

# FCC SAR TEST REPORT

Client Name : UOSHON TELECOM GROUP LIMITED

Address : RM.B, 6/F TEDA BUILDING, 87 WING LOKST SHEUNG  
WAN HONGKONG

Product Name : Mobile Phone

Date : Jul. 29, 2019

**Shenzhen Anbotek Compliance Laboratory Limited**

## Contents

|                                                     |    |
|-----------------------------------------------------|----|
| 1. Statement of Compliance.....                     | 6  |
| 2. General Information.....                         | 7  |
| 2.1. Client Information.....                        | 7  |
| 2.2. Testing Laboratory Information.....            | 7  |
| 2.3. Description of Equipment Under Test (EUT)..... | 7  |
| 2.4. Device Category and SAR Limits.....            | 9  |
| 2.5. Applied Standard.....                          | 9  |
| 2.6. Environment of Test Site.....                  | 9  |
| 2.7. Test Configuration.....                        | 9  |
| 3. Specific Absorption Rate (SAR).....              | 10 |
| 3.1. Introduction.....                              | 10 |
| 3.2. SAR Definition.....                            | 10 |
| 4. SAR Measurement System.....                      | 11 |
| 4.1. E-Field Probe.....                             | 12 |
| 4.2. Data Acquisition Electronics (DAE).....        | 12 |
| 4.3. Robot.....                                     | 13 |
| 4.4. Measurement Server.....                        | 13 |
| 4.5. Phantom.....                                   | 15 |
| 4.6. Device Holder.....                             | 16 |
| 4.7. Data Storage and Evaluation.....               | 17 |
| 5. Test Equipment List.....                         | 19 |
| 6. Tissue Simulating Liquids.....                   | 21 |
| 7. System Verification Procedures.....              | 23 |
| 8. EUT Testing Position.....                        | 25 |
| 8.1. Define two imaginary lines on the handset..... | 25 |
| 8.2. Position for Cheek/Touch.....                  | 26 |
| 8.3. Position for Ear / 15°Tilt.....                | 26 |
| 8.4. Body Worn Position.....                        | 27 |
| 9. Measurement Procedures.....                      | 28 |
| 9.1. Spatial Peak SAR Evaluation.....               | 28 |
| 9.2. Power Reference Measurement.....               | 29 |
| 9.3. Area Scan Procedures.....                      | 29 |
| 9.4. Zoom Scan Procedures.....                      | 30 |
| 9.5. Volume Scan Procedures.....                    | 31 |
| 9.6. Power Drift Monitoring.....                    | 31 |
| 10. Conducted Power.....                            | 32 |
| 11. Antenna Location.....                           | 34 |
| 12. SAR Test Results Summary.....                   | 35 |
| 12.1. Head SAR Results.....                         | 35 |

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|                                                      |    |
|------------------------------------------------------|----|
| 12.2. Body SAR Results.....                          | 36 |
| 13. Simultaneous Transmission Analysis.....          | 37 |
| 13.1. Simultaneous TX SAR Considerations.....        | 37 |
| 13.2. Evaluation of Simultaneous SAR.....            | 37 |
| 14. Measurement Uncertainty.....                     | 38 |
| Appendix A. EUT Photos and Test Setup Photos.....    | 39 |
| Appendix B. Plots of SAR System Check.....           | 41 |
| Appendix C. Plots of SAR Test Data.....              | 45 |
| Appendix D. DASY System Calibration Certificate..... | 53 |

## TEST REPORT

Applicant : UOSHON TELECOM GROUP LIMITED  
Manufacturer : SHENZHEN NEWDELL SCIENCE & TECHNOLOGY CO., LTD.  
Product Name : Mobile Phone  
Model No. : F28A  
Trade Mark : Uoshou  
Rating(s) : DC 3.7V, 1000mAh Battery inside

Test Standard(s) : IEEE 1528-2013; IEC 62209-2:2010;  
ANSI/IEEE C95.1:2005; FCC 47 CFR Part 2 (2.1093:2013);

The device described above is tested by Shenzhen Anbotech Compliance Laboratory Limited to determine the maximum emission levels emanating from the device and the severe levels of the device can endure and its performance criterion. The measurement results are contained in this test report and Shenzhen Anbotech Compliance Laboratory Limited is assumed full of responsibility for the accuracy and completeness of these measurements. Also, this report shows that the EUT (Equipment Under Test) is technically compliant with the IEEE 1528-2013, IEC 62209-2:2010, ANSI/IEEE C95.1:2005 and FCC 47 CFR Part 2 (2.1093:2013) requirements.

This report applies to above tested sample only and shall not be reproduced in part without written approval of Shenzhen Anbotech Compliance Laboratory Limited.

Date of Receipt

Apr. 15, 2019

Date of Test

Apr. 16~19, 2019

Prepared By



*Bobby Wang*

(Engineer / Bobby Wang)

Reviewer

*Snowy Meng*

(Supervisor / Snowy Meng)

Approved & Authorized Signer

*Sally Zhang*

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## Version

| Version No. | Date          | Description |
|-------------|---------------|-------------|
| 01          | Jul. 29, 2019 | Original    |
|             |               |             |
|             |               |             |
|             |               |             |
|             |               |             |

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1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing are as follows.

| Frequency Band   | Highest Reported 1g-SAR(W/Kg) |       | SAR Test Limit<br>(W/Kg) |
|------------------|-------------------------------|-------|--------------------------|
|                  | Head                          | Body  |                          |
| GSM 850          | 0.126                         | 0.711 | 1.6                      |
| PCS 1900         | 0.047                         | 0.465 |                          |
| Simultaneous SAR | 0.546                         | 0.921 |                          |
| Test Result      | PASS                          |       |                          |

<Highest SAR Summary>

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-2005, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013 and IEC 62209-2:2010

## 2. General Information

### 2.1. Client Information

|              |   |                                                                             |
|--------------|---|-----------------------------------------------------------------------------|
| Applicant    | : | UOSHON TELECOM GROUP LIMITED                                                |
| Address      | : | RM.B, 6/F TEDA BUILDING, 87 WING LOKST SHEUNG WAN HONGKONG                  |
| Manufacturer | : | SHENZHEN NEWDELL SCIENCE & TECHNOLOGY CO., LTD.                             |
| Address      | : | 2/F, NO.2 Plant, NO.139, Zhongxing Road, Bantian, Longgang, Shenzhen, China |
| Factory      | : | SHENZHEN NEWDELL SCIENCE & TECHNOLOGY CO., LTD.                             |
| Address      | : | 2/F, NO.2 Plant, NO.139, Zhongxing Road, Bantian, Longgang, Shenzhen, China |

### 2.2. Testing Laboratory Information

|            |   |                                                                                                                                             |
|------------|---|---------------------------------------------------------------------------------------------------------------------------------------------|
| Test Site: | : | Shenzhen Anbotek Compliance Laboratory Limited                                                                                              |
| Address:   | : | 1/F, Building D, Sogood Science and Technology Park, Sanwei community, Hangcheng Street, Bao'an District, Shenzhen, Guangdong, China.518102 |

### 2.3. Description of Equipment Under Test (EUT)

|                     |                      |                                                                                                                                                   |
|---------------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Name        | :                    | Mobile Phone                                                                                                                                      |
| Model No.           | :                    | F28A                                                                                                                                              |
| Trade Mark          | :                    | Uoshou                                                                                                                                            |
| Test Power Supply   | :                    | DC 3.7V Battery inside                                                                                                                            |
| Test Sample No.     | :                    | 1-2-1(Normal Sample), 1-2-2(Normal Sample)                                                                                                        |
| Product Description | Operation Frequency: | BDR+EDR: 2402MHz~2480MHz<br>GSM/GPRS 850<br>TX:824.2~848.8 MHz; RX:869.2~893.8 MHz<br>PCS/GPRS 1900<br>TX:1850.2~1909.8 MHz; RX:1930.2~1989.8 MHz |
|                     | Transfer Rate:       | BDR+EDR: 1/2/3 Mbits/s                                                                                                                            |

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|                                                                                                                                     |                     |                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------|
|                                                                                                                                     | Number of Channel:  | BDR+EDR: 79 Channels                                    |
|                                                                                                                                     | GPRS Class          | 8/10/12                                                 |
|                                                                                                                                     | Modulation Type:    | GSM/GPRS: GMSK<br>BDR+EDR: GFSK, $\pi/4$ -DQPSK, 8-DPSK |
|                                                                                                                                     | Antenna Type:       | GSM/GPRS: PIFA Antenna<br>BDR+EDR: PIFA Antenna         |
|                                                                                                                                     | Antenna Gain(Peak): | GSM 850: 0 dBi<br>PCS 1900: 0 dBi<br>BDR+EDR: 0 dBi     |
| <b>Remark:</b> 1) For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual. |                     |                                                         |

## 2. 4. Device Category and SAR Limits

This device belongs to portable device category because its radiating structure is allowed to be used within 20 centimeters of the body of the user. Limit for General Population/Uncontrolled exposure should be applied for this device, it is 1.6 W/kg as averaged over any 1 gram of tissue.

## 2. 5. Applied Standard

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

- IEEE 1528-2013
- FCC 47 CFR Part 2 (2.1093:2013)
- ANSI/IEEE C95.1:2005
- IEC 62209-2:2010
- KDB 447498 D01
- KDB 648474 D04
- KDB 865664 D01

## 2. 6. Environment of Test Site

| Items            | Required | Actual |
|------------------|----------|--------|
| Temperature (°C) | 18-25    | 22~23  |
| Humidity (%RH)   | 30-70    | 55~65  |

## 2. 7. Test Configuration

The device was controlled by using a base station emulator. Communication between the device and the emulator was established by air link. The distance between the EUT and the antenna of the emulator is larger than 50 cm and the output power radiated from the emulator antenna is at least 30 dB smaller than the output power of EUT. The EUT was set from the emulator to radiate maximum output power during all tests.

### 3. Specific Absorption Rate (SAR)

#### 3.1. Introduction

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

#### 3.2. SAR Definition

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

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

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

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

$$SAR = C \left( \frac{\delta T}{\delta t} \right)$$

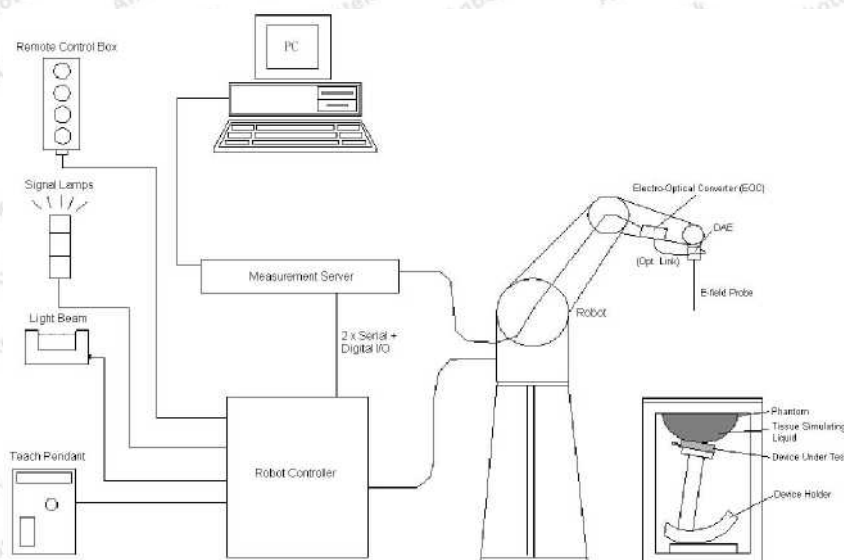
Where: C is the specific heat capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

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

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

## 4. SAR Measurement System



### DASY System Configurations

The DASY system for performance compliance tests is illustrated above graphically. This system consists of the following items:

- A standard high precision 6-axis robot with controller, a teach pendant and software
- A data acquisition electronic (DAE) attached to the robot arm extension
- A dosimetric probe equipped with an optical surface detector system
- The electro-optical converter (EOC) performs the conversion between optical and electrical signals
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the accuracy of the probe positioning
- A computer operating Windows XP
- DASY software
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom
- A device holder
- Tissue simulating liquid
- Dipole for evaluating the proper functioning of the system

components are described in details in the following sub-sections.

#### 4. 1. E-Field Probe

The SAR measurement is conducted with the dosimetric probe (manufactured by SPEAG).The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. This probe has a built in optical surface detection system to prevent from collision with phantom.

##### ➤ E-Field Probe Specification

###### <EX3DV4 Probe>

|                      |                                                                                                                                                             |                                                                                                                    |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| <b>Construction</b>  | Symmetrical design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |  <p><b>Photo of EX3DV4</b></p> |
| <b>Frequency</b>     | 10 MHz to 6 GHz; Linearity: $\pm 0.2$ dB                                                                                                                    |                                                                                                                    |
| <b>Directivity</b>   | $\pm 0.3$ dB in HSL (rotation around probe axis)<br>$\pm 0.5$ dB in tissue material (rotation normal to probe axis)                                         |                                                                                                                    |
| <b>Dynamic Range</b> | 10 $\mu$ W/g to 100 mW/g; Linearity: $\pm 0.2$ dB (noise: typically $< 1$ $\mu$ W/g)                                                                        |                                                                                                                    |
| <b>Dimensions</b>    | Overall length: 330 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm                        |                                                                                                                    |

##### ➤ E-Field Probe Calibration

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than  $\pm 10\%$ . The spherical isotropy shall be evaluated and within  $\pm 0.25$ dB. The sensitivity parameters (NormX, NormY, and NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested. The calibration data can be referred to appendix C of this report.

#### 4. 2. Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

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

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**Photo of DAE**

#### 4. 3. Robot

The SPEAG DASY system uses the high precision robots (DASY5: TX60XL) type 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  $\pm 0.035$  mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)



**Photo of DASY5**

#### 4. 4. Measurement Server

The measurement server is based on a PC/104 CPU board with CPU (DASY5: 400 MHz, Intel Celeron), chip disk (DASY5: 128 MB), RAM (DASY5: 128 MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical

detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.

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



Photo of Server for DASY5

#### 4. 5. Phantom

##### <SAM Twin Phantom>

|                          |                                                            |
|--------------------------|------------------------------------------------------------|
| <b>Shell Thickness</b>   | 2 ± 0.2 mm;<br>Center ear point: 6 ± 0.2 mm                |
| <b>Filling Volume</b>    | Approx. 25 liters                                          |
| <b>Dimensions</b>        | Length: 1000 mm; Width: 500 mm;<br>Height: adjustable feet |
| <b>Measurement Areas</b> | Left Hand, Right Hand, Flat Phantom                        |



**Photo of SAM Phantom**

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

##### <ELI4 Phantom>

|                        |                                                  |
|------------------------|--------------------------------------------------|
| <b>Shell Thickness</b> | 2 ± 0.2 mm (sagging: <1%)                        |
| <b>Filling Volume</b>  | Approx. 30 liters                                |
| <b>Dimensions</b>      | Major ellipse axis: 600 mm<br>Minor axis: 400 mm |



**Photo of ELI4 Phantom**

The ELI4 phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with standard and all known tissue simulating liquids.

#### 4. 6. Device Holder

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5 mm distance, a positioning uncertainty of  $\pm 0.5\text{mm}$  would produce a SAR uncertainty of  $\pm 20\%$ . Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity  $\epsilon = 3$  and loss tangent  $\delta = 0.02$ . The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.



**Device Holder**

## 4. 7. Data Storage and Evaluation

### ➤ Data Storage

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files. The post-processing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type (e.g., [V/m], [A/m], [mW/g]). Some of these units are not available in certain situations or give meaningless results, e.g., a SAR-output in a non-lose media, will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

### ➤ Data Evaluation

The DASY post-processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

|                           |                           |                                                                         |
|---------------------------|---------------------------|-------------------------------------------------------------------------|
| <b>Probe parameters:</b>  | - Sensitivity             | Norm <sub>i</sub> , a <sub>i0</sub> , a <sub>i1</sub> , a <sub>i2</sub> |
|                           | - Conversion factor       | ConvF <sub>i</sub>                                                      |
|                           | - Diode compression point | dcp <sub>i</sub>                                                        |
| <b>Device parameters:</b> | - Frequency               | f                                                                       |
|                           | - Crest factor            | cf                                                                      |
| <b>Media parameters:</b>  | - Conductivity            | σ                                                                       |
|                           | - Density                 | ρ                                                                       |

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

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

The formula for each channel can be given as:

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

with  $V_i$  = compensated signal of channel i, (i = x, y, z)

$U_i$  = input signal of channel i, (i = x, y, z)

cf = crest factor of exciting field (DASY parameter)

dcp<sub>i</sub> = diode compression point (DASY parameter)

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

$$\text{E-field Probes: } E_i = \sqrt{\frac{V_i}{\text{Norm}_i \cdot \text{ConvF}}}$$

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

with  $V_i$  = compensated signal of channel i, (i = x, y, z)

Norm<sub>i</sub> = sensor sensitivity of channel i, (i = x, y, z),  $\mu\text{V}/(\text{V/m})^2$  for E-field Probes

ConvF = sensitivity enhancement in solution

$a_{ij}$  = sensor sensitivity factors for H-field probes

f = carrier frequency [GHz]

$E_i$  = electric field strength of channel i in V/m

$H_i$  = magnetic field strength of channel i in A/m

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

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

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

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

with SAR = local specific absorption rate in mW/g

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

$\sigma$  = conductivity in [mho/m] or [Siemens/m]

$\rho$  = equivalent tissue density in g/cm<sup>3</sup>

Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.

