

In Collaboration with

DASY5 Validation Report for Head TSL Test Laboratory: CTTL, Beijing, China

Date: 12.05.2018

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1099

Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1 Medium parameters used: f = 750 MHz; $\sigma = 0.865$ S/m; $\varepsilon_r = 43.13$; $\rho = 1000$ kg/m3 Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 SN7514; ConvF(9.47, 9.47, 9.47) @ 750 MHz; Calibrated: 8/27/2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1555; Calibrated: 8/20/2018
- Phantom: MFP_V5.1C; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

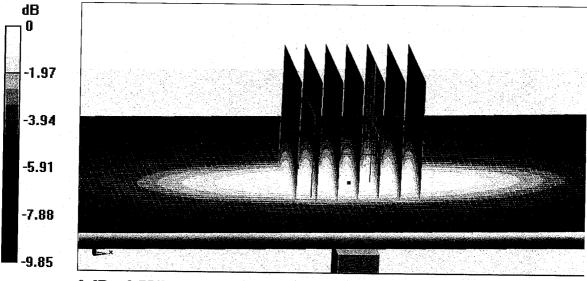
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 53.37 V/m; Power Drift = 0.00 dB

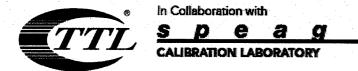
Peak SAR (extrapolated) = 3.12 W/kg

SAR(1 g) = 2.07 W/kg; SAR(10 g) = 1.38 W/kg

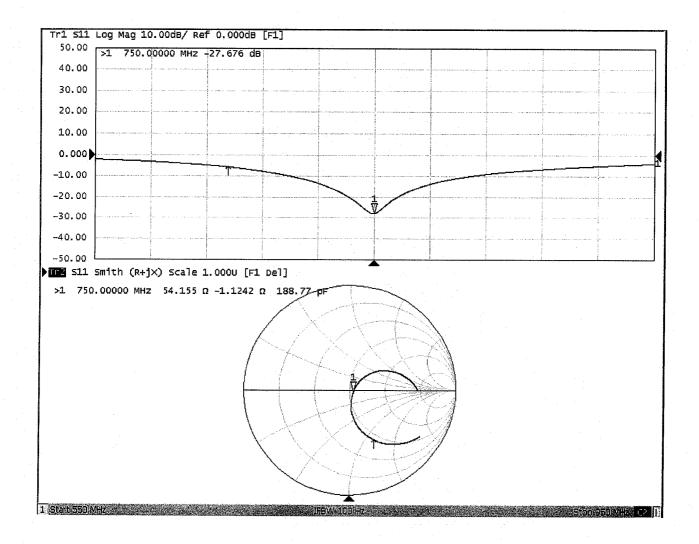
Maximum value of SAR (measured) = 2.75 W/kg



0 dB = 2.75 W/kg = 4.39 dBW/kg



Impedance Measurement Plot for Head TSL





DASY5 Validation Report for Body TSL

Date: 12.05.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1099

Communication System: UID 0, CW; Frequency: 750 MHz; Duty Cycle: 1:1

Medium parameters used: f = 750 MHz; $\sigma = 0.951$ S/m; $\varepsilon_r = 54.02$; $\rho = 1000$ kg/m3

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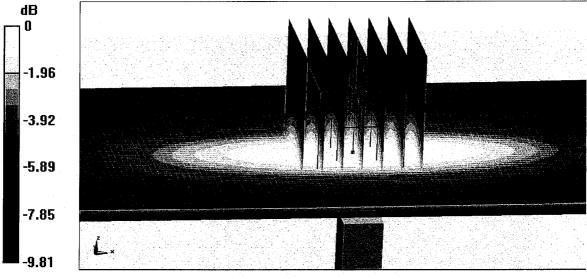
Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 SN7514; ConvF(9.68, 9.68, 9.68) @ 750 MHz; Calibrated: • 8/27/2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1555; Calibrated: 8/20/2018
- Phantom: MFP V5.1C; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 • (7450)

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

Reference Value = 51.51 V/m; Power Drift = -0.07 dBPeak SAR (extrapolated) = 3.29 W/kg SAR(1 g) = 2.15 W/kg; SAR(10 g) = 1.44 W/kgMaximum value of SAR (measured) = 2.88 W/kg

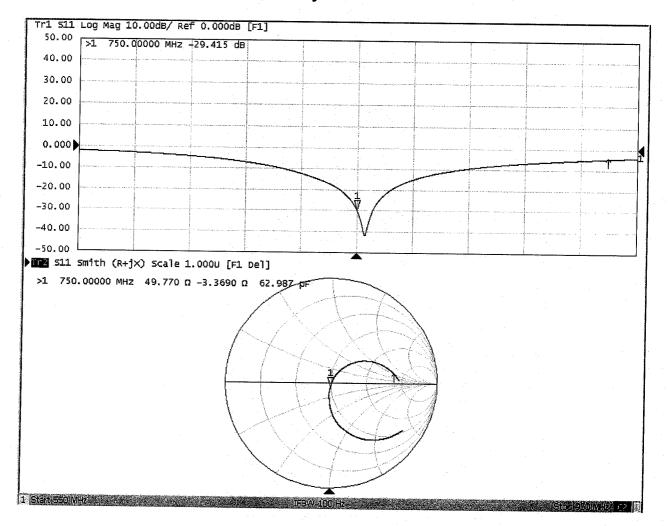


0 dB = 2.88 W/kg = 4.59 dBW/kg



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Impedance Measurement Plot for Body TSL





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Z18-60533 **Certificate No:**

ALIBRATION CERTIFICATE

Sporton

Object

D835V2 - SN: 4d162

Calibration Procedure(s)

FF-Z11-003-01 Calibration Procedures for dipole validation kits

Calibration date:

Client

December 5, 2018

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 NRVD	102196	07-Mar-18 (CTTL, No.J18X01510)	Mar-19
Power sensor NRV-Z5	100596	07-Mar-18 (CTTL, No.J18X01510)	Mar-19
Reference Probe EX3DV4	SN 7514	27-Aug-18(SPEAG,No.EX3-7514_Aug18)	Aug-19
DAE4	SN 1555	20-Aug-18(SPEAG, No.DAE4-1555_Aug18)	Aug-19
Secondary Standards	ID#	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	23-Jan-18 (CTTL, No.J18X00560)	Jan-19
NetworkAnalyzer E5071C	MY46110673	24-Jan-18 (CTTL, No.J18X00561)	Jan-19
		and the second secon	

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	A.
Approved by:	Qi Dianyuan	SAR Project Leader	- Andrew -

Issued: December 8, 2018

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



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Glossary:

TSL ConvF N/A tissue simulating liquid sensitivity in TSL / NORMx,y,z 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%.

