

Appendix C for KSCR221000198201

Calibration Certificate

Object	Apply	No	Model	SN	Calibration Date
Dipole	<input checked="" type="checkbox"/>	1	D3500V2	1101	2021/09/09
	<input checked="" type="checkbox"/>	2	D3700V2	1103	2021/09/09
	<input checked="" type="checkbox"/>	3	D3900V2	1080	2021/09/13
DAE	<input checked="" type="checkbox"/>	4	DAE4	1245	2022/05/30
	<input checked="" type="checkbox"/>	5	DAE4	1245	2023/04/25
Probe	<input checked="" type="checkbox"/>	6	EX3DV4	7767	2022/10/28



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1 Dipole

1.1 D3500V2 - SN 1101

Calibration Laboratory of Schmid & Partner Engineering AG Zugstrasse 65, 8004 Zurich, Switzerland		Schweizerischer Kalibrierdienst Service suisse d'étalonnage Service svizzero di taratura Swiss Calibration Service	
Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates		Accreditation No.: SCS 0108	
Client: SGS-CN (Auden)		Certificate No.: D3500V2-1101_Sep21	
CALIBRATION CERTIFICATE			
Object: D3500V2 - SN 1101			
Calibration procedure(s): QA CAL-22 v6 Calibration Procedure for SAR Validation Sources between 3-10 GHz			
Calibration date: September 09, 2021			
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 ± 0.1°C and humidity < 70%).			
Calibrator Equipment used (MATE 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 B19284 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N termination combination	SN 310882 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EXD3V4	SN 3503	30-Dec-20 (No. EX3-3503_Dec20)	Dec-21
DAE4	SN 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter S4105	SN 063612415	30-Oct-19 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN U83729783	07-Oct-19 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN M74199217	07-Oct-19 (in house check Oct-20)	In house check: Oct-22
RF generator N85 S87-08	SN 110872	15-Jun-19 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8363A	SN U54106477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21
Calibrated by:	Name: Leif Myer	Function: Laboratory Technician	Signature:
Approved by:	Name: Korja Polovic	Function: Technical Manager	Signature:
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Issued: September 10, 2021			
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Measurement Conditions	
DASY system configuration, as far as not given on page 1.	
DASY Version	DASYV2
Extrapolation	Advanced Extrapolation
Phantom	Modular Flat Phantom VS.0
Distance Dipole Center - TSL	10 mm
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm
Frequency	3400 MHz ± 1 MHz 3500 MHz ± 1 MHz

Head TSL parameters at 3400 MHz			
The following parameters and calculations were applied:			
Nominal Head TSL parameters	Temperature	Permittivity	Conductivity
	22.0 °C	38.0	2.81 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.1 ± 6 %	2.88 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 3400 MHz	
SAR averaged over 1 cm ² (1 g) of Head TSL	Condition
SAR measured	100 mW input power
SAR for nominal Head TSL parameters	normalized to 1W
	68.5 W/kg ± 19.9 % (k=2)

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

Head TSL parameters at 3500 MHz			
The following parameters and calculations were applied:			
Nominal Head TSL parameters	Temperature	Permittivity	Conductivity
	22.0 °C	37.9	2.91 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.9 ± 6 %	2.98 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 3500 MHz	
SAR averaged over 1 cm ² (1 g) of Head TSL	Condition
SAR measured	100 mW input power
SAR for nominal Head TSL parameters	normalized to 1W
	66.9 W/kg ± 19.9 % (k=2)

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

Appendix (Additional assessments outside the scope of SCS 0108)	
Antenna Parameters with Head TSL at 3400 MHz	
Impedance, transformed to feed point	44.9 Ω - 5.8 jΩ
Return Loss	-21.9 dB

Antenna Parameters with Head TSL at 3500 MHz	
Impedance, transformed to feed point	53.4 Ω - 3.8 jΩ
Return Loss	-20.1 dB

General Antenna Parameters and Design	
Electrical Delay (one direction)	1.132 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 CC signals. On arms of the dipoles, small and 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

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DASY5 Validation Report for Head TSL

Date: 09/09/2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1101

Communication System: UID 0 - CW; Frequency: 3500 MHz; Frequency: 3400 MHz;

Medium parameters used: $f = 3500 \text{ MHz}$; $\epsilon = 2.96 \text{ S/m}$; $\epsilon_0 = 37.9$; $\rho = 1000 \text{ kg/m}^3$;Medium parameters used: $f = 3400 \text{ MHz}$; $\epsilon = 2.88 \text{ S/m}$; $\epsilon_0 = 38.1$; $\rho = 1000 \text{ kg/m}^3$;

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, ConvF(7.97, 7.97, 7.97) @ 3400 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(1535); SEMCAD X 14.6.14(7301)

