

## Appendix for SAR\_Report\_FCC\_60320\_6171830\_KX-TGFA61\_Confidential

### EUT Information

|                     |                              |
|---------------------|------------------------------|
| <b>Manufacturer</b> | Panasonic Corporation        |
| <b>Model Name</b>   | KX-TGFA61                    |
| <b>FCC ID</b>       | ACJ96NKX-TGFA61              |
| <b>EUT Type</b>     | portable device / DECT phone |

### Prepared by

|                           |  |
|---------------------------|--|
| <b>Testing Laboratory</b> | IMST GmbH, Test Center<br>Carl-Friedrich-Gauß-Str. 2 – 4<br>47475 Kamp-Lintfort<br>Germany |
|---------------------------|--|

### Prepared for

|                  |   |
|------------------|---|
| <b>Applicant</b> | Panasonic Corporation<br>1-62, 4-chome, Minoshima, Hakata-ku<br>Fukuoka 812-8531<br>Japan |
|------------------|---|

### Test Specification

|                                |  |
|--------------------------------|--|
| <b>Applied Rules/Standards</b> | IEEE 1528-2013; FCC CFR 47 § 2.1093  |
| <b>Exposure Category</b>       | <input checked="" type="checkbox"/> general public / uncontrolled exposure <input type="checkbox"/> occupational / controlled exposure |

### Report Information

|                        |  |
|------------------------|--|
| <b>Data Stored</b>     | 60320_6171830_KX-TGFA61  |
| <b>Issue Date</b>      | December 07, 2017  |
| <b>Revision Date</b>   | -  |
| <b>Revision Number</b> | -  |
| <b>Appendixes</b>      | Appendix A - Pictures<br>Appendix B - SAR Distribution Plots<br>Appendix C - System Verification Plots<br>Appendix D – Certificates of Conformity<br>Appendix E – Calibration Certificates for DAEs<br>Appendix F – Calibration Certificates for E-Field Probes<br>Appendix G – Calibration Certificates for Dipoles |

## Appendix A - Pictures

### Pictures of the EUT



Pic. 1: *Front and right side views of the device under test.*



Pic. 2: *Back and left side views of the device under test.*



Fig. 13: *Pictures of the used headset RP-TCA430.*



### Pictures of Test Positions of the EUT



Pic. 3: Cheek position, left side.



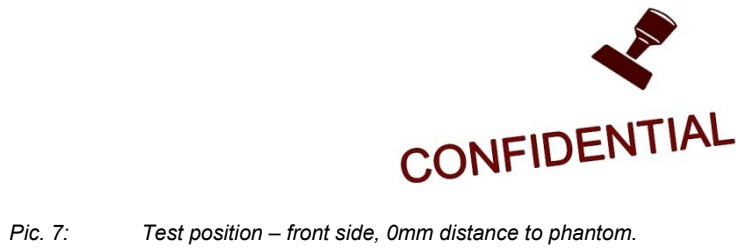
Pic. 4: Tilted position, left side.



Pic. 5: Cheek position, right side.



Pic. 6: Tilted position, right side.



Pic. 7: Test position – front side, 0mm distance to phantom.



Pic. 8: Test position – back side, 0mm distance to phantom.

## Appendix B - SAR Distribution Plots

### Worst Case Plots for Head and Body Worn Configuration SAR Measurement per Technology

Test Laboratory: IMST GmbH, DASY Yellow (II); File Name: [TGFA61\\_yplm\\_1.da4](#)

DUT: Panasonic; Type: TGFA61; Serial: -  
Program Name: DECT US

Communication System: DECT US; Frequency: 1924.99 MHz; Duty Cycle: 1:24  
Medium parameters used:  $f = 1925$  MHz;  $\sigma = 1.46$  mho/m;  $\epsilon_r = 38.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Left Section

#### DASY4 Configuration:

- Probe: ET3DV6R - SN1669; ConvF(5.33, 5.33, 5.33); Calibrated: 2/16/2017
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 9/25/2017
- Phantom: SAM 1340; Type: QD 000 P40 CB; Serial: TP-1340
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**Cheek Left/Area Scan (7x11x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 0.037 mW/g

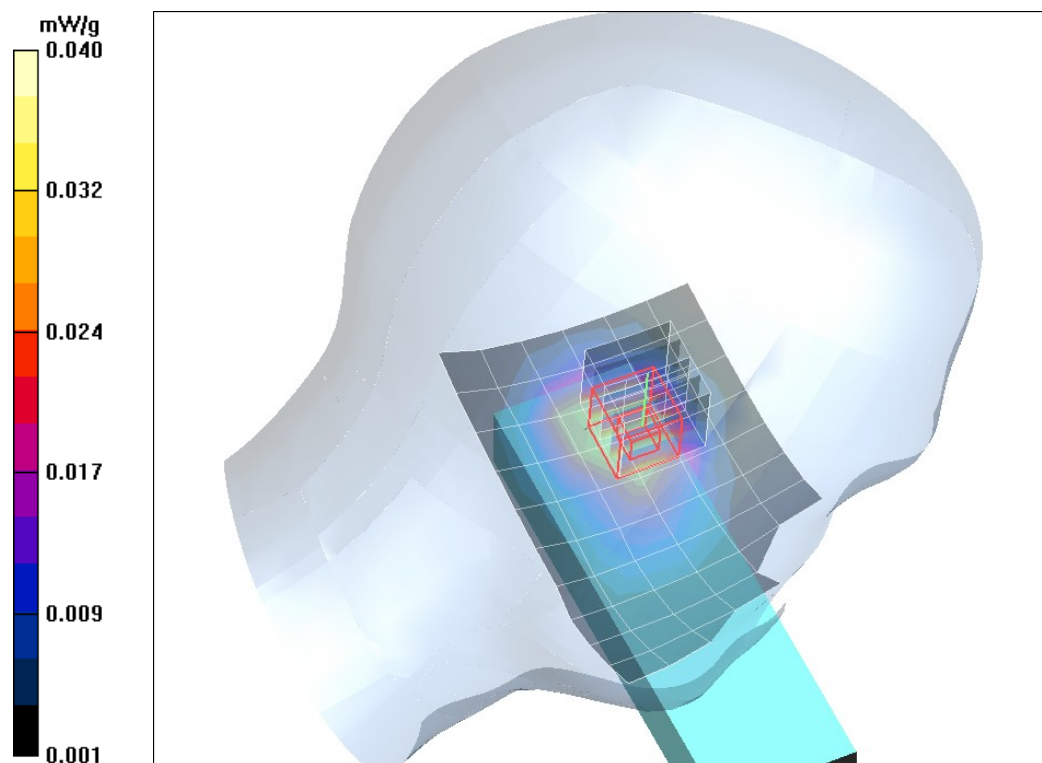
**Cheek Left/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm

Reference Value = 4.82 V/m; Power Drift = 0.117 dB

Peak SAR (extrapolated) = 0.062 W/kg

**SAR(1 g) = 0.036 mW/g; SAR(10 g) = 0.021 mW/g**

Maximum value of SAR (measured) = 0.040 mW/g



Plot. 1: SAR distribution plot for DECT, channel 2, head configuration, left cheek.

