

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



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
**S** Servizio svizzero di taratura  
**S** Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)  
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

**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.

<b>DASY Version</b>	DASY5	V52.10.0
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom	
<b>Distance Dipole Center - TSL</b>	10 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	2600 MHz ± 1 MHz	

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	39.0	1.96 mho/m
<b>Measured Head TSL parameters</b>	(22.0 ± 0.2) °C	37.2 ± 6 %	2.04 mho/m ± 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

### SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	14.9 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	57.9 W/kg ± 17.0 % (k=2)

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	250 mW input power	6.57 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.8 W/kg ± 16.5 % (k=2)

### Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	52.5	2.16 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	51.6 ± 6 %	2.22 mho/m ± 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	----	----

### SAR result with Body TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	14.1 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	55.5 W/kg ± 17.0 % (k=2)

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	condition	
SAR measured	250 mW input power	6.25 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.8 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	46.8 $\Omega$ - 5.0 $j\Omega$
Return Loss	- 24.2 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	43.5 $\Omega$ - 5.3 $j\Omega$
Return Loss	- 21.0 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.151 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

**Additional EUT Data**

Manufactured by	SPEAG
Manufactured on	October 30, 2007

**DASY5 Validation Report for Head TSL**

Date: 20.07.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1012**

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used:  $f = 2600 \text{ MHz}$ ;  $\sigma = 2.04 \text{ S/m}$ ;  $\epsilon_r = 37.2$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.96, 7.96, 7.96); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

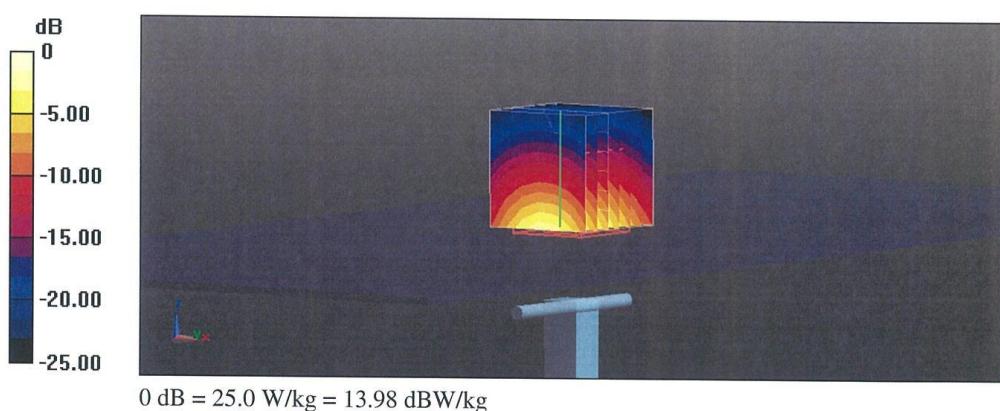
**Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$ 

Reference Value = 113.6 V/m; Power Drift = 0.05 dB

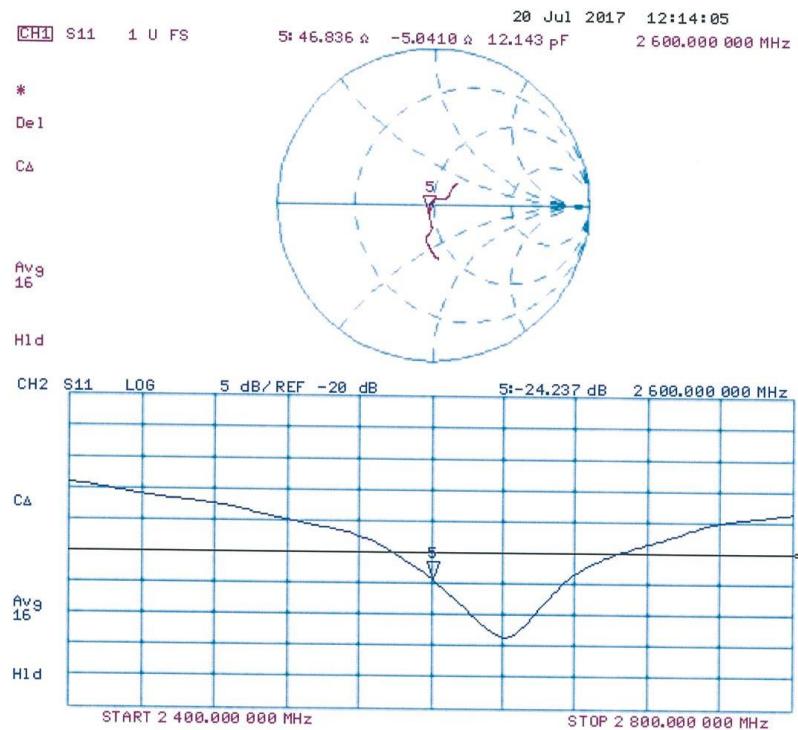
Peak SAR (extrapolated) = 32.3 W/kg

**SAR(1 g) = 14.9 W/kg; SAR(10 g) = 6.57 W/kg**

Maximum value of SAR (measured) = 25.0 W/kg



## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 21.07.2017

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1012**

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used:  $f = 2600 \text{ MHz}$ ;  $\sigma = 2.22 \text{ S/m}$ ;  $\epsilon_r = 51.6$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.94, 7.94, 7.94); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