Dipole Calibration for Head Tissue/Pin=100 mW, $d=10\text{mm}$, $f=3500\text{MHz}$ /Zoom Scan, $\text{dist}=1.4\text{mm}$ (8x8x8)/Cube 0; Measurement grid: $\text{dx}=4\text{mm}$, $\text{dy}=4\text{mm}$, $\text{dz}=1.4\text{mm}$

Reference Value = 71.98 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 18.2 W/kg

SAR(1 g) = 6.71 W/kg; SAR(10 g) = 2.52 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) = 12.5 W/kg

Dipole Calibration for Head Tissue/Pin=100 mW, $d=10\text{mm}$, $f=3400\text{MHz}$ /Zoom Scan, $\text{dist}=1.4\text{mm}$ (8x8x8)/Cube 0; Measurement grid: $\text{dx}=4\text{mm}$, $\text{dy}=4\text{mm}$, $\text{dz}=1.4\text{mm}$

Reference Value = 73.38 V/m; Power Drift = 0.07 dB

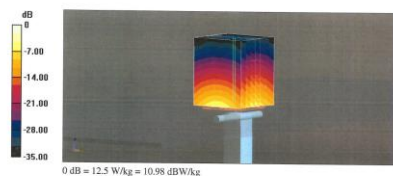
Peak SAR (extrapolated) = 18.3 W/kg

SAR(1 g) = 6.89 W/kg; SAR(10 g) = 2.57 W/kg

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 75.5%

Maximum value of SAR (measured) = 12.5 W/kg



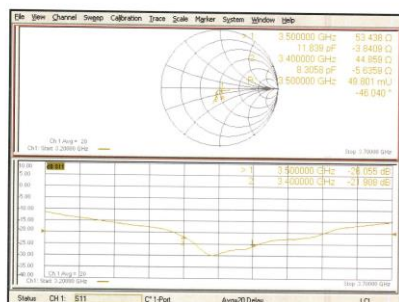
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Impedance Measurement Plot for Head TSL



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1.2 D3700V2 - SN 1103



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Object: D3700V2 - SN:1103																																			
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Approved by: Kajsa Pokras Technical Manager <i>[Signature]</i>																																			
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Measurement Conditions			
DASY system configuration, as far as not given on page 1.			
DASY Version	DASY32	V52.10.4	
Extrapolation	Advanced Extrapolation		
Phantom	Modular Flat Phantom VS.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	3700 MHz ± 1 MHz		

Head TSL parameters at 3700 MHz			
The following parameters and calculations were applied.			
Nominal Head TSL parameters	Temperature	Permittivity	Conductivity
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.7 ± 6 %	3.12 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 3700 MHz			
SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition		
SAR measured	100 mW input power	6.75 W/kg	
SAR for nominal Head TSL parameters	normalized to 1W	67.5 W/kg ± 19.9 % (k=2)	

SAR averaged over 10 cm ³ (10 g) of Head TSL			
SAR measured	100 mW input power	2.44 W/kg	
SAR for nominal Head TSL parameters	normalized to 1W	24.4 W/kg ± 19.5 % (k=2)	

Appendix (Additional assessments outside the scope of SCS 0108)	
Antenna Parameters with Head TSL at 3700 MHz	
Impedance, transformed to feed point	45.1 Ω + 1.8 jΩ
Return Loss	-25.3 dB

General Antenna Parameters and Design	
Electrical Delay (one direction)	1.153 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

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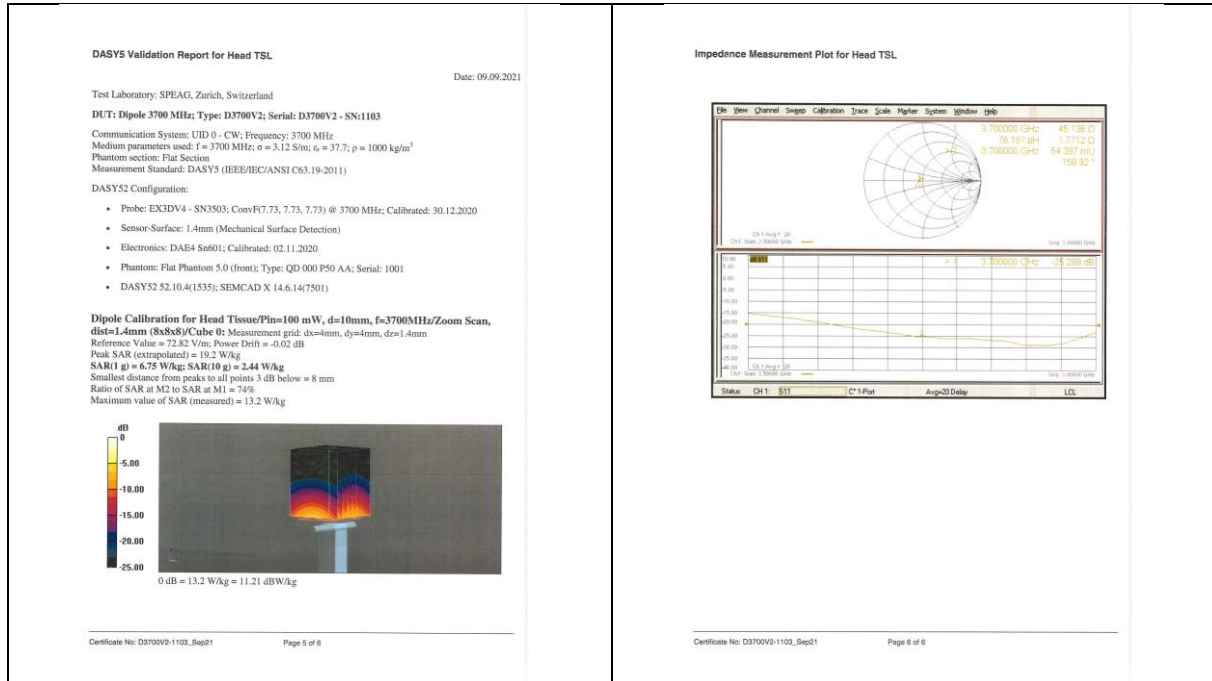
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1.3 D3900V2 - SN 1080

