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

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

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

Accreditation No.: SCS 0108

Client **Eurofins**

Certificate No: D900V2-164_Sep15

CALIBRATION CERTIFICATE

Object	D900V2 - SN:164
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	September 30, 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)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe EX3DV4	SN: 7349	30-Dec-14 (No. EX3-7349_Dec14)	Dec-15
DAE4	SN: 601	17-Aug-15 (No. DAE4-601_Aug15)	Aug-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100972	15-Jun-15 (in house check Jun-15)	In house check: Jun-18
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: October 1, 2015

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	41.5	0.97 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.6 ± 6 %	0.96 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.71 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**10.9 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.73 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**6.96 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	55.0	1.05 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.6 ± 6 %	1.03 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.80 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**11.3 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.81 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**7.29 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.1 Ω - 5.0 jΩ
Return Loss	- 25.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.0 Ω - 6.5 jΩ
Return Loss	- 21.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.408 ns

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	May 16, 2002

Date: 30.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN:164

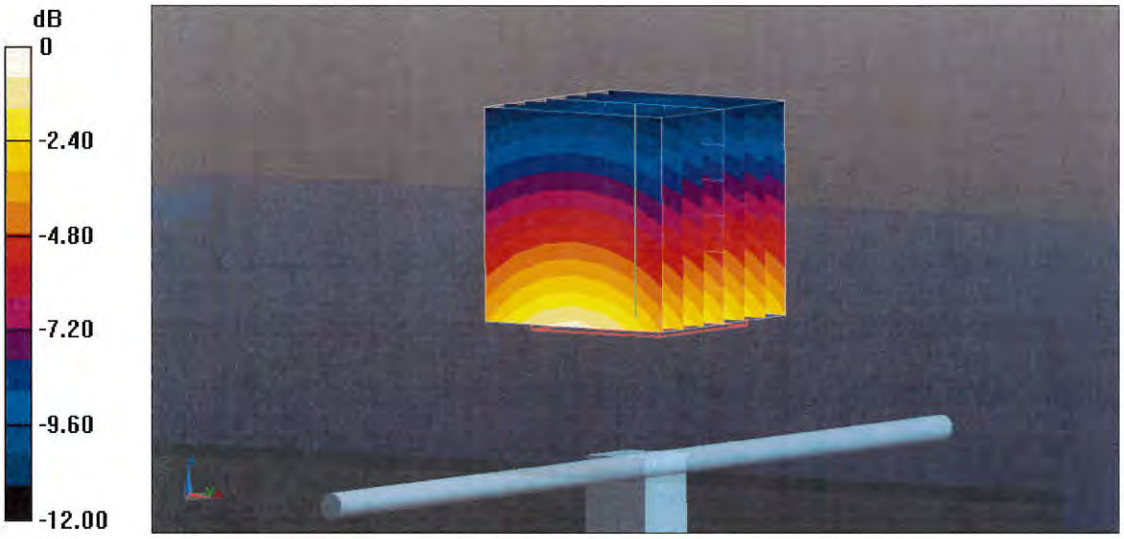
Communication System: UID 0 - CW; Frequency: 900 MHz
Medium parameters used: f = 900 MHz; σ = 0.96 S/m; ε_r = 41.6; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.73, 9.73, 9.73); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

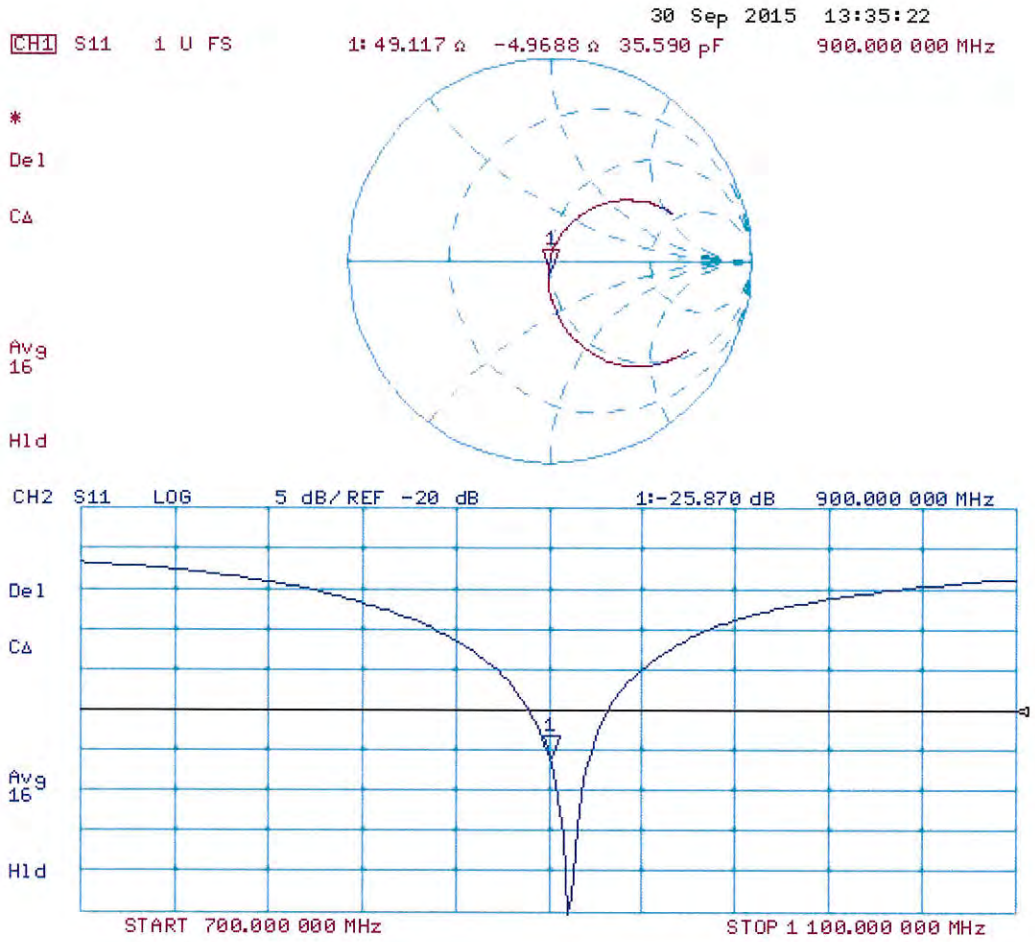
Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 64.45 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 4.28 W/kg
SAR(1 g) = 2.71 W/kg; SAR(10 g) = 1.73 W/kg
Maximum value of SAR (measured) = 3.73 W/kg



0 dB = 3.73 W/kg = 5.72 dBW/kg

Impedance Measurement Plot for Head TSL



Date: 30.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN:164

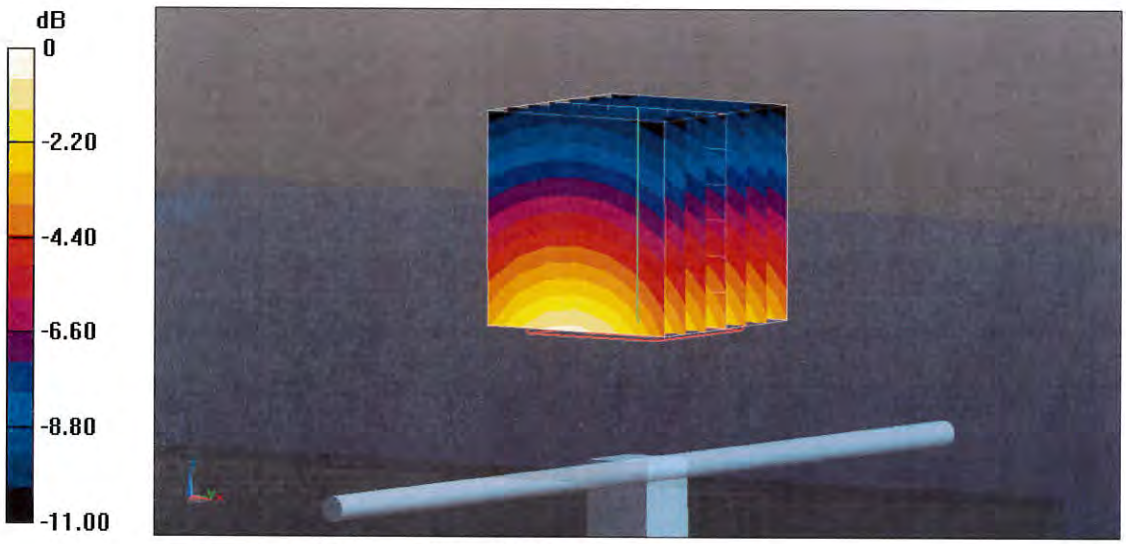
Communication System: UID 0 - CW; Frequency: 900 MHz
Medium parameters used: f = 900 MHz; σ = 1.03 S/m; ε_r = 53.6; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.39, 9.39, 9.39); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

