# FCC SAR Test Report

| | | |
|---|---|---|
| **Report No.** | : | **SA160802C11** |
| **Applicant** | : | **Winmate Inc.** |
| **Address** | : | **9F, No. 111-6, Shing-De Rd., San-Chung Dist., New Taipei City 24158, Taiwan, R.O.C.** |
| **Product** | : | **UMTS/LTE Data Module** |
| **FCC ID** | : | **PX9E430RM** |
| **Brand** | : | **Winmate** |
| **Model No.** | : | **TOBY-L201** |
| **Standards** | : | **FCC 47 CFR Part 2 (2.1093) / IEEE C95.1:1992 / IEEE Std 1528:2013**<br>**KDB 865664 D01 v01r04 / KDB 865664 D02 v01r02**<br>**KDB 447498 D01 v06 / KDB 941225 D01 v03r01 / KDB 941225 D05 v02r05** |
| **Sample Received Date** | : | **Aug. 02, 2016** |
| **Date of Testing** | : | **Nov. 30, 2016** |
| **Lab Address** | : | **No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan, R.O.C.** |
| **Test Location** | : | **No. 19, Hwa Ya 2nd Rd, Wen Hwa Vil, Kwei Shan Dist., Taoyuan City 33383, Taiwan (R.O.C)** |

**CERTIFICATION:** The above equipment have been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch – Lin Kou Laboratories**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by TAF or any government agencies.

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Testing Laboratory
2021

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# Release Control Record

| Report No. | Reason for Change | Date Issued |
|---|---|---|
| SA160802C11 | Initial release | Dec. 06, 2016 |
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# 1. Summary of Maximum SAR Value

| Equipment Class | Mode | Highest Reported Body-worn $SAR_{1g}$ (1.5 cm Gap) (W/kg) |
|---|---|---|
| PCB | WCDMA II | 0.24 |
| | WCDMA V | 0.25 |
| | LTE 2 | 0.29 |
| | LTE 4 | 0.35 |
| | LTE 5 | 0.33 |
| | LTE 13 | 0.46 |
| | LTE 17 | 0.33 |

**Note:**

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

## 2. Description of Equipment Under Test

| | |
|---|---|
| **EUT Type** | UMTS/LTE Data Module |
| **FCC ID** | PX9E430RM |
| **Brand Name** | Winmate |
| **Model Name** | TOBY-L201 |
| **Tx Frequency Bands (Unit: MHz)** | WCDMA Band II : 1852.4 ~ 1907.6<br>WCDMA Band V : 826.4 ~ 846.6<br>LTE Band 2 : 1850.7 ~ 1909.3 (1.4M), 1851.5 ~ 1908.5 (3M), 1852.5 ~ 1907.5 (5M), 1855 ~ 1905 (10M), 1857.5 ~ 1902.5 (15M), 1860 ~ 1900 (20M)<br>LTE Band 4 : 1710.7 ~ 1754.3 (1.4M), 1711.5 ~ 1753.5 (3M), 1712.5 ~ 1752.5 (5M), 1715 ~ 1750 (10M), 1717.5 ~ 1747.5 (15M), 1720 ~ 1745 (20M)<br>LTE Band 5 : 824.7 ~ 848.3 (1.4M), 825.5 ~ 847.5 (3M), 826.5 ~ 846.5 (5M), 829 ~ 844 (10M)<br>LTE Band 13 : 779.5 ~ 784.5 (5M), 782 (10M)<br>LTE Band 17 : 706.5 ~ 713.5 (5M), 709 ~ 711 (10M) |
| **Uplink Modulations** | WCDMA : QPSK<br>LTE : QPSK, 16QAM |
| **Maximum Tune-up Conducted Power (Unit: dBm)** | WCDMA Band II : 23.0<br>WCDMA Band V : 23.0<br>LTE Band 2 : 23.5<br>LTE Band 4 : 24.5<br>LTE Band 5 : 22.5<br>LTE Band 13 : 23.0<br>LTE Band 17 : 23.0 |
| **Antenna Type** | PIFA Antenna |
| **EUT Stage** | Production Unit |

**Note:**

1. The EUT is installed in Elegant Industrial PDA (Brand: Winmate, Model: E430RM4L, XXX430XXXXXXXX (X=A-Z, 0-9, a-z, "-", "/" , "\" or blank))
2. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

**List of Accessory:**

| | | |
|---|---|---|
| **Battery** | **Brand Name** | Winmate |
| | **Model Name** | E430 |
| | **Power Rating** | 3.7Vdc, 3900mAh |
| | **Type** | Li-ion |

# 3. SAR Measurement System

## 3.1 Definition of Specific Absorption Rate (SAR)

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

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

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

SAR is expressed in units of Watts per kilogram (W/kg)
SAR measurement can be related to the electrical field in the tissue by

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

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

## 3.2 SPEAG DASY System

DASY system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY4/5 software defined. The DASY software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.

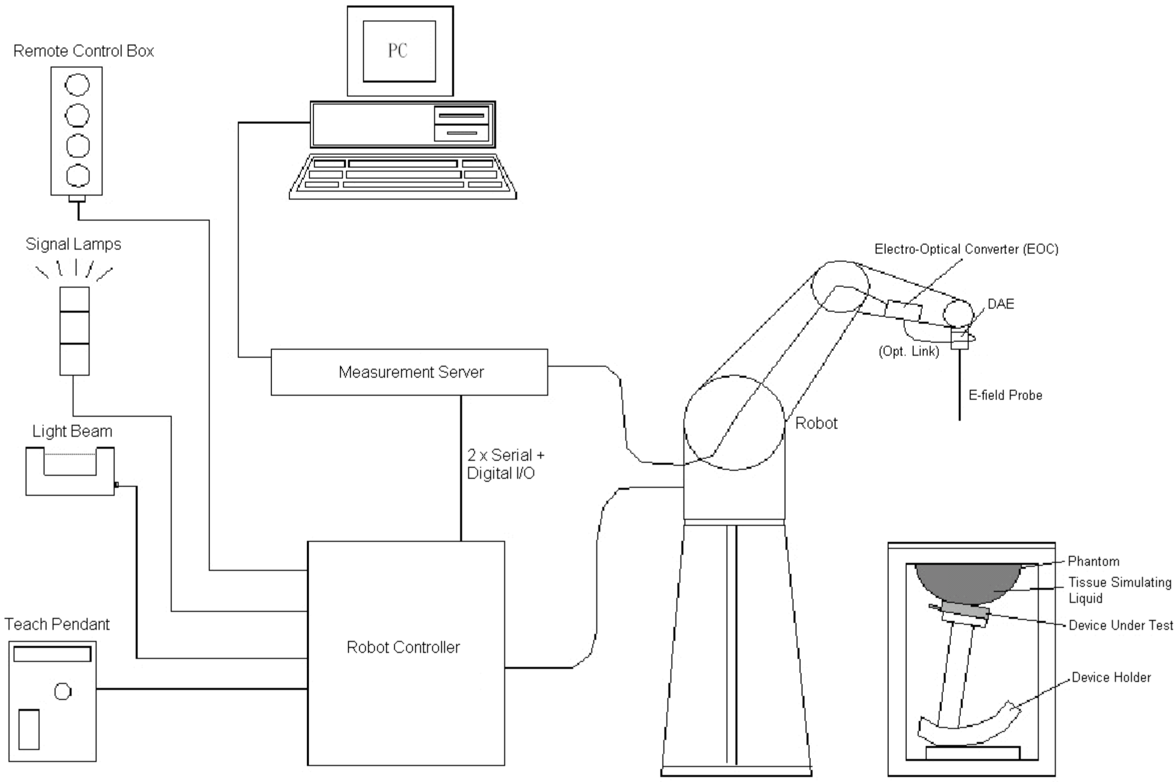



**Fig-3.1 SPEAG DASY52 System Setup**

### 3.2.1 Robot

The SPEAG DASY52 systems use the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version (CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

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

**Fig-3.2 SPEAG DASY52 System**

### 3.2.2 Probes

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

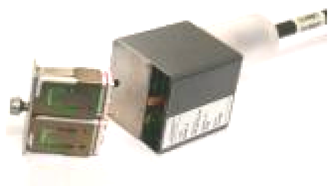
| | |
|---|---|
| **Model** | EX3DV4 |
| **Construction** | Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE). |
| **Frequency** | 10 MHz to 6 GHz<br>Linearity: ± 0.2 dB |
| **Directivity** | ± 0.3 dB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

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

| | |
|---|---|
| **Model** | ET3DV6 |
| **Construction** | Symmetrical design with triangular core Built-in optical fiber for surface detection system.<br>Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |
| **Frequency** | 10 MHz to 2.3 GHz; Linearity: ± 0.2 dB |
| **Directivity** | ± 0.2 dB in TSL (rotation around probe axis)<br>± 0.4 dB in TSL (rotation normal to probe axis) |
| **Dynamic Range** | 5 µW/g to 100 mW/g; Linearity: ± 0.2 dB |
| **Dimensions** | Overall length: 337 mm (Tip: 16 mm)<br>Tip diameter: 6.8 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.7 mm |

### 3.2.3 Data Acquisition Electronics (DAE)

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



### 3.2.4 Phantoms

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

| Model | ELI |
|---|---|
| Construction | Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles. |
| Material | Vinylester, glass fiber reinforced (VE-GF) |
| Shell Thickness | 2.0 ± 0.2 mm (bottom plate) |
| Dimensions | Major axis: 600 mm<br>Minor axis: 400 mm |
| Filling Volume | approx. 30 liters |

### 3.2.5 Device Holder

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

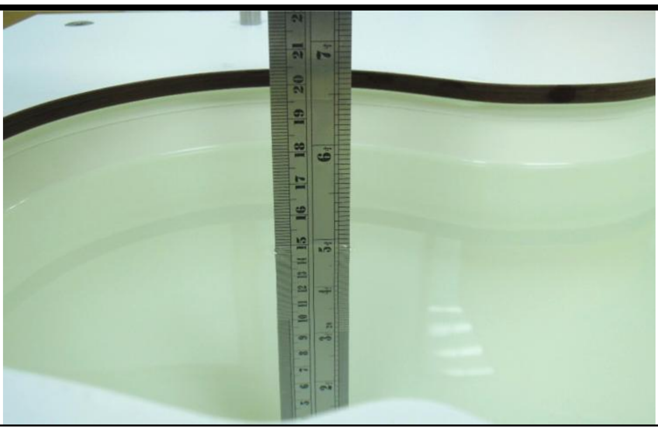
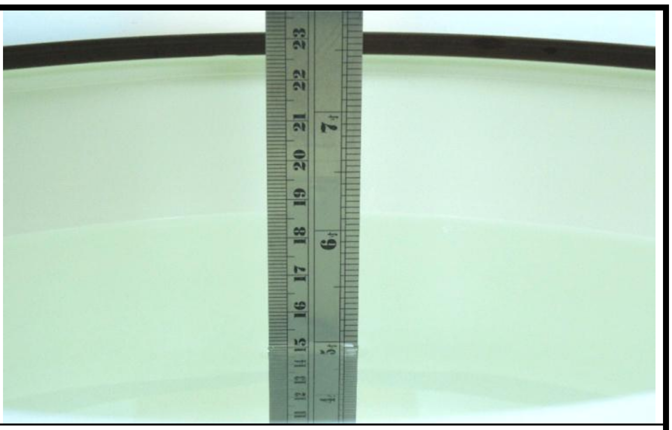
| Model | Laptop Extensions Kit |  |
|---|---|---|
| Construction | Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting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

### 3.2.6 System Validation Dipoles

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

### 3.2.7 Tissue Simulating Liquids

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

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

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

Table-3.1 Targets of Tissue Simulating Liquid

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

The following table gives the recipes for tissue simulating liquids.

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

| Tissue Type | Bactericide | DGBE | HEC | NaCl | Sucrose | Triton X-100 | Water | Diethylene Glycol Mono-hexylether |
|---|---|---|---|---|---|---|---|---|
| H750 | 0.2 | - | 0.2 | 1.5 | 56.0 | - | 42.1 | - |
| H835 | 0.2 | - | 0.2 | 1.5 | 57.0 | - | 41.1 | - |
| H900 | 0.2 | - | 0.2 | 1.4 | 58.0 | - | 40.2 | - |
| H1450 | - | 43.3 | - | 0.6 | - | - | 56.1 | - |
| H1640 | - | 45.8 | - | 0.5 | - | - | 53.7 | - |
| H1750 | - | 47.0 | - | 0.4 | - | - | 52.6 | - |
| H1800 | - | 44.5 | - | 0.3 | - | - | 55.2 | - |
| H1900 | - | 44.5 | - | 0.2 | - | - | 55.3 | - |
| H2000 | - | 44.5 | - | 0.1 | - | - | 55.4 | - |
| H2300 | - | 44.9 | - | 0.1 | - | - | 55.0 | - |
| H2450 | - | 45.0 | - | 0.1 | - | - | 54.9 | - |
| H2600 | - | 45.1 | - | 0.1 | - | - | 54.8 | - |
| H3500 | - | 8.0 | - | 0.2 | - | 20.0 | 71.8 | - |
| H5G | - | - | - | - | - | 17.2 | 65.5 | 17.3 |
| B750 | 0.2 | - | 0.2 | 0.8 | 48.8 | - | 50.0 | - |
| B835 | 0.2 | - | 0.2 | 0.9 | 48.5 | - | 50.2 | - |
| B900 | 0.2 | - | 0.2 | 0.9 | 48.2 | - | 50.5 | - |
| B1450 | - | 34.0 | - | 0.3 | - | - | 65.7 | - |
| B1640 | - | 32.5 | - | 0.3 | - | - | 67.2 | - |
| B1750 | - | 31.0 | - | 0.2 | - | - | 68.8 | - |
| B1800 | - | 29.5 | - | 0.4 | - | - | 70.1 | - |
| B1900 | - | 29.5 | - | 0.3 | - | - | 70.2 | - |
| B2000 | - | 30.0 | - | 0.2 | - | - | 69.8 | - |
| B2300 | - | 31.0 | - | 0.1 | - | - | 68.9 | - |
| B2450 | - | 31.4 | - | 0.1 | - | - | 68.5 | - |
| B2600 | - | 31.8 | - | 0.1 | - | - | 68.1 | - |
| B3500 | - | 28.8 | - | 0.1 | - | - | 71.1 | - |
| B5G | - | - | - | - | - | 10.7 | 78.6 | 10.7 |

## 3.3 SAR System Verification

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

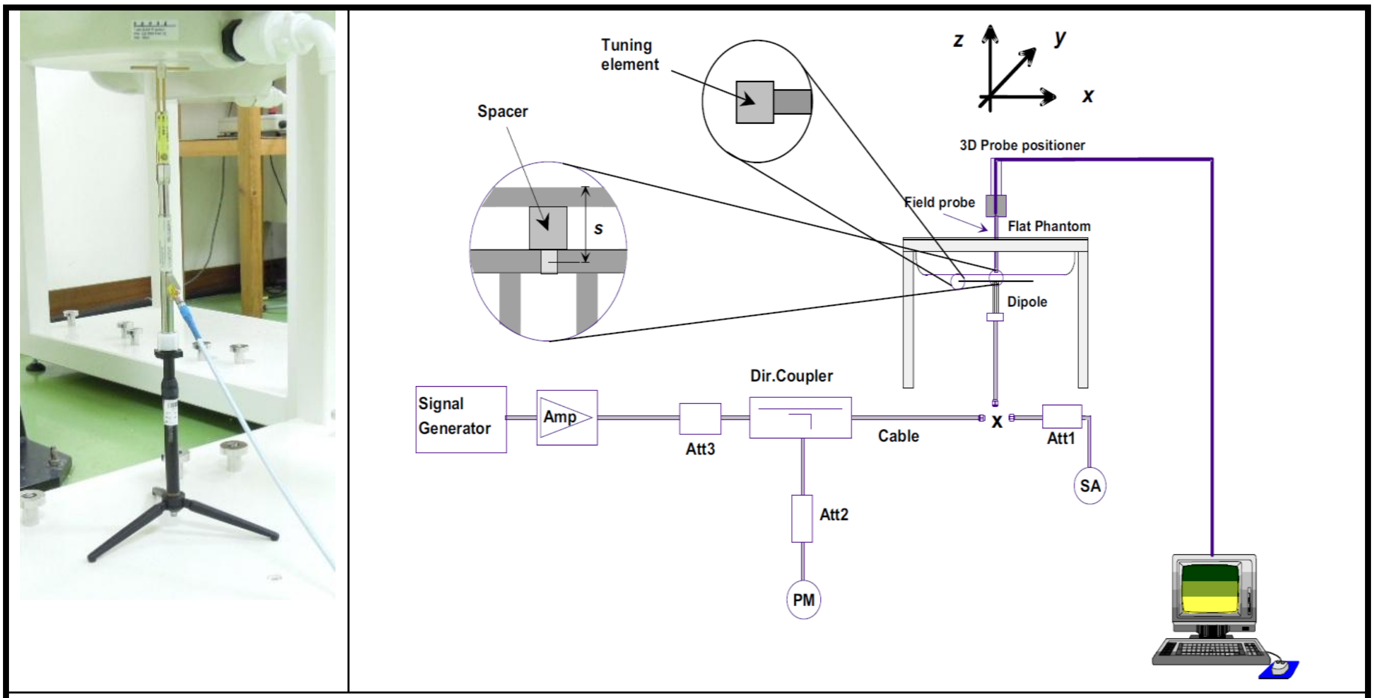



**Fig-3.3 System Verification Setup**

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

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

## 3.4 SAR Measurement Procedure

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

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

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

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

### 3.4.1 Area & Zoom Scan Procedure

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

| Items | <= 2 GHz | 2-3 GHz | 3-4 GHz | 4-5 GHz | 5-6 GHz |
|---|---|---|---|---|---|
| Area Scan ($\Delta x$, $\Delta y$) | <= 15 mm | <= 12 mm | <= 12 mm | <= 10 mm | <= 10 mm |
| Zoom Scan ($\Delta x$, $\Delta y$) | <= 8 mm | <= 5 mm | <= 5 mm | <= 4 mm | <= 4 mm |
| Zoom Scan ($\Delta z$) | <= 5 mm | <= 5 mm | <= 4 mm | <= 3 mm | <= 2 mm |
| Zoom Scan Volume | >= 30 mm | >= 30 mm | >= 28 mm | >= 25 mm | >= 22 mm |

**Note:**

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

### 3.4.2 Volume Scan Procedure

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

### 3.4.3 Power Drift Monitoring

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

### 3.4.4 Spatial Peak SAR Evaluation

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

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

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

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

### 3.4.5 SAR Averaged Methods

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

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

# 4. SAR Measurement Evaluation

## 4.1 EUT Configuration and Setting

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

For WWAN SAR testing, the EUT was linked and controlled by base station emulator (Agilent E5515C is used for GSM/WCDMA/CDMA, and Anritsu MT8820C is used for LTE). Communication between the EUT and the emulator was established by air link. The distance between the EUT and the communicating antenna of the emulator is larger than 50 cm and the output power radiated from the emulator antenna is at least 30 dB smaller than the output power of EUT. The EUT was set from the emulator to radiate maximum output power during SAR testing.

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

**Release 5 HSDPA Data Devices**

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

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

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

**HSPA+ SAR Guidance**

The 3G SAR test reduction procedure is applied to HSPA+ (uplink) with 12.2 kbps RMC as the primary mode. Otherwise, when SAR is required for Rel. 6 HSPA, SAR is required for Rel. 7 HSPA+. Power is measured for HSPA+ that supports uplink 16QAM according to configurations in Table C.11.1.4 of 3GPP TS 34.121-1 to determine SAR test reduction.

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

This device contains LTE transmitter which follows 3GPP standards, is category 3, supports both QPSK and 16QAM modulations, and supported LTE band and channel bandwidth is listed in below. The output power was tested per 3GPP TS 36.521-1 maximum transmit procedures for both QPSK and 16QAM modulation. The results please refer to section 4.6 of this report.

| EUT Supported LTE Band and Channel Bandwidth | | | | | | |
|---|---|---|---|---|---|---|
| LTE Band | BW 1.4 MHz | BW 3 MHz | BW 5 MHz | BW 10 MHz | BW 15 MHz | BW 20 MHz |
| 2 | V | V | V | V | V | V |
| 4 | V | V | V | V | V | V |
| 5 | V | V | V | V | | |
| 13 | | | V | V | | |
| 17 | | | V | V | | |

The LTE maximum power reduction (MPR) in accordance with 3GPP TS 36.101 is active all times during LTE operation. The allowed MPR for the maximum output power is specified in below.

| Modulation | Channel Bandwidth / RB Configurations | | | | | | LTE MPR Setting (dB) |
|---|---|---|---|---|---|---|---|
| | BW 1.4 MHz | BW 3 MHz | BW 5 MHz | BW 10 MHz | BW 15 MHz | BW 20 MHz | |
| QPSK | > 5 | > 4 | > 8 | > 12 | > 16 | > 18 | 1 |
| 16QAM | <= 5 | <= 4 | <= 8 | <= 12 | <= 16 | <= 18 | 1 |
| 16QAM | > 5 | > 4 | > 8 | > 12 | > 16 | > 18 | 2 |

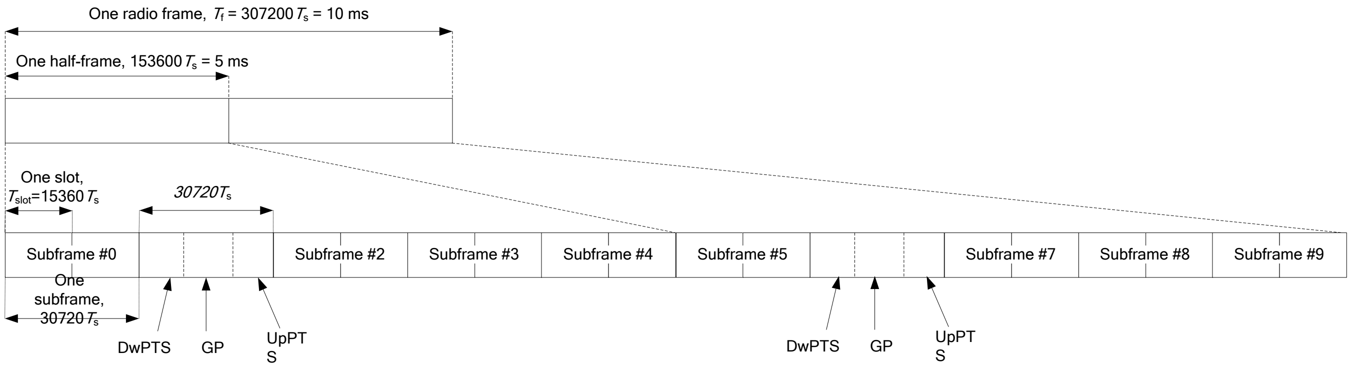
**Note:** MPR is according to the standard and implemented in the circuit (mandatory).

