

1.4. D1900V2 Dipole Calibration Certificate

 <p>In Collaboration with s p e a g CALIBRATION LABORATORY</p> <p>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</p>		  <p>中国认可 国际互认 CNAS 校准 CALIBRATION CNAS L0570</p>																																																														
Client	HTW	Certificate No: Z21-60019																																																														
<h3>CALIBRATION CERTIFICATE</h3> <table border="1"> <tr> <td>Object</td> <td>D1900V2 - SN: 5d226</td> </tr> <tr> <td>Calibration Procedure(s)</td> <td>FF-Z11-003-01 Calibration Procedures for dipole validation kits</td> </tr> <tr> <td>Calibration date:</td> <td>January 22, 2021</td> </tr> <tr> <td colspan="2"> <p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature(22 ± 3)°C and humidity<70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p> </td> </tr> <tr> <td colspan="2"> <table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date(Calibrated by, Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power Meter NRP2</td> <td>106276</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>Power sensor NRP6A</td> <td>101369</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>ReferenceProbe EX3DV4</td> <td>SN 7600</td> <td>30-Nov-20(CTTL-SPEAG, No.Z20-60421)</td> <td>Nov-21</td> </tr> <tr> <td>DAE4</td> <td>SN 771</td> <td>10-Feb-20(CTTL-SPEAG, No.Z20-60017)</td> <td>Feb-21</td> </tr> <tr> <td colspan="2">Secondary Standards</td> <td>ID #</td> <td>Cal Date(Calibrated by, Certificate No.)</td> </tr> <tr> <td colspan="2">Signal Generator E4438C</td> <td>MY49071430</td> <td>25-Feb-20 (CTTL, No.J20X00516)</td> </tr> <tr> <td colspan="2">NetworkAnalyzer E5071C</td> <td>MY46110673</td> <td>10-Feb-20 (CTTL, No.J20X00515)</td> </tr> </tbody> </table> </td> </tr> <tr> <td>Calibrated by:</td> <td>Name Zhao Jing</td> <td>Function SAR Test Engineer</td> <td>Signature</td> </tr> <tr> <td>Reviewed by:</td> <td>Name Lin Hao</td> <td>Function SAR Test Engineer</td> <td>Signature</td> </tr> <tr> <td>Approved by:</td> <td>Name Qi Dianyuan</td> <td>Function SAR Project Leader</td> <td>Signature</td> </tr> <tr> <td colspan="4" style="text-align: right;">Issued: January 29, 2021</td> </tr> <tr> <td colspan="4">This calibration certificate shall not be reproduced except in full without written approval of the laboratory.</td> </tr> </table>			Object	D1900V2 - SN: 5d226	Calibration Procedure(s)	FF-Z11-003-01 Calibration Procedures for dipole validation kits	Calibration date:	January 22, 2021	<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature(22 ± 3)°C and humidity<70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p>		<table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date(Calibrated by, Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power Meter NRP2</td> <td>106276</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>Power sensor NRP6A</td> <td>101369</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>ReferenceProbe EX3DV4</td> <td>SN 7600</td> <td>30-Nov-20(CTTL-SPEAG, No.Z20-60421)</td> <td>Nov-21</td> </tr> <tr> <td>DAE4</td> <td>SN 771</td> <td>10-Feb-20(CTTL-SPEAG, No.Z20-60017)</td> <td>Feb-21</td> </tr> <tr> <td colspan="2">Secondary Standards</td> <td>ID #</td> <td>Cal Date(Calibrated by, Certificate No.)</td> </tr> <tr> <td colspan="2">Signal Generator E4438C</td> <td>MY49071430</td> <td>25-Feb-20 (CTTL, No.J20X00516)</td> </tr> <tr> <td colspan="2">NetworkAnalyzer E5071C</td> <td>MY46110673</td> <td>10-Feb-20 (CTTL, No.J20X00515)</td> </tr> </tbody> </table>		Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration	Power Meter NRP2	106276	12-May-20 (CTTL, No.J20X02965)	May-21	Power sensor NRP6A	101369	12-May-20 (CTTL, No.J20X02965)	May-21	ReferenceProbe EX3DV4	SN 7600	30-Nov-20(CTTL-SPEAG, No.Z20-60421)	Nov-21	DAE4	SN 771	10-Feb-20(CTTL-SPEAG, No.Z20-60017)	Feb-21	Secondary Standards		ID #	Cal Date(Calibrated by, Certificate No.)	Signal Generator E4438C		MY49071430	25-Feb-20 (CTTL, No.J20X00516)	NetworkAnalyzer E5071C		MY46110673	10-Feb-20 (CTTL, No.J20X00515)	Calibrated by:	Name Zhao Jing	Function SAR Test Engineer	Signature	Reviewed by:	Name Lin Hao	Function SAR Test Engineer	Signature	Approved by:	Name Qi Dianyuan	Function SAR Project Leader	Signature	Issued: January 29, 2021				This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
Object	D1900V2 - SN: 5d226																																																															
Calibration Procedure(s)	FF-Z11-003-01 Calibration Procedures for dipole validation kits																																																															
Calibration date:	January 22, 2021																																																															
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature(22 ± 3)°C and humidity<70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p>																																																																
<table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date(Calibrated by, Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power Meter NRP2</td> <td>106276</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>Power sensor NRP6A</td> <td>101369</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>ReferenceProbe EX3DV4</td> <td>SN 7600</td> <td>30-Nov-20(CTTL-SPEAG, No.Z20-60421)</td> <td>Nov-21</td> </tr> <tr> <td>DAE4</td> <td>SN 771</td> <td>10-Feb-20(CTTL-SPEAG, No.Z20-60017)</td> <td>Feb-21</td> </tr> <tr> <td colspan="2">Secondary Standards</td> <td>ID #</td> <td>Cal Date(Calibrated by, Certificate No.)</td> </tr> <tr> <td colspan="2">Signal Generator E4438C</td> <td>MY49071430</td> <td>25-Feb-20 (CTTL, No.J20X00516)</td> </tr> <tr> <td colspan="2">NetworkAnalyzer E5071C</td> <td>MY46110673</td> <td>10-Feb-20 (CTTL, No.J20X00515)</td> </tr> </tbody> </table>		Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration	Power Meter NRP2	106276	12-May-20 (CTTL, No.J20X02965)	May-21	Power sensor NRP6A	101369	12-May-20 (CTTL, No.J20X02965)	May-21	ReferenceProbe EX3DV4	SN 7600	30-Nov-20(CTTL-SPEAG, No.Z20-60421)	Nov-21	DAE4	SN 771	10-Feb-20(CTTL-SPEAG, No.Z20-60017)	Feb-21	Secondary Standards		ID #	Cal Date(Calibrated by, Certificate No.)	Signal Generator E4438C		MY49071430	25-Feb-20 (CTTL, No.J20X00516)	NetworkAnalyzer E5071C		MY46110673	10-Feb-20 (CTTL, No.J20X00515)																															
Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration																																																													
Power Meter NRP2	106276	12-May-20 (CTTL, No.J20X02965)	May-21																																																													
Power sensor NRP6A	101369	12-May-20 (CTTL, No.J20X02965)	May-21																																																													
ReferenceProbe EX3DV4	SN 7600	30-Nov-20(CTTL-SPEAG, No.Z20-60421)	Nov-21																																																													
DAE4	SN 771	10-Feb-20(CTTL-SPEAG, No.Z20-60017)	Feb-21																																																													
Secondary Standards		ID #	Cal Date(Calibrated by, Certificate No.)																																																													
Signal Generator E4438C		MY49071430	25-Feb-20 (CTTL, No.J20X00516)																																																													
NetworkAnalyzer E5071C		MY46110673	10-Feb-20 (CTTL, No.J20X00515)																																																													
Calibrated by:	Name Zhao Jing	Function SAR Test Engineer	Signature																																																													
Reviewed by:	Name Lin Hao	Function SAR Test Engineer	Signature																																																													
Approved by:	Name Qi Dianyuan	Function SAR Project Leader	Signature																																																													
Issued: January 29, 2021																																																																
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.																																																																



