

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3263

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750 | 41.9 | 0.89 | 6.27 | 6.27 | 6.27 | 0.29 | 1.87 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.18 | 6.18 | 6.18 | 0.49 | 1.42 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.27 | 5.27 | 5.27 | 0.49 | 1.46 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 4.96 | 4.96 | 4.96 | 0.66 | 1.28 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 4.63 | 4.63 | 4.63 | 0.58 | 1.41 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.40 | 4.40 | 4.40 | 0.71 | 1.34 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.25 | 4.25 | 4.25 | 0.80 | 1.25 | ± 12.0 % |

^C 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3263

Calibration Parameter Determined in Body Tissue Simulating Media

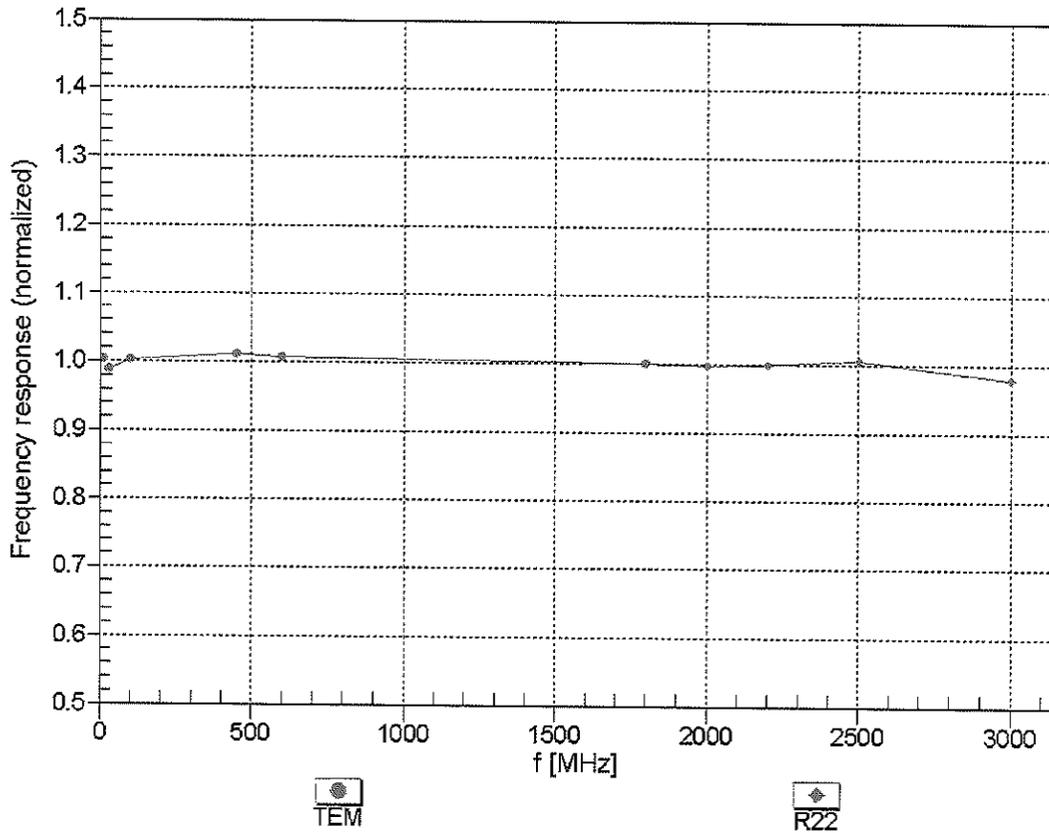
| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750 | 55.5 | 0.96 | 6.07 | 6.07 | 6.07 | 0.53 | 1.42 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.08 | 6.08 | 6.08 | 0.57 | 1.36 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 4.88 | 4.88 | 4.88 | 0.54 | 1.50 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.66 | 4.66 | 4.66 | 0.56 | 1.51 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 4.42 | 4.42 | 4.42 | 0.69 | 1.33 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.28 | 4.28 | 4.28 | 0.80 | 1.08 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 4.11 | 4.11 | 4.11 | 0.80 | 1.09 | ± 12.0 % |

^C 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

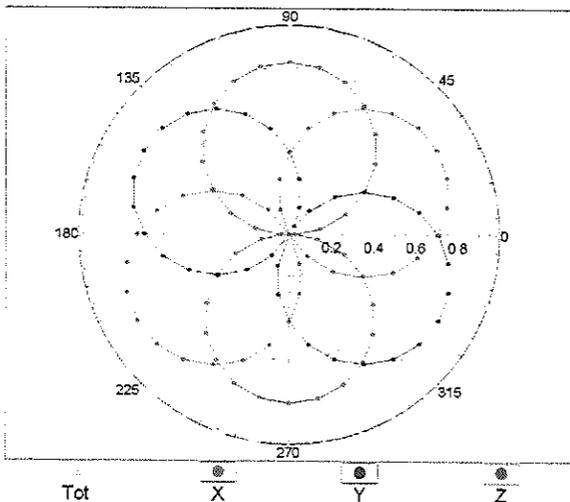
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



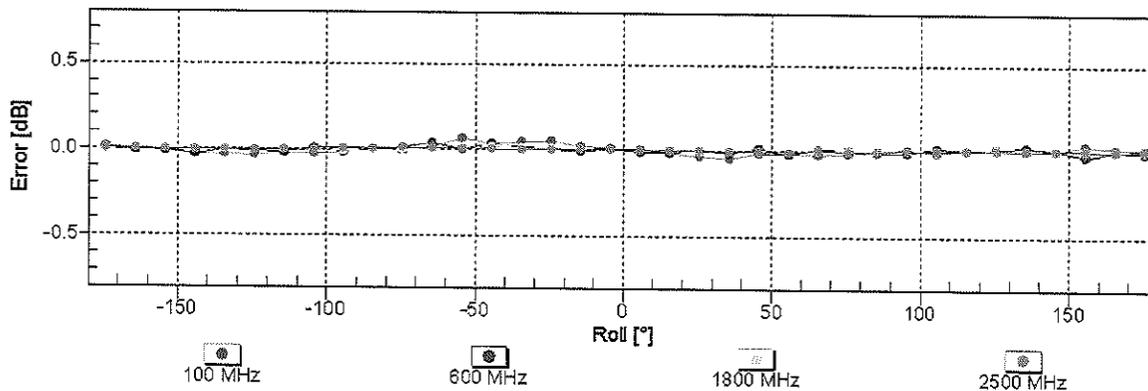
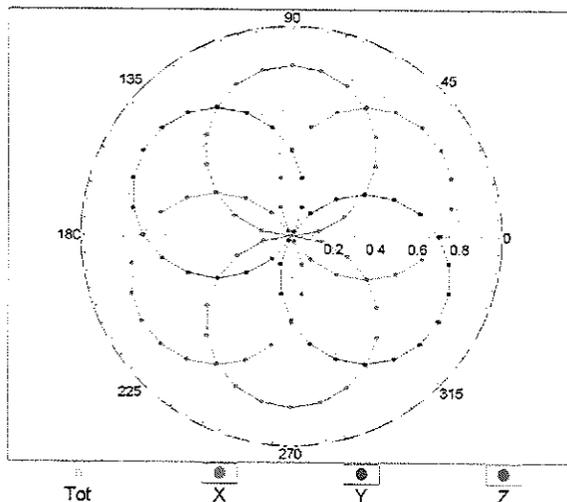
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

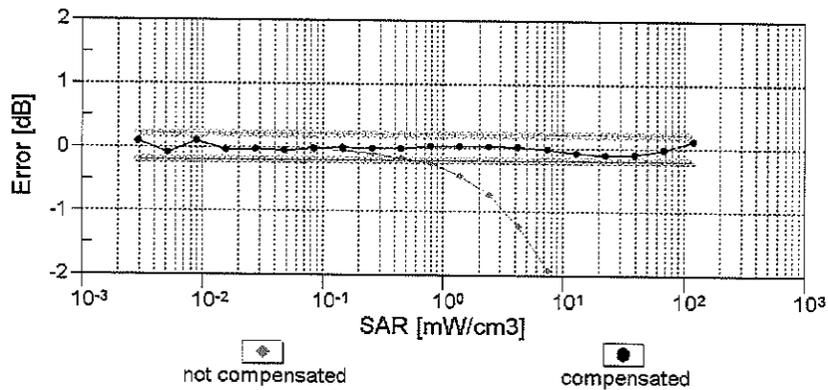
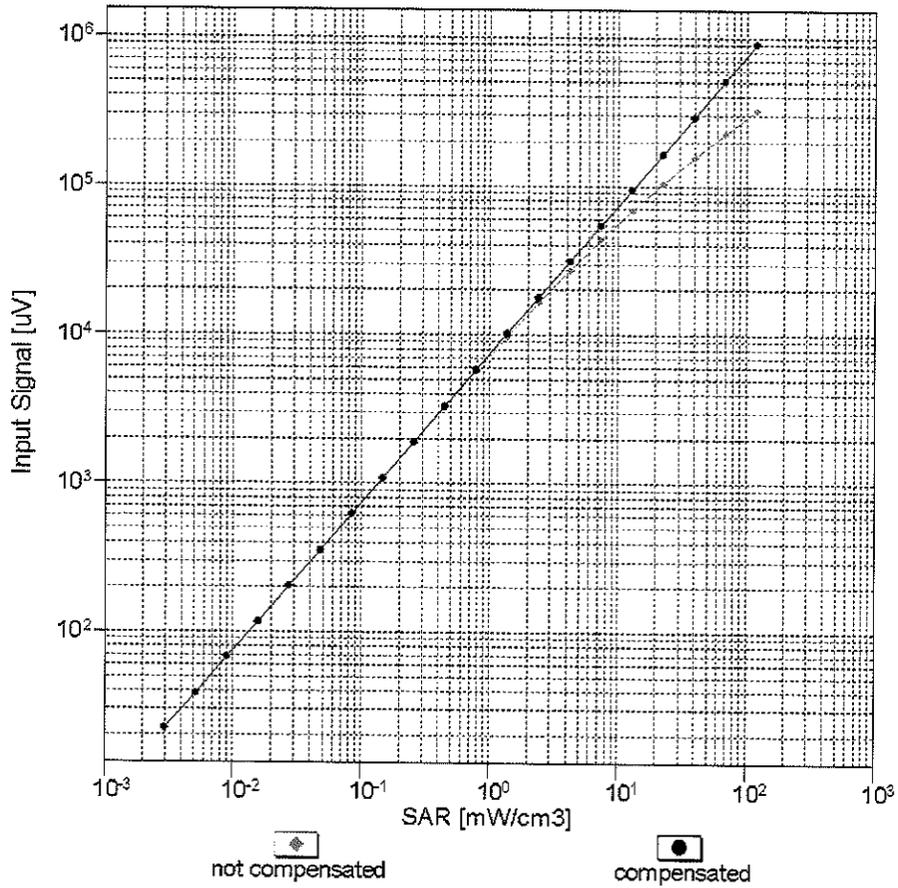


f=1800 MHz,R22



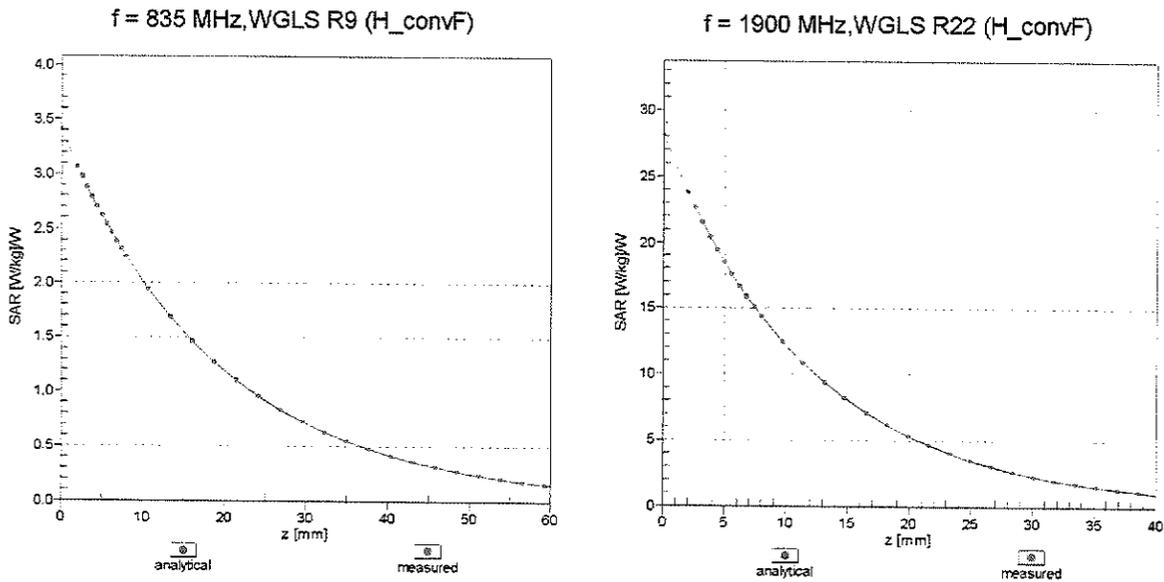
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range $f(SAR_{head})$ (TEM cell, $f_{eval} = 1900$ MHz)

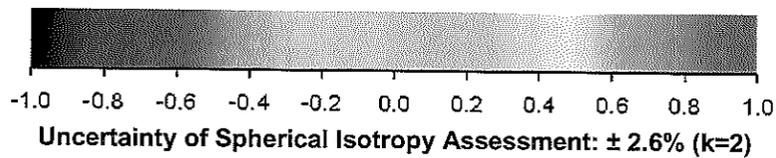
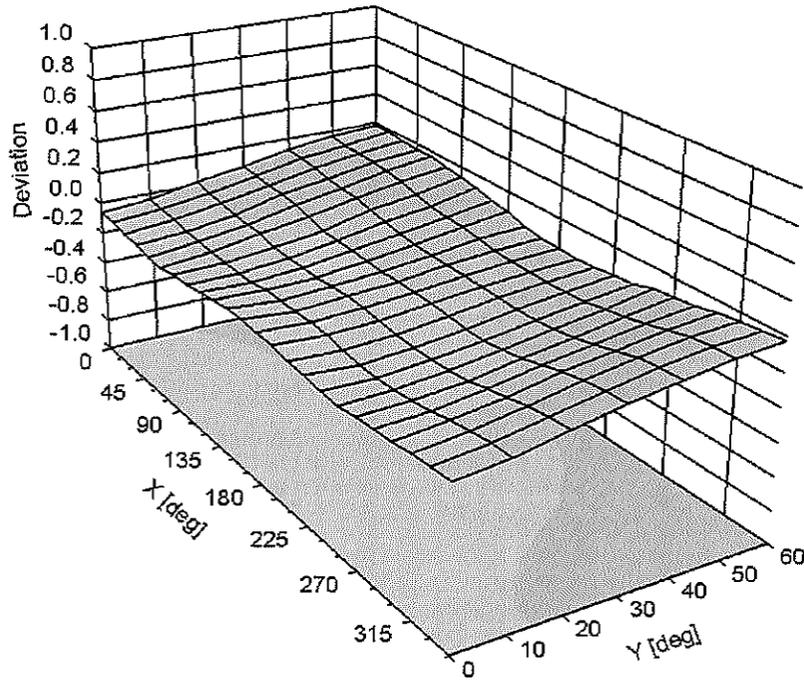


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), f = 900 MHz



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3263

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 65.6 |
| 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 | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |

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



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Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **ES3-3319_Mar15**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3319**

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

Calibration date: **March 19, 2015**

PM ✓
3/26/15

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 E4419B | GB41293874 | 03-Apr-14 (No. 217-01911) | Apr-15 |
| Power sensor E4412A | MY41498087 | 03-Apr-14 (No. 217-01911) | Apr-15 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 03-Apr-14 (No. 217-01915) | Apr-15 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 03-Apr-14 (No. 217-01919) | Apr-15 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 03-Apr-14 (No. 217-01920) | Apr-15 |
| Reference Probe ES3DV2 | SN: 3013 | 30-Dec-14 (No. ES3-3013_Dec14) | Dec-15 |
| DAE4 | SN: 660 | 14-Jan-15 (No. DAE4-660_Jan15) | Jan-16 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-13) | In house check: Apr-16 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

| | Name | Function | Signature |
|----------------|---------------|-----------------------|-----------|
| Calibrated by: | Israe Elnaouq | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: March 19, 2015

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



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

- 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

Methods Applied and Interpretation of Parameters:

- *NORM_{x,y,z}*: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). *NORM_{x,y,z}* are only intermediate values, i.e., the uncertainties of *NORM_{x,y,z}* does not affect the E^2 -field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)_{x,y,z}* = *NORM_{x,y,z}* * *frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCP_{x,y,z}*: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR*: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *A_{x,y,z}*; *B_{x,y,z}*; *C_{x,y,z}*; *D_{x,y,z}*; *VR_{x,y,z}*: *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_{x,y,z}* * *ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 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_x* (no uncertainty required).

Probe ES3DV3

SN:3319

Manufactured: January 10, 2012
Calibrated: March 19, 2015

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---------------------------------------|----------|----------|----------|--------------|
| Norm ($\mu V/(V/m)^2$) ^A | 1.12 | 1.08 | 1.15 | $\pm 10.1\%$ |
| DCP (mV) ^B | 104.4 | 106.0 | 104.4 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu V}$ | C | D dB | VR mV | Unc ^E (k=2) |
|---------------|---|---|---------|------------------------|------|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 176.1 | $\pm 3.3\%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 192.7 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 174.6 | |
| 10010- CAA | SAR Validation (Square, 100ms, 10ms) | X | 3.26 | 64.8 | 13.4 | 10.00 | 41.7 | $\pm 1.9\%$ |
| | | Y | 2.66 | 62.2 | 11.7 | | 39.5 | |
| | | Z | 3.51 | 64.8 | 13.2 | | 42.1 | |
| 10011- CAB | UMTS-FDD (WCDMA) | X | 3.47 | 68.1 | 19.1 | 2.91 | 142.9 | $\pm 0.5\%$ |
| | | Y | 3.37 | 67.9 | 19.1 | | 133.0 | |
| | | Z | 3.57 | 68.7 | 19.4 | | 138.6 | |
| 10012- CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps) | X | 3.48 | 71.8 | 20.2 | 1.87 | 143.9 | $\pm 0.7\%$ |
| | | Y | 3.23 | 70.9 | 19.9 | | 134.6 | |
| | | Z | 3.68 | 72.8 | 20.6 | | 140.5 | |
| 10013- CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps) | X | 11.18 | 70.5 | 23.1 | 9.46 | 143.4 | $\pm 3.3\%$ |
| | | Y | 10.98 | 70.5 | 23.2 | | 129.9 | |
| | | Z | 11.19 | 70.6 | 23.1 | | 138.8 | |
| 10021- DAB | GSM-FDD (TDMA, GMSK) | X | 15.55 | 92.7 | 26.1 | 9.39 | 126.5 | $\pm 1.7\%$ |
| | | Y | 21.21 | 98.0 | 27.2 | | 142.0 | |
| | | Z | 19.50 | 96.1 | 27.0 | | 125.4 | |
| 10023- DAB | GPRS-FDD (TDMA, GMSK, TN 0) | X | 23.54 | 100.0 | 28.4 | 9.57 | 142.6 | $\pm 2.2\%$ |
| | | Y | 23.24 | 99.9 | 28.0 | | 137.4 | |
| | | Z | 23.57 | 99.6 | 28.2 | | 139.7 | |
| 10024- DAB | GPRS-FDD (TDMA, GMSK, TN 0-1) | X | 17.00 | 90.2 | 22.7 | 6.56 | 128.9 | $\pm 2.2\%$ |
| | | Y | 35.20 | 99.7 | 24.9 | | 148.2 | |
| | | Z | 33.12 | 99.6 | 25.4 | | 123.8 | |
| 10027- DAB | GPRS-FDD (TDMA, GMSK, TN 0-1-2) | X | 44.20 | 99.6 | 23.6 | 4.80 | 146.0 | $\pm 1.9\%$ |
| | | Y | 49.99 | 99.9 | 23.0 | | 136.6 | |
| | | Z | 41.43 | 99.6 | 23.9 | | 141.4 | |
| 10028- DAB | GPRS-FDD (TDMA, GMSK, TN 0-1-2-3) | X | 46.56 | 99.7 | 22.7 | 3.55 | 127.7 | $\pm 2.2\%$ |
| | | Y | 58.11 | 99.8 | 21.9 | | 145.3 | |
| | | Z | 55.65 | 99.6 | 22.2 | | 124.3 | |
| 10032- CAA | IEEE 802.15.1 Bluetooth (GFSK, DH5) | X | 34.25 | 99.4 | 21.1 | 1.16 | 140.3 | $\pm 1.7\%$ |
| | | Y | 40.72 | 100.0 | 20.6 | | 135.7 | |
| | | Z | 45.39 | 100.0 | 20.8 | | 136.4 | |
| 10100- CAB | LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 6.30 | 67.1 | 19.5 | 5.67 | 127.4 | $\pm 1.4\%$ |
| | | Y | 6.58 | 68.4 | 20.3 | | 149.0 | |
| | | Z | 6.55 | 68.0 | 19.9 | | 146.3 | |

| | | | | | | | | |
|-----------|--|---|-------|------|------|------|-------|--------|
| 10103-CAB | LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 10.47 | 75.6 | 25.8 | 9.29 | 146.6 | ±3.0 % |
| | | Y | 10.18 | 75.8 | 26.3 | | 136.2 | |
| | | Z | 10.38 | 75.3 | 25.6 | | 140.8 | |
| 10108-CAC | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 6.18 | 66.6 | 19.4 | 5.80 | 126.9 | ±1.4 % |
| | | Y | 6.40 | 67.8 | 20.1 | | 147.0 | |
| | | Z | 6.44 | 67.6 | 19.9 | | 145.7 | |
| 10117-CAB | IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK) | X | 10.24 | 69.0 | 21.3 | 8.07 | 142.7 | ±2.5 % |
| | | Y | 10.25 | 69.2 | 21.5 | | 136.7 | |
| | | Z | 10.16 | 68.8 | 21.2 | | 136.6 | |
| 10151-CAB | LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK) | X | 9.85 | 74.8 | 25.6 | 9.28 | 140.8 | ±3.0 % |
| | | Y | 9.49 | 74.7 | 25.9 | | 130.5 | |
| | | Z | 9.90 | 74.8 | 25.6 | | 136.8 | |
| 10154-CAC | LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK) | X | 6.13 | 67.1 | 19.7 | 5.75 | 146.6 | ±1.4 % |
| | | Y | 6.11 | 67.4 | 19.9 | | 147.7 | |
| | | Z | 6.12 | 67.1 | 19.7 | | 142.3 | |
| 10160-CAB | LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK) | X | 6.33 | 66.7 | 19.4 | 5.82 | 128.9 | ±1.4 % |
| | | Y | 6.33 | 67.1 | 19.7 | | 128.7 | |
| | | Z | 6.57 | 67.6 | 19.9 | | 147.4 | |
| 10169-CAB | LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | X | 4.89 | 66.4 | 19.5 | 5.73 | 127.5 | ±1.2 % |
| | | Y | 4.99 | 67.5 | 20.2 | | 149.3 | |
| | | Z | 5.09 | 67.3 | 20.0 | | 145.1 | |
| 10172-CAB | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | X | 7.99 | 75.8 | 26.3 | 9.21 | 127.6 | ±2.7 % |
| | | Y | 9.29 | 81.7 | 29.6 | | 149.8 | |
| | | Z | 8.04 | 75.8 | 26.3 | | 123.6 | |
| 10175-CAC | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | X | 5.08 | 67.3 | 20.0 | 5.72 | 149.3 | ±1.4 % |
| | | Y | 5.00 | 67.6 | 20.3 | | 145.0 | |
| | | Z | 5.09 | 67.3 | 20.0 | | 145.0 | |
| 10181-CAB | LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK) | X | 5.08 | 67.3 | 20.0 | 5.72 | 148.5 | ±1.4 % |
| | | Y | 5.06 | 67.9 | 20.4 | | 147.1 | |
| | | Z | 5.11 | 67.4 | 20.0 | | 144.8 | |
| 10196-CAB | IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK) | X | 9.89 | 68.7 | 21.2 | 8.10 | 134.6 | ±2.2 % |
| | | Y | 9.84 | 68.9 | 21.4 | | 130.4 | |
| | | Z | 9.82 | 68.5 | 21.1 | | 130.4 | |
| 10225-CAB | UMTS-FDD (HSPA+) | X | 7.02 | 67.1 | 19.5 | 5.97 | 138.0 | ±1.4 % |
| | | Y | 6.88 | 67.0 | 19.5 | | 133.2 | |
| | | Z | 7.01 | 67.1 | 19.5 | | 134.6 | |
| 10237-CAB | LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | X | 8.01 | 75.9 | 26.4 | 9.21 | 128.0 | ±2.7 % |
| | | Y | 9.39 | 82.1 | 29.9 | | 149.7 | |
| | | Z | 8.34 | 76.9 | 26.9 | | 129.1 | |
| 10252-CAB | LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK) | X | 9.05 | 73.6 | 25.1 | 9.24 | 130.6 | ±3.0 % |
| | | Y | 8.76 | 73.7 | 25.5 | | 123.6 | |
| | | Z | 9.10 | 73.6 | 25.1 | | 127.8 | |
| 10267-CAB | LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 9.81 | 74.7 | 25.6 | 9.30 | 139.3 | ±3.0 % |
| | | Y | 9.50 | 74.8 | 25.9 | | 130.7 | |
| | | Z | 9.81 | 74.6 | 25.5 | | 135.0 | |

| | | | | | | | | |
|-----------|---|---|-------|------|------|------|-------|--------|
| 10275-CAB | UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4) | X | 4.49 | 67.1 | 18.9 | 3.96 | 140.1 | ±0.7 % |
| | | Y | 4.46 | 67.2 | 19.0 | | 137.6 | |
| | | Z | 4.52 | 67.1 | 18.9 | | 137.1 | |
| 10291-AAB | CDMA2000, RC3, SO55, Full Rate | X | 3.68 | 67.0 | 18.8 | 3.46 | 129.3 | ±0.7 % |
| | | Y | 3.64 | 67.3 | 19.0 | | 130.3 | |
| | | Z | 3.84 | 67.9 | 19.2 | | 148.6 | |
| 10292-AAB | CDMA2000, RC3, SO32, Full Rate | X | 3.64 | 67.2 | 18.8 | 3.39 | 131.8 | ±0.5 % |
| | | Y | 3.60 | 67.4 | 19.1 | | 128.2 | |
| | | Z | 3.71 | 67.5 | 19.0 | | 128.0 | |
| 10297-AAA | LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK) | X | 6.43 | 67.5 | 19.9 | 5.81 | 147.2 | ±1.7 % |
| | | Y | 6.39 | 67.7 | 20.0 | | 145.4 | |
| | | Z | 6.42 | 67.5 | 19.8 | | 143.2 | |
| 10311-AAA | LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK) | X | 6.73 | 67.1 | 19.7 | 6.06 | 129.7 | ±1.4 % |
| | | Y | 6.75 | 67.5 | 19.9 | | 130.8 | |
| | | Z | 6.75 | 67.3 | 19.7 | | 126.2 | |
| 10400-AAB | IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle) | X | 10.14 | 68.9 | 21.5 | 8.37 | 136.7 | ±2.5 % |
| | | Y | 10.23 | 69.5 | 22.0 | | 136.5 | |
| | | Z | 10.13 | 68.9 | 21.5 | | 132.8 | |
| 10403-AAB | CDMA2000 (1xEV-DO, Rev. 0) | X | 4.97 | 69.2 | 19.3 | 3.76 | 143.5 | ±0.5 % |
| | | Y | 4.87 | 69.3 | 19.4 | | 141.0 | |
| | | Z | 5.02 | 69.2 | 19.3 | | 139.6 | |
| 10404-AAB | CDMA2000 (1xEV-DO, Rev. A) | X | 4.91 | 69.3 | 19.4 | 3.77 | 139.8 | ±0.7 % |
| | | Y | 4.67 | 68.9 | 19.1 | | 138.9 | |
| | | Z | 4.89 | 69.1 | 19.3 | | 137.1 | |
| 10415-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle) | X | 2.93 | 70.1 | 19.6 | 1.54 | 137.8 | ±0.7 % |
| | | Y | 2.84 | 69.8 | 19.6 | | 138.2 | |
| | | Z | 3.04 | 70.8 | 19.9 | | 134.2 | |
| 10416-AAA | IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle) | X | 9.94 | 68.7 | 21.3 | 8.23 | 134.6 | ±2.2 % |
| | | Y | 10.00 | 69.1 | 21.7 | | 134.1 | |
| | | Z | 9.89 | 68.5 | 21.2 | | 130.1 | |

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%.