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Measurement Conditions

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

DASY Version	DASY52	52.10.2.1495
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	42.7 ± 6 %	0.88 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	2.35 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	9.61 mW /g ± 18.8 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.56 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	6.35 mW /g ± 18.7 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.7 ± 6 %	0.99 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C		

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	_ Condition	
SAR measured	250 mW input power	2.47 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	9.70 mW /g ± 18.8 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	1.64 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	6.47 mW /g ± 18.7 % (k=2)



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Appendix (Additional assessments outside the scope of CNAS L0570)

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Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.6Ω- 2.56jΩ	
Return Loss	- 28.9dB	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.2Ω- 6.92jΩ	
Return Loss	- 22.3dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.306 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

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DASY5 Validation Report for Head TSL

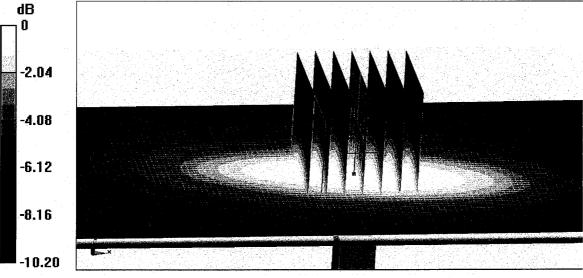
Date: 12.04.2018

Test Laboratory: CTTL, Beijing, China DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d162 Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1 Medium parameters used: f = 835 MHz; $\sigma = 0.881$ S/m; $\varepsilon_r = 42.71$; $\rho = 1000$ kg/m3 Phantom section: Right Section **DASY5** Configuration:

- Probe: EX3DV4 SN7514; ConvF(9.09, 9.09, 9.09) @ 835 MHz; Calibrated: 8/27/2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1555; Calibrated: 8/20/2018
- Phantom: MFP V5.1C; Type: QD 000 P51CA; Serial: 1062 ٠
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 ٠ (7450)

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

Reference Value = 57.75 V/m; Power Drift = 0.03 dBPeak SAR (extrapolated) = 3.50 W/kgSAR(1 g) = 2.35 W/kg; SAR(10 g) = 1.56 W/kg Maximum value of SAR (measured) = 3.11 W/kg



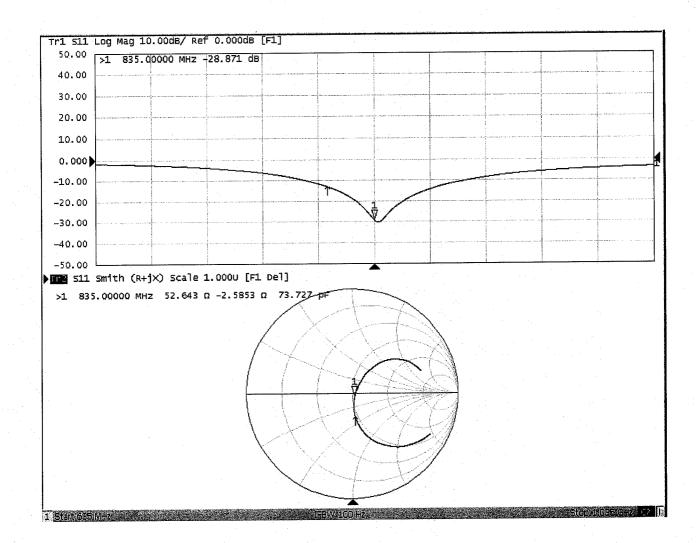
0 dB = 3.11 W/kg = 4.93 dBW/kg



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Impedance Measurement Plot for Head TSL





DASY5 Validation Report for Body TSL Test Laboratory: CTTL, Beijing, China **DUT: Dipole 835 MHz: Type: D835V2: Seria**

Date: 12.04.2018

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d162 Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: f = 835 MHz; σ = 0.986 S/m; ϵ_r = 53.72; ρ = 1000 kg/m3

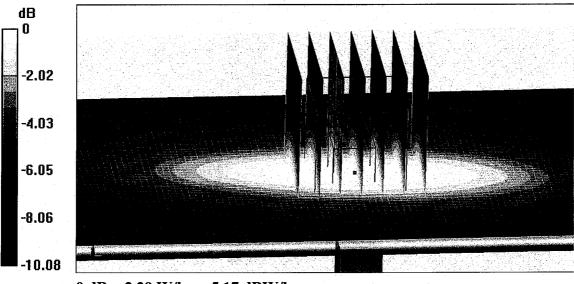
Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 SN7514; ConvF(9.47, 9.47, 9.47) @ 835 MHz; Calibrated: 8/27/2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1555; Calibrated: 8/20/2018
- Phantom: MFP_V5.1C; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 55.24 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 3.72 W/kg

SAR(1 g) = 2.47 W/kg; SAR(10 g) = 1.64 W/kg Maximum value of SAR (measured) = 3.29 W/kg



