

DASY5 Validation Report for Head TSL

Date: 19.11.2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: CLA13; Type: CLA13; Serial: CLA13 - SN: 1016

Communication System: UID 0 - CW; Frequency: 13 MHz

Medium parameters used: $f = 13 \text{ MHz}$; $\sigma = 0.72 \text{ S/m}$; $\epsilon_r = 53.1$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(15.33, 15.33, 15.33) @ 13 MHz; Calibrated: 10.01.2024
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 18.10.2024
- Phantom: ELI v6.0; Type: QDOVA003AA; Serial: TP:2034
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

CLA Calibration for HSL-LF Tissue/CLA-13, touch configuration, Pin=1W/Zoom Scan, dist=1.4mm (8x10x8)/Cube 0; Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=1.4\text{mm}$

Reference Value = 31.10 V/m; Power Drift = -0.00 dB

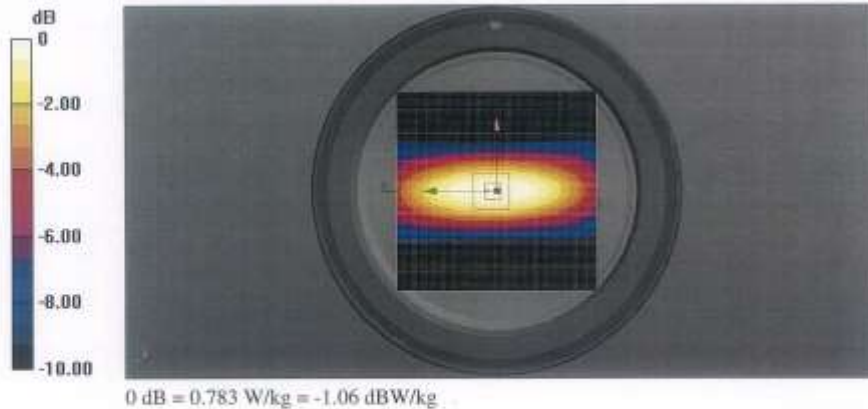
Peak SAR (extrapolated) = 1.06 W/kg

SAR(1 g) = 0.540 W/kg; SAR(10 g) = 0.338 W/kg

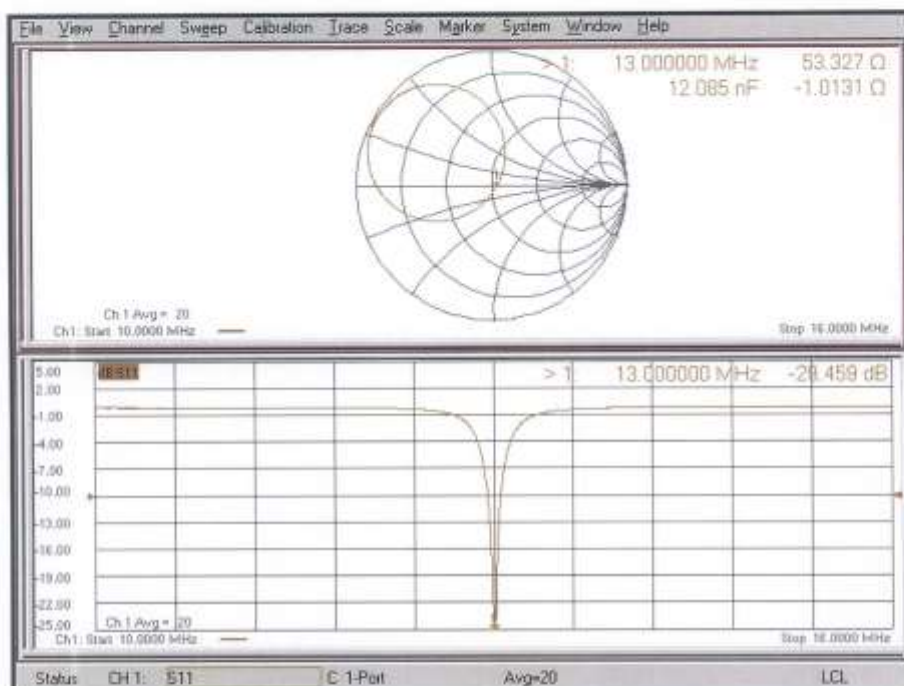
Smallest distance from peaks to all points 3 dB below = 22.7 mm

Ratio of SAR at M2 to SAR at M1 = 79.3%

Maximum value of SAR (measured) = 0.783 W/kg



Impedance Measurement Plot for Head TSL



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Accreditation No.: **SCS 0108**

Client **HCT**
Gyeonggi-do, Republic of Korea

Certificate No. **D750V3-1014_May24**

CALIBRATION CERTIFICATE

Object **D750V3 - SN:1014**

Calibration procedure(s) **QA CAL-05.v12
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz**

Calibration date: **May 20, 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&E critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP2	SN: 104778	26-Mar-24 (No. 217-04036/04037)	Mar-25
Power sensor NRP-Z91	SN: 103244	26-Mar-24 (No. 217-04036)	Mar-25
Power sensor NRP-Z91	SN: 103245	26-Mar-24 (No. 217-04037)	Mar-25
Reference 20 dB Attenuator	SN: BH8394 (20k)	26-Mar-24 (No. 217-04046)	Mar-25
Type-N mismatch combination	SN: 310982 / 06327	26-Mar-24 (No. 217-04047)	Mar-25
Reference Probe EX3DV4	SN: 7349	03-Nov-23 (No. EX3-7349_Nov23)	Nov-24
DAE4	SN: 781	16-Feb-24 (No. DAE4-781_Fev24)	Fev-25
Secondary Standards	ID #	Check Date (In house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (In house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (In house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (In house check Oct-22)	In house check: Oct-24
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (In house check Oct-22)	In house check: Oct-24
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (In house check Oct-22)	In house check: Oct-24

Calibrated by:	Name Paulo Pina	Function Laboratory Technician	Signature
Approved by:	Sven Kühn	Technical Manager	

Issued: May 20, 2024

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Certificate No: D750V3-1014_May24

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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:

- 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 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	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	750 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.9	0.89 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	43.2 $\pm$ 6 %	0.88 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	250 mW input power	2.09 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.50 W/kg $\pm$ 17.0 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.37 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.54 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	$53.6 \Omega + 2.7 j\Omega$
Return Loss	- 27.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.037 ns
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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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DASY5 Validation Report for Head TSL

Date: 20.05.2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN:1014

Communication System: UID 0 - CW; Frequency: 750 MHz

Medium parameters used: $f = 750$ MHz; $\sigma = 0.88$ S/m; $\epsilon_r = 43.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(10.11, 10.11, 10.11) @ 750 MHz; Calibrated: 03.11.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn781; Calibrated: 16.02.2024
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 59.58 V/m; Power Drift = 0.03 dB

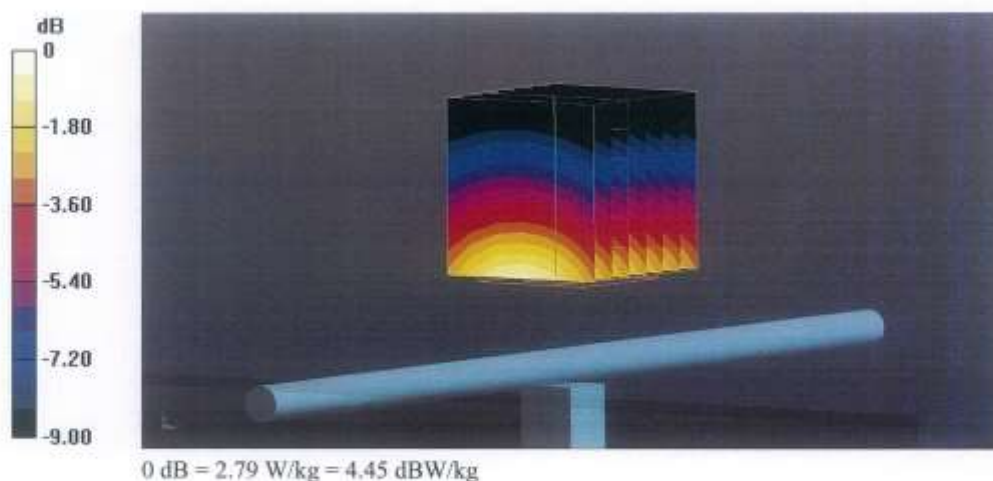
Peak SAR (extrapolated) = 3.13 W/kg

SAR(1 g) = 2.09 W/kg; SAR(10 g) = 1.37 W/kg

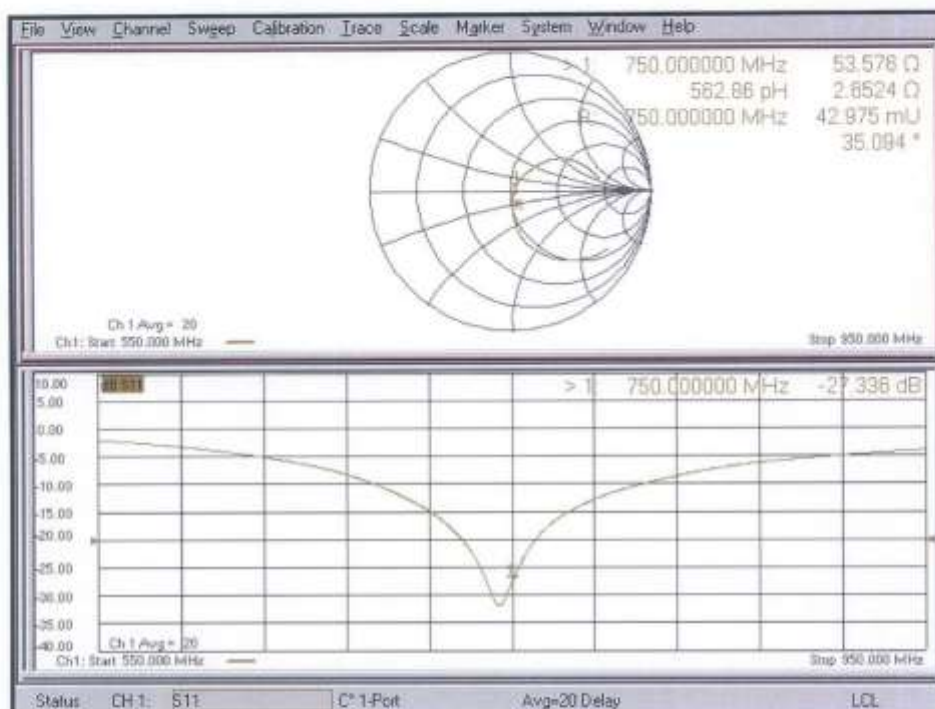
Smallest distance from peaks to all points 3 dB below = 24.1 mm

Ratio of SAR at M2 to SAR at M1 = 66.4%

Maximum value of SAR (measured) = 2.79 W/kg



Impedance Measurement Plot for Head TSL



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Accreditation No.: **SCS 0108**

Client **HCT**
 Gyeonggi-do, Republic of Korea

Certificate No. **D835V2-4d165_Apr25**

CALIBRATION CERTIFICATE

Object **D835V2 - SN: 4d165**

Calibration procedure(s) **QA CAL-05.v12**
 Calibration Procedure for SAR Validation Sources between 0.7 - 3 GHz

Calibration date **April 14, 2025**

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 Cal
Power Sensor R&S NRP-33T	SN: 100967	26-Mar-25 (No. 217-04290)	Mar-26
Power Sensor R&S NRP16A	SN: 101859	06-Feb-25 (No. 4030A315009541)	Feb-26
Spectrum Analyzer R&S FSV40	SN: 101832	29-Jan-25 (No. 4030A315009658)	Jan-26
3.5mm mismatch combination	SN: 1152	24-Mar-25 (No. 217-04293)	Mar-26
CCP DAK-12	SN: 1016	24-Sept-24 (No. CCP-DAK12-1016_Sep24)	Sep-25
CCP DAK-3.5	SN: 1249	23-Sept-24 (No. CCP-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	Leif Klysnar	Laboratory Technician	
Approved by	Sven Köhn	Technical Manager	

Issued: April 14, 2025

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결	담당자	확인자
제	기리	기리
직위/명	DL 17/24	DL 17/24
일	2025.04.17	2025.04.17

Certificate No: D835V2-4d165_Apr25

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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

- 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%.