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

lossary:

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, "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
- 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%.



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

Measurement Conditions

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

DASY Version	DASY52	V52.10.4
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	1900 MHz \pm 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 \pm 0.2) °C	40.1 \pm 6 %	1.38 mho/m \pm 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	9.85 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	39.8 W/kg \pm 18.8 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.05 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.3 W/kg \pm 18.7 % (k=2)



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

Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.5Ω+ 7.88jΩ
Return Loss	- 21.6dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.102 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
-----------------	-------



In Collaboration with
s p e a g
CALIBRATION LABORATORY

Address: 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

DASY5 Validation Report for Head TSL

Date: 01.22.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d226

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

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.38$ S/m; $\epsilon_r = 40.06$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7600; ConvF(8.7, 8.7, 8.7) @ 1900 MHz; Calibrated: 2020-11-30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2020-02-10
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.77 V/m; Power Drift = -0.06 dB

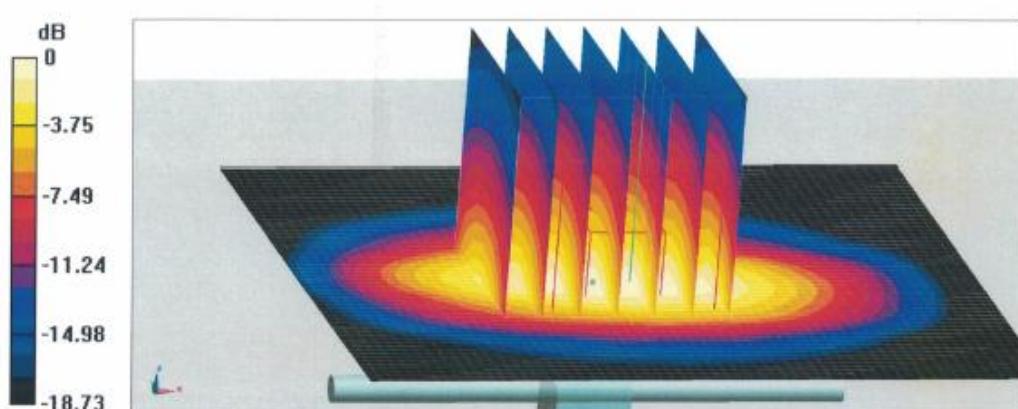
Peak SAR (extrapolated) = 19.0 W/kg

SAR(1 g) = 9.85 W/kg; SAR(10 g) = 5.05 W/kg

Smallest distance from peaks to all points 3 dB below = 10 mm

Ratio of SAR at M2 to SAR at M1 = 52.1%

Maximum value of SAR (measured) = 15.4 W/kg

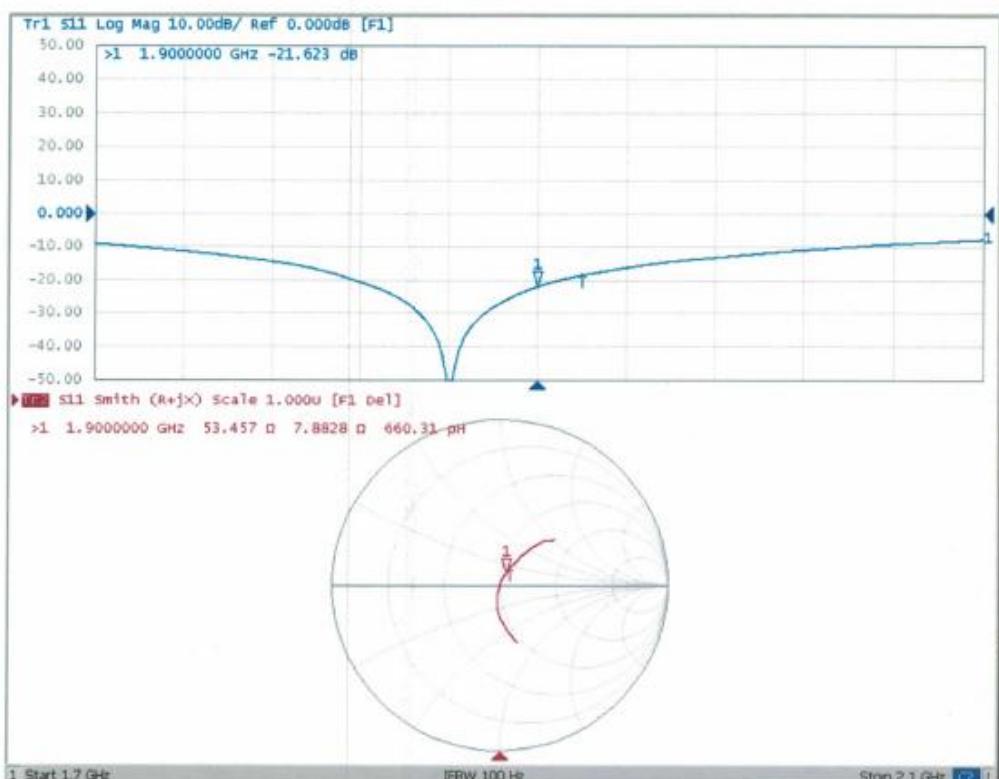


0 dB = 15.4 W/kg = 11.88 dBW/kg



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

Impedance Measurement Plot for Head TSL



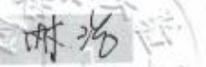
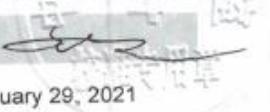
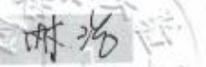
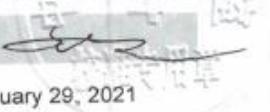
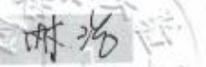
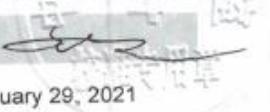
Extended Dipole Calibrations

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-1900						
Date of measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary impedance (ohm)	Delta (ohm)
2021-01-22	-21.6		53.5		7.88	
2022-01-17	-22.4	3.70	53.9	0.4	7.35	0.53
2023-01-15	-22.1	2.31	53.6	0.1	7.46	0.42

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. D2450V2 Dipole Calibration Certificate

 In Collaboration with s p e a g CALIBRATION LABORATORY		  中国认可 国际互认 校准 CALIBRATION CNAS L0570																																
Client HTW CALIBRATION CERTIFICATE		Certificate No: Z21-60020																																
Object D2450V2 - SN: 1009																																		
Calibration Procedure(s) FF-Z11-003-01 Calibration Procedures for dipole validation kits																																		
Calibration date: January 25, 2021																																		
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature($22\pm3^{\circ}\text{C}$) and humidity<70%.</p>																																		
Calibration Equipment used (M&TE critical for calibration)																																		
