

**ELECTRONIC TECHNOLOGY SYSTEMS  
DR. GENZ GMBH**

# **TEST - REPORT**

**SAR Compliance Test Report**

**Test report no.:**

**G0M20605-0487-S-2**

# **SAR**



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# 1 General Information

## 1.1 Notes

The purpose of conformity testing is to increase the probability of adherence to the essential requirements or conformity specifications, as appropriate.

The complexity of the technical specifications, however, means that full and thorough testing is impractical for both technical and economic reasons.

Furthermore, there is no guarantee that a test sample which has passed all the relevant tests conforms to a specification.

The existence of the tests nevertheless provides the confidence that the test sample possesses the qualities as maintained and that its performance generally conforms to representative cases of communications equipment.

The test results of this test report relate exclusively to the item tested as specified in 1.5.

The test report may only be reproduced or published in full.

Reproduction or publication of extracts from the report requires the prior written approval of the ELECTRONIC TECHNOLOGY SYSTEMS DR. GENZ GMBH.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualification of all persons taking them.

### Tester:

07.11.2006

Mr. Cersovsky

*i.s. Kurš*

Date

ETS-Lab.

Name

Signature

### Technical responsibility for area of testing:

07.11.2006

N. Kaspar

*N. Kaspar*

Date

ETS

Name

Signature

## 1.2 Testing laboratory

### 1.2.1 Location

ELECTRONIC TECHNOLOGY SYSTEM DR. GENZ GMBH (ETS)

Storkower Straße 38c

D-15526 Reichenwalde b. Berlin

Germany

Telephone : +49 33631 888 00

Fax : +49 33631 888 660

### 1.2.2 Details of accreditation status

**ACCREDITED TESTING LABORATORY**

**DAR-REGISTRATION NUMBER:** DAT-P-201/96

**FCC FILED TEST LABORATORY** REG. No. 96970

**BLUETOOTH QUALIFICATION TEST FACILITY (BQTF)**

ACCREDITED BY BLUETOOTH QUALIFICATION REVIEW BOARD

**INDUSTRY CANADA FILED TEST LABORATORY** REG. No. IC 3470

**A2LA ACCREDITED** Certificate Number 1983-01

## 1.3 Details of approval holder

|           |                              |
|-----------|------------------------------|
| Name      | : KIRK telecom A/S           |
| Street    | : Langmarksvej 34            |
| Town      | : DK-8700 Horsens            |
| Country   | : Denmark                    |
| Telephone | : +45 7628 1280              |
| Fax       | : +45 7560 2851              |
| Contact   | : Mr. Henrik Birch Rasmussen |
| E-Mail    | : hbr@kirktelecom.dk         |

## 1.4 Manufacturer: (if applicable)

|         |   |
|---------|---|
| Name    | : |
| Street  | : |
| Town    | : |
| Country | : |

## 1.5 Application details

Date of receipt of application : 15.05.2006  
Date of receipt of test item : 15.05.2006  
Date of test : 23.05.2006

## 1.6 Test item

FCC ID : PXAPP6N20-1G9  
Description of test item : DECT PP, Portable Part  
Type identification : PP6N20 1G9  
Brand Name : Brand Name: Kirk telecom A/S  
Serial number : without; Identical prototype  
Device category : PUE (Part 15 unlicensed PCS portable TX held to ear)

## Technical data

TX Frequency range : 1921.536 – 1928.448 MHz  
Max. radiated RF output power : UPCS / 20,31 dBm (107,4 mW)  
Power supply : 3.7 V DC  
Antenna Tx : integral  
Antenna RX : integral  
Additional information : ./.

## 1.7 Test Results

Max. SAR Measurement : 0.075 W/kg (averaged over 1 gram)

This EUT has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE Std. C95.1-1992 and had been tested in accordance with the measurement procedures specified in FCC/OET Bulletin 65 Supplement C (2001) and IEEE Std. 1528-2003, December 2003.

## 1.8 Test standards

Standards : - IEEE Std. 1528-2003, December 2003

FCC Rule Part(s) : - FCC OET Bulletin 65, Supplement C, Edition 01-01

## 2 Technical test

### 2.1 Summary of test results

#### Applicable Configuration

|                     |   |
|---------------------|---|
| Handset (Head)      | X |
| Handset (Body)      | X |
| Headset (Head)      |   |
| Body Worn Equipment |   |

EUT complies with the RF radiation exposure limits of the FCC as shown by the SAR measurement results. These measurements are taken to simulate the RF effects exposure under worst-case conditions. The EUT complies with the requirements in respect to all parameters subject to the test. The test results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because innumerable factors may interact to determine the specific biological outcome of an exposure to electromagnetic fields, any protection guide shall consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [1]

In case of multiple hotspots the secondary hotspots within 2dB of the maximum SAR value will be recorded and displayed in the measurement plots. The secondary hotspots with a peak SAR value below 0.5 W/kg will not be measured by the system, due to the high margin to the limits.

### 2.2 Test environment

Room temperature : 22.1 -22.6 °C

Liquid temperature : 22.0 -22.3 °C

Relative humidity content : 20 ... 75 %

Air pressure : 86 ... 103 k P a

Details of power supply : 3.7 V DC

## 2.3 Test equipment utilized

| No.       | Measurement device:                  | Type:              | Manufacturer:    |
|-----------|--------------------------------------|--------------------|------------------|
| ETS 0449  | Stäubli Robot                        | RX90B L            | Stäubli          |
| ETS 0450  | Stäubli Robot Controller             | CS/MBs&p           | Stäubli          |
| ETS 0451  | DASY 4 Measurement Server            |                    | Schmid & Partner |
| ETS 0452  | Control Pendant                      |                    | Stäubli          |
| ETS 0453  | Compaq Computer                      | Pentium IV, 2 GHz, | Schmid & Partner |
| ETS 0454  | Dabu Acquisition Electronics         | DAE3V1             | Schmid & Partner |
| ETS 0455  | Dummy Probe                          |                    | Schmid & Partner |
| ETS 0456  | Dosimetric E-Field Probe             | ET3DV6             | Schmid & Partner |
| ETS 0457  | Dosimetric E-Field Probe             | ET3DV6             | Schmid & Partner |
| ETS 0458  | Dosimetric H-Field Probe             | H3DV6              | Schmid & Partner |
| ETS 0459  | System Validation Kit                | D900V2             | Schmid & Partner |
| ETS 0460  | System Validation Kit                | D1800V2            | Schmid & Partner |
| ETS 0461  | System Validation Kit                | D1900V2            | Schmid & Partner |
| ETS 0462  | System Validation Kit                | D2450V2            | Schmid & Partner |
| ETS 0463  | Probe Alignment Unit                 | LBV2               | Schmid & Partner |
| ETS 0464  | SAM Twin phantom                     | V 4.0              | Schmid & Partner |
| ETS 0465  | Mounting Device                      | V 3.1              | Schmid & Partner |
| ETS 0224a | Millivoltmeter                       | URV 5              | Rohde & Schwarz  |
| ETS 0219  | Power sensor                         | NRV-Z2             | Rohde & Schwarz  |
| ETS 0268  | RF signal generator                  | SMP 02             | Rohde & Schwarz  |
| ETS 0322  | Insertion unit                       | URV5-Z4            | Rohde & Schwarz  |
| ETS 0466  | Directional Coupler                  | HP 87300B          | HP               |
| ETS0231   | Radio Communication Tester           | CMD65              | Rohde & Schwarz  |
| ETS 0467  | Universal Radio Communication Tester | CMU 200            | Rohde & Schwarz  |
| ETS 0468  | Network Analyzer 300 kHz to 3 GHz    | 8753C              | Agilent          |
| ETS 0469  | Dielectric Probe Kit                 | 85070C             | Agilent          |

## 2.4 Definitions

### 2.4.1 SAR

The specific absorption rate (SAR) is defined as the time derivative of the incremental energy ( $dW$ ) absorbed by (dissipated in) an incremental mass ( $dm$ ) contained in a volume element ( $dV$ ) of a given density ( $\rho_t$ ), expressed in watts per kilogram (W/kg)

$$\text{SAR} = \frac{d}{dt} \left( \frac{dW}{dm} \right) = \frac{d}{dt} \left( \frac{dW}{\rho_t dV} \right) = \frac{\sigma}{\rho_t} |E_t|^2$$

where:

$$\frac{dW}{dt} = \int_V E \cdot J dV = \int_V \sigma E^2 dV$$

### 2.4.2 Uncontrolled Exposure

The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category, and the general population/uncontrolled exposure limits apply to these devices. [2]

### 2.4.3 Controlled Exposure

In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate, warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on the risk of potential exposure and instructions on methods to minimize such exposure risks. [2]

## 2.5 Measurement System Description

### 2.5.1 System Setup

Measurements are performed using the DASY4 automated dosimetric assessment system (figure 1) made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland.



Figure 1

The DASY4 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- 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.
- An unit to operate the optical surface detector which is connected to the EOC.
- The Electro-optical converter (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the measurement server.
- The functions of the measurement server is to perform the time critical task such as signal filtering, surveillance of the robot operation, fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows NT.
- DASY4 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes (see Application Notes).
- System validation dipoles allowing to validate the proper functioning of the system.

## 2.5.2 Phantom Description



Figure 2

The SAM twin phantom V4.0 (figure 2) is a fiberglass shell phantom with 2 mm shell thickness. It has three measurement areas:

- Left hand
- Right hand
- Flat phantom

The phantom is integrated in a wooden table.

The bottom plate of the table 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. Only one device holder is necessary if two phantoms are used (e.g., for different liquids).

A cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. Free space scans of devices on the cover are possible.

On the phantom top, three reference markers are provided to identify the phantom positions with respect to the robot.

## 2.5.3 Tissue Simulating Liquids

The parameters of the tissue simulating liquid strongly influence the SAR. The parameters for the different frequencies are defined in the corresponding compliance standards (e.g., EN 50361, IEEE P1528-2003, December 2003).

Tissue dielectric properties

| Frequency<br>(MHz) | Head                                             |                                    | Body                                             |                                    |
|--------------------|--------------------------------------------------|------------------------------------|--------------------------------------------------|------------------------------------|
|                    | Relative Dielectric<br>Constant ( $\epsilon_r$ ) | Conductivity ( $\sigma$ )<br>(S/m) | Relative Dielectric<br>Constant ( $\epsilon_r$ ) | Conductivity ( $\sigma$ )<br>(S/m) |
| 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                               |
| 1450               | 40.5                                             | 1.20                               | 54.0                                             | 1.30                               |
| 1800               | 40.0                                             | 1.40                               | 53.3                                             | 1.52                               |
| 1900               | 40.0                                             | 1.40                               | 53.3                                             | 1.52                               |
| 2000               | 40.0                                             | 1.40                               | 53.3                                             | 1.52                               |
| 2450               | 39.2                                             | 1.80                               | 52.7                                             | 1.95                               |
| 3000               | 38.5                                             | 2.40                               | 52.0                                             | 2.73                               |

### 2.5.4 Device Holder

The DASY device holder (figure 3.1 and 3.2) 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 openings). The rotation centers for both scales is the ear opening. Thus the device needs no repositioning when changing the angles.