## 5. Test Equipment List

| Manufacturer | Name of Equipment                    | Type/Model     | Serial Number | Calibration   |               |
|--------------|--------------------------------------|----------------|---------------|---------------|---------------|
|              |                                      |                |               | Last Cal.     | Due Date      |
| SPEAG        | 835MHz System Validation Kit         | D835V2         | 4d154         | Jun. 16,2018  | Jun. 15,2021  |
| SPEAG        | 1900MHz System Validation Kit        | D1900V2        | 5d175         | Jun. 15, 2016 | Jun. 14, 2019 |
| SPEAG        | Data Acquisition Electronics         | DAE4           | 387           | Sept. 06,2018 | Sept. 05,2019 |
| SPEAG        | Dosimetric E-Field Probe             | EX3DV4         | 7396          | May 12,2018   | May 11,2019   |
| R&S          | UNIVERSAL RADIO COMMUNICATION TESTER | CMU 200        | 117888        | Nov. 05, 2018 | Nov. 04, 2019 |
| Agilent      | ENA Series Network Analyzer          | E5071C         | MY46317418    | Jun.12,2018   | Jun.11, 2019  |
| SPEAG        | DAK                                  | DAK-3.5        | 1226          | NCR           | NCR           |
| SPEAG        | SAM Twin Phantom                     | QD000P40CD     | 1802          | NCR           | NCR           |
| AR           | Amplifier                            | ZHL-42W        | QA1118004     | NCR           | NCR           |
| Agilent      | Power Meter                          | N1914A         | MY50001102    | Dec. 06, 2018 | Nov. 06, 2019 |
| Agilent      | Power Sensor                         | N8481H         | MY51240001    | Dec. 06, 2018 | Nov. 06, 2019 |
| R&S          | Spectrum Analyzer                    | N9020A         | MY51170037    | May.23, 2018  | May. 22, 2019 |
| Agilent      | Signal Generation                    | N5182A         | MY48180656    | May.23, 2018  | May. 22, 2019 |
| Worken       | Directional Coupler                  | 0110A05601O-10 | COM5BNW1A2    | May.23, 2018  | May. 22, 2019 |

### Note:

1. The calibration certificate of DASY can be referred to appendix C of this report.
2. The dipole calibration interval can be extended to 3 years with justification. The dipoles are also not physically damaged, or repaired during the interval.
3. The Insertion Loss calibration of Dual Directional Coupler and Attenuator were characterized via the network analyzer and compensated during system check.
4. The dielectric probe kit was calibrated via the network analyzer, with the specified procedure (calibrated in pure water) and calibration kit (standard) short circuit, before the dielectric measurement. The specific procedure and calibration kit are provided by Agilent.
5. In system check we need to monitor the level on the power meter, and adjust the power amplifier level to have precise power level to the dipole; the measured SAR will be normalized to 1W input

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power according to the ratio of 1W to the input power to the dipole. For system check, the calibration of the power amplifier is deemed not critically required for correct measurement; the power meter is critical and we do have calibration for it

## 6. Tissue Simulating Liquids

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. 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, which is shown in Fig. 6.1. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown as followed:

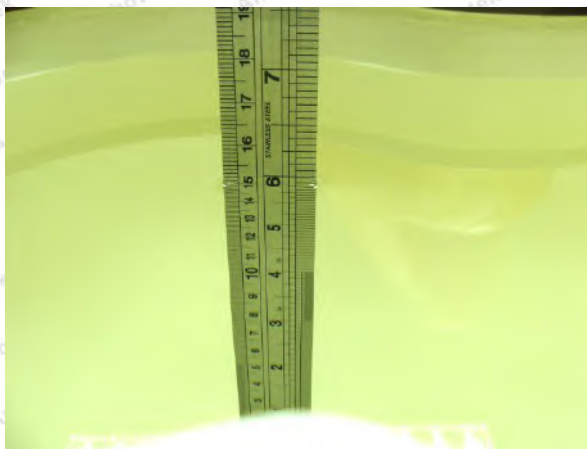


Photo of Liquid Height for Head SAR



Photo of Liquid Height for Body SAR

The following table gives the recipes for tissue simulating liquid.

| Frequency (MHz) | Water (%) | Sugar (%) | Cellulose (%) | Salt (%) | Preventol (%) | DGBE (%) | Conductivity ( $\sigma$ ) | Permittivity ( $\epsilon_r$ ) |
|-----------------|-----------|-----------|---------------|----------|---------------|----------|---------------------------|-------------------------------|
| For Head        |           |           |               |          |               |          |                           |                               |
| 900             | 40.3      | 57.9      | 0.2           | 1.4      | 0.2           | 0        | 0.97                      | 41.5                          |
| 1750            | 55.2      | 0         | 0             | 0.3      | 0             | 44.5     | 1.37                      | 40.1                          |
| 1800,1900,2000  | 55.2      | 0         | 0             | 0.3      | 0             | 44.5     | 1.40                      | 40.0                          |
| 2450            | 55.0      | 0         | 0             | 0        | 0             | 45.0     | 1.80                      | 39.2                          |
| 2600            | 54.8      | 0         | 0             | 0.1      | 0             | 45.1     | 1.96                      | 39.0                          |
| For Body        |           |           |               |          |               |          |                           |                               |
| 900             | 50.8      | 48.2      | 0             | 0.9      | 0.1           | 0        | 0.97                      | 55.2                          |
| 1750            | 70.2      | 0         | 0             | 0.4      | 0             | 29.4     | 1.49                      | 53.4                          |
| 1800,1900,2000  | 70.2      | 0         | 0             | 0.4      | 0             | 29.4     | 1.52                      | 53.3                          |
| 2450            | 68.6      | 0         | 0             | 0        | 0             | 31.4     | 1.95                      | 52.7                          |

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|      |      |   |   |     |   |      |      |      |
|------|------|---|---|-----|---|------|------|------|
| 2600 | 68.1 | 0 | 0 | 0.1 | 0 | 31.8 | 2.16 | 52.5 |
|------|------|---|---|-----|---|------|------|------|

The following table shows the measuring results for simulating liquid.

| Tissue Type | Measured Frequency (MHz) | Target Tissue |          | Measured Tissue |          |          |          | Liquid Temp. | Test Data  |
|-------------|--------------------------|---------------|----------|-----------------|----------|----------|----------|--------------|------------|
|             |                          | $\epsilon_r$  | $\sigma$ | $\epsilon_r$    | Dev. (%) | $\sigma$ | Dev. (%) |              |            |
| 900HSL      | 850                      | 41.5          | 0.97     | 41.68           | 0.43     | 0.96     | -1.03    | 21.9         | 04/16/2019 |
| 900MSL      | 850                      | 55.00         | 1.05     | 55.26           | 0.47     | 1.06     | 0.95     | 22.4         | 04/17/2019 |
| 1900HSL     | 1900                     | 40.0          | 1.40     | 40.19           | 0.47     | 1.43     | 2.14     | 22.6         | 04/18/2019 |
| 1900MSL     | 1900                     | 53.30         | 1.52     | 53.41           | 0.21     | 1.53     | 0.66     | 22.1         | 04/19/2019 |

## 7. System Verification Procedures

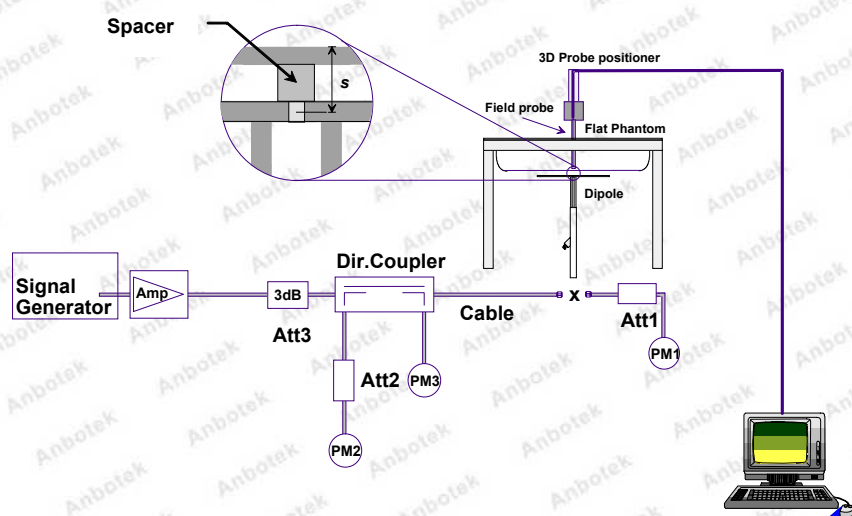
Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder.

### ➤ Purpose of System Performance check

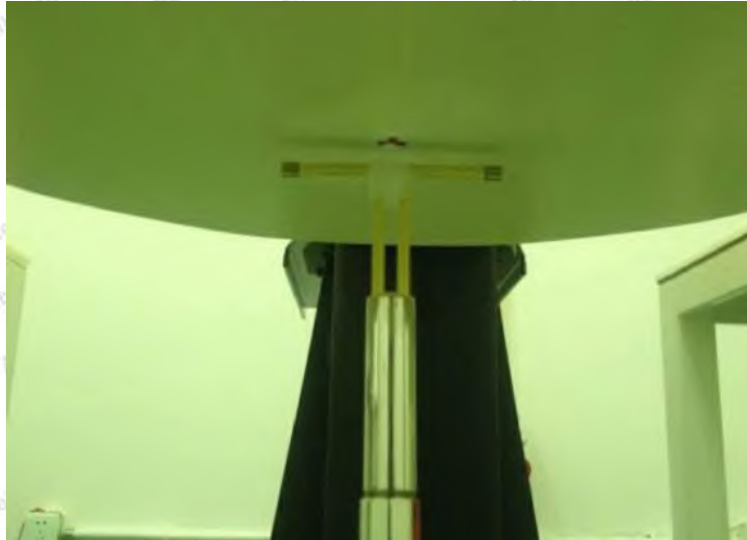
The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

### ➤ System Setup

In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



**System Setup for System Evaluation**



**Photo of Dipole Setup**

### ➤ Validation Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10%. The table below shows the target SAR and measured SAR after normalized to 1W input power. It indicates that the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

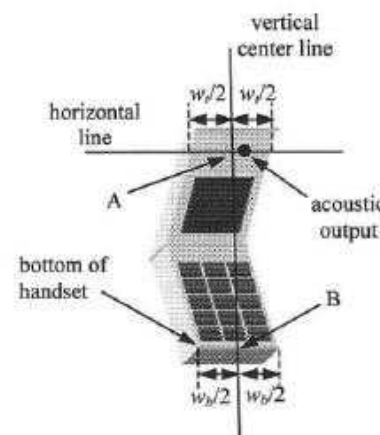
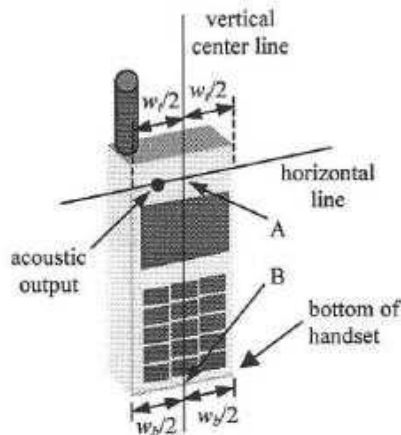
| Frequency (MHz) | Liquid Type | Power fed onto reference dipole (mW) | Targeted SAR (W/kg) | Measured SAR (W/kg) | Normalized SAR (W/kg) | Deviation (%) | Date       |
|-----------------|-------------|--------------------------------------|---------------------|---------------------|-----------------------|---------------|------------|
| 850             | Head        | 250                                  | 9.50                | 2.31                | 9.24                  | -2.74         | 04/16/2019 |
| 850             | Body        | 250                                  | 9.52                | 2.53                | 10.12                 | 6.30          | 04/17/2019 |
| 1900            | Head        | 250                                  | 39.70               | 9.99                | 39.96                 | 0.65          | 04/18/2019 |
| 1900            | Body        | 250                                  | 39.60               | 9.26                | 37.04                 | -6.46         | 04/19/2019 |

### Target and Measurement SAR after Normalized

## 8. EUT Testing Position

### 8.1. Define two imaginary lines on the handset

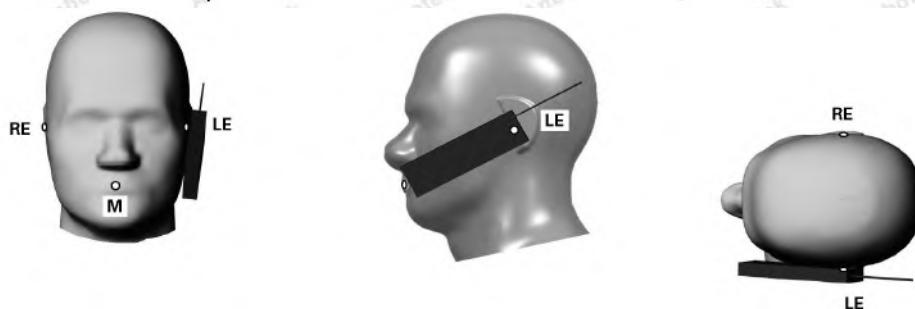
- The vertical centerline passes through two points on the front side of the handset - the midpoint of the width  $w_t$  of the handset at the level of the acoustic output, and the midpoint of the width  $w_b$  of the bottom of the handset.
- The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output. The horizontal line is also tangential to the face of the handset at point A.
- 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.



**Handset Vertical and Horizontal Reference Lines**

## 8. 2. Position for Cheek/Touch

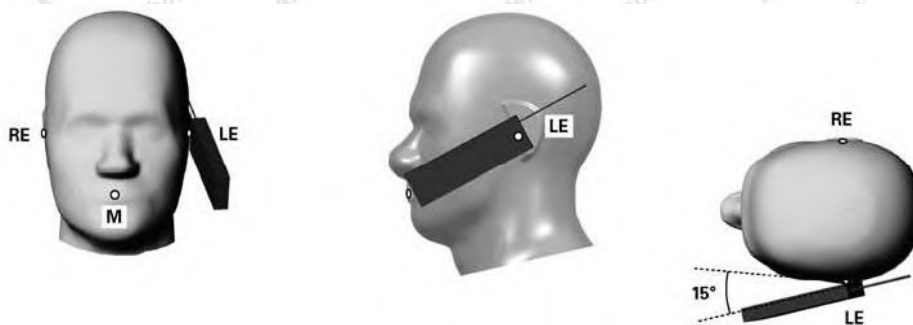
- To position the device with the vertical center line of the body of the device and the horizontal line crossing the center piece in a plane parallel to the sagittal plane of the phantom. While maintaining the device in this plane, align the vertical center line with the reference plane containing the 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.
- 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.



**Cheek Position**

## 8. 3. Position for Ear / 15°Tilt

- To position the device in the “cheek” position described above.
- 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. 8.3).

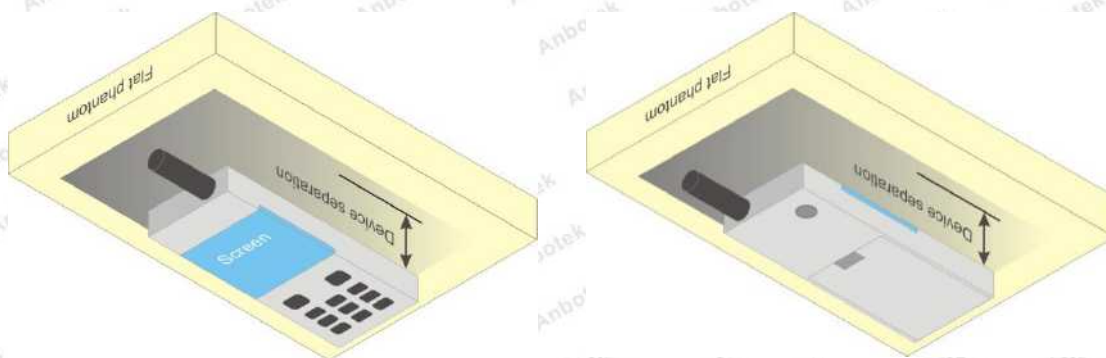


**Tilt Position**

#### 8. 4. Body Worn Position

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration. Per KDB 648474 D04, 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 FCC KDB 447498 D01 should be 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 applicable. When the reported SAR for body-worn accessory, measured without a headset connected to the handset is  $< 1.2 \text{ W/kg}$ , the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a handset attached to the handset.

Accessories for body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are test with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-chip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.



