



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

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM _{x,y,z}
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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



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, dz = 5 mm	
Frequency	2450 MHz $\pm$ 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 $\pm$ 0.2) °C	40.0 $\pm$ 6 %	1.85 mho/m $\pm$ 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	13.1 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	51.9 mW / g $\pm$ 18.8 % (k=2)
SAR averaged over 10 cm³ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	6.12 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	24.4 mW / g $\pm$ 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 $\pm$ 0.2) °C	54.2 $\pm$ 6 %	2.00 mho/m $\pm$ 6 %
Body TSL temperature change during test	<1.0 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.8 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	50.9 mW / g $\pm$ 18.8 % (k=2)
SAR averaged over 10 cm³ (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	5.93 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	23.7 mW / g $\pm$ 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	52.9Ω+ 2.01jΩ
Return Loss	- 29.3dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.9Ω+ 4.38jΩ
Return Loss	- 27.2dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.021 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

Additional EUT Data

Manufactured by	SPEAG
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DASY5 Validation Report for Head TSL

Date: 09.20.2018

Test Laboratory: CCTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 973

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.851$ S/m; $\epsilon_r = 40$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7514; ConvF(6.95, 6.95, 6.95) @ 2450 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 (1); SEMCAD X Version 14.6.11 (7439)

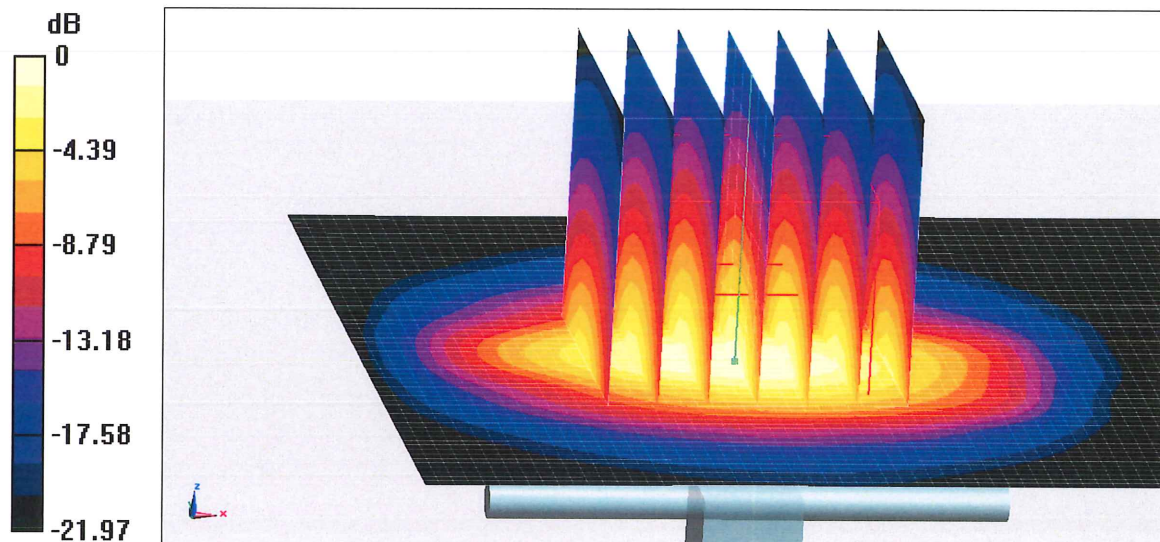
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.86 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 27.0 W/kg

SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.12 W/kg

Maximum value of SAR (measured) = 21.9 W/kg



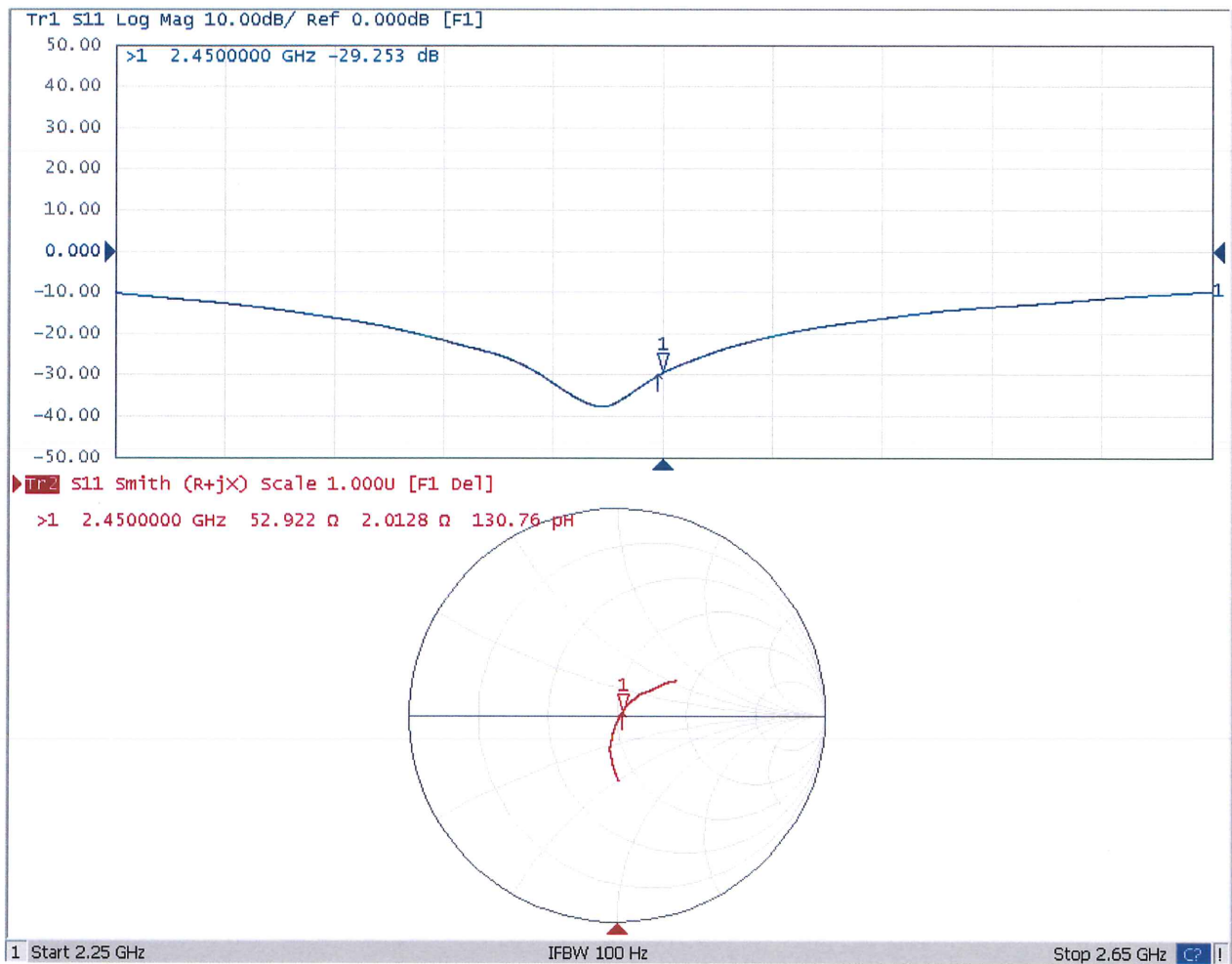
0 dB = 21.9 W/kg = 13.40 dBW/kg



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Impedance Measurement Plot for Head TSL





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DASY5 Validation Report for Body TSL

Date: 09.21.2018

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 973

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.003$ S/m; $\epsilon_r = 54.24$; $\rho = 1000$ kg/m³

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7514; ConvF(7.13, 7.13, 7.13) @ 2450 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 (1); SEMCAD X Version 14.6.11 (7439)

