

SAR TEST REPORT

Report Reference No. : LCS170831044-SAR

Date of Issue : Nov. 14, 2017

Testing Laboratory Name : Shenzhen LCS Compliance Testing Laboratory Ltd.

Address : 1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China

Applicant's Name : Quanzhou HengLiDa Tel-Equipment Co.,Ltd.

Address : 659 Xingpu, Xiamei Town, Nan'an City, Fujian Province, China

Test Specification

Standard : IEEE 1528:2013
47CFR §2.1093

Test Report Form No. : LCSEMC-1.0

TRF Originator : Shenzhen LCS Compliance Testing Laboratory Ltd.

Master TRF : Dated 2011-03

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Test Item Description : Two-way Radio

Trade Mark :  HengLiDa 亨利达

Model/Type reference : T-M6P

Listed Models : N/A

Modulation Type : FM

Ratings : DC 3.70V

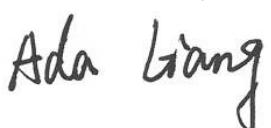
Hardware version : T-M3D VER6.0

Software version : T-M3

Date of Test : Nov. 13, 2017

Result : Pass

Compiled by:



Ada Liang/ File administrators

Supervised by:



Glin Lu/ Technique principal

Approved by:



Gavin Liang/ Manager

TEST REPORT

| | | |
|--------------------------|-------------------------|--------------------------------|
| Test Report No. : | LCS170831042-SAR | Nov. 14, 2017 Date of issue |
|--------------------------|-------------------------|--------------------------------|

Equipment under Test : Two way radio
Model /Type : T-M6P
Listed Models : N/A
Applicant : Quanzhou HengLiDa Tel-Equipment Co.,Ltd.
Address : 659 Xingpu, Xiamei Town, Nan'an City, Fujian Province,China
Manufacturer : Quanzhou HengLiDa Tel-Equipment Co.,Ltd.
Address : 659 Xingpu, Xiamei Town, Nan'an City, Fujian Province,China

| | |
|--------------------|---------------|
| Test result | Pass * |
|--------------------|---------------|

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

**** Modified History ****

| Revision | Issue Date | Revisions | Revised By |
|----------|---------------|---------------|-------------|
| 00 | Nov. 14, 2017 | Initial Issue | Gavin Liang |
| | | | |
| | | | |

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1. TEST STANDARDS

The tests were performed according to following standards:

[IEEE 1528-2013 \(2014-06\)](#): Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques

[IEEE Std. C95-3 \(2002\)](#): IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave

[IEEE Std. C95-1 \(1992\)](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

[IEC 62209-2 \(2010\)](#): Human exposure to radio frequency fields from hand-held and bodymounted wireless communication devices. Human models, instrumentation, and procedures. 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)

[KDB 865664D01v01r04](#): SAR Measurement Requirements for 100 MHz to 6 GHz

[KDB 865664D02v01r02](#): RF Exposure Compliance Reporting and Documentation Considerations

[447498 D01 General RF Exposure Guidance v06](#): Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies

[2015 October TCB Workshop](#): SAR may be scaled if radio is tested at lower power without overheating as invalid SAR results cannot be scaled to compensate for power droop

2. SUMMARY

2.1. Product Description

| | |
|--------------------|-----------------------|
| Name of EUT | Two-way Radio |
| Model Number | T-M6P |
| Power Supply | DC 3.70V from battery |
| Frequency Range | 462.55MHz-462.725MHz |
| Rate Power | 0.5W |
| Modulation Type | FM |
| Channel Separation | 12.5KHz |
| Antenna Type | Integral antenna |
| Antennal Gain | 2.0dBi |

Frequency list

| Channel | Frequency(MHz) | Type |
|---------|----------------|------|
| 1 | 462.5500 | FRS |
| 2 | 462.5625 | FRS |
| 3 | 462.5750 | FRS |
| 4 | 462.5875 | FRS |
| 5 | 462.6000 | FRS |
| 6 | 462.6125 | FRS |
| 7 | 462.6250 | FRS |
| 8 | 462.6375 | FRS |
| 9 | 462.6500 | FRS |
| 10 | 462.6625 | FRS |
| 11 | 462.6750 | FRS |
| 12 | 462.6875 | FRS |
| 13 | 462.7000 | FRS |
| 14 | 462.7125 | FRS |
| 15 | 462.7250 | FRS |

2.2. Summary SAR Results

The maximum of results of SAR found during testing are follows:

<Highest Reported standalone SAR Summary>

| Mode | Channel Separation | Frequency (MHz) | Position | Maximum Report SAR Results (W/kg) | |
|------|--------------------|-----------------|-----------|-----------------------------------|----------------|
| | | | | 100% duty cycle | 50% duty cycle |
| FRS | 12.5KHz | 462.6375 | Face-held | 1.06 | 0.53 |
| FRS | 12.5KHz | 462.6375 | Body-Worn | 1.16 | 0.58 |

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013.

2.3. EUT operation mode

The spatial peak SAR values were assessed for UHF systems. Battery and accessories shall be specified by the manufacturer. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output.

2.4. TEST Configuration

Face-Held Configuration

Face-held Configuration- per FCC KDB447498 "A test separation distance of 25 mm must be applied for in-front-of the face SAR test exclusion and SAR measurements."

Body-worn Configuration

Body-worn measurements-per FCC KDB447498 "When body-worn accessory SAR testing is required, the body-worn accessory requirements in section 4.2.2 should be applied. PTT two-way radios that support held-to-ear operating mode must also be tested according to the exposure configurations required for handsets. This generally does not apply to cellphones with PTT options that have already been tested in more conservative configurations in applicable wireless modes for SAR compliance at 100% duty factor."

3. TEST ENVIRONMENT

3.1. Address of the test laboratory

Shenzhen LCS Compliance Testing Laboratory Ltd.
1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China

There is one 3m semi-anechoic chamber fulfils CISPR 16-1-4 according to ANSI C63.10:2013 and CISPR 16-1-4:2010 SVSWR requirement for radiated emission above 1GHz.

1.3.2 Laboratory accreditation

The test facility is recognized, certified, or accredited by the following organizations:

CNAS Registration Number. is L4595.

FCC Designation Number. is CN5024.

Industry Canada Registration Number. is 9642A-1.

ESMD Registration Number. is ARCB0108.

UL Registration Number. is 100571-492.

TUV SUD Registration Number. is SCN1081.