<table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date(Calibrated by, Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power Meter NRP2</td> <td>106276</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>Power sensor NRP6A</td> <td>101369</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>ReferenceProbe EX3DV4</td> <td>SN 7600</td> <td>30-Nov-20(CTTL-SPEAG, No.Z20-60421)</td> <td>Nov-21</td> </tr> <tr> <td>DAE4</td> <td>SN 771</td> <td>10-Feb-20(CTTL-SPEAG, No.Z20-60017)</td> <td>Feb-21</td> </tr> <tr> <td>Secondary Standards</td> <td>ID #</td> <td>Cal Date(Calibrated by, Certificate No.)</td> <td>Scheduled Calibration</td> </tr> <tr> <td>Signal Generator E4438C</td> <td>MY49071430</td> <td>25-Feb-20 (CTTL, No.J20X00516)</td> <td>Feb-21</td> </tr> <tr> <td>NetworkAnalyzer E5071C</td> <td>MY46110673</td> <td>10-Feb-20 (CTTL, No.J20X00515)</td> <td>Feb-21</td> </tr> </tbody> </table>			Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration	Power Meter NRP2	106276	12-May-20 (CTTL, No.J20X02965)	May-21	Power sensor NRP6A	101369	12-May-20 (CTTL, No.J20X02965)	May-21	ReferenceProbe EX3DV4	SN 7600	30-Nov-20(CTTL-SPEAG, No.Z20-60421)	Nov-21	DAE4	SN 771	10-Feb-20(CTTL-SPEAG, No.Z20-60017)	Feb-21	Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration	Signal Generator E4438C	MY49071430	25-Feb-20 (CTTL, No.J20X00516)	Feb-21	NetworkAnalyzer E5071C	MY46110673	10-Feb-20 (CTTL, No.J20X00515)	Feb-21
Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration																															
Power Meter NRP2	106276	12-May-20 (CTTL, No.J20X02965)	May-21																															
Power sensor NRP6A	101369	12-May-20 (CTTL, No.J20X02965)	May-21																															
ReferenceProbe EX3DV4	SN 7600	30-Nov-20(CTTL-SPEAG, No.Z20-60421)	Nov-21																															
DAE4	SN 771	10-Feb-20(CTTL-SPEAG, No.Z20-60017)	Feb-21																															
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration																															
Signal Generator E4438C	MY49071430	25-Feb-20 (CTTL, No.J20X00516)	Feb-21																															
NetworkAnalyzer E5071C	MY46110673	10-Feb-20 (CTTL, No.J20X00515)	Feb-21																															
<table border="1"> <thead> <tr> <th>Calibrated by:</th> <th>Name</th> <th>Function</th> <th>Signature</th> </tr> </thead> <tbody> <tr> <td>Zhao Jing</td> <td>SAR Test Engineer</td> <td></td> </tr> <tr> <th>Reviewed by:</th> <td>Lin Hao</td> <td>SAR Test Engineer</td> <td></td> </tr> <tr> <th>Approved by:</th> <td>Qi Dianyuan</td> <td>SAR Project Leader</td> <td></td> </tr> </tbody> </table>			Calibrated by:	Name	Function	Signature	Zhao Jing	SAR Test Engineer		Reviewed by:	Lin Hao	SAR Test Engineer		Approved by:	Qi Dianyuan	SAR Project Leader																		
Calibrated by:	Name	Function	Signature																															
Zhao Jing	SAR Test Engineer																																	
Reviewed by:	Lin Hao	SAR Test Engineer																																
Approved by:	Qi Dianyuan	SAR Project Leader																																
<p>Issued: January 29, 2021</p> <p>This calibration certificate shall not be reproduced except in full without written approval of the laboratory.</p>																																		



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

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, "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
- 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%.



