3.52	$\infty$
SAR correction	1.9	Rectangular	$\sqrt{3}$	1	1.10	$\infty$
Liquid Conductivity (target)	5	Rectangular	$\sqrt{3}$	0.64	1.85	$\infty$
Liquid Conductivity (meas)	3.42	Rectangular	$\sqrt{3}$	0.78	1.54	$\infty$
Liquid Permittivity (target )	5	Rectangular	$\sqrt{3}$	0.6	1.73	$\infty$
Liquid Permittivity (meas)	3.38	Rectangular	$\sqrt{3}$	0.26	0.51	$\infty$
Temp. unc. - Conductivity	3.4	Rectangular	$\sqrt{3}$	0.78	1.53	$\infty$
Temp. unc. - Permittivity	0.4	Rectangular	$\sqrt{3}$	0.23	0.05	$\infty$
<b>Combined Std. Uncertainty</b>		RSS			11.54	361
<b>Expanded STD Uncertainty</b>		$k=2$			<b>23.07%</b>	
<b>Expanded STD Uncertainty</b>		$k=2$			<b>1.80dB</b>	

Table: Worst-case uncertainty for DASY5 assessed according to IEEE1528-2003.

The budge is valid for the frequency range 300 MHz to 6G Hz and represents a worst-case analysis.



## 9. EXPOSURE LIMIT

(A). Limits for Occupational/Controlled Exposure (W/kg)

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

(B). 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 1gram 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 individuals who have no knowledge or control of their exposure.

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

**NOTE**  
**GENERAL POPULATION/UNCONTROLLED EXPOSURE**  
**PARTIAL BODY LIMIT**  
**1.6 W/kg**



## 10. EUT ARRANGEMENT

Please refer to IEEE1528-2003 illustration below.

### 10.1 ANTHROPOMORPHIC HEAD PHANTOM

Figure 7-1a shows the front, back and side views of SAM. The point “M” is the reference point for the center of mouth, “LE” is the left ear reference point (ERP), and “RE” is the right ERP. The ERPs are 15 mm posterior to the entrance to ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 7-1b. The plane passing through the two ear reference points and M is defined as the Reference Plane. The line N-F (Neck-Front) perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 7-1c). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines should be marked on the external phantom shell to facilitate handset positioning. Posterior to the N-F line, the thickness of the phantom shell with the shape of an ear is a flat surface 6 mm thick at the ERPs. Anterior to the N-F line, the ear is truncated as illustrated in Figure 7-1b. The ear truncation is introduced to avoid the handset from touching the ear lobe, which can cause unstable handset positioning at the cheek.

Figure 7-1a  
Front, back and side view of SAM (model for the phantom shell)



Figure 7-1b

Close up side view of phantom showing the ear region

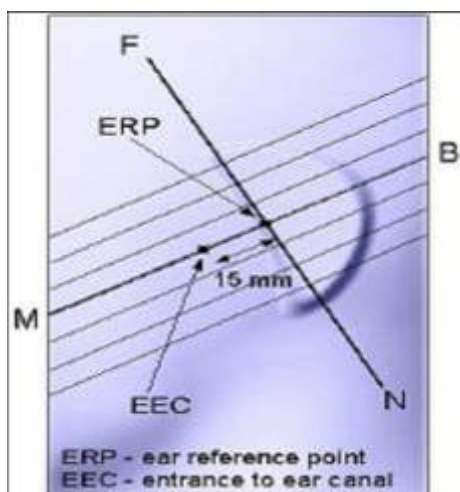


Figure 7-1b

Close up side view of phantom showing the ear region

Figure 7-1c

Side view of the phantom showing relevant markings and the 7 cross sectional plane locations

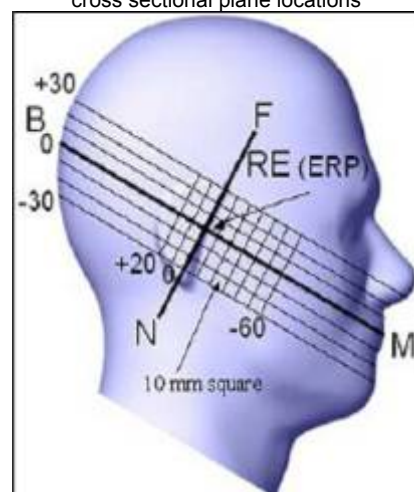


Figure 7-1c

Side view of the phantom showing relevant markings and the 7 cross sectional plane locations



## 10.2 DEFINITION OF THE “CHEEK/TOUCH” POSITION

The “cheek” or “touch” position is defined as follows:

- Ready the handset for talk operation, if necessary. For example, for handsets with a cover piece, open the cover. (If the handset can also be used with the cover closed both configurations must be tested.)
- Define two imaginary lines on the handset: the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset: the midpoint of the width  $w_t$  of the handset at the level of the acoustic output (point A on Figures 7-2a and 7-2b), and the midpoint of the width  $w_b$  of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Figure 7-2a). The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output. However, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset (see Figure 7-2b), especially for clamshell handsets, handsets with flip pieces, and other irregularly-shaped handsets.
- Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 7-2c), such that the plane defined by the vertical center line and the horizontal line of the handset is approximately parallel to the sagittal plane of the phantom.
- Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the pinna.
- e) While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is in the plane normal to MB-NF including the line MB (called the reference plane).
- f. Rotate the handset around the vertical centerline until the handset (horizontal line) is symmetrical with respect to the line NF.
- g. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE and maintaining the handset contact with the pinna, rotate the handset about the line NF until any point on the handset is in contact with a phantom point below the pinna (cheek). See Figure 7-2c. The physical angles of rotation should be noted.

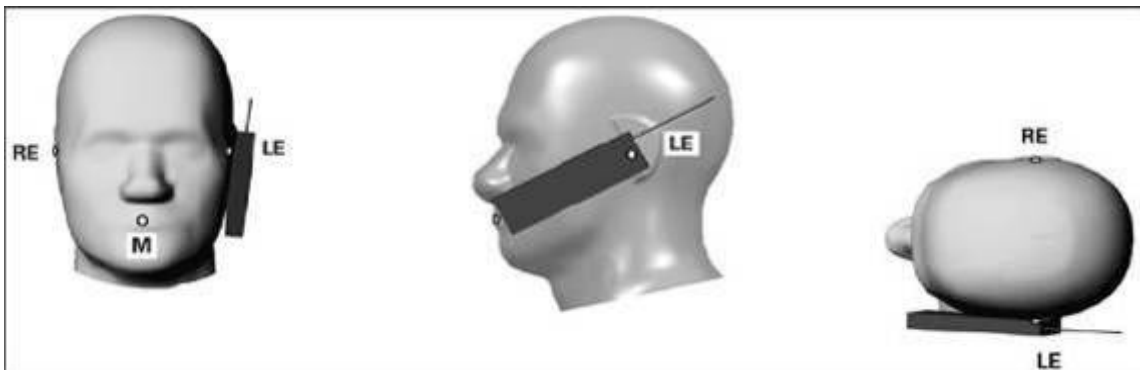


Figure 7.2c

Phone “cheek” or “touch” position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for handset positioning, are indicated.

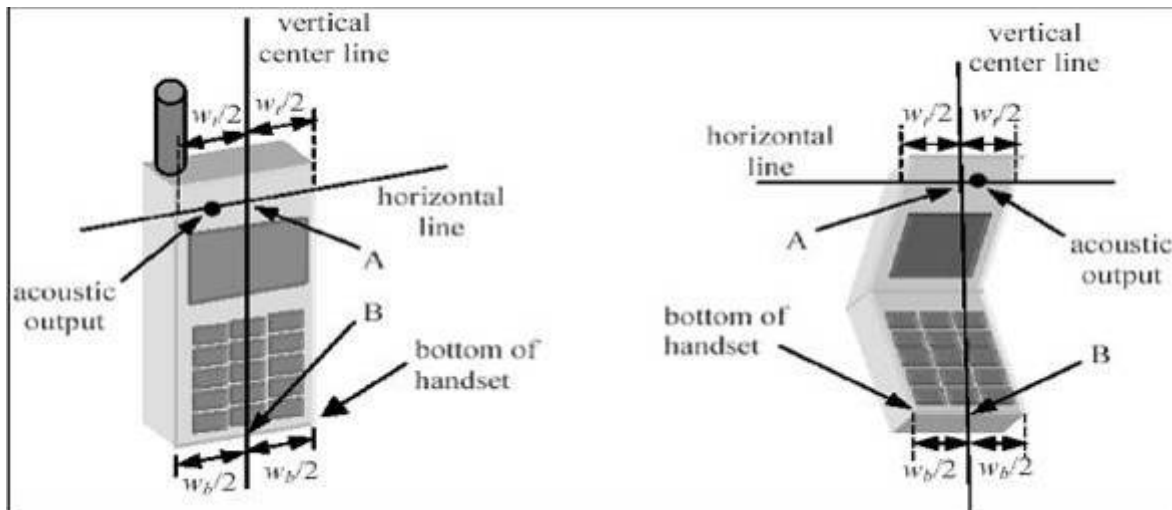


Figure 7.2a

Figure 7.2b

## 10.3 DEFINITION OF THE “TILTED” POSITION

The “tilted” position is defined as follows:

- Repeat steps (a) – (g) of 7.2 to place the device in the “cheek position.”
- While maintaining the orientation of the handset move the handset away from the pinna along the line passing through RE and LE in order to enable a rotation of the handset by 15 degrees.
- Rotate the handset around the horizontal line by 15 degrees.
- While maintaining the orientation of the handset, move the handset towards the phantom on a line passing through RE and LE until any part of the handset touches the ear. The tilted position is obtained when the contact is on the pinna. If the contact is at any location other than the pinna (e.g., the antenna with the back of the phantom head), the angle of the handset should be reduced. In this case, the tilted position is obtained if any part of the handset is in contact with the pinna as well as a second part of the handset is contact with the phantom (e.g., the antenna with the back of the head).

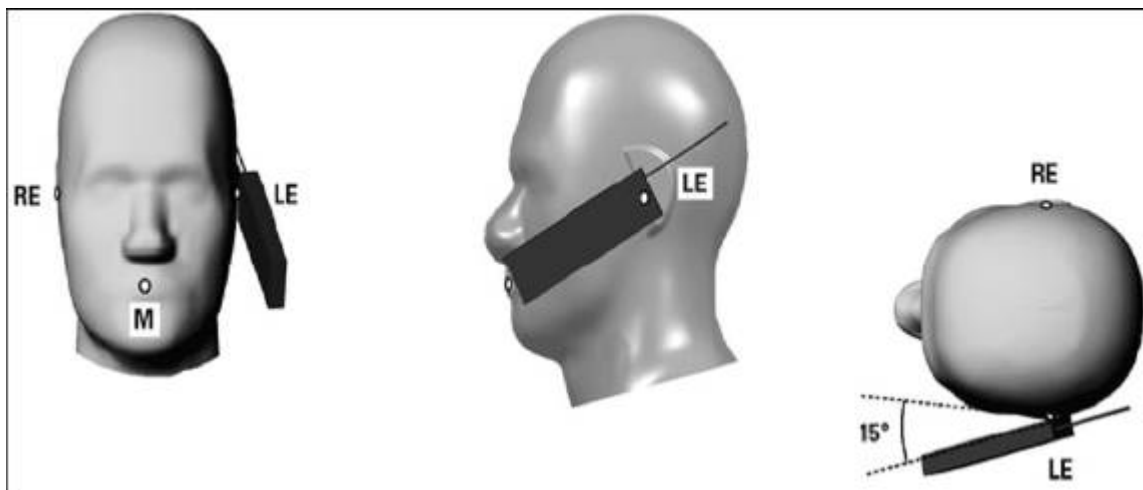


Figure 7-3

Phone “tilted” position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for handset positioning, are indicated.



## 10.4 BODY WORN TEST

This EUT was tested in six different positions. They are front side, rear side, Edge 1; Edge 2, Edge 3 and Edge 4 of tablet. In these positions, the surface of EUT is touching with phantom 0 mm.

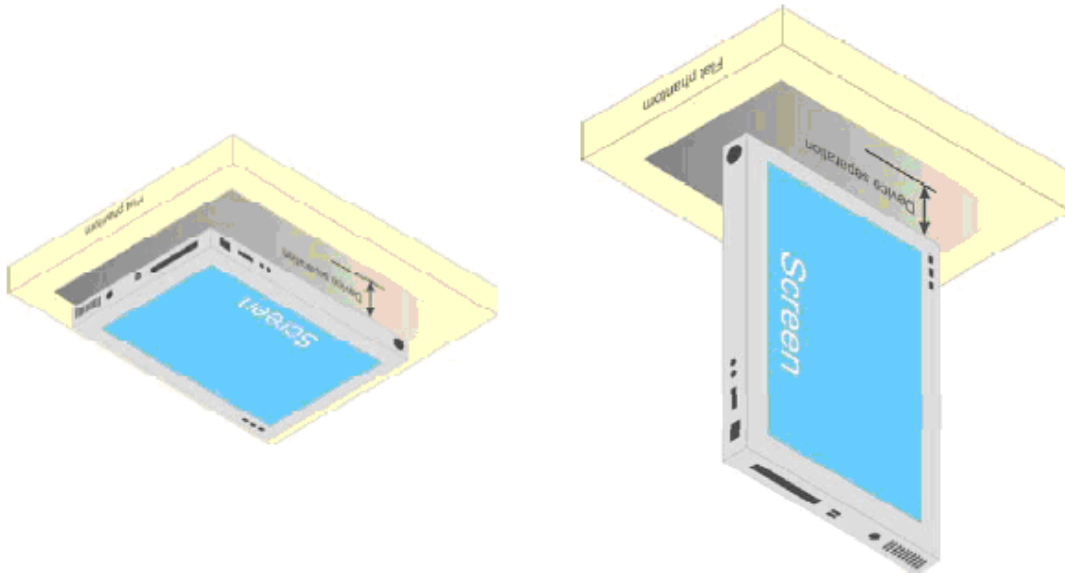


Fig Illustration for Lap-touching Position



## 11. MEASUREMENT RESULTS

### 11.1 TEST LIQUIDS CONFIRMATION

#### SIMULATED TISSUE LIQUID PARAMETER CONFIRMATION

The dielectric parameters were checked prior to assessment using the HP85070C dielectric probe kit. The dielectric parameters measured are reported in each correspondent section.

#### IEEE SCC-34/SC-2 P1528 RECOMMENDED TISSUE DIELECTRIC PARAMETERS

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in P1528

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	45.3	5.27	48.2	6.00

( $\epsilon_r$  = relative permittivity,  $\sigma$  = conductivity and  $\rho$  = 1000 kg/m<sup>3</sup>)



## 11.2 LIQUID MEASUREMENT RESULTS

The following table show the measuring results for simulating liquid:

Liquid Type	Liquid Temp. (°C)	Parameters	Target	Measured	Deviation (%)	Limited (%)	Measured Date
Head835	21.5	Permitivity( $\epsilon$ )	41.50	40.912	-1.42	$\pm 5$	2014-12-25
		Conductivity( $\sigma$ )	0.90	0.916	1.78	$\pm 5$	
Body835	21.5	Permitivity( $\epsilon$ )	55.20	56.271	1.94	$\pm 5$	2014-12-24
		Conductivity( $\sigma$ )	0.97	0.961	-0.93	$\pm 5$	
Head1900	21.5	Permitivity( $\epsilon$ )	40.00	41.352	3.38	$\pm 5$	2014-12-25
		Conductivity( $\sigma$ )	1.40	1.426	1.86	$\pm 5$	
Body1900	21.5	Permitivity( $\epsilon$ )	53.30	53.612	0.59	$\pm 5$	2014-12-24
		Conductivity( $\sigma$ )	1.52	1.572	3.42	$\pm 5$	
Head2450	21.5	Permitivity( $\epsilon$ )	39.20	38.836	-0.93	$\pm 5$	2014-12-26
		Conductivity( $\sigma$ )	1.80	1.831	1.72	$\pm 5$	
Body2450	21.5	Permitivity( $\epsilon$ )	52.70	51.319	-2.62	$\pm 5$	2014-12-26
		Conductivity( $\sigma$ )	1.95	1.908	-2.15	$\pm 5$	

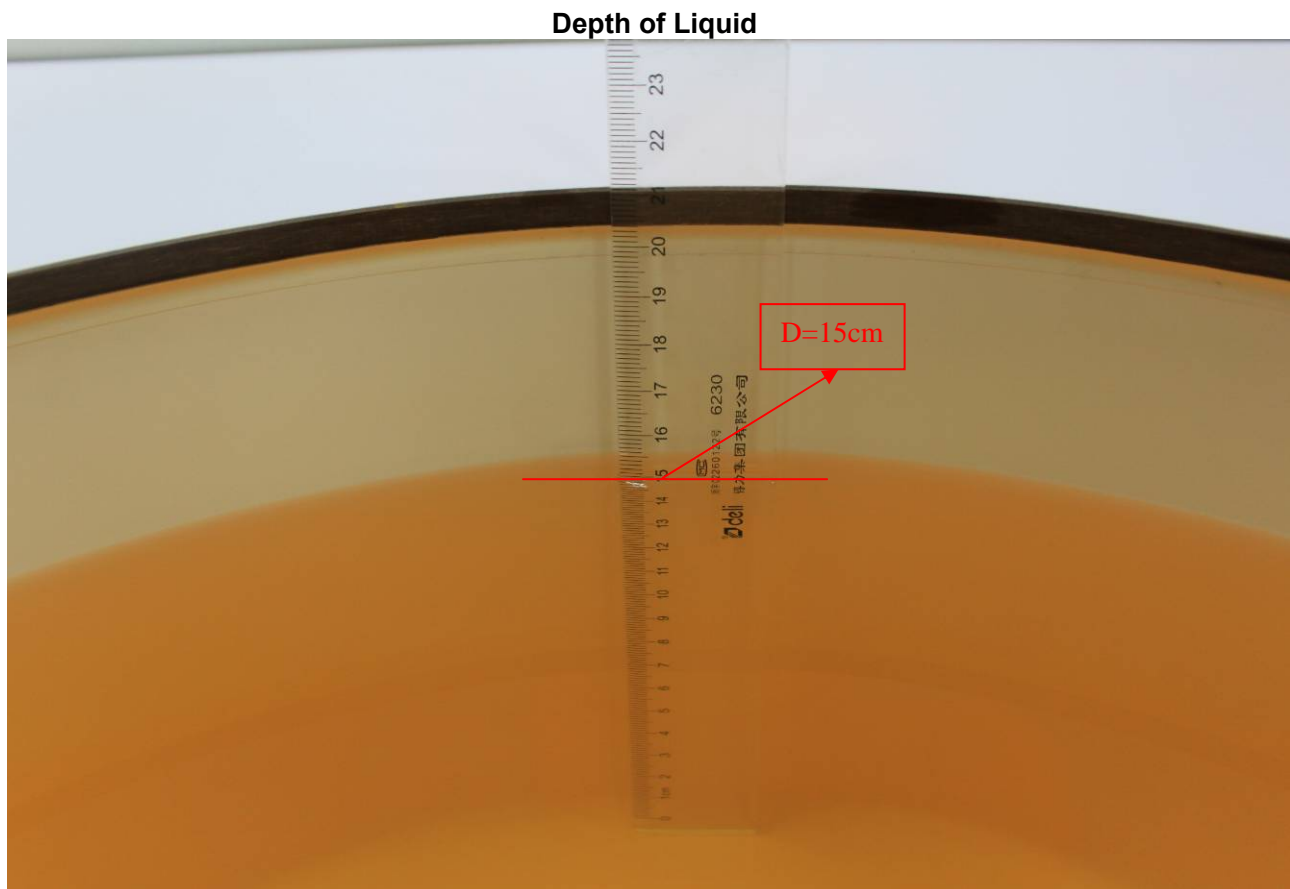


## 11.3 SYSTEM PERFORMANCE CHECK

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications of  $\pm 10\%$ . The system performance check results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

### SYSTEM PERFORMANCE CHECK MEASUREMENT CONDITIONS

- The measurements were performed in the flat section of the SAM twin phantom filled with head and body simulating liquid of the following parameters.
- The DASY5 system withan E-fileld probe EX3DV4 SN: 3798 was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point 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 15 mm (below 1 GHz) and 10 mm (above 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 10mm was aligned with the dipole.
- Special 7x7x7 fine cube was chosen for cube integration (dx= 5 mm, dy= 5 mm, dz= 5 mm).
- Distance between probe sensors and phantom surface was set to 2 mm.
- The dipole input power was 250mW $\pm 3\%$ .
- The results are normalized to 1 W input power.



- Note: For SAR testing, the depth is 15cm shown above



## SYSTEM PERFORMANCE CHECK RESULTS

Liquid Type	Ambient Temp. (°C)	Liquid Temp. (°C)	Input Power (W)	Measured SAR1g (W/Kg)	1W Target SAR1g(W/Kg)	1W Normalized SAR1g(W/Kg)	Deviation (%)	Limited (%)	Date
Head835	22	21.5	0.25	2.43	9.50	9.72	2.32	± 10	2014-12-25
Body835	22	21.5	0.25	2.52	9.53	10.08	5.77	± 10	2014-12-24
Head1900	22	21.5	0.25	10.90	40.40	43.60	7.92	± 10	2014-12-25
Body1900	22	21.5	0.25	9.76	40.50	39.04	-3.60	± 10	2014-12-24
Head2450	22	21.5	0.25	12.46	52.60	49.84	-5.25	± 10	2014-12-26
Body2450	22	21.5	0.25	12.90	49.20	51.60	4.88	± 10	2014-12-26



## 11.4 EUT TUNE-UP PROCEDURES AND TEST MODE

The following procedure had been used to prepare the EUT for the SAR test.

