# 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: GSM mobile phone**

**Brand Name: WINCOM, FreshFun**

**Model No.: F9**

**Series Model: F2, F3, F5, F6, F8, S8, V3**

**Test Report Number:**
**C140911S03-SF**

**Issued for**

**WING CHONG INTERNATIONAL ELECTRONIC LIMITED**

**7/F KIN ON COMM BLDG 49-1 JERVOIS ST SHEUNG WAN HK**

**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**

ACCREDITED
TESTING CERT #2541.01

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# Revision History

| Revision | REPORT NO. | Date | Page Revised | Contents |
|---|---|---|---|---|
| Original | C140911S03-SF | September 19, 2014 | N/A | N/A |


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# 1. CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

| | |
|---|---|
| **Product Name:** | GSM mobile phone |
| **Brand Name:** | WINCOM, FreshFun |
| **Model Name.:** | F9 |
| **Series Model:** | F2, F3, F5, F6, F8, S8, V3 |
| **Devices supporting GPRS:** | Class B |
| **Description Test Mode:** | SIM 1 and SIM2 is a chipset unit and tested as single chipset |
| **Device Category:** | PORTABLE DEVICES |
| **Exposure Category:** | GENERAL POPULATION/UNCONTROLLED EXPOSURE |
| **Date of Test:** | September 15, 2014 |
| **Applicant:** | **WING CHONG INTERNATIONAL ELECTRONIC LIMITED**<br>7/F KIN ON COMM BLDG 49-1 JERVOIS ST SHEUNG WAN HK |
| **Manufacturer:** | **WINCOM ELECTRONIC LIMITED**<br>Not1 NOTRH DISTRICT CHANG XUE LNDUSTRIAL PARK BANTIAN SHE NZHEN CHINA |
| **Application Type:** | 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 | |

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.

***Approved by:***

Jeff fang

Jeff.fang
RF Manager
Compliance Certification Services Inc.

***Tested by:***

Sam. ye.

Sam.ye
Test Engineer
Compliance Certification Services Inc.


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# 2. EUT DESCRIPTION

| | | |
|---|---|---|
| **Product Name:** | GSM mobile phone | |
| **Brand Name:** | WINCOM, FreshFun | |
| **Model Name.:** | F9 | |
| **Series Model:** | F2, F3, F5, F6, F8, S8, V3 | |
| **Model Discrepancy:** | The same Motherboard chipset and appearance,only model name different | |
| **FCC ID:** | 2AC8V-F9 | |
| **Power reduction:** | NO | |
| **DTM Description:** | N/A | |
| **Device Category:** | Production unit | |
| **Frequency Range:** | GSM 850: 824.2 ~ 848.8 MHz<br>PCS1900: 1850.2 ~ 1909.8 MHz<br>Bluetooth: 2402 ~ 2480 MHz | |
| **Transmit Power(Average):** | GSM 850:30.12 dBm<br>GSM 1900:28.81 dBm<br>Bluetooth: 1.62 dBm | |
| **Max. Reported SAR(1g):** | Head:<br>GSM 850:0.178 W/kg<br>GSM 1900:0.256 W/kg | Body:<br>GSM 850:0.335 W/kg<br>GSM 1900:0.551 W/kg |
| **Modulation Technique:** | GSM/GPRS: GMSK<br>Bluetooth : GFSK + π/4DQPSK+8DPSK | |
| **Accessories:** | Battery（rating）：<br>Capacitance:1100 mAh<br>Rated Voltage:3.7V | |
| **Antenna Specification:** | GSM: PIFA antenna<br>Bluetooth : Dipole antenna | |
| **Operating Mode:** | Maximum continuous output | |


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# 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 447498 D01v05r02 General RF Exposure Guidance v05
☒ KDB 648474 D04v01r02 Handset SAR
☒ KDB 865664 D01v01r03 Measurement 100 MHz to 6 GHz
☒ KDB 865664 D02v01r01 RF Exposure Reporting
☒ KDB 941225 D03v01 SAR Test Reduction Procedures GSM/GPRS/EDGE

# 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.


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# 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 ± 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 ±10%. The spherical isotropy was evaluated with the procedure described in [8] and found to be better than ±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 |


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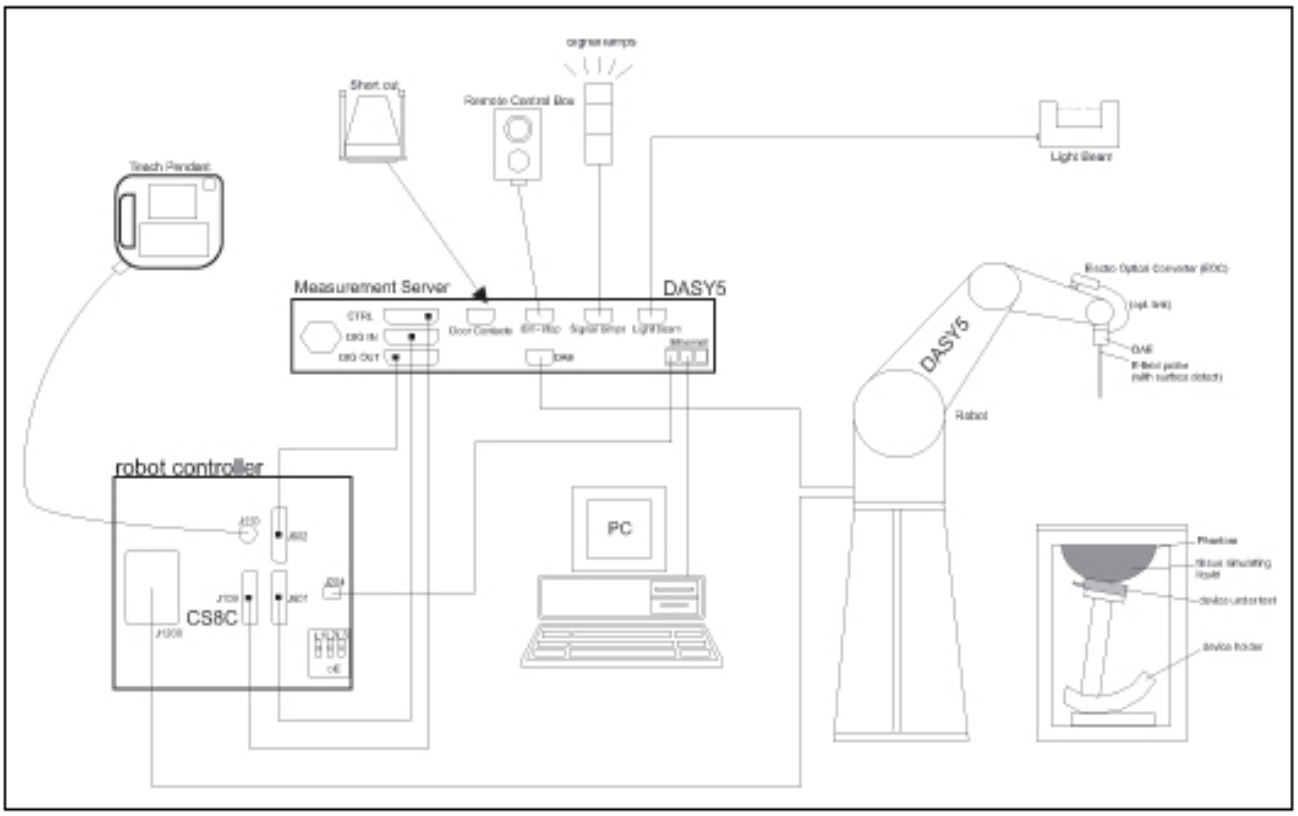
## 6.1 MEASUREMENT SYSTEM DIAGRAM




**The DASY5 system for performing compliance tests consists of the following items:**

- A standard high precision 6-axis robot (St¨aubli 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.
- DASY5 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.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## 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: ± 0.2 dB (30 MHz to 3 GHz)

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

**Dynamic Range:** 10 μW/g to > 100 mW/g; Linearity: ± 0.2 dB
(noise: typically < 1 μW/g)


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**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 ±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 ± 0.2 mm (sagging: <1%)

**Filling Volume:** Approx. 25 liters

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

**Minor axis:** 400 mm 500mm

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**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 l/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 < 1GHz); > 40 W (f > 1GHz)

**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 l/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 < 1GHz); > 40 W (f > 1GHz)

**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

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# 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:

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

H-field probes:

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

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
$aij$ = Sensor sensitivity factors for H-field probes
$f$ = Carrier frequency (GHz)
$Ei$ = Electric field strength of channel i in V/m
$Hi$ = Magnetic field strength of channel i in A/m

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

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


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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$^3$

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

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

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

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

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

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


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## 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 then 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.


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**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:

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

Since the decay of the boundary effect dominates for small probes ($a \ll \lambda$), the cos-term can be omitted. Factors *Sb* (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.


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# 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 Veff** |
| Measurement System | | | | | | |
| Probe Calibration (*k*=1) | 6.00 | Normal | 1 | 1 | 6.00 | ∞ |
| Probe Isotropy | 4.70 | Rectangular | √3 | 0.7 | 1.90 | ∞ |
| Modulation Response | 2.40 | Rectangular | √3 | 1 | 1.39 | ∞ |
| Hemispherical Isotropy | 9.60 | Rectangular | √3 | 0.7 | 3.88 | ∞ |
| Boundary Effect | 2.00 | Rectangular | √3 | 1 | 1.15 | ∞ |
| Linearity | 4.70 | Rectangular | √3 | 1 | 2.71 | ∞ |
| System Detection Limit | 1.00 | Rectangular | √3 | 1 | 0.58 | ∞ |
| Readout Electronics | 0.30 | Normal | 1 | 1 | 0.30 | ∞ |
| Response Time | 0.80 | Rectangular | √3 | 1 | 0.46 | ∞ |
| Integration Time | 2.60 | Rectangular | √3 | 1 | 1.50 | ∞ |
| RF Ambient Noise | 3.00 | Rectangular | √3 | 1 | 1.73 | ∞ |
| RF Ambient Reflections | 3.00 | Rectangular | √3 | 1 | 1.73 | ∞ |
| Probe Positioner | 0.40 | Rectangular | √3 | 1 | 0.23 | ∞ |
| Probe Positioning | 2.90 | Rectangular | √3 | 1 | 1.67 | ∞ |
| Max. SAR Evaluation | 2.00 | Rectangular | √3 | 1 | 1.15 | ∞ |
| **Test sample Related** | | | | | | |
| 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 | √3 | 1 | 2.89 | ∞ |
| Power Scaling | 0 | Rectangular | √3 | 1 | 0.00 | ∞ |
| **Phantom and Tissue Parameters** | | | | | | |
| Phantom Uncertainty | 6.1 | Rectangular | √3 | 1 | 3.52 | ∞ |
| SAR correction | 1.9 | Rectangular | √3 | 1 | 1.10 | ∞ |
| Liquid Conductivity (target) | 5 | Rectangular | √3 | 0.64 | 1.85 | ∞ |
| Liquid Conductivity (meas) | 1.97 | Rectangular | √3 | 0.78 | 0.89 | ∞ |
| Liquid Permittivity (target ) | 5 | Rectangular | √3 | 0.6 | 1.73 | ∞ |
| Liquid Permittivity (meas) | -2.70 | Rectangular | √3 | 0.26 | -0.41 | ∞ |
| Temp. unc. - Conductivity | 3.4 | Rectangular | √3 | 0.78 | 1.53 | ∞ |
| Temp. unc. - Permittivity | 0.4 | Rectangular | √3 | 0.23 | 0.05 | ∞ |
| **Combined Std. Uncertainty** | | RSS | | | 11.46 | 361 |
| **Expanded STD Uncertainty** | | *k*=2 | | | **22.92%** | |
| **Expanded STD Uncertainty** | | *k*=2 | | | **1.79dB** | |

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.


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# 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 1 gram of tissue defined as a tissue volume in the shape of a cube. **SAR for hands, wrists, feet and ankles** is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

**Population/Uncontrolled Environments** are defined as locations where there is the exposure of 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**


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# 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)

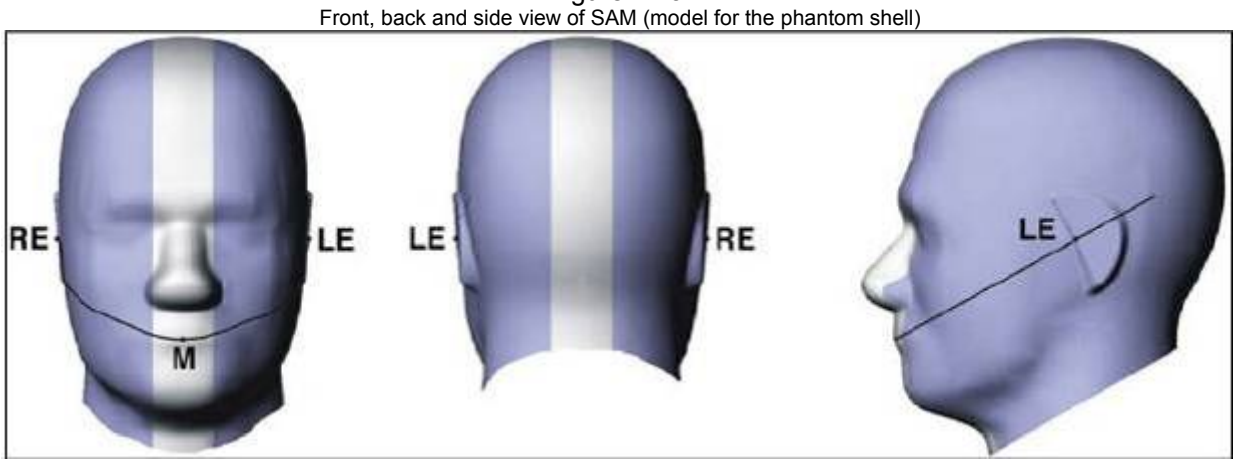


Figure 7-1b
Close up side view of phantom showing the ear region

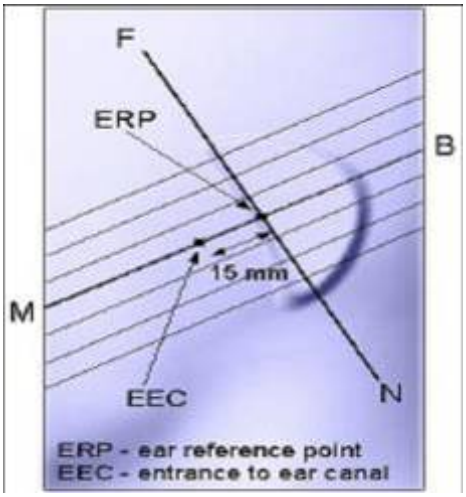


Figure 7-1b
Close up side view of phantom showing the ear region

Figure 7-1c
Side view of the phantom showing relevant markings and the 7 cross sectional plane locations

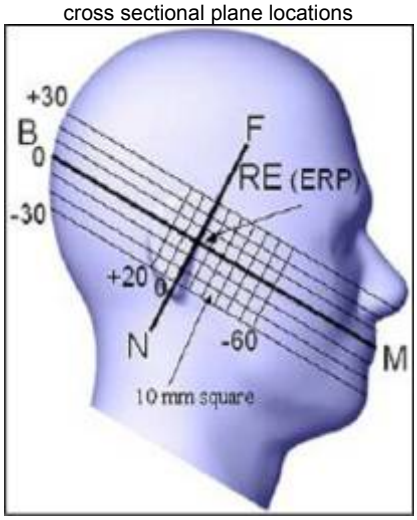


Figure 7-1c
Side view of the phantom showing relevant markings and the 7 cross sectional plane locations


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## 10.2 DEFINITION OF THE "CHEEK/TOUCH" POSITION

The "cheek" or "touch" position is defined as follows:

a. 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.)

b. 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 wt 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 wb 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.

c. 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.

d. Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the pinna.

e. 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.

