



## SAR Test Report

Product Name : Tablet PC

Model No. : TC978, Le Pan S

FCC ID : ZDRTC978

Applicant: Matsunichi Digital Development (Shenzhen) Co., Ltd

Address : F/22, Matsunichi Building, No.9996, Shennan Boulevard,  
Nanshan District, Shenzhen, China

Date of Receipt : 27/06/2012

Date of Test : 28/06/2012

Issued Date : 29/06/2012

Report No. : 126S072R-HP-US-P03V01

Report Version : V1.1

The test results relate only to the samples tested.

The test report shall not be reproduced except in full without the written approval of QuieTek Corporation.

# Test Report Certification

Issued Date: 29/06/2012

Report No.: 126S072R-HP-US-P03V01

**QuieTek**

Product Name : Tablet PC  
Applicant : Matsunichi Digital Development (Shenzhen) Co., Ltd  
Address : F/22, Matsunichi Building, No.9996, Shennan Boulevard, Nanshan District, Shenzhen, China  
Manufacturer : Guangzhou Singulargold Electronics Co., Ltd  
Address : No.6, Lianhua yan Road, Science City, Guangzhou Hi-Tech Industrial Development Zone, Guangzhou, China  
Model No. : TC978, Le Pan S  
FCC ID : ZDRTC978  
Brand Name : Le Pan  
EUT Voltage : DC 5V  
Applicable Standard : FCC Oet65 Supplement C June 2001  
IEEE Std. 1528-2003,47CFR § 2.1093  
Test Result : Max. SAR Measurement (1g)  
0.406W/kg  
Performed Location : Suzhou EMC Laboratory  
No.99 Hongye Rd., Suzhou Industrial Park Loufeng Hi-Tech Development Zone., Suzhou, China  
TEL: +86-512-6251-5088 / FAX: +86-512-6251-5098  
FCC Registration Number: 800392  
Documented By : Alice Ni  
(Engineering ADM: Alice Ni)  
Reviewed By : Robin Wu  
(Engineering Supervisor: Robin Wu)  
Approved By : Marlin Chen  
(Manager: Marlin Chen)

## Laboratory Information

We, **QuieTek Corporation**, are an independent EMC and safety consultancy that was established the whole facility in our laboratories. The test facility has been accredited/accepted(audited or listed) by the following related bodies in compliance with ISO 17025, EN 45001 and specified testing scope:

Taiwan R.O.C.	:	BSMI, NCC, TAF
Germany	:	TUV Rheinland
Norway	:	Nemko, DNV
USA	:	FCC, NVLAP
Japan	:	VCCI
China	:	CNAS

The related certificate for our laboratories about the test site and management system can be downloaded from QuieTek Corporation's Web Site : <http://www.quietek.com/tw/ctg/cts/accreditations.htm>  
The address and introduction of QuieTek Corporation's laboratories can be founded in our Web site : <http://www.quietek.com/>

If you have any comments, Please don't hesitate to contact us. Our contact information is as below:

## **HsinChu Testing Laboratory :**

No.75-2, 3rd Lin, Wangye Keng, Yonghxing Tsuen, Qiongliong Shiang, Hsinchu County 307, Taiwan, R.O.C.  
TEL:+886-3-592-8858 / FAX:+886-3-592-8859 E-Mail : [service@quietek.com](mailto:service@quietek.com)

## **LinKou Testing Laboratory :**

No.5-22, Ruishukeng, Linkou Dist., New Taipei City 24451, Taiwan, R.O.C.  
TEL : 886-2-8601-3788 / FAX : 886-2-8601-3789 E-Mail : [service@quietek.com](mailto:service@quietek.com)

## Suzhou Testing Laboratory :

No.99 Hongye Rd., Suzhou Industrial Park Loufeng Hi-Tech Development Zone., SuZhou, China  
TEL : +86-512-6251-5088 / FAX : 86-512-6251-5098 E-Mail : [service@quietek.com](mailto:service@quietek.com)

## TABLE OF CONTENTS

<b>Description</b>	<b>Page</b>
<b>1. General Information .....</b>	<b>6</b>
1.1. EUT DESCRIPTION.....	6
1.2. TEST ENVIRONMENT .....	7
<b>2. SAR Measurement System .....</b>	<b>8</b>
2.1. DASY5 SYSTEM DESCRIPTION .....	8
2.1.1. Applications .....	9
2.1.2. Area Scans .....	9
2.1.3. Zoom Scan (Cube Scan Averaging) .....	9
2.1.4. Uncertainty of Inter-/Extrapolation and Averaging .....	9
2.2. DASY5 E-FIELD PROBE.....	10
2.2.1. Isotropic E-Field Probe Specification .....	10
2.3. BOUNDARY DETECTION UNIT AND PROBE MOUNTING DEVICE.....	11
2.4. DATA ACQUISITION ELECTRONICS (DAE) AND MEASUREMENT SERVER .....	11
2.5. ROBOT.....	12
2.6. LIGHT BEAM UNIT .....	12
2.7. DEVICE HOLDER .....	13
2.8. SAM TWIN PHANTOM.....	13
<b>3. Tissue Simulating Liquid .....</b>	<b>14</b>
3.1. THE COMPOSITION OF THE TISSUE SIMULATING LIQUID .....	14
3.2. TISSUE CALIBRATION RESULT .....	15
3.3. TISSUE DIELECTRIC PARAMETERS FOR HEAD AND BODY PHANTOMS .....	16
<b>4. SAR Measurement Procedure .....</b>	<b>17</b>
4.1. SAR SYSTEM VALIDATION .....	17
4.1.1. Validation Dipoles .....	17
4.1.2. Validation Result .....	18
4.2. SAR MEASUREMENT PROCEDURE .....	19
<b>5. SAR Exposure Limits .....</b>	<b>20</b>
<b>6. Test Equipment List.....</b>	<b>21</b>
<b>7. Measurement Uncertainty.....</b>	<b>22</b>
<b>8. Conducted Power Measurement .....</b>	<b>23</b>
<b>9. Test Results.....</b>	<b>24</b>

9.1. SAR TEST RESULTS SUMMARY .....	24
<b>Appendix A. SAR System Validation Data .....</b>	<b>26</b>
<b>Appendix B. SAR measurement Data .....</b>	<b>27</b>
<b>Appendix C. Test Setup Photographs &amp; EUT Photographs .....</b>	<b>36</b>
<b>Appendix D. Probe Calibration Data .....</b>	<b>43</b>
<b>Appendix E. Dipole Calibration Data.....</b>	<b>54</b>
<b>Appendix F. DAE Calibration Data.....</b>	<b>62</b>

## 1. General Information

### 1.1. EUT Description

Product Name	Tablet PC
Model No.	TC978, Le Pan S
Hardware Version	R007
Software Version	17.92
Device Category	Portable
<b>Wi-Fi</b>	
Frequency Range	802.11b/g/n(20MHz): 2412 - 2462 MHz
Channel Number	802.11b/g/n(20MHz): 11
Type of Modulation	802.11b: DSSS; 802.11g/n: OFDM
Data Rate	802.11b: 1/2/5.5/11 Mbps
	802.11g: 6/9/12/18/24/36/48/54 Mbps
	802.11n: up to 65 Mbps
Peak Antenna Gain	2.67dBi
Max. Output Power (Average)	802.11b: 19.75dBm
	802.11g: 18.54dBm
	802.11n(20MHz): 18.74dBm
<b>Bluetooth</b>	
Bluetooth Frequency	2402~2480MHz
Bluetooth Version	V4.0
Type of modulation	FHSS
Data Rate	1Mbps(GFSK), 2Mbps(Pi/4 DQPSK), 3Mbps (8DPSK)
Peak Antenna Gain	2.67dBi
<b>Component</b>	
Battery #1	M/N: WD4585170P-2P Rated Voltage and Capacitance: 3.7V/6800mAh
Battery #2	M/N: E438483-2P Rated Voltage and Capacitance: 3.7V/6800mAh

Note: They are only for different marketing requirement.

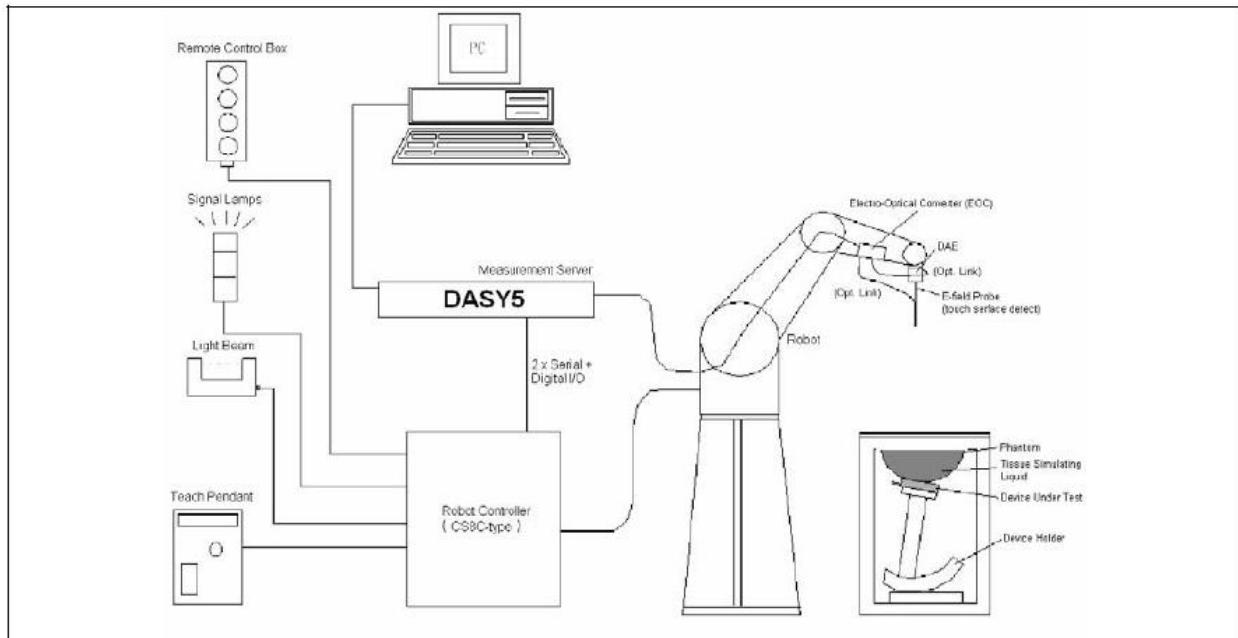
## 1.2. Test Environment

Ambient conditions in the laboratory:

Items	Required	Actual
Temperature (°C)	18-25	21.5± 2
Humidity (%RH)	30-70	52

## 2. SAR Measurement System

### 2.1. DASY5 System Description



The DASY5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

### **2.1.1. Applications**

Predefined procedures and evaluations for automated compliance testing with all worldwide standards, e.g., IEEE 1528, OET 65, IEC 62209-1, IEC 62209-2, EN 50360, EN 50383 and others.

### **2.1.2. Area Scans**

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a 10mm<sup>2</sup> step integral, with 1mm interpolation used to locate the peak SAR area used for zoom scan assessments.

When an Area Scan has measured all reachable points, it computes the field maxima found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE 1528-2003, EN 50361 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan).

### **2.1.3. Zoom Scan (Cube Scan Averaging)**

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. A density of 1000 kg/m<sup>3</sup> is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1 g cube is 10mm, with the side length of the 10 g cube 21,5mm.

The zoom scan integer steps can be user defined so as to reduce uncertainty, but normal practice for typical test applications utilize a physical step of 7x7x7 (5mmx5mmx5mm) providing a volume of 30mm in the X & Y axis, and 30mm in the Z axis.

