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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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	Manufactured by		

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BRATION LABORATORY

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

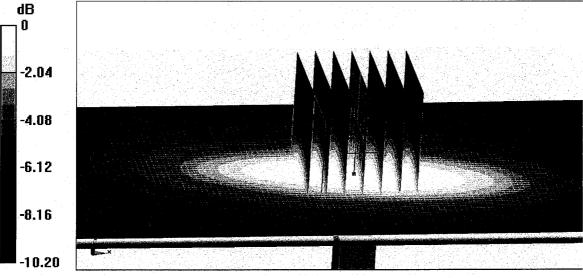
Date: 12.04.2018

#### 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



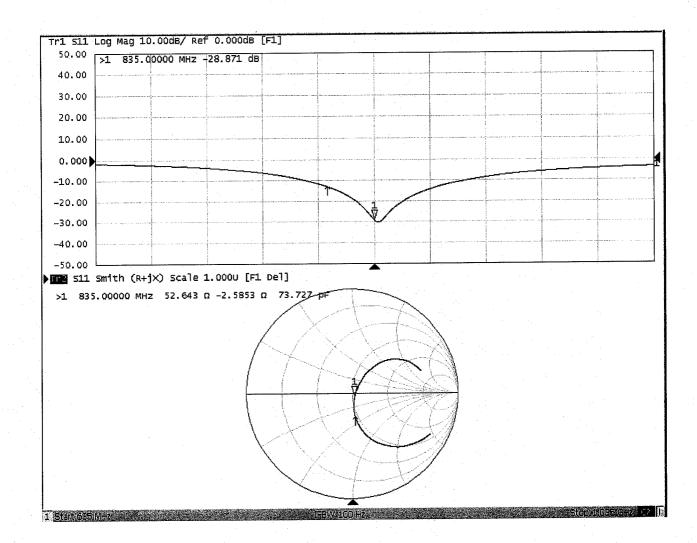
0 dB = 3.11 W/kg = 4.93 dBW/kg



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### Impedance Measurement Plot for Head TSL





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**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;  $\sigma$  = 0.986 S/m;  $\epsilon_r$  = 53.72;  $\rho$  = 1000 kg/m3

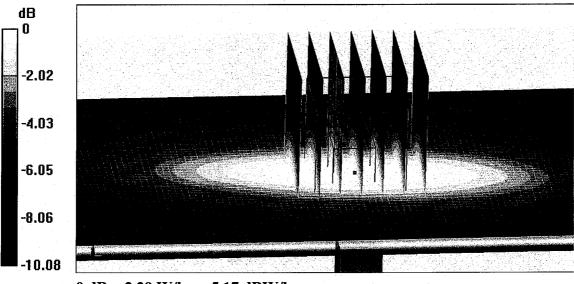
Phantom section: Center Section

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



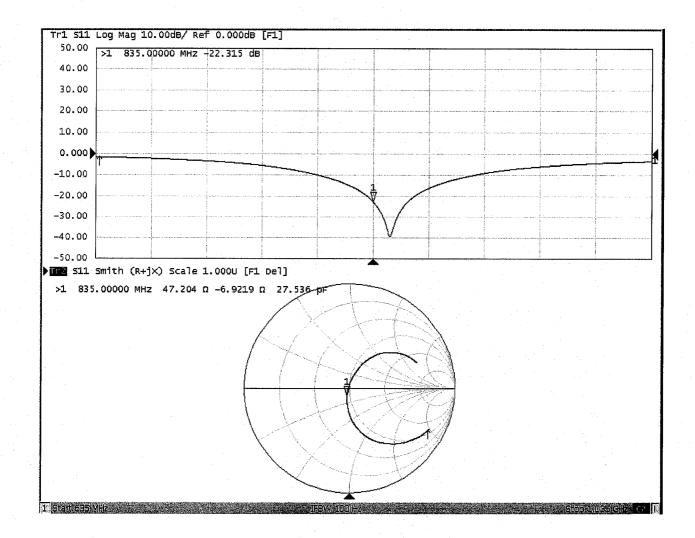
0 dB = 3.29 W/kg = 5.17 dBW/kg

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#### Impedance Measurement Plot for Body TSL





## D835V2, Serial No. 4d162 Extended Dipole Calibrations

Referring to KDB 865664 D01 v01r02, 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.

	D835V2 – serial no. 4d162											
	835 Head								835 Body			
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2018.12.5	-28.9		52.6		-2.56		-22.3		47.2		-6.92	
2019.11.25	-29.2	1.0	53.4	0.8	-1.48	1.08	-21.1	5.4	46.6	-0.6	-7.81	-0.89
2020.11.25	-29.3	1.4	52.8	0.2	-2.19	0.37	-22.6	1.3	47.7	0.5	-6.80	0.12

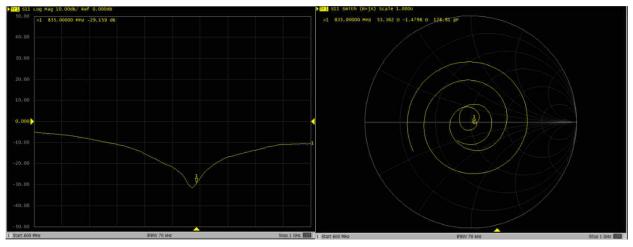
#### <Justification of the extended calibration>

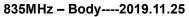
The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

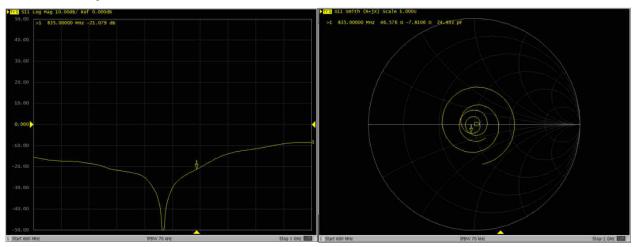


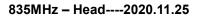
#### Dipole Verification Data> 835V2, serial no. 4d162

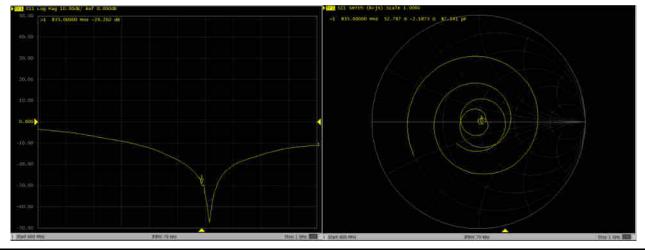
#### 835MHz - Head----2019.11.25





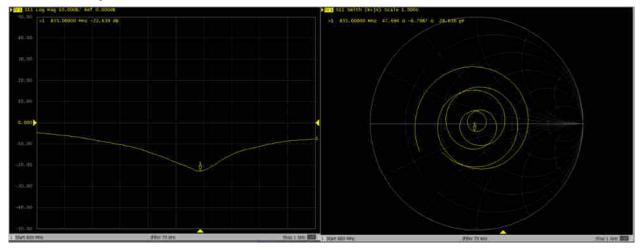








#### 835MHz - Body----2020.11.25



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<b>O</b>		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:

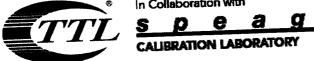
e) DASY4/5 System Handbook

## 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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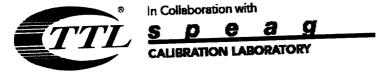
R result with Head 13L	Condition	
SAR averaged over 1 $-cm^3$ (1 g) of Head TSL		8.91 mW / g
SAR measured	250 mW input power	
SAR for nominal Head TSL parameters	normalized to 1W	36.5 mW /g ± 18.8 % (k=2)
SAR for normal field for parameters $SAR$ averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
	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           1.49 mho/m           1.48 mho/m ± 6 %	
TOL seremeters	22.0 °C	53.4		
Nominal Body TSL parameters	(22.0 ± 0.2) °C	53.8 ± 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 2 1011 /0 (10 =/



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# 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	



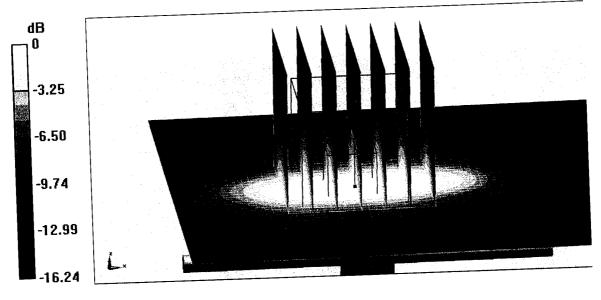
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Date: 07.30.2018

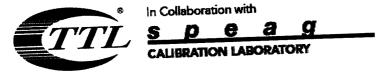
**DASY5 Validation Report for Head TSL** Test Laboratory: CTTL, Beijing, China **DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1137** Communication System: UID 0, CW; Frequency: 1750 MHz; Duty Cycle: 1:1 Medium parameters used: f = 1750 MHz;  $\sigma = 1.332$  S/m;  $\epsilon r = 41.17$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