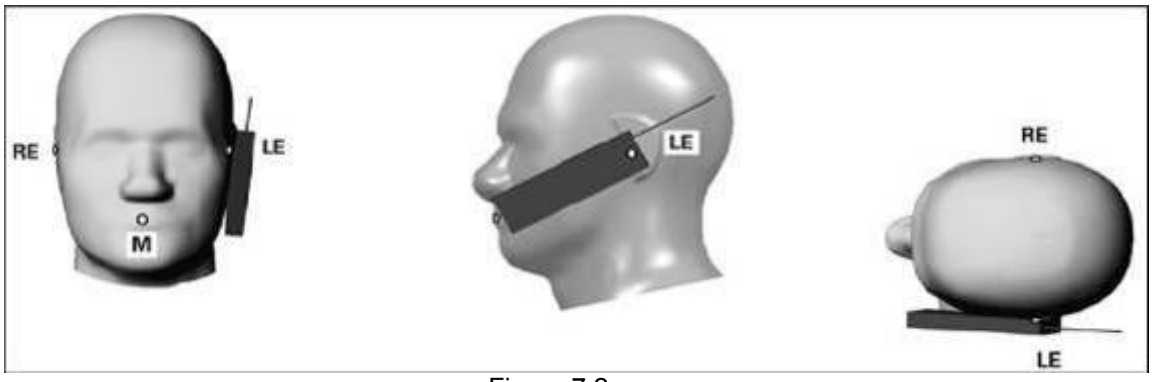


Figure 7.2c
Phone "cheek" or "touch" position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for handset positioning, are indicated.


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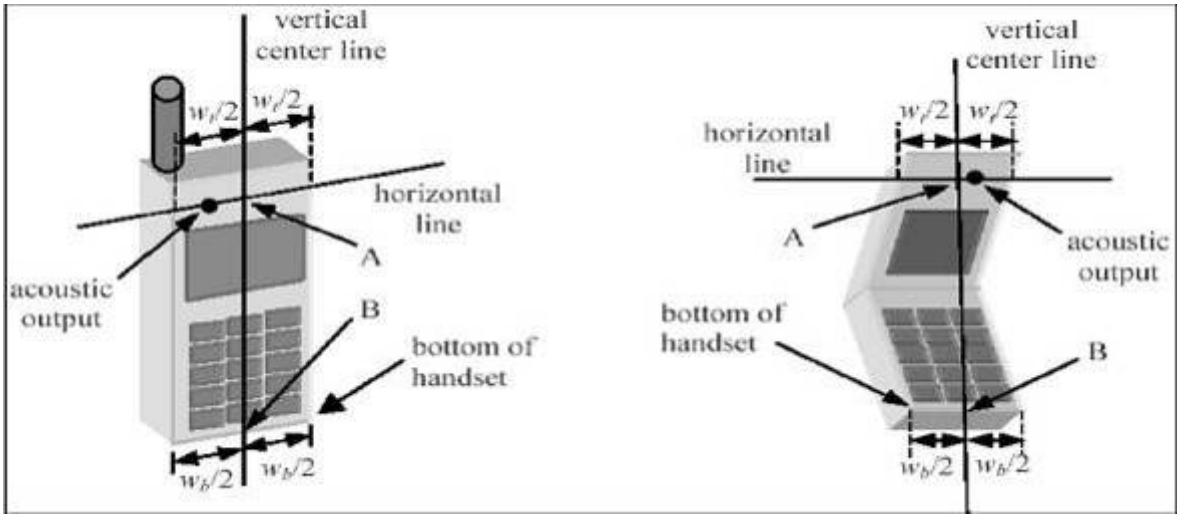


Figure 7.2a Figure 7.2b

## 10.3 DEFINITION OF THE "TILTED" POSITION

The "tilted" position is defined as follows:

a. Repeat steps (a) – (g) of 7.2 to place the device in the "cheek position."

b. 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.

c. Rotate the handset around the horizontal line by 15 degrees.

d. 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).

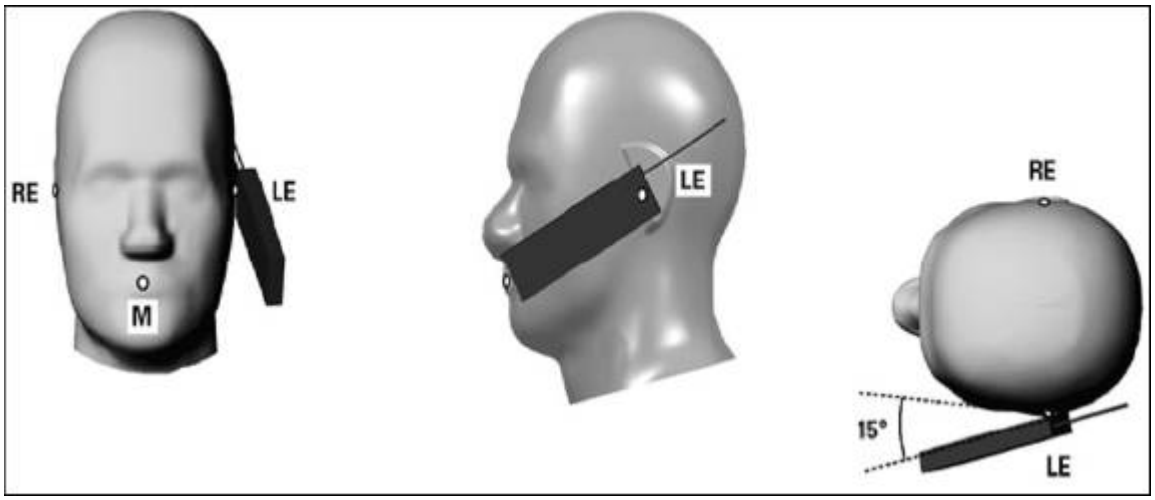


Figure 7-3
Phone "tilted" position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for handset positioning, are indicated.


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# 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.

**KDB865664 D01 RECOMMENDED TISSUE DIELECTRIC PARAMETERS**

The head and Body tissue dielectric parameters recommended by the KDB865664 D01 have been incorporated in the following table.

| Target Frequency (MHz) | Head | | Body | |
|---|---|---|---|---|
| | $\varepsilon_r$ | $\sigma$ (S/m) | $\varepsilon_r$ | $\sigma$ (S/m) |
| 150 | 52.3 | 0.76 | 61.9 | 0.80 |
| 300 | 45.3 | 0.87 | 58.2 | 0.92 |
| 450 | 43.5 | 0.87 | 56.7 | 0.94 |
| 835 | 41.5 | 0.90 | 55.2 | 0.97 |
| 900 | 41.5 | 0.97 | 55.0 | 1.05 |
| 915 | 41.5 | 0.98 | 55.0 | 1.06 |
| 1450 | 40.5 | 1.20 | 54.0 | 1.30 |
| 1610 | 40.3 | 1.29 | 53.8 | 1.40 |
| 1800-2000 | 40.0 | 1.40 | 53.3 | 1.52 |
| 2450 | 39.2 | 1.80 | 52.7 | 1.95 |
| 3000 | 38.5 | 2.40 | 52.0 | 2.73 |
| 5800 | 35.3 | 5.27 | 48.2 | 6.00 |

($\varepsilon_r$ = relative permittivity, $\sigma$ = conductivity and $\rho$ = 1000 kg/m$^3$)


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## 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(ε ) | 41.50 | 41.89 | 0.94 | ± 5 | 2014-9-15 |
| | | Conductivity(σ) | 0.90 | 0.89 | -1.11 | ± 5 | |
| Body835 | 21.5 | Permitivity(ε ) | 55.20 | 54.67 | -0.96 | ± 5 | 2014-9-15 |
| | | Conductivity(σ) | 0.97 | 0.96 | -1.03 | ± 5 | |
| Head1900 | 21.5 | Permitivity(ε ) | 40.00 | 38.92 | -2.70 | ± 5 | 2014-9-15 |
| | | Conductivity(σ) | 1.40 | 1.41 | 0.71 | ± 5 | |
| Body1900 | 21.5 | Permitivity(ε ) | 53.30 | 53.17 | -0.24 | ± 5 | 2014-9-15 |
| | | Conductivity(σ) | 1.52 | 1.55 | 1.97 | ± 5 | |


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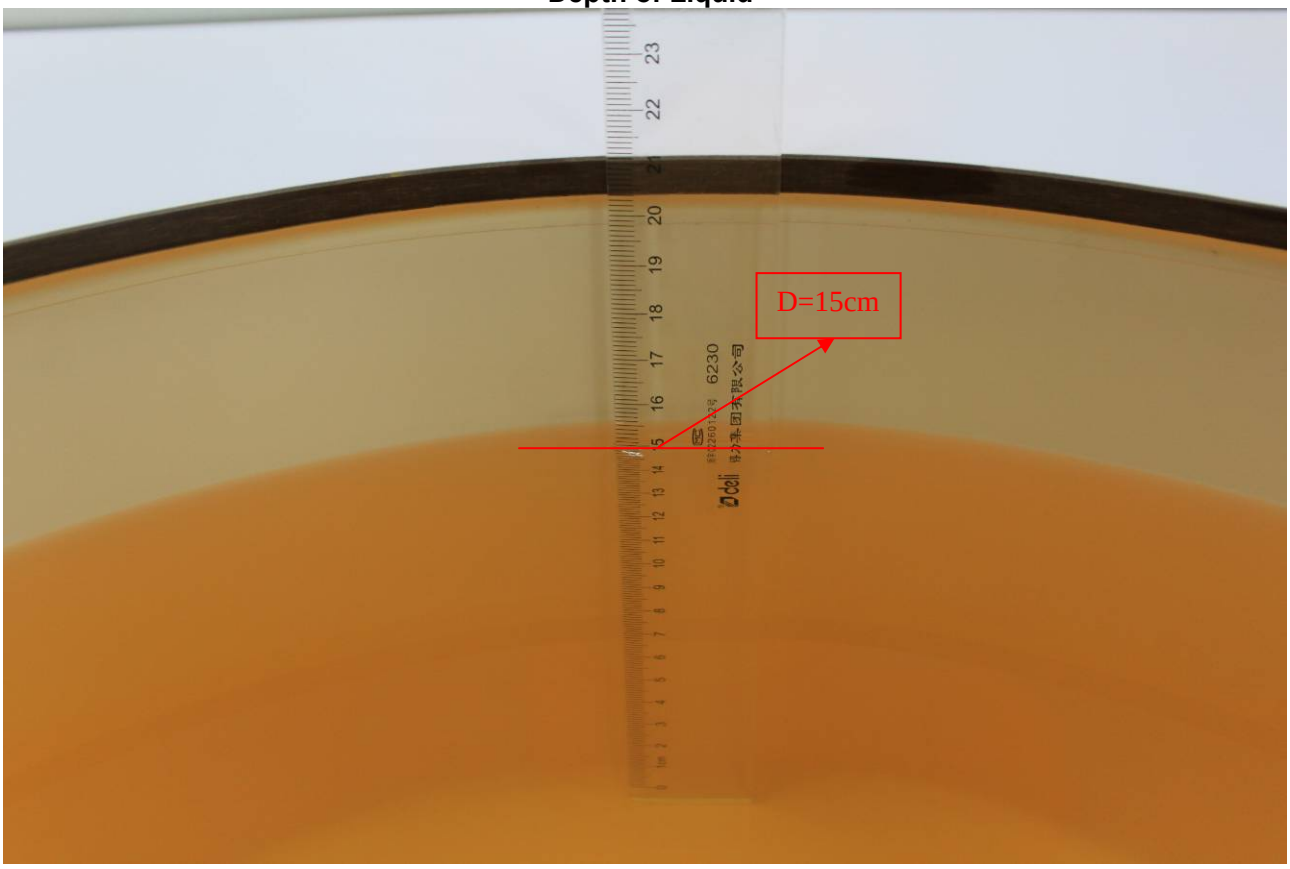
## 11.3 SYSTEM PERFORMANCE CHECK

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 ±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±3%.
- The results are normalized to 1 W input power.

**Depth of Liquid**




- Note: For SAR testing, the depth is 15cm shown above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**SYSTEM PERFORMANCE CHECK RESULTS**

| Liquid Type | Ambient Temp. (° C) | Liquid Temp. (°C) | Input Power (W) | Measured $SAR_{1g}$ (W/Kg) | 1W Target $SAR_{1g}$(W/Kg) | 1W Normalized $SAR_{1g}$(W/Kg) | Deviation (%) | Limited (%) | Date |
|---|---|---|---|---|---|---|---|---|---|
| Head835 | 22 | 21.5 | 0.25 | 2.38 | 9.50 | 9.52 | 0.21 | ± 10 | 2014-9-15 |
| Body835 | 22 | 21.5 | 0.25 | 2.36 | 9.53 | 9.44 | -0.94 | ± 10 | 2014-9-15 |
| Head1900 | 22 | 21.5 | 0.25 | 9.92 | 40.40 | 39.68 | -1.78 | ± 10 | 2014-9-15 |
| Body1900 | 22 | 21.5 | 0.25 | 10.25 | 40.50 | 41.00 | 1.23 | ± 10 | 2014-9-15 |


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## 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 test, the EUT was set in GSM Voice for GSM850 and PCS1900 due to its highest frame-average power.
3. For body SAR testing, the EUT was set in GPRS 4 Tx slots for GSM850 and GPRS 4 Tx PCS1900 due to its highest frame-average power.

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

| Band | GSM 850 | | | GSM 1900 | | |
|---|---|---|---|---|---|---|
| Channel | 128.00 | 190.00 | 251.00 | 512.00 | 661.00 | 810.00 |
| Frequency(MHz) | 824.20 | 836.60 | 848.80 | 1850.20 | 1880.00 | 1909.80 |
| Maximum Burst-Averaged Output Power | | | | | | |
| GSM(GMSK,1Uplink) | **29.92** | 29.83 | 29.69 | 27.32 | 28.41 | **28.79** |
| GPRS 8 (GMSK,1 Uplink) | **30.12** | 30.03 | 30.02 | 27.41 | 28.53 | **28.81** |
| GPRS 10 (GMSK,2 Uplink) | 28.97 | 28.95 | 28.84 | 26.14 | 26.23 | 26.54 |
| GPRS 11 (GMSK,3 Uplink) | 27.45 | 27.34 | 27.29 | 25.37 | 25.47 | 25.48 |
| GPRS 12 (GMSK,4 Uplink) | 26.52 | 25.51 | 26.61 | 24.72 | 24.66 | 24.68 |
| Maximum Frame-Averaged Output Power | | | | | | |
| GSM(GMSK,1Uplink) | 20.90 | 20.81 | 20.67 | 18.30 | 19.39 | 19.77 |
| GPRS 8 (GMSK,1 Uplink) | 21.09 | 21.00 | 20.99 | 18.38 | 19.50 | 19.78 |
| GPRS 10 (GMSK,2 Uplink) | 22.94 | 22.92 | 22.81 | 20.11 | 20.20 | 20.51 |
| GPRS 11 (GMSK,3 Uplink) | 23.19 | 23.08 | 23.03 | 21.11 | 21.21 | 21.22 |
| GPRS 12 (GMSK,4 Uplink) | 23.51 | 22.50 | **23.60** | **21.71** | 21.65 | 21.67 |

**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 D01v05r02, the maximum output power channel is used for SAR testing and for further SAR test reduction.


