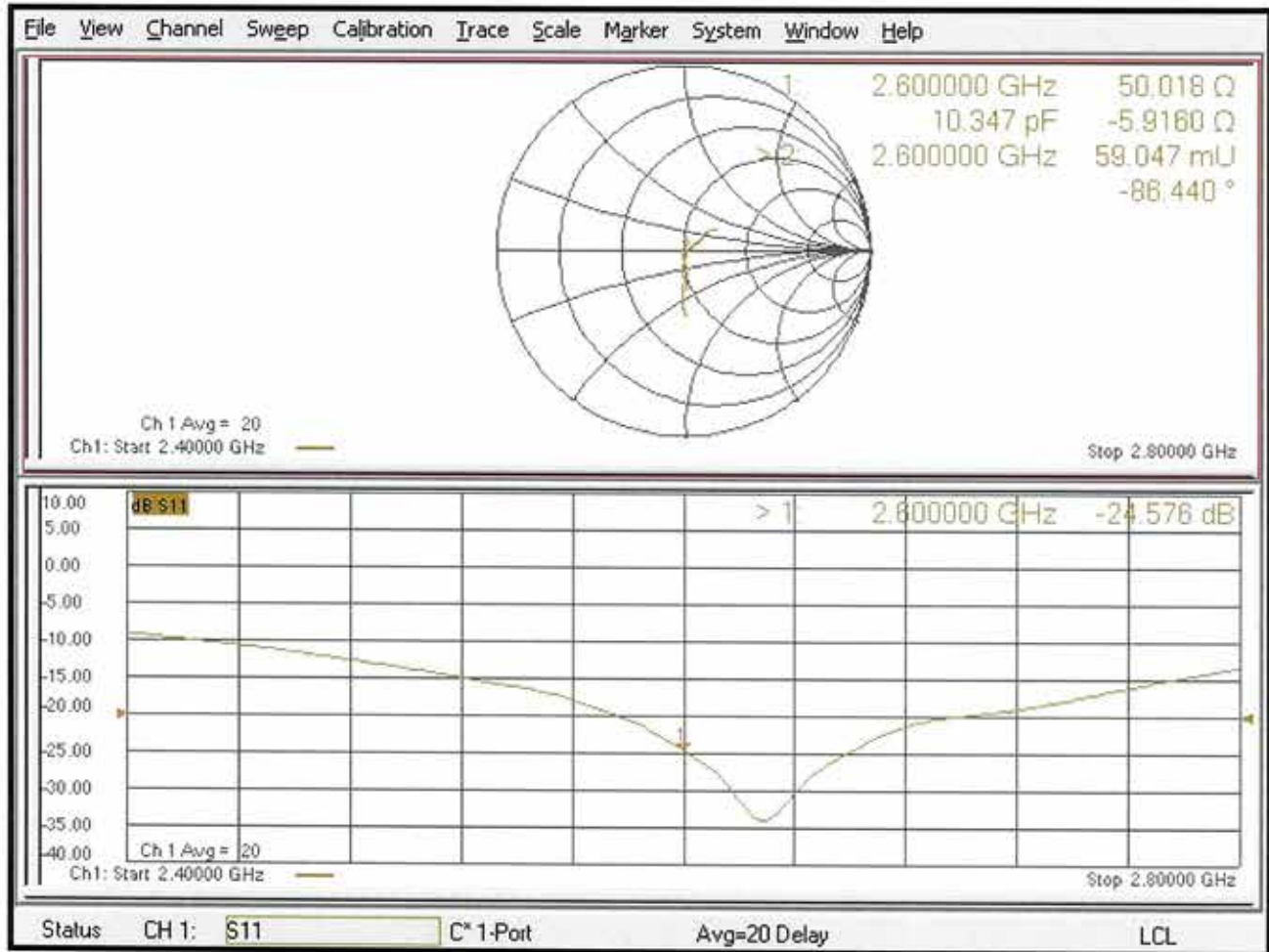


# Impedance Measurement Plot for Head TSL





## D2600V2, serial no. 1089 Extended Dipole Calibrations

Referring to KDB 865664, if dipoles are verified in return loss ( $< -20\text{dB}$ , within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

### <Justification of the extended calibration>

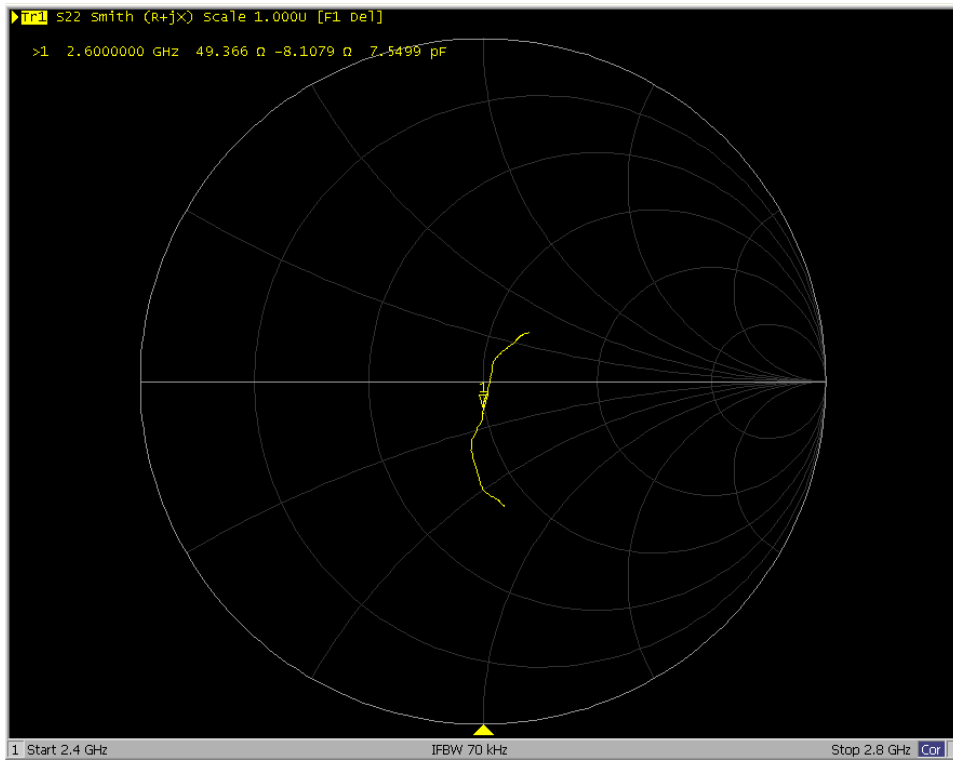
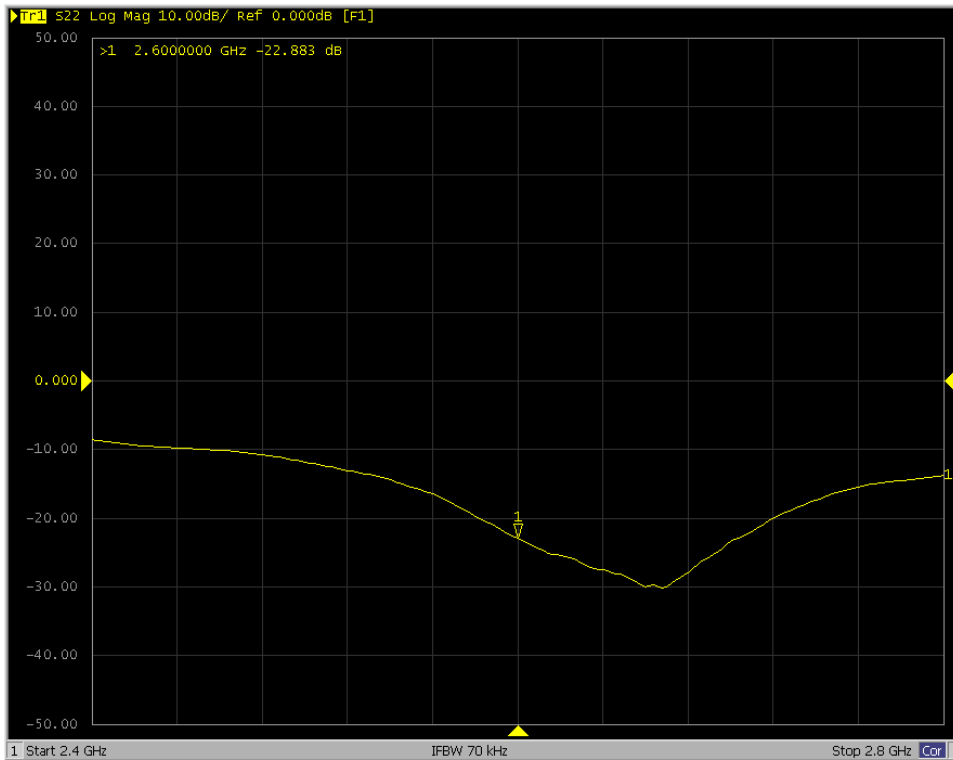
D2600V2 – serial no. 1089						
2600MHZ						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
03.24.2022 (Cal. Report)	-24.576		50.018		-5.916	
03.23.2023 (extended)	-22.883	-6.89	45.128	-4.89	-7.3409	-1.4249

The return loss is  $< -20\text{dB}$ , within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.



<Dipole Verification Data> - D2600 V2, serial no. 1089 (Data of Measurement : 03.23.2023)

2600 MHz - Head





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Sporton**

Certificate No: **D3500V2-1036\_Mar22**

## CALIBRATION CERTIFICATE

Object **D3500V2 - SN:1036**

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

Calibration date: **March 23, 2022**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	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
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: 3503	08-Mar-22 (No. EX3-3503_Mar22)	Mar-23
DAE4	SN: 601	01-Nov-21 (No. DAE4-601_Nov21)	Nov-22
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

Calibrated by: **Michael Weber**      Name: Michael Weber      Function: Laboratory Technician

Approved by: **Sven Kühn**      Name: Sven Kühn      Function: Deputy Manager

Signature

Issued: March 28, 2022

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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:**

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

**Additional Documentation:**

- c) DASY System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

## Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	3500 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.9	2.91 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	37.4 $\pm$ 6 %	2.94 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.78 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>67.4 W/kg <math>\pm</math> 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.52 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>25.1 W/kg <math>\pm</math> 19.5 % (k=2)</b>

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.3 $\Omega$ - 1.8 j $\Omega$
Return Loss	- 30.9 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.140 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
-----------------	-------

## DASY5 Validation Report for Head TSL

Date: 23.03.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1036**

Communication System: UID 0 - CW; Frequency: 3500 MHz

Medium parameters used:  $f = 3500$  MHz;  $\sigma = 2.94$  S/m;  $\epsilon_r = 37.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(7.91, 7.91, 7.91) @ 3500 MHz; Calibrated: 08.03.2022
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3500MHz/Zoom Scan,**

**dist=1.4mm (8x8x8)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.91 V/m; Power Drift = 0.06 dB

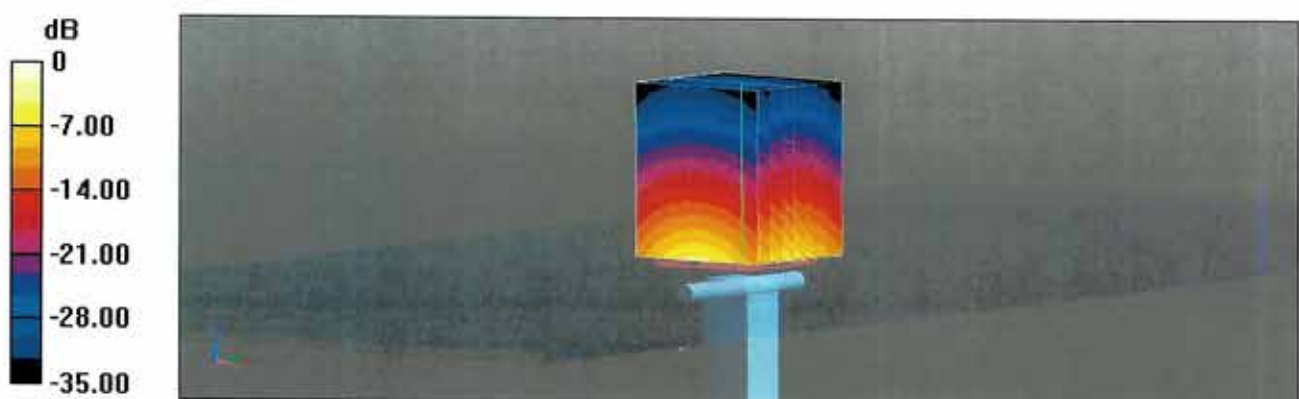
Peak SAR (extrapolated) = 18.5 W/kg

**SAR(1 g) = 6.78 W/kg; SAR(10 g) = 2.52 W/kg**

Smallest distance from peaks to all points 3 dB below = 8 mm

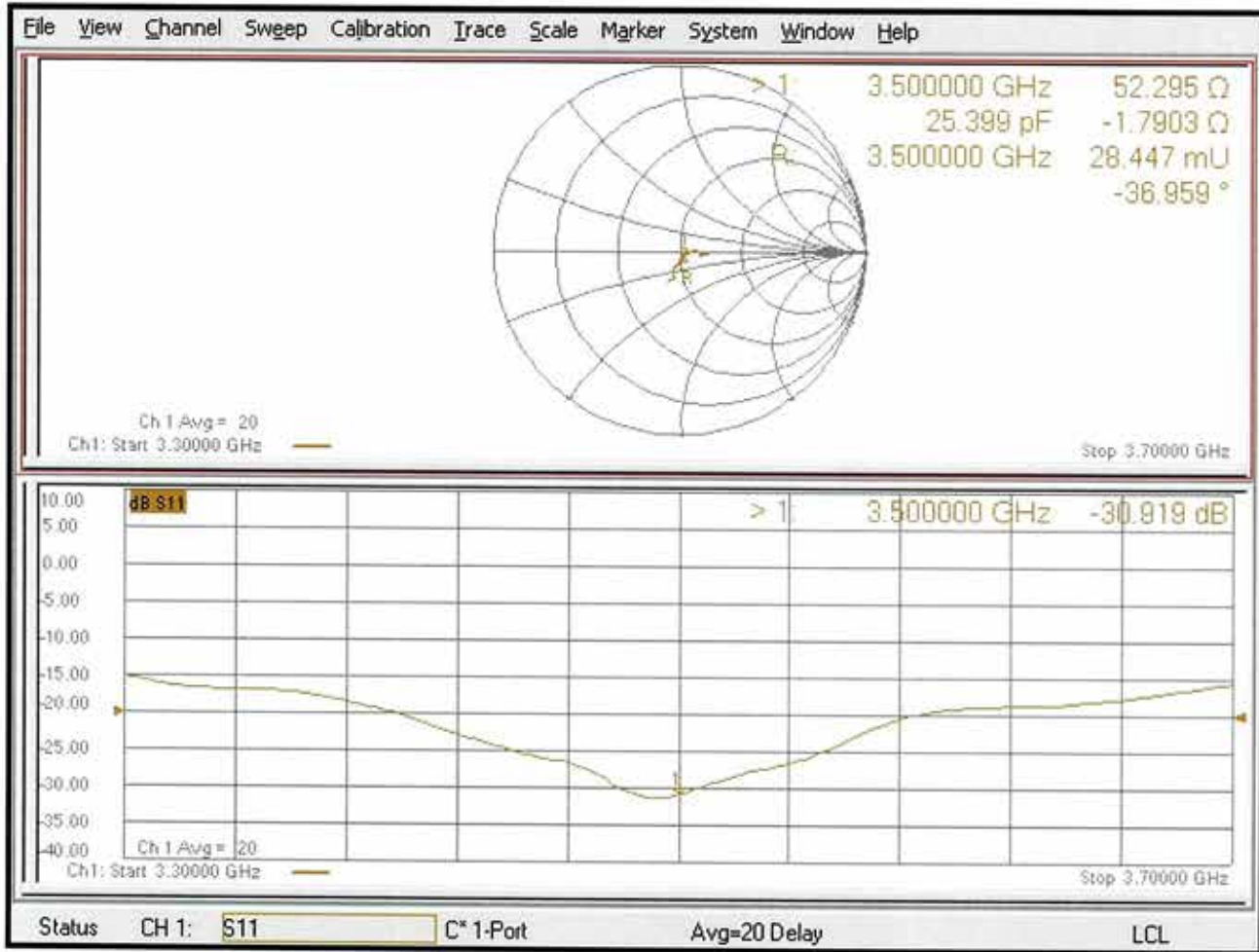
Ratio of SAR at M2 to SAR at M1 = 74.5%

Maximum value of SAR (measured) = 12.9 W/kg





# Impedance Measurement Plot for Head TSL





## D3500V2, serial no. 1036 Extended Dipole Calibrations

Referring to KDB 865664, if dipoles are verified in return loss ( $< -20\text{dB}$ , within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