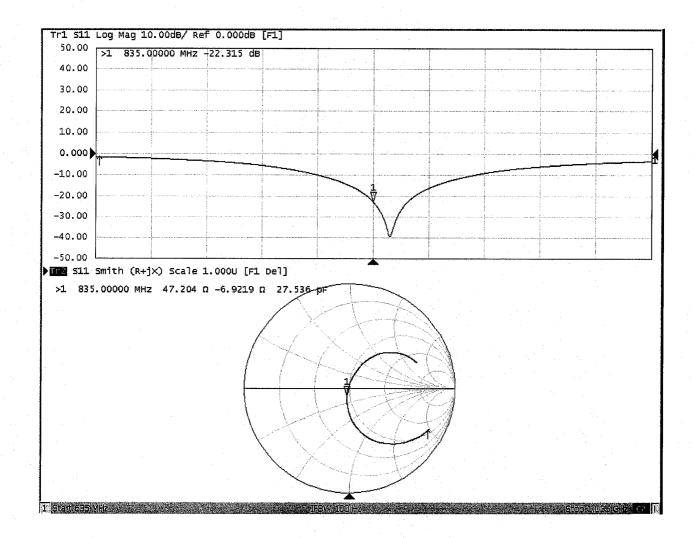
0 dB = 3.29 W/kg = 5.17 dBW/kg

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Impedance Measurement Plot for Body TSL



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Add: No.51 Xueyuan Ro Tel: +86-10-62304633-2 E-mail: cttl@chinattl.co	2079 Fax: +80-	, Beijing, 100191, China 10-62304633-2504 w.chinattl.cn		CNAS L0570
O		Ce	rtificate No: Z18-60)258
Client Sporton	RIFICATE			
Object	D1750V2	- SN: 1137		
Calibration Procedure(s)	FF-Z11-0 Calibratic	03-01 In Procedures for di	pole validation kits	
Calibration date: This calibration Certificate do	July 30, 2	The product of the second s		
This calibration Certificate do measurements(SI). The meas pages and are part of the cert All calibrations have been humidity<70%. Calibration Equipment used (ificate. conducted in th	ne closed laborator		
Calibration Equipment used (d by Cortificate No.)	Scheduled Calibration
Primary Standards	<u>ID #</u>	Cal Date(Calibrate	ed by, Certificate No.)	Oct-18
Power Meter NRVD	102083	01-Nov-17 (CTTL, 01-Nov-17 (CTTL,	No. (17X08756)	Oct-18
Power sensor NRV-Z5	100542	12 Son 17(SPEA(G,No.EX3-7464_Sep17)	Sep-18
Reference Probe EX3DV4 DAE4	SN 7464 SN 1524	13-Sep-17(SPEAG	G,No.DAE4-1524_Sep17)	Sep-18
o dan Standards	ID#	Cal Date(Calibrate	ed by, Certificate No.)	Scheduled Calibration
Secondary Standards Signal Generator E4438C	MY49071430	23-Jan-18 (CTTL,	No.J18X00560)	Jan-19
NetworkAnalyzer E5071C	MY46110673	24-Jan-18 (CTTL,	No.J18X00561)	Jan-19
	Name	Function		Signature
Calibrated by:	Zhao Jing	SAR Test El	ngineer	A CAL
Reviewed by:	Lin Hao	SAR Test E	ngineer	S-INATO SE
Approved by:	Qi Dianyuan	SAR Projec	York was strategies.	
			Issued: Augu	ıst 3, 2018
This calibration certificate s	hall not be repro	oduced except in ful	I without written approval	of the laboratory.

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Glossary:

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

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:

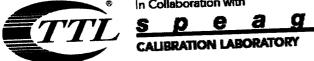
e) DASY4/5 System Handbook

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
- 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.

DASY52	52.10.1.1476
Advanced Extrapolation	
Triple Flat Phantom 5.1C	
10 mm	with Spacer
dx, dy, dz = 5 mm	
1750 MHz ± 1 MHz	
	DASY52 Advanced Extrapolation Triple Flat Phantom 5.1C 10 mm dx, dy, dz = 5 mm

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Head TSL parameters

ters and calculations were applied.

The following parameters and calculations we	Temperature	Permittivity	Conductivity
	22.0 °C	40.1	1.37 mho/m
Nominal Head TSL parameters Measured Head TSL parameters	(22.0 ± 0.2) °C	41.2 ± 6 %	1.33 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		

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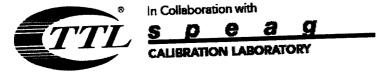
R result with Head 13L	Condition	
SAR averaged over 1 $-cm^3$ (1 g) of Head TSL		8.91 mW / g
SAR measured	250 mW input power	
SAR for nominal Head TSL parameters	normalized to 1W	36.5 mW /g ± 18.8 % (k=2)
SAR for normal field for parameters SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
	250 mW input power	4.81 mW / g
SAR measured		19.5 mW /g ± 18.7 % (k=2)
SAR for nominal Head TSL parameters	normalized to 1W	10.0 mm rg = 10.0 mm rg

Body TSL parameters

he following parameters and calculations were a	Temperature	Permittivity	Conductivity
TOL seremeters	22.0 °C	53.4	1.49 mho/m
Nominal Body TSL parameters	(22.0 ± 0.2) °C	53.8 ± 6 %	1.48 mho/m ± 6 %
Measured Body TSL parameters			
Body TSL temperature change during test	<1.0 °C		

SAR result with Body TSL

(result with body to	Condition	
SAR averaged over 1 cm^3 (1 g) of Body TSL	250 mW input power	9.17 mW / g
SAR measured		
SAR for nominal Body TSL parameters	normalized to 1W	37.0 mW /g ± 18.8 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Body TSL	Condition	
	250 mW input power	5.05 mW / g
SAR measured		20.3 mW /g ± 18.7 % (k=2)
SAR for nominal Body TSL parameters	normalized to 1W	20.3 1111 /g 1 1011 /0 (10 =/



Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.3- 0.87 jΩ
	- 40.7 dB
Return Loss	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.8Ω- 2.59 jΩ
Return Loss	- 24.3 dB

General Antenna Parameters and Design

	1.087 ns
Electrical Delay (one direction)	