**Test Laboratory: IMST GmbH, DASY Yellow (II); File Name:**  
**TGFA61\_y\_dect\_fm\_front\_clip\_hs\_0mm.da4**

**DUT: Panasonic; Type: TGFA61; Serial: -**  
**Program Name: US DECT**

Communication System: DECT US; Frequency: 1924.99 MHz; Duty Cycle: 1:24  
Medium parameters used:  $f = 1925$  MHz;  $\sigma = 1.53$  mho/m;  $\epsilon_r = 50.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6R - SN1669; ConvF(4.79, 4.79, 4.79); Calibrated: 2/16/2017
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 9/25/2017
- Phantom: SAM 1340; Type: QD 000 P40 CB; Serial: TP-1340
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**Body/Area Scan (7x14x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 0.030 mW/g

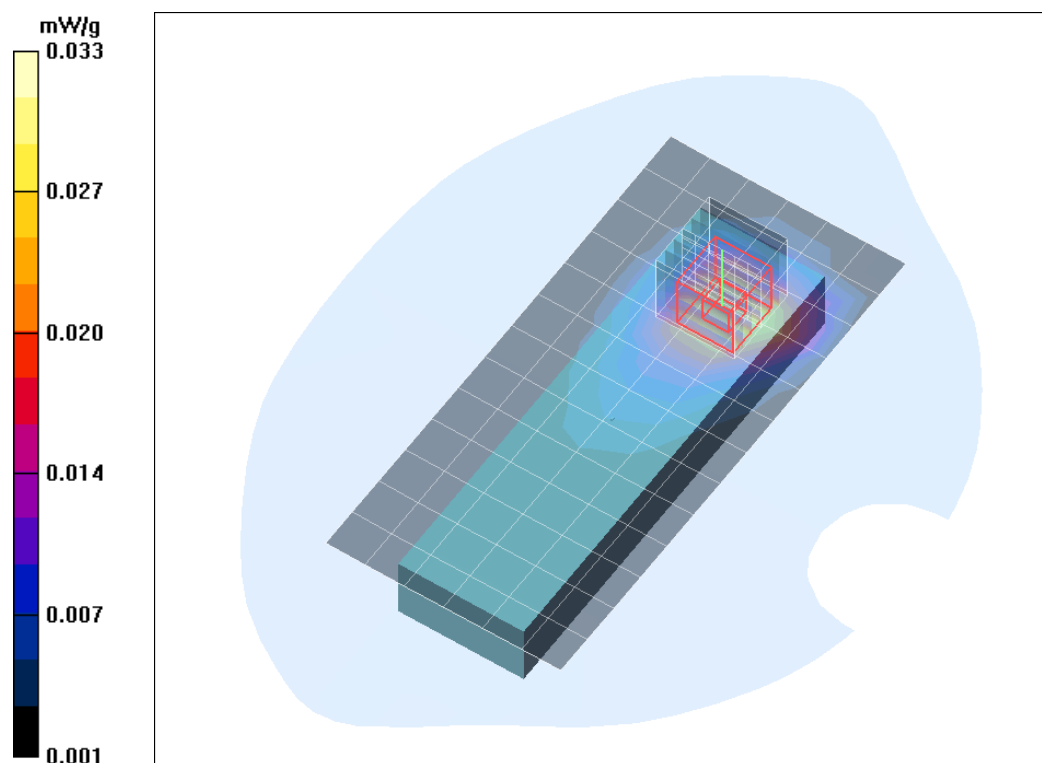
**Body/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 4.64 V/m; Power Drift = -0.189 dB

Peak SAR (extrapolated) = 0.047 W/kg

**SAR(1 g) = 0.030 mW/g; SAR(10 g) = 0.018 mW/g**

Maximum value of SAR (measured) = 0.033 mW/g



Plot 2: SAR distribution plot for DECT, channel 2, body-worn configuration, front side, 0mm distance to phantom.

## Appendix C - System Verification Plots

Test Laboratory: IMST GmbH, DASY Yellow (II); File Name: [281117\\_y\\_1669\\_335.da4](#)

DUT: Dipole 1900 MHz SN: 535; Type: D1900V2; Serial: D1900V2 - SN535  
 Program Name: System Performance Check at 1900 MHz

Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1  
 Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.44$  mho/m;  $\epsilon_r = 38.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
 Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6R - SN1669; ConvF(5.33, 5.33, 5.33); Calibrated: 2/16/2017
- Sensor-Surface: 3.7mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 9/25/2017
- Phantom: SAM 1340; Type: QD 000 P40 CB; Serial: TP-1340
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**d=10mm, Pin=250mW/Area Scan (5x8x1):** Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (measured) = 10.3 mW/g

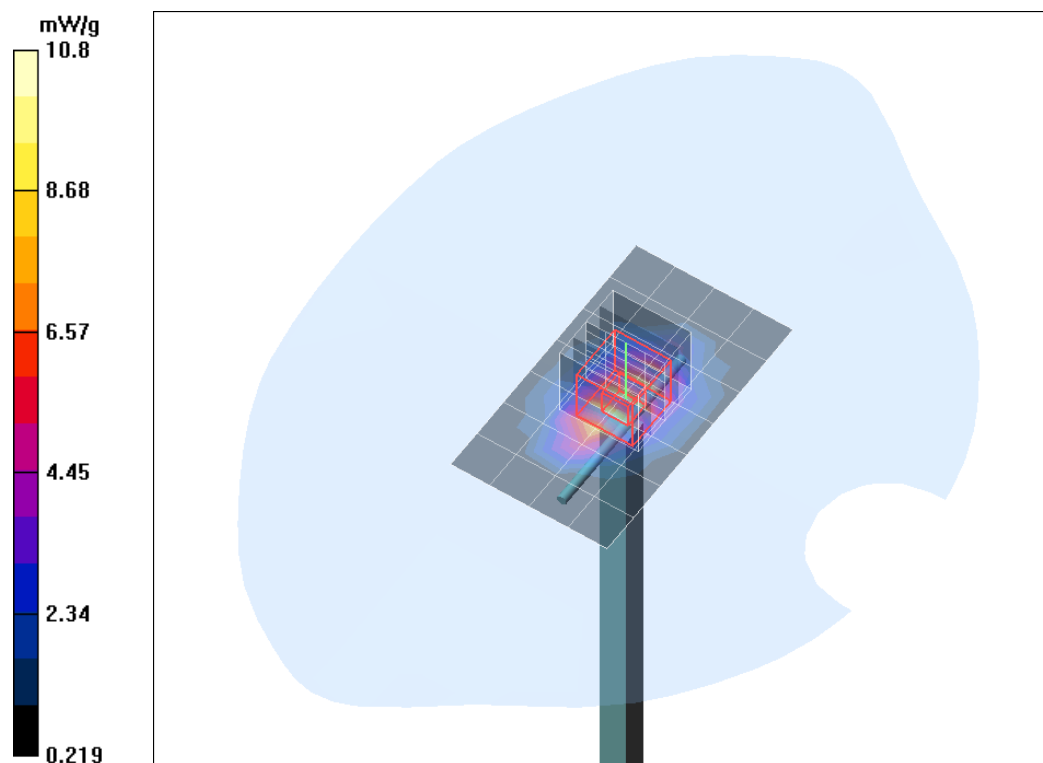
**d=10mm, Pin=250mW/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm

Reference Value = 93.8 V/m; Power Drift = -0.184 dB

Peak SAR (extrapolated) = 14.8 W/kg

**SAR(1 g) = 9.18 mW/g; SAR(10 g) = 4.91 mW/g**

Maximum value of SAR (measured) = 10.8 mW/g



Plot. 3: System Verification Measurement 1900 MHz, Head.

Test Laboratory: IMST GmbH, DASY Yellow (II); File Name: [231117\\_y\\_1669\\_631.da4](#)

DUT: Dipole 1900 MHz SN: 535; Type: D1900V2; Serial: D1900V2 - SN535

Program Name: System Performance Check at 1900 MHz

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

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.5$  mho/m;  $\epsilon_r = 50.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

DASY4 Configuration:

- Probe: ET3DV6R - SN1669; ConvF(4.79, 4.79, 4.79); Calibrated: 2/16/2017
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 9/25/2017
- Phantom: SAM 1340; Type: QD 000 P40 CB; Serial: TP-1340
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

