

## Appendix D. Probe Calibration Data

国家无线电监测中心检测中心  
The State Radio monitoring center Testing Center

## 校准证书

## Calibration Certificate



器具名称 电场探头 E-Field Probe  
Instrument

型号/规格 EX3DV4  
Type/Model

生产厂家 Schmid & Partner Engineering AG  
Manufacturer

出厂编号 SN:3710  
Serial No.

客户名称 快特电波科技(苏州)有限公司  
Name of Client

客户地址 苏州工业园区娄葑高新技术开发区宏业路 99 号  
Address of Client

校准日期 2011.2.25  
Calibration Date

所有的校准工作都是在屏蔽实验室中完成: 环境温度 (22±3) °C 湿度<70%  
All calibrations have been conducted in the closed laboratory facility: environment  
temperature (22±3) °C and humidity<70%

授权签字人:

Approved by



地址: 北京市西城区北礼士路 80 号  
Add: No.80 Bei Lishi Road, Xi Cheng District Beijing 100037, P.R.China

电话 Tel: +86-10-68009202 68009203  
传真 Fax: +86-10-68009205 68009195

第 1 页 共 7 页 证书编号 Certificate No.SRTC2011-CAL002-001

国家无线电监测中心检测中心  
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校准规范 Reference documents of the measurement(Code, Name)

SRMC3003-V2.0.0 比吸收率(SAR) 测试系统校准规范

校准环境及地点 Place and environmental condition of the measurement

温度 Temperature 23.2°C 湿度 Humidity 32.5 %

地点 Location SRTC room 226

主要校准设备 Primary Calibration Equipment used	型号 Model/Type	序列号 ID#	校准日期 Cal Date	校准有效期至 Scheduled Calibration
功率计 Power meter	E4417A	SN: MY45101004	2010.8	2011.8
功率传感器 Power sensor	E9300B	SN: MY41496001	2010.8	2011.8
功率传感器 Power sensor	E9300B	SN: MY41496003	2010.8	2011.8
参考 DAE Reference DAE	DAE4	SN: 720	2011.1	2012.1
信号源 Signal generator	SML03	SN:103514	2010.8	2011.8
网络分析仪 Network analyzer	8714ET	SN:US40372083	2010.8	2011.8
次要校准设备 Secondary Calibration Equipment	型号 Model/Type	序列号 ID#		
波导 Waveguide	WGLS R9	SN:1006		
波导 Waveguide	WGLS R14	SN:1003		
波导 Waveguide	WGLS R22	SN:1006		

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注:

1. 所使用的校准系统和计量标准可溯源到国家基准或标准。

测量和置信区间的不确定度都是证书的一部分，并将在以下内容中给出。

**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.**

2. 除非拥有本实验室的书面许可，否则不得复制该校准证书。

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

3. 我中心仅对加盖“国家无线电监测中心检验中心”章的完整证书负责

**SRTC is responsible for the whole of certificate only with stamp of SRTC.**

4. 本证书的校准结果仅对所校准的计量器具有效

**The calibration results would be valid only for the items calibration.**

5. 本证书中英文两种语言表达，准确含义以中文为准。

**The certification is written by Chinese and English. Exact meaning should be explained only on Chinese version.**

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## 备注

**Glossary**

TSL	模拟组织液 tissue simulating liquid
NORMx, y, z	自由空间灵敏度 sensitivity in free space
ConvF	模拟组织液中的灵敏度/自由空间的灵敏度 sensitivity in TSL/NORM x, y, z
DCP	二极管压缩点 diode compression point
角度 $\varphi$	沿探头轴向旋转 $\varphi$ $\varphi$ rotation around probe axis
角度 $\theta$	沿探头法平面中的一个轴旋转 $\theta$ , 例如 $\theta=0$ , 代表垂直于探头轴向 $\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta=0$ is normal to probe axis

本校准证书中使用的方法参考如下标准

**Calibration is preformed according to the Following Standards**

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in Human Head from Wireless Communication Devices: Measurement Techniques", December 2003
- 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) Federal Communication Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