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

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S Swiss Calibration Service

Accreditation No.: **SCS 0108**

Certificate No.: **D3900V2-1080_Sep21**



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

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Multilateral Agreement for the recognition of calibration certificates

Glossary:
TSL: Issue 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 62039-1528, "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 805664, "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 loaded 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%.

CALIBRATION CERTIFICATE

Object: **D3900V2 - SN 1080**

Calibration procedure(s): **QA CAL-22-V6
Calibration Procedure for SAR Validation Sources between 3-10 GHz**

Calibration date: **September 13, 2021**

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 closest laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (MSTE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN 134718	09-Apr-21 (No. 217-0329/03492)	Apr-22
Power sensor NRP-231	SN 103244	09-Apr-21 (No. 217-0329/1)	Apr-22
Power sensor NRP-231	SN 103245	09-Apr-21 (No. 217-0329/2)	Apr-22
Reference 20 dB attenuator	SN 890868 (206)	09-Apr-21 (No. 217-0334/3)	Apr-22
Type II mismatch combination	SN 100862 / 08327	09-Apr-21 (No. 217-0334/4)	Apr-22
Reference Probe EX320V4	SN 3503	30-Dec-20 (No. 630-3883, Dec-20)	Dec-21
DAE4	SN 4601	02-Nov-20 (No. DAE-4-601, Nov-20)	Nov-21

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN 0839612475	30-Oct-14 (in house check Oct-20)	In house check, Oct-22
Power sensor NP 86A1A	SN U337262783	07-Oct-15 (in house check Oct-20)	In house check, Oct-22
Power sensor NP 86A1A	SN M741082117	07-Oct-15 (in house check Oct-20)	In house check, Oct-22
RF generator RAS SMT-06	SN 150972	15-Jun-10 (in house check Oct-20)	In house check, Oct-22
Network Analyser Agilent E8363A	SN USA1080477	31-Mar-14 (in house check Oct-20)	In house check, Oct-21

Calibrated by:	Name: Ulf Kugler	Function: Laboratory Technician	Signature: <i>[Signature]</i>
Approved by:	Name: Katja Polzella	Function: Technical Manager	Signature: <i>[Signature]</i>

Issued: September 15, 2021

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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 VS-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	3900 MHz ± 1 MHz 4100 MHz ± 1 MHz	

Head TSL parameters at 3900 MHz
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	37.4 ± 6 %	3.28 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 3900 MHz

SAR averaged over 1 cm ² (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.08 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	70.8 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ² (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.44 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.4 W/kg ± 19.5 % (k=2)

Head TSL parameters at 4100 MHz
The following parameters and calculations were applied:

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.2	3.53 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.2 ± 6 %	3.48 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 4100 MHz

SAR averaged over 1 cm ² (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	5.93 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	59.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ² (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	



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DASYS Validation Report for Head TSL

Date: 13.09.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN:1080

Communication System: UID 0 - CW; Frequency: 3900 MHz; Frequency: 4100 MHz

Medium parameters used: $f = 3900$ MHz; $\sigma = 3.28$ S/m; $\epsilon_r = 37.4$; $\rho = 1000$ kg/m³Medium parameters used: $f = 4100$ MHz; $\sigma = 3.46$ S/m; $\epsilon_r = 37.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASYS2 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(7.39, 7.39, 7.39) @ 3900 MHz, ConvF(7.26, 7.26, 7.26) @ 4100 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DA44 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 090 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm 3900/Zoom Scan, dist=1.4mm

(8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 74.67 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 20.5 W/kg

