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



S Schweizerischer Kalibrierdienst

C Service suisse d'étalonnage

Servizio svizzero di taratura

S Swiss Calibration Service

Accreditation No.: SCS 0108

Accredited by the Swiss Accreditation Service (SAS)

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

UL USA Client

Certificate No: D5GHzV2-1138_Feb23

CALIBRATION CERTIFICATE

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Calibration Laboratory of

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



Schweizerischer Kalibrierdienst

Service suisse d'étalonnage

Servizio svizzero di taratura

Swiss Calibration Service

Accreditation No.: SCS 0108

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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
	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

c) DASY System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The source is mounted in a touch configuration below the center marking of the flat phantom.
- *Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
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)
	5250 MHz ± 1 MHz	,
Frequency	5600 MHz ± 1 MHz	
. requeitoy	5750 MHz ± 1 MHz	
	5850 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	35.5 ± 6 %	4.70 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^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.97 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.27 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.6 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 %	5.07 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 ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.25 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.35 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.4 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.2 ± 6 %	5.18 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.84 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.3 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.2 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5850 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.2	5.32 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.9 ± 6 %	5.27 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5850 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.02 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.7 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	48.1 Ω - 4.5 jΩ	
Return Loss	- 26.0 dB	

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	53.7 Ω + 0.1 jΩ	
Return Loss	- 28.9 dB	

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	56.4 Ω + 0.3 jΩ	
Return Loss	- 24.4 dB	

Antenna Parameters with Head TSL at 5850 MHz

Impedance, transformed to feed point	57.1 Ω - 1.5 jΩ	
Return Loss	- 23.3 dB	

General Antenna Parameters and Design

Electrical Delay (one direction)	1.201 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

P	
Manufactured by	SPEAG
	OFEAG

Date: 03.02.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1138

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5850 MHz Medium parameters used: f = 5250 MHz; $\sigma = 4.7$ S/m; $\varepsilon_r = 35.5$; $\rho = 1000$ kg/m³ Medium parameters used: f = 5600 MHz; $\sigma = 5.07$ S/m; $\varepsilon_r = 35.4$; $\rho = 1000$ kg/m³ Medium parameters used: f = 5750 MHz; $\sigma = 5.18$ S/m; $\varepsilon_r = 35.2$; $\rho = 1000$ kg/m³ Medium parameters used: f = 5850 MHz; $\sigma = 5.27$ S/m; $\varepsilon_r = 34.9$; $\rho = 1000$ kg/m³ 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(5.08, 5.08, 5.08) @ 5750 MHz, ConvF(4.99, 4.99, 4.99) @ 5850 MHz; Calibrated: 08.03.2022
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

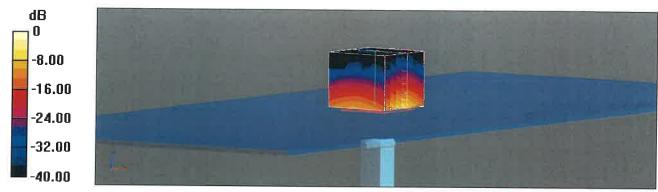
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 75.08 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 27.2 W/kg SAR(1 g) = 7.97 W/kg; SAR(10 g) = 2.27 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 71% Maximum value of SAR (measured) = 18.3 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 = 73.91 V/m; Power Drift = -0.01 dB Peak SAR (extrapolated) = 30.3 W/kg SAR(1 g) = 8.25 W/kg; SAR(10 g) = 2.35 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 68.4%Maximum value of SAR (measured) = 19.3 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 71.97 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 30.4 W/kg SAR(1 g) = 7.84 W/kg; SAR(10 g) = 2.22 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 66.5%Maximum value of SAR (measured) = 18.7 W/kg