### **2.1.4. Uncertainty of Inter-/Extrapolation and Averaging**

In order to evaluate the uncertainty of the interpolation, extrapolation and averaged SAR calculation algorithms of the Postprocessor, DASY5 allows the generation of measurement grids which are artificially predefined by analytically based test functions. Therefore, the grids of area scans and zoom scans can be filled with uncertainty test data, according to the SAR benchmark functions of IEEE 1528. The three analytical functions shown in equations as below are used to describe the possible range of the expected SAR distributions for the tested handsets. The field gradients are covered by the spatially flat distribution f1, the spatially steep distribution f3 and f2 accounts for H-field cancellation on the phantom/tissue surface.

$$f_1(x, y, z) = Ae^{-\frac{z}{2a}} \cos^2 \left( \frac{\pi}{2} \frac{\sqrt{x'^2 + y'^2}}{5a} \right)$$

$$f_2(x, y, z) = Ae^{-\frac{z}{a}} \frac{a^2}{a^2 + x'^2} \left( 3 - e^{-\frac{2z}{a}} \right) \cos^2 \left( \frac{\pi}{2} \frac{y'}{3a} \right)$$

$$f_3(x, y, z) = A \frac{a^2}{\frac{a^2}{4} + x'^2 + y'^2} \left( e^{-\frac{2z}{a}} + \frac{a^2}{2(a + 2z)^2} \right)$$

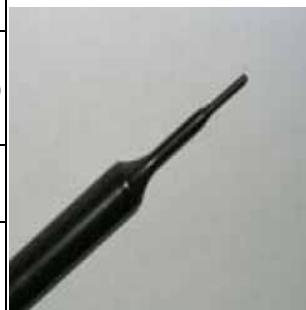
## 2.2. DASY5 E-Field Probe

The SAR measurement is conducted with the dosimetric probe manufactured by SPEAG. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.

SPEAG conducts the probe calibration in compliance with international and national standards (e.g. IEEE 1528, EN 62209-1, IEC 62209, etc.) under ISO 17025. The calibration data are in Appendix D.

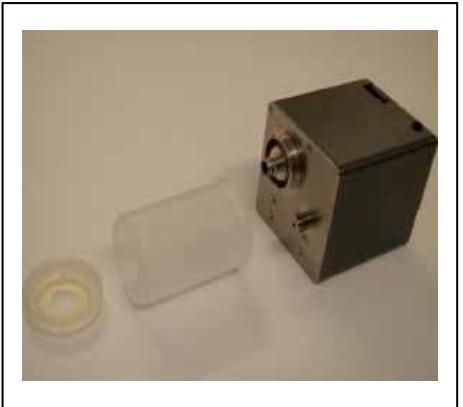
### 2.2.1. Isotropic E-Field Probe Specification

<b>Model</b>	EX3DV4
<b>Construction</b>	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
<b>Frequency</b>	10 MHz to 6 GHz Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)
<b>Directivity</b>	$\pm 0.3$ dB in HSL (rotation around probe axis) $\pm 0.5$ dB in tissue material (rotation normal to probe axis)
<b>Dynamic Range</b>	10 $\mu$ W/g to 100 mW/g Linearity: $\pm 0.2$ dB (noise: typically $< 1$ $\mu$ W/g)
<b>Dimensions</b>	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm
<b>Application</b>	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.



### 2.3. Boundary Detection Unit and Probe Mounting Device

The DASY probes use a precise connector and an additional holder for the probe, consisting of a plastic tube and a flexible silicon ring to center the probe. The connector at the DAE is flexibly mounted and held in the default position with magnets and springs. Two switching systems in the connector mount detect frontal and lateral probe collisions and trigger the necessary software response.



### 2.4. DATA Acquisition Electronics (DAE) and Measurement Server

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit.

Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The input impedance of the DAE4 is 200M Ohm; the inputs are symmetrical and floating. Common mode rejection is above 80dB.



The DASY5 measurement server is based on a PC/104 CPU board with a 400MHz intel ULV Celeron, 128MB chipdisk and 128MB RAM. The necessary circuits for communication with the DAE electronics box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY5 I/O board, which is directly connected to the PC/104 bus of the CPU board.



## 2.5. Robot

The DASY5 system uses the high precision robots TX90 XL type out of the newer series from Stäubli SA (France). For the 6-axis controller DASY5 system, the CS8C robot controller version from Stäubli is used.

The XL robot series have many features that are important for our application:

- High precision (repeatability 0.02 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)
- 6-axis controller



## 2.6. Light Beam Unit

The light beam switch allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, such that the robot coordinates are valid for the probe tip.

The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions.

During probe rotations, the probe tip will keep its actual position.



## 2.7. Device Holder

The DASY5 device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (EPR).

Thus the device needs no repositioning when changing the angles.

The DASY5 device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity  $\epsilon_r = 3$  and loss tangent  $\delta = 0.02$ . The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.



## 2.8. SAM Twin Phantom

The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region where shell thickness increases to 6mm). It has three measurement areas:

- Left head
- Right head
- Flat phantom



The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

### 3. Tissue Simulating Liquid

#### 3.1. The composition of the tissue simulating liquid

INGREDIENT (% Weight)	2450MHz Body
Water	73.2
Salt	0.04
Sugar	0.00
HEC	0.00
Preventol	0.00
DGBE	26.7

### 3.2. Tissue Calibration Result

The dielectric parameters of the liquids were verified prior to the SAR evaluation using DASY5 Dielectric Probe Kit and Agilent Vector Network Analyzer E5071C

<b>Body Tissue Simulant Measurement</b>				
Frequency [MHz]	Description	Dielectric Parameters		Tissue Temp. [°C]
		$\epsilon_r$	$\sigma$ [s/m]	
2450MHz	Reference result ± 5% window	52.7 50.07 to 55.34	1.95 1.85 to 2.05	N/A
	28-06-2012	52.63	2.00	21.0

### 3.3. Tissue Dielectric Parameters for Head and Body Phantoms

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations described in Reference [12] and extrapolated according to the head parameters specified in P1528.

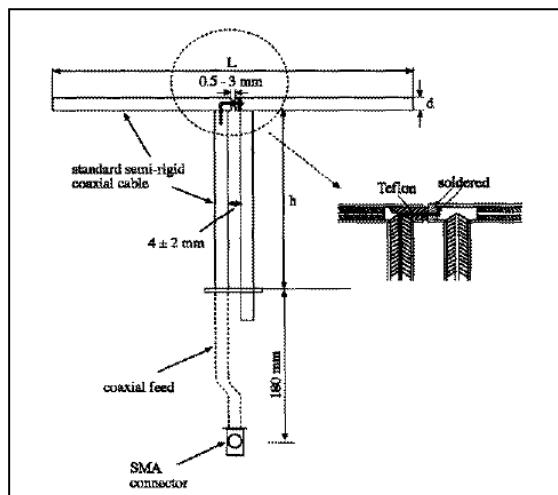
Target Frequency (MHz)	Head		Body	
	$\epsilon_r$	$\sigma$ (S/m)	$\epsilon_r$	$\sigma$ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
<b>2450</b>	<b>39.2</b>	<b>1.80</b>	<b>52.7</b>	<b>1.95</b>
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

( $\epsilon_r$  = relative permittivity,  $\sigma$  = conductivity and  $\rho = 1000$  kg/m<sup>3</sup>)

## 4. SAR Measurement Procedure

### 4.1. SAR System Validation

#### 4.1.1. Validation Dipoles



The dipoles used is based on the IEEE-1528 standard, and is complied with mechanical and electrical specifications in line with the requirements of both IEEE and FCC Supplement C. the table below provides details for the mechanical and electrical specifications for the dipoles.

Frequency	L (mm)	h (mm)	d (mm)
2450MHz	51.5	30.4	3.6

#### 4.1.2. Validation Result

**System Performance Check at 2450MHz for Body****Validation Dipole: D2450V2, SN: 839**

Frequency [MHz]	Description	SAR [w/kg] 1g	SAR [w/kg] 10g	Tissue Temp. [°C]
2450 MHz	Reference result ± 10% window	48.7 43.83 to 53.57	22.8 20.52 to 25.08	N/A
	28-06-2012	49.20	22.56	21.0

Note: All SAR values are normalized to 1W forward power.

#### 4.2. SAR Measurement Procedure

The DASY5 calculates SAR using the following equation,

$$SAR = \frac{\sigma |E|^2}{\rho}$$

$\sigma$ : represents the simulated tissue conductivity

$\rho$ : represents the tissue density

The EUT is set to transmit at the required power in line with product specification, at each frequency relating to the LOW, MID, and HIGH channel settings.

Pre-scans are made on the device to establish the location for the transmitting antenna, using a large area scan in either air or tissue simulation fluid.

The EUT is placed against the Universal Phantom where the maximum area scan dimensions are larger than the physical size of the resonating antenna. When the scan size is not large enough to cover the peak SAR distribution, it is modified by either extending the area scan size in both the X and Y directions, or the device is shifted within the predefined area.

The area scan is then run to establish the peak SAR location (interpolated resolution set at 1mm<sup>2</sup> ) which is then used to orient the center of the zoom scan. The zoom scan is then executed and the 1g and 10g averages are derived from the zoom scan volume (interpolated resolution set at 1mm<sup>3</sup> ).

## 5. SAR Exposure Limits

SAR assessments have been made in line with the requirements of IEEE-1528, FCC Supplement C, and comply with ANSI/IEEE C95.1-1992 "Uncontrolled Environments" limits. These limits apply to a location which is deemed as "Uncontrolled Environment" which can be described as a situation where the general public may be exposed to an RF source with no prior knowledge or control over their exposure.

### **Limits for General Population/Uncontrolled Exposure (W/kg)**

Type Exposure	Uncontrolled Environment Limit
Spatial Peak SAR (1g cube tissue for brain or body)	1.60 W/kg
Spatial Average SAR (whole body)	0.08 W/kg
Spatial Peak SAR (10g for hands, feet, ankles and wrist)	4.00 W/kg

## 6. Test Equipment List

Instrument	Manufacturer	Model No.	Serial No.	Cali. Due Date
Stäubli Robot TX60L	Stäubli	TX60L	F10/5C90A1/A/01	only once
Controller	Stäubli	SP1	S-0034	only once
Dipole Validation Kits	Speag	D2450V2	839	2013.02.23
SAM Twin Phantom	Speag	SAM	TP-1561/1562	N/A
Device Holder	Speag	SD 000 H01 HA	N/A	N/A
Data Acquisition Electronic	Speag	DAE4	1220	2013.01.23
E-Field Probe	Speag	EX3DV4	3710	2013.03.12
SAR Software	Speag	DASY5	V5.2 Build 162	N/A
Power Amplifier	Mini-Circuit	ZHL-42	D051404-28	N/A
Directional Coupler	Agilent	778D	20160	N/A
Vector Network	Agilent	E5071C	MY48367267	2013.04.10
Signal Generator	Agilent	E4438C	MY49070163	2013.04.18
Power Meter	Anritsu	ML2495A	0905006	2013.01.12
Wide Bandwidth Sensor	Anritsu	MA2411B	0846014	2013.01.12