D835V2 - SN: 4d165

April 14, 2025

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	15 mm	with spacer
Zoom Scan Resolution	dx, dy = 6mm, dz = 1.5mm	Graded Ratio = 1.5 mm (Z direction)
Frequency	835MHz $\pm$ 1MHz	

HSL parameters at 835 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal HSL parameters	22.0 °C	41.5	0.900 mho/m
Measured HSL parameters	(22.0 $\pm$ 0.2)°C	42.6 $\pm$ 6%	0.930 mho/m $\pm$ 6%
HSL temperature change during test	< 0.5 °C		

SAR result with HSL at 835 MHz

SAR averaged over 1 cm ³ (1 g) of HSL	Condition	
SAR for nominal HSL parameters	24 dBm input power	2.34 W/kg
SAR for nominal HSL parameters	normalized to 1W	9.32 W/kg $\pm$ 17.0% (k = 2)

SAR averaged over 10 cm ³ (10 g) of HSL	Condition	
SAR for nominal HSL parameters	24 dBm input power	1.51 W/kg
SAR for nominal HSL parameters	normalized to 1W	6.01 W/kg $\pm$ 16.5% (k = 2)

D835V2 - SN: 4d165

April 14, 2025

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with HSL at 835 MHz

Impedance	50.3 Ω - 5.9 j Ω
Return Loss	-24.6 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.389 ns
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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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D835V2 - SN: 4d165

April 14, 2025

System Performance Check Report

Summary

U/pole	Frequency (MHz)	TSL	Power (dBm)
D835V2 - SHADTES	835	HSL	24

Exposure Conditions

Position Section, TSL	Test Distance (mm)	Serial	Group, USB	Frequency (MHz)	Channel Number	Conversion Factor	TSL Conductivity (S/m)	TSL Permittivity
Flat	15	CBL 0---	835, 0			9.51	0.93	42.6

Hardware Setup

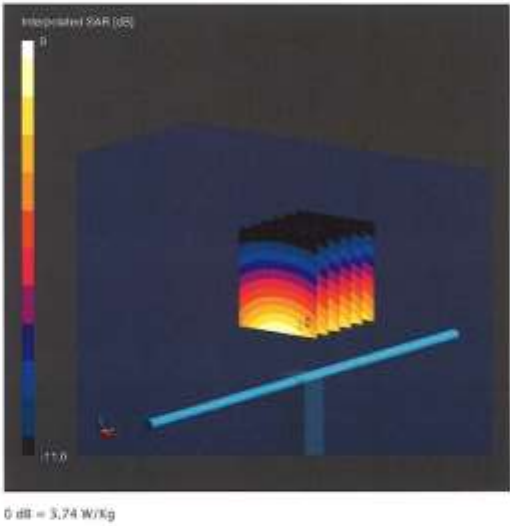
Hardware	TSL, Measured Date	Probe, Calibration Date	DRE, Calibration Date
Flat V4.9 head	HSL, 2025-04-14	DK3DVR - SN7549, 2025-01-10	DAK4ip Sr1836, 2024-10-28

Scans Setup

	Zoom Scan
Grid Extents (mm)	50 x 10 x 50
Grid Steps (mm)	6.0 x 0.0 x 1.5
Sensor Surface (mm)	1.4
Graded Grid	Yes
Grading Ratio	1.8
MMA	N/A
Surface Detection	VMS - 8p
Scan Method	Measured

Measurement Results

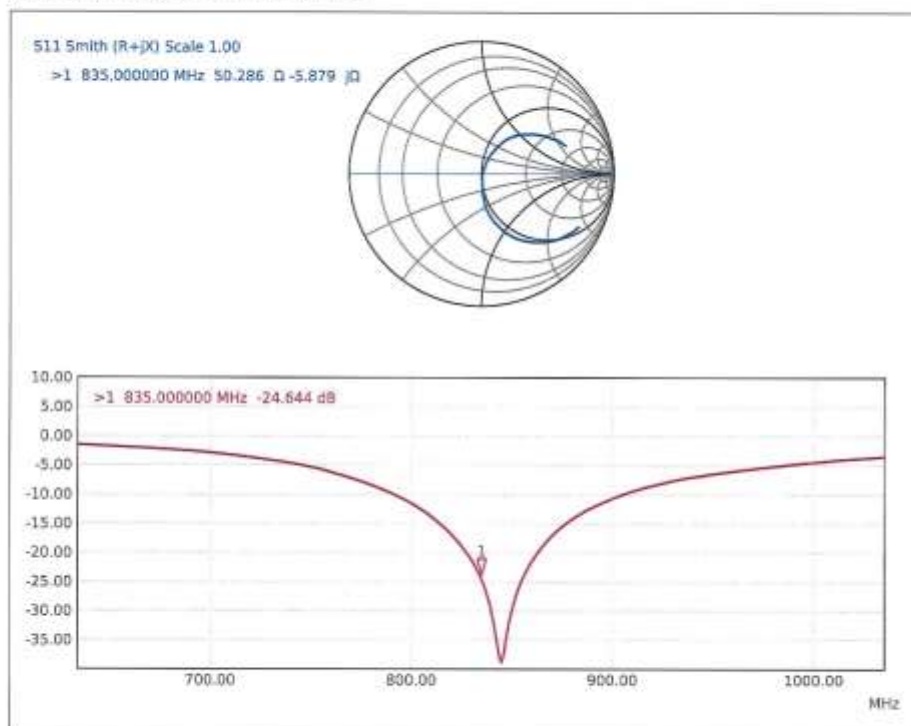
	Zoom Scan
Date	2025-04-14
psSAR1g (W/Kg)	2.34
psSAR10g (W/Kg)	1.51
Power D10g (dB)	0.99
Power Scaling	Disabled
Scaling Factor (dB)	
TSL Correction	Positive / Negative



D835V2 - SN: 4d165

April 14, 2025

Impedance Measurement Plot for HSL



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Accreditation No.: **SCS 0108**

Client **HCT**
 Gyeonggi-do, Republic of Korea

Certificate No. **D1800V2-2d015_Apr25**

CALIBRATION CERTIFICATE

Object D1800V2 - SN: 2d015

Calibration procedure(s) QA CAL-05.v12
 Calibration Procedure for SAR Validation Sources between 0.7 - 3 GHz

Calibration date April 17, 2025

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&E critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Cal
Power Sensor R&S NRP-33T	SN: 100967	26-Mar-25 (No. 217-04290)	Mar-26
Power Sensor R&S NRP18A	SN: 101859	06-Feb-25 (No. 4030A315009541)	Feb-26
Spectrum Analyzer R&S FSV40	SN: 101832	29-Jan-25 (No. 4030A315009658)	Jan-26
3.5mm mismatch combination	SN: 1152	24-Mar-25 (No. 217-04293)	Mar-26
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
DAE4p	SN: 1662	05-Nov-24 (No. DAE4p-1662_Nov24)	Nov-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: 182061	28-May-24 (No. 675-CAL18-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	
Approved by	Sven Kühn	Technical Manager	
			Issued: April 22, 2025
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재	김	리	준			
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일	자	2025/05/02		2025/05/02		

Certificate No: D1800V2-2d015_Apr25

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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

- 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 885664, "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%.

D1800V2 - SN: 2d015

April 17, 2025

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 = 6mm, dz = 1.5mm	Graded Ratio = 1.5 mm (Z direction)
Frequency	1800MHz $\pm$ 1MHz	

HSL parameters at 1800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal HSL parameters	22.0 °C	40.0	1.40 mho/m
Measured HSL parameters	(22.0 $\pm$ 0.2)°C	41.3 $\pm$ 6%	1.39 mho/m $\pm$ 6%
HSL temperature change during test	< 0.5 °C		

SAR result with HSL at 1800 MHz

SAR averaged over 1 cm ³ (1 g) of HSL	Condition	
SAR for nominal HSL parameters	24 dBm input power	9.56 W/kg
SAR for nominal HSL parameters	normalized to 1W	38.1 W/kg $\pm$ 17.0% (k = 2)

SAR averaged over 10 cm ³ (10 g) of HSL	Condition	
SAR for nominal HSL parameters	24 dBm input power	5.04 W/kg
SAR for nominal HSL parameters	normalized to 1W	20.1 W/kg $\pm$ 16.5% (k = 2)

D1800V2 - SN: 2d015

April 17, 2025

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with HSL at 1800 MHz

Impedance	46.8 Ω - 4.1 j Ω
Return Loss	-25.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.214 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured. The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

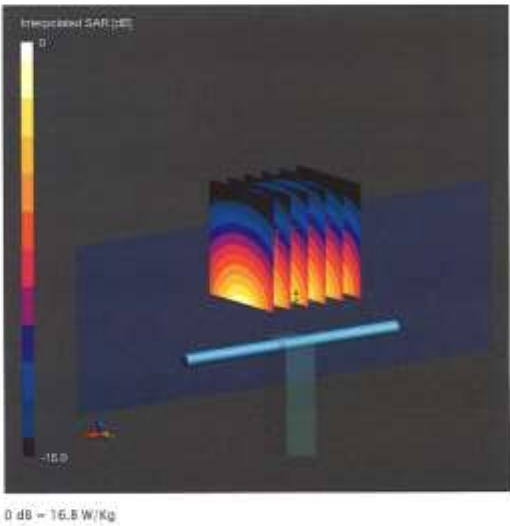
Manufactured by	SPEAG
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D1800V2 - SN: 2d015