SAR(1 g) = 7.65 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 = 72.4%

Maximum value of SAR (measured) = 13.8 W/kg

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm 4100/Zoom Scan, dist=1.4mm

(8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.33 V/m; Power Drift = 0.07 dB

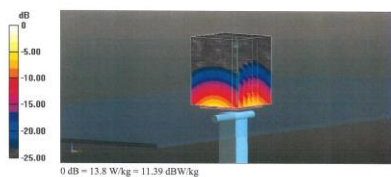
Peak SAR (extrapolated) = 20.1 W/kg

SAR(1 g) = 6.93 W/kg; SAR(10 g) = 2.4 W/kg

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 73%

Maximum value of SAR (measured) = 13.8 W/kg



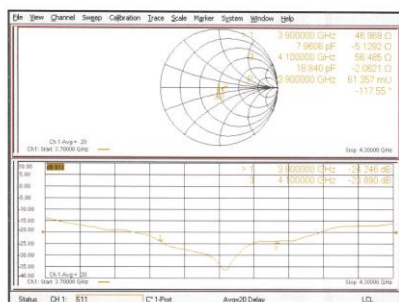
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Impedance Measurement Plot for Head TSL



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Member of the SGS Group (SGS SA)

2 DAE4 - SN 1245

<p>Schmid & Partner Engineering AG Zugstrasse 10, 8004 Zurich, Switzerland Phone +41 44 245 9700, Fax +41 44 245 9770 www.spgg.ch, info@spgg.ch</p> <p style="text-align: center;">s p e a g</p> <p style="text-align: center;">IMPORTANT NOTICE</p> <p>USAGE OF THE DAE4</p> <p>The DAE4 unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE4. Special attention shall be given to the following points:</p> <p>Battery Exchange: The battery cover of the DAE4 unit is fixed using a screw, over tightening the screw may cause the threads inside the DAE4 to wear out.</p> <p>Shipping of the DAE4: Before shipping the DAE4 to SPEAG for calibration, remove the batteries and pack the DAE4 in an anti-static bag. This anti-static bag shall then be packed into a larger box or container which protects the DAE4 from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.</p> <p>E-stop Failures: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE4 carefully and keep the DAE4 unit in a non-dusty environment if not used for measurements.</p> <p>Repair: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.</p> <p>DASY Configuration Files: Since the exact values of the DAE4 input resistances, as measured during the calibration procedure of a DAE4 unit, are not used by the DASY software, a nominal value of 200 MOhm is given in the corresponding configuration file.</p> <p>Important Note: Warranty and calibration is void if the DAE4 unit is disassembled partly or fully by the Customer.</p> <p>Important Note: Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.</p> <p>Important Note: To prevent damage of the DAE4 probe connector pins, use great care when installing the probe to the DAE4. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE4 while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE4.</p> <p>TN_EH100306AE DAE4.docx 07.03.2019</p>	<p>Calibration Laboratory of Schmid & Partner Engineering AG Zugstrasse 10, 8004 Zurich, Switzerland</p> <p>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</p> <p>Accreditation No.: SCS 0108</p> <p>Client: SGS-CN (Auden) Certificate No.: DAE4-1245_May22</p> <p>CALIBRATION CERTIFICATE</p> <p>Object: DAE4 - SD 000 D04 BM - SN: 1245</p> <p>Calibration procedure(s): QA CAL-06 v30 Calibration procedure for the data acquisition electronics (DAE)</p> <p>Calibration date: May 30, 2022</p> <p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3) °C and humidity < 70%.</p> <p>Calibration Equipment used (MATE critical for calibration)</p> <table border="1"><thead><tr><th>Primary Standards</th><th>ID #</th><th>Cal Date (Certificate No.)</th><th>Scheduled Calibration</th></tr></thead><tbody><tr><td>Ketway Multimeter Type 2001</td><td>SN: 0810276</td><td>31-Aug-21 (No.31368)</td><td>Aug-22</td></tr></tbody></table> <table border="1"><thead><tr><th>Secondary Standards</th><th>ID #</th><th>Check Date (in house)</th><th>Scheduled Check</th></tr></thead><tbody><tr><td>Auto DAE Calibration Unit</td><td>SE LWS 003 AA 1001</td><td>24-Jan-22 (in house check)</td><td>In house check: Jan-23</td></tr><tr><td>Calibrator Blue V2.1</td><td>SE LWS 006 AA 1002</td><td>24-Jan-22 (in house check)</td><td>In house check: Jan-23</td></tr></tbody></table> <p>Calibrated by: Domènec Sallent Function: Laboratory Technician Signature: <i>[Signature]</i></p> <p>Approved by: Ben Kohn Technical Manager Signature: <i>[Signature]</i></p> <p>This calibration certificate shall not be reproduced except in full without written approval of the laboratory.</p> <p>Issued: May 30, 2022</p> <p>Certificate No: DAE4-1245_May22 Page 1 of 5</p>	Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	Ketway Multimeter Type 2001	SN: 0810276	31-Aug-21 (No.31368)	Aug-22	Secondary Standards	ID #	Check Date (in house)	Scheduled Check	Auto DAE Calibration Unit	SE LWS 003 AA 1001	24-Jan-22 (in house check)	In house check: Jan-23	Calibrator Blue V2.1	SE LWS 006 AA 1002	24-Jan-22 (in house check)	In house check: Jan-23
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Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	19994.45	1.52	0.00
Channel X - Input	20004.58	2.22	0.01
Channel X + Input	-20000.14	1.12	-0.01
Channel Y + Input	19994.72	1.58	0.00
Channel Y - Input	20001.22	-1.00	-0.00
Channel Y + Input	-20003.05	-1.57	0.01
Channel Z + Input	19992.84	0.19	0.00
Channel Z - Input	20003.09	0.58	0.00
Channel Z + Input	-20001.73	-0.27	0.00

