



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China  
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209  
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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3842

### Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz] <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
750	41.9	0.89	9.41	9.41	9.41	0.30	0.90	±12.1%
900	41.5	0.97	9.15	9.15	9.15	0.16	1.37	±12.1%
1750	40.1	1.37	7.89	7.89	7.89	0.23	1.09	±12.1%
1900	40.0	1.40	7.58	7.58	7.58	0.20	1.19	±12.1%
2450	39.2	1.80	6.92	6.92	6.92	0.32	1.16	±12.1%
2600	39.0	1.96	6.78	6.78	6.78	0.40	0.93	±12.1%

<sup>C</sup> Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>F</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3842

### Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz] <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
750	55.5	0.96	9.31	9.31	9.31	0.30	0.90	± 12.1%
900	55.0	1.05	9.02	9.02	9.02	0.24	1.15	± 12.1%
1750	53.4	1.49	7.57	7.57	7.57	0.23	1.12	± 12.1%
1900	53.3	1.52	7.32	7.32	7.32	0.22	1.21	± 12.1%
2450	52.7	1.95	7.01	7.01	7.01	0.42	1.04	± 12.1%
2600	52.5	2.16	6.97	6.97	6.97	0.42	1.01	± 12.1%

<sup>C</sup> Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

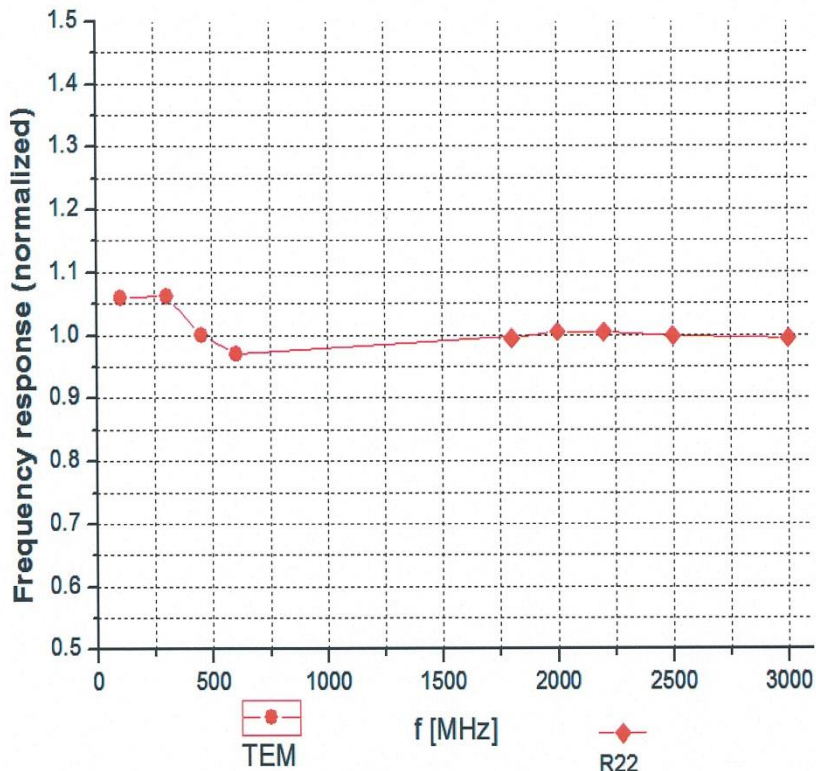
<sup>F</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



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### Frequency Response of E-Field (TEM-Cell: ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field:  $\pm 7.4\%$  (k=2)

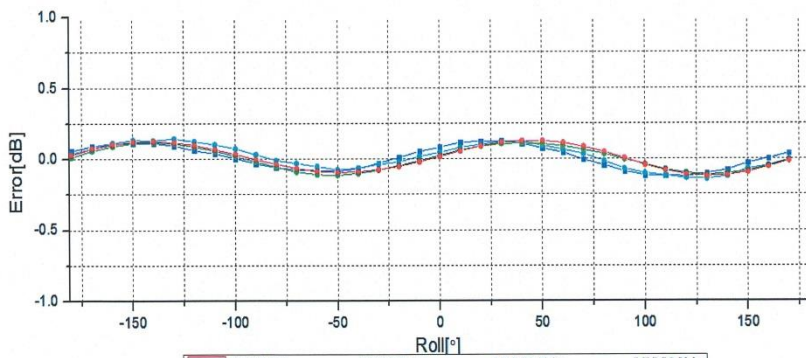
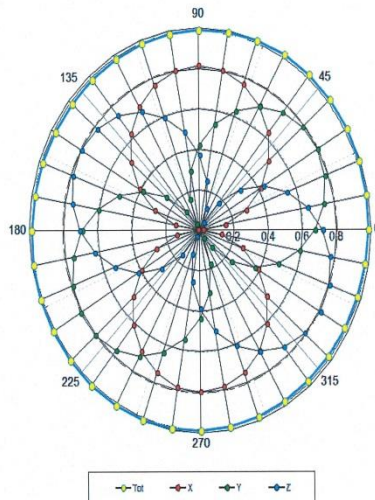
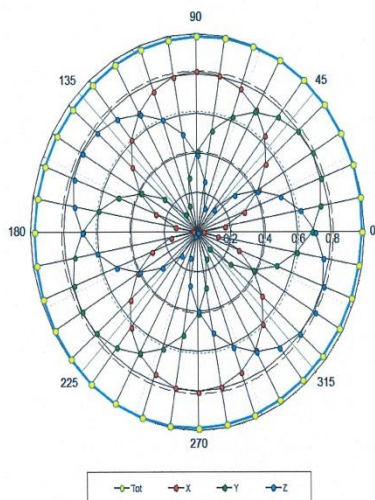


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### Receiving Pattern ( $\Phi$ ), $\theta=0^\circ$