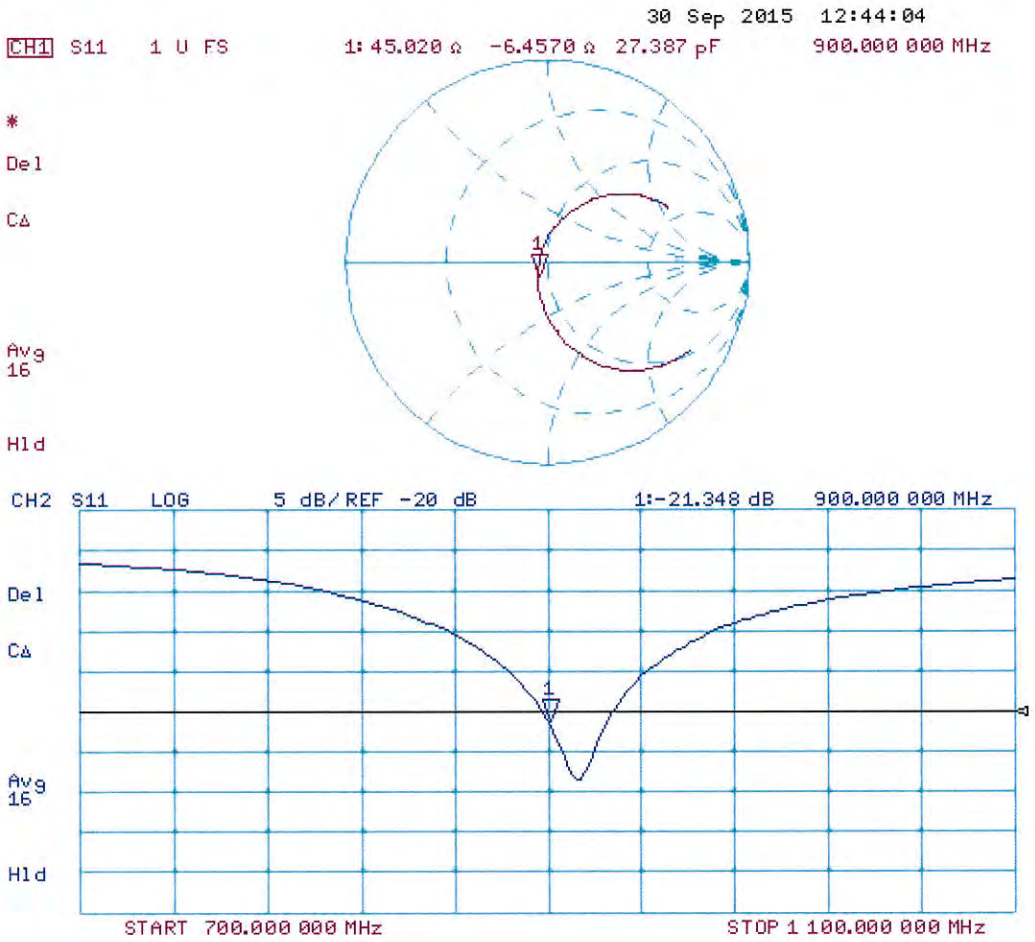
Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 63.07 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 4.18 W/kg
SAR(1 g) = 2.8 W/kg; SAR(10 g) = 1.81 W/kg
Maximum value of SAR (measured) = 3.72 W/kg



0 dB = 3.72 W/kg = 5.71 dBW/kg

Impedance Measurement Plot for Body TSL



Validation Report
No. VAL_0281_EF 2018-01

Kind of doc.:
QM Template

EUROFINS PRODUCT SERVICE GmbH
Storkower Str. 38c, 15526 Reichenwalde, Germany

1 Customer

Eurofins Product Service GmbH

2 Object

Equipment Number	EF00281
Equipment Name:	System validation dipole
Equipment Type:	D900V2
Serial Number:	164
Manufacturer:	Schmid & Partner Engineering AG

3 State of Measurement

Validation:	☒
Performance Control:	☒
Other:	☐

4 Performance of Measurement

4.1 Generals

(e.g. object of validation such as specific setup, non-standard method or SW, specification of the requirements, test set-up configuration, risk analysis etc.)

Dipol verification

4.2 Validation procedure / measurement

(e.g. comparison of results achieved with other methods, interlaboratory comparison, systematic assessment of factors influencing the result, assessment of the uncertainty of the results based on scientific understanding of the theoretical principles of the method and practical experience; criteria/requirements for approval/rejection etc.)

According KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04 3.2.2 Dipole calibration

Limits for the verification: return loss <20% to the original measurement or >20 dB minimum return-loss
Impedance <5 Ω to the original measurement.

4.3 Used reference equipment

Equipment name	Equipment type	Manufacturer	Equipment number	Cal. Date	Cal. Due Date
RF Network analyzer	8752 C	Hewlett-Packard Company Santa Clara	EF00140	2017-07-28	2018-07-28

- new acquired (incl. calibration) ☐
- new calibrated ☐
- check reference standard ☒

4.4 Environmental conditions

Temperature:	_23_°C ± 2°C
Relative Air Humidity:	_50_ rH ± 5%
Air Pressure:	_1020_ hPa ± 5%

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5 Results

5.1 General:

(e.g. measurement results, user instructions such as handling, transport, storage, preparation; checks to be made before the work started; information about how to install (operations)-, to maintain-, to train and to use; safety measures etc.)

	Original measurement	Verification measurement	Margin
Impedance, transformend to feed point	45.0 Ω + 6.5 jΩ	49.62 Ω + 7.16 jΩ	4.6 Ω
Return Loss	-21.3 dB	-22.84 dB	-7.2 % / -1.54 dB
Tissue Validation εr	55.0	53.697	-2.37 %
Tissue Validation σ [S/m]	1.05	1.088	3.62 %
System validation	11.3 W/kg (1g)	10.84W/kg (1g)	-4.07 %
Date:	15.09.2015	17.01.2018	

5.2 Measurement uncertainty

The reported expanded uncertainty of measurement is stated as the standard uncertainty multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.
+/- 2.5 %

5.3 Results of Validation

Validated ☒
Not validated ☐

6 Operator

Pudell — Name
P. Pudell — Signature

Place and Date of Verification: Reichenwalde, 25.01.2018

Attachment:
Impedance, Return Loss, System validierung

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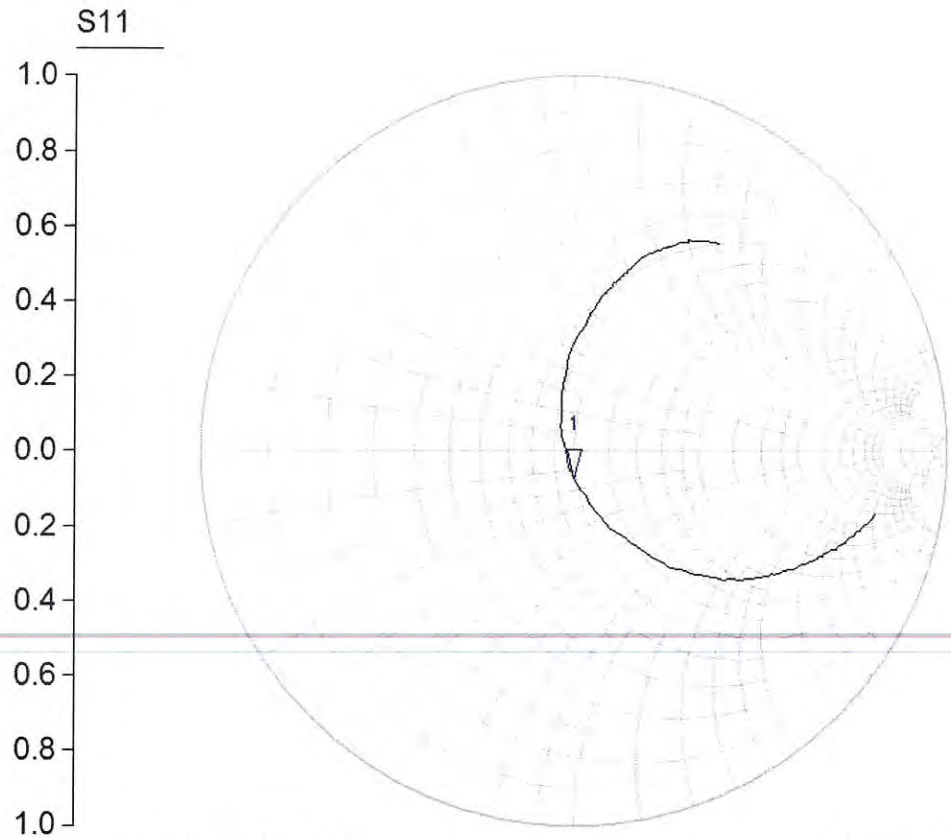

Mkr	Trace	X-Axis	Value	Notes
1 ▽	S11	900.0000 MHz	49.62 - j7.16 ohms	24.772 pF

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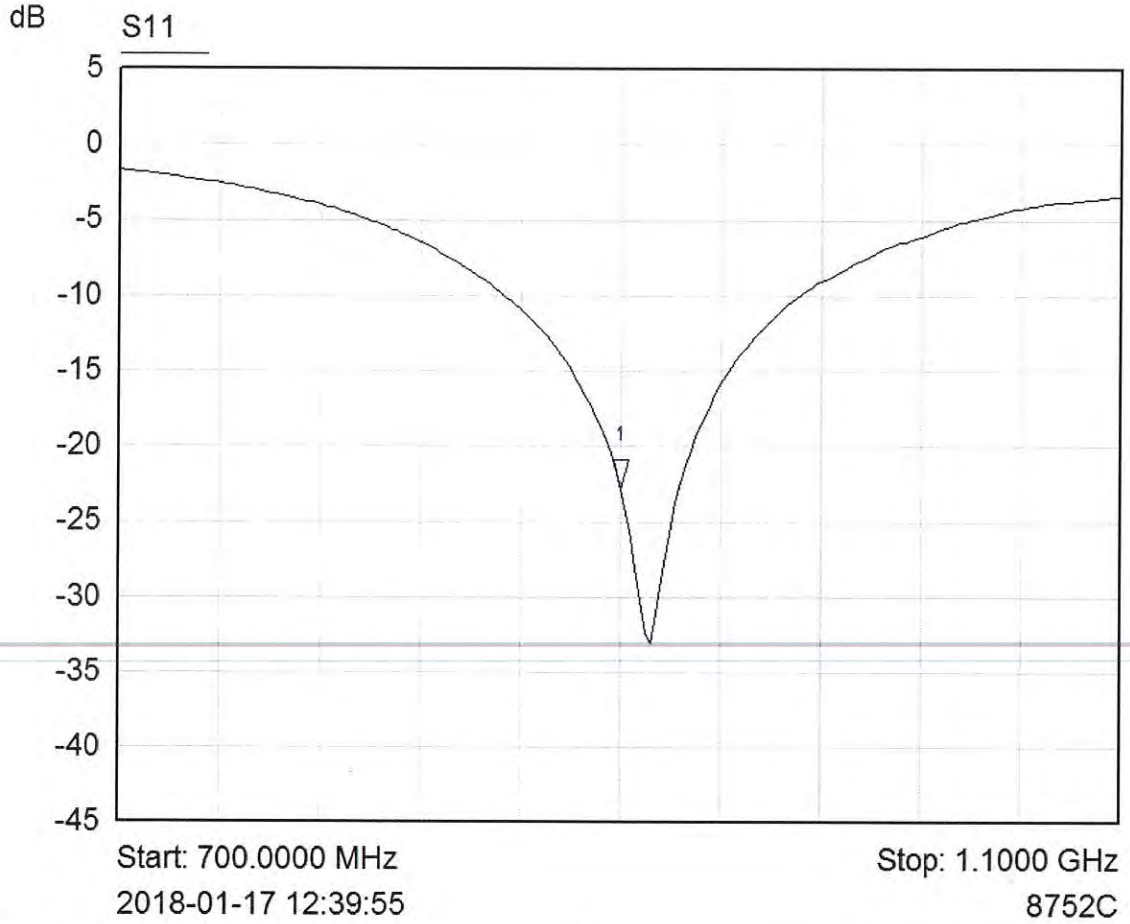

