Report No.: LCS180412044-SAR

8.2	D835V2	Dipole	Calibration	Certificate
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**Calibration Laboratory of** Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland

Accredited by the Swiss Accreditation Service (SAS)

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Schweizerischer Kalibrierdienst S Service suisse d'étalonnage С

Servizio svizzero di taratura s Swiss Calibration Service

Accreditation No.: SCS 0108

Certificate No: D835V2-4d069\_Jul16

Dbject	D835V2 - SN:4d0	069		
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz			
Calibration date:	alibration date: July 20, 2016			
The measurements and the unce	rtainties with confidence p	ional standards, which realize the physical un robability are given on the following pages an ry facility: environment temperature $(22 \pm 3)^{\circ}$	d are part of the certificate.	
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17	
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17	
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17	
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17	
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17	
Reference Probe EX3DV4	SN: 7349	15-Jun-16 (No. EX3-7349_Jun16)	Jun-17	
DAE4	SN: 601	30-Dec-15 (No. DAE4-601_Dec15)	Dec-16	
Secondary Standards	ID #	Check Date (in house)	Scheduled Check	
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (No. 217-02222)	In house check: Oct-16	
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (No. 217-02222)	In house check: Oct-16	
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (No. 217-02223)	In house check: Oct-16	
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Jun-15)	In house check: Oct-16	
The generator nato own-oo	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16	
Network Analyzer HP 8753E		Function	Signature	
	Name	Function		
	Name Michael Weber	Laboratory Technician	Milles	
Network Analyzer HP 8753E			M.Mess Lelle	

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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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- 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%.

Certificate No: D835V2-4d069\_Jul16

Page 2 of 8

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# **Measurement Conditions**

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
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	40.6 ± 6 %	0.94 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	250 mW input power	2.45 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	9.44 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	1.59 W/kg

# **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	54.9 ± 6 %	1.01 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.50 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	9.69 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	2011 - 2012 - 2012 - 2014
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	1.63 W/kg

Certificate No: D835V2-4d069\_Jul16

Page 3 of 8

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.9 Ω - 2.1 jΩ
Return Loss	- 31.1 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.8 Ω - 2.5 jΩ	-
Return Loss	- 31.0 dB	

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

Electrical Delay (one direction)	1.394 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		
Manufactured on	November 09, 2007		

Certificate No: D835V2-4d069\_Jul16

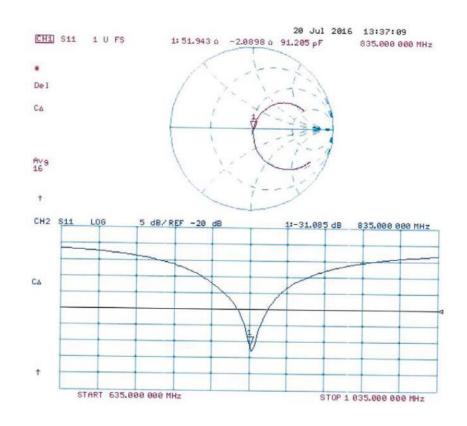
Page 4 of 8

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DASY5 Validation Report for Head TSL	
	ate: 20.07.2016
Test Laboratory: SPEAG, Zurich, Switzerland	
DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: D835V2 - SN:4d069	
Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: $f = 835$ MHz; $\sigma = 0.94$ S/m; $\varepsilon_r = 40.6$ ; $\rho = 1000$ kg/m <sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)	
DASY52 Configuration:	
• Probe: EX3DV4 - SN7349; ConvF(9.72, 9.72, 9.72); Calibrated: 15.06.2016;	
Sensor-Surface: 1.4mm (Mechanical Surface Detection)	
Electronics: DAE4 Sn601; Calibrated: 30.12.2015	
Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001	
• DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)	
Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7). Measurement grid: $dx=5mm$ , $dy=5mm$ , $dz=5mm$ Reference Value = 62.09 V/m; Power Drift = 0.02 dB Peak SAR (extrapolated) = 3.70 W/kg SAR(1 g) = 2.45 W/kg; SAR(10 g) = 1.59 W/kg Maximum value of SAR (measured) = 3.26 W/kg	
$\begin{array}{c} dB \\ -2.20 \\ -4.40 \\ -6.60 \\ -8.80 \\ -11.00 \end{array}$ $0 \ dB = 3.26 \ W/kg = 5.13 \ dBW/kg$	
Certificate No: D835V2-4d069_Jul16 Page 5 of 8	
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Report No.: LCS180412044-SAR