In addition, the device is compliant with additional maximum power reduction (A-MPR) requirements defined in 3GPP TS 36.101 section 6.2.4 that was disabled for all FCC compliance testing.

During LTE SAR testing, the related parameters of operating band, channel bandwidth, uplink channel number, modulation type, and RB was set in base station simulator. When the EUT has registered and communicated to base station simulator, the simulator set to make EUT transmitting the maximum radiated power.

**TDD-LTE Setup Configurations**

According to KDB 941225 D05, SAR testing for TDD-LTE device must be tested using a fixed periodic duty factor according to the highest transmission duty factor implemented for the device and supported by the defined 3GPP TDD-LTE configurations. The TDD-LTE of this device supports frame structure type 2 defined in 3GPP TS 36.211 section 4.2, and the frame structure configuration can be referred to below.




**3GPP TS 36.211 Figure 4.2-1: Frame Structure Type 2**

<table>
<tr><th rowspan="3">Special Subframe Configuration</th><th colspan="3">Normal Cyclic Prefix in Downlink</th><th colspan="3">Extended Cyclic Prefix in Downlink</th></tr>
<tr><th rowspan="2">DwPTS</th><th colspan="2">UpPTS</th><th rowspan="2">DwPTS</th><th colspan="2">UpPTS</th></tr>
<tr><th>Normal Cyclic Prefix in Uplink</th><th>Extended Cyclic Prefix in Uplink</th><th>Normal Cyclic Prefix in Uplink</th><th>Extended Cyclic Prefix in Uplink</th></tr>
<tr><td>0</td><td>6592 • Ts</td><td rowspan="5">2192 • Ts</td><td rowspan="5">2560 • Ts</td><td>7680 • Ts</td><td rowspan="4">2192 • Ts</td><td rowspan="4">2560 • Ts</td></tr>
<tr><td>1</td><td>19760 • Ts</td><td>20480 • Ts</td></tr>
<tr><td>2</td><td>21952 • Ts</td><td>23040 • Ts</td></tr>
<tr><td>3</td><td>24144 • Ts</td><td>25600 • Ts</td></tr>
<tr><td>4</td><td>26336 • Ts</td><td>7680 • Ts</td><td rowspan="4">4384 • Ts</td><td rowspan="4">5120 • Ts</td></tr>
<tr><td>5</td><td>6592 • Ts</td><td rowspan="5">4384 • Ts</td><td rowspan="5">5120 • Ts</td><td>20480 • Ts</td></tr>
<tr><td>6</td><td>19760 • Ts</td><td>23040 • Ts</td></tr>
<tr><td>7</td><td>21952 • Ts</td><td>12800 • Ts</td></tr>
<tr><td>8</td><td>24144 • Ts</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>9</td><td>13168 • Ts</td><td>-</td><td>-</td><td>-</td></tr>
</table>

**3GPP TS 36.211 Table 4.2-1: Configuration of Special Subframe**

| Uplink-Downlink Configuration | Downlink-to-Uplink Switch-Point Periodicity | Subframe Number | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | 5 ms | D | S | U | U | U | D | S | U | U | U |
| 1 | 5 ms | D | S | U | U | D | D | S | U | U | D |
| 2 | 5 ms | D | S | U | D | D | D | S | U | D | D |
| 3 | 10 ms | D | S | U | U | U | D | D | D | D | D |
| 4 | 10 ms | D | S | U | U | D | D | D | D | D | D |
| 5 | 10 ms | D | S | U | D | D | D | D | D | D | D |
| 6 | 5 ms | D | S | U | U | U | D | S | U | U | D |

**3GPP TS 36.211 Table 4.2-2: Uplink-Downlink Configurations**

The variety of different TD-LTE uplink-downlink configurations allows a network operator to allocate the network's capacity between uplink and downlink traffic to meet the needs of the network. The uplink duty cycle of these seven configurations can readily be computed and shown in below.

| UL-DL Configuration | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Highest Duty-Cycle | 63.33% | 43.33% | 23.33% | 31.67% | 21.67% | 11.67% | 53.33% |

Considering the highest transmission duty cycle, TDD-LTE was tested using Uplink-Downlink Configuration 0 with 6 uplink subframe and 2 special subframe. The special subframe was set to special subframe configuration 7 using extended cyclic prefix uplink. Therefore, SAR testing for TDD-LTE was performed at the maximum output power with highest transmission duty cycle of 63.33%.

## 4.2 EUT Testing Position

### 4.2.1 Body-worn Accessory Exposure Conditions

Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in KDB 447498 D01 are used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

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

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

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

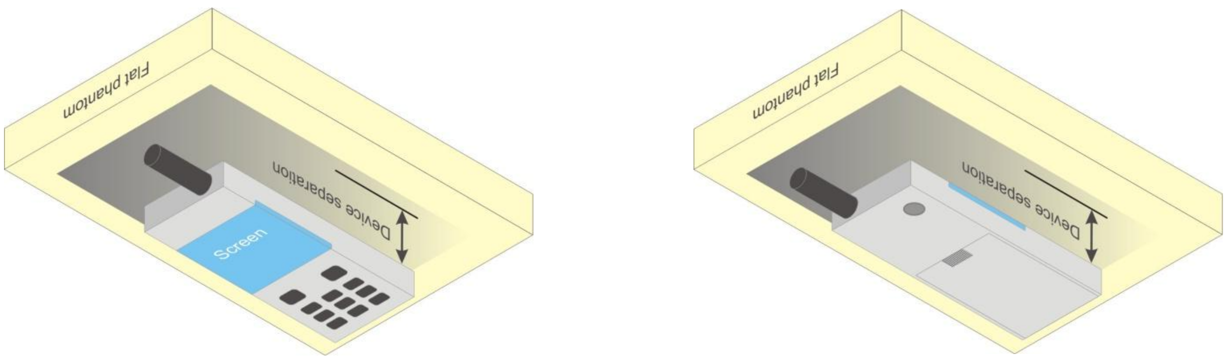



**Fig-4.1 Illustration for Body Worn Position**

## 4.3 Tissue Verification

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

| Test Date | Tissue Type | Frequency (MHz) | Liquid Temp. (℃) | Measured Conductivity (σ) | Measured Permittivity ($\varepsilon_r$) | Target Conductivity (σ) | Target Permittivity ($\varepsilon_r$) | Conductivity Deviation (%) | Permittivity Deviation (%) |
|---|---|---|---|---|---|---|---|---|---|
| Nov. 30, 2016 | Body | 750 | 23.4 | 0.960 | 56.414 | 0.96 | 55.5 | 0.00 | 1.65 |
| Nov. 30, 2016 | Body | 835 | 23.4 | 1.013 | 54.670 | 0.97 | 55.2 | 4.43 | -0.96 |
| Nov. 30, 2016 | Body | 1750 | 23.4 | 1.444 | 51.451 | 1.49 | 53.4 | -3.09 | -3.65 |
| Nov. 30, 2016 | Body | 1900 | 23.3 | 1.575 | 51.005 | 1.52 | 53.3 | 3.62 | -4.31 |

**Note:**

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

## 4.4 System Validation

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

| Test Date | Probe S/N | Calibration Point | | Measured Conductivity (σ) | Measured Permittivity ($\varepsilon_r$) | Validation for CW | | | Validation for Modulation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Sensitivity Range | Probe Linearity | Probe Isotropy | Modulation Type | Duty Factor | PAR |
| Nov. 30, 2016 | 1790 | Body | 750 | 0.960 | 56.414 | Pass | Pass | Pass | N/A | N/A | N/A |
| Nov. 30, 2016 | 1790 | Body | 835 | 1.013 | 54.670 | Pass | Pass | Pass | N/A | N/A | N/A |
| Nov. 30, 2016 | 1790 | Body | 1750 | 1.444 | 51.451 | Pass | Pass | Pass | N/A | N/A | N/A |
| Nov. 30, 2016 | 1790 | Body | 1900 | 1.575 | 51.005 | Pass | Pass | Pass | N/A | N/A | N/A |

## 4.5 System Verification

The measuring result for system verification is tabulated as below.

| Test Date | Mode | Frequency (MHz) | 1W Target SAR-1g (W/kg) | Measured SAR-1g (W/kg) | Normalized to 1W SAR-1g (W/kg) | Deviation (%) | Dipole S/N | Probe S/N | DAE S/N |
|---|---|---|---|---|---|---|---|---|---|
| Nov. 30, 2016 | Body | 750 | 8.77 | 2.13 | 8.52 | -2.85 | 1013 | 1790 | 1277 |
| Nov. 30, 2016 | Body | 835 | 9.57 | 2.22 | 8.88 | -7.21 | 4d121 | 1790 | 1277 |
| Nov. 30, 2016 | Body | 1750 | 37.50 | 8.77 | 35.08 | -6.45 | 1055 | 1790 | 1277 |
| Nov. 30, 2016 | Body | 1900 | 40.70 | 9.82 | 39.28 | -3.49 | 5d036 | 1790 | 1277 |

**Note:**

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

## 4.6 Maximum Output Power

### 4.6.1 Maximum Conducted Power

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

| Mode | WCDMA Band II | WCDMA Band V |
|---|---|---|
| RMC 12.2K | 23.0 | 23.0 |
| HSDPA | 23.0 | 23.0 |
| HSUPA | 22.5 | 22.5 |

| Mode | LTE 2 | LTE 4 | LTE 5 | LTE 13 | LTE 17 |
|---|---|---|---|---|---|
| QPSK / 16QAM | 23.5 | 24.5 | 22.5 | 23.0 | 23.0 |

### 4.6.2 Measured Conducted Power Result

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

| Band | WCDMA Band II | | | WCDMA Band V | | | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|
| Channel | 9262 | 9400 | 9538 | 4132 | 4182 | 4233 | |
| Frequency (MHz) | 1852.4 | 1880.0 | 1907.6 | 826.4 | 836.4 | 846.6 | |
| RMC 12.2K | 21.67 | 22.73 | **22.99** | 22.58 | 22.20 | **22.70** | - |
| HSDPA Subtest-1 | 21.55 | 22.58 | 22.85 | 22.49 | 22.10 | 22.60 | 0 |
| HSDPA Subtest-2 | 21.51 | 22.51 | 22.77 | 22.45 | 22.09 | 22.53 | 0 |
| HSDPA Subtest-3 | 21.05 | 22.07 | 22.34 | 21.97 | 21.62 | 22.08 | 0.5 |
| HSDPA Subtest-4 | 21.09 | 22.12 | 22.34 | 21.96 | 21.62 | 22.08 | 0.5 |
| HSUPA Subtest-1 | 21.51 | 21.99 | 22.28 | 21.67 | 21.73 | 22.02 | 0 |
| HSUPA Subtest-2 | 19.39 | 20.48 | 20.63 | 20.06 | 20.11 | 20.51 | 2 |
| HSUPA Subtest-3 | 20.02 | 20.80 | 21.11 | 20.45 | 20.25 | 21.01 | 1 |
| HSUPA Subtest-4 | 19.63 | 20.53 | 21.00 | 20.14 | 19.92 | 20.46 | 2 |
| HSUPA Subtest-5 | 21.18 | 22.30 | 22.46 | 22.13 | 21.67 | 22.23 | 0 |

