# FCC SAR Test Report

| | | |
|---|---|---|
| **Report No.** | : | **SA171127W003** |
| **Applicant** | : | **Corporativo Lanix S.A. de C.V.** |
| **Address** | : | **Carretera Internacional Hermosillo-Nogales Km 8.5, Hermosillo Sonora, Mexico** |
| **Product** | : | **Feature phone** |
| **FCC ID** | : | **ZC4U300** |
| **Brand** | : | **LANIX** |
| **Model No.** | : | **U300** |
| **Standards** | : | **FCC 47 CFR Part 2 (2.1093) / IEEE C95.1:1992 / IEEE 1528:2013**<br>**KDB 865664 D01 v01r04 / KDB 865664 D02 v01r02**<br>**KDB 447498 D01 v06 / KDB 648474 D04 v01r03**<br>**KDB 941225 D01 v03r01 / KDB 941225 D06 v02r01** |
| **Sample Received Date** | : | **Jan. 03, 2018** |
| **Date of Testing** | : | **Jan. 05, 2018 ~ Jan. 08, 2018** |

**CERTIFICATION:** The above equipment have been tested by **BV 7LAYERS COMMUNICATIONS TECHNOLOGY (SHENZHEN) CO. LTD.**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by A2LA or any government agencies.

**Prepared By :** Kei

Kei Zhang / Engineer

**Approved By :** Bill

Bill Yao / Manager

ACCREDITED
Certificate # 3939.01

# Table of Contents

# Release Control Record

| Report No. | Reason for Change | Date Issued |
|---|---|---|
| SA171127W003 | Initial release | Feb. 05, 2018 |
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# 1. Summary of Maximum SAR Value

| Equipment Class | Mode | Highest Reported Head $SAR_{1g}$ (W/kg) | Highest Reported Body-worn $SAR_{1g}$ (1.0 cm Gap) (W/kg) | Highest Reported Hotspot $SAR_{1g}$ (1.0 cm Gap) (W/kg) |
|---|---|---|---|---|
| PCE | GSM850 | 0.39 | 0.64 | 0.64 |
| | GSM1900 | 0.65 | 0.54 | 0.54 |
| | WCDMA II | 0.70 | 0.59 | 0.59 |
| | WCDMA V | 0.46 | 0.71 | 0.71 |
| DSS | Bluetooth | N/A | N/A | N/A |
| Highest Simultaneous Transmission SAR | | Head (W/kg) | Body-worn (W/kg) | Hotspot (W/kg) |
| PCE + DSS | | N/A | 0.72 | N/A |

**Note:**

1. The SAR limit **(Head & Body: $SAR_{1g}$ 1.6 W/kg, Extremity: $SAR_{10g}$ 4.0 W/kg)** for general population / uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992.

## 2. Description of Equipment Under Test

| | |
|---|---|
| **EUT Type** | Feature phone |
| **FCC ID** | ZC4U300 |
| **Brand Name** | LANIX |
| **Model Name** | U300 |
| **IMEI Code** | 352273017386340 |
| **HW Version** | V1.0 |
| **SW Version** | U300_SW_01 |
| **Tx Frequency Bands (Unit: MHz)** | GSM850 : 824.2 ~ 848.8<br>GSM1900 : 1850.2 ~ 1909.8<br>WCDMA Band II : 1852.4 ~ 1907.6<br>WCDMA Band V : 826.4 ~ 846.6<br>Bluetooth : 2402 ~ 2480 |
| **Uplink Modulations** | GSM & GPRS : GMSK<br>WCDMA : QPSK<br>Bluetooth : GFSK, π/4-DQPSK, 8-DPSK, LE |
| **Maximum Tune-up Conducted Power (Unit: dBm)** | GSM850 : 28.5<br>GSM1900 : 30.0<br>WCDMA Band II : 20.5<br>WCDMA Band V : 20.5<br>Bluetooth : -4.0 |
| **Antenna Type** | Bluetooth: Monopole Antenna<br>WWAN: Fixed Internal Antenna |
| **EUT Stage** | Production Unit |

**Note:**

1. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

**List of Accessory:**

| | | |
|---|---|---|
| **Battery** | **Brand Name** | LANIX |
| | **Model Name** | U300-BAT |
| | **Power Rating** | 3.7Vdc, 800mAh |
| | **Type** | Li-ion |

# 3. SAR Measurement System

## 3.1 Definition of Specific Absorption Rate (SAR)

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

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

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

SAR measurement can be related to the electrical field in the tissue by

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

## 3.2 SPEAG DASY System

DASY system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY5 software defined. The DASY software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.

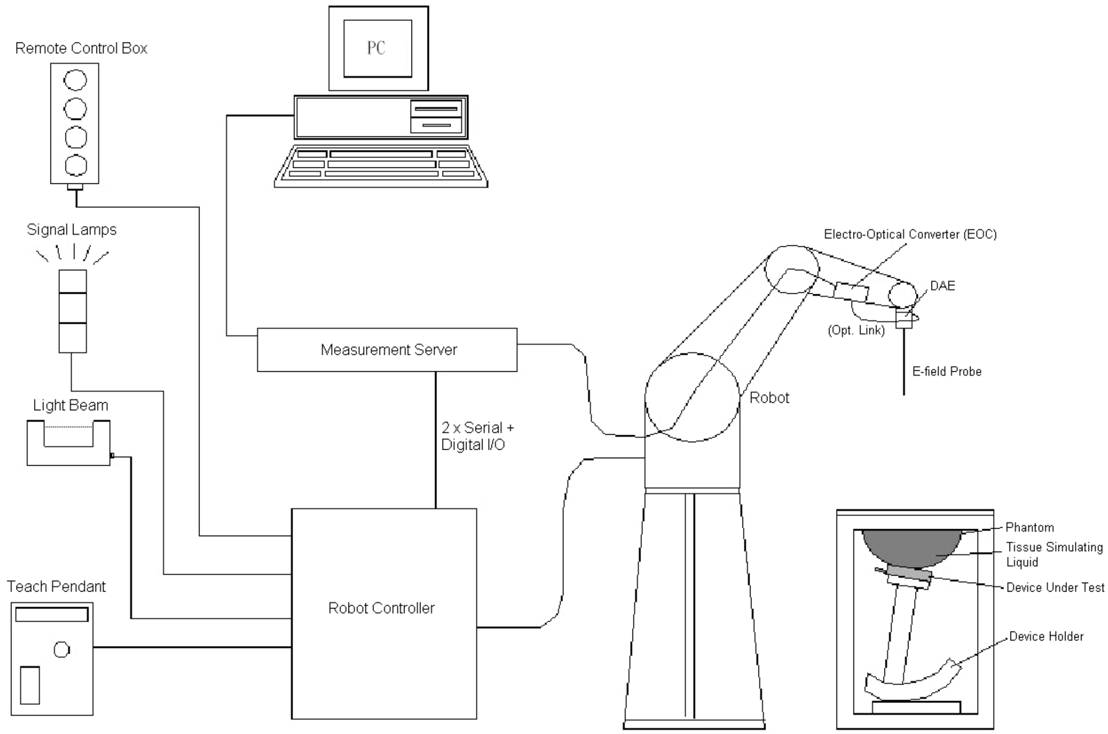



**Fig-3.1 DASY System Setup**

### 3.2.1 Robot

The DASY system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

**Fig-3.2 DASY5**

### 3.2.2 Probes

The SAR measurement is conducted with the dosimetric probe. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.

| | |
|---|---|
| **Model** | EX3DV4 |
| **Construction** | Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE). |
| **Frequency** | 10 MHz to 6 GHz<br>Linearity: ± 0.2 dB |
| **Directivity** | ± 0.3 dB in HSL (rotation around probe axis)<br>± 0.5 dB in tissue material (rotation normal to probe axis) |
| **Dynamic Range** | 10 µW/g to 100 mW/g<br>Linearity: ± 0.2 dB (noise: typically < 1 µW/g) |
| **Dimensions** | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm |

| | |
|---|---|
| **Model** | ES3DV3 |
| **Construction** | Symmetrical design with triangular core. Interleaved sensors. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE). |
| **Frequency** | 10 MHz to 4 GHz<br>Linearity: ± 0.2 dB |
| **Directivity** | ± 0.2 dB in HSL (rotation around probe axis)<br>± 0.3 dB in tissue material (rotation normal to probe axis) |
| **Dynamic Range** | 5 µW/g to 100 mW/g<br>Linearity: ± 0.2 dB |
| **Dimensions** | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 3.9 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.0 mm |

### 3.2.3 Data Acquisition Electronics (DAE)

| | |
|---|---|
| **Model** | DAE3, DAE4 |
| **Construction** | Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop. |
| **Measurement Range** | -100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV) |
| **Input Offset Voltage** | < 5µV (with auto zero) |
| **Input Bias Current** | < 50 fA |
| **Dimensions** | 60 x 60 x 68 mm |

### 3.2.4 Phantoms

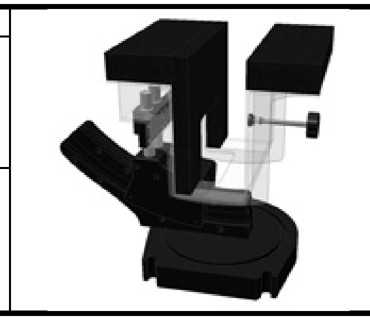
| Model | Twin SAM |
|---|---|
| Construction | The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom 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 teaching three points with the robot. |
| Material | Vinylester, glass fiber reinforced (VE-GF) |
| Shell Thickness | 2 ± 0.2 mm (6 ± 0.2 mm at ear point) |
| Dimensions | Length: 1000 mm<br>Width: 500 mm<br>Height: adjustable feet |
| Filling Volume | approx. 25 liters |

| Model | ELI |
|---|---|
| Construction | Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI 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 compatible with all SPEAG dosimetric probes and dipoles. |
| Material | Vinylester, glass fiber reinforced (VE-GF) |
| Shell Thickness | 2.0 ± 0.2 mm (bottom plate) |
| Dimensions | Major axis: 600 mm<br>Minor axis: 400 mm |
| Filling Volume | approx. 30 liters |

### 3.2.5 Device Holder

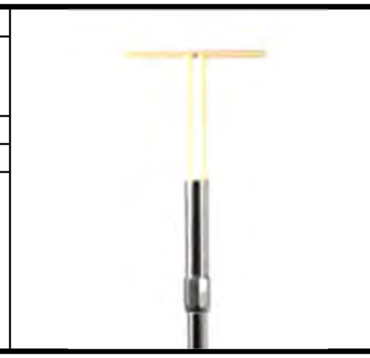
| | |
|---|---|
| **Model** | Mounting Device |
| **Construction** | In combination with the Twin SAM Phantom or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). |
| **Material** | POM |

| | |
|---|---|
| **Model** | Laptop Extensions Kit |
| **Construction** | Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. |
| **Material** | POM, Acrylic glass, Foam |



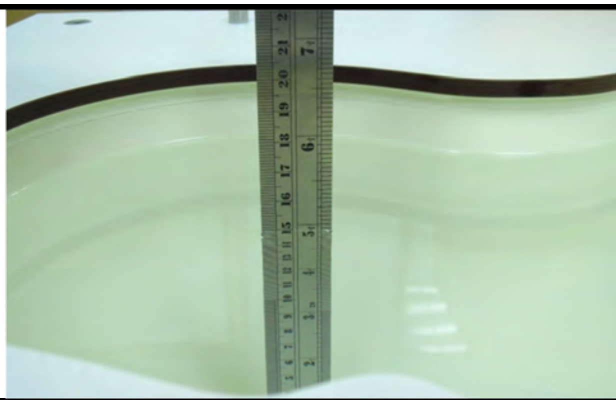
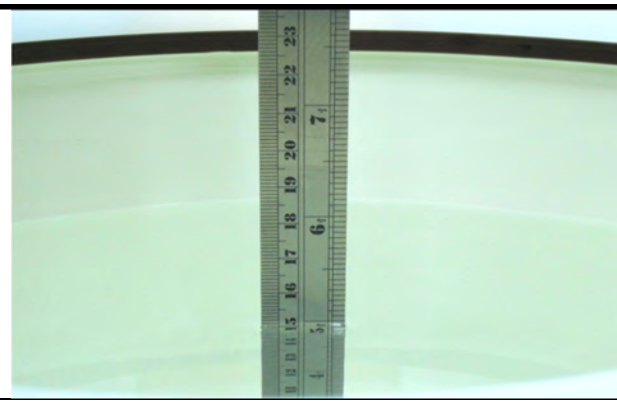
### 3.2.6 System Validation Dipoles

| | |
|---|---|
| **Model** | D-Serial |
| **Construction** | Symmetrical dipole with l/4 balun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions. |
| **Frequency** | 750 MHz to 5800 MHz |
| **Return Loss** | > 20 dB |
| **Power Capability** | > 100 W (f < 1GHz), > 40 W (f > 1GHz) |



### 3.2.7 Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in Table-3.1.

| | |
|---|---|
|  |  |
| **Photo of Liquid Height for Head Position** | **Photo of Liquid Height for Body Position** |

The dielectric properties of the head tissue simulating liquids are defined in IEEE 1528, and KDB 865664 D01 Appendix A. For the body tissue simulating liquids, the dielectric properties are defined in KDB 865664 D01 Appendix A. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using a dielectric assessment kit and a network analyzer.

**Table-3.1 Targets of Tissue Simulating Liquid**

| Frequency (MHz) | Target Permittivity | Range of ±5% | Target Conductivity | Range of ±5% |
|---|---|---|---|---|
| **For Head** | | | | |
| 750 | 41.9 | 39.8 ~ 44.0 | 0.89 | 0.85 ~ 0.93 |
| 835 | 41.5 | 39.4 ~ 43.6 | 0.90 | 0.86 ~ 0.95 |
| 900 | 41.5 | 39.4 ~ 43.6 | 0.97 | 0.92 ~ 1.02 |
| 1450 | 40.5 | 38.5 ~ 42.5 | 1.20 | 1.14 ~ 1.26 |
| 1640 | 40.3 | 38.3 ~ 42.3 | 1.29 | 1.23 ~ 1.35 |
| 1750 | 40.1 | 38.1 ~ 42.1 | 1.37 | 1.30 ~ 1.44 |
| 1800 | 40.0 | 38.0 ~ 42.0 | 1.40 | 1.33 ~ 1.47 |
| 1900 | 40.0 | 38.0 ~ 42.0 | 1.40 | 1.33 ~ 1.47 |
| 2000 | 40.0 | 38.0 ~ 42.0 | 1.40 | 1.33 ~ 1.47 |
| 2300 | 39.5 | 37.5 ~ 41.5 | 1.67 | 1.59 ~ 1.75 |
| 2450 | 39.2 | 37.2 ~ 41.2 | 1.80 | 1.71 ~ 1.89 |
| 2600 | 39.0 | 37.1 ~ 41.0 | 1.96 | 1.86 ~ 2.06 |
| 3500 | 37.9 | 36.0 ~ 39.8 | 2.91 | 2.76 ~ 3.06 |
| 5200 | 36.0 | 34.2 ~ 37.8 | 4.66 | 4.43 ~ 4.89 |
| 5300 | 35.9 | 34.1 ~ 37.7 | 4.76 | 4.52 ~ 5.00 |
| 5500 | 35.6 | 33.8 ~ 37.4 | 4.96 | 4.71 ~ 5.21 |
| 5600 | 35.5 | 33.7 ~ 37.3 | 5.07 | 4.82 ~ 5.32 |
| 5800 | 35.3 | 33.5 ~ 37.1 | 5.27 | 5.01 ~ 5.53 |
| **For Body** | | | | |
| 750 | 55.5 | 52.7 ~ 58.3 | 0.96 | 0.91 ~ 1.01 |
| 835 | 55.2 | 52.4 ~ 58.0 | 0.97 | 0.92 ~ 1.02 |
| 900 | 55.0 | 52.3 ~ 57.8 | 1.05 | 1.00 ~ 1.10 |
| 1450 | 54.0 | 51.3 ~ 56.7 | 1.30 | 1.24 ~ 1.37 |
| 1640 | 53.8 | 51.1 ~ 56.5 | 1.40 | 1.33 ~ 1.47 |
| 1750 | 53.4 | 50.7 ~ 56.1 | 1.49 | 1.42 ~ 1.56 |
| 1800 | 53.3 | 50.6 ~ 56.0 | 1.52 | 1.44 ~ 1.60 |
| 1900 | 53.3 | 50.6 ~ 56.0 | 1.52 | 1.44 ~ 1.60 |
| 2000 | 53.3 | 50.6 ~ 56.0 | 1.52 | 1.44 ~ 1.60 |
| 2300 | 52.9 | 50.3 ~ 55.5 | 1.81 | 1.72 ~ 1.90 |
| 2450 | 52.7 | 50.1 ~ 55.3 | 1.95 | 1.85 ~ 2.05 |
| 2600 | 52.5 | 49.9 ~ 55.1 | 2.16 | 2.05 ~ 2.27 |
| 3500 | 51.3 | 48.7 ~ 53.9 | 3.31 | 3.14 ~ 3.48 |
| 5200 | 49.0 | 46.6 ~ 51.5 | 5.30 | 5.04 ~ 5.57 |
| 5300 | 48.9 | 46.5 ~ 51.3 | 5.42 | 5.15 ~ 5.69 |
| 5500 | 48.6 | 46.2 ~ 51.0 | 5.65 | 5.37 ~ 5.93 |
| 5600 | 48.5 | 46.1 ~ 50.9 | 5.77 | 5.48 ~ 6.06 |
| 5800 | 48.2 | 45.8 ~ 50.6 | 6.00 | 5.70 ~ 6.30 |

The following table gives the recipes for tissue simulating liquids.

**Table-3.2 Recipes of Tissue Simulating Liquid**

| Tissue Type | Bactericide | DGBE | HEC | NaCl | Sucrose | Triton X-100 | Water | Diethylene Glycol Mono-hexylether |
|---|---|---|---|---|---|---|---|---|
| H750 | 0.2 | - | 0.2 | 1.5 | 56.0 | - | 42.1 | - |
| H835 | 0.2 | - | 0.2 | 1.5 | 57.0 | - | 41.1 | - |
| H900 | 0.2 | - | 0.2 | 1.4 | 58.0 | - | 40.2 | - |
| H1450 | - | 43.3 | - | 0.6 | - | - | 56.1 | - |
| H1640 | - | 45.8 | - | 0.5 | - | - | 53.7 | - |
| H1750 | - | 47.0 | - | 0.4 | - | - | 52.6 | - |
| H1800 | - | 44.5 | - | 0.3 | - | - | 55.2 | - |
| H1900 | - | 44.5 | - | 0.2 | - | - | 55.3 | - |
| H2000 | - | 44.5 | - | 0.1 | - | - | 55.4 | - |
| H2300 | - | 44.9 | - | 0.1 | - | - | 55.0 | - |
| H2450 | - | 45.0 | - | 0.1 | - | - | 54.9 | - |
| H2600 | - | 45.1 | - | 0.1 | - | - | 54.8 | - |
| H3500 | - | 28.0 | - | 0.2 | - | 20.0 | 71.8 | - |
| H5G | - | - | - | - | - | 17.2 | 65.5 | 17.3 |
| B750 | 0.2 | - | 0.2 | 0.8 | 48.8 | - | 50.0 | - |
| B835 | 0.2 | - | 0.2 | 0.9 | 48.5 | - | 50.2 | - |
| B900 | 0.2 | - | 0.2 | 0.9 | 48.2 | - | 50.5 | - |
| B1450 | - | 34.0 | - | 0.3 | - | - | 65.7 | - |
| B1640 | - | 32.5 | - | 0.3 | - | - | 67.2 | - |
| B1750 | - | 31.0 | - | 0.2 | - | - | 68.8 | - |
| B1800 | - | 29.5 | - | 0.4 | - | - | 70.1 | - |
| B1900 | - | 29.5 | - | 0.3 | - | - | 70.2 | - |
| B2000 | - | 30.0 | - | 0.2 | - | - | 69.8 | - |
| B2300 | - | 31.0 | - | 0.1 | - | - | 68.9 | - |
| B2450 | - | 31.4 | - | 0.1 | - | - | 68.5 | - |
| B2600 | - | 31.8 | - | 0.1 | - | - | 68.1 | - |
| B3500 | - | 28.8 | - | 0.1 | - | - | 71.1 | - |
| B5G | - | - | - | - | - | 10.7 | 78.6 | 10.7 |

## 3.3 SAR System Verification

The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.

