Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2117
E-mail: emf@caict.ac.cn http://www.caict.ac.cn

DASY5 Validation Report for Head TSL Date: 2022-09-16

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN: 1026

Communication System: UID 0, CW; Frequency: 3900 MHz; Frequency: 4100 MHz; Duty Cycle: 1:1

Medium parameters used: f = 3900 MHz; σ = 3.31 S/m; ε_r = 38; ρ = 1000 kg/m^3

Medium parameters used: f = 4100 MHz; σ = 3.498 S/m; ε_r = 37.47; ρ = 1000 kg/m^3

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(6.76, 6.76, 6.76) @ 3900 MHz; ConvF(6.71, 6.71, 6.71) @ 4100 MHz; Calibrated: 2022-01-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2022-01-12
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration /Pin=100mW, d=10mm, f=3900 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.50 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 17.5 W/kg
SAR(1 g) = 6.65 W/kg; SAR(10 g) = 2.37 W/kg
Smallest distance from peaks to all points 3 dB below = 7.9 mm
Ratio of SAR at M2 to SAR at M1 = 76.4%
Maximum value of SAR (measured) = 12.4 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=4100 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 63.37 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 18.6 W/kg
SAR(1 g) = 6.79 W/kg; SAR(10 g) = 2.4 W/kg
Smallest distance from peaks to all points 3 dB below = 7.9 mm
Ratio of SAR at M2 to SAR at M1 = 75.1%
Maximum value of SAR (measured) = 13.1 W/kg

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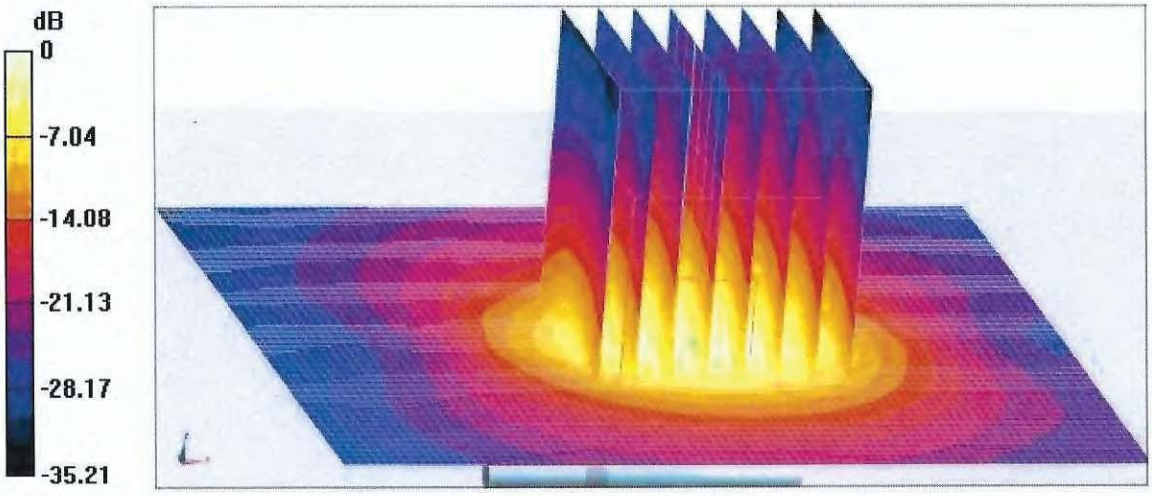

