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 CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
 Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
 E-mail: ctll@chinattl.com Http://www.chinattl.cn

#### Measurement Conditions

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

<b>DASY Version</b>	DASY52	52.8.8.1258
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Triple Flat Phantom 5.1C	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	1900 MHz ± 1 MHz	

#### Head TSL parameters

The following parameters and calculations were applied.

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

#### SAR result with Head TSL

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

#### Body TSL parameters

The following parameters and calculations were applied.

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

#### SAR result with Body TSL

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

Certificate No: Z16-97090

Page 3 of 8



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## Appendix

### Antenna Parameters with Head TSL

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

### Antenna Parameters with Body TSL

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

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.304 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

### Additional EUT Data

Manufactured by	SPEAG
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### DASY5 Validation Report for Head TSL

Date: 06.15.2016

Test Laboratory: CTTL, Beijing, China

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

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

Medium parameters used:  $f = 1900 \text{ MHz}$ ;  $\sigma = 1.381 \text{ S/m}$ ;  $\epsilon_r = 40.33$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

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

DASY5 Configuration:

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

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

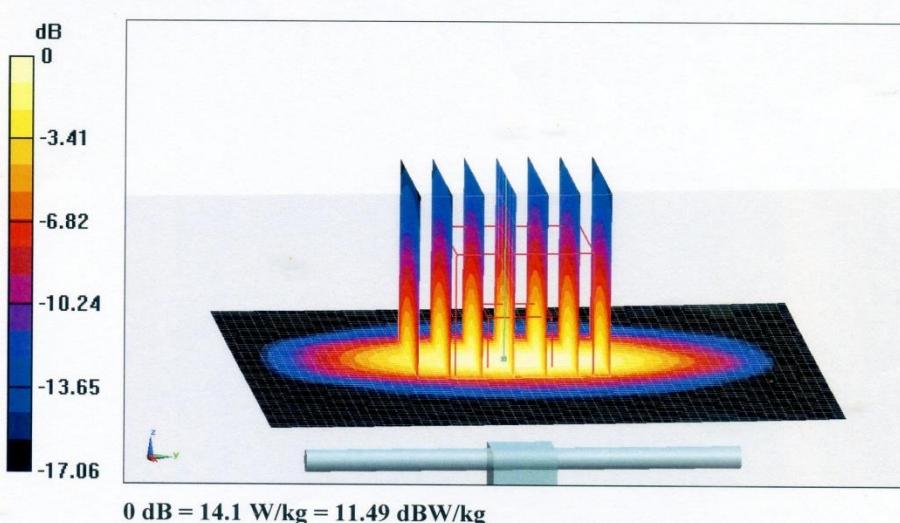
$dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

