DASY5 Validation Report for Head TSL

Date: 23.04.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1178

Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz; σ = 2.03 S/m; ϵ_r = 37.5; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.84, 7.84, 7.84) @ 2600 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

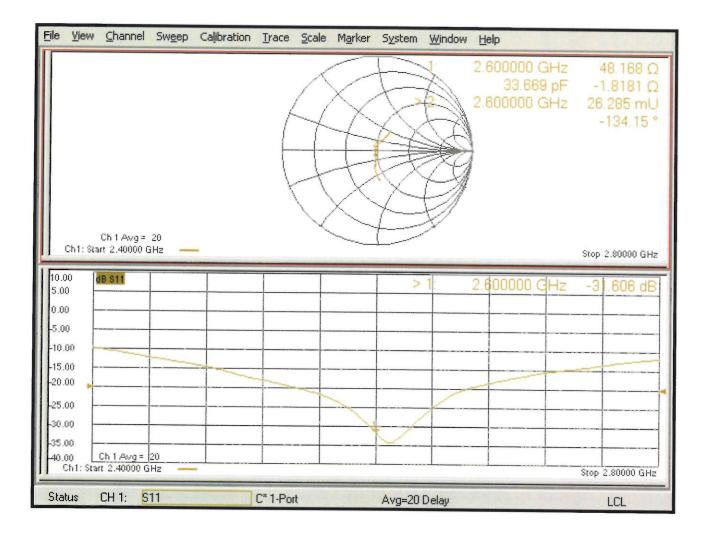
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 119.4 V/m; Power Drift = 0.07 dB Peak SAR (extrapolated) = 29.0 W/kg SAR(1 g) = 14.5 W/kg; SAR(10 g) = 6.44 W/kg Smallest distance from peaks to all points 3 dB below = 8.9 mm Ratio of SAR at M2 to SAR at M1 = 50.3% Maximum value of SAR (measured) = 24.2 W/kg



0 dB = 24.2 W/kg = 13.84 dBW/kg

Impedance Measurement Plot for Head TSL



Justification for Extended SAR Dipole Calibrations

Instead of the typical annual calibration recommended by measurement standards, longer calibration intervals of up to three years may be considered when it is demonstrated that the SAR target, impedance and return loss of a dipole have remain stable according to the following requirements

KDB 865664 D01v01r04 requirements

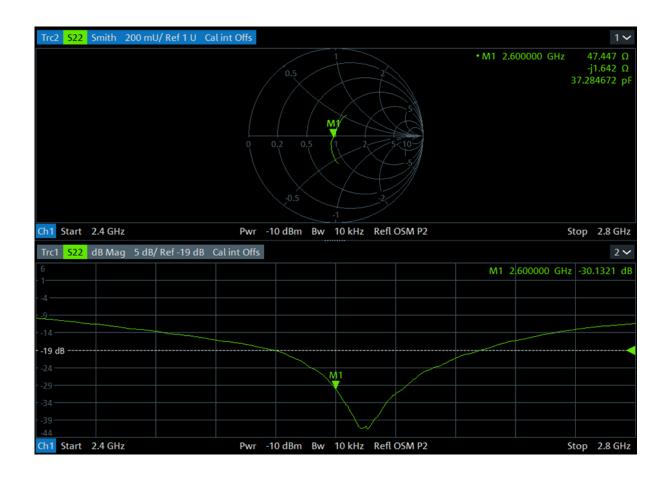
a) return loss : < - 20 dB, within 20% of previous measurement

b) impedance : within 5 $\boldsymbol{\Omega}$ from previous measurement

Dipole Antenna	Head/Body	Date of Measurement	Return Loss (dB)	Δ%	Impedance (Ω)	ΔΩ
D26001/2 SN + 1179	Head	2021.04.23	-31.6	F	48.2	ſ
D2600V2-SN : 1178 Head	2022.04.19	-30.1	-5	47.4	Z	

c) extrapolated peak SAR : within 10% of that reported in the calibration data

Dipole Antenna	Head/Body	Date of Measurement	extrapolated peak SAR (W/kg)	Δ%
	Llood	2021.04.23	13.0	4
D2600V2-SN : 1178	Head	2022.04.14	13.5	4





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- Servizio svizzero di taratura S **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

