2300 MHz Dipole Calibration Certificate

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

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Accreditation No.: **SCS 0108**

Client **CTTL (Auden)**

Certificate No: **D2300V2-1018_Jul18**

CALIBRATION CERTIFICATE

Object	D2300V2 - SN:1018
Calibration procedure(s)	QA CAL-05.v10 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	July 24, 2018

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)	Apr-19
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19
Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-18 (No. 217-02682)	Apr-19
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-18 (No. 217-02683)	Apr-19
Reference Probe EX3DV4	SN: 7349	30-Dec-17 (No. EX3-7349_Dec17)	Dec-18
DAE4	SN: 601	26-Oct-17 (No. DAE4-601_Oct17)	Oct-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-17)	In house check: Oct-18

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

Issued: July 24, 2018

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Accreditation No.: **SCS 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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, “Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)”, July 2016
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	V52.10.1
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2300 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.5	1.67 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.3 ± 6 %	1.69 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	12.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**49.0 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.95 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.6 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	52.9	1.81 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.3 ± 6 %	1.85 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	11.9 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**47.0 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.73 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**22.7 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	50.8 Ω - 2.9 jΩ
Return Loss	- 30.4 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.8 Ω - 2.4 jΩ
Return Loss	- 27.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.169 ns

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	March 30, 2009

DASY5 Validation Report for Head TSL

Date: 24.07.2018

Test Laboratory: SPEAG, Zurich, Switzerland

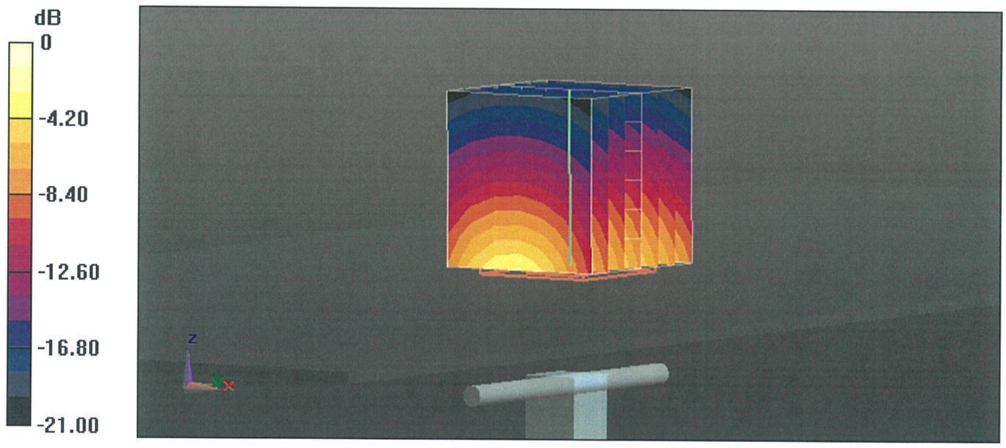
DUT: Dipole 2300 MHz; Type: D2300V2; Serial: D2300V2 - SN:1018

Communication System: UID 0 - CW; Frequency: 2300 MHz
Medium parameters used: f = 2300 MHz; σ = 1.69 S/m; ε_r = 38.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

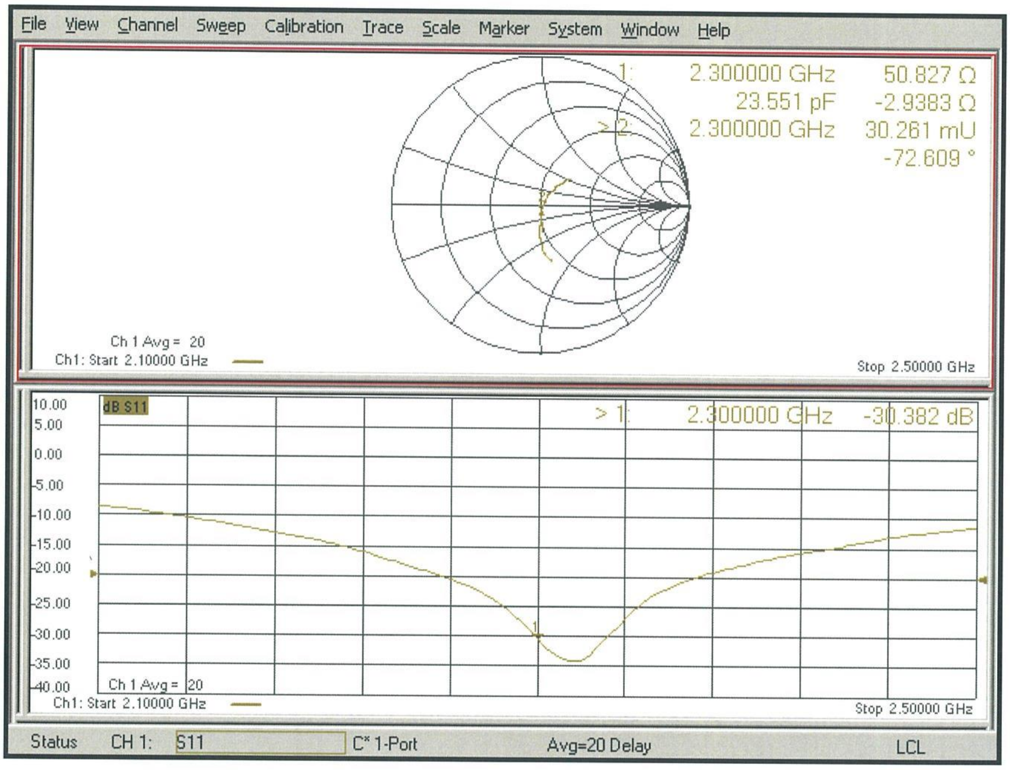
- Probe: EX3DV4 - SN7349; ConvF(8.08, 8.08, 8.08) @ 2300 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

