

DASY5 Validation Report for Body TSL

Date: 12.03.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d169

Communication System: UID 0 - CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.48$ S/m; $\epsilon_r = 53.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.23, 8.23, 8.23) @ 1900 MHz; Calibrated: 31.12.2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.10.2018
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

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

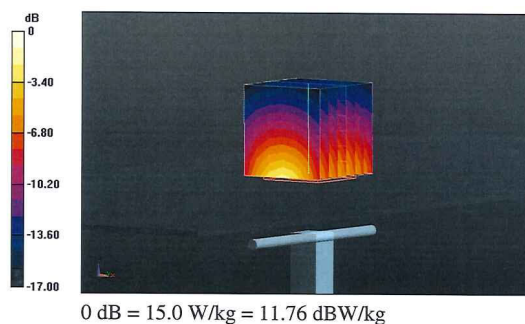
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.2 V/m; Power Drift = -0.01 dB

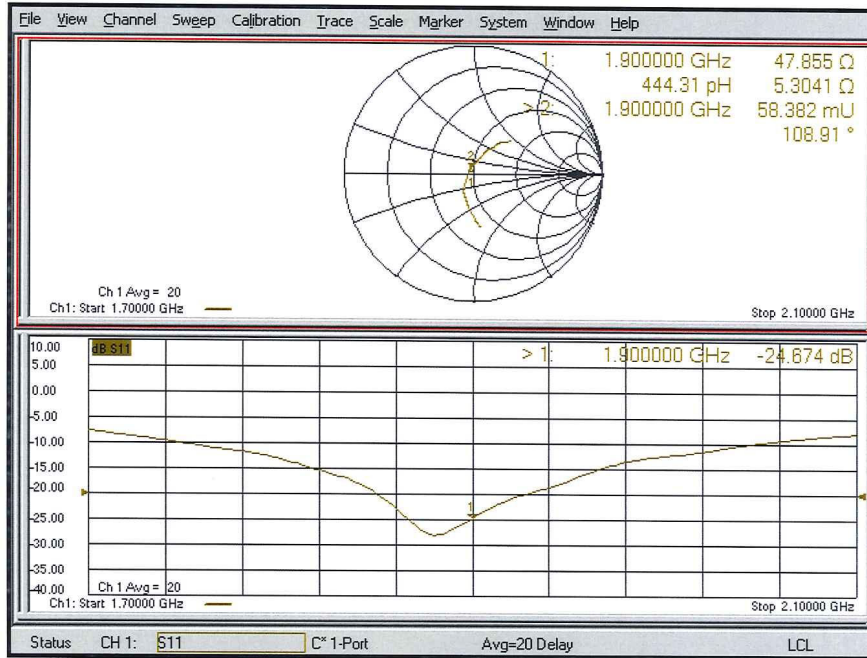
Peak SAR (extrapolated) = 17.5 W/kg

SAR(1 g) = 9.87 W/kg; SAR(10 g) = 5.22 W/kg

Maximum value of SAR (measured) = 15.0 W/kg



Impedance Measurement Plot for Body TSL



D1900V2 Calibration for Impedance and Return-loss

| | | | |
|-------------|-------------------------------|--------|---------|
| Equipment | Dipole Antenna | Model | D1900V2 |
| Manufacture | Schmid&Partner Engineering AG | Serial | 5d169 |
| Tested by | Hisayoshi Sato | | |

1. Test environment

| | | | |
|---------------------|----------------|-------------------|-------|
| Date | March 31, 2020 | | |
| Ambient Temperature | 24.0 deg.C | Relative humidity | 47%RH |
| Date | March 31, 2021 | | |
| Ambient Temperature | 22.5 deg.C | Relative humidity | 45%RH |

2. Equipment used

March 31, 2020

| Control No. | Instrument | Manufacturer | Model No | Serial No | Test Item | Calibration Date * Interval(month) |
|----------------|------------------------|---------------------------------|-----------------|------------------|-----------|---------------------------------------|
| EST-57 | 2.4mm Calibration Kit | Keysight Technologies Inc | 85056A | MY44300225 | SAR | 2019/08/21 * 12 |
| EST-30 | Network Analyzer | AGILENT | N5230A | MY46400314 | SAR | 2019/08/28 * 12 |
| MPF-03 | 2mm Oval Flat Phantom | Schmid&Partner Engineering AG | QDOVA001BB | 1203 | SAR | 2019/05/14 * 12 |
| MPSAM-03 | SAM Phantom | Schmid&Partner Engineering AG | QD000P40CD | 1764 | SAR | 2019/05/13 * 12 |
| MOS-30 | Thermo-Hygrometer | CUSTOM | CTH-201 | 3001 | SAR | 2019/07/03 * 12 |
| MHBBL600-10000 | Head Simulating Liquid | Schmid & Partner Engineering AG | HBBL600-10000V6 | SL AAH U16 BC | | - |
| MMBBL600-6000 | Body Simulating Liquid | Schmid & Partner Engineering AG | MBBL600-6000 | SL AAM U16 BC | | - |

March 31, 2021

| Control No. | Instrument | Manufacturer | Model No | Serial No | Test Item | Calibration Date * Interval(month) |
|----------------|------------------------|---------------------------------|-----------------|------------------|-----------|---------------------------------------|
| EST-63 | Network Analyzer | Keysight Technologies Inc | E5071C | MY46523746 | SAR | 2020/06/04 * 12 |
| EST-64 | Calibration Kit | Keysight Technologies Inc | 85032F | MY53200995 | SAR | 2020/06/03 * 12 |
| MPF-03 | 2mm Oval Flat Phantom | Schmid&Partner Engineering AG | QDOVA001BB | 1203 | SAR | 2020/05/25 * 12 |
| MPSAM-03 | SAM Phantom | Schmid&Partner Engineering AG | QD000P40CD | 1764 | SAR | 2020/05/25 * 12 |
| MOS-35 | Digital thermometer | HANNA | Checktemp 4 | - | SAR | 2020/07/10 * 12 |
| MHBBL600-10000 | Head Simulating Liquid | Schmid & Partner Engineering AG | HBBL600-10000V6 | SL AAH U16 BC | | - |
| MMBBL600-6000 | Body Simulating Liquid | Schmid & Partner Engineering AG | MBBL600-6000 | SL AAM U16 BC | | - |

3. Test Result

| Impedance, Transformed to feed point | cal day | Head (real part) [Ω] | Head (img part) [$j\Omega$] | Deviation (real part) [Ω] | Deviation (img part) [$j\Omega$] | Tolerance | Result |
|--------------------------------------|-----------|----------------------------------|----------------------------------|---------------------------------------|---------------------------------------|----------------------------|----------|
| Calibration (SPEAG) | 2019/3/19 | 51.60 | 3.80 | - | - | - | - |
| Calibration(ULJ) | 2020/3/31 | 51.39 | 4.32 | -0.21 | 0.52 | $\pm 5\Omega \pm 5j\Omega$ | Complied |
| Calibration(ULJ) | 2021/3/31 | 51.75 | 2.47 | 0.15 | -1.33 | $\pm 5\Omega \pm 5j\Omega$ | Complied |

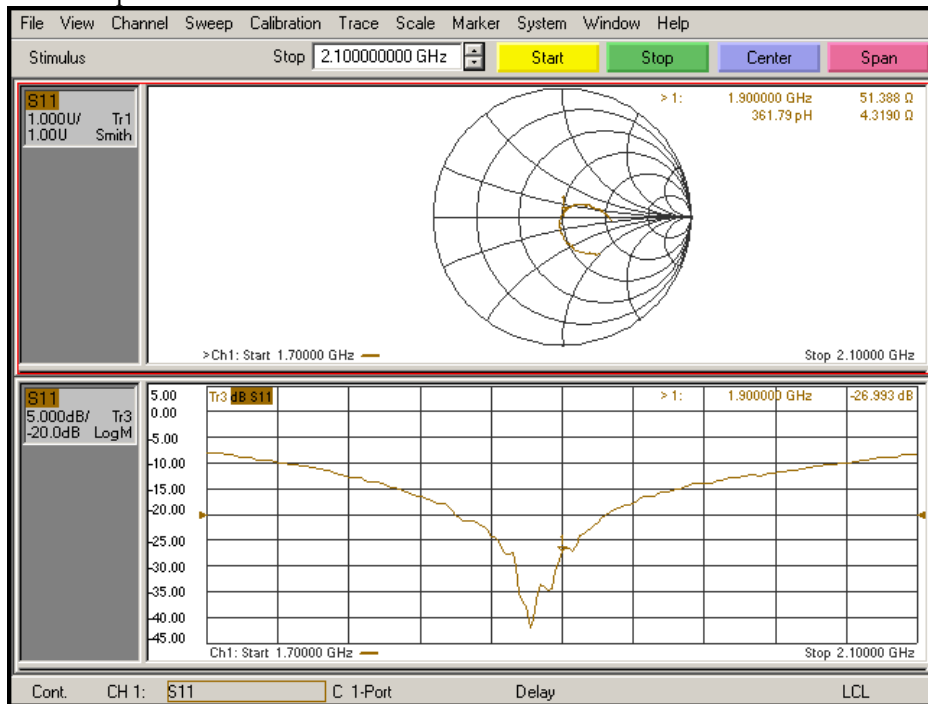
| Return loss | cal day | Head [dB] | Deviation [dB] | Tolerance [+/-dB] | Result |
|---------------------|-----------|--------------|-------------------|----------------------|----------|
| Calibration (SPEAG) | 2019/3/19 | -27.80 | - | - | - |
| Calibration(ULJ) | 2020/3/31 | -26.99 | 0.81 | 5.56 | Complied |
| Calibration(ULJ) | 2021/3/31 | -30.03 | -2.23 | 5.56 | Complied |

| Impedance, Transformed to feed point | cal day | Body (real part) [Ω] | Body (img part) [$j\Omega$] | Deviation (real part) [Ω] | Deviation (img part) [$j\Omega$] | Tolerance | Result |
|--------------------------------------|-----------|----------------------------------|----------------------------------|---------------------------------------|---------------------------------------|----------------------------|----------|
| Calibration (SPEAG) | 2019/3/19 | 47.90 | 5.30 | - | - | - | - |
| Calibration(ULJ) | 2020/3/31 | 44.71 | 1.90 | -3.19 | -3.40 | $\pm 5\Omega \pm 5j\Omega$ | Complied |
| Calibration(ULJ) | 2021/3/31 | 45.33 | 3.21 | -2.57 | -2.09 | $\pm 5\Omega \pm 5j\Omega$ | Complied |