**Body Worn Position**

## 9. Measurement Procedures

The measurement procedures are as follows:

- (a) Use base station simulator (if applicable) or engineering software to transmit RF power continuously (continuous Tx) in the middle channel.
- (b) Keep EUT to radiate maximum output power or 100% duty factor (if applicable)
- (c) Measure output power through RF cable and power meter.
- (d) Place the EUT in the positions as setup photos demonstrates.
- (e) Set scan area, grid size and other setting on the DASY software.
- (f) Measure SAR transmitting at the middle channel for all applicable exposure positions.
- (g) Identify the exposure position and device configuration resulting the highest SAR
- (h) Measure SAR at the lowest and highest channels at the worst exposure position and device configuration if applicable.

According to the 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

### 9.1. 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 from 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

## 9. 2. Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

## 9. 3. Area Scan Procedures

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

|                                                                                                        | $\leq 3 \text{ GHz}$                                                                                                                                                                                                                                                   | $> 3 \text{ GHz}$                                                                  |
|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | $5 \pm 1 \text{ mm}$                                                                                                                                                                                                                                                   | $\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5 \text{ mm}$                         |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location              | $30^\circ \pm 1^\circ$                                                                                                                                                                                                                                                 | $20^\circ \pm 1^\circ$                                                             |
| Maximum area scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$                 | $\leq 2 \text{ GHz}: \leq 15 \text{ mm}$<br>$2 - 3 \text{ GHz}: \leq 12 \text{ mm}$                                                                                                                                                                                    | $3 - 4 \text{ GHz}: \leq 12 \text{ mm}$<br>$4 - 6 \text{ GHz}: \leq 10 \text{ mm}$ |
|                                                                                                        | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device. |                                                                                    |

#### 9. 4. Zoom Scan Procedures

Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the zoom scan evaluates the averaged SAR for 1 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

|                                                                                                                                                                                                                                                                                                             |                                           |                                                                                             | $\leq 3$ GHz                                          | $> 3$ GHz                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------------------------------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------------------------|
| Maximum zoom scan spatial resolution: $\Delta x_{\text{Zoom}}, \Delta y_{\text{Zoom}}$                                                                                                                                                                                                                      |                                           |                                                                                             | $\leq 2$ GHz: $\leq 8$ mm<br>2 – 3 GHz: $\leq 5$ mm * | 3 – 4 GHz: $\leq 5$ mm*<br>4 – 6 GHz: $\leq 4$ mm *                           |
| Maximum zoom scan spatial resolution, normal to phantom surface                                                                                                                                                                                                                                             | uniform grid: $\Delta z_{\text{Zoom}}(n)$ |                                                                                             | $\leq 5$ mm                                           | 3 – 4 GHz: $\leq 4$ mm<br>4 – 5 GHz: $\leq 3$ mm<br>5 – 6 GHz: $\leq 2$ mm    |
|                                                                                                                                                                                                                                                                                                             | graded grid                               | $\Delta z_{\text{Zoom}}(1)$ : between 1 <sup>st</sup> two points closest to phantom surface | $\leq 4$ mm                                           | 3 – 4 GHz: $\leq 3$ mm<br>4 – 5 GHz: $\leq 2.5$ mm<br>5 – 6 GHz: $\leq 2$ mm  |
|                                                                                                                                                                                                                                                                                                             |                                           | $\Delta z_{\text{Zoom}}(n>1)$ : between subsequent points                                   | $\leq 1.5 \cdot \Delta z_{\text{Zoom}}(n-1)$          |                                                                               |
| Minimum zoom scan volume                                                                                                                                                                                                                                                                                    | x, y, z                                   |                                                                                             | $\geq 30$ mm                                          | 3 – 4 GHz: $\geq 28$ mm<br>4 – 5 GHz: $\geq 25$ mm<br>5 – 6 GHz: $\geq 22$ mm |
| Note: $\delta$ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.                                                                                                                                                           |                                           |                                                                                             |                                                       |                                                                               |
| * When zoom scan is required and the <u>reported</u> SAR from the <i>area scan based 1-g SAR estimation</i> procedures of KDB 447498 is $\leq 1.4$ W/kg, $\leq 8$ mm, $\leq 7$ mm and $\leq 5$ mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. |                                           |                                                                                             |                                                       |                                                                               |

## 9.5. Volume Scan Procedures

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.

## 9.6. 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.

## 10. Conducted Power

### <GSM Conducted power>

| GSM850                        | Burst Average Power (dBm) |        |        | Frame-Average Power (dBm) |        |        |
|-------------------------------|---------------------------|--------|--------|---------------------------|--------|--------|
| TX Channel                    | 128                       | 190    | 251    | 128                       | 190    | 251    |
| Frequency (MHz)               | 824.2                     | 836.6  | 848.6  | 824.2                     | 836.6  | 848.6  |
| GSM (GMSK, 1 Tx slot)         | 31.31                     | 31.15  | 31.24  | 22.28                     | 22.21  | 22.21  |
| GPRS (GMSK, 1 Tx slot) – CS1  | 31.22                     | 31.08  | 31.26  | 22.19                     | 22.23  | 22.23  |
| GPRS (GMSK, 2 Tx slots) – CS1 | 28.34                     | 28.60  | 28.21  | 22.32                     | 22.58  | 22.19  |
| GPRS (GMSK, 3 Tx slots) – CS1 | 26.54                     | 26.45  | 26.27  | 22.28                     | 22.19  | 22.01  |
| GPRS (GMSK, 4 Tx slots) – CS1 | 25.41                     | 25.32  | 25.61  | 22.40                     | 22.31  | 22.60  |
| PCS1900                       | Burst Average Power (dBm) |        |        | Frame-Average Power (dBm) |        |        |
| TX Channel                    | 512                       | 661    | 810    | 512                       | 661    | 810    |
| Frequency (MHz)               | 1850.2                    | 1880.0 | 1909.8 | 1850.2                    | 1880.0 | 1909.8 |
| GSM (GMSK, 1 Tx slot)         | 28.15                     | 28.38  | 28.44  | 19.12                     | 19.35  | 19.41  |
| GPRS (GMSK, 1 Tx slot) – CS1  | 27.81                     | 27.87  | 27.12  | 18.78                     | 18.84  | 18.09  |
| GPRS (GMSK, 2 Tx slots) – CS1 | 24.15                     | 24.18  | 24.27  | 18.13                     | 18.16  | 18.25  |
| GPRS (GMSK, 3 Tx slots) – CS1 | 22.96                     | 23.23  | 23.15  | 18.70                     | 18.97  | 18.89  |
| GPRS (GMSK, 4 Tx slots) – CS1 | 22.71                     | 22.42  | 22.35  | 19.70                     | 19.41  | 19.34  |

Remark: The frame-averaged power is linearly scaled the maximum burst averaged power over 8 time slots.

The calculated method are shown as below:

Frame-averaged power = Maximum burst averaged power (1 Tx Slot) – 9.03 dB

Frame-averaged power = Maximum burst averaged power (2 Tx Slots) – 6.02 dB

Frame-averaged power = Maximum burst averaged power (3 Tx Slots) - 4.26 dB

Frame-averaged power = Maximum burst averaged power (4 Tx Slots) – 3.01 dB

#### Note:

1. Per KDB 447498 D01, the maximum output power channel is used for SAR testing and for further SAR test reduction
2. For Head SAR testing, GSM should be evaluated, therefore the EUT was set in GSM Voice for GSM850 and PCS1900.
3. For Hotspot mode SAR testing, GPRS and EDGE should be evaluated, therefore the EUT was set in GPRS 4 Tx slots for GSM850 and PCS1900 due to its highest frame-average power.

<Bluetooth Conducted Power>

| Mode     | Channel | Frequency (MHz) | Conducted Average Power (dBm) |
|----------|---------|-----------------|-------------------------------|
| GFSK     | 00      | 2402            | 4.765                         |
|          | 39      | 2441            | 4.791                         |
|          | 78      | 2480            | 5.064                         |
| π/4DQPSK | 00      | 2402            | 5.776                         |
|          | 39      | 2441            | 5.849                         |
|          | 78      | 2480            | 5.596                         |
| 8DPSK    | 00      | 2402            | 5.996                         |
|          | 39      | 2441            | <b>6.051</b>                  |
|          | 78      | 2480            | 5.773                         |

**Note:**

- Per KDB 447498 D01Chapter 4.3.1, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances  $\leq 50$  mm are determined by:

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

$f(\text{GHz})$  is the RF channel transmit frequency in GHz

Power and distance are rounded to the nearest mW and mm before calculation

The result is rounded to one decimal place for comparison

| Bluetooth Max Power (dBm) | Separation Distance (mm) | Frequency (GHz) | exclusion thresholds |
|---------------------------|--------------------------|-----------------|----------------------|
| 6.051                     | 0                        | 2.441           | 1.259                |

- Per KDB 447498 D01Chapter 4.3.1, when the minimum test separation distance is  $< 5$  mm, a distance of 5 mm is applied to determine SAR test exclusion. The test exclusion threshold is 1.071 which is  $\leq 3$ , SAR test for BT mode is not required.
- Per KDB 447498 D01Chapter 4.3.2b), When an antenna qualifies for the standalone SAR test exclusion of 4.3.1 and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to the following to determine the simultaneous transmission SAR test exclusion criteria:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})} / x] \text{ W/kg}$ , for test separation distances  $\leq 50$  mm;

where  $x = 7.5$  for 1-g SAR and  $x = 18.75$  for 10-g SAR.

0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distance is  $> 50$  mm.

| Test position | Bluetooth Max Power (dBm) | Separation Distance (mm) | Frequency (GHz) | Scaled SAR value (W/kg) |
|---------------|---------------------------|--------------------------|-----------------|-------------------------|
| Head          | 6.051                     | 5                        | 2.441           | <b>0.420</b>            |
| Body          | 6.051                     | 10                       | 2.441           | <b>0.210</b>            |

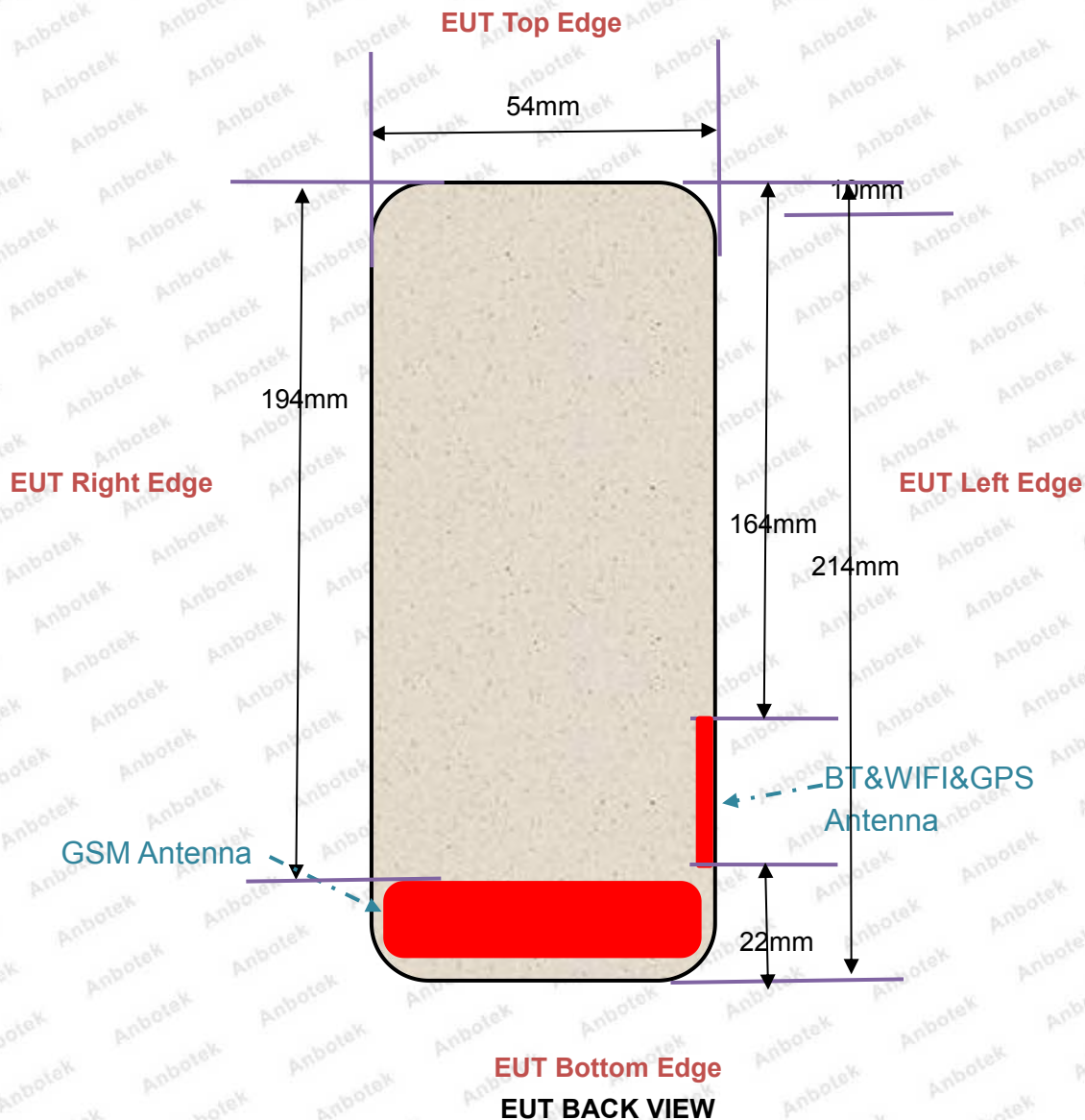
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## 11. Antenna Location



| Distance of The Antenna to the EUT surface and edge |       |      |          |             |           |            |
|-----------------------------------------------------|-------|------|----------|-------------|-----------|------------|
| Antennas                                            | Front | Back | Top Side | Bottom Side | Left Side | Right Side |
| WWAN                                                | /     | /    | >25mm    | <25mm       | <25mm     | <25mm      |
| BT                                                  | /     | /    | >25mm    | <25mm       | <25mm     | >25mm      |

**General Note:** Referring to KDB 941225 D06, When the overall device length and width are  $\geq 9\text{cm} \times 5\text{cm}$ , the test distance is 10mm, SAR must be measured for all sides and surfaces with a transmitting antenna located with 25mm from that surface or edge.

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## 12. SAR Test Results Summary

General Note:

- Per KDB 447498 D01v05r01, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.

*Scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.*

*Reported SAR(W/kg)= Measured SAR(W/kg)\* Scaling Factor*

- Per KDB 447498 D01v05r01, for each exposure position, if the highest output channel reported SAR≤0.8W/kg, other channels SAR testing are not necessary

### 12.1. Head SAR Results

#### <GSM for Sample1>

| Plot No. | Band    | Mode      | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR <sub>1g</sub> (W/kg) | Reported SAR <sub>1g</sub> (W/kg) |
|----------|---------|-----------|---------------|----------|-----|-------------|---------------------|---------------------|----------------|------------------|-----------------------------------|-----------------------------------|
|          | GSM850  | GSM Voice | Right Cheek   | 0        | 190 | 836.4       | 31.15               | 32.00               | 1.22           | 0.07             | 0.100                             | 0.122                             |
|          | GSM850  | GSM Voice | Right Tilt    | 0        | 190 | 836.4       | 31.15               | 32.00               | 1.22           | 0.04             | 0.033                             | 0.040                             |
| #1       | GSM850  | GSM Voice | Left Cheek    | 0        | 190 | 836.4       | 31.15               | 32.00               | 1.22           | 0.03             | 0.104                             | <b>0.126</b>                      |
|          | GSM850  | GSM Voice | Left Tilt     | 0        | 190 | 836.4       | 31.15               | 32.00               | 1.22           | -0.08            | 0.039                             | 0.047                             |
|          | PCS1900 | GSM Voice | Right Cheek   | 0        | 661 | 1880.0      | 28.38               | 29.00               | 1.15           | 0.09             | 0.029                             | 0.034                             |
|          | PCS1900 | GSM Voice | Right Tilt    | 0        | 661 | 1880.0      | 28.38               | 29.00               | 1.15           | -0.15            | 0.0025                            | 0.003                             |
| #2       | PCS1900 | GSM Voice | Left Cheek    | 0        | 661 | 1880.0      | 28.38               | 29.00               | 1.15           | -0.04            | 0.041                             | <b>0.047</b>                      |
|          | PCS1900 | GSM Voice | Left Tilt     | 0        | 661 | 1880.0      | 28.38               | 29.00               | 1.15           | -0.05            | 0.0027                            | 0.003                             |

#### <Worst case for Sample2>

| Plot No. | Band    | Mode      | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR <sub>1g</sub> (W/kg) | Reported SAR <sub>1g</sub> (W/kg) |
|----------|---------|-----------|---------------|----------|-----|-------------|---------------------|---------------------|----------------|------------------|-----------------------------------|-----------------------------------|
| #3       | GSM850  | GSM Voice | Left Cheek    | 0        | 190 | 836.4       | 31.15               | 32.00               | 1.22           | -0.11            | 0.101                             | 0.123                             |
| #4       | PCS1900 | GSM Voice | Left Cheek    | 0        | 661 | 1880.0      | 28.38               | 29.00               | 1.15           | 0.08             | 0.039                             | 0.045                             |

**Note:**

Per KDB865664 D01, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/Kg; if the deviation among the repeated measurement is ≤20%,and the measured SAR <1.45W/Kg, only one repeated measurement is required.