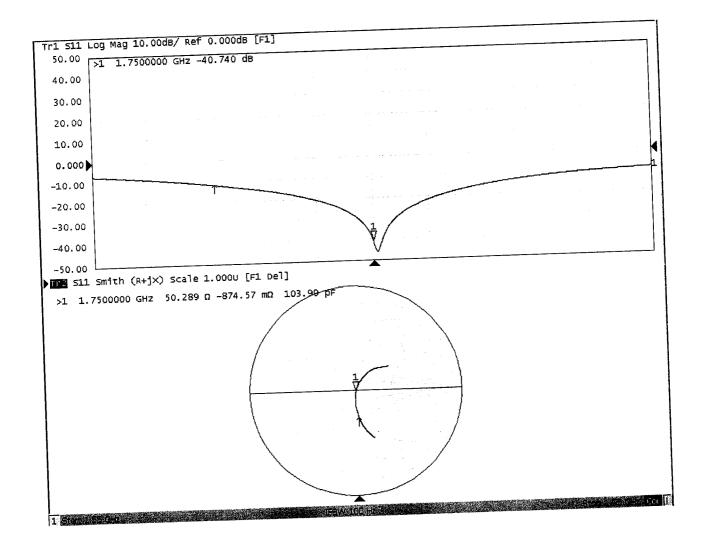
0 dB = 13.5 W/kg = 11.30 dBW/kg

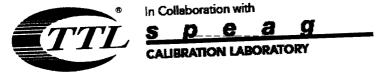


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# Impedance Measurement Plot for Head TSL





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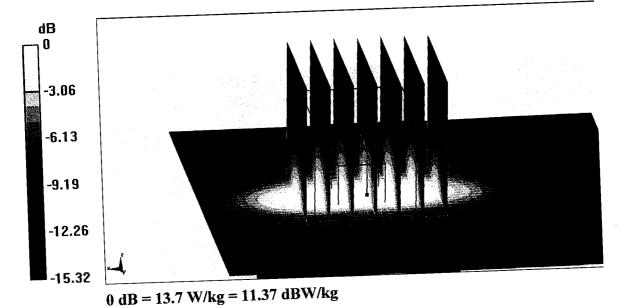
## **DASY5 Validation Report for Body TSL**

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;  $\sigma$  = 1.477 S/m;  $\epsilon$ r = 53.84;  $\rho$  = 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)

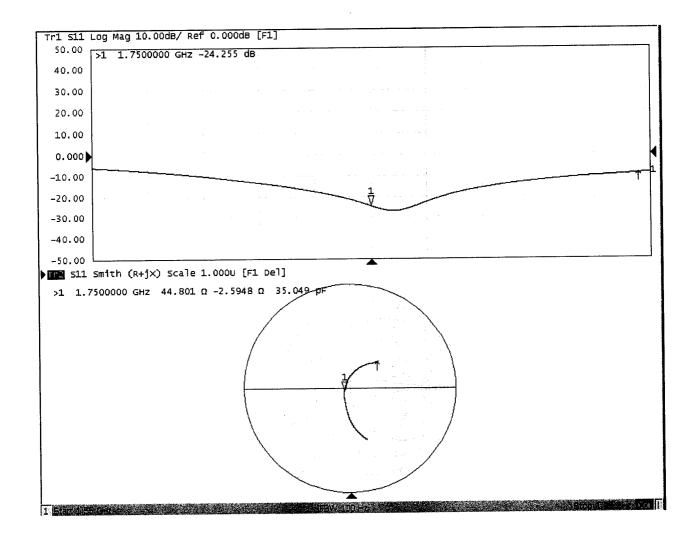
System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 77.55 V/m; Power Drift = 0.06 dB Peak SAR (extrapolated) = 16.0 W/kg SAR(1 g) = 9.17 W/kg; SAR(10 g) = 5.05 W/kg Maximum value of SAR (measured) = 13.7 W/kg





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### Impedance Measurement Plot for Body TSL





## D1750V2, Serial No. 1137 Extended Dipole Calibrations

Referring to KDB 865664 D01 v01r02, 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.

D1750V2 – serial no. 1137												
1750 Head					1750 Body							
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2018.7.30	-40.7		50.3		-0.87		-24.3		44.8		-2.59	
2019.7.23	-40.4	0.7	51	0.7	-0.15	0.72	-24.7	-1.6	46.1	1.3	-2.1	0.49
2020.7.23	-40.7	0	51.1	0.8	-0.16	0.71	24.8	-2.1	45.3	0.5	-2.86	-0.27

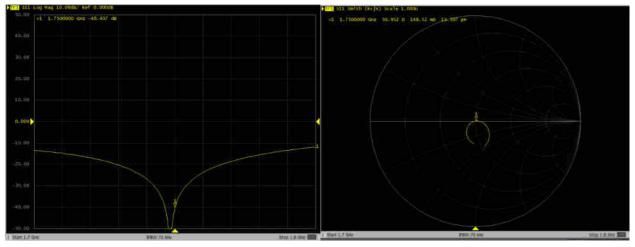
#### <Justification of the extended calibration>

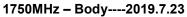
The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

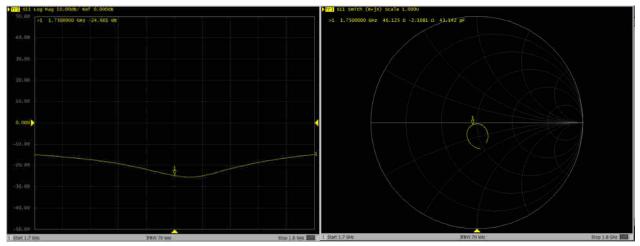


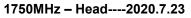
#### Dipole Verification Data> D1750V2, serial no. 1137

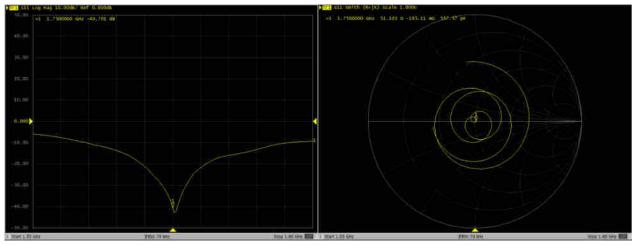
#### 1750MHz - Head----2019.7.23





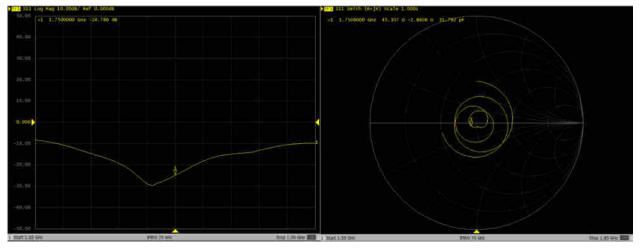




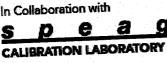




#### 1750MHz - Body----2020.7.23







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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.

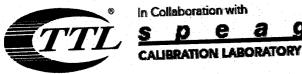
All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.

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

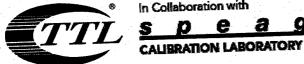
### Additional Documentation:

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		

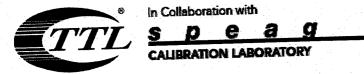
### **Body TSL parameters**

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+ 6.19jΩ
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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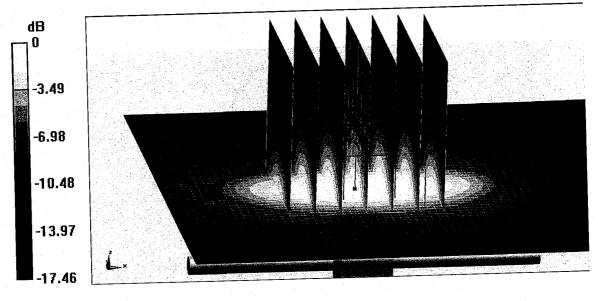
Date: 12.06.2018

**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;  $\sigma$  = 1.441 S/m;  $\epsilon_r$  = 39.59;  $\rho$  = 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

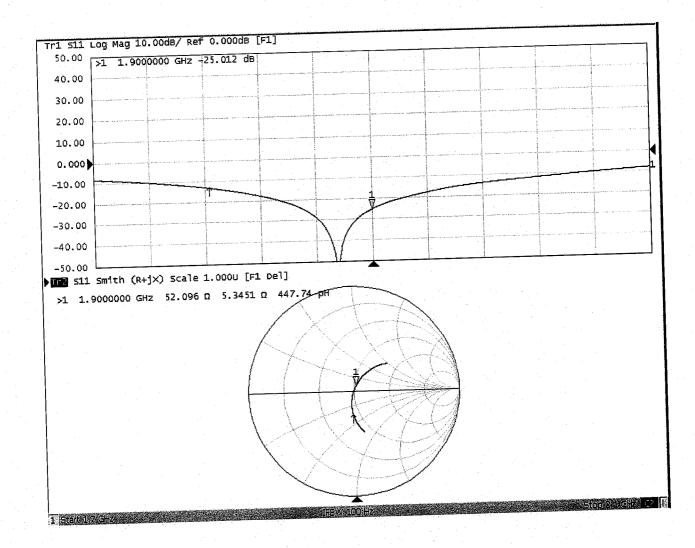


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## Impedance Measurement Plot for Head TSL





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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;  $\sigma$  = 1.564 S/m;  $\epsilon_r$  = 51.82;  $\rho$  = 1000 kg/m3