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

Peak SAR (extrapolated) = 18.0W/kg

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

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

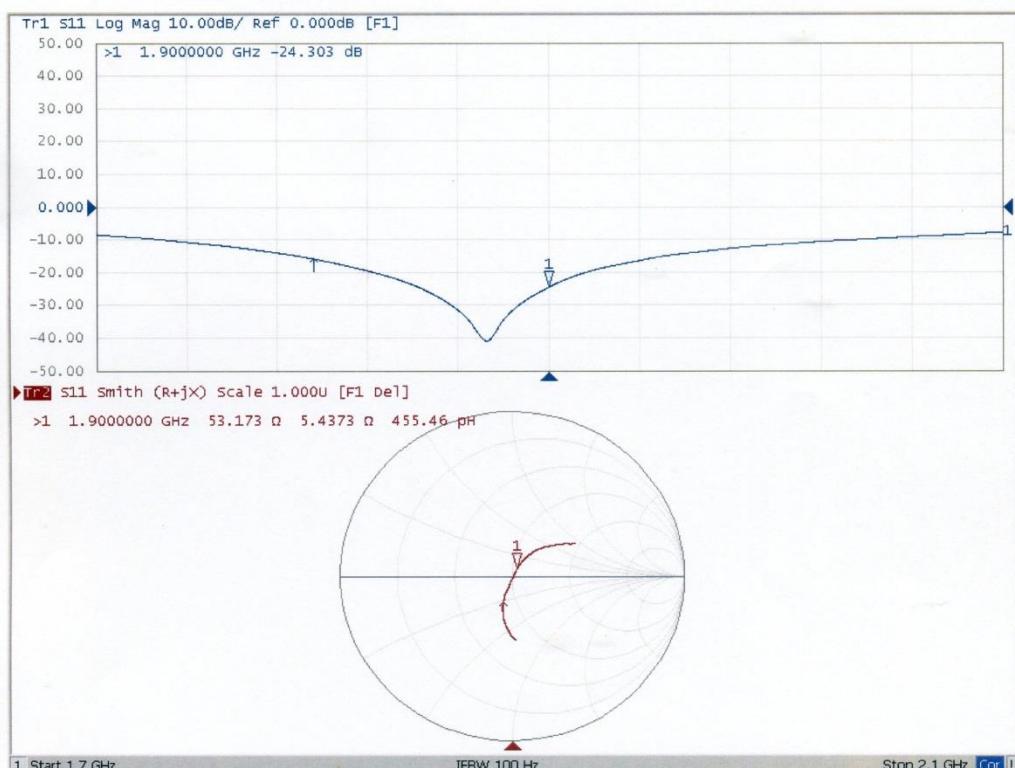




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### Impedance Measurement Plot for Head TSL





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## DASY5 Validation Report for Body TSL

Date: 06.15.2016

Test Laboratory: CTTL, Beijing, China

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

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

Medium parameters used:  $f = 1900 \text{ MHz}$ ;  $\sigma = 1.537 \text{ S/m}$ ;  $\epsilon_r = 53.34$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Center Section

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

DASY5 Configuration:

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

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

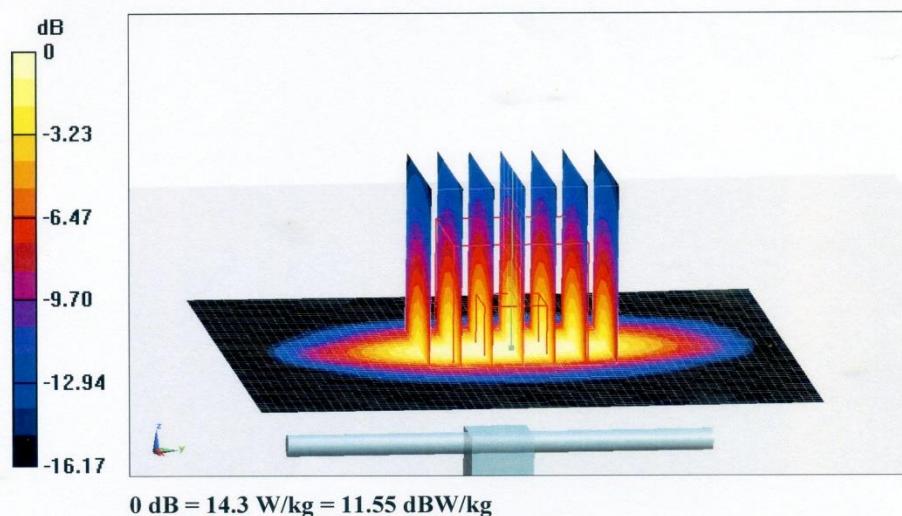
$dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