### <Justification of the extended calibration>

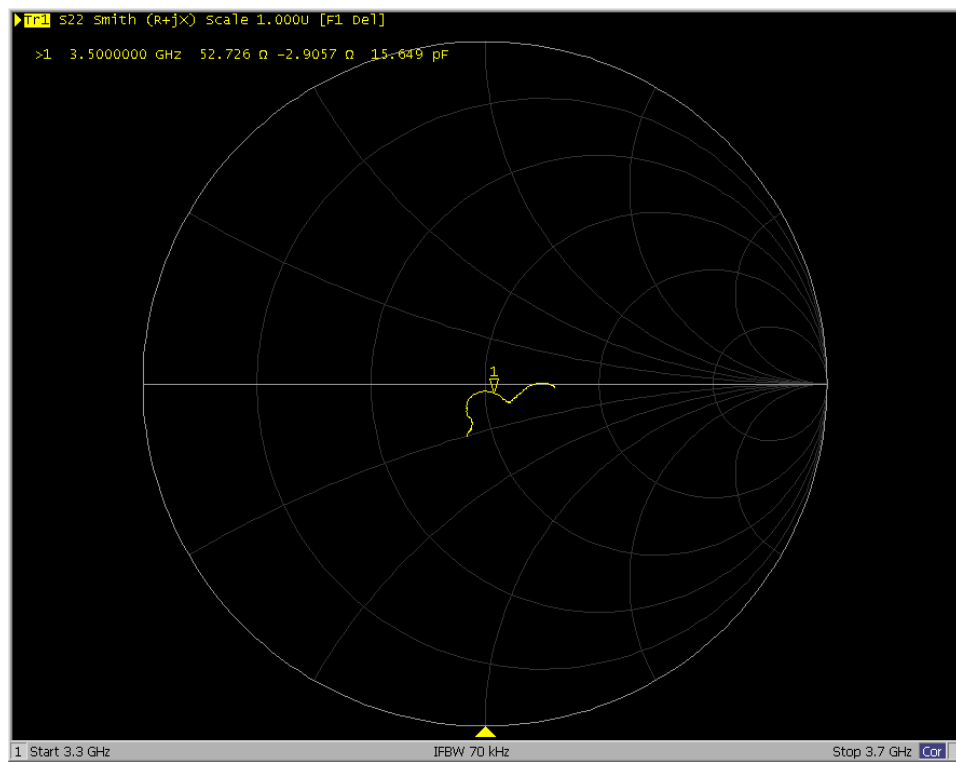
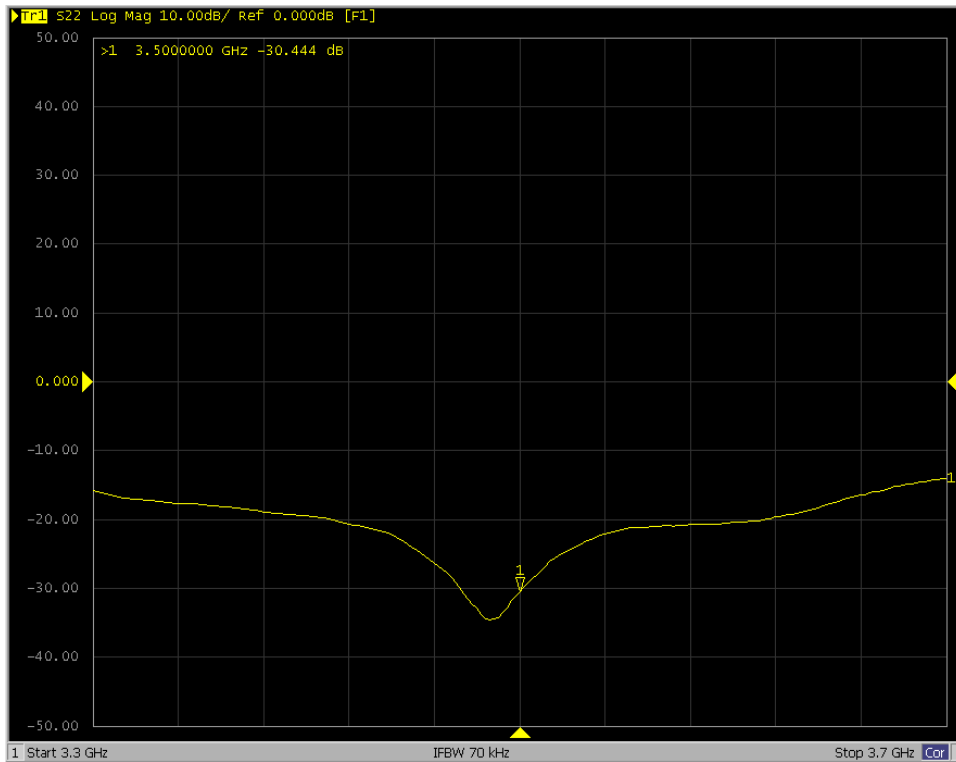
D3500V2 – serial no. 1036						
3500MHZ						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
03.23.2022 (Cal. Report)	-30.919		52.295		-1.7903	
03.22.2023 (extended)	-30.444	-1.53	52.726	0.431	-2.9057	-1.1154

The return loss is  $< -20\text{dB}$ , within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.



<Dipole Verification Data> - D3500 V2, serial no. 1036 (Data of Measurement : 03.22.2023)

3500 MHz - Head





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Accreditation No.: **SCS 0108**

Client **Sporton**

Certificate No: **D3700V2-1022\_Jul21**

## CALIBRATION CERTIFICATE

Object **D3700V2 - SN:1022**

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

Calibration date: **July 14, 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 ( $22 \pm 3$ )°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
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: 3503	30-Dec-20 (No. EX3-3503_Dec20)	Dec-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

Calibrated by: **Jeton Kastrati** (Name) Laboratory Technician (Function)  (Signature)

Approved by: **Katja Pokovic** (Name) Technical Manager (Function)  (Signature)

Issued: July 14, 2021

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

### Glossary:

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

### Calibration is Performed According to the Following Standards:

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

### Additional Documentation:

- c) DASY System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	3700 MHz ± 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.7	3.12 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.7 ± 6 %	3.12 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.82 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	68.2 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.47 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.7 W/kg ± 19.5 % (k=2)

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.2 $\Omega$ - 4.0 j $\Omega$
Return Loss	- 27.7 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.125 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
-----------------	-------

## DASY5 Validation Report for Head TSL

Date: 14.07.2021

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1022**

Communication System: UID 0 - CW; Frequency: 3700 MHz

Medium parameters used:  $f = 3700$  MHz;  $\sigma = 3.12$  S/m;  $\epsilon_r = 37.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(7.73, 7.73, 7.73) @ 3700 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3700MHz/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.98 V/m; Power Drift = -0.08 dB

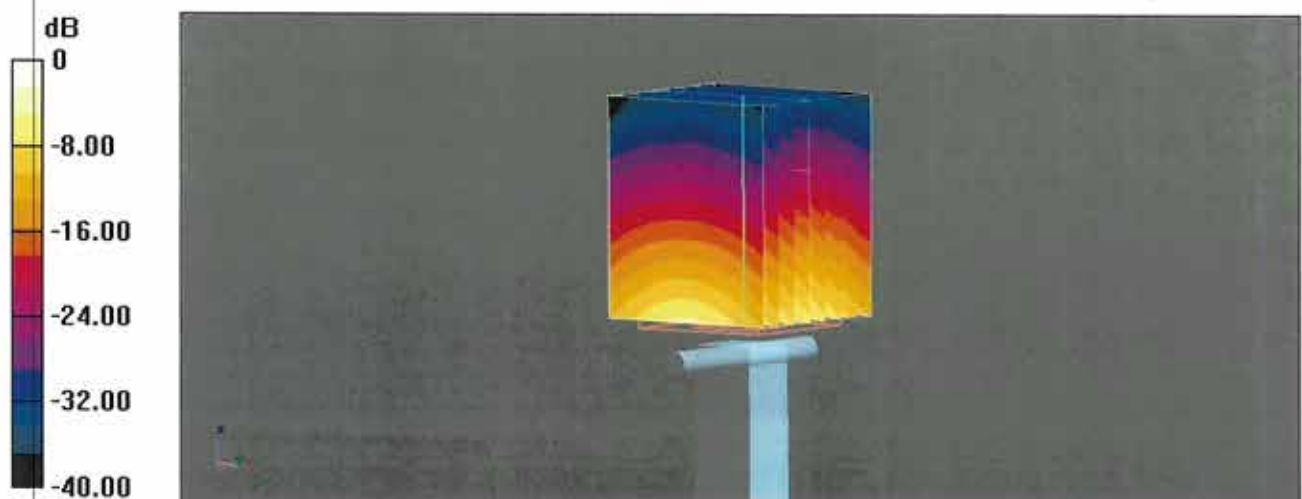
Peak SAR (extrapolated) = 19.2 W/kg

**SAR(1 g) = 6.82 W/kg; SAR(10 g) = 2.47 W/kg**

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 72.8%

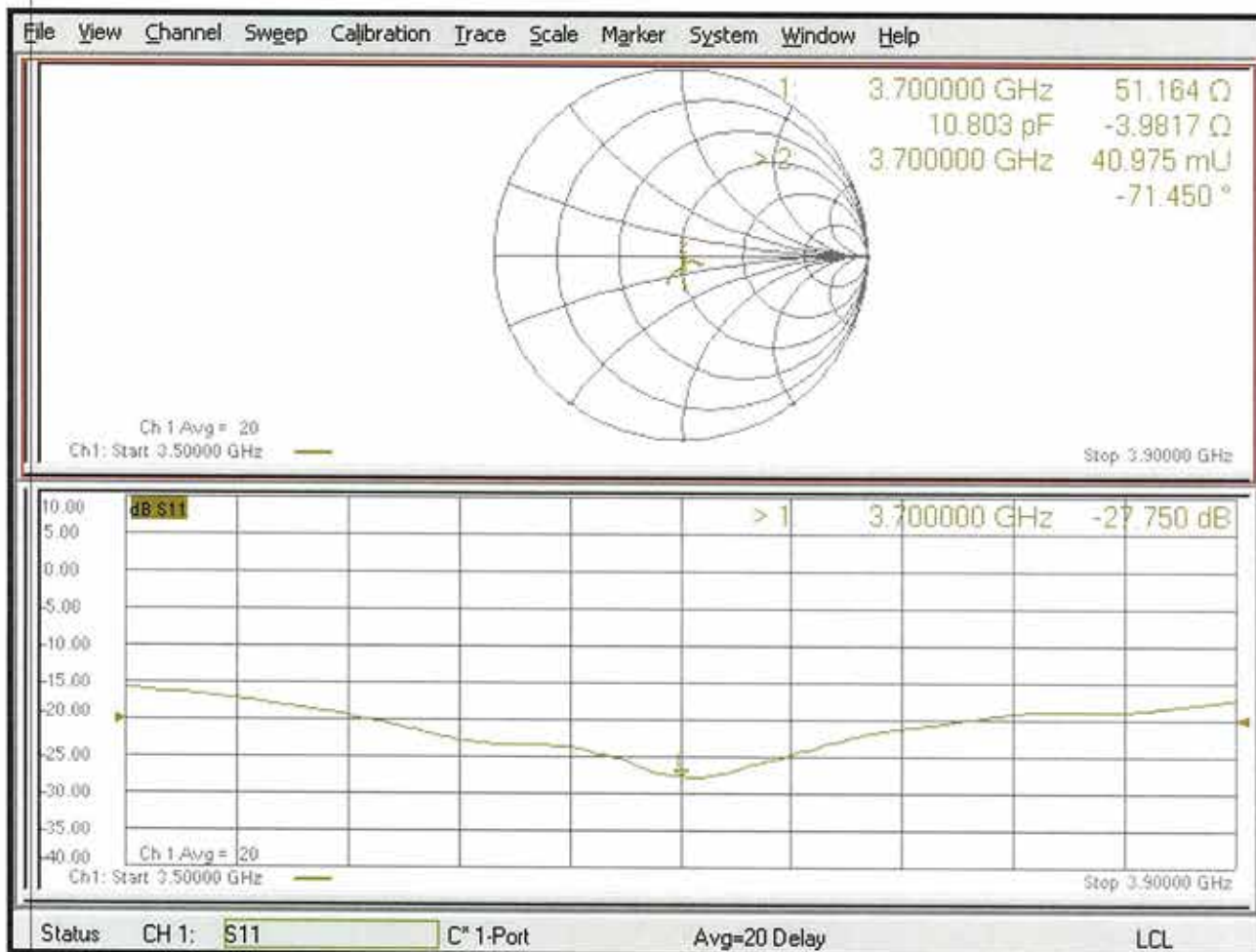
Maximum value of SAR (measured) = 13.1 W/kg



0 dB = 13.1 W/kg = 11.16 dBW/kg



# Impedance Measurement Plot for Head TSL





## D3700V2, serial no. 1022 Extended Dipole Calibrations

Referring to KDB 865664, if dipoles are verified in return loss ( $< -20\text{dB}$ , within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