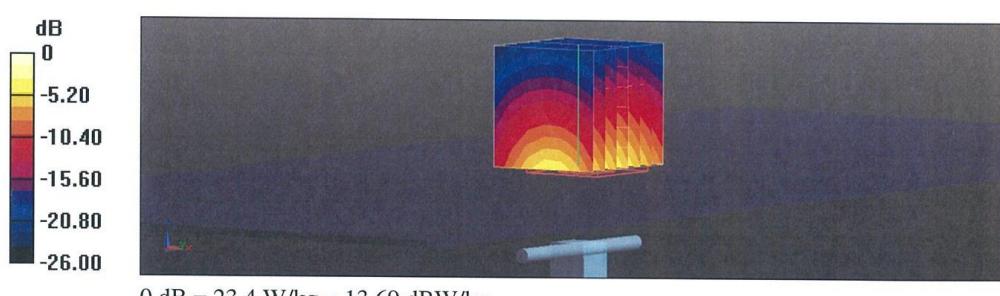
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 106.6 V/m; Power Drift = -0.07 dB

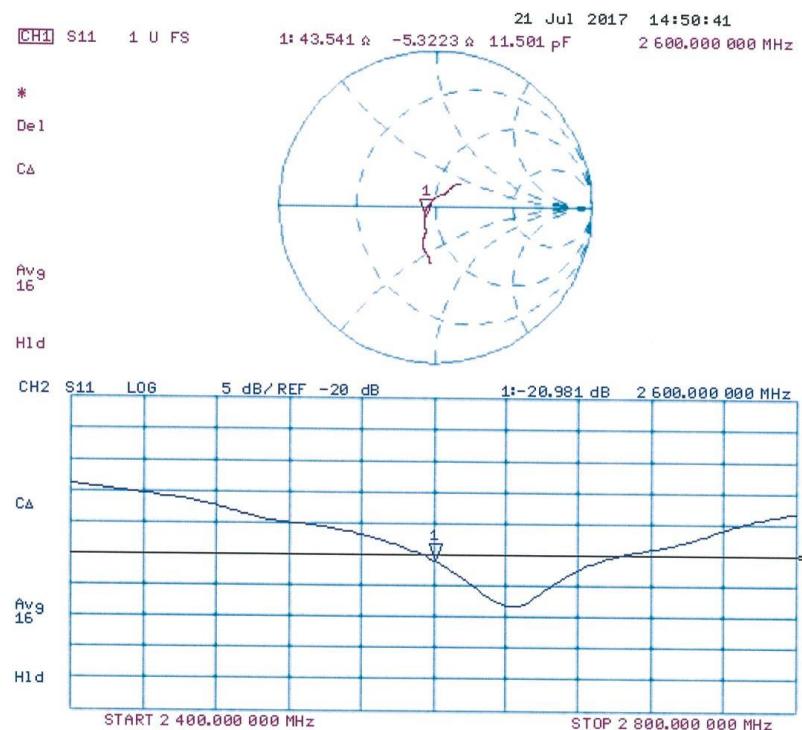
Peak SAR (extrapolated) = 30.1 W/kg

**SAR(1 g) = 14.1 W/kg; SAR(10 g) = 6.25 W/kg**

Maximum value of SAR (measured) = 23.4 W/kg



## Impedance Measurement Plot for Body TSL



## ANNEX I DAE Calibration Certificate

**Calibration Laboratory of**  
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Accreditation No.: **SCS 0108**

Client **CTTL-BJ (Auden)**

Certificate No: **DAE4-1525\_Oct17**

### CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 1525																						
Calibration procedure(s)	QA CAL-06.v29 Calibration procedure for the data acquisition electronics (DAE)																						
Calibration date:	October 02, 2017																						
<p>This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature <math>(22 \pm 3)^\circ\text{C}</math> and humidity <math>&lt; 70\%</math>.</p> <p>Calibration Equipment used (M&amp;TE critical for calibration)</p> <table border="1"> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date (Certificate No.)</th> <th>Scheduled Calibration</th> </tr> <tr> <td>Keithley Multimeter Type 2001</td> <td>SN: 0810278</td> <td>31-Aug-17 (No:21092)</td> <td>Aug-18</td> </tr> <tr> <th>Secondary Standards</th> <th>ID #</th> <th>Check Date (in house)</th> <th>Scheduled Check</th> </tr> <tr> <td>Auto DAE Calibration Unit</td> <td>SE UWS 053 AA 1001</td> <td>05-Jan-17 (in house check)</td> <td>In house check: Jan-18</td> </tr> <tr> <td>Calibrator Box V2.1</td> <td>SE UMS 006 AA 1002</td> <td>05-Jan-17 (in house check)</td> <td>In house check: Jan-18</td> </tr> </table> <p>Calibrated by: <b>Dominique Steffen</b>      Function: <b>Laboratory Technician</b>      Signature: </p> <p>Approved by: <b>Sven Kühn</b>      Function: <b>Deputy Manager</b>      Signature: </p> <p>Issued: October 2, 2017</p> <p>This calibration certificate shall not be reproduced except in full without written approval of the laboratory.</p>				Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	Keithley Multimeter Type 2001	SN: 0810278	31-Aug-17 (No:21092)	Aug-18	Secondary Standards	ID #	Check Date (in house)	Scheduled Check	Auto DAE Calibration Unit	SE UWS 053 AA 1001	05-Jan-17 (in house check)	In house check: Jan-18	Calibrator Box V2.1	SE UMS 006 AA 1002	05-Jan-17 (in house check)	In house check: Jan-18
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Accreditation No.: **SCS 0108**

### Glossary

<b>DAE</b>	data acquisition electronics
Connector angle	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 following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement:* Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

**DC Voltage Measurement**

A/D - Converter Resolution nominal

High Range: 1LSB =  $6.1\mu V$ , full range =  $-100...+300 mV$ Low Range: 1LSB =  $61nV$ , full range =  $-1.....+3mV$ 

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	$405.912 \pm 0.02\% (k=2)$	$405.954 \pm 0.02\% (k=2)$	$405.400 \pm 0.02\% (k=2)$
Low Range	$3.99166 \pm 1.50\% (k=2)$	$4.00980 \pm 1.50\% (k=2)$	$3.99550 \pm 1.50\% (k=2)$