Figure 3.1



Figure 3.2

The DASY device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity  $\epsilon = 3$  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.

### 2.5.5 Probes

The SAR measurements were conducted with the dosimetric probe ET3DV6 (figure 4), designed in the classical triangular configuration and optimized for dosimetric evaluation. [3] The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY4 software reads the reflection during a software approach and looks for the maximum using a 2<sup>nd</sup> order fitting. The approach is stopped at reaching the maximum.



Figure 4

## Probe Specifications

|                |                                                                                                                                                                                              |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Calibration:   | In air from 10 MHz to 2.5 GHz<br>In brain and muscle simulating tissue at Frequencies of 835 MHz, 900 MHz, 1800 MHz, 1900 MHz and 2450 MHz<br>Calibration certificates please find attached. |
| Frequency:     | 10 MHz to > 3 GHz; Linearity: $\pm 0.2$ dB (30 MHz to 3 GHz)                                                                                                                                 |
| Directivity:   | $\pm 0.2$ dB in HSL (rotation around probe axis)<br>$\pm 0.4$ dB in HSL (rotation normal probe axis)                                                                                         |
| Dynamic Range: | 5 $\mu$ W/g to > 100 mW/g;                                                                                                                                                                   |
| Linearity:     | $\pm 0.2$ dB                                                                                                                                                                                 |
| Dimensions:    | Overall length: 330 mm<br>Tip length: 16 mm<br>Body diameter: 12 mm<br>Tip diameter: 6.8 mm<br>Distance from probe tip to dipole centers: 2.7 mm                                             |
| Application:   | General dosimetry up to 3 GHz<br>Compliance tests of mobile phones<br>Fast automatic scanning in arbitrary phantoms                                                                          |

## 2.6 Test System Specification

### Positioner

|                |                                              |
|----------------|----------------------------------------------|
| Robot:         | Stäubli Animation Corp. Robot Model: RX90B L |
| Repeatability: | 0.02 mm                                      |
| No. of axis:   | 6                                            |

### Data Acquisition Electronic (DAE) System

#### Cell Controller

|                   |                                                                                     |
|-------------------|-------------------------------------------------------------------------------------|
| Processor:        | Pentium IV                                                                          |
| Clock Speed:      | 2.0 GHz                                                                             |
| Operating System: | Windows 2000                                                                        |
| Data Card:        | DASY4 PC-Board                                                                      |
| Data Converter    |                                                                                     |
| Features:         | Signal Amplifier, multiplexer, A/D converter, & control logic                       |
| Software:         | DASY4 software                                                                      |
| Connecting Lines: | Optical downlink for data and status info.<br>Optical uplink for commands and clock |

### PC Interface Card

|           |                                                                                                                                                                                     |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function: | 24 bit (64 MHz) DSP for real time processing<br>Link to DAE3<br>16 bit A/D converter for surface detection system<br>serial link to robot<br>direct emergency stop output for robot |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**E-Field Probes**

|               |                                              |
|---------------|----------------------------------------------|
| Model:        | ET3DV6 SN1711                                |
| Construction: | Triangular core fiber optic detection system |
| Frequency:    | 10 MHz to 6 GHz                              |
| Linearity:    | $\pm 0.2$ dB (30MHz to 3 GHz)                |

**Phantom**

|                 |                         |
|-----------------|-------------------------|
| Phantom:        | SAM Twin Phantom (V4.0) |
| Shell Material: | Fiberglass              |
| Thickness:      | $2.0 \pm 0.2$ mm        |

**2.7 Measurement Procedure**

The evaluation was performed using the following procedure:

1. The SAR measurement was taken at a selected spatial reference point to monitor power variations during testing. This fixed location point was measured and used as a reference value.
2. The SAR distribution at the exposed side of the head was measured at a distance of 3.9mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 10mm x 10mm.
3. Based on the area scan data, the area of the maximum absorption was determined by spline interpolation. Around this point, a volume of 30mm x 30mm x 30mm (fine resolution volume scan, zoom scan) was assessed by measuring 5 x 5 x 5 points. On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure:
  - a. The data at the surface was extrapolated, since the center of the dipoles is 2.7mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2mm. The extrapolation was based on a least square algorithm [4]. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.
  - b. The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were computed using the 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y, and z directions) [4] [5]. The volume was integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.
  - c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as procedure #1, was re-measured. If the value changed by more than 5 %, the evaluation is repeated.

## 2.8 Reference Points

### 2.8.1 Ear Reference Points

Figure 5.1 shows the front, back and side views of SAM. The point "M" is the reference point for the center of mouth, "LE" is the left ear reference point (ERP), and "RE" is the right ERP. The ERPs are 15 mm posterior to the entrance to ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 5.2. The plane passing through the two ear reference points and M is defined as the Reference Plane. The line N-F (Neck-Front) perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 5.3). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines should be marked on the external phantom shell to facilitate handset positioning. Posterior to the N-F line, the thickness of the N-F line, the ear is truncated as illustrated in Figure 5.2. The ear truncation is introduced to avoid the handset from touching the ear lobe, which can cause unstable handset positioning at the cheek. [6]



Figure 5.1

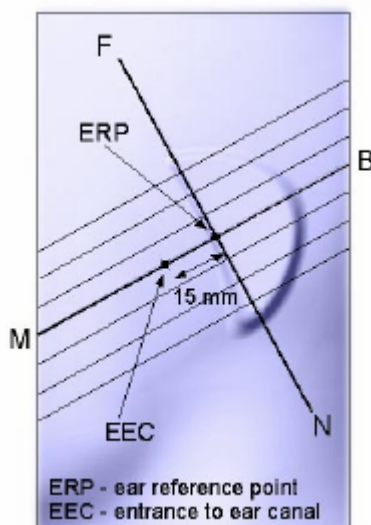


Figure 5.2

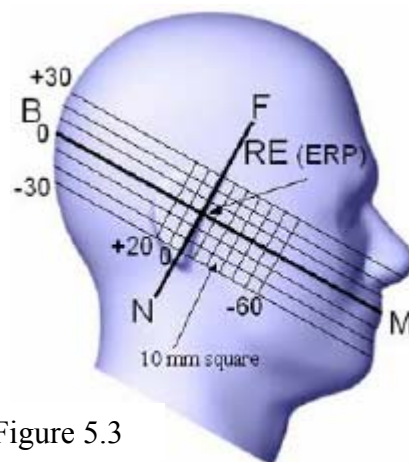


Figure 5.3

## 2.8.2 Handset Reference Points

Two imaginary lines on the handset were defined: the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset: the midpoint of the width  $w_t$  of the handset at the level of the acoustic output (point A on Figures 6.1 and 6.2), and the midpoint of the width  $w_b$  of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Figure 6.1). The two lines intersect at point A. For many handsets, point A coincides with the center of the acoustic output. However, the acoustic output may be located elsewhere on the horizontal line. The vertical centerline is not necessarily parallel to the front face of the handset (see Figure 6.2), especially for clamshell handsets, handsets with flip pieces, and other irregularly-shaped handsets. [6]

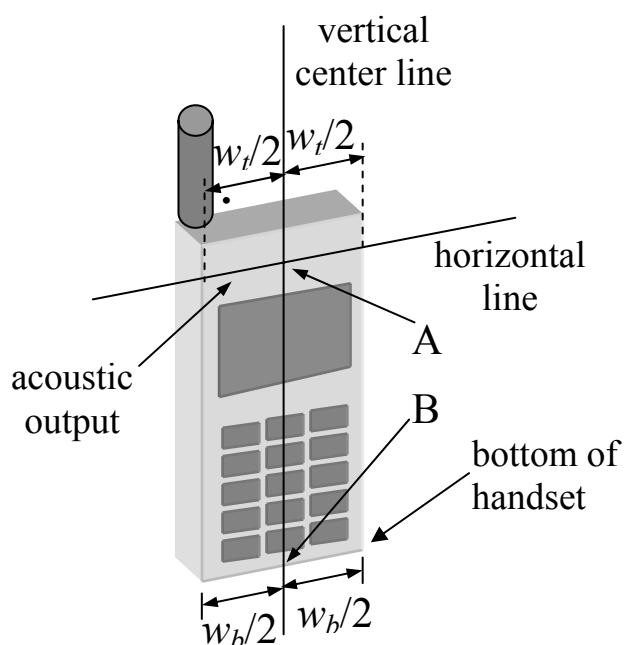


Figure 6.1

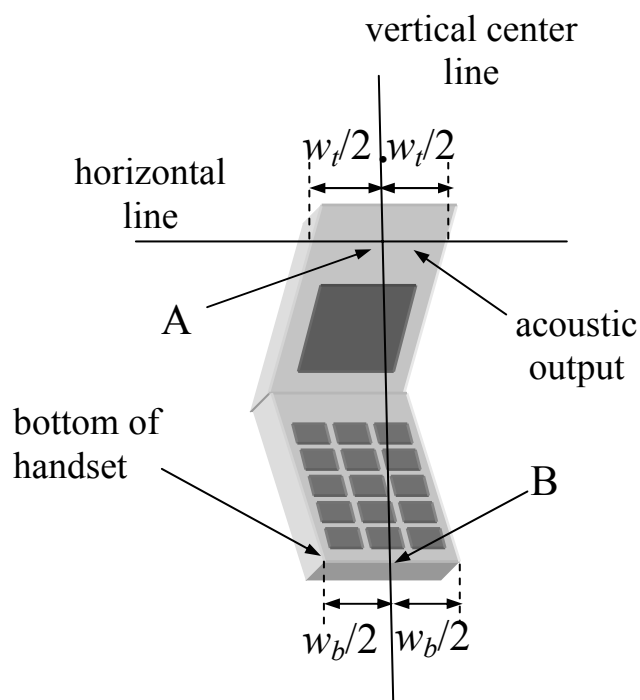


Figure 6.2

## 2.9 Test Positions

### 2.9.1 "Cheek" / "Touch" Position

The EUT was positioned close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 7), such that the plane defined by the vertical center line and the horizontal line of the handset is approximately parallel to the sagittal plane of the phantom.

The EUT was translated towards the phantom along the line passing through RE and LE until the handset touches the pinna.

While maintaining the handset in this plane, the EUT was rotated it around the LE-RE line until the vertical centerline was in the plane normal to MB-NF including the line MB (called the reference plane).

The EUT was rotated around the vertical centerline until the handset (horizontal line) was symmetrical with respect to the line NF.

While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE and maintaining the handset contact with the pinna, the EUT was rotated about the line NF until any point on the handset was in contact with a phantom point below the pinna (cheek). [6] See Figure 7.

