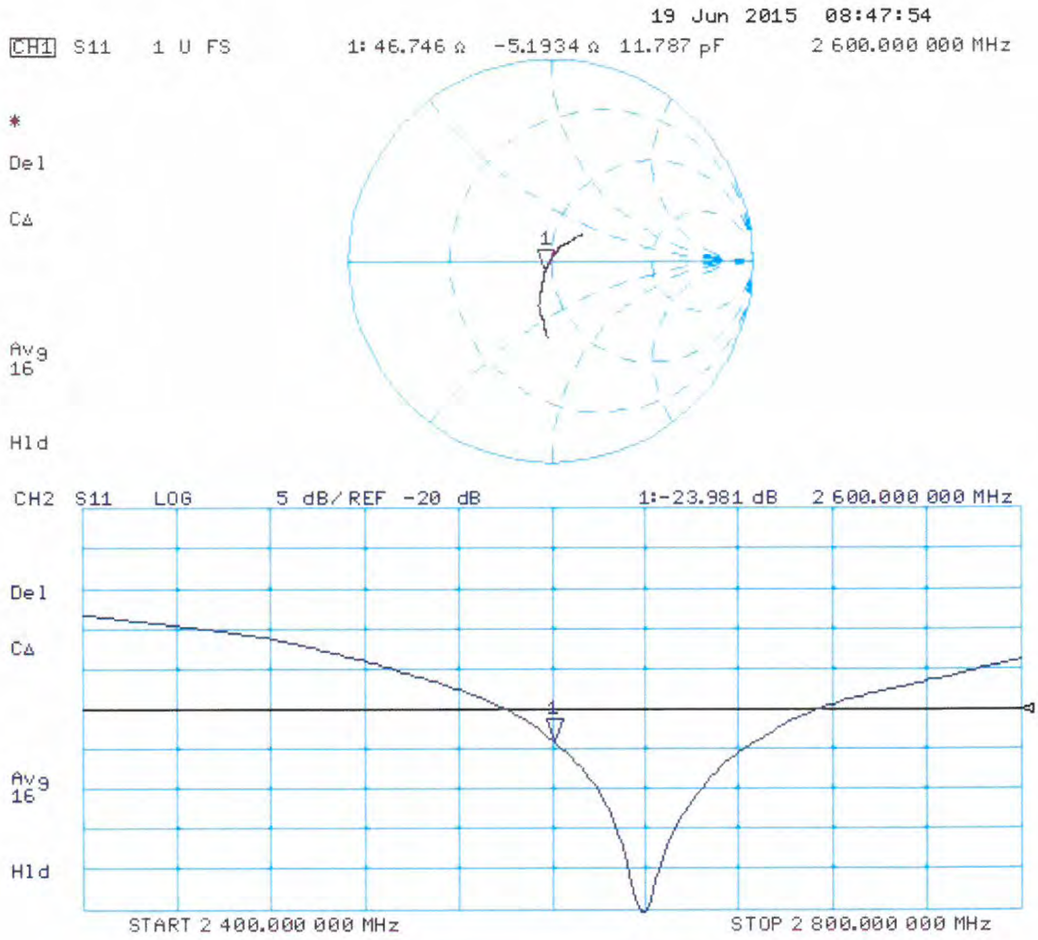
## Impedance Measurement Plot for Body TSL



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ilac-MRA CNAS CALIBRATION No. L0570

Client **Bureau Veritas(Auden)** **Certificate No: Z14-97141**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D5GHzV2 - SN: 1133 |
| Calibration Procedure(s) | TMC-OS-E-02-194<br>Calibration Procedures for dipole validation kits |
| Calibration date: | November 6, 2014 |