To setup the desire channel frequency and the maximum output power. A Radio Communication Tester "CMU200 " was used to program the EUT.

### General Note:

1. Per KDB 447498 D01v05r02, the maximum output power channel is used for SAR testing and for further SAR test reduction.
2. For head SAR testing, the EUT was set in GSM Voice for GSM850 and GSM1900 due to its highest frame-average power.
3. For body worn SAR testing, the EUT was set in GPRS 4 Tx for GSM850 and GSM1900 due to its highest frame-average power.

### GSM Conducted output power(dBm):

Band	GSM 850			GSM 1900		
Channel	128	190	251	512	661	810
Frequency(MHz)	824.2	836.6	848.8	1850.2	1880	1909.8
Maximum Burst-Averaged Output Power						
GSM(GMSK,1Uplink)	32.72	<b>32.82</b>	32.78	29.34	29.43	<b>29.52</b>
GPRS 8 (GMSK,1 Uplink)	32.65	32.79	32.76	29.32	29.39	29.51
GPRS 10 (GMSK,2 Uplink)	31.96	32.03	32.05	28.76	28.86	28.94
GPRS 11 (GMSK,3 Uplink)	30.31	30.36	30.39	27.19	27.26	27.31
GPRS 12 (GMSK,4 Uplink)	29.36	29.47	29.44	26.12	26.18	26.21
Maximum Frame-Averaged Output Power						
GSM(GMSK,1Uplink)	23.70	23.80	23.76	20.32	20.41	20.50
GPRS 8 (GMSK,1 Uplink)	23.62	23.76	23.73	20.29	20.36	20.48
GPRS 10 (GMSK,2 Uplink)	25.93	26.00	26.02	22.73	22.83	22.91
GPRS 11 (GMSK,3 Uplink)	26.05	26.10	26.13	22.93	23.00	23.05
GPRS 12 (GMSK,4 Uplink)	26.35	<b>26.46</b>	26.43	23.11	23.17	<b>23.20</b>

**Remark:** The frame-averaged power is linearly scaled the maximum burst-averaged power based on time slots. The calculated methods are shown as below:

Frame-averaged power = Burst-averaged power (1 Uplink) – 9.03 dBm

Frame-averaged power = Burst averaged power (2 Uplink) – 6.02 dBm

Frame-averaged power = Burst-averaged power (3 Uplink) – 4.26 dBm

Frame-averaged power = Burst averaged power (4 Uplink) – 3.01 dBm

**Note:** Per KDB 447498 D01, the maximum output power channel is used for SAR testing and for further SAR test reduction.



## WCDMA Conducted output power(dBm):

As the SAR body tests for WCDMA **Band II and Band V**, we established the radio link through call processing. The maximum output power were verified on high, middle and low channels for each test band according to 3GPP TS 34.121 with the following configuration: a 12.2kbps RMC, 64,144,384 kbps RMC with TPC set to all "all '1's" b Test loop Mode 1

The following procedures had been used to prepare the EUT for the SAR test.

## HSDPA Setup Configuration:

**Table C.10.1.4:  $\beta$  values for transmitter characteristics tests with HS-DPCCH**

Sub-test	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c/\beta_d$	$\beta_{hs}$ (Note 1, Note 2)	CM (dB) (Note 3)	MPR (dB) (Note 3)
1	2/15	15/15	64	2/15	4/15	0.0	0.0
2	12/15 (Note 4)	15/15 (Note 4)	64	12/15 (Note 4)	24/15	1.0	0.0
3	15/15	8/15	64	15/8	30/15	1.5	0.5
4	15/15	4/15	64	15/4	30/15	1.5	0.5

Note 1:  $\Delta_{ACK}$ ,  $\Delta_{NACK}$  and  $\Delta_{CQI} = 30/15$  with  $\beta_{hs} = 30/15 * \beta_c$ .

Note 2: For the HS-DPCCH power mask requirement test in clause 5.2C, 5.7A, and the Error Vector Magnitude (EVM) with HS-DPCCH test in clause 5.13.1A, and HSDPA EVM with phase discontinuity in clause 5.13.1AA,  $\Delta_{ACK}$  and  $\Delta_{NACK} = 30/15$  with  $\beta_{hs} = 30/15 * \beta_c$ , and  $\Delta_{CQI} = 24/15$  with  $\beta_{hs} = 24/15 * \beta_c$ .

Note 3: CM = 1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{hs}/\beta_c = 24/15$ . For all other combinations of DPDCH, DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.

Note 4: For subtest 2 the  $\beta_c/\beta_d$  ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 11/15$  and  $\beta_d = 15/15$ .

## HSUPA Setup Configuration:

**Table C.11.1.3:  $\beta$  values for transmitter characteristics tests with HS-DPCCH and E-DCH**

Sub-test	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c/\beta_d$	$\beta_{hs}$ (Note 1)	$\beta_{ec}$	$\beta_{ed}$ (Note 5) (Note 6)	$\beta_{ed}$ (SF)	$\beta_{ed}$ (Codes)	CM (dB) (Note 2)	MPR (dB) (Note 2)	AG Index (Note 6)	E- TFCI
1	11/15 (Note 3)	15/15 (Note 3)	64	11/15 (Note 3)	22/15	209/25	1309/225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	$\beta_{ed1}: 47/15$ $\beta_{ed2}: 47/15$	4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	2/15	56/75	4	1	3.0	2.0	17	71
5	15/15 (Note 4)	15/15 (Note 4)	64	15/15 (Note 4)	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1:  $\Delta_{ACK}$ ,  $\Delta_{NACK}$  and  $\Delta_{CQI} = 30/15$  with  $\beta_{hs} = 30/15 * \beta_c$ .

Note 2: CM = 1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{hs}/\beta_c = 24/15$ . For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.

Note 3: For subtest 1 the  $\beta_c/\beta_d$  ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 10/15$  and  $\beta_d = 15/15$ .

Note 4: For subtest 5 the  $\beta_c/\beta_d$  ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 14/15$  and  $\beta_d = 15/15$ .

Note 5: In case of testing by UE using E-DPDCH Physical Layer category 1, Sub-test 3 is omitted according to TS25.306 Table 5.1g.

Note 6:  $\beta_{ed}$  can not be set directly, it is set by Absolute Grant Value.



Band	WCDMA Band II			WCDMA Band V		
Channel	9262	9400	9538	4132	4182	4233
Frequency(MHz)	1852.4	1880	1907.6	826.4	836.4	846.6
RMC12.2K	22.85	23.04	<b>23.24</b>	22.84	<b>22.98</b>	22.78
HSDPA Subtest-1	21.77	22.05	22.25	21.84	22.05	21.81
HSDPA Subtest-2	19.95	20.56	20.78	20.36	20.59	20.36
HSDPA Subtest-3	19.01	19.52	19.55	19.29	19.48	19.38
HSDPA Subtest-4	18.93	19.21	19.26	19.12	19.05	18.61
HSUPA Subtest-1	20.33	20.64	20.79	20.25	20.47	20.33
HSUPA Subtest-2	19.53	19.91	20.44	19.58	19.86	20.53
HSUPA Subtest-3	18.41	18.59	19.53	18.47	18.52	19.56
HSUPA Subtest-4	18.21	18.42	19.65	19.26	19.49	19.66
HSUPA Subtest-5	20.94	21.19	21.34	20.83	21.08	21.22

**Note:**

Per KDB 941225 D01, RMC 12.2kbps setting is used to evaluate SAR. If HSDPA/HSUPA output power is < 0.25dB higher than RMC, HSDPA/HSUPA SAR evaluation can be excluded.

**WLAN Conducted output power(dBm):**

Mode	Channel	Frequency	Average power(dBm)
802.11 b	1	2412 MHZ	16.32
	6	2437 MHZ	16.27
	11	2462 MHZ	<b>16.41</b>
802.11 g	1	2412 MHZ	11.97
	6	2437 MHZ	<b>13.22</b>
	11	2462 MHZ	12.15
802.11 n 20M	1	2412 MHZ	11.93
	6	2437 MHZ	<b>13.05</b>
	11	2462 MHZ	12.09
802.11 n 40M	3	2422 MHZ	9.23
	6	2442 MHZ	<b>11.39</b>
	9	2452 MHZ	9.45

**Bluetooth Conducted output power(dBm):**

Channel	Frequency	Average power(dBm)	
		Data Rate	
		1Mbps	3Mbps
CH00	2402MHz	2.81	2.16
CH39	2441 MHz	<b>2.86</b>	<b>2.23</b>
CH78	2480 MHz	2.74	2.05

**BLE 4.0 Conducted output power(dBm):**

Channel	Frequency	Average power(dBm)
		Data Rate(1Mbps)
CH00	2402 MHz	-4.93
CH19	2440 MHz	<b>-4.67</b>
CH39	2480 MHz	-5.16



According to KDB447498 D01: The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances  $\leq 50$  mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f_{\text{GHz}}}] \leq 3.0$  for 1-g SAR and  $\leq 7.5$  for 10-g extremity SAR, where

- $f_{\text{GHz}}$  is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation<sup>25</sup>
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below
- If the test separation distance (antenna-user) is  $< 5$  mm, 5 mm is used for excluded SAR calculation

	Wireless Interface	Bluetooth
	Tune-up Maximum power (dBm)	3
	Tune-up Maximum rated power (mW)	1.995
Head	Antenna to user (mm)	5
	Frequency(GHz)	2.441
	SAR exclusion threshold	0.623
Body	Antenna to user (mm)	5
	Frequency(GHz)	2.441
	SAR exclusion threshold	0.623

Per KDB 447498 D01 exclusion thresholds is  $0.623 < 3$ , Bluetooth RF exposure evaluation is not required.

Mode	The Tune-up Maximum Power(Customer Declared)(dBm)	Range	Measured Conduct Maximum Power(dBm)
GSM 850	32+/-1	31~33	32.82
GPRS 850-1TS	32+/-1	31~33	32.79
GPRS 850-2TS	32+/-1	31~33	32.05
GPRS 850-3TS	30+/-1	29~31	30.39
GPRS 850-4TS	29+/-1	28~30	29.47
GSM 1900	29+/-1	28~30	29.52
GPRS 1900-1TS	29+/-1	28~30	29.51
GPRS 1900-2TS	28.5+/-1	27.5~29.5	28.94
GPRS 1900-3TS	27+/-1	26~28	27.31
GPRS 1900-4TS	26+/-1	25~27	26.21
WCDMA Band II	23+/-1	22~24	23.24
HSDPA Band II sub 1	22+/-1	21~23	22.25
HSDPA Band II sub 2	20+/-1	19~21	20.78
HSDPA Band II sub 3	19+/-1	18~20	19.55
HSDPA Band II sub 4	19+/-1	18~20	19.26
HSUPA Band II sub 1	20+/-1	19~21	20.79
HSUPA Band II sub 2	20+/-1	19~21	20.44
HSUPA Band II sub 3	19+/-1	18~20	19.53



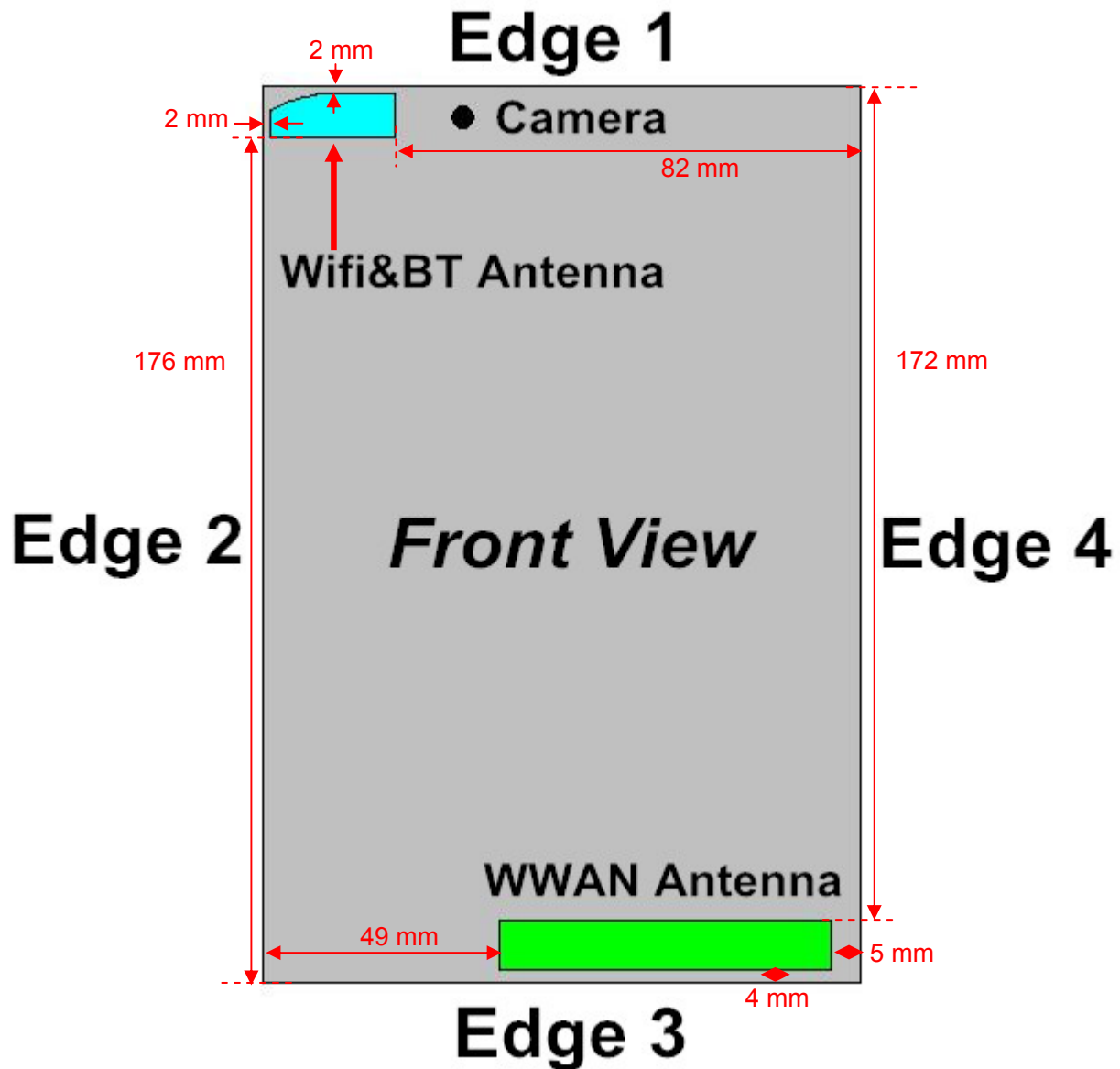
HSUPA Band II sub 4	19+/-1	18~20	19.65
HSUPA Band II sub 5	21+/-1	20~22	21.34
WCDMA Band V	22.5+/-1	21.5~23.5	22.98
HSDPA Band V sub 1	22+/-1	21~23	22.05
HSDPA Band V sub 2	20+/-1	19~21	20.59
HSDPA Band V sub 3	19+/-1	18~20	19.48
HSDPA Band V sub 4	19+/-1	18~20	19.12
HSUPA Band V sub 1	20+/-1	19~21	20.47
HSUPA Band V sub 2	20+/-1	19~21	20.53
HSUPA Band V sub 3	19+/-1	18~20	19.56
HSUPA Band V sub 4	19+/-1	18~20	19.66
HSUPA Band V sub 5	21+/-1	20~22	21.22
IEEE 802.11b	16+/-1	15~17	16.41
IEEE 802.11g	12.5+/-1	11.5~13.5	13.22
IEEE 802.11n(20M)	12.5+/-1	11.5~13.5	13.05
IEEE 802.11n(40M)	10+/-2	8~12	11.39
Bluetooth (1MHz)	2+/-1	1~3	2.86
Bluetooth (3MHz)	2+/-1	1~3	2.23
BLE 4.0 (1MHz)	-5+/-1	-6~-4	-4.67

So, they are in tune-up range and complied.



## 11.5 SAR TEST CONFIGURATIONS

### Body-Worn Accessory Exposure Conditions



Device dimensions (H x W): 188 x 108 x11 mm

Antennas	Wireless Interface
WWAN Antenna	GSM850/PCS1900 WCDMA Band V/Band II
Wifi&BT Antenna	WLAN 2.4GHz Bluetooth

#### Test Mode

GSM 850/PCS1900	Data transmission mode(GPRS)/Voice mode
WCDMA Band II WCDMA Band V	Data transmission mode(12.2k RMC)
WLAN 2.4GHz	Data transmission mode(802.11b)



## 11.6 BODY TEST EXCLUSION THRESHOLDS

The following SAR test exclusion Thresholds based on KDB 447498 D01 General RF Exposure Guidance v05r02) 4.3.1)

Exposure Position	Wireless Interface	WWAN				WLAN
		GPRS 850 Class 12	GPRS1900 Class12	WCDMA Band II	WCDMA Band V	802.11 b
	Maximum power	30	27	24	23.5	17
	Maximum rated power(mW)	1000.00	501.19	251.19	223.87	50.12
Front	Antenna to user (mm)	7				9
	SAR exclusion threshold	22.78	15.24	15.24	22.78	17.25
	SAR testing required?	Yes	Yes	Yes	Yes	Yes
Rear	Antenna to user (mm)	5				5
	SAR exclusion threshold	16.27	10.88	10.88	16.27	9.58
	SAR testing required?	Yes	Yes	Yes	Yes	Yes
Edge1	Antenna to user (mm)	172				5
	SAR exclusion threshold	855.33	1329.00	1329.00	855.33	9.58
	SAR testing required?	Yes	No	No	No	Yes
Edge2	Antenna to user (mm)	49				5
	SAR exclusion threshold	159.44	106.65	106.6	159.44	9.58
	SAR testing required?	Yes	Yes	Yes	Yes	Yes
Edge3	Antenna to user (mm)	5				176
	SAR exclusion threshold	16.27	10.88	10.88	16.27	1356.00
	SAR testing required?	Yes	Yes	Yes	Yes	No
Edge4	Antenna to user (mm)	5				82
	SAR exclusion threshold	16.27	10.88	10.88	16.27	416.00
	SAR testing required?	Yes	Yes	Yes	Yes	No

### Note:

- Maximum power is the source-based time-average power and represents the maximum RF output power among production units
- Per KDB 447498 D01v05r02, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user.
- Per KDB 447498 D01v05r02, standalone SAR test exclusion threshold is applied; If the distance of the antenna to the user is < 5mm, 5mm is used to determine SAR exclusion threshold
- Per KDB 447498 D01v05r02, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:  

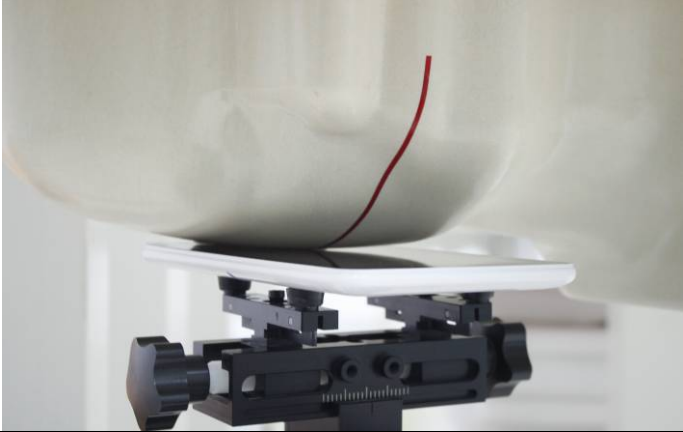
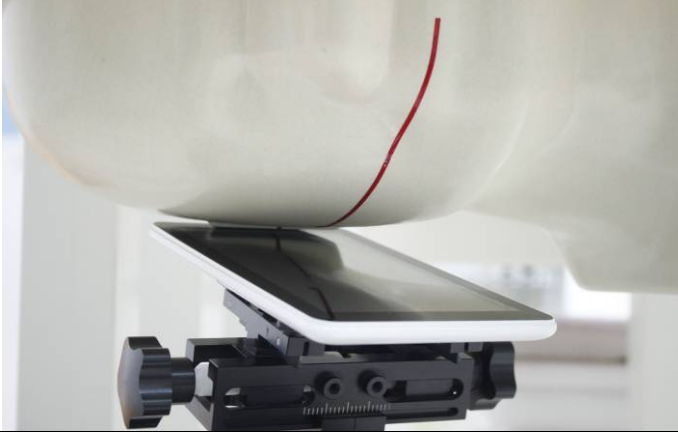

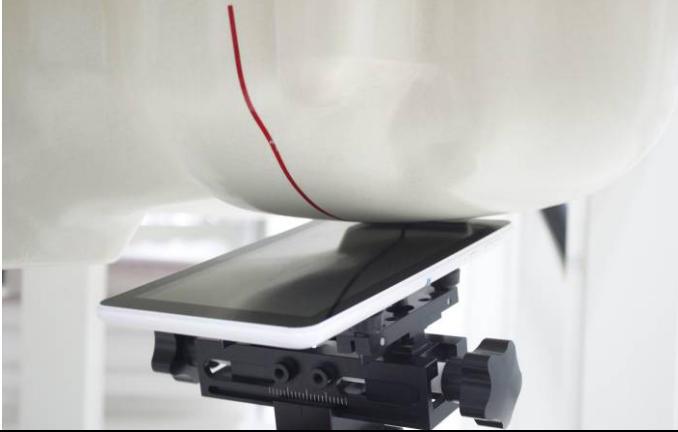
$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR}$$

$$f(\text{GHz}) \text{ is the RF channel transmit frequency in GHz}$$
 Power and distance are rounded to the nearest mW and mm before calculation  
 The result is rounded to one decimal place for comparison  
 For < 50 mm distance, we just calculate mW of the exclusion threshold value (3.0) to do compare.  
 This formula is  $[3.0] / [\sqrt{f(\text{GHz})}] \cdot [\text{min. test separation distance, mm}] = \text{exclusion threshold of mW.}$
- Per KDB 447498 D01v05r02, at 100 MHz to 6 GHz and for *test separation distances* > 50 mm, the SAR test exclusion threshold is determined according to the following  
 a) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm) · ( f(MHz)/150)] mW, at 100 MHz to 1500 MHz  
 b) [Threshold at 50 mm in step 1) + (test separation distance - 50 mm) · 10] mW at > 1500 MHz and ≤ 6 GHz
- When the minimum *test separation distance* is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.



