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CALIBRATION
No. L0570

**DASY5 Validation Report for Body TSL** Date: 24.07.2014

Test Laboratory: TMC, Beijing, China

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d134**

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

Medium parameters used: f = 835 MHz; $\sigma$ = 0.986 S/m; $\varepsilon_r$ = 55.6; $\rho$ = 1000 kg/m$^3$

Phantom section: Left Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(8.96, 8.96, 8.96); Calibrated: 2013-09-03;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2014-01-23
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

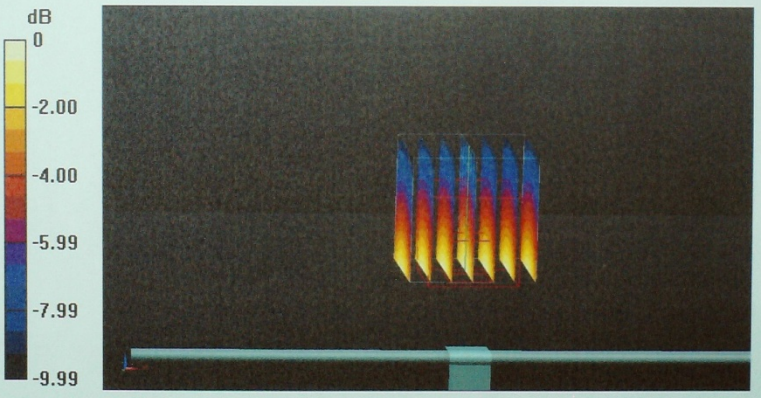
**System Performance Check at Frequencies below 1 GHz/d=15mm, Pin=250 mW, dist=2.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 57.01 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.66 W/kg

**SAR(1 g) = 2.47 W/kg; SAR(10 g) = 1.64 W/kg**

Maximum value of SAR (measured) = 3.10 W/kg




0 dB = 3.10 W/kg = 4.91 dBW/kg

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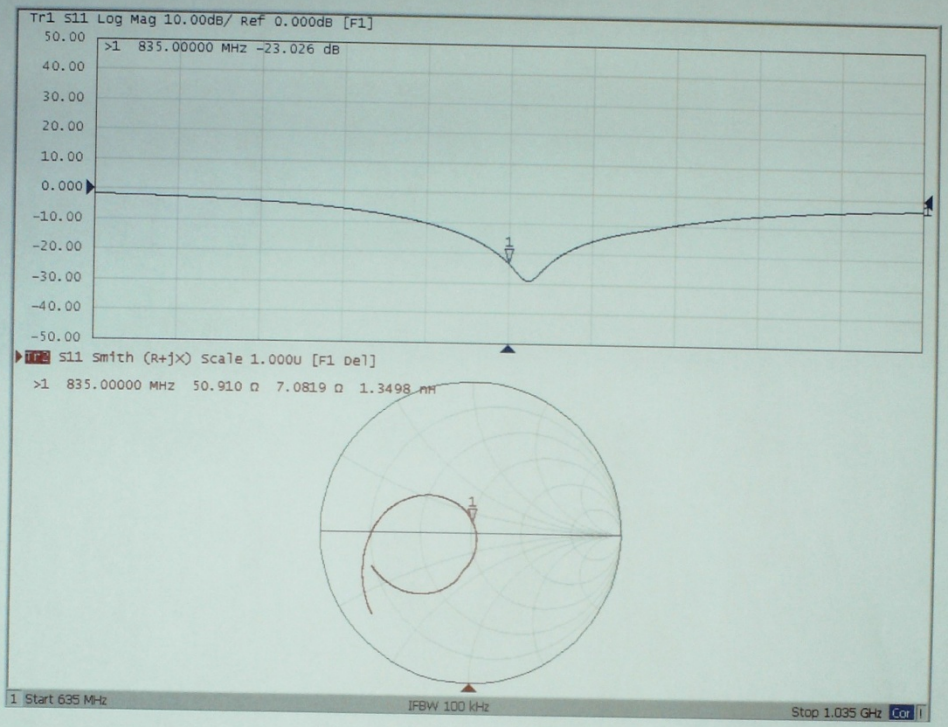
No. L0570

**Impedance Measurement Plot for Body TSL**




Certificate No: Z14-97067

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# Extended Dipole Calibrations

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

| Head | | | | | | |
|---|---|---|---|---|---|---|
| Date of measurement | Return-loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Imaginary impedance (ohm) | Delta (ohm) |
| 2014-07-24 | -28.92 | | 48.84 | | 3.34 | |
| 2015-07-23 | -28.70 | -0.76 | 50.34 | 1.50 | 3.24 | -0.1 |
| 2016-07-25 | -28.81 | -0.38 | 50.16 | 1.32 | 3.28 | -0.06 |

| Body | | | | | | |
|---|---|---|---|---|---|---|
| Date of measurement | Return-loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Imaginary impedance (ohm) | Delta (ohm) |
| 2014-07-24 | -23.03 | | 50.91 | | 7.08 | |
| 2015-07-23 | -24.64 | 7.00 | 48.52 | -2.39 | 6.25 | -0.83 |
| 2016-07-25 | -23.86 | 3.60 | 48.95 | -1.96 | 6.70 | -0.38 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5ohm of prior calibration. Therefore the verification result should support extended calibration.