**f=600 MHz, TEM**

**f=1800 MHz, R22**

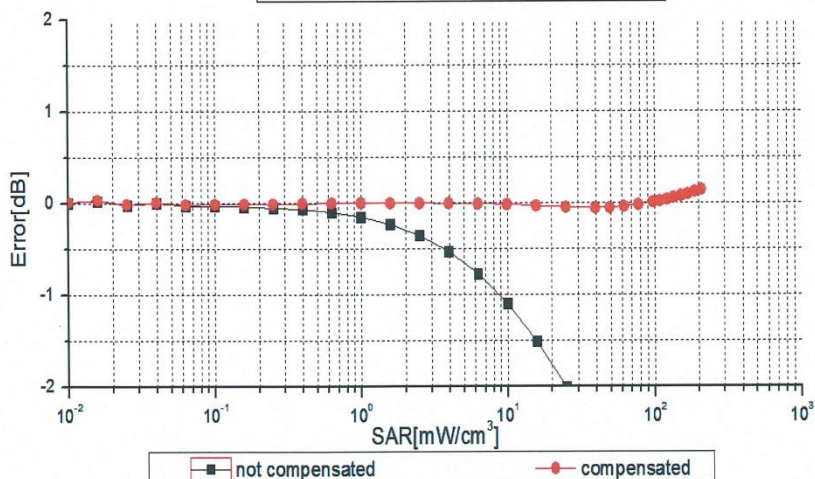
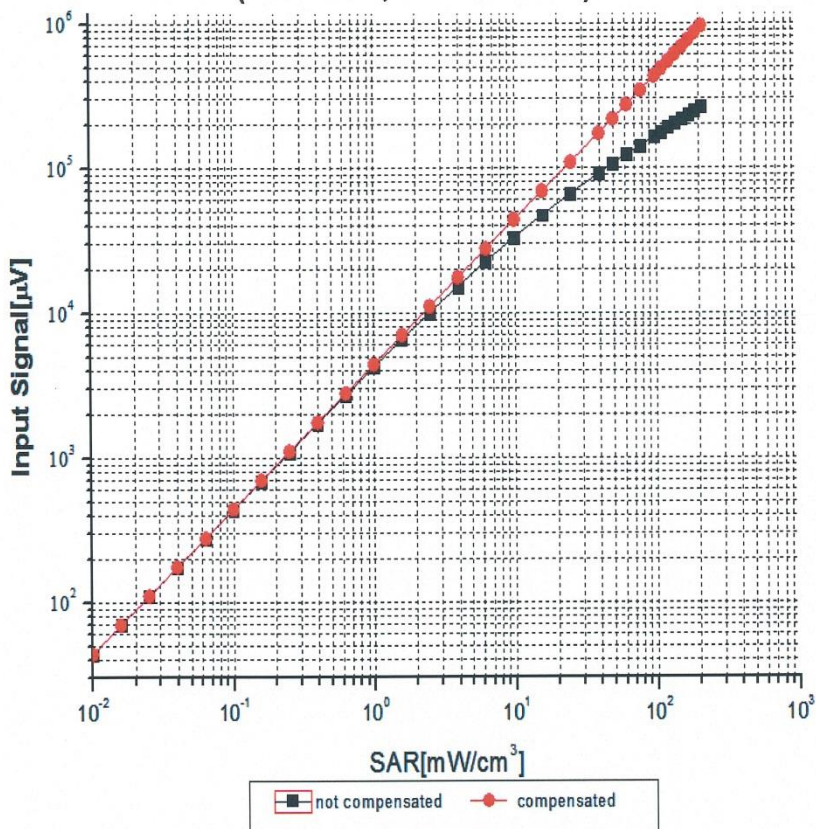


**Uncertainty of Axial Isotropy Assessment:  $\pm 1.2\%$  (k=2)**



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### Dynamic Range f(SAR<sub>head</sub>) (TEM cell, f = 900 MHz)



Uncertainty of Linearity Assessment: ±0.9% (k=2)

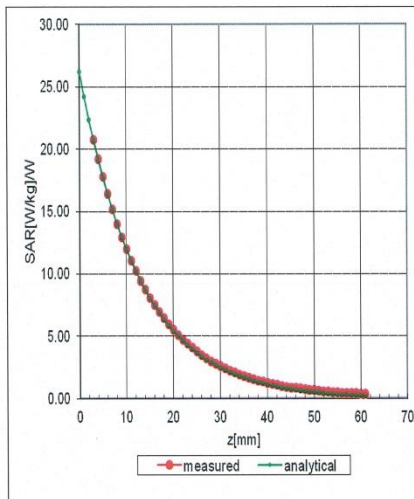
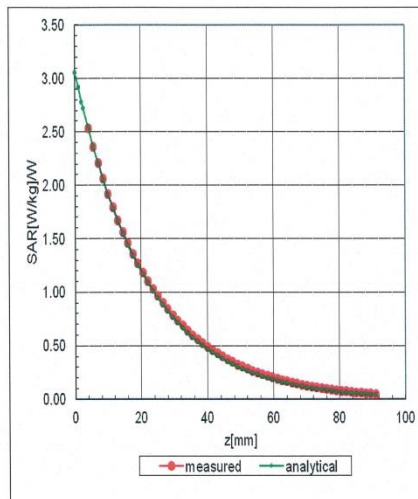


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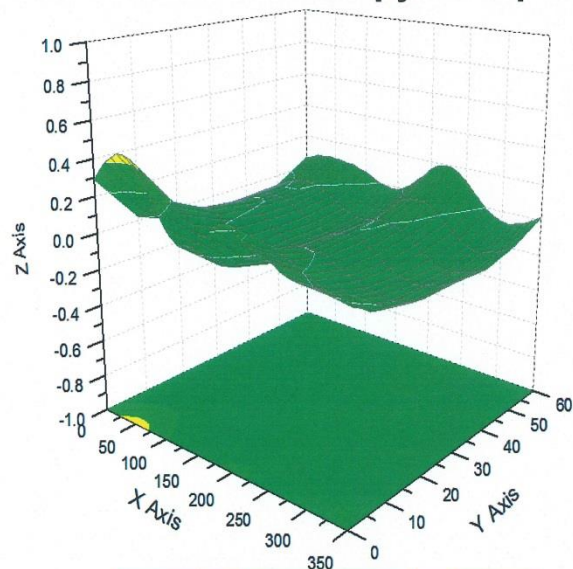
## Conversion Factor Assessment

f=750 MHz, WGLS R9(H\_convF)

f=1750 MHz, WGLS R22(H\_convF)