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 = 115.7 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 23.9 W/kg
SAR(1 g) = 12.4 W/kg; SAR(10 g) = 5.95 W/kg
Maximum value of SAR (measured) = 19.9 W/kg



0 dB = 19.9 W/kg = 12.99 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 16.07.2018

Test Laboratory: SPEAG, Zurich, Switzerland

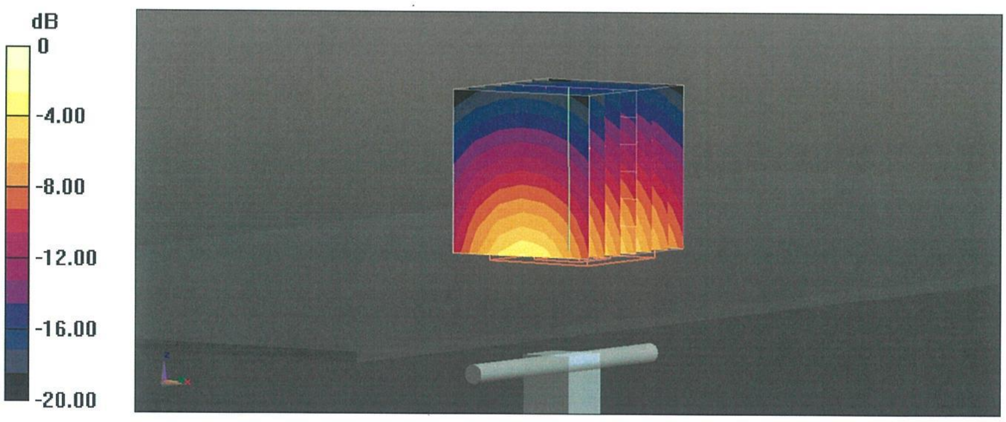
DUT: Dipole 2300 MHz; Type: D2300V2; Serial: D2300V2 - SN:1018

Communication System: UID 0 - CW; Frequency: 2300 MHz
Medium parameters used: f = 2300 MHz; σ = 1.85 S/m; ε_r = 52.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