**Connector Angle**

Connector Angle to be used in DASY system	$53.5^\circ \pm 1^\circ$
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**Appendix (Additional assessments outside the scope of SCS0108)**

**1. DC Voltage Linearity**

High Range	Reading ( $\mu$ V)	Difference ( $\mu$ V)	Error (%)
Channel X + Input	200030.95	-2.42	-0.00
Channel X + Input	20004.11	-0.05	-0.00
Channel X - Input	-20003.75	2.02	-0.01
Channel Y + Input	200031.20	-2.23	-0.00
Channel Y + Input	20001.46	-2.74	-0.01
Channel Y - Input	-20005.92	-0.05	0.00
Channel Z + Input	200032.03	-1.05	-0.00
Channel Z + Input	20001.94	-2.11	-0.01
Channel Z - Input	-20006.15	-0.20	0.00

Low Range	Reading ( $\mu$ V)	Difference ( $\mu$ V)	Error (%)
Channel X + Input	2000.66	0.19	0.01
Channel X + Input	200.40	-0.18	-0.09
Channel X - Input	-198.67	0.81	-0.40
Channel Y + Input	2000.90	0.48	0.02
Channel Y + Input	199.98	-0.58	-0.29
Channel Y - Input	-200.18	-0.62	0.31
Channel Z + Input	2000.68	0.32	0.02
Channel Z + Input	199.07	-1.45	-0.72
Channel Z - Input	-201.14	-1.52	0.76

**2. Common mode sensitivity**

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading ( $\mu$ V)	Low Range Average Reading ( $\mu$ V)
Channel X	200	18.32	16.76
	-200	-15.73	-17.08
Channel Y	200	-20.47	-20.86
	-200	20.66	20.31
Channel Z	200	13.43	13.46
	-200	-15.65	-15.97

**3. Channel separation**

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X ( $\mu$ V)	Channel Y ( $\mu$ V)	Channel Z ( $\mu$ V)
Channel X	200	-	0.08	-3.66
Channel Y	200	7.12	-	1.80
Channel Z	200	10.44	4.52	-

#### 4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	15817	15005
Channel Y	16329	14457
Channel Z	15576	15478

#### 5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Input 10MΩ

	Average ( $\mu$ V)	min. Offset ( $\mu$ V)	max. Offset ( $\mu$ V)	Std. Deviation ( $\mu$ V)
Channel X	0.63	-0.54	2.27	0.51
Channel Y	-2.07	-3.42	-1.02	0.49
Channel Z	-0.89	-2.38	0.83	0.54

#### 6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

#### 7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

#### 8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

#### 9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

## ANNEX J SPOT CHECK

### J.1 Dielectric Performance and System Validation

**Table J.1-1: Targets for tissue simulating liquid**

Frequency(MHz)	Liquid Type	Conductivity( $\sigma$ )	$\pm 5\%$ Range	Permittivity( $\epsilon$ )	$\pm 5\%$ Range
2450	Head	1.80	1.71~1.89	39.2	37.2~41.2
1900	Body	1.52	1.44~1.60	53.3	50.6~56.0
2600	Body	2.16	2.05~2.27	52.5	49.9~55.1

**Table J.1-2: Dielectric Performance of Head Tissue Simulating Liquid**

Measurement Date (yyyy-mm-dd)	Type	Frequency	Permittivity $\epsilon$	Drift (%)	Conductivity $\sigma$ (S/m)	Drift (%)
2019-6-17	Head	2450 MHz	39.55	0.89	1.771	-1.61
2019-6-6	Body	1900 MHz	53.15	-0.28	1.54	1.32
2019-6-6	Body	2600 MHz	51.66	-1.60	2.143	-0.79

**Table J.1-3: System Validation of Head**

Measurement Date (yyyy-mm-dd)	Frequency	Target value (W/kg)		Measured value(W/kg)		Deviation	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
2019-6-17	2450 MHz	24.2	51.7	24.5	52.1	1.24%	0.77%

**Table J.1-4: System Validation of Body**

Measurement Date (yyyy-mm-dd)	Frequency	Target value (W/kg)		Measured value(W/kg)		Deviation	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
2019-6-6	1900 MHz	21.4	40.4	21.35	40.17	-0.23%	-0.57%
2019-6-6	2600 MHz	24.5	54.1	25.23	54.75	2.98%	1.20%

## J.2 Conducted power of selected case

Table J.2-1: The conducted Power for WIFI

Band	Channel	Frequency	Measured Power (dBm)
<b>WLAN2450</b>	<b>6</b>	<b>2437 MHz</b>	<b>15.51</b>
<b>WCDMA1900</b>	<b>9662</b>	<b>1872.4 MHz</b>	<b>23.01</b>
<b>WCDMA1900</b>	<b>9800</b>	<b>1880 MHz</b>	<b>23.18</b>
<b>WCDMA1900</b>	<b>9938</b>	<b>1907.6MHz</b>	<b>23.09</b>
<b>LTEBand2</b>	<b>18700</b>	<b>1860 MHz</b>	<b>23.11</b>
<b>LTEBand7</b>	<b>21350</b>	<b>2560 MHz</b>	<b>22.01</b>