TUV RH Registration Number. is UA 50296516-001

3.2. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

| | |
|-----------------------|--------------|
| Temperature: | 18-25 ° C |
| Humidity: | 40-65 % |
| Atmospheric pressure: | 950-1050mbar |

3.3. SAR Limits

FCC Limit (1g Tissue)

| Exposure Limits | SAR (W/kg) | |
|---|--|--|
| | (General Population / Uncontrolled Exposure Environment) | (Occupational / Controlled Exposure Environment) |
| Spatial Average (averaged over the whole body) | 0.08 | 0.4 |
| Spatial Peak (averaged over any 1 g of tissue) | 1.60 | 8.0 |
| Spatial Peak (hands/wrists/feet/ankles averaged over 10 g) | 4.0 | 20.0 |

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

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

3.4. Equipments Used during the Test

| Test Equipment | Manufacturer | Type/Model | Serial Number | Calibration | |
|-----------------------------------|--------------|------------|---------------|------------------|----------------------|
| | | | | Last Calibration | Calibration Interval |
| Data Acquisition Electronics DAEx | SPEAG | DAE4 | 1315 | 2017/07/26 | 1 |
| E-field Probe | SPEAG | EX3DV4 | 3836 | 2017/07/07 | 1 |
| System Validation Dipole D450V3 | SPEAG | D450V3 | 1072 | 2015/11/25 | 3 |
| Network analyzer | Agilent | 8753E | US37390562 | 2017/03/05 | 1 |
| Dielectric Probe Kit | Agilent | 85070E | US44020288 | / | / |
| Power meter | Agilent | E4417A | GB41292254 | 2016/12/15 | 1 |
| Power sensor | Agilent | 8481H | MY41095360 | 2016/12/15 | 1 |
| Power sensor | Agilent | 8481H | MY41095361 | 2016/12/15 | 1 |
| Signal generator | IFR | 2032 | 203002/100 | 2017/10/12 | 1 |
| Amplifier | AR | 75A250 | 302205 | 2017/10/12 | 1 |

Note:

- 1) Per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three year extended calibration interval. Each measured dipole is expected to evaluate with following criteria at least on annual interval.
 - a) There is no physical damage on the dipole;
 - b) System check with specific dipole is within 10% of calibrated values;
 - c) The most recent return-loss results, measured at least annually, deviates by no more than 20% from the previous measurement;
 - d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 50 Ω from the previous measurement.
- 2) Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

4. SAR Measurements System configuration

4.1. SAR Measurement Set-up

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

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

A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.

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

A unit to operate the optical surface detector which is connected to the EOC.

The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.

The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows 2003.

DASY5 software and SEMCAD data evaluation software.

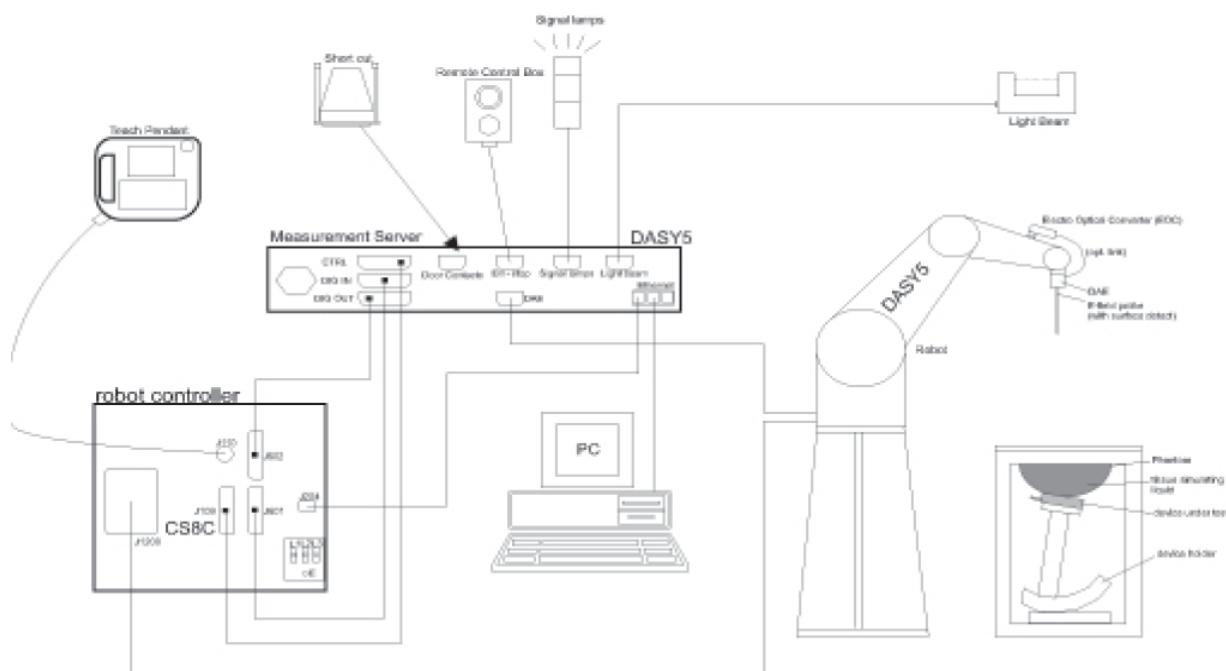
Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.

The generic twin phantom enabling the testing of left-hand and right-hand usage.

The device holder for handheld Mobile Phones.

Tissue simulating liquid mixed according to the given recipes.

System validation dipoles allowing to validate the proper functioning of the system.



4.2. DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe ES3DV3 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

Probe Specification

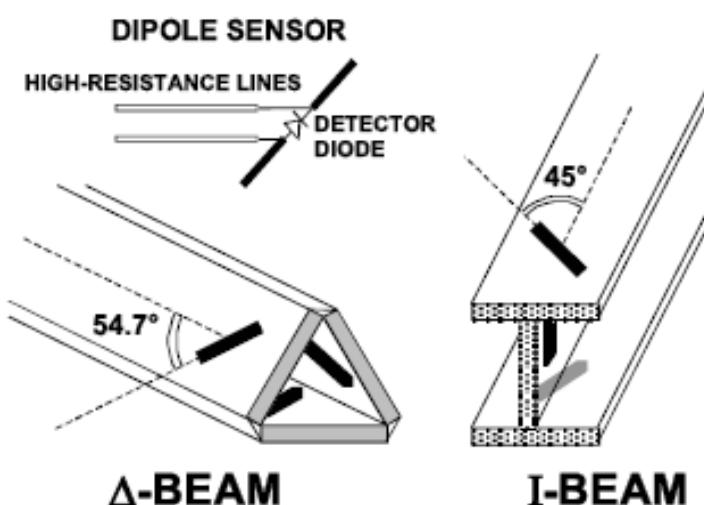
| | |
|---------------|--|
| Construction | Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |
| Calibration | ISO/IEC 17025 calibration service available. |
| Frequency | 10 MHz to 4 GHz; Linearity: ± 0.2 dB (30 MHz to 4 GHz) |
| Directivity | ± 0.2 dB in HSL (rotation around probe axis) ± 0.3 dB in tissue material (rotation normal to probe axis) |
| Dynamic Range | 5 μ W/g to > 100 mW/g; Linearity: ± 0.2 dB |
| Dimensions | Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm |
| Application | General dosimetry up to 4 GHz Dosimetry in strong gradient fields Compliance tests of Mobile Phones |
| Compatibility | DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI |



Isotropic E-Field Probe

The isotropic E-Field probe has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change.