### <Justification of the extended calibration>

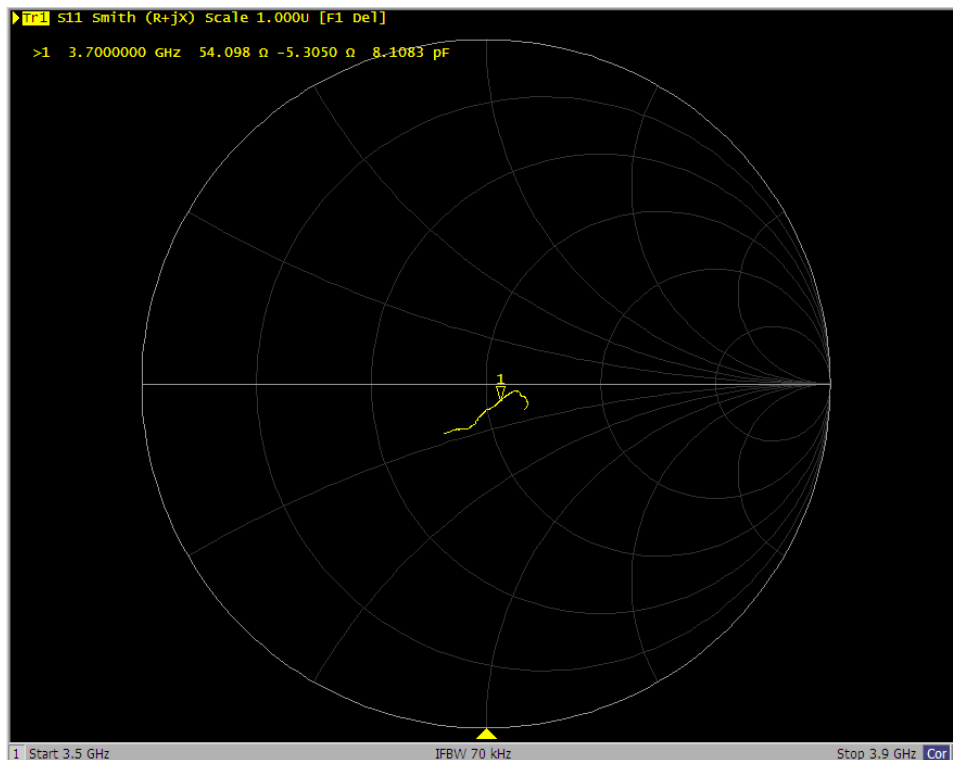
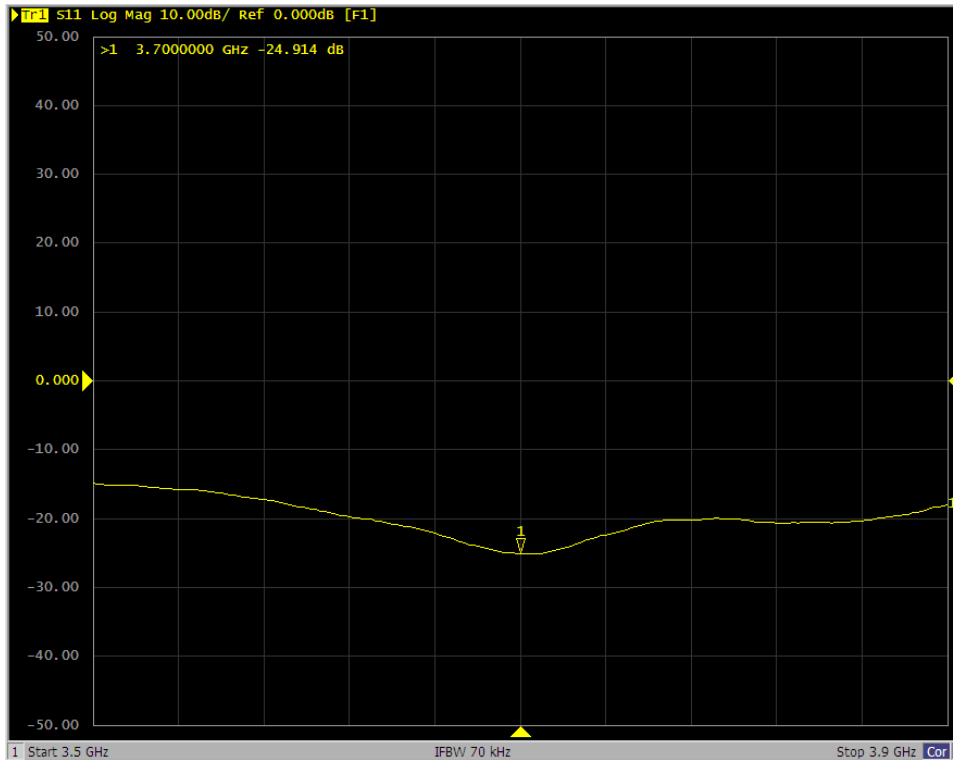
D3700V2 – serial no. 1022						
3700MHZ						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
07.14.2021 (Cal. Report)	-27.75		51.164		-3.9817	
07.13.2022 (extended)	-24.914	10.21	54.098	2.934	-5.305	-1.3233

The return loss is  $< -20\text{dB}$ , within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.



<Dipole Verification Data> - D3700 V2, serial no. 1022 (Data of Measurement : 07.13.2022)

3700 MHz - Head



SPORTON INTERNATIONAL INC.

TEL : 886-3-327-3456

FAX : 886-3-328-4978



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Accreditation No.: **SCS 0108**

Client **Sporton**

Certificate No: **D3900V2-1017\_Apr22**

**CALIBRATION CERTIFICATE**

Object: **D3900V2 - SN:1017**

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

Calibration date: **April 22, 2022**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
Power sensor NRP-Z91	SN: 103245	04-Apr-22 (No. 217-03525)	Apr-23
Reference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
Type-N mismatch combination	SN: 310982 / 06327	04-Apr-22 (No. 217-03528)	Apr-23
Reference Probe EX3DV4	SN: 3503	08-Mar-22 (No. EX3-3503_Mar22)	Mar-23
DAE4	SN: 601	01-Nov-21 (No. DAE4-601_Nov21)	Nov-22

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

Calibrated by: **Joanna Lleshaj** (Name), **Laboratory Technician** (Function), *[Signature]* (Signature)

Approved by: **Sven Kühn** (Name), **Deputy Manager** (Function), *[Signature]* (Signature)

Issued: April 28, 2022

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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:**

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

**Additional Documentation:**

- c) DASY System Handbook

**Methods Applied and Interpretation of Parameters:**

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

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

## Measurement Conditions

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

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	3900 MHz ± 1 MHz 4100 MHz ± 1 MHz	

## Head TSL parameters at 3900 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.5	3.32 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.5 ± 6 %	3.25 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL at 3900 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.89 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>68.7 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.41 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.9 W/kg ± 19.5 % (k=2)</b>

## Head TSL parameters at 4100 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	37.2	3.53 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.3 ± 6 %	3.42 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL at 4100 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.84 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>68.3 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.7 W/kg ± 19.5 % (k=2)</b>

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL at 3900 MHz

Impedance, transformed to feed point	49.4 $\Omega$ - 7.0 j $\Omega$
Return Loss	- 23.0 dB

### Antenna Parameters with Head TSL at 4100 MHz

Impedance, transformed to feed point	60.1 $\Omega$ + 0.0 j $\Omega$
Return Loss	- 20.8 dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.104 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: 22.04.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN:1017**

Communication System: UID 0 - CW; Frequency: 3900 MHz, Frequency: 4100 MHz  
Medium parameters used:  $f = 3900$  MHz;  $\sigma = 3.25$  S/m;  $\epsilon_r = 36.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>,  
Medium parameters used:  $f = 4100$  MHz;  $\sigma = 3.42$  S/m;  $\epsilon_r = 36.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: Flat Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(7.39, 7.39, 7.39) @ 3900 MHz, ConvF(7.26, 7.26, 7.26) @ 4100 MHz; Calibrated: 08.03.2022
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=3900MHz/Zoom Scan,**

**dist=1.4mm (8x8x8)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 69.24 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 19.6 W/kg

**SAR(1 g) = 6.89 W/kg; SAR(10 g) = 2.41 W/kg**

Smallest distance from peaks to all points 3 dB below = 8.2 mm

Ratio of SAR at M2 to SAR at M1 = 73.9%

Maximum value of SAR (measured) = 13.7 W/kg

**Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm, f=4100MHz/Zoom Scan,**

**dist=1.4mm (8x8x8)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 69.78 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 19.4 W/kg

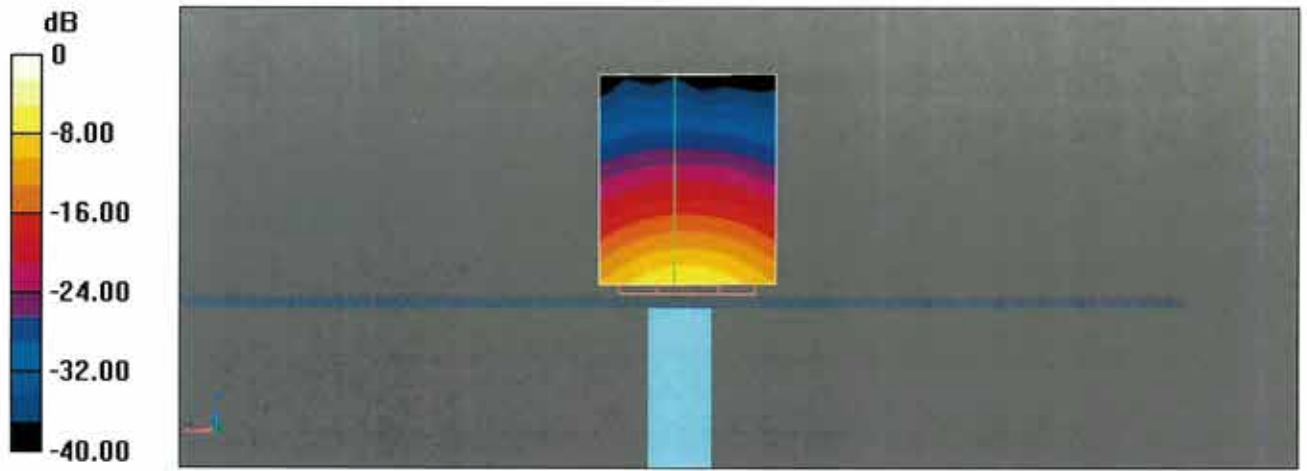
**SAR(1 g) = 6.84 W/kg; SAR(10 g) = 2.38 W/kg**

Smallest distance from peaks to all points 3 dB below = 8.4 mm

Ratio of SAR at M2 to SAR at M1 = 74.1%

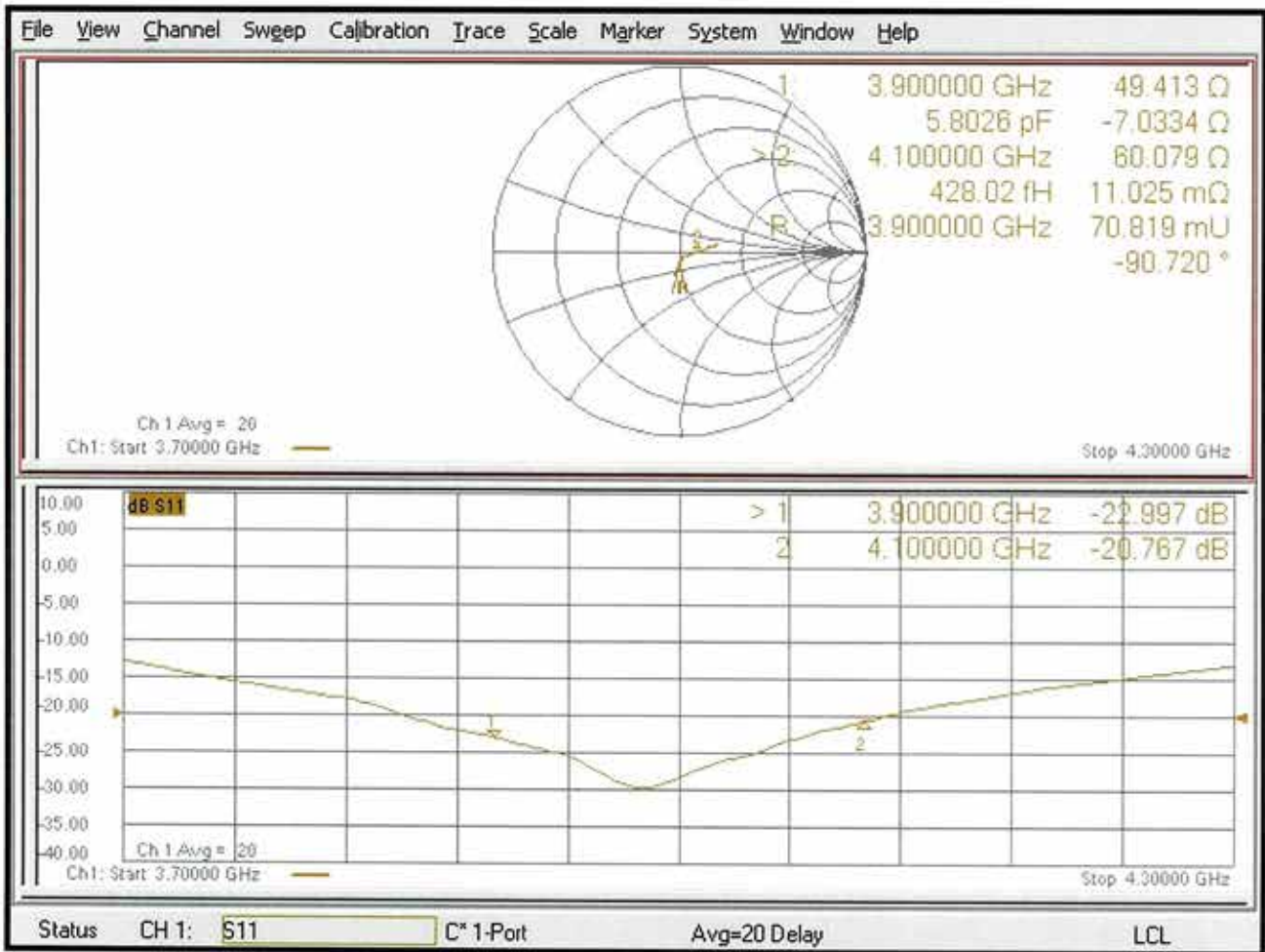
Maximum value of SAR (measured) = 13.5 W/kg





0 dB = 13.7 W/kg = 11.36 dBW/kg

# Impedance Measurement Plot for Head TSL





## D3900V2, serial no. 1017 Extended Dipole Calibrations

Referring to KDB 865664, if dipoles are verified in return loss ( $<-20\text{dB}$ , within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

