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Report No.: LCSA09223010EB

# **Calibration certificate**

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D2450V2-SN 965(2023-06-12)

D5GHzV2-SN 1046(2023-06-20)

2. DAE

DAE3-SN 419(2023-06-20)

3. Probe

EX3DV4-SN 3805(2023-06-21)



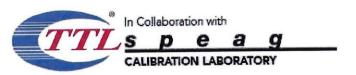








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Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191

Tel: +86-10-62304633-2117

E-mail: cttl@chinattl.com

http://www.caict.ac.cn

Client

SHENZHEN LCS

**Certificate No:** 

J23Z60236

# **CALIBRATION CERTIFICATE**

Object

D2450V2 - SN: 965

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date:

June 12, 2023

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
Power Meter NRP2	106277	22-Sep-22 (CTTL, No.J22X09561)	Sep-23
Power sensor NRP8S	104291	22-Sep-22 (CTTL, No.J22X09561)	Sep-23
Reference Probe EX3DV4	SN 3617	31-Mar-23(CTTL-SPEAG,No.Z23-60161)	Mar-24
DAE4	SN 1556	11-Jan-23(CTTL-SPEAG,No.Z23-60034)	Jan-24
	The second secon		
Secondary Standards	ID#	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	05-Jan-23 (CTTL, No.J23X00107)	Jan-24
NetworkAnalyzer E5071C	MY46110673	10-Jan-23 (CTTL, No. J23X00104)	Jan-24
140thon analyzor 2007 10			•

Name Function Signature

Calibrated by: Zhao Jing SAR Test Engineer

Reviewed by: Lin Hao SAR Test Engineer

Approved by: Qi Dianyuan SAR Project Leader

Issued: June 16, 2023

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Tel: +86-10-62304633-2117

E-mail: cttl@chinattl.com

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Glossary:

TSL

tissue simulating liquid

ConvF N/A sensitivity in TSL / NORMx,y,z not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020

b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### **Additional Documentation:**

c) 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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Tel: +86-10-62304633-2117

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#### **Measurement Conditions**

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

DASY Version	DASY52	52.10.4
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	40.1 ± 6 %	1.82 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.5 W/kg ± 18.8 % ( <i>k</i> =2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	6.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.0 W/kg ± 18.7 % (k=2)



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Tel: +86-10-62304633-2117

E-mail: cttl@chinattl.com

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.9Ω+ 3.63jΩ	
Return Loss	- 27.9dB	

## **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.059 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point 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 feed-point may be damaged.

#### **Additional EUT Data**

Manufactured by	SPEAG
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Report No.: LCSA09223010EB

Date: 2023-06-12





Add: No.52 Hua Yuan Bei Road, Haidian District, Beijing, 100191, China

Tel: +86-10-62304633-2117

E-mail: cttl@chinattl.com

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## **DASY5 Validation Report for Head TSL**

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 965

Communication System: UID 0, CW; Frequency: 2450 MHz

Medium parameters used: f = 2450 MHz;  $\sigma = 1.824$  S/m;  $\varepsilon_r = 40.07$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

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

**DASY5** Configuration:

Probe: EX3DV4 - SN3617; ConvF(7.68, 7.68, 7.68) @ 2450 MHz; Calibrated:
 2023-03-31

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1556; Calibrated: 2023-01-11

Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062

DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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

dy=5mm, dz=5mm

Reference Value = 93.68 V/m; Power Drift = -0.04 dB

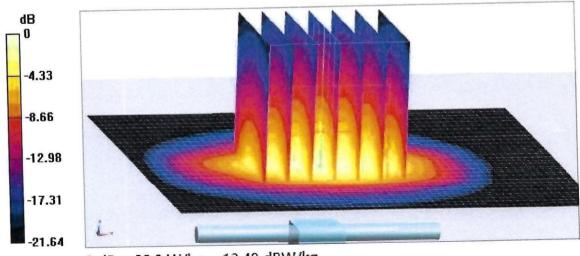
Peak SAR (extrapolated) = 27.6 W/kg

SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.26 W/kg

Smallest distance from peaks to all points 3 dB below = 8.9 mm

Ratio of SAR at M2 to SAR at M1 = 49.6%

Maximum value of SAR (measured) = 22.3 W/kg



0 dB = 22.3 W/kg = 13.48 dBW/kg



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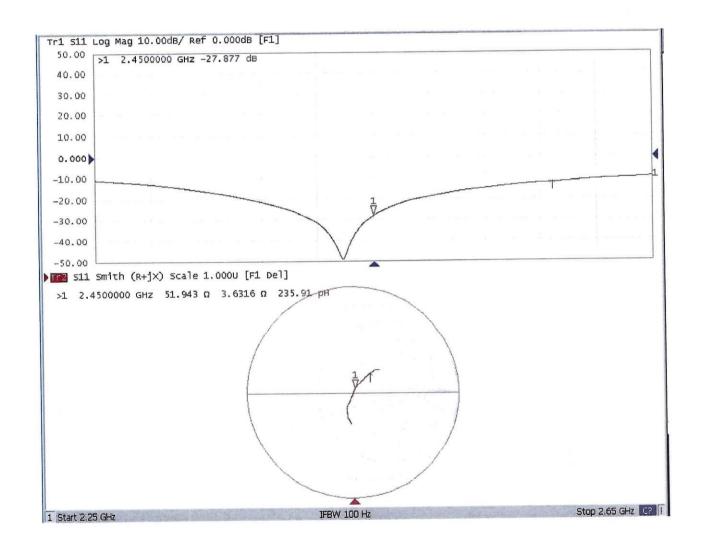