Impedance Measurement Plot for Head TSL



Certificate No: D835V2-4d069\_Jul16

Page 6 of 8

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Date: 20.07.2016

# DASY5 Validation Report for Body TSL

Test Laboratory: SPEAG, Zurich, Switzerland

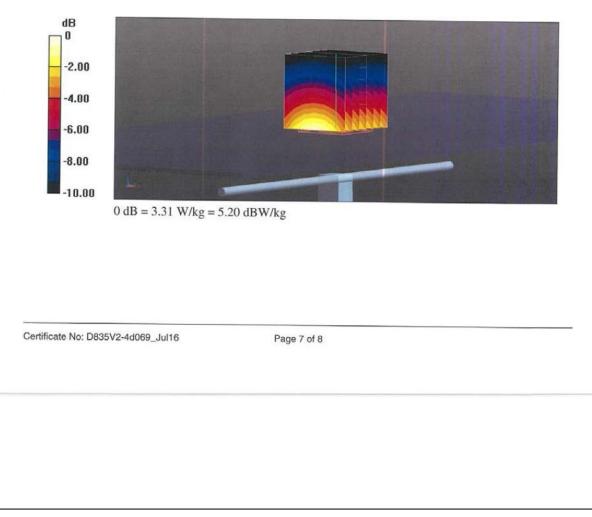
DUT: Dipole 835 MHz D835V2; Type: D835V2; Serial: D835V2 - SN: 4d069

Communication System: UID 0 - CW; Frequency: 835 MHz Medium parameters used: f = 835 MHz;  $\sigma$  = 1.01 S/m;  $\epsilon_r$  = 54.9;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

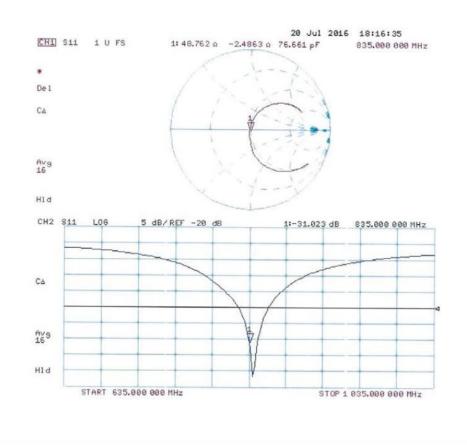
DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(9.73, 9.73, 9.73); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 60.64 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 3.68 W/kg SAR(1 g) = 2.5 W/kg; SAR(10 g) = 1.63 W/kg Maximum value of SAR (measured) = 3.31 W/kg



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Certificate No: D835V2-4d069\_Jul16