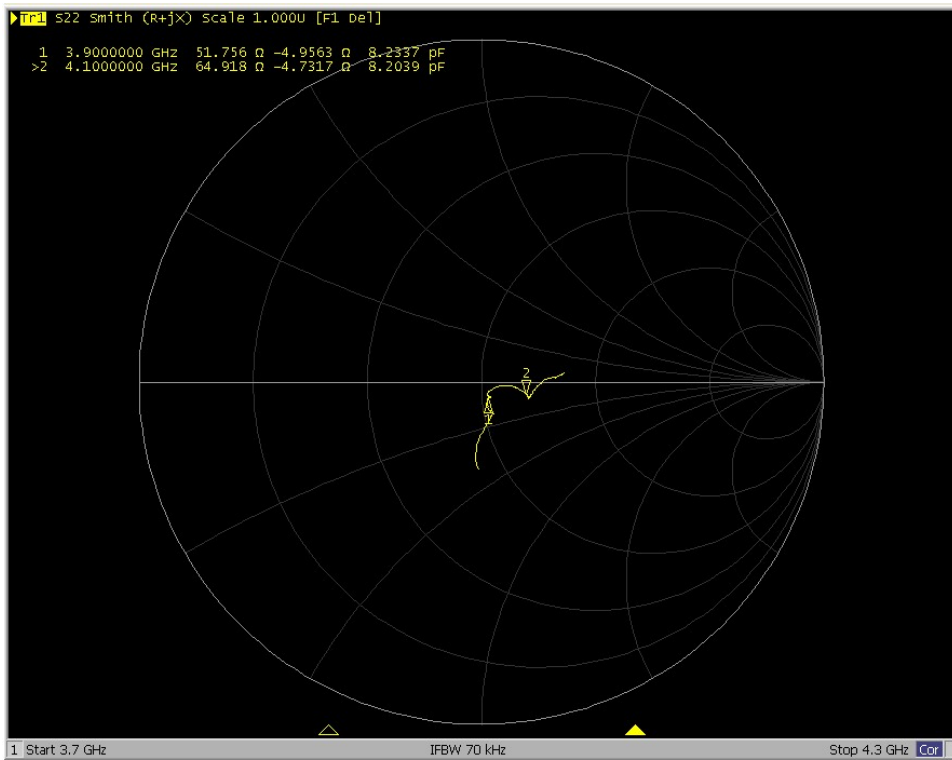
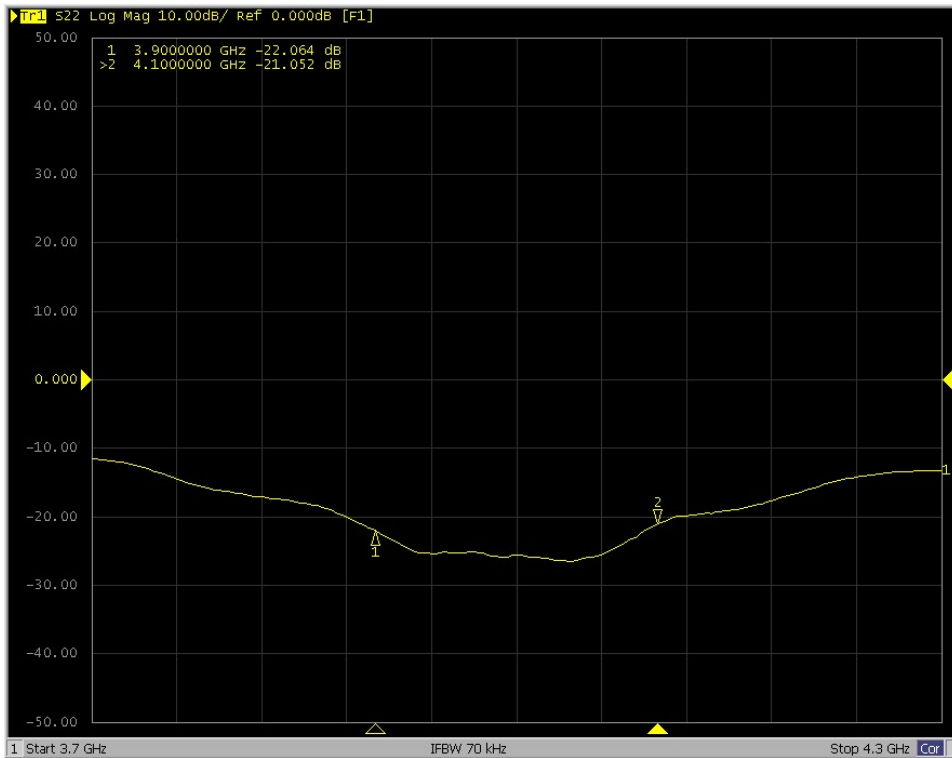
### <Justification of the extended calibration>

D3900V2 – serial no. 1017						
3900MHZ						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
04.22.2022 (Cal. Report)	-22.997		49.413		-7.0334	
04.21.2023 (extended)	-22.064	4.06	51.756	2.343	-4.9563	2.0771
4100MHZ						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
04.22.2022 (Cal. Report)	-20.767		60.079		0.011025	
04.21.2023 (extended)	-21.052	-1.37	64.918	4.839	-4.7317	-4.74273

The return loss is  $<-20\text{dB}$ , within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

<Dipole Verification Data> - D3900 V2, serial no. 1017 (Data of Measurement : 04.21.2023)

3900 MHz - Head





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

Accreditation No.: **SCS 0108**

Client **Sporton**

Certificate No: **D5GHzV2-1171\_Apr21**

## CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1171**

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

Calibration date: **April 20, 2021**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	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
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: 3503	30-Dec-20 (No. EX3-3503_Dec20)	Dec-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

Calibrated by:	Name <b>Michael Weber</b>	Function Laboratory Technician	Signature 
Approved by:	Name <b>Katja Pokovic</b>	Technical Manager	

Issued: April 20, 2021

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



Accredited by the Swiss Accreditation Service (SAS)

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

### Glossary:

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

### Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

### Additional Documentation:

- DASY4/5 System Handbook

### Methods Applied and Interpretation of Parameters:

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

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

## Measurement Conditions

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

DASY Version	DASY5	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 ± 1 MHz 5600 MHz ± 1 MHz 5750 MHz ± 1 MHz 5850 MHz ± 1 MHz	

## Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.9 ± 6 %	4.57 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.08 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>80.3 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.0 W/kg ± 19.5 % (k=2)</b>

### Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.4 ± 6 %	4.93 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.41 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>83.4 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.39 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.7 W/kg ± 19.5 % (k=2)</b>

### Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.1 ± 6 %	5.09 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 <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.11 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>80.4 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>22.8 W/kg ± 19.5 % (k=2)</b>



## Head TSL parameters at 5850 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.2	5.32 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.0 ± 6 %	5.19 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

## SAR result with Head TSL at 5850 MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>82.3 W/kg ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>23.1 W/kg ± 19.5 % (k=2)</b>

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	50.4 $\Omega$ - 9.7 j $\Omega$
Return Loss	- 20.3 dB

### Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	55.5 $\Omega$ - 4.5 j $\Omega$
Return Loss	- 23.5 dB

### Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	55.9 $\Omega$ - 5.8 j $\Omega$
Return Loss	- 22.1 dB

### Antenna Parameters with Head TSL at 5850 MHz

Impedance, transformed to feed point	57.7 $\Omega$ - 6.6 j $\Omega$
Return Loss	- 20.5 dB

## General Antenna Parameters and Design

Electrical Delay (one direction)	1.206 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: 20.04.2021

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1171**

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5850 MHz

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 4.57$  S/m;  $\epsilon_r = 34.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5600$  MHz;  $\sigma = 4.93$  S/m;  $\epsilon_r = 34.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.09$  S/m;  $\epsilon_r = 34.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5850$  MHz;  $\sigma = 5.19$  S/m;  $\epsilon_r = 34$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.5, 5.5, 5.5) @ 5250 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.08, 5.08, 5.08) @ 5750 MHz, ConvF(4.99, 4.99, 4.99) @ 5850 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

**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 = 76.43 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 27.7 W/kg

**SAR(1 g) = 8.08 W/kg; SAR(10 g) = 2.32 W/kg**

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

Ratio of SAR at M2 to SAR at M1 = 71.2%

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 = 77.80 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 31.0 W/kg

**SAR(1 g) = 8.41 W/kg; SAR(10 g) = 2.39 W/kg**

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

Ratio of SAR at M2 to SAR at M1 = 68.6%

Maximum value of SAR (measured) = 19.6 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 = 75.01 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 31.5 W/kg

**SAR(1 g) = 8.11 W/kg; SAR(10 g) = 2.30 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.4 mm

Ratio of SAR at M2 to SAR at M1 = 66.9%

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

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

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

Reference Value = 76.40 V/m; Power Drift = 0.06 dB

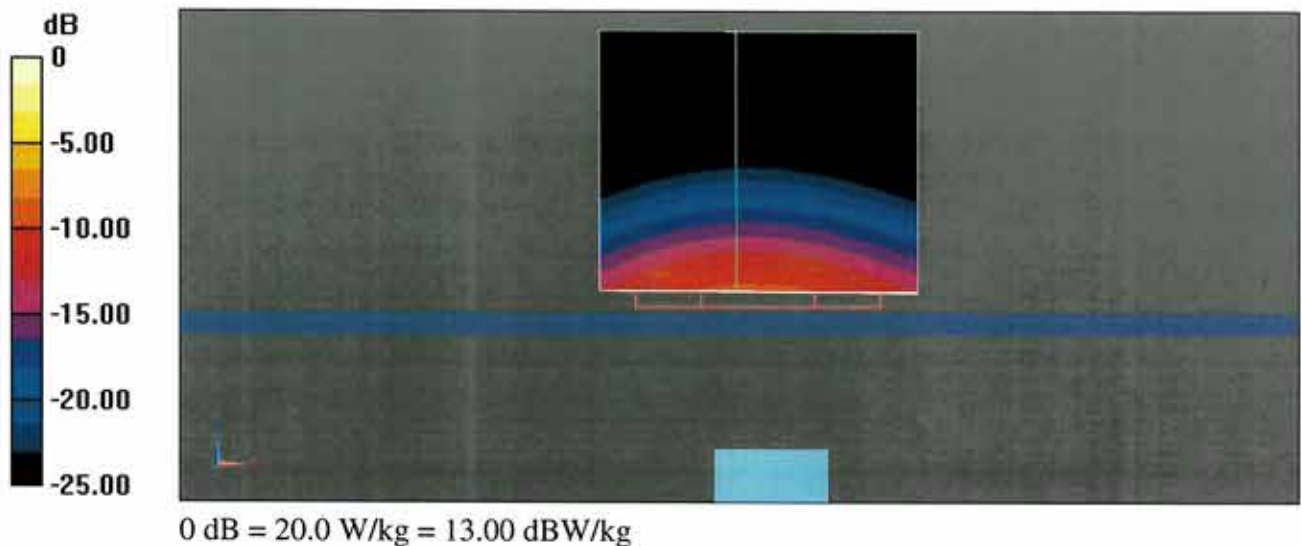
Peak SAR (extrapolated) = 33.2 W/kg

**SAR(1 g) = 8.29 W/kg; SAR(10 g) = 2.34 W/kg**

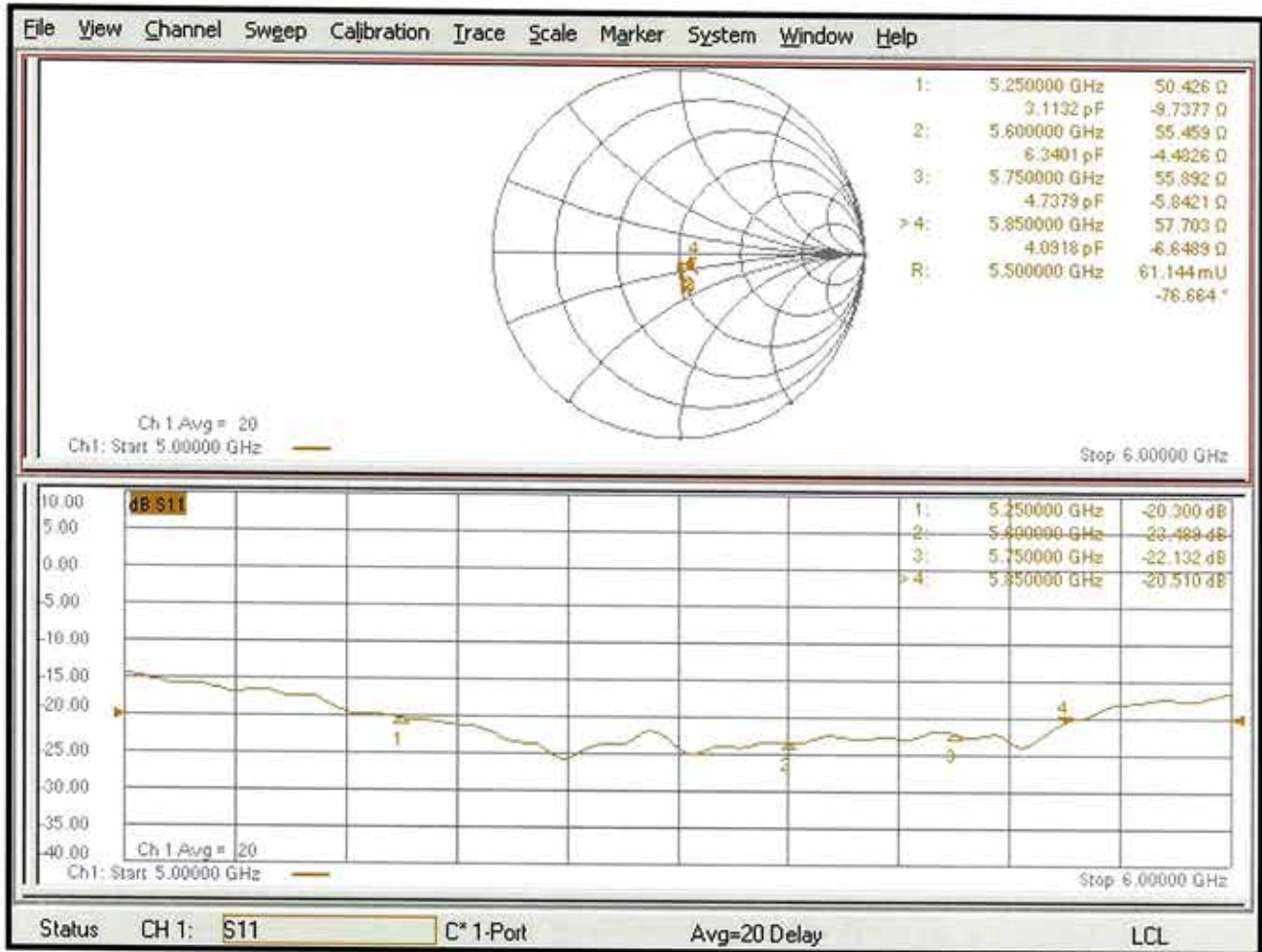
Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 65.7%

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



# Impedance Measurement Plot for Head TSL





## D5000V2, serial no. 1171 Extended Dipole Calibrations

Referring to KDB 865664, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

### <Justification of the extended calibration>

D5000V2 – serial no. 1171						
5250MHZ						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
04.20.2021 (Cal. Report)	-20.3		50.4		-9.7	
04.19.2022 (extended)	-22.054	-8.64	49.363	-1.037	-7.3205	2.3795
04.18.2023 (extended)	-22.32	-9.95	47.54	-2.86	-6.2723	3.4277
5600MHZ						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
04.20.2021 (Cal. Report)	-23.5		55.5		-4.5	
04.19.2022 (extended)	-24.852	-5.75	54.716	-0.784	-3.8107	0.6893
04.18.2023 (extended)	-23.298	0.86	55.77	0.27	-3.6833	0.8167
5750MHZ						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
04.20.2021 (Cal. Report)	-22.1		55.9		-5.8	
04.19.2022 (extended)	-24.551	-11.09	53.48	-2.42	-5.9049	-0.1049
04.18.2023 (extended)	-23.666	-7.09	52.673	-3.227	-6.4029	-0.6029



