



Appendix C for KSCR240600114701

Calibration Certificate

Object	Apply	No	Model	SN	Calibration Date	Due date of calibration
Dipole	☒	1	D450V3	1103	2024/06/03	2027/06/02
DAE	☒	2	DAE4	918	2023/08/07	2024/08/06
Probe	☒	3	EX3DV4	7767	2023/10/26	2024/10/25

1 Dipole

1.1 D450V3 - SN 1103

Calibration Laboratory of Schmid & Partner Engineering AG Zugstrasse 43, 8004 Zug, 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		S Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service Accreditation No.: SCS 0108	
Client: SGS Bachow		Certificate No.: D450V3-1103_Jun24	
CALIBRATION CERTIFICATE			
Object: D450V3 - SN: 1103			
Calibration procedure(s): QA CAL-15.v11 Calibration Procedure for SAR Validation Sources below 700 MHz			
Calibration date: June 03, 2024			
This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory facility, environment temperature (22 ± 3)°C and humidity < 70%.			
Calibration Equipment used (MATE critical for calibration)			
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NP92	SN: 104718	26 Mar-24 (No. 217-04036/04037)	Mar-25
Power sensor NRP-Z91	SN: 103244	26 Mar-24 (No. 217-04036)	Mar-25
Power sensor NRP-Z91	SN: 103245	26 Mar-24 (No. 217-04037)	Mar-25
Reference 20 dB Attenuator	SN: 891934 (209)	26 Mar-24 (No. 217-04046)	Mar-25
Type-N mismatch combination	SN: 310802 / 00327	26 Mar-24 (No. 217-04047)	Mar-25
Reference Probe EX20V4	SN: 3077	10 Jan-24 (No. EX2-3077_Jan24)	Jan-25
DAE4	SN: 854	15 Jan-24 (No. DAE4-854_Jan24)	Jan-25
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter NP92	SN: 107183	08 Nov-21 (in house check Dec-22)	In house check: Dec-24
Power sensor NRP-Z91	SN: 103052	19 Dec-20 (in house check Dec-22)	In house check: Dec-24
Power sensor NRP-Z91	SN: 103418	01 Jan-20 (in house check Dec-22)	In house check: Dec-24
RF generator HP 8540C	SN: US394201700	04 Aug-19 (in house check Jun-22)	In house check: Jun-24
Network Analyzer Agilent E8363A	SN: US41030477	31 Mar-14 (in house check Dec-22)	In house check: Oct-24
Calibrated by:	Name: Jeffrey Köttemann	Function: Laboratory Technician	Signature: 
Approved by:	Evert Kuhn	Technical Manager	
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
Issued: June 5, 2024			
Certificate No: D450V3-1103_Jun24		Page 1 of 6	

Measurement Conditions	
DASY system configuration, as far as not given on page 1.	
DASY Version	DASY5 V52.10.4
Extrapolation	Advanced Extrapolation
Phantom	EL4 Flat Phantom Shell thickness: 2 ± 0.2 mm
Distance Dipole Center - TSL	15 mm with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm
Frequency	450 MHz ± 1 MHz

Head TSL parameters			
The following parameters and calculations were applied:			
	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	43.5	0.87 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	45.0 ± 6 %	0.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL		
SAR averaged over 1 cm² (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.15 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	4.63 W/kg ± 18.1 % (k=2)
SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	0.765 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	3.08 W/kg ± 17.6 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)	
Antenna Parameters with Head TSL	
Impedance, transformed to feed point	59.0 Ω ± 0.5 Ω
Return Loss	-21.6 dB
General Antenna Parameters and Design	
Electrical Delay (one direction)	1.351 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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Additional EUT Data	
Manufactured by	SPEAG

DASY5 Validation Report for Head TSL

Date: 03.06.2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN:1103

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used: $f = 450 \text{ MHz}$; $\sigma = 0.87 \text{ S/m}$; $\epsilon_r = 45.0$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(10.64, 10.64, 10.64) @ 450 MHz; Calibrated: 10.01.2024
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 15.01.2024
- Phantom: ELJ v6.0; Type: QDOVA003AA; Serial: TP-2034
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue($d=15\text{mm}$, $P_{in}=250\text{mW}$ /Zoom Scan (7x7x7)/Cube 0:Measurement grid: $d_x=5\text{mm}$, $d_y=5\text{mm}$, $d_z=5\text{mm}$

