## **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

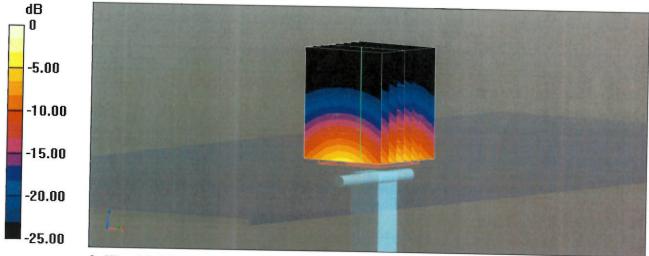
Communication System: UID 0 - CW; Frequency: 3500 MHz Medium parameters used: f = 3500 MHz;  $\sigma$  = 2.91 S/m;  $\epsilon_r$  = 37.1;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

#### 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

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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

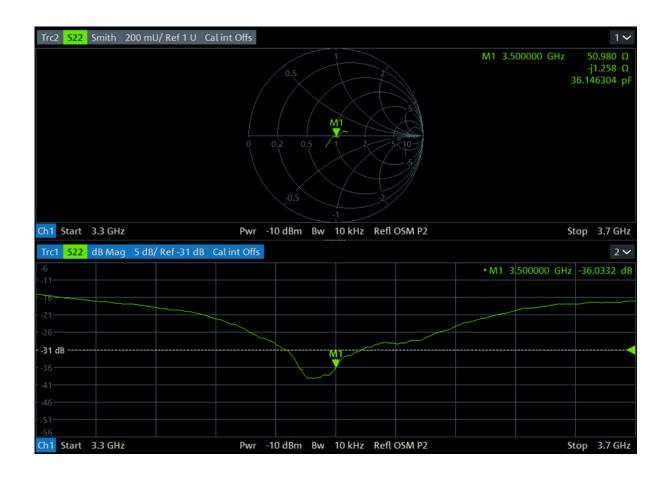
a) return loss : < - 20 dB, within 20% of previous measurement

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%
	Llood	2021.04.21	66.3	2
D3500V2-SN : 1121	Head	2022.05.02	64.3	-3







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 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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The measurements and the uncerta	ainties with confidence pr	onal standards, which realize the physical units obability are given on the following pages and y facility: environment temperature (22 $\pm$ 3)°C a	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)	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		
	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

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- C Servizio svizzero di taratura
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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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.80 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	67.9 W/kg ± 19.9 % (k=2)
CAD successful over 10 cm <sup>3</sup> (10 g) of Head TSI	condition	
SAR averaged over 10 cm <sup>3</sup> (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

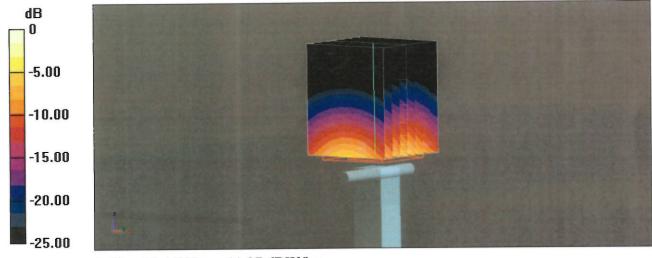
Communication System: UID 0 - CW; Frequency: 3700 MHz Medium parameters used: f = 3700 MHz;  $\sigma$  = 3.08 S/m;  $\epsilon_r$  = 36.9;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

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)