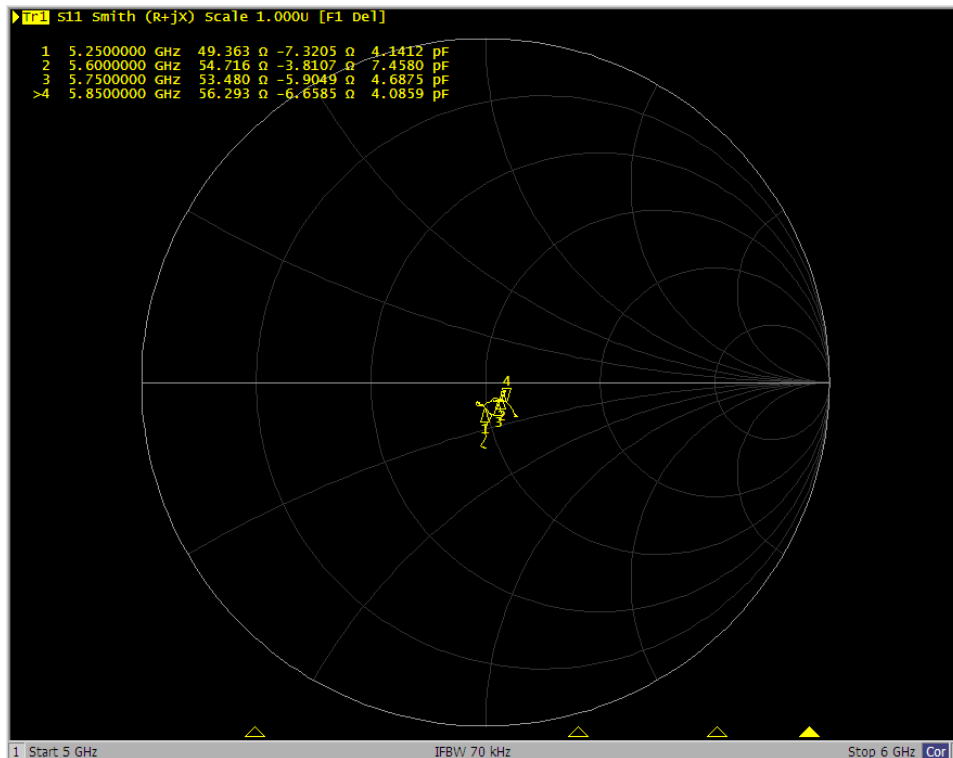
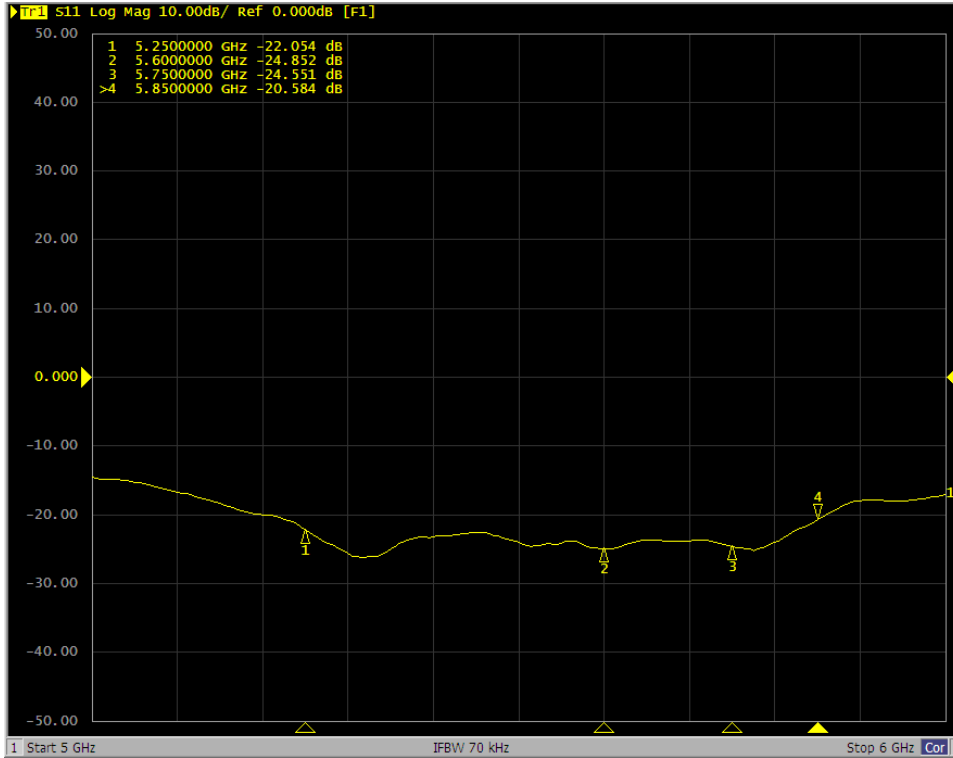
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	5850MHZ					
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
04.20.2021 (Cal. Report)	-20.5		57.7		-6.6	
04.19.2022 (extended)	-20.584	-0.41	56.293	-1.407	-6.6585	-0.0585
04.18.2023 (extended)	-20.099	1.96	55.011	-2.689	-9.7852	-3.1852

The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

<Dipole Verification Data> - D5000 V2, serial no. 1171 (Data of Measurement : 04.19.2022)

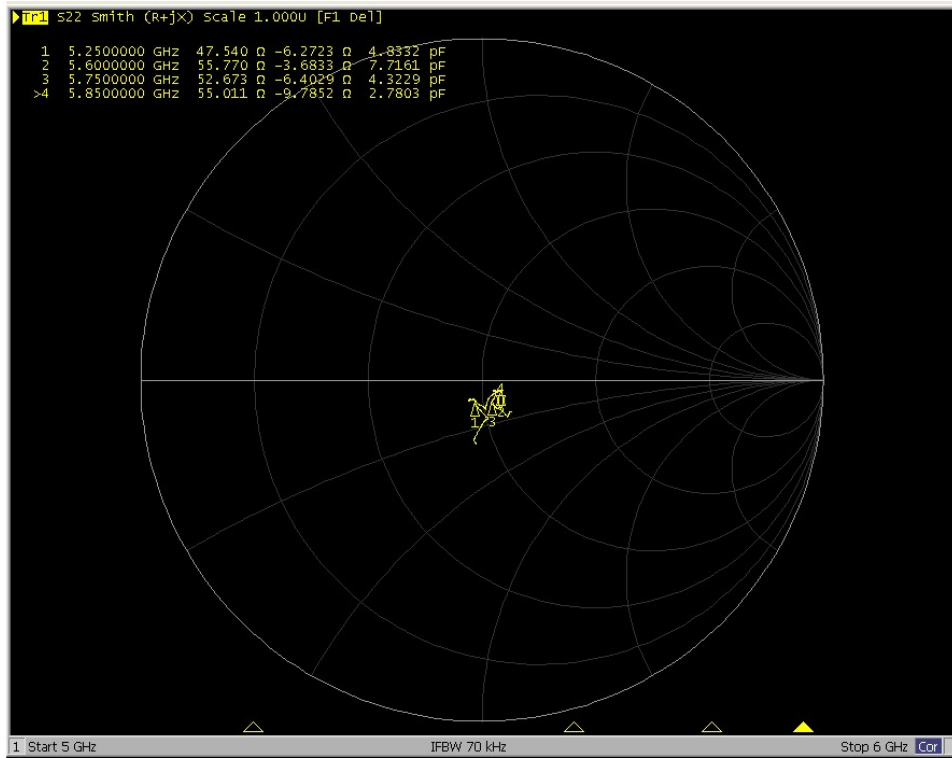
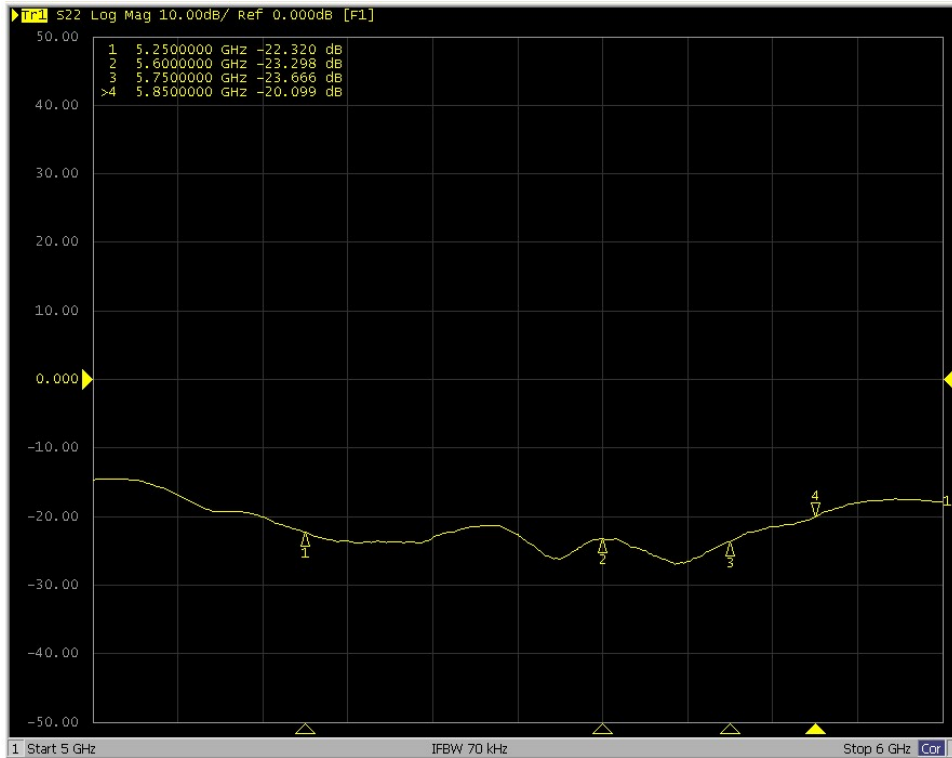
5000 MHz - Head





<Dipole Verification Data> - D5000 V2, serial no. 1171 (Data of Measurement : 04.18.2023)

5000 MHz - Head





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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Sporton**  
**Taoyuan City, Taiwan**

Certificate No: **D6.5GHzV2-1003\_Mar23**

## CALIBRATION CERTIFICATE

Object **D6.5GHzV2 - SN:1003**

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

Calibration date: **March 15, 2023**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power sensor R&S NRP33T	SN: 100967	01-Apr-22 (No. 217-03526)	Apr-23
Reference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
Mismatch combination	SN: 84224 / 360D	26-Apr-22 (No. 217-03545)	Apr-23
Reference Probe EX3DV4	SN: 7405	02-Jun-22 (No. EX3-7405_Jun22)	Jun-23
DAE4	SN: 908	27-Jun-22 (No. DAE4-908_Jun22)	Jun-23

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator Anapico APSIN20G	SN: 827	18-Dec-18 (in house check Dec-21)	In house check: Dec-23
Network Analyzer Keysight E5063A	SN:MY54504221	31-Oct-19 (in house check Oct-22)	In house check: Oct-25

Calibrated by:	Name	Function	Signature
	Leif Klynsner	Laboratory Technician	
Approved by:	Name	Function	Signature
	Sven Kühn	Technical Manager	

Issued: March 16, 2023

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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.

### 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.
- 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.

<b>DASY Version</b>	DASY6	V16.2
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	Modular Flat Phantom	
<b>Distance Dipole Center - TSL</b>	5 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy = 3.4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
<b>Frequency</b>	6500 MHz $\pm$ 1 MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	34.5	6.07 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	34.3 $\pm$ 6 %	6.02 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

## SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	29.7 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>297 W/kg <math>\pm</math> 24.7 % (k=2)</b>

<b>SAR averaged over 8 cm<sup>3</sup> (8 g) of Head TSL</b>	Condition	
SAR measured	100 mW input power	6.66 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>66.5 W/kg <math>\pm</math> 24.4 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	100 mW input power	5.46 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>54.5 W/kg <math>\pm</math> 24.4 % (k=2)</b>

## Appendix

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.7 $\Omega$ - 2.8 j $\Omega$
Return Loss	- 25.7 dB

### APD (Absorbed Power Density)

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

APD averaged over 4 cm <sup>2</sup>	condition	
APD measured	100 mW input power	133 W/m <sup>2</sup>
APD measured	normalized to 1W	<b>1330 W/m<sup>2</sup> <math>\pm</math> 28.9 % (k=2)</b>

\*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-1003, 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: 1003	-

## Exposure Conditions

Phantom Section, TSL	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz]	Conversion Factor	TSL Cond. [S/m]	TSL Permittivity
Flat, HSL	5.00	Band	CW,	6500	5.50	6.02	34.3

## Hardware Setup

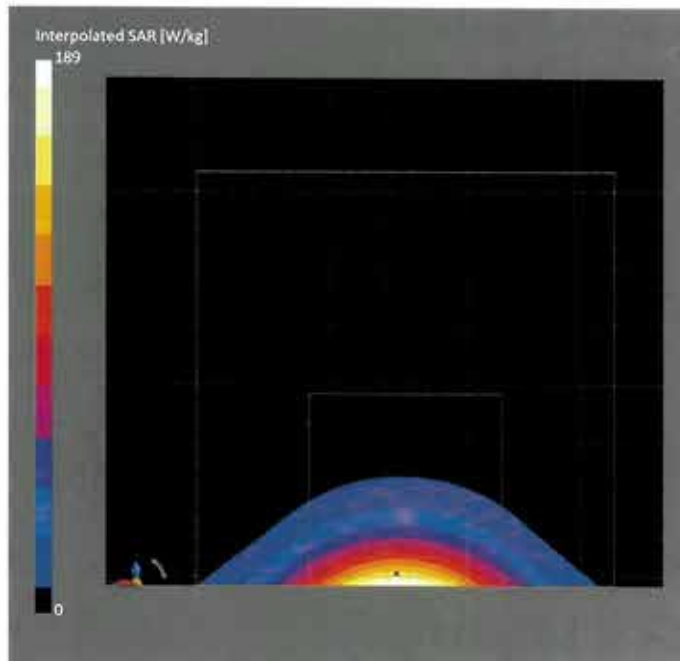
Phantom	TSL	Probe, Calibration Date	DAE, Calibration Date
MFP V8.0 Center - 1182	HBBL600-10000V6	EX3DV4 - SN7405, 2022-06-02	DAE4 Sn908, 2022-06-27