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## 12.2. Body SAR Results

### <GSM for Sample1>

| Plot No. | Band    | Mode          | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR <sub>1g</sub> (W/kg) | Reported SAR <sub>1g</sub> (W/kg) |
|----------|---------|---------------|---------------|----------|-----|-------------|---------------------|---------------------|----------------|------------------|-----------------------------------|-----------------------------------|
|          | GSM850  | GPRS 4TX Slot | Front         | 10       | 190 | 836.4       | 25.32               | 26.00               | 1.17           | 0.03             | 0.487                             | 0.570                             |
| #5       | GSM850  | GPRS 4TX Slot | Back          | 10       | 190 | 836.4       | 25.32               | 26.00               | 1.17           | -0.09            | 0.608                             | <b>0.711</b>                      |
|          | GSM850  | GPRS 4TX Slot | Back          | 10       | 190 | 836.4       | 25.32               | 26.00               | 1.17           | 0.06             | 0.535                             | 0.626                             |
|          | PCS1900 | GPRS 4TX Slot | Front         | 10       | 661 | 1880.0      | 22.42               | 23.00               | 1.14           | -0.02            | 0.365                             | 0.417                             |
| #6       | PCS1900 | GPRS 4TX Slot | Back          | 10       | 661 | 1880.0      | 22.42               | 23.00               | 1.14           | -0.07            | 0.407                             | <b>0.465</b>                      |
|          | PCS1900 | GPRS 4TX Slot | Back          | 10       | 661 | 1880.0      | 22.42               | 23.00               | 1.14           | -0.02            | 0.442                             | 0.504                             |

### <GSM for Sample2>

| Plot No. | Band    | Mode          | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR <sub>1g</sub> (W/kg) | Reported SAR <sub>1g</sub> (W/kg) |
|----------|---------|---------------|---------------|----------|-----|-------------|---------------------|---------------------|----------------|------------------|-----------------------------------|-----------------------------------|
| #7       | GSM850  | GPRS 4TX Slot | Back          | 10       | 190 | 836.4       | 25.32               | 26.00               | 1.17           | 0.03             | 0.613                             | 0.717                             |
| #8       | PCS1900 | GPRS 4TX Slot | Back          | 10       | 661 | 1880.0      | 22.42               | 23.00               | 1.14           | 0.08             | 0.397                             | 0.454                             |

#### Note:

- Per IEC62209-2:2010 Chapter 6.1.4.2, only Back and Front of the mobile phone are required for test. The mobile do not support Hotspot mode and other surfaces are not need to be tested
- Per KDB865664 D01, for each frequency band, repeated SAR measurement is required only when the measured SAR is  $\geq 0.8\text{W/Kg}$ ; if the deviation among the repeated measurement is  $\leq 20\%$ , and the measured SAR  $< 1.45\text{W/Kg}$ , only one repeated measurement is required.

## 13. Simultaneous Transmission Analysis

### 13.1. Simultaneous TX SAR Considerations

| No. | Applicable Simultaneous Transmission |
|-----|--------------------------------------|
| 1.  | GSM+ BT                              |

### 13.2. Evaluation of Simultaneous SAR

#### < Head Exposure Conditions >

Simultaneous transmission SAR for WLAN and GSM/WCDMA

| Test Position | GSM850 SAR <sub>1-g</sub> (W/Kg) | GSM1900 SAR <sub>1-g</sub> (W/Kg) | BT SAR <sub>1-g</sub> (W/Kg) | MAX. ΣSAR <sub>1-g</sub> (W/Kg) | SAR <sub>1-g</sub> Limit (W/Kg) | Simut. Meas. Required |
|---------------|----------------------------------|-----------------------------------|------------------------------|---------------------------------|---------------------------------|-----------------------|
| Right Cheek   | 0.122                            | 0.034                             | 0.420                        | 0.542                           | 1.6                             | NO                    |
| Right Tilt    | 0.040                            | 0.003                             | 0.420                        | 0.460                           | 1.6                             | NO                    |
| Left Cheek    | <b>0.126</b>                     | <b>0.047</b>                      | 0.420                        | <b>0.546</b>                    | 1.6                             | NO                    |
| Left Tilt     | 0.047                            | 0.003                             | 0.420                        | 0.467                           | 1.6                             | NO                    |

#### <Body Exposure Conditions>

| Test Position | GSM850 SAR <sub>1-g</sub> (W/Kg) | GSM1900 SAR <sub>1-g</sub> (W/Kg) | BT SAR <sub>1-g</sub> (W/Kg) | MAX. ΣSAR <sub>1-g</sub> (W/Kg) | SAR <sub>1-g</sub> Limit (W/Kg) | Simut. Meas. Required |
|---------------|----------------------------------|-----------------------------------|------------------------------|---------------------------------|---------------------------------|-----------------------|
| Front         | 0.570                            | 0.417                             | 0.210                        | 0.780                           | 1.6                             | NO                    |
| Back          | <b>0.711</b>                     | <b>0.465</b>                      | 0.210                        | <b>0.921</b>                    | 1.6                             | NO                    |

## 14. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is  $< 1.5$  W/Kg, the extensive SAR measurement uncertainty analysis described in IEC 62209-2:2010 is not required in SAR reports submitted for equipment approval.

## Appendix A. EUT Photos and Test Setup Photos



Left Cheek



Left Tilt 15°



Right Cheek



Right Tilt 15°



Body Front(10mm)



Body Back(10mm)



**Closed With Earphone(10mm)**

## Appendix B. Plots of SAR System Check

Date: 04/16/2019

### 835MHz Head System Check

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d160**

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

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.96 \text{ S/m}$ ;  $\epsilon_r = 41.68$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(9.71, 9.71, 9.71); Calibrated: 12.5.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn387; Calibrated: 6.9.2018
- Phantom: SAM1; Type: QD000P40CD; Serial: TP:1670
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.10 (7164)

**Configuration/Pin=250mW/Area Scan (7x7x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$

Maximum value of SAR (measured) = 2.80 W/kg

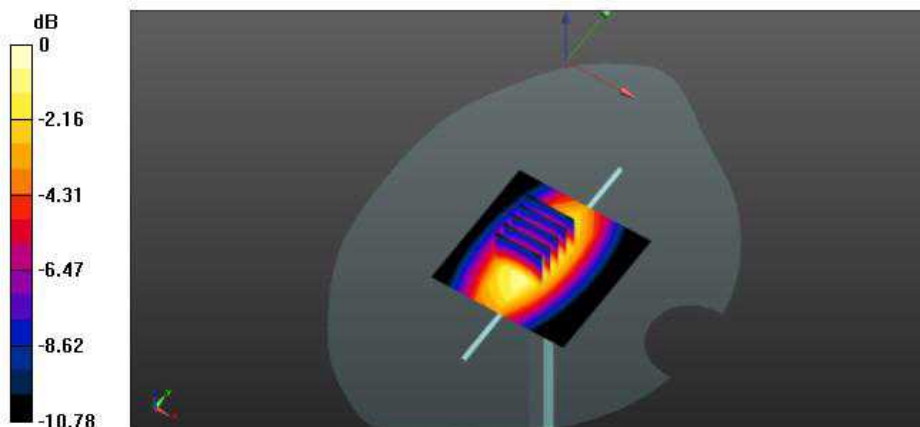
**Configuration/Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 56.553 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.39 W/kg

**SAR(1 g) = 2.31 W/kg; SAR(10 g) = 1.62 W/kg**

Maximum value of SAR (measured) = 2.86 W/kg



0 dB = 2.86 W/kg = 4.56 dBW/kg

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### 835MHz Body System Check

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d160**

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

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 1.06 \text{ S/m}$ ;  $\epsilon_r = 55.26$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(9.88, 9.88, 9.88); Calibrated: 12.5.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn387; Calibrated: 6.9.2018
- Phantom: SAM1; Type: QD000P40CD; Serial: TP:1670
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.10 (7164)

**Configuration/Pin=250mW/Area Scan (7x7x1):** Measurement grid:  $dx=15\text{mm}$ ,  $dy=15\text{mm}$

Maximum value of SAR (measured) = 2.97 W/kg

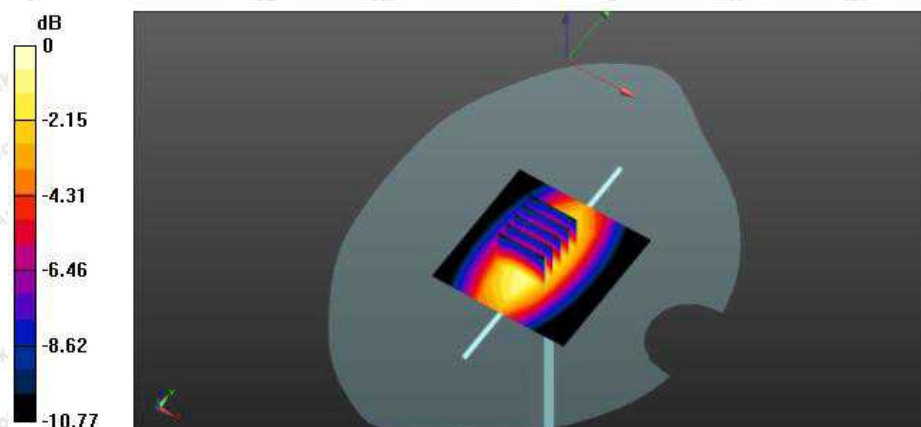
**Configuration/Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid:  $dx=8\text{mm}$ ,  $dy=8\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 60.007 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 4.02 W/kg

**SAR(1 g) = 2.53 W/kg; SAR(10 g) = 1.75 W/kg**

Maximum value of SAR (measured) = 3.58 W/kg



0 dB = 3.01 W/kg = 4.79 dBW/kg

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Date: 04/18/2019

### 1900MHz Head System Check

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d179**

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

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.43$  S/m;  $\epsilon_r = 40.19$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

#### DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(8.13, 8.13, 8.13); Calibrated: 12.5.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn387; Calibrated: 6.9.2018
- Phantom: SAM1; Type: QD000P40CD; Serial: TP:1670
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.10 (7164)

**Configuration/Pin=250mW/Area Scan (71x71x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 11.3 W/kg

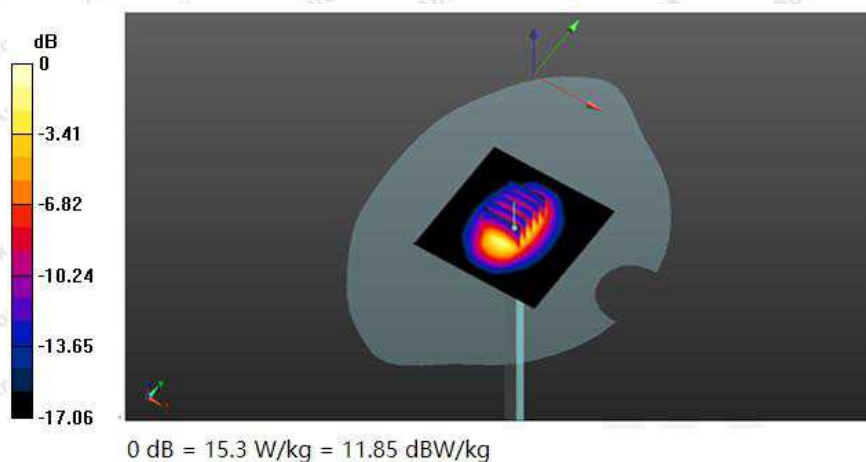
**Configuration/Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 100.5 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 18.0 W/kg

**SAR(1 g) = 9.99 W/kg; SAR(10 g) = 5.12 W/kg**

Maximum value of SAR (measured) = 15.3 W/kg



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Date: 04/19/2019

### 1900MHz Body System Check

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d179**

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

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.53$  S/m;  $\epsilon_r = 53.41$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

#### DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(7.97, 7.97, 7.97); Calibrated: 12.5.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn387; Calibrated: 6.9.2018
- Phantom: SAM1; Type: QD000P40CD; Serial: TP:1670
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.10 (7164)

**Configuration/Pin=250mW/Area Scan (7x7x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 10.7 W/kg

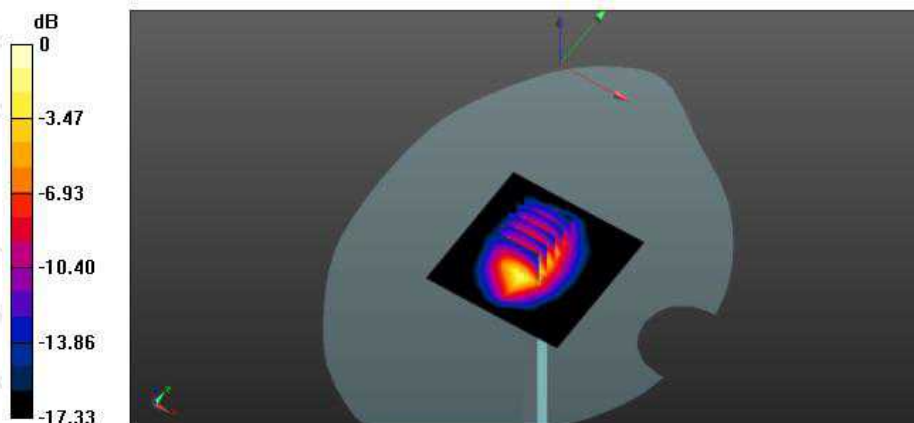
**Configuration/Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 86.92 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 17.0 W/kg

**SAR(1 g) = 9.26 W/kg; SAR(10 g) = 4.84 W/kg**

Maximum value of SAR (measured) = 10.4 W/kg



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## Appendix C. Plots of SAR Test Data

#1

Date: 04/16/2019

### GSM850\_GSM Voice\_Left Cheek\_Ch190

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

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.96$  S/m;  $\epsilon_r = 41.68$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(9.71, 9.71, 9.71); Calibrated: 12.5.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn387; Calibrated: 6.9.2018
- Phantom: SAM1; Type: QD000P40CD; Serial: TP:1670
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.10 (7164)

**LEFT HEAD/L-C/Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 0.116 W/kg

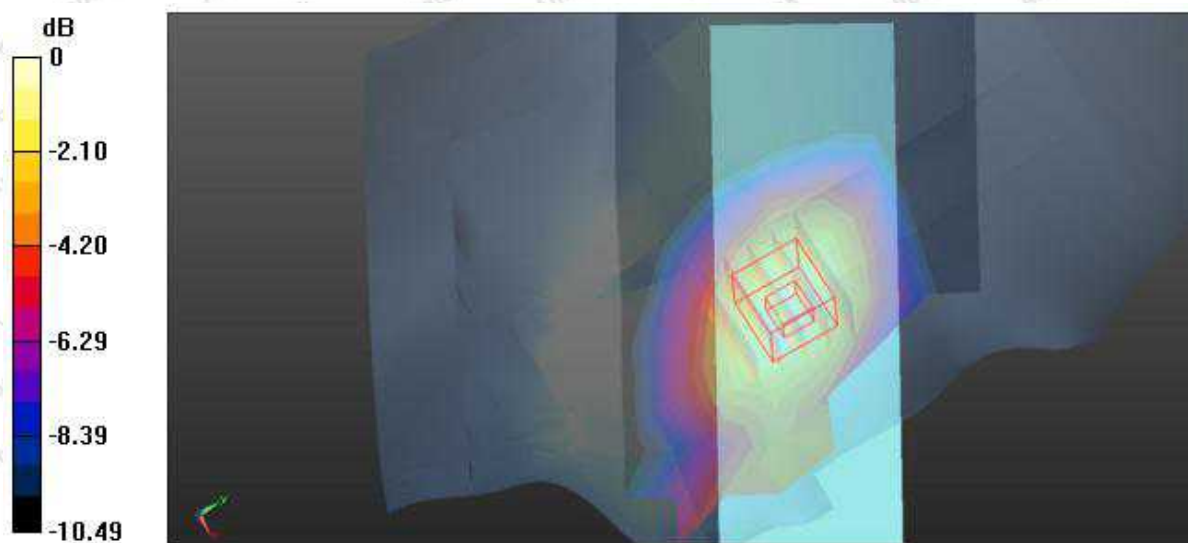
**LEFT HEAD/L-C/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 2.002 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.137 W/kg

**SAR(1 g) = 0.104 W/kg; SAR(10 g) = 0.074 W/kg**

Maximum value of SAR (measured) = 0.121 W/kg



### PCS1900\_GSM Voice\_Left Cheek\_Ch661

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

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.43$  S/m;  $\epsilon_r = 40.19$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

#### DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(8.13, 8.13, 8.13); Calibrated: 12.5.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn387; Calibrated: 6.9.2018
- Phantom: SAM1; Type: QD000P40CD; Serial: TP:1670
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.10 (7164)

**LEFT HEAD/L-C/Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 0.0889 W/kg

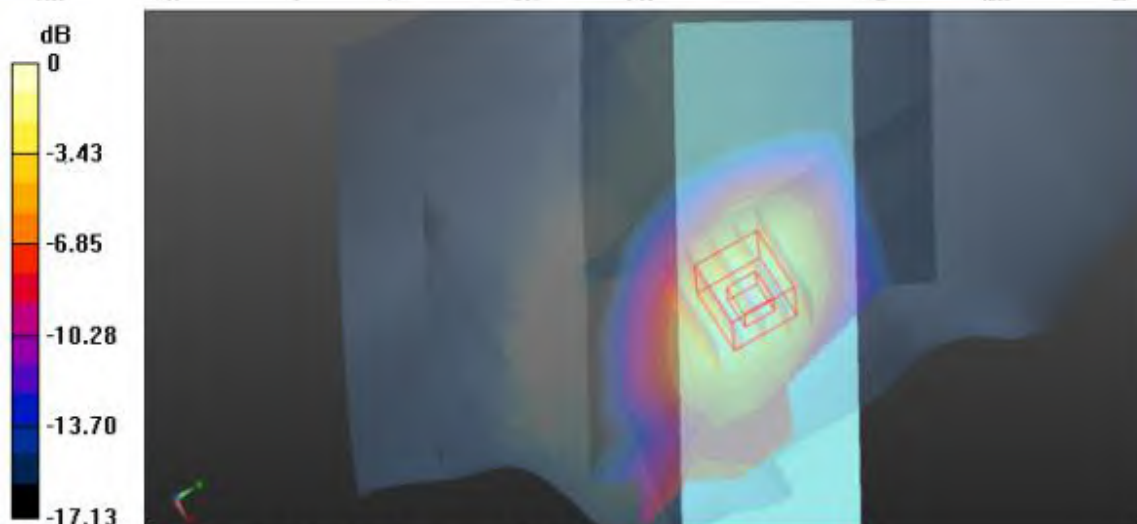
**LEFT HEAD/L-C/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 7.585 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 0.109 W/kg

**SAR(1 g) = 0.041 W/kg; SAR(10 g) = 0.025 W/kg**

Maximum value of SAR (measured) = 0.0901 W/kg



0 dB = 0.0901 W/kg = -10.45 dBW/kg

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### GSM850\_GSM Voice\_Left Cheek\_Ch190

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

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.96$  S/m;  $\epsilon_r = 41.68$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

#### DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(9.71, 9.71, 9.71); Calibrated: 12.5.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn387; Calibrated: 6.9.2018
- Phantom: SAM1; Type: QD000P40CD; Serial: TP:1670
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.10 (7164)

**LEFT HEAD/L-C/Area Scan (8x13x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 0.178 W/kg

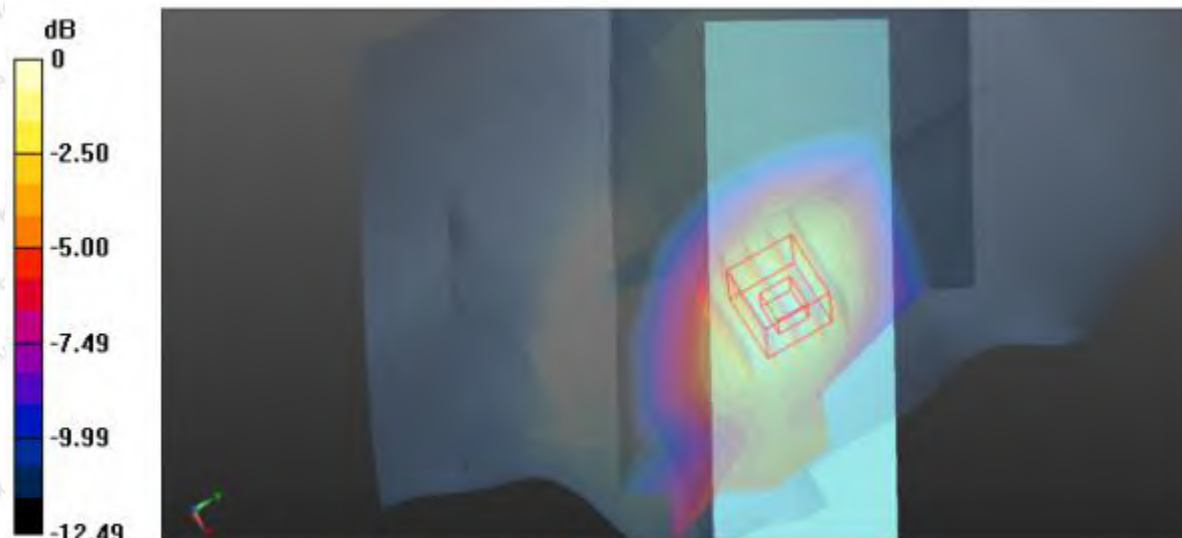
**LEFT HEAD/L-C/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 10.628 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 0.243 W/kg

**SAR(1 g) = 0.101 W/kg; SAR(10 g) = 0.074 W/kg**

Maximum value of SAR (measured) = 0.187 W/kg



0 dB = 0.187 W/kg = -7.28 dBW/kg

### PCS1900\_GSM Voice\_Left Cheek\_Ch661

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

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.43$  S/m;  $\epsilon_r = 40.19$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

#### DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(8.13, 8.13, 8.13); Calibrated: 12.5.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn387; Calibrated: 6.9.2018
- Phantom: SAM1; Type: QD000P40CD; Serial: TP:1670
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.10 (7164)

**LEFT HEAD/L-C/Area Scan (8x14x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 0.0863 W/kg

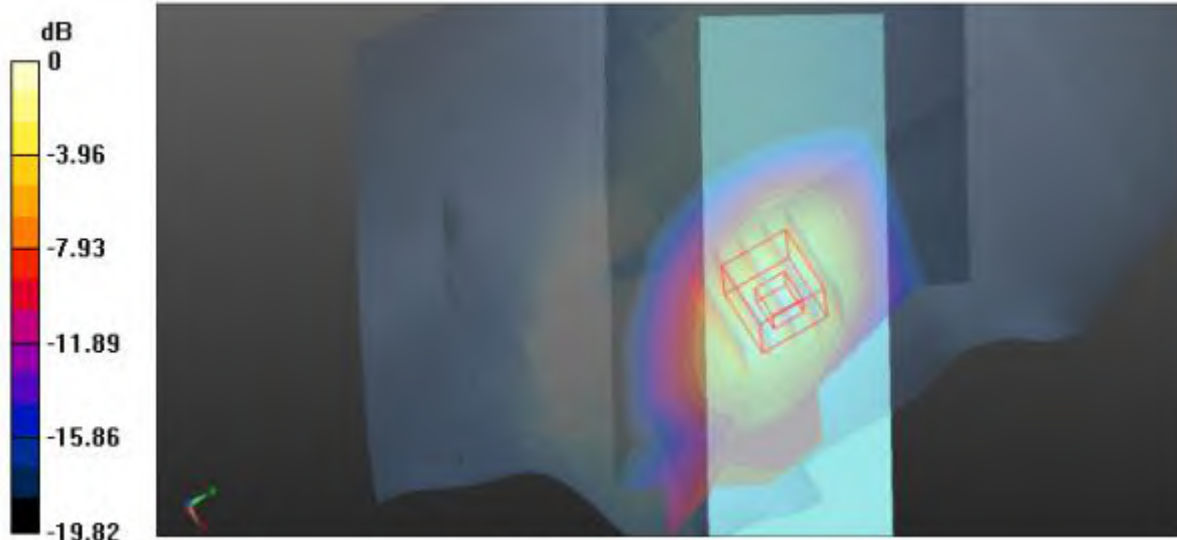
**LEFT HEAD/L-C/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 5.310 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 0.117 W/kg

**SAR(1 g) = 0.039 W/kg; SAR(10 g) = 0.018 W/kg**

Maximum value of SAR (measured) = 0.0751 W/kg



0 dB = 0.0751 W/kg = -11.24 dBW/kg

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#5

Date: 04/17/2019

### GSM850\_GPRS 4TX\_Body Back\_Ch190

Communication System: UID 0, GPRS(4 Tx slots) (0); Frequency: 836.6 MHz; Duty Cycle: 1:1.99986

Medium parameters used (interpolated):  $f = 836.6$  MHz;  $\sigma = 1.06$  S/m;  $\epsilon_r = 55.32$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(9.88, 9.88, 9.88); Calibrated: 12.5.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn387; Calibrated: 6.9.2018
- Phantom: SAM; Type: QD000P40CD; Serial: TP:1670
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.10 (7164)

**BODY/4ST-BACK/Area Scan (7x15x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 0.721 W/kg

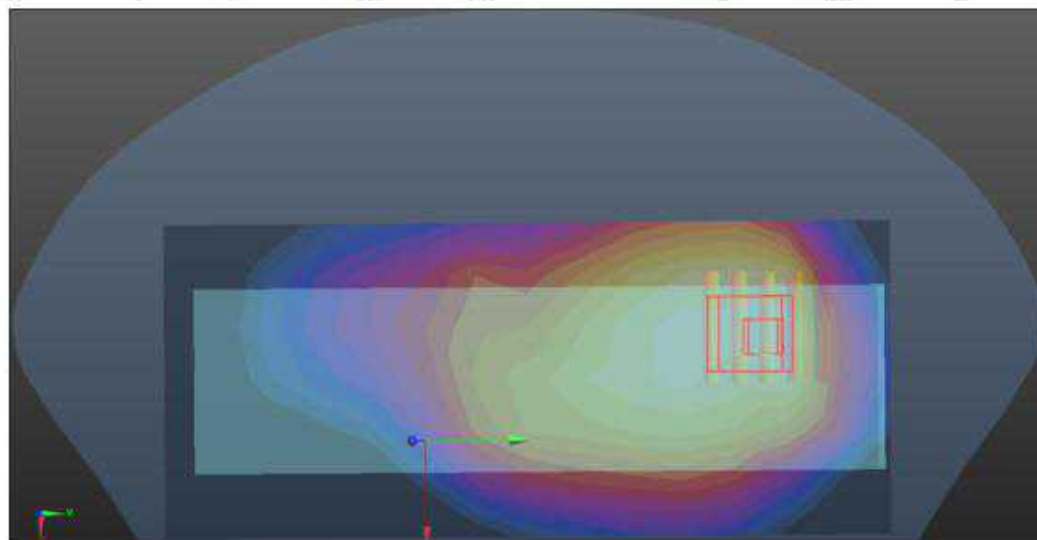
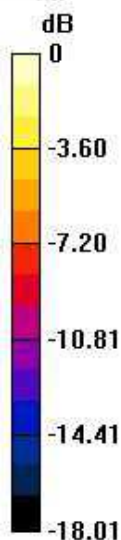
**BODY/4ST-BACK/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 18.421 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 1.00 W/kg

**SAR(1 g) = 0.608 W/kg; SAR(10 g) = 0.405 W/kg**

Maximum value of SAR (measured) = 0.806 W/kg



0 dB = 0.806 W/kg = -0.94 dBW/kg

#6

Date: 04/19/2019

### PCS1900\_GPRS 4TX\_Body Back\_Ch661

Communication System: UID 0, GPRS(4 Tx slots) (0); Frequency: 1880 MHz; Duty Cycle: 1:1.99986

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.53$  S/m;  $\epsilon_r = 53.41$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(7.97, 7.97, 7.97); Calibrated: 12.5.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn387; Calibrated: 6.9.2018
- Phantom: SAM; Type: QD000P40CD; Serial: TP:1670
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.10 (7164)

**BODY/4ST-BACK/Area Scan (7x15x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 0.519 W/kg

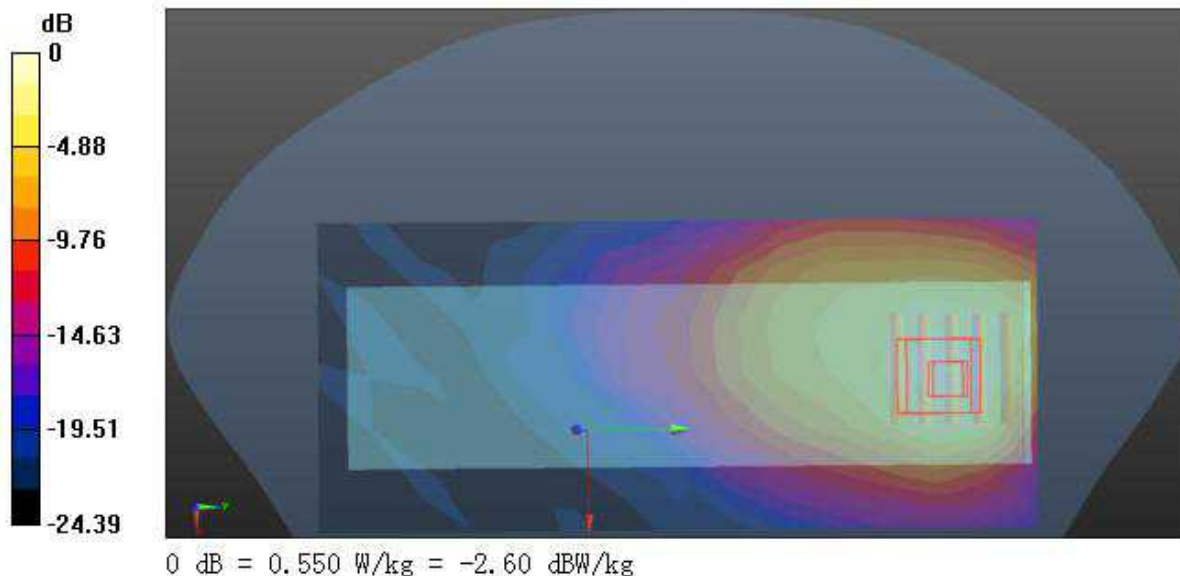
**BODY/4ST-BACK/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 4.494 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 0.731 W/kg

**SAR(1 g) = 0.407 W/kg; SAR(10 g) = 0.220 W/kg**

Maximum value of SAR (measured) = 0.550 W/kg



#7

Date: 04/17/2019

### GSM850\_GPRS 4TX\_Body Back\_Ch190

Communication System: UID 0, GPRS(4 Tx slots) (0); Frequency: 836.6 MHz; Duty Cycle: 1:1.99986

Medium parameters used (interpolated):  $f = 836.6$  MHz;  $\sigma = 1.06$  S/m;  $\epsilon_r = 55.32$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(9.88, 9.88, 9.88); Calibrated: 12.5.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn387; Calibrated: 6.9.2018
- Phantom: SAM; Type: QD000P40CD; Serial: TP:1670
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.10 (7164)

**BODY/4ST-BACK 2/Area Scan (7x15x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 0.703 W/kg

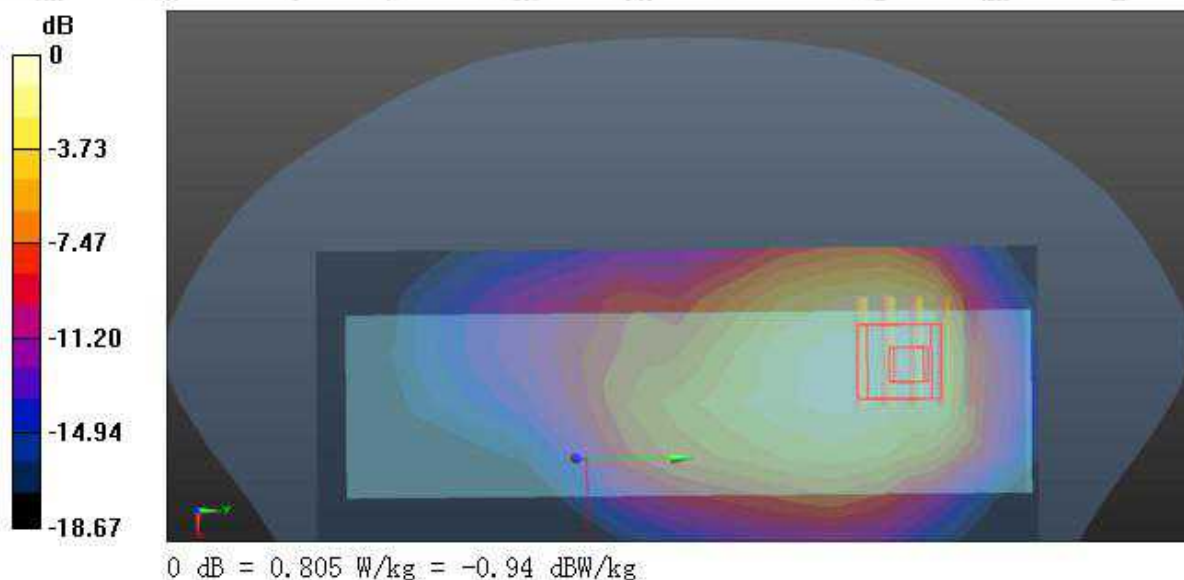
**BODY/4ST-BACK 2/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 16.544 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 0.998 W/kg