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方法及参数介绍

**Methods Applied and Interpretation of Parameters**

- NORMx, y, z: NORMx, y, z 是中间变量, 其不确定度不影响 TSL 中电场强度的不确定度。  
NORM x, y, z are only intermediate value, i.e., the uncertainties of NORM x, y, z does not effect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF)
- NORM(f)x, y, z= NORMx, y, z\*频率响应。在 DASY4.2 以后的版本中, 这项工作由软件完成, 频率响应的不确定度包含在 ConvF 的不确定度中。  
NORM(f) x, y, z= NORM x, y, z\*frequency response (see Frequency Response Chart ). This linearization is implemented in DASY4 software version later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCPx,y,z: DCP 是与探头的线性度相关的参数, 其测试是基于功率扫描的方法进行的, 另外 DCP 既不依赖于频率也不依赖于介质。  
DCP x, 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.
- ConvF 和边界效应: 当频率大于 800MHz 时, 利用平坦模型中的电场或是波导中的人工电场进行测试。我们也利用相同的配置来得到边界效应的相关参数 (alpha, depth)。DASY 软件的这项功能可以用来补偿测试中发生的边界效应, 使在边界附近测试的时候能够更加准确。而 ConvFx,y,z=NORMx, y, z\*ConvF。DASY4.4 以后的版本允许的频率扩展范围为±50MHz 到±100MHz。  
ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Stand for f≤800MHz) and inside waveguide using analytical field distributions based on power measurement for f>800MHz .The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given .These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL 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 ±50MHz to ±100 MHz.
- 各向同性: 探头暴露在平板天线和一个平面模型产生的电场中, 这个电场的梯度较低。  
Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.

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测试条件

**Measurement Conditions**

DASY 版本 DASY Version	DSAY 5	V52.2.0.163
模型 Phantom	Flat phantom	—

探头敏感度参数

**Probe Sensitivity Parameters**

	数值 Value	单位 Unit
X 轴	1.00	$\mu V/(V/m)^2$
Y 轴	1.00	$\mu V/(V/m)^2$
Z 轴	1.00	$\mu V/(V/m)^2$

1. 二极管压缩点

**Diode Compression Point**

	数值 Value	单位 Unit	不确定度 Uncertainty ( $k = 2$ )
X 轴	98.60	mV	10.82%
Y 轴	97.38	mV	10.82%
Z 轴	99.74	mV	10.82%

2. 转换因子: 头部 TSL

**Probe Conversion Factors: Head Tissue Liquid**

频率(MHz) Frequency	频率范围 Validity (MHz)	介电常数 Permittivity	导电率 Conductivity	Alpha	Depth	ConvFx/ ConvFy/ ConvFz $\mu V/(V/m)^2$	不确定度 Uncertainty ( $k = 2$ )		
850	$\pm 100$	41.56	0.9106	0.395	0.882	3.843	4.303	4.435	13.02%
900	$\pm 100$	41.24	0.9487	0.337	0.974	3.913	4.377	4.502	13.02%
1800	$\pm 100$	39.21	1.348	0.156	1.648	3.784	4.193	4.328	13.02%
1900	$\pm 100$	38.75	1.450	0.178	1.515	3.609	4.015	4.146	13.02%
2450	$\pm 100$	38.23	1.982	0.126	1.725	3.214	3.653	3.661	13.02%

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## 3. 转换因子: 腹部 TSL

## Probe Conversion Factors: Body Tissue Liquid

频率(MHz) Frequency	频率范围 Validity (MHz)	介电常数 Permittivity	导电率 Conductivity	Alpha	Depth	ConvFx/ ConvFy/ ConvFz $\mu V/(V/m)^2$	不确定度 Uncertainty (k = 2)
850	±100	55.36	1.004	0.459	0.807	4.438	4.985
900	±100	54.48	1.055	0.378	0.863	4.530	5.101
1800	±100	52.83	1.501	0.152	1.732	4.333	4.832
1900	±100	52.43	1.615	0.183	1.491	4.193	4.677
2450	±100	52.95	1.911	0.137	1.758	3.702	4.126
						4.265	4.265
						13.02%	13.02%

## 4. 各向同向性

## Probe Isotropy

	数值 Value	单位 Unit	不确定度 Uncertainty (k = 2)
轴向各向同向性 Axial Isotropy	0.157	dB	10.18%
球面各向同向性 Spherical Isotropy	0.125	dB	10.18%