| LTE Band / BW | RB Size | RB Offset | QPSK | | | 3GPP MPR (dB) | 16QAM | | | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low CH 18607 | Mid CH 18900 | High CH 19193 | | Low CH 18607 | Mid CH 18900 | High CH 19193 | |
| | | | 1850.7 MHz | 1880.0 MHz | 1909.3 MHz | | 1850.7 MHz | 1880.0 MHz | 1909.3 MHz | |
| 2 / 1.4M | 1 | 0 | 21.78 | 22.90 | 21.65 | 0 | 20.55 | 21.71 | 20.90 | 1 |
| | 1 | 2 | 21.54 | 22.39 | 22.24 | 0 | 20.61 | 21.02 | 20.91 | 1 |
| | 1 | 5 | 22.49 | 21.52 | 22.68 | 0 | 21.66 | 20.53 | 21.24 | 1 |
| | 3 | 0 | 21.52 | 21.89 | 21.63 | 0 | 20.51 | 21.52 | 20.52 | 1 |
| | 3 | 1 | 21.56 | 21.53 | 22.19 | 0 | 20.52 | 21.16 | 20.92 | 1 |
| | 3 | 3 | 22.05 | 22.10 | 21.88 | 0 | 20.55 | 20.81 | 21.46 | 1 |
| | 6 | 0 | 20.79 | 21.52 | 21.24 | 1 | 19.51 | 20.16 | 19.94 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK | | | 3GPP MPR (dB) | 16QAM | | | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low CH 18615 | Mid CH 18900 | High CH 19185 | | Low CH 18615 | Mid CH 18900 | High CH 19185 | |
| | | | 1851.5 MHz | 1880.0 MHz | 1908.5 MHz | | 1851.5 MHz | 1880.0 MHz | 1908.5 MHz | |
| 2 / 3M | 1 | 0 | 21.79 | 22.91 | 21.66 | 0 | 20.57 | 21.73 | 20.92 | 1 |
| | 1 | 7 | 21.55 | 22.40 | 22.25 | 0 | 20.63 | 21.04 | 20.93 | 1 |
| | 1 | 14 | 22.50 | 21.53 | 22.69 | 0 | 21.68 | 20.55 | 21.26 | 1 |
| | 8 | 0 | 20.53 | 21.90 | 20.64 | 1 | 19.51 | 20.54 | 19.54 | 2 |
| | 8 | 3 | 20.57 | 21.54 | 21.20 | 1 | 19.52 | 20.18 | 19.94 | 2 |
| | 8 | 7 | 21.06 | 21.11 | 21.89 | 1 | 19.57 | 19.83 | 20.48 | 2 |
| | 15 | 0 | 20.80 | 21.53 | 21.25 | 1 | 19.53 | 20.18 | 19.96 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK | | | 3GPP MPR (dB) | 16QAM | | | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low CH 18625 | Mid CH 18900 | High CH 19175 | | Low CH 18625 | Mid CH 18900 | High CH 19175 | |
| | | | 1852.5 MHz | 1880.0 MHz | 1907.5 MHz | | 1852.5 MHz | 1880.0 MHz | 1907.5 MHz | |
| 2 / 5M | 1 | 0 | 21.87 | 22.99 | 21.74 | 0 | 20.65 | 21.81 | 21.00 | 1 |
| | 1 | 12 | 21.51 | 22.48 | 22.33 | 0 | 20.71 | 21.12 | 21.01 | 1 |
| | 1 | 24 | 22.58 | 21.61 | 22.77 | 0 | 21.76 | 20.63 | 21.34 | 1 |
| | 12 | 0 | 20.61 | 21.98 | 20.72 | 1 | 19.51 | 20.62 | 19.61 | 2 |
| | 12 | 6 | 20.65 | 21.62 | 21.28 | 1 | 19.56 | 20.26 | 20.02 | 2 |
| | 12 | 13 | 21.14 | 21.19 | 21.97 | 1 | 19.65 | 19.91 | 20.56 | 2 |
| | 25 | 0 | 20.88 | 21.61 | 21.33 | 1 | 19.55 | 20.26 | 20.04 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK | | | 3GPP MPR (dB) | 16QAM | | | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Low CH 18650 | Mid CH 18900 | High CH 19150 | | Low CH 18650 | Mid CH 18900 | High CH 19150 | |
| | | | 1855.0 MHz | 1880.0 MHz | 1905.0 MHz | | 1855.0 MHz | 1880.0 MHz | 1905.0 MHz | |
| 2 / 10M | 1 | 0 | 21.95 | 23.07 | 21.82 | 0 | 20.73 | 21.89 | 21.08 | 1 |
| | 1 | 24 | 21.59 | 22.56 | 22.41 | 0 | 20.79 | 21.20 | 21.09 | 1 |
| | 1 | 49 | 22.66 | 21.69 | 22.85 | 0 | 21.84 | 20.71 | 21.42 | 1 |
| | 25 | 0 | 20.69 | 22.06 | 20.80 | 1 | 19.51 | 20.70 | 19.60 | 2 |
| | 25 | 12 | 20.73 | 21.70 | 21.36 | 1 | 19.52 | 20.34 | 20.10 | 2 |
| | 25 | 25 | 21.22 | 21.27 | 22.05 | 1 | 19.73 | 19.99 | 20.64 | 2 |
| | 50 | 0 | 20.96 | 21.69 | 21.41 | 1 | 19.55 | 20.34 | 20.12 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 18675 1857.5 MHz | QPSK Mid CH 18900 1880.0 MHz | QPSK High CH 19125 1902.5 MHz | 3GPP MPR (dB) | 16QAM Low CH 18675 1857.5 MHz | 16QAM Mid CH 18900 1880.0 MHz | 16QAM High CH 19125 1902.5 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 / 15M | 1 | 0 | 22.04 | 23.16 | 21.91 | 0 | 20.82 | 21.98 | 21.17 | 1 |
| | 1 | 37 | 21.68 | 22.65 | 22.50 | 0 | 20.88 | 21.29 | 21.18 | 1 |
| | 1 | 74 | 22.75 | 21.78 | 22.94 | 0 | 21.93 | 20.80 | 21.51 | 1 |
| | 36 | 0 | 20.78 | 22.15 | 20.89 | 1 | 19.55 | 20.79 | 19.57 | 2 |
| | 36 | 19 | 20.82 | 21.79 | 21.45 | 1 | 19.65 | 20.43 | 20.19 | 2 |
| | 36 | 39 | 21.31 | 21.36 | 22.14 | 1 | 19.82 | 20.08 | 20.73 | 2 |
| | 75 | 0 | 21.05 | 21.78 | 21.50 | 1 | 19.52 | 20.43 | 20.21 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 18700 1860.0 MHz | QPSK Mid CH 18900 1880.0 MHz | QPSK High CH 19100 1900.0 MHz | 3GPP MPR (dB) | 16QAM Low CH 18700 1860.0 MHz | 16QAM Mid CH 18900 1880.0 MHz | 16QAM High CH 19100 1900.0 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 / 20M | 1 | 0 | 22.15 | **23.27** | 22.02 | 0 | 20.93 | 22.09 | 21.28 | 1 |
| | 1 | 50 | 21.79 | 22.76 | 22.61 | 0 | 20.99 | 21.40 | 21.29 | 1 |
| | 1 | 99 | 22.86 | 21.89 | 23.05 | 0 | 22.04 | 20.91 | 21.62 | 1 |
| | 50 | 0 | 20.89 | 22.26 | 21.00 | 1 | 19.60 | 20.90 | 19.68 | 2 |
| | 50 | 25 | 20.93 | 21.90 | 21.56 | 1 | 19.70 | 20.54 | 20.30 | 2 |
| | 50 | 50 | 21.42 | 21.47 | 22.25 | 1 | 19.93 | 20.19 | 20.84 | 2 |
| | 100 | 0 | 21.16 | 21.89 | 21.61 | 1 | 19.63 | 20.54 | 20.32 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 19957 1710.7 MHz | QPSK Mid CH 20175 1732.5 MHz | QPSK High CH 20393 1754.3 MHz | 3GPP MPR (dB) | 16QAM Low CH 19957 1710.7 MHz | 16QAM Mid CH 20175 1732.5 MHz | 16QAM High CH 20393 1754.3 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 / 1.4M | 1 | 0 | 22.78 | 23.93 | 22.95 | 0 | 21.79 | 22.87 | 22.36 | 1 |
| | 1 | 2 | 23.49 | 22.95 | 22.55 | 0 | 22.26 | 21.83 | 21.56 | 1 |
| | 1 | 5 | 23.24 | 22.61 | 23.34 | 0 | 22.46 | 21.55 | 21.77 | 1 |
| | 3 | 0 | 22.54 | 22.66 | 22.53 | 0 | 21.54 | 21.56 | 21.55 | 1 |
| | 3 | 1 | 22.58 | 22.51 | 22.52 | 0 | 21.51 | 21.52 | 21.53 | 1 |
| | 3 | 3 | 22.59 | 22.51 | 22.52 | 0 | 21.51 | 21.52 | 21.53 | 1 |
| | 6 | 0 | 22.46 | 22.21 | 21.58 | 1 | 21.03 | 20.82 | 20.51 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 19965 1711.5 MHz | QPSK Mid CH 20175 1732.5 MHz | QPSK High CH 20385 1753.5 MHz | 3GPP MPR (dB) | 16QAM Low CH 19965 1711.5 MHz | 16QAM Mid CH 20175 1732.5 MHz | 16QAM High CH 20385 1753.5 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 / 3M | 1 | 0 | 22.82 | 23.97 | 22.99 | 0 | 21.83 | 22.91 | 22.40 | 1 |
| | 1 | 7 | 23.53 | 22.99 | 22.51 | 0 | 22.30 | 21.87 | 21.52 | 1 |
| | 1 | 14 | 23.28 | 22.65 | 23.38 | 0 | 22.50 | 21.51 | 21.81 | 1 |
| | 8 | 0 | 22.38 | 22.70 | 21.57 | 1 | 20.98 | 21.37 | 21.47 | 2 |
| | 8 | 3 | 22.62 | 22.22 | 22.48 | 1 | 21.24 | 20.83 | 21.42 | 2 |
| | 8 | 7 | 22.63 | 21.79 | 21.71 | 1 | 21.28 | 21.43 | 20.61 | 2 |
| | 15 | 0 | 22.50 | 22.25 | 21.62 | 1 | 21.07 | 20.86 | 20.52 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 19975 1712.5 MHz | QPSK Mid CH 20175 1732.5 MHz | QPSK High CH 20375 1752.5 MHz | 3GPP MPR (dB) | 16QAM Low CH 19975 1712.5 MHz | 16QAM Mid CH 20175 1732.5 MHz | 16QAM High CH 20375 1752.5 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 / 5M | 1 | 0 | 22.86 | 24.01 | 23.03 | 0 | 21.87 | 22.95 | 22.44 | 1 |
| | 1 | 12 | 23.57 | 23.03 | 22.51 | 0 | 22.34 | 21.91 | 21.54 | 1 |
| | 1 | 24 | 23.32 | 22.69 | 23.42 | 0 | 22.54 | 21.52 | 21.85 | 1 |
| | 12 | 0 | 22.42 | 22.74 | 21.61 | 1 | 21.02 | 21.41 | 21.51 | 2 |
| | 12 | 6 | 22.66 | 22.26 | 22.52 | 1 | 21.28 | 20.87 | 21.46 | 2 |
| | 12 | 13 | 22.67 | 21.83 | 21.75 | 1 | 21.32 | 21.47 | 20.65 | 2 |
| | 25 | 0 | 22.54 | 22.29 | 21.66 | 1 | 21.11 | 20.90 | 20.56 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 20000 1715.0 MHz | QPSK Mid CH 20175 1732.5 MHz | QPSK High CH 20350 1750.0 MHz | 3GPP MPR (dB) | 16QAM Low CH 20000 1715.0 MHz | 16QAM Mid CH 20175 1732.5 MHz | 16QAM High CH 20350 1750.0 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 / 10M | 1 | 0 | 22.91 | 24.06 | 23.08 | 0 | 21.92 | 23.00 | 22.49 | 1 |
| | 1 | 24 | 23.62 | 23.08 | 22.51 | 0 | 22.39 | 21.96 | 21.59 | 1 |
| | 1 | 49 | 23.37 | 22.74 | 23.47 | 0 | 22.59 | 21.54 | 21.90 | 1 |
| | 25 | 0 | 22.47 | 22.79 | 21.66 | 1 | 21.07 | 21.46 | 20.54 | 2 |
| | 25 | 12 | 22.71 | 22.31 | 21.55 | 1 | 21.33 | 20.92 | 21.51 | 2 |
| | 25 | 25 | 22.72 | 21.88 | 21.80 | 1 | 21.37 | 21.52 | 20.70 | 2 |
| | 50 | 0 | 22.59 | 22.34 | 21.71 | 1 | 21.16 | 20.95 | 20.61 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 20025 1717.5 MHz | QPSK Mid CH 20175 1732.5 MHz | QPSK High CH 20325 1747.5 MHz | 3GPP MPR (dB) | 16QAM Low CH 20025 1717.5 MHz | 16QAM Mid CH 20175 1732.5 MHz | 16QAM High CH 20325 1747.5 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 / 15M | 1 | 0 | 22.98 | 24.13 | 23.15 | 0 | 21.99 | 23.07 | 22.56 | 1 |
| | 1 | 37 | 23.69 | 23.15 | 22.52 | 0 | 22.46 | 22.03 | 21.66 | 1 |
| | 1 | 74 | 23.44 | 22.81 | 23.54 | 0 | 22.66 | 21.56 | 21.97 | 1 |
| | 36 | 0 | 22.54 | 22.86 | 21.73 | 1 | 21.14 | 21.53 | 20.61 | 2 |
| | 36 | 19 | 22.78 | 22.38 | 21.62 | 1 | 21.40 | 20.99 | 20.51 | 2 |
| | 36 | 39 | 22.79 | 21.95 | 21.87 | 1 | 21.44 | 20.55 | 20.77 | 2 |
| | 75 | 0 | 22.66 | 22.41 | 21.78 | 1 | 21.23 | 21.02 | 20.68 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 20050 1720.0 MHz | QPSK Mid CH 20175 1732.5 MHz | QPSK High CH 20300 1745.0 MHz | 3GPP MPR (dB) | 16QAM Low CH 20050 1720.0 MHz | 16QAM Mid CH 20175 1732.5 MHz | 16QAM High CH 20300 1745.0 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 / 20M | 1 | 0 | 23.09 | **24.24** | 23.26 | 0 | 22.10 | 23.18 | 22.67 | 1 |
| | 1 | 50 | 23.80 | 23.26 | 22.59 | 0 | 22.57 | 22.14 | 21.77 | 1 |
| | 1 | 99 | 23.55 | 22.92 | 23.65 | 0 | 22.77 | 21.67 | 22.08 | 1 |
| | 50 | 0 | 22.65 | 22.97 | 21.84 | 1 | 21.25 | 21.64 | 20.51 | 2 |
| | 50 | 25 | 22.89 | 22.49 | 21.73 | 1 | 21.51 | 21.10 | 20.52 | 2 |
| | 50 | 50 | 22.90 | 22.06 | 21.98 | 1 | 21.55 | 20.66 | 20.55 | 2 |
| | 100 | 0 | 22.77 | 22.52 | 21.89 | 1 | 21.34 | 21.13 | 20.55 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 20407 824.7 MHz | QPSK Mid CH 20525 836.5 MHz | QPSK High CH 20643 848.3 MHz | 3GPP MPR (dB) | 16QAM Low CH 20407 824.7 MHz | 16QAM Mid CH 20525 836.5 MHz | 16QAM High CH 20643 848.3 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 / 1.4M | 1 | 0 | 22.20 | 22.15 | 21.50 | 0 | 21.07 | 21.15 | 21.09 | 1 |
| | 1 | 2 | 22.21 | 21.55 | 21.74 | 0 | 21.25 | 20.86 | 21.17 | 1 |
| | 1 | 5 | 21.99 | 21.47 | 22.15 | 0 | 21.22 | 20.84 | 21.21 | 1 |
| | 3 | 0 | 21.26 | 20.91 | 20.61 | 0 | 19.84 | 19.84 | 19.52 | 1 |
| | 3 | 1 | 21.22 | 20.70 | 20.74 | 0 | 19.81 | 19.56 | 19.76 | 1 |
| | 3 | 3 | 21.14 | 20.57 | 21.01 | 0 | 20.24 | 19.51 | 20.00 | 1 |
| | 6 | 0 | 21.19 | 20.71 | 20.81 | 1 | 19.80 | 19.60 | 19.76 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 20415 825.5 MHz | QPSK Mid CH 20525 836.5 MHz | QPSK High CH 20635 847.5 MHz | 3GPP MPR (dB) | 16QAM Low CH 20415 825.5 MHz | 16QAM Mid CH 20525 836.5 MHz | 16QAM High CH 20635 847.5 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 / 3M | 1 | 0 | 22.28 | 22.23 | 21.58 | 0 | 21.15 | 21.23 | 21.17 | 1 |
| | 1 | 7 | 22.29 | 21.63 | 21.82 | 0 | 21.33 | 20.94 | 21.25 | 1 |
| | 1 | 14 | 22.07 | 21.55 | 22.23 | 0 | 21.30 | 20.92 | 21.29 | 1 |
| | 8 | 0 | 21.34 | 20.99 | 20.69 | 1 | 19.92 | 19.92 | 19.55 | 2 |
| | 8 | 3 | 21.30 | 20.78 | 20.82 | 1 | 19.89 | 19.64 | 19.84 | 2 |
| | 8 | 7 | 21.22 | 20.65 | 21.09 | 1 | 20.32 | 19.51 | 20.08 | 2 |
| | 15 | 0 | 21.27 | 20.79 | 20.89 | 1 | 19.88 | 19.68 | 19.84 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 20425 826.5 MHz | QPSK Mid CH 20525 836.5 MHz | QPSK High CH 20625 846.5 MHz | 3GPP MPR (dB) | 16QAM Low CH 20425 826.5 MHz | 16QAM Mid CH 20525 836.5 MHz | 16QAM High CH 20625 846.5 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 / 5M | 1 | 0 | 22.36 | 22.31 | 21.66 | 0 | 21.23 | 21.31 | 21.25 | 1 |
| | 1 | 12 | 22.37 | 21.71 | 21.90 | 0 | 21.41 | 21.02 | 21.33 | 1 |
| | 1 | 24 | 22.15 | 21.63 | 22.31 | 0 | 21.38 | 21.00 | 21.37 | 1 |
| | 12 | 0 | 21.42 | 21.07 | 20.77 | 1 | 20.00 | 20.00 | 19.63 | 2 |
| | 12 | 6 | 21.38 | 20.86 | 20.90 | 1 | 19.97 | 19.72 | 19.92 | 2 |
| | 12 | 13 | 21.30 | 20.73 | 21.17 | 1 | 20.40 | 19.59 | 20.16 | 2 |
| | 25 | 0 | 21.35 | 20.87 | 20.97 | 1 | 19.96 | 19.76 | 19.92 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 20450 829.0 MHz | QPSK Mid CH 20525 836.5 MHz | QPSK High CH 20600 844.0 MHz | 3GPP MPR (dB) | 16QAM Low CH 20450 829.0 MHz | 16QAM Mid CH 20525 836.5 MHz | 16QAM High CH 20600 844.0 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 / 10M | 1 | 0 | 22.44 | 22.39 | 21.74 | 0 | 21.31 | 21.39 | 21.33 | 1 |
| | 1 | 24 | **22.45** | 21.79 | 21.98 | 0 | 21.49 | 21.10 | 21.41 | 1 |
| | 1 | 49 | 22.23 | 21.71 | 22.39 | 0 | 21.46 | 21.08 | 21.45 | 1 |
| | 25 | 0 | 21.50 | 21.15 | 20.85 | 1 | 20.08 | 20.08 | 19.71 | 2 |
| | 25 | 12 | 21.46 | 20.94 | 20.98 | 1 | 20.05 | 19.80 | 20.00 | 2 |
| | 25 | 25 | 21.38 | 20.81 | 21.25 | 1 | 20.48 | 19.67 | 20.24 | 2 |
| | 50 | 0 | 21.43 | 20.95 | 21.05 | 1 | 20.04 | 19.84 | 20.00 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 23205 779.5 MHz | QPSK Mid CH 23230 782.0 MHz | QPSK High CH 23255 784.5 MHz | 3GPP MPR (dB) | 16QAM Low CH 23205 779.5 MHz | 16QAM Mid CH 23230 782.0 MHz | 16QAM High CH 23255 784.5 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 13 / 5M | 1 | 0 | 21.62 | 22.08 | 22.27 | 0 | 21.03 | 21.23 | 21.50 | 1 |
| | 1 | 12 | 22.07 | 22.26 | 22.01 | 0 | 21.36 | 21.51 | 21.33 | 1 |
| | 1 | 24 | 22.48 | 22.11 | 22.45 | 0 | 21.69 | 21.37 | 21.68 | 1 |
| | 12 | 0 | 21.11 | 21.14 | 21.18 | 1 | 20.13 | 20.13 | 20.18 | 2 |
| | 12 | 6 | 21.15 | 21.22 | 21.22 | 1 | 20.15 | 20.21 | 20.19 | 2 |
| | 12 | 13 | 21.31 | 21.23 | 21.30 | 1 | 20.30 | 20.22 | 20.29 | 2 |
| | 25 | 0 | 21.26 | 21.22 | 21.28 | 1 | 20.24 | 20.20 | 20.24 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Mid CH 23230 782.0 MHz | 3GPP MPR (dB) | 16QAM Mid CH 23230 782.0 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|
| 13 / 10M | 1 | 0 | 21.68 | 0 | 21.01 | 1 |
| | 1 | 24 | 22.35 | 0 | 21.29 | 1 |
| | 1 | 49 | **22.58** | 0 | 21.77 | 1 |
| | 25 | 0 | 21.09 | 1 | 20.05 | 2 |
| | 25 | 12 | 21.23 | 1 | 20.16 | 2 |
| | 25 | 25 | 21.32 | 1 | 20.31 | 2 |
| | 50 | 0 | 21.26 | 1 | 20.25 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 23755 706.5 MHz | QPSK Mid CH 23790 710.0 MHz | QPSK High CH 23825 713.5 MHz | 3GPP MPR (dB) | 16QAM Low CH 23755 706.5 MHz | 16QAM Mid CH 23790 710.0 MHz | 16QAM High CH 23825 713.5 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 17 / 5M | 1 | 0 | 22.32 | 22.55 | 22.65 | 0 | 21.40 | 21.58 | 21.59 | 1 |
| | 1 | 12 | 22.76 | 22.62 | 22.63 | 0 | 21.88 | 21.43 | 21.83 | 1 |
| | 1 | 24 | 22.33 | 22.00 | 22.45 | 0 | 21.77 | 21.24 | 21.85 | 1 |
| | 12 | 0 | 21.69 | 21.85 | 21.87 | 1 | 20.59 | 20.80 | 20.88 | 2 |
| | 12 | 6 | 21.73 | 21.73 | 21.65 | 1 | 20.76 | 20.74 | 20.74 | 2 |
| | 12 | 13 | 21.49 | 21.48 | 21.45 | 1 | 20.60 | 20.48 | 20.34 | 2 |
| | 25 | 0 | 21.58 | 21.68 | 21.68 | 1 | 20.61 | 20.58 | 20.60 | 2 |

| LTE Band / BW | RB Size | RB Offset | QPSK Low CH 23780 709.0 MHz | QPSK Mid CH 23790 710.0 MHz | QPSK High CH 23800 711.0 MHz | 3GPP MPR (dB) | 16QAM Low CH 23780 709.0 MHz | 16QAM Mid CH 23790 710.0 MHz | 16QAM High CH 23800 711.0 MHz | 3GPP MPR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 17 / 10M | 1 | 0 | 22.43 | 22.66 | 22.76 | 0 | 21.52 | 21.70 | 21.71 | 1 |
| | 1 | 24 | **22.88** | 22.73 | 22.74 | 0 | 22.00 | 21.55 | 21.95 | 1 |
| | 1 | 49 | 22.44 | 22.11 | 22.56 | 0 | 21.89 | 21.36 | 21.97 | 1 |
| | 25 | 0 | 21.80 | 21.96 | 21.98 | 1 | 20.71 | 20.92 | 21.00 | 2 |
| | 25 | 12 | 21.84 | 21.84 | 21.76 | 1 | 20.88 | 20.86 | 20.86 | 2 |
| | 25 | 25 | 21.60 | 21.59 | 21.56 | 1 | 20.72 | 20.60 | 20.46 | 2 |
| | 50 | 0 | 21.69 | 21.79 | 21.79 | 1 | 20.73 | 20.70 | 20.72 | 2 |

## 4.7 SAR Testing Results

### 4.7.1 SAR Test Reduction Considerations

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

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

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

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

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

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

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

**<KDB 941225 D05, SAR Evaluation Considerations for LTE Devices>**

(1) QPSK with 1 RB and 50% RB allocation

Start with the largest channel bandwidth and measure SAR, using the RB offset and required test channel combination with the highest maximum output power among RB offsets at the upper edge, middle and lower edge of each required test channel. When the reported SAR is ≤ 0.8 W/kg, testing of the remaining RB offset configurations and required test channels is not required; otherwise, SAR is required for the remaining required test channels and only for the RB offset configuration with the highest output power for that channel. When the reported SAR of a required test channel is > 1.45 W/kg, SAR is required for all three RB offset configurations for that required test channel.

(2) QPSK with 100% RB allocation

SAR is not required when the highest maximum output power for 100% RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.

(3) Higher order modulations

SAR is required only when the highest maximum output power for the configuration in the higher order modulation is > 1/2 dB higher than the same configuration in QPSK or when the reported SAR for the QPSK configuration is > 1.45 W/kg.

(4) Other channel bandwidth

SAR is required when the highest maximum output power of the smaller channel bandwidth is > 1/2 dB higher than the equivalent channel configurations in the largest channel bandwidth configuration or the reported SAR of a configuration for the largest channel bandwidth is > 1.45 W/kg.

### 4.7.2 SAR Results for Body-worn Exposure Condition (Separation Distance is 1.5 cm Gap)

| Plot No. | Band | Mode | Test Position | Ch. | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaled SAR-1g (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|
| | WCDMA II | RMC12.2K | Front Face | 9538 | 23.0 | 22.99 | 1.00 | 0.04 | 0.163 | 0.16 |
| 01 | WCDMA II | RMC12.2K | Rear Face | 9538 | 23.0 | 22.99 | 1.00 | -0.14 | 0.238 | **0.24** |
| | WCDMA V | RMC12.2K | Front Face | 4233 | 23.0 | 22.70 | 1.07 | 0.03 | 0.152 | 0.16 |
| 02 | WCDMA V | RMC12.2K | Rear Face | 4233 | 23.0 | 22.70 | 1.07 | 0 | 0.231 | **0.25** |

| Plot No. | Band | Mode | Test Position | Ch. | RB# | RB Offset | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Scaling Factor | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaled SAR-1g (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LTE 2 | QPSK20M | Front Face | 18900 | 1 | 0 | 23.5 | 23.27 | 1.05 | 0.05 | 0.264 | 0.28 |
| | LTE 2 | QPSK20M | Front Face | 18900 | 50 | 0 | 22.5 | 22.26 | 1.06 | 0.15 | 0.181 | 0.19 |
| 03 | LTE 2 | QPSK20M | Rear Face | 18900 | 1 | 0 | 23.5 | 23.27 | 1.05 | -0.09 | 0.272 | **0.29** |
| | LTE 2 | QPSK20M | Rear Face | 18900 | 50 | 0 | 22.5 | 22.26 | 1.06 | 0.01 | 0.187 | 0.20 |
| 04 | LTE 4 | QPSK20M | Front Face | 20175 | 1 | 0 | 24.5 | 24.24 | 1.06 | 0.07 | 0.325 | **0.35** |
| | LTE 4 | QPSK20M | Front Face | 20175 | 50 | 0 | 23.5 | 22.97 | 1.13 | -0.03 | 0.235 | 0.27 |
| | LTE 4 | QPSK20M | Rear Face | 20175 | 1 | 0 | 24.5 | 24.24 | 1.06 | 0.04 | 0.272 | 0.29 |
| | LTE 4 | QPSK20M | Rear Face | 20175 | 50 | 0 | 23.5 | 22.97 | 1.13 | 0.07 | 0.199 | 0.22 |
| | LTE 5 | QPSK10M | Front Face | 20450 | 1 | 24 | 22.5 | 22.45 | 1.01 | 0.01 | 0.242 | 0.24 |
| | LTE 5 | QPSK10M | Front Face | 20450 | 25 | 0 | 21.5 | 21.50 | 1.00 | -0.01 | 0.183 | 0.18 |
| 05 | LTE 5 | QPSK10M | Rear Face | 20450 | 1 | 24 | 22.5 | 22.45 | 1.01 | 0.03 | 0.33 | **0.33** |
| | LTE 5 | QPSK10M | Rear Face | 20450 | 25 | 0 | 21.5 | 21.50 | 1.00 | 0.04 | 0.219 | 0.22 |
| 06 | LTE 13 | QPSK10M | Front Face | 23230 | 1 | 49 | 23.0 | 22.58 | 1.10 | 0.09 | 0.419 | **0.46** |
| | LTE 13 | QPSK10M | Front Face | 23230 | 25 | 25 | 22.0 | 21.32 | 1.17 | 0 | 0.36 | 0.42 |
| | LTE 13 | QPSK10M | Rear Face | 23230 | 1 | 49 | 23.0 | 22.58 | 1.10 | 0.01 | 0.418 | 0.46 |
| | LTE 13 | QPSK10M | Rear Face | 23230 | 25 | 25 | 22.0 | 21.32 | 1.17 | 0.01 | 0.366 | 0.43 |
| | LTE 17 | QPSK10M | Front Face | 23780 | 1 | 24 | 23.0 | 22.88 | 1.03 | -0.12 | 0.191 | 0.20 |
| | LTE 17 | QPSK10M | Front Face | 23800 | 25 | 0 | 22.0 | 21.98 | 1.00 | 0.02 | 0.122 | 0.12 |
| 07 | LTE 17 | QPSK10M | Rear Face | 23780 | 1 | 24 | 23.0 | 22.88 | 1.03 | -0.10 | 0.324 | **0.33** |
| | LTE 17 | QPSK10M | Rear Face | 23800 | 25 | 0 | 22.0 | 21.98 | 1.00 | 0.09 | 0.197 | 0.20 |

### 4.7.3 SAR Measurement Variability

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

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

**Test Engineer：** Mars Chang, and Austin Lin

# 5. Calibration of Test Equipment

| Equipment | Manufacturer | Model | SN | Cal. Date | Cal. Interval |
|---|---|---|---|---|---|
| System Validation Dipole | SPEAG | D750V3 | 1013 | Aug. 30, 2016 | 1 Year |
| System Validation Dipole | SPEAG | D835V2 | 4d121 | Aug. 25, 2016 | 1 Year |
| System Validation Dipole | SPEAG | D1750V2 | 1055 | Aug. 31, 2016 | 1 Year |
| System Validation Dipole | SPEAG | D1900V2 | 5d036 | Jan. 22, 2016 | 1 Year |
| Dosimetric E-Field Probe | SPEAG | ET3DV6 | 1790 | Jun. 24, 2016 | 1 Year |
| Data Acquisition Electronics | SPEAG | DAE4 | 1277 | Jul. 22, 2016 | 1 Year |
| Wireless Communication Test Set | Agilent | E5515C | MY50260642 | Nov. 19, 2015 | 2 Years |
| Radio Communication Analyzer | Anritsu | MT8820C | 6201381727 | May 04, 2016 | 1 Year |
| Spectrum Analyzer | R&S | FSL6 | 102006 | Mar. 25, 2016 | 1 Year |
| ENA Series Network Analyzer | Agilent | E5071C | MY46214281 | Jun. 13, 2016 | 1 Year |
| MXG Analong Signal Generator | Agilent | N5181A | MY50143868 | Jul. 07, 2016 | 1 Year |
| Power Meter | Anritsu | ML2495A | 1218009 | Jul. 06, 2016 | 1 Year |
| Power Sensor | Anritsu | MA2411B | 1207252 | Jul. 06, 2016 | 1 Year |
| Thermometer | YFE | YF-160A | 150601220 | May 04, 2016 | 1 Year |