**d=10mm, Pin=250mW/Area Scan (7x9x1):** Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 10.4 mW/g

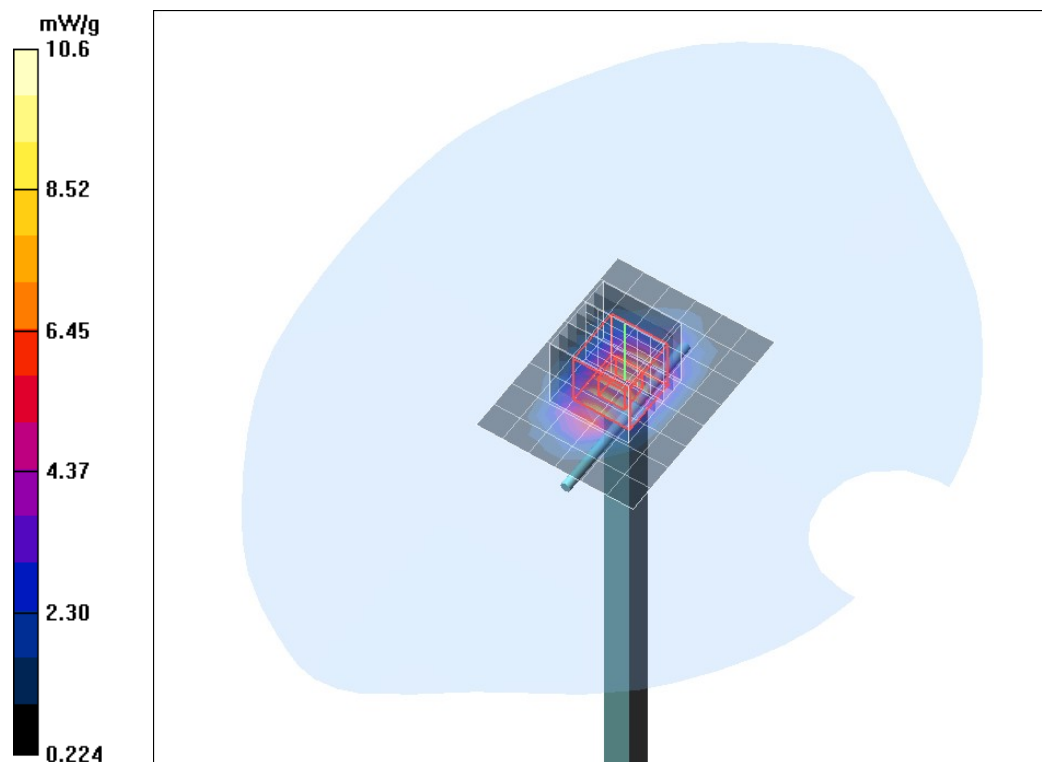
**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 89.1 V/m; Power Drift = 0.078 dB

Peak SAR (extrapolated) = 14.6 W/kg

**SAR(1 g) = 9.34 mW/g; SAR(10 g) = 5.07 mW/g**

Maximum value of SAR (measured) = 10.6 mW/g



Plot. 4: System Verification Measurement 1900 MHz, Body.

## Appendix D – Certificates of Conformity

Schmid &amp; Partner Engineering AG

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Zeughausstrasse 43, 8004 Zurich, Switzerland  
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### Certificate of conformity

|                       |  |
|-----------------------|--|
| Item                  | Dosimetric Assessment System DASY4   |
| Type No               | SD 000 401A, SD 000 402A   |
| Software Version No   | DASY 4.7   |
| Manufacturer / Origin | Schmid & Partner Engineering AG<br>Zeughausstrasse 43, CH-8004 Zürich, Switzerland |

### References

- [1] IEEE 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- [2] IEC 62209 – 1, "Specific Absorption Rate (SAR) in the frequency range of 300 MHz to 3 GHz – Measurement Procedure, Part 1: Hand-held mobile wireless communication devices", February 2005
- [3] IEC 62209 – 2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation and Procedures, Part 2: Procedure to determine the Specific Absorption Rate (SAR) for ... including accessories and multiple transmitters", March 2010
- [4] KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"
- [5] ANSI-C63.19-2011, "American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids", May 2011

### Conformity

We certify that this **system is designed to be fully compliant** with the standards [1 – 5] for RF emission tests of wireless devices.

### Uncertainty

The uncertainty of the measurements with this system was evaluated according to the above standards and is documented in the applicable chapters of the DASY4 system handbook and in Chapter 27 of the DASY5 system handbook.

The uncertainty values represent current state of methodology and are subject to changes. They are applicable to all laboratories using DASY4 provided the following requirements are met (responsibility of the system end user):

- 1) the system is used by an experienced engineer who follows the manual and the guidelines taught during the training provided by SPEAG,
- 2) the probe and validation dipoles have been calibrated for the relevant frequency bands and media within the requested period,
- 3) the DAE has been calibrated within the requested period,
- 4) the "minimum distance" between probe sensor and inner phantom shell and the radiation source is selected properly,
- 5) the system performance check has been successful,
- 6) the operational mode of the DUT is CW, CDMA, FDMA or TDMA (GSM, DCS, PCS, IS136, PDC) and the measurement/integration time per point is  $\geq 500$  ms,
- 7) if applicable, the probe modulation factor is evaluated and applied according to field level, modulation and frequency,
- 8) the dielectric parameters of the liquid are conform with the standard requirement,
- 9) the DUT has been positioned as described in the manual.
- 10) the uncertainty values from the calibration certificates, and the laboratory and measurement equipment dependent uncertainties, are updated by end user accordingly.

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Date 19.09.2016

  
 Signature / Stamp

Doc No 880 – SD00040XA-Standards\_1609 – G

KP/FB

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Fig. 9: Certificate of conformity for the used DASY4 system:



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**Certificate of Conformity / First Article Inspection**

|              |   |
|--------------|---|
| Item         | SAM Twin Phantom V4.0 and V5.0  |
| Type No      | QD 000 P40 C  |
| Series No    | TP-1150 and higher  |
| Manufacturer | Untersee Composites<br>Knebelstrasse 8, CH-8268 Mannenbach, Switzerland |

**Tests**

Complete tests were made on the pre-series QD 000 P40 A, # TP-1001, on the series first article QD 000 P40 B # TP-1006. Certain parameters are retested on series items.

| Test                        | Requirement   | Details   | Units tested                        |
|-----------------------------|---|---|-------------------------------------|
| Dimensions                  | Compliant with the geometry according to the CAD model.                             | IT'IS CAD File *                                  | First article, Samples              |
| Material thickness of shell | 2mm +/- 0.2mm in flat section, other locations: +/- 0.2mm with respect to CAD file  | in flat section, in the cheek area                | First article, Samples, TP-1314 ff. |
| Material thickness at ERP   | 6mm +/- 0.2mm at ERP  |   | First article, All items            |
| Material parameters         | rel. permittivity 2 – 5, loss tangent ≤ 0.05, at f ≤ 6 GHz                          | rel. permittivity 3.5 +/- 0.5 loss tangent ≤ 0.05 | Material samples                    |
| Material resistivity        | Compatibility with tissue simulating liquids .                                      | Compatible with SPEAG liquids. **                 | Phantoms, Material sample           |
| Sagging                     | Sagging of the flat section in tolerance when filled with tissue simulating liquid. | < 1% for filling height up to 155 mm              | Prototypes, Sample testing          |

\* The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of the other documents.

\*\* Note: Compatibility restrictions apply certain liquid components mentioned in the standard, containing e.g. DGBE, DGMHE or Triton X-100. Observe technical note on material compatibility.

**Standards**

- [1] OET Bulletin 65, Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition 01-01
- [2] IEEE 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, December 2003
- [3] IEC 62209–1 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", 2005-02-18
- [4] IEC 62209–2 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", 2010-03-30

**Conformity**

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of **hand-held** SAR measurements and system performance checks as specified in [1 – 4] and further standards.

**Date** 25.07.2011

**Signature / Stamp**

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 info@speag.com, http://www.speag.com

Fig. 10: Certificate of conformity for the used SAM phantom.



