



In Collaboration with

s p e a g
CALIBRATION LABORATORY



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DASY5 Validation Report for Head TSL

Date: 2023-10-17

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1079

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz,

Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used: $f = 5200$ MHz; $\sigma = 4.67$ S/m; $\epsilon_r = 36.33$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 5300$ MHz; $\sigma = 4.785$ S/m; $\epsilon_r = 36.13$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 5500$ MHz; $\sigma = 4.996$ S/m; $\epsilon_r = 35.76$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 5600$ MHz; $\sigma = 5.11$ S/m; $\epsilon_r = 35.61$; $\rho = 1000$ kg/m³

Medium parameters used: $f = 5800$ MHz; $\sigma = 5.308$ S/m; $\epsilon_r = 35.34$; $\rho = 1000$ kg/m³

Phantom section: Right Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(5.5, 5.5, 5.5) @ 5200 MHz; ConvF(5.5, 5.5, 5.5) @ 5300 MHz; ConvF(5.01, 5.01, 5.01) @ 5500 MHz; ConvF(5.01, 5.01, 5.01) @ 5600 MHz; ConvF(5.15, 5.15, 5.15) @ 5800 MHz; Calibrated: 2023-03-31
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2023-01-11
- 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=5200 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 57.18 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 31.6 W/kg

SAR(1 g) = 7.83 W/kg; SAR(10 g) = 2.2 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mm

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

Maximum value of SAR (measured) = 18.5 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=5300 MHz/Zoom Scan,

dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 57.14 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 33.1 W/kg

SAR(1 g) = 7.96 W/kg; SAR(10 g) = 2.25 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 64.4%

Maximum value of SAR (measured) = 19.1 W/kg

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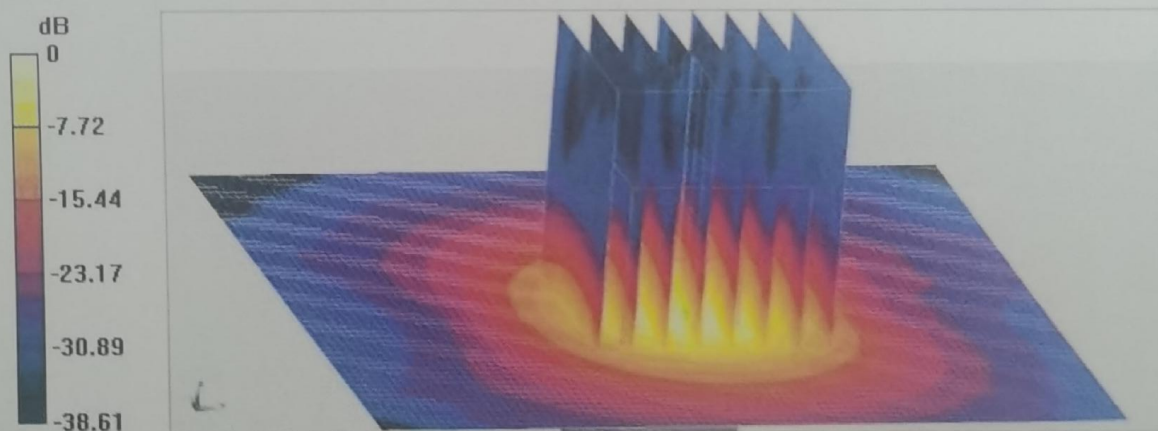
E-mail: emf@caict.ac.cn

<http://www.caict.ac.cn>

Dipole Calibration /Pin=100mW, d=10mm, f=5500 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
 Reference Value = 58.01 V/m; Power Drift = -0.06 dB
 Peak SAR (extrapolated) = 36.1 W/kg
SAR(1 g) = 8.27 W/kg; SAR(10 g) = 2.31 W/kg
 Smallest distance from peaks to all points 3 dB below = 7.4 mm
 Ratio of SAR at M2 to SAR at M1 = 62.9%
 Maximum value of SAR (measured) = 20.0 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 = 56.92 V/m; Power Drift = -0.03 dB
 Peak SAR (extrapolated) = 36.4 W/kg
SAR(1 g) = 8.13 W/kg; SAR(10 g) = 2.29 W/kg
 Smallest distance from peaks to all points 3 dB below = 7.2 mm
 Ratio of SAR at M2 to SAR at M1 = 62%
 Maximum value of SAR (measured) = 19.8 W/kg

Dipole Calibration /Pin=100mW, d=10mm, f=5800 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
 Reference Value = 55.83 V/m; Power Drift = -0.04 dB
 Peak SAR (extrapolated) = 37.1 W/kg
SAR(1 g) = 7.88 W/kg; SAR(10 g) = 2.2 W/kg
 Smallest distance from peaks to all points 3 dB below = 7.4 mm
 Ratio of SAR at M2 to SAR at M1 = 60.6%
 Maximum value of SAR (measured) = 19.6 W/kg