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

| Channel | Frequency | Average power(dBm) | | |
|---|---|---|---|---|
| | | Date Rate | | |
| | | 1Mbps | 2Mbps | 3Mbps |
| CH00 | 2402MHZ | 1.32 | 0.75 | 0.38 |
| CH39 | 2441MHZ | 1.54 | 0.83 | 0.44 |
| CH78 | 2480MHZ | **1.62** | 0.96 | 0.49 |

According to KDB447498 D01: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:
[(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)] · [$\sqrt{f_{(GHz)}}$] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR,[24] where

- $f_{(GHz)}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation[25]
- 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 < 5mm, 5mm is used for excluded SAR calculation

| | Wireless Interface | Bluetooth |
|---|---|---|
| Tune-up Maximum power (dBm) | | 2 |
| Tune-up Maximum rated power (mW) | | 1.585 |
| Head | Antenna to user (mm) | 5 |
| | Frequency(GHz) | 2.480 |
| | SAR exclusion threshold | 0.499 |
| Body | Antenna to user (mm) | 15 |
| | Frequency(GHz) | 2.480 |
| | SAR exclusion threshold | 0.166 |

Per KDB 447498 D01v05r02 exclusion thresholds is[(*max. power of channel, including tune-up tolerance:1.585 mW*)/(*min. test separation distance: 5mm*)] · [√2.480] =0.499< 3, Bluetooth RF exposure evaluation is not required.


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| Mode | The Tune-up Maximum Power(Customer Declared)(dBm) | Range | Measured Conduct Maximum Power(dBm) |
|---|---|---|---|
| GSM 850 | 30.5+/-1 | 29.5~30.5 | 29.92 |
| GPRS 850-1TS | 30+/-1 | 29~31 | 30.12 |
| GPRS 850-2TS | 28.5+/-1 | 27.5~29.5 | 28.97 |
| GPRS 850-3TS | 27+/-1 | 26~28 | 27.45 |
| GPRS 850-4TS | 26+/-1 | 25~27 | 26.61 |
| GSM 1900 | 28+/-1 | 27~29 | 28.79 |
| GPRS 1900-1TS | 28+/-1 | 27~29 | 28.81 |
| GPRS 1900-2TS | 26+/-1 | 25~27 | 26.54 |
| GPRS 1900-3TS | 25+/-1 | 24~26 | 25.48 |
| GPRS 1900-4TS | 24+/-1 | 23~25 | 24.72 |
| Bluetooth 1Mbps | 1+/-1 | 0~2 | 1.62 |
| Bluetooth 2 Mbps | 0.5+/-1 | -0.5~1.5 | 0.96 |
| Bluetooth 3Mbps | 0+/-1 | -1~1 | 0.49 |

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


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## 11.5 SAR TEST CONFIGURATIONS

**Body Exposure Conditions**

Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in KDB 447498 are used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

Body-worn accessories that do not contain metallic or conductive components may be tested according to worst-case exposure configurations, typically according to the smallest test separation distance required for the group of body-worn accessories with similar operating and exposure characteristics. All body-worn accessories containing metallic components are tested in conjunction with the host device.

Body-worn accessory SAR compliance is based on a single minimum test separation distance for all wireless and operating modes applicable to each body-worn accessory used by the host, and according to the relevant voice and/or data mode transmissions and operations. If a body-worn accessory supports voice only operations in its normal and expected use conditions, testing of data mode for body-worn compliance is not required.

A conservative minimum test separation distance for supporting off-the-shelf body-worn accessories that may be acquired by users of consumer handsets is used to test for body-worn accessory SAR compliance. This distance is determined by the handset manufacturer, according to the requirements of Supplement C 01-01. Devices that are designed to operate on the body of users using lanyards and straps, or without requiring additional body-worn accessories, will be tested using a conservative minimum test separation distance <= 5 mm to support compliance.

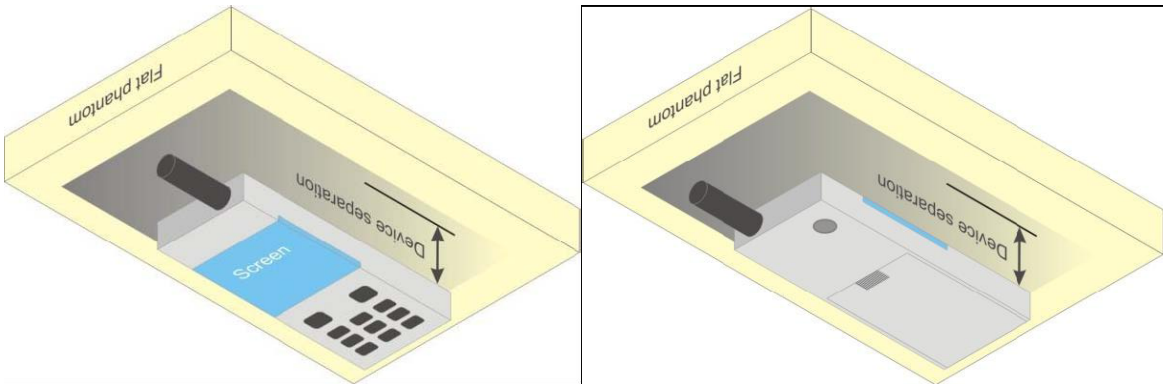


**Illustration for Body Worn Position**


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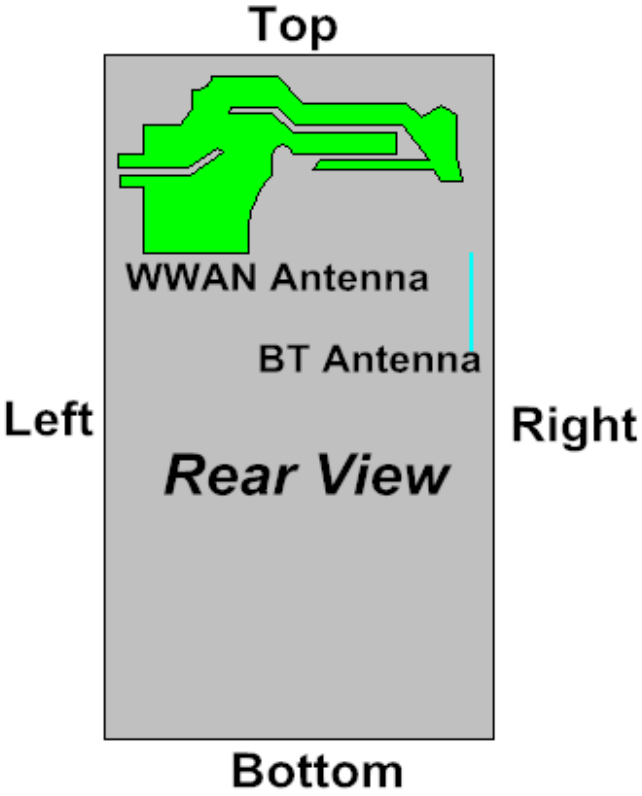
**Antenna Position**




Device dimensions (H x W): 108 x 45 mm

| Antennas | Wireless Interface |
|---|---|
| WWAN Antenna | GSM850<br>PCS1900 |
| BT Antenna | Bluetooth |

**Test Mode**

| | |
|---|---|
| GSM 850/PCS1900 | Data transmission mode(GPRS)/Voice mode(GSM) |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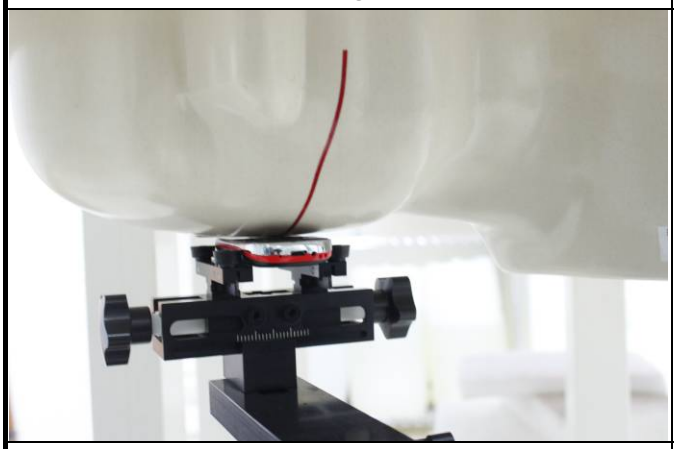
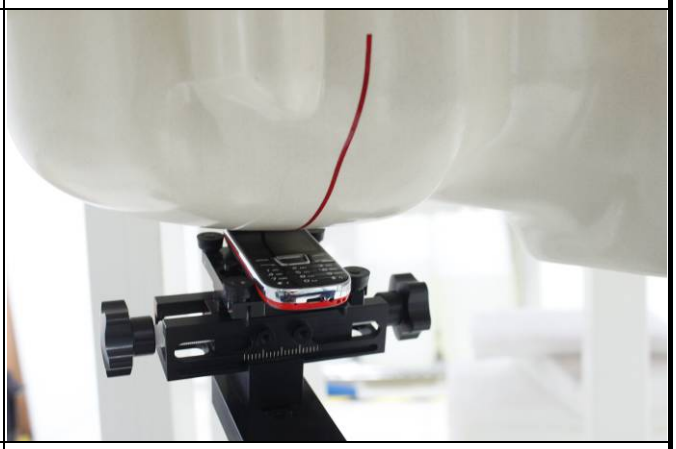
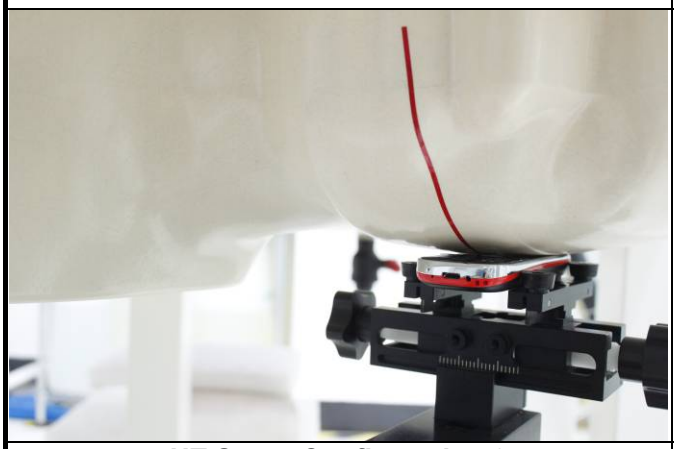
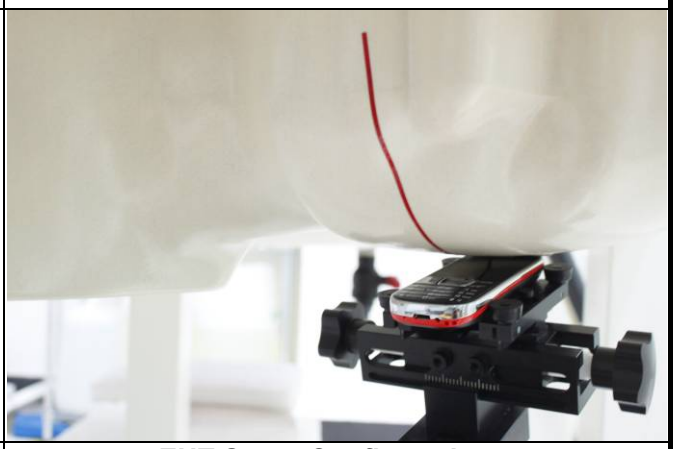
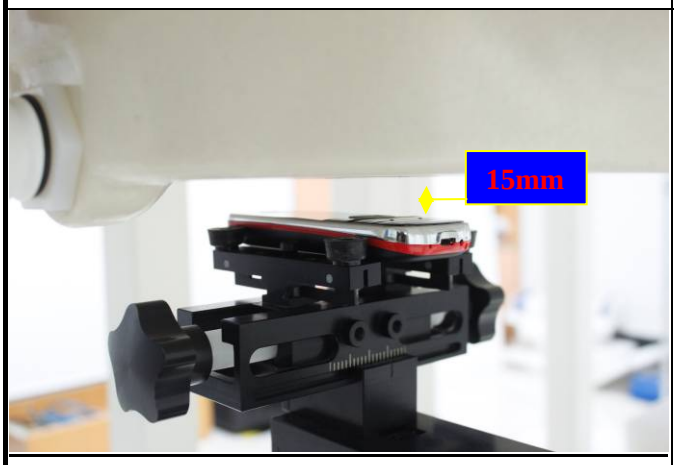
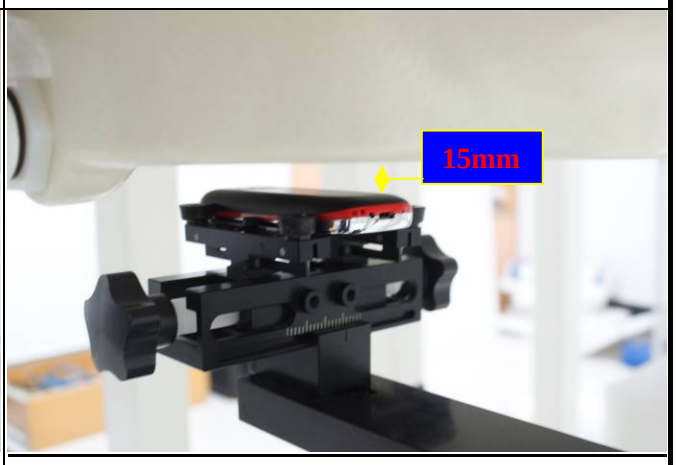
## 11.6 EUT SETUP PHOTOS

| Cheek device with right head phantom. | Tilt device with right head phantom |
|---|---|
|  |  |
| **EUT Setup Configuration 1** | **EUT Setup Configuration 2** |
| **Cheek device with left head phantom.** | **Tilt device with left head phantom** |
|  |  |
| **UT Setup Configuration 3** | **EUT Setup Configuration 4** |
| **Front in body position** | **Rear in body position** |
|   |   |
| **EUT Setup Configuration 5** | **EUT Setup Configuration 6** |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## 11.7 SAR MEASUREMENT RESULTS

**Head SAR Test Records**

**GSM SAR**

| 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 | 128 | 824.2 | 29.92 | 30.5 | 1.143 | -0.06 | 0.123 | 0.141 |
| GSM850 | Voice | Right Tilted | 128 | 824.2 | 29.92 | 30.5 | 1.143 | 0.07 | 0.051 | 0.058 |
| GSM850 | Voice | Left Cheek | 128 | 824.2 | 29.92 | 30.5 | 1.143 | 0.12 | 0.156 | 0.178 |
| GSM850 | Voice | Left Tilted | 128 | 824.2 | 29.92 | 30.5 | 1.143 | 0.14 | 0.084 | 0.096 |
| PCS1900 | Voice | Right Cheek | 810 | 1909.8 | 28.79 | 29 | 1.050 | -0.02 | 0.184 | 0.193 |
| PCS1900 | Voice | Right Tilted | 810 | 1909.8 | 28.79 | 29 | 1.050 | 0.16 | 0.224 | 0.235 |
| PCS1900 | Voice | Left Cheek | 810 | 1909.8 | 28.79 | 29 | 1.050 | -0.07 | 0.241 | 0.253 |
| PCS1900 | Voice | Left Tilted | 810 | 1909.8 | 28.79 | 29 | 1.050 | 0.08 | 0.244 | 0.256 |

**SAR Results for Body Position 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 | 15 | 251 | 848.8 | 26.61 | 27 | 1.143 | -0.31 | 0.109 | 0.118 |
| GSM850 | GPRS 4slots | Rear | 15 | 251 | 848.8 | 26.61 | 27 | 1.143 | -0.56 | 0.201 | 0.217 |
| GSM850 | Voice | Front | 15 | 251 | 848.8 | 29.92 | 30.5 | 1.197 | 0.12 | 0.103 | 0.118 |
| GSM850 | Voice | Rear | 15 | 251 | 848.8 | 29.92 | 30.5 | 1.197 | -0.01 | 0.293 | 0.335 |
| PCS1900 | GPRS 4slots | Front | 15 | 512 | 1850.2 | 24.72 | 25 | 1.138 | 0.13 | 0.241 | 0.255 |
| PCS1900 | GPRS 4slots | Rear | 15 | 512 | 1850.2 | 24.72 | 25 | 1.138 | -0.47 | 0.510 | 0.539 |
| PCS1900 | Voice | Front | 15 | 512 | 1850.2 | 28.79 | 29 | 1.148 | -0.06 | 0.243 | 0.255 |
| PCS1900 | Voice | Rear | 15 | 512 | 1850.2 | 28.79 | 29 | 1.148 | 0.05 | 0.525 | 0.551 |


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## 11.8 REPEATED SAR MEASUREMENT

**Note:**

1. Per KDB 865664 D01v01,for each frequence band,repeated SAR measurement is required only when the measured SAR is ≥ 0.8W/Kg
2. Per KDB 865664 D01v01,if the ratio of largest to smallest SAR for the original and first repeated measurement is ≤1.2 and the measured SAR ＜1.45W/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 ≥ 1.45 W/kg
4. The ratio is the difference in percentage between original and repeated measured SAR.