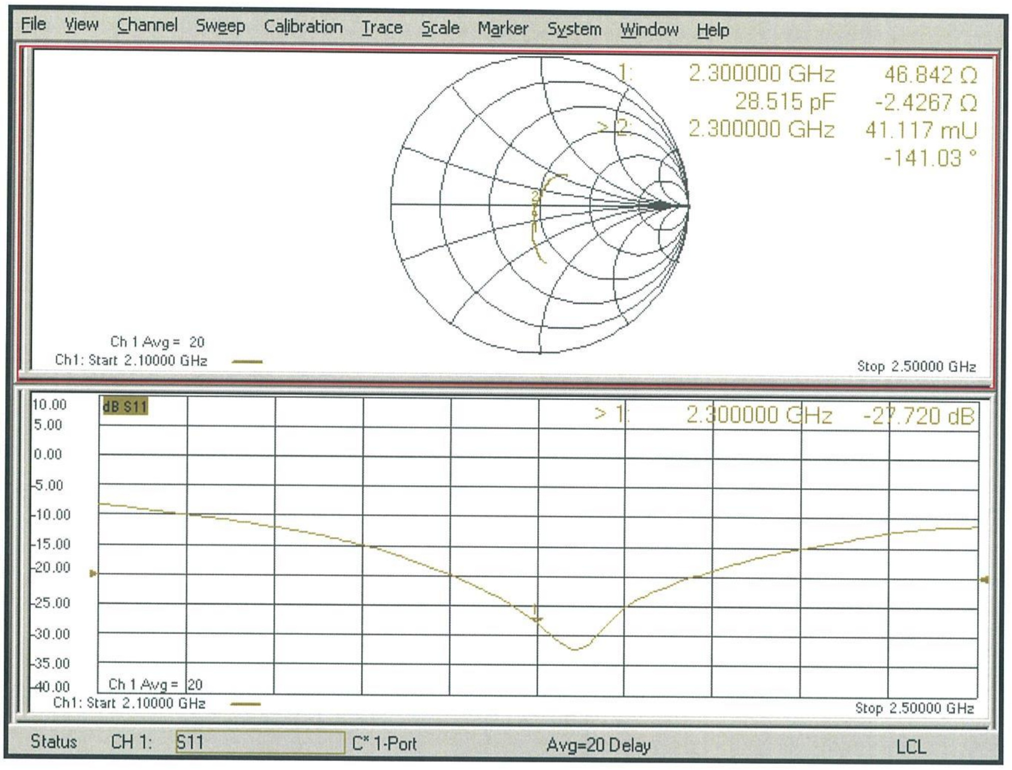
- Probe: EX3DV4 - SN7349; ConvF(8.08, 8.08, 8.08) @ 2300 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

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 = 106.5 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 22.4 W/kg
SAR(1 g) = 11.9 W/kg; SAR(10 g) = 5.73 W/kg
Maximum value of SAR (measured) = 18.8 W/kg



0 dB = 18.8 W/kg = 12.74 dBW/kg

Impedance Measurement Plot for Body TSL



2450 MHz Dipole Calibration Certificate

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Accreditation No.: SCS 0108

Client CTTL-BJ (Auden)

Certificate No: D2450V2-853_Jul17

CALIBRATION CERTIFICATE

Object: D2450V2 - SN:853

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

Calibration date: July 21, 2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02522)	Apr-18
Reference 20 dB Attenuator	SN: 5058 (20k)	07-Apr-17 (No. 217-02528)	Apr-18
Type-N mismatch combination	SN: 5047.2 / 06327	07-Apr-17 (No. 217-02529)	Apr-18
Reference Probe EX3DV4	SN: 7349	31-May-17 (No. EX3-7349_May17)	May-18
DAE4	SN: 601	28-Mar-17 (No. DAE4-601_Mar17)	Mar-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M.Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 24, 2017

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Accreditation No.: **SCS 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
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	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.8 ± 6 %	1.87 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	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.2 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.7 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	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.1 ± 6 %	2.04 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	12.9 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**50.4 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.03 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.8 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	52.0 Ω + 5.0 jΩ
Return Loss	- 25.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.6 Ω + 6.3 jΩ
Return Loss	- 24.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.161 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	November 10, 2009

DASY5 Validation Report for Head TSL

Date: 20.07.2017

Test Laboratory: SPEAG, Zurich, Switzerland

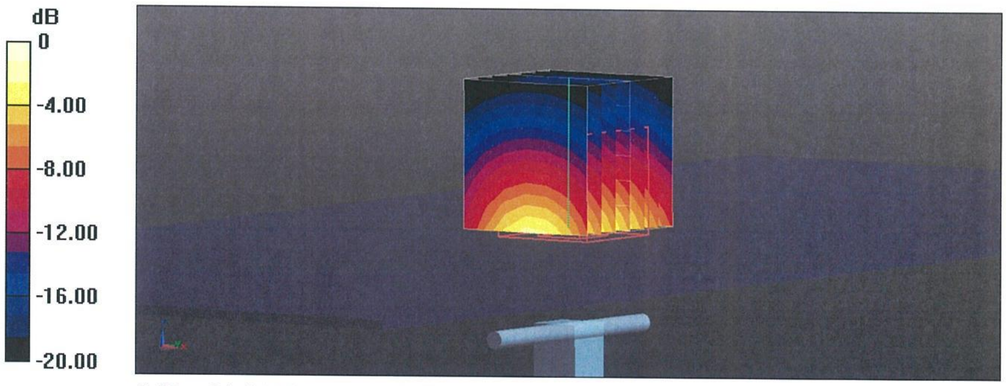
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 853

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.87 S/m; ε_r = 37.8; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