Mkr	Trace	X-Axis	Value	Notes
1 ▽	S11	900.0000 MHz	-22.84 dB	

EUROFINS PRODUCT SERVICE GmbH
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Date Time: 2018-01-17 16:05:48

Test Laboratory: Eurofins Product Service GmbH

Dipol Valid.900 (m)_250mW ELI4_17.01.2018

DUT: Dipole 900 MHz; Type: D900V2; Serial: 164

Communication System: UID 0 - n/a, CW; Frequency: 900 MHz;Duty Cycle: 1:1
Medium: Muscle 900 MHz Medium parameters used: f = 900 MHz; σ = 1.088 S/m; ε_r = 53.697; ρ = 1000 kg/m^3
Phantom section: Flat Section

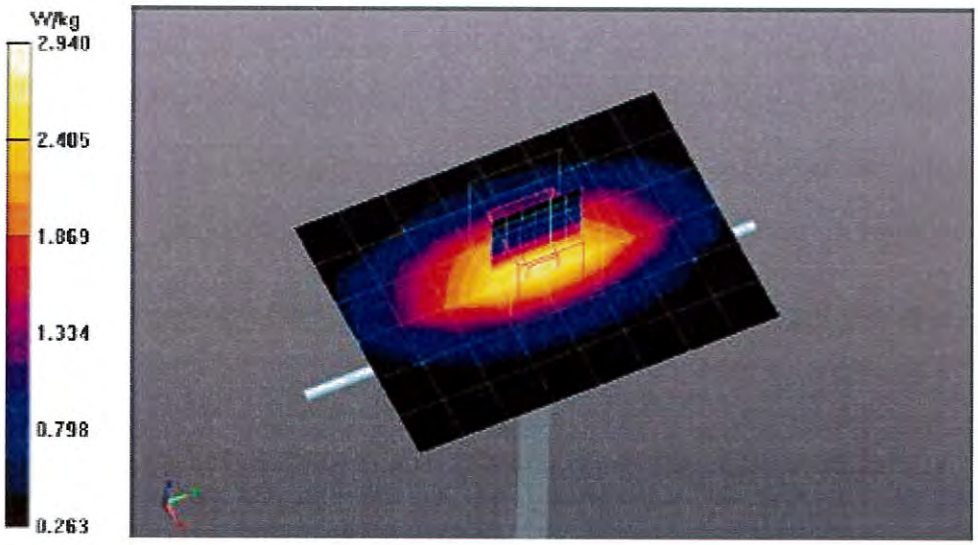
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5.2 Configuration:

- Probe: EX3DV4 - SN3893; ConvF(10.31, 10.31, 10.31); Calibrated: 2017-09-25;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 2017-09-18
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BB; Serial: SN:1013
- Measurement SW: DASY52, Version 52.8 (6); SEMCAD X Version 14.6.9 (7117)

System Performance Check at Frequencies below 1 GHz/d=15mm, Pin=250 mW, dist=4.0mm (EX-Probe)/Area Scan (7x9x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 2.77 W/kg

System Performance Check at Frequencies below 1 GHz/d=15mm, Pin=250 mW, dist=4.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 53.574 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 4.07 W/kg
SAR(1 g) = 2.71 W/kg; SAR(10 g) = 1.77 W/kg
Maximum value of SAR (measured) = 2.94 W/kg



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Accreditation No.: SCS 0108

Client **Eurofins**

Certificate No: D1900V2-5d025_Sep15

CALIBRATION CERTIFICATE

Object	D1900V2 - SN:5d025
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	September 29, 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)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	01-Apr-15 (No. 217-02131)	Mar-16
Type-N mismatch combination	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02134)	Mar-16
Reference Probe EX3DV4	SN: 7349	30-Dec-14 (No. EX3-7349_Dec14)	Dec-15
DAE4	SN: 601	17-Aug-15 (No. DAE4-601_Aug15)	Aug-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100972	15-Jun-15 (in house check Jun-15)	In house check: Jun-18
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: September 30, 2015

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

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

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.3 ± 6 %	1.38 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.0 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**40.2 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.21 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**20.9 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.6 ± 6 %	1.52 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.2 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**40.7 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.38 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**21.5 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.7 Ω + 4.9 jΩ
Return Loss	- 25.9 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.4 Ω + 5.9 jΩ
Return Loss	- 24.1 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.199 ns

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	July 29, 2002

Date: 29.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d025

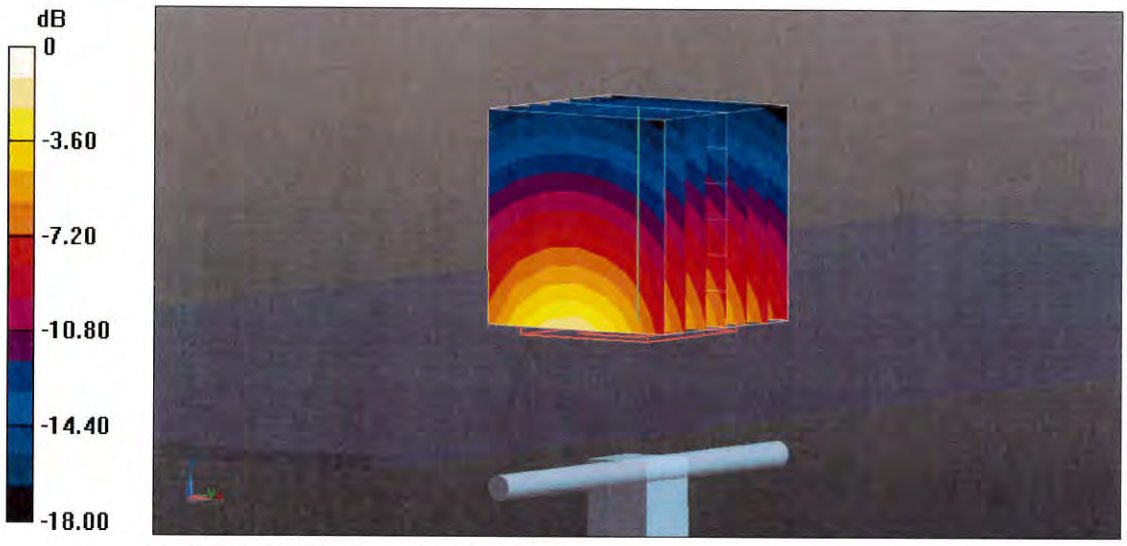
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.38 S/m; ε_r = 39.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.14, 8.14, 8.14); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

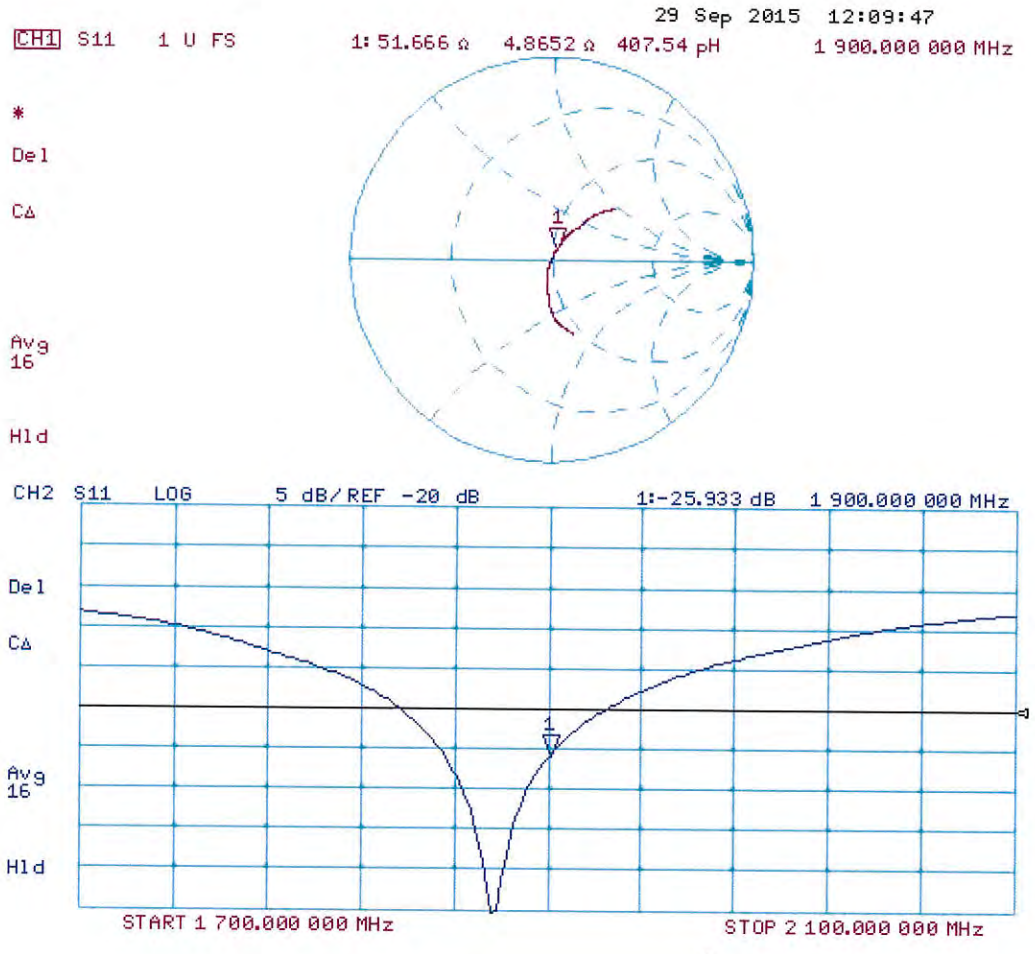
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 109.8 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 18.9 W/kg
SAR(1 g) = 10 W/kg; SAR(10 g) = 5.21 W/kg
Maximum value of SAR (measured) = 15.6 W/kg