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power Meter NRVD | 102083 | 16-Sep-14 (TMC, No.J14X03421) | Sep -15 |
| Power sensor NRV-Z5 | 100595 | 16-Sep-14 (TMC, No. J14X03421) | Sep -15 |
| Reference Probe EX3DV4 | SN 3846 | 24-Sep-14(SPEAG,No.EX3-3846_Sep14) | Sep -15 |
| DAE3 | SN 536 | 23-Jan-14 (SPEAG, DAE3-536_Jan14) | Jan -15 |
| **Secondary Standards** | **ID #** | **Cal Date(Calibrated by, Certificate No.)** | **Scheduled Calibration** |
| Signal Generator E4438C | MY49071430 | 10-Feb-14 (TMC, No.JZ14-808) | Feb-15 |
| Network Analyzer N5230C | MY49000861 | 2-Jan-14 (TMC, No.JZ13-633) | Jan-15 |

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

Issued: November 8, 2014

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**Glossary:**

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

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

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

b) IEC 62209-2, "Evaluation of Human Exposure to Radio Frequency Field from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6GHz: Human models, Instrumentation, and Procedures"; Part 2:"Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", March 2010

c) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

**Additional Documentation:**

d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

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## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY52 | 52.8.8.1222 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Triple Flat Phantom 5.1C | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy = 4 mm, dz = 1.4 mm | Graded Ratio = 1.4 (Z direction) |
| **Frequency** | 5200 MHz ± 1 MHz<br>5300 MHz ± 1 MHz<br>5500 MHz ± 1 MHz<br>5600 MHz ± 1 MHz<br>5800 MHz ± 1 MHz | |

## Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 36.0 | 4.66 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 35.8 ± 6 % | 4.58 mho/m ± 6 % |
| **Head TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Head TSL at 5200 MHz

| | | |
|---|---|---|
| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
| SAR measured | 100 mW input power | 7.73 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **77.2 mW /g ± 23.0 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 100 mW input power | 2.24 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **22.3 mW /g ± 22.2 % (k=2)** |

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## Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.9 | 4.76 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 35.3 ± 6 % | 4.71 mho/m ± 6 % |
| **Head TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Head TSL at 5300 MHz

| | | |
|---|---|---|
| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
| SAR measured | 100 mW input power | 7.99 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **79.6 mW /g ± 23.0 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 100 mW input power | 2.29 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **22.8 mW /g ± 22.2 % (k=2)** |

## Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.6 | 4.96 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.9 ± 6 % | 4.85 mho/m ± 6 % |
| **Head TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Head TSL at 5500 MHz

| | | |
|---|---|---|
| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
| SAR measured | 100 mW input power | 8.15 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **81.1 mW /g ± 23.0 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 100 mW input power | 2.33 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **23.2 mW /g ± 22.2 % (k=2)** |

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## Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.5 | 5.07 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 35.1 ± 6 % | 4.94 mho/m ± 6 % |
| **Head TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Head TSL at 5600 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.27 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **82.4 mW /g ± 23.0 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 100 mW input power | 2.39 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **23.8 mW /g ± 22.2 % (k=2)** |

## Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 35.3 | 5.27 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 34.9 ± 6 % | 5.36 mho/m ± 6 % |
| **Head TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Head TSL at 5800 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.04 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **80.3 mW /g ± 23.0 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 100 mW input power | 2.30 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **23.0 mW /g ± 22.2 % (k=2)** |

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## Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 49.0 | 5.30 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 49.6 ± 6 % | 5.37 mho/m ± 6 % |
| **Body TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Body TSL at 5200 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.34 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **73.6 mW /g ± 23.0 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | Condition | |
| SAR measured | 100 mW input power | 2.08 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **20.9 mW /g ± 22.2 % (k=2)** |

## Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.9 | 5.42 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 49.5 ± 6 % | 5.49 mho/m ± 6 % |
| **Body TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Body TSL at 5300 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.45 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **74.7 mW /g ± 23.0 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | Condition | |
| SAR measured | 100 mW input power | 2.11 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **21.2 mW /g ± 22.2 % (k=2)** |

