



TEST REPORT

No.I22N00588-SAR

For

TCL Communication Ltd.

GSM Quad Band Mobile Phone

Model Name: 1068A

With

Hardware Version: M1265A_MB_PCB_V1.0

Software Version: 1068A_OFUS1_1SIM_V1.0_20220127_UNLOCK

FCC ID: 2ACCJB168

Issued Date: 2022-03-22

Designation Number: CN1210

Note:

The test results in this test report relate only to the devices specified in this report. This report shall not be reproduced except in full without the written approval of SAICT.

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No.I22N00588-SAR

REPORT HISTORY

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CONTENTS

| | |
|---|-----------|
| 1. SUMMARY OF TEST REPORT | 5 |
| 1.1. TEST ITEMS | 5 |
| 1.2. TEST STANDARDS | 5 |
| 1.3. TEST RESULT..... | 5 |
| 1.4. TESTING LOCATION | 5 |
| 1.5. PROJECT DATA | 5 |
| 1.6. SIGNATURE | 5 |
| 2. STATEMENT OF COMPLIANCE | 6 |
| 3. CLIENT INFORMATION | 7 |
| 3.1. APPLICANT INFORMATION..... | 7 |
| 3.2. MANUFACTURER INFORMATION | 7 |
| 4. EQUIPMENT UNDER TEST (EUT) AND ANCILLARY EQUIPMENT (AE) | 8 |
| 4.1. ABOUT EUT | 8 |
| 4.2. INTERNAL IDENTIFICATION OF EUT USED DURING THE TEST | 8 |
| 4.3. INTERNAL IDENTIFICATION OF AE USED DURING THE TEST..... | 8 |
| 4.4. GENERAL DESCRIPTION..... | 8 |
| 5. TEST METHODOLOGY | 9 |
| 5.1. APPLICABLE LIMIT REGULATIONS..... | 9 |
| 5.2. APPLICABLE MEASUREMENT STANDARDS | 9 |
| 6. SPECIFIC ABSORPTION RATE (SAR)..... | 10 |
| 6.1. INTRODUCTION..... | 10 |
| 6.2. SAR DEFINITION..... | 10 |
| 7. TISSUE SIMULATING LIQUIDS | 11 |
| 7.1. TARGETS FOR TISSUE SIMULATING LIQUID | 11 |
| 7.2. DIELECTRIC PERFORMANCE | 11 |
| 8. SYSTEM VERIFICATION | 13 |
| 8.1. SYSTEM SETUP..... | 13 |
| 8.2. SYSTEM VERIFICATION | 14 |
| 9. MEASUREMENT PROCEDURES | 15 |
| 9.1. TESTS TO BE PERFORMED..... | 15 |
| 9.2. GENERAL MEASUREMENT PROCEDURE | 17 |
| 9.3. POWER DRIFT..... | 18 |
| 10. CONDUCTED OUTPUT POWER | 19 |
| 11. TRANSMIT ANTENNA | 20 |
| 11.1. ANTENNA LOCATIONS..... | 20 |

| | |
|---|-----------|
| 12. SUMMARY OF TEST RESULTS..... | 21 |
| 12.1. TESTING ENVIRONMENT | 21 |
| 12.2. SAR RESULTS..... | 22 |
| 13. SAR MEASUREMENT VARIABILITY | 24 |
| 14. MEASUREMENT UNCERTAINTY | 25 |
| 14.1. MEASUREMENT UNCERTAINTY FOR NORMAL SAR TESTS (300MHz~3GHz) | 25 |
| 15. MAIN TEST INSTRUMENTS..... | 26 |
| ANNEX A: GRAPH RESULTS | 27 |
| ANNEX B: SYSTEM VERIFICATION RESULTS..... | 31 |
| ANNEX C: SAR MEASUREMENT SETUP..... | 33 |
| C.1. MEASUREMENT SET-UP | 33 |
| C.2. DASY5 E-FIELD PROBE SYSTEM | 34 |
| C.3. E-FIELD PROBE CALIBRATION..... | 35 |
| C.4. OTHER TEST EQUIPMENT..... | 36 |
| ANNEX D: POSITION OF THE WIRELESS DEVICE IN RELATION TO THE PHANTOM..... | 39 |
| D.1. GENERAL CONSIDERATIONS | 39 |
| D.2. BODY-WORN DEVICE | 40 |
| D.3. DUT SETUP PHOTOS..... | 40 |
| ANNEX E: EQUIVALENT MEDIA RECIPES | 41 |
| ANNEX F: SYSTEM VALIDATION..... | 42 |
| ANNEX G: PROBE CALIBRATION CERTIFICATE | 43 |
| ANNEX H: DAE CALIBRATION CERTIFICATE..... | 52 |
| ANNEX I: DIPOLE CALIBRATION CERTIFICATE | 55 |
| ANNEX J: SPOT CHECK TEST | 67 |
| J.1. INTERNAL IDENTIFICATION OF EUT USED DURING THE SPOT CHECK TEST..... | 67 |
| J.2. MEASUREMENT RESULTS | 67 |
| J.3. GRAPH RESULTS FOR SPOT CHECK | 68 |
| J.4. SYSTEM VERIFICATION RESULTS FOR SPOT CHECK | 72 |



No.I22N00588-SAR

1. Summary of Test Report

1.1. Test Items

Description: GSM Quad Band Mobile Phone
Model Name: 1068A
Applicant's Name: TCL Communication Ltd.
Manufacturer's Name: TCL Communication Ltd.

1.2. Test Standards

ANSI C95.1-1992, IEEE 1528-2013

1.3. Test Result

Pass. Please refer to "12. Summary of Test Results" and "ANNEX J: Spot Check Test"

1.4. Testing Location

Address: Building G, Shenzhen International Innovation Center, No.1006 Shennan Road, Futian District, Shenzhen, Guangdong, P. R. China

1.5. Project Data

Testing Start Date: 2021-12-08

Testing End Date: 2022-03-03

1.6. Signature

Li Yongfu

(Prepared this test report)

Zhang Yunzhuang

(Reviewed this test report)

Cao Junfei

(Approved this test report)

2. Statement of Compliance

This EUT is a variant product and the report of original sample is No.I21N03609-SAR. According to “Justification Letter” provided by applicant, we quote the test results of original sample and spot check the worst case in annex J.

The maximum results of Specific Absorption Rate (SAR) found during testing for TCL Communication Ltd. GSM Quad Band Mobile Phone 1068A are as follows:

Table 2.1: Highest Reported SAR for Head (1g)

| Exposure Configuration | Technology Band | Highest Reported SAR 1g(W/Kg) | Equipment Class |
|-----------------------------------|-----------------|----------------------------------|-----------------|
| Head (Separation Distance 0mm) | GSM850 | 0.78 | PCE |
| | PCS1900 | 0.97 | |

Table 2.2: Highest Reported SAR for Body-worn (1g)

| Exposure Configuration | Technology Band | Highest Reported SAR 1g(W/Kg) | Equipment Class |
|---|-----------------|----------------------------------|-----------------|
| Body-worn (Separation Distance 15mm) | GSM850 | 0.96 | PCE |
| | PCS1900 | 0.55 | |

The SAR values found for the Mobile Phone are below the maximum recommended levels of 1.6 W/Kg as averaged over any 1g tissue according to the ANSI C95.1-1992.

The measurement together with the test system set-up is described in annex C of this test report. A detailed description of the equipment under test can be found in chapter 4 of this test report.

The highest reported SAR value is obtained at the case of **(Table 2.1&2.2)**, Head value is **0.97 W/kg (1g)** and Body-worn value is **0.96 W/kg (1g)**.

3. Client Information

3.1. Applicant Information

| | |
|---------------|--|
| Company Name: | TCL Communication Ltd. |
| Address: | 5/F, Building 22E, 22 Science Park East Avenue, Hong Kong Science Park, Shatin, NT |
| City: | Hong Kong |
| Country: | China |
| Telephone: | +86 755 3664 5759 |

3.2. Manufacturer Information

| | |
|---------------|--|
| Company Name: | TCL Communication Ltd. |
| Address: | 5/F, Building 22E, 22 Science Park East Avenue, Hong Kong Science Park, Shatin, NT |
| City: | Hong Kong |
| Country: | China |
| Telephone: | +86 755 3664 5759 |

4. Equipment under Test (EUT) and Ancillary Equipment (AE)

4.1. About EUT

| | |
|-------------------------------------|---|
| Description: | GSM Quad Band Mobile Phone |
| Model Name: | 1068A |
| Condition of EUT as received: | No obvious damage in appearance |
| Frequency Bands: | GSM 850/1900 |
| Tested Tx Frequency: | 824 – 849MHz (GSM850) |
| | 1850 – 1910MHz (GSM1900) |
| GPRS/EDGE: | Not Support |
| Test device Production information: | Production unit |
| Device type: | Portable device |
| Antenna type: | Integrated antenna |
| Hotspot mode: | Not Support |
| Product Dimensions: | Long 108.2mm; Wide 45.0mm; Overall Diagonal 111mm |

4.2. Internal Identification of EUT used during the test

| EUT ID* | IMEI | HW Version | SW Version | Receipt Date |
|---------|-----------------|------------------------|---|--------------|
| UT04aa | 358894690001791 | PIO | V1.0 | 2021-12-02 |
| UT05aa | 358894690000694 | PIO | V1.0 | 2021-12-02 |
| UT06aa | 358894690000173 | PIO | V1.0 | 2021-12-02 |
| UT13aa | 358894690000057 | PIO | V1.0 | 2021-12-02 |
| UT04aa | 356645970000818 | M1265A_MB_ PCB_V1.0 | 1068A_OFUS1_1SIM_V1.0 _20220127_UNLOCK | 2022-03-03 |

*EUT ID: is used to identify the test sample in the lab internally.

Note: It is performed to test SAR with the UT05aa & UT06aa & UT13aa & UT04aa, and conducted power with the UT04aa.

4.3. Internal Identification of AE used during the test

| AE ID* | Description | Model | Manufacturer |
|--------|-------------|----------|--------------|
| AE1 | Battery | TLi004FA | TIANMAO |

*AE ID: is used to identify the test sample in the lab internally.

4.4. General Description

According to client's description, the table below shows the difference between 1068D and 1068X:

| / | 1068D | 1068X |
|------------------------|-------|--------|
| Single SIM or Dual SIM | Dual | Single |

We'll perform the SAR measurement with 1068D and Spot check test with 1068X.

5. Test Methodology

5.1. Applicable Limit Regulations

ANSI C95.1–1992 IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

It specifies the maximum exposure limit of **1.6 W/kg** as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

5.2. Applicable Measurement Standards

IEEE 1528–2013 Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Experimental Techniques.

KDB 447498 D01 General RF Exposure Guidance v06 Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies

KDB 648474 D04 Handset SAR v01r03 SAR Evaluation Considerations for Wireless Handsets

KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04 SAR Measurement Requirements for 100 MHz to 6 GHz

KDB 865664 D02 RF Exposure Reporting v01r02 RF Exposure Compliance Reporting and Documentation Considerations

TCB workshop April 2019; RF Exposure Procedures (Tissue Simulating Liquids)

6. Specific Absorption Rate (SAR)

6.1. Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

6.2. SAR Definition

The SAR definition is 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). The equation description is as below:

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

SAR is expressed in units of Watts per kilogram (W/kg)

SAR measurement can be either related to the temperature elevation in tissue by

$$SAR = c \left(\frac{\delta T}{\delta t} \right)$$

Where: C is the specific heat capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

Where: σ is the conductivity of the tissue, ρ is the mass density of tissue and E is the RMS electrical field strength.

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

7. Tissue Simulating Liquids

7.1. Targets for tissue simulating liquid

Table 7.1: Targets for tissue simulating liquid

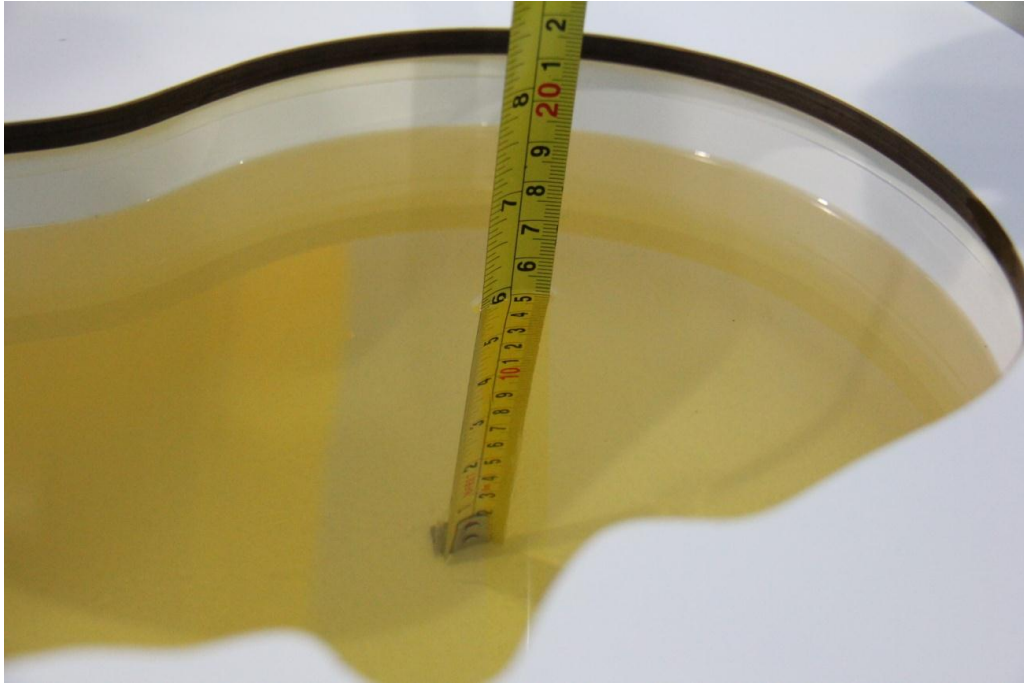
| Frequency (MHz) | Liquid Type | Conductivity (σ) | $\pm 5\%$ Range | Permittivity (ϵ) | $\pm 5\%$ Range |
|-----------------|-------------|---------------------------|-----------------|-----------------------------|-----------------|
| 835 | Head | 0.90 | 0.86~0.95 | 41.5 | 39.4~43.6 |
| 1900 | Head | 1.40 | 1.33~1.47 | 40.0 | 38.0~42.0 |

7.2. Dielectric Performance

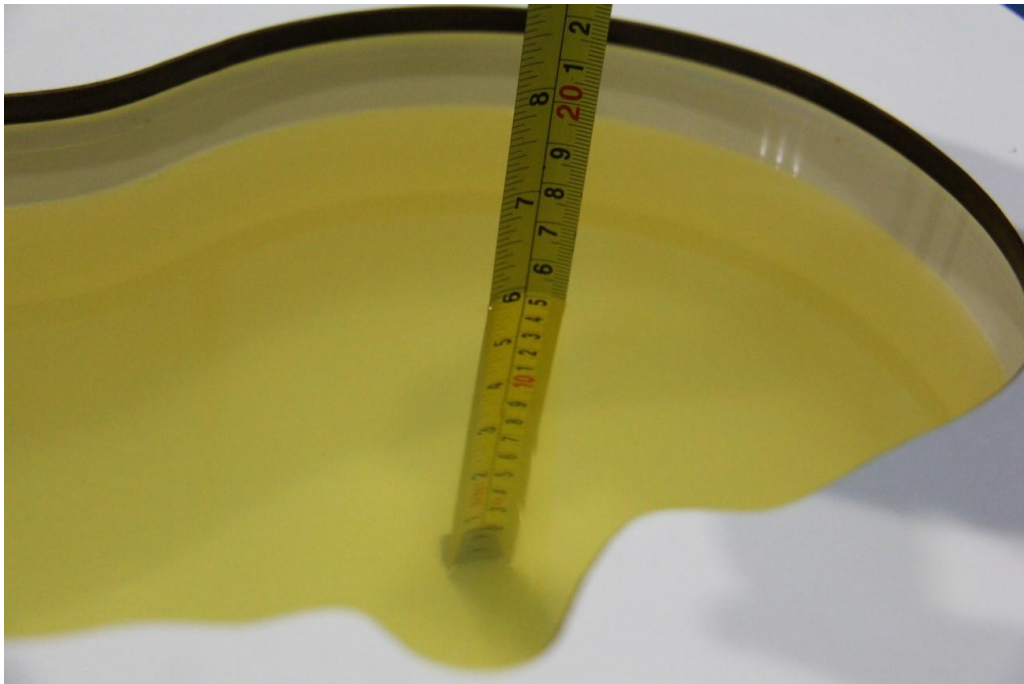
Table 7.2: Dielectric Performance of Tissue Simulating Liquid

| Measurement Date (yyyy-mm-dd) | Type | Frequency | Conductivity σ (S/m) | Drift (%) | Permittivity ϵ | Drift (%) |
|-------------------------------|------|-----------|-----------------------------|-----------|-------------------------|-----------|
| 2021-12-08 | Head | 835 | 0.918 | 2.00 | 40.84 | -1.59 |
| 2021-12-10 | Head | 1900 | 1.415 | 1.07 | 39.27 | -1.82 |
| 2022-03-03 | Head | 835 | 0.927 | 3.00 | 40.35 | -2.77 |
| 2022-03-03 | Head | 1900 | 1.429 | 2.07 | 39.51 | -1.23 |

Note: The liquid temperature is 22.0°C.



