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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Element**

Certificate No: **D2450V2-750\_May22**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN:750**

Calibration procedure(s) **QA CAL-05.v11  
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz**

Calibration date: **May 11, 2022**

✓ ATM  
6/11/22

✓ YW 5/22/2023

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 ( $22 \pm 3$ )°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         | 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: 7349           | 31-Dec-21 (No. EX3-7349_Dec21)    | Dec-22                 |
| DAE4                            | SN: 601            | 02-May-22 (No. DAE4-601_May22)    | May-23                 |
| 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: **Aldonia Georgiadou** **Laboratory Technician**

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

Signature

ATM

SL

Issued: May 12, 2022

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



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Accreditation No.: **SCS 0108**

**Glossary:**

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

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

- a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- 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, dz = 5 mm      |             |
| Frequency                    | 2450 MHz $\pm$ 1 MHz   |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 39.2           | 1.80 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 38.2 $\pm$ 6 % | 1.85 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                                          | 250 mW input power | 13.4 W/kg                                      |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>52.6 W/kg <math>\pm</math> 17.0 % (k=2)</b> |

|                                                         |                    |                                                |
|---------------------------------------------------------|--------------------|------------------------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                                                |
| SAR measured                                            | 250 mW input power | 6.20 W/kg                                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>24.5 W/kg <math>\pm</math> 16.5 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 52.7           | 1.95 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 51.5 $\pm$ 6 % | 2.02 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

## SAR result with Body TSL

|                                                       |                    |                                                |
|-------------------------------------------------------|--------------------|------------------------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                                                |
| SAR measured                                          | 250 mW input power | 12.9 W/kg                                      |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>50.5 W/kg <math>\pm</math> 17.0 % (k=2)</b> |

|                                                         |                    |                                                |
|---------------------------------------------------------|--------------------|------------------------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                                |
| SAR measured                                            | 250 mW input power | 6.04 W/kg                                      |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>23.9 W/kg <math>\pm</math> 16.5 % (k=2)</b> |

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

### Antenna Parameters with Head TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $54.8 \Omega + 8.1 j\Omega$ |
| Return Loss                          | - 21.0 dB                   |

### Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $50.8 \Omega + 8.7 j\Omega$ |
| Return Loss                          | - 21.3 dB                   |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.153 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: 11.05.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:750**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.85$  S/m;  $\epsilon_r = 38.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- 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/ $P_{in}=250$ mW, $d=10$ mm/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 116.5 V/m; Power Drift = 0.04 dB

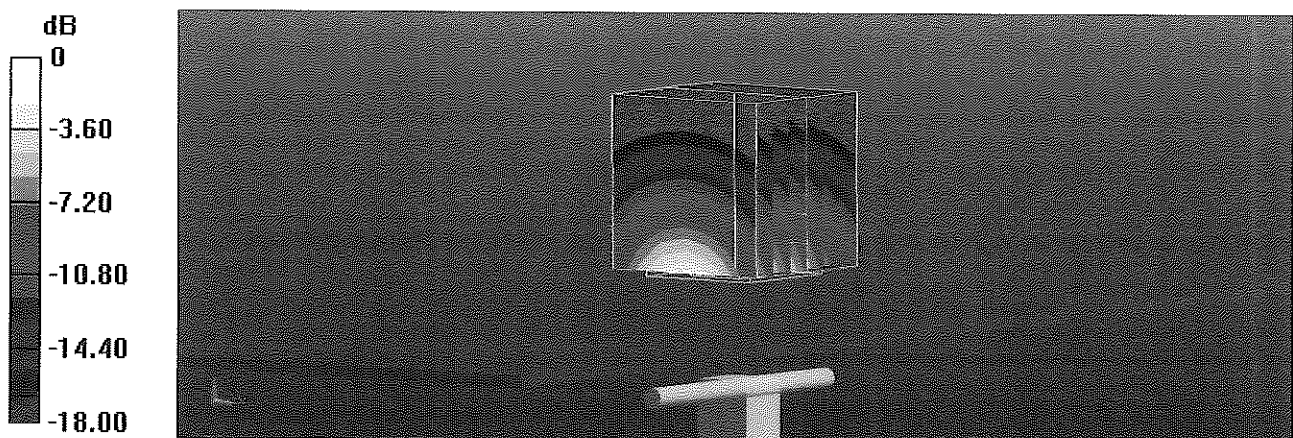
Peak SAR (extrapolated) = 26.8 W/kg

**SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.2 W/kg**

Smallest distance from peaks to all points 3 dB below = 9 mm

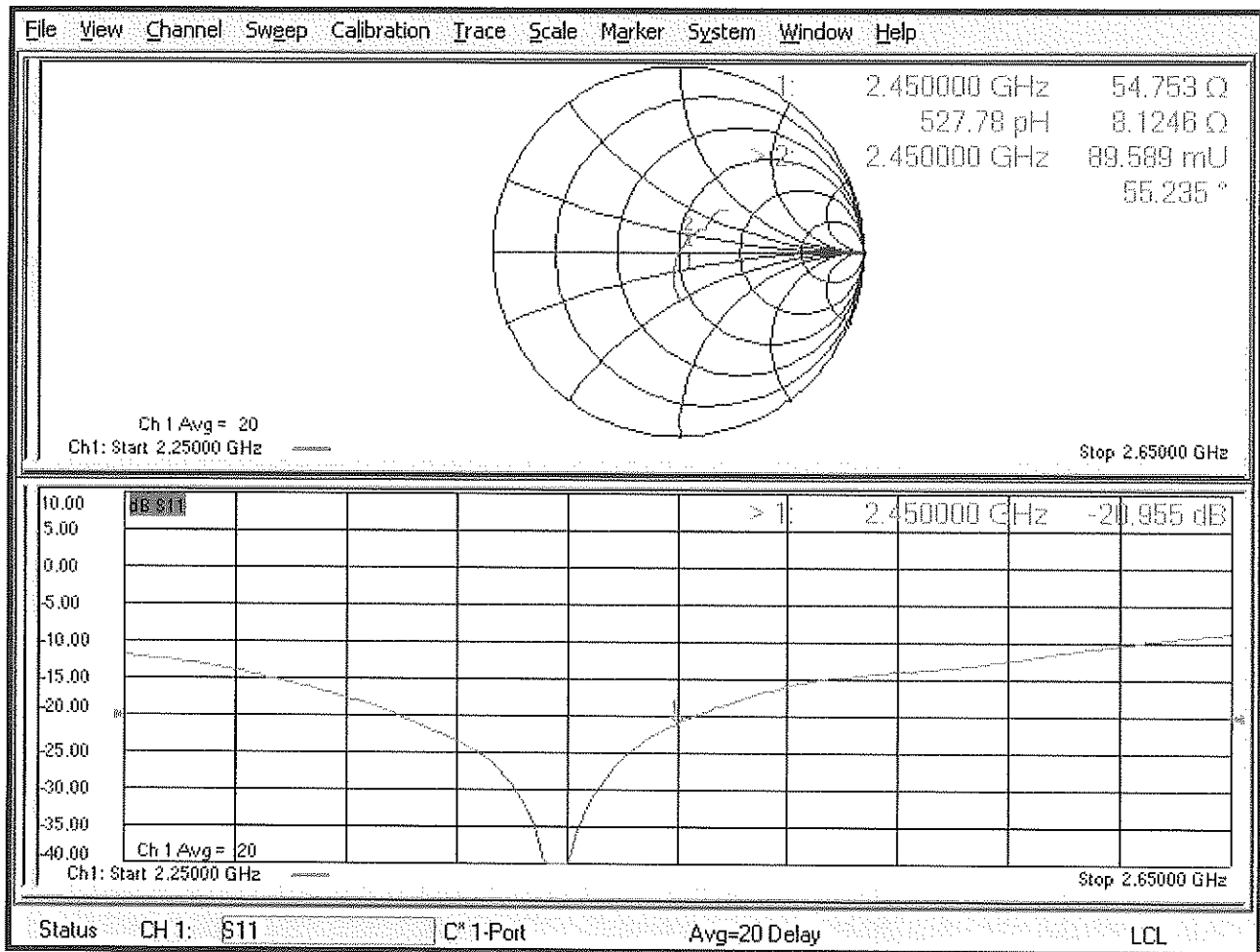
Ratio of SAR at M2 to SAR at M1 = 50%

Maximum value of SAR (measured) = 22.2 W/kg



0 dB = 22.2 W/kg = 13.46 dBW/kg

# Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 11.05.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:750**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.02$  S/m;  $\epsilon_r = 51.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

### **Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**

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

Reference Value = 106.7 V/m; Power Drift = -0.07 dB

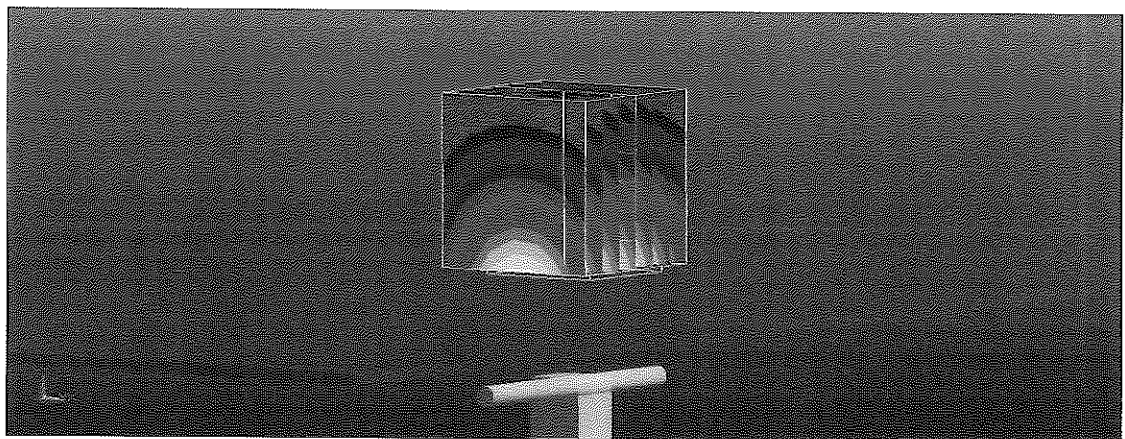
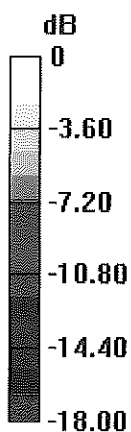
Peak SAR (extrapolated) = 24.3 W/kg

**SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.04 W/kg**

Smallest distance from peaks to all points 3 dB below = 8.9 mm

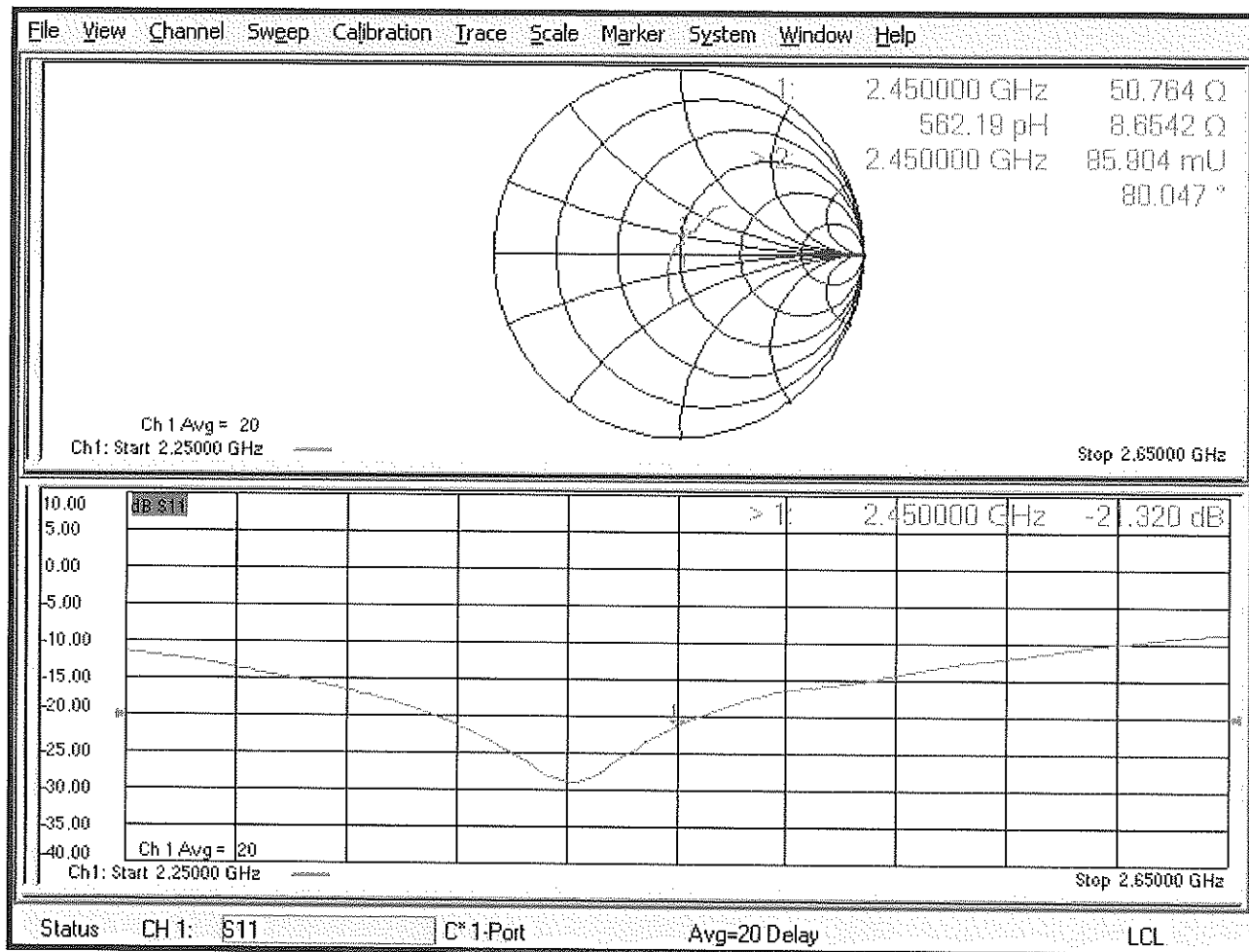
Ratio of SAR at M2 to SAR at M1 = 54%

Maximum value of SAR (measured) = 20.1 W/kg



0 dB = 20.1 W/kg = 13.03 dBW/kg

## Impedance Measurement Plot for Body TSL



## Certification of Calibration

Object: D2450V2 – SN: 750

Calibration procedure(s): Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: May 11, 2023

Description: SAR Validation Dipole at 2450 MHz.

### Calibration Equipment used:

| Manufacturer       | Model         | Description                         | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|--------------------|---------------|-------------------------------------|------------|--------------|------------|---------------|
| Agilent            | 8753ES        | S-Parameter Vector Network Analyzer | 6/14/2022  | Annual       | 6/14/2023  | US39170118    |
| Agilent            | E4438C        | ESG Vector Signal Generator         | 11/17/2022 | Annual       | 11/17/2023 | MY45093852    |
| Amplifier Research | 15S1G6        | Amplifier                           | CBT        | N/A          | CBT        | 343972        |
| Rohde & Schwarz    | NRX           | Power Meter                         | 1/11/2023  | Annual       | 1/11/2024  | 102583        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 5/19/2022  | Annual       | 5/19/2023  | 106562        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 5/19/2022  | Annual       | 5/19/2023  | 106559        |
| Traceable          | 4040 90080-06 | Therm./ Clock/ Humidity Monitor     | 5/11/2022  | Biennial     | 5/11/2024  | 221514974     |
| Control Company    | 4353          | Long Stem Thermometer               | 9/10/2021  | Biennial     | 9/10/2023  | 210774685     |
| Agilent            | 85033E        | 3.5mm Standard Calibration Kit      | 6/21/2022  | Annual       | 6/21/2023  | MY53402352    |
| Mini-Circuits      | VLF-6000+     | Low Pass Filter DC to 6000 MHz      | CBT        | N/A          | CBT        | N/A           |
| Narda              | 4772-3        | Attenuator (3dB)                    | CBT        | N/A          | CBT        | 9406          |
| Mini-Circuits      | ZHDC-16-63-S+ | 50-6000MHz Bidirectional Coupler    | CBT        | N/A          | CBT        | N/A           |
| Pasternack         | NC-100        | Torque Wrench                       | 12/5/2022  | Biennial     | 12/5/2024  | N/A           |
| SPEAG              | DAK-3.5       | Dielectric Assessment Kit           | 8/15/2022  | Annual       | 8/15/2023  | 1041          |
| SPEAG              | EX3DV4        | SAR Probe                           | 2/13/2023  | Annual       | 2/13/2024  | 7427          |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 2/15/2023  | Annual       | 2/15/2024  | 1403          |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name            | Function                   | Signature                                                                             |
|----------------|-----------------|----------------------------|---------------------------------------------------------------------------------------|
| Calibrated By: | Arturo Oliveros | Compliance Engineer I      |  |
| Approved By:   | Greg Snyder     | Executive VP of Operations |  |

# DIPOLE CALIBRATION EXTENSION

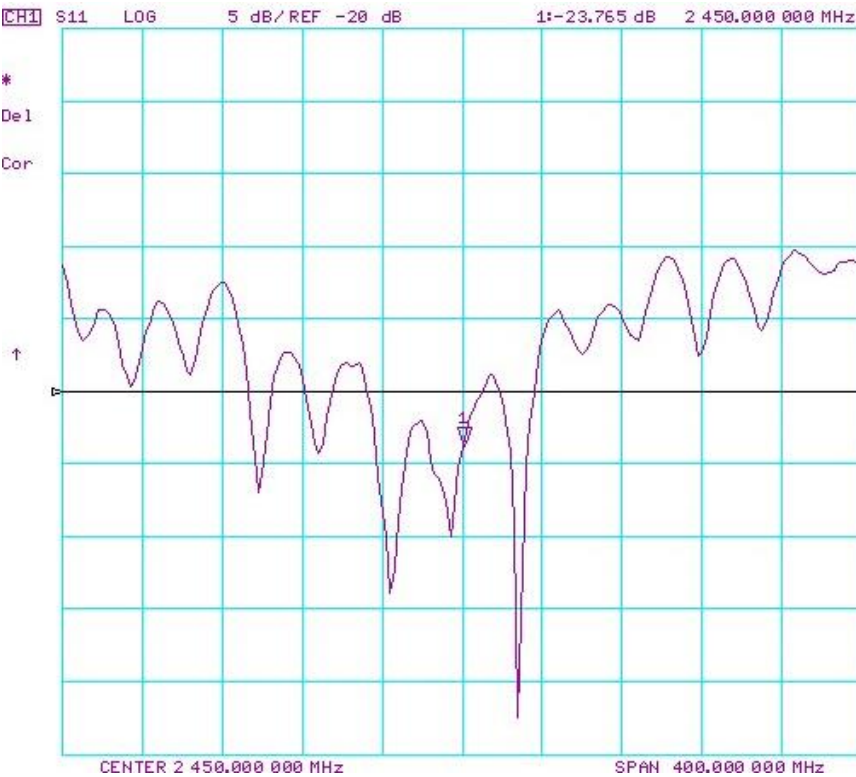
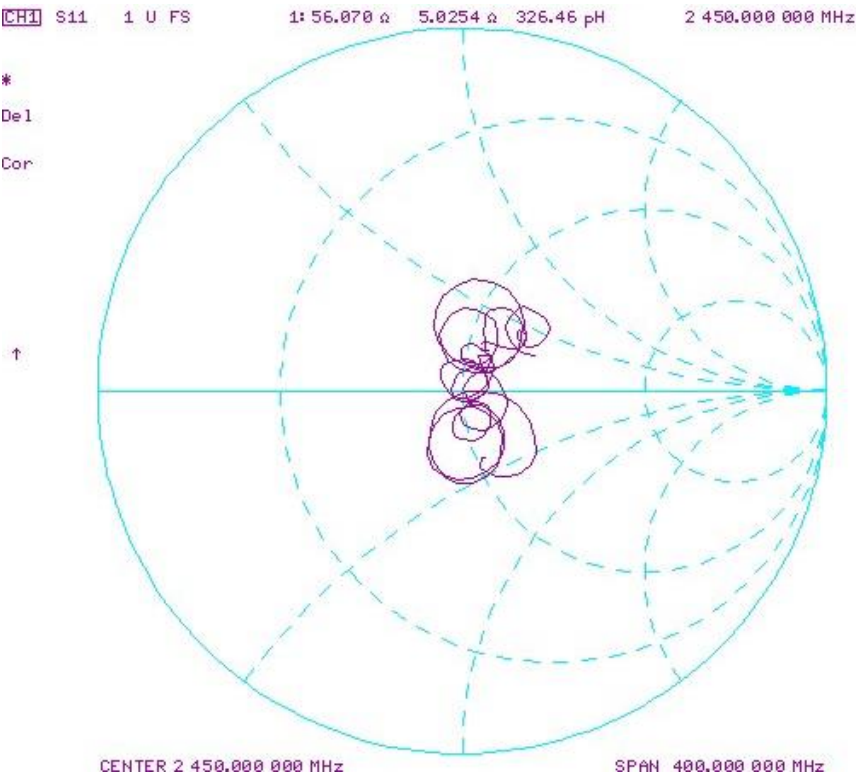
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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.

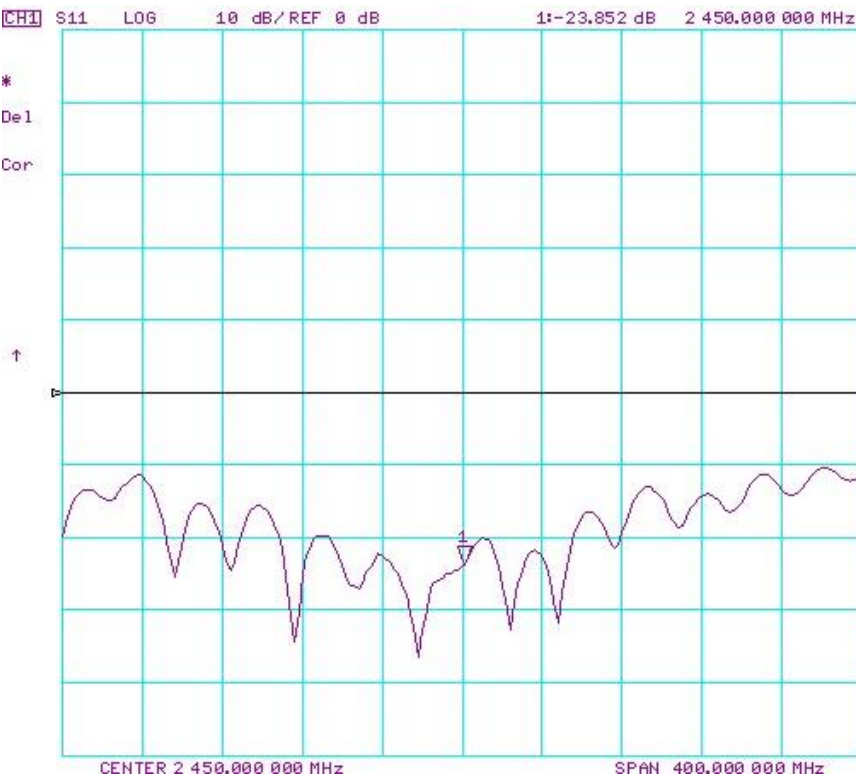
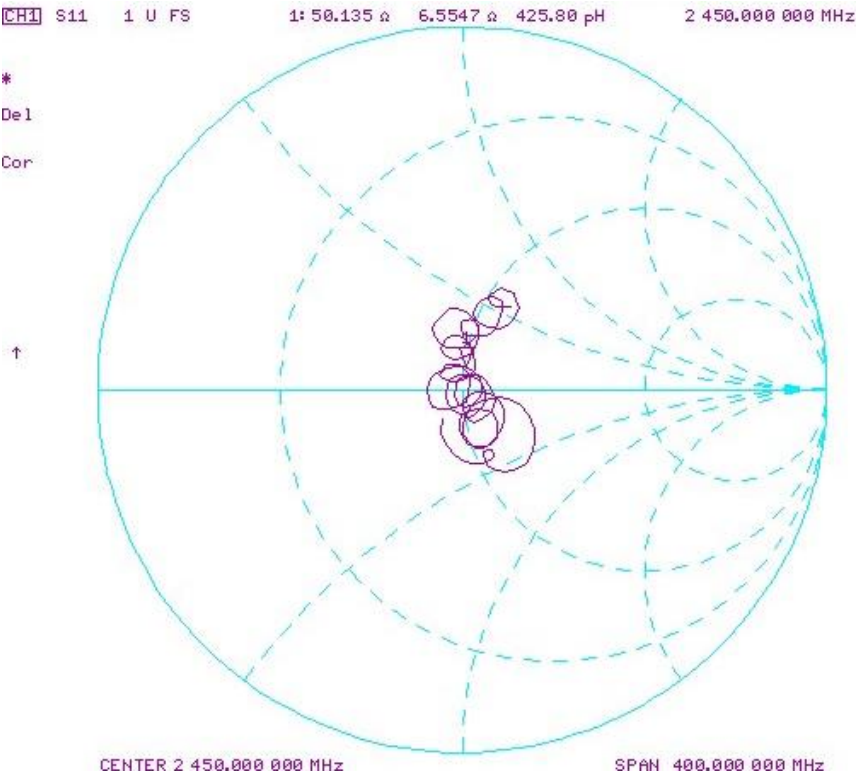
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|-----------|
| 5/11/2022        | 5/11/2023      | 1.153                             | 5.26                                             | 4.89                                   | -7.03%           | 2.45                                              | 2.28                                    | -6.94%            | 54.8                                  | 56.1                               | 1.3                   | 8.1                                        | 5                                       | 3.1                        | -21                               | -23.8                          | -13.20%       | PASS      |
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 20.0 dBm | Measured Body SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Body SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
| 5/11/2022        | 5/11/2023      | 1.153                             | 5.05                                             | 4.76                                   | -5.74%           | 2.39                                              | 2.26                                    | -5.44%            | 50.8                                  | 50.1                               | 0.7                   | 8.7                                        | 6.6                                     | 2.1                        | -21.3                             | -23.9                          | -12.00%       | PASS      |

Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL





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Accreditation No.: **SCS 0108**

Client **PC Test**

Certificate No: **D2450V2-921\_Nov21**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN:921**

Calibration procedure(s) **QA CAL-05.v11**  
**Calibration Procedure for SAR Validation Sources between 0.7-3 GHz**

Calibration date: **November 09, 2021**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). **12/14/2022**  
 The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

**✓ YW 12/13/2023**

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: 7349           | 28-Dec-20 (No. EX3-7349_Dec20)    | Dec-21                 |
| 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: 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-22 |

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

Approved by: **Niels Kuster** Quality Manager

Signature

Issued: November 11, 2021

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**Glossary:**

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

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

- a) IEC/IEEE 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, dz = 5 mm      |             |
| Frequency                    | 2450 MHz $\pm$ 1 MHz   |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 39.2           | 1.80 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 39.1 $\pm$ 6 % | 1.87 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                                          | 250 mW input power | 13.8 W/kg                                      |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>54.2 W/kg <math>\pm</math> 17.0 % (k=2)</b> |

|                                                         |                    |                                                |
|---------------------------------------------------------|--------------------|------------------------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                                                |
| SAR measured                                            | 250 mW input power | 6.43 W/kg                                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>25.5 W/kg <math>\pm</math> 16.5 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 52.7           | 1.95 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 51.2 $\pm$ 6 % | 2.01 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

## SAR result with Body TSL

|                                                       |                    |                                                |
|-------------------------------------------------------|--------------------|------------------------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                                                |
| SAR measured                                          | 250 mW input power | 12.7 W/kg                                      |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | <b>49.7 W/kg <math>\pm</math> 17.0 % (k=2)</b> |

|                                                         |                    |                                                |
|---------------------------------------------------------|--------------------|------------------------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                                                |
| SAR measured                                            | 250 mW input power | 5.98 W/kg                                      |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | <b>23.6 W/kg <math>\pm</math> 16.5 % (k=2)</b> |

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

### Antenna Parameters with Head TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $52.7 \Omega + 6.6 j\Omega$ |
| Return Loss                          | - 23.2 dB                   |

### Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $49.9 \Omega + 7.9 j\Omega$ |
| Return Loss                          | - 22.1 dB                   |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.148 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: 09.11.2021

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:921**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.87$  S/m;  $\epsilon_r = 39.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 28.12.2020
- 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=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 118.8 V/m; Power Drift = 0.00 dB

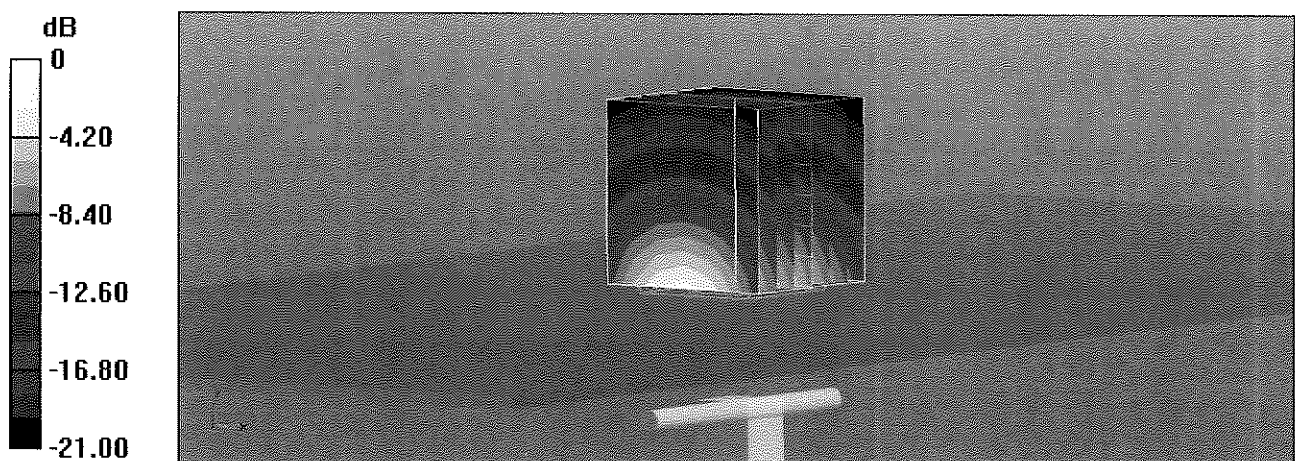
Peak SAR (extrapolated) = 26.7 W/kg

**SAR(1 g) = 13.8 W/kg; SAR(10 g) = 6.43 W/kg**

Smallest distance from peaks to all points 3 dB below = 9 mm

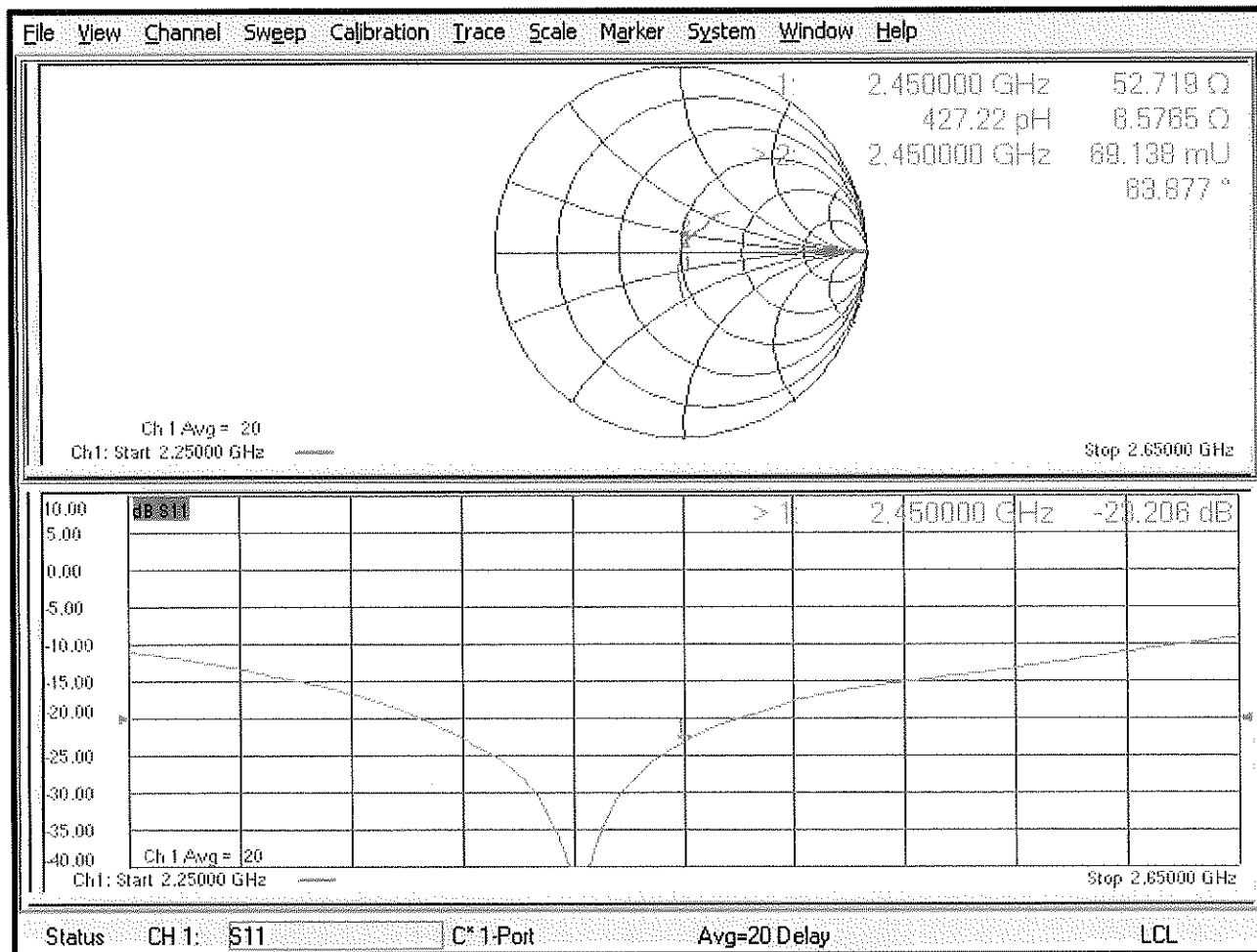
Ratio of SAR at M2 to SAR at M1 = 51.8%

Maximum value of SAR (measured) = 22.4 W/kg



0 dB = 22.4 W/kg = 13.49 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 09.11.2021

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:921**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.01$  S/m;  $\epsilon_r = 51.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12) @ 2450 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**

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

Reference Value = 108.3 V/m; Power Drift = -0.07 dB

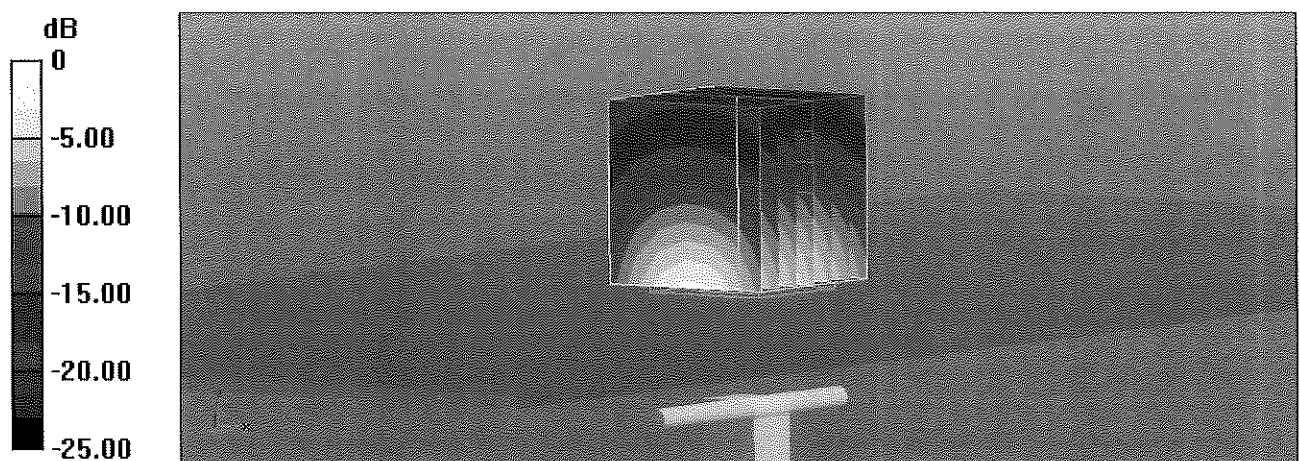
Peak SAR (extrapolated) = 23.5 W/kg

**SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.98 W/kg**

Smallest distance from peaks to all points 3 dB below = 9 mm

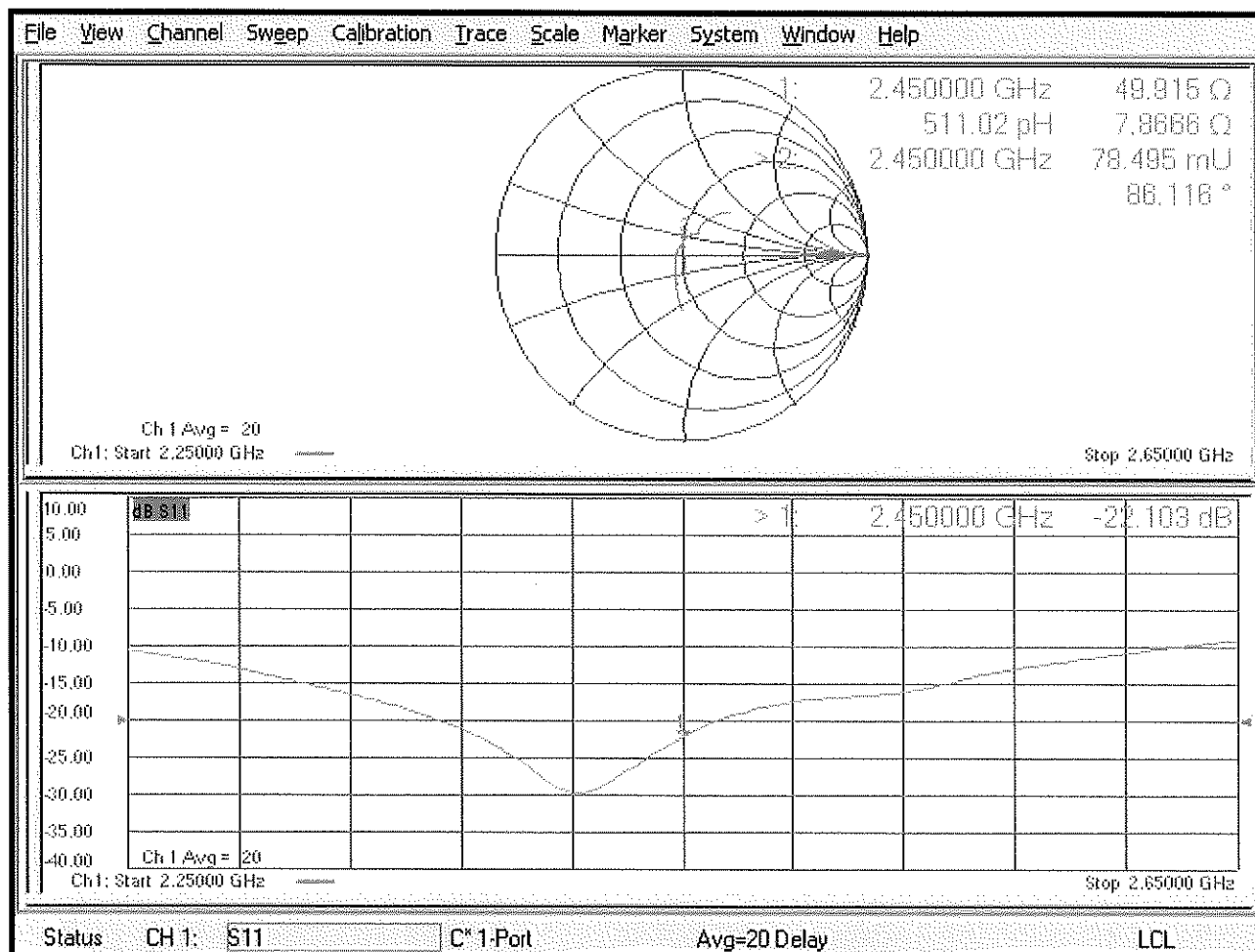
Ratio of SAR at M2 to SAR at M1 = 54.9%

Maximum value of SAR (measured) = 19.9 W/kg



0 dB = 19.9 W/kg = 12.99 dBW/kg

# Impedance Measurement Plot for Body TSL



## Certification of Calibration

Object: D2450V2 – SN: 921

Calibration procedure(s): Procedure for Calibration Extension for SAR Dipoles.

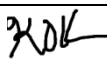
Extended Calibration date: November 09, 2022

Description: SAR Validation Dipole at 2450 MHz.