In Collaboration with
s p e a g
 CALIBRATION LABORATORY

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

Measurement Conditions

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

DASY Version	DASY52	V52.10.4
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	39.5 ± 6 %	1.81 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.0 W/kg ± 18.8 % (k=2)
SAR averaged over 10 cm³ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.97 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.9 W/kg ± 18.7 % (k=2)



In Collaboration with
s p e a g
CALIBRATION LABORATORY

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

Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.9Ω+ 2.04jΩ
Return Loss	- 27.4dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.064 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
-----------------	-------



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

DASY5 Validation Report for Head TSL

Date: 01.25.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 1009

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.81$ S/m; $\epsilon_r = 39.52$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7600; ConvF(7.79, 7.79, 7.79) @ 2450 MHz; Calibrated: 2020-11-30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2020-02-10
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

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

Reference Value = 102.7 V/m; Power Drift = -0.06 dB

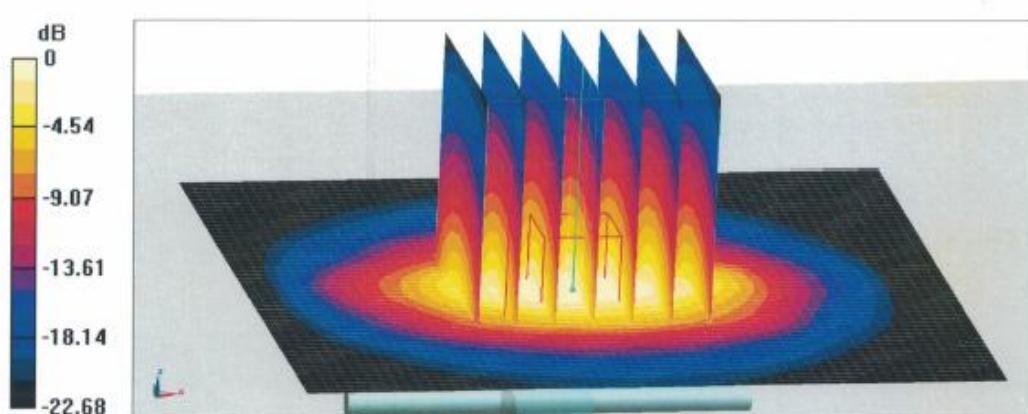
Peak SAR (extrapolated) = 27.2 W/kg

SAR(1 g) = 13 W/kg; SAR(10 g) = 5.97 W/kg

Smallest distance from peaks to all points 3 dB below = 9.5 mm

Ratio of SAR at M2 to SAR at M1 = 47.2%

Maximum value of SAR (measured) = 22.0 W/kg



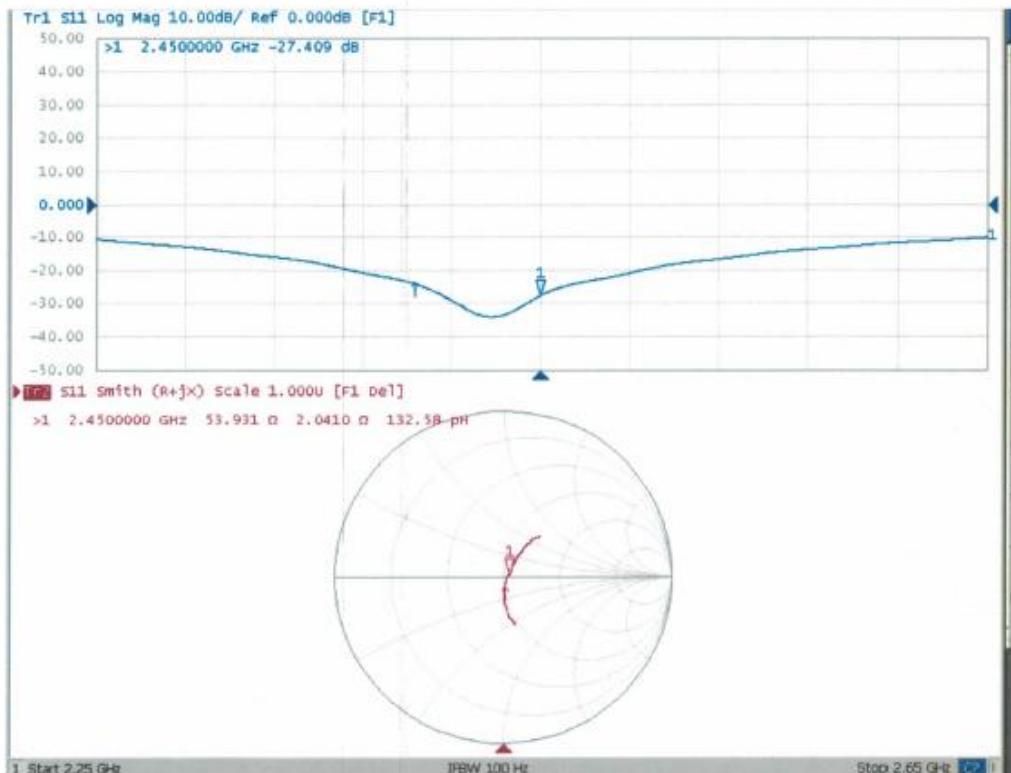
0 dB = 22.0 W/kg = 13.42 dBW/kg



In Collaboration with
s p e a g
CALIBRATION LABORATORY

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

Impedance Measurement Plot for Head TSL



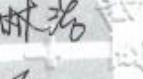
Extended Dipole Calibrations

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-2450						
Date of measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary impedance (ohm)	Delta (ohm)
2021-01-25	-27.4		53.9		2.04	
2022-01-17	-27.9	1.82	53.5	0.4	2.34	0.3
2023-01-15	-27.3	-0.36	53.7	0.2	2.16	0.12

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.