Certificate No:	D2600V2-1097	Sep21

Client UL Korea (Dyms	stec)	Certi	ficate No: D2600V2-1097_Sep21
CALIBRATION C	ERTIFICATI		
Object	D2600V2 - SN:10	097	
Calibration procedure(s)	QA CAL-05.v11 Calibration Proce	dure for SAR Validation So	ources between 0.7-3 GHz
Calibration date:	September 29, 2	021	
The measurements and the uncerta	ainties with confidence predimentation and the closed laborator	onal standards, which realize the phy obability are given on the following p y facility: environment temperature (2	ages and are part of the certificate.
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
ower sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
ype-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EX3DV4	SN: 7349	28-Dec-20 (No. EX3-7349_Dec20	
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20) Nov-21
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
ower meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20) In house check: Oct-22
ower sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20	In house check: Oct-22
ower sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20) In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20) In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20	
	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Techniciar	
Approved by:	Katja Pokovic	Technical Manager	deller
This calibration certificate shall not I	be reproduced except in	full without written approval of the la	Issued: September 29, 2021

Certificate No: D2600V2-1097_Sep21





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Servizio svizzero di taratura

S Swiss Calibration Service

Accreditation No.: SCS 0108

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Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

c) DASY 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss: This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. 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	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2600 MHz ± 1 MHz	

Head TSL parameters The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.1 ± 6 %	2.04 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

SAR measured250 mW isSAR for nominal Head TSL parametersnormalize	
SAR for nominal Head TSL parameters normaliz	out power 14.7 W/kg
	d to 1W 57.1 W/kg ± 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL cond	3 to 1W 57.1 W/kg ± 17.0 % (k=

SAR measured	250 mW input power	6.50 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.5 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	50.1 Ω - 6.0 jΩ
Return Loss	- 24.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.157 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

DASY5 Validation Report for Head TSL

Date: 29.09.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1097

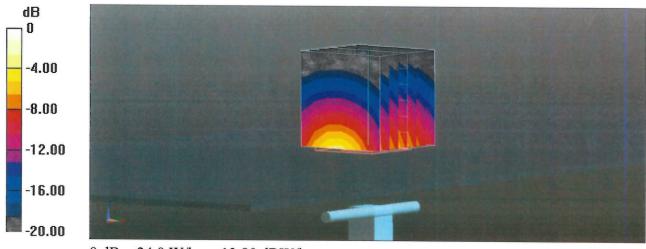
Communication System: UID 0 - CW; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz; $\sigma = 2.04$ S/m; $\varepsilon_r = 37.1$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(7.84, 7.84, 7.84) @ 2600 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

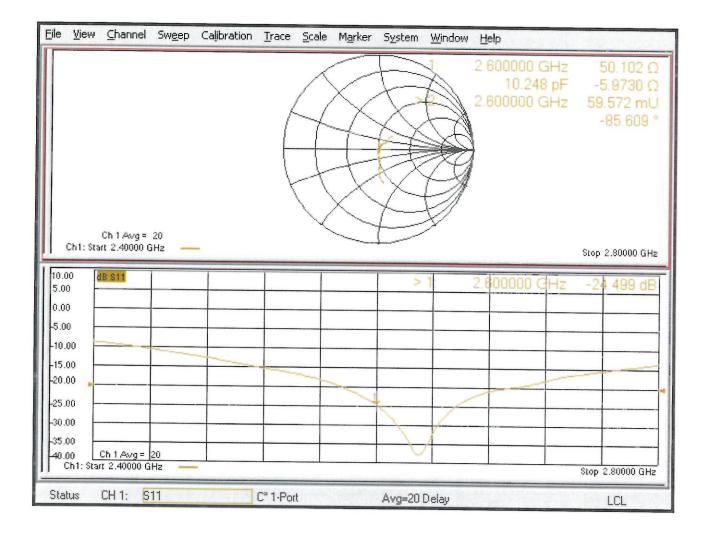
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 118.8 V/m; Power Drift = 0.10 dB Peak SAR (extrapolated) = 29.3 W/kg SAR(1 g) = 14.7 W/kg; SAR(10 g) = 6.5 W/kg Smallest distance from peaks to all points 3 dB below = 8.9 mm Ratio of SAR at M2 to SAR at M1 = 50.2% Maximum value of SAR (measured) = 24.0 W/kg



0 dB = 24.0 W/kg = 13.80 dBW/kg

Impedance Measurement Plot for Head TSL



Justification for Extended SAR Dipole Calibrations

Instead of the typical annual calibration recommended by measurement standards, longer calibration intervals of up to three years may be considered when it is demonstrated that the SAR target, impedance and return loss of a dipole have remain stable according to the following requirements