## 11.7 EUT SETUP PHOTOS

### Head SAR Test Configuration

Cheek device with right head phantom.	Tilt device with right head phantom
	
<b><u>EUT Setup Configuration 1</u></b>	<b><u>EUT Setup Configuration 2</u></b>
Cheek device with left head phantom.	Tilt device with left head phantom
	
<b><u>EUT Setup Configuration 3</u></b>	<b><u>EUT Setup Configuration 4</u></b>



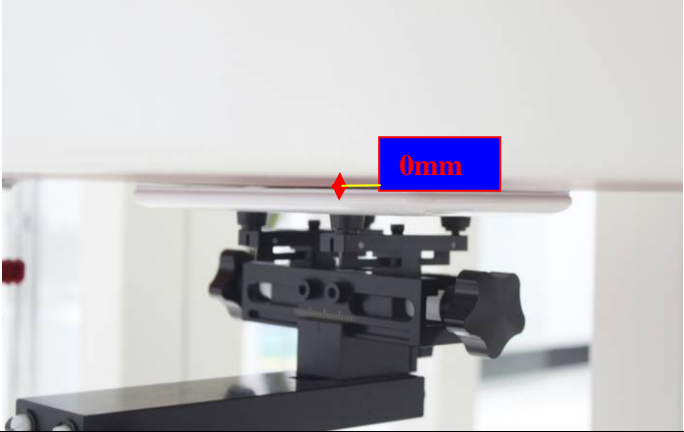
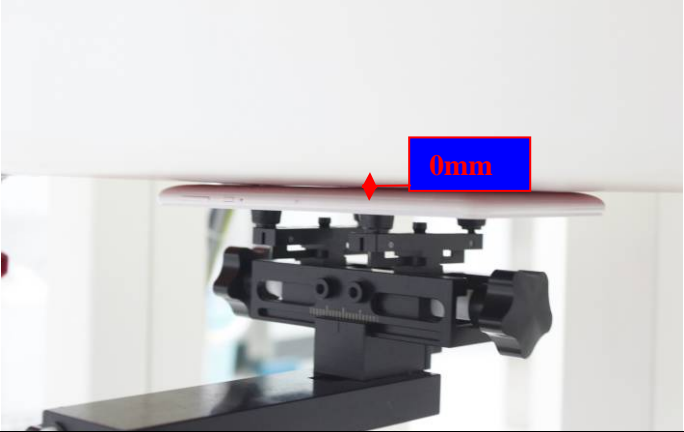

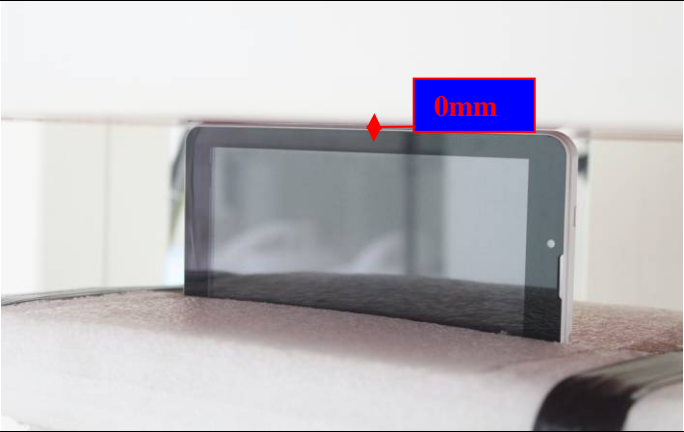

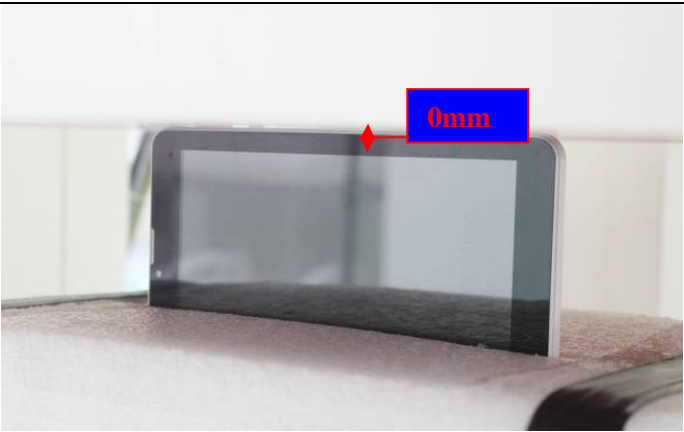
## 11.8 SAR MEASUREMENT RESULTS

### Head SAR Test Records

Band	Mode	Test Position	Ch.	Freq. (MHZ)	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	SAR1g (mW/g)	Scaled SAR1g (mW/g)
GSM850	Voice	Right Cheek	190	836.6	32.82	33	1.042	0.08	0.061	0.064
GSM850	Voice	Right Tilted	190	836.6	32.82	33	1.042	0.09	0.040	0.042
GSM850	Voice	Left Cheek	190	836.6	32.82	33	1.042	0.07	0.062	0.065
GSM850	Voice	Left Tilted	190	836.6	32.82	33	1.042	0.02	0.032	0.033
GSM1900	Voice	Right Cheek	810	1909.8	29.52	30	1.117	0.07	0.104	0.116
GSM1900	Voice	Right Tilted	810	1909.8	29.52	30	1.117	0.06	0.051	0.057
GSM1900	Voice	Left Cheek	810	1909.8	29.52	30	1.117	0.09	0.065	0.073
GSM1900	Voice	Left Tilted	810	1909.8	29.52	30	1.117	0.09	0.061	0.068
WCDMA II	RMC 12.2k	Right Cheek	9538	1907.6	23.24	24	1.191	0.01	0.130	0.155
WCDMA II	RMC 12.2k	Right Tilted	9538	1907.6	23.24	24	1.191	0.13	0.061	0.073
WCDMA II	RMC 12.2k	Left Cheek	9538	1907.6	23.24	24	1.191	0.14	0.096	0.114
WCDMA II	RMC 12.2k	Left Tilted	9538	1907.6	23.24	24	1.191	0.05	0.068	0.081
WCDMA V	RMC 12.2k	Right Cheek	4182	836.4	22.98	23.5	1.127	-0.08	0.035	0.039
WCDMA V	RMC 12.2k	Right Tilted	4182	836.4	22.98	23.5	1.127	-0.12	0.022	0.025
WCDMA V	RMC 12.2k	Left Cheek	4182	836.4	22.98	23.5	1.127	0.11	0.037	0.042
WCDMA V	RMC 12.2k	Left Tilted	4182	836.4	22.98	23.5	1.127	0.15	0.022	0.025
WLAN 2.4G	802.11 b	Right Cheek	11	2462	16.41	17	1.146	0.08	0.303	0.347
WLAN 2.4G	802.11 b	Right Tilted	11	2462	16.41	17	1.146	0.07	0.232	0.266
WLAN 2.4G	802.11 b	Left Cheek	11	2462	16.41	17	1.146	0.05	0.122	0.140
WLAN 2.4G	802.11 b	Left Tilted	11	2462	16.41	17	1.146	-0.14	0.102	0.117



## Body SAR Test Configuration

Front in body position	Rear in body position
	
<u>EUT Setup Configuration 1</u>	<u>EUT Setup Configuration 2</u>
Edge1 in body position	Edge2 in body position
	
<u>EUT Setup Configuration 3</u>	<u>EUT Setup Configuration 4</u>
Edge3 in body position	Edge4 in body position
	
<u>EUT Setup Configuration 5</u>	<u>EUT Setup Configuration 6</u>



## SAR Results for Body-Worn Test Records

Band	Mode	Test Position	Dist. (mm)	Ch.	Freq. (MHZ)	max Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	SAR1g (mW/g)	Scaled SAR1g (mW/g)
GSM850	GPRS 4slots	Front	0	190	836.6	29.47	30	1.130	0.07	0.136	0.154
GSM850	GPRS 4slots	Rear	0	190	836.6	29.47	30	1.130	-0.11	0.202	0.228
GSM850	GPRS 4slots	Edge 1	0	190	836.6	29.47	30	1.130	-0.10	0.00201	0.002
GSM850	GPRS 4slots	Edge 2	0	190	836.6	29.47	30	1.130	0.13	0.099	0.112
GSM850	GPRS 4slots	Edge 3	0	190	836.6	29.47	30	1.130	0.02	0.072	0.081
GSM850	GPRS 4slots	Edge 4	0	190	836.6	29.47	30	1.130	-0.12	0.053	0.060
GSM1900	GPRS 4slots	Front	0	810	1909.8	26.21	27	1.199	0.06	0.115	0.138
GSM1900	GPRS 4slots	Rear	0	810	1909.8	26.21	27	1.199	0.00	0.372	0.446
GSM1900	GPRS 4slots	Edge 2	0	810	1909.8	26.21	27	1.199	-0.13	0.078	0.094
GSM1900	GPRS 4slots	Edge 3	0	810	1909.8	26.21	27	1.199	0.05	0.111	0.133
GSM1900	GPRS 4slots	Edge 4	0	810	1909.8	26.21	27	1.199	-0.08	0.073	0.088
WCDMA II	RMC 12.2k	Front	0	9538	1907.6	23.24	24	1.191	0.04	0.141	0.168
WCDMA II	RMC 12.2k	Rear	0	9538	1907.6	23.24	24	1.191	0.00	0.382	0.455
WCDMA II	RMC 12.2k	Edge 2	0	9538	1907.6	23.24	24	1.191	0.06	0.150	0.179
WCDMA II	RMC 12.2k	Edge 3	0	9538	1907.6	23.24	24	1.191	0.11	0.111	0.132
WCDMA II	RMC 12.2k	Edge 4	0	9538	1907.6	23.24	24	1.191	0.08	0.073	0.087
WCDMA V	RMC 12.2k	Front	0	4182	836.4	22.98	23.5	1.127	0.06	0.055	0.062
WCDMA V	RMC 12.2k	Rear	0	4182	836.4	22.98	23.5	1.127	0.07	0.077	0.087
WCDMA V	RMC 12.2k	Edge 2	0	4182	836.4	22.98	23.5	1.127	-0.01	0.047	0.053
WCDMA V	RMC 12.2k	Edge 3	0	4182	836.4	22.98	23.5	1.127	0.08	0.027	0.030
WCDMA V	RMC 12.2k	Edge 4	0	4182	836.4	22.98	23.5	1.127	0.06	0.020	0.023
WLAN 2.4G	802.11 b	Front	0	11	2462	16.41	17	1.146	0.09	0.276	0.316
WLAN 2.4G	802.11 b	Rear	0	11	2462	16.41	17	1.146	-0.09	0.607	0.695
WLAN 2.4G	802.11 b	Edge 1	0	11	2462	16.41	17	1.146	-0.11	0.212	0.243
WLAN 2.4G	802.11 b	Edge 2	0	11	2462	16.41	17	1.146	-0.01	0.249	0.285



## 11.9 REPEATED SAR MEASUREMENT

Band	Mode	Test Position	Dist. (mm)	Ch.	Original Measured SAR1g (mW/g)	1st Repeated SAR1g (mW/g)	Ratio	Original Measured SAR1g (mW/g)	2nd Repeated SAR1g (mW/g)	Ratio
--	--	--	--	--	--	--	--	--	--	--

### Note:

1. Per KDB 865664 D01v01,for each frequency band, repeated SAR measurement is required only when the measured SAR is  $\geq 0.8\text{W/Kg}$
2. Per KDB 865664 D01v01,if the ratio of largest to smallest SAR for the original and first repeated measurement is  $\leq 1.2$  and the measured SAR  $< 1.45\text{W/Kg}$ ,only one repeated measurement is required.
3. Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is  $> 1.20$  or when the original or repeated measurement is  $\geq 1.45\text{ W/kg}$
4. The ratio is the difference in percentage between original and repeated measured SAR.



## 11.10 SAR HANDSETS MULTI XMITER ASSESSMENT

	Position	Applicable Combination
Simultaneous Transmission	Head	WWAN (voice) + WLAN
		WWAN (voice) + BT
	Body-worn	WWAN (data) + WLAN
		WWAN (data) + BT

**Note:**

- 2.4GHz WLAN and BT share the same antenna, and cannot transmit simultaneously.
- The reported SAR summation is calculated based on the same configuration and test position.
- For simultaneous transmission analysis, Bluetooth SAR is estimated per KDB 447498 D01v05 based on the formula below.  
(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] • [ √ f(GHz)/x] W/kg  
for test separation distances ≤ 50 mm; where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.  
0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm.

**Bluetooth:**

	Max power	Head (5mm distance)	Body (5mm distance)
Estimated SAR (W/kg)	3 dBm	0.083 W/kg	0.083 W/kg

- Per KDB 447498 D01v05, simultaneous transmission SAR is compliant if,
  - Scalar SAR summation < 1.6W/kg.
  - $SPLSR = (SAR1 + SAR2)1.5 / (\text{min. separation distance, mm})$ , and the peak separation distance is determined from the square root of  $[(x1-x2)^2 + (y1-y2)^2 + (z1-z2)^2]$ , where (x1, y1, z1) and (x2, y2, z2) are the coordinates of the extrapolated peak SAR locations in the zoom scan  
If  $SPLSR \leq 0.04$ , simultaneously transmission SAR is compliant
  - Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg



## Result of SUM $\Sigma$ SAR1g of Head

SUM $\Sigma$ SAR1g (GSM850+WLAN(2.4G) or Bluetooth)						
Position	Distance	Stand alone SAR(1g) [W/kg]			SUM SAR(1g)[W/kg]	SUM SAR(1g)[W/kg]
	[mm]	GSM850	WLAN 2.4G	Bluetooth	WWAN + WLAN(2.4G)	WWAN + Bluetooth
Right Cheek	0	0.064	0.347	0.083	0.411	0.147
Right Tilted	0	0.042	0.266	0.083	0.308	0.125
Left Cheek	0	0.065	0.140	0.083	0.205	0.148
Left Tilted	0	0.033	0.117	0.083	0.150	0.116

SUM $\Sigma$ SAR1g (PCS1900+WLAN(2.4G) or Bluetooth)						
Position	Distance	Stand alone SAR(1g) [W/kg]			SUM SAR(1g)[W/kg]	SUM SAR(1g)[W/kg]
	[mm]	PCS 1900	WLAN 2.4G	Bluetooth	WWAN + WLAN(2.4G)	WWAN + Bluetooth
Right Cheek	0	0.116	0.347	0.083	0.463	0.199
Right Tilted	0	0.057	0.266	0.083	0.323	0.140
Left Cheek	0	0.073	0.140	0.083	0.213	0.156
Left Tilted	0	0.068	0.117	0.083	0.185	0.151

SUM $\Sigma$ SAR1g (WCDMA Band II+WLAN(2.4G) or Bluetooth)						
Position	Distance	Stand alone SAR(1g) [W/kg]			SUM SAR(1g)[W/kg]	SUM SAR(1g)[W/kg]
	[mm]	WCDMA II	WLAN 2.4G	Bluetooth	WWAN + WLAN(2.4G)	WWAN + Bluetooth
Right Cheek	0	0.155	0.347	0.083	0.502	0.238
Right Tilted	0	0.073	0.266	0.083	0.339	0.156
Left Cheek	0	0.114	0.140	0.083	0.254	0.197
Left Tilted	0	0.081	0.117	0.083	0.198	0.164

SUM $\Sigma$ SAR1g (WCDMA Band V+WLAN(2.4G) or Bluetooth)						
Position	Distance	Stand alone SAR(1g) [W/kg]			SUM SAR(1g)[W/kg]	SUM SAR(1g)[W/kg]
	[mm]	WCDMA V	WLAN 2.4G	Bluetooth	WWAN + WLAN(2.4G)	WWAN + Bluetooth
Right Cheek	0	0.039	0.347	0.083	0.386	0.122
Right Tilted	0	0.025	0.266	0.083	0.291	0.108
Left Cheek	0	0.042	0.140	0.083	0.182	0.125
Left Tilted	0	0.025	0.117	0.083	0.142	0.108

**Result of SUM  $\Sigma$ SAR1g for Body worn**

SUM $\Sigma$ SAR1g (GSM850+WLAN(2.4G) or Bluetooth)						
Position	Distance	Stand alone SAR(1g) [W/kg]			SUM SAR(1g)[W/kg]	SUM SAR(1g)[W/kg]
	[mm]	GPRS850	WLAN 2.4G	Bluetooth	WWAN + WLAN(2.4G)	WWAN + Bluetooth
Front	0	0.154	0.316	0.083	0.470	0.237
Rear	0	0.228	0.695	0.083	0.923	0.311
Edge1	0	0.002	0.243	0.083	0.245	0.085
Edge2	0	0.112	0.285	0.083	0.397	0.195
Edge3	0	0.081	--	0.083	--	0.164
Edge4	0	0.060	--	0.083	--	0.143

SUM $\Sigma$ SAR1g (PCS1900+WLAN(2.4G) or Bluetooth)						
Position	Distance	Stand alone SAR(1g) [W/kg]			SUM SAR(1g)[W/kg]	SUM SAR(1g)[W/kg]
	[mm]	GPRS 1900	WLAN 2.4G	Bluetooth	WWAN + WLAN(2.4G)	WWAN + Bluetooth
Front	0	0.138	0.316	0.083	0.454	0.221
Rear	0	0.446	0.695	0.083	1.141	0.529
Edge1	0	--	0.243	0.083	--	--
Edge2	0	0.094	0.285	0.083	0.379	0.177
Edge3	0	0.133	--	0.083	--	0.216
Edge4	0	0.088	--	0.083	--	0.171



SUM $\Sigma$ SAR1g (WCDMA Band II+WLAN(2.4G) or Bluetooth)						
Position	Distance	Stand alone SAR(1g) [W/kg]			SUM SAR(1g)[W/kg]	SUM SAR(1g)[W/kg]
	[mm]	WCDMA II	WLAN 2.4G	Bluetooth	WWAN + WLAN(2.4G)	WWAN + Bluetooth
Front	0	0.168	0.316	0.083	0.484	0.251
Rear	0	0.455	0.695	0.083	1.150	0.538
Edge1	0	--	0.243	0.083	--	--
Edge2	0	0.179	0.285	0.083	0.464	0.262
Edge3	0	0.132	--	0.083	--	0.215
Edge4	0	0.087	--	0.083	--	0.170

SUM $\Sigma$ SAR1g (WCDMA Band V+WLAN(2.4G) or Bluetooth)						
Position	Distance	Stand alone SAR(1g) [W/kg]			SUM SAR(1g)[W/kg]	SUM SAR(1g)[W/kg]
	[mm]	WCDMA V	WLAN 2.4G	Bluetooth	WWAN + WLAN(2.4G)	WWAN + Bluetooth
Front	0	0.062	0.316	0.083	0.378	0.145
Rear	0	0.087	0.695	0.083	0.782	0.170
Edge1	0	--	0.243	0.083	--	--
Edge2	0	0.053	0.285	0.083	0.338	0.136
Edge3	0	0.030	--	0.083	--	0.113
Edge4	0	0.023	--	0.083	--	0.106



## 12. EUT PHOTO









**13. EQUIPMENT LIST & CALIBRATION STATUS**

Name of Equipment	Manufacturer	Type/Model	Serial Number	Last Calibration	Calibration Due
P C	HP	Core(rm)3.16G	CZCO48171H	N/A	N/A
Signal Generator	Agilent	83732B	US37101915	05/30/2014	05/29/2015
S-Parameter Network Analyzer	Agilent	E5071B	MY42301382	03/17/2014	03/16/2015
Wireless Communication Test Set	R&S	CMU200	SN:109525	01/24/2014	01/23/2015
Power Meter	Agilent	E4416A	GB41292714	03/18/2014	03/17/2015
Peak & Average sensor	Agilent	E9327A	us40441788	03/18/2014	03/17/2015
E-field PROBE	SPEAG	EX3DV4	3798	07/28/2014	07/27/2015
DAE	SPEAG	DEA4	1245	07/22/2014	07/23/2015
DIPOLE 835MHZ ANTENNA	SPEAG	D835V2	4d114	07/30/2013	07/28/2015
DIPOLE 1900MHZ ANTENNA	SPEAG	D1900V2	5d136	07/22/2013	07/20/2015
DIPOLE 2450MHZ ANTENNA	SPEAG	D2450V2	817	07/31/2013	07/29/2015
DUMMY PROBE	SPEAG	DP_2	SPDP2001AA	N/A	N/A
SAM PHANTOM (ELI4 v4.0)	SPEAG	QDOVA001BB	1102	N/A	N/A
Twin SAM Phantom	SPEAG	QD000P40CD	1609	N/A	N/A
ROBOT	SPEAG	TX60	F10/5E6AA1/A101	N/A	N/A
ROBOT KRC	SPEAG	CS8C	F10/5E6AA1/C101	N/A	N/A
LIQUID CALIBRATION KIT	ANTENNESSA	41/05 OCP9	00425167	N/A	N/A



## 14. FACILITIES

All measurement facilities used to collect the measurement data are located at

☒ No.10, Weiye Rd., Innovation Park, Eco & Tec. Development Part, Kunshan City, Jiangsu Province, China.