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

	SPEAG
Manufactured by	

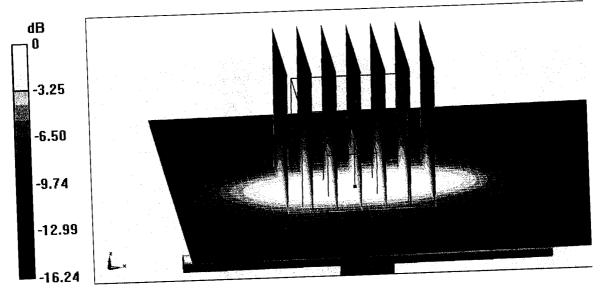


Date: 07.30.2018

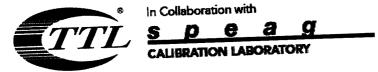
DASY5 Validation Report for Head TSL Test Laboratory: CTTL, Beijing, China **DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1137** Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1 Medium parameters used: f = 1750 MHz; $\sigma = 1.332$ S/m; $\epsilon r = 41.17$; $\rho = 1000$ kg/m3 Phantom section: Center Section DASY5 Configuration:

- Probe: EX3DV4 SN7464; ConvF(8.7, 8.7, 8.7) @ 1750 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
- Pnanton: MFF_V5.1C, Type: QD 00011101
 Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11
- Measurement Sw: DAS 132, Version 52.10 (1), 4 (7439)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 96.50 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 16.1 W/kg SAR(1 g) = 8.91 W/kg; SAR(10 g) = 4.81 W/kg Maximum value of SAR (measured) = 13.5 W/kg



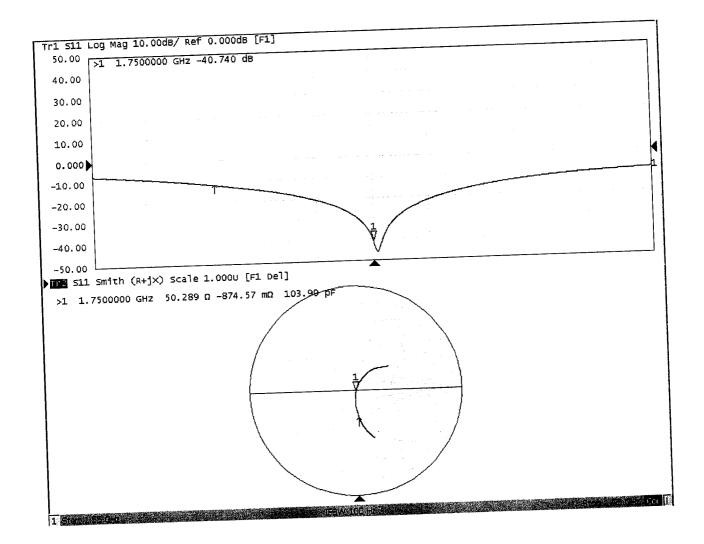
0 dB = 13.5 W/kg = 11.30 dBW/kg

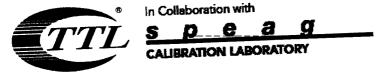


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Impedance Measurement Plot for Head TSL





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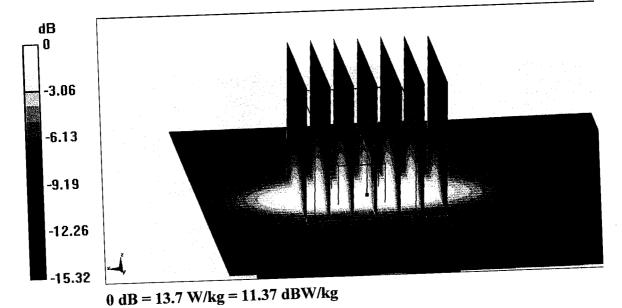
DASY5 Validation Report for Body TSL

Date: 07.30.2018

Test Laboratory: CTTL, Beijing, China DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1137 Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1 Medium parameters used: f = 1750 MHz; σ = 1.477 S/m; ϵ r = 53.84; ρ = 1000 kg/m3 Phantom section: Left Section DASY5 Configuration:

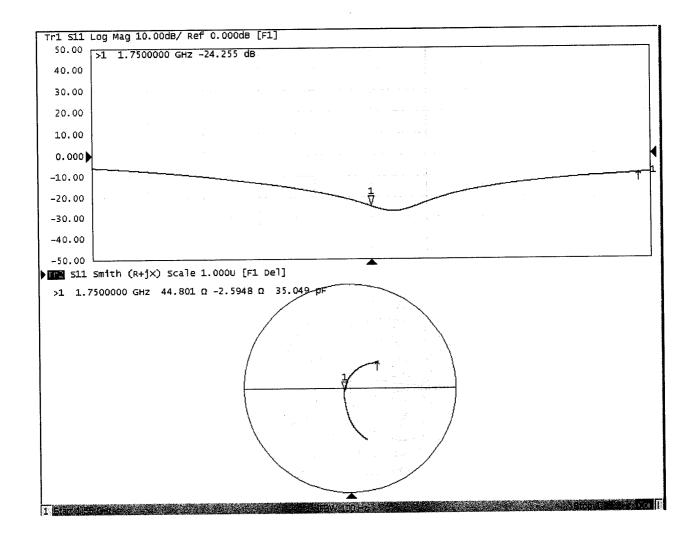
- Probe: EX3DV4 SN7464; ConvF(8.6, 8.6, 8.6) @ 1750 MHz; Calibrated: • 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1524; Calibrated: 9/13/2017
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 ٠ • (7439)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 77.55 V/m; Power Drift = 0.06 dB Peak SAR (extrapolated) = 16.0 W/kg SAR(1 g) = 9.17 W/kg; SAR(10 g) = 5.05 W/kg Maximum value of SAR (measured) = 13.7 W/kg

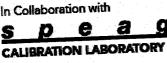




Impedance Measurement Plot for Body TSL







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CALIBRATION GERTIFICATE

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Client

Sporton

Z18-60536 **Certificate No:**

FF-Z11-003-01 Calibration Procedures for dipole validation kits

December 7, 2018

D1900V2 - SN: 5d182

Calibration date:

Calibration Procedure(s)

Object

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.