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## Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.6 | 5.65 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 49.3 ± 6 % | 5.58 mho/m ± 6 % |
| **Body TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Body TSL at 5500 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.98 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **80.0 mW /g ± 23.0 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | Condition | |
| SAR measured | 100 mW input power | 2.24 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **22.5 mW /g ± 22.2 % (k=2)** |

## Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.5 | 5.77 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 49.5 ± 6 % | 5.71 mho/m ± 6 % |
| **Body TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Body TSL at 5600 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 8.17 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **82.0 mW /g ± 23.0 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | Condition | |
| SAR measured | 100 mW input power | 2.30 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **23.1 mW /g ± 22.2 % (k=2)** |

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## Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 48.2 | 6.00 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 48.7 ± 6 % | 5.92 mho/m ± 6 % |
| **Body TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Body TSL at 5800 MHz

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 100 mW input power | 7.39 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **74.0 mW /g ± 23.0 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | Condition | |
| SAR measured | 100 mW input power | 2.07 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **20.8 mW /g ± 22.2 % (k=2)** |

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## Appendix

### Antenna Parameters with Head TSL at 5200 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 42.3Ω + 1.71jΩ |
| Return Loss | - 21.4dB |

### Antenna Parameters with Head TSL at 5300 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 44.5Ω + 2.71jΩ |
| Return Loss | - 23.7dB |

### Antenna Parameters with Head TSL at 5500 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 46.0Ω - 1.90jΩ |
| Return Loss | - 26.7dB |

### Antenna Parameters with Head TSL at 5600 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 47.1Ω - 3.20jΩ |
| Return Loss | - 27.1dB |

### Antenna Parameters with Head TSL at 5800 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 43.3Ω - 1.57jΩ |
| Return Loss | - 22.7dB |

### Antenna Parameters with Body TSL at 5200 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 43.0Ω + 1.37jΩ |
| Return Loss | - 22.3dB |

### Antenna Parameters with Body TSL at 5300 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 46.7Ω + 1.91jΩ |
| Return Loss | - 28.0dB |

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## Antenna Parameters with Body TSL at 5500 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 47.2Ω - 3.46jΩ |
| Return Loss | - 26.8dB |

## Antenna Parameters with Body TSL at 5600 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 47.7Ω - 4.27jΩ |
| Return Loss | - 26.1dB |

## Antenna Parameters with Body TSL at 5800 MHz

| | |
|---|---|
| Impedance, transformed to feed point | 43.7Ω - 2.65jΩ |
| Return Loss | - 22.7dB |

## General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.239 ns |

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

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

## Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |

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**DASY5 Validation Report for Head TSL** Date: 06.11.2014

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1133**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz,

Medium parameters used: f = 5200 MHz; σ = 4.58 mho/m; εr = 35.76; ρ = 1000 kg/m3, Medium parameters used: f = 5300 MHz; σ = 4.71 mho/m; εr = 35.31; ρ = 1000 kg/m3, Medium parameters used: f = 5500 MHz; σ = 4.85 mho/m; εr = 34.9; ρ = 1000 kg/m3, Medium parameters used: f = 5600 MHz; σ = 4.94 mho/m; εr = 35.08; ρ = 1000 kg/m3, Medium parameters used: f = 5800 MHz; σ = 5.36 mho/m; εr = 34.92; ρ = 1000 kg/m3,

Phantom section: Center Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(5.00,5.00,5.00); Calibrated: 2014/9/24, ConvF(4.79,4.79,4.79); Calibrated: 2014/9/24, ConvF(4.64,4.64,4.64); Calibrated: 2014/9/24, ConvF(4.25,4.25,4.25); Calibrated: 2014/9/24, ConvF(4.44,4.44,4.44); Calibrated: 2014/9/24,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn536; Calibrated: 23/1/2014
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/3
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole Calibration for Head Tissue/Pin=100mW, d=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 71.30 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 30.3 W/kg