KDB 865664 D01v01r04 requirements

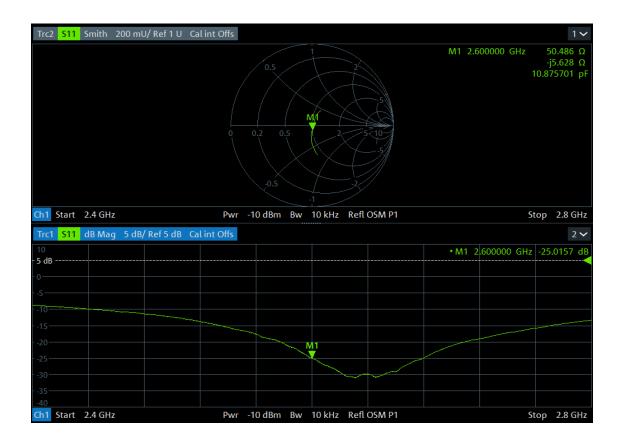
a) return loss : < - 20 dB, within 20% of previous measurement

b) impedance : within 5 $\boldsymbol{\Omega}$ from previous measurement

Dipole Antenna	Head/Body	Date of Measurement	Return Loss (dB)	Δ%	Impedance (Ω)	ΔΩ
D2600V2-SN : 1097	Head	2021.09.29	-24.5	-2.4	50.1	0.2
D2000V2-SN . 1097	пеац	2022.08.29	-25.1	-2.4	50.5	0.2

c) extrapolated peak SAR : within 10% of that reported in the calibration data

Dipole Antenna	Head/Body	Date of Measurement	extrapolated peak SAR (W/kg)	Δ%
D2C00V2 CN - 1007	llood	2021.09.29	29.3	C
D2600V2-SN : 1097	Head	2022.09.19	31.3	6







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Client UL Korea (Dymstec)

Certificate No: D3500V2-1121_Apr21

Accreditation No.: SCS 0108

CALIBRATION CERTIFICATE

Object	D3500V2 - SN:	1121	
Collibration areas (01 011 1-		
Calibration procedure(s)	QA CAL-22.v6		
1	Calibration Proc	edure for SAR Validation Source	es between 3-10 GHz
1			
Calibration date:	April 21, 2021		
This calibration certificate docume	ents the traceability to na	tional standards, which realize the physical u	inits of measurements (SI)
The measurements and the uncer	tainties with confidence	probability are given on the following pages a	and are part of the certificate
All calibrations have been conduc	ted in the closed laborate	bry facility: environment temperature (22 \pm 3)	°C and humidity < 70%
			o and humility < 70%.
Calibration Equipment used (M&T	E critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EX3DV4	SN: 3503	30-Dec-20 (No. EX3-3503_Dec20)	Dec-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21
Socondan, Ctandant	1		
Secondary Standards Power meter E4419B	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Vetwork Analyzer Aglient E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21
	News		
Calibrated by:	Name	Function	Signature
Sansrated by.	Jeffrey Katzman	Laboratory Technician	11.1
			S.K.fr Mag
Approved by:	Katta D. L. S		
ippioved by.	Katja Pokovic	Technical Manager	11/11
			reas
his collibration and the			Issued: April 23, 2021
ins calibration certificate shall not b	be reproduced except in t	full without written approval of the laboratory.	



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Glossary:

TO	11 12 12 15 15
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	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	3500 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.9	2.91 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.1 ± 6 %	2.91 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	100 mW input power	6.66 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	66.3 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.51 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.0 W/kg ± 19.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.8 Ω - 1.5 ϳΩ
Return Loss	- 35.5 dB

General Antenna Parameters and Design

h hadrical Dolou (one direction)	
Electrical Delay (one direction)	· · · · · · · · · · · · · · · · · · ·
	1.134 ns
	1.104115

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	
í	i wanulactured by	
		SPEAG