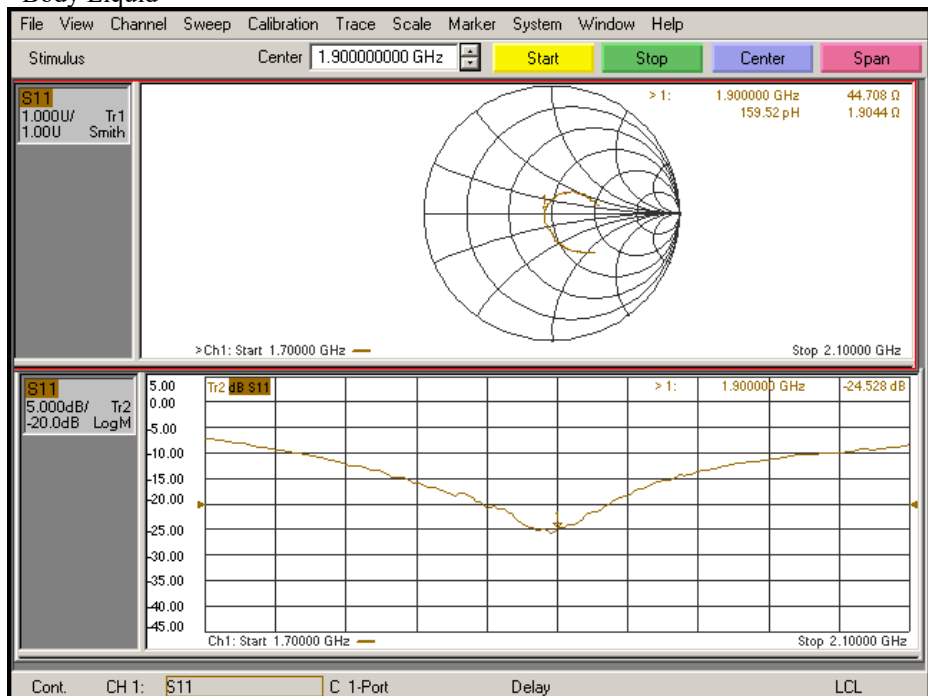
| Return loss | cal day | Body [dB] | Deviation [dB] | Tolerance [+/-dB] | Result |
|---------------------|-----------|--------------|-------------------|----------------------|----------|
| Calibration (SPEAG) | 2019/3/19 | -24.70 | - | - | - |
| Calibration(ULJ) | 2020/3/31 | -24.53 | 0.17 | 4.94 | Complied |
| Calibration(ULJ) | 2021/3/31 | -24.40 | 0.30 | 4.94 | Complied |

Tolerance: According to the KDB865664 D1

Measurement Plots
March 31, 2020
<Head Liquid>



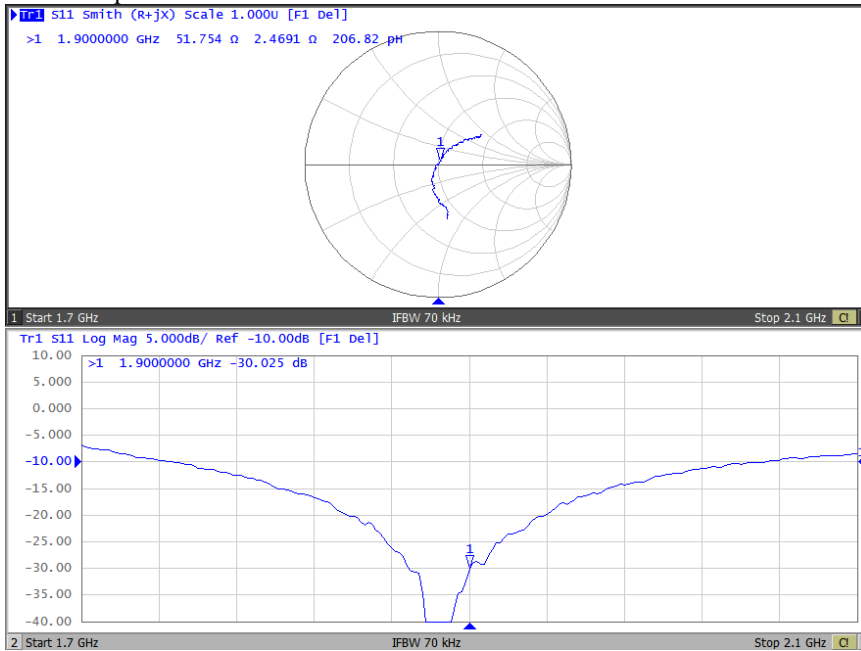
<Body Liquid>



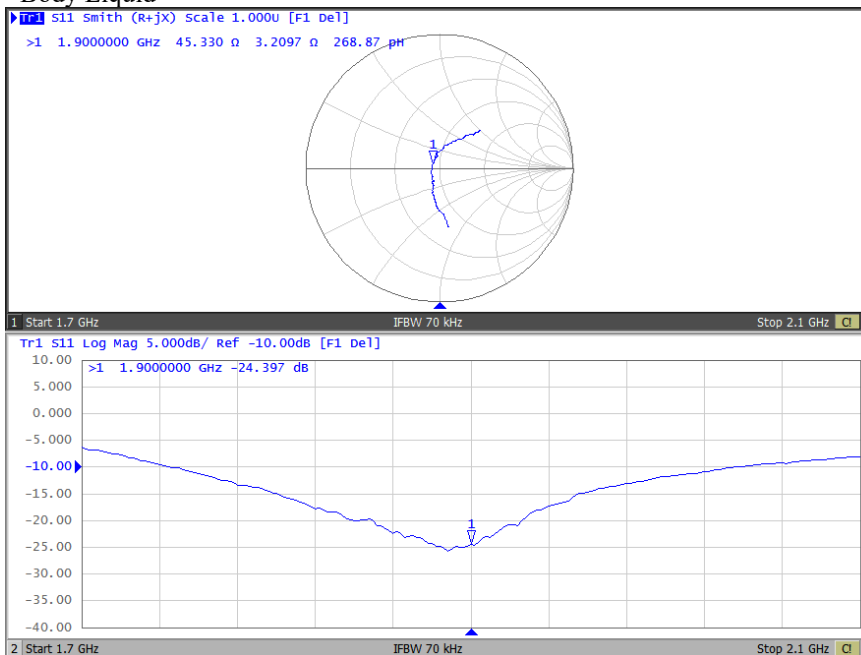
Measurement Plots

March 31, 2021

<Head Liquid>



<Body Liquid>



E.9 System Check Dipole SAR Calibration Certificate -Dipole 2450MHz (D2450V2 S/N: 713)

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



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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 **UL Japan (KYCOM)**

Certificate No: **D2450V2-713_Sep19**

| CALIBRATION CERTIFICATE | | | |
|---|---|-----------------------------------|------------------------------|
| Object | D2450V2 - SN:713 | | |
| Calibration procedure(s) | QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz | | |
| Calibration date: | September 09, 2019 | | |
| This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. | | | |
| All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. | | | |
| Calibration Equipment used (M&TE critical for calibration) | | | |
| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
| Power meter NRP | SN: 104778 | 03-Apr-19 (No. 217-02892/02893) | Apr-20 |
| Power sensor NRP-Z91 | SN: 103244 | 03-Apr-19 (No. 217-02892) | Apr-20 |
| Power sensor NRP-Z91 | SN: 103245 | 03-Apr-19 (No. 217-02893) | Apr-20 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-19 (No. 217-02894) | Apr-20 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-19 (No. 217-02895) | Apr-20 |
| Reference Probe EX3DV4 | SN: 7349 | 29-May-19 (No. EX3-7349_May19) | May-20 |
| D4E4 | SN: 601 | 30-Apr-19 (No. DAE4-601_Apr19) | Apr-20 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB39512475 | 30-Oct-14 (in house check Feb-19) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-18) | In house check: Oct-19 |
| Calibrated by: | Name Leif Klysner | Function Laboratory Technician | Signature |
| Approved by: | Name Katja Pokovic | Function Technical Manager | Signature |
| | | | Issued: September 13, 2019 |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. | | | |

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



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

Additional Documentation:

- e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The 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 | V52.10.2 |
| 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 | 37.9 \pm 6 % | 1.86 mho/m \pm 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm³ (1 g) of Head TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 13.7 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 53.5 W/kg \pm 17.0 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Head TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 6.35 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 25.1 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 | 50.7 \pm 6 % | 2.04 mho/m \pm 6 % |
| Body TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Body TSL

| SAR averaged over 1 cm³ (1 g) of Body TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 13.3 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 51.6 W/kg \pm 17.0 % (k=2) |

| SAR averaged over 10 cm³ (10 g) of Body TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 6.18 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 24.3 W/kg \pm 16.5 % (k=2) |

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 53.5 Ω + 1.6 j Ω |
| Return Loss | - 28.6 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 49.6 Ω + 4.0 j Ω |
| Return Loss | - 27.9 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.159 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: 09.09.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:713

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.86$ S/m; $\epsilon_r = 37.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.9, 7.9, 7.9) @ 2450 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

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

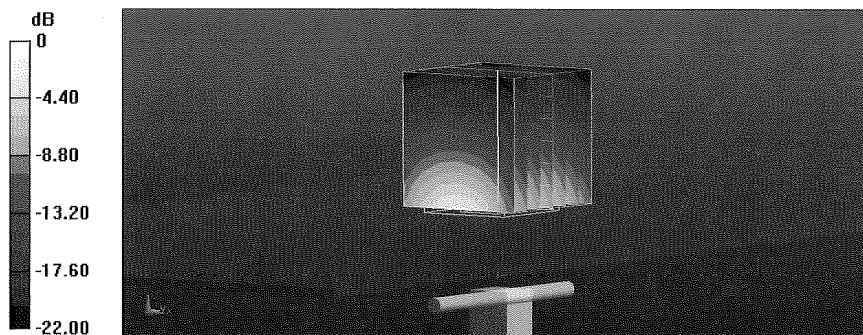
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 118.4 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 27.2 W/kg