## 15. REFERENCES

- [1] Federal Communications Commission, \Report and order: Guidelines for evaluating the environ-mental effects of radiofrequency radiation", Tech. Rep. FCC 96-326, FCC, Washington, D.C. 20554, 1996.
- [2] David L. Means Kwok Chan, Robert F. Cleveland, \Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields", Tech. Rep., Federal Communication Commision, O\_ce of Engineering & Technology, Washington, DC, 1997.
- [3] Thomas Schmid, Oliver Egger, and Niels Kuster, \Automated E-\_eld scanning system for dosimetric assessments", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp. 105{113, Jan. 1996.
- [4] Niels Kuster, Ralph K.astle, and Thomas Schmid, \Dosimetric evaluation of mobile communications equipment with known precision", IEICE Transactions on Communications, vol. E80-B, no. 5, pp. 645{652, May 1997.
- [5] CENELEC, \Considerations for evaluating of human exposure to electromagnetic fields (EMFs) from mobile telecommunication equipment (MTE) in the frequency range 30MHz – 6GHz", Tech. Rep., CENELEC, European Committee for Electrotechnical Standardization, Brussels, 1997.
- [6] ANSI, ANSI/IEEE C95.1-1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.
- [7] Katja Pokovic, Thomas Schmid, and Niels Kuster, \Robust setup for precise calibration of E-\_eld probes in tissue simulating liquids at mobile communications frequencies", in ICECOM \_ 97, Dubrovnik, October 15{17, 1997, pp. 120{124.
- [8] Katja Pokovic, Thomas Schmid, and Niels Kuster, \E-\_eld probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23{25 June, 1996, pp. 172{175.
- [9] Volker Hombach, Klaus Meier, Michael Burkhardt, Eberhard K. uhn, and Niels Kuster, \The dependence of EM energy absorption upon human head modeling at 900 MHz", IEEE Transactions onMicrowave Theory and Techniques, vol. 44, no. 10, pp. 1865{1873, Oct. 1996.
- [10] Klaus Meier, Ralf Kastle, Volker Hombach, Roger Tay, and Niels Kuster, \The dependence of EM energy absorption upon human head modeling at 1800 MHz", IEEE Transactions on Microwave Theory and Techniques, Oct. 1997, in press.
- [11] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.
- [12] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, Numerical Recepies in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992..Dosimetric Evaluation of Sample device, month 1998 9
- [13] NIS81 NAMAS, \The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.
- [14] Barry N. Taylor and Christ E. Kuyatt, \Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994. Dosimetric Evaluation of Sample device, month 1998 10



## 16. ATTACHMENTS

Exhibit	Content
1	System Performance Check Plots
2	Dipole calibration report D835V2 SN:4d114
3	Dipole calibration report D1900V2-SN:5d136
4	Dipole calibration report D2450V2 SN: 817
5	Probe calibration report EX3DV4 SN3798
6	DAE calibration report DEA4 SD000D04BM SN:1245
7	SAR Test Plots



## **APPENDIX A: PLOTS OF PERFORMANCE CHECK**

The plots are showing as followings.



Test Laboratory: Compliance Certification Services Inc.

Date: 12/25/2014

**System Performance Check-Head D835****DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: 4d114**

Communication System: UID 0, CW; Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.916$  S/m;  $\epsilon_r = 40.912$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(9.3, 9.3, 9.3); Calibrated: 7/28/2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/22/2014
- Phantom: Twin SAM Phantom; Type: QD 000 P40 CD; Serial: 1609
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

**System Performance Check at Frequencies Low 1 GHz/Pin=250 mW, dist=15 mm (EX-Probe)/Area Scan (7x12x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 2.93 W/kg

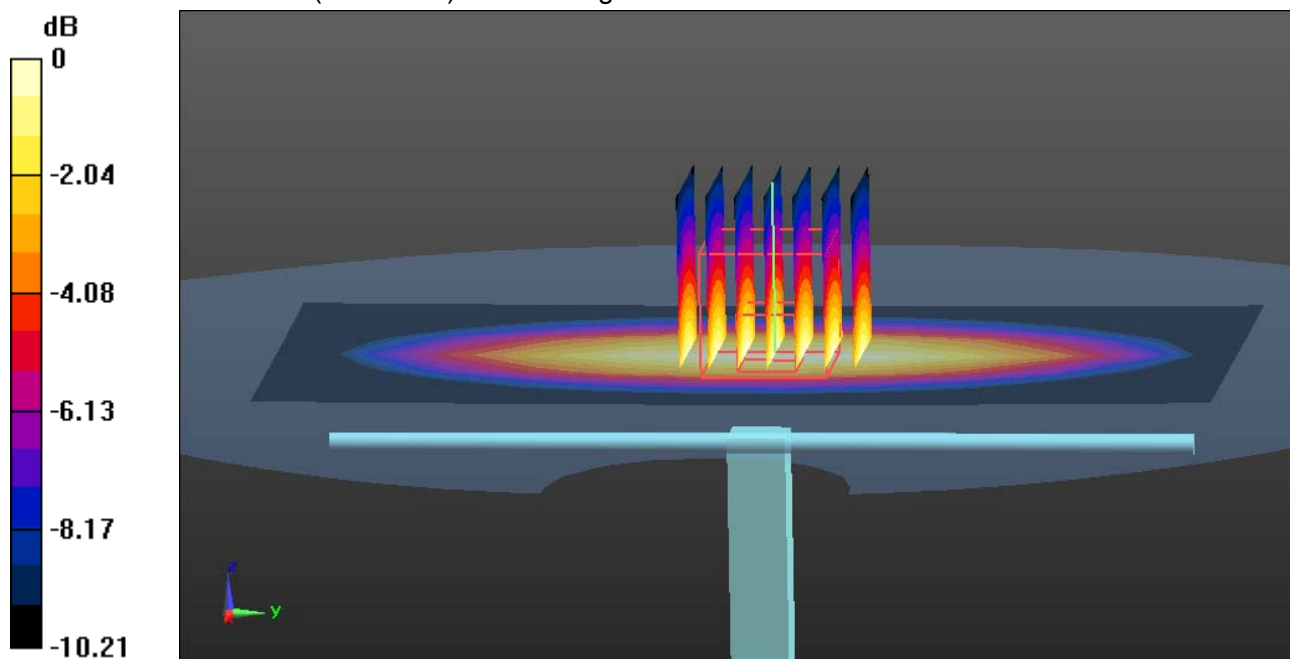
**System Performance Check at Frequencies Low 1 GHz/Pin=250 mW, dist=15 mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.55 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 3.53 W/kg

**SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.59 W/kg**

Maximum value of SAR (measured) = 3.02 W/kg



0 dB = 3.02 W/kg = 4.67 dBW/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 12/24/2014

**System Performance Check-Body D835****DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: 4d114**

Communication System: UID 0, CW; Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.961$  S/m;  $\epsilon_r = 56.271$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(9.22, 9.22, 9.22); Calibrated: 7/28/2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/22/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1102
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

**System Performance Check at Frequencies Low 1 GHz/dist=15mm, Pin=250 mW(EX-Probe)/Area****Scan (7x12x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 3.30 W/kg

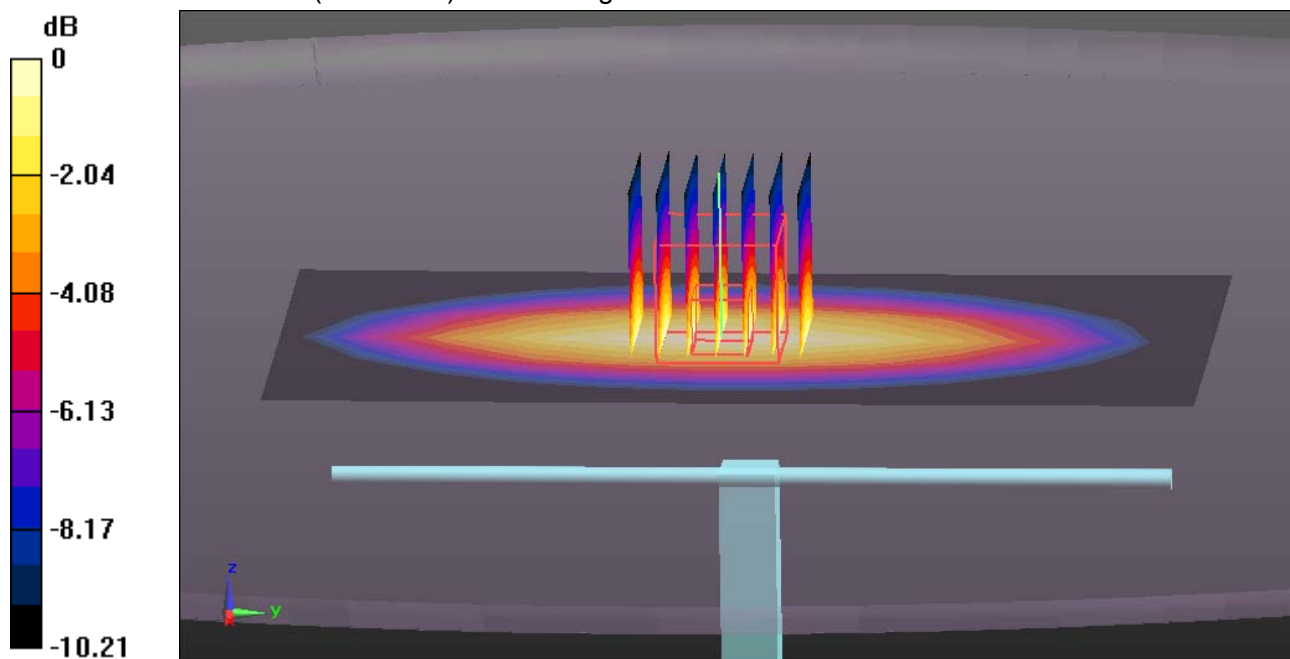
**System Performance Check at Frequencies Low 1 GHz/dist=15mm, Pin=250 mW(EX-****Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 60.69 V/m; Power Drift = -0.10 dB

Peak SAR (extrapolated) = 3.87 W/kg

**SAR(1 g) = 2.52 W/kg; SAR(10 g) = 1.72 W/kg**

Maximum value of SAR (measured) = 3.30 W/kg



0 dB = 3.30 W/kg = 5.19 dBW/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 12/25/2014

**System Performance Check-Head D1900****DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: 5d136**

Communication System: UID 0, CW; Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.426$  S/m;  $\epsilon_r = 41.352$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(7.75, 7.75, 7.75); Calibrated: 7/28/2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/22/2014
- Phantom: Twin SAM Phantom; Type: QD 000 P40 CD; Serial: 1609
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

**System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Area Scan (7x8x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 14.5 W/kg

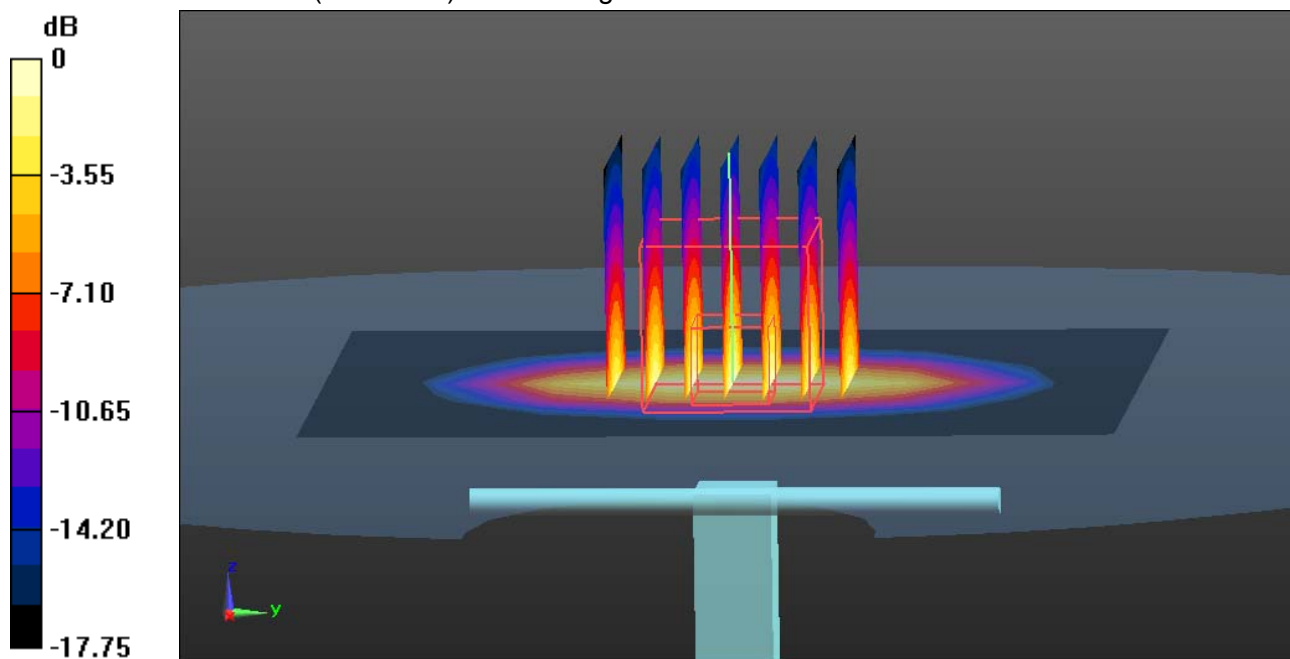
**System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 107.4 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 20.1 W/kg

**SAR(1 g) = 10.9 W/kg; SAR(10 g) = 5.62 W/kg**

Maximum value of SAR (measured) = 15.7 W/kg



0 dB = 15.7 W/kg = 11.96 dBW/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 12/24/2014

**System Performance Check-Body D1900****DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: 5d136**

Communication System: UID 0, CW; Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.572$  S/m;  $\epsilon_r = 53.612$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

**DASY Configuration:**

- Probe: EX3DV4 - SN3798; ConvF(7.09, 7.09, 7.09); Calibrated: 7/28/2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/22/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1102
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

**System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Area Scan (7x8x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 14.1 W/kg

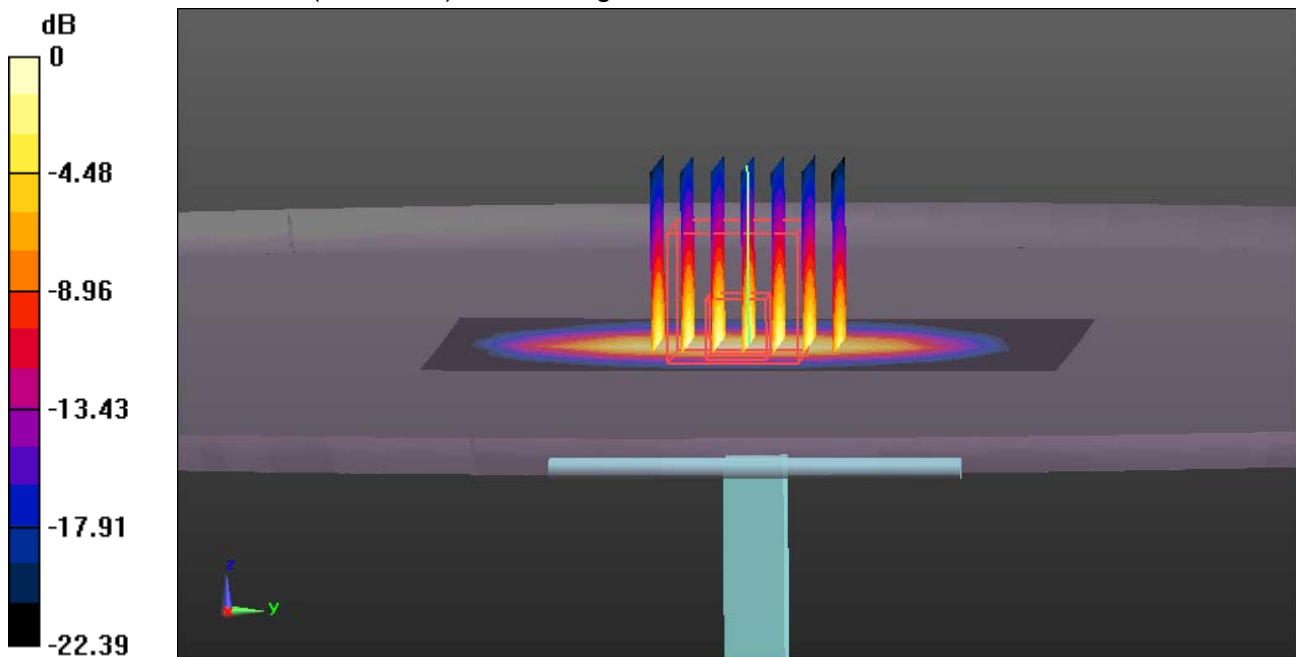
**System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.29 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 20.8 W/kg

**SAR(1 g) = 9.76 W/kg; SAR(10 g) = 4.6 W/kg**

Maximum value of SAR (measured) = 14.9 W/kg



0 dB = 14.9 W/kg = 11.73 dBW/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 12/26/2014

**System Performance Check-Head D2450****DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: 817**

Communication System: UID 0, CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.831$  S/m;  $\epsilon_r = 38.836$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

**DASY Configuration:**

- Probe: EX3DV4 - SN3798; ConvF(7.04, 7.04, 7.04); Calibrated: 7/28/2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/22/2014
- Phantom: Twin SAM Phantom; Type: QD 000 P40 CD; Serial: 1609
- DASY52 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

**System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Area Scan (9x10x1):** Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 17.9 W/kg

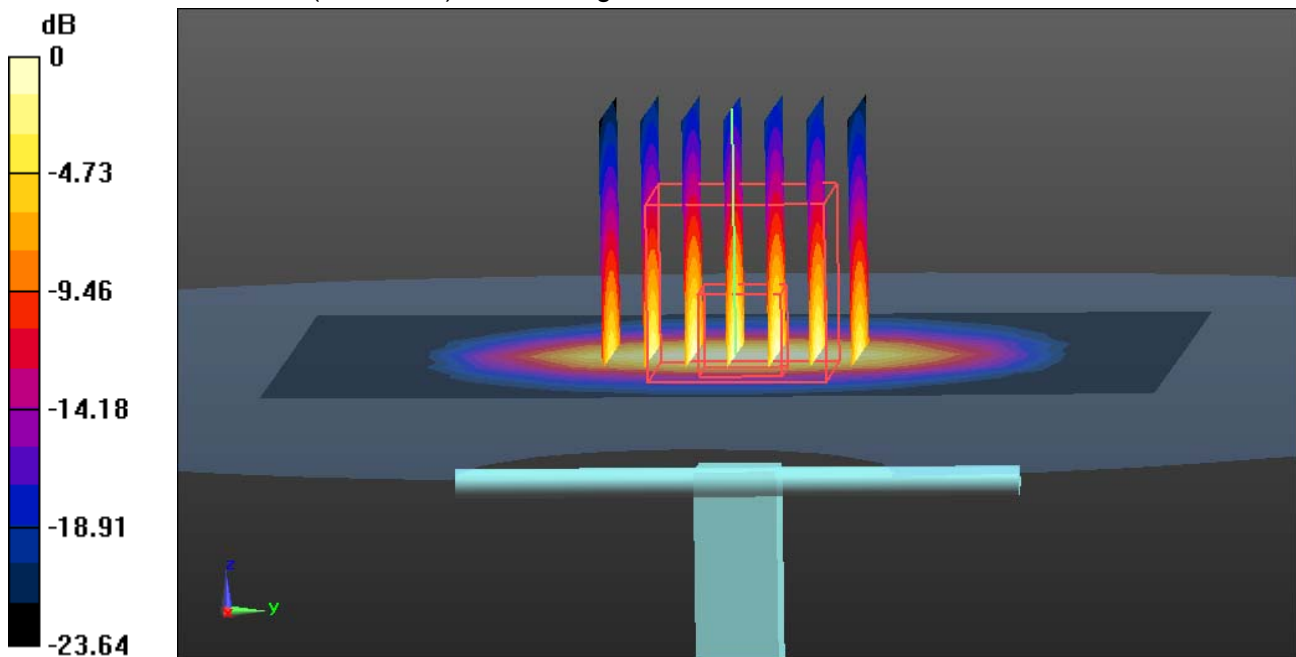
**System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.3 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 26.8 W/kg

**SAR(1 g) = 12.46 W/kg; SAR(10 g) = 5.57 W/kg**

Maximum value of SAR (measured) = 17.9 W/kg



0 dB = 17.9 W/kg = 12.53 dBW/kg



Test Laboratory: Compliance Certification Services Inc.

