# SAR TEST REPORT

## Test Report No. : 12950350H-A-R2

| | | |
|---|---|---|
| **Applicant** | : | **Panasonic Corporation** |
| **Type of Equipment** | : | **SIP Cordless handset** |
| **Model No.** | : | **KX-TPA73** |
| **FCC ID** | : | **ACJ96NKX-TPA73** |
| **Test regulation** | : | **FCC47CFR 2.1093** |
| **Test Result** | : | **Complied (Refer to SECTION 4)** |

**Reported SAR(1g) Value**

**The highest reported SAR(1g)**

| | |
|---|---|
| Head | : 0.03 W/kg |
| Body worn | : 0.09 W/kg |
| Simultaneous transmission(Head) | : 0.05 W/kg |
| Simultaneous transmission(Body worn) | : 0.11 W/kg |

1. This test report shall not be reproduced in full or partial, without the written approval of UL Japan, Inc.
2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the limits of the above regulation.
4. The test results in this report are traceable to the national or international standards.
5. This test report covers SAR technical requirements. It does not cover administrative issues such as Manual or non-SAR test related Requirements. (if applicable)
6. The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
7. This test report must not be used by the customer to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.
8. The information provided from the customer for this report is identified in SECTION 1.
9. This report is a revised version of 12950350H-A-R1. 12950350H-A-R1 is replaced with this report.

**Date of test:** September 9 and 12, 2019

**Representative test engineer:**

Hisayoshi Sato
Engineer
Consumer Technology Division

**Approved by :**

Takayuki Shimada
Leader
Consumer Technology Division

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☒ There is no testing item of "Non-accreditation".


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# REVISION HISTORY

## Original Test Report No.: 12950350H-A

| Revision | Test report No. | Date | Page revised | Contents |
|---|---|---|---|---|
| - (Original) | 12950350H-A | September 27, 2019 | - | - |
| 1 | 12950350H-A-R1 | January 6, 2020 | P.1 | Correction of Reported SAR(1g) Value in Cover sheet;<br>Head: from 0.04 W/kg to 0.03 W/kg<br>Body worn: from 0.12 W/kg to 0.09 W/kg<br>Simultaneous transmission(Head): from 0.06 W/kg to 0.05 W/kg<br>Simultaneous transmission(Body worn): from 0.14 W/kg to 0.11 W/kg |
| 1 | 12950350H-A-R1 | January 6, 2020 | P.6 | Correction of Antenna Gain in Clause 2.3;<br>from 0.5 dBi to 1.5 dBi |
| 1 | 12950350H-A-R1 | January 6, 2020 | P.6 | Correction of Antenna Gain in Clause 2.4;<br>from -0.5 dBi to 0 dBi |
| 1 | 12950350H-A-R1 | January 6, 2020 | P.9 | Correction of DECT value in Stand-alone SAR result in Clause 4.2;<br><Head SAR><br>Tune-up upper Power: from 21.00 dBm / 125.89 mW to 20.00 dBm / 100.00 mW<br>Scaled factor: from 1.396 to 1.109<br>Reported SAR: from 0.038 W/kg to 0.030 W/kg<br><Body worn SAR><br>Tune-up upper Power: from 21.00 dBm / 125.89 mW to 20.00 dBm / 100.00 mW<br>Scaled factor: from 1.396 to 1.109<br>Reported SAR: from 0.117 W/kg to 0.093 W/kg |
| 1 | 12950350H-A-R1 | January 6, 2020 | P.9 | Correction of Simultaneous transmission SAR result in Clause 4.3;<br>Head SAR: from 0.057 W/kg to 0.050 W/kg<br>Body worn SAR: 0.138 W/kg to 0.114 W/kg |
| 1 | 12950350H-A-R1 | January 6, 2020 | P.10 | Correction of Maximum tune-up tolerance limit of DECT value in SECTION 5;<br>from 21.00 dBm / 125.89 mW to 20.00 dBm / 100.00 mW |
| 1 | 12950350H-A-R1 | January 6, 2020 | P.13, 14 | Correction of Output Power value of DECT in Clause 6.2;<br>from 21.00 dBm / 126 mW to 20.00 dBm / 100.00 mW |
| 1 | 12950350H-A-R1 | January 6, 2020 | P.18 | Correction of Tune-up upper Power value of DECT in Clause 7.1;<br>from 21.00 dBm to 20.00 dBm |
| 1 | 12950350H-A-R1 | January 6, 2020 | P.25 | - Correction of Tune-up upper Power value in Clause 11.1;<br>from 21.00 dBm to 20.00 dBm<br>- Changes in the following scaled factor values due to changes in the above Tune-up upper Power values;<br>1921.536 MHz: from 1.396 to 1.109<br>1924.992 MHz: from 1.403 to 1.114<br>1928.448 MHz: from 1.403 to 1.114 |
| 1 | 12950350H-A-R1 | January 6, 2020 | P.26 | - Correction of Tune-up upper Power value in Clause 11.3<br>from 21.00 dBm to 20.00 dBm<br>- Changes in the following scaled factor values due to changes in the above Tune-up upper Power values;<br>1921.536 MHz: from 1.396 to 1.109<br>1924.992 MHz: from 1.403 to 1.114<br>1928.448 MHz: from 1.403 to 1.114 |
| 1 | 12950350H-A-R1 | January 6, 2020 | P.28 | Correction of Stand alone SAR value of DECT in SCTION 12;<br><Head SAR><br>Left cheek: from 0.036 to 0.029<br>Left tilt: from 0.025 to 0.020<br>Right cheek: from 0.038 to 0.030<br>Right tilt: from 0.020 to 0.016<br><Body worn SAR><br>Front: from 0.056 to 0.044<br>Rear 1: from 0.117 to 0.093<br>Rear 2: from 0.112 to 0.089 |
| 2 | 12950350H-A-R2 | February 4, 2020 | P.26 | Correction of the table column of Clause 11.3.<br>from 10-g SAR(W/kg) to 1-g SAR(W/kg) |

## Reference: Abbreviations (Including words undescribed in this report)

| | |
|---|---|
| A2LA | The American Association for Laboratory Accreditation |
| AC | Alternating Current |
| AFH | Adaptive Frequency Hopping |
| AM | Amplitude Modulation |
| Amp, AMP | Amplifier |
| ANSI | American National Standards Institute |
| Ant, ANT | Antenna |
| AP | Access Point |
| Atten., ATT | Attenuator |
| AV | Average |
| BPSK | Binary Phase-Shift Keying |
| BR | Bluetooth Basic Rate |
| BT | Bluetooth |
| BT LE | Bluetooth Low Energy |
| BW | BandWidth |
| Cal Int | Calibration Interval |
| CCK | Complementary Code Keying |
| Ch., CH | Channel |
| CISPR | Comite International Special des Perturbations Radioelectriques |
| CW | Continuous Wave |
| DBPSK | Differential BPSK |
| DC | Direct Current |
| DFS | Dynamic Frequency Selection |
| DQPSK | Differential QPSK |
| DSSS | Direct Sequence Spread Spectrum |
| EDR | Enhanced Data Rate |
| EIRP, e.i.r.p. | Equivalent Isotropically Radiated Power |
| EMC | ElectroMagnetic Compatibility |
| EMI | ElectroMagnetic Interference |
| EN | European Norm |
| ERP, e.r.p. | Effective Radiated Power |
| EU | European Union |
| EUT | Equipment Under Test |
| Fac. | Factor |
| FCC | Federal Communications Commission |
| FHSS | Frequency Hopping Spread Spectrum |
| FM | Frequency Modulation |
| Freq. | Frequency |
| GFSK | Gaussian Frequency-Shift Keying |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| Hori. | Horizontal |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronics Engineers |
| IF | Intermediate Frequency |
| ILAC | International Laboratory Accreditation Conference |
| ISED | Innovation, Science and Economic Development Canada |
| ISO | International Organization for Standardization |
| JAB | Japan Accreditation Board |
| LAN | Local Area Network |
| LIMS | Laboratory Information Management System |
| MCS | Modulation and Coding Scheme |
| MRA | Mutual Recognition Arrangement |
| NIST | National Institute of Standards and Technology |
| NS | No signal detect. |
| NSA | Normalized Site Attenuation |
| NVLAP | National Voluntary Laboratory Accreditation Program |
| OBW | Occupied Band Width |
| OFDM | Orthogonal Frequency Division Multiplexing |
| P/M | Power meter |
| PCB | Printed Circuit Board |
| PER | Packet Error Rate |
| PHY | Physical Layer |
| PK | Peak |
| PN | Pseudo random Noise |
| PRBS | Pseudo-Random Bit Sequence |
| PSD | Power Spectral Density |
| QAM | Quadrature Amplitude Modulation |
| QP | Quasi-Peak |
| QPSK | Quadri-Phase Shift Keying |
| RBW | Resolution Band Width |
| RDS | Radio Data System |
| RE | Radio Equipment |
| RF | Radio Frequency |
| RMS | Root Mean Square |
| Rx | Receiving |
| SA, S/A | Spectrum Analyzer |
| SG | Signal Generator |
| SVSWR | Site-Voltage Standing Wave Ratio |
| TR | Test Receiver |
| Tx | Transmitting |
| VBW | Video BandWidth |
| Vert. | Vertical |
| WLAN | Wireless LAN |

## CONTENTS PAGE



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## SECTION1: Customer information

| | | |
|---|---|---|
| Company Name | : | Panasonic Corporation |
| Address | : | 4-1-62, Minoshima, Hakata-ku, Fukuoka, 812-8531, Japan |
| Telephone Number | : | +81-70-1349-4205 |
| Contact Person | : | Michihito Miyazaki |

*The information provided from the customer is as follows;
- Applicant, Type of Equipment, Model No. on the cover and other relevant pages
- Operating/Test Mode(s) (Mode(s)) on all the relevant pages
- SECTION 1: Customer information
- SECTION 2: Equipment under test (E.U.T.)
- SECTION 5: Tune-up tolerance information and software information

* The laboratory is exempted from liability of any test results affected from the information in SECTION 2.

## SECTION2: Equipment under test (E.U.T.)

### 2.1 Identification of E.U.T.

| | | |
|---|---|---|
| Type of Equipment | : | SIP Cordless handset |
| Model No. | : | KX-TPA73 |
| Serial No. | : | S12CA000028 |
| Rating | : | Li-ion Battery:<br>M/N: N4HPGMA00001<br>DC 3.7V 800mAh 3Wh<br>No optional batteries. |
| Body worn Accessory | : | Belt clip |
| Accessory | : | Headset is intended |
| Receipt Date of Sample<br>(Information from test lab.) | : | 2019/08/21 |
| Country of Mass-production | : | Vietnam |
| Condition of EUT | : | Production prototype<br>(Not for Sale: This sample is equivalent to mass-produced items.) |
| Modification of EUT | : | No Modification by the test lab |

### 2.2 Product description

<EUT>

| | | |
|---|---|---|
| Feature of EUT | : | Cordless Telephone handset, 2.2 inch color LCD, 1xLED with 3 colors, several hardware key, Radio Interface is DECT, Rating Li-ion Battery 800 mAh, Belt clip |

<Valiant model>
Tested model: KX-TPA73 has variant model: KX-TPA73C.
Those difference is only the destination.

## 2.3 Radio Specification DECT (Digital Enhanced Cordless Telecommunications)

| | |
|---|---|
| Number of Antenna | 1 |
| Mode | Talk Mode |
| Frequency of operation | 1920 MHz - 1930 MHz |
| Clock frequencies in the system (radio part) | 13.824 MHz |
| Type of modulation | GMSK |
| Bandwidth & Channel spacing | < 2.5 MHz and 1.728MHz |
| Antenna type | Plate antenna |
| Antenna Gain | 1.5 dBi |

## 2.4 Radio Specification Bluetooth

| | |
|---|---|
| Number of Antenna | 1 |
| Mode | DH1 |
| Frequency of operation | 2402 MHz - 2480 MHz |
| Clock frequencies in the system (radio part) | 26 MHz |
| Type of modulation | GFSK, Bluetooth v2.1 (w/o EDR) |
| Bandwidth & Channel spacing | 79 MHz & 1 MHz/CH [BT] |
| Antenna type | Pattern antenna |
| Antenna Gain | 0 dBi |

## SECTION3: Test standard information

### 3.1 Test Specification

Title : **FCC47CFR 2.1093**
Radiofrequency radiation exposure evaluation: portable devices.
: **IEEE Std 1528-2013:**
IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.

: **Published RF exposure KDB procedures**

| | | |
|---|---|---|
| ☑ | **KDB447498D01(v06)** | RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices |
| ☐ | **KDB447498D02(v02r01)** | SAR Measurement Procedures for USB Dongle Transmitters |
| ☑ | **KDB648474D04(v01r03)** | SAR Evaluation Considerations for Wireless Handsets |
| ☐ | **KDB941225D01(v03r01)** | 3G SAR Measurement Procedures |
| ☐ | **KDB941225D05(v02r05)** | SAR Evaluation Considerations for LTE Devices |
| ☐ | **KDB941225D06(v02r01)** | SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities (Hot Spot SAR) |
| ☐ | **KDB941225D07(v01r02)** | SAR Evaluation Procedures for UMPC Mini-Tablet Devices |
| ☐ | **KDB616217D04(v01r02)** | SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers |
| ☑ | **KDB865664D01(v01r04)** | SAR Measurement Requirements for 100MHz to 6 GHz |
| ☐ | **KDB248227D01(v02r02)** | SAR Guidance for 802.11(Wi-Fi) Transmitters |

**Reference**
[1]SPEAG uncertainty document (AN 15-7/AN19-17) for DASY 5 System from SPEAG (Schmid & Partner Engineering AG).

### 3.2 Procedure

| **Transmitter** | **WLAN and Bluetooth** |
|---|---|
| **Test Procedure** | Published RF exposure KDB procedures |
| **Category** | FCC47CFR 2.1093 |
| Note: UL Japan, Inc. 's SAR Work Procedures 13-EM-W0429 and 13-EM-W0430 | |

### 3.3 Additions or deviations to standard

Other than above, no addition, exclusion nor deviation has been made from the standard.