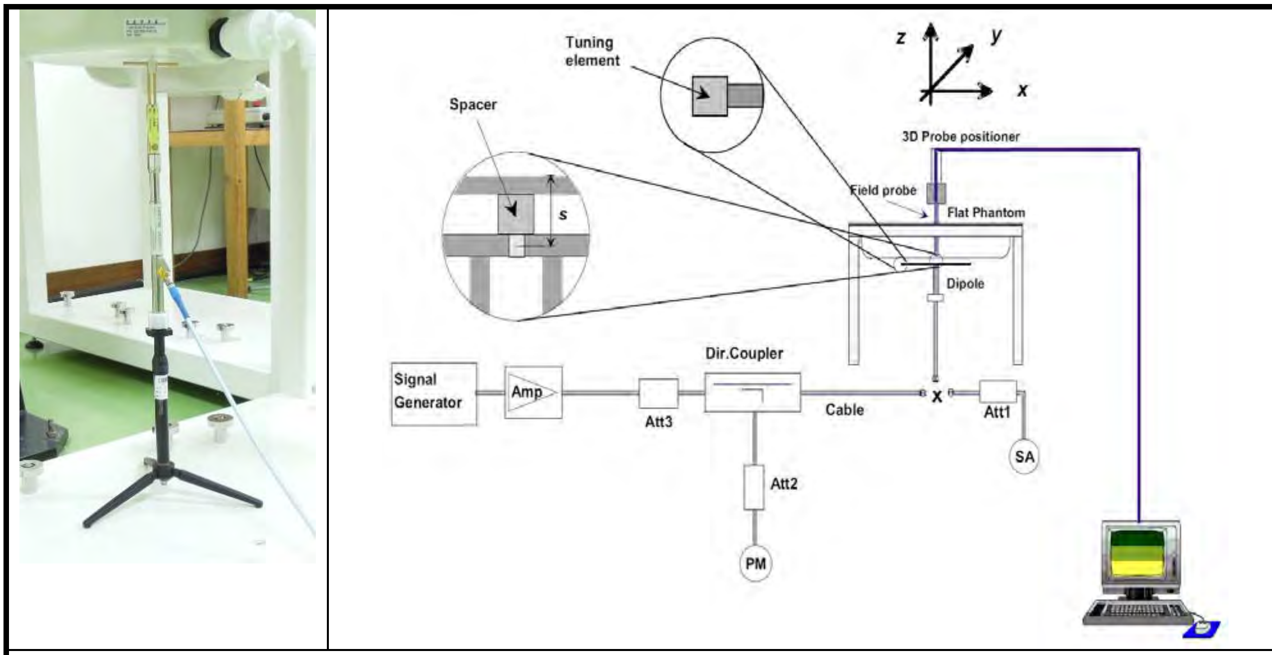



**Fig-3.4 System Verification Setup**

The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The spectrum analyzer measures the forward power at the location of the system check dipole connector. The signal generator is adjusted for the desired forward power (250 mW is used for 700 MHz to 3 GHz, 100 mW is used for 3.5 GHz to 6 GHz) at the dipole connector and the power meter is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter.

After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.

## 3.4 SAR Measurement Procedure

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

(a) Power reference measurement
(b) Area scan
(c) Zoom scan
(d) Power drift measurement

The SAR measurement procedures for each of test conditions are as follows:

(a) Make EUT to transmit maximum output power
(b) Measure conducted output power through RF cable
(c) Place the EUT in the specific position of phantom
(d) Perform SAR testing steps on the DASY system
(e) Record the SAR value

### 3.4.1 Area & Zoom Scan Procedure

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. According to KDB 865664 D01, the resolution for Area and Zoom scan is specified in the table below.

| Items | <= 2 GHz | 2-3 GHz | 3-4 GHz | 4-5 GHz | 5-6 GHz |
|---|---|---|---|---|---|
| Area Scan (Δx, Δy) | <= 15 mm | <= 12 mm | <= 12 mm | <= 10 mm | <= 10 mm |
| Zoom Scan (Δx, Δy) | <= 8 mm | <= 5 mm | <= 5 mm | <= 4 mm | <= 4 mm |
| Zoom Scan (Δz) | <= 5 mm | <= 5 mm | <= 4 mm | <= 3 mm | <= 2 mm |
| Zoom Scan Volume | >= 30 mm | >= 30 mm | >= 28 mm | >= 25 mm | >= 22 mm |

**Note:**

When zoom scan is required and report SAR is <= 1.4 W/kg, the zoom scan resolution of Δx / Δy (2-3GHz: <= 8 mm, 3-4GHz: <= 7 mm, 4-6GHz: <= 5 mm) may be applied.

### 3.4.2 Volume Scan Procedure

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

### 3.4.3 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drift more than 5%, the SAR will be retested.

### 3.4.4 Spatial Peak SAR Evaluation

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

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

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

### 3.4.5 SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

# 4. SAR Measurement Evaluation

## 4.1 EUT Configuration and Setting

**<Connections between EUT and System Simulator>**

For WWAN SAR testing, the EUT was linked and controlled by base station emulator (Agilent E5515C is used for GSM/WCDMA). Communication between the EUT and the emulator was established by air link. The distance between the EUT and the communicating 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 EUT. The EUT was set from the emulator to radiate maximum output power during SAR testing.

**<Considerations Related to GSM / GPRS / EDGE for Setup and Testing>**

The maximum multi-slot capability supported by this device is as below.

1. This EUT is class B device
2. This EUT supports GPRS multi-slot class 12 (max. uplink: 4, max. downlink: 4, total timeslots: 5)

For GSM850 frequency band, the power control level is set to 5 for GSM mode and GPRS (GMSK: CS1), and set to 8 for EDGE (GMSK: MCS1, 8PSK: MCS9). For GSM1900 frequency band, the power control level is set to 0 for GSM mode and GPRS (GMSK: CS1), and set to 2 for EDGE (GMSK: MCS1, 8PSK: MCS9).

SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested.

**<Considerations Related to WCDMA for Setup and Testing>**

**WCDMA Handsets Head SAR**

SAR for next to the ear head exposure is measured using a 12.2 kbps RMC with TPC bits configured to all “1’s”. The 3G SAR test reduction procedure is applied to AMR configurations with 12.2 kbps RMC as the primary mode.

**WCDMA Handsets Body-worn SAR**

SAR for body-worn configurations is measured using a 12.2 kbps RMC with TPC bits configured to all “1’s”. The 3G SAR test reduction procedure is applied to other spreading codes and multiple $DPDCH_n$ configurations supported by the handset with 12.2 kbps RMC as the primary mode.

**Handsets with Release 5 HSDPA**

The 3G SAR test reduction procedure is applied to HSDPA body-worn configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSDPA using the HSDPA body SAR procedures in the “Release 5 HSDPA Data Devices”, for the highest reported SAR body-worn exposure configuration in 12.2 kbps RMC. Handsets with both HSDPA and HSUPA are tested according to Release 6 HSPA test procedures.

**Handsets with Release 6 HSUPA**

The 3G SAR test reduction procedure is applied to HSPA (HSUPA/HSDPA with RMC) body-worn configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSPA using the HSPA body SAR procedures in the “Release 6 HSPA Data Devices”, for the highest reported body-worn exposure SAR configuration in 12.2 kbps RMC. When VOIP is applicable for next to the ear head exposure in HSPA, the 3G SAR test reduction procedure is applied to HSPA with 12.2 kbps RMC as the primary mode; otherwise, the same HSPA configuration used for body-worn measurements is tested for next to the ear head exposure.

**Release 5 HSDPA Data Devices**

The 3G SAR test reduction procedure is applied to body SAR with 12.2 kbps RMC as the primary mode. Otherwise, body SAR for HSDPA is measured using an FRC with H-Set 1 in Sub-test 1 and a 12.2 kbps RMC configured in Test Loop Mode 1, for the highest reported SAR configuration in 12.2 kbps RMC without HSDPA. HSDPA is configured according to the applicable UE category of a test device. The number of HS-DSCH / HS-PDSCHs, HARQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the H-set. To maintain a consistent test configuration and stable transmission conditions, QPSK is used in the H-set for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 4 ms and a CQI repetition factor of 2 to maintain a constant rate of active CQI slots. DPCCH and DPDCH gain factors ($\beta_c$, $\beta_d$), and HS-DPCCH power offset parameters ($\Delta_{ACK}$, $\Delta_{NACK}$, $\Delta_{CQI}$) are set according to values indicated in below. The CQI value is determined by the UE category, transport block size, number of HS-PDSCHs and modulation used in the H-set.

| Sub-test | $\beta_c$ | $\beta_d$ | $\beta_d$ (SF) | $\beta_c$ / $\beta_d$ | $\beta_{hs}$ (1) | CM (dB)(2) | MPR |
|---|---|---|---|---|---|---|---|
| 1 | 2 / 15 | 15 / 15 | 64 | 2 / 15 | 4 / 15 | 0.0 | 0 |
| 2 | 12 / 15 (3) | 15 / 15 (3) | 64 | 12 / 15 (3) | 24 / 15 | 1.0 | 0 |
| 3 | 15 / 15 | 8 / 15 | 64 | 15 / 8 | 30 / 15 | 1.5 | 0.5 |
| 4 | 15 / 15 | 4 / 15 | 64 | 15 / 4 | 30 / 15 | 1.5 | 0.5 |

Note 1: $\Delta_{ACK}$, $\Delta_{NACK}$ and $\Delta_{CQI}$ = 8 ⇔ $A_{hs} = \beta_{hs} / \beta_c = 30 / 15$ ⇔ $\beta_{hs} = 30 / 15 * \beta_c$.
Note 2: CM = 1 for $\beta_c / \beta_d = 12 / 15$, $\beta_{hs} / \beta_c = 24 / 15$.
Note 3: For subtest 2 the $\beta_c / \beta_d$ ratio of 12 / 15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 11 / 15$ and $\beta_d = 15 / 15$.

**Release 6 HSUPA Data Devices**

The 3G SAR test reduction procedure is applied to body SAR with 12.2 kbps RMC as the primary mode. Otherwise, body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 and power control algorithm 2, according to the highest reported body SAR configuration in 12.2 kbps RMC without HSPA. When VOIP applies to head exposure, the 3G SAR test reduction procedure is applied with 12.2 kbps RMC as the primary mode. Otherwise, the same HSPA configuration used for body SAR measurements are applied to head exposure testing. Due to inner loop power control requirements in HSPA, a communication test set is required for output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and E-DCH configurations for HSPA are configured according to the β values indicated in below.

| Sub-test | $\beta_c$ | $\beta_d$ | $\beta_d$ (SF) | $\beta_c / \beta_d$ | $\beta_{hs}$ (1) | $\beta_{ec}$ | $\beta_{ed}$ | $\beta_{ed}$ (SF) | $\beta_{ed}$ (codes) | CM (2) (dB) | MPR (dB) | AG (4) Index | E-TFCI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11 / 15 (3) | 15 / 15 (3) | 64 | 11 / 15 (3) | 22 / 15 | 209 / 225 | 1039 / 225 | 4 | 1 | 1.0 | 0.0 | 20 | 75 |
| 2 | 6 / 15 | 15 / 15 | 64 | 6 / 15 | 12 / 15 | 12 / 15 | 94 / 75 | 4 | 1 | 3.0 | 2.0 | 12 | 67 |
| 3 | 15 / 15 | 9 / 15 | 64 | 15 / 9 | 30 / 15 | 30 / 15 | $\beta_{ed1}$: 47/15<br>$\beta_{ed2}$: 47/15 | 4 | 2 | 2.0 | 1.0 | 15 | 92 |
| 4 | 2 / 15 | 15 / 15 | 64 | 2 / 15 | 4 / 15 | 2 / 15 | 56 / 75 | 4 | 1 | 3.0 | 2.0 | 17 | 71 |
| 5 | 15 / 15 (4) | 15 / 15 (4) | 64 | 15 / 15 (4) | 30 / 15 | 24 / 15 | 134 / 15 | 4 | 1 | 1.0 | 0.0 | 21 | 81 |

Note 1: $\Delta_{ACK}$, $\Delta_{NACK}$ and $\Delta_{CQI}$ = 8 ⇔ $A_{hs}$ = $\beta_{hs}$ / $\beta_c$ = 30 / 15 ⇔ $\beta_{hs}$ = 30 / 15 * $\beta_c$.

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

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

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

Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g.

Note 6: $\beta_{ed}$ cannot be set directly; it is set by Absolute Grant Value.

## 4.2 EUT Testing Position

According to KDB 648474 D04, handsets are tested for SAR compliance in head, body-worn accessory and other use configurations described in the following subsections.

### 4.2.1 Head Exposure Conditions

Head exposure is limited to next to the ear voice mode operations. Head SAR compliance is tested according to the test positions defined in IEEE Std 1528-2013 using the SAM phantom illustrated as below.

1. Define two imaginary lines on the handset
(a) The vertical centerline passes through two points on the front side of the handset - the midpoint of the width $w_t$ of the handset at the level of the acoustic output, and the midpoint of the width $w_b$ of the bottom of the handset.
(b) The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output. The horizontal line is also tangential to the face of the handset at point A.
(c) 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, especially for clamshell handsets, handsets with flip covers, and other irregularly shaped handsets.

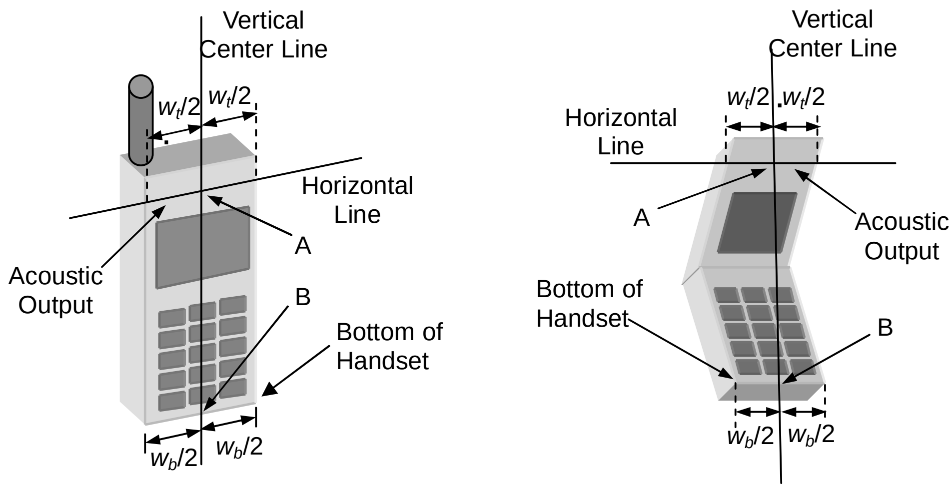



**Fig-4.1 Illustration for Handset Vertical and Horizontal Reference Lines**

2. Cheek Position
(a) To position the device with the vertical center line of the body of the device and the horizontal line crossing the center piece in a plane parallel to the sagittal plane of the phantom. While maintaining the device in this plane, align the vertical center line with the reference plane containing the three ear and mouth reference point (M: Mouth, RE: Right Ear, and LE: Left Ear) and align the center of the ear piece with the line RE-LE.
(b) To move the device towards the phantom with the ear piece aligned with the line LE-RE until the phone touched the ear. While maintaining the device in the reference plane and maintaining the phone contact with the ear,

move the bottom of the phone until any point on the front side is in contact with the cheek of the phantom or until contact with the ear is lost (see Fig-4.2).

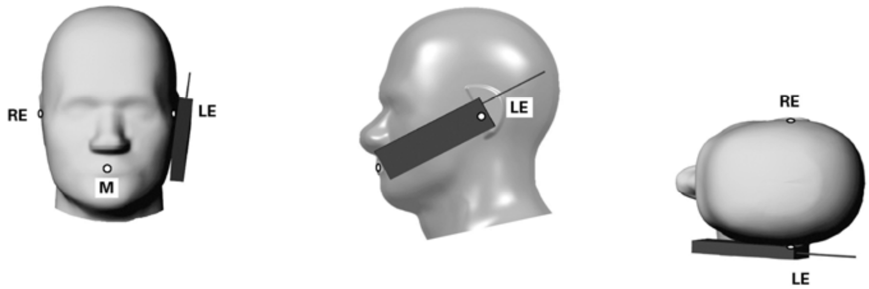



**Fig-4.2 Illustration for Cheek Position**

3. Tilted Position
(a) To position the device in the “cheek” position described above.
(b) While maintaining the device the reference plane described above and pivoting against the ear, moves it outward away from the mouth by an angle of 15 degrees or until contact with the ear is lost (see Fig-4.3).

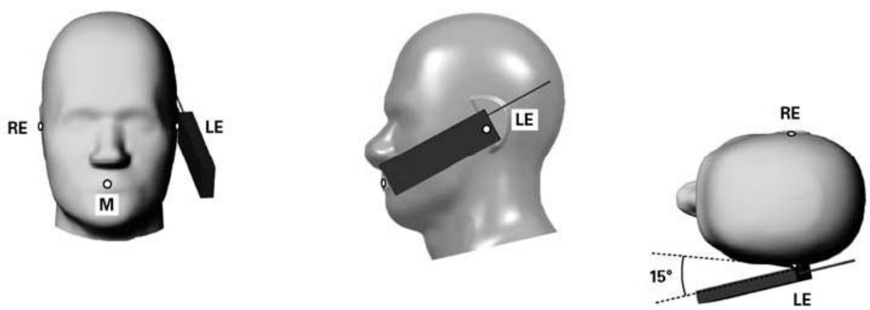



**Fig-4.3 Illustration for Tilted Position**

### 4.2.2 Body-worn Accessory 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 D01 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.

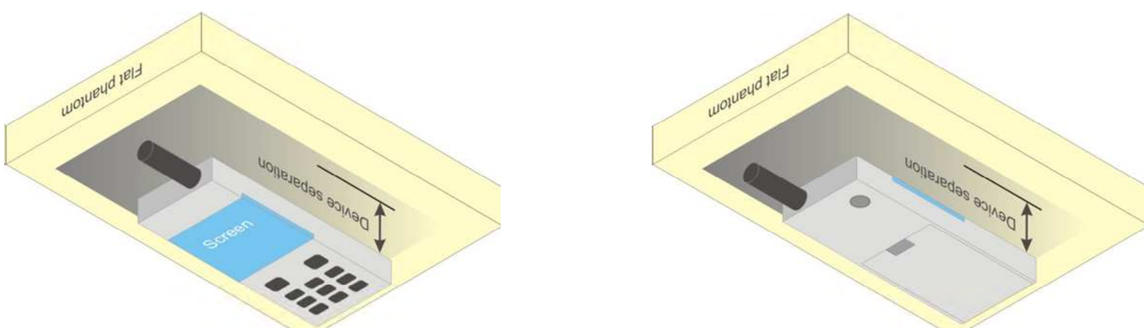
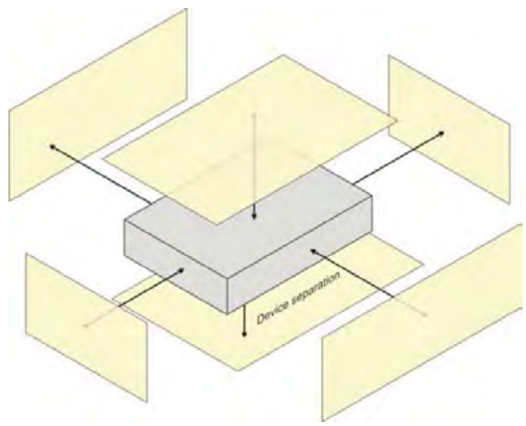



**Fig-4.4 Illustration for Body Worn Position**

### 4.2.3 Hotspot Mode Exposure Conditions

For handsets that support hotspot mode operations, with wireless router capabilities and various web browsing functions, the relevant hand and body exposure conditions are tested according to the hotspot SAR procedures in KDB 941225 D06. A test separation distance of 10 mm is required between the phantom and all surfaces and edges with a transmitting antenna located within 25 mm from that surface or edge. When the form factor of a handset is smaller than 9 cm x 5 cm, a test separation distance of 5 mm (instead of 10 mm) is required for testing hotspot mode. When the separation distance required for body-worn accessory testing is larger than or equal to that tested for hotspot mode, in the same wireless mode and for the same surface of the phone, the hotspot mode SAR data may be used to support body-worn accessory SAR compliance for that particular configuration (surface).