0 dB = 15.6 W/kg = 11.93 dBW/kg

Impedance Measurement Plot for Head TSL



Date: 29.09.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d025

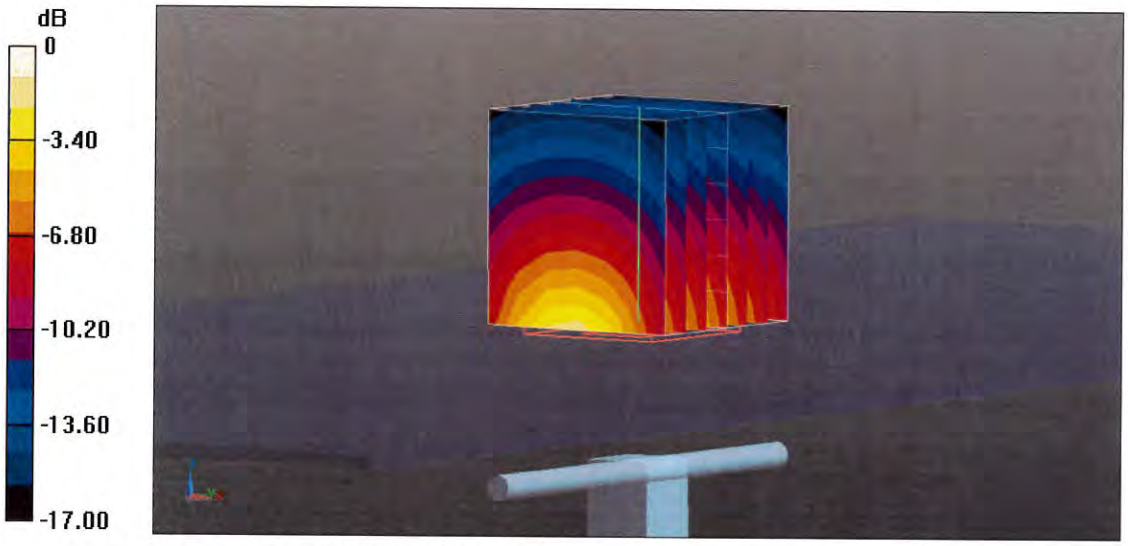
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.52 S/m; ε_r = 52.6; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.9, 7.9, 7.9); Calibrated: 30.12.2014;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 17.08.2015
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

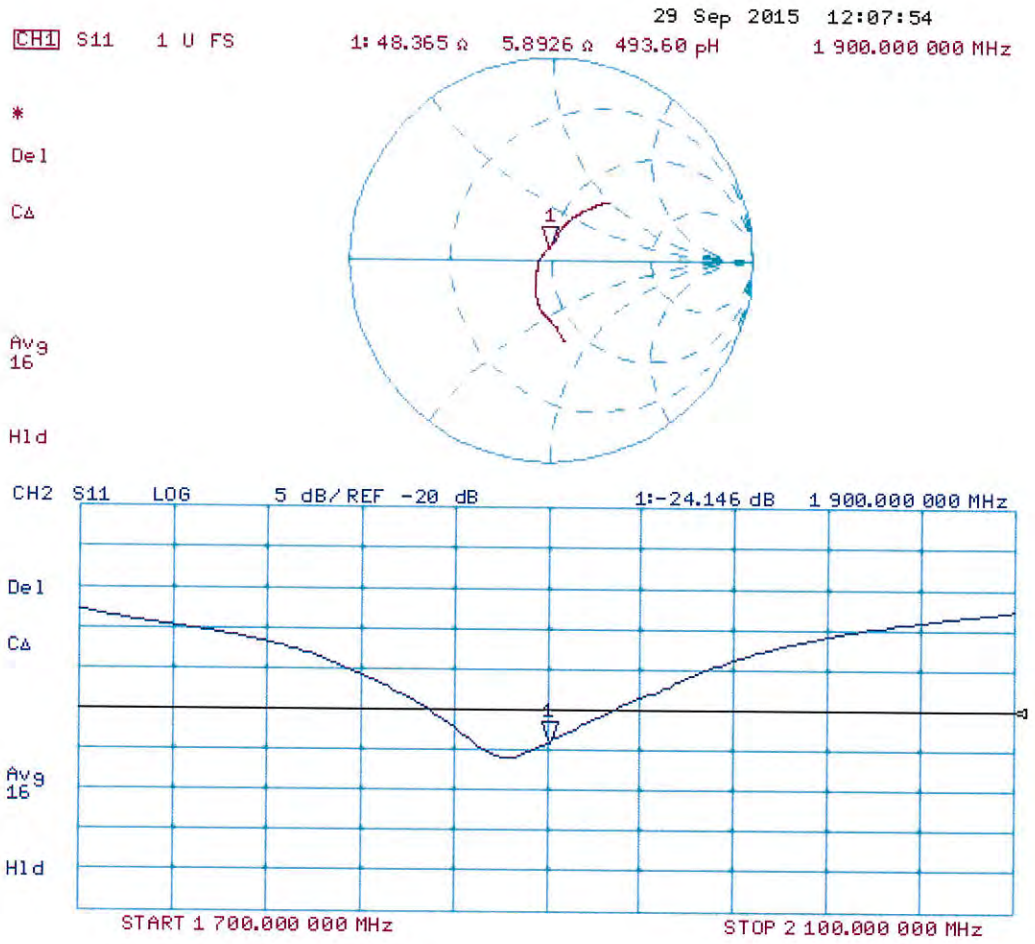
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 104.6 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 18.2 W/kg
SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.38 W/kg
Maximum value of SAR (measured) = 15.4 W/kg



0 dB = 15.4 W/kg = 11.88 dBW/kg

Impedance Measurement Plot for Body TSL



Validation Report
No. VAL_0283_EF 2018-01

Kind of doc.:
QM Template

EUROFINS PRODUCT SERVICE GmbH
Storkower Str. 38c, 15526 Reichenwalde, Germany

1 Customer

Eurofins Product Service GmbH

2 Object

Equipment Number	EF00283
Equipment Name:	System validation dipole
Equipment Type:	D1900V2
Serial Number:	5d025
Manufacturer:	Schmid & Partner Engineering AG

3 State of Measurement

Validation:	☒
Performance Control:	☒
Other:	☐

4 Performance of Measurement

4.1 Generals

(e.g. object of validation such as specific setup, non-standard method or SW, specification of the requirements, test set-up configuration, risk analysis etc.)

Dipol verification

4.2 Validation procedure / measurement

(e.g. comparison of results achieved with other methods, interlaboratory comparison, systematic assessment of factors influencing the result, assessment of the uncertainty of the results based on scientific understanding of the theoretical principles of the method and practical experience; criteria/requirements for approval/rejection etc.)

According KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04 3.2.2 Dipole calibration

Limits for the verification: return loss <20% to the original measurement or >20 dB minimum return-loss
Impedance <5 Ω to the original measurement.

4.3 Used reference equipment

Equipment name	Equipment type	Manufacturer	Equipment number	Cal. Date	Cal. Due Date
RF Network analyzer	8752 C	Hewlett-Packard Company Santa Clara	EF00140	2017-07-28	2018-07-28

- new acquired (incl. calibration) ☐
- new calibrated ☐
- check reference standard ☒

4.4 Environmental conditions

Temperature:	_23_ °C ± 2°C
Relative Air Humidity:	_50_ rH ± 5%
Air Pressure:	_1020_ hPa ± 5%

EUROFINS PRODUCT SERVICE GmbH
Storkower Str. 38c, 15526 Reichenwalde, Germany

5 Results

5.1 General:

(e.g. measurement results, user instructions such as handling, transport, storage, preparation; checks to be made before the work started; information about how to install (operations)-, to maintain-, to train and to use; safety measures etc.)