Page 8 of 8

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NZHEN LCS COMPLIANCE	TESTING LABO	ORATORY LTD.	FCC ID: 2A06ZK400	) Rep	oort No.: LCS180412044-SAI
B D1900V2 Dipol	le Calibra	ation Certific	cate		
Add: No.51 Xueyua Tel; +86-10-623046	n Road, Haidian Dis	Control Contro Control Control Control Control Control Control Control Control Co		NAS	中国认可 国际互认 校准 CALIBRATION CNAS L0570
E-mail: cttl@chinatt	l.com <u>Http:/</u>	/www.chinattl.cn	Certificate No: Z	16-97050	CNAS 20070
Client Tejer	12.11		ertificate No. 2	16-97050	
CALIBITATION OF		-		Service Service	
Object	D1900	V2 - SN: 5d155			
Calibration Procedure(s)		-2-003-01 tion Procedures for di	pole validation kits		
Calibration date:	April 14				
This calibration Certificate of measurements(SI). The measurements (SI) and are part of the certification of the	asurements and				
All calibrations have been humidity<70%.	conducted in	the closed laboratory	y facility: environmen	t temperature	(22±3)℃ and
Calibration Equipment used	(M&TE critical fo	or calibration)			
Primary Standards	ID #	Cal Date(Calibrated	by, Certificate No.)	Scheduled	Calibration
Power Meter NRP2 Power sensor NRP-Z91	101919 101547	01-Jul-15 (CTTL, No 01-Jul-15 (CTTL, No		Jun	
Reference Probe EX3DV4	SN 3617		No.EX3-3617_Aug15)	Jun Aug	
DAE4	SN 1331	and the second of the second states and the second states	DAE4-1331_Jan16)	Jan-	
Secondary Standards	ID #	Cal Date(Calibrated	by, Certificate No.)	Scheduled	Calibration
Signal Generator E4438C Network Analyzer E5071C	MY49071430 MY46110673	01-Feb-16 (CTTL, N 26-Jan-16 (CTTL, N		Jan- Jan-	
	Name	Function		Signa	ture
Calibrated by:	Zhao Jing	SAR Test Engi	neer	the state	S-
Reviewed by:	Qi Dianyuan	SAR Project L	eader	000	Z
Approved by:	Lu Bingsong	Deputy Directo	or of the laboratory	the sen	tr
			Issued: April		1.30
This calibration certificate sh	all not be reproc	duced except in full wit	thout written approval	of the laborato	ory.
Certificate No: Z16-97050	1	Page 1 of 8			
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Page 82 of 104



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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, "Procedure to measure the Specific Absorption Rate (SAR) For hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)", February 2005
- 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	52.8.8.1258
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

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.6 ± 6 %	1.39 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	10.2 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	41.0 mW /g ± 20.8 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.31 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	21.3 mW /g ± 20.4 % (k=2)

#### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	54.2 ± 6 %	1.50 mho/m ± 6 %
Body TSL temperature change during test	<1.0 °C		

#### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.87 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	39.9 mW /g ± 20.8 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	5.21 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	21.0 mW /g ± 20.4 % (k=2)

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#### Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.5Ω+ 6.24jΩ	
Return Loss	- 24.0dB	

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.6Ω+ 5.79jΩ	
Return Loss	- 24.7dB	

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.310 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
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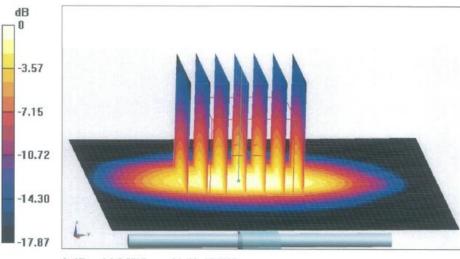
#### **DASY5 Validation Report for Head TSL** Test Laboratory: CTTL, Beijing, China

Date: 04.14.2016

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d155** Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1 Medium parameters used: f = 1900 MHz;  $\sigma = 1.386$  S/m;  $\epsilon r = 39.58$ ;  $\rho = 1000$  kg/m3 Phantom section: Center Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007) DASY5 Configuration:

- Probe: EX3DV4 SN3617; ConvF(8.07, 8.07, 8.07); Calibrated: 8/26/2015;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2016-01-21
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 103.1V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 19.1W/kg SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.31 W/kg Maximum value of SAR (measured) = 14.8 W/kg