### Calibration Equipment used:

| Manufacturer       | Model         | Description                         | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|--------------------|---------------|-------------------------------------|------------|--------------|------------|---------------|
| Agilent            | 8753ES        | S-Parameter Vector Network Analyzer | 12/17/2021 | Annual       | 12/17/2022 | MY40000670    |
| Agilent            | E4438C        | ESG Vector Signal Generator         | 3/24/2022  | Annual       | 3/24/2023  | MY45093678    |
| Amplifier Research | 15S1G6        | Amplifier                           | CBT        | N/A          | CBT        | 343972        |
| Anritsu            | ML2495A       | Power Meter                         | 3/17/2022  | Annual       | 3/17/2023  | 0941001       |
| Anritsu            | MA2411B       | Pulse Power Sensor                  | 3/2/2022   | Annual       | 3/2/2023   | 1126066       |
| Anritsu            | MA2411B       | Pulse Power Sensor                  | 3/28/2022  | Annual       | 3/28/2023  | 1339007       |
| Traceable          | 4040 90080-06 | Therm./ Clock/ Humidity Monitor     | 5/11/2022  | Biennial     | 5/11/2024  | 221514974     |
| Control Company    | 4353          | Long Stem Thermometer               | 9/10/2021  | Biennial     | 9/10/2023  | 210774685     |
| Agilent            | 85033E        | 3.5mm Standard Calibration Kit      | 6/21/2022  | Annual       | 6/21/2023  | MY53402352    |
| Mini-Circuits      | VLF-6000+     | Low Pass Filter DC to 6000 MHz      | CBT        | N/A          | CBT        | N/A           |
| Narda              | 4772-3        | Attenuator (3dB)                    | CBT        | N/A          | CBT        | 9406          |
| Mini-Circuits      | ZHDC-16-63-S+ | 50-6000MHz Bidirectional Coupler    | CBT        | N/A          | CBT        | N/A           |
| Pasternack         | NC-100        | Torque Wrench                       | 3/19/2022  | Annual       | 3/19/2023  | N/A           |
| SPEAG              | DAK-3.5       | Dielectric Assessment Kit           | 4/11/2022  | Annual       | 4/11/2023  | 1323          |
| SPEAG              | EX3DV4        | SAR Probe                           | 3/22/2022  | Annual       | 3/22/2023  | 7421          |
| SPEAG              | EX3DV4        | SAR Probe                           | 1/19/2022  | Annual       | 1/19/2023  | 3837          |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 3/22/2022  | Annual       | 3/22/2023  | 604           |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 1/13/2022  | Annual       | 1/13/2023  | 793           |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name            | Function                      | Signature                                                                             |
|----------------|-----------------|-------------------------------|---------------------------------------------------------------------------------------|
| Calibrated By: | Arturo Oliveros | Associate Compliance Engineer |  |
| Approved By:   | Kaitlin O'Keefe | Managing Director             |  |

# DIPOLE CALIBRATION EXTENSION

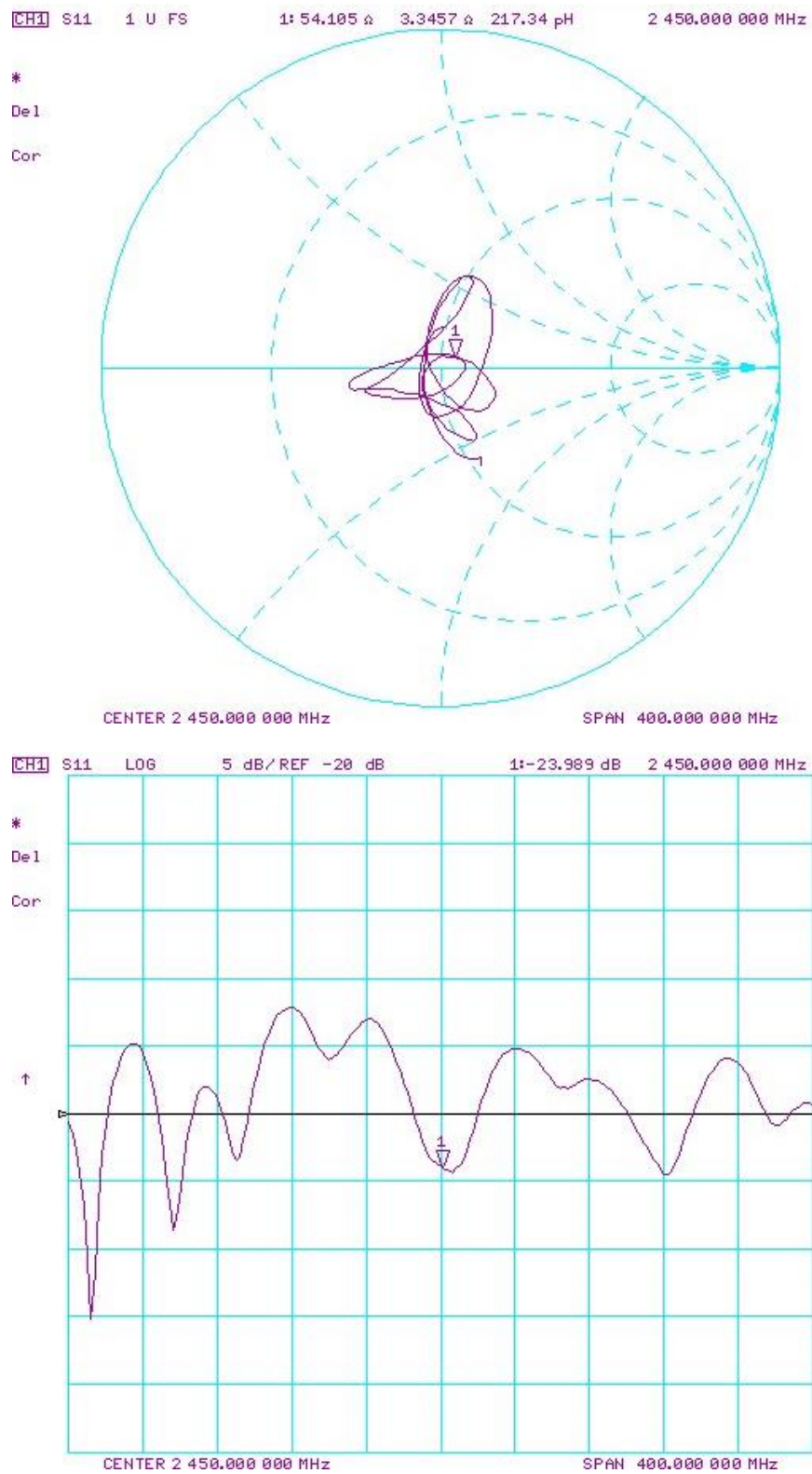
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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.

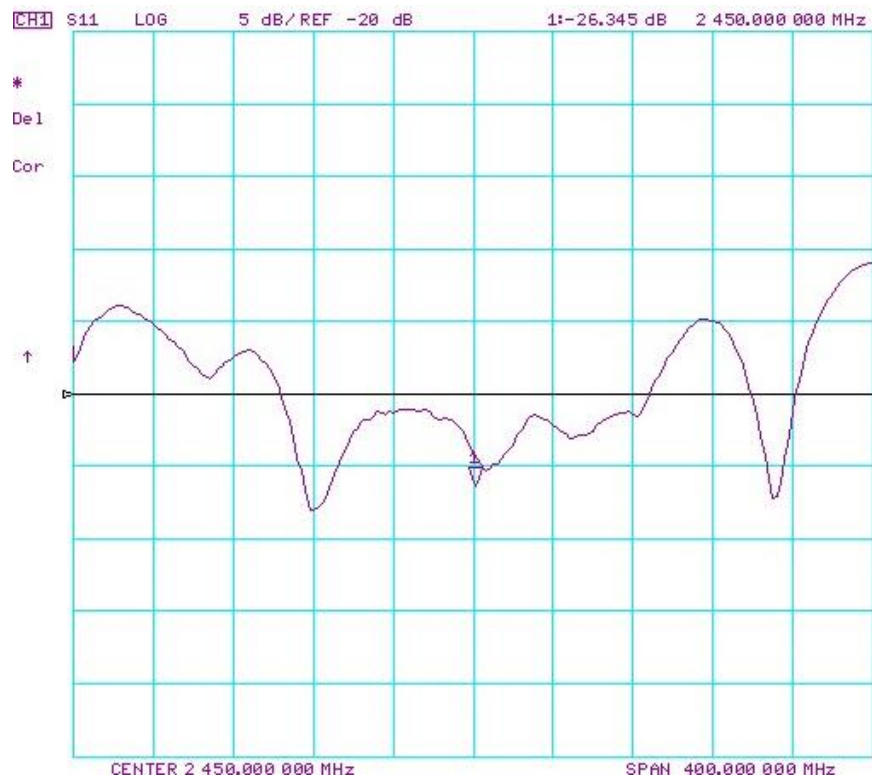
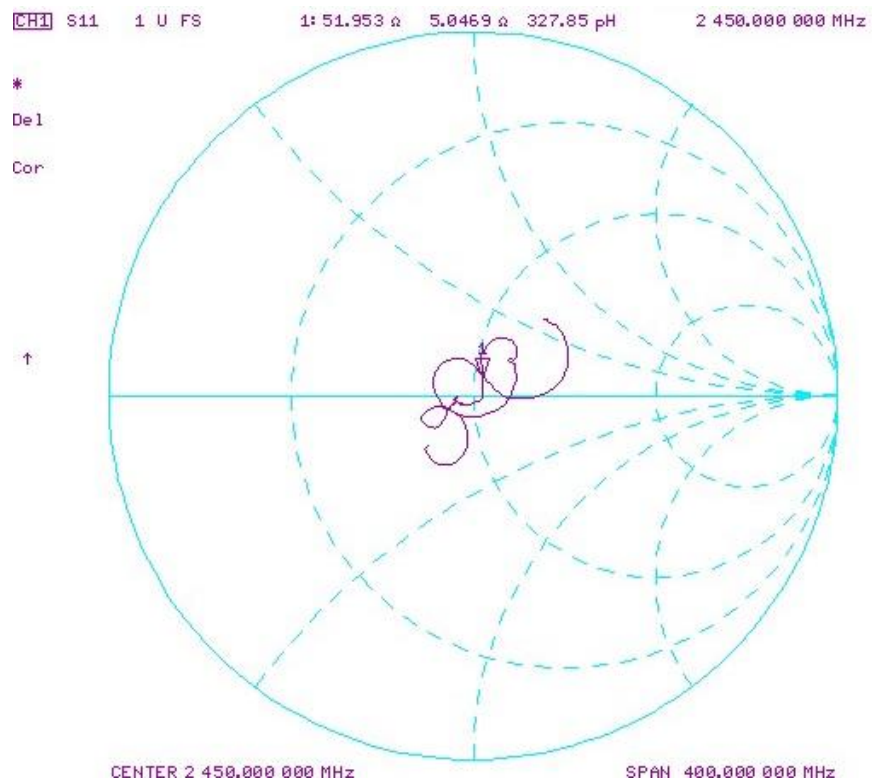
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|-----------|
| 11/9/2021        | 11/9/2022      | 1.148                             | 5.42                                             | 5.47                                   | 0.92%            | 2.55                                              | 2.56                                    | 0.39%             | 52.7                                  | 54.1                               | 1.4                   | 6.6                                        | 3.3                                     | 3.3                        | -23.2                             | -24                            | -3.40%        | PASS      |
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 20.0 dBm | Measured Body SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Body SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
| 11/9/2021        | 11/9/2022      | 1.148                             | 4.97                                             | 5.03                                   | 1.21%            | 2.36                                              | 2.34                                    | -0.85%            | 49.9                                  | 52                                 | 2.1                   | 7.9                                        | 5                                       | 2.9                        | -22.1                             | -26.3                          | -19.20%       | PASS      |

Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



## Certification of Calibration

Object D2450V2 – SN: 921

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

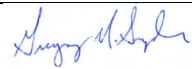
Extension Calibration date: November 9, 2023

Description: SAR Validation Dipole at 2450 MHz.

### Calibration Equipment used:

| Manufacturer       | Model         | Description                         | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|--------------------|---------------|-------------------------------------|------------|--------------|------------|---------------|
| Agilent            | 8753ES        | S-Parameter Vector Network Analyzer | 6/2/2023   | Annual       | 6/12/2024  | MY40003841    |
| Agilent            | E4438C        | ESG Vector Signal Generator         | 4/25/2023  | Annual       | 4/25/2024  | US41460739    |
| Amplifier Research | 15S1G6        | Amplifier                           | CBT        | N/A          | CBT        | 343972        |
| Rohde & Schwarz    | NRX           | Power Meter                         | 1/11/2023  | Annual       | 1/11/2024  | 102583        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 1/19/2023  | Annual       | 1/19/2024  | 106563        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 1/11/2023  | Annual       | 1/11/2024  | 106564        |
| Traceable          | 4040 90080-06 | Therm./ Clock/ Humidity Monitor     | 5/11/2022  | Biennial     | 5/11/2024  | 221514974     |
| Control Company    | 4353          | Ultra Long Stem Thermometer         | 10/24/2023 | Annual       | 10/24/2024 | 200645916     |
| Agilent            | 85033E        | 3.5mm Standard Calibration Kit      | 7/18/2023  | Annual       | 7/18/2024  | MY53402352    |
| Mini-Circuits      | VL6-6000+     | Low Pass Filter DC to 6000 MHz      | CBT        | N/A          | CBT        | N/A           |
| Narda              | 4772-3        | Attenuator (3dB)                    | CBT        | N/A          | CBT        | 9406          |
| Mini-Circuits      | ZHDC-16-63-S+ | 50-6000MHz Bidirectional Coupler    | CBT        | N/A          | CBT        | N/A           |
| Pasternack         | NC-100        | Torque Wrench                       | 12/5/2022  | Biennial     | 12/5/2024  | N/A           |
| SPEAG              | DAK-3.5       | Dielectric Assessment Kit           | 5/9/2023   | Annual       | 5/9/2024   | 1070          |
| SPEAG              | EX3DV4        | SAR Probe                           | 4/18/2023  | Annual       | 4/18/2024  | 7532          |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 4/14/2023  | Annual       | 4/14/2024  | 501           |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name            | Function                   | Signature                                                                             |
|----------------|-----------------|----------------------------|---------------------------------------------------------------------------------------|
| Calibrated By: | Arturo Oliveros | Compliance Engineer        |  |
| Approved By:   | Greg Snyder     | Executive VP of Operations |  |

# DIPOLE CALIBRATION EXTENSION

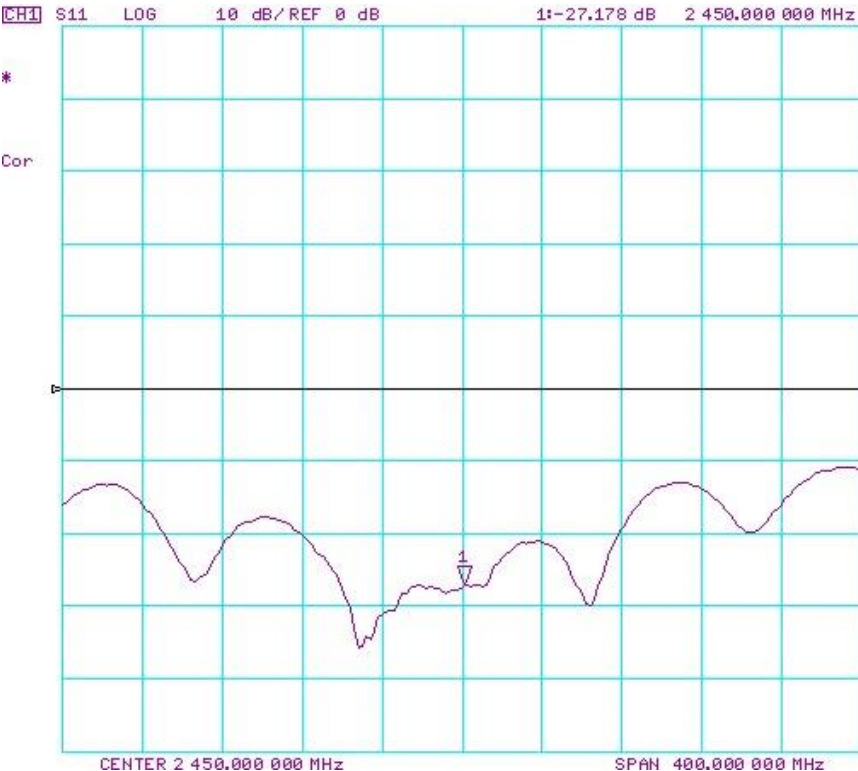
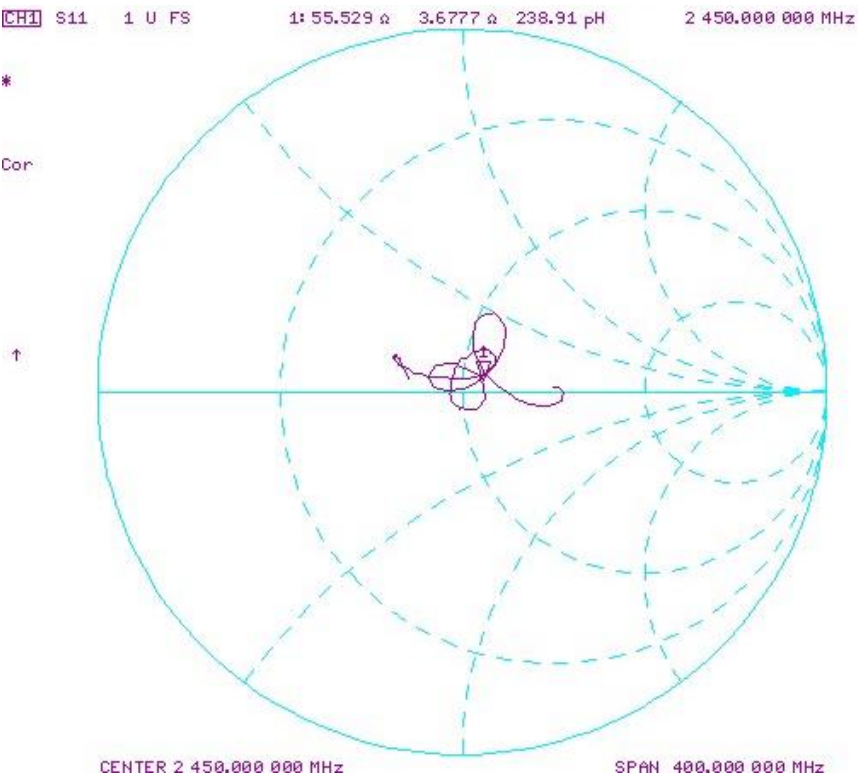
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) |
|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|
| 11/9/2021        | 11/9/2023      | 1.148                             | 5.42                                             | 5.43                                   | 0.18%            | 2.55                                              | 2.48                                    | -2.75%            | 52.7                                  | 55.5                               | 2.8                   | 6.6                                        | 3.7                                     | 2.9                        | -23.2                             | -27.2                          | -17.10%       |

Impedance & Return-Loss Measurement Plot for Head TSL





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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**

Client **Element**

Certificate No: **D2450V2-855\_Nov22**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN:855**

Calibration procedure(s) **QA CAL-05.v11**  
**Calibration Procedure for SAR Validation Sources between 0.7-3 GHz**

Calibration date: **November 15, 2022**

✓ *ATM*

*12/16/22*

✓ **YW 12/13/2023**

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 ( $22 \pm 3$ )°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         | 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: 7349           | 31-Dec-21 (No. EX3-7349_Dec21)    | Dec-22                 |
| DAE4                            | SN: 601            | 31-Aug-22 (No. DAE4-601_Aug22)    | Aug-23                 |
| 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: **Jeton Kastrati** **Laboratory Technician**

Signature *[Handwritten Signature]*

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

Signature *[Handwritten Signature]*

Issued: November 16, 2022

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

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   |             |
| Distance Dipole Center - TSL | 10 mm                  | with Spacer |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |             |
| Frequency                    | 2450 MHz $\pm$ 1 MHz   |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 39.2           | 1.80 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 38.4 $\pm$ 6 % | 1.87 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                                          | 250 mW input power | 13.4 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 52.4 W/kg $\pm$ 17.0 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 6.24 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 24.6 W/kg $\pm$ 16.5 % (k=2) |

## Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 52.7           | 1.95 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 51.7 $\pm$ 6 % | 2.01 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

## SAR result with Body TSL

|                                                       |                    |                              |
|-------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                              |
| SAR measured                                          | 250 mW input power | 12.8 W/kg                    |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 50.2 W/kg $\pm$ 17.0 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 6.03 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 23.8 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 | $52.5 \Omega + 6.3 j\Omega$ |
| Return Loss                          | - 23.6 dB                   |

### Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $48.9 \Omega + 7.9 j\Omega$ |
| Return Loss                          | - 21.9 dB                   |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.157 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: 15.11.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:855**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.87$  S/m;  $\epsilon_r = 38.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 31.08.2022
- 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=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 116.1 V/m; Power Drift = 0.01 dB

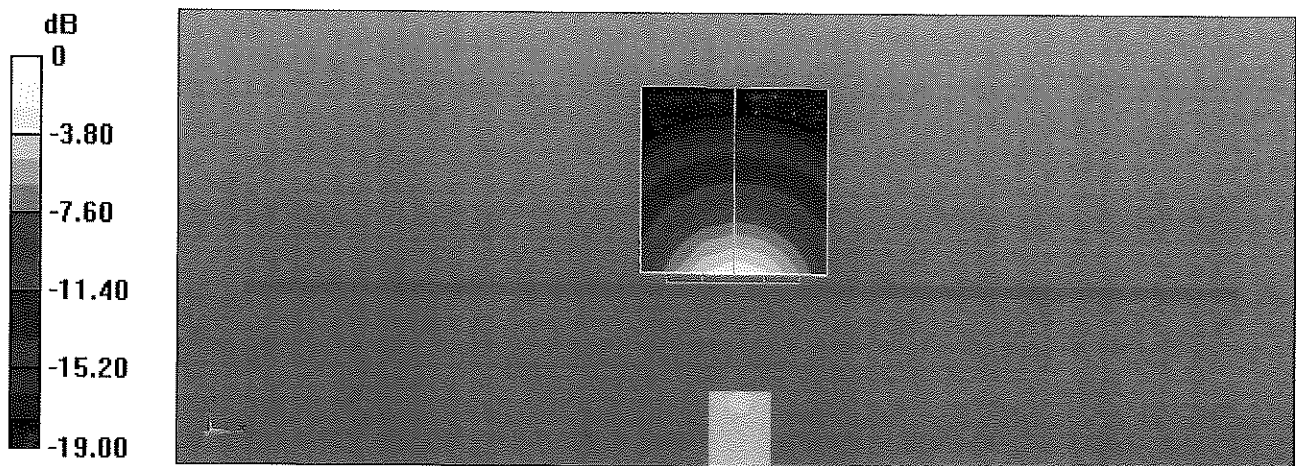
Peak SAR (extrapolated) = 26.2 W/kg

**SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.24 W/kg**

Smallest distance from peaks to all points 3 dB below = 9 mm

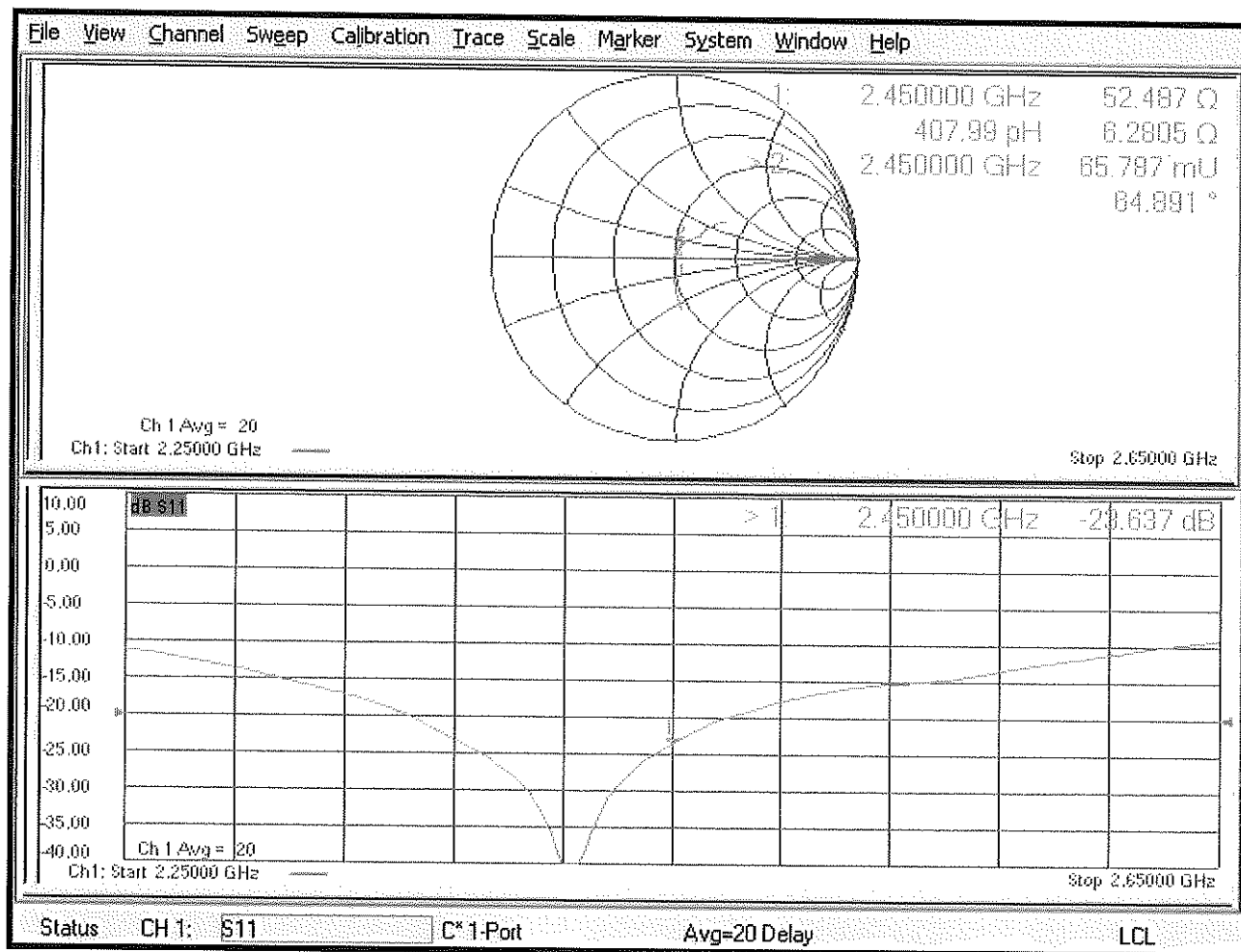
Ratio of SAR at M2 to SAR at M1 = 51.1%

Maximum value of SAR (measured) = 22.0 W/kg



0 dB = 22.0 W/kg = 13.42 dBW/kg

# Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 15.11.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:855**

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.01$  S/m;  $\epsilon_r = 51.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 31.08.2022
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

### Dipole Calibration for Body Tissue/ $P_{in}=250$ mW, $d=10$ mm 2/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 108.4 V/m; Power Drift = -0.04 dB

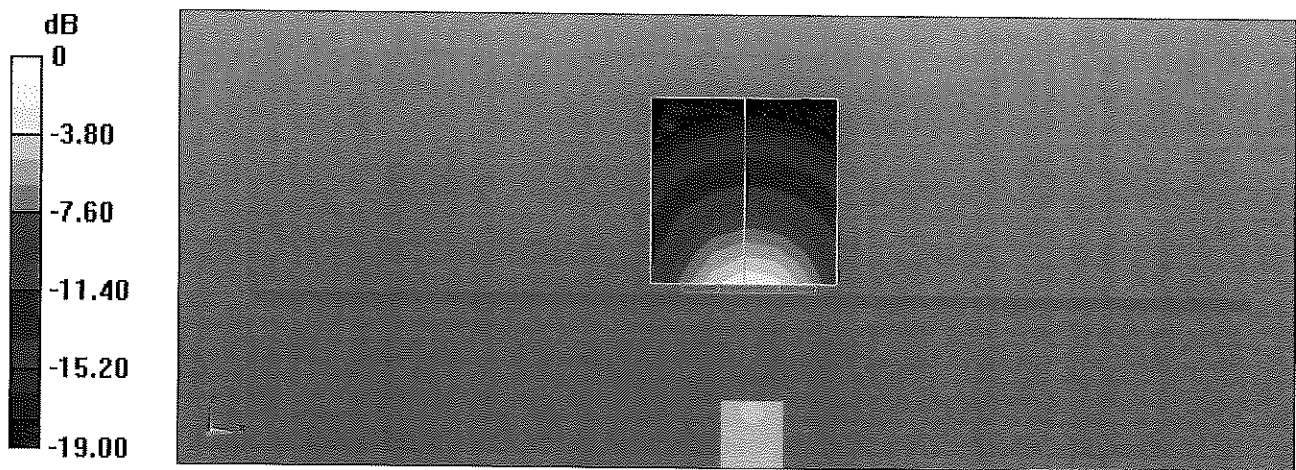
Peak SAR (extrapolated) = 24.1 W/kg

**SAR(1 g) = 12.8 W/kg; SAR(10 g) = 6.03 W/kg**

Smallest distance from peaks to all points 3 dB below = 8.9 mm

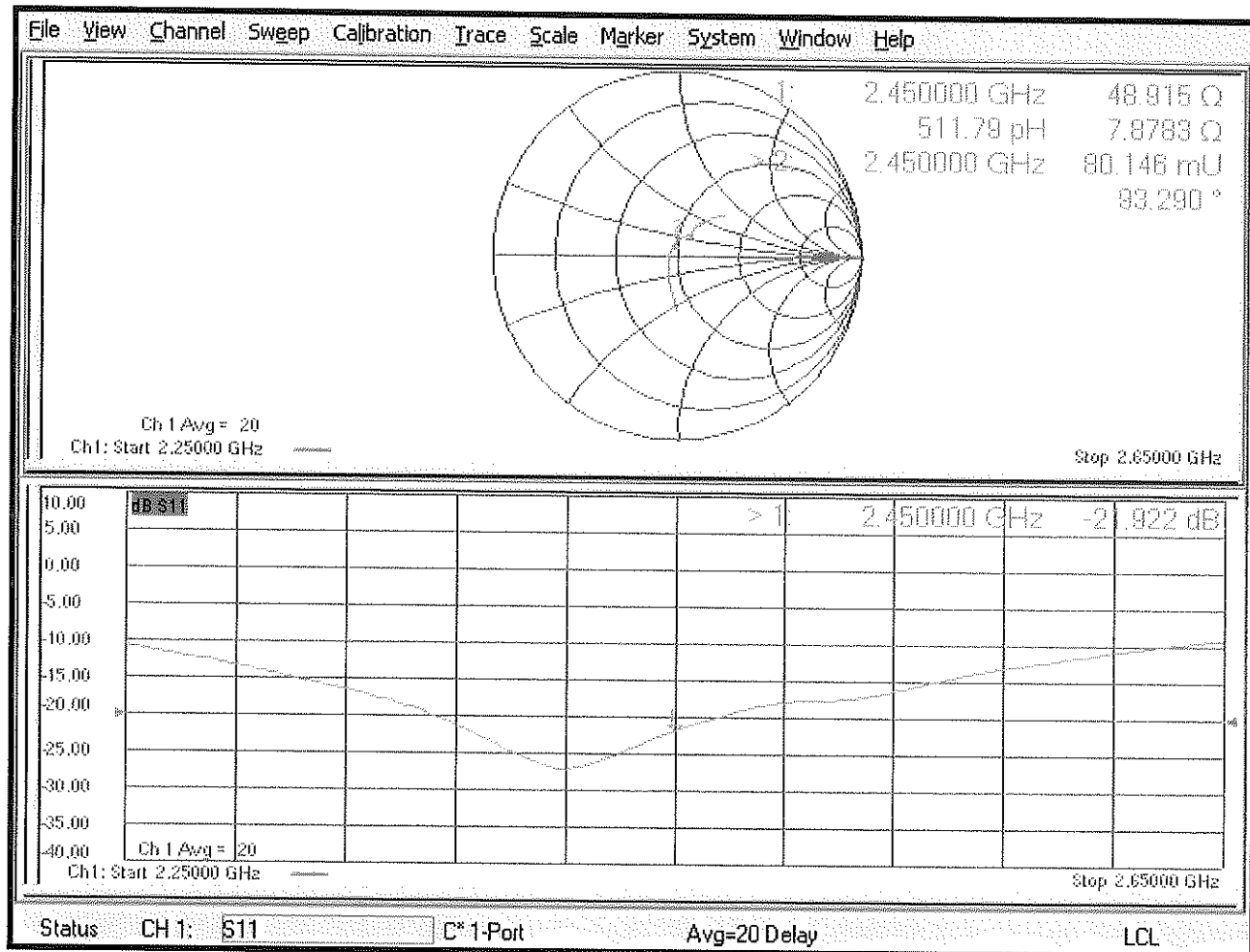
Ratio of SAR at M2 to SAR at M1 = 53.7%

Maximum value of SAR (measured) = 20.4 W/kg



0 dB = 20.4 W/kg = 13.10 dBW/kg

## Impedance Measurement Plot for Body TSL



## Certification of Calibration

Object: D2450V2 – SN: 855

Calibration procedure(s): Procedure for Calibration Extension for SAR Dipoles.

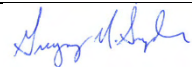
Extension Calibration date: November 15, 2023

Description: SAR Validation Dipole at 2450 MHz.

### Calibration Equipment used:

| Manufacturer       | Model         | Description                         | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|--------------------|---------------|-------------------------------------|------------|--------------|------------|---------------|
| Agilent            | 8753ES        | S-Parameter Vector Network Analyzer | 6/2/2023   | Annual       | 6/12/2024  | MY40003841    |
| Agilent            | E4438C        | ESG Vector Signal Generator         | 4/25/2023  | Annual       | 4/25/2024  | US41460739    |
| Amplifier Research | 15S1G6        | Amplifier                           | CBT        | N/A          | CBT        | 343972        |
| Rohde & Schwarz    | NRX           | Power Meter                         | 1/11/2023  | Annual       | 1/11/2024  | 102583        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 1/19/2023  | Annual       | 1/19/2024  | 106563        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 1/11/2023  | Annual       | 1/11/2024  | 106564        |
| Traceable          | 4040 90080-06 | Therm./ Clock/ Humidity Monitor     | 5/11/2022  | Biennial     | 5/11/2024  | 221514974     |
| Control Company    | 4353          | Ultra Long Stem Thermometer         | 10/24/2023 | Annual       | 10/24/2024 | 200645916     |
| Agilent            | 85033E        | 3.5mm Standard Calibration Kit      | 7/18/2023  | Annual       | 7/18/2024  | MY53402352    |
| Mini-Circuits      | VLF-6000+     | Low Pass Filter DC to 6000 MHz      | CBT        | N/A          | CBT        | N/A           |
| Narda              | 4772-3        | Attenuator (3dB)                    | CBT        | N/A          | CBT        | 9406          |
| Mini-Circuits      | ZHDC-16-63-S+ | 50-6000MHz Bidirectional Coupler    | CBT        | N/A          | CBT        | N/A           |
| Pasternack         | NC-100        | Torque Wrench                       | 12/5/2022  | Biennial     | 12/5/2024  | N/A           |
| SPEAG              | DAK-3.5       | Dielectric Assessment Kit           | 5/9/2023   | Annual       | 5/9/2024   | 1070          |
| SPEAG              | EX3DV4        | SAR Probe                           | 11/9/2023  | Annual       | 11/9/2024  | 7639          |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 11/14/2023 | Annual       | 11/14/2024 | 1403          |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name            | Function                   | Signature                                                                             |
|----------------|-----------------|----------------------------|---------------------------------------------------------------------------------------|
| Calibrated By: | Arturo Oliveros | Compliance Engineer        |  |
| Approved By:   | Greg Snyder     | Executive VP of Operations |  |

# DIPOLE CALIBRATION EXTENSION

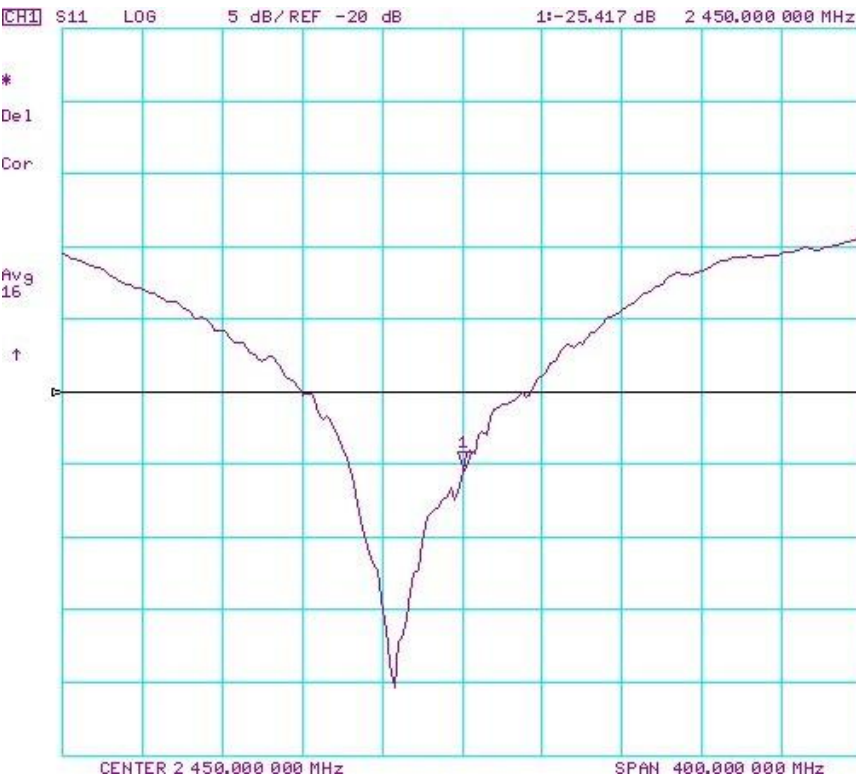
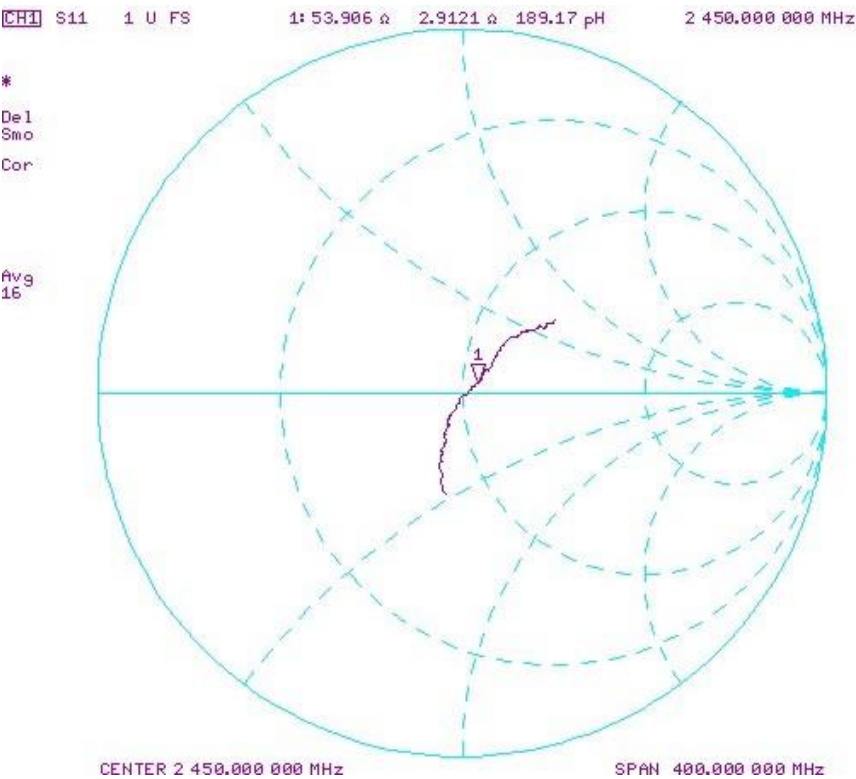
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) |
|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|
| 11/15/2022       | 11/15/2023     | 1.157                             | 5.24                                             | 5.13                                   | -2.10%           | 2.46                                              | 2.38                                    | -3.25%            | 52.5                                  | 53.9                               | 1.4                   | 6.3                                        | 2.9                                     | 3.4                        | -23.6                             | -25.4                          | -7.70%        |

Impedance & Return-Loss Measurement Plot for Head TSL





Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **Element**

Certificate No: **D2600V2-1042\_May22**

## CALIBRATION CERTIFICATE

Object **D2600V2 - SN:1042**

Calibration procedure(s) **QA CAL-05.v11**  
**Calibration Procedure for SAR Validation Sources between 0.7-3 GHz**

Calibration date: **May 11, 2022**

✓ **YW 5/22/2023**

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 ( $22 \pm 3$ )°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         | 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: 7349           | 31-Dec-21 (No. EX3-7349_Dec21)    | Dec-22                 |
| DAE4                            | SN: 601            | 02-May-22 (No. DAE4-601_May22)    | May-23                 |
| 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: **Aldonia Georgiadou** **Laboratory Technician**