	Original measurement	Verification measurement	Margin
Impedance, transformend to feed point	48.4 Ω + 5.9 jΩ	46.72 Ω + 4.90 jΩ	1.68 Ω
Return Loss	-24.1 dB	-24.3 dB	0.83 % / -0.2 dB
Tissue Validation εr	53.3	53.687	0.73 %
Tissue Validation σ [S/m]	1.52	1.521	0.07 %
System validation	40.7 W/kg (1g)	41.6 W/kg (1g)	2.21 %
Date:	15.09.2015	25.01.2018	

5.2 Measurement uncertainty

The reported expanded uncertainty of measurement is stated as the standard uncertainty multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.
+/- 2.5 %

5.3 Results of Validation

Validated ☒
Not validated ☐

6 Operator

Pudell
Name

B. Pudell
Signature

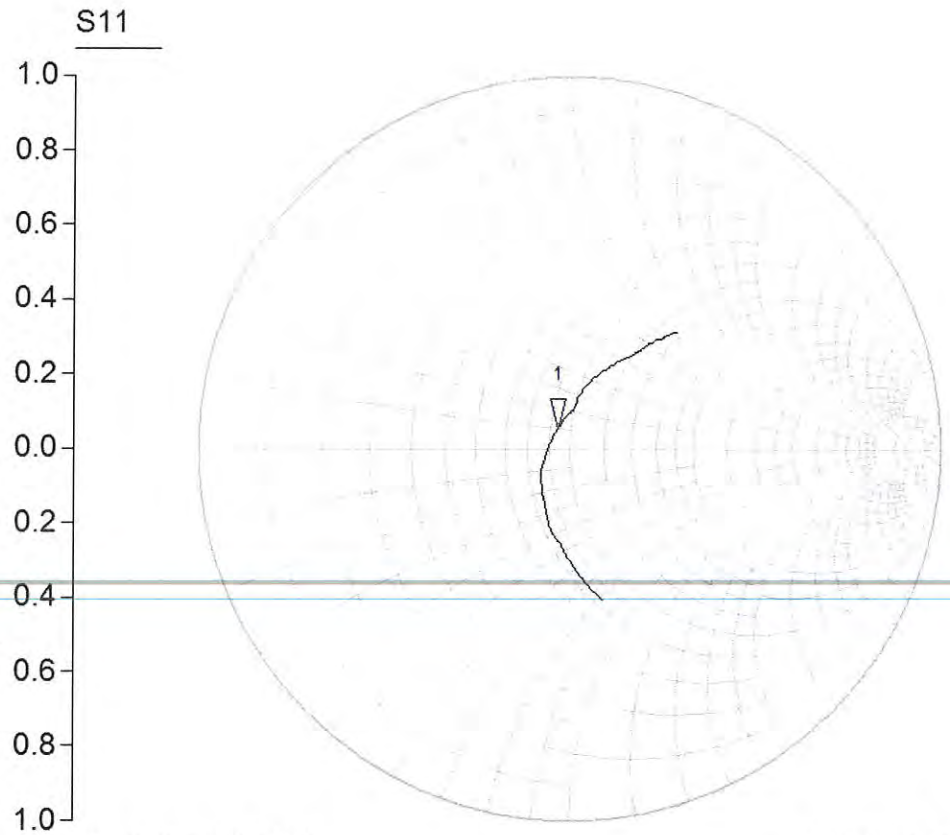
Place and Date of Verification: Reichenwalde, 25.01.2018

Attachment:
Impedance, Return Loss, System validierung

Validation Report
No. VAL_0283_EF 2018-01

Kind of doc.:
QM Template

EUROFINS PRODUCT SERVICE GmbH
Storkower Str. 38c, 15526 Reichenwalde, Germany



Mkr	Trace	X-Axis	Value	Notes
1 ▽	S11	1.9000 GHz	46.72 + j4.90 ohms	24.772 pF

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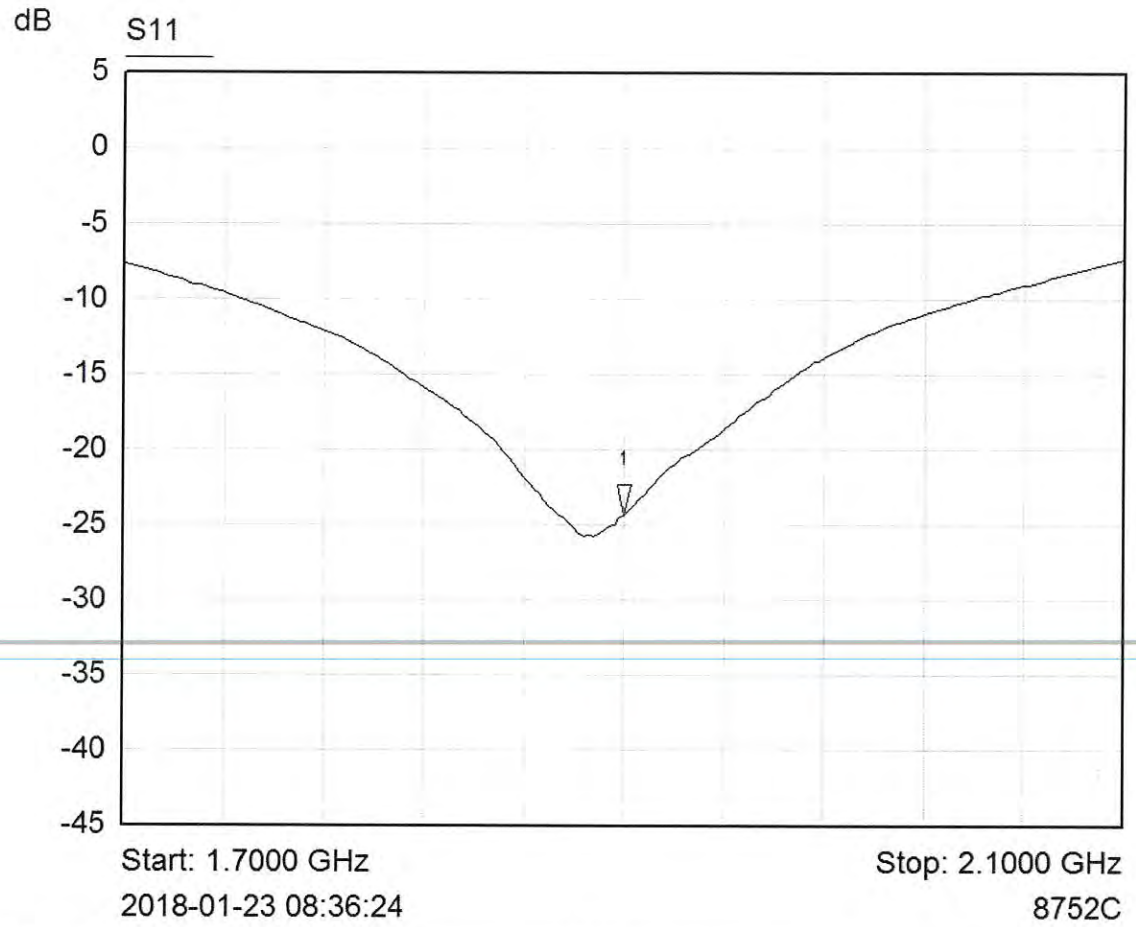


Mkr	Trace	X-Axis	Value	Notes
1 ▽	S11	1.9000 GHz	-24.30 dB	24.772 pF

EUROFINS PRODUCT SERVICE GmbH
Storkower Str. 38c, 15526 Reichenwalde, Germany

Date Time: 2018-01-23 09:08:06

Test Laboratory: Eurofins Product Service GmbH

Dipol Valid.1900 (m)_250mW ELI4_23.01.2018

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

Communication System: UID 0 - n/a, CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: Muscle 1900 MHz Medium parameters used (interpolated): f = 1900 MHz; σ = 1.521 S/m; ε_r = 53.687; ρ = 1000 kg/m^3
Phantom section: Flat Section

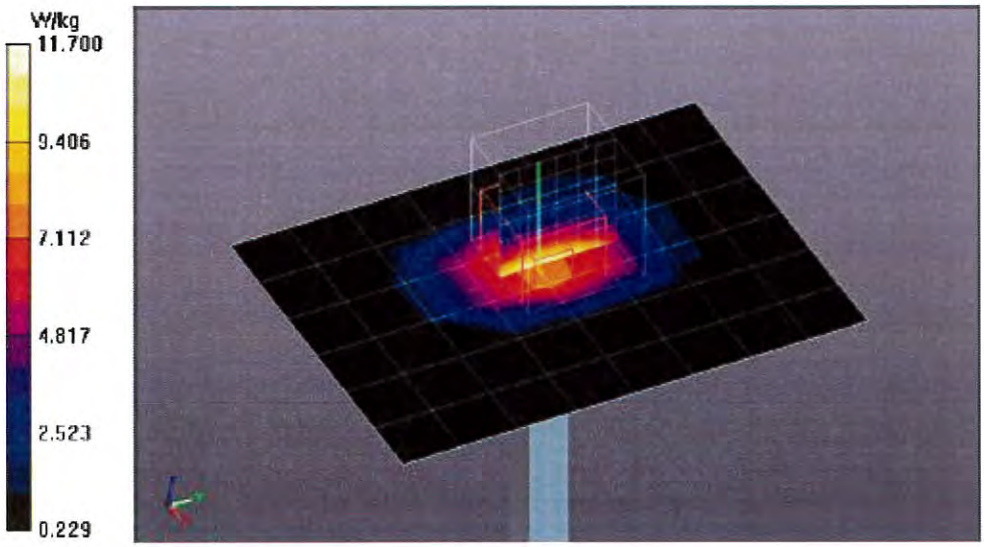
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5.2 Configuration:

- Probe: EX3DV4 - SN3893; ConvF(8.51, 8.51, 8.51); Calibrated: 2017-09-25;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 2017-09-18
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BB; Serial: SN:1013
- Measurement SW: DASY52, Version 52.8 (6); SEMCAD X Version 14.6.9 (7117)

System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=4.0mm (EX-Probe)/Area Scan (7x9x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 8.23 W/kg

System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=4.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 85.022 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 18.6 W/kg
SAR(1 g) = 10.4 W/kg; SAR(10 g) = 5.48 W/kg
Maximum value of SAR (measured) = 11.7 W/kg



ANNEX B System Validation Reports

Test Laboratory: Eurofins Product Service GmbH

Dipol Valid.900 (m)_250mW ELI4_16.01.2018

DUT: Dipole 900 MHz; Type: D900V2; Serial: 164

Communication System: UID 0 - n/a, CW; Frequency: 900 MHz;Duty Cycle: 1:1
Medium: Muscle 900 MHz Medium parameters used: f = 900 MHz; σ = 1.088 S/m; ε_r = 53.697; ρ = 1000 kg/m^3
Phantom section: Flat Section