0 dB = 14.8 W/kg = 11.70 dBW/kg

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Page 5 of 8

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E ISAN UNAGENISATION	TRE // WWW.Commatt.com	
Impedance Measu	rement Plot for Head TSL	
Tr1 S11 Log Mag 10.00dB/ Re 50.00		
40.00 >1 1.9000000 GHZ	-24.004 dB	
30.00		
20.00		
10.00		
0.000		-
-10.00		
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-30.00		
-40.00		
-50.00		
1 Start 1.7 GHz	IFBW 100 Hz Stop 2.1 0	GHz C2 I
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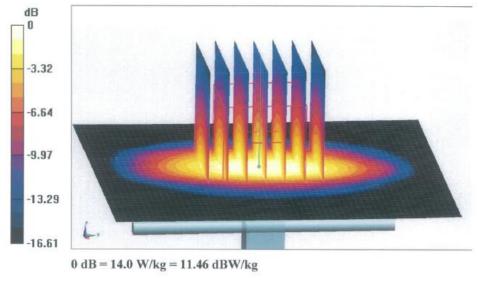


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 Http://www.chinattl.cn

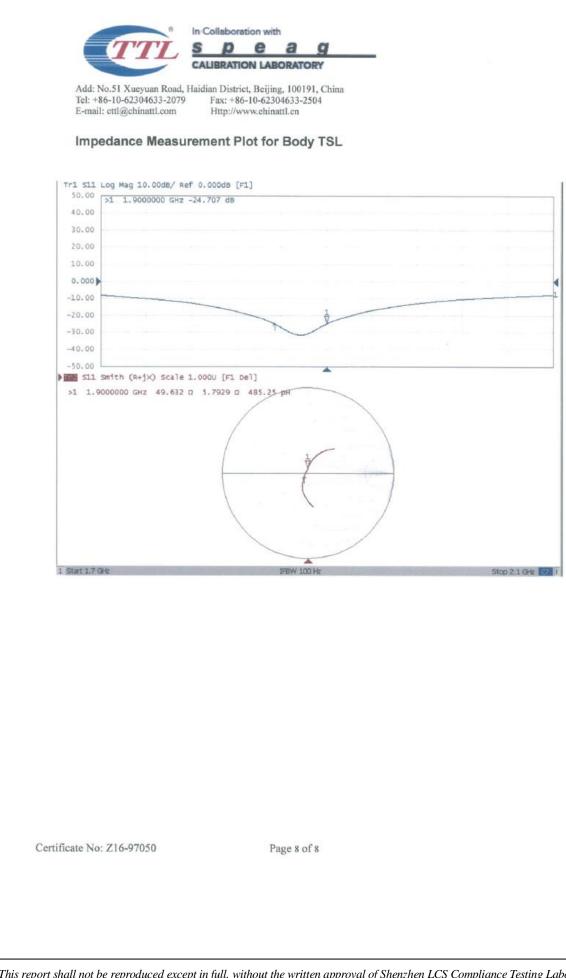
**DASY5 Validation Report for Body TSL** Date: 04.14.2016 Test Laboratory: CTTL, Beijing, China DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d155 Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1 Medium parameters used: f = 1900 MHz;  $\sigma = 1.501 \text{ S/m}$ ;  $\varepsilon_r = 54.22$ ;  $\rho = 1000 \text{ kg/m}^3$ Phantom section: Left Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007) DASY5 Configuration: Probe: EX3DV4 - SN3617; ConvF(7.74, 7.74, 7.74); Calibrated: 8/26/2015; Sensor-Surface: 2mm (Mechanical Surface Detection) Electronics: DAE4 Sn1331; Calibrated: 2016-01-21 Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1 Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7372) System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 98.40 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 17.6 W/kg SAR(1 g) = 9.87 W/kg; SAR(10 g) = 5.21 W/kg Maximum value of SAR (measured) = 14.0 W/kg