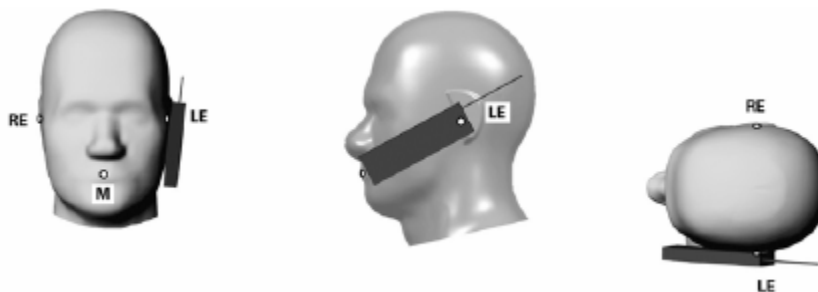


Figure 7

## 2.9.2 "Tilted" Position

The EUT was in "cheek position".

While maintaining the orientation of the handset move the handset away from the pinna along the line passing through RE and LE in order to enable a rotation of the handset by 15 degrees.

The EUT was rotated around the horizontal line by 15 degrees.

While maintaining the orientation of the handset, the EUT was moved towards the phantom on a line passing through RE and LE until any part of the handset touched the ear. The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna (e.g., the antenna with the back of the phantom head), the angle of the handset would be reduced. In this case, the tilted position is obtained if any part of the handset was in contact with the pinna as well as a second part of the handset was in contact with the phantom (e.g., the antenna with the back of the head). [6] See Figure 8.

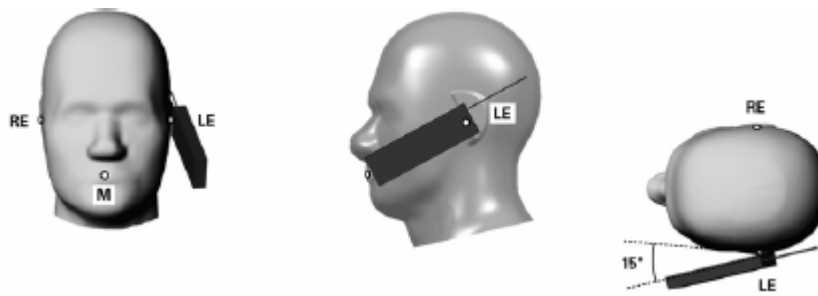


Figure 8

### 2.9.3 Belt Clip/Holster Configuration

Test configurations for body-worn operated EUTs are carried out while the belt-clip and/or holster is attached to the EUT and placed against a flat phantom in a regular configuration (see Figure 9). An EUT with a headset output is tested with a headset connected to the device.

Body dielectric parameters are used.

There are two categories for accessories for body-worn operation configurations:

1. accessories not containing metallic components
2. accessories containing metallic components.

When the EUT is equipped with accessories not containing metallic components the tests are done with the accessory that dictates the closest spacing to the body. For accessories containing metallic parts a test with each one is implemented. If the multiple accessories share an identical metallic component (e.g. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that has the closest spacing to the body is tested.

In case that a EUT authorized to be body-worn is not supplied or has no options to be operated with any accessories, a test configuration where a separation distance between the back of the device and the flat phantom is used. All test position spacings are documented.

Transmitters operating in front of a person's face (e.g. push-to-talk configurations) are tested for SAR compliance with the front of the device positioned to face the flat platform. SAR Compliance tests for shoulder, waist or chest-worn transmitters are carried out with the accessories including headsets and microphones attached to the device and placed against a flat phantom in a regular configuration.

The SAR measurements are performed to investigate the worst-case positioning. This is documented and used to perform Body SAR testing. [2].



Figure 9

## 2.9.4 Headset Configuration

Headsets which have their radiating structure in close proximity to the head are measured according to the following conditions.

- Head tissue liquid is used.
- The EUT is positioned on the surface of the head of phantom according the picture below. Right and left position is tested according to the normal use (see figure 10).
- Additional metallic parts like clips or others are subject of testing, too.



Figure 10

Headsets which have their radiating structure in close proximity to the body are tested as body worn equipment.

## 2.10 Measurement uncertainty

The uncertainty budget has been determined for the DASY4 system performance check according to IEEE Std. 1528-2003 December 2003.

| Error Description                    | Tol.<br>(± %) | Prob.<br>dist. | Div.       | $(^ci)^1$<br>(1g) | Std. unc.<br>(1g) (± %) | $(^vi)^2$  |
|--------------------------------------|---------------|----------------|------------|-------------------|-------------------------|------------|
| <b>Measurement System</b>            |               |                |            |                   |                         |            |
| Probe Calibration                    | 4.8           | N              | 1          | 1                 | 4.8                     | $\infty$   |
| Axial Isotropy                       | 4.7           | R              | $\sqrt{3}$ | 0.7               | 1.9                     | $\infty$   |
| Hemispherical Isotropy               | 9.6           | R              | $\sqrt{3}$ | 0.7               | 3.9                     | $\infty$   |
| Boundary Effects                     | 1.0           | R              | $\sqrt{3}$ | 1                 | 0.6                     | $\infty$   |
| Linearity                            | 4.7           | R              | $\sqrt{3}$ | 1                 | 2.7                     | $\infty$   |
| System Detection Limit               | 1.0           | R              | $\sqrt{3}$ | 1                 | 0.6                     | $\infty$   |
| Readout Electronics                  | 1.0           | N              | 1          | 1                 | 1.0                     | $\infty$   |
| Response Time                        | 0.8           | R              | $\sqrt{3}$ | 1                 | 0.5                     | $\infty$   |
| Integration Time                     | 2.6           | R              | $\sqrt{3}$ | 1                 | 1.5                     | $\infty$   |
| RF Ambient Conditions                | 3.0           | R              | $\sqrt{3}$ | 1                 | 1.7                     | $\infty$   |
| Probe Positioner                     | 0.4           | R              | $\sqrt{3}$ | 1                 | 0.2                     | $\infty$   |
| Probe Positioning                    | 2.9           | R              | $\sqrt{3}$ | 1                 | 1.7                     | $\infty$   |
| Algorithms for Max. SAR Eval.        | 1.0           | R              | $\sqrt{3}$ | 1                 | 0.6                     | $\infty$   |
| <b>Test Sample Related</b>           |               |                |            |                   |                         |            |
| Device Positioning                   | 2.9           | N              | 1          | 1                 | 2.9                     | 145        |
| Device Holder                        | 3.6           | N              | 1          | 1                 | 3.6                     | 5          |
| Power Drift                          | 5.0           | R              | $\sqrt{3}$ | 1                 | 2.9                     | $\infty$   |
| <b>Phantom and Setup</b>             |               |                |            |                   |                         |            |
| Phantom Uncertainty                  | 4.0           | R              | $\sqrt{3}$ | 1                 | 2.3                     | $\infty$   |
| Liquid Conductivity (target)         | 5.0           | R.             | $\sqrt{3}$ | 0.64              | 1.8                     | $\infty$   |
| Liquid Conductivity (meas.)          | 2.6           | N              | 1          | 0.64              | 1.7                     | $\infty$   |
| Liquid Permittivity (target)         | 5.0           | R              | $\sqrt{3}$ | 0.6               | 1.7                     | $\infty$   |
| Liquid Permittivity (meas.)          | 3.8           | N              | 1          | 0.6               | 2.3                     | $\infty$   |
| <b>Combined Standard Uncertainty</b> |               |                |            |                   | <b>10.4</b>             | <b>330</b> |
| <b>Expanded Uncertainty kp=2</b>     |               |                |            |                   |                         |            |
| <b>Coverage Factor for 95%</b>       |               |                |            |                   | <b>20.8</b>             |            |

The budget is valid for the frequency range 300MHz – 3 GHz and represent a worst case analysis. For specific tests and configurations, the uncertainty could be considerable smaller.

### 3. Tissue and System Verification

#### 3.1 Tissue Verification

Dielectric parameters of the simulating liquids were verified using a Dielectric Probe Kit Agilent 85070D to a tolerance of  $\pm 5 \%$ .

Room Temperature: 22.1 -22.6 ° C

|                                 | Measured Tissue Parameters |                        |
|---------------------------------|----------------------------|------------------------|
|                                 | 1900 MHz Brain             |                        |
|                                 | Target                     | Measured<br>23.05.2006 |
| Date                            |                            | 22.1 ° C               |
| Liquid Temperature:             |                            | 22.1 ° C               |
| Dielectric Constant: $\epsilon$ | 40.0                       | 39.9                   |
| Conductivity: $\sigma$          | 1.40                       | 1.42                   |

Room Temperature: 22.1 -22.6 ° C

|                                 | Measured Tissue Parameters |                        |
|---------------------------------|----------------------------|------------------------|
|                                 | 1900 MHz Muscle            |                        |
|                                 | Target                     | Measured<br>23.05.2006 |
| Date                            |                            | 22,1 ° C               |
| Liquid Temperature:             |                            | 22,1 ° C               |
| Dielectric Constant: $\epsilon$ | 53.3                       | 51.9                   |
| Conductivity: $\sigma$          | 1.52                       | 1.58                   |

### 3.2 System Verification

Prior to the assessment, the system was verified by using a 1900 MHz validation dipole. Power level of 250 mW was supplied to the dipole antenna placed under the flat section of SAM Phantom. This system validation is valid for a frequency range of  $900 \pm 100$  MHz.

The system was verified to a tolerance of  $\pm 10$  %.

**Liquid Temperature:** 22.0 -22.3 °C  
**Room Temperature:** 22.1 -22.6 °C  
**Liquid Depth:** > 15.5 cm

| System Dipole Validation Target & Measurement |                        |                 |                        |                        |               |
|-----------------------------------------------|------------------------|-----------------|------------------------|------------------------|---------------|
| Date                                          | System Validation Kit: | Liquid          | Targeted SAR 1g (mW/g) | Measured SAR 1g (mW/g) | Deviation (%) |
| 23.05.2006                                    | D1900V2 SN5d025        | 1900 MHz Head   | 40,4                   | 43,2                   | 6,93          |
| 23.05.2006                                    | D1900V2 SN5d025        | 1900 MHz Muscle | 45,6                   | 45,6                   | 0,00          |

Comment: Please find attached the measurement plots.

## 4. Test Results

### Procedures Used To Establish Test Signal

The EUT was placed into simulated call mode (e.g. AMPS, Cellular CDMA & PCS CDMA modes) using manufacturers test codes. Such test signals offer a consistent means for testing SAR and are recommended for evaluating SAR [2]. The actual transmission is activated through a base station simulator or similar when test modes are not available or inappropriate for testing the EUT.

The EUT is rechargeable battery operated. The battery used for the SAR measurements was completely charged. The device was tested at full power verified by implementing conducted output power measurements. For confirming of the output power it was tested before and after each SAR measurement. The test was repeated if a conducted power deviation of more than 5 % occurred.

