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Accreditation No.: **SCS 108**

Client **Intertek**

Certificate No: **D2450V2-718_Dec14**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 718**

Calibration procedure(s) **QA CAL-05.v9**
 Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **December 08, 2014**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^\circ\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter 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-13 (No. ES3-3205_Dec13) | Dec-14 |
| 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: **Michael Weber** **Laboratory Technician**

Signature

Approved by: **Katja Pokovic** **Technical Manager**

Issued: December 8, 2014

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



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Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

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 | 2450 MHz \pm 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|---------------------|----------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 39.2 | 1.80 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 39.7 \pm 6 % | 1.84 mho/m \pm 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| | | |
|---|--------------------|------------------------------|
| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 12.9 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 51.2 W/kg \pm 17.0 % (k=2) |

| | | |
|---|--------------------|------------------------------|
| SAR averaged over 10 cm³ (10 g) of Head TSL | condition | |
| SAR measured | 250 mW input power | 5.99 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 23.9 W/kg \pm 16.5 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|---------------------|----------------|----------------------|
| Nominal Body TSL parameters | 22.0 °C | 52.7 | 1.95 mho/m |
| Measured Body TSL parameters | (22.0 \pm 0.2) °C | 51.0 \pm 6 % | 2.03 mho/m \pm 6 % |
| Body TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Body TSL

| | | |
|---|--------------------|------------------------------|
| SAR averaged over 1 cm³ (1 g) of Body TSL | Condition | |
| SAR measured | 250 mW input power | 13.0 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 50.6 W/kg \pm 17.0 % (k=2) |

| | | |
|---|--------------------|------------------------------|
| SAR averaged over 10 cm³ (10 g) of Body TSL | condition | |
| SAR measured | 250 mW input power | 5.99 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 23.6 W/kg \pm 16.5 % (k=2) |

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $54.4 \Omega + 3.1 j\Omega$ |
| Return Loss | - 25.7 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $50.4 \Omega + 4.4 j\Omega$ |
| Return Loss | - 27.1 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.147 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 | September 10, 2002 |

DASY5 Validation Report for Head TSL

Date: 08.12.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 718

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.84$ S/m; $\epsilon_r = 39.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.12.2013;
- 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:

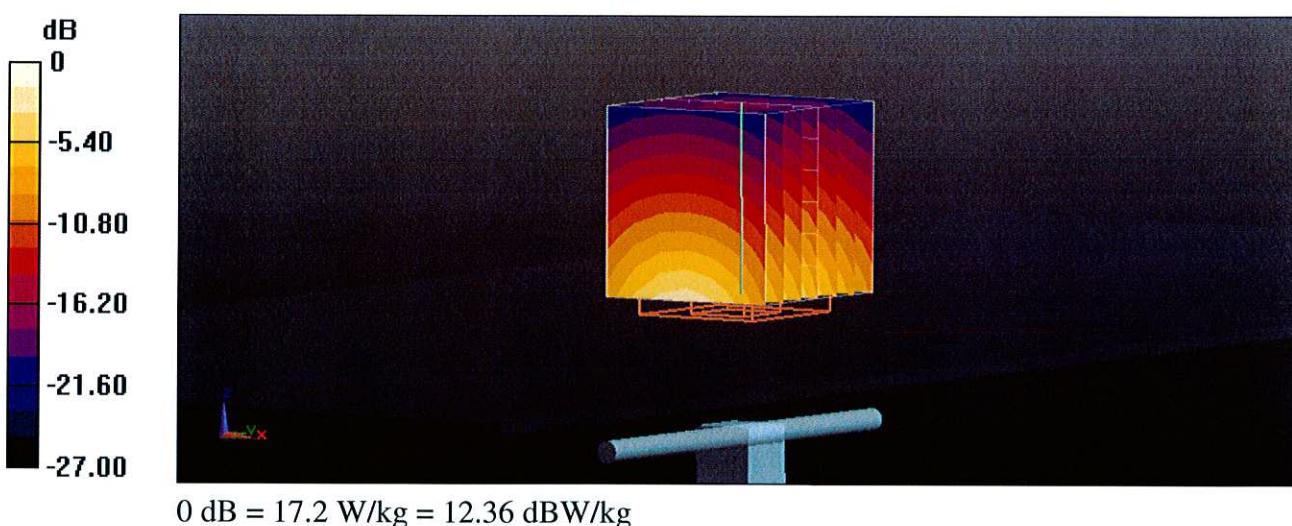
Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 100.3 V/m; Power Drift = 0.04 dB