## Appendix E – Calibration Certificates for DAEs

### DAE 4 – SN: 631

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



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

Accredited by the Swiss Accreditation Service (SAS)  
The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **IMST**

Certificate No: **DAE4-631\_Sep17**

| CALIBRATION CERTIFICATE  |   |                                   |                            |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |
|--|---|-----------------------------------|----------------------------|-------------------|------|----------------------------|-----------------------|-------------------------------|-------------|----------------------|--------|---------------------|------|-----------------------|-----------------|---------------------------|--------------------|----------------------------|------------------------|---------------------|--------------------|----------------------------|------------------------|
| Object   | DAE4 - SD 000 D04 BM - SN: 631  |                                   |                            |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |
| Calibration procedure(s)   | QA CAL-06.v29<br>Calibration procedure for the data acquisition electronics (DAE) |                                   |                            |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |
| Calibration date:  | September 25, 2017  |                                   |                            |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |
| <p>This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity &lt; 70%.</p> <p>Calibration Equipment used (M&amp;TE critical for calibration)</p> <table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date (Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Keithley Multimeter Type 2001</td> <td>SN: 0610278</td> <td>31-Aug-17 (No:21092)</td> <td>Aug-18</td> </tr> <tr> <th>Secondary Standards</th> <th>ID #</th> <th>Check Date (in house)</th> <th>Scheduled Check</th> </tr> <tr> <td>Auto DAE Calibration Unit</td> <td>SE UWS 053 AA 1001</td> <td>05-Jan-17 (in house check)</td> <td>In house check: Jan-18</td> </tr> <tr> <td>Calibrator Box V2.1</td> <td>SE UMS 006 AA 1002</td> <td>05-Jan-17 (in house check)</td> <td>In house check: Jan-18</td> </tr> </tbody> </table> |   |                                   |                            | Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration | Keithley Multimeter Type 2001 | SN: 0610278 | 31-Aug-17 (No:21092) | Aug-18 | Secondary Standards | ID # | Check Date (in house) | Scheduled Check | Auto DAE Calibration Unit | SE UWS 053 AA 1001 | 05-Jan-17 (in house check) | In house check: Jan-18 | Calibrator Box V2.1 | SE UMS 006 AA 1002 | 05-Jan-17 (in house check) | In house check: Jan-18 |
| Primary Standards  | ID #  | Cal Date (Certificate No.)        | Scheduled Calibration      |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |
| Keithley Multimeter Type 2001  | SN: 0610278   | 31-Aug-17 (No:21092)              | Aug-18                     |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |
| Secondary Standards  | ID #  | Check Date (in house)             | Scheduled Check            |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |
| Auto DAE Calibration Unit  | SE UWS 053 AA 1001  | 05-Jan-17 (in house check)        | In house check: Jan-18     |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |
| Calibrator Box V2.1  | SE UMS 006 AA 1002  | 05-Jan-17 (in house check)        | In house check: Jan-18     |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |
| Calibrated by:   | Name<br>Eric Hainfeld   | Function<br>Laboratory Technician | Signature<br>              |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |
| Approved by:   | Sven Kühn   | Deputy Manager                    |                            |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |
|  |   |                                   | Issued: September 25, 2017 |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory.  |   |                                   |                            |                   |      |                            |                       |                               |             |                      |        |                     |      |                       |                 |                           |                    |                            |                        |                     |                    |                            |                        |

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

Accredited by the Swiss Accreditation Service (SAS)  
The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

## Glossary

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

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

| Calibration Factors | X                         | Y                         | Z                         |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range          | 404.336 $\pm$ 0.02% (k=2) | 404.289 $\pm$ 0.02% (k=2) | 406.231 $\pm$ 0.02% (k=2) |
| Low Range           | 3.94735 $\pm$ 1.50% (k=2) | 3.92769 $\pm$ 1.50% (k=2) | 3.95902 $\pm$ 1.50% (k=2) |

### Connector Angle

|   |                                    |
|---|------------------------------------|
| Connector Angle to be used in DASY system | 33,5 $^{\circ}$ $\pm$ 1 $^{\circ}$ |
|---|------------------------------------|

## Appendix (Additional assessments outside the scope of SCS0108)

### 1. DC Voltage Linearity

| High Range        | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 199995.55                 | 0.72                         | 0.00      |
| Channel X + Input | 20004.05                  | 2.52                         | 0.01      |
| Channel X - Input | -19994.83                 | 6.07                         | -0.03     |
| Channel Y + Input | 199994.15                 | -0.58                        | -0.00     |
| Channel Y + Input | 20002.15                  | 0.75                         | 0.00      |
| Channel Y - Input | -19999.60                 | 1.34                         | -0.01     |
| Channel Z + Input | 199993.59                 | -1.31                        | -0.00     |
| Channel Z + Input | 19996.59                  | -4.78                        | -0.02     |
| Channel Z - Input | -20003.58                 | -2.60                        | 0.01      |

| Low Range         | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 2001.41                   | 0.38                         | 0.02      |
| Channel X + Input | 201.48                    | 0.00                         | 0.00      |
| Channel X - Input | -197.83                   | 0.61                         | -0.31     |
| Channel Y + Input | 2001.47                   | 0.39                         | 0.02      |
| Channel Y + Input | 201.40                    | -0.19                        | -0.09     |
| Channel Y - Input | -198.57                   | -0.21                        | 0.10      |
| Channel Z + Input | 2000.55                   | -0.40                        | -0.02     |
| Channel Z + Input | 200.68                    | -0.75                        | -0.37     |
| Channel Z - Input | -198.98                   | -0.48                        | 0.24      |

### 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                            | 1.06   | -0.65                                       |
|           | -200                           | 1.24   | -0.01                                       |
| Channel Y | 200                            | 18.66  | 18.55                                       |
|           | -200                           | -19.18                                       | -19.88                                      |
| Channel Z | 200                            | 4.24   | 3.96  |
|           | -200                           | -5.83  | -6.07                                       |

### 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                | -                           | 0.62                        | -3.68                       |
| Channel Y | 200                | 9.20                        | -                           | -0.18                       |
| Channel Z | 200                | 6.70                        | 7.94                        | -                           |

#### 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 | 15993            | 15998           |
| Channel Y | 15462            | 16407           |
| Channel Z | 16651            | 17171           |

#### 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 | 0.63               | -0.83                  | 1.59                   | 0.40                      |
| Channel Y | -0.35              | -1.18                  | 1.64                   | 0.49                      |
| Channel Z | 0.32               | -0.69                  | 1.56                   | 0.54                      |

#### 6. Input Offset Current

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

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

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

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

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

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

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



## Appendix F – Calibration Certificates for E-Field Probes

### Probe ET3DV6R – SN1669

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



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

Accredited by the Swiss Accreditation Service (SAS)  
The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **IMST**

Certificate No: **ET3-1669\_Feb17**

### CALIBRATION CERTIFICATE

Object: **ET3DV6R - SN:1669**

Calibration procedure(s): **QA CAL-01.v9, QA CAL-12.v9, QA CAL-23.v5, QA CAL-25.v6  
Calibration procedure for dosimetric E-field probes**

Calibration date: **February 16, 2017**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI)  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|------------------|-----------------------------------|------------------------|
| Power meter NRP            | SN: 104778       | 06-Apr-16 (No. 217-02288/02289)   | Apr-17                 |
| Power sensor NRP-Z91       | SN: 103244       | 06-Apr-16 (No. 217-02288)         | Apr-17                 |
| Power sensor NRP-Z91       | SN: 103245       | 06-Apr-16 (No. 217-02289)         | Apr-17                 |
| Reference 20 dB Attenuator | SN: S5277 (20x)  | 05-Apr-16 (No. 217-02293)         | Apr-17                 |
| Reference Probe ES3DV2     | SN: 3013         | 31-Dec-16 (No. ES3-3013_Dec16)    | Dec-17                 |
| DAE4                       | SN: 660          | 7-Dec-16 (No. DAE4-660_Dec16)     | Dec-17                 |
| Secondary Standards        | ID               | Check Date (in house)             | Scheduled Check        |
| Power meter E4419B         | SN: GB41293874   | 06-Apr-16 (in house check Jun-16) | In house check: Jun-16 |
| Power sensor E4412A        | SN: MY41498087   | 06-Apr-16 (in house check Jun-16) | In house check: Jun-16 |
| Power sensor E4412A        | SN: 000110210    | 06-Apr-16 (in house check Jun-16) | In house check: Jun-16 |
| RF generator HP 8648C      | SN: US3642U01700 | 04-Aug-99 (in house check Jun-16) | In house check: Jun-16 |
| Network Analyzer HP 8753E  | SN: US37390585   | 18-Oct-01 (in house check Oct-16) | In house check: Oct-17 |

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

Issued: February 16, 2017

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

Certificate No: **ET3-1669\_Feb17**

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**S** Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

#### Glossary:

|                          |   |
|--------------------------|---|
| TSL                      | tissue simulating liquid  |
| NORM <sub>x,y,z</sub>    | sensitivity in free space   |
| ConvF                    | sensitivity in TSL / NORM <sub>x,y,z</sub>  |
| DCP                      | diode compression point   |
| CF                       | crest factor (1/duty_cycle) of the RF signal  |
| A, B, C, D               | 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),<br>i.e., $\vartheta = 0$ is normal to probe axis |
| Connector Angle          | information used in DASY system to align probe sensor X to the robot coordinate system  |

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### 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 affect the E<sup>2</sup>-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 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
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A, B, C, D 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<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.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).