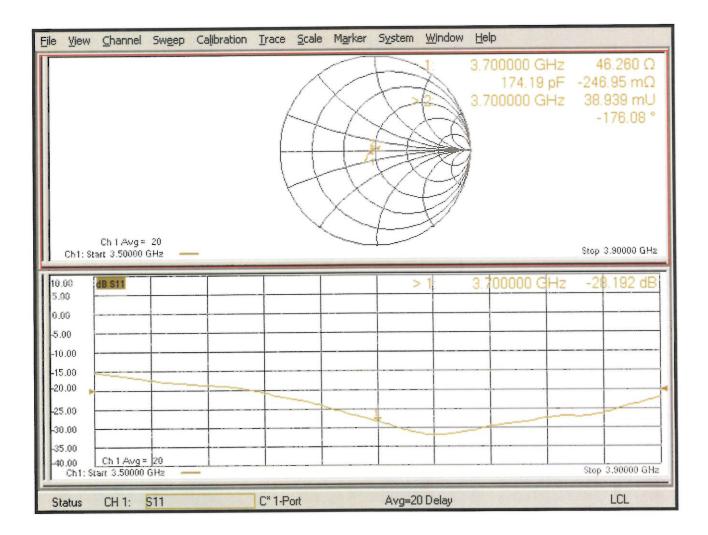
## Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3700MHz/Zoom Scan,

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  $\boldsymbol{\Omega}$  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%
	Llood	2021.05.21	67.9	1 0
D3700V2-SN : 1036	Head	2022.05.09	67	-1.3





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Accreditation No.: SCS 0108

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#### Client **UL Korea (Dymstec)**

Certificate No: D3900V2-1069\_Apr21

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ted in the closed laborato	bry facility: environment temperature (22 $\pm$ 3)	°C and humidity < 70%.
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ID #	Cal Date (Certificate No.)	Scheduled Calibration
SN: 104778		Apr-22
SN: 103244		Apr-22
SN: 103245		Apr-22
SN: BH9394 (20k)		Apr-22
SN: 310982 / 06327		Apr-22
SN: 3503		Dec-21
SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21
ID #	Check Date (in house)	Cabadulad OL
SN: GB39512475		Scheduled Check
SN: US37292783		In house check: Oct-22
		In house check: Oct-22
SN: 100972		In house check: Oct-22
SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22 In house check: Oct-21
Name	Function	Signature
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		J. Ktom
Katia Dalva	-	
naija Pokovic	Technical Manager	dell
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Accreditation No.: SCS 0108

<b>Glossary:</b> 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	V32.10.4	
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 <sup>3</sup> (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

## Appendix (Additional assessments outside the scope of SCS 0108)

## Antenna Parameters with Head TSL

Impedance, transformed to feed point	46.6 Ω - 4.4 ϳΩ
Return Loss	- 24.7 dB

## General Antenna Parameters and Design

Electrical Delay (one direction)	
	1 (0)
	1.104 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 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: 21.04.2021

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN:1069

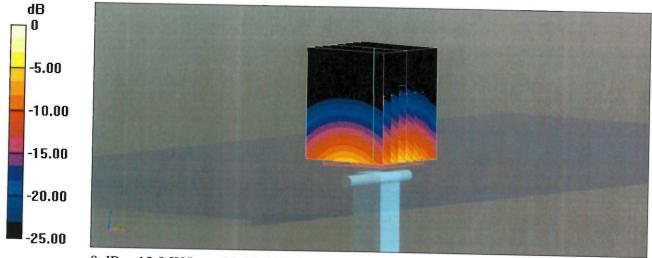
Communication System: UID 0 - CW; Frequency: 3900 MHz Medium parameters used: f = 3900 MHz;  $\sigma$  = 3.23 S/m;  $\epsilon_r$  = 36.6;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN3503; ConvF(7.39, 7.39, 7.39) @ 3900 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)

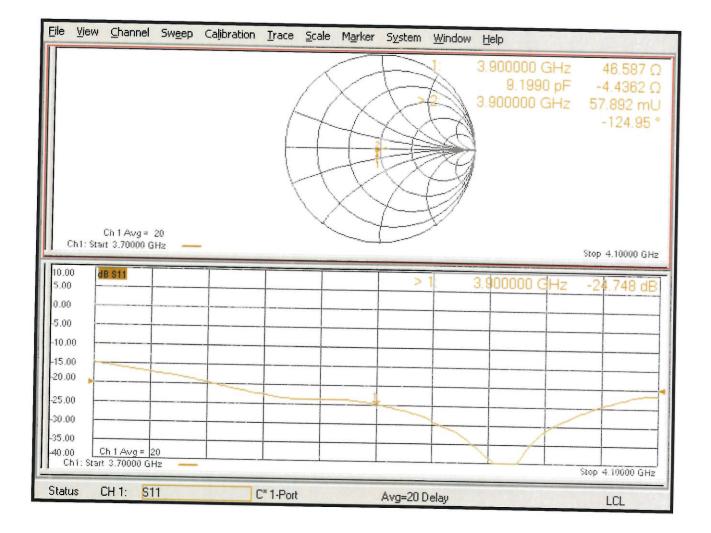
# Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3900MHz/Zoom Scan,

dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.29 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 19.9 W/kg
SAR(1 g) = 7.02 W/kg; SAR(10 g) = 2.44 W/kg
Smallest distance from peaks to all points 3 dB below = 8 mm
Ratio of SAR at M2 to SAR at M1 = 74%
Maximum value of SAR (measured) = 13.9 W/kg



0 dB = 13.9 W/kg = 11.44 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

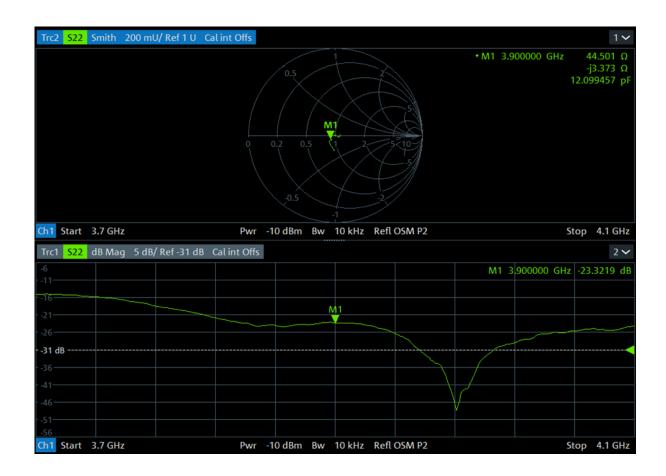
a) return loss : < - 20 dB, within 20% of previous measurement

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

Dipole Antenna	Head/Body	Date of Measurement	Return Loss (dB)	Δ%	Impedance (Ω)	ΔΩ
D3900V2-SN : 1069	Head	2021.04.21	-24.7	-5.7	46.6	-4.5
	пеай	2022.04.19	-23.3	-5.7	44.5	-4.5

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%
D3900V2-SN : 1069	Llood	2021.04.21	70.1	0.1
	Head	2022.05.09	70.0	-0.1





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

Accreditation No.: SCS 0108

Certificate No: D5GHzV2-1209\_Nov21

Client UL Korea (Dymstec)

## CALIBRATION CERTIFICATE

The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

			and the second	
Object	D5GHzV2 - SN:	1209		
Calibration procedure(s)	QA CAL-22.v6			
	Calibration Procedure for SAR Validation Sources between 3-10 GHz			
			s between 3-10 GHz	
Calibration date:	November 24, 20	021		
This calibration cortificate desuma				
The measurements and the uncert	ainties with confidence of	onal standards, which realize the physical ur robability are given on the following pages a	nits of measurements (SI).	
	annues with connuence p	robability are given on the following pages a	nd are part of the certificate.	
All calibrations have been conduct	ed in the closed laborato	ry facility: environment temperature (22 $\pm$ 3)°		
		$(22 \pm 3)^{-1}$	C and numidity $< 70\%$ .	
Calibration Equipment used (M&TE	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	01-Nov-21 (No. DAE4-601_Nov21)	Nov-22	
Secondary Standarda	1.5.4			
Secondary Standards Power meter E4419B	ID #	Check Date (in house)	Scheduled Check	
	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-22	
	Name	Function	Oliveration	
Calibrated by:	Jeton Kastrati	Laboratory Technician	Signature	
		Laboratory rechnician	TIM	
		Ŷ	TYL	
Approved by:	Niels Kuster	Quality Manager	1.185	
This calibration certificate shall not t	De reproduced execution	full without written approval of the laboratory.	Issued: November 25, 2021	
the share so the share shall not	se reproduced except in	iun without written approval of the laboratory.		