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# Impedance Measurement Plot for Head TSL





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Tel: +86-10-62304633-2117

E-mail: emf@caict.ac.cn

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Client

SHENZHEN LCS

**Certificate No:** 

Z23-60057

# **CALIBRATION CERTIFICATE**

Object D5GHzV2 - SN: 1046

Calibration Procedure(s)

FF-Z11-003-01

Calibration Procedures for dipole validation kits

Calibration date:

June 20, 2023

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)

ID#	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
106276	10-May-23 (CTTL, No.J22X03103)	May-24
		May-24
		May-24
SN 1555	25-May-23(SPEAG,No.DAE4-1555_Aug22)	May-24
ID#	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
MY49070393	17-May-23 (CTTL, No.J22X03157)	May-24
MY46110673	10-Jan-23 (CTTL, No. J23X00104)	Jan-24
	106276 101369 SN 3846 SN 1555 ID# MY49070393	106276 10-May-23 (CTTL, No.J22X03103) 101369 10-May-23 (CTTL, No.J22X03103) SN 3846 20-May-23(SPEAG,No.EX3-3846_May22) SN 1555 25-May-23(SPEAG,No.DAE4-1555_Aug22) ID # Cal Date (Calibrated by, Certificate No.) MY49070393 17-May-23 (CTTL, No.J22X03157)

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	林格
Approved by:	Qi Dianyuan	SAR Project Leader	203

Issued: June 26, 2023

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Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China Tel: +86-10-62304633-2117

E-mail: emf@caict.ac.cn

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Glossary:

TSL

tissue simulating liquid

ConvF N/A sensitivity in TSL / NORMx,y,z not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020

b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### **Additional Documentation:**

c) 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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Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China

Tel: +86-10-62304633-2117

E-mail: emf@caict.ac.cn

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### **Measurement Conditions**

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

DASY Version	DASY52	52.10.4
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	5250 MHz ±1 MHz 5600 MHz ±1 MHz 5800 MHz ±1 MHz	

Head TSL parameters at 5250MHz

The following parameters and calculations were applied.

ne following parameters and calculations were a	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 ℃	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ±0.2) ℃	35.5 ±6 %	4.67 mho/m ±6 %
Head TSL temperature change during test	<1.0 ℃		

SAR result with Head TSL at 5250MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.71 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	76.9 W/kg ±24.4 % ( <i>k</i> =2)
SAR averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.6 W/kg ±24.2 % (k=2)

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Head TSL parameters at 5600MHz

The following parameters and calculations were applied.

le following parameters and calculations were	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 ℃	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ±0.2) ℃	34.9 ±6 %	5.05 mho/m ±6 %
Head TSL temperature change during test	<1.0 ℃	-	

SAR result with Head TSL at 5600MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.06 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.3 W/kg ±24.4 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg ±24.2 % (k=2)

Head TSL parameters at 5800MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 ℃	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ±0.2) ℃	34.6 ±6 %	5.25 mho/m ±6 %
Head TSL temperature change during test	<1.0 ℃		

SAR result with Head TSL at 5800MHz

SAR averaged over 1 $cm^3$ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.71 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	76.8 W/kg ±24.4 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.14 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.3 W/kg ±24.2 % (k=2)



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Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China

Tel: +86-10-62304633-2117

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

## Antenna Parameters with Head TSL at 5250MHz

Impedance, transformed to feed point	47.6Ω- 3.86jΩ
Return Loss	- 26.6dB

## Antenna Parameters with Head TSL at 5600MHz

Impedance, transformed to feed point	53.8Ω- 0.04jΩ
Return Loss	- 28.7dB

## Antenna Parameters with Head TSL at 5800MHz

Impedance, transformed to feed point	52.3Ω- 4.38jΩ
Return Loss	- 26.3dB

## **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.113 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point 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 feed-point may be damaged.

#### **Additional EUT Data**

SPEAG

Report No.: LCSA09223010EB





Date: 2023-06-20

Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China

Tel: +86-10-62304633-2117

E-mail: emf@caict.ac.cn

http://www.caic.ac.cn

## **DASY5 Validation Report for Head TSL**

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1061

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz,

Frequency: 5800 MHz

Medium parameters used: f = 5250 MHz;  $\sigma$  = 4.672 S/m;  $\epsilon_r$  = 35.47;  $\rho$  = 1000 kg/m³ Medium parameters used: f = 5600 MHz;  $\sigma$  = 5.049 S/m;  $\epsilon_r$  = 34.87;  $\rho$  = 1000 kg/m³ Medium parameters used: f = 5800 MHz;  $\sigma$  = 5.245 S/m;  $\epsilon_r$  = 34.61;  $\rho$  = 1000 kg/m³

Phantom section: Right Section

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

**DASY5** Configuration:

Probe: EX3DV4 - SN3846; ConvF(5.44, 5.44, 5.44) @ 5250 MHz;
 ConvF(4.75, 4.75, 4.75) @ 5600 MHz; ConvF(4.9, 4.9, 4.9) @ 5800 MHz;
 Calibrated: 2023-05-20

- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1555; Calibrated: 2023-05-25
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 65.88 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 32.8 W/kg

SAR(1 g) = 7.71 W/kg; SAR(10 g) = 2.17 W/kg

Smallest distance from peaks to all points 3 dB below = 6.8 mm

Ratio of SAR at M2 to SAR at M1 = 63.3%

Maximum value of SAR (measured) = 18.5 W/kg

Dipole Calibration /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 = 66.28 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 38.0 W/kg

SAR(1 g) = 8.06 W/kg; SAR(10 g) = 2.26 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 60.1%

Maximum value of SAR (measured) = 19.8 W/kg