# 6. Measurement Uncertainty

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

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

# 7. Information on the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

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

**Taiwan HwaYa EMC/RF/Safety/Telecom Lab:**
Add: No. 19, Hwa Ya 2nd Rd, Wen Hwa Vil., Kwei Shan Hsiang, Taoyuan Hsien 333, Taiwan, R.O.C.
Tel: 886-3-318-3232
Fax: 886-3-327-0892

**Taiwan LinKo EMC/RF Lab:**
Add: No. 47-2, 14th Ling, Chia Pau Vil., Linkou Dist., New Taipei City 244, Taiwan, R.O.C.
Tel: 886-2-2605-2180
Fax: 886-2-2605-1924

**Taiwan HsinChu EMC/RF Lab:**
Add: No. 81-1, Lu Liao Keng, 9th Ling, Wu Lung Vil., Chiung Lin Township, Hsinchu County 307, Taiwan, R.O.C.
Tel: 886-3-593-5343
Fax: 886-3-593-5342

**Email:** service.adt@tw.bureauveritas.com
**Web Site:** www.adt.com.tw

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

**---END---**

# Appendix A. SAR Plots of System Verification

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

## System Check_B750_161130

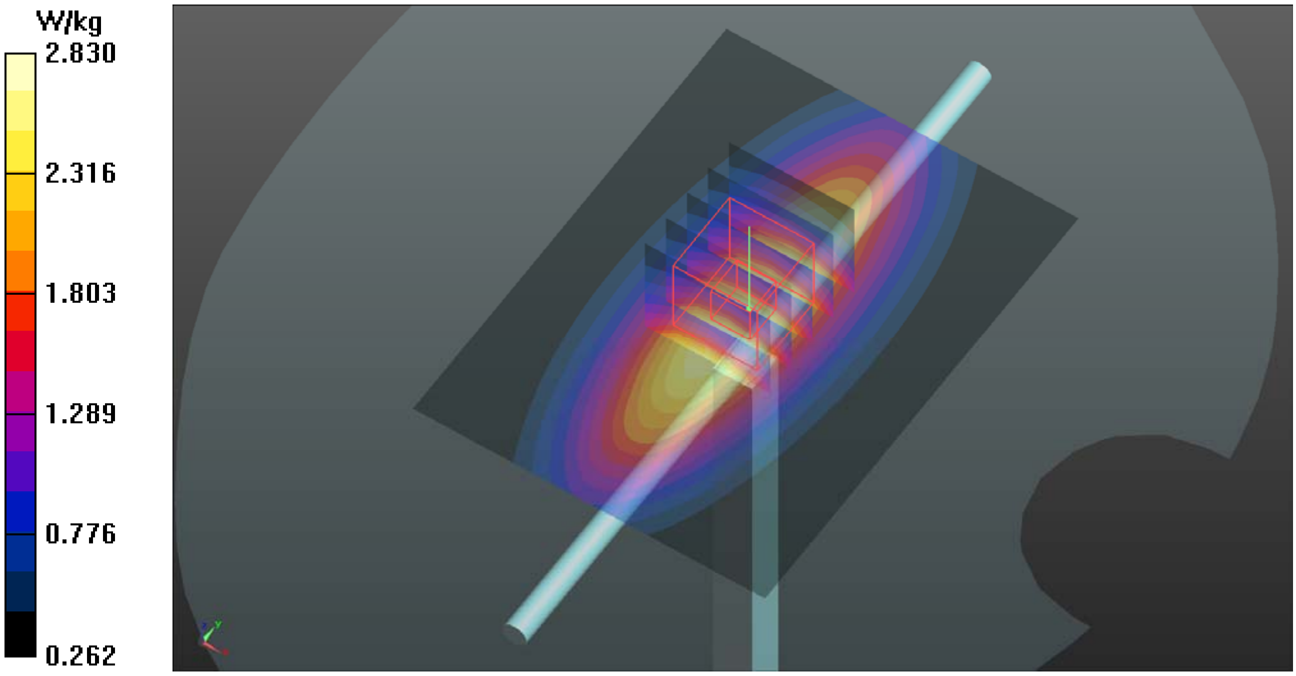
### DUT: Dipole 750 MHz; Type: D750V3; SN: 1013

Communication System: CW; Frequency: 750 MHz;Duty Cycle: 1:1
Medium: B06T09N1_1130 Medium parameters used: f = 750 MHz; σ = 0.96 S/m; $\varepsilon_r$ = 56.414; ρ = 1000 kg/$m^3$
Ambient Temperature：23.5 ℃；Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1790; ConvF(6.44, 6.44, 6.44); Calibrated: 2016/06/24;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2016/07/22
- Phantom: Twin SAM Phantom_1485; Type: QD000P40;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7373)

**Pin=250mW/Area Scan (61x81x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 2.85 W/kg

**Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 56.64 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 3.18 W/kg
**SAR(1 g) = 2.13 W/kg; SAR(10 g) = 1.41 W/kg**
Maximum value of SAR (measured) = 2.83 W/kg



# System Check_B835_161130

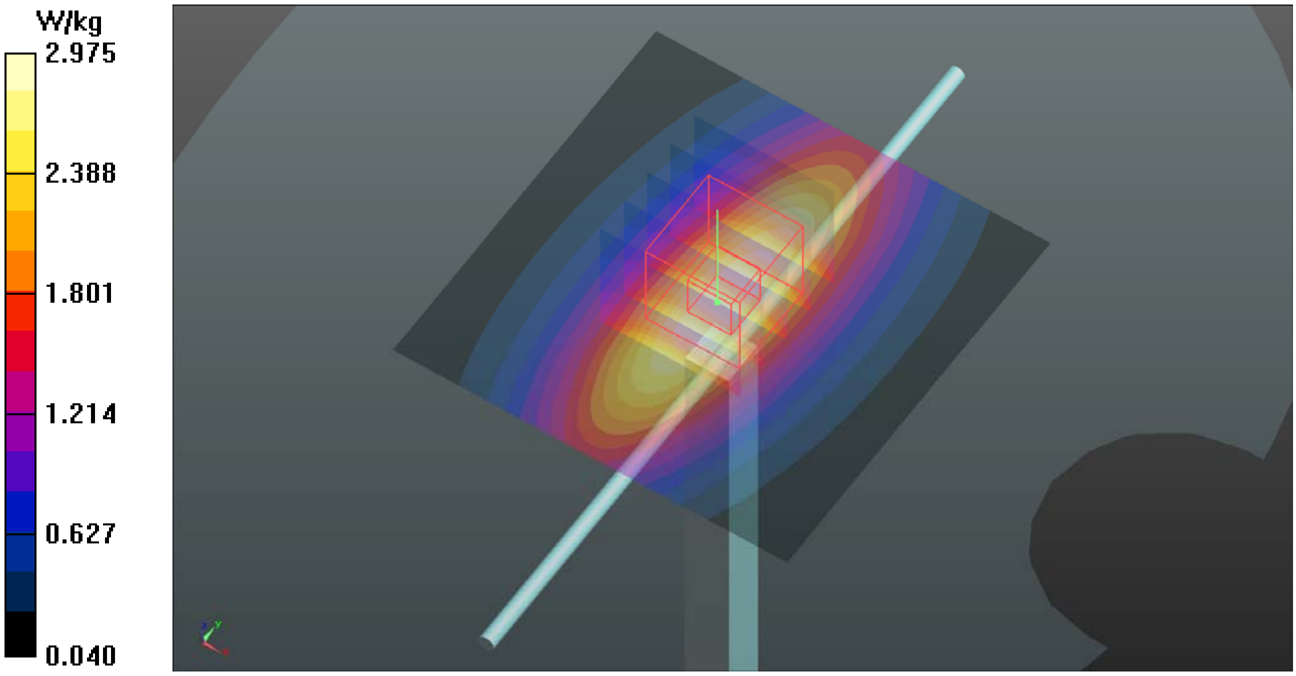
## DUT: Dipole 835 MHz; Type: D835V2; SN: 4d121

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium: B07T10N3_1130 Medium parameters used: f = 835 MHz; $\sigma$ = 1.013 S/m; $\varepsilon_r$ = 54.67; $\rho$ = 1000 kg/$m^3$
Ambient Temperature：23.5 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1790; ConvF(6.37, 6.37, 6.37); Calibrated: 2016/06/24;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2016/07/22
- Phantom: Twin SAM Phantom_1485; Type: QD000P40;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7373)

**Pin=250mW/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 2.97 W/kg

**Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 56.40 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 3.35 W/kg
**SAR(1 g) = 2.22 W/kg; SAR(10 g) = 1.46 W/kg**
Maximum value of SAR (measured) = 2.97 W/kg



## System Check_B1750_161130

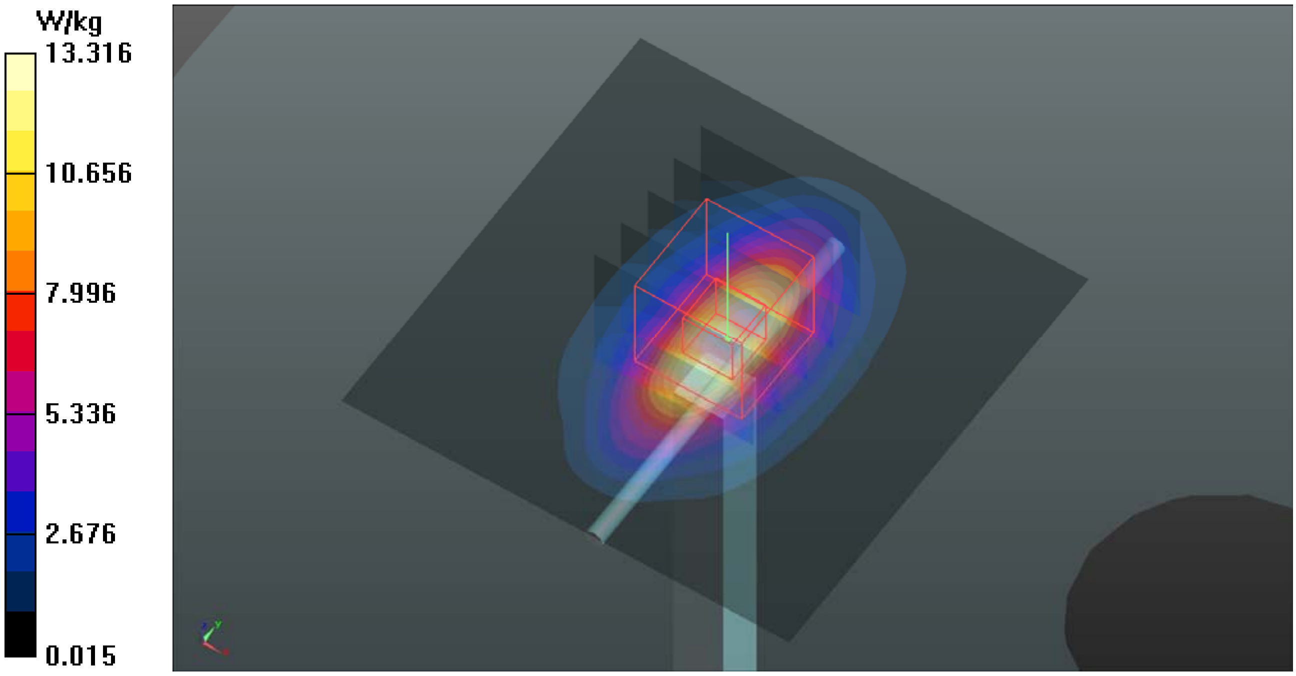
**DUT: Dipole 1750 MHz; Type: D1750V2; SN: 1055**

Communication System: CW; Frequency: 1750 MHz;Duty Cycle: 1:1
Medium: B16T20N1_1130 Medium parameters used: f = 1750 MHz; σ = 1.444 S/m; $\varepsilon_r$ = 51.451; ρ = 1000 kg/m$^3$
Ambient Temperature：23.6 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1790; ConvF(4.94, 4.94, 4.94); Calibrated: 2016/06/24;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2015/07/22
- Phantom: Twin SAM Phantom_1654; Type: QD000P40;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7373)

**Pin=250mW/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 13.3 W/kg

**Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 98.90 V/m; Power Drift = -0.17 dB
Peak SAR (extrapolated) = 15.5 W/kg
**SAR(1 g) = 8.77 W/kg; SAR(10 g) = 4.69 W/kg**
Maximum value of SAR (measured) = 13.3 W/kg



## System Check_B1900_161130

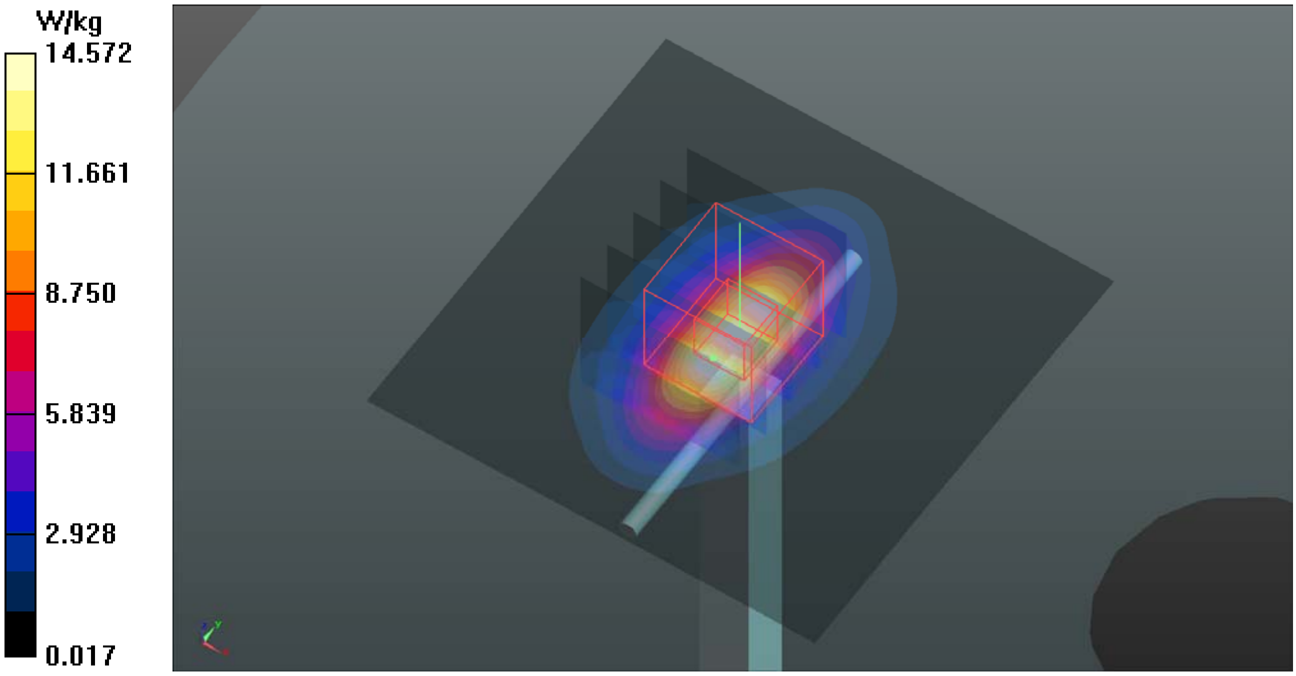
### DUT: Dipole 1900 MHz; Type: D1900V2; SN: 5d036

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: B16T20N1_1130 Medium parameters used: f = 1900 MHz; $\sigma$ = 1.575 S/m; $\varepsilon_r$ = 51.005; $\rho$ = 1000 kg/m$^3$
Ambient Temperature：23.6 ℃；Liquid Temperature：23.3 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1790; ConvF(4.74, 4.74, 4.74); Calibrated: 2016/06/24;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2016/07/22
- Phantom: Twin SAM Phantom_1654; Type: QD000P40;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7373)

**Pin=250mW/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 14.6 W/kg

**Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 96.42 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 17.7 W/kg
**SAR(1 g) = 9.82 W/kg; SAR(10 g) = 5.1 W/kg**
Maximum value of SAR (measured) = 13.9 W/kg



# Appendix B. SAR Plots of SAR Measurement

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

Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2016/11/30

## P01 WCDMA II_RMC12.2K_Rear Face_1.5cm_Ch9538

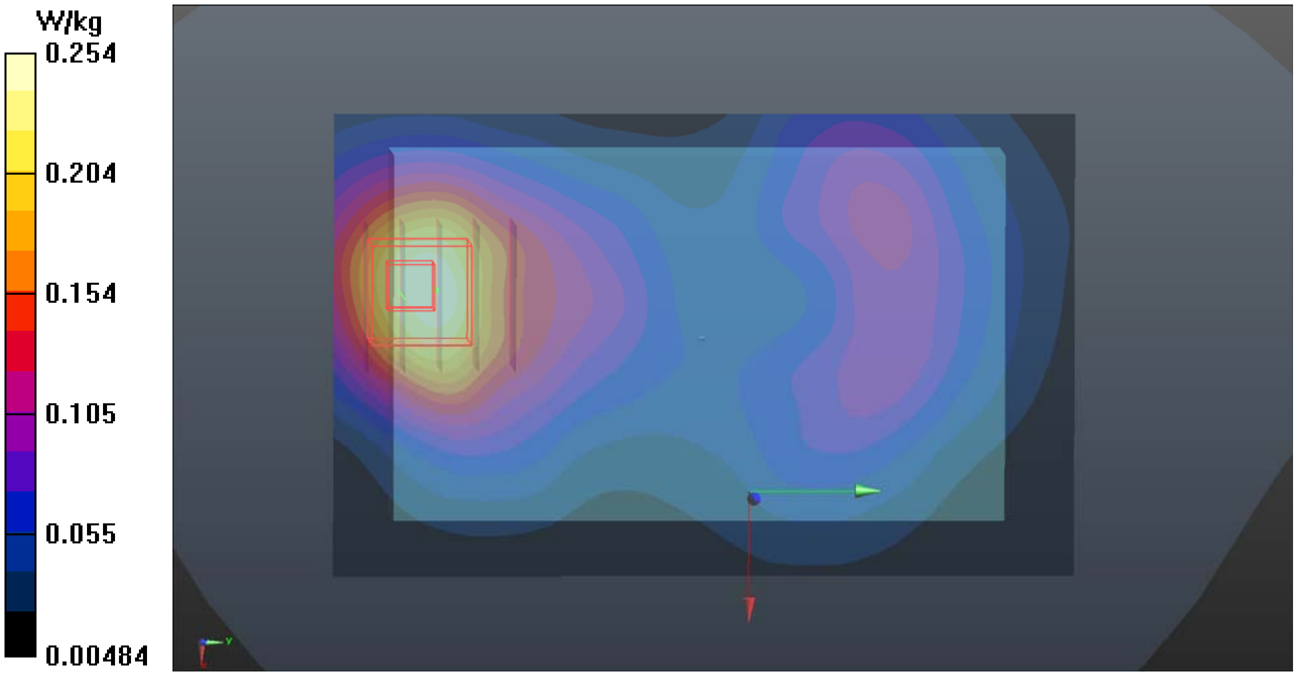
**DUT: 160802C11**

Communication System: WCDMA; Frequency: 1907.6 MHz;Duty Cycle: 1:1
Medium: B16T20N1_1130 Medium parameters used: f = 1908 MHz; $\sigma = 1.583$ S/m; $\varepsilon_r = 50.984$; $\rho = 1000$ kg/m$^3$
Ambient Temperature：23.6 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1790; ConvF(4.74, 4.74, 4.74); Calibrated: 2016/06/24;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2016/07/22
- Phantom: Twin SAM Phantom_1654; Type: QD000P40;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7373)

**- Area Scan (71x111x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.254 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 6.538 V/m; Power Drift = -0.14 dB
Peak SAR (extrapolated) = 0.380 W/kg
**SAR(1 g) = 0.238 W/kg; SAR(10 g) = 0.145 W/kg**
Maximum value of SAR (measured) = 0.255 W/kg



