1.1. D835V2 Dipole Calibration Certificate

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





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

Accreditation No.: SCS 0108

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

Client

CCIC-HTW (Auden)

Certificate No: D835V2-4d238_Feb18

bject	D835V2 - SN:4d23	38	
alibration procedure(s)	QA CAL-05.v9 Calibration proced	dure for dipole validation kits abov	e 700 MHz
alibration date:	February 19, 2018	В	
he measurements and the unce	cted in the closed laborator	onal standards, which realize the physical unitrobability are given on the following pages and y facility: environment temperature $(22\pm3)^{\circ}$ C	
Calibration Equipment assay	Ť	C. I. D. La (Contificato No.)	Scheduled Calibration
Primary Standards	ID#	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522)	Apr-18
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02522)	Apr-18
Power sensor NRP-Z91	SN: 103245	07-Apr-17 (No. 217-02528)	Apr-18
Reference 20 dB Attenuator	SN: 5058 (20k)	07-Apr-17 (No. 217-02529)	Apr-18
Type-N mismatch combination	SN: 5047.2 / 06327	30-Dec-17 (No. EX3-7349_Dec17)	Dec-18
Type-14 Illioniator.	SN: 7349	26-Oct-17 (No. DAE4-601_Oct17)	Oct-18
Reference Probe EX3DV4	SN: 601		
Reference Probe EX3DV4	SN: 601		Scheduled Check
Reference Probe EX3DV4 DAE4	SN: 601	Check Date (in house)	Scheduled Check In house check: Oct-18
Reference Probe EX3DV4 DAE4 Secondary Standards	L	Check Date (in house) 07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A	ID#	Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	In house check: Oct-18 In house check: Oct-18
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A	ID # SN: GB37480704	Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A	ID # SN: GB37480704 SN: US37292783	Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16)	In house check: Oct-18 In house check: Oct-18
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	ID # SN: GB37480704 SN: US37292783 SN: MY41092317	Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	In house check: Oct-18 In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A	ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: US37390585	Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16)	In house check: Oct-18 Signature
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06	ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972	Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17)	In house check: Oct-18 Signature
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E	ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: US37390585 Name	Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17) Function Laboratory Technician	In house check: Oct-18
Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E	ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: US37390585 Name	Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17) Function	In house check: Oct-18 Signature

Certificate No: D835V2-4d238_Feb18

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Calibration Laboratory of

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





Schweizerischer Kalibrierdienst Service suisse d'étalonnage

C Servizio svizzero di taratura

Accreditation No.: SCS 0108

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

Glossary:

TSL

tissue simulating liquid

ConvF N/A

sensitivity in TSL / NORM x,y,z 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%.

Certificate No: D835V2-4d238_Feb18

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Measurement Conditions

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

ASY system configuration, as far as not g	DASY5	V52.10.0
DASY Version		
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
	dx, dy , $dz = 5 mm$	
Zoom Scan Resolution	835 MHz ± 1 MHz	
Frequency	835 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

he following parameters and calculations were appli	Temperature	Permittivity	Conductivity
1701	22.0 °C	41.5	0.90 mho/m
Nominal Head TSL parameters	(22.0 ± 0.2) °C	41.2 ± 6 %	0.92 mho/m ± 6 %
Measured Head TSL parameters Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
	250 mW input power	2.42 W/kg
SAR measured	normalized to 1W	9.51 W/kg ± 17.0 % (k=2)
SAR for nominal Head TSL parameters	normalized to TVV	0.01

1 and 10 am ³ (10 a) of Head TSL	condition	
SAR averaged over 10 cm³ (10 g) of Head TSL	250 mW input power	1.56 W/kg
SAR measured		6.15 W/kg ± 16.5 % (k=2)
SAR for nominal Head TSL parameters	normalized to 1W	0.10 Wing _ 1010 10 (1)

Body TSL parameters

The following parameters and calculations were applied.

d. Temperature	Permittivity	Conductivity
22.0 °C	55.2	0.97 mho/m
(22.0 ± 0.2) °C	55.0 ± 6 %	0.99 mho/m ± 6 %
	Temperature	22.0 °C 55.2 (22.0 ± 0.2) °C 55.0 ± 6 %

SAR result with Body TSL

	Condition	
SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	0.45 \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
	250 mW input power	2.45 W/kg
SAR measured	and to 1W	9.64 W/kg ± 17.0 % (k=2)
SAR for nominal Body TSL parameters	normalized to 1W	ole i i i i j