Low Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	2001.91	0.41	0.22
Channel X - Input	202.54	0.65	0.32
Channel X + Input	-197.86	0.07	-0.04
Channel Y + Input	2002.05	0.58	0.03
Channel Y - Input	201.27	-0.57	-0.28
Channel Y + Input	-199.23	-0.06	0.03
Channel Z + Input	2001.98	0.08	0.00
Channel Z - Input	200.09	-1.53	-0.76
Channel Z + Input	-199.85	-1.57	0.79

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	-200	-5.87	-7.69
	-200	9.12	7.79
Channel Y	-200	-8.68	-9.28
	-200	8.52	6.36
Channel Z	-200	-5.36	-5.60
	-200	3.58	3.06

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	4.07	-3.14
Channel Y	200	9.36	-	4.27
Channel Z	200	10.11	7.14	-

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4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	15984	17040
Channel Y	16562	16768
Channel Z	16035	15668

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Input 10MΩ	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	1.00	-0.15	1.93	0.45
Channel Y	-0.18	-1.28	0.94	0.45
Channel Z	-0.58	-2.81	0.58	0.60

6. Input Offset Current

Nominal input circuitry offset current on all channels: <25nA

7. Input Resistance (Typical values for information)

	Zeroing (Ω/Ohm)	Measuring (MΩhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.5

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+8	+14
Supply (- Vcc)	-0.01	-8	-9

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s p e a g

IMPORTANT NOTICE

USAGE OF THE DAE4

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

Battery Exchange: The battery cover of the DAE4 unit is fixed using a screw, over tightening the screw may cause the threads inside the DAE to wear out.

Shipping of the DAE: Before shipping the DAE to SPEAG for calibration, remove the batteries and pack the DAE in an anti-static bag. This anti-static bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

E-Stop Failures: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

Repair: Minor repairs are performed at no extra cost during the annual calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

DASY Configuration Files: Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 MΩhm is given in the corresponding configuration file.

Important Note:
Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.

Important Note:
Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the annual calibration procedure.

Important Note:
To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.

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07.03.2019

Calibration Laboratory of
Schmid & Partner
Engineering AG

Zugspitzstrasse 43, 8004 Zurich, Switzerland

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: **SGS**
Kunshan City, China

S Schweizerischer Kalibrierdienst
C Service suisse de Mesurage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accreditation No.: SCS 0108

Certificate No: DAE4-1245_Apr23

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 1245		
Calibration procedure(s)	QA CAL-06.v30 Calibration procedure for the data acquisition electronics (DAE)		
Calibration date	April 25, 2023		
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 (20 ± 3°C and humidity < 70%).			
Calibration Equipment used (MATE critical for calibration)			
Primary Standards	SI #	Cal Date (Certificate No.)	Scheduled Calibration
Kathley Multimeter Type 2001	201 20020219	29-Aug-22 (No 24389)	Aug-23
Secondary Standards	SI #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UMS 053 AA 1001	27-Jan-23 (in house check)	In house check: Jan-24
Calibrator Box V2.1	SE UMS 006 AA 1002	27-Jan-23 (in house check)	In house check: Jan-24
Calibrated by:	Name Dominique Stoffer	Function Laboratory Technician	Signature
Approved by:	Sven Kuhn	Technical Manager	
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