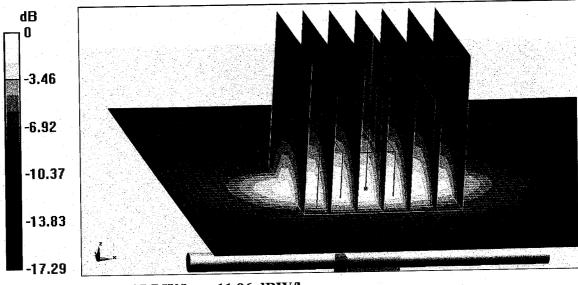
Phantom section: Right Section

**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

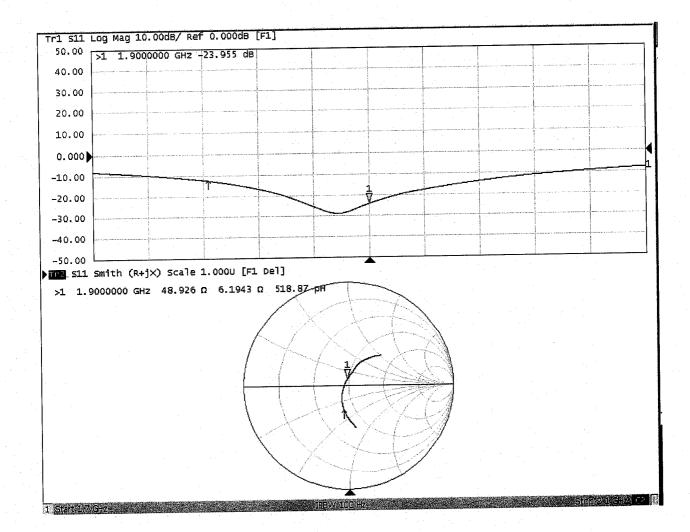


0 dB = 15.7 W/kg = 11.96 dBW/kg



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## Impedance Measurement Plot for Body TSL





## D1900V2, Serial No. 5d182 Extended Dipole Calibrations

Referring to KDB 865664 D01 v01r02, 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.

D1900V2 – serial no. 5d182												
1900 Head					1900 Body							
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2018.12.7	-25		52.1		5.35		-24		48.9		6.19	
2019.11.25	-25.2	-0.8	53.9	1.8	5.15	-0.2	-24.2	-0.8	48.7	-0.2	5.93	-0.26
2020.11.25	-25.8	3.2	52.6	0.5	4.56	-0.79	-24.2	-0.8	49.6	0.7	6.11	-0.08

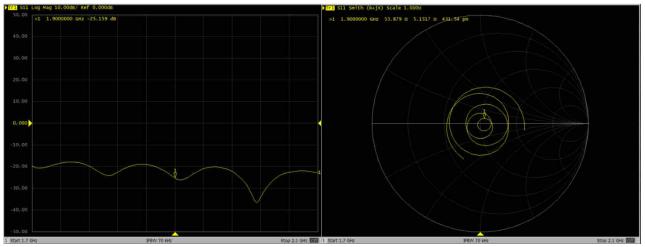
#### <Justification of the extended calibration>

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

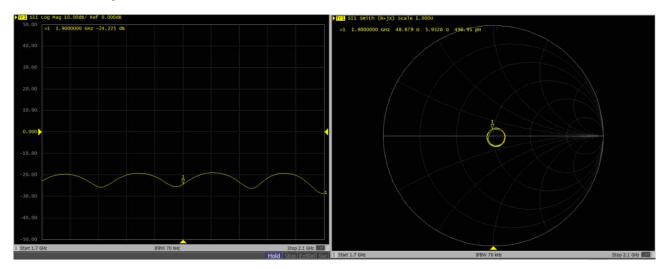


#### Dipole Verification Data> D1900V2, serial no. 5d182

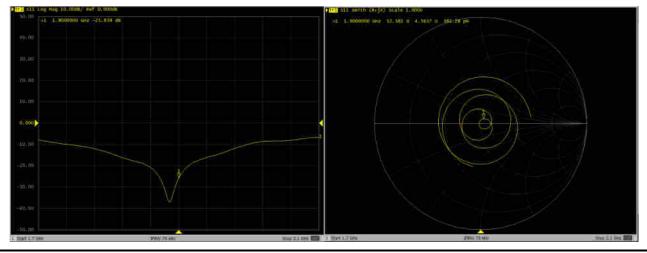
#### 1900MHz - Head----2019.11.25





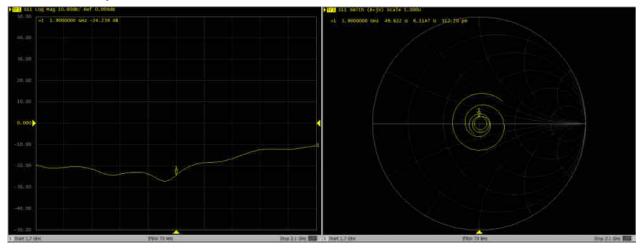








#### 1900MHz - Body----2020.11.25



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E-mail: cttl@china Client Spol	•	//www.chinattl.cn	and a state of the
CALIBRATION C	ST NAME OF GROOM		8-60391
		1 ( <del>    )</del>	
Object	D2300	0V2 - SN: 1056	
Calibration Procedure(s)		1-003-01 ation Procedures for dipole validation kits	
Calibration date:		nber 1, 2018	
measurements(SI). The me pages and are part of the ce	asurements and ertificate.	traceability to national standards, which rea I the uncertainties with confidence probability a the closed laboratory facility: environment	are given on the following
Calibration Equipment used	(M&TE critical f	or calibration)	
Primary Standards	ID #		
	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
and the second se	102196	<u>Cal Date(</u> Calibrated by, Certificate No.) 07-Mar-18 (CTTL, No.J18X01510)	Scheduled Calibration Mar-19
Power Meter NRVD Power sensor NRV-Z5	102196 100596		
Power Meter NRVD Power sensor NRV-Z5 Reference Probe EX3DV4	102196 100596	07-Mar-18 (CTTL, No.J18X01510)	Mar-19
Power Meter NRVD Power sensor NRV-Z5 Reference Probe EX3DV4	102196 100596	07-Mar-18 (CTTL, No.J18X01510) 07-Mar-18 (CTTL, No.J18X01510)	Mar-19 Mar-19
Power Meter NRVD Power sensor NRV-Z5 Reference Probe EX3DV4 DAE4 Secondary Standards	102196 100596 SN 7514 SN 1555 ID #	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) Cal Date(Calibrated by, Certificate No.)	Mar-19 Mar-19 Aug-19
Power Meter NRVD Power sensor NRV-Z5 Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C	102196 100596 SN 7514 SN 1555 ID # MY49071430	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) <u>Cal Date(Calibrated by, Certificate No.)</u> 23-Jan-18 (CTTL, No.J18X00560)	Mar-19 Mar-19 Aug-19 Aug-19
Power Meter NRVD Power sensor NRV-Z5 Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C	102196 100596 SN 7514 SN 1555 ID #	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) Cal Date(Calibrated by, Certificate No.)	Mar-19 Mar-19 Aug-19 Aug-19 Scheduled Calibration
Power Meter NRVD Power sensor NRV-Z5 Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C	102196 100596 SN 7514 SN 1555 ID # MY49071430	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) <u>Cal Date(Calibrated by, Certificate No.)</u> 23-Jan-18 (CTTL, No.J18X00560)	Mar-19 Mar-19 Aug-19 Aug-19 Scheduled Calibration Jan-19 Jan-19
Power Meter NRVD Power sensor NRV-Z5 Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	102196 100596 SN 7514 SN 1555 <u>ID #</u> MY49071430 MY46110673	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) <u>Cal Date(Calibrated by, Certificate No.)</u> 23-Jan-18 (CTTL, No.J18X00560) 24-Jan-18 (CTTL, No.J18X00561)	Mar-19 Mar-19 Aug-19 Aug-19 Scheduled Calibration Jan-19
Power Meter NRVD Power sensor NRV-Z5 Reference Probe EX3DV4	102196 100596 SN 7514 SN 1555 ID # MY49071430 MY46110673 Name	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) <u>Cal Date(Calibrated by, Certificate No.)</u> 23-Jan-18 (CTTL, No.J18X00560) 24-Jan-18 (CTTL, No.J18X00561) Function	Mar-19 Mar-19 Aug-19 Aug-19 Scheduled Calibration Jan-19 Jan-19
Power Meter NRVD Power sensor NRV-Z5 Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	102196 100596 SN 7514 SN 1555 ID # MY49071430 MY46110673 Name Zhao Jing	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) <u>Cal Date(Calibrated by, Certificate No.)</u> 23-Jan-18 (CTTL, No.J18X00560) 24-Jan-18 (CTTL, No.J18X00561) Function SAR Test Engineer	Mar-19 Mar-19 Aug-19 Aug-19 Scheduled Calibration Jan-19 Jan-19
Power Meter NRVD Power sensor NRV-Z5 Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	102196 100596 SN 7514 SN 1555 ID # MY49071430 MY46110673 Name Zhao Jing Lin Hao	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) Cal Date(Calibrated by, Certificate No.) 23-Jan-18 (CTTL, No.J18X00560) 24-Jan-18 (CTTL, No.J18X00561) Function SAR Test Engineer SAR Test Engineer	Mar-19 Mar-19 Aug-19 Aug-19 Scheduled Calibration Jan-19 Jan-19 Signature
Power Meter NRVD Power sensor NRV-Z5 Reference Probe EX3DV4 DAE4 Secondary Standards Signal Generator E4438C NetworkAnalyzer E5071C	102196 100596 SN 7514 SN 1555 <u>ID #</u> MY49071430 MY46110673 Name Zhao Jing Lin Hao Qi Dianyuan	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) <u>Cal Date(Calibrated by, Certificate No.)</u> 23-Jan-18 (CTTL, No.J18X00560) 24-Jan-18 (CTTL, No.J18X00561) Function SAR Test Engineer SAR Test Engineer	Mar-19 Mar-19 Aug-19 Aug-19 Scheduled Calibration Jan-19 Jan-19 Signature



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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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#### **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	2300 MHz ± 1 MHz	

#### **Head TSL parameters**

The following parameters and calculations were applied.