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

Peak SAR (extrapolated) = 17.8 W/kg

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

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



Certificate No: Z16-97090

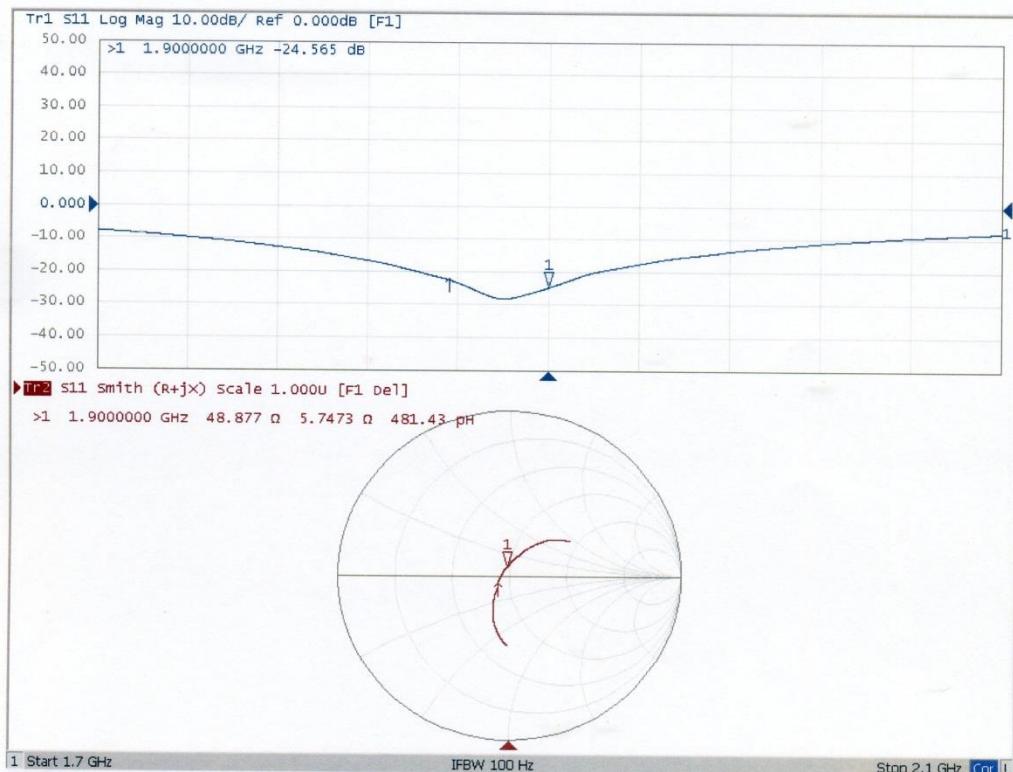
Page 7 of 8



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### Impedance Measurement Plot for Body TSL



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Page 8 of 8



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Client

CCIS

Certificate No: Z16-97091

## CALIBRATION CERTIFICATE

Object D2450V2 - SN: 910

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

Calibration date: Jun 15, 2016

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

All calibrations have been conducted in the closed laboratory facility: environment temperature( $22\pm3$ )°C and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	01-Jul-15 (CTTL, No.J15X04256)	Jun-16
Power sensor NRP-Z91	101547	01-Jul-15 (CTTL, No.J15X04256)	Jun-16
Reference Probe EX3DV4	SN 7307	19-Feb-16(SPEAG, No.EX3-7307_Feb16)	Feb-17
DAE4	SN 771	02-Feb-16(CTTL-SPEAG, No.Z16-97011)	Feb-17
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	01-Feb-16 (CTTL, No.J16X00893)	Jan-17
Network Analyzer E5071C	MY46110673	26-Jan-16 (CTTL, No.J16X00894)	Jan-17

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

Issued: Jun 17, 2016

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## 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) IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- d) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

## Additional Documentation:

- e) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

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

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



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### Measurement Conditions

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

<b>DASY Version</b>	DASY52	52.8.8.1258
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Triple Flat Phantom 5.1C	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	2450 MHz ± 1 MHz	

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	39.2	1.80 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	39.0 ± 6 %	1.77 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	<1.0 °C	----	----

### SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	13.0 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	52.4 mW /g ± 20.8 % (k=2)
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	6.06 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	24.3 mW /g ± 20.4 % (k=2)

### Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	52.7	1.95 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	52.9 ± 6 %	1.97 mho/m ± 6 %
<b>Body TSL temperature change during test</b>	<1.0 °C	----	----

### SAR result with Body TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	13.0 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	51.8 mW /g ± 20.8 % (k=2)
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	6.18 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	24.7 mW /g ± 20.4 % (k=2)



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## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.6Ω+ 2.77jΩ
Return Loss	- 25.8dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.7Ω+ 4.28jΩ
Return Loss	- 27.3dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.263 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

Manufactured by	SPEAG
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### DASY5 Validation Report for Head TSL

Date: 06.15.2016

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 910**

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

Medium parameters used:  $f = 2450 \text{ MHz}$ ;  $\sigma = 1.767 \text{ S/m}$ ;  $\epsilon_r = 39.01$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(7.36, 7.36, 7.36); Calibrated: 2/19/2016;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2/2/2016
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

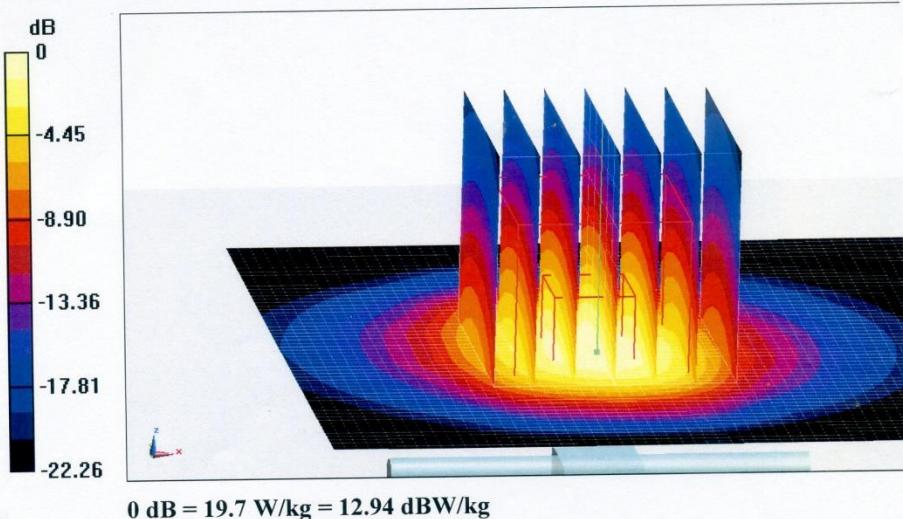
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 106.5 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 26.7 W/kg