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## 11.9 SAR HANDSETS MULTI XMITER ASSESSMENT

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

**Note:**

1. The reported SAR summation is calculated based on the same configuration and test position.
2. 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 (10mm distance) |
|---|---|---|---|
| Estimated SAR (W/kg) | 2 dBm | 0.067 | 0.022 |

3 Per KDB 447498 D01v05, simultaneous transmission SAR is compliant if,

1) Scalar SAR summation < 1.6W/kg.
2) SPLSR = (SAR1 + SAR2)1.5 / (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 ≤ 0.04, simultaneously transmission SAR is compliant
3) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg


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**Result of SUM ∑SAR1g of Head**

| SUM ∑SAR1g (GSM850+ Bluetooth) | | | | |
|---|---|---|---|---|
| Position | Distance | Stand alone SAR(1g) [W/kg] | | SUM SAR(1g)[W/kg] |
| | [mm] | GSM850 | Bluetooth | WWAN + Bluetooth |
| Right Cheek | 0 | 0.141 | 0.067 | 0.208 |
| Right Tilted | 0 | 0.058 | 0.067 | 0.125 |
| Left Cheek | 0 | 0.178 | 0.067 | 0.245 |
| Left Tilted | 0 | 0.096 | 0.067 | 0.163 |

| SUM ∑SAR1g (PCS1900 Bluetooth) | | | | |
|---|---|---|---|---|
| Position | Distance | Stand alone SAR(1g) [W/kg] | | SUM SAR(1g)[W/kg] |
| | [mm] | PCS1900 | Bluetooth | WWAN + Bluetooth |
| Right Cheek | 0 | 0.193 | 0.067 | 0.260 |
| Right Tilted | 0 | 0.235 | 0.067 | 0.302 |
| Left Cheek | 0 | 0.253 | 0.067 | 0.320 |
| Left Tilted | 0 | 0.256 | 0.067 | 0.323 |

**Result of SUM ∑SAR1g for Body**

| SUM ∑SAR1g (GSM850+ Bluetooth) | | | | |
|---|---|---|---|---|
| Position | Distance | Stand alone SAR(1g) [W/kg] | | SUM SAR(1g)[W/kg] |
| | [mm] | GSM850 | Bluetooth | WWAN + Bluetooth |
| Front | 15 | 0.118 | 0.022 | 0.140 |
| Rear | 15 | 0.335 | 0.022 | 0.357 |

| SUM ∑SAR1g (PCS1900 Bluetooth) | | | | |
|---|---|---|---|---|
| Position | Distance | Stand alone SAR(1g) [W/kg] | | SUM SAR(1g)[W/kg] |
| | [mm] | PCS1900 | Bluetooth | WWAN + Bluetooth |
| Front | 15 | 0.255 | 0.022 | 0.277 |
| Rear | 15 | 0.551 | 0.022 | 0.573 |


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# 12. EUT PHOTO

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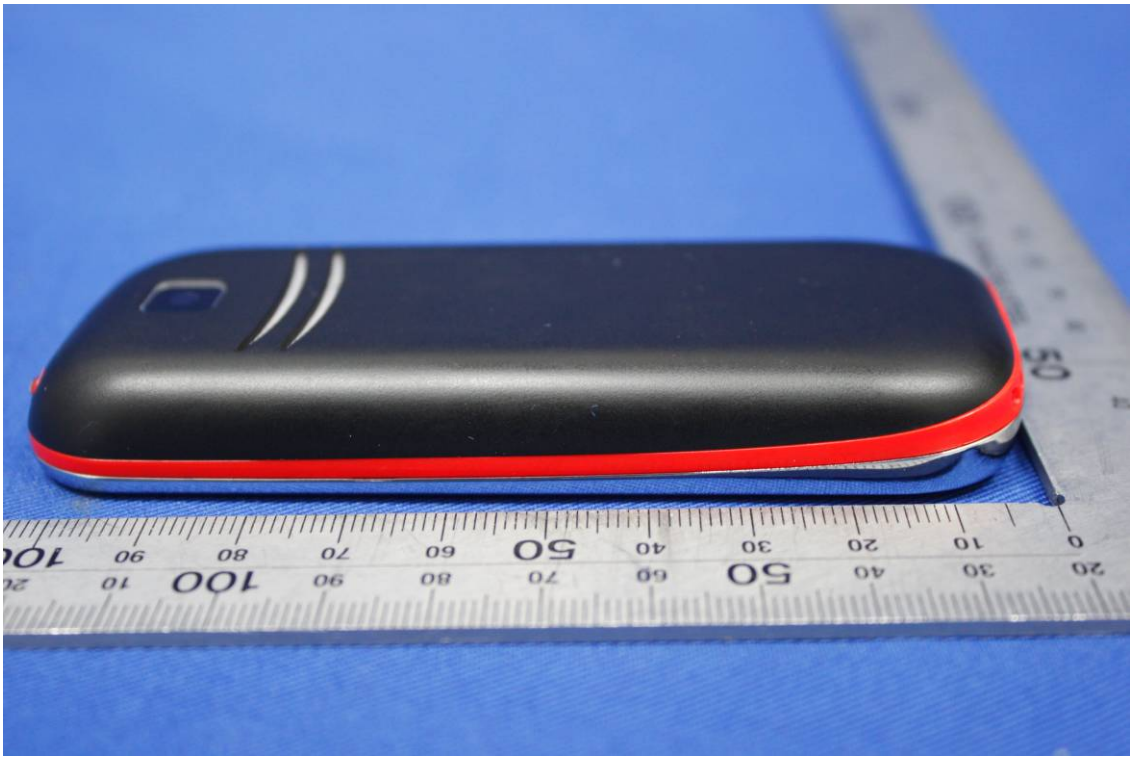

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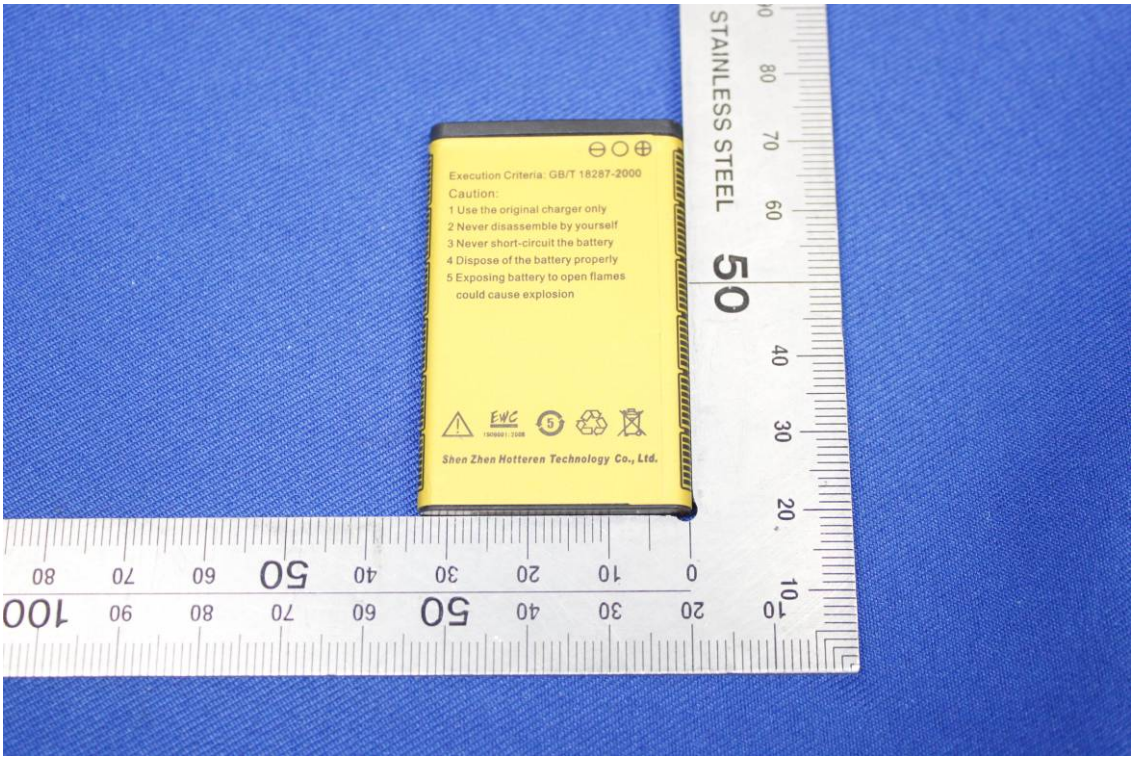



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# 13. EQUIPMENT LIST & CALIBRATION STATUS

| 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 | 7/21/2015 |
| DIPOLE 835MHZ ANTENNA | SPEAG | D835V2 | 4d114 | 07/30/2013 | 07/28/2015 |
| DIPOLE 1900MHZ ANTENNA | SPEAG | D1900V2 | 5d136 | 07/22/2013 | 07/20/2015 |
| DUMMY PROBE | SPEAG | DP_2 | SPDP2001AA | 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 |


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# 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

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[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.

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[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.

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[13] NIS81 NAMAS, \The treatment of uncertainity 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


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# 16. ATTACHMENTS

| Exhibit | Content |
|---|---|
| 1 | System Performance Check Plots |
| 2 | Dipole calibration report D835V2 SN:4d114 |
| 3 | Dipole calibration report D1900V2-SN:5d136 |
| 4 | DAE calibration report DEA4 SD000D04BM SN: 1245 |
| 5 | Probe calibration report EX3DV4 SN :3798 |
| 6 | SAR Test Plots |


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## APPENDIX A: PLOTS OF PERFORMANCE CHECK

**The plots are showing as followings.**


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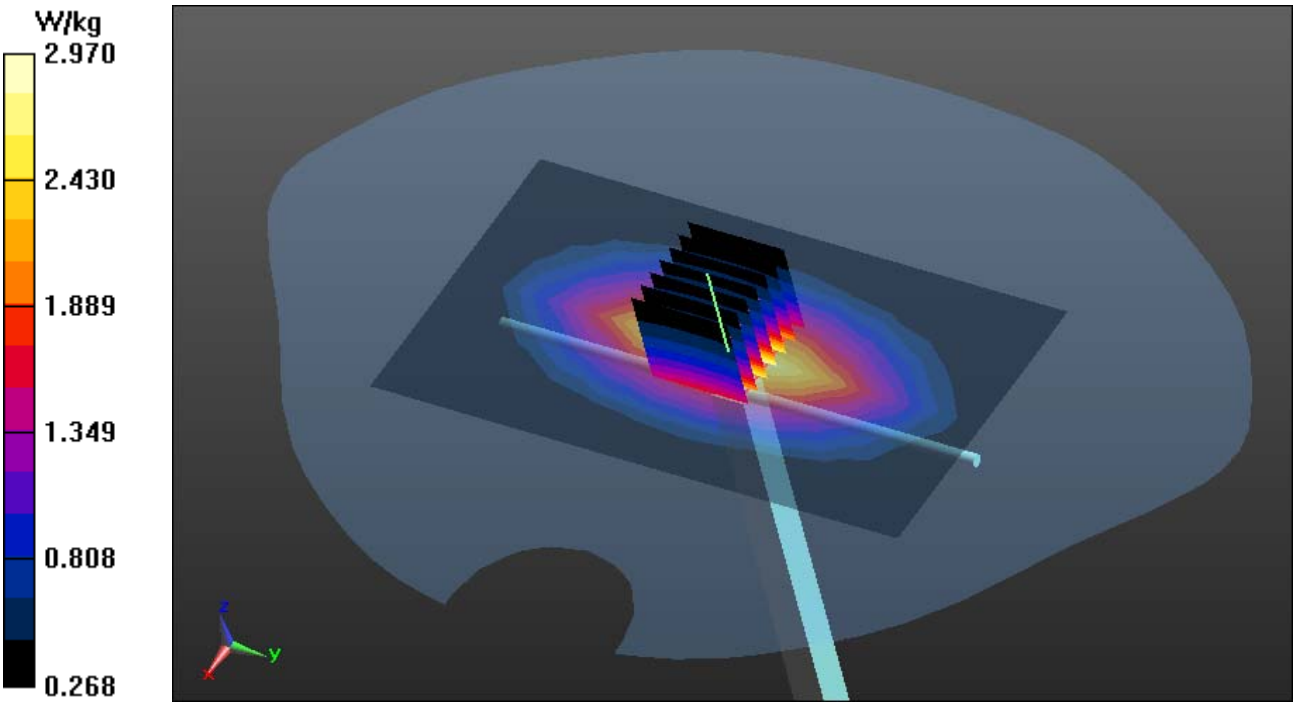
Test Laboratory: Compliance Certification Services Inc. Date: 9/15/2014
**System Performance Check-Head D835**
**DUT: Dipole 835 MHz D835V2; Type: D835V2; SN4d114**
Communication System: CW; Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: f = 835 MHz; $\sigma$ = 0.891 S/m; $\varepsilon_r$ = 41.886; $\rho$ = 1000 kg/m$^3$
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(9.30, 9.30, 9.30); Calibrated: 07/28/2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 07/22/2014
- 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 Low 1 GHz/d=15mm, Pin=250 mW, dist=3.0mm (EX-Probe)/Area Scan (7x12x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 2.95 W/kg

**System Performance Check at Frequencies Low 1 GHz/d=15mm, Pin=250 mW, dist=3.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 59.03 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 3.54 W/kg
**SAR(1 g) = 2.38 W/kg; SAR(10 g) = 1.57 W/kg**
Maximum value of SAR (measured) = 2.97 W/kg





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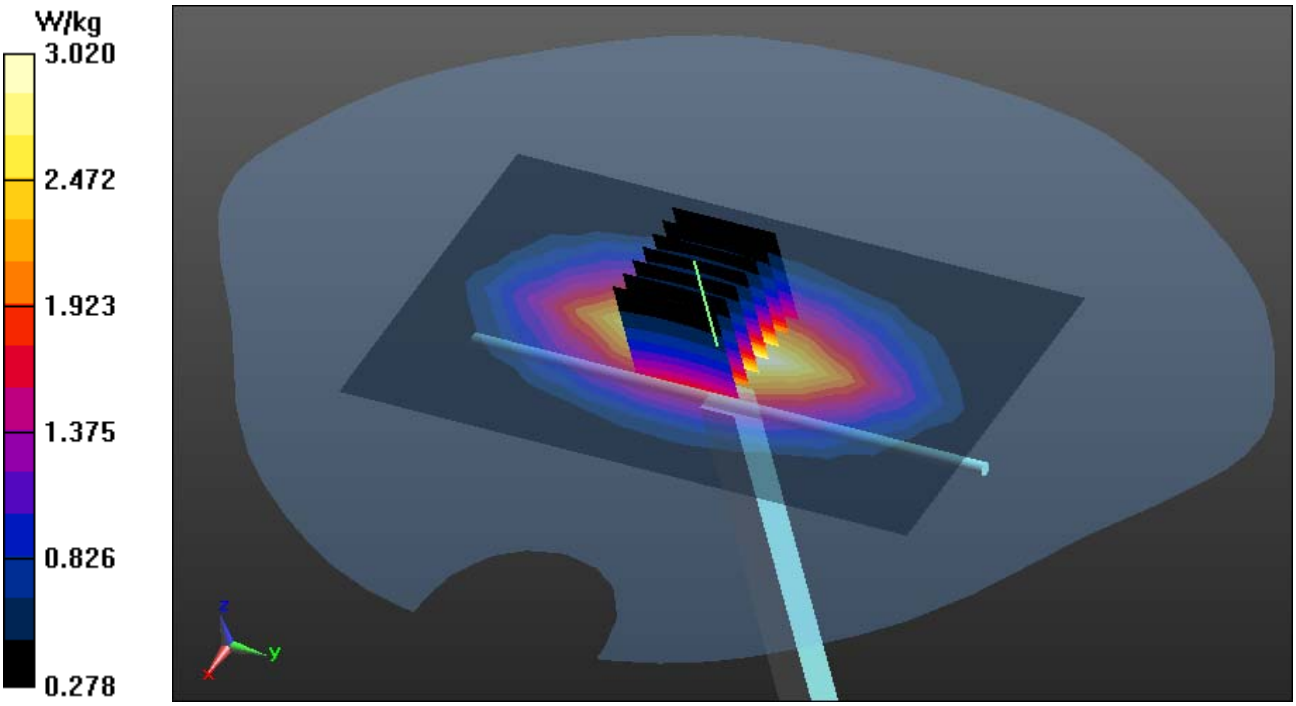
Test Laboratory: Compliance Certification Services Inc. Date: 9/15/2014
**System Performance Check-Body D835**
**DUT: Dipole 835 MHz D835V2; Type: D835V2; SN4d114**
Communication System: CW; Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: f = 835 MHz; $\sigma$ = 0.962 S/m; $\varepsilon_r$ = 54.669; $\rho$ = 1000 kg/m$^3$
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(9.22, 9.22, 9.22); Calibrated: 07/28/2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 07/22/2014
- 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 Low 1 GHz/d=15mm, Pin=250 mW, dist=3.0mm (EX-Probe)/Area Scan (7x12x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 3.25 W/kg