1.6. D2600V2 Dipole Calibration Certificate

 TTL speag CALIBRATION LABORATORY		In Collaboration with  IEC MRA  CNAS 中国认可 国际互认 校准 CALIBRATION CNAS L0570																																	
Client	HTW	Certificate No: Z21-60021																																	
CALIBRATION CERTIFICATE																																			
Object	D2600V2 - SN: 1150																																		
Calibration Procedure(s)	FF-Z11-003-01 Calibration Procedures for dipole validation kits																																		
Calibration date:	January 25, 2021																																		
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature(22 ± 3)°C and humidity<70%.</p>																																			
Calibration Equipment used (M&TE critical for calibration)																																			
<table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date(Calibrated by, Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power Meter NRP2</td> <td>106276</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>Power sensor NRP6A</td> <td>101369</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>Reference Probe EX3DV4</td> <td>SN 7600</td> <td>30-Nov-20(CTTL-SPEAG, No.Z20-60421)</td> <td>Nov-21</td> </tr> <tr> <td>DAE4</td> <td>SN 771</td> <td>10-Feb-20(CTTL-SPEAG, No.Z20-60017)</td> <td>Feb-21</td> </tr> <tr> <td>Secondary Standards</td> <td>ID #</td> <td>Cal Date(Calibrated by, Certificate No.)</td> <td>Scheduled Calibration</td> </tr> <tr> <td>Signal Generator E4438C</td> <td>MY49071430</td> <td>25-Feb-20 (CTTL, No.J20X00516)</td> <td>Feb-21</td> </tr> <tr> <td>Network Analyzer E5071C</td> <td>MY46110673</td> <td>10-Feb-20 (CTTL, No.J20X00515)</td> <td>Feb-21</td> </tr> </tbody> </table>				Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration	Power Meter NRP2	106276	12-May-20 (CTTL, No.J20X02965)	May-21	Power sensor NRP6A	101369	12-May-20 (CTTL, No.J20X02965)	May-21	Reference Probe EX3DV4	SN 7600	30-Nov-20(CTTL-SPEAG, No.Z20-60421)	Nov-21	DAE4	SN 771	10-Feb-20(CTTL-SPEAG, No.Z20-60017)	Feb-21	Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration	Signal Generator E4438C	MY49071430	25-Feb-20 (CTTL, No.J20X00516)	Feb-21	Network Analyzer E5071C	MY46110673	10-Feb-20 (CTTL, No.J20X00515)	Feb-21
Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration																																
Power Meter NRP2	106276	12-May-20 (CTTL, No.J20X02965)	May-21																																
Power sensor NRP6A	101369	12-May-20 (CTTL, No.J20X02965)	May-21																																
Reference Probe EX3DV4	SN 7600	30-Nov-20(CTTL-SPEAG, No.Z20-60421)	Nov-21																																
DAE4	SN 771	10-Feb-20(CTTL-SPEAG, No.Z20-60017)	Feb-21																																
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration																																
Signal Generator E4438C	MY49071430	25-Feb-20 (CTTL, No.J20X00516)	Feb-21																																
Network Analyzer E5071C	MY46110673	10-Feb-20 (CTTL, No.J20X00515)	Feb-21																																
Calibrated by:	Name Zhao Jing	Function SAR Test Engineer	Signature 																																
Reviewed by:	Name Lin Hao	Function SAR Test Engineer	Signature 																																
Approved by:	Name Qi Dianyuan	Function SAR Project Leader	Signature 																																
Issued: January 29, 2021																																			
<p>This calibration certificate shall not be reproduced except in full without written approval of the laboratory.</p>																																			



In Collaboration with
s p e a g
CALIBRATION LABORATORY

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

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, "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
- 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%.



In Collaboration with
s p e a g
 CALIBRATION LABORATORY

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

Measurement Conditions

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

DASY Version	DASY52	V52.10.4
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	2600 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.7 ± 6 %	1.97 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	14.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	56.5 W/kg ± 18.8 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	6.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.0 W/kg ± 18.7 % (k=2)



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

Appendix(Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.5Ω- 6.58jΩ
Return Loss	- 23.6dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.047 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
-----------------	-------



In Collaboration with
s p e a g
CALIBRATION LABORATORY

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

DASY5 Validation Report for Head TSL

Date: 01.25.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1150

Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2600$ MHz; $\sigma = 1.966$ S/m; $\epsilon_r = 39.65$; $\rho = 1000$ kg/m 3

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7600; ConvF(7.67, 7.67, 7.67) @ 2600 MHz; Calibrated: 2020-11-30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2020-02-10
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