April 17, 2025

System Performance Check Report

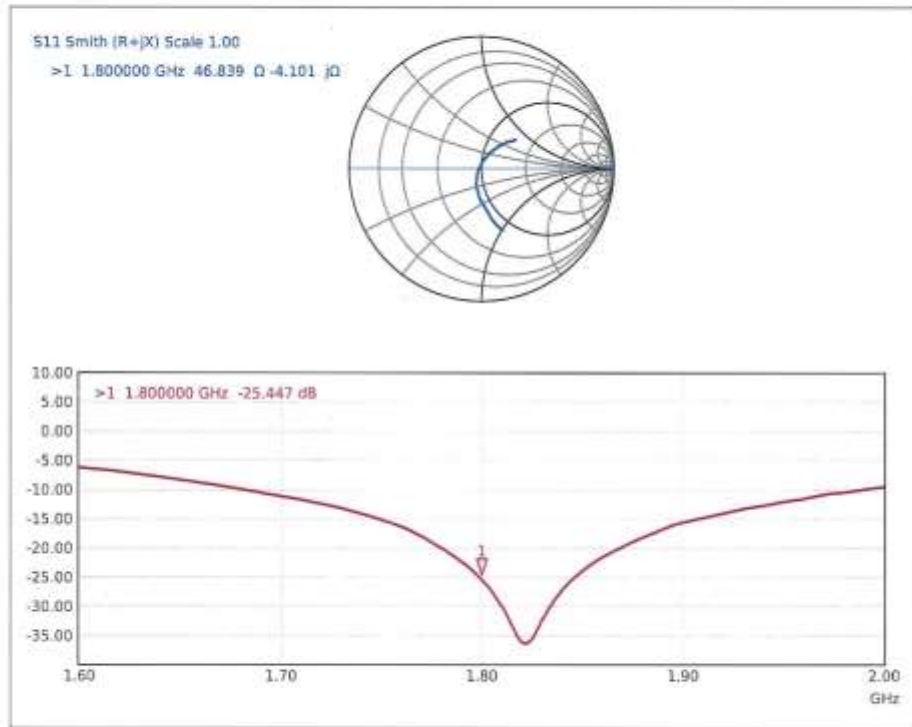
Summary								
Device	Frequency (MHz)			TSL	Power (dBm)			
D1800V2 - SN2d015	1800			HSL	34			
Exposure Conditions								
Phantom Section, TSL	Test Distance (mm)	Band	Group, UHF	Frequency (MHz), Channel Number		Conversion Factor	TSL Conductivity (S/m)	TSL Permittivity
Flat	10	DM, D--		1800, 0		7.94	1.38	41.3
Hardware Setup								
Phantom	TSL, Measured Date			Probe, Calibration Date			DAE, Calibration Date	
MPP V6.0 Carrier	HSL, 2025-04-17			EK3DV4 - SN7549, 2025-01-10			DA6Aig SN1882, 2024-11-05	
Scans Setup				Measurement Results				
Zoom Scan				Zoom Scan				
Grid Exports (mm)				Date				
30 x 30 x 30				2025-04-17				
Grid Steps (mm)				edSAR1g (W/Kg)				
6.0 x 6.0 x 1.5				9.58				
Sensor Surface (mm)				edSAR10g (W/Kg)				
1.4				5.04				
Graded Grid				Power Drift (dB)				
Yes				0.00				
Grading Ratio				Power Scaling				
1.5				Disabled				
MVA				Scaling Factor (dB)				
N/A				TSL Correction				
Surface Detection				Positive / Negative				
VMS + Gp								
Scan Method				Measured				



D1800V2 - SN: 2d015

April 17, 2025

Impedance Measurement Plot for HSL



Certificate No: D1800V2-2d015_Apr25

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Accreditation No.: **SCS 0108**

Client **HCT**
 Gyeonggi-do, Republic of Korea

Certificate No. **D1900V2-5d061_Jan25**

CALIBRATION CERTIFICATE

Object **D1900V2 - SN: 5d061**

Calibration procedure(s) **QA CAL-05.v12**
Calibration Procedure for SAR Validation Sources between 0.7 - 3 GHz

Calibration date **January 20, 2025**

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 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	25-Jan-24 (No. 4030-315007551)	Jan-25
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	Paulo Pina	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	
			Issued: January 21, 2025
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

Certificate No: D1900V2-5d061_Jan25

Page 1 of 6

Handwritten notes and signatures at the bottom right of the page.

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 Multilateral Agreement for the recognition of calibration certificates

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

- 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%.

D1900V2 - SN: 5d061

January 20, 2025

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 = 6mm, dz = 1.5mm	Graded Ratio = 1.5 mm (Z direction)
Frequency	1900MHz $\pm$ 1MHz	

Head TSL parameters at 1900 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2)°C	39.8 $\pm$ 6%	1.40 mho/m $\pm$ 6%
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL at 1900 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	24 dBm input power	9.75 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	38.8 W/kg $\pm$ 17.0% (k = 2)

SAR averaged over 10 cm³ (10 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	24 dBm input power	5.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	20.4 W/kg $\pm$ 16.5% (k = 2)

D1900V2 - SN: 5d061

January 20, 2025

Appendix (Additional assessments outside the scope of SCS 0108)**Antenna Parameters with Head TSL at 1900 MHz**

Impedance	50.3 Ω + 5.4 j Ω
Return Loss	-25.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.194 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured. The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
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D1900V2 - SN: 5d061

January 20, 2025

System Performance Check Report

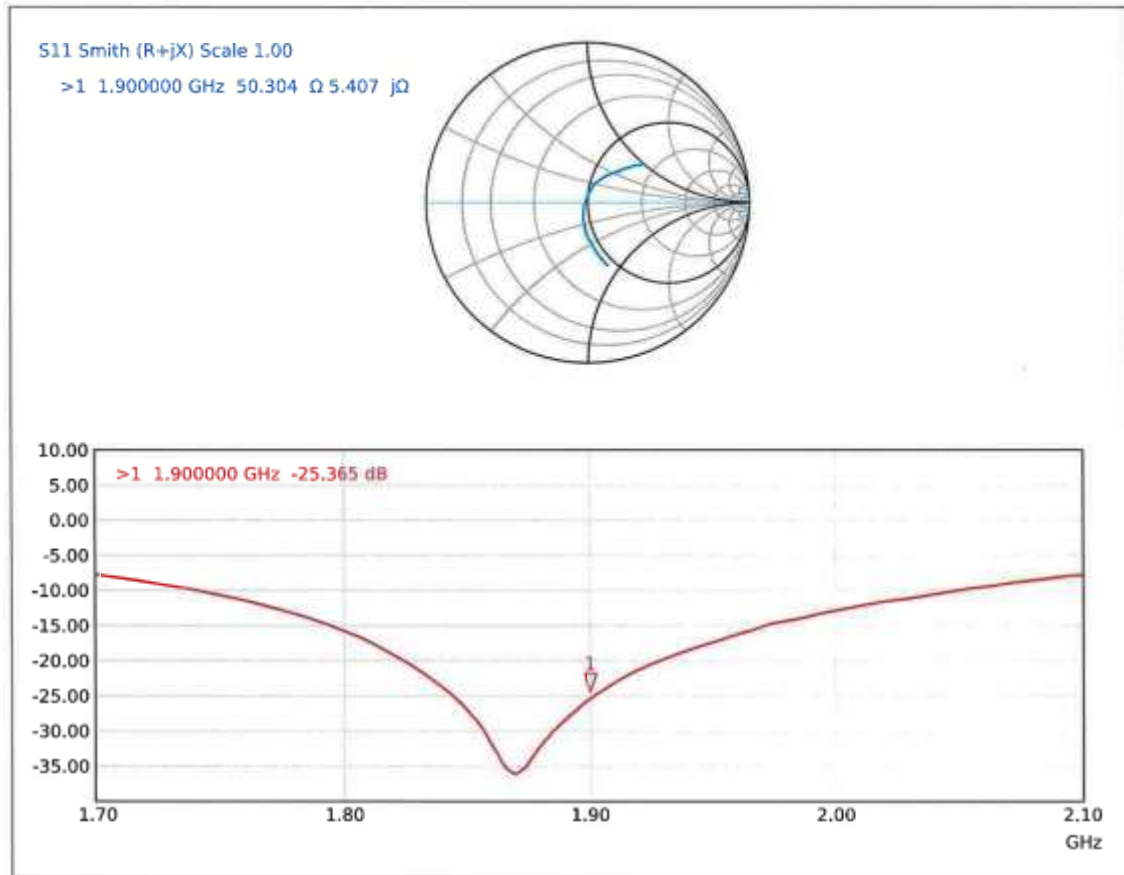
Summary								
Dipole		Frequency [MHz]			TSL	Power [dBm]		
D1900V2 – SN5d061		1900			HSL	24		
Exposure Conditions								
Phantom Section, TSL	Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number		Conversion Factor	TSL Conductivity [S/m]	TSL Permittivity
Flat	10	CW, 0---		1900, 0		7.68	1.40	39.8
Hardware Setup								
Phantom	TSL Measured Date			Probe, Calibration Date			DAE, Calibration Date	
MFP V8.0 Center	HSL, 2025-01-20			EX3DV4 – SN7349, 2025-01-10			DAE4ip Sn1836, 2024-10-28	
Scans Setup								
				Zoom Scan				
Grid Extents [mm]				30 x 30 x 30				
Grid Steps [mm]				6.0 x 6.0 x 1.5				
Sensor Surface [mm]				1.4				
Graded Grid				Yes				
Grading Ratio				1.5				
MAIA				N/A				
Surface Detection				VMS + 6p				
Scan Method				Measured				
Measurement Results								
				Zoom Scan				
Date				2025-01-20				
psSAR1g [W/Kg]				9.75				
psSAR10g [W/Kg]				5.12				
Power Drift [dB]				0.00				
Power Scaling				Disabled				
Scaling Factor [dB]								
TSL Correction				Positive / Negative				



D1900V2 - SN: 5d061

January 20, 2025

Impedance Measurement Plot for Head TSL



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Accreditation No.: SCS 0108

Client

HCT

Gyeonggi-do, Republic of Korea

Certificate No.

D2450V2-1049_Mar25

CALIBRATION CERTIFICATE

Object D2450V2 - SN: 1049

Calibration procedure(s) QA CAL-05.v12
Calibration Procedure for SAR Validation Sources between 0.7 - 3 GHz

Calibration date March 13, 2025

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 Cal
Power Sensor R&S NRP-33T	SN: 100967	28-Mar-24 (No. 217-04038)	Mar-25
Power Sensor R&S NRP18A	SN: 101859	06-Feb-25 (No. 4030A315009541)	Feb-26
Spectrum Analyzer R&S FSV40	SN: 101832	29-Jan-25 (No. 4030A315009658)	Jan-26
Mismatch; Short [S4189] 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 EX30V4	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

Calibrated by	Name Krešimir Franjić	Function Laboratory Technician	Signature
Approved by	Name Sven Kühn	Function Technical Manager	Signature

Issued: March 14, 2025

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결 재	검 정 자 장 = 1/2	확 인 자
직위/성명	DC 1/24	457 1/154
일 자	2025.04.01	2025.04.01

Certificate No: D2450V2-1049_Mar25

Page 1 of 6

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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

- 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%.

D2450V2 - SN: 1049

March 13, 2025

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 = 5mm, dz = 1.5mm	Graded Ratio = 1.5 mm (Z direction)
Frequency	2450MHz $\pm$ 1MHz	

HSL parameters at 2450 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal HSL parameters	22.0 °C	39.2	1.80 mho/m
Measured HSL parameters	(22.0 $\pm$ 0.2) °C	37.9 $\pm$ 6%	1.86 mho/m $\pm$ 6%
HSL temperature change during test	< 0.5 °C		

SAR result with HSL at 2450 MHz

SAR averaged over 1 cm ³ (1 g) of HSL	Condition	
SAR for nominal HSL parameters	24 dBm input power	13.2 W/kg
SAR for nominal HSL parameters	normalized to 1W	52.6 W/kg $\pm$ 17.0% (k = 2)

SAR averaged over 10 cm ³ (10 g) of HSL	Condition	
SAR for nominal HSL parameters	24 dBm input power	6.18 W/kg
SAR for nominal HSL parameters	normalized to 1W	24.6 W/kg $\pm$ 16.5% (k = 2)

D2450V2 - SN: 1049

March 13, 2025

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with HSL at 2450 MHz

Impedance	$49.5 \Omega + 8.6 j\Omega$
Return Loss	-21.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.16 ns
----------------------------------	---------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured. The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
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D2450V2 - SN: 1049

March 13, 2025

System Performance Check Report

Summary

Dipole	Frequency (MHz)	TSL	Power (dBm)
D2450V2 - SN1049	2450	HSL	24

Exposure Conditions

Phantom Section, TSL	Test Distance (mm)	Band	Group, UID	Frequency (MHz), Channel Number	Conversion Factor	TSL Conductivity (S/m)	TSL Permittivity
Hsl	10	CN, 0—		2450, 0	7.06	1.86	37.5