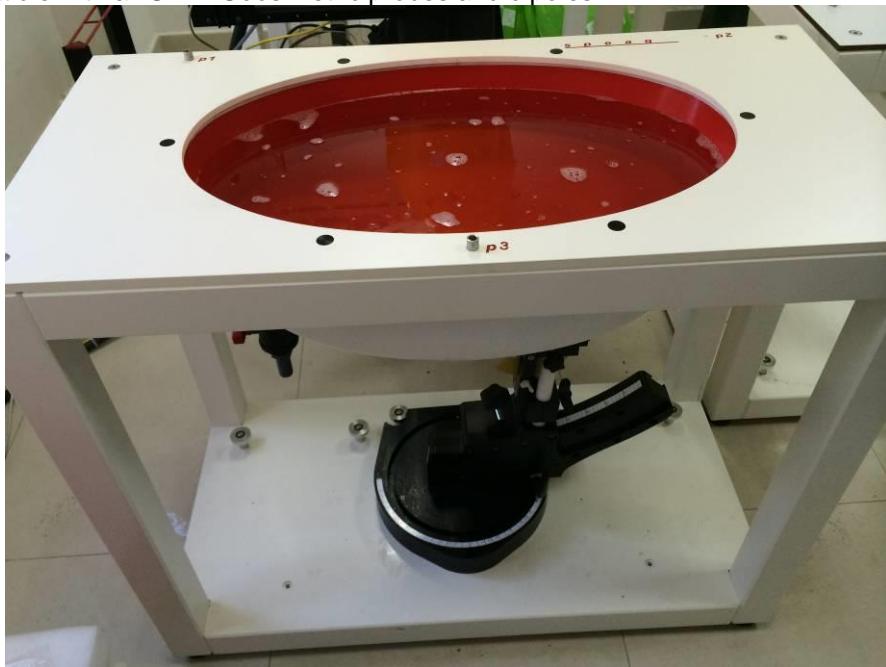
The E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below:



4.3. Phantoms

Phantom for compliance testing of handheld andbody-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissuesimulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A

cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.

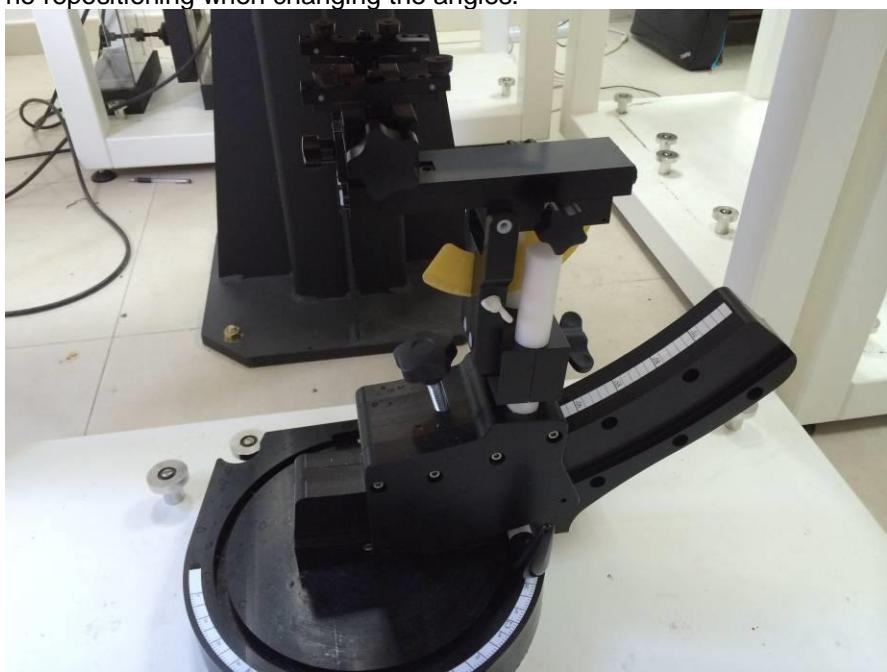


ELI Phantom

4.4. Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SPEAG as an integral part of the DASY system.

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.



Device holder supplied by SPEAG

4.5. Scanning Procedure

The DASY5 installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

The “reference” and “drift” measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT’s output power and should vary max. $\pm 5\%$.

The “surface check” measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above $\pm 0.1\text{mm}$). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe (It does not depend on the surface reflectivity or the probe angle to the surface within $\pm 30^\circ$.)

Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values before running a detailed measurement around the hot spot. Before starting the area scan a grid spacing of 15 mm x 15 mm is set. During the scan the distance of the probe to the phantom remains unchanged. After finishing area scan, the field maxima within a range of 2 dB will be ascertained.

Zoom Scan

Zoom Scans are used to estimate the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default Zoom Scan is done by 7x7x7 points within a cube whose base is centered around the maxima found in the preceding area scan.

Spatial Peak Detection

The procedure for spatial peak SAR evaluation has been implemented and can determine values of masses of 1g and 10g, as well as for user-specific masses. The DASY5 system allows evaluations that combine measured data and robot positions, such as:

- maximum search
- extrapolation
- boundary correction
- peak search for averaged SAR

During a maximum search, global and local maxima searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard’s method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation. Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Zoom Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard’s method for extrapolation. For a grid using 7x7x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1g and 10g cubes.

A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube 7x7x7 scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 5mm steps.

4.6. Data Storage and Evaluation

Data Storage

The DASY5 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension “.DA4”. The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [$^\circ\text{C}$], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

Data Evaluation

The SEMCAD software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

| | | |
|--------------------|---------------------------|----------------------|
| Probe parameters: | - Sensitivity | Normi, ai0, ai1, ai2 |
| | - Conversion factor | ConvFi |
| | - Diode compression point | Dcp <i>i</i> |
| Device parameters: | - Frequency | f |
| | - Crest factor | cf |
| Media parameters: | - Conductivity | σ |
| | - Density | ρ |

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY5 components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcpi}$$

With V_i = compensated signal of channel i ($i = x, y, z$)
 U_i = input signal of channel i ($i = x, y, z$)
 cf = crest factor of exciting field (DASY parameter)
 $dcpi$ = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

$$E - \text{fieldprobes} : E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$H - \text{fieldprobes} : H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

With V_i = compensated signal of channel i ($i = x, y, z$)
 $Norm_i$ = sensor sensitivity of channel i ($i = x, y, z$)
 $[mV/(V/m)2]$ for E-field Probes
 $ConvF$ = sensitivity enhancement in solution
 aij = sensor sensitivity factors for H-field probes
 f = carrier frequency [GHz]
 E_i = electric field strength of channel i in V/m
 H_i = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

with SAR = local specific absorption rate in mW/g
 E_{tot} = total field strength in V/m
 σ = conductivity in [mho/m] or [Siemens/m]
 ρ = equivalent tissue density in g/cm³

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

4.7. SAR Measurement System

The SAR measurement system being used is the DASY5 system, the system is controlled remotely from a PC, which contains the software to control the robot and data acquisition equipment. The software also displays the data obtained from test scans.

In operation, the system first does an area (2D) scan at a fixed depth within the liquid from the inside wall of the phantom. When the maximum SAR point has been found, the system will then carry out a 3D scan centred at that point to determine volume averaged SAR level.

4.7.1 Tissue Dielectric Parameters for Head and Body Phantoms

The liquid is consisted of water, salt, Glycol, Sugar, Preventol and Cellulose. The liquid has previously been proven to be suited for worst-case. It's satisfying the latest tissue dielectric parameters requirements proposed by the KDB865664.

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

(ϵ_r = relative permittivity, σ = conductivity and $\rho = 1000 \text{ kg/m}^3$)

4.8. Dielectric Performance

Dielectric performance of Head and Body tissue simulating liquid.