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

Reference Value = 104.6 V/m; Power Drift = -0.03 dB

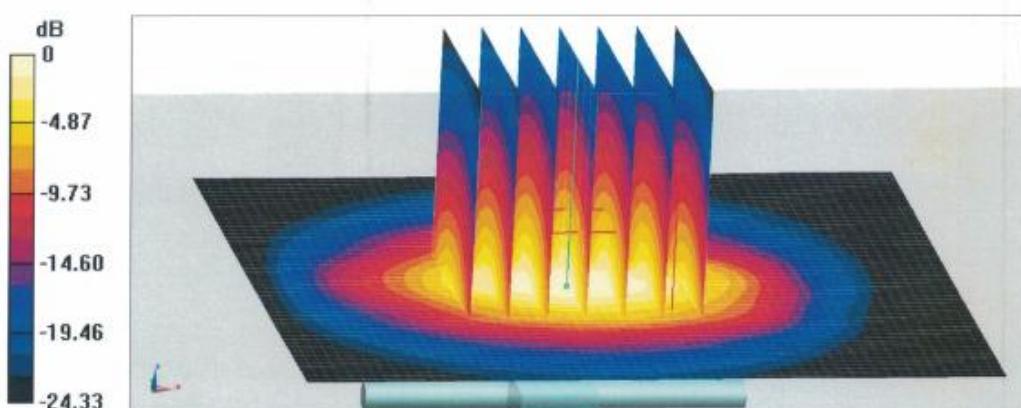
Peak SAR (extrapolated) = 31.1 W/kg

SAR(1 g) = 14.1 W/kg; SAR(10 g) = 6.24 W/kg

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 45.3%

Maximum value of SAR (measured) = 24.6 W/kg



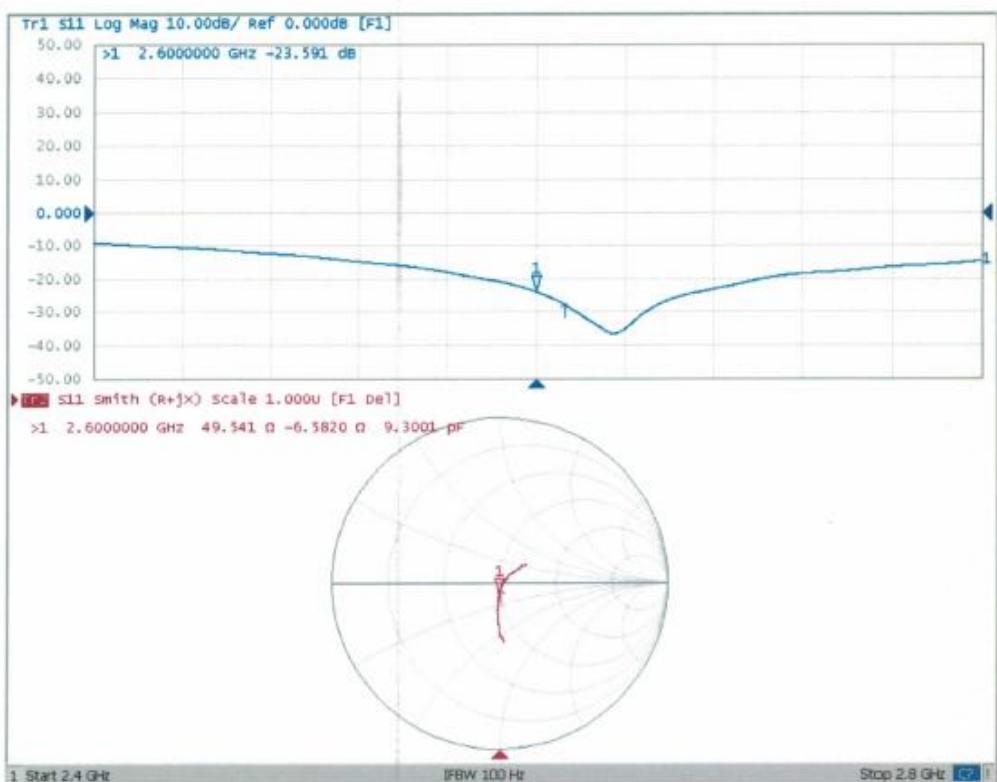
0 dB = 24.6 W/kg = 13.91 dBW/kg



In Collaboration with
s p e a g
CALIBRATION LABORATORY

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

Impedance Measurement Plot for Head TSL



Certificate No: Z21-60021

Page 6 of 6

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-2600						
Date of measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary impedance (ohm)	Delta (ohm)
2022-01-25	-23.6		49.5		-6.58	
2022-01-17	-24.0	1.69	49.1	0.4	-6.03	0.55
2023-01-15	-23.8	0.85	49.3	0.2	-6.33	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. D5GHzV2 Dipole Calibration Certificate