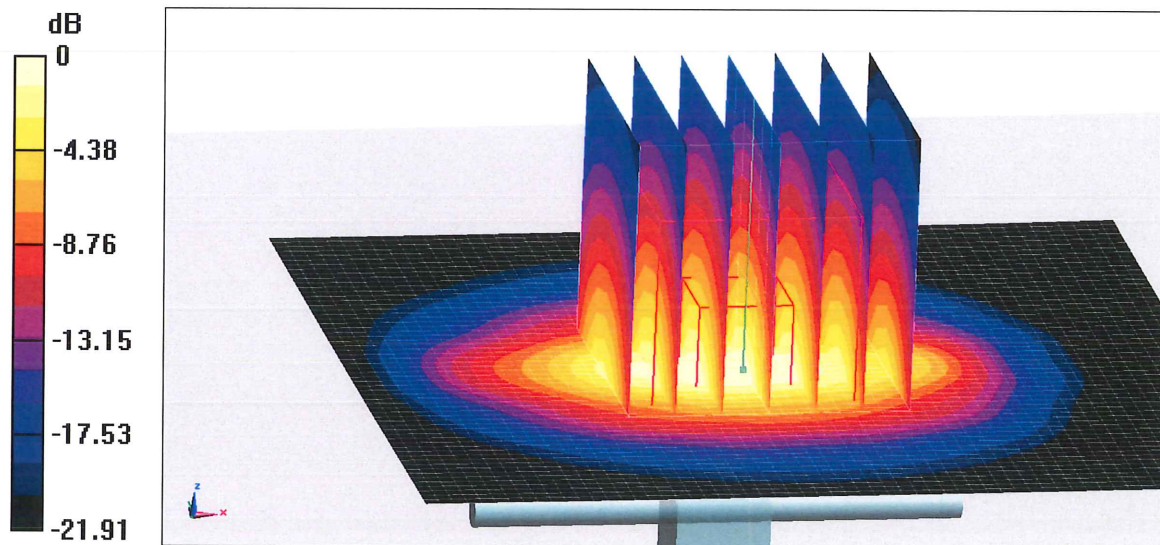
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.27 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 26.5 W/kg