**SAR(1 g) = 7.73 W/kg; SAR(10 g) = 2.24 W/kg**

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

**Dipole Calibration for Head Tissue/Pin=100mW, d=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.12 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 31.9 W/kg

**SAR(1 g) = 7.99 W/kg; SAR(10 g) = 2.29 W/kg**

Maximum value of SAR (measured) = 18.8 W/kg

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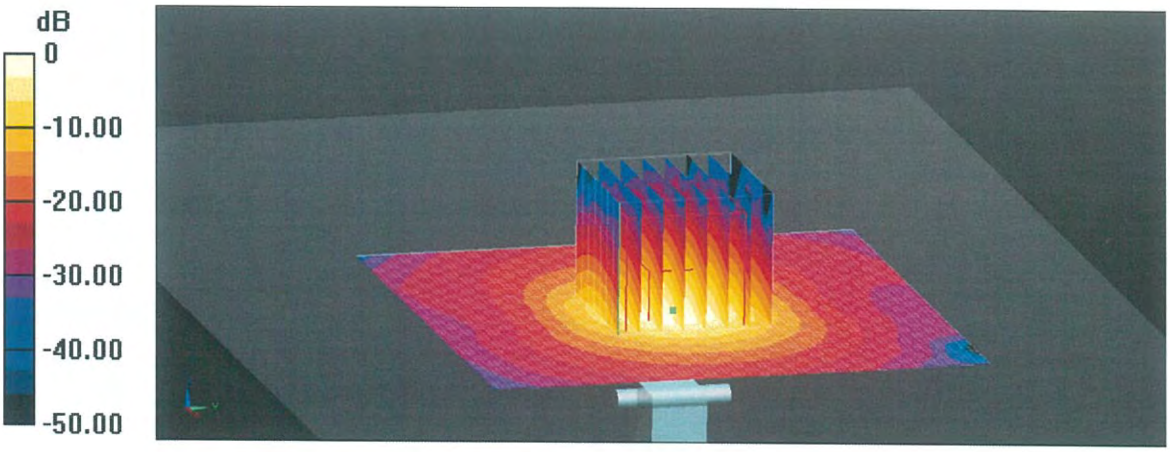
**Dipole Calibration for Head Tissue/Pin=100mW, d=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.21 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 34.5 W/kg
**SAR(1 g) = 8.15 W/kg; SAR(10 g) = 2.33 W/kg**
Maximum value of SAR (measured) = 19.2 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 73.75 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 33.0 W/kg
**SAR(1 g) = 8.27 W/kg; SAR(10 g) = 2.39 W/kg**
Maximum value of SAR (measured) = 19.8 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, d=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 68.92 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 35.9 W/kg
**SAR(1 g) = 8.04 W/kg; SAR(10 g) = 2.3 W/kg**
Maximum value of SAR (measured) = 19.3 W/kg