Picture 7-1: Liquid depth in the Head Phantom (835MHz)

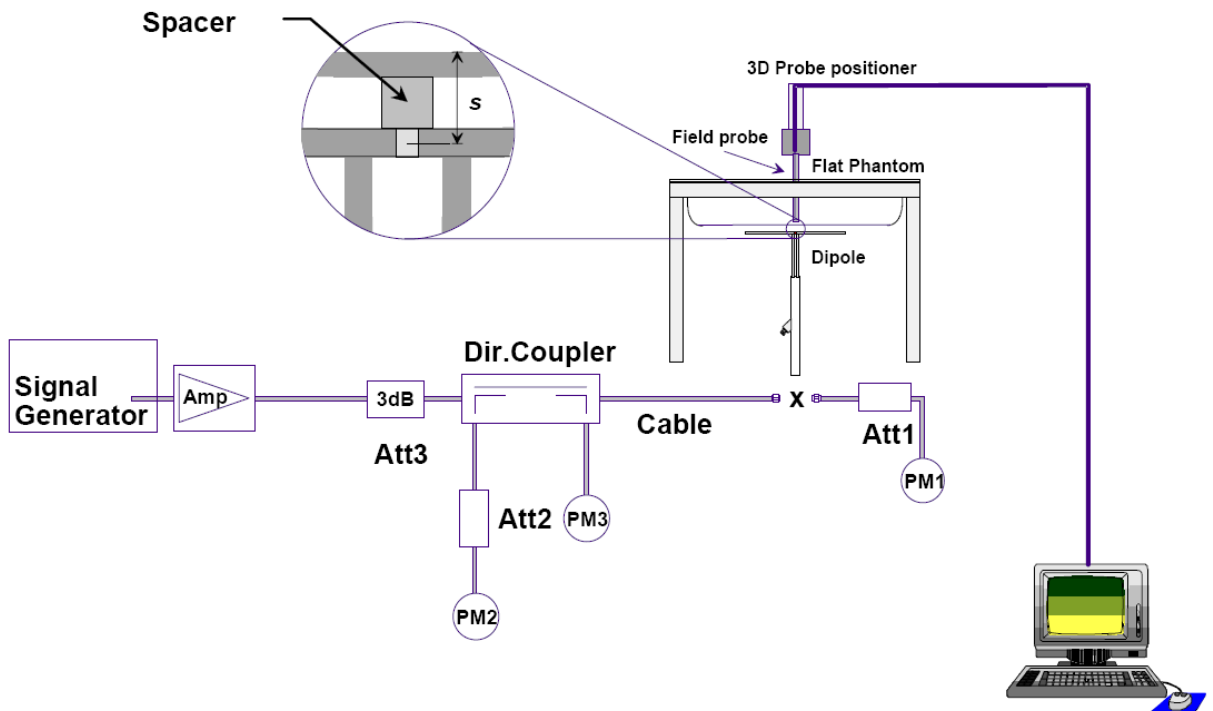


Picture 7-2: Liquid depth in the Head Phantom (1900MHz)

8. System verification

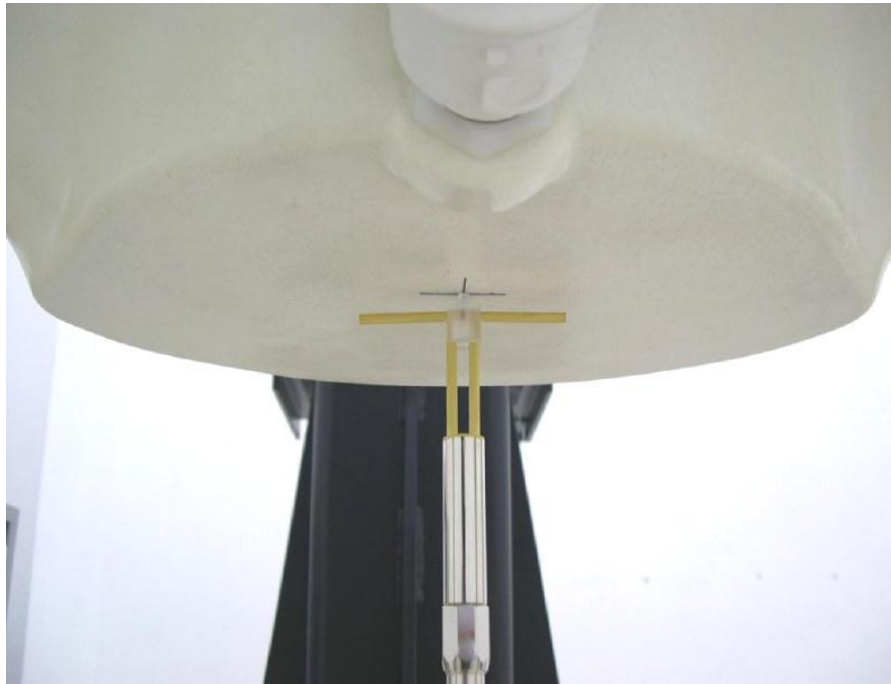
8.1. System Setup

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



Picture 8.1 System Setup for System Evaluation

For the dipole below 3GHz, the output power on dipole port must be calibrated to 24 dBm (250mW) before dipole is connected.



Picture 8.2 Photo of Dipole Setup

8.2. System Verification

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device.

Table 8.1: System Verification of Head

| Measurement Date | Frequency (MHz) | Target value (W/kg) | | Measured value (W/kg) | | | | Deviation (%) | |
|------------------|-----------------|---------------------|-------|-----------------------|------|-----------------|-------|---------------|------|
| | | | | / | | Normalize to 1W | | | |
| | | 10 g | 1 g | 10 g | 1 g | 10 g | 1 g | 10 g | 1 g |
| 2021-12-08 | 835 | 6.29 | 9.64 | 1.62 | 2.51 | 6.48 | 10.04 | 3.02 | 4.15 |
| 2021-12-10 | 1900 | 20.50 | 40.20 | 5.23 | 10.4 | 20.92 | 41.60 | 2.05 | 3.48 |
| 2022-03-03 | 835 | 6.29 | 9.64 | 1.60 | 2.48 | 6.40 | 9.92 | 1.75 | 2.90 |
| 2022-03-03 | 1900 | 20.50 | 40.20 | 5.19 | 10.3 | 20.76 | 41.20 | 1.27 | 2.49 |

9. Measurement Procedures

9.1. Tests to be performed

In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in picture 9.1.

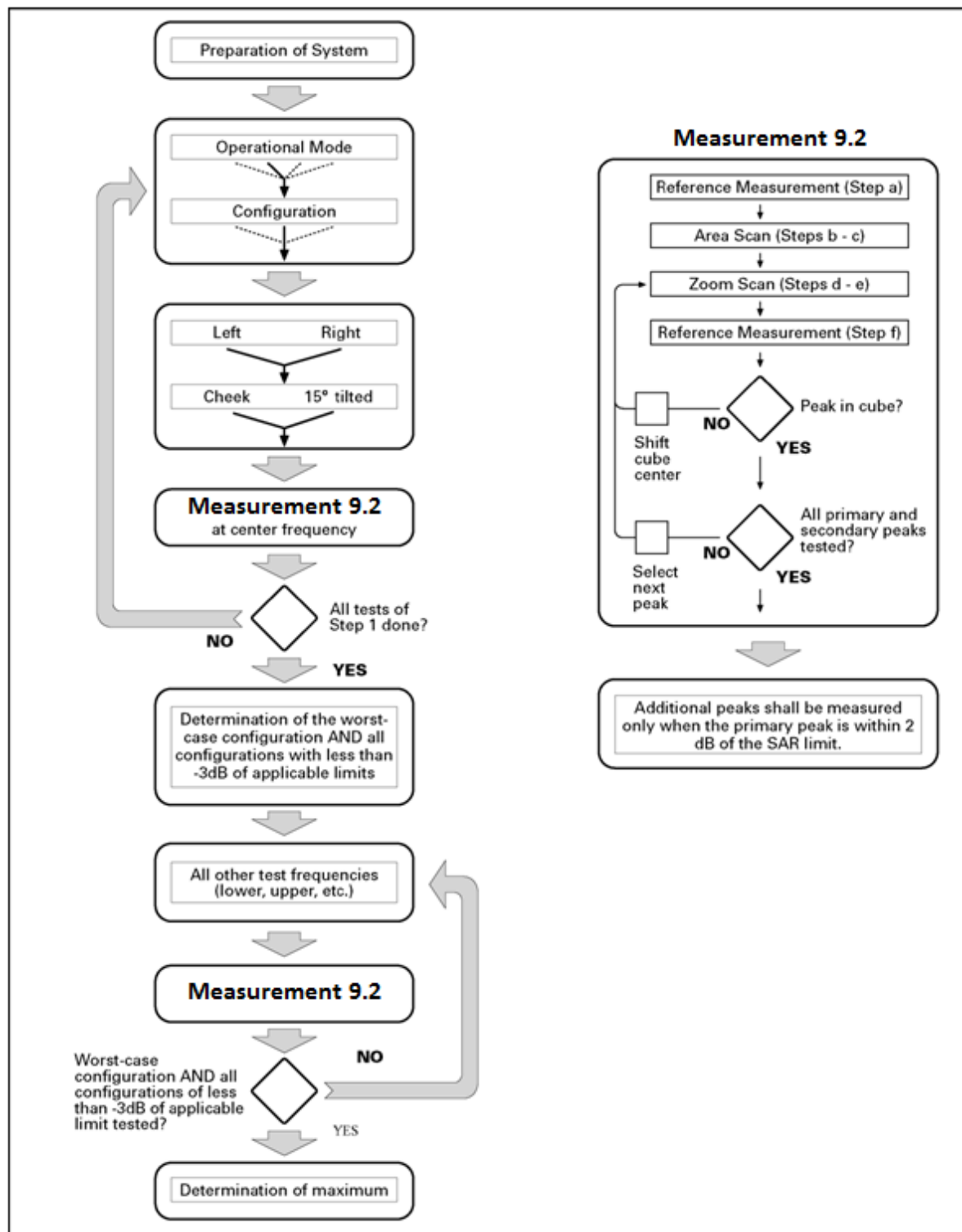
Step 1: The tests described in 9.2 shall be performed at the channel that is closest to the center of the transmit frequency band (f_c) for:

- a) all device positions (cheek and tilt, for both left and right sides of the SAM phantom, as described in annex D),
- b) all configurations for each device position in a), e.g., antenna extended and retracted, and
- c) all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.

If more than three frequencies need to be tested according to 11.1 (i.e., $N_C > 3$), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

Step 2: For the condition providing highest peak spatial-average SAR determined in Step 1, perform all tests described in 9.2 at all other test frequencies, i.e., lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the peak spatial-average SAR value determined in Step 1 is within 3 dB of the applicable SAR limit, it is recommended that all other test frequencies shall be tested as well.

Step 3: Examine all data to determine the highest value of the peak spatial-average SAR found in Steps 1 to 2.



Picture 9.1 Block diagram of the tests to be performed

9.2. General Measurement Procedure

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements and fully documented in SAR reports to qualify for TCB approval. Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2013. The results should be documented as part of the system validation records and may be requested to support test results when all the measurement parameters in the following table are not satisfied.

| | | | | |
|--|------------------------------------|--|--|--|
| | | | $\leq 3 \text{ GHz}$ | $> 3 \text{ GHz}$ |
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | | | $5 \pm 1 \text{ mm}$ | $\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5 \text{ mm}$ |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location | | | $30^\circ \pm 1^\circ$ | $20^\circ \pm 1^\circ$ |
| Maximum area scan spatial resolution: Δx_{Area} , Δy_{Area} | | | $\leq 2 \text{ GHz: } \leq 15 \text{ mm}$ $2 - 3 \text{ GHz: } \leq 12 \text{ mm}$ | $3 - 4 \text{ GHz: } \leq 12 \text{ mm}$ $4 - 6 \text{ GHz: } \leq 10 \text{ mm}$ |
| | | | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be \leq the corresponding x or y dimension of the test device with at least one measurement point on the test device. | |
| Maximum zoom scan spatial resolution: Δx_{Zoom} , Δy_{Zoom} | | | $\leq 2 \text{ GHz: } \leq 8 \text{ mm}$ $2 - 3 \text{ GHz: } \leq 5 \text{ mm}^*$ | $3 - 4 \text{ GHz: } \leq 5 \text{ mm}^*$ $4 - 6 \text{ GHz: } \leq 4 \text{ mm}^*$ |
| Maximum zoom scan spatial resolution, normal to phantom surface | uniform grid: $\Delta z_{Zoom}(n)$ | | $\leq 5 \text{ mm}$ | $3 - 4 \text{ GHz: } \leq 4 \text{ mm}$ $4 - 5 \text{ GHz: } \leq 3 \text{ mm}$ $5 - 6 \text{ GHz: } \leq 2 \text{ mm}$ |
| | graded grid | $\Delta z_{Zoom}(1)$: between 1 st two points closest to phantom surface | $\leq 4 \text{ mm}$ | $3 - 4 \text{ GHz: } \leq 3 \text{ mm}$ $4 - 5 \text{ GHz: } \leq 2.5 \text{ mm}$ $5 - 6 \text{ GHz: } \leq 2 \text{ mm}$ |
| | | $\Delta z_{Zoom}(n>1)$: between subsequent points | $\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$ | |
| Minimum zoom scan volume | x, y, z | | $\geq 30 \text{ mm}$ | $3 - 4 \text{ GHz: } \geq 28 \text{ mm}$ $4 - 5 \text{ GHz: } \geq 25 \text{ mm}$ $5 - 6 \text{ GHz: } \geq 22 \text{ mm}$ |
| Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details. | | | | |
| * When zoom scan is required and the <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is $\leq 1.4 \text{ W/kg}$, $\leq 8 \text{ mm}$, $\leq 7 \text{ mm}$ and $\leq 5 \text{ mm}$ zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. | | | | |

9.3. Power Drift

To control the output power stability during the SAR test, DASY5 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in Section 14 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

10. Conducted Output Power

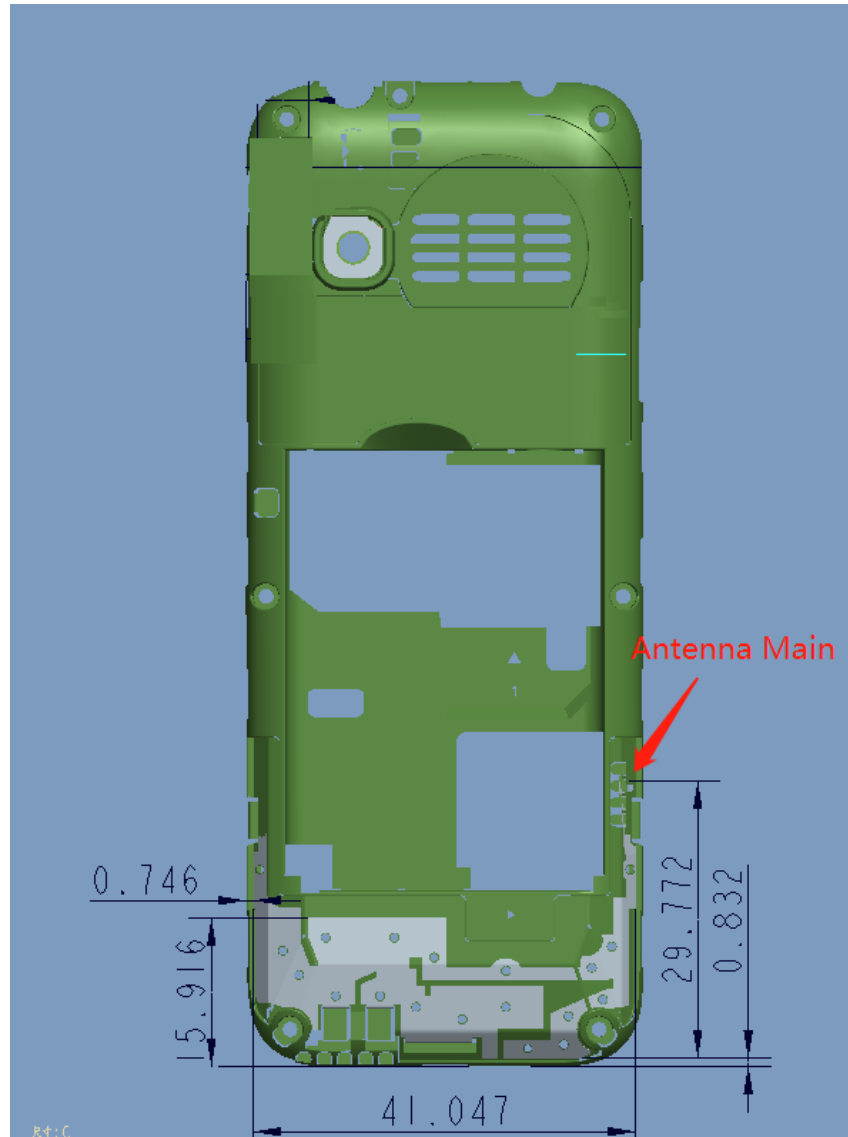
During the process of testing, the EUT was controlled via Agilent Digital Radio Communication tester (E5515C) to ensure the maximum power transmission and proper modulation. This result contains conducted output power for the EUT. In all cases, the measured peak output power should be greater and within 5% than EMI measurement.