## Deviation from Isotropy in Liquid



Uncertainty of Spherical Isotropy Assessment:  $\pm 3.2\%$  (K=2)







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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3842

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	67.2
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disable
Probe Overall Length	337mm
Probe Body Diameter	10mm
Tip Length	9mm
Tip Diameter	2.5mm
Probe Tip to Sensor X Calibration Point	1mm
Probe Tip to Sensor Y Calibration Point	1mm
Probe Tip to Sensor Z Calibration Point	1mm
Recommended Measurement Distance from Surface	1.4mm

1.2. D835V2 Dipole Calibration Certificate

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中国认可  
国际互认  
校准  
CALIBRATION  
CNAS L0570

Client: CIQ(Shenzhen) Certificate No: Z16-97016

**CALIBRATION CERTIFICATE**

Object: D835V2 - SN: 4d153

Calibration Procedure(s): FD-Z11-2-003-01  
Calibration Procedures for dipole validation kits



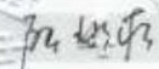
Calibration date: Jun 16, 2016

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 NRP2	101919	01-Jul-15 (CTTL, No.J15X04256)	Jun-16
Power sensor NRP-Z91	101547	01-Jul-15 (CTTL, No.J15X04256)	Jun-16
Reference Probe EX3DV4	SN 7307	19-Feb-16(SPEAG,No.EX3-7307_Feb16)	Feb-17
DAE4	SN 771	02-Feb-16(CTTL-SPEAG,No.Z16-97011)	Feb-17
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	01-Feb-16 (CTTL, No.J16X00893)	Jan-17
Network Analyzer E5071C	MY46110673	26-Jan-16 (CTTL, No.J16X00894)	Jan-17

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Qi Dianyuan	SAR Project Leader	
Approved by:	Lu Bingsong	Deputy Director of the laboratory	

Issued: Jun 17, 2016

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

Certificate No: Z16-97016 Page 1 of 8





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**Glossary:**

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
N/A	not applicable or not measured

**Calibration is Performed According to the Following Standards:**

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "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
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

**Additional Documentation:**

- DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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



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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	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz $\pm$ 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 $\pm$ 0.2) °C	41.0 $\pm$ 6 %	0.89 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °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	2.30 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	9.24 mW / g $\pm$ 20.8 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.50 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	6.02 mW / g $\pm$ 20.4 % (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 $\pm$ 0.2) °C	55.4 $\pm$ 6 %	0.99 mho/m $\pm$ 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	2.43 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	9.57 mW / g $\pm$ 20.8 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	1.61 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	6.36 mW / g $\pm$ 20.4 % (k=2)



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## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.2Ω- 3.11jΩ
Return Loss	- 29.8dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.6Ω- 2.33jΩ
Return Loss	- 27.4dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.508 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**

Date: 06.16.2016

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d154**

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 835 \text{ MHz}$ ;  $\sigma = 0.891 \text{ S/m}$ ;  $\epsilon_r = 40.97$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

**DASY5 Configuration:**

- Probe: EX3DV4 - SN7307; ConvF(10.01, 10.01,10.01); Calibrated: 2/19/2016;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2016-02-02
- 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)

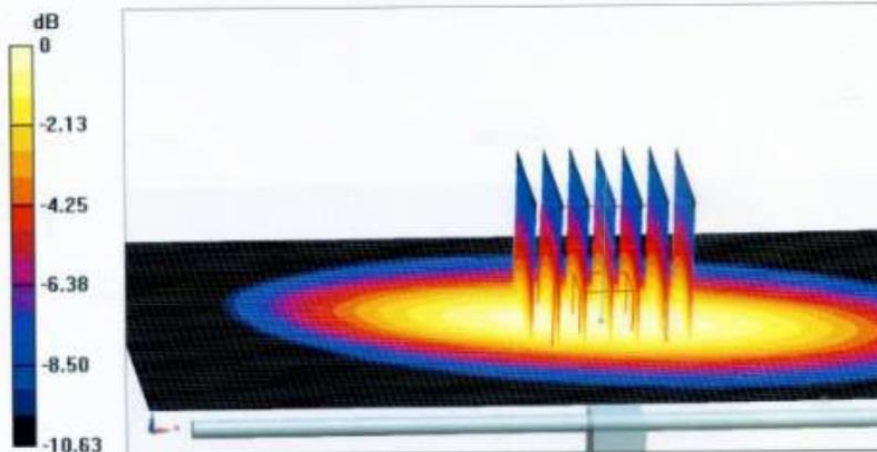
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.14V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 3.41 W/kg