## 1.4. D1750V2 Dipole Calibration Certificate

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CALIBRATION No. L0570

Client CIQ-SZ(Auden) Certificate No: Z15-97069

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1750V2 - SN: 1062 |
| Calibration Procedure(s) | TMC-OS-E-02-194<br>Calibration procedure for dipole validation kits |
| Calibration date: | July 25, 2015 |

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 | 11-Sep-14 (TMC, No.JZ13-443) | Sep-15 |
| Power sensor NRV-Z5 | 100595 | 11-Sep-14 (TMC, No. JZ13-443) | Sep -15 |
| Reference Probe EX3DV4 | SN 3846 | 3- Sep-14 (SPEAG, No.EX3-3846_Sep13) | Sep-15 |
| DAE4 | SN 1331 | 23-Jan-15 (SPEAG, DAE4-1331_Jan14) | Jan -16 |
| Signal Generator E4438C | MY49070393 | 13-Nov-14 (TMC, No.JZ13-394) | Nov-15 |
| Network Analyzer E8362B | MY43021135 | 19-Oct-14 (TMC, No.JZ13-278) | Oct-15 |

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

Issued: July 28, 2015

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CALIBRATION
No. L0570

**Glossary:**

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

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

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) For hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)", February 2005
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, 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 | 39.7 ± 6 % | 1.35 mho/m ± 6 % |
| **Head TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 9.20 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **37.1 mW /g ± 20.8 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 250 mW input power | 4.97 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **20.0 mW /g ± 20.4 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 53.4 | 1.49 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 54.3 ± 6 % | 1.47 mho/m ± 6 % |
| **Body TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 9.22 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **37.3 mW /g ± 20.8 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | Condition | |
| SAR measured | 250 mW input power | 4.95 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **20.0 mW /g ± 20.4 % (k=2)** |

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## Appendix

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 51.1Ω+ 1.62jΩ |
| Return Loss | - 34.2dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 49.2Ω+ 4.25jΩ |
| Return Loss | - 27.2dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.257 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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CALIBRATION
No. L0570

**DASY5 Validation Report for Head TSL** Date: 25.07.2015

Test Laboratory: TMC, Beijing, China

**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1062**

Communication System: UID 0, CW; Frequency: 1750 MHz;Duty Cycle: 1:1

Medium parameters used: f = 1750 MHz; $\sigma$ = 1.352 S/m; $\varepsilon_r$ = 39.69; $\rho$ = 1000 kg/m$^3$

Phantom section: Center Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(7.85, 7.85, 7.85); Calibrated: 2014-09-03;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2015-01-23
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/2
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

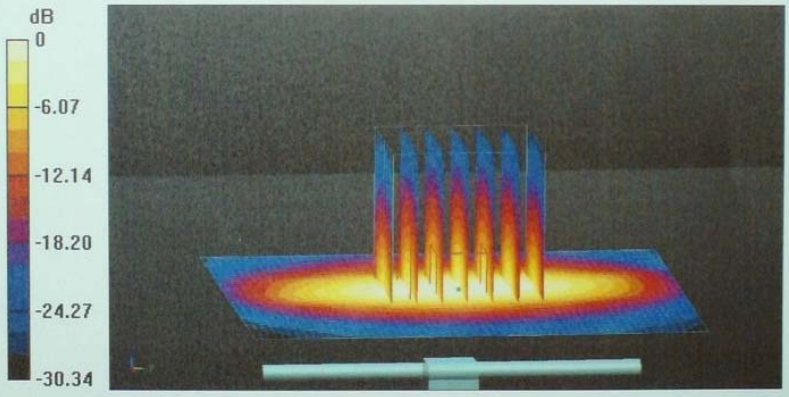
**System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=2.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.92 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 16.3 W/kg

**SAR(1 g) = 9.2 W/kg; SAR(10 g) = 4.97 W/kg**

Maximum value of SAR (measured) = 13.0 W/kg




0 dB = 12.9 W/kg = 11.10 dBW/kg

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CALIBRATION
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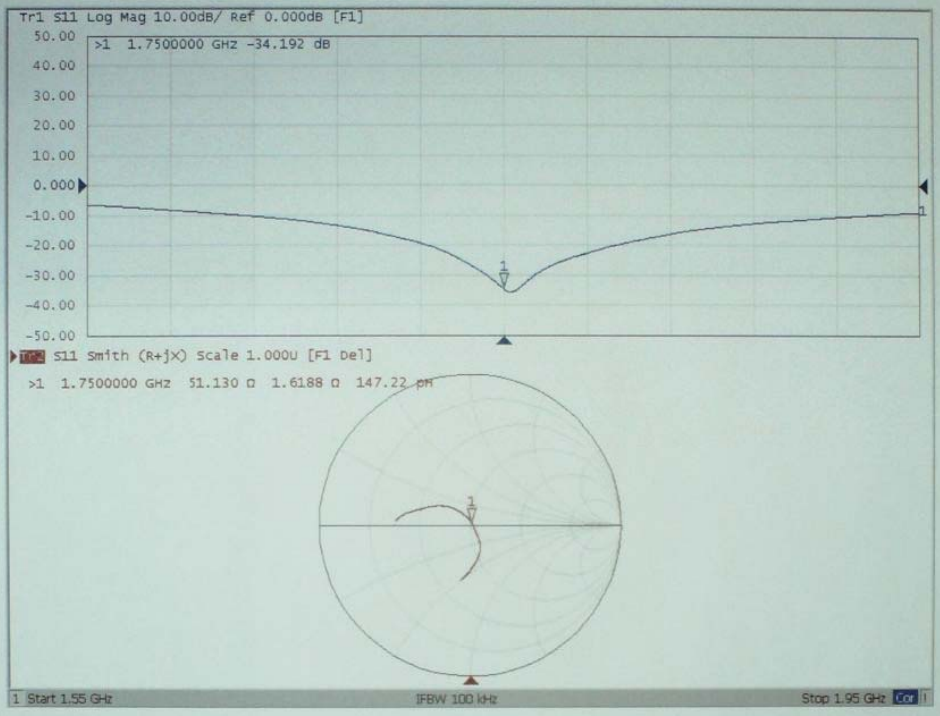
**Impedance Measurement Plot for Head TSL**