Signature

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

Issued: May 12, 2022

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



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

**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.

|                                     |                        |             |
|-------------------------------------|------------------------|-------------|
| <b>DASY Version</b>                 | DASY52                 | V52.10.4    |
| <b>Extrapolation</b>                | Advanced Extrapolation |             |
| <b>Phantom</b>                      | Modular Flat Phantom   |             |
| <b>Distance Dipole Center - TSL</b> | 10 mm                  | with Spacer |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm      |             |
| <b>Frequency</b>                    | 2600 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             | 39.0           | 1.96 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 37.6 $\pm$ 6 % | 2.02 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                                                | 250 mW input power | 14.2 W/kg                                      |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>55.8 W/kg <math>\pm</math> 17.0 % (k=2)</b> |

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | condition          |                                                |
| SAR measured                                                  | 250 mW input power | 6.30 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>24.9 W/kg <math>\pm</math> 16.5 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Body TSL parameters</b>             | 22.0 °C             | 52.5           | 2.16 mho/m           |
| <b>Measured Body TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 51.1 $\pm$ 6 % | 2.20 mho/m $\pm$ 6 % |
| <b>Body TSL temperature change during test</b> | < 0.5 °C            | ----           | ----                 |

## SAR result with Body TSL

|                                                             |                    |                                                |
|-------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                                                |
| SAR measured                                                | 250 mW input power | 13.6 W/kg                                      |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>53.7 W/kg <math>\pm</math> 17.0 % (k=2)</b> |

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                                                |
| SAR measured                                                  | 250 mW input power | 6.04 W/kg                                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>24.0 W/kg <math>\pm</math> 16.5 % (k=2)</b> |

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

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 47.5 $\Omega$ - 8.9 j $\Omega$ |
| Return Loss                          | - 20.5 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 44.2 $\Omega$ - 7.2 j $\Omega$ |
| Return Loss                          | - 20.2 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.150 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: 11.05.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1042**

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used:  $f = 2600$  MHz;  $\sigma = 2.02$  S/m;  $\epsilon_r = 37.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.84, 7.84, 7.84) @ 2600 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- 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=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**

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

Reference Value = 117.1 V/m; Power Drift = 0.00 dB

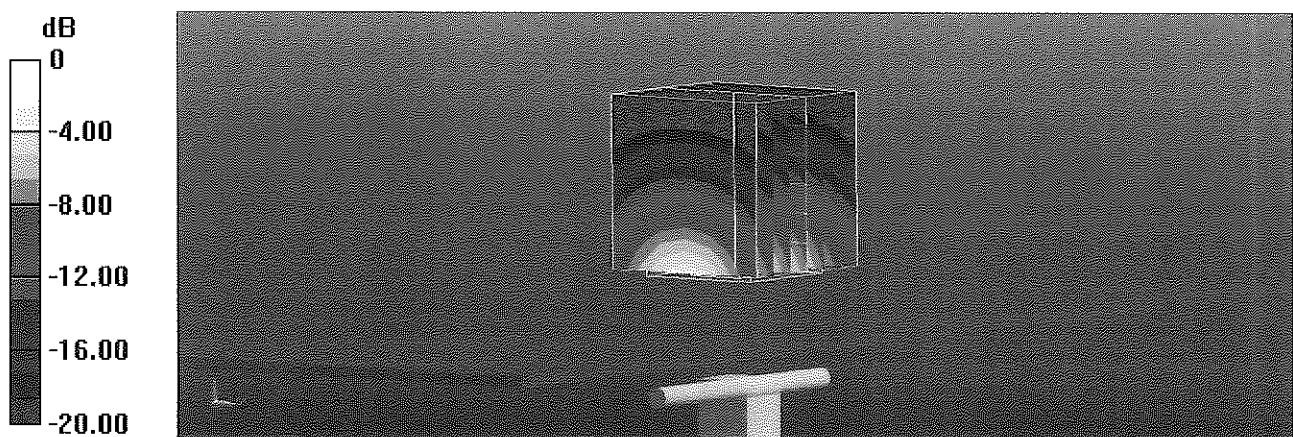
Peak SAR (extrapolated) = 28.9 W/kg

**SAR(1 g) = 14.2 W/kg; SAR(10 g) = 6.3 W/kg**

Smallest distance from peaks to all points 3 dB below = 9 mm

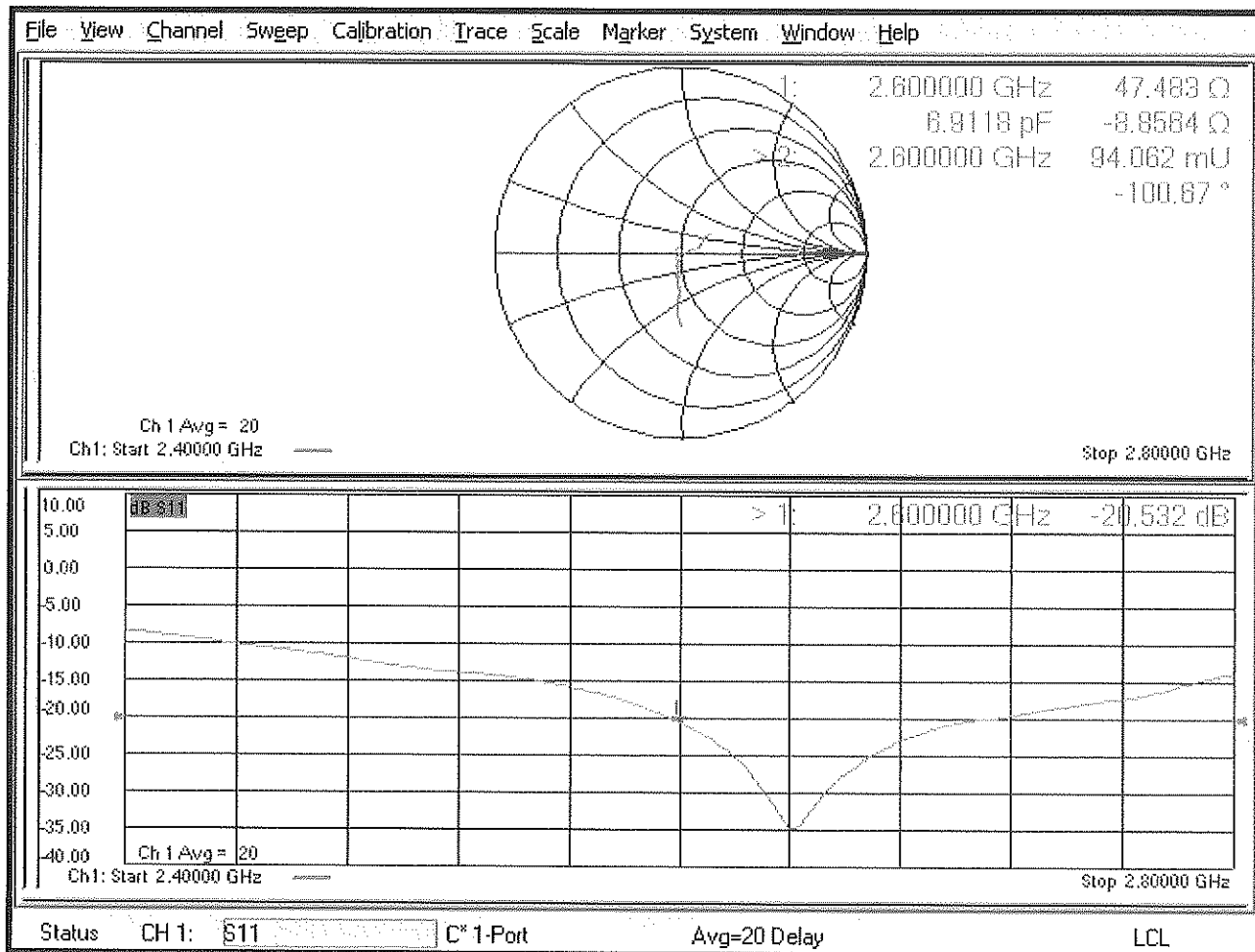
Ratio of SAR at M2 to SAR at M1 = 49.3%

Maximum value of SAR (measured) = 24.1 W/kg



0 dB = 24.1 W/kg = 13.83 dBW/kg

# Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 11.05.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1042**

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used:  $f = 2600$  MHz;  $\sigma = 2.2$  S/m;  $\epsilon_r = 51.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.91, 7.91, 7.91) @ 2600 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.05.2022
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

### **Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**

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

Reference Value = 107.5 V/m; Power Drift = -0.07 dB

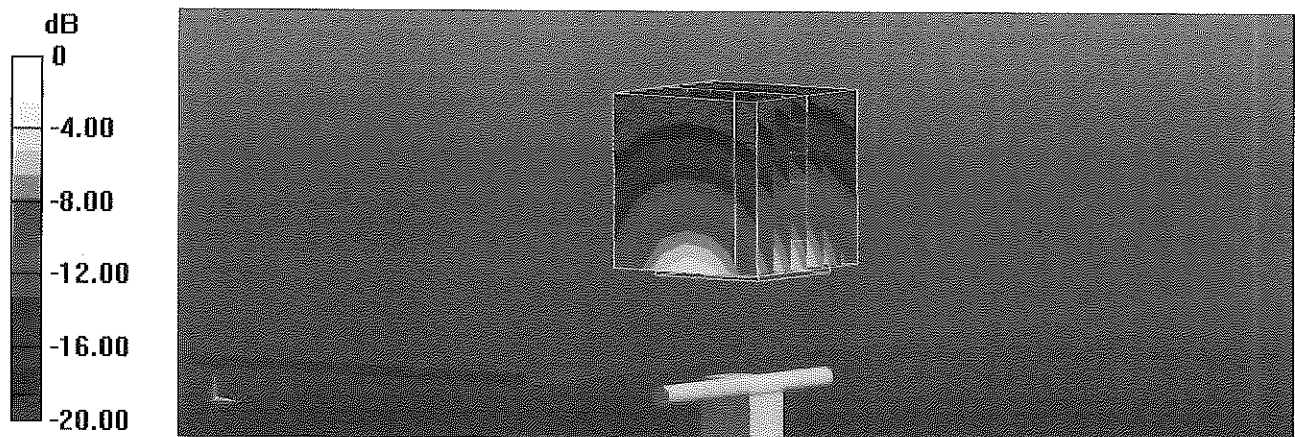
Peak SAR (extrapolated) = 27.0 W/kg

**SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.04 W/kg**

Smallest distance from peaks to all points 3 dB below = 8.5 mm

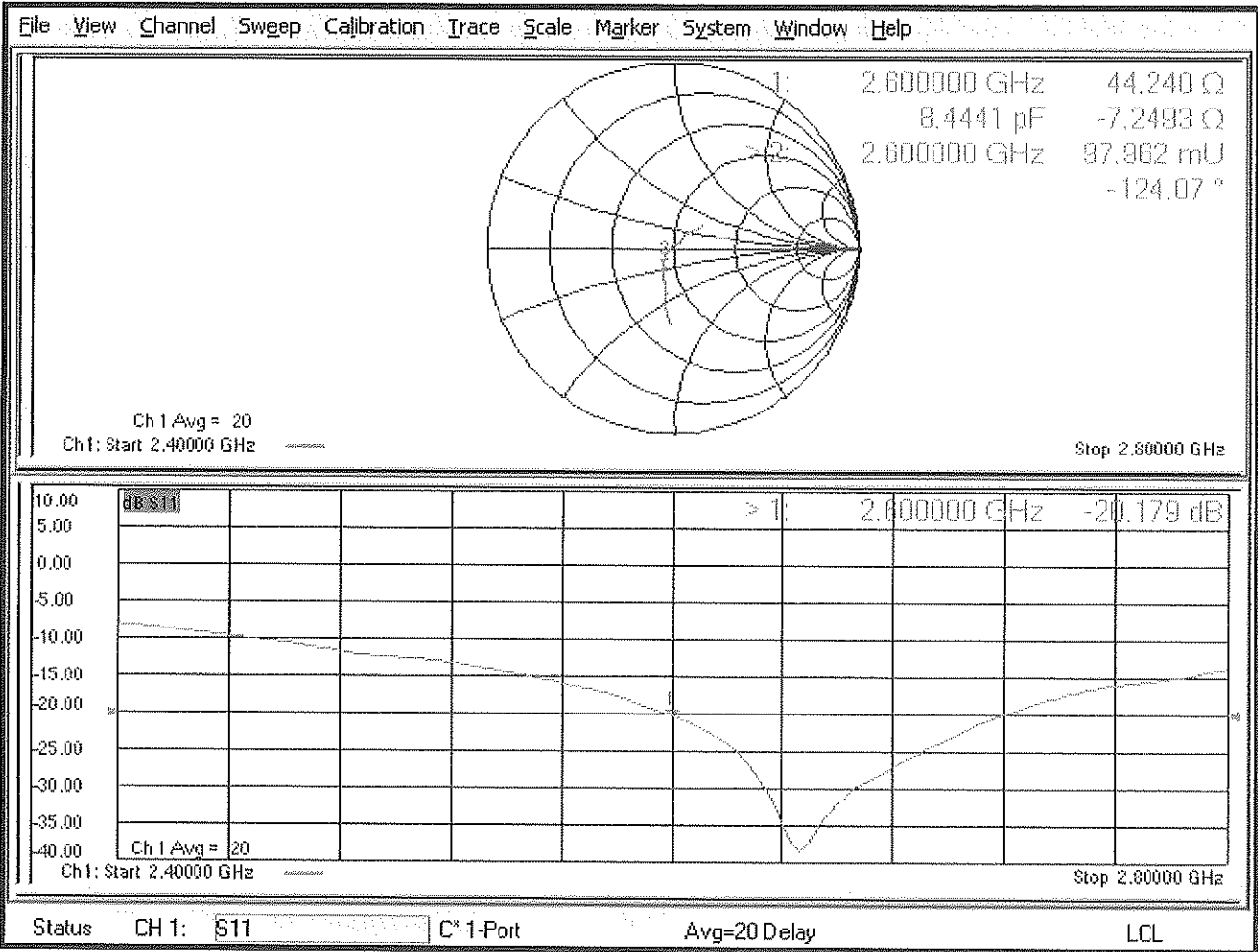
Ratio of SAR at M2 to SAR at M1 = 50.9%

Maximum value of SAR (measured) = 22.4 W/kg



0 dB = 22.4 W/kg = 13.49 dBW/kg

Impedance Measurement Plot for Body TSL



## Certification of Calibration

Object: D2600V2 – SN: 1042

Calibration procedure(s): Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: May 11, 2023

Description: SAR Validation Dipole at 2600 MHz.

### Calibration Equipment used:

| Manufacturer       | Model         | Description                         | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|--------------------|---------------|-------------------------------------|------------|--------------|------------|---------------|
| Agilent            | 8753ES        | S-Parameter Vector Network Analyzer | 6/14/2022  | Annual       | 6/14/2023  | US39170118    |
| Agilent            | E4438C        | ESG Vector Signal Generator         | 11/17/2022 | Annual       | 11/17/2023 | MY45093852    |
| Amplifier Research | 15S1G6        | Amplifier                           | CBT        | N/A          | CBT        | 343972        |
| Rohde & Schwarz    | NRX           | Power Meter                         | 1/11/2023  | Annual       | 1/11/2024  | 102583        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 5/19/2022  | Annual       | 5/19/2023  | 106562        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 5/19/2022  | Annual       | 5/19/2023  | 106559        |
| Traceable          | 4040 90080-06 | Therm./ Clock/ Humidity Monitor     | 5/11/2022  | Biennial     | 5/11/2024  | 221514974     |
| Control Company    | 4353          | Long Stem Thermometer               | 9/10/2021  | Biennial     | 9/10/2023  | 210774685     |
| Agilent            | 85033E        | 3.5mm Standard Calibration Kit      | 6/21/2022  | Annual       | 6/21/2023  | MY53402352    |
| Mini-Circuits      | VLF-6000+     | Low Pass Filter DC to 6000 MHz      | CBT        | N/A          | CBT        | N/A           |
| Narda              | 4772-3        | Attenuator (3dB)                    | CBT        | N/A          | CBT        | 9406          |
| Mini-Circuits      | ZHDC-16-63-S+ | 50-6000MHz Bidirectional Coupler    | CBT        | N/A          | CBT        | N/A           |
| Pasternack         | NC-100        | Torque Wrench                       | 12/5/2022  | Biennial     | 12/5/2024  | N/A           |
| SPEAG              | DAK-3.5       | Dielectric Assessment Kit           | 8/15/2022  | Annual       | 8/15/2023  | 1041          |
| SPEAG              | EX3DV4        | SAR Probe                           | 2/13/2023  | Annual       | 2/13/2024  | 7427          |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 2/15/2023  | Annual       | 2/15/2024  | 1403          |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name            | Function                   | Signature                                                                             |
|----------------|-----------------|----------------------------|---------------------------------------------------------------------------------------|
| Calibrated By: | Arturo Oliveros | Compliance Engineer I      |  |
| Approved By:   | Greg Snyder     | Executive VP of Operations |  |

# DIPOLE CALIBRATION EXTENSION

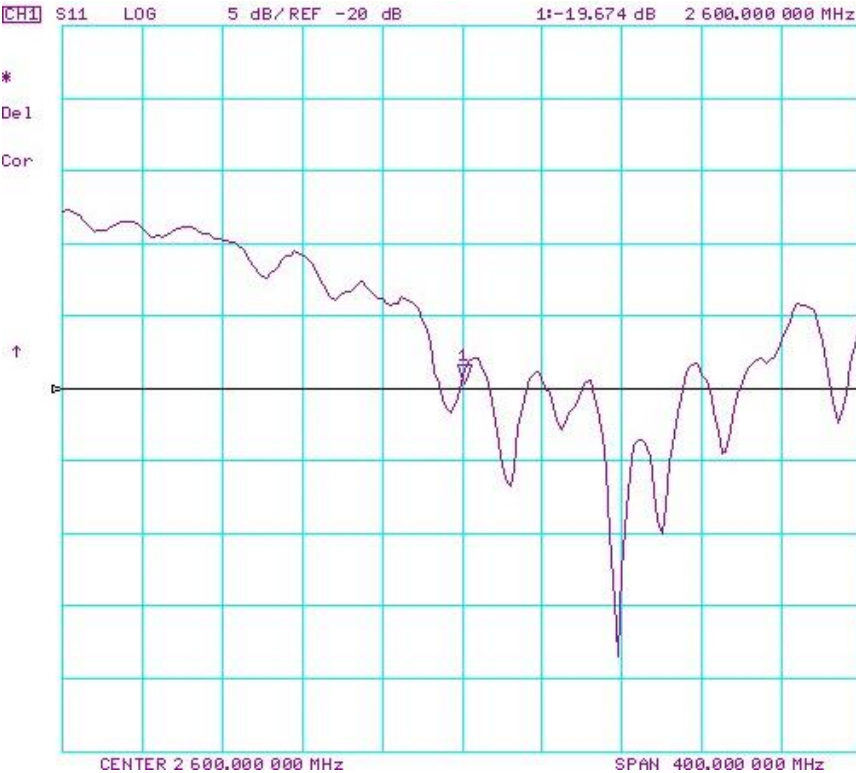
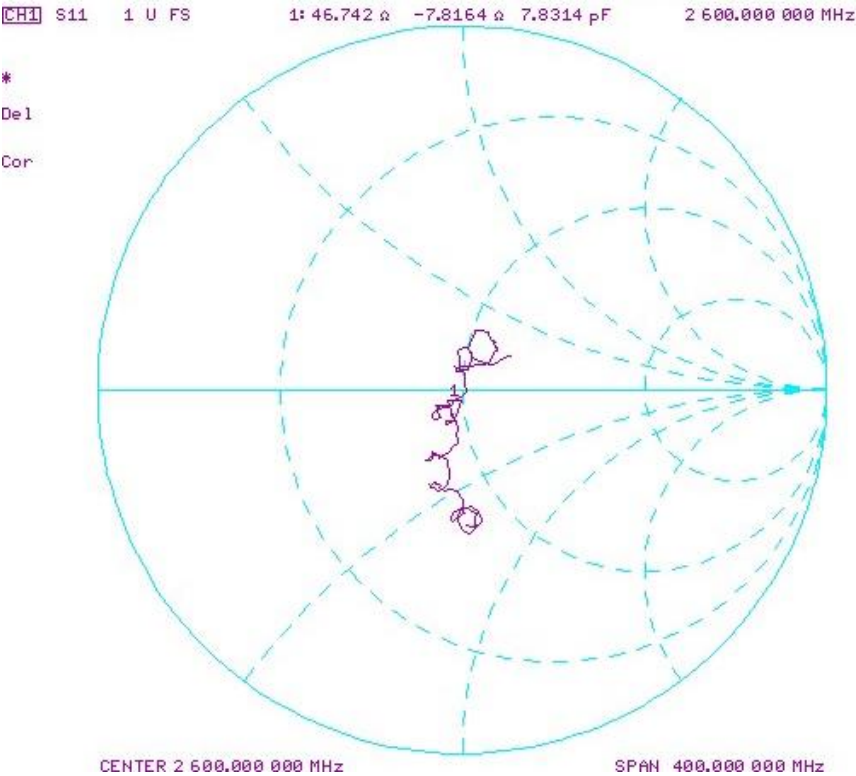
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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.

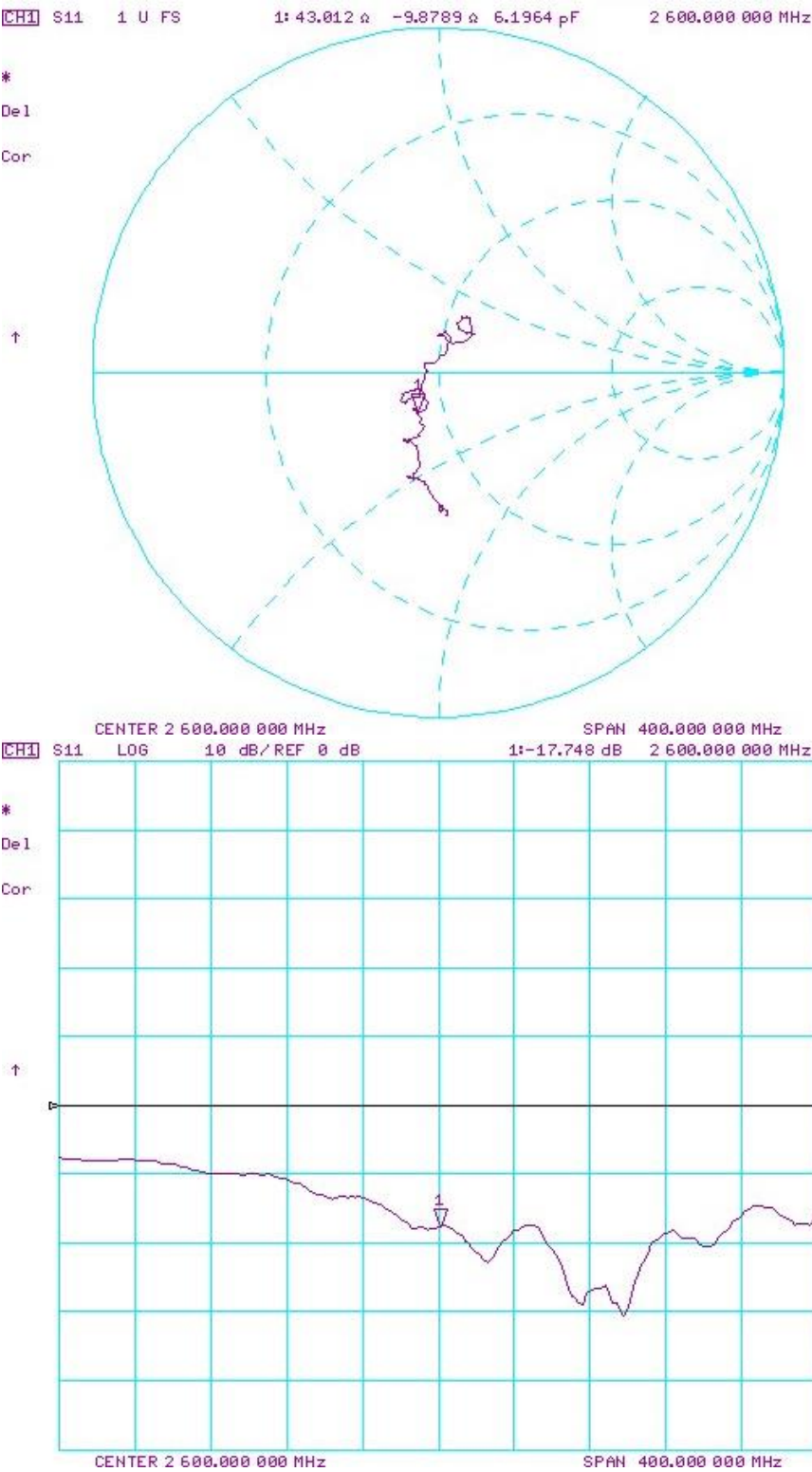
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|-----------|
| 5/11/2022        | 5/11/2023      | 1.15                              | 5.58                                             | 5.63                                   | 0.90%            | 2.49                                              | 2.52                                    | 1.20%             | 47.5                                  | 46.7                               | 0.8                   | -8.9                                       | -7.8                                    | 1.1                        | -20.5                             | -19.7                          | 4.00%         | PASS      |
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 20.0 dBm | Measured Body SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Body SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
| 5/11/2022        | 5/11/2023      | 1.15                              | 5.37                                             | 5.53                                   | 2.98%            | 2.4                                               | 2.54                                    | 5.83%             | 44.2                                  | 43                                 | 1.2                   | -7.2                                       | -9.9                                    | 2.7                        | -20.2                             | -17.7                          | 12.10%        | PASS      |

Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL





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 **Element**

Certificate No: **D2600V2-1068\_Nov22**

## CALIBRATION CERTIFICATE

Object **D2600V2 - SN:1068**

Calibration procedure(s) **QA CAL-05.v11**  
**Calibration Procedure for SAR Validation Sources between 0.7-3 GHz**

Calibration date: **November 15, 2022**

✓  
 ATM

12/6/22

✓ YW 12/28/2023

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  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)      | Scheduled Calibration |
|-----------------------------|--------------------|---------------------------------|-----------------------|
| Power meter NRP             | SN: 104778         | 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: 7349           | 31-Dec-21 (No. EX3-7349_Dec21)  | Dec-22                |
| DAE4                        | SN: 601            | 31-Aug-22 (No. DAE4-601_Aug22)  | Aug-23                |

| 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 |

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

Issued: November 16, 2022

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



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

**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, dz = 5 mm      |             |
| Frequency                    | 2600 MHz $\pm$ 1 MHz   |             |

## Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 39.0           | 1.96 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 37.8 $\pm$ 6 % | 2.03 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                                          | 250 mW input power | 14.4 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 56.5 W/kg $\pm$ 17.0 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 6.43 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 25.4 W/kg $\pm$ 16.5 % (k=2) |

## Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 52.5           | 2.16 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 51.3 $\pm$ 6 % | 2.19 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

## SAR result with Body TSL

|                                                       |                    |                              |
|-------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                              |
| SAR measured                                          | 250 mW input power | 13.6 W/kg                    |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 53.9 W/kg $\pm$ 17.0 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                              |
| SAR measured                                            | 250 mW input power | 6.07 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 24.1 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 | 47.8 $\Omega$ - 5.9 j $\Omega$ |
| Return Loss                          | - 23.9 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 44.5 $\Omega$ - 5.0 j $\Omega$ |
| Return Loss                          | - 22.1 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.148 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: 15.11.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1068**

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used:  $f = 2600$  MHz;  $\sigma = 2.03$  S/m;  $\epsilon_r = 37.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.84, 7.84, 7.84) @ 2600 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 31.08.2022
- 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=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 118.5 V/m; Power Drift = 0.01 dB

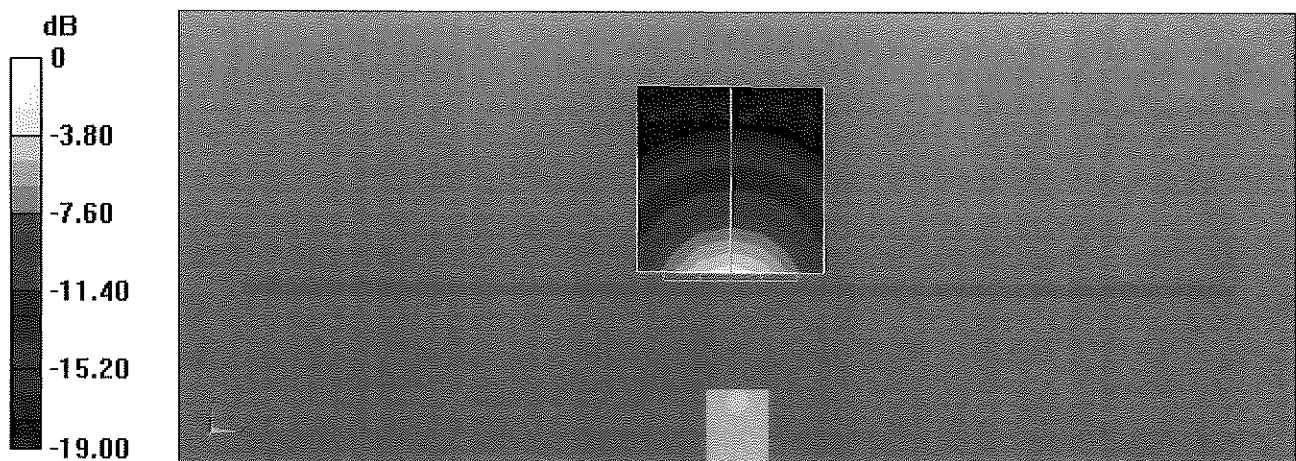
Peak SAR (extrapolated) = 29.2 W/kg

**SAR(1 g) = 14.4 W/kg; SAR(10 g) = 6.43 W/kg**

Smallest distance from peaks to all points 3 dB below = 9 mm

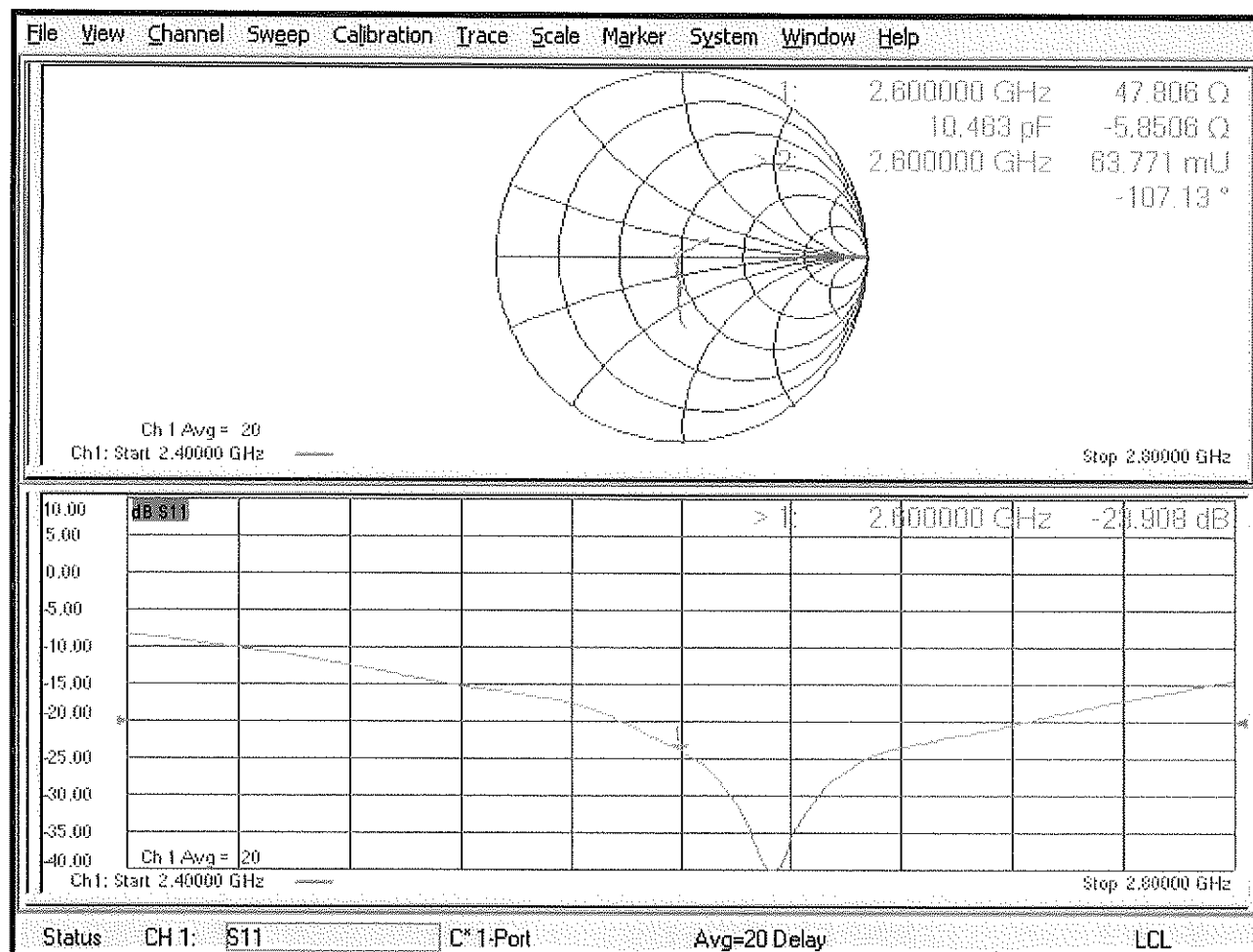
Ratio of SAR at M2 to SAR at M1 = 49.4%

Maximum value of SAR (measured) = 24.5 W/kg



0 dB = 24.5 W/kg = 13.88 dBW/kg

# Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 15.11.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1068**

Communication System: UID 0 - CW; Frequency: 2600 MHz

Medium parameters used:  $f = 2600$  MHz;  $\sigma = 2.19$  S/m;  $\epsilon_r = 51.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.91, 7.91, 7.91) @ 2600 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 31.08.2022
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

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

Reference Value = 107.9 V/m; Power Drift = -0.05 dB

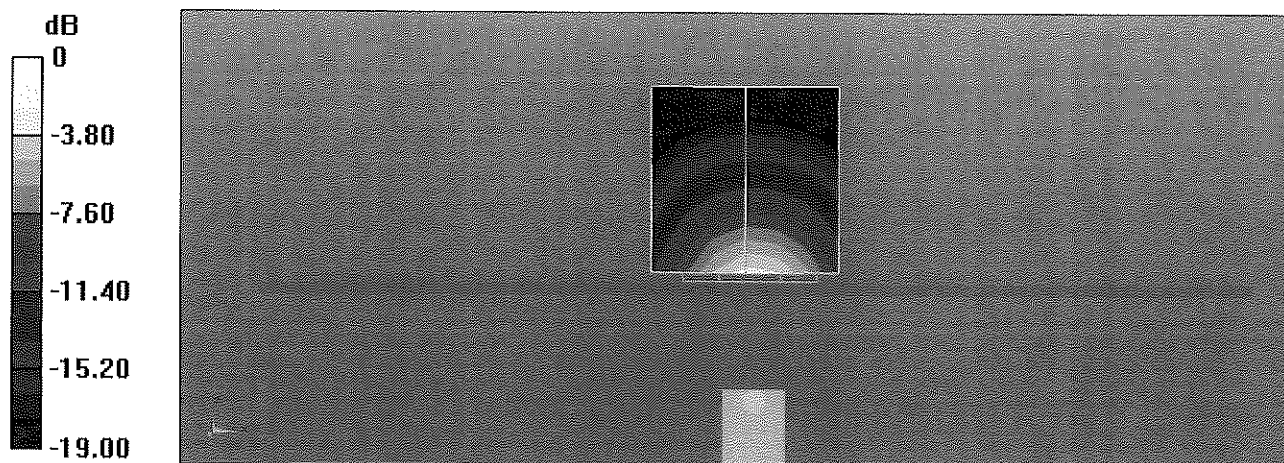
Peak SAR (extrapolated) = 27.0 W/kg

**SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.07 W/kg**

Smallest distance from peaks to all points 3 dB below = 8.5 mm

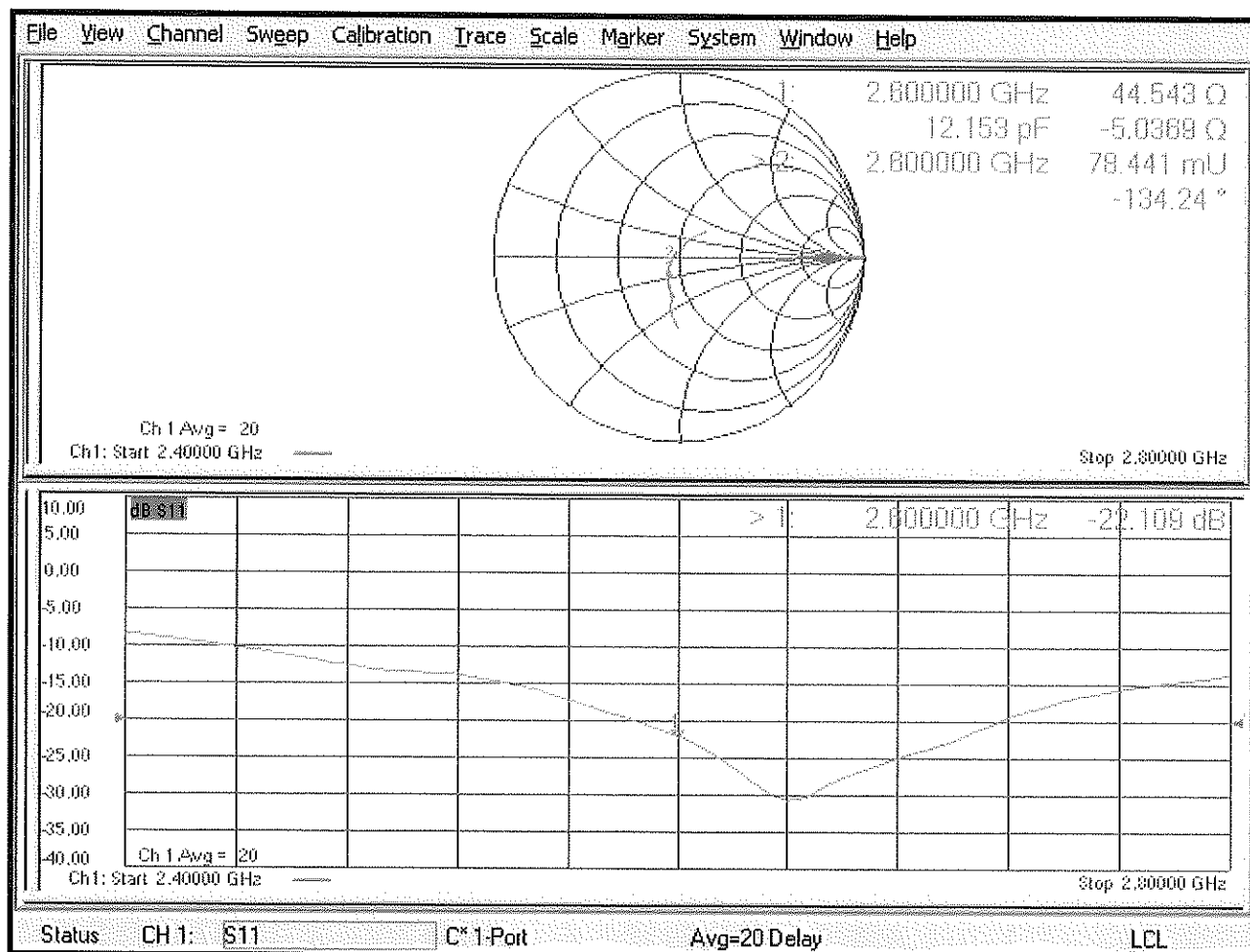
Ratio of SAR at M2 to SAR at M1 = 51.2%

Maximum value of SAR (measured) = 22.5 W/kg



0 dB = 22.5 W/kg = 13.51 dBW/kg

# Impedance Measurement Plot for Body TSL



## Certification of Verification

Object: D2600V2 – SN: 1068

Calibration procedure(s): Procedure for Calibration Extension for SAR Dipoles.

Calibration Date: November 15, 2022

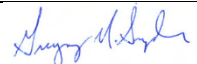
Extension Calibration date: November 15, 2023

Description: SAR Validation Dipole at 2600 MHz.

