



In Collaboration with

**s p e a g**  
**CALIBRATION LABORATORY**

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
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### Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
N/A	not applicable or not measured

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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



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## Measurement Conditions

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

<b>DASY Version</b>	DASY52	52.10.1.1476
<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 = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
<b>Frequency</b>	5200 MHz $\pm$ 1 MHz 5300 MHz $\pm$ 1 MHz 5800 MHz $\pm$ 1 MHz	

## Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	36.0	4.66 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	36.0 $\pm$ 6 %	4.80 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	<1.0 °C	----	----

## SAR result with Head TSL at 5200 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	7.61 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>76.2 mW / g <math>\pm</math> 24.4 % (k=2)</b>
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	2.20 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.0 mW / g <math>\pm</math> 24.2 % (k=2)</b>



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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	35.8 ± 6 %	4.90 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.86 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>78.6 mW / g ± 24.4 % (k=2)</b>
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.28 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.8 mW / g ± 24.2 % (k=2)</b>

### 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	34.8 ± 6 %	5.42 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.76 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>77.5 mW / g ± 24.4 % (k=2)</b>
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.23 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.2 mW / g ± 24.2 % (k=2)</b>



### Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	49.0	5.30 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	48.4 ± 6 %	5.35 mho/m ± 6 %
<b>Body TSL temperature change during test</b>	<1.0 °C	----	----

### SAR result with Body TSL at 5200 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	100 mW input power	7.15 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>71.3 mW /g ± 24.4 % (k=2)</b>
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	Condition	
SAR measured	100 mW input power	2.05 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>20.5 mW /g ± 24.2 % (k=2)</b>

### Body TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	48.9	5.42 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	48.1 ± 6 %	5.47 mho/m ± 6 %
<b>Body TSL temperature change during test</b>	<1.0 °C	----	----

### SAR result with Body TSL at 5300 MHz

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	100 mW input power	7.39 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>73.7 mW /g ± 24.4 % (k=2)</b>
<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	Condition	
SAR measured	100 mW input power	2.12 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>21.1 mW /g ± 24.2 % (k=2)</b>



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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	47.1 ± 6 %	6.17 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 <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.46 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>74.3 mW /g ± 24.4 % (k=2)</b>
SAR averaged over 10 cm <sup>3</sup> (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	<b>21.0 mW /g ± 24.2 % (k=2)</b>

## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	53.6Ω - 6.87jΩ
Return Loss	- 22.5dB

### Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	50.7Ω + 1.28jΩ
Return Loss	- 36.7dB

### Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	55.0Ω +6.61jΩ
Return Loss	- 22.1dB

### Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	53.1Ω - 5.01jΩ
Return Loss	- 24.9dB

### Antenna Parameters with Body TSL at 5300 MHz

Impedance, transformed to feed point	48.9Ω + 3.26jΩ
Return Loss	- 29.2dB

### Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	55.57Ω + 8.75jΩ
Return Loss	- 20.1dB



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## General Antenna Parameters and Design

Electrical Delay (one direction)	1.051 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: 08.29.2018

Test Laboratory: CCTL, Beijing, China

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1218**

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

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 4.796$  S/m;  $\epsilon_r = 36.02$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5300$  MHz;  $\sigma = 4.902$  S/m;  $\epsilon_r = 35.79$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.424$  S/m;  $\epsilon_r = 34.79$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Phantom section: Center Section

### **DASY5 Configuration:**

- Probe: EX3DV4 - SN7464; ConvF(5.82, 5.82, 5.82) @ 5200 MHz; Calibrated: 9/12/2017, ConvF(5.53, 5.53, 5.53) @ 5300 MHz; Calibrated: 9/12/2017, ConvF(5.11, 5.11, 5.11) @ 5800 MHz; Calibrated: 9/12/2017,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1524; Calibrated: 9/13/2017
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

### **Dipole Calibration /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 = 57.36 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 31.5 W/kg

**SAR(1 g) = 7.61 W/kg; SAR(10 g) = 2.2 W/kg**

Maximum value of SAR (measured) = 17.6 W/kg

### **Dipole Calibration /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 = 59.56 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 33.9 W/kg

**SAR(1 g) = 7.86 W/kg; SAR(10 g) = 2.28 W/kg**

Maximum value of SAR (measured) = 19.0 W/kg

### **Dipole Calibration /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 = 57.44 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 36.9 W/kg

**SAR(1 g) = 7.76 W/kg; SAR(10 g) = 2.23 W/kg**

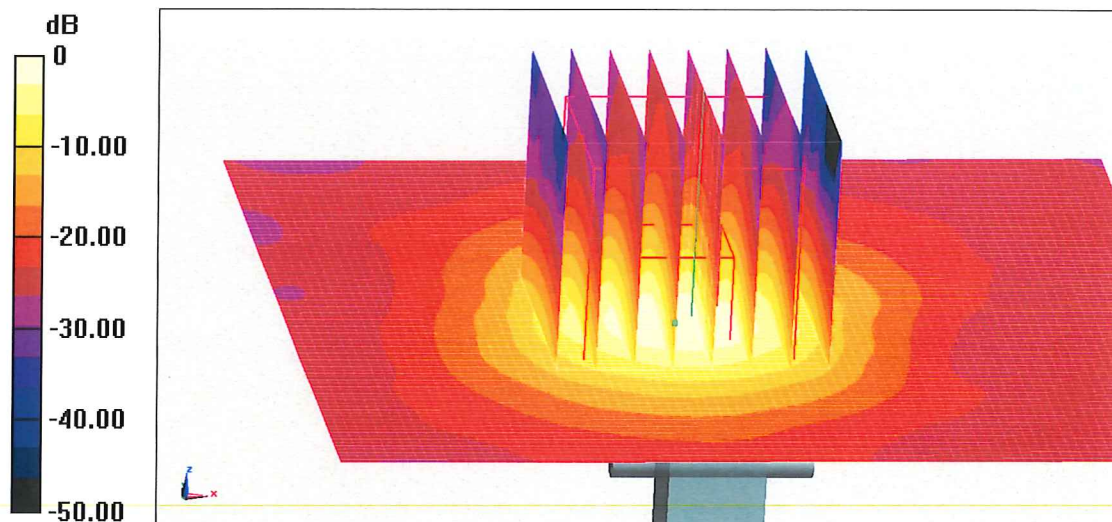
Maximum value of SAR (measured) = 19.2 W/kg





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## Impedance Measurement Plot for Head TSL