Date: 12/26/2014

**System Performance Check-Body D2450****DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: 817**

Communication System: UID 0, CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.908$  S/m;  $\epsilon_r = 51.319$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Room Ambient Temperature: 22°C; Liquid Temperature: 21.5°C

Phantom section: Flat Section

Measurement Standard: DASYS (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3798; ConvF(6.82, 6.82, 6.82); Calibrated: 7/28/2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 7/22/2014
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1102
- DASYS 52.8.8(1222);
- SEMCAD X Version 14.6.10 (7331)

**System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Area Scan (9x10x1):** Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 17.4 W/kg

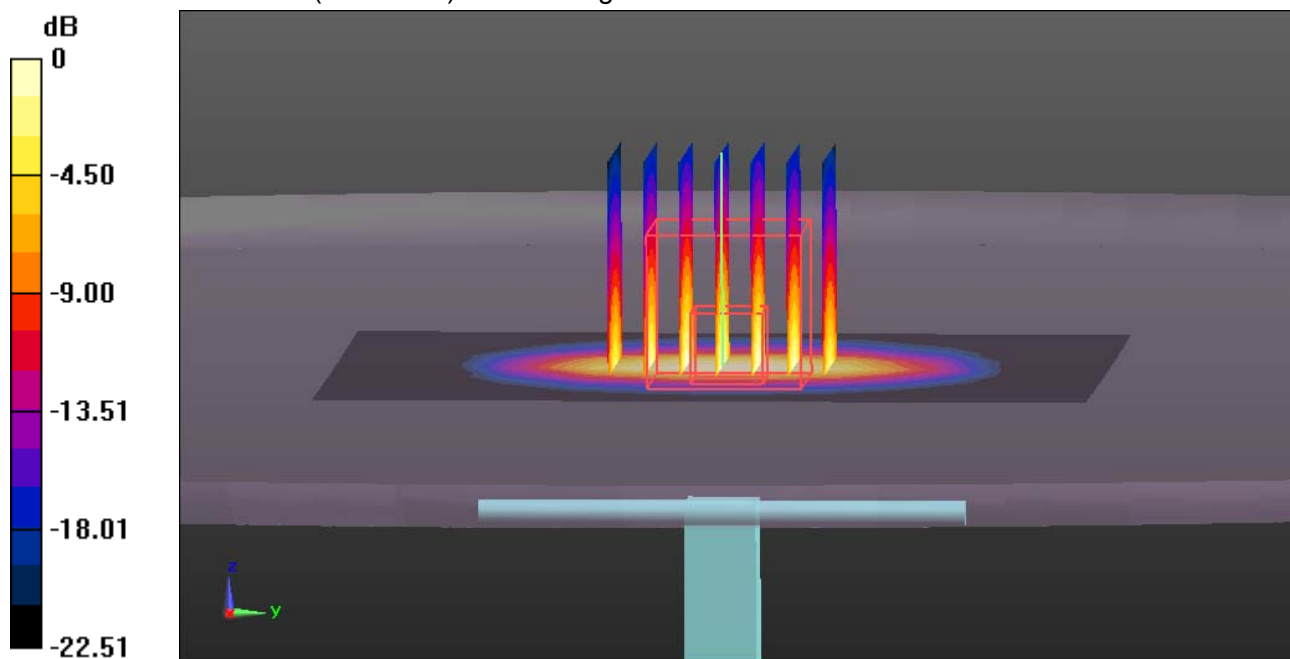
**System Performance Check at Frequencies above 1 GHz/Pin=250 mW, dist=10mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 100.2 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 27.1 W/kg

**SAR(1 g) = 12.9 W/kg; SAR(10 g) = 5.9 W/kg**

Maximum value of SAR (measured) = 17.4 W/kg



0 dB = 17.4 W/kg = 12.41 dBW/kg



## **APPENDIX B: DASY CALIBRATION CERTIFICATE**

**The DASY Calibration Certificates are showing as followings .**



**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  
**S** Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)  
The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**Client **CCS-CN (Auden)**Certificate No: **D835V2-4d114\_Jul13**

## CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d114**

Calibration procedure(s) **QA CAL-05.v9**  
**Calibration procedure for dipole validation kits above 700 MHz**

Calibration date: **July 30, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

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

Issued: July 30, 2013

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



**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  
**S** Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)  
The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

## 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:

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

- DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

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



## Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz $\pm$ 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 $\pm$ 0.2) °C	41.8 $\pm$ 6 %	0.92 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.41 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.50 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.58 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	6.24 W/kg $\pm$ 16.5 % (k=2)

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	54.9 $\pm$ 6 %	1.00 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	---	---

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.44 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.53 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.61 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	6.32 W/kg $\pm$ 16.5 % (k=2)



## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.1 $\Omega$ - 1.3 j $\Omega$
Return Loss	- 32.1 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.2 $\Omega$ - 3.0 j $\Omega$
Return Loss	- 29.1 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.399 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. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

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

### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	June 29, 2010



## DASY5 Validation Report for Head TSL

Date: 30.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d114**

Communication System: UID 0 - CW ; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.92$  S/m;  $\epsilon_r = 41.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

### DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.05, 6.05, 6.05); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

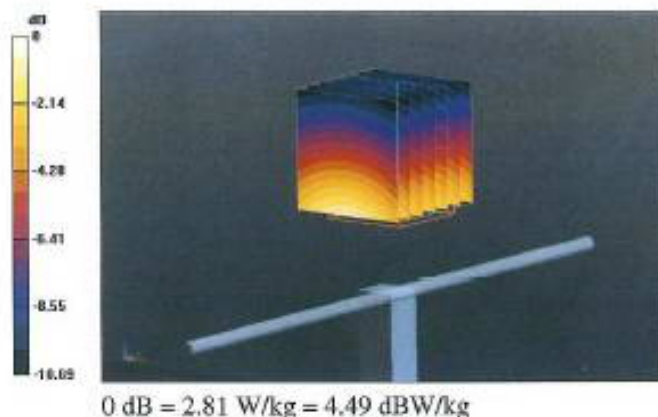
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.702 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 3.60 W/kg

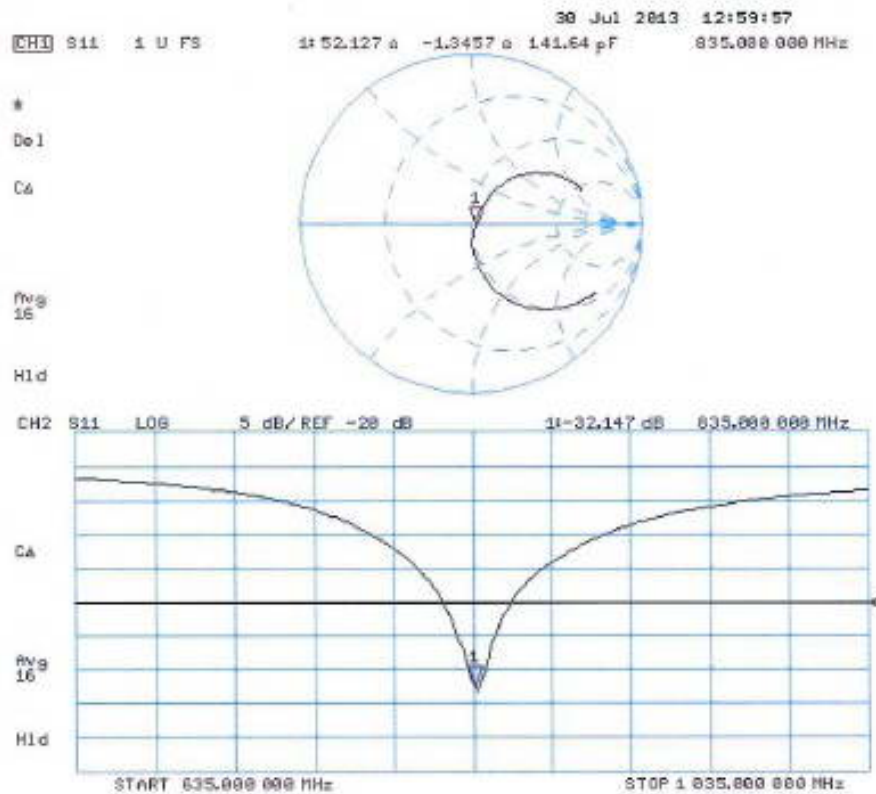
**SAR(1 g) = 2.41 W/kg; SAR(10 g) = 1.58 W/kg**

Maximum value of SAR (measured) = 2.81 W/kg





## Impedance Measurement Plot for Head TSL





## DASY5 Validation Report for Body TSL

Date: 22.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d114**

Communication System: UID 0 - CW ; Frequency: 835 MHz

Medium parameters used:  $f = 835$  MHz;  $\sigma = 1$  S/m;  $\epsilon_r = 54.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

### DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.04, 6.04, 6.04); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

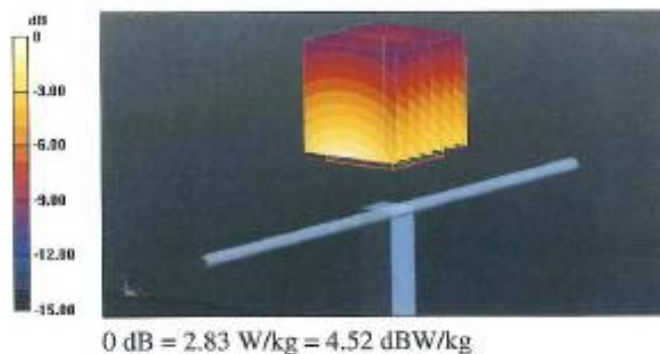
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 54.853 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 3.56 W/kg

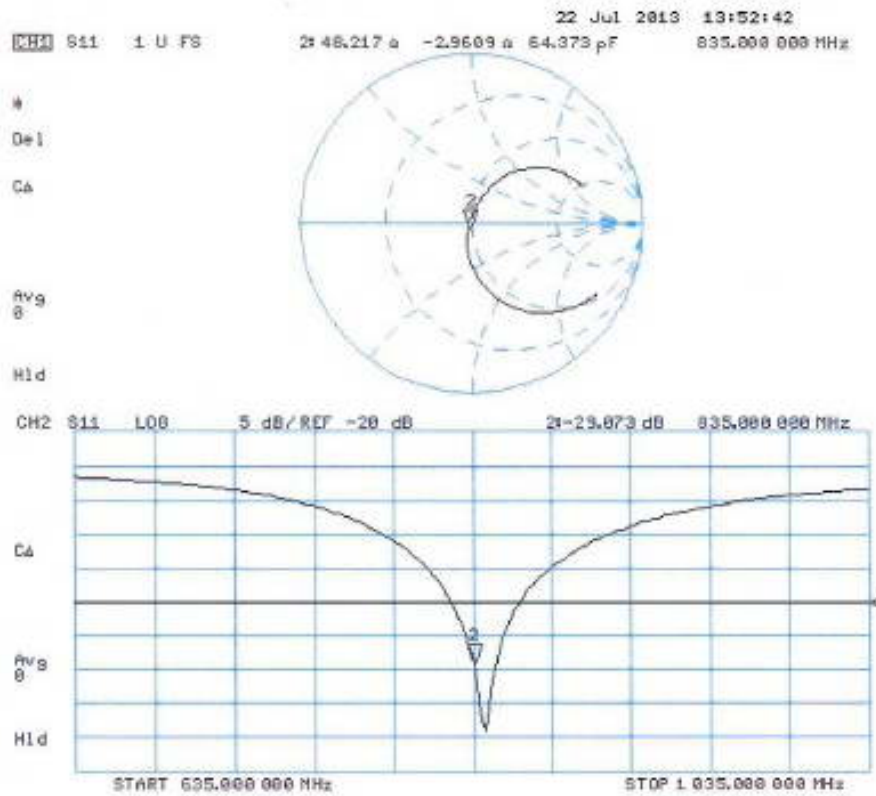
**SAR(1 g) = 2.44 W/kg; SAR(10 g) = 1.61 W/kg**

Maximum value of SAR (measured) = 2.83 W/kg





## Impedance Measurement Plot for Body TSL





## D835V2, Serial No.4d114 Extended Dipole Calibrations

Per IEEE Std 1528-2003, the dipole should have a return loss better than -20dB at the test frequency to reduce uncertainty in the power measurement

Per KDB 865664 D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

### Justification of the extended calibration

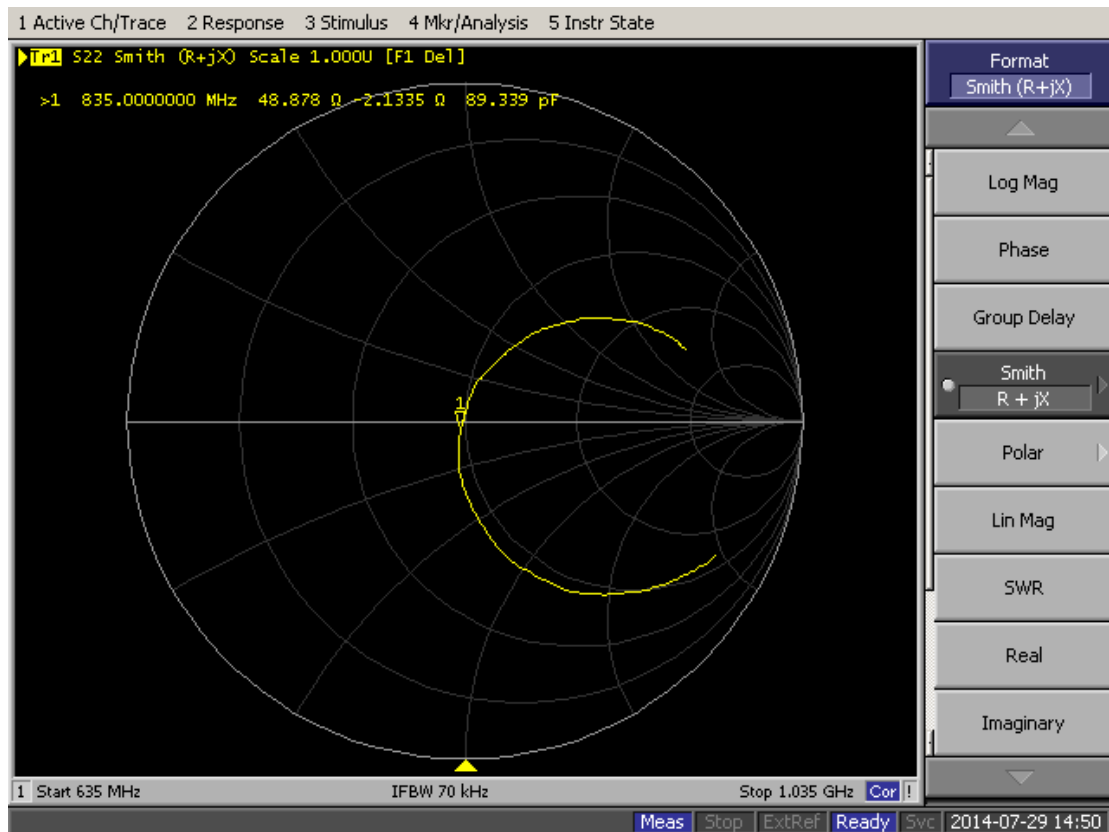
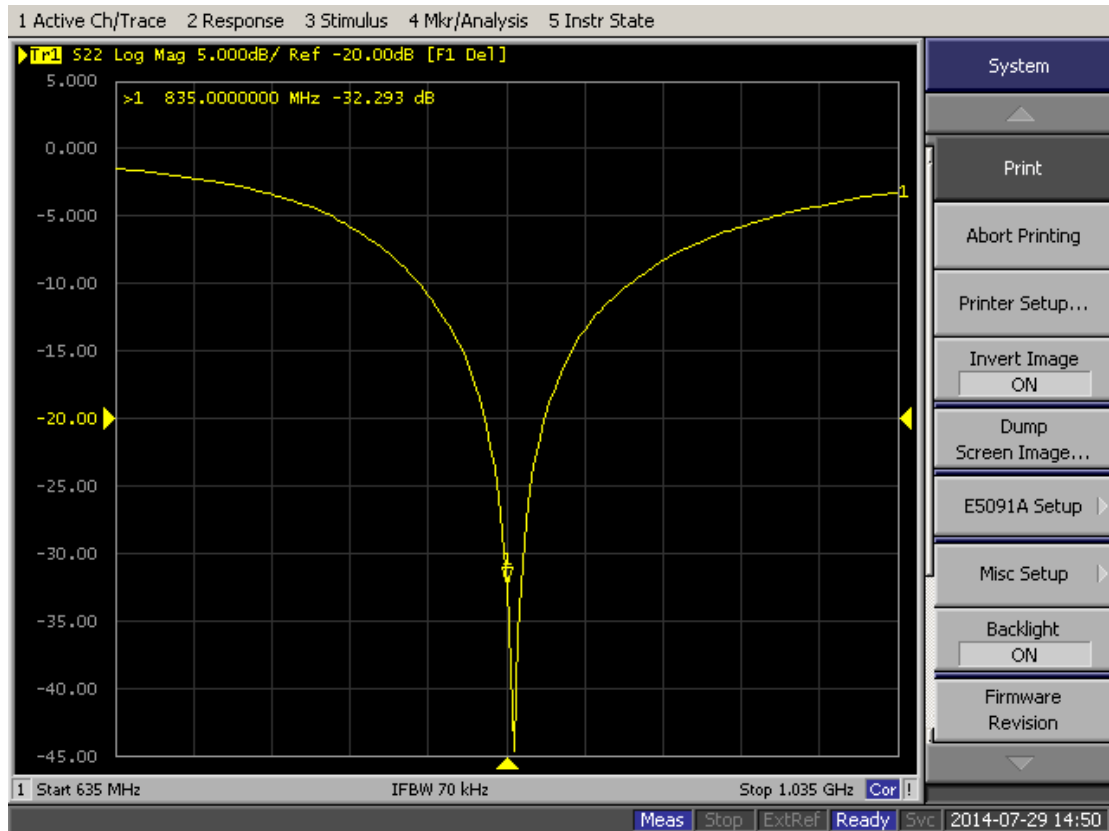
D850V2 Serial No.4d114						
850 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
7.30.2013	-32.147	--	52.127	--	-1.346	--
7.29.2014	-32.293	0.45	48.878	3.249	-2.134	0.788

D850V2 Serial No.4d114						
850 Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
7.30.2013	-29.073	--	48.217	--	-2.961	--
7.29.2014	-27.435	5.63	46.911	1.306	-2.689	0.272