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Servizio svizzero di taratura

Swiss Calibration Service

Accreditation No.: SCS 0108

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#### Glossary:

tissue simulating liquid
sensitivity in TSL / NORM x,y,z
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	V 32.10.4
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

## Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.9 ± 6 %	4.58 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

## SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.81 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.4 W/kg ± 19.5 % (k=2)

## Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.4 ± 6 %	4.94 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

## SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.10 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 W/kg ± 19.5 % (k=2)

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# Head TSL parameters at 5800 MHz The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.1 ± 6 %	5.15 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

## SAR result with Head TSL at 5800 MHz

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SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.92 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.0 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.4 W/kg ± 19.5 % (k=2)

## Appendix (Additional assessments outside the scope of SCS 0108)

## Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	49.7 Ω - 2.7 jΩ
Return Loss	- 31.3 dB

## Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	51.1 Ω + 2.6 jΩ
Return Loss	- 31.0 dB

### Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	52.2 Ω + 3.8 jΩ
Return Loss	- 27.3 dB

#### **General Antenna Parameters and Design**

Electrical Dalay (and dimention)	
Electrical Delay (one direction)	1.202 ns
	1.202 113

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

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Manufactured by	
	SPEAG
	of end

Date: 24.11.2021

Test Laboratory: SPEAG, Zurich, Switzerland

## DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1209

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz MHz Medium parameters used: f = 5250 MHz;  $\sigma = 4.58$  S/m;  $\varepsilon_r = 35.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used: f = 5600 MHz;  $\sigma = 4.94$  S/m;  $\varepsilon_r = 35.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used: f = 5800 MHz;  $\sigma = 5.15$  S/m;  $\varepsilon_r = 35.1$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

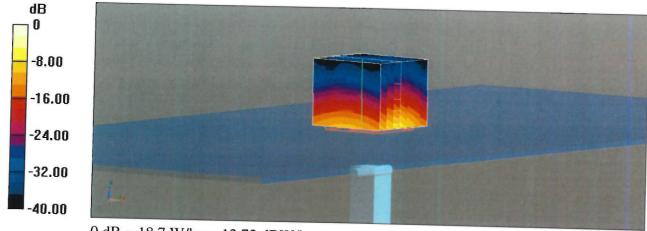
- Probe: EX3DV4 SN3503; ConvF(5.5, 5.5, 5.5) @ 5250 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.01, 5.01, 5.01) @ 5800 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 76.11 V/m; Power Drift = -0.00 dB Peak SAR (extrapolated) = 25.9 W/kg SAR(1 g) = 7.81 W/kg; SAR(10 g) = 2.24 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 71.4% Maximum value of SAR (measured) = 17.5 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 76.32 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 29.1 W/kg SAR(1 g) = 8.1 W/kg; SAR(10 g) = 2.31 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 68.8% Maximum value of SAR (measured) = 18.7 W/kg

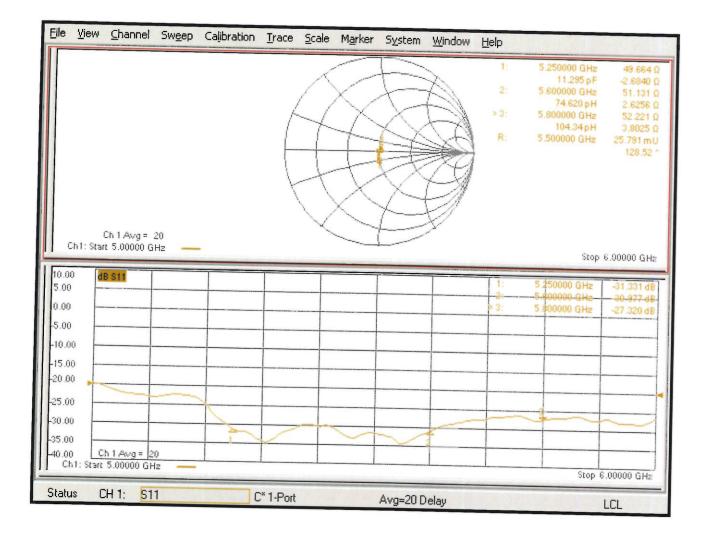
# Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 73.50 V/m; Power Drift = -0.04 dB Peak SAR (extrapolated) = 30.5 W/kg SAR(1 g) = 7.92 W/kg; SAR(10 g) = 2.24 W/kg Smallest distance from peaks to all points 3 dB below = 7.4 mm Ratio of SAR at M2 to SAR at M1 = 66.7% Maximum value of SAR (measured) = 18.8 W/kg