Temperature		Conductivity
22.0 °C	<b>Permittivity</b> 39.5	1.67 mho/m
(22.0 ± 0.2) °C	39.4 ± 6 %	1.70 mho/m ± 6 %
<1.0 °C		
(	(22.0 ± 0.2) °C	$(22.0 \pm 0.2)$ °C $39.4 \pm 6 \%$

#### SAR result with Head TSL

Condition	
250 mW input power	12.6 mW / g
normalized to 1W	49.9 mW /g ± 18.8 % (k=2)
Condition	
250 mW input power	5.97 mW / g
normalized to 1W	23.8 mW /g ± 18.7 % (k=2)
	250 mW input power normalized to 1W Condition 250 mW input power

#### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.9	1.81 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.0 ± 6 %	1.86 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C		

#### SAR result with Body TSL

SAR averaged over 1 _ <i>cm</i> <sup>3</sup> _(1 g) of Body TSL	Condition		
SAR measured	250 mW input power	12.2 mW / g	
SAR for nominal Body TSL parameters	normalized to 1W	48.1 mW /g ± 18.8 % (k=2)	
SAR averaged over 10 $cm^3$ (10 g) of Body TSL	Condition		
SAR measured	250 mW input power	5.82 mW / g	
SAR for nominal Body TSL parameters	normalized to 1W	23.1 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	46.5Ω- 3.86jΩ
Return Loss	- 25.3dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	43.9Ω- 2.30jΩ
Return Loss	- 23.1dB

# **General Antenna Parameters and Design**

Electrical Delay (one direction)	1 000
	1.033 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**

Manufastus II	
Manufactured by	SPEAG



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

Date: 11.01.2018

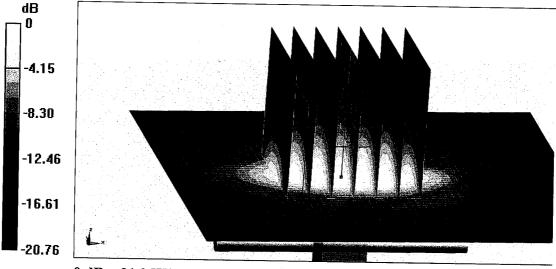
DUT: Dipole 2300 MHz; Type: D2300V2; Serial: D2300V2 - SN: 1056 Communication System: UID 0, CW; Frequency: 2300 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2300 MHz;  $\sigma$  = 1.7 S/m;  $\epsilon_r$  = 39.42;  $\rho$  = 1000 kg/m3 Phantom section: Center Section **DASY5** Configuration:

- Probe: EX3DV4 SN7514; ConvF(7.42, 7.42, 7.42) @ 2300 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 • (7450)

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

Reference Value = 106.4 V/m; Power Drift = -0.02 dBPeak SAR (extrapolated) = 26.1 W/kg

SAR(1 g) = 12.6 W/kg; SAR(10 g) = 5.97 W/kg Maximum value of SAR (measured) = 21.0 W/kg



0 dB = 21.0 W/kg = 13.22 dBW/kg

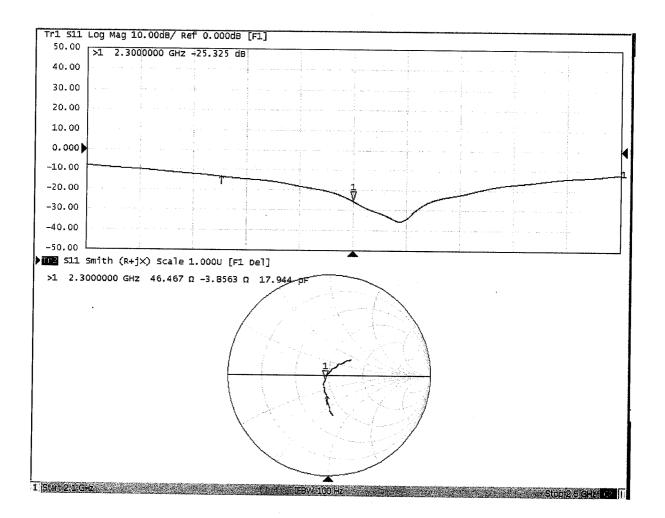


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#### Impedance Measurement Plot for Head TSL





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**DASY5 Validation Report for Body TSL** 

http://www.chinattl.cn

Date: 11.01.2018

Test Laboratory: CTTL, Beijing, China DUT: Dipole 2300 MHz; Type: D2300V2; Serial: D2300V2 - SN: 1056 Communication System: UID 0, CW; Frequency: 2300 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2300 MHz;  $\sigma = 1.864$  S/m;  $\varepsilon_r = 52.96$ ;  $\rho = 1000$  kg/m3 Phantom section: Right Section **DASY5** Configuration:

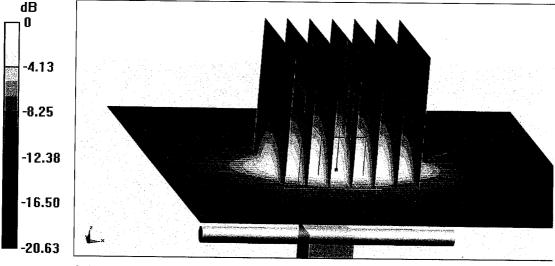
- Probe: EX3DV4 SN7514; ConvF(7.25, 7.25, 7.25) @ 2300 MHz; Calibrated: 8/27/2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1555; Calibrated: 8/20/2018
- Phantom: MFP V5.1C; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 • (7450)

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

Reference Value = 99.95 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 24.5 W/kg

SAR(1 g) = 12.2 W/kg; SAR(10 g) = 5.82 W/kg Maximum value of SAR (measured) = 20.0 W/kg



0 dB = 20.0 W/kg = 13.01 dBW/kg



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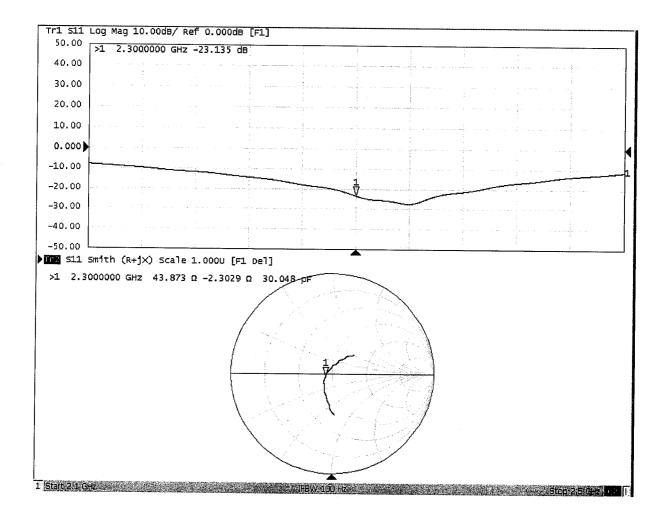
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Impedance Measurement Plot for Body TSL





# D2300V2, Serial No. 1056 Extended Dipole Calibrations

Referring to KDB 865664 D01 v01r02, 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.