^A The uncertainties of NormX,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 7 and 8).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750 | 41.9 | 0.89 | 6.69 | 6.69 | 6.69 | 0.40 | 1.70 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.41 | 6.41 | 6.41 | 0.43 | 1.62 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.29 | 5.29 | 5.29 | 0.80 | 1.16 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 5.10 | 5.10 | 5.10 | 0.80 | 1.24 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 4.77 | 4.77 | 4.77 | 0.64 | 1.38 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.55 | 4.55 | 4.55 | 0.80 | 1.29 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.39 | 4.39 | 4.39 | 0.80 | 1.31 | ± 12.0 % |

^C 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319

Calibration Parameter Determined in Body Tissue Simulating Media

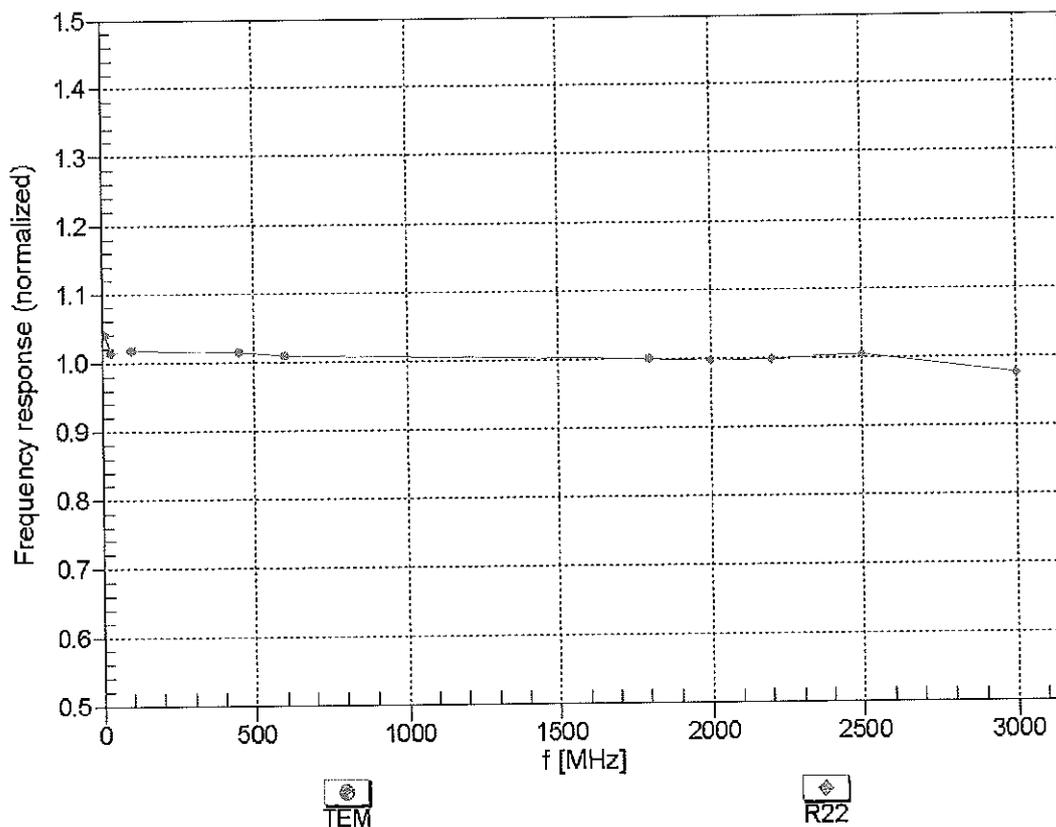
| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth (mm) ^G | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750 | 55.5 | 0.96 | 6.10 | 6.10 | 6.10 | 0.34 | 1.80 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.07 | 6.07 | 6.07 | 0.47 | 1.56 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 4.83 | 4.83 | 4.83 | 0.70 | 1.36 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.53 | 4.53 | 4.53 | 0.71 | 1.39 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 4.24 | 4.24 | 4.24 | 0.80 | 1.26 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.11 | 4.11 | 4.11 | 0.80 | 1.10 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 3.90 | 3.90 | 3.90 | 0.80 | 1.11 | ± 12.0 % |

^C 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

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

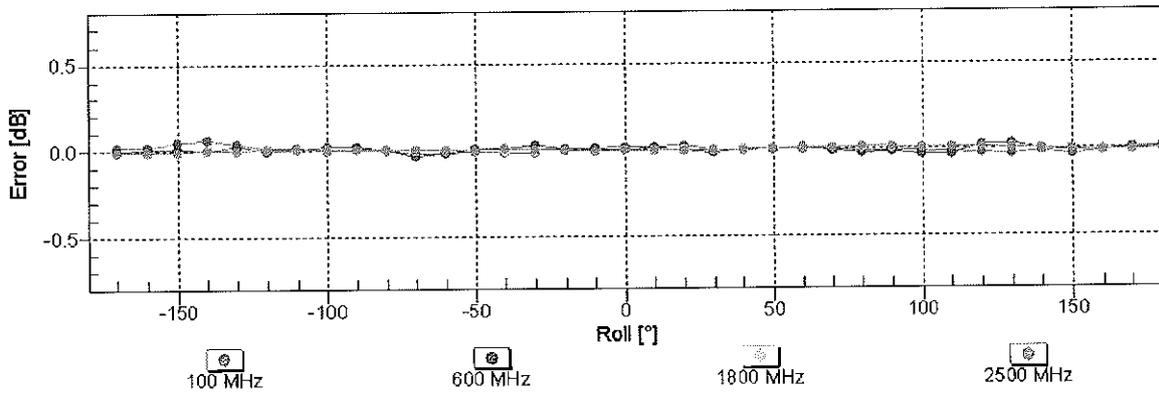
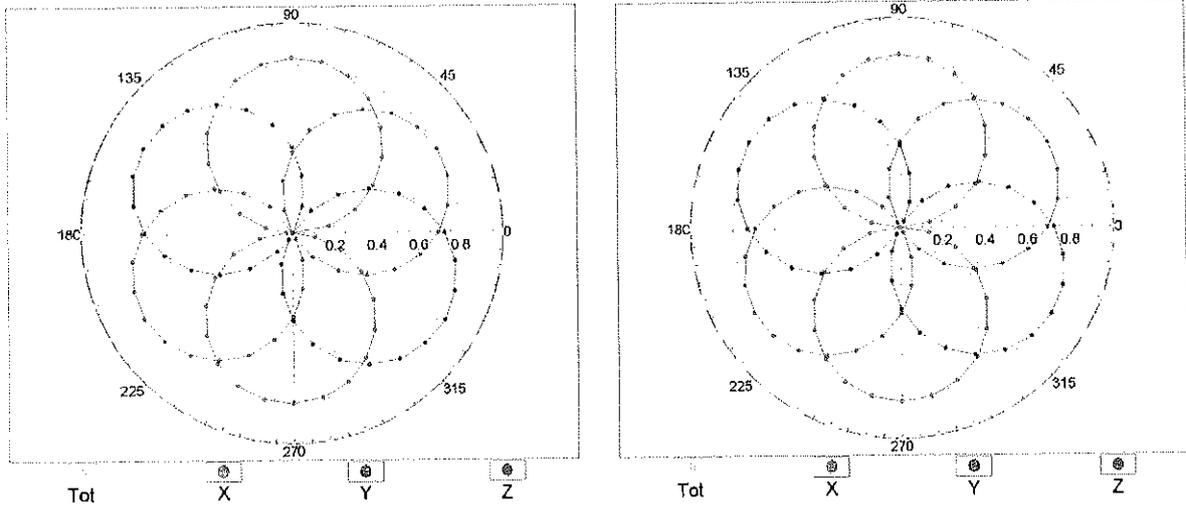


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

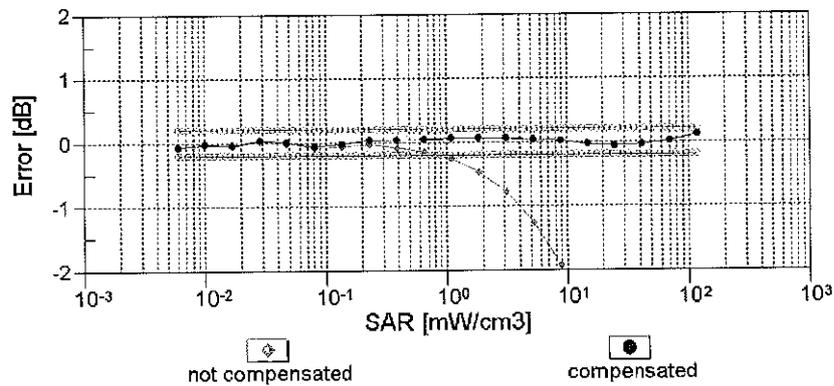
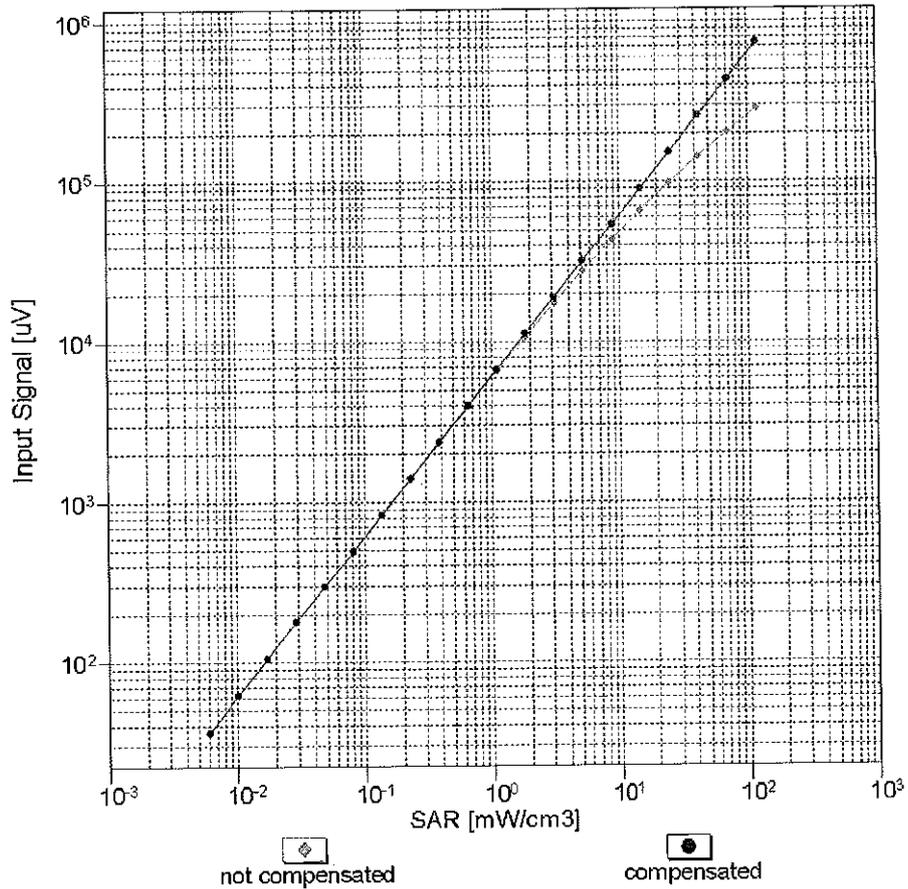
f=600 MHz,TEM

f=1800 MHz,R22



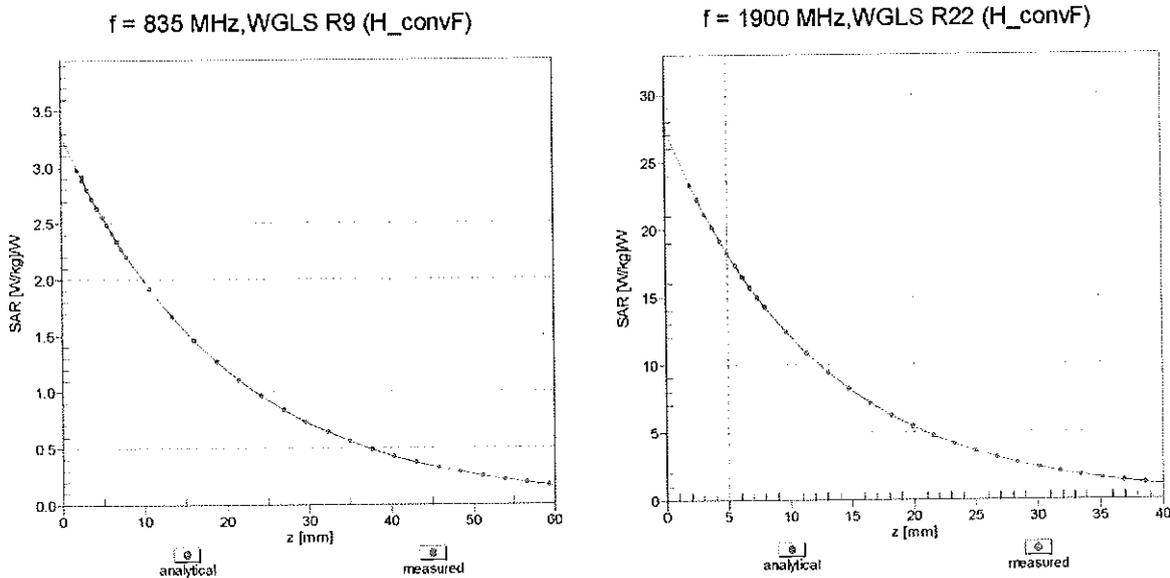
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Dynamic Range $f(SAR_{head})$ (TEM cell , $f_{eval}= 1900$ MHz)

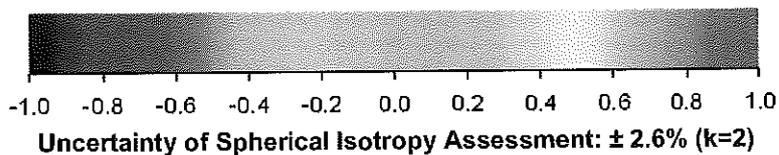
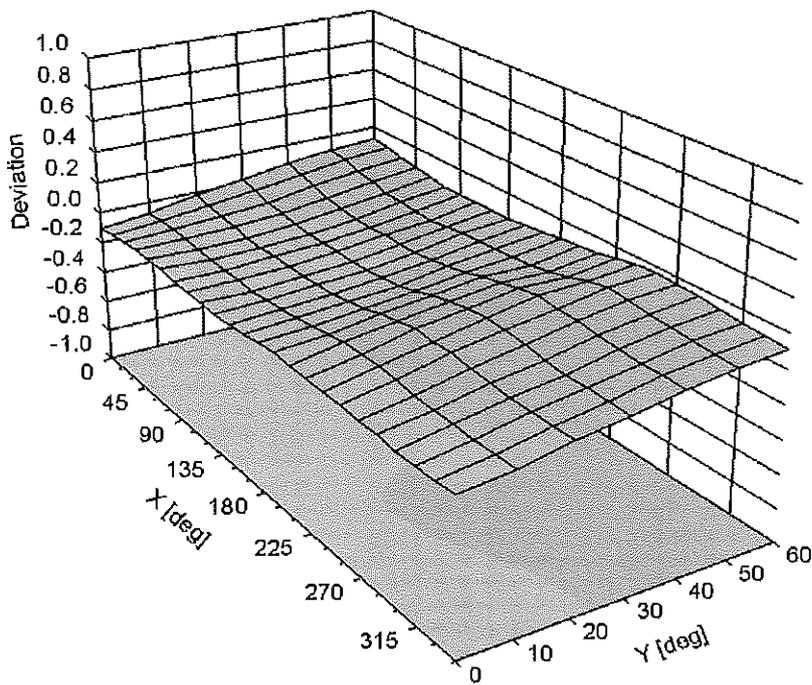


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), f = 900 MHz



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3319**Other Probe Parameters**

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -120.2 |
| 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 | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |



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 **PC Test**

Certificate No: **ES3-3333_Oct15**

CALIBRATION CERTIFICATE

Object: **ES3DV3 - SN:3333**

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

Calibration date: **October 29, 2015**

*BN ✓
11/03/15*

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 E4419B | GB41293874 | 01-Apr-15 (No. 217-02128) | Mar-16 |
| Power sensor E4412A | MY41498087 | 01-Apr-15 (No. 217-02128) | Mar-16 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 01-Apr-15 (No. 217-02129) | Mar-16 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 01-Apr-15 (No. 217-02132) | Mar-16 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 01-Apr-15 (No. 217-02133) | Mar-16 |
| Reference Probe ES3DV2 | SN: 3013 | 30-Dec-14 (No. ES3-3013_Dec14) | Dec-15 |
| DAE4 | SN: 660 | 14-Jan-15 (No. DAE4-660_Jan15) | Jan-16 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (In house check Apr-13) | In house check: Apr-16 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 |

| | | | |
|----------------|------------------------------|--|---------------|
| Calibrated by: | Name Lutz Klysner | Function Laboratory Technician | Signature |
| Approved by: | Name Katja Pokovic | Function Technical Manager | |

Issued: October 29, 2015

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



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 _{x,y,z} | sensitivity in free space |
| ConvF | sensitivity in TSL / NORM _{x,y,z} |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C, D | modulation dependent linearization parameters |
| Polarization ϕ | ϕ rotation around probe axis |
| Polarization θ | θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis |
| 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 865604, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: 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_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 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_x (no uncertainty required).

Probe ES3DV3

SN:3333

Manufactured: January 24, 2012
Calibrated: October 29, 2015

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3333

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|--------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 1.07 | 0.90 | 0.88 | $\pm 10.1\%$ |
| DCP (mV) ^B | 106.8 | 108.5 | 106.8 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Unc ^E (k=2) |
|---------------|---|---|---------|------------------------------|------|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 201.0 | $\pm 3.5\%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 187.1 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 184.8 | |
| 10010- CAA | SAR Validation (Square, 100ms, 10ms) | X | 2.43 | 80.7 | 11.4 | 10.00 | 41.6 | $\pm 2.2\%$ |
| | | Y | 4.35 | 67.4 | 13.2 | | 35.6 | |
| | | Z | 1.46 | 57.0 | 8.7 | | 36.2 | |
| 10011- CAB | UMTS-FDD (WCDMA) | X | 3.35 | 67.9 | 19.1 | 2.91 | 138.2 | $\pm 0.5\%$ |
| | | Y | 3.48 | 68.8 | 19.2 | | 127.5 | |
| | | Z | 3.37 | 67.6 | 18.6 | | 149.0 | |
| 10012- CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps) | X | 3.80 | 72.8 | 20.8 | 1.87 | 141.0 | $\pm 0.7\%$ |
| | | Y | 3.68 | 73.3 | 20.8 | | 128.0 | |
| | | Z | 3.01 | 69.3 | 18.8 | | 128.2 | |
| 10013- CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps) | X | 11.52 | 71.7 | 23.9 | 9.46 | 139.3 | $\pm 3.0\%$ |
| | | Y | 10.94 | 70.4 | 22.9 | | 147.1 | |
| | | Z | 10.95 | 70.8 | 23.4 | | 144.5 | |
| 10021- DAB | GSM-FDD (TDMA, GMSK) | X | 21.45 | 95.2 | 26.5 | 9.39 | 139.9 | $\pm 2.5\%$ |
| | | Y | 9.12 | 82.9 | 21.9 | | 142.0 | |
| | | Z | 11.47 | 88.1 | 23.9 | | 127.6 | |
| 10023- DAB | GPRS-FDD (TDMA, GMSK, TN 0) | X | 20.81 | 95.6 | 27.0 | 9.57 | 135.8 | $\pm 2.2\%$ |
| | | Y | 9.78 | 84.4 | 22.7 | | 135.3 | |
| | | Z | 8.12 | 83.5 | 22.1 | | 144.6 | |
| 10024- DAB | GPRS-FDD (TDMA, GMSK, TN 0-1) | X | 39.84 | 99.8 | 25.2 | 6.56 | 140.9 | $\pm 1.9\%$ |
| | | Y | 35.07 | 100.0 | 25.0 | | 128.4 | |
| | | Z | 35.20 | 99.8 | 24.7 | | 131.9 | |
| 10027- DAB | GPRS-FDD (TDMA, GMSK, TN 0-1-2) | X | 47.16 | 99.8 | 23.9 | 4.80 | 124.9 | $\pm 2.5\%$ |
| | | Y | 49.75 | 99.6 | 22.8 | | 145.4 | |
| | | Z | 45.37 | 99.9 | 23.1 | | 148.5 | |
| 10028- DAB | GPRS-FDD (TDMA, GMSK, TN 0-1-2-3) | X | 56.24 | 99.6 | 22.6 | 3.55 | 140.4 | $\pm 2.7\%$ |
| | | Y | 56.95 | 99.7 | 21.9 | | 129.1 | |
| | | Z | 48.45 | 99.6 | 22.1 | | 133.2 | |
| 10032- CAA | IEEE 802.15.1 Bluetooth (GFSK, DH5) | X | 18.03 | 98.1 | 22.8 | 1.16 | 127.5 | $\pm 1.9\%$ |
| | | Y | 35.17 | 99.6 | 20.7 | | 141.1 | |
| | | Z | 21.08 | 99.9 | 21.9 | | 127.5 | |
| 10100- CAB | LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 6.36 | 87.6 | 19.8 | 5.67 | 137.5 | $\pm 1.2\%$ |
| | | Y | 6.29 | 87.4 | 19.6 | | 128.9 | |
| | | Z | 6.35 | 87.5 | 19.7 | | 139.5 | |

| | | | | | | | | |
|-----------|--|---|-------|------|------|------|-------|--------|
| 10103-CAB | LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 10.85 | 76.6 | 26.4 | 9.29 | 130.8 | ±2.7 % |
| | | Y | 9.58 | 73.7 | 24.8 | | 143.0 | |
| | | Z | 9.94 | 75.6 | 26.2 | | 149.3 | |
| 10108-CAC | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 6.21 | 67.0 | 19.7 | 5.80 | 128.9 | ±1.2 % |
| | | Y | 6.16 | 66.9 | 19.5 | | 129.2 | |
| | | Z | 6.22 | 67.2 | 19.7 | | 138.0 | |
| 10117-CAB | IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK) | X | 10.05 | 68.7 | 21.2 | 8.07 | 126.1 | ±2.5 % |
| | | Y | 10.13 | 69.0 | 21.3 | | 146.1 | |
| | | Z | 9.97 | 68.7 | 21.1 | | 126.2 | |
| 10151-CAB | LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK) | X | 10.11 | 75.5 | 26.0 | 9.28 | 125.8 | ±3.3 % |
| | | Y | 9.08 | 73.2 | 24.7 | | 138.2 | |
| | | Z | 9.32 | 74.8 | 26.0 | | 143.1 | |
| 10154-CAC | LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK) | X | 5.97 | 66.8 | 19.6 | 5.75 | 133.4 | ±1.2 % |
| | | Y | 5.92 | 66.7 | 19.5 | | 127.0 | |
| | | Z | 5.91 | 68.7 | 19.5 | | 134.2 | |
| 10160-CAB | LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK) | X | 6.40 | 67.3 | 19.9 | 5.82 | 137.8 | ±1.2 % |
| | | Y | 6.31 | 67.1 | 19.6 | | 130.7 | |
| | | Z | 6.32 | 67.1 | 19.6 | | 139.8 | |
| 10169-CAB | LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | X | 5.05 | 67.3 | 20.1 | 5.73 | 136.8 | ±1.2 % |
| | | Y | 4.89 | 67.0 | 19.9 | | 131.1 | |
| | | Z | 4.93 | 67.2 | 20.0 | | 137.4 | |
| 10172-CAB | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | X | 10.74 | 83.9 | 30.3 | 9.21 | 136.8 | ±2.7 % |
| | | Y | 7.34 | 74.3 | 25.5 | | 125.9 | |
| | | Z | 7.74 | 76.6 | 27.1 | | 131.2 | |
| 10175-CAC | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | X | 4.97 | 66.9 | 19.9 | 5.72 | 130.8 | ±1.2 % |
| | | Y | 4.86 | 66.9 | 19.8 | | 128.5 | |
| | | Z | 4.97 | 67.3 | 20.1 | | 137.0 | |
| 10181-CAB | LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK) | X | 4.99 | 67.0 | 19.9 | 5.72 | 130.1 | ±1.2 % |
| | | Y | 4.88 | 67.0 | 19.9 | | 127.6 | |
| | | Z | 4.95 | 67.2 | 20.0 | | 136.2 | |
| 10196-CAB | IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK) | X | 10.00 | 69.2 | 21.7 | 8.10 | 137.9 | ±2.2 % |
| | | Y | 9.75 | 68.7 | 21.2 | | 137.5 | |
| | | Z | 9.94 | 69.4 | 21.7 | | 145.3 | |
| 10225-CAB | UMTS-FDD (HSPA+) | X | 7.08 | 67.5 | 19.8 | 5.97 | 147.1 | ±1.4 % |
| | | Y | 7.06 | 67.7 | 19.8 | | 142.3 | |
| | | Z | 7.04 | 67.7 | 19.9 | | 148.8 | |
| 10237-CAB | LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | X | 10.66 | 83.5 | 30.1 | 9.21 | 144.0 | ±3.0 % |
| | | Y | 7.43 | 74.7 | 25.7 | | 127.6 | |
| | | Z | 7.86 | 77.1 | 27.4 | | 132.3 | |
| 10252-CAB | LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK) | X | 10.81 | 78.7 | 27.9 | 9.24 | 139.7 | ±3.0 % |
| | | Y | 8.48 | 72.4 | 24.4 | | 130.1 | |
| | | Z | 8.71 | 74.1 | 25.8 | | 135.2 | |
| 10267-CAB | LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 11.73 | 79.9 | 28.3 | 9.30 | 148.6 | ±3.3 % |
| | | Y | 9.11 | 73.2 | 24.8 | | 139.0 | |
| | | Z | 9.38 | 74.9 | 26.1 | | 142.7 | |

| | | | | | | | | |
|-----------|---|---|-------|------|------|------|-------|--------|
| 10275-CAB | UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4) | X | 4.52 | 67.6 | 19.3 | 3.96 | 144.5 | ±0.7 % |
| | | Y | 4.67 | 68.3 | 19.6 | | 146.0 | |
| | | Z | 4.41 | 67.0 | 18.9 | | 130.0 | |
| 10291-AAB | CDMA2000, RC3, SO55, Full Rate | X | 3.68 | 67.2 | 19.0 | 3.46 | 134.5 | ±0.5 % |
| | | Y | 3.91 | 68.9 | 19.9 | | 133.2 | |
| | | Z | 3.86 | 68.5 | 19.6 | | 146.9 | |
| 10292-AAB | CDMA2000, RC3, SO32, Full Rate | X | 3.63 | 67.5 | 19.1 | 3.39 | 134.9 | ±0.5 % |
| | | Y | 3.93 | 69.3 | 20.0 | | 136.0 | |
| | | Z | 3.81 | 68.5 | 19.6 | | 148.6 | |
| 10297-AAA | LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK) | X | 6.20 | 67.1 | 19.7 | 5.81 | 129.0 | ±1.2 % |
| | | Y | 6.20 | 67.0 | 19.6 | | 128.0 | |
| | | Z | 6.32 | 67.5 | 19.9 | | 142.7 | |
| 10311-AAA | LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK) | X | 6.76 | 67.6 | 20.0 | 6.06 | 134.7 | ±1.4 % |
| | | Y | 6.75 | 67.5 | 19.9 | | 133.5 | |
| | | Z | 6.90 | 68.1 | 20.3 | | 149.2 | |
| 10400-AAC | IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle) | X | 10.30 | 69.7 | 22.1 | 8.37 | 140.1 | ±2.5 % |
| | | Y | 10.05 | 69.0 | 21.5 | | 141.2 | |
| | | Z | 9.94 | 69.0 | 21.7 | | 126.3 | |
| 10403-AAB | CDMA2000 (1xEV-DO, Rev. 0) | X | 4.80 | 68.5 | 19.0 | 3.76 | 129.3 | ±0.5 % |
| | | Y | 5.30 | 71.1 | 20.2 | | 148.4 | |
| | | Z | 5.10 | 70.4 | 19.9 | | 135.2 | |
| 10404-AAB | CDMA2000 (1xEV-DO, Rev. A) | X | 4.77 | 68.8 | 19.2 | 3.77 | 127.3 | ±0.7 % |
| | | Y | 5.35 | 71.7 | 20.5 | | 145.4 | |
| | | Z | 5.03 | 70.6 | 20.1 | | 133.3 | |
| 10415-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle) | X | 2.77 | 69.7 | 19.7 | 1.54 | 147.0 | ±0.7 % |
| | | Y | 3.73 | 75.4 | 22.2 | | 143.7 | |
| | | Z | 3.25 | 72.2 | 20.7 | | 133.9 | |
| 10416-AAA | IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle) | X | 10.11 | 69.4 | 21.8 | 8.23 | 144.7 | ±2.5 % |
| | | Y | 9.86 | 68.8 | 21.4 | | 139.3 | |
| | | Z | 9.72 | 68.6 | 21.3 | | 126.0 | |

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%.

^A The uncertainties of Norm X,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 7 and 8).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3333

Calibration Parameter Determined In Head Tissue Simulating Media

| f (MHz) ^c | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 750 | 41.9 | 0.89 | 6.46 | 6.46 | 6.46 | 0.75 | 1.22 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.16 | 6.16 | 6.16 | 0.36 | 1.67 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.21 | 5.21 | 5.21 | 0.80 | 1.19 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 5.03 | 5.03 | 5.03 | 0.73 | 1.25 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 4.73 | 4.73 | 4.73 | 0.60 | 1.43 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.53 | 4.53 | 4.53 | 0.80 | 1.28 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.39 | 4.39 | 4.39 | 0.80 | 1.29 | ± 12.0 % |

^c 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3333

Calibration Parameter Determined in Body Tissue Simulating Media

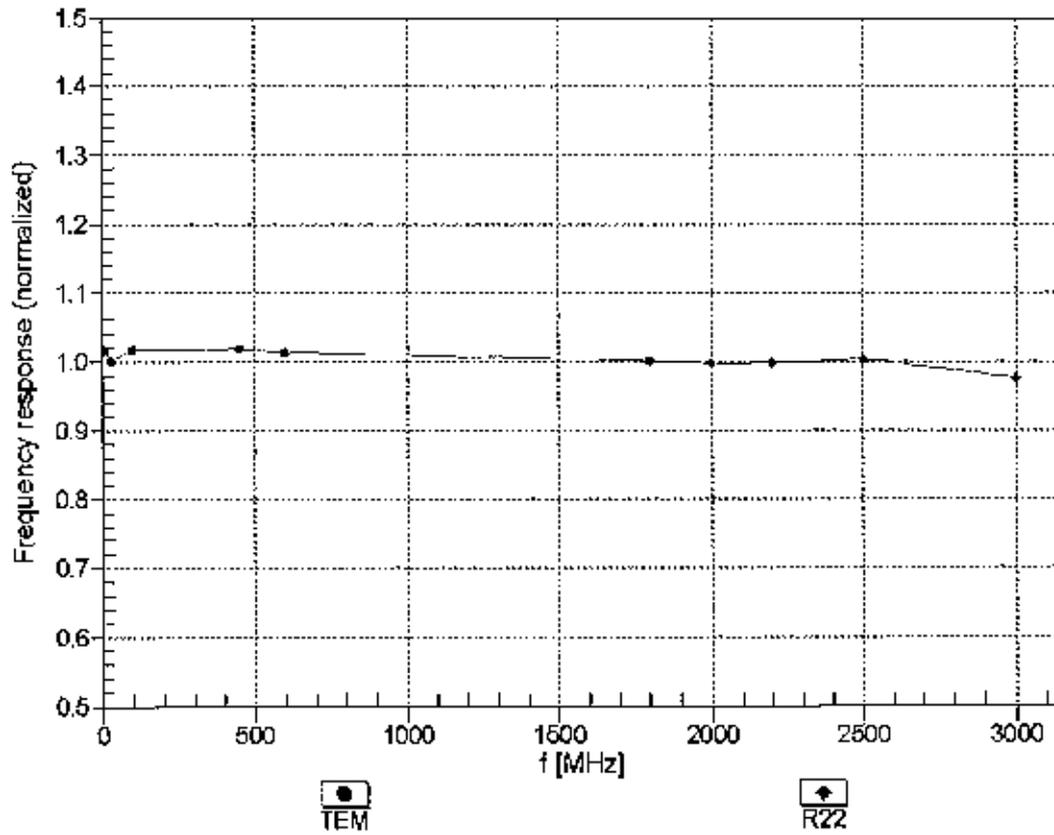
| f (MHz) ^c | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^g | Depth ^g (mm) | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 750 | 55.5 | 0.98 | 6.31 | 6.31 | 6.31 | 0.70 | 1.26 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.25 | 6.25 | 6.25 | 0.47 | 1.54 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 4.90 | 4.90 | 4.90 | 0.49 | 1.63 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.70 | 4.70 | 4.70 | 0.54 | 1.49 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 4.51 | 4.51 | 4.51 | 0.80 | 1.15 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.34 | 4.34 | 4.34 | 0.80 | 1.15 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 4.23 | 4.23 | 4.23 | 0.80 | 1.03 | ± 12.0 % |

^c 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, 160 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^g 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.