Table 10.1: The conducted power measurement results for GSM

| GSM850 | Tune up | Conducted Power (dBm) | | |
|---------|-------------|-----------------------|--------------------|--------------------|
| | | Ch.251 (848.8MHz) | Ch.190 (836.6MHz) | Ch.128 (824.2MHz) |
| | 33.0 | 31.95 | 32.03 | 32.02 |
| GSM1900 | Tune up | Conducted Power(dBm) | | |
| | | Ch.810 (1909.8MHz) | Ch.661 (1880.0MHz) | Ch.512 (1850.2MHz) |
| | 31.0 | 30.11 | 30.21 | 30.32 |

11. Transmit Antenna

11.1. Antenna Locations



Picture 11.1 Antenna Locations (Back View)

12. Summary of Test Results

According to the client's decision rule in the test registration form, which is "based on the measurement results as the basis of the conformity statement", the test conclusion of this report meets the limit requirements.

The calculated SAR is obtained by the following formula:

$$\text{Reported SAR} = \text{Measured SAR} \times 10^{(P_{\text{Target}} - P_{\text{Measured}})/10}$$

Where P_{Target} is the power of manufacturing upper limit;

P_{Measured} is the measured power in chapter 10.

General Note:

The device support dual SIMs, SIM1 was used for the all configuration SAR testing and SIM2 test the worst case SAR of SIM1.

M2: Mode name (1068X)

Duty Cycle

| Mode | Duty Cycle |
|----------------|------------|
| Speech for GSM | 1:8.3 |

12.1. Testing Environment

| | |
|-----------------------------|--------------|
| Temperature: | 18°C~25°C |
| Relative humidity: | 30%~70% |
| Ground system resistance: | <4Ω |
| Ambient noise & Reflection: | < 0.012 W/kg |

12.2. SAR results

Table 12.1: SAR Values (GSM 850 - Head)

| Frequency | | Test Mode | Test Position | Figure No./ Note | Conducted Power (dBm) | Max. tune-up Power (dBm) | Measured SAR(1g) (W/kg) | Reported SAR(1g) (W/kg) | Power Drift(dB) |
|-----------|-------|-----------|---------------|------------------|-----------------------|--------------------------|-------------------------|-------------------------|-----------------|
| Ch. | MHz | | | | | | | | |
| 190 | 836.6 | Speech | Left Cheek | / | 32.03 | 33.0 | 0.428 | 0.54 | 0.06 |
| 190 | 836.6 | Speech | Left Tilt | / | 32.03 | 33.0 | 0.191 | 0.24 | 0.11 |
| 190 | 836.6 | Speech | Right Cheek | / | 32.03 | 33.0 | 0.412 | 0.52 | 0.02 |
| 190 | 836.6 | Speech | Right Tilt | / | 32.03 | 33.0 | 0.203 | 0.25 | -0.01 |
| 190 | 836.6 | Speech | Left Cheek | 1/M2 | 32.03 | 33.0 | 0.484 | 0.61 | 0.08 |

Table 12.2: SAR Values (GSM 850 - Body)

| Frequency | | Test Mode | Test Position | Figure No./ Note | Conducted Power (dBm) | Max. tune-up Power (dBm) | Measured SAR(1g) (W/kg) | Reported SAR(1g) (W/kg) | Power Drift(dB) |
|----------------------------|-------|-----------|---------------|------------------|-----------------------|--------------------------|-------------------------|-------------------------|-----------------|
| Ch. | MHz | | | | | | | | |
| Body-Worn Test Data (15mm) | | | | | | | | | |
| 190 | 836.6 | Speech | Front | / | 32.03 | 33.0 | 0.187 | 0.23 | -0.03 |
| 190 | 836.6 | Speech | Rear | / | 32.03 | 33.0 | 0.505 | 0.63 | -0.04 |
| 251 | 848.8 | Speech | Rear | / | 31.95 | 33.0 | 0.647 | 0.82 | 0.05 |
| 128 | 824.2 | Speech | Rear | / | 32.02 | 33.0 | 0.312 | 0.39 | 0.01 |
| 251 | 848.8 | Speech | Rear | SIM2 | 31.95 | 33.0 | 0.611 | 0.78 | 0.03 |
| 251 | 848.8 | Speech | Rear | 2/M2 | 31.95 | 33.0 | 0.751 | 0.96 | 0.01 |

Table 12.3: SAR Values (GSM 1900 - Head)

| Frequency | | Test Mode | Test Position | Figure No./ Note | Conducted Power (dBm) | Max. tune-up Power (dBm) | Measured SAR(1g) (W/kg) | Reported SAR(1g) (W/kg) | Power Drift(dB) |
|-----------|--------|-----------|---------------|------------------|-----------------------|--------------------------|-------------------------|-------------------------|-----------------|
| Ch. | MHz | | | | | | | | |
| 512 | 1850.2 | Speech | Left Cheek | / | 30.32 | 31.0 | 0.584 | 0.68 | -0.01 |
| 512 | 1850.2 | Speech | Left Tilt | / | 30.32 | 31.0 | 0.268 | 0.31 | 0.02 |
| 512 | 1850.2 | Speech | Right Cheek | / | 30.32 | 31.0 | 0.805 | 0.94 | -0.10 |
| 512 | 1850.2 | Speech | Right Tilt | / | 30.32 | 31.0 | 0.290 | 0.34 | 0.02 |
| 810 | 1910.0 | Speech | Right Cheek | / | 30.11 | 31.0 | 0.778 | 0.95 | -0.02 |
| 661 | 1880.0 | Speech | Right Cheek | 3 | 30.21 | 31.0 | 0.806 | 0.97 | 0.05 |
| 661 | 1880.0 | Speech | Right Cheek | SIM2 | 30.21 | 31.0 | 0.731 | 0.88 | -0.01 |
| 661 | 1880.0 | Speech | Right Cheek | M2 | 30.21 | 31.0 | 0.797 | 0.96 | -0.03 |

Table 12.4: SAR Values (GSM 1900 - Body)

| Frequency | | Test Mode | Test Position | Figure No./ Note | Conducted Power (dBm) | Max. tune-up Power (dBm) | Measured SAR(1g) (W/kg) | Reported SAR(1g) (W/kg) | Power Drift(dB) |
|----------------------------|--------|-----------|---------------|------------------|-----------------------|--------------------------|-------------------------|-------------------------|-----------------|
| Ch. | MHz | | | | | | | | |
| Body-Worn Test Data (15mm) | | | | | | | | | |
| 512 | 1850.2 | Speech | Front | / | 30.32 | 31.0 | 0.339 | 0.40 | -0.16 |
| 512 | 1850.2 | Speech | Rear | / | 30.32 | 31.0 | 0.344 | 0.40 | 0.15 |
| 512 | 1850.2 | Speech | Rear | 4/M2 | 30.32 | 31.0 | 0.472 | 0.55 | 0.16 |

13. SAR Measurement Variability

SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium.

The following procedures are applied to determine if repeated measurements are required.

- 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 ($\sim 10\%$ 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 .

Table 13.1: SAR Measurement Variability for GSM850 Body

| Frequency | | Test Position | Original | 1 st Repeated | Ratio | 2 nd Repeated |
|-----------|--------|---------------|------------|--------------------------|-------|--------------------------|
| Ch. | MHz | | SAR (W/kg) | SAR (W/kg) | | SAR (W/kg) |
| 661 | 1880.0 | Right Cheek | 0.806 | 0.793 | 1.02 | / |

14. Measurement Uncertainty

14.1. Measurement Uncertainty for Normal SAR Tests (300MHz~3GHz)

| No. | Error Description | Type | Uncertainty value | Probably Distribution | Div. | (Ci) 1g | (Ci) 10g | Std. Unc. (1g) | Std. Unc. (10g) | Degree of freedom |
|--|---|--|-------------------|-----------------------|------------|--------------|--------------|----------------|-----------------|-------------------|
| Measurement system | | | | | | | | | | |
| 1 | Probe calibration | B | 12 | N | 2 | 1 | 1 | 6.0 | 6.0 | ∞ |
| 2 | Axial isotropy | B | 4.7 | R | $\sqrt{3}$ | $\sqrt{0.5}$ | $\sqrt{0.5}$ | 4.3 | 4.3 | ∞ |
| 3 | Hemispherical isotropy | B | 9.6 | R | $\sqrt{3}$ | 1 | 1 | 4.8 | 4.8 | ∞ |
| 4 | Boundary effect | B | 1.1 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| 5 | Linearity | B | 4.7 | R | $\sqrt{3}$ | 1 | 1 | 2.7 | 2.7 | ∞ |
| 6 | Detection limit | B | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| 7 | Modulation response | B | 4.0 | R | $\sqrt{3}$ | 1 | 1 | 2.3 | 2.3 | ∞ |
| 8 | Readout electronics | B | 1.0 | N | 1 | 1 | 1 | 1.0 | 1.0 | ∞ |
| 9 | Response time | B | 0.8 | R | $\sqrt{3}$ | 1 | 1 | 0.5 | 0.5 | ∞ |
| 10 | Integration time | B | 1.7 | R | $\sqrt{3}$ | 1 | 1 | 1.0 | 1.0 | ∞ |
| 11 | RF ambient conditions-noise | B | 3.0 | R | $\sqrt{3}$ | 1 | 1 | 1.7 | 1.7 | ∞ |
| 12 | RF ambient conditions-reflection | B | 3.0 | R | $\sqrt{3}$ | 1 | 1 | 1.7 | 1.7 | ∞ |
| 13 | Probe positioned mech. restrictions | B | 0.35 | R | $\sqrt{3}$ | 1 | 1 | 0.2 | 0.2 | ∞ |
| 14 | Probe positioning with respect to phantom shell | B | 2.9 | R | $\sqrt{3}$ | 1 | 1 | 1.7 | 1.7 | ∞ |
| 15 | Post-processing | B | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| Test sample related | | | | | | | | | | |
| 16 | Test sample positioning | A | 3.3 | N | 1 | 1 | 1 | 3.3 | 3.3 | 5 |
| 17 | Device holder uncertainty | A | 3.4 | N | 1 | 1 | 1 | 3.4 | 3.4 | 5 |
| 18 | Drift of output power | B | 5.0 | R | $\sqrt{3}$ | 1 | 1 | 2.9 | 2.9 | ∞ |
| Phantom and set-up | | | | | | | | | | |
| 19 | Phantom uncertainty | B | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 | ∞ |
| 20 | Liquid conductivity (target) | B | 5.0 | R | $\sqrt{3}$ | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| 21 | Liquid conductivity (meas.) | A | 1.3 | N | 1 | 0.64 | 0.43 | 0.83 | 0.56 | 9 |
| 22 | Liquid permittivity (target) | B | 5.0 | R | $\sqrt{3}$ | 0.6 | 0.49 | 1.7 | 1.4 | ∞ |
| 23 | Liquid permittivity (meas.) | A | 1.6 | N | 1 | 0.6 | 0.49 | 0.96 | 0.78 | 9 |
| Combined standard uncertainty | | $u_c = \sqrt{\sum_{i=1}^{23} c_i^2 u_i^2}$ | | | | | | 11.3 | 11.2 | 95.5 |
| Expanded uncertainty (Confidence interval of 95 %) | | $u_e = 2u_c$ | | | | | | 22.6 | 22.4 | |

15. Main Test Instruments

Table 15.1: List of Main Instruments for original sample test

| No. | Name | Type | Serial Number | Calibration Date | Valid Period |
|-----|-----------------------|---------|---------------|------------------|--------------|
| 01 | Network analyzer | E5071C | MY46103759 | 2021-11-15 | One year |
| 02 | Dielectric probe | 85070E | MY44300317 | / | / |
| 03 | Power meter | E4418B | MY50000366 | 2021-12-13 | One year |
| 04 | Power sensor | E9304A | MY50000188 | | |
| 05 | Power meter | NRP | 101460 | 2022-01-15 | One year |
| 06 | Power sensor | NRP-Z91 | 100553 | | |
| 07 | Signal Generator | E8257D | MY47461211 | 2022-01-15 | One year |
| 08 | Amplifier | VTL5400 | 0404 | / | / |
| 09 | E-field Probe | ES3DV3 | 3151 | 2021-04-26 | One year |
| 10 | DAE | DAE4 | 786 | 2021-04-09 | One year |
| 11 | Dipole Validation Kit | D835V2 | 4d057 | 2021-10-18 | Three year |
| 12 | Dipole Validation Kit | D1900V2 | 5d088 | 2021-10-18 | Three year |
| 13 | BTS | MT8820C | 6201341853 | 2022-01-15 | One year |
| 14 | BTS | E5515C | GB46110722 | 2022-01-15 | One year |
| 15 | Software | DASY5 | / | / | / |

ANNEX A: Graph Results

GSM850 Head

Date: 2021-12-8

Electronics: DAE4 Sn786

Medium: Head 835MHz

Medium parameters used (interpolated): $f = 836.6$ MHz; $\sigma = 0.919$ S/m; $\epsilon_r = 40.823$; $\rho = 1000$ kg/m³

Communication System: UID 0, GSM (0) Frequency: 836.6 MHz Duty Cycle: 1:8.3

Probe: ES3DV3 – SN3151 ConvF (6.40, 6.40, 6.40);

Left Cheek Middle/Area Scan (51x61x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 0.588 W/kg

Left Cheek Middle/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 7.931 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 0.671 W/kg

SAR(1 g) = 0.484 W/kg; SAR(10 g) = 0.324 W/kg

Maximum value of SAR (measured) = 0.596 W/kg

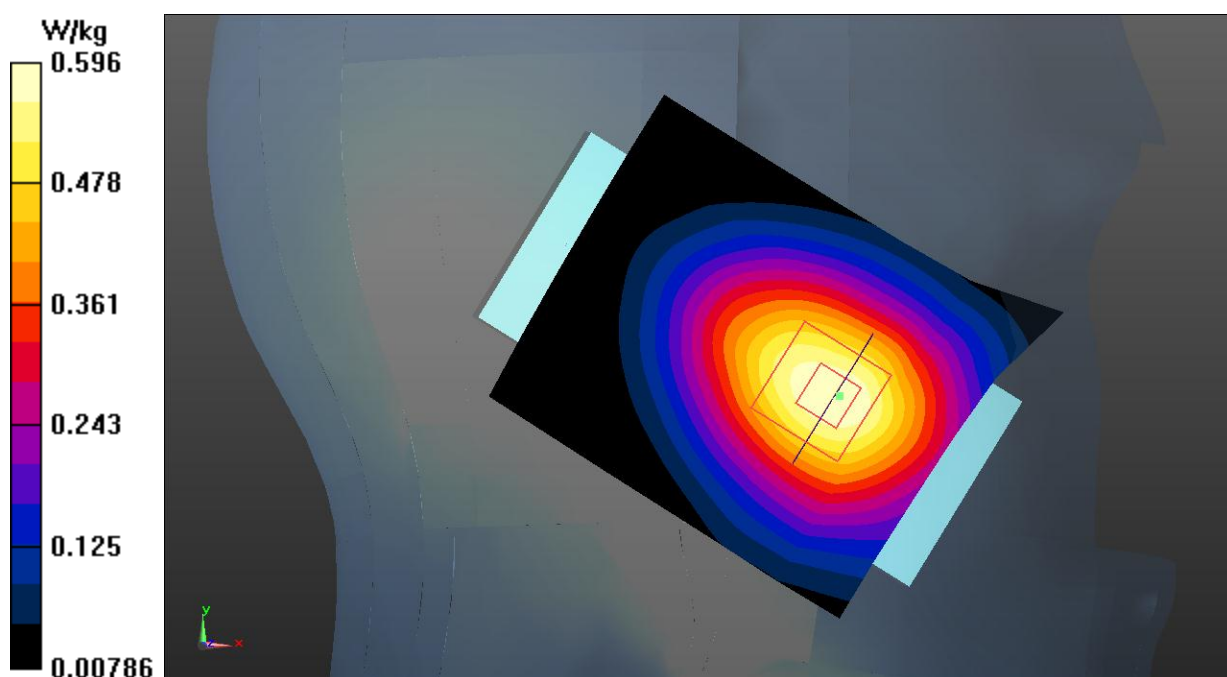


Fig.1 GSM 850 Head

GSM850 Body-worn

Date: 2021-12-8

Electronics: DAE4 Sn786

Medium: Head 835MHz

Medium parameters used (interpolated): $f = 848.8$ MHz; $\sigma = 0.925$ S/m; $\epsilon_r = 40.798$; $\rho = 1000$ kg/m³