	D2300V2 – serial no. 1056											
2300 Head							2300 B	ody				
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2018.11.01	-25.3		46.5		-3.86		-23.1		43.9		-2.30	
2019.11.01	-24.4	3.6	45.9	-0.6	-4.08	-0.22	-22.4	3	43.3	-0.6	-2.30	0
2020.11.01	-25.2	0.4	46.2	-0.3	-3.66	0.2	-23.3	-0.9	44.0	0.1	-2.14	0.16

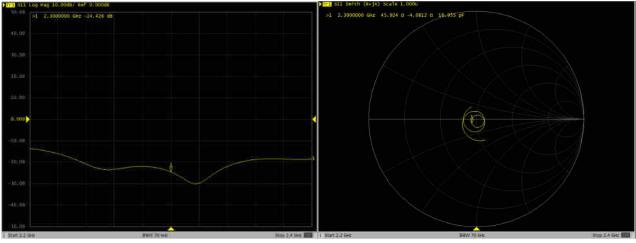
#### <Justification of the extended calibration>

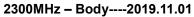
The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

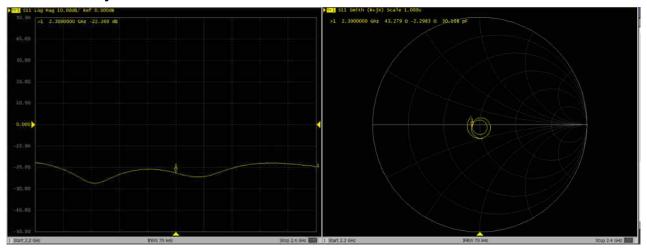


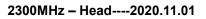
#### Dipole Verification Data> D2300V2, serial no. 1056

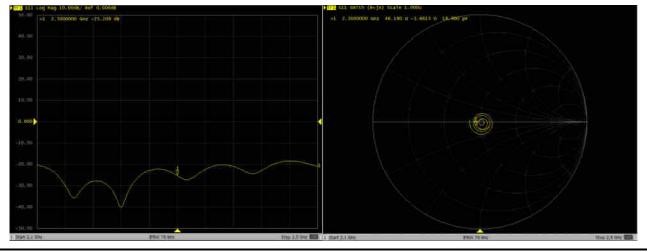
#### 2300MHz – Head----2019.11.01





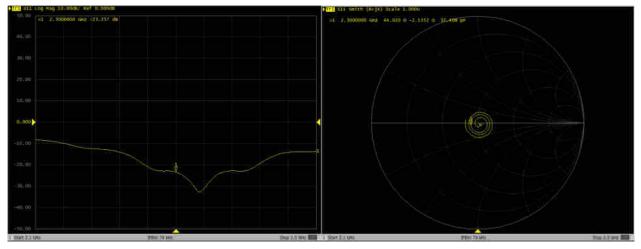








#### 2300MHz - Body----2020.11.01



#### Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland

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- S Swiss Calibration Service

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### Certificate No: D2450V2-924\_Sep20

# CALIBRATION CERTIFICATE

Dbject	D2450V2 - SN:92	4	
Galibration procedure(s)	QA CAL-05.v11		
	Calibration Proce	dure for SAR Validation Sources	between 0.7-3 GHz
Calibration date:	September 02, 20	020	
			100
		onal standards, which realize the physical un robability are given on the following pages ar	
	a to the other states and the states and	y facility: environment temperature $(22 \pm 3)^{\circ}$	Pand humidin - 700
All calibrations have been conducte	d in the closed laborator	$\gamma$ facility: environment temperature (22 ± a).	G and humidaty < 70%.
Calibration Equipment used (M&TE	critical for calibration)		
Primary Standarda	10 #	Cal Date (Cartificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21
<sup>9</sup> ower sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: BH9394 (20k)	31-Mar-20 (No. 217-03106)	Apr-21
Type-N mismatch combination	SN: 310982 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX30V4	SN: 7349	29-Jun-20 (No. EX3-7349_Jun20)	Jun-21
DAE4	SN: 601	27-Dec-19 (No. DAE4-601_Dec19)	Dec-20
Secondary Standards	ID II	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Ocl-20
	Name	Function	Signature
Calibrated by:	Jeffrey Katzman	Laboratory Technician	D. Kits
Approved by:	Kalja Pokovic	Technical Manager	delly
This calibration cartificate shall not	he reproduced executiv	full without written approval of the laborator	Issued: September 2, 2020

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland



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Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### 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:

- 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 the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) 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
- d) KDB 865664, "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. α.
- 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 6 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%.

Certificate No: D2450V2-924\_Sep20

Accreditation No.: SCS 0108

### Measurement Conditions

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

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, $dy$ , $dz = 5 mm$	
Frequency	2450 MHz ± 1 MHz	
	1 (b)	

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	$38.9\pm6~\%$	1.84 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	(1114)	

# SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.4 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.04 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.0 W/kg ± 16.5 % (k=2)

# Appendix (Additional assessments outside the scope of SCS 0108)

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.9 Ω + 7.2 jΩ	
Return Loss	- 22.1 dB	

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.155 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 and 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 leadpoint may be damaged.

#### Additional EUT Data

Manufactured by	SPEAG

### DASY5 Validation Report for Head TSL

Date: 02.09.2020

Test Laboratory: SPEAG, Zurich, Switzerland

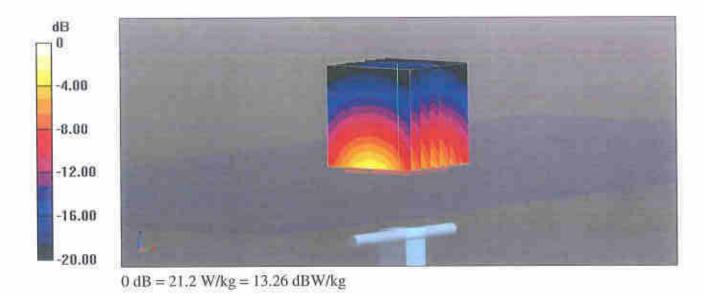
### DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:924

Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 1.84$  S/m;  $\epsilon_r = 38.9$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard; DASY5 (IEEE/IEC/ANSI C63.19-2011)

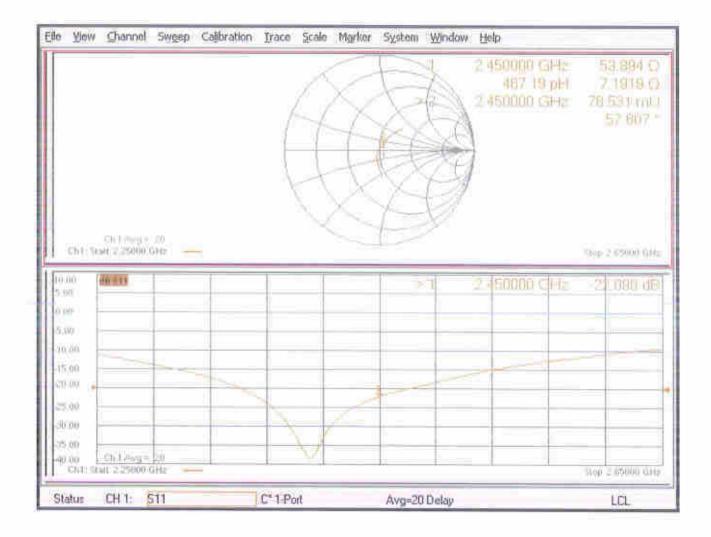
#### DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.74, 7.74, 7.74) @ 2450 MHz; Calibrated: 29.06.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 115.2 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 25.4 W/kg SAR(1 g) = 13.0 W/kg; SAR(10 g) = 6.04 W/kg Smallest distance from peaks to all points 3 dB below = 9 mm Ratio of SAR at M2 to SAR at M1 = 51% Maximum value of SAR (measured) = 21.2 W/kg



# Impedance Measurement Plot for Head TSL



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	CALIBRA	TION LABORATORY	Hac MRA	い A S 校准
Add: No.51 Xueyu Tel: +86-10-62304 E-mail: cttl@china	633-2079 Fax:	strict, Beijing, 100191, Chi +86-10-62304633-2504 /www.chinattl.cn	ina Hillinghillinghilling	CALIBRATION CNAS L0570
Client Spo	and the second second state		Certificate No: Z	18-60537
CALIBRATION C	EBTIEIGA	ne -		
Object	D2600	V2 - SN: 1070		
Calibration Procedure(s)			Vielander en state	
		-003-01 ition Procedures for c	lingle validation kits	
Collibration data.	the first of the second stands	n an		
Calibration date:	Decem	ber 7, 2018		
This calibration Certificate measurements(SI). The me pages and are part of the ce	asurements and			ealize the physical units of are given on the following
All calibrations have been humidity<70%. Calibration Equipment used			ry facility: environmen	t temperature(22±3)℃ and
Primary Standards	ID #	Cal Date(Calibrate	d by, Certificate No.)	Scheduled Calibration
Power Meter NRVD	102196	07-Mar-18 (CTTL, I	· · · · · · · · · · · · · · · · · · ·	Mar-19
Power sensor NRV-Z5	100596	07-Mar-18 (CTTL, I		Mar-19
Reference Probe EX3DV4	1		No.EX3-7514_Aug18)	Aug-19
DAE4	SN 1555	20-Aug-18(SPEAG	No.DAE4-1555_Aug18,	3) Aug-19
Secondary Standards	ID#	Cal Date(Calibrated	d by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	23-Jan-18 (CTTL, N	No.J18X00560)	Jan-19
Network Analyzer E5071C	MY46110673	24-Jan-18 (CTTL, N	√o.J18X00561)	Jan-19
	Name	Function		Signature
Calibrated by:	화장, 승규는 가슴 것 것 것			
	Zhao Jing	SAR Test Eng	lineer	
Reviewed by:	Lin Hao	SAR Test Eng	lineer	#HB
Approved by:	Qi Dianyuan	SAR Project I	_eader	
				ember 10, 2018
This calibration certificate sh	all not be reprod	luced except in full w	ithout written approval of	of the laboratory





Tel: +86-10-62304633-2079 E-mail: cttl@chinattl.com

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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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### **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	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	39.1 ± 6 %	1.93 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	14.4 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	58.1 mW /g ± 18.8 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	6.50 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	26.1 mW /g ± 18.7 % (k=2)

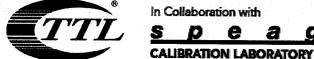
#### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.5	2.16 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.0 ± 6 %	2.18 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	13.8 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	54.6 mW /g ± 18.8 % (k=2)
SAR averaged over 10 $cm^3$ (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	6.18 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	24.6 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	48.6Ω- 6.33jΩ
Return Loss	- 23.7dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.8Ω- 5.36jΩ
Return Loss	- 22.1dB