Certificate No: Z15-97069 Page 6 of 8

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CALIBRATION No. L0570

**DASY5 Validation Report for Body TSL** Date: 25.07.2015

Test Laboratory: TMC, Beijing, China

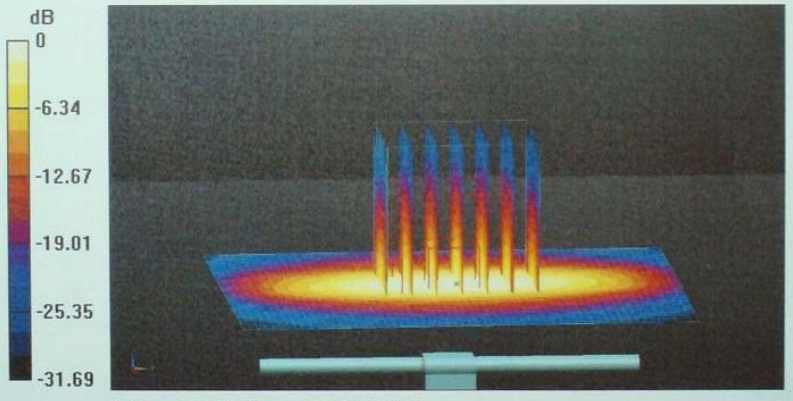
**DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1062**

Communication System: UID 0, CW; Frequency: 1750 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1750 MHz; $\sigma$ = 1.47 S/m; $\varepsilon_r$ = 54.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Right Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN3846; ConvF(7.56, 7.56, 7.56); Calibrated: 2014-09-03;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2015-01-23
- 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)

**System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=2.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.11 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 16.4 W/kg
**SAR(1 g) = 9.22 W/kg; SAR(10 g) = 4.95 W/kg**
Maximum value of SAR (measured) = 13.0 W/kg




0 dB = 12.8 W/kg = 11.07 dBW/kg

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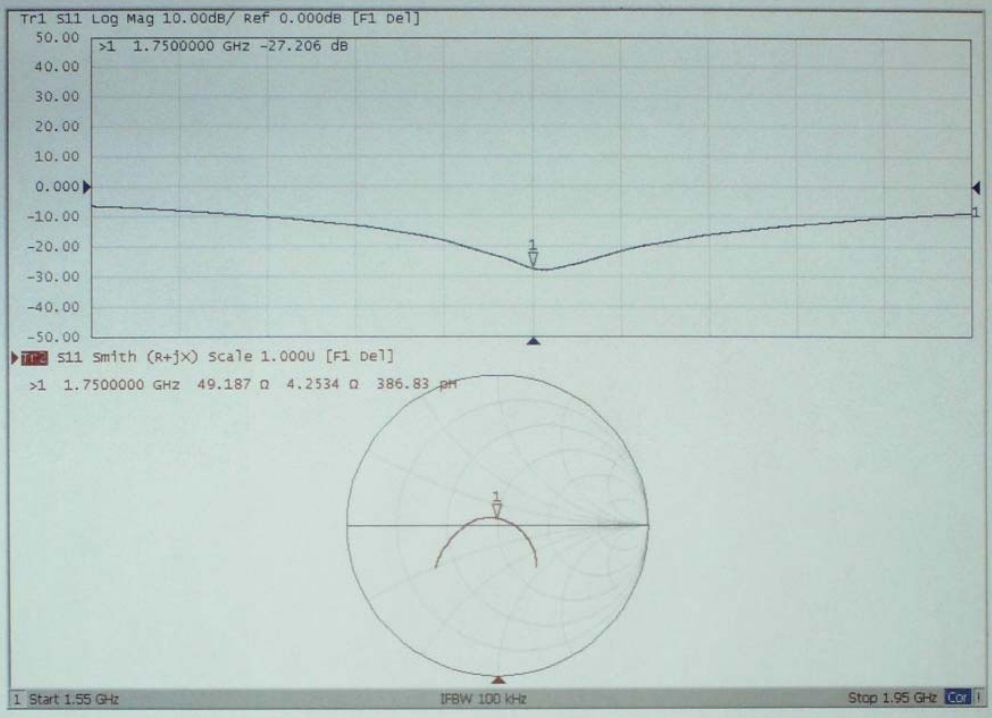
**Impedance Measurement Plot for Body TSL**




Certificate No: Z15-97069 Page 8 of 8

# Extended Dipole Calibrations

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

| Head | | | | | | |
|---|---|---|---|---|---|---|
| Date of measurement | Return-loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Imaginary impedance (ohm) | Delta (ohm) |
| 2015-07-25 | -34.20 | | 51.10 | | 1.62 | |
| 2016-07-23 | -33.70 | 0.50 | 52.42 | 1.32 | 2.28 | -0.66 |

| Body | | | | | | |
|---|---|---|---|---|---|---|
| Date of measurement | Return-loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Imaginary impedance (ohm) | Delta (ohm) |
| 2015-07-25 | -27.20 | | 49.20 | | 4.25 | |
| 2016-07-23 | -25.40 | 1.80 | 50.58 | 1.38 | 3.80 | -0.45 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5ohm of prior calibration. Therefore the verification result should support extended calibration.