12 mg (10 m) of Body TSI	condition	
SAR averaged over 10 cm ³ (10 g) of Body TSL	250 mW input power	1.60 W/kg
SAR measured	normalized to 1W	6.32 W/kg ± 16.5 % (k=2)
SAR for nominal Body TSL parameters	Hormanzed to 144	

Certificate No: D835V2-4d238_Feb18

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.8 Ω - 4.0 jΩ
Impedance, transformed to reed perm	- 27.8 dB
Deturn Loss	- 27.6 UD
Return Loss	

Antenna Parameters with Body TSL

10 St. (1997)	47.0.0.60.10
Impedance, transformed to feed point	47.6 Ω - 6.0 jΩ
	- 23.6 dB
Return Loss	

General Antenna Parameters and Design

L. J. D. J. (consideration)	1.391 ns
Electrical Delay (one direction)	

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

SPEAG	
luna 00, 2017	
June 02, 2017	
	SPEAG June 02, 2017

Certificate No: D835V2-4d238_Feb18

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DASY5 Validation Report for Head TSL

Date: 19.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d238

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: f = 835 MHz; σ = 0.92 S/m; ϵ_r = 41.2; ρ = 1000 kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(9.9, 9.9, 9.9); Calibrated: 30.12.2017;

• Sensor-Surface: 1.4mm (Mechanical Surface Detection)

• Electronics: DAE4 Sn601; Calibrated: 26.10.2017

Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001

DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

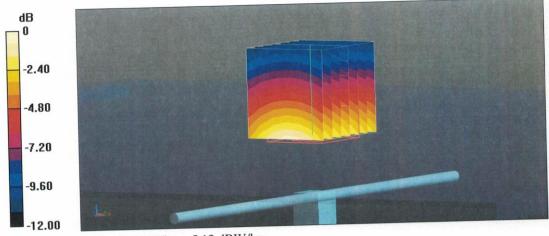
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 62.44 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 3.69 W/kg

SAR(1 g) = 2.42 W/kg; SAR(10 g) = 1.56 W/kg

Maximum value of SAR (measured) = 3.25 W/kg

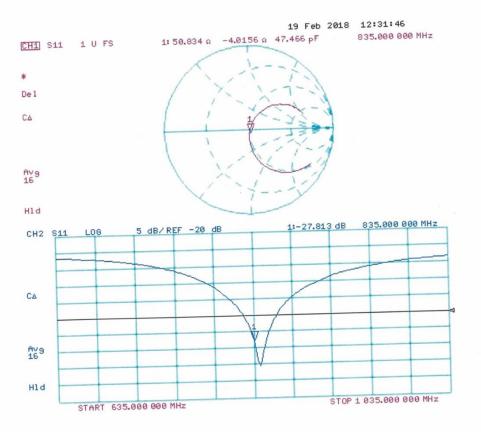


0 dB = 3.25 W/kg = 5.12 dBW/kg

Certificate No: D835V2-4d238_Feb18

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Impedance Measurement Plot for Head TSL



Certificate No: D835V2-4d238_Feb18

DASY5 Validation Report for Body TSL

Date: 19.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN:4d238

Communication System: UID 0 - CW; Frequency: 835 MHz

Medium parameters used: f = 835 MHz; σ = 0.99 S/m; ϵ_r = 55; ρ = 1000 kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(10.05, 10.05, 10.05); Calibrated: 30.12.2017;

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Electronics: DAE4 Sn601; Calibrated: 26.10.2017

Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005

• DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

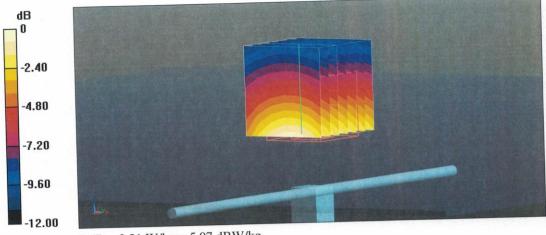
Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 60.24 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.70 W/kg