## J.3 SAR test result for spot check

Frequency			Ambient Temperature: 22.5 °C			Liquid Temperature: 22.1 °C					
Ch	MHz.	Test Position	Figure No./ Note	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)	Power Drift (dB)	
6	2437	Right check	Fig J.1	15.51	16.5	0.384	<b>0.48</b>	0.727	<b>0.91</b>	0.05	
9400	1880	Bottom	/	23.18	23.5	0.575	<b>0.62</b>	1.06	<b>1.14</b>	-0.01	
9262	1852.4	Bottom	Fig J.2	23.01	23.5	0.585	<b>0.65</b>	1.13	<b>1.26</b>	-0.16	
9538	1907.6	Bottom	/	23.09	23.5	0.552	<b>0.61</b>	1.03	<b>1.13</b>	0.05	
18700	1860	Bottom	Fig J.3	23.11	23.5	0.492	<b>0.54</b>	0.953	<b>1.04</b>	0.11	
21350	2560	Bottom	Fig J.4	22.01	22.2	0.456	0.48	1.01	<b>1.06</b>	-0.09	
9262	1852.4	Bottom	Headset1	23.01	23.5	0.561	<b>0.63</b>	1.082	<b>1.21</b>	0.08	
9262	1852.4	Bottom	Headset2	23.01	23.5	0.561	<b>0.63</b>	1.090	<b>1.22</b>	0.07	
9262	1852.4	Bottom	Headset3	23.01	23.5	0.559	<b>0.63</b>	1.113	<b>1.25</b>	0.06	
9262	1852.4	Bottom	Headset4	23.01	23.5	0.545	<b>0.63</b>	1.095	<b>1.23</b>	-0.12	

Note1: The distance between the EUT and the phantom bottom is 10mm

## J.4 Reported SAR Comparison

Exposure Configuration	Technology Band	Reported SAR 1g (W/kg): spot check	Reported SAR 1g (W/kg): original
Head (Separation Distance 0mm)	<b>WLAN2450</b>	0.91	0.99
Hotspot (Separation Distance 10MM)	<b>WCDMA1900</b>	<b>1.26</b>	1.19
	<b>LTEBand2</b>	1.04	1.19
	<b>LTEBand7</b>	1.06	1.19

Note: The spot check results marked blue are larger than the original result.

**Table J5.1: List of Main Instruments**

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	E5071C	MY46110673	January 24, 2018	One year
02	Power meter	NRVD	102083	November 01,2017	One year
03	Power sensor	NRV-Z5	100542		
04	Signal Generator	E4438C	MY49070393	January 02,2018	One Year
05	Amplifier	60S1G4	0331848	No Calibration Requested	
06	BTS	CMW500	159889	December 20, 2017	One year
07	E-field Probe	SPEAG EX3DV4	7464	September 12,2017	One year
08	DAE	SPEAG DAE4	1525	October 02, 2017	One year
09	Dipole Validation Kit	SPEAG D1900V2	5d101	July 26,2017	One year
10	Dipole Validation Kit	SPEAG D2450V2	853	July 21,2017	One year
11	Dipole Validation Kit	SPEAG D2600V2	1012	July 21,2017	One year

\*\*\*END OF REPORT BODY\*\*\*

## J.5 GRAPH RESULTS

### WLAN2450\_CH6 Right Cheek

Date: 6/17/2019

Electronics: DAE4 Sn1525

Medium: head 2450 MHz

Medium parameters used:  $f = 2437 \text{ MHz}$ ;  $\sigma = 1.775 \text{ mho/m}$ ;  $\epsilon_r = 38.71$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.5^\circ\text{C}$ , Liquid Temperature:  $22.3^\circ\text{C}$

Communication System: WLAN2450 2437 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(7.72,7.72,7.72)

**Area Scan (91x151x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) = 1.15 W/kg

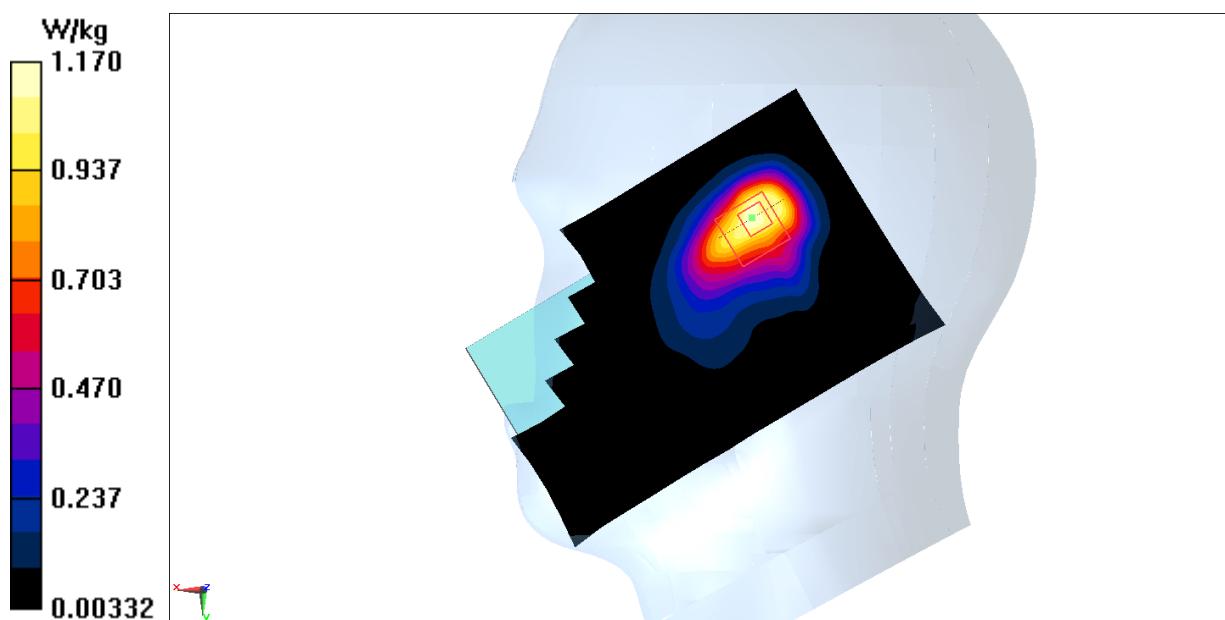
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 13.74 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 1.46 W/kg