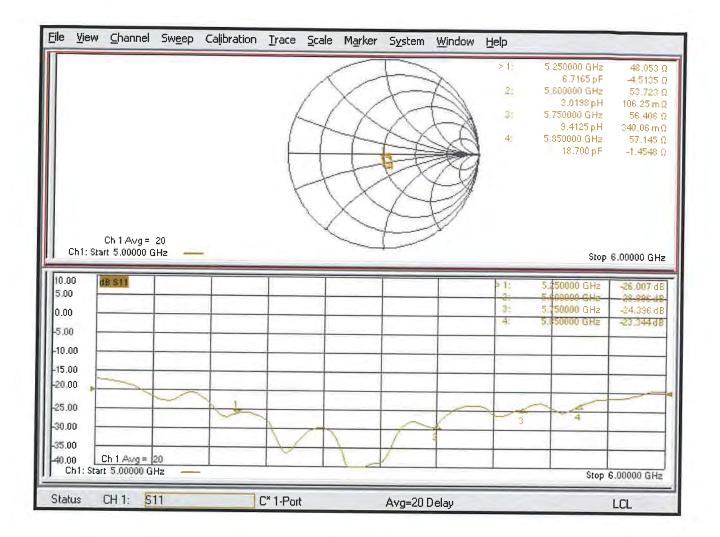
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5850 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm Reference Value = 71.46 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 31.7 W/kg SAR(1 g) = 8.02 W/kg; SAR(10 g) = 2.28 W/kg Smallest distance from peaks to all points 3 dB below = 7.2 mm Ratio of SAR at M2 to SAR at M1 = 65.6% Maximum value of SAR (measured) = 19.5 W/kg



0 dB = 19.5 W/kg = 12.89 dBW/kg

Impedance Measurement Plot for Head TSL





Equipment Location	Equipment	Model Name	Date of
	Name		Verification
UL Verification Services Inc.	Dipole	D5GHzV2-1038	January 29,
47173 Benicia Street	Antenna		2024
Fremont, CA 94538, U.S.A.			

Number:	Check List:	Result:
1	Return/Loss and Impedance	Pass
2	Dipole Arms	Pass

Equipment List:		
Equipment Name:	Calibration Date:	
R&S ZNLE6 Vector Network	02/28/2025	
Analyzer		
ZV-Z135 Calibration Kit	03/31/2024	