校准员 张军 远  
Calibrated by

核验员 王 鹏  
Checked by

## Appendix E. Dipole Calibration Data

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



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
**C** 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 108

Client Quietek (Auden)

Certificate No: D835V2-4d094\_Mar10

### CALIBRATION CERTIFICATE

Object D835V2 - SN: 4d094

Calibration procedure(s)  
QA CAL-05.v7  
Calibration procedure for dipole validation kits

Calibration date: March 15, 2010

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 (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	06-Oct-09 (No. 217-01086)	Oct-10
Power sensor HP 8481A	US37292783	06-Oct-09 (No. 217-01086)	Oct-10
Reference 20 dB Attenuator	SN: 5086 (20g)	31-Mar-09 (No. 217-01025)	Mar-10
Type-N mismatch combination	SN: 5047.2 / 06327	31-Mar-09 (No. 217-01029)	Mar-10
Reference Probe ES3DV3	SN: 3205	26-Jun-09 (No. ES3-3205_Jun09)	Jun-10
DAE4	SN: 601	02-Mar-10 (No. DAE4-601_Mar10)	Mar-11
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-09)	In house check; Oct-11
RF generator R&S SMT-06	100005	4-Aug-99 (in house check Oct-09)	In house check; Oct-11
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-09)	In house check; Oct-10

Calibrated by: Name Dimce Iliev Function Laboratory Technician

Approved by: Name Katja Pokovic Function Technical Manager

Issued: March 15, 2010

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 108

**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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- 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) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**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.

**Measurement Conditions**

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

<b>DASY Version</b>	DASY5	V5.2
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom V4.9	
<b>Distance Dipole Center - TSL</b>	15 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	835 MHz $\pm$ 1 MHz	

**Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	41.5	0.90 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	42.9 $\pm$ 6 %	0.91 mho/m $\pm$ 6 %
<b>Head TSL temperature during test</b>	(21.5 $\pm$ 0.2) °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	2.43 mW / g
SAR normalized	normalized to 1W	9.72 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	9.70 mW / g $\pm$ 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	1.58 mW / g
SAR normalized	normalized to 1W	6.32 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	6.30 mW / g $\pm$ 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	55.2	0.97 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	55.3 ± 6 %	1.01 mho/m ± 6 %
<b>Body TSL temperature during test</b>	(21.3 ± 0.2) °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	2.55 mW / g
SAR normalized	normalized to 1W	10.2 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>9.90 mW / g ± 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	1.67 mW / g
SAR normalized	normalized to 1W	6.68 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>6.53 mW / g ± 16.5 % (k=2)</b>

**Appendix****Antenna Parameters with Head TSL**

Impedance, transformed to feed point	52.2 $\Omega$ - 2.7 $j\Omega$
Return Loss	- 29.4 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	48.0 $\Omega$ - 4.8 $j\Omega$
Return Loss	- 25.5 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.388 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.  
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	September 15, 2009

**DASY5 Validation Report for Head TSL**

Date/Time: 08.03.2010 10:52:27

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d094**

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: HSL900

Medium parameters used:  $f = 835$  MHz;  $\sigma = 0.91$  mho/m;  $\epsilon_r = 42.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.04, 6.04, 6.04); Calibrated: 26.06.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.03.2010
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- Measurement SW: DASY5, V5.2 Build 157; SEMCAD X Version 14.0 Build 57

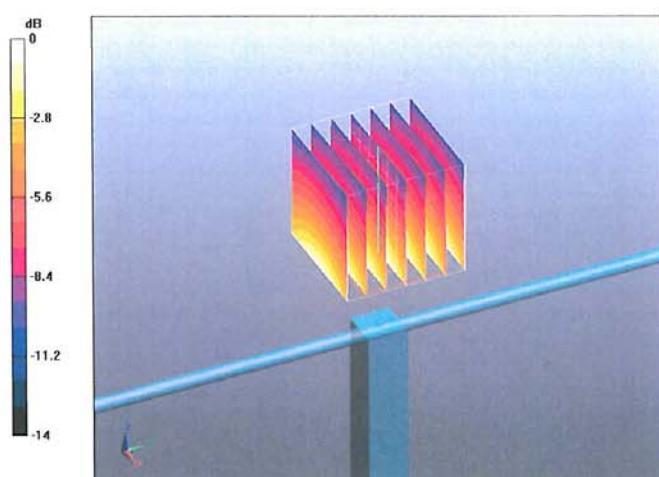
**Pin=250 mW /d=15mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 57.3 V/m; Power Drift = 0.00297 dB