**Mixture Type:** 1900 MHz Head

**Date:** 08.05.2006

**Liquid Temperature:** 22.0 -22.3 ° C

**Room Temperature:** 22.1 -22.6 ° C

| Frequency |         |             | Power<br>Drift dBm | Antenna Pos. | Phantom<br>Section | Test<br>Position | SAR<br>(W/kg) |
|-----------|---------|-------------|--------------------|--------------|--------------------|------------------|---------------|
| MHz       | Channel | Modulation  |                    |              |                    |                  |               |
| 1924.99   | 2       | DECT (UPCS) | 0,058              | Integral     | Left Ear           | Cheek            | 0.042         |
| 1924.99   | 2       | DECT (UPCS) | 0.037              | Integral     | Left Ear           | Tilt             | 0.037         |
| 1921.54   | 4       | DECT (UPCS) | -0,0007            | Integral     | Right Ear          | Cheek            | 0.046         |
| 1924.99   | 2       | DECT (UPCS) | -0.084             | Integral     | Right Ear          | Cheek            | <b>0.049</b>  |
| 1924.99   | 2       | DECT (UPCS) | -0.057             | Integral     | Right Ear          | Tilt             | 0.035         |
| 1928.45   | 0       | DECT (UPCS) | -0.066             | Integral     | Right Ear          | Cheek            | 0.047         |

Mixture Type: 1900 MHz Muscle

Date: 09.05.2006

Liquid Temperature: 22.0 -22.3 °C

Room Temperature: 22.1 -22.6 °C

Antenna: 0

| Frequency |         |             | Power<br>Drift dBm | Antenna Pos. | Phantom<br>Section | Test<br>Position | SAR<br>(W/kg) |
|-----------|---------|-------------|--------------------|--------------|--------------------|------------------|---------------|
| MHz       | Channel | Modulation  |                    |              |                    |                  |               |
| 1921.54   | 4       | DECT (UPCS) | -0.037             | Integral     | Flat               | Front            | <b>0.075</b>  |
| 1924.99   | 2       | DECT (UPCS) | -0.080             | Integral     | Flat               | Front            | 0.067         |
| 1924.99   | 2       | DECT (UPCS) | 0.058              | Integral     | Flat               | Back             | 0.063         |
| 1928.45   | 0       | DECT (UPCS) | -0.025             | Integral     | Flat               | Front            | 0.074         |

Note: Device positioning: spacing from flat phantom was adjusted at 0 cm.

Limits:

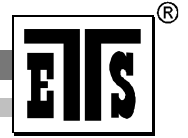
| Exposure Limits                                                                       | SAR (W/kg)                                              |                                                 |
|---------------------------------------------------------------------------------------|---------------------------------------------------------|-------------------------------------------------|
|                                                                                       | Uncontrolled Exposure/General<br>Population Environment | Controlled Exposure/Occupational<br>Environment |
| Spatial Average SAR<br>(averaged over the whole body)                                 | 0.08                                                    | 0.40                                            |
| Spatial Peak SAR<br>(averaged over any 1g of tissue)                                  | 1.60                                                    | 8.00                                            |
| Spatial Peak SAR<br>(Hands, Feet, Ankles, Wrist)<br>(averaged over any 10g of tissue) | 4.00                                                    | 20.00                                           |

Notes:

1. Test data represent the worst case SAR value and test procedure used are according to OET Bulletin 65, Supplement C (01-01).
2. All modes of operation were investigated.

## 5. References

- [1] ANSI/IEEE C95.3 – 1991, *IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic fields, 300 kHz to 100 GHz*, New York: IEEE, Aug. 1992
- [2] Federal Communications Commission, OET Bulletin 65 (Edition 97-01), Supplement C (Edition 01-01), *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, July 2001.
- [3] T. Schmid, O. Egger, N. Kuster, *Automated E-field scanning system for dosimetric assessments*, IEEE Transaction on Microwave Theory and Techniques, vol. 44, Jan. 1996, pp. 105-113.
- [4] W. Gander, *Computermathematics*, Birkhaeuser, Basel, 1992.
- [5] W.H. Press, S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery, *Numerical Recipes in C, The Art of Scientific Computing*, Second edition, Cambridge University Press, 1992.
- [6] IEEE Standards Coordinating Committee 34 – IEEE Std. 1528-2003, December 2003, *Recommended Practice for Determining the Peak Spatial-Average Absorption Rate (SAR in the Human Body Due to Wireless Communications Devices: Experimental Techniques*.
- [7] DASY4 *Dosimetric Assessment System Manual*; Draft; September 6, 2002; Schmid & Partner Engineering AG



## 6. Appendix

- |    |            |                         |                                                |
|----|------------|-------------------------|------------------------------------------------|
| 1. | Appendix A | Calibration Certificate | D1900V2 SN5d025<br>ET3DV6 SN1711<br>DAE3V1-522 |
| 2. | Appendix B | Measurement Plots       |                                                |
| 3. | Appendix C | Pictures                |                                                |

## Appendix A

### Calibration Certificate

Note:

According to ETS 's internal quality management instruction based on EN 17025 the calibration cycle for field probes and related equipment is determined to 2 years. Additionally, ETS has prolonged the calibration interval for SPEAG System Validation Dipoles by three additional years. These QM procedures are acknowledged by the accreditation bodies mentioned on page 3 of this report during several accreditation audits.

# Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

## Calibration Certificate

### 1900 MHz System Validation Dipole

Type:

**D1900V2**

Serial Number:

**5d025**

Place of Calibration:

**Zurich**

Date of Calibration:

**October 14, 2002**

Calibration Interval:

**24 months**

Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG.

Wherever applicable, the standards used in the calibration process are traceable to international standards. In all other cases the standards of the Laboratory for EMF and Microwave Electronics at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland have been applied.

Calibrated by:

*D. Vella*

Approved by:

*Blanc Hatz*

**DASY**

**Dipole Validation Kit**

**Type: D1900V2**

**Serial: 5d025**

**Manufactured: July 29, 2002**

**Calibrated: October 14, 2002**

## **1. Measurement Conditions**

The measurements were performed in the flat section of the new SAM twin phantom filled with head simulating glycol solution of the following electrical parameters at 1900 MHz:

|                        |                   |           |
|------------------------|-------------------|-----------|
| Relative Dielectricity | <b>38.7</b>       | $\pm 5\%$ |
| Conductivity           | <b>1.45 mho/m</b> | $\pm 5\%$ |

The DASY4 System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 5.2 at 1900 MHz) was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.

The dipole input power (forward power) was  $250\text{mW} \pm 3\%$ . The results are normalized to 1W input power.

## **2 SAR Measurement with DASY4 System**

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

|                                                  |                  |
|--------------------------------------------------|------------------|
| averaged over $1\text{ cm}^3$ (1 g) of tissue:   | <b>40.4 mW/g</b> |
| averaged over $10\text{ cm}^3$ (10 g) of tissue: | <b>20.6 mW/g</b> |

### **3. Dipole Impedance and Return Loss**

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

|                      |                 |                                       |
|----------------------|-----------------|---------------------------------------|
| Electrical delay:    | <b>1.196 ns</b> | (one direction)                       |
| Transmission factor: | <b>0.997</b>    | (voltage transmission, one direction) |

The dipole was positioned at the flat phantom sections according to section 1 and the distance holder was in place during impedance measurements.

|                                  |                                |
|----------------------------------|--------------------------------|
| Feedpoint impedance at 1900 MHz: | $\text{Re}\{Z\} = 51.6 \Omega$ |
|----------------------------------|--------------------------------|

|                               |
|-------------------------------|
| $\text{Im}\{Z\} = 4.7 \Omega$ |
|-------------------------------|

|                         |                 |
|-------------------------|-----------------|
| Return Loss at 1900 MHz | <b>-26.3 dB</b> |
|-------------------------|-----------------|

### **4. Handling**

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

### **5. Design**

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.

### **6. Power Test**

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

Test Laboratory: SPEAG, Zurich, Switzerland  
File Name: SN5d025\_SN1507\_HSL1900\_141002.da4

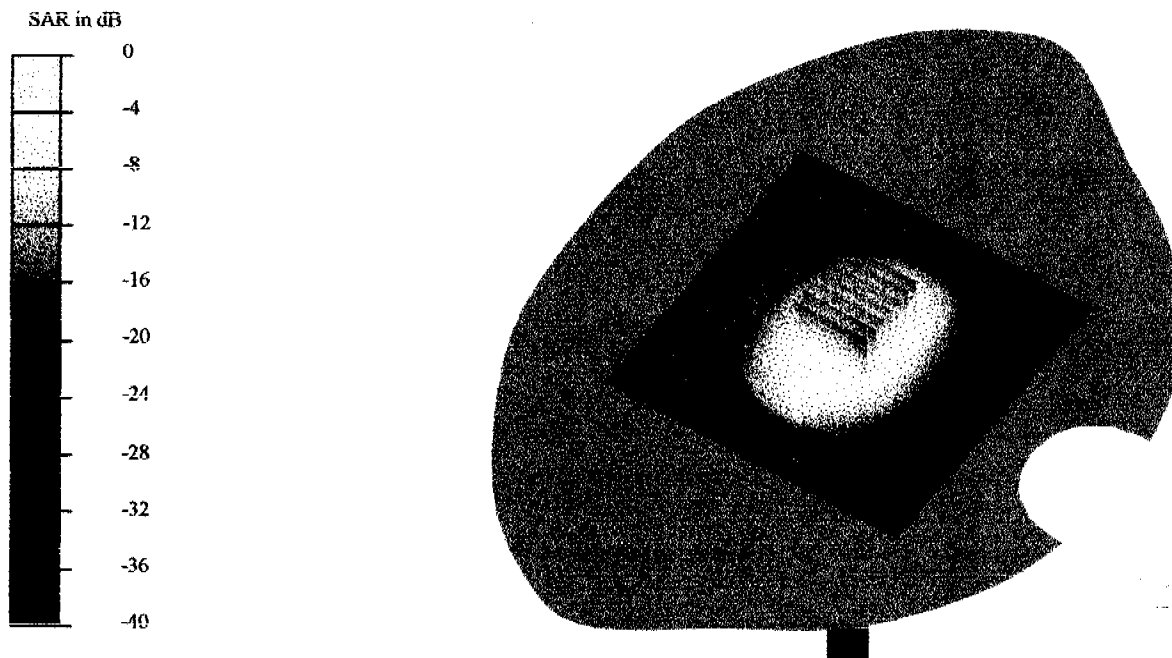
**DUT: Dipole 1900 MHz Type & Serial Number: D1900V2 - SN5d025**  
**Program: Dipole Calibration; Pin = 250 mW; d = 10 mm**

Communication System: CW-1900; Frequency: 1900 MHz; Duty Cycle: 1:1  
Medium: HSL 1900 MHz ( $\sigma = 1.45$  mho/m,  $\epsilon = 38.7$ ,  $\rho = 1000$  kg/m<sup>3</sup>)  
Phantom section: FlatSection