### 3.4 Exposure limit

(A) Limits for Occupational/Controlled Exposure (W/kg)

| Spatial Average (averaged over the whole body) | Spatial Peak (averaged over any 1g of tissue) | Spatial Peak (hands/wrists/feet/ankles averaged over 10g) |
|---|---|---|
| 0.4 | 8.0 | 20.0 |

(B) Limits for General population/Uncontrolled Exposure (W/kg)

| Spatial Average (averaged over the whole body | Spatial Peak (averaged over any 1g of tissue) | Spatial Peak (hands/wrists/feet/ankles averaged over 10g) |
|---|---|---|
| 0.08 | 1.6 | 4.0 |

**Occupational/Controlled Environments:** are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

**General Population/Uncontrolled Environments:** are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

**NOTE:GENERAL POPULATION/UNCONTROLLED EXPOSURE**
**SPATIAL PEAK(averaged over any 1g of tissue) LIMIT**
**1.6 W/kg**

### 3.5 SAR

Specific Absorption Rate (SAR): The time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ), as shown in the following equation:

$$\mathrm{SAR} = \frac{\mathrm{d}}{\mathrm{dt}}\left(\frac{\mathrm{dW}}{\mathrm{dm}}\right) = \frac{\mathrm{d}}{\mathrm{dt}}\left(\frac{\mathrm{dW}}{\rho\mathrm{dV}}\right)$$

SAR is expressed in units of watts per kilogram (W/kg) or equivalently milliwatts per gram (mW/g).

SAR is related to the E-field at a point by the following equation:

$$\mathrm{SAR} = \frac{\sigma|\mathrm{E}|^2}{\rho}$$

where
σ = conductivity of the tissue (S/m)
ρ = mass density of the tissue (kg/m3)
E = rms E-field strength (V/m)

### 3.6 Test Location

*Shielded room for SAR testings
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## SECTION4: Test result

### 4.1 Result

Complied
Highest values at each band are listed next section.

### 4.2 Stand-alone SAR result

**Reported SAR**
Measured SAR is scaled to the maximum tune-up tolerance limit by the following formulas.
Reported SAR= Measured SAR [W/kg] · Scaled factor
Maximum tune-up tolerance limit is by the specification from a customer.

* Scaled factor = Maximum tune-up tolerance limit [mW] / Measured power [mW]

**Head SAR**

| Mode | Frequency [MHz] | Tune-up upper Power [dBm] | Measured average Power [dBm] | Tune-up upper Power [mW] | Measured average Power [mW] | Scaled factor | Measured SAR [W/kg] | Reported SAR [W/kg] |
|---|---|---|---|---|---|---|---|---|
| DECT | 1921.536 | 20.00 | 19.55 | 100.00 | 90.16 | 1.109 | 0.027 | 0.030 |
| Bluetooth | 2468 | 9.00 | 7.92 | 7.94 | 6.19 | 1.282 | 0.016 | 0.021 |

**Body worn SAR**

| Mode | Frequency [MHz] | Tune-up upper Power [dBm] | Measured average Power [dBm] | Tune-up upper Power [mW] | Measured average Power [mW] | Scaled factor | Measured SAR [W/kg] | Reported SAR [W/kg] |
|---|---|---|---|---|---|---|---|---|
| DECT | 1921.536 | 20.00 | 19.55 | 100.00 | 90.16 | 1.109 | 0.084 | 0.093 |
| Bluetooth | 2468 | 9.00 | 7.92 | 7.94 | 6.19 | 1.282 | 0.016 | 0.021 |

**Note(s):**
The sample used by the SAR test is not more than 2 dB lower than the maximum tune-up tolerance limit. That is, measured power is included the tune-up tolerance range.

### 4.3 Simultaneous transmission SAR result

Head SAR: 0.050 W/kg
Body worn SAR: 0.114 W/kg

Refer to Section 12 “Simultaneous Transmission SAR Analysis”.

## SECTION5: Tune-up tolerance information and software information

Maximum tune-up tolerance limit

| Mode | Maximum frequency in each band | Maximum tune-up tolerance limit [dBm] | Maximum tune-up tolerance limit [mW] |
|---|---|---|---|
| DECT | 1928.448 | 20.00 | 100.00 |
| Bluetooth | 2480 | 9.00 | 7.94 |

For Maximum tune-up tolerance limit is defined by a customer as duty100%.

| Software setting |
|---|
| *The power value of the EUT was set for testing as follows (setting value might be different from product specification value);<br><br>DECT<br>Power settings: 96<br>Software: Ver.00.01<br><br>Bluetooth<br>Power settings: 9 dBm<br>Software: Ver.14.03<br><br>*This setting of software is the worst case.<br>The test was performed with condition that obtained the maximum average power in pre-check.<br>Any conditions under the normal use do not exceed the condition of setting.<br>In addition, end users cannot change the settings of the output power of the product. |


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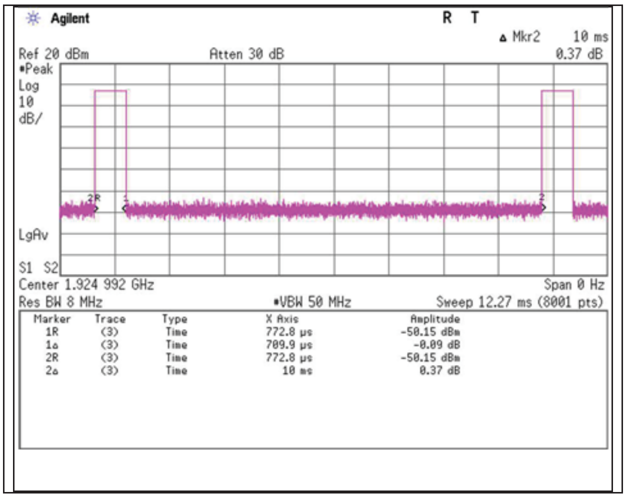
Duty Confirmation for DECT

**Tx on / (Tx on + Tx off) =** **0.071**

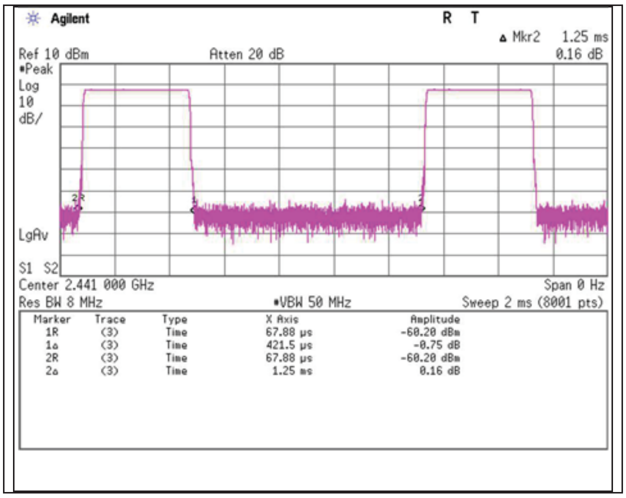
**Tx on / (Tx on + Tx off) * 100 =** **7.1 %**




Duty Confirmation for Bluetooth

**Tx on / (Tx on + Tx off) =** **0.337**

**Tx on / (Tx on + Tx off) * 100 =** **33.7 %**



## SECTION6: RF Exposure Conditions (Test Configurations)

### 6.1 Summary of the distance between antenna and surface of EUT

DECT

| Position | D [mm] |
|---|---|
| Front | 14.27 |
| Rear 1 | 3.38 |

Bluetooth

| Position | D [mm] |
|---|---|
| Front | 8.77 |
| Rear 2 | 10.54 |

*Details are shown in appendix 4

### 6.2 SAR test exclusion considerations according to KDB447498 D01

The following is based on KDB447498D01.
1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
*[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] ·[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR*

1. The upper frequency of the frequency band was used in order to calculate standalone SAR test exclusion considerations.
2. Power and distance are rounded to the nearest mW and mm before calculation
3. The result is rounded to one decimal place for comparison
4. The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion. When the separation of antenna to EUT's surfaces and edges are ≤ 50 mm, the separation distance used for the SAR exclusion calculations is 5 mm.
5. "N/A" displayed on below exclusion calculation means not applicable this formula since distance between antenna and surface is > 50 mm.

When the calculated threshold value by a numerical formula above-mentioned in the following table is 3.0 or less, SAR test is excluded.

SAR exclusion calculations for antenna <50mm from the user

| Antenna | Tx Interface | Frequency (MHz) | Output Power | | Calculated Threshold Value | |
|---|---|---|---|---|---|---|
| | | | dBm | mW | Front | Rear 1 |
| Main | DECT | 1928.448 | 20.00 | 100 | 27.8 -MEASURE- | 27.8 -MEASURE- |

SAR exclusion calculations for antenna <50mm from the user

| Antenna | Tx Interface | Frequency (MHz) | Output Power | | Calculated Threshold Value | |
|---|---|---|---|---|---|---|
| | | | dBm | mW | Front | Rear 2 |
| Main | Bluetooth | 2480 | 9.00 | 8 | 2.5 -EXEMPT- | 2.5 -EXEMPT- |

* The test was also performed Bluetooth conservatively.

2) At 100 MHz to 6 GHz and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following.

*a) [(3·50)/(√f(GHz))) + (test separation distance - 50 mm)·(f(MHz)/150)] mW at > 100 MHz and ≤ 1500 MHz*

*b) [(3·50)/(√f(GHz))) + (test separation distance - 50 mm)·10] mW at > 1500 MHz and ≤ 6 GHz*

1. The upper frequency of the frequency band was used in order to calculate standalone SAR test exclusion considerations.
2. Power and distance are rounded to the nearest mW and mm before calculation
3. "N/A" displayed on below exclusion calculation means not applicable this formula since distance between antenna and surface is < 50 mm.

When output power is less than the calculated threshold value by a numerical formula above-mentioned in the following table, SAR test is excluded.

SAR exclusion calculations for antenna >50mm from the user

| Antenna | Tx Interface | Frequency (MHz) | Output Power | | Calculated Threshold Value | |
|---|---|---|---|---|---|---|
| | | | dBm | mW | Front | Rear 1 |
| Main | DECT | 1928.448 | 20.00 | 100 | N/A | N/A |

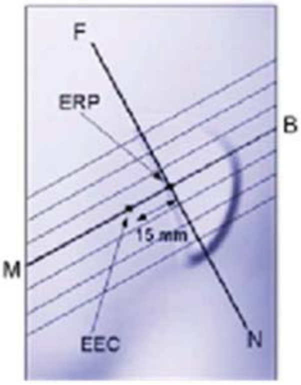
SAR exclusion calculations for antenna >50mm from the user

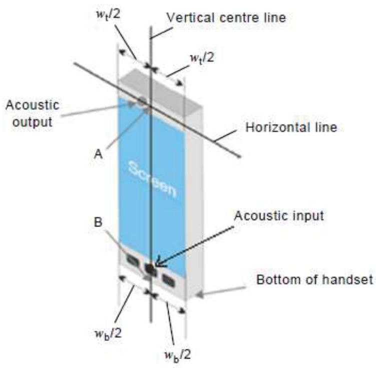
| Antenna | Tx Interface | Frequency (MHz) | Output Power | | Calculated Threshold Value | |
|---|---|---|---|---|---|---|
| | | | dBm | mW | Front | Rear 2 |
| Main | Bluetooth | 2480 | 9.00 | 8 | N/A | N/A |

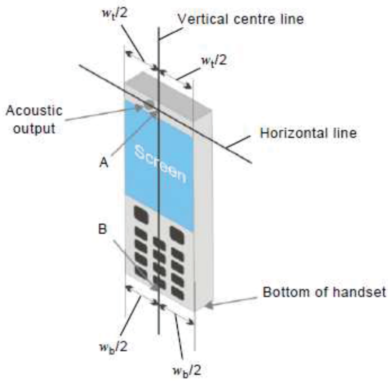
## 6.3 Description of the Head setup

### Initial ear position

A handset should be initially positioned with the earpiece region pressed against the ear spacer of a head phantom.
The device should be positioned parallel to the "N-F" line defined along the base of the ear spacer that contains the "ear reference point". The "test device reference point" is aligned to the "ear reference point" on the head phantom and the "vertical centerline" is aligned to the "phantom reference plane".



**Cheek position**

The device is brought toward the mouth of the head phantom by pivoting against the "ear reference point" or along the "N-F" line.

This test position is established:

i) When any point on the display, keypad or mouthpiece portions of the handset is in contact with the phantom.

ii) (or) When any portion of a foldout, sliding or similar keypad cover opened to its intended self-adjusting normal use position is in contact with the cheek or mouth of the phantom.


**Tilt position**

If the earpiece of the handset is not in full contact with the phantom's ear spacer and the peak SAR location for the "Cheek/Touch" position is located at the ear spacer region or corresponds to the earpiece region of the handset, the device should be returned to the "initial ear position" by rotating it away from the mouth until the earpiece is in full contact with the ear spacer. Otherwise the handset should be moved away from the cheek perpendicular to the line passes through both "ear reference points" for approximate 2-3 cm. While it is in this position, the handset is tilted away from the mouth with respect to the "test device reference point" by 15°. After the tilt, it is then moved back toward the head perpendicular to the line passes through both "ear reference points" until the device touches the phantom or the ear spacer. If the antenna touches the head first, the positioning process should be repeated with a tilt angle less than 15° so that the device and its antenna would touch the phantom simultaneously.


**Test position for Head**

| No. | Position | Test distance | Tested |
|---|---|---|---|
| 1 | Left Cheek | 0mm | ☑ |
| 2 | Left tilt | 0mm | ☑ |
| 3 | Right Cheek | 0mm | ☑ |
| 4 | Right tilt | 0mm | ☑ |

## 6.4 Description of the Body worn setup

### Procedure for SAR test position determination

-The tested procedure was performed according to
the KDB 648474 D04, Handset SAR v01r03(SAR Evaluation Considerations for Wireless Handsets).

### Test position for Body setup

DECT

| No. | Position | Test distance | SAR |
|---|---|---|---|
| | | | Tested |
| 1 | Front | 0mm | ☑ |
| 2 | Rear 1 | 0mm | ☑ |

Bluetooth

| No. | Position | Test distance | SAR |
|---|---|---|---|
| | | | Tested |
| 1 | Front | 0mm | ☑ |
| 2 | Rear 2 | 0mm | ☑ |

## SECTION7: Description of the operating mode

### 7.1 Output Power and SAR test required

**DECT**

| Mode | Ch # | Freq. (MHz) | Tune-up upper Power (dBm) (Burst) | Measured average Power (dBm) (Burst) | Initial test configuration | Note(s) |
|---|---|---|---|---|---|---|
| DECT | 4 | 1921.536 | 20.00 | 19.55 | Yes | |
| | 2 | 1924.992 | 20.00 | 19.53 | | |
| | 0 | 1928.448 | 20.00 | 19.53 | | |

**Bluetooth**

| Mode | Data Rate | Ch # | Freq. (MHz) | Tune-up upper Power (dBm) (Burst) | Measured average Power (dBm) (Burst) | Initial test configuration | Note(s) |
|---|---|---|---|---|---|---|---|
| Bluetooth | DH1 | 0 | 2402 | 7.00 | - | | |
| | | 1 | 2403 | 8.00 | - | | |
| | | 52 | 2454 | 8.00 | - | | |
| | | 53 | 2455 | 9.00 | 7.85 | | |
| | | 66 | 2468 | 9.00 | 7.92 | Yes | |
| | | 78 | 2480 | 9.00 | 7.87 | | |

**Note(s):**

1. Initial SAR test channel was chosen. (shaded blue frame)

Correlation of Output Power

## SECTION8: Test surrounding

### 8.1 Measurement uncertainty

This measurement uncertainty budget is suggested by IEEE Std 1528(2013) and IEC62209-2:2010, and determined by Schmid & Partner Engineering AG (DASY5 Uncertainty Budget). Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz Section 2.8.1., when the highest measured SAR(1g) within a frequency band is < 1.5W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std.1528 (2013) is not required in SAR reports submitted for equipment approval.