## P02 WCDMA V_RMC12.2K_Rear Face_1.5cm_Ch4233

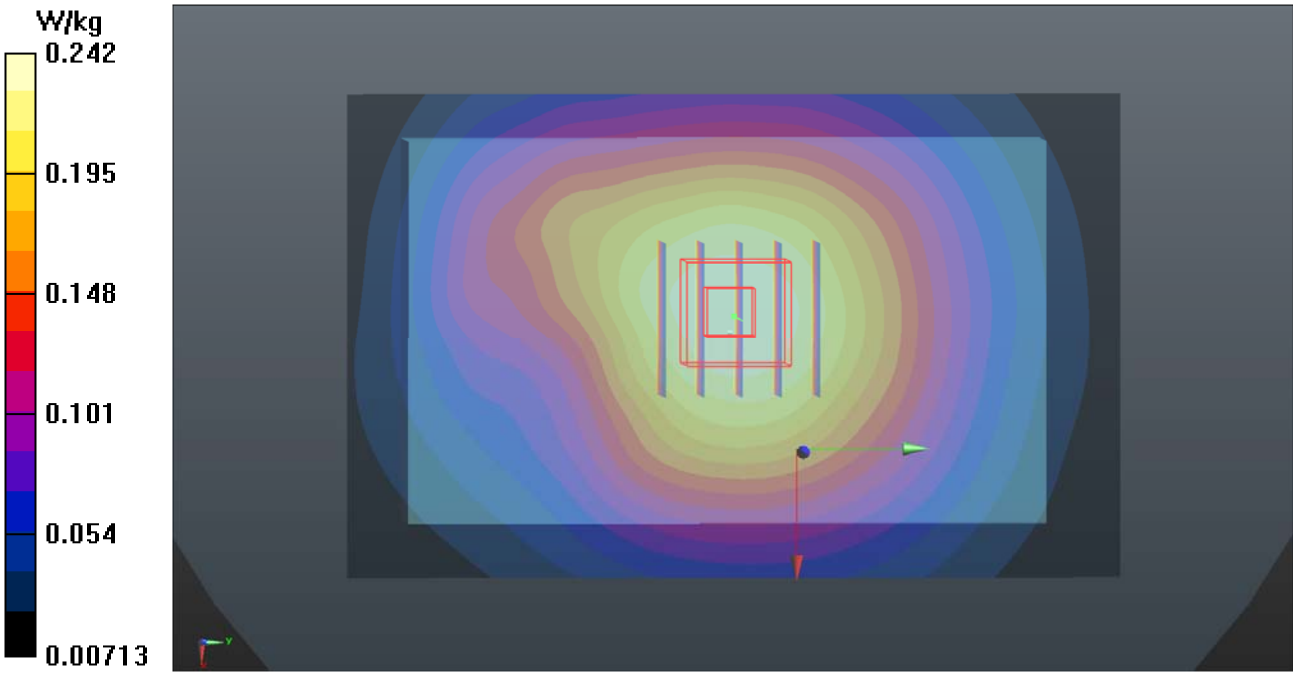
### DUT: 160802C11

Communication System: WCDMA; Frequency: 846.6 MHz;Duty Cycle: 1:1
Medium: B07T10N3_1130 Medium parameters used: f = 847 MHz; $\sigma$ = 1.025 S/m; $\varepsilon_r$ = 54.546; $\rho$ = 1000 kg/$m^3$
Ambient Temperature：23.5 ℃；Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1790; ConvF(6.37, 6.37, 6.37); Calibrated: 2016/06/24;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2016/07/22
- Phantom: Twin SAM Phantom_1485; Type: QD000P40;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7373)

**- Area Scan (71x111x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.242 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 15.91 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 0.284 W/kg
**SAR(1 g) = 0.231 W/kg; SAR(10 g) = 0.175 W/kg**
Maximum value of SAR (measured) = 0.242 W/kg



## P03 LTE 2_QPSK20M_Rear Face_1.5cm_Ch18900_1RB_OS0

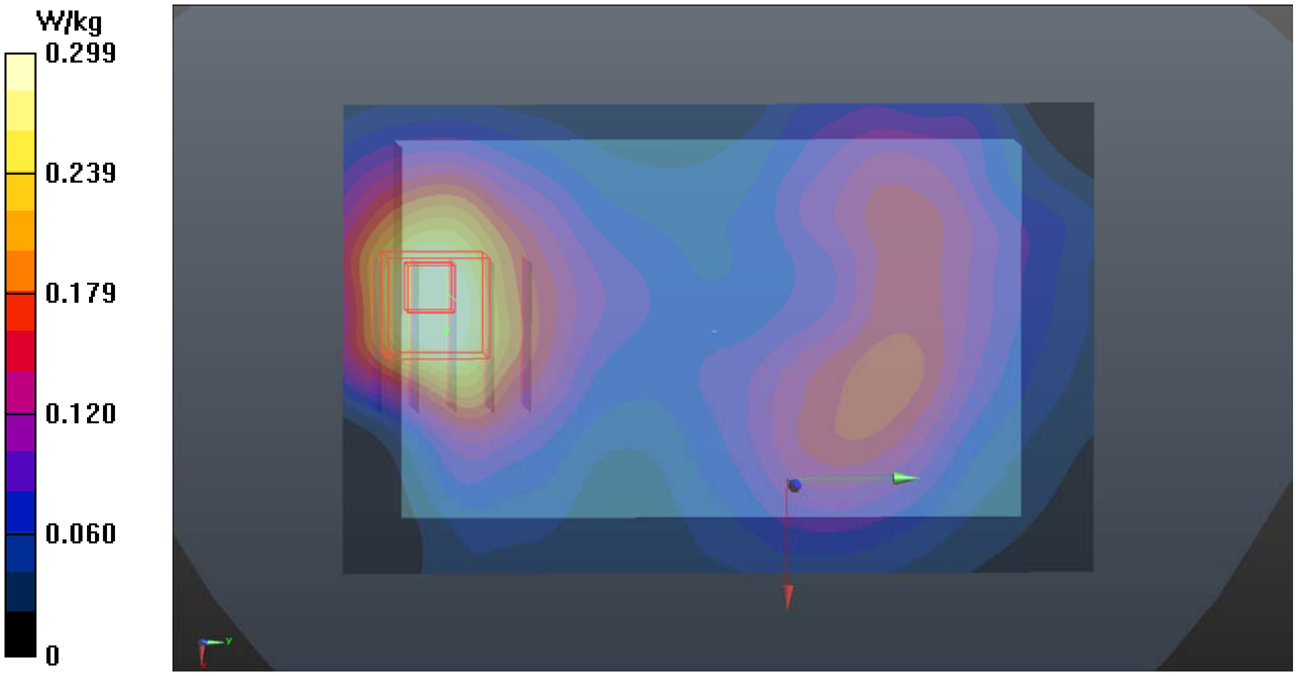
**DUT: 160802C11**

Communication System: LTE; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: B16T20N1_1130 Medium parameters used: f = 1880 MHz; $\sigma = 1.558$ S/m; $\varepsilon_r = 51.065$; $\rho = 1000$ kg/m$^3$
Ambient Temperature：23.6 ℃； Liquid Temperature：23.3 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1790; ConvF(4.74, 4.74, 4.74); Calibrated: 2016/06/24;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2016/07/22
- Phantom: Twin SAM Phantom_1654; Type: QD000P40;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7373)

**- Area Scan (71x111x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.299 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 7.779 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 0.421 W/kg
**SAR(1 g) = 0.272 W/kg; SAR(10 g) = 0.170 W/kg**
Maximum value of SAR (measured) = 0.284 W/kg



## P04 LTE 4_QPSK20M_Front Face_1.5cm_Ch20175_1RB_OS0

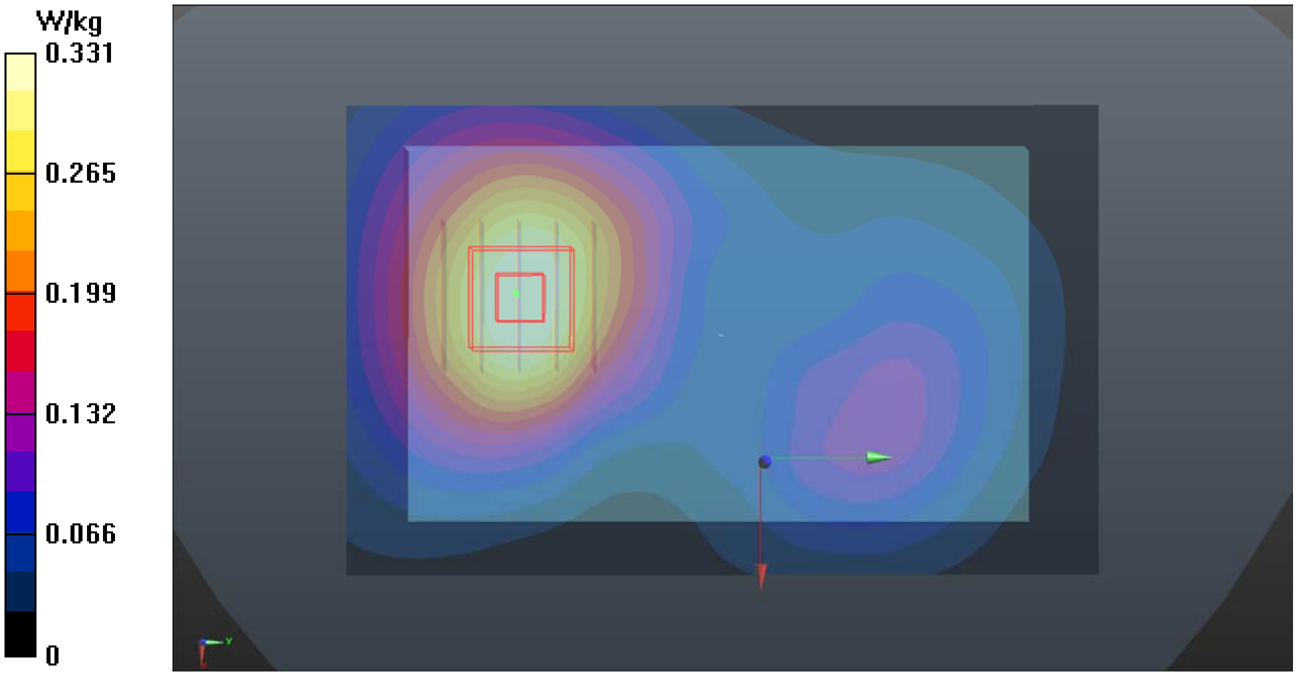
### DUT: 160802C11

Communication System: LTE; Frequency: 1732.5 MHz;Duty Cycle: 1:1
Medium: B16T20N1_1130 Medium parameters used: f = 1732.5 MHz; σ = 1.43 S/m; $\varepsilon_r$ = 51.494; ρ = 1000 kg/m$^3$
Ambient Temperature：23.6 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1790; ConvF(4.94, 4.94, 4.94); Calibrated: 2016/06/24;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2016/07/22
- Phantom: Twin SAM Phantom_1654; Type: QD000P40;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7373)

**- Area Scan (71x111x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.331 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 7.099 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 0.426 W/kg
**SAR(1 g) = 0.325 W/kg; SAR(10 g) = 0.224 W/kg**
Maximum value of SAR (measured) = 0.349 W/kg



## P05 LTE 5_QPSK10M_Rear Face_1.5cm_Ch20450_1RB_OS24

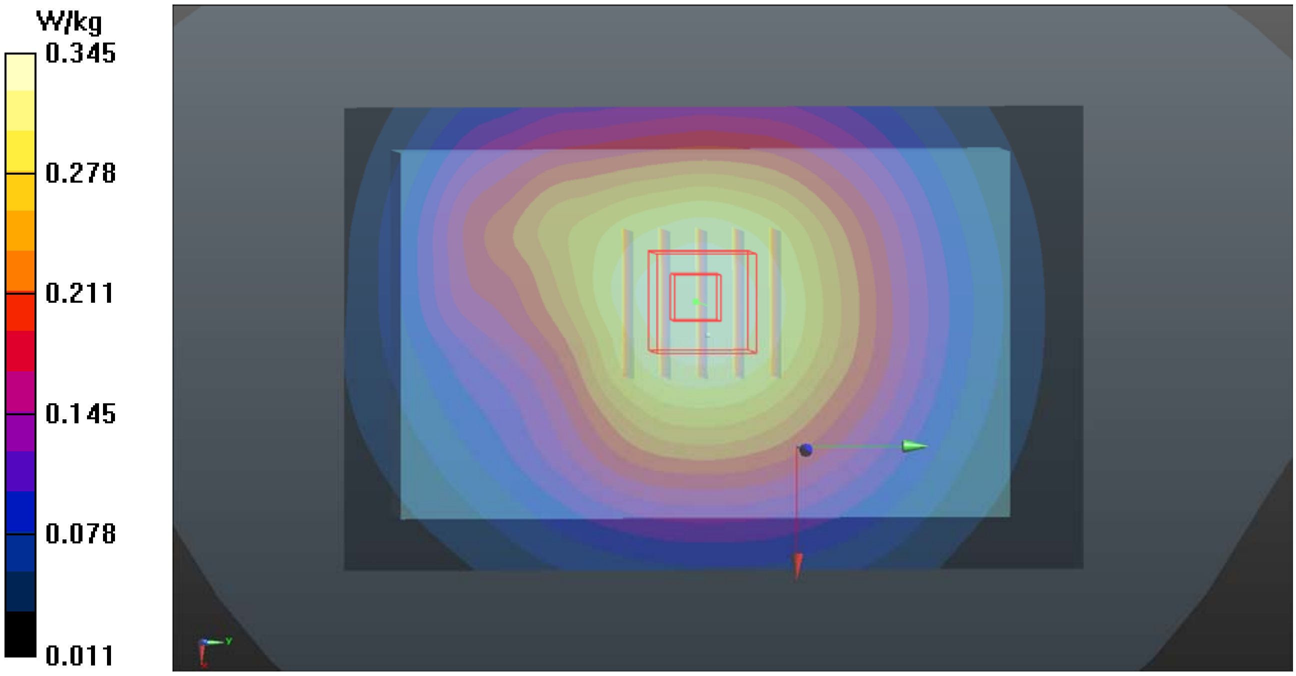
**DUT: 160802C11**

Communication System: LTE; Frequency: 829 MHz;Duty Cycle: 1:1
Medium: B07T10N3_1130 Medium parameters used: f = 829 MHz; $\sigma$ = 1.007 S/m; $\varepsilon_r$ = 54.738; $\rho$ = 1000 kg/$m^3$
Ambient Temperature：23.5 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1790; ConvF(6.37, 6.37, 6.37); Calibrated: 2016/06/24;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2016/07/22
- Phantom: Twin SAM Phantom_1485; Type: QD000P40;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7373)

**- Area Scan (71x111x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.345 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 18.95 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 0.403 W/kg
**SAR(1 g) = 0.330 W/kg; SAR(10 g) = 0.252 W/kg**
Maximum value of SAR (measured) = 0.347 W/kg



## P06 LTE 13_QPSK10M_Front Face_1.5cm_Ch23230_1RB_OS49

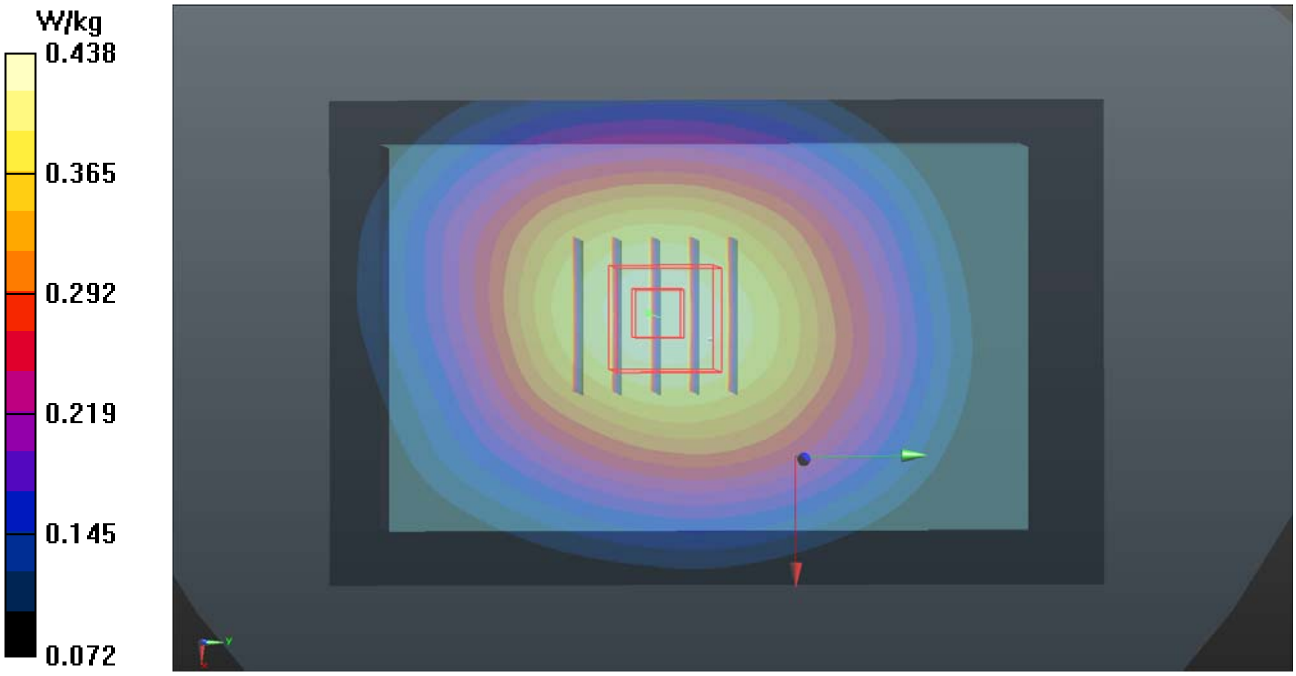
### DUT: 160802C11

Communication System: LTE; Frequency: 782 MHz;Duty Cycle: 1:1
Medium: B06T09N1_1130 Medium parameters used: f = 782 MHz; σ = 0.99 S/m; $\varepsilon_r$ = 56.124; ρ = 1000 kg/$m^3$
Ambient Temperature：23.5 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1790; ConvF(6.44, 6.44, 6.44); Calibrated: 2016/06/24;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2016/07/22
- Phantom: Twin SAM Phantom_1485; Type: QD000P40;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7373)

**- Area Scan (71x111x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.435 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 21.19 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 0.507 W/kg
**SAR(1 g) = 0.419 W/kg; SAR(10 g) = 0.324 W/kg**
Maximum value of SAR (measured) = 0.438 W/kg



## P07 LTE 17_QPSK10M_Rear Face_1.5cm_Ch23780_1RB_OS24

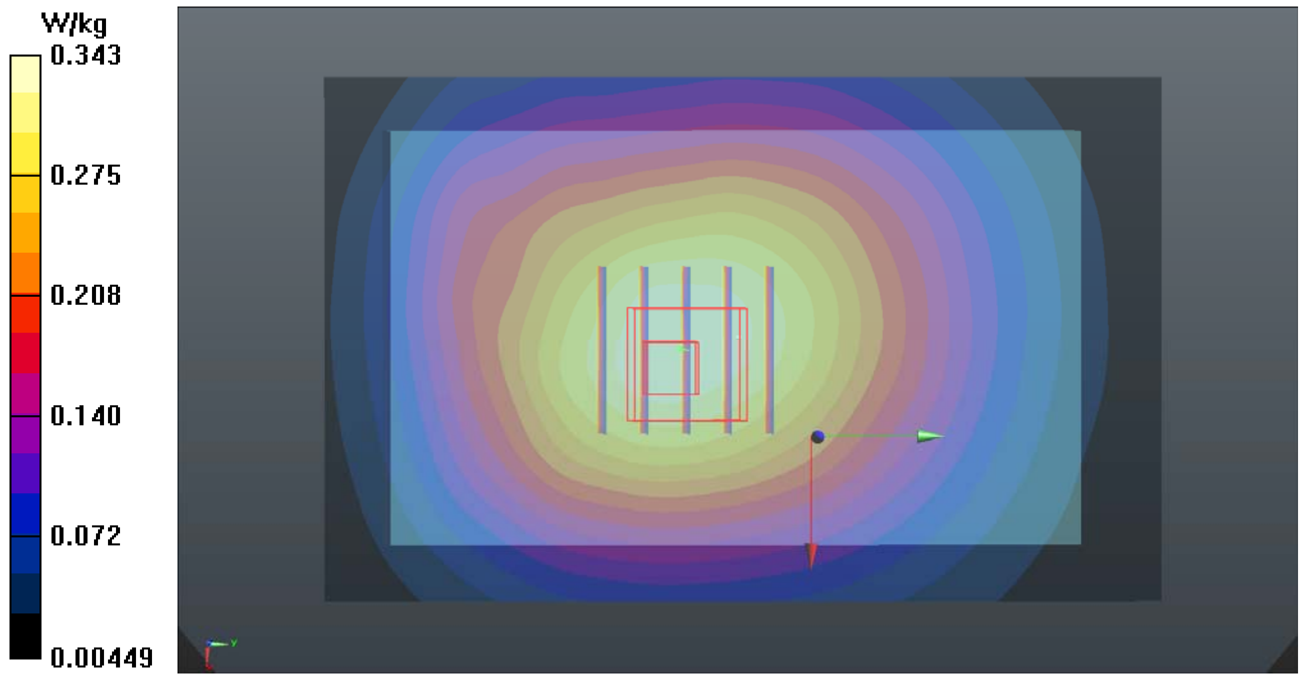
**DUT: 160802C11**

Communication System: LTE; Frequency: 709 MHz;Duty Cycle: 1:1
Medium: B06T09N1_1130 Medium parameters used: f = 709 MHz; $\sigma$ = 0.922 S/m; $\varepsilon_r$ = 56.824; $\rho$ = 1000 kg/m$^3$
Ambient Temperature：23.5 ℃； Liquid Temperature：23.4 ℃

DASY5 Configuration:
- Probe: ET3DV6 - SN1790; ConvF(6.44, 6.44, 6.44); Calibrated: 2016/06/24;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1277; Calibrated: 2016/07/22
- Phantom: Twin SAM Phantom_1485; Type: QD000P40;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7373)

**- Area Scan (71x111x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.343 W/kg

**- Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 19.54 V/m; Power Drift = -0.10 dB
Peak SAR (extrapolated) = 0.400 W/kg
**SAR(1 g) = 0.324 W/kg; SAR(10 g) = 0.243 W/kg**
Maximum value of SAR (measured) = 0.346 W/kg



# Appendix C. Calibration Certificate for Probe and Dipole

The SPEAG calibration certificates are shown as follows.