1) Impedance and Return/Loss

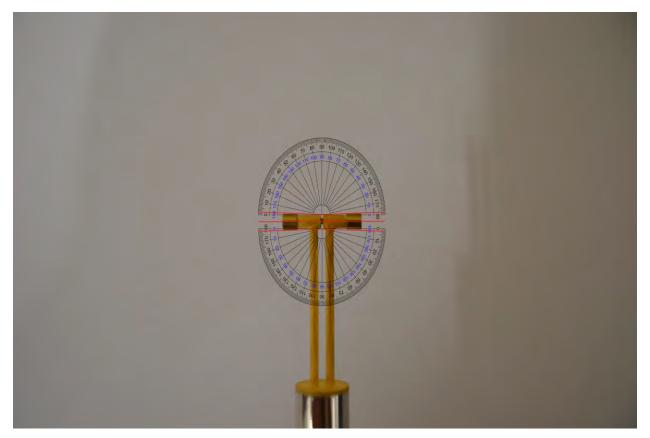
Frc1 S11 Smith 200 mU/ R	ef1U Cal					1 \
				Μ	1 5.250000 GHz	
		0.5	2			j3.902 Ω 118.301283 pH
		/ X X			2 5.600000 GHz	
				IV.	12 J.000000 GHZ	-j613.332 ml
			5			46.337893 pF
				M	3 5.750000 GHz	
		0 0.2 0.5				j5.350 Ω
		0 0.2 0.5 0	- X107			148.090180 pH
			5	M	4 5.850000 GHz	55.403 Ω
		\land				-j4.497 Ω
		$\wedge \times \checkmark$				6.050115 pF
		-0.5	-2/			
			_ /			
		1	/			
1 Center 5.5 GHz	Pwr -10 dBr	m Bw 10 kHz Refl OSM P1	/			Span 1 GH:
		m Bw 10 kHz Refl OSM P1				Span 1 GH: 2 🗸
rc2 <mark>S11</mark> dB Mag 10 dB/ R		m Bw 10 kHz Refl OSM P1			M1 5.250000	2 ~
c2 <mark>511</mark> dB Mag 10 dB/ R		m Bw 10 kHz Refl OSM P1				2 ► GHz -25.1461 d
c2 S11 dB Mag 10 dB/ R		m Bw 10 kHz Refl OSM P1				2 - GHz -25.1461 d GHz -30.2766 d
rc2 S11 dB Mag 10 dB/ R		m Bw 10 kHz Refl OSM P1			M2 5.600000 (• M3 5.763300 (2 - GHz -25.1461 d GHz -30.2766 d
I1 Center 5.5 GHz rc2 S11 dB Mag 10 dB/ R		m Bw 10 kHz Refl OSM P1			M2 5.600000 (• M3 5.763300 (GHz -25.1461 d GHz -30.2766 d GHz -23.6338 d
rc2 S11 dB Mag 10 dB/ R	tef 0 dB Cal	m Bw 10 kHz Refl OSM P1			M2 5.600000 (• M3 5.763300 (M4 5.850000 (GHz -25.1461 d GHz -30.2766 d GHz -23.6338 d
2 511 dB Mag 10 dB/ R	tef 0 dB Cal	m Bw 10 kHz Refl OSM P1		M3	M2 5.600000 (• M3 5.763300 (GHz -25.1461 d GHz -30.2766 d GHz -23.6338 d
2 511 dB Mag 10 dB/ R	tef 0 dB Cal	m Bw 10 kHz Refl OSM P1			M2 5.600000 (• M3 5.763300 (M4 5.850000 (GHz -25.1461 d GHz -30.2766 d GHz -23.6338 d
c2 S11 dB Mag 10 dB/ R	tef 0 dB Cal	m Bw 10 kHz Refl OSM P1	M2		M2 5.600000 (• M3 5.763300 (M4 5.850000 (GHz -25.1461 d GHz -30.2766 d GHz -23.6338 d
dB	tef 0 dB Cal	m Bw 10 kHz Refl OSM P1	M2		M2 5.600000 (• M3 5.763300 (M4 5.850000 (GHz -25.1461 d GHz -30.2766 d GHz -23.6338 d
c2 S11 dB Mag 10 dB/ R	tef 0 dB Cal	m Bw 10 kHz Refl OSM P1	M2		M2 5.600000 (• M3 5.763300 (M4 5.850000 (GHz -25.1461 d GHz -30.2766 d GHz -23.6338 d
vc2 S11 dB Mag 10 dB/ R 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	tef 0 dB Cal	m Bw 10 kHz Refl OSM P1	M2		M2 5.600000 (• M3 5.763300 (M4 5.850000 (GHz -25.1461 d GHz -30.2766 d GHz -23.6338 d
c2 S11 dB Mag 10 dB/ R	tef 0 dB Cal	m Bw 10 kHz Refl OSM P1	M2		M2 5.600000 (• M3 5.763300 (M4 5.850000 (GHz -25.1461 d GHz -30.2766 d GHz -23.6338 d

02:51:29 30.01.2024

• Return/Loss is greater than the -20 dB cutoff and Impedance is within 5 Ω of previous value.



2) Dipole Arms



• The center red line indicates that the arms of the dipole fall within $\pm 2^\circ$



Equipment Location	Equipment	Model Name	Date of
	Name		Verification
UL Verification Services Inc.	Dipole	D5GHzV2-1138	February 6,
47173 Benicia Street	Antenna		2025
Fremont, CA 94538, U.S.A.			

Number:	Check List:	Result:
1	Visual Inspection	Pass
2	Return/Loss and Impedance	Pass
3	Dipole Arms	Pass

Equipment List:		
Equipment Name: Calibration Date:		
R&S Vector Network Analyzer 3/5/2024		
ZN-Z135 Calibration Kit 5/17/2024		

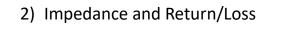


1) Photo of Dipole



• The connector of dipole contains no abnormalities.