DASY5 Validation Report for Head TSL

Date: 21.04.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1121

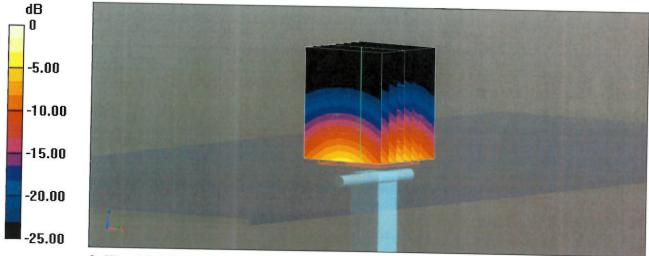
Communication System: UID 0 - CW; Frequency: 3500 MHz Medium parameters used: f = 3500 MHz; σ = 2.91 S/m; ϵ_r = 37.1; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.91, 7.91, 7.91) @ 3500 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3500MHz/Zoom Scan,

dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 71.53 V/m; Power Drift = -0.07 dB Peak SAR (extrapolated) = 18.1 W/kg SAR(1 g) = 6.66 W/kg; SAR(10 g) = 2.51 W/kg Smallest distance from peaks to all points 3 dB below = 8.2 mm Ratio of SAR at M2 to SAR at M1 = 75% Maximum value of SAR (measured) = 12.6 W/kg



0 dB = 12.6 W/kg = 11.00 dBW/kg

Impedance Measurement Plot for Head TSL

[011	Charline	# 59	veep	Caļibi	ration	Trace	Scale	Marker	System	Window	He	lp					
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Justification for Extended SAR Dipole Calibrations

Instead of the typical annual calibration recommended by measurement standards, longer calibration intervals of up to three years may be considered when it is demonstrated that the SAR target, impedance and return loss of a dipole have remain stable according to the following requirements

KDB 865664 D01v01r04 requirements

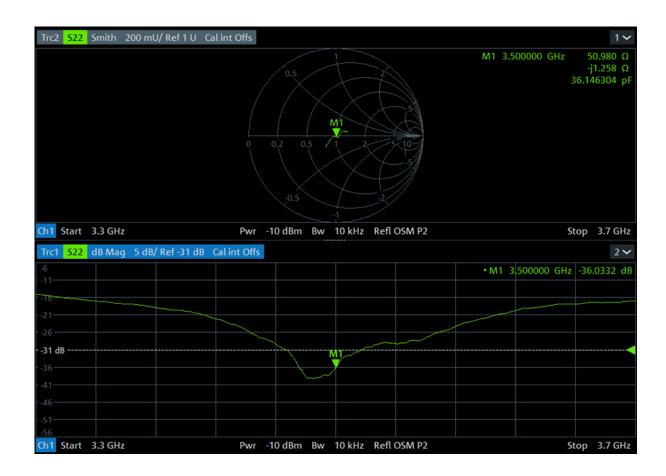
a) return loss : < - 20 dB, within 20% of previous measurement

b) impedance : within 5 $\boldsymbol{\Omega}$ from previous measurement

Dipole Antenna	Head/Body	Date of Measurement	Return Loss (dB)	Δ%	Impedance (Ω)	ΔΩ
D3500V2-SN : 1121	Head	2021.04.21	-35.5	1	50.8	0.2
D3500V2-5N . 1121	пеац	2022.04.19	-36.0	Ţ	50.9	0.2

c) extrapolated peak SAR : within 10% of that reported in the calibration data

Dipole Antenna	Head/Body	Date of Measurement	extrapolated peak SAR (W/kg)	Δ%
D25001/2 CN - 1121	Hood	2021.04.21	18.1	0.0
D3500V2-SN : 1121	Head	2022.05.02	16.5	-8.8







Accreditation No.: SCS 0108

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Client UL Korea (Dymstec)

Certificate No: D3700V2-1036_May21

CALIBRATION CERTIFICATE

Object	D3700V2 - SN:10	36			
	DONOTIL ONITO				
Calibration procedure(s)	QA CAL-22.v6 Calibration Proces	dure for SAR Validation Sources b	petween 3-10 GHz		
Calibration date:	May 21, 2021				
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This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}C$ 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	09-Apr-21 (No. 217-03291/03292)	Apr-22		
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22		
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22		
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22		
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22		
Reference Probe EX3DV4	SN: 3503	30-Dec-20 (No. EX3-3503_Dec20)	Dec-21		
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21		
DAE4	1314.001	02-110V-20 (110: DAL4-001_110V20)	1100-21		
Secondary Standards	ID #	Check Date (in house)	Scheduled Check		
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22		
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22		
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22		
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22		
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21		
	[10] And A. M. Marken, and A. Marken, and A Marken, and A. Marken, and				
	Name	Function	Signature		
Calibrated by:	Jeffrey Katzman	Laboratory Technician	Atto		
Approved by:	Katja Pokovic	Technical Manager	Ally		
This calibration certificate shall not	be reproduced except in	full without written approval of the laboratory.	Issued: May 21, 2021		





Schweizerischer Kalibrierdienst

- S Service suisse d'étalonnage
- C Servizio svizzero di taratura
- S **Swiss Calibration Service**

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

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%.