SAR(1 g) = 0.727 W/kg; SAR(10 g) = 0.384 W/kg

Maximum value of SAR (measured) = 1.17 W/kg



**Fig J.1**

**WCDMA1900 \_CH9262 Bottom**

Date: 6/6/2019

Electronics: DAE4 Sn1525

Medium: body 1900 MHz

Medium parameters used:  $f = 1852.4$  MHz;  $\sigma = 1.571$  mho/m;  $\epsilon_r = 53.24$ ;  $\rho = 1000$  kg/m $^3$ 

Ambient Temperature: 22.1°C, Liquid Temperature: 22.2°C

Communication System: WCDMA1900-BII 1907.6 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(7.82,7.82,7.82)

**Area Scan (161x91x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 1.72 W/kg

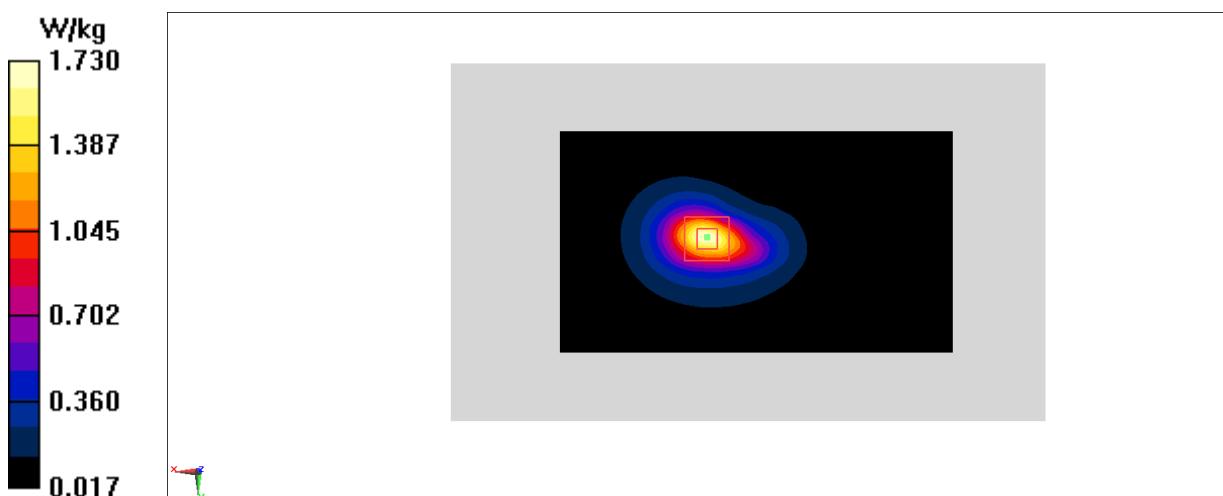
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 20.79 V/m; Power Drift = -0.16 dB

Peak SAR (extrapolated) = 2.07 W/kg

SAR(1 g) = 1.13 W/kg; SAR(10 g) = 0.585 W/kg

Maximum value of SAR (measured) = 1.73 W/kg

**Fig J.2**

**LTE1900-FDD2\_CH18700 Bottom**

Date: 6/6/2019

Electronics: DAE4 Sn1525

Medium: body 1900 MHz

Medium parameters used:  $f = 1860$  MHz;  $\sigma = 1.525$  mho/m;  $\epsilon_r = 53.21$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.1°C, Liquid Temperature: 22.2°C

Communication System: LTE1900-FDD2 1900 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(8.32,8.32,8.32)

**Area Scan (151x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.44 W/kg

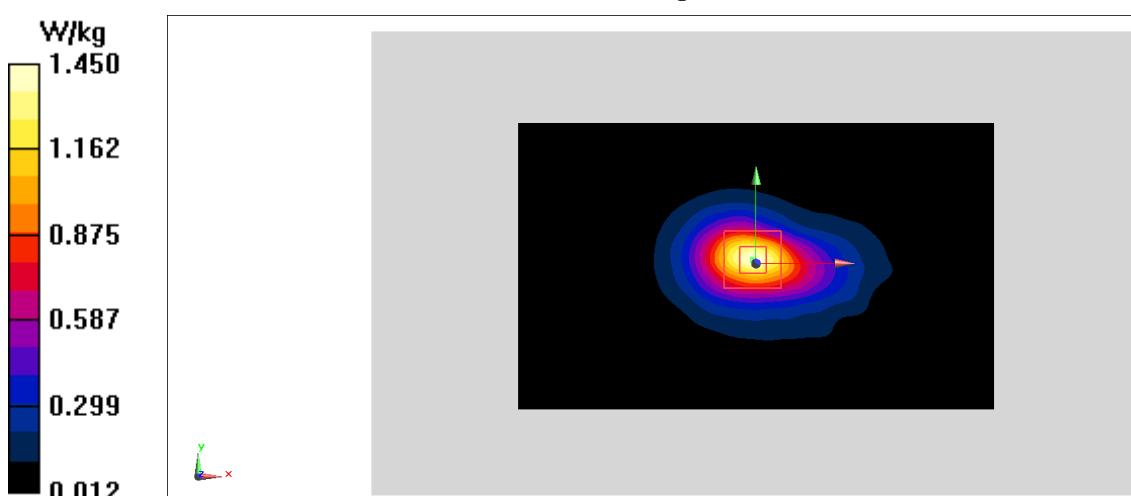
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 25.63 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 1.73 W/kg

SAR(1 g) = 0.953 W/kg; SAR(10 g) = 0.492 W/kg

Maximum value of SAR (measured) = 1.45 W/kg

**Fig J.3**

**LTE2500-FDD7\_CH21350 Bottom**

Date: 6/6/2019

Electronics: DAE4 Sn1525

Medium: body 2600 MHz

Medium parameters used:  $f = 2560$  MHz;  $\sigma = 2.118$  mho/m;  $\epsilon_r = 53.21$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.1°C, Liquid Temperature: 22.2°C