### Calibration Equipment used:

| Manufacturer       | Model         | Description                         | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|--------------------|---------------|-------------------------------------|------------|--------------|------------|---------------|
| Agilent            | 8753ES        | S-Parameter Vector Network Analyzer | 6/2/2023   | Annual       | 6/12/2024  | MY40003841    |
| Agilent            | E4438C        | ESG Vector Signal Generator         | 4/25/2023  | Annual       | 4/25/2024  | US41460739    |
| Amplifier Research | 15S1G6        | Amplifier                           | CBT        | N/A          | CBT        | 343972        |
| Rohde & Schwarz    | NRX           | Power Meter                         | 1/11/2023  | Annual       | 1/11/2024  | 102583        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 1/19/2023  | Annual       | 1/19/2024  | 106563        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 1/11/2023  | Annual       | 1/11/2024  | 106564        |
| Traceable          | 4040 90080-06 | Therm./ Clock/ Humidity Monitor     | 5/11/2022  | Biennial     | 5/11/2024  | 221514974     |
| Control Company    | 4353          | Ultra Long Stem Thermometer         | 10/24/2023 | Annual       | 10/24/2024 | 200645916     |
| Agilent            | 85033E        | 3.5mm Standard Calibration Kit      | 7/18/2023  | Annual       | 7/18/2024  | MY53402352    |
| Mini-Circuits      | VL6-6000+     | Low Pass Filter DC to 6000 MHz      | CBT        | N/A          | CBT        | N/A           |
| Narda              | 4772-3        | Attenuator (3dB)                    | CBT        | N/A          | CBT        | 9406          |
| Mini-Circuits      | ZHDC-16-63-S+ | 50-6000MHz Bidirectional Coupler    | CBT        | N/A          | CBT        | N/A           |
| Pasternack         | NC-100        | Torque Wrench                       | 12/5/2022  | Biennial     | 12/5/2024  | N/A           |
| SPEAG              | DAK-3.5       | Dielectric Assessment Kit           | 5/9/2023   | Annual       | 5/9/2024   | 1070          |
| SPEAG              | EX3DV4        | SAR Probe                           | 11/9/2023  | Annual       | 11/9/2024  | 7639          |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 11/14/2023 | Annual       | 11/14/2024 | 1403          |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name            | Function                   | Signature                                                                             |
|----------------|-----------------|----------------------------|---------------------------------------------------------------------------------------|
| Calibrated By: | Arturo Oliveros | Compliance Engineer        |  |
| Approved By:   | Greg Snyder     | Executive VP of Operations |  |

# DIPOLE CALIBRATION EXTENSION

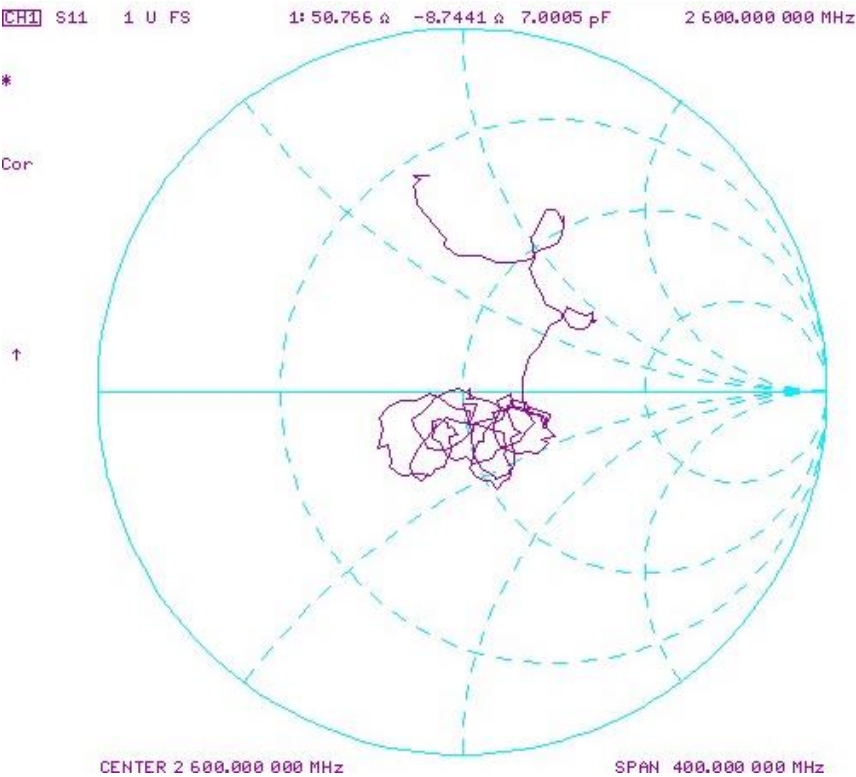
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) |
|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|
| 11/15/2022       | 11/15/2023     | 1.148                             | 5.65                                             | 5.2                                    | -7.96%           | 2.54                                              | 2.35                                    | -7.48%            | 47.8                                  | 50.8                               | 3                     | -5.9                                       | -8.7                                    | 2.8                        | -23.9                             | -21.2                          | 11.20%        |

Impedance & Return-Loss Measurement Plot for Head TSL





Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **PC Test**

Certificate No: **D3500V2-1126\_Jun21**

## CALIBRATION CERTIFICATE

Object **D3500V2 - SN:1126**

KT ✓ 09/13/2022

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

Calibration date: **June 09, 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: **Michael Weber** **Laboratory Technician**

Signature

Approved by: **Katja Pokovic** **Technical Manager**

Issued: June 10, 2021

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



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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:

- 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       |                                  |
| 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 | 37.1 $\pm$ 6 % | 2.92 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 | 6.73 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 67.0 W/kg $\pm$ 19.9 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
| SAR measured                                            | 100 mW input power | 2.51 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 25.0 W/kg $\pm$ 19.5 % (k=2) |

## Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 51.3           | 3.31 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 51.6 $\pm$ 6 % | 3.29 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

## SAR result with Body TSL

|                                                       |                    |                              |
|-------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                              |
| SAR measured                                          | 100 mW input power | 6.34 W/kg                    |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 63.6 W/kg $\pm$ 19.9 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                              |
| SAR measured                                            | 100 mW input power | 2.36 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 23.6 W/kg $\pm$ 19.5 % (k=2) |

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

### Antenna Parameters with Head TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.4 $\Omega$ - 1.7 j $\Omega$ |
| Return Loss                          | - 35.0 dB                      |

### Antenna Parameters with Body TSL

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.2 $\Omega$ + 0.8 j $\Omega$ |
| Return Loss                          | - 27.8 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.135 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: 09.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1126**

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

Medium parameters used:  $f = 3500$  MHz;  $\sigma = 2.92$  S/m;  $\epsilon_r = 37.1$ ;  $\rho = 1000$  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: 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=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 = 72.49 V/m; Power Drift = 0.08 dB

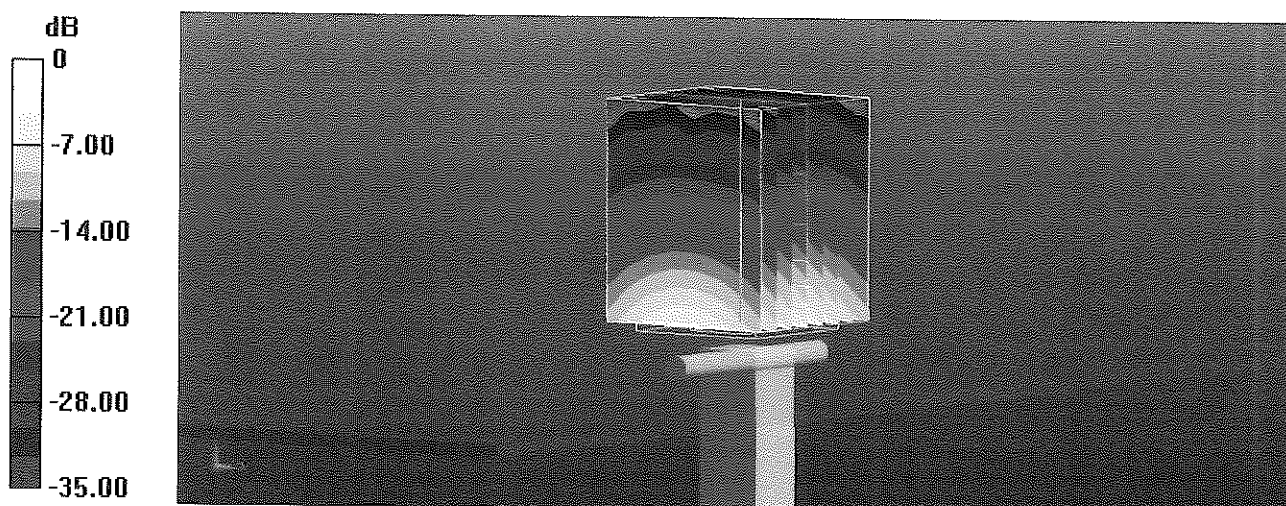
Peak SAR (extrapolated) = 18.3 W/kg

**SAR(1 g) = 6.73 W/kg; SAR(10 g) = 2.51 W/kg**

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

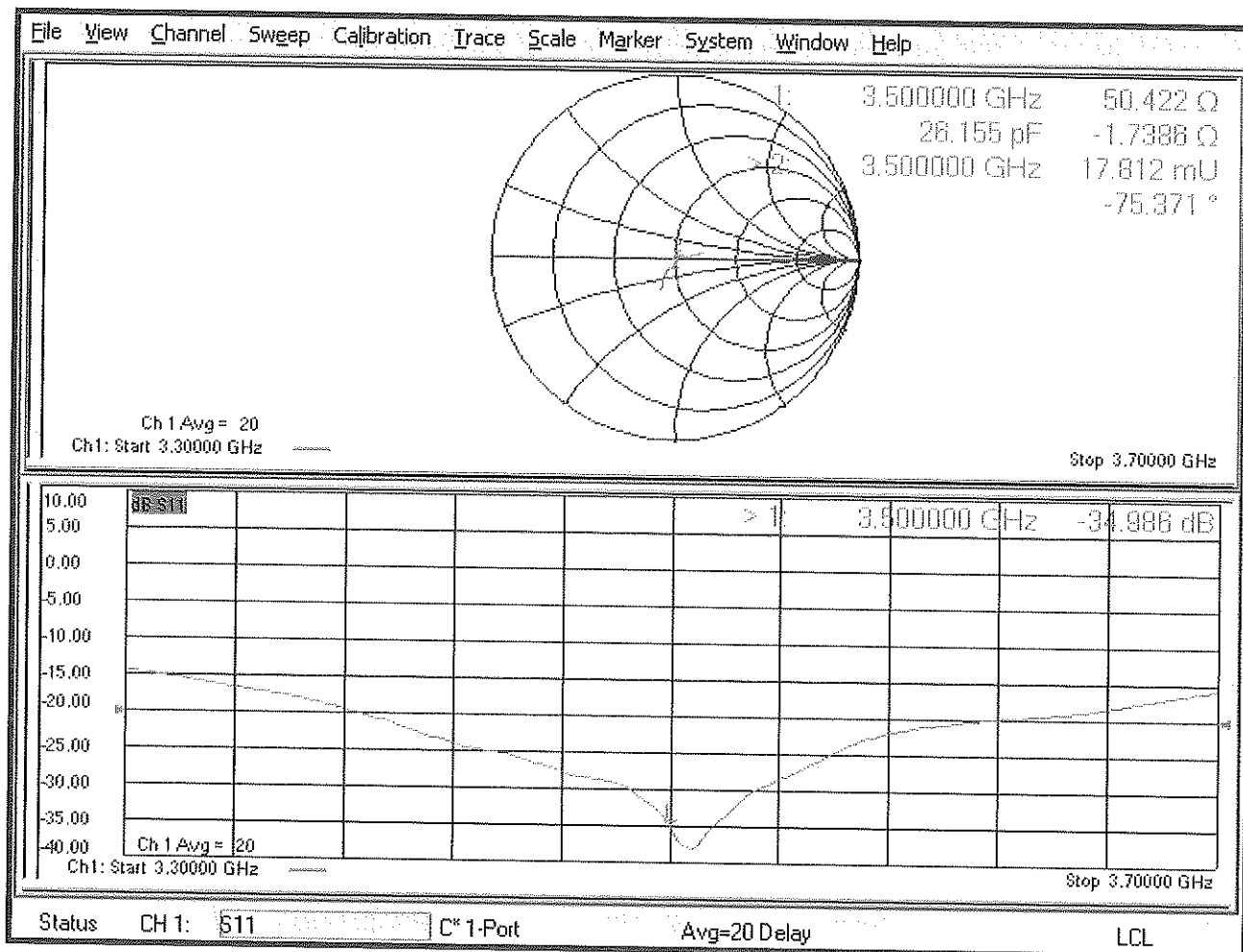
Ratio of SAR at M2 to SAR at M1 = 73.8%

Maximum value of SAR (measured) = 12.8 W/kg



0 dB = 12.8 W/kg = 11.08 dBW/kg

# Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 09.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1126**

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

Medium parameters used:  $f = 3500$  MHz;  $\sigma = 3.29$  S/m;  $\epsilon_r = 51.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(7.46, 7.46, 7.46) @ 3500 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

**Dipole Calibration for Body 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 = 64.24 V/m; Power Drift = -0.02 dB

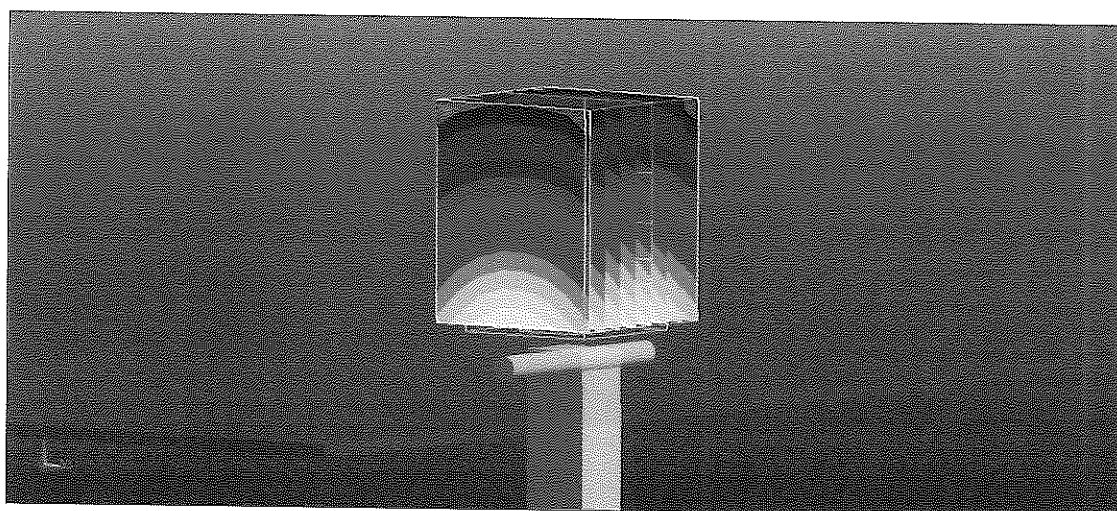
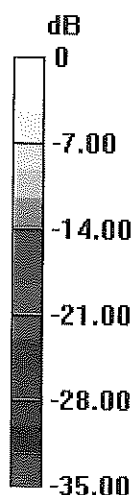
Peak SAR (extrapolated) = 17.0 W/kg

**SAR(1 g) = 6.34 W/kg; SAR(10 g) = 2.36 W/kg**

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

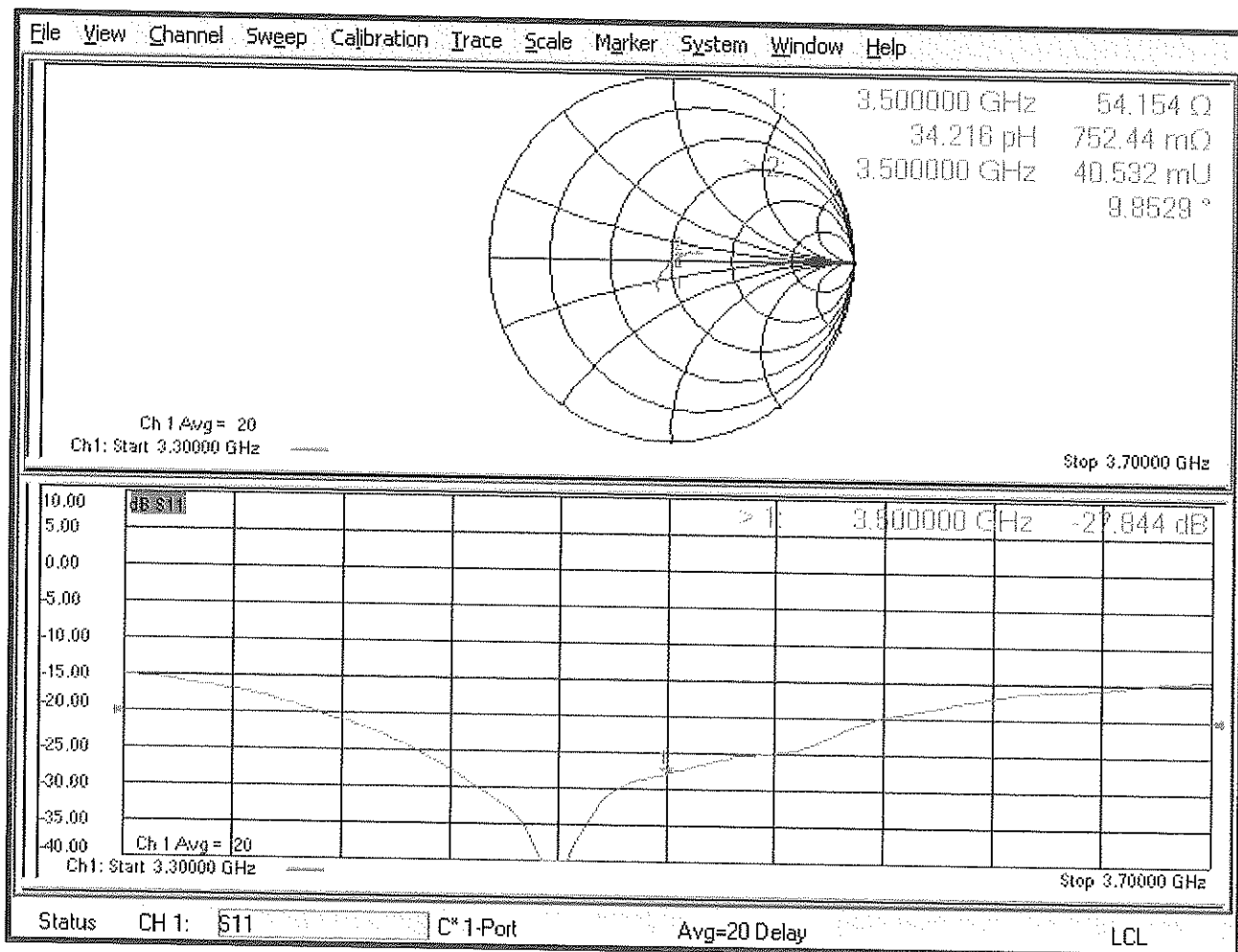
Ratio of SAR at M2 to SAR at M1 = 75.5%

Maximum value of SAR (measured) = 11.9 W/kg



0 dB = 11.9 W/kg = 11.74 dBW/kg

# Impedance Measurement Plot for Body TSL



# Certification of Calibration

Object: D3500V2 – SN: 1126

Calibration procedure(s): Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: June 9, 2022

Description: SAR Validation Dipole at 3500 MHz.

## Calibration Equipment used:

| Manufacturer       | Model         | Description                         | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|--------------------|---------------|-------------------------------------|------------|--------------|------------|---------------|
| Agilent            | 8753ES        | S-Parameter Vector Network Analyzer | 2/11/2022  | Annual       | 2/11/2023  | MY40003841    |
| Agilent            | N5182A        | MXG Vector Signal Generator         | 5/6/2022   | Annual       | 5/6/2023   | MY51240479    |
| Amplifier Research | 15S1G6        | Amplifier                           | CBT        | N/A          | CBT        | 343972        |
| Anritsu            | MA2411B       | Pulse Power Sensor                  | 3/2/2022   | Annual       | 3/2/2023   | 1126066       |
| Anritsu            | MA2411B       | Pulse Power Sensor                  | 3/28/2022  | Annual       | 3/28/2023  | 1339007       |
| Anritsu            | ML2495A       | Power Meter                         | 3/31/2022  | Annual       | 3/31/2023  | 1138001       |
| Control Company    | 4353          | Long Stem Thermometer               | 10/28/2020 | Biennial     | 10/28/2022 | 200670623     |
| Control Company    | 4040          | Therm./Clock/Humidity Monitor       | 3/12/2021  | Biennial     | 3/12/2023  | 210202100     |
| Agilent            | 85033E        | 3.5mm Standard Calibration Kit      | 44384      | Annual       | 44749      | MY53402352    |
| Mini-Circuits      | VLF-6000+     | Low Pass Filter DC to 6000 MHz      | CBT        | N/A          | CBT        | N/A           |
| Narda              | 4772-3        | Attenuator (3dB)                    | CBT        | N/A          | CBT        | 9406          |
| Mini-Circuits      | ZHDC-16-63-S+ | Coupler                             | CBT        | N/A          | CBT        | F709401716    |
| Seekonk            | NC-100        | Torque Wrench                       | 7/30/2020  | Biennial     | 7/30/2022  | 22217         |
| SPEAG              | DAK-3.5       | Portable Dielectric Assessment Kit  | 10/7/2021  | Annual       | 10/7/2022  | 1045          |
| SPEAG              | EX3DV4        | SAR Probe                           | 11/16/2021 | Annual       | 11/16/2022 | 7639          |
| SPEAG              | EX3DV4        | SAR Probe                           | 4/22/2022  | Annual       | 4/22/2023  | 7532          |
| SPEAG              | DAE4          | Data Acquisition Electronics        | 11/11/2021 | Annual       | 11/11/2022 | 1646          |
| SPEAG              | DAE4          | Data Acquisition Electronics        | 4/13/2022  | Annual       | 4/13/2023  | 501           |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name            | Function           | Signature           |
|----------------|-----------------|--------------------|---------------------|
| Calibrated By: | Parker Jones    | Department Manager | <i>Parker Jones</i> |
| Approved By:   | Kaitlin O'Keefe | Managing Director  | <i>KOK</i>          |

# DIPOLE CALIBRATION EXTENSION

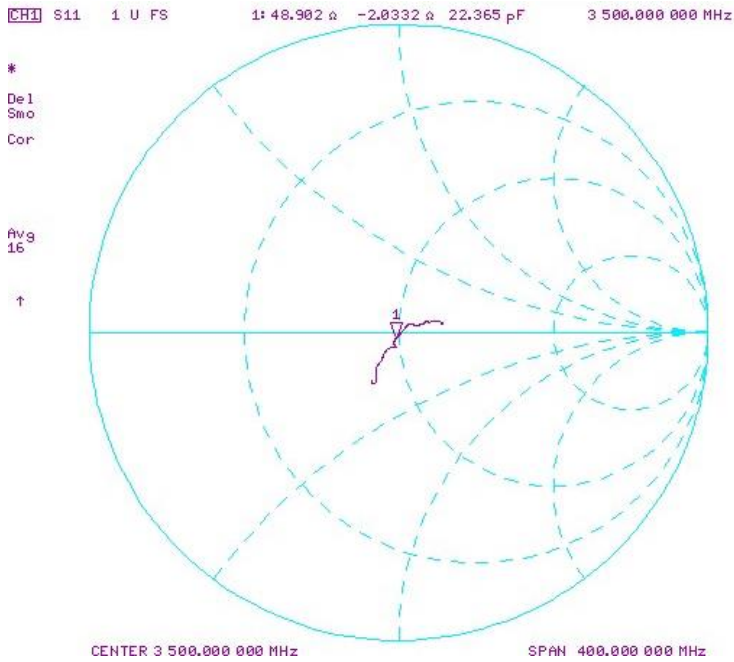
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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.

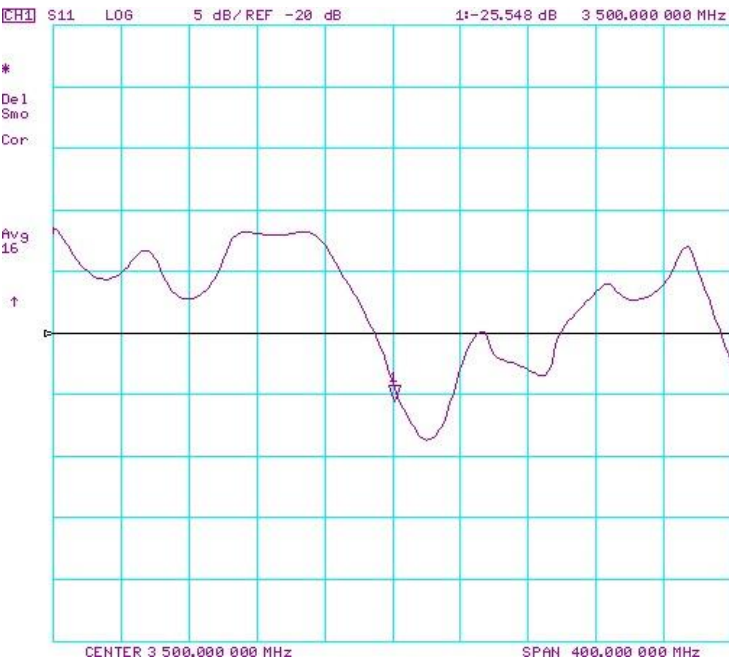
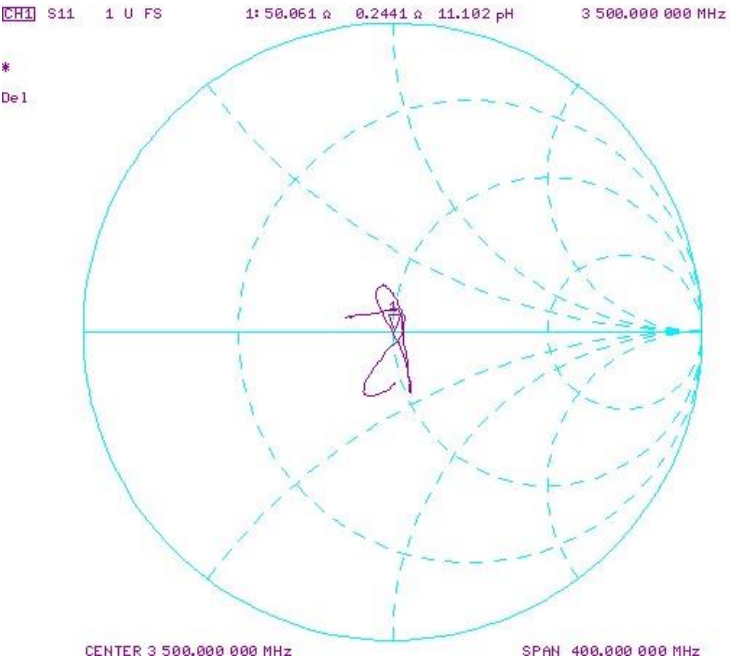
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|-----------|
| 6/9/2021         | 6/9/2022       | 1.135                             | 6.7                                              | 6.65                                   | -0.75%           | 2.5                                               | 2.53                                    | 1.20%             | 50.4                                  | 48.9                               | 1.5                   | -1.7                                       | -2                                      | 0.3                        | -35                               | -29.9                          | 14.60%        | PASS      |
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 20.0 dBm | Measured Body SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Body SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
| 6/9/2021         | 6/9/2022       | 1.135                             | 6.36                                             | 6.64                                   | 4.40%            | 2.36                                              | 2.45                                    | 3.81%             | 54.2                                  | 50.1                               | 4.1                   | 0.8                                        | 0.2                                     | 0.6                        | -27.8                             | -25.5                          | 8.10%         | PASS      |

Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL





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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**

Client **PC Test**

Certificate No: **D3700V2-1097\_Jun21**

## CALIBRATION CERTIFICATE

Object **D3700V2 - SN:1097**

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

Calibration date: **June 09, 2021**

6/9/2022

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  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards               | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|---------------------------------|--------------------|-----------------------------------|------------------------|
| Power meter NRP                 | SN: 104778         | 09-Apr-21 (No. 217-03291/03292)   | Apr-22                 |
| Power sensor NRP-Z91            | SN: 103244         | 09-Apr-21 (No. 217-03291)         | Apr-22                 |
| Power sensor NRP-Z91            | SN: 103245         | 09-Apr-21 (No. 217-03292)         | Apr-22                 |
| 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: **Michael Weber** Laboratory Technician

Signature

Approved by: **Katja Pokovic** Technical Manager

Issued: June 10, 2021

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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:**

- 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       |                                  |
| 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 $\pm$ 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 $\pm$ 0.2) °C | 36.9 $\pm$ 6 % | 3.08 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 | 6.82 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 68.1 W/kg $\pm$ 19.9 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
| SAR measured                                            | 100 mW input power | 2.46 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 24.5 W/kg $\pm$ 19.5 % (k=2) |

## Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 51.0           | 3.55 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 51.3 $\pm$ 6 % | 3.50 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

## SAR result with Body TSL

|                                                       |                    |                              |
|-------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                              |
| SAR measured                                          | 100 mW input power | 6.20 W/kg                    |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 62.3 W/kg $\pm$ 19.9 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                              |
| SAR measured                                            | 100 mW input power | 2.22 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 22.2 W/kg $\pm$ 19.5 % (k=2) |

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

### Antenna Parameters with Head TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $47.3 \Omega + 0.9 j\Omega$ |
| Return Loss                          | - 30.6 dB                   |

### Antenna Parameters with Body TSL

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $45.6 \Omega + 1.8 j\Omega$ |
| Return Loss                          | - 26.1 dB                   |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.132 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: 09.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN:1097**

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

Medium parameters used:  $f = 3700$  MHz;  $\sigma = 3.08$  S/m;  $\epsilon_r = 36.9$ ;  $\rho = 1000$  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(1527); SEMCAD X 14.6.14(7483)

**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 = 72.08 V/m; Power Drift = 0.06 dB

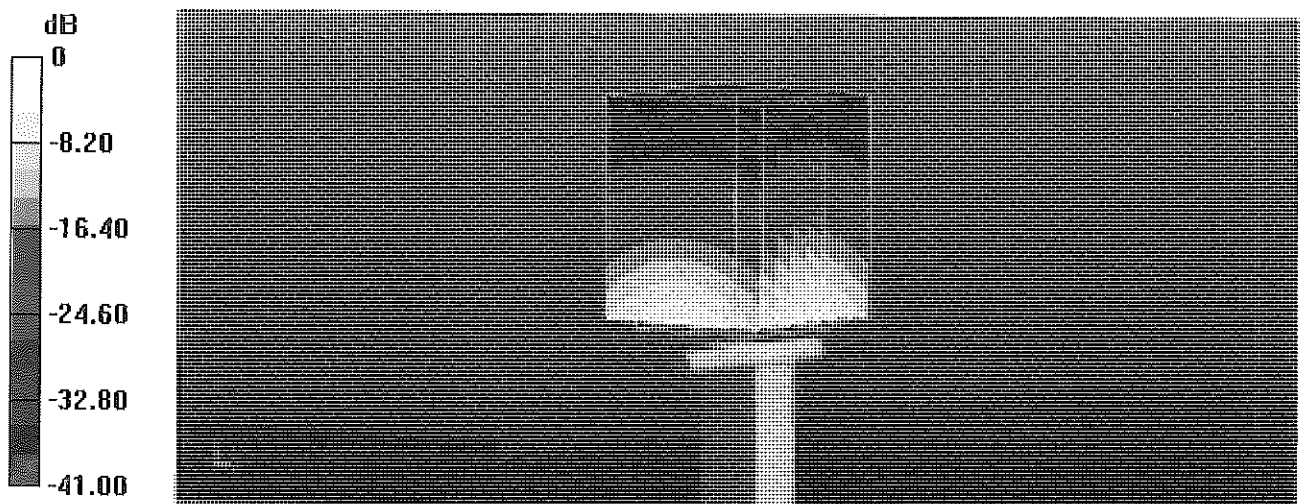
Peak SAR (extrapolated) = 19.5 W/kg

**SAR(1 g) = 6.82 W/kg; SAR(10 g) = 2.46 W/kg**

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

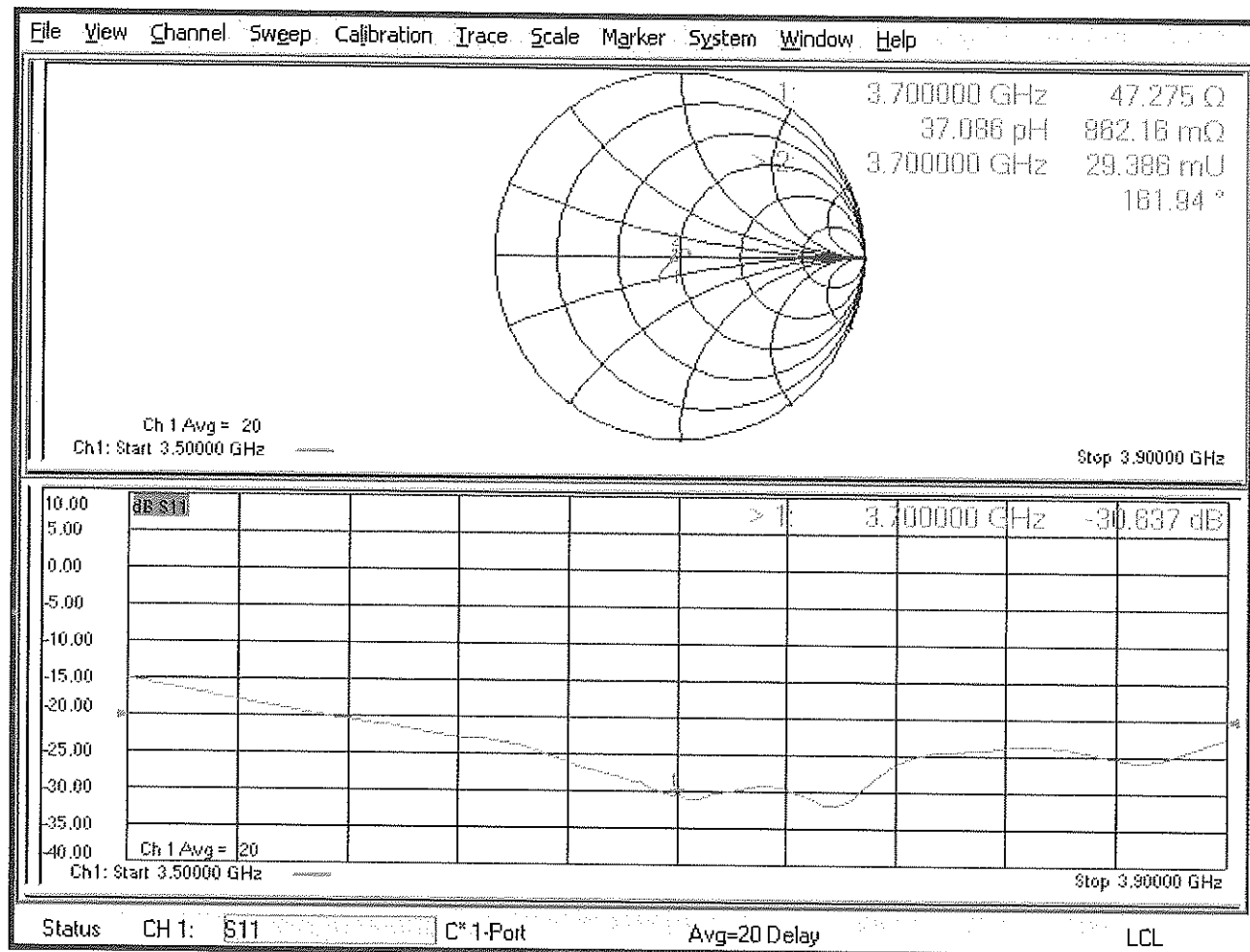
Ratio of SAR at M2 to SAR at M1 = 73.7%

Maximum value of SAR (measured) = 13.2 W/kg



0 dB = 13.2 W/kg = 11.20 dBW/kg

# Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 09.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN: 1097**

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

Medium parameters used:  $f = 3700$  MHz;  $\sigma = 3.5$  S/m;  $\epsilon_r = 51.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

### DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(7.31, 7.31, 7.31) @ 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 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

**Dipole Calibration for Body 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 = 64.18 V/m; Power Drift = 0.00 dB

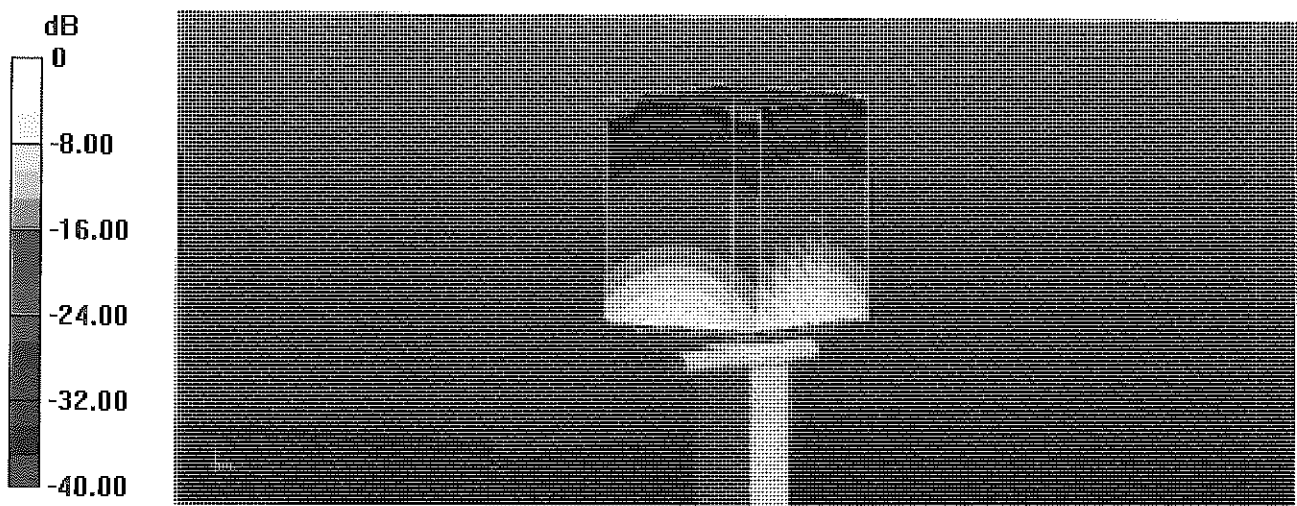
Peak SAR (extrapolated) = 17.1 W/kg

**SAR(1 g) = 6.2 W/kg; SAR(10 g) = 2.22 W/kg**

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

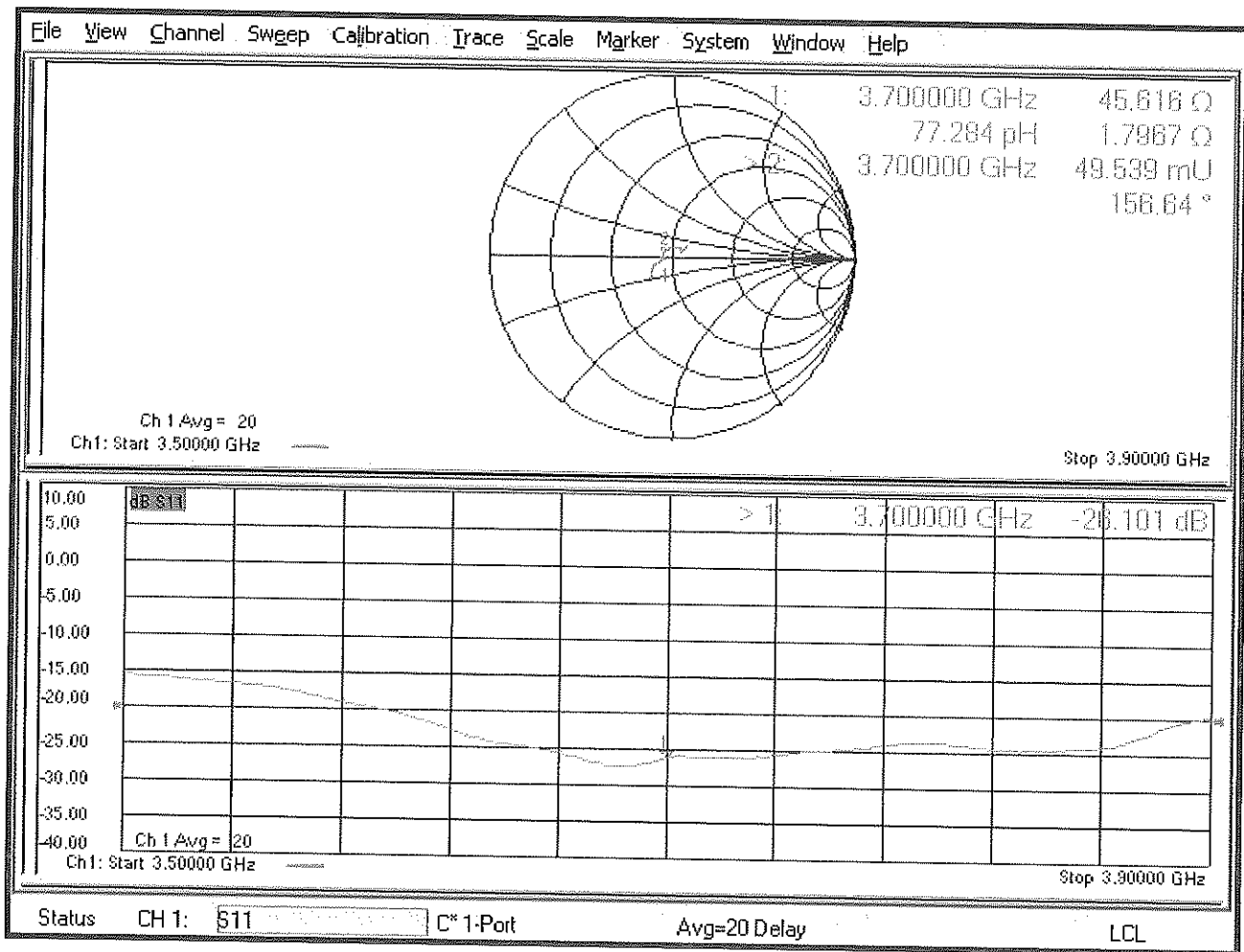
Ratio of SAR at M2 to SAR at M1 = 74.7%

Maximum value of SAR (measured) = 12.1 W/kg



0 dB = 12.1 W/kg = 10.83 dBW/kg

# Impedance Measurement Plot for Body TSL



## Certification of Calibration

Object: D3700V2 – SN: 1097

Calibration procedure(s): Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: June 09, 2022

Description: SAR Validation Dipole at 3700 MHz.