Certificate No: Z16-97050

Page 7 of 8

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	e Calibration	Certificate	
Calibration Laborato Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zuri			<ul> <li>S Schweizerischer Kalibrierdienst</li> <li>Service suisse d'étalonnage</li> <li>Servizio svizzero di taratura</li> <li>Swiss Calibration Service</li> </ul>
Accredited by the Swiss Accredit The Swiss Accreditation Servic Multilateral Agreement for the	ce is one of the signator	ies to the EA	Accreditation No.: SCS 0108
Client Auden		Certificate	No: D2450V2-869_Jun16
CALIBRATION	CERTIFICAT	E	
Object	D2450V2 - SN:8	369	
Calibration procedure(s)	QA CAL-05.v9 Calibration proc	edu <b>re</b> for dipole validation kits at	pove 700 MHz
Calibration date:	June 21, 2016		
The measurements and the unce	ertainties with confidence p	tional standards, which realize the physical $t$ probability are given on the following pages a pry facility: environment temperature (22 $\pm$ 3)	and are part of the certificate.
All calibrations have been condu	ertainties with confidence p	probability are given on the following pages a bry facility: environment temperature (22 ± 3) Cal Date (Certificate No.)	and are part of the certificate. °C and humidity < 70%. Scheduled Calibration
All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter NRP Power sensor NRP-Z91	ertainties with confidence p cted in the closed laborato TE critical for calibration) ID # SN: 104778 SN: 103244	Cal Date (Certificate No.) 06-Apr-16 (No. 217-02288)	and are part of the certificate. °C and humidity < 70%.
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Calibration Laboratory of

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

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- 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%.

Certificate No: D2450V2-869\_Jun16

Page 2 of 8

Page 91 of 104

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Service suisse d'étalonnage С

Accreditation No.: SCS 0108

- Servizio svizzero di taratura
- Swiss Calibration Service



#### Measurement Conditions

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

DASY Version	DASY5	V52.8.8
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	

## 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	38.2 ± 6 %	1.87 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	250 mW input power	13.7 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.5 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	6.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.0 W/kg ± 16.5 % (k=2)

### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.1 ± 6 %	2.02 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	51.4 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.04 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.9 W/kg ± 16.5 % (k=2)

Certificate No: D2450V2-869\_Jun16

Page 3 of 8

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

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.1 Ω + 6.8 jΩ
Return Loss	- 22.9 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.5 Ω + 7.8 jΩ		
Return Loss	- 21.9 dB		

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.158 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		
Manufactured on	August 18, 2010		

Certificate No: D2450V2-869\_Jun16

Page 4 of 8

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Date: 21.06.2016

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

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:869

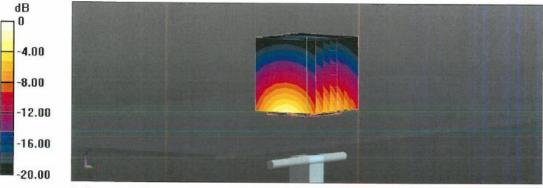
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 1.87$  S/m;  $\varepsilon_r = 38.2$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.72, 7.72, 7.72); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

# Dipole Calibration for Head Tissue 2/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 115.5 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 27.7 W/kg SAR(1 g) = 13.7 W/kg; SAR(10 g) = 6.33 W/kgMaximum value of SAR (measured) = 22.5 W/kg