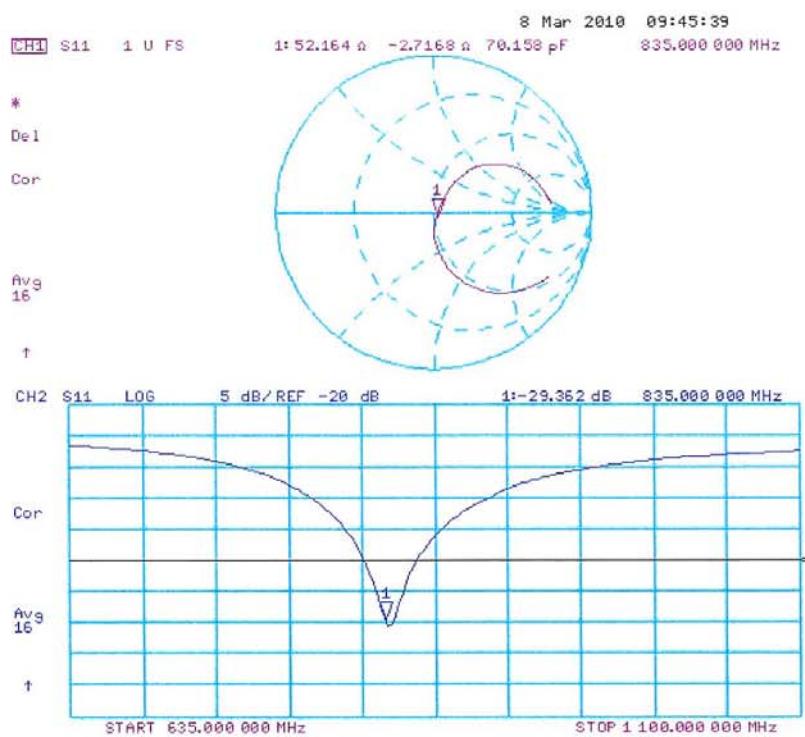
Peak SAR (extrapolated) = 3.65 W/kg

**SAR(1 g) = 2.43 mW/g; SAR(10 g) = 1.58 mW/g**

Maximum value of SAR (measured) = 2.84 mW/g



0 dB = 2.84mW/g

**Impedance Measurement Plot for Head TSL**

**DASY5 Validation Report for Body**

Date/Time: 15.03.2010 11:52:53

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d094**

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: MSL900

Medium parameters used:  $f = 835$  MHz;  $\sigma = 1.01$  mho/m;  $\epsilon_r = 55.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.97, 5.97, 5.97); Calibrated: 26.06.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.03.2010
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- Measurement SW: DASY5, V5.2 Build 157; SEMCAD X Version 14.0 Build 57

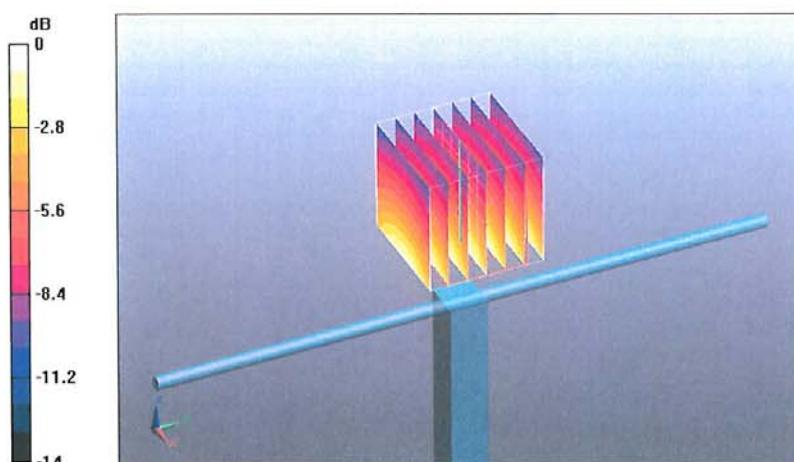
**Pin250 mW /d=15mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 55.9 V/m; Power Drift = -0.00975 dB