Communication System: UID 0, GSM (0) Frequency: 848.8 MHz Duty Cycle: 1:8.3

Probe: ES3DV3 – SN3151 ConvF (6.40, 6.40, 6.40);

Rear Side High/Area Scan (61x61x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 0.902 W/kg

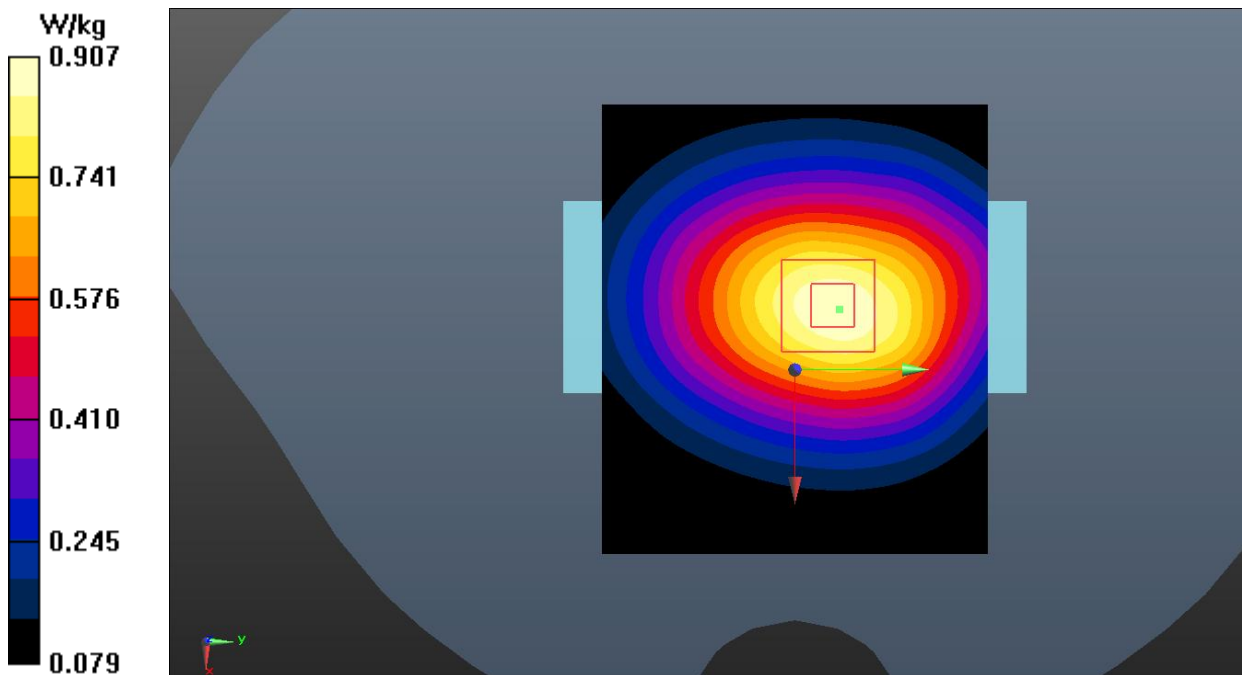
Rear Side High/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 27.97 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 1.03 W/kg

SAR(1 g) = 0.751 W/kg; SAR(10 g) = 0.524 W/kg

Maximum value of SAR (measured) = 0.907 W/kg

**Fig.2 GSM 850 Body-worn**

GSM1900 Head

Date: 2021-12-10

Electronics: DAE4 Sn786

Medium: Head 1900MHz

Medium parameters used: $f = 1880$ MHz; $\sigma = 1.397$ S/m; $\epsilon_r = 39.347$; $\rho = 1000$ kg/m³

Communication System: UID 0, GSM (0) Frequency: 1880 MHz Duty Cycle: 1:8.3

Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

Right Cheek Middle/Area Scan (61x61x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 1.08 W/kg

Right Cheek Middle/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 9.791 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 1.31 W/kg

SAR(1 g) = 0.806 W/kg; SAR(10 g) = 0.476 W/kg

Maximum value of SAR (measured) = 0.962 W/kg

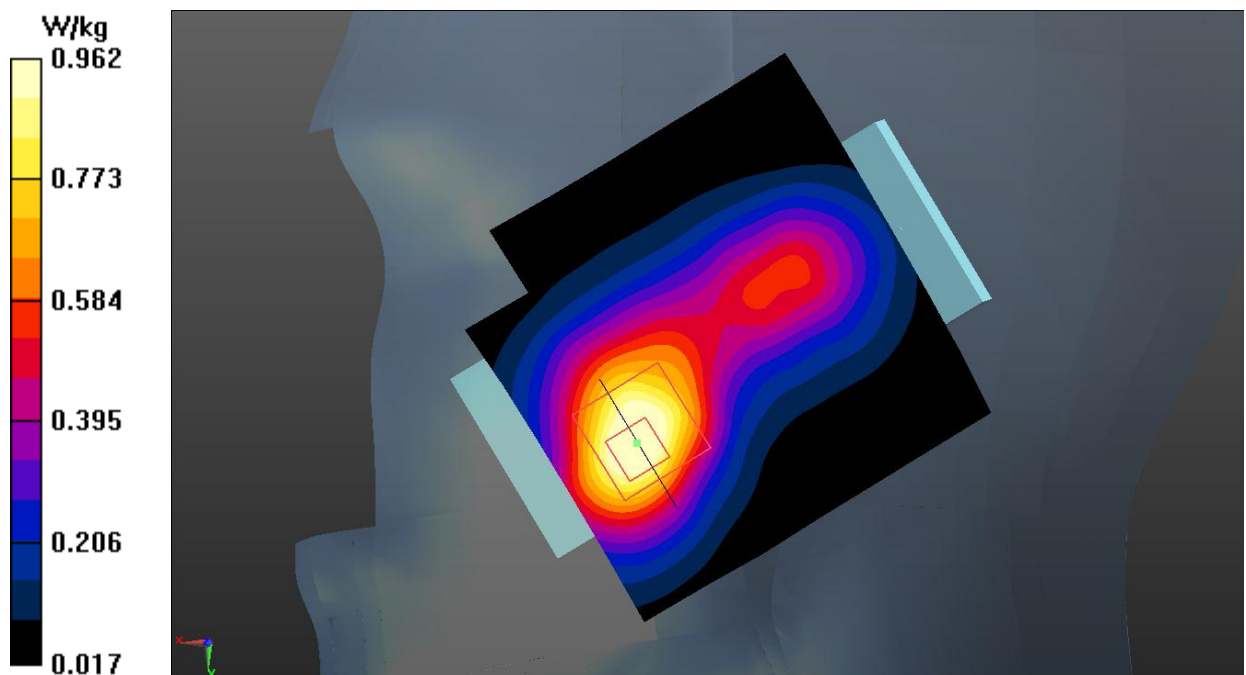


Fig.3 GSM 1900 Head

GSM1900 Body-worn

Date: 2021-12-10

Electronics: DAE4 Sn786

Medium: Head 1900MHz

Medium parameters used (interpolated): $f = 1850.2$ MHz; $\sigma = 1.361$ S/m; $\epsilon_r = 39.487$; $\rho = 1000$ kg/m³

Communication System: UID 0, GSM (0) Frequency: 1850.2 MHz Duty Cycle: 1:8.3

Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

Rear Side Low/Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.605 W/kg

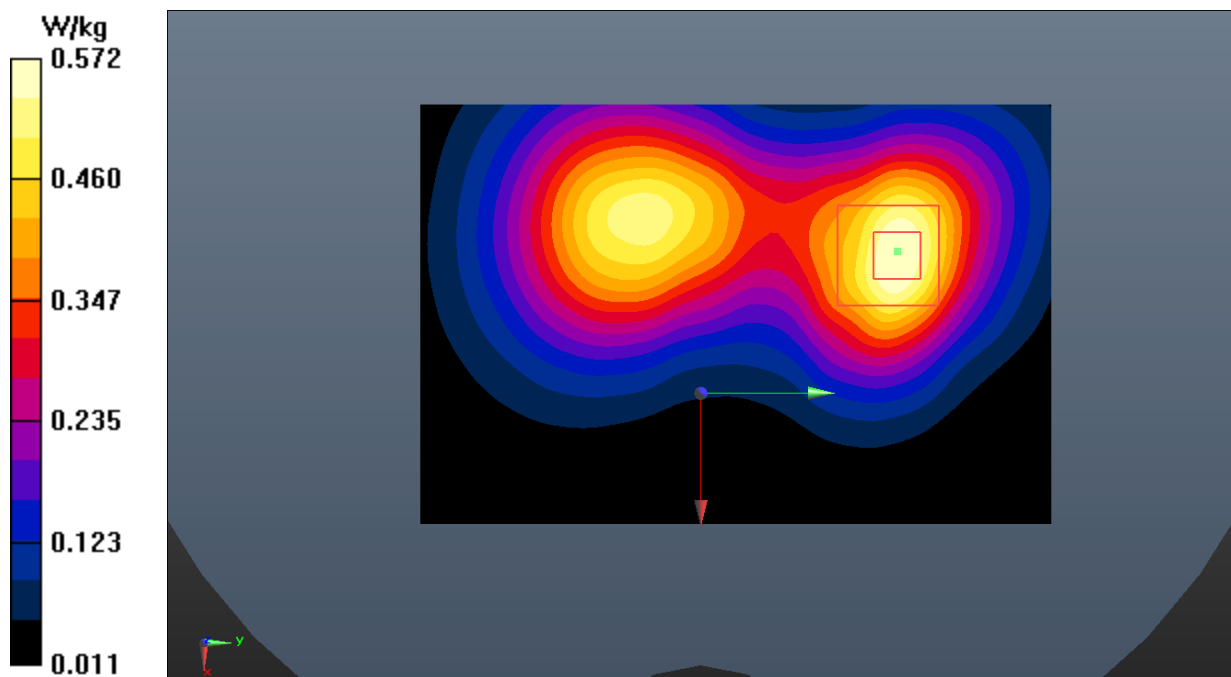
Rear Side Low/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 11.53 V/m; Power Drift = 0.16 dB

Peak SAR (extrapolated) = 0.791 W/kg

SAR(1 g) = 0.472 W/kg; SAR(10 g) = 0.273 W/kg

Maximum value of SAR (measured) = 0.572 W/kg

**Fig.4 GSM 1900 Body-worn**

ANNEX B: SystemVerification Results

835MHz

Date: 2021-12-8

Electronics: DAE4 Sn786

Medium: Head 835MHz

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.918 \text{ S/m}$; $\epsilon_r = 40.842$; $\rho = 1000 \text{ kg/m}^3$

Communication System: CW_TMC Frequency: 835 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (6.40, 6.40, 6.40);

System Validation/Area Scan (81x151x1): Interpolated grid: $dx=1.000 \text{ mm}$, $dy=1.000 \text{ mm}$

Reference Value = 65.913 V/m; Power Drift = 0.05 dB

SAR(1 g) = 2.47 W/kg; SAR(10 g) = 1.60 W/kg

Maximum value of SAR (interpolated) = 3.42 W/kg

System Validation/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 65.913 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 3.88 W/kg

SAR(1 g) = 2.51 W/kg; SAR(10 g) = 1.62 W/kg

Maximum value of SAR (measured) = 3.48 W/kg

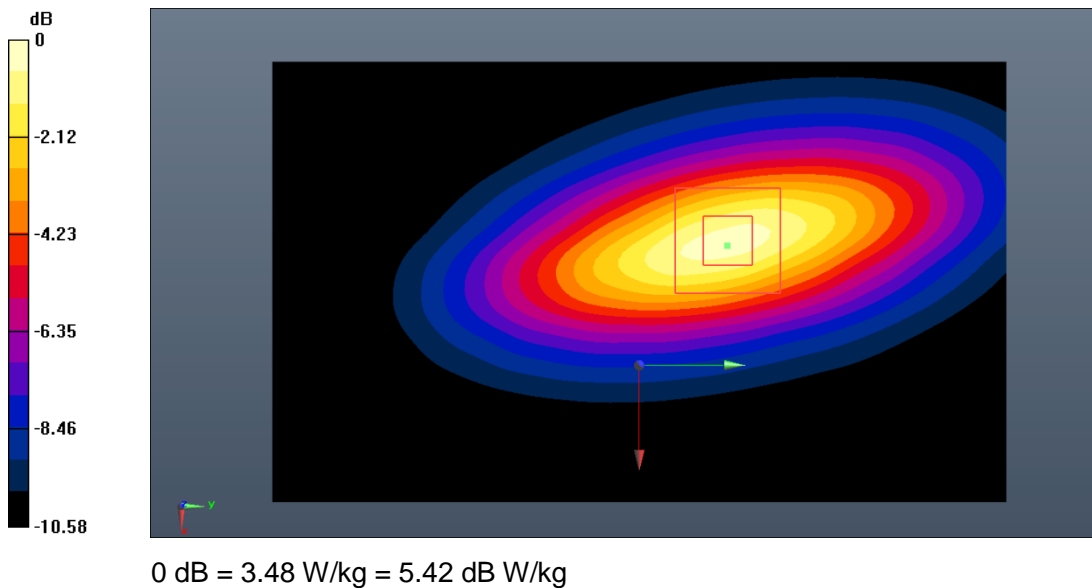


Fig.B.1. Validation 835MHz 250mW

1900MHz

Date: 2021-12-10

Electronics: DAE4 Sn786

Medium: Head 1900MHz

Medium parameters used: $f = 1900 \text{ MHz}$; $\sigma = 1.415 \text{ S/m}$; $\epsilon_r = 39.269$; $\rho = 1000 \text{ kg/m}^3$

Communication System: CW_TMC Frequency: 1900 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

System Validation/Area Scan (91x91x1): Interpolated grid: $dx=1.000 \text{ mm}$, $dy=1.000 \text{ mm}$

Reference Value = 82.264 V/m; Power Drift = 0.12 dB

SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.14 W/kg

Maximum value of SAR (interpolated) = 12.3 W/kg

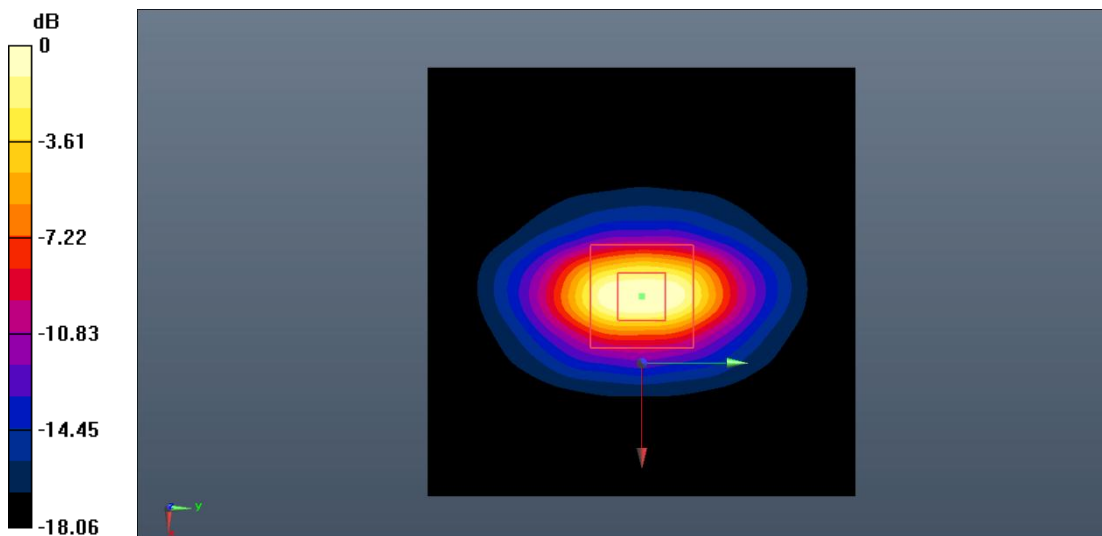
System Validation/Zoom Scan (7x7x7)/Cube0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 82.264 V/m; Power Drift = 0.12 dB