0 dB = 13.1 W/kg = 11.17 dBW/kg

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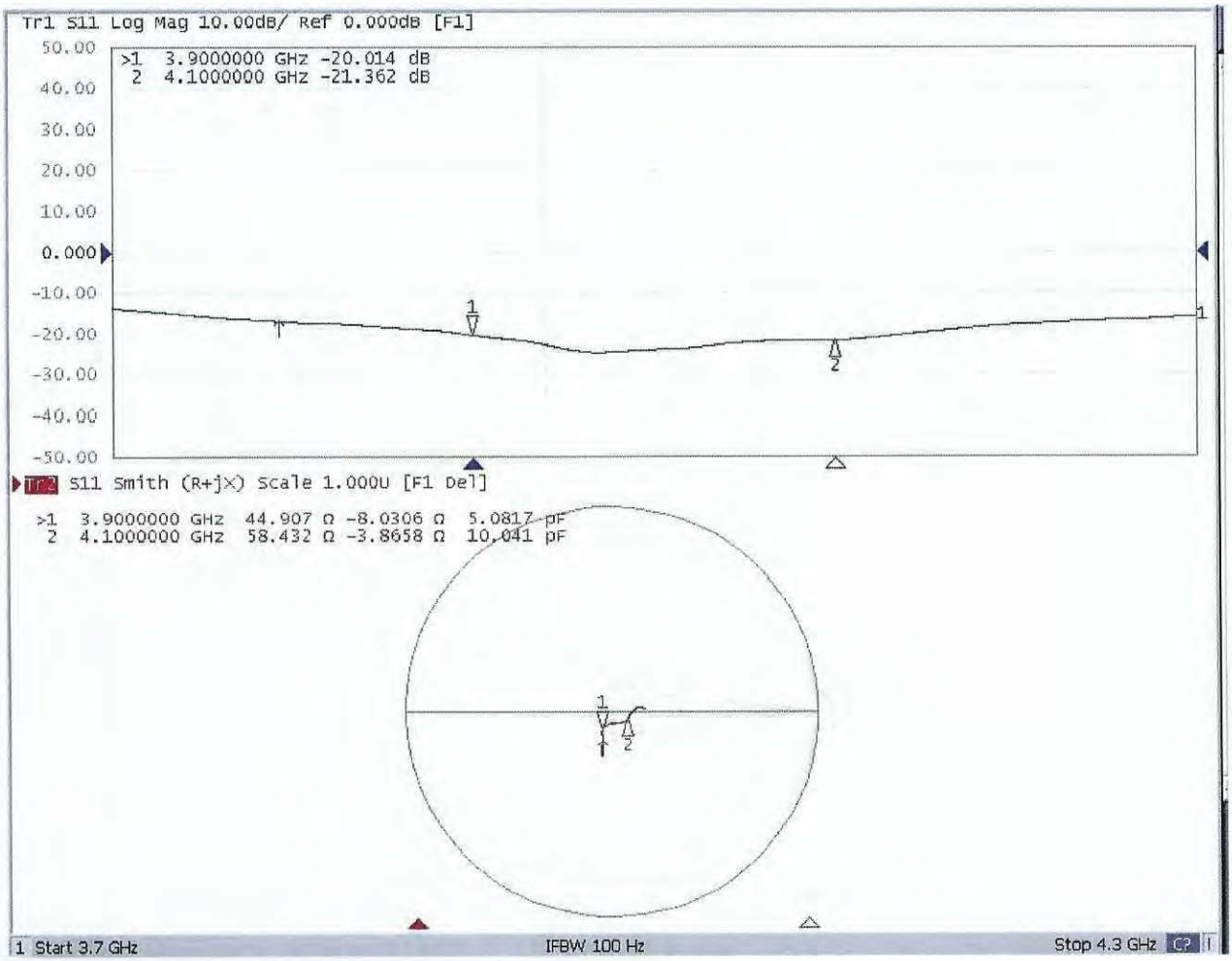
Impedance Measurement Plot for Head TSL



In Collaboration with
CALIBRATION LABORATORY
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CALIBRATION
CNAS L0570

Client **SGS** **Certificate No: Z22-60490**

CALIBRATION CERTIFICATE

Object D5GHzV2 - SN: 1165

Calibration Procedure(s) FF-Z11-003-01
Calibration Procedures for dipole validation kits

Calibration date: November 1, 2022

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
Power Meter NRP2	106276	10-May-22 (CTTL, No.J22X03103)	May-23
Power sensor NRP6A	101369	10-May-22 (CTTL, No.J22X03103)	May-23
Reference Probe EX3DV4	SN 7464	26-Jan-22(SPEAG,No.EX3-7464_Jan22)	Jan-23
DAE4	SN 1556	12-Jan-22(CTTL-SPEAG,No.Z22-60007)	Jan-23
Secondary Standards	**ID #**	**Cal Date (Calibrated by, Certificate No.)**	**Scheduled Calibration**
Signal Generator E4438C	MY49071430	13-Jan-22 (CTTL, No. J22X00409)	Jan-23
Network Analyzer E5071C	MY46110673	14-Jan-22 (CTTL, No.J22X00406)	Jan-23

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: November 7, 2022

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Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORMx,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-mounted 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) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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

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Measurement Conditions

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

DASY Version	DASY52	52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz	

Head TSL parameters at 5250MHz

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 ℃	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) ℃	35.2 ± 6 %	4.68 mho/m ± 6 %
Head TSL temperature change during test	<1.0 ℃	----	----

SAR result with Head TSL at 5250MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.76 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**77.3 W/kg ± 24.4 % (*k*=2)**
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.21 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.1 W/kg ± 24.2 % (*k*=2)**

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Head TSL parameters at 5600MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 ℃	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ±0.2) ℃	34.6 ±6 %	5.05 mho/m ±6 %
Head TSL temperature change during test	<1.0 ℃	----	----

SAR result with Head TSL at 5600MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**81.3 W/kg ±24.4 % (*k*=2)**
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.1 W/kg ±24.2 % (*k*=2)**

Head TSL parameters at 5750MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 ℃	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ±0.2) ℃	34.4 ±6 %	5.21 mho/m ±6 %
Head TSL temperature change during test	<1.0 ℃	----	----

SAR result with Head TSL at 5750MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.76 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**77.1 W/kg ±24.4 % (*k*=2)**
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.15 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**21.3 W/kg ±24.2 % (*k*=2)**

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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL at 5250MHz

Impedance, transformed to feed point	49.0Ω- 4.73jΩ
Return Loss	- 26.3dB

Antenna Parameters with Head TSL at 5600MHz

Impedance, transformed to feed point	53.5Ω+ 1.12jΩ
Return Loss	- 28.9dB

Antenna Parameters with Head TSL at 5750MHz

Impedance, transformed to feed point	54.6Ω- 1.85jΩ
Return Loss	- 26.5dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.114 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point 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 feed-point may be damaged.