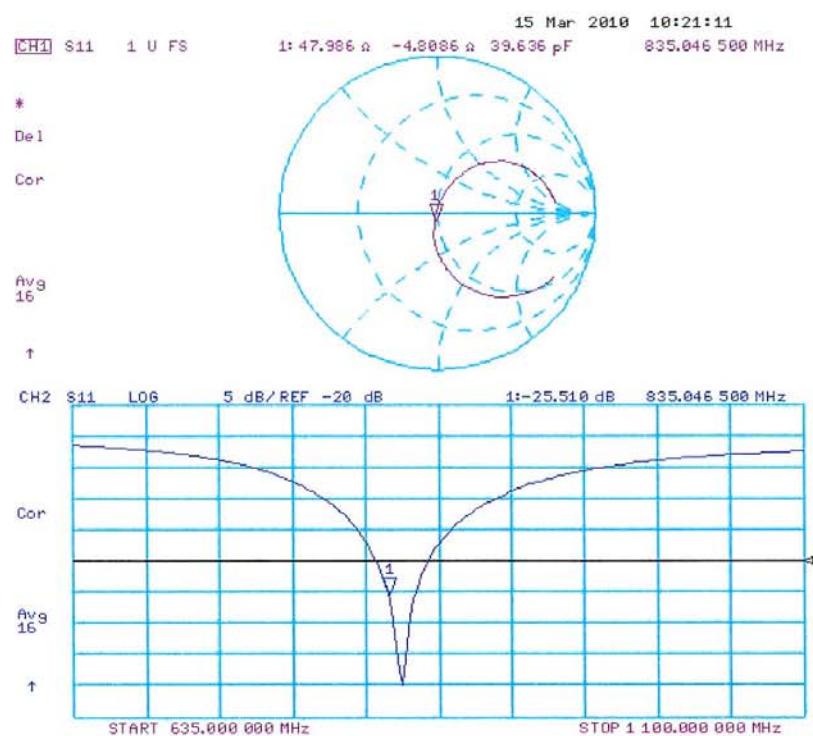
Peak SAR (extrapolated) = 3.77 W/kg

**SAR(1 g) = 2.55 mW/g; SAR(10 g) = 1.67 mW/g**

Maximum value of SAR (measured) = 2.98 mW/g



0 dB = 2.98mW/g

**Impedance Measurement Plot for Body TSL**

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



S Schweizerischer Kalibrierdienst  
C Service suisse d'étalonnage  
C 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 108**Client **Quietek (Auden)**Certificate No: **D1900V2-5d121\_Mar10**

## CALIBRATION CERTIFICATE

Object D1900V2 - SN: 5d121

Calibration procedure(s) QA CAL-05.v7  
Calibration procedure for dipole validation kits

Calibration date: March 23, 2010

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  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&amp;TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	06-Oct-09 (No. 217-01086)	Oct-10
Power sensor HP 8481A	US37292783	06-Oct-09 (No. 217-01086)	Oct-10
Reference 20 dB Attenuator	SN: 5086 (20g)	31-Mar-09 (No. 217-01025)	Mar-10
Type-N mismatch combination	SN: 5047.2 / 06327	31-Mar-09 (No. 217-01029)	Mar-10
Reference Probe ES3DV3	SN: 3205	26-Jun-09 (No. ES3-3205_Jun09)	Jun-10
DAE4	SN: 601	02-Mar-10 (No. DAE4-601_Mar10)	Mar-11
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-09)	In house check: Oct-11
RF generator R&S SMT-06	100005	4-Aug-99 (in house check Oct-09)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-09)	In house check: Oct-10

Calibrated by: Name **Dimce Iliev** Function **Laboratory Technician** Signature

Approved by: Name **Katja Pokovic** Function **Technical Manager** Signature

Issued: March 23, 2010  
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Calibration Laboratory of  
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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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- 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) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