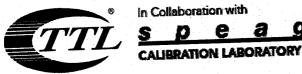
All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

		Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Primary Standards Power Meter NRVD Power sensor NRV-Z5 Reference Probe EX3DV4 DAE4	100596	Car Date(Cambrated 3), 220 07-Mar-18 (CTTL, No.J18X01510) 07-Mar-18 (CTTL, No.J18X01510) 27-Aug-18(SPEAG,No.EX3-7514_Aug18) 20-Aug-18(SPEAG,No.DAE4-1555_Aug18)	Mar-19 Mar-19 Aug-19 Aug-19
Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	ID # MY49071430 MY46110673		Scheduled Calibration Jan-19 Jan-19

	Name	Function	Signature
Calibrated by:	Zhao Jing S	SAR Test Engineer	Con To Use
Reviewed by:	Lin Hao	SAR Test Engineer	Min Victor
Approved by:	Qi Dianyuan	SAR Project Leader	
			ssued: December 10, 2018
	inete shall not be reproduced e	except in full without writte	en approval of the laboratory.

This calibration certificate shall not be repro-



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lossary:

TSL ConvF N/A

tissue simulating liquid sensitivity in TSL / NORMx,y,z 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

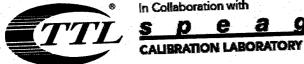
Additional Documentation:

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
- . 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 p 8

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Measurement Conditions

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

DASY Version	DASY52	52.10.2.1495
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 ± 1 MHz	

Head TSL parameters

neters and calculations were applied.

The following parameters and calculations mere	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.6 ± 6 %	1.44 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		

P result with Head TSL SA

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
	250 mW input power	10.1 mW / g
SAR measured SAR for nominal Head TSL parameters	normalized to 1W	39.6 mW /g ± 18.8 % (k=2)
	Condition	
SAR averaged over 10 cm^3 (10 g) of Head TSL	250 mW input power	5.25 mW / g
SAR measured	normalized to 1W	20.7 mW /g ± 18.7 % (k=2)
SAR for nominal Head TSL parameters		

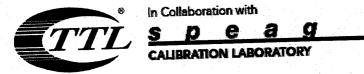
Body TSL parameters

he following parameters and calculations were a	Temperature	Permittivity	Conductivity
	22.0 °C	53.3	1.52 mho/m
Nominal Body TSL parameters	(22.0 ± 0.2) °C	51.8 ± 6 %	1.56 mho/m ± 6 %
Measured Body TSL parameters			
Body TSL temperature change during test	<1.0 °C		

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
	250 mW input power	10.2 mW / g
SAR measured		39.9 mW /g ± 18.8 % (k=2)
SAR for nominal Body TSL parameters	normalized to 1W	39.9 mw /g ± 10.0 // (* =/
SAR averaged over 10 cm^3 (10 g) of Body TSL	Condition	
	250 mW input power	5.31 mW / g
SAR measured		20.9 mW /g ± 18.7 % (k=2)
SAR for nominal Body TSL parameters	normalized to 1W	20.9 MW/g 1 10.7 / (K 2)

Certificate No: Z18-60536



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.1Ω+ 5.35jΩ
Return Loss	- 25.0dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.9Ω+ 6.19ϳΩ
Return Loss	- 24.0dB

General Antenna Parameters and Design

	1.067 ns
Electrical Delay (one direction)	

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

		SPEAG
Manufactured by	· · · · · · · · · · · · · · · · · · ·	



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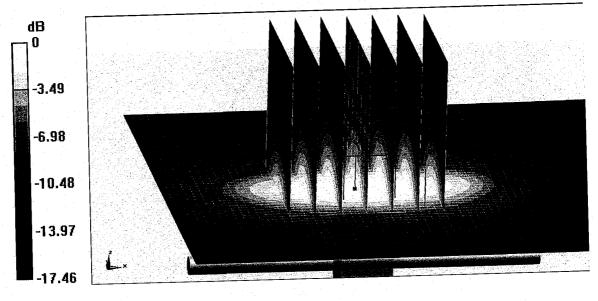
Date: 12.06.2018

DASY5 Validation Report for Head TSL Test Laboratory: CTTL, Beijing, China DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d182 Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1 Medium parameters used: f = 1900 MHz; σ = 1.441 S/m; ϵ_r = 39.59; ρ = 1000 kg/m3 Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 SN7514; ConvF(7.73, 7.73, 7.73) @ 1900 MHz; Calibrated: 8/27/2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection) •
- Electronics: DAE4 Sn1555; Calibrated: 8/20/2018
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 95.91 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 19.3 W/kg SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.25 W/kg Maximum value of SAR (measured) = 15.8 W/kg



0 dB = 15.8 W/kg = 11.99 dBW/kg

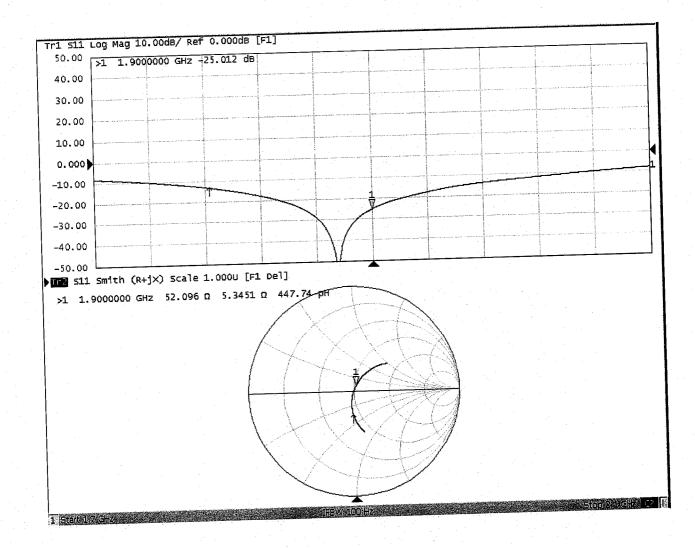


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Impedance Measurement Plot for Head TSL





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DASY5 Validation Report for Body TSL