Hardware Setup

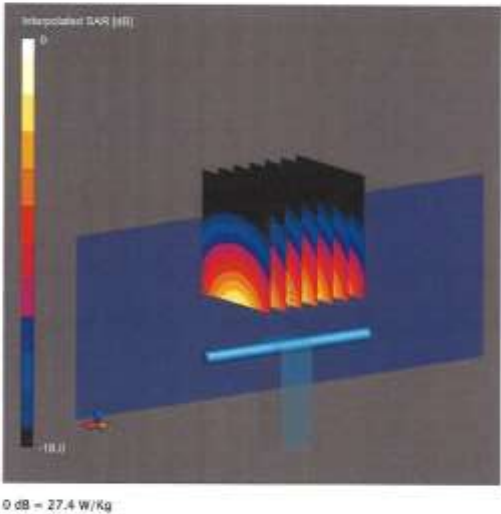
Phantom	TSL, Measured Date	Probe, Calibration Date	DAE, Calibration Date
MTP VES Center	HSL, 2025-03-13	EXD04N - SN7349, 2025-01-10	DAE04p SN1896, 2024-10-28

Scans Setup

	Zoom Scan
Grid Extent (mm)	30 x 30 x 30
Grid Steps (mm)	5.0 x 5.0 x 1.5
Sensor Surface (mm)	1.4
Graded Grid	Yes
Grading Ratio	1.5
NAA	N/A
Surface Detection	VMS + 6p
Scan Method	Measured

Measurement Results

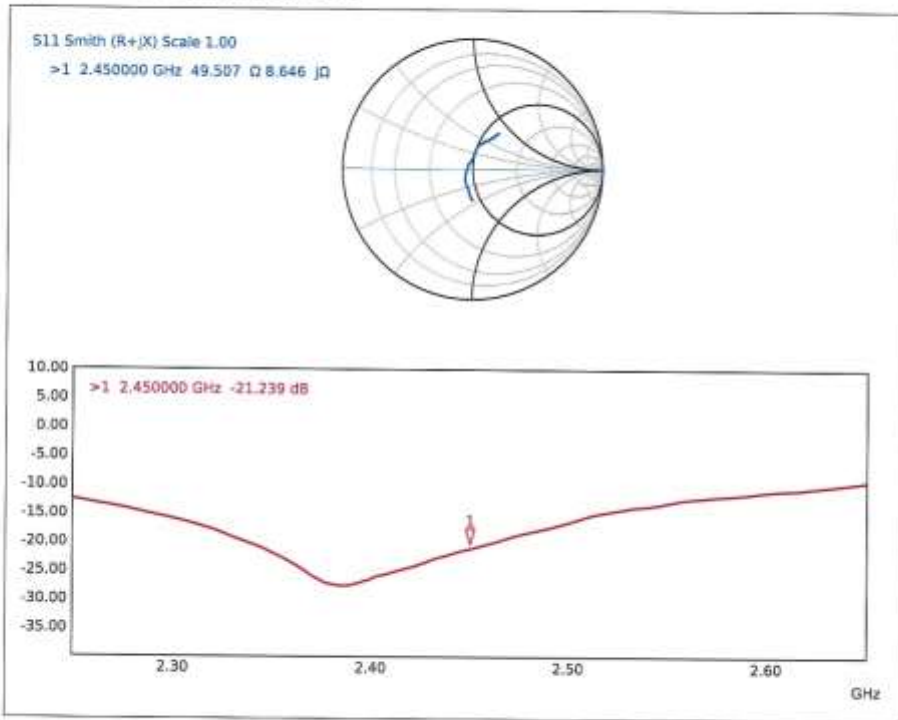
	Zoom Scan
Date	2025-03-13
psSAR1g (W/Kg)	13.2
psSAR10g (W/Kg)	6.18
Power Dens (dB)	8.02
Power Scaling	Disabled
Scaling Factor (dB)	
TSL Correction	Positive / Negative



D2450V2 - SN: 1049

March 13, 2025

Impedance Measurement Plot for HSL



Certificate No: D2450V2-1049_Mar25

Page 6 of 6

Appendix: Transfer Calibration at Four Validation Locations on SAM Head¹

Evaluation Condition

Phantom	SAM Head Phantom	For usage with cSAR3DV2-R/L
---------	------------------	-----------------------------

SAR result with SAM Head (Top $\approx$ C0)

SAR averaged over 1 cm ³ (1 g) of HSL	Condition	
SAR for nominal HSL parameters	normalized to 1W	56.1 W/kg $\pm$ 17.5 % (k=2)
SAR averaged over 10 cm ³ (10 g) of HSL	condition	
SAR for nominal HSL parameters	normalized to 1W	26.1 W/kg $\pm$ 16.9 % (k=2)

SAR result with SAM Head (Mouth $\approx$ F90)

SAR averaged over 1 cm ³ (1 g) of HSL	Condition	
SAR for nominal HSL parameters	normalized to 1W	57.2 W/kg $\pm$ 17.5 % (k=2)
SAR averaged over 10 cm ³ (10 g) of HSL	condition	
SAR for nominal HSL parameters	normalized to 1W	27.4 W/kg $\pm$ 16.9 % (k=2)

SAR result with SAM Head (Neck $\approx$ H0)

SAR averaged over 1 cm ³ (1 g) of HSL	Condition	
SAR for nominal HSL parameters	normalized to 1W	53.9 W/kg $\pm$ 17.5 % (k=2)
SAR averaged over 10 cm ³ (10 g) of HSL	condition	
SAR for nominal HSL parameters	normalized to 1W	25.0 W/kg $\pm$ 16.9 % (k=2)

SAR result with SAM Head (Ear $\approx$ D90)

SAR averaged over 1 cm ³ (1 g) of HSL	Condition	
SAR for nominal HSL parameters	normalized to 1W	34.5 W/kg $\pm$ 17.5 % (k=2)
SAR averaged over 10 cm ³ (10 g) of HSL	condition	
SAR for nominal HSL parameters	normalized to 1W	17.4 W/kg $\pm$ 16.9 % (k=2)

¹ Additional assessments outside the current scope of SCS 0108.

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Accreditation No.: **SCS 0108**

Client: **HCT**
Gyeonggi-do, Republic of Korea

Certificate No.: **D2600V2-1106_Apr25**

CALIBRATION CERTIFICATE

Object: **D2600V2 - SN: 1106**

Calibration procedure(s): **QA CAL-05.v12**
Calibration Procedure for SAR Validation Sources between 0.7 - 3 GHz

Calibration date: **April 15, 2025**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.
All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3) °C and humidity < 70%.
Calibration Equipment used (MATE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Cal
Power Sensor R&S NRP-33T	SN: 100967	26-Mar-25 (No. 217-04290)	Mar-26
Power Sensor R&S NRP18A	SN: 101859	06-Feb-25 (No. 4030A315009541)	Feb-26
Spectrum Analyzer R&S FSV40	SN: 101832	29-Jan-25 (No. 4030A315009658)	Jan-26
3.5mm mismatch combination	SN: 1152	24-Mar-25 (No. 217-04293)	Mar-26
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	26-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-S4568-240528)	May-25
Mismatch; SMA	SN: 1102	22-May-24 (No. 675-Mismatch_SMA-240522)	May-25

	Name	Function	Signature
Calibrated by	Leif Klysnar	Laboratory Technician	<i>Leif Klysnar</i>
Approved by	Sven Kühn	Technical Manager	<i>Sven Kühn</i>
Issued: April 15, 2025			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

Certificate No: D2600V2-1106_Apr25

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결	담 당 자	확 인 자
제	7221	<i>[Signature]</i>
4월/25	06/17/25	07/17/25
발 주	0456102	2761052

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Glossary

TSL tissue simulating liquid
Con_vF 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 as 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%.

D2600V2 - SN: 1106

April 15, 2025

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 = 5mm, dz = 1.5mm	Graded Ratio = 1.5 mm (Z direction)
Frequency	2600MHz $\pm$ 1MHz	

HSL parameters at 2600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal HSL parameters	22.0 °C	39.0	1.96 mho/m
Measured HSL parameters	(22.0 $\pm$ 0.2)°C	37.3 $\pm$ 6%	2.02 mho/m $\pm$ 6%
HSL temperature change during test	< 0.5 °C		

SAR result with HSL at 2600 MHz

SAR averaged over 1 cm ³ (1 g) of HSL	Condition	
SAR for nominal HSL parameters	24 dBm input power	14.0 W/kg
SAR for nominal HSL parameters	normalized to 1W	55.7 W/kg $\pm$ 17.0% (k = 2)

SAR averaged over 10 cm ³ (10 g) of HSL	Condition	
SAR for nominal HSL parameters	24 dBm input power	6.28 W/kg
SAR for nominal HSL parameters	normalized to 1W	25.0 W/kg $\pm$ 16.5% (k = 2)

D2600V2 - SN: 1106

April 15, 2025

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with HSL at 2600 MHz

Impedance	48.3 Ω - 7.4 j Ω
Return Loss	-22.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.149 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured. The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
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D2600V2 - SN: 1106

April 15, 2025

System Performance Check Report

Summary

Dipole	Frequency [MHz]	TSL	Power [dBm]
D2600V2 - SN: 1106	2600	HBL	24

Exposure Conditions

Phantom Section, TSL	Test Distance [mm]	Band	Coupling, U/D	Frequency [MHz], Channel Number	Conversion Factor	TSL Conductivity [S/m]	TSL Permittivity
Flat	10	CW, D--		2600, 0	7.2E	2.02	57.3

Hardware Setup

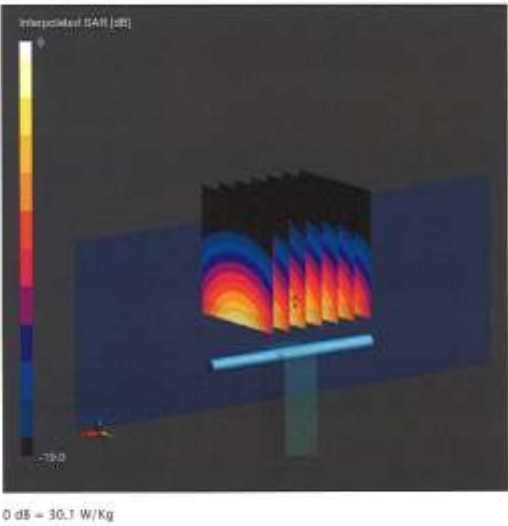
Phantom	TSL Measured Date	Probe, Calibration Date	SAC, Calibration Date
MFP V8.5 Center	HBL, 2025-04-15	EX30V8 - SN7246, 2025-01-10	BADsig Sn1836, 2024-10-28

Scans Setup

	Zoom Scan
Grid Extents [mm]	30 x 30 x 30
Grid Steps [mm]	3.0 x 3.0 x 1.5
Sensor Surface [mm]	1.4
Grated Grid	Yes
Coupling Rate	1.2
ASA	N/A
Surface Detection	All points
Scan Method	Measured