**System Performance Check at Frequencies Low 1 GHz/d=15mm, Pin=250 mW, dist=3.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 60.53 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 3.56 W/kg
**SAR(1 g) = 2.36 W/kg; SAR(10 g) = 1.54 W/kg**
Maximum value of SAR (measured) = 3.02 W/kg





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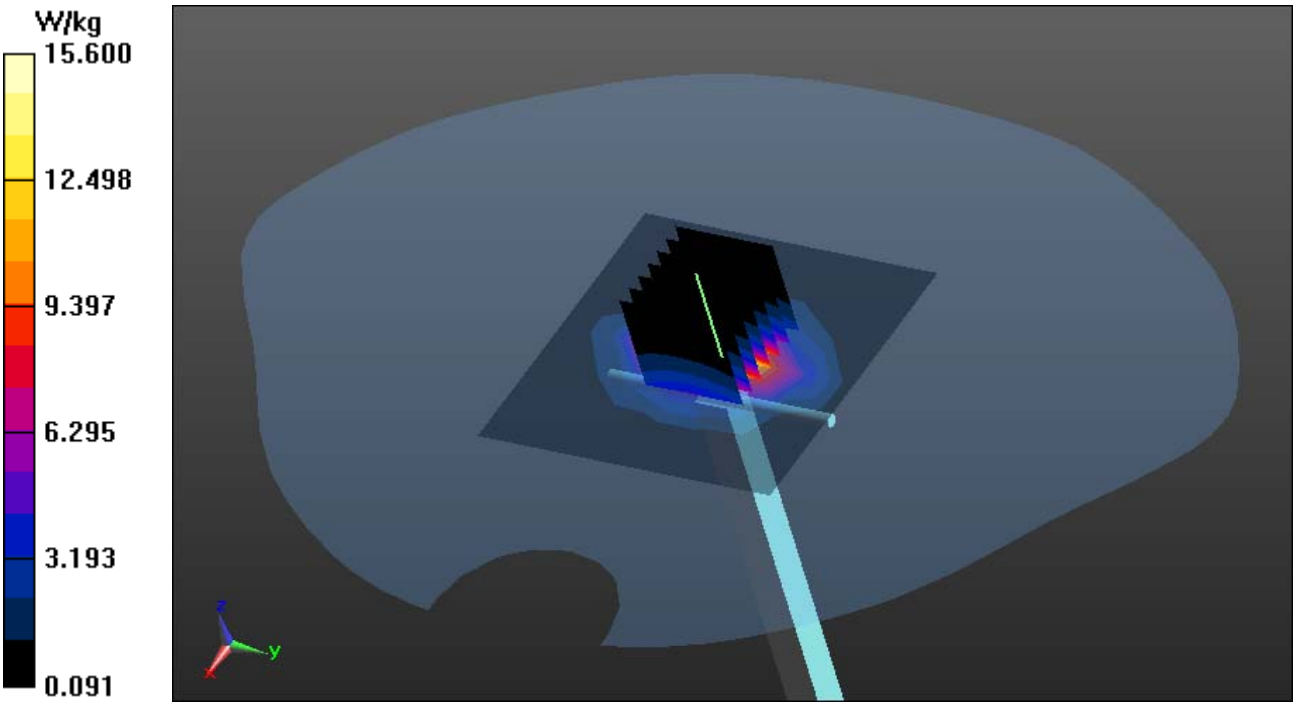
Test Laboratory: Compliance Certification Services Inc. Date: 9/15/2014
**System Performance Check-Head D1900**
**DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; SN:5d136**
Communication System: CW; Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.411 S/m; $\varepsilon_r$ = 38.923; $\rho$ = 1000 kg/m$^3$
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(7.75, 7.75, 7.75); Calibrated: 07/28/2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 07/22/2014
- 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/d=10mm, Pin=250 mW, dist=10mm (EX-Probe)/Area Scan (7x7x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 14.3 W/kg

**System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=10mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 104.1 V/m; Power Drift = 0.17 dB
Peak SAR (extrapolated) = 21.6 W/kg
**SAR(1 g) = 9.92 W/kg; SAR(10 g) = 4.89 W/kg**
Maximum value of SAR (measured) = 15.6 W/kg





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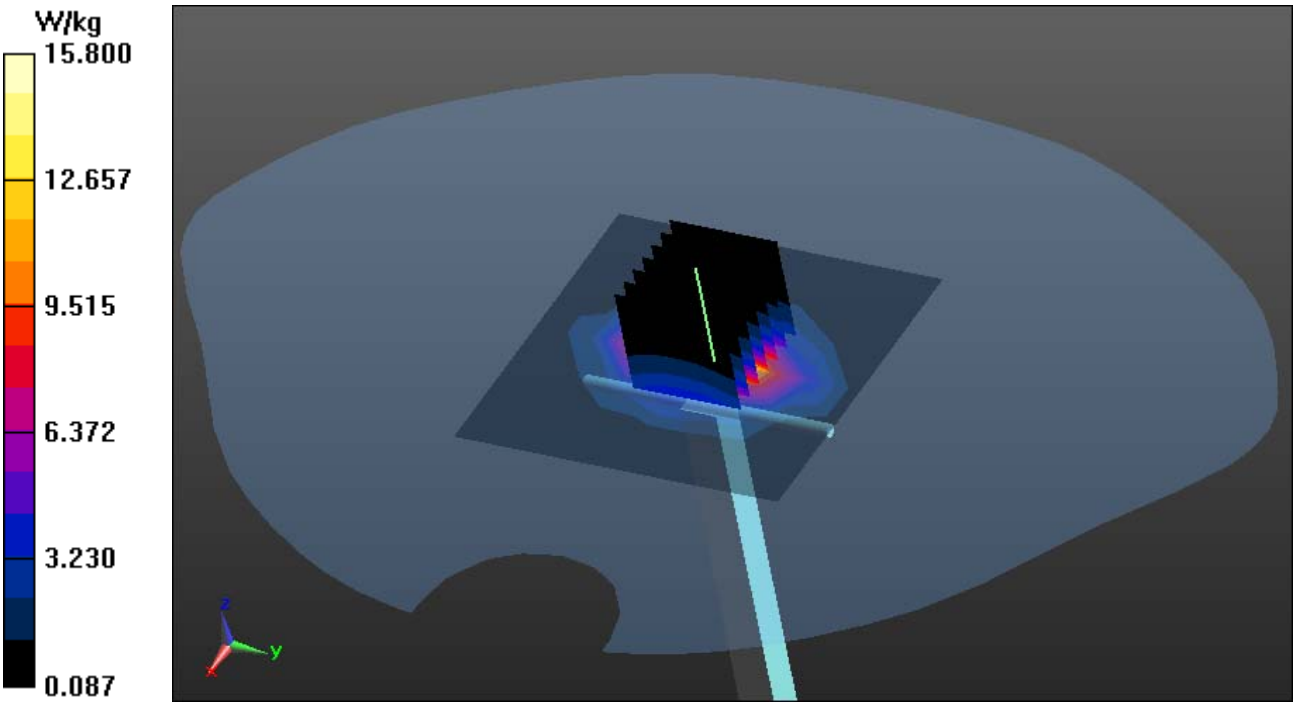
Test Laboratory: Compliance Certification Services Inc. Date: 9/15/2014
**System Performance Check-Body D1900**
**DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; SN:5d136**
Communication System: CW; Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.548 S/m; $\varepsilon_r$ = 53.171; $\rho$ = 1000 kg/m$^3$
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(7.09, 7.09, 7.09); Calibrated: 07/28/2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1245; Calibrated: 07/22/2014
- 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/d=10mm, Pin=250 mW, dist=10mm (EX-Probe)/Area Scan (7x7x1):** Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 14.6 W/kg

**System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=10mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 100.0 V/m; Power Drift = 0.20 dB
Peak SAR (extrapolated) = 21.5 W/kg
**SAR(1 g) = 10.25 W/kg; SAR(10 g) = 4.83 W/kg**
Maximum value of SAR (measured) = 15.8 W/kg





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## APPENDIX B: DASY CALIBRATION CERTIFICATE

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


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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
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<br>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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter EPM-442A | GB37480704 | 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: | Claudio Leubler | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: July 30, 2013

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


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

**S** Schweizerischer Kalibrierdienst
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**S** Servizio svizzero di taratura
Swiss Calibration Service

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

**Accreditation No.: SCS 108**

**Glossary:**

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

**Calibration is Performed According to the Following Standards:**

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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%.


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## 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 ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 41.5 | 0.90 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 41.8 ± 6 % | 0.92 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (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 ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (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 ± 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 ± 0.2) °C | 54.9 ± 6 % | 1.00 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (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 ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (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 ± 16.5 % (k=2)** |


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## Appendix

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 52.1 Ω - 1.3 jΩ |
| Return Loss | - 32.1 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 48.2 Ω - 3.0 jΩ |
| 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 |


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## 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**

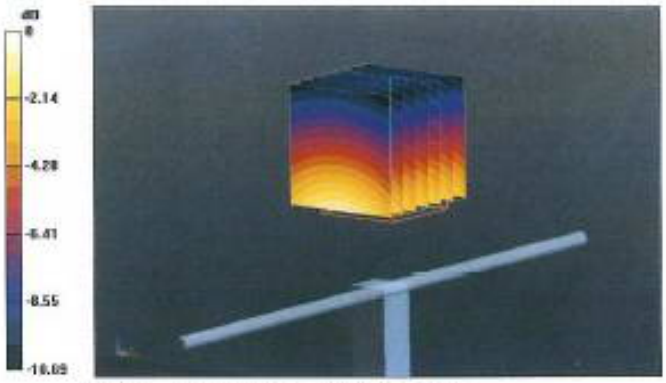
Communication System: UID 0 - CW ; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; $\sigma$ = 0.92 S/m; $\varepsilon_r$ = 41.8; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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




0 dB = 2.81 W/kg = 4.49 dBW/kg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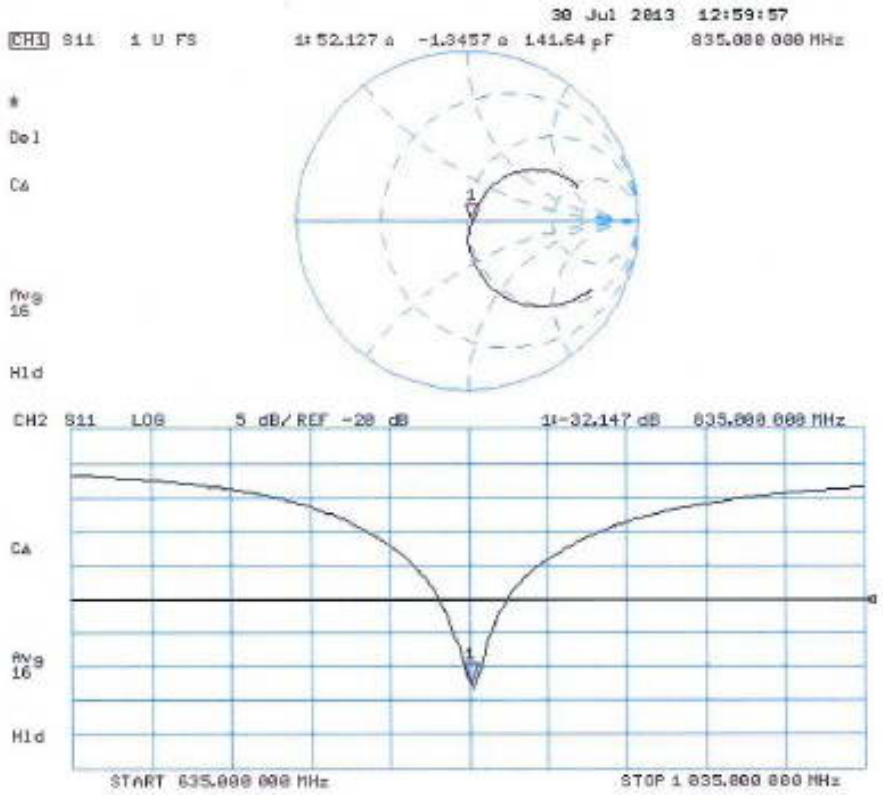
**Impedance Measurement Plot for Head TSL**





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## DASY5 Validation Report for Body TSL

Date: 22.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

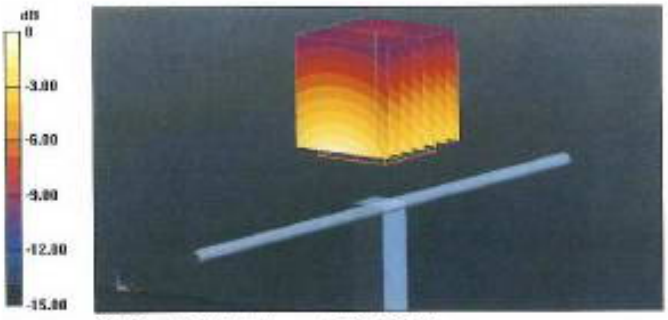
**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d114**

Communication System: UID 0 - CW ; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; $\sigma$ = 1 S/m; $\varepsilon_r$ = 54.9; $\rho$ = 1000 kg/m$^3$
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




0 dB = 2.83 W/kg = 4.52 dBW/kg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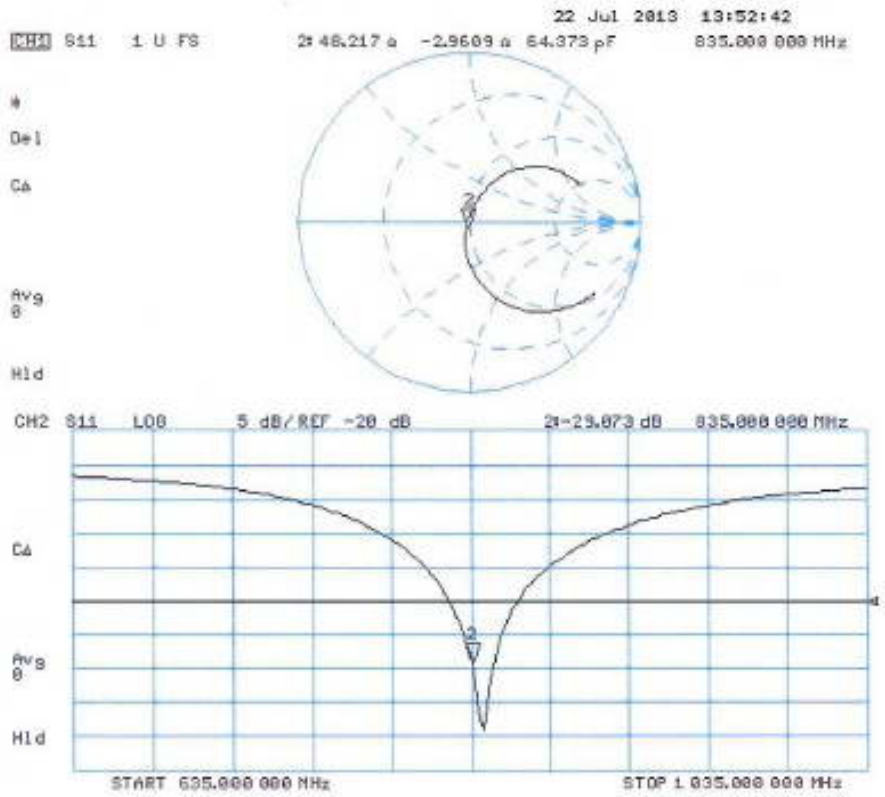
**Impedance Measurement Plot for Body TSL**





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## 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.