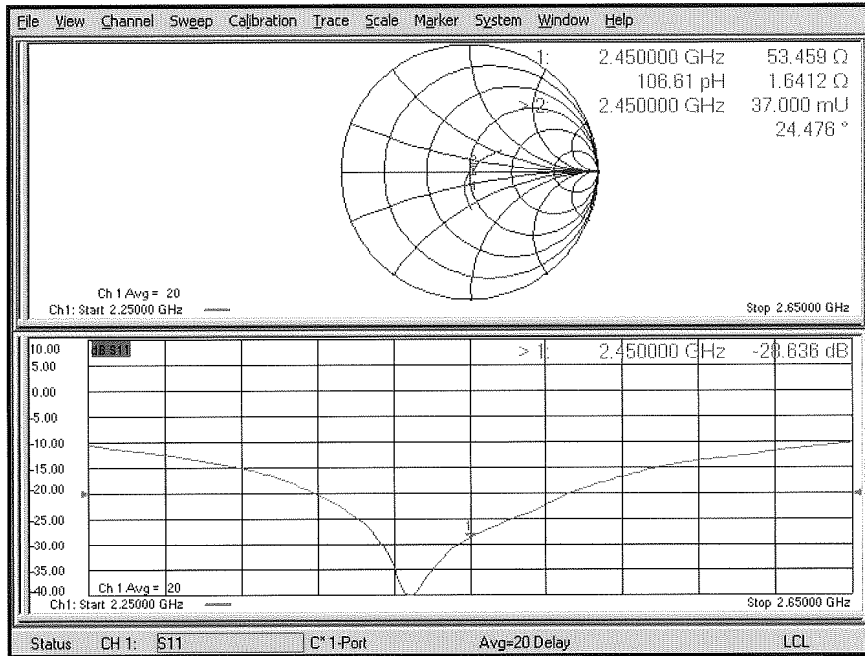
SAR(1 g) = 13.7 W/kg; SAR(10 g) = 6.35 W/kg

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



0 dB = 22.5 W/kg = 13.52 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 09.09.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:713

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

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.04$ S/m; $\epsilon_r = 50.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.94, 7.94, 7.94) @ 2450 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

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

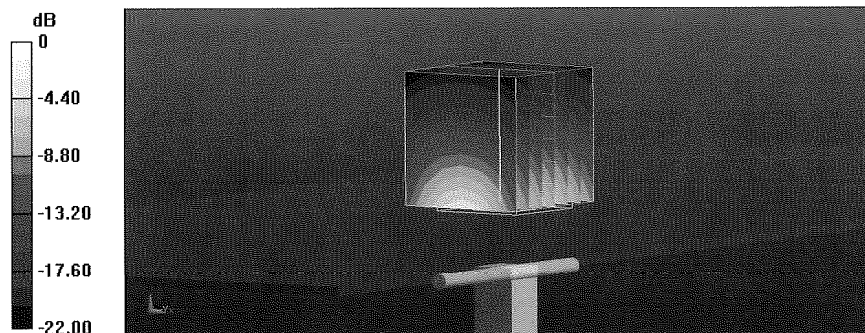
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 109.7 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 26.6 W/kg

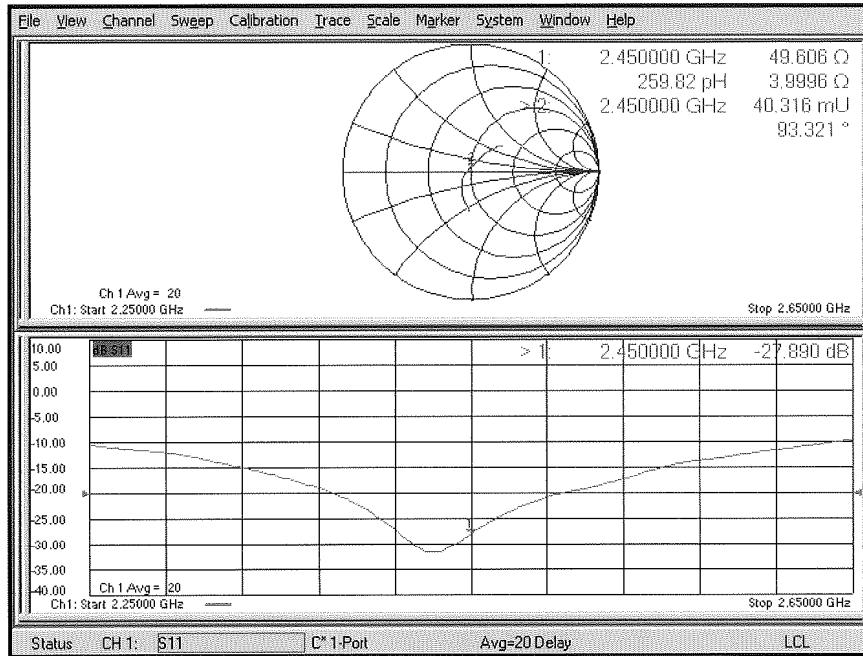
SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.18 W/kg

Maximum value of SAR (measured) = 21.9 W/kg



0 dB = 21.9 W/kg = 13.40 dBW/kg

Impedance Measurement Plot for Body TSL



D2450V2 Calibration for Impedance and Return-loss

| | | | |
|-------------|-------------------------------|--------|---------|
| Equipment | Dipole Antenna | Model | D2450V2 |
| Manufacture | Schmid&Partner Engineering AG | Serial | 713 |
| Tested by | Hisayoshi Sato | | |

1. Test environment

| | | | |
|---------------------|--------------------|-------------------|--------|
| Date | September 10, 2020 | | |
| Ambient Temperature | 24.5 deg.C | Relative humidity | 50 %RH |
| Date | September 2, 2021 | | |
| Ambient Temperature | 23.0 deg.C | Relative humidity | 40 %RH |

2. Equipment used

September 10, 2020

| Control No. | Instrument | Manufacturer | Model No | Serial No | Test Item | Calibration Date * Interval(month) |
|----------------|------------------------|---------------------------------|-----------------|---------------|-----------|------------------------------------|
| EST-30 | Network Analyzer | Keysight Technologies Inc | N5230A | MY46400314 | SAR | 2020/08/17 * 12 |
| EST-62 | Calibration Kit | Keysight Technologies Inc | 85032F | MY41495257 | SAR | 2019/09/26 * 12 |
| MPF-03 | 2mm Oval Flat Phantom | Schmid&Partner Engineering AG | QDOVA001BB | 1203 | SAR | 2020/05/25 * 12 |
| MPSAM-03 | SAM Phantom | Schmid&Partner Engineering AG | QD000P40CD | 1764 | SAR | 2020/05/25 * 12 |
| MOS-30 | Thermo-Hygrometer | CUSTOM | CTH-201 | 3001 | SAR | 2020/07/10 * 12 |
| MHBBL600-10000 | Head Simulating Liquid | Schmid & Partner Engineering AG | HBBL600-10000V6 | SL AAH U16 BC | | - |
| MMBBL600-6000 | Body Simulating Liquid | Schmid & Partner Engineering AG | MBBL600-6000 | SL AAM U16 BC | | - |

September 2, 2021

| Control No. | Instrument | Manufacturer | Model No | Serial No | Test Item | Calibration Date * Interval(month) |
|----------------|------------------------|---------------------------------|-----------------|---------------|-----------|------------------------------------|
| EST-63 | Network Analyzer | Keysight Technologies Inc | E5071C | MY46523746 | SAR | 2021/07/02 * 12 |
| EST-57 | 2.4mm Calibration Kit | Keysight Technologies Inc | 85056A | MY44300225 | SAR | 2020/09/01 * 12 |
| MPSAM-02 | SAM Phantom | Schmid&Partner Engineering AG | QD000P40CB | 1333 | SAR | 2021/05/27 * 12 |
| MPF-02 | 2mm Oval Flat Phantom | Schmid&Partner Engineering AG | QDOVA001BB | 1045 | SAR | 2021/05/28 * 12 |
| MOS-33 | Thermo-Hygrometer | CUSTOM | CTH-201 | - | SAR | 2021/07/08 * 12 |
| MHBBL600-10000 | Head Simulating Liquid | Schmid & Partner Engineering AG | HBBL600-10000V6 | SL AAH U16 BC | | - |
| MMBBL600-6000 | Body Simulating Liquid | Schmid & Partner Engineering AG | MBBL600-6000 | SL AAM U16 BC | | - |

3. Test Result

| Impeadance,Transformed to feed point | cal day | Head (real part) [Ω] | Head (img part) [$j\Omega$] | Deviation (real part) [Ω] | Deviation (img part) [$j\Omega$] | Tolerance | Result |
|--------------------------------------|-----------|----------------------------------|----------------------------------|---------------------------------------|---------------------------------------|----------------------------|----------|
| Calibration (SPEAG) | 2019/9/9 | 53.50 | 1.60 | - | - | - | - |
| Calibration(ULJ) | 2020/9/10 | 54.30 | 1.13 | 0.80 | -0.47 | $\pm 5\Omega \pm 5j\Omega$ | Complied |
| Calibration(ULJ) | 2021/9/2 | 52.24 | 1.35 | -1.27 | -0.25 | $\pm 5\Omega \pm 5j\Omega$ | Complied |