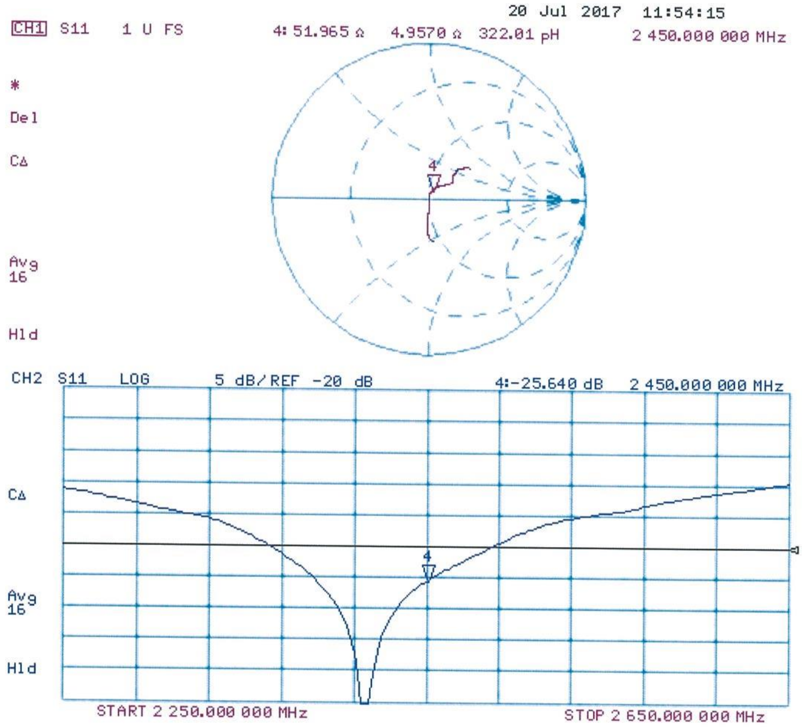
- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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 = 112.7 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 27.0 W/kg
SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.26 W/kg
Maximum value of SAR (measured) = 21.5 W/kg



0 dB = 21.5 W/kg = 13.32 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 21.07.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 853

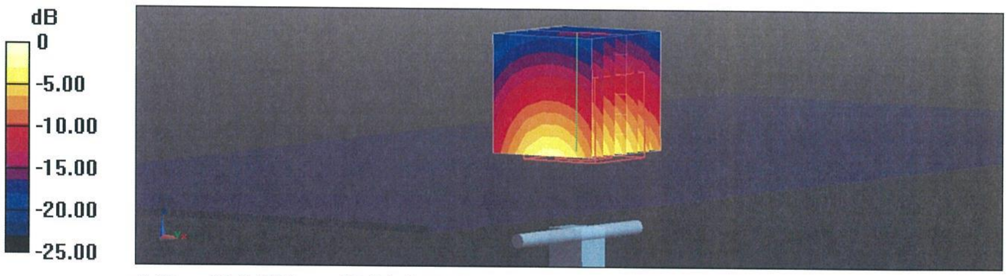
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.04 S/m; ε_r = 52.1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.1, 8.1, 8.1); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 28.03.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

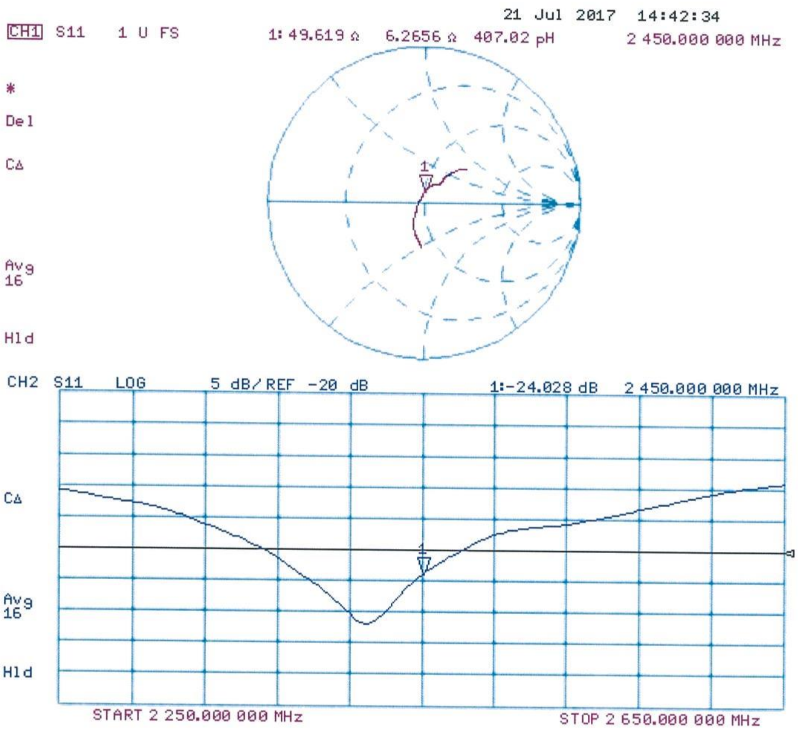
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 104.1 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 25.5 W/kg
SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.03 W/kg
Maximum value of SAR (measured) = 20.0 W/kg