## 7. Measurement Uncertainty

DASY5 Uncertainty								
Measurement uncertainty for 300 MHz to 3 GHz averaged over 1 gram / 10 gram.								
Error Description	Uncert. value	Prob. Dist.	Div.	(ci) 1g	(ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(vi) V <sub>eff</sub>
<b>Measurement System</b>								
Probe Calibration	±6.0%	N	1	1	1	±6.0%	±6.0%	∞
Axial Isotropy	±4.7%	R	$\sqrt{3}$	0.7	0.7	±1.9%	±1.9%	∞
Hemispherical Isotropy	±9.6%	R	$\sqrt{3}$	0.7	0.7	±3.9%	±3.9%	∞
Boundary Effects	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%	∞
System Detection Limits	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Readout Electronics	±0.3%	N	1	1	1	±0.3%	±0.3%	∞
Response Time	±0.8%	R	$\sqrt{3}$	1	1	±0.5%	±0.5%	∞
Integration Time	±2.6%	R	$\sqrt{3}$	1	1	±1.5%	±1.5%	∞
RF Ambient Noise	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
RF Ambient Reflections	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
Probe Positioner	±0.4%	R	$\sqrt{3}$	1	1	±0.2%	±0.2%	∞
Probe Positioning	±2.9%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%	∞
Max. SAR Eval.	±1.0%	R	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
<b>Test Sample Related</b>								
Device Positioning	±2.9%	N	1	1	1	±2.9%	±2.9%	145
Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%	5
Power Drift	±5.0%	R	$\sqrt{3}$	1	1	±2.9%	±2.9%	∞
<b>Phantom and Setup</b>								
Phantom Uncertainty	±4.0%	R	$\sqrt{3}$	1	1	±2.3%	±2.3%	∞
Liquid Conductivity (target)	±5.0%	R	$\sqrt{3}$	0.64	0.43	±1.8%	±1.2%	∞
Liquid Conductivity (meas.)	±2.5%	N	1	0.64	0.43	±1.6%	±1.1%	∞
Liquid Permittivity (target)	±5.0%	R	$\sqrt{3}$	0.6	0.49	±1.7%	±1.4%	∞
Liquid Permittivity (meas.)	±2.5%	N	1	0.6	0.49	±1.5%	±1.2%	∞
<b>Combined Std. Uncertainty</b>							±10.9%	±10.7%
<b>Expanded STD Uncertainty</b>							±21.9%	±21.4%

## 8. Conducted Power Measurement

### Wi-Fi output power

Test Mode	Data Rate (Mbps)	Channel No.	Frequency (MHz)	Average Power (dBm)
802.11b	1	01	2412	19.52
		06	2437	19.71
		11	2462	19.75
802.11g	6	01	2412	18.45
		06	2437	18.54
		11	2462	18.46
802.11n(20MHz)	6.5	01	2412	18.11
		06	2437	18.74
		11	2462	18.38

## **9. Test Results**

### **9.1. SAR Test Results Summary**

#### **9.1.1. Test position and configuration**

Body SAR was performed with the device configured in the positions according to FCC OET65. SAR test was performed with the device 0mm (touch) from the phantom for the worst case due to antenna position. Test Position: bottom, primary landscape, primary portrait. Please refer to the test photograph for details.

#### **9.1.2. Co-located SAR**

Bluetooth output power is less than Pref, and shares the same antenna with WLAN, they cannot transmit simultaneously. Therefore, standalone SAR and simultaneous SAR for Bluetooth is not required.

#### **9.1.3. Referenced Documents**

FCC KDB 248227 D01 and KDB 447498 D01 and KDB 616217 D03

### 9.1.4. Test Result

SAR MEASUREMENT													
Ambient Temperature (°C) : 21.5 ±2				Relative Humidity (%): 52									
Liquid Temperature (°C) : 21.0 ±2				Depth of Liquid (cm):>15									
Product: Tablet PC													
Test Mode: 802.11b													
Test Position Body	Antenna Position	Frequency		Separation Distance (mm)	Average Power (dBm)	Power Drift (<±0.2)	SAR 1g (W/kg)	Limit (W/kg)					
		Channel	MHz										
Bottom	Fixed	1	2412	0	19.52	0.09	0.370	1.6					
Bottom	Fixed	6	2437	0	19.71	0.05	0.402	1.6					
Bottom	Fixed	11	2462	0	19.75	0.18	0.406	1.6					
Primary landscape	Fixed	11	2462	0	19.75	-0.12	0.227	1.6					
Primary portrait	Fixed	11	2462	0	19.75	0.18	0.082	1.6					
Bottom (With Battery #2)	Fixed	11	2462	0	19.75	0.10	0.355	1.6					
Test Mode: 802.11g													
Bottom	Fixed	6	2437	0	19.52	0.10	0.214	1.6					
Test Mode: 802.11n(20MHz)													
Bottom	Fixed	6	2437	0	19.52	-0.14	0.228	1.6					
Note: when the 1-g SAR is 0.8 W/kg, testing for low and high channel is optional.													

## Appendix A. SAR System Validation Data

Date/Time: 28-06-2012

Test Laboratory: QuieTek Lab

System Check Body 2450MHz

**DUT: Dipole 2450 MHz D2450V2; Type: D2450V2**

Communication System: CW; Communication System Band: D2450 (2450.0 MHz); Duty Cycle: 1:1;

Frequency: 2450 MHz; Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2$  mho/m;  $\epsilon_r = 52.63$ ;  $\rho = 1000$  kg/m<sup>3</sup> ;

Phantom section: Flat Section ; Input Power=250mW

Ambient temperature ( ) : 21.5, Liquid temperature ( ) : 21.0

DASY5 Configuration:

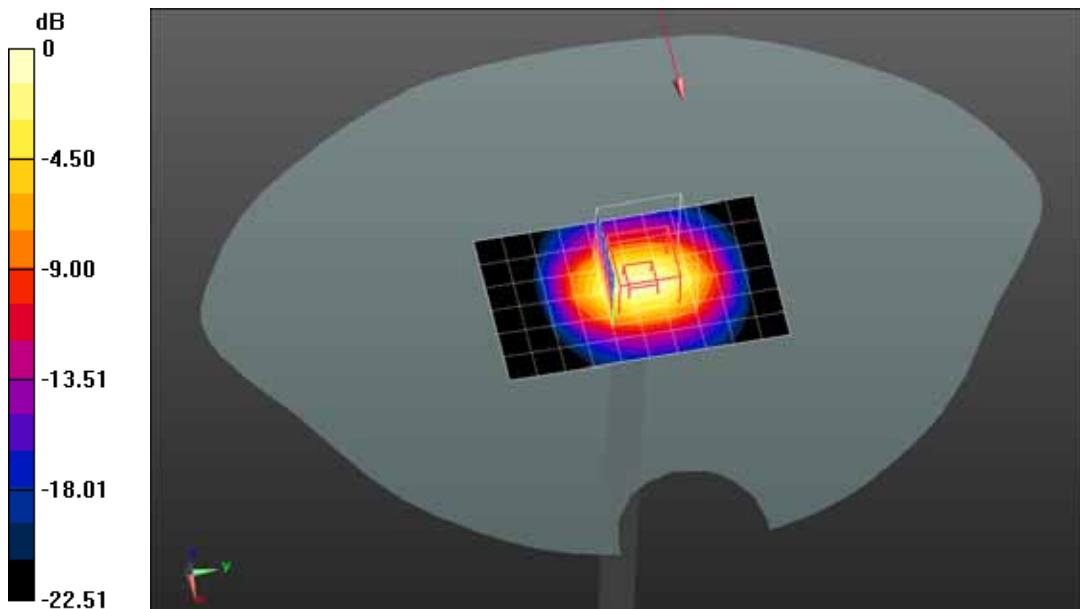
- Probe: EX3DV4 - SN3710; ConvF(6.98, 6.98, 6.98); Calibrated: 12/03/2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 23/01/2012
- Phantom: SAM1; Type: SAM; Serial: TP1561
- Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

**Configuration/System Check Body 2450MHz/Area Scan (7x11x1):** Measurement grid: dx=10mm, dy=10mm, Maximum value of SAR (measured) = 13.5 mW/g

**Configuration/System Check Body 2450MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm, Reference Value = 81.585 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 25.479 mW/g

**SAR(1 g) = 12.3 mW/g; SAR(10 g) = 5.64 mW/g** Maximum value of SAR (measured) = 14.1 mW/g



0 dB = 14.1 mW/g = 22.98 dB mW/g

## Appendix B. SAR measurement Data

Date/Time: 28-06-2012

Test Laboratory: QuieTek Lab

802.11b 2412MHz-Bottom

**DUT: Tablet PC; Type: TC978**

Communication System: Wi-Fi; Communication System Band: 802.11b; Duty Cycle: 1:1; Frequency: 2412 MHz; Medium parameters used:  $f = 2412$  MHz;  $\sigma = 1.95$  mho/m;  $\epsilon_r = 52.76$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section

Ambient temperature ( ): 21.5, Liquid temperature ( ): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(6.98, 6.98, 6.98); Calibrated: 12/03/2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 23/01/2012
- Phantom: SAM1; Type: SAM; Serial: TP1561
- Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

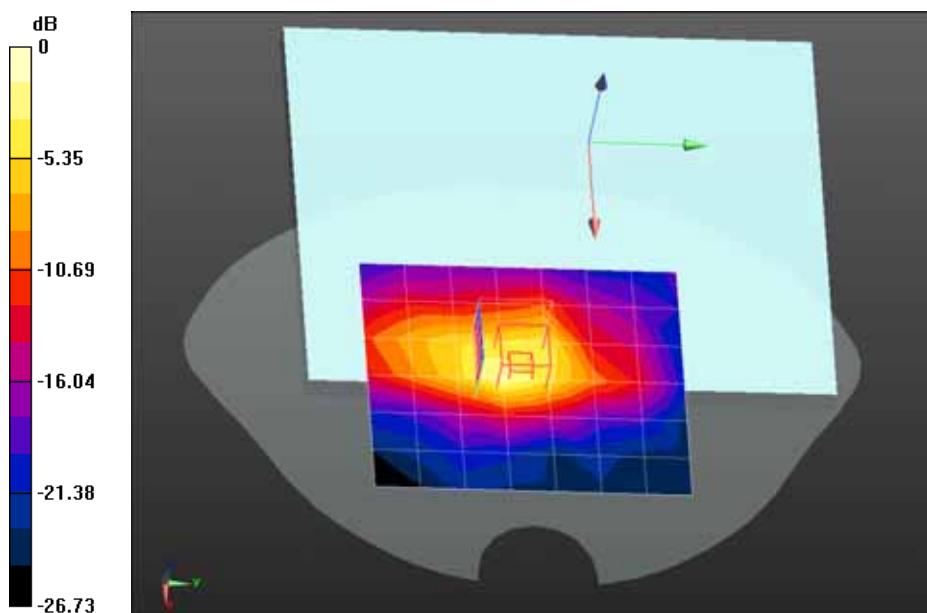
**Configuration/802.11b Low-Bottom/Area Scan (7x8x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (measured) = 0.294 mW/g

**Configuration/802.11b Low-Bottom/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm, Reference Value = 13.303 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 0.839 mW/g

**SAR(1 g) = 0.370 mW/g; SAR(10 g) = 0.162 mW/g** Maximum value of SAR (measured) = 0.395 mW/g



0 dB = 0.395 mW/g = -8.07 dB mW/g

Date/Time: 28-06-2012

Test Laboratory: QuieTek Lab

802.11b 2437MHz-Bottom

**DUT: Tablet PC; Type: TC978**

Communication System: Wi-Fi; Communication System Band: 802.11b; Duty Cycle: 1:1; Frequency: 2437 MHz; Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.98$  mho/m;  $\epsilon_r = 52.68$ ;  $\rho = 1000$  kg/m<sup>3</sup> ; Phantom section: Flat Section

Ambient temperature ( ): 21.5, Liquid temperature ( ): 21.0

DASY5 Configuration:

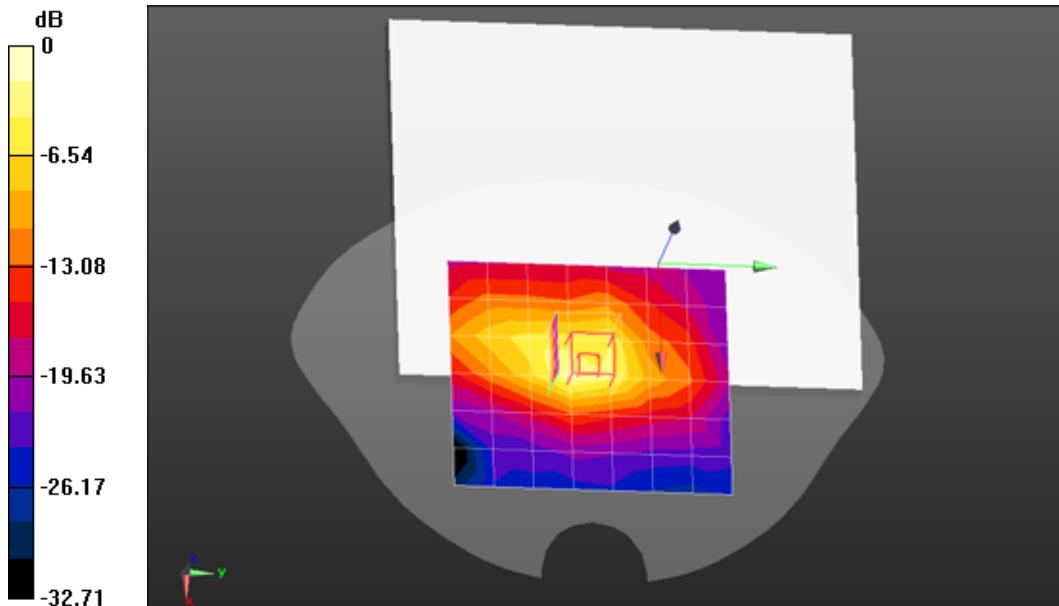
- Probe: EX3DV4 - SN3710; ConvF(6.98, 6.98, 6.98); Calibrated: 12/03/2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 23/01/2012
- Phantom: SAM1; Type: SAM; Serial: TP1561
- Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

**Configuration/802.11b Mid-Bottom/Area Scan (7x8x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (measured) = 0.294 mW/g

**Configuration/802.11b Mid-Bottom/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm, Reference Value = 13.934 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 0.936 mW/g

**SAR(1 g) = 0.402 mW/g; SAR(10 g) = 0.173 mW/g** Maximum value of SAR (measured) = 0.427 mW/g

Date/Time: 28-06-2012

Test Laboratory: QuieTek Lab

802.11b 2462MHz-Bottom

**DUT: Tablet PC; Type: TC978**

Communication System: Wi-Fi; Communication System Band: 802.11b; Duty Cycle: 1:1; Frequency: 2462 MHz; Medium parameters used:  $f = 2462$  MHz;  $\sigma = 2.02$  mho/m;  $\epsilon_r = 52.58$ ;  $\rho = 1000$  kg/m<sup>3</sup> ; Phantom section: Flat Section

Ambient temperature ( ): 21.5, Liquid temperature ( ): 21.0

DASY5 Configuration:

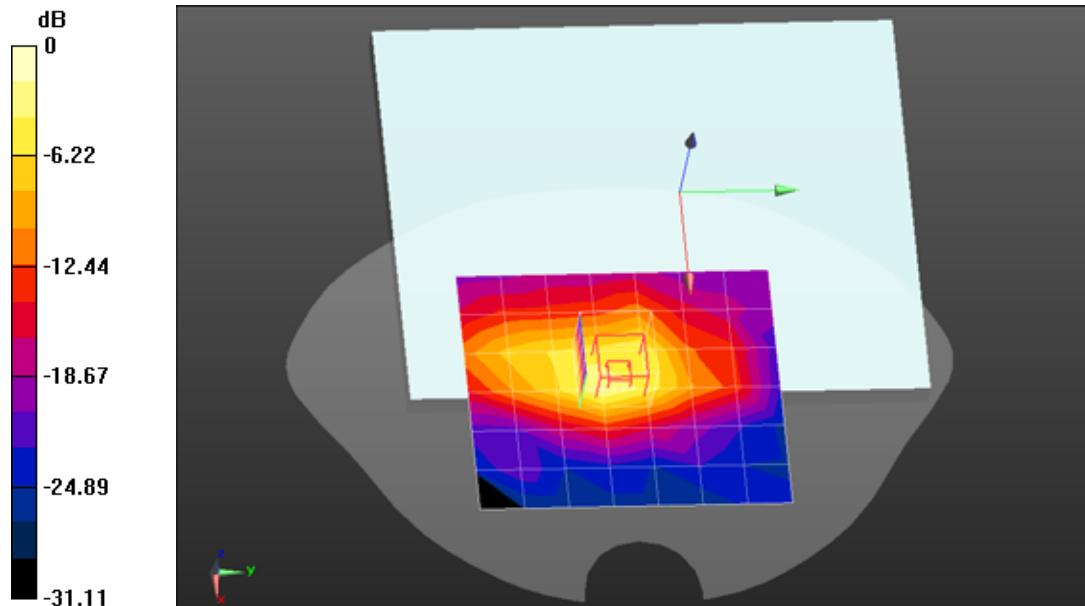
- Probe: EX3DV4 - SN3710; ConvF(6.98, 6.98, 6.98); Calibrated: 12/03/2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 23/01/2012
- Phantom: SAM1; Type: SAM; Serial: TP1561
- Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

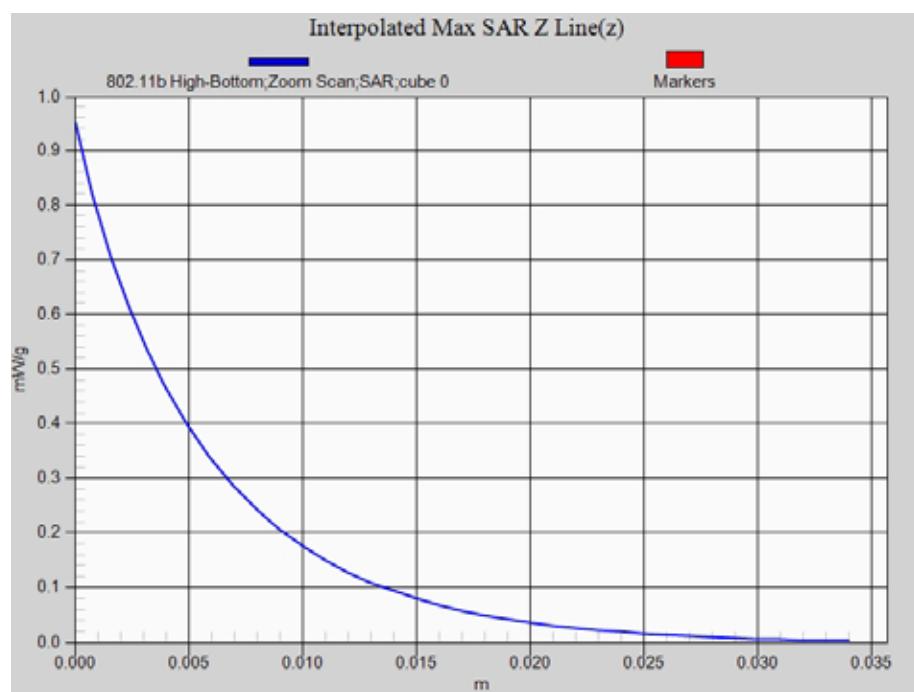
**Configuration/802.11b High-Bottom/Area Scan (7x8x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (measured) = 0.300 mW/g

**Configuration/802.11b High-Bottom/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm, Reference Value = 12.792 V/m; Power Drift = 0.18 dB

Peak SAR (extrapolated) = 0.951 mW/g

**SAR(1 g) = 0.406 mW/g; SAR(10 g) = 0.175 mW/g** Maximum value of SAR (measured) = 0.454 mW/g

**Z-Axis Plot**

Date/Time: 28-06-2012

Test Laboratory: QuieTek Lab

802.11b 2462MHz-Primary landscape

**DUT: Tablet PC; Type: TC978**

Communication System: Wi-Fi; Communication System Band: 802.11b; Duty Cycle: 1:1; Frequency: 2462 MHz; Medium parameters used:  $f = 2462$  MHz;  $\sigma = 2.02$  mho/m;  $\epsilon_r = 52.58$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section

Ambient temperature ( ): 21.5, Liquid temperature ( ): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(6.98, 6.98, 6.98); Calibrated: 12/03/2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 23/01/2012
- Phantom: SAM1; Type: SAM; Serial: TP1561
- Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

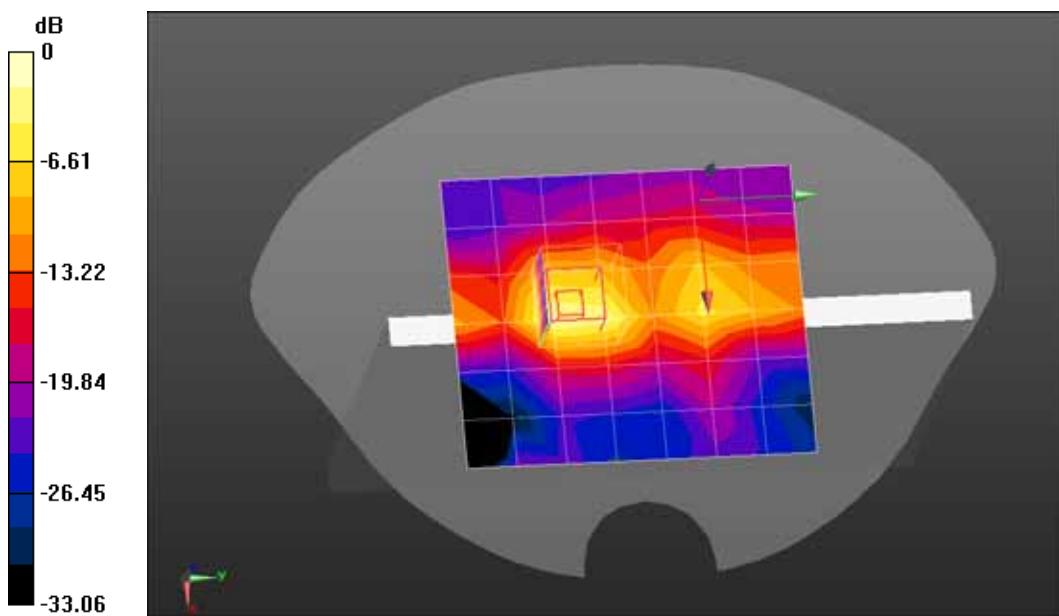
**Configuration/802.11b High-Primary landscape/Area Scan (7x8x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (measured) = 0.176 mW/g

**Configuration/802.11b High-Primary landscape/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm, Reference Value = 5.705 V/m; Power Drift = -0.12 dB

Peak SAR (extrapolated) = 0.524 mW/g

**SAR(1 g) = 0.227 mW/g; SAR(10 g) = 0.097 mW/g** Maximum value of SAR (measured) = 0.257 mW/g



Date/Time: 28-06-2012

Test Laboratory: QuieTek Lab

802.11b 2462MHz-Primary portrait

**DUT: Tablet PC; Type: TC978**

Communication System: Wi-Fi; Communication System Band: 802.11b; Duty Cycle: 1:1; Frequency: 2462 MHz; Medium parameters used:  $f = 2462$  MHz;  $\sigma = 2.02$  mho/m;  $\epsilon_r = 52.58$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section

Ambient temperature ( ): 21.5, Liquid temperature ( ): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(6.98, 6.98, 6.98); Calibrated: 12/03/2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 23/01/2012
- Phantom: SAM1; Type: SAM; Serial: TP1561
- Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