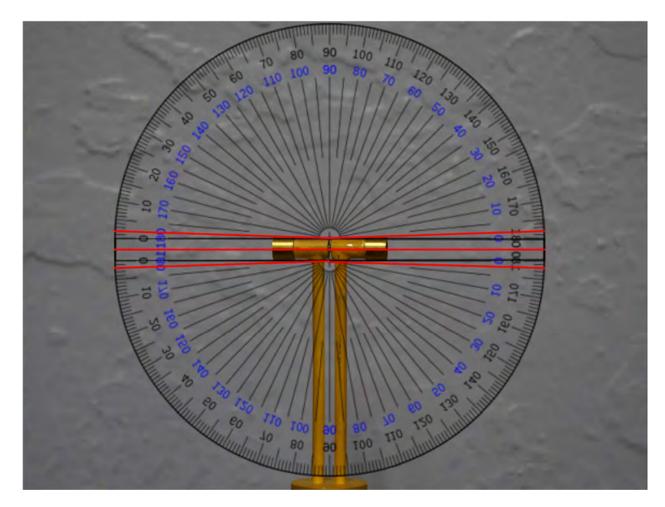
Trc1 S11 Smith 200 mU/ Ref 1 U Cal	
	M2 5.600000 GHz 46.928
0.5	-j3.550
	7.99130: M3 5.750000 GHz 52.39
	ins 5.150000 driz 52.55A
	120 77520
	Maria M4 5.850000 GHz 57.55 14.55
0, 0,2 0,5	-j4.55 5.97308
-0.5	
h1 Center 5.5 GHz Pwr -10 dBm Bw 1.5 kHz Refl OSN	-1
Trc2 S11 dB Mag 10 dB/ Ref 0 dB Cal	API Span 1
Trc2 511 dB Mag 10 dB/ Ref 0 dB Cat	M2 5.600000 GHz -26.294
Glass Glas Glass Glass <thg< th=""><th>M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421</th></thg<>	M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421
Grc2 S11 dB Mag 10 dB/ Ref 0 dB Cal od8	M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421 M4 5.850000 GHz -21.728 M4
Glass Glas Glass Glass <thg< td=""><td>M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421</td></thg<>	M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421
Grc2 S11 dB Mag 10 dB/ Ref 0 dB Cal od8	M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421 M4 5.850000 GHz -21.728 M4
GdB Image: 10 dB/ Ref 0 dB Cal 0dB 0dB 0dB 10dB 0dB 0dB	M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421 M4 5.850000 GHz -21.728 M4
Gas Gas <td>M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421 M4 5.850000 GHz -21.728 M4</td>	M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421 M4 5.850000 GHz -21.728 M4
Trc2 S11 dB Mag 10 dB/ Ref 0 dB Cal OdB	M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421 M4 5.850000 GHz -21.728 M4
Trc2 S11 dB Mag 10 dB/ Ref 0 dB Cal 0dB 0dB 0 <t< td=""><td>M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421 M4 5.850000 GHz -21.728 M4</td></t<>	M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421 M4 5.850000 GHz -21.728 M4
Trc2 S11 dB Mag 10 dB/ Ref 0 dB Cal 0dB 0	M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421 M4 5.850000 GHz -21.728 M4
Trc2 S11 dB Mag 10 dB/ Ref 0 dB Cal 0dB 0dB 0 <t< td=""><td>M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421 M4 5.850000 GHz -21.728 M4</td></t<>	M2 5.600000 GHz -26.294 M3 5.750000 GHz -25.421 M4 5.850000 GHz -21.728 M4

~

- 06:14:49 07.02.2025
 - Return/Loss is greater than the -20 dB cutoff and Impedance is within 5 Ω of previous value.



3) Dipole Arms



• The center red line indicates that the arms of the dipole fall within $\pm 2^{\circ}$

Calibration Laboratory of Schmid & Partner Engineering AG

UL

Fremont, USA

Client



S Schweizerischer Kalibrierdienst Service suisse d'étalonnage

C Service suisse d'étalonnage Servizio svizzero di taratura

S Swiss Calibration Service

Accreditation No.: SCS 0108

Zeughausstrasse 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

Certificate No.

D5GHzV2-1168_Feb25

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN: 1168
Calibration procedure(s)	QA CAL-22.v7 Calibration Procedure for SAR Validation Sources between 3 - 10 GHz
Calibration date	February 6, 2025
The measurements and the un	ments the traceability to national standards, which realize the physical units of measurements (SI). certainties 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%.