<Head>

| Error Description | Uncert. value | Prob. Dist. | Div. | (ci) 1g | (ci) 10g | Std. Unc. (1g) | Std.Unc. (10g) |
|---|---|---|---|---|---|---|---|
| **Measurement System** | | | | | | | |
| Probe Calibration | ± 6.55 % | N | 1 | 1 | 1 | ±6.55% | ±6.55% |
| Axial Isotropy | ± 4.7 % | R | √3 | 0.7 | 0.7 | ±1.9% | ±1.9% |
| Hemispherical Isotropy | ± 9.6 % | R | √3 | 0.7 | 0.7 | ±3.9% | ±3.9% |
| Linearity | ± 4.7 % | R | √3 | 1 | 1 | ±2.7% | ±2.7% |
| Modulation Response | ± 2.4 % | R | √3 | 1 | 1 | ±1.4% | ±1.4% |
| System Detection Limits | ± 1.0 % | R | √3 | 1 | 1 | ±0.6% | ±0.6% |
| Boundary Effects | ± 2.0 % | R | √3 | 1 | 1 | ±1.2% | ±1.2% |
| Readout Electronics | ± 0.3 % | N | 1 | 1 | 1 | ±0.3% | ±0.3% |
| Response Time | ± 0.8 % | R | √3 | 1 | 1 | ±0.5% | ±0.5% |
| Integration Time | ± 2.6 % | R | √3 | 1 | 1 | ±1.5% | ±1.5% |
| RF Ambient Noise | ± 3.0 % | R | √3 | 1 | 1 | ±1.7% | ±1.7% |
| RF Ambient Reflections | ± 3.0 % | R | √3 | 1 | 1 | ±1.7% | ±1.7% |
| Probe Positioner | ± 0.04 % | R | √3 | 1 | 1 | ±0.0% | ±0.0% |
| Probe Positioning | ± 0.8 % | R | √3 | 1 | 1 | ±0.5% | ±0.5% |
| Post-processing | ± 4.0 % | R | √3 | 1 | 1 | ±2.3% | ±2.3% |
| **Test Sample Related** | | | | | | | |
| Device Holder | ± 3.6 % | N | 1 | 1 | 1 | ±3.6% | ±3.6% |
| Test sample Positioning | ± 2.9 % | N | 1 | 1 | 1 | ±2.9% | ±2.9% |
| Power Scaling | ± 0.0 % | R | √3 | 1 | 1 | ±0.0% | ±0.0% |
| Power Drift | ± 5.0 % | R | √3 | 1 | 1 | ±2.9% | ±2.9% |
| **Phantom and Setup** | | | | | | | |
| Phantom Uncertainty | ± 7.6 % | R | √3 | 1 | 1 | ±4.4% | ±4.4% |
| SAR correction | ± 1.9 % | N | 1 | 1 | 0.84 | ±1.9% | ±1.6% |
| Liquid Conductivity (mea.) | - 1.7 % | N | 1 | 0.78 | 0.71 | ±1.3% | ±1.2% |
| Liquid Permittivity (mea.) | - 3.3 % | N | 1 | 0.23 | 0.26 | ±0.8% | ±0.9% |
| Temp. unc. - Conductivity | ± 3.4 % | R | √3 | 0.78 | 0.71 | ±1.5% | ±1.4% |
| Temp. unc. - Permittivity | ± 0.4 % | R | √3 | 0.23 | 0.26 | ±0.1% | ±0.1% |
| Combined Std. Uncertainty | | | | | | ±12.0% | ±11.9% |
| **Expanded STD Uncertainty ( $\kappa$ =2)** | | | | | | ±24.0% | ±23.9% |

<Body>

| Error Description | Uncert. value | Prob. Dist. | Div. | (ci) 1g | (ci) 10g | Std. Unc. (1g) | Std.Unc. (10g) |
|---|---|---|---|---|---|---|---|
| **Measurement System** | | | | | | | |
| Probe Calibration | ± 6.55 % | N | 1 | 1 | 1 | ±6.55% | ±6.55% |
| Axial Isotropy | ± 4.7 % | R | √3 | 0.7 | 0.7 | ±1.9% | ±1.9% |
| Hemispherical Isotropy | ± 9.6 % | R | √3 | 0.7 | 0.7 | ±3.9% | ±3.9% |
| Linearity | ± 4.7 % | R | √3 | 1 | 1 | ±2.7% | ±2.7% |
| Modulation Response | ± 2.4 % | R | √3 | 1 | 1 | ±1.4% | ±1.4% |
| System Detection Limits | ± 1.0 % | R | √3 | 1 | 1 | ±0.6% | ±0.6% |
| Boundary Effects | ± 2.0 % | R | √3 | 1 | 1 | ±1.2% | ±1.2% |
| Readout Electronics | ± 0.3 % | N | 1 | 1 | 1 | ±0.3% | ±0.3% |
| Response Time | ± 0.8 % | R | √3 | 1 | 1 | ±0.5% | ±0.5% |
| Integration Time | ± 2.6 % | R | √3 | 1 | 1 | ±1.5% | ±1.5% |
| RF Ambient Noise | ± 3.0 % | R | √3 | 1 | 1 | ±1.7% | ±1.7% |
| RF Ambient Reflections | ± 3.0 % | R | √3 | 1 | 1 | ±1.7% | ±1.7% |
| Probe Positioner | ± 0.04 % | R | √3 | 1 | 1 | ±0.0% | ±0.0% |
| Probe Positioning | ± 0.8 % | R | √3 | 1 | 1 | ±0.5% | ±0.5% |
| Post-processing | ± 4.0 % | R | √3 | 1 | 1 | ±2.3% | ±2.3% |
| **Test Sample Related** | | | | | | | |
| Device Holder | ± 3.6 % | N | 1 | 1 | 1 | ±3.6% | ±3.6% |
| Test sample Positioning | ± 2.9 % | N | 1 | 1 | 1 | ±2.9% | ±2.9% |
| Power Scaling | ± 0.0 % | R | √3 | 1 | 1 | ±0.0% | ±0.0% |
| Power Drift | ± 5.0 % | R | √3 | 1 | 1 | ±2.9% | ±2.9% |
| **Phantom and Setup** | | | | | | | |
| Phantom Uncertainty | ± 7.6 % | R | √3 | 1 | 1 | ±4.4% | ±4.4% |
| SAR correction | ± 1.9 % | N | 1 | 1 | 0.84 | ±1.9% | ±1.6% |
| Liquid Conductivity (mea.) | - 1.7 % | N | 1 | 0.78 | 0.71 | ±1.3% | ±1.2% |
| Liquid Permittivity (mea.) | - 3.3 % | N | 1 | 0.23 | 0.26 | ±0.8% | ±0.9% |
| Temp. unc. - Conductivity | ± 3.4 % | R | √3 | 0.78 | 0.71 | ±1.5% | ±1.4% |
| Temp. unc. - Permittivity | ± 0.4 % | R | √3 | 0.23 | 0.26 | ±0.1% | ±0.1% |
| Combined Std. Uncertainty | | | | | | ±12.0% | ±11.9% |
| **Expanded STD Uncertainty ( $\kappa$ =2)** | | | | | | ±24.0% | ±23.9% |

Note: This uncertainty budget for validation is worst-case.
Table of uncertainties are listed for ISO/IEC 17025.

## SECTION9: Parameter Check

The dielectric parameters were checked prior to assessment using the DAK dielectric probe kit.
The dielectric parameters measurement is reported in each correspondent section.

According to KDB865664 D01, +/- 5% tolerances are required for εr and σ and then below table which is the target value of the simulated tissue liquid is quoted from KDB865664 D01.

| Target Frequency | Head | | Body | |
|---|---|---|---|---|
| (MHz) | $\varepsilon_r$ | σ (S/m) | $\varepsilon_r$ | σ (S/m) |
| 150 | 52.3 | 0.76 | 61.9 | 0.80 |
| 300 | 45.3 | 0.87 | 58.2 | 0.92 |
| 450 | 43.5 | 0.87 | 56.7 | 0.94 |
| 835 | 41.5 | 0.90 | 55.2 | 0.97 |
| 900 | 41.5 | 0.97 | 55.0 | 1.05 |
| 915 | 41.5 | 0.98 | 55.0 | 1.06 |
| 1450 | 40.5 | 1.20 | 54.0 | 1.30 |
| 1610 | 40.3 | 1.29 | 53.8 | 1.40 |
| 1800 – 2000 | 40.0 | 1.40 | 53.3 | 1.52 |
| 2450 | 39.2 | 1.80 | 52.7 | 1.95 |
| 3000 | 38.5 | 2.40 | 52.0 | 2.73 |
| 5800 | 35.3 | 5.27 | 48.2 | 6.00 |

($\varepsilon_r$ = relative permittivity, $\sigma$ = conductivity and $\rho$ = 1000 kg/m$^3$)

**Abbreviations and remarks for the liquid data**

σ : Conductivity / εr: Relative Permittivity
*1 The Target value is a parameter defined in KDB 865664D01.
*2 The dielectric parameters should be linearly interpolated between the closest pair of target frequencies to determine the applicable dielectric parameters corresponding to the device test frequency.

### 9.1 For SAR system Check

| DIELECTRIC PARAMETERS MEASUREMENT RESULTS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Ambient Temp. [deg.c] | Relative Humidity [%] | Liquid type | Liquid Temp. [deg.c] | Measured Frequency [MHz] | Parameters | Target Value | Measured | Deviation [%] | Limit [%] | Remark |
| 2019/9/12 | 24.0 | 45 | HBBL600-10000 | 23.5 | 1950 | σ [mho/m] | 1.40 | 1.40 | 0.3 | +/-5 | *1 |
| | | | | | | εr | 40.0 | 38.6 | **-3.6** | +/-5 | |
| 2019/9/9 | 24.0 | 43 | HBBL600-10000 | 23.5 | 2450 | σ [mho/m] | 1.80 | 1.81 | 0.7 | +/-5 | *1 |
| | | | | | | εr | 39.2 | 39.9 | 1.9 | +/-5 | |

**Correlation confirmation with measured TSL parameters of the calibration certificate of system check dipoles (Refer to Appendix 3)**

+/- 6% limit for deviation provided by manufacture tolerances are required for εr and σ and then below table which is the target value of the simulated tissue liquid is quoted from data measured TSL parameters of dipole calibration.

| Freq [MHz] | Model,S/N | Head | |
|---|---|---|---|
| | | ε | σ |
| 1950 | D1950,1149 | 40.4 | 1.43 |
| 2450 | D2450, 765 | 37.7 | 1.85 |

| DIELECTRIC PARAMETERS MEASUREMENT RESULTS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Ambient Temp. [deg.c] | Relative Humidity [%] | Liquid type | Liquid Temp. [deg.c] | Measured Frequency [MHz] | Parameters | Target Value*1 | Measured | Deviation [%] | Limit [%] | Remark |
| 2019/9/12 | 24.0 | 45 | HBBL600-10000 | 23.5 | 1950 | σ [mho/m] | 1.43 | 1.40 | -1.9 | +/-6 | |
| | | | | | | εr | 40.4 | 38.6 | -4.5 | +/-6 | |
| 2019/9/9 | 24.0 | 43 | HBBL600-10000 | 23.5 | 2450 | σ [mho/m] | 1.85 | 1.81 | **-2.0** | +/-6 | |
| | | | | | | εr | 37.7 | 39.9 | **5.9** | +/-6 | |

## 9.2 For SAR measurement

| DIELECTRIC PARAMETERS MEASUREMENT RESULTS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Ambient Temp. [deg.c] | Relative Humidity [%] | Liquid type | Liquid Temp. [deg.c] | Measured Frequency [MHz] | Parameters | Target Value | Measured | Deviation [%] | Limit [%] | Remark |
| 2019/9/12 | 24.0 | 45 | HBBL600-10000 | 23.5 | 1921.536 | σ [mho/m] | 1.40 | 1.38 | **-1.7** | +/-5 | *1 |
| | | | | | | εr | 40.0 | 38.7 | -3.2 | +/-5 | |
| 2019/9/12 | 24.0 | 45 | HBBL600-10000 | 23.5 | 1924.992 | σ [mho/m] | 1.40 | 1.38 | -1.5 | +/-5 | *1 |
| | | | | | | εr | 40.0 | 38.7 | -3.3 | +/-5 | |
| 2019/9/12 | 24.0 | 45 | HBBL600-10000 | 23.5 | 1928.448 | σ [mho/m] | 1.40 | 1.38 | -1.2 | +/-5 | *1 |
| | | | | | | εr | 40.0 | 38.7 | **-3.3** | +/-5 | |
| 2019/9/9 | 24.0 | 43 | HBBL600-10000 | 23.5 | 2455 | σ [mho/m] | 1.81 | 1.82 | 0.6 | +/-5 | *2 |
| | | | | | | εr | 39.2 | 39.9 | 1.9 | +/-5 | |
| 2019/9/9 | 24.0 | 43 | HBBL600-10000 | 23.5 | 2468 | σ [mho/m] | 1.82 | 1.83 | 0.3 | +/-5 | *2 |
| | | | | | | εr | 39.2 | 39.9 | 1.9 | +/-5 | |
| 2019/9/9 | 24.0 | 43 | HBBL600-10000 | 23.5 | 2480 | σ [mho/m] | 1.83 | 1.84 | 0.1 | +/-5 | *2 |
| | | | | | | εr | 39.2 | 39.9 | 1.9 | +/-5 | |

## SECTION10: System Check confirmation

The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ±0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm ± 0.5 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm ± 0.5 cm for measurements > 3 GHz.
The DASY system with an E-Field Probe was used for the measurements.
The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom).
The standard measuring distance was 10 mm (above 1GHz to 6GHz) and 15 mm (below 1GHz) from dipole center to the simulating liquid surface.
The coarse grid with a grid spacing of 12 mm (1GHz to 3GHz) and15 mm (below 1GHz) was aligned with the dipole.
For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
Special 7x7x7 (below 3 GHz) and/or 8x8x7 (above 3 GHz) fine cube was chosen for the cube.
Distance between probe sensors and phantom surface was set to 3 mm.
For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm
The dipole input power (forward power) was 100 mW(For 5GHz band) or 250 mW(For other band).
The results are normalized to 1 W input power.