Reference Value = 39.05 V/m; Power Drift = 0.01 dB

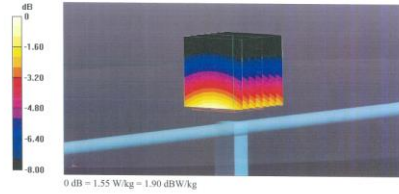
Peak SAR (extrapolated) = 1.79 W/kg

SAR(M1) g = 1.15 W/kg; SAR(M2) g = 0.765 W/kg

Smallest distance from peaks to all points 3 dB below: Larger than measurement grid ($> 15 \text{ mm}$)

Ratio of SAR at M2 to SAR at M1 = 64.2%

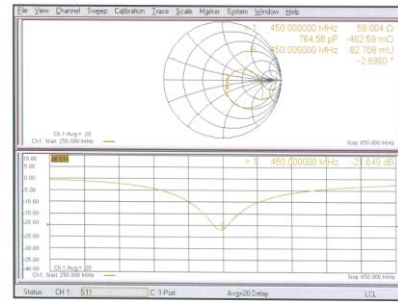
Maximum value of SAR (measured) = 1.55 W/kg



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Impedance Measurement Plot for Head TSL



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2 DAE4 - SN 918

TTL Calibration Laboratory		CAICT	
In Collaboration with TTL Calibration Laboratory Add: No. 52 HuaYuanBei Road, Haidian District, Beijing, 100191, China Tel: +86-10-4230403-2117 E-mail: emf@caict.ac.cn http://www.caict.ac.cn		In Collaboration with TTL Calibration Laboratory Add: No. 52 HuaYuanBei Road, Haidian District, Beijing, 100191, China Tel: +86-10-4230403-2117 E-mail: emf@caict.ac.cn http://www.caict.ac.cn	
Client: Auden Certificate No: J23260347			
CALIBRATION CERTIFICATE			
Object	DAE4 - SN: 918		
Calibration Procedure(s)	FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAE)		
Calibration date:	August 07, 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 22±3°C and humidity <70%.			
Calibration Equipment used (M&TE critical for calibration)			
Primary Standards	ID #	Cal Date (Calibrated by: Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	12-Jun-23 (CTTL No.J23X05436)	Jun-24
Calibrated by:	Name	Function	Signature
	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyan	SAR Project Leader	
Issued August 13, 2023			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
Certificate No: J23260347		Page 1 of 3	
Glossary:			
DAE:	data acquisition electronics		
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.		
Methods Applied and Interpretation of Parameters:			
• 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 report provide only calibration results for DAE, it does not contain other performance test results.			
Certificate No: J23260347		Page 2 of 3	
TTL Calibration Laboratory		CAICT	
In Collaboration with TTL Calibration Laboratory Add: No. 52 HuaYuanBei Road, Haidian District, Beijing, 100191, China Tel: +86-10-4230403-2117 E-mail: emf@caict.ac.cn http://www.caict.ac.cn		In Collaboration with TTL Calibration Laboratory Add: No. 52 HuaYuanBei Road, Haidian District, Beijing, 100191, China Tel: +86-10-4230403-2117 E-mail: emf@caict.ac.cn http://www.caict.ac.cn	
DC Voltage Measurement			
A/D Converter Resolution nominal			
High Range: 1LSB = 61μV Full range = -100...+300 mV			
Low Range: 1LSB = 610V Full range = -1...+3mV			
DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec.			
Calibration Factors	X	Y	Z
High Range	404.345 ± 0.15% (k=2)	404.521 ± 0.15% (k=2)	404.051 ± 0.15% (k=2)
Low Range	4.01038 ± 0.7% (k=2)	3.99083 ± 0.7% (k=2)	4.00746 ± 0.7% (k=2)
Connector Angle			
Connector Angle to be used in DASY system		321.5° ± 1°	
Certificate No: J23260347		Page 3 of 3	