Measurement Results

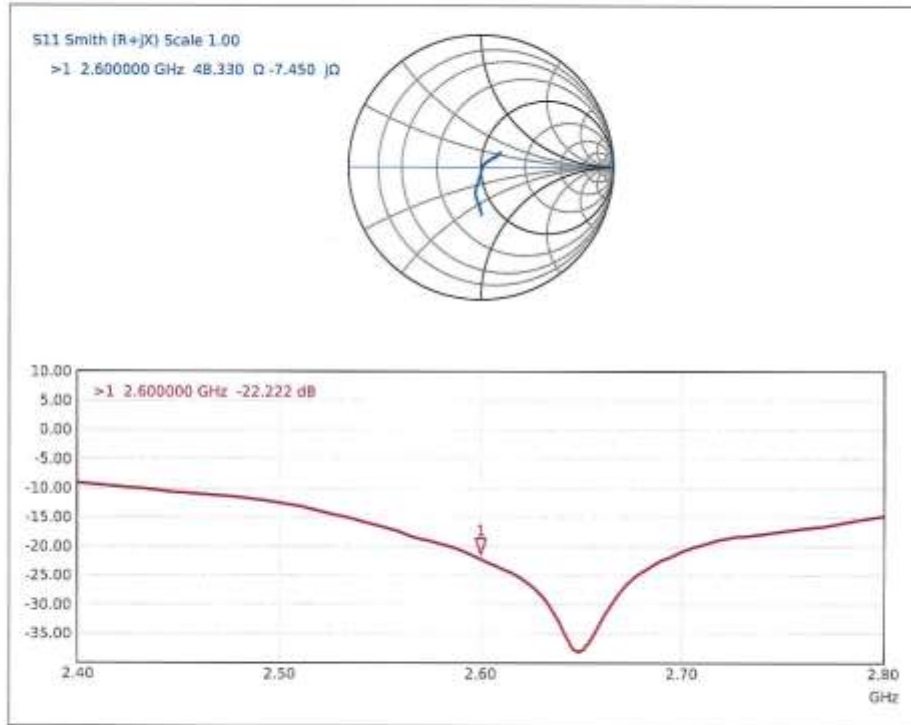
	Zoom Scan
Date	2025-04-15
ptSAR1g [W/Kg]	14.0
ptSAR10g [W/Kg]	6.38
Power Drift [dB]	0.00
Power Scaling	Disabled
Scaling Factor [dB]	
TSL Correction	Positive / Negative



D2600V2 - SN: 1106

April 15, 2025

Impedance Measurement Plot for HSL



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



S Schweizerischer Kalibrierdienst
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S 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

Client **HCT**
Gyeonggi-do, Republic of Korea

Certificate No. **D5GHzV2-1107_Apr24**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1107**

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

Calibration date: **April 19, 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 $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP2	SN: 104778	26-Mar-24 (No. 217-04036/04037)	Mar-25
Power sensor NRP-Z91	SN: 103244	26-Mar-24 (No. 217-04036)	Mar-25
Power sensor NRP-Z91	SN: 103245	26-Mar-24 (No. 217-04037)	Mar-25
Reference 20 dB Attenuator	SN: BH9394 (20k)	26-Mar-24 (No. 217-04046)	Mar-25
Type-N mismatch combination	SN: 310982 / 06327	26-Mar-24 (No. 217-04047)	Mar-25
Reference Probe EX3DV4	SN: 3503	07-Mar-24 (No. EX3-3503_Mar24)	Mar-25
DAE4	SN: 601	30-Jan-24 (No. DAE4-601_Jan24)	Jan-25
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-22)	In house check: Oct-24
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24

Calibrated by: **Paulo Pina** **Laboratory Technician**

Approved by: **Sven Kühn** **Technical Manager**

Issued: April 23, 2024

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

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



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S Swiss Calibration Service

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

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:

- 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 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 = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5750 MHz $\pm$ 1 MHz 5800 MHz $\pm$ 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 $\pm$ 0.2) °C	37.1 $\pm$ 6 %	4.65 mho/m $\pm$ 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	80.2 W/kg $\pm$ 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 W/kg $\pm$ 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	36.5 ± 6 %	5.05 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	8.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.1 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.5 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	36.3 ± 6 %	5.22 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	7.95 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.9 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.8 W/kg ± 19.5 % (k=2)

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35,3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.2 ± 6 %	5.27 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.89 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.3 W/kg ± 19.9 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.24 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.5 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	49.0 Ω - 2.7 j Ω
Return Loss	- 30.8 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	54.2 Ω + 1.9 j Ω
Return Loss	- 27.1 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	56.1 Ω + 1.6 j Ω
Return Loss	- 24.6 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	55.3 Ω + 0.5 j Ω
Return Loss	- 25.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.196 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
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DASY5 Validation Report for Head TSL

Date: 19.04.2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1107

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5800 MHz

Medium parameters used: $f = 5250$ MHz; $\sigma = 4.65$ S/m; $\epsilon_r = 37.1$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5600$ MHz; $\sigma = 5.05$ S/m; $\epsilon_r = 36.5$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5750$ MHz; $\sigma = 5.22$ S/m; $\epsilon_r = 36.3$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5800$ MHz; $\sigma = 5.27$ S/m; $\epsilon_r = 36.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.39, 5.39, 5.39) @ 5250 MHz, ConvF(5, 5, 5) @ 5600 MHz, ConvF(4.98, 4.98, 4.98) @ 5750 MHz, ConvF(4.86, 4.86, 4.86) @ 5800 MHz; Calibrated: 07.03.2024
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.01.2024
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; 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 = 73.63 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 26.9 W/kg

SAR(1 g) = 7.97 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 = 70.9%

Maximum value of SAR (measured) = 18.2 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 = 72.81 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 30.3 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 = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 68%

Maximum value of SAR (measured) = 19.4 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 = 71.06 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 30.9 W/kg

SAR(1 g) = 7.95 W/kg; SAR(10 g) = 2.26 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 66.2%

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

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 71.08 V/m; Power Drift = 0.08 dB

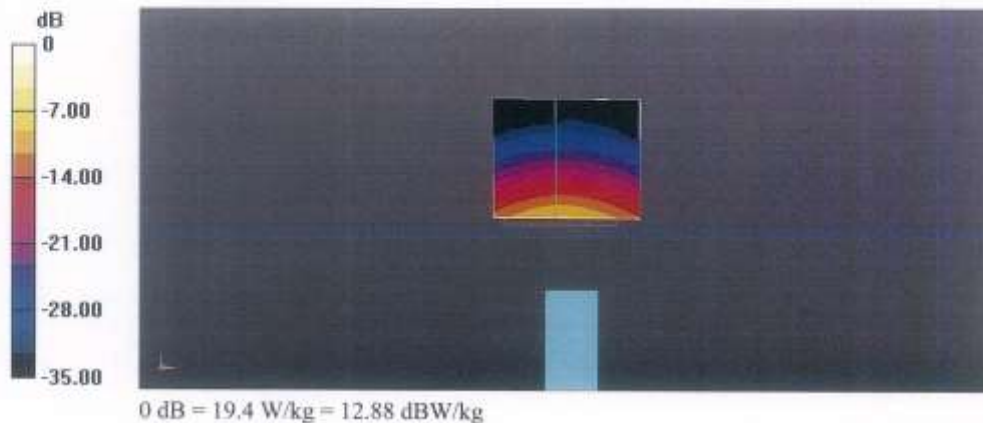
Peak SAR (extrapolated) = 31.1 W/kg

SAR(1 g) = 7.89 W/kg; SAR(10 g) = 2.24 W/kg

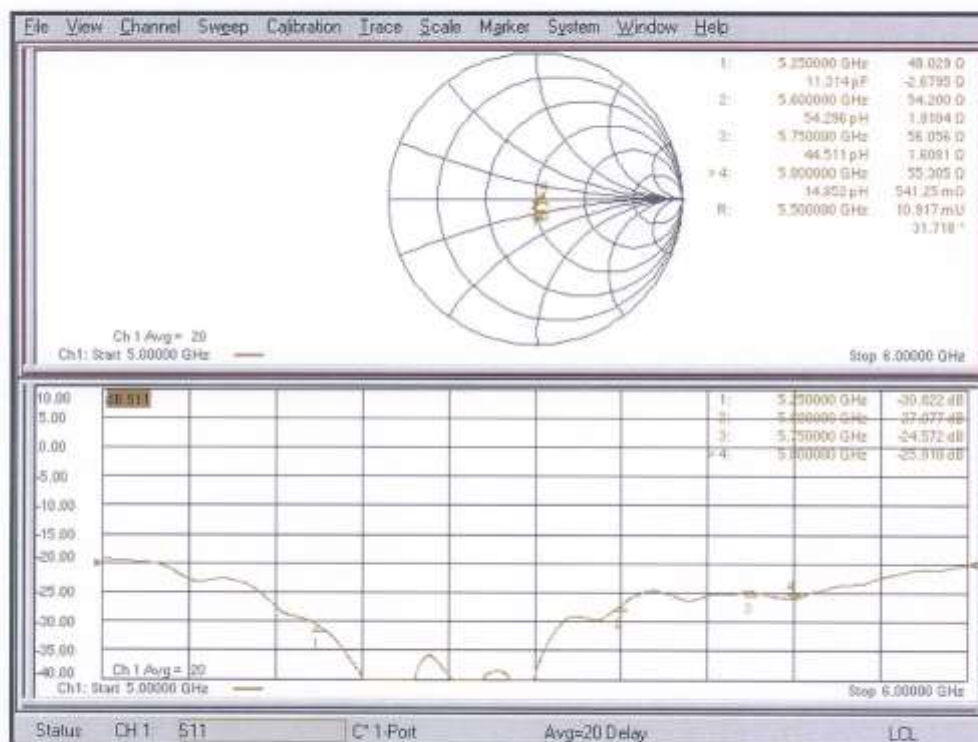
Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 65.8%

Maximum value of SAR (measured) = 19.2 W/kg



Impedance Measurement Plot for Head TSL



Appendix: Transfer Calibration at Four Validation Locations on SAM Head¹

Evaluation Conditions (f=5250 MHz)

Phantom	SAM Head Phantom	For usage with cSAR3DV2-R/L
---------	------------------	-----------------------------

SAR result with SAM Head (Top)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	85.8 W/kg $\pm$ 20.3 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	24.8 W/kg $\pm$ 19.9 % (k=2)

SAR result with SAM Head (Mouth)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	85.0 W/kg $\pm$ 20.3 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	24.0 W/kg $\pm$ 19.9 % (k=2)

SAR result with SAM Head (Neck)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	83.1 W/kg $\pm$ 20.3 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	23.9 W/kg $\pm$ 19.9 % (k=2)

SAR result with SAM Head (Ear)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	53.8 W/kg $\pm$ 20.3 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	18.3 W/kg $\pm$ 19.9 % (k=2)

¹ Additional assessments outside the current scope of SCS 0108

Appendix: Transfer Calibration at Four Validation Locations on SAM Head²

Evaluation Conditions (f=5800 MHz)

Phantom	SAM Head Phantom	For usage with cSAR3DV2-R/L
---------	------------------	-----------------------------

SAR result with SAM Head (Top)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	82.4 W/kg $\pm$ 20.3 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	23.4 W/kg $\pm$ 19.9 % (k=2)

SAR result with SAM Head (Mouth)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	89.1 W/kg $\pm$ 20.3 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	25.4 W/kg $\pm$ 19.9 % (k=2)

SAR result with SAM Head (Neck)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	79.5 W/kg $\pm$ 20.3 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	22.4 W/kg $\pm$ 19.9 % (k=2)

SAR result with SAM Head (Ear)

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR for nominal Head TSL parameters	normalized to 1W	56.6 W/kg $\pm$ 20.3 % (k=2)
SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR for nominal Head TSL parameters	normalized to 1W	19.1 W/kg $\pm$ 19.9 % (k=2)

² Additional assessments outside the current scope of SCS 0108

Certification of Calibration

Object	D5GHzV2 – SN:1107
Calibration procedure(s)	Procedure for Calibration Extension for SAR Dipoles.
Extended Calibration date	Apr.19, 2026
Description	SAR Validation Dipole at 5GHz

Note: Calibrated Before Testing. Prior to testing, the measurement paths containing a cable, amplifier, attenuator, coupler or filter were connected to a calibrated source (i.e. signal generator) to determine the losses of the measurement path.