Additional EUT Data

Manufactured by	SPEAG

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DASY5 Validation Report for Head TSL Date: 2022-11-01

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1165

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz

Medium parameters used: f = 5250 MHz; σ = 4.677 S/m; ε_r = 35.15; ρ = 1000 kg/m^3

Medium parameters used: f = 5600 MHz; σ = 5.047 S/m; ε_r = 34.56; ρ = 1000 kg/m^3

Medium parameters used: f = 5750 MHz; σ = 5.211 S/m; ε_r = 34.35; ρ = 1000 kg/m^3

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(5.43, 5.43, 5.43) @ 5250 MHz; ConvF(4.91, 4.91, 4.91) @ 5600 MHz; ConvF(4.85, 4.85, 4.85) @ 5750 MHz; Calibrated: 2022-01-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2022-01-12
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 66.46 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 31.1 W/kg

SAR(1 g) = 7.76 W/kg; SAR(10 g) = 2.22 W/kg

Smallest distance from peaks to all points 3 dB below = 7.5 mm

Ratio of SAR at M2 to SAR at M1 = 65.3%

Maximum value of SAR (measured) = 18.3 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 66.78 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 35.8 W/kg

SAR(1 g) = 8.17 W/kg; SAR(10 g) = 2.33 W/kg

Smallest distance from peaks to all points 3 dB below = 7.5 mm

Ratio of SAR at M2 to SAR at M1 = 62.3%

Maximum value of SAR (measured) = 20.0 W/kg

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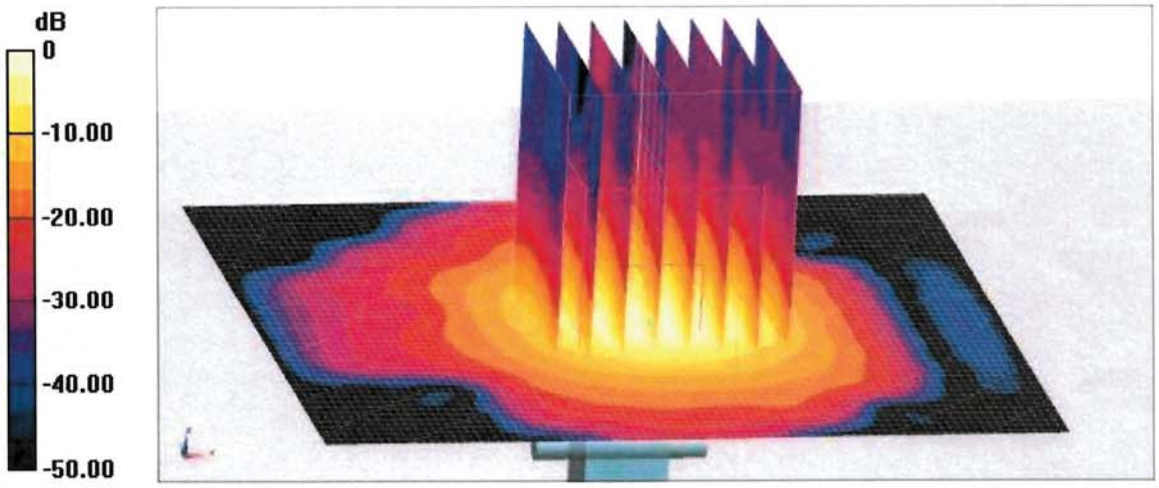
Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 64.99 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 35.9 W/kg
SAR(1 g) = 7.76 W/kg; SAR(10 g) = 2.15 W/kg
Smallest distance from peaks to all points 3 dB below = 6.8 mm
Ratio of SAR at M2 to SAR at M1 = 61.4%
Maximum value of SAR (measured) = 19.1 W/kg