#### 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.

**Measurement Conditions**

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

DASY Version	DASY5	V5.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz $\pm$ 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 $\pm$ 0.2) °C	41.1 $\pm$ 6 %	1.45 mho/m $\pm$ 6 %
Head TSL temperature during test	(21.5 $\pm$ 0.2) °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 mW / g
SAR normalized	normalized to 1W	40.4 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	39.8 mW / g $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	5.30 mW / g
SAR normalized	normalized to 1W	21.2 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	21.1 mW / g $\pm$ 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	53.3	1.52 mho/m
<b>Measured Body TSL parameters</b>	(22.0 ± 0.2) °C	54.9 ± 6 %	1.58 mho/m ± 6 %
<b>Body TSL temperature during test</b>	(21.5 ± 0.2) °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	10.5 mW / g
SAR normalized	normalized to 1W	42.0 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>41.4 mW / g ± 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	5.60 mW / g
SAR normalized	normalized to 1W	22.4 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	<b>22.3 mW / g ± 16.5 % (k=2)</b>

**Appendix****Antenna Parameters with Head TSL**

Impedance, transformed to feed point	50.6 $\Omega$ + 7.4 $j\Omega$
Return Loss	- 22.7 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	46.1 $\Omega$ + 7.1 $j\Omega$
Return Loss	- 21.5 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.205 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.  
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 25, 2009

**DASY5 Validation Report for Head TSL**

Date/Time: 23.03.2010 12:23:06

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d121**

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

Medium: HSL U11 BB

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.45$  mho/m;  $\epsilon_r = 41.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.09, 5.09, 5.09); Calibrated: 26.06.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.03.2010
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY5, V5.2 Build 157; SEMCAD X Version 14.0 Build 57

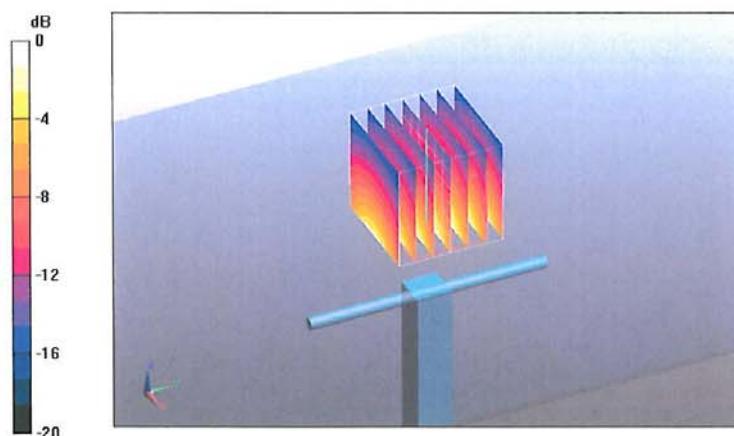
**Pin=250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.6 V/m; Power Drift = 0.00658 dB