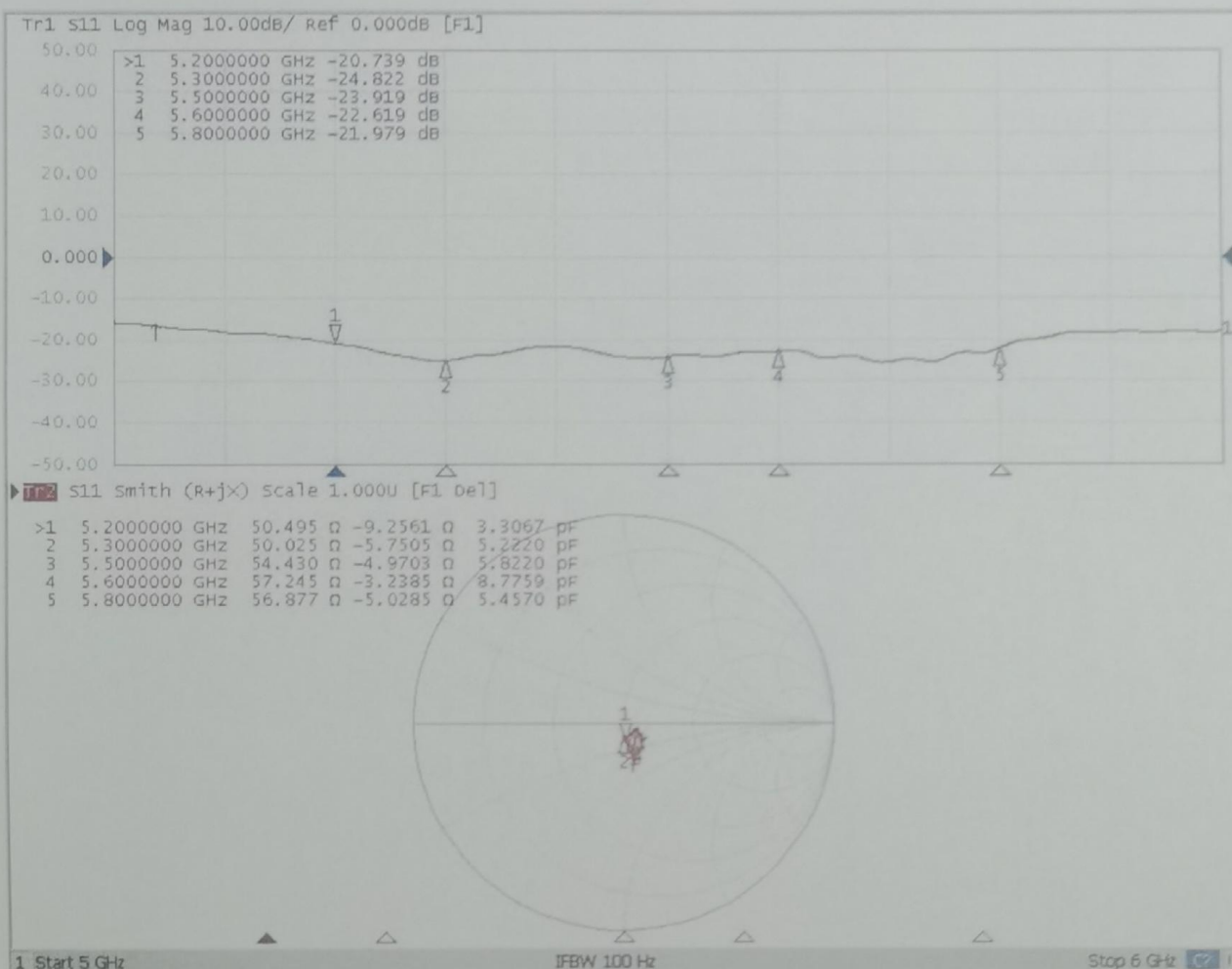


0 dB = 19.6 W/kg = 12.92 dBW/kg



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Impedance Measurement Plot for Head TSL





Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **SRTC (Auden)**

Certificate No: **D6.5GHzV2-1055_Nov21**

CALIBRATION CERTIFICATE

Object **D6.5GHzV2 - SN:1055**

Calibration procedure(s) **QA CAL-22.v6**
Calibration Procedure for SAR Validation Sources between 3-10 GHz

Calibration date: **November 29, 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 $(22 \pm 3)^{\circ}\text{C}$ 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	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Power sensor R&S NRP33T	SN: 100967	08-Apr-21 (No. 217-03293)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EX3DV4	SN: 7405	30-Dec-20 (No. EX3-7405_Dec20)	Dec-21
DAE4	SN: 908	24-Jun-21 (No. DAE4-908_Jun21)	Jun-22
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator Anapico APSIN20G	SN: 669	28-Mar-17 (in house check Dec-18)	In house check: Dec-21
Network Analyzer R&S ZVL13	SN: 101093	10-May-12 (in house check Dec-18)	In house check: Dec-21

Calibrated by: **Name** **Function**
Leif Klysner **Laboratory Technician**

Approved by: **Niels Kuster** **Quality Manager**

Signature

Issued: November 29, 2021

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



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Accreditation No.: **SCS 0108**