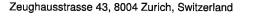
Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Cal
Power Sensor R&S NRP-33T	SN: 100967	28-Mar-24 (No. 217-04038)	Mar-25
Power Sensor R&S NRP18A	SN: 101859	22-Jul-24 (No. 4030A315008547)	Jul-25
Spectrum Analyzer R&S FSV40	SN: 101832	29-Jan-25 (No. 4030A315009658)	Jan-26
Mismatch; Short [S4188] Attenuator [S4423]	SN: 1152	28-Mar-24 (No. 217-04050)	Mar-25
OCP DAK-12	SN: 1016	24-Sept-24 (No. OCP-DAK12-1016_Sep24)	Sep-25
OCP DAK-3.5	SN: 1249	23-Sept-24 (No. OCP-DAK3.5-1249_Sep24)	Sep-25
Reference Probe EX3DV4	SN: 7349	10-Jan-25 (No. EX3-7349_Jan25)	Jan-26
DAE4ip	SN: 1836	28-Oct-24 (No. DAE4ip-1836_Oct24)	Oct-25

Secondary Standards	ID	Check Date (in house)	Scheduled Check
ACAD Source Box	SN: 1000	28-May-24 (No. 675-ACAD_Source_Box-240528)	May-25
Signal Generator R&S SMB100A	SN: 182081	28-May-24 (No. 675-CAL16-S4588-240528)	May-25
Mismatch; SMA	SN: 1102	22-May-24 (No. 675-Mismatch_SMA-240522)	May-25

	Name	Function	Signature
Calibrated by	Claudio Leubler	Laboratory Technician	YO
Approved by	Sven Kūhn	Technical Manager	S.C.
This calibration certifica	te shall not be reproduced except in	full without written approval of the lab	Issued: February 6, 2025 poratory.

Calibration Laboratory of Schmid & Partner Engineering AG



ilac-MRA



S Schweizerischer Kalibrierdienst

C Service suisse d'étalonnage

Servizio svizzero di taratura

S Swiss Calibration Service

Accreditation No.: SCS 0108

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

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

- 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.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation

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 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	DASY8 Module SAR	16.4.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with spacer
Zoom Scan Resolution	dx, dy = 4mm, dz = 1.4mm	Graded Ratio = 1.4 mm (Z direction)
Frequency	5250MHz ±1MHz 5600MHz ±1MHz 5750MHz ±1MHz 5850MHz ±1MHz	

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	35.1 ±6%	4.55 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 ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	20 dBm input power	8.11 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.1 W/kg ±19.9% (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	20 dBm input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 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	34.4 ±6%	4.92 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 ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	20 dBm input power	8.15 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.5 W/kg ±19.9% (k = 2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	20 dBm input power	2.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.4 W/kg ±19.5% (k = 2)

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ±0.2)°C	34.2 ±6%	5.08 mho/m ±6%
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	20 dBm input power	7.94 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.4 W/kg ±19.9% (k = 2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	20 dBm input power	2.25 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 W/kg ±19.5% (k = 2)

Head TSL parameters at 5850 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.2	5.32 mho/m
Measured Head TSL parameters	(22.0 ±0.2)°C	34.1 ±6%	5.18 mho/m ±6%
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 5850 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	20 dBm input power	8.13 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.3 W/kg ±19.9% (k = 2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	20 dBm input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 W/kg ±19.5% (k = 2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5250 MHz

Impedance	
Return Loss	48.8 Ω – 4.4 jΩ
	-26.8 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance	
Return Loss	52.3 Ω – 1.7 jΩ
	-31.0 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance	
Return Loss	58.0 Ω + 4.1 jΩ
	-21.6 dB