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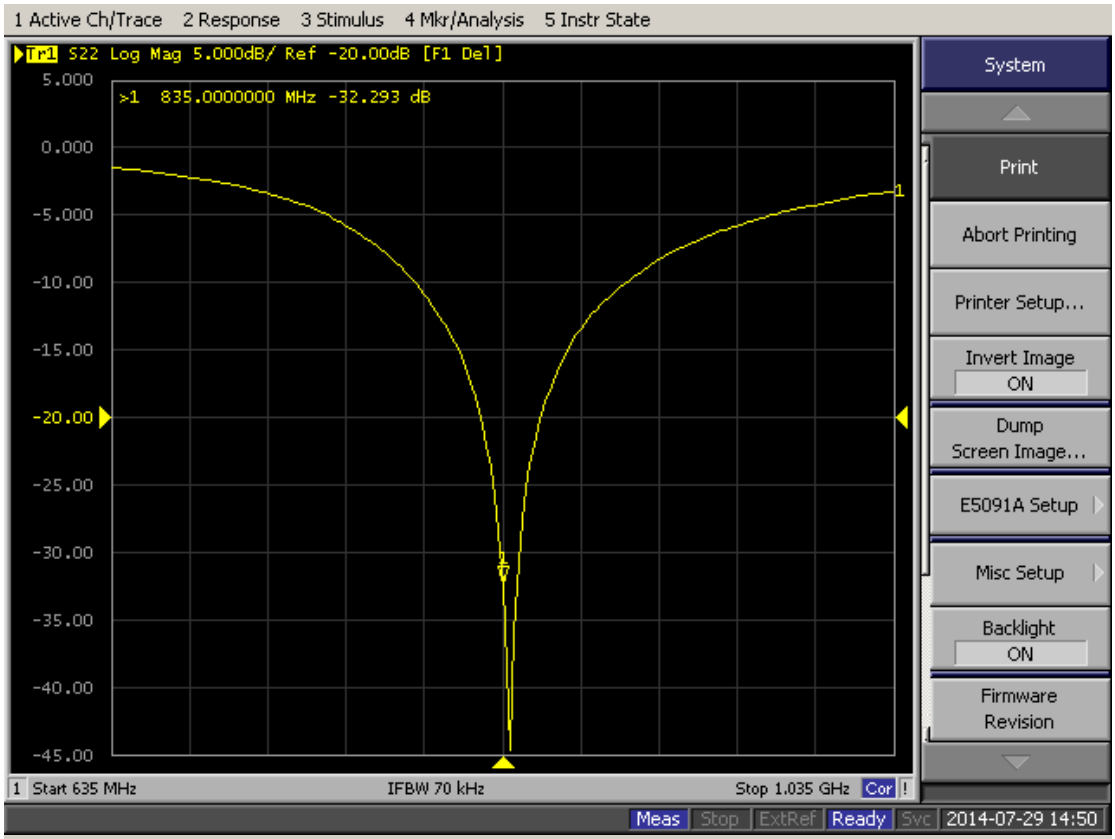
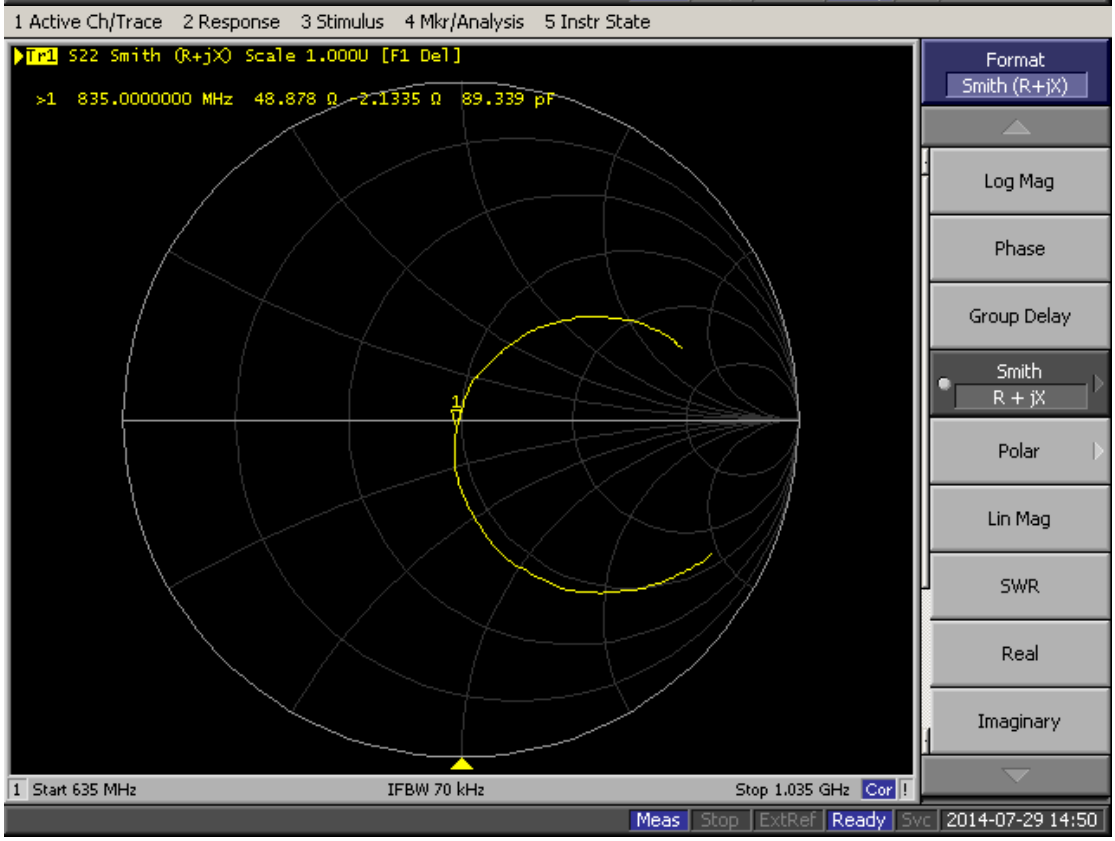
Dipole Verification Data D850V2 Serial No.4d114
850MHz-Head





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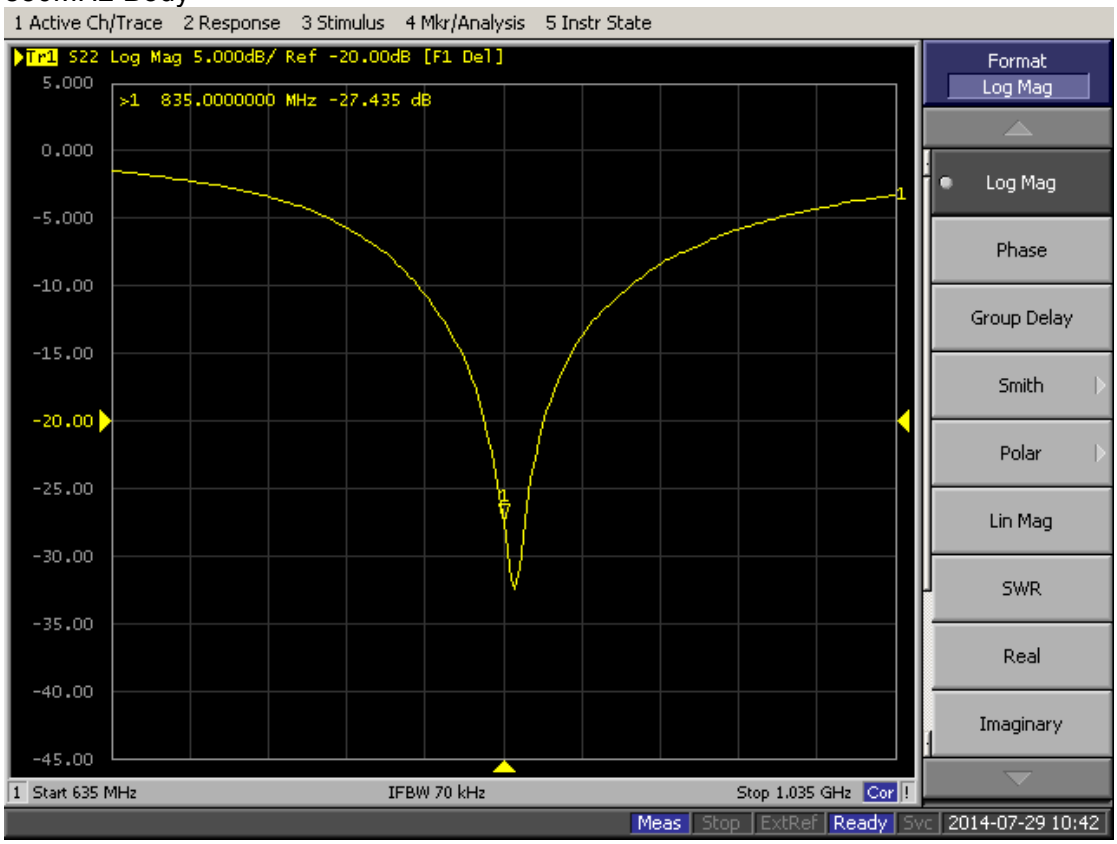
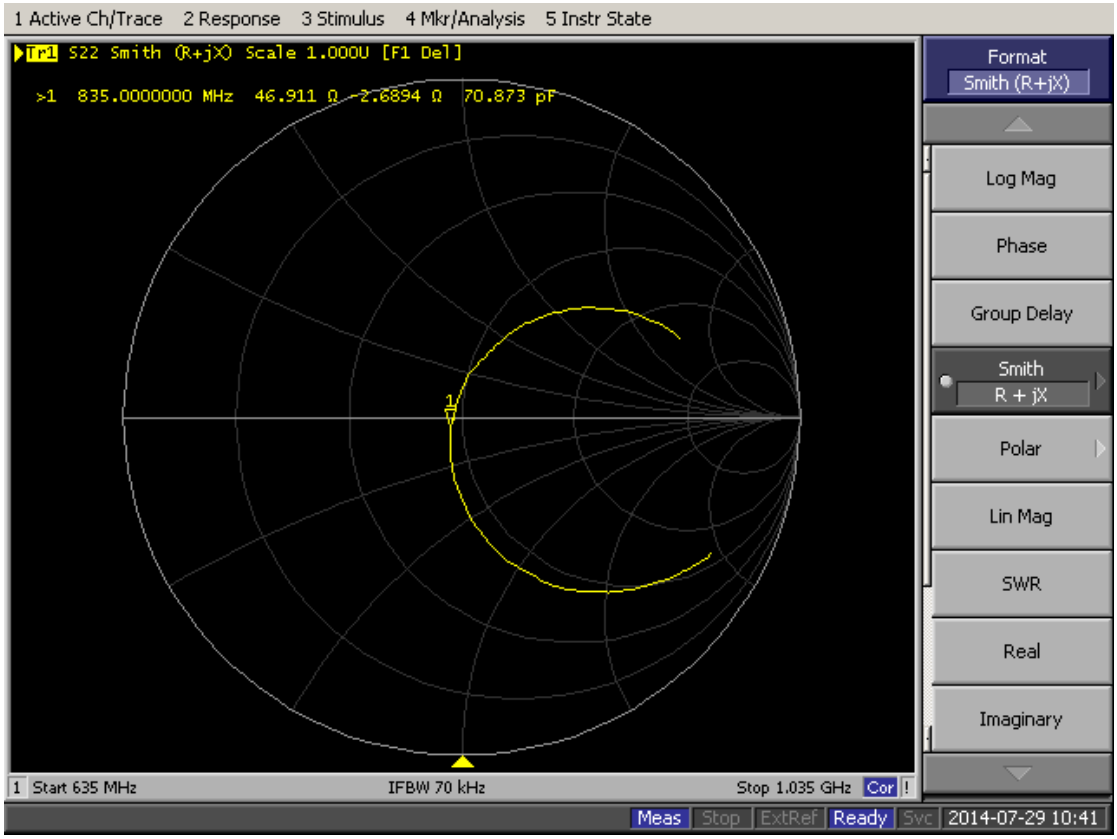
850MHz-Body





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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: D1900V2-5d136_Jul13**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1900V2 - SN: 5d136 |
| Calibration procedure(s) | QA CAL-05.v9<br>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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter EPM-442A | GB37480704 | 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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**S** Swiss Calibration Service

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**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:**

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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%.