Based on the antenna location shown on appendix D of this report, the SAR testing required for hotspot mode is listed as below.

| Antenna | Front Face | Rear Face | Left Side | Right Side | Top Side | Bottom Side |
|---|---|---|---|---|---|---|
| WWAN Ant-0 | V | V | V | V | V | V |
| BT | - | - | - | - | - | - |

### 4.2.4 SAR Test Exclusion Evaluations

According to KDB 447498 D01, the SAR test exclusion condition is based on source-based time-averaged maximum conducted output power, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The SAR exclusion threshold is determined by the following formula.

$$\frac{\textbf{Max. Tune up Power}_{(mW)}}{\textbf{Min. Test Separation Distance}_{(mm)}} \times \sqrt{f_{(GHz)}} \leq 3.0 \text{ for SAR-1g}, \leq 7.5 \text{ for SAR-10g}$$

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

| Mode | Max. Tune-up Power (dBm) | Max. Tune-up Power (mW) | Body-Worn | | |
|---|---|---|---|---|---|
| | | | Ant. to Surface (mm) | Calculated Result | Require SAR Testing? |
| BT (2.48 GHz) | -4.0 | 0.40 | 10 | 0.1 | No |

**Note:**

1. When separation distance <= 50 mm and the calculated result shown in above table is <= 3.0 for SAR-1g exposure condition, or <= 7.5 for SAR-10g exposure condition, the SAR testing exclusion is applied.

### 4.2.5 Simultaneous Transmission Possibilities

The simultaneous transmission possibilities for this device are listed as below.

| Simultaneous TX Combination | Capable Transmit Configurations | Head (Voice / VoIP) | Body-worn (Voice / VoIP) | Hotspot (Data) |
|---|---|---|---|---|
| 1 | GSM850 (Voice / Data) + BT (Data) | No | Yes | No |
| 2 | GSM1900 (Voice / Data) + BT (Data) | No | Yes | No |
| 3 | WCDMA II (Voice / Data) + BT (Data) | No | Yes | No |
| 4 | WCDMA V (Voice / Data) + BT (Data) | No | Yes | No |

## 4.3 Tissue Verification

The measuring results for tissue simulating liquid are shown as below.

| Test Date | Tissue Type | Frequency (MHz) | Liquid Temp. (℃) | Measured Conductivity (σ) | Measured Permittivity ($\varepsilon_r$) | Target Conductivity (σ) | Target Permittivity ($\varepsilon_r$) | Conductivity Deviation (%) | Permittivity Deviation (%) |
|---|---|---|---|---|---|---|---|---|---|
| Jan. 06, 2018 | H850 | 835 | 22.2 | 0.894 | 41.663 | 0.90 | 41.50 | -0.67 | 0.39 |
| Jan. 05, 2018 | H1900 | 1900 | 22.1 | 1.374 | 39.600 | 1.40 | 40.00 | -1.86 | -1.00 |
| Jan. 07, 2018 | B850 | 835 | 22.2 | 0.977 | 55.586 | 0.97 | 55.20 | 0.72 | 0.70 |
| Jan. 08, 2018 | B1900 | 1900 | 22.3 | 1.585 | 53.657 | 1.52 | 53.30 | 4.28 | 0.67 |

**Note:**

The dielectric properties of the tissue simulating liquid must be measured within 24 hours before the SAR testing and within ±5% of the target values. Liquid temperature during the SAR testing must be within ±2 ℃.

## 4.4 System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01. The validation status in tabulated summary is as below.

| Test Date | Probe S/N | Calibration Point | | Measured Conductivity (σ) | Measured Permittivity ($\varepsilon_r$) | Validation for CW | | | Validation for Modulation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Sensitivity Range | Probe Linearity | Probe Isotropy | Modulation Type | Duty Factor | PAR |
| Jan. 06, 2018 | 3873 | Head | 835 | 0.894 | 41.663 | Pass | Pass | Pass | GMSK | Pass | N/A |
| Jan. 05, 2018 | 3873 | Head | 1900 | 1.374 | 39.600 | Pass | Pass | Pass | GMSK | Pass | N/A |
| Jan. 07, 2018 | 3873 | Body | 835 | 0.977 | 55.586 | Pass | Pass | Pass | GMSK | Pass | N/A |
| Jan. 08, 2018 | 3873 | Body | 1900 | 1.585 | 53.657 | Pass | Pass | Pass | GMSK | Pass | N/A |

## 4.5 System Verification

The measuring result for system verification is tabulated as below.

| Test Date | Mode | Frequency (MHz) | 1W Target SAR-1g (W/kg) | Measured SAR-1g (W/kg) | Normalized to 1W SAR-1g (W/kg) | Deviation (%) | Dipole S/N | Probe S/N | DAE S/N |
|---|---|---|---|---|---|---|---|---|---|
| Jan. 06, 2018 | Head | 835 | 9.49 | 2.40 | 9.60 | 1.16 | 4d139 | 3873 | 1341 |
| Jan. 05, 2018 | Head | 1900 | 39.80 | 9.89 | 39.56 | -0.60 | 5d159 | 3873 | 1341 |
| Jan. 07, 2018 | Body | 835 | 9.71 | 2.33 | 9.32 | -4.02 | 4d139 | 3873 | 1341 |
| Jan. 08, 2018 | Body | 1900 | 40.30 | 10.80 | 43.20 | 7.20 | 5d159 | 3873 | 1341 |

**Note:**

Comparing to the reference SAR value provided by SPEAG, the validation data should be within its specification of 10 %. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.

## 4.6 Maximum Output Power

### 4.6.1 Maximum Conducted Power

The maximum conducted average power (Unit: dBm) including tune-up tolerance is shown as below.

| Mode | GSM850 | GSM1900 |
|---|---|---|
| GSM (GMSK, 1Tx-slot) | 28.5 | 30.0 |
| GPRS (GMSK, 1Tx-slot) | 28.5 | 30.0 |
| GPRS (GMSK, 2Tx-slot) | 27.5 | 27.5 |
| GPRS (GMSK, 3Tx-slot) | 26.5 | 26.0 |
| GPRS (GMSK, 4Tx-slot) | 24.5 | 24.0 |

| Mode | WCDMA Band II | WCDMA Band V |
|---|---|---|
| RMC 12.2K | 20.5 | 20.5 |
| HSDPA | 20.0 | 20.0 |
| HSUPA | 19.5 | 19.5 |

| Mode | 2.4G Bluetooth |
|---|---|
| GFSK | -4.0 |
| π/4-DQPSK | -4.0 |
| 8DPSK | -4.0 |

### 4.6.2 Measured Conducted Power Result

The measuring conducted average power (Unit: dBm) is shown as below.

| Band | GSM850 | | | GSM1900 | | |
|---|---|---|---|---|---|---|
| Channel | 128 | 189 | 251 | 512 | 661 | 810 |
| Frequency (MHz) | 824.2 | 836.4 | 848.8 | 1850.2 | 1880.0 | 1909.8 |
| **Maximum Burst-Averaged Output Power** | | | | | | |
| GSM (GMSK, 1Tx-slot) | **28.18** | 28.11 | 28.01 | **29.81** | 29.51 | 29.44 |
| GPRS (GMSK, 1Tx-slot) | 28.15 | 28.07 | 27.98 | 29.80 | 29.50 | 29.43 |
| GPRS (GMSK, 2Tx-slot) | 27.19 | 27.11 | 27.00 | 27.41 | 27.11 | 27.04 |
| GPRS (GMSK, 3Tx-slot) | 26.37 | 26.30 | 26.21 | 25.66 | 25.36 | 25.29 |
| GPRS (GMSK, 4Tx-slot) | 24.28 | 24.21 | 24.11 | 23.48 | 23.18 | 23.11 |
| **Maximum Frame-Averaged Output Power** | | | | | | |
| GSM (GMSK, 1Tx-slot) | 19.18 | 19.11 | 19.01 | 20.81 | 20.51 | 20.44 |
| GPRS (GMSK, 1Tx-slot) | 19.15 | 19.07 | 18.98 | 20.80 | 20.50 | 20.43 |
| GPRS (GMSK, 2Tx-slot) | 21.19 | 21.11 | 21.00 | **21.41** | 21.11 | 21.04 |
| GPRS (GMSK, 3Tx-slot) | **22.11** | 22.04 | 21.95 | 21.40 | 21.10 | 21.03 |
| GPRS (GMSK, 4Tx-slot) | 21.28 | 21.21 | 21.11 | 20.48 | 20.18 | 20.11 |

**Note:**

1. SAR testing was performed on the maximum frame-averaged power mode.
2. The frame-averaged power is linearly proportion to the slot number configured and it is linearly scaled the maximum burst-averaged power based on time slots. The calculated method is shown as below:
   Frame-averaged power = 10 x log (Burst-averaged power mW x Slot used / 8)
3. The configuration of time-slot for GSM has transmitting signal in one time-slot during one frame (8 time-slots).

| Band | WCDMA Band II | | | WCDMA Band V | | | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|
| Channel | 9262 | 9400 | 9538 | 4132 | 4182 | 4233 | |
| Frequency (MHz) | 1852.4 | 1880.0 | 1907.6 | 826.4 | 836.4 | 846.6 | |
| RMC 12.2K | **20.26** | 20.15 | 20.23 | **20.46** | 20.41 | 20.43 | - |
| HSDPA Subtest-1 | 19.46 | 19.35 | 19.43 | 19.63 | 19.58 | 19.60 | 0 |
| HSDPA Subtest-2 | 19.40 | 19.29 | 19.37 | 19.59 | 19.54 | 19.56 | 0 |
| HSDPA Subtest-3 | 19.02 | 18.91 | 18.99 | 19.25 | 19.20 | 19.22 | 0.5 |
| HSDPA Subtest-4 | 18.98 | 18.87 | 18.95 | 19.23 | 19.18 | 19.20 | 0.5 |

**<Bluetooth>**

| Mode | Bluetooth GFSK | | |
|---|---|---|---|
| Channel / Frequency (MHz) | 0 (2402) | 39 (2441) | 78 (2480) |
| Average Power | **-4.52** | -4.66 | -4.68 |
| **Mode** | **Bluetooth π/4-DQPSK** | | |
| **Channel / Frequency (MHz)** | **0 (2402)** | **39 (2441)** | **78 (2480)** |
| Average Power | **-4.65** | -4.72 | -4.74 |
| **Mode** | **Bluetooth 8DPSK** | | |
| **Channel / Frequency (MHz)** | **0 (2402)** | **39 (2441)** | **78 (2480)** |
| Average Power | **-4.66** | -4.73 | -4.72 |

## 4.7 SAR Testing Results

### 4.7.1 SAR Test Reduction Considerations

**<KDB 447498 D01, General RF Exposure Guidance>**

Testing of other required channels within the operating mode of a frequency band is not required when the reported SAR for the mid-band or highest output power channel is:

(1) ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz

(2) ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz

(3) ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

**<KDB 941225 D01, 3G SAR Measurement Procedures>**

The mode tested for SAR is referred to as the primary mode. The equivalent modes considered for SAR test reduction are denoted as secondary modes. Both primary and secondary modes must be in the same frequency band. When the maximum output power and tune-up tolerance specified for production units in a secondary mode is ≤ 1/4 dB higher than the primary mode or when the highest reported SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode.

### 4.7.2 SAR Results for Head Exposure Condition

| Plot No. | Band | Mode | Test Position | Ch. | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaling Factor | Scaled SAR-1g (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|
| | GSM850 | GPRS11 | Right Cheek | 128 | 26.5 | 26.37 | 0.00 | 0.373 | 1.03 | 0.38 |
| | GSM850 | GPRS11 | Right Tilted | 128 | 26.5 | 26.37 | 0.03 | 0.197 | 1.03 | 0.20 |
| 1 | GSM850 | GPRS11 | Left Cheek | 128 | 26.5 | 26.37 | 0.03 | 0.383 | 1.03 | **0.39** |
| | GSM850 | GPRS11 | Left Tilted | 128 | 26.5 | 26.37 | 0.09 | 0.195 | 1.03 | 0.20 |
| 2 | GSM1900 | GPRS10 | Right Cheek | 512 | 27.5 | 27.41 | -0.06 | 0.635 | 1.02 | **0.65** |
| | GSM1900 | GPRS10 | Right Tilted | 512 | 27.5 | 27.41 | -0.07 | 0.345 | 1.02 | 0.35 |
| | GSM1900 | GPRS10 | Left Cheek | 512 | 27.5 | 27.41 | 0.06 | 0.503 | 1.02 | 0.51 |
| | GSM1900 | GPRS10 | Left Tilted | 512 | 27.5 | 27.41 | 0.10 | 0.279 | 1.02 | 0.28 |
| 3 | WCDMA II | RMC12.2K | Right Cheek | 9262 | 20.5 | 20.26 | 0.10 | 0.659 | 1.06 | **0.70** |
| | WCDMA II | RMC12.2K | Right Tilted | 9262 | 20.5 | 20.26 | 0.02 | 0.351 | 1.06 | 0.37 |
| | WCDMA II | RMC12.2K | Left Cheek | 9262 | 20.5 | 20.26 | 0.10 | 0.503 | 1.06 | 0.53 |
| | WCDMA II | RMC12.2K | Left Tilted | 9262 | 20.5 | 20.26 | -0.10 | 0.281 | 1.06 | 0.30 |
| | WCDMA V | RMC12.2K | Right Cheek | 4132 | 20.5 | 20.46 | 0.04 | 0.429 | 1.01 | 0.43 |
| | WCDMA V | RMC12.2K | Right Tilted | 4132 | 20.5 | 20.46 | -0.03 | 0.212 | 1.01 | 0.21 |
| 4 | WCDMA V | RMC12.2K | Left Cheek | 4132 | 20.5 | 20.46 | 0.02 | 0.457 | 1.01 | **0.46** |
| | WCDMA V | RMC12.2K | Left Tilted | 4132 | 20.5 | 20.46 | 0.09 | 0.211 | 1.01 | 0.21 |

### 4.7.3 SAR Results for Body-worn Exposure Condition (Separation Distance is 1.0 cm Gap)

| Plot No. | Band | Mode | Test Position | Ch. | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaling Factor | Scaled SAR-1g (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|
| | GSM850 | GPRS11 | Front Face | 128 | 26.5 | 26.37 | 0.01 | 0.542 | 1.03 | 0.56 |
| 5 | GSM850 | GPRS11 | Rear Face | 128 | 26.5 | 26.37 | -0.05 | 0.62 | 1.03 | **0.64** |
| | GSM1900 | GPRS10 | Front Face | 512 | 27.5 | 27.41 | 0.03 | 0.393 | 1.02 | 0.40 |
| 6 | GSM1900 | GPRS10 | Rear Face | 512 | 27.5 | 27.41 | 0.03 | 0.53 | 1.02 | **0.54** |
| | WCDMA II | RMC12.2K | Front Face | 9262 | 20.5 | 20.26 | 0.19 | 0.408 | 1.06 | 0.43 |
| 7 | WCDMA II | RMC12.2K | Rear Face | 9262 | 20.5 | 20.26 | -0.02 | 0.563 | 1.06 | **0.59** |
| | WCDMA V | RMC12.2K | Front Face | 4132 | 20.5 | 20.46 | 0.01 | 0.391 | 1.01 | 0.39 |
| 8 | WCDMA V | RMC12.2K | Rear Face | 4132 | 20.5 | 20.46 | 0.01 | 0.705 | 1.01 | **0.71** |

### 4.7.4 SAR Results for Hotspot Exposure Condition (Separation Distance is 1.0 cm Gap)

| Plot No. | Band | Mode | Test Position | Ch. | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaling Factor | Scaled SAR-1g (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|
| | GSM850 | GPRS11 | Front Face | 128 | 26.5 | 26.37 | 0.01 | 0.542 | 1.03 | 0.56 |
| 5 | GSM850 | GPRS11 | Rear Face | 128 | 26.5 | 26.37 | -0.05 | 0.62 | 1.03 | **0.64** |
| | GSM850 | GPRS11 | Left Side | 128 | 26.5 | 26.37 | -0.02 | 0.311 | 1.03 | 0.32 |
| | GSM850 | GPRS11 | Right Side | 128 | 26.5 | 26.37 | -0.03 | 0.218 | 1.03 | 0.22 |
| | GSM850 | GPRS11 | Top Side | 128 | 26.5 | 26.37 | -0.02 | 0.00761 | 1.03 | 0.01 |
| | GSM850 | GPRS11 | Bottom Side | 128 | 26.5 | 26.37 | -0.06 | 0.031 | 1.03 | 0.03 |
| | GSM1900 | GPRS10 | Front Face | 512 | 27.5 | 27.41 | 0.03 | 0.393 | 1.02 | 0.40 |
| 6 | GSM1900 | GPRS10 | Rear Face | 512 | 27.5 | 27.41 | 0.03 | 0.53 | 1.02 | **0.54** |
| | GSM1900 | GPRS10 | Left Side | 512 | 27.5 | 27.41 | 0.05 | 0.165 | 1.02 | 0.17 |
| | GSM1900 | GPRS10 | Right Side | 512 | 27.5 | 27.41 | -0.04 | 0.272 | 1.02 | 0.28 |
| | GSM1900 | GPRS10 | Top Side | 512 | 27.5 | 27.41 | -0.04 | 0.042 | 1.02 | 0.04 |
| | GSM1900 | GPRS10 | Bottom Side | 512 | 27.5 | 27.41 | -0.01 | 0.334 | 1.02 | 0.34 |
| | WCDMA II | RMC12.2K | Front Face | 9262 | 20.5 | 20.26 | 0.19 | 0.408 | 1.06 | 0.43 |
| 7 | WCDMA II | RMC12.2K | Rear Face | 9262 | 20.5 | 20.26 | -0.01 | 0.563 | 1.06 | **0.59** |
| | WCDMA II | RMC12.2K | Left Side | 9262 | 20.5 | 20.26 | 0.09 | 0.173 | 1.06 | 0.18 |
| | WCDMA II | RMC12.2K | Right Side | 9262 | 20.5 | 20.26 | 0.10 | 0.23 | 1.06 | 0.24 |
| | WCDMA II | RMC12.2K | Top Side | 9262 | 20.5 | 20.26 | 0.10 | 0.042 | 1.06 | 0.04 |
| | WCDMA II | RMC12.2K | Bottom Side | 9262 | 20.5 | 20.26 | 0.01 | 0.301 | 1.06 | 0.32 |
| | WCDMA V | RMC12.2K | Front Face | 4132 | 20.5 | 20.46 | 0.01 | 0.391 | 1.01 | 0.39 |
| 8 | WCDMA V | RMC12.2K | Rear Face | 4132 | 20.5 | 20.46 | 0.01 | 0.705 | 1.01 | **0.71** |
| | WCDMA V | RMC12.2K | Left Side | 4132 | 20.5 | 20.46 | -0.05 | 0.339 | 1.01 | 0.34 |
| | WCDMA V | RMC12.2K | Right Side | 4132 | 20.5 | 20.46 | 0.00 | 0.26 | 1.01 | 0.26 |
| | WCDMA V | RMC12.2K | Top Side | 4132 | 20.5 | 20.46 | 0.01 | 0.00864 | 1.01 | 0.01 |
| | WCDMA V | RMC12.2K | Bottom Side | 4132 | 20.5 | 20.46 | 0.00 | 0.028 | 1.01 | 0.03 |

#### 4.7.5 SAR Measurement Variability

According to KDB 865664 D01, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are ≤ 1.45 W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is ≤ 1.10, the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

Since all the measured SAR are less than 0.8 W/kg, the repeated measurement is not required.