0 dB = 19.1 W/kg = 12.81 dBW/kg

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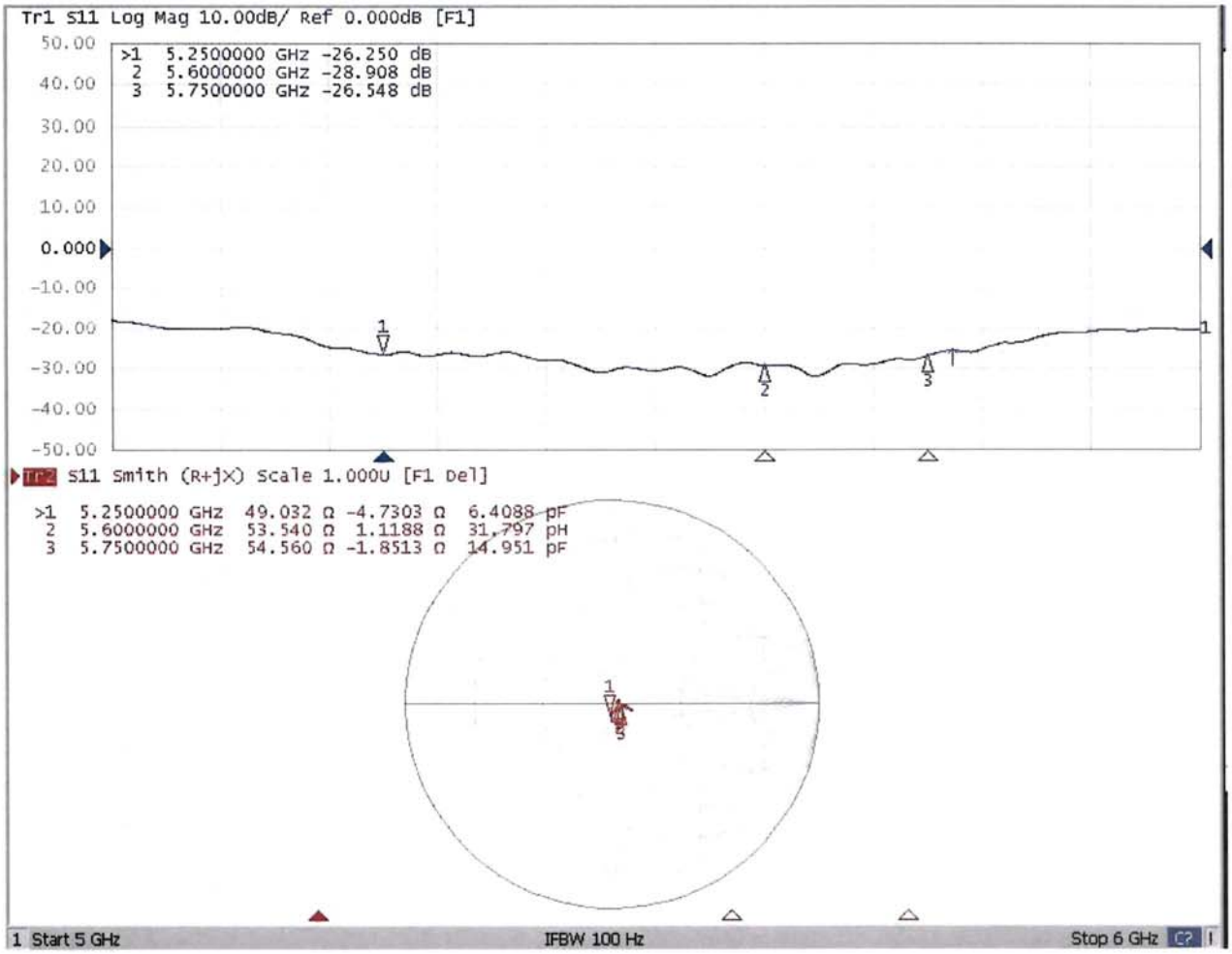
Impedance Measurement Plot for Head TSL



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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio 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 Shenzhen**

Certificate No. **D6.5GHzV2-1102_Sep23**

CALIBRATION CERTIFICATE

Object: D6.5GHzV2 - SN:1102

Calibration procedure(s): QA CAL-22.v7
Calibration Procedure for SAR Validation Sources between 3-10 GHz

Calibration date: September 11, 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 (Certificate No.)	Scheduled Calibration
Power sensor R&S NRP33T	SN: 100967	03-Apr-23 (No. 217-03806)	Apr-24
Reference 20 dB Attenuator	SN: BH9394 (20k)	30-Mar-23 (No. 217-03809)	Mar-24
Mismatch combination	SN: 84224 / 360D	03-Apr-23 (No. 217-03812)	Apr-24
Reference Probe EX3DV4	SN: 7405	12-Jun-23 (No. EX3-7405_Jun23)	Jun-24
DAE4	SN: 908	03-Jul-23 (No. DAE4-908_Jul23)	Jul-24

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator Anapico APSIN20G	SN: 827	18-Dec-18 (in house check Dec-21)	In house check: Dec-23
Power sensor NRP-Z23	SN: 100169	10-Jan-19 (in house check Nov-22)	In house check: Nov-23
Power sensor NRP-18T	SN: 100950	28-Sep-22 (in house check Nov-22)	In house check: Nov-23
Network Analyzer Keysight E5063A	SN:MY54504221	31-Oct-19 (in house check Oct-22)	In house check: Oct-25

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Sven Kühn	Technical Manager	

Issued: September 12, 2023

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 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.

Additional Documentation:

b) 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 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 absorbed power density (APD):* The absorbed power density is evaluated according to Samaras T, Christ A, Kuster N, "*Compliance assessment of the epithelial or absorbed power density above 6 GHz using SAR measurement systems*", Bioelectromagnetics, 2021 (submitted). The additional evaluation uncertainty of 0.55 dB (rectangular distribution) is considered.

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	V16.2
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	34.5	6.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.7 ± 6 %	6.01 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	29.2 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**291 W/kg ± 24.7 % (k=2)**

SAR averaged over 8 cm³ (8 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.63 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**65.9 W/kg ± 24.4 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.42 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**53.9 W/kg ± 24.4 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.3 Ω - 3.2 jΩ
Return Loss	- 29.9 dB

APD (Absorbed Power Density)

APD averaged over 1 cm²	Condition	
APD measured	100 mW input power	290 W/m²
APD measured	normalized to 1W	**2900 W/m² ± 29.2 % (k=2)**

APD averaged over 4 cm²	condition	
APD measured	100 mW input power	133 W/m²
APD measured	normalized to 1W	**1330 W/m² ± 28.9 % (k=2)**

*The reported APD values have been derived using the psSAR1g and psSAR8g.