Composition of the Head Tissue Equivalent Matter

| Mixture % | Frequency (Brain) 450MHz |
|------------------------------------|--|
| Water | 38.56 |
| Sugar | 56.32 |
| Salt | 3.95 |
| Preventol | 0.10 |
| Cellulose | 1.07 |
| Dielectric Parameters Target Value | f=450MHz $\epsilon_r=43.5$ $\sigma=0.87$ |

Composition of the Body Tissue Equivalent Matter

| Mixture % | Frequency (Brain) 450MHz |
|------------------------------------|--|
| Water | 56.16 |
| Sugar | 46.78 |
| Salt | 1.49 |
| Preventol | 0.10 |
| Cellulose | 0.47 |
| Dielectric Parameters Target Value | f=450MHz $\epsilon_r=56.7$ $\sigma=0.94$ |

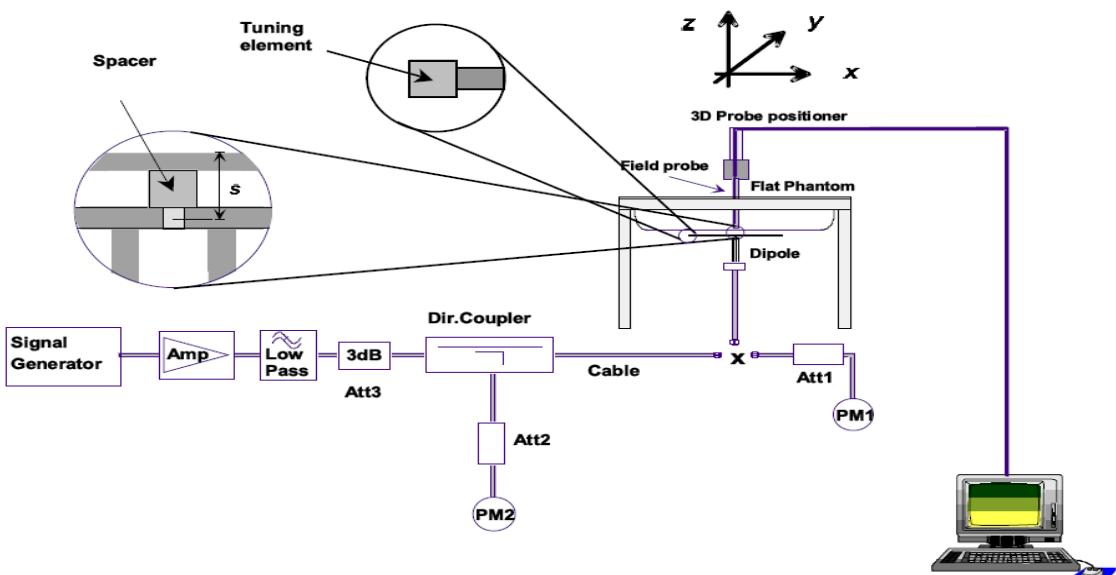
| Tissue Type | Measured Frequency (MHz) | Target Tissue | | Measured Tissue | | Dev. % | | Liquid Temp. | Test Data |
|-------------|--------------------------|---------------|----------|-----------------|----------|--------------|----------|--------------|------------|
| | | ϵ_r | σ | ϵ_r | σ | ϵ_r | σ | | |
| 450H | 450 | 43.5 | 0.87 | 43.9 | 0.88 | 0.92% | 1.15% | 22.2 degree | 2017-11-13 |
| 450B | 450 | 56.7 | 0.93 | 56.1 | 0.94 | -1.06% | 1.08% | 22.2 degree | 2017-11-13 |

4.9. System Check

The purpose of the system check is to verify that the system operates within its specifications at the device test frequency. The system check is simple check of repeatability to make sure that the system works correctly at the time of the compliance test;

System check results have to be equal or near the values determined during dipole calibration with the relevant liquids and test system ($\pm 10\%$).

System check is performed regularly on all frequency bands where tests are performed with the DASY5 system.



The output power on dipole port must be calibrated to 30 dBm (1000mW) before dipole is connected.

Justification for Extended SAR Dipole Calibrations

Referring to KDB 865664D01V01r04, if dipoles are verified in return loss (<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended. While calibration intervals not exceed 3 years.

System Check in Head Tissue Simulating Liquid

| Freq | Test Date | Temp | 250mW Measured | | 1W Normalized | | 1W Target | | Limit ($\pm 10\%$ Deviation) | |
|--------|------------|------|-------------------|--------------------|-------------------|--------------------|-------------------|--------------------|-------------------------------|--------------------|
| | | | SAR _{1g} | SAR _{10g} | SAR _{1g} | SAR _{10g} | SAR _{1g} | SAR _{10g} | SAR _{1g} | SAR _{10g} |
| 450MHz | 2017/11/13 | 22.2 | 1.251 | 0.802 | 5.004 | 3.208 | 4.57 | 3.07 | 4.86% | 1.50% |

System Check in Body Tissue Simulating Liquid

| Freq | Test Date | Temp | 250mW Measured | | 1W Normalized | | 1W Target | | Limit ($\pm 10\%$ Deviation) | |
|--------|------------|------|-------------------|--------------------|-------------------|--------------------|-------------------|--------------------|-------------------------------|--------------------|
| | | | SAR _{1g} | SAR _{10g} | SAR _{1g} | SAR _{10g} | SAR _{1g} | SAR _{10g} | SAR _{1g} | SAR _{10g} |
| 450MHz | 2017/11/13 | 22.2 | 1.162 | 0.784 | 4.648 | 3.136 | 4.48 | 2.95 | 1.09% | -0.85% |

Note:

1. The graph results see system check.
2. Target Values used derive from the calibration certificate

4.10. Measurement Procedures

Tests to be performed

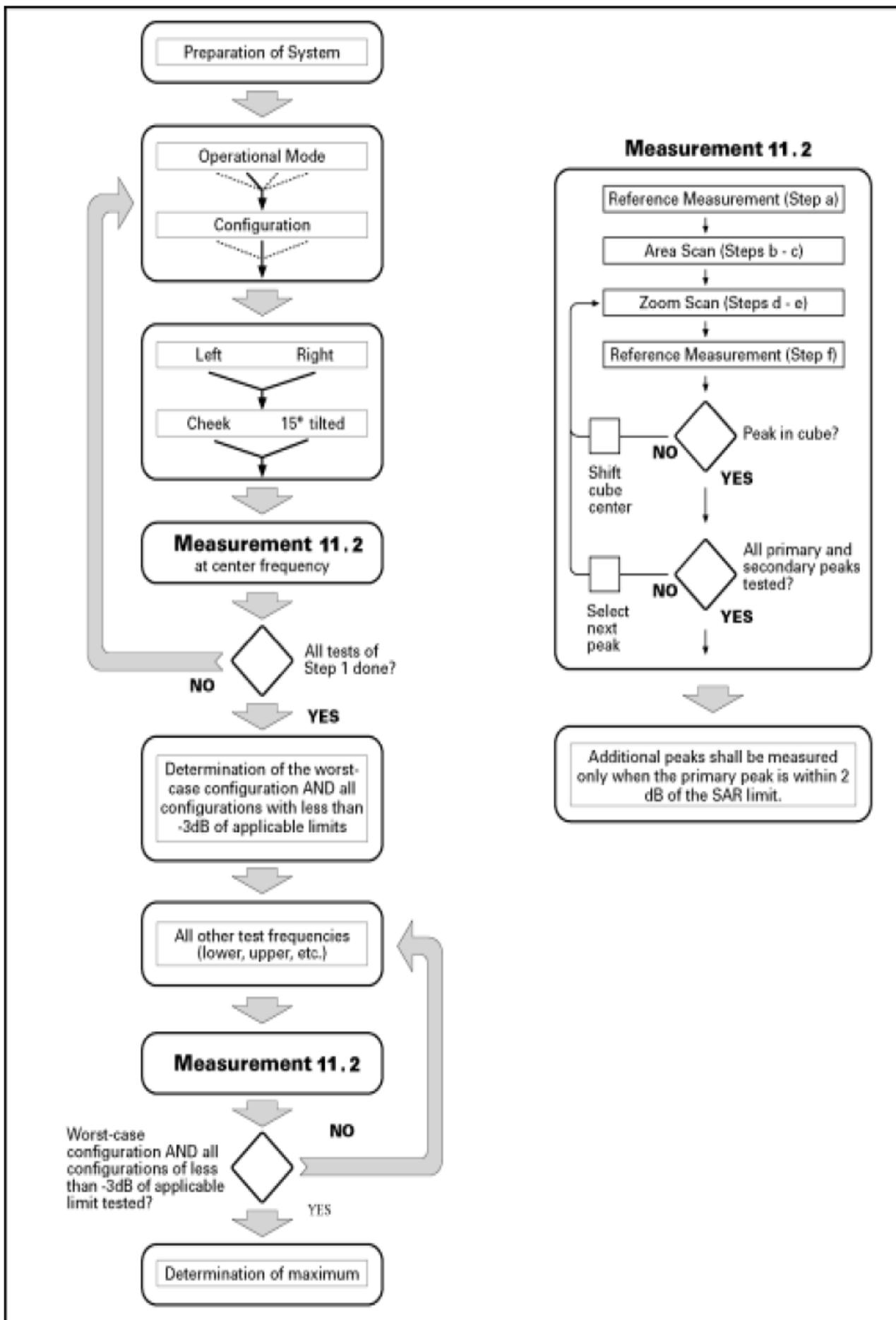
In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in Picture 11

Step 1: The tests described in 11.2 shall be performed at the channel that is closest to the centre of the transmit frequency band (f_c) for:

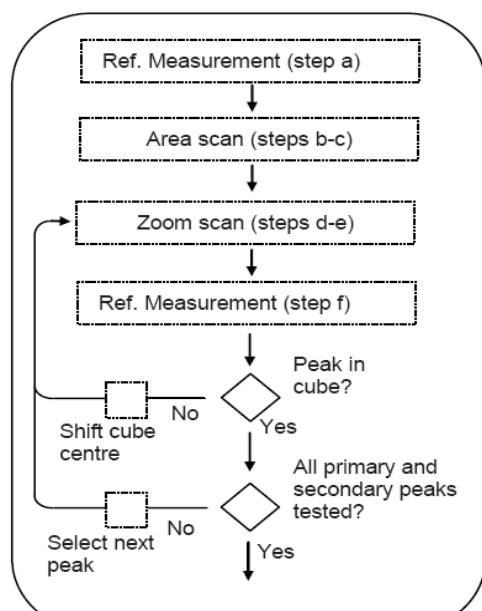
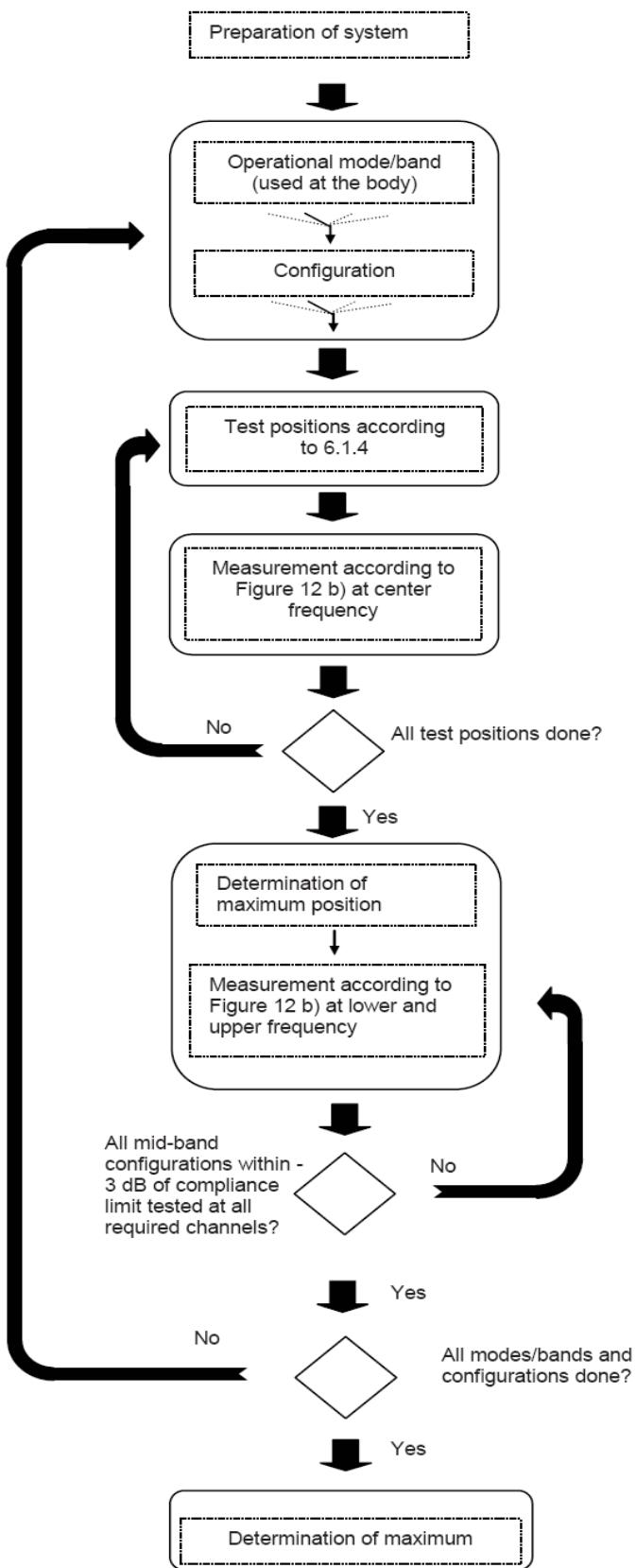
- a) all device positions (cheek and tilt, for both left and right sides of the SAM phantom, as described in Chapter 8),
- b) all configurations for each device position in a), e.g., antenna extended and retracted, and
- c) all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.
- d) 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 11.2 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 11 Block diagram of the tests to be performed



Additional peaks shall be measured only when the primary peak is within 2 dB of the AR limit.