## Scan Setup

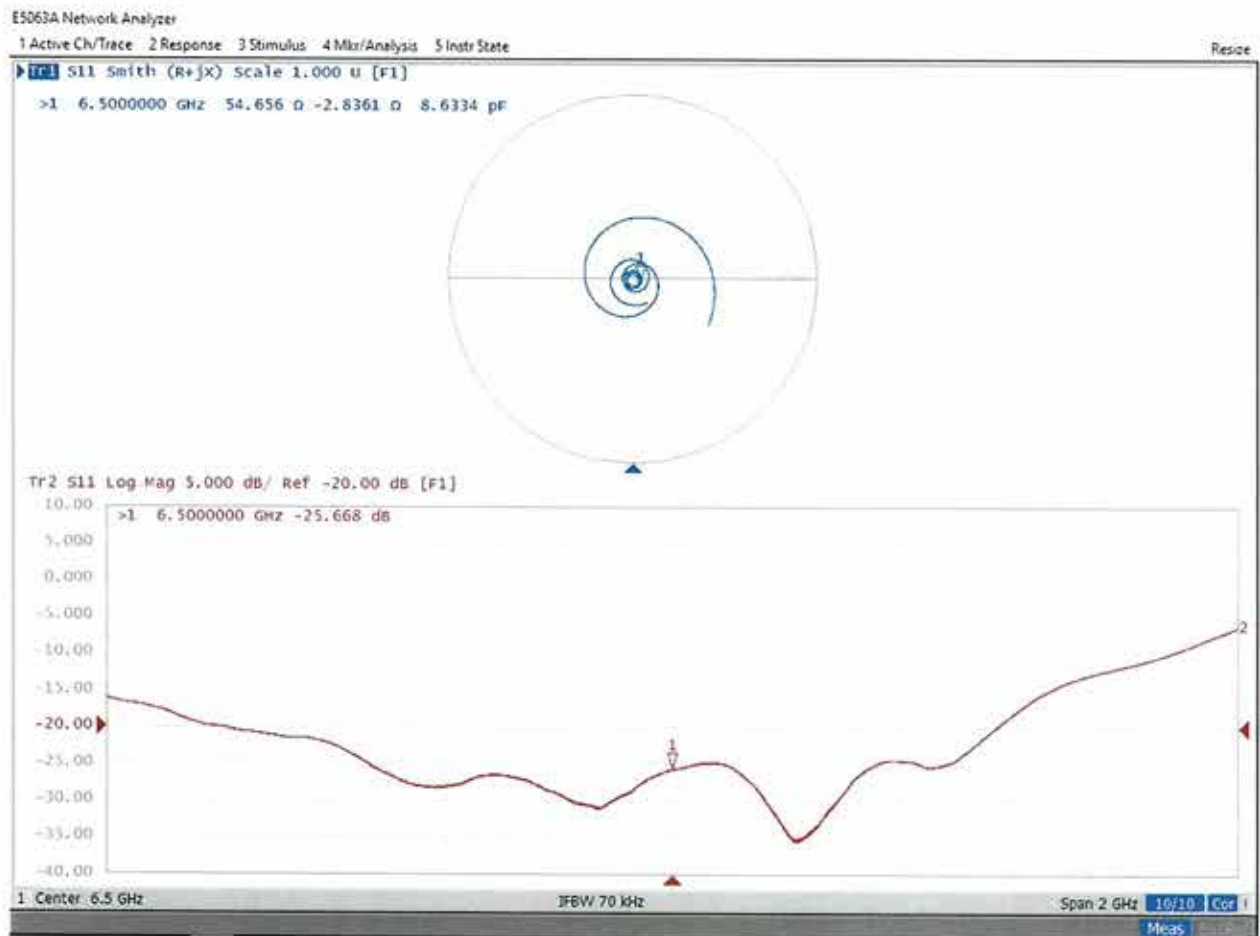
	Zoom Scan
Grid Extents [mm]	22.0 x 22.0 x 22.0
Grid Steps [mm]	3.4 x 3.4 x 1.4
Sensor Surface [mm]	1.4
Graded Grid	Yes
Grading Ratio	1.4
MAIA	N/A
Surface Detection	VMS + 6p
Scan Method	Measured

## Measurement Results

	Zoom Scan
Date	2023-03-15, 12:03
psSAR1g [W/Kg]	29.7
psSAR8g [W/Kg]	6.66
psSAR10g [W/Kg]	5.46
Power Drift [dB]	0.01
Power Scaling	Disabled
Scaling Factor [dB]	
TSL Correction	No correction
M2/M1 [%]	55.0
Dist 3dB Peak [mm]	4.7



# Impedance Measurement Plot for Head TSL





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Accreditation No.: **SCS 0108**

Client **Sporton**

Certificate No: **CLA13-1011\_Jul20**

## CALIBRATION CERTIFICATE

Object **CLA13 - SN: 1011**

Calibration procedure(s) **QA CAL-15.v9  
Calibration Procedure for SAR Validation Sources below 700 MHz**

Calibration date: **July 08, 2020**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: CC2552 (20x)	31-Mar-20 (No. 217-03106)	Apr-21
Type-N mismatch combination	SN: 310982 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX3DV4	SN: 3877	31-Dec-19 (No. EX3-3877_Dec19)	Dec-20
DAE4	SN: 654	26-Jun-20 (No. DAE4-654_Jun20)	Jun-21
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-20)	In house check: Jun-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

	<b>Name</b>	<b>Function</b>	<b>Signature</b>
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 9, 2020

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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) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

- e) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The 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.

<b>DASY Version</b>	DASY5	V52.10.4
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	ELI4 Flat Phantom	Shell thickness: $2 \pm 0.2$ mm
<b>EUT Positioning</b>	Touch Position	
<b>Zoom Scan Resolution</b>	$dx, dy = 4.0$ mm, $dz = 1.4$ mm	Graded Ratio = 1.4 (Z direction)
<b>Frequency</b>	$13$ MHz $\pm 1$ MHz	

## Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	55.5	0.75 mho/m
<b>Measured Head TSL parameters</b>	$(22.0 \pm 0.2)$ °C	$54.7 \pm 6$ %	$0.72$ mho/m $\pm 6$ %
<b>Head TSL temperature change during test</b>	$< 0.5$ °C	----	----

## SAR result with Head TSL

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	1 W input power	0.539 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>0.555 W/kg <math>\pm 18.4</math> % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	1 W input power	0.333 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>0.343 W/kg <math>\pm 18.0</math> % (k=2)</b>

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.5 $\Omega$ - 0.7 j $\Omega$
Return Loss	- 35.8 dB

### Additional EUT Data

Manufactured by	SPEAG
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# DASY5 Validation Report for Head TSL

Date: 08.07.2020

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: CLA13; Type: CLA13; Serial: CLA13 - SN: 1011**

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

Medium parameters used:  $f = 13 \text{ MHz}$ ;  $\sigma = 0.72 \text{ S/m}$ ;  $\epsilon_r = 54.7$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(15.25, 15.25, 15.25) @ 13 MHz; Calibrated: 31.12.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 26.06.2020
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

**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 = 28.94 V/m; Power Drift = -0.03 dB

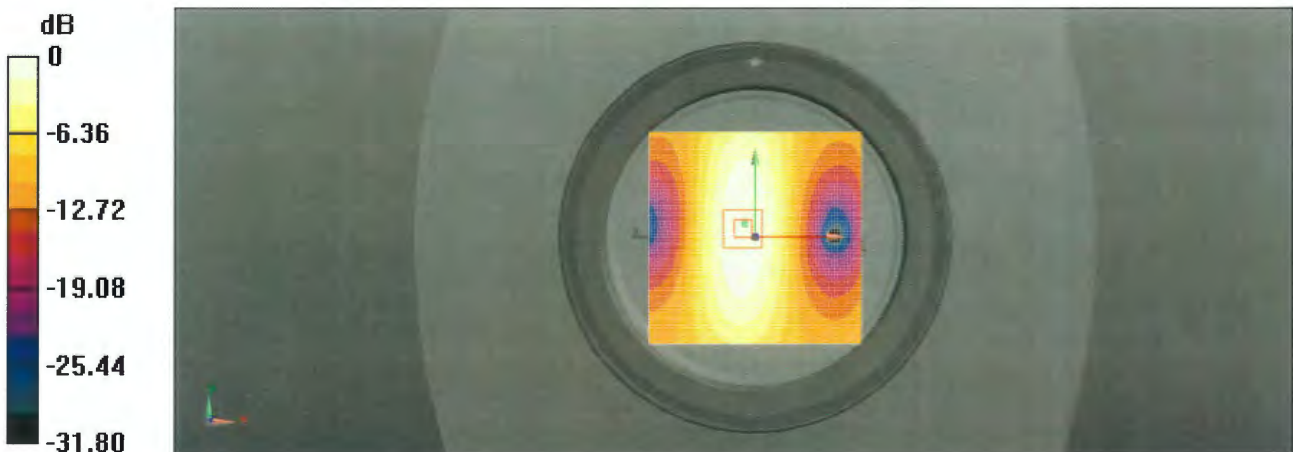
Peak SAR (extrapolated) = 1.14 W/kg

**SAR(1 g) = 0.539 W/kg; SAR(10 g) = 0.333 W/kg**

Smallest distance from peaks to all points 3 dB below: Larger than measurement grid (> 30 mm)

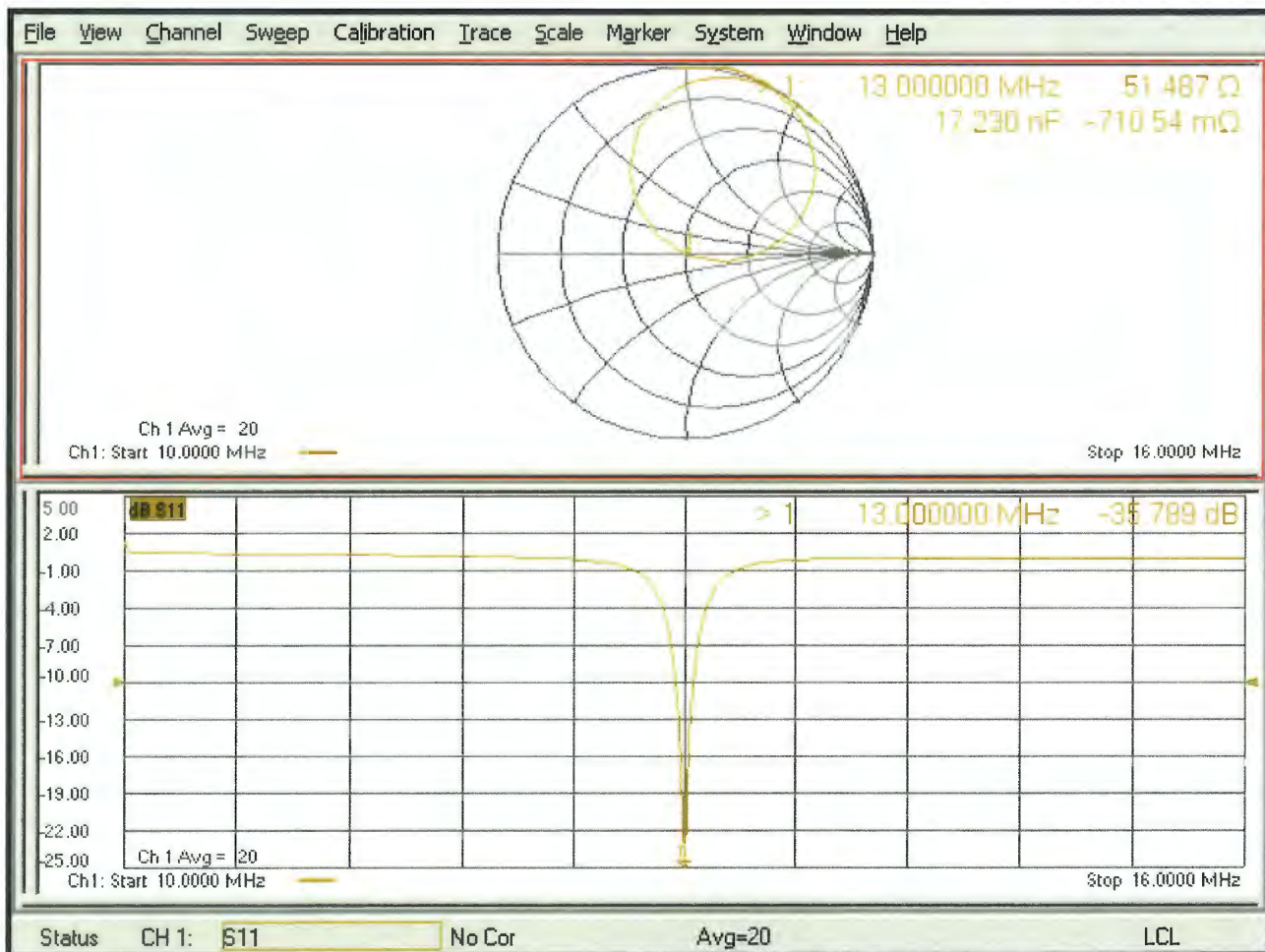
Ratio of SAR at M2 to SAR at M1 = 77.1%

Maximum value of SAR (measured) = 0.807 W/kg



0 dB = 0.825 W/kg = -0.84 dBW/kg

# Impedance Measurement Plot for Head TSL





### CLA13, serial no. 1011 Extended Dipole Calibrations

Referring to KDB 865664, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

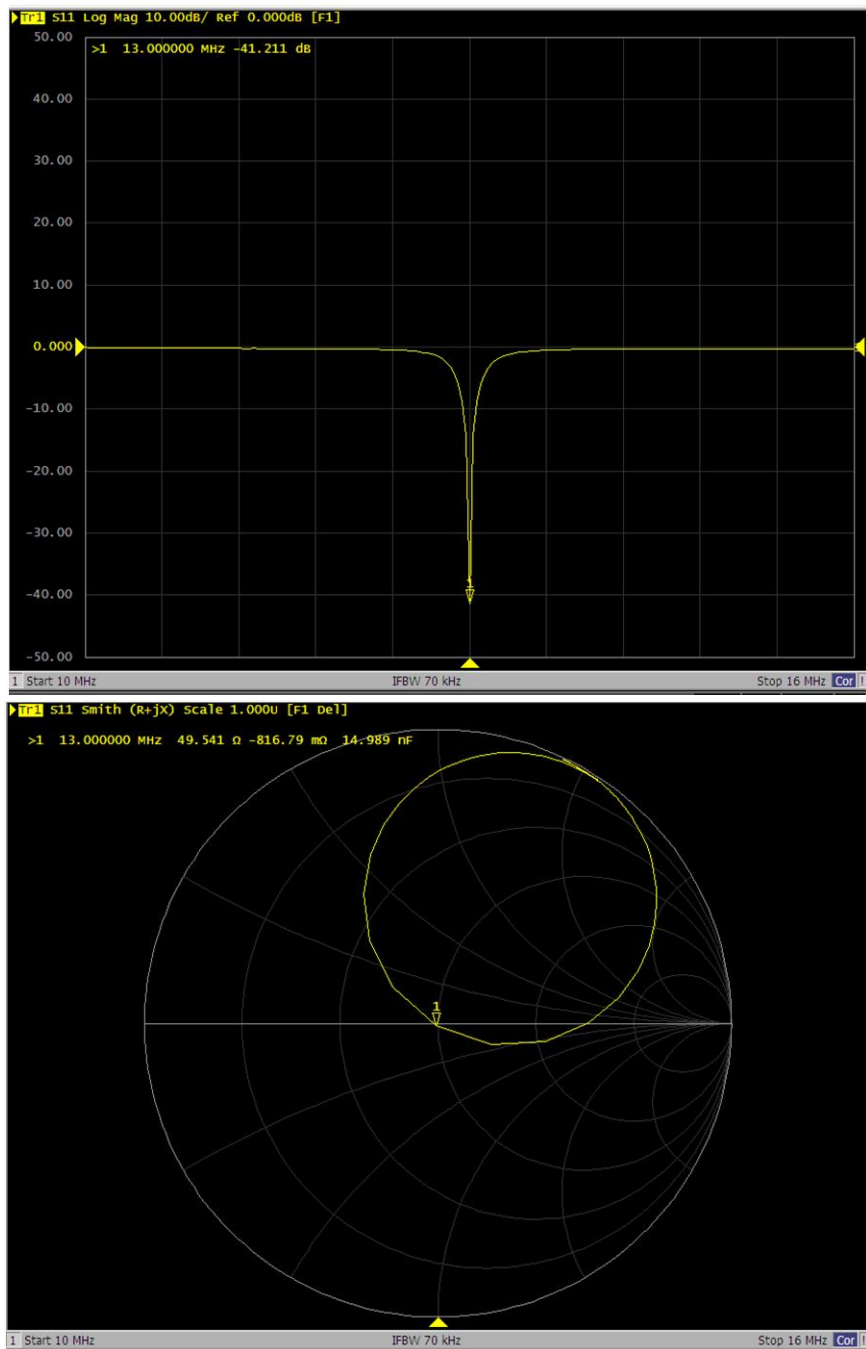
#### <Justification of the extended calibration>

CLA13 – serial no. 1011						
13MHZ						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
07.08.2020 (Cal. Report)	-35.789		51.487		-0.71054	
07.07.2021 (extended)	-39.709	10.95	49.575	-1.912	-0.94841	-0.23787
07.06.2022 (extended)	-41.211	15.15	49.541	-1.946	-0.81679	-0.10625