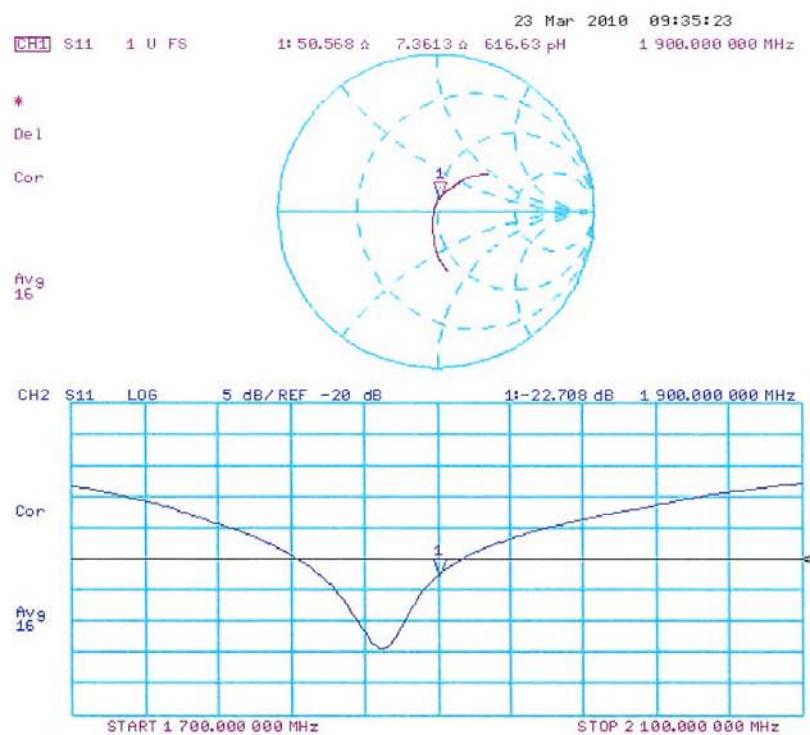
Peak SAR (extrapolated) = 18.5 W/kg

**SAR(1 g) = 10.1 mW/g; SAR(10 g) = 5.3 mW/g**

Maximum value of SAR (measured) = 12.8 mW/g



0 dB = 12.8mW/g

**Impedance Measurement Plot for Head TSL**

**DASY5 Validation Report for Body**

Date/Time: 17.03.2010 13:29:09

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d121**

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

Medium: MSL U11 BB

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.58$  mho/m;  $\epsilon_r = 55$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.59, 4.59, 4.59); Calibrated: 26.06.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.03.2010
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY5, V5.2 Build 157; SEMCAD X Version 14.0 Build 57

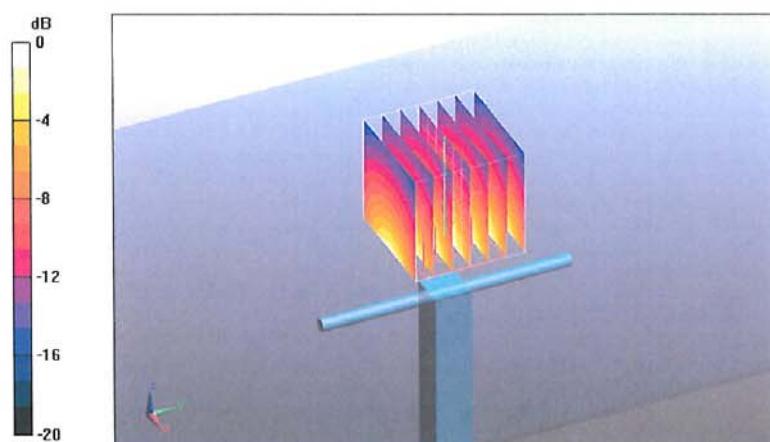
**Pin250 mW /d=10mm, dist=3.0mm (ES-Probe)/Zoom Scan (7x7x7) /Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97 V/m; Power Drift = 0.00345 dB