**0 dB = 18.0 W/kg = 12.54 dBW/kg**

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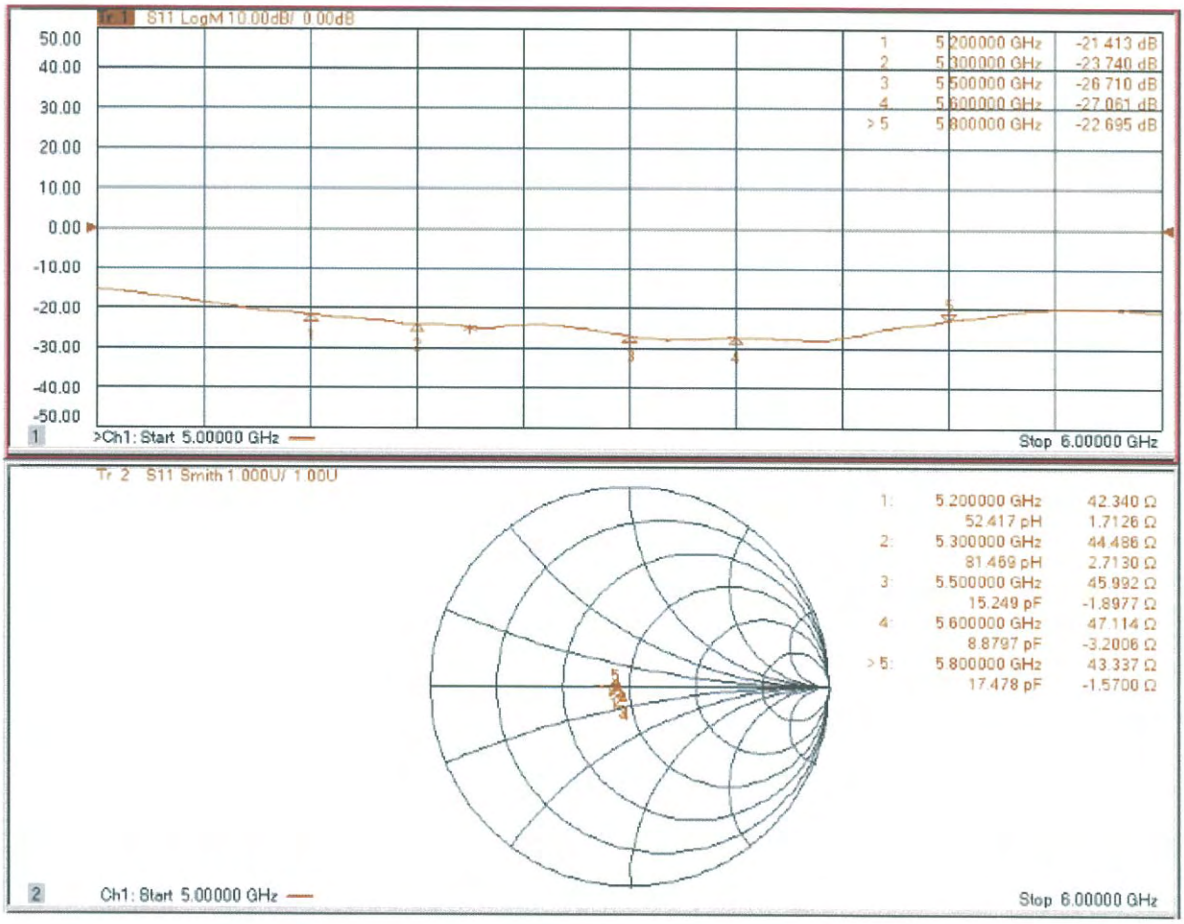
## Impedance Measurement Plot for Head TSL



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**DASY5 Validation Report for Body TSL** Date: 04.11.2014

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1133**

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz,

Medium parameters used: f = 5200 MHz; σ = 5.37 mho/m; εr = 49.6; ρ = 1000 kg/m3, Medium parameters used: f = 5300 MHz; σ = 5.49 mho/m; εr = 49.5; ρ = 1000 kg/m3, Medium parameters used: f = 5500 MHz; σ = 5.58 mho/m; εr = 49.3; ρ = 1000 kg/m3, Medium parameters used: f = 5600 MHz; σ = 5.71 mho/m; εr = 49.54; ρ = 1000 kg/m3, Medium parameters used: f = 5800 MHz; σ = 5.92 mho/m; εr = 48.7; ρ = 1000 kg/m3,

Phantom section: Center Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(4.32,4.32,4.32); Calibrated: 2014/9/24, ConvF(4.18,4.18,4.18); Calibrated: 2014/9/24, ConvF(3.8,3.8,3.8); Calibrated: 2014/9/24, ConvF(3.76,3.76,3.76); Calibrated: 2014/9/24, ConvF(3.86,3.86,3.86); Calibrated: 2014/9/24,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn536; Calibrated: 23/1/2014
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/3
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Dipole Calibration for Head Tissue/Pin=100mW, d=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 65.00 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 31.6 W/kg