**SAR(1 g) = 13 W/kg; SAR(10 g) = 6.06 W/kg**

Maximum value of SAR (measured) = 19.7 W/kg

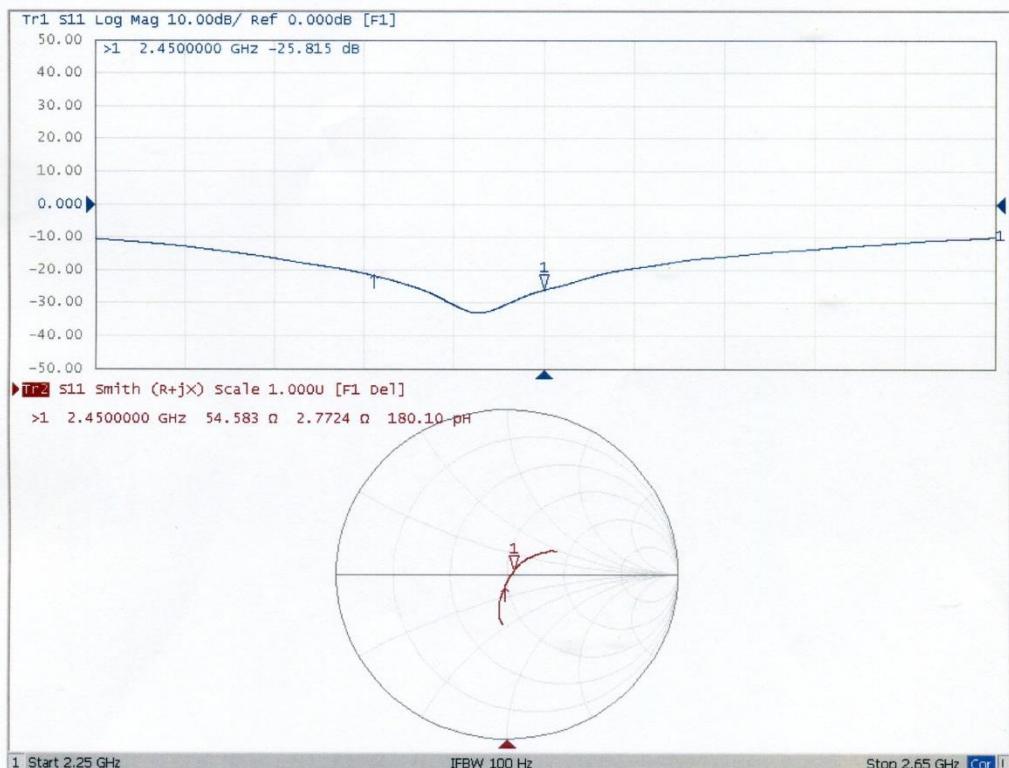




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### Impedance Measurement Plot for Head TSL



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Page 6 of 8



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## DASY5 Validation Report for Body TSL

Date: 06.15.2016

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 910**

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

Medium parameters used:  $f = 2450 \text{ MHz}$ ;  $\sigma = 1.972 \text{ S/m}$ ;  $\epsilon_r = 52.92$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Center Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(7.22, 7.22, 7.22); Calibrated: 2/19/2016;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2/2/2016
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