#### 4.7.6 Simultaneous Multi-band Transmission Evaluation

**<Estimated SAR Calculation>**

According to KDB 447498 D01, when standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR was estimated according to following formula to result in substantially conservative SAR values of <= 0.4 W/kg to determine simultaneous transmission SAR test exclusion.

$$\text{Estimated SAR} = \frac{\text{Max. Tune up Power}_{(\text{mW})}}{\text{Min. Test Separation Distance}_{(\text{mm})}} \times \frac{\sqrt{f_{(\text{GHz})}}}{7.5}$$

If the minimum test separation distance is < 5 mm, a distance of 5 mm is used for estimated SAR calculation. When the test separation distance is > 50 mm, the 0.4 W/kg is used for SAR-1g.

| Mode / Band | Frequency (GHz) | Max. Tune-up Power (dBm) | Test Position | Separation Distance (mm) | Estimated SAR (W/kg) |
|---|---|---|---|---|---|
| BT (DSS) | 2.48 | -4.0 | Body-worn | 10 | 0.01 |

**Note:**

1. The separation distance is determined from the outer housing of the EUT to the user.
2. When standalone SAR testing is not required, an estimated SAR can be applied to determine simultaneous transmission SAR test exclusion.

**<SAR Summation Analysis>**

Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneous transmitting antenna. When the sum of $SAR_{1g}$ of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit ($SAR_{1g}$ 1.6 W/kg), the simultaneous transmission SAR is not required. When the sum of $SAR_{1g}$ is greater than the SAR limit ($SAR_{1g}$ 1.6 W/kg), SAR test exclusion is determined by the SPLSR.

| No. | Conditions (SAR1 + SAR2) | Exposure Condition | Test Position | Max. SAR1 | Max. SAR2 | SAR Summation | SPLSR Analysis |
|---|---|---|---|---|---|---|---|
| 1 | GSM850 + BT (DSS) | Body-Worn | Front Face | 0.56 | 0.01 | 0.57 | ∑SAR < 1.6, Not required |
| | | | Rear Face | 0.64 | 0.01 | 0.65 | ∑SAR < 1.6, Not required |

| No. | Conditions (SAR1 + SAR2) | Exposure Condition | Test Position | Max. SAR1 | Max. SAR2 | SAR Summation | SPLSR Analysis |
|---|---|---|---|---|---|---|---|
| 2 | GSM1900 + BT (DSS) | Body-Worn | Front Face | 0.40 | 0.01 | 0.41 | ∑SAR < 1.6, Not required |
| | | | Rear Face | 0.54 | 0.01 | 0.55 | ∑SAR < 1.6, Not required |

| No. | Conditions (SAR1 + SAR2) | Exposure Condition | Test Position | Max. SAR1 | Max. SAR2 | SAR Summation | SPLSR Analysis |
|---|---|---|---|---|---|---|---|
| 3 | WCDMA II + BT (DSS) | Body-Worn | Front Face | 0.43 | 0.01 | 0.44 | ∑SAR < 1.6, Not required |
| | | | Rear Face | 0.59 | 0.01 | 0.60 | ∑SAR < 1.6, Not required |

| No. | Conditions (SAR1 + SAR2) | Exposure Condition | Test Position | Max. SAR1 | Max. SAR2 | SAR Summation | SPLSR Analysis |
|---|---|---|---|---|---|---|---|
| 4 | WCDMA V + BT (DSS) | Body-Worn | Front Face | 0.39 | 0.01 | 0.40 | ∑SAR < 1.6, Not required |
| | | | Rear Face | 0.71 | 0.01 | 0.72 | ∑SAR < 1.6, Not required |

**Test Engineer：**Xianxiong Qin

# 5. Calibration of Test Equipment

| Equipment | Manufacturer | Model | SN | Cal. Date | Cal. Interval |
|---|---|---|---|---|---|
| System Validation Dipole | SPEAG | D835V2 | 4d139 | Aug. 28, 2017 | 1 Year |
| System Validation Dipole | SPEAG | D1900V2 | 5d159 | Aug. 26, 2017 | 1 Year |
| Dosimetric E-Field Probe | SPEAG | EX3DV4 | 3873 | Aug. 25, 2017 | 1 Year |
| Data Acquisition Electronics | SPEAG | DAE4 | 1341 | Aug. 23, 2017 | 1 Year |
| Wireless Communication Test Set | Agilent | E5515C | MY50260600 | Jun. 28, 2017 | 1 Year |
| ENA Series Network Analyzer | Agilent | E5071C | MY46214638 | Jul. 24, 2017 | 1 Year |
| MXG Analog Signal Generator | KEYSIGHT | N5183A | MY50143024 | Mar. 01, 2017 | 1 Year |
| Power Meter | Agilent | N1914A | MY52180044 | Aug. 12, 2016 | 2 Years |
| Power Sensor | Agilent | E9304A H18 | MY52050011 | Jan. 04, 2018 | 1 Year |
| Power Meter | Agilent | ML2495A | 1506002 | Mar. 01, 2017 | 1 Year |
| Power Sensor | Agilent | MA2411B | 1339353 | Mar. 01, 2017 | 1 Year |
| Temp. & Humi. Recorder | CLOCK | HTC-1 | 157248 | Jul. 26, 2017 | 1 Year |
| Electronic Thermometer | YONGFA | YF-160A | 120100323 | Sep. 22, 2017 | 1 Year |
| Coupler | Woken | 0110A056020-10 | COM27RW1A3 | Sep. 20, 2017 | 1 Year |

# 6. Measurement Uncertainty

| Source of Uncertainty | Tolerance (± %) | Probability Distribution | Divisor | Ci (1g) | Ci (10g) | Standard Uncertainty (± %, 1g) | Standard Uncertainty (± %, 10g) | Vi |
|---|---|---|---|---|---|---|---|---|
| **Measurement System** | | | | | | | | |
| Probe Calibration | 6.0 | Normal | 1 | 1 | 1 | 6.0 | 6.0 | ∞ |
| Axial Isotropy | 4.7 | Rectangular | √3 | 0.707 | 0.707 | 1.9 | 1.9 | ∞ |
| Hemispherical Isotropy | 9.6 | Rectangular | √3 | 0.707 | 0.707 | 3.9 | 3.9 | ∞ |
| Boundary Effect | 1.0 | Rectangular | √3 | 1 | 1 | 0.6 | 0.6 | ∞ |
| Linearity | 4.7 | Rectangular | √3 | 1 | 1 | 2.7 | 2.7 | ∞ |
| System Detection Limits | 0.25 | Rectangular | √3 | 1 | 1 | 0.14 | 0.14 | ∞ |
| Readout Electronics | 0.3 | Normal | 1 | 1 | 1 | 0.3 | 0.3 | ∞ |
| Response Time | 0.0 | Rectangular | √3 | 1 | 1 | 0.0 | 0.0 | ∞ |
| Integration Time | 1.7 | Rectangular | √3 | 1 | 1 | 1.0 | 1.0 | ∞ |
| RF Ambient Conditions - Noise | 3.0 | Rectangular | √3 | 1 | 1 | 1.7 | 1.7 | ∞ |
| RF Ambient Conditions - Reflections | 3.0 | Rectangular | √3 | 1 | 1 | 1.7 | 1.7 | ∞ |
| Probe Positioner Mechanical Tolerance | 0.4 | Rectangular | √3 | 1 | 1 | 0.2 | 0.2 | ∞ |
| Probe Positioning with Respect to Phantom Shell | 2.9 | Rectangular | √3 | 1 | 1 | 1.7 | 1.7 | ∞ |
| Extrapolation, interpolation, and integration algorithms for max. SAR evaluation | 2.0 | Rectangular | √3 | 1 | 1 | 1.2 | 1.2 | ∞ |
| **Test Sample Related** | | | | | | | | |
| Test Sample Positioning | 1.5 / 0.7 | Normal | 1 | 1 | 1 | 1.5 | 0.7 | 32 |
| Device Holder Uncertainty | 4.2 / 1.8 | Normal | 1 | 1 | 1 | 4.2 | 1.8 | 32 |
| Output Power Variation - SAR Drift Measurement | 5.0 | Rectangular | √3 | 1 | 1 | 2.9 | 2.9 | ∞ |
| **Phantom and Tissue Parameters** | | | | | | | | |
| Phantom Uncertainty (Shape and Thickness Tolerances) | 7.2 | Rectangular | √3 | 1 | 1 | 4.2 | 4.2 | ∞ |
| Liquid Conductivity - Deviation from Target Values | 5.0 | Rectangular | √3 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid Conductivity - Measurement Uncertainty | 1.0 | Normal | 1 | 0.64 | 0.43 | 0.6 | 0.4 | 25 |
| Liquid Permittivity - Deviation from Target Values | 5.0 | Rectangular | √3 | 0.60 | 0.49 | 1.7 | 1.4 | ∞ |
| Liquid Permittivity - Measurement Uncertainty | 0.5 | Normal | 1 | 0.60 | 0.49 | 0.3 | 0.2 | 25 |
| **Combined Standard Uncertainty** | | | | | | ± 11.2 % | ± 10.4 % | |
| **Expanded Uncertainty (K=2)** | | | | | | **± 22.4 %** | **± 20.8 %** | |

**Uncertainty budget for frequency range 300 MHz to 3 GHz**

# 7. Information on the Testing Laboratories

We, BV 7LAYERS COMMUNICATIONS TECHNOLOGY (SHENZHEN) CO. LTD., were founded in 2015 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

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The road map of all our labs can be found in our web site also.

**---END---**

# Appendix A. SAR Plots of System Verification

The plots for system verification with largest deviation for each SAR system combination are shown as follows.

Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2018/01/06

## System Check_H835_180106

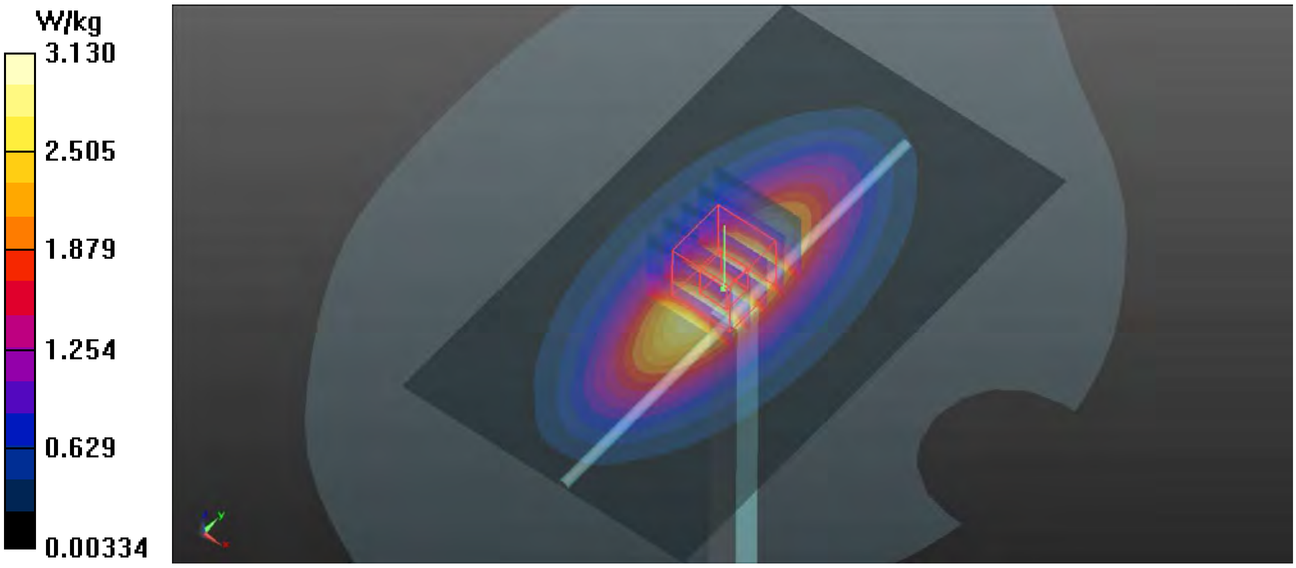
### DUT: Dipole:835 MHz;Type:D835V2; SN;4d139

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium: H835_0106 Medium parameters used: f = 835 MHz; $\sigma$ = 0.894 S/m; $\varepsilon_r$ = 41.663; $\rho$ = 1000 kg/m$^3$
Ambient Temperature：23.1 ℃; Liquid Temperature：22.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3873; ConvF(9.74, 9.74, 9.74); Calibrated: 2017/08/25;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2017/08/23
- Phantom: Left Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1722
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=250mW/Area Scan (71x121x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 3.13 W/kg

**Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 59.33 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 3.55 W/kg
**SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.57 W/kg**
Maximum value of SAR (measured) = 3.19 W/kg



## System Check_H1900_180105

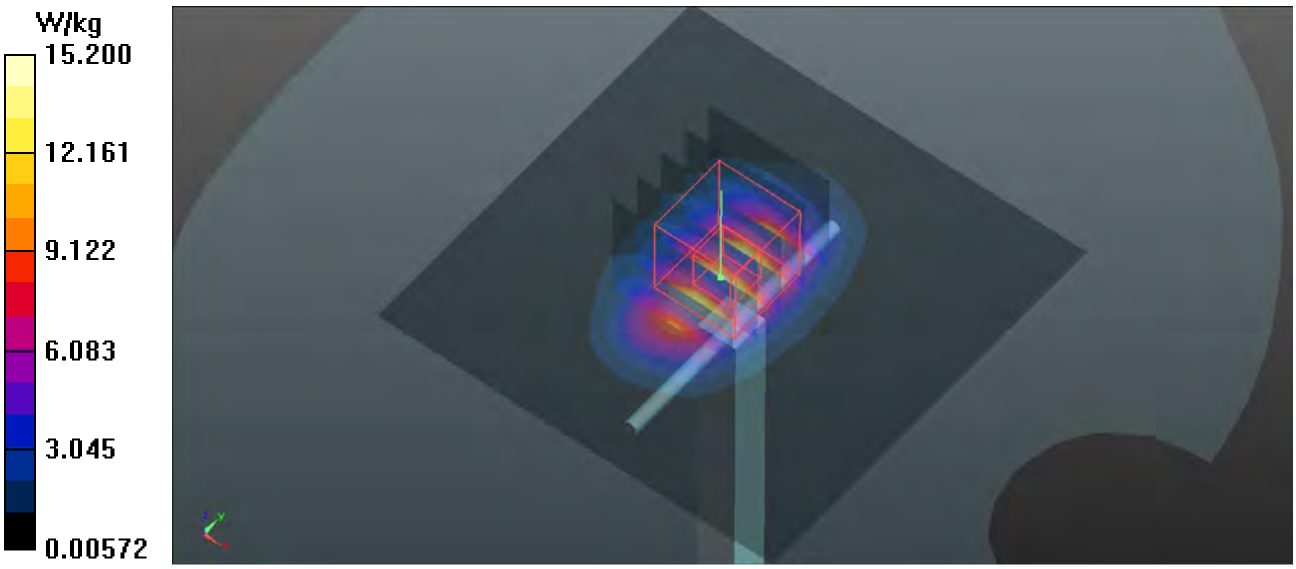
### DUT: Dipole: 1900MHz;Type:D1900V2; SN:5d159

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: H1900_0105 Medium parameters used: f = 1900 MHz; $\sigma$ = 1.374 S/m; $\varepsilon_r$ = 39.6; $\rho$ = 1000 $kg/m^3$
Ambient Temperature：23.3 ℃; Liquid Temperature：22.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3873; ConvF(8.37, 8.37, 8.37); Calibrated: 2017/08/25;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2017/08/23
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=250mW/Area Scan (71x71x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 15.2 W/kg

**Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 101.1 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 18.6 W/kg
**SAR(1 g) = 9.89 W/kg; SAR(10 g) = 5.07 W/kg**
Maximum value of SAR (measured) = 15.5 W/kg



# System Check_B835_180107

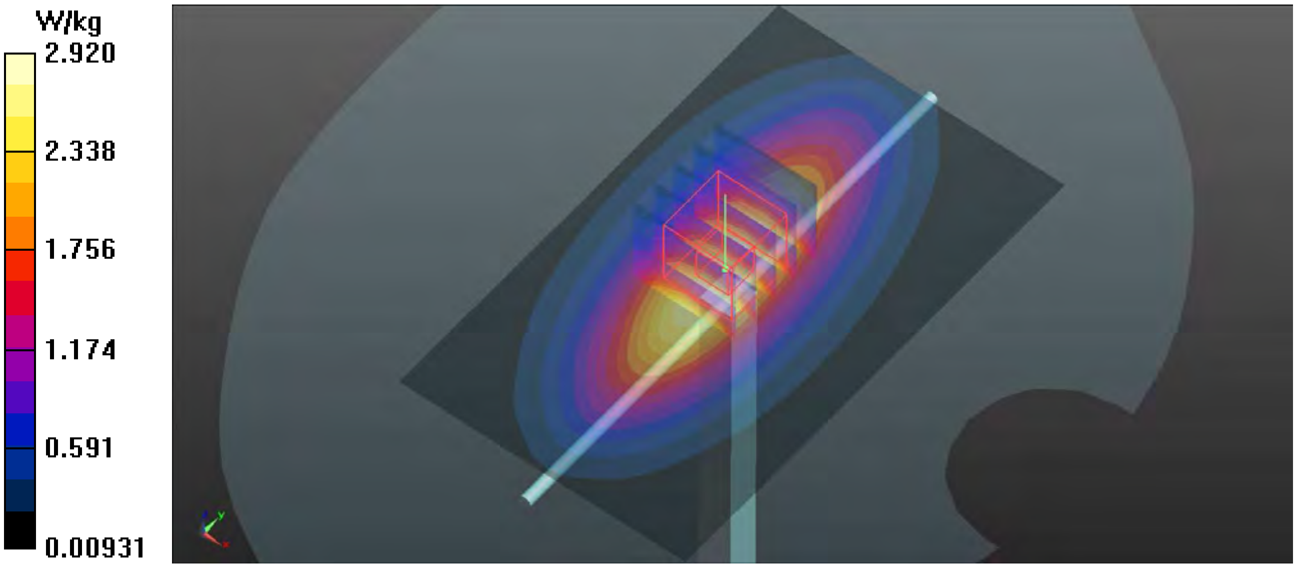
### DUT: Dipole:835 MHz; Type:D835V2; SN:4d139

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium: B835_0107 Medium parameters used: f = 835 MHz; $\sigma = 0.977$ S/m; $\varepsilon_r = 55.586$; $\rho = 1000$ kg/m$^3$
Ambient Temperature：23.2 ℃; Liquid Temperature：22.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3873; ConvF(9.62, 9.62, 9.62); Calibrated: 2017/08/25;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2017/08/23
- Phantom: Left Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1722
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=250mW/Area Scan (61x101x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 2.92 W/kg

**Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 56.50 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 3.40 W/kg
**SAR(1 g) = 2.33 W/kg; SAR(10 g) = 1.55 W/kg**
Maximum value of SAR (measured) = 2.92 W/kg



## System Check_B1900_180108

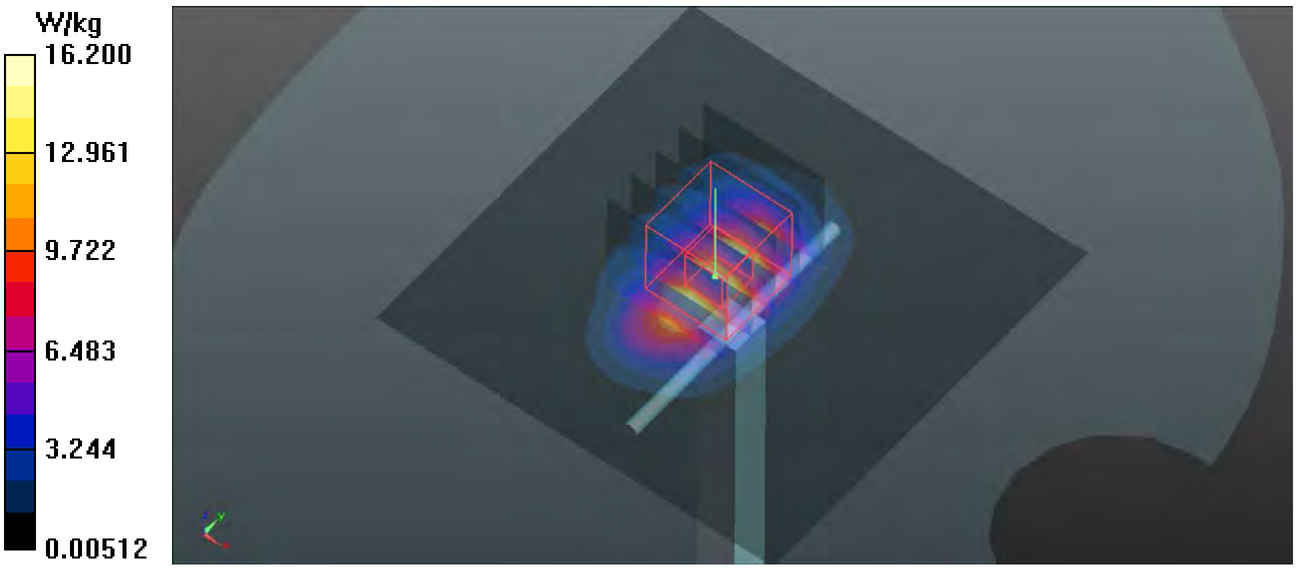
### DUT: Dipole: 1900MHz;Type:D1900V2; SN:5d159

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: B1900_0108 Medium parameters used: f = 1900 MHz; σ = 1.585 S/m; $\varepsilon_r$ = 53.657; ρ = 1000 kg/m$^3$
Ambient Temperature：23.3 ℃; Liquid Temperature：22.3 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3873; ConvF(7.77, 7.77, 7.77); Calibrated: 2017/08/25;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2017/08/23
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Pin=250mW/Area Scan (71x71x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 16.2 W/kg

**Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 95.15 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 19.6 W/kg
**SAR(1 g) = 10.8 W/kg; SAR(10 g) = 5.61 W/kg**
Maximum value of SAR (measured) = 16.7 W/kg



# Appendix B. SAR Plots of SAR Measurement

The SAR plots for highest measured SAR in each exposure configuration, wireless mode and frequency band combination, and measured SAR > 1.5 W/kg are shown as follows.

Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2018/01/06

## P01 GSM850_GPRS11_Left Cheek_Ch128

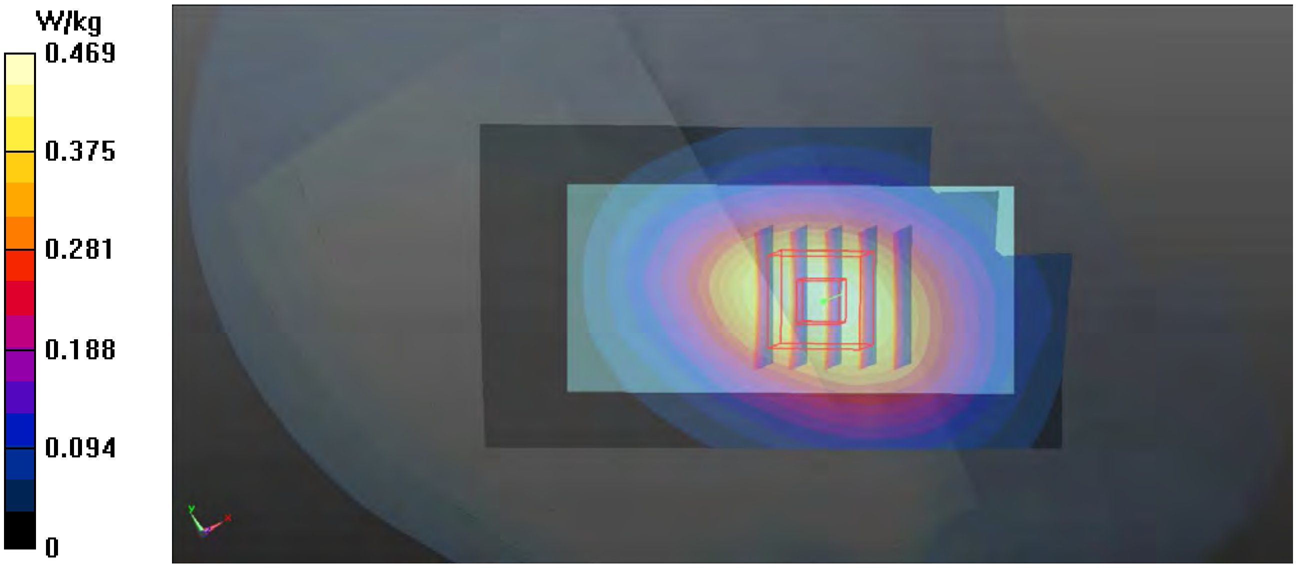
### DUT: 171127W003

Communication System: GPRS11; Frequency: 824.2 MHz;Duty Cycle: 1:2.7
Medium: H835_0106 Medium parameters used: f = 824.2 MHz; σ = 0.884 S/m; $\varepsilon_r$ = 41.785; ρ = 1000 kg/m$^3$
Ambient Temperature：23.1 ℃; Liquid Temperature：22.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3873; ConvF(9.74, 9.74, 9.74); Calibrated: 2017/08/25;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2017/08/23
- Phantom: Left Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1722
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**- Area Scan (51x91x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.469 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 7.077 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 0.507 W/kg
**SAR(1 g) = 0.383 W/kg; SAR(10 g) = 0.268 W/kg**
Maximum value of SAR (measured) = 0.471 W/kg



## P02 GSM1900_GPRS10_Right Cheek_Ch512

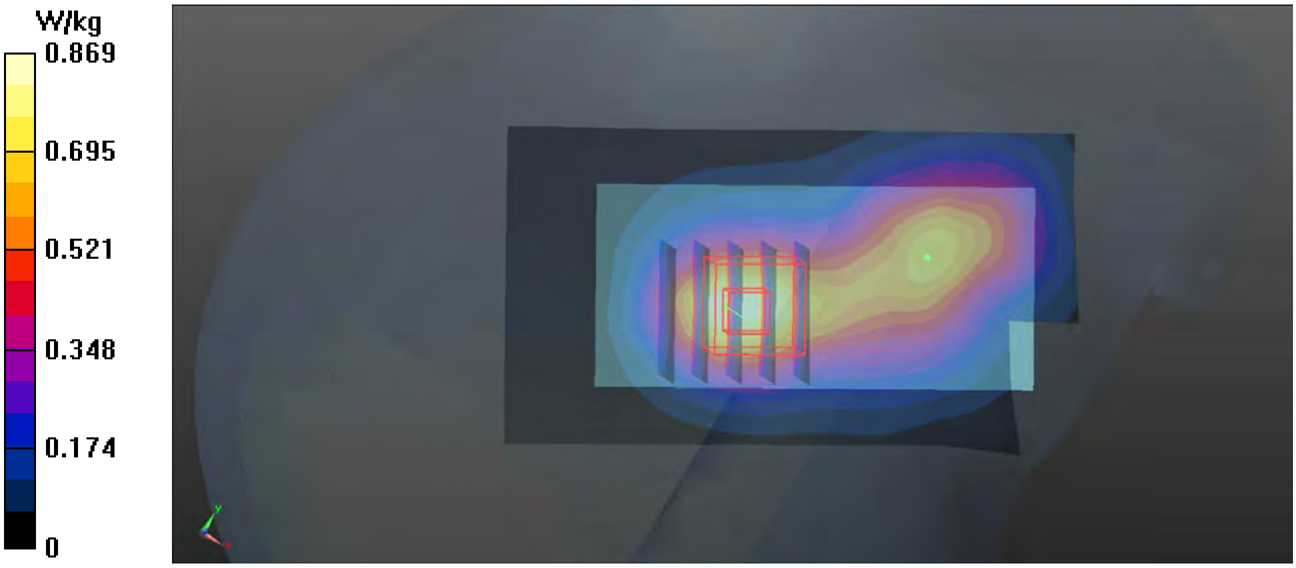
### DUT: 171127W003

Communication System: GPRS10; Frequency: 1850.2 MHz;Duty Cycle: 1:4
Medium: H1900_0105 Medium parameters used: f = 1850.2 MHz; σ = 1.399 S/m; $\varepsilon_r$ = 39.344; ρ = 1000 kg/m$^3$
Ambient Temperature：23.3 ℃; Liquid Temperature：22.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3873; ConvF(8.37, 8.37, 8.37); Calibrated: 2017/08/25;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2017/08/23
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**- Area Scan (51x91x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.869 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 7.653 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 0.942 W/kg
**SAR(1 g) = 0.635 W/kg; SAR(10 g) = 0.385 W/kg**
Maximum value of SAR (measured) = 0.804 W/kg



# P03 WCDMA II_RMC12.2K_Right Cheek_Ch9262

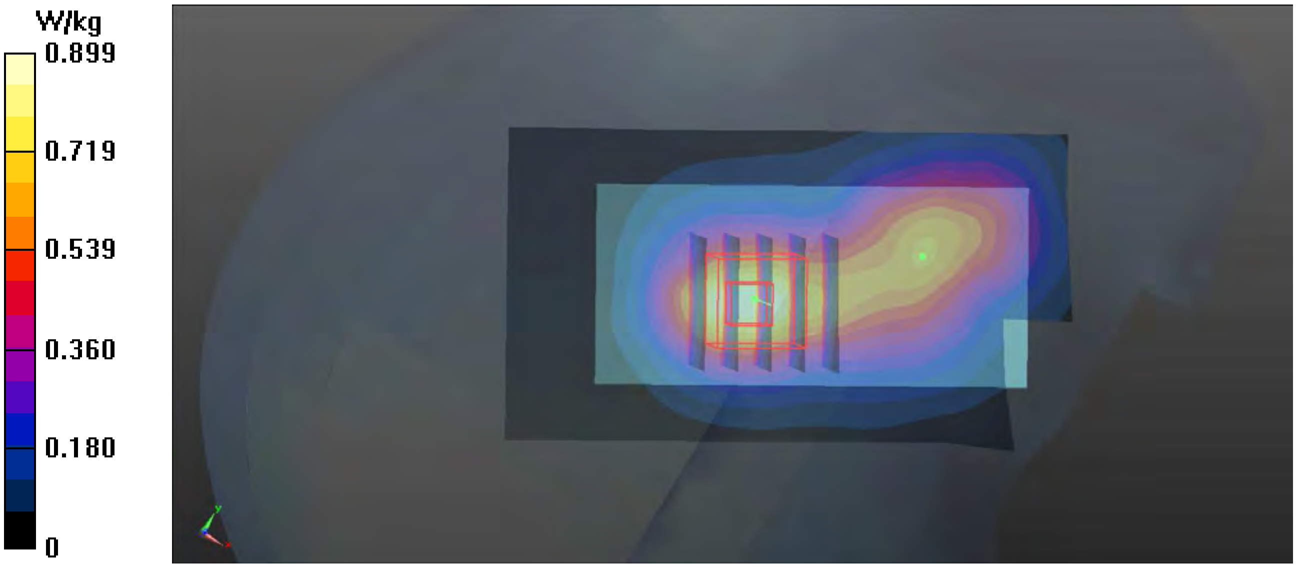
## DUT: 171127W003

Communication System: WCDMA; Frequency: 1852.4 MHz;Duty Cycle: 1:1
Medium: H1900_0105 Medium parameters used: f = 1852.4 MHz; σ = 1.4 S/m; $\varepsilon_r$ = 39.364; ρ = 1000 kg/$m^3$
Ambient Temperature：23.3 ℃; Liquid Temperature：22.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3873; ConvF(8.37, 8.37, 8.37); Calibrated: 2017/08/25;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2017/08/23
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**- Area Scan (51x91x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.899 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 7.241 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 0.984 W/kg
**SAR(1 g) = 0.659 W/kg; SAR(10 g) = 0.396 W/kg**
Maximum value of SAR (measured) = 0.845 W/kg



## P04 WCDMA V_RMC12.2K_Left Cheek_Ch4132

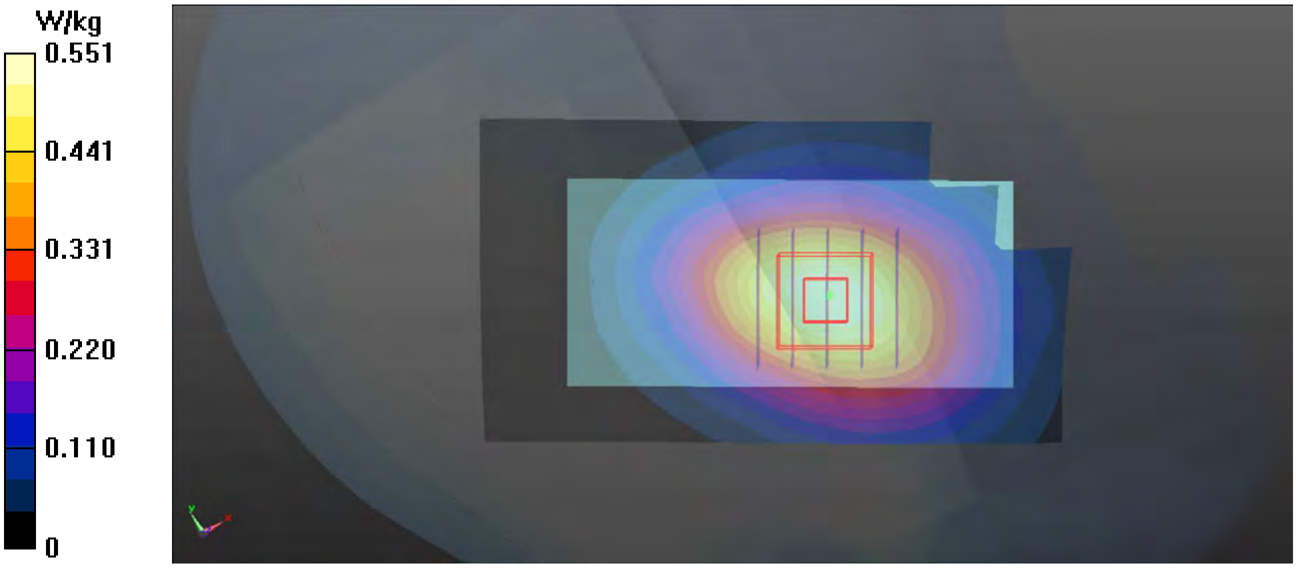
### DUT: 171127W003

Communication System: WCDMA; Frequency: 826.4 MHz;Duty Cycle: 1:1
Medium: H835_0106 Medium parameters used: f = 826.4 MHz; $\sigma$ = 0.886 S/m; $\varepsilon_r$ = 41.759; $\rho$ = 1000 kg/m$^3$
Ambient Temperature：23.1 ℃; Liquid Temperature：22.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3873; ConvF(9.74, 9.74, 9.74); Calibrated: 2017/08/25;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2017/08/23
- Phantom: Left Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1722
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**- Area Scan (51x91x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.551 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 7.005 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 0.593 W/kg
**SAR(1 g) = 0.457 W/kg; SAR(10 g) = 0.322 W/kg**
Maximum value of SAR (measured) = 0.552 W/kg



# P05 GSM850_GPRS11_Rear Face_1cm_Ch128

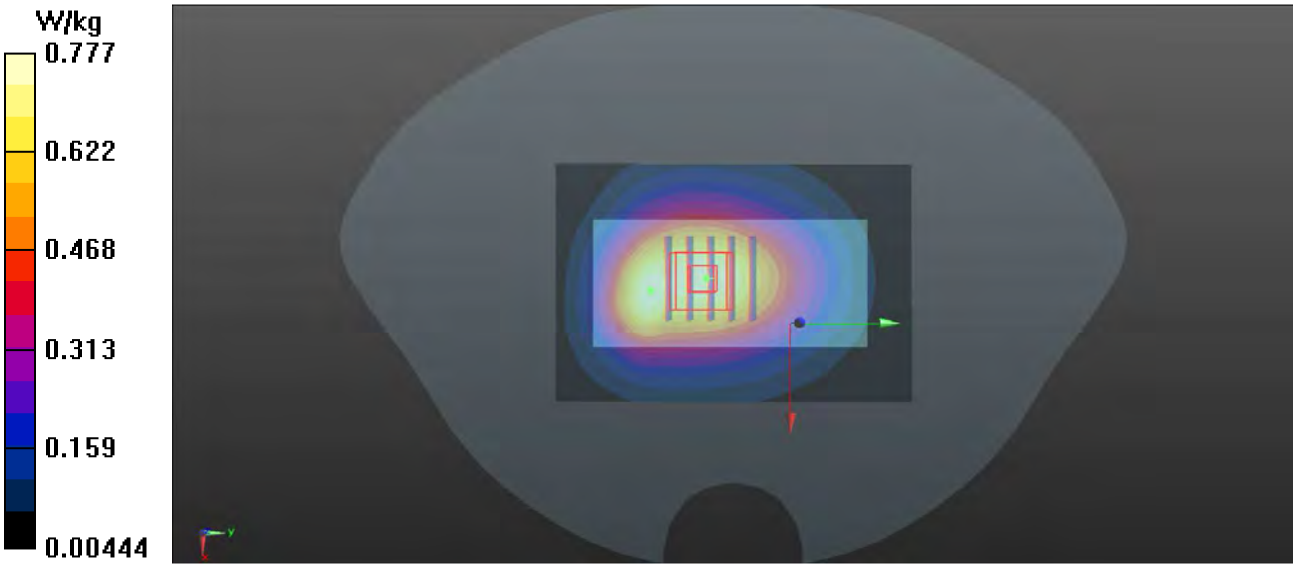
## DUT: 171127W003

Communication System: GPRS11; Frequency: 824.2 MHz;Duty Cycle: 1:2.7
Medium: B835_0107 Medium parameters used: f = 824.2 MHz; σ = 0.967 S/m; $\varepsilon_r$ = 55.696; ρ = 1000 kg/$m^3$
Ambient Temperature：23.2 ℃; Liquid Temperature：22.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3873; ConvF(9.62, 9.62, 9.62); Calibrated: 2017/08/25;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2017/08/23
- Phantom: Left Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1722
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**- Area Scan (61x91x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.777 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 24.95 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 0.859 W/kg
**SAR(1 g) = 0.620 W/kg; SAR(10 g) = 0.438 W/kg**
Maximum value of SAR (measured) = 0.779 W/kg