Figure 12b – General procedure

Figure 12a – Tests to be performed

Picture 12 Block diagram of the tests to be performed

Measurement procedure

The following procedure shall be performed for each of the test conditions (see Picture 11) described in 11.1:

- a) Measure the local SAR at a test point within 8 mm or less in the normal direction from the inner surface of the phantom.
- b) Measure the two-dimensional SAR distribution within the phantom (area scan procedure). The boundary of the measurement area shall not be closer than 20 mm from the phantom side walls. The distance between the measurement points should enable the detection of the location of local maximum with an accuracy of better than half the linear dimension of the tissue cube after interpolation. A maximum grip spacing of 20 mm for frequencies below 3 GHz and $(60/f [GHz])$ mm for frequencies of 3GHz and greater is recommended. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz and $\delta\ln(2)/2$ mm for frequencies of 3 GHz and greater, where δ is the plane wave skin depth and $\ln(x)$ is the natural logarithm. The maximum variation of the sensor-phantom surface shall be ± 1 mm for frequencies below 3 GHz and ± 0.5 mm for frequencies of 3 GHz and greater. At all measurement points the angle of the probe with respect to the line normal to the surface should be less than 5°. If this cannot be achieved for a measurement distance to the phantom inner surface shorter than the probe diameter, additional measurement distance to the phantom inner surface shorter than the probe diameter, additional
- c) From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that are not within the zoom-scan volume; additional peaks shall be measured only when the primary peak is within 2 dB of the SAR limit. This is consistent with the 2 dB threshold already stated;
- d) Measure the three-dimensional SAR distribution at the local maxima locations identified in step
- e) The horizontal grid step shall be $(24 / f[GHz])$ mm or less but not more than 8 mm. The minimum zoom size of 30 mm by 30 mm and 30 mm for frequencies below 3 GHz. For higher frequencies, the minimum zoom size of 22 mm by 22 mm and 22 mm. The grip step in the vertical direction shall be $(8-f[GHz])$ mm or less but not more than 5 mm, if uniform spacing is used. If variable spacing is used in the vertical direction, the maximum spacing between the two closest measured points to the phantom shell shall be $(12 / f[GHz])$ mm or less but not more than 4 mm, and the spacing between father points shall increase by an incremental factor not exceeding 1.5. When variable spacing is used, extrapolation routines shall be tested with the same spacing as used in measurements. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz and $\delta\ln(2)/2$ mm for frequencies of 3 GHz and greater, where δ is the plane wave skin depth and $\ln(x)$ is the natural logarithm. Separate grids shall be centered on each of the local SAR maxima found in step c). Uncertainties due to field distortion between the media boundary and the dielectric enclosure of the probe should also be minimized, which is achieved is the distance between the phantom surface and physical tip of the probe is larger than probe tip diameter. Other methods may utilize correction procedures for these boundary effects that enable high precision measurements closer than half the probe diameter. For all measurement points, the angle of the probe with respect to the flat phantom surface shall be less than 5°. If this cannot be achieved an additional uncertainty evaluation is needed.
- f) Use post processing(e.g. interpolation and extrapolation) procedures to determine the local SAR values at the spatial resolution needed for mass averaging.

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 Table 2 to Table 6 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

5. TEST CONDITIONS AND RESULTS

5.1. Conducted Power Results

<FRS ERP Power>

According KDB 447498 D01 General RF Exposure Guidance v06 section 4.1.2) states that "Unless it is specified differently in the published RF exposure KDB procedures, these requirements also apply to test reduction and test exclusion considerations. Time-averaged maximum conducted output power applies to SAR and, as required by § 2.1091(c), time-averaged ERP applies to MPE. When an antenna port is not available on the device to support conducted power measurement, such as FRS and certain Part 15 transmitters with built-in integral antennas, the maximum output power allowed for production units should be used to determine RF exposure test exclusion and compliance."

SAR may be scaled if radio is tested at lower power without overheating as invalid SAR results cannot be scaled to compensate for power droop according to October 2015 TCB Workshop.

| Modulation Type | Channel Separation | Test Frequency | Measured Average ERP Power | |
|-----------------|--------------------|----------------|----------------------------|---------|
| | | | (dBm) | (Watts) |
| FM | 12.5KHz | 462.6375 | 26.47 | 0.4436 |

Manufacturing tolerance

| | FRS (Average ERP Power) |
|-----------------|--------------------------|
| Frequency (MHz) | 462.6375 |
| Target (dBm) | 26.00 |
| Tolerance ±(dB) | 1.0 |

5.2. Transmit Antennas



5.3. Standalone SAR Test Exclusion Considerations

Per KDB447498 for standalone 1-g head or body SAR evaluation by measurement or numerical simulation is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied.

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR, where}$

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz

- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

| Standalone SAR test exclusion considerations | | | | | | | |
|--|-----------------|---------------|-----------------------------|--------------------------|--------------------|--------------------------|--------------------------|
| Communication system | Frequency (MHz) | Configuration | Maximum Average Power (dBm) | Separation Distance (mm) | Calculation Result | SAR Exclusion Thresholds | Standalone SAR Exclusion |
| FRS | 462.6375 | Head Face | 27 | 25 | 13.6 | 3.0 | no |
| | | Body worn | 27 | 5 | 68.2 | 3.0 | no |

Remark:

1. When the minimum test separation distance is < 5 mm, a distance of 5 mm applied to determine SAR test exclusion
2. PTT devices standalone SAR test exclusion considerations should at 50% duty cycle.
3. CW mode states duty cycle is 100%, PTT mode states duty cycle is 50%.

5.4. Standalone SAR Test Exclusion Considerations and Estimated SAR

Per KDB447498 requires when the standalone SAR test exclusion of section 4.3.1 is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to the following to determine simultaneous transmission SAR test exclusion;

- (max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] • [√f(GHz)/x] W/kg for test separation distances ≤ 50 mm;
where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.
- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm

Per FCC KD B447498 D01, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the transmitting antenna in a specific physical test configuration is ≤ 1.6 W/Kg. When the sum is greater than the SAR limit, SAR test exclusion is determined by the SAR to peak location separation ratio.

$$\text{Ratio} = \frac{(\text{SAR}_1 + \text{SAR}_2)^{1.5}}{(\text{peak location separation, mm})} < 0.04$$

| Estimated stand alone SAR | | | | | | |
|---------------------------|-----------------|---------------|---|--------------------------|-------------------------------------|----------------|
| Communication system | Frequency (MHz) | Configuration | Maximum Power (including tune-up tolerance) (dBm) | Separation Distance (mm) | Estimated SAR _{1-g} (W/kg) | |
| | | | | | 100% Duty Cycle | 50% Duty Cycle |
| N/A | N/A | Head Face | N/A | N/A | N/A | N/A |
| N/A | N/A | Body Worn | N/A | N/A | N/A | N/A |

Remark:

1. When the minimum test separation distance is < 5 mm, a distance of 5 mm applied to determine SAR test exclusion

5.5. Test reduction procedure

The maximum power level, $P_{\max,m}$, that can be transmitted by a device before the SAR averaged over a mass, m, exceeds a given limit, SAR_{\lim} , can be defined. Any device transmitting at power levels below $P_{\max,m}$ can then be excluded from SAR testing. The lowest possible value for $P_{\max,m}$ is: $P_{\max,m} = \text{SAR}_{\lim} * \square m$.