SAR(1 g) = 2.45 W/kg; SAR(10 g) = 1.6 W/kg

Maximum value of SAR (measured) = 3.21 W/kg

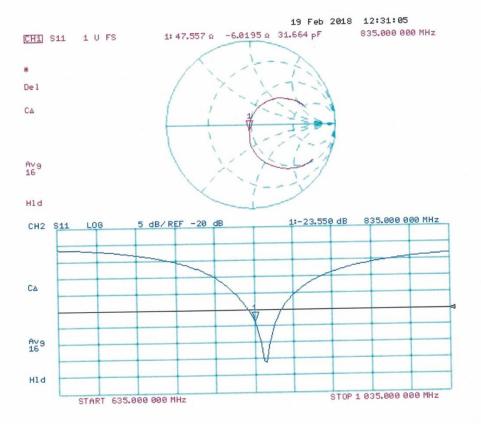


0 dB = 3.21 W/kg = 5.07 dBW/kg

Certificate No: D835V2-4d238_Feb18

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Impedance Measurement Plot for Body TSL



Certificate No: D835V2-4d238_Feb18

Extended Dipole Calibrations

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, 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.

Head-835						
Date of	Return-loss (dB)	Dolto (9/)	Real Impedance	Delta	Imaginary	Delta
measurement	Return-1055 (db) Delta	Delta (%)	(ohm)	(ohm)	impedance (ohm)	(ohm)
2018/2/19	-27.8		50.8		-4.0	
2019/2/3	-27.1	-2.52%	49.9	0.9	-3.6	0.4

Body-835						
Date of	Poturn loss (dP)	Dolto (9/)	Real Impedance	Delta	Imaginary	Delta
measurement	Return-loss (dB) Delta	Delta (%)	(ohm)	(ohm)	impedance (ohm)	(ohm)
2018/2/19	-23.6		47.6		-6.0	
2019/2/3	-24.2	2.54%	47.1	0.5	-6.2	0.2

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 50hm of prior calibration. Therefore the verification result should support extended calibration.

1.2. D1900V2 Dipole Calibration Certificate

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





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

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CCIC HTW (Audam)

Client CCIC-HTW (Au	CCIC-HTW (Auden)		Certificate No: D1900V2-5d226_Feb18	
CALIBRATION (CERTIFICAT	E		
Object	D1900V2 - SN:5	5d226		
Calibration procedure(s)	QA CAL-05.v9			
	Calibration procedure for dipole validation kits above 700 MHz			
Calibration date:	February 22, 20	18		
All calibrations have been conducted Calibration Equipment used (M&T		ory facility: environment temperature (22 ± 3)°C and humidity < 70%.	
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	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 HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-17)	In house check: Oct-18	
	Name	Function	Signature	
Calibrated by:	Michael Weber	Laboratory Technician	M.NESES	
Approved by:	Katja Pokovic	Technical Manager	LLUS	
This calibration certificate shall no	t be reproduced except in	full without written approval of the lab	Issued: February 22, 2018	

Certificate No: D1900V2-5d226_Feb18

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Calibration Laboratory of Schmid & Partner

Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland





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Multilateral Agreement for the recognition of calibration certificates

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
- 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%.

Certificate No: D1900V2-5d226_Feb18

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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	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	40.7 ± 6 %	1.39 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	40.3 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.25 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.1 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	55.2 ± 6 %	1.48 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	9.71 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	39.8 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.16 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.9 W/kg ± 16.5 % (k=2)

Certificate No: D1900V2-5d226_Feb18

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$52.2 \Omega + 6.0 i\Omega$	
Return Loss	- 24.0 dB	

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.9 Ω + 7.5 iΩ	
Return Loss	- 22.0 dB	

General Antenna Parameters and Design

Floatrical Delevides all in it	
Electrical Delay (one direction)	1.195 ns
	1.19518

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 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	
	April 16, 2015

Certificate No: D1900V2-5d226_Feb18

DASY5 Validation Report for Head TSL

Date: 22.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d226

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

Medium parameters used: f = 1900 MHz; σ = 1.39 S/m; ϵ_r = 40.7; ρ = 1000 kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.18, 8.18, 8.18); 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 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

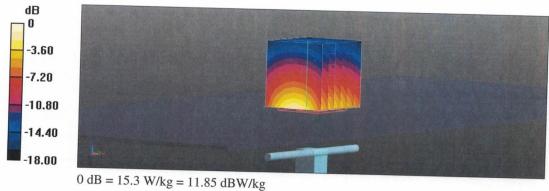
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 109.6 V/m; Power Drift = -0.09 dB