3 EX3DV4 - SN 7767

Schmid & Partner Engineering AG Zingststrasse 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		 S Schweizerischer Kalibrierdienst C Service suisse d'étalonnage S Servizio italiano di taratura S Swiss Calibration Service		Schweizerischer Kalibrierdienst C Service suisse d'étalonnage S Servizio italiano di taratura S Swiss Calibration Service		Schmid & Partner Engineering AG Zingststrasse 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		 S Schweizerischer Kalibrierdienst C Service suisse d'étalonnage S Servizio italiano di taratura S Swiss Calibration Service		Schweizerischer Kalibrierdienst C Service suisse d'étalonnage S Servizio italiano di taratura S Swiss Calibration Service																																	
Client: SGS Kuranan		Certificate No.: EX-7767_Oct23																																									
CALIBRATION CERTIFICATE																																											
Object:		EX3DV4 - SN:7767																																									
Calibration procedure(s):		QA CAL-01-v10, QA CAL-12-v10, QA CAL-14-v7, QA CAL-23-v6, QA CAL-25-v6 Calibration procedure for dosimetric E-field probes																																									
Calibration date:		October 26, 2023																																									
This calibration certificate documents the traceability to national standards, which realizes the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given in the following pages and are part of the certificate. All calibrations have been conducted in the closed laboratory building: environment temperature (22 ± 2) °C and humidity < 70%. Calibration Equipment used (MATE critical for calibration)																																											
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Calibrated by:		Name: Joana Llesha Function: Laboratory Technician		Signature: [Signature]																																							
Approved by:		Evan Kuhn Technical Manager		[Signature]																																							
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EX3DV4 - SN:7767											
October 26, 2023											
Parameters of Probe: EX3DV4 - SN:7767											
Basic Calibration Parameters											
		Sensor X		Sensor Y		Sensor Z		Unc (k = 2)			
Norm (µV/(Vm/m²)) ^A		0.68		0.72		0.56		±10.1%			
DCP (mV)		103.4		105.4		106.6		±4.7%			
Calibration Results for Modulation Response											
UFD Communication System Name		A dB		B dB_μV		C dB		D dB_VR		Max dev. Max Unc ^B k=2	
G CW		X 1 0.00		0.00		1.00		0.00		132.5 ±1.9% A.C.P.%	
		Y 0.00		0.00		1.00		0.00		148.5 ±1.9% A.C.P.%	
		Z 0.00		0.00		1.00		0.00		136.5 ±1.9% A.C.P.%	
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%.											
^A The uncertainties of Norm X, Y, Z are due to the IT field uncertainty value TSL, see page 6. ^B Uncertainty parameter uncertainty for maximum specified field strength. ^C Uncertainty is determined using the max. deviation from three observed approximating rectangular distribution and is expressed for the square of the field value.											
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EX3DV4 - SN:7767											
October 26, 2023											
Parameters of Probe: EX3DV4 - SN:7767											
Other Probe Parameters											
Sensor Arrangement		Triangular									
Connector Angle		40.9°									
Mechanical Surface Detection Mode		enabled									
Optical Surface Detection Mode		disabled									
Probe Overall Length		337 mm									
Probe Body Diameter		10 mm									
Tip Length		9 mm									
Tip Diameter		2.8 mm									
Probe Tip to Sensor X Calibration Point		1 mm									
Probe Tip to Sensor Y Calibration Point		1 mm									
Probe Tip to Sensor Z Calibration Point		1 mm									
Recommended Measurement Distance from Surface		1.4 mm									
Note: Measurement distance from surface can be increased to 3-4 mm for air Sea Ray.											
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EX3DV4 - SN:7767

October 26, 2023

Parameters of Probe: EX3DV4 - SN:7767

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ¹	Relative Permittivity ²	Conductivity ³ (S/m)	Conv ⁴ X	Conv ⁴ Y	Conv ⁴ Z	Alpha ⁵	Depth ⁶ (mm)	Unc ⁷ (k=2)
150	52.3	0.78	13.37	13.37	13.37	0.00	1.25	±13.5%
450	43.5	0.87	11.62	11.62	11.62	0.16	1.30	±13.3%
750	41.9	0.89	10.54	10.19	10.87	0.59	1.27	±12.6%
855	41.5	0.90	10.39	9.85	10.00	0.36	1.27	±12.0%
900	41.5	0.97	10.29	9.75	9.99	0.58	1.27	±12.0%
1750	40.1	1.27	9.45	8.73	9.54	0.24	1.27	±12.0%
1900	40.0	1.40	8.54	7.95	8.42	0.28	1.27	±12.0%
2100	39.8	1.49	8.41	7.80	8.34	0.28	1.27	±12.0%
2300	39.5	1.67	8.70	8.12	8.61	0.29	1.27	±12.0%
2450	39.2	1.80	8.36	7.75	8.29	0.28	1.27	±12.0%
2800	39.0	1.98	8.01	7.49	7.95	0.27	1.27	±12.0%
3500	38.2	2.71	7.41	6.83	7.31	0.33	1.27	±14.0%
3700	37.9	2.91	7.54	7.02	7.52	0.34	1.27	±14.0%
3750	37.7	3.13	7.21	6.62	7.10	0.34	1.27	±14.0%
3800	37.5	3.32	7.17	6.59	7.08	0.34	1.27	±14.0%
4100	37.2	3.53	6.86	6.39	6.86	0.35	1.27	±14.0%
4200	37.1	3.63	6.64	6.08	6.65	0.35	1.27	±14.0%
4400	36.9	3.84	6.59	6.06	6.50	0.36	1.27	±14.0%
4600	36.7	4.04	6.05	6.11	6.07	0.36	1.27	±14.0%
4800	36.4	4.25	6.78	6.23	6.87	0.36	1.27	±14.0%
4900	36.3	4.40	6.43	5.87	6.30	0.39	1.38	±14.0%
5200	36.0	4.66	6.01	5.50	5.93	0.30	1.80	±14.0%
5300	35.9	4.76	5.80	5.36	5.75	0.29	1.67	±14.0%
5500	35.6	4.96	5.50	5.07	5.48	0.32	1.70	±14.0%
5900	35.5	5.07	5.25	4.78	5.16	0.34	1.75	±14.0%
5920	35.3	5.27	5.26	4.79	5.17	0.34	1.86	±14.0%

