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

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Swiss Calibration Service

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Accreditation No.: SCS 0108

Client **Morlab (Auden)**

Certificate No: DAE4-1643_Nov20

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BO - SN: 1643
Calibration procedure(s)	QA CAL-06.v30 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	November 30, 2020

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 (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	07-Sep-20 (No:28647)	Sep-21
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	09-Jan-20 (in house check)	In house check: Jan-21
Calibrator Box V2.1	SE UMS 006 AA 1002	09-Jan-20 (in house check)	In house check: Jan-21

	Name	Function	Signature
Calibrated by:	Eric Hainfeld	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	i.V.

Issued: November 30, 2020

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 following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *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 voltage
  - *Input 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.

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

Calibration Factors	X	Y	Z
High Range	404.997 ± 0.02% (k=2)	404.705 ± 0.02% (k=2)	405.460 ± 0.02% (k=2)
Low Range	4.00435 ± 1.50% (k=2)	3.99545 ± 1.50% (k=2)	4.01998 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	116.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199993.39	-1.57	-0.00
Channel X	+ Input	20001.93	-0.19	-0.00
Channel X	- Input	-20000.77	0.64	-0.00
Channel Y	+ Input	199992.54	-2.04	-0.00
Channel Y	+ Input	19999.33	-2.67	-0.01
Channel Y	- Input	-20002.89	-1.28	0.01
Channel Z	+ Input	199995.27	0.26	0.00
Channel Z	+ Input	19999.93	-1.84	-0.01
Channel Z	- Input	-20001.63	0.06	-0.00

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.80	0.38	0.02
Channel X	+ Input	202.14	0.33	0.16
Channel X	- Input	-197.83	0.25	-0.13
Channel Y	+ Input	2002.10	0.77	0.04
Channel Y	+ Input	200.39	-1.33	-0.66
Channel Y	- Input	-198.90	-0.75	0.38
Channel Z	+ Input	2001.56	0.39	0.02
Channel Z	+ Input	200.76	-0.78	-0.39
Channel Z	- Input	-199.89	-1.58	0.80

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	-2.88	-4.37
	- 200	6.47	4.34
Channel Y	200	-2.89	-3.82
	- 200	3.09	2.28
Channel Z	200	2.19	2.37
	- 200	-4.94	-4.88

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	-	-0.31	-3.64
Channel Y	200	6.86	-	1.13
Channel Z	200	10.67	4.39	-

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	16034	15888
Channel Y	16076	15593
Channel Z	15905	16557

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	0.05	-0.77	0.86	0.33
Channel Y	-1.01	-1.98	0.32	0.36
Channel Z	-1.08	-2.17	-0.24	0.35

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
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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Accreditation No.: SCS 0108

Client **Morlab (Auden)** **Certificate No: D6500V2-1039_Jun20**

CALIBRATION CERTIFICATE

Object D6500V2 - SN:1039

Calibration procedure(s) QA CAL-22.v4
Calibration Procedure for SAR Validation Sources between 3-10 GHz

Calibration date: June 02, 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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	01-Apr-21 (No. 217-03100/03101)	Apr-22
Power sensor NRP-Z91	SN: 103244	01-Apr-21 (No. 217-03100)	Apr-22
Power sensor NRP-Z91	SN: 103245	01-Apr-21 (No. 217-03101)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	31-Mar-21 (No. 217-03106)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX3DV4	SN: 3503	31-Dec-20 (No. EX3-3503_Dec19)	Dec-21
DAE4	SN: 601	27-Dec-20 (No. DAE4-601_Dec19)	Dec-21

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: June 2, 2021

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Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEC IEEE Std 62209-1528 ED1, "Measurement procedure for the assessment of Specific Specific Absorption Rate (SAR) of Human to radio frequency fields from hand-held and body-worn wireless communications devices-Part 1528: Human models, instrumentation and procedures (Frequency range of 4 MHz to 10 GHz)".