Communication System: LTE2500-FDD7 2560 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(7.30,7.30,7.30)

**Area Scan (141x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.62 W/kg

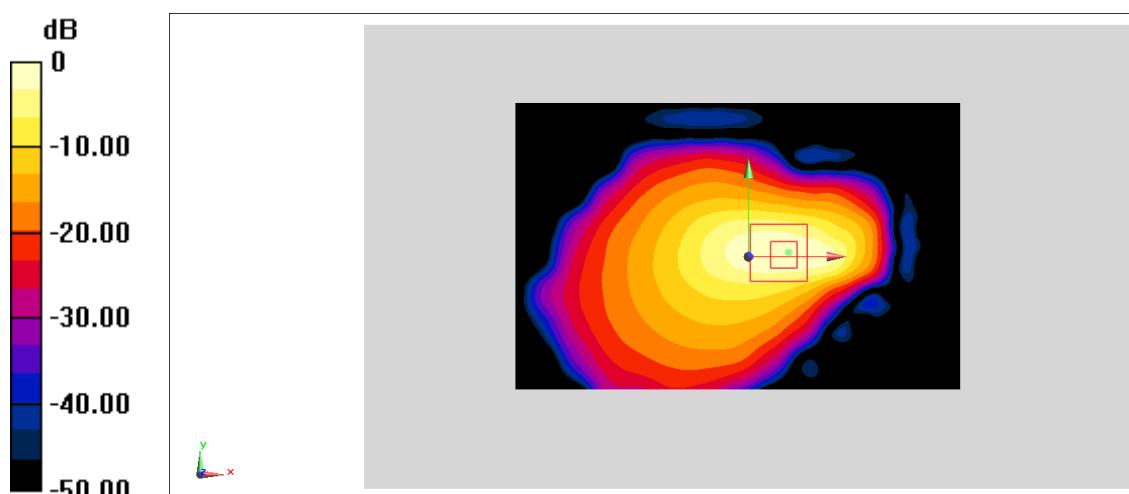
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 11.50 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 2.01 W/kg

SAR(1 g) = 1.01 W/kg; SAR(10 g) = 0.456 W/kg

Maximum value of SAR (measured) = 1.52 W/kg

**Fig J.4**

## J.6 ANNEX System Verification Results

### 2450 MHz

Date: 6/17/2019

Electronics: DAE4 Sn1525

Medium: Head 2450 MHz

Medium parameters used:  $f = 2450 \text{ MHz}$ ;  $\sigma = 1.771 \text{ mho/m}$ ;  $\epsilon_r = 39.55$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature: 22.5°C Liquid Temperature: 22.3°C

Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(7.72,7.72,7.72)

**System Validation /Area Scan (81x191x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Reference Value =113.68 V/m; Power Drift = 0.010 dB

**Fast SAR: SAR(1 g) = 12.89 W/kg; SAR(10 g) = 6.01 W/kg**

Maximum value of SAR (interpolated) = 21.4 W/kg

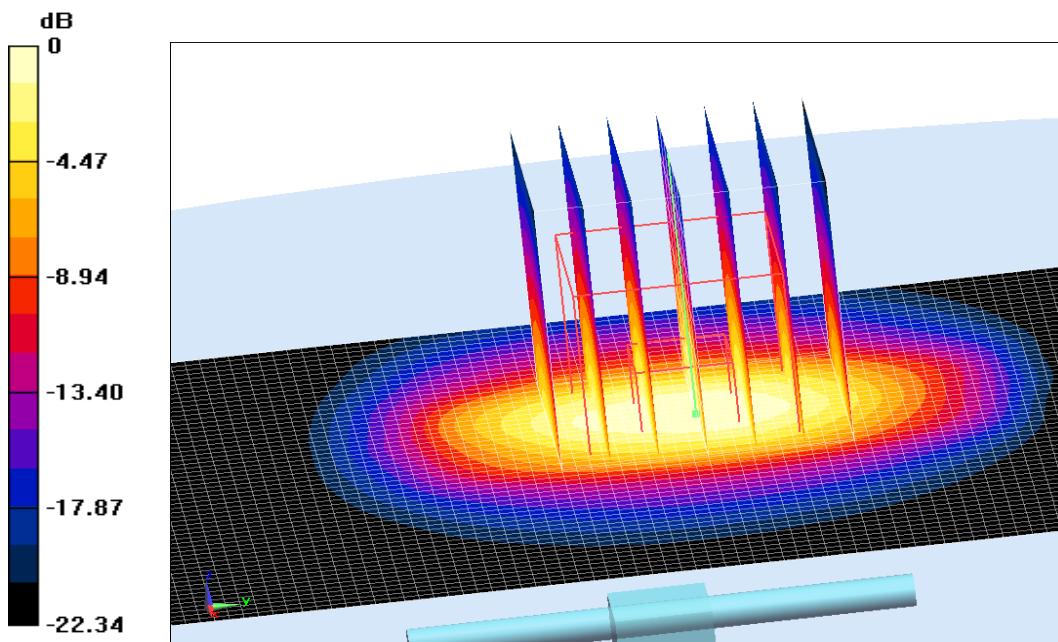
**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =113.68 V/m; Power Drift = 0.010 dB

Peak SAR (extrapolated) = 26.79 W/kg

**SAR(1 g) = 13.18 W/kg; SAR(10 g) = 6.18 W/kg**

Maximum value of SAR (measured) = 21.83 W/kg



$$0 \text{ dB} = 21.83 \text{ W/kg} = 13.39 \text{ dB W/kg}$$

**Fig J.5 validation 2450 MHz 250mW**

## 1900 MHz

Date: 6/6/2019

Electronics: DAE4 Sn1525

Medium: Body 1900 MHz

Medium parameters used:  $f = 1900 \text{ MHz}$ ;  $\sigma = 1.540 \text{ mho/m}$ ;  $\epsilon_r = 53.15$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature: 22.5°C Liquid Temperature: 22.3°C