**SAR(1 g) = 2.3 W/kg; SAR(10 g) = 1.5 W/kg**

Maximum value of SAR (measured) = 2.91 W/kg

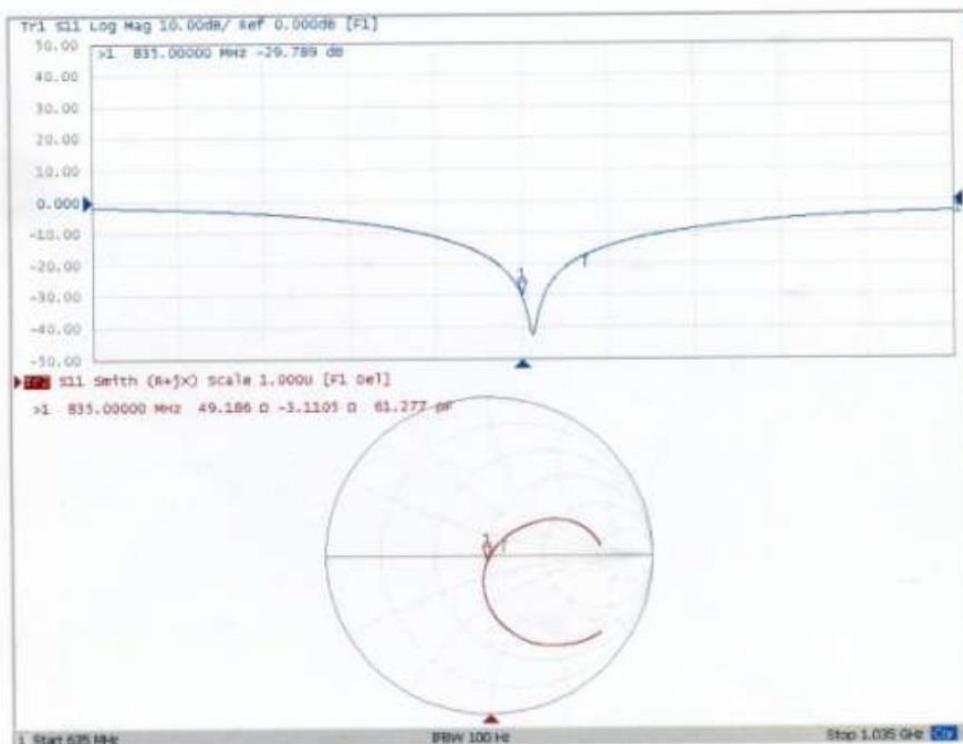




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**Impedance Measurement Plot for Head TSL**





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**DASY5 Validation Report for Body TSL**

Date: 06.16.2016

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d154**

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.991$  S/m;  $\epsilon_r = 55.41$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Center Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(9.83,9.83, 9.83); Calibrated: 2/19/2016;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2016-02-02
- 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)

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

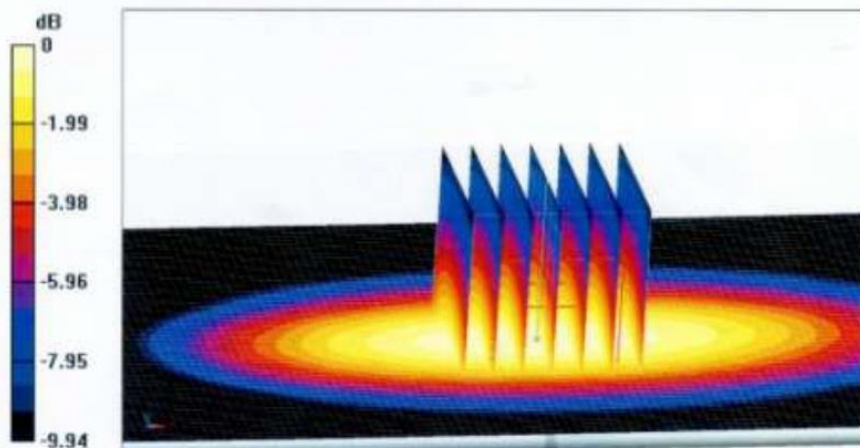
dy=5mm, dz=5mm

Reference Value = 54.01 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 3.53 W/kg

**SAR(1 g) = 2.43 W/kg; SAR(10 g) = 1.61 W/kg**

Maximum value of SAR (measured) = 3.04 W/kg

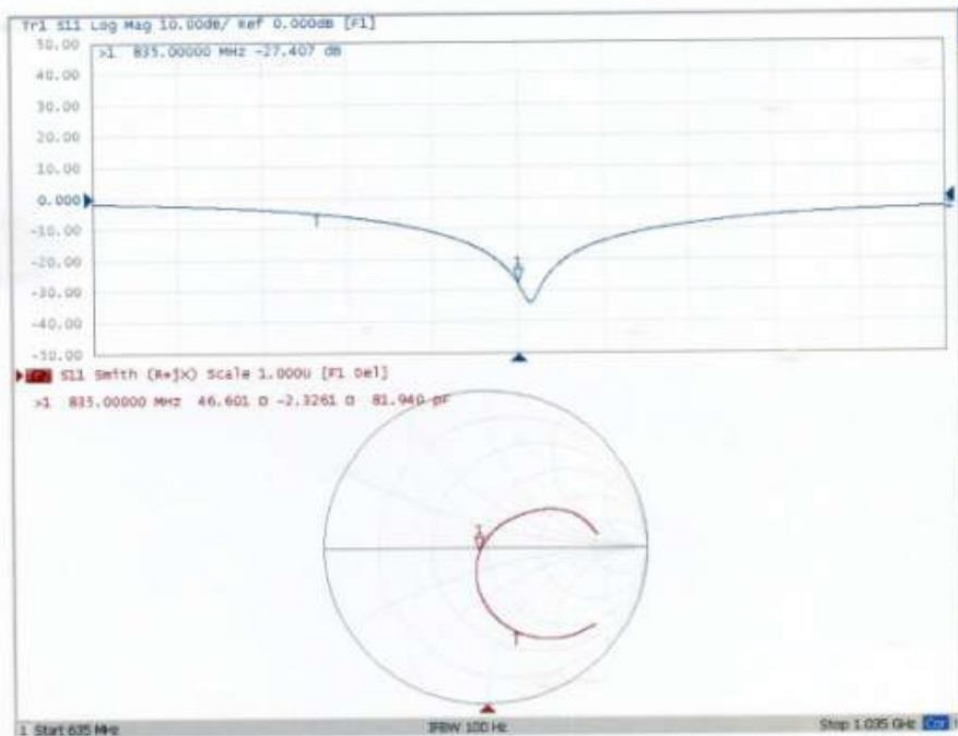


0 dB = 3.04 W/kg = 4.83 dBW/kg



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**Impedance Measurement Plot for Body TSL**



## Extended Dipole Calibrations

Referring to KDB865664 D01, if dipoles are verified in return loss ( $< -20\text{dB}$ , 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.