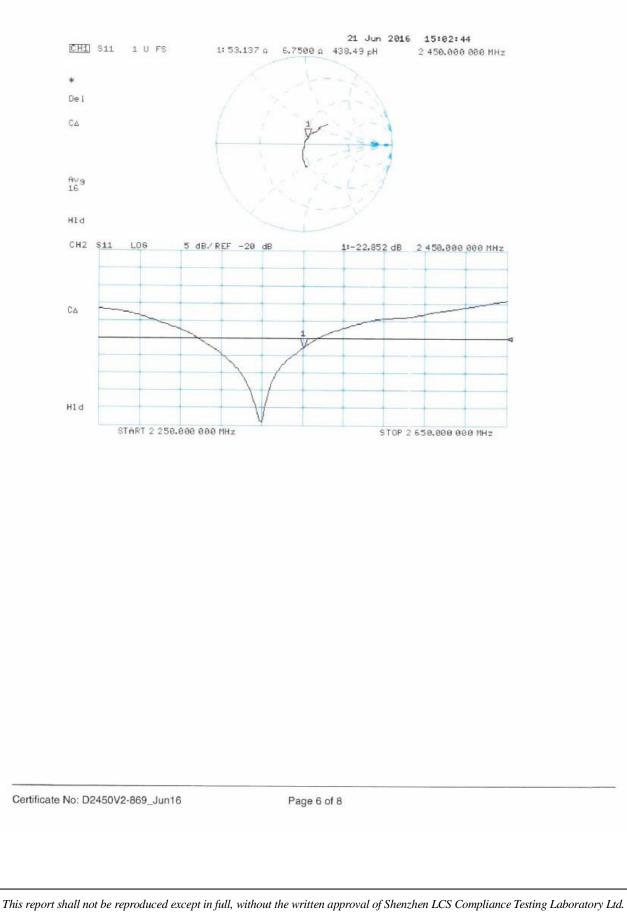
0 dB = 22.5 W/kg = 13.52 dBW/kg

Certificate No: D2450V2-869\_Jun16

Page 5 of 8

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Impedance Measurement Plot for Head TSL



Page 95 of 104

Date: 21.06.2016

## DASY5 Validation Report for Body TSL

Test Laboratory: SPEAG, Zurich, Switzerland

# DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:869

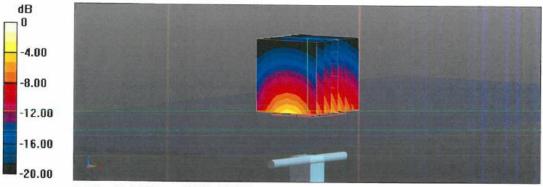
Communication System: UID 0 - CW; Frequency: 2450 MHz Medium parameters used: f = 2450 MHz;  $\sigma = 2.02$  S/m;  $\varepsilon_r = 52.1$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.79, 7.79, 7.79); Calibrated: 15.06.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.12.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

# Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 107.7 V/m; Power Drift = -0.05 dB Peak SAR (extrapolated) = 26.4 W/kg SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.04 W/kgMaximum value of SAR (measured) = 21.6 W/kg



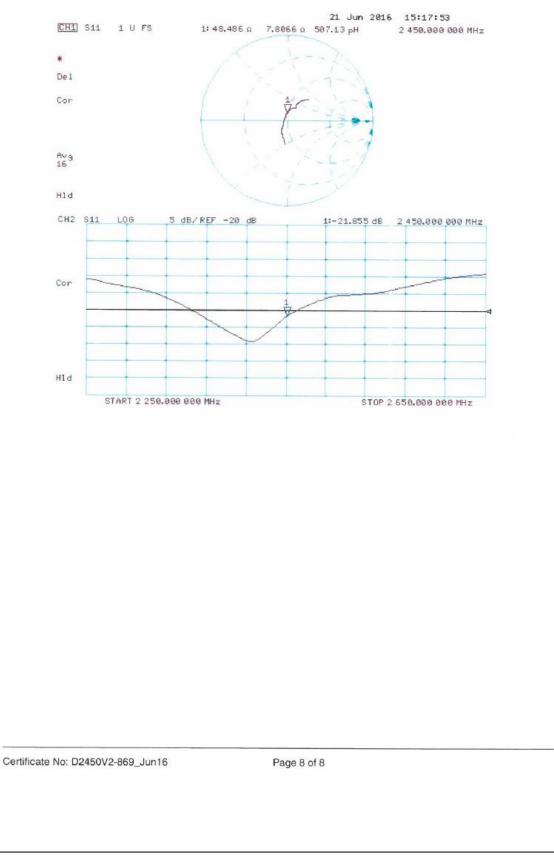
0 dB = 21.6 W/kg = 13.34 dBW/kg

Certificate No: D2450V2-869\_Jun16

Page 7 of 8

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Impedance Measurement Plot for Body TSL