 <p>In Collaboration with TTL s p e a g CALIBRATION LABORATORY</p> <p>Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504 E-mail: ctll@chinattl.com http://www.chinattl.cn</p>		  <p>中国认可 国际互认 CNAS CALIBRATION CNAS L0570</p>																																																														
Client	HTW	Certificate No: Z21-60022																																																														
<h3>CALIBRATION CERTIFICATE</h3> <table border="1"> <tr> <td>Object</td> <td>D5GHzV2 - SN: 1273</td> </tr> <tr> <td>Calibration Procedure(s)</td> <td>FF-Z11-003-01 Calibration Procedures for dipole validation kits</td> </tr> <tr> <td>Calibration date:</td> <td>January 26, 2021</td> </tr> <tr> <td colspan="2"> <p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature(22 ± 3)°C and humidity<70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p> </td> </tr> <tr> <td colspan="2"> <table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date(Calibrated by, Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power Meter NRP2</td> <td>106276</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>Power sensor NRP6A</td> <td>101369</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>ReferenceProbe EX3DV4</td> <td>SN 7600</td> <td>30-Nov-20(CTTL-SPEAG, No.Z20-60421)</td> <td>Nov-21</td> </tr> <tr> <td>DAE4</td> <td>SN 771</td> <td>10-Feb-20(CTTL-SPEAG, No.Z20-60017)</td> <td>Feb-21</td> </tr> <tr> <td colspan="2">Secondary Standards</td> <td>ID #</td> <td>Cal Date(Calibrated by, Certificate No.)</td> </tr> <tr> <td colspan="2">Signal Generator E4438C</td> <td>MY49071430</td> <td>25-Feb-20 (CTTL, No.J20X00516)</td> </tr> <tr> <td colspan="2">NetworkAnalyzerE5071C</td> <td>MY46110673</td> <td>10-Feb-20 (CTTL, No.J20X00515)</td> </tr> </tbody> </table> </td> </tr> <tr> <td>Calibrated by:</td> <td>Name Zhao Jing</td> <td>Function SAR Test Engineer</td> <td>Signature</td> </tr> <tr> <td>Reviewed by:</td> <td>Name Lin Hao</td> <td>Function SAR Test Engineer</td> <td>Signature</td> </tr> <tr> <td>Approved by:</td> <td>Name Qi Dianyuan</td> <td>Function SAR Project Leader</td> <td>Signature</td> </tr> <tr> <td colspan="4" style="text-align: right;">Issued: January 29, 2021</td> </tr> <tr> <td colspan="4">This calibration certificate shall not be reproduced except in full without written approval of the laboratory.</td> </tr> </table>			Object	D5GHzV2 - SN: 1273	Calibration Procedure(s)	FF-Z11-003-01 Calibration Procedures for dipole validation kits	Calibration date:	January 26, 2021	<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature(22 ± 3)°C and humidity<70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p>		<table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date(Calibrated by, Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power Meter NRP2</td> <td>106276</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>Power sensor NRP6A</td> <td>101369</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>ReferenceProbe EX3DV4</td> <td>SN 7600</td> <td>30-Nov-20(CTTL-SPEAG, No.Z20-60421)</td> <td>Nov-21</td> </tr> <tr> <td>DAE4</td> <td>SN 771</td> <td>10-Feb-20(CTTL-SPEAG, No.Z20-60017)</td> <td>Feb-21</td> </tr> <tr> <td colspan="2">Secondary Standards</td> <td>ID #</td> <td>Cal Date(Calibrated by, Certificate No.)</td> </tr> <tr> <td colspan="2">Signal Generator E4438C</td> <td>MY49071430</td> <td>25-Feb-20 (CTTL, No.J20X00516)</td> </tr> <tr> <td colspan="2">NetworkAnalyzerE5071C</td> <td>MY46110673</td> <td>10-Feb-20 (CTTL, No.J20X00515)</td> </tr> </tbody> </table>		Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration	Power Meter NRP2	106276	12-May-20 (CTTL, No.J20X02965)	May-21	Power sensor NRP6A	101369	12-May-20 (CTTL, No.J20X02965)	May-21	ReferenceProbe EX3DV4	SN 7600	30-Nov-20(CTTL-SPEAG, No.Z20-60421)	Nov-21	DAE4	SN 771	10-Feb-20(CTTL-SPEAG, No.Z20-60017)	Feb-21	Secondary Standards		ID #	Cal Date(Calibrated by, Certificate No.)	Signal Generator E4438C		MY49071430	25-Feb-20 (CTTL, No.J20X00516)	NetworkAnalyzerE5071C		MY46110673	10-Feb-20 (CTTL, No.J20X00515)	Calibrated by:	Name Zhao Jing	Function SAR Test Engineer	Signature	Reviewed by:	Name Lin Hao	Function SAR Test Engineer	Signature	Approved by:	Name Qi Dianyuan	Function SAR Project Leader	Signature	Issued: January 29, 2021				This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
Object	D5GHzV2 - SN: 1273																																																															
Calibration Procedure(s)	FF-Z11-003-01 Calibration Procedures for dipole validation kits																																																															
Calibration date:	January 26, 2021																																																															
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature(22 ± 3)°C and humidity<70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p>																																																																
<table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date(Calibrated by, Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power Meter NRP2</td> <td>106276</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>Power sensor NRP6A</td> <td>101369</td> <td>12-May-20 (CTTL, No.J20X02965)</td> <td>May-21</td> </tr> <tr> <td>ReferenceProbe EX3DV4</td> <td>SN 7600</td> <td>30-Nov-20(CTTL-SPEAG, No.Z20-60421)</td> <td>Nov-21</td> </tr> <tr> <td>DAE4</td> <td>SN 771</td> <td>10-Feb-20(CTTL-SPEAG, No.Z20-60017)</td> <td>Feb-21</td> </tr> <tr> <td colspan="2">Secondary Standards</td> <td>ID #</td> <td>Cal Date(Calibrated by, Certificate No.)</td> </tr> <tr> <td colspan="2">Signal Generator E4438C</td> <td>MY49071430</td> <td>25-Feb-20 (CTTL, No.J20X00516)</td> </tr> <tr> <td colspan="2">NetworkAnalyzerE5071C</td> <td>MY46110673</td> <td>10-Feb-20 (CTTL, No.J20X00515)</td> </tr> </tbody> </table>		Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration	Power Meter NRP2	106276	12-May-20 (CTTL, No.J20X02965)	May-21	Power sensor NRP6A	101369	12-May-20 (CTTL, No.J20X02965)	May-21	ReferenceProbe EX3DV4	SN 7600	30-Nov-20(CTTL-SPEAG, No.Z20-60421)	Nov-21	DAE4	SN 771	10-Feb-20(CTTL-SPEAG, No.Z20-60017)	Feb-21	Secondary Standards		ID #	Cal Date(Calibrated by, Certificate No.)	Signal Generator E4438C		MY49071430	25-Feb-20 (CTTL, No.J20X00516)	NetworkAnalyzerE5071C		MY46110673	10-Feb-20 (CTTL, No.J20X00515)																															
Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration																																																													
Power Meter NRP2	106276	12-May-20 (CTTL, No.J20X02965)	May-21																																																													
Power sensor NRP6A	101369	12-May-20 (CTTL, No.J20X02965)	May-21																																																													
ReferenceProbe EX3DV4	SN 7600	30-Nov-20(CTTL-SPEAG, No.Z20-60421)	Nov-21																																																													
DAE4	SN 771	10-Feb-20(CTTL-SPEAG, No.Z20-60017)	Feb-21																																																													
Secondary Standards		ID #	Cal Date(Calibrated by, Certificate No.)																																																													
Signal Generator E4438C		MY49071430	25-Feb-20 (CTTL, No.J20X00516)																																																													
NetworkAnalyzerE5071C		MY46110673	10-Feb-20 (CTTL, No.J20X00515)																																																													
Calibrated by:	Name Zhao Jing	Function SAR Test Engineer	Signature																																																													
Reviewed by:	Name Lin Hao	Function SAR Test Engineer	Signature																																																													
Approved by:	Name Qi Dianyuan	Function SAR Project Leader	Signature																																																													
Issued: January 29, 2021																																																																
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.																																																																



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: ctl@chinattl.com <http://www.chinattl.cn>

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, "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 2013
- 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%.