0 dB = 20.0 W/kg = 13.01 dBW/kg

Impedance Measurement Plot for Body TSL



ANNEX I Extended Calibration SAR Dipole

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dBm, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

Justification of Extended Calibration SAR Dipole D750V3– serial no.1017

Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2017-7-19	-27.5		54.4		0.5	
2018-7-17	-26.0	5.5	55.1	0.7	-1.0	-1.5

Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2017-7-19	-29.1		49.3		-3.4	
2018-7-17	-29.3	-0.69	51.5	2.2	-3.1	0.3

Justification of Extended Calibration SAR Dipole D835V2– serial no.4d069

Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2017-7-19	-32.4		52.1		-1.2	
2018-7-17	-30.3	6.5	53.0	1.1	-1.0	0.2

Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2017-7-19	-26.9		47.9		-3.9	
2018-7-17	-25.5	5.2	48.5	0.6	-5.0	-1.1

Justification of Extended Calibration SAR Dipole D1750V2– serial no.1003

Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2017-7-21	-37.1		50.9		1.1	
2018-7-19	-35.6	4.0	49.5	-1.4	-1.6	-2.7

Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2017-7-21	-30.2		47.0		0.1	
2018-7-19	-27.6	8.6	46.0	-1.0	-0.3	-0.4

Justification of Extended Calibration SAR Dipole D1900V2– serial no.5d101

Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2017-7-26	-24.5		51.7		5.8	
2018-7-24	-22.9	6.5	50.6	-1.1	7.2	1.4

Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2017-7-26	-22.0		46.2		6.6	
2018-7-24	-21.4	2.7	46.4	0.2	7.4	0.8

Justification of Extended Calibration SAR Dipole D2450V2– serial no.853

Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2017-7-21	-25.6		52.0		5.0	
2018-7-19	-23.1	9.8	53.6	1.6	6.3	1.3

Body						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (johm)	Delta (johm)
2017-7-21	-24.0		49.6		6.3	
2018-7-19	-22.0	8.3	50.4	0.8	8.0	1.7

ANNEX J Variant Product Test

J.1 Dielectric Performance and System Validation

Table J.1-1: Dielectric Performance of Head Tissue Simulating Liquid

Measurement Date (yyyy-mm-dd)	Type	Frequency	Permittivity ε	Drift (%)	Conductivity σ (S/m)	Drift (%)
2019-12-29	Head	750 MHz	41.7	-0.57	0.898	0.90
	Body	750 MHz	55.35	-0.27	0.951	-0.94
2019-12-29	Head	835 MHz	41.6	0.24	0.901	0.11
	Body	835 MHz	56.1	1.63	0.988	1.86
2019-12-29	Head	1750 MHz	40.68	1.50	1.38	0.73
	Body	1750 MHz	53.22	-0.34	1.514	1.61
2019-12-30	Head	1900 MHz	39.55	-1.13	1.39	-0.71
	Body	1900 MHz	53.19	-0.21	1.536	1.05
2019-12-30	Head	2300 MHz	39.35	-0.38	1.655	-0.90
	Body	2300 MHz	53.56	1.25	1.825	0.83
2019-12-30	Head	2450 MHz	39.76	1.43	1.805	0.28
	Body	2450 MHz	51.8	-1.71	1.93	-1.03

Table J.1-2: System Validation of Head

Measurement Date (yyyy-mm-dd)	Frequency	Target value (W/kg)		Measured value(W/kg)		Deviation	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
2019-12-29	750 MHz	5.57	8.57	5.52	8.56	-0.90%	-0.12%
2019-12-29	835 MHz	6.29	9.70	6.28	9.8	-0.16%	1.03%
2019-12-29	1750 MHz	19.3	36.6	19.4	36.04	0.52%	-1.53%
2019-12-30	1900 MHz	20.8	39.7	20.6	40.28	-0.96%	1.46%
2019-12-30	2300 MHz	24.1	49.7	24.52	50.6	1.74%	1.81%
2019-12-30	2450 MHz	24.2	51.6	24.36	52.4	0.66%	1.55%