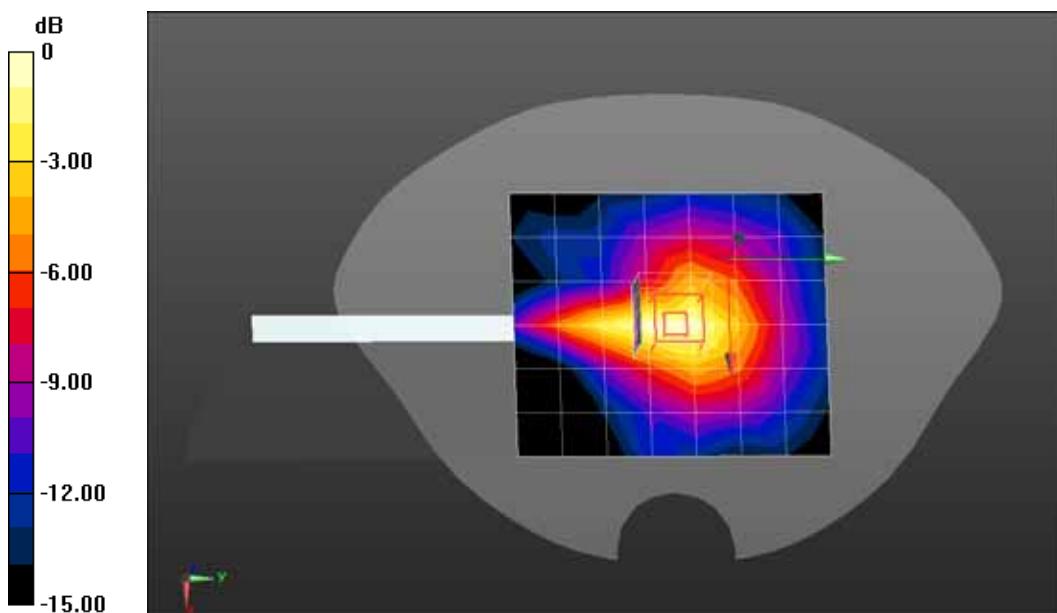
**Configuration/802.11b High-Primary portrait/Area Scan (7x8x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (measured) = 0.0892 mW/g

**Configuration/802.11b High-Primary portrait/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm, Reference Value = 6.651 V/m; Power Drift = 0.18 dB

Peak SAR (extrapolated) = 0.160 mW/g

**SAR(1 g) = 0.082 mW/g; SAR(10 g) = 0.040 mW/g** Maximum value of SAR (measured) = 0.0930 mW/g



0 dB = 0.0930 mW/g = -20.63 dB mW/g

Date/Time: 28-06-2012

Test Laboratory: QuieTek Lab

802.11b 2462MHz-Bottom(with battery #2)

**DUT: Tablet PC; Type: TC978**

Communication System: Wi-Fi; Communication System Band: 802.11b; Duty Cycle: 1:1; Frequency: 2462 MHz; Medium parameters used:  $f = 2462$  MHz;  $\sigma = 2.02$  mho/m;  $\epsilon_r = 52.58$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section

Ambient temperature ( ): 21.5, Liquid temperature ( ): 21.0

DASY5 Configuration:

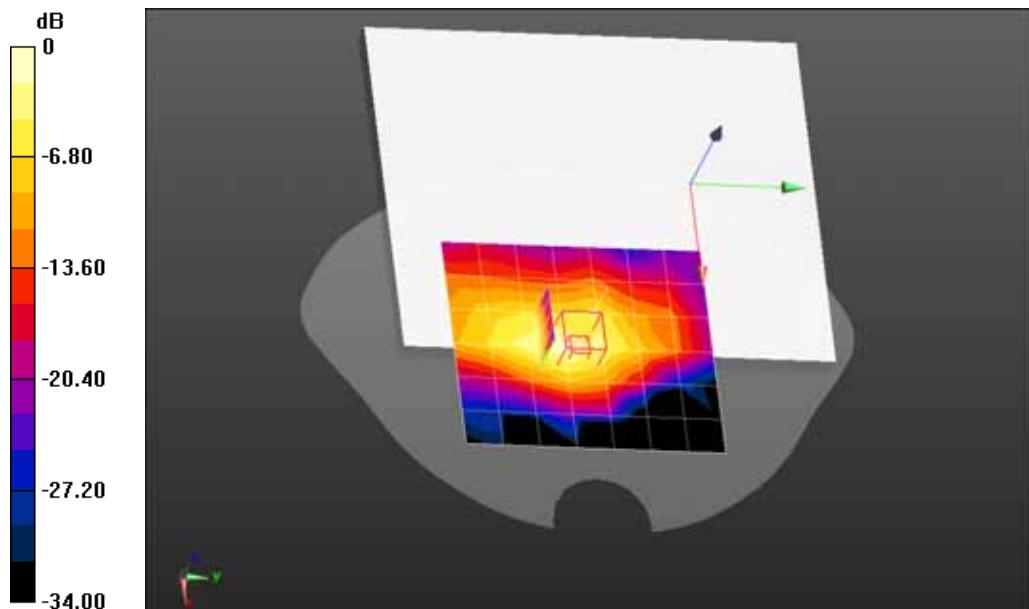
- Probe: EX3DV4 - SN3710; ConvF(6.98, 6.98, 6.98); Calibrated: 12/03/2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 23/01/2012
- Phantom: SAM1; Type: SAM; Serial: TP1561
- Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

**Configuration/802.11b High-Bottom/Area Scan (7x8x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (measured) = 0.318 mW/g

**Configuration/802.11b High-Bottom/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm, Reference Value = 13.577 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 0.809 mW/g

**SAR(1 g) = 0.355 mW/g; SAR(10 g) = 0.159 mW/g** Maximum value of SAR (measured) = 0.365 mW/g

Date/Time: 28-06-2012

Test Laboratory: QuieTek Lab

802.11g 2437MHz-Bottom

**DUT: Tablet PC; Type: TC978**

Communication System: Wi-Fi; Communication System Band: 802.11b; Duty Cycle: 1:1; Frequency: 2437 MHz; Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.98$  mho/m;  $\epsilon_r = 52.68$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section

Ambient temperature ( ): 21.5, Liquid temperature ( ): 21.0

DASY5 Configuration:

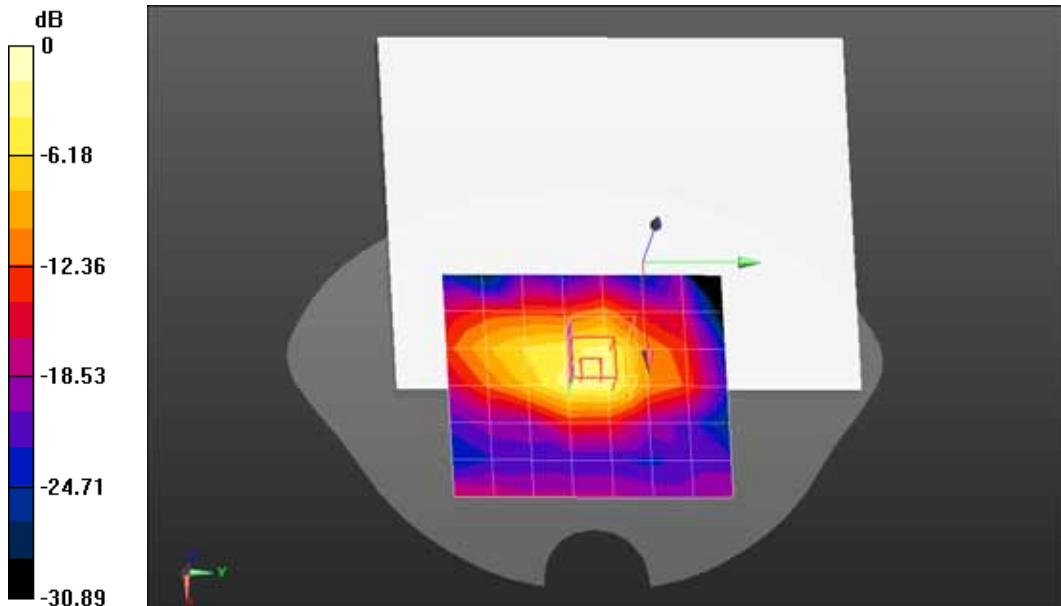
- Probe: EX3DV4 - SN3710; ConvF(6.98, 6.98, 6.98); Calibrated: 12/03/2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 23/01/2012
- Phantom: SAM1; Type: SAM; Serial: TP1561
- Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

**Configuration/802.11g Mid-Bottom/Area Scan (7x8x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (measured) = 0.123 mW/g

**Configuration/802.11g Mid-Bottom/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm, Reference Value = 9.969 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 0.498 mW/g

**SAR(1 g) = 0.214 mW/g; SAR(10 g) = 0.094 mW/g** Maximum value of SAR (measured) = 0.228 mW/g

Date/Time: 28-06-2012

Test Laboratory: QuieTek Lab

802.11n(20MHz) 2437MHz-Bottom

**DUT: Tablet PC; Type: TC978**

Communication System: Wi-Fi; Communication System Band: 802.11n(20MHz); Duty Cycle: 1:1; Frequency: 2437 MHz; Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.98$  mho/m;  $\epsilon_r = 52.68$ ;  $\rho = 1000$  kg/m<sup>3</sup>; Phantom section: Flat Section

Ambient temperature ( ): 21.5, Liquid temperature ( ): 21.0

DASY5 Configuration:

- Probe: EX3DV4 - SN3710; ConvF(6.98, 6.98, 6.98); Calibrated: 12/03/2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1220; Calibrated: 23/01/2012
- Phantom: SAM1; Type: SAM; Serial: TP1561
- Measurement SW: DASY52, Version 52.8 (1); SEMCAD X Version 14.6.5 (6469)

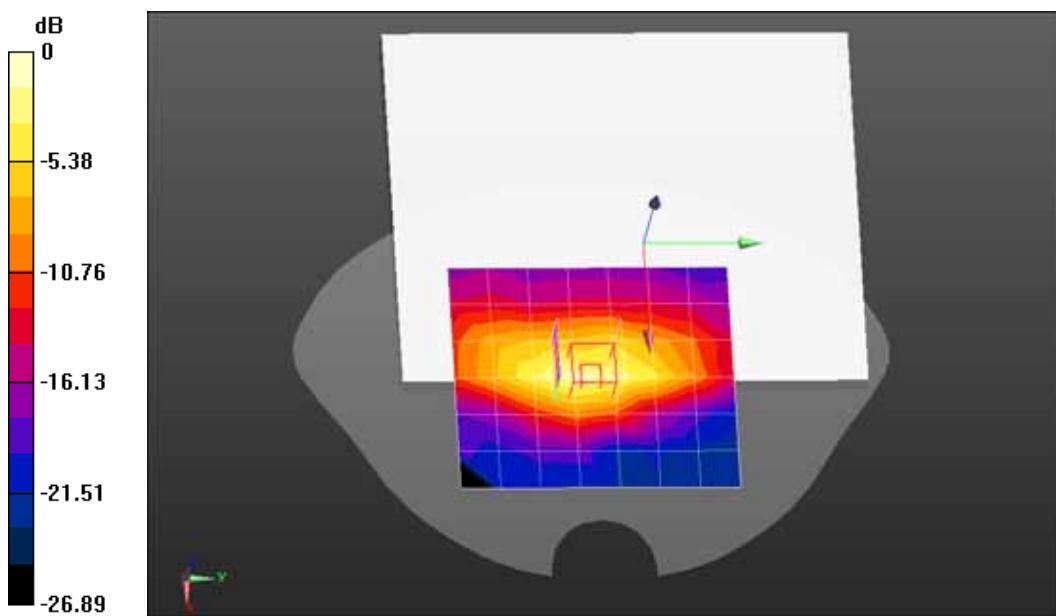
**Configuration/802.11n(20MHz) Mid-Bottom/Area Scan (7x8x1):** Measurement grid: dx=20mm, dy=20mm

Maximum value of SAR (measured) = 0.188 mW/g

**Configuration/802.11n(20MHz) Mid-Bottom/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm, Reference Value = 11.601 V/m; Power Drift = -0.14 dB