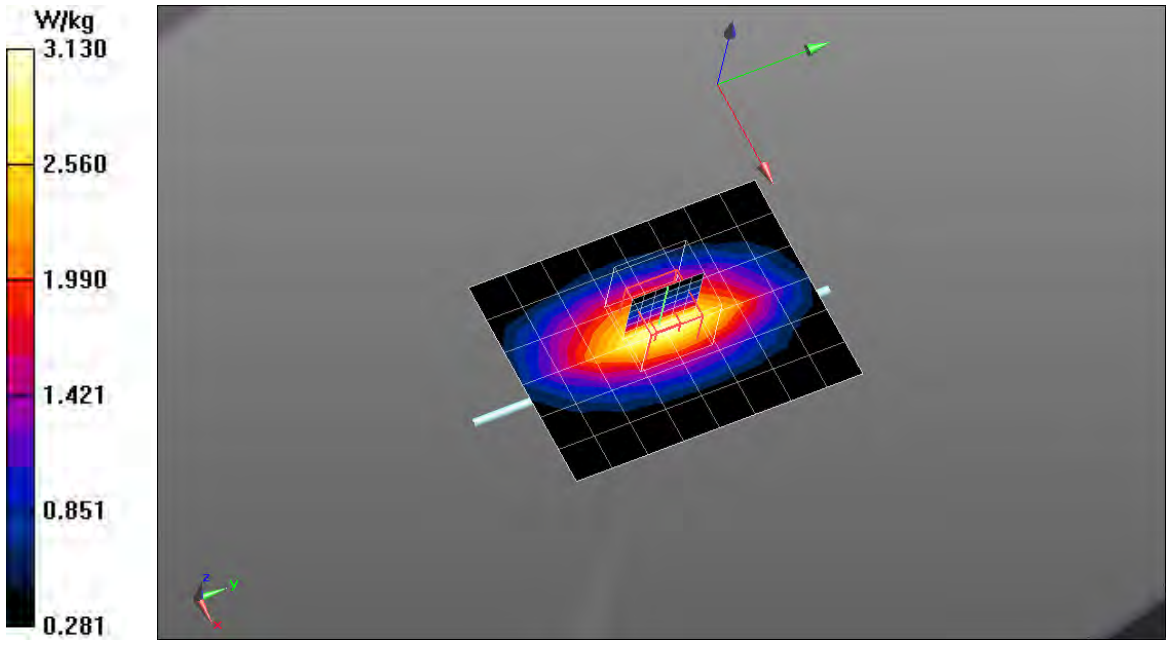
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5.2 Configuration:

- Probe: EX3DV4 - SN3893; ConvF(10.31, 10.31, 10.31); Calibrated: 2017-09-25;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 2017-09-18
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BB; Serial: SN:1013
- Measurement SW: DASY52, Version 52.8 (6); SEMCAD X Version 14.6.9 (7117)

System Performance Check at Frequencies below 1 GHz/d=15mm, Pin=250 mW, dist=4.0mm (EX-Probe)/Area Scan (7x9x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 3.08 W/kg

System Performance Check at Frequencies below 1 GHz/d=15mm, Pin=250 mW, dist=4.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 53.685 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 4.27 W/kg
SAR(1 g) = 2.89 W/kg; SAR(10 g) = 1.88 W/kg
Maximum value of SAR (measured) = 3.13 W/kg



Test Laboratory: Eurofins Product Service GmbH

Dipol Valid.900 (m)_250mW ELI4_17.01.2018

DUT: Dipole 900 MHz; Type: D900V2; Serial: 164

Communication System: UID 0 - n/a, CW; Frequency: 900 MHz;Duty Cycle: 1:1
Medium: Muscle 900 MHz Medium parameters used: f = 900 MHz; σ = 1.088 S/m; ε_r = 53.697; ρ = 1000 kg/m^3
Phantom section: Flat Section

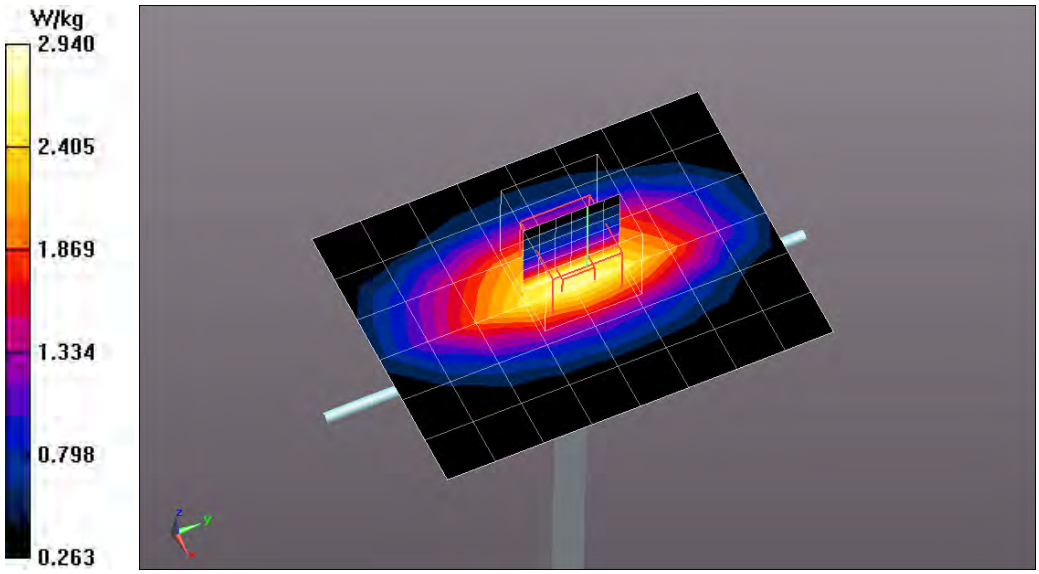
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5.2 Configuration:

- Probe: EX3DV4 - SN3893; ConvF(10.31, 10.31, 10.31); Calibrated: 2017-09-25;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 2017-09-18
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BB; Serial: SN:1013
- Measurement SW: DASY52, Version 52.8 (6); SEMCAD X Version 14.6.9 (7117)

System Performance Check at Frequencies below 1 GHz/d=15mm, Pin=250 mW, dist=4.0mm (EX-Probe)/Area Scan (7x9x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 2.77 W/kg

System Performance Check at Frequencies below 1 GHz/d=15mm, Pin=250 mW, dist=4.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 53.574 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 4.07 W/kg
SAR(1 g) = 2.71 W/kg; SAR(10 g) = 1.77 W/kg
Maximum value of SAR (measured) = 2.94 W/kg



Test Laboratory: Eurofins Product Service GmbH

Dipol Valid.1900 (m)_250mW ELI4_23.01.2018

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

Communication System: UID 0 - n/a, CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: Muscle 1900 MHz Medium parameters used (interpolated): f = 1900 MHz; σ = 1.521 S/m; ε_r = 53.687; ρ = 1000 kg/m^3
Phantom section: Flat Section

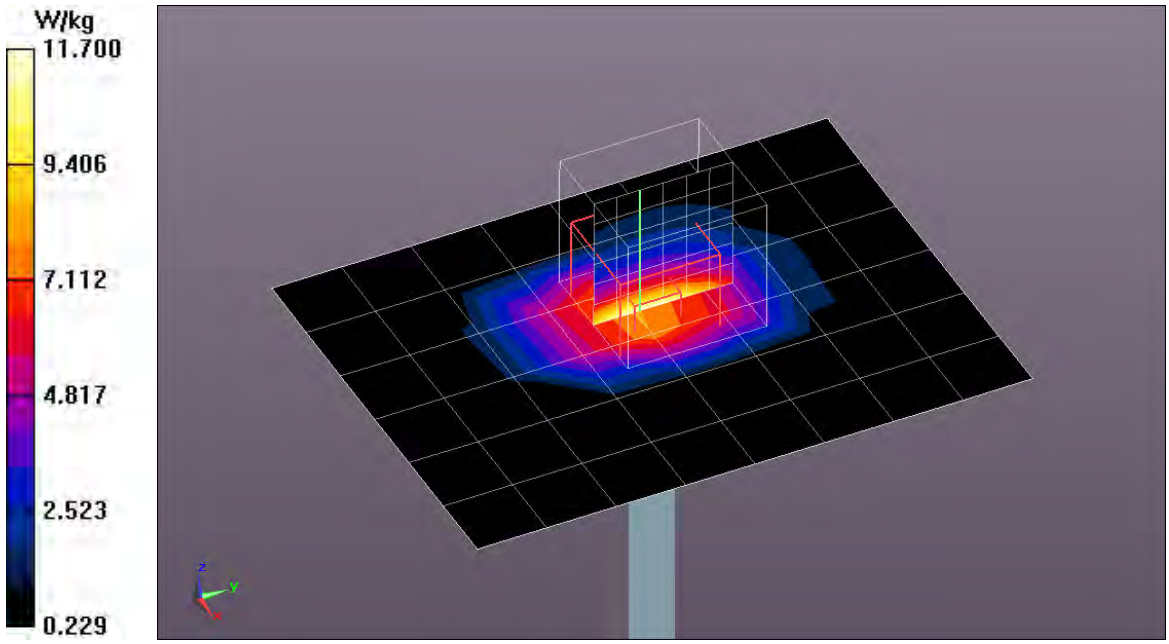
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5.2 Configuration:

- Probe: EX3DV4 - SN3893; ConvF(8.51, 8.51, 8.51); Calibrated: 2017-09-25;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 2017-09-18
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BB; Serial: SN:1013
- Measurement SW: DASY52, Version 52.8 (6); SEMCAD X Version 14.6.9 (7117)