Communication System: CW Frequency: 1900 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(7.82,7.82,7.82)

**System Validation /Area Scan (81x191x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Reference Value =103.41 V/m; Power Drift = 0.07 dB

**Fast SAR: SAR(1 g) = 10.46 W/kg; SAR(10 g) = 5.48 W/kg**

Maximum value of SAR (interpolated) = 17.78 W/kg

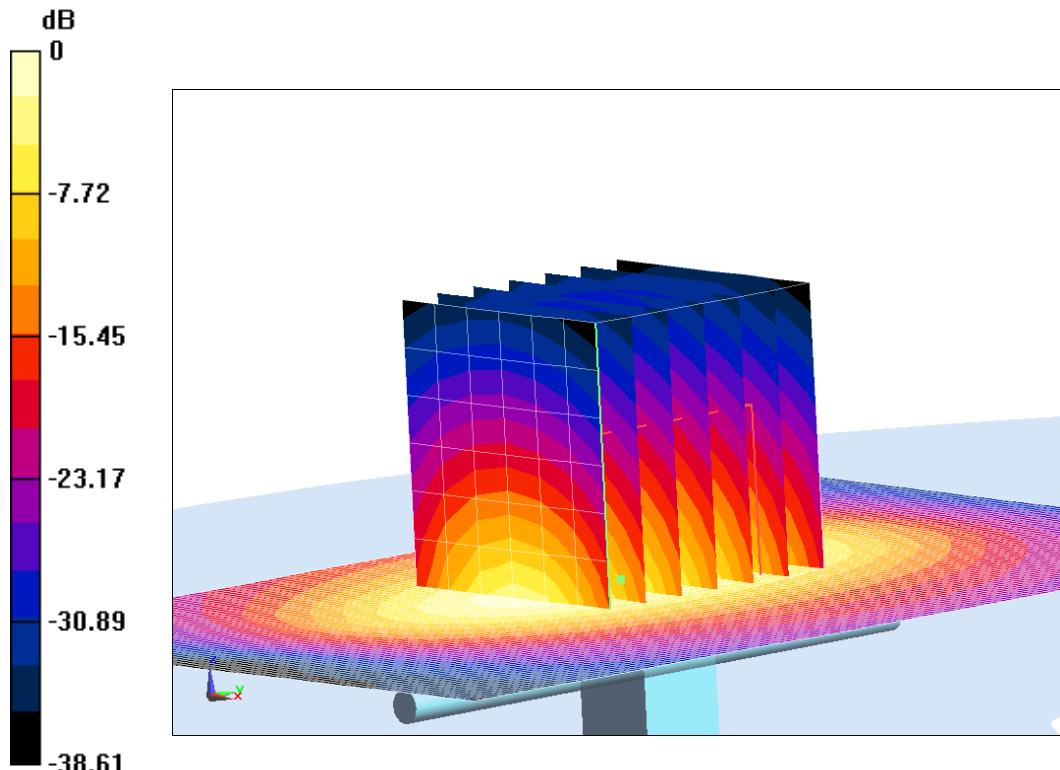
**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =103.41 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 17.91 W/kg

**SAR(1 g) = 10.51 W/kg; SAR(10 g) = 5.50 W/kg**

Maximum value of SAR (measured) = 14.17 W/kg



$$0 \text{ dB} = 14.17 \text{ W/kg} = 11.51 \text{ dB W/kg}$$

**Fig J.6 validation 1900 MHz 250mW**

## 2600 MHz

Date: 6/6/2019

Electronics: DAE4 Sn1525

Medium: Body 2600 MHz

Medium parameters used:  $f = 2600 \text{ MHz}$ ;  $\sigma = 2.143 \text{ mho/m}$ ;  $\epsilon_r = 51.66$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature:  $22.5^\circ\text{C}$  Liquid Temperature:  $22.3^\circ\text{C}$

Communication System: CW Frequency: 2600 MHz Duty Cycle: 1:1

Probe: EX3DV4 – SN7464 ConvF(7.30,7.30,7.30)

**System Validation /Area Scan (81x191x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Reference Value =  $108.81 \text{ V/m}$ ; Power Drift =  $0.09 \text{ dB}$