**Target Value**

| Freq [MHz] | Model,S/N | Head | |
|---|---|---|---|
| | | (SPEAG) 1g [W/kg] | (SPEAG) 10g[W/kg] |
| 1950 | D1950,1149 | 41.60 | 21.40 |
| 2450 | D2450, 765 | 53.60 | 24.72 |

| Date Tested | Test Freq | Model,S/N | T.S. Liquid | | Measured Results | | Target (Ref. Value) | Delta ±10 % |
|---|---|---|---|---|---|---|---|---|
| | | | | | Zoom Scan | Normalize to 1 W | | |
| 2019/9/12 | 1950 | D1950,1149 | Head | 1g | 10.50 | 42.0 | 41.60 | 1.0 |
| | | | | 10g | 5.41 | 21.6 | 21.40 | 1.1 |
| 2019/9/9 | 2450 | D2450,765 | Head | 1g | 13.00 | 52.0 | 53.60 | -3.0 |
| | | | | 10g | 6.05 | 24.20 | 24.72 | -2.1 |

*The target(reference) SAR values can be obtained from the calibration certificate of system validation dipoles(Refer to Appendix 3). The target SAR values are SAR measured value in the calibration certificate scaled to 1W.

## SECTION11: Measured and Reported (Scaled) SAR Results

**KDB 447498 D01 (General RF Exposure Guidance):**

Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

- ✧ ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
- ✧ ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
- ✧ ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

- When reported SAR value is exceed 1.2W/kg (if any), device holder perturbation verification is required; however, since distance between device holder and antenna of EUT is enough, it was not conducted.
- Reported SAR= Measured SAR [W/kg] · Scaled factor
  * Scaled factor = Maximum tune-up tolerance limit [mW] / Measured power [mW]
- Maximum tune-up tolerance limit is by the specification from a customer.

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## 11.1 Result of Head SAR of DECT

| Test Position | Dist. (mm) | Mode | Ch #. | Freq. (MHz) | Power (dBm) | | Scaled factor | 1-g SAR (W/kg) | | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Tune-up upper Power | Measured average Power | | Meas. | Reported | |
| Left cheek | 0 | GMSK | 4 | 1921.536 | 20.00 | 19.55 | 1.109 | 0.026 | 0.029 | |
| | | | 2 | 1924.992 | 20.00 | 19.53 | 1.114 | | | |
| | | | 0 | 1928.448 | 20.00 | 19.53 | 1.114 | | | |
| Left tilt | 0 | GMSK | 4 | 1921.536 | 20.00 | 19.55 | 1.109 | 0.018 | 0.020 | |
| | | | 2 | 1924.992 | 20.00 | 19.53 | 1.114 | | | |
| | | | 0 | 1928.448 | 20.00 | 19.53 | 1.114 | | | |
| Right cheek | 0 | GMSK | 4 | 1921.536 | 20.00 | 19.55 | 1.109 | 0.027 | 0.030 | 1 |
| | | | 2 | 1924.992 | 20.00 | 19.53 | 1.114 | | | |
| | | | 0 | 1928.448 | 20.00 | 19.53 | 1.114 | | | |
| Right tilt | 0 | GMSK | 4 | 1921.536 | 20.00 | 19.55 | 1.109 | 0.014 | 0.016 | |
| | | | 2 | 1924.992 | 20.00 | 19.53 | 1.114 | | | |
| | | | 0 | 1928.448 | 20.00 | 19.53 | 1.114 | | | |

## 11.2 Result of Head SAR of Bluetooth

| Test Position | Dist. (mm) | Mode | Ch #. | Freq. (MHz) | Power (dBm) | | Scaled factor | 1-g SAR (W/kg) | | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Tune-up upper Power | Measured average Power | | Meas. | Reported | |
| Left cheek | 0 | DH1 | 53 | 2455 | 9.00 | 7.85 | 1.303 | | | |
| | | | 66 | 2468 | 9.00 | 7.92 | 1.282 | 0.016 | 0.021 | 2 |
| | | | 78 | 2480 | 9.00 | 7.87 | 1.297 | | | |
| Left tilt | 0 | DH1 | 53 | 2455 | 9.00 | 7.85 | 1.303 | | | |
| | | | 66 | 2468 | 9.00 | 7.92 | 1.282 | 0.006 | 0.008 | |
| | | | 78 | 2480 | 9.00 | 7.87 | 1.297 | | | |
| Right cheek | 0 | DH1 | 53 | 2455 | 9.00 | 7.85 | 1.303 | | | |
| | | | 66 | 2468 | 9.00 | 7.92 | 1.282 | 0.010 | 0.013 | |
| | | | 78 | 2480 | 9.00 | 7.87 | 1.297 | | | |
| Right tilt | 0 | DH1 | 53 | 2455 | 9.00 | 7.85 | 1.303 | | | |
| | | | 66 | 2468 | 9.00 | 7.92 | 1.282 | 0.006 | 0.008 | |
| | | | 78 | 2480 | 9.00 | 7.87 | 1.297 | | | |

## 11.3 Result of Body worn SAR of DECT

| Test Position | Dist. (mm) | Mode | Ch #. | Freq. (MHz) | Power (dBm) | | Scaled factor | 1-g SAR (W/kg) | | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Tune-up upper Power | Measured average Power | | Meas. | Reported | |
| Front | 0 | GMSK | 4 | 1921.536 | 20.00 | 19.55 | 1.109 | 0.040 | 0.044 | |
| | | | 2 | 1924.992 | 20.00 | 19.53 | 1.114 | | | |
| | | | 0 | 1928.448 | 20.00 | 19.53 | 1.114 | | | |
| Rear 1 | 0 | GMSK | 4 | 1921.536 | 20.00 | 19.55 | 1.109 | 0.084 | 0.093 | 3 |
| | | | 2 | 1924.992 | 20.00 | 19.53 | 1.114 | 0.081 | 0.090 | |
| | | | 0 | 1928.448 | 20.00 | 19.53 | 1.114 | 0.078 | 0.087 | |
| Rear 2 | 0 | GMSK | 4 | 1921.536 | 20.00 | 19.55 | 1.109 | 0.080 | 0.089 | |
| | | | 2 | 1924.992 | 20.00 | 19.53 | 1.114 | | | |
| | | | 0 | 1928.448 | 20.00 | 19.53 | 1.114 | | | |

## 11.4 Result of Body worn SAR of Bluetooth

| Test Position | Dist. (mm) | Mode | Ch #. | Freq. (MHz) | Power (dBm) | | Scaled factor | 1-g SAR (W/kg) | | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Tune-up upper Power | Measured average Power | | Meas. | Reported | |
| Front | 0 | DH1 | 53 | 2455 | 9.00 | 7.85 | 1.303 | | | |
| | | | 66 | 2468 | 9.00 | 7.92 | 1.282 | 0.016 | 0.021 | |
| | | | 78 | 2480 | 9.00 | 7.87 | 1.297 | | | |
| Rear 1 | 0 | DH1 | 53 | 2455 | 9.00 | 7.85 | 1.303 | | | |
| | | | 66 | 2468 | 9.00 | 7.92 | 1.282 | 0.016 | 0.021 | 4 |
| | | | 78 | 2480 | 9.00 | 7.87 | 1.297 | | | |
| Rear 2 | 0 | DH1 | 53 | 2455 | 9.00 | 7.85 | 1.303 | | | |
| | | | 66 | 2468 | 9.00 | 7.92 | 1.282 | 0.016 | 0.021 | |
| | | | 78 | 2480 | 9.00 | 7.87 | 1.297 | | | |

## 11.5 Repeated measurement

According to KDB865664 D1.
1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

| Wireless Technologies | Test Configuration | | | Dist. (mm) | Mode | Ch #. | Freq. (MHz) | Meas. SAR (W/kg) | | Largest to Smallest SAR Ratio | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Transmit Antenna | Exposure | Position | | | | | Original | Repeated | | |
| DECT | Main | Head | Right cheek | 0 | GMSK | 4 | 1921.536 | 0.027 | N/A | N/A | - |
| Bluetooth | Main | Head | Left cheek | 0 | DH1 | 66 | 2468 | 0.016 | N/A | N/A | - |
| DECT | Main | Body | Rear 1 | 0 | GMSK | 4 | 1921.536 | 0.084 | N/A | N/A | - |
| Bluetooth | Main | Body | Rear 1 | 0 | DH1 | 66 | 2468 | 0.016 | N/A | N/A | - |

**Note(s):**
N/A: Repeated Measurement is not required since the original highest measured SAR for all band is < 0.80 W/kg.

## SECTION12: Simultaneous Transmission SAR Analysis

Head

| Test Position | Stand alone SAR value (W/kg) | | ∑ 1-g SAR (mW/g) |
|---|---|---|---|
| | DECT | Bluetooth | |
| Left cheek | 0.029 | 0.021 | 0.050 |
| Left tilt | 0.020 | 0.008 | 0.028 |
| Right cheek | 0.030 | 0.013 | 0.043 |
| Right tilt | 0.016 | 0.008 | 0.024 |

Body worn

| Test Position | Stand alone SAR value (W/kg) | | ∑ 1-g SAR (mW/g) |
|---|---|---|---|
| | DECT | Bluetooth | |
| Front | 0.044 | 0.021 | 0.065 |
| Rear 1 | 0.093 | 0.021 | 0.114 |
| Rear 2 | 0.089 | 0.021 | 0.110 |

**Conclusion:**

Simultaneous transmission SAR measurement(Volume Scan) is not required because sum of the 1-g SAR is < 1.6 W/kg.

## SECTION13: Test instruments

| Control No. | Instrument | Manufacturer | Model No | Serial No | Test Item | Calibration Date * Interval(month) |
|---|---|---|---|---|---|---|
| SSDA-09 | Dipole Antenna | Schmid&Partner Engineering AG | D1950V3 | 1149 | SAR(D1950) | 2019/04/17 * 12 |
| COTS-MSAR-03 | Dasy5 | Schmid&Partner Engineering AG | DASY5 | - | SAR | - |
| MHBBL600-10000 | Head Simulating Liquid | Schmid&Partner Engineering AG | SL AAH U16 BC | - | SAR | Pre Check |
| MHSL1950 | Tissue simulation liquid (Head) | Schmid&Partner Engineering AG | HSL1950V2 | SL AAH 195 CA | SAR*Daily Check Target Value ±5% | Pre Check |
| MDAE-02 | Data Acquisition Electronics | Schmid&Partner Engineering AG | DAE4 | 1369 | SAR | 2019/05/08 * 12 |
| MPB-08 | Dosimetric E-Field Probe | Schmid&Partner Engineering AG | EX3DV4 | 3917 | SAR | 2019/05/15 * 12 |
| MPSAM-03 | SAM Phantom | Schmid&Partner Engineering AG | QD000P40CD | 1764 | SAR | 2019/05/14 * 12 |
| MDH-04 | Device holder | Schmid&Partner Engineering AG | Mounting device for transmitter | - | SAR | Pre Check |
| MOS-35 | Digital thermometer | HANNA | Checktemp 4 | - | SAR | 2019/07/03 * 12 |
| MRBT-03 | SAR robot | Schmid&Partner Engineering AG | TX60 Lspeag | F13/5PPLD1/A/01 | SAR | 2019/04/26 * 12 |
| MPM-11 | Dual Power Meter | Agilent | E4419B | MY45102060 | SAR | 2019/08/02 * 12 |
| MPSE-15 | Power sensor | Agilent | E9301A | MY41498311 | SAR | 2019/08/02 * 12 |
| MPSE-16 | Power sensor | Agilent | E9301A | MY41498313 | SAR | 2019/08/02 * 12 |
| MRFA-24 | Pre Amplifier | R&K | R&K CGA020M602-2633R | B30550 | SAR | 2019/06/17 * 12 |
| MSG-10 | Signal Generator | Agilent | N5181A | MY47421098 | SAR | 2018/11/14 * 12 |
| MRENT-S16 | Dipole Antenna | Schmid&Partner Engineering AG | D2450V2 | 765 | SAR(D2450) | 2019/05/09 * 12 |
| MAT-78 | Attenuator | Telegrartner | J01156A0011 | 0042294119 | SAR | Pre Check |
| MAT-81 | Attenuator | Weinschel Associates | WA1-20-33 | 100131 | SAR | 2019/04/02 * 12 |
| MPSE-24 | Power sensor | Anritsu Limited | MA24106A | 1026164 | SAR | 2019/08/02 * 12 |
| COTS-MPSE-02 | Software for MA24106A | Anritsu Limited | Anritsu PowerXpert | - | SAR | - |
| MHDC-21 | Dual Directional Coupler | Agilent | 778D | MY52180243 | SAR(0.1-2GHz) | Pre Check |
| MHDC-12 | Dual Directional Coupler | Hewlett Packard | 772D | 2839A0016 | SAR(2-18GHz) | Pre Check |
| MDAM-02 | Digital Angle Meter | SHINWA | 76826 | - | SAR | 2018/04/26 * 24 |

**The expiration date of the calibration is the end of the expired month.**
**All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.**

**As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.**

**SAR room is checked before every testing and ambient noise is <0.012W/kg**

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## APPENDIX 1 : System Check

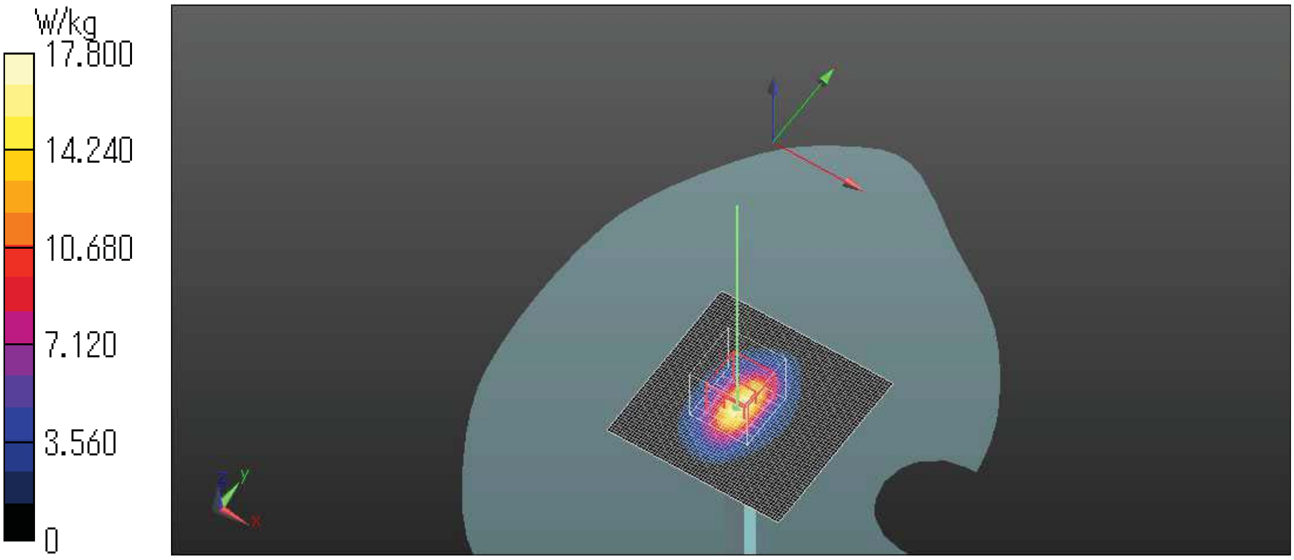
**20190912 1950MHz System Check**
Communication System: UID 0, #CW (0); Communication System Band: D1950 (1950.0 MHz); Frequency: 1950 MHz; Duty Cycle: 1:1
Medium parameters used: f = 1950 MHz; $\sigma$ = 1.404 S/m; $\varepsilon_r$ = 38.569; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.93, 7.93, 7.93) @ 1950 MHz; Calibrated: 2019/05/15
Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface)
Electronics: DAE4 Sn1369; Calibrated: 2019/05/08
Phantom: SAM 20degree; Type: QD000P40CD; Serial: TP:1764
Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