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

**S** **Schweizerischer Kalibrierdienst**
**C** **Service suisse d'étalonnage**
**S** **Servizio svizzero di taratura**
**Swiss Calibration Service**

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

**Accreditation No.: SCS 0108**

**Client** **B.V. ADT (Auden)**

**Certificate No: D750V3-1013_Aug16**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D750V3 - SN: 1013 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | August 30, 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 (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 06-Apr-16 (No. 217-02288/02289) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103244 | 06-Apr-16 (No. 217-02288) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103245 | 06-Apr-16 (No. 217-02289) | Apr-17 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 05-Apr-16 (No. 217-02292) | Apr-17 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 05-Apr-16 (No. 217-02295) | Apr-17 |
| Reference Probe EX3DV4 | SN: 7349 | 15-Jun-16 (No. EX3-7349_Jun16) | Jun-17 |
| DAE4 | SN: 601 | 30-Dec-15 (No. DAE4-601_Dec15) | Dec-16 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power meter EPM-442A | SN: GB37480704 | 07-Oct-15 (No. 217-02222) | In house check: Oct-16 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (No. 217-02222) | In house check: Oct-16 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (No. 217-02223) | In house check: Oct-16 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Jun-15) | In house check: Oct-16 |
| Network Analyzer HP 8753E | SN: US37390585 | 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 |

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

Issued: August 30, 2016

## Glossary:

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

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## Additional Documentation:

e) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.8.8 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 15 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 750 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 41.9 | 0.89 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 42.4 ± 6 % | 0.91 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 2.09 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **8.24 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.36 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **5.37 W/kg ± 16.5 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 55.5 | 0.96 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 54.9 ± 6 % | 0.99 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 2.25 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **8.77 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.47 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **5.76 W/kg ± 16.5 % (k=2)** |

## Appendix (Additional assessments outside the scope of SCS 0108)

## Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 53.9 Ω + 0.5 jΩ |
| Return Loss | - 28.4 dB |

## Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 49.5 Ω - 2.2 jΩ |
| Return Loss | - 32.8 dB |

## General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.034 ns |

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

## Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | March 22, 2010 |

## DASY5 Validation Report for Head TSL

Date: 30.08.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1013**

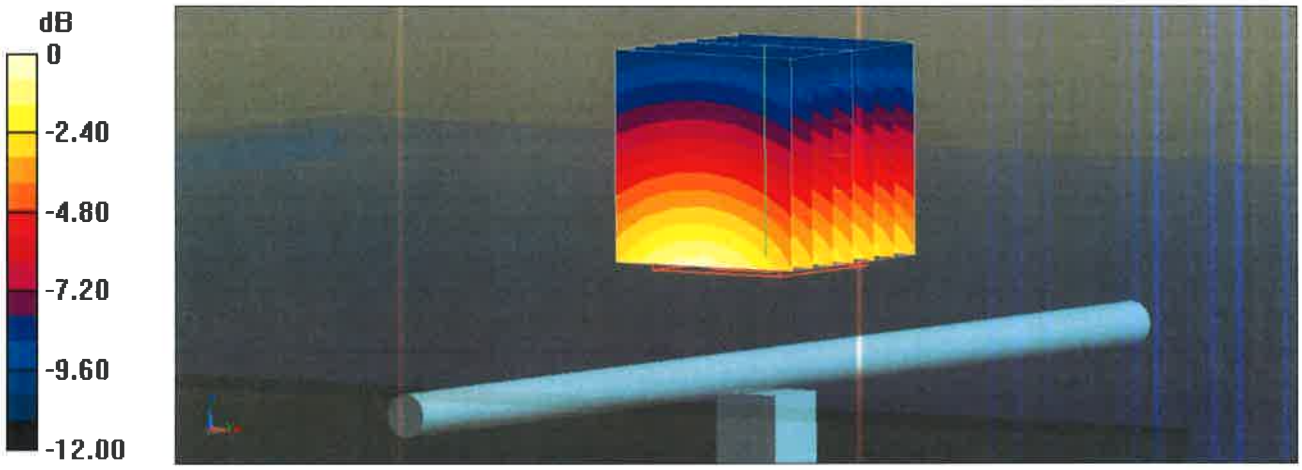
Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: f = 750 MHz; $\sigma = 0.91$ S/m; $\varepsilon_r = 42.4$; $\rho = 1000$ kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.07, 10.07, 10.07); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

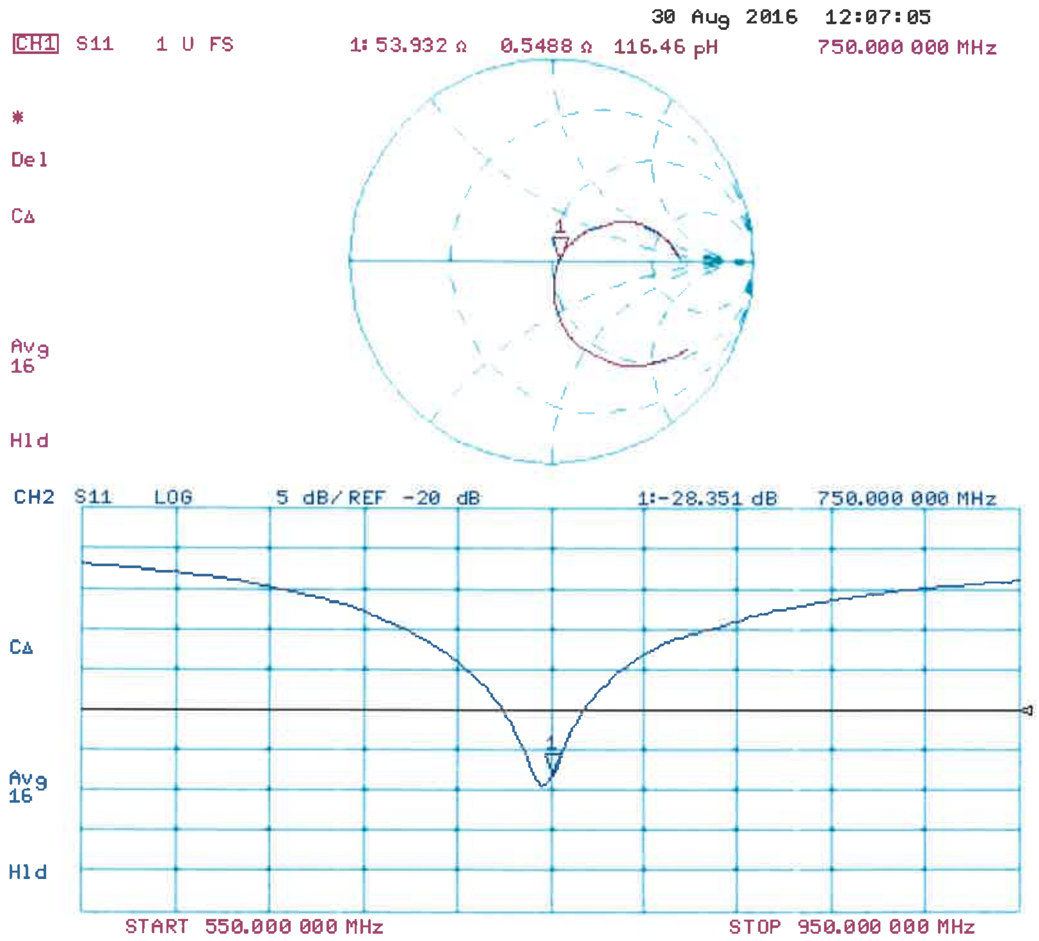
### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 58.15 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 3.12 W/kg
**SAR(1 g) = 2.09 W/kg; SAR(10 g) = 1.36 W/kg**
Maximum value of SAR (measured) = 2.78 W/kg




0 dB = 2.78 W/kg = 4.44 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 30.08.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1013**

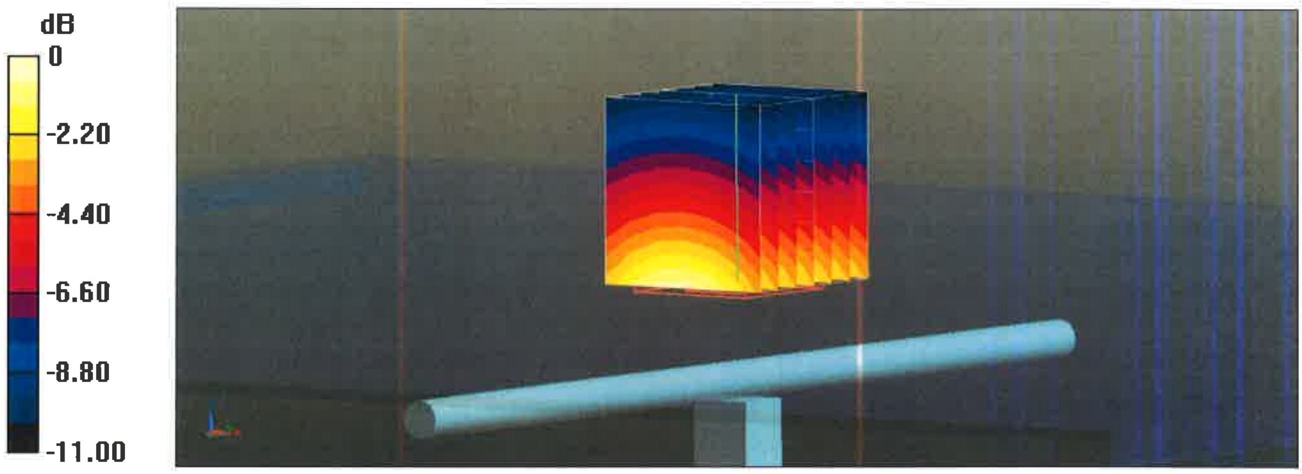
Communication System: UID 0 - CW; Frequency: 750 MHz
Medium parameters used: f = 750 MHz; $\sigma = 0.99$ S/m; $\varepsilon_r = 54.9$; $\rho = 1000$ kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.99, 9.99, 9.99); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

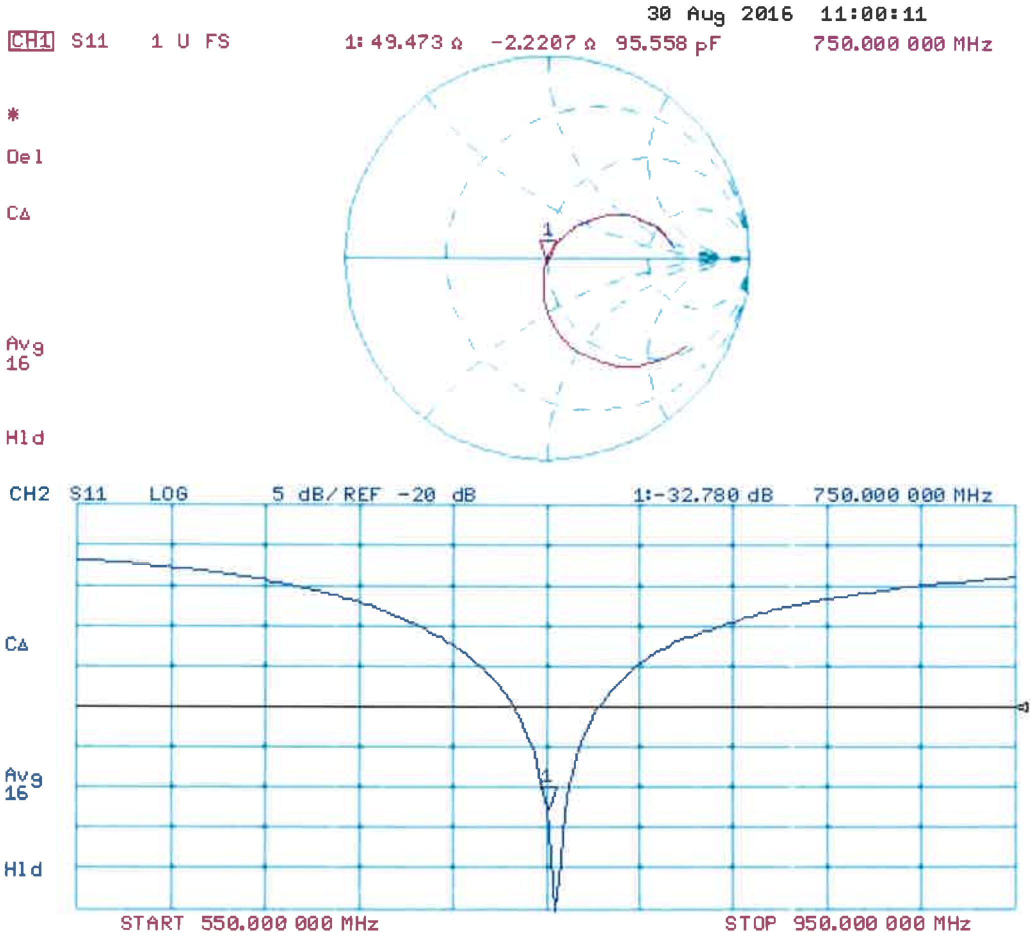
## Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 57.64 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 3.40 W/kg
**SAR(1 g) = 2.25 W/kg; SAR(10 g) = 1.47 W/kg**
Maximum value of SAR (measured) = 3.01 W/kg




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

## Impedance Measurement Plot for Body TSL



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

**S** **Schweizerischer Kalibrierdienst**
**C** **Service suisse d'étalonnage**
**S** **Servizio svizzero di taratura**
**Swiss Calibration Service**

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

**Accreditation No.: SCS 0108**

**Client** **B.V. ADT (Auden)**

**Certificate No: D835V2-4d121_Aug16**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D835V2 - SN:4d121 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | August 25, 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 (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 06-Apr-16 (No. 217-02288/02289) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103244 | 06-Apr-16 (No. 217-02288) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103245 | 06-Apr-16 (No. 217-02289) | Apr-17 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 05-Apr-16 (No. 217-02292) | Apr-17 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 05-Apr-16 (No. 217-02295) | Apr-17 |
| Reference Probe EX3DV4 | SN: 7349 | 15-Jun-16 (No. EX3-7349_Jun16) | Jun-17 |
| DAE4 | SN: 601 | 30-Dec-15 (No. DAE4-601_Dec15) | Dec-16 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power meter EPM-442A | SN: GB37480704 | 07-Oct-15 (No. 217-02222) | In house check: Oct-16 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (No. 217-02222) | In house check: Oct-16 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (No. 217-02223) | In house check: Oct-16 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Jun-15) | In house check: Oct-16 |
| Network Analyzer HP 8753E | SN: US37390585 | 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 |

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

Issued: August 29, 2016

## Glossary:

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

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, “IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”, June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, “SAR Measurement Requirements for 100 MHz to 6 GHz”

## Additional Documentation:

e) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.8.8 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 15 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 835 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 41.5 | 0.90 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 42.1 ± 6 % | 0.93 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 2.40 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **9.40 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.54 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **6.05 W/kg ± 16.5 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 55.2 | 0.97 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 54.7 ± 6 % | 1.01 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 2.47 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **9.57 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.61 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **6.28 W/kg ± 16.5 % (k=2)** |

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 51.3 Ω - 3.4 jΩ |
| Return Loss | - 29.0 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 47.5 Ω - 5.4 jΩ |
| Return Loss | - 24.3 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.394 ns |

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | June 29, 2010 |

## DASY5 Validation Report for Head TSL

Date: 25.08.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d121**

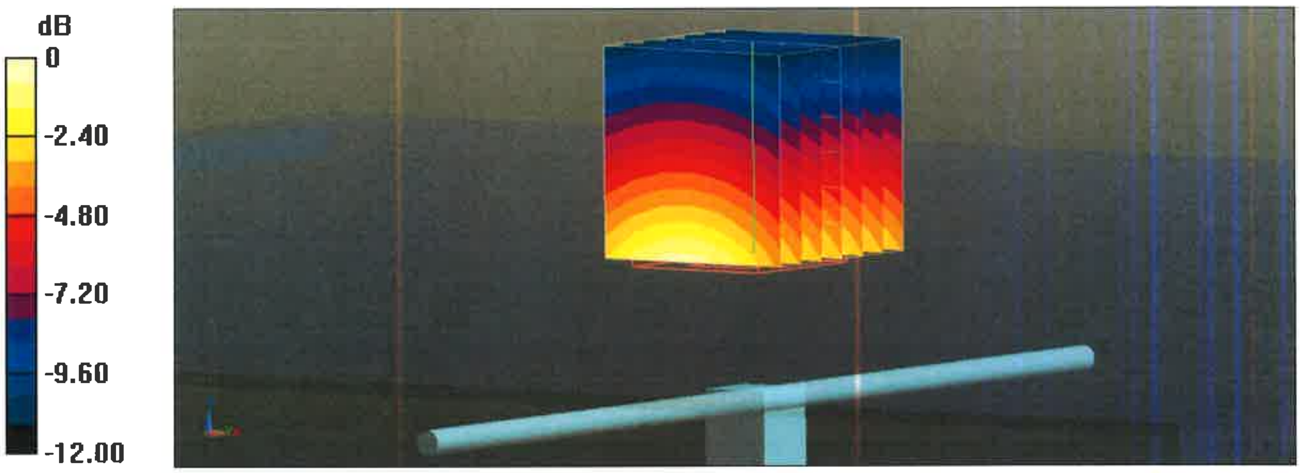
Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; $\sigma$ = 0.93 S/m; $\varepsilon_r$ = 42.1; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.72, 9.72, 9.72); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

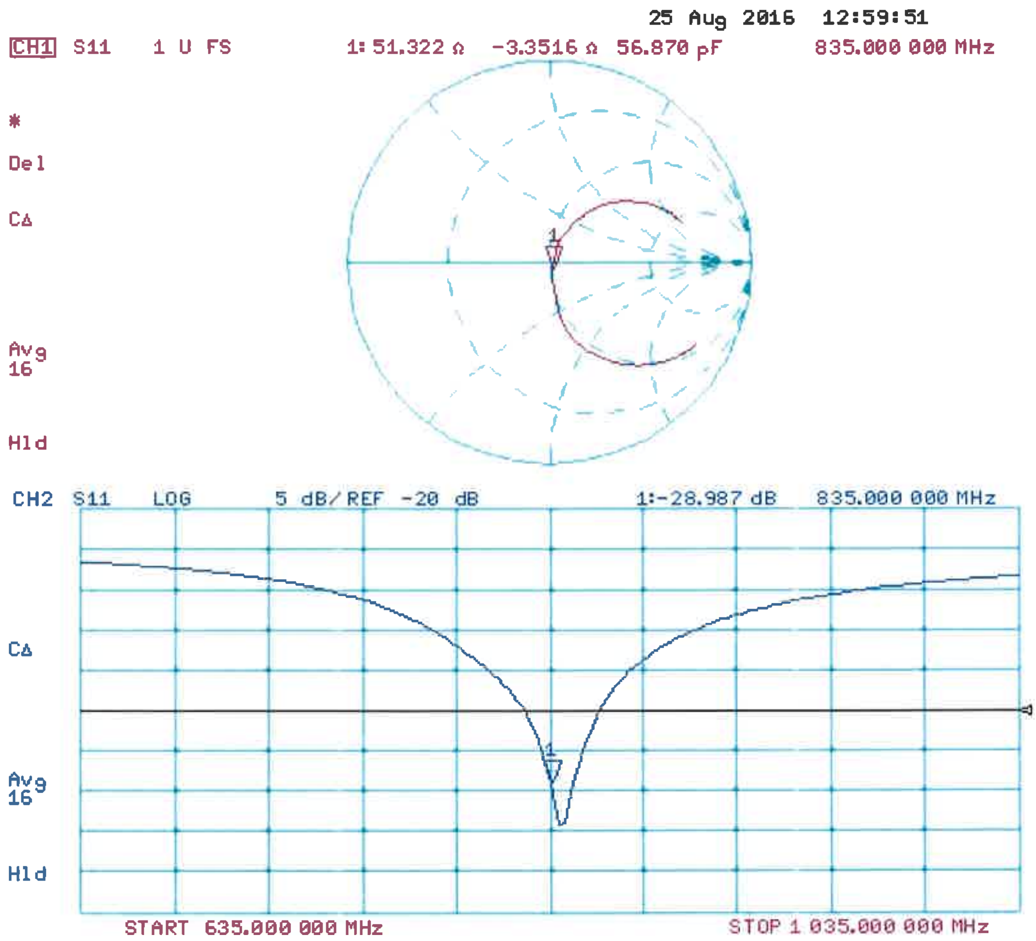
### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 61.81 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 3.64 W/kg
**SAR(1 g) = 2.4 W/kg; SAR(10 g) = 1.54 W/kg**
Maximum value of SAR (measured) = 3.21 W/kg




0 dB = 3.21 W/kg = 5.07 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 25.08.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d121**

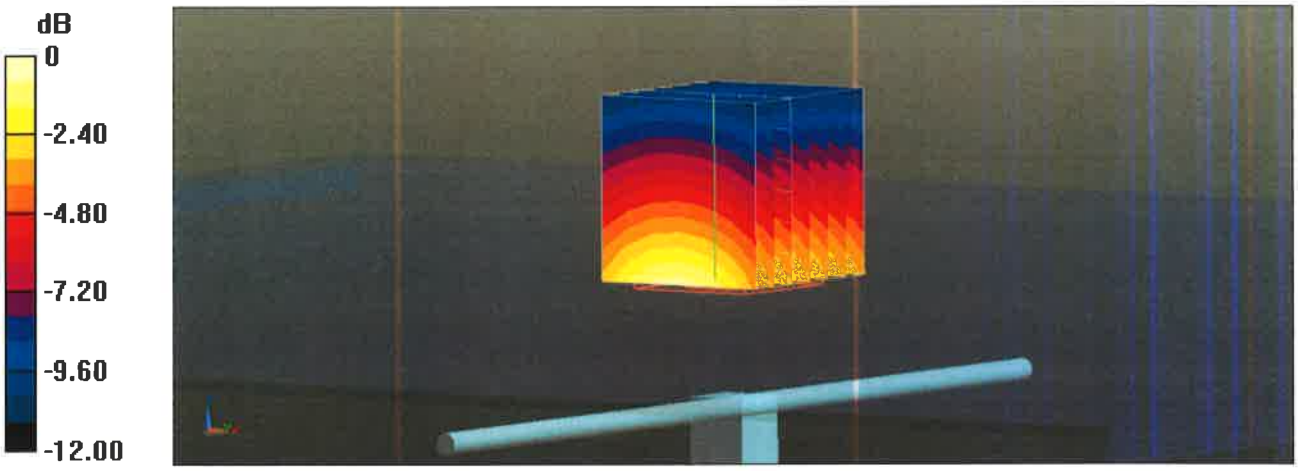
Communication System: UID 0 - CW; Frequency: 835 MHz
Medium parameters used: f = 835 MHz; $\sigma$ = 1.01 S/m; $\varepsilon_r$ = 54.7; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.73, 9.73, 9.73); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