General Antenna Parameters and Design

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-1102, UID 0 -, Channel 6500 (6500.0MHz)

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
D6.5GHz	10.0 x 10.0 x 10.0	SN: 1102	-

Exposure Conditions

Phantom Section, TSL	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.50	6.01	33.7

Hardware Setup

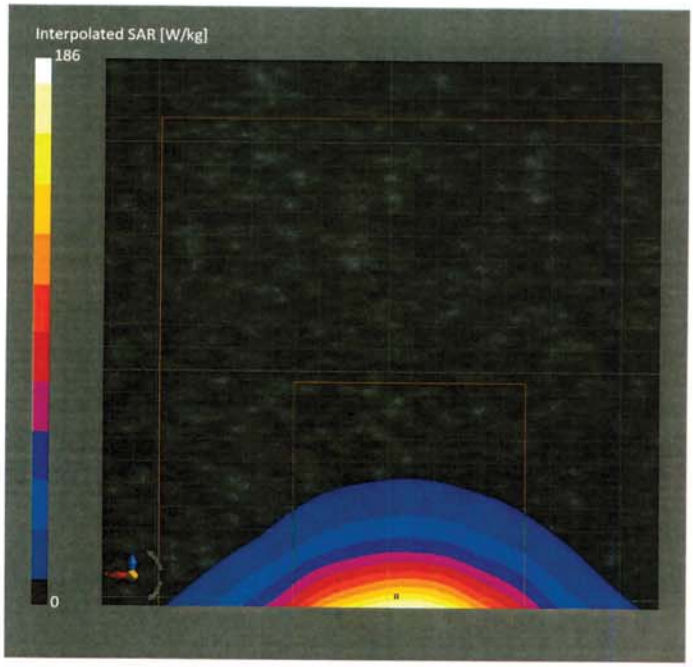
Phantom	TSL	Probe, Calibration Date	DAE, Calibration Date
MFP V8.0 Center - 1182	HBBL600-10000V6	EX3DV4 - SN7405, 2023-06-12	DAE4 Sn908, 2023-07-03

Scan Setup

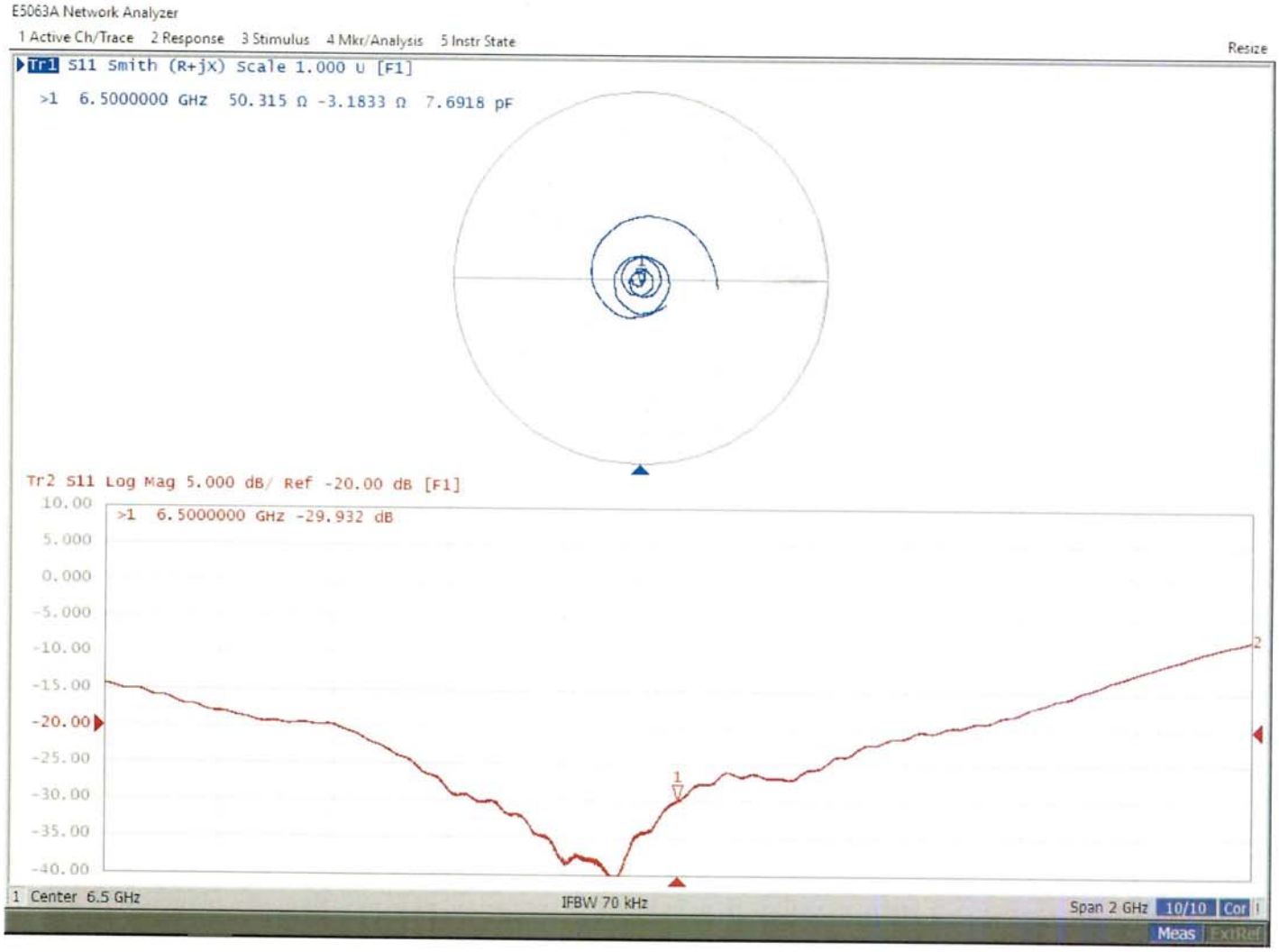
	Zoom Scan
Grid Extents [mm]	22.0 x 22.0 x 22.0
Grid Steps [mm]	3.4 x 3.4 x 1.4
Sensor Surface [mm]	1.4
Graded Grid	Yes
Grading Ratio	1.4
MAIA	N/A
Surface Detection	VMS + 6p
Scan Method	Measured