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## 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 ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 40.0 | 1.40 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 38.9 ± 6 % | 1.36 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (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 ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (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 ± 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 ± 0.2) °C | 53.4 ± 6 % | 1.49 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (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 ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (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 ± 16.5 % (k=2)** |


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## Appendix

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 52.9 Ω + 7.2 jΩ |
| Return Loss | - 22.5 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 47.7 Ω + 7.3 jΩ |
| 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 |


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## 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**

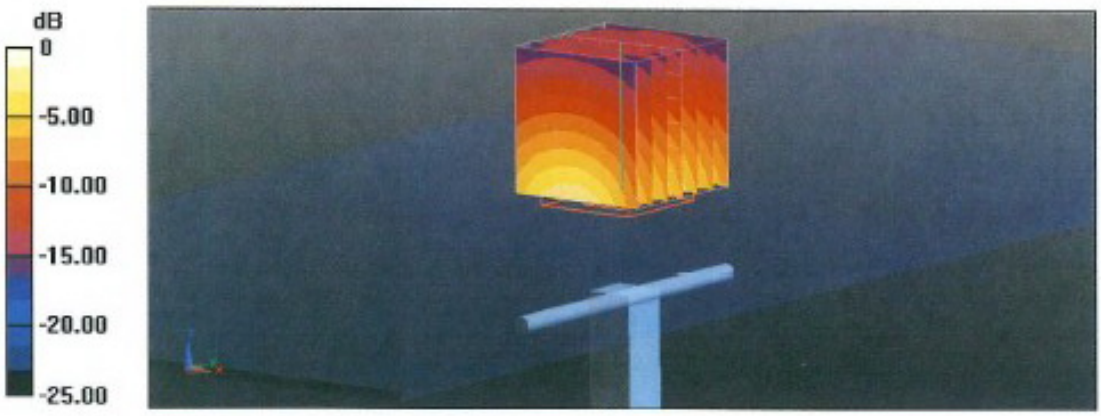
Communication System: UID 0 - CW ; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.36 S/m; $\varepsilon_r$ = 38.9; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

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




0 dB = 12.4 W/kg = 10.93 dBW/kg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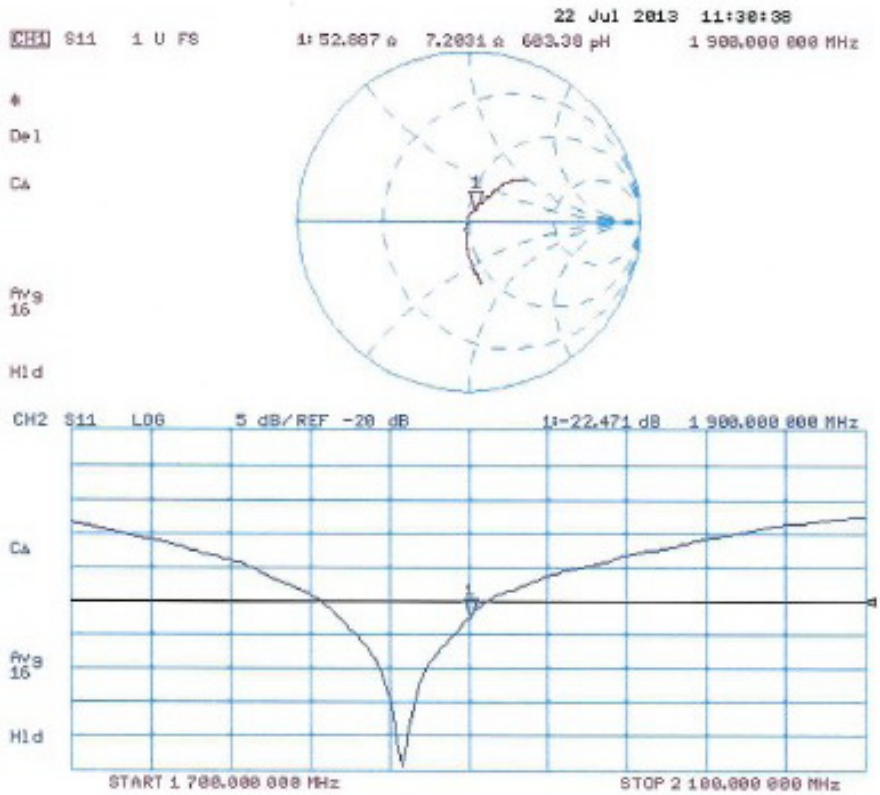
**Impedance Measurement Plot for Head TSL**





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## DASY5 Validation Report for Body TSL

Date: 22.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

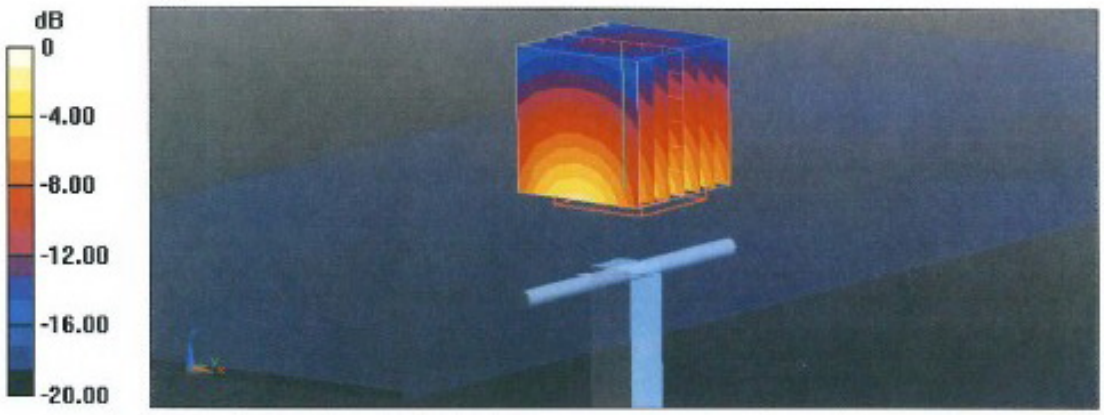
**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d136**

Communication System: UID 0 - CW ; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.49 S/m; $\varepsilon_r$ = 53.4; $\rho$ = 1000 kg/m$^3$
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: 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 = 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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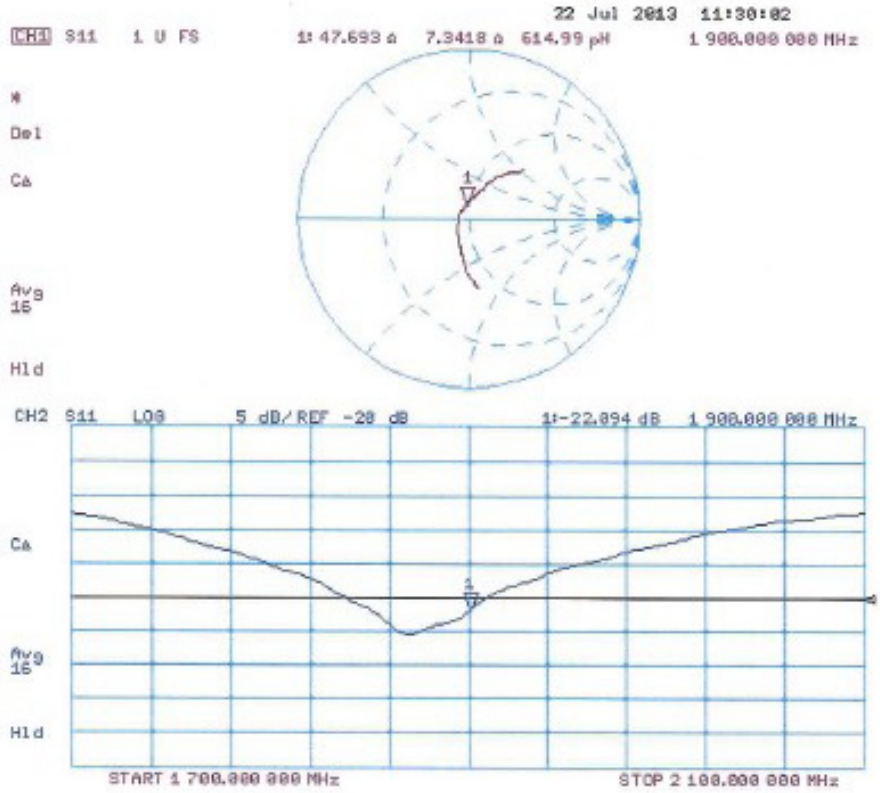
**Impedance Measurement Plot for Body TSL**





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## 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.


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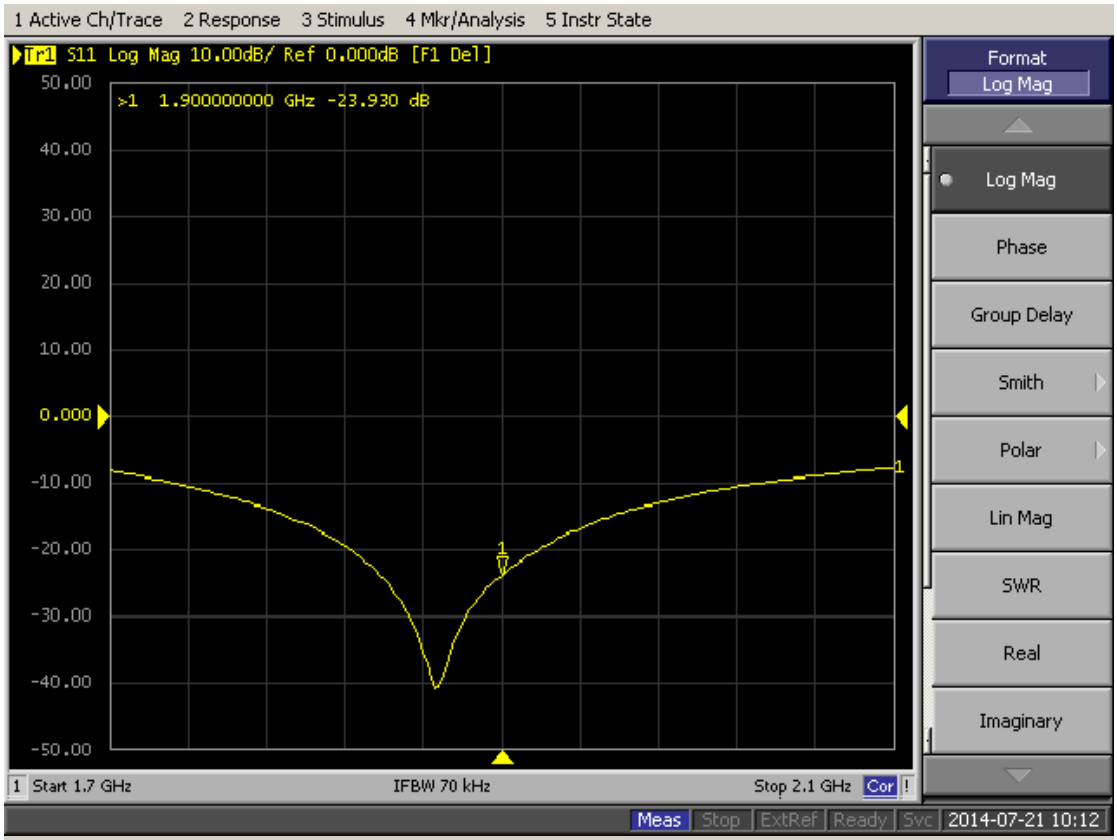
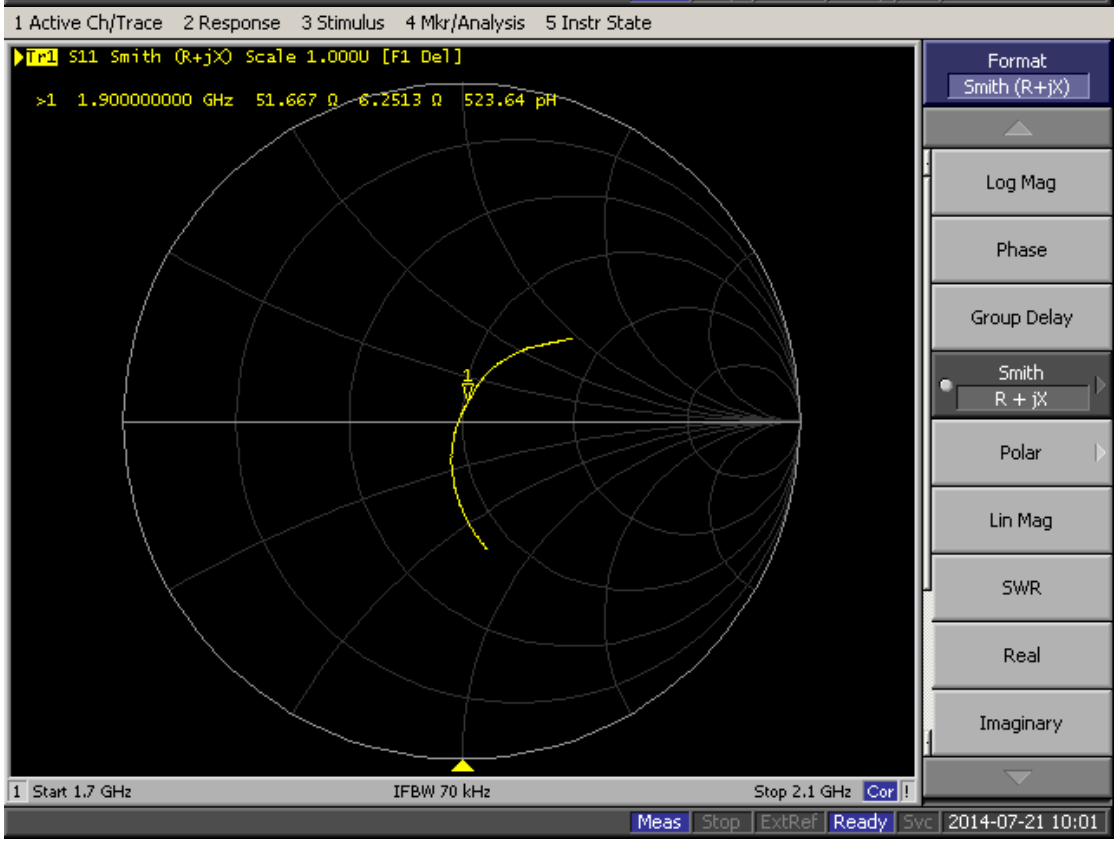
Dipole Verification Data D1900V2 Serial No.5d136
1900MHz-Head





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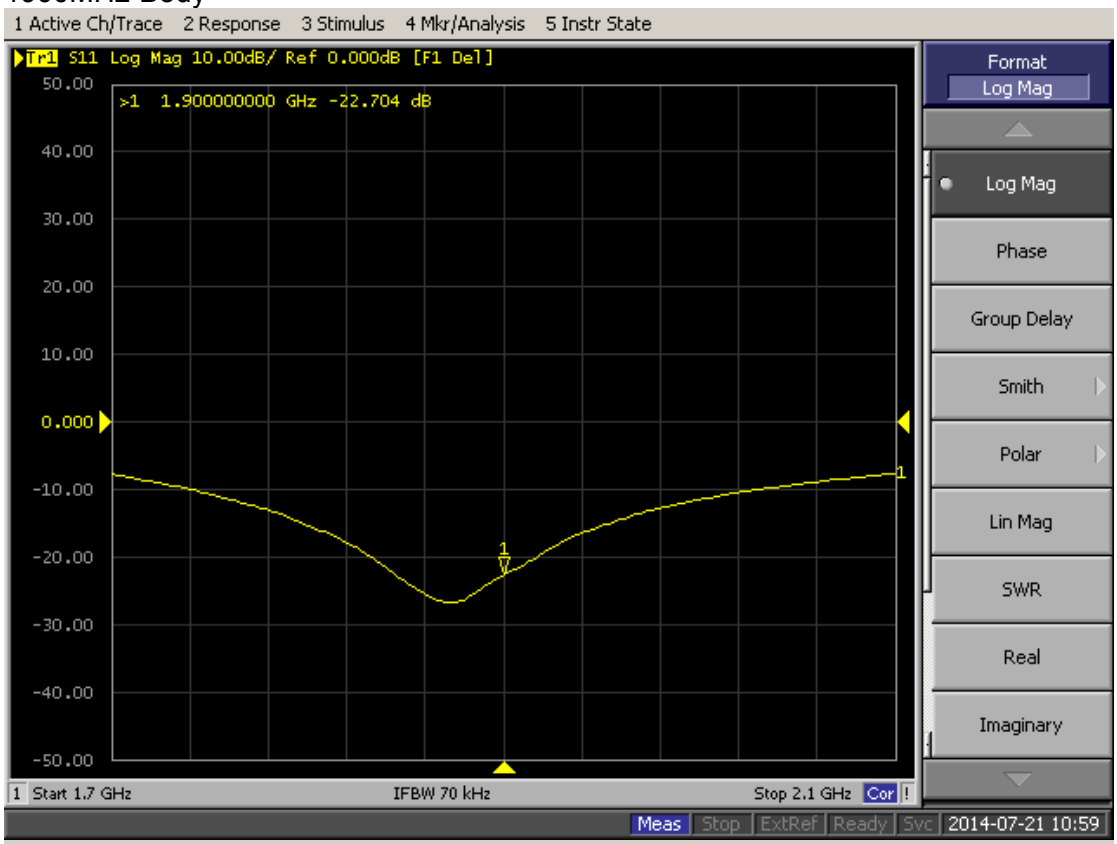
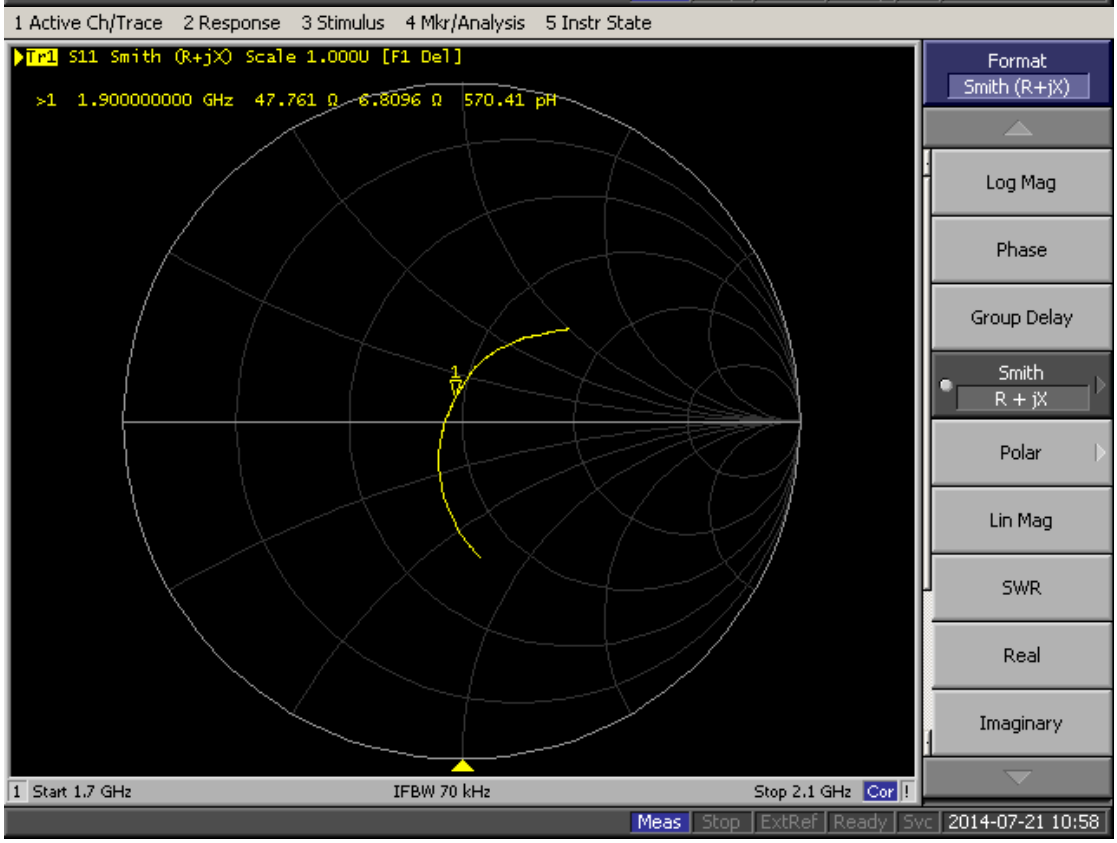
1900MHz-Body