Peak SAR (extrapolated) = 25.8 W/kg

SAR(1 g) = 10.4 W/kg; SAR(10 g) = 5.23 W/kg

Maximum value of SAR (measured) = 12.4 W/kg



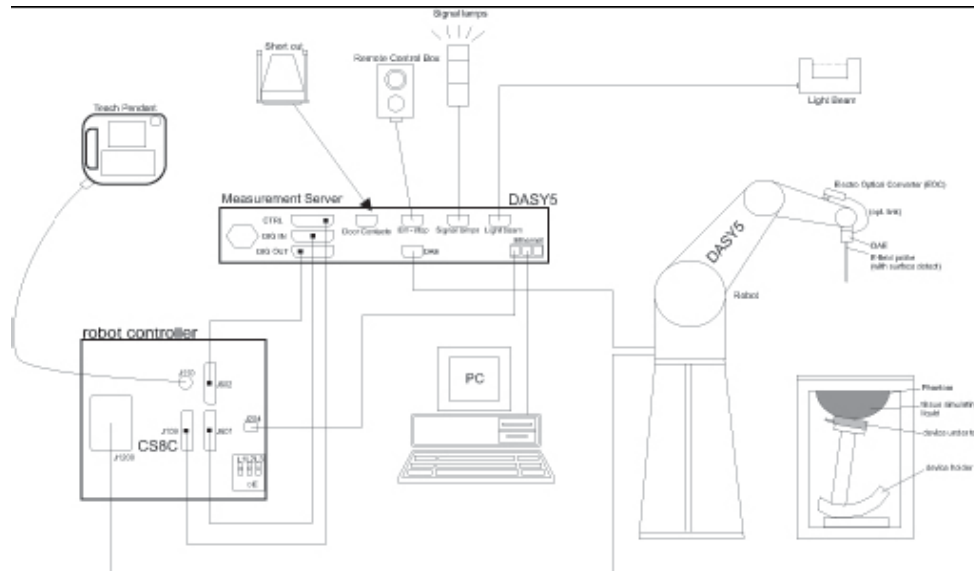
0 dB = 12.4 W/kg = 10.93 dB W/kg

Fig.B.2. Validation 1900MHz 250mW

ANNEX C: SAR Measurement Setup

C.1. Measurement Set-up

DASY5 system for performing compliance tests is illustrated above graphically. This system consists of the following items:



Picture C.1 SAR Lab Test Measurement Set-up

- A standard high precision 6-axis robot (Stäubli TX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (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.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- 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.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

C.2. DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY5 software reads the reflection during a software approach and looks for the maximum using 2nd order curve fitting. The approach is stopped at reaching the maximum.

Probe Specifications:

| | |
|-----------------------|---|
| Model: | ES3DV3, EX3DV4 |
| Frequency | 10MHz — 6.0GHz(EX3DV4) |
| Range: | 10MHz — 4GHz(ES3DV3) |
| Calibration: | In head and body simulating tissue at Frequencies from 835 up to 5800MHz |
| Linearity: | ± 0.2 dB(30 MHz to 6 GHz) for EX3DV4 ± 0.2 dB(30 MHz to 4 GHz) for ES3DV3 |
| Dynamic Range: | 10 mW/kg — 100W/kg |
| Probe Length: | 330 mm |
| Probe Tip | |
| Length: | 20 mm |
| Body Diameter: | 12 mm |
| Tip Diameter: | 2.5 mm (3.9 mm for ES3DV3) |
| Tip-Center: | 1 mm (2.0mm for ES3DV3) |
| Application: | SAR Dosimetry Testing Compliance tests of mobile phones Dosimetry in strong gradient fields |



Picture C.2 Near-field Probe



Picture C.3 E-field Probe

C.3. E-field Probe Calibration

Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm²) using an RF Signal generator, TEM cell, and RF Power Meter.

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equate to 1 mW/ cm².

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The E-field in the medium correlates with the temperature rise in the dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C \frac{\Delta T}{\Delta t}$$

Where:

Δt = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

ΔT = Temperature increase due to RF exposure.

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

Where:

σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m³).

C.4. Other Test Equipment

C.4.1. Data Acquisition Electronics (DAE)

The data acquisition electronics consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.



PictureC.4: DAE

C.4.2. Robot

The SPEAG DASY system uses the high precision robots (DASY5: RX160L) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability 0.02mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements (brushless synchron motors; no stepper motors)
- Low ELF interference (motor control fields shielded via the closed metallic construction shields)



Picture C.5 DASY 5

C.4.3. Measurement Server

The Measurement server is based on a PC/104 CPU board with CPU (DASY5: 400 MHz, Intel Celeron), chipdisk (DASY5:128MB), RAM (DASY5:128MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all real-time data evaluation of field measurements and surface detection, controls robot movements and handles safety operation. The PC operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with an expansion port which is reserved for future applications. Please note that this expansion port does not have a standardized pinout, and therefore only devices provided by SPEAG can be connected. Devices from any other supplier could seriously damage the measurement server.



Picture C.6 Server for DASY 5

C.4.4. Device Holder for Phantom

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5mm distance, a positioning uncertainty of $\pm 0.5\text{mm}$ would produce a SAR uncertainty of $\pm 20\%$. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.

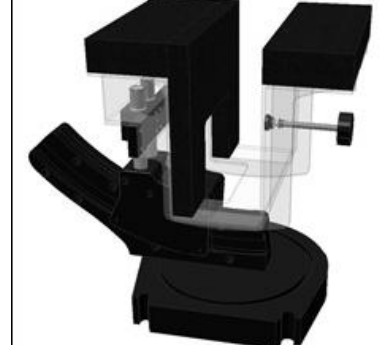
The DASY device holder is constructed of low-loss

POM material having the following dielectric

parameters: relative permittivity $\epsilon = 3$ and loss tangent $\delta = 0.02$. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

<Laptop Extension Kit>

The extension is lightweight and made of POM, acrylic glass and foam. It 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 and ELI phantoms.

**Picture C.7-1: Device Holder****Picture C.7-2: Laptop Extension Kit**

C.4.5. Phantom

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a table. The shape of the shell is based on data from an anatomical study designed to represent the 90th percentile of the population. The phantom enables the dissymmetric evaluation of SAR for both left and right handed handset usage, as well as body-worn usage using the flat phantom region. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. The shell phantom has a 2mm shell thickness (except the ear region where shell thickness increases to 6 mm).

Shell Thickness: 2 ± 0.2 mm

Filling Volume: Approx. 25 liters

Dimensions: 810 x 1000 x 500 mm (H x L x W)

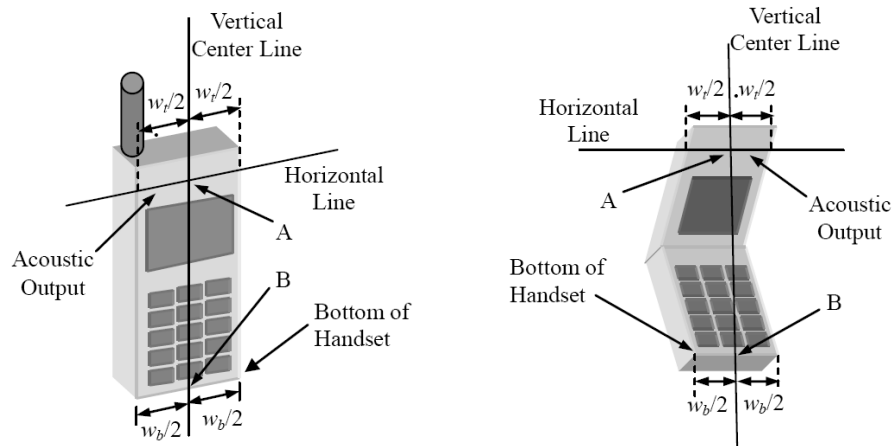
Available: Special

**Picture C.8: SAM Twin Phantom**

ANNEX D: Position of the wireless device in relation to the phantom

D.1. General Considerations

This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.



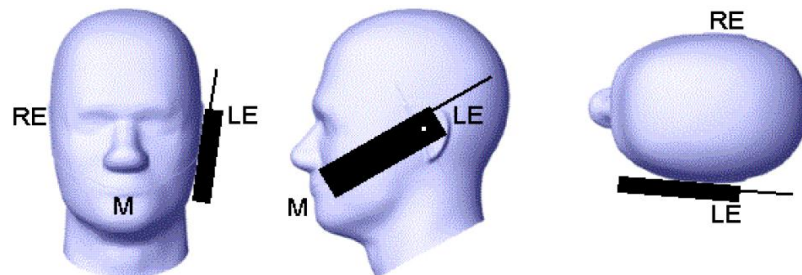
w_t Width of the handset at the level of the acoustic

w_b Width of the bottom of the handset

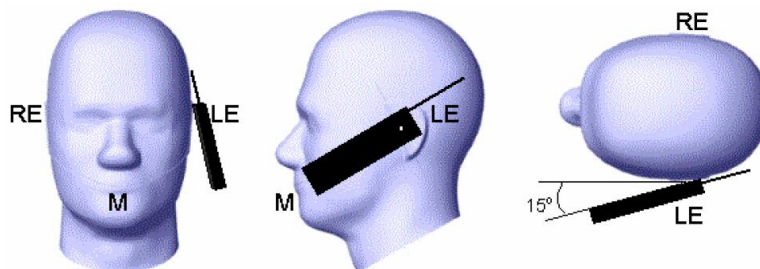
A Midpoint of the width w_t of the handset at the level of the acoustic output

B Midpoint of the width w_b of the bottom of the handset

Picture D.1-a Typical “fixed” case handset Picture D.1-b Typical “clam-shell” case handset



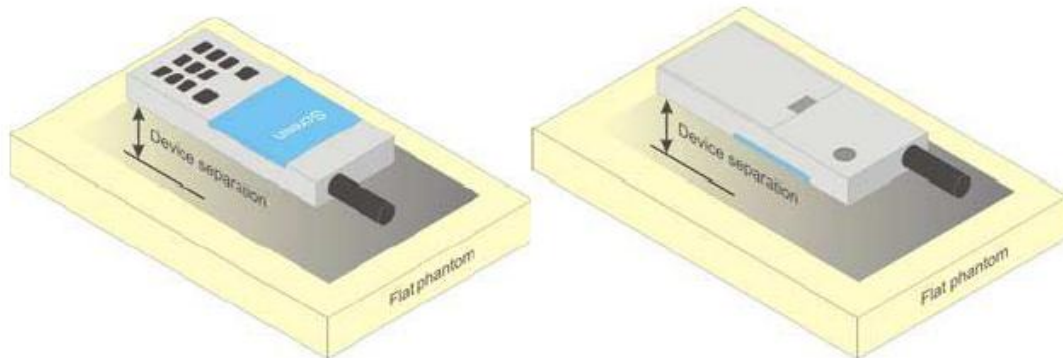
Picture D.2 Cheek position of the wireless device on the left side of SAM



Picture D.3 Tilt position of the wireless device on the left side of SAM

D.2. Body-worn device

A typical example of a body-worn device is a mobile phone, wireless enabled PDA or other battery operated wireless device with the ability to transmit while mounted on a person's body using a carry accessory approved by the wireless device manufacturer.



Picture D.4 Test positions for body-worn devices

D.3. DUT Setup Photos



Picture D.6

ANNEX E: Equivalent Media Recipes

The liquid used for the frequency range of 700-6000 MHz consisted of water, sugar, salt, preventol, glycol monobutyl and Cellulose. The liquid has been previously proven to be suited for worst-case. The Table E.1 shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528 and IEC 62209.

Table E.1: Composition of the Tissue Equivalent Matter

| Frequency (MHz) | 835 | 1750 | 1900 | 2450 | 2600 | 5200 | 5800 |
|------------------------------------|----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| Water | 41.45 | 55.242 | 55.242 | 58.79 | 58.79 | 65.53 | 66.10 |
| Sugar | 56.0 | / | / | / | / | / | / |
| Salt | 1.45 | 0.306 | 0.306 | 0.06 | 0.06 | | |
| Preventol | 0.1 | / | / | / | / | 17.24 | 16.95 |
| Cellulose | 1.0 | / | / | / | / | 17.24 | 16.95 |
| Glycol Monobutyl | / | 44.452 | 44.452 | 41.15 | 41.15 | / | / |
| Diethylenglycol monohexylether | / | / | / | / | / | / | / |
| Triton X-100 | / | / | / | / | / | / | / |
| Dielectric Parameters Target Value | $\epsilon=41.5$ $\sigma=0.90$ | $\epsilon=40.08$ $\sigma=1.37$ | $\epsilon=40.0$ $\sigma=1.40$ | $\epsilon=39.20$ $\sigma=1.80$ | $\epsilon=39.01$ $\sigma=1.96$ | $\epsilon=35.99$ $\sigma=4.66$ | $\epsilon=35.30$ $\sigma=5.27$ |

Note: There is a little adjustment respectively for 750, 5300 and 5600, based on the recipe of closest frequency in table E.1

ANNEX F: System Validation

The SAR system must be validated against its performance specifications before it is deployed. When SAR probes, system components or software are changed, upgraded or recalibrated, these must be validated with the SAR system(s) that operates with such components.

Table F.1: System Validation

| Probe SN. | Liquid name | Validation date | Frequency point | Status (OK or Not) |
|-----------|--------------|-----------------|-----------------|--------------------|
| 3151 | Head 750MHz | 2021-04-29 | 750 MHz | OK |
| 3151 | Head 835MHz | 2021-04-29 | 835 MHz | OK |
| 3151 | Head 1750MHz | 2021-04-29 | 1750 MHz | OK |
| 3151 | Head 1900MHz | 2021-04-29 | 1900 MHz | OK |
| 3151 | Head 2450MHz | 2021-04-30 | 2450 MHz | OK |
| 3151 | Head 2550MHz | 2021-04-30 | 2550 MHz | OK |



No.I22N00588-SAR

ANNEX G: Probe Calibration CertificateIn Collaboration with
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E-mail: cttl@chinattl.com <http://www.chinattl.cn>Client **CTTL(South Branch)**Certificate No: **Z21-60094****CALIBRATION CERTIFICATE**Object **ES3DV3 - SN : 3151**Calibration Procedure(s) **FF-Z11-004-02**
Calibration Procedures for Dosimetric E-field ProbesCalibration date: **April 26, 2021**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|--------------------------|-------------|--|-----------------------|
| Power Meter NRP2 | 101919 | 16-Jun-20(CTTL, No.J20X04344) | Jun-21 |
| Power sensor NRP-Z91 | 101547 | 16-Jun-20(CTTL, No.J20X04344) | Jun-21 |
| Power sensor NRP-Z91 | 101548 | 16-Jun-20(CTTL, No.J20X04344) | Jun-21 |
| Reference 10dBAttenuator | 18N50W-10dB | 10-Feb-20(CTTL, No.J20X00525) | Feb-22 |
| Reference 20dBAttenuator | 18N50W-20dB | 10-Feb-20(CTTL, No.J20X00526) | Feb-22 |
| Reference Probe EX3DV4 | SN 3617 | 27-Jan-21(SPEAG, No.EX3-3617_Jan21) | Jan-22 |
| DAE4 | SN 1556 | 15-Jan-21(SPEAG, No.DAE4-1556_Jan21) | Jan-22 |
| Secondary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| SignalGenerator MG3700A | 6201052605 | 23-Jun-20(CTTL, No.J20X04343) | Jun-21 |
| Network Analyzer E5071C | MY46110673 | 21-Jan-21(CTTL, No.J20X00515) | Jan-22 |

| | Name | Function | Signature |
|----------------|-------------|--------------------|-----------|
| Calibrated by: | Yu Zongying | SAR Test Engineer | |
| Reviewed by: | Lin Hao | SAR Test Engineer | |
| Approved by: | Qi Dianyuan | SAR Project Leader | |

Issued: April 28, 2021

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Certificate No: Z21-60094

Page 1 of 9



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Glossary:

| | |
|-----------------------|--|
| TSL | tissue simulating liquid |
| NORM _{x,y,z} | sensitivity in free space |
| ConvF | sensitivity in TSL / NORM _{x,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), $\theta=0$ 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:

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

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}:** Assessed for E-field polarization $\theta=0$ ($f \leq 900\text{MHz}$ in TEM-cell; $f > 1800\text{MHz}$: waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not effect the E^2 -field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z} = NORM_{x,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.
- DCP_{x,y,z}:** DCP are numerical linearization parameters assessed based on the data of power sweep (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.
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,y,z}; A,B,C** 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 $f \leq 800\text{MHz}$) and inside waveguide using analytical field distributions based on power measurements for $f > 800\text{MHz}$. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,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 $\pm 50\text{MHz}$ to $\pm 100\text{MHz}$.
- 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 NORM_x (no uncertainty required).