ET3DV6R – SN:1669

February 16, 2017

# Probe ET3DV6R

## SN:1669

Manufactured: February 8, 2002  
Calibrated: February 16, 2017

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



ET3DV6R- SN:1669

February 16, 2017

## DASY/EASY - Parameters of Probe: ET3DV6R - SN:1669

### Basic Calibration Parameters

|   | Sensor X | Sensor Y | Sensor Z | Unc (k=2)    |
|---|----------|----------|----------|--------------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 1.70     | 1.86     | 1.71     | $\pm 10.1\%$ |
| DCP (mV) <sup>B</sup>                                     | 98.9     | 100.5    | 98.9     |              |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc<br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|--------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 243.9    | $\pm 3.3\%$  |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 238.0    |              |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 249.0    |              |

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

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

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

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



ET3DV6R- SN:1669

February 16, 2017

## DASY/EASY - Parameters of Probe: ET3DV6R - SN:1669

### Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>D</sup> | Depth <sup>G</sup> (mm) | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 300                  | 45.3                               | 0.87                            | 8.22    | 8.22    | 8.22    | 0.17               | 2.50                    | ± 13.3 %  |
| 450                  | 43.5                               | 0.87                            | 7.75    | 7.75    | 7.75    | 0.21               | 2.60                    | ± 13.3 %  |
| 750                  | 41.9                               | 0.89                            | 6.74    | 6.74    | 6.74    | 0.40               | 2.37                    | ± 12.0 %  |
| 900                  | 41.5                               | 0.97                            | 6.28    | 6.28    | 6.28    | 0.49               | 2.18                    | ± 12.0 %  |
| 1750                 | 40.1                               | 1.37                            | 5.60    | 5.60    | 5.60    | 0.78               | 2.09                    | ± 12.0 %  |
| 1900                 | 40.0                               | 1.40                            | 5.33    | 5.33    | 5.33    | 0.73               | 2.26                    | ± 12.0 %  |

<sup>C</sup> Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 126, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<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.

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



ET3DV6R- SN:1669

February 16, 2017

## DASY/EASY - Parameters of Probe: ET3DV6R - SN:1669

### Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) <sup>c</sup> | Relative Permittivity <sup>f</sup> | Conductivity (S/m) <sup>f</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>d</sup> | Depth (mm) <sup>d</sup> | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 750                  | 55.5                               | 0.96                            | 6.56    | 6.56    | 6.56    | 0.51               | 1.97                    | ± 12.0 %  |
| 1750                 | 53.4                               | 1.49                            | 4.99    | 4.99    | 4.99    | 0.80               | 2.45                    | ± 12.0 %  |
| 1900                 | 53.3                               | 1.52                            | 4.79    | 4.79    | 4.79    | 0.80               | 2.37                    | ± 12.0 %  |

<sup>c</sup> Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>f</sup> At 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.

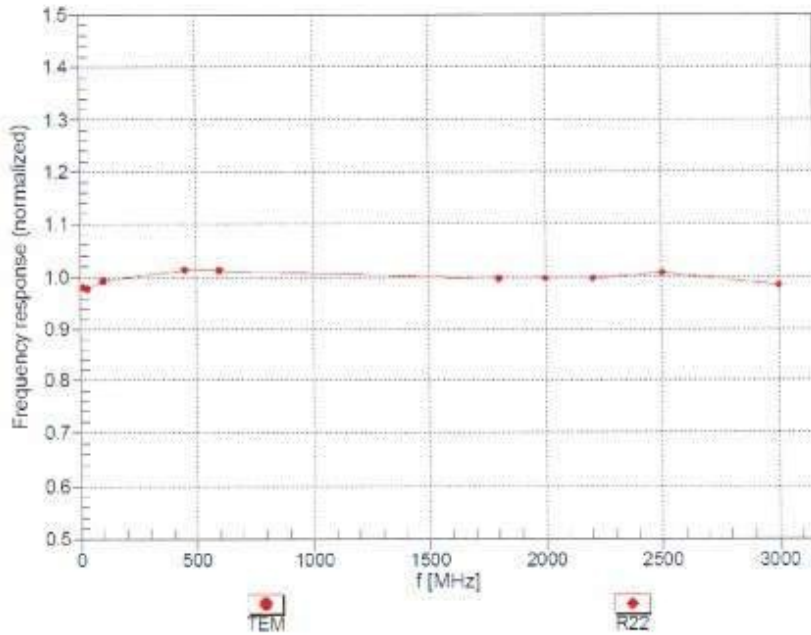
<sup>d</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter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



ET3DV6R- SN:1669

February 16, 2017

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



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



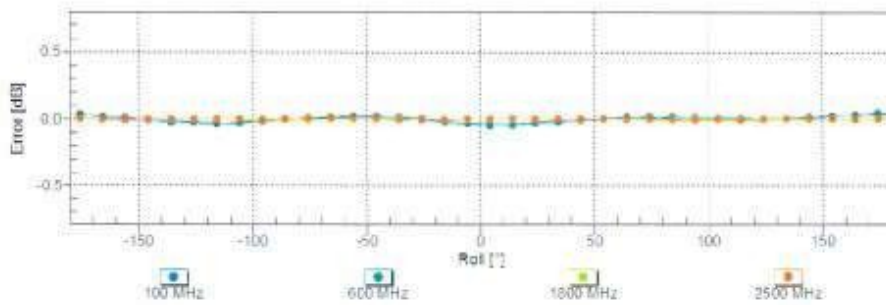
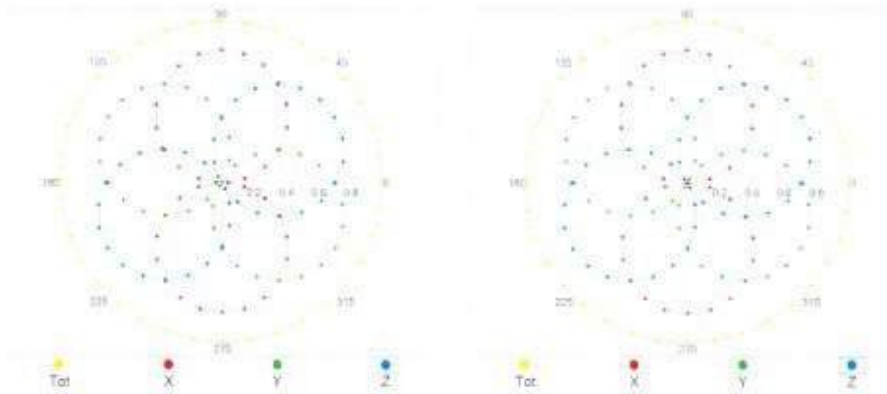
ET3DV6R-SN:1669