Certificate No: DAE4-1245_Apr23


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Calibration Laboratory of Schmid & Partner Engineering AG Zuglinswilerstrasse 42, 8094 Zurich, Switzerland 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	 Schweizerischer Kalibrierdienst Service suisse d'étalonnage Service suisse d'étalonnage Service Calibration Service Accreditation No.: SCS 0108	DC Voltage Measurement A/D Converter Resolution nominal High Range: 1LSB = 6.1µV, full range = -100...+300 mV Low Range: 1LSB = 61nV, full range = -1...+3mV DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec												
Glossary DAE data acquisition electronics Connector angle information used in DASY system to align probe sensor X to the robot coordinate system.		<table border="1"><thead><tr><th>Calibration Factors</th><th>X</th><th>Y</th><th>Z</th></tr></thead><tbody><tr><td>High Range</td><td>405.243 ± 0.02% (k=2)</td><td>403.938 ± 0.02% (k=2)</td><td>405.064 ± 0.02% (k=2)</td></tr><tr><td>Low Range</td><td>3.89474 ± 1.50% (k=2)</td><td>3.89478 ± 1.50% (k=2)</td><td>4.00994 ± 1.50% (k=2)</td></tr></tbody></table>	Calibration Factors	X	Y	Z	High Range	405.243 ± 0.02% (k=2)	403.938 ± 0.02% (k=2)	405.064 ± 0.02% (k=2)	Low Range	3.89474 ± 1.50% (k=2)	3.89478 ± 1.50% (k=2)	4.00994 ± 1.50% (k=2)
Calibration Factors	X	Y	Z											
High Range	405.243 ± 0.02% (k=2)	403.938 ± 0.02% (k=2)	405.064 ± 0.02% (k=2)											
Low Range	3.89474 ± 1.50% (k=2)	3.89478 ± 1.50% (k=2)	4.00994 ± 1.50% (k=2)											
Methods Applied and Interpretation of Parameters <ul style="list-style-type: none">DC Voltage Measurement: Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.Connector angle: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.<ul style="list-style-type: none">DC Voltage Measurement Linearity: Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.Common mode sensitivity: Influence of a positive or negative common mode voltage on the differential measurement.Channel separation: Influence of a voltage on the neighbor channels not subject to an input voltage.AD Converter Values with inputs shorted: Values on the internal AD converter corresponding to zero input voltageInput Offset Measurement: Output voltage and statistical results over a large number of zero voltage measurements.Input Offset Current: Typical value for information; Maximum channel input offset current, not considering the input resistance.Input resistance: Typical value for information; DAE input resistance at the connector, during internal auto-zeroing and during measurement.Low Battery Alarm Voltage: Typical value for information. Below this voltage, a battery alarm signal is generated.Power consumption: Typical value for information. Supply currents in various operating modes.		Connector Angle Connector Angle to be used in DASY system 32.0° ± 1°												
Certificate No: DAE4-1245_Apr23 Page 2 of 5		Certificate No: DAE4-1245_Apr23 Page 3 of 5												

Appendix (Additional assessments outside the scope of SCS0108)			
1. DC Voltage Linearity			
High Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	199988.00	2.90	0.00
Channel X - Input	20005.77	2.75	0.01
Channel Y + Input	199988.00	2.19	-0.01
Channel Y - Input	199996.00	1.08	0.00
Channel Z + Input	20003.12	0.26	0.00
Channel Z - Input	-20000.51	0.53	-0.00
Channel Z + Input	199994.62	-1.06	-0.00
Channel Z - Input	20002.17	-0.70	-0.00
Channel Z - Input	-20001.94	-0.91	0.00
Low Range	Reading (µV)	Difference (µV)	Error (%)
Channel X + Input	2002.91	0.81	0.04
Channel X - Input	203.06	0.73	0.36
Channel Y + Input	-196.56	0.88	-0.45
Channel Y - Input	2002.33	0.29	0.01
Channel Z + Input	201.91	-0.29	-0.19
Channel Z - Input	-196.22	-0.79	0.40
Channel Z + Input	2002.20	0.24	0.01
Channel Z - Input	201.28	-0.88	-0.44
Channel Z - Input	-196.93	-1.36	0.69
2. Common mode sensitivity			
DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec			
Common mode Input Voltage (mV)	High Range Average Reading (µV)	Low Range Average Reading (µV)	
Channel X	200	-6.42	-8.27
Channel X	-200	8.81	6.00
Channel Y	200	7.04	7.13
Channel Y	-200	-14.70	-15.29
Channel Z	200	-4.52	-5.35
Channel Z	-200	3.50	3.52
3. Channel separation			
DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec			
Input Voltage (mV)	Channel X (µV)	Channel Y (µV)	Channel Z (µV)
Channel X	200	3.29	-3.29
Channel Y	200	9.00	4.00
Channel Z	200	10.03	7.20

4. AD-Converter Values with inputs shorted				
DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec; Input 10MΩ				
Channel X	High Range (LSB)	Low Range (LSB)		
Channel X	16001	16100		
Channel Y	16079	16051		
Channel Z	16040	15891		
5. Input Offset Measurement				
DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec; Input 10MΩ				
Channel X	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	0.77	-0.63	1.89	0.49
Channel Y	-0.24	-1.72	1.19	0.52
Channel Z	-0.85	-2.62	0.59	0.61
6. Input Offset Current				
Nominal input circuitry offset current on all channels: <25A				
7. Input Resistance (Typical values for information)				
Channel X	Zeroing (MΩ)	Measuring (MΩ)		
Channel X	200	200		
Channel Y	200	200		
Channel Z	200	200		
8. Low Battery Alarm Voltage (Typical values for information)				
Typical values	Alarm Level (VDC)			
Supply (+ Vcc)	+7.9			
Supply (- Vcc)	-7.6			
9. Power Consumption (Typical values for information)				
Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)	
Supply (+ Vcc)	+0.01	+6	+14	
Supply (- Vcc)	-0.01	-8	-9	