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

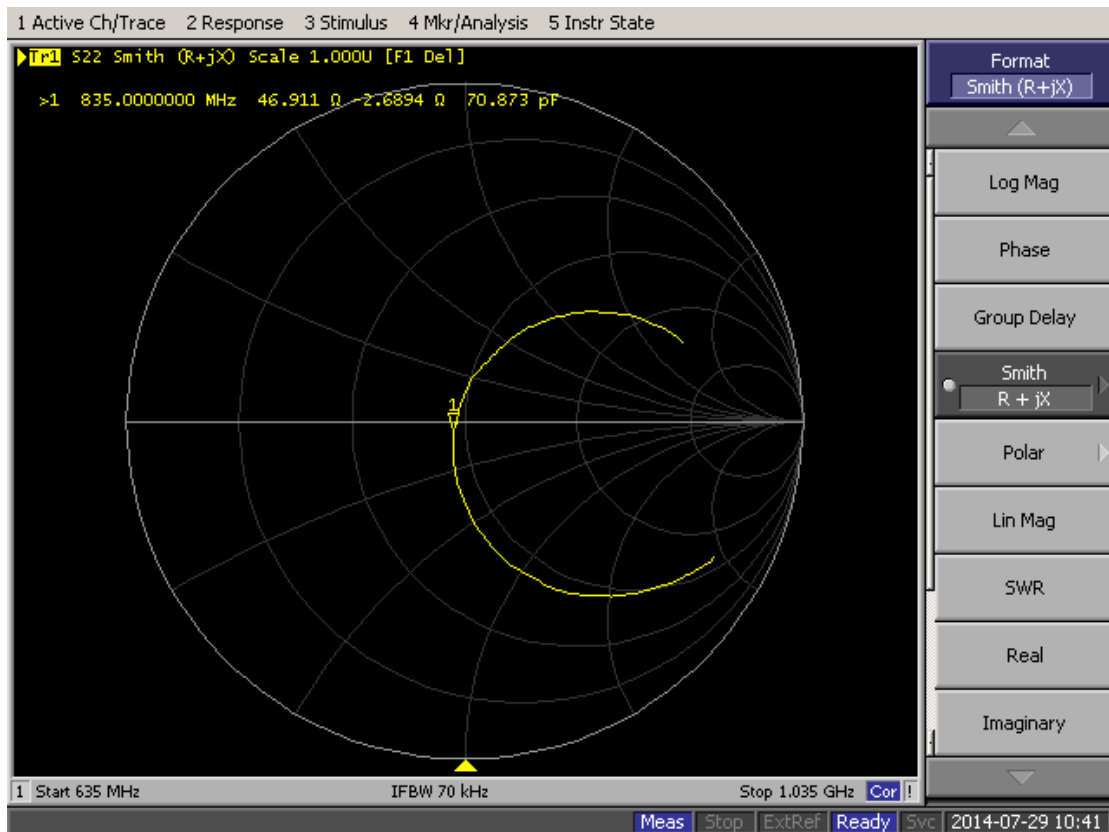
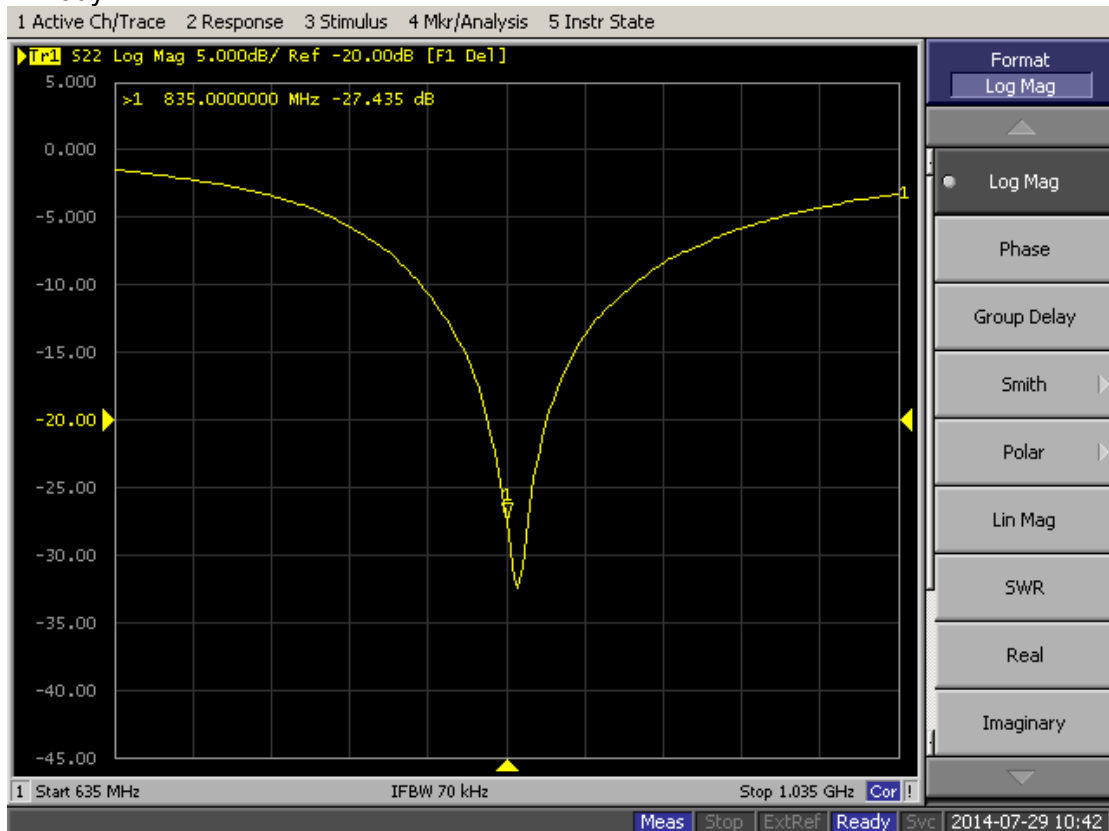


## Dipole Verification Data D850V2 Serial No.4d114 850MHz-Head





## 850MHz-Body





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**Client **CCS-CN (Auden)**Certificate No: **D1900V2-5d136\_Jul13**

## CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d136**Calibration procedure(s) **QA CAL-05.v9  
Calibration procedure for dipole validation kits above 700 MHz**Calibration date: **July 22, 2013**

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

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

Calibration Equipment used (M&amp;TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	QB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

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

Issued: July 22, 2013

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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:

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

- DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

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



## Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz $\pm$ 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 $\pm$ 0.2) °C	38.9 $\pm$ 6 %	1.36 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	40.4 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.3 W/kg $\pm$ 16.5 % (k=2)

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.4 $\pm$ 6 %	1.49 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	---	---

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	40.5 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.37 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	21.6 W/kg $\pm$ 16.5 % (k=2)



## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.9 $\Omega$ + 7.2 j $\Omega$
Return Loss	- 22.5 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.7 $\Omega$ + 7.3 j $\Omega$
Return Loss	- 22.1 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.203 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. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

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

### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	April 14, 2010



## DASY5 Validation Report for Head TSL

Date: 22.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d136**

Communication System: UID 0 - CW ; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.36$  S/m;  $\epsilon_r = 38.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

### DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.98, 4.98, 4.98); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

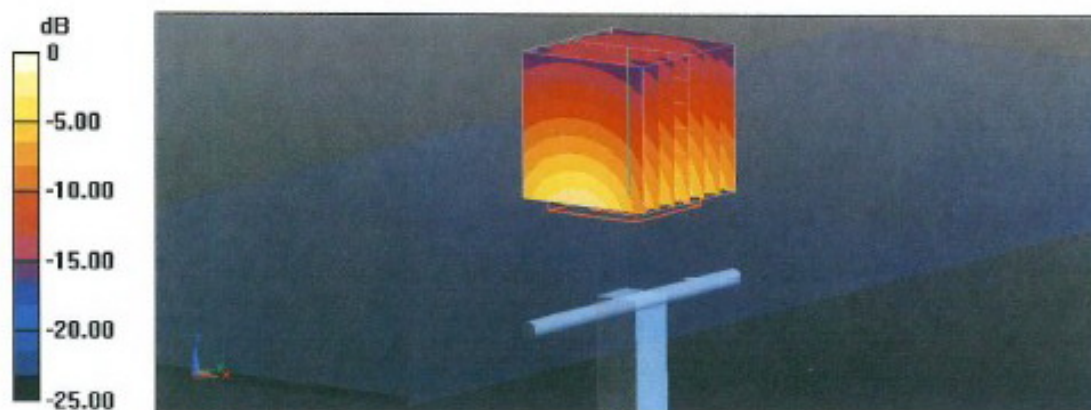
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.803 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 18.1 W/kg

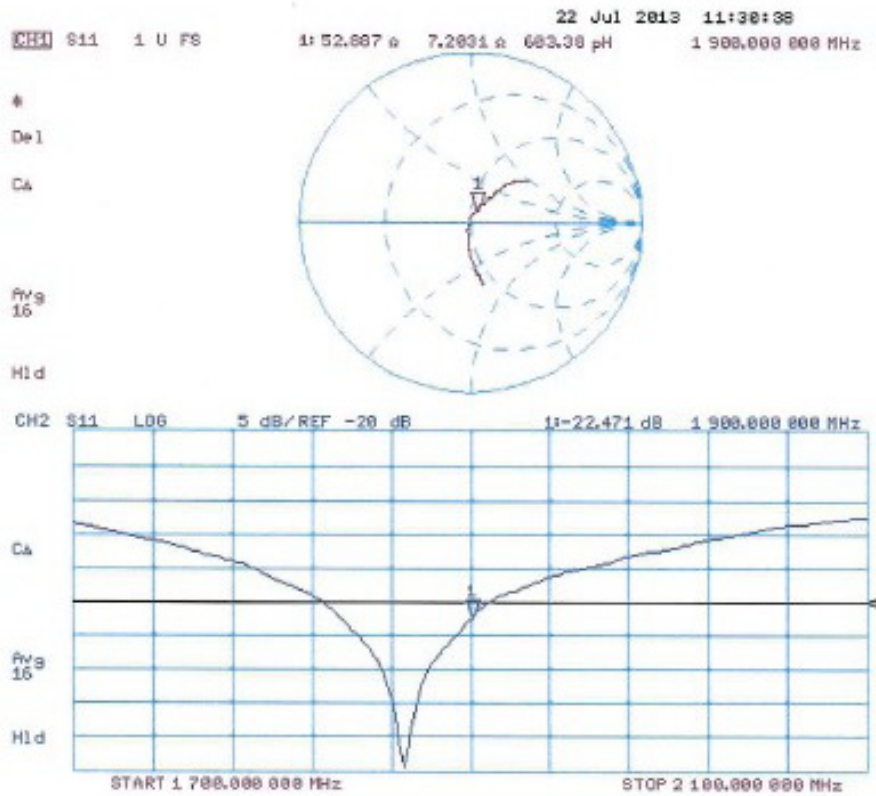
**SAR(1 g) = 10 W/kg; SAR(10 g) = 5.29 W/kg**

Maximum value of SAR (measured) = 12.4 W/kg





## Impedance Measurement Plot for Head TSL





## DASY5 Validation Report for Body TSL

Date: 22.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d136**

Communication System: UID 0 - CW ; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.49$  S/m;  $\epsilon_r = 53.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

### DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.6, 4.6, 4.6); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAB4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

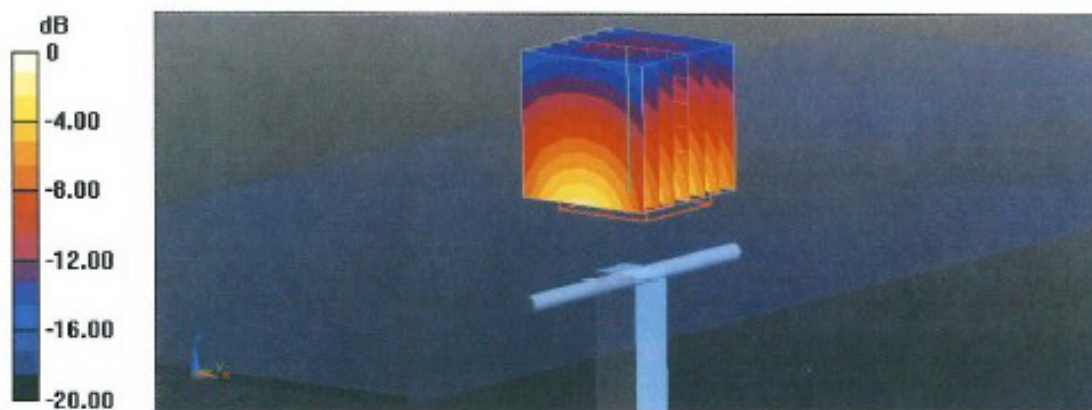
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.803 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 17.0 W/kg

**SAR(1 g) = 10 W/kg; SAR(10 g) = 5.37 W/kg**

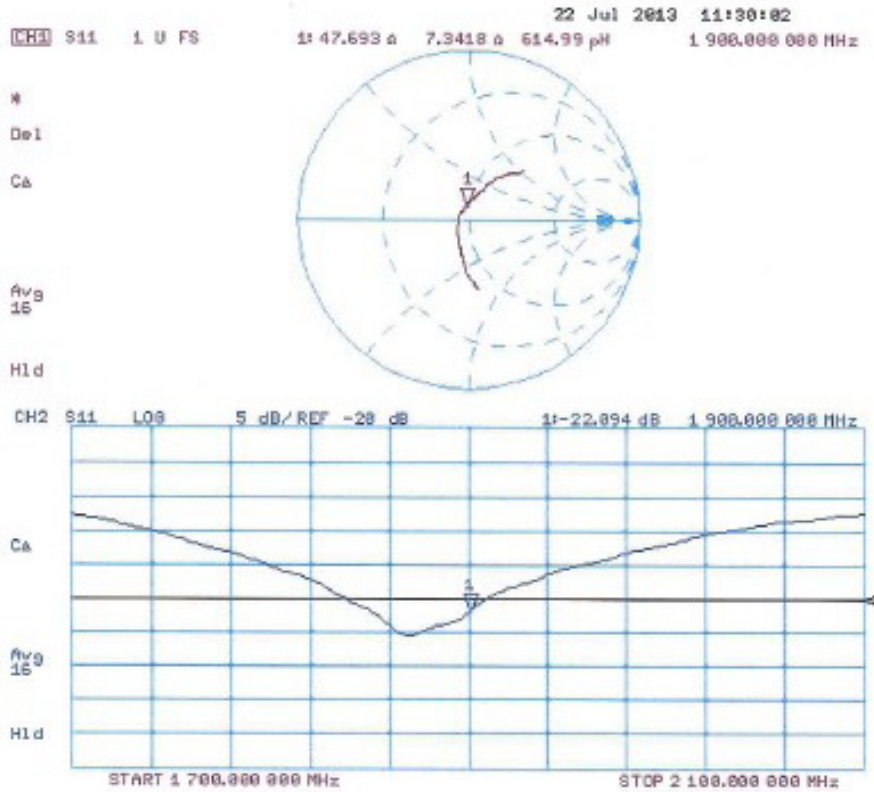
Maximum value of SAR (measured) = 12.5 W/kg



0 dB = 12.5 W/kg = 10.97 dBW/kg



## Impedance Measurement Plot for Body TSL





## D1900V2, Serial No.5d136 Extended Dipole Calibrations

Per IEEE Std 1528-2003, the dipole should have a return loss better than -20dB at the test frequency to reduce uncertainty in the power measurement

Per KDB 865664 D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

### Justification of the extended calibration

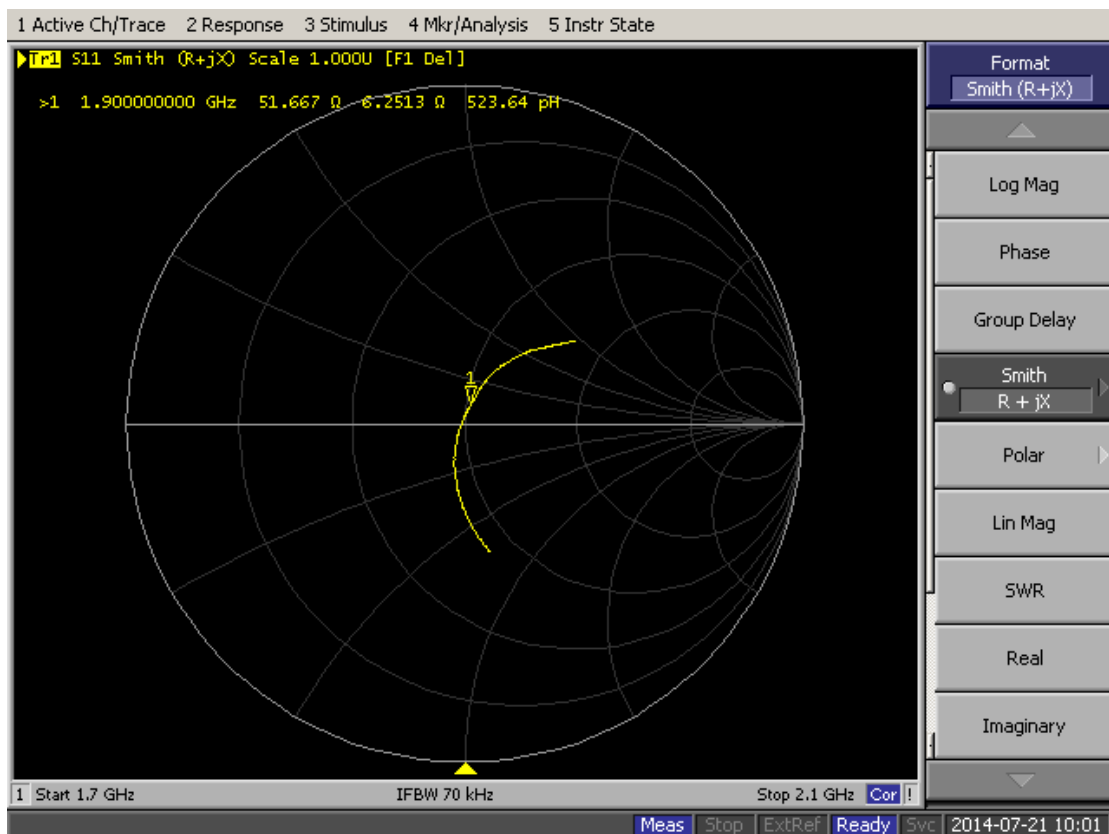
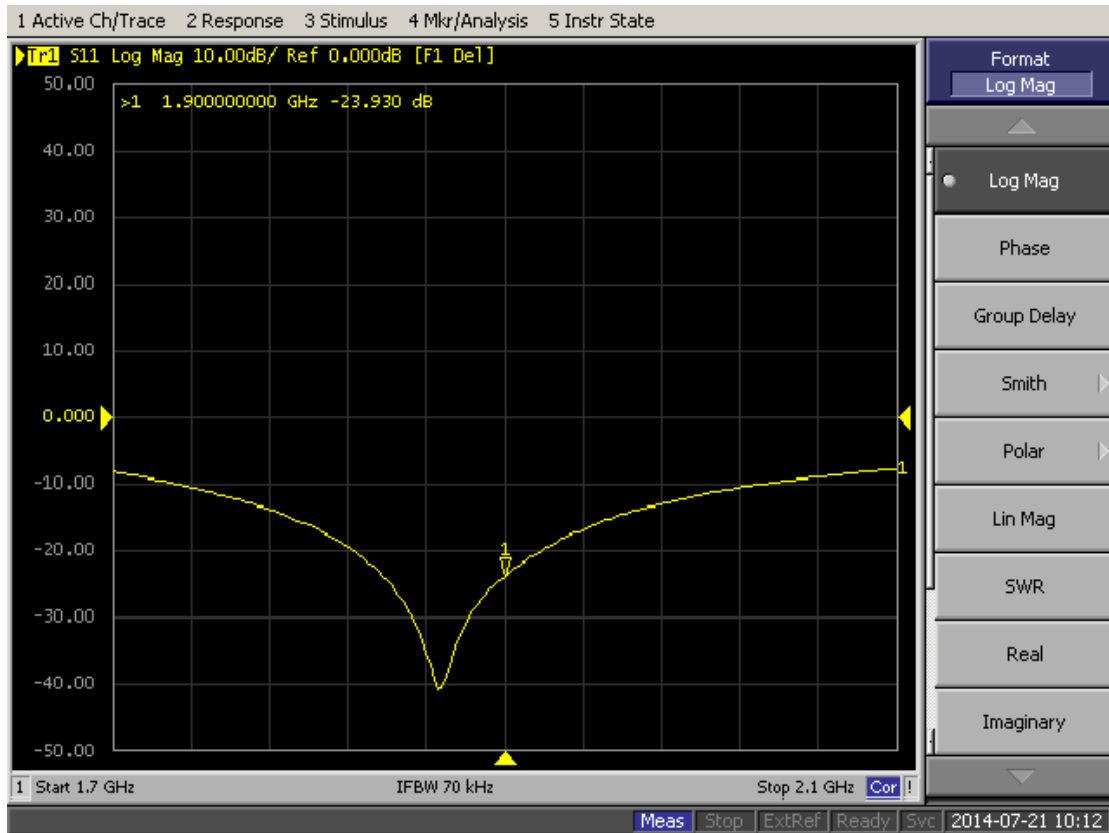
D1900V2 Serial No.5d136						
1900 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
7.22.2013	-22.471	--	52.887	--	7.2031	--
7.21.2014	-23.930	6.49	51.667	1.22	6.2513	0.9518

D1900V2 Serial No.5d136						
1900 Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
7.22.2013	-22.094	--	47.693	--	7.3418	--
7.21.2014	-22.704	2.76	47.761	0.068	6.8096	0.5322