February 16, 2017

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

f=600 MHz,TEM

f=1800 MHz,R22



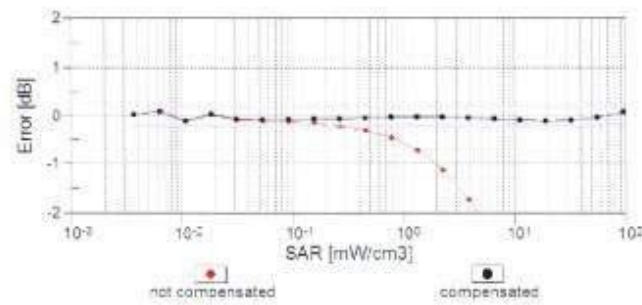
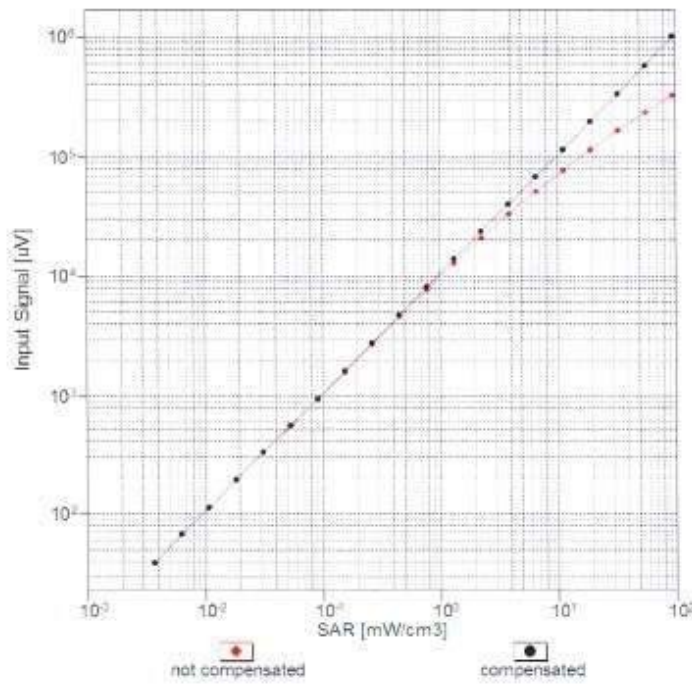
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)



ET3DV6R- SN:1669

February 16, 2017

### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f_{\text{eval}} = 1900 \text{ MHz}$ )



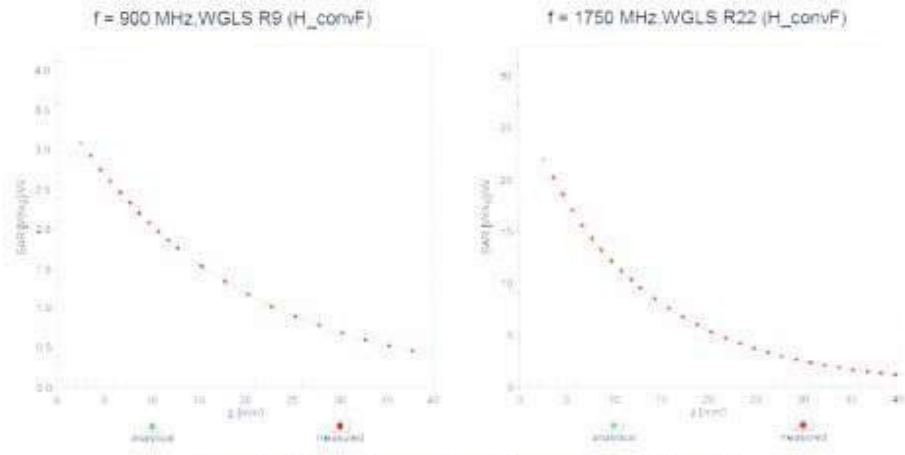
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  (k=2)



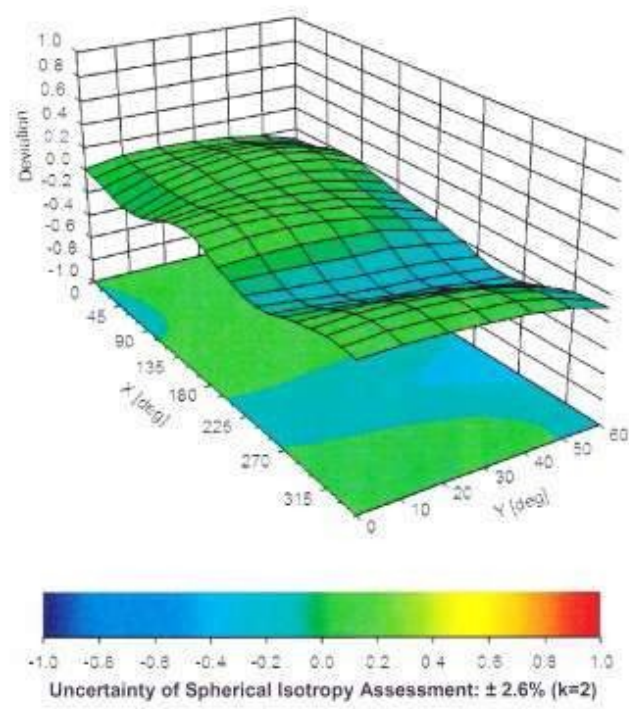
ET3DV6R- SN:1669

February 16, 2017

### Conversion Factor Assessment



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





ET3DV6R- SN:1669

February 16, 2017

**DASY/EASY - Parameters of Probe: ET3DV6R - SN:1669****Other Probe Parameters**

|   |            |
|---|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | 4.3        |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disabled   |
| Probe Overall Length                          | 337 mm     |
| Probe Body Diameter                           | 10 mm      |
| Tip Length                                    | 10 mm      |
| Tip Diameter                                  | 6.8 mm     |
| Probe Tip to Sensor X Calibration Point       | 2.7 mm     |
| Probe Tip to Sensor Y Calibration Point       | 2.7 mm     |
| Probe Tip to Sensor Z Calibration Point       | 2.7 mm     |
| Recommended Measurement Distance from Surface | 4 mm       |

Certificate No. ET3-1669\_Feb17

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## Appendix G – Calibration Certificates for Dipoles