Table J.1-2: System Validation of Body

Measurement Date (yyyy-mm-dd)	Frequency	Target value (W/kg)		Measured value(W/kg)		Deviation	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
2019-12-29	750 MHz	5.63	8.55	5.6	8.72	-0.53%	1.99%
2019-12-29	835 MHz	6.32	9.68	6.4	9.52	1.27%	-1.65%
2019-12-29	1750 MHz	19.5	36.8	19.76	36.48	1.33%	-0.87%
2019-12-30	1900 MHz	20.9	39.7	20.64	39.32	-1.24%	-0.96%
2019-12-30	2300 MHz	22.9	47.2	22.56	46.72	-1.48%	-1.02%
2019-12-30	2450 MHz	24.5	52.3	24.88	51.48	1.55%	-1.57%

J.2 Spot Check

J.2.1 Conducted power of selected case

Table J.2-1: The conducted power results for 2G- Normal Power

GSM 850MHZ	Measured Power (dBm)		
	251	190	128
Speech	/	32.23	/
GPRS(2Tx)	/	/	31.09
GSM1900MHZ	Measured Power (dBm)		
	810	661	512
Speech	/	28.98	/
GPRS(2Tx)	27.05	27.16	27.13

Table J.2-2: The conducted power results for 2G-Low Power

GSM1900MHZ	Measured Power (dBm)		
	810	661	512
GPRS(2Tx)	/	21.53	/

Table J.2-3: The conducted Power for WCDMA- Normal Power

Item	band	FDDII result		
	ARFCN	9538/9938	9400/9800	9262/9662
WCDMA	\	(1907.6MHz)	(1880MHz)	(1852.4MHz)
		21.94	/	22.39
Item	band	FDDIV result		
	ARFCN	1513/1738	1412/1637	1312/1537
WCDMA	\	(1752.6MHz)	(1732.4MHz)	(1712.4MHz)
		22.18	/	/
Item	band	FDDV result		
	ARFCN	4233/4458	4183/4408	4132/4357
WCDMA	\	(846.6MHz)	(836.6MHz)	(826.4MHz)
			24.45	24.27

Table J.2-4: The conducted Power for WCDMA- Low Power

Item	band	FDDII result		
	ARFCN	9538/9938	9400/9800	9262/9662
WCDMA	\	(1907.6MHz)	(1880MHz)	(1852.4MHz)
		/	/	18.83
Item	band	FDDIV result		
	ARFCN	1513/1738	1412/1637	1312/1537
WCDMA	\	(1752.6MHz)	(1732.4MHz)	(1712.4MHz)
		18.66	/	/

Table J.2-5: The conducted Power for LTE-Normal Power

LTE Band2	1RB-Middle	1900(19100)	22.83
LTE Band4	1RB-Middle	1720(20050)	22.81

LTE Band4	1RB-Middle	1745(20300)	22.66
LTE Band5	1RB-Middle	829(20450)	23.29
LTE Band12	1RB-Middle	704 (23060)	23.42
LTE Band14	1RB-Middle	793(2330)	23.23
LTE Band30	1RB-Middle	2310 (27710)	22.26

Table J.2-6: The conducted Power for LTE-Low Power

LTE Band2	1RB-Middle	1860(18700)	18.69
LTE Band4	1RB-Middle	1745(20300)	19.21
LTE Band30	1RB-High	2310 (27710)	20.42

Table J.2-7: The conducted Power for WLAN

Mode / data rate	Channel	Measured Power (dBm)
802.11b – 5.5Mbps	6	18.77
802.11b – 5.5Mbps	11	18.71