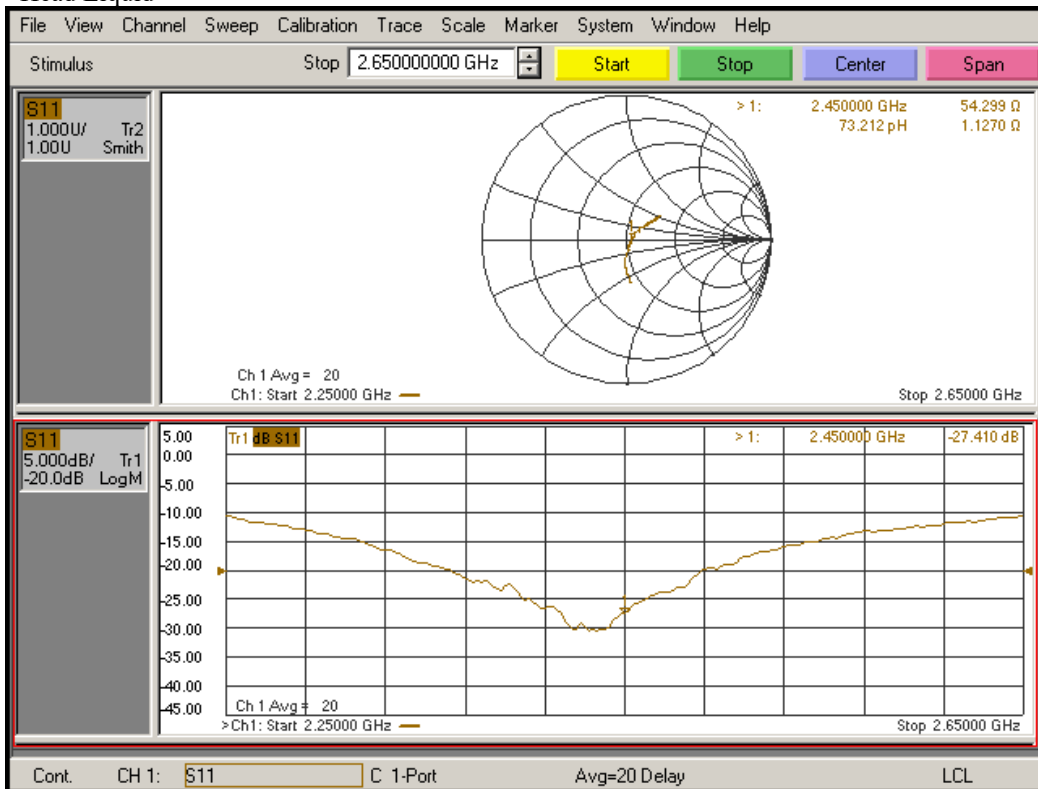
| Return loss | cal day | Head [dB] | Deviation [dB] | Tolerance [+/-dB] | Result |
|---------------------|-----------|--------------|-------------------|----------------------|----------|
| Calibration (SPEAG) | 2019/9/9 | -28.60 | - | - | - |
| Calibration(ULJ) | 2020/9/10 | -27.41 | 1.19 | 5.72 | Complied |
| Calibration(ULJ) | 2021/9/2 | -31.84 | -3.24 | 5.72 | Complied |

| Impeadance,Transformed to feed point | cal day | Body (real part) [Ω] | Body (img part) [$j\Omega$] | Deviation (real part) [Ω] | Deviation (img part) [$j\Omega$] | Tolerance | Result |
|--------------------------------------|-----------|----------------------------------|----------------------------------|---------------------------------------|---------------------------------------|----------------------------|----------|
| Calibration (SPEAG) | 2019/9/9 | 49.60 | 4.00 | - | - | - | - |
| Calibration(ULJ) | 2020/9/10 | 47.88 | 2.10 | -1.72 | -1.90 | $\pm 5\Omega \pm 5j\Omega$ | Complied |
| Calibration(ULJ) | 2021/9/2 | 49.60 | 4.77 | 0.00 | 0.77 | $\pm 5\Omega \pm 5j\Omega$ | Complied |

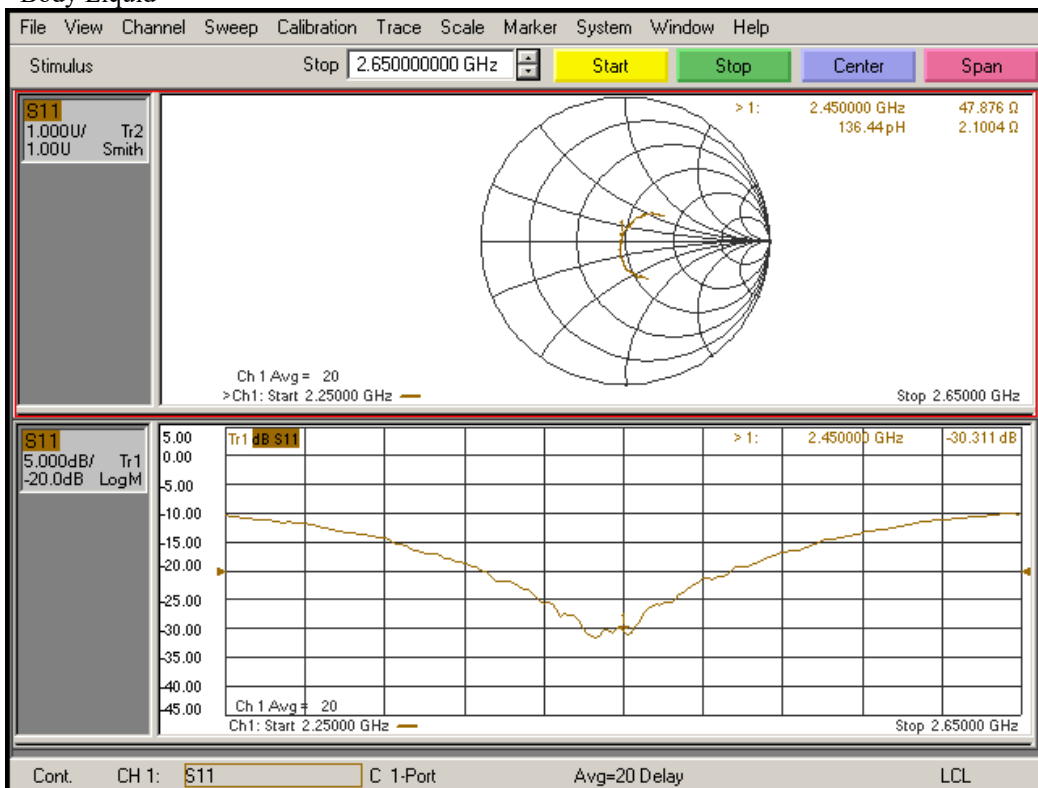
| Return loss | cal day | Body [dB] | Deviation [dB] | Tolerance [+/-dB] | Result |
|---------------------|-----------|--------------|-------------------|----------------------|----------|
| Calibration (SPEAG) | 2019/9/9 | -27.90 | - | - | - |
| Calibration(ULJ) | 2020/9/10 | -30.31 | -2.41 | 5.58 | Complied |
| Calibration(ULJ) | 2021/9/2 | -26.33 | 1.57 | 5.58 | Complied |

Tolerance: According to the KDB865664 D1

Measurement Plots(September 10, 2020)
<Head Liquid>

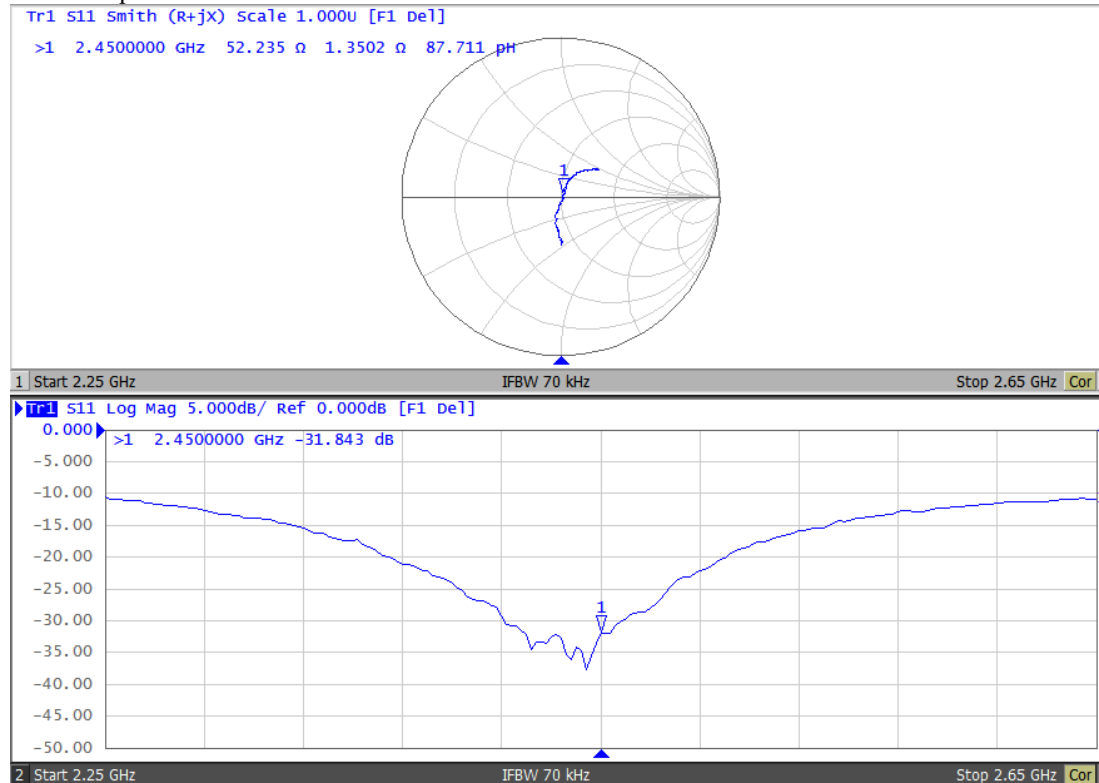


<Body Liquid>

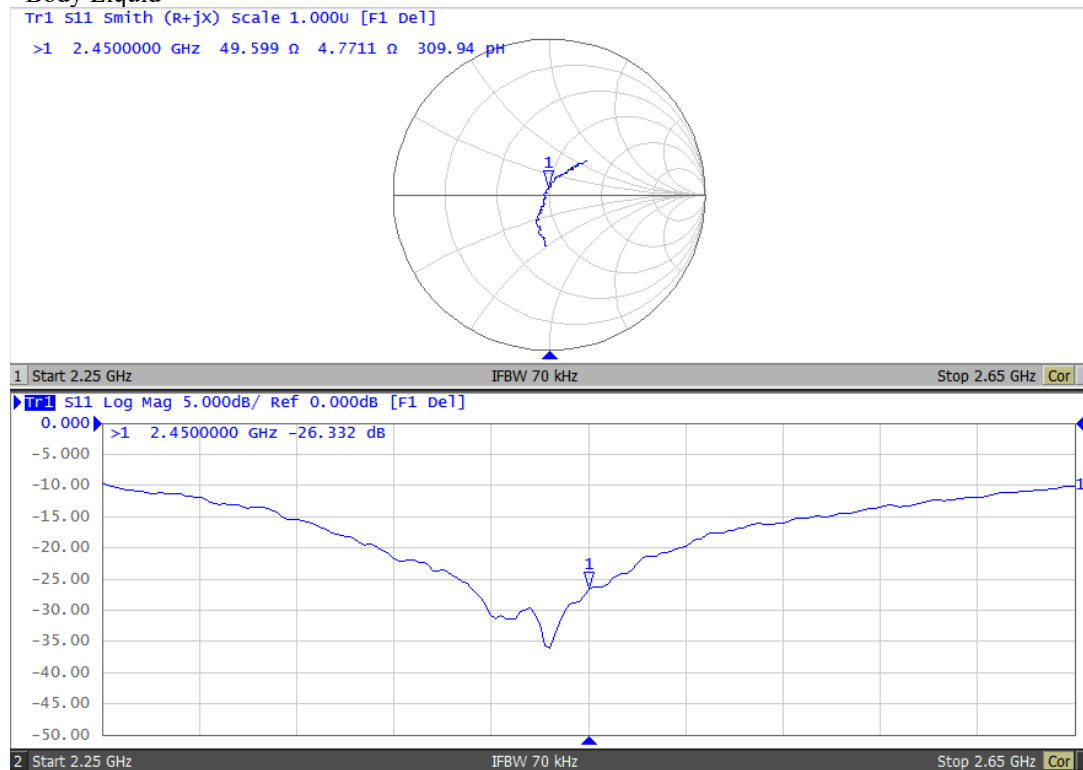


Measurement Plots (September 2, 2021)