**DASY4 Configuration:**

- Probe: ET3DV6 - SN1507; ConvF(5.2, 5.2, 5.2); Calibrated: 1/24/2002
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 - SN410; Calibrated: 7/18/2002
- Phantom: SAM 4.0 - TP:1006
- Software: DASY4, V4.0 Build 35

**Area Scan (81x81x1):** Measurement grid: dx=15mm, dy=15mm  
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm  
Reference Value = 93 V/m  
Peak SAR = 18.3 mW/g  
SAR(1 g) = 10.1 mW/g; SAR(10 g) = 5.16 mW/g  
Power Drift = -0.0005 dB



14 Oct 2002 11:23:57

CH1 S11 1 U F8

1: 51.551  $\Omega$  4.6641  $\Omega$  390.69  $\mu\text{H}$

1 900.000 000 MHz

$\gamma$

De1

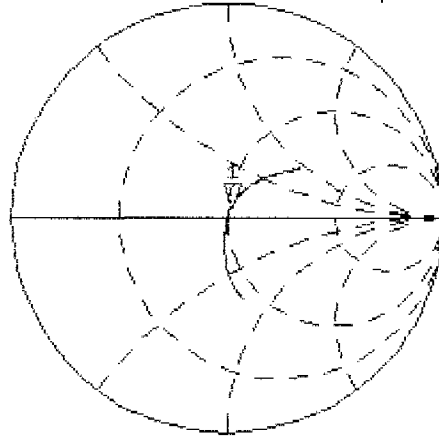
PRm

Cor

Avg

16

↑



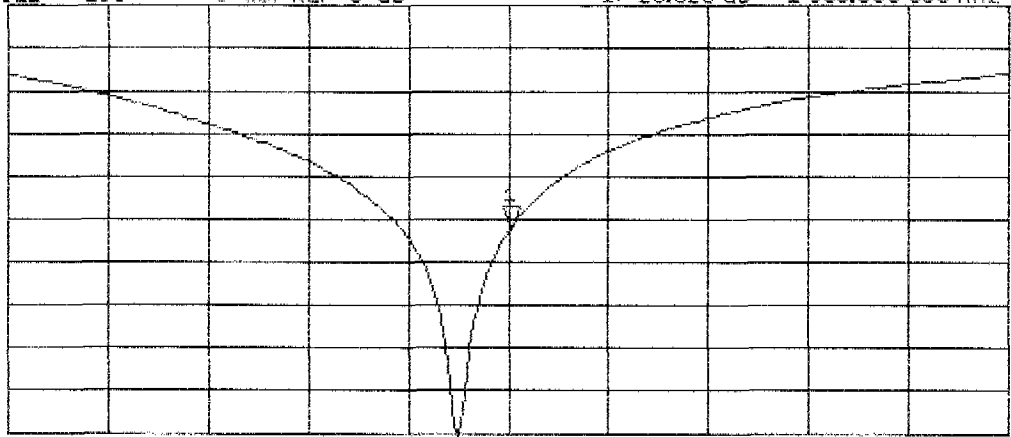
CH2 S11 LOG 5 dB/REF 0 dB

1: -26.320 dB 1 900.000 000 MHz

PRm

Cor

↑



START 1 700.000 000 MHz

STOP 2 100.000 000 MHz

**D2: 1900MHz SYSTEM VALIDATION DIPOLE****CALIBRATION CERTIFICATE****1900 MHz System Validation Dipole (Muscle)**

|                       |               |
|-----------------------|---------------|
| Type:                 | D1900V2       |
| Serial Number:        | 5d025         |
| Place of Calibration: | Reichenwalde  |
| Date of Calibration:  | July 24, 2003 |
| Calibration Interval: | 24 month      |

ETS Dr. Genz GmbH hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of ETS Dr. Genz GmbH.

Wherever applicable, the standards used in the calibration process are traceable to International standards.

|                |            |
|----------------|------------|
| Calibrated by: | W. Treffke |
| Approved by:   | K. Damm    |



# DASY

## DIPOLE VALIDATION KIT

**Type:** D1900V2

**Serial:** 5d025

Manufactured : Juli 29, 2002  
Calibrated : Juli 24, 2003

## Measurement Conditions

The measurements were performed in the flat section of the new SAM twin phantom filled with body simulating solution of the following electrical parameters at 1900 MHz:

|                       |             |          |
|-----------------------|-------------|----------|
| Relative permittivity | 51.41       | +/- 5 %  |
| Conductivity          | 1.565 mho/m | +/- 10 % |

The DASY System with a dosimetric E-field probe ET3DV6 (SN: 1711, conversion factor 5,0 at 1900 MHz body) was used for the measurements.

The dipole feed-point was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10 mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 10 mm was aligned with the dipole. The 7x7x7 fine cube was chosen for cube integration.

The dipole input power (forward power) was 250 mW +/- 3 %. The results are normalized to 1 W input power.

## SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 4. The results (see figure supplied) have been normalized to a dipole input power of 1 W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1711 and applying the advanced extrapolation are:

Averaged over 1 cm<sup>3</sup> (1 g) of tissue: 45.6 mW/g

Averaged over 10 cm<sup>3</sup> (10 g) of tissue: 23.7 mW/g

## Dipole impedance and return loss

The dipole was positioned at the flat phantom sections according to section 4 (Measurement conditions) (with body tissue inside the phantom) and the distance holder was in place during impedance measurements.

Feed-point impedance at 1900 MHz:  $\text{Re}\{Z\} = 54.9 \Omega$

$\text{Im}\{Z\} = -3.8 \Omega$

Return Loss at 1900 MHz: - 24.2 dB

Test Laboratory: ELECTRONIC TECHNOLOGY SYSTEMS DR. GENZ GMBH

File Name: [Dipol Calibr.1900 \(m\) 250mW.da4](#)

## Dipol Calibr.1900 (m) 250mW

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: 5d025**

**Program: Dipol Calibration 1900 Muscle**

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

Medium: Muscle 1800 MHz ( $\sigma = 1.56554$  mho/m,  $\epsilon_r = 51.4058$ ,  $\rho = 1000$  kg/m<sup>3</sup>)

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6 - SN1711; ConvF(5, 5, 5); Calibrated: 11/29/2002
- Sensor-Surface: 4mm (Mechanical And Optical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 9/11/2002
- Phantom: SAM 12; Type: TP-1217; Serial: QD000P40CA
- Measurement SW: DASY4, V4.1 Build 47; Postprocessing SW: SEMCAD, V1.6 Build 115

**(24dBm)/Area Scan (81x81x1):** Measurement grid: dx=10mm, dy=10mm

Reference Value = 92.1 V/m

Power Drift = 0.001 dB

Maximum value of SAR = 12.9 mW/g

**(24dBm)/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

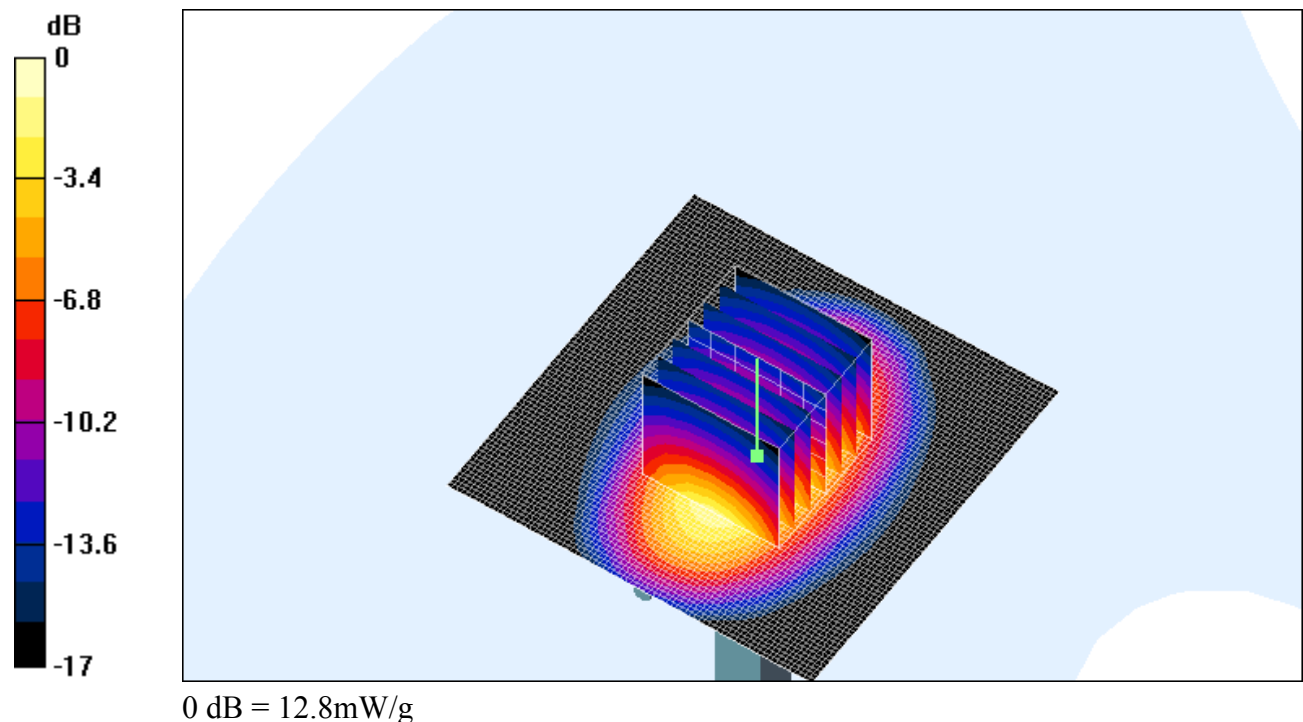
Peak SAR (extrapolated) = 20.4 W/kg

SAR(1 g) = 11.4 mW/g; SAR(10 g) = 5.93 mW/g

Reference Value = 92.1 V/m

Power Drift = 0.001 dB

Maximum value of SAR = 12.8 mW/g





Accredited by the Swiss Federal Office of Metrology and Accreditation  
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 **ETS Dr. Genz**

Certificate No: **ET3-1711\_Nov05**

## CALIBRATION CERTIFICATE

Object **ET3DV6 - SN:1711**

Calibration procedure(s) **QA GAL-01.v5 and QA GAL-12.v4  
Calibration procedure for dosimetric E-field probes**