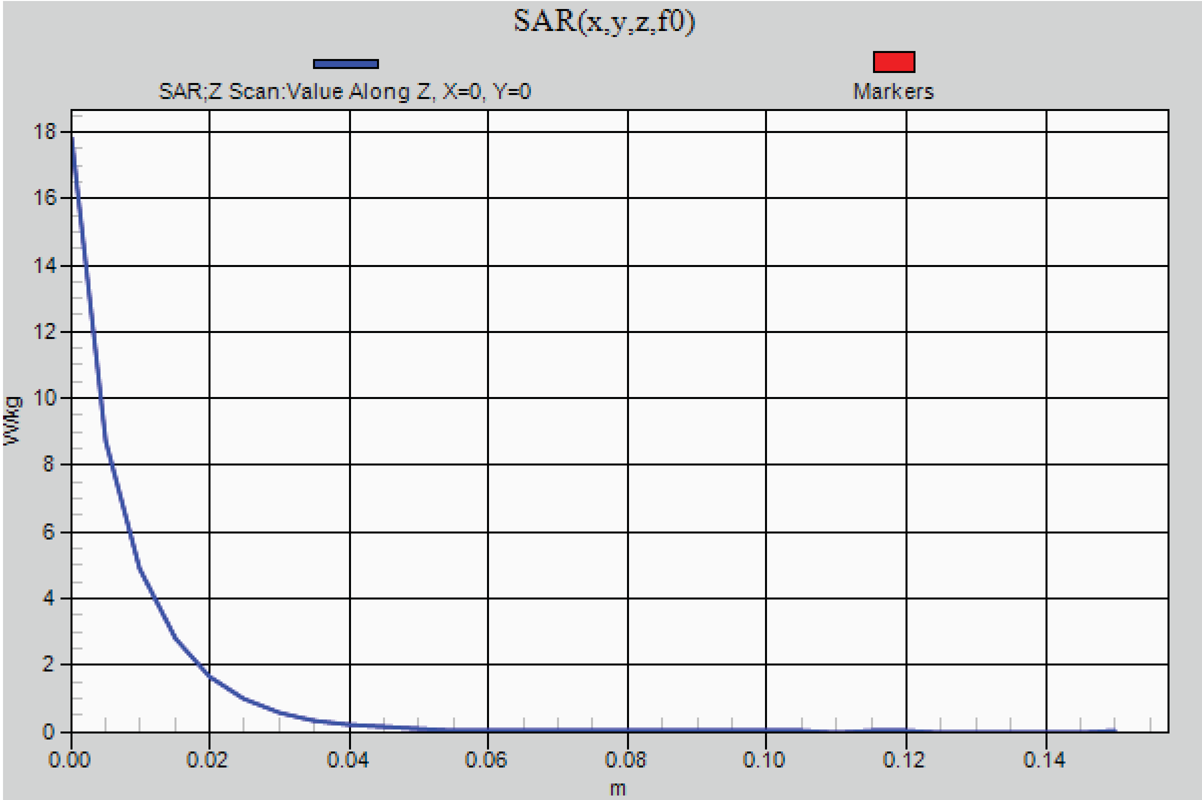
**Pin/250mW/Area Scan (61x61x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 16.4 W/kg

**Pin/250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 112.9 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 20.2 W/kg
**SAR(1 g) = 10.5 W/kg; SAR(10 g) = 5.41 W/kg**
Maximum value of SAR (measured) = 16.7 W/kg

**Pin/250mW/Z Scan (1x1x31):** Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 17.8 W/kg

Date: 2019/09/12
Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.


W/kg
17.800
14.240
10.680
7.120
3.560
0


SAR(x,y,z,f0)
SAR;Z Scan:Value Along Z, X=0, Y=0
Markers
W/kg
m
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
18
16
14
12
10
8
6
4
2
0

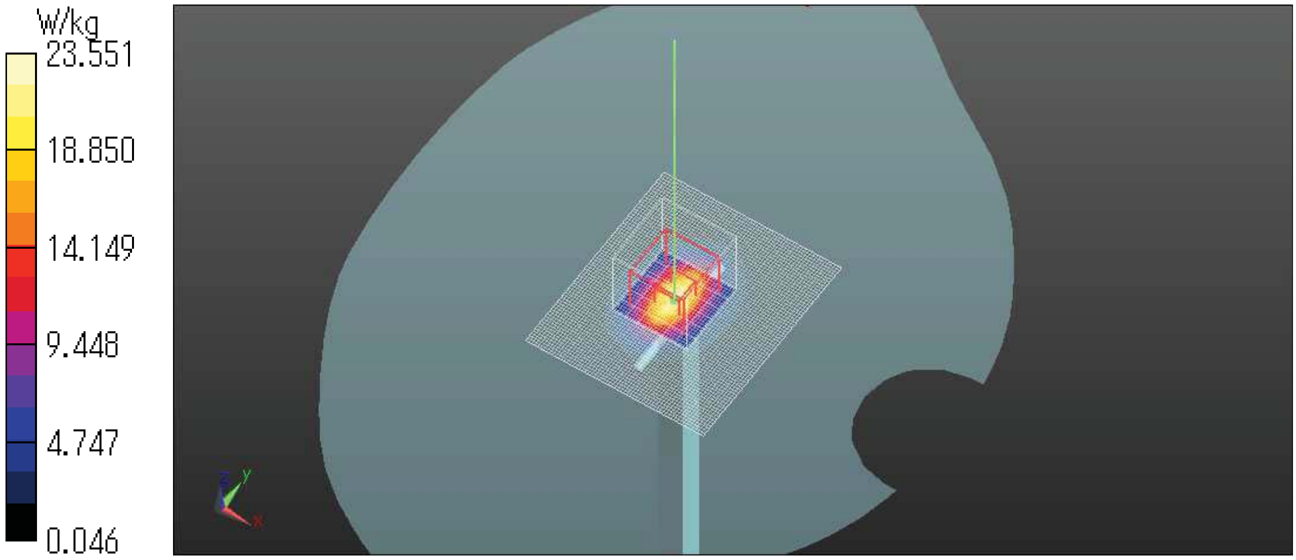
**20190909 2450MHz System Check Power 250mW**
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.813 S/m; $\varepsilon_r$ = 39.926; ρ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.41, 7.41, 7.41) @ 2450 MHz; Calibrated: 2019/05/15
Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface)
Electronics: DAE4 Sn1369; Calibrated: 2019/05/08
Phantom: SAM 20degree; Type: QD000P40CD; Serial: TP:1764
Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

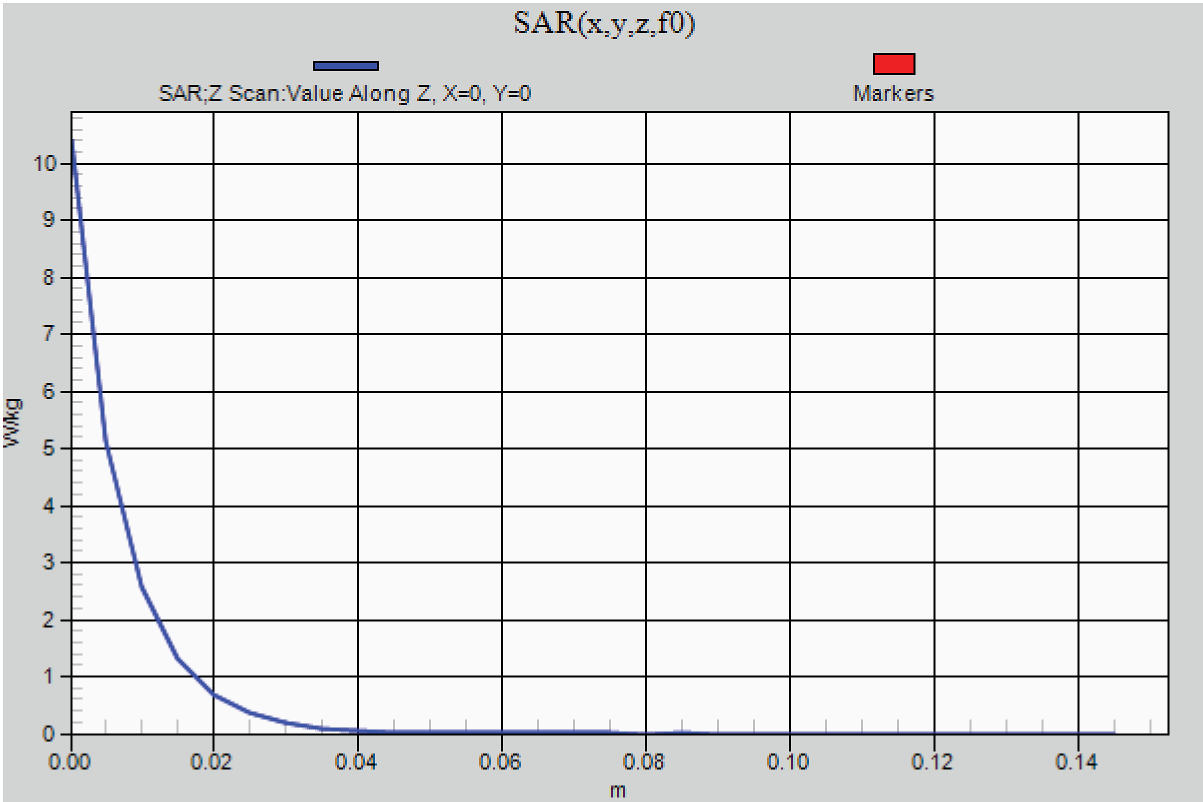
**Area Scan (61x71x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 23.6 W/kg

**Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 114.7 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 27.6 W/kg
**SAR(1 g) = 13 W/kg; SAR(10 g) = 6.05 W/kg**
Maximum value of SAR (measured) = 22.2 W/kg

**Z Scan (1x1x31):** Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 10.4 W/kg

Date: 2019/09/09
Ambient Temp. : 24.0 degree.C. Liquid Temp.; 23.5 degree.C.

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## APPENDIX 2 : SAR Measurement data

### Evaluation procedure

**The evaluation was performed with the following procedure:**

**Step 1:** Measurement of the E-field at a fixed location above the ear point or central position of flat phantom was used as a reference value for assessing the power drop.

**Step 2:** The SAR distribution at the exposed side of head or body position was measured at a distance of each device from the inner surface of the shell. The area covered the entire dimension of the antenna of EUT and the horizontal grid spacing was 15 mm x 15 mm, 12 mm x 12 mm or 10mm x 10mm. Based on these data, the area of the maximum absorption was determined by spline interpolation.

**Step 3:** Around this point found in the Step 2 (area scan), a volume of 30mm x 30mm x 30mm or more was assessed by measuring 7 x 7 x 7 points at least for below 3GHz and a volume of 28 mm x 28mm x 22.5mm or more was assessed by measuring 8 x 8 x 6(ratio step method (*1)) points at least for 5GHz band.

And for any secondary peaks found in the Step2 which are within 2dB of maximum peak and not with this Step3 (Zoom scan) is repeated. On the basis of this data set, the spatial peak SAR value was evaluated under the following procedure:

(1). The data at the surface were extrapolated, since the center of the dipoles is 1mm(EX3DV4) away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.3 mm. The extrapolation was based on a least square algorithm [4]. A polynomial of the fourth order was calculated through the points in z-axes.
This polynomial was then used to evaluate the points between the surface and the probe tip.

(2). The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed by the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the “Not a knot"-condition (in x, y and z-directions) [4], [5]. The volume was integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.

(3). All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

***1. Ratio step method parameters used;**
**The first measurement point: 2mm from the phantom surface, the initial grid separation: 2mm, subsequent graded grid ratio: 1.5**
**These parameters comply with the requirement of the KDB 865664D01.**

**Step 4**: Re-measurement of the E-field at the same location as in Step 1.
Confirmation after SAR testing
It was checked that the power drift [W] is within +/-5%.The verification of power drift during the SAR test is that DASY5 system calculates the power drift by measuring the e-filed at the same location at beginning and the end of the scan measurement for each test position.

DASY5 system calculation Power drift value[dB] =20log(Ea)/(Eb)
Before SAR testing : Eb[V/m]
After SAR testing : Ea[V/m]

Limit of power drift[W] =+/-5%
X[dB]=10log[P]=10log(1.05/1)=10log(1.05)-10log(1)=0.212dB

from E-filed relations with power.
p=E^2/η=E^2/
Therefore, The correlation of power and the E-filed
XdB=10log(P)=10log(E)^2=20log(E)

Therefore,
The calculated power drift of DASY5 System must be the less than +/-0.212dB.