<Head Liquid>



<Body Liquid>



E.10 System Check Dipole SAR Calibration Certificate -Dipole 2600MHz(D2600V2,S/N: 1030)

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **UL Japan (Vitec)**

Certificate No: **D2600V2-1030_Mar19**

CALIBRATION CERTIFICATE

Object **D2600V2 - SN:1030**

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

Calibration date: **March 14, 2019**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---------------------------------|--------------------|-----------------------------------|------------------------|
| Power meter NRP | SN: 104778 | 04-Apr-18 (No. 217-02672/02673) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-18 (No. 217-02672) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-18 (No. 217-02673) | Apr-19 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-18 (No. 217-02682) | Apr-19 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-18 (No. 217-02683) | Apr-19 |
| Reference Probe EX3DV4 | SN: 7349 | 31-Dec-18 (No. EX3-7349_Dec18) | Dec-19 |
| DAE4 | SN: 601 | 04-Oct-18 (No. DAE4-601_Oct18) | Oct-19 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB39512475 | 07-Oct-15 (in house check Feb-19) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-18) | In house check: Oct-19 |

| | Name | Function | Signature |
|----------------|---------------|-----------------------|-----------|
| Calibrated by: | Manu Seitz | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: March 15, 2019

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

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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:

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

Additional Documentation:

- e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The 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 | V52.10.2 |
| 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 | 37.1 \pm 6 % | 2.01 mho/m \pm 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 14.3 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 55.9 W/kg \pm 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 6.29 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 24.8 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 | 50.8 \pm 6 % | 2.17 mho/m \pm 6 % |
| Body TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Body TSL

| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 13.7 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 54.3 W/kg \pm 17.0 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|--|
| SAR measured | 250 mW input power | 6.06 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 | 49.0 Ω - 5.4 $j\Omega$ |
| Return Loss | - 25.1 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|-------------------------------|
| Impedance, transformed to feed point | 45.0 Ω - 4.0 $j\Omega$ |
| Return Loss | - 23.4 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.152 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: 14.03.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1030

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

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.01$ S/m; $\epsilon_r = 37.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.74, 7.74, 7.74) @ 2600 MHz; Calibrated: 31.12.2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.10.2018
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

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

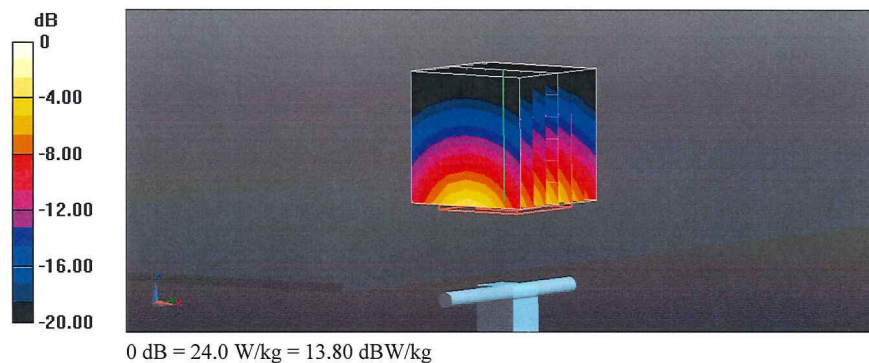
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 118.7 V/m; Power Drift = -0.01 dB

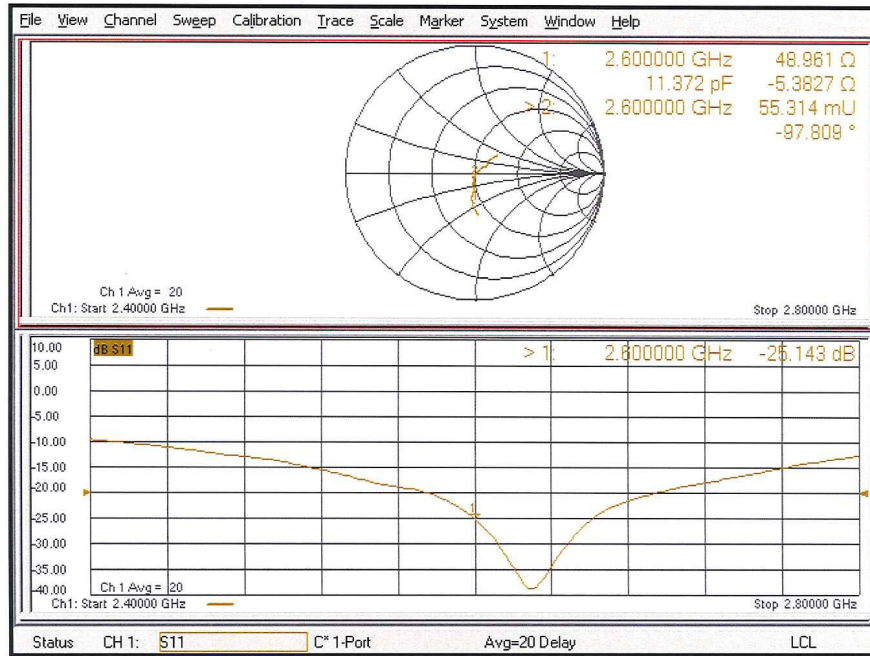
Peak SAR (extrapolated) = 29.4 W/kg

SAR(1 g) = 14.3 W/kg; SAR(10 g) = 6.29 W/kg

Maximum value of SAR (measured) = 24.0 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 14.03.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN:1030

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

Medium parameters used: $f = 2600$ MHz; $\sigma = 2.17$ S/m; $\epsilon_r = 50.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.89, 7.89, 7.89) @ 2600 MHz; Calibrated: 31.12.2018
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.10.2018
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

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

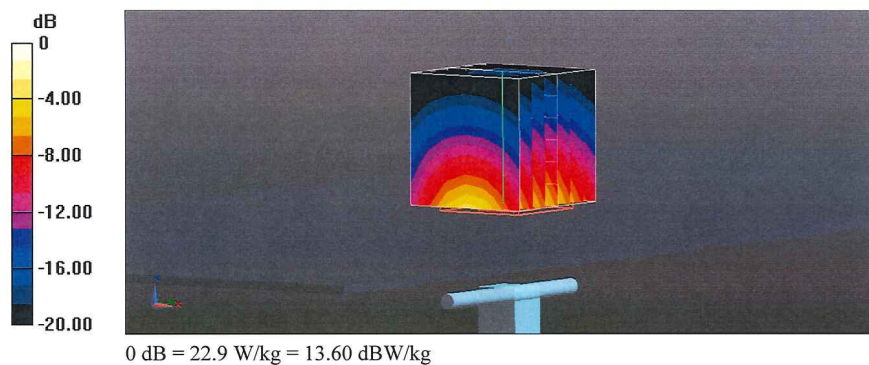
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 108.7 V/m; Power Drift = -0.01 dB

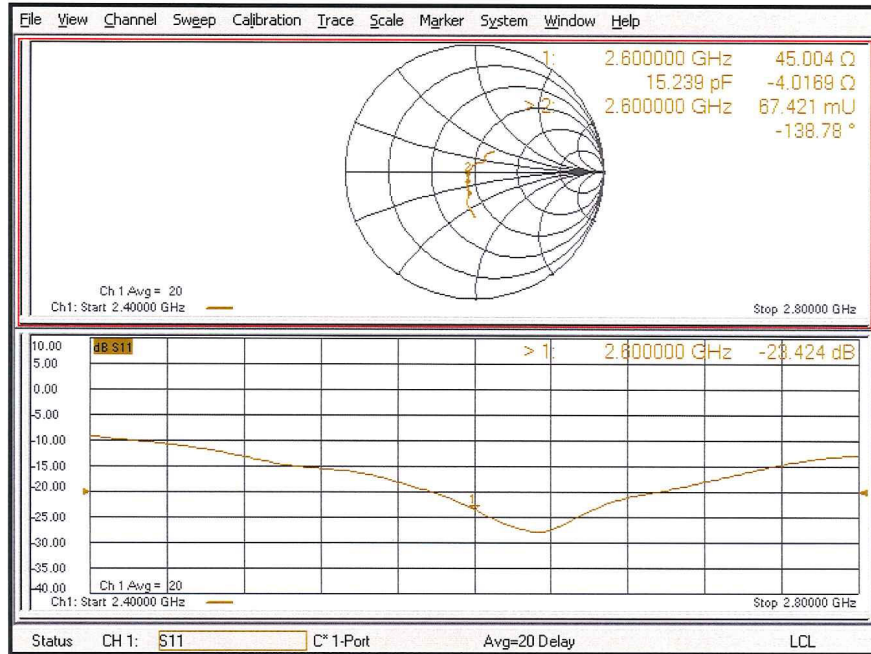
Peak SAR (extrapolated) = 28.2 W/kg

SAR(1 g) = 13.7 W/kg; SAR(10 g) = 6.06 W/kg

Maximum value of SAR (measured) = 22.9 W/kg



Impedance Measurement Plot for Body TSL



D2600V2 Calibration for Impedance and Return-loss

| | | | |
|-------------|-------------------------------|--------|---------|
| Equipment | Dipole Antenna | Model | D2600V2 |
| Manufacture | Schmid&Partner Engineering AG | Serial | 1030 |
| Tested by | Hisayoshi Sato | | |

1. Test environment

| | | | |
|---------------------|----------------|-------------------|-------|
| Date | March 31, 2020 | | |
| Ambient Temperature | 24.0 deg.C | Relative humidity | 47%RH |
| Date | March 31, 2021 | | |
| Ambient Temperature | 22.5 deg.C | Relative humidity | 45%RH |