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

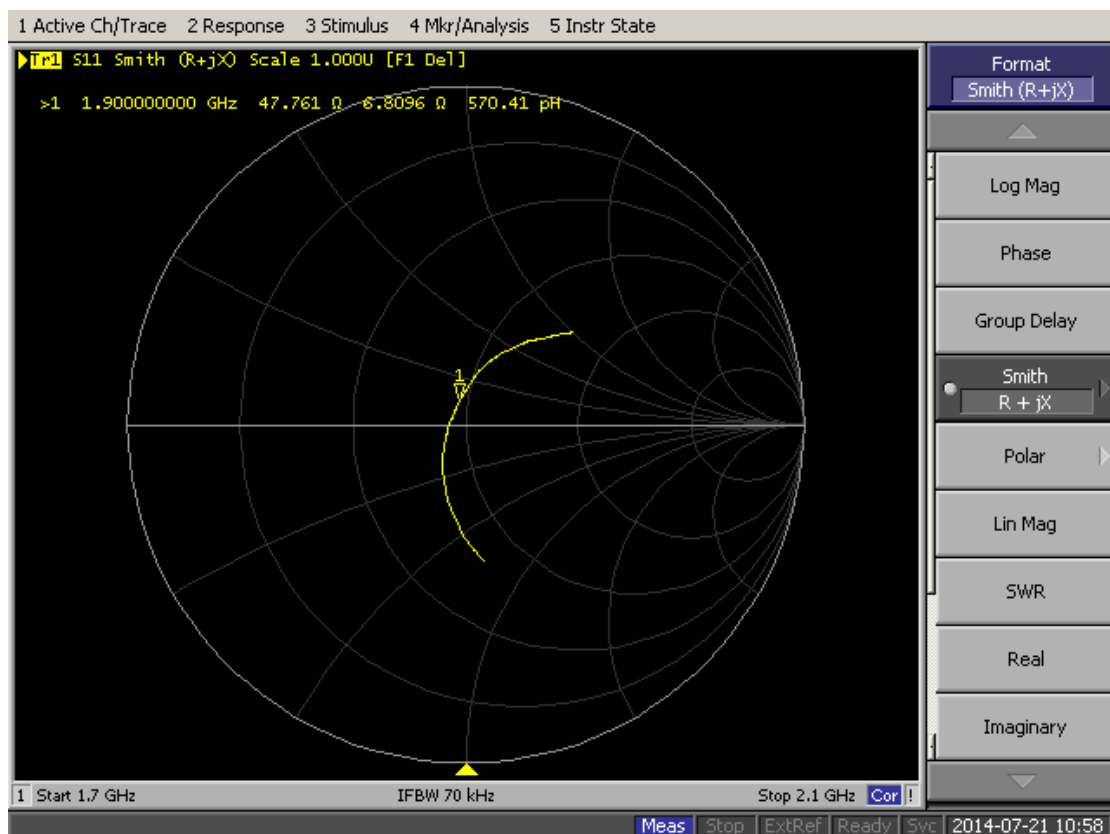
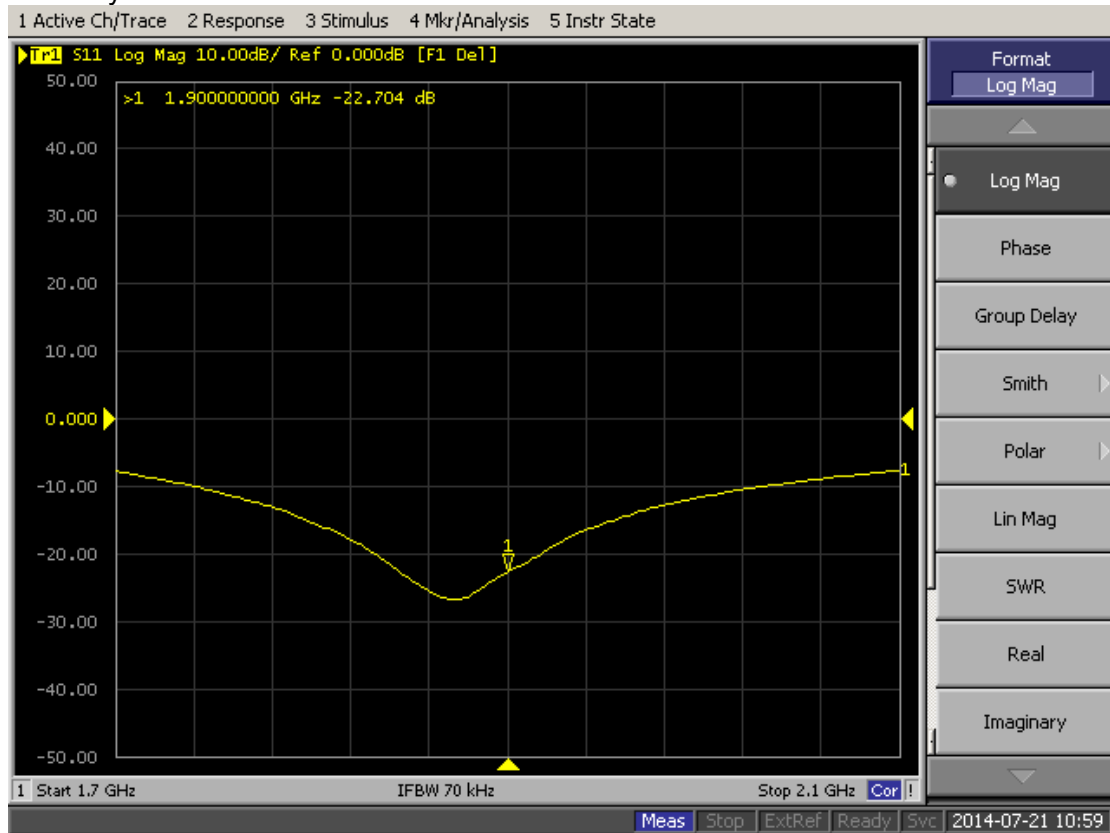


## Dipole Verification Data D1900V2 Serial No.5d136 1900MHz-Head





## 1900MHz-Body





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Accreditation No.: **SCS 108**Client **CCS-CN (Auden)**Certificate No: **D2450V2-817\_Jul13**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 817**Calibration procedure(s) **QA CAL-05.v9  
Calibration procedure for dipole validation kits above 700 MHz**Calibration date: **July 31, 2013**

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

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

Calibration Equipment used (M&amp;TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	25-Apr-13 (No. DAE4-601_Apr13)	Apr-14
Secondary Standards	ID #	Check Date (In house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Israa El-Naouq	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 31, 2013

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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:

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

- DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

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



## Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	37.8 $\pm$ 6 %	1.81 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.6 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.5 W/kg $\pm$ 16.5 % (k=2)

## Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	50.5 $\pm$ 6 %	2.01 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.6 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.2 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.87 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.1 W/kg $\pm$ 16.5 % (k=2)



## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.5 $\Omega$ + 2.9 j $\Omega$
Return Loss	- 27.1 dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.7 $\Omega$ + 4.5 j $\Omega$
Return Loss	- 27.0 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.159 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	October 23, 2007



## DASY5 Validation Report for Head TSL

Date: 31.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 817**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.81$  S/m;  $\epsilon_r = 37.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

### DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.52, 4.52, 4.52); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

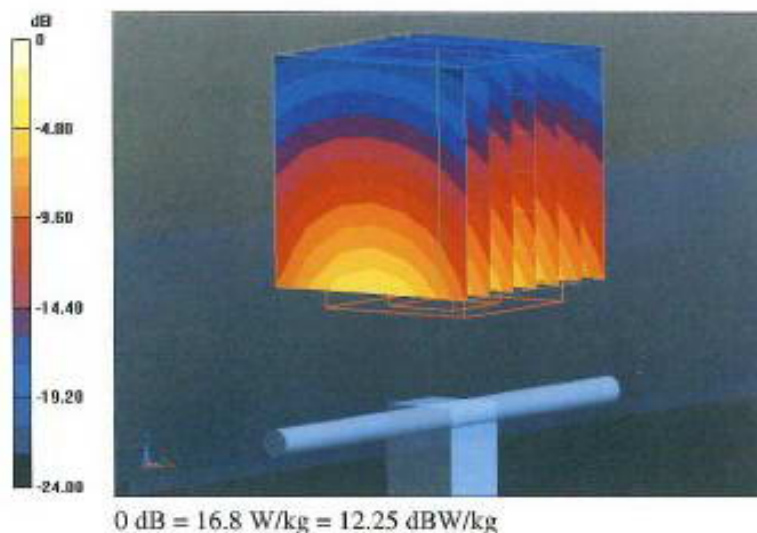
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.781 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 27.7 W/kg

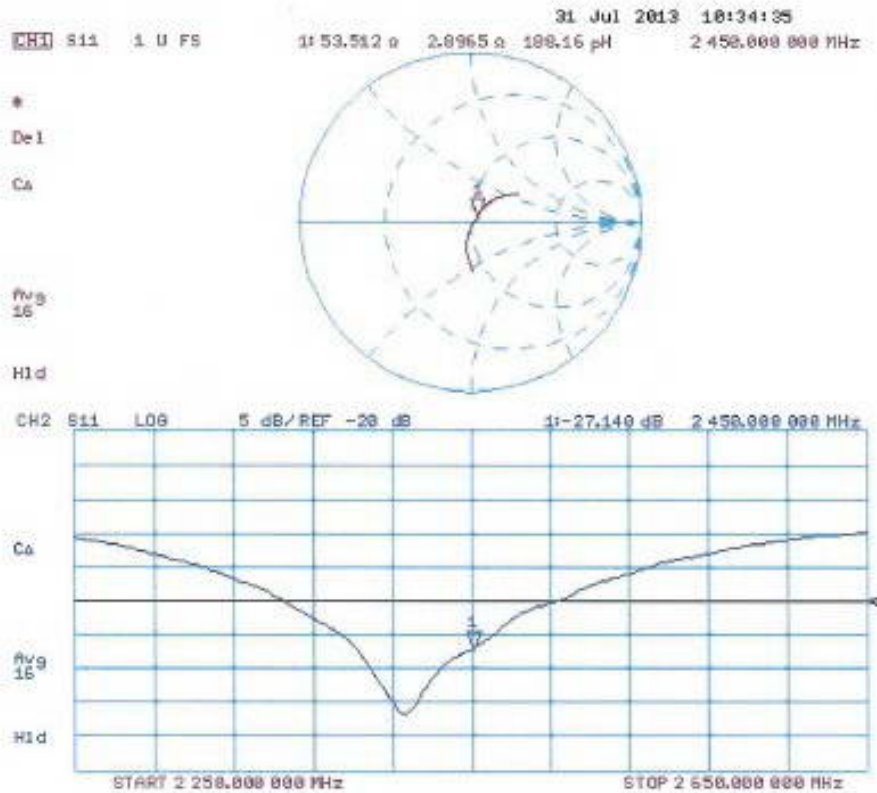
**SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.18 W/kg**

Maximum value of SAR (measured) = 16.8 W/kg





## Impedance Measurement Plot for Head TSL





## DASY5 Validation Report for Body TSL

Date: 31.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 817**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.01$  S/m;  $\epsilon_r = 50.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

### DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.42, 4.42, 4.42); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

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

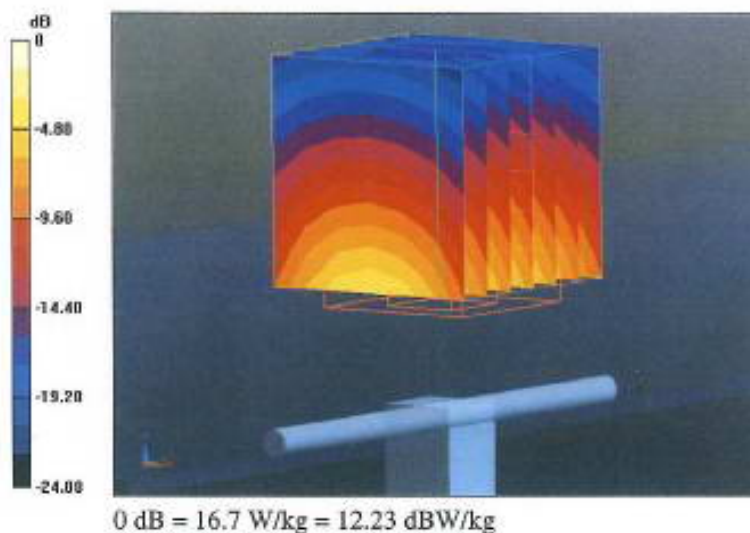
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.151 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 26.3 W/kg

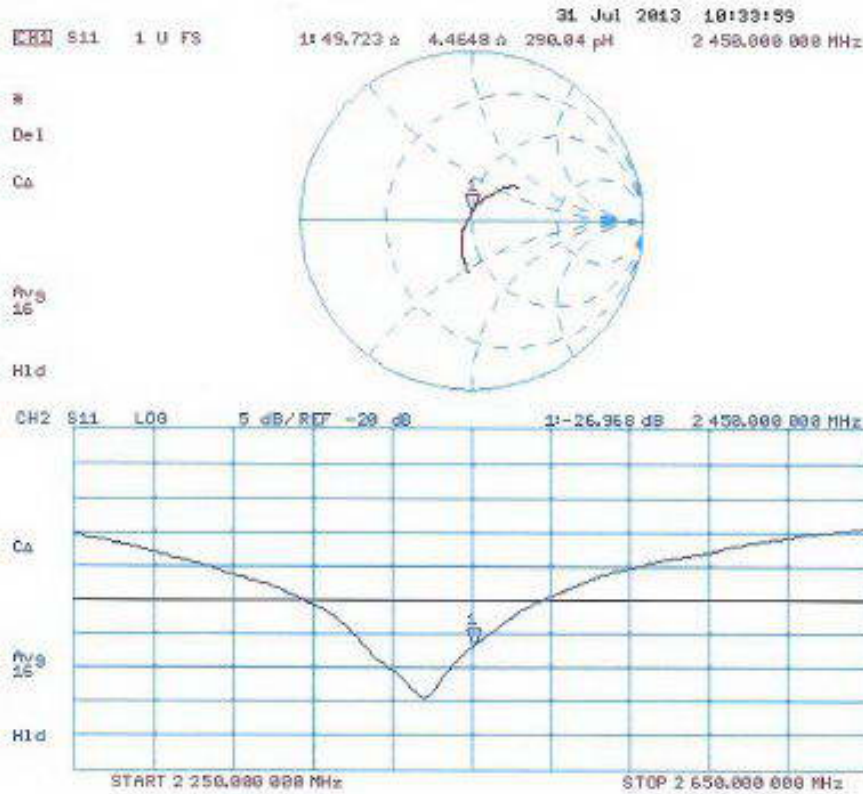
**SAR(1 g) = 12.6 W/kg; SAR(10 g) = 5.87 W/kg**

Maximum value of SAR (measured) = 16.7 W/kg





## Impedance Measurement Plot for Body TSL





## D2450V2, Serial No.817 Extended Dipole Calibrations

Per IEEE Std 1528-2003, the dipole should have a return loss better than -20dB at the test frequency to reduce uncertainty in the power measurement.

Per KDB 865664 D01, if dipoles are verified in return loss ( $< -20\text{dB}$ , within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

### Justification of the extended calibration

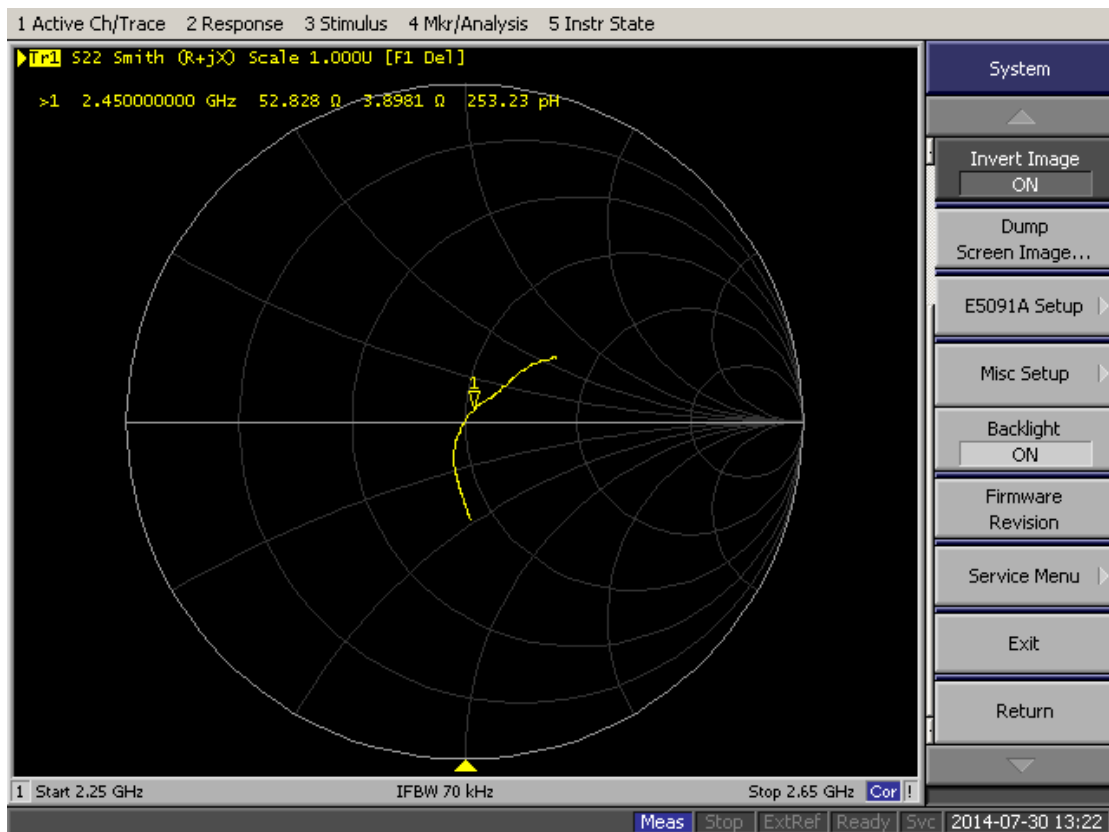
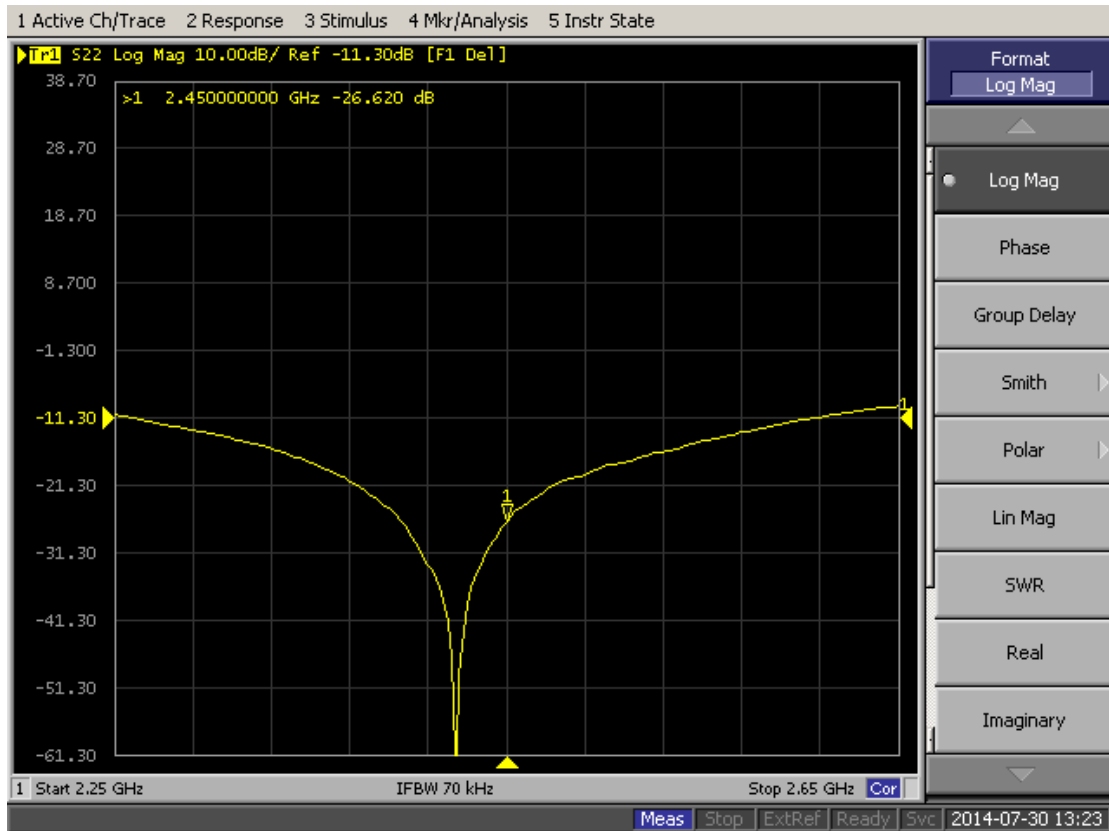
D2450V2 Serial No.817						
2450 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
7.31.2013	-27.140	--	53.512	--	2.897	--
7.30.2014	-26.620	1.92	52.828	0.684	3.898	0.911

D2450V2 Serial No.817						
2450 Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
7.31.2013	-26.968	--	49.723	--	4.465	--
7.30.2014	-25.469	5.56	49.237	0.486	5.234	0.769

The return loss is  $< -20\text{dB}$ , within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