Certificate No:Z21-60094

Page 2 of 9



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DASY/EASY – Parameters of Probe: ES3DV3 – SN:3151

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|--|----------|----------|----------|--------------|
| Norm($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 1.17 | 1.25 | 1.20 | $\pm 10.0\%$ |
| DCP(mV) ^B | 105.1 | 105.5 | 103.7 | |

Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB· μV | C | D dB | VR mV | Unc ^E (k=2) |
|-----|---------------------------|---|------|---------------------|-----|------|-------|------------------------|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 277.8 | $\pm 2.2\%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 288.5 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 279.6 | |

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%.

^A The uncertainties of Norm X, Y, Z do not affect the E^2 -field uncertainty inside TSL (see Page 4).

^B Numerical linearization parameter; uncertainty not required.

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

DASY/EASY – Parameters of Probe: ES3DV3 – SN:3151

Calibration Parameter Determined in Head Tissue Simulating Media

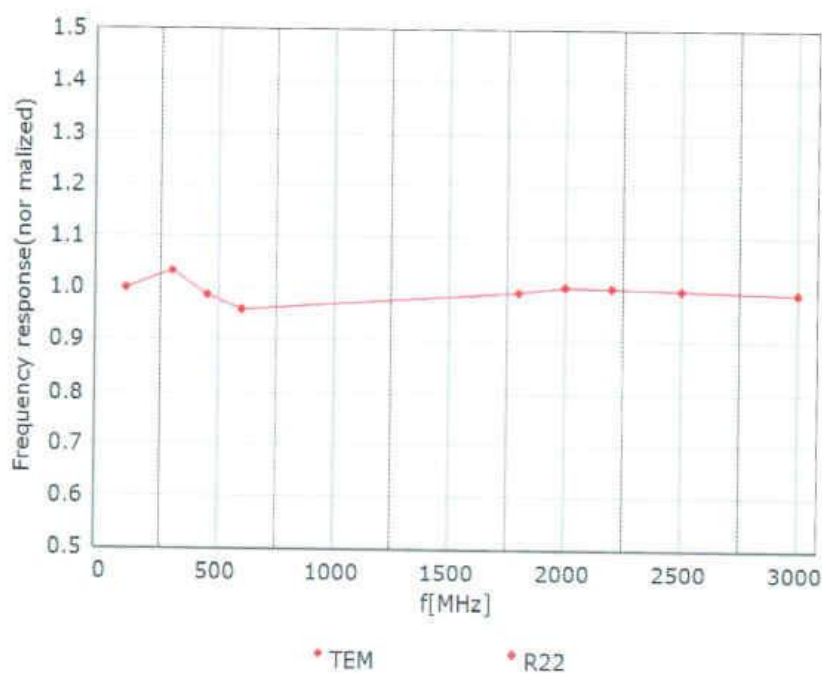
| f [MHz] ^C | Relative Permittivity ^F | Conductivity (S/m) ^F | ConvF X | ConvF Y | ConvF Z | Alpha ^G | Depth ^G (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750 | 41.9 | 0.89 | 6.40 | 6.40 | 6.40 | 0.40 | 1.40 | ±12.1% |
| 900 | 41.5 | 0.97 | 6.19 | 6.19 | 6.19 | 0.37 | 1.57 | ±12.1% |
| 1450 | 40.5 | 1.20 | 5.48 | 5.48 | 5.48 | 0.31 | 1.61 | ±12.1% |
| 1750 | 40.1 | 1.37 | 5.25 | 5.25 | 5.25 | 0.61 | 1.27 | ±12.1% |
| 1900 | 40.0 | 1.40 | 5.09 | 5.09 | 5.09 | 0.65 | 1.25 | ±12.1% |
| 2000 | 40.0 | 1.40 | 5.07 | 5.07 | 5.07 | 0.63 | 1.29 | ±12.1% |
| 2300 | 39.5 | 1.67 | 4.83 | 4.83 | 4.83 | 0.60 | 1.36 | ±12.1% |
| 2450 | 39.2 | 1.80 | 4.58 | 4.58 | 4.58 | 0.60 | 1.45 | ±12.1% |
| 2600 | 39.0 | 1.96 | 4.39 | 4.39 | 4.39 | 0.70 | 1.33 | ±12.1% |

^C Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

^F At frequency below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Frequency Response of E-Field (TEM-Cell: ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field: $\pm 7.4\%$ ($k=2$)

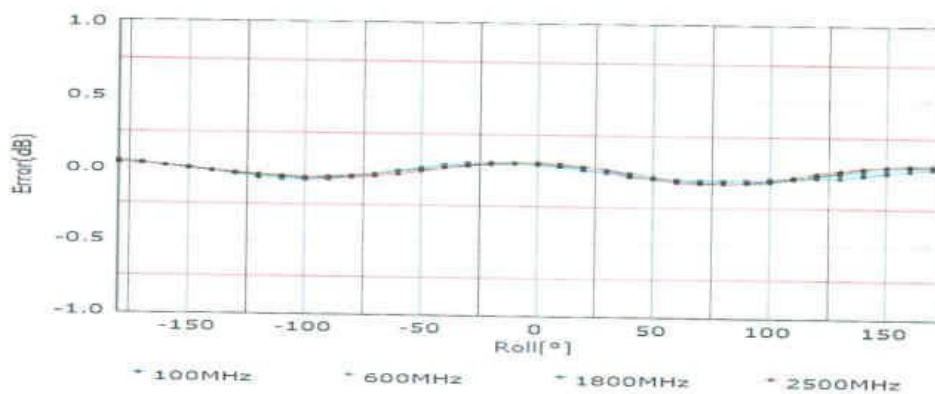
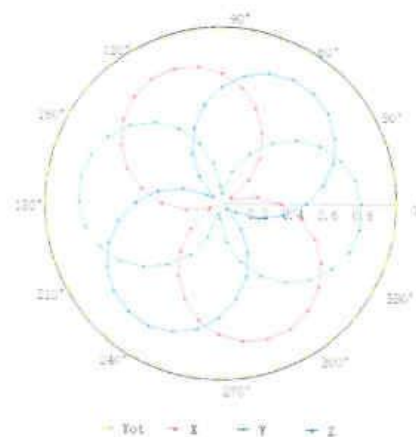
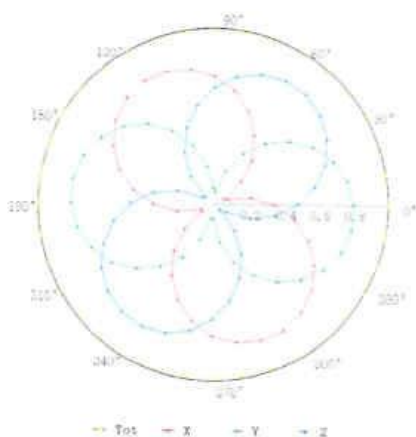


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Receiving Pattern (Φ), $\theta=0^\circ$

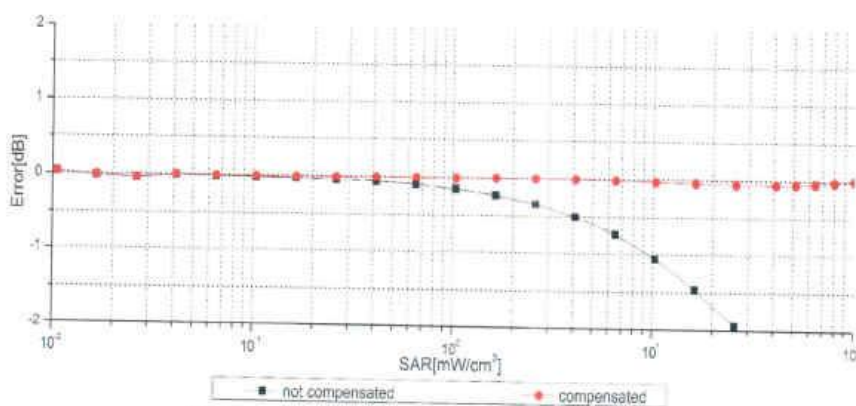
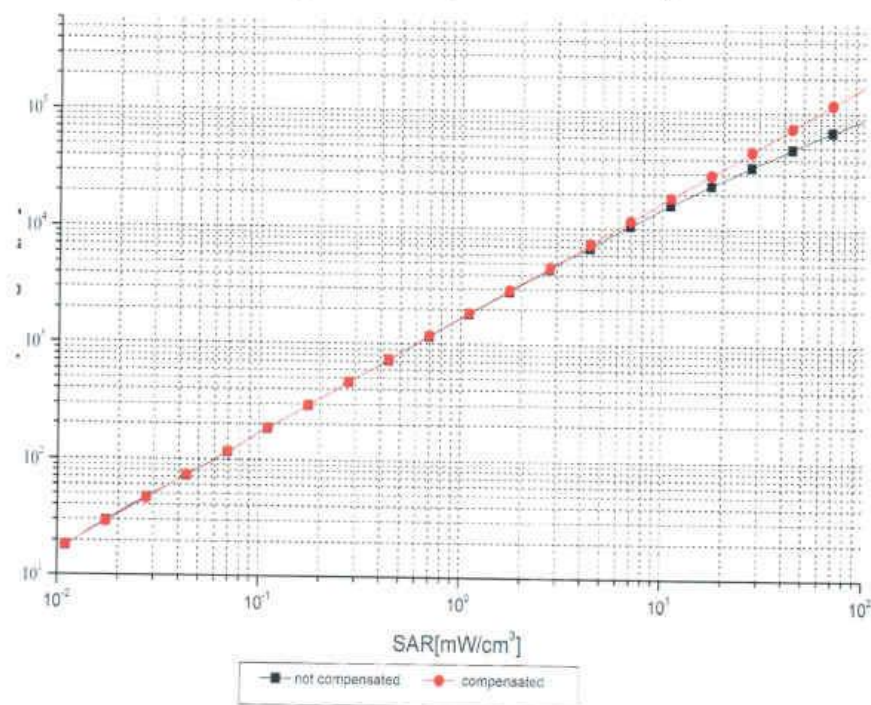
f=600 MHz, TEM

f=1800 MHz, R22



Uncertainty of Axial Isotropy Assessment: $\pm 1.2\%$ ($k=2$)

Dynamic Range f(SAR_{head}) (TEM cell, f = 900 MHz)

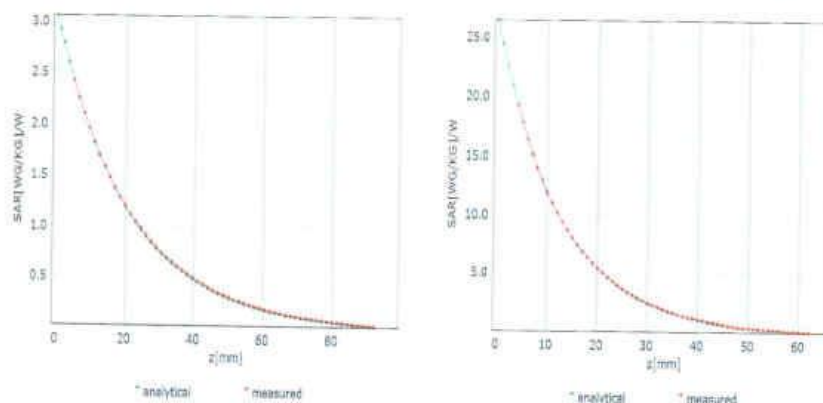


Uncertainty of Linearity Assessment: $\pm 0.9\%$ ($k=2$)

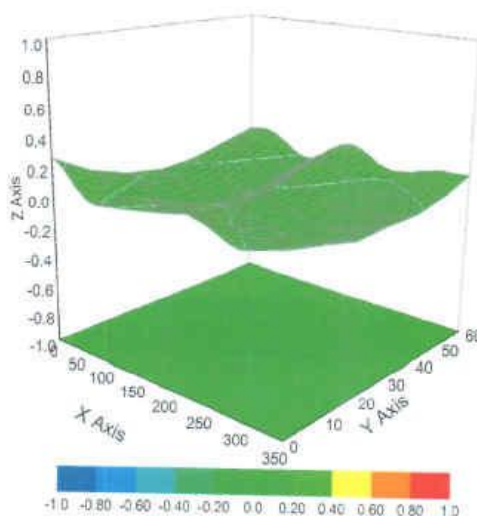
Conversion Factor Assessment

f=750 MHz,WGLS R9(H_convF)

f=1750 MHz,WGLS R22(H_convF)



Deviation from Isotropy in Liquid



Uncertainty of Spherical Isotropy Assessment: $\pm 3.2\%$ ($k=2$)



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DASY/EASY – Parameters of Probe: ES3DV3 – SN:3151

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 87.5 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disable |
| Probe Overall Length | 337mm |
| Probe Body Diameter | 10mm |
| Tip Length | 10mm |
| Tip Diameter | 4mm |
| Probe Tip to Sensor X Calibration Point | 2mm |
| Probe Tip to Sensor Y Calibration Point | 2mm |
| Probe Tip to Sensor Z Calibration Point | 2mm |
| Recommended Measurement Distance from Surface | 3mm |



No.I22N00588-SAR

ANNEX H: DAE Calibration CertificateIn Collaboration with
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CNAS L0570Client : **CTTL(South Branch)**Certificate No: **Z21-60093****CALIBRATION CERTIFICATE**Object **DAE4 - SN: 786**Calibration Procedure(s) **FF-Z11-002-01**
Calibration Procedure for the Data Acquisition Electronics (DAEx)Calibration date: **April 09, 2021**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|------------------------|---------|--|-----------------------|
| Process Calibrator 753 | 1971018 | 16-Jun-20 (CTTL, No.J20X04342) | Jun-21 |

| | Name | Function | Signature |
|----------------|-------------|--------------------|-----------|
| Calibrated by: | Yu Zongying | SAR Test Engineer | |
| Reviewed by: | Lin Hao | SAR Test Engineer | |
| Approved by: | Qi Dianyuan | SAR Project Leader | |

Issued: April 11, 2021

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Certificate No: Z21-60093

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Glossary:

DAE data acquisition electronics
Connector angle information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters:

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The report provide only calibration results for DAE, it does not contain other performance test results.