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

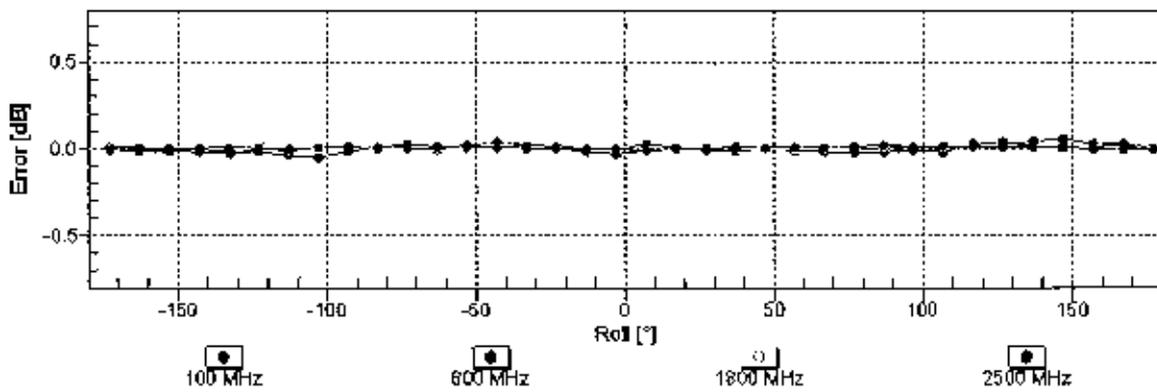
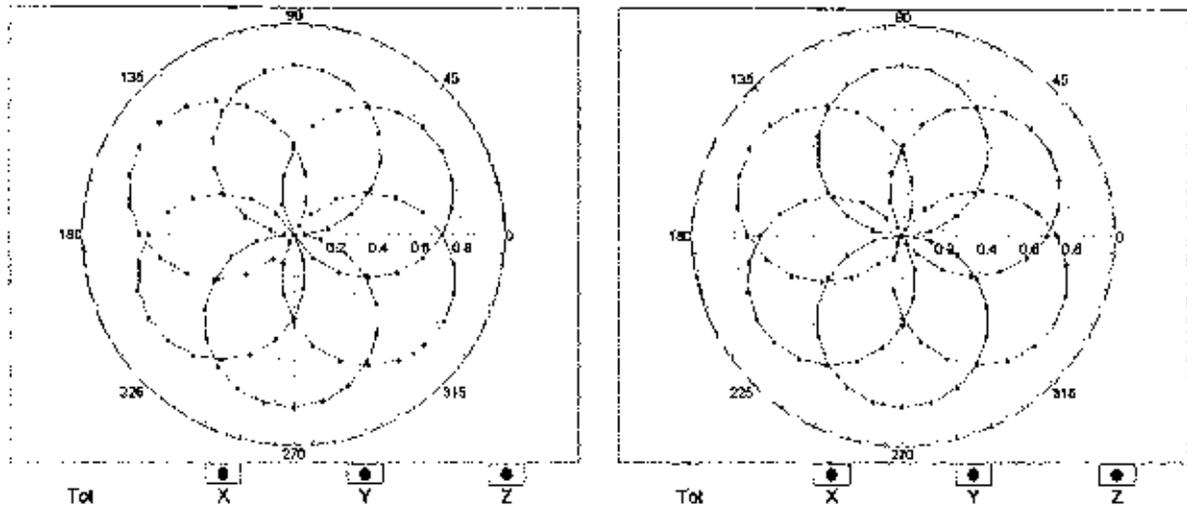


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

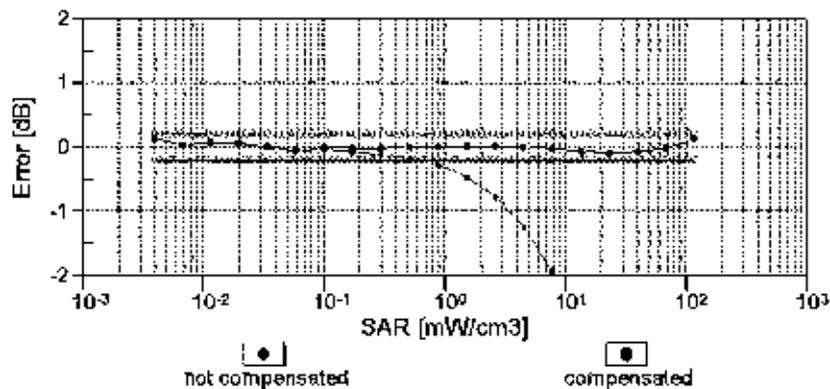
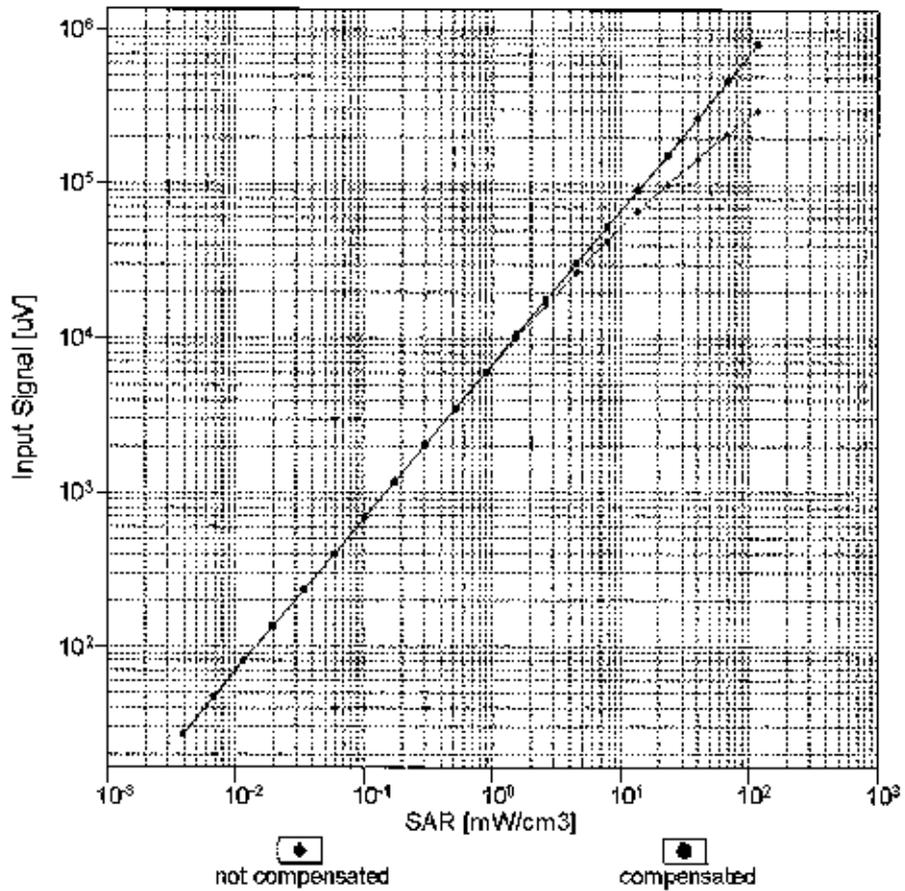
f=600 MHz, TEM

f=1800 MHz, R22



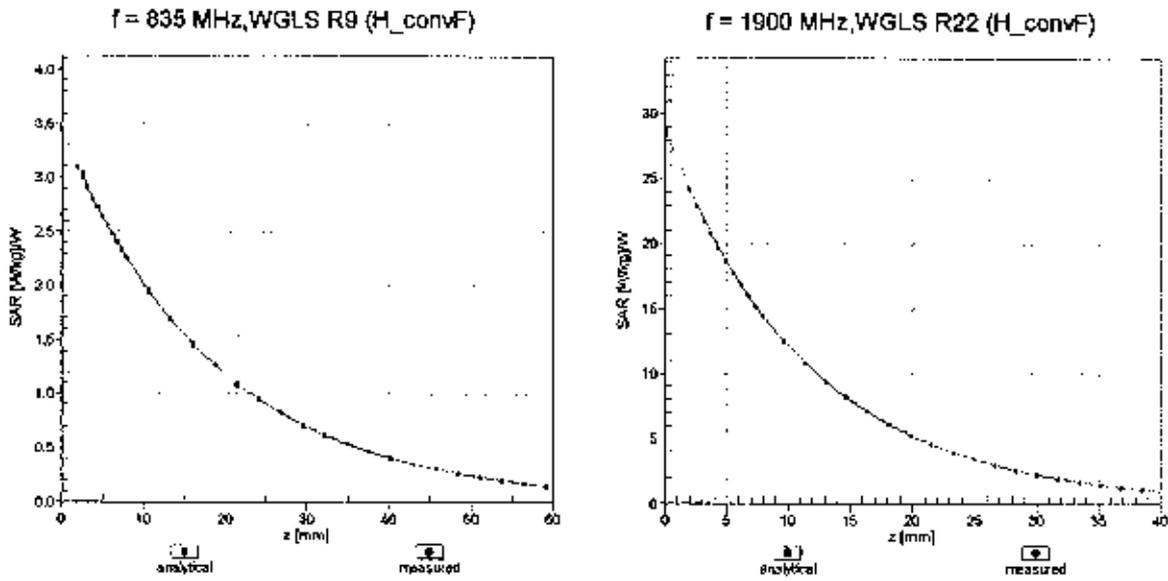
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Dynamic Range f(SAR_{head}) (TEM cell , f_{eval}= 1900 MHz)

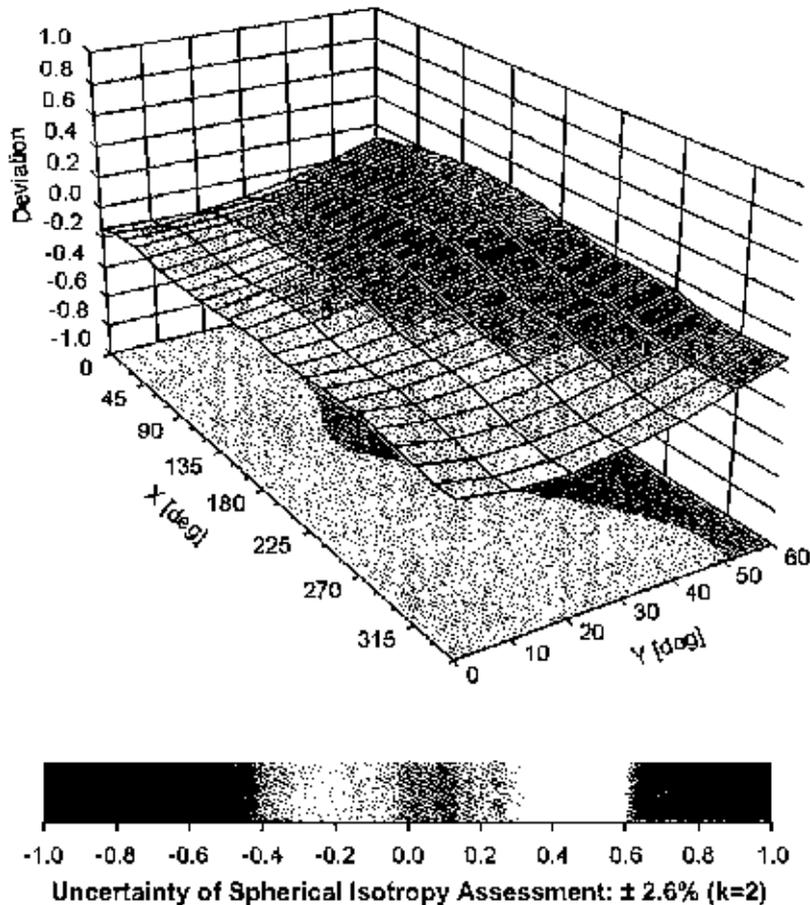


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), f = 900 MHz



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3333**Other Probe Parameters**

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -32.8 |
| 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 | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |

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



S Schweizerischer Kalibrierdienst
C Service suisse d'établissement
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 **PG Test**

Certificate No: **ES3-3334_Nov15**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3334**

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: **November 17, 2015**

BV
11/24/15

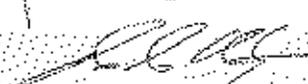
This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

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 E4419B | GB41293874 | 01-Apr-15 (No. 217-02128) | Mar-16 |
| Power sensor E4412A | MY41498087 | 01-Apr-15 (No. 217-02128) | Mar-16 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 01-Apr-15 (No. 217-02129) | Mar-16 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 01-Apr-15 (No. 217-02132) | Mar-16 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 01-Apr-15 (No. 217-02133) | Mar-16 |
| Reference Probe ES3DV2 | SN: 3013 | 30-Dec-14 (No. ES3-3013 Dec14) | Dec-15 |
| DAE4 | SN: 660 | 14-Jan-15 (No. DAE4-660_Jan15) | Jan-16 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-13) | In house check: Apr-16 |
| Network Analyzer HP 8753E | US3739J585 | 18-Oct-01 (in house check Oct-15) | In house check: Oct-16 |

Calibrated by: **Jeton Kastrioti** (Name) **Laboratory Technician** (Function)  (Signature)

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

Issued: November 17, 2015

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



Accredited by the Swiss Accreditation Service (SAS)
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Glossary:

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

- 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) 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
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- **NORM_{x,y,z}:** Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- **NORM(f)_{x,y,z} = NORM_{x,y,z} * frequency_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- **DCP_{x,y,z}:** DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- **PAR:** PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- **A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}; 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_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 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_x (no uncertainty required).

Probe ES3DV3

SN:3334

Manufactured: January 24, 2012
Calibrated: November 17, 2015

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3334

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|--------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 1.03 | 1.03 | 0.99 | $\pm 10.1\%$ |
| DCP (mV) ^B | 107.6 | 105.3 | 107.9 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Unc ^E (k=2) |
|---------------|---|---|---------|------------------------------|------|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 192.1 | $\pm 2.7\%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 183.6 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 183.3 | |
| 10010- CAA | SAR Validation (Square, 100ms, 10ms) | X | 2.27 | 60.1 | 10.2 | 10.00 | 38.6 | $\pm 1.4\%$ |
| | | Y | 1.99 | 59.3 | 10.2 | | 38.4 | |
| | | Z | 5.38 | 67.8 | 12.9 | | 37.2 | |
| 10011- CAB | UMTS-FDD (WCDMA) | X | 3.40 | 68.0 | 18.9 | 2.91 | 131.7 | $\pm 0.5\%$ |
| | | Y | 3.27 | 67.0 | 18.2 | | 130.2 | |
| | | Z | 3.41 | 68.3 | 19.1 | | 148.5 | |
| 10012- CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps) | X | 2.93 | 68.9 | 18.7 | 1.87 | 132.9 | $\pm 0.7\%$ |
| | | Y | 3.12 | 69.6 | 18.8 | | 130.2 | |
| | | Z | 3.24 | 71.1 | 19.7 | | 128.2 | |
| 10013- CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps) | X | 10.90 | 70.3 | 23.0 | 9.46 | 133.5 | $\pm 3.3\%$ |
| | | Y | 10.53 | 69.0 | 22.1 | | 124.6 | |
| | | Z | 11.14 | 71.2 | 23.6 | | 147.1 | |
| 10021- DAB | GSM-FDD (TDMA, GMSK) | X | 15.05 | 91.0 | 24.4 | 9.39 | 139.5 | $\pm 1.9\%$ |
| | | Y | 10.11 | 85.5 | 23.3 | | 131.9 | |
| | | Z | 11.84 | 87.6 | 23.4 | | 130.0 | |
| 10023- DAB | GPRS-FDD (TDMA, GMSK, TN 0) | X | 10.42 | 84.9 | 22.6 | 9.57 | 131.5 | $\pm 3.0\%$ |
| | | Y | 13.29 | 89.7 | 24.6 | | 141.1 | |
| | | Z | 14.17 | 90.2 | 24.2 | | 148.7 | |
| 10024- DAB | GPRS-FDD (TDMA, GMSK, TN 0-1) | X | 11.26 | 83.1 | 19.4 | 6.56 | 140.7 | $\pm 1.9\%$ |
| | | Y | 26.29 | 95.5 | 23.8 | | 134.7 | |
| | | Z | 16.82 | 88.9 | 21.3 | | 131.6 | |
| 10027- DAB | GPRS-FDD (TDMA, GMSK, TN 0-1-2) | X | 64.74 | 99.9 | 22.2 | 4.80 | 131.5 | $\pm 2.2\%$ |
| | | Y | 56.71 | 99.8 | 22.7 | | 124.7 | |
| | | Z | 63.10 | 99.9 | 22.2 | | 124.1 | |
| 10028- DAB | GPRS-FDD (TDMA, GMSK, TN 0-1-2-3) | X | 62.11 | 99.6 | 21.6 | 3.55 | 146.1 | $\pm 1.9\%$ |
| | | Y | 77.61 | 99.8 | 21.2 | | 132.0 | |
| | | Z | 72.33 | 99.7 | 21.2 | | 133.3 | |
| 10032- CAA | IEEE 802.15.1 Bluetooth (GFSK, DH5) | X | 96.24 | 92.7 | 15.9 | 1.16 | 137.2 | $\pm 1.7\%$ |
| | | Y | 95.69 | 93.1 | 16.2 | | 129.5 | |
| | | Z | 98.67 | 94.1 | 16.4 | | 149.7 | |
| 10100- CAB | LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 6.14 | 66.8 | 19.2 | 5.67 | 126.2 | $\pm 1.7\%$ |
| | | Y | 6.21 | 66.8 | 19.1 | | 139.9 | |
| | | Z | 6.41 | 67.9 | 19.9 | | 145.9 | |

| | | | | | | | | |
|-----------|--|---|-------|------|------|------|-------|--------|
| 10103-CAB | LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 10.07 | 75.4 | 25.8 | 9.29 | 138.2 | ±2.5 % |
| | | Y | 9.54 | 73.3 | 24.5 | | 130.5 | |
| | | Z | 9.84 | 75.1 | 25.8 | | 130.6 | |
| 10108-CAC | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 6.34 | 67.6 | 19.8 | 5.80 | 149.5 | ±1.4 % |
| | | Y | 6.13 | 66.6 | 19.1 | | 132.1 | |
| | | Z | 6.19 | 67.2 | 19.7 | | 137.8 | |
| 10117-CAB | IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK) | X | 10.13 | 68.9 | 21.2 | 8.07 | 138.8 | ±2.7 % |
| | | Y | 10.16 | 68.9 | 21.1 | | 149.6 | |
| | | Z | 9.96 | 68.7 | 21.1 | | 127.1 | |
| 10151-CAB | LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK) | X | 9.42 | 74.4 | 25.5 | 9.28 | 132.9 | ±3.0 % |
| | | Y | 9.50 | 74.0 | 25.0 | | 143.7 | |
| | | Z | 9.01 | 73.4 | 25.0 | | 126.5 | |
| 10154-CAC | LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK) | X | 6.03 | 67.1 | 19.6 | 5.75 | 145.5 | ±1.4 % |
| | | Y | 5.81 | 66.0 | 18.9 | | 128.9 | |
| | | Z | 5.91 | 66.8 | 19.5 | | 135.1 | |
| 10160-CAB | LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK) | X | 6.19 | 66.5 | 19.2 | 5.82 | 126.7 | ±1.4 % |
| | | Y | 6.20 | 66.4 | 19.0 | | 132.8 | |
| | | Z | 6.39 | 67.5 | 19.8 | | 141.1 | |
| 10169-CAB | LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | X | 5.05 | 67.6 | 20.0 | 5.73 | 146.8 | ±1.4 % |
| | | Y | 4.82 | 66.2 | 19.2 | | 132.2 | |
| | | Z | 4.96 | 67.4 | 20.0 | | 143.8 | |
| 10172-CAB | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | X | 8.88 | 79.7 | 28.3 | 9.21 | 147.9 | ±3.0 % |
| | | Y | 8.00 | 76.1 | 26.2 | | 138.9 | |
| | | Z | 8.39 | 78.5 | 27.8 | | 141.5 | |
| 10175-CAC | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | X | 4.99 | 67.3 | 19.9 | 5.72 | 140.7 | ±1.2 % |
| | | Y | 4.80 | 66.2 | 19.1 | | 131.3 | |
| | | Z | 4.90 | 67.1 | 19.8 | | 136.1 | |
| 10181-CAB | LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK) | X | 4.99 | 67.3 | 19.9 | 5.72 | 145.4 | ±1.4 % |
| | | Y | 4.81 | 66.2 | 19.2 | | 130.9 | |
| | | Z | 4.89 | 67.1 | 19.8 | | 136.0 | |
| 10196-CAB | IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK) | X | 9.78 | 68.8 | 21.3 | 8.10 | 131.0 | ±2.5 % |
| | | Y | 9.73 | 68.4 | 21.0 | | 140.7 | |
| | | Z | 9.94 | 69.4 | 21.6 | | 146.6 | |
| 10225-CAB | UMTS-FDD (HSPA+) | X | 6.88 | 66.9 | 19.3 | 5.97 | 133.9 | ±1.7 % |
| | | Y | 6.96 | 67.1 | 19.3 | | 144.8 | |
| | | Z | 6.71 | 66.6 | 19.2 | | 125.7 | |
| 10237-CAB | LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | X | 9.00 | 80.2 | 28.5 | 9.21 | 148.2 | ±3.0 % |
| | | Y | 7.73 | 75.1 | 25.7 | | 131.6 | |
| | | Z | 8.27 | 78.2 | 27.7 | | 136.1 | |
| 10252-CAB | LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK) | X | 9.59 | 76.3 | 26.7 | 9.24 | 144.1 | ±2.7 % |
| | | Y | 8.74 | 72.9 | 24.5 | | 133.4 | |
| | | Z | 9.14 | 75.2 | 26.1 | | 136.9 | |
| 10267-CAB | LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 9.25 | 73.9 | 25.3 | 9.30 | 124.8 | ±3.0 % |
| | | Y | 9.40 | 73.7 | 24.9 | | 142.1 | |
| | | Z | 9.86 | 76.1 | 26.5 | | 145.3 | |

| | | | | | | | | |
|-----------|---|---|-------|------|------|------|-------|--------|
| 10275-CAB | UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4) | X | 4.38 | 66.9 | 18.7 | 3.96 | 133.3 | ±0.9 % |
| | | Y | 4.44 | 66.9 | 18.6 | | 148.2 | |
| | | Z | 4.30 | 66.7 | 18.6 | | 128.9 | |
| 10291-AAB | CDMA2000, RC3, SQ55, Full Rate | X | 3.68 | 67.3 | 18.7 | 3.46 | 145.8 | ±0.7 % |
| | | Y | 3.58 | 66.6 | 18.2 | | 136.3 | |
| | | Z | 3.62 | 67.3 | 18.8 | | 139.4 | |
| 10292-AAB | CDMA2000, RC3, SQ32, Full Rate | X | 3.73 | 68.0 | 19.1 | 3.39 | 147.5 | ±0.7 % |
| | | Y | 3.55 | 66.7 | 18.3 | | 138.5 | |
| | | Z | 3.60 | 67.6 | 18.9 | | 143.0 | |
| 10297-AAA | LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK) | X | 6.30 | 67.4 | 19.7 | 5.81 | 141.4 | ±1.2 % |
| | | Y | 6.11 | 66.5 | 19.1 | | 130.3 | |
| | | Z | 6.17 | 67.0 | 19.5 | | 138.8 | |
| 10311-AAA | LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK) | X | 6.88 | 68.0 | 20.1 | 6.06 | 147.0 | ±1.7 % |
| | | Y | 6.68 | 67.1 | 19.5 | | 136.0 | |
| | | Z | 6.75 | 67.7 | 20.0 | | 141.6 | |
| 10400-AAC | IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle) | X | 9.97 | 68.8 | 21.4 | 8.37 | 126.9 | ±2.7 % |
| | | Y | 10.07 | 68.9 | 21.4 | | 143.6 | |
| | | Z | 10.21 | 69.7 | 22.0 | | 147.4 | |
| 10403-AAB | CDMA2000 (1xEV-DO, Rev. 0) | X | 4.77 | 68.5 | 18.8 | 3.76 | 134.9 | ±0.5 % |
| | | Y | 4.69 | 68.1 | 18.5 | | 126.7 | |
| | | Z | 4.74 | 68.8 | 18.9 | | 129.4 | |
| 10404-AAB | CDMA2000 (1xEV-DO, Rev. A) | X | 4.72 | 68.7 | 18.8 | 3.77 | 132.9 | ±0.7 % |
| | | Y | 4.78 | 68.9 | 18.9 | | 147.4 | |
| | | Z | 4.63 | 68.7 | 18.9 | | 127.1 | |
| 10415-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle) | X | 2.72 | 68.9 | 18.8 | 1.54 | 131.9 | ±0.5 % |
| | | Y | 2.65 | 68.0 | 18.1 | | 145.9 | |
| | | Z | 2.72 | 69.3 | 19.0 | | 127.3 | |
| 10416-AAA | IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle) | X | 9.81 | 68.6 | 21.2 | 8.23 | 131.6 | ±2.7 % |
| | | Y | 9.90 | 68.7 | 21.2 | | 144.1 | |
| | | Z | 9.97 | 69.3 | 21.7 | | 146.0 | |

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%.

^A The uncertainties of Norm X,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 7 and 8).

^B Numerical linearization parameter: uncertainty not required.

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3334

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^c | Relative Permittivity ^e | Conductivity (S/m) ^e | ConvF X | ConvF Y | ConvF Z | Alpha ^g | Depth (mm) ^h | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 6 | 55.5 | 0.75 | 6.13 | 6.13 | 6.13 | 0.00 | 1.00 | ± 13.3 % |
| 13 | 55.5 | 0.75 | 5.76 | 5.76 | 5.76 | 0.00 | 1.00 | ± 13.3 % |
| 750 | 41.9 | 0.89 | 6.56 | 6.56 | 6.56 | 0.24 | 2.36 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.37 | 6.37 | 6.37 | 0.37 | 1.70 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.39 | 5.39 | 5.39 | 0.58 | 1.32 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 5.18 | 5.18 | 5.18 | 0.77 | 1.20 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 4.85 | 4.85 | 4.85 | 0.71 | 1.28 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.58 | 4.58 | 4.58 | 0.79 | 1.17 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.46 | 4.46 | 4.46 | 0.80 | 1.26 | ± 12.0 % |

^c 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.

^e At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^g 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.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3334

Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) ^c | Relative Permittivity ^f | Conductivity (S/m) ^f | ConvF X | ConvF Y | ConvF Z | Alpha ^g | Depth ^g (mm) | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 750 | 55.5 | 0.96 | 6.37 | 6.37 | 6.37 | 0.74 | 1.22 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.24 | 6.24 | 6.24 | 0.31 | 1.94 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 5.03 | 5.03 | 5.03 | 0.50 | 1.57 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.84 | 4.84 | 4.84 | 0.50 | 1.58 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 4.61 | 4.61 | 4.61 | 0.74 | 1.23 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.45 | 4.45 | 4.45 | 0.74 | 1.20 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 4.29 | 4.29 | 4.29 | 0.80 | 1.20 | ± 12.0 % |

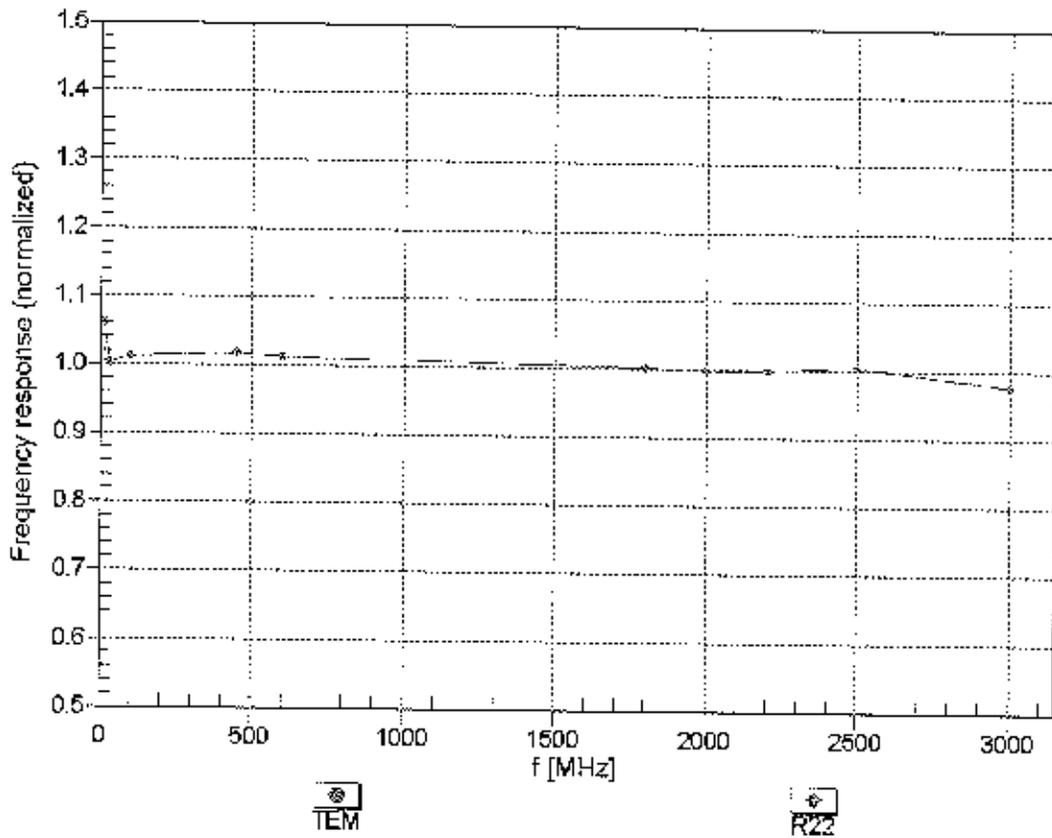
^c Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 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.

^f At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^g 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.

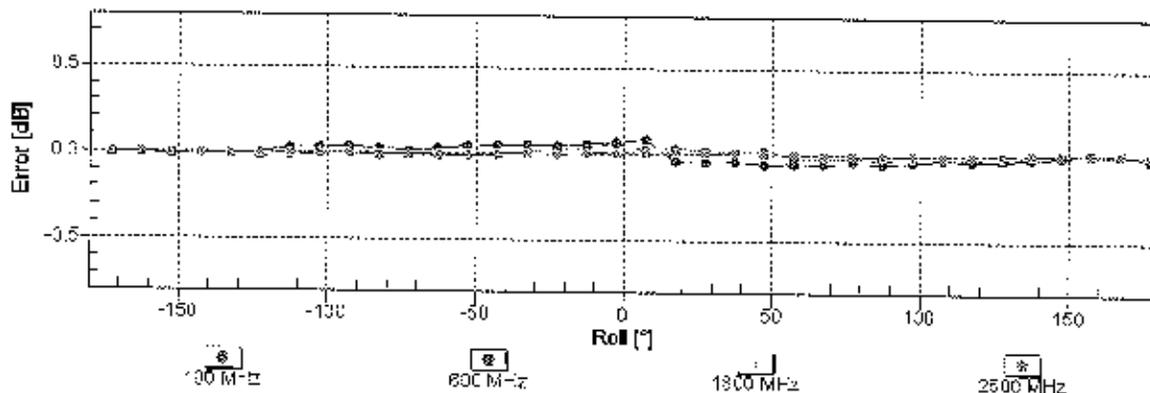
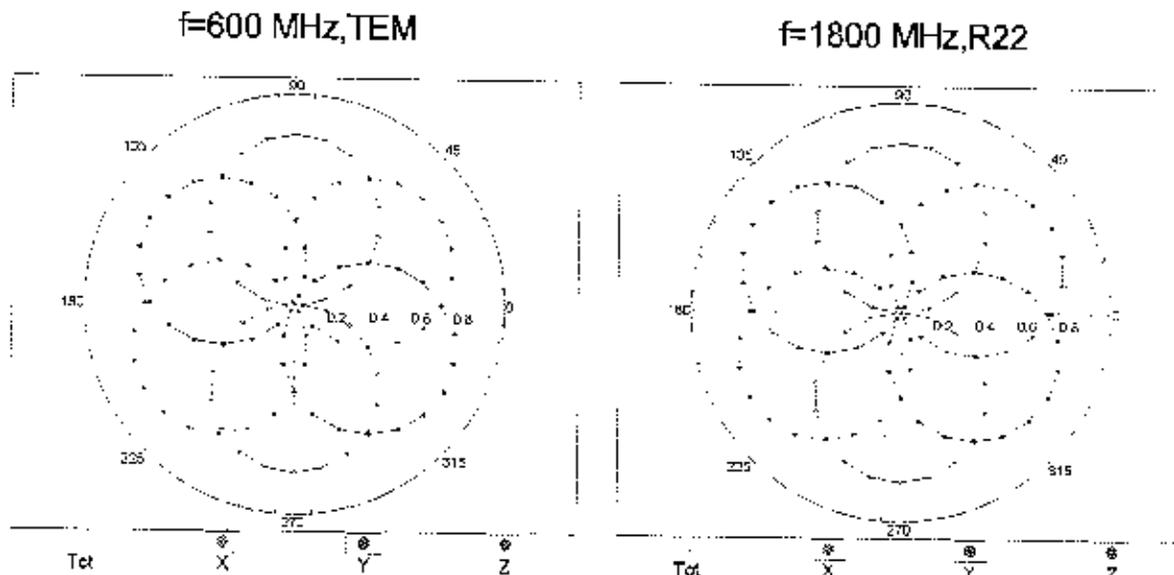
Frequency Response of E-Field

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



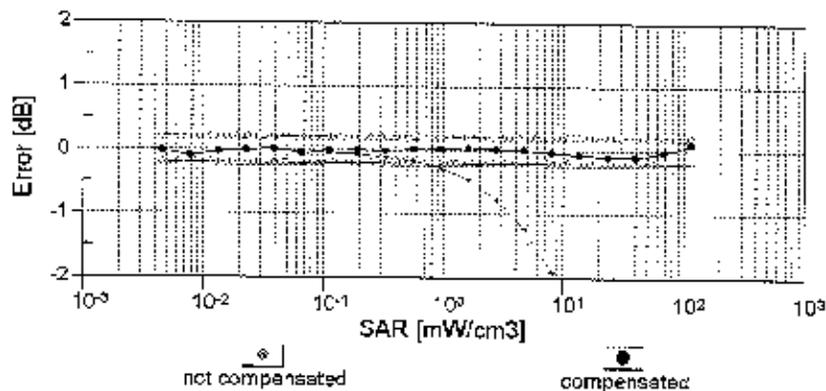
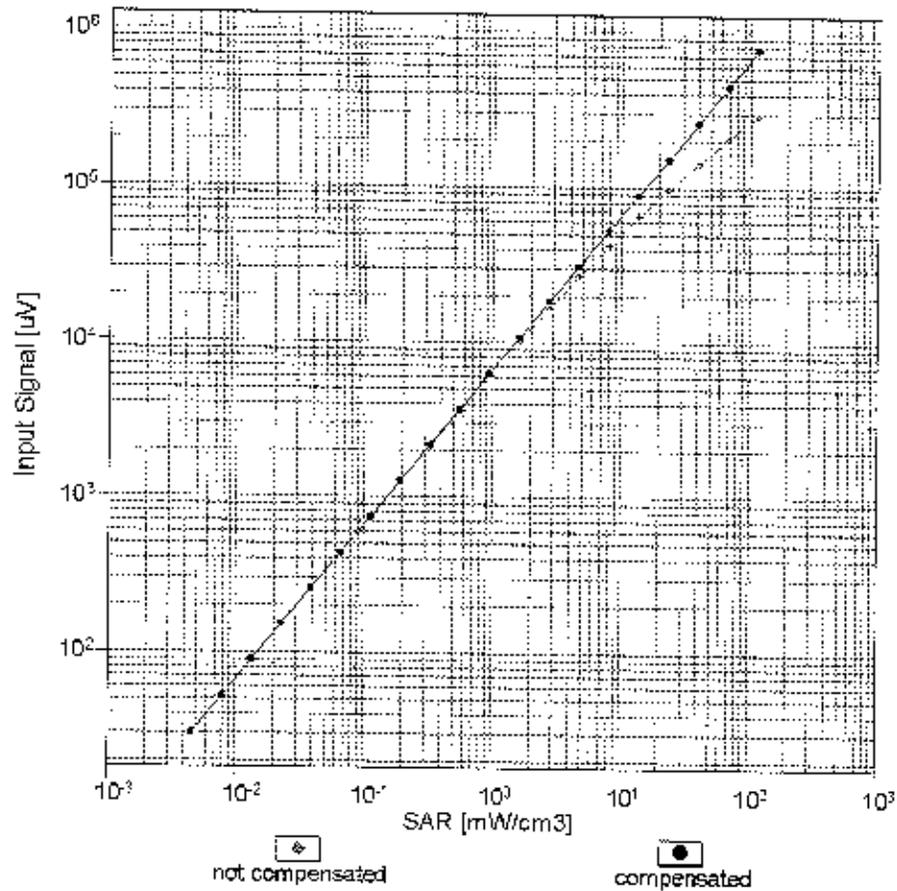
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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