¹ Frequency validity below 200 MHz of ±0.5 MHz only applies for Q207 at 4 and higher (see Page 10), else it is restricted to ±0.5 MHz. The uncertainty in the RSS of the Conv⁴ uncertainty at calibration frequency and the uncertainty for the lowest frequency band. Frequency validity below 200 MHz is ±0.5%, 0.5, 4%, 10 and 70 MHz for Conv⁴ dependence at 30, 100, 1000 and 10000 MHz respectively. Validity of Conv⁴ assessed at 5.0 to 14.4 MHz and Conv⁴ assessed at 13.0 MHz to 14.4 MHz. Above 5.0 MHz frequency validity can be extended to ±10 MHz.

² The values are calculated using the uncertainty of the TRL that is used for and the test item. ±10% from the target values (typically better than ±10%) and are used for TRL with uncertainty of up to ±10% if TRL with deviations from the target of less than ±10% are used, the calibration uncertainties due to 1% for 0.7-3.5 GHz and 10-15% for 3-5 GHz.

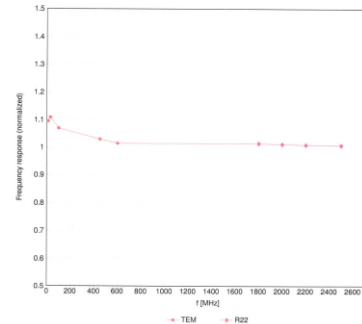
³ Alpha values are determined during calibration. SPAD warrants that the weighting correction due to the boundary effect after compensation is always less than ±1% for frequencies below 3.0 GHz and below ±0.5% for frequencies between 3-5 GHz at any distance larger than half the probe tip diameter from the boundary.

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Frequency Response of E-Field
(TEM-Cell:01110 EXX Waveguide:R22)

Uncertainty of Frequency Response of E-Field: ±0.3% (k=2)

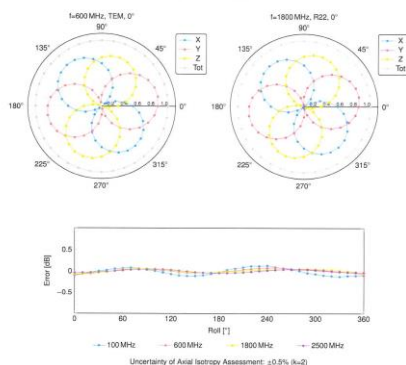
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Receiving Pattern (φ, θ = 0°)



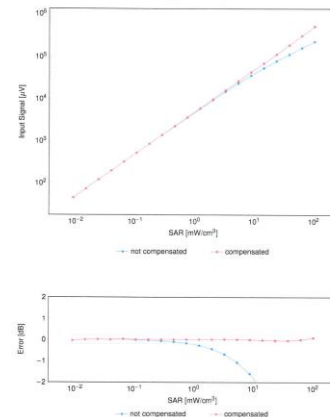
Uncertainty of Axial Isotropy Assessment: ±0.5% (k=2)

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Dynamic Range f(SAR_{head})
(TEM cell, f_{test} = 1900 MHz)

Uncertainty of Linearity Assessment: ±0.6% (k=2)

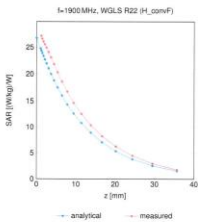
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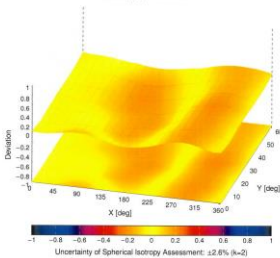
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Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (x, y), f = 900 MHz



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