**SAR(1 g) = 0.613 W/kg; SAR(10 g) = 0.402 W/kg**

Maximum value of SAR (measured) = 0.805 W/kg



#8

Date: 04/19/2019

### PCS1900\_GPRS 4TX\_Body Back\_Ch661

Communication System: UID 0, GPRS(4 Tx slots) (0); Frequency: 1880 MHz; Duty Cycle: 1:1.99986

Medium parameters used:  $f = 1880$  MHz;  $\sigma = 1.53$  S/m;  $\epsilon_r = 53.41$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(7.97, 7.97, 7.97); Calibrated: 12.5.2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn387; Calibrated: 6.9.2018
- Phantom: SAM; Type: QD000P40CD; Serial: TP:1670
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.10 (7164)

**BODY/4ST-BACK 2/Area Scan (7x15x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 0.535 W/kg

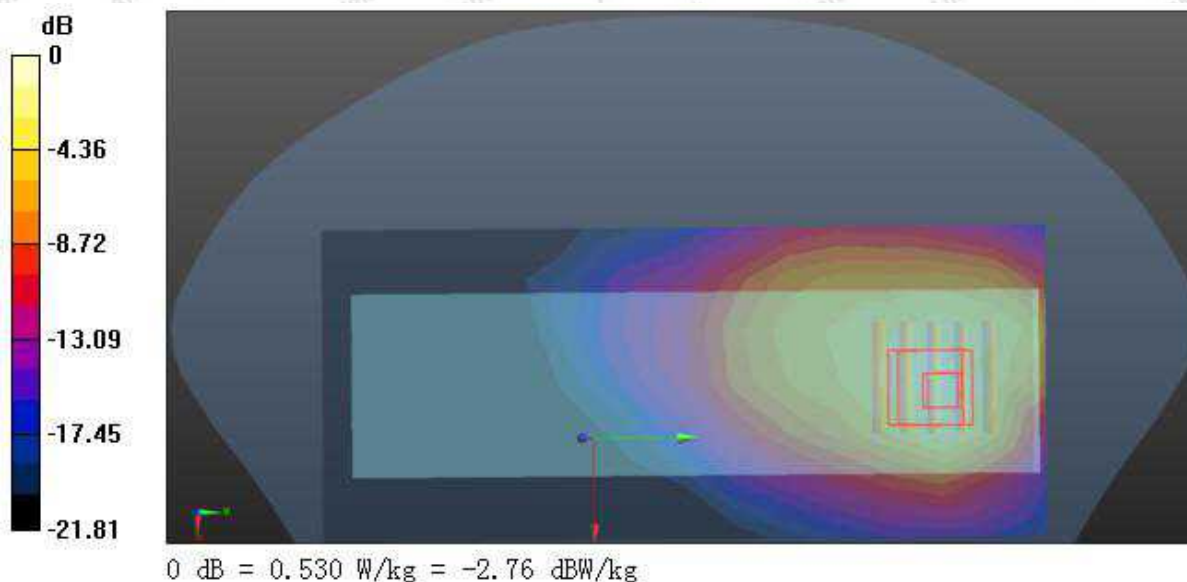
**BODY/4ST-BACK 2/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 4.472 V/m; Power Drift = 0.08 dB

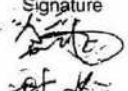
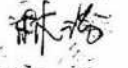
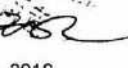
Peak SAR (extrapolated) = 0.715 W/kg

**SAR(1 g) = 0.397 W/kg; SAR(10 g) = 0.213 W/kg**

Maximum value of SAR (measured) = 0.530 W/kg



## Appendix D. DASY System Calibration Certificate

|                                                                                                                                                                                                                                                                           |         |                                                                       |                                          |                                                                                   |  |                                                                                    |  |                                                                                     |                                                                                       |                                                 |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----------------------------------------------------------------------|------------------------------------------|-----------------------------------------------------------------------------------|--|------------------------------------------------------------------------------------|--|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------|--|
|                                                                                                                                                                                          |         | In Collaboration with                                                 |                                          |  |  |  |  |  |                                                                                       | 中国认可<br>国际互认<br>校准<br>CALIBRATION<br>CNAS L0570 |  |
| Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China<br>Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209<br>E-mail: cttl@chinattl.com Http://www.chinattl.cn                                                                                              |         |                                                                       |                                          |                                                                                   |  |                                                                                    |  |                                                                                     |                                                                                       |                                                 |  |
| Client                                                                                                                                                                                                                                                                    |         |                                                                       |                                          | Anbotek (Auden)                                                                   |  |                                                                                    |  | Certificate No: Z18-98671                                                           |                                                                                       |                                                 |  |
| <b>CALIBRATION CERTIFICATE</b>                                                                                                                                                                                                                                            |         |                                                                       |                                          |                                                                                   |  |                                                                                    |  |                                                                                     |                                                                                       |                                                 |  |
| Object                                                                                                                                                                                                                                                                    |         | EX3DV4 - SN:7396                                                      |                                          |                                                                                   |  |                                                                                    |  |                                                                                     |                                                                                       |                                                 |  |
| Calibration Procedure(s)                                                                                                                                                                                                                                                  |         | FF-Z12-006-08<br>Calibration Procedures for Dosimetric E-field Probes |                                          |                                                                                   |  |                                                                                    |  |                                                                                     |                                                                                       |                                                 |  |
| Calibration date:                                                                                                                                                                                                                                                         |         | May12, 2018                                                           |                                          |                                                                                   |  |                                                                                    |  |                                                                                     |                                                                                       |                                                 |  |
| This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. |         |                                                                       |                                          |                                                                                   |  |                                                                                    |  |                                                                                     |                                                                                       |                                                 |  |
| All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.                                                                                                                                                 |         |                                                                       |                                          |                                                                                   |  |                                                                                    |  |                                                                                     |                                                                                       |                                                 |  |
| Calibration Equipment used (M&TE critical for calibration)                                                                                                                                                                                                                |         |                                                                       |                                          |                                                                                   |  |                                                                                    |  |                                                                                     |                                                                                       |                                                 |  |
| Primary Standards                                                                                                                                                                                                                                                         |         | ID #                                                                  | Cal Date(Calibrated by, Certificate No.) |                                                                                   |  |                                                                                    |  |                                                                                     | Scheduled Calibration                                                                 |                                                 |  |
| Power Meter                                                                                                                                                                                                                                                               | NRP2    | 101919                                                                | 20-Jun-17 (CTTL, No.J17X07447)           |                                                                                   |  |                                                                                    |  |                                                                                     | Jun-18                                                                                |                                                 |  |
| Power sensor                                                                                                                                                                                                                                                              | NRP-Z91 | 101547                                                                | 20-Jun-17 (CTTL, No.J17X07447)           |                                                                                   |  |                                                                                    |  |                                                                                     | Jun-18                                                                                |                                                 |  |
| Power sensor                                                                                                                                                                                                                                                              | NRP-Z91 | 101548                                                                | 20-Jun-17 (CTTL, No.J17X07447)           |                                                                                   |  |                                                                                    |  |                                                                                     | Jun-18                                                                                |                                                 |  |
| Reference10dBAttenuator                                                                                                                                                                                                                                                   |         | 18N50W-10dB                                                           | 13-Mar-18(CTTL, No.J18X01547)            |                                                                                   |  |                                                                                    |  |                                                                                     | Mar-19                                                                                |                                                 |  |
| Reference20dBAttenuator                                                                                                                                                                                                                                                   |         | 18N50W-20dB                                                           | 13-Mar-18(CTTL, No.J18X01548)            |                                                                                   |  |                                                                                    |  |                                                                                     | Mar-19                                                                                |                                                 |  |
| Reference Probe EX3DV4                                                                                                                                                                                                                                                    |         | SN 7433                                                               | 26-Sep-17(SPEAG, No.EX3-7433_Sep17)      |                                                                                   |  |                                                                                    |  |                                                                                     | Sep-18                                                                                |                                                 |  |
| DAE4                                                                                                                                                                                                                                                                      |         | SN 549                                                                | 13-Dec-17(SPEAG, No.DAE4-549_Dec17)      |                                                                                   |  |                                                                                    |  |                                                                                     | Dec -18                                                                               |                                                 |  |
| Secondary Standards                                                                                                                                                                                                                                                       |         | ID #                                                                  | Cal Date(Calibrated by, Certificate No.) |                                                                                   |  |                                                                                    |  |                                                                                     | Scheduled Calibration                                                                 |                                                 |  |
| SignalGeneratorMG3700A                                                                                                                                                                                                                                                    |         | 6201052605                                                            | 27-Jun-17 (CTTL, No.J17X04776)           |                                                                                   |  |                                                                                    |  |                                                                                     | Jun-18                                                                                |                                                 |  |
| Network Analyzer E5071C                                                                                                                                                                                                                                                   |         | MY46110673                                                            | 13-Jan-18 (CTTL, No.J18X00285)           |                                                                                   |  |                                                                                    |  |                                                                                     | Jan -19                                                                               |                                                 |  |
| Calibrated by:                                                                                                                                                                                                                                                            |         | Name                                                                  | Function                                 |                                                                                   |  |                                                                                    |  |                                                                                     | Signature                                                                             |                                                 |  |
|                                                                                                                                                                                                                                                                           |         | Yu Zongying                                                           | SAR Test Engineer                        |                                                                                   |  |                                                                                    |  |                                                                                     |  |                                                 |  |
| Reviewed by:                                                                                                                                                                                                                                                              |         | Lin Hao                                                               | SAR Test Engineer                        |                                                                                   |  |                                                                                    |  |                                                                                     |  |                                                 |  |
| Approved by:                                                                                                                                                                                                                                                              |         | Qi Dianyuan                                                           | SAR Project Leader                       |                                                                                   |  |                                                                                    |  |                                                                                     |  |                                                 |  |
| Issued: May13, 2018                                                                                                                                                                                                                                                       |         |                                                                       |                                          |                                                                                   |  |                                                                                    |  |                                                                                     |                                                                                       |                                                 |  |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory.                                                                                                                                                           |         |                                                                       |                                          |                                                                                   |  |                                                                                    |  |                                                                                     |                                                                                       |                                                 |  |



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#### Glossary:

|                       |                                                                                                                                        |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| TSL                   | tissue simulating liquid                                                                                                               |
| NORM <sub>x,y,z</sub> | sensitivity in free space                                                                                                              |
| ConvF                 | sensitivity in TSL / NORM <sub>x,y,z</sub>                                                                                             |
| DCP                   | diode compression point                                                                                                                |
| CF                    | crest factor (1/duty_cycle) of the RF signal                                                                                           |
| A,B,C,D               | modulation dependent linearization parameters                                                                                          |
| Polarization $\Phi$   | $\Phi$ rotation around probe axis                                                                                                      |
| Polarization $\theta$ | $\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), $\theta=0$ is normal to probe axis |

Connector Angle information used in DASY system to align probe sensor X to the robot coordinate system

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)", February 2005
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Methods Applied and Interpretation of Parameters:

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





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# Probe EX3DV4

## SN: 7396

Calibrated: May 12, 2018

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)





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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7396

### Basic Calibration Parameters

|                                                          | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|----------------------------------------------------------|----------|----------|----------|-----------|
| Norm( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 0.54     | 0.53     | 0.50     | ±10.0%    |
| DCP(mV) <sup>B</sup>                                     | 97.8     | 104.5    | 102.5    |           |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A dB | B dB $\sqrt{\mu\text{V}}$ | C   | D dB | VR mV | Unc <sup>E</sup> (k=2) |
|-----|---------------------------|---|------|---------------------------|-----|------|-------|------------------------|
| 0   | CW                        | X | 0.0  | 0.0                       | 1.0 | 0.00 | 199.9 | ±2.4%                  |
|     |                           | Y | 0.0  | 0.0                       | 1.0 |      | 203.3 |                        |
|     |                           | Z | 0.0  | 0.0                       | 1.0 |      | 195.0 |                        |

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

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

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

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



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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7396

### Calibration Parameter Determined in Head Tissue Simulating Media

| f [MHz] <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750                  | 41.9                               | 0.89                            | 9.82    | 9.82    | 9.82    | 0.30               | 0.85                    | ±12.1%      |
| 835                  | 41.5                               | 0.90                            | 9.71    | 9.71    | 9.71    | 0.15               | 1.36                    | ±12.1%      |
| 900                  | 41.5                               | 0.97                            | 9.87    | 9.87    | 9.87    | 0.16               | 1.37                    | ±12.1%      |
| 1750                 | 40.1                               | 1.37                            | 8.61    | 8.61    | 8.61    | 0.25               | 1.04                    | ±12.1%      |
| 1900                 | 40.0                               | 1.40                            | 8.13    | 8.13    | 8.13    | 0.24               | 1.01                    | ±12.1%      |
| 2100                 | 39.8                               | 1.49                            | 8.14    | 8.14    | 8.14    | 0.24               | 1.04                    | ±12.1%      |
| 2300                 | 39.5                               | 1.67                            | 7.85    | 7.85    | 7.85    | 0.40               | 0.75                    | ±12.1%      |
| 2450                 | 39.2                               | 1.80                            | 7.57    | 7.57    | 7.57    | 0.50               | 0.75                    | ±12.1%      |
| 2600                 | 39.0                               | 1.96                            | 7.38    | 7.38    | 7.38    | 0.64               | 0.68                    | ±12.1%      |
| 5250                 | 35.9                               | 4.71                            | 5.33    | 5.33    | 5.33    | 0.45               | 1.30                    | ±13.3%      |
| 5600                 | 35.5                               | 5.07                            | 4.89    | 4.89    | 4.89    | 0.45               | 1.35                    | ±13.3%      |
| 5750                 | 35.4                               | 5.22                            | 4.92    | 4.92    | 4.92    | 0.45               | 1.45                    | ±13.3%      |

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

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

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





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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7396

### Calibration Parameter Determined in Body Tissue Simulating Media

| f [MHz] <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750                  | 55.5                               | 0.96                            | 10.09   | 10.09   | 10.09   | 0.30               | 0.90                    | ±12.1%      |
| 835                  | 55.2                               | 0.97                            | 9.88    | 9.88    | 9.88    | 0.19               | 1.32                    | ±12.1%      |
| 900                  | 55.0                               | 1.05                            | 9.82    | 9.82    | 9.82    | 0.23               | 1.15                    | ±12.1%      |
| 1750                 | 53.4                               | 1.49                            | 8.24    | 8.24    | 8.24    | 0.24               | 1.06                    | ±12.1%      |
| 1900                 | 53.3                               | 1.52                            | 7.97    | 7.97    | 7.97    | 0.19               | 1.24                    | ±12.1%      |
| 2100                 | 53.2                               | 1.62                            | 8.18    | 8.18    | 8.18    | 0.19               | 1.39                    | ±12.1%      |
| 2300                 | 52.9                               | 1.81                            | 7.88    | 7.88    | 7.88    | 0.55               | 0.80                    | ±12.1%      |
| 2450                 | 52.7                               | 1.95                            | 7.53    | 7.53    | 7.53    | 0.46               | 0.89                    | ±12.1%      |
| 2600                 | 52.5                               | 2.16                            | 7.38    | 7.38    | 7.38    | 0.52               | 0.80                    | ±12.1%      |
| 5250                 | 48.9                               | 5.36                            | 4.93    | 4.93    | 4.93    | 0.45               | 1.80                    | ±13.3%      |
| 5600                 | 48.5                               | 5.77                            | 4.19    | 4.19    | 4.19    | 0.48               | 1.90                    | ±13.3%      |
| 5750                 | 48.3                               | 5.94                            | 4.52    | 4.52    | 4.52    | 0.48               | 1.95                    | ±13.3%      |

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

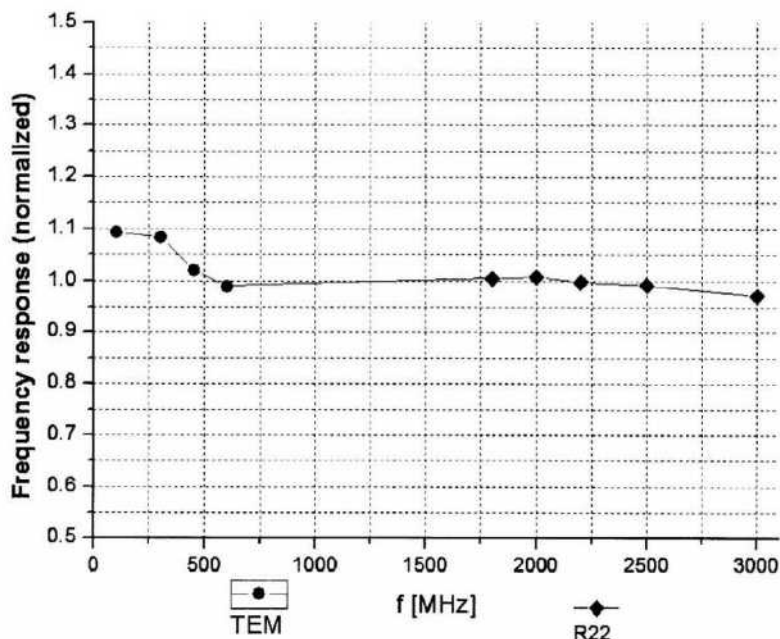
<sup>F</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to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