Peak SAR (extrapolated) = 0.530 mW/g

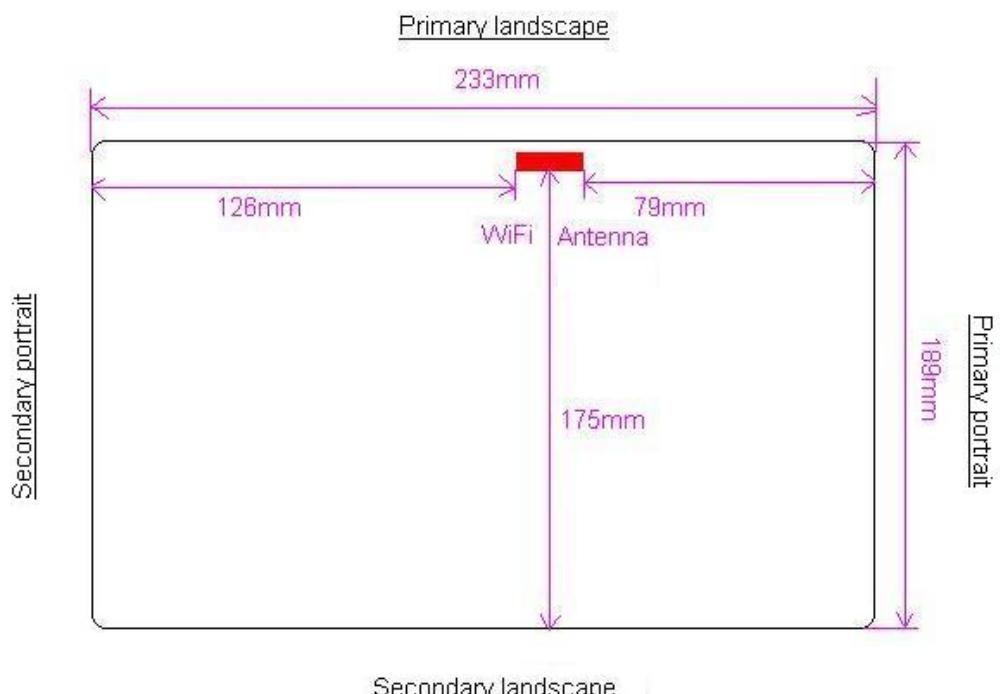
**SAR(1 g) = 0.228 mW/g; SAR(10 g) = 0.102 mW/g** Maximum value of SAR (measured) = 0.235 mW/g



## Appendix C. Test Setup Photographs & EUT Photographs

### Antenna to Antenna/User Separation Distances

#### Bottom of the Tablet



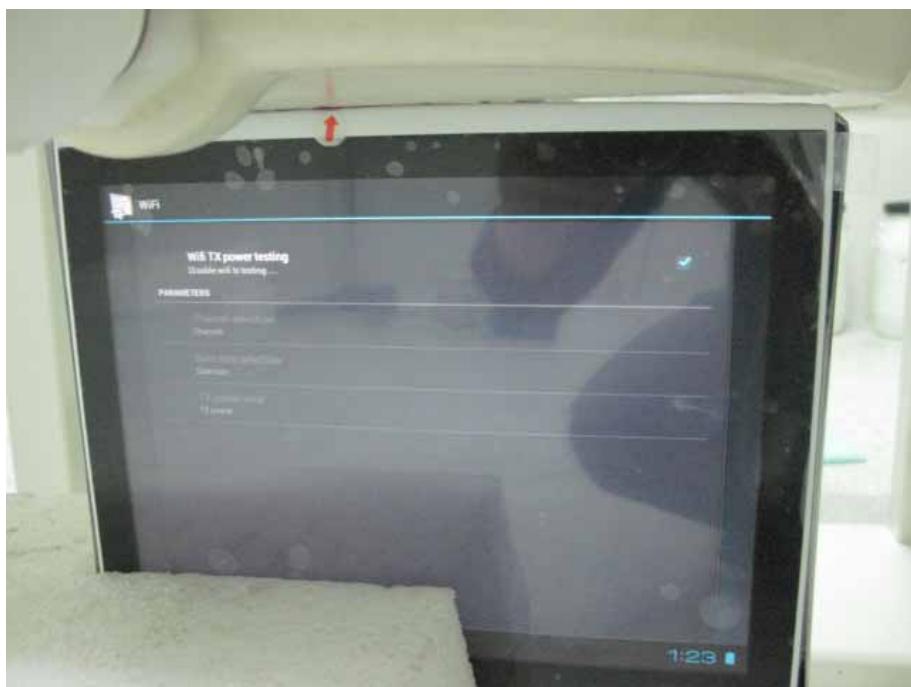
Antenna-to-user separation distances:	<b>WiFi Antenna</b> Tablet-Bottom face: 5mm from WiFi Antenna-to-user Tablet-Edges with the following configurations <ul style="list-style-type: none"><li>• Primary landscape: 3mm from WiFi Antenna-to-user</li><li>• Secondary landscape: 175mm from WiFi Antenna-to-user</li><li>• Primary portrait: 189mm from WiFi Antenna-to-user</li><li>• Secondary portrait: 126mm from WiFi Antenna-to-user</li></ul>
---------------------------------------	--

**Test Setup Photographs**

Bottom Touch



Primary landscape Touch



Primary portrait Touch



**Depth of the liquid in the phantom – Zoom in**

Note: The position used in the measurements were according to IEEE 1528 - 2003



**EUT Photographs**

(1) EUT Photo



(2) EUT Photo



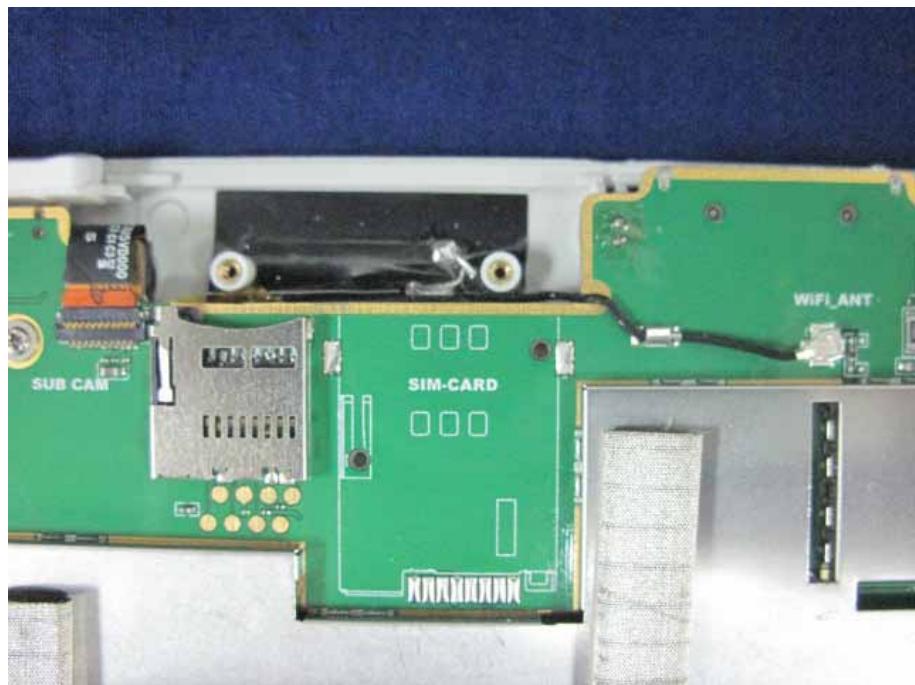
(3) EUT Photo(with battery #1)



(4) EUT Photo(with battery #2)



## (5) EUT Photo



## Appendix D. Probe Calibration Data

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  
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-CN (Auden)

Certificate No: EX3-3710\_Mar12

### CALIBRATION CERTIFICATE

Object EX3DV4 - SN:3710

Calibration procedure(s) QA CAL-01.v8, QA CAL-12.v7, QA CAL-14.v3, QA CAL-23.v4,  
QA CAL-25.v4  
Calibration procedure for dosimetric E-field probes

Calibration date: March 12, 2012

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
Power meter E4419B	GB41293874	31-Mar-11 (No. 217-01372)	Apr-12
Power sensor E4412A	NY41498087	31-Mar-11 (No. 217-01372)	Apr-12
Reference 3 dB Attenuator	SN: S5054 (3c)	29-Mar-11 (No. 217-01369)	Apr-12
Reference 20 dB Attenuator	SN: S5086 (20b)	29-Mar-11 (No. 217-01367)	Apr-12
Reference 30 dB Attenuator	SN: S5129 (30b)	29-Mar-11 (No. 217-01370)	Apr-12
Reference Probe ES3DV2	SN: 3013	29-Dec-11 (No. ES3-3013_Dec11)	Dec-12
DAE4	SN: 654	3-May-11 (No. DAE4-654_May11)	May-12
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

Calibrated by:	Name: Jeton Kastrati Function: Laboratory Technician	Signature:
Approved by:	Name: Katja Pokovic Function: Technical Manager	Signature:

Issued: March 13, 2012

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
NORM $x,y,z$	sensitivity in free space
ConvF	sensitivity in TSL / NORM $x,y,z$
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C	modulation dependent linearization parameters
Polarization $\varphi$	$\varphi$ rotation around probe axis
Polarization $\vartheta$	$\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis

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

- 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
- 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

#### Methods Applied and Interpretation of Parameters:

- $NORM_{x,y,z}$ : Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide).  $NORM_{x,y,z}$  are only intermediate values, i.e., the uncertainties of  $NORM_{x,y,z}$  does not affect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- $NORM(f)x,y,z = NORM_{x,y,z} * frequency\_response$  (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 with CW signal (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  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. 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  $NORM_{x,y,z} * ConvF$  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  $\pm 50$  MHz to  $\pm 100$  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.

EX3DV4 – SN:3710

March 12, 2012

# Probe EX3DV4

## SN:3710

Manufactured: July 21, 2009  
Repaired: February 21, 2012  
Calibrated: March 12, 2012

Calibrated for DASY/EASY Systems  
(Note: non-compatible with DASY2 system!)

EX3DV4- SN:3710

March 12, 2012

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3710****Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.51	0.56	0.44	$\pm 10.1\%$
DCP (mV) <sup>B</sup>	101.3	98.9	100.9	

**Modulation Calibration Parameters**

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc <sup>E</sup> (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	114.4	$\pm 2.2\%$
			Y	0.00	0.00	1.00	94.4	
			Z	0.00	0.00	1.00	114.2	

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 NormX,Y,Z do not affect the  $E^2$ -field uncertainty inside TSL (see Pages 5 and 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.

EX3DV4- SN:3710

March 12, 2012

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3710**

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	Depth (mm)	Unct. (k=2)
450	43.5	0.87	9.61	9.61	9.61	0.12	1.00	± 13.4 %
750	41.9	0.89	9.51	9.51	9.51	0.24	1.16	± 12.0 %
835	41.5	0.90	9.18	9.18	9.18	0.22	1.15	± 12.0 %
900	41.5	0.97	8.97	8.97	8.97	0.19	1.35	± 12.0 %
1810	40.0	1.40	8.32	8.32	8.32	0.79	0.60	± 12.0 %
1900	40.0	1.40	8.16	8.16	8.16	0.72	0.66	± 12.0 %
2450	39.2	1.80	7.25	7.25	7.25	0.36	0.91	± 12.0 %
2600	39.0	1.96	6.96	6.96	6.96	0.39	0.95	± 12.0 %
3500	37.9	2.91	6.80	6.80	6.80	0.33	1.09	± 13.1 %
5200	36.0	4.66	5.21	5.21	5.21	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.95	4.95	4.95	0.35	1.80	± 13.1 %
5800	35.3	5.27	4.56	4.56	4.56	0.45	1.80	± 13.1 %

<sup>c</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>f</sup> At frequencies 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.