2. Equipment used

March 31, 2020

| Control No. | Instrument | Manufacturer | Model No | Serial No | Test Item | Calibration Date * Interval(month) |
|----------------|------------------------|---------------------------------|-----------------|------------------|-----------|---------------------------------------|
| EST-63 | Network Analyzer | Keysight Technologies Inc | E5071C | MY46523746 | SAR | 2019/04/13 * 12 |
| EST-64 | Calibration Kit | Keysight Technologies Inc | 85032F | MY53200995 | SAR | 2019/04/16 * 12 |
| MPF-03 | 2mm Oval Flat Phantom | Schmid&Partner Engineering AG | QDOVA001BB | 1203 | SAR | 2019/05/14 * 12 |
| MPSAM-03 | SAM Phantom | Schmid&Partner Engineering AG | QD000P40CD | 1764 | SAR | 2019/05/13 * 12 |
| MOS-30 | Thermo-Hygrometer | CUSTOM | CTH-201 | 3001 | SAR | 2019/07/03 * 12 |
| MHBBL600-10000 | Head Simulating Liquid | Schmid & Partner Engineering AG | HBBL600-10000V6 | SL AAH U16 BC | | - |
| MMBBL600-6000 | Body Simulating Liquid | Schmid & Partner Engineering AG | MBBL600-6000 | SL AAM U16 BC | | - |

March 31, 2021

| Control No. | Instrument | Manufacturer | Model No | Serial No | Test Item | Calibration Date * Interval(month) |
|----------------|------------------------|---------------------------------|-----------------|------------------|-----------|---------------------------------------|
| EST-63 | Network Analyzer | Keysight Technologies Inc | E5071C | MY46523746 | SAR | 2020/06/04 * 12 |
| EST-64 | Calibration Kit | Keysight Technologies Inc | 85032F | MY53200995 | SAR | 2020/06/03 * 12 |
| MPF-03 | 2mm Oval Flat Phantom | Schmid&Partner Engineering AG | QDOVA001BB | 1203 | SAR | 2020/05/25 * 12 |
| MPSAM-03 | SAM Phantom | Schmid&Partner Engineering AG | QD000P40CD | 1764 | SAR | 2020/05/25 * 12 |
| MOS-35 | Digital thermometer | HANNA | Checktemp 4 | - | SAR | 2020/07/10 * 12 |
| MHBBL600-10000 | Head Simulating Liquid | Schmid & Partner Engineering AG | HBBL600-10000V6 | SL AAH U16 BC | | - |
| MMBBL600-6000 | Body Simulating Liquid | Schmid & Partner Engineering AG | MBBL600-6000 | SL AAM U16 BC | | - |

3. Test Result

| Impedance, Transformed to feed point | cal day | Head (real part) [Ω] | Head (img part) [$j\Omega$] | Deviation (real part) [Ω] | Deviation (img part) [$j\Omega$] | Tolerance | Result |
|--------------------------------------|-----------|----------------------------------|----------------------------------|---------------------------------------|---------------------------------------|----------------------------|----------|
| Calibration (SPEAG) | 2019/3/14 | 49.00 | -5.40 | - | - | - | - |
| Calibration(ULJ) | 2020/3/31 | 51.27 | -6.79 | 2.27 | -1.39 | $\pm 5\Omega \pm j5\Omega$ | Complied |
| Calibration(ULJ) | 2021/3/31 | 51.12 | -4.86 | 2.12 | 0.54 | $\pm 5\Omega \pm j5\Omega$ | Complied |

| Return loss | cal day | Head [dB] | Deviation [dB] | Tolerance [+/-dB] | Result |
|---------------------|-----------|--------------|-------------------|----------------------|----------|
| Calibration (SPEAG) | 2019/3/14 | -25.10 | - | - | - |
| Calibration(ULJ) | 2020/3/31 | -23.18 | 1.92 | 5.02 | Complied |
| Calibration(ULJ) | 2021/3/31 | -26.21 | -1.11 | 5.02 | Complied |

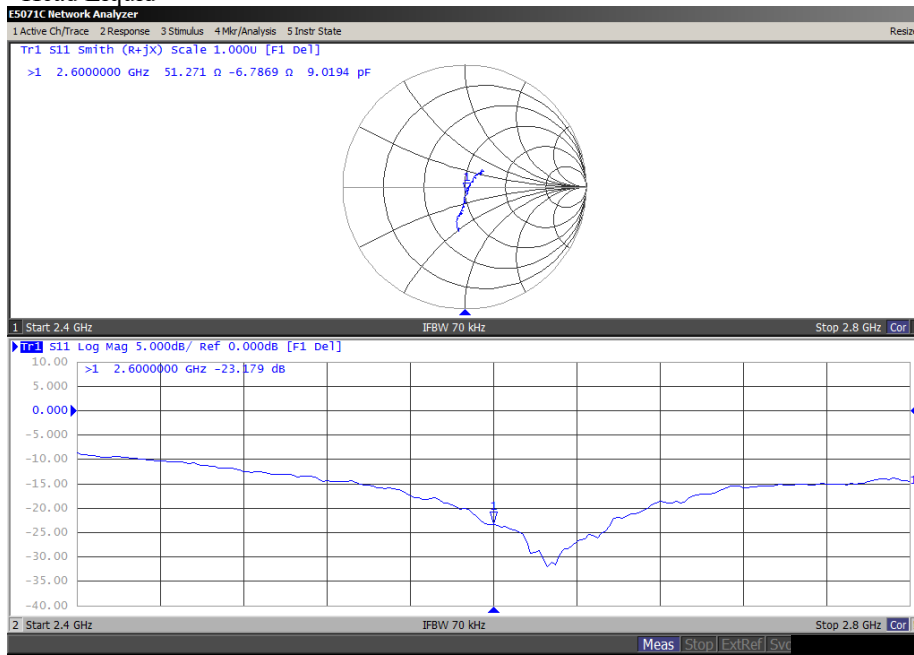
| Impedance, Transformed to feed point | cal day | Body (real part) [Ω] | Body (img part) [$j\Omega$] | Deviation (real part) [Ω] | Deviation (img part) [$j\Omega$] | Tolerance | Result |
|--------------------------------------|-----------|----------------------------------|----------------------------------|---------------------------------------|---------------------------------------|----------------------------|----------|
| Calibration (SPEAG) | 2019/3/14 | 45.00 | -4.00 | - | - | - | - |
| Calibration(ULJ) | 2020/3/31 | 48.98 | -5.89 | 3.98 | -1.89 | $\pm 5\Omega \pm j5\Omega$ | Complied |
| Calibration(ULJ) | 2021/3/31 | 46.40 | -3.63 | 1.40 | 0.37 | $\pm 5\Omega \pm j5\Omega$ | Complied |

| Return loss | cal day | Body [dB] | Deviation [dB] | Tolerance [+/-dB] | Result |
|---------------------|-----------|--------------|-------------------|----------------------|----------|
| Calibration (SPEAG) | 2019/3/14 | -23.40 | - | - | - |
| Calibration(ULJ) | 2020/3/31 | -24.25 | -0.85 | 4.68 | Complied |
| Calibration(ULJ) | 2021/3/31 | -25.52 | -2.12 | 4.68 | Complied |

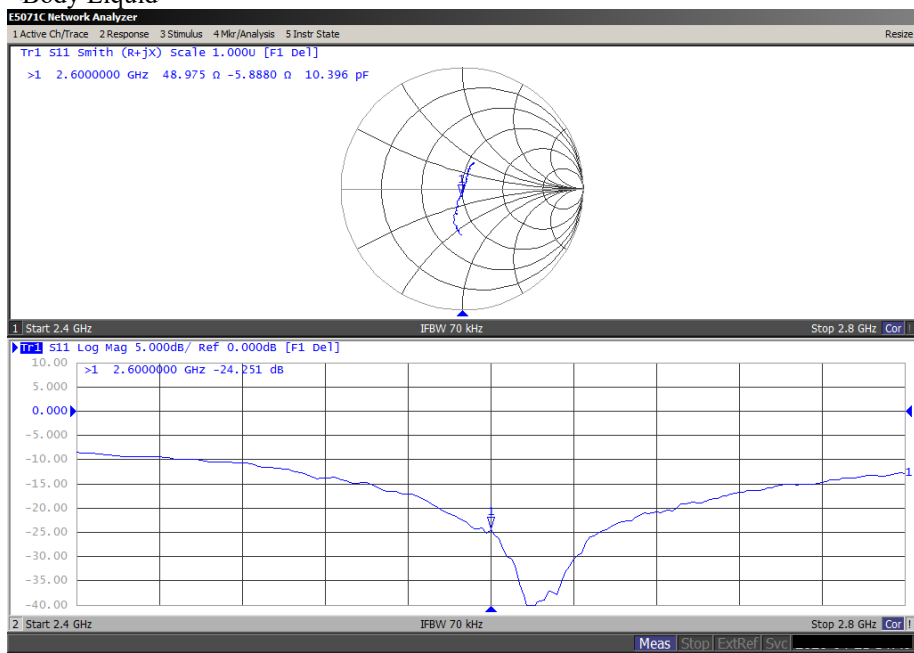
Tolerance: According to the KDB865664 D1

Measurement Plots (March 31, 2020)