**SAR(1 g) = 7.34 W/kg; SAR(10 g) = 2.08 W/kg**

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

**Dipole Calibration for Head Tissue/Pin=100mW, d=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 65.04 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 32.3 W/kg

**SAR(1 g) = 7.45 W/kg; SAR(10 g) = 2.11 W/kg**

Maximum value of SAR (measured) = 17.8 W/kg

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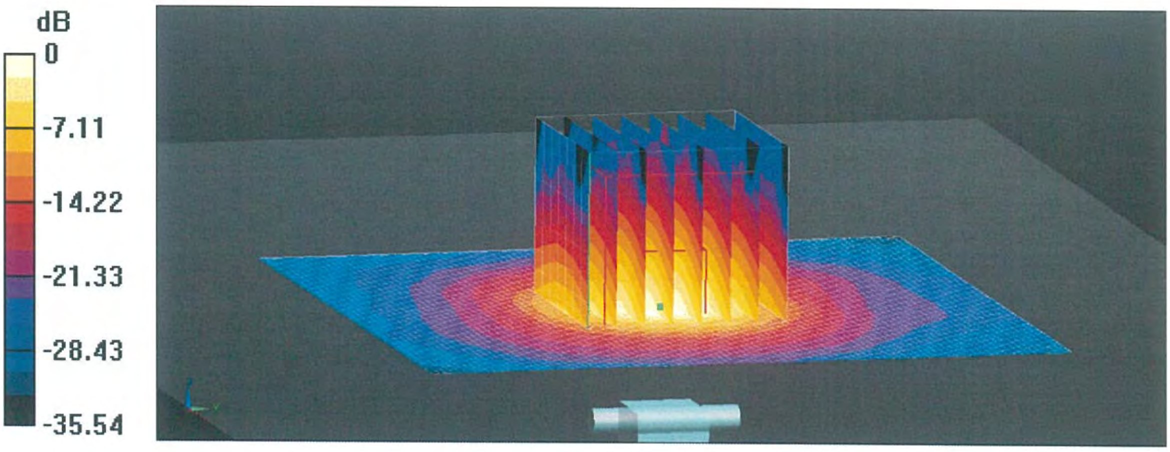
**Dipole Calibration for Head Tissue/Pin=100mW, d=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 69.24 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 34.9 W/kg
**SAR(1 g) = 7.98 W/kg; SAR(10 g) = 2.24 W/kg**
Maximum value of SAR (measured) = 19.3 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.89 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 37.1 W/kg
**SAR(1 g) = 8.17 W/kg; SAR(10 g) = 2.3 W/kg**
Maximum value of SAR (measured) = 19.7 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, d=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 66.55 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 33.9 W/kg
**SAR(1 g) = 7.39 W/kg; SAR(10 g) = 2.07 W/kg**
Maximum value of SAR (measured) = 18.0 W/kg