**Fast SAR: SAR(1 g) = 13.90 W/kg; SAR(10 g) = 6.11 W/kg**

Maximum value of SAR (interpolated) =  $29.85 \text{ W/kg}$

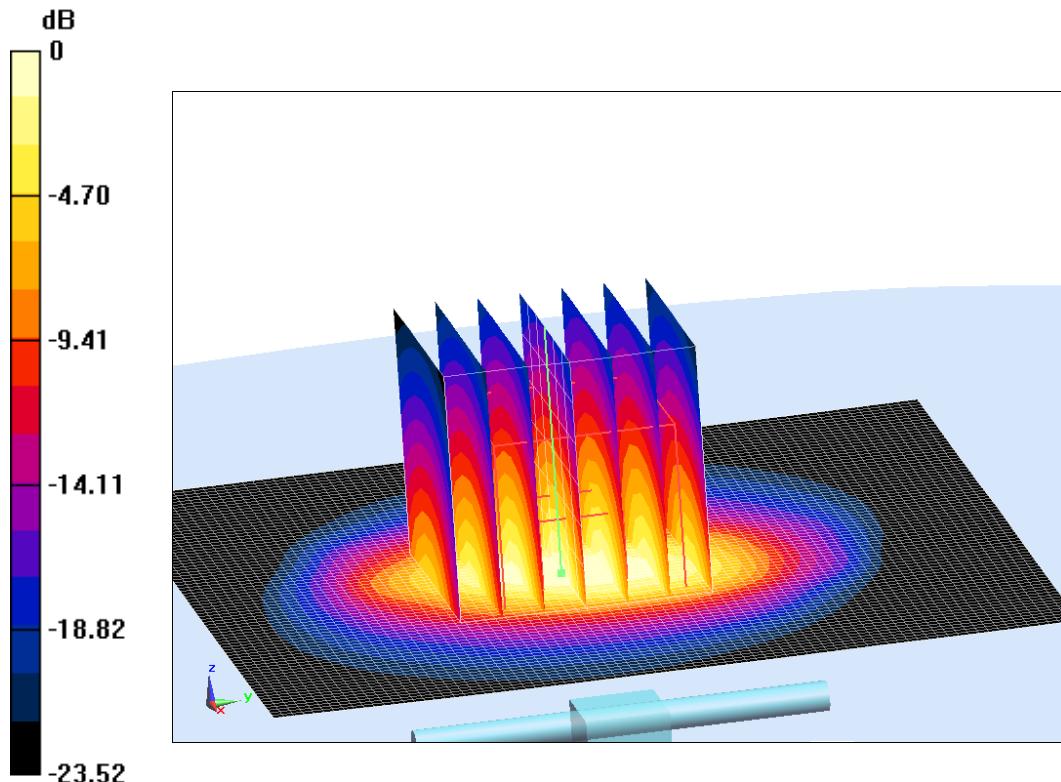
**System Validation /Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value =  $108.81 \text{ V/m}$ ; Power Drift =  $0.09 \text{ dB}$

Peak SAR (extrapolated) =  $30.13 \text{ W/kg}$

**SAR(1 g) = 13.77 W/kg; SAR(10 g) = 6.13 W/kg**

Maximum value of SAR (measured) =  $23.93 \text{ W/kg}$



$0 \text{ dB} = 23.93 \text{ W/kg} = 13.79 \text{ dB W/kg}$

**Fig J.7 validation 2600 MHz 250mW**

**Table J.6-1 Comparison between area scan and zoom scan for system verification**

Date	Band	Position	Area scan (1g)	Zoom scan (1g)	Drift (%)
2019-6-19	2450	Head	12.89	13.18	-2.20
2019-6-6	1900	Body	10.46	10.51	-0.48
2019-6-6	2600	Body	13.9	13.77	0.94



## ANNEX Probe Calibration Certificate



In Collaboration with  
**s p e a g**  
CALIBRATION LABORATORY

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中国认可  
国际互认  
校准  
CALIBRATION  
CNAS L0570

Client

CTTL

Certificate No: Z18-60357

### CALIBRATION CERTIFICATE

Object EX3DV4 - SN:7464

Calibration Procedure(s) FF-Z11-004-01  
Calibration Procedures for Dosimetric E-field Probes

Calibration date: September 30, 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( $22\pm3$ )°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 NRP2	101919	20-Jun-18 (CTTL, No.J18X05032)	Jun-19
Power sensor NRP-Z91	101547	20-Jun-18 (CTTL, No.J18X05032)	Jun-19
Power sensor NRP-Z91	101548	20-Jun-18 (CTTL, No.J18X05032)	Jun-19
Reference10dBAttenuator	18N50W-10dB	09-Feb-18(CTTL, No.J18X01133)	Feb-20
Reference20dBAttenuator	18N50W-20dB	09-Feb-18(CTTL, No.J18X01132)	Feb-20
Reference Probe EX3DV4	SN 3846	25-Jan-18(SPEAG, No.EX3-3846_Jan18)	Jan-19
DAE4	SN 777	15-Dec-17(SPEAG, No.DAE4-777_Dec17)	Dec-18
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
SignalGeneratorMG3700A	6201052605	21-Jun-18 (CTTL, No.J18X05033)	Jun-19
Network Analyzer E5071C	MY46110673	14-Jan-18 (CTTL, No.J18X00561)	Jan-19

Calibrated by:	Name	Function	Signature
	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: October 09, 2018

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



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**Glossary:**

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A,B,C,D	modulation dependent linearization parameters
Polarization $\Phi$	$\Phi$ rotation around probe axis
Polarization $\theta$	$\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i $\theta=0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

**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"

**Methods Applied and Interpretation of Parameters:**

- $NORMx,y,z$ : Assessed for E-field polarization  $\theta=0$  ( $f \leq 900\text{MHz}$  in TEM-cell;  $f > 1800\text{MHz}$ : waveguide).  $NORMx,y,z$  are only intermediate values, i.e., the uncertainties of  $NORMx,y,z$  does not effect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- $NORM(f)x,y,z = NORMx,y,z * frequency\_response$  (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- $DCPx,y,z$ : DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- $Ax,y,z; Bx,y,z; Cx,y,z; VRx,y,z; A, B, C$  are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters*: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800\text{MHz}$ ) and inside waveguide using analytical field distributions based on power measurements for  $f > 800\text{MHz}$ . The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to  $NORMx,y,z * ConvF$  whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50\text{MHz}$  to  $\pm 100\text{MHz}$ .
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the  $NORMx$  (no uncertainty required).



No. I19Z60967-SEM03  
Page 206 of 239



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# Probe EX3DV4

SN: 7464

Calibrated: September 30, 2018

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

Certificate No: Z18-60357

Page 3 of 11



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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7464

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm( $\mu$ V/(V/m) <sup>2</sup> ) <sup>A</sup>	0.46	0.44	0.46	$\pm 10.0\%$
DCP(mV) <sup>B</sup>	100.7	101.4	99.4	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB/ $\mu$ V	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	169.3	$\pm 2.2\%$
		Y	0.0	0.0	1.0		163.1	
		Z	0.0	0.0	1.0		167.0	

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%.

<sup>A</sup> The uncertainties of Norm X, Y, Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 5 and Page 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.