J.2.2 Measurement results

Test Band	Channel	Frequency	Tune-Up	Measured Power	Test Position	Measured 10g SAR	Measured 1g SAR	Reported 10g SAR	Reported 1g SAR	Power Drift
GSM850	190	836.6	33.2	32.23	Left Cheek	0.156	0.201	0.20	0.25	0.07
GSM850	128	824.2	32	31.09	Rear	0.434	0.561	0.54	0.69	-0.02
PCS1900	661	1880	30	28.98	Right Cheek	0.097	0.159	0.12	0.20	-0.1
PCS1900	661	1880	22.5	21.53	Bottom	0.271	0.516	0.34	0.65	-0.02
PCS1900	810	1909.8	28	27.05	Rear	0.524	0.903	0.65	1.12	0.05
PCS1900	661	1880	28	27.16	Rear	0.496	0.869	0.60	1.05	0.08
PCS1900	512	1850.2	28	27.13	Rear	0.516	0.925	0.63	1.13	-0.13
WCDMA1900-BII	9538	1907.6	23.2	21.94	Right Cheek	0.0858	0.139	0.11	0.19	-0.02
WCDMA1900-BII	9262	1852.4	20.2	18.83	Bottom	0.35	0.664	0.48	0.91	-0.01
WCDMA1900-BII	9262	1852.4	23.2	22.39	Rear	0.418	0.757	0.50	0.91	0.06
WCDMA1700-BIV	1513	1752.6	22.5	21.18	Right Cheek	0.0792	0.125	0.11	0.17	-0.09
WCDMA1700-BIV	1513	1752.6	20	18.66	Bottom	0.366	0.714	0.50	0.97	0.12
WCDMA1700-BIV	1513	1752.6	22.5	21.18	Rear	0.402	0.723	0.54	0.98	0.11
WCDMA850-BV	4183	836.6	25.5	24.45	Left Cheek	0.328	0.426	0.42	0.54	-0.09
WCDMA850-BV	4132	826.4	25.5	24.27	Rear	0.462	0.597	0.61	0.79	0
LTE1900-FDD2	19100	1900 MHz	24	22.83	Right Cheek	0.119	0.199	0.16	0.26	-0.03
LTE1900-FDD2	18700	1860 MHz	20	18.69	Bottom	0.423	0.815	0.57	1.10	0.05
LTE1900-FDD2	19100	1900 MHz	24	22.83	Rear	0.314	0.565	0.41	0.74	-0.03
LTE1700-FDD4	20050	1720 MHz	24	22.81	Right Cheek	0.0831	0.128	0.11	0.17	-0.08
LTE1700-FDD4	20300	1745 MHz	20.5	19.21	REar	0.333	0.587	0.45	0.79	-0.19
LTE1700-FDD4	20300	1745 MHz	24	22.66	Rear	0.319	0.609	0.43	0.83	-0.14
LTE850-FDD5	20450	829 MHz	24.5	23.29	Left Cheek	0.25	0.33	0.33	0.44	-0.1
LTE850-FDD5	20450	829 MHz	24.5	23.29	Rear	0.356	0.467	0.47	0.62	-0.05
LTE700-FDD12	23060	704 MHz	24.5	23.42	Left Cheek	0.198	0.26	0.25	0.33	0.09
LTE700-FDD12	23060	704 MHz	24.5	23.42	Rear	0.359	0.471	0.46	0.60	-0.07
LTE700-FDD14	2330	-1307 MHz	24.5	23.23	Left Cheek	0.246	0.322	0.33	0.43	0.04
LTE700-FDD14	2330	-1307 MHz	24.5	23.23	Rear	0.447	0.589	0.60	0.79	-0.02
LTE2300-FDD30	27710	2310 MHz	24	22.26	Left Cheek	0.119	0.216	0.18	0.32	-0.08
LTE2300-FDD30	27710	2310 MHz	21.5	20.42	Rear	0.454	0.901	0.58	1.16	0.08
LTE2300-FDD30	27710	2310 MHz	24	22.26	Rear	0.324	0.619	0.48	0.92	0.07
WLAN2450	11	2462	20	18.71	Left Cheek	0.422	0.843	0.57	1.13	0.08
WLAN2450	6	2437	20.5	18.77	REar	0.131	0.247	0.20	0.37	0.08

J.2.3 Reported SAR Comparison

Table J.3.3-1: Comparison

Exposure Configuration	Technology Band	Reported SAR 1g(W/kg) Original	Reported SAR 1g(W/kg) Spot check	Equipment Class
Head (Separation Distance 0mm)	GSM 850	0.17	0.25	PCE
	PCS 1900	0.22	0.20	
	UMTS FDD 2	0.22	0.19	
	UMTS FDD 4	0.17	0.17	
	UMTS FDD 5	0.54	0.54	
	LTE Band 2	0.23	0.26	
	LTE Band 4	0.21	0.17	
	LTE Band 5	0.36	0.44	
	LTE Band 12	0.25	0.33	
	LTE Band 14	0.42	0.43	
	LTE Band 30	0.26	0.32	
	WiFi 2.4 GHz	1.28	1.13	DTS
Hotspot (Separation Distance 10mm)	GSM 850	0.62	0.69	PCE
	PCS 1900	0.84	0.65	
	UMTS FDD 2	1.25	0.91	
	UMTS FDD 4	1.12	0.97	
	UMTS FDD 5	0.70	0.79	
	LTE Band 2	1.31	1.10	
	LTE Band 4	1.17	0.79	
	LTE Band 5	0.40	0.62	
	LTE Band 12	0.53	0.60	
	LTE Band 14	0.62	0.79	
	LTE Band 30	1.10	1.16	
	WiFi 2.4 GHz	0.34	0.37	DTS
Body worn (Separation Distance 15mm)	PCS 1900	0.87	1.13	PCE
	UMTS FDD 2	0.94	0.91	
	UMTS FDD 4	1.00	0.98	
	LTE Band 2	0.79	0.74	
	LTE Band 4	1.20	0.83	
	LTE Band 30	1.13	0.92	

Note: The spot check results marked by blue are larger than the original result. So they replace the original result and others are shared.