Calibration date: **November 21, 2005**

Condition of the calibrated item **In Tolerance**

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 (Calibrated by, Certificate No.) | Scheduled Calibration |
|----------------------------|-----------------|-------------------------------------------|-----------------------|
| Power meter E4419B         | GB41293874      | 3-May-05 (METAS, No. 251-00466)           | May-06                |
| Power sensor E4412A        | MY41495277      | 3-May-05 (METAS, No. 251-00466)           | May-06                |
| Power sensor E4412A        | MY41498087      | 3-May-05 (METAS, No. 251-00466)           | May-06                |
| Reference 3 dB Attenuator  | SN: S5054 (3c)  | 11-Aug-05 (METAS, No. 251-00499)          | Aug-06                |
| Reference 20 dB Attenuator | SN: S5086 (20b) | 3-May-05 (METAS, No. 251-00467)           | May-06                |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 11-Aug-05 (METAS, No. 251-00500)          | Aug-06                |
| Reference Probe ES3DV2     | SN: 3013        | 7-Jan-05 (SPEAG, No. ES3-3013_Jan05)      | Jan-06                |
| DAE4                       | SN: 654         | 27-Oct-05 (SPEAG, No. DAE4-654_Oct05)     | Oct-06                |

| Secondary Standards       | ID #         | Check Date (in house)                    | Scheduled Check        |
|---------------------------|--------------|------------------------------------------|------------------------|
| RF generator HP 8648C     | US3642U01700 | 4-Aug-99 (SPEAG, in house check Dec-03)  | In house check: Dec-05 |
| Network Analyzer HP 8753E | US37390585   | 18-Oct-01 (SPEAG, in house check Nov-04) | In house check: Nov 05 |

|                |               |                       |           |
|----------------|---------------|-----------------------|-----------|
|                | Name          | Function              | Signature |
| Calibrated by: | Nico Vetterli | Laboratory Technician |           |
| Approved by:   | Katja Polovic | Technical Manager     |           |

Issued: November 21, 2005

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



Accredited by the Swiss Federal Office of Metrology and Accreditation  
 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 <sub>x,y,z</sub>    | sensitivity in free space                                                                                                                            |
| ConF                     | sensitivity in TSL / NORM <sub>x,y,z</sub>                                                                                                           |
| DCP                      | diode compression point                                                                                                                              |
| Polarization $\phi$      | $\phi$ 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
- CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz), July 2001

### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the  $E^2$ -field uncertainty inside TSL (see below *ConvF*).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* *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*.
- DCP<sub>x,y,z</sub>**: 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 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<sub>x,y,z</sub> \* *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.

# Probe ET3DV6

## SN:1711

|                  |                   |
|------------------|-------------------|
| Manufactured:    | August 7, 2002    |
| Last calibrated: | December 16, 2003 |
| Recalibrated:    | November 21, 2005 |

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

## DASY - Parameters of Probe: ET3DV6 SN:1711

### Sensitivity in Free Space<sup>A</sup>

### Diode Compression<sup>B</sup>

|       |              |                                     |       |       |
|-------|--------------|-------------------------------------|-------|-------|
| NormX | 1.45 ± 10.1% | $\mu\text{V}/(\text{V}/\text{m})^2$ | DCP X | 95 mV |
| NormY | 1.68 ± 10.1% | $\mu\text{V}/(\text{V}/\text{m})^2$ | DCP Y | 95 mV |
| NormZ | 1.59 ± 10.1% | $\mu\text{V}/(\text{V}/\text{m})^2$ | DCP Z | 95 mV |

### Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 8.

### Boundary Effect

**TSL**                      **900 MHz**      **Typical SAR gradient: 5 % per mm**

|                                           |                              |               |               |
|-------------------------------------------|------------------------------|---------------|---------------|
| Sensor Center to Phantom Surface Distance |                              | <b>3.7 mm</b> | <b>4.7 mm</b> |
| SAR <sub>be</sub> [%]                     | Without Correction Algorithm | 8.2           | 4.4           |
| SAR <sub>be</sub> [%]                     | With Correction Algorithm    | 0.0           | 0.2           |

**TSL**                      **1810 MHz**      **Typical SAR gradient: 10 % per mm**

|                                           |                              |               |               |
|-------------------------------------------|------------------------------|---------------|---------------|
| Sensor Center to Phantom Surface Distance |                              | <b>3.7 mm</b> | <b>4.7 mm</b> |
| SAR <sub>be</sub> [%]                     | Without Correction Algorithm | 14.6          | 10.0          |
| SAR <sub>be</sub> [%]                     | With Correction Algorithm    | 0.6           | 0.1           |

### Sensor Offset

Probe Tip to Sensor Center                      **2.7 mm**

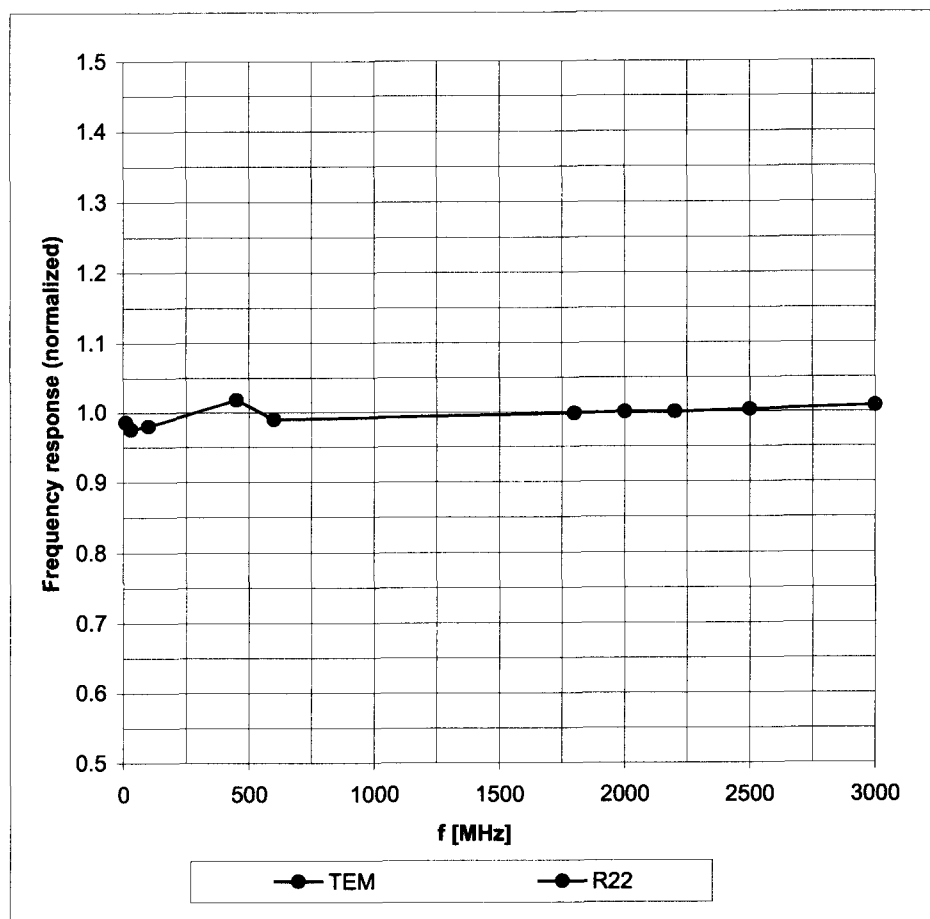
**The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.**

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 8).

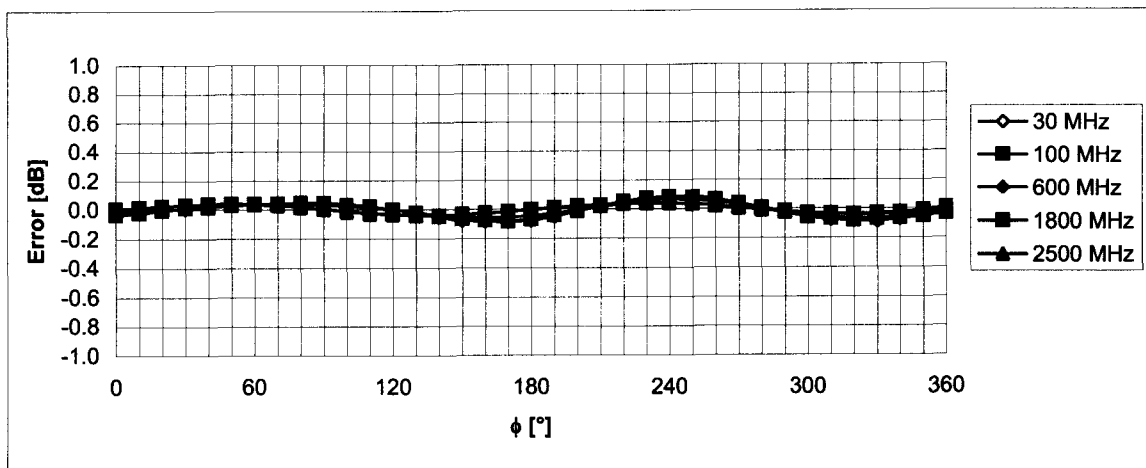
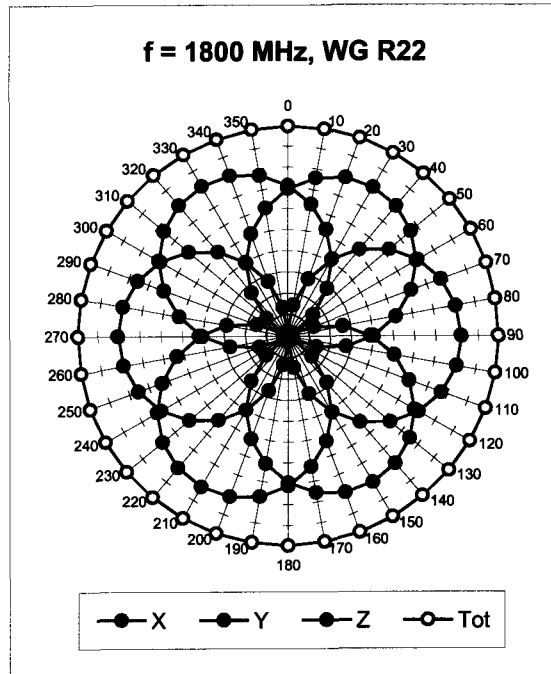
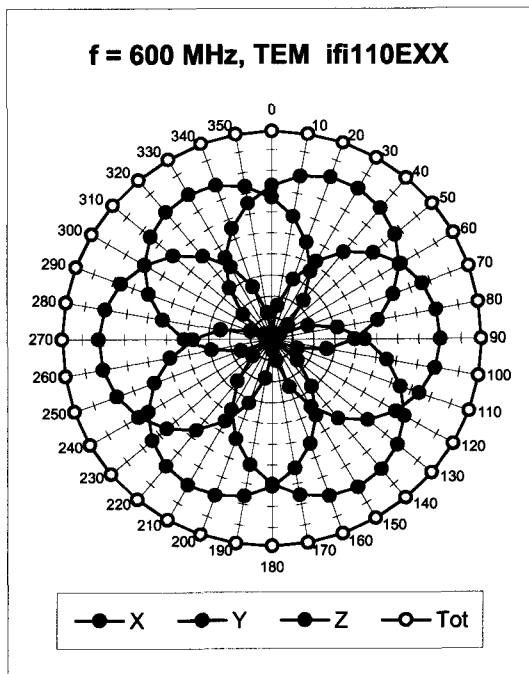
<sup>B</sup> Numerical linearization parameter: uncertainty not required.