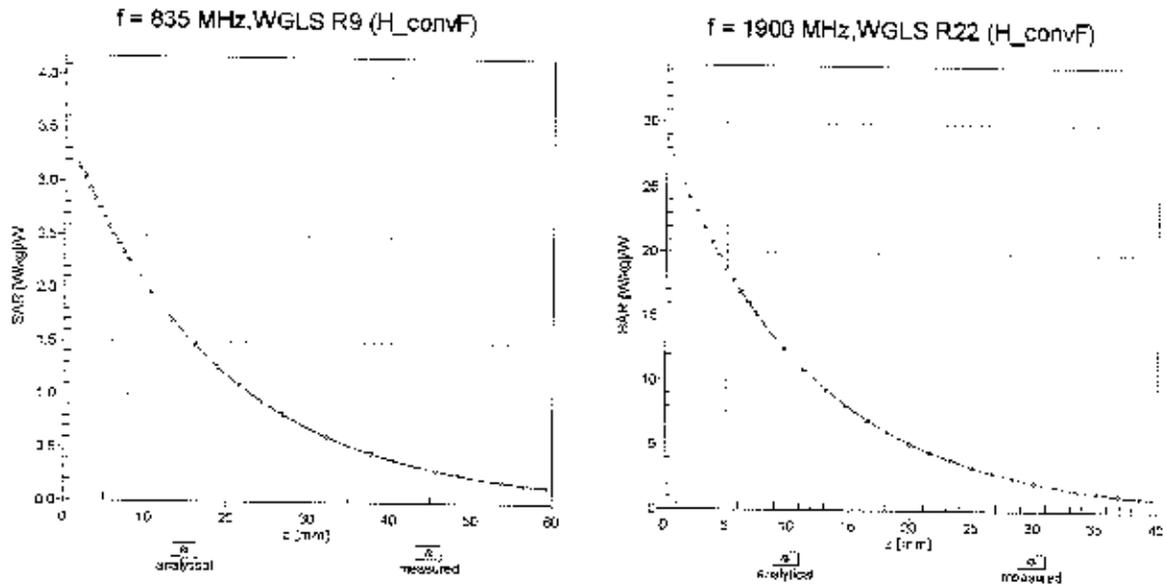
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

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

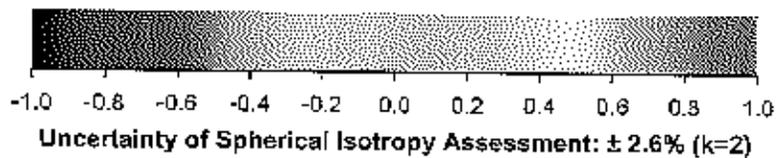
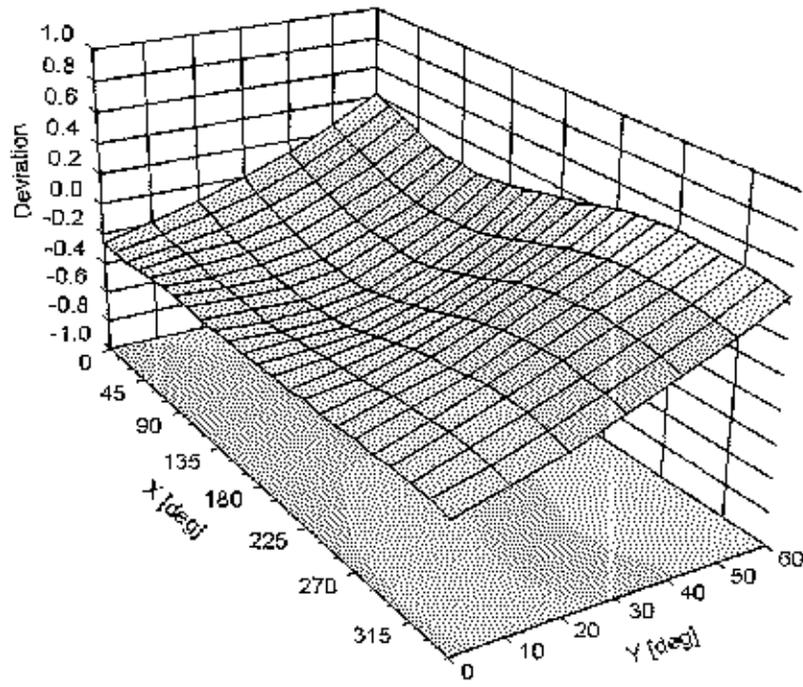


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), f = 900 MHz



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3334

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 17.4 |
| 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 | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |

**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**

Client **PC Test**

Certificate No: **ES3-3351_Jun15**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3351**

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

Calibration date: **June 22, 2015**

*BN ✓
06/25/15*

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 E4419B | GB41293874 | 01-Apr-15 (No. 217-02128) | Mar-16 |
| Power sensor E4412A | MY41498087 | 01-Apr-15 (No. 217-02128) | Mar-16 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 01-Apr-15 (No. 217-02129) | Mar-16 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 01-Apr-15 (No. 217-02132) | Mar-16 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 01-Apr-15 (No. 217-02133) | Mar-16 |
| Reference Probe ES3DV2 | SN: 3013 | 30-Dec-14 (No. ES3-3013_Dec14) | Dec-15 |
| DAE4 | SN: 660 | 14-Jan-15 (No. DAE4-660_Jan15) | Jan-16 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-13) | In house check: Apr-16 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

| | | | |
|----------------|------------------------------|--|-----------------------------------|
| Calibrated by: | Name Leif Klysner | Function Laboratory Technician | Signature <i>Leif Klysner</i> |
| Approved by: | Name Katja Pokovic | Function Technical Manager | Signature <i>Katja Pokovic</i> |
| | | | Issued: June 22, 2015 |

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



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

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below *ConvF*).
- NORM(f)_{x,y,z} = NORM_{x,y,z} * frequency_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}; 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 ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 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_x (no uncertainty required).

Probe ES3DV3

SN:3351

Manufactured: May 22, 2012
Calibrated: June 22, 2015

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3351

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|--------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.99 | 1.17 | 1.19 | $\pm 10.1\%$ |
| DCP (mV) ^B | 113.6 | 105.2 | 104.5 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Unc ^E (k=2) |
|---------------|---|---|---------|------------------------------|------|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 188.8 | $\pm 3.8\%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 196.2 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 151.3 | |
| 10010- CAA | SAR Validation (Square, 100ms, 10ms) | X | 2.73 | 65.7 | 12.7 | 10.00 | 35.9 | $\pm 1.2\%$ |
| | | Y | 1.18 | 58.1 | 9.8 | | 37.4 | |
| | | Z | 2.44 | 61.9 | 12.5 | | 42.0 | |
| 10011- CAB | UMTS-FDD (WCDMA) | X | 3.43 | 68.2 | 18.9 | 2.91 | 148.5 | $\pm 0.5\%$ |
| | | Y | 3.14 | 66.5 | 18.1 | | 114.3 | |
| | | Z | 3.26 | 66.5 | 18.1 | | 119.3 | |
| 10012- CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps) | X | 3.13 | 70.5 | 19.4 | 1.87 | 149.0 | $\pm 0.5\%$ |
| | | Y | 2.46 | 65.9 | 17.0 | | 115.2 | |
| | | Z | 3.02 | 68.7 | 18.5 | | 120.9 | |
| 10013- CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps) | X | 10.59 | 69.9 | 22.6 | 9.46 | 139.1 | $\pm 2.5\%$ |
| | | Y | 10.11 | 68.9 | 22.4 | | 103.4 | |
| | | Z | 10.74 | 69.4 | 22.4 | | 114.3 | |
| 10021- DAB | GSM-FDD (TDMA, GMSK) | X | 4.33 | 75.1 | 18.5 | 9.39 | 125.5 | $\pm 1.4\%$ |
| | | Y | 5.13 | 77.6 | 20.0 | | 144.5 | |
| | | Z | 17.70 | 96.1 | 27.5 | | 123.5 | |
| 10023- DAB | GPRS-FDD (TDMA, GMSK, TN 0) | X | 4.56 | 75.8 | 18.9 | 9.57 | 147.7 | $\pm 2.2\%$ |
| | | Y | 5.75 | 78.8 | 20.2 | | 140.4 | |
| | | Z | 18.60 | 97.9 | 28.5 | | 117.3 | |
| 10024- DAB | GPRS-FDD (TDMA, GMSK, TN 0-1) | X | 3.42 | 71.8 | 15.3 | 6.56 | 119.6 | $\pm 1.4\%$ |
| | | Y | 14.95 | 90.8 | 22.0 | | 132.7 | |
| | | Z | 29.34 | 98.9 | 25.6 | | 106.6 | |
| 10027- DAB | GPRS-FDD (TDMA, GMSK, TN 0-1-2) | X | 28.96 | 99.9 | 23.5 | 4.80 | 135.7 | $\pm 1.9\%$ |
| | | Y | 55.26 | 99.9 | 21.9 | | 107.5 | |
| | | Z | 35.15 | 99.9 | 24.6 | | 120.0 | |
| 10028- DAB | GPRS-FDD (TDMA, GMSK, TN 0-1-2-3) | X | 36.32 | 96.2 | 20.3 | 3.55 | 147.5 | $\pm 1.9\%$ |
| | | Y | 73.22 | 99.9 | 20.7 | | 117.0 | |
| | | Z | 52.78 | 99.6 | 22.4 | | 128.3 | |
| 10032- CAA | IEEE 802.15.1 Bluetooth (GFSK, DH5) | X | 31.23 | 99.5 | 20.1 | 1.16 | 122.8 | $\pm 1.4\%$ |
| | | Y | 0.74 | 62.4 | 7.0 | | 135.2 | |
| | | Z | 56.68 | 99.6 | 20.2 | | 141.5 | |
| 10100- CAB | LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 6.01 | 66.4 | 18.9 | 5.67 | 112.7 | $\pm 1.2\%$ |
| | | Y | 6.14 | 66.9 | 19.3 | | 124.6 | |
| | | Z | 6.37 | 67.2 | 19.4 | | 129.3 | |

| | | | | | | | | |
|-----------|--|---|-------|------|------|------|-------|--------|
| 10103-CAB | LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 8.50 | 71.4 | 23.6 | 9.29 | 137.9 | ±2.7 % |
| | | Y | 8.12 | 70.6 | 23.6 | | 105.2 | |
| | | Z | 9.68 | 73.4 | 24.7 | | 118.6 | |
| 10108-CAC | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 5.88 | 66.0 | 18.8 | 5.80 | 111.2 | ±1.2 % |
| | | Y | 5.99 | 66.5 | 19.2 | | 122.8 | |
| | | Z | 6.28 | 66.9 | 19.4 | | 128.7 | |
| 10117-CAB | IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK) | X | 10.19 | 69.3 | 21.2 | 8.07 | 149.1 | ±2.2 % |
| | | Y | 9.73 | 68.2 | 20.9 | | 111.5 | |
| | | Z | 9.97 | 68.3 | 20.8 | | 117.7 | |
| 10151-CAB | LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK) | X | 8.07 | 71.0 | 23.5 | 9.28 | 132.7 | ±2.5 % |
| | | Y | 8.82 | 74.2 | 25.9 | | 147.0 | |
| | | Z | 9.11 | 72.5 | 24.4 | | 115.3 | |
| 10154-CAC | LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK) | X | 5.55 | 65.4 | 18.6 | 5.75 | 107.9 | ±0.9 % |
| | | Y | 5.67 | 66.0 | 19.0 | | 120.3 | |
| | | Z | 5.96 | 66.3 | 19.1 | | 126.2 | |
| 10160-CAB | LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK) | X | 5.96 | 65.9 | 18.7 | 5.82 | 111.9 | ±1.2 % |
| | | Y | 6.12 | 66.6 | 19.3 | | 125.0 | |
| | | Z | 6.38 | 66.8 | 19.3 | | 131.2 | |
| 10169-CAB | LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | X | 4.68 | 66.6 | 19.4 | 5.73 | 130.7 | ±0.9 % |
| | | Y | 4.81 | 67.2 | 20.0 | | 144.7 | |
| | | Z | 4.74 | 65.5 | 18.9 | | 109.9 | |
| 10172-CAB | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | X | 6.59 | 73.2 | 25.1 | 9.21 | 143.9 | ±2.5 % |
| | | Y | 6.42 | 72.7 | 25.3 | | 113.3 | |
| | | Z | 7.92 | 75.5 | 26.2 | | 127.2 | |
| 10175-CAC | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | X | 4.68 | 66.5 | 19.4 | 5.72 | 128.6 | ±0.9 % |
| | | Y | 4.80 | 67.2 | 20.0 | | 144.2 | |
| | | Z | 4.73 | 65.5 | 18.9 | | 109.1 | |
| 10181-CAB | LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK) | X | 4.71 | 66.7 | 19.5 | 5.72 | 128.9 | ±1.2 % |
| | | Y | 4.78 | 67.1 | 19.9 | | 143.9 | |
| | | Z | 5.12 | 67.3 | 19.9 | | 149.9 | |
| 10196-CAB | IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK) | X | 9.72 | 68.8 | 21.1 | 8.10 | 138.3 | ±1.9 % |
| | | Y | 9.32 | 67.9 | 20.9 | | 105.9 | |
| | | Z | 9.58 | 67.8 | 20.6 | | 111.2 | |
| 10225-CAB | UMTS-FDD (HSPA+) | X | 6.60 | 66.5 | 18.9 | 5.97 | 117.6 | ±1.2 % |
| | | Y | 6.69 | 66.9 | 19.3 | | 132.0 | |
| | | Z | 7.08 | 67.2 | 19.5 | | 139.9 | |
| 10237-CAB | LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | X | 6.57 | 73.1 | 25.0 | 9.21 | 144.5 | ±2.2 % |
| | | Y | 6.59 | 73.6 | 25.8 | | 114.3 | |
| | | Z | 8.03 | 76.0 | 26.4 | | 127.7 | |
| 10252-CAB | LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK) | X | 7.44 | 70.0 | 23.2 | 9.24 | 122.9 | ±2.5 % |
| | | Y | 8.16 | 73.3 | 25.5 | | 138.8 | |
| | | Z | 8.43 | 71.6 | 24.1 | | 108.3 | |
| 10267-CAB | LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 8.01 | 70.7 | 23.4 | 9.30 | 130.5 | ±2.7 % |
| | | Y | 8.86 | 74.4 | 26.1 | | 146.7 | |
| | | Z | 9.12 | 72.6 | 24.5 | | 114.0 | |

| | | | | | | | | |
|-----------|---|---|-------|------|------|------|-------|--------|
| 10275-CAB | UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4) | X | 4.49 | 67.5 | 18.8 | 3.96 | 146.9 | ±0.7 % |
| | | Y | 4.13 | 65.9 | 18.1 | | 117.5 | |
| | | Z | 4.36 | 66.2 | 18.2 | | 121.1 | |
| 10291-AAB | CDMA2000, RC3, SO55, Full Rate | X | 3.66 | 67.7 | 18.9 | 3.46 | 133.9 | ±0.5 % |
| | | Y | 3.37 | 66.1 | 18.1 | | 109.3 | |
| | | Z | 3.54 | 66.0 | 18.0 | | 112.1 | |
| 10292-AAB | CDMA2000, RC3, SO32, Full Rate | X | 3.55 | 67.5 | 18.7 | 3.39 | 136.7 | ±0.7 % |
| | | Y | 3.35 | 66.4 | 18.2 | | 110.1 | |
| | | Z | 3.44 | 65.7 | 17.9 | | 112.9 | |
| 10297-AAA | LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK) | X | 5.86 | 65.9 | 18.8 | 5.81 | 109.3 | ±1.2 % |
| | | Y | 6.00 | 66.5 | 19.3 | | 122.6 | |
| | | Z | 6.23 | 66.7 | 19.3 | | 126.8 | |
| 10311-AAA | LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK) | X | 6.42 | 66.5 | 19.1 | 6.06 | 114.1 | ±1.2 % |
| | | Y | 6.60 | 67.2 | 19.7 | | 127.9 | |
| | | Z | 6.85 | 67.4 | 19.7 | | 132.6 | |
| 10400-AAC | IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle) | X | 10.03 | 69.2 | 21.5 | 8.37 | 141.2 | ±1.9 % |
| | | Y | 9.51 | 68.0 | 21.1 | | 106.9 | |
| | | Z | 9.90 | 68.2 | 21.1 | | 114.0 | |
| 10403-AAB | CDMA2000 (1xEV-DO, Rev. 0) | X | 5.00 | 70.6 | 19.6 | 3.76 | 146.5 | ±0.5 % |
| | | Y | 4.32 | 67.9 | 18.3 | | 115.0 | |
| | | Z | 4.63 | 67.5 | 18.3 | | 121.9 | |
| 10404-AAB | CDMA2000 (1xEV-DO, Rev. A) | X | 4.99 | 71.0 | 19.8 | 3.77 | 143.8 | ±0.5 % |
| | | Y | 4.37 | 68.5 | 18.7 | | 113.5 | |
| | | Z | 4.56 | 67.5 | 18.2 | | 120.2 | |
| 10415-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle) | X | 3.07 | 71.2 | 19.9 | 1.54 | 145.7 | ±0.5 % |
| | | Y | 2.43 | 66.6 | 17.4 | | 116.6 | |
| | | Z | 2.59 | 67.1 | 17.8 | | 124.3 | |
| 10416-AAA | IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle) | X | 9.84 | 69.0 | 21.3 | 8.23 | 139.6 | ±1.9 % |
| | | Y | 9.37 | 67.9 | 21.0 | | 106.5 | |
| | | Z | 9.84 | 68.4 | 21.1 | | 117.4 | |

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%.

^A The uncertainties of NormX,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 7 and 8).

^B Numerical linearization parameter; uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3351

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750 | 41.9 | 0.89 | 6.43 | 6.43 | 6.43 | 0.31 | 1.96 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.17 | 6.17 | 6.17 | 0.21 | 2.59 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.24 | 5.24 | 5.24 | 0.55 | 1.35 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 5.07 | 5.07 | 5.07 | 0.54 | 1.42 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 4.74 | 4.74 | 4.74 | 0.69 | 1.31 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.46 | 4.46 | 4.46 | 0.80 | 1.26 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.35 | 4.35 | 4.35 | 0.80 | 1.26 | ± 12.0 % |

^C 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3351

Calibration Parameter Determined in Body Tissue Simulating Media

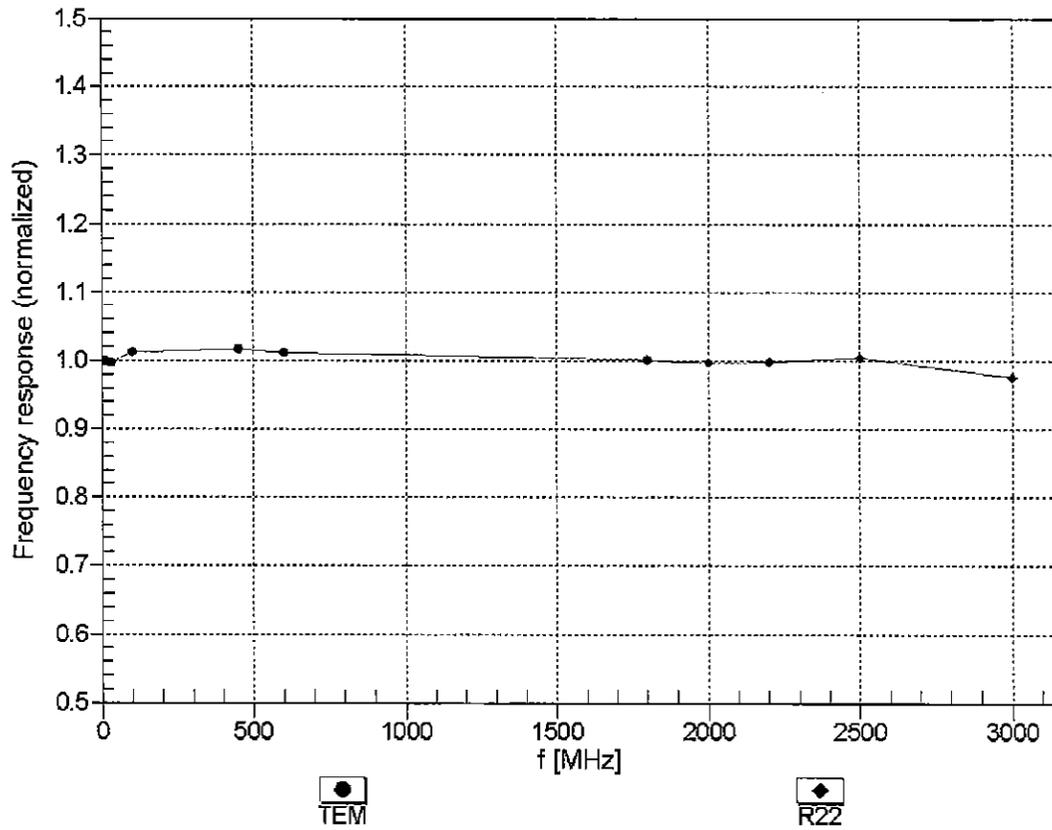
| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750 | 55.5 | 0.96 | 6.21 | 6.21 | 6.21 | 0.29 | 1.98 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.11 | 6.11 | 6.11 | 0.77 | 1.20 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 4.88 | 4.88 | 4.88 | 0.68 | 1.30 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.68 | 4.68 | 4.68 | 0.61 | 1.46 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 4.47 | 4.47 | 4.47 | 0.80 | 1.16 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.30 | 4.30 | 4.30 | 0.80 | 1.16 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 4.16 | 4.16 | 4.16 | 0.80 | 1.20 | ± 12.0 % |

^C 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

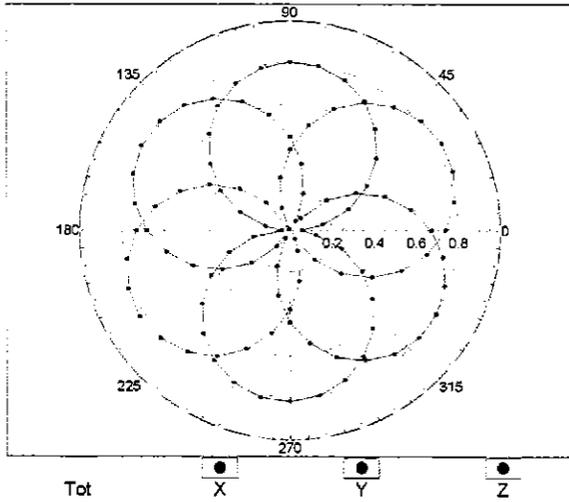
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



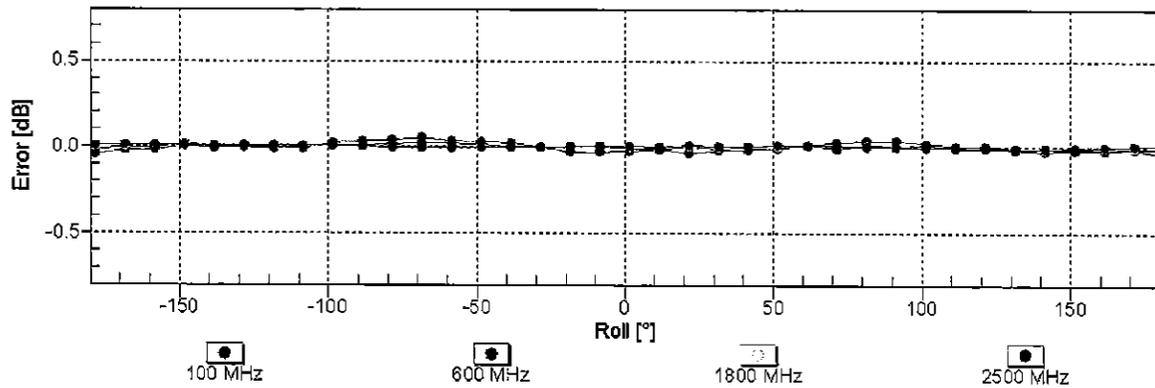
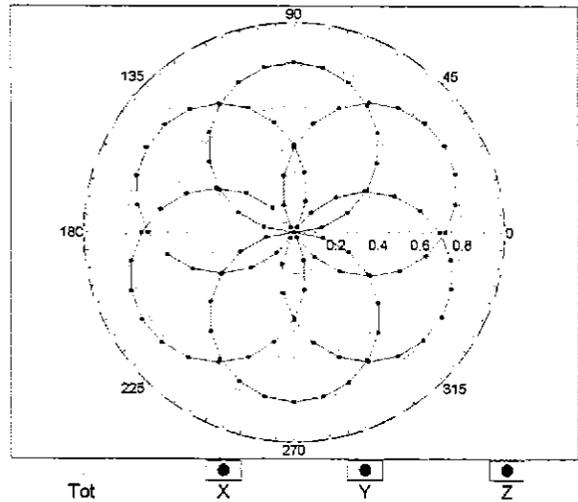
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

f=600 MHz,TEM

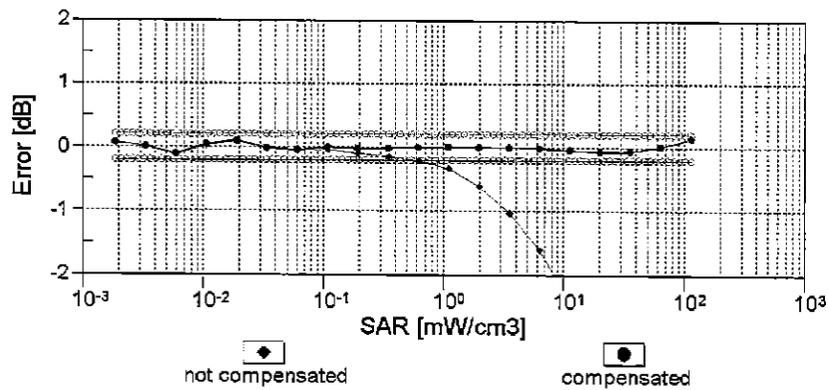
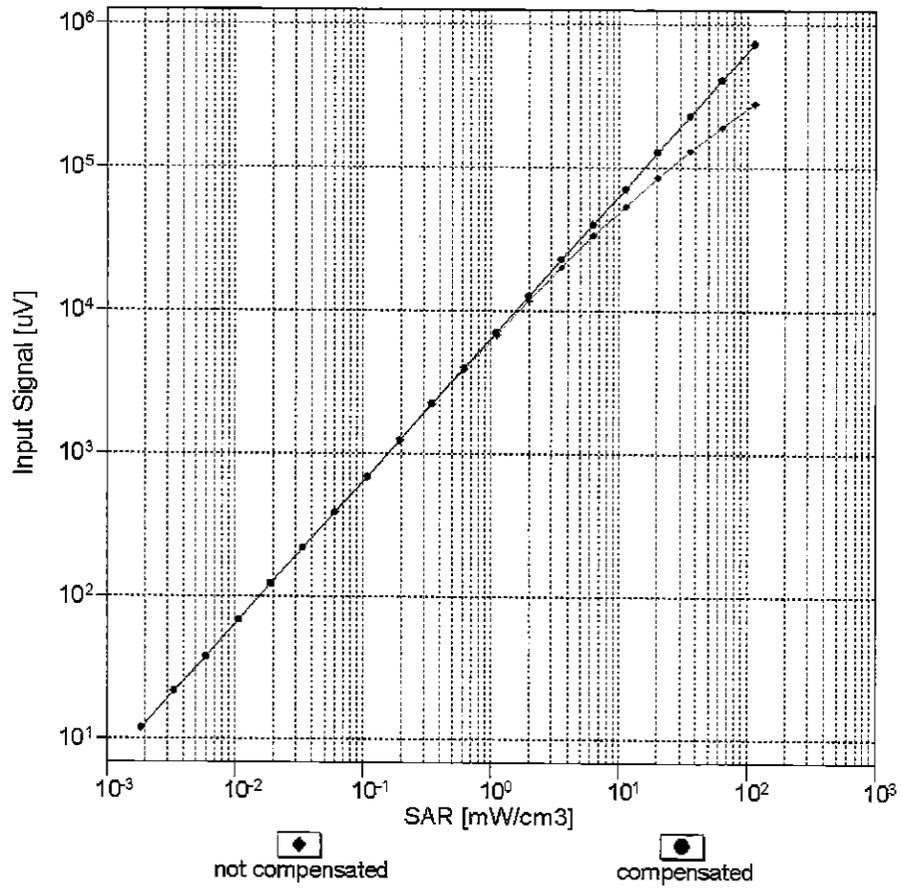


f=1800 MHz,R22



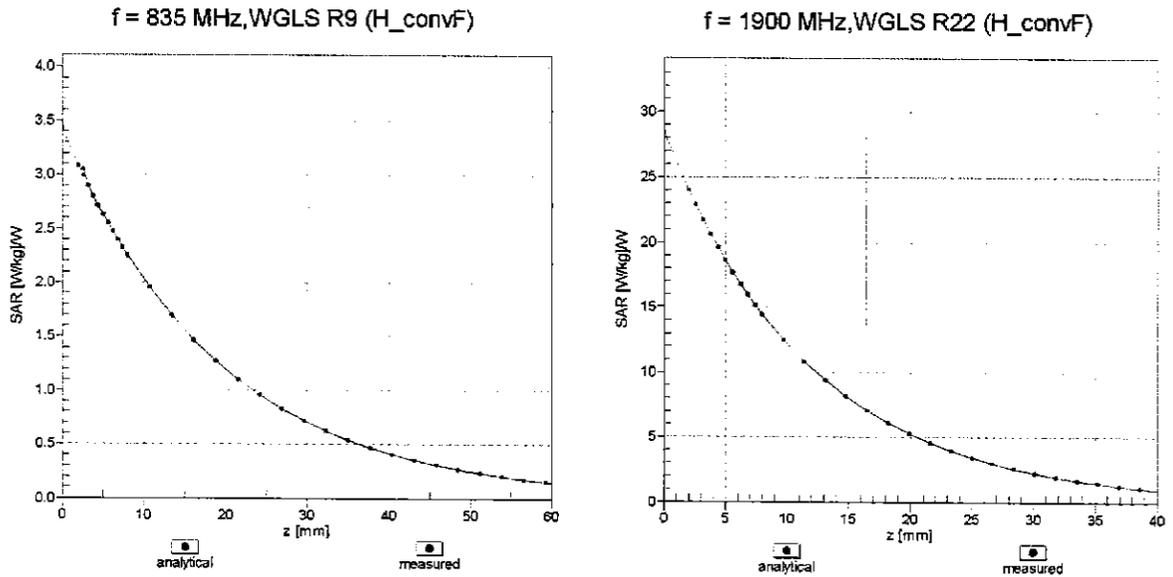
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range $f(SAR_{head})$ (TEM cell , $f_{eval} = 1900$ MHz)



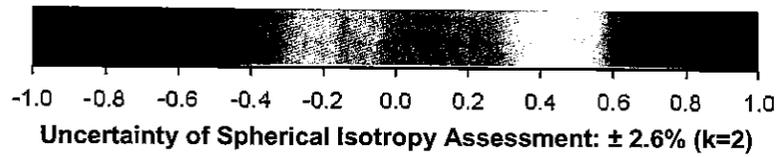
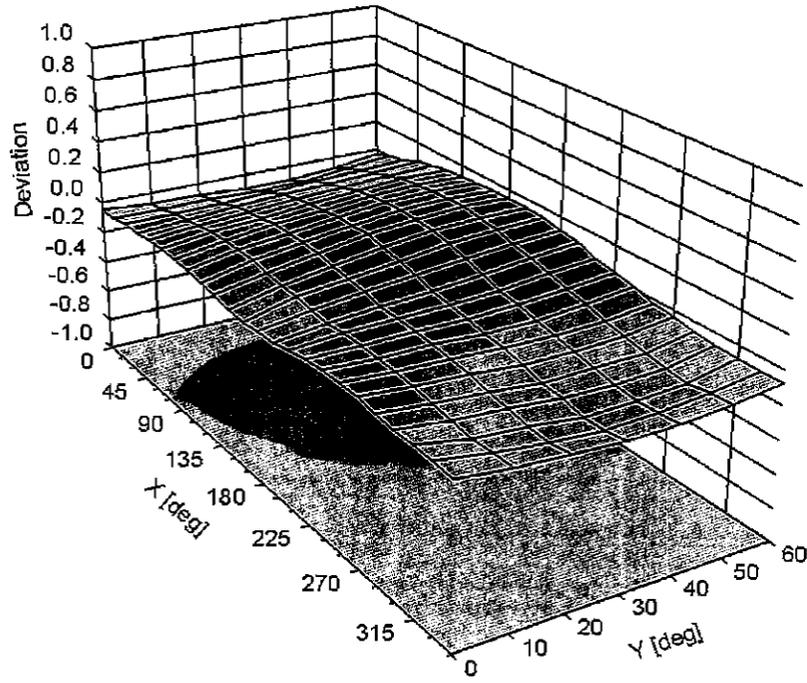
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), f = 900 MHz



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3351

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 21.5 |
| 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 | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |



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 **PC Test**

Certificate No: **EX3-7308_Jul15**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:7308**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes**

Calibration date: **July 21, 2015**

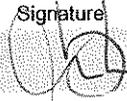
*BN ✓
08/04/15*

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 E4419B | GB41293874 | 01-Apr-15 (No. 217-02128) | Mar-16 |
| Power sensor E4412A | MY41498087 | 01-Apr-15 (No. 217-02128) | Mar-16 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 01-Apr-15 (No. 217-02129) | Mar-16 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 01-Apr-15 (No. 217-02132) | Mar-16 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 01-Apr-15 (No. 217-02133) | Mar-16 |
| Reference Probe ES3DV2 | SN: 3013 | 30-Dec-14 (No. ES3-3013_Dec14) | Dec-15 |
| DAE4 | SN: 660 | 14-Jan-15 (No. DAE4-660_Jan15) | Jan-16 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-13) | In house check: Apr-16 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

Calibrated by: **Claudio Leubler** (Name) **Laboratory Technician** (Function)  (Signature)

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

Issued: July 22, 2015

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Glossary:

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

- 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) 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
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- *NORM_{x,y,z}*: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). *NORM_{x,y,z}* are only intermediate values, i.e., the uncertainties of *NORM_{x,y,z}* does not affect the E^2 -field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)_{x,y,z}* = *NORM_{x,y,z}* * *frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCP_{x,y,z}*: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR*: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}*: *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_{x,y,z}* * *ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 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_x* (no uncertainty required).