Date: 12.05.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d182

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

Medium parameters used: f = 1900 MHz; σ = 1.564 S/m; ϵ_r = 51.82; ρ = 1000 kg/m3

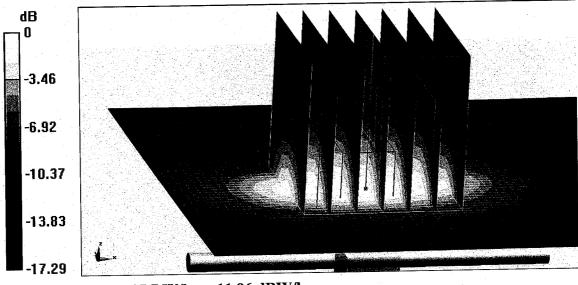
Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 SN7514; ConvF(7.53, 7.53, 7.53) @ 1900 MHz; Calibrated: • 8/27/2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1555; Calibrated: 8/20/2018 •
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062 • •
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 ٠ (7450)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 84.07 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 18.9 W/kg SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.31 W/kg

Maximum value of SAR (measured) = 15.7 W/kg

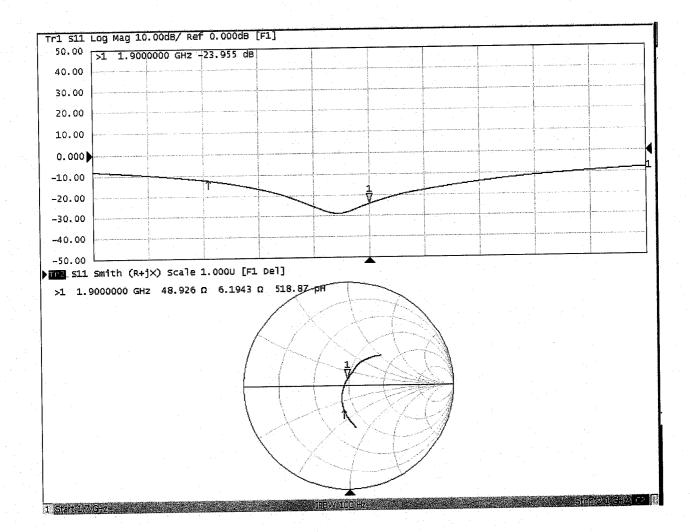


0 dB = 15.7 W/kg = 11.96 dBW/kg



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Impedance Measurement Plot for Body TSL



		CAN G		NAS	中国认可 国际互认 校准 CALIBRATION
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E-mail: cttl@chinattl.c		ww.chinattl.cn	ertificate No: Z	18-60051	
Client Sporto	<u>)n</u>				
CALIBRATION CE	RTIFICATI	E			
Object	D2450V	2 - SN: 924			
Calibration Procedure(s)	FF-Z11- Calibrati	003-01 on Procedures for di	pole validation kits		
Calibration date:	March 2	2, 2018			
This calibration Certificate d measurements(SI). The mean pages and are part of the cer	surements and t	raceability to nationa he uncertainties with	al standards, which re a confidence probabilit	ealize the phys ary are given on	sical units of the following
All calibrations have been humidity<70%.	conducted in t	he closed laborator	y facility: environme	nt temperature	e(22±3)℃ and
Calibration Equipment used	(M&TE critical fo	or calibration)			
Primary Standards	ID#	Cal Date(Calibrate	d by, Certificate No.)		Calibration
Power Meter NRVD	102083	01-Nov-17 (CTTL, I			:t-18
Power sensor NRV-Z5	100542	01-Nov-17 (CTTL, I			xt-18
Reference Probe EX3DV4	SN 7464	•	No.EX3-7464_Sep17	,	ep-18
DAE4	SN 1525	02-Oct-17(SPEAG,	No.DAE4-1525_Oct17	7) O	ct-18
Secondary Standards	ID#	Cal Date(Calibrated	d by, Certificate No.)		d Calibration
Signal Generator E4438C	MY49071430	23-Jan-18 (CTTL, N	No.J18X00560)		an-19
NetworkAnalyzer E5239A	MY55491241	29-Jun-17 (CTTL, I	No.J18X00561)	Ju	ın-18
	Name	Function		Sign	ature
Calibrated by:	Zhao Jing	SAR Test En	gineer	~ 32	
Reviewed by:	Lin Hao	SAR Test En	gineer	States	6
Approved by:	Qi Dianyuan	SAR Project	Leader	ČĦ	Z
			issued: Ma	arch 25, 2018	
This calibration certificate sh	nall not be repro	duced except in full v			tory.

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Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "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%.



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CALIBRATION LABORATORY

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Measurement Conditions

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

DASY Version	DASY52	52.10.0.1446
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.

ne following parameters and sales and sales	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	40.3 ± 6 %	1.84 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		

SAR result with Head TSL

Tesuit With Houd <u>10</u>	Qanditian	
SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.0 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	51.8 mW /g ± 18.8 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.98 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	23.9 mW /g ± 18.7 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

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

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.9 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	50.7 mW /g ± 18.8 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	5.88 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	23.3 mW /g ± 18.7 % (k=2)



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.9Ω+ 4.08jΩ
Return Loss	- 27.7dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.8Ω+ 4.69jΩ
Return Loss	- 26.5dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.060 ns
Lieutical Delay (one direction)	

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

1		00540
	Manufactured by	SPEAG
	Manufactured by	



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ALIBRATION LABORATORY

DASY5 Validation Report for Head TSL

Test Laboratory: CTTL, Beijing, China

Date: 03.22.2018

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 924 Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2450 MHz; $\sigma = 1.841$ S/m; $\epsilon r = 40.32$; $\rho = 1000$ kg/m3 Phantom section: Center Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 SN7464; ConvF(7.89, 7.89, 7.89); Calibrated: 9/12/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection) .
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1 •
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

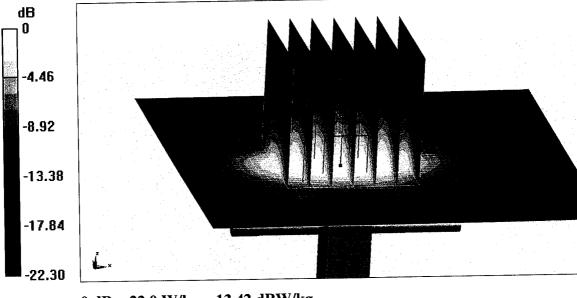
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 101.2 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 27.2 W/kg