#### **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.015 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	SDEAC
indiana da by	SPEAG





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**DASY5 Validation Report for Head TSL** 

Date: 12.06.2018

Test Laboratory: CTTL, Beijing, China **DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1070** Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2600 MHz;  $\sigma = 1.926$  S/m;  $\epsilon_r = 39.1$ ;  $\rho = 1000$  kg/m3 Phantom section: Center Section DASY5 Configuration:

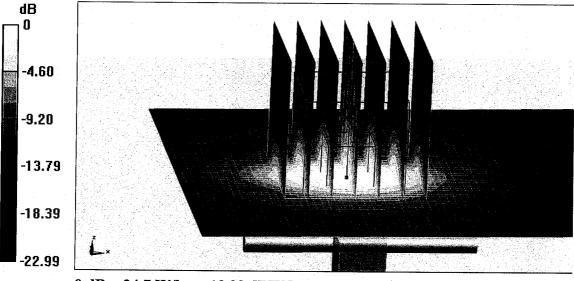
- Probe: EX3DV4 SN7514; ConvF(6.92, 6.92, 6.92) @ 2600 MHz; Calibrated: 8/27/2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1555; Calibrated: 8/20/2018
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

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

Reference Value = 99.07 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 31.1 W/kg

SAR(1 g) = 14.4 W/kg; SAR(10 g) = 6.5 W/kg Maximum value of SAR (measured) = 24.7 W/kg



0 dB = 24.7 W/kg = 13.93 dBW/kg

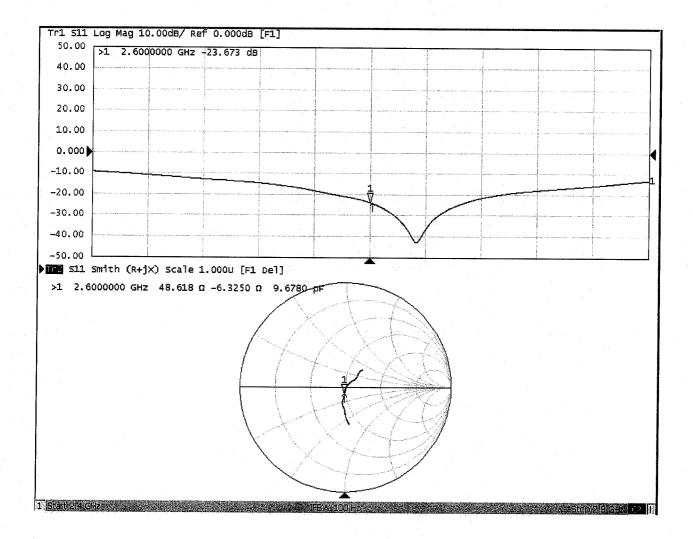




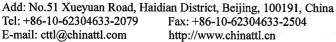
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Fax: +86-10-62304633-2504 http://www.chinattl.cn

#### Impedance Measurement Plot for Head TSL







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#### **DASY5 Validation Report for Body TSL**

Date: 12.06.2018

Test Laboratory: CTTL, Beijing, China DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1070 Communication System: UID 0, CW; Frequency: 2600 MHz; Duty Cycle: 1:1 Medium parameters used: f = 2600 MHz;  $\sigma = 2.181 \text{ S/m}$ ;  $\varepsilon_r = 51.03$ ;  $\rho = 1000 \text{ kg/m3}$ Phantom section: Right Section **DASY5** Configuration:

- Probe: EX3DV4 SN7514; ConvF(7.06, 7.06, 7.06) @ 2600 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)

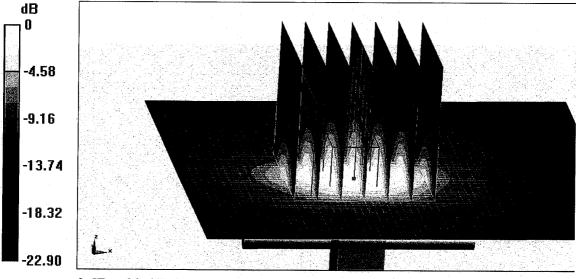
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 87.90 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 29.5 W/kg

SAR(1 g) = 13.8 W/kg; SAR(10 g) = 6.18 W/kg

Maximum value of SAR (measured) = 23.6 W/kg



0 dB = 23.6 W/kg = 13.73 dBW/kg



D



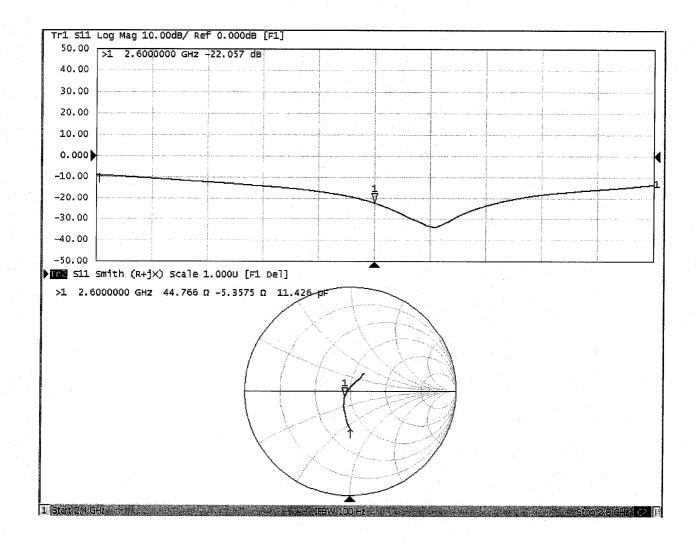
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#### Impedance Measurement Plot for Body TSL





# D2600V2, Serial No. 1070 Extended Dipole Calibrations

Referring to KDB 865664 D01 v01r02, 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.

	D2600V2 – serial no. 1070											
			2600 He	ad					2600 B	ody		
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2018.12.7	-23.7		48.6		-6.33		-22.1		44.8		-5.36	
2019.11.25	-23.1	2.5	48.6	0	-6.82	-0.49	-22.0	0.5	45.3	0.5	-4.65	0.71
2020.11.25	-23.5	0.8	48.8	0.2	-5.93	0.4	-22.0	0.5	44.5	-0.3	-5.04	0.32

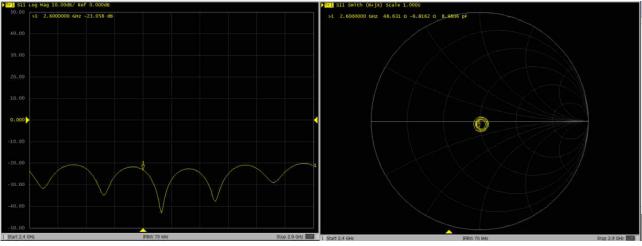
#### <Justification of the extended calibration>

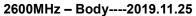
The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

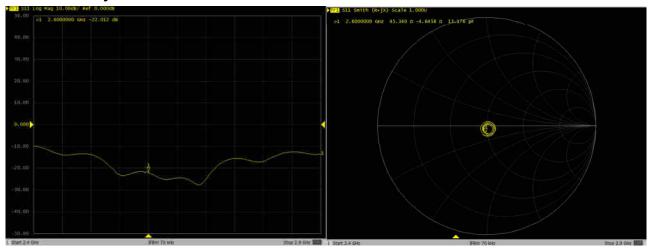


#### Dipole Verification Data> D2600V2, serial no. 1070

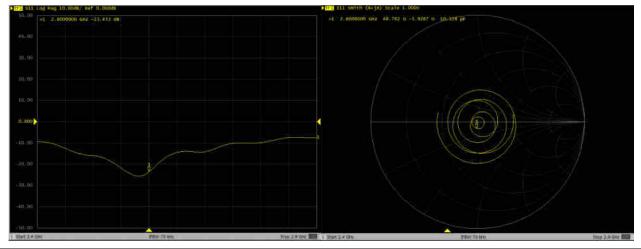
#### 2600MHz - Head----2019.11.25





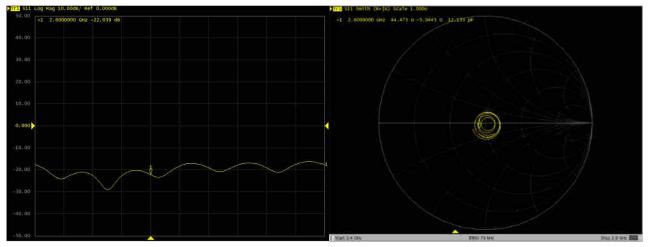








#### 2600MHz - Body----2020.11.25



#### **Calibration Laboratory of** Schmid & Partner **Engineering AG** Zeughausstrasse 43, 8004 Zurich, Switzerland





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Swiss Calibration Service

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#### Accreditation No.: SCS 0108

Client Sporton		Certi	ficate No: D3500V2-1076_Apr19
CALIBRATION C	ERTIFICAT	E	
Object	D3500V2 - SN:1	076	
Calibration procedure(s)	QA CAL-22.v4 Calibration Proc	edure for SAR Validation S	ources between 3-6 GHz
Calibration date:	April 29, 2019		
This calibration certificate docume The measurements and the uncert	nts the traceability to nata	ional standards, which realize the ph probability are given on the following p	vsical units of measurements (SI). bages and are part of the certificate.
		ry facility: environment temperature (	
Calibration Equipment used (M&TE	E critical for calibration)		
Primary Standards	- ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-19 (No. 217-02894)	Apr-20
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02895)	Apr-20
Reference Probe EX3DV4	SN: 3503	25-Mar-19 (No. EX3-3503_Mar19)	
DAE4	SN: 601	04-Oct-18 (No. DAE4-601_Oct18)	Oct-19
		,	
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	07-Oct-15 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	
o	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	Miller
Approved by:	Katja Pokovic	Technical Manager	JUL -
This calibration certificate shall not	be reproduced except in	full without written approval of the lab	Issued: April 29, 2019

#### **Calibration Laboratory of**

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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Accreditation No.: SCS 0108

# **Glossary:**

	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:

- 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 the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) 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
- » d) KDB 865664, "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%.