Head						
Date of measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary impedance (ohm)	Delta (ohm)
2016-06-16	-29.80		49.20		3.11	
2017-06-15	-29.86	-0.69	50.03	0.83	3.28	0.17

Body						
Date of measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary impedance (ohm)	Delta (ohm)
2016-06-16	-27.40		46.60		2.33	
2017-06-15	-27.33	0.81	46.09	-0.51	2.12	0.21

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



### 1.3. D1900V2 Dipole Calibration Certificate

**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)  
The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **CIQ(Auden)**

Certificate No: **D1900V2-5d101\_Jul15**

CALIBRATION CERTIFICATE																																															
Object	D1900V2 - SN: 5d101																																														
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz																																														
Calibration date:	July 23, 2015																																														
<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 (22 ± 3)°C and humidity &lt; 70%.</p> <p>Calibration Equipment used (M&amp;TE critical for calibration)</p> <table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date (Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power meter EPM-442A</td> <td>GB37480704</td> <td>07-Oct-14 (No. 217-02020)</td> <td>Oct-15</td> </tr> <tr> <td>Power sensor HP 8481A</td> <td>US37292783</td> <td>07-Oct-14 (No. 217-02020)</td> <td>Oct-15</td> </tr> <tr> <td>Power sensor HP 8481A</td> <td>MY41092317</td> <td>07-Oct-14 (No. 217-02021)</td> <td>Oct-15</td> </tr> <tr> <td>Reference 20 dB Attenuator</td> <td>SN: 5058 (20k)</td> <td>01-Apr-15 (No. 217-02131)</td> <td>Mar-16</td> </tr> <tr> <td>Type-N mismatch combination</td> <td>SN: 5047.2 / 06327</td> <td>01-Apr-15 (No. 217-02134)</td> <td>Mar-16</td> </tr> <tr> <td>Reference Probe ES3DV3</td> <td>SN: 3205</td> <td>30-Dec-14 (No. ES3-3205_Dec14)</td> <td>Dec-15</td> </tr> <tr> <td>DAE4</td> <td>SN: 601</td> <td>18-Aug-14 (No. DAE4-601_Aug14)</td> <td>Aug-15</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Secondary Standards</th> <th>ID #</th> <th>Check Date (in house)</th> <th>Scheduled Check</th> </tr> </thead> <tbody> <tr> <td>RF generator R&amp;S SMT-06</td> <td>100005</td> <td>04-Aug-99 (in house check Oct-13)</td> <td>In house check: Oct-16</td> </tr> <tr> <td>Network Analyzer HP 8753E</td> <td>US37390585 S4206</td> <td>18-Oct-01 (in house check Oct-14)</td> <td>In house check: Oct-15</td> </tr> </tbody> </table>				Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15	Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15	Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15	Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16	Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16	Reference Probe ES3DV3	SN: 3205	30-Dec-14 (No. ES3-3205_Dec14)	Dec-15	DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-15	Secondary Standards	ID #	Check Date (in house)	Scheduled Check	RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16	Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15
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Calibrated by:	Name Michael Weber	Function Laboratory Technician	Signature 																																												
Approved by:	Name Katja Pokovic	Function Technical Manager																																													
Issued: July 23, 2015																																															
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.																																															

**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)  
The Swiss Accreditation Service is one of the signatories to the EA  
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, "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%.

**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	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	39.7 ± 6 %	1.38 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	10.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>40.7 W/kg ± 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>21.5 W/kg ± 16.5 % (k=2)</b>

**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	52.7 ± 6 %	1.54 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	10.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>40.4 W/kg ± 17.0 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.47 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>21.7 W/kg ± 16.5 % (k=2)</b>

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

**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	50.7 $\Omega$ + 5.7 j $\Omega$
Return Loss	- 24.9 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	47.4 $\Omega$ + 5.8 j $\Omega$
Return Loss	- 23.6 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.203 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	March 28, 2008

**DASY5 Validation Report for Head TSL**

Date: 23.07.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d101**

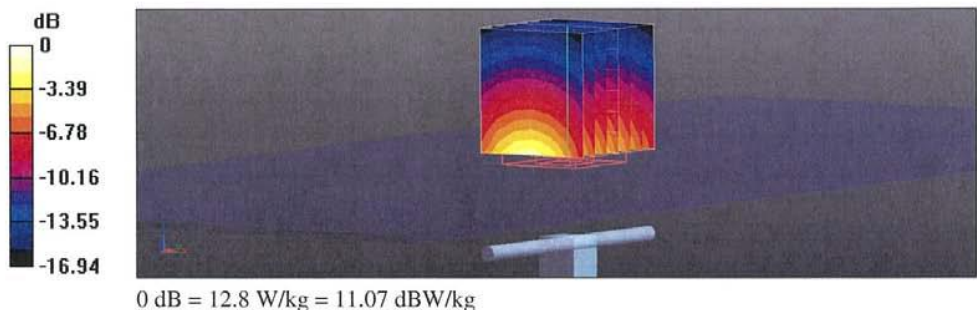
Communication System: UID 0 - CW; Frequency: 1900 MHz  
Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.38$  S/m;  $\epsilon_r = 39.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

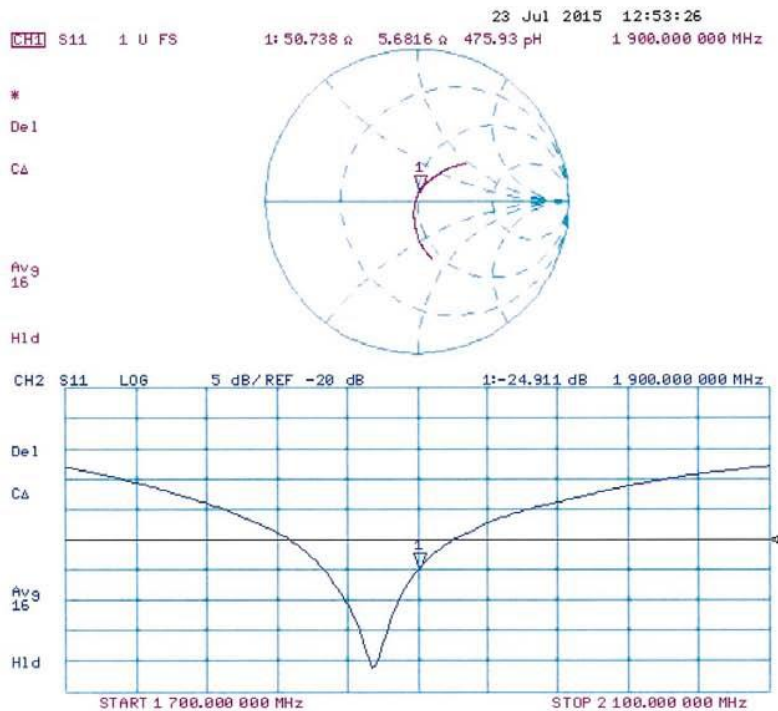
- Probe: ES3DV3 - SN3205; ConvF(5, 5, 5); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