5. Input Offset Measurement				
DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec; Input 10MΩ				
Channel X	Average (µV)	min. Offset (µV)	max. Offset (µV)	Std. Deviation (µV)
Channel X	0.77	-0.63	1.89	0.49
Channel Y	-0.24	-1.72	1.19	0.52
Channel Z	-0.85	-2.62	0.59	0.61
6. Input Offset Current				
Nominal input circuitry offset current on all channels: <25A				
7. Input Resistance (Typical values for information)				
Channel X	Zeroing (MΩ)	Measuring (MΩ)		
Channel X	200	200		
Channel Y	200	200		
Channel Z	200	200		
8. Low Battery Alarm Voltage (Typical values for information)				
Typical values	Alarm Level (VDC)			
Supply (+ Vcc)	+7.9			
Supply (- Vcc)	-7.6			
9. Power Consumption (Typical values for information)				
Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)	
Supply (+ Vcc)	+0.01	+6	+14	
Supply (- Vcc)	-0.01	-8	-9	

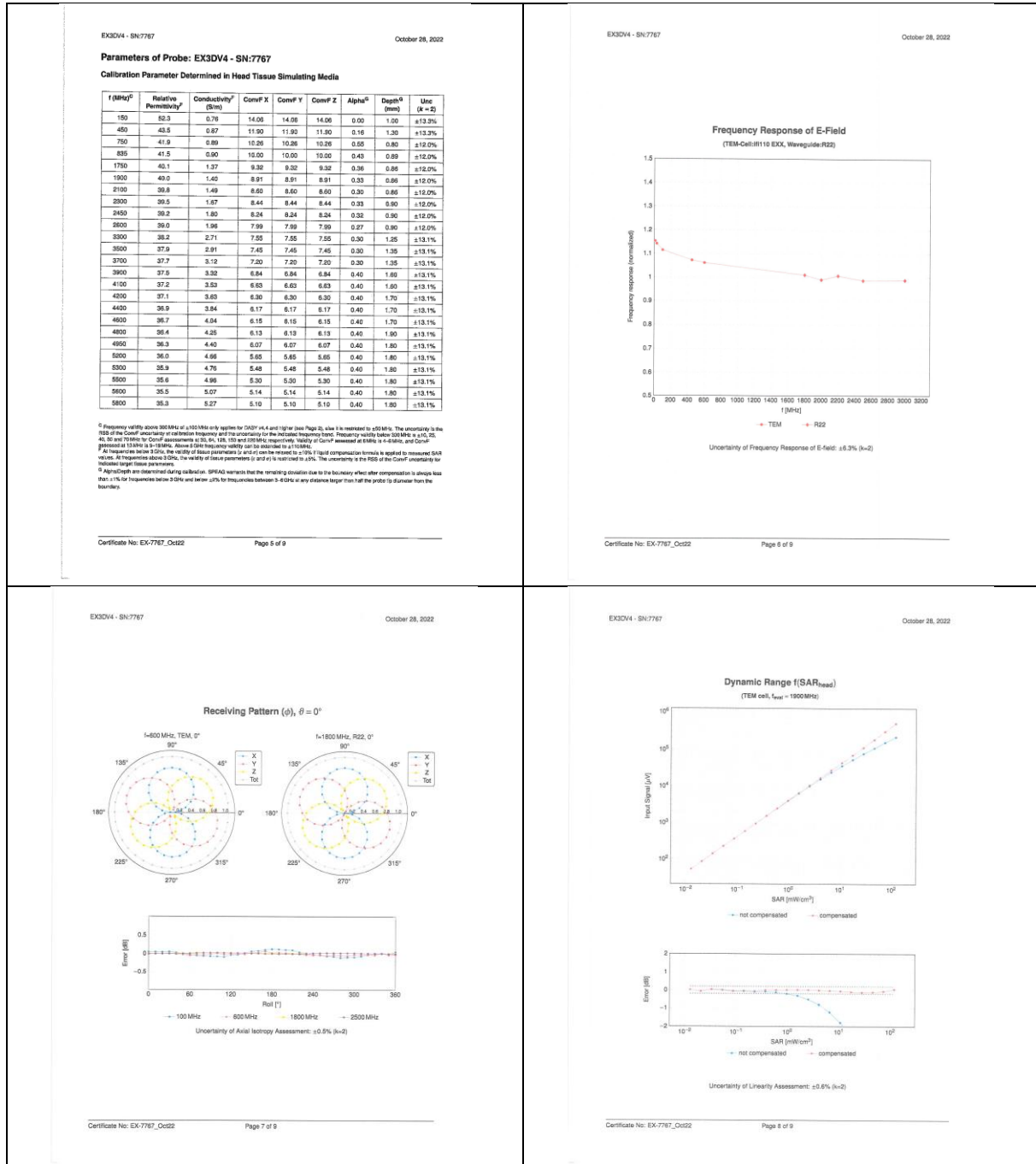


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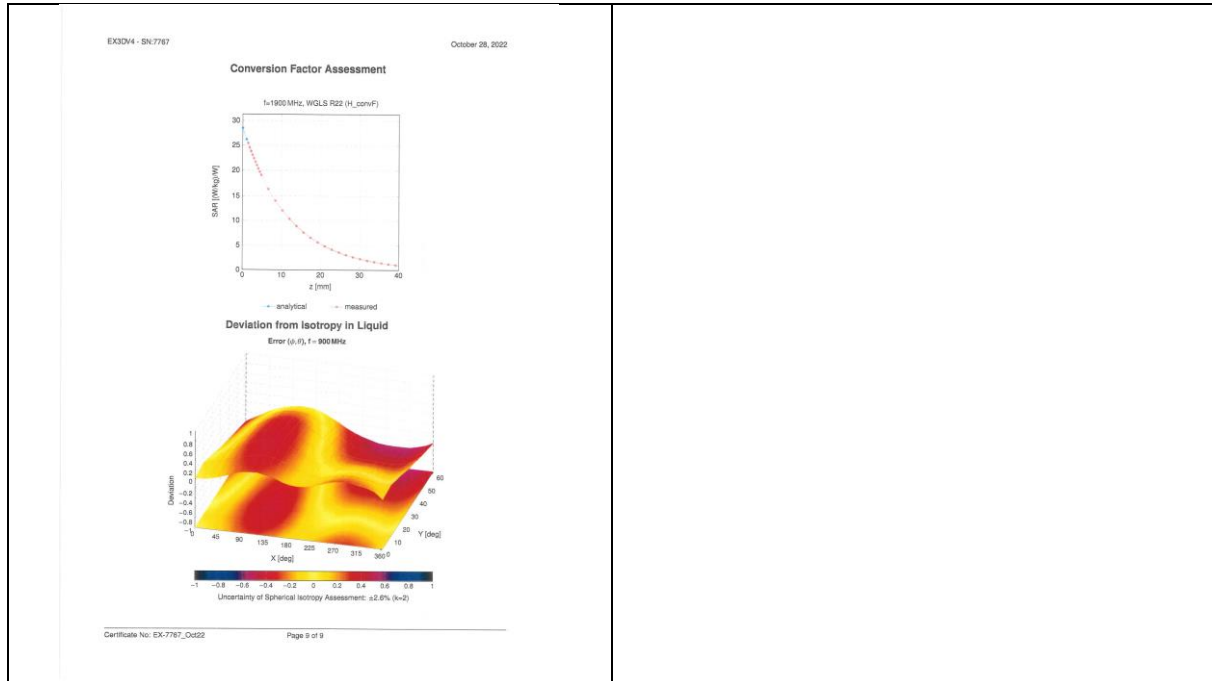
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5 Impedance and return loss