Measurement Results

	Zoom Scan
Date	2023-09-11, 12:05
psSAR1g [W/Kg]	29.2
psSAR8g [W/Kg]	6.63
psSAR10g [W/Kg]	5.42
Power Drift [dB]	0.00
Power Scaling	Disabled
Scaling Factor [dB]	
TSL Correction	No correction
M2/M1 [%]	50.6
Dist 3dB Peak [mm]	4.8



Impedance Measurement Plot for Head TSL



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Zeughausstrasse 43, 8004 Zurich, Switzerland

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Swiss Calibration Service

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Accreditation No.: SCS 0108

Client **SGS**
Shenzhen

Certificate No: DAE4-760_Aug24

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 760
Calibration procedure(s)	QA CAL-06.v30 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	August 15, 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 (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	29-Aug-23 (No:37421)	Aug-24
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	23-Jan-24 (in house check)	In house check: Jan-25
Calibrator Box V2.1	SE UMS 006 AA 1002	23-Jan-24 (in house check)	In house check: Jan-25

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Laboratory Technician	
Approved by:	Sven Kühn	Technical Manager	

Issued: August 15, 2024

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	403.727 ± 0.02% (k=2)	404.955 ± 0.02% (k=2)	405.264 ± 0.02% (k=2)
Low Range	3.95802 ± 1.50% (k=2)	3.99271 ± 1.50% (k=2)	3.98120 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	21.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199997.21	0.41	0.00
Channel X	+ Input	20005.44	2.67	0.01
Channel X	- Input	-19998.02	4.19	-0.02
Channel Y	+ Input	199992.32	-4.39	-0.00
Channel Y	+ Input	20003.08	0.53	0.00
Channel Y	- Input	-20001.40	1.00	-0.00
Channel Z	+ Input	199996.46	-0.29	-0.00
Channel Z	+ Input	20003.03	0.49	0.00
Channel Z	- Input	-20001.18	1.13	-0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.70	0.50	0.02
Channel X	+ Input	202.67	1.31	0.65
Channel X	- Input	-198.00	0.37	-0.18
Channel Y	+ Input	2000.59	-0.43	-0.02
Channel Y	+ Input	200.88	-0.39	-0.19
Channel Y	- Input	-198.17	0.38	-0.19
Channel Z	+ Input	2001.40	0.30	0.02
Channel Z	+ Input	200.83	-0.45	-0.23
Channel Z	- Input	-199.73	-1.22	0.62

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	10.49	8.92
	- 200	-7.09	-8.26
Channel Y	200	8.44	8.55
	- 200	-9.61	-9.59
Channel Z	200	7.93	7.75
	- 200	-8.72	-9.22

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	-	0.75	0.09
Channel Y	200	0.89	-	1.77
Channel Z	200	-6.50	-0.49	-

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	15968	15430
Channel Y	16010	16001
Channel Z	15992	14516

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	0.78	-0.56	1.81	0.43
Channel Y	-0.12	-1.48	1.00	0.48
Channel Z	-0.56	-2.23	1.59	0.60

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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CALIBRATION
CNAS L0570

Client : SGS

Certificate No: 24J02Z000094

CALIBRATION CERTIFICATE

Object	DAE4 - SN: 896
Calibration Procedure(s)	FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)
Calibration date:	March 18, 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)℃ 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

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Jun	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: March 20, 2024

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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.

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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	403.759 ± 0.15% (k=2)	404.293 ± 0.15% (k=2)	404.210 ± 0.15% (k=2)
Low Range	3.98212 ± 0.7% (k=2)	4.00285 ± 0.7% (k=2)	3.97331 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	267.5° ± 1 °

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CALIBRATION
CNAS L0570

Client : SGS

Certificate No: 24J02Z000499

CALIBRATION CERTIFICATE

Object	DAE4ip - SN: 1803
Calibration Procedure(s)	FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)
Calibration date:	August 8, 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)℃ 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	11-Jun-24 (CTTL, No.24J02X005147)	Jun-25

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Jun	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: August 20, 2024

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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.