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

<Dipole Verification Data> - CLA13 , serial no. 1011 (Data of Measurement : 07.06.2022)

13 MHz – Head



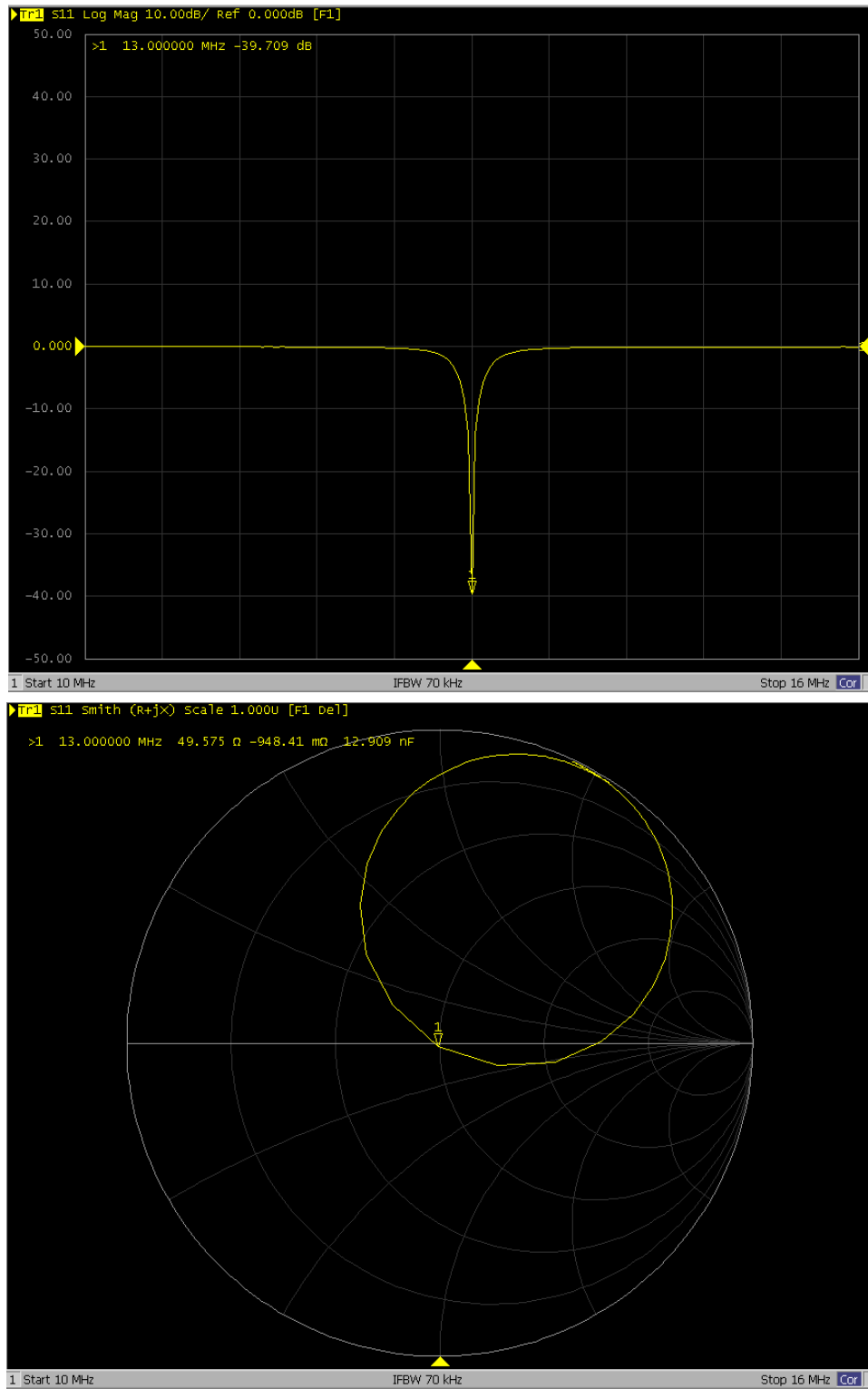
SPORTON INTERNATIONAL INC.

TEL: 886-3-327-3456

FAX : 886-3-328-4978

<Dipole Verification Data> - CLA13 , serial no. 1011 (Data of Measurement : 07.07.2021)

13 MHz - Head







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Accreditation No.: **SCS 0108**

Client **Sporton**

Certificate No: **5G-Veri10-1020\_Jan23/2**

**CALIBRATION CERTIFICATE (Replacement of No: 5G-Veri10-1020\_Jan23)**

Object **5G Verification Source 10 GHz - SN: 1020**

Calibration procedure(s) **QA CAL-45.v4  
Calibration procedure for sources in air above 6 GHz**

Calibration date: **January 20, 2023**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Reference Probe EUmmWV3	SN: 9374	2023-01-03(No. EUmmWV3-9374_Jan23)	Jan-24
DAE4ip	SN: 1602	2022-06-27 (No. DAE4ip-1602_Jun22)	Jun-23
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMF100A	SN: 100184	19-May-22 (in house check Nov-22)	In house check: Nov-23
Power sensor R&S NRP18S-10	SN: 101258	31-May-22 (in house check Nov-22)	In house check: Nov-23

Calibrated by:	Name <b>Leif Klysner</b>	Function <b>Laboratory Technician</b>	Signature 
Approved by:	Name <b>Sven Kühn</b>	Technical Manager	

Issued: March 16, 2023

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Accreditation No.: **SCS 0108**

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## 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:* E field is measured in two x-y-plane (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 (1cm<sup>2</sup> and 4cm<sup>2</sup>) 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/m<sup>2</sup>) averaged over the surface area of 1 cm<sup>2</sup> and 4cm<sup>2</sup> 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%.

## 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 GHz $\pm$ 10 MHz	

## Calibration Parameters, 10 GHz

### Circular Averaging

Distance Horn Aperture to Measured Plane	<i>Prad</i> <sup>†</sup> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDlot+, psPDmod+) (W/m <sup>2</sup> )		Uncertainty (k = 2)
				1 cm <sup>2</sup>	4 cm <sup>2</sup>	
10 mm	86.1	152	1.27 dB	59.4	54.9	1.28 dB

Distance Horn Aperture to Measured Plane	<i>Prad</i> <sup>†</sup> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Power Density psPDn+, psPDlot+, psPDmod+ (W/m <sup>2</sup> )			Uncertainty (k = 2)
				1 cm <sup>2</sup>	4 cm <sup>2</sup>		
10 mm	86.1	152	1.27 dB	59.2, 59.5, 59.6	54.6, 54.9, 55.2		1.28 dB

### Square Averaging

Distance Horn Aperture to Measured Plane	<i>Prad</i> <sup>†</sup> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Avg Power Density Avg (psPDn+, psPDlot+, psPDmod+) (W/m <sup>2</sup> )		Uncertainty (k = 2)
				1 cm <sup>2</sup>	4 cm <sup>2</sup>	
10 mm	86.1	152	1.27 dB	59.4	54.8	1.28 dB

Distance Horn Aperture to Measured Plane	<i>Prad</i> <sup>†</sup> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Power Density psPDn+, psPDlot+, psPDmod+ (W/m <sup>2</sup> )			Uncertainty (k = 2)
				1 cm <sup>2</sup>	4 cm <sup>2</sup>		
10 mm	86.1	152	1.27 dB	59.2, 59.5, 59.6	54.5, 54.9, 55.1		1.28 dB

### Max Power Density

Distance Horn Aperture to Measured Plane	<i>Prad</i> <sup>†</sup> (mW)	Max E-field (V/m)	Uncertainty (k = 2)	Max Power Density Sn, Stot,  Stot  (W/m <sup>2</sup> )	Uncertainty (k = 2)
				60.9, 61.2, 61.3	
10 mm	86.1	152	1.27 dB	60.9, 61.2, 61.3	1.28 dB

<sup>†</sup> Assessed ohmic and mismatch loss plus numerical offset: 0.55 dB

# DASY Report

## Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

### Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 172.0	SN: 1020	-

### Exposure Conditions

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

### Hardware Setup

Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2023-01-03	DAE4ip Sn1602, 2022-06-27

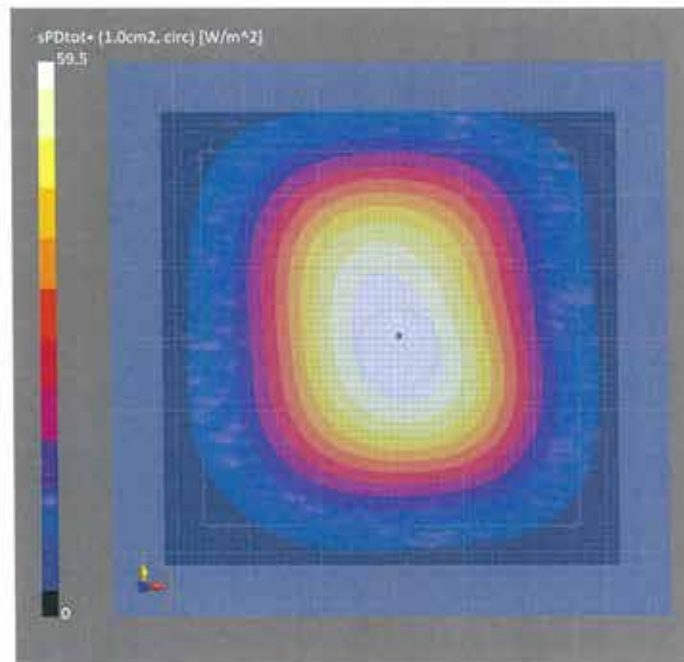
### Scan Setup

Sensor Surface [mm]  
MAIA

5G Scan  
10.0  
MAIA not used

### Measurement Results

	5G Scan
Date	2023-01-20, 09:26
Avg. Area [cm <sup>2</sup> ]	1.00
Avg. Type	Circular Averaging
psPDn+ [W/m <sup>2</sup> ]	59.2
psPDtot+ [W/m <sup>2</sup> ]	59.5
psPDmod+ [W/m <sup>2</sup> ]	59.6
Max(Sn) [W/m <sup>2</sup> ]	60.9
Max(Stot) [W/m <sup>2</sup> ]	61.2
Max( Stot ) [W/m <sup>2</sup> ]	61.3
E <sub>max</sub> [V/m]	152
Power Drift [dB]	-0.01



# DASY Report

## Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

### Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 172.0	SN: 1020	-

### Exposure Conditions

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

### Hardware Setup

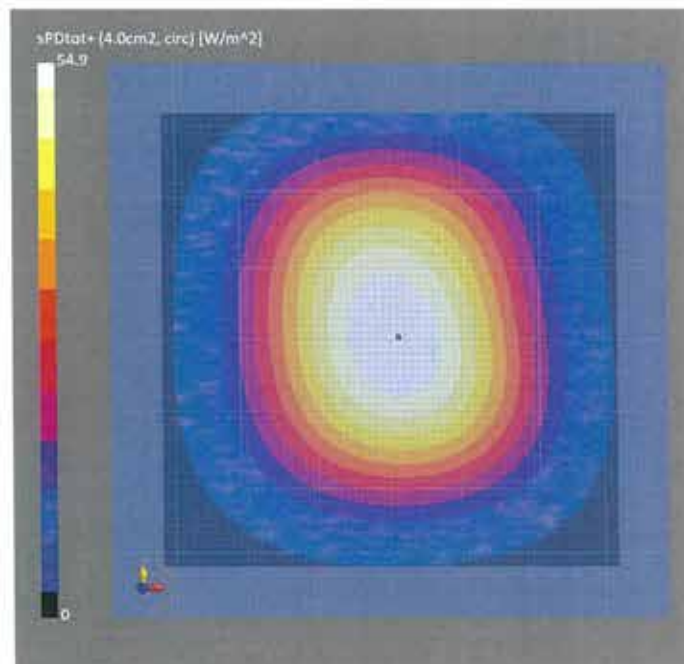
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2023-01-03	DAE4ip Sn1602, 2022-06-27

### Scan Setup

Sensor Surface [mm]	5G Scan
MAIA	10.0 MAIA not used

### Measurement Results

	5G Scan
Date	2023-01-20, 09:26
Avg. Area [cm <sup>2</sup> ]	4.00
Avg. Type	Circular Averaging
psPDn+ [W/m <sup>2</sup> ]	54.6
psPDtot+ [W/m <sup>2</sup> ]	54.9
psPDmod+ [W/m <sup>2</sup> ]	55.2
Max(Sn) [W/m <sup>2</sup> ]	60.9
Max(Stot) [W/m <sup>2</sup> ]	61.2
Max( Stot ) [W/m <sup>2</sup> ]	61.3
E <sub>max</sub> [V/m]	152
Power Drift [dB]	-0.01



# DASY Report

## Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

### Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 172.0	SN: 1020	-

### Exposure Conditions

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

### Hardware Setup

Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2023-01-03	DAE4ip Sn1602, 2022-06-27

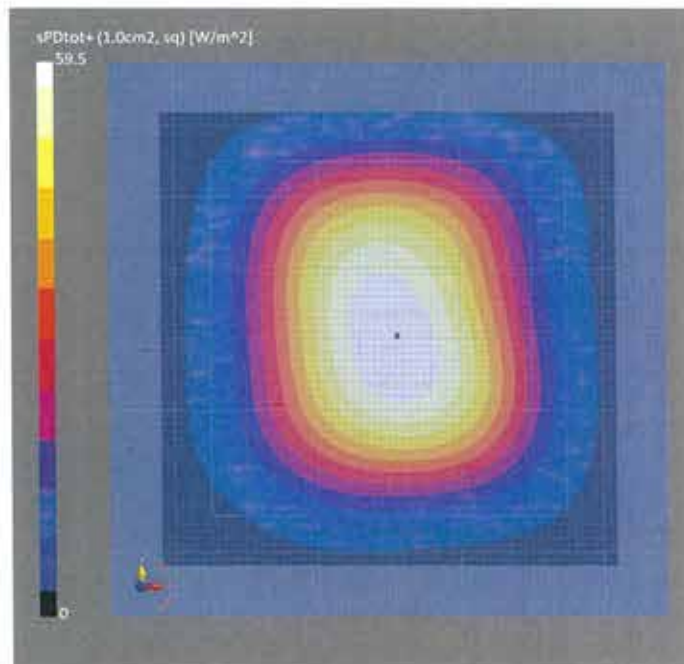
### Scan Setup

Sensor Surface [mm]  
MAIA

5G Scan  
10.0  
MAIA not used

### Measurement Results

	5G Scan
Date	2023-01-20, 09:26
Avg. Area [cm <sup>2</sup> ]	1.00
Avg. Type	Square Averaging
psPDn+ [W/m <sup>2</sup> ]	59.2
psPDtot+ [W/m <sup>2</sup> ]	59.5
psPDmod+ [W/m <sup>2</sup> ]	59.6
Max(Sn) [W/m <sup>2</sup> ]	60.9
Max(Stot) [W/m <sup>2</sup> ]	61.2
Max( Stot ) [W/m <sup>2</sup> ]	61.3
E <sub>max</sub> [V/m]	152
Power Drift [dB]	-0.01



# DASY Report

## Measurement Report for 5G Verification Source 10 GHz, UID 0 -, Channel 10000 (10000.0MHz)

### Device under Test Properties

Name, Manufacturer	Dimensions [mm]	IMEI	DUT Type
5G Verification Source 10 GHz	100.0 x 100.0 x 172.0	SN: 1020	-