## 1.5. D1900V2 Dipole Calibration Certificate

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CNAS 校准 CNAS L0442

Client CIQ SZ (Auden) **Certificate No: J15-2-3052**

**CALIBRATION CERTIFICATE**

| | |
|---|---|
| Object | D1900V2 - SN: 5d150 |
| Calibration Procedure(s) | TMC-OS-E-02-194<br>Calibration procedure for dipole validation kits |
| Calibration date: | December 12, 2015 |

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 | 11-Sep-15 (TMC, No.JZ13-443) | Sep-16 |
| Power sensor NRV-Z5 | 100595 | 11-Sep-15 (TMC, No. JZ13-443) | Sep -16 |
| Reference Probe ES3DV3 | SN 3149 | 5- Sep-15 (SPEAG, No.ES3-3149_Sep13) | Sep-16 |
| DAE4 | SN 777 | 22-Feb-15 (SPEAG, DAE4-777_Feb13) | Feb -16 |
| Signal Generator E4438C | MY49070393 | 13-Nov-15 (TMC, No.JZ13-394) | Nov-16 |
| Network Analyzer E8362B | MY43021135 | 19-Oct-15 (TMC, No.JZ13-278) | Oct-16 |

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

Issued: December 17, 2015

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**Glossary:**

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

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

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) For hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)", February 2005
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 | 52.8.7.1137 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Twin Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 1900 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 40.0 | 1.40 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 38.9 ± 6 % | 1.42 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 | 9.71 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **38.3 mW /g ± 20.8 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 250 mW input power | 5.08 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **20.2 mW /g ± 20.4 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 53.3 | 1.52 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 53.7 ± 6 % | 1.53 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 | 9.98 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **39.9 mW /g ± 20.8 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | Condition | |
| SAR measured | 250 mW input power | 5.26 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **21.0 mW /g ± 20.4 % (k=2)** |

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## Appendix

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 50.3Ω+ 3.17jΩ |
| Return Loss | - 30.0dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 48.8Ω+ 3.92jΩ |
| Return Loss | - 27.7dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.048 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: 12.12.2015

Test Laboratory: TMC, Beijing, China

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d150**

Communication System: CW; Frequency: 1900 MHz

Medium parameters used: f = 1900 MHz; $\sigma$ = 1.416 mho/m; $\varepsilon r$ = 38.91; $\rho$ = 1000 kg/m$^3$

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3149; ConvF(5.06,5.06,5.06); Calibrated: 2015/9/5
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 22/2/2015
- Phantom: SAM 1186; Type: QD000P40CC;
- DASY52 52.8.7(1137); SEMCAD X Version 14.6.10 (7164)

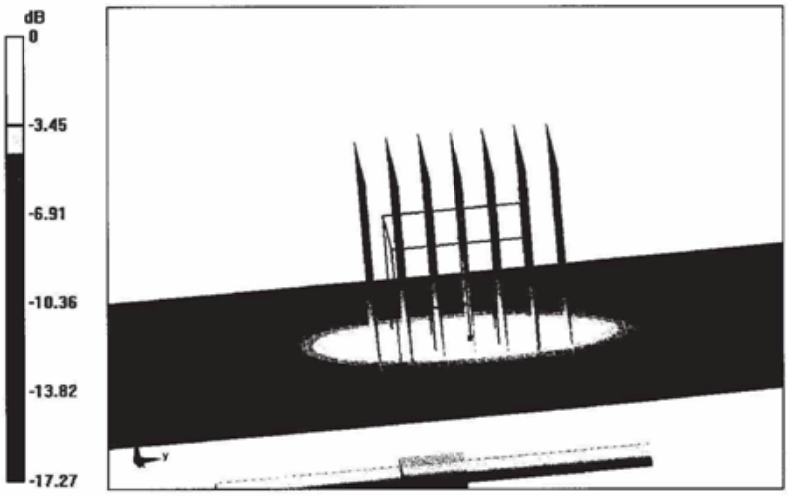
**Dipole Calibration for Head Tissue/Pin=250mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 90.054 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 17.9 W/kg

**SAR(1 g) = 9.71 W/kg; SAR(10 g) = 5.08 W/kg**

Maximum value of SAR (measured) = 11.8 W/kg




0 dB = 11.8 W/kg = 10.72 dBW/kg

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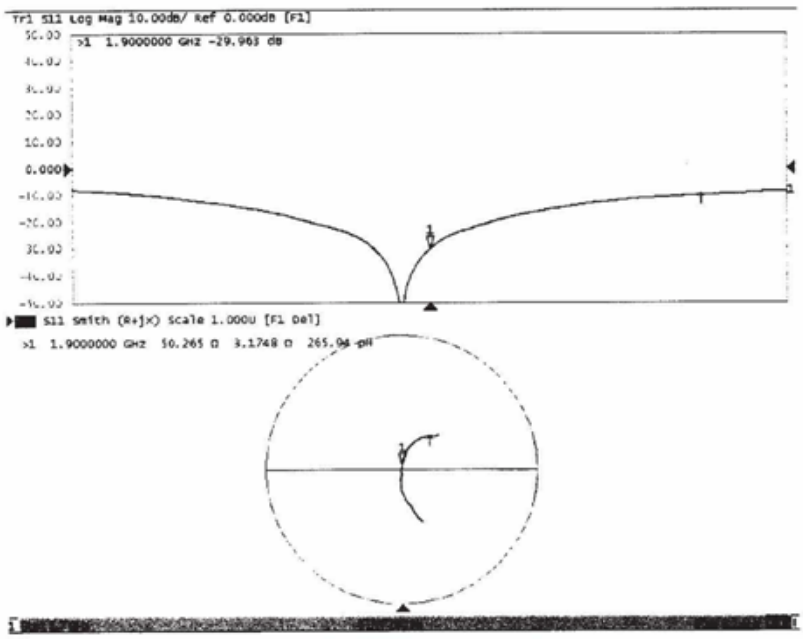
**Impedance Measurement Plot for Head TSL**