## Frequency Response of E-Field

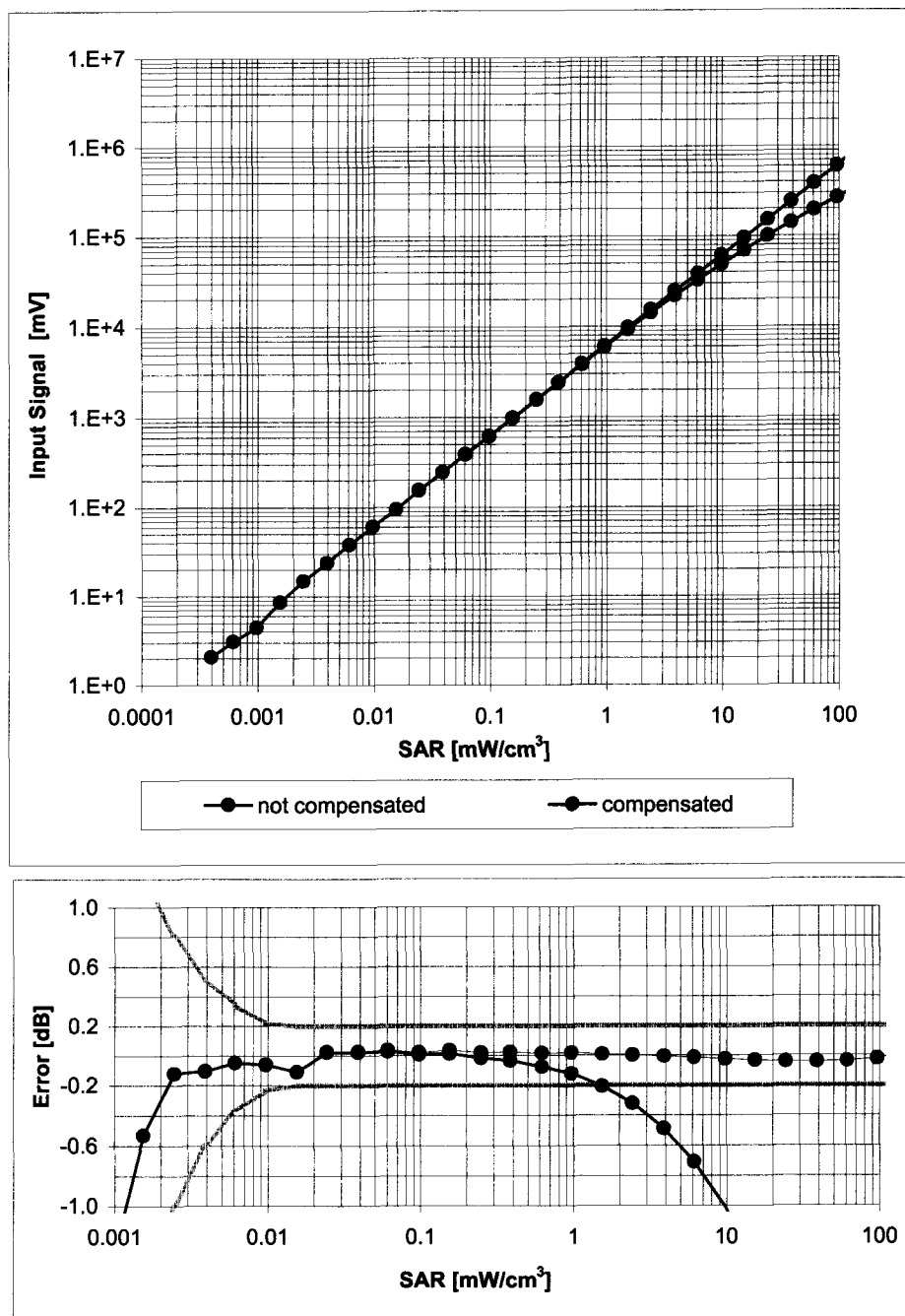
(TEM-Cell:ifi110 EXX, Waveguide: R22)



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

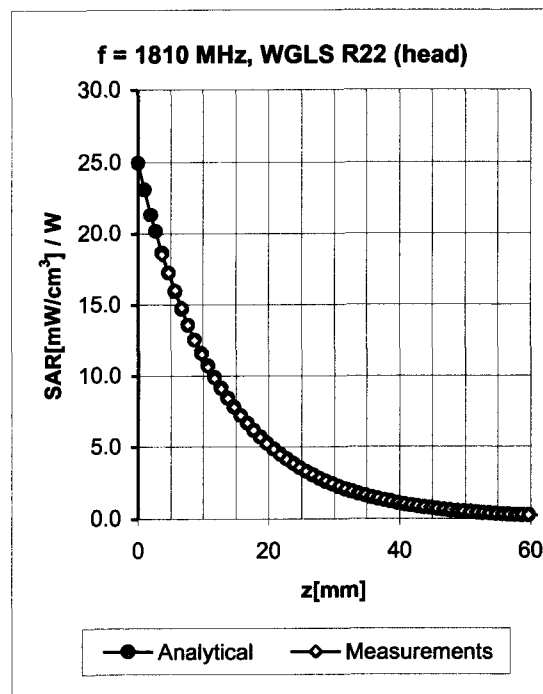
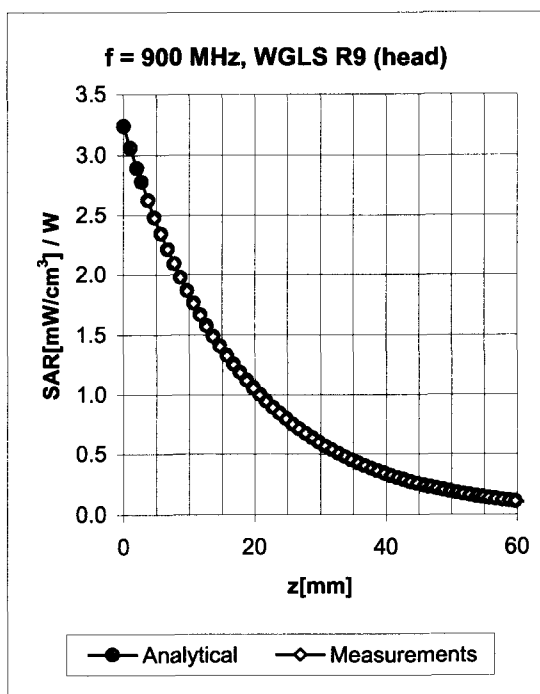
Receiving Pattern ( $\phi$ ),  $\vartheta = 0^\circ$ Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

# Dynamic Range $f(\text{SAR}_{\text{head}})$ (Waveguide R22, $f = 1800 \text{ MHz}$ )



Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

## Conversion Factor Assessment

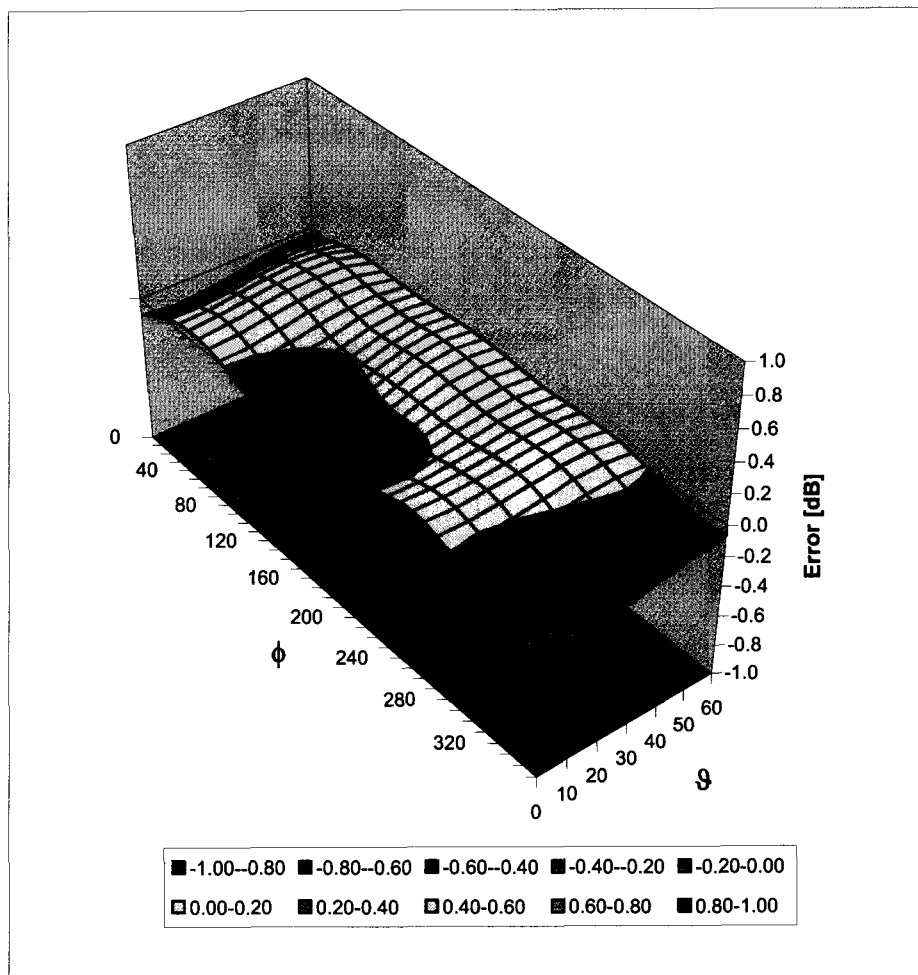


| f [MHz] | Validity [MHz] <sup>c</sup> | TSL  | Permittivity | Conductivity | Alpha | Depth | ConvF Uncertainty  |
|---------|-----------------------------|------|--------------|--------------|-------|-------|--------------------|
| 450     | ± 50 / ± 100                | Head | 43.5 ± 5%    | 0.87 ± 5%    | 0.02  | 2.48  | 6.52 ± 13.3% (k=2) |
| 900     | ± 50 / ± 100                | Head | 41.5 ± 5%    | 0.97 ± 5%    | 0.55  | 1.87  | 5.99 ± 11.0% (k=2) |
| 1810    | ± 50 / ± 100                | Head | 40.0 ± 5%    | 1.40 ± 5%    | 0.57  | 2.55  | 4.84 ± 11.0% (k=2) |
| 1950    | ± 50 / ± 100                | Head | 40.0 ± 5%    | 1.40 ± 5%    | 0.56  | 2.59  | 4.54 ± 11.0% (k=2) |
| 2450    | ± 50 / ± 100                | Head | 39.2 ± 5%    | 1.80 ± 5%    | 0.70  | 2.28  | 4.27 ± 11.8% (k=2) |
| 450     | ± 50 / ± 100                | Body | 56.7 ± 5%    | 0.94 ± 5%    | 0.02  | 2.36  | 6.96 ± 13.3% (k=2) |
| 900     | ± 50 / ± 100                | Body | 55.0 ± 5%    | 1.05 ± 5%    | 0.49  | 2.11  | 5.73 ± 11.0% (k=2) |
| 1810    | ± 50 / ± 100                | Body | 53.3 ± 5%    | 1.52 ± 5%    | 0.56  | 2.77  | 4.31 ± 11.0% (k=2) |
| 1950    | ± 50 / ± 100                | Body | 53.3 ± 5%    | 1.52 ± 5%    | 0.57  | 2.61  | 4.13 ± 11.0% (k=2) |
| 2450    | ± 50 / ± 100                | Body | 52.7 ± 5%    | 1.95 ± 5%    | 0.79  | 1.67  | 4.11 ± 11.8% (k=2) |

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

## Deviation from Isotropy in HSL

Error ( $\phi$ ,  $\vartheta$ ),  $f = 900$  MHz



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.6\%$  ( $k=2$ )

## IMPORTANT NOTICE

### USAGE OF PROBES IN ORGANIC SOLVENTS

Diethylene Glycol Monobutyl Ether (the basis for liquids above 1 GHz), as many other organic solvents, is a very effective softener for synthetic materials. These solvents can cause irreparable damage to certain SPEAG products, except those which are explicitly declared as compliant with organic solvents.