System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=4.0mm (EX-Probe)/Area Scan (7x9x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 8.23 W/kg

System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=4.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 85.022 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 18.6 W/kg
SAR(1 g) = 10.4 W/kg; SAR(10 g) = 5.48 W/kg
Maximum value of SAR (measured) = 11.7 W/kg



Test Laboratory: Eurofins Product Service GmbH

Dipol Valid.1900 (m)_250mW ELI4_24.01.2018

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

Communication System: UID 0 - n/a, CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium: Muscle 1900 MHz Medium parameters used (interpolated): f = 1900 MHz; σ = 1.521 S/m; ε_r = 53.687; ρ = 1000 kg/m^3
Phantom section: Flat Section

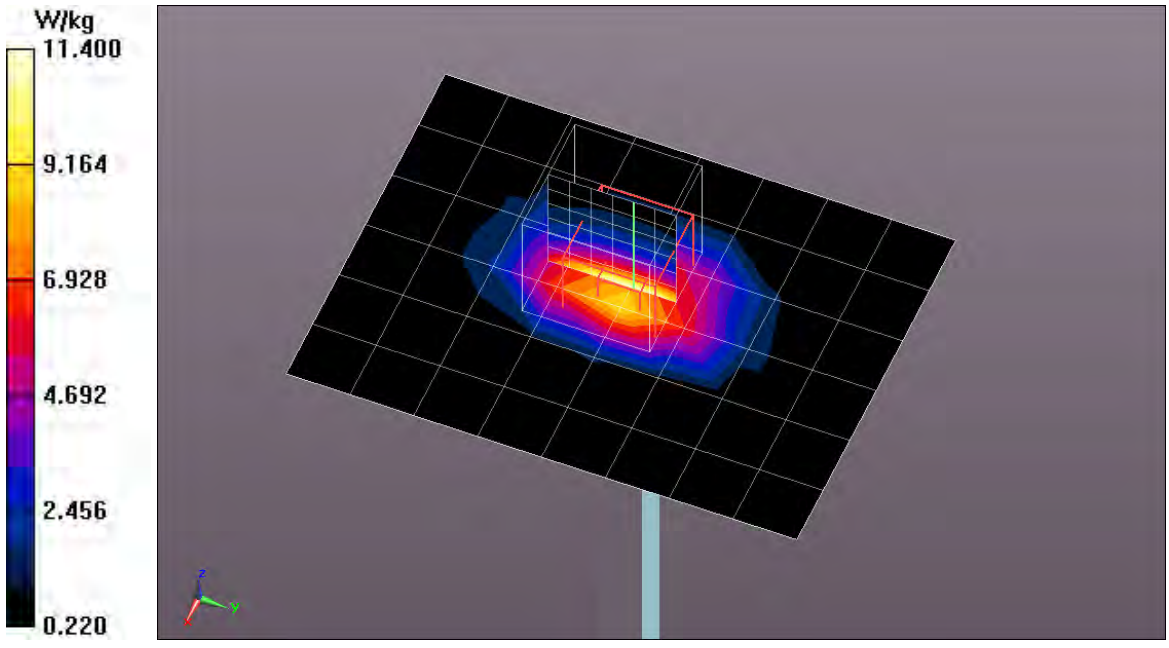
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5.2 Configuration:

- Probe: EX3DV4 - SN3893; ConvF(8.51, 8.51, 8.51); Calibrated: 2017-09-25;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 2017-09-18
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BB; Serial: SN:1013
- Measurement SW: DASY52, Version 52.8 (6); SEMCAD X Version 14.6.9 (7117)

System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=4.0mm (EX-Probe)/Area Scan (7x9x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 9.25 W/kg

System Performance Check at Frequencies above 1 GHz/d=10mm, Pin=250 mW, dist=4.0mm (EX-Probe)/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 87.252 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 18.4 W/kg
SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.36 W/kg
Maximum value of SAR (measured) = 11.4 W/kg



ANNEX C SAR Measurement Reports

Test Laboratory: Eurofins Product Service GmbH

GSM 850 CH 188 GPRS 2xSlot_Flat_Front_0mm

DUT: SAMBA-3G; Type: USB Dongle; Serial: 16690

Communication System: UID 0 - n/a, GPRS 850 2xSlot; Frequency: 836.2 MHz;Duty Cycle: 1:4.14954
Medium: Muscle 900 MHz Medium parameters used (interpolated): f = 836.2 MHz; σ = 1.01 S/m; ε_r = 54.683; ρ = 1000 kg/m^3
Phantom section: Flat Section

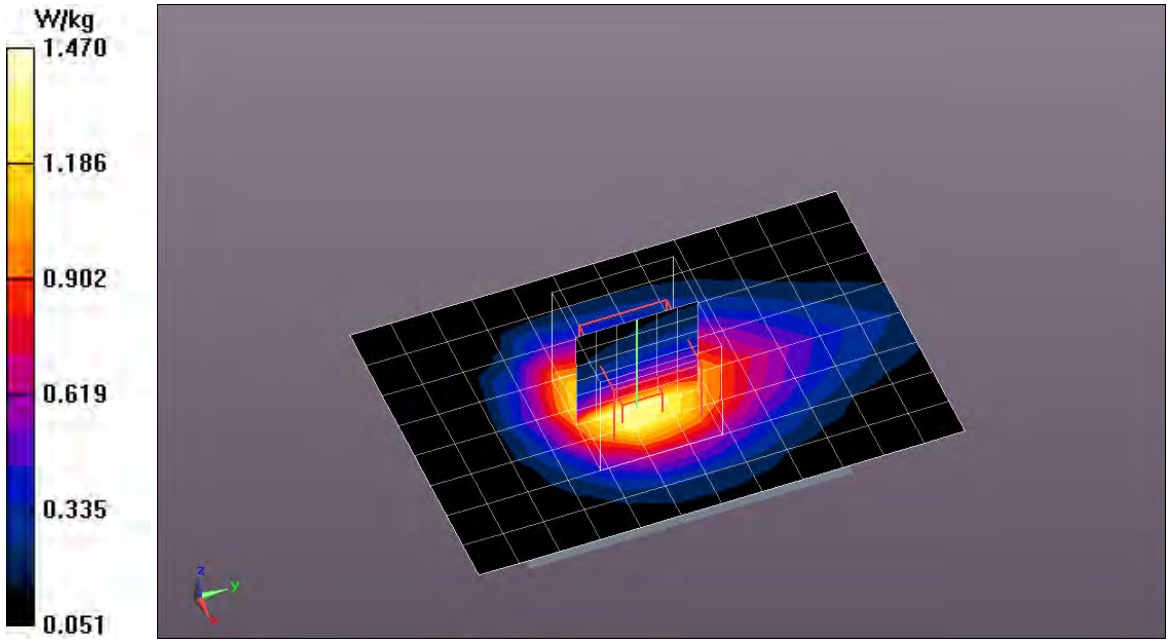
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5.2 Configuration:

- Probe: EX3DV4 - SN3893; ConvF(10.31, 10.31, 10.31); Calibrated: 2017-09-25;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 2017-09-18
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BB; Serial: SN:1013
- Measurement SW: DASY52, Version 52.8 (6); SEMCAD X Version 14.6.9 (7117)

Configuration/SAMBA-3G/Area Scan (9x13x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 1.44 W/kg

Configuration/SAMBA-3G/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 38.680 V/m; Power Drift = -0.15 dB
Peak SAR (extrapolated) = 2.36 W/kg
SAR(1 g) = 1.35 W/kg; SAR(10 g) = 0.816 W/kg
Maximum value of SAR (measured) = 1.47 W/kg



Test Laboratory: Eurofins Product Service GmbH

GSM 850 CH 188 GPRS 2xSlot_Flat_Front_0mm Repeat 1

DUT: SAMBA-3G; Type: USB Dongle; Serial: 16690

Communication System: UID 0 - n/a, GPRS 850 2xSlot; Frequency: 836.2 MHz;Duty Cycle: 1:4.14954
Medium: Muscle 900 MHz Medium parameters used (interpolated): f = 836.2 MHz; σ = 1.01 S/m; ε_r = 54.683; ρ = 1000 kg/m^3
Phantom section: Flat Section

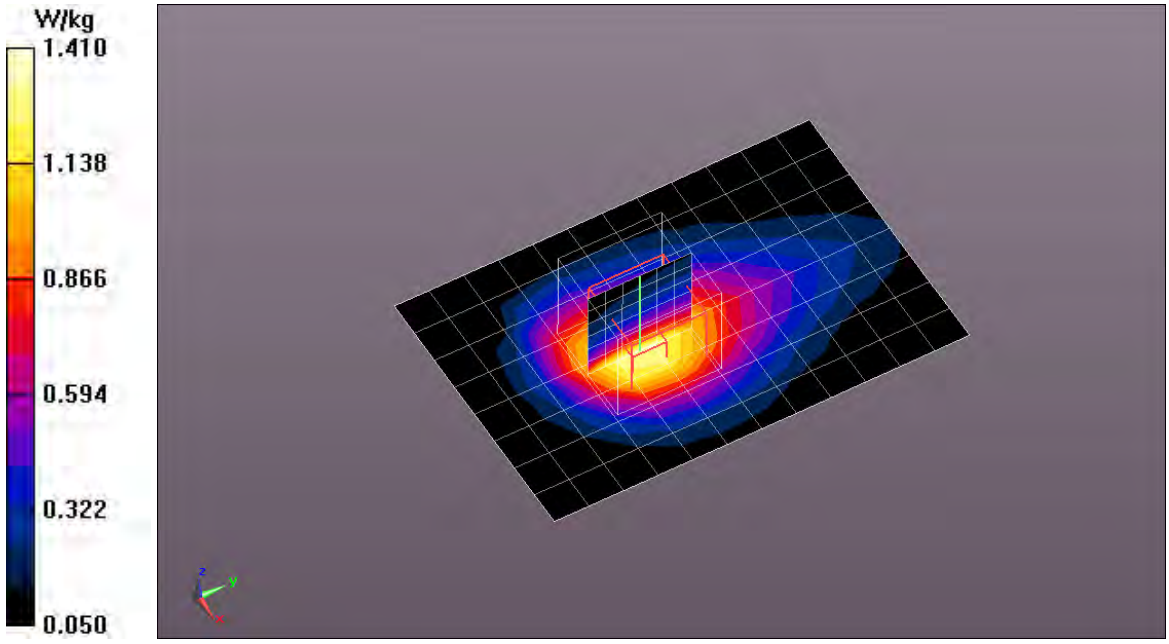
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5.2 Configuration:

- Probe: EX3DV4 - SN3893; ConvF(10.31, 10.31, 10.31); Calibrated: 2017-09-25;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 2017-09-18
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BB; Serial: SN:1013
- Measurement SW: DASY52, Version 52.8 (6); SEMCAD X Version 14.6.9 (7117)

Configuration/SAMBA-3G/Area Scan (9x13x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 1.38 W/kg

Configuration/SAMBA-3G/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 34.820 V/m; Power Drift = -0.18 dB
Peak SAR (extrapolated) = 2.26 W/kg
SAR(1 g) = 1.3 W/kg; SAR(10 g) = 0.785 W/kg
Maximum value of SAR (measured) = 1.41 W/kg



Test Laboratory: Eurofins Product Service GmbH

UMTS V CH 4132 RMC+12.2_Flat_Front_0mm

DUT: SAMBA-3G; Type: USB Dongle; Serial: 16690

Communication System: UID 0 - n/a, UMTS FDD V; Frequency: 826.4 MHz;Duty Cycle: 1:2.18776
Medium: Muscle 900 MHz Medium parameters used (interpolated): f = 826.4 MHz; σ = 1 S/m; ε_r = 54.848; ρ = 1000 kg/m^3
Phantom section: Flat Section

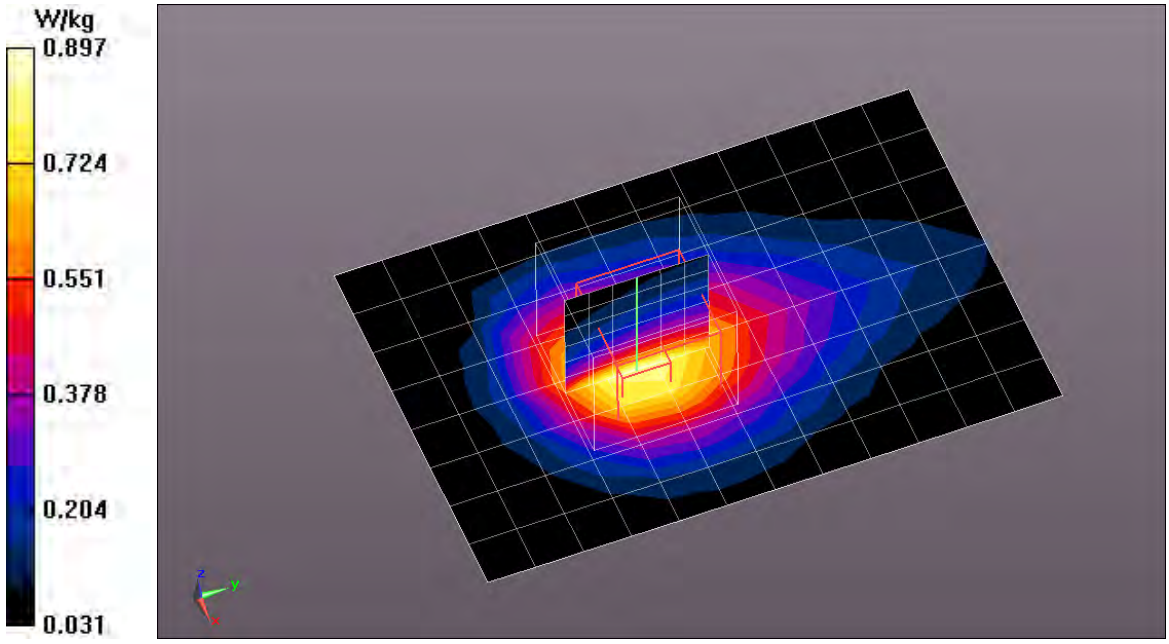
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5.2 Configuration:

- Probe: EX3DV4 - SN3893; ConvF(10.31, 10.31, 10.31); Calibrated: 2017-09-25;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 2017-09-18
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BB; Serial: SN:1013
- Measurement SW: DASY52, Version 52.8 (6); SEMCAD X Version 14.6.9 (7117)

Configuration/SAMBA-3G/Area Scan (9x13x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 0.863 W/kg

Configuration/SAMBA-3G/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 26.328 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 1.39 W/kg
SAR(1 g) = 0.822 W/kg; SAR(10 g) = 0.500 W/kg
Maximum value of SAR (measured) = 0.897 W/kg



Test Laboratory: Eurofins Product Service GmbH

GSM 1900 CH 661 GPRS 2xSlot_Flat_Back_0mm

DUT: SAMBA-3G; Type: USB Dongle; Serial: 16690

Communication System: UID 0 - n/a, GPRS 1900 2xSlot; Frequency: 1880 MHz;Duty Cycle: 1:4.14954
Medium: Muscle 1900 MHz Medium parameters used: f = 1880 MHz; σ = 1.492 S/m; ε_r = 53.676; ρ = 1000 kg/m^3
Phantom section: Flat Section

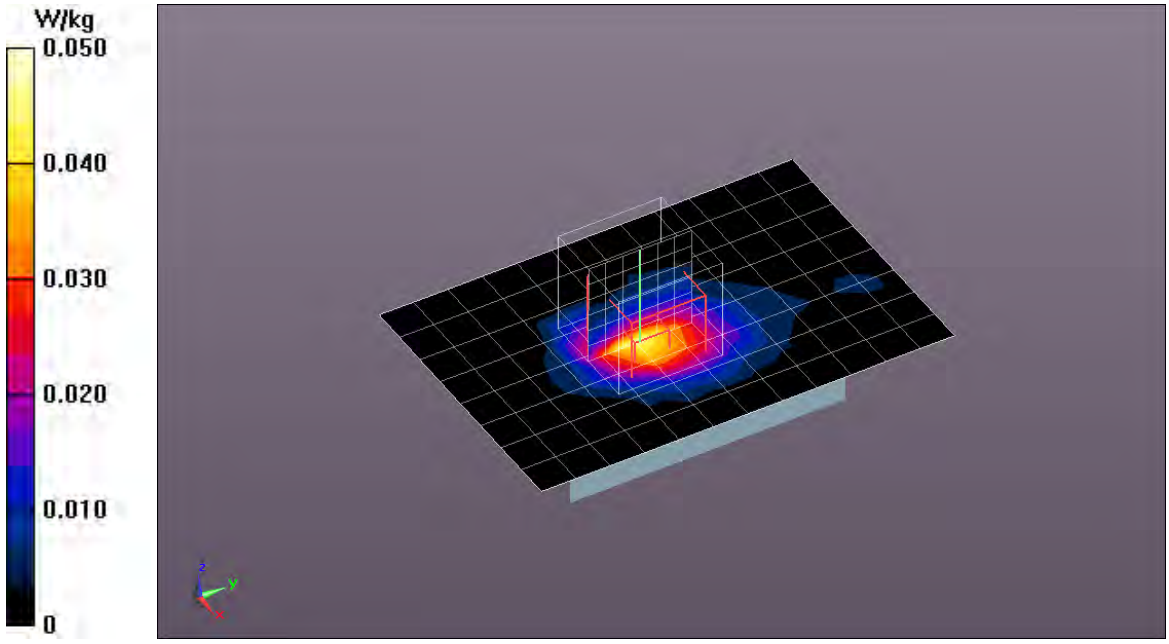
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5.2 Configuration:

- Probe: EX3DV4 - SN3893; ConvF(8.51, 8.51, 8.51); Calibrated: 2017-09-25;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 2017-09-18
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BB; Serial: SN:1013
- Measurement SW: DASY52, Version 52.8 (6); SEMCAD X Version 14.6.9 (7117)

Configuration/SAMBA-3G/Area Scan (9x13x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 0.0479 W/kg

Configuration/SAMBA-3G/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.905 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 0.0900 W/kg
SAR(1 g) = 0.044 W/kg; SAR(10 g) = 0.020 W/kg
Maximum value of SAR (measured) = 0.0503 W/kg



Test Laboratory: Eurofins Product Service GmbH

UMTS II CH 9400 RMC+12.2_Flat_Back_0mm

DUT: SAMBA-3G; Type: USB Dongle; Serial: 16690

Communication System: UID 0 - n/a, UMTS FDD II; Frequency: 1880 MHz;Duty Cycle: 1:2.18776
Medium: Muscle 1900 MHz Medium parameters used: f = 1880 MHz; σ = 1.492 S/m; ε_r = 53.676; ρ = 1000 kg/m^3
Phantom section: Flat Section

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

DASY5.2 Configuration:

- Probe: EX3DV4 - SN3893; ConvF(8.51, 8.51, 8.51); Calibrated: 2017-09-25;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn522; Calibrated: 2017-09-18
- Phantom: Flat Phantom ELI4.0; Type: QDOVA001BB; Serial: SN:1013
- Measurement SW: DASY52, Version 52.8 (6); SEMCAD X Version 14.6.9 (7117)

Configuration/SAMBA-3G/Area Scan (9x13x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 0.0446 W/kg

Configuration/SAMBA-3G/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.881 V/m; Power Drift = -0.15 dB
Peak SAR (extrapolated) = 0.0820 W/kg
SAR(1 g) = 0.038 W/kg; SAR(10 g) = 0.018 W/kg
Maximum value of SAR (measured) = 0.0447 W/kg