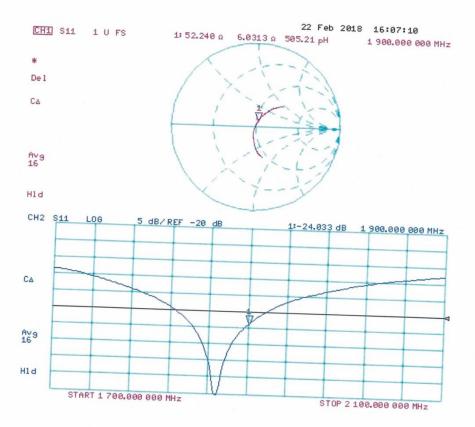
Peak SAR (extrapolated) = 18.5 W/kg

SAR(1 g) = 10 W/kg; SAR(10 g) = 5.25 W/kg

Maximum value of SAR (measured) = 15.3 W/kg



Impedance Measurement Plot for Head TSL



Certificate No: D1900V2-5d226_Feb18

DASY5 Validation Report for Body TSL

Date: 22.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d226

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

Medium parameters used: f = 1900 MHz; σ = 1.48 S/m; ϵ_r = 55.2; ρ = 1000 kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(8.15, 8.15, 8.15); 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 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

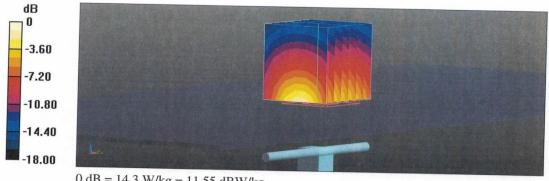
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 102.8 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 17.2 W/kg

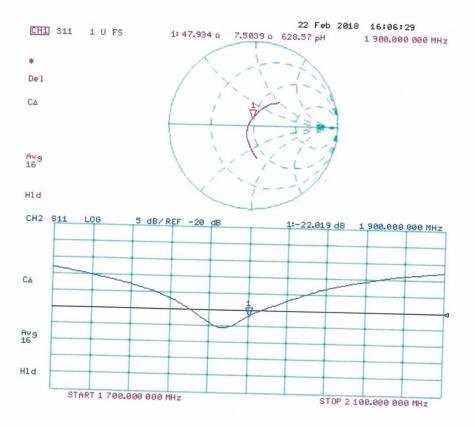
SAR(1 g) = 9.71 W/kg; SAR(10 g) = 5.16 W/kg

Maximum value of SAR (measured) = 14.3 W/kg



0 dB = 14.3 W/kg = 11.55 dBW/kg

Impedance Measurement Plot for Body TSL



Certificate No: D1900V2-5d226_Feb18

Extended Dipole Calibrations

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, 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.

			Head-1900			
Date of	Deturn lose (dD)	Dolto (9/)	Real Impedance	Delta	Imaginary	Delta
measurement	Return-loss (dB)	Delta (%)	(ohm)	(ohm)	impedance (ohm)	(ohm)
2018/2/22	-24.0		52.2		6.0	
2019/2/20	-24.5	2.08%	52.6	0.4	6.5	0.5

			Body-1900			
Date of	Return-loss (dB)	Delta (%)	Real Impedance	Delta	Imaginary	Delta
measurement	Return-1055 (db)	Della (%)	(ohm)	(ohm)	impedance (ohm)	(ohm)
2018/2/22	-22.0		47.9		7.5	
2019/2/20	-22.3	1.36%	47.3	0.6	7.1	0.4

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 50hm of prior calibration. Therefore the verification result should support extended calibration.

1.3. D2450V2 Dipole Calibration Certificate

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





Schweizerischer Kalibrierdienst Service suisse d'étalonnage 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