Accreditation No.: SCS 0108

Measurement Conditions

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

DASY Version	DASY5	V52.10.4	
Extrapolation	Advanced Extrapolation		
Phantom	Modular Flat Phantom		
Distance Dipole Center - TSL	10 mm	with Spacer	
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)	
Frequency	3700 MHz ± 1 MHz		

Head TSL parameters

The following parameters and calculations were applied.

The following parameters and constrained in the	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.7	3.12 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.9 ± 6 %	3.08 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	100 mW input power	6.80 W/kg
SAR for nominal Head TSL parameters		67.9 W/kg ± 19.9 % (k=2)
CAD successful over 10 cm ³ (10 g) of Head TSI	condition	
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition 100 mW input power	2.44 W/kg

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	46.3 Ω - 0.2 jΩ
Return Loss	- 28.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.141 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

DASY5 Validation Report for Head TSL

Date: 21.05.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1036

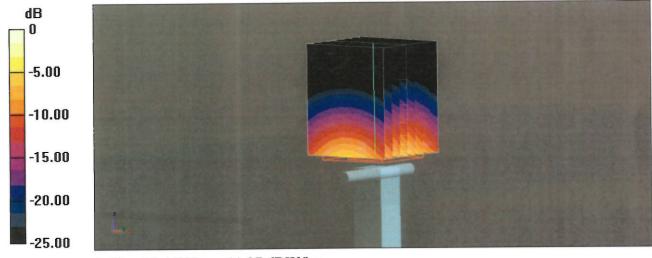
Communication System: UID 0 - CW; Frequency: 3700 MHz Medium parameters used: f = 3700 MHz; σ = 3.08 S/m; ϵ_r = 36.9; ρ = 1000 kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.73, 7.73, 7.73) @ 3700 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

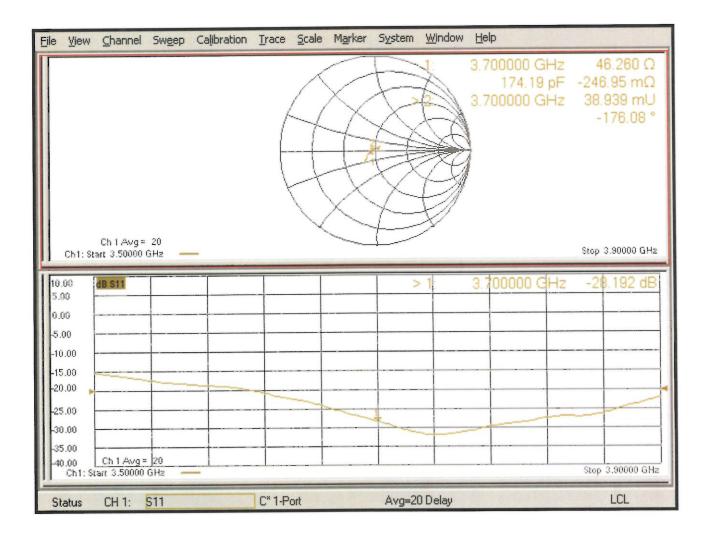
Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3700MHz/Zoom Scan,

dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 74.06 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 19.2 W/kg SAR(1 g) = 6.80 W/kg; SAR(10 g) = 2.44 W/kg Smallest distance from peaks to all points 3 dB below = 8.2 mm Ratio of SAR at M2 to SAR at M1 = 73.2% Maximum value of SAR (measured) = 13.4 W/kg



0 dB = 13.4 W/kg = 11.27 dBW/kg

Impedance Measurement Plot for Head TSL



Justification for Extended SAR Dipole Calibrations

Instead of the typical annual calibration recommended by measurement standards, longer calibration intervals of up to three years may be considered when it is demonstrated that the SAR target, impedance and return loss of a dipole have remain stable according to the following requirements