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<u>SHENZ</u>	ZHEN LCS COMPLIANCE TESTING LA	BORATORY LTD.	FCC ID: 2A06ZK400	Report No.: LCS180412044-SAR		
8.5	DAE4 Calibration Certificate					
	Add: No.51 Xueyuan Ro Tel: +86-10-62304633-2 E-mail: ettl@chinattl.co Client : CIQ(She	m <u>Http://www.chir</u>	a g ORATORY ng, 100191, China 104633-2209 natl.en	中国认为 国际互持 校准 CALIBRA CNAS LO No: Z17-97120		
	CALIBRATION CER	CALIBRATION CERTIFICATE				
	Object	DAE4 - SN: 13	DAE4 - SN: 1315 JP462			
	Calibration Procedure(s)		FD-Z11-2-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)			
	Calibration date:	July 26, 2017				
	This calibration Certificate documents the traceability to national standards, which realize the physical units 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					
	Process Calibrator 753 1971	018 27-June	-17 (CTTL, No:J16X04778)	June-18		
	Nar Collibrated hu	and the second second second	nction	Signature		
		Zongying SA	R Test Engineer	2-TB		
	Reviewed by: Qi	Dianyuan SA	R Project Leader	202		
	Approved by:	Bingsong De	puty Director of the laboratory	TR \$3507		
	Issued: Uuly 27, 2016 This calibration certificate shall not be reproduced except in full without written approval of the laboratory.					
	Certificate No: Z17-97120		Page 1 of 3			
<i>T</i>	This report shall not be reproduced except	in full, without the wri	itten approval of Shenzhen LCS	Compliance Testing Laboratory Ltd.		



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Glossary:

DAE Connector angle data acquisition electronics information used in DASY system to align probe sensor X to the robot coordinate system.

# Methods Applied and Interpretation of Parameters:

- DC Voltage Measurement: Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- Connector angle: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The report provide only calibration results for DAE, it does not contain other performance test results.

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Page 2 of 3

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# **DC Voltage Measurement**

A/D - Converter Resolution nominal

Calibration Factors	x	Y	Z
High Range	405.179 $\pm$ 0.15% (k=2)	405.018 ± 0.15% (k=2)	404.98 ± 0.15% (k=2)
Low Range			3.98861 ± 0.7% (k=2)

# **Connector Angle**

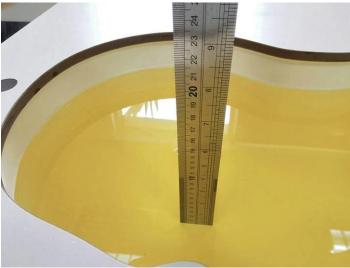
Connector Angle to be used in DASY system

20.5°±1°

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Report No.: LCS180412044-SAR

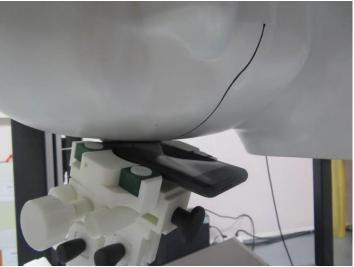
# 9 Test Setup Photos



Photograph of the depth in the Head Phantom



Photograph of the depth in the Body Phantom



**Right Head Tilt Setup Photo** 

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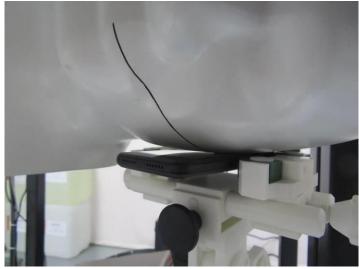
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**Right Head Cheek Setup Photo** 



Left Head Tilt Setup Photo



Left Head Cheek Setup Photo

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10mm Back Side Setup Photo



**10mm Front Side Setup Photo** 



10mm Left SideSetup Photo

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10mm Right Side Setup Photo



10mm Top Side Setup Photo



**10mm Bottom Side Setup Photo** 

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