**Measurement data**

Plot No. 1
**DECT Head Right cheek GMSK 1921.536MHz**
Communication System: UID 0, #DECT (0); Communication System Band: FCC; Frequency: 1921.54 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 1921.54 MHz; σ = 1.376 S/m; $\varepsilon_r$ = 38.711; ρ = 1000 kg/m$^3$
Phantom section: Right Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.93, 7.93, 7.93) @ 1921.54 MHz; Calibrated: 2019/05/15
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2019/05/08
Phantom: SAM 20degree; Type: QD000P40CD; Serial: TP:1764
Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

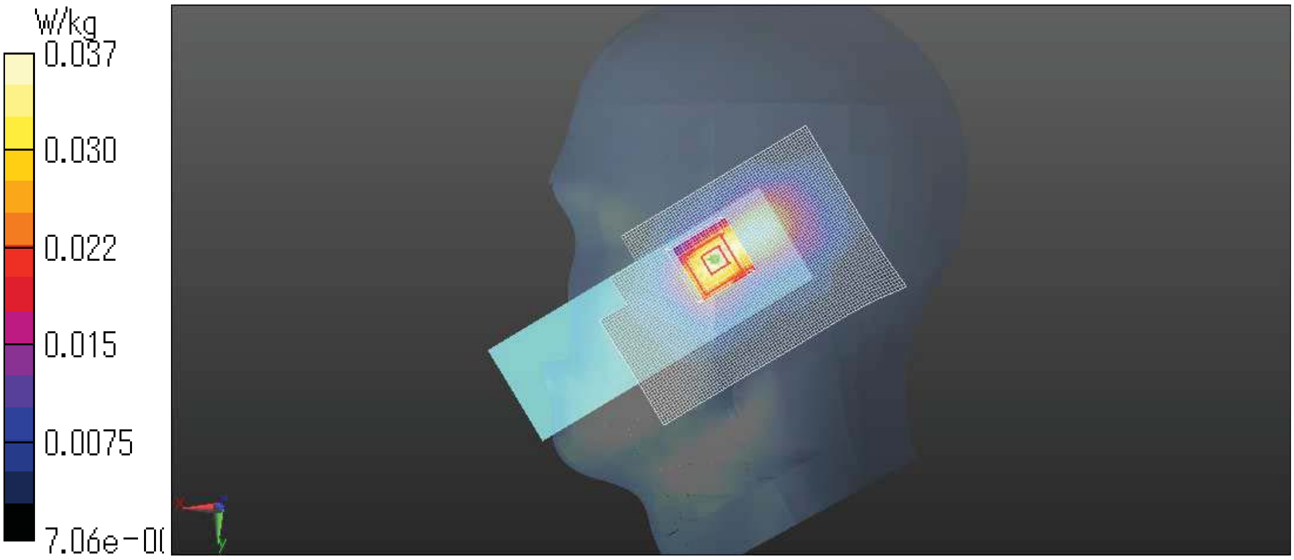
**DECT Right Head/Right cheek/Area Scan (61x91x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0390 W/kg

**DECT Right Head/Right cheek/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.273 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 0.0430 W/kg
**SAR(1 g) = 0.027 W/kg; SAR(10 g) = 0.016 W/kg**

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.0372 W/kg

Date: 2019/09/12
Ambient Temp. : 24.0 degree.C.     Liquid Temp.; 23.5 degree.C.



Plot No. 2

**Bluetooth Head Left cheek 2468MHz**

Communication System: UID 0, #Bluetooth (0); Communication System Band: Bluetooth; Frequency: 2468 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2468 MHz; σ = 1.826 S/m; $\varepsilon_r$ = 39.902; ρ = 1000 kg/m$^3$
Phantom section: Left Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.41, 7.41, 7.41) @ 2468 MHz; Calibrated: 2019/05/15
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2019/05/08
Phantom: SAM 20degree; Type: QD000P40CD; Serial: TP:1764
Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

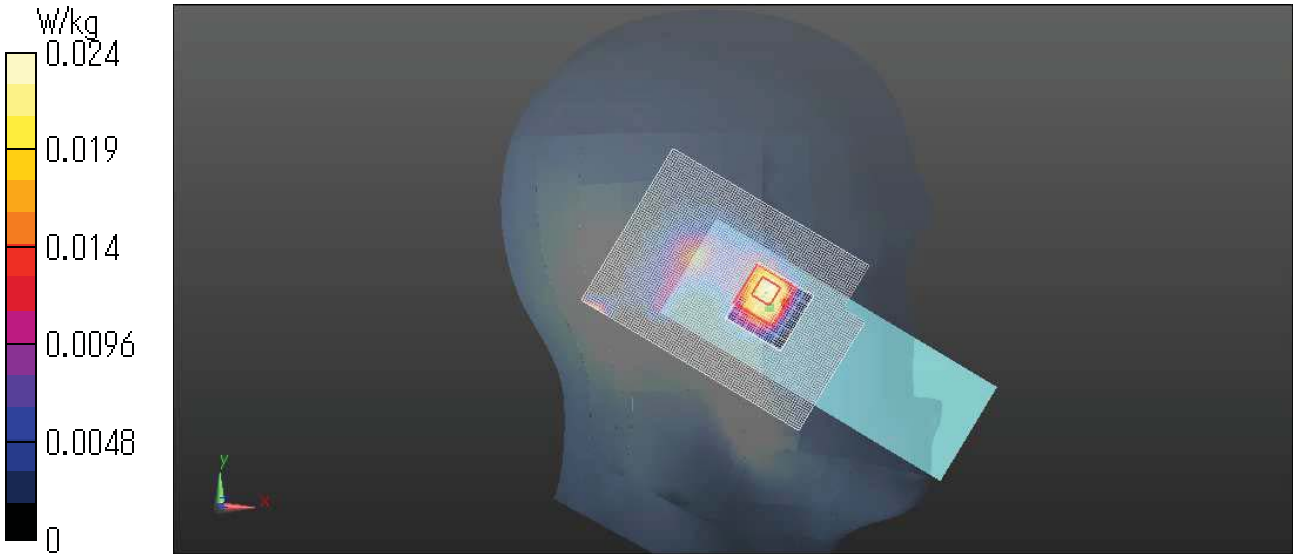
**BT Head Left/Left cheek/Area Scan (71x101x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0328 W/kg

**BT Head Left/Left cheek/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.363 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 0.0290 W/kg
**SAR(1 g) = 0.016 W/kg; SAR(10 g) = 0.00747 W/kg**
Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.0240 W/kg

Date: 2019/09/09
Ambient Temp. : 24.0 degree.C.     Liquid Temp.; 23.5 degree.C.

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Plot No.3
**DECT Body worn Rear 1 0mm GMSK 1921.536MHz**
Communication System: UID 0, #DECT (0); Communication System Band: FCC; Frequency: 1921.54 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 1921.54 MHz; σ = 1.376 S/m; $\varepsilon_r$ = 38.711; ρ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.93, 7.93, 7.93) @ 1921.54 MHz; Calibrated: 2019/05/15
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2019/05/08
Phantom: SAM 20degree; Type: QD000P40CD; Serial: TP:1764
Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

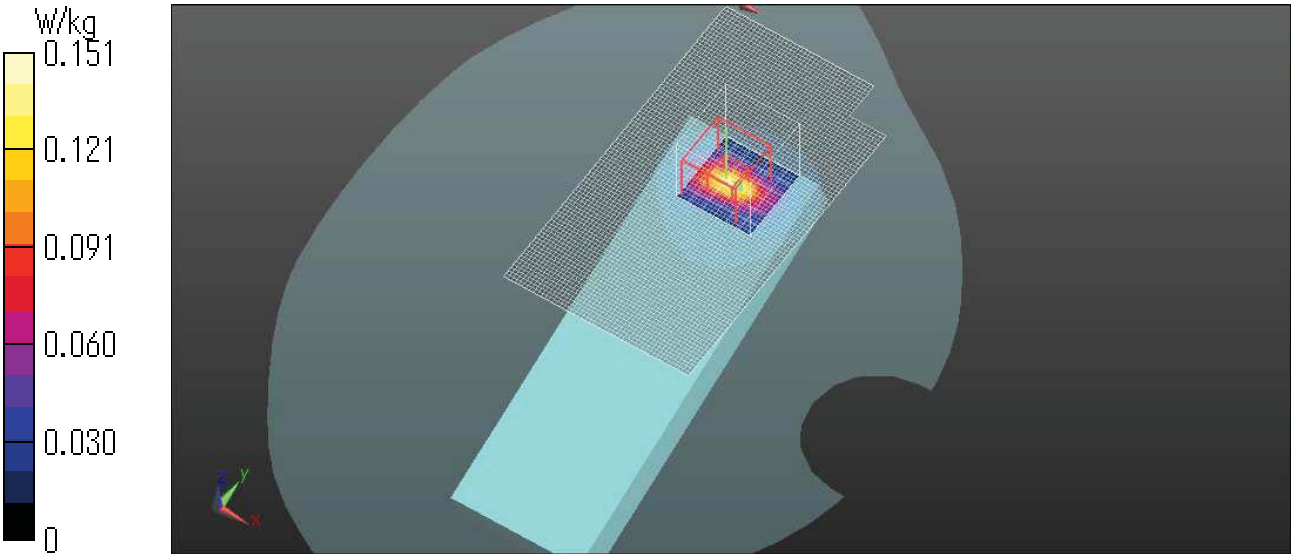
**DECT Body/Rear 1/Area Scan (51x91x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.143 W/kg

**DECT Body/Rear1/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 10.57 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 0.202 W/kg
**SAR(1 g) = 0.084 W/kg; SAR(10 g) = 0.034 W/kg**

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.151 W/kg

Date: 2019/09/12
Ambient Temp. : 24.0 degree.C.     Liquid Temp.; 23.5 degree.C.

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Plot No. 4
**Bluetooth Body worn Rear 1 0mm 2468MHz**
Communication System: UID 0, #Bluetooth (0); Communication System Band: Bluetooth; Frequency: 2468 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2468 MHz; $\sigma$ = 1.826 S/m; $\varepsilon_r$ = 39.902; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration
Probe: EX3DV4 - SN3917; ConvF(7.41, 7.41, 7.41) @ 2468 MHz; Calibrated: 2019/05/15
Sensor-Surface: 1.4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1369; Calibrated: 2019/05/08
Phantom: SAM 20degree; Type: QD000P40CD; Serial: TP:1764
Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

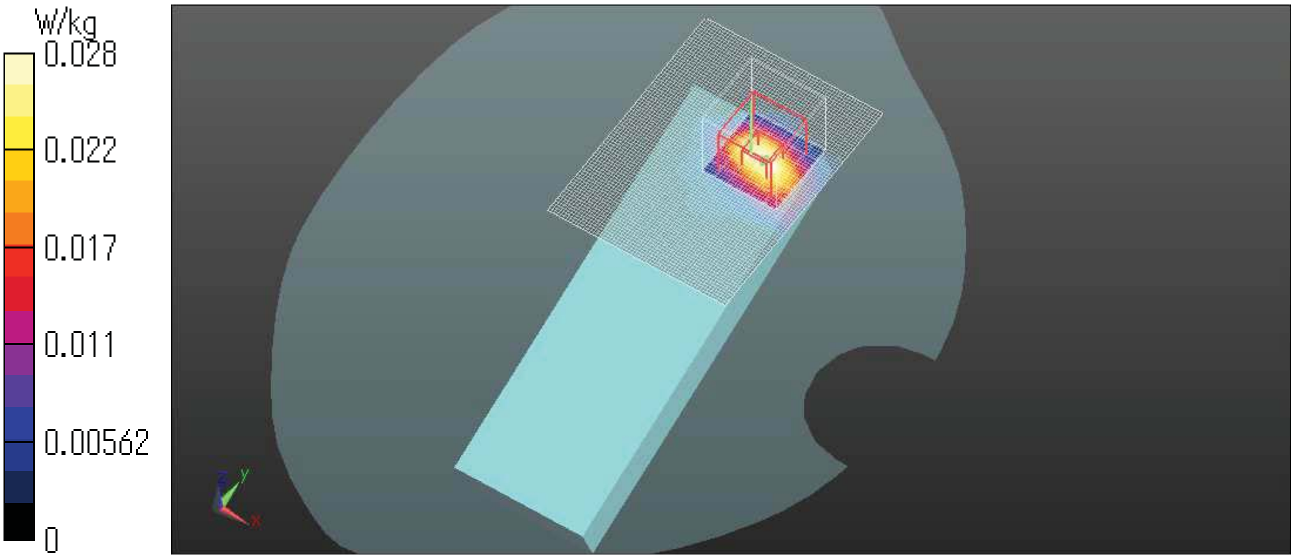
**BT Body/Rear tilt/Area Scan (61x81x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0303 W/kg

**BT Body/Rear tilt/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.143 V/m; Power Drift = -0.11 dB
Peak SAR (extrapolated) = 0.0470 W/kg
**SAR(1 g) = 0.016 W/kg; SAR(10 g) = 0.0069 W/kg**

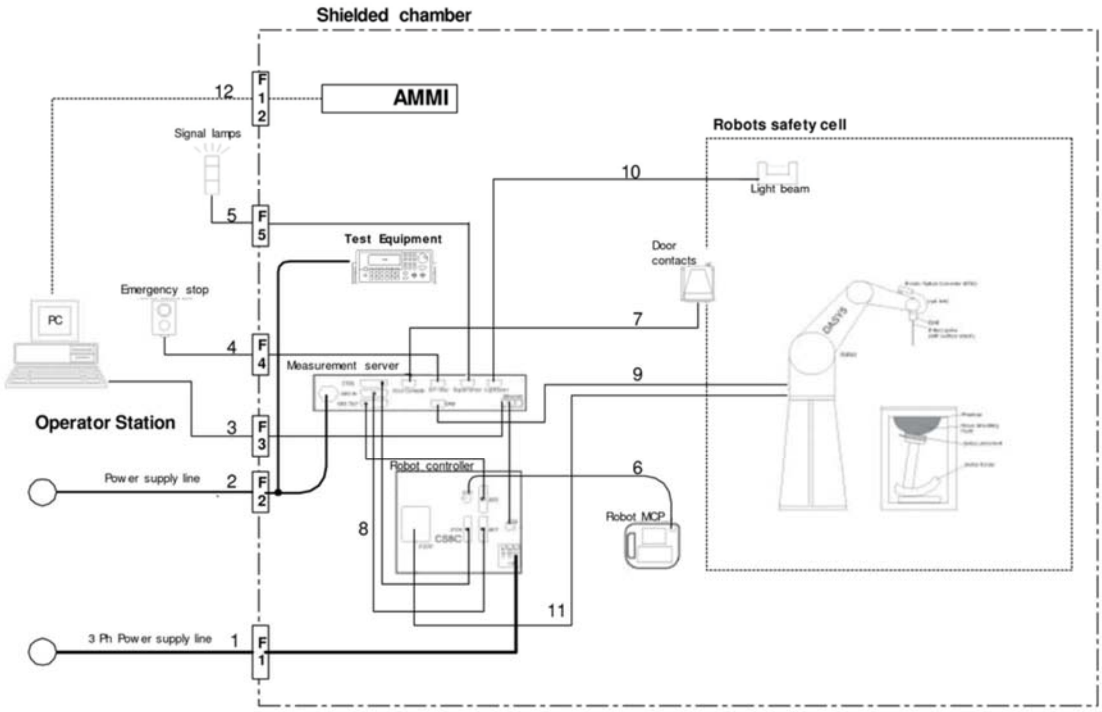
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.0281 W/kg

Date: 2019/09/10
Ambient Temp. : 24.0 degree.C.     Liquid Temp.; 23.5 degree.C.