### 8.1.1 Dipole 1900 MHz – SN535

**Calibration Laboratory of  
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **IMST**

Certificate No: **D1900V2-535\_Mar15**

| CALIBRATION CERTIFICATE  |  |                                   |                        |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
|--|--|-----------------------------------|------------------------|-------------------|------|----------------------------|-----------------------|----------------------|------------|---------------------------|--------|-----------------------|------------|---------------------------|--------|-----------------------|------------|---------------------------|--------|----------------------------|----------------|---------------------------|--------|-----------------------------|--------------------|---------------------------|--------|------------------------|----------|--------------------------------|--------|------|---------|--------------------------------|--------|---------------------|------|-----------------------|-----------------|-------------------------|--------|-----------------------------------|------------------------|---------------------------|------------------|-----------------------------------|------------------------|
| Object   | D1900V2 - SN: 535  |                                   |                        |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| Calibration procedure(s)   | QA CAL-05.v9<br>Calibration procedure for dipole validation kits above 700 MHz |                                   |                        |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| Calibration date:  | March 24, 2015   |                                   |                        |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| <p>This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).<br/>The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity &lt; 70%.</p> <p>Calibration Equipment used (M&amp;TE critical for calibration)</p> <table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date (Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power meter EPM-442A</td> <td>GB37480704</td> <td>07-Oct-14 (No. 217-02020)</td> <td>Oct-15</td> </tr> <tr> <td>Power sensor HP 8481A</td> <td>US37292783</td> <td>07-Oct-14 (No. 217-02020)</td> <td>Oct-15</td> </tr> <tr> <td>Power sensor HP 8481A</td> <td>MY41092317</td> <td>07-Oct-14 (No. 217-02021)</td> <td>Oct-15</td> </tr> <tr> <td>Reference 20 dB Attenuator</td> <td>SN: 5058 (20k)</td> <td>03-Apr-14 (No. 217-01918)</td> <td>Apr-15</td> </tr> <tr> <td>Type-N mismatch combination</td> <td>SN: 5047.2 / 06327</td> <td>03-Apr-14 (No. 217-01921)</td> <td>Apr-15</td> </tr> <tr> <td>Reference Probe ES3DV3</td> <td>SN: 3205</td> <td>30-Dec-14 (No. ES3-3205_Dec14)</td> <td>Dec-15</td> </tr> <tr> <td>DAE4</td> <td>SN: 601</td> <td>18-Aug-14 (No. DAE4-601_Aug14)</td> <td>Aug-15</td> </tr> </tbody> </table><br><table border="1"> <thead> <tr> <th>Secondary Standards</th> <th>ID #</th> <th>Check Date (in house)</th> <th>Scheduled Check</th> </tr> </thead> <tbody> <tr> <td>RF generator R&amp;S SMT-06</td> <td>100005</td> <td>04-Aug-99 (in house check Oct-13)</td> <td>In house check: Oct-16</td> </tr> <tr> <td>Network Analyzer HP 8753E</td> <td>US37390585 S4206</td> <td>18-Oct-01 (in house check Oct-14)</td> <td>In house check: Oct-15</td> </tr> </tbody> </table> |  |                                   |                        | Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration | Power meter EPM-442A | GB37480704 | 07-Oct-14 (No. 217-02020) | Oct-15 | Power sensor HP 8481A | US37292783 | 07-Oct-14 (No. 217-02020) | Oct-15 | Power sensor HP 8481A | MY41092317 | 07-Oct-14 (No. 217-02021) | Oct-15 | Reference 20 dB Attenuator | SN: 5058 (20k) | 03-Apr-14 (No. 217-01918) | Apr-15 | Type-N mismatch combination | SN: 5047.2 / 06327 | 03-Apr-14 (No. 217-01921) | Apr-15 | Reference Probe ES3DV3 | SN: 3205 | 30-Dec-14 (No. ES3-3205_Dec14) | Dec-15 | DAE4 | SN: 601 | 18-Aug-14 (No. DAE4-601_Aug14) | Aug-15 | Secondary Standards | ID # | Check Date (in house) | Scheduled Check | RF generator R&S SMT-06 | 100005 | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 | Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |
| Primary Standards  | ID #   | Cal Date (Certificate No.)        | Scheduled Calibration  |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| Power meter EPM-442A   | GB37480704   | 07-Oct-14 (No. 217-02020)         | Oct-15                 |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| Power sensor HP 8481A  | US37292783   | 07-Oct-14 (No. 217-02020)         | Oct-15                 |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| Power sensor HP 8481A  | MY41092317   | 07-Oct-14 (No. 217-02021)         | Oct-15                 |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| Reference 20 dB Attenuator   | SN: 5058 (20k)   | 03-Apr-14 (No. 217-01918)         | Apr-15                 |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| Type-N mismatch combination  | SN: 5047.2 / 06327   | 03-Apr-14 (No. 217-01921)         | Apr-15                 |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| Reference Probe ES3DV3   | SN: 3205   | 30-Dec-14 (No. ES3-3205_Dec14)    | Dec-15                 |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| DAE4   | SN: 601  | 18-Aug-14 (No. DAE4-601_Aug14)    | Aug-15                 |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| Secondary Standards  | ID #   | Check Date (in house)             | Scheduled Check        |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| RF generator R&S SMT-06  | 100005   | 04-Aug-99 (in house check Oct-13) | In house check: Oct-16 |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| Network Analyzer HP 8753E  | US37390585 S4206   | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| Calibrated by:   | Name<br>Michael Weber  | Function<br>Laboratory Technician | Signature<br>          |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| Approved by:   | Katja Pokovic  | Technical Manager                 |                        |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |
| <p>Issued: March 24, 2015</p> <p>This calibration certificate shall not be reproduced except in full without written approval of the laboratory.</p>   |  |                                   |                        |                   |      |                            |                       |                      |            |                           |        |                       |            |                           |        |                       |            |                           |        |                            |                |                           |        |                             |                    |                           |        |                        |          |                                |        |      |         |                                |        |                     |      |                       |                 |                         |        |                                   |                        |                           |                  |                                   |                        |

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



**S** Schweizerischer Kalibrierdienst  
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

#### Glossary:

|       |                                 |
|-------|---------------------------------|
| TSL   | tissue simulating liquid        |
| ConvF | sensitivity in TSL / NORM x,y,z |
| N/A   | not applicable or not measured  |

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

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

- DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

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

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

### Measurement Conditions

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

|                              |                        |             |
|------------------------------|------------------------|-------------|
| DASY Version                 | DASY5                  | V52.8.8     |
| Extrapolation                | Advanced Extrapolation |             |
| Phantom                      | Modular Flat Phantom   |             |
| Distance Dipole Center - TSL | 10 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 1900 MHz $\pm$ 1 MHz   |             |

### Head TSL parameters

The following parameters and calculations were applied.

|   | Temperature         | Permittivity   | Conductivity         |
|---|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 40.0           | 1.40 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 39.0 $\pm$ 6 % | 1.38 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

### SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 10.0 W/kg                                      |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>40.1 W/kg <math>\pm</math> 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 5.24 W/kg                                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>21.0 W/kg <math>\pm</math> 16.5 % (k=2)</b> |

### Body TSL parameters

The following parameters and calculations were applied.

|   | Temperature         | Permittivity   | Conductivity         |
|---|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 53.3           | 1.52 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 52.8 $\pm$ 6 % | 1.50 mho/m $\pm$ 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 | 9.88 W/kg                                      |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>39.7 W/kg <math>\pm</math> 17.0 % (k=2)</b> |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |  |
|---|--------------------|--|
| SAR measured  | 250 mW input power | 5.28 W/kg                                      |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>21.2 W/kg <math>\pm</math> 16.5 % (k=2)</b> |



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

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 53.6 $\Omega$ + 6.4 j $\Omega$ |
| Return Loss                          | - 23.0 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 49.1 $\Omega$ + 7.4 j $\Omega$ |
| Return Loss                          | - 22.5 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.185 ns |
|----------------------------------|----------|

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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

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

### Additional EUT Data

|                 |                |
|-----------------|----------------|
| Manufactured by | SPEAG          |
| Manufactured on | March 22, 2001 |

## DASY5 Validation Report for Head TSL

Date: 24.03.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 535**

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.38$  S/m;  $\epsilon_r = 39$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

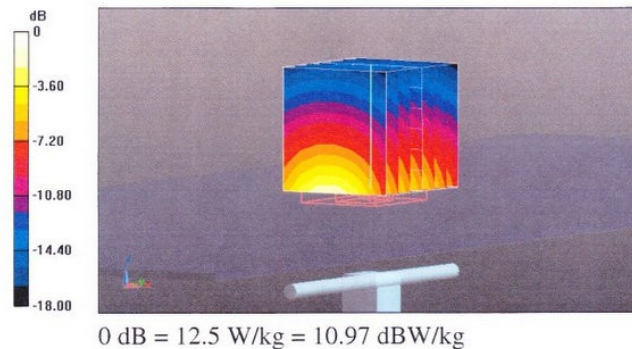
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.90 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 18.4 W/kg

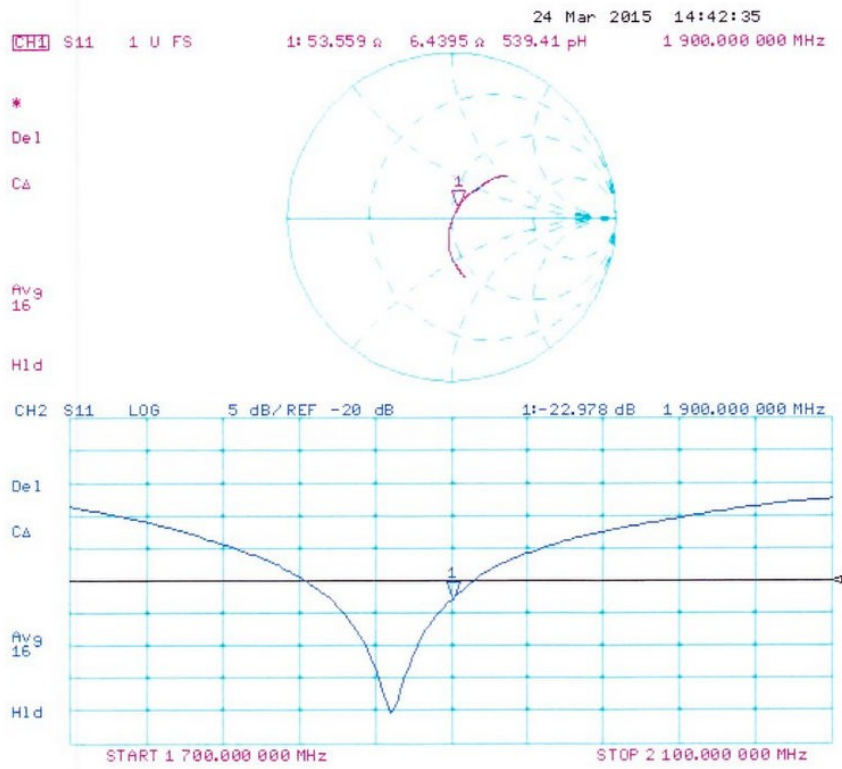
**SAR(1 g) = 10 W/kg; SAR(10 g) = 5.24 W/kg**