<Head Liquid>

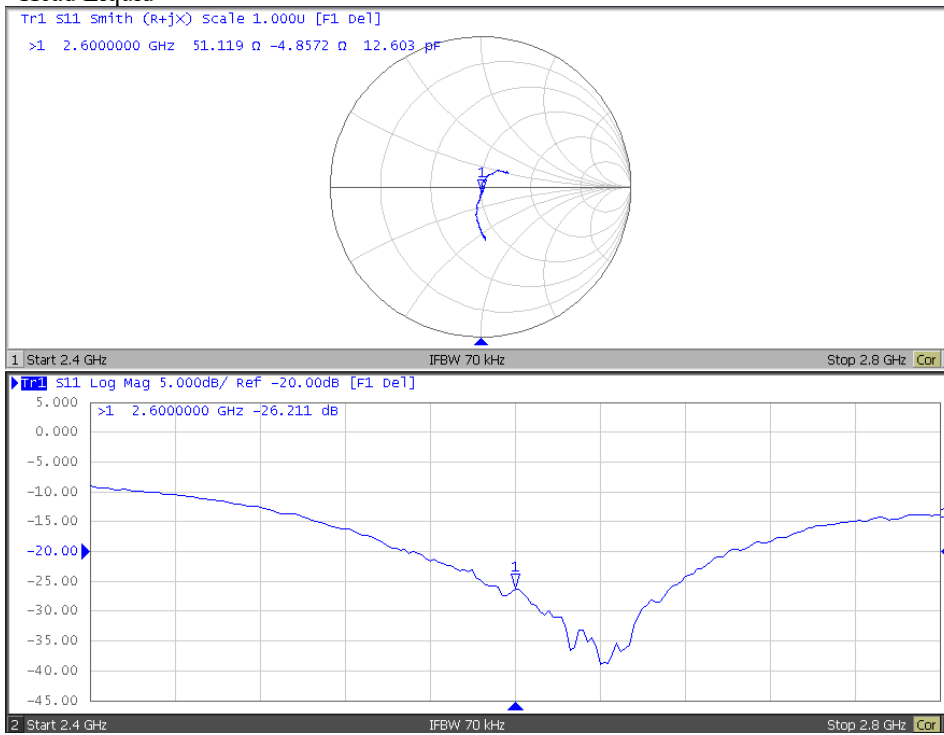


<Body Liquid>

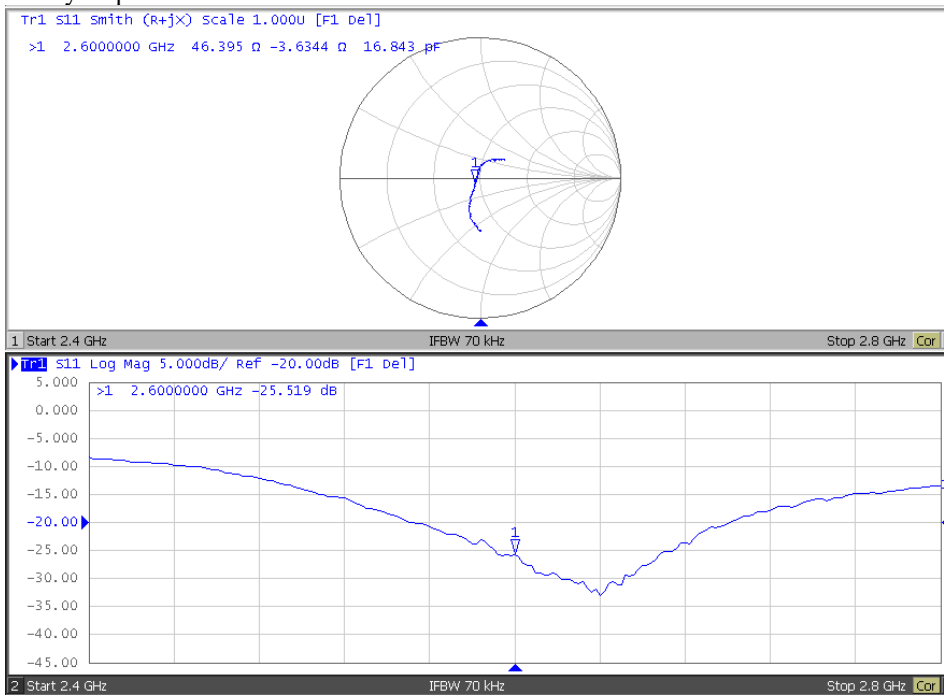


Measurement Plots (March 31, 2021)

<Head Liquid>



<Body Liquid>



E.11 System Check Dipole SAR Calibration Certificate -Dipole 3500MHz (D3500V2 S/N: 1052)

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **UL Japan (KYCOM)**

Certificate No: **D3500V2-1052_Dec19**

| CALIBRATION CERTIFICATE | | | |
|---|--|-----------------------------------|------------------------------|
| Object | D3500V2 - SN:1052 | | |
| Calibration procedure(s) | QA CAL-22.v4 Calibration Procedure for SAR Validation Sources between 3-6 GHz | | |
| Calibration date: | December 11, 2019 | | |
| This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate. | | | |
| All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%. | | | |
| Calibration Equipment used (M&TE critical for calibration) | | | |
| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
| Power meter NRP | SN: 104778 | 03-Apr-19 (No. 217-02892/02893) | Apr-20 |
| Power sensor NRP-Z91 | SN: 103244 | 03-Apr-19 (No. 217-02892) | Apr-20 |
| Power sensor NRP-Z91 | SN: 103245 | 03-Apr-19 (No. 217-02893) | Apr-20 |
| Reference 20 dB Attenuator | SN: 5058 (20k) | 04-Apr-19 (No. 217-02894) | Apr-20 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-19 (No. 217-02895) | Apr-20 |
| Reference Probe EX3DV4 | SN: 3503 | 25-Mar-19 (No. EX3-3503_Mar19) | Mar-20 |
| DAE4 | SN: 601 | 30-Apr-19 (No. DAE4-601_Apr19) | Apr-20 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB39512475 | 30-Oct-14 (in house check Feb-19) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-19) | In house check: Oct-20 |
| Calibrated by: | Name Michael Weber | Function Laboratory Technician | Signature |
| Approved by: | Katja Pokovic | Technical Manager | |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. | | | Issued: December 12, 2019 |

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S Swiss Calibration Service

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

Accreditation No.: **SCS 0108**

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The 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 | V52.10.3 |
| 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 ± 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 ± 0.2) °C | 37.0 ± 6 % | 2.90 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 6.80 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 67.7 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.55 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 25.4 W/kg ± 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 ± 0.2) °C | 49.8 ± 6 % | 3.33 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Body TSL

| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 6.42 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 66.7 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
|---|--------------------|---------------------------------|
| SAR measured | 100 mW input power | 2.38 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 23.6 W/kg ± 19.5 % (k=2) |

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.9 Ω - 4.1 j Ω |
| Return Loss | - 26.3 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 52.9 Ω - 2.4 j Ω |
| Return Loss | - 28.7 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.138 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: 11.12.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1052

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

Medium parameters used: $f = 3500$ MHz; $\sigma = 2.9$ S/m; $\epsilon_r = 37$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(7.75, 7.75, 7.75) @ 3500 MHz; Calibrated: 25.03.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474)

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 = 72.71 V/m; Power Drift = -0.01 dB

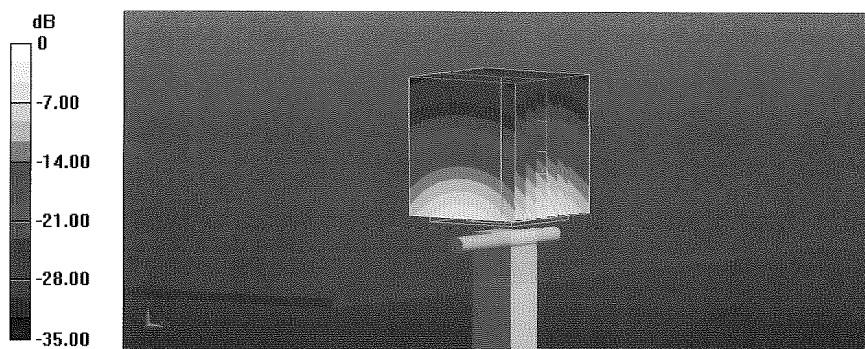
Peak SAR (extrapolated) = 18.4 W/kg

SAR(1 g) = 6.8 W/kg; SAR(10 g) = 2.55 W/kg

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

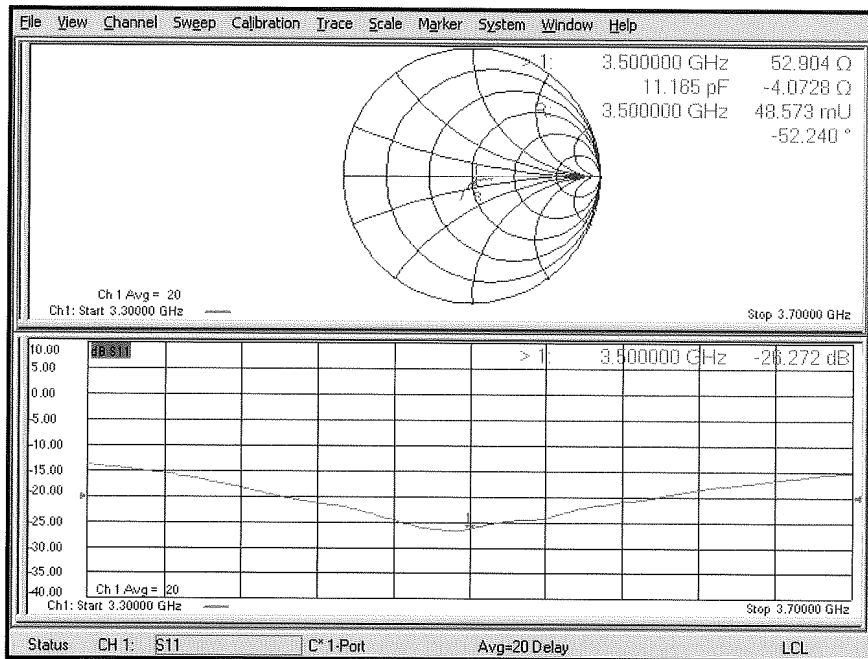
Ratio of SAR at M2 to SAR at M1 = 74.4%

Maximum value of SAR (measured) = 12.7 W/kg



0 dB = 12.7 W/kg = 11.05 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 11.12.2019

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN:1052

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

Medium parameters used: $f = 3500$ MHz; $\sigma = 3.33$ S/m; $\epsilon_r = 49.8$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(7.35, 7.35, 7.35) @ 3500 MHz; Calibrated: 25.03.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474)

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 = 66.02 V/m; Power Drift = -0.04 dB