KDB 865664 D01v01r04 requirements

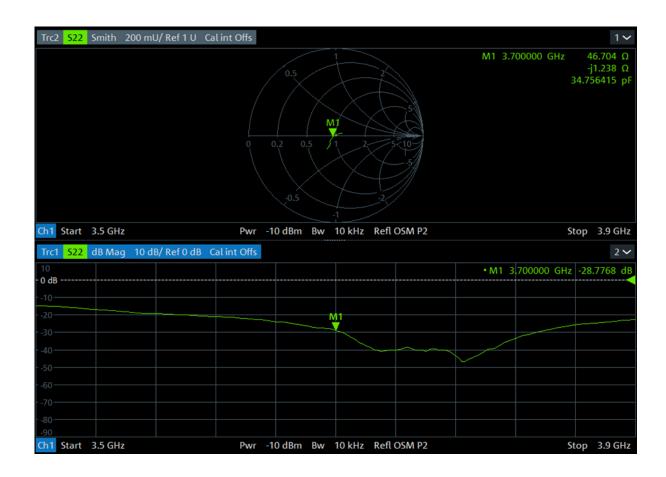
a) return loss : < - 20 dB, within 20% of previous measurement

b) impedance : within 5 Ω from previous measurement

Dipole Antenna	Head/Body	Date of Measurement	Return Loss (dB)	Δ%	Impedance (Ω)	ΔΩ
D3700V2-SN : 1036	Head	2021.05.21	-28.2	2.1	46.3	0.9
D3700V2-SIN . 1030	пеай	2022.04.21	-28.8	2.1	46.7	0.9

c) extrapolated peak SAR : within 10% of that reported in the calibration data

Dipole Antenna	Head/Body	Date of Measurement	extrapolated peak SAR (W/kg)	Δ%
D27001/2 CN - 402C	Hoad	2021.05.21	19.2	0.0
D3700V2-SN : 1036	Head	2022.05.09	17.5	-8.8





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Accreditation No.: SCS 0108

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Client **UL Korea (Dymstec)**

Certificate No: D3900V2-1069_Apr21

Object	D3900V2 - SN:1	1060	
~	D3900V2 - 5IN:	1069	
Calibration procedure(s)	QA CAL-22.v6		
	Calibration Proc	edure for SAR Validation Source	es between 3-10 GHz
Calibration date:	April 21, 2021		
his calibration certificate docum	ents the traceability to nat	tional standards, which realize the physical u	nits of measurements (SI).
te measurements and the unce	rtainties with confidence p	probability are given on the following pages a	and are part of the certificate.
Il calibrations have been conduc	ted in the closed laborate	ny faaility an increase	
	ted in the closed laborato	ry facility: environment temperature (22 \pm 3)	°C and humidity < 70%.
Calibration Equipment used (M&T	E critical for calibration)		
rimary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
wer meter NRP	SN: 104778		
wer meter NRP wer sensor NRP-Z91	SN: 104778 SN: 103244	09-Apr-21 (No. 217-03291/03292)	Apr-22
ower meter NRP ower sensor NRP-Z91 ower sensor NRP-Z91		09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291)	Apr-22 Apr-22
ower meter NRP ower sensor NRP-Z91 ower sensor NRP-Z91 eference 20 dB Attenuator	SN: 103244 SN: 103245	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292)	Apr-22 Apr-22 Apr-22
ower meter NRP ower sensor NRP-Z91 ower sensor NRP-Z91 eference 20 dB Attenuator ype-N mismatch combination	SN: 103244	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343)	Apr-22 Apr-22 Apr-22 Apr-22
ower meter NRP ower sensor NRP-Z91 ower sensor NRP-Z91 eference 20 dB Attenuator ype-N mismatch combination eference Probe EX3DV4	SN: 103244 SN: 103245 SN: BH9394 (20k)	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22
ower meter NRP ower sensor NRP-Z91 ower sensor NRP-Z91 eference 20 dB Attenuator ype-N mismatch combination	SN: 103244 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291) 09-Apr-21 (No. 217-03292) 09-Apr-21 (No. 217-03343) 09-Apr-21 (No. 217-03344) 30-Dec-20 (No. EX3-3503_Dec20)	Apr-22 Apr-22 Apr-22 Apr-22 Apr-22 Dec-21
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Schweizerischer Kalibrierdienst

Service suisse d'étalonnage C

Servizio svizzero di taratura S

Swiss Calibration Service

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

Accreditation No.: SCS 0108

Glossary:	
TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
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- 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	V52.10.4
Extrapolation	Advanced Extrapolation	V02.10.4
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	3900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.5	3.32 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.6 ± 6 %	3.23 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	100 mW input power	7.02 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	70.1 W/kg ± 19.9 % (k=2)

condition	
100 mW input power	2.44 W/ka
normalized to 1W	24.3 W/kg ± 19.5 % (k=2)
	100 mW input power