5.6. SAR Measurement Results

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

| Test Frequency MHz | Mode | Maximum Allowed Power (dBm) | Measured ERP (dBm) | Test Configuration | Measurement SAR _{1-g} (W/Kg) | | Power drift | Scaling Factor | Reported SAR _{1-g} (W/kg) | | SAR limit 1g (W/kg) | Ref. Plot |
|--|------|-----------------------------|--------------------|--------------------|---------------------------------------|----------------|-------------|----------------|------------------------------------|----------------|---------------------|-----------|
| | | | | | 100% Duty Cycle | 50% Duty Cycle | | | 100% Duty Cycle | 50% Duty Cycle | | |
| The EUT display towards phantom for 12.5 KHz (Analog, face held, 25mm distance) | | | | | | | | | | | | |
| 462.6375 | FRS | 27.00 | 26.47 | Face Held | 0.94 | 0.470 | -0.03 | 1.13 | 1.06 | 0.53 | 1.60 | 1 |
| The EUT display towards ground for 12.5 KHz (Analog, Body-Worn, 0mm distance) | | | | | | | | | | | | |
| 462.6375 | FRS | 27.00 | 26.47 | Body Worn | 1.03 | 0.515 | -0.08 | 1.13 | 1.16 | 0.58 | 1.60 | 2 |

Note:

- When devices that are designed to operate on the body of users using lanyards and straps, or without requiring additional body-worn accessories, must be tested for SAR compliance using a conservative minimum test separation distance ≤ 5 mm to support compliance refer to KDB447498.
- Except when area scan based 1-g SAR estimation applies, a zoom scan measurement is required at the highest peak SAR location determined in the area scan to determine the 1-g SAR. When the 1-g SAR of the highest peak is within 2 dB of the SAR limit, additional zoom scans are required for other peaks within 2 dB of the highest peak that have not been included in any zoom scan to ensure there is no increase in SAR refer to KDB865664D01v01r04.
- PTT devices standalone SAR test exclusion considerations should at 50% duty cycle.
- CW mode states duty cycle is 100%, PTT mode states duty cycle is 50%.

5.7. Simultaneous TX SAR Considerations

5.7.1 Introduction

For the DUT, only with FRS modular, share only one antenna, not need consider simultaneous transmission;

5.7.2 Evaluation of Simultaneous SAR

N/A

5.8. 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.

- Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
- When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
- 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).
- 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 .

The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.

| Frequency (MHz) | Mode | Test Position | Repeated SAR (yes/no) | Highest Measured SAR _{1-g} (W/kg) | First Repeated | |
|-----------------|------|---------------|-----------------------|--|------------------------------------|-------------------------------|
| | | | | | Measured SAR _{1-g} (W/kg) | Largest to Smallest SAR Ratio |
| 462.6375 | FRS | Face Held | yes | 0.94 | 0.99 | 1.05 |
| | | Body Worn | yes | 1.03 | 1.10 | 1.07 |

5.9. Measurement Uncertainty (300-3GHz)

According to IEC62209-1/IEEE 1528:2013

| 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 | 5.50% | N | 1 | 1 | 1 | 5.50% | 5.50% | ∞ |
| 2 | Axial isotropy | B | 4.70% | R | $\sqrt{3}$ | 0.7 | 0.7 | 1.90% | 1.90% | ∞ |
| 3 | Hemispherical isotropy | B | 9.60% | R | $\sqrt{3}$ | 0.7 | 0.7 | 3.90% | 3.90% | ∞ |
| 4 | Boundary Effects | B | 1.00% | R | $\sqrt{3}$ | 1 | 1 | 0.60% | 0.60% | ∞ |
| 5 | Probe Linearity | B | 4.70% | R | $\sqrt{3}$ | 1 | 1 | 2.70% | 2.70% | ∞ |
| 6 | Detection limit | B | 1.00% | R | $\sqrt{3}$ | 1 | 1 | 0.60% | 0.60% | ∞ |
| 7 | RF ambient conditions-noise | B | 0.00% | R | $\sqrt{3}$ | 1 | 1 | 0.00% | 0.00% | ∞ |
| 8 | RF ambient conditions-reflection | B | 0.00% | R | $\sqrt{3}$ | 1 | 1 | 0.00% | 0.00% | ∞ |
| 9 | Response time | B | 0.80% | R | $\sqrt{3}$ | 1 | 1 | 0.50% | 0.50% | ∞ |
| 10 | Integration time | B | 5.00% | R | $\sqrt{3}$ | 1 | 1 | 2.90% | 2.90% | ∞ |
| 11 | RF ambient | B | 3.00% | R | $\sqrt{3}$ | 1 | 1 | 1.70% | 1.70% | ∞ |
| 12 | Probe positioned mech. restrictions | B | 0.40% | R | $\sqrt{3}$ | 1 | 1 | 0.20% | 0.20% | ∞ |
| 13 | Probe positioning with respect to phantom shell | B | 2.90% | R | $\sqrt{3}$ | 1 | 1 | 1.70% | 1.70% | ∞ |
| 14 | Max.SAR evalation | B | 3.90% | R | $\sqrt{3}$ | 1 | 1 | 2.30% | 2.30% | ∞ |
| Test Sample Related | | | | | | | | | | |
| 15 | Test sample positioning | A | 1.86% | N | 1 | 1 | 1 | 1.86% | 1.86% | ∞ |
| 16 | Device holder uncertainty | A | 1.70% | N | 1 | 1 | 1 | 1.70% | 1.70% | ∞ |
| 17 | Drift of output power | B | 5.00% | R | $\sqrt{3}$ | 1 | 1 | 2.90% | 2.90% | ∞ |
| Phantom and Set-up | | | | | | | | | | |
| 18 | Phantom uncertainty | B | 4.00% | R | $\sqrt{3}$ | 1 | 1 | 2.30% | 2.30% | ∞ |
| 19 | Liquid conductivity (target) | B | 5.00% | R | $\sqrt{3}$ | 0.64 | 0.43 | 1.80% | 1.20% | ∞ |
| 20 | Liquid conductivity (meas.) | A | 0.50% | N | 1 | 0.64 | 0.43 | 0.32% | 0.26% | ∞ |
| 21 | Liquid permittivity (target) | B | 5.00% | R | $\sqrt{3}$ | 0.64 | 0.43 | 1.80% | 1.20% | ∞ |

| | | | | | | | | | | |
|--|--|---|-------|-----|---|------|------|--------|--------|----------|
| 22 | Liquid cpermittivity (meas.) | A | 0.16% | N | 1 | 0.64 | 0.43 | 0.10% | 0.07% | ∞ |
| Combined standard uncertainty | $u_c = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$ | / | / | / | / | / | / | 10.20% | 10.00% | ∞ |
| Expanded uncertainty (confidence interval of 95 %) | $u_e = 2u_c$ | / | R | K=2 | / | / | / | 20.40% | 20.00% | ∞ |