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**DASY5 Validation Report for Body TSL** Date: 12.10.2015

Test Laboratory: TMC, Beijing, China

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d150**

Communication System: CW; Frequency: 1900 MHz;

Medium parameters used: f = 1900 MHz; $\sigma$ = 1.528 mho/m; $\varepsilon r$ = 53.74; $\rho$ = 1000 kg/m$^3$

Phantom section: Flat Phantom

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3149; ConvF(4.72,4.72,4.72) ; Calibrated: 2015/9/5
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn777; Calibrated: 22/2/2015
- Phantom: SAM1186; Type: QD000P40CC;
- DASY52 52.8.7(1137); SEMCAD X Version 14.6.10 (7164)

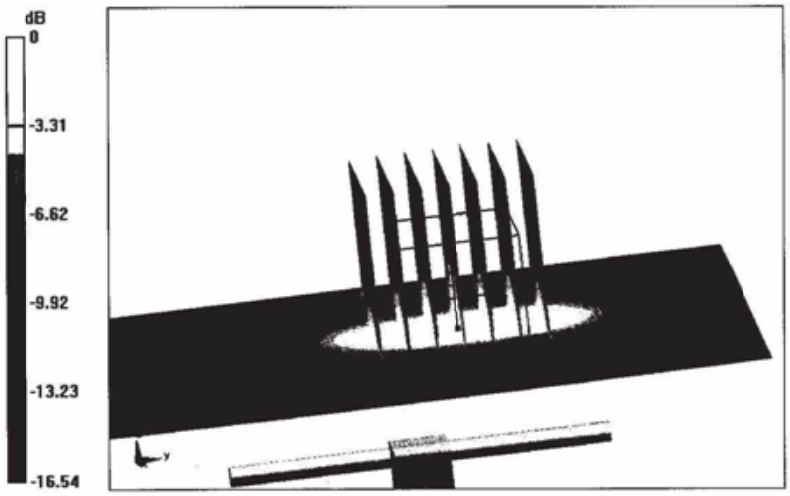
**Dipole Calibration for Body Tissue/Pin=250mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 83.606 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 17.7 W/kg