## P06 GSM1900_GPRS10_Rear Face_1cm_Ch512

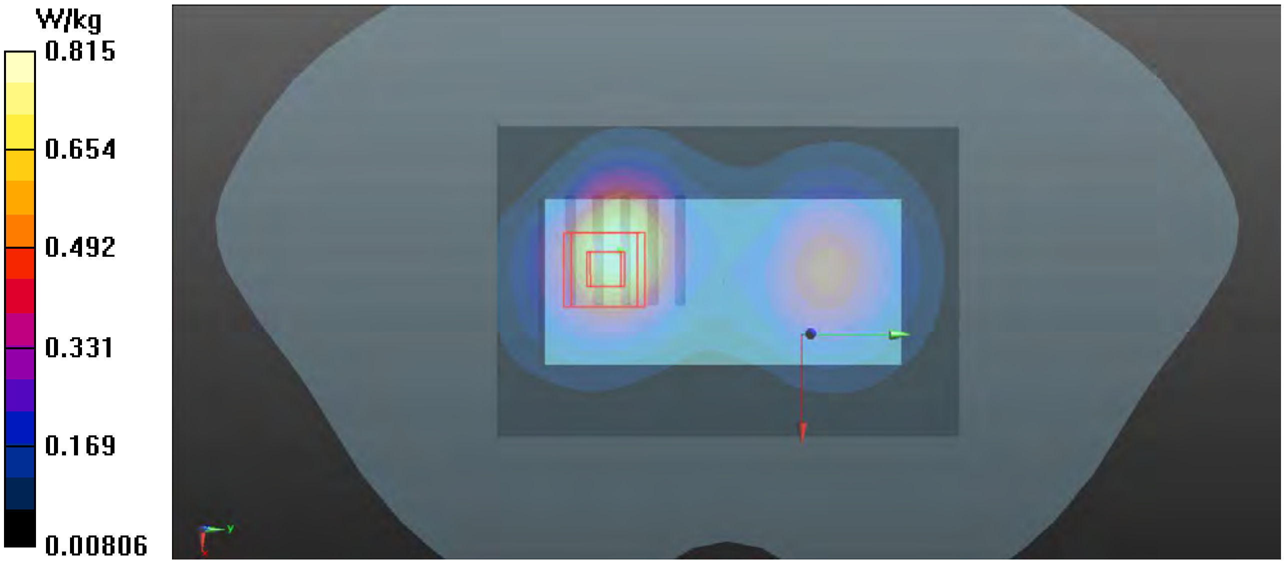
### DUT: 171127W003

Communication System: GPRS10; Frequency: 1850.2 MHz;Duty Cycle: 1:4
Medium: B1900_0108 Medium parameters used: f = 1850.2 MHz; $\sigma$ = 1.536 S/m; $\varepsilon_r$ = 53.82; $\rho$ = 1000 kg/m$^3$
Ambient Temperature：23.3 ℃; Liquid Temperature：22.3 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3873; ConvF(7.77, 7.77, 7.77); Calibrated: 2017/08/25;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2017/08/23
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**- Area Scan (61x91x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.815 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 7.391 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 0.885 W/kg
**SAR(1 g) = 0.530 W/kg; SAR(10 g) = 0.298 W/kg**
Maximum value of SAR (measured) = 0.760 W/kg



## P07 WCDMA II_RMC12.2K_Rear Face_1cm_Ch9262

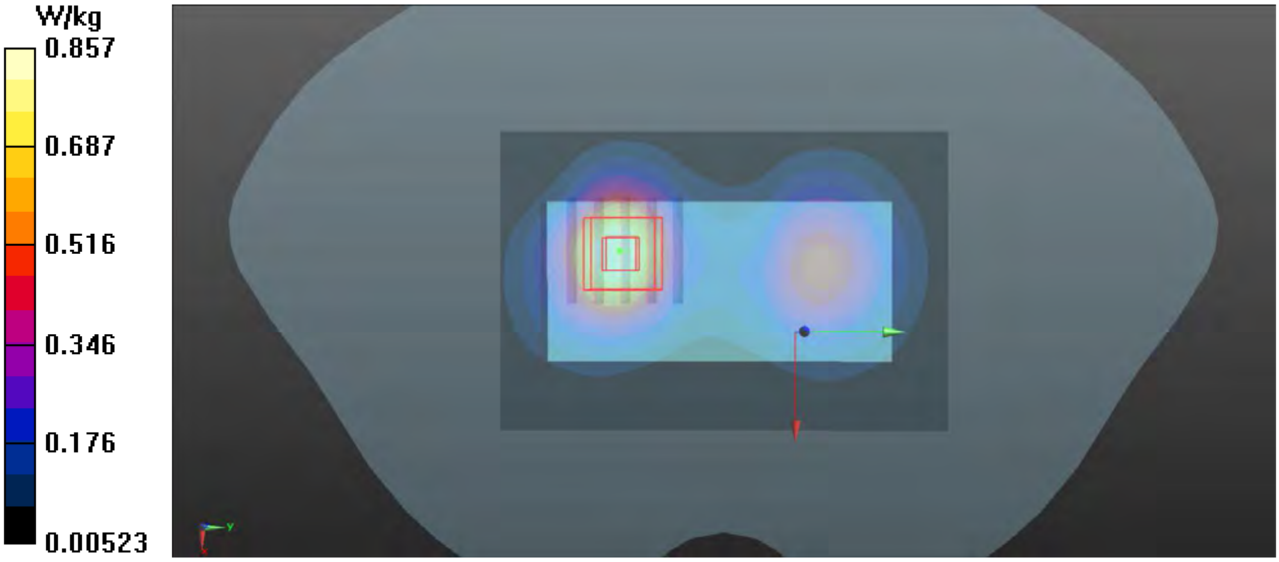
**DUT: 171127W003**

Communication System: WCDMA; Frequency: 1852.4 MHz;Duty Cycle: 1:1
Medium: B1900_0108 Medium parameters used: f = 1852.4 MHz; $\sigma$ = 1.538 S/m; $\varepsilon_r$ = 53.815; $\rho$ = 1000 $kg/m^3$
Ambient Temperature：23.3 ℃; Liquid Temperature：22.3 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3873; ConvF(7.77, 7.77, 7.77); Calibrated: 2017/08/25;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2017/08/23
- Phantom: Front Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1695
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**- Area Scan (61x91x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.857 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 9.577 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 0.950 W/kg
**SAR(1 g) = 0.563 W/kg; SAR(10 g) = 0.317 W/kg**
Maximum value of SAR (measured) = 0.808 W/kg



Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2018/01/07

## P08 WCDMA V_RMC12.2K_Rear Face_1cm_Ch4132

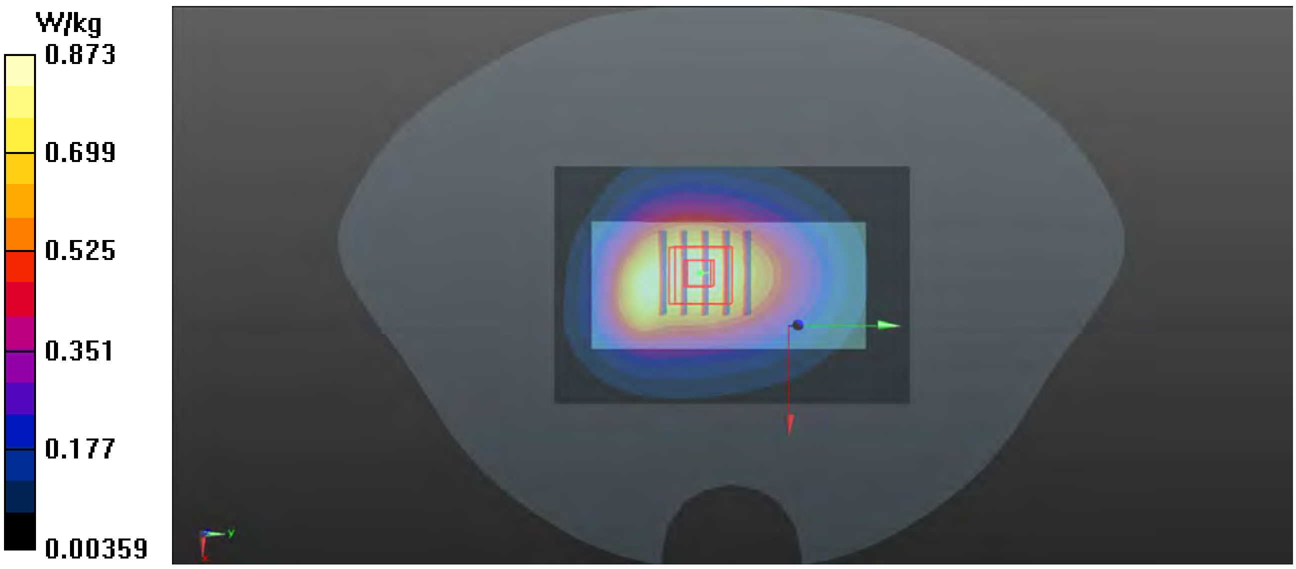
### DUT: 171127W003

Communication System: WCDMA; Frequency: 826.4 MHz;Duty Cycle: 1:1
Medium: B835_0107 Medium parameters used: f = 826.4 MHz; $\sigma$ = 0.969 S/m; $\varepsilon_r$ = 55.677; $\rho$ = 1000 kg/m$^3$
Ambient Temperature：23.2 ℃; Liquid Temperature：22.2 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3873; ConvF(9.62, 9.62, 9.62); Calibrated: 2017/08/25;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1341; Calibrated: 2017/08/23
- Phantom: Left Phantom with CRP v5.0; Type: QD000P40CD; Serial: TP:1722
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**- Area Scan (61x91x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.873 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 26.15 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 0.960 W/kg
**SAR(1 g) = 0.705 W/kg; SAR(10 g) = 0.501 W/kg**
Maximum value of SAR (measured) = 0.878 W/kg



# Appendix C. Calibration Certificate for Probe and Dipole

The SPEAG calibration certificates are shown as follows.

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中国认可
国际互认
校准
CALIBRATION
CNAS L0570

Client ADT_CN

Certificate No: Z17-97118

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D835V2 - SN: 4d139 |
| Calibration Procedure(s) | FF-Z11-003-01<br>Calibration Procedures for dipole validation kits |
| Calibration date: | August 28, 2017 |

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)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power Meter NRVD | 102083 | 22-Sep-16 (CTTL, No.J16X06809) | Sep-17 |
| Power sensor NRV-Z5 | 100595 | 22-Sep-16 (CTTL, No.J16X06809) | Sep-17 |
| Reference Probe EX3DV4 | SN 3617 | 23-Jan-17(SPEAG,No.EX3-3617_Jan17) | Jan-18 |
| DAE4 | SN 1331 | 19-Jan-17(CTTL-SPEAG,No.Z17-97015) | Jan-18 |
| Secondary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 13-Jan-17 (CTTL, No.J17X00286) | Jan-18 |
| Network Analyzer E5071C | MY46110673 | 13-Jan-17 (CTTL, No.J17X00285) | Jan-18 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Zhao Jing | SAR Test Engineer | |
| Reviewed by: | Lin Hao | SAR Test Engineer | |
| Approved by: | Qi Dianyuan | SAR Project Leader | |

Issued: August 31, 2017

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
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**Glossary:**

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

**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, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
c) IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
d) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

**Additional Documentation:**

e) 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** | DASY52 | 52.10.0.1446 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Triple Flat Phantom 5.1C | |
| **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 | 41.2 ± 6 % | 0.89 mho/m ± 6 % |
| **Head TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Head TSL

| | | |
|---|---|---|
| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
| SAR measured | 250 mW input power | 2.35 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **9.49 mW /g ± 18.8 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 250 mW input power | 1.52 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **6.13 mW /g ± 18.7 % (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 | 55.6 ± 6 % | 0.98 mho/m ± 6 % |
| **Body TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Body TSL

| | | |
|---|---|---|
| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
| SAR measured | 250 mW input power | 2.45 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **9.71 mW /g ± 18.8 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | Condition | |
| SAR measured | 250 mW input power | 1.61 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **6.39 mW /g ± 18.7 % (k=2)** |

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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 48.4Ω- 2.62jΩ |
| Return Loss | - 30.1dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 45.6Ω- 4.60jΩ |
| Return Loss | - 23.6dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.497 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 |

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**DASY5 Validation Report for Head TSL** Date: 08.28.2017

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d139**

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: f = 835 MHz; $\sigma$ = 0.887 S/m; $\varepsilon_r$ = 41.22; $\rho$ = 1000 kg/m$^3$

Phantom section: Left Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(9.73, 9.73, 9.73); Calibrated: 1/23/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 1/19/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

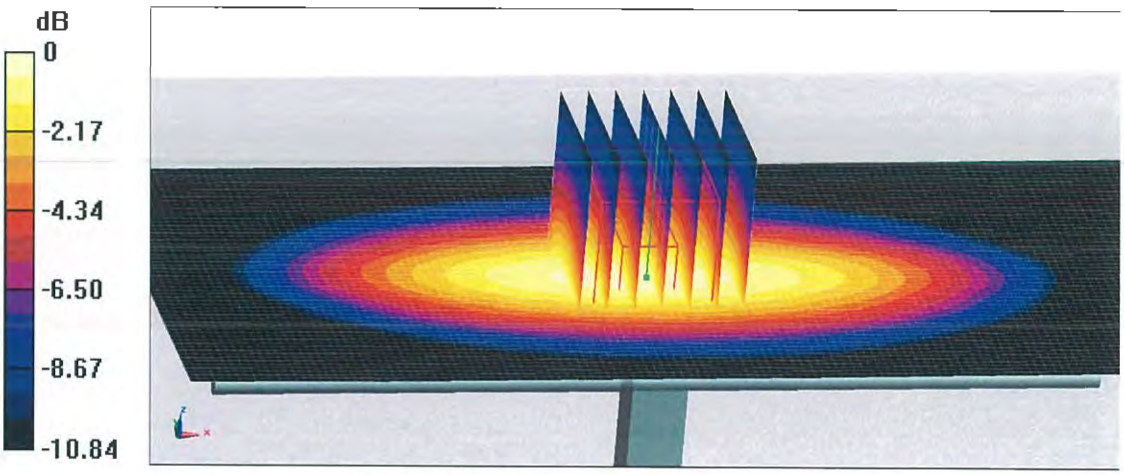
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.65V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 3.61 W/kg

**SAR(1 g) = 2.35 W/kg; SAR(10 g) = 1.52 W/kg**

Maximum value of SAR (measured) = 3.18 W/kg




**0 dB = 3.18 W/kg = 5.02 dBW/kg**

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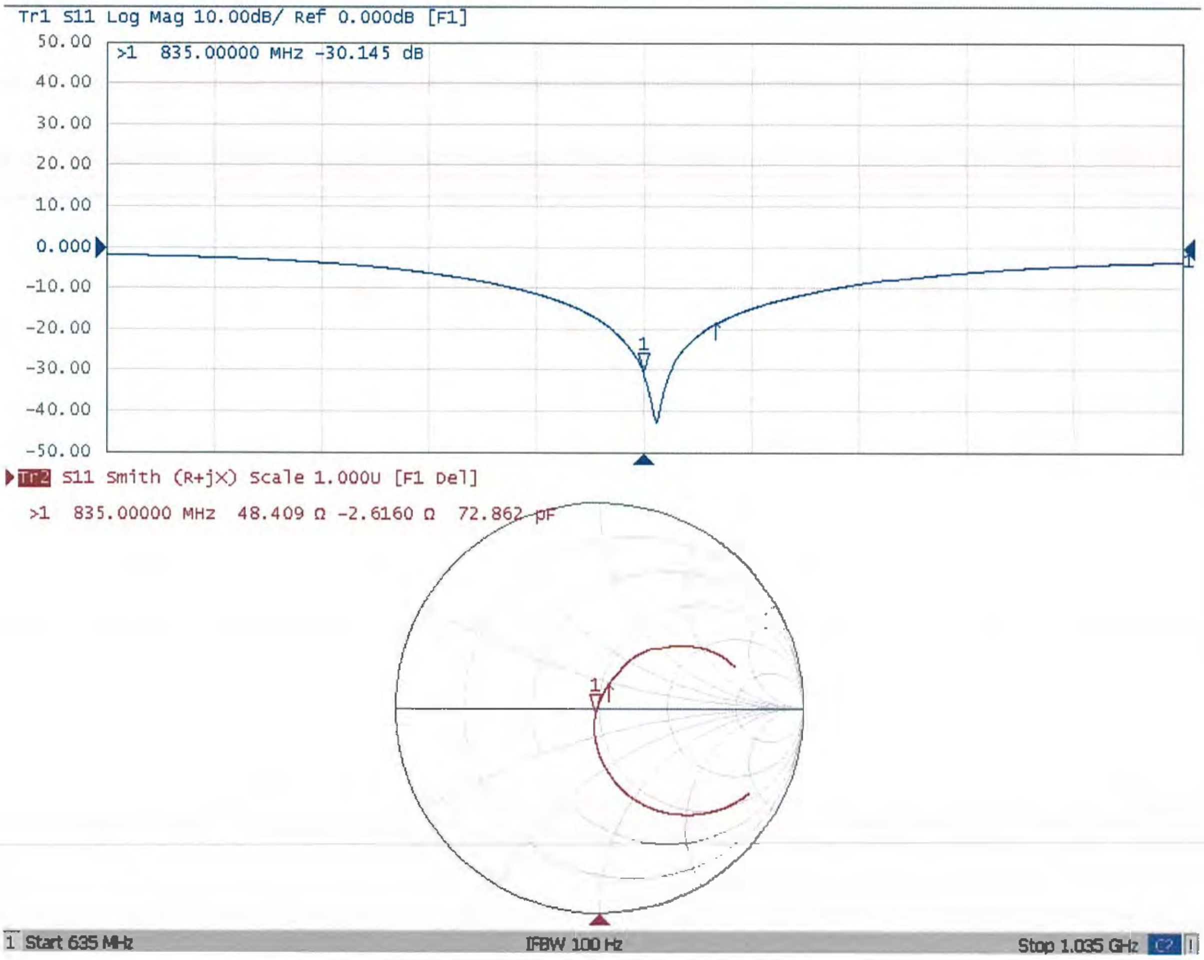
## Impedance Measurement Plot for Head TSL



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**DASY5 Validation Report for Body TSL** Date: 08.27.2017

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d139**

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: f = 835 MHz; $\sigma$ = 0.984 S/m; $\varepsilon_r$ = 55.62; $\rho$ = 1000 kg/m$^3$

Phantom section: Right Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(9.64,9.64, 9.64); Calibrated: 1/23/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 1/19/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

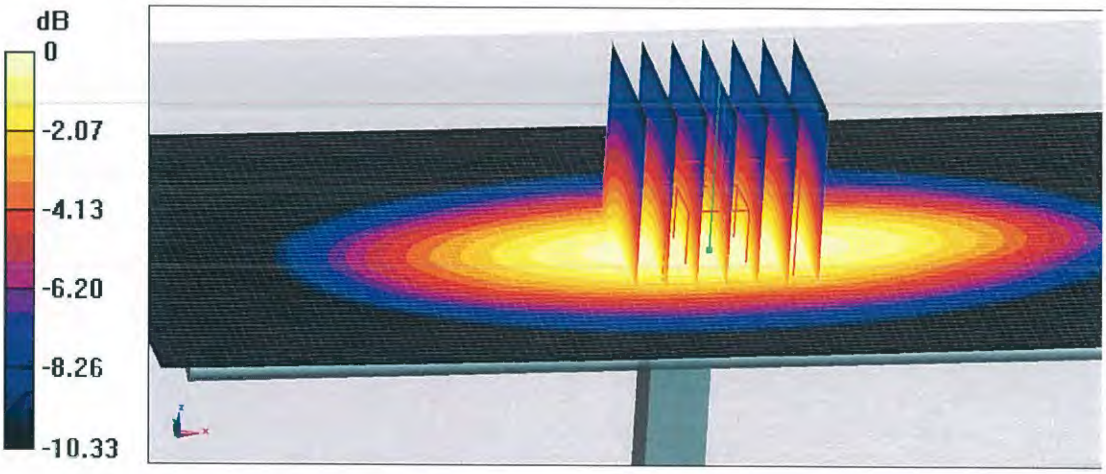
**Dipole Calibration/Zoom Sean (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.07 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 3.71 W/kg