Additional Documentation:

b) DASY6 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	DASY6	V6.14
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	5 mm	with Spacer
Zoom Scan Resolution	dx, dy = 3.4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	6500 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	34.7	6.04 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.3 ± 6 %	6.39 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	24.8 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**248 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.21 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.1 W/kg ± 19.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 6500 MHz

Impedance, transformed to feed point	50.4 Ω - 8.1 jΩ
Return Loss	- 21.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.094 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

DASY6 Validation Report for Head TSL

Measurement Report for D6.5GHz-1008, UID 0-, Channel 6500 (6500.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
D6.5GHz	16.0 x 6.0 x 300.0	SN: 1008	-

Exposure Conditions

Phantom Section Section, TSL	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
Flat, HSL	5.00	Band n260	CW,	6500, 6500	5.75

Hardware Setup

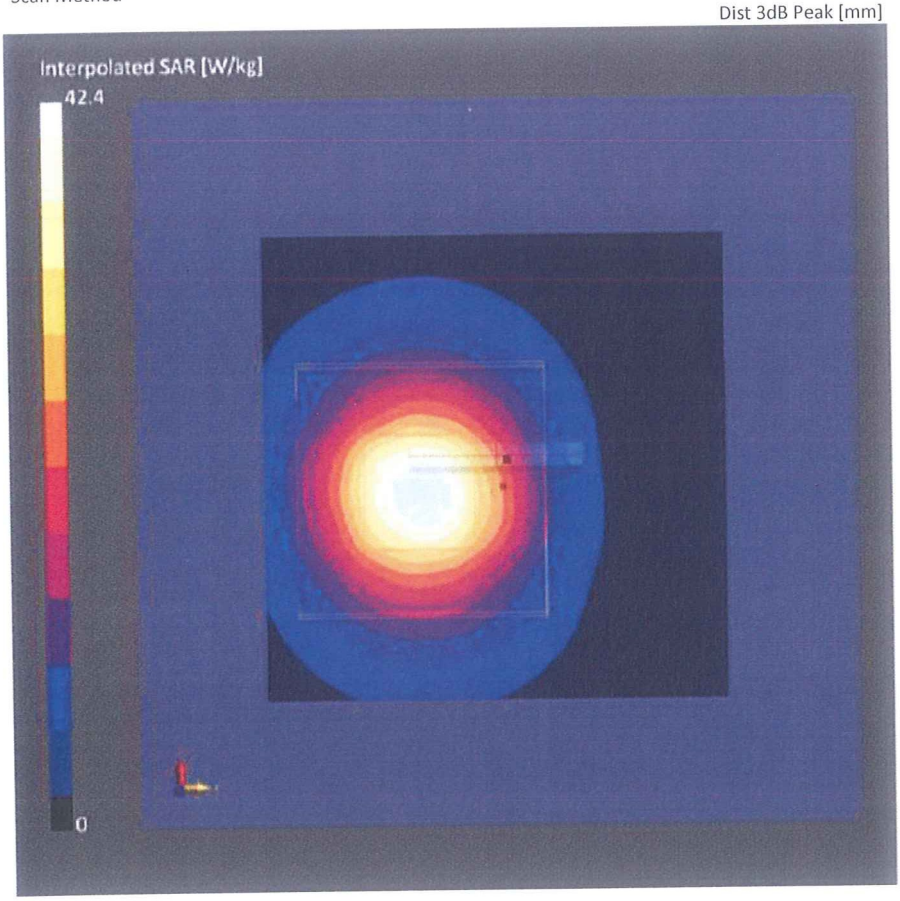
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
MFP V8.0 Centre - 1182	HBBL600-10000V6	EX3D4 – SN7405, 2020-05-18	DAE4 Sn908,2020-05-27

Scan Setup

	Zoom Scan
Grid Extents [mm]	22.0 x 22.0 x 22.0
Grid Steps [lambda]	3.4 x 3.4 x 3.4
Sensor Surface [mm]	1.4
Graded Grid	Yes
Grading Radio	1.4
MAIA	N/A
Surface Detetion	VMS + 6p
Scan Method	Measured

Measurement Results

	Zoom Scan
Date	2021-06-20, 14:51
psSAR1g[W/kg]	24.8
psSAR10g[W/kg]	5.21
Power Drift [dB]	0.07
Power Scaling	Disabled
Scaling Factor[dB]	
TSL Correction	Enabled
M2/M1 [%]	50.2
Dist 3dB Peak [mm]	4.68



Impedance Measurement Plot for Head TSL