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
 Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
 E-mail: ctl@chinattl.com <http://www.chinattl.cn>

Measurement Conditions

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

DASY Version	DASY52	V52.10.4
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 5750 MHz ± 1 MHz	

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.0 ± 6 %	4.68 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.82 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.2 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm³ (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.3 W/kg ± 24.2 % (k=2)



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
 Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
 E-mail: cttl@chinattl.com <http://www.chinattl.cn>

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.4 ± 6 %	5.06 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.6 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.3 W/kg ± 24.2 % (k=2)

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.2 ± 6 %	5.22 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.94 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.3 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.25 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg ± 24.2 % (k=2)



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: ctl@chinattl.com <http://www.chinattl.cn>

Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	$47.8\Omega - 1.46j\Omega$
Return Loss	- 31.3dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	$51.6\Omega + 2.95j\Omega$
Return Loss	- 29.6dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	$50.0\Omega + 3.42j\Omega$
Return Loss	- 29.3dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.101 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
-----------------	-------



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

DASY5 Validation Report for Head TSL

Date: 01.26.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1273

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz,

Medium parameters used: $f = 5250$ MHz; $\sigma = 4.678$ S/m; $\epsilon_r = 36.04$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5600$ MHz; $\sigma = 5.055$ S/m; $\epsilon_r = 35.43$; $\rho = 1000$ kg/m³, Medium parameters used: $f = 5750$ MHz; $\sigma = 5.219$ S/m; $\epsilon_r = 35.21$; $\rho = 1000$ kg/m³,

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7600; ConvF(5.68, 5.68, 5.68) @ 5250 MHz; ConvF(5.11, 5.11, 5.11) @ 5600 MHz; ConvF(5.07, 5.07, 5.07) @ 5750 MHz; Calibrated: 2020-11-30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2020-02-10
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

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 = 65.72 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 32.0 W/kg

SAR(1 g) = 7.82 W/kg; SAR(10 g) = 2.23 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 64.5%

Maximum value of SAR (measured) = 18.4 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 = 67.05 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 35.4 W/kg

SAR(1 g) = 8.16 W/kg; SAR(10 g) = 2.33 W/kg

Smallest distance from peaks to all points 3 dB below = 7.5 mm

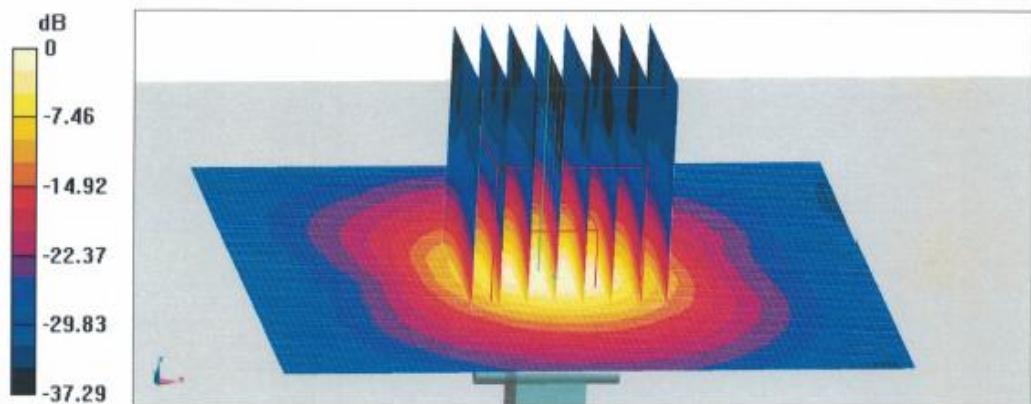
Ratio of SAR at M2 to SAR at M1 = 62.8%

Maximum value of SAR (measured) = 20.4 W/kg



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: ctl@chinattl.com <http://www.chinattl.cn>

**Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm**
Reference Value = 66.61 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 35.8 W/kg
SAR(1 g) = 7.94 W/kg; SAR(10 g) = 2.25 W/kg
Smallest distance from peaks to all points 3 dB below = 7.6 mm
Ratio of SAR at M2 to SAR at M1 = 61.7%
Maximum value of SAR (measured) = 19.7 W/kg



0 dB = 19.7 W/kg = 12.94 dBW/kg



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com http://www.chinattl.cn

Impedance Measurement Plot for Head TSL



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-5250						
Date of measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary impedance (ohm)	Delta (ohm)
2021-01-26	-31.3		47.8		-1.46	
2022-01-17	-31.8	1.60	47.3	0.5	-1.06	0.4
2023-01-15	-31.5	0.64	47.7	0.1	-1.36	0.1

Head-5600						
Date of measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary impedance (ohm)	Delta (ohm)
2021-01-26	-29.6		51.6		2.95	
2022-01-17	-30.1	1.06	51.2	0.4	2.75	0.2
2023-01-15	-29.9	-0.66	51.8	0.2	2.90	0.05

Head-5750						
Date of measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary impedance (ohm)	Delta (ohm)
2021-01-26	-29.3		50.0		3.42	
2022-01-17	-29.6	1.02	50.7	0.7	3.02	0.4
2023-01-15	-29.8	1.71	50.4	0.4	3.22	0.2

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.