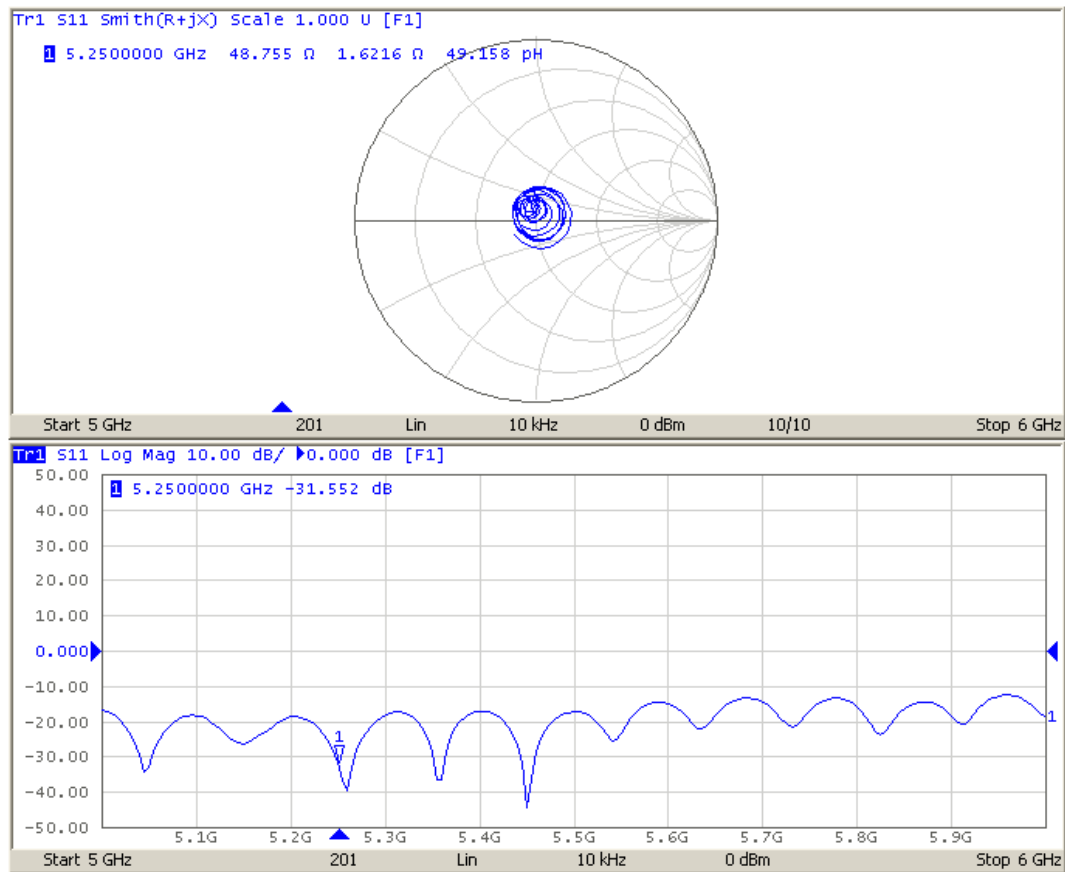
Dipole Calibration Extension

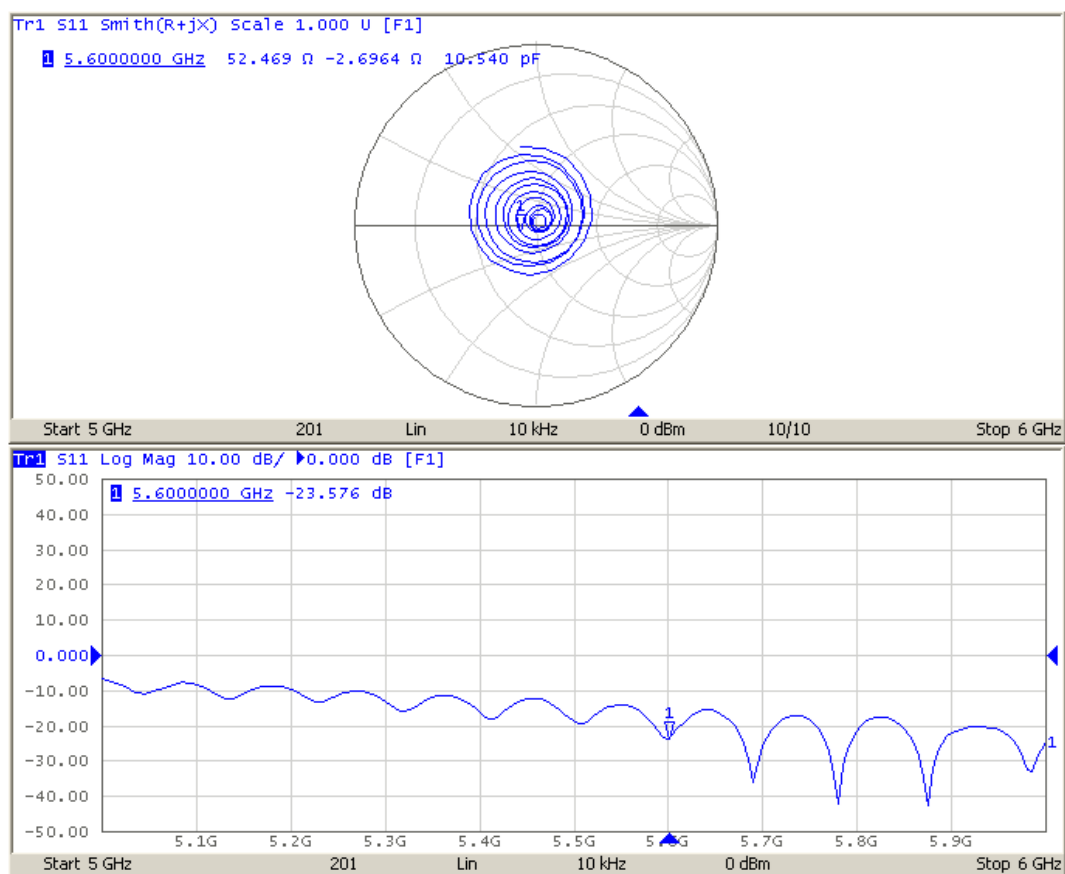
Per HDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

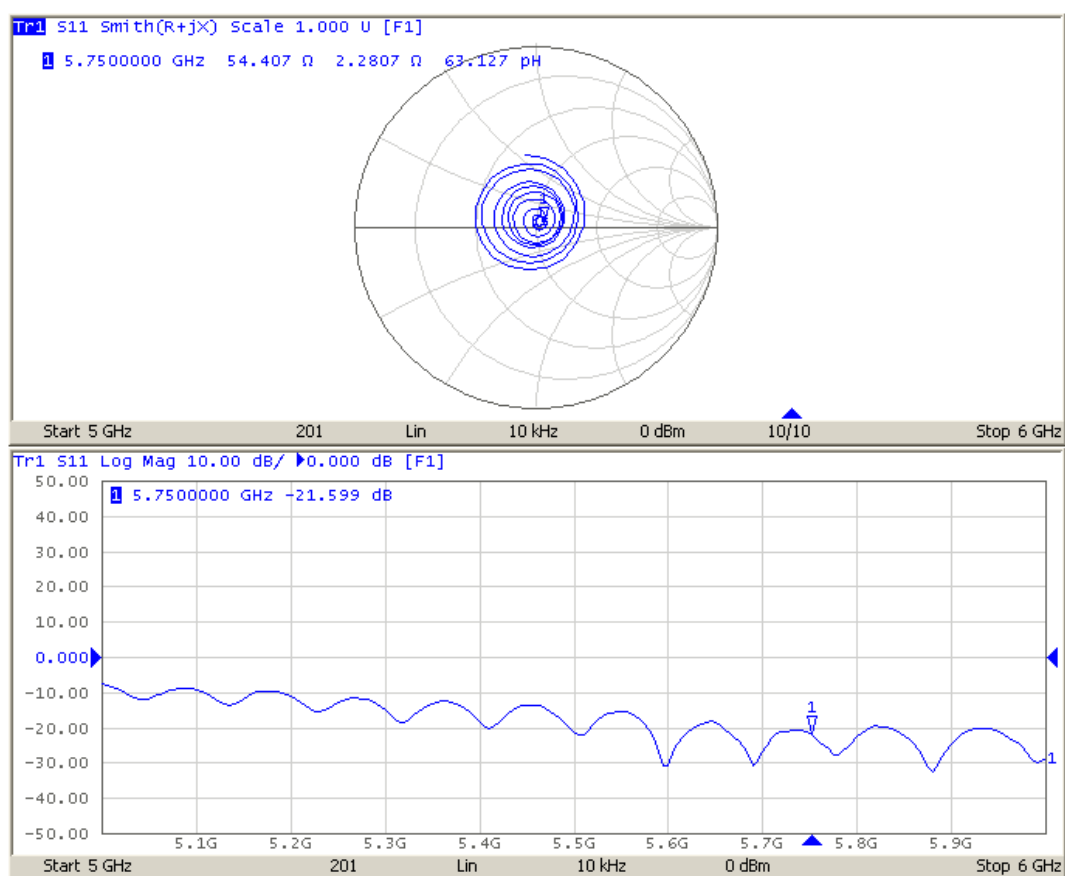
1. The measured SAR does not deviate more than 10% from the target on the calibration certificate.
2. The return-loss does not deviate more than 20% from the previous measurement and meets the required 20dB minimum return-loss requirement.
3. The measurement of real or imaginary parts of impedance does not deviate more than 5Ω from the previous measurement.

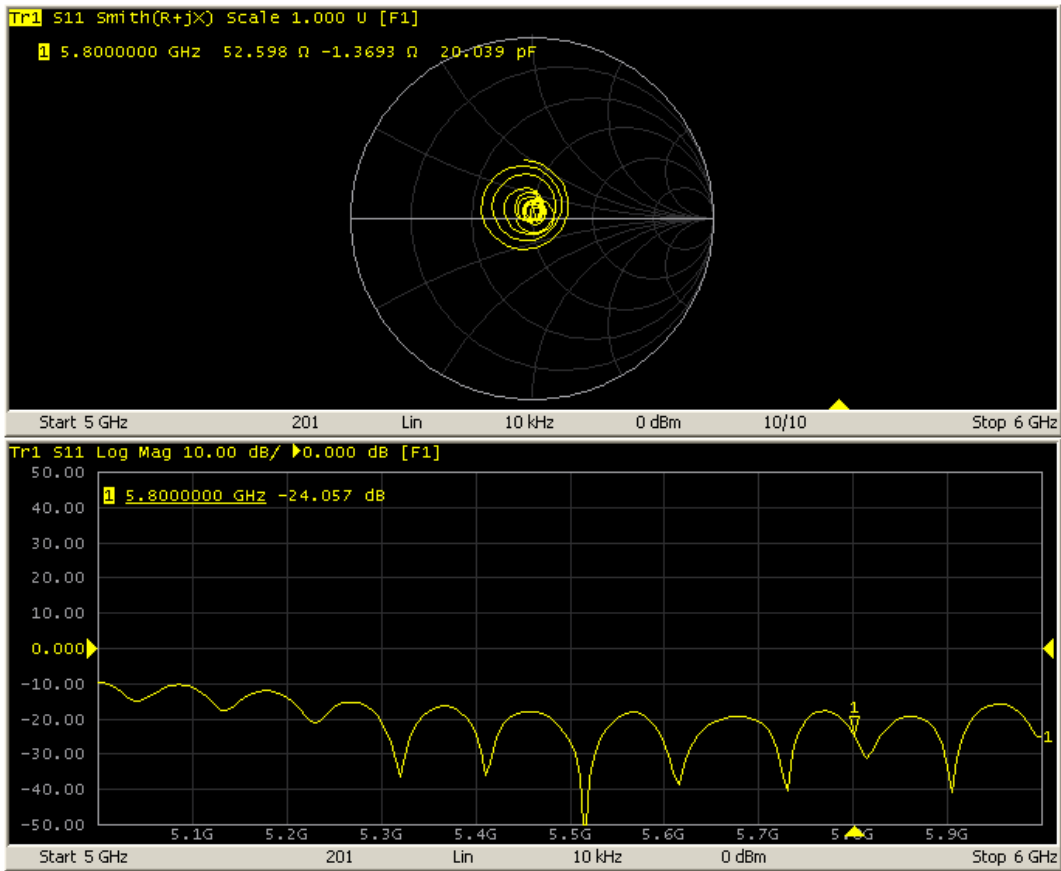
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