### Calibration Equipment used:

| Manufacturer       | Model         | Description                         | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|--------------------|---------------|-------------------------------------|------------|--------------|------------|---------------|
| Agilent            | 8753ES        | S-Parameter Vector Network Analyzer | 12/17/2021 | Annual       | 12/17/2022 | MY40000670    |
| Agilent            | E4438C        | ESG Vector Signal Generator         | 3/24/2022  | Annual       | 3/24/2023  | MY45093678    |
| Amplifier Research | 15S1G6        | Amplifier                           | CBT        | N/A          | CBT        | 343972        |
| Anritsu            | ML2495A       | Power Meter                         | 3/17/2022  | Annual       | 3/17/2023  | 0941001       |
| Anritsu            | MA2411B       | Pulse Power Sensor                  | 3/2/2022   | Annual       | 3/2/2023   | 1126066       |
| Anritsu            | MA2411B       | Pulse Power Sensor                  | 3/28/2022  | Annual       | 3/28/2023  | 1339007       |
| Traceable          | 4040 90080-06 | Therm./ Clock/ Humidity Monitor     | 5/11/2022  | Biennial     | 5/11/2024  | 221514974     |
| Control Company    | 4353          | Long Stem Thermometer               | 10/28/2020 | Biennial     | 10/28/2022 | 200670633     |
| Agilent            | 85033E        | 3.5mm Standard Calibration Kit      | 7/7/2021   | Annual       | 7/7/2022   | MY53402352    |
| Mini-Circuits      | VLF-6000+     | Low Pass Filter DC to 6000 MHz      | CBT        | N/A          | CBT        | N/A           |
| Narda              | 4772-3        | Attenuator (3dB)                    | CBT        | N/A          | CBT        | 9406          |
| Mini-Circuits      | ZHDC-16-63-S+ | 50-6000MHz Bidirectional Coupler    | CBT        | N/A          | CBT        | N/A           |
| Pasternack         | NC-100        | Torque Wrench                       | 3/19/2022  | Annual       | 3/19/2023  | N/A           |
| SPEAG              | DAK-3.5       | Dielectric Assessment Kit           | 10/7/2021  | Annual       | 10/7/2022  | 1045          |
| SPEAG              | EX3DV4        | SAR Probe                           | 11/16/2021 | Annual       | 11/16/2022 | 7639          |
| SPEAG              | EX3DV4        | SAR Probe                           | 4/22/2022  | Annual       | 4/22/2023  | 7532          |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 11/11/2021 | Annual       | 11/11/2022 | 1646          |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 4/13/2022  | Annual       | 4/13/2023  | 501           |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name            | Function           | Signature           |
|----------------|-----------------|--------------------|---------------------|
| Calibrated By: | Parker Jones    | Department Manager | <i>Parker Jones</i> |
| Approved By:   | Kaitlin O'Keefe | Managing Director  | <i>KOK</i>          |

# DIPOLE CALIBRATION EXTENSION

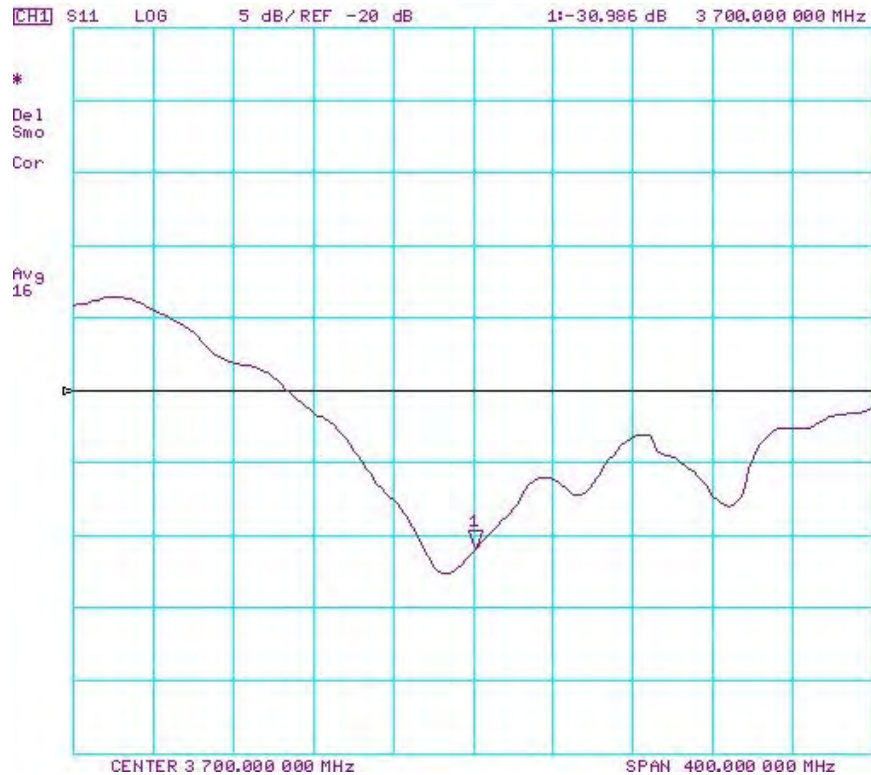
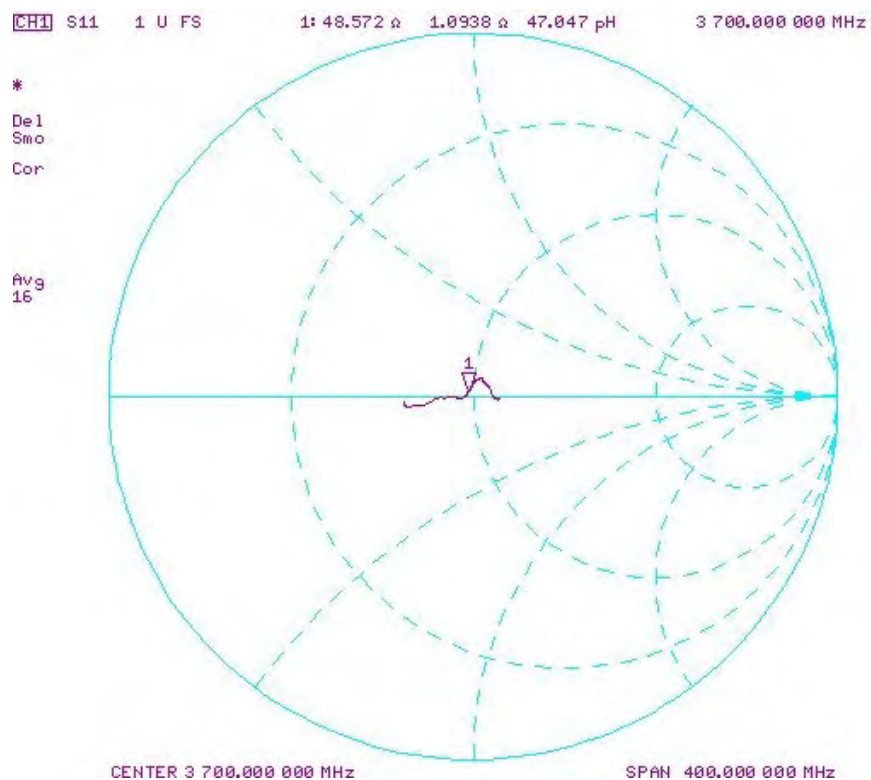
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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.

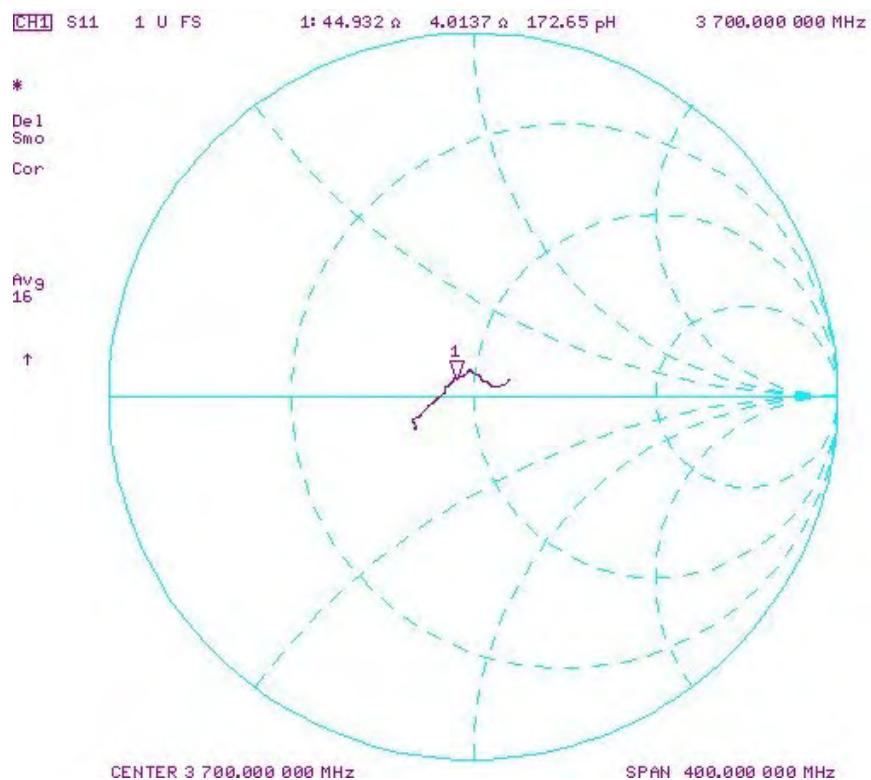
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|-----------|
| 6/9/2021         | 6/9/2022       | 1.132                             | 6.81                                             | 6.54                                   | -3.98%           | 2.45                                              | 2.4                                     | -2.04%            | 47.3                                  | 48.6                               | 1.3                   | 0.9                                        | 1.1                                     | 0.2                        | -30.6                             | -31                            | -1.30%        | PASS      |
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 20.0 dBm | Measured Body SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Body SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
| 6/9/2021         | 6/9/2022       | 1.132                             | 6.23                                             | 6.57                                   | 5.46%            | 2.22                                              | 2.37                                    | 6.76%             | 45.6                                  | 44.9                               | 0.7                   | 1.8                                        | 4                                       | 2.2                        | -26.1                             | -25.8                          | 1.10%         | PASS      |

Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



## Certification of Calibration

Object D3700V2 – SN: 1097

Calibration procedure(s) Procedure for Calibration Extension for SAR Dipoles.

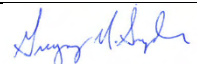
Extension Calibration date: June 09, 2023

Description: SAR Validation Dipole at 3700 MHz.

### Calibration Equipment used:

| Manufacturer       | Model         | Description                         | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|--------------------|---------------|-------------------------------------|------------|--------------|------------|---------------|
| Agilent            | 8753ES        | S-Parameter Vector Network Analyzer | 6/14/2022  | Annual       | 6/14/2023  | US39170118    |
| Agilent            | E4438C        | ESG Vector Signal Generator         | 11/17/2022 | Annual       | 11/17/2023 | MY45093852    |
| Amplifier Research | 15S1G6        | Amplifier                           | CBT        | N/A          | CBT        | 343972        |
| Rohde & Schwarz    | NRX           | Power Meter                         | 1/11/2023  | Annual       | 1/11/2024  | 102583        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 1/19/2023  | Annual       | 1/19/2024  | 106563        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 1/11/2023  | Annual       | 1/11/2024  | 106564        |
| Traceable          | 4040 90080-06 | Therm./ Clock/ Humidity Monitor     | 5/11/2022  | Biennial     | 5/11/2024  | 221514974     |
| Control Company    | 4353          | Long Stem Thermometer               | 9/10/2021  | Biennial     | 9/10/2023  | 210774685     |
| Agilent            | 85033E        | 3.5mm Standard Calibration Kit      | 6/21/2022  | Annual       | 6/21/2023  | MY53402352    |
| Mini-Circuits      | VLF-6000+     | Low Pass Filter DC to 6000 MHz      | CBT        | N/A          | CBT        | N/A           |
| Narda              | 4772-3        | Attenuator (3dB)                    | CBT        | N/A          | CBT        | 9406          |
| Mini-Circuits      | ZHDC-16-63-S+ | 50-6000MHz Bidirectional Coupler    | CBT        | N/A          | CBT        | N/A           |
| Pasternack         | NC-100        | Torque Wrench                       | 12/5/2022  | Biennial     | 12/5/2024  | N/A           |
| SPEAG              | DAK-3.5       | Dielectric Assessment Kit           | 8/15/2022  | Annual       | 8/15/2023  | 1041          |
| SPEAG              | EX3DV4        | SAR Probe                           | 1/17/2023  | Annual       | 1/17/2024  | 3837          |
| SPEAG              | EX3DV4        | SAR Probe                           | 12/9/2022  | Annual       | 12/9/2023  | 7490          |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 12/13/2022 | Annual       | 12/13/2023 | 1644          |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 1/17/2023  | Annual       | 1/17/2024  | 793           |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name            | Function                   | Signature                                                                             |
|----------------|-----------------|----------------------------|---------------------------------------------------------------------------------------|
| Calibrated By: | Arturo Oliveros | Compliance Engineer        |  |
| Approved By:   | Greg Snyder     | Executive VP of Operations |  |

# DIPOLE CALIBRATION EXTENSION

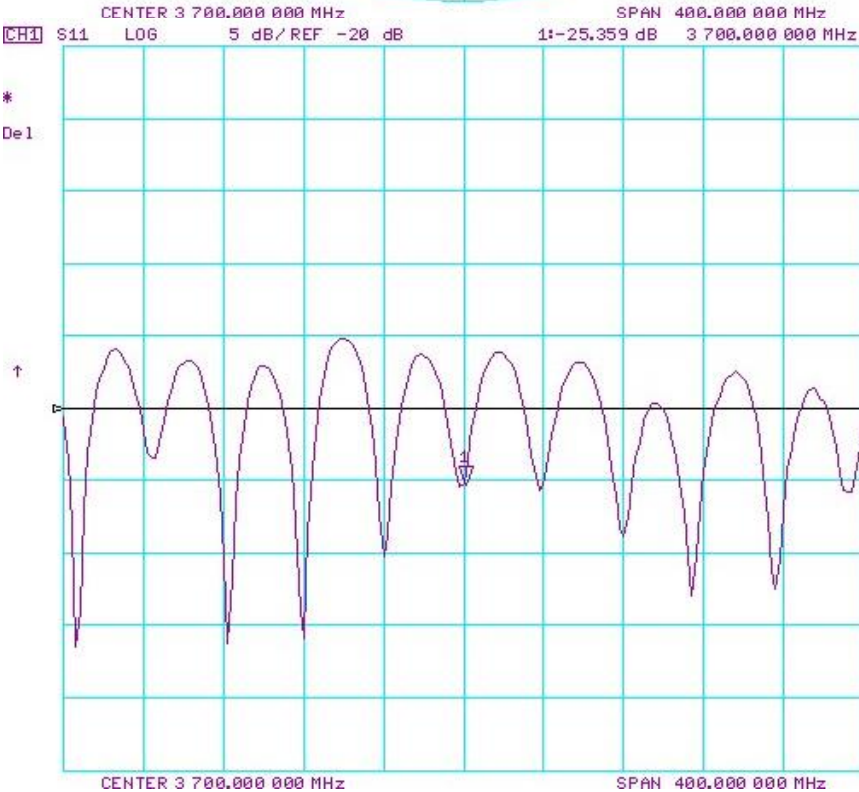
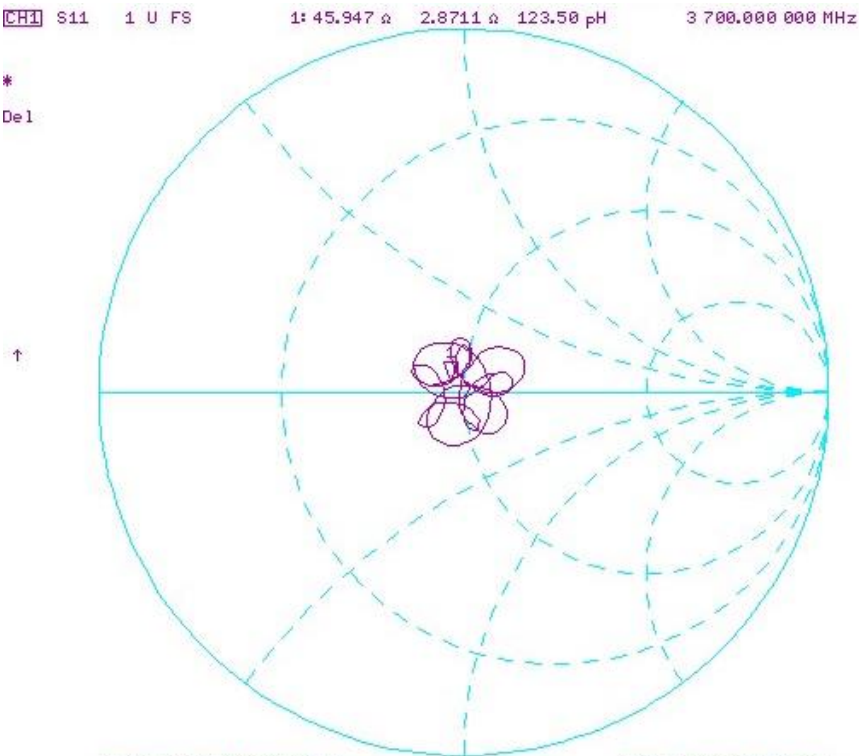
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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.

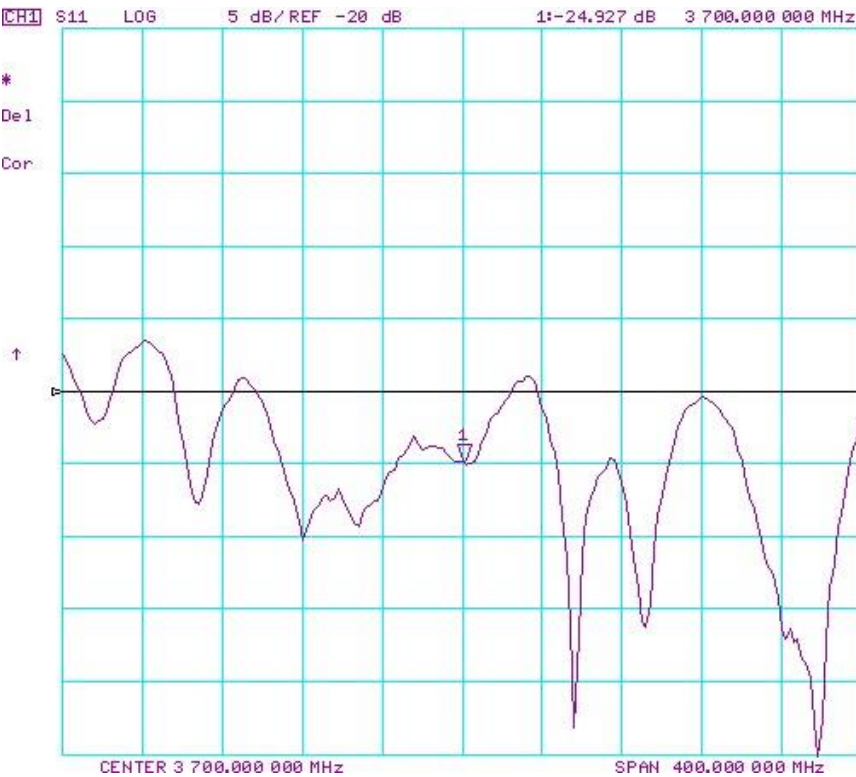
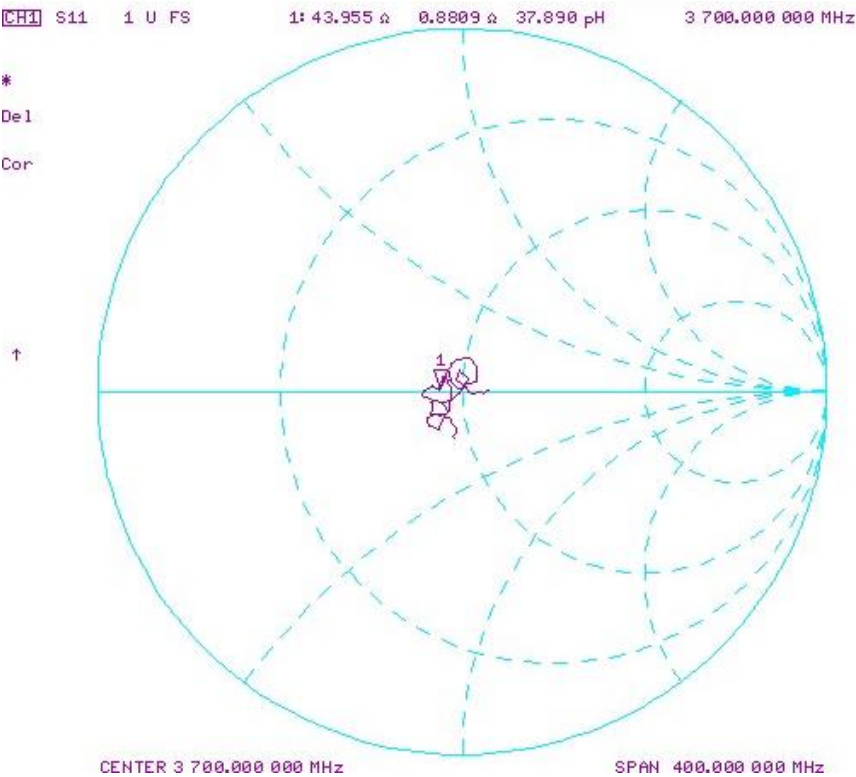
The following dipole was checked to pass the above 3 requirements to have 3-year calibration period from the calibration date:

| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|-----------|
| 6/9/2021         | 6/9/2023       | 1.132                             | 6.81                                             | 6.62                                   | -2.79%           | 2.45                                              | 2.45                                    | 0.00%             | 47.3                                  | 46                                 | 1.3                   | 0.9                                        | 2.9                                     | 2                          | -30.6                             | -25.4                          | 17.10%        | PASS      |
| Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 20.0 dBm | Measured Body SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 20.0 dBm | Measured Body SAR (10g) W/kg @ 20.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
| 6/9/2021         | 6/9/2023       | 1.132                             | 6.23                                             | 6.04                                   | -3.05%           | 2.22                                              | 2.19                                    | -1.35%            | 45.6                                  | 44                                 | 1.6                   | 1.8                                        | 0.9                                     | 0.9                        | -26.1                             | -24.9                          | 4.50%         | PASS      |

Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL





Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **PC Test**

Certificate No: **D3900V2-1073\_Jun21**

## CALIBRATION CERTIFICATE

Object **D3900V2 - SN:1073**

BN<sup>✓</sup> 06-11-22

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

BN<sup>✓</sup> 06-15-21

Calibration date: **June 10, 2021**

PN<sup>✓</sup> 8-21-23

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)      | Scheduled Calibration |
|-----------------------------|--------------------|---------------------------------|-----------------------|
| Power meter NRP             | SN: 104778         | 09-Apr-21 (No. 217-03291/03292) | Apr-22                |
| Power sensor NRP-Z91        | SN: 103244         | 09-Apr-21 (No. 217-03291)       | Apr-22                |
| Power sensor NRP-Z91        | SN: 103245         | 09-Apr-21 (No. 217-03292)       | Apr-22                |
| 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: **Michael Weber** Name: **Michael Weber** Function: **Laboratory Technician**

Signature

*[Signature]*

Approved by: **Katja Pokovic** Name: **Katja Pokovic** Function: **Technical Manager**

*[Signature]*

Issued: June 10, 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

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:

- 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                    | 3900 MHz $\pm$ 1 MHz<br>4100 MHz $\pm$ 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 $\pm$ 0.2) °C | 36.6 $\pm$ 6 % | 3.25 mho/m $\pm$ 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 | 6.98 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 69.7 W/kg $\pm$ 19.9 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
| SAR measured                                            | 100 mW input power | 2.42 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 24.0 W/kg $\pm$ 19.5 % (k=2) |

## 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 $\pm$ 0.2) °C | 36.4 $\pm$ 6 % | 3.42 mho/m $\pm$ 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 | 6.85 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 68.5 W/kg $\pm$ 19.9 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
| SAR measured                                            | 100 mW input power | 2.36 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 23.5 W/kg $\pm$ 19.5 % (k=2) |

### Body TSL parameters at 3900 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 50.8         | 3.78 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 51.0 ± 6 %   | 3.73 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Body TSL at 3900 MHz

|                                                       |                    |                          |
|-------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                          |
| SAR measured                                          | 100 mW input power | 6.41 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 64.3 W/kg ± 19.9 % (k=2) |

|                                                         |                    |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                          |
| SAR measured                                            | 100 mW input power | 2.20 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 22.0 W/kg ± 19.5 % (k=2) |

### Body TSL parameters at 4100 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 50.5         | 4.01 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 50.7 ± 6 %   | 3.98 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | -----        | ----             |

### SAR result with Body TSL at 4100 MHz

|                                                       |                    |                          |
|-------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                          |
| SAR measured                                          | 100 mW input power | 6.33 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 63.4 W/kg ± 19.9 % (k=2) |

|                                                         |                    |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                          |
| SAR measured                                            | 100 mW input power | 2.16 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 21.6 W/kg ± 19.5 % (k=2) |

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

### Antenna Parameters with Head TSL at 3900 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 46.5 $\Omega$ - 3.9 j $\Omega$ |
| Return Loss                          | - 25.2 dB                      |

### Antenna Parameters with Head TSL at 4100 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 59.2 $\Omega$ + 3.1 j $\Omega$ |
| Return Loss                          | - 21.0 dB                      |

### Antenna Parameters with Body TSL at 3900 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 46.1 $\Omega$ - 3.0 j $\Omega$ |
| Return Loss                          | - 25.8 dB                      |

### Antenna Parameters with Body TSL at 4100 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 58.7 $\Omega$ + 4.7 j $\Omega$ |
| Return Loss                          | - 20.9 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.103 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: 10.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN:1073**

Communication System: UID 0 - CW; Frequency: 3900 MHz, Frequency: 4100 MHz

Medium parameters used:  $f = 3900$  MHz;  $\sigma = 3.25$  S/m;  $\epsilon_r = 36.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 4100$  MHz;  $\sigma = 3.42$  S/m;  $\epsilon_r = 36.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(7.39, 7.39, 7.39) @ 3900 MHz, ConvF(7.26, 7.26, 7.26) @ 4100 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=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 = 73.94 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 20.1 W/kg

**SAR(1 g) = 6.98 W/kg; SAR(10 g) = 2.42 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.9 mm

Ratio of SAR at M2 to SAR at M1 = 74.6%

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 = 71.95 V/m; Power Drift = 0.04 dB

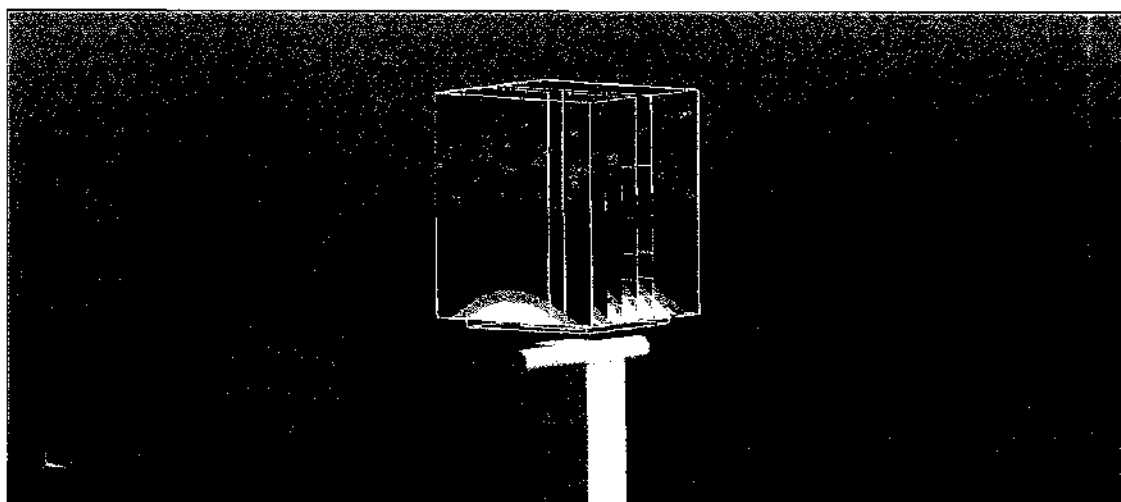
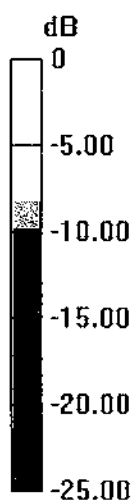
Peak SAR (extrapolated) = 19.8 W/kg

**SAR(1 g) = 6.85 W/kg; SAR(10 g) = 2.36 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.9 mm

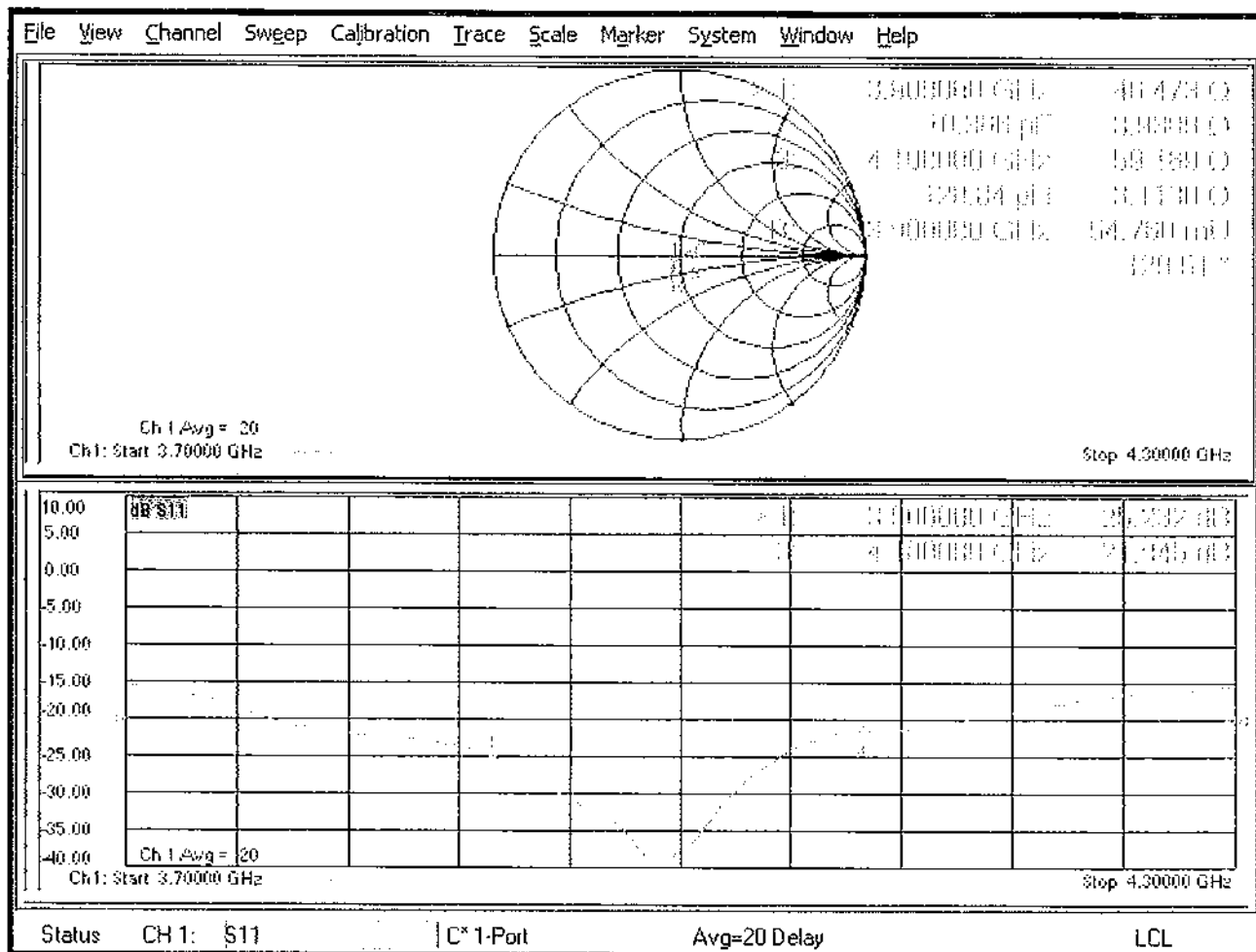
Ratio of SAR at M2 to SAR at M1 = 74.2%

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



## DASY5 Validation Report for Body TSL

Date: 01.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 3900 MHz; Type: D3900V2; Serial: D3900V2 - SN: 1073**

Communication System: UID 0 - CW; Frequency: 3900 MHz, Frequency: 4100 MHz

Medium parameters used:  $f = 3900$  MHz;  $\sigma = 3.73$  S/m;  $\epsilon_r = 51$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 4100$  MHz;  $\sigma = 3.98$  S/m;  $\epsilon_r = 50.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(7.18, 7.18, 7.18) @ 3900 MHz, ConvF(6.88, 6.88, 6.88) @ 4100 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

**Dipole Calibration for Body 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 = 64.23 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 19.2 W/kg

**SAR(1 g) = 6.41 W/kg; SAR(10 g) = 2.2 W/kg**

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

Ratio of SAR at M2 to SAR at M1 = 72.5%

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

**Dipole Calibration for Body 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 = 62.35 V/m; Power Drift = 0.01 dB

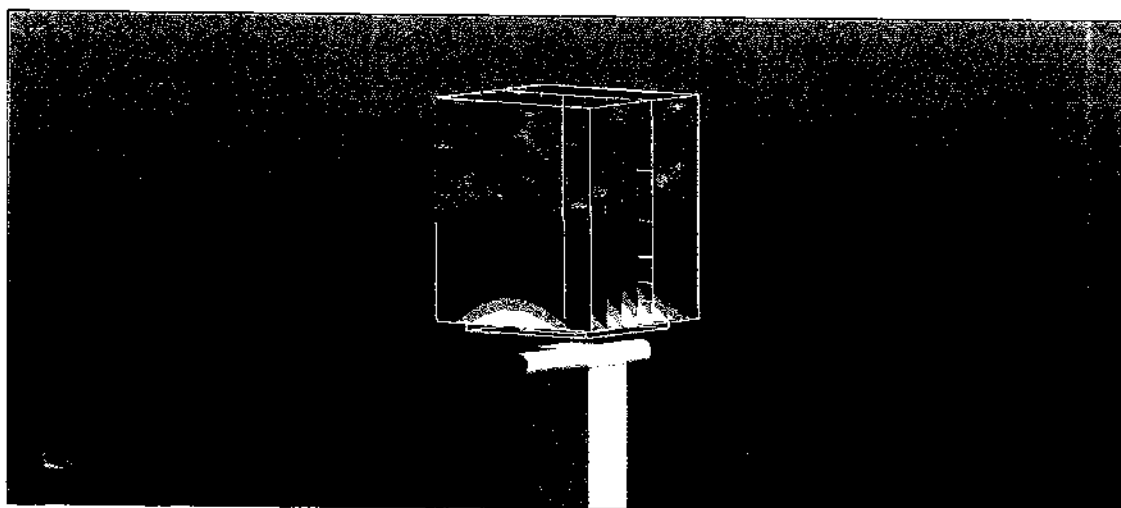
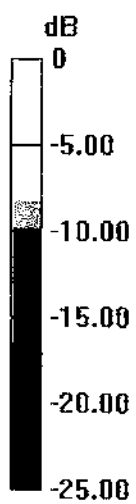
Peak SAR (extrapolated) = 19.8 W/kg

**SAR(1 g) = 6.33 W/kg; SAR(10 g) = 2.16 W/kg**

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

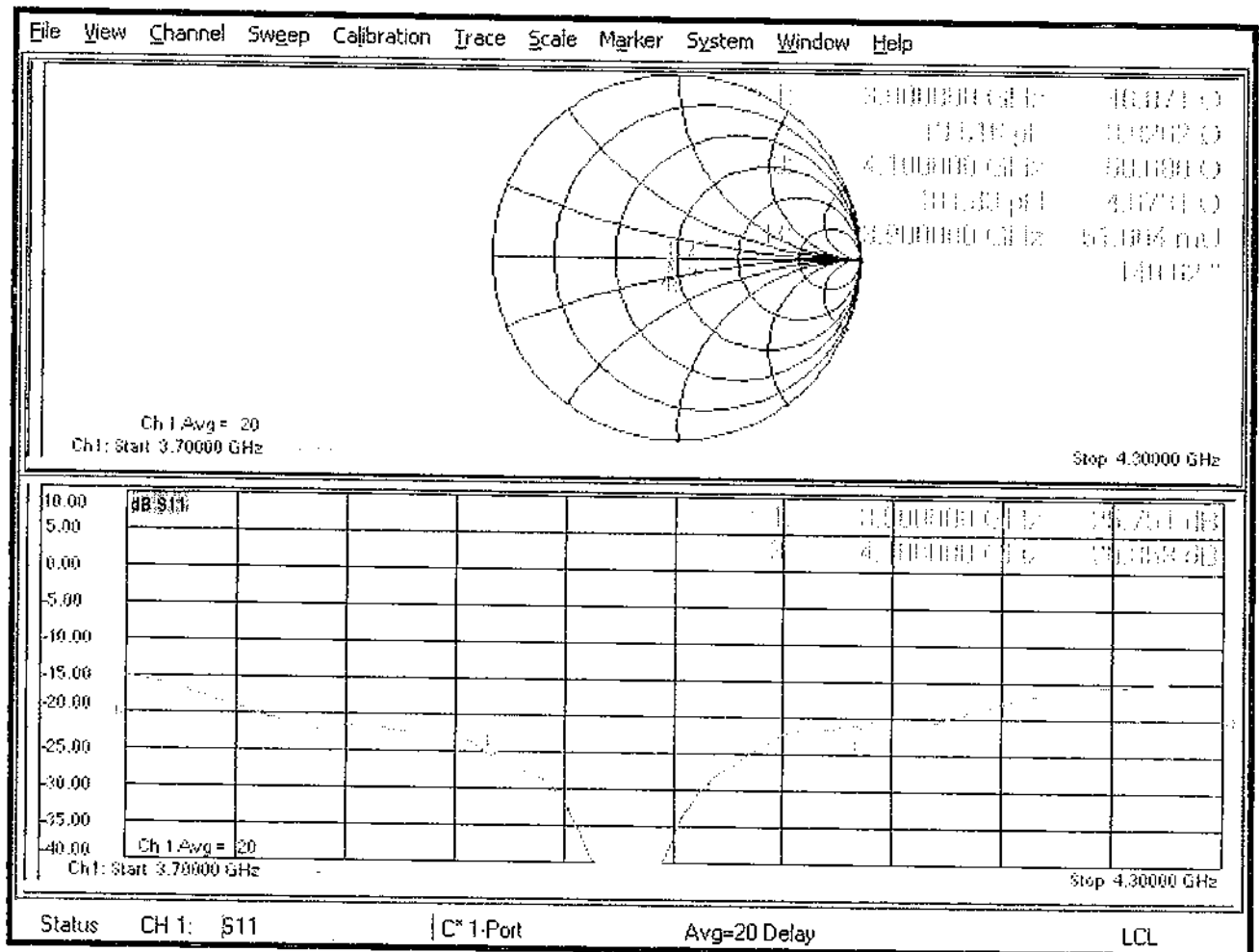
Ratio of SAR at M2 to SAR at M1 = 70.9%

Maximum value of SAR (measured) = 13.0 W/kg



0 dB = 13.0 W/kg = 11.14 dBW/kg

# Impedance Measurement Plot for Body TSL



## Certification of Calibration

Object **D3900V2 – SN: 1073**

Calibration procedure(s) **Procedure for Calibration Extension for SAR Dipoles.**

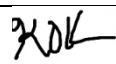
Extension Calibration date: **06/10/2022**