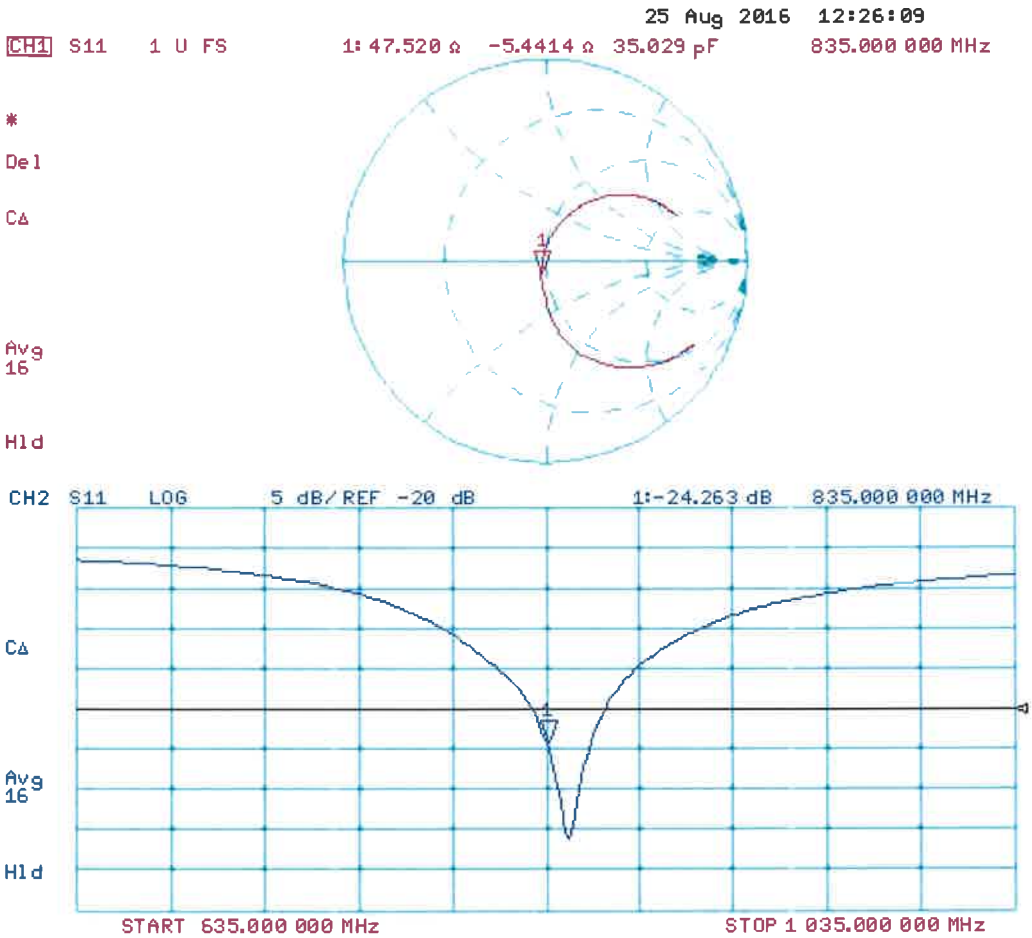
### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 60.17 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 3.63 W/kg
**SAR(1 g) = 2.47 W/kg; SAR(10 g) = 1.61 W/kg**
Maximum value of SAR (measured) = 3.26 W/kg




0 dB = 3.26 W/kg = 5.13 dBW/kg

# Impedance Measurement Plot for Body TSL



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

**S** **Schweizerischer Kalibrierdienst**
**C** **Service suisse d'étalonnage**
**S** **Servizio svizzero di taratura**
**Swiss Calibration Service**

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

**Accreditation No.: SCS 0108**

**Client** **B.V. ADT (Auden)**

**Certificate No: D1750V2-1055_Aug16**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1750V2 - SN:1055 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | August 31, 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 (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 06-Apr-16 (No. 217-02288/02289) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103244 | 06-Apr-16 (No. 217-02288) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103245 | 06-Apr-16 (No. 217-02289) | Apr-17 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 05-Apr-16 (No. 217-02292) | Apr-17 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 05-Apr-16 (No. 217-02295) | Apr-17 |
| Reference Probe EX3DV4 | SN: 7349 | 15-Jun-16 (No. EX3-7349_Jun16) | Jun-17 |
| DAE4 | SN: 601 | 30-Dec-15 (No. DAE4-601_Dec15) | Dec-16 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power meter EPM-442A | SN: GB37480704 | 07-Oct-15 (No. 217-02222) | In house check: Oct-16 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (No. 217-02222) | In house check: Oct-16 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (No. 217-02223) | In house check: Oct-16 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Jun-15) | In house check: Oct-16 |
| Network Analyzer HP 8753E | SN: US37390585 | 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Johannes Kurikka | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: August 31, 2016

## Glossary:

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

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, “IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”, June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, “SAR Measurement Requirements for 100 MHz to 6 GHz”

## Additional Documentation:

e) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.8.8 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 1750 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 40.1 | 1.37 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 40.3 ± 6 % | 1.37 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 9.22 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **36.9 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 4.87 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **19.5 W/kg ± 16.5 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 53.4 | 1.49 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 53.1 ± 6 % | 1.49 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 9.39 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **37.5 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.02 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **20.1 W/kg ± 16.5 % (k=2)** |

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 50.6 Ω + 1.3 jΩ |
| Return Loss | - 37.2 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 47.4 Ω + 1.1 jΩ |
| Return Loss | - 30.6 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.223 ns |

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | February 19, 2010 |

## DASY5 Validation Report for Head TSL

Date: 24.08.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN:1055**

Communication System: UID 0 - CW; Frequency: 1750 MHz
Medium parameters used: f = 1750 MHz; $\sigma$ = 1.37 S/m; $\varepsilon_r$ = 40.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

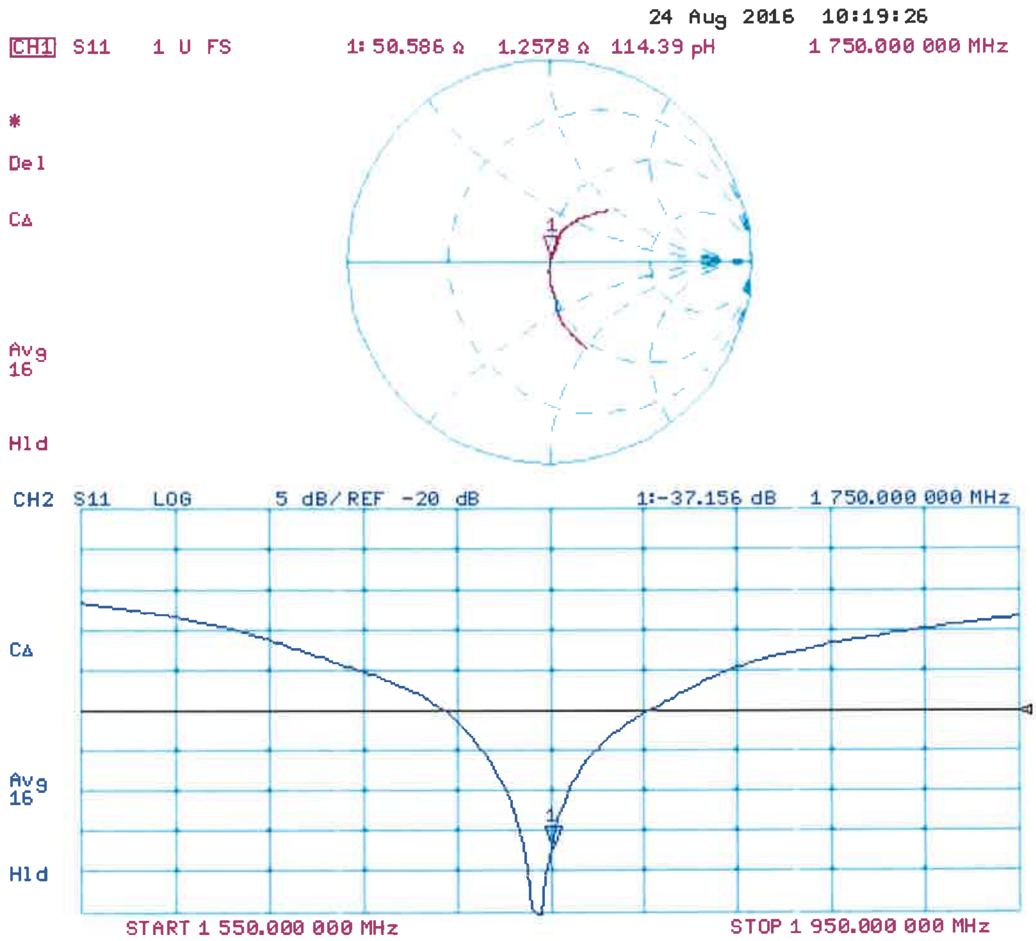
- Probe: EX3DV4 - SN7349; ConvF(8.46, 8.46, 8.46); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 105.4 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 17.1 W/kg
**SAR(1 g) = 9.22 W/kg; SAR(10 g) = 4.87 W/kg**
Maximum value of SAR (measured) = 14.3 W/kg


0 dB = 14.3 W/kg = 11.55 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 31.08.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN:1055**

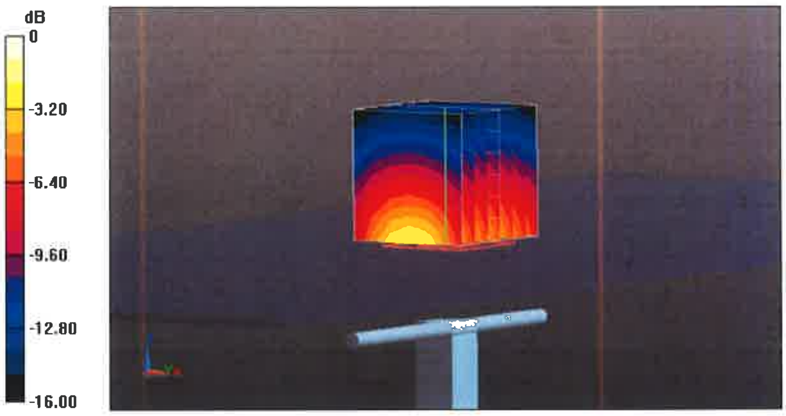
Communication System: UID 0 - CW; Frequency: 1750 MHz
Medium parameters used: f = 1750 MHz; $\sigma$ = 1.49 S/m; $\varepsilon_r$ = 53.1; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.25, 8.25, 8.25); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

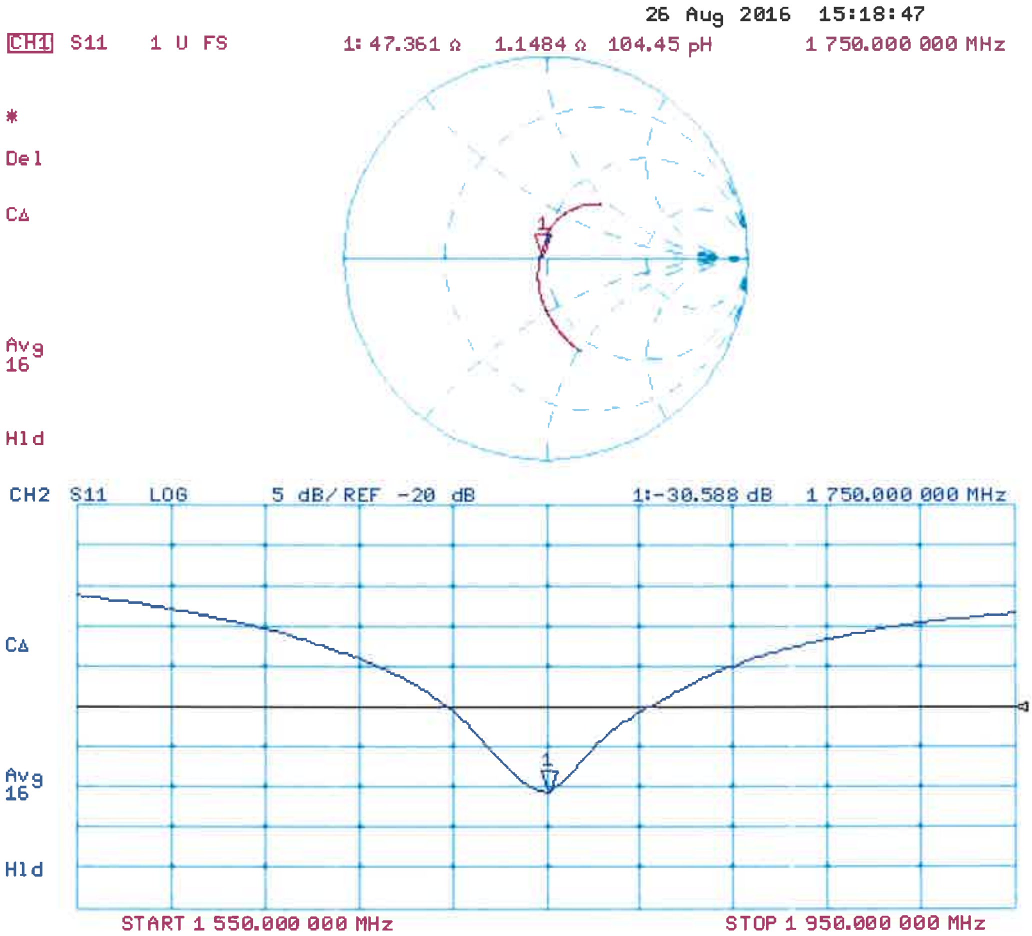
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 101.4 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 16.5 W/kg
**SAR(1 g) = 9.39 W/kg; SAR(10 g) = 5.02 W/kg**
Maximum value of SAR (measured) = 14.2 W/kg




0 dB = 14.2 W/kg = 11.52 dBW/kg

## Impedance Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** Swiss Calibration Service

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

**Accreditation No.: SCS 0108**

**Client** **B.V. ADT (Auden)**

**Certificate No: D1900V2-5d036_Jan16**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1900V2 - SN: 5d036 |
| Calibration procedure(s) | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |
| Calibration date: | January 22, 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 (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter EPM-442A | GB37480704 | 07-Oct-15 (No. 217-02222) | Oct-16 |
| Power sensor HP 8481A | US37292783 | 07-Oct-15 (No. 217-02222) | Oct-16 |
| Power sensor HP 8481A | MY41092317 | 07-Oct-15 (No. 217-02223) | Oct-16 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 01-Apr-15 (No. 217-02131) | Mar-16 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 01-Apr-15 (No. 217-02134) | Mar-16 |
| Reference Probe EX3DV4 | SN: 7349 | 31-Dec-15 (No. EX3-7349_Dec15) | Dec-16 |
| DAE4 | SN: 601 | 30-Dec-15 (No. DAE4-601_Dec15) | Dec-16 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| RF generator R&S SMT-06 | 100972 | 15-Jun-15 (in house check Jun-15) | In house check: Jun-18 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 |

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

Issued: January 25, 2016

## Glossary:

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

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## Additional Documentation:

e) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.8.8 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 1900 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 40.0 | 1.40 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 39.3 ± 6 % | 1.39 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 9.73 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **38.9 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.10 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **20.4 W/kg ± 16.5 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 53.3 | 1.52 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 52.7 ± 6 % | 1.52 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 10.2 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **40.7 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.36 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **21.4 W/kg ± 16.5 % (k=2)** |

## Appendix (Additional assessments outside the scope of SCS 0108)

## Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 52.1 Ω + 5.3 jΩ |
| Return Loss | - 25.0 dB |

## Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 47.7 Ω + 6.9 jΩ |
| Return Loss | - 22.6 dB |

## General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.195 ns |

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

## Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | May 08, 2003 |

## DASY5 Validation Report for Head TSL

Date: 22.01.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d036**

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.39 S/m; $\varepsilon_r$ = 39.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

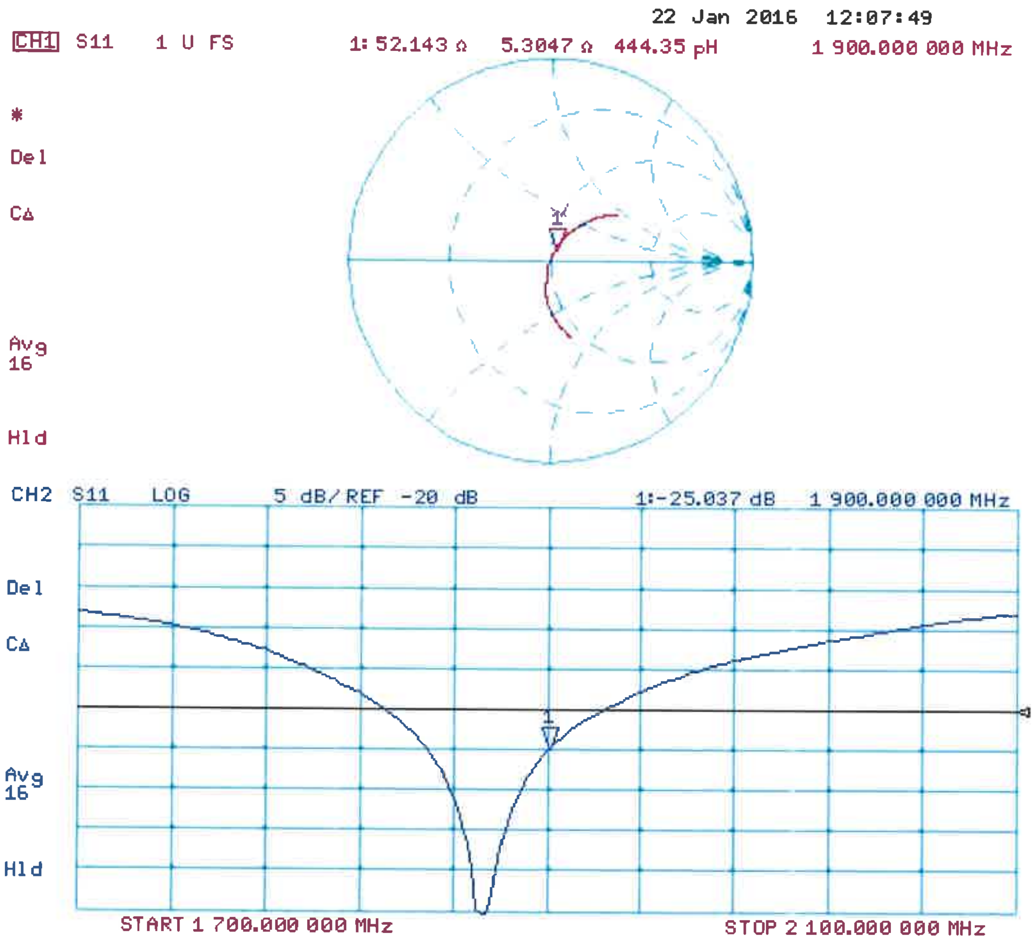
- Probe: EX3DV4 - SN7349; ConvF(8.2, 8.2, 8.2); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 107.9 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 17.8 W/kg
**SAR(1 g) = 9.73 W/kg; SAR(10 g) = 5.1 W/kg**
Maximum value of SAR (measured) = 14.8 W/kg


0 dB = 14.8 W/kg = 11.70 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 20.01.2016

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d036**

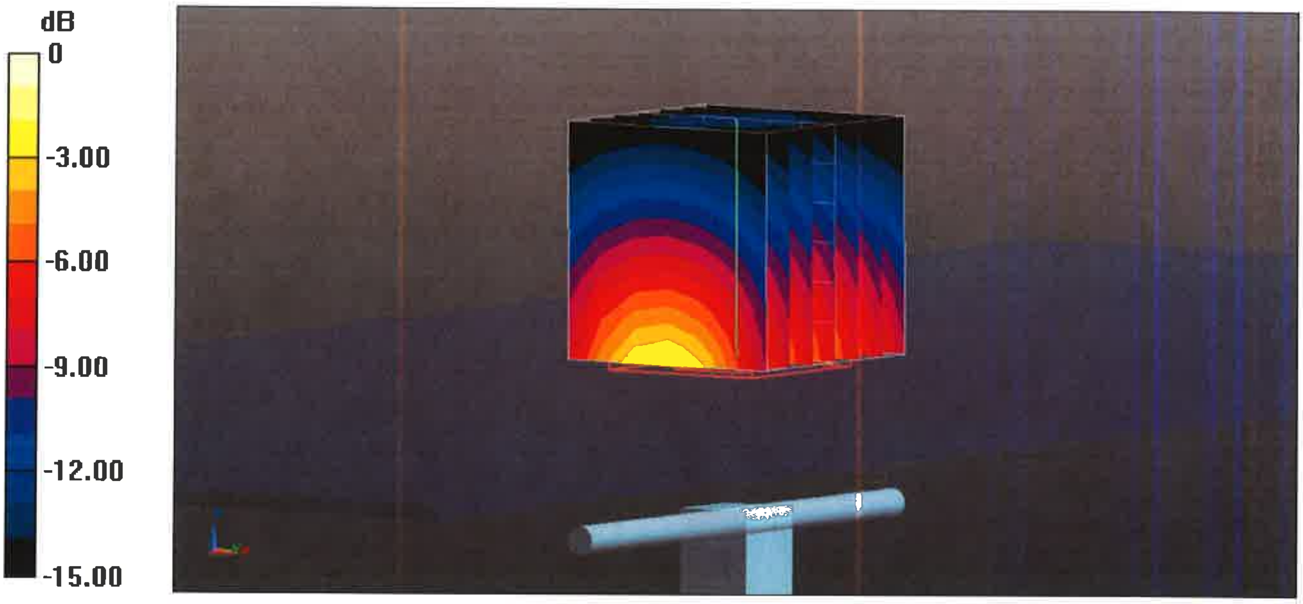
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.52 S/m; $\varepsilon_r$ = 52.7; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.03, 8.03, 8.03); Calibrated: 31.12.2015;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