#### **Measurement Conditions**

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

DASY Version	DASY5	V52.10.2	
Extrapolation	Advanced Extrapolation		
Phantom	Modular Flat Phantom		
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	3500 MHz ± 1 MHz		

# Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.9	2.91 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.4 ± 6 %	2.90 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

# SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.80 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	67.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.54 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.3 W/kg ± 19.5 % (k=2)

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# Appendix (Additional assessments outside the scope of SCS 0108)

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.7 Ω - 5.8 jΩ
Return Loss	- 23.0 dB

#### **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.143 ns
	1.145 115

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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Manufactured by	SPEAG

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

Date: 29.04.2019

Test Laboratory: SPEAG, Zurich, Switzerland

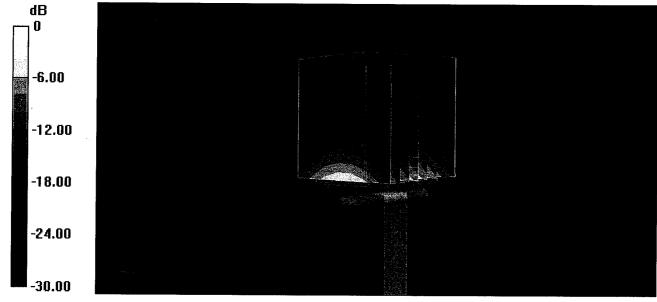
# DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1076

Communication System: UID 0 - CW; Frequency: 3500 MHz Medium parameters used: f = 3500 MHz;  $\sigma = 2.9$  S/m;  $\epsilon_r = 37.4$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.75, 7.75, 7.75) @ 3500 MHz; Calibrated: 25.03.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.10.2018
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

**Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm/Zoom Scan, dist=1.4mm** (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 72.24 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 18.6 W/kg SAR(1 g) = 6.8 W/kg; SAR(10 g) = 2.54 W/kg Maximum value of SAR (measured) = 12.8 W/kg



0 dB = 12.8 W/kg = 11.07 dBW/kg

# Impedance Measurement Plot for Head TSL

Ch 1 Avg = 20 Ch 1: Start 3:30000 GHz	allbration Irace Scale Marker Sy	stem Window Help 1: 3.500000 GHz 7.8406 pF 3.500000 GHz	-5.7997 Ω
10.00     5.00       5.00		> 1: 3.\$00000 GHz	-22.968 dB



# D3500V2, Serial No. 1076 Extended Dipole Calibrations

Referring to KDB 865664 D01 v01r02, 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.

		D35	i00V2 – serial no. '	1076		
			3500 Head			
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2019.4.29	-23		54.7		-5.8	
2020.4.15	-22.9	0.4	55.7	1	-4.9	0.9

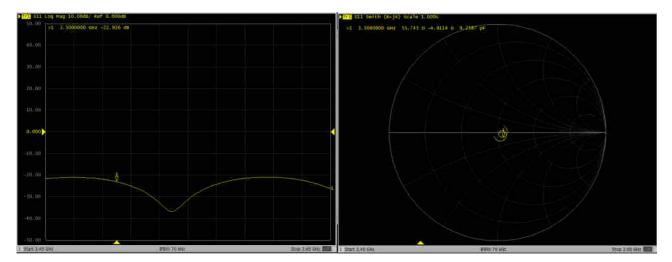
#### <Justification of the extended calibration>

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.



#### Dipole Verification Data> D3500V2, serial no. 1076

# 3500MHz - Head



# Calibration Laboratory of Schmid & Partner Engineering AG

Sporton

Client

Zeughausstrasse 43, 8004 Zurich, Switzerland

BC-MRA



S

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- Swiss Calibration Service

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Certificate No: D3700V2-1037\_Apr19

# CALIBRATION CERTIFICATE

Object	D3700V2 - SN:10	037	
Calibration procedure(s)	QA CAL-22.v4 Calibration Proce	dure for SAR Validation Sources	between 3-6 GHz
Calibration date:	April 29, 2019		
The measurements and the uncert	ainties with confidence p	onal standards, which realize the physical un robability are given on the following pages an ry facility: environment temperature (22 $\pm$ 3)°C	d are part of the certificate.
Calibration Equipment used (M&TE			
Primary Standards	-ID-#	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-19 (No. 217-02894)	Apr-20
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02895)	Apr-20
Reference Probe EX3DV4	SN: 3503	25-Mar-19 (No. EX3-3503_Mar19)	Mar-20
DAE4	SN: 601	04-Oct-18 (No. DAE4-601_Oct18)	Oct-19
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	07-Oct-15 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19
		Function	Signature
Calibrated by:	Name Michael Weber	Laboratory Technician	Miller
Approved by:	Katja Pokovic	Technical Manager	Jally
			Issued: April 29, 2019
This calibration certificate shall no	t be reproduced except in	n full without written approval of the laborator	у.

**Calibration Laboratory of** 

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

# **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:

- 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 the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) 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
- d) KDB 865664, "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%.

# **Measurement Conditions**

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

DASY Version	DASY5	V52.10.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
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	3700 MHz ± 1 MHz	

#### **Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.7	3.12 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.1 ± 6 %	3.06 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

# SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.85 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	68.5 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head ISL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 100 mW input power	2.49 W/kg

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	46.4 Ω - 0.6 jΩ
Return Loss	- 28.4 dB

#### **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.138 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
Thandaotal Cu Dy	

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

Date: 29.04.2019

Test Laboratory: SPEAG, Zurich, Switzerland

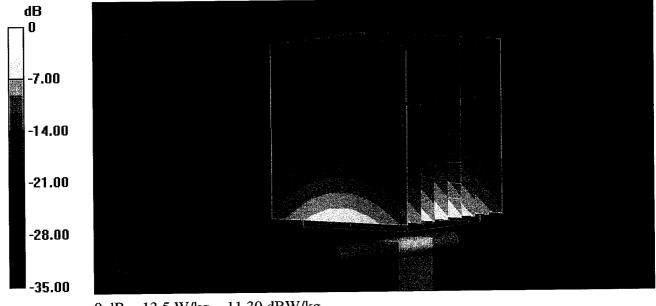
#### DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1037

Communication System: UID 0 - CW; Frequency: 3700 MHz Medium parameters used: f = 3700 MHz;  $\sigma = 3.06$  S/m;  $\varepsilon_r = 37.1$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.5, 7.5, 7.5) @ 3700 MHz; Calibrated: 25.03.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.10.2018
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3700MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 71.88 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 19.5 W/kg SAR(1 g) = 6.85 W/kg; SAR(10 g) = 2.49 W/kg Maximum value of SAR (measured) = 13.5 W/kg



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

## Impedance Measurement Plot for Head TSL

Elle <u>Vi</u> ew <u>C</u> hannel Sw <u>e</u> ep Calibration	Irace <u>S</u> cale Marker System Window <u>H</u> elp
Ch 1 Avg = 20	1: 3.700000 GHz 46.394 9 70.115 pF -613.49 m 3.700000 GHz 37.950 m -169.98
Ch1: Start 3.50000 GHz	Stop 3.90000 Gi
10.00 5.00 0.00 -5.00 -10.00	> 1: 3.700000 GHz -28.416 d
-15.00 -20.00 -25.00 -30.00 -35.00 -40.00 Ch 1 Avg = 20 Ch1: Start 3.50000 GHz	Stop 3.90000 Gł



# D3700V2, Serial No. 1037 Extended Dipole Calibrations

Referring to KDB 865664 D01 v01r02, 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.

D3700V2 – serial no. 1037						
3700 Head						
Date of Measurement	Return-Loss (dB)     Delta (%)     Real Impedance     Imaginary       (dB)     Operation (0,0,0,0)     Operation (0,0,0,0)     Operation (0,0,0,0)					Delta (ohm)
2019.4.29	-28.4		46.4		-0.6	
2020.4.15	-28.4	0	46.3	-0.1	-0.4	0.2

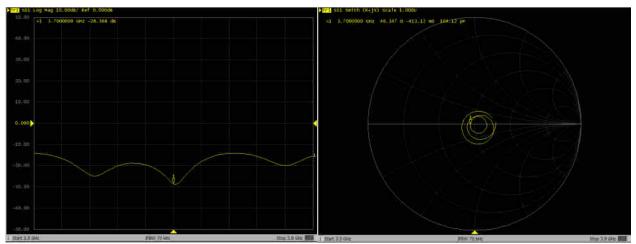
#### <Justification of the extended calibration>

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.