**SAR(1 g) = 2.45 W/kg; SAR(10 g) = 1.61 W/kg**

Maximum value of SAR (measured) = 3.29 W/kg




**0 dB = 3.29 W/kg = 5.17 dBW/kg**

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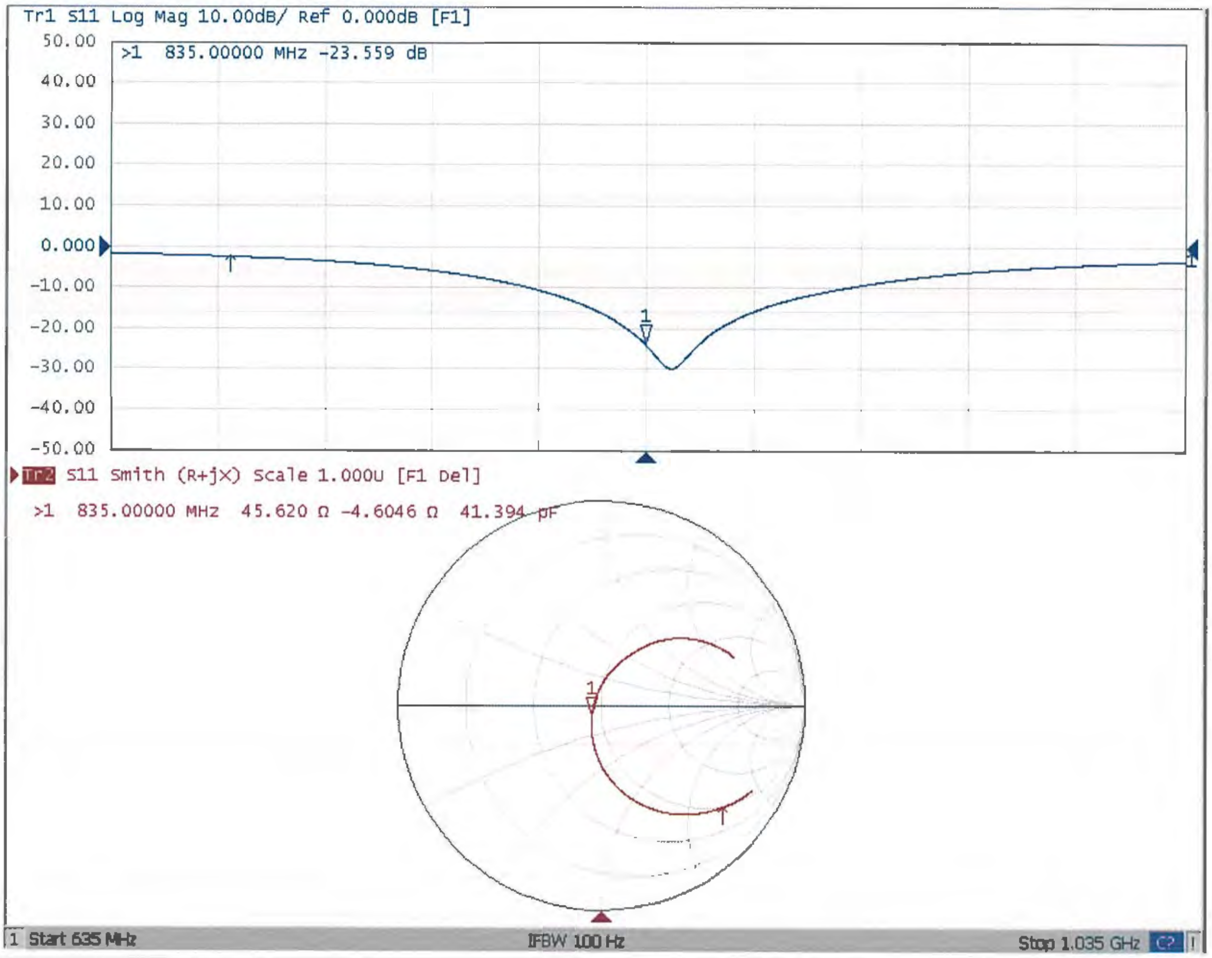
## Impedance Measurement Plot for Body TSL



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CALIBRATION LABORATORY
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CALIBRATION
CNAS L0570

Client ADT_CN Certificate No: Z17-97121

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1900V2 - SN: 5d159 |
| Calibration Procedure(s) | FF-Z11-003-01<br>Calibration Procedures for dipole validation kits |
| Calibration date: | August 26, 2017 |

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)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power Meter NRVD | 102083 | 22-Sep-16 (CTTL, No.J16X06809) | Sep-17 |
| Power sensor NRV-Z5 | 100595 | 22-Sep-16 (CTTL, No.J16X06809) | Sep-17 |
| Reference Probe EX3DV4 | SN 3617 | 23-Jan-17(SPEAG,No.EX3-3617_Jan17) | Jan-18 |
| DAE4 | SN 1331 | 19-Jan-17(CTTL-SPEAG,No.Z17-97015) | Jan-18 |
| Secondary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 13-Jan-17 (CTTL, No.J17X00286) | Jan-18 |
| Network Analyzer E5071C | MY46110673 | 13-Jan-17 (CTTL, No.J17X00285) | Jan-18 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Zhao Jing | SAR Test Engineer | |
| Reviewed by: | Lin Hao | SAR Test Engineer | |
| Approved by: | Qi Dianyuan | SAR Project Leader | |

Issued: August 30, 2017

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**Glossary:**

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

**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, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
c) IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
d) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

**Additional Documentation:**

e) 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** | DASY52 | 52.10.0.1446 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Triple Flat Phantom 5.1C | |
| **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 | 39.9 ± 6 % | 1.41 mho/m ± 6 % |
| **Head TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Head TSL

| | | |
|---|---|---|
| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
| SAR measured | 250 mW input power | 10.0 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **39.8 mW /g ± 18.8 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 250 mW input power | 5.16 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **20.6 mW /g ± 18.7 % (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 | 53.6 ± 6 % | 1.53 mho/m ± 6 % |
| **Body TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Body TSL

| | | |
|---|---|---|
| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
| SAR measured | 250 mW input power | 10.1 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **40.3 mW /g ± 18.8 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | Condition | |
| SAR measured | 250 mW input power | 5.30 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **21.2 mW /g ± 18.7 % (k=2)** |

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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 52.2Ω+ 6.65jΩ |
| Return Loss | - 23.3dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 49.7Ω+ 8.08jΩ |
| Return Loss | - 21.9dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.309 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 |

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**DASY5 Validation Report for Head TSL** Date: 08.26.2017

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d159**

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used: f = 1900 MHz; σ = 1.413 S/m; εr = 39.85; ρ = 1000 kg/m3

Phantom section: Left Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(8.26, 8.26, 8.26); Calibrated: 1/23/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 1/19/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

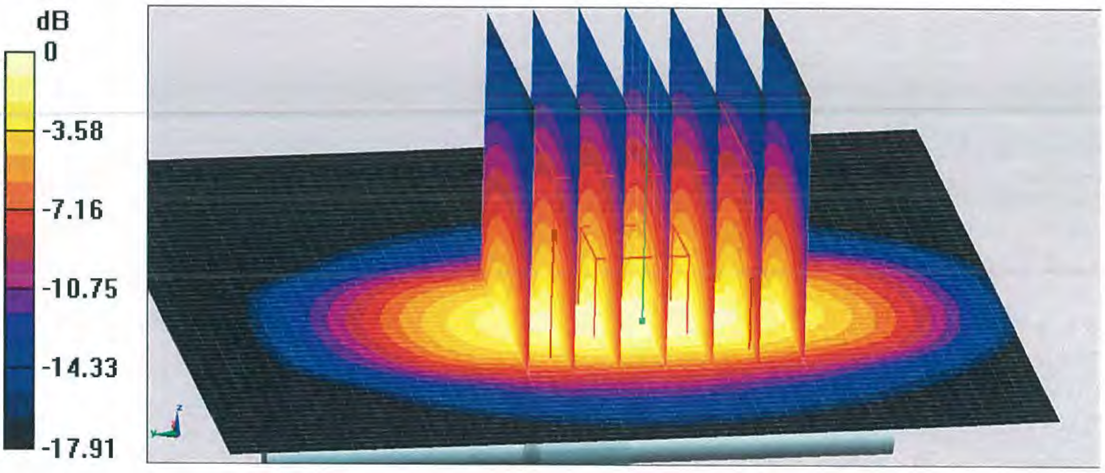
**System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.78 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 19.3 W/kg

**SAR(1 g) = 10 W/kg; SAR(10 g) = 5.16 W/kg**

Maximum value of SAR (measured) = 15.8 W/kg




**0 dB = 15.8 W/kg = 11.99 dBW/kg**

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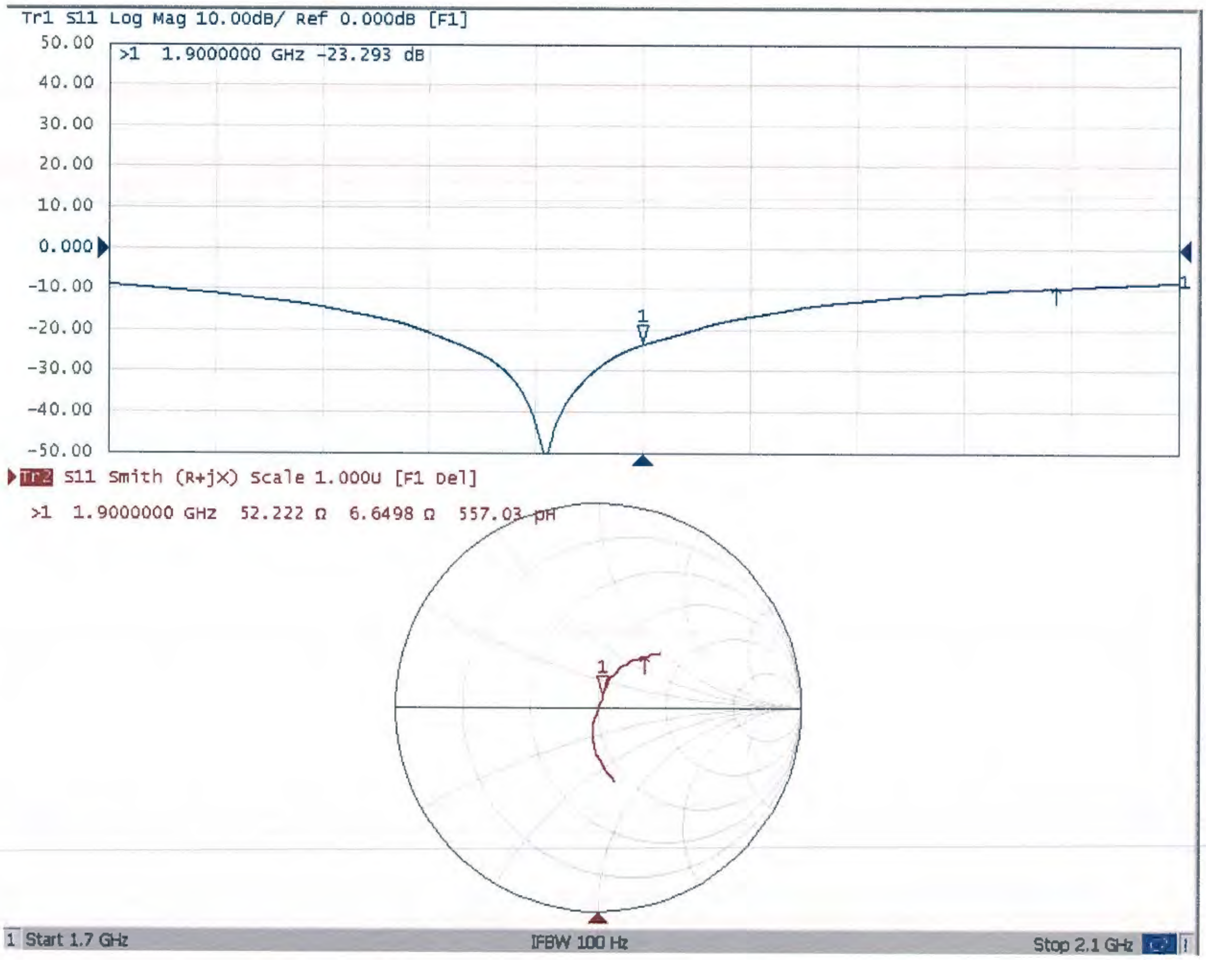
## Impedance Measurement Plot for Head TSL



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**DASY5 Validation Report for Body TSL** Date: 08.26.2017

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d159**

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used: f = 1900 MHz; $\sigma$ = 1.528 S/m; $\varepsilon_r$ = 53.55; $\rho$ = 1000 kg/m$^3$

Phantom section: Center Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.95, 7.95, 7.95); Calibrated: 1/23/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 1/19/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

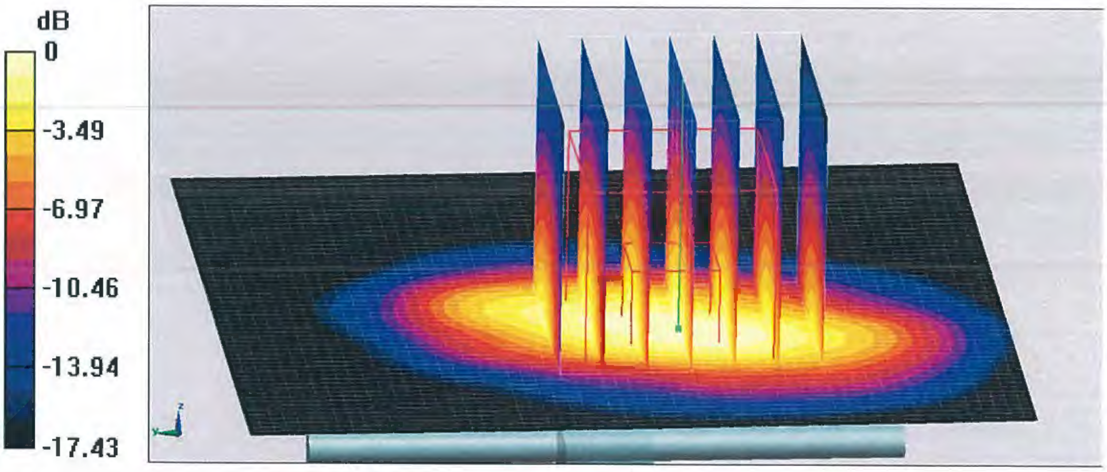
**System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 92.01 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 18.5 W/kg

**SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.3 W/kg**

Maximum value of SAR (measured) = 15.6 W/kg




**0 dB = 15.6 W/kg = 11.93 dBW/kg**

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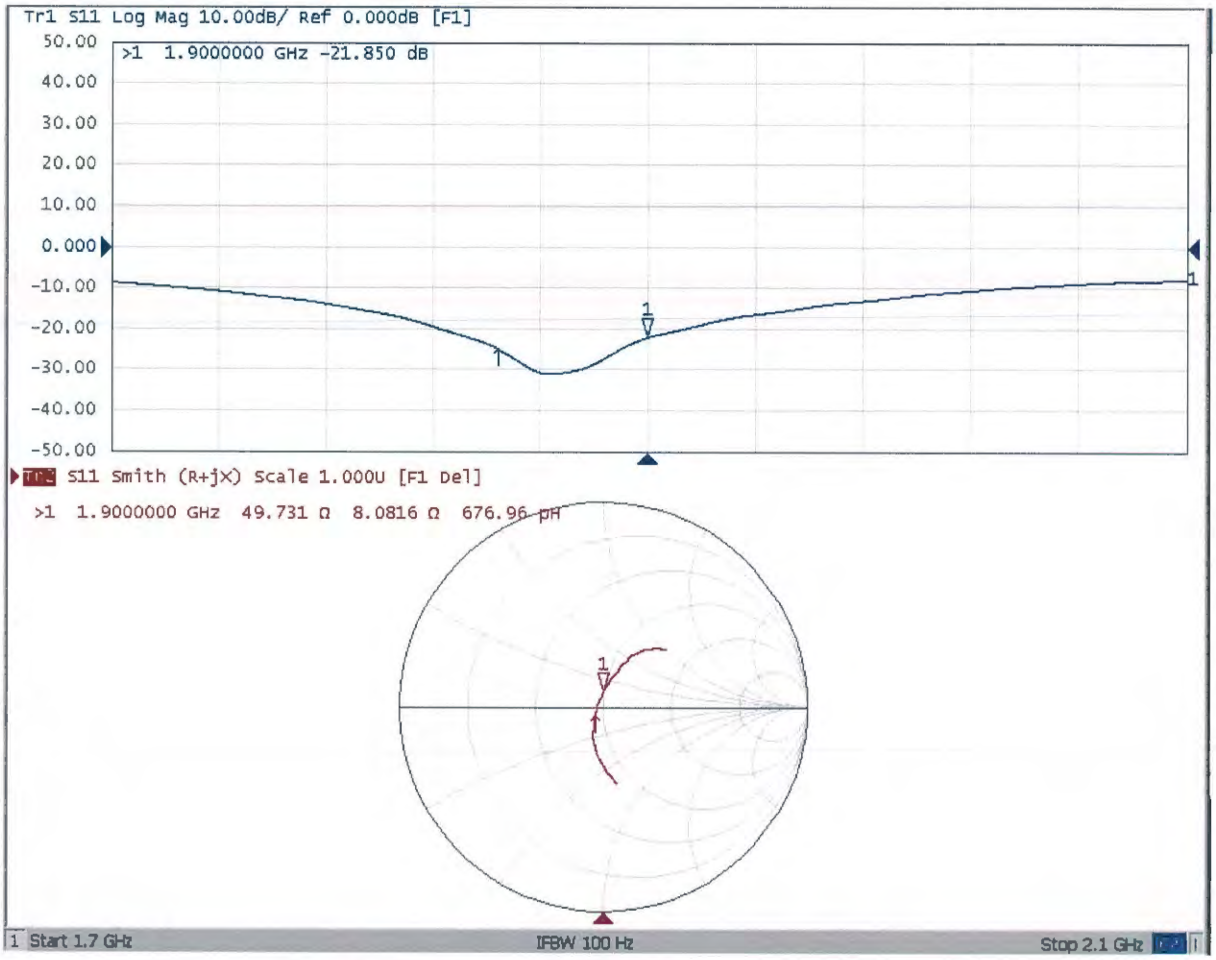
## Impedance Measurement Plot for Body TSL



**Calibration Laboratory of**
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**Accreditation No.: SCS 0108**

**Client** **ADT-CN (Auden)**

**Certificate No: EX3-3873_Aug17**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3873 |
| Calibration procedure(s) | QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | August 25, 2017 |

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 NRP | SN: 104778 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02525) | Apr-18 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Reference Probe ES3DV2 | SN: 3013 | 31-Dec-16 (No. ES3-3013_Dec16) | Dec-17 |
| DAE4 | SN: 660 | 7-Dec-16 (No. DAE4-660_Dec16) | Dec-17 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB41293874 | 06-Apr-16 (in house check Jun-16) | In house check: Jun-18 |
| Power sensor E4412A | SN: MY41498087 | 06-Apr-16 (in house check Jun-16) | In house check: Jun-18 |
| Power sensor E4412A | SN: 000110210 | 06-Apr-16 (in house check Jun-16) | In house check: Jun-18 |
| RF generator HP 8648C | SN: US3642U01700 | 04-Aug-99 (in house check Jun-16) | In house check: Jun-18 |
| Network Analyzer HP 8753E | SN: US37390585 | 18-Oct-01 (in house check Oct-16) | In house check: Oct-17 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Michael Weber | Laboratory Technician | M.Weber |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: August 26, 2017

## 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, ", "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## 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).