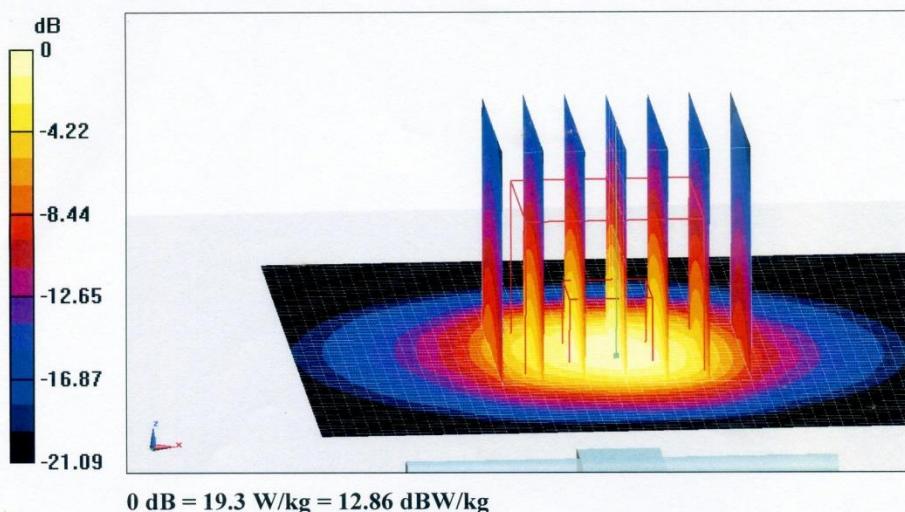
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 98.89 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 25.6 W/kg

**SAR(1 g) = 13 W/kg; SAR(10 g) = 6.18 W/kg**

Maximum value of SAR (measured) = 19.3 W/kg

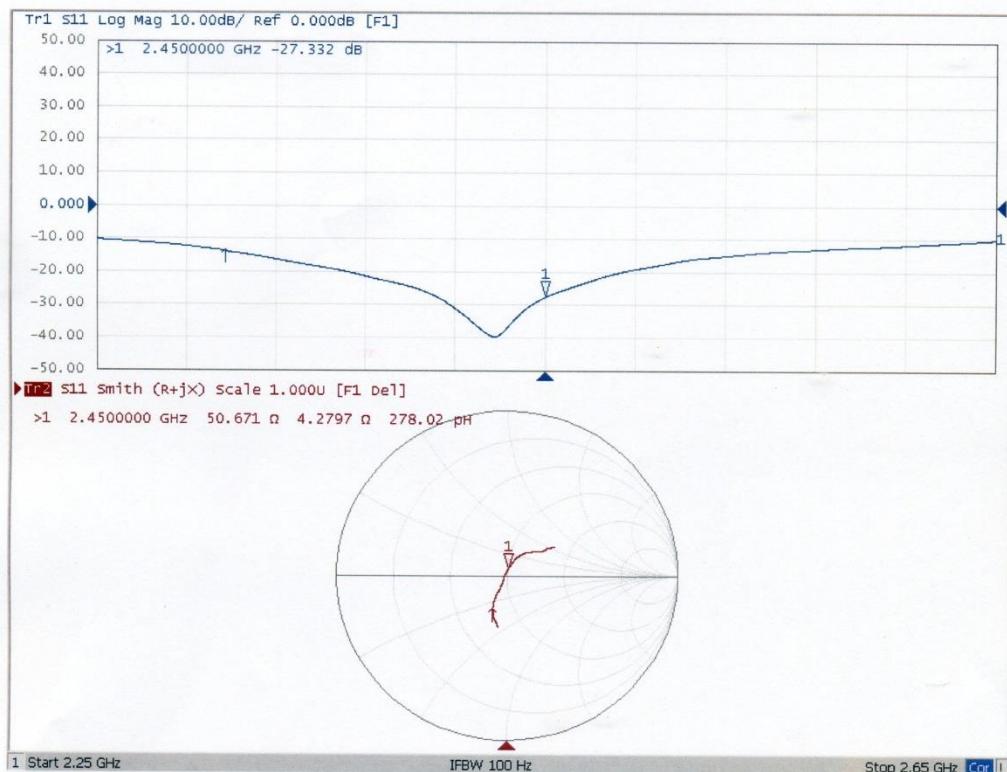




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### Impedance Measurement Plot for Body TSL



## Calibration information for DAE



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Client : CCIS

Certificate No: Z17-97019

## CALIBRATION CERTIFICATE

Object	DAE4 - SN: 1373
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Calibration Procedure(s)	FD-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)
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Calibration date:	February 09, 2017
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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( $22\pm3$ )°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

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

Issued: February 10, 2017

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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 =  $6.1\mu V$ , full range =  $-100...+300 mV$   
Low Range: 1LSB =  $61nV$ , full range =  $-1.....+3mV$

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

Calibration Factors	X	Y	Z
High Range	$403.884 \pm 0.15\% (k=2)$	$403.846 \pm 0.15\% (k=2)$	$404.143 \pm 0.15\% (k=2)$
Low Range	$3.98683 \pm 0.7\% (k=2)$	$4.00771 \pm 0.7\% (k=2)$	$4.01106 \pm 0.7\% (k=2)$

## Connector Angle

Connector Angle to be used in DASY system	$220^\circ \pm 1^\circ$
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