## Dipole Verification Data> D3700V2, serial no. 1037

#### 3700MHz - Head



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Certificate No: D3900V2-1022\_Jul19

## CALIBRATION CERTIFICATE

bject	03900V2 - SN:10	22	
alibration procedure(s) (	QA CAL-22.v4 Calibration Proce	dure for SAR Validation Sources	between 3-6 GHz
Calibration date:	July 11, 2019		
The measurements and the uncertain	inties with confidence p	onal standards, which realize the physical unit robability are given on the following pages and ry facility: environment temperature (22 ± 3)°C	are part of the centricate.
Calibration Equipment used (M&TE	critical for calibration)	Cal Date (Certificate No.)	Scheduled Calibration
Primary Standards	SN: 104778	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power meter NRP Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-19 (No. 217-02894)	Apr-20
	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02895)	Apr-20
Type-N mismatch combination Reference Probe EX3DV4	SN: 3503	25-Mar-19 (No. EX3-3503_Mar19)	Mar-20
DAE4	SN: 601	30-Apr-19 (No. DAE4-601_Apr19)	Apr-20
		190 - 200 - 200 - 200 - 200 - 200 - 200 - 200 - 200 - 200 - 200 - 200 - 200 - 200 - 200 - 200 - 200 - 200 - 200	Scheduled Check
Secondary Standards	ID #	Check Date (in house)	
	ID # SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power meter E4419B	110	30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18)	In house check: Oct-20 In house check: Oct-20
Power meter E4419B Power sensor HP 8481A	SN: GB39512475	30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18)	In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A	SN: GB39512475 SN: US37292783	30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18)	In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: GB39512475 SN: US37292783 SN: MY41092317	30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18)	In house check: Oct-20 In house check: Oct-20 In house check: Oct-20
Secondary Standards Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A	SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972	30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-18) Function	In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-19 Signature
Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477	30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-18)	In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-19 Signature
Power meter E4419B Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer Agilent E8358A	SN: GB39512475 SN: US37292783 SN: MY41092317 SN: 100972 SN: US41080477 Name	30-Oct-14 (in house check Feb-19) 07-Oct-15 (in house check Oct-18) 07-Oct-15 (in house check Oct-18) 15-Jun-15 (in house check Oct-18) 31-Mar-14 (in house check Oct-18) Function	In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-20 In house check: Oct-19 Signature

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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#### 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:

- 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 the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) 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
- KDB 865664, "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%.

#### **Measurement Conditions**

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

DASY Version	DASY5	V52.10.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
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	3900 MHz ± 1 MHz 4100 MHz ± 1 MHz	

#### Head TSL parameters at 3900 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.5	3.32 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.2 ± 6 %	3.23 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL at 3900 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.03 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	70.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.46 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.6 W/kg ± 19.5 % (k=2)

#### Head TSL parameters at 4100 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.2	3.53 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.0 ± 6 %	3.41 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL at 4100 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.64 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	66.6 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.2 W/kg ± 19.5 % (k=2)

## Appendix (Additional assessments outside the scope of SCS 0108)

#### Antenna Parameters with Head TSL at 3900 MHz

Impedance, transformed to feed point	47.2 Ω - 4.1 jΩ	
Return Loss	- 25.9 dB	

#### Antenna Parameters with Head TSL at 4100 MHz

Impedance, transformed to feed point	57.0 Ω + 0.7 jΩ
Return Loss	- 23.6 dB

#### **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

Monuf	actured by	SPEAG
	actured by	JFEAG

## DASY5 Validation Report for Head TSL

Date: 11.07.2019

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN:1022

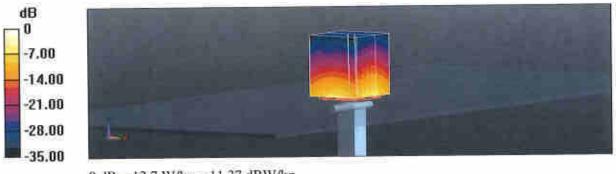
Communication System: UID 0 - CW; Frequency: 3900 MHz, Frequency: 4100 MHz Medium parameters used: f = 3900 MHz;  $\sigma$  = 3.23 S/m;  $\epsilon_r$  = 37.2;  $\rho$  = 1000 kg/m<sup>3</sup>. Medium parameters used: f = 4100 MHz;  $\sigma$  = 3.41 S/m;  $\epsilon_r$  = 37;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.25, 7.25, 7.25) @ 3900 MHz, ConvF(7.05, 7.05, 7.05) @ 4100 MHz; Calibrated: 25.03.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

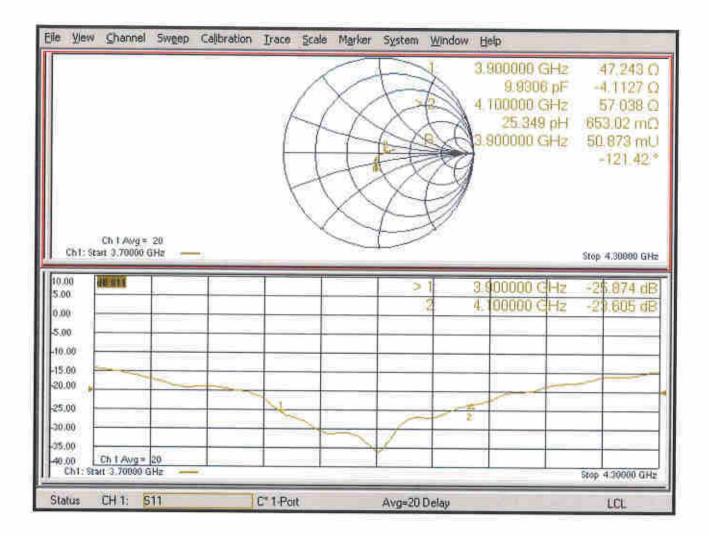
Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3900MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 73.25 V/m; Power Drift = -0.09 dB Peak SAR (extrapolated) = 20.0 W/kg SAR(1 g) = 7.03 W/kg; SAR(10 g) = 2.46 W/kg Maximum value of SAR (measured) = 13.7 W/kg

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=4100MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 69.96 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 19.0 W/kg SAR(1 g) = 6.64 W/kg; SAR(10 g) = 2.32 W/kg Maximum value of SAR (measured) = 13.2 W/kg



0 dB = 13.7 W/kg = 11.37 dBW/kg

Impedance Measurement Plot for Head TSL





# D3900V2, Serial No. 1022 Extended Dipole Calibrations

Referring to KDB 865664 D01 v01r02, 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.

D3900V2 – serial no. 1022						
	3900 Head					
Date of Measurement	Return-Loss (dB)	Delta (%) Impedance Delta (ohm) Impedance				Delta (ohm)
2019.7.11	-25.9	-25.9 47.2 -4.1				
2020.7.7	-26.3	-1.5	47.9	0.7	-1.7	2.4
	D3900V2 – serial no. 1022					
			4100 Head			
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2019.7.11	-23.6		57.0		0.7	
2020.7.7	-23.3	1.3	58.2	1.2	-1.1	-1.8

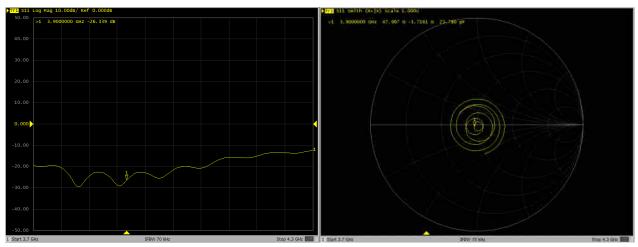
#### <Justification of the extended calibration>

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

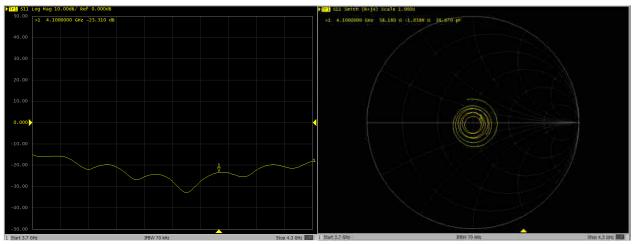


#### Dipole Verification Data> D3900V2, serial no. 1022

#### 3900MHz - Head



#### 4100MHz - Head

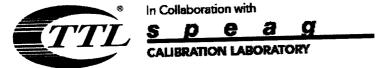


		tion with <b>C A C</b> <b>DN LABORATORY</b>		
Add: No.51 Xueyuan Tel: +86-10-6230463 E-mail: cttl@chinattl.	3-2512 Fax: +8	ict, Beijing, 100191, China 86-10-62304633-2504 www.chinattl.cn		CALIBRATION CNAS L0570
Client Spor	· · · · · · · · · · · · · · · · · · ·		ertificate No: Z1	8-60259
CALIBRATION CE	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		
This calibration Certificate of measurements(SI). The mea pages and are part of the ce All calibrations have been humidity<70%.	surements and rtificate.	the uncertainties with	confidence probability	are given on the following
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%.

In Collaboration with



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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)