# Probe EX3DV4

## SN:3873

Manufactured: March 13, 2012
Calibrated: August 25, 2017

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

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3873

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 0.37 | 0.45 | 0.48 | ± 10.1 % |
| DCP (mV)[B] | 97.7 | 98.5 | 96.4 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB$\sqrt{\mu V}$ | C | D dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 135.8 | ±2.5 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 129.6 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 136.3 | |

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 Norm X,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.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3873

## 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) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 41.9 | 0.89 | 10.08 | 10.08 | 10.08 | 0.45 | 0.97 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 9.74 | 9.74 | 9.74 | 0.43 | 0.92 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 9.72 | 9.72 | 9.72 | 0.49 | 0.80 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 8.62 | 8.62 | 8.62 | 0.31 | 0.88 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 8.37 | 8.37 | 8.37 | 0.28 | 0.86 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 7.85 | 7.85 | 7.85 | 0.31 | 0.88 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 7.36 | 7.36 | 7.36 | 0.33 | 0.86 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 7.17 | 7.17 | 7.17 | 0.31 | 0.95 | ± 12.0 % |
| 5250 | 35.9 | 4.71 | 5.04 | 5.04 | 5.04 | 0.35 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.66 | 4.66 | 4.66 | 0.40 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 4.70 | 4.70 | 4.70 | 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.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3873

## Calibration Parameter Determined in Body Tissue Simulating Media

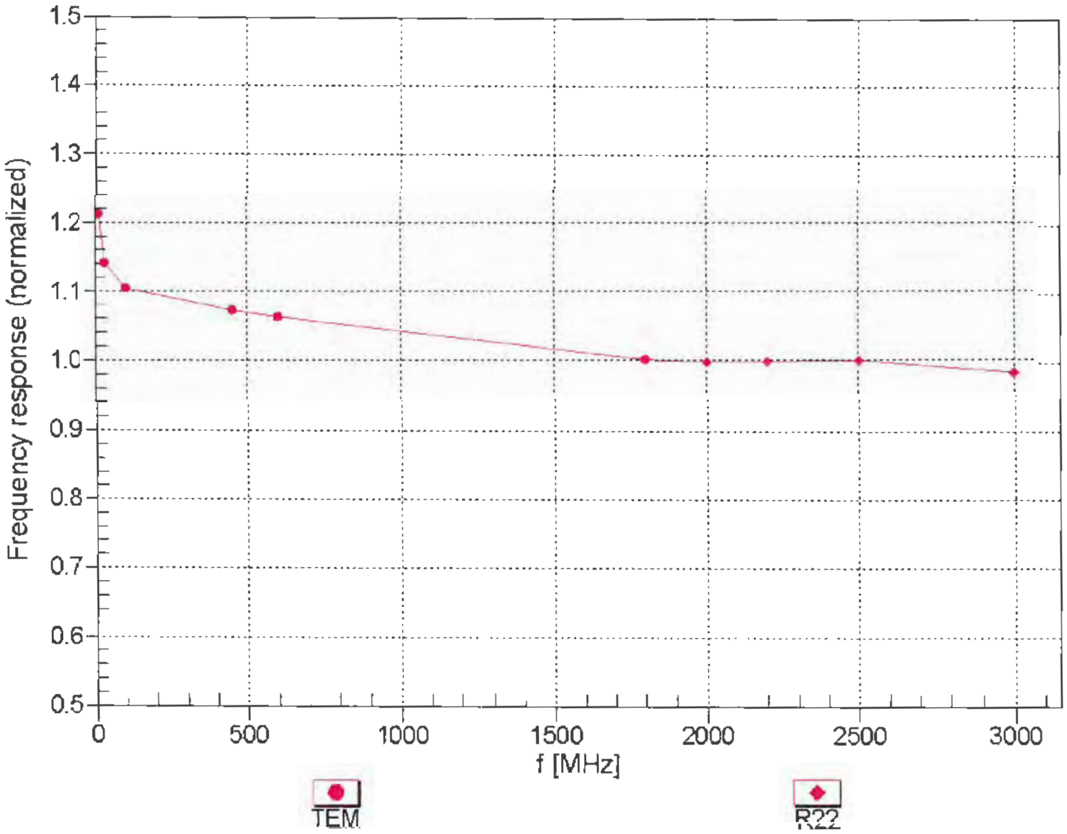
| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 55.5 | 0.96 | 9.72 | 9.72 | 9.72 | 0.44 | 0.85 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 9.62 | 9.62 | 9.62 | 0.47 | 0.80 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 9.49 | 9.49 | 9.49 | 0.47 | 0.80 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 8.04 | 8.04 | 8.04 | 0.38 | 0.80 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 7.77 | 7.77 | 7.77 | 0.22 | 1.12 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 7.56 | 7.56 | 7.56 | 0.40 | 0.80 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 7.45 | 7.45 | 7.45 | 0.31 | 0.89 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 7.19 | 7.19 | 7.19 | 0.34 | 0.90 | ± 12.0 % |
| 5250 | 48.9 | 5.36 | 4.61 | 4.61 | 4.61 | 0.35 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 3.90 | 3.90 | 3.90 | 0.45 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 4.16 | 4.16 | 4.16 | 0.45 | 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.

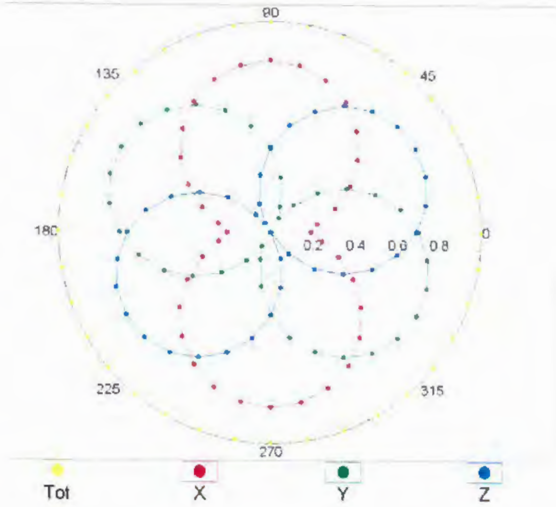
# Frequency Response of E-Field
## (TEM-Cell:ifi110 EXX, Waveguide: R22)



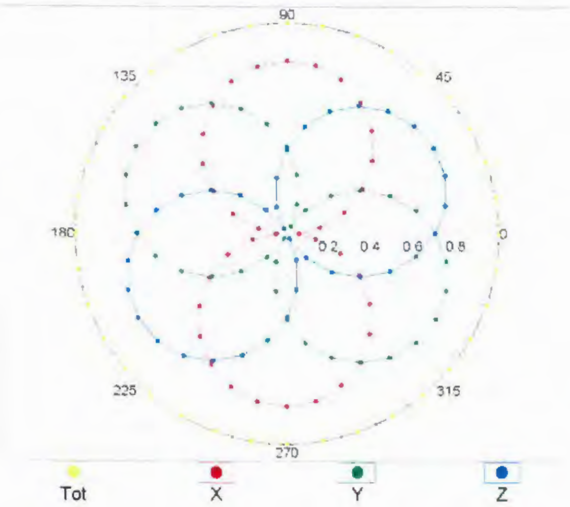

**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

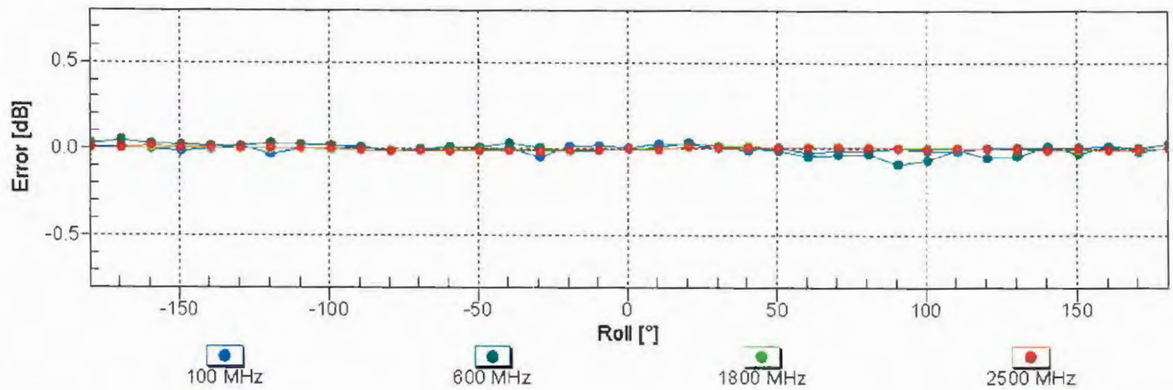
# Receiving Pattern (φ), ϑ = 0°

f=600 MHz,TEM



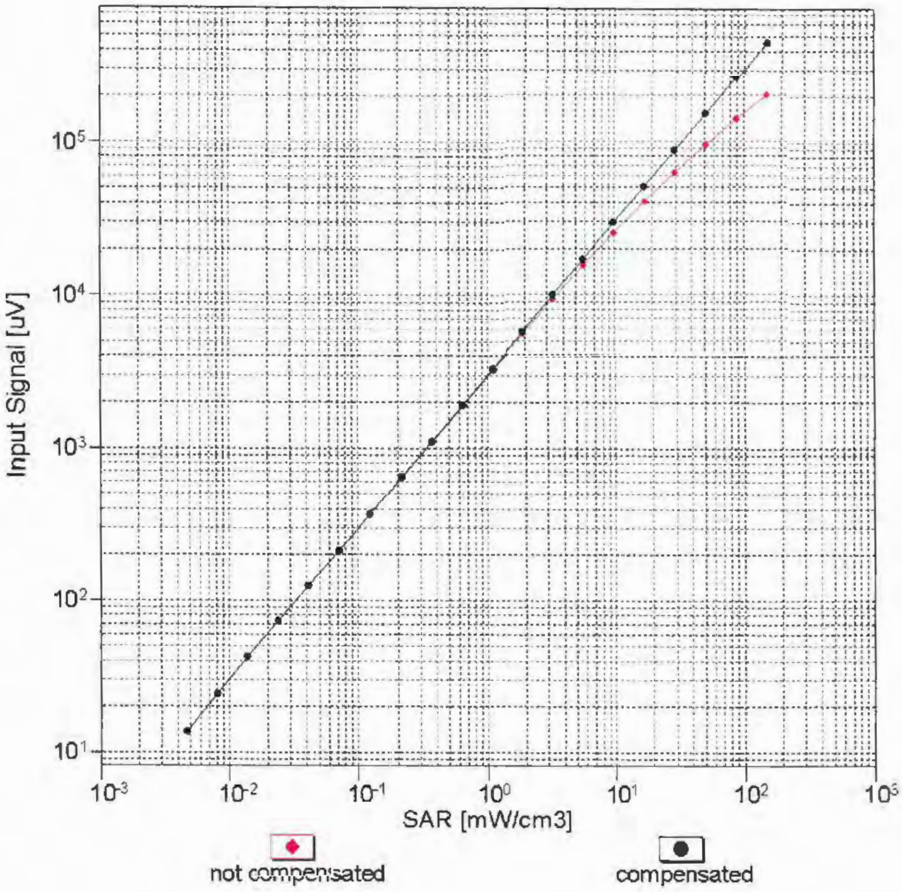

f=1800 MHz,R22

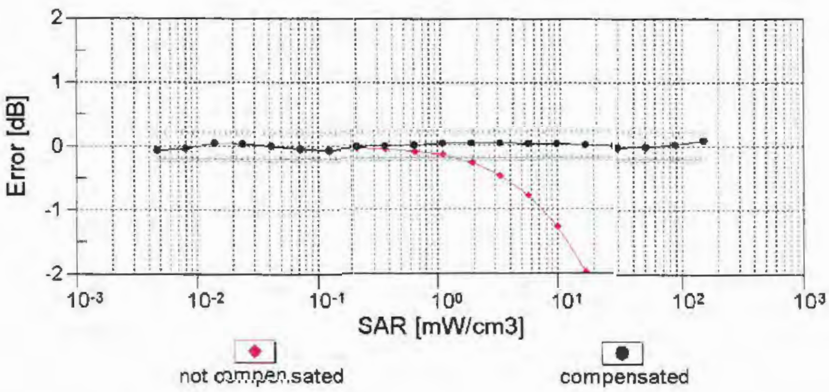



**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

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

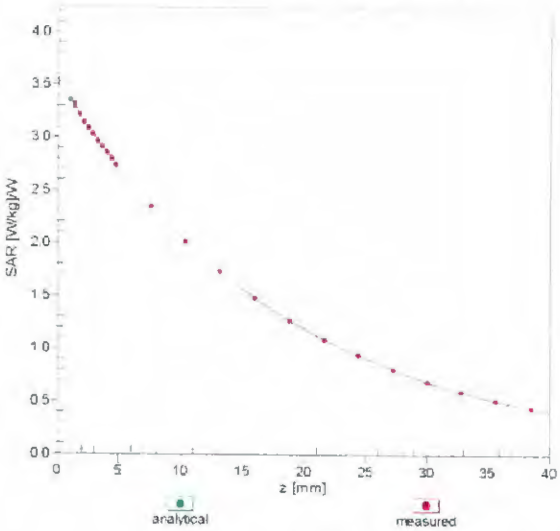


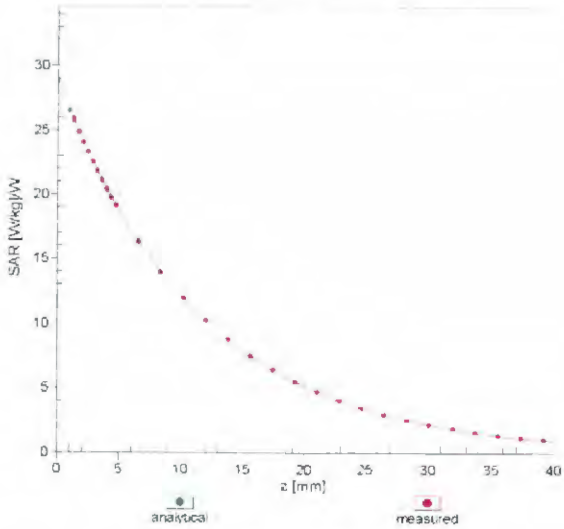

**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

# Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

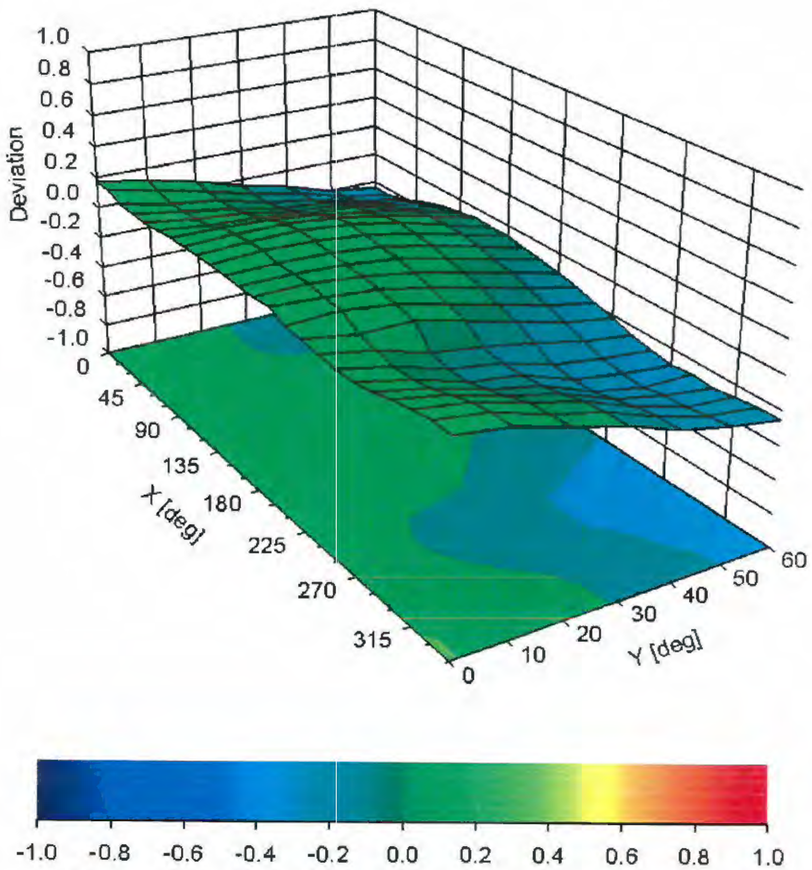



f = 1900 MHz,WGLS R22 (H_convF)




# Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




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

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3873

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 20.6 |
| 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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# IMPORTANT NOTICE

## USAGE OF THE DAE 4

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

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

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

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

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

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

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

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

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

Schmid & Partner Engineering

**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 0108**

Client **ADT - CN (Auden)**

Certificate No: **DAE4-1341_Aug17**

# CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BM - SN: 1341

Calibration procedure(s): QA CAL-06.v29
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: August 23, 2017

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 | 09-Sep-16 (No:19065) | Sep-17 |
| **Secondary Standards** | **ID #** | **Check Date (in house)** | **Scheduled Check** |
| Auto DAE Calibration Unit | SE UWS 053 AA 1001 | 05-Jan-17 (in house check) | In house check: Jan-18 |
| Calibrator Box V2.1 | SE UMS 006 AA 1002 | 05-Jan-17 (in house check) | In house check: Jan-18 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Dominique Steffen | Laboratory Technician | [signature] |
| Approved by: | Sven Kühn | Deputy Manager | i.V. [signature] |

Issued: August 23, 2017

## Glossary

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

## Methods Applied and Interpretation of Parameters

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

## DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

| Calibration Factors | X | Y | Z |
|---|---|---|---|
| High Range | 403.749 ± 0.02% (k=2) | 403.973 ± 0.02% (k=2) | 403.679 ± 0.02% (k=2) |
| Low Range | 3.98630 ± 1.50% (k=2) | 4.00466 ± 1.50% (k=2) | 3.99894 ± 1.50% (k=2) |

## Connector Angle

| | |
|---|---|
| **Connector Angle** to be used in DASY system | 170.0 ° ± 1 ° |

## Appendix (Additional assessments outside the scope of SCS0108)

### 1. DC Voltage Linearity

| High Range | | Reading (μV) | Difference (μV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 199998.01 | 2.04 | 0.00 |
| Channel X | + Input | 20005.63 | 4.10 | 0.02 |
| Channel X | - Input | -19999.63 | 1.45 | -0.01 |
| Channel Y | + Input | 199997.95 | 1.77 | 0.00 |
| Channel Y | + Input | 20002.49 | 1.03 | 0.01 |
| Channel Y | - Input | -20001.95 | -0.83 | 0.00 |
| Channel Z | + Input | 199995.98 | 0.02 | 0.00 |
| Channel Z | + Input | 19998.77 | -2.65 | -0.01 |
| Channel Z | - Input | -20001.11 | 0.05 | -0.00 |

| Low Range | | Reading (μV) | Difference (μV) | Error (%) |
|---|---|---|---|---|
| Channel X | + Input | 2000.82 | -0.17 | -0.01 |
| Channel X | + Input | 201.96 | 0.46 | 0.23 |
| Channel X | - Input | -198.18 | 0.21 | -0.11 |
| Channel Y | + Input | 2001.19 | 0.09 | 0.00 |
| Channel Y | + Input | 201.31 | -0.20 | -0.10 |
| Channel Y | - Input | -199.28 | -0.86 | 0.43 |
| Channel Z | + Input | 2001.04 | 0.10 | 0.01 |
| Channel Z | + Input | 200.17 | -1.16 | -0.58 |
| Channel Z | - Input | -199.16 | -0.71 | 0.36 |

### 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 | 11.79 | 10.79 |
| | - 200 | -10.21 | -11.83 |
| Channel Y | 200 | -5.80 | -6.00 |
| | - 200 | 4.72 | 4.57 |
| Channel Z | 200 | -22.01 | -22.12 |
| | - 200 | 20.50 | 20.45 |

### 3. Channel separation

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

| | Input Voltage (mV) | Channel X (μV) | Channel Y (μV) | Channel Z (μV) |
|---|---|---|---|---|
| Channel X | 200 | - | -3.45 | -2.23 |
| Channel Y | 200 | 4.82 | - | -1.93 |
| Channel Z | 200 | 9.88 | 3.48 | - |

## 4. AD-Converter Values with inputs shorted

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

| | High Range (LSB) | Low Range (LSB) |
|---|---|---|
| **Channel X** | 15987 | 17563 |
| **Channel Y** | 15933 | 17230 |
| **Channel Z** | 16265 | 16764 |

## 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** | 1.08 | 0.13 | 1.96 | 0.44 |
| **Channel Y** | -0.23 | -1.08 | 0.90 | 0.37 |
| **Channel Z** | -1.89 | -3.06 | -0.74 | 0.41 |

## 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 |

# Appendix D. Photographs of EUT and Setup