SAR(1 g) = 13 W/kg; SAR(10 g) = 5.98 W/kg

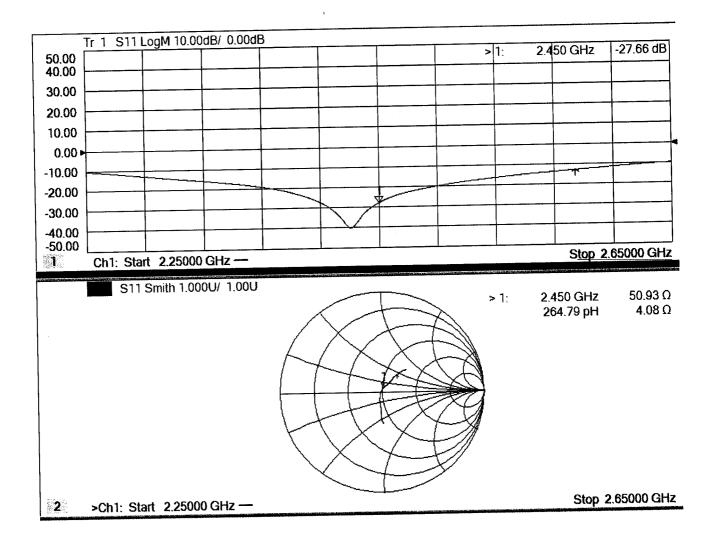
Maximum value of SAR (measured) = 22.0 W/kg



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



Impedance Measurement Plot for Head TSL





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LIBRATION LABORATORY

DASY5 Validation Report for Body TSL

Date: 03.22.2018

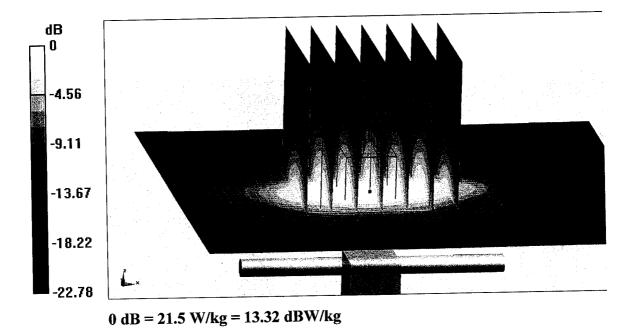
Test Laboratory: CTTL, Beijing, China DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 924 Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2450 MHz; σ = 1.998 S/m; ϵ_r = 51.28; ρ = 1000 kg/m³ Phantom section: Left Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 SN7464; ConvF(8.09, 8.09, 8.09); Calibrated: 9/12/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1525; Calibrated: 10/2/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

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

Reference Value = 98.09 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 27.1 W/kg SAR(1 g) = 12.9 W/kg; SAR(10 g) = 5.88 W/kg Maximum value of SAR (measured) = 21.5 W/kg

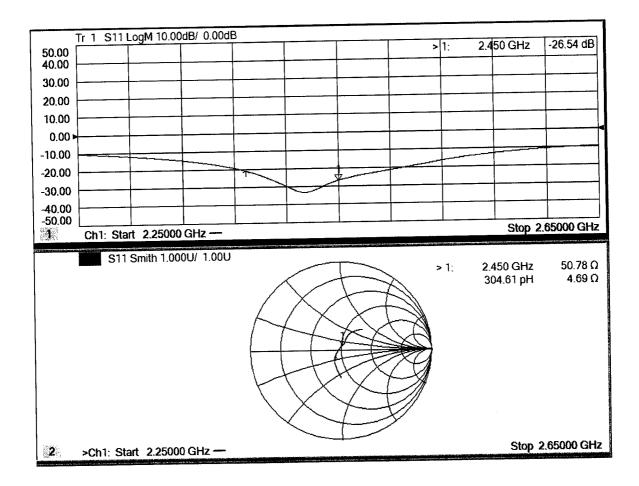




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Impedance Measurement Plot for Body TSL

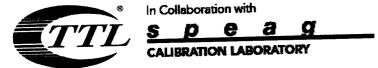


		tion with C A C DN LABORATORY				
Add: No.51 Xueyuan Tel: +86-10-6230463 E-mail: cttl@chinattl.	3-2512 Fax: +8	ict, Beijing, 100191, China 86-10-62304633-2504 www.chinattl.cn		CALIBRATION CNAS L0570		
Client Spor	· · · · · · · · · · · · · · · · · · ·		ertificate No: Z1	8-60259		
CALIBRATION CE	the second	E				
Object	D5GHz	∨2 - SN: 1167				
Calibration Procedure(s)	FF-Z11- Calibrat	-003-01 tion Procedures for di	pole validation kits			
Calibration date:	August	03, 2018				
measurements(SI). The mean pages and are part of the ce	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					
Calibration Equipment used	(M&TE critical f	or calibration)				
Primary Standards	ID#	Cal Date(Calibrate	d by, Certificate No.)	Scheduled Calibration		
Power Meter NRP2	102083	01-Nov-17 (CTTL, N	lo.J17X08756)	Oct-18		
Power sensor NRP-Z91	100542	01-Nov-17 (CTTL, N		Oct-18		
ReferenceProbe EX3DV4	SN 7464		No.EX3-7464_Sep17)	Sep-18		
DAE4	SN 1524	13-Sep-17(SPEAG,	No.DAE4-1524_Sep17	/) Sep-18		
		Cal Date(Calibrated	by Cortificate No.)	Scheduled Calibration		
Secondary Standards	ID#	23-Jan-18 (CTTL, N		Jan-19		
Signal Generator E4438C NetworkAnalyzerE5071C	MY49071430 MY46110673	24-Jan-18 (CTTL, N		Jan-19		
	Name	Function		Signature		
Calibrated by:	Zhao Jing	SAR Test Eng	gineer			
Reviewed by:	Lin Hao	SAR Test En	gineer	THE AS		
Approved by:	Qi Dianyuan	SAR Project	Leader	- Both		
				just 6, 2018		
This calibration certificate s	hall not be repro	oduced except in full v	vithout written approva	l of the laboratory.		