CALIBRATION	CERTIFICAT	1 2	
Object	D2450V2 - SN:	1009	
Calibration procedure(s)	QA CAL-05.v9 Calibration prod	cedure for dipole validation kits	above 700 MHz
Calibration date:	February 05, 20	018	
		ational standards, which realize the physical probability are given on the following page: ory facility: environment temperature (22 \pm	s and are part of the certificate.
Calibration Equipment used (M&	TE critical for calibration)		7070.
Calibration Equipment used (M&	TE critical for calibration)		770/6.
Calibration Equipment used (M& Primary Standards	TE critical for calibration)	Cal Date (Certificate No.)	Scheduled Calibration
Calibration Equipment used (M& Primary Standards Power meter NRP	ID # SN: 104778	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522)	
Calibration Equipment used (M& Primary Standards Power meter NRP Power sensor NRP-Z91	ID # SN: 104778 SN: 103244	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521)	Scheduled Calibration
Calibration Equipment used (M& Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	ID # SN: 104778 SN: 103244 SN: 103245	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522)	Scheduled Calibration Apr-18
Calibration Equipment used (M& Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k)	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528)	Scheduled Calibration Apr-18 Apr-18
Calibration Equipment used (M& Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	ID # SN: 104778 SN: 103244 SN: 103245	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529)	Scheduled Calibration Apr-18 Apr-18 Apr-18
Calibration Equipment used (M& Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Dec-18
Calibration Equipment used (M& Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4	ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18
Calibration Equipment used (M& Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards	ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Dec-18
Calibration Equipment used (M& Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Secondary Standards Power meter EPM-442A	ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house) 07-Oct-15 (in house check Oct-16)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18
Calibration Equipment used (M& Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 RAE4 Recondary Standards Rower meter EPM-442A Rower sensor HP 8481A	ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check
Calibration Equipment used (M& Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 DECONDARY Standards Power meter EPM-442A Power sensor HP 8481A Dower sensor HP 8481A Decomposition of the sensor HP 8	ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
Calibration Equipment used (M&Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards	ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
Calibration Equipment used (M&Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 PAE4 Recondary Standards Ower meter EPM-442A Ower sensor HP 8481A Ower sensor HP 8481A F generator R&S SMT-06	ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
Calibration Equipment used (M&Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Recondary Standa	ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02521) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18 In house check: Oct-18
Calibration Equipment used (M&Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Recondary Standa	ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: US37390585	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02522) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 Signature
Calibration Equipment used (M&Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Reference Probe EX3DV4 DAE4 Recondary Standards Rower meter EPM-442A Rower sensor HP 8481A	ID # SN: 104778 SN: 103244 SN: 103245 SN: 5058 (20k) SN: 5047.2 / 06327 SN: 7349 SN: 601 ID # SN: GB37480704 SN: US37292783 SN: MY41092317 SN: 100972 SN: US37390585 Name	Cal Date (Certificate No.) 04-Apr-17 (No. 217-02521/02522) 04-Apr-17 (No. 217-02521) 04-Apr-17 (No. 217-02521) 07-Apr-17 (No. 217-02528) 07-Apr-17 (No. 217-02529) 30-Dec-17 (No. EX3-7349_Dec17) 26-Oct-17 (No. DAE4-601_Oct17) Check Date (in house) 07-Oct-15 (in house check Oct-16) 07-Oct-15 (in house check Oct-16) 15-Jun-15 (in house check Oct-16) 18-Oct-01 (in house check Oct-17)	Scheduled Calibration Apr-18 Apr-18 Apr-18 Apr-18 Dec-18 Oct-18 Scheduled Check In house check: Oct-18 In house check: Oct-18 In house check: Oct-18 In house check: Oct-18

Certificate No: D2450V2-1009_Feb18

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Calibration Laboratory of

Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst

C Service suisse d'étalonnage

Servizio svizzero di taratura
Swiss Calibration Service

Accreditation No.: SCS 0108

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

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

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%.

Certificate No: D2450V2-1009_Feb18

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Measurement Conditions

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

DASY Version	DASY5	
Extrapolation	Advanced Extrapolation	V52.10.0
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy , $dz = 5 mm$	with Spacer
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	37.9 ± 6 %	1.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

input power 13.2 W/kg	
10.2 W/kg	
ali	alized to 1W 51.5 W/kg ± 17.0 %

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.13 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.1 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	51.4 ± 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	12.7 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	49.4 W/kg ± 17.0 % (k=2)

mW input power	
mipat power	5.92 W/kg
	23.3 W/kg ± 16.5 % (k=2)
	rmalized to 1W

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.0		
Return Loss	$53.8 \Omega + 2.2 j\Omega$		
	- 27.4 dB		

Antenna Parameters with Body TSL

Impedance, transformed to feed point	10.0.0		
Return Loss	$49.9 \Omega + 4.6 j\Omega$		
	- 26.7 dB		

General Antenna Parameters and Design

Electrical Delay (one direction)	1.152 ns
	11102 118

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 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	CDEAG			
Manufactured on	SPEAG			
	October 17, 2017			