**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 = 98.88 V/m; Power Drift = 0.02 dB  
Peak SAR (extrapolated) = 18.2 W/kg  
**SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.34 W/kg**  
Maximum value of SAR (measured) = 12.8 W/kg



Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 23.07.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d101**

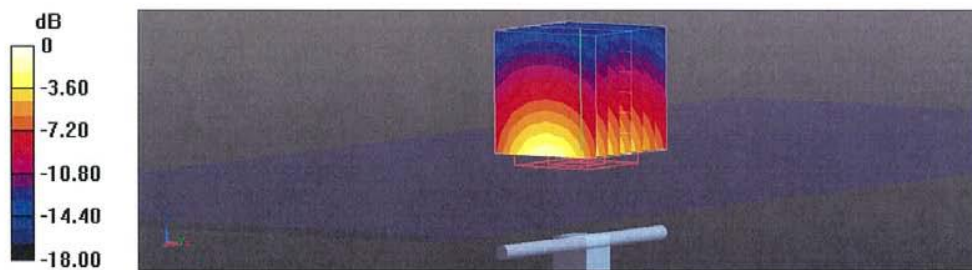
Communication System: UID 0 - CW; Frequency: 1900 MHz  
Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.54$  S/m;  $\epsilon_r = 52.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.65, 4.65, 4.65); Calibrated: 30.12.2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

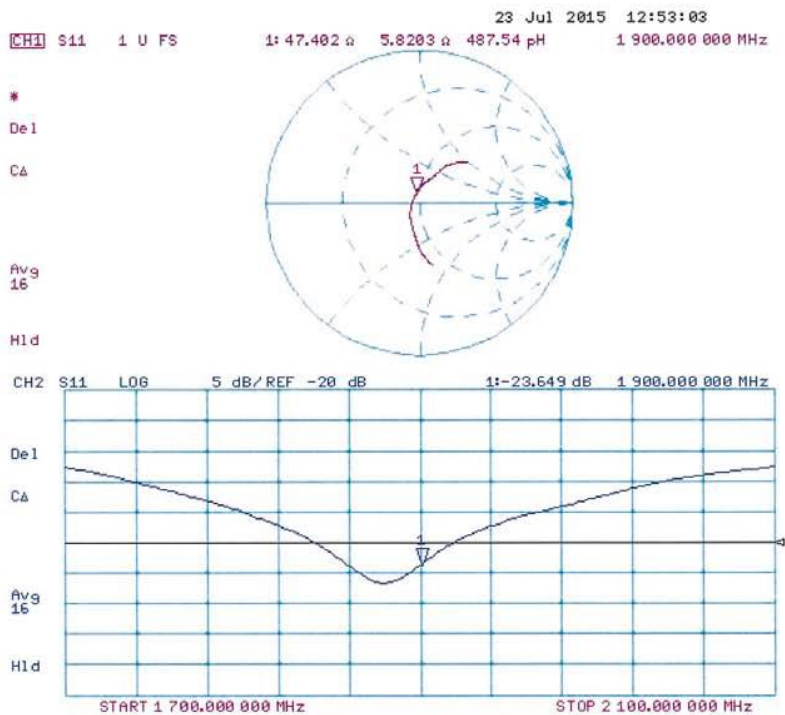
**Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**

Measurement grid: dx=5mm, dy=5mm, dz=5mm  
Reference Value = 95.76 V/m; Power Drift = -0.01 dB  
Peak SAR (extrapolated) = 17.1 W/kg  
**SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.47 W/kg**  
Maximum value of SAR (measured) = 12.7 W/kg



0 dB = 12.7 W/kg = 11.04 dBW/kg

Impedance Measurement Plot for Body TSL





## Extended Dipole Calibrations


Referring to KDB865664 D01, if dipoles are verified in return loss ( $<-20\text{dB}$ , 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.

Head						
Date of measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary impedance (ohm)	Delta (ohm)
2015-07-23	-24.90		50.7		5.7	
2016-07-22	-24.70	2.33	52.1	1.4	5.2	-0.5
2017-07-22	-24.58	3.75	51.6	0.9	5.4	-0.3

Body						
Date of measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary impedance (ohm)	Delta (ohm)
2015-07-23	-23.6		47.4		5.8	
2016-07-22	-23.7	-1.14	48.5	1.1	5.2	-0.6
2017-07-22	-23.2	4.71	48.1	0.7	5.3	-0.5


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

1.4. D2450V2 Dipole Calibration Certificate



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

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E-mail: cttl@chinattl.com Http://www.chinattl.cn



CALIBRATION  
No. L0570

Client **CIQ-SZ(Auden)** Certificate No: **Z15-97070**

**CALIBRATION CERTIFICATE**

Object: **D2450V2 - SN: 884**

Calibration Procedure(s): **TMC-OS-E-02-194**  
**Calibration procedure for dipole validation kits**

Calibration date: **September 1, 2015**

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.

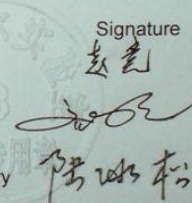
All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRVD	102083	11-Sep-14 (TMC, No.JZ13-443)	Sep-15
Power sensor NRV-Z5	100595	11-Sep-14 (TMC, No. JZ13-443)	Sep -15
Reference Probe ES3DV3 DAE3	SN 3149	5- Sep-14 (SPEAG, No.ES3-3149_Sep13)	Sep-15
	SN 536	23-Jan-15 (SPEAG, DAE3-536_Jan14)	Jan -16
Signal Generator E4438C	MY49070393	13-Nov-14 (TMC, No.JZ13-394)	Nov-15
Network Analyzer E8362B	MY43021135	19-Oct-14 (TMC, No.JZ13-278)	Oct-15

	Name	Function
Calibrated by:	Zhao Jing	SAR Test Engineer
Reviewed by:	Qi Dianyuan	SAR Project Leader
Approved by:	Lu Bingsong	Deputy Director of the laboratory