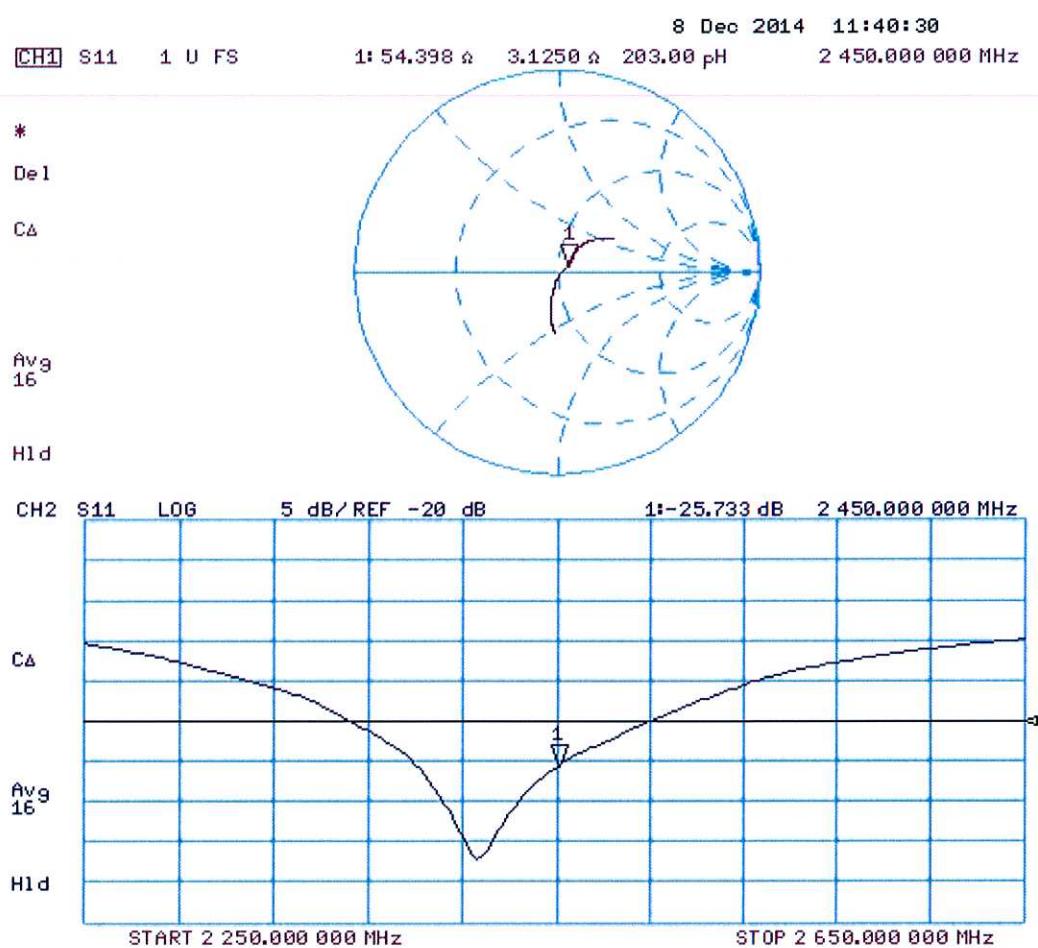
Peak SAR (extrapolated) = 26.7 W/kg

SAR(1 g) = 12.9 W/kg; SAR(10 g) = 5.99 W/kg

Maximum value of SAR (measured) = 17.2 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 08.12.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 718

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.03$ S/m; $\epsilon_r = 51$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2013;
- 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:

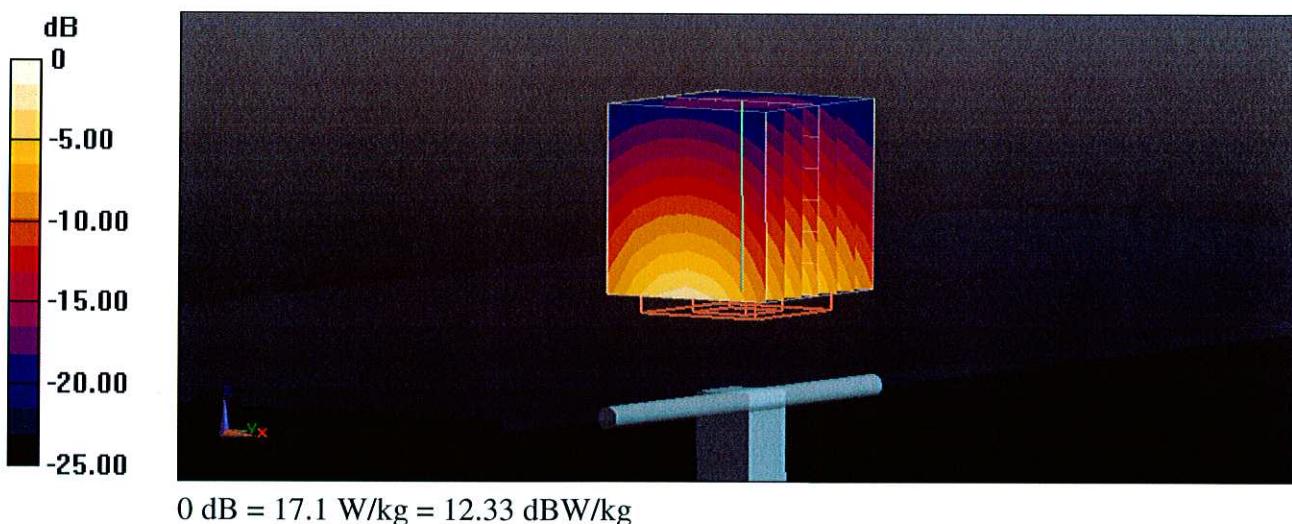
Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 94.84 V/m; Power Drift = -0.00 dB

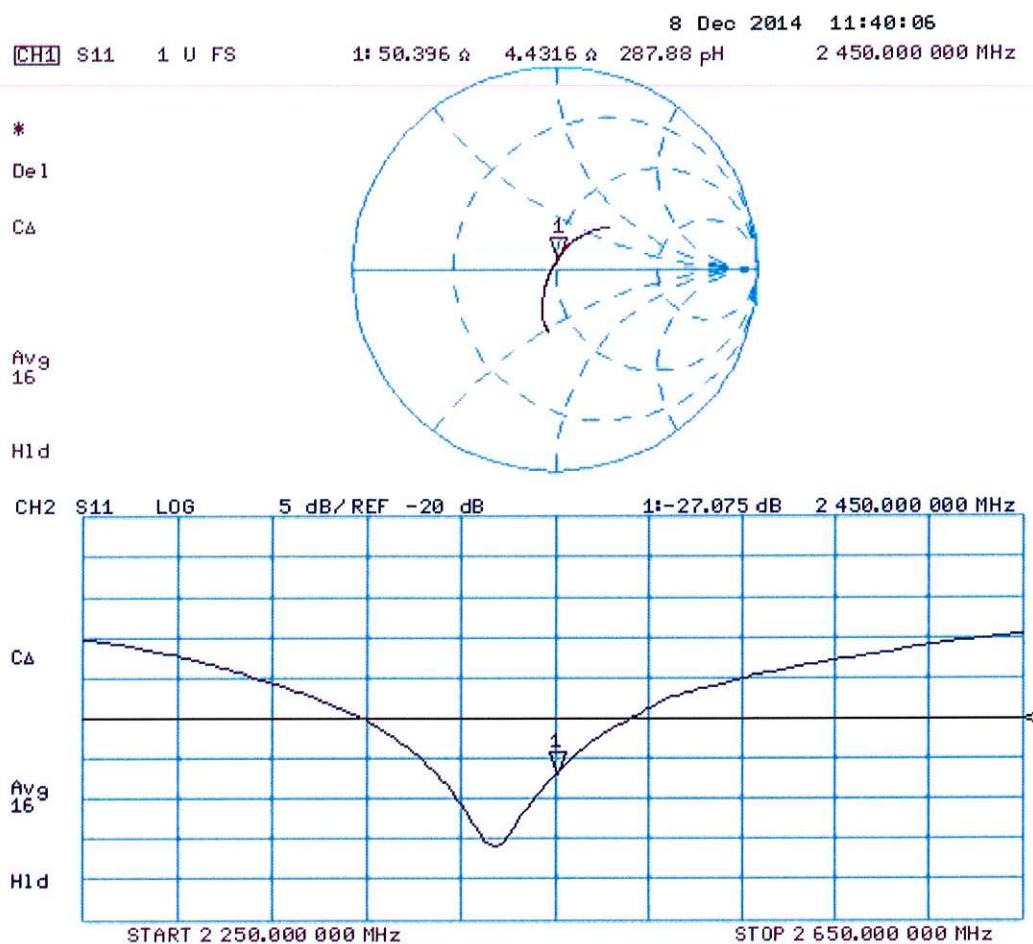
Peak SAR (extrapolated) = 26.9 W/kg

SAR(1 g) = 13 W/kg; SAR(10 g) = 5.99 W/kg

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



Impedance Measurement Plot for Body TSL



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 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 $f \leq 6$ 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

s p e a g

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