DASY5 Validation Report for Head TSL

Date: 05.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:1009

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

Medium parameters used: f = 2450 MHz; σ = 1.87 S/m; ϵ_r = 37.9; ρ = 1000 kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

• Probe: EX3DV4 - SN7349; ConvF(7.88, 7.88, 7.88); 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 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

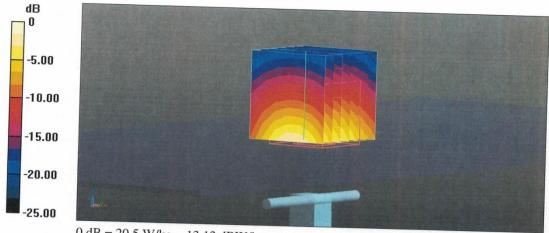
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 111.8 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 26.6 W/kg

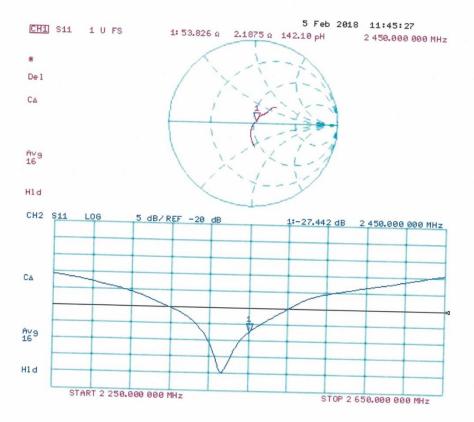
SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.13 W/kg

Maximum value of SAR (measured) = 20.5 W/kg



0 dB = 20.5 W/kg = 13.12 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 05.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:1009

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

Medium parameters used: f = 2450 MHz; σ = 2.04 S/m; ϵ_r = 51.4; ρ = 1000 kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

Probe: EX3DV4 - SN7349; ConvF(8.01, 8.01, 8.01); 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 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

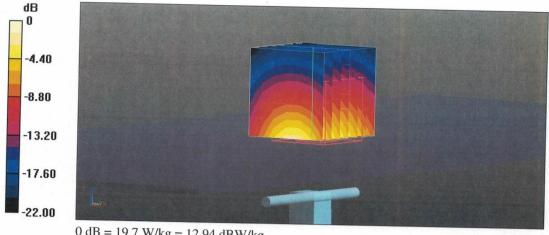
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 104.2 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 25.5 W/kg

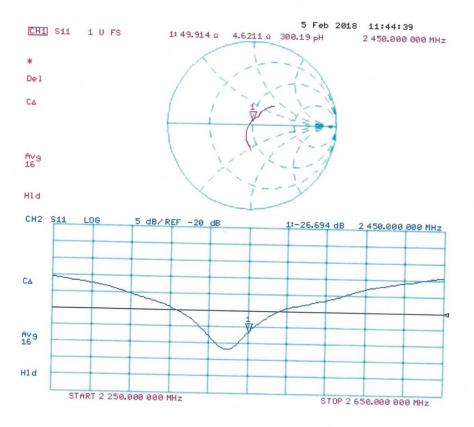
SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.92 W/kg

Maximum value of SAR (measured) = 19.7 W/kg



0 dB = 19.7 W/kg = 12.94 dBW/kg

Impedance Measurement Plot for Body TSL



Extended Dipole Calibrations

Referring to KDB865664 D01, if dipoles are verified in return loss (<-20dB, 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.

Head-2450						
Date of	Deturn less (dD) Delta (0/)	Real Impedance	Delta	Imaginary	Delta	
measurement	Return-loss (dB)	dB) Delta (%)	(ohm)	(ohm)	impedance (ohm)	(ohm)
2018-02-05	-27.4		53.8		2.2	
2019-02-03	-26.8	-2.19%	52.9	0.9	1.9	0.3

Body-2450						
Date of	Return-loss (dB)	Dolto (9/)	Real Impedance	Delta	Imaginary	Delta
measurement	Return-1055 (db)	ss (dB) Delta (%)	(ohm)	(ohm)	impedance (ohm)	(ohm)
2018-02-05	-26.7		49.9		4.6	
2019-02-03	-26.1	-2.25%	49.1	0.8	4.2	0.4

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5ohm of prior calibration. Therefore the verification result should support extended calibration.