**SAR(1 g) = 9.98 W/kg; SAR(10 g) = 5.26 W/kg**

Maximum value of SAR (measured) = 12.1 W/kg




0 dB = 12.1 W/kg = 10.83 dBW/kg

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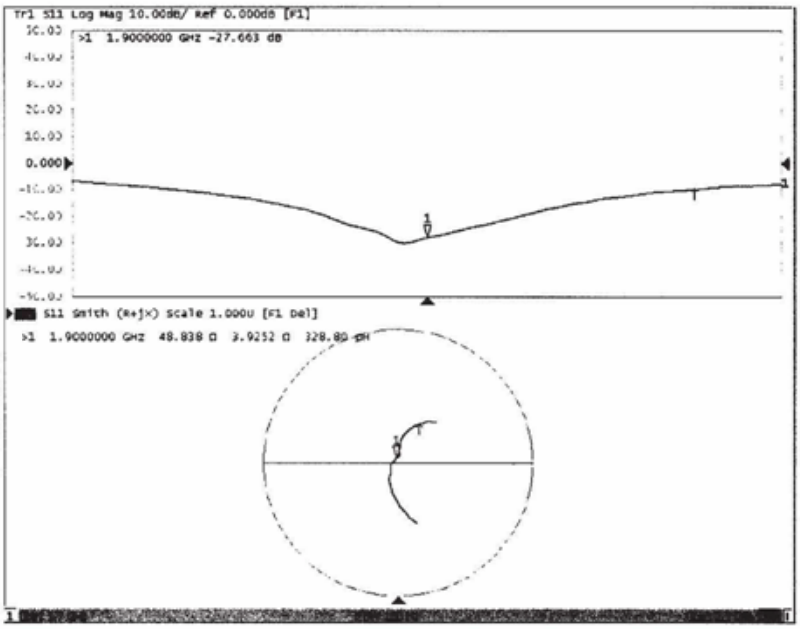
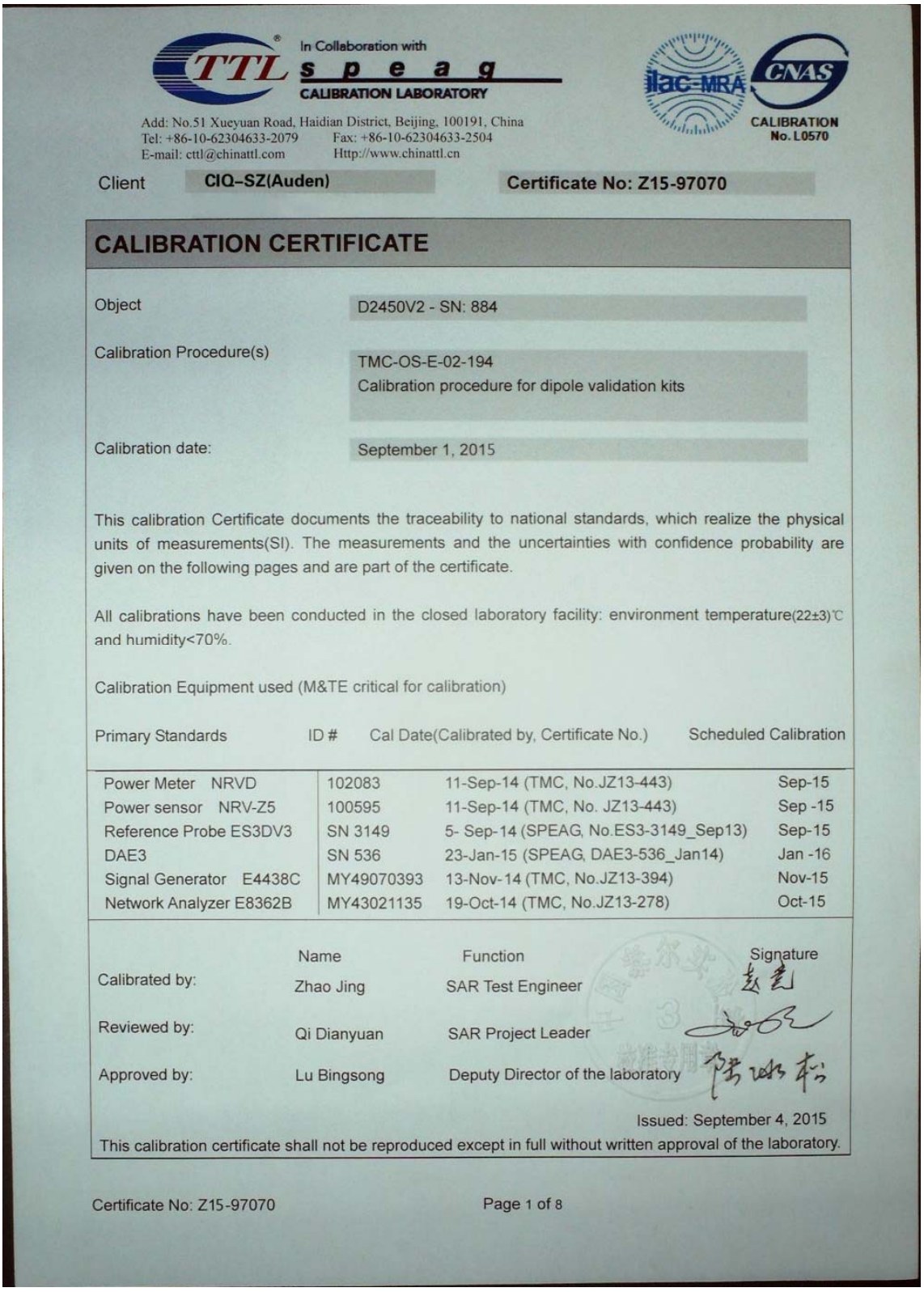
**Impedance Measurement Plot for Body TSL**



## 1.6. D2450V2 Dipole Calibration Certificate



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CNAS CALIBRATION No. L0570

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Client CIQ–SZ(Auden) Certificate No: Z15-97070

**CALIBRATION CERTIFICATE**

Object D2450V2 - SN: 884

Calibration Procedure(s) TMC-OS-E-02-194
Calibration procedure for dipole validation kits

Calibration date: September 1, 2015

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 | 11-Sep-14 (TMC, No.JZ13-443) | Sep-15 |
| Power sensor NRV-Z5 | 100595 | 11-Sep-14 (TMC, No. JZ13-443) | Sep -15 |
| Reference Probe ES3DV3 | SN 3149 | 5- Sep-14 (SPEAG, No.ES3-3149_Sep13) | Sep-15 |
| DAE3 | SN 536 | 23-Jan-15 (SPEAG, DAE3-536_Jan14) | Jan -16 |
| Signal Generator E4438C | MY49070393 | 13-Nov-14 (TMC, No.JZ13-394) | Nov-15 |
| Network Analyzer E8362B | MY43021135 | 19-Oct-14 (TMC, No.JZ13-278) | Oct-15 |

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

Issued: September 4, 2015

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**Glossary:**

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

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

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

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

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, dz = 5 mm | |
| **Frequency** | 2450 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 39.2 | 1.80 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 40.2 ± 6 % | 1.84 mho/m ± 6 % |
| **Head TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.1 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **52.1 mW /g ± 20.8 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | Condition | |
| SAR measured | 250 mW input power | 6.17 mW / g |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.6 mW /g ± 20.4 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 52.7 | 1.95 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 51.3 ± 6 % | 2.00 mho/m ± 6 % |
| **Body TSL temperature change during test** | <1.0 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 $cm^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 13.1 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **51.6 mW /g ± 20.8 % (k=2)** |
| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | Condition | |
| SAR measured | 250 mW input power | 6.11 mW / g |
| SAR for nominal Body TSL parameters | normalized to 1W | **24.2 mW /g ± 20.4 % (k=2)** |

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## Appendix

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 58.3Ω- 0.76jΩ |
| Return Loss | - 22.3dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 58.1Ω+ 2.61jΩ |
| Return Loss | - 22.1dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.224 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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CALIBRATION
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**DASY5 Validation Report for Head TSL** Date: 01.09.2015