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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	404.849 ± 0.15% (k=2)	405.360 ± 0.15% (k=2)	404.890 ± 0.15% (k=2)
Low Range	3.99209 ± 0.7% (k=2)	3.97188 ± 0.7% (k=2)	4.01870 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	329° ± 1 °

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CNAS CALIBRATION CNAS L0570

Client : SGS

Certificate No: 24J02Z000823

CALIBRATION CERTIFICATE

Object	DAE4ip - SN: 1830
Calibration Procedure(s)	FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)
Calibration date:	October 18, 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)℃ 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	11-Jun-24 (CTTL, No.24J02X005147)	Jun-25

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Jun	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: October 18, 2024

Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China
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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.

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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	404.872 ± 0.15% (k=2)	405.068 ± 0.15% (k=2)	405.048 ± 0.15% (k=2)
Low Range	3.98963 ± 0.7% (k=2)	4.00827 ± 0.7% (k=2)	4.00862 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	44.5° ± 1 °

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Accreditation No.: SCS 0108

Client **SGS**
Shenzhen

Certificate No. **EUmm-9533_Aug24**

CALIBRATION CERTIFICATE

Object EUmmWV4 - SN:9533

Calibration procedure(s) QA CAL-02.v9, QA CAL-25.v8, QA CAL-42.v3
Calibration procedure for E-field probes optimized for close near field evaluations in air

Calibration date August 23, 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 (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power sensor NRP33T	SN: 100967	28-Mar-24 (No. 217-04038)	Mar-25
Power sensor NRP110T	SN: 101244	04-Apr-24 (No. 0001A300740056)	Apr-25
Spectrum analyzer FSV40	SN: 101832	25-Jan-24 (No. 4030-315007551)	Jan-25
Harmonic mixer FS-Z75	SN: 101566	11-Apr-24 (No. 0001A300750054)	Apr-25
Marmonic mixer FS-Z110	SN: 101633	05-Apr-24 (No. 0001A300740055)	Apr-25
Ref. Probe EUmmWV3	SN: 9374	04-Dec-23 (No. EUmm-9374_Dec23)	Dec-24
DAE4ip	SN: 1662	08-Nov-23 (No. DAE4ip-1662_Nov23)	Nov-24

Secondary Standards	ID	Check Date (in house)	Scheduled Check
Generator APSIN26G	SN: 2023	30-Nov-21 (in house check Jun-24)	In house check: Jun-25
Power sensor NRP40T	SN: 101439	08-Nov-21 (in house check Jun-24)	In house check: Jun-25
Power sensor NRP110T	SN: 101226	15-Nov-21 (in house check Jun-24)	In house check: Jun-25

	Name	Function	Signature
Calibrated by	Joanna Lleshaj	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	

Issued: August 26, 2024

Glossary

NORMx,y	sensitivity in free space
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system
Sensor Angles	sensor deviation from the probe axis, used to calculate the field orientation and polarization
$\vec{k}$	is the wave propagation direction

Calibration is Performed According to the Following Standards:

a) IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y*: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). For frequencies > 6 GHz, the far field in front of waveguide horn antennas is measured for a set of frequencies in various waveguide bands up to 110 GHz.
- *DCPx,y*: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal. DCP does not depend on frequency nor media.
  Note: As the field is measured with a diode detector sensor, it is warrantied that the probe response is linear (E^2) below the documented lowest calibrated value.
- *PAR*: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- The frequency sensor model parameters are determined prior to calibration based on a frequency sweep (sensor model involving resistors R, R_p, inductance L and capacitors C, C_p).
- *Ax,y; Bx,y; Cx,y; Dx,y; VRx,y: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).
- *Equivalent Sensor Angle*: The two probe sensors are mounted in the same plane at different angles. The angles are assessed using the information gained by determining the *NORMx* (no uncertainty required).
- *Spherical isotropy (3D deviation from isotropy)*: in a locally homogeneous field realized using an open waveguide / horn setup.

Parameters of Probe: EUmmWV4 - SN:9533

Basic Calibration Parameters

	Sensor X	Sensor Y	Unc ($k = 2$)
Norm ($\mu V/(V/m)^2$)	0.01856	0.01974	±10.1%
DCP (mV) [B]	106.0	105.0	±4.7%
Equivalent Sensor Angle	-61.3	36.3	

Calibration Results for Frequency Response (750 MHz – 110 GHz)