Description: **SAR Validation Dipole at 3900 and 4100 MHz.**

### Calibration Equipment used:

| Manufacturer          | Model         | Description                                             | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|-----------------------|---------------|---------------------------------------------------------|------------|--------------|------------|---------------|
| Agilent               | N5182A        | MXG Vector Signal Generator                             | 6/21/2021  | Annual       | 6/21/2022  | MY47420603    |
| Amplifier Research    | 1551G6        | Amplifier                                               | CBT        | N/A          | CBT        | 343971        |
| Anritsu               | MA2411B       | Pulse Power Sensor                                      | 9/21/2021  | Annual       | 9/21/2022  | 1339008       |
| Anritsu               | MA2411B       | Pulse Power Sensor                                      | 10/21/2021 | Annual       | 10/21/2022 | 1339027       |
| Anritsu               | ML2496A       | Power Meter                                             | 11/29/2021 | Annual       | 11/29/2022 | 1840005       |
| Anritsu               | ML2496A       | Power Meter                                             | 2/11/2022  | Annual       | 2/11/2023  | 1405003       |
| Control Company       | 4040          | Therm./ Clock/ Humidity Monitor                         | 3/12/2021  | Biennial     | 3/12/2023  | 210202100     |
| Control Company       | 4352          | Ultra Long Stem Thermometer                             | 10/25/2021 | Annual       | 10/25/2022 | 200645916     |
| Control Company       | 4353          | Long Stem Thermometer                                   | 10/28/2020 | Biennial     | 10/28/2022 | 200670653     |
| MiniCircuits          | VLF-6000+     | Low Pass Filter                                         | CBT        | N/A          | CBT        | N/A           |
| Mini-Circuits         | BW-N20W5+     | DC to 18 GHz Precision Fixed 20 dB Attenuator           | CBT        | N/A          | CBT        | N/A           |
| Mini-Circuits         | NLP-1200+     | Low Pass Filter DC to 1000 MHz                          | CBT        | N/A          | CBT        | N/A           |
| Mini-Circuits         | NLP-2950+     | Low Pass Filter DC to 2700 MHz                          | CBT        | N/A          | CBT        | N/A           |
| Narda                 | 4772-3        | Attenuator (3dB)                                        | CBT        | N/A          | CBT        | 9406          |
| Pasternack            | NC-100        | Torque Wrench                                           | 8/4/2020   | Biennial     | 8/4/2022   | N/A           |
| Mini-Circuits         | ZHDC-16-63-S+ | Coupler                                                 | CBT        | N/A          | CBT        | N/A           |
| Rohde & Schwarz       | ZNLE6         | Vector Network Analyzer                                 | 10/20/2021 | Annual       | 10/20/2022 | 101307        |
| SPEAG                 | DAK-3.5       | Dielectric Assessment Kit                               | 10/20/2021 | Annual       | 10/20/2022 | 1091          |
| Keysight Technologies | 85033E        | Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm) | 9/27/2021  | Annual       | 9/27/2022  | MY53401181    |
| SPEAG                 | EX3DV4        | SAR Probe                                               | 11/16/2021 | Annual       | 11/16/2022 | 7538          |
| SPEAG                 | DAE4          | Dasy Data Acquisition Electronics                       | 11/10/2021 | Annual       | 11/10/2022 | 1323          |
| SPEAG                 | EX3DV4        | SAR Probe                                               | 8/5/2021   | Annual       | 8/5/2022   | 7670          |
| SPEAG                 | DAE4          | Dasy Data Acquisition Electronics                       | 8/3/2021   | Annual       | 8/3/2022   | 1681          |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name                | Function                 | Signature                                                                             |
|----------------|---------------------|--------------------------|---------------------------------------------------------------------------------------|
| Calibrated By: | Bizunesh Baldinazzo | Test Engineer            | BB                                                                                    |
| Approved By:   | Kaitlin O'Keefe     | Senior Technical Manager |  |

# DIPOLE CALIBRATION EXTENSION

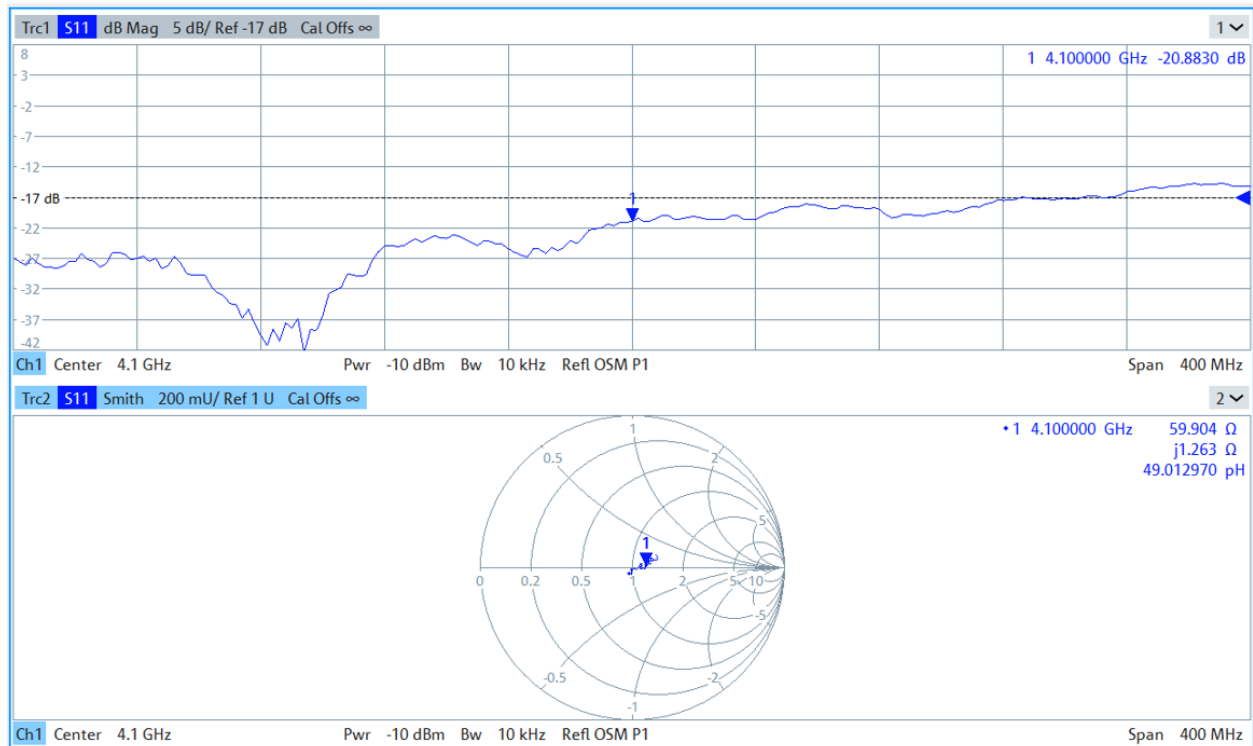
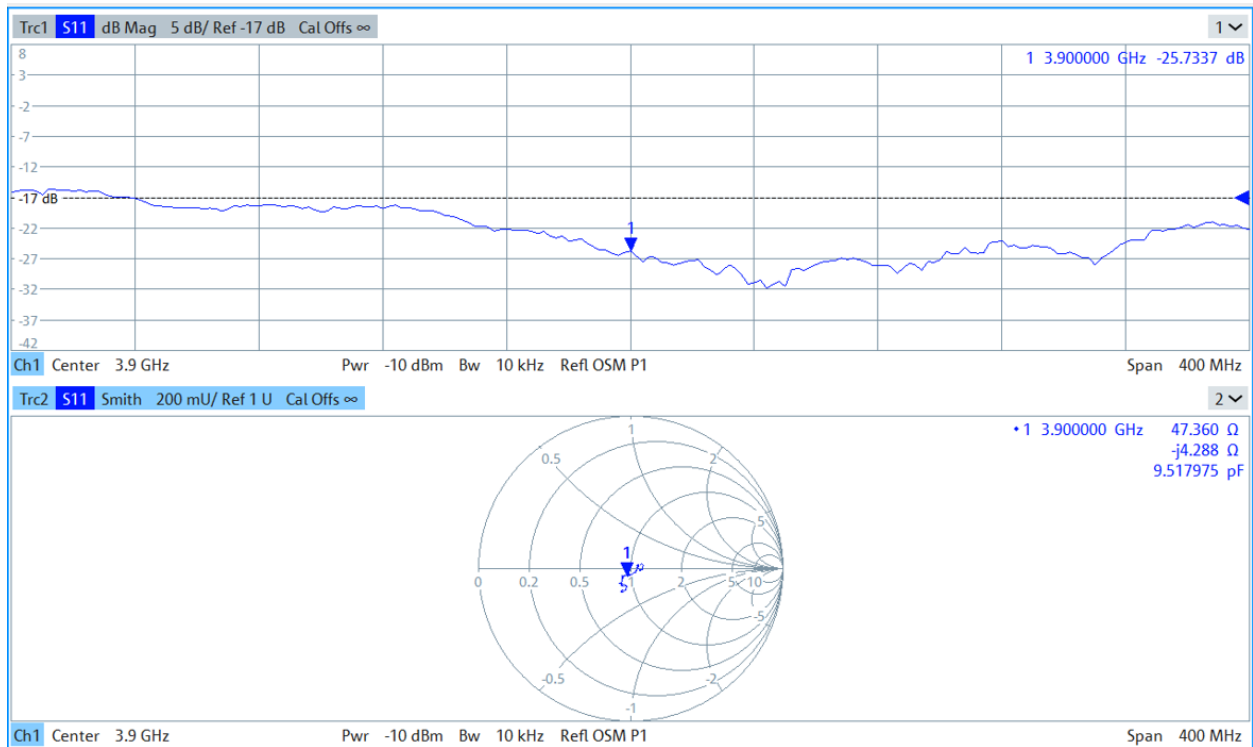
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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.

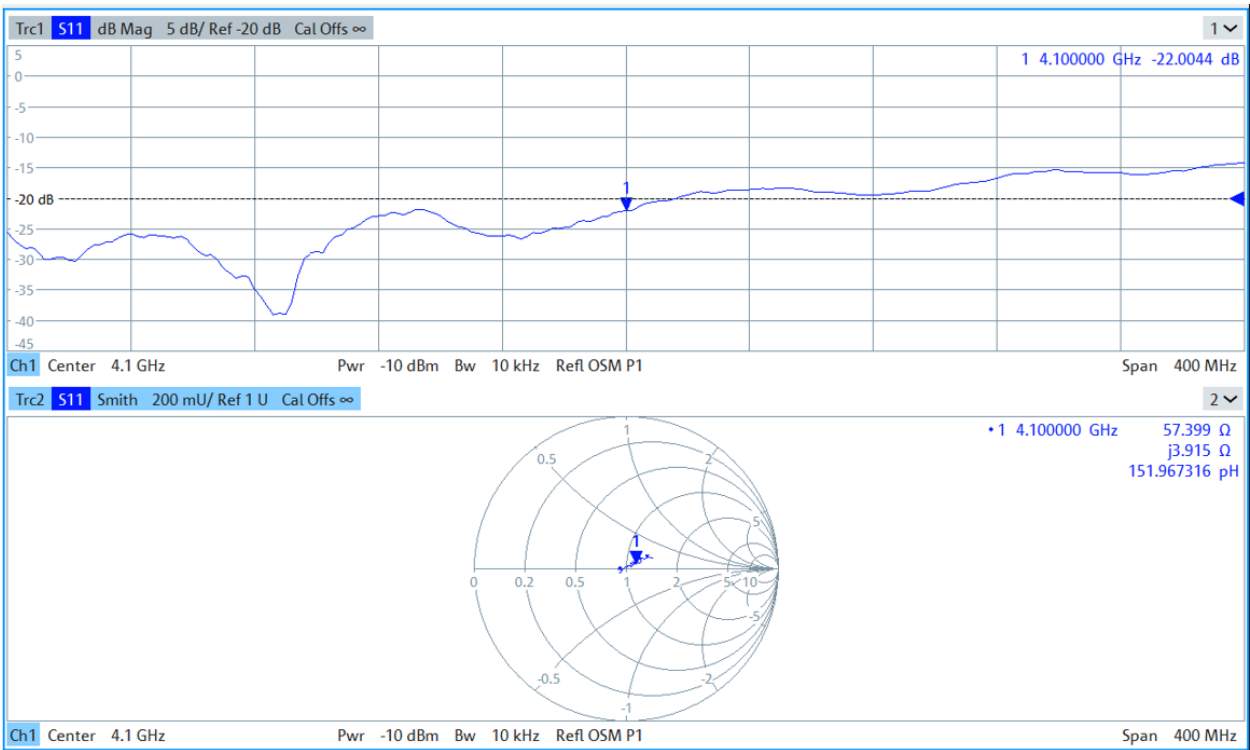
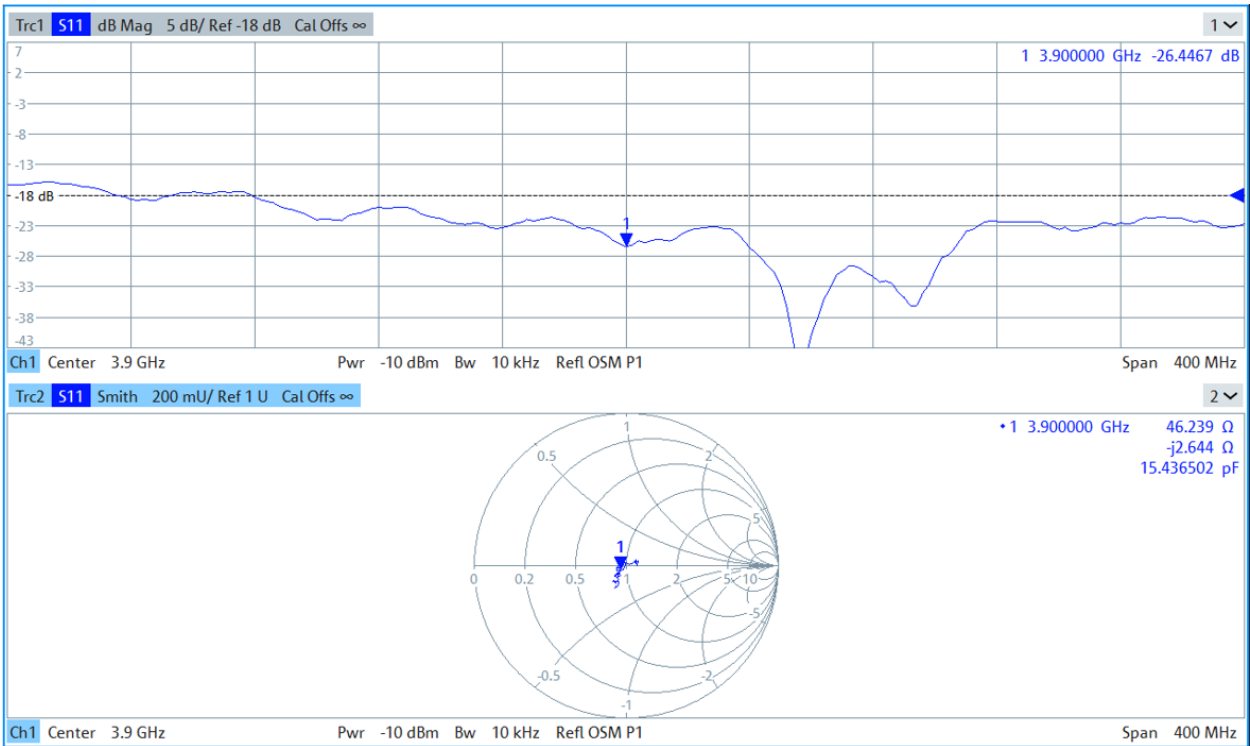
The following dipole was checked to pass the above 3 requirements to have 2-year calibration period from the calibration date:

| Frequency (MHz) | Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 17.0 dBm | Measured Head SAR (1g) W/kg @ 17.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 17.0 dBm | Measured Head SAR (10g) W/kg @ 17.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|-----------------|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|-----------|
| 3900            | 6/10/2021        | 6/10/2022      | 1.103                             | 6.97                                             | 7.18                                   | 3.01%            | 2.4                                               | 2.57                                    | 7.08%             | 46.5                                  | 47.4                               | 0.9                   | -3.9                                       | -4.3                                    | 0.4                        | -25.2                             | -25.7                          | 0.30%         | PASS      |
| 4100            | 6/10/2021        | 6/10/2022      | 1.103                             | 6.85                                             | 6.62                                   | -3.36%           | 2.35                                              | 2.32                                    | -1.28%            | 59.2                                  | 59.9                               | 0.7                   | 3.1                                        | 1.3                                     | 1.8                        | -21                               | -20.9                          | 0.10%         | PASS      |
| Frequency (MHz) | Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 17.0 dBm | Measured Body SAR (1g) W/kg @ 17.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 17.0 dBm | Measured Body SAR (10g) W/kg @ 17.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
| 3900            | 6/10/2021        | 6/10/2022      | 1.103                             | 6.43                                             | 6.26                                   | -2.64%           | 2.2                                               | 2.19                                    | -0.45%            | 46.1                                  | 46.2                               | 0.1                   | -3                                         | -2.6                                    | 0.4                        | -25.8                             | -26.4                          | -2.50%        | PASS      |
| 4100            | 6/10/2021        | 6/10/2022      | 1.103                             | 6.34                                             | 6.62                                   | 4.42%            | 2.16                                              | 2.32                                    | 7.41%             | 58.7                                  | 57.4                               | 1.3                   | 4.7                                        | 3.9                                     | 0.8                        | -20.9                             | -22.0                          | -5.30%        | PASS      |

## Impedance & Return-Loss Measurement Plot for Head TSL



Impedance & Return-Loss Measurement Plot for Body TSL



## Certification of Calibration

Object: D3900V2 – SN: 1073

Calibration procedure(s): Procedure for Calibration Extension for SAR Dipoles.

Extension Calibration date: 08/21/2023

Description: SAR Validation Dipole at 3900 and 4100 MHz.

### Calibration Equipment used:

| Manufacturer          | Model         | Description                                             | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|-----------------------|---------------|---------------------------------------------------------|------------|--------------|------------|---------------|
| Agilent               | N5182A        | MXG Vector Signal Generator                             | 11/30/2022 | Annual       | 11/30/2023 | MY47420603    |
| Amplifier Research    | 15S1G6        | Amplifier                                               | CBT        | N/A          | CBT        | 343971        |
| Anritsu               | MA24106A      | USB Power Sensor                                        | 1/9/2023   | Annual       | 1/9/2024   | 1344545       |
| Anritsu               | MA24106A      | USB Power Sensor                                        | 1/9/2023   | Annual       | 1/9/2024   | 1349511       |
| Control Company       | 4040          | Therm./ Clock/ Humidity Monitor                         | 3/27/2023  | Biennial     | 3/27/2025  | 230208060     |
| Control Company       | 4352          | Long Stem Thermometer                                   | 9/10/2021  | Biennial     | 9/10/2023  | 210774675     |
| MiniCircuits          | VL6-6000+     | Low Pass Filter                                         | CBT        | N/A          | CBT        | N/A           |
| Narda                 | 4772-3        | Attenuator (3dB)                                        | CBT        | N/A          | CBT        | 9406          |
| Pasternack            | PE5011-1      | Torque Wrench                                           | 12/21/2021 | Biennial     | 12/21/2023 | 82475         |
| Mini-Circuits         | ZHDC-16-63-S+ | Coupler                                                 | CBT        | N/A          | CBT        | N/A           |
| Rohde & Schwarz       | ZNLE6         | Vector Network Analyzer                                 | 10/21/2022 | Annual       | 10/21/2023 | 101307        |
| SPEAG                 | DAK-3.5       | Dielectric Assessment Kit                               | 11/14/2022 | Annual       | 11/14/2023 | 1277          |
| Keysight Technologies | 85033E        | Standard Mechanical Calibration Kit (DC to 9GHz, 3.5mm) | 11/11/2022 | Annual       | 11/11/2023 | MY53401181    |
| SPEAG                 | EX3DV4        | SAR Probe                                               | 6/15/2023  | Annual       | 6/15/2024  | 7409          |
| SPEAG                 | DAE4          | Dasy Data Acquisition Electronics                       | 6/15/2023  | Annual       | 6/15/2024  | 1334          |
| SPEAG                 | EX3DV4        | SAR Probe                                               | 6/14/2023  | Annual       | 6/14/2024  | 7661          |
| SPEAG                 | DAE4          | Dasy Data Acquisition Electronics                       | 5/11/2023  | Annual       | 5/11/2024  | 728           |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name              | Function                   | Signature                |
|----------------|-------------------|----------------------------|--------------------------|
| Calibrated By: | Brodie Halbfoster | Test Engineer              | <i>Brodie Halbfoster</i> |
| Approved By:   | Greg Snyder       | Executive VP of Operations | <i>Greg Snyder</i>       |

# DIPOLE CALIBRATION EXTENSION

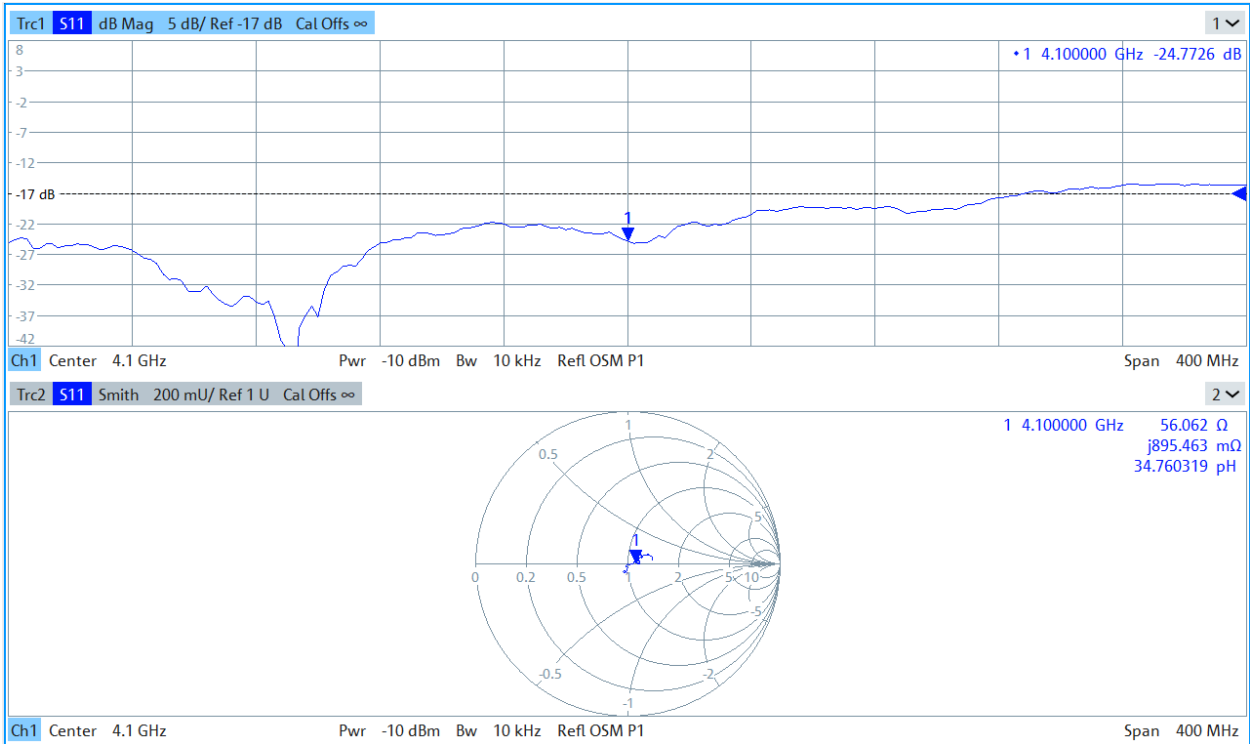
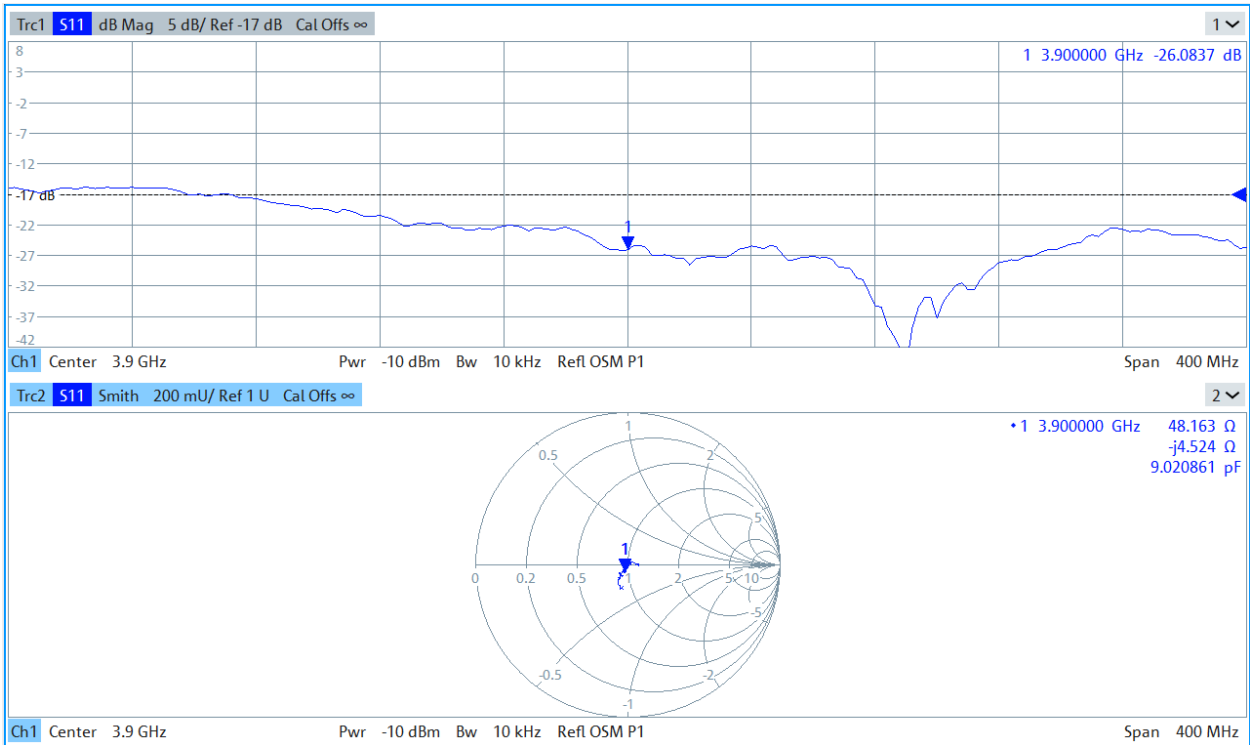
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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 3-year calibration period from the calibration date:

| Frequency (MHz) | Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 20.0 dBm | Measured Head SAR (1g) W/kg @ 20.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 20.0 dBm | Measured Head SAR (10g) W/kg @ 20.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|-----------------|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|-----------|
| 3900            | 6/10/2021        | 8/21/2023      | 1.103                             | 6.97                                             | 6.96                                   | -0.14%           | 2.4                                               | 2.31                                    | -3.75%            | 46.5                                  | 48.2                               | 1.7                   | -3.9                                       | -4.5                                    | 0.6                        | -25.2                             | -26.1                          | -3.50%        | PASS      |
| 4100            | 6/10/2021        | 8/21/2023      | 1.103                             | 6.85                                             | 7.10                                   | 3.65%            | 2.35                                              | 2.50                                    | 6.38%             | 59.2                                  | 56.1                               | 3.1                   | 3.1                                        | 0.9                                     | 2.2                        | -21                               | -24.8                          | -18.00%       | PASS      |

Impedance & Return-Loss Measurement Plot for Head TSL





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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Element**

Certificate No: **D5GHzV2-1123\_Mar22**

## CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1123**

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

Calibration date: **March 22, 2022**

✓ YW 5/16/2023

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 ( $22 \pm 3$ )°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: | Name<br><b>Aldonia Georgiadou</b> | Function<br><b>Laboratory Technician</b> | Signature<br> |
| Approved by:   | <b>Sven Kühn</b>                  | <b>Deputy Manager</b>                    |               |

Issued: March 22, 2022

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



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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                    | 5250 MHz $\pm$ 1 MHz<br>5600 MHz $\pm$ 1 MHz<br>5750 MHz $\pm$ 1 MHz<br>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 | 35.1 $\pm$ 6 % | 4.55 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 <sup>3</sup> (1 g) of Head TSL | Condition          |                              |
| SAR measured                                          | 100 mW input power | 8.09 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 80.5 W/kg $\pm$ 19.9 % (k=2) |

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
| SAR measured                                            | 100 mW input power | 2.30 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 22.9 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 | 34.6 ± 6 %   | 4.90 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Head TSL at 5600 MHz

|                                                             |                    |                                 |
|-------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                                 |
| SAR measured                                                | 100 mW input power | 8.43 W/kg                       |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>83.7 W/kg ± 19.9 % (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 | 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 | 34.4 ± 6 %   | 5.05 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Head TSL at 5750 MHz

|                                                             |                    |                                 |
|-------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                                 |
| SAR measured                                                | 100 mW input power | 8.11 W/kg                       |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>80.5 W/kg ± 19.9 % (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 | 2.29 W/kg                       |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>22.7 W/kg ± 19.5 % (k=2)</b> |

### 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 | 34.3 ± 6 %   | 5.10 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C        | ---          | ---              |

### SAR result with Head TSL at 5800 MHz

|                                                             |                    |                                 |
|-------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                                 |
| SAR measured                                                | 100 mW input power | 8.10 W/kg                       |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>80.5 W/kg ± 19.9 % (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 | 2.27 W/kg                       |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>22.5 W/kg ± 19.5 % (k=2)</b> |

### Body TSL parameters at 5250 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 48.9         | 5.36 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 48.2 ± 6 %   | 5.50 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Body TSL at 5250 MHz

|                                                             |                    |                                 |
|-------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                                 |
| SAR measured                                                | 100 mW input power | 7.55 W/kg                       |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>75.4 W/kg ± 19.9 % (k=2)</b> |

|                                                               |                    |                                 |
|---------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                                 |
| SAR measured                                                  | 100 mW input power | 2.09 W/kg                       |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>20.8 W/kg ± 19.5 % (k=2)</b> |

### Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 48.5         | 5.77 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 47.6 ± 6 %   | 5.97 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Body TSL at 5600 MHz

|                                                             |                    |                                 |
|-------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                                 |
| SAR measured                                                | 100 mW input power | 7.80 W/kg                       |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>77.8 W/kg ± 19.9 % (k=2)</b> |

|                                                               |                    |                                 |
|---------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                                 |
| SAR measured                                                  | 100 mW input power | 2.15 W/kg                       |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>21.4 W/kg ± 19.5 % (k=2)</b> |

### Body TSL parameters at 5750 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 48.3         | 5.94 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 47.3 ± 6 %   | 6.18 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Body TSL at 5750 MHz

|                                                             |                    |                                 |
|-------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                                 |
| SAR measured                                                | 100 mW input power | 7.55 W/kg                       |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>75.3 W/kg ± 19.9 % (k=2)</b> |

|                                                               |                    |                                 |
|---------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                                 |
| SAR measured                                                  | 100 mW input power | 2.08 W/kg                       |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>20.7 W/kg ± 19.5 % (k=2)</b> |

### Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 48.2         | 6.00 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 47.3 ± 6 %   | 6.25 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Body TSL at 5800 MHz

|                                                             |                    |                                 |
|-------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b> | Condition          |                                 |
| SAR measured                                                | 100 mW input power | 7.45 W/kg                       |
| SAR for nominal Body TSL parameters                         | normalized to 1W   | <b>74.3 W/kg ± 19.9 % (k=2)</b> |

|                                                               |                    |                                 |
|---------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | condition          |                                 |
| SAR measured                                                  | 100 mW input power | 2.03 W/kg                       |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>20.2 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 | $53.6 \Omega - 2.7 j\Omega$ |
| Return Loss                          | - 27.3 dB                   |

### Antenna Parameters with Head TSL at 5600 MHz

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $57.2 \Omega + 3.0 j\Omega$ |
| Return Loss                          | - 22.7 dB                   |

### Antenna Parameters with Head TSL at 5750 MHz

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $56.7 \Omega + 4.1 j\Omega$ |
| Return Loss                          | - 22.7 dB                   |

### Antenna Parameters with Head TSL at 5800 MHz

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $55.7 \Omega + 2.4 j\Omega$ |
| Return Loss                          | - 24.7 dB                   |

### Antenna Parameters with Body TSL at 5250 MHz

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $52.8 \Omega - 1.6 j\Omega$ |
| Return Loss                          | - 30.0 dB                   |

### Antenna Parameters with Body TSL at 5600 MHz

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $57.7 \Omega + 4.2 j\Omega$ |
| Return Loss                          | - 21.8 dB                   |

### Antenna Parameters with Body TSL at 5750 MHz

|                                      |                             |
|--------------------------------------|-----------------------------|
| Impedance, transformed to feed point | $57.9 \Omega + 4.7 j\Omega$ |
| Return Loss                          | - 21.5 dB                   |

## Antenna Parameters with Body TSL at 5800 MHz

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | $56.0\ \Omega + 4.8\ j\Omega$ |
| Return Loss                          | - 22.8 dB                     |

## General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.205 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: 22.03.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1123**

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

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 4.55$  S/m;  $\epsilon_r = 35.1$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5600$  MHz;  $\sigma = 4.9$  S/m;  $\epsilon_r = 34.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.05$  S/m;  $\epsilon_r = 34.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.1$  S/m;  $\epsilon_r = 34.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(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(5.01, 5.01, 5.01) @ 5800 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=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 = 78.80 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 28.1 W/kg

**SAR(1 g) = 8.09 W/kg; SAR(10 g) = 2.30 W/kg**

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

Ratio of SAR at M2 to SAR at M1 = 70.5%

Maximum value of SAR (measured) = 18.4 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 = 78.34 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 31.7 W/kg

**SAR(1 g) = 8.43 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 = 67.7%

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 = 75.77 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 32.3 W/kg

**SAR(1 g) = 8.11 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 = 65.9%

Maximum value of SAR (measured) = 19.3 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 = 75.72 V/m; Power Drift = -0.02 dB

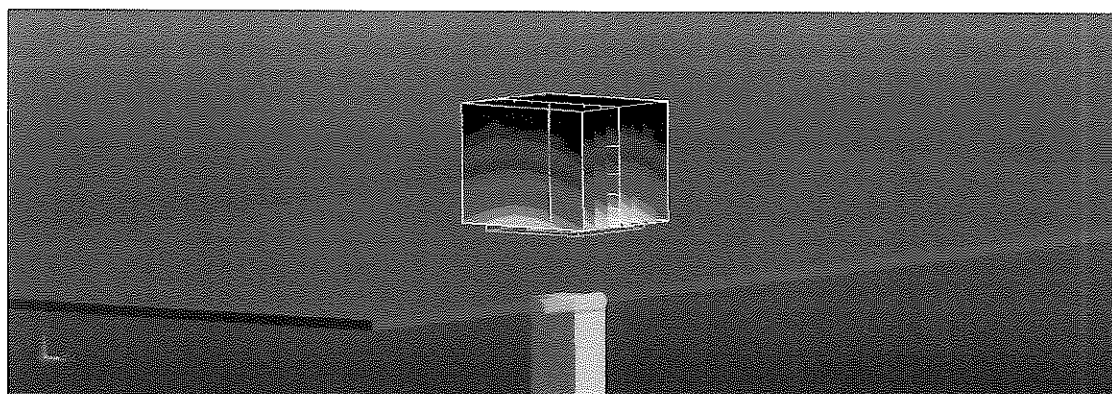
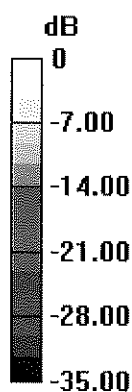
Peak SAR (extrapolated) = 32.6 W/kg

**SAR(1 g) = 8.10 W/kg; SAR(10 g) = 2.27 W/kg**

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

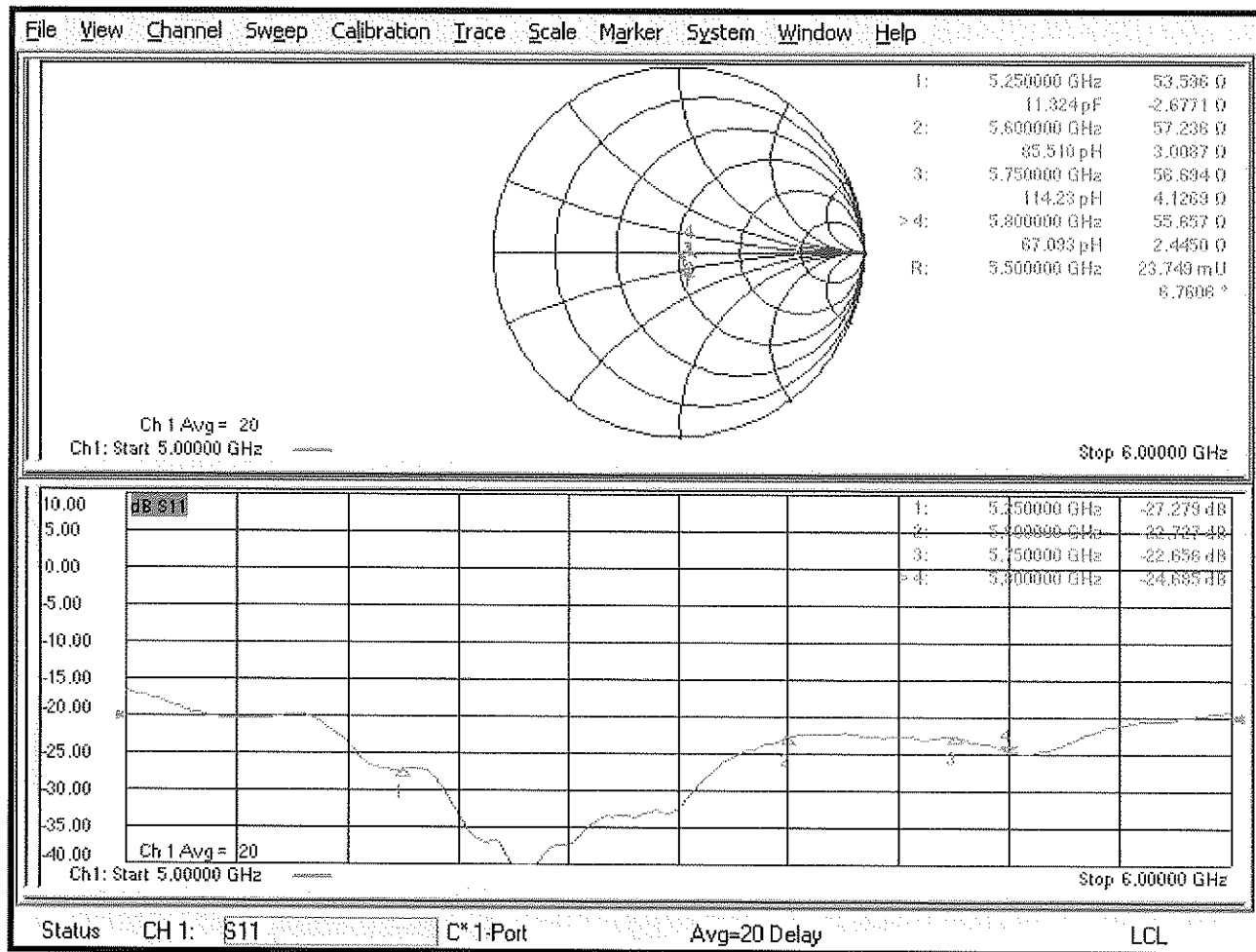
Ratio of SAR at M2 to SAR at M1 = 65.5%

Maximum value of SAR (measured) = 19.4 W/kg



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

# Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 17.03.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1123**

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

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 5.5$  S/m;  $\epsilon_r = 48.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.97$  S/m;  $\epsilon_r = 47.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5750$  MHz;  $\sigma = 6.18$  S/m;  $\epsilon_r = 47.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.25$  S/m;  $\epsilon_r = 47.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.26, 5.26, 5.26) @ 5250 MHz, ConvF(4.79, 4.79, 4.79) @ 5600 MHz, ConvF(4.66, 4.66, 4.66) @ 5750 MHz, ConvF(4.62, 4.62, 4.62) @ 5800 MHz; Calibrated: 08.03.2022
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration for Body 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 = 67.23 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 29.5 W/kg

**SAR(1 g) = 7.55 W/kg; SAR(10 g) = 2.09 W/kg**

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

Ratio of SAR at M2 to SAR at M1 = 66.8%

Maximum value of SAR (measured) = 17.7 W/kg

**Dipole Calibration for Body 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 = 66.83 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 33.8 W/kg

**SAR(1 g) = 7.80 W/kg; SAR(10 g) = 2.15 W/kg**

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

Ratio of SAR at M2 to SAR at M1 = 63.2%

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

**Dipole Calibration for Body 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 = 64.54 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 34.1 W/kg

**SAR(1 g) = 7.55 W/kg; SAR(10 g) = 2.08 W/kg**

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

Ratio of SAR at M2 to SAR at M1 = 61.3%

Maximum value of SAR (measured) = 18.6 W/kg

**Dipole Calibration for Body 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 = 65.49 V/m; Power Drift = -0.08 dB

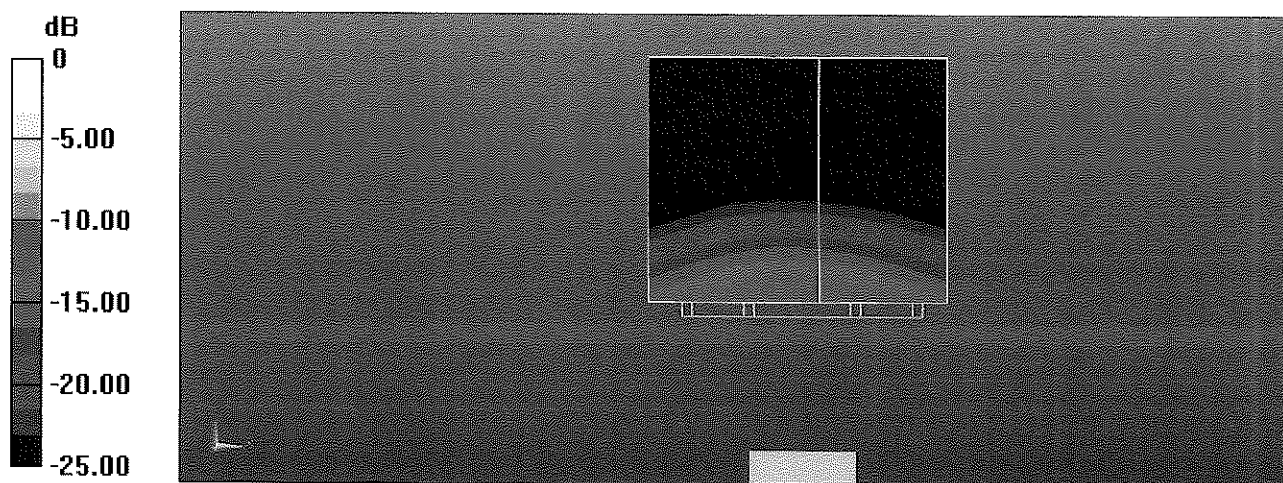
Peak SAR (extrapolated) = 32.8 W/kg

**SAR(1 g) = 7.45 W/kg; SAR(10 g) = 2.03 W/kg**

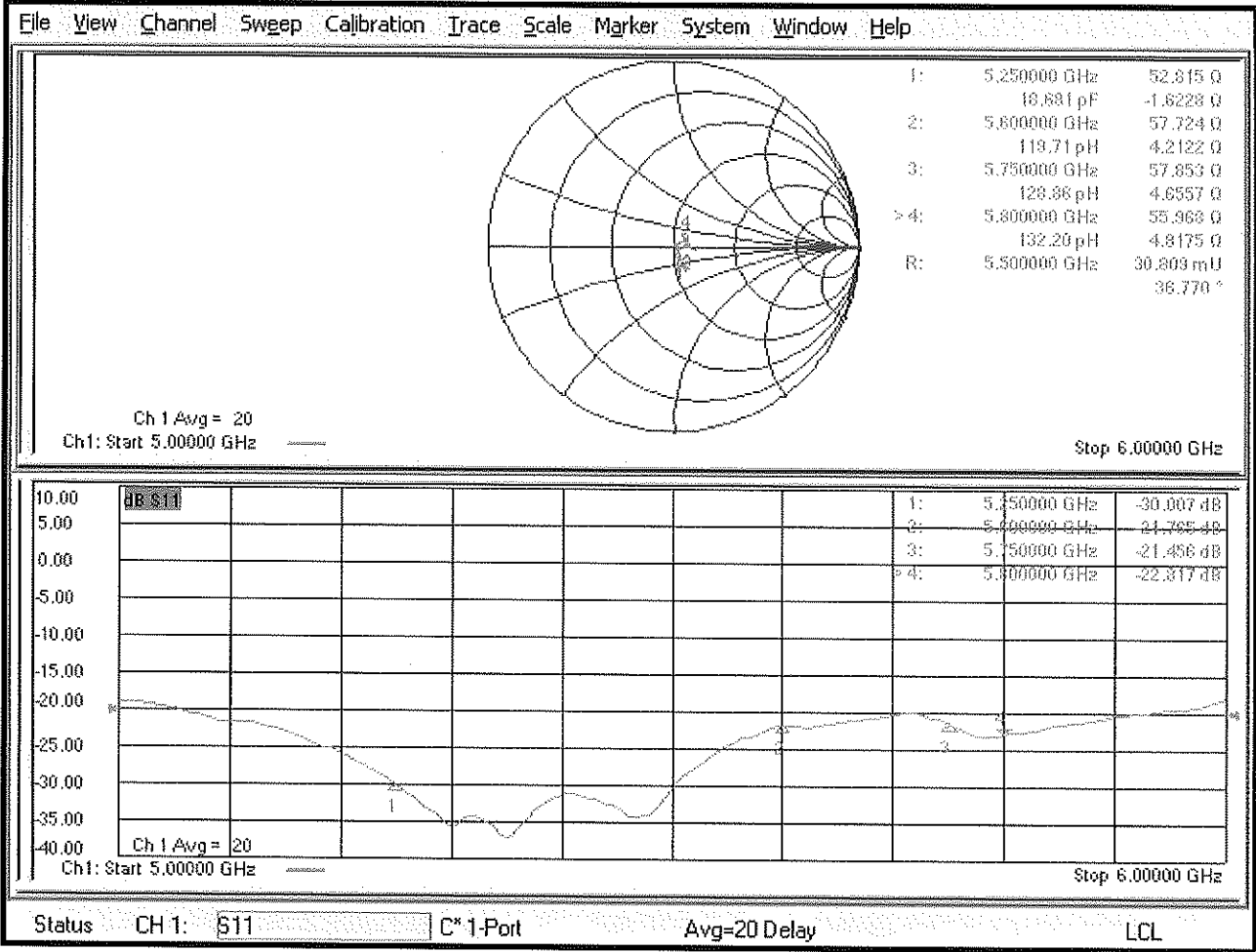
Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 62.8%

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



Impedance Measurement Plot for Body TSL



## Certification of Calibration

Object: D5GHzV2 – SN: 1123

Calibration procedure(s): Procedure for Calibration Extension for SAR Dipoles.