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Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORMx,y,z
	not applicable or not measured
N/A	not applicable et de la

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:

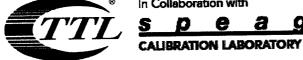
e) DASY4/5 System Handbook

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%.

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Measurement Conditions

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

DASY Version	DASY52	52.10.1.1476
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	

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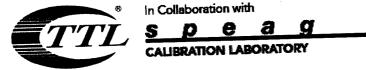
Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

S	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	35.9 ± 6 %	4.82 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.69 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	77.0 mW /g ± 24.4 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.20 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	22.0 mW /g ± 24.2 % (k=2)



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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	35.1 ± 6 %	5.18 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		

٦

SAR result with Head TSL at 5600 MHz

(result with mean rom at other		
SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
	100 mW input power	8.09 mW / g
SAR measured	normalized to 1W	80.8 mW /g ± 24.4 % (k=2)
SAR for nominal Head TSL parameters		
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.32 mW / g
	normalized to 1W	23.2 mW /g ± 24.2 % (k=2)
SAR for nominal Head TSL parameters		

Head TSL parameters at 5750 MHz

pllowing parameters and calculations were applied.

he following parameters and calculations were	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	34.9 ± 6 %	5.37 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C		

SAR result with Head TSL at 5750 MHz

result with near 15L at 0100 mile		
SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.70 mW / g
	normalized to 1W	76.9 mW /g ± 24.4 % (k=2)
SAR for nominal Head TSL parameters	Condition	
SAR averaged over 10 cm^3 (10 g) of Head TSL		2.17 mW / g
SAR measured	100 mW input power	
SAR for nominal Head TSL parameters	normalized to 1W	21.6 mW /g ± 24.2 % (k=2)



Body TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.9	5.36 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.4 ± 6 %	5.32 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C		

SAR result with Body TSL at 5250 MHz

SAR averaged over 1 cm^3 (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	74.4 mW /g ± 24.4 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.10 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	20.9 mW /g ± 24.2 % (k=2)

Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.5	5.77 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.7 ± 6 %	5.79 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C		

SAR result with Body TSL at 5600 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.73 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	77.1 mW /g ± 24.4 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.16 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	21.5 mW /g ± 24.2 % (k=2)

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Body TSL parameters at 5750 MHz The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.3	5.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.5 ± 6 %	5.93 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C		

SAR result with Body TSL at 5750 MHz

	Condition	
SAR averaged over 1 cm^3 (1 g) of Body TSL		
SAR measured	100 mW input power	7.43 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	74.3 mW /g ± 24.4 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Body TSL	Condition	
SAR measured	100 mW input power	2.08 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	20.8 mW /g ± 24.2 % (k=2)



Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	50.3Ω - 9.42jΩ
Return Loss	- 20.6dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	58.1Ω - 7.15jΩ
Return Loss	- 20.0dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	53.5Ω - 7.66jΩ
Return Loss	- 21.8dB

Antenna Parameters with Body TSL at 5250 MHz

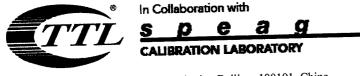
Impedance, transformed to feed point	49.5Ω - 7.40jΩ
Return Loss	- 22.6dB

Antenna Parameters with Body TSL at 5600 MHz

Impedance, transformed to feed point	58.0Ω - 6.37jΩ
Return Loss	- 20.5dB

Antenna Parameters with Body TSL at 5750 MHz

Impedance, transformed to feed point	54.5Ω - 7.07jΩ
Return Loss	- 21.9dB



General Antenna Parameters and Design

	1.065 ns
l	1.000 119
Electrical Delay (one direction)	
Electrical Delay (one an electric)	

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

I		SPEAG	
	Manufactured by		



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DASY5 Validation Report for Head TSL

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1167

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

Medium parameters used: f = 5250 MHz; σ = 4.822 S/m; ϵ r = 35.92; ρ = 1000 kg/m3, Medium parameters used: f = 5600 MHz; σ = 5.184 S/m; ϵ r = 35.14; ρ = 1000 kg/m3, Medium parameters used: f = 5750 MHz; σ = 5.365 S/m; ϵ r = 34.88; ρ = 1000 kg/m3,

Phantom section: Center Section

DASY5 Configuration:

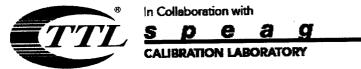
- Probe: EX3DV4 SN7464; ConvF(5.68, 5.68, 5.68) @ 5250 MHz; Calibrated: 9/12/2017, ConvF(4.98, 4.98, 4.98) @ 5600 MHz; Calibrated: 9/12/2017, ConvF(5.04, 5.04, 5.04) @ 5750 MHz; Calibrated: 9/12/2017,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection) •
- Electronics: DAE4 Sn1524; Calibrated: 9/13/2017
- Phantom: MFP_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 • (7439)

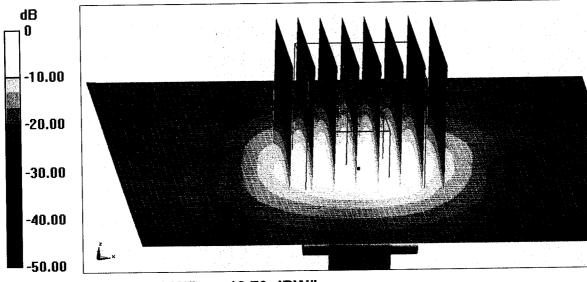
Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 65.09 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 32.4 W/kg SAR(1 g) = 7.69 W/kg; SAR(10 g) = 2.2 W/kg Maximum value of SAR (measured) = 18.0 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 = 63.53 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 36.2 W/kg SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.32 W/kg Maximum value of SAR (measured) = 19.7 W/kg

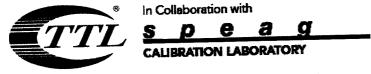
Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 63.79 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 36.2 W/kg SAR(1 g) = 7.7 W/kg; SAR(10 g) = 2.17 W/kg Maximum value of SAR (measured) = 19.0 W/kg

Date: 07.27.2018





0 dB = 19.0 W/kg = 12.79 dBW/kg



Impedance Measurement Plot for Head TSL