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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.**

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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<br>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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Keithley Multimeter Type 2001 | SN: 0810278 | 01-Oct-13 (No:13976) | Oct-14 |
| **Secondary Standards** | **ID #** | **Check Date (in house)** | **Scheduled Check** |
| Auto DAE Calibration Unit | SE UWS 053 AA 1001 | 07-Jan-14 (in house check) | In house check: Jan-15 |
| Calibrator Box V2.1 | SE UMS 006 AA 1002 | 07-Jan-14 (in house check) | In house check: Jan-15 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | R.Mayoraz | Technician | |
| Approved by: | Fin Bomholt | Deputy Technical Manager | i.v. |

Issued: July 22, 2014

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**Accreditation No.: SCS 108**

## Glossary

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

## Methods Applied and Interpretation of Parameters

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


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## DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

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

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

| Calibration Factors | X | Y | Z |
|---|---|---|---|
| **High Range** | 405.988 ± 0.02% (k=2) | 404.710 ± 0.02% (k=2) | 405.849 ± 0.02% (k=2) |
| **Low Range** | 4.00335 ± 1.50% (k=2) | 3.98492 ± 1.50% (k=2) | 4.02547 ± 1.50% (k=2) |

## Connector Angle

| | |
|---|---|
| **Connector Angle** to be used in DASY system | 30.5 ° ± 1 ° |


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

### 1. DC Voltage Linearity

| High Range | | Reading (µV) | Difference (µV) | 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 (µV) | Difference (µV) | 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 | 199.61 | -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 (µV) | Low Range Average Reading (µV) |
|---|---|---|---|
| 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 (µV) | Channel Y (µV) | Channel Z (µV) |
|---|---|---|---|---|
| Channel X | 200 | - | 2.85 | -2.60 |
| Channel Y | 200 | 9.53 | - | 4.34 |
| Channel Z | 200 | 9.98 | 6.64 | - |


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## 4. AD-Converter Values with inputs shorted

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

| | High Range (LSB) | Low Range (LSB) |
|---|---|---|
| Channel X | 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 10MΩ

| | Average (µV) | min. Offset (µV) | max. Offset (µV) | Std. Deviation (µV) |
|---|---|---|---|---|
| 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: <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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter E4419B | GB41293874 | 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: S5054 (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 Leuthier | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: July 28, 2014

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**Accreditation No.: SCS 108**

## Glossary:

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

a) 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

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

## Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the $E^2$-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: 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 ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (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 (μV/(V/m)²)[A] | 0.54 | 0.51 | 0.59 | ± 10.1 % |
| DCP (mV)[B] | 97.6 | 99.3 | 96.2 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 145.7 | ±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%.

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




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

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unct. (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 % |
| 5800 | 35.3 | 5.27 | 4.55 | 4.55 | 4.55 | 0.40 | 1.80 | ± 13.1 % |

[C] 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.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] 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) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (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 % |

[C] 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.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] 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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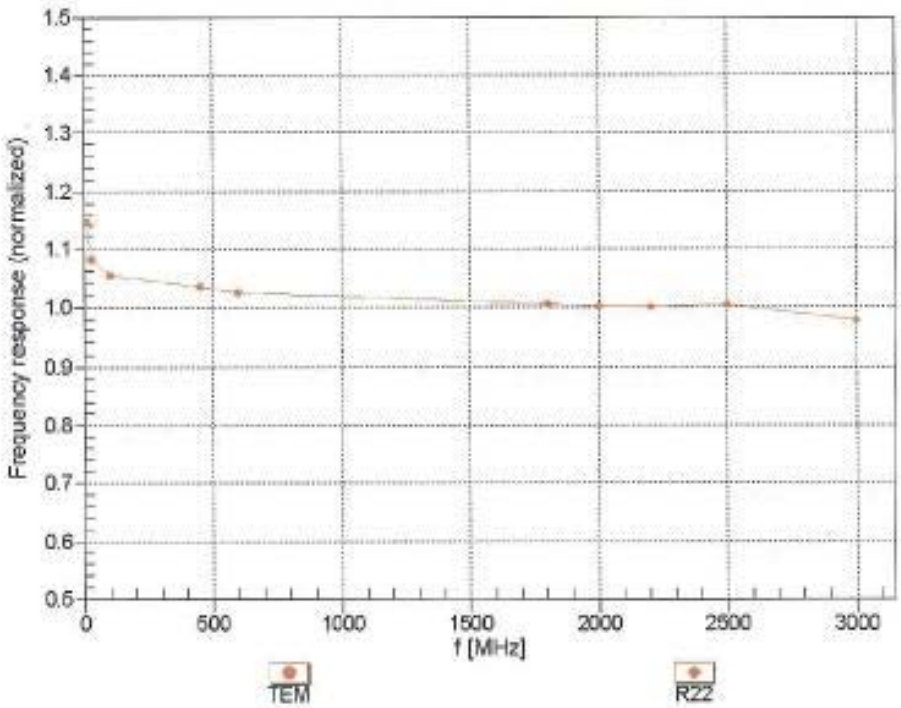
EX3DV4– SN:3798 July 28, 2014

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




Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)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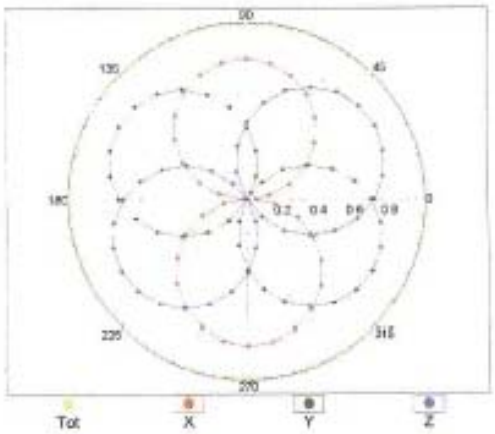
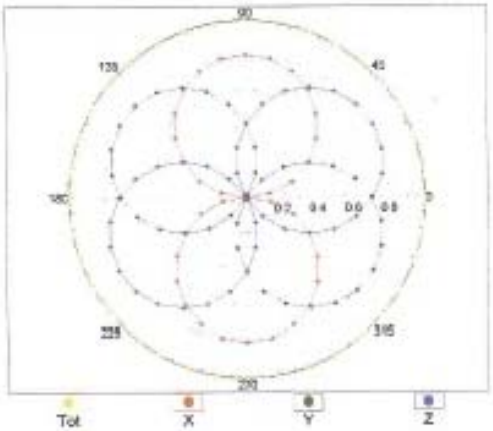
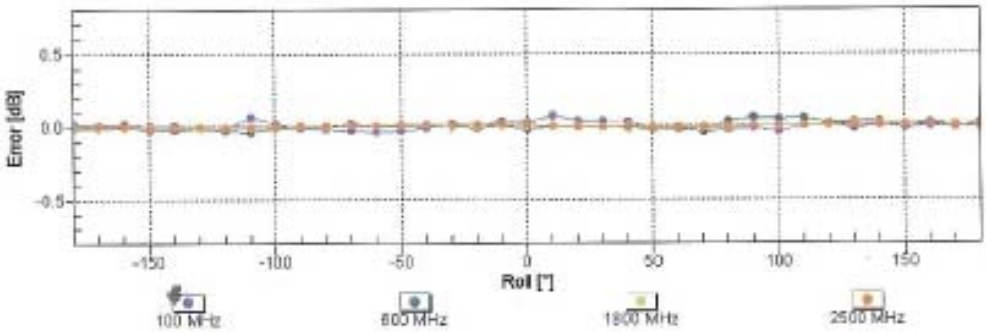
## Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM




f=1800 MHz,R22




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

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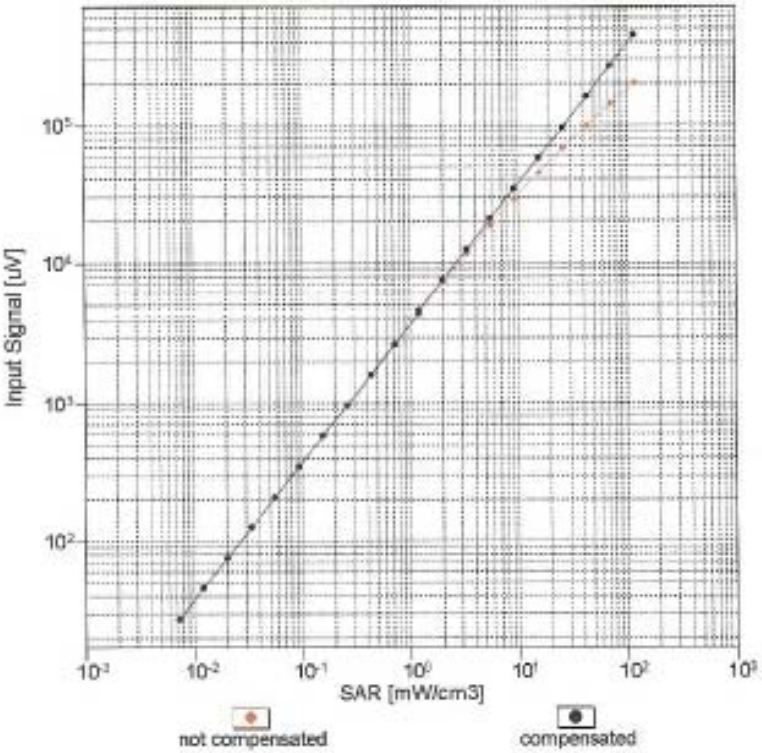
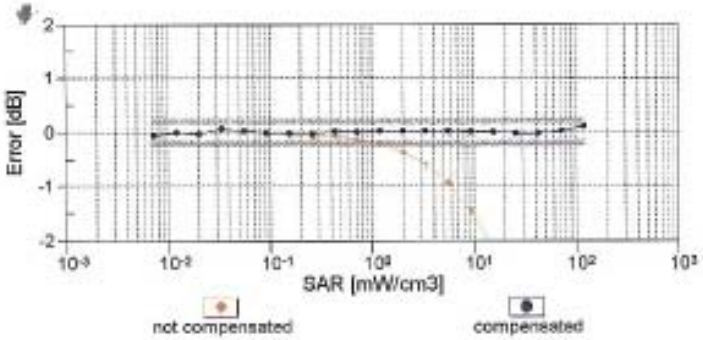
## Dynamic Range f(SAR$_{head}$)
(TEM cell , $f_{eval}$= 1900 MHz)




**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**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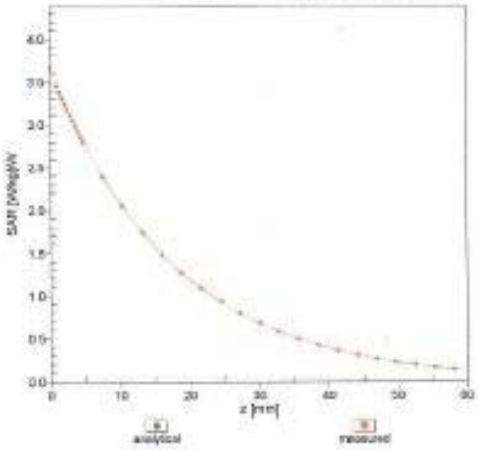
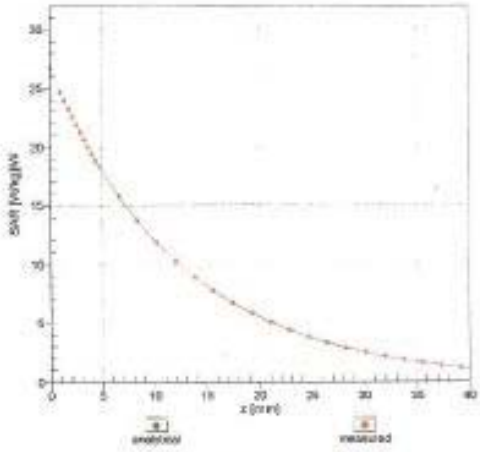
## Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF)

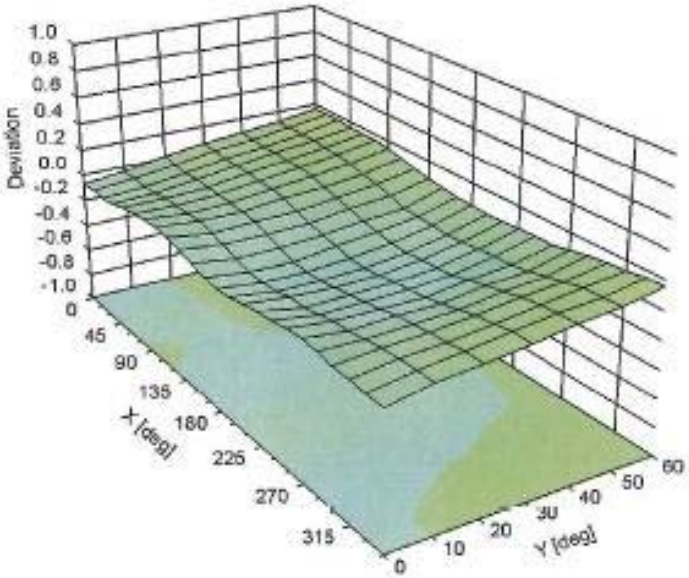


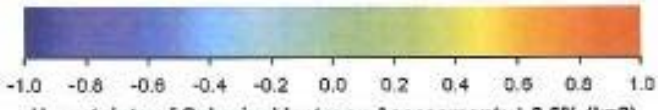

f = 1810 MHz,WGLS R22 (H_convF)




## Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz




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

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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 |




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## APPENDIX C: PLOTS OF SAR TEST RESULT

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

**END REPORT**


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