EX3DV4- SN:3710

March 12, 2012

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3710****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	Depth (mm)	Unct. (k=2)
450	56.7	0.94	10.69	10.69	10.69	0.06	1.00	± 13.4 %
750	55.5	0.96	9.33	9.33	9.33	0.43	0.86	± 12.0 %
835	55.2	0.97	9.13	9.13	9.13	0.63	0.70	± 12.0 %
900	55.0	1.05	9.04	9.04	9.04	0.39	0.88	± 12.0 %
1810	53.3	1.52	7.73	7.73	7.73	0.33	1.10	± 12.0 %
1900	53.3	1.52	7.43	7.43	7.43	0.42	0.90	± 12.0 %
2450	52.7	1.95	6.98	6.98	6.98	0.79	0.59	± 12.0 %
2600	52.5	2.16	6.68	6.68	6.68	0.79	0.52	± 12.0 %
3500	51.3	3.31	6.23	6.23	6.23	0.36	1.13	± 13.1 %
5200	49.0	5.30	4.20	4.20	4.20	0.50	1.90	± 13.1 %
5500	48.6	5.65	3.82	3.82	3.82	0.50	1.90	± 13.1 %
5800	48.2	6.00	3.89	3.89	3.89	0.60	1.90	± 13.1 %

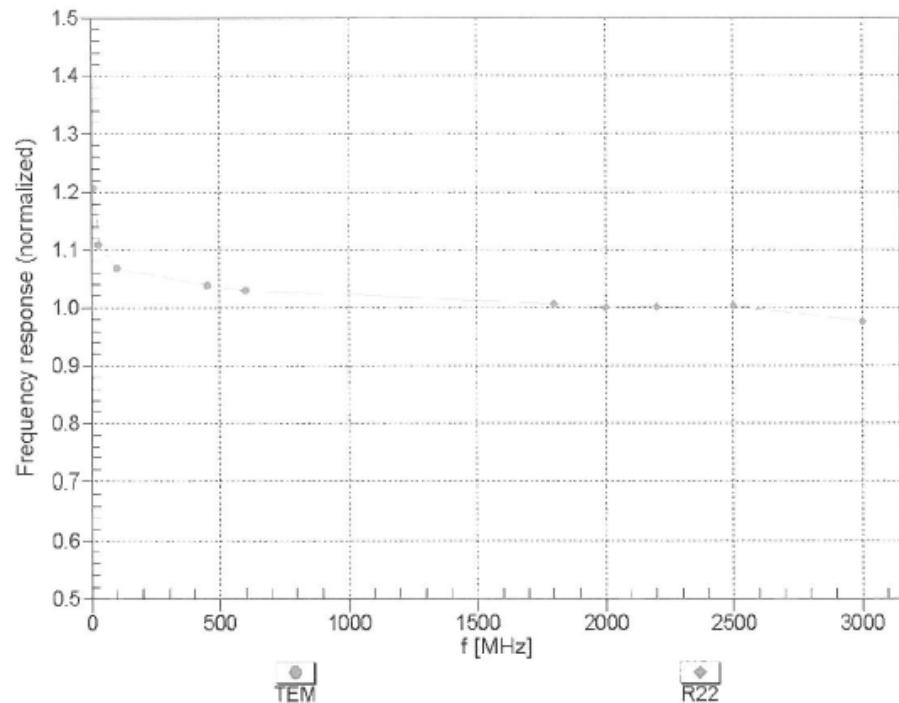
<sup>c</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.<sup>f</sup> At frequencies below 3 GHz, 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.

EX3DV4– SN:3710

March 12, 2012

### Frequency Response of E-Field

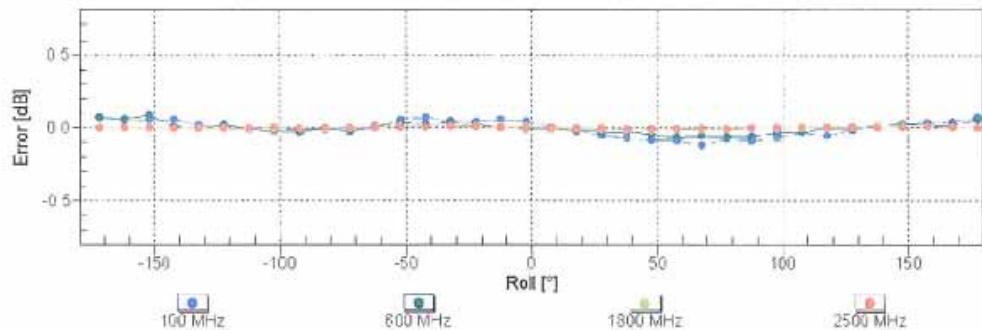
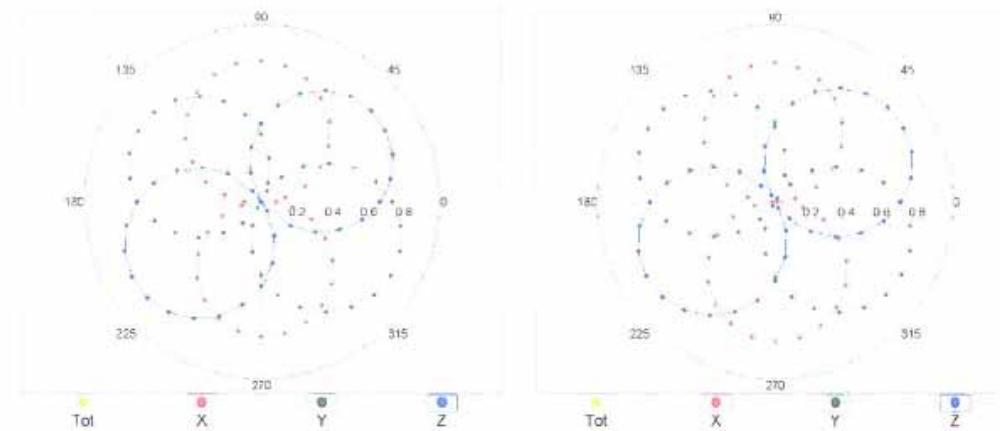
(TEM-Cell:ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

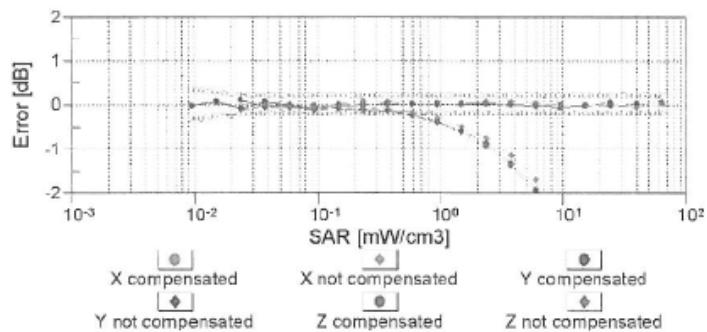
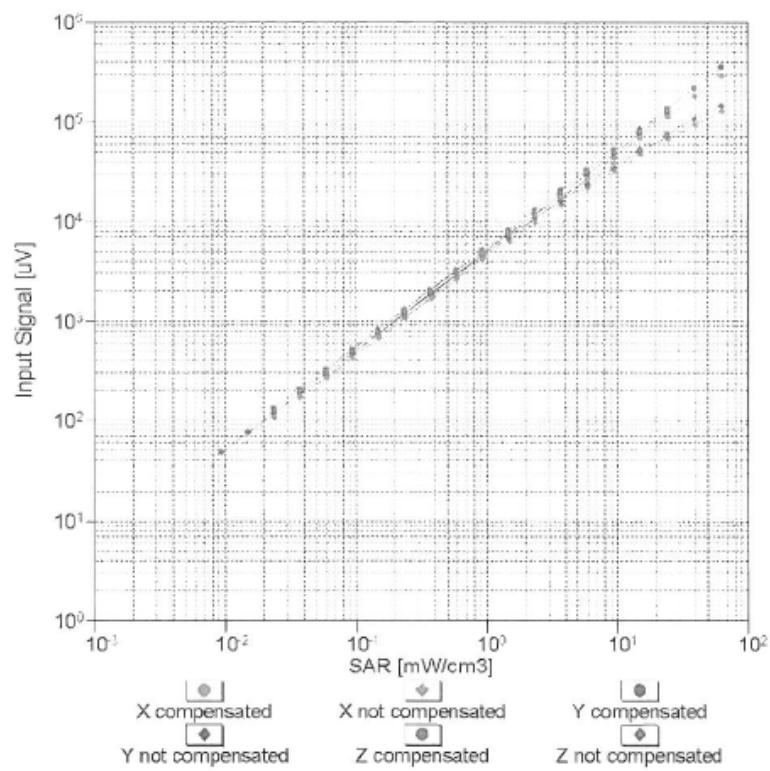
EX3DV4- SN.3710

March 12, 2012

**Receiving Pattern ( $\phi$ ),  $\theta = 0^\circ$**  $f=600$  MHz, TEM $f=1800$  MHz, R22Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

EX3DV4- SN:3710

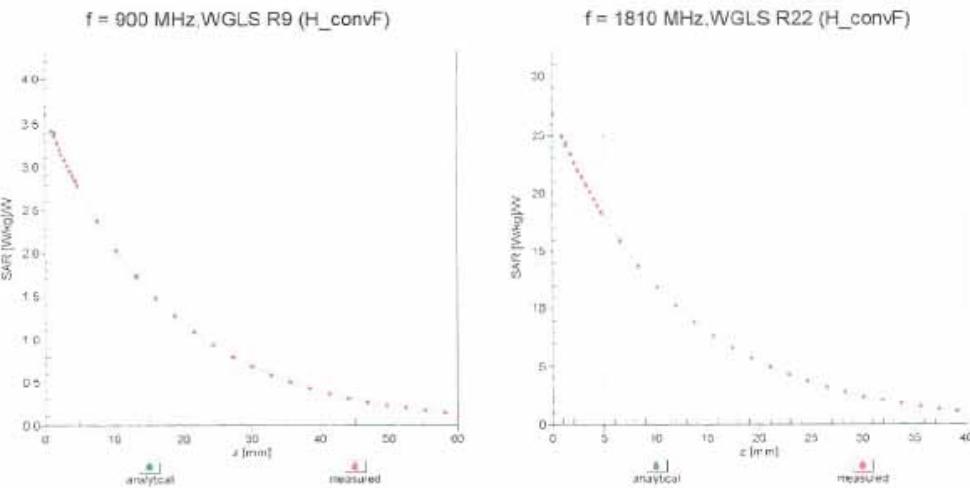
March 12, 2012

**Dynamic Range f(SAR<sub>head</sub>)**  
(TEM cell , f = 900 MHz)**Uncertainty of Linearity Assessment:  $\pm 0.6\%$  (k=2)**

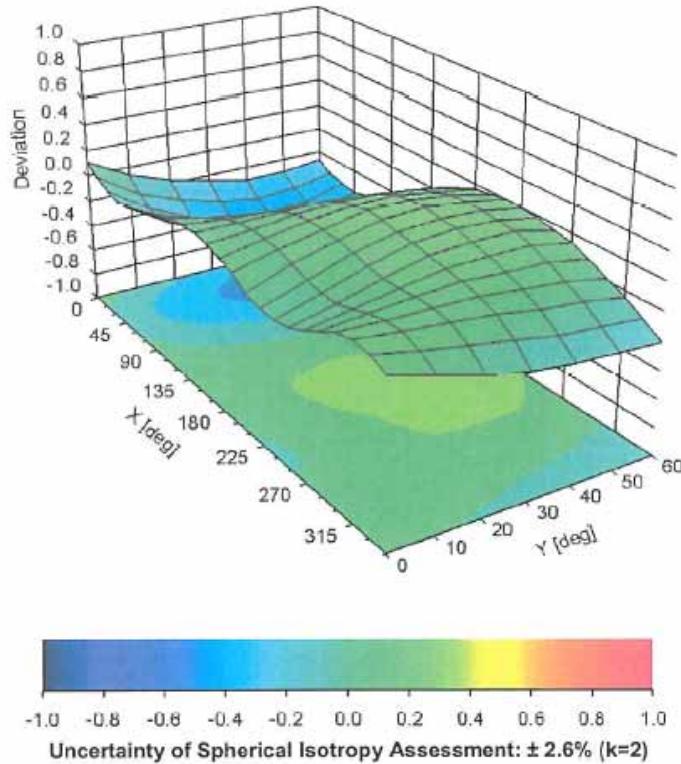
EX3DV4- SN:3710

March 12, 2012

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid Error ( $\phi, \theta$ ), $f = 900 \text{ MHz}$



EX3DV4- SN:3710

March 12, 2012

**DASY/EASY - Parameters of Probe: EX3DV4 - SN:3710****Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	Not applicable
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

## 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-CN (Auden)

Certificate No: D2450V2-839\_Feb12

### CALIBRATION CERTIFICATE

Object D2450V2 - SN: 839

Calibration procedure(s)  
QA CAL-05.v8  
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: February 23, 2012

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 ( $22 \pm 3$ )°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	05-Oct-11 (No. 217-01451)	Oct-12
Power sensor HP 8481A	US37292783	05-Oct-11 (No. 217-01451)	Oct-12
Reference 20 dB Attenuator	SN: 5086 (20g)	29-Mar-11 (No. 217-01368)	Apr-12
Type N mismatch combination	SN: 5017.2 / 06327	29-Mar-11 (No. 217-01371)	Apr-12
Reference Probe ES3DV3	SN: 3205	30-Dec-11 (No. ES3-3205_Dec11)	Dec-12
DAE4	SN: 601	04-Jul-11 (No. DAE4-601_Jul11)	Jul-12

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

Calibrated by:	Name	Function	Signature
	Israe El-Naouq	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 23, 2012

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.