**Compatible Probes:**

- ET3DV6
- ET3DV6R
- ES3DVx
- EX3DVx
- ER3DV6
- H3DV6

**Important Note for ET3DV6 Probes:**

The ET3DV6 probes shall not be exposed to solvents longer than necessary for the measurements and shall be cleaned daily after use with warm water and stored dry.

**s p e a g**

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Schmid & Partner Engineering AG

## **Additional Conversion Factors**

**for Dosimetric E-Field Probe**

Type:

**ET3DV6**

Serial Number:

**1711**

Place of Assessment:

**Zurich**

Date of Assessment:

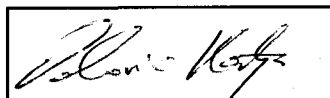
**November 23, 2005**

Probe Calibration Date:

**November 21, 2005**

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The assessment was performed using the FDTD numerical code SEMCAD of Schmid & Partner Engineering AG. The evaluation is coupled with measured conversion factors (probe calibration date indicated above). The uncertainty of the numerical assessment is based on the extrapolation from measured value at 900 MHz or at 1810 MHz.

Assessed by:



**Dosimetric E-Field Probe ET3DV6 SN:1711**Conversion factor ( $\pm$  standard deviation)**150  $\pm$  50 MHz**      *ConvF*      **8.1  $\pm$  10 %**

$\epsilon_r = 52.3 \pm 5\%$   
 $\sigma = 0.76 \pm 5\%$  mho/m  
(head tissue)

**150  $\pm$  50 MHz**      *ConvF*      **7.8  $\pm$  10 %**

$\epsilon_r = 61.9 \pm 5\%$   
 $\sigma = 0.80 \pm 5\%$  mho/m  
(body tissue)

**300  $\pm$  50 MHz**      *ConvF*      **7.3  $\pm$  9 %**

$\epsilon_r = 45.3 \pm 5\%$   
 $\sigma = 0.87 \pm 5\%$  mho/m  
(head tissue)

**Important Note:**

For numerically assessed probe conversion factors, parameters Alpha and Delta in the DASY software must have the following entries: Alpha = 0 and Delta = 1.

Please see also Section 4.7 of the DASY4 Manual.



Accredited by the Swiss Federal Office of Metrology and Accreditation  
 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 **ETS Dr. Genz**

Certificate No: **DAE3-522\_Nov05**

## CALIBRATION CERTIFICATE

Object **DAE3 - SD 000 D03 AA - SN: 522**

Calibration procedure(s) **QA CAL-06.v12**  
**Calibration procedure for the data acquisition electronics (DAE)**

Calibration date: **November 23, 2005**

Condition of the calibrated item **In Tolerance**

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 (Calibrated by, Certificate No.) | Scheduled Calibration |
|-----------------------------------|--------------------|-------------------------------------------|-----------------------|
| Fluke Process Calibrator Type 702 | SN: 6295803        | 7-Oct-05 (Sintrel, No.E-050073)           | Oct-06                |
| Secondary Standards               | ID #               | Check Date (in house)                     | Scheduled Check       |
| Calibrator Box V1.1               | SE UMS 006 AB 1002 | 29-Jun-05 (SPEAG, in house check)         | In house check Jun-06 |

|                |                              |                               |               |
|----------------|------------------------------|-------------------------------|---------------|
| Calibrated by: | Name<br><b>Eric Hainfeld</b> | Function<br><b>Technician</b> | Signature<br> |
| Approved by:   | <b>Fin Bornholt</b>          | <b>R&amp;D Director</b>       |               |

Issued: November 23, 2005

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



## 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 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:** DAE input resistance at the connector, during internal auto-zeroing and during measurement.
- **Low Battery Alarm Voltage:** Typical value for information. Below this voltage, a battery alarm signal is generated.
- **Power consumption:** Typical value for information. Supply currents in various operating modes.

## DC Voltage Measurement

A/D - Converter Resolution nominal

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

Low Range: 1LSB = 61 nV , full range = -1.....+3mV

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

| Calibration Factors | X                        | Y                        | Z                        |
|---------------------|--------------------------|--------------------------|--------------------------|
| High Range          | 404.289 $\pm$ 0.1% (k=2) | 403.958 $\pm$ 0.1% (k=2) | 404.788 $\pm$ 0.1% (k=2) |
| Low Range           | 3.95603 $\pm$ 0.7% (k=2) | 3.93852 $\pm$ 0.7% (k=2) | 3.96295 $\pm$ 0.7% (k=2) |

## Connector Angle

|                                           |                |
|-------------------------------------------|----------------|
| Connector Angle to be used in DASY system | 60 ° $\pm$ 1 ° |
|-------------------------------------------|----------------|

## Appendix

### 1. DC Voltage Linearity

| High Range |         | Input ( $\mu\text{V}$ ) | Reading ( $\mu\text{V}$ ) | Error (%) |
|------------|---------|-------------------------|---------------------------|-----------|
| Channel X  | + Input | 200000                  | 199999.5                  | 0.00      |
| Channel X  | + Input | 20000                   | 20004.13                  | 0.02      |
| Channel X  | - Input | 20000                   | -19999.46                 | 0.00      |
| Channel Y  | + Input | 200000                  | 200000.3                  | 0.00      |
| Channel Y  | + Input | 20000                   | 20003.71                  | 0.02      |
| Channel Y  | - Input | 20000                   | -20000.98                 | 0.00      |
| Channel Z  | + Input | 200000                  | 199999.5                  | 0.00      |
| Channel Z  | + Input | 20000                   | 20001.35                  | 0.01      |
| Channel Z  | - Input | 20000                   | -20001.38                 | 0.01      |

| Low Range |         | Input ( $\mu\text{V}$ ) | Reading ( $\mu\text{V}$ ) | Error (%) |
|-----------|---------|-------------------------|---------------------------|-----------|
| Channel X | + Input | 2000                    | 2000                      | 0.00      |
| Channel X | + Input | 200                     | 200.74                    | 0.37      |
| Channel X | - Input | 200                     | -200.66                   | 0.33      |
| Channel Y | + Input | 2000                    | 2000                      | 0.00      |
| Channel Y | + Input | 200                     | 199.67                    | -0.17     |
| Channel Y | - Input | 200                     | -200.19                   | 0.09      |
| Channel Z | + Input | 2000                    | 2000.1                    | 0.00      |
| Channel Z | + Input | 200                     | 199.46                    | -0.27     |
| Channel Z | - Input | 200                     | -200.78                   | 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 ( $\mu\text{V}$ ) | Low Range Average Reading ( $\mu\text{V}$ ) |
|-----------|--------------------------------|----------------------------------------------|---------------------------------------------|
| Channel X | 200                            | -4.69                                        | -5.13                                       |
|           | - 200                          | 5.48                                         | 5.55                                        |
| Channel Y | 200                            | -0.70                                        | -0.94                                       |
|           | - 200                          | 0.03                                         | 0.01                                        |
| Channel Z | 200                            | 16.03                                        | 15.52                                       |
|           | - 200                          | -17.34                                       | -18.11                                      |

### 3. Channel separation

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

|           | Input Voltage (mV) | Channel X ( $\mu\text{V}$ ) | Channel Y ( $\mu\text{V}$ ) | Channel Z ( $\mu\text{V}$ ) |
|-----------|--------------------|-----------------------------|-----------------------------|-----------------------------|
| Channel X | 200                | -                           | 2.29                        | 0.70                        |
| Channel Y | 200                | 1.28                        | -                           | 2.45                        |
| Channel Z | 200                | -2.82                       | -0.11                       | -                           |

#### 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 | 15727            | 15989           |
| Channel Y | 15754            | 16141           |
| Channel Z | 16032            | 16721           |

#### 5. Input Offset Measurement

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

Input 10M $\Omega$

|           | Average ( $\mu$ V) | min. Offset ( $\mu$ V) | max. Offset ( $\mu$ V) | Std. Deviation ( $\mu$ V) |
|-----------|--------------------|------------------------|------------------------|---------------------------|
| Channel X | 0.86               | -1.08                  | 2.33                   | 0.61                      |
| Channel Y | -1.73              | -3.15                  | 0.41                   | 0.60                      |
| Channel Z | -1.20              | -2.72                  | 0.46                   | 0.55                      |

#### 6. Input Offset Current

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

#### 7. Input Resistance

|           | Zeroing (MOhm) | Measuring (MOhm) |
|-----------|----------------|------------------|
| Channel X | 0.2000         | 199.2            |
| Channel Y | 0.2000         | 200.1            |
| Channel Z | 0.2001         | 197.2            |

#### 8. Low Battery Alarm Voltage (verified during pre test)

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

#### 9. Power Consumption (verified during pre test)

| Typical values | Switched off (mA) | Stand by (mA) | Transmitting (mA) |
|----------------|-------------------|---------------|-------------------|
| Supply (+ Vcc) | +0.0              | +6            | +14               |
| Supply (- Vcc) | -0.01             | -8            | -9                |

## IMPORTANT NOTICE

### USAGE OF THE DAE 3

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

**Battery Exchange:** The battery cover of the DAE3 unit is connected to a fragile 3-pin battery connector. Customer is responsible to apply utmost caution not to bend or damage the connector when changing batteries.

**Shipping of the DAE:** Before shipping the DAE to SPEAG for calibration Customer shall remove the batteries and pack the DAE in an antistatic bag. The packaging shall protect the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

**E-Stop Failures:** Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, Customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

**Repair:** Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

**Important Note:**

**Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.**

**Important Note:**

**Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.**