Probe EX3DV4

SN:7308

Manufactured: March 11, 2014
Calibrated: July 21, 2015

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7308

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|--------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.50 | 0.60 | 0.45 | $\pm 10.1\%$ |
| DCP (mV) ^B | 98.7 | 98.5 | 103.0 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Unc ^E (k=2) |
|-----------|---|---|---------|------------------------------|------|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 157.9 | $\pm 3.3\%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 152.7 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 146.1 | |
| 10010-CAA | SAR Validation (Square, 100ms, 10ms) | X | 1.57 | 63.2 | 12.0 | 10.00 | 44.9 | $\pm 0.9\%$ |
| | | Y | 4.80 | 74.9 | 16.5 | | 43.8 | |
| | | Z | 0.93 | 58.1 | 8.8 | | 41.8 | |
| 10062-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps) | X | 10.36 | 69.2 | 21.9 | 8.68 | 145.4 | $\pm 3.3\%$ |
| | | Y | 10.44 | 69.2 | 21.9 | | 144.1 | |
| | | Z | 9.89 | 68.5 | 21.5 | | 130.2 | |
| 10117-CAB | IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK) | X | 10.03 | 68.2 | 20.8 | 8.07 | 127.1 | $\pm 3.0\%$ |
| | | Y | 10.43 | 69.2 | 21.4 | | 148.2 | |
| | | Z | 10.05 | 68.6 | 21.1 | | 138.2 | |
| 10196-CAB | IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK) | X | 10.03 | 68.9 | 21.4 | 8.10 | 146.1 | $\pm 3.0\%$ |
| | | Y | 10.09 | 68.9 | 21.4 | | 143.5 | |
| | | Z | 9.59 | 68.3 | 21.1 | | 131.0 | |
| 10317-AAB | IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle) | X | 10.17 | 69.0 | 21.6 | 8.36 | 144.5 | $\pm 3.3\%$ |
| | | Y | 10.23 | 69.0 | 21.6 | | 141.8 | |
| | | Z | 9.72 | 68.4 | 21.3 | | 130.2 | |
| 10400-AAC | IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle) | X | 10.28 | 69.1 | 21.6 | 8.37 | 144.6 | $\pm 3.3\%$ |
| | | Y | 10.32 | 69.1 | 21.6 | | 142.0 | |
| | | Z | 9.81 | 68.5 | 21.3 | | 129.4 | |
| 10401-AAC | IEEE 802.11ac WiFi (40MHz, 64-QAM, 99pc duty cycle) | X | 10.70 | 68.8 | 21.5 | 8.60 | 129.8 | $\pm 3.0\%$ |
| | | Y | 10.55 | 68.4 | 21.2 | | 123.2 | |
| | | Z | 10.64 | 69.1 | 21.6 | | 140.3 | |
| 10402-AAC | IEEE 802.11ac WiFi (80MHz, 64-QAM, 99pc duty cycle) | X | 10.84 | 69.0 | 21.4 | 8.53 | 130.1 | $\pm 3.0\%$ |
| | | Y | 10.57 | 68.4 | 21.0 | | 123.5 | |
| | | Z | 10.91 | 69.6 | 21.7 | | 142.7 | |

| | | | | | | | | |
|-----------|---|---|-------|------|------|------|-------|--------|
| 10417-AAA | IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps, 99pc duty cycle) | X | 10.10 | 68.9 | 21.5 | 8.23 | 145.0 | ±3.0 % |
| | | Y | 10.15 | 68.9 | 21.5 | | 142.0 | |
| | | Z | 9.64 | 68.3 | 21.1 | | 130.3 | |

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%.

^A The uncertainties of Norm X,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 6 and 7).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7308

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 5250 | 35.9 | 4.71 | 5.20 | 5.20 | 5.20 | 0.35 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.65 | 4.65 | 4.65 | 0.40 | 1.80 | ± 13.1 % |
| 5750 | 35.4 | 5.22 | 4.86 | 4.86 | 4.86 | 0.40 | 1.80 | ± 13.1 % |

^C 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7308

Calibration Parameter Determined in Body Tissue Simulating Media

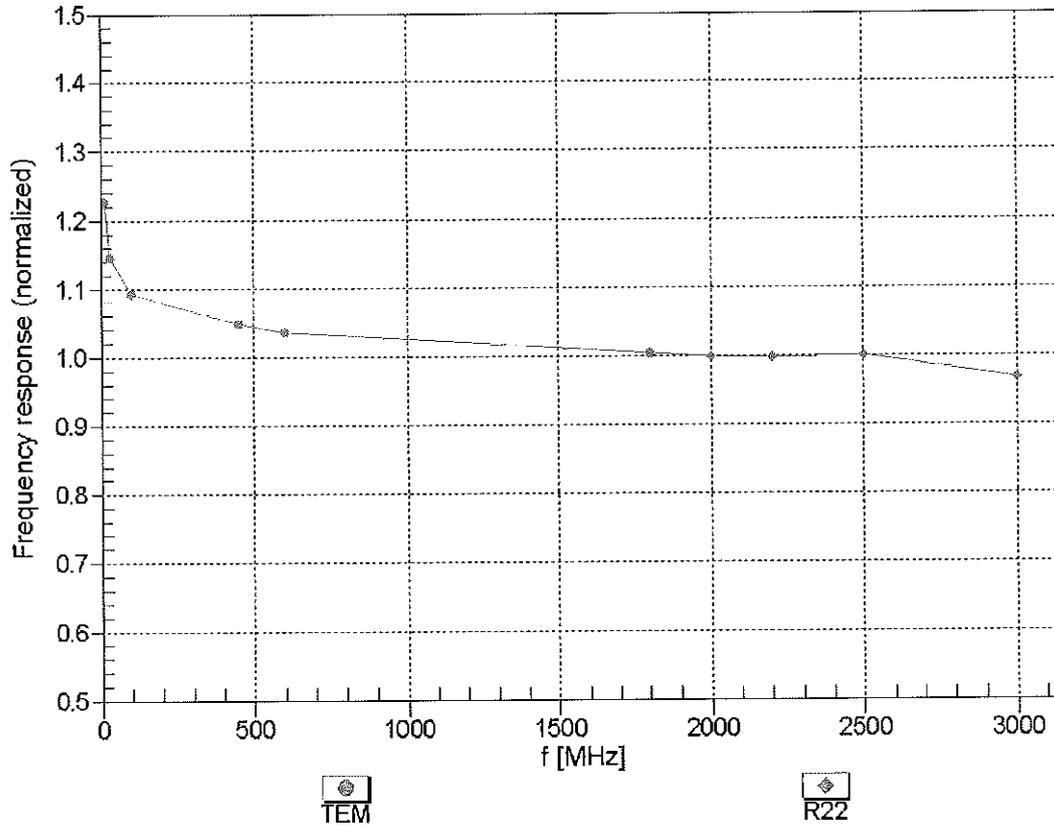
| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 5250 | 48.9 | 5.36 | 4.63 | 4.63 | 4.63 | 0.40 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 3.92 | 3.92 | 3.92 | 0.50 | 1.90 | ± 13.1 % |
| 5750 | 48.3 | 5.94 | 4.24 | 4.24 | 4.24 | 0.50 | 1.90 | ± 13.1 % |

^C 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

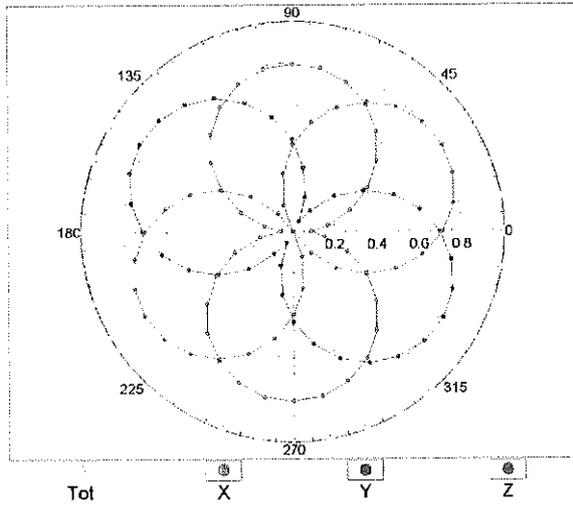
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



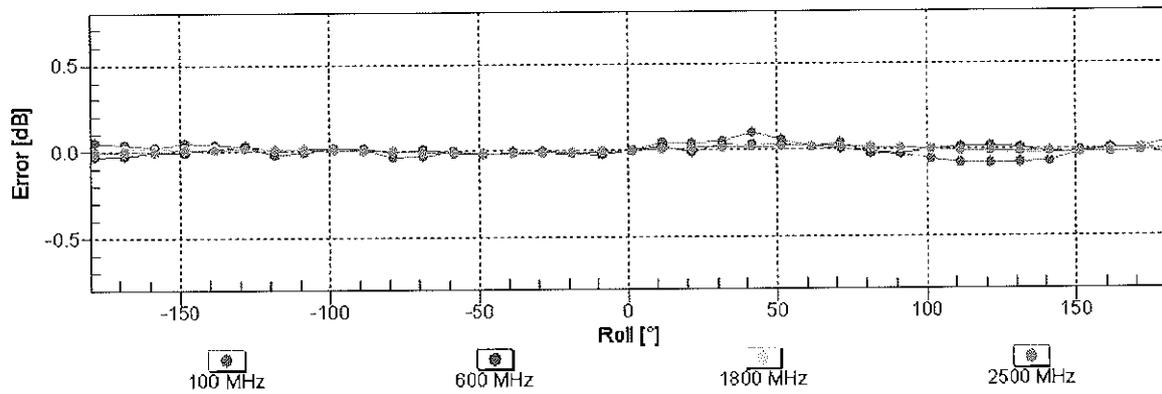
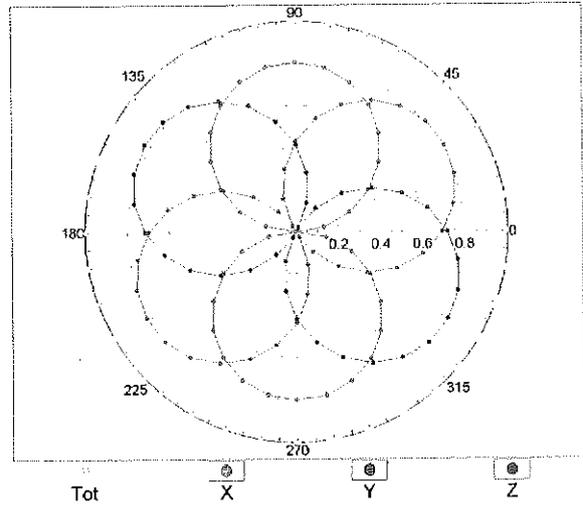
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz,TEM

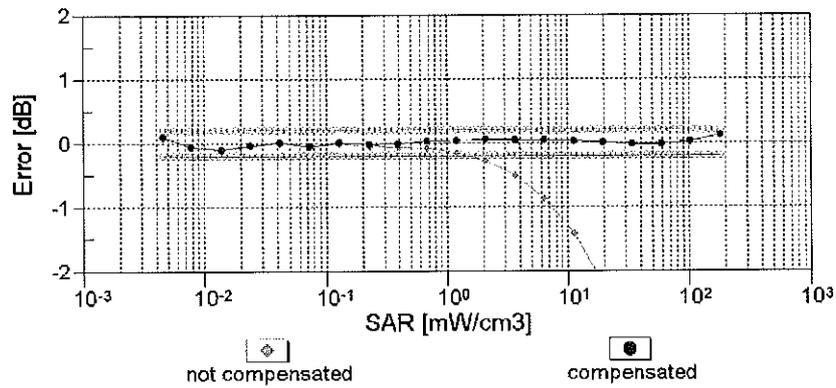
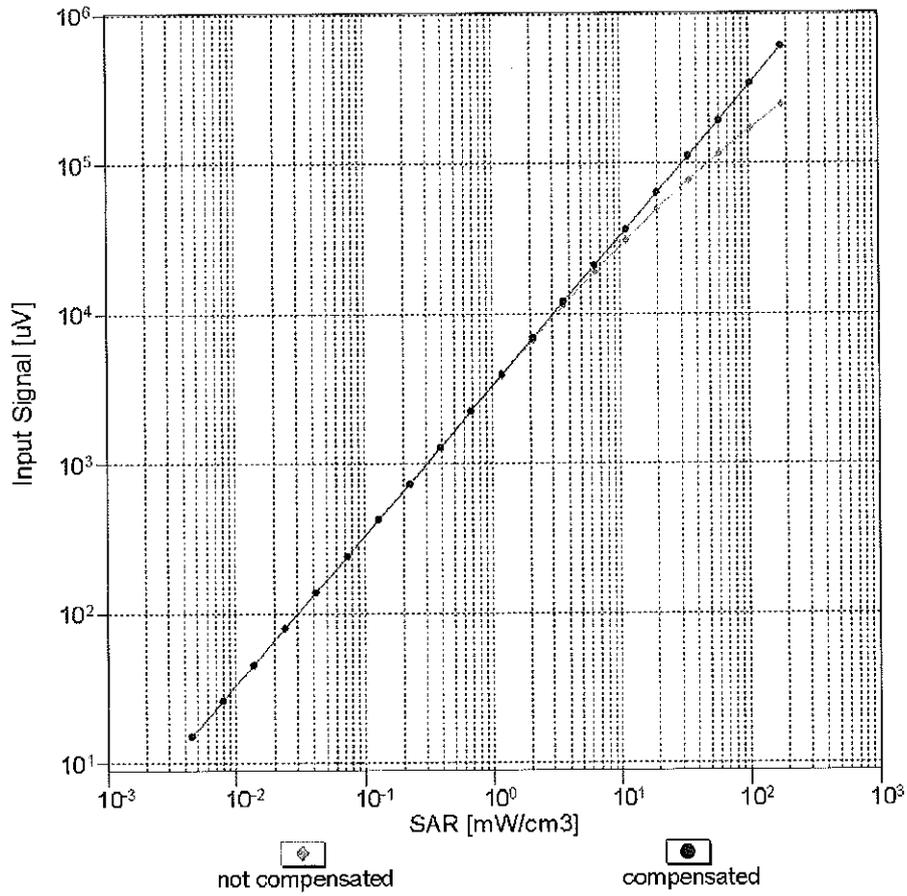


f=1800 MHz,R22



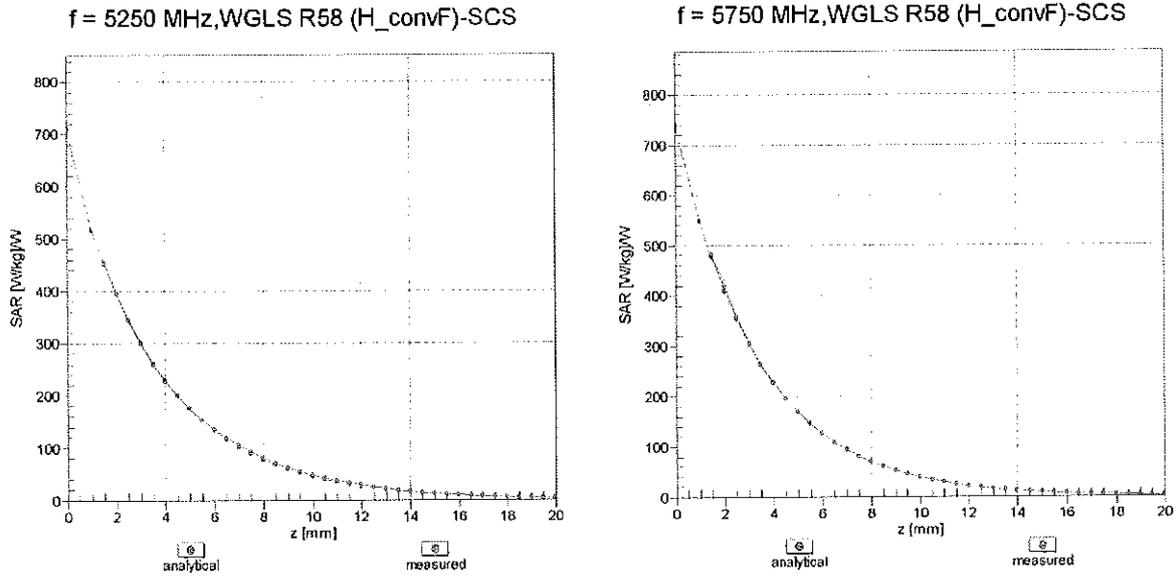
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range $f(SAR_{head})$ (TEM cell , $f_{eval}= 1900$ MHz)

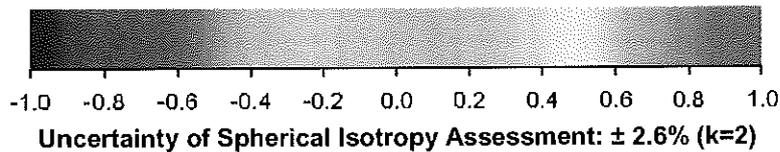
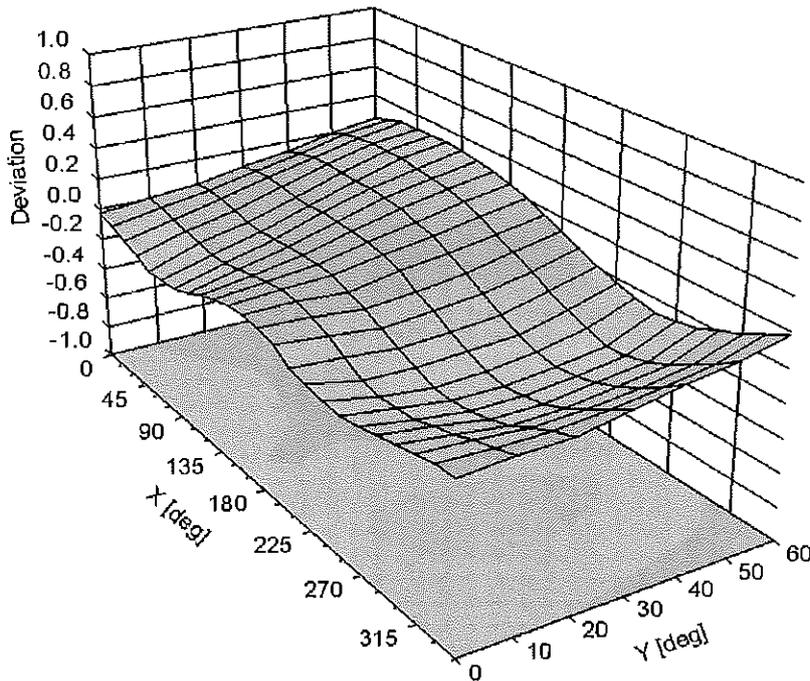


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, ϑ), f = 900 MHz



DASY/EASY - Parameters of Probe: EX3DV4 - SN:7308**Other Probe Parameters**

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 111.5 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 1.4 mm |



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 **PC Test**

Certificate No: **EX3-7357_Apr15**

CALIBRATION CERTIFICATE

Object: **EX3DV4 - SN:7357**

Calibration procedure(s): **QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes**

Calibration date: **April 23, 2015**

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)

*PNV ✓
05/05/15*

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|----------------------------|-----------------|-----------------------------------|------------------------|
| Power meter E4419B | GB41293874 | 01-Apr-15 (No. 217-02128) | Mar-16 |
| Power sensor E4412A | MY41498087 | 01-Apr-15 (No. 217-02128) | Mar-16 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 01-Apr-15 (No. 217-02129) | Mar-16 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 01-Apr-15 (No. 217-02132) | Mar-16 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 01-Apr-15 (No. 217-02133) | Mar-16 |
| Reference Probe ES3DV2 | SN: 3013 | 30-Dec-14 (No. ES3-3013_Dec14) | Dec-15 |
| DAE4 | SN: 660 | 14-Jan-15 (No. DAE4-660_Jan15) | Jan-16 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-13) | In house check: Apr-16 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

| | | | |
|----------------|--------------------------------|--|---------------|
| Calibrated by: | Name Claudio Leubler | Function Laboratory Technician | Signature |
| Approved by: | Name Katja Pokovic | Function Technical Manager | |

Issued: April 23, 2015

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



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

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}; 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_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 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_x (no uncertainty required).

Probe EX3DV4

SN:7357

Manufactured: February 5, 2015
Calibrated: April 23, 2015

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7357

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|----------|----------|----------|---------------|
| Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.41 | 0.49 | 0.42 | $\pm 10.1 \%$ |
| DCP (mV) ^B | 103.9 | 96.9 | 101.6 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu\text{V}}$ | C | D dB | VR mV | Unc ^E (k=2) |
|---------------|---|---|---------|------------------------------|-------|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 146.9 | $\pm 3.3 \%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 157.7 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 138.2 | |
| 10010- CAA | SAR Validation (Square, 100ms, 10ms) | X | 0.83 | 57.1 | 8.0 | 10.00 | 45.6 | $\pm 0.7 \%$ |
| | | Y | 1.12 | 59.0 | 9.6 | | 45.6 | |
| | | Z | 0.93 | 58.4 | 8.9 | | 43.4 | |
| 10012- CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps) | X | 3.61 | 73.9 | 21.5 | 1.87 | 133.3 | $\pm 0.9 \%$ |
| | | Y | 2.64 | 66.3 | 17.3 | | 127.2 | |
| | | Z | 3.06 | 70.4 | 19.9 | | 149.2 | |
| 10013- CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps) | X | 10.42 | 68.9 | 22.1 | 9.46 | 142.7 | $\pm 3.3 \%$ |
| | | Y | 10.68 | 69.5 | 22.6 | | 140.9 | |
| | | Z | 10.33 | 68.6 | 21.9 | | 134.3 | |
| 10032- CAA | IEEE 802.15.1 Bluetooth (GFSK, DH5) | X | 0.06 | 0.0 | 100.0 | 1.16 | 149.4 | $\pm 3.5 \%$ |
| | | Y | 0.26 | 57.7 | 4.5 | | 143.7 | |
| | | Z | 0.05 | 0.6 | 100.0 | | 143.3 | |
| 10062- CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps) | X | 10.19 | 68.8 | 21.5 | 8.68 | 144.0 | $\pm 3.5 \%$ |
| | | Y | 10.40 | 69.2 | 21.8 | | 145.6 | |
| | | Z | 10.11 | 68.5 | 21.4 | | 138.3 | |
| 10103- CAB | LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 7.21 | 67.1 | 21.4 | 9.29 | 132.3 | $\pm 1.9 \%$ |
| | | Y | 7.94 | 69.4 | 22.8 | | 136.4 | |
| | | Z | 7.15 | 66.8 | 21.3 | | 145.0 | |
| 10117- CAB | IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK) | X | 10.10 | 68.5 | 20.9 | 8.07 | 131.3 | $\pm 2.5 \%$ |
| | | Y | 10.12 | 68.3 | 20.8 | | 128.9 | |
| | | Z | 9.95 | 68.0 | 20.6 | | 124.4 | |
| 10151- CAB | LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK) | X | 6.97 | 67.1 | 21.5 | 9.28 | 148.9 | $\pm 1.9 \%$ |
| | | Y | 7.50 | 68.7 | 22.5 | | 130.8 | |
| | | Z | 6.89 | 66.6 | 21.3 | | 141.8 | |
| 10172- CAB | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | X | 5.57 | 68.9 | 22.9 | 9.21 | 141.8 | $\pm 1.9 \%$ |
| | | Y | 5.84 | 69.6 | 23.4 | | 139.9 | |
| | | Z | 5.43 | 68.1 | 22.5 | | 134.4 | |
| 10196- CAB | IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK) | X | 9.69 | 68.2 | 20.8 | 8.10 | 124.8 | $\pm 3.3 \%$ |
| | | Y | 10.09 | 69.0 | 21.4 | | 148.5 | |
| | | Z | 9.90 | 68.6 | 21.1 | | 143.9 | |
| 10237- CAB | LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | X | 5.57 | 69.0 | 22.9 | 9.21 | 140.3 | $\pm 1.9 \%$ |
| | | Y | 5.85 | 69.6 | 23.4 | | 141.2 | |
| | | Z | 5.43 | 68.0 | 22.4 | | 133.8 | |

| | | | | | | | | |
|-----------|---|---|-------|------|------|------|-------|--------|
| 10252-CAB | LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK) | X | 6.62 | 67.0 | 21.6 | 9.24 | 143.6 | ±2.2 % |
| | | Y | 7.21 | 68.9 | 22.9 | | 144.8 | |
| | | Z | 6.54 | 66.4 | 21.3 | | 137.3 | |
| 10267-CAB | LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 7.00 | 67.1 | 21.6 | 9.30 | 149.1 | ±1.9 % |
| | | Y | 7.52 | 68.7 | 22.6 | | 128.6 | |
| | | Z | 6.91 | 66.6 | 21.3 | | 142.7 | |
| 10317-AAB | IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 99pc duty cycle) | X | 9.81 | 68.2 | 21.0 | 8.36 | 123.5 | ±3.3 % |
| | | Y | 10.26 | 69.1 | 21.6 | | 148.1 | |
| | | Z | 10.06 | 68.7 | 21.3 | | 144.2 | |
| 10400-AAB | IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle) | X | 9.88 | 68.2 | 21.0 | 8.37 | 123.6 | ±2.7 % |
| | | Y | 9.94 | 68.1 | 21.0 | | 124.7 | |
| | | Z | 10.15 | 68.8 | 21.3 | | 144.7 | |
| 10401-AAB | IEEE 802.11ac WiFi (40MHz, 64-QAM, 99pc duty cycle) | X | 10.61 | 68.7 | 21.2 | 8.60 | 132.4 | ±3.0 % |
| | | Y | 10.82 | 69.0 | 21.5 | | 134.7 | |
| | | Z | 10.54 | 68.4 | 21.1 | | 126.8 | |
| 10402-AAB | IEEE 802.11ac WiFi (80MHz, 64-QAM, 99pc duty cycle) | X | 10.66 | 68.6 | 21.1 | 8.53 | 133.5 | ±3.0 % |
| | | Y | 11.03 | 69.4 | 21.5 | | 136.6 | |
| | | Z | 10.56 | 68.3 | 20.9 | | 126.5 | |
| 10415-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle) | X | 4.15 | 76.8 | 22.5 | 1.54 | 130.0 | ±0.9 % |
| | | Y | 2.63 | 66.8 | 17.4 | | 129.6 | |
| | | Z | 3.25 | 72.3 | 20.7 | | 147.1 | |
| 10416-AAA | IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle) | X | 9.99 | 68.7 | 21.2 | 8.23 | 146.6 | ±3.3 % |
| | | Y | 10.19 | 69.0 | 21.5 | | 149.3 | |
| | | Z | 9.96 | 68.6 | 21.2 | | 141.2 | |
| 10417-AAA | IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps, 99pc duty cycle) | X | 10.02 | 68.8 | 21.3 | 8.23 | 148.2 | ±2.7 % |
| | | Y | 9.78 | 68.0 | 20.9 | | 124.2 | |
| | | Z | 9.96 | 68.6 | 21.2 | | 142.5 | |

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%.