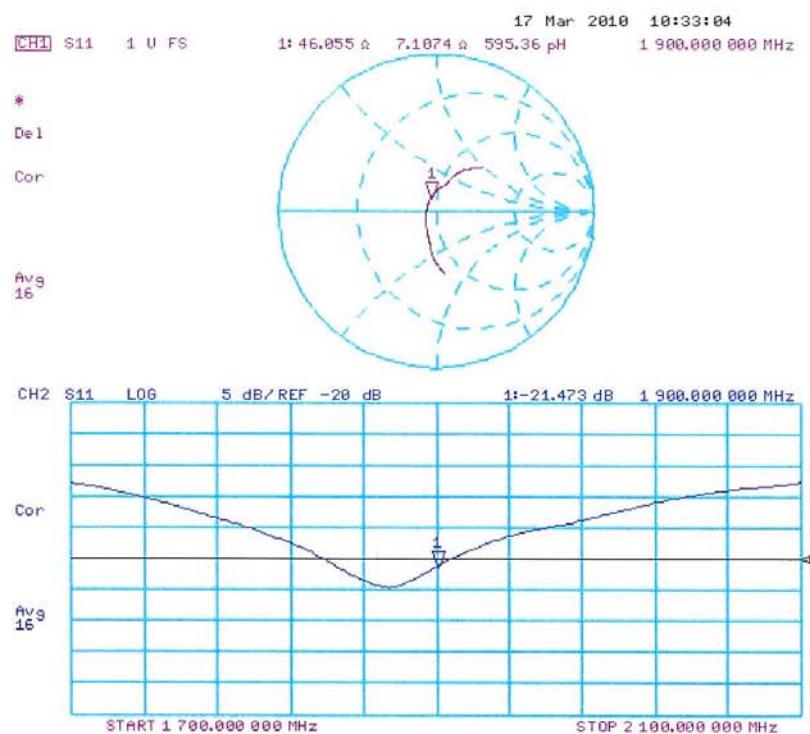
Peak SAR (extrapolated) = 17.6 W/kg

**SAR(1 g) = 10.5 mW/g; SAR(10 g) = 5.6 mW/g**

Maximum value of SAR (measured) = 13.3 mW/g



0 dB = 13.3mW/g

**Impedance Measurement Plot for Body TSL**

## Appendix F. DAE Calibration Data

**Calibration Laboratory of**  
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Accreditation No.: SCS 108

Client **Quietek (Auden)**

Certificate No: **DAE4-1220\_Dec10**

### CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BJ - SN: 1220**

Calibration procedure(s) **QA CAL-06.v22**  
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **December 3, 2010**

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  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	28-Sep-10 (No:10376)	Sep-11
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Calibrator Box V1.1	SE UMS 006 AB 1004	07-Jun-10 (in house check)	In house check: Jun-11

Calibrated by:	Name <b>Eric Hainfeld</b>	Function <b>Technician</b>	Signature 
Approved by:	<b>Fin Bomholt</b>	R&D Director	

Issued: December 3, 2010

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Accreditation No.: SCS 108

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

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

Calibration Factors	X	Y	Z
High Range	$405.229 \pm 0.1\% \text{ (k=2)}$	$404.950 \pm 0.1\% \text{ (k=2)}$	$404.184 \pm 0.1\% \text{ (k=2)}$
Low Range	$3.97007 \pm 0.7\% \text{ (k=2)}$	$3.98601 \pm 0.7\% \text{ (k=2)}$	$3.99287 \pm 0.7\% \text{ (k=2)}$

**Connector Angle**

Connector Angle to be used in DASY system	$177.5^\circ \pm 1^\circ$
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**Appendix****1. DC Voltage Linearity**

High Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	200002.4	1.22	0.00
Channel X	+ Input	20001.01	0.91	0.00
Channel X	- Input	-19997.57	2.63	-0.01
Channel Y	+ Input	200008.1	-2.52	-0.00
Channel Y	+ Input	19998.92	-1.38	-0.01
Channel Y	- Input	-20001.39	-1.29	0.01
Channel Z	+ Input	200011.1	1.59	0.00
Channel Z	+ Input	19998.31	-1.89	-0.01
Channel Z	- Input	-20000.79	-0.99	0.00

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	1999.8	-0.22	-0.01
Channel X	+ Input	199.68	-0.32	-0.16
Channel X	- Input	-200.45	-0.25	0.12
Channel Y	+ Input	1999.6	-0.27	-0.01
Channel Y	+ Input	199.03	-1.07	-0.54
Channel Y	- Input	-200.66	-0.76	0.38
Channel Z	+ Input	2000.0	-0.04	-0.00
Channel Z	+ Input	198.94	-1.26	-0.63
Channel Z	- Input	-201.36	-1.46	0.73

**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 (µV)	Low Range Average Reading (µV)
Channel X	200	10.60	8.62
	-200	-7.59	-9.45
Channel Y	200	-9.68	-9.86
	-200	9.01	8.51
Channel Z	200	12.06	12.10
	-200	-13.84	-14.49

**3. Channel separation**

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

	Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200	-	2.85	-0.96
Channel Y	200	1.60	-	3.41
Channel Z	200	2.29	-1.66	-

**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	15905	14404
Channel Y	16020	13780
Channel Z	15698	14978

**5. Input Offset Measurement**

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

Input 10MΩ

	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	-0.06	-1.34	1.46	0.43
Channel Y	-0.85	-2.00	0.10	0.32
Channel Z	-0.99	-2.44	0.46	0.44

**6. Input Offset Current**

Nominal Input circuitry offset current on all channels: &lt;25fA

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

	Zeroing (kOhm)	Measuring (MΩ)
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