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



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



Uncertainty of Frequency Response of E-field:  $\pm 7.4\%$  (k=2)



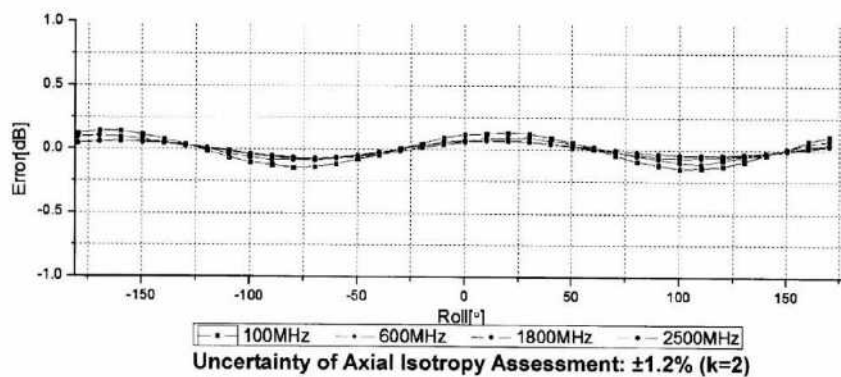
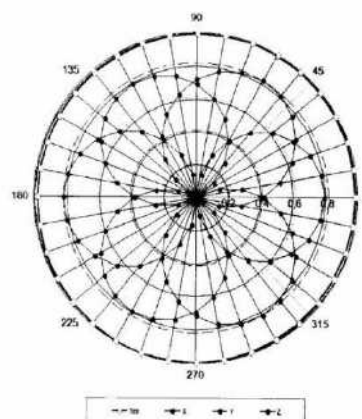
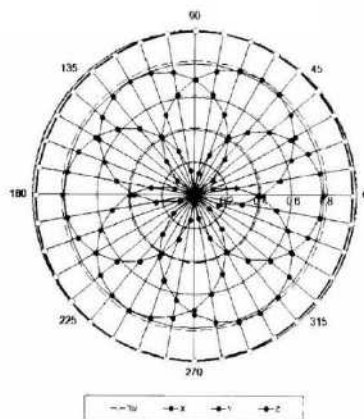


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## Receiving Pattern ( $\Phi$ ), $\theta=0^\circ$

**f=600 MHz, TEM**

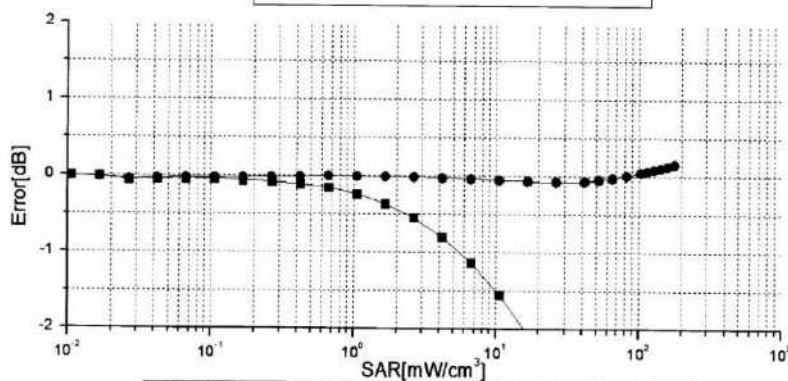
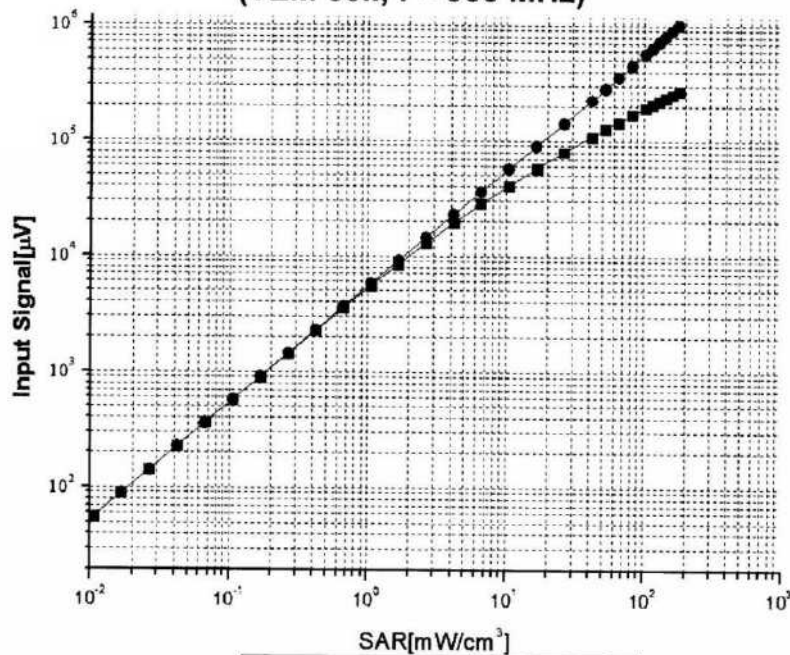
**f=1800 MHz, R22**





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### Dynamic Range f(SAR<sub>head</sub>) (TEM cell, f = 900 MHz)



Uncertainty of Linearity Assessment:  $\pm 0.9\%$  ( $k=2$ )

Certificate No: Z18-98671

Page 9 of 11

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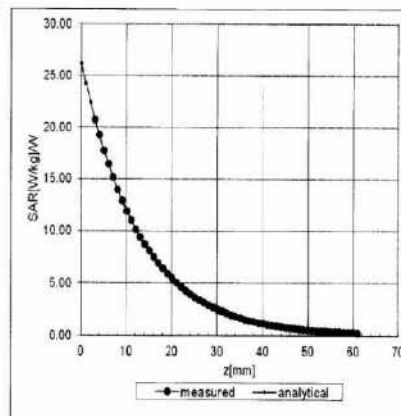
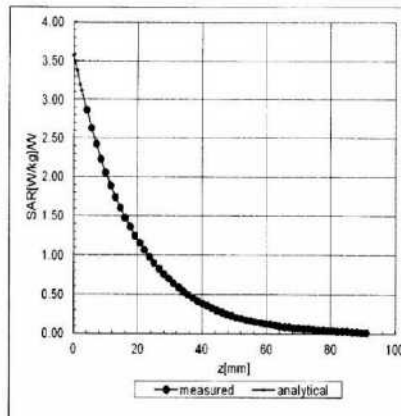


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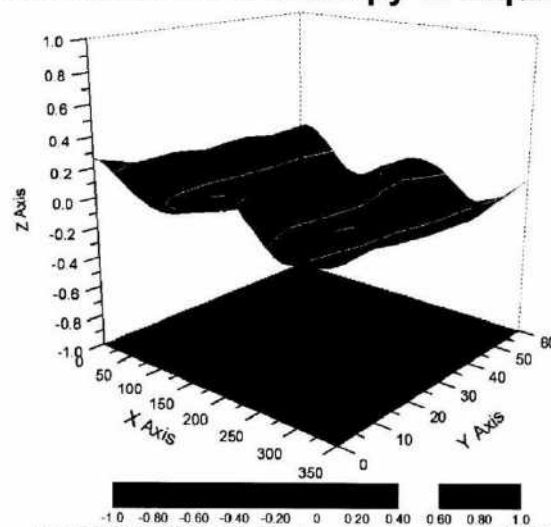
## Conversion Factor Assessment

f=900 MHz, WGLS R9(H\_convF)

f=1750 MHz, WGLS R22(H\_convF)



## Deviation from Isotropy in Liquid



Uncertainty of Spherical Isotropy Assessment:  $\pm 3.2\%$  (K=2)



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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7396

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | 156.9      |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disable    |
| Probe Overall Length                          | 337mm      |
| Probe Body Diameter                           | 10mm       |
| Tip Length                                    | 9mm        |
| Tip Diameter                                  | 2.5mm      |
| Probe Tip to Sensor X Calibration Point       | 1mm        |
| Probe Tip to Sensor Y Calibration Point       | 1mm        |
| Probe Tip to Sensor Z Calibration Point       | 1mm        |
| Recommended Measurement Distance from Surface | 1.4mm      |



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Client Anbotek (Auden)

Certificate No: Z18-97089

## CALIBRATION CERTIFICATE

Object D835V2 - SN: 4d154

Calibration Procedure(s) FD-Z11-2-003-01  
Calibration Procedures for dipole validation kits

Calibration date: Jun 16, 2018

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 NRP2       | 101919  | 01-Jul-17 (CTTL, No.J17X04256)           | Jun-18                |
| Power sensor NRP-Z91   | 101547  | 01-Jul-17 (CTTL, No.J17X04256)           | Jun-18                |
| Reference Probe EX3DV4 | SN 7307 | 19-Feb-18(SPEAG,No.EX3-7307_Feb18)       | Feb-19                |
| DAE4                   | SN 771  | 02-Feb-18(CTTL-SPEAG,No.Z18-97011)       | Feb-19                |

| Secondary Standards     | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|------------------------------------------|-----------------------|
| Signal Generator E4438C | MY49071430 | 01-Feb-18 (CTTL, No.J18X00893)           | Jan-19                |
| Network Analyzer E5071C | MY46110673 | 26-Jan-18 (CTTL, No.J18X00894)           | Jan-19                |

|                | Name        | Function                          | Signature |
|----------------|-------------|-----------------------------------|-----------|
| Calibrated by: | Zhao Jing   | SAR Test Engineer                 |           |
| Reviewed by:   | Qi Dianyuan | SAR Project Leader                |           |
| Approved by:   | Lu Bingsong | Deputy Director of the laboratory |           |

Issued: Jun 17, 2018

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

Certificate No: Z18-97089

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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:**

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) For hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)", February 2005
- 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
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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





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**Measurement Conditions**

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

|                              |                          |             |
|------------------------------|--------------------------|-------------|
| DASY Version                 | DASY52                   | 52.8.8.1258 |
| 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 $\pm$ 1 MHz      |             |

**Head TSL parameters**

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 41.5           | 0.90 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 41.0 $\pm$ 6 % | 0.89 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | <1.0 °C             | ----           | ----                 |

**SAR result with Head TSL**

|                                                         |                    |                                |
|---------------------------------------------------------|--------------------|--------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL   | Condition          |                                |
| SAR measured                                            | 250 mW input power | 2.30 mW / g                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 9.24 mW / g $\pm$ 20.8 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | Condition          |                                |
| SAR measured                                            | 250 mW input power | 1.50 mW / g                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 6.02 mW / g $\pm$ 20.4 % (k=2) |

**Body TSL parameters**

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 55.2           | 0.97 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 55.4 $\pm$ 6 % | 0.99 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | <1.0 °C             | ----           | ----                 |

**SAR result with Body TSL**

|                                                         |                    |                                |
|---------------------------------------------------------|--------------------|--------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL   | Condition          |                                |
| SAR measured                                            | 250 mW input power | 2.43 mW / g                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 9.57 mW / g $\pm$ 20.8 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (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   | 6.36 mW / g $\pm$ 20.4 % (k=2) |

Certificate No: Z18-97089

Page 3 of 8





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## Appendix

### Antenna Parameters with Head TSL

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 49.2Ω- 3.11jΩ |
| Return Loss                          | - 29.8dB      |

### Antenna Parameters with Body TSL

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 46.6Ω- 2.33jΩ |
| Return Loss                          | - 27.4dB      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.508 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: 06.16.2018

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d154**

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

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.891 \text{ S/m}$ ;  $\epsilon_r = 40.97$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(10.01, 10.01,10.01); Calibrated: 2/19/2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2018-02-02
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

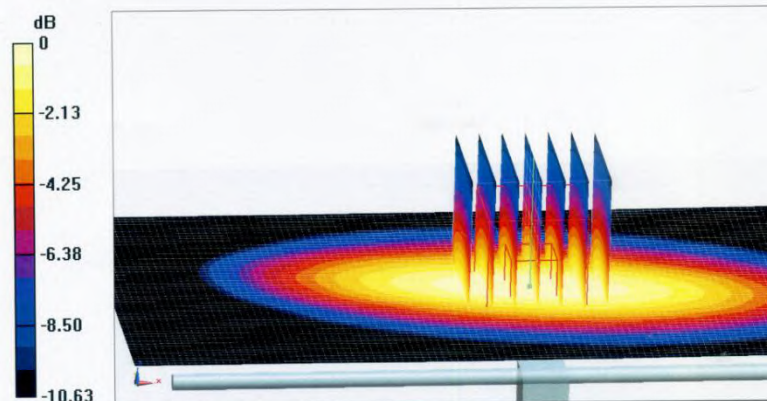
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 58.14V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.41 W/kg

**SAR(1 g) = 2.3 W/kg; SAR(10 g) = 1.5 W/kg**

Maximum value of SAR (measured) = 2.91 W/kg



0 dB = 2.91 W/kg = 4.64 dBW/kg

Certificate No: Z18-97089

Page 5 of 8

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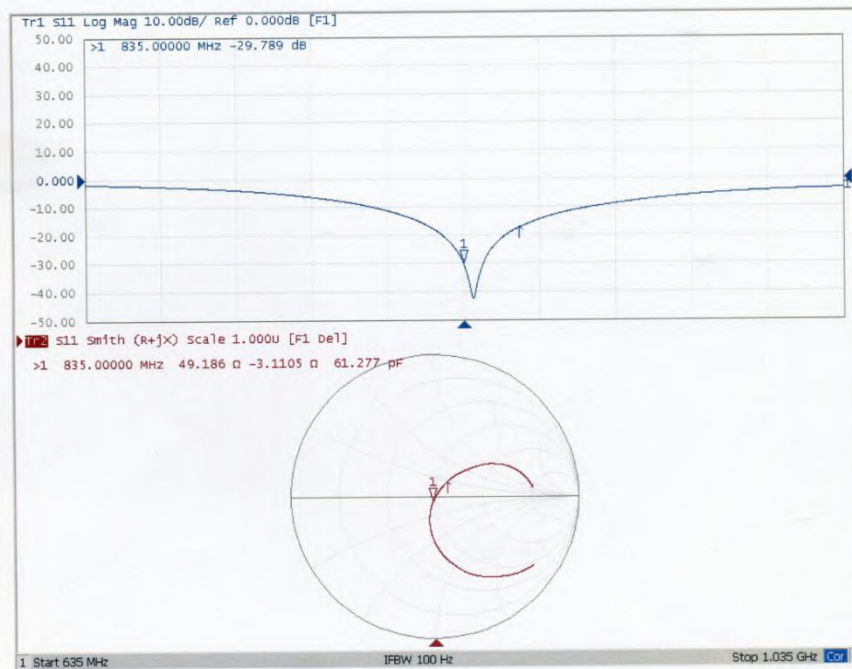
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### Impedance Measurement Plot for Head TSL





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**DASY5 Validation Report for Body TSL**

Date: 06.16.2018

Test Laboratory: CCTL, Beijing, China

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d154**

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

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.991 \text{ S/m}$ ;  $\epsilon_r = 55.41$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Center Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(9.83,9.83, 9.83); Calibrated: 2/19/2018;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2018-02-02
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

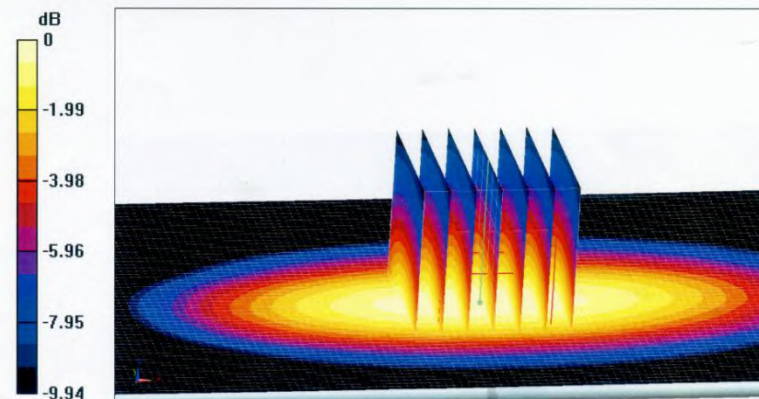
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  
 $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 54.01 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.53 W/kg

**SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.61 W/kg**

Maximum value of SAR (measured) = 3.04 W/kg



Certificate No: Z18-97089

Page 7 of 8

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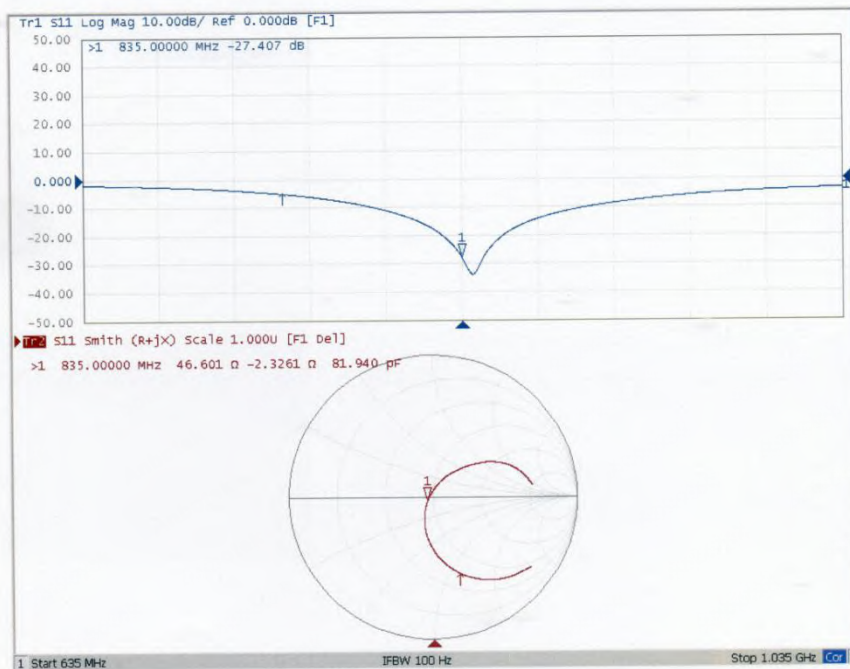
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### Impedance Measurement Plot for Body TSL



Schmid &amp; Partner Engineering AG

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info@speag.com, <http://www.speag.com>

## 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 &amp; Partner Engineering

TN\_BR040315AD DAE4.doc

11.12.2009

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Anbotek (Auden)**

Certificate No: **DAE4-387\_Sep08**

## CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BM - SN: 387**

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

Calibration date: **September 06, 2018**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards             | ID #               | Cal Date (Certificate No.) | Scheduled Calibration  |
|-------------------------------|--------------------|----------------------------|------------------------|
| Keithley Multimeter Type 2001 | SN: 0810278        | 15-Aug-18 (No:21092)       | Aug-19                 |
| Secondary Standards           | ID #               | Check Date (in house)      | Scheduled Check        |
| Auto DAE Calibration Unit     | SE UWS 053 AA 1001 | 05-Jan-18 (in house check) | In house check: Jan-19 |
| Calibrator Box V2.1           | SE UMS 006 AA 1002 | 05-Jan-18 (in house check) | In house check: Jan-19 |

|                |                   |                       |           |
|----------------|-------------------|-----------------------|-----------|
| Calibrated by: | Name              | Function              | Signature |
|                | Dominique Steffen | Laboratory Technician |           |
| Approved by:   | Name              | Function              | Signature |
|                | Sven Kühn         | Deputy Manager        |           |

Issued: September 03, 2018

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Certificate No: DAE4-387\_Sep18

Page 1 of 5

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Accreditation No.: SCS 0108

#### Glossary

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

#### Methods Applied and Interpretation of Parameters

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



#### DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

| Calibration Factors | X                         | Y                         | Z                         |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range          | 404.489 $\pm$ 0.02% (k=2) | 404.852 $\pm$ 0.02% (k=2) | 404.862 $\pm$ 0.02% (k=2) |
| Low Range           | 3.97827 $\pm$ 1.50% (k=2) | 3.95875 $\pm$ 1.50% (k=2) | 3.97982 $\pm$ 1.50% (k=2) |

#### Connector Angle

|                                           |                  |
|-------------------------------------------|------------------|
| Connector Angle to be used in DASY system | 53.0 ° $\pm$ 1 ° |
|-------------------------------------------|------------------|

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

**1. DC Voltage Linearity**

| High Range        | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 200032.85                 | -3.31                        | -0.00     |
| Channel X + Input | 20007.64                  | 1.88                         | 0.01      |
| Channel X - Input | -20003.48                 | 1.18                         | -0.01     |
| Channel Y + Input | 200034.23                 | -1.43                        | -0.00     |
| Channel Y + Input | 20006.60                  | 0.91                         | 0.00      |
| Channel Y - Input | -20004.04                 | 0.72                         | -0.00     |
| Channel Z + Input | 200035.38                 | -0.83                        | -0.00     |
| Channel Z + Input | 20003.69                  | -2.11                        | -0.01     |
| Channel Z - Input | -20006.38                 | -1.59                        | 0.01      |

| Low Range         | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 2001.63                   | 0.08                         | 0.00      |
| Channel X + Input | 202.29                    | 0.70                         | 0.35      |
| Channel X - Input | -197.90                   | 0.60                         | -0.30     |
| Channel Y + Input | 2001.33                   | -0.07                        | -0.00     |
| Channel Y + Input | 200.86                    | -0.60                        | -0.30     |
| Channel Y - Input | -199.87                   | -1.23                        | 0.62      |
| Channel Z + Input | 2001.61                   | 0.27                         | 0.01      |
| Channel Z + Input | 200.60                    | -0.70                        | -0.35     |
| Channel Z - Input | -199.51                   | -0.85                        | 0.43      |

**2. Common mode sensitivity**

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

|           | Common mode Input Voltage (mV) | High Range Average Reading ( $\mu\text{V}$ ) | Low Range Average Reading ( $\mu\text{V}$ ) |
|-----------|--------------------------------|----------------------------------------------|---------------------------------------------|
| Channel X | 200                            | 13.50                                        | 11.56                                       |
|           | -200                           | -8.64                                        | -11.18                                      |
| Channel Y | 200                            | -0.81                                        | -1.28                                       |
|           | -200                           | 1.05                                         | 0.09                                        |
| Channel Z | 200                            | 7.17                                         | 6.91                                        |
|           | -200                           | -9.46                                        | -9.01                                       |

**3. Channel separation**

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

|           | Input Voltage (mV) | Channel X ( $\mu\text{V}$ ) | Channel Y ( $\mu\text{V}$ ) | Channel Z ( $\mu\text{V}$ ) |
|-----------|--------------------|-----------------------------|-----------------------------|-----------------------------|
| Channel X | 200                | -                           | -1.70                       | 0.33                        |
| Channel Y | 200                | 10.70                       | -                           | -0.38                       |
| Channel Z | 200                | 7.11                        | 7.89                        | -                           |

#### 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 | 15969            | 17466           |
| Channel Y | 15661            | 16162           |
| Channel Z | 15990            | 16190           |

#### 5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec  
Input 10M $\Omega$

|           | Average ( $\mu$ V) | min. Offset ( $\mu$ V) | max. Offset ( $\mu$ V) | Std. Deviation ( $\mu$ V) |
|-----------|--------------------|------------------------|------------------------|---------------------------|
| Channel X | 0.73               | -2.58                  | 3.29                   | 0.62                      |
| Channel Y | 0.41               | -0.49                  | 1.23                   | 0.40                      |
| Channel Z | -0.80              | -1.88                  | 0.30                   | 0.42                      |

#### 6. Input Offset Current

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

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

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

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

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

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

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



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Client **Anbotek (Auden)**

Certificate No: **Z16-97090**

### CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d175**

Calibration Procedure(s) **FD-Z11-2-003-01**  
**Calibration Procedures for dipole validation kits**

Calibration date: **Jun 15, 2016**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards      | ID #    | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|------------------------|---------|------------------------------------------|-----------------------|
| Power Meter NRP2       | 101919  | 01-Jul-15 (CTTL, No.J15X04256)           | Jun-16                |
| Power sensor NRP-Z91   | 101547  | 01-Jul-15 (CTTL, No.J15X04256)           | Jun-16                |
| Reference Probe EX3DV4 | SN 7307 | 19-Feb-16(SPEAG,No.EX3-7307_Feb16)       | Feb-17                |
| DAE4                   | SN 771  | 02-Feb-16(CTTL-SPEAG,No.Z16-97011)       | Feb-17                |

| Secondary Standards     | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|------------------------------------------|-----------------------|
| Signal Generator E4438C | MY49071430 | 01-Feb-16 (CTTL, No.J16X00893)           | Jan-17                |
| Network Analyzer E5071C | MY46110673 | 26-Jan-16 (CTTL, No.J16X00894)           | Jan-17                |

|                | Name        | Function                          | Signature |
|----------------|-------------|-----------------------------------|-----------|
| Calibrated by: | Zhao Jing   | SAR Test Engineer                 |           |
| Reviewed by:   | Qi Dianyuan | SAR Project Leader                |           |
| Approved by:   | Lu Bingsong | Deputy Director of the laboratory |           |

Issued: Jun 17, 2016

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Page 1 of 8

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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:**

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) For hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)", February 2005
- 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
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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



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#### Measurement Conditions

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

|                              |                          |             |
|------------------------------|--------------------------|-------------|
| DASY Version                 | DASY52                   | 52.8.8.1258 |
| 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 $\pm$ 1 MHz     |             |

#### Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 40.0           | 1.40 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 40.3 $\pm$ 6 % | 1.38 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | <1.0 °C             | ----           | ----                 |

#### SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL   | Condition          |                                |
|---------------------------------------------------------|--------------------|--------------------------------|
| SAR measured                                            | 250 mW input power | 9.99 mW / g                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 40.4 mW / g $\pm$ 20.8 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | Condition          |                                |
| SAR measured                                            | 250 mW input power | 5.28 mW / g                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 21.3 mW / g $\pm$ 20.4 % (k=2) |

#### Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 53.3           | 1.52 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 53.3 $\pm$ 6 % | 1.54 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | <1.0 °C             | ----           | ----                 |

#### SAR result with Body TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL   | Condition          |                                |
|---------------------------------------------------------|--------------------|--------------------------------|
| SAR measured                                            | 250 mW input power | 10.1 mW / g                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 40.1 mW / g $\pm$ 20.8 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | Condition          |                                |
| SAR measured                                            | 250 mW input power | 5.39 mW / g                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 21.5 mW / g $\pm$ 20.4 % (k=2) |

Certificate No: Z16-97090

Page 3 of 8





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### Appendix

#### Antenna Parameters with Head TSL

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 53.2Ω+ 5.44jΩ |
| Return Loss                          | - 24.3dB      |

#### Antenna Parameters with Body TSL

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 48.9Ω+ 5.75jΩ |
| Return Loss                          | - 24.6dB      |

#### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.304 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: 06.15.2016

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d175**

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

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.381$  S/m;  $\epsilon_r = 40.33$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(8.1, 8.1, 8.1); Calibrated: 2/19/2016;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2/2/2016
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

#### System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:

dx=5mm, dy=5mm, dz=5mm

Reference Value = 103.5V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 18.0W/kg

SAR(1 g) = 9.99 W/kg; SAR(10 g) = 5.28 W/kg

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



Certificate No: Z16-97090

Page 5 of 8

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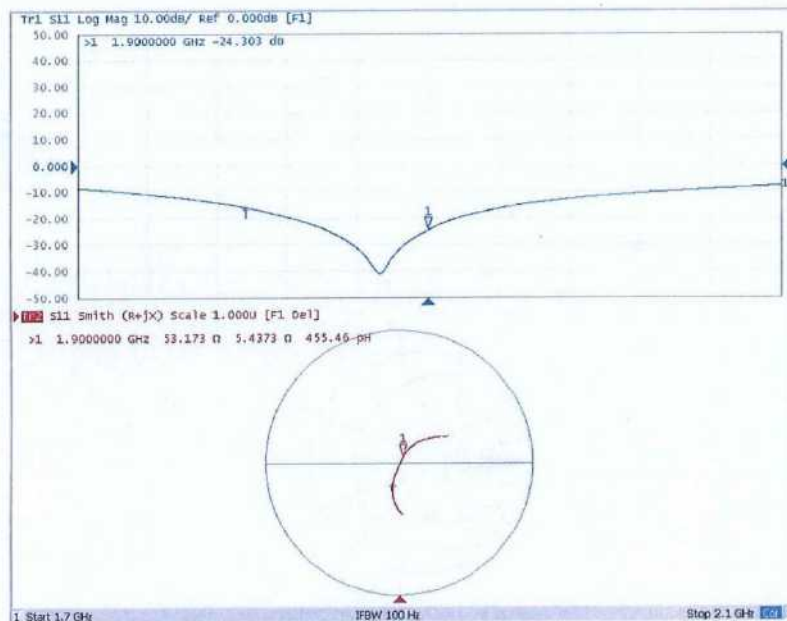
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### Impedance Measurement Plot for Head TSL



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Page 6 of 8





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#### DASY5 Validation Report for Body TSL

Date: 06.15.2016

Test Laboratory: CCTL, Beijing, China

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d175

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

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.537$  S/m;  $\epsilon_r = 53.34$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Center Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(7.67, 7.67, 7.67); Calibrated: 2/19/2016;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2/2/2016
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:

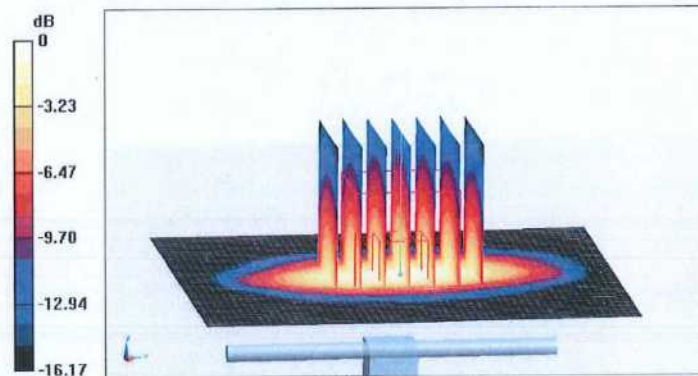
$dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 96.11 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 17.8 W/kg

SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.39 W/kg

Maximum value of SAR (measured) = 14.3 W/kg



Certificate No: Z16-97090

Page 7 of 8

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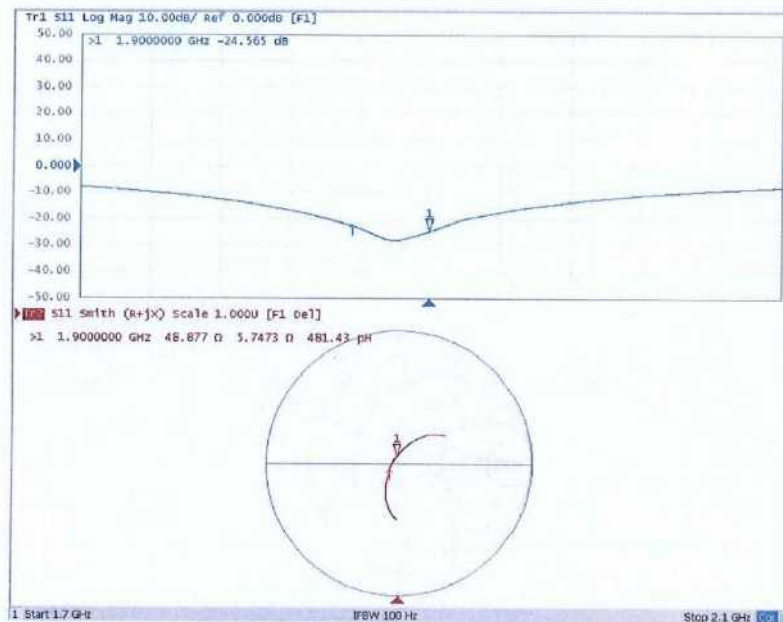
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**Impedance Measurement Plot for Body TSL**



Certificate No: Z16-97090

Page 8 of 8



### Justification of the extended calibration of Dipole D1900V2 SN: 5d179

Per KDB 865664, we have Measured the Impedance and Return Loss as below, and the return loss is  $< -20\text{dB}$ , with 20% of prior calibration; the real or imaginary parts of the impedance is with 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

| Dipole 1900 Head TST                | Target Value                | Measured Value              | Difference                   |
|-------------------------------------|-----------------------------|-----------------------------|------------------------------|
| Impedance transformed to feed point | $51.54\Omega + 3.07j\Omega$ | $51.72\Omega + 3.24j\Omega$ | $R=0.18\Omega, X=0.17\Omega$ |
| Return Loss                         | -29.42dB                    | -30.00dB                    | 1.97%                        |
| Dipole 1900 Body TST                | Target Value                | Measured Value              | Difference                   |
| Impedance transformed to feed point | $48.35\Omega + 4.32j\Omega$ | $49.59\Omega + 6.94j\Omega$ | $R=1.24\Omega, X=2.62\Omega$ |
| Return Loss                         | -26.55dB                    | -26.23dB                    | 1.21%                        |
| Measured Date                       | 2016-06-15                  | 2018-06-04                  | -----                        |
| Impedance Test-Head                 |                             | Return Loss Test-Head       |                              |
|                                     |                             |                             |                              |
| Impedance Test-Body                 |                             | Return Loss Test- Body      |                              |
|                                     |                             |                             |                              |

\*\*\*\*\*END OF REPORT\*\*\*\*\*

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