J.3 List of Main Instruments

Table J.4.1: List of Main Instruments

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	E5071C	MY46110673	January 24, 2019	One year
02	Power meter	NRP2	106277	September 4, 2019	One year
03	Power sensor	NRP8S	104291		
04	Signal Generator	E4438C	MY49070393	January 4, 2019	One Year
05	Amplifier	60S1G4	0331848	No Calibration Requested	
06	BTS	E5515C	MY50263375	January 17, 2019	One year
07	BTS	CMW500	159890	January 3, 2019	One year
08	E-field Probe	SPEAG EX3DV4	3617	January 31, 2019	One year
09	DAE	SPEAG DAE4	771	January 11,2019	One year
10	Dipole Validation Kit	SPEAG D750V3	1017	July 18, 2019	One year
11	Dipole Validation Kit	SPEAG D835V2	4d069	July 18, 2019	One year
12	Dipole Validation Kit	SPEAG D1750V2	1003	July 16, 2019	One year
13	Dipole Validation Kit	SPEAG D1900V2	5d101	July 17, 2019	One year
14	Dipole Validation Kit	SPEAG D2300V2	1018	July 17, 2019	One year
15	Dipole Validation Kit	SPEAG D2450V2	853	July 17, 2019	One year

J.4 GRAPH RESULTS

GSM850_CH190 Left Cheek
Date: 12/29/2019
Electronics: DAE4 Sn771
Medium: head 835 MHz
Medium parameters used: f = 836.6; σ = 0.903 mho/m; εr = 41.6; ρ = 1000 kg/m^3
Ambient Temperature: 22.5°C, Liquid Temperature: 22.3°C
Communication System: GSM850 836.6 Duty Cycle: 1：8.3
Probe: EX3DV4 – SN3617 ConvF(9.75,9.75,9.75)

Area Scan (71x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.235 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.63 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 0.253 W/kg
SAR(1 g) = 0.201 W/kg; SAR(10 g) = 0.156 W/kg
Maximum value of SAR (measured) = 0.237 W/kg

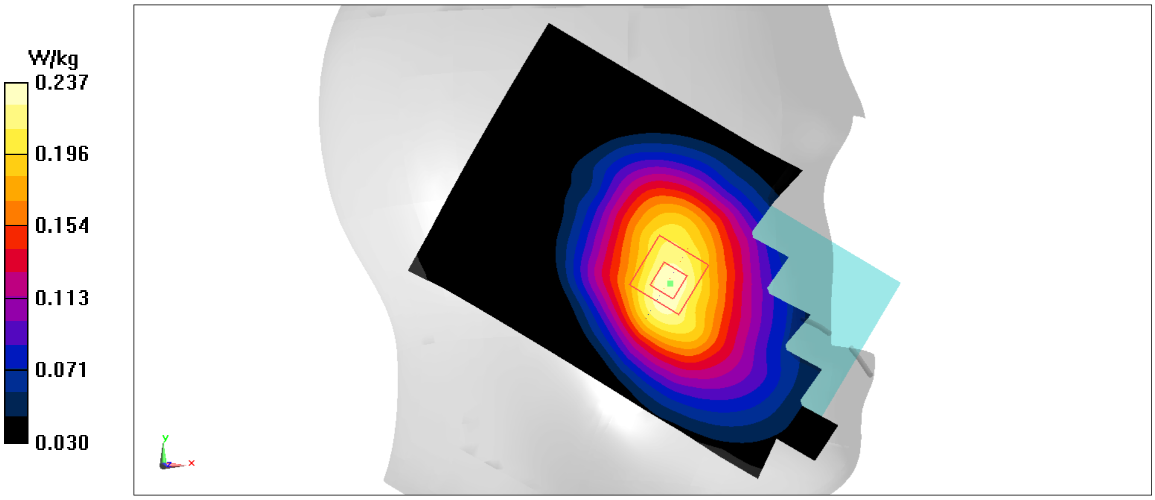


Fig A.1