^A The uncertainties of NormX,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 6 and 7).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7357

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^c | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 2450 | 39.2 | 1.80 | 7.31 | 7.31 | 7.31 | 0.36 | 0.80 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 7.06 | 7.06 | 7.06 | 0.38 | 0.80 | ± 12.0 % |
| 5200 | 36.0 | 4.66 | 5.14 | 5.14 | 5.14 | 0.40 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 4.93 | 4.93 | 4.93 | 0.40 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 4.70 | 4.70 | 4.70 | 0.40 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.38 | 4.38 | 4.38 | 0.45 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 4.41 | 4.41 | 4.41 | 0.45 | 1.80 | ± 13.1 % |

^c 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7357

Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 2450 | 52.7 | 1.95 | 6.95 | 6.95 | 6.95 | 0.26 | 0.99 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 6.68 | 6.68 | 6.68 | 0.28 | 0.99 | ± 12.0 % |
| 5200 | 49.0 | 5.30 | 4.27 | 4.27 | 4.27 | 0.50 | 1.90 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 4.11 | 4.11 | 4.11 | 0.50 | 1.90 | ± 13.1 % |
| 5500 | 48.6 | 5.65 | 3.83 | 3.83 | 3.83 | 0.50 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 3.72 | 3.72 | 3.72 | 0.55 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 3.82 | 3.82 | 3.82 | 0.55 | 1.90 | ± 13.1 % |

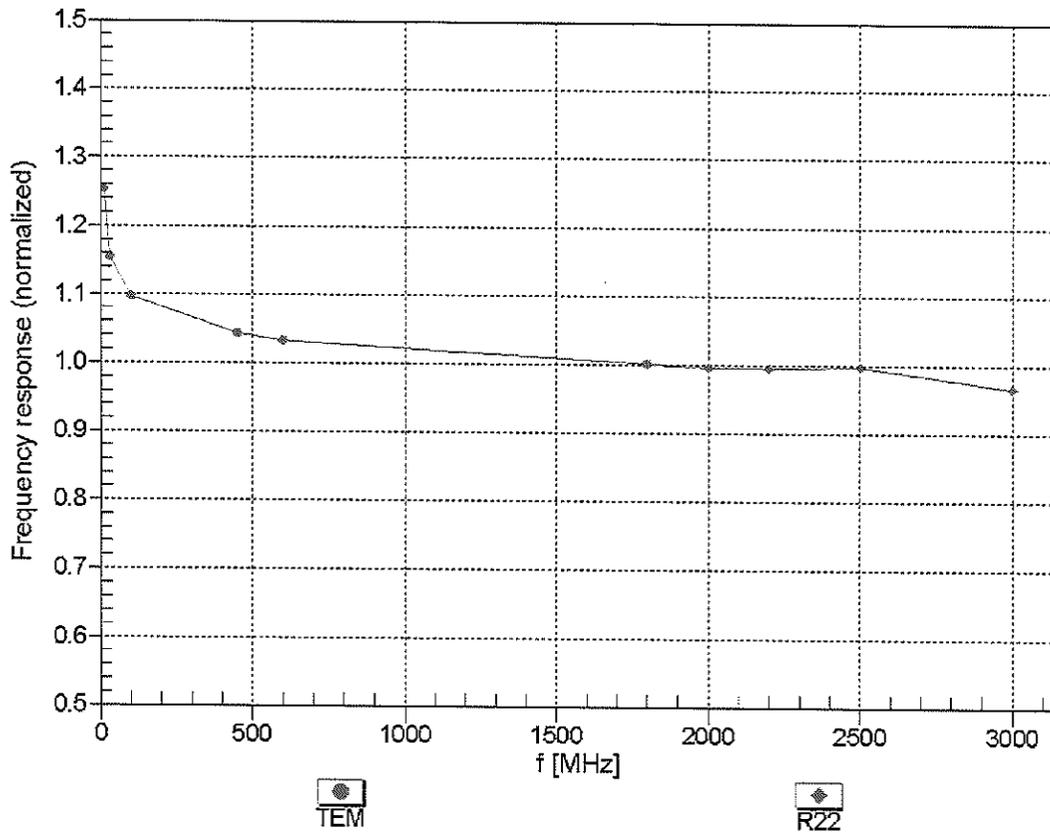
^C Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

Frequency Response of E-Field

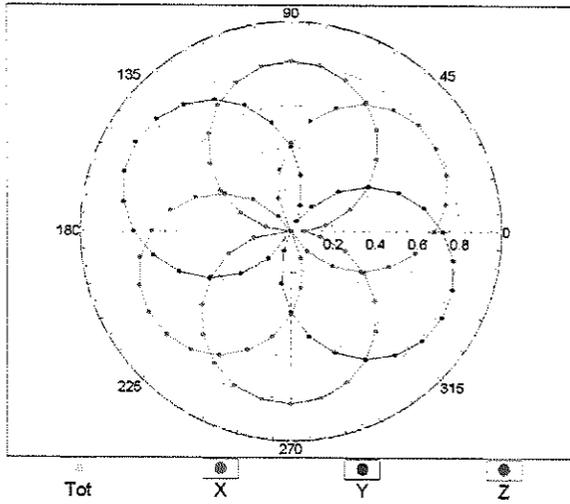
(TEM-Cell:ifi110 EXX, Waveguide: R22)



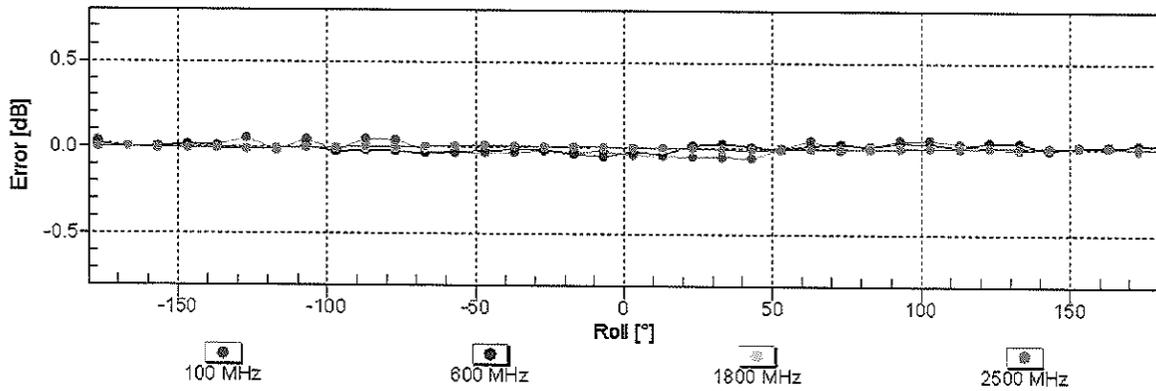
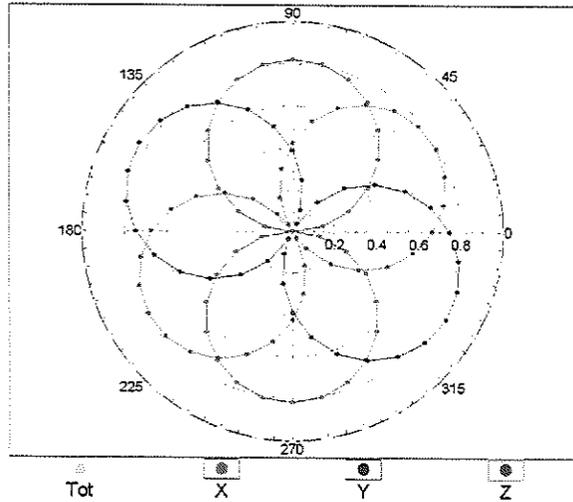
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

Receiving Pattern (ϕ), $\vartheta = 0^\circ$

f=600 MHz,TEM

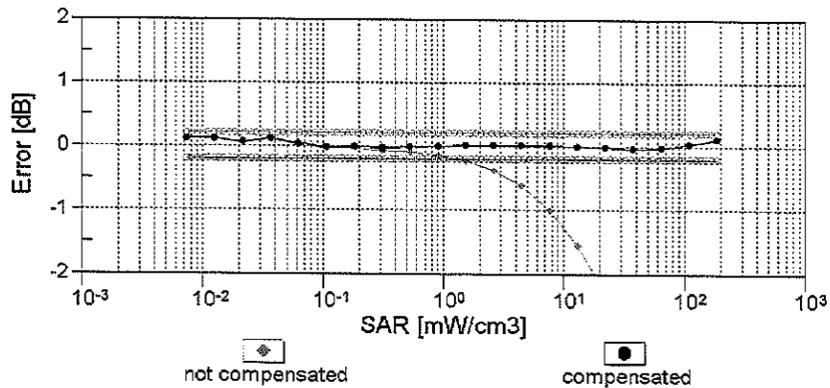
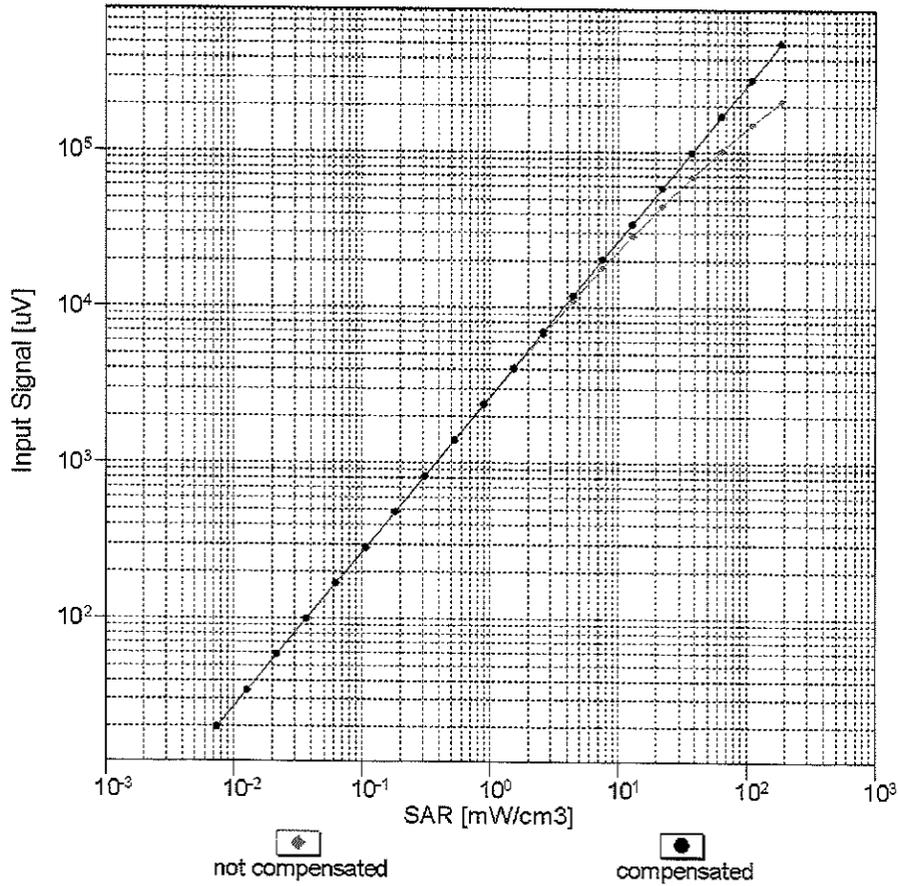


f=1800 MHz,R22



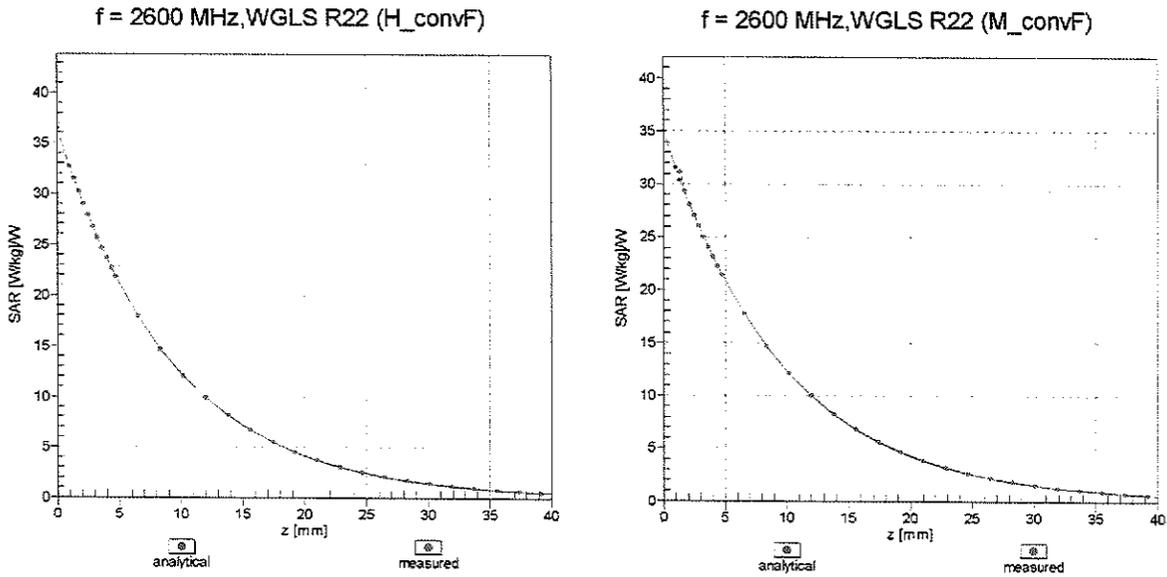
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Dynamic Range f(SAR_{head}) (TEM cell , f_{eval}= 1900 MHz)

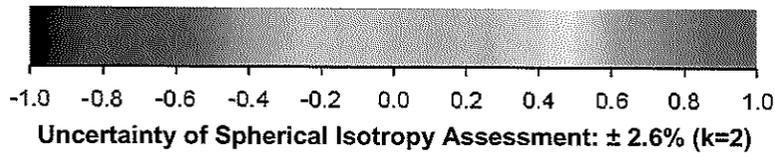
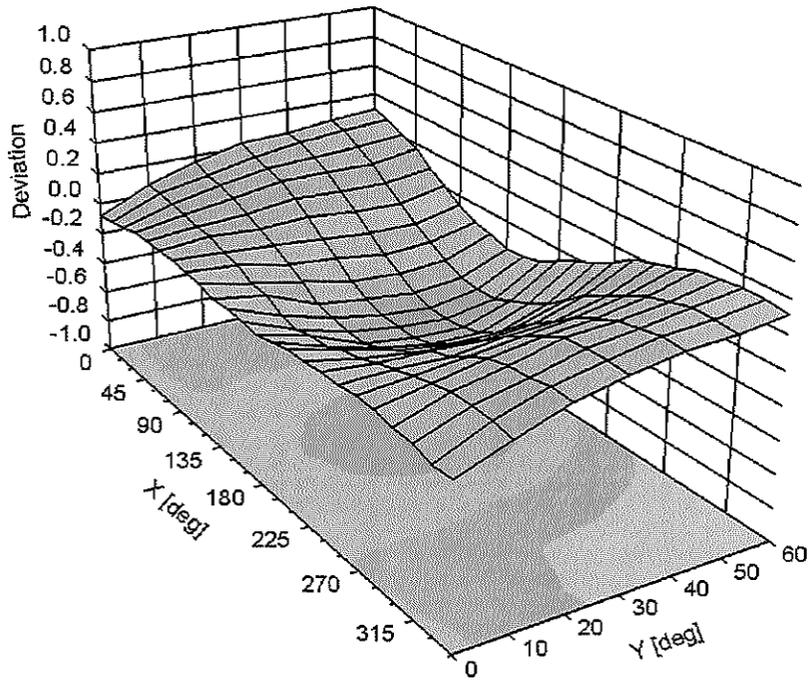


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, ϑ), f = 900 MHz



DASY/EASY - Parameters of Probe: EX3DV4 - SN:7357

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 13.1 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 1.4 mm |



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 **PC Test**

Certificate No: **ES3-3209_Mar15**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3209**

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

Calibration date: **March 19, 2015**

BW ✓
3/26

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 E4419B | GB41293874 | 03-Apr-14 (No. 217-01911) | Apr-15 |
| Power sensor E4412A | MY41498087 | 03-Apr-14 (No. 217-01911) | Apr-15 |
| Reference 3 dB Attenuator | SN: S5054 (3c) | 03-Apr-14 (No. 217-01915) | Apr-15 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 03-Apr-14 (No. 217-01919) | Apr-15 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 03-Apr-14 (No. 217-01920) | Apr-15 |
| Reference Probe ES3DV2 | SN: 3013 | 30-Dec-14 (No. ES3-3013_Dec14) | Dec-15 |
| DAE4 | SN: 660 | 14-Jan-15 (No. DAE4-660_Jan15) | Jan-16 |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| RF generator HP 8648C | US3642U01700 | 4-Aug-99 (in house check Apr-13) | In house check: Apr-16 |
| Network Analyzer HP 8753E | US37390585 | 18-Oct-01 (in house check Oct-14) | In house check: Oct-15 |

| | | | |
|----------------|------------------------------|--|---------------|
| Calibrated by: | Name Israe Elnaouq | Function Laboratory Technician | Signature |
| Approved by: | Name Katja Pokovic | Function Technical Manager | |

Issued: March 19, 2015

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Glossary:

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

- 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

Methods Applied and Interpretation of Parameters:

- *NORM_{x,y,z}*: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). *NORM_{x,y,z}* are only intermediate values, i.e., the uncertainties of *NORM_{x,y,z}* does not affect the E^2 -field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)_{x,y,z}* = *NORM_{x,y,z}* * *frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCP_{x,y,z}*: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR*: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *A_{x,y,z}*; *B_{x,y,z}*; *C_{x,y,z}*; *D_{x,y,z}*; *VR_{x,y,z}*: *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_{x,y,z}* * *ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 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_x* (no uncertainty required).

Probe ES3DV3

SN:3209

Manufactured: October 14, 2008
Calibrated: March 19, 2015

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---------------------------------------|----------|----------|----------|--------------|
| Norm ($\mu V/(V/m)^2$) ^A | 1.35 | 1.33 | 1.14 | $\pm 10.1\%$ |
| DCP (mV) ^B | 102.0 | 100.9 | 103.3 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB $\sqrt{\mu V}$ | C | D dB | VR mV | Unc ^E (k=2) |
|-----------|---|---|---------|------------------------|------|---------|----------|---------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 214.5 | $\pm 3.5\%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 192.6 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 199.1 | |
| 10010-CAA | SAR Validation (Square, 100ms, 10ms) | X | 2.61 | 65.1 | 12.2 | 10.00 | 42.3 | $\pm 1.7\%$ |
| | | Y | 1.39 | 57.8 | 8.9 | | 42.7 | |
| | | Z | 4.57 | 70.3 | 14.0 | | 38.3 | |
| 10011-CAB | UMTS-FDD (WCDMA) | X | 3.12 | 66.3 | 18.1 | 2.91 | 130.3 | $\pm 0.7\%$ |
| | | Y | 3.08 | 65.6 | 17.5 | | 132.2 | |
| | | Z | 3.32 | 67.7 | 19.0 | | 137.6 | |
| 10012-CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps) | X | 2.54 | 66.8 | 17.8 | 1.87 | 131.1 | $\pm 0.7\%$ |
| | | Y | 2.67 | 67.1 | 17.7 | | 131.6 | |
| | | Z | 2.85 | 69.2 | 19.1 | | 138.0 | |
| 10013-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps) | X | 10.78 | 70.5 | 23.4 | 9.46 | 146.9 | $\pm 2.7\%$ |
| | | Y | 10.39 | 69.2 | 22.5 | | 123.5 | |
| | | Z | 10.50 | 69.9 | 23.1 | | 128.4 | |
| 10021-DAB | GSM-FDD (TDMA, GMSK) | X | 3.65 | 74.2 | 17.7 | 9.39 | 130.0 | $\pm 1.9\%$ |
| | | Y | 6.62 | 83.5 | 22.0 | | 149.4 | |
| | | Z | 4.25 | 76.8 | 19.2 | | 136.2 | |
| 10023-DAB | GPRS-FDD (TDMA, GMSK, TN 0) | X | 3.95 | 75.3 | 18.4 | 9.57 | 138.8 | $\pm 2.5\%$ |
| | | Y | 4.99 | 78.2 | 19.8 | | 143.3 | |
| | | Z | 4.11 | 75.8 | 18.9 | | 129.3 | |
| 10024-DAB | GPRS-FDD (TDMA, GMSK, TN 0-1) | X | 6.44 | 80.3 | 17.7 | 6.56 | 135.0 | $\pm 1.7\%$ |
| | | Y | 3.76 | 73.7 | 16.0 | | 144.2 | |
| | | Z | 11.61 | 88.5 | 20.7 | | 148.0 | |
| 10027-DAB | GPRS-FDD (TDMA, GMSK, TN 0-1-2) | X | 43.77 | 99.9 | 21.8 | 4.80 | 131.8 | $\pm 1.7\%$ |
| | | Y | 13.95 | 87.5 | 19.0 | | 142.7 | |
| | | Z | 39.96 | 99.9 | 22.1 | | 145.6 | |
| 10028-DAB | GPRS-FDD (TDMA, GMSK, TN 0-1-2-3) | X | 62.88 | 99.8 | 20.4 | 3.55 | 144.5 | $\pm 2.2\%$ |
| | | Y | 2.45 | 70.4 | 12.9 | | 130.3 | |
| | | Z | 80.83 | 99.9 | 19.9 | | 135.1 | |
| 10032-CAA | IEEE 802.15.1 Bluetooth (GFSK, DH5) | X | 0.32 | 58.4 | 4.3 | 1.16 | 144.1 | $\pm 1.9\%$ |
| | | Y | 16.25 | 79.9 | 12.1 | | 129.5 | |
| | | Z | 95.90 | 91.1 | 14.4 | | 134.6 | |
| 10100-CAB | LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 6.32 | 67.4 | 19.8 | 5.67 | 138.3 | $\pm 1.4\%$ |
| | | Y | 6.35 | 67.3 | 19.5 | | 144.4 | |
| | | Z | 6.20 | 67.1 | 19.6 | | 127.7 | |

| | | | | | | | | |
|-----------|--|---|-------|------|------|------|-------|--------|
| 10103-CAB | LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 8.72 | 73.1 | 25.3 | 9.29 | 138.6 | ±2.7 % |
| | | Y | 8.88 | 72.9 | 24.9 | | 147.9 | |
| | | Z | 8.48 | 72.3 | 24.9 | | 127.4 | |
| 10108-CAC | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 6.14 | 66.9 | 19.6 | 5.80 | 136.2 | ±1.7 % |
| | | Y | 6.20 | 66.8 | 19.4 | | 142.8 | |
| | | Z | 6.10 | 66.8 | 19.6 | | 126.2 | |
| 10117-CAB | IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK) | X | 10.05 | 68.9 | 21.4 | 8.07 | 126.8 | ±2.2 % |
| | | Y | 9.98 | 68.5 | 21.1 | | 132.4 | |
| | | Z | 10.23 | 69.4 | 21.7 | | 140.4 | |
| 10151-CAB | LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK) | X | 8.16 | 72.2 | 25.0 | 9.28 | 133.6 | ±2.7 % |
| | | Y | 8.33 | 72.0 | 24.5 | | 142.6 | |
| | | Z | 8.40 | 73.1 | 25.6 | | 147.5 | |
| 10154-CAC | LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK) | X | 5.83 | 66.5 | 19.4 | 5.75 | 133.1 | ±1.4 % |
| | | Y | 5.89 | 66.3 | 19.2 | | 139.3 | |
| | | Z | 6.00 | 67.2 | 19.9 | | 146.5 | |
| 10160-CAB | LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK) | X | 6.26 | 66.9 | 19.6 | 5.82 | 138.8 | ±1.7 % |
| | | Y | 6.34 | 67.0 | 19.5 | | 145.1 | |
| | | Z | 6.22 | 66.9 | 19.7 | | 128.8 | |
| 10169-CAB | LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | X | 4.77 | 66.7 | 19.8 | 5.73 | 135.9 | ±1.4 % |
| | | Y | 4.89 | 66.6 | 19.5 | | 141.8 | |
| | | Z | 4.85 | 66.8 | 19.9 | | 128.3 | |
| 10172-CAB | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | X | 6.77 | 75.0 | 26.9 | 9.21 | 144.2 | ±2.5 % |
| | | Y | 6.56 | 72.6 | 25.2 | | 131.1 | |
| | | Z | 6.68 | 74.0 | 26.4 | | 137.1 | |
| 10175-CAC | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | X | 4.80 | 66.9 | 19.9 | 5.72 | 135.2 | ±1.4 % |
| | | Y | 4.87 | 66.5 | 19.5 | | 140.6 | |
| | | Z | 5.03 | 67.7 | 20.4 | | 149.4 | |
| 10181-CAB | LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK) | X | 4.77 | 66.7 | 19.8 | 5.72 | 134.7 | ±1.2 % |
| | | Y | 4.88 | 66.5 | 19.5 | | 140.6 | |
| | | Z | 4.84 | 66.8 | 19.9 | | 127.8 | |
| 10196-CAB | IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK) | X | 9.97 | 69.5 | 21.9 | 8.10 | 145.2 | ±2.2 % |
| | | Y | 9.60 | 68.2 | 21.0 | | 125.1 | |
| | | Z | 9.80 | 69.1 | 21.7 | | 133.9 | |
| 10225-CAB | UMTS-FDD (HSPA+) | X | 6.95 | 67.5 | 19.8 | 5.97 | 147.3 | ±1.4 % |
| | | Y | 6.73 | 66.4 | 19.1 | | 128.7 | |
| | | Z | 6.89 | 67.4 | 19.8 | | 137.2 | |
| 10237-CAB | LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | X | 6.85 | 75.4 | 27.2 | 9.21 | 146.0 | ±2.5 % |
| | | Y | 6.54 | 72.5 | 25.1 | | 131.6 | |
| | | Z | 6.76 | 74.4 | 26.6 | | 138.2 | |
| 10252-CAB | LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK) | X | 7.58 | 71.3 | 24.6 | 9.24 | 126.6 | ±2.5 % |
| | | Y | 7.73 | 71.1 | 24.2 | | 133.3 | |
| | | Z | 7.82 | 72.4 | 25.3 | | 139.0 | |
| 10267-CAB | LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 8.18 | 72.2 | 25.1 | 9.30 | 133.6 | ±2.7 % |
| | | Y | 8.35 | 72.0 | 24.6 | | 141.1 | |
| | | Z | 8.42 | 73.2 | 25.6 | | 147.0 | |

| | | | | | | | | |
|-----------|---|---|-------|------|------|------|-------|--------|
| 10275-CAB | UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4) | X | 4.22 | 66.1 | 18.4 | 3.96 | 128.8 | ±0.9 % |
| | | Y | 4.24 | 65.9 | 18.1 | | 133.8 | |
| | | Z | 4.39 | 67.1 | 19.0 | | 141.7 | |
| 10291-AAB | CDMA2000, RC3, SO55, Full Rate | X | 3.51 | 66.7 | 18.6 | 3.46 | 140.9 | ±0.7 % |
| | | Y | 3.52 | 66.2 | 18.1 | | 143.4 | |
| | | Z | 3.58 | 67.2 | 19.0 | | 131.7 | |
| 10292-AAB | CDMA2000, RC3, SO32, Full Rate | X | 3.45 | 66.7 | 18.5 | 3.39 | 142.0 | ±0.7 % |
| | | Y | 3.50 | 66.4 | 18.2 | | 146.9 | |
| | | Z | 3.61 | 67.8 | 19.3 | | 132.2 | |
| 10297-AAA | LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK) | X | 6.15 | 66.9 | 19.6 | 5.81 | 136.3 | ±1.4 % |
| | | Y | 6.20 | 66.8 | 19.4 | | 140.3 | |
| | | Z | 6.11 | 66.8 | 19.6 | | 126.6 | |
| 10311-AAA | LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK) | X | 6.80 | 67.8 | 20.1 | 6.06 | 143.2 | ±1.7 % |
| | | Y | 6.80 | 67.5 | 19.9 | | 147.4 | |
| | | Z | 6.71 | 67.6 | 20.1 | | 131.9 | |
| 10400-AAB | IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle) | X | 10.31 | 70.0 | 22.4 | 8.37 | 147.9 | ±3.0 % |
| | | Y | 9.88 | 68.5 | 21.3 | | 127.2 | |
| | | Z | 10.13 | 69.5 | 22.1 | | 135.8 | |
| 10403-AAB | CDMA2000 (1xEV-DO, Rev. 0) | X | 4.60 | 68.6 | 18.9 | 3.76 | 128.2 | ±0.5 % |
| | | Y | 4.58 | 67.9 | 18.4 | | 134.2 | |
| | | Z | 4.86 | 69.6 | 19.5 | | 142.6 | |
| 10404-AAB | CDMA2000 (1xEV-DO, Rev. A) | X | 4.57 | 68.9 | 19.1 | 3.77 | 149.7 | ±0.5 % |
| | | Y | 4.51 | 68.0 | 18.5 | | 132.3 | |
| | | Z | 4.78 | 69.6 | 19.5 | | 140.3 | |
| 10415-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle) | X | 2.47 | 67.0 | 17.9 | 1.54 | 128.1 | ±0.7 % |
| | | Y | 2.46 | 66.4 | 17.4 | | 132.5 | |
| | | Z | 2.72 | 69.1 | 19.2 | | 140.6 | |
| 10416-AAA | IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle) | X | 10.12 | 69.7 | 22.1 | 8.23 | 146.8 | ±2.7 % |
| | | Y | 9.66 | 68.2 | 21.1 | | 125.0 | |
| | | Z | 9.91 | 69.2 | 21.8 | | 134.3 | |

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%.

^A The uncertainties of NormX,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Pages 7 and 8).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750 | 41.9 | 0.89 | 6.34 | 6.34 | 6.34 | 0.29 | 2.02 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 6.04 | 6.04 | 6.04 | 0.23 | 2.57 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 5.23 | 5.23 | 5.23 | 0.80 | 1.08 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 5.05 | 5.05 | 5.05 | 0.10 | 2.40 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 4.76 | 4.76 | 4.76 | 0.70 | 1.27 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 4.53 | 4.53 | 4.53 | 0.80 | 1.22 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 4.36 | 4.36 | 4.36 | 0.75 | 1.31 | ± 12.0 % |

^C 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

Calibration Parameter Determined in Body Tissue Simulating Media

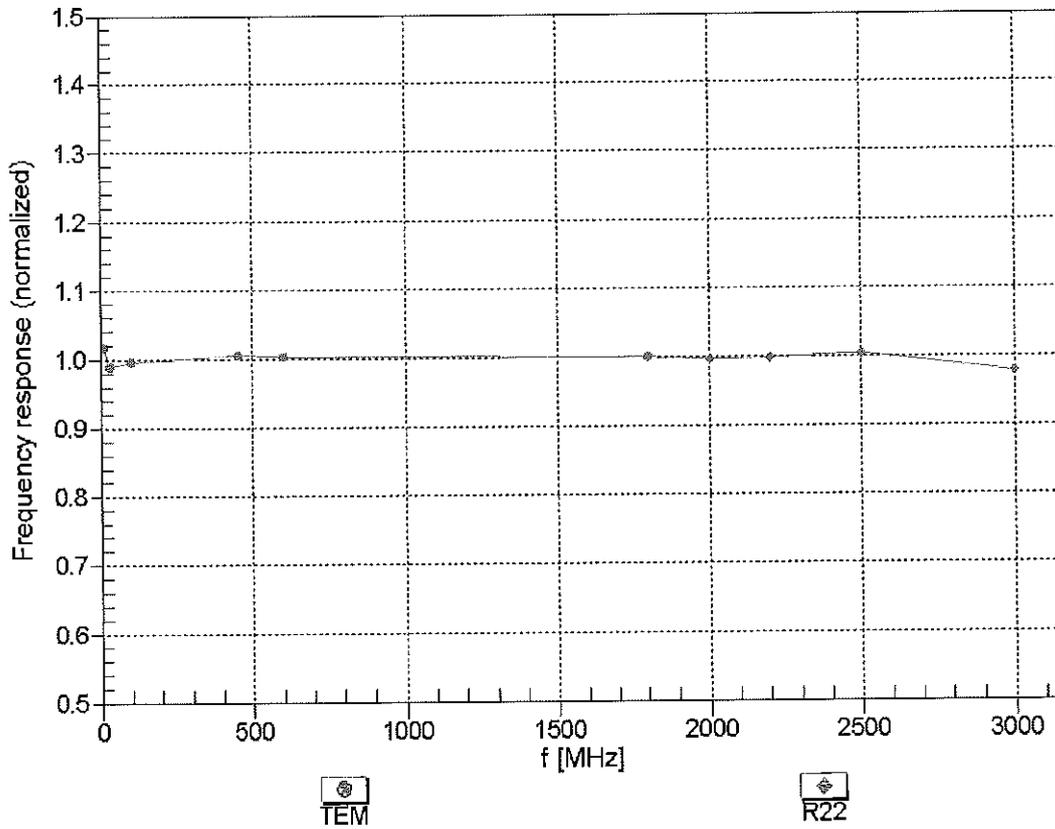
| f (MHz) ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth (mm) ^G | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750 | 55.5 | 0.96 | 6.12 | 6.12 | 6.12 | 0.34 | 1.81 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 6.07 | 6.07 | 6.07 | 0.37 | 1.79 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 4.86 | 4.86 | 4.86 | 0.67 | 1.43 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 4.57 | 4.57 | 4.57 | 0.57 | 1.53 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 4.28 | 4.28 | 4.28 | 0.80 | 1.19 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 4.12 | 4.12 | 4.12 | 0.72 | 1.15 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 3.92 | 3.92 | 3.92 | 0.80 | 1.10 | ± 12.0 % |

^C 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.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G 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.