Impedance & Return-loss Measurement Plot for Head TSL









Result

Calibration Date	Extension Date	Certificate Electrical Delay(ns)	Certificate SAR Target Head(1g) W/kg@17.0dBm	Measured Head SAR(1g) W/kg@17.0dBm	Deviation 1g(%)	Certificate SAR Target Head(10g) W/kg@17.0dBm	Measured Head SAR(10g) W/kg@17.0dBm	Deviation 10g(%)	Certificate Impedance Head(Ohm) Real	Measured Impedance Head(Ohm) Real	Difference (Ohm) Real	Certificate Impedance Head(Ohm) Imaginary	Measured Impedance Head(Ohm) Imaginary	Difference (Ohm) Imaginary	Certificate ReturnLoss Head(dB)	Measured ReturnLoss Head(dB)	Deviation(%)	PASS/FAIL
04/19/2025	04/19/2026	1.196	4.01	4	-0.25	11.6	11.5	-0.43	49.0	48.8	0.200	-2.7	1.6	-4.3	-30.8	-31.6	2.60	PASS
04/19/2025	04/19/2026	1.196	4.1	4	-2.56	11.8	11.7	-0.43	54.2	52.5	1.700	1.9	-2.7	4.6	-27.1	-23.6	-12.92	PASS
04/19/2025	04/19/2026	1.196	4.0	3.9	-2.38	11.4	11.3	-0.88	56.1	54.4	1.700	1.6	2.3	-0.7	-24.6	-21.6	-12.20	PASS
04/19/2025	04/19/2026	1.196	4.0	3.9	-1.64	11.3	11.2	-0.44	55.3	52.6	2.700	0.5	-1.4	1.9	-25.9	-24.1	-6.95	PASS

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **HCT**
Gyeonggi-do, Republic of Korea

Certificate No. **D6.5GHzV2-1012_Sep24**

CALIBRATION CERTIFICATE

Object **D6.5GHzV2 - SN:1012**

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

Calibration date: **September 17, 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 R&S NRP33T	SN: 100967	28-Mar-24 (No. 217-04038)	Mar-25
Reference 20 dB Attenuator	SN: BH9394 (20k)	26-Mar-24 (No. 217-04046)	Mar-25
Mismatch combination	SN: 84224 / 3600	28-Mar-24 (No. 217-04050)	Mar-25
Reference Probe EX3DV4	SN: 7405	01-Jul-24 (No. EX3-7405_Jul24)	Jul-25
DAE4	SN: 908	27-Mar-24 (No. DAE4-908_Mar24)	Mar-25
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator Anapico APSIN20G	SN: 827	18-Dec-18 (in house check Jan-24)	in house check: Jan-25
Power sensor NRP-Z23	SN: 100189	10-Jan-19 (in house check Jan-24)	in house check: Jan-25
Power sensor NRP-18T	SN: 100950	28-Sep-22 (in house check Jan-24)	in house check: Jan-25
Network Analyzer Keysight E5063A	SN: MY54504221	31-Oct-19 (in house check Oct-22)	in house check: Oct-24

Calibrated by:	Name Alexis Georgiadou	Function Laboratory Technician	Signature
Approved by:	Name Sven Kühn	Technical Manager	

Issued: September 18, 2024

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

Certificate No: D6.5GHzV2-1012_Sep24

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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 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 $\pm$ 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	34.6 $\pm$ 6 %	6.24 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	29.7 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	297 W/kg $\pm$ 24.7 % (k=2)

SAR averaged over 8 cm ³ (8 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.64 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	66.5 W/kg $\pm$ 24.4 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	5.45 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	54.6 W/kg $\pm$ 24.4 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.1 Ω - 5.5 j Ω
Return Loss	- 25.1 dB

APD (Absorbed Power Density)

APD averaged over 1 cm ²	Condition	
APD measured	100 mW input power	296 W/m ²
APD measured	normalized to 1W	2960 W/m ² $\pm$ 29.2 % (k=2)

APD averaged over 4 cm ²	condition	
APD measured	100 mW input power	133 W/m ²
APD measured	normalized to 1W	1330 W/m ² $\pm$ 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.

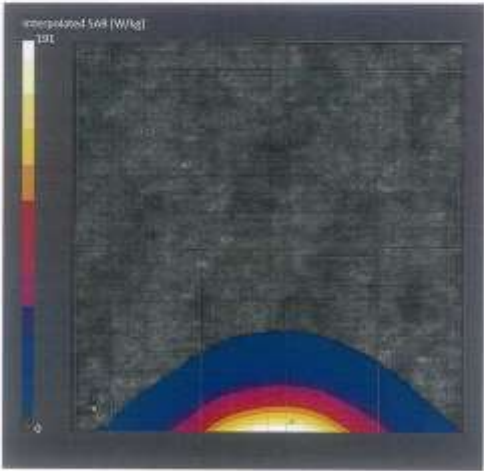
Additional EUT Data

Manufactured by	SPEAG
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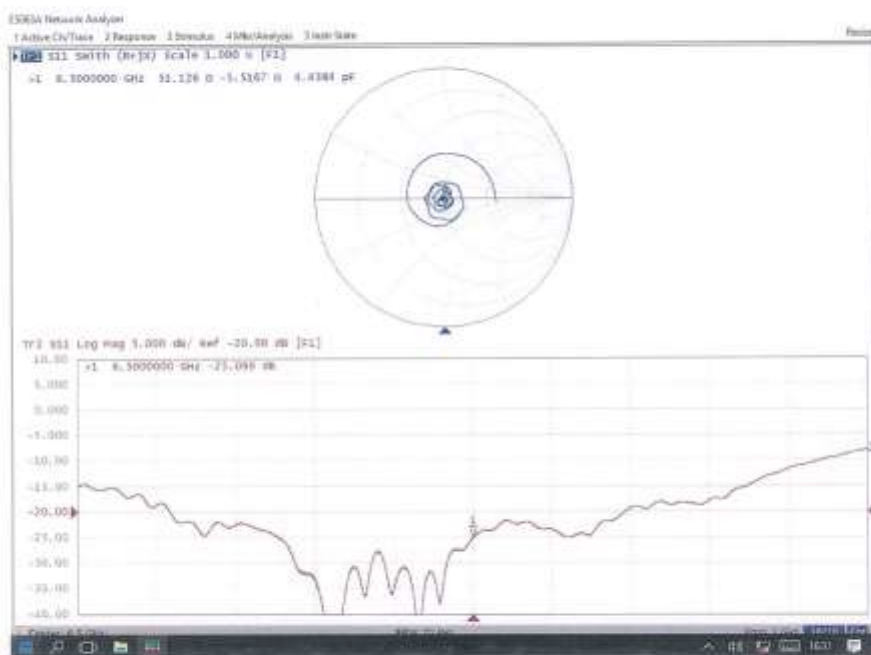
DASY6 Validation Report for Head TSL

Measurement Report for D6.5GHz-1012, UID 0 -, Channel 6500 (6500.0MHz)

Device under Test Properties				DUT Type			
Name, Manufacturer	Dimensions [mm]	IMEI					
D6.5GHz	16.0 x 6.0 x 300.0	SN: 1012					
Exposure Conditions							
Phantom	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.14	6.24	34.6
Hardware Setup				Measurement Results			
Phantom	TSL			Probe, Calibration Date		DAE, Calibration Date	
MFP V8.0 Center - 1182	HBBL600-10000V6			EX3DV4 - SN7405, 2024-07-01		DAE4 Sn908, 2024-03-27	
Scan Setup				Zoom Scan			
Grid Extents [mm]	22.0 x 22.0 x 22.0			Date	2024-09-17, 13:56		
Grid Steps [mm]	3.4 x 3.4 x 1.4			psSAR1g [W/Kg]	29.7		
Sensor Surface [mm]	1.4			psSAR8g [W/Kg]	6.64		
Graded Grid	Yes			psSAR10g [W/Kg]	5.45		
Grading Ratio	1.4			Power Drift [dB]	-0.02		
MAIA	N/A			Power Scaling	Disabled		
Surface Detection	VMS + 6p			Scaling Factor [dB]			
Scan Method	Measured			TSL Correction	No correction		
				M2/M1 [%]	50.5		
				Dist 3dB Peak [mm]	4.8		



Impedance Measurement Plot for Head TSL



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Accreditation No.: **SCS 0108**

Client **HCT**
 Gyeonggi-do, Republic of Korea

Certificate No. **5G-Ver10-1018_Apr25**

CALIBRATION CERTIFICATE

Object **5G Verification Source 10 GHz - SN: 1018**

Calibration procedure(s) **QA CAL-45.v5**
 Calibration procedure for sources in air > 6 GHz

Calibration date **April 11, 2025**

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 Cal
Reference Probe SPEAG EUMM/WV3	SN: 9374	28-Aug-24 (No. Eumm_9374_Aug24)	Aug-25
DAE4ip	SN: 1602	06-Nov-24 (No. DAE4ip-1602_Nov24)	Nov-25
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Signal Generator R&S SMF100A	SN: 100184	26-Nov-24 (No. 5G-Source-Cal-IHC-202411)	Nov-25
Power Sensor R&S NRP18S-10	SN: 101258	26-Nov-24 (No. 5G-Source-Cal-IHC-202411)	Nov-25
Network Analyzer Keysight E5063A	SN: MY54504221	30-Sept-24 (No. 675-CAL18-S4489-Sep24)	Sep-26

결	담당자	확인자
제	김지현	
확인/일	PL / 4.11	PL / 4.11
일 자	2025. 05. 02	2025. 05. 02

	Name	Function	Signature
Calibrated by	Joanna Lieshaj	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	
Issued: April 14, 2025			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

Certificate No: 5G-Ver10-1018_Apr25

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Accreditation No.: **SCS 0108**

Glossary

CW Continuous wave

Calibration is Performed According to the Following Standards

- Internal procedure QA CAL-45, Calibration procedure for sources in air above 6 GHz.
- IEC/IEEE 63195-1, "Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (frequency range of 6 GHz to 300 GHz)", May 2022

Methods Applied and Interpretation of Parameters

- Coordinate System:** z-axis in the waveguide horn boresight, x-axis is in the direction of the E-field, y-axis normal to the others in the field scanning plane parallel to the horn flare and horn flange.
- Measurement Conditions:** (1) 10 GHz: The radiated power is the forward power to the horn antenna minus ohmic and mismatch loss. The forward power is measured prior and after the measurement with a power sensor. During the measurements, the horn is directly connected to the cable and the antenna ohmic and mismatch losses are determined by far-field measurements. (2) 30, 45, 60 and 90 GHz: The verification sources are switched on for at least 30 minutes. Absorbers are used around the probe cub and at the ceiling to minimize reflections.
- Horn Positioning:** The waveguide horn is mounted vertically on the flange of the waveguide source to allow vertical positioning of the EUmmW probe during the scan. The plane is parallel to the phantom surface. Probe distance is verified using mechanical gauges positioned on the flare of the horn.
- E-field distribution:** The E-field is measured in two x-y-planes (10mm, 10mm + $\lambda/4$) with a vectorial E-field probe. The E-field value stated as calibration value represents the E-field-maxima and the averaged (1cm² and 4cm²) power density values at 10mm in front of the horn.
- Field polarization:** Above the open horn, linear polarization of the field is expected. This is verified graphically in the field representation.