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DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = $6.1\mu\text{V}$, full range = $-100\dots+300\text{ mV}$

Low Range: 1LSB = 61nV , full range = $-1\dots+3\text{mV}$

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

| Calibration Factors | X | Y | Z |
|---------------------|----------------------------|----------------------------|----------------------------|
| High Range | $404.112 \pm 0.15\% (k=2)$ | $404.269 \pm 0.15\% (k=2)$ | $404.666 \pm 0.15\% (k=2)$ |
| Low Range | $3.97192 \pm 0.7\% (k=2)$ | $3.97396 \pm 0.7\% (k=2)$ | $3.95762 \pm 0.7\% (k=2)$ |

Connector Angle

| | |
|---|-------------------------|
| Connector Angle to be used in DASY system | $229^\circ \pm 1^\circ$ |
|---|-------------------------|



No.I22N00588-SAR

ANNEX I: Dipole Calibration Certificate

835MHz Dipole Calibration Certificate

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Client

SAICT

Certificate No: Z21-60355

CALIBRATION CERTIFICATE

Object: D835V2 - SN: 4d057

Calibration Procedure(s): FF-Z11-003-01
Calibration Procedures for dipole validation kits

Calibration date: October 18, 2021

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

All calibrations have been conducted in the closed laboratory facility: environment temperature $(22\pm3)^{\circ}\text{C}$ and humidity $<70\%$.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|---|-----------------------|
| Power Meter NRP2 | 106277 | 24-Sep-21 (CTTL, No.J21X08326) | Sep-22 |
| Power sensor NRP8S | 104291 | 24-Sep-21 (CTTL, No.J21X08326) | Sep-22 |
| Reference Probe EX3DV4 | SN 7517 | 03-Feb-21(CTTL-SPEAG.No.Z21-60001) | Feb-22 |
| DAE4 | SN 1556 | 15-Jan-21(SPEAG.No.DAE4-1556_Jan21) | Jan-22 |
| Secondary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593) | Jan-22 |
| NetworkAnalyzer E5071C | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232) | Jan-22 |

| | Name | Function | Signature |
|----------------|-------------|--------------------|-----------|
| Calibrated by: | Zhao Jing | SAR Test Engineer | |
| Reviewed by: | Lin Hao | SAR Test Engineer | |
| Approved by: | Qi Dianyuan | SAR Project Leader | |

Issued: October 24, 2021

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Certificate No: Z21-60355

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Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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



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Measurement Conditions

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

| | | |
|------------------------------|--------------------------|-------------|
| DASY Version | DASY52 | V52.10.4 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 15 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 835 MHz \pm 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---------------------|----------------|----------------------|
| Nominal Head TSL parameters | 22.0 °C | 41.5 | 0.90 mho/m |
| Measured Head TSL parameters | (22.0 \pm 0.2) °C | 40.9 \pm 6 % | 0.89 mho/m \pm 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL

| SAR averaged over 1 cm^3 (1 g) of Head TSL | Condition | |
|--|--------------------|----------------------------------|
| SAR measured | 250 mW input power | 2.39 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 9.64 W/kg \pm 18.8 % ($k=2$) |
| SAR averaged over 10 cm^3 (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 1.56 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 6.29 W/kg \pm 18.7 % ($k=2$) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 49.8Ω- 4.19jΩ |
| Return Loss | - 27.5dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.301 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: 10.18.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 4d057

Communication System: UID 0, CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.886 \text{ S/m}$; $\epsilon_r = 40.9$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7517; ConvF(9.81, 9.81, 9.81) @ 835 MHz; Calibrated: 2021-02-03
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7501)

Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.86 V/m; Power Drift = 0.00 dB

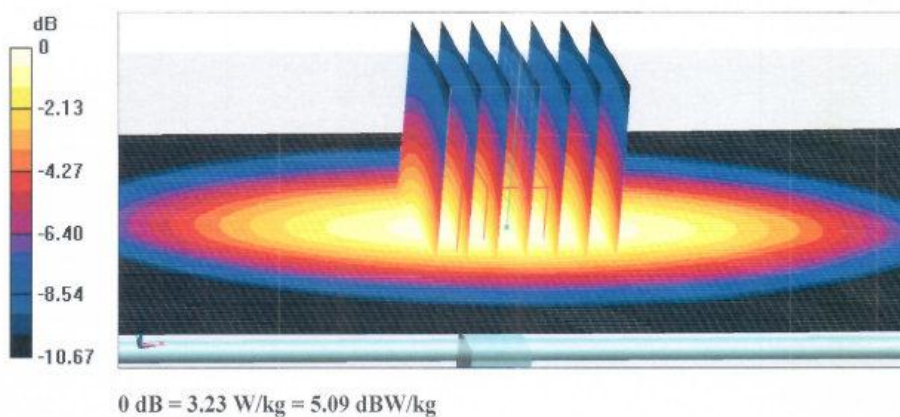
Peak SAR (extrapolated) = 3.68 W/kg

SAR(1 g) = 2.39 W/kg; SAR(10 g) = 1.56 W/kg

Smallest distance from peaks to all points 3 dB below = 18 mm

Ratio of SAR at M2 to SAR at M1 = 64.9%

Maximum value of SAR (measured) = 3.23 W/kg

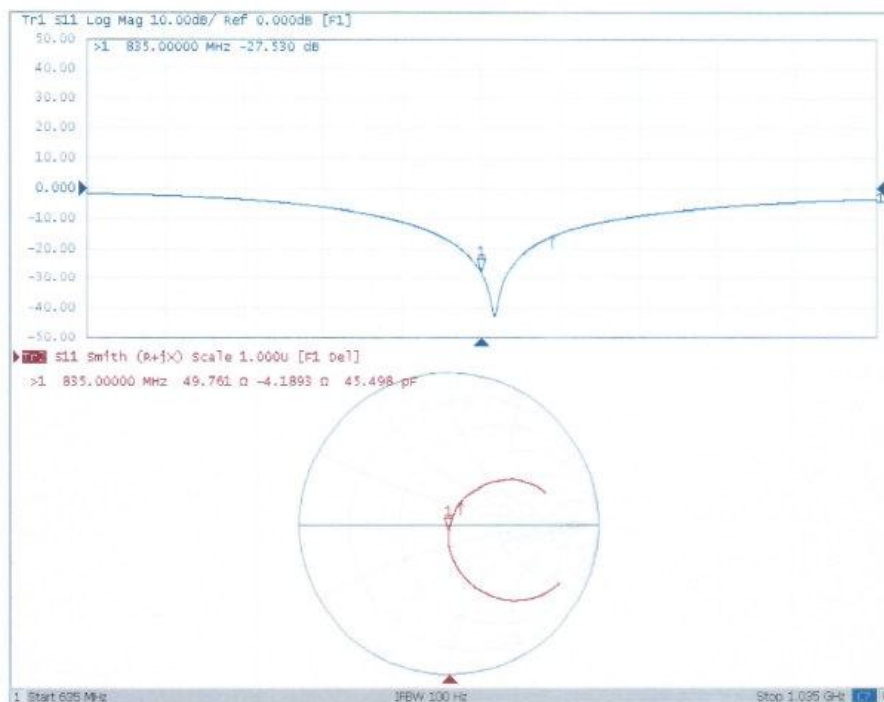




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Impedance Measurement Plot for Head TSL





No.I22N00588-SAR

1900MHz Dipole Calibration Certificate

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E-mail: cttl@chinattl.com http://www.chinattl.cnClient **SAICT**Certificate No: **Z21-60357****CALIBRATION CERTIFICATE**Object **D1900V2 - SN: 5d088**Calibration Procedure(s) **FF-Z11-003-01**
Calibration Procedures for dipole validation kitsCalibration date: **October 18, 2021**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|---|-----------------------|
| Power Meter NRP2 | 106277 | 24-Sep-21 (CTTL, No.J21X08326) | Sep-22 |
| Power sensor NRP8S | 104291 | 24-Sep-21 (CTTL, No.J21X08326) | Sep-22 |
| Reference Probe EX3DV4 | SN 7517 | 03-Feb-21(CTTL-SPEAG, No.Z21-60001) | Feb-22 |
| DAE4 | SN 1556 | 15-Jan-21(SPEAG, No.DAE4-1556_Jan21) | Jan-22 |
| Secondary Standards | ID # | Cal Date (Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 01-Feb-21 (CTTL, No.J21X00593) | Jan-22 |
| NetworkAnalyzer E5071C | MY46110673 | 14-Jan-21 (CTTL, No.J21X00232) | Jan-22 |

| | Name | Function | Signature |
|----------------|------------|--------------------|-----------|
| Calibrated by: | Zhao Jing | SAR Test Engineer | |
| Reviewed by: | Lin Hao | SAR Test Engineer | |
| Approved by: | Qi Dianyan | SAR Project Leader | |

Issued: October 24, 2021

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

Certificate No: Z21-60357

Page 1 of 6



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Glossary:

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

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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



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Measurement Conditions

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

| | | |
|------------------------------|--------------------------|-------------|
| DASY Version | DASY52 | V52.10.4 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | Triple Flat Phantom 5.1C | |
| Distance Dipole Center - TSL | 10 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 1900 MHz \pm 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 \pm 0.2) °C | 39.9 \pm 6 % | 1.39 mho/m \pm 6 % |
| Head TSL temperature change during test | <1.0 °C | ---- | ---- |

SAR result with Head TSL

| | | |
|--|--------------------|----------------------------------|
| SAR averaged over 1 cm^3 (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 10.0 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 40.2 W/kg \pm 18.8 % ($k=2$) |
| SAR averaged over 10 cm^3 (10 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 5.10 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 20.5 W/kg \pm 18.7 % ($k=2$) |



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Appendix (Additional assessments outside the scope of CNAS L0570)

Antenna Parameters with Head TSL

| | |
|--------------------------------------|----------------------------|
| Impedance, transformed to feed point | $53.7\Omega + 6.80j\Omega$ |
| Return Loss | - 22.6dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.110 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: 10.18.2021

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d088

Communication System: UID 0, CW; Frequency: 1900 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.387$ S/m; $\epsilon_r = 39.88$; $\rho = 1000$ kg/m³

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7517; ConvF(7.81, 7.81, 7.81) @ 1900 MHz; Calibrated: 2021-02-03
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2021-01-15
- Phantom: MFP_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7501)

System Performance Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid:

dx=5mm, dy=5mm, dz=5mm

Reference Value = 103.6 V/m; Power Drift = 0.00 dB

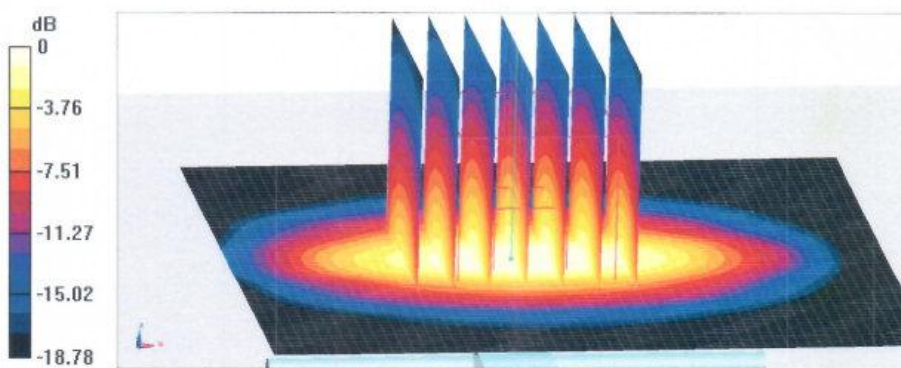
Peak SAR (extrapolated) = 19.2 W/kg

SAR(1 g) = 10 W/kg; SAR(10 g) = 5.1 W/kg

Smallest distance from peaks to all points 3 dB below = 10 mm

Ratio of SAR at M2 to SAR at M1 = 52.1%

Maximum value of SAR (measured) = 15.8 W/kg



0 dB = 15.8 W/kg = 11.99 dBW/kg

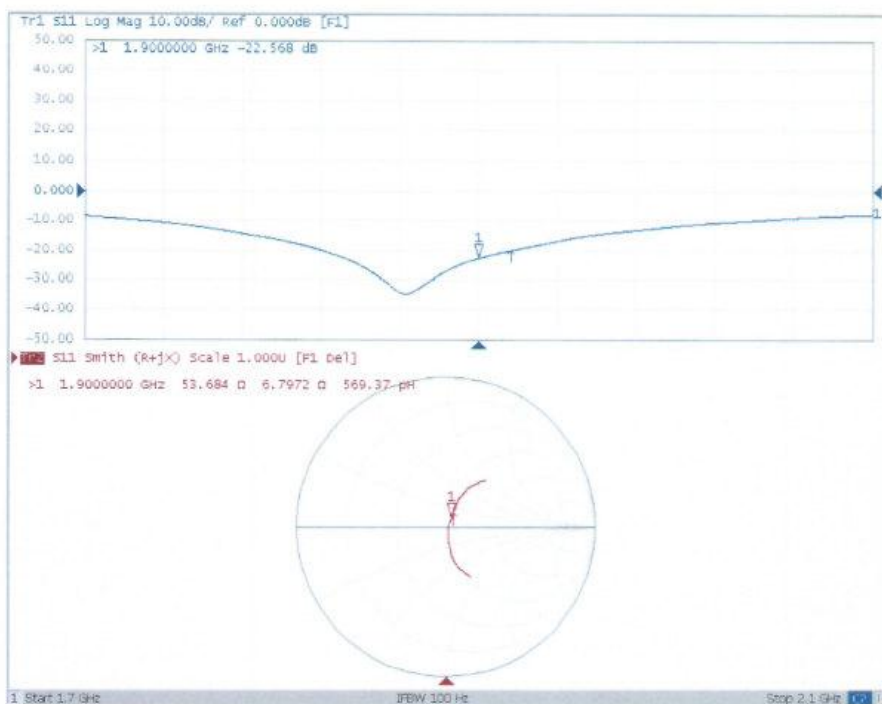
Certificate No: Z21-60357

Page 5 of 6



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Impedance Measurement Plot for Head TSL



ANNEX J: Spot Check Test

As the test lab for 1068A from TCL Communication Ltd., we, Shenzhen Academy of Information and Communications Technology, declare on our sole responsibility that, according to “Justification Letter” provided by applicant, only the Spot check test should be performed. The test results are as below.

J.1. Internal Identification of EUT used during the spot check test

| EUT ID* | IMEI | HW Version | SW Version | Receipt Date |
|---------|-----------------|------------------------|---|--------------|
| UT04aa | 356645970000818 | M1265A_MB _PCB_V1.0 | 1068A_OFUS1_1SIM_V1.0 _20220127_UNLOCK | 2022-03-03 |

J.2. Measurement results

GSM850 SAR Values

| Frequency | | Test Position | | Conducted Power (dBm) | Max. tune-up Power (dBm) | SAR(1g) (W/kg) | | |
|-----------|-------|---------------|------------|-----------------------|--------------------------|-----------------|--------------|---------------|
| Ch. | MHz | | | | | Spot check data | | Original data |
| | | | | | | Measured SAR | Reported SAR | |
| 190 | 836.6 | Head | Left Cheek | 32.03 | 33.0 | 0.620 | 0.78 | 0.61 |
| 251 | 848.8 | Body | Rear | 31.95 | 33.0 | 0.685 | 0.87 | 0.96 |

GSM1900 SAR Values

| Frequency | | Test Position | | Conducted Power (dBm) | Max. tune-up Power (dBm) | SAR(1g) (W/kg) | | |
|-----------|--------|---------------|-------------|-----------------------|--------------------------|-----------------|--------------|---------------|
| Ch. | MHz | | | | | Spot check data | | Original data |
| | | | | | | Measured SAR | Reported SAR | |
| 661 | 1880.0 | Head | Right Cheek | 30.21 | 31.0 | 0.735 | 0.88 | 0.97 |
| 512 | 1850.2 | Body | Rear | 30.32 | 31.0 | 0.324 | 0.38 | 0.55 |

J.3. Graph Results for Spot Check

GSM850 Head

Date: 2022-3-3

Electronics: DAE4 Sn786

Medium: Head 835MHz

Medium parameters used (interpolated): $f = 836.6$ MHz; $\sigma = 0.928$ S/m; $\epsilon_r = 40.326$; $\rho = 1000$ kg/m³

Communication System: UID 0, GSM (0) Frequency: 836.6 MHz Duty Cycle: 1:8.3

Probe: ES3DV3 – SN3151 ConvF (6.40, 6.40, 6.40);

Left Cheek Middle/Area Scan (61x61x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 0.724 W/kg

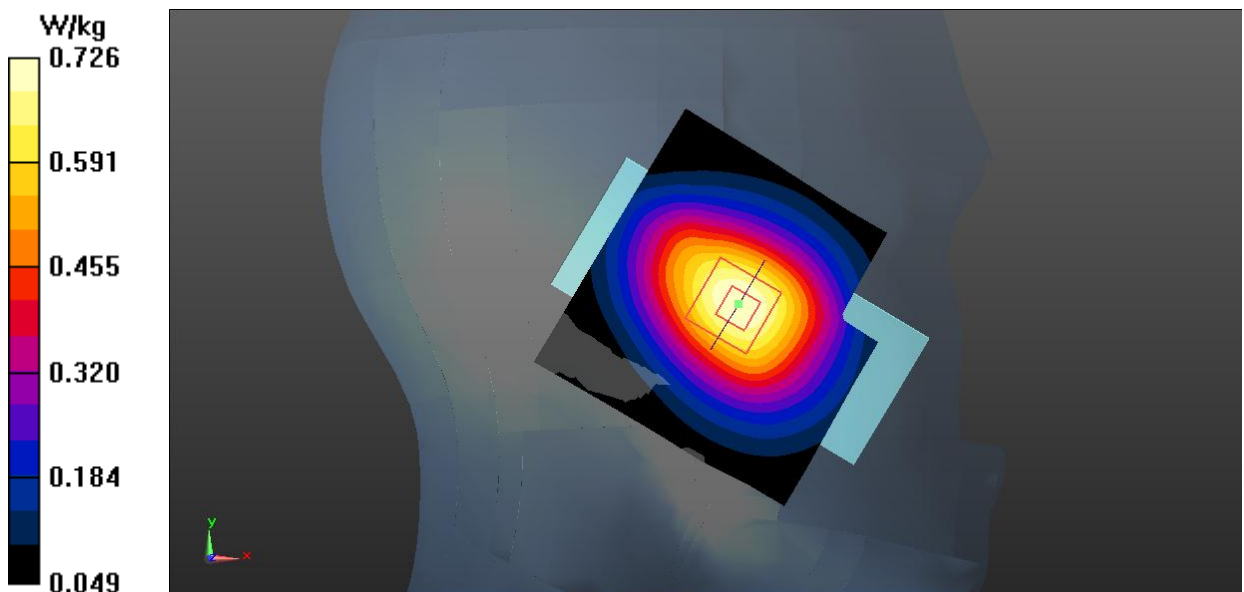
Left Cheek Middle/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 10.45 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 0.835 W/kg