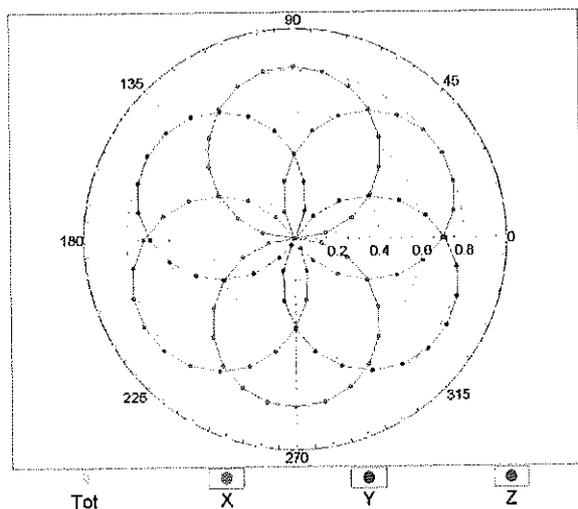
Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)



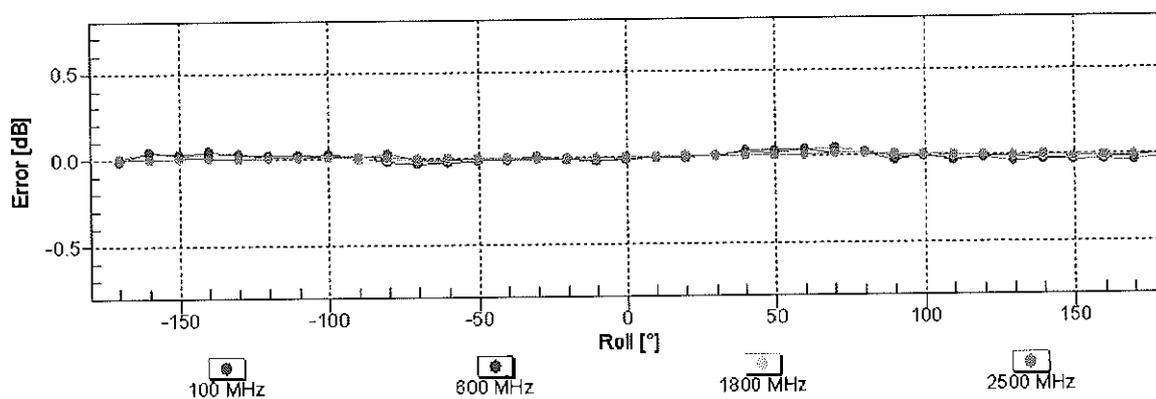
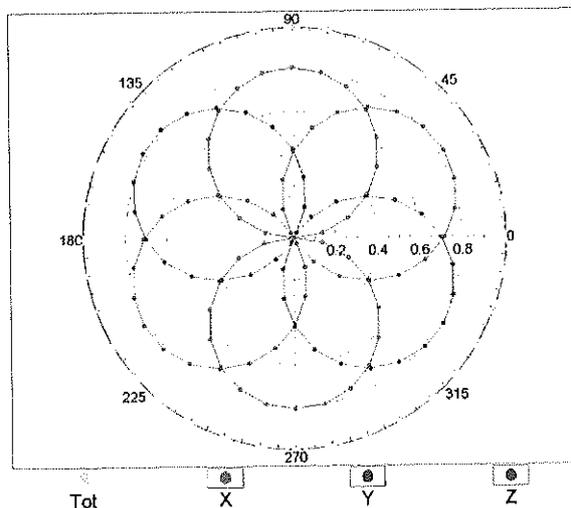
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

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

f=600 MHz, TEM

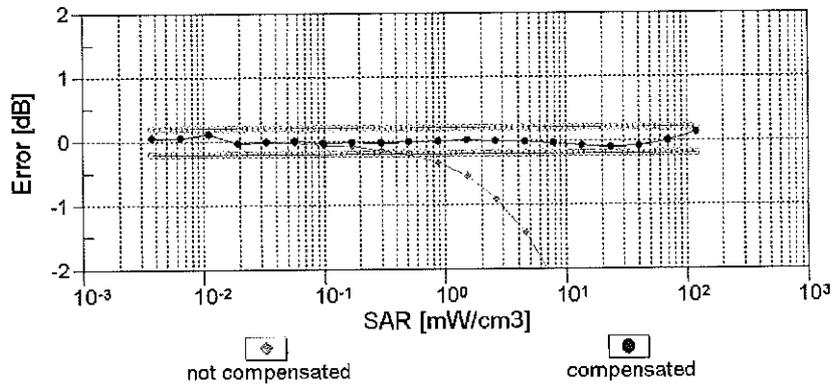
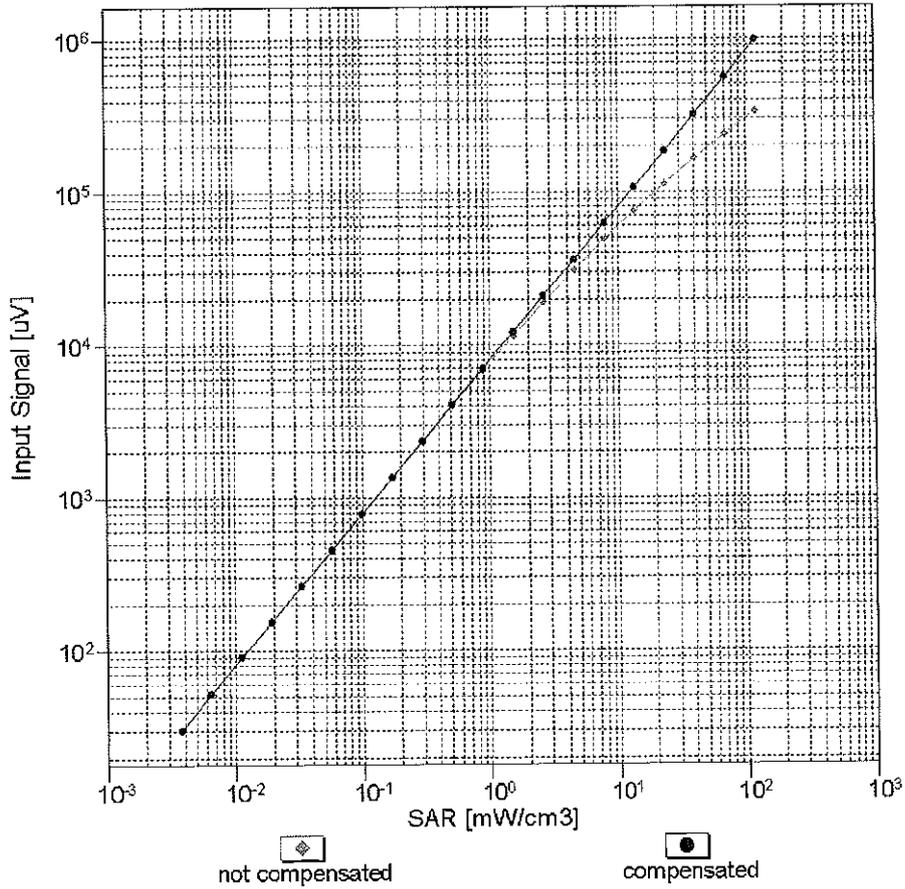


f=1800 MHz, R22



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

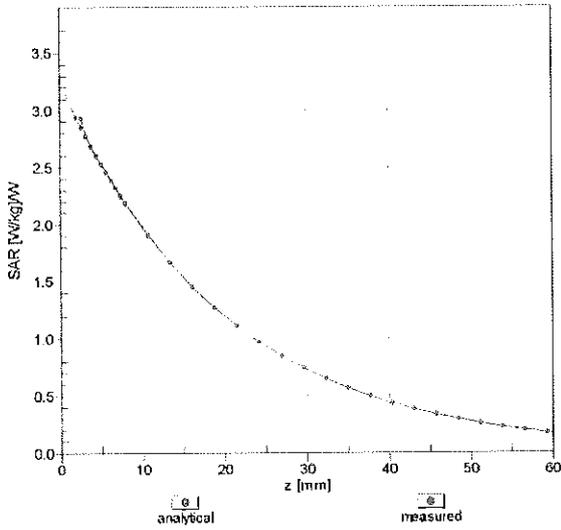
Dynamic Range $f(SAR_{head})$ (TEM cell , $f_{eval}= 1900$ MHz)



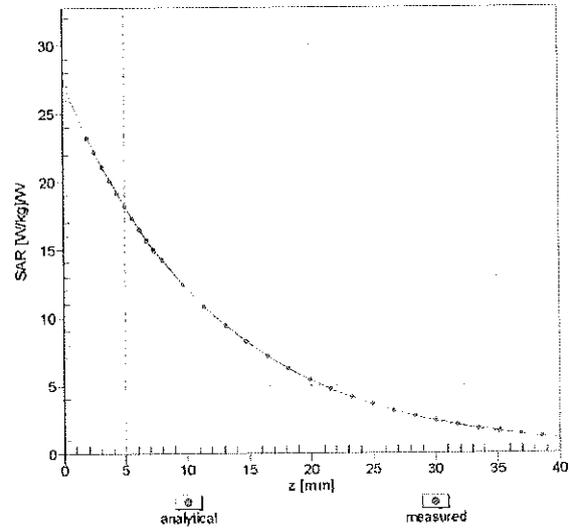
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment

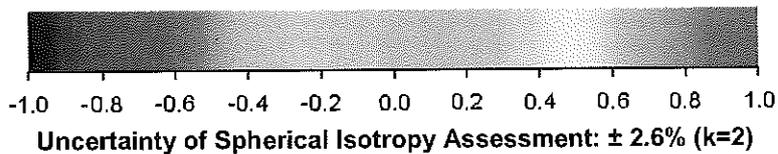
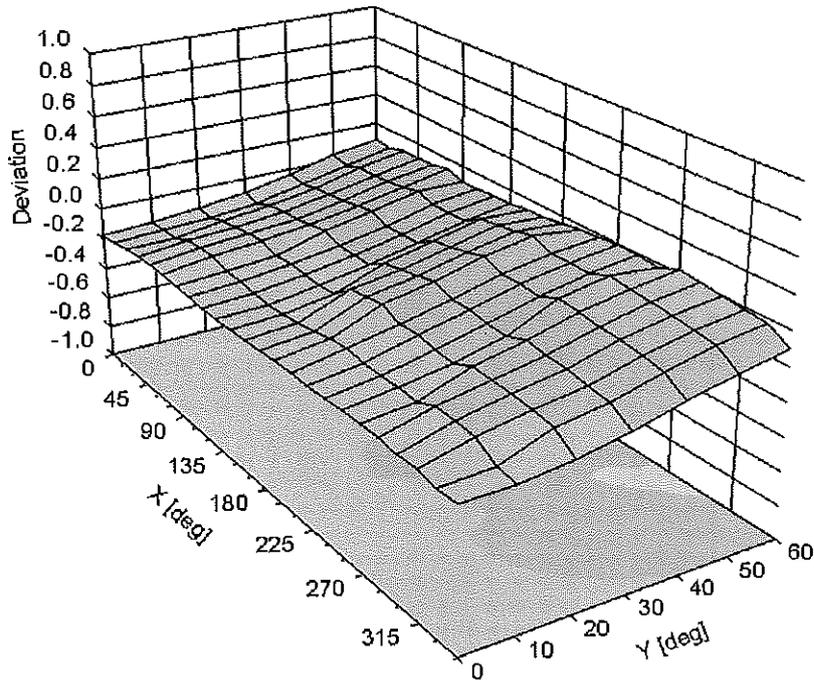
f = 835 MHz, WGLS R9 (H_convF)



f = 1900 MHz, WGLS R22 (H_convF)



Deviation from Isotropy in Liquid Error (ϕ, θ), f = 900 MHz



DASY/EASY - Parameters of Probe: ES3DV3 - SN:3209

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | -40.3 |
| 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 | 4 mm |
| Probe Tip to Sensor X Calibration Point | 2 mm |
| Probe Tip to Sensor Y Calibration Point | 2 mm |
| Probe Tip to Sensor Z Calibration Point | 2 mm |
| Recommended Measurement Distance from Surface | 3 mm |

APPENDIX D: SAR TISSUE SPECIFICATIONS

Measurement Procedure for Tissue verification:

- 1) The network analyzer and probe system was configured and calibrated.
- 2) The probe was immersed in the tissue. The tissue was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
- 3) The complex admittance with respect to the probe aperture was measured
- 4) The complex relative permittivity ϵ can be calculated from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\epsilon_r\epsilon_0}{[\ln(b/a)]^2} \int_a^b \int_a^b \int_0^\pi \cos\phi' \frac{\exp[-j\omega r(\mu_0\epsilon_r'\epsilon_0)^{1/2}]}{r} d\phi' d\rho' d\rho$$

where Y is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho' \cos\phi'$, ω is the angular frequency, and $j = \sqrt{-1}$.

Table D-I
Composition of the Tissue Equivalent Matter

| Frequency (MHz) | 750 | 750 | 835 | 835 | 1750 | 1750 | 1900 | 1900 | 2450 | 2450 | 5200-5800 | 5200-5800 |
|---------------------------|--------------|------------|-------|-------|------|------|-------|-------|------------|------|------------|-----------|
| Tissue | Head | Body | Head | Body | Head | Body | Head | Body | Head | Body | Head | Body |
| Ingredients (% by weight) | | | | | | | | | | | | |
| Bactericide | See page 2-3 | See page 2 | 0.1 | 0.1 | | | | | See page 4 | | See page 5 | |
| DGBE | | | | | 47 | 31 | 44.92 | 29.44 | | 26.7 | | |
| HEC | | | 1 | 1 | | | | | | | | |
| NaCl | | | 1.45 | 0.94 | 0.4 | 0.2 | 0.18 | 0.39 | | | | |
| Sucrose | | | 57 | 44.9 | | | | | | | | |
| Polysorbate (Tween) 80 | | | | | | | | | | | | 20 |
| Water | | | 40.45 | 53.06 | 52.6 | 68.8 | 54.9 | 70.17 | | 73.2 | | 80 |

| | | | | |
|---|--|------------------------------|--|--|
| FCC ID: ZNFH830 | PCTEST <small>ENGINEERING LABORATORY, INC.</small> | SAR EVALUATION REPORT | | Reviewed by: Quality Manager |
| Test Dates: 01/18/16 – 03/03/16 | DUT Type: Portable Handset | | | APPENDIX D: Page 1 of 5 |

2 Composition / Information on ingredients

The Item is composed of the following ingredients:

| | |
|------------------------|---|
| H ₂ O | Water, 35 – 58% |
| Sucrose | Sugar, white, refined, 40 – 60% |
| NaCl | Sodium Chloride, 0 – 6% |
| Hydroxyethyl-cellulose | Medium Viscosity (CAS# 9004-62-0), <0.3% |
| Preventol-D7 | Preservative: aqueous preparation, (CAS# 55965-84-9), containing 5-chloro-2-methyl-3(2H)-isothiazolone and 2-methyl-3(2H)-isothiazolone, 0.1 – 0.7% |

Relevant for safety; Refer to the respective Safety Data Sheet*.

Figure D-1
Composition of 750 MHz Head and Body Tissue Equivalent Matter

Note: 750MHz liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

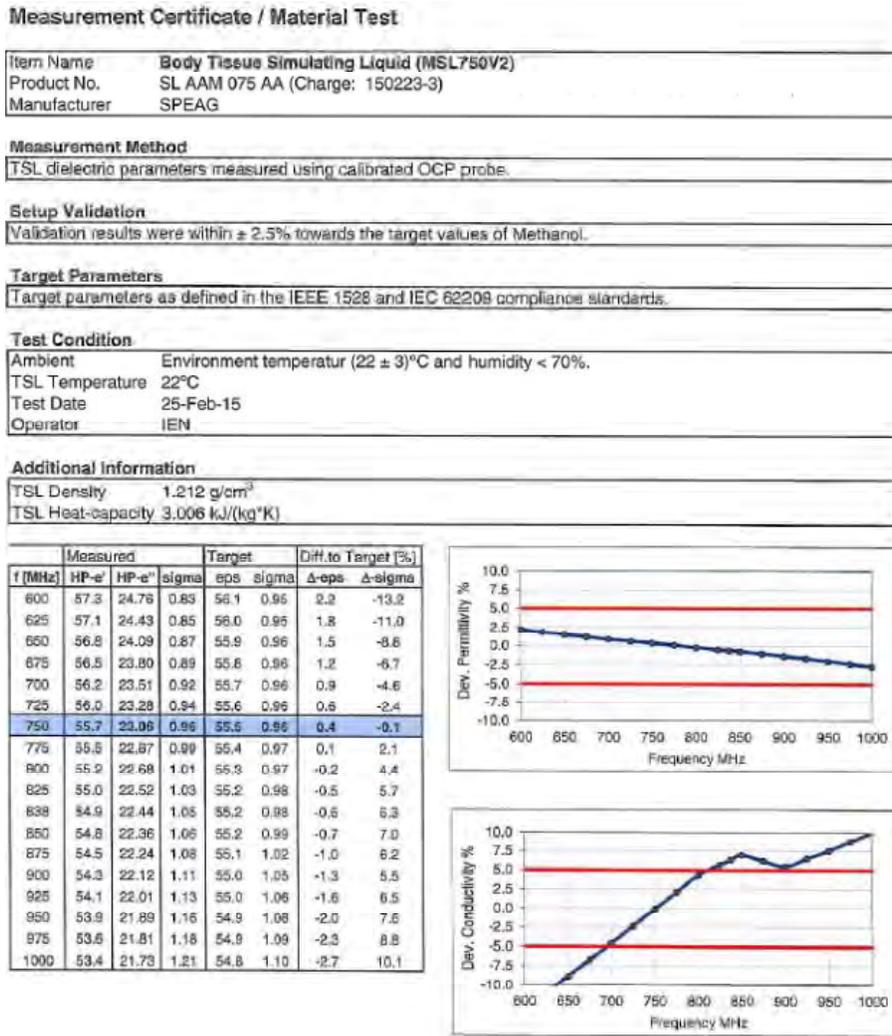


Figure D-2
750MHz Body Tissue Equivalent Matter

| | | | | |
|------------------------------------|--|-----------------------|----|---------------------------------|
| FCC ID: ZNFH830 | PCTEST Engineering Laboratory, Inc. | SAR EVALUATION REPORT | LG | Reviewed by: Quality Manager |
| Test Dates: 01/18/16 – 03/03/16 | DUT Type: Portable Handset | | | APPENDIX D: Page 2 of 5 |

Measurement Certificate / Material Test

| | |
|--------------|--|
| Item Name | Head Tissue Simulating Liquid (HSL750V2) |
| Product No. | SL AAH 075 AA (Charge: 150213-1) |
| Manufacturer | SPEAG |

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within $\pm 2.5\%$ towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

Test Condition

| | |
|-----------------|--|
| Ambient | Environment temperatur (22 ± 3)°C and humidity < 70% |
| TSL Temperature | 22°C |
| Test Date | 18-Feb-15 |
| Operator | IEN |

Additional Information

| | |
|-------------------|-------------------------|
| TSL Density | 1.284 g/cm ³ |
| TSL Heat-capacity | 2.701 kJ/(kg*K) |

| f [MHz] | Measured | | | Target | | Diff.to Target [%] | |
|---------|----------|--------|-------|--------|-------|--------------------|-----------------|
| | HP-e' | HP-e'' | sigma | eps | sigma | Δ -eps | Δ -sigma |
| 600 | 44.6 | 22.42 | 0.75 | 42.7 | 0.88 | 4.5 | -15.1 |
| 625 | 44.3 | 22.20 | 0.77 | 42.6 | 0.89 | 3.9 | -12.7 |
| 650 | 43.9 | 21.98 | 0.79 | 42.5 | 0.89 | 3.3 | -10.3 |
| 675 | 43.5 | 21.75 | 0.82 | 42.3 | 0.89 | 2.8 | -8.0 |
| 700 | 43.1 | 21.53 | 0.84 | 42.2 | 0.89 | 2.2 | -5.7 |
| 725 | 42.8 | 21.36 | 0.86 | 42.1 | 0.89 | 1.8 | -3.3 |
| 750 | 42.5 | 21.22 | 0.89 | 41.9 | 0.89 | 1.3 | -0.9 |
| 775 | 42.2 | 21.06 | 0.91 | 41.8 | 0.90 | 0.9 | 1.4 |
| 800 | 41.8 | 20.90 | 0.93 | 41.7 | 0.90 | 0.3 | 3.7 |
| 825 | 41.5 | 20.77 | 0.95 | 41.6 | 0.91 | -0.2 | 5.1 |
| 838 | 41.4 | 20.71 | 0.96 | 41.5 | 0.91 | -0.4 | 5.8 |
| 850 | 41.2 | 20.65 | 0.98 | 41.5 | 0.92 | -0.7 | 6.6 |
| 875 | 40.9 | 20.53 | 1.00 | 41.5 | 0.94 | -1.4 | 6.0 |
| 900 | 40.6 | 20.42 | 1.02 | 41.5 | 0.97 | -2.1 | 5.4 |
| 925 | 40.4 | 20.32 | 1.05 | 41.5 | 0.98 | -2.6 | 6.5 |
| 950 | 40.1 | 20.22 | 1.07 | 41.4 | 0.99 | -3.2 | 7.5 |
| 975 | 39.8 | 20.14 | 1.09 | 41.4 | 1.00 | -3.8 | 8.7 |
| 1000 | 39.5 | 20.05 | 1.12 | 41.3 | 1.01 | -4.3 | 9.9 |

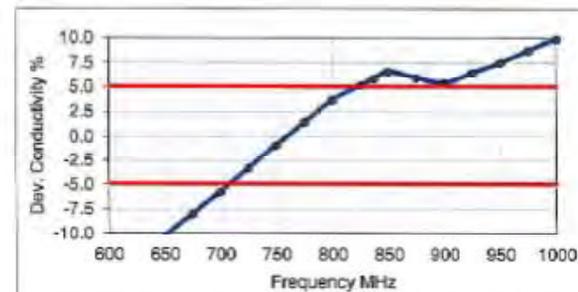
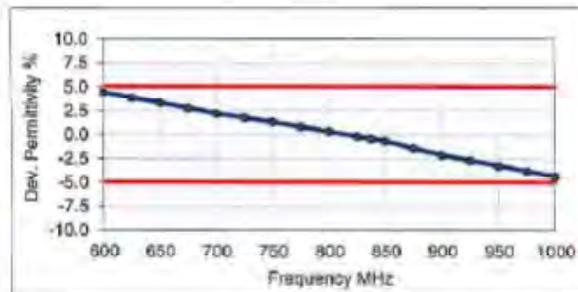


Figure D-3
750MHz Head Tissue Equivalent Matter

| | | | | |
|------------------------------------|---|-----------------------|---|---------------------------------|
| FCC ID: ZNFH830 |  | SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 01/18/16 – 03/03/16 | DUT Type: Portable Handset | | | APPENDIX D: Page 3 of 5 |

2 Composition / Information on ingredients

The Item is composed of the following ingredients:

| | |
|---|---|
| H ₂ O | Water, 52 – 75% |
| C ₈ H ₁₈ O ₃ | Diethylene glycol monobutyl ether (DGBE), 25 – 48% (CAS-No. 112-34-5, EC-No. 203-961-6, EC-index-No. 603-096-00-8) Relevant for safety; Refer to the respective Safety Data Sheet*. |
| NaCl | Sodium Chloride, <1.0% |

Figure D-4
Composition of 2.4 GHz Head Tissue Equivalent Matter

Note: 2.4 GHz head liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

Measurement Certificate / Material Test

| | |
|---|---|
| Item Name | Head Tissue Simulating Liquid (HSL2450V2) |
| Product No. | SL AAH 245 BA (Charge: 150206-3) |
| Manufacturer | SPEAG |
| Measurement Method | |
| TSL dielectric parameters measured using calibrated OCP probe. | |
| Setup Validation | |
| Validation results were within ± 2.5% towards the target values of Methanol. | |
| Target Parameters | |
| Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards. | |
| Test Condition | |
| Ambient: | Environment temperatur (22 ± 3)°C and humidity < 70%. |
| TSL Temperature | 23°C |
| Test Date | 11-Feb-15 |
| Operator | IEH |
| Additional Information | |
| TSL Density | 0.988 g/cm ³ |
| TSL Heat-capacity | 3.680 kJ/(kg*K) |

| f (MHz) | Measured | | | Target | | Diff to Target (%) | |
|---------|----------|--------|-------|--------|-------|--------------------|---------|
| | HP-e' | HP-e'' | sigma | eps | sigma | A-eps | Δ-sigma |
| 1900 | 40.4 | 11.89 | 1.26 | 40.0 | 1.40 | 1.0 | -10.2 |
| 1925 | 40.3 | 11.98 | 1.28 | 40.0 | 1.40 | 0.7 | -8.3 |
| 1950 | 40.2 | 12.07 | 1.31 | 40.0 | 1.40 | 0.4 | -6.4 |
| 1975 | 40.1 | 12.15 | 1.34 | 40.0 | 1.40 | 0.2 | -4.6 |
| 2000 | 40.0 | 12.23 | 1.36 | 40.0 | 1.40 | -0.1 | -2.8 |
| 2025 | 39.9 | 12.32 | 1.39 | 40.0 | 1.42 | -0.2 | -2.4 |
| 2050 | 39.8 | 12.41 | 1.42 | 39.9 | 1.44 | -0.9 | -9.6 |
| 2075 | 39.7 | 12.50 | 1.44 | 39.9 | 1.47 | -0.4 | -1.6 |
| 2100 | 39.6 | 12.59 | 1.47 | 39.8 | 1.49 | -0.5 | -1.2 |
| 2125 | 39.5 | 12.66 | 1.50 | 39.8 | 1.51 | -0.7 | -0.9 |
| 2150 | 39.4 | 12.73 | 1.52 | 39.7 | 1.53 | -0.8 | -0.7 |
| 2175 | 39.3 | 12.83 | 1.55 | 39.7 | 1.56 | -0.9 | -0.2 |
| 2200 | 39.2 | 12.92 | 1.58 | 39.6 | 1.58 | -1.1 | 0.2 |
| 2225 | 39.1 | 13.00 | 1.61 | 39.6 | 1.60 | -1.2 | 0.6 |
| 2250 | 39.0 | 13.08 | 1.64 | 39.6 | 1.62 | -1.3 | 0.5 |
| 2275 | 38.9 | 13.17 | 1.67 | 39.5 | 1.64 | -1.5 | 1.4 |
| 2300 | 38.8 | 13.26 | 1.70 | 38.5 | 1.67 | -1.7 | 1.8 |
| 2325 | 38.7 | 13.34 | 1.73 | 39.4 | 1.69 | -1.8 | 2.2 |
| 2350 | 38.6 | 13.42 | 1.75 | 39.4 | 1.71 | -2.0 | 2.5 |
| 2375 | 38.5 | 13.50 | 1.78 | 39.3 | 1.73 | -2.1 | 2.9 |
| 2400 | 38.4 | 13.58 | 1.81 | 39.3 | 1.76 | -2.3 | 3.3 |
| 2425 | 38.3 | 13.65 | 1.84 | 39.2 | 1.78 | -2.4 | 3.6 |
| 2450 | 38.2 | 13.73 | 1.87 | 39.2 | 1.80 | -2.6 | 3.9 |
| 2475 | 38.1 | 13.80 | 1.90 | 39.2 | 1.83 | -2.8 | 4.0 |
| 2500 | 38.0 | 13.87 | 1.93 | 39.1 | 1.85 | -3.0 | 4.0 |
| 2525 | 37.9 | 13.90 | 1.95 | 39.1 | 1.88 | -3.1 | 3.8 |
| 2550 | 37.8 | 13.93 | 1.98 | 39.1 | 1.91 | -3.2 | 3.5 |
| 2575 | 37.7 | 14.05 | 2.01 | 39.0 | 1.94 | -3.5 | 4.0 |
| 2600 | 37.6 | 14.17 | 2.05 | 38.0 | 1.96 | -3.7 | 4.4 |
| 2625 | 37.4 | 14.23 | 2.08 | 39.0 | 1.99 | -3.9 | 4.4 |
| 2650 | 37.3 | 14.29 | 2.11 | 38.9 | 2.02 | -4.1 | 4.4 |
| 2675 | 37.2 | 14.37 | 2.14 | 38.9 | 2.05 | -4.3 | 4.6 |
| 2700 | 37.1 | 14.45 | 2.17 | 38.9 | 2.07 | -4.5 | 4.7 |

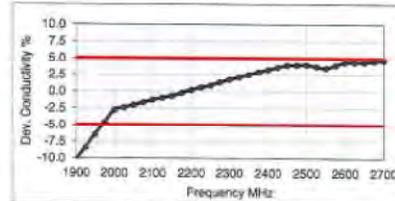
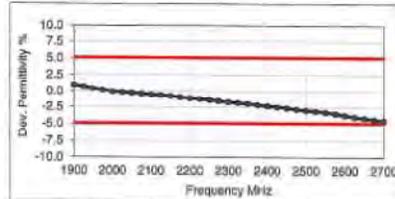


Figure D-5
2.4 GHz Head Tissue Equivalent Matter

| | | | | |
|------------------------------------|---|-----------------------|---|---------------------------------|
| FCC ID: ZNFH830 |  | SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 01/18/16 – 03/03/16 | DUT Type: Portable Handset | | | APPENDIX D: Page 4 of 5 |

2 Composition / Information on ingredients

The Item is composed of the following ingredients:

| | |
|-------------|----------|
| Water | 50 – 65% |
| Mineral oil | 10 – 30% |
| Emulsifiers | 8 – 25% |
| Sodium salt | 0 – 1.5% |

Figure D-6
Composition of 5 GHz Head Tissue Equivalent Matter

Note: 5GHz head liquid recipes are proprietary SPEAG. Since the composition is approximate to the actual liquids utilized, the manufacturer tissue-equivalent liquid data sheets are provided below.

Measurement Certificate / Material Test

| | |
|--------------|---|
| Item Name | Head Tissue Simulating Liquid (HBBL3500-5800V5) |
| Product No. | SL AAH 502 AE (Charge: 141104-1) |
| Manufacturer | SPEAG |

Measurement Method

TSL dielectric parameters measured using calibrated OCP probe.

Setup Validation

Validation results were within $\pm 2.5\%$ towards the target values of Methanol.

Target Parameters

Target parameters as defined in the IEEE 1528 and IEC 62209 compliance standards.