Dipole D3500V2 SN 1101 for 3400MHz				
Head Liquid				
Date of Measurement	Return Loss(dB)	Δ %	Impedance (Ω)	$\Delta\Omega$
2021/09/09	-21.908	/	44.859	/
2022/09/09	-22.037	0.59%	45.114	0.255 Ω
Dipole D3500V2 SN 1101 for 3500MHz				
Head Liquid				
Date of Measurement	Return Loss(dB)	Δ %	Impedance (Ω)	$\Delta\Omega$
2021/09/09	-26.055	/	53.438	/
2022/09/09	-25.972	-0.32%	53.881	0.443
Dipole D3700V2 SN 1103				
Head Liquid				
Date of Measurement	Return Loss(dB)	Δ %	Impedance (Ω)	$\Delta\Omega$
2021/09/09	-25.289	/	45.136	/
2022/09/09	-24.992	-1.17%	53.806	0.368
Dipole D3900V2 SN 1080 for 3900MHz				
Head Liquid				
Date of Measurement	Return Loss(dB)	Δ %	Impedance (Ω)	$\Delta\Omega$
2021/09/13	-24.246	/	46.969	/
2022/09/13	-24.035	-0.87%	47.122	0.153
Dipole D3900V2 SN 1080 for 4100MHz				
Head Liquid				
Date of Measurement	Return Loss(dB)	Δ %	Impedance (Ω)	$\Delta\Omega$
2021/09/13	-23.890	/	56.485	/
2022/09/13	-24.023	0.56%	56.976	0.491



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