### Exposure Conditions

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

### Hardware Setup

Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave Phantom - 1002	Air	EUmmWV3 - SN9374_F1-55GHz, 2023-01-03	DAE4ip Sn1602, 2022-06-27

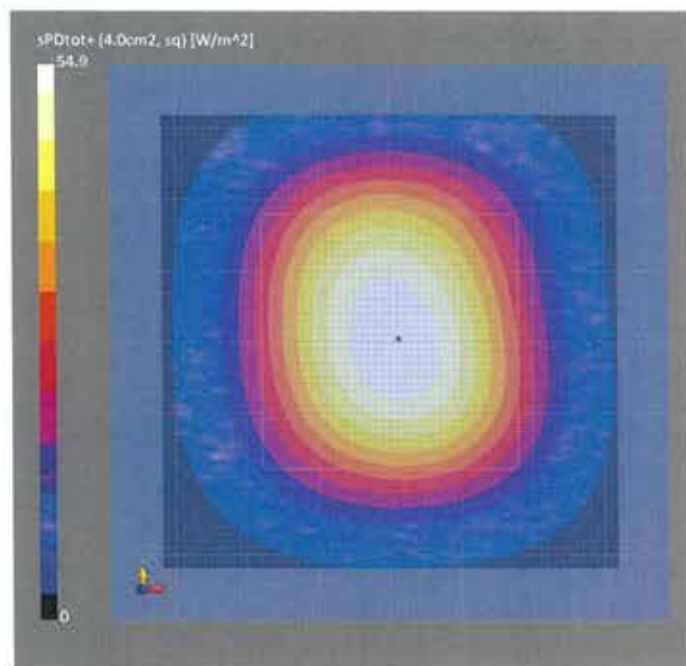
### Scan Setup

Sensor Surface [mm]  
MAIA

5G Scan  
10.0  
MAIA not used

### Measurement Results

Date	2023-01-20, 09:26
Avg. Area [cm <sup>2</sup> ]	4.00
Avg. Type	Square Averaging
psPDn+ [W/m <sup>2</sup> ]	54.5
psPDtot+ [W/m <sup>2</sup> ]	54.9
psPDmod+ [W/m <sup>2</sup> ]	55.1
Max{Sn} [W/m <sup>2</sup> ]	60.9
Max{Stot} [W/m <sup>2</sup> ]	61.2
Max{ Stot } [W/m <sup>2</sup> ]	61.3
E <sub>max</sub> [V/m]	152
Power Drift [dB]	-0.01





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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client

**Sporton**  
 Taoyuan City, Taiwan

Certificate No.

**EUmm-9424\_Mar23**

**CALIBRATION CERTIFICATE**

Object: EUmmWV3 - SN:9424

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

Calibration date: March 21, 2023

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3) °C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power sensor NRP110T	SN: 101244	14-Mar-22 (No. 20A1037915)	Mar-23
Spectrum analyzer FSV40	SN: 101832	23-Jan-23 (No. 4030-315005314)	Jan-24
Ref. Probe EUmmWV3	SN: 9374	03-Jan-23 (No. EUmmWV3-9374_Jan23)	Jan-24
DAE4	SN: 789	03-Jan-23 (No. DAE4-789_Jan23)	Jan-24

Secondary Standards	ID	Check Date (in house)	Scheduled Check
Generator APSIN26G	SN: 669	28-Mar-17 (in house check May-22)	In house check: May-23
Generator Agilent E8251A	SN: US41140111	28-Mar-17 (in house check May-22)	In house check: May-23

	Name	Function	Signature
Calibrated by	Leif Klysner	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	

Issued: March 21, 2023

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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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

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

## Calibration is Performed According to the Following Standards:

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

## Methods Applied and Interpretation of Parameters:

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

### Parameters of Probe: EUmmWV3 - SN:9424

#### Basic Calibration Parameters

	Sensor X	Sensor Y	Unc (k = 2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ )	0.02350	0.02442	$\pm 10.1\%$
DCP (mV) <sup>B</sup>	104.0	103.0	$\pm 4.7\%$
Equivalent Sensor Angle	-61.5	35.9	

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

Frequency GHz	Target E-Field V/m	Deviation Sensor X dB	Deviation Sensor Y dB	Unc (k = 2) dB
0.75	77.2	0.07	-0.13	$\pm 0.43$
1.8	140.4	-0.00	-0.01	$\pm 0.43$
2.0	133.0	0.13	0.16	$\pm 0.43$
2.2	124.8	-0.08	-0.06	$\pm 0.43$
2.5	123.0	0.09	0.09	$\pm 0.43$
3.5	256.2	-0.22	-0.25	$\pm 0.43$
3.7	249.8	0.01	-0.05	$\pm 0.43$
6.6	76.1	-0.29	-0.28	$\pm 0.98$
8.0	68.3	-0.22	-0.21	$\pm 0.98$
10.0	67.5	-0.03	-0.03	$\pm 0.98$
15.0	55.3	0.27	0.20	$\pm 0.98$
26.6	114.9	-0.19	-0.19	$\pm 0.98$
30.0	121.2	-0.09	-0.09	$\pm 0.98$
35.0	119.8	0.11	0.13	$\pm 0.98$
40.0	105.8	0.28	0.31	$\pm 0.98$
50.0	60.5	0.62	0.56	$\pm 0.98$
55.0	75.8	-0.10	-0.08	$\pm 0.98$
60.0	80.0	0.34	0.34	$\pm 0.98$
65.0	77.7	0.12	0.21	$\pm 0.98$
70.0	73.8	0.28	0.24	$\pm 0.98$
75.0	73.2	-0.07	-0.16	$\pm 0.98$
75.0	80.8	0.20	0.13	$\pm 0.98$
80.0	79.9	-0.53	-0.51	$\pm 0.98$
85.0	47.6	-0.68	-0.69	$\pm 0.98$
90.0	72.3	-0.40	-0.39	$\pm 0.98$
92.0	72.0	-0.25	-0.24	$\pm 0.98$
95.0	66.6	-0.13	-0.17	$\pm 0.98$
97.0	57.0	-0.09	-0.16	$\pm 0.98$
100.0	55.0	-0.08	-0.15	$\pm 0.98$
105.0	53.0	-0.14	-0.14	$\pm 0.98$
110.0	61.1	0.14	0.19	$\pm 0.98$

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

<sup>B</sup> Linearization parameter uncertainty for maximum specified field strength.

### Parameters of Probe: EUmmWV3 - SN:9424

#### Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB $\sqrt{\mu V}$	C	D dB	VR mV	Max dev.	Max Unc <sup>E</sup> k = 2
0	CW	X	0.00	0.00	1.00	0.00	139.7	±2.5%	±4.7%
		Y	0.00	0.00	1.00		74.8		
10352	Pulse Waveform (200Hz, 10%)	X	1.90	60.00	14.35	10.00	6.0	±1.7%	±9.6%
		Y	14.00	74.00	17.00		6.0		
10353	Pulse Waveform (200Hz, 20%)	X	1.33	60.00	13.13	6.99	12.0	±1.2%	±9.6%
		Y	2.00	62.00	13.00		12.0		
10354	Pulse Waveform (200Hz, 40%)	X	0.81	60.00	11.76	3.98	23.0	±1.2%	±9.6%
		Y	0.80	60.00	11.76		23.0		
10355	Pulse Waveform (200Hz, 60%)	X	0.48	60.00	11.02	2.22	27.0	±1.0%	±9.6%
		Y	0.57	60.00	10.88		27.0		
10387	QPSK Waveform, 1 MHz	X	1.11	60.00	11.66	1.00	22.0	±1.8%	±9.6%
		Y	1.05	60.00	11.48		22.0		
10388	QPSK Waveform, 10 MHz	X	1.28	60.00	11.71	0.00	22.0	±0.8%	±9.6%
		Y	1.36	60.00	11.78		22.0		
10396	64-QAM Waveform, 100 kHz	X	2.44	62.61	14.80	3.01	17.0	±0.7%	±9.6%
		Y	2.35	62.76	15.13		17.0		
10399	64-QAM Waveform, 40 MHz	X	2.12	60.00	12.25	0.00	19.0	±0.9%	±9.6%
		Y	2.14	60.00	12.39		19.0		
10414	WLAN CCDF, 64-QAM, 40 MHz	X	3.25	60.00	12.71	0.00	12.0	±0.8%	±9.6%
		Y	3.15	60.00	12.83		12.0		

Note: For details on UID parameters see Appendix

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

## Parameters of Probe: EUmmWV3 - SN:9424

### Calibration Results for Linearity Response

Frequency GHz	Target E-Field V/m	Deviation Sensor X dB	Deviation Sensor Y dB	Unc (k = 2) dB
0.9	50.0	0.02	-0.06	±0.2
0.9	100.0	-0.02	0.07	±0.2
0.9	500.0	0.01	-0.01	±0.2
0.9	1000.0	0.04	0.02	±0.2
0.9	1500.0	0.02	0.02	±0.2
0.9	2100.0	-0.01	0.02	±0.2

### Sensor Frequency Model Parameters (750 MHz – 55 GHz)

	Sensor X	Sensor Y
R (Ω)	171.20	190.32
R <sub>p</sub> (Ω)	181.35	194.12
L (nH)	0.22217	0.22233
C (pF)	0.1328	0.1531
C <sub>p</sub> (pF)	0.0378	0.0388

### Sensor Frequency Model Parameters (55 GHz – 110 GHz)

	Sensor X	Sensor Y
R (Ω)	23.65	29.94
R <sub>p</sub> (Ω)	144.36	155.81
L (nH)	0.07537	0.07794
C (pF)	0.0498	0.0523
C <sub>p</sub> (pF)	0.0647	0.0588

### Sensor Model Parameters

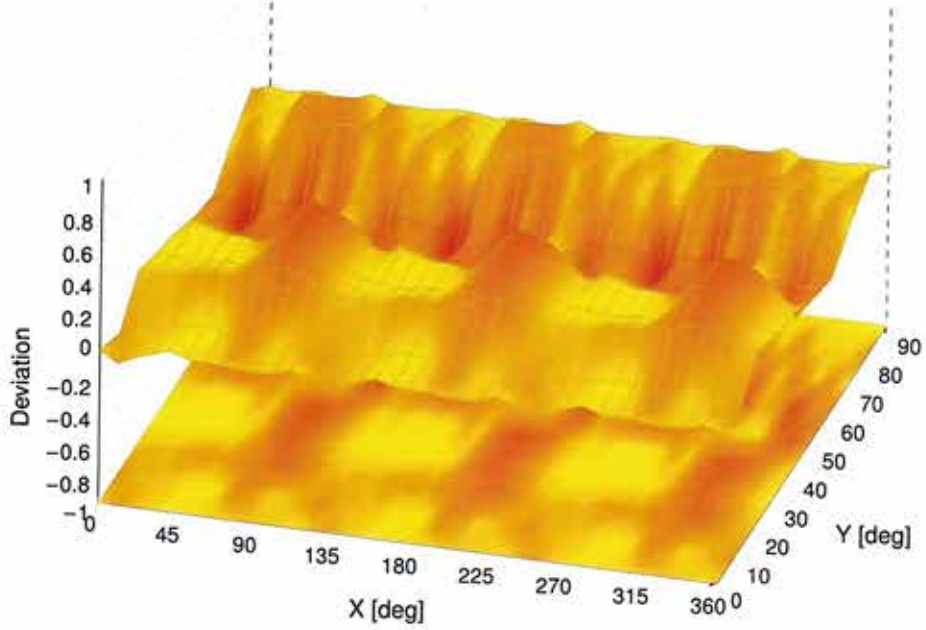
	C1 fF	C2 fF	α V <sup>-1</sup>	T1 ms V <sup>-2</sup>	T2 ms V <sup>-1</sup>	T3 ms	T4 V <sup>-2</sup>	T5 V <sup>-1</sup>	T6
x	42.4	311.46	34.33	2.66	3.85	5.01	0.00	1.25	1.01
y	30.3	219.40	33.58	0.92	3.70	4.98	0.00	1.15	1.01

### Other Probe Parameters

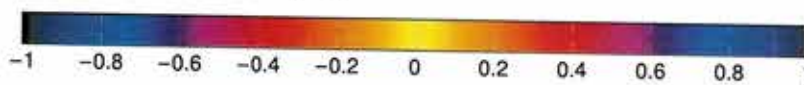
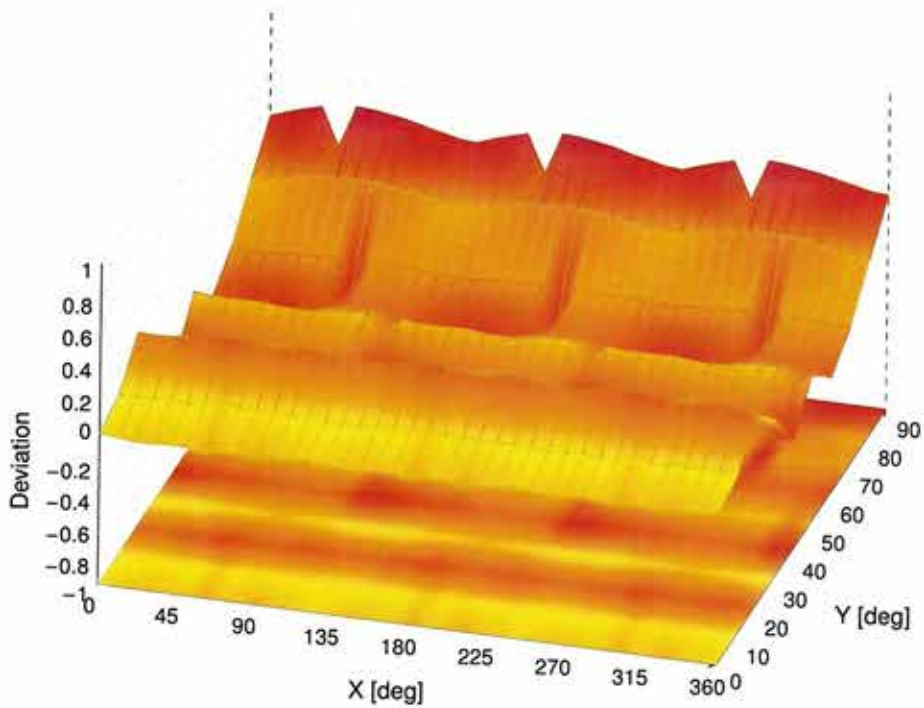
Sensor Arrangement	Rectangular
Connector Angle	120.9°
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	320 mm
Probe Body Diameter	8 mm
Tip Length	23 mm
Tip Diameter	8.0 mm
Probe Tip to Sensor X Calibration Point	1.5 mm
Probe Tip to Sensor Y Calibration Point	1.5 mm

### Deviation from Isotropy in Air

30GHz: 3D isotropy, E-field parallel to probe axis



60GHz: 3D isotropy, E-field parallel to probe axis



Probe isotropy for  $E_{tot}$ : probe rotated  $\phi = 0^\circ$  to  $360^\circ$ , tilted from field propagation direction  $\vec{k}$   
Parallel to the field propagation ( $\psi = 0^\circ - 90^\circ$ ) at 30 GHz: deviation within  $\pm 0.31$  dB  
Parallel to the field propagation ( $\psi = 0^\circ - 90^\circ$ ) at 60 GHz: deviation within  $\pm 0.40$  dB