Test Condition

Ambient Environment temperatur (22 ± 3)°C and humidity < 70%.
 TSL Temperature 22°C
 Test Date 25-Feb-15
 Operator IEN

Additional Information

TSL Density 0.985 g/cm³
 TSL Heat-capacity 3.383 kJ/(kg*K)

| f [MHz] | Measured HP-e' | HP-e'' | sigma | eps | sigma | Delta-eps | Delta-sigma | Diff.to Target [%] |
|---------|----------------|--------|-------|------|-------|-----------|-------------|--------------------|
| 3400 | 38.5 | 15.11 | 2.86 | 38.0 | 2.81 | 1.2 | 1.8 | |
| 3500 | 38.4 | 15.08 | 2.94 | 37.9 | 2.91 | 1.2 | 0.9 | |
| 3600 | 38.2 | 15.07 | 3.02 | 37.8 | 3.02 | 1.0 | 0.2 | |
| 3700 | 38.1 | 15.05 | 3.10 | 37.7 | 3.12 | 1.1 | -0.6 | |
| 3800 | 38.0 | 15.04 | 3.18 | 37.6 | 3.22 | 1.1 | -1.2 | |
| 3900 | 37.9 | 15.05 | 3.27 | 37.5 | 3.32 | 1.1 | -1.6 | |
| 4000 | 37.8 | 15.07 | 3.35 | 37.4 | 3.43 | 1.2 | -2.2 | |
| 4100 | 37.6 | 15.09 | 3.44 | 37.2 | 3.53 | 1.0 | -2.5 | |
| 4200 | 37.5 | 15.14 | 3.54 | 37.1 | 3.63 | 1.0 | -2.5 | |
| 4300 | 37.4 | 15.18 | 3.63 | 37.0 | 3.73 | 1.0 | -2.7 | |
| 4400 | 37.3 | 15.24 | 3.73 | 36.9 | 3.84 | 1.1 | -2.7 | |
| 4500 | 37.1 | 15.29 | 3.83 | 36.8 | 3.94 | 0.9 | -2.7 | |
| 4600 | 37.0 | 15.37 | 3.93 | 36.7 | 4.04 | 0.9 | -2.7 | |
| 4700 | 36.8 | 15.42 | 4.03 | 36.6 | 4.14 | 0.7 | -2.7 | |
| 4800 | 36.7 | 15.47 | 4.13 | 36.4 | 4.25 | 0.7 | -2.7 | |
| 4850 | 36.6 | 15.50 | 4.18 | 36.4 | 4.30 | 0.6 | -2.7 | |
| 4900 | 36.5 | 15.54 | 4.24 | 36.3 | 4.35 | 0.5 | -2.5 | |
| 4950 | 36.5 | 15.55 | 4.28 | 36.3 | 4.40 | 0.6 | -2.7 | |
| 5000 | 36.4 | 15.59 | 4.34 | 36.2 | 4.45 | 0.5 | -2.5 | |
| 5050 | 36.3 | 15.62 | 4.39 | 36.2 | 4.50 | 0.4 | -2.5 | |
| 5100 | 36.2 | 15.66 | 4.44 | 36.1 | 4.55 | 0.3 | -2.5 | |
| 5150 | 36.2 | 15.67 | 4.48 | 36.0 | 4.60 | 0.4 | -2.5 | |
| 5200 | 36.1 | 15.71 | 4.55 | 36.0 | 4.68 | 0.3 | -2.3 | |
| 5250 | 36.0 | 15.73 | 4.59 | 35.9 | 4.71 | 0.2 | -2.5 | |
| 5300 | 35.9 | 15.76 | 4.65 | 35.9 | 4.76 | 0.1 | -2.3 | |
| 5350 | 35.9 | 15.78 | 4.70 | 35.8 | 4.81 | 0.2 | -2.3 | |
| 5400 | 35.8 | 15.81 | 4.75 | 35.8 | 4.86 | 0.1 | -2.3 | |
| 5450 | 35.7 | 15.82 | 4.80 | 35.7 | 4.91 | 0.0 | -2.3 | |
| 5500 | 35.6 | 15.84 | 4.85 | 35.6 | 4.96 | -0.1 | -2.3 | |
| 5550 | 35.6 | 15.87 | 4.90 | 35.6 | 5.01 | 0.0 | -2.3 | |
| 5600 | 35.5 | 15.90 | 4.95 | 35.5 | 5.07 | -0.1 | -2.3 | |
| 5650 | 35.4 | 15.94 | 5.01 | 35.5 | 5.12 | -0.2 | -2.1 | |
| 5700 | 35.4 | 15.96 | 5.06 | 35.4 | 5.17 | 0.0 | -2.1 | |
| 5750 | 35.3 | 16.00 | 5.12 | 35.4 | 5.22 | -0.2 | -1.9 | |
| 5800 | 35.2 | 16.01 | 5.16 | 35.3 | 5.27 | -0.3 | -2.1 | |
| 5850 | 35.1 | 16.04 | 5.22 | 35.3 | 5.34 | -0.6 | -2.2 | |
| 5900 | 35.1 | 16.06 | 5.27 | 35.3 | 5.40 | -0.6 | -2.4 | |

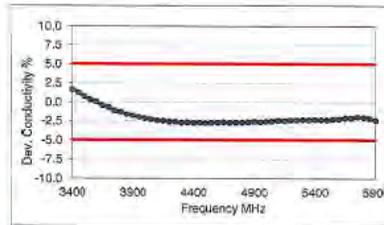
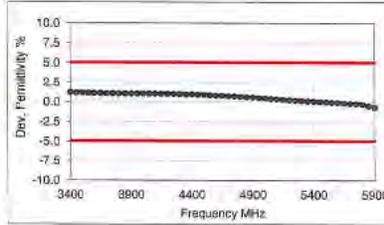


Figure D-7
5GHz Head Tissue Equivalent Matter

| | | | | |
|------------------------------------|---|-----------------------|---|---------------------------------|
| FCC ID: ZNFH830 |  | SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 01/18/16 – 03/03/16 | DUT Type: Portable Handset | | | APPENDIX D: Page 5 of 5 |

APPENDIX E: SAR SYSTEM VALIDATION

Per FCC KDB Publication 865664 D02v01r02, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in FCC KDB Publication 865664 D01v01r04 and IEEE 1528-2013. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

Table E-I
SAR System Validation Summary – 1g

| SAR SYSTEM # | FREQ. [MHz] | DATE | PROBE SN | PROBE TYPE | PROBE CAL. POINT | | COND. | PERM. | CW VALIDATION | | | MOD. VALIDATION | | |
|--------------|-------------|------------|----------|------------|------------------|------|-------|-------------------|---------------|-----------------|----------------|-----------------|-------------|------|
| | | | | | | | (σ) | (ε _r) | SENSITIVITY | PROBE LINEARITY | PROBE ISOTROPY | MOD. TYPE | DUTY FACTOR | PAR |
| K | 750 | 9/17/2015 | 3022 | ES3DV2 | 750 | Head | 0.894 | 42.461 | PASS | PASS | PASS | N/A | N/A | N/A |
| G | 835 | 11/28/2015 | 3334 | ES3DV3 | 835 | Head | 0.923 | 41.629 | PASS | PASS | PASS | GMSK | PASS | N/A |
| G | 1750 | 12/2/2015 | 3334 | ES3DV3 | 1750 | Head | 1.362 | 39.189 | PASS | PASS | PASS | N/A | N/A | N/A |
| D | 1900 | 11/30/2015 | 3209 | ES3DV3 | 1900 | Head | 1.457 | 38.613 | PASS | PASS | PASS | GMSK | PASS | N/A |
| H | 2450 | 7/20/2015 | 3263 | ES3DV3 | 2450 | Head | 1.845 | 38.994 | PASS | PASS | PASS | OFDM/TDD | PASS | PASS |
| E | 5250 | 10/6/2015 | 7308 | EX3DV4 | 5250 | Head | 4.621 | 36.087 | PASS | PASS | PASS | OFDM | N/A | PASS |
| E | 5600 | 10/6/2015 | 7308 | EX3DV4 | 5600 | Head | 4.982 | 35.624 | PASS | PASS | PASS | OFDM | N/A | PASS |
| E | 5750 | 10/6/2015 | 7308 | EX3DV4 | 5750 | Head | 5.151 | 35.406 | PASS | PASS | PASS | OFDM | N/A | PASS |
| D | 5800 | 11/5/2015 | 7357 | EX3DV4 | 5800 | Head | 5.081 | 34.637 | PASS | PASS | PASS | OFDM | N/A | PASS |
| K | 750 | 9/15/2015 | 3022 | ES3DV2 | 750 | Body | 0.950 | 54.166 | PASS | PASS | PASS | N/A | N/A | N/A |
| E | 835 | 9/11/2015 | 3351 | ES3DV3 | 835 | Body | 0.986 | 54.118 | PASS | PASS | PASS | GMSK | PASS | N/A |
| K | 1750 | 9/13/2015 | 3022 | ES3DV2 | 1750 | Body | 1.491 | 52.532 | PASS | PASS | PASS | N/A | N/A | N/A |
| I | 1900 | 11/4/2015 | 3333 | ES3DV3 | 1900 | Body | 1.579 | 51.524 | PASS | PASS | PASS | GMSK | PASS | N/A |
| J | 1900 | 5/18/2015 | 3319 | ES3DV3 | 1900 | Body | 1.576 | 53.321 | PASS | PASS | PASS | GMSK | PASS | N/A |
| J | 2450 | 4/28/2015 | 3319 | ES3DV3 | 2450 | Body | 1.962 | 51.310 | PASS | PASS | PASS | OFDM/TDD | PASS | PASS |
| D | 5300 | 11/9/2015 | 7357 | EX3DV4 | 5300 | Body | 5.568 | 47.186 | PASS | PASS | PASS | OFDM | N/A | PASS |
| D | 5500 | 11/9/2015 | 7357 | EX3DV4 | 5500 | Body | 5.824 | 46.816 | PASS | PASS | PASS | OFDM | N/A | PASS |
| D | 5600 | 11/9/2015 | 7357 | EX3DV4 | 5600 | Body | 5.977 | 46.653 | PASS | PASS | PASS | OFDM | N/A | PASS |
| D | 5800 | 11/9/2015 | 7357 | EX3DV4 | 5800 | Body | 6.257 | 46.285 | PASS | PASS | PASS | OFDM | N/A | PASS |

Table E-II
SAR System Validation Summary – 10g

| SAR SYSTEM # | FREQ. [MHz] | DATE | PROBE SN | PROBE TYPE | PROBE CAL. POINT | | COND. | PERM. | CW VALIDATION | | | MOD. VALIDATION | | |
|--------------|-------------|-----------|----------|------------|------------------|------|-------|-------------------|---------------|-----------------|----------------|-----------------|-------------|-----|
| | | | | | | | (σ) | (ε _r) | SENSITIVITY | PROBE LINEARITY | PROBE ISOTROPY | MOD. TYPE | DUTY FACTOR | PAR |
| I | 750 | 11/5/2015 | 3333 | ES3DV3 | 750 | Body | 0.973 | 54.585 | PASS | PASS | PASS | N/A | N/A | N/A |
| J | 835 | 4/28/2015 | 3319 | ES3DV3 | 835 | Body | 0.992 | 54.192 | PASS | PASS | PASS | GMSK | PASS | N/A |
| I | 835 | 11/3/2015 | 3333 | ES3DV3 | 835 | Body | 1.006 | 54.946 | PASS | PASS | PASS | GMSK | PASS | N/A |
| K | 1750 | 2/10/2016 | 3022 | ES3DV2 | 1750 | Body | 1.484 | 51.369 | PASS | PASS | PASS | N/A | N/A | N/A |
| G | 1900 | 12/3/2015 | 3334 | ES3DV3 | 1900 | Body | 1.552 | 50.709 | PASS | PASS | PASS | GMSK | PASS | N/A |

NOTE: While the probes have been calibrated for both CW and modulated signals, all measurements were performed using communication systems calibrated for CW signals only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01r04 for scenarios when CW probe calibrations are used with other signal types. SAR systems were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (>5 dB), such as OFDM according to FCC KDB Publication 865664 D01v01r04.

| | | | | |
|------------------------------------|---|-----------------------|---|---------------------------------|
| FCC ID: ZNFH830 |  | SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 01/18/16 - 03/03/16 | DUT Type: Portable Handset | | | APPENDIX E: Page 1 of 1 |

APPENDIX G: SENSOR TRIGGERING DATA SUMMARY

ZNFH830 Sensor Triggering Data Summary

Per FCC Guidance, this device was tested by the manufacturer to determine the proximity sensor triggering distances for all applicable sides and edges of the device. The technical descriptions in the filing contain the complete set of triggering data required by the FCC.

When proximity sensor is ON, the antenna switching (ASDiv) is disabled for UMTS/LTE B2/4. Hence, UMTS/LTE B2/4 transmission from the diversity antenna is disabled for held-to-ear conditions.

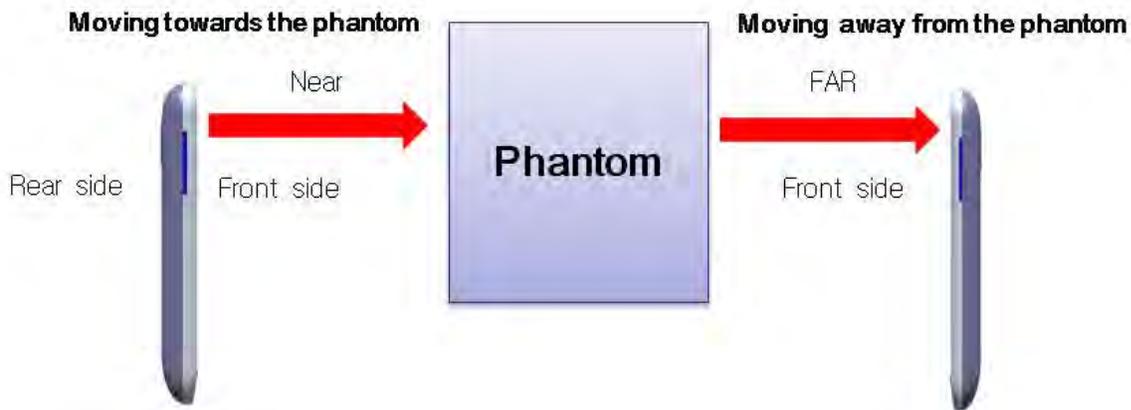
Additionally, when proximity sensor is ON, 2.4 and 5 GHz WIFI will operate at reduced power level during voice or VoIP scenarios. Detailed descriptions of the power reduction mechanism are included in the operational description.

The operational description contains information explaining how this device remains compliant in the event of a sensor malfunction.

| | | |
|---|--|--|
| FCC ID: ZNFH830 |  SAR EVALUATION REPORT  | Reviewed by: Quality Manager |
| Test Dates: 01/18/2016 – 03/03/2016 | DUT Type: Portable Handset | APPENDIX G: Page 1 of 10 |

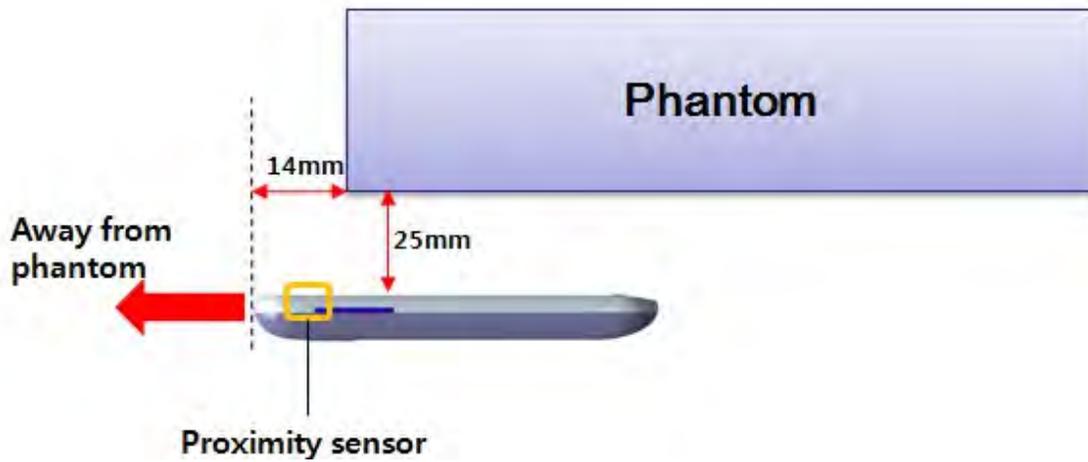
The device was moved towards and away from a flat phantom, parallel to the phantom, according to the tablet proximity sensor procedures in KDB 616217 to determine the triggering distance.

| Distance of DUT front surface to the Phantom (mm) | Proximity Sensor Status - Front side (toward phantom) | Distance of DUT front surface to the Phantom (mm) | Proximity Sensor Status - Front side (away from phantom) |
|---|---|---|--|
| 50 | OFF | 60 | OFF |
| 47 | OFF | 55 | OFF |
| 44 | OFF | 50 | ON |
| 41 | OFF | 40 | ON |
| 38 | OFF | 35 | ON |
| 35 | ON | 30 | ON |
| 32 | ON | 25 | ON |
| 29 | ON | 20 | ON |
| 26 | ON | 15 | ON |
| 20 | ON | 10 | ON |
| 10 | ON | 5 | ON |
| 0 | ON | 0 | ON |



| | | | |
|--|---|---|---------------------------------|
| FCC ID: ZNFH830 |  SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 01/18/2016 – 03/03/2016 | DUT Type: Portable Handset | | APPENDIX G: Page 2 of 10 |

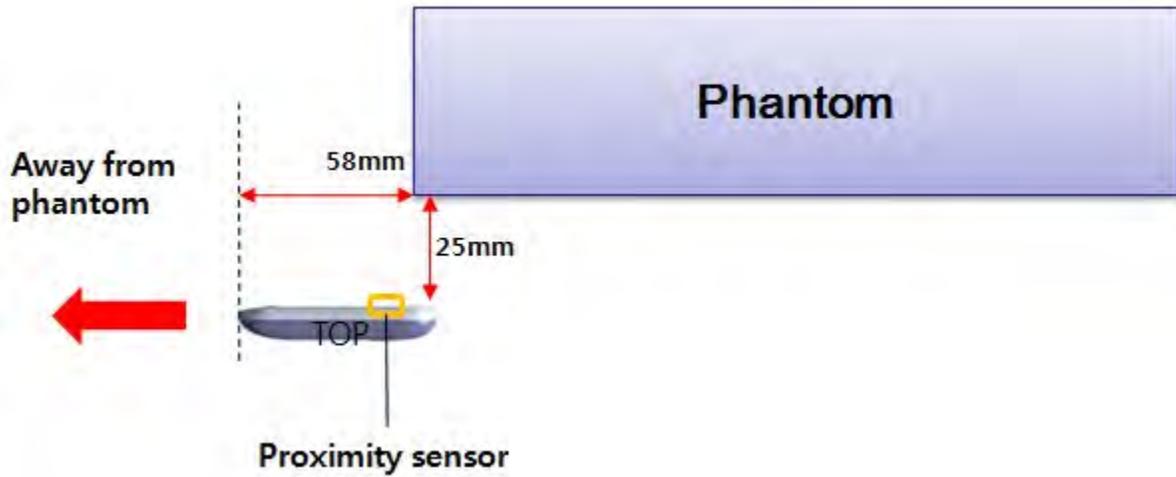
With the device's front side positioned underneath a flat phantom and at 2.5 cm below the phantom, the proximity sensor is triggered. The device is then gradually moved across its length towards the edge of the flat phantom and the alignment between the top edge of the device and the edge of the phantom is identified.



| Distance from the top edge of the DUT to the Phantom Edge (mm) | Proximity Sensor Status |
|--|-------------------------|
| 0 | ON |
| 1 | ON |
| 2 | ON |
| ⋮ | ON |
| 12 | ON |
| 13 | ON |
| 14 | ON |
| 15 | OFF |
| ⋮ | OFF |

| | | | |
|--|---|---|---------------------------------|
| FCC ID: ZNFH830 |  SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 01/18/2016 – 03/03/2016 | DUT Type: Portable Handset | | APPENDIX G: Page 3 of 10 |

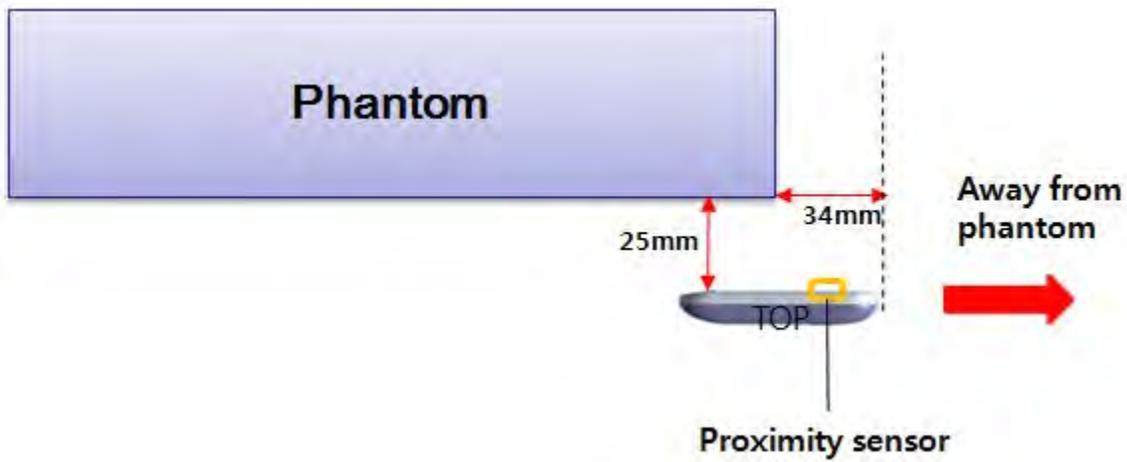
With the device's front side positioned underneath a flat phantom and at 2.5 cm below the phantom, the proximity sensor is triggered. The device is then gradually moved horizontally across its width towards the edge of the flat phantom and the alignment between the right edge of the device and the edge of the phantom is identified.



| Distance from the right edge of the DUT to the Phantom Edge (mm) | Proximity Sensor Status |
|--|-------------------------|
| 0 | ON |
| 1 | ON |
| 2 | ON |
| ⋮ | ON |
| 56 | ON |
| 57 | ON |
| 58 | ON |
| 59 | OFF |
| ⋮ | OFF |

| | | | |
|--|---|---|---------------------------------|
| FCC ID: ZNFH830 |  SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 01/18/2016 – 03/03/2016 | DUT Type: Portable Handset | | APPENDIX G: Page 4 of 10 |

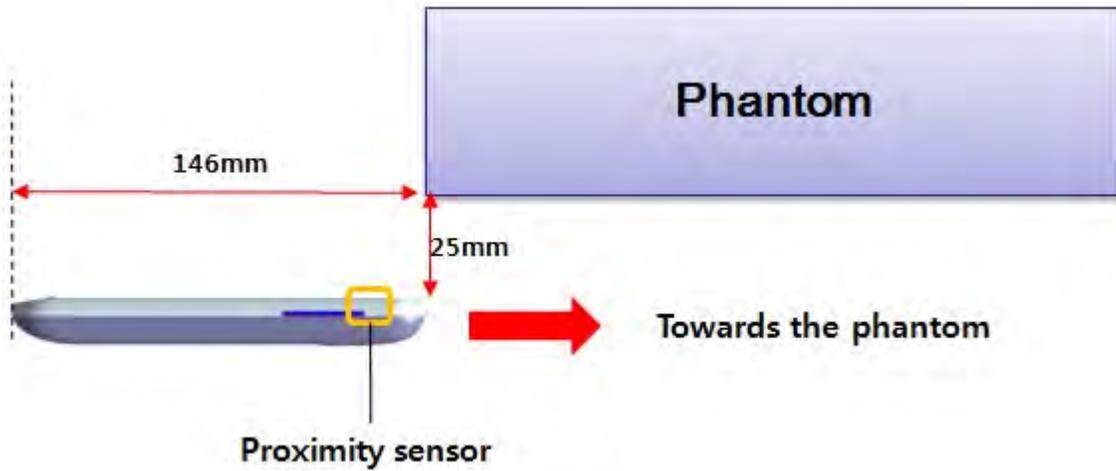
With the device's front side positioned underneath a flat phantom and at 2.5 cm below the phantom, the proximity sensor is triggered. The device is then gradually moved horizontally across its width towards the edge of the flat phantom and the alignment between the left edge of the device and the edge of the phantom is identified.



| Distance from the left edge of the DUT to the Phantom Edge (mm) | Proximity Sensor Status |
|---|-------------------------|
| 0 | ON |
| 1 | ON |
| 2 | ON |
| ⋮ | ON |
| 32 | ON |
| 33 | ON |
| 34 | ON |
| 35 | OFF |
| ⋮ | OFF |

| | | | |
|--|---|---|---------------------------------|
| FCC ID: ZNFH830 |  SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 01/18/2016 – 03/03/2016 | DUT Type: Portable Handset | | APPENDIX G: Page 5 of 10 |

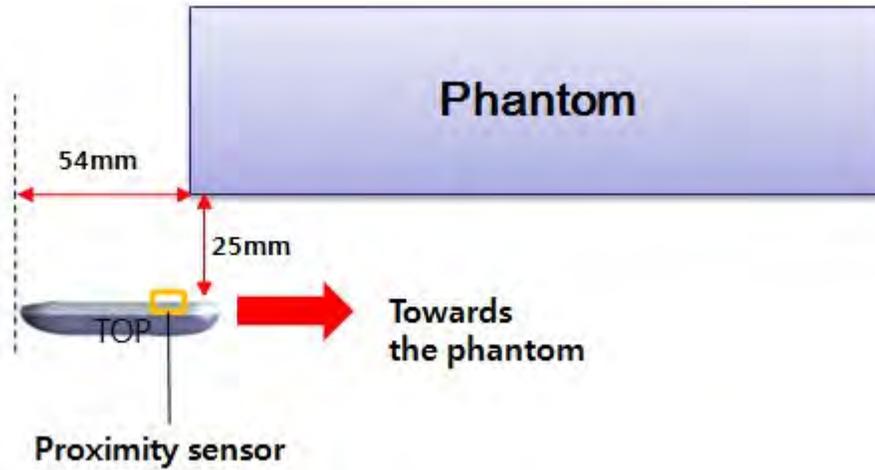
The device was then positioned with the device's front side positioned fully outside the boundary of a flat phantom and at 2.5 cm below the phantom. The device is then gradually moved across its length towards the edge of the flat phantom and the alignment between the bottom edge of the device and the edge of the phantom is identified.



| Distance from the bottom edge of the DUT to the Phantom Edge (mm) | Proximity Sensor Status |
|---|-------------------------|
| 149 | OFF |
| 148 | OFF |
| 147 | OFF |
| 146 | ON |
| 145 | ON |
| ⋮ | ON |
| 0 | ON |

| | | | |
|--|---|---|---------------------------------|
| FCC ID: ZNFH830 |  SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 01/18/2016 – 03/03/2016 | DUT Type: Portable Handset | | APPENDIX G: Page 6 of 10 |

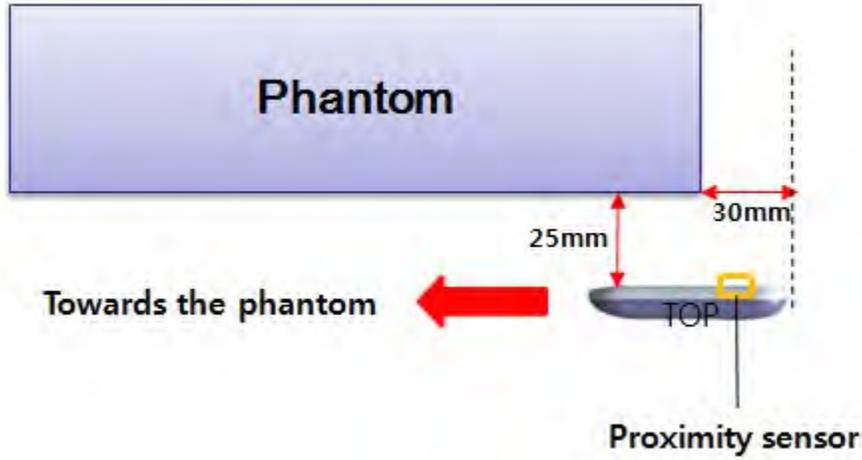
The device was then positioned with the device's front side positioned fully outside the boundary of a flat phantom and at 2.5 cm below the phantom. The device is then gradually moved across its width towards the edge of the flat phantom and the alignment between the right edge of the device and the edge of the phantom is identified.



| Distance from the right edge of the DUT to the Phantom Edge (mm) | proximity Sensor Status |
|--|-------------------------|
| ∞ | OFF |
| 57 | OFF |
| 56 | OFF |
| 55 | OFF |
| 54 | ON |
| 53 | ON |
| ∞ | ON |
| 0 | ON |

| | | | |
|--|---|--|---------------------------------|
| FCC ID: ZNFH830 |  SAR EVALUATION REPORT |  LG | Reviewed by: Quality Manager |
| Test Dates: 01/18/2016 – 03/03/2016 | DUT Type: Portable Handset | | APPENDIX G: Page 7 of 10 |

The device was then positioned with the device's front side positioned fully outside the boundary of a flat phantom and at 2.5 cm below the phantom. The device is then gradually moved across its width towards the edge of the flat phantom and the alignment between the left edge of the device and the edge of the phantom is identified.

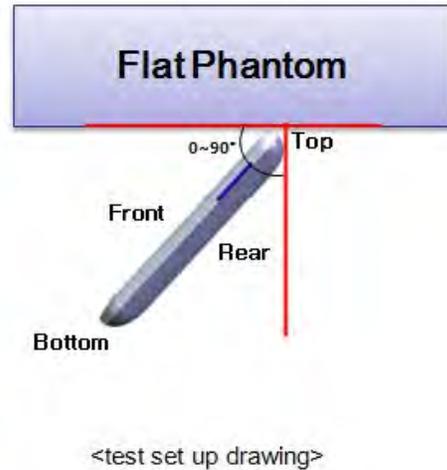


| Distance from the left edge of the DUT to the Phantom Edge (mm) | Proximity Sensor Status |
|---|-------------------------|
| 33 | OFF |
| 32 | OFF |
| 31 | OFF |
| 30 | ON |
| 29 | ON |
| 28 | ON |
| 27 | ON |
| 26 | ON |
| 25 | ON |
| 24 | ON |
| 23 | ON |
| 22 | ON |
| 21 | ON |
| 20 | ON |
| 19 | ON |
| 18 | ON |
| 17 | ON |
| 16 | ON |
| 15 | ON |
| 14 | ON |
| 13 | ON |
| 12 | ON |
| 11 | ON |
| 10 | ON |
| 9 | ON |
| 8 | ON |
| 7 | ON |
| 6 | ON |
| 5 | ON |
| 4 | ON |
| 3 | ON |
| 2 | ON |
| 1 | ON |
| 0 | ON |

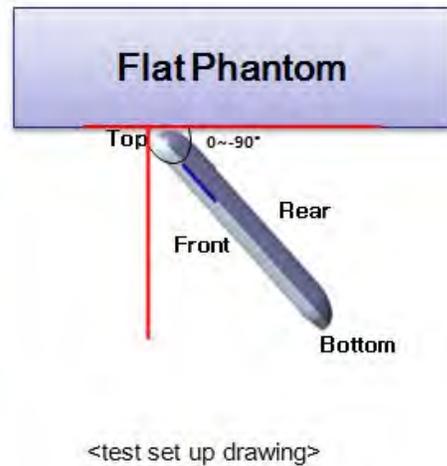
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| FCC ID: ZNFH830 |  SAR EVALUATION REPORT |  | Reviewed by: Quality Manager |
| Test Dates: 01/18/2016 – 03/03/2016 | DUT Type: Portable Handset | | APPENDIX G: Page 8 of 10 |

The device was then positioned with the top of the device held perpendicular to the flat phantom and was rotated in 5° intervals toward the front of the device and toward the rear of the device.

| Distance / degrees to the DUT | | Sensor triggered status | |
|-------------------------------|-----------|-------------------------|--------------------------|
| (mm) | (degrees) | Mode | Power |
| 0 | 0 | Near | Reduced power (Appendix) |
| 0 | 5 | Near | |
| 0 | 10 | Near | |
| 0 | 15 | Near | |
| 0 | 20 | Near | |
| 0 | 25 | Near | |
| 0 | 30 | Near | |
| 0 | 35 | Near | |
| 0 | 40 | Near | |
| 0 | 45 | Near | |
| 0 | 50 | Near | |
| 0 | 55 | Near | |
| 0 | 60 | Near | |
| 0 | 65 | Near | |
| 0 | 70 | Near | |
| 0 | 75 | Near | |
| 0 | 80 | Near | |
| 0 | 85 | Near | |
| 0 | 90 | Near | |



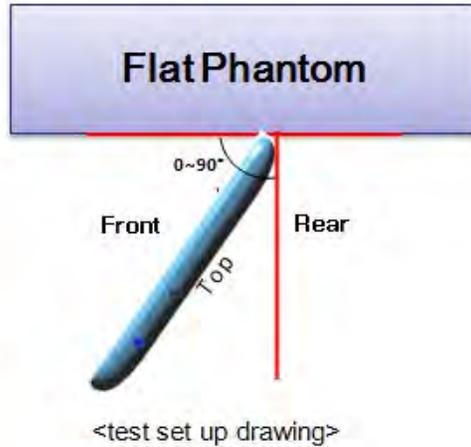
| Distance / degrees to the DUT | | Sensor triggered status | |
|-------------------------------|-----------|-------------------------|----------------------|
| (mm) | (degrees) | Mode | Power |
| 0 | 0 | Near | Appendix |
| 0 | 5 | Far | Max power (Appendix) |
| 0 | 10 | Far | |
| 0 | 15 | Far | |
| 0 | 20 | Far | |
| 0 | 25 | Far | |
| 0 | 30 | Far | |
| 0 | 35 | Far | |
| 0 | 40 | Far | |
| 0 | 45 | Far | |
| 0 | 50 | Far | |
| 0 | 55 | Far | |
| 0 | 60 | Far | |
| 0 | 65 | Far | |
| 0 | 70 | Far | |
| 0 | 75 | Far | |
| 0 | 80 | Far | |
| 0 | 85 | Far | |
| 0 | 90 | Far | |



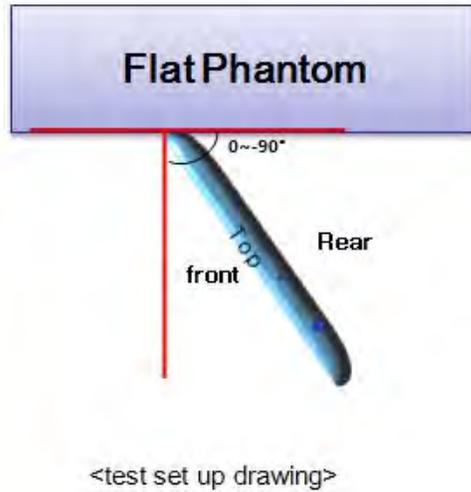
| | | | |
|--|-------------------------------|--|---------------------------------|
| FCC ID: ZNFH830 | SAR EVALUATION REPORT | | Reviewed by: Quality Manager |
| Test Dates: 01/18/2016 – 03/03/2016 | DUT Type: Portable Handset | | APPENDIX G: Page 9 of 10 |

The device was then positioned with the left edge of the device held perpendicular to the flat phantom and was rotated in 5° intervals toward the front of the device and toward the rear of the device.

| Distance / degrees to the DUT | | Sensor triggered status | |
|-------------------------------|-----------|-------------------------|--------------------------|
| (mm) | (degrees) | Mode | Power |
| 0 | 0 | Near | Reduced power (Appendix) |
| 0 | 5 | Near | |
| 0 | 10 | Near | |
| 0 | 15 | Near | |
| 0 | 20 | Near | |
| 0 | 25 | Near | |
| 0 | 30 | Near | |
| 0 | 35 | Near | |
| 0 | 40 | Near | |
| 0 | 45 | Near | |
| 0 | 50 | Near | |
| 0 | 55 | Near | |
| 0 | 60 | Near | |
| 0 | 65 | Near | |
| 0 | 70 | Near | |
| 0 | 75 | Far | |
| 0 | 80 | Far | |
| 0 | 85 | Far | |
| 0 | 90 | Far | |



| Distance / degrees to the DUT | | Sensor triggered status | |
|-------------------------------|-----------|-------------------------|----------------------|
| (mm) | (degrees) | Mode | Power |
| 0 | 0 | Far | Max power (Appendix) |
| 0 | 5 | Far | |
| 0 | 10 | Far | |
| 0 | 15 | Far | |
| 0 | 20 | Far | |
| 0 | 25 | Far | |
| 0 | 30 | Far | |
| 0 | 35 | Far | |
| 0 | 40 | Far | |
| 0 | 45 | Far | |
| 0 | 50 | Far | |
| 0 | 55 | Far | |
| 0 | 60 | Far | |
| 0 | 65 | Far | |
| 0 | 70 | Far | |
| 0 | 75 | Far | |
| 0 | 80 | Far | |
| 0 | 85 | Far | |
| 0 | 90 | Far | |



| | | | |
|--|-------------------------------|--|---------------------------------|
| FCC ID: ZNFH830 | SAR EVALUATION REPORT | | Reviewed by: Quality Manager |
| Test Dates: 01/18/2016 – 03/03/2016 | DUT Type: Portable Handset | | APPENDIX G: Page 10 of 10 |