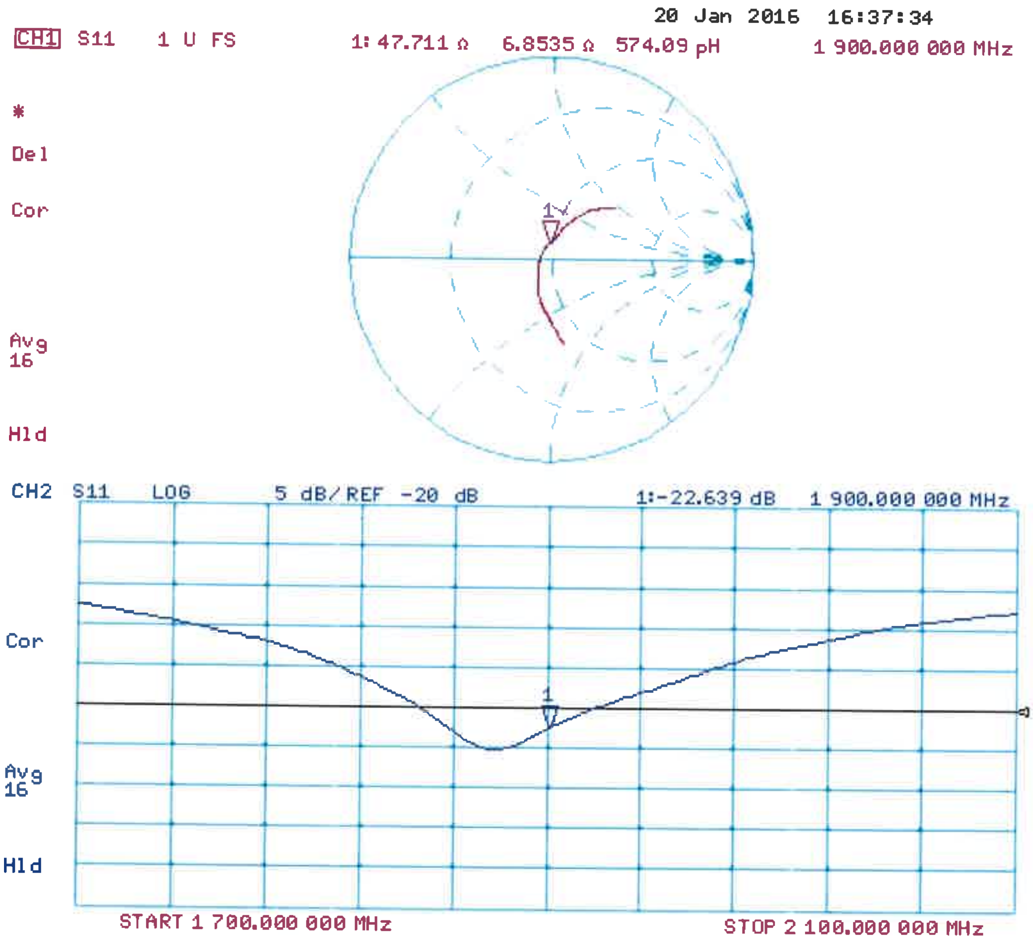
### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 105.0 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 18.0 W/kg
**SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.36 W/kg**
Maximum value of SAR (measured) = 15.3 W/kg




0 dB = 15.3 W/kg = 11.85 dBW/kg

## Impedance Measurement Plot for Body TSL



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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
**S** Servizio svizzero di taratura
Swiss Calibration Service

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

**Accreditation No.: SCS 0108**

**Client** **BV ADT (Auden)**

**Certificate No: ET3-1790_Jun16**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | ET3DV6 - SN:1790 |
| Calibration procedure(s) | QA CAL-01.v9, QA CAL-23.v5, QA CAL-25.v6<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | June 24, 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 (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 06-Apr-16 (No. 217-02288/02289) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103244 | 06-Apr-16 (No. 217-02288) | Apr-17 |
| Power sensor NRP-Z91 | SN: 103245 | 06-Apr-16 (No. 217-02289) | Apr-17 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 05-Apr-16 (No. 217-02293) | Apr-17 |
| Reference Probe ES3DV2 | SN: 3013 | 31-Dec-15 (No. ES3-3013_Dec15) | Dec-16 |
| DAE4 | SN: 660 | 23-Dec-15 (No. DAE4-660_Dec15) | Dec-16 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB41293874 | 06-Apr-16 (in house check Jun-16) | In house check: Jun-18 |
| Power sensor E4412A | SN: MY41498087 | 06-Apr-16 (in house check Jun-16) | In house check: Jun-18 |
| Power sensor E4412A | SN: 000110210 | 06-Apr-16 (in house check Jun-16) | In house check: Jun-18 |
| RF generator HP 8648C | SN: US3642U01700 | 04-Aug-99 (in house check Jun-16) | In house check: Jun-18 |
| Network Analyzer HP 8753E | SN: US37390585 | 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Leif Klysner | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: June 27, 2016

## Glossary:

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

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## Methods Applied and Interpretation of Parameters:

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

# Probe ET3DV6

# SN:1790

Manufactured: May 28, 2003
Calibrated: June 24, 2016

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

# DASY/EASY - Parameters of Probe: ET3DV6 - SN:1790

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 2.16 | 2.10 | 1.75 | ± 10.1 % |
| DCP (mV)[B] | 100.0 | 100.1 | 99.6 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 290.6 | ±3.5 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 278.4 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 263.0 | |

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%.

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

# DASY/EASY - Parameters of Probe: ET3DV6 - SN:1790

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 41.9 | 0.89 | 7.03 | 7.03 | 7.03 | 0.37 | 2.48 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.71 | 6.71 | 6.71 | 0.37 | 2.37 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 6.53 | 6.53 | 6.53 | 0.38 | 2.42 | ± 12.0 % |
| 1640 | 40.3 | 1.29 | 5.70 | 5.70 | 5.70 | 0.53 | 2.61 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.57 | 5.57 | 5.57 | 0.65 | 2.25 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 5.35 | 5.35 | 5.35 | 0.80 | 2.08 | ± 12.0 % |
| 2000 | 40.0 | 1.40 | 5.25 | 5.25 | 5.25 | 0.80 | 2.05 | ± 12.0 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters ($\varepsilon$ 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 ($\varepsilon$ and $\sigma$) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

# DASY/EASY - Parameters of Probe: ET3DV6 - SN:1790

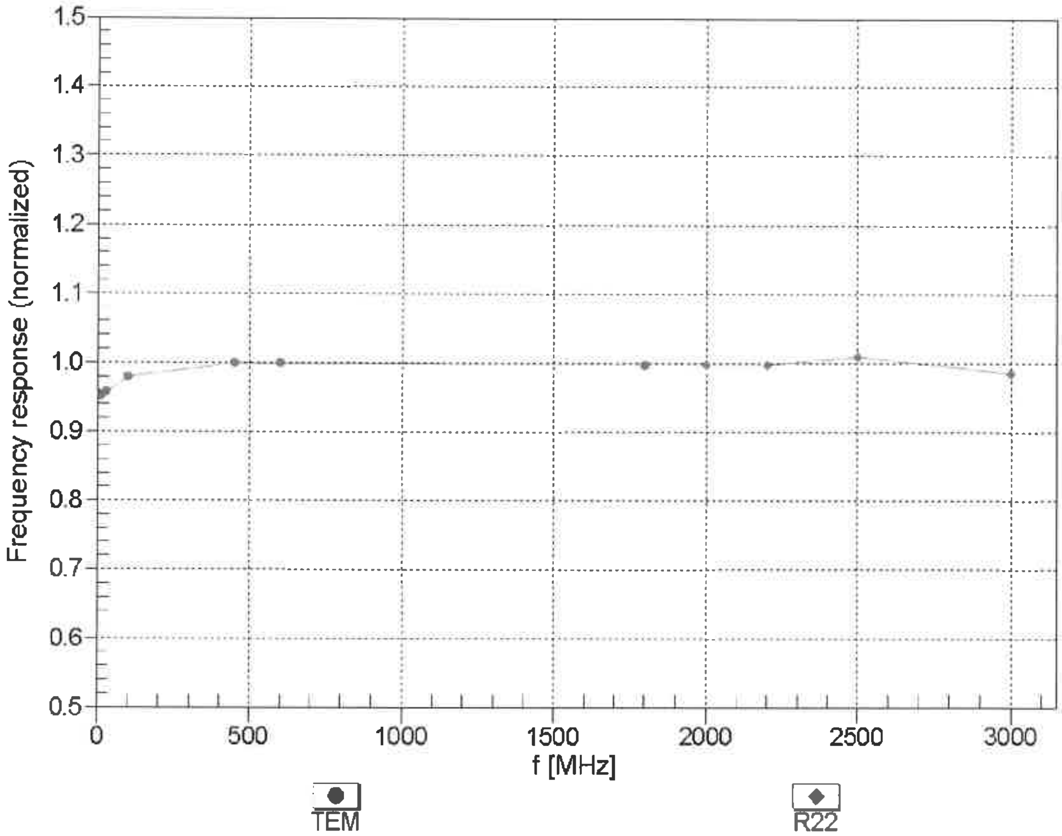
## Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 55.5 | 0.96 | 6.44 | 6.44 | 6.44 | 0.40 | 2.24 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.37 | 6.37 | 6.37 | 0.33 | 2.57 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 6.35 | 6.35 | 6.35 | 0.40 | 2.40 | ± 12.0 % |
| 1640 | 53.8 | 1.40 | 5.26 | 5.26 | 5.26 | 0.63 | 2.79 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 4.94 | 4.94 | 4.94 | 0.80 | 2.37 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.74 | 4.74 | 4.74 | 0.80 | 2.31 | ± 12.0 % |
| 2000 | 53.3 | 1.52 | 4.85 | 4.85 | 4.85 | 0.80 | 2.26 | ± 12.0 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters ($\varepsilon$ 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 ($\varepsilon$ and $\sigma$) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

# Frequency Response of E-Field

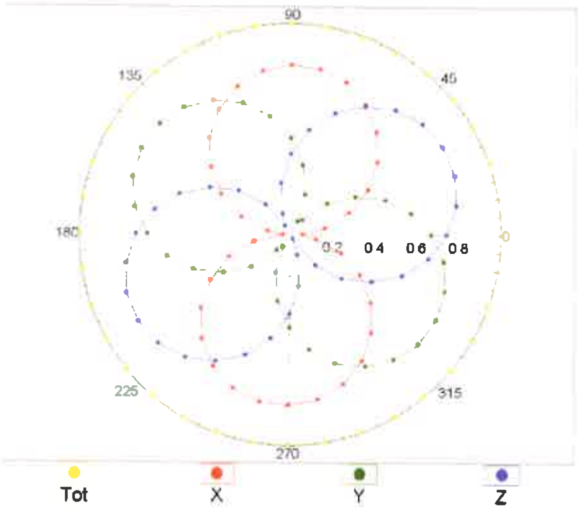
**(TEM-Cell:ifi110 EXX, Waveguide: R22)**



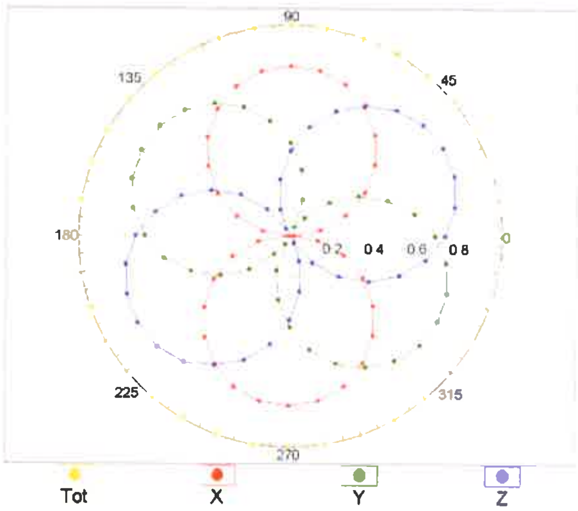

**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

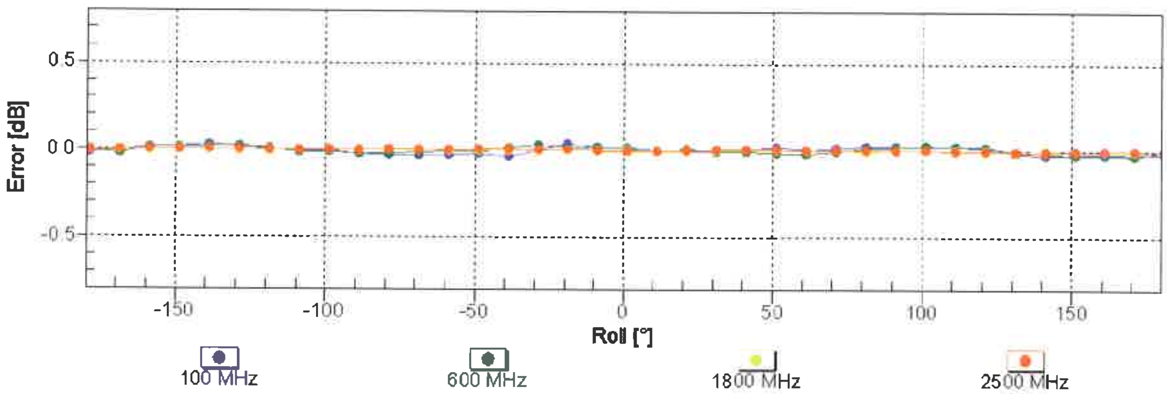
# Receiving Pattern (ϕ), $\vartheta = 0°$

f=600 MHz,TEM



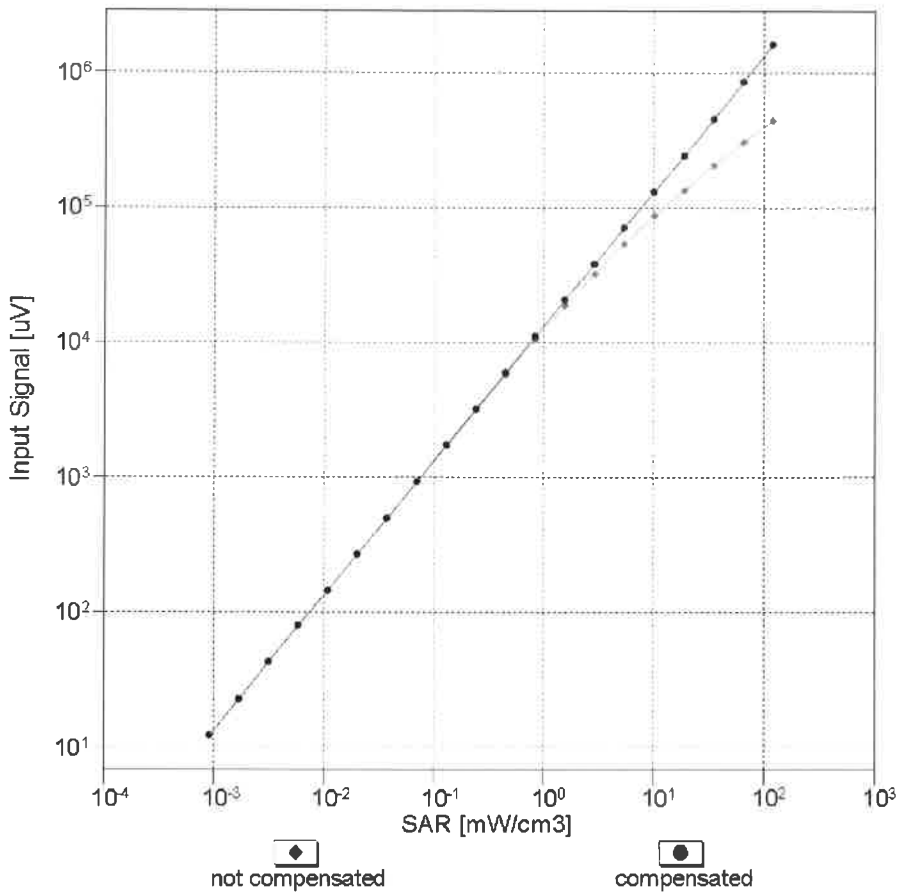

f=1800 MHz,R22

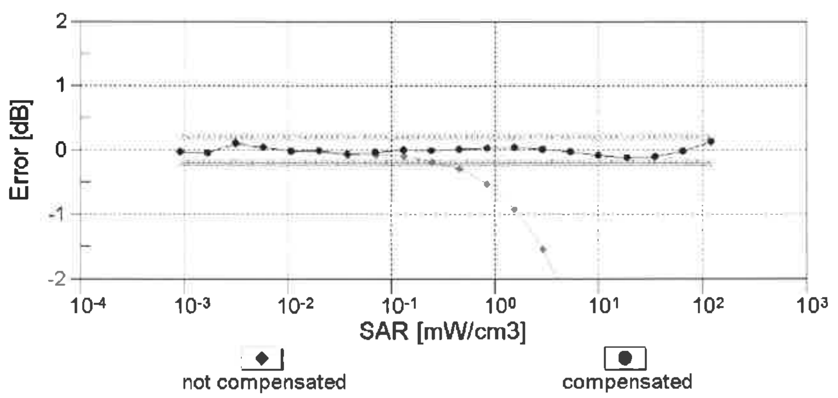



**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

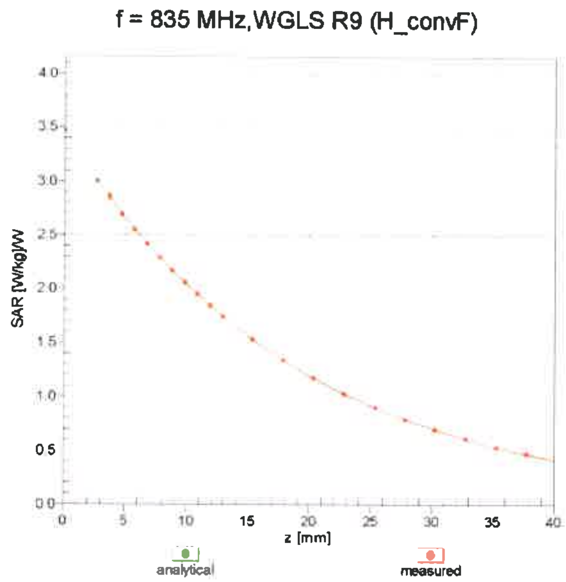
# Dynamic Range f($SAR_{head}$)
**(TEM cell , $f_{eval}$= 1900 MHz)**

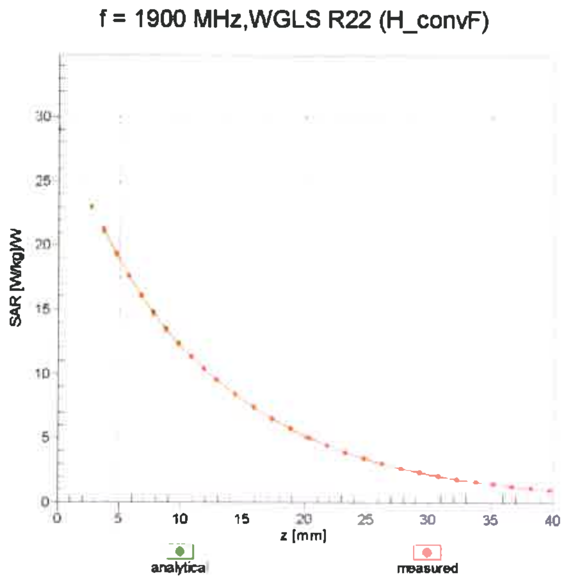



**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

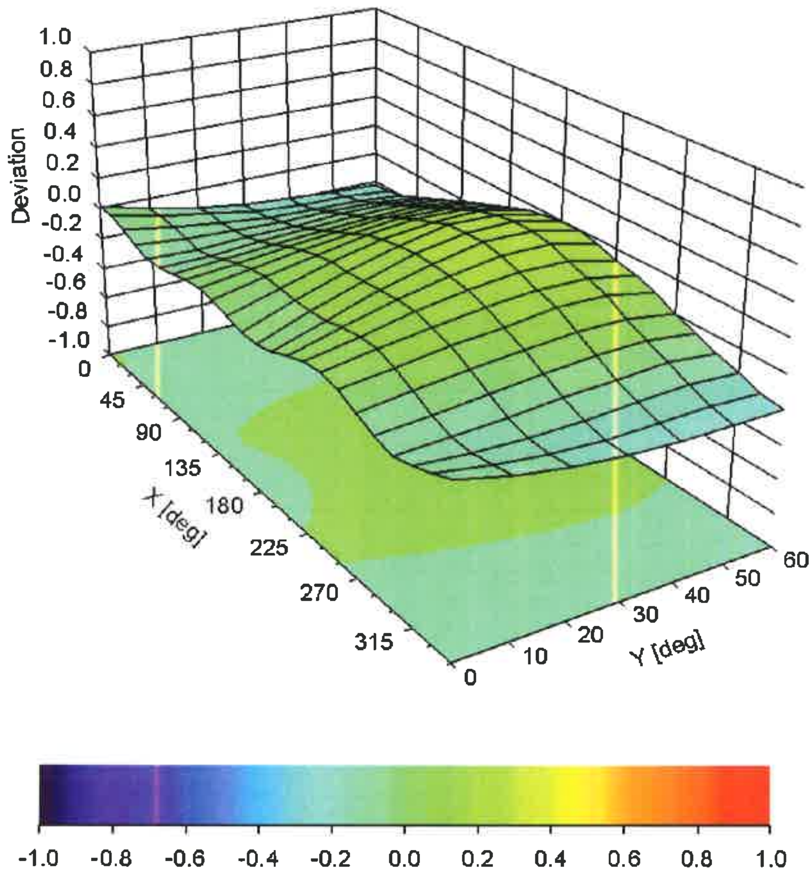
# Conversion Factor Assessment




# Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




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

# DASY/EASY - Parameters of Probe: ET3DV6 - SN:1790

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -18.8 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 10 mm |
| Tip Diameter | 6.8 mm |
| Probe Tip to Sensor X Calibration Point | 2.7 mm |
| Probe Tip to Sensor Y Calibration Point | 2.7 mm |
| Probe Tip to Sensor Z Calibration Point | 2.7 mm |
| Recommended Measurement Distance from Surface | 4 mm |