Antenna Parameters with Head TSL at 5850 MHz

Impedance	
Return Loss	55.0 Ω + 4.2 jΩ
	-24.1 dB

General Antenna Parameters and Design

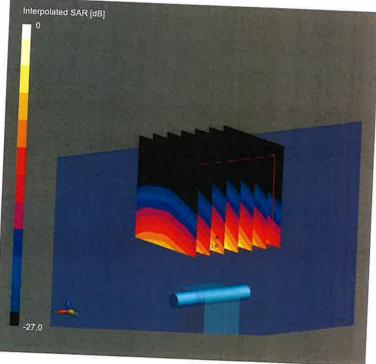
Electrical Delay (one direction)		1 100	_
	1	1.189 ns	

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

Additional EUT Data

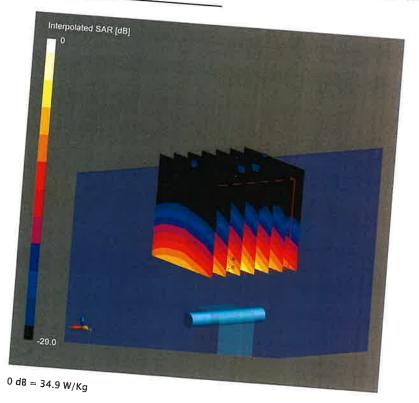
Manufactured by	
	SPEAG

Summary									
Dipole			Frequency (N	/Hz1					
D5GHzV2 - SN1168			5250		TSL	Power [dBm]			
		-			HSL	20			
Exposure Condition	าร								
Phantom Section, TSL	Test Distance (mm)	Band	Group, UID	Frequency [Mł	Hz], Channel Number	Conversion Factor			
Flat	10	-	CW, 0	5250, 0			TSL Conductivity [S/m]	TSL Permittiv	
						5.68	4.55	35.1	
Hardware Setup		_							
Phantom	TSL, Measured (Date	Р	robe, Calibration	Date				
MFP V8.0 Center	HSL, 2025-02-0	06		X3DV4 - SN7349		DAE, Calibration Date			
344					, 2025-01-10	DAE4i	p Sn1836, 2024–10–28		
cans Setup					Measurement	Deput			
				Zoom Scan	incustri ement	Results			
Grid Extents [mm]			2	2 x 22 x 22				Zoom Sca	
Grid Steps [mm]					Date			2025-02-0	
Sensor Surface (mm]		_	4.0	x 4.0 x 1.4	psSAR1g [W/Kg]			8.1	
Fraded Grid				1.4	psSAR10g (W/Kg]			
				Yes	Power Drift [dB]			2.3	
irading Ratlo				1.4	Power Scaling			-0.06	
1AIA				N/A				Disabled	
urface Detection			-		Scaling Factor [dB]			
can Method				VMS + 6p	TSL Correction		Po	ositive / Negative	
				Measured					



 $0 \, dB = 32.6 \, W/Kg$

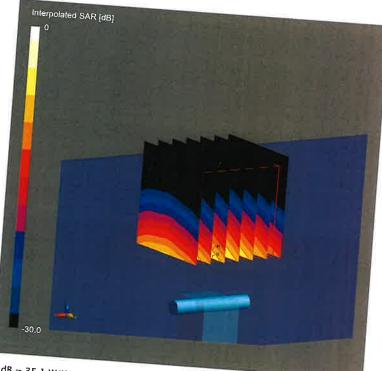
Dipole									
			Frequency [MHzi					
D5GHzV2 - SN1168		-	5600			TSL	Power [dBm]		
Exposure Condition					ł	HSL	20		
Phantom Section, TSL									
Flat	Test Distance [mm]	Band	Group, UID	Frequency []	MHz], Channel Numb				
	10		CW, 0	5600, 0		Der	Conversion Factor	TSL Conductivity [S/m]	TSL Permittivi
Hardware Setup							5.21	4.92	34,4
Phantom	TSL, Measured D	-							54.4
MFP V8.0 Center			Pr	obe, Calibratio	n Date				
	HSL, 2025-02-00	5	EX	3DV4 - SN734	9, 2025-01-10		DAE, C	alibration Date	
Scans Setup					-12023-01-10	_	DAE4ip	Sn1836, 2024-10-28	
					Measureme	ant I			
Grid Extents [mm]			Z	oom Scan			vesuits		
Grid Steps [mm]			22	x 22 x 22	Date				Zoom Scan
ensor Surface [mm]			4.0 x	4.0 x 1.4	psSAR1g [W/k				2025-02-06
iraded Grid				1.4		-			8.15
				Yes	psSAR10g [W/	-			
rading Ratio		-			Power Drift [d8	3]			2.34
AIA				1.4	Power Scaling				-0.02
rface Detection				N/A	Scaling Factor [dB]			Disabled
In Method			VM	S + 6p	TSL Correction	-			
			Me	asured		-		Positiv	e / Negative