Frequency GHz	Target E-Field V/m	Deviation Sensor X dB	Deviation Sensor Y dB	Unc ($k = 2$) dB
0.75	77.2	−0.20	−0.31	±0.43
1.8	140.4	−0.01	−0.02	±0.43
2.0	133.0	0.11	0.15	±0.43
2.2	124.8	−0.06	−0.05	±0.43
2.5	123.0	0.06	0.09	±0.43
3.5	256.2	−0.14	−0.16	±0.43
3.7	249.8	−0.01	−0.05	±0.43
6.6	74.7	0.07	−0.31	±0.98
8.0	67.2	−0.03	−0.12	±0.98
10.0	66.2	−0.02	0.03	±0.98
15.0	51.2	−0.08	0.11	±0.98
26.6	112.6	0.21	0.19	±0.98
30.0	121.9	0.02	0.00	±0.98
35.0	121.3	−0.16	−0.13	±0.98
40.0	102.3	−0.29	−0.22	±0.98
50.0	61.5	0.08	−0.04	±0.98
55.0	75.9	0.01	0.02	±0.98
60.0	80.5	−0.01	0.00	±0.98
65.0	77.1	0.17	0.08	±0.98
70.0	74.3	0.22	0.12	±0.98
75.0	74.8	0.04	0.04	±0.98
75.0	96.6	0.02	0.03	±0.98
80.0	95.4	−0.16	−0.09	±0.98
85.0	58.0	−0.12	−0.12	±0.98
90.0	84.0	−0.00	−0.01	±0.98
92.0	83.9	0.04	0.04	±0.98
95.0	76.2	0.04	0.03	±0.98
97.0	69.1	0.07	0.05	±0.98
100.0	66.9	0.13	0.13	±0.98
105.0	67.2	−0.20	−0.14	±0.98
110.0	78.1	0.03	−0.01	±0.98

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%.

[B] Linearization parameter uncertainty for maximum specified field strength.

Parameters of Probe: EUmmWV4 - SN:9533

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B $dB\sqrt{\mu V}$	C	D dB	VR mV	Max dev.	Max Unc[E] $k=2$
0	CW	X	0.00	0.00	1.00	0.00	120.2	±2.2%	±4.7%
		Y	0.00	0.00	1.00		96.1		
10352	Pulse Waveform (200Hz, 10%)	X	3.18	60.00	14.78	10.00	6.0	±1.4%	±9.6%
		Y	3.10	60.00	14.56		6.0		
10353	Pulse Waveform (200Hz, 20%)	X	2.22	60.00	13.60	6.99	12.0	±0.9%	±9.6%
		Y	2.10	60.00	13.50		12.0		
10354	Pulse Waveform (200Hz, 40%)	X	1.33	60.00	12.33	3.98	23.0	±1.4%	±9.6%
		Y	1.23	60.00	12.37		23.0		
10355	Pulse Waveform (200Hz, 60%)	X	0.79	60.00	11.65	2.22	27.0	±1.0%	±9.6%
		Y	0.76	60.00	11.63		27.0		
10387	QPSK Waveform, 1 MHz	X	1.24	60.00	12.31	1.00	22.0	±1.2%	±9.6%
		Y	1.24	60.00	12.30		22.0		
10388	QPSK Waveform, 10 MHz	X	1.29	60.00	12.02	0.00	22.0	±0.7%	±9.6%
		Y	1.31	60.00	12.04		22.0		
10396	64-QAM Waveform, 100 kHz	X	2.76	62.57	14.67	3.01	17.0	±0.6%	±9.6%
		Y	3.35	65.34	15.99		17.0		
10399	64-QAM Waveform, 40 MHz	X	2.09	60.00	12.49	0.00	19.0	±0.8%	±9.6%
		Y	2.09	60.00	12.53		19.0		
10414	WLAN CCDF, 64-QAM, 40 MHz	X	3.23	60.00	12.90	0.00	12.0	±1.0%	±9.6%
		Y	3.19	60.00	12.95		12.0		

Note: For details on UID parameters see Appendix

[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

Parameters of Probe: EUmmWV4 - SN:9533

Calibration Results for Linearity Response

Frequency GHz	Target E-Field V/m	Deviation Sensor X dB	Deviation Sensor Y dB	Unc ($k = 2$) dB
0.9	50.0	−0.00	0.08	±0.2
0.9	100.0	0.03	−0.08	±0.2
0.9	500.0	0.00	−0.01	±0.2
0.9	1000.0	0.03	0.02	±0.2
0.9	1500.0	0.01	0.01	±0.2
0.9	2100.0	−0.01	−0.01	±0.2

Sensor Frequency Model Parameters (750 MHz – 55 GHz)

	Sensor X	Sensor Y
R (Ω)	62.96	75.72
R_p (Ω)	83.99	89.83
L (nH)	0.06312	0.06400
C (pF)	0.2430	0.3093
C_p (pF)	0.0872	0.0817

Sensor Frequency Model Parameters (55 GHz – 110 GHz)

	Sensor X	Sensor Y
R (Ω)	73.16	50.44
R_p (Ω)	292.97	168.63
L (nH)	0.14777	0.08142
C (pF)	0.0314	0.0622
C_p (pF)	0.0359	0.0600

Sensor Model Parameters

	C1 fF	C2 fF	α V^{-1}	T1 $ms V^{-2}$	T2 $ms V^{-1}$	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
x	57.6	416.30	33.52	2.66	8.59	4.98	0.00	1.88	1.01
y	54.2	390.33	33.25	0.92	7.79	4.98	0.00	1.80	1.01

Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle	121.0°
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	320 mm
Probe Body Diameter	8 mm
Tip Length	23 mm
Tip Diameter	8.0 mm
Probe Tip to Sensor X Calibration Point	1.5 mm
Probe Tip to Sensor Y Calibration Point	1.5 mm