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 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.
- *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	V16.0
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 $\pm$ 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 $\pm$ 0.2) °C	34.3 $\pm$ 6 %	6.13 mho/m $\pm$ 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	28.8 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	287 W/kg $\pm$ 24.7 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.2 W/kg $\pm$ 24.4 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.1 Ω - 2.2 j Ω
Return Loss	- 32.3 dB

APD (Absorbed Power Density)

APD averaged over 1 cm ²	Condition	
APD measured	100 mW input power	287 W/m ²
APD measured	normalized to 1W	2870 W/m ² $\pm$ 29.2 % (k=2)

APD averaged over 4 cm ²	condition	
APD measured	100 mW input power	130 W/m ²
APD measured	normalized to 1W	1300 W/m ² $\pm$ 28.9 % (k=2)

*The reported APD values have been derived using 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
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DASY6 Validation Report for Head TSL

Measurement Report for D6.5GHz-1055, 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: 1055	-

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	5.75	6.13	34.3

Hardware Setup

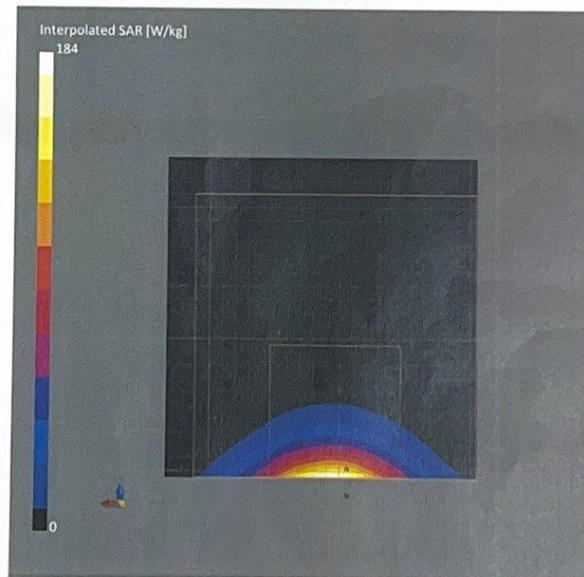
Phantom	TSL	Probe, Calibration Date	DAE, Calibration Date
MFP V8.0 Center - 1182	HBBL600-10000V6	EX3DV4 - SN7405, 2020-12-30	DAE4 Sn908, 2021-06-24

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	2021-11-29, 10:54
psSAR1g [W/Kg]	28.8
psSAR10g [W/Kg]	5.32
Power Drift [dB]	-0.01
Power Scaling	Disabled
Scaling Factor [dB]	
TSL Correction	No correction
M2/M1 [%]	50.3
Dist 3dB Peak [mm]	4.8



Impedance Measurement Plot for Head TSL

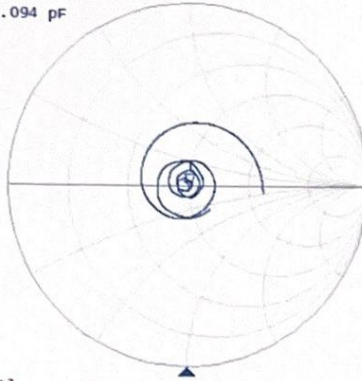
ES063A Network Analyzer

1 Active Ch/Trace 2 Response 3 Stimulus 4 Mkr/Analysis 5 Instr State

Resize

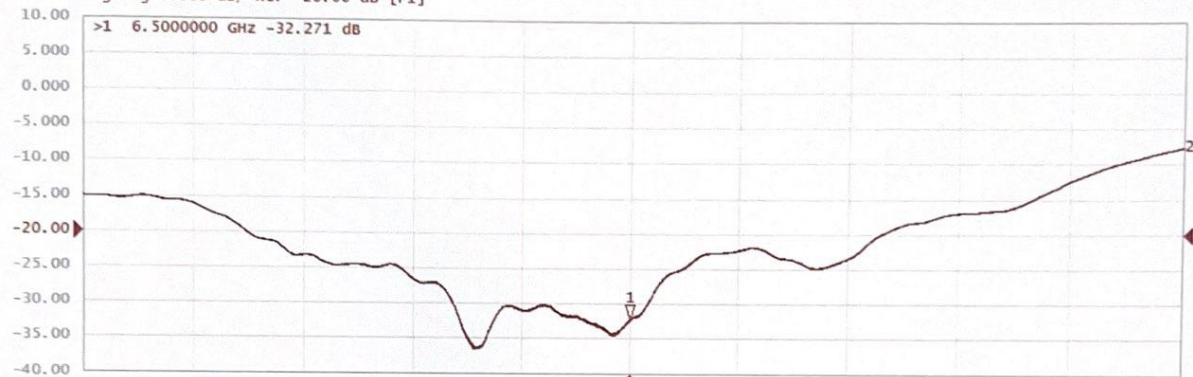
▶ Tr1 S11 Smith (R+jX) Scale 1.000 u [F1]

>1 6.500000 GHz 51.091 Ω -2.2072 Ω 11.094 pF



Tr2 S11 Log Mag 5.000 dB/ Ref -20.00 dB [F1]

>1 6.500000 GHz -32.271 dB



1 Center 6.5 GHz

IFBW 70 kHz

Span 2 GHz 10/10 Cor 1

Meas Plot