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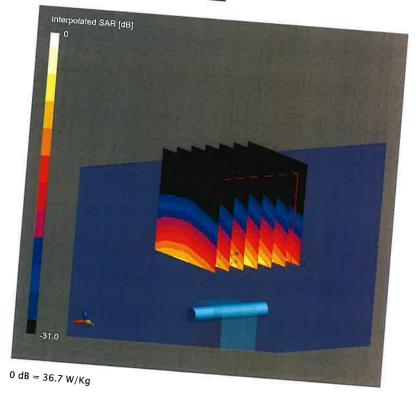
Dipole		-						
D5GHzV2 - SN1168			Frequency [M	/Hz]				
			5750		TSL	Power [dBm]	
Exposure Condition	ns				HSL	20		
Phantom Section, TSL	Test Distance [mm]							
Flat		Band	Group, UID	Frequency [Mł	Iz], Channel Number			
	10		CW, 0	5750, 0		Conversion Factor	TSL Conductivity [S/m]	TSL Permittiv
Hardware Setup						5.38	5.08	34.2
Phantom	TSL, Measured D							
MFP V8.0 Center			Pro	obe, Calibration	Date			
	HSL, 2025-02-0	6		3DV4 - SN7349,			alibration Date	
cans Setup				5147349,	2025-01-10	DAE4ip	5n1836, 2024-10-28	
					Measuroman			
Grid Extents (mm)			z	oom Scan	Measurement	Results		
Grid Steps [mm]			22 ;	x 22 x 22	Date			Zoom Scan
ensor Surface [mm]			4.0 x	4.0 x 1.4	psSAR1g [W/Kg]			2025-02-06
				1.4				7.94
raded Grid					psSAR10g [W/Kg]			
ading Ratio				Yes	Power Drift [dB]			2.25
NA		-		1.4	Power Scaling			0.00
face Detection				N/A	Scaling Factor [dB]			Disabled
n Method			VM	S + 6p	TSL Correction			
				asured				/e / Negative

Positive / Negative



0 dB = 35.1 W/Kg

Dipole		_							
D5GHzV2 - SN1168			Frequency [A	/Hz]		-			
			5850		т.	SL	Power [dBm]		
Exposure Condition	ns				H	SL	20		
Phantom Section, TSL	Test Distance [mm]								
Flat		Band	Group, UID	Frequency [M	Hz], Channel Numbe	-			
	10		CW, 0	5850, 0		er	Conversion Factor	TSL Conductivity [S/m]	TSI Den tut
Hardware Setup							5.11	5.18	TSL Permittiv
Phantom	701								34.1
MFP V8.0 Center	TSL, Measured D		Pro	obe, Calibration	Date	_			
in center	HSL, 2025-02-06	5					DAE, Calibration Date		
Scans Setup		EX3DV4 - SN7349, 2025-01-10				DAE4ip Sn1836, 2024-10-28			
Grid Extents [mm]			Z	oom Scan	Measureme	nt R	lesults		
Grid Steps [mm]			22 >	(22 x 22	Date				Zoom Scan
ensor Surface [mm]			4.0 x 4	4.0 x 1.4	-				2025-02-06
				1.4	psSAR1g [W/Kg	-			
raded Grid					psSAR10g [W/K	g]			8.13
ading Ratio				Yes	Power Drift [dB]				2.31
AIA				1.4	Power Scaling	-			-0.06
face Detection		_		N/A	Scaling Factor [df	21			Disabled
n Method			VMs	5 + 6p	TSL Correction	-1			
			Max	sured					e / Negative



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Impedance Measurement Plot for Head TSL