**0 dB = 17.1 W/kg = 12.32 dBW/kg**

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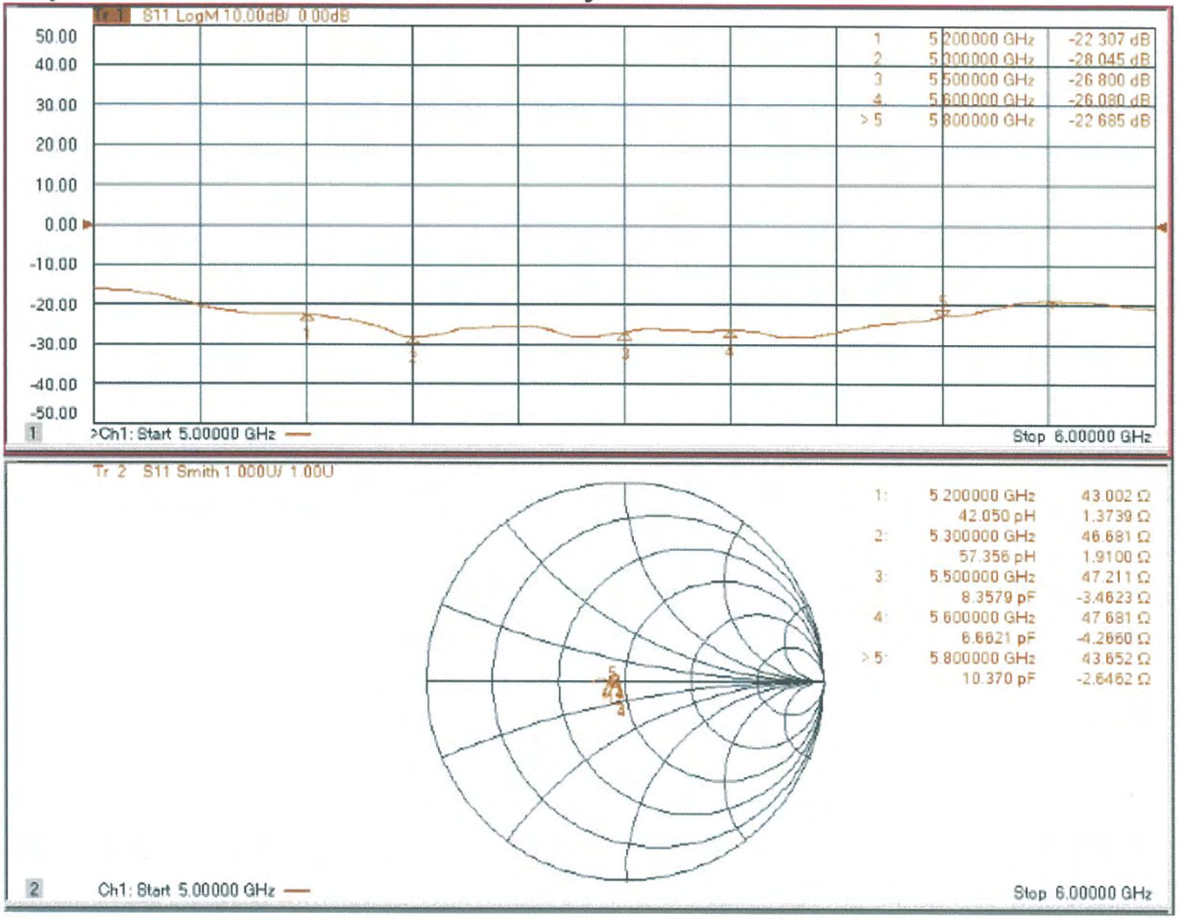
## Impedance Measurement Plot for Body TSL



**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 108**

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

**Certificate No: EX3-3873_Aug14**

# CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3873

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

Calibration date: August 26, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter E4419B | GB41293874 | 03-Apr-14 (No. 217-01911) | Apr-15 |
| Power sensor E4412A | MY41498087 | 03-Apr-14 (No. 217-01911) | Apr-15 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 03-Apr-14 (No. 217-01915) | Apr-15 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 03-Apr-14 (No. 217-01919) | Apr-15 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 03-Apr-14 (No. 217-01920) | Apr-15 |
| Reference Probe ES3DV2 | SN: 3013 | 30-Dec-13 (No. ES3-3013_Dec13) | Dec-14 |
| DAE4 | SN: 660 | 13-Dec-13 (No. DAE4-660_Dec13) | Dec-14 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-13) | In house check: Apr-16 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-13) | In house check: Oct-14 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Israe El-Naouq | Laboratory Technician | [signature] |
| Approved by: | Katja Pokovic | Technical Manager | [signature] |

Issued: August 26, 2014

## Glossary:

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

## Calibration is Performed According to the Following Standards:

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

## Methods Applied and Interpretation of Parameters:

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

# Probe EX3DV4

## SN:3873

Manufactured: March 13, 2012
Calibrated: August 26, 2014

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