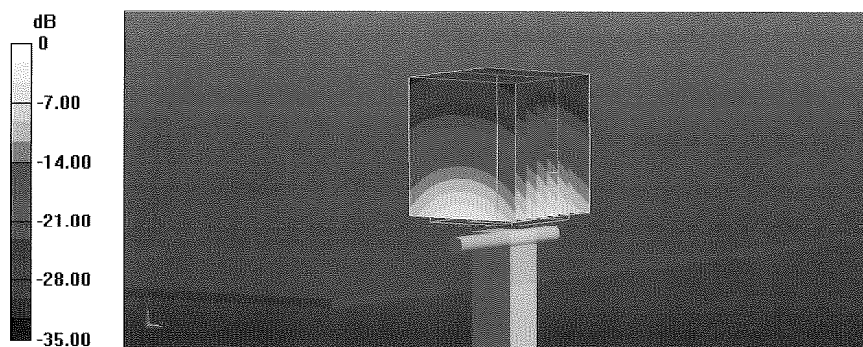
Peak SAR (extrapolated) = 17.5 W/kg

SAR(1 g) = 6.42 W/kg; SAR(10 g) = 2.38 W/kg

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

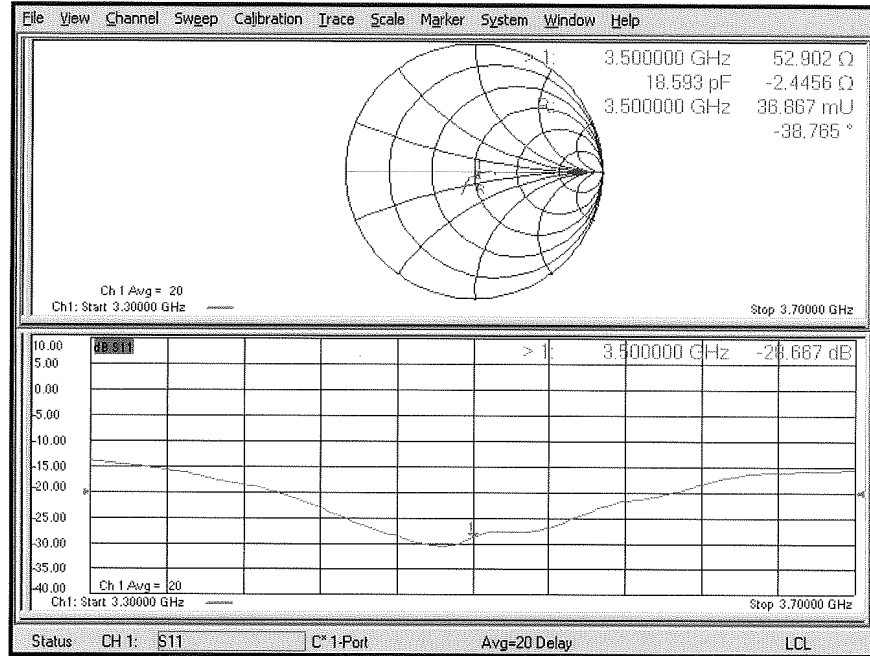
Ratio of SAR at M2 to SAR at M1 = 74.8%

Maximum value of SAR (measured) = 12.0 W/kg



0 dB = 12.0 W/kg = 10.80 dBW/kg

Impedance Measurement Plot for Body TSL



D3500V2 Calibration for Impedance and Return-loss

| | | | |
|-------------|-------------------------------|--------|---------|
| Equipment | Dipole Antenna | Model | D3500V2 |
| Manufacture | Schmid&Partner Engineering AG | Serial | 1052 |
| Tested by | Hisayoshi Sato | | |

1. Test environment

| | | | |
|---------------------|-------------------|-------------------|--------|
| Date | December 18, 2020 | | |
| Ambient Temperature | 24.5 deg.C | Relative humidity | 50 %RH |

2. Equipment used

| Control No. | Instrument | Manufacturer | Model No | Serial No | Test Item | Calibration Date * Interval(month) |
|----------------|------------------------|---------------------------------|-----------------|---------------|-----------|------------------------------------|
| EST-30 | Network Analyzer | Keysight Technologies Inc | N5230A | MY46400314 | SAR | 2020/08/17 * 12 |
| EST-62 | Calibration Kit | Keysight Technologies Inc | 85032F | MY41495257 | SAR | 2020/09/26 * 12 |
| MPF-03 | 2mm Oval Flat Phantom | Schmid&Partner Engineering AG | QDOVA001BB | 1203 | SAR | 2020/05/25 * 12 |
| MPSAM-03 | SAM Phantom | Schmid&Partner Engineering AG | QD000P40CD | 1764 | SAR | 2020/05/25 * 12 |
| MOS-30 | Thermo-Hygrometer | CUSTOM | CTH-201 | 3001 | SAR | 2020/07/10 * 12 |
| MHBBL600-10000 | Head Simulating Liquid | Schmid & Partner Engineering AG | HBBL600-10000V6 | SL AAH U16 BC | | - |
| MMBBL600-6000 | Body Simulating Liquid | Schmid & Partner Engineering AG | MBBL600-6000 | SL AAM U16 BC | | - |

3. Test Result

| Impedance, T transformed to feed point | cal day | Head (real part) [Ω] | Head (img part) [jΩ] | Deviation (real part) [Ω] | Deviation (img part) [jΩ] | Tolerance | Result |
|--|------------|----------------------|----------------------|---------------------------|---------------------------|-------------|----------|
| Calibration (SPEAG) | 2019/12/11 | 52.90 | -4.10 | - | - | - | - |
| Calibration(ULJ) | 2020/12/18 | 52.08 | -4.81 | -0.82 | -0.71 | +/-5Ω+/-5jΩ | Complied |

| Return loss | cal day | Head [dB] | Deviation [dB] | Tolerance [+/-dB] | Result |
|---------------------|------------|-----------|----------------|-------------------|----------|
| Calibration (SPEAG) | 2019/12/11 | -26.30 | - | - | - |
| Calibration(ULJ) | 2020/12/18 | -25.81 | 0.49 | 5.26 | Complied |

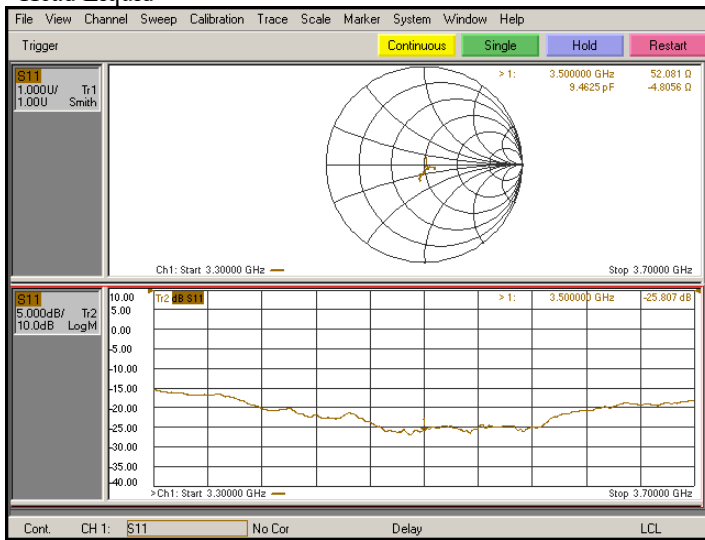
| Impedance, T transformed to feed point | cal day | Body (real part) [Ω] | Body (img part) [jΩ] | Deviation (real part) [Ω] | Deviation (img part) [jΩ] | Tolerance | Result |
|--|------------|----------------------|----------------------|---------------------------|---------------------------|-------------|----------|
| Calibration (SPEAG) | 2019/12/11 | 52.90 | -2.40 | - | - | - | - |
| Calibration(ULJ) | 2020/12/18 | 51.75 | -2.66 | -1.15 | -0.26 | +/-5Ω+/-5jΩ | Complied |

| Return loss | cal day | Body [dB] | Deviation [dB] | Tolerance [+/-dB] | Result |
|---------------------|------------|-----------|----------------|-------------------|----------|
| Calibration (SPEAG) | 2019/12/11 | -28.70 | - | - | - |
| Calibration(ULJ) | 2020/12/18 | -30.09 | -1.39 | 5.74 | Complied |

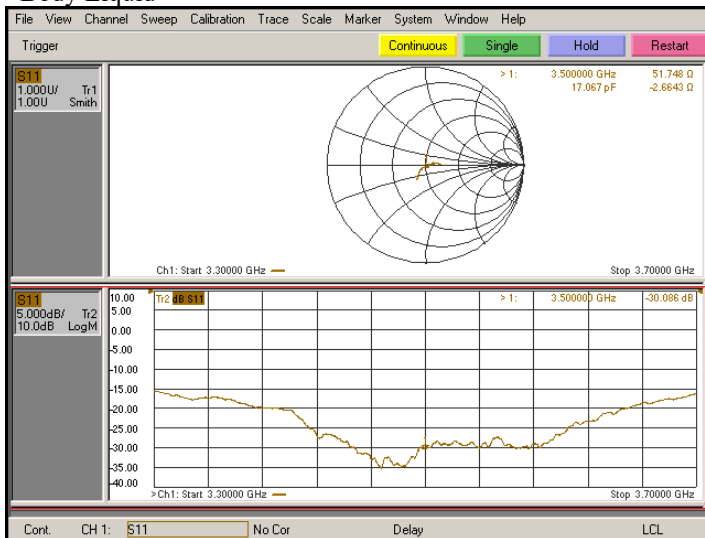
Tolerance: According to the KDB865664 D1

Measurement Plots

<Head Liquid>



<Body Liquid>



E.12 System Check Dipole SAR Calibration Certificate -Dipole 3700MHz (D3700V2 S/N: 1078)

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



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

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

Accreditation No.: **SCS 0108**

Client **UL Japan (RCC)**

Certificate No: **D3700V2-1078_Aug20**

CALIBRATION CERTIFICATE

Object **D3700V2 - SN:1078**

Calibration procedure(s) **QA CAL-22.v5
Calibration Procedure for SAR Validation Sources between 3-10 GHz**

Calibration date: **August 05, 2020**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---------------------------------|--------------------|-----------------------------------|------------------------|
| Power meter NRP | SN: 104778 | 01-Apr-20 (No. 217-03100/03101) | Apr-21 |
| Power sensor NRP-Z91 | SN: 103244 | 01-Apr-20 (No. 217-03100) | Apr-21 |
| Power sensor NRP-Z91 | SN: 103245 | 01-Apr-20 (No. 217-03101) | Apr-21 |
| Reference 20 dB Attenuator | SN: BH9394 (20k) | 31-Mar-20 (No. 217-03106) | Apr-21 |
| Type-N mismatch combination | SN: 310982 / 06327 | 31-Mar-20 (No. 217-03104) | Apr-21 |
| Reference Probe EX3DV4 | SN: 3503 | 31-Dec-19 (No. EX3-3503_Dec19) | Dec-20 |
| DAE4 | SN: 601 | 27-Dec-19 (No. DAE4-601_Dec19) | Dec-20 |
| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB39512475 | 30-Oct-14 (in house check Feb-19) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-19) | In house check: Oct-20 |

| | | | |
|----------------|-----------------|-----------------------|-----------|
| | Name | Function | Signature |
| Calibrated by: | Claudio Leubler | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: August 5, 2020

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