SAR(1 g) = 12.8 W/kg; SAR(10 g) = 5.93 W/kg

Maximum value of SAR (measured) = 21.3 W/kg

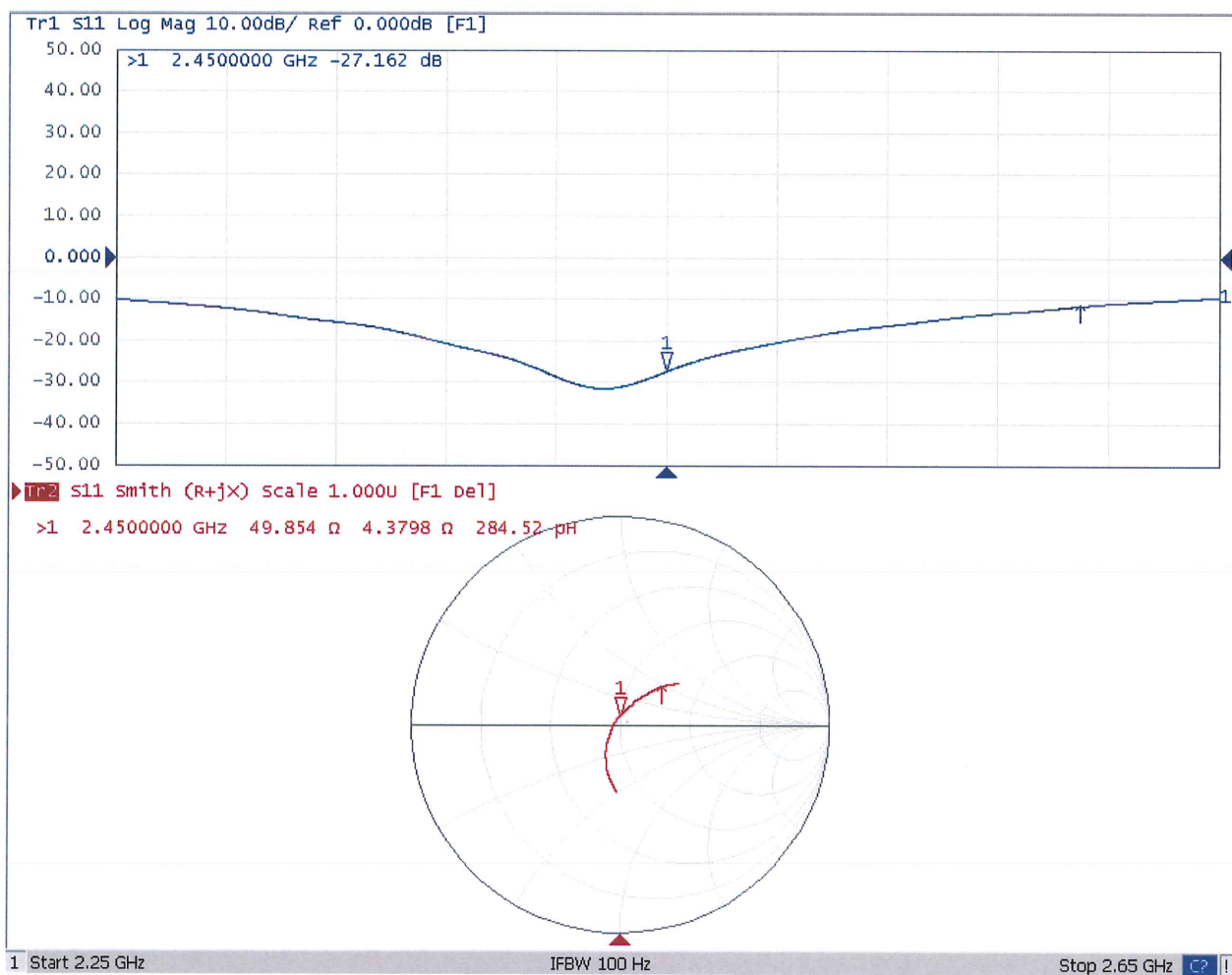


0 dB = 21.3 W/kg = 13.28 dBW/kg



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Impedance Measurement Plot for Body TSL



Dipole Internal Calibration Record					
Asset No. :	E-434	Model No. :	D2450V2	Serial No. :	973
Environmental	23.5°C, 53 %	Original Cal. Date :	September 21, 2018	Next Cal. Date :	September 20, 2021
Standard List					
1	IEEE Std 1528-2013	IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate(SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, June 2013			
2	IEC 62209-2	Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body(frequency range of 30 MHz to 6 GHz), March 2010			
3	KDB865664	SAR Measurement Requirements for 100 MHz to 6 GHz			
Equipment Information					
Equipment :	Manufacturer :	Model No. :	Serial No. :	Cal.Organization :	Cal. Date :
Power Amplifier	Mini-Circuits	ZHL-42W+	QA1333003	NA	March 8, 2019
DC Source	Iteck	OT6154	M00157	NA	September 31, 2019
Power Meter	Anritsu	ML2495A	1128008	NA	December 5, 2019
Power Sensor	Anritsu	MA2411B	1126001	NA	December 5, 2019
Power Meter	Anritsu	ML2487A	6K00004714	NA	June 20, 2019
Power Sensor	Anritsu	MA2491A	1725282	NA	June 20, 2019
Dual directional coupler	Woken	TS-PCC0M-05	107090019	NA	March 10, 2019
Signal Generator	R & S	N5172B	MY56200462	NA	April 22, 2019
ENA Network Analyzer	Agilent	E5071C	MY46524658	NA	March 16, 2019
Model No	For Head Tissue				
D2450V2	Item	Original Cal. Result	Verified on 2019/12/3	Deviation	Result
	Impedance, transformed to feed point	52.9Ω+2.01jΩ	51.869Ω+1.09jΩ	<5Ω	Pass
	Return Loss(dB)	-29.3	-27.192	-7.2%	Pass
	SAR Value for 1α(mW/g)	13.1	12.9	-1.5%	Pass
	SAR Value for 10α(mW/g)	6.12	5.99	-2.1%	Pass
	For Body Tissue				
	Item	Original Cal. Result	Verified on 2019/12/3	Deviation	Result
	Impedance, transformed to feed point	49.9Ω+4.38jΩ	48.100Ω+5.29jΩ	<5Ω	Pass
	Return Loss(dB)	-27.2	-24.913	-8.4%	Pass
	SAR Value for 1α(mW/g)	12.8	13.1	2.3%	Pass
	SAR Value for 10α(mW/g)	5.93	6.12	3.2%	Pass
Impedance Test-Head			Return Loss-Head		