Calibrated Quantity

- Local peak E-field (V/m) and average of peak spatial components of the poynting vector (W/m²) averaged over the surface area of 1 cm² and 4cm² at the nominal operational frequency of the verification source. Both square and circular averaging results are listed.

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%.

5G Verification Source 10 GHz - SN: 1018

April 11, 2025

Measurement Conditions

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

DASY Version	DASY8 Module mmWave	V3.2
Phantom	5G Phantom	
Distance Horn Aperture - plane	10 mm	
Number of measured planes	2 (10mm, 10mm + $\lambda/4$)	
Frequency	10.0 GHz $\pm$ 10 MHz	

Calibration Parameters, 10 GHz

Circular Averaging

Distance Horn Aperture to Measurement Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m ²)		Uncertainty (k = 2)
				1cm ²	4cm ²	
10 mm	93.3	155	1.27 dB	61.0	56.7	1.28 dB

Distance Horn Aperture to Measurement Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Power Density psPDn+, psPDtot+, psPDmod+ (W/m ²)		Uncertainty (k = 2)
				1cm ²	4cm ²	
10 mm	93.3	155	1.27 dB	60.7, 61.0, 61.3	56.4, 56.8, 57.0	1.28 dB

Square Averaging

Distance Horn Aperture to Measurement Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDtot+, psPDmod+) (W/m ²)		Uncertainty (k = 2)
				1cm ²	4cm ²	
10 mm	93.3	155	1.27 dB	61.0	56.6	1.28 dB

Distance Horn Aperture to Measurement Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Power Density psPDn+, psPDtot+, psPDmod+ (W/m ²)		Uncertainty (k = 2)
				1cm ²	4cm ²	
10 mm	93.3	155	1.27 dB	60.7, 61.0, 61.3	56.3, 56.6, 56.9	1.28 dB

Max Power Density

Distance Horn Aperture to Measurement Plane	Prad ¹ (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Max Power Density Sn, Stot, (Stot) (W/m ²)	Uncertainty (k = 2)
10 mm	93.3	155	1.27 dB	62.5, 63.1, 63.2	1.28 dB

¹ Assessed ohmic and mismatch loss plus numerical offset: 0.30 dB

5G Verification Source 10 GHz - SN: 1018

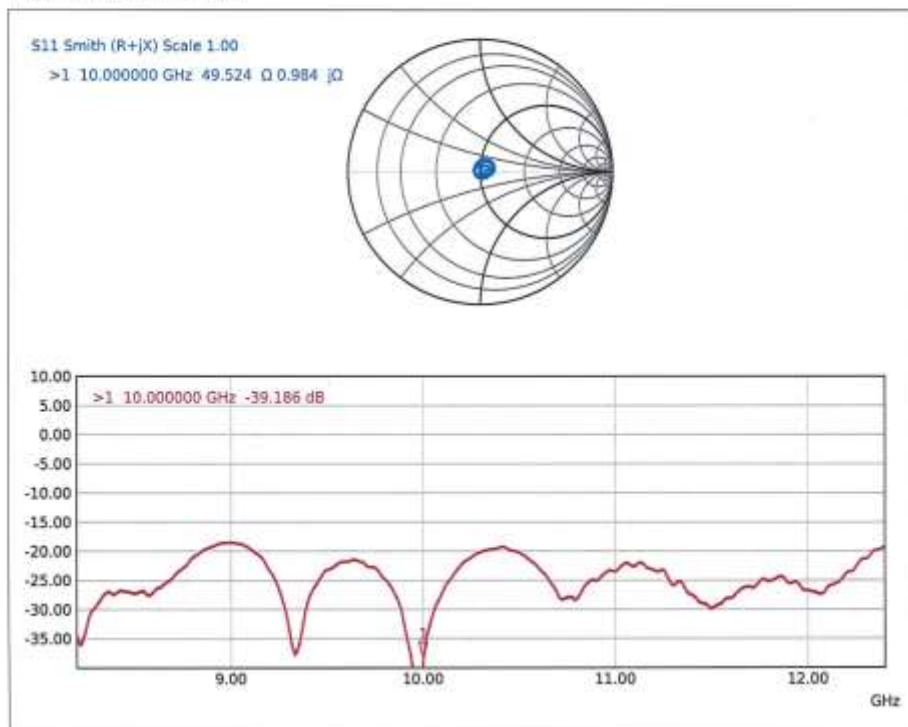
April 11, 2025

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Impedance, transformed to feed point	49.5 Ω + 1.0 j Ω
Return Loss	-39.2 dB

Impedance Measurement Plot



5G Verification Source 10 GHz - SN: 1018

April 11, 2025

DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000.0 (10000.0 MHz)

Device Under Test Properties

Model, Manufacturer	Dimensions [mm]	BSI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 172.0	SR: 1018	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
SC -	10.0 mm	Validation band	OK, 0--	10000.0, 10000	1.0

Hardware Setup

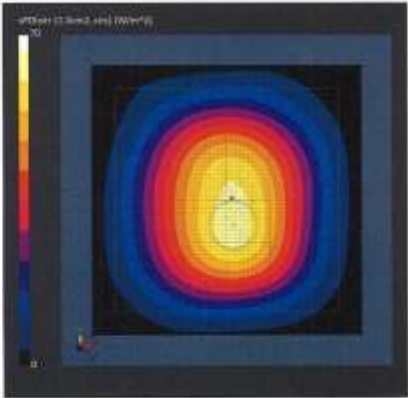
Phantom	Medium	Probe, Calibration Date	DAS, Calibration Date
miniWave Phantom -	Air -	SIUrmWV3 - SN9274_F1 - 5GHz, 2024-08-28	DAS4ip - SN1602, 2024-11-06

Scans Setup

Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

Scan Type	SC Scan
Date	2025-04-11
Avg. Area [cm²]	1.00
Avg. Type	Circular Averaging
psPDm+ [W/m²]	80.7
psPDtot+ [W/m²]	81.0
psPDmod+ [W/m²]	61.3
Max(S0) [W/m²]	62.5
Max(S0+0) [W/m²]	63.1
Max(S0+0) [W/m²]	85.2
E _{max} [V/m]	155
Power Drift [dB]	0.0



5G Verification Source 10 GHz - SN: 1018

April 11, 2025

DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000.0 (10000.0 MHz)

Device Under Test Properties

Model, Manufacturer	Dimensions [mm]	MSI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 172.0	SN: 1018	-

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
SC -	10.0 mm	Validation band	CW, 0 -	10000.0, 10000	1.0

Hardware Setup

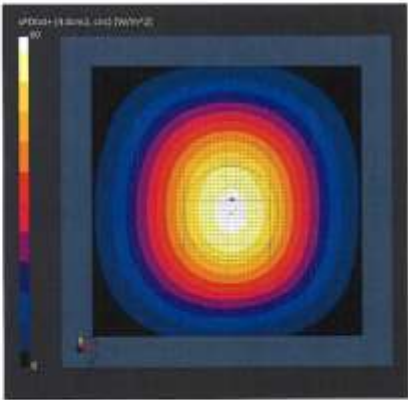
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
miniWave Phantom -	Air -	GIImmWV3 - SM9374_F1 - 5G Hz, 2024-08-28	DAE4p - SN1002, 2024-11-06

Scans Setup

Sensor Surface [mm]	10.0
MAIA	MAIA not used

Measurement Results

Scan Type	5G Scan
Date	2025-04-11
Avg. Area [cm ²]	4.00
Avg. Type	Circular Averaging
pcPDm+ [W/m ²]	56.4
pcPDm+ [W/m ²]	56.8
pcPDmod+ [W/m ²]	57.0
Max(Sr0) [W/m ²]	62.1
Max(Soc0) [W/m ²]	63.1
Max(Soc0) [W/m ²]	63.2
E _{max} [V/m]	1.55
Power Drift [dB]	0.0



5G Verification Source 10 GHz - SN: 1018

April 11, 2025

DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000.0 (10000.0 MHz)

Device Under Test Properties

Model, Manufacturer	Dimensions (mm)	UID	DUT Type
5G Verification Source 10 GHz	106.0 x 100.0 x 772.0	SN: 1018	-

Exposure Conditions

Phantom Section	Position, Test Distance (mm)	Band	Group, UID	Frequency (MHz), Channel Number	Conversion Factor
5G -	10.0 mm	Validation band	CW, 0 -	10000.0, 10000	1.0

Hardware Setup

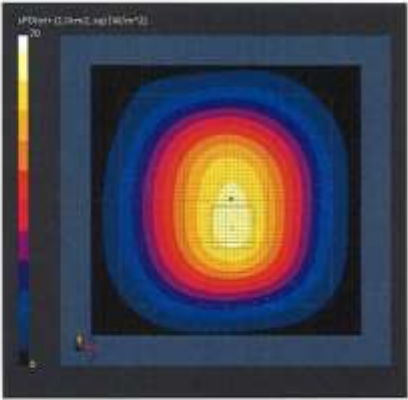
Phantom	Medium	Probe, Calibration Date	DAB, Calibration Date
mirWave Phantom -	Air -	EllerWV3 - SN0374_F1-55G4a, 2024-08-28	DAB4p - SN1603, 2024-11-06

Scans Setup

Sensor Surface (mm)	10.0
WASA	MXIA not used

Measurement Results

Scan Type	5G Scan
Date	2025-04-11
Avg. Area (cm ²)	1.00
Avg. Type	Square Averaging
ppPDn+ (W/m ²)	60.7
ppPDncc+ (W/m ²)	61.0
ppPDnmod+ (W/m ²)	61.3
Max(Sn) (W/m ²)	62.5
Max(SnD) (W/m ²)	63.1
Max(SnccD) (W/m ²)	63.2
E _{max} (V/m)	155
Power Drift (dB)	0.6



5G Verification Source 10 GHz - SN: 1018

April 11, 2025

DASY Report

Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000.0 (10000.0 MHz)

Device Under Test Properties

Model, Manufacturer	Dimensions (mm)	IMD	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 172.0	SN: 1018	-

Exposure Conditions

Phantom Section	Position, Test Distance (mm)	Band	Group, UID	Frequency (MHz), Channel Number	Conversion Factor
SG -	10.0 mm	Verification band	CW, 0--	10000.0, 10000	1.0

Hardware Setup

Phantom	Medium	Probe, Calibration Date	DAL, Calibration Date
isoWave Phantom -	Air	ELKEMWAVE - SN9574_F1-55GHz, 2024-08-28	DABlip - SN1602, 2024-11-06

Scans Setup

Sensor Surface (mm)	10.0
Media	MEDIA not used

Measurement Results

Scan Type	SG Scan
Date	2025-04-11
Avg. Area [cm ²]	4.00
Avg. Type	Square Averaging
psPDn+ [W/m ²]	58.3
pmPDn+ [W/m ²]	56.6
psPDnred+ [W/m ²]	58.9
Max(Sn) [W/m ²]	62.5
Max(Sn0) [W/m ²]	63.1
Max(Sn00) [W/m ²]	63.2
F _{max} [V/m]	155
Power Drift [dB]	0.0