SAR(1 g) = 0.620 W/kg; SAR(10 g) = 0.435 W/kg

Maximum value of SAR (measured) = 0.726 W/kg



GSM850 Body

Date: 2022-3-3

Electronics: DAE4 Sn786

Medium: Head 835MHz

Medium parameters used (interpolated): $f = 848.8$ MHz; $\sigma = 0.94$ S/m; $\epsilon_r = 40.179$; $\rho = 1000$ kg/m³

Communication System: UID 0, GSM (0) Frequency: 848.8 MHz Duty Cycle: 1:8.3

Probe: ES3DV3 – SN3151 ConvF (6.40, 6.40, 6.40);

Rear Side High/Area Scan (61x91x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 0.828 W/kg

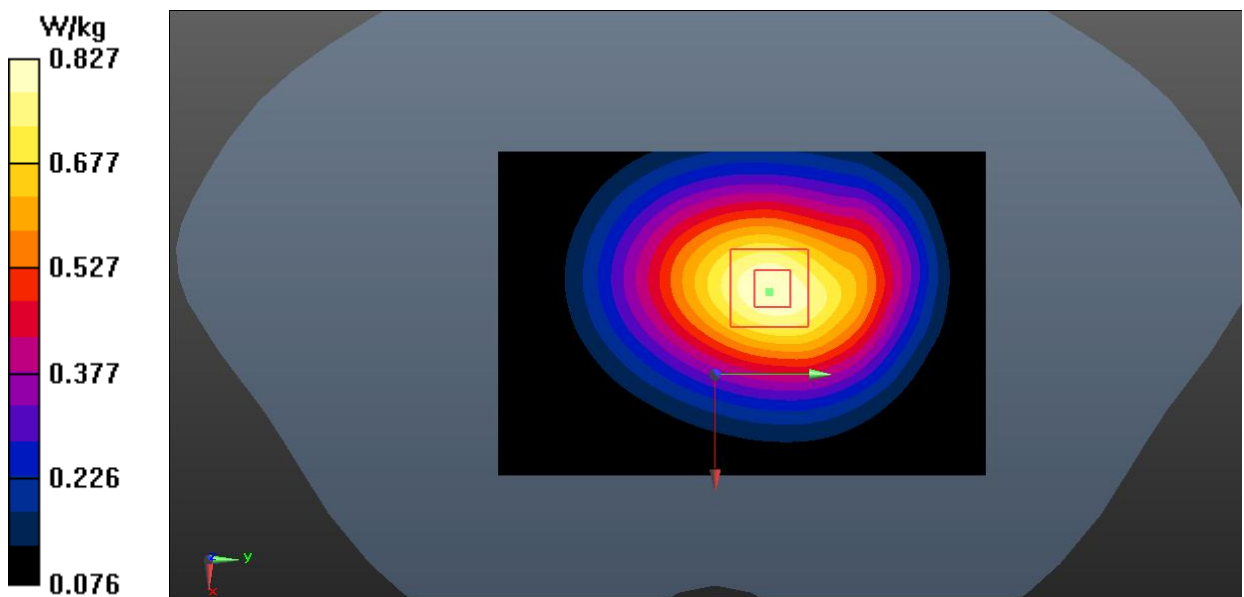
Rear Side High/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 24.60 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 0.943 W/kg

SAR(1 g) = 0.685 W/kg; SAR(10 g) = 0.479 W/kg

Maximum value of SAR (measured) = 0.827 W/kg



GSM1900 Head

Date: 2022-3-3

Electronics: DAE4 Sn786

Medium: Head 1900MHz

Medium parameters used: $f = 1880$ MHz; $\sigma = 1.411$ S/m; $\epsilon_r = 39.585$; $\rho = 1000$ kg/m³

Communication System: UID 0, GSM (0) Frequency: 1880 MHz Duty Cycle: 1:8.3

Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

Right Cheek Middle/Area Scan (61x61x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 1.02 W/kg

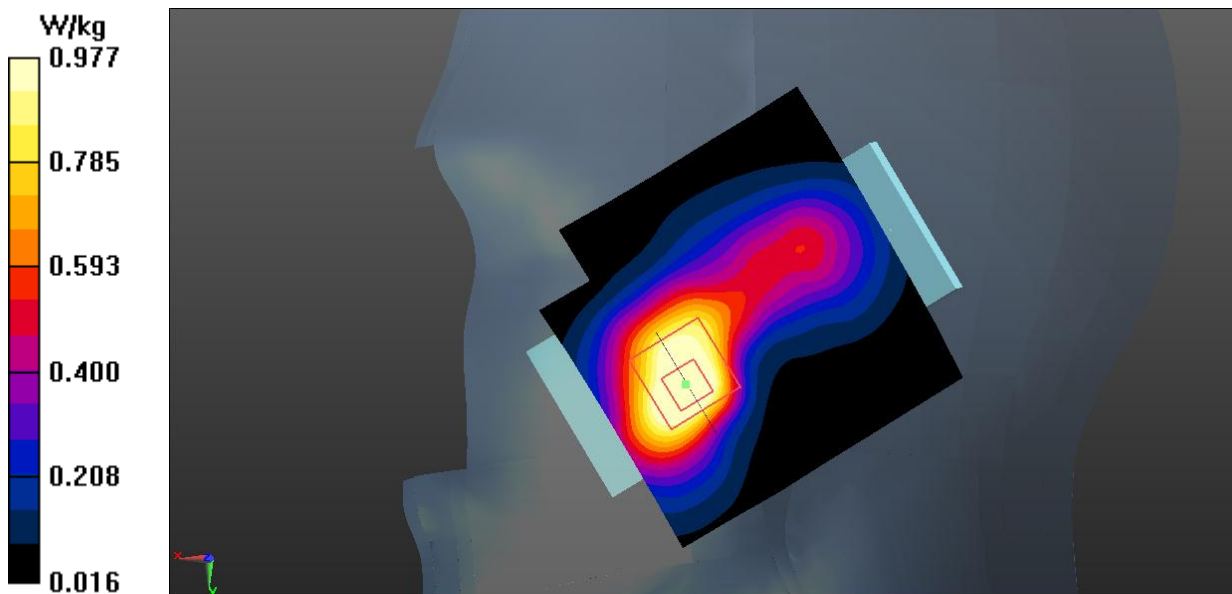
Right Cheek Middle/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 10.40 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 1.20 W/kg

SAR(1 g) = 0.735 W/kg; SAR(10 g) = 0.426 W/kg

Maximum value of SAR (measured) = 0.977 W/kg



GSM1900 Body

Date: 2022-3-3

Electronics: DAE4 Sn786

Medium: Head 1900MHz

Medium parameters used (interpolated): $f = 1850.2$ MHz; $\sigma = 1.385$ S/m; $\epsilon_r = 39.70$; $\rho = 1000$ kg/m³

Communication System: UID 0, GSM (0) Frequency: 1850.2 MHz Duty Cycle: 1:8.3

Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

Rear Side Low/Area Scan (61x91x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 0.458 W/kg

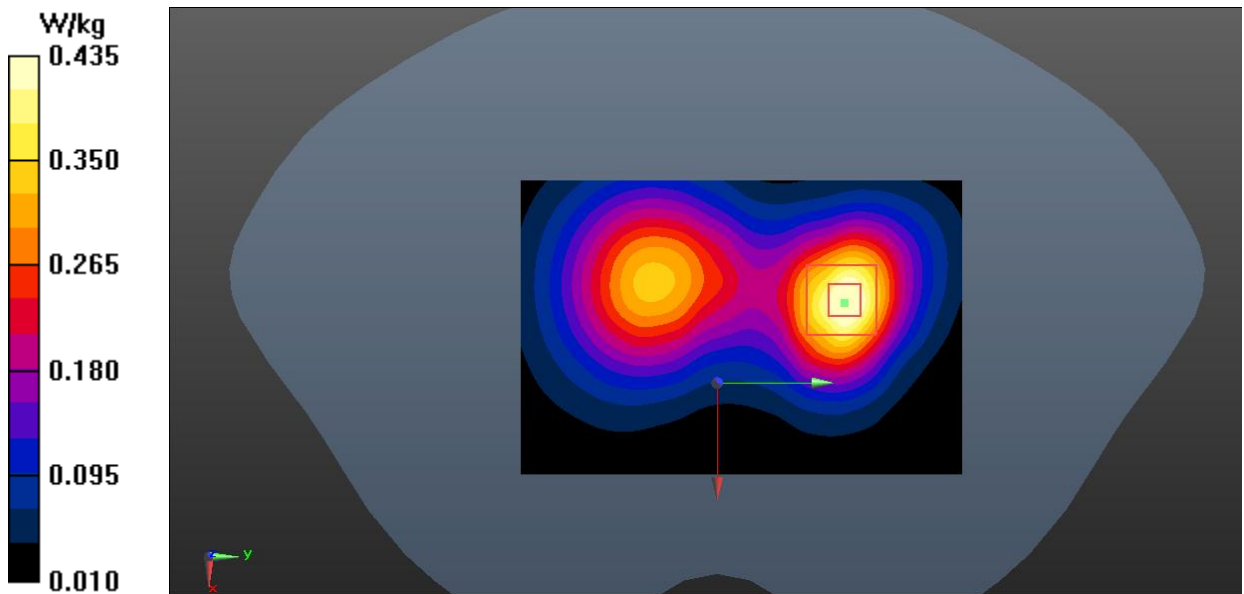
Rear Side Low/Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8$ mm, $dy=8$ mm, $dz=5$ mm

Reference Value = 10.84 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 0.540 W/kg

SAR(1 g) = 0.324 W/kg; SAR(10 g) = 0.189 W/kg

Maximum value of SAR (measured) = 0.435 W/kg



J.4. System Verification Results for Spot Check

835MHz

Date: 2022-3-3

Electronics: DAE4 Sn786

Medium: Head 835MHz

Medium parameters used: $f = 835 \text{ MHz}$; $\sigma = 0.927 \text{ S/m}$; $\epsilon_r = 40.345$; $\rho = 1000 \text{ kg/m}^3$

Communication System: CW_TMC Frequency: 835 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (6.40, 6.40, 6.40);

System Validation/Area Scan (91x161x1): Interpolated grid: $dx=1.000 \text{ mm}$, $dy=1.000 \text{ mm}$

Reference Value = 65.822 V/m; Power Drift = 0.08 dB

SAR(1 g) = 2.44 W/kg; SAR(10 g) = 1.58 W/kg

Maximum value of SAR (interpolated) = 3.37 W/kg

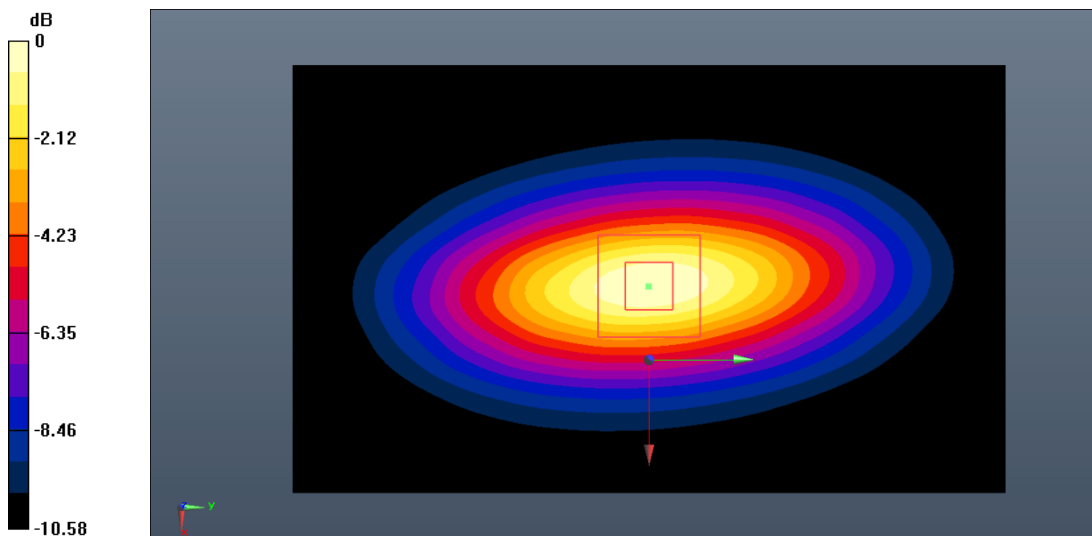
System Validation /Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 65.822 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 4.06 W/kg

SAR(1 g) = 2.48 W/kg; SAR(10 g) = 1.60 W/kg

Maximum value of SAR (measured) = 3.40 W/kg



0 dB = 3.40 W/kg = 5.31 dB W/kg

1900MHz

Date: 2022-3-3

Electronics: DAE4 Sn786

Medium: Head 1900MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.429$ S/m; $\epsilon_r = 39.507$; $\rho = 1000$ kg/m³

Communication System: CW_TMC Frequency: 1900 MHz Duty Cycle: 1:1

Probe: ES3DV3 – SN3151 ConvF (5.09, 5.09, 5.09);

System Validation/Area Scan (91x91x1): Interpolated grid: $dx=1.000$ mm, $dy=1.000$ mm

Reference Value = 83.248 V/m; Power Drift = 0.12 dB

SAR(1 g) = 10.0 W/kg; SAR(10 g) = 5.12 W/kg

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

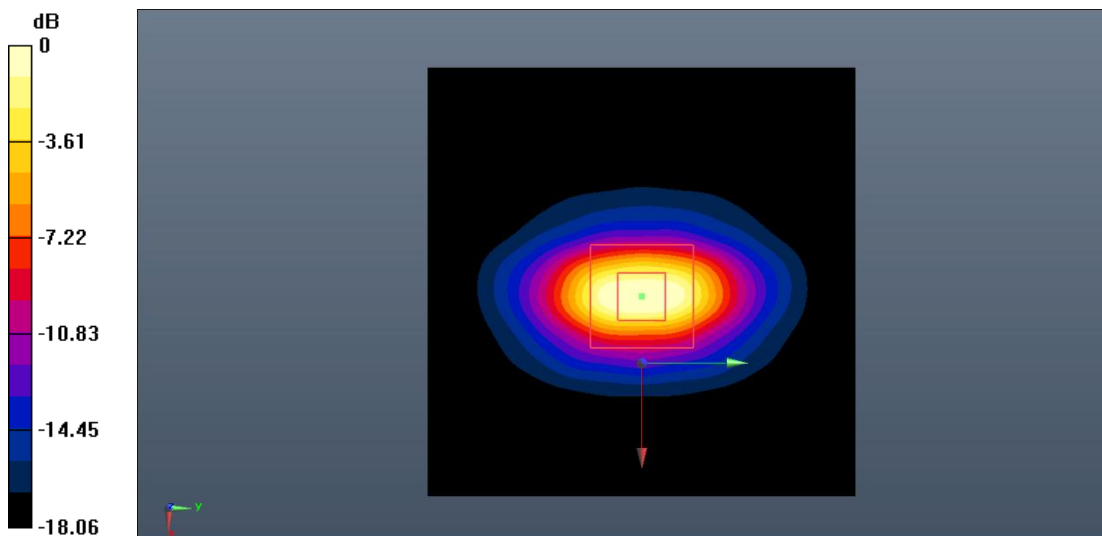
System Validation/Zoom Scan (7x7x7)/Cube0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 83.248 V/m; Power Drift = 0.12 dB

Peak SAR (extrapolated) = 24.4 W/kg

SAR(1 g) = 10.3 W/kg; SAR(10 g) = 5.19 W/kg

Maximum value of SAR (measured) = 12.3 W/kg



0 dB = 12.3 W/kg = 10.90 dB W/kg

*****END OF REPORT*****