Maximum value of SAR (measured) = 12.5 W/kg





### Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 24.03.2015

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 535**

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used:  $f = 1900$  MHz;  $\sigma = 1.5$  S/m;  $\epsilon_r = 52.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

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

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

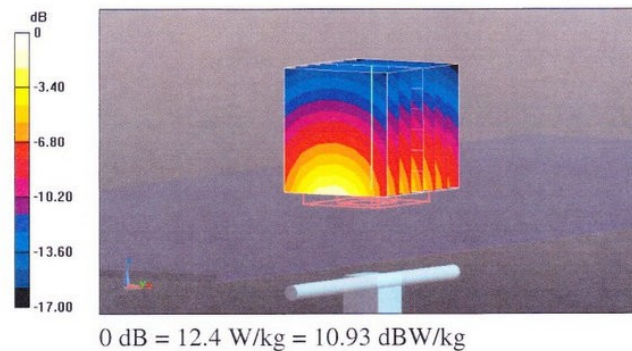
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.36 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 16.8 W/kg

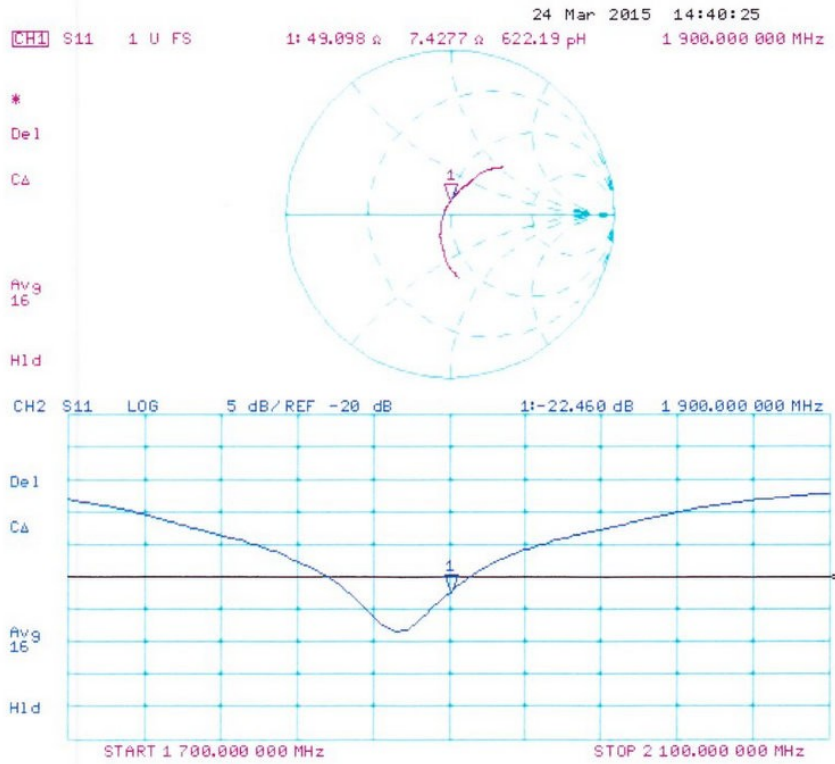
**SAR(1 g) = 9.88 W/kg; SAR(10 g) = 5.28 W/kg**

Maximum value of SAR (measured) = 12.4 W/kg





### Impedance Measurement Plot for Body TSL

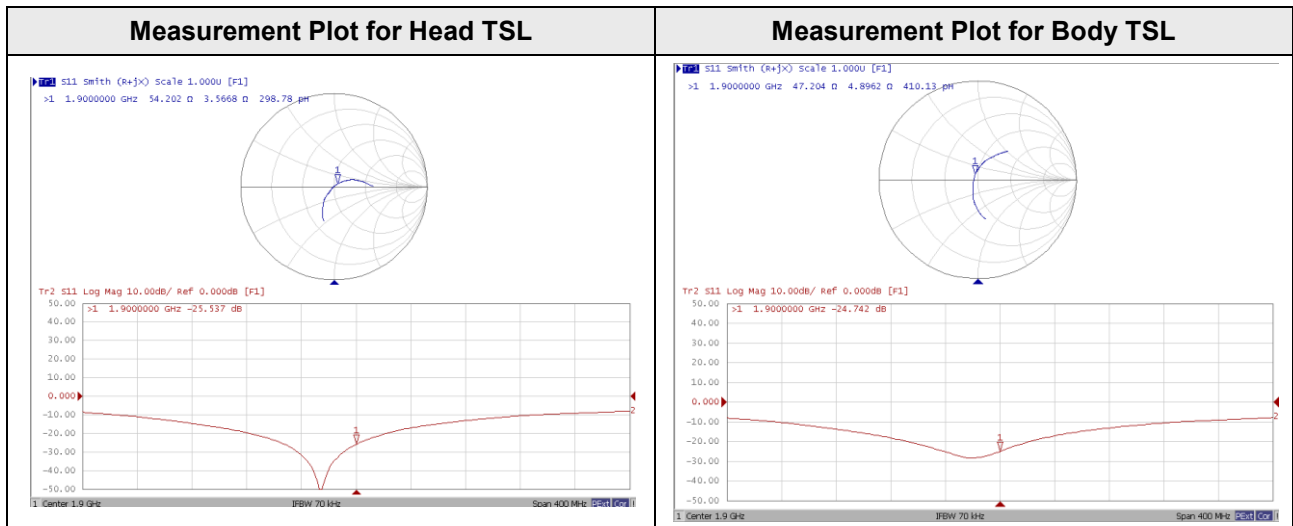




### Extended Dipole Calibration for D1900V2, SN: 535

Referring to section 3.2.2 of KDB 865664 D01, the tables below contain the measurement results for the impedance and return loss of the dipole.

| Justification of the Extended Calibration |                    |                 |                     |                 |                |                 |
|---|--------------------|-----------------|---------------------|-----------------|----------------|-----------------|
| <b>1900 HEAD TSL</b>                      | <b>Calibration</b> |                 | <b>Verification</b> |                 |                |                 |
|   | March 24, 2015     |                 | March 07, 2017      |                 |                |                 |
|   | Target             |                 | Measured            |                 | Delta          |                 |
| Impedance transformed to feed point       | R [ $\Omega$ ]     | X [ $j\Omega$ ] | R [ $\Omega$ ]      | X [ $j\Omega$ ] | R [ $\Omega$ ] | X [ $j\Omega$ ] |
|   | 53.6               | +6.4            | 54.2                | +3.6            | <b>+0.6</b>    | <b>-2.8</b>     |
|   | Target [dB]        |                 | Measured [dB]       |                 | Delta [%]      |                 |
| Return Loss                               | -23.0              |                 | -25.3               |                 | <b>+10.0</b>   |                 |
| <b>1900 BODY TSL</b>                      | <b>Calibration</b> |                 | <b>Verification</b> |                 |                |                 |
|   | March 24, 2015     |                 | March 08, 2017      |                 |                |                 |
|   | Target             |                 | Measured            |                 | Delta          |                 |
| Impedance transformed to feed point       | R [ $\Omega$ ]     | X [ $j\Omega$ ] | R [ $\Omega$ ]      | X [ $j\Omega$ ] | R [ $\Omega$ ] | X [ $j\Omega$ ] |
|   | 49.1               | +7.4            | 47.2                | +4.9            | <b>-1.9</b>    | <b>-2.5</b>     |
|   | Target [dB]        |                 | Measured [dB]       |                 | Delta [%]      |                 |
| Return Loss                               | -22.5              |                 | -24.7               |                 | <b>+9.8</b>    |                 |



The impedance is within 5 ohm of prior calibration.  
 The return loss is <-20 dB and within 20% of prior calibration.  
 Therefore the verification result supports extended dipole calibration.