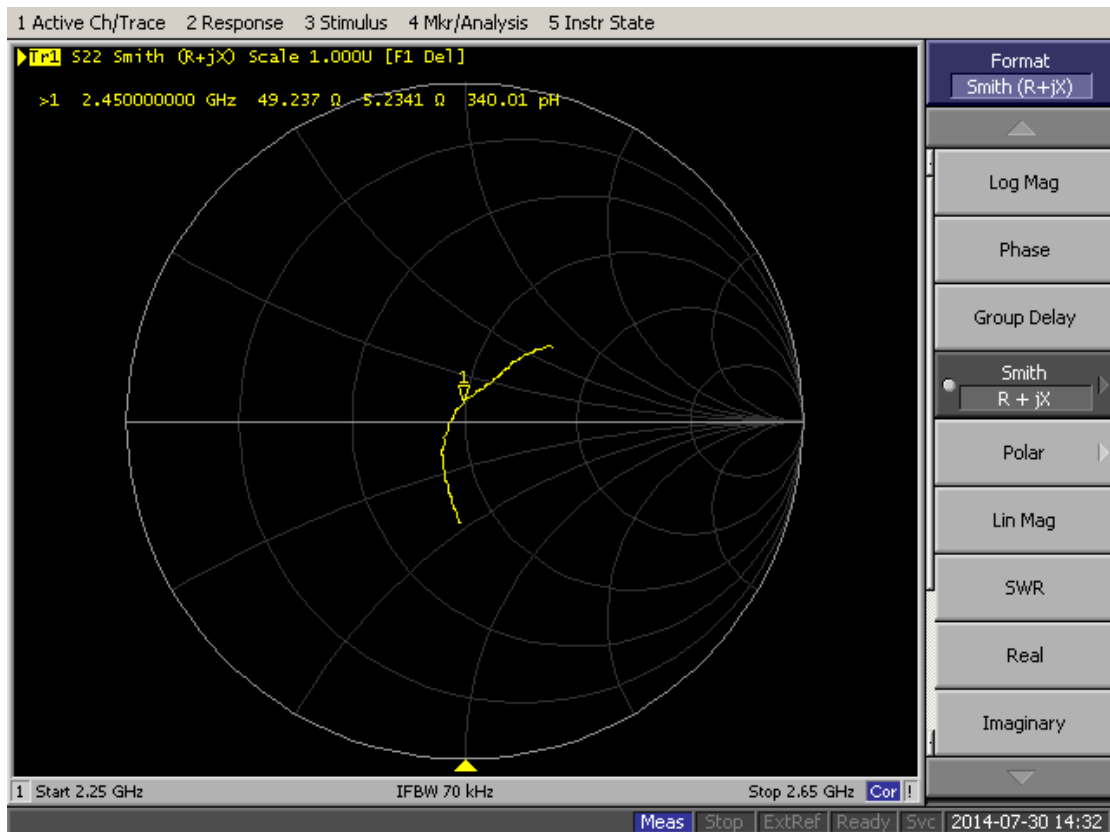
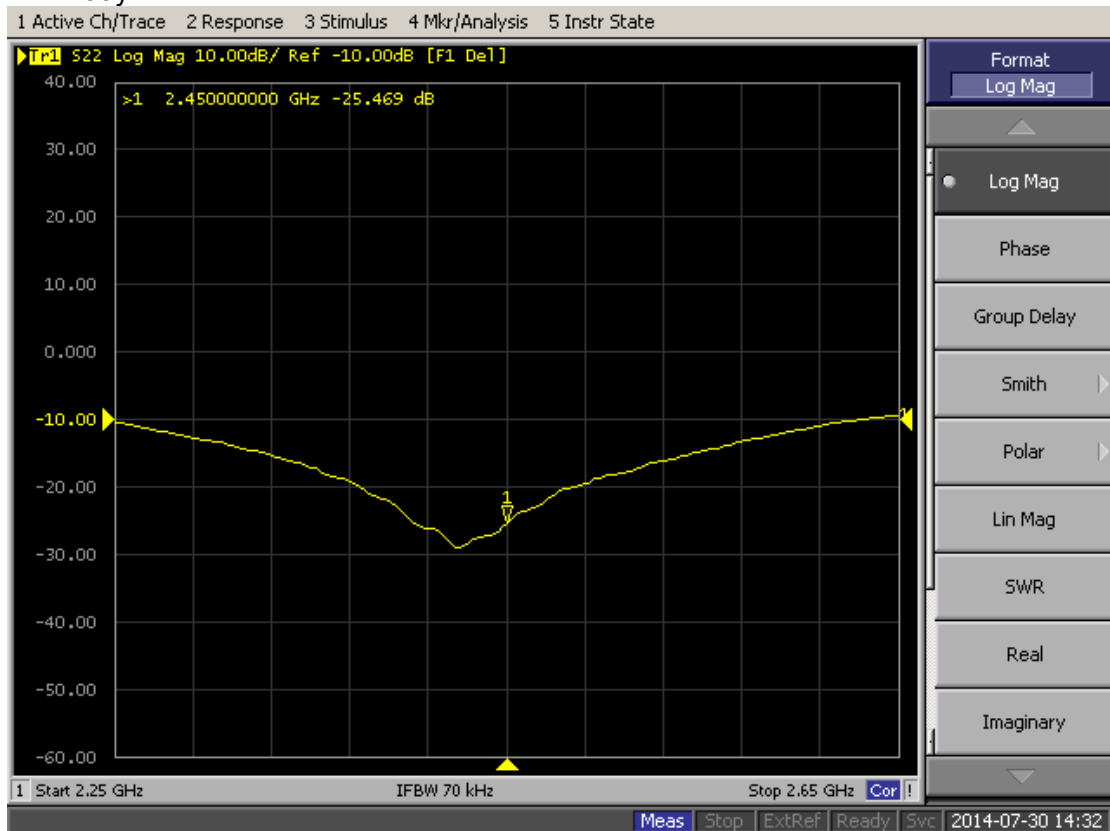


## Dipole Verification Data D2450V2 Serial No.817 2450 MHz-Head





## 2450 MHz-Body





Schmid & Partner Engineering AG

s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland  
Phone +41 44 245 9700, Fax +41 44 245 9779  
info@speag.com, http://www.speag.com

1245

## IMPORTANT NOTICE

### USAGE OF THE DAE 4

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

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

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

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

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

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

#### Important Note:

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

#### Important Note:

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

#### Important Note:

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

Schmid & Partner Engineering

TN\_BR040315AD DAE4.doc

11.12.2009



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Accreditation No.: SCS 108

Client **CCS-CN (Auden)**

Certificate No: DAE4-1245\_Jul14

## CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BM - SN: 1245**Calibration procedure(s) **QA CAL-06.v26  
Calibration procedure for the data acquisition electronics (DAE)**Calibration date: **July 22, 2014**

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

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

Calibration Equipment used (M&amp;TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0610276	01-Oct-13 (No:13976)	Oct-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit Calibrator Box V2.1	SE UWS 053 AA 1001	07-Jan-14 (in house check)	in house check: Jan-15
	SE UMS 006 AA 1002	07-Jan-14 (in house check)	in house check: Jan-15

Calibrated by:	Name R. Mayraz	Function Technician	Signature 
Approved by:	Fin Bornholt	Deputy Technical Manager	

Issued: July 22, 2014

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## Glossary

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

## Methods Applied and Interpretation of Parameters

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



## DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

Calibration Factors	X	Y	Z
High Range	405.988 $\pm$ 0.02% (k=2)	404.710 $\pm$ 0.02% (k=2)	405.848 $\pm$ 0.02% (k=2)
Low Range	4.00335 $\pm$ 1.50% (k=2)	3.98492 $\pm$ 1.50% (k=2)	4.02547 $\pm$ 1.50% (k=2)

## Connector Angle

Connector Angle to be used in DASY system	30.5 $^{\circ}$ $\pm$ 1 $^{\circ}$
---	------------------------------------



## Appendix (Additional assessments outside the scope of SCS108)

### 1. DC Voltage Linearity

High Range		Reading ( $\mu\text{V}$ )	Difference ( $\mu\text{V}$ )	Error (%)
Channel X	+ Input	199996.75	-0.27	-0.00
Channel X	+ Input	20001.39	1.15	0.01
Channel X	- Input	-20000.78	0.74	-0.00
Channel Y	+ Input	199998.13	1.27	0.00
Channel Y	+ Input	20000.37	0.12	0.00
Channel Y	- Input	-20002.24	-0.66	0.00
Channel Z	+ Input	199998.24	1.21	0.00
Channel Z	+ Input	20000.36	0.20	0.00
Channel Z	- Input	-20001.75	-0.03	0.00

Low Range		Reading ( $\mu\text{V}$ )	Difference ( $\mu\text{V}$ )	Error (%)
Channel X	+ Input	2000.33	-0.09	-0.00
Channel X	+ Input	200.90	0.40	0.20
Channel X	- Input	-198.83	0.46	-0.23
Channel Y	+ Input	2000.00	-0.26	-0.01
Channel Y	+ Input	199.81	-0.91	-0.45
Channel Y	- Input	-200.08	-0.81	0.41
Channel Z	+ Input	2001.30	1.40	0.07
Channel Z	+ Input	200.05	-0.31	-0.15
Channel Z	- Input	-200.89	-1.31	0.66

### 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 ( $\mu\text{V}$ )	Low Range Average Reading ( $\mu\text{V}$ )
Channel X	200	-7.83	-9.32
	- 200	10.88	9.44
Channel Y	200	-7.71	-8.33
	- 200	5.77	5.63
Channel Z	200	-5.90	-5.96
	- 200	4.79	4.74

### 3. Channel separation

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

	Input Voltage (mV)	Channel X ( $\mu\text{V}$ )	Channel Y ( $\mu\text{V}$ )	Channel Z ( $\mu\text{V}$ )
Channel X	200	-	2.85	-2.60
Channel Y	200	9.53	-	4.34
Channel Z	200	9.98	8.64	-



#### 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	15875	16740
Channel Y	16455	16504
Channel Z	15939	16860

#### 5. Input Offset Measurement

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

Input 10M $\Omega$ 

	Average ( $\mu$ V)	min. Offset ( $\mu$ V)	max. Offset ( $\mu$ V)	Std. Deviation ( $\mu$ V)
Channel X	1.16	-0.50	2.34	0.49
Channel Y	-0.81	-2.25	0.40	0.49
Channel Z	-0.59	-1.82	0.83	0.56

#### 6. Input Offset Current

Nominal input circuitry offset current on all channels: &lt;25fA

#### 7. Input Resistance (Typical values for information)

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

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

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

#### 9. Power Consumption (Typical values for information)

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



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Accreditation No.: SCS 108

Client CCS-CN (Auden)

Certificate No: EX3-3798\_Jul14

## CALIBRATION CERTIFICATE

Object EX3DV4 - SN:3798

Calibration procedure(s) QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6  
Calibration procedure for dosimetric E-field probes

Calibration date: July 28, 2014

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

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

Calibration Equipment used (M&amp;TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5064 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	
			Issued: July 28, 2014

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## Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization $\phi$	$\phi$ rotation around probe axis
Polarization $\theta$	$\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

## Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

## Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\theta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* frequency\_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical Isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).



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**Probe EX3DV4**

**SN:3798**

Manufactured: April 5, 2011  
Calibrated: July 28, 2014

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



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## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3798

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.54	0.51	0.59	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	97.6	99.3	96.2	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>C</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	145.7	$\pm 2.7 \%$
		Y	0.0	0.0	1.0		142.0	
		Z	0.0	0.0	1.0		132.7	

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

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the  $E^2$ -field uncertainty inside TSL (see Pages 5 and 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>C</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.



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## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3798

### Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>E</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Uncl. (k=2)
835	41.5	0.90	9.30	9.30	9.30	0.28	1.12	± 12.0 %
900	41.5	0.97	9.13	9.13	9.13	0.58	0.68	± 12.0 %
1810	40.0	1.40	7.82	7.82	7.82	0.41	0.81	± 12.0 %
1900	40.0	1.40	7.75	7.75	7.75	0.40	0.83	± 12.0 %
2450	39.2	1.80	7.04	7.04	7.04	0.33	0.92	± 12.0 %
5200	36.0	4.66	4.81	4.81	4.81	0.40	1.80	± 13.1 %
5300	35.9	4.76	4.60	4.60	4.60	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.67	4.67	4.67	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.56	4.56	4.56	0.40	1.80	± 13.1 %
5900	35.3	5.27	4.55	4.55	4.55	0.40	1.80	± 13.1 %

<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>E</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



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## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3798

### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
835	55.2	0.97	9.22	9.22	9.22	0.32	1.07	± 12.0 %
900	55.0	1.05	8.96	8.96	8.96	0.55	0.76	± 12.0 %
1810	53.3	1.52	7.26	7.26	7.26	0.46	0.80	± 12.0 %
1900	53.3	1.52	7.09	7.09	7.09	0.38	0.87	± 12.0 %
2450	52.7	1.95	6.82	6.82	6.82	0.77	0.58	± 12.0 %
5200	49.0	5.30	4.41	4.41	4.41	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.23	4.23	4.23	0.45	1.90	± 13.1 %
5500	48.6	5.65	3.91	3.91	3.91	0.50	1.90	± 13.1 %
5600	48.5	5.77	3.75	3.75	3.75	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.09	4.09	4.09	0.50	1.90	± 13.1 %

<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

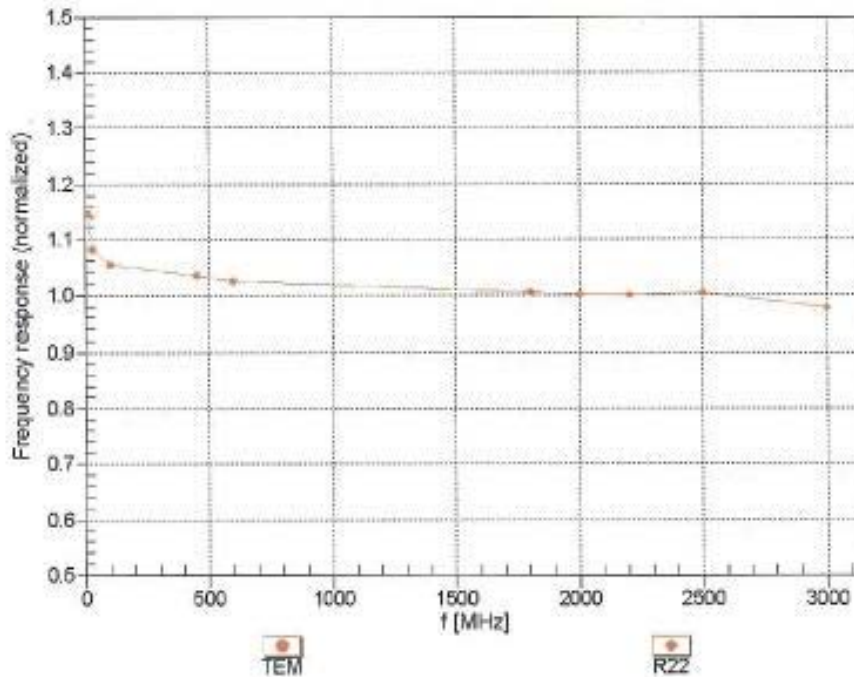
<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



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## Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



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

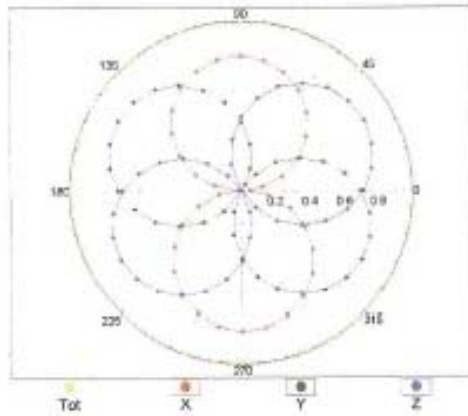


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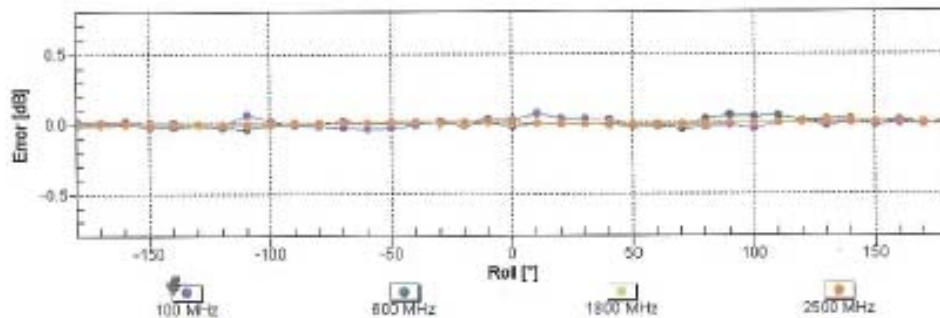
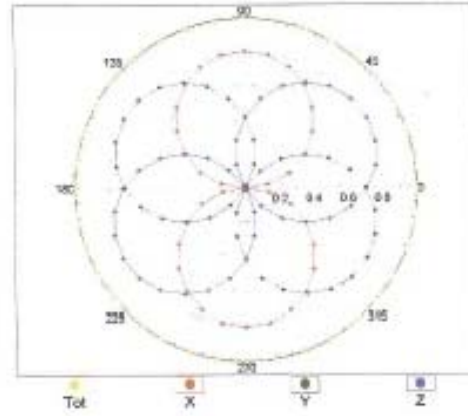
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## Receiving Pattern ( $\phi$ ), $\theta = 0^\circ$

f=600 MHz,TEM



f=1800 MHz,R22



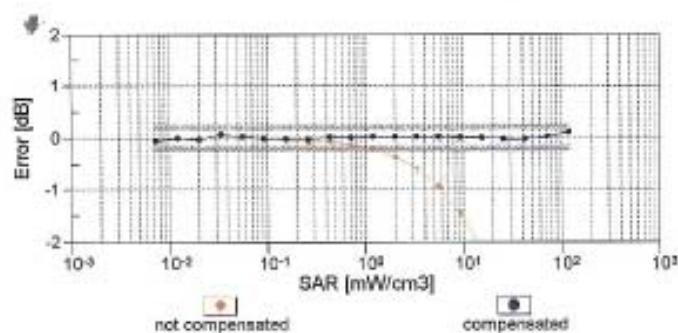
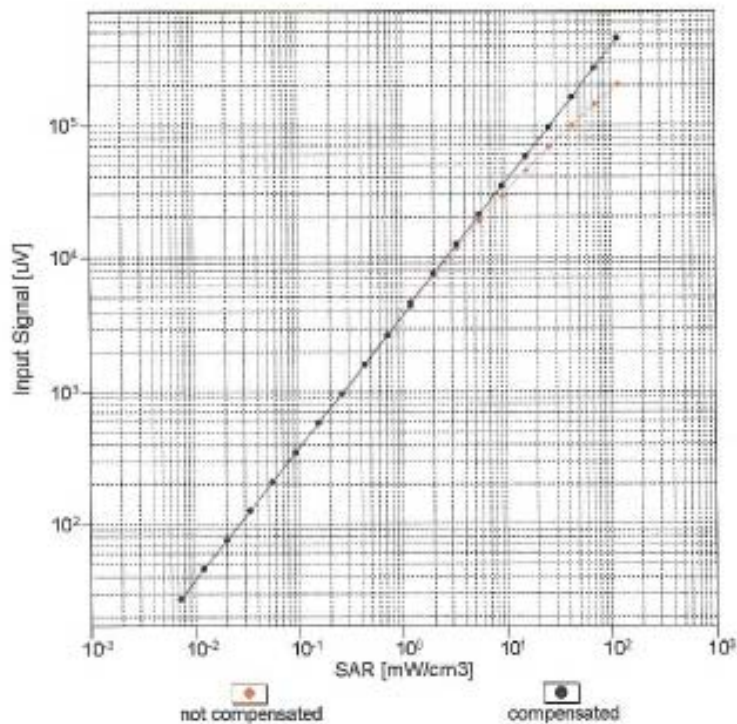
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)



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## Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f_{\text{eval}} = 1900 \text{ MHz}$ )



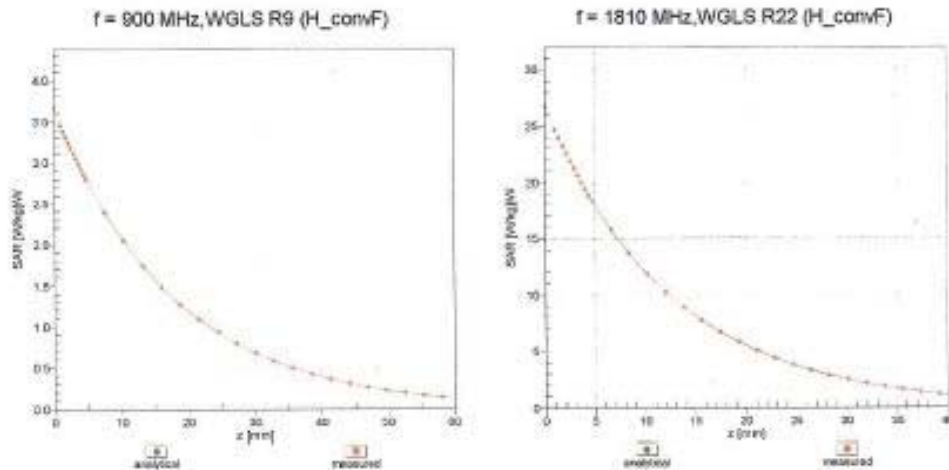
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )



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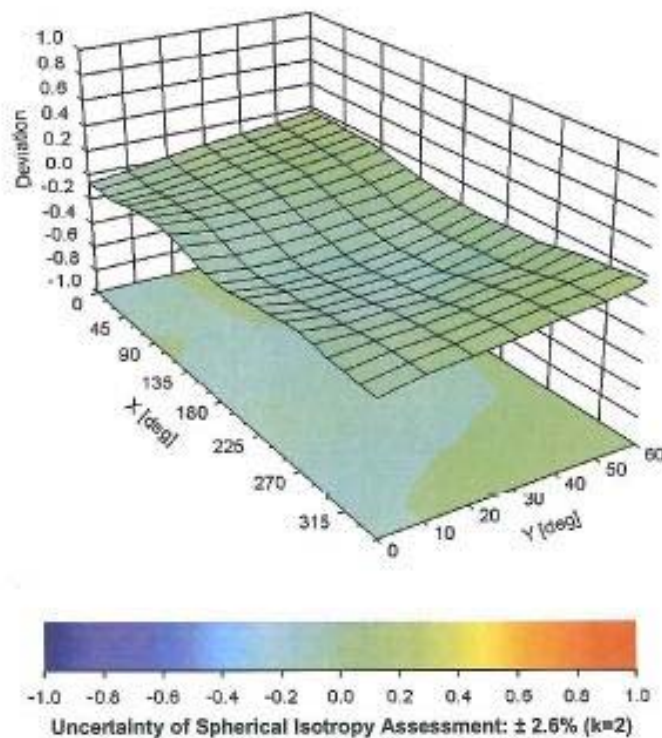
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## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

Error ( $\phi, \theta$ ),  $f = 900 \text{ MHz}$





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## DASY/EASY - Parameters of Probe: EX3DV4 - SN:3798

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-39.7
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm



## **APPENDIX C: PLOTS OF SAR TEST RESULT**

The plots are showing in the file named Appendix C Plots of SAR Test Result

**END REPORT**