Signature

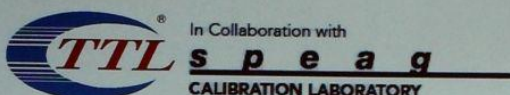


Issued: September 4, 2015

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Certificate No: Z15-97070

Page 1 of 8



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**Glossary:**

TSL tissue simulating liquid  
 ConvF sensitivity in TSL / NORM<sub>x,y,z</sub>  
 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) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

**Additional Documentation:**

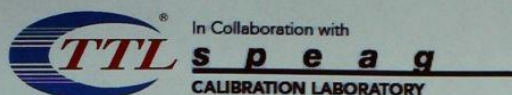
- d) DASY4/5 System Handbook

**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%.

Appendix A: Calibration Certificate



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**Measurement Conditions**

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

DASY Version	DASY52	52.8.8.1222
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

**Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.2 ± 6 %	1.84 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °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	13.1 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	52.1 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	6.17 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	24.6 mW / g ± 20.4 % (k=2)

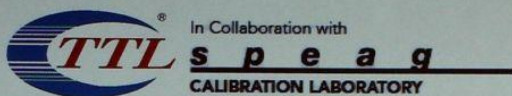
**Body TSL parameters**

The following parameters and calculations were applied.

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

**SAR result with Body TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.1 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	51.6 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	6.11 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	24.2 mW / g ± 20.4 % (k=2)



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**Appendix**

**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	58.3Ω- 0.76jΩ
Return Loss	- 22.3dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	58.1Ω+ 2.61jΩ
Return Loss	- 22.1dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.224 ns
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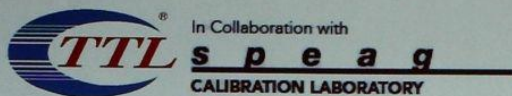
After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

**Additional EUT Data**

Manufactured by	SPEAG
-----------------	-------



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**DASY5 Validation Report for Head TSL**

Date: 01.09.2015

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 884**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.84$  S/m;  $\epsilon_r = 40.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3149; ConvF(4.48, 4.48, 4.48); Calibrated: 2014-09-05;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn536; Calibrated: 2015-01-23
- 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 (7331)

**System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW,**

**dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:**

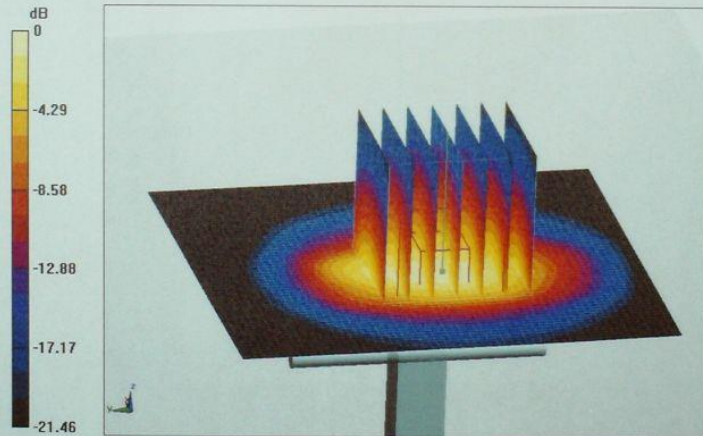
dx=5mm, dy=5mm, dz=5mm

Reference Value = 99.491 V/m; Power Drift = -0.03 dB

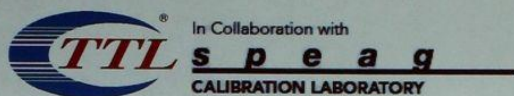
Peak SAR (extrapolated) = 26.6 W/kg

**SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.17 W/kg**

Maximum value of SAR (measured) = 17.1 W/kg



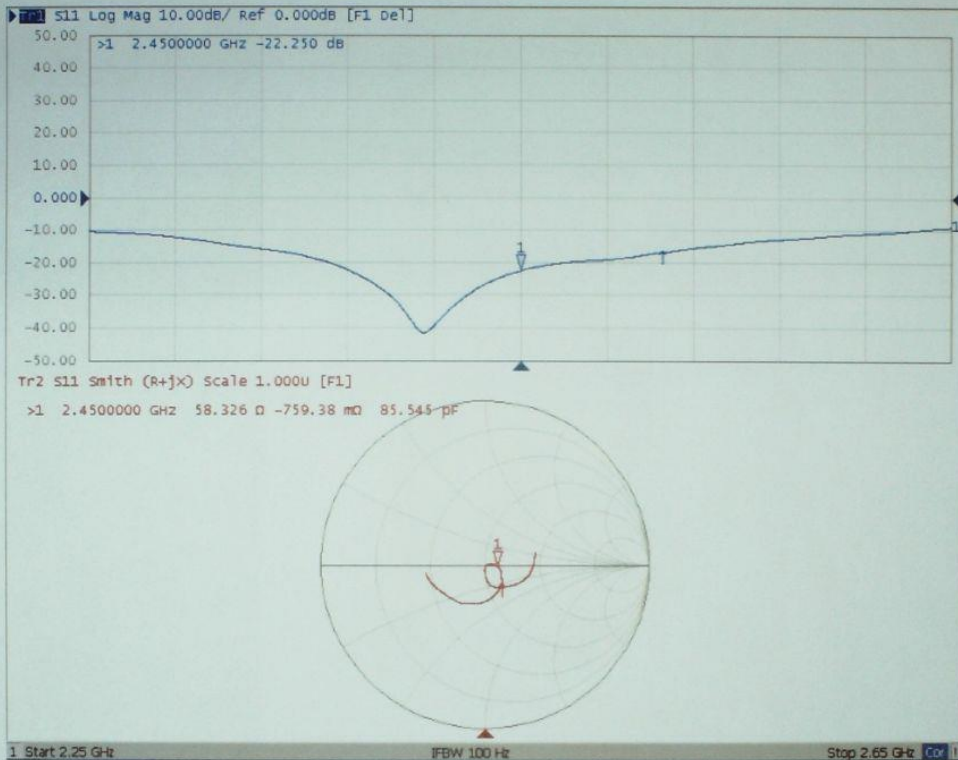
0 dB = 17.1 W/kg = 12.33 dBW/kg

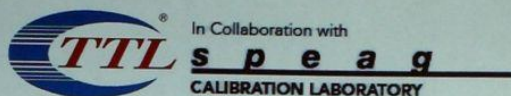


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Impedance Measurement Plot for Head TSL