## APPENDIX 3 : System specifications

### Configuration and peripherals




The DASY5 system for performing compliance tests consist of the following items:

a) A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
An arm extension for accommodating the data acquisition electronics (DAE).

b) An isotropic field probe optimized and calibrated for the targeted measurement.

c) A data acquisition electronic (DAE), which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

d) The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection.
The EOC is connected to the measurement server.

e) The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.

f) The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.

g) A computer running WinXP and the DASY5 software.

h) Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.

i) The phantom, the device holder and other accessories according to the targeted measurement.

## Specifications

### a)Robot TX60L

| | | |
|---|---|---|
| **Number of Axes** | : | 6 |
| **Nominal Load** | : | 2 kg |
| **Maximum Load** | : | 5kg |
| **Reach** | : | 920mm |
| **Repeatability** | : | +/-0.03mm |
| **Control Unit** | : | CS8c |
| **Programming Language** | : | VAL3 |
| **Weight** | : | 52.2kg |
| **Manufacture** | : | Stäubli Robotics |

### b)E-Field Probe

| | | |
|---|---|---|
| **Model** | : | EX3DV4 |
| **Construction** | : | Symmetrical design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material<br>(resistant to organic solvents, e.g., glycol ether) |
| **Frequency** | : | 10 MHz to > 6 GHz Linearity: ± 0.2 dB (30 MHz to 6 GHz) |
| **Directivity** | : | +/-0.3 dB in HSL (rotation around probe axis)<br>+/-0.5 dB in tissue material (rotation normal probe axis) |
| **Dynamic Range** | : | 10uW/g to > 100 mW/g;Linearity<br>+/-0.2 dB(noise: typically < 1uW/g) |
| **Dimensions** | : | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 2.5mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm |
| **Application** | : | Highprecision dosimetric measurement in any exposure scenario<br>(e.g., very strong gradient fields).Only probe which enables compliance<br>testing for frequencies up to 6GHz with precision of better 30%. |
| **Manufacture** | : | Schmid & Partner Engineering AG |

**EX3DV4 E-field Probe**

**c)Data Acquisition Electronic (DAE4)**

| | | |
|---|---|---|
| **Features** | : | Signal amplifier, multiplexer, A/D converter and control logic<br>Serial optical link for communication with DASY5 embedded system (fully remote controlled)<br>Two step probe touch detector for mechanical surface detection and emergency robot stop |
| **Measurement Range** | : | -100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV) |
| **Input Offset voltage** | : | < 5 μV (with auto zero) |
| **Input Resistance** | : | 200 MΩ |
| **Input Bias Current** | : | < 50 fA |
| **Battery Power** | : | > 10 h of operation (with two 9.6 V NiMH accus) |
| **Dimension** | : | 60 x 60 x 68 mm |
| **Manufacture** | : | Schmid & Partner Engineering AG |

**d)Electro-Optic Converter (EOC)**

| | | |
|---|---|---|
| **Version** | : | EOC 61 |
| **Description** | : | for TX60 robot arm, including proximity sensor |
| **Manufacture** | : | Schmid & Partner Engineering AG |

**e)DASY5 Measurement server**

| | | |
|---|---|---|
| **Features** | : | Intel ULV Celeron 400MHz<br>128MB chip disk and 128MB RAM<br>16 Bit A/D converter for surface detection system<br>Vacuum Fluorescent Display<br>Robot Interface<br>Serial link to DAE (with watchdog supervision)<br>Door contact port (Possibility to connect a light curtain)<br>Emergency stop port (to connect the remote control)<br>Signal lamps port<br>Light beam port<br>Three Ethernet connection ports<br>Two USB 2.0 Ports<br>Two serial links<br>Expansion port for future applications |
| **Dimensions (L x W x H)** | : | 440 x 241 x 89 mm |
| **Manufacture** | : | Schmid & Partner Engineering AG |

**f) Light Beam Switches**

| | | |
|---|---|---|
| **Version** | : | LB5 |
| **Dimensions (L x H)** | : | 110 x 80 mm |
| **Thickness** | : | 12 mm |
| **Beam-length** | : | 80 mm |
| **Manufacture** | : | Schmid & Partner Engineering AG |

**g)Software**

| | | |
|---|---|---|
| **Item** | : | Dosimetric Assessment System DASY5 |
| **Type No.** | : | SD 000 401A, SD 000 402A |
| **Software version No.** | : | DASY52, Version 52.6 (1) |
| **Manufacture / Origin** | : | Schmid & Partner Engineering AG |

**h)Robot Control Unit**

| | | |
|---|---|---|
| **Weight** | : | 70 Kg |
| **AC Input Voltage** | : | selectable |
| **Manufacturer** | : | Stäubli Robotics |

## i)Phantom and Device Holder

### Phantom

| | | |
|---|---|---|
| **Type** | : | SAM Twin Phantom V4.0 |
| **Description** | : | The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot. |
| **Material** | : | Vinylester, glass fiber reinforced (VE-GF) |
| **Shell Material** | : | Fiberglass |
| **Thickness** | : | 2.0 +/-0.2 mm |
| **Dimensions** | : | Length: 1000 mm Width: 500 mm Height: adjustable feet |
| **Volume** | : | Approx. 25 liters |
| **Manufacture** | : | Schmid & Partner Engineering AG |

| | | |
|---|---|---|
| **Type** | : | 2mm Flat phantom ERI4.0 |
| **Description** | : | Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is supported by software version DASY4.5 and higher and is compatible with all SPEAG dosimetric probes and dipoles. |
| **Material** | : | Vinylester, glass fiber reinforced (VE-GF) |
| **Shell Thickness** | : | 2.0 ± 0.2 mm (sagging: <1%) |
| **Filling Volume** | : | approx. 30 liters |
| **Dimensions** | : | Major ellipse axis: 600 mm Minor axis: 400 mm |
| **Manufacture** | : | Schmid & Partner Engineering AG |

### Device Holder

In combination with the Twin SAM Phantom V4.0/V4.0c or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).

**Material** : POM

### Laptio Extensions kit

Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin-SAM, ELI4 Phantoms.

**Material** : POM, Acrylic glass, Foam

### Urethane

For this measurement, the urethane foam was used as device holder.

**j)Simulated Tissues (Liquid)**

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for required for routine SAR evaluation.

| Mixture (%) | Frequency (MHz) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 450 | | 900 | | 1800 | | 1950 | | 2450 | |
| Tissue Type | Head | Body | Head | Body | Head | Body | Head | Body | Head | Body |
| Water | 38.91 | 46.21 | 40.29 | 50.75 | 55.24 | 70.17 | 55.41 | 69.79 | 55.0 | 68.64 |
| Sugar | 56.93 | 51.17 | 57.90 | 48.21 | - | - | - | - | - | - |
| Cellulose | 0.25 | 0.18 | 0.24 | 0.00 | - | - | | - | - | - |
| Salt (NaCl) | 3.79 | 2.34 | 1.38 | 0.94 | 0.31 | 0.39 | 0.08 | 0.2 | - | - |
| Preventol | 0.12 | 0.08 | 0.18 | 0.10 | - | | | | - | - |
| DGMBE | - | - | - | - | 44.45 | 29.44 | 44.51 | 30.0 | 45.0 | 31.37 |
| Dielectric Constant | 43.42 | 58.0 | 42.54 | 56.1 | 42.0 | 56.8 | 39.9 | 54.0 | 39.8 | 52.5 |
| Conductivity (S/m) | 0.85 | 0.83 | 0.91 | 0.95 | 1.0 | 1.07 | 1.42 | 1.45 | 1.88 | 1.78 |

Note: DGMBE(Diethylenglycol-monobuthyl ether)
The simulated tissue (liquid) of 1800MHz was used for the test frequency of 1700MHz to 1800MHz.

| Mixture (%) | Frequency(MHz) | |
|---|---|---|
| | 650&750 | 1450 |
| Tissue Type | Head and Body | Head and Body |
| Water | 35-58% | 52-75% |
| Sugar | 40-60% | - |
| Cellulose | <0.3% | - |
| Salt (NaCl) | 0-6% | <1% |
| Preventol | 0.1-0.7% | - |
| DGMBE | - | 25-48% |

| Mixture (%) | Frequency(MHz) | |
|---|---|---|
| | 5800 | |
| Tissue Type | Head | Body |
| Water | 64.0 | 78.0 |
| Mineral Oil | 18.0 | 11.0 |
| Emulsifiers | 15.0 | 9.0 |
| Additives and salt | 3.0 | 2.0 |

**Product identifier**

| | |
|---|---|
| Trade name | Broad Band Tissue Simulation Liquid<br>HBBL600-10000V6, MBBL600-6000V6, HU16B, MU16B |
| Manufacturer/Supplier | Schmid & Partner Engineering AG |

**Declarable components:**

| | | |
|---|---|---|
| CAS: 107-21-1<br>EINECS: 203-473-3<br>Reg.nr.: 01-2119456816-28-0000 | **Ethanediol**<br>STOT RE 2, H373;<br>Acute Tox. 4, H302 | < 5.2% |
| CAS: 68608-26-4<br>EINECS: 271-781-5<br>Reg.nr.: 01-2119527859-22-0000 | **Sodium petroleum sulfonate**<br>Eye Irrit. 2, H319 | < 2.9% |
| CAS: 107-41-5<br>EINECS: 203-489-0<br>Reg.nr.: 01-2119539582-35-0000 | **Hexylene Glycol / 2-Methyl-pentane-2,4-diol**<br>Skin Irrit. 2, H315; Eye Irrit. 2, H319 | < 2.9% |
| CAS: 68920-66-1<br>NLP: 500-236-9<br>Reg.nr.: 01-2119489407-26-0000 | **Alkoxylated alcohol, > $C_{16}$**<br>Aquatic Chronic 2, H411;<br>Skin Irrit. 2, H315; Eye Irrit. 2, H319 | < 2.0% |

## System Check Dipole SAR Calibration Certificate -Dipole 2450MHz(D2450V2,S/N:765)

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

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S Swiss Calibration Service

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

Accreditation No.: **SCS 0108**

Client **KYCOM**

Certificate No: **D2450V2-765_May19**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D2450V2 - SN:765 |
| Calibration procedure(s) | QA CAL-05.v11<br>Calibration Procedure for SAR Validation Sources between 0.7-3 GHz |
| Calibration date: | May 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 | 31-Dec-18 (No. EX3-7349_Dec18) | Dec-19 |
| 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-18) | In house check: Oct-19 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Michael Weber | Laboratory Technician | M.Weber |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: May 16, 2019





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Accreditation No.: **SCS 0108**

**Glossary:**

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

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

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

**Additional Documentation:**

e) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The 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 ± 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 ± 0.2) °C | 37.7 ± 6 % | 1.85 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 | 250 mW input power | 13.4 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **52.4 W/kg ± 17.0 % (k=2)** |

| SAR averaged over 10 $cm^3$ (10 g) of Head TSL | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 6.18 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **24.4 W/kg ± 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 ± 0.2) °C | 50.7 ± 6 % | 2.03 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 | 250 mW input power | 13.1 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **51.0 W/kg ± 17.0 % (k=2)** |

| SAR averaged over 10 $cm^3$ (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 | **23.8 W/kg ± 16.5 % (k=2)** |



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

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 54.3 Ω + 5.5 jΩ |
| Return Loss | - 23.5 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 50.1 Ω + 7.4 jΩ |
| Return Loss | - 22.6 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.156 ns |

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

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

### Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |



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**DASY5 Validation Report for Head TSL**

Date: 06.05.2019

Test Laboratory: SPEAG, Zurich, Switzerland

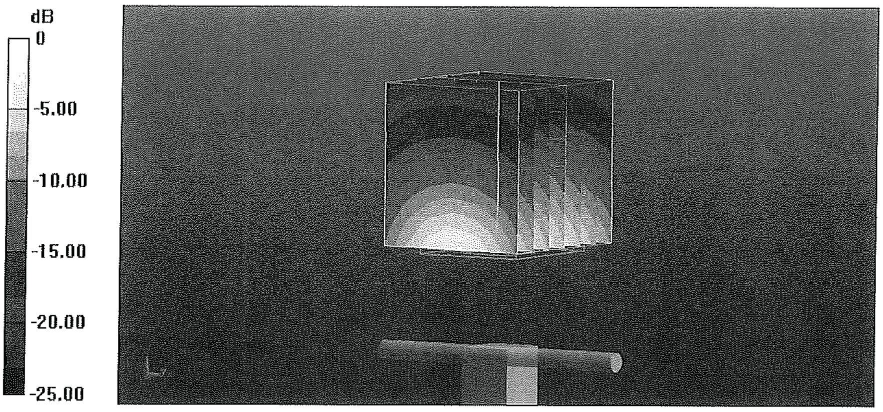
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:765**

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 1.85 S/m; $\varepsilon_r$ = 37.7; $\rho$ = 1000 kg/m$^3$
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: 31.12.2018
- 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(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 = 116.5 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 26.7 W/kg
**SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.18 W/kg**
Maximum value of SAR (measured) = 22.0 W/kg




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



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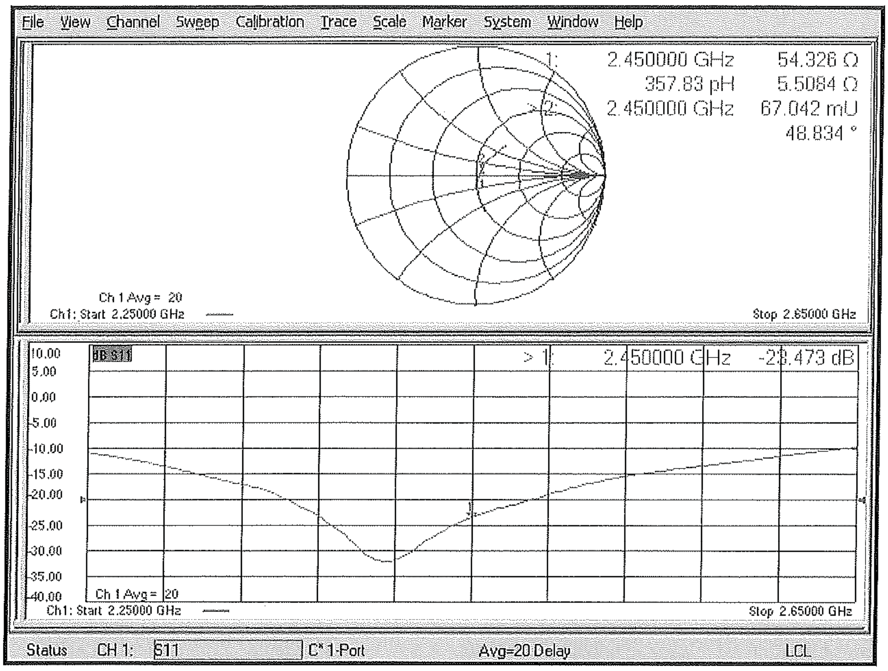
**Impedance Measurement Plot for Head TSL**