Extended Calibration date: March 22, 2023

Description: SAR Validation Dipole at 5250,5600,5750,5800 MHz.

### Calibration Equipment used:

| Manufacturer       | Model         | Description                         | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|--------------------|---------------|-------------------------------------|------------|--------------|------------|---------------|
| Agilent            | 8753ES        | S-Parameter Vector Network Analyzer | 6/14/2022  | Annual       | 6/14/2023  | US39170118    |
| Agilent            | E4438C        | ESG Vector Signal Generator         | 11/17/2022 | Annual       | 11/17/2023 | MY45093852    |
| Amplifier Research | 15S1G6        | Amplifier                           | CBT        | N/A          | CBT        | 343972        |
| Rohde & Schwarz    | NRX           | Power Meter                         | 1/11/2023  | Annual       | 1/11/2024  | 102583        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 5/19/2022  | Annual       | 5/19/2023  | 106562        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 5/19/2022  | Annual       | 5/19/2023  | 106559        |
| Traceable          | 4040 90080-06 | Therm./ Clock/ Humidity Monitor     | 5/11/2022  | Biennial     | 5/11/2024  | 221514974     |
| Control Company    | 4353          | Long Stem Thermometer               | 9/10/2021  | Biennial     | 9/10/2023  | 210774685     |
| Agilent            | 85033E        | 3.5mm Standard Calibration Kit      | 6/21/2022  | Annual       | 6/21/2023  | MY53402352    |
| Mini-Circuits      | VLF-6000+     | Low Pass Filter DC to 6000 MHz      | CBT        | N/A          | CBT        | N/A           |
| Narda              | 4772-3        | Attenuator (3dB)                    | CBT        | N/A          | CBT        | 9406          |
| Mini-Circuits      | ZHDC-16-63-S+ | 50-6000MHz Bidirectional Coupler    | CBT        | N/A          | CBT        | N/A           |
| Pasternack         | NC-100        | Torque Wrench                       | 12/5/2022  | Biennial     | 12/5/2024  | N/A           |
| SPEAG              | DAK-3.5       | Dielectric Assessment Kit           | 5/16/2022  | Annual       | 5/16/2023  | 1070          |
| SPEAG              | EX3DV4        | SAR Probe                           | 2/13/2023  | Annual       | 2/13/2024  | 7308          |
| SPEAG              | EX3DV4        | SAR Probe                           | 3/16/2023  | Annual       | 3/16/2024  | 7421          |
| SPEAG              | EX3DV4        | SAR Probe                           | 2/13/2023  | Annual       | 2/13/2024  | 7427          |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 2/15/2023  | Annual       | 2/15/2024  | 467           |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 3/15/2023  | Annual       | 3/15/2024  | 604           |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 2/15/2023  | Annual       | 2/15/2024  | 1403          |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name            | Function                   | Signature                                                                             |
|----------------|-----------------|----------------------------|---------------------------------------------------------------------------------------|
| Calibrated By: | Arturo Oliveros | Compliance Engineer I      |  |
| Approved By:   | Greg Snyder     | Executive VP of Operations |  |

# DIPOLE CALIBRATION EXTENSION

Per KDB 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:

| Frequency (MHz) | Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 17.0 dBm | Measured Head SAR (1g) W/kg @ 17.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 17.0 dBm | Measured Head SAR (10g) W/kg @ 17.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) | PASS/FAIL |
|-----------------|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|-----------|
| 5250            | 3/22/2022        | 3/22/2023      | 1.205                             | 4.03                                             | 4.00                                   | -0.62%           | 1.15                                              | 1.15                                    | -1.31%            | 53.6                                  | 53.5                               | 0.1                   | -2.7                                       | -6.1                                    | 3.4                        | -27.3                             | -28.6                          | 12.90%        | PASS      |
| 5600            | 3/22/2022        | 3/22/2023      | 1.205                             | 4.19                                             | 4.24                                   | 1.31%            | 1.19                                              | 1.20                                    | 1.27%             | 57.2                                  | 61.7                               | 4.5                   | 3.0                                        | -1.8                                    | 4.8                        | -22.7                             | -24.4                          | -7.60%        | PASS      |
| 5750            | 3/22/2022        | 3/22/2023      | 1.205                             | 4.03                                             | 3.86                                   | -4.10%           | 1.14                                              | 1.10                                    | -3.08%            | 56.7                                  | 55.7                               | 1.0                   | 4.1                                        | 3.9                                     | 0.2                        | -22.7                             | -25.5                          | -12.30%       | PASS      |
| 5800            | 3/22/2022        | 3/22/2023      | 1.205                             | 4.03                                             | 3.71                                   | -7.83%           | 1.13                                              | 1.07                                    | -4.89%            | 55.7                                  | 57.6                               | 1.9                   | 2.4                                        | 1.8                                     | 0.6                        | -24.7                             | -23.2                          | 6.10%         | PASS      |

| Frequency (MHz) | Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Body (1g) W/kg @ 17.0 dBm | Measured Body SAR (1g) W/kg @ 17.0 dBm | Deviation 1g (%) | Certificate SAR Target Body (10g) W/kg @ 17.0 dBm | Measured Body SAR (10g) W/kg @ 17.0 dBm | Deviation 10g (%) | Certificate Impedance Body (Ohm) Real | Measured Impedance Body (Ohm) Real | Difference (Ohm) Real | Certificate Impedance Body (Ohm) Imaginary | Measured Impedance Body (Ohm) Imaginary | Difference (Ohm) Imaginary | Certificate Return Loss Body (dB) | Measured Return Loss Body (dB) | Deviation (%) | PASS/FAIL |
|-----------------|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|-----------|
| 5250            | 3/22/2022        | 3/22/2023      | 1.205                             | 3.77                                             | 3.58                                   | -5.04%           | 1.04                                              | 1.03                                    | -0.96%            | 52.8                                  | 55.6                               | 2.8                   | -1.6                                       | -5.8                                    | 4.2                        | -30.0                             | -31.6                          | -12.20%       | PASS      |
| 5600            | 3/22/2022        | 3/22/2023      | 1.205                             | 3.89                                             | 3.98                                   | 2.31%            | 1.07                                              | 1.13                                    | 5.61%             | 57.7                                  | 56.3                               | -1.4                  | 4.2                                        | 0.2                                     | -4.0                       | -21.8                             | -25.8                          | -18.30%       | PASS      |
| 5750            | 3/22/2022        | 3/22/2023      | 1.205                             | 3.77                                             | 3.51                                   | -6.77%           | 1.04                                              | 1.00                                    | -3.38%            | 57.9                                  | 57.1                               | 0.8                   | 4.7                                        | 2.0                                     | 2.7                        | -21.5                             | -23                            | -6.80%        | PASS      |
| 5800            | 3/22/2022        | 3/22/2023      | 1.205                             | 3.72                                             | 3.66                                   | -1.48%           | 1.01                                              | 1.04                                    | 2.97%             | 56.0                                  | 56.5                               | 0.5                   | 4.8                                        | 3.6                                     | 1.2                        | -22.8                             | -25.8                          | -13.10%       | PASS      |

Impedance & Return-Loss Measurement Plot for Head TSL

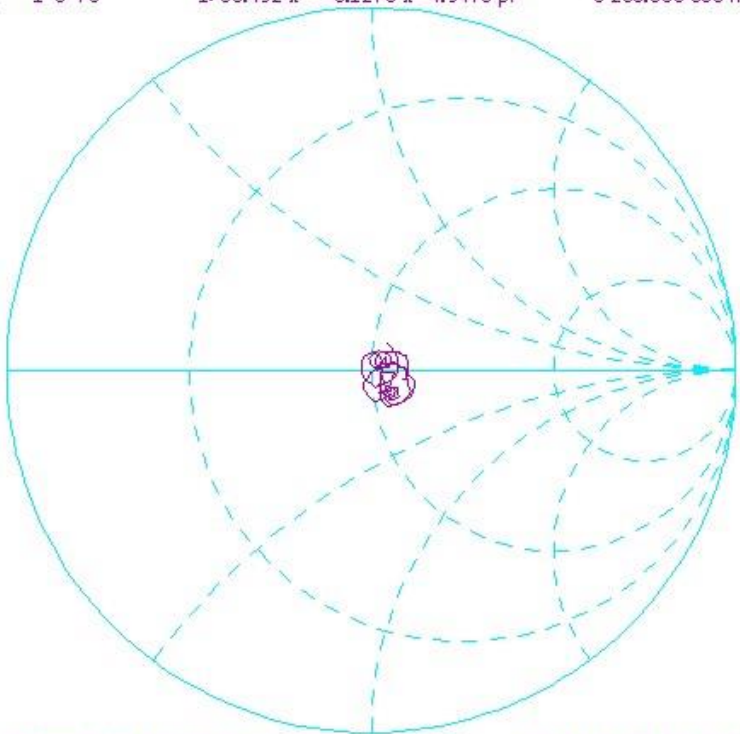
CH1 S11 1 U FS 1: 53.492  $\Omega$  -6.1270  $\Omega$  4.9478 pF 5 250.000 000 MHz

\*

De1

Cor

↑



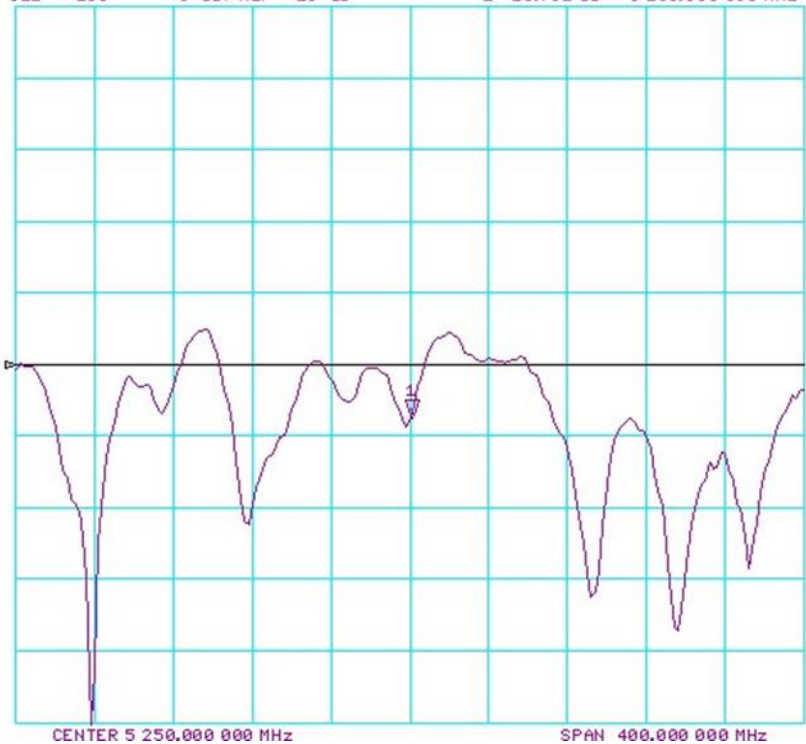
CH1 S11 LOG CENTER 5 250.000 000 MHz SPAN 400.000 000 MHz 5 dB/REF -20 dB 1:-23.782 dB 5 250.000 000 MHz

\*

De1

Cor

↑



Object:

D5GHzV2 – SN: 1123

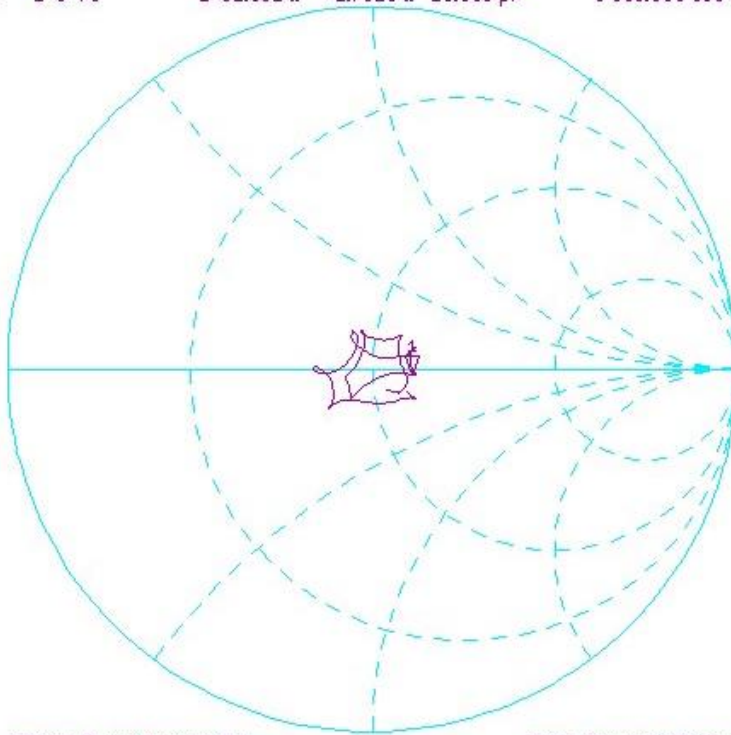
Date Issued:

03/22/2023

[CH1] S11 1 U FS 1: 61.652  $\Omega$  -1.7910  $\Omega$  15.868 pF 5 600.000 000 MHz

\*  
Del

↑



CENTER 5 600.000 000 MHz

SPAN 400.000 000 MHz

[CH1] S11 LOG 5 dB/REF -20 dB 1:-24.419 dB 5 600.000 000 MHz

\*  
Del

↑



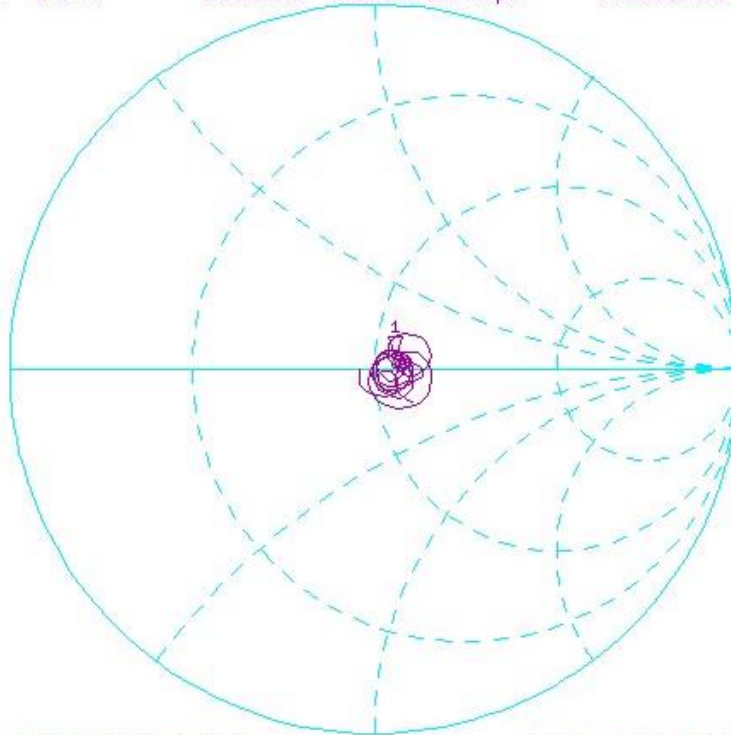
CENTER 5 600.000 000 MHz

SPAN 400.000 000 MHz

CH1 S11 1 U FS 1: 55.654  $\Omega$  3.9180  $\Omega$  108.45 pF 5 750.000 000 MHz

\*  
Del  
Cor

↑



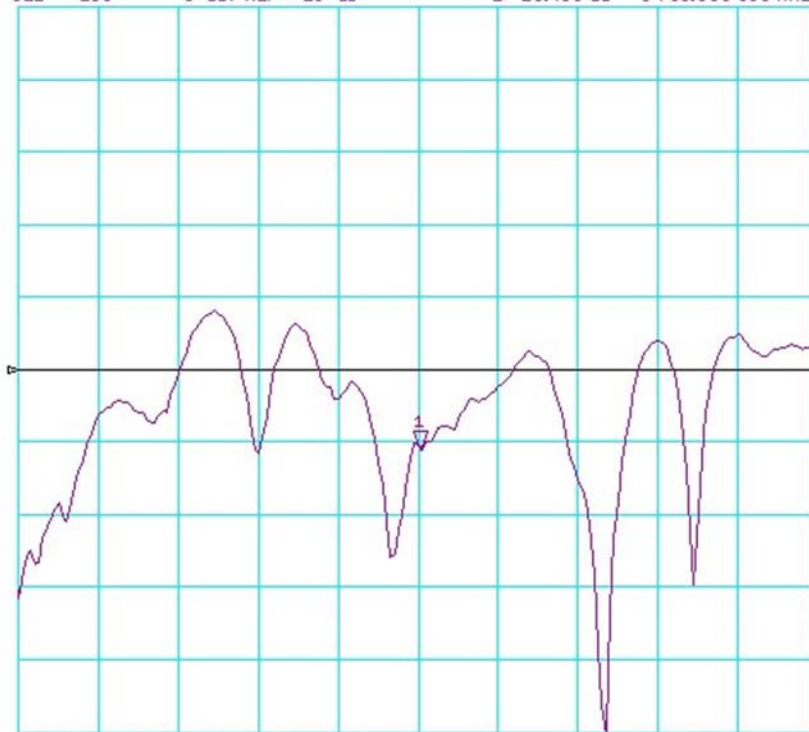
CENTER 5 750.000 000 MHz

SPAN 400.000 000 MHz

CH1 S11 LOG 5 dB/REF -20 dB 1:-25.489 dB 5 750.000 000 MHz

\*  
Del  
Cor

↑



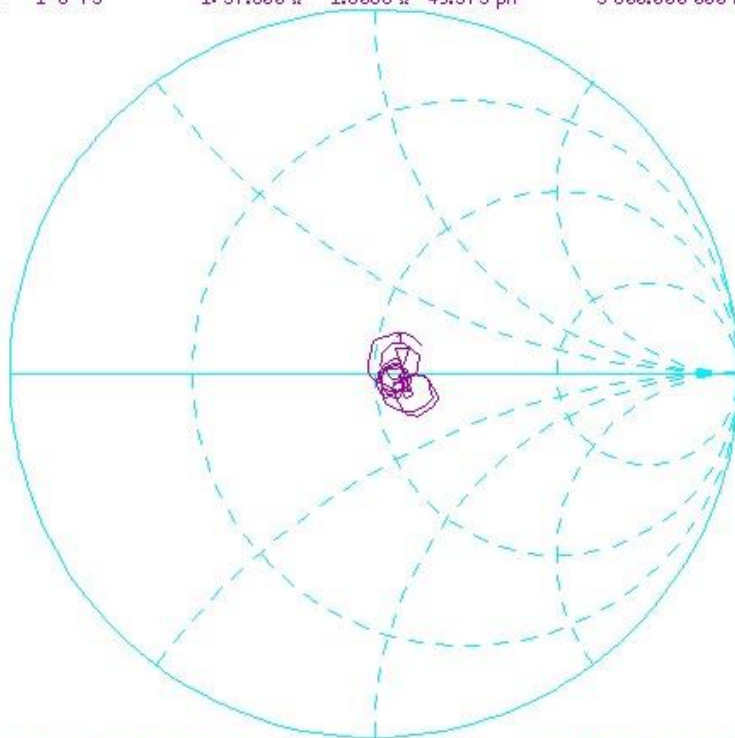
CENTER 5 750.000 000 MHz

SPAN 400.000 000 MHz

CH1 S11 1 U FS 1: 57.600  $\Omega$  1.8066  $\Omega$  49.575  $\mu$ H 5 800.000 000 MHz

\*  
Del  
Cor

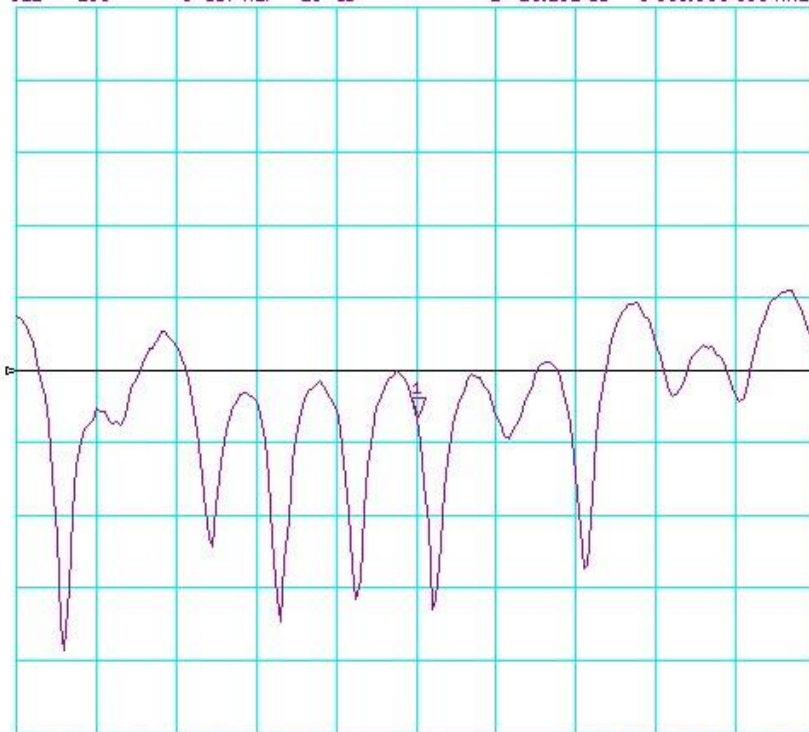
↑



CENTER 5 800.000 000 MHz SPAN 400.000 000 MHz  
CH1 S11 LOG 5 dB/REF -20 dB 1:-23.202 dB 5 800.000 000 MHz

\*  
Del  
Cor

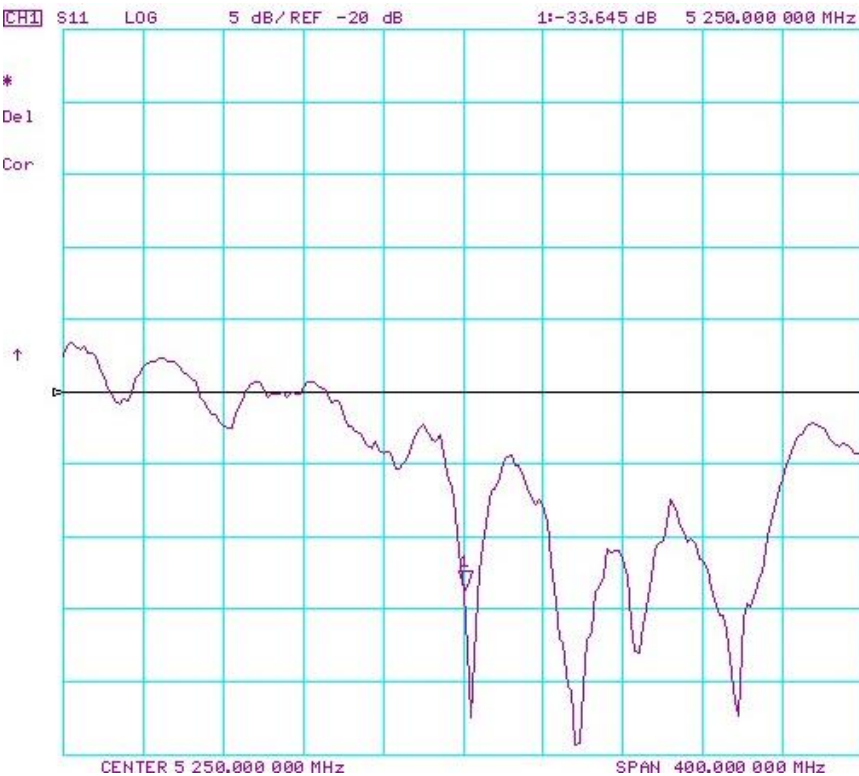
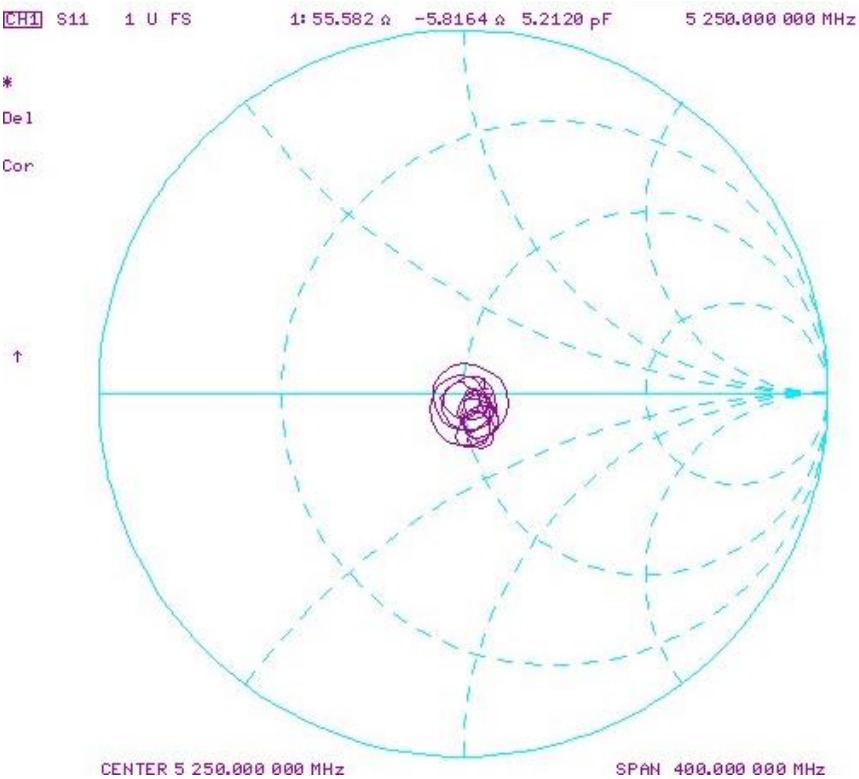
↑



CENTER 5 800.000 000 MHz

SPAN 400.000 000 MHz

Impedance & Return-Loss Measurement Plot for Body TSL

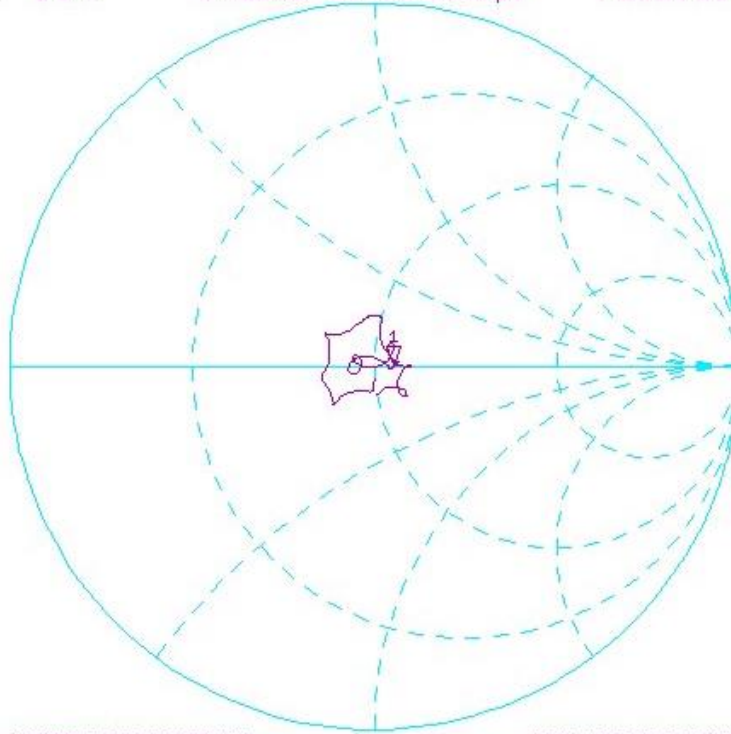


CHI S11 1 U FS 1: 55.291  $\Omega$  0.1719  $\Omega$  4.8848  $\mu$ H 5 600.000 000 MHz

\*

De1

↑



CHI S11 LOG 5 dB/REF -20 dB 1:-25.782 dB 5 600.000 000 MHz

\*

De1

↑



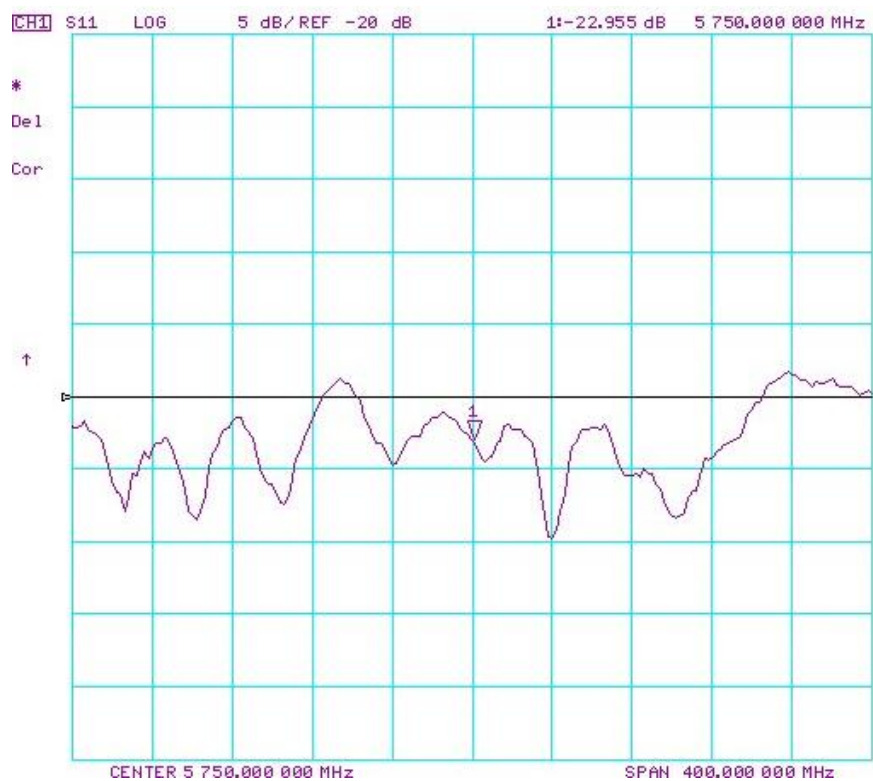
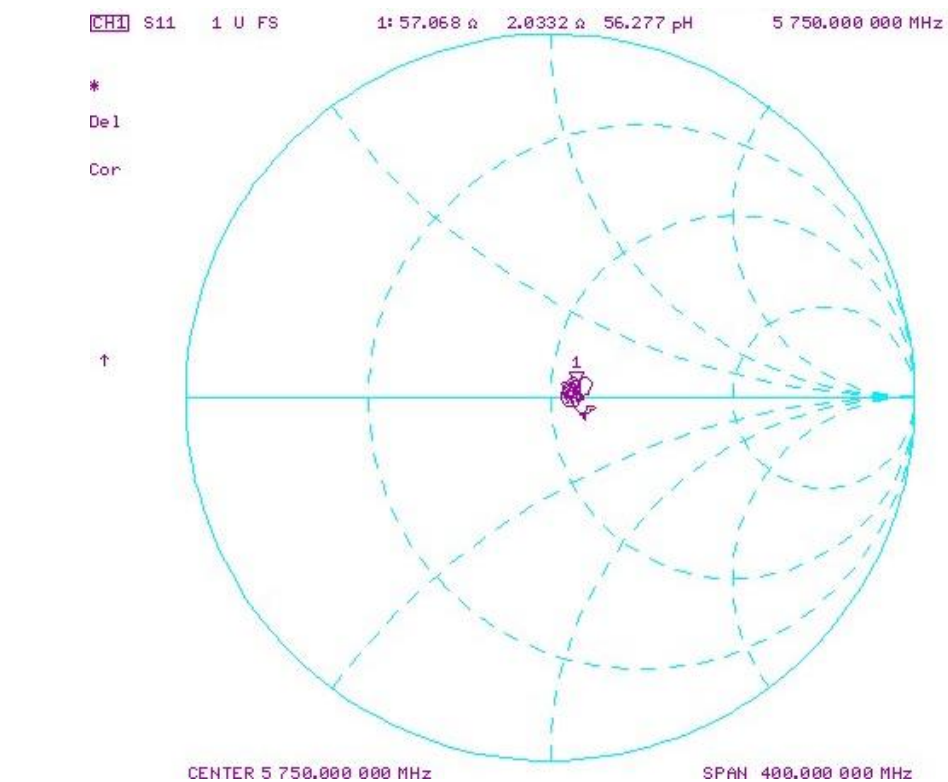
Object:

D5GHzV2 – SN: 1123

Date Issued:

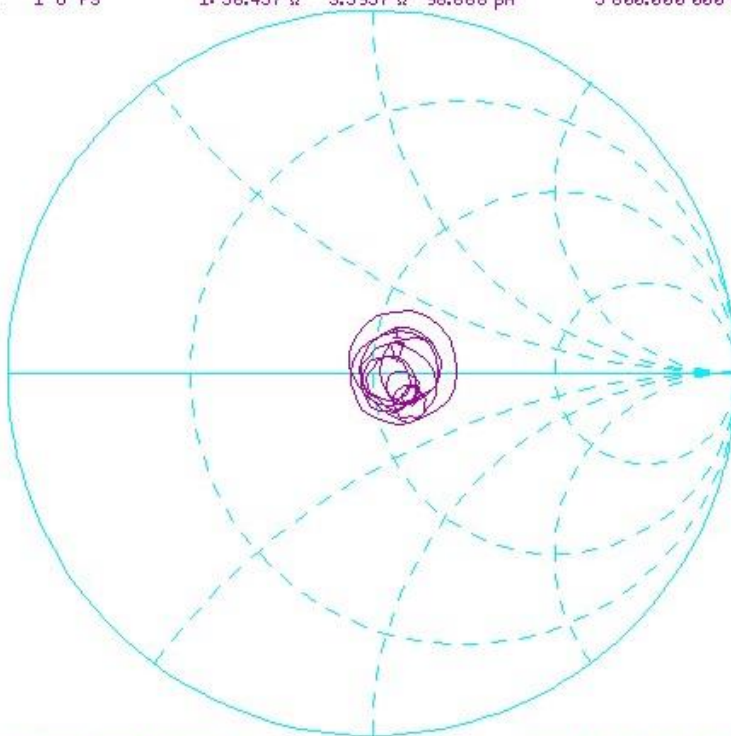
03/22/2023

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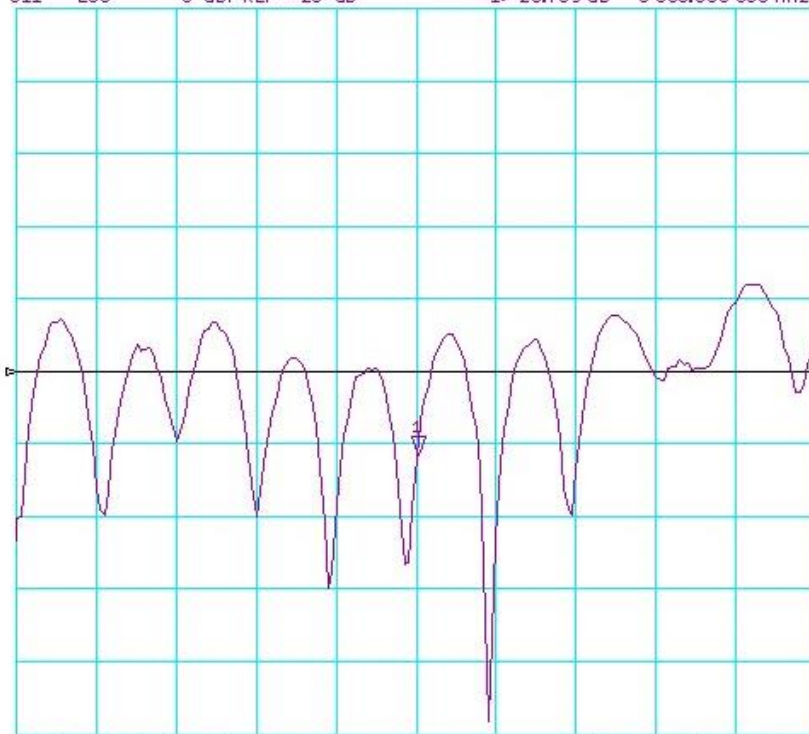
[CH1] S11 1 U FS 1: 56.457  $\Omega$  3.5957  $\Omega$  98.668 pF 5 800.000 000 MHz