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**DASY5 Validation Report for Body TSL**

Date: 01.09.2015

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 884**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.988$  S/m;  $\epsilon_r = 51.25$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Center Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ES3DV3 - SN3149; ConvF(4.21, 4.21, 4.21); Calibrated: 2014-09-03;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn536; Calibrated: 2015-01-23
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/2
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:**

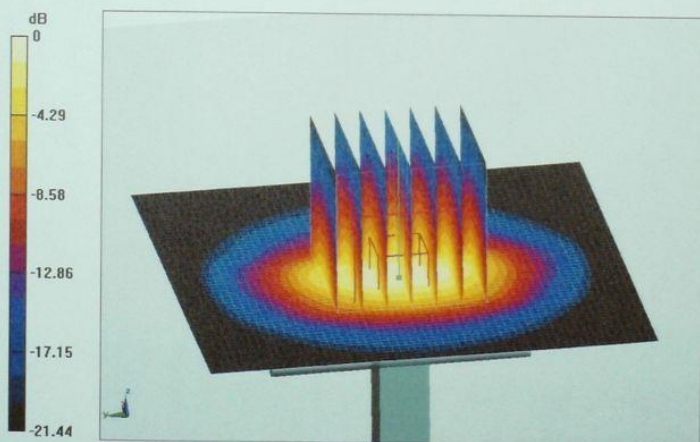
dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.180 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 27.6 W/kg

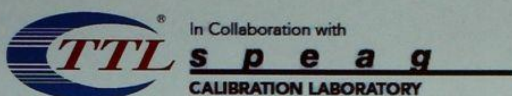
**SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.11 W/kg**

Maximum value of SAR (measured) = 17.4 W/kg



**0 dB = 17.4 W/kg = 12.41 dBW/kg**

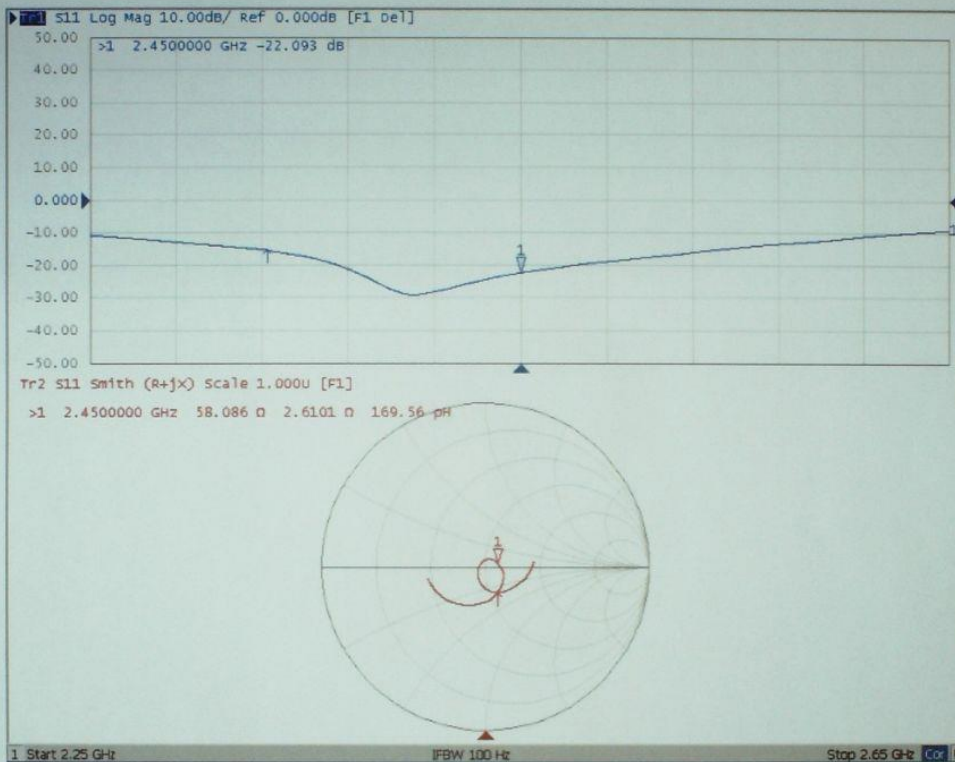




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Impedance Measurement Plot for Body TSL



## Extended Dipole Calibrations

Referring to KDB865664 D01, if dipoles are verified in return loss ( $<-20\text{dB}$ , 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.

Head						
Date of measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary impedance (ohm)	Delta (ohm)
2015-09-01	-22.3		58.3		-0.76	
2016-08-31	-21.8	2.24	58.5	0.2	-0.68	0.08

Body						
Date of measurement	Return-loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary impedance (ohm)	Delta (ohm)
2015-09-01	-22.1		58.1		2.61	
2016-08-31	-21.5	2.71	59.0	0.9	2.36	-0.25

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

1.5. DAE4 Calibration Certificate



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中国认可  
 国际互认  
 校准  
 CALIBRATION  
 CNAS L0570

Client : **CIQ(Shenzhen)**

Certificate No: **Z17-97109**

**CALIBRATION CERTIFICATE**

Object: **DAE4 - SN: 1315**

Calibration Procedure(s): **FF-Z11-002-01**  
 Calibration Procedure for the Data Acquisition Electronics (DAEx)

Calibration date: **August 15, 2017**

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
Process Calibrator 753	1971018	27-Jun-17 (CTTL, No.J17X05859)	June-18

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

Issued: August 16, 2017

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



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**Glossary:**

DAE 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 report provide only calibration results for DAE, it does not contain other performance test results.



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**DC Voltage Measurement**

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV, 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	405.175 ± 0.15% (k=2)	405.013 ± 0.15% (k=2)	404.971 ± 0.15% (k=2)
Low Range	3.99087 ± 0.7% (k=2)	3.98644 ± 0.7% (k=2)	3.98913 ± 0.7% (k=2)

**Connector Angle**

Connector Angle to be used in DASY system	20.5° ± 1 °
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