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 884**

Communication System: UID 0, CW; Frequency: 2450 MHz;Duty Cycle: 1:1

Medium parameters used: f = 2450 MHz; $\sigma$ = 1.84 S/m; $\varepsilon_r$ = 40.2; $\rho$ = 1000 kg/m$^3$

Phantom section: Left Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3149; ConvF(4.48, 4.48, 4.48); Calibrated: 2014-09-05;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn536; Calibrated: 2015-01-23
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

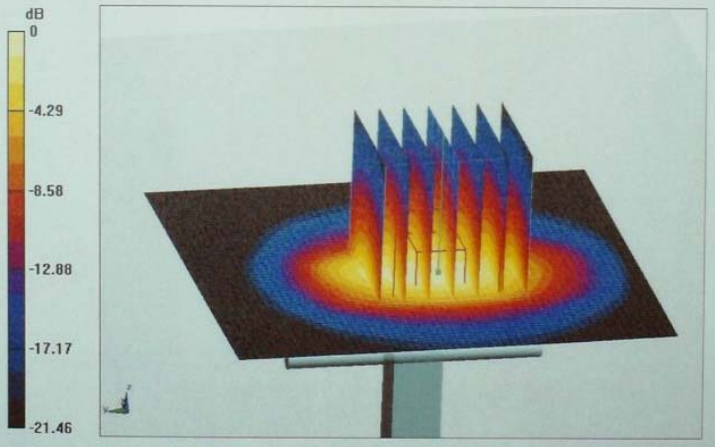
**System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.491 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 26.6 W/kg

**SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.17 W/kg**

Maximum value of SAR (measured) = 17.1 W/kg




**0 dB = 17.1 W/kg = 12.33 dBW/kg**

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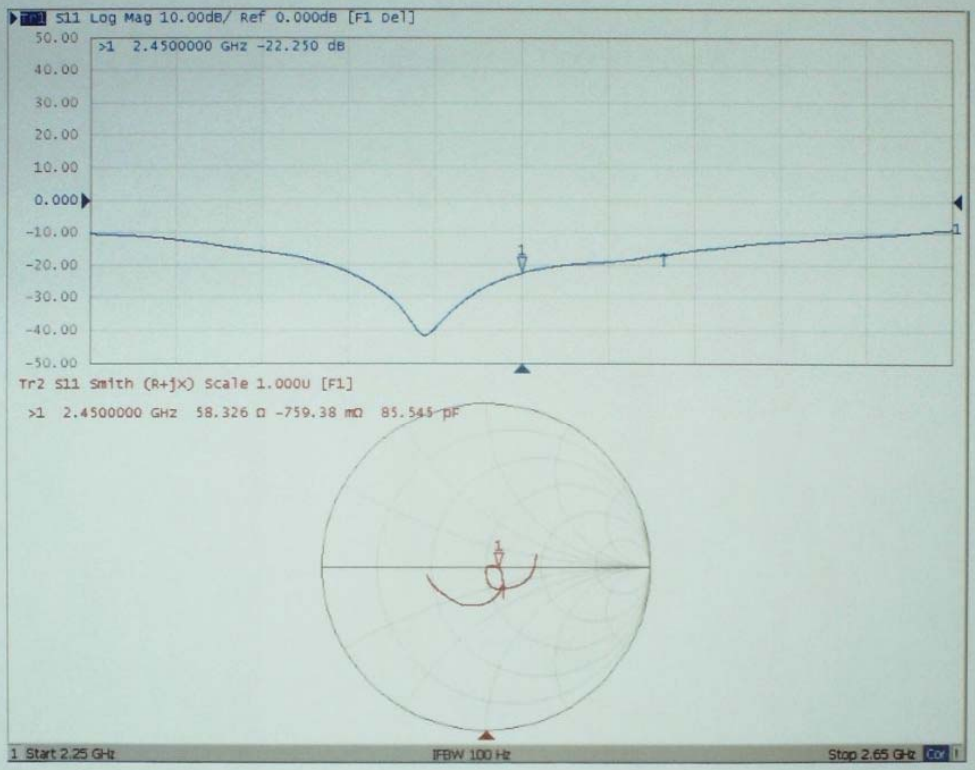
**Impedance Measurement Plot for Head TSL**




Certificate No: Z15-97070 Page 6 of 8

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CALIBRATION
No. L0570

**DASY5 Validation Report for Body TSL** Date: 01.09.2015

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 884**

Communication System: UID 0, CW; Frequency: 2450 MHz;Duty Cycle: 1:1

Medium parameters used: f = 2450 MHz; $\sigma$ = 1.988 S/m; $\varepsilon_r$ = 51.25; $\rho$ = 1000 kg/m$^3$

Phantom section: Center Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3149; ConvF(4.21, 4.21, 4.21); Calibrated: 2014-09-03;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn536; Calibrated: 2015-01-23
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/2
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