\*  
Del  
Cor  
  
↑



CENTER 5 800.000 000 MHz SPAN 400.000 000 MHz  
[CH1] S11 LOG 5 dB/REF -20 dB 1:-25.789 dB 5 800.000 000 MHz

\*  
Del  
Cor  
  
↑





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 **Element**

Certificate No: **D5GHzV2-1066\_Nov22**

## CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1066**

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

Calibration date: **November 17, 2022**

✓  
ATM

12/6/22

✓ YW 12/5/2023

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  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards               | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|---------------------------------|--------------------|-----------------------------------|------------------------|
| Power meter NRP                 | SN: 104778         | 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            | 31-Aug-22 (No. DAE4-601_Aug22)    | Aug-23                 |
| 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: **Jeffrey Katzman** Name **Jeffrey Katzman** Function **Laboratory Technician**

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

Signature

*[Signature of Jeffrey Katzman]*  
*[Signature of Sven Kühn]*

Issued: November 17, 2022

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



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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 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<br>5600 MHz $\pm$ 1 MHz<br>5750 MHz $\pm$ 1 MHz<br>5850 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 | 36.0 $\pm$ 6 % | 4.60 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 <sup>3</sup> (1 g) of Head TSL | Condition          |                                                |
| SAR measured                                          | 100 mW input power | 8.03 W/kg                                      |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>80.3 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 | 2.31 W/kg                                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>23.1 W/kg <math>\pm</math> 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 $\pm$ 0.2) °C | 35.4 $\pm$ 6 % | 4.97 mho/m $\pm$ 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 | 8.40 W/kg                                      |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>83.9 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 | 2.41 W/kg                                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>24.1 W/kg <math>\pm</math> 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 | 35.2 ± 6 %   | 5.13 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Head TSL at 5750 MHz

|                                                             |                    |                                 |
|-------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                                 |
| SAR measured                                                | 100 mW input power | 7.97 W/kg                       |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>79.5 W/kg ± 19.9 % (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 | 2.27 W/kg                       |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>22.6 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 | 35.1 ± 6 %   | 5.24 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Head TSL at 5850 MHz

|                                                             |                    |                                 |
|-------------------------------------------------------------|--------------------|---------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b> | Condition          |                                 |
| SAR measured                                                | 100 mW input power | 8.23 W/kg                       |
| SAR for nominal Head TSL parameters                         | normalized to 1W   | <b>82.2 W/kg ± 19.9 % (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 | 2.34 W/kg                       |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>23.4 W/kg ± 19.5 % (k=2)</b> |

### Body TSL parameters at 5250 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 48.9         | 5.36 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 48.3 ± 6 %   | 5.49 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Body TSL at 5250 MHz

|                                                       |                    |                          |
|-------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                          |
| SAR measured                                          | 100 mW input power | 7.47 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 74.5 W/kg ± 19.9 % (k=2) |

|                                                         |                    |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                          |
| SAR measured                                            | 100 mW input power | 2.09 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 20.9 W/kg ± 19.5 % (k=2) |

### Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 48.5         | 5.77 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 47.7 ± 6 %   | 5.96 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Body TSL at 5600 MHz

|                                                       |                    |                          |
|-------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                          |
| SAR measured                                          | 100 mW input power | 7.90 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 78.9 W/kg ± 19.9 % (k=2) |

|                                                         |                    |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                          |
| SAR measured                                            | 100 mW input power | 2.20 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 22.0 W/kg ± 19.5 % (k=2) |

### Body TSL parameters at 5750 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 48.3         | 5.94 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 47.4 ± 6 %   | 6.17 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Body TSL at 5750 MHz

|                                                       |                    |                          |
|-------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                          |
| SAR measured                                          | 100 mW input power | 7.34 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 73.3 W/kg ± 19.9 % (k=2) |

|                                                         |                    |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                          |
| SAR measured                                            | 100 mW input power | 2.04 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 20.3 W/kg ± 19.5 % (k=2) |

### Body TSL parameters at 5850 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 48.1         | 6.06 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 47.2 ± 6 %   | 6.31 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C        | ----         | ----             |

### SAR result with Body TSL at 5850 MHz

|                                                       |                    |                          |
|-------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                          |
| SAR measured                                          | 100 mW input power | 7.54 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 75.2 W/kg ± 19.9 % (k=2) |

|                                                         |                    |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                          |
| SAR measured                                            | 100 mW input power | 2.09 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 20.8 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 | $50.5\ \Omega - 4.4\ j\Omega$ |
| Return Loss                          | - 27.1 dB                     |

### Antenna Parameters with Head TSL at 5600 MHz

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | $56.9\ \Omega - 0.1\ j\Omega$ |
| Return Loss                          | - 23.8 dB                     |

### Antenna Parameters with Head TSL at 5750 MHz

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | $55.3\ \Omega + 1.7\ j\Omega$ |
| Return Loss                          | - 25.5 dB                     |

### Antenna Parameters with Head TSL at 5850 MHz

|                                      |                               |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | $56.1\ \Omega - 1.5\ j\Omega$ |
| Return Loss                          | - 24.6 dB                     |

### Antenna Parameters with Body TSL at 5250 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 50.1 $\Omega$ - 2.4 j $\Omega$ |
| Return Loss                          | - 32.4 dB                      |

### Antenna Parameters with Body TSL at 5600 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 56.9 $\Omega$ + 1.5 j $\Omega$ |
| Return Loss                          | - 23.6 dB                      |

### Antenna Parameters with Body TSL at 5750 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 56.9 $\Omega$ + 2.1 j $\Omega$ |
| Return Loss                          | - 23.4 dB                      |

### Antenna Parameters with Body TSL at 5850 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 57.3 $\Omega$ - 0.5 j $\Omega$ |
| Return Loss                          | - 23.4 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.195 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: 14.11.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1066**

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

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 4.60$  S/m;  $\epsilon_r = 36.0$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5600$  MHz;  $\sigma = 4.97$  S/m;  $\epsilon_r = 35.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.13$  S/m;  $\epsilon_r = 35.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5850$  MHz;  $\sigma = 5.24$  S/m;  $\epsilon_r = 35.1$ ;  $\rho = 1000$  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: 08.03.2022
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 31.08.2022
- 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=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 = 74.31 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 27.1 W/kg

**SAR(1 g) = 8.03 W/kg; SAR(10 g) = 2.31 W/kg**

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

Ratio of SAR at M2 to SAR at M1 = 70.8%

Maximum value of SAR (measured) = 18.1 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 = 74.64 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 30.6 W/kg

**SAR(1 g) = 8.40 W/kg; SAR(10 g) = 2.41 W/kg**

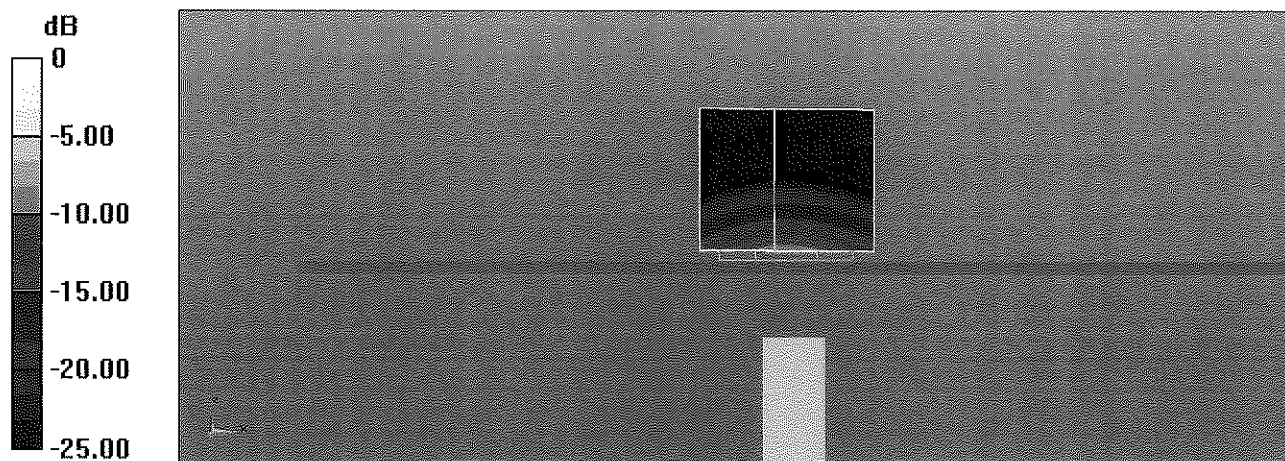
Smallest distance from peaks to all points 3 dB below = 7.4 mm

Ratio of SAR at M2 to SAR at M1 = 68.2%

Maximum value of SAR (measured) = 19.4 W/kg

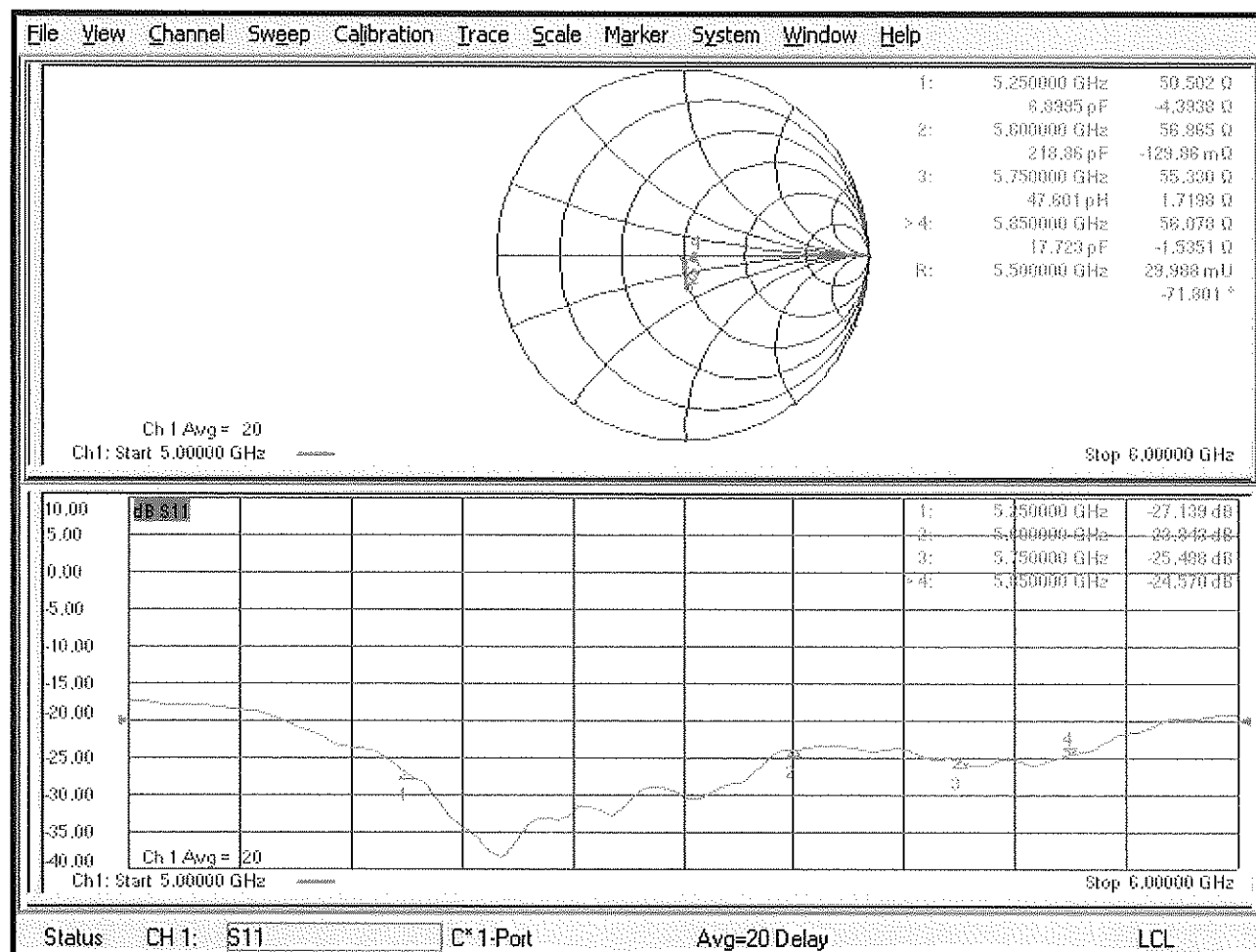
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 71.74 V/m; Power Drift = -0.02 dB  
Peak SAR (extrapolated) = 30.7 W/kg  
**SAR(1 g) = 7.97 W/kg; SAR(10 g) = 2.27 W/kg**  
Smallest distance from peaks to all points 3 dB below = 7.5 mm  
Ratio of SAR at M2 to SAR at M1 = 66.3%  
Maximum value of SAR (measured) = 18.8 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 = 72.18 V/m; Power Drift = -0.04 dB  
Peak SAR (extrapolated) = 32.4 W/kg  
**SAR(1 g) = 8.23 W/kg; SAR(10 g) = 2.34 W/kg**  
Smallest distance from peaks to all points 3 dB below = 7.5 mm  
Ratio of SAR at M2 to SAR at M1 = 65.6%  
Maximum value of SAR (measured) = 19.7 W/kg



0 dB = 19.7 W/kg = 12.93 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 17.11.2022

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1066**

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

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 5.49$  S/m;  $\epsilon_r = 48.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.96$  S/m;  $\epsilon_r = 47.7$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5750$  MHz;  $\sigma = 6.17$  S/m;  $\epsilon_r = 47.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5850$  MHz;  $\sigma = 6.31$  S/m;  $\epsilon_r = 47.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.26, 5.26, 5.26) @ 5250 MHz, ConvF(4.79, 4.79, 4.79) @ 5600 MHz, ConvF(4.66, 4.66, 4.66) @ 5750 MHz, ConvF(4.61, 4.61, 4.61) @ 5850 MHz; Calibrated: 08.03.2022
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 31.08.2022
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration for Body 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 = 66.40 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 28.2 W/kg

**SAR(1 g) = 7.47 W/kg; SAR(10 g) = 2.09 W/kg**

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

Ratio of SAR at M2 to SAR at M1 = 67.4%

Maximum value of SAR (measured) = 17.3 W/kg

**Dipole Calibration for Body 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 = 65.97 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 33.0 W/kg

**SAR(1 g) = 7.90 W/kg; SAR(10 g) = 2.20 W/kg**

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

Ratio of SAR at M2 to SAR at M1 = 64.2%

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

**Dipole Calibration for Body 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 = 64.01 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 32.0 W/kg

**SAR(1 g) = 7.34 W/kg; SAR(10 g) = 2.04 W/kg**

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

Ratio of SAR at M2 to SAR at M1 = 62.7%

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

**Dipole Calibration for Body 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 = 63.69 V/m; Power Drift = -0.07 dB

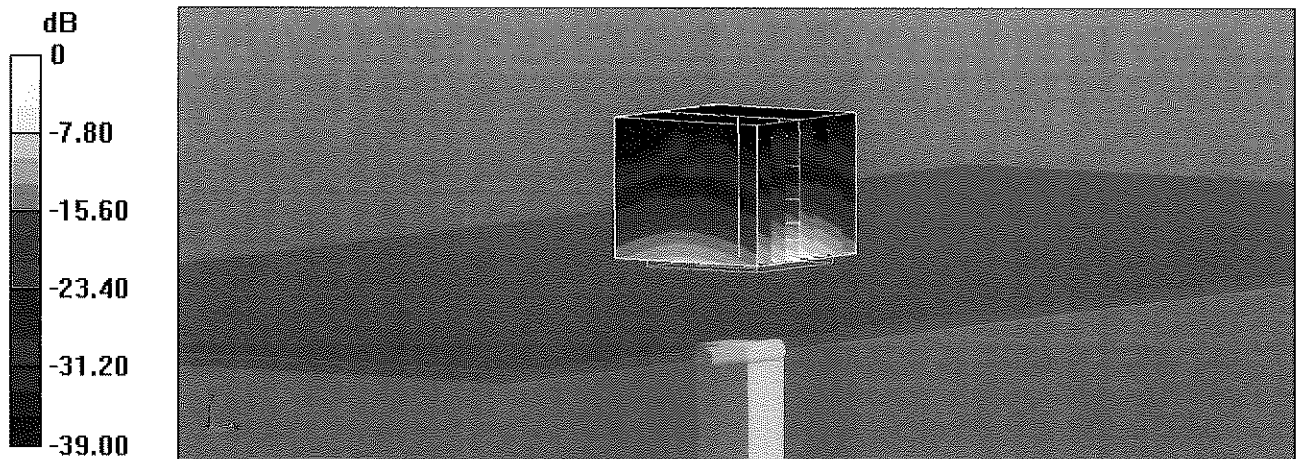
Peak SAR (extrapolated) = 33.1 W/kg

**SAR(1 g) = 7.54 W/kg; SAR(10 g) = 2.09 W/kg**

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

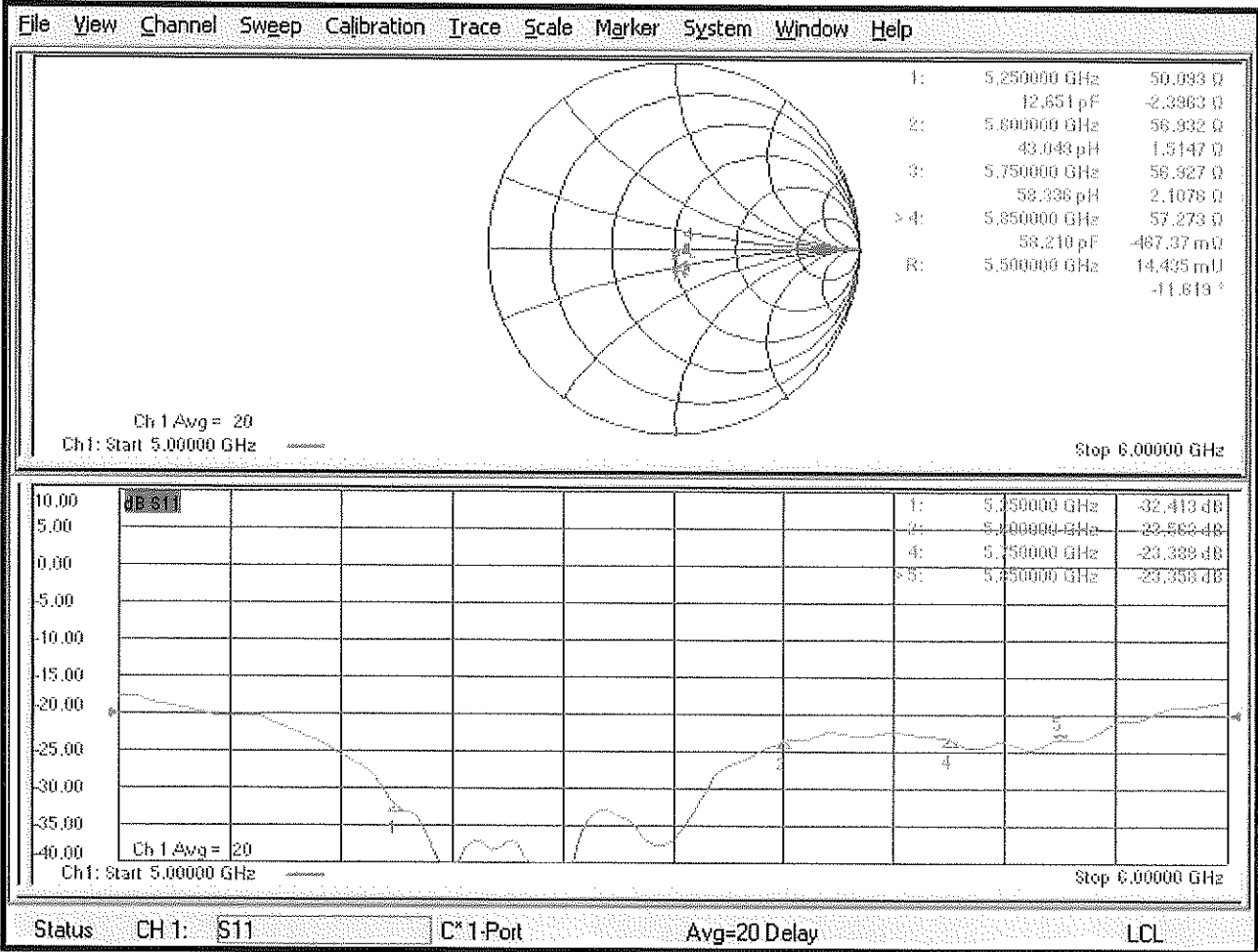
Ratio of SAR at M2 to SAR at M1 = 62.4%

Maximum value of SAR (measured) = 19.0 W/kg



0 dB = 19.2 W/kg = 12.84 dBW/kg

Impedance Measurement Plot for Body TSL



## Certification of Calibration

Object: D5GHzV2 – SN: 1066

Calibration procedure(s): Procedure for Calibration Extension for SAR Dipoles.

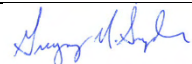
Extension Calibration date: November 17, 2023

Description: SAR Validation Dipole at 5250,5600,5750,5850 MHz.

### Calibration Equipment used:

| Manufacturer       | Model         | Description                         | Cal Date   | Cal Interval | Cal Due    | Serial Number |
|--------------------|---------------|-------------------------------------|------------|--------------|------------|---------------|
| Agilent            | 8753ES        | S-Parameter Vector Network Analyzer | 6/2/2023   | Annual       | 6/12/2024  | MY40003841    |
| Agilent            | E4438C        | ESG Vector Signal Generator         | 4/25/2023  | Annual       | 4/25/2024  | US41460739    |
| Amplifier Research | 15S1G6        | Amplifier                           | CBT        | N/A          | CBT        | 343972        |
| Rohde & Schwarz    | NRX           | Power Meter                         | 1/11/2023  | Annual       | 1/11/2024  | 102583        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 1/19/2023  | Annual       | 1/19/2024  | 106563        |
| Rohde & Schwarz    | NRP-Z81       | Wide Band Power Sensor              | 1/11/2023  | Annual       | 1/11/2024  | 106564        |
| Traceable          | 4040 90080-06 | Therm./ Clock/ Humidity Monitor     | 5/11/2022  | Biennial     | 5/11/2024  | 221514974     |
| Control Company    | 4353          | Ultra Long Stem Thermometer         | 10/24/2023 | Annual       | 10/24/2024 | 200645916     |
| Agilent            | 85033E        | 3.5mm Standard Calibration Kit      | 7/18/2023  | Annual       | 7/18/2024  | MY53402352    |
| Mini-Circuits      | VLF-6000+     | Low Pass Filter DC to 6000 MHz      | CBT        | N/A          | CBT        | N/A           |
| Narda              | 4772-3        | Attenuator (3dB)                    | CBT        | N/A          | CBT        | 9406          |
| Mini-Circuits      | ZHDC-16-63-S+ | 50-6000MHz Bidirectional Coupler    | CBT        | N/A          | CBT        | N/A           |
| Pasternack         | NC-100        | Torque Wrench                       | 12/5/2022  | Biennial     | 12/5/2024  | N/A           |
| SPEAG              | DAK-3.5       | Dielectric Assessment Kit           | 5/9/2023   | Annual       | 5/9/2024   | 1070          |
| SPEAG              | EX3DV4        | SAR Probe                           | 10/2/2023  | Annual       | 10/2/2024  | 3949          |
| SPEAG              | DAE4          | Dasy Data Acquisition Electronics   | 9/12/2023  | Annual       | 9/12/2024  | 1684          |

Measurement Uncertainty =  $\pm 23\%$  (k=2)

|                | Name            | Function                   | Signature                                                                             |
|----------------|-----------------|----------------------------|---------------------------------------------------------------------------------------|
| Calibrated By: | Arturo Oliveros | Compliance Engineer        |  |
| Approved By:   | Greg Snyder     | Executive VP of Operations |  |

# DIPOLE CALIBRATION EXTENSION

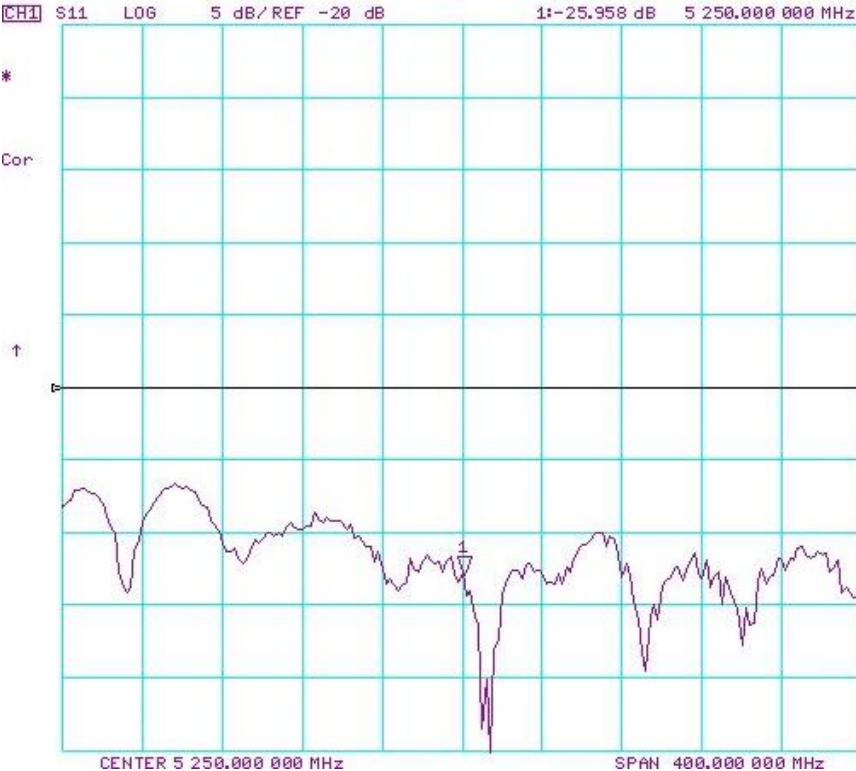
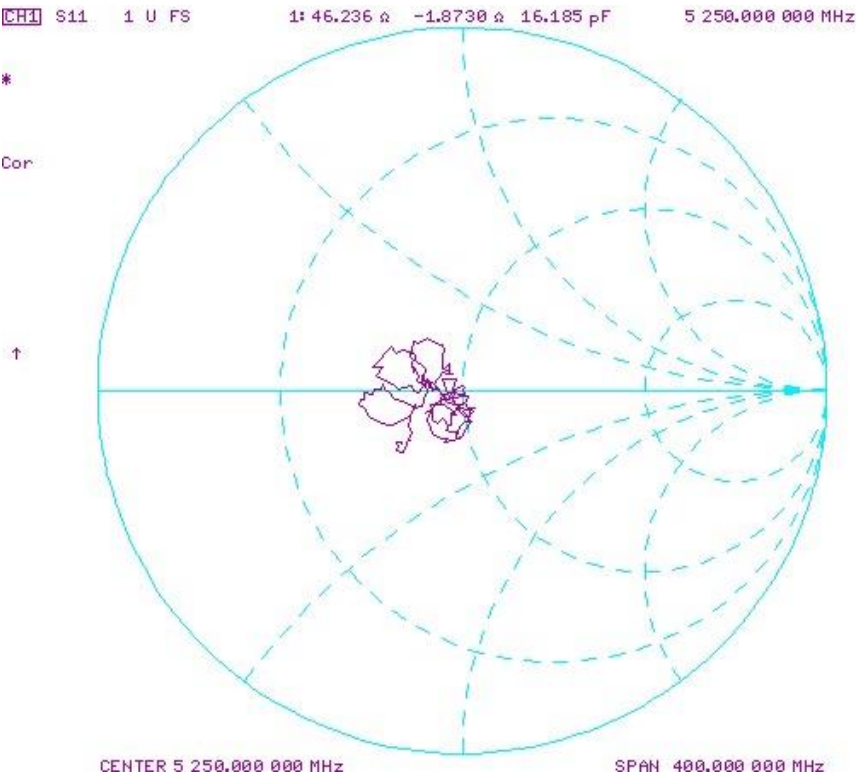
Per KDB 865664 D01, calibration intervals of up to three years may be considered for reference dipoles when it is demonstrated that the SAR target, impedance and return loss of a dipole have remained stable according to the following requirements:

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:

| Frequency (MHz) | Calibration Date | Extension Date | Certificate Electrical Delay (ns) | Certificate SAR Target Head (1g) W/kg @ 17.0 dBm | Measured Head SAR (1g) W/kg @ 17.0 dBm | Deviation 1g (%) | Certificate SAR Target Head (10g) W/kg @ 17.0 dBm | Measured Head SAR (10g) W/kg @ 17.0 dBm | 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 Return Loss Head (dB) | Measured Return Loss Head (dB) | Deviation (%) |
|-----------------|------------------|----------------|-----------------------------------|--------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------|------------------------------------|-----------------------|--------------------------------------------|-----------------------------------------|----------------------------|-----------------------------------|--------------------------------|---------------|
| 5250            | 11/17/2022       | 11/17/2023     | 1.195                             | 4.02                                             | 3.93                                   | -2.12%           | 1.16                                              | 1.12                                    | -3.03%            | 50.5                                  | 46.2                               | 4.3                   | -4.4                                       | -1.9                                    | 2.5                        | -27.1                             | -26.0                          | 4.20%         |
| 5600            | 11/17/2022       | 11/17/2023     | 1.195                             | 4.20                                             | 4.00                                   | -4.65%           | 1.21                                              | 1.13                                    | -6.22%            | 56.9                                  | 52.3                               | 4.6                   | -0.1                                       | -3.1                                    | 3.0                        | -23.8                             | -24.7                          | -3.70%        |
| 5750            | 11/17/2022       | 11/17/2023     | 1.195                             | 3.98                                             | 3.68                                   | -7.42%           | 1.13                                              | 1.04                                    | -7.96%            | 55.3                                  | 51.5                               | 3.8                   | 1.7                                        | 3.1                                     | 1.4                        | -25.5                             | -21.4                          | 16.20%        |
| 5850            | 11/17/2022       | 11/17/2023     | 1.195                             | 4.11                                             | 3.84                                   | -6.57%           | 1.17                                              | 1.08                                    | -7.69%            | 56.1                                  | 52.9                               | 3.2                   | -1.5                                       | -5.6                                    | 4.1                        | -24.6                             | -22.3                          | 9.20%         |

Impedance & Return-Loss Measurement Plot for Head TSL

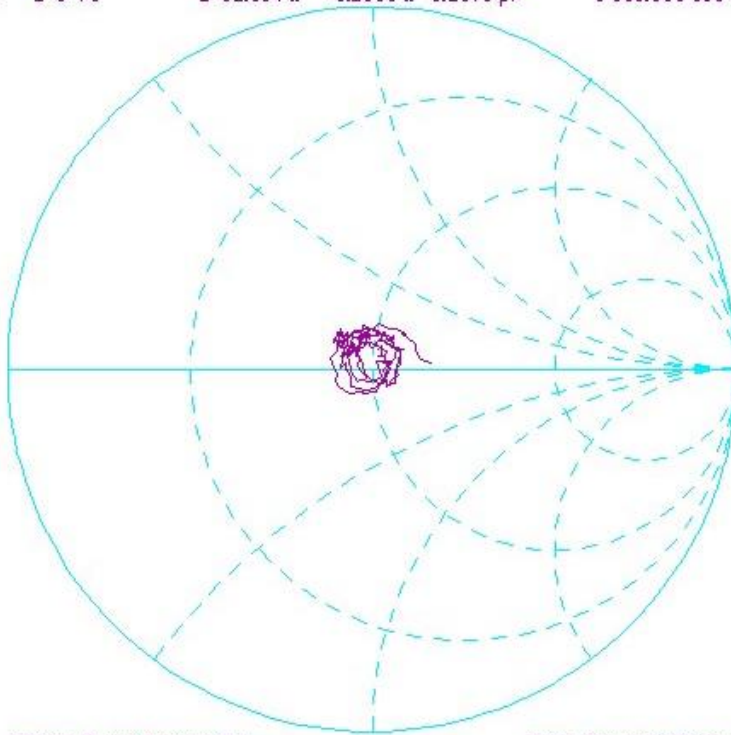


[CH1] S11 1 U FS 1: 52.334  $\Omega$  -3.1035  $\Omega$  9.1575 pF 5 600.000 000 MHz

\*

Cor

↑



CENTER 5 600.000 000 MHz

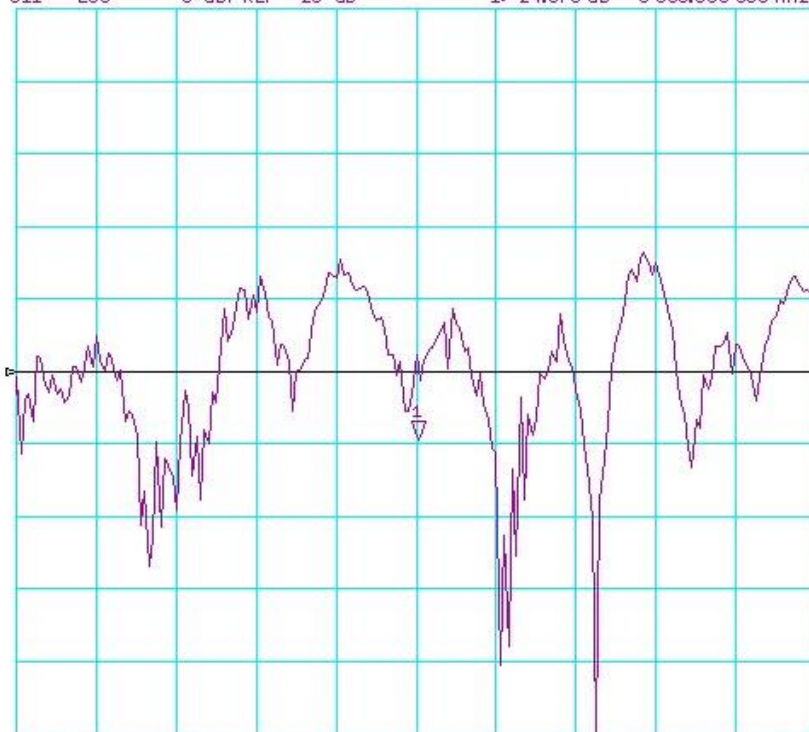
SPAN 400.000 000 MHz

[CH1] S11 LOG 5 dB/REF -20 dB 1:-24.670 dB 5 600.000 000 MHz

\*

Cor

↑



CENTER 5 600.000 000 MHz

SPAN 400.000 000 MHz

Object:

D5GHzV2 – SN: 1066

Date Issued:

11/17/2023

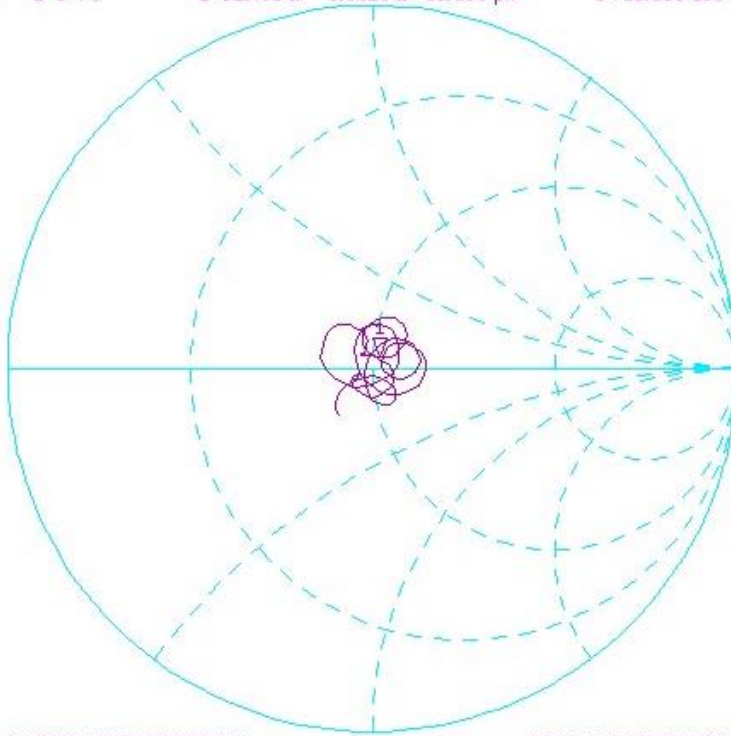
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[CH1] S11 1 U FS 1: 51.496  $\Omega$  3.0820  $\Omega$  85.308  $\mu\text{H}$  5 750.000 000 MHz

\*

Cor

↑



CENTER 5 750.000 000 MHz

SPAN 400.000 000 MHz

[CH1] S11 LOG 5 dB/REF -20 dB 1:-21.376 dB 5 750.000 000 MHz

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Cor

↑



CENTER 5 750.000 000 MHz

SPAN 400.000 000 MHz

Object:

D5GHzV2 – SN: 1066

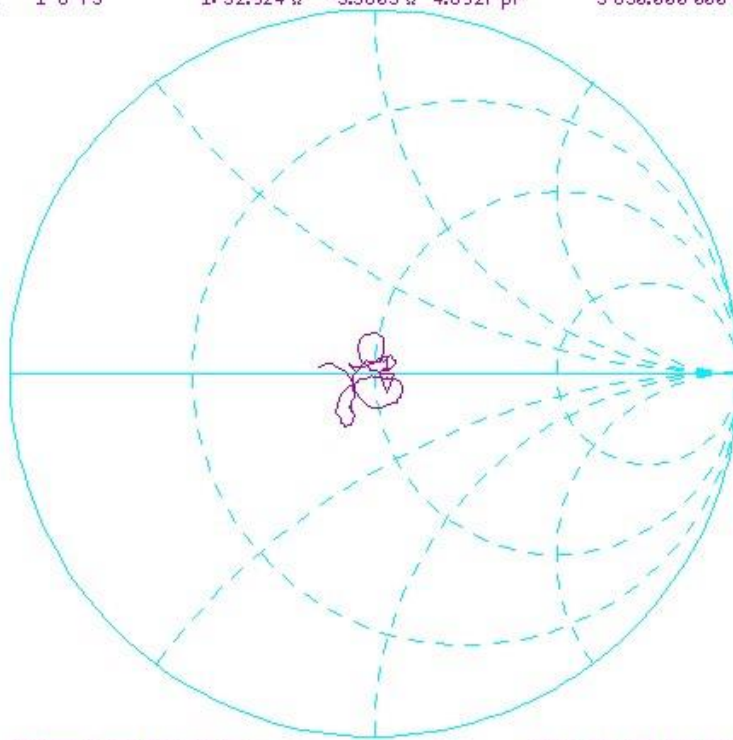
Date Issued:

11/17/2023

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29 Nov 2023 04:40:19  
 [CH1] S11 1 U FS 1: 52.924  $\Omega$  -5.5605  $\Omega$  4.8927 pF 5 850.000 000 MHz

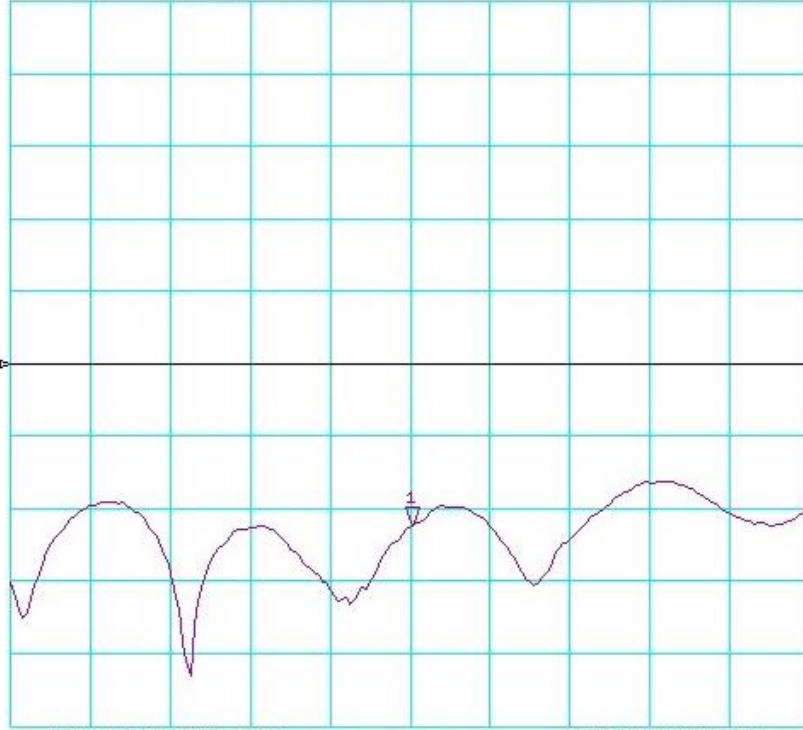
\*  
 Cor  
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CENTER 5 850.000 000 MHz SPAN 300.000 000 MHz

[CH1] S11 L06 5 dB/REF -20 dB 1:-22.341 dB 5 850.000 000 MHz

\*  
 Cor  
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CENTER 5 850.000 000 MHz SPAN 300.000 000 MHz