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**DASY5 Validation Report for Body TSL**

Date: 09.05.2019

Test Laboratory: SPEAG, Zurich, Switzerland

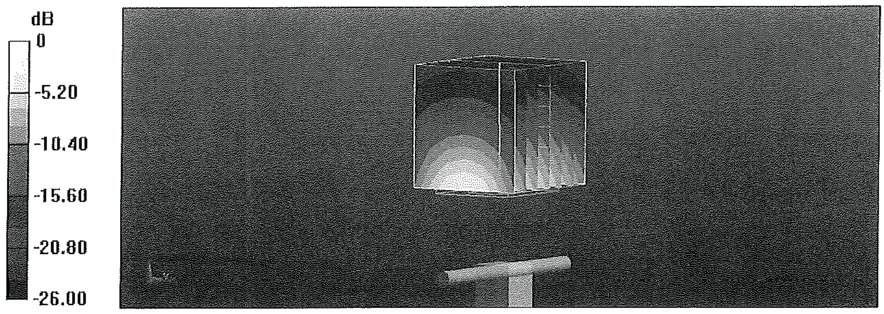
**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:765**

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma$ = 2.03 S/m; $\varepsilon_r$ = 50.7; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.09, 8.09, 8.09) @ 2450 MHz; Calibrated: 31.12.2018
- 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(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 = 109.2 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 26.4 W/kg
**SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.04 W/kg**
Maximum value of SAR (measured) = 21.7 W/kg




0 dB = 21.7 W/kg = 13.36 dBW/kg



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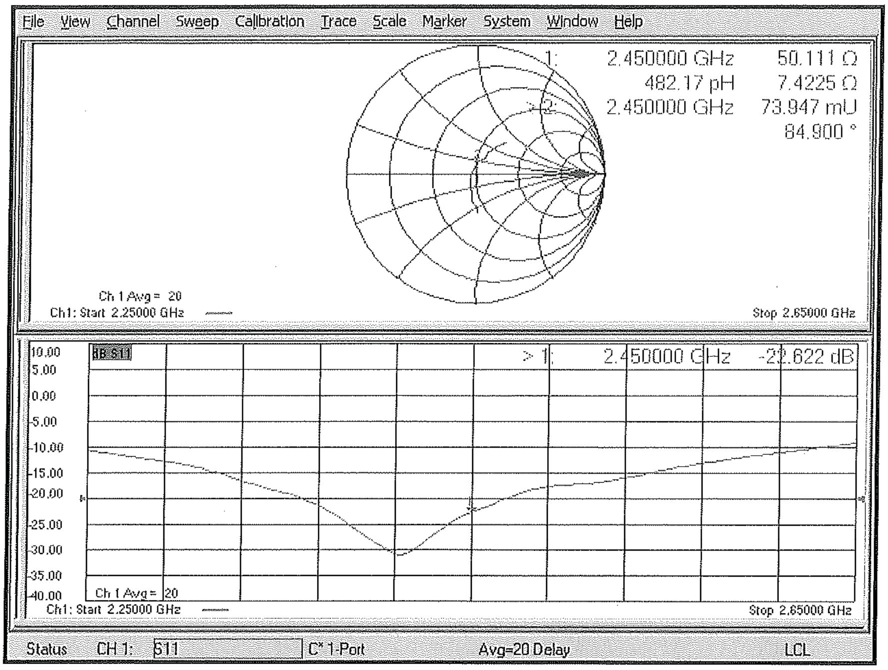
**Impedance Measurement Plot for Body TSL**



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## System Check Dipole SAR Calibration Certificate -Dipole 1950MHz(D1950V3,S/N:1149)


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


**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
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**S** Swiss Calibration Service

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**Accreditation No.: SCS 0108**

Client **UL Japan (KYCOM)**

**Certificate No: D1950V3-1149_Apr19**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1950V3 - SN:1149 |
| Calibration procedure(s) | QA CAL-05.v11<br>Calibration Procedure for SAR Validation Sources between 0.7-3 GHz |
| Calibration date: | April 17, 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 | 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: | Michael Weber | Laboratory Technician | M.Weber |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: April 18, 2019

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) 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%.



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## 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** | 1950 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 40.0 | 1.40 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 40.4 ± 6 % | 1.43 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 | 250 mW input power | 10.4 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **41.2 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.35 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **21.3 W/kg ± 16.5 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 53.3 | 1.52 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 53.8 ± 6 % | 1.55 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 | 250 mW input power | 10.0 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **39.6 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 $cm^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.20 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **20.7 W/kg ± 16.5 % (k=2)** |



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

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 48.1 Ω - 2.9 jΩ |
| Return Loss | - 28.9 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 44.9 Ω - 2.7 jΩ |
| Return Loss | - 24.4 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.200 ns |

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

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

### Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |



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**DASY5 Validation Report for Head TSL**

Date: 17.04.2019

Test Laboratory: SPEAG, Zurich, Switzerland

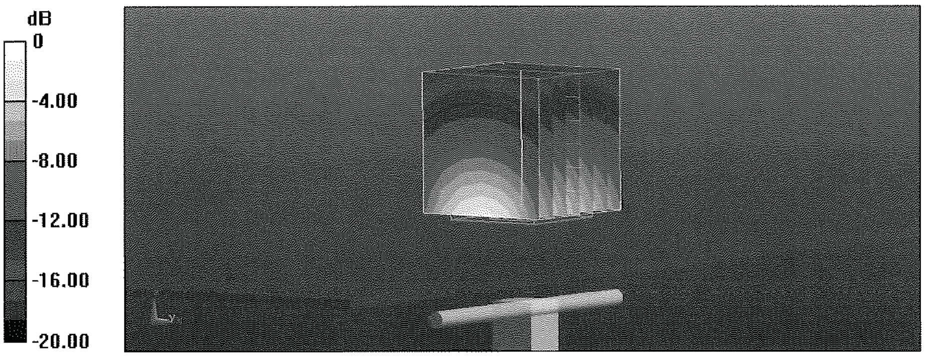
**DUT: Dipole 1950 MHz; Type: D1950V3; Serial: D1950V3 - SN:1149**

Communication System: UID 0 - CW; Frequency: 1950 MHz
Medium parameters used: f = 1950 MHz; σ = 1.43 S/m; $\varepsilon_r$ = 40.4; ρ = 1000 kg/m$^3$
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) @ 1950 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 = 111.2 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 18.9 W/kg
**SAR(1 g) = 10.4 W/kg; SAR(10 g) = 5.35 W/kg**
Maximum value of SAR (measured) = 16.0 W/kg




0 dB = 16.0 W/kg = 12.04 dBW/kg



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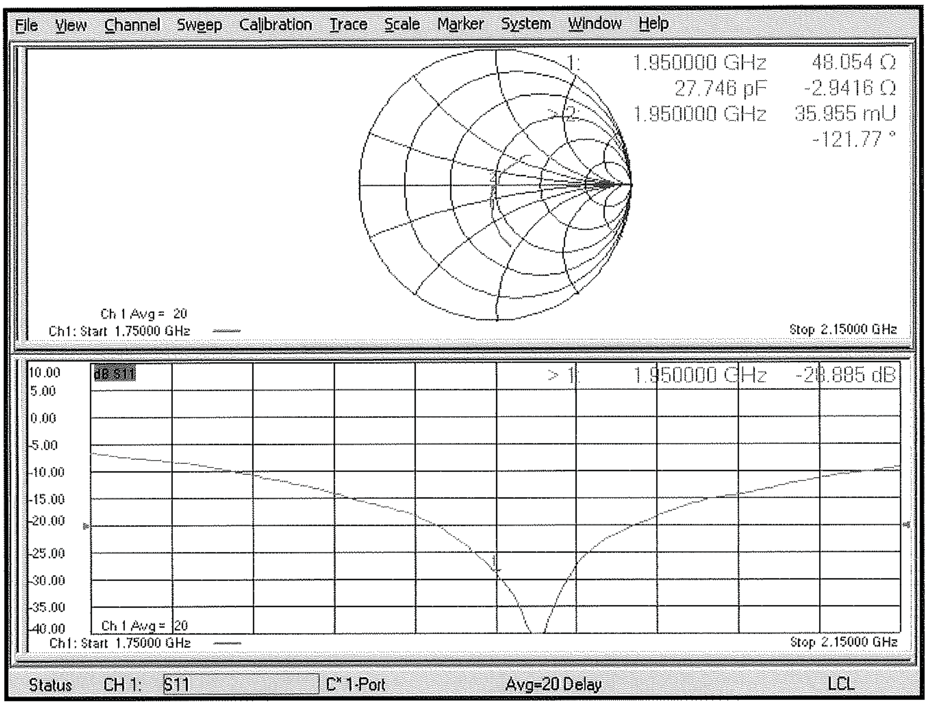
### Impedance Measurement Plot for Head TSL







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## DASY5 Validation Report for Body TSL

Date: 17.04.2019

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 1950 MHz; Type: D1950V3; Serial: D1950V3 - SN:1149**

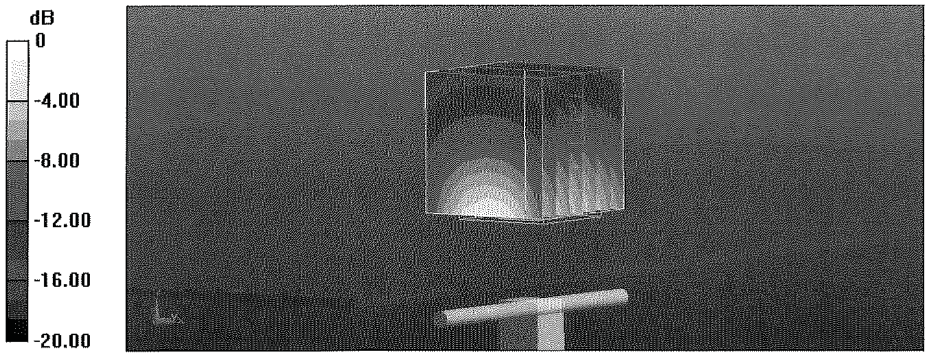
Communication System: UID 0 - CW; Frequency: 1950 MHz
Medium parameters used: f = 1950 MHz; $\sigma$ = 1.55 S/m; $\varepsilon_r$ = 53.8; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.37, 8.37, 8.37) @ 1950 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:

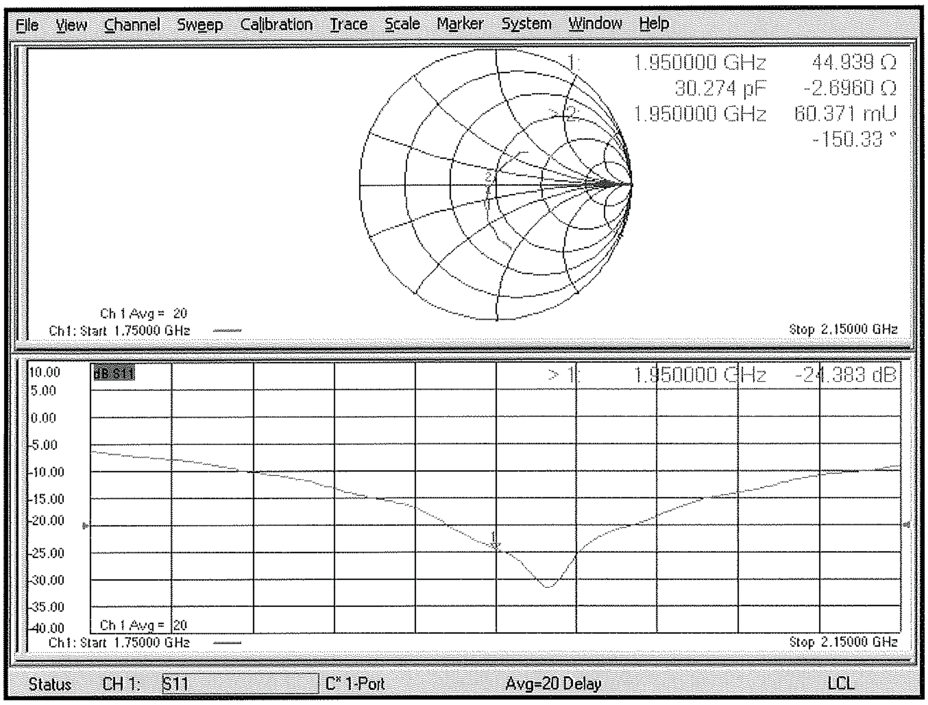
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 103.6 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 17.9 W/kg
**SAR(1 g) = 10 W/kg; SAR(10 g) = 5.2 W/kg**
Maximum value of SAR (measured) = 15.2 W/kg




0 dB = 15.2 W/kg = 11.82 dBW/kg

Certificate No: D1950V3-1149_Apr19 Page 7 of 8

**Impedance Measurement Plot for Body TSL**



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**Dosimetric E-Field Probe Calibration Certificate (EX3DV4, S/N: 3917)**

**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
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 (KYCOM)**

Certificate No: **EX3-3917_May19**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3917 |
| Calibration procedure(s) | QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v5, QA CAL-23.v5, QA CAL-25.v7<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | May 15, 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: S5277 (20x) | 04-Apr-19 (No. 217-02894) | Apr-20 |
| DAE4 | SN: 660 | 19-Dec-18 (No. DAE4-660_Dec18) | Dec-19 |
| Reference Probe ES3DV2 | SN: 3013 | 31-Dec-18 (No. ES3-3013_Dec18) | Dec-19 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB41293874 | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A | SN: MY41498087 | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A | SN: 000110210 | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| RF generator HP 8648C | SN: US3642U01700 | 04-Aug-99 (in house check Jun-18) | In house check: Jun-20 |
| Network Analyzer E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-18) | In house check: Oct-19 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Jeton Kastrati | Laboratory Technician | [signature] |
| Approved by: | Katja Pokovic | Technical Manager | [signature] |

Issued: May 16, 2019

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

Certificate No: EX3-3917_May19 Page 1 of 20

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Accreditation No.: **SCS 0108**

## Glossary:

| | |
|---|---|
| TSL | tissue simulating liquid |
| NORMx,y,z | sensitivity in free space |
| ConvF | sensitivity in TSL / NORMx,y,z |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C, D | modulation dependent linearization parameters |
| Polarization φ | φ rotation around probe axis |
| Polarization ϑ | ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis |
| Connector Angle | information used in DASY system to align probe sensor X to the robot coordinate system |

## 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"

## Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the $E^2$-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).



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