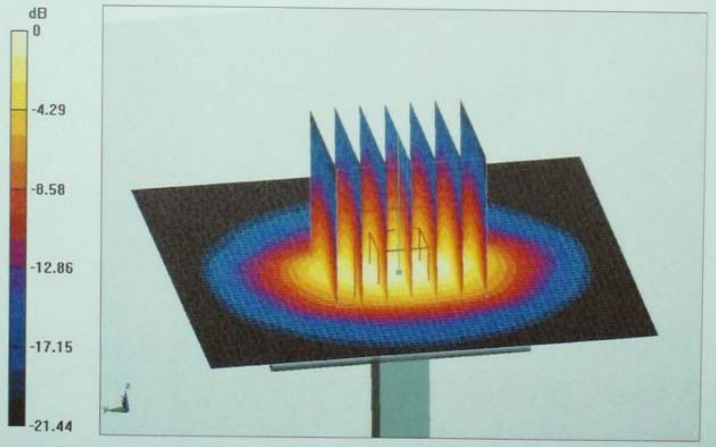
**System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.180 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 27.6 W/kg

**SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.11 W/kg**

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




**0 dB = 17.4 W/kg = 12.41 dBW/kg**

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CALIBRATION
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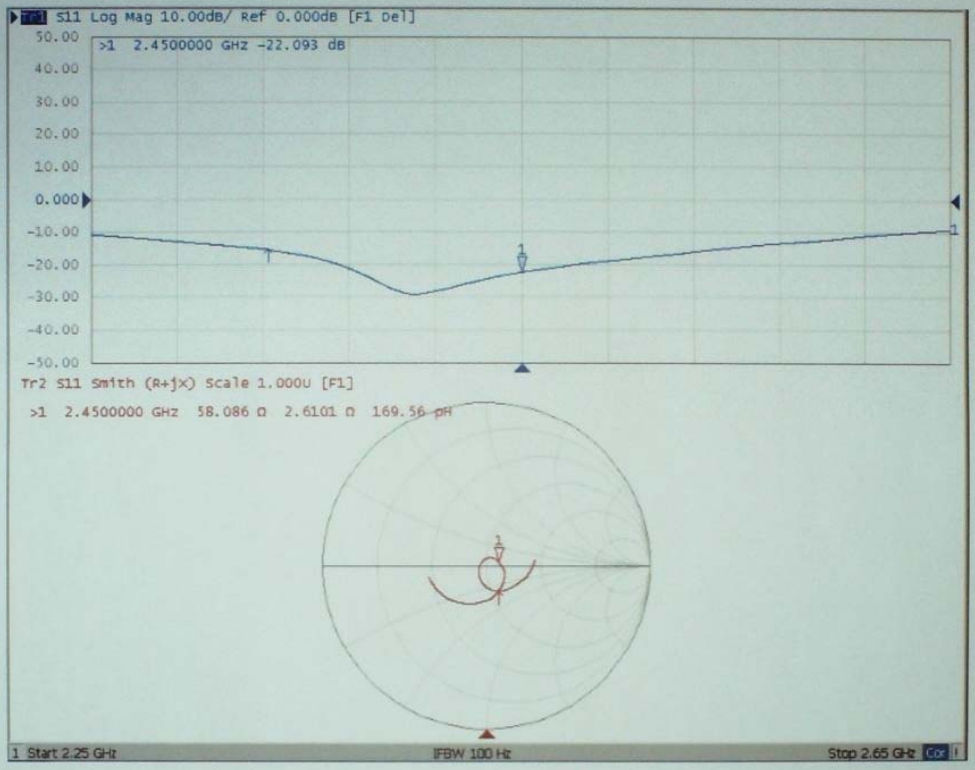
**Impedance Measurement Plot for Body TSL**




Certificate No: Z15-97070 Page 8 of 8

# Extended Dipole Calibrations

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

| Head | | | | | | |
|---|---|---|---|---|---|---|
| Date of measurement | Return-loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Imaginary impedance (ohm) | Delta (ohm) |
| 2015-09-01 | -22.3 | | 58.3 | | -0.76 | |
| 2016-08-31 | -21.8 | 2.24 | 58.5 | 0.2 | -0.68 | 0.08 |

| Body | | | | | | |
|---|---|---|---|---|---|---|
| Date of measurement | Return-loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Imaginary impedance (ohm) | Delta (ohm) |
| 2015-09-01 | -22.1 | | 58.1 | | 2.61 | |
| 2016-08-31 | -21.5 | 2.71 | 59.0 | 0.9 | 2.36 | -0.25 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5ohm of prior calibration. Therefore the verification result should support extended calibration.

## 1.7. DAE4 Calibration Certificate

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CNAS 中国认可 国际互认 校准 CALIBRATION CNAS L0570

Client : CIQ(Shenzhen) Certificate No: Z16-97120

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | DAE4 - SN: 1315 |
| Calibration Procedure(s) | FD-Z11-2-002-01<br>Calibration Procedure for the Data Acquisition Electronics (DAEx) |
| Calibration date: | July 26, 2016 |

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Process Calibrator 753 | 1971018 | 27-June-16 (CTTL, No:J16X04778) | June-17 |

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

Issued: July 27, 2016

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**Glossary:**

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

**Methods Applied and Interpretation of Parameters:**

- *DC Voltage Measurement*: Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.

- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.

- The report provide only calibration results for DAE, it does not contain other performance test results.

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## DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV
Low Range: 1LSB = 61nV , full range = -1.....+3mV

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

| Calibration Factors | X | Y | Z |
|---|---|---|---|
| High Range | 405.179 ± 0.15% (k=2) | 405.018 ± 0.15% (k=2) | 404.98 ± 0.15% (k=2) |
| Low Range | 3.99015 ± 0.7% (k=2) | 3.98549 ± 0.7% (k=2) | 3.98861 ± 0.7% (k=2) |

## Connector Angle

| | |
|---|---|
| **Connector Angle** to be used in DASY system | 20.5° ± 1 ° |



------End------