DASY Version	DASY5	V52.8.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

**Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.9 ± 6 %	1.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Head TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.2 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	51.9 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.09 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	24.1 mW /g ± 16.5 % (k=2)

**Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.3 ± 6 %	2.02 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Body TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.4 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	48.7 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.76 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	22.8 mW / g ± 16.5 % (k=2)

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

Impedance, transformed to feed point	55.7 $\Omega$ - 1.0 $j\Omega$
Return Loss	- 25.2 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	52.1 $\Omega$ + 1.0 $j\Omega$
Return Loss	- 32.9 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.160 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	July 20, 2009

**DASY5 Validation Report for Head TSL**

Date: 23.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 839**

Communication System: CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.86$  mho/m;  $\epsilon_r = 38.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

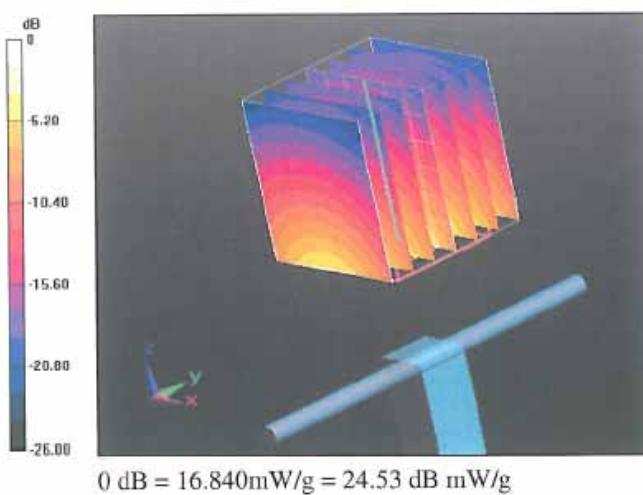
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.155 V/m; Power Drift = 0.08 dB

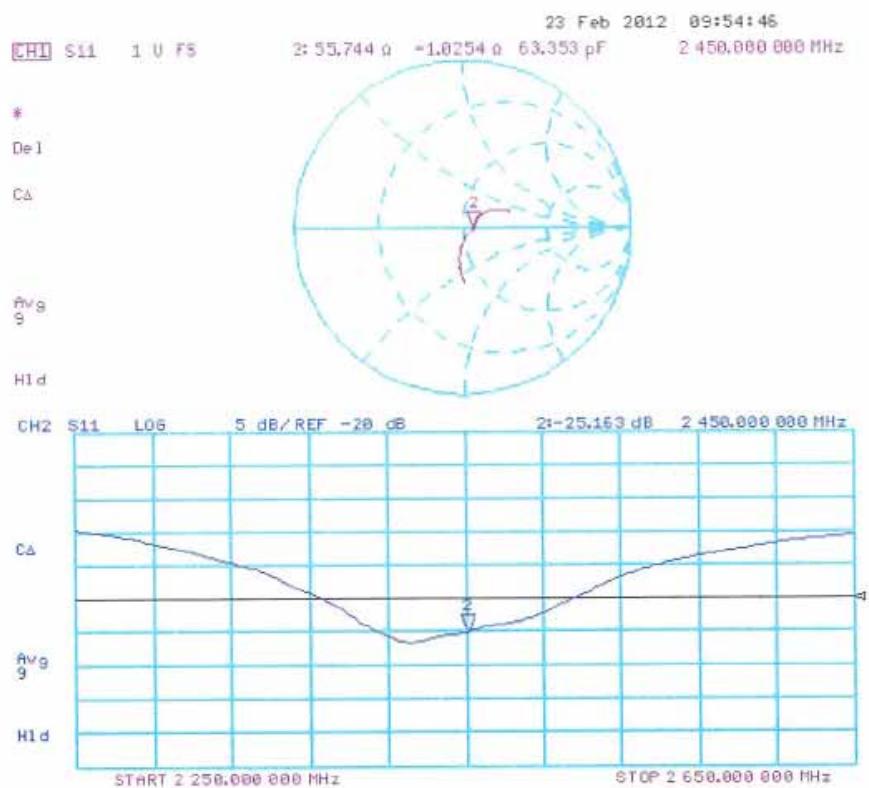
Peak SAR (extrapolated) = 27.8700

SAR(1 g) = 13.2 mW/g; SAR(10 g) = 6.09 mW/g

Maximum value of SAR (measured) = 16.839 mW/g



## Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 23.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 839**

Communication System: CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.02$  mho/m;  $\epsilon_r = 52.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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

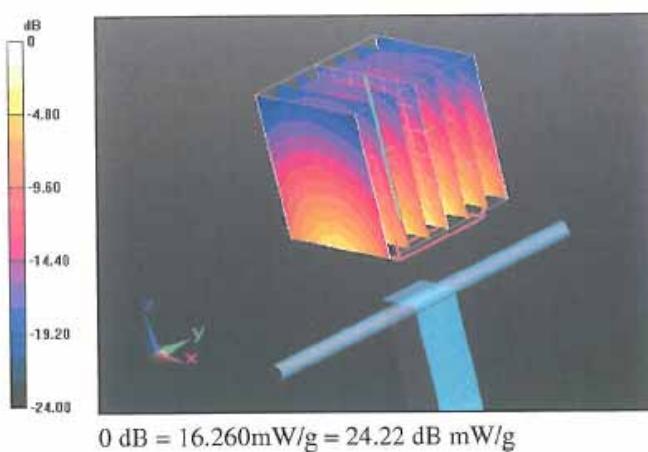
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 93.056 V/m; Power Drift = 0.0053 dB

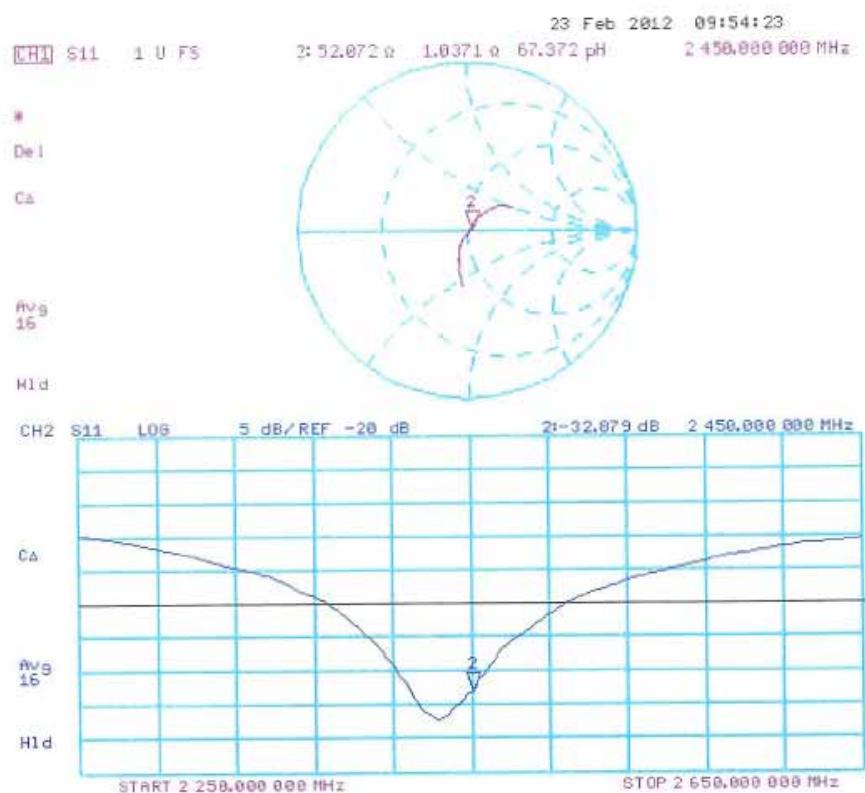
Peak SAR (extrapolated) = 25.2250

SAR(1 g) = 12.4 mW/g; SAR(10 g) = 5.76 mW/g

Maximum value of SAR (measured) = 16.258 mW/g



## Impedance Measurement Plot for Body TSL



**Appendix F. DAE Calibration Data**

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

Client Quietek-CN (Auden)

Certificate No: DAE4-1220\_Jan12

**CALIBRATION CERTIFICATE**

Object DAE4 - SD 000 D04 BJ - SN: 1220

Calibration procedure(s) QA CAL-06.v24  
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: January 23, 2012

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
Keithley Multimeter Type 2001	SN: 0810278	28-Sep-11 (No:11450)	Sep-12
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Calibrator Box V2.1	SE UWS 053 AA 1001	05-Jan-12 (in house check)	In house check: Jan-13

Calibrated by:	Name Dominique Steffen	Function Technician	Signature 
Approved by:	Fin Bomholt	R&D Director	

Issued: January 23, 2012

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  
**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**

### 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	$405.267 \pm 0.1\% (\text{k}=2)$	$404.990 \pm 0.1\% (\text{k}=2)$	$404.221 \pm 0.1\% (\text{k}=2)$
Low Range	$3.97762 \pm 0.7\% (\text{k}=2)$	$3.99629 \pm 0.7\% (\text{k}=2)$	$3.98707 \pm 0.7\% (\text{k}=2)$

**Connector Angle**

Connector Angle to be used in DASY system	$176.5^\circ \pm 1^\circ$
---	---------------------------

**Appendix****1. DC Voltage Linearity**

High Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	199991.77	-2.52	-0.00
Channel X	+ Input	20001.19	1.01	0.01
Channel X	- Input	-19996.52	3.93	-0.02
Channel Y	+ Input	199992.70	-2.15	-0.00
Channel Y	+ Input	19999.00	-1.14	-0.01
Channel Y	- Input	-19999.75	0.71	-0.00
Channel Z	+ Input	199991.55	-3.11	-0.00
Channel Z	+ Input	19999.33	-0.76	-0.00
Channel Z	- Input	-20001.23	-0.67	0.00

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	1999.14	-1.60	-0.08
Channel X	+ Input	201.79	0.59	0.29
Channel X	- Input	-198.19	0.48	-0.24
Channel Y	+ Input	1999.56	-0.99	-0.05
Channel Y	+ Input	200.20	-0.96	-0.48
Channel Y	- Input	-199.38	-0.54	0.27
Channel Z	+ Input	2000.07	-0.52	-0.03
Channel Z	+ Input	200.32	-0.83	-0.41
Channel Z	- Input	-199.60	-0.78	0.39

**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	10.22	8.65
	-200	-6.99	-8.91
Channel Y	200	-10.43	-11.02
	-200	7.95	9.22
Channel Z	200	14.25	13.66
	-200	-15.77	-14.99

**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	-	-1.62	-2.79
Channel Y	200	8.07	-	-2.95
Channel Z	200	7.90	6.93	-

**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	15896	16218
Channel Y	16012	15924
Channel Z	15702	15710

**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	0.67	-0.77	1.84	0.43
Channel Y	-1.44	-2.35	-0.02	0.39
Channel Z	-0.81	-1.60	0.01	0.37

**6. Input Offset Current**

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