0 dB = 18.7 W/kg = 12.72 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	
		2021-11-24	-31.33	-19.06	49.66	-1.85	
		2022-04-21	-25.36		47.82		
D5GHzV2-SN:1209	Head	2021-11-24	-30.98	3.63	51.13	-0.54	
		2022-04-21	-32.10	5.05	50.59	-0.34	
		2021-11-24	-27.32	13.25	52.22	0.19	
		2022-04-21	-30.94	13.23	52.41		

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

Dipole Antenna	Head/Body	Date of Measurement	extrapolated peak SAR(W/kg)	Δ%	
D5GHzV2-SN:1209	Head	2021-11-24	78.00	5.64	
		2022-04-21	82.40	5.04	
		2021-11-24	80.90	5.07	
		2022-04-21	85.00	5.07	
		2021-11-24	79.00	0.76	
		2022-04-21	79.60	0.70	





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Accreditation No.: SCS 0108

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#### Client UL Korea (Dymstec)

Certificate No: CLA13-1015\_Aug22

CALIBRAT	ION	CERT	IFI	CAT	Έ
	itin an	The second		100 Mar 100	1000

			실	1 0	- H - H	4 1
Object	CLA13 - SN: 10	15	100	-	~	1.
			재	7	7	HA.
Calibration procedure(s)	QA CAL-15.v9			1	/	1 . 1
			_			
	Calibration Proce	edure for SAR Validation S	Source	s below	N 700 M	Hz
Calibration date:	August 23, 2022					
_						
This calibration certificate docume	nts the traceability to nat	ional standards, which realize the pl	hysical u	nits of me	easurement	s (SI).
The measurements and the uncert	tainties with confidence p	probability are given on the following	g pages a	nd are pa	art of the ce	rtificate.
All calibrations have been conduct	ed in the closed laborato	ry facility: environment temperature	e (22 ± 3) <sup>o</sup>	°C and hu	umidity < 70	1%.
					94-947588500088 <b>4</b> 5 - 1993885	e soerenaan 33
Calibration Equipment used (M&TE	E critical for calibration)					
	Ĩ					
Primary Standards	ID #	Cal Date (Certificate No.)		5	Scheduled (	Calibration
Power meter NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524	4)	A	Apr-23	
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)		A	Apr-23	
Power sensor NRP-Z91	SN: 103245	04-Apr-22 (No. 217-03525)		A	pr-23	
Reference 20 dB Attenuator	SN: CC2552 (20x)	04-Apr-22 (No. 217-03527)		A	pr-23	
Type-N mismatch combination	SN: 310982 / 06327	04-Apr-22 (No. 217-03528)		A	pr-23	
Reference Probe EX3DV4	SN: 3877	31-Dec-21 (No. EX3-3877_Dec21		C	)ec-22	
DAE4	SN: 654	26-Jan-22 (No. DAE4-654_Jan22	2)	J	an-23	
Secondary Standards	ID #	Check Date (in house)		- -		
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-22	201		cheduled C	
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-22			n house che	
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-22			n house che	
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-2			n house che	
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20	22)	12.0	house che	
	1	of mailing (in house check Oct-20	20)	Ir	n house che	eck: Oct-22
	Name	Function		c	Signature	
Calibrated by:	Jeffrey Katzman	Laboratory Technicia	an	15.52.5	Ignature	1
			AT 1	0	A.L	A
				C	1. 2	-
Approved by:	Sven Kühn	Technical Manager				
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