According to IEC62209-2/2010

| 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 | 6.20% | N | 1 | 1 | 1 | 6.20% | 6.20% | ∞ |
| 2 | Axial isotropy | B | 4.70% | R | $\sqrt{3}$ | 0.7 | 0.7 | 1.90% | 1.90% | ∞ |
| 3 | Hemispherical isotropy | B | 9.60% | R | $\sqrt{3}$ | 0.7 | 0.7 | 3.90% | 3.90% | ∞ |
| 4 | Boundary Effects | B | 2.00% | R | $\sqrt{3}$ | 1 | 1 | 1.20% | 1.20% | ∞ |
| 5 | Probe Linearity | B | 4.70% | R | $\sqrt{3}$ | 1 | 1 | 2.70% | 2.70% | ∞ |
| 6 | Detection limit | B | 1.00% | R | $\sqrt{3}$ | 1 | 1 | 0.60% | 0.60% | ∞ |
| 7 | RF ambient conditions-noise | B | 0.00% | R | $\sqrt{3}$ | 1 | 1 | 0.00% | 0.00% | ∞ |
| 8 | RF ambient conditions-reflection | B | 0.00% | R | $\sqrt{3}$ | 1 | 1 | 0.00% | 0.00% | ∞ |
| 9 | Response time | B | 0.80% | R | $\sqrt{3}$ | 1 | 1 | 0.50% | 0.50% | ∞ |
| 10 | Integration time | B | 5.00% | R | $\sqrt{3}$ | 1 | 1 | 2.90% | 2.90% | ∞ |
| 11 | RF Ambient | B | 3.00% | R | $\sqrt{3}$ | 1 | 1 | 1.70% | 1.70% | ∞ |
| 12 | Probe positioned mech. restrictions | B | 0.80% | R | $\sqrt{3}$ | 1 | 1 | 0.50% | 0.50% | ∞ |
| 13 | Probe positioning with respect to phantom shell | B | 6.70% | R | $\sqrt{3}$ | 1 | 1 | 3.90% | 3.90% | ∞ |
| 14 | Max.SAR Evaluation | B | 3.90% | R | $\sqrt{3}$ | 1 | 1 | 2.30% | 2.30% | ∞ |
| 15 | Modulation Response | B | 2.40% | R | $\sqrt{3}$ | 1 | 1 | 1.40% | 1.40% | ∞ |
| Test Sample Related | | | | | | | | | | |
| 16 | Test sample positioning | A | 1.86% | N | 1 | 1 | 1 | 1.86% | 1.86% | ∞ |
| 17 | Device holder uncertainty | A | 1.70% | N | 1 | 1 | 1 | 1.70% | 1.70% | ∞ |

| | | | | | | | | | | |
|--|--|---|-------|-----|------------|------|------|--------|--------|----------|
| 18 | Drift of output power | B | 5.00% | R | $\sqrt{3}$ | 1 | 1 | 2.90% | 2.90% | ∞ |
| Phantom and Set-up | | | | | | | | | | |
| 19 | Phantom uncertainty | B | 6.10% | R | $\sqrt{3}$ | 1 | 1 | 3.50% | 3.50% | ∞ |
| 20 | SAR correction | B | 1.90% | R | $\sqrt{3}$ | 1 | 0.84 | 1.11% | 0.90% | ∞ |
| 21 | Liquid conductivity (target) | B | 5.00% | R | $\sqrt{3}$ | 0.64 | 0.43 | 1.80% | 1.20% | ∞ |
| 22 | Liquid conductivity (meas.) | A | 0.50% | N | 1 | 0.64 | 0.43 | 0.32% | 0.26% | ∞ |
| 23 | Liquid permittivity (target) | B | 5.00% | R | $\sqrt{3}$ | 0.64 | 0.43 | 1.80% | 1.20% | ∞ |
| 24 | Liquid cpermittivity (meas.) | A | 0.16% | N | 1 | 0.64 | 0.43 | 0.10% | 0.07% | ∞ |
| 25 | Temp.Unc.-Conductivity | B | 3.40% | R | $\sqrt{3}$ | 0.78 | 0.71 | 1.50% | 1.40% | ∞ |
| 26 | Temp.Unc.-Permittivity | B | 0.40% | R | $\sqrt{3}$ | 0.23 | 0.26 | 0.10% | 0.10% | ∞ |
| Combined standard uncertainty | $u_c = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$ | / | / | / | / | / | / | 12.90% | 12.70% | ∞ |
| Expanded uncertainty (confidence interval of 95 %) | $u_e = 2u_c$ | / | R | K=2 | / | / | / | 25.80% | 25.40% | ∞ |

Uncertainty of a System Performance Check with DASY5 System

According to IEC62209-2/2010

| 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 | 6.00% | N | 1 | 1 | 1 | 6.00% | 6.00% | ∞ |
| 2 | Axial isotropy | B | 4.70% | R | $\sqrt{3}$ | 0.7 | 0.7 | 1.90% | 1.90% | ∞ |
| 3 | Hemispherical isotropy | B | 0.00% | R | $\sqrt{3}$ | 0.7 | 0.7 | 0.00% | 0.00% | ∞ |
| 4 | Boundary Effects | B | 1.00% | R | $\sqrt{3}$ | 1 | 1 | 0.60% | 0.60% | ∞ |
| 5 | Probe Linearity | B | 4.70% | R | $\sqrt{3}$ | 1 | 1 | 2.70% | 2.70% | ∞ |
| 6 | Detection limit | B | 1.00% | R | $\sqrt{3}$ | 1 | 1 | 0.60% | 0.60% | ∞ |
| 7 | RF ambient conditions-noise | B | 0.00% | R | $\sqrt{3}$ | 1 | 1 | 0.00% | 0.00% | ∞ |
| 8 | RF ambient conditions-reflection | B | 0.00% | R | $\sqrt{3}$ | 1 | 1 | 0.00% | 0.00% | ∞ |
| 9 | Response time | B | 0.80% | R | $\sqrt{3}$ | 1 | 1 | 0.50% | 0.50% | ∞ |
| 10 | Integration time | B | 5.00% | R | $\sqrt{3}$ | 1 | 1 | 2.90% | 2.90% | ∞ |

| | | | | | | | | | | |
|--|---|---|-------|---|------------|------|------|--------|--------|----------|
| 11 | RF Ambient | B | 3.00% | R | $\sqrt{3}$ | 1 | 1 | 1.70% | 1.70% | ∞ |
| 12 | Probe positioned mech. restrictions | B | 0.80% | R | $\sqrt{3}$ | 1 | 1 | 0.50% | 0.50% | ∞ |
| 13 | Probe positioning with respect to phantom shell | B | 6.70% | R | $\sqrt{3}$ | 1 | 1 | 3.90% | 3.90% | ∞ |
| 14 | Max.SAR Evalation | B | 3.90% | R | $\sqrt{3}$ | 1 | 1 | 2.30% | 2.30% | ∞ |
| 15 | Modulation Response | B | 2.40% | R | $\sqrt{3}$ | 1 | 1 | 1.40% | 1.40% | ∞ |
| Test Sample Related | | | | | | | | | | |
| 16 | Test sample positioning | A | 0.00% | N | 1 | 1 | 1 | 0.00% | 0.00% | ∞ |
| 17 | Device holder uncertainty | A | 2.00% | N | 1 | 1 | 1 | 2.00% | 2.00% | ∞ |
| 18 | Drift of output power | B | 3.40% | R | $\sqrt{3}$ | 1 | 1 | 2.00% | 2.00% | ∞ |
| Phantom and Set-up | | | | | | | | | | |
| 19 | Phantom uncertainty | B | 4.00% | R | $\sqrt{3}$ | 1 | 1 | 2.30% | 2.30% | ∞ |
| 20 | SAR correction | B | 1.90% | R | $\sqrt{3}$ | 1 | 0.84 | 1.11% | 0.90% | ∞ |
| 21 | Liquid conductivity (meas.) | A | 0.50% | N | 1 | 0.64 | 0.43 | 0.32% | 0.26% | ∞ |
| 22 | Liquid cpermittivity (meas.) | A | 0.16% | N | 1 | 0.64 | 0.43 | 0.10% | 0.07% | ∞ |
| 23 | Temp.Unc.-Conductivity | B | 1.70% | R | $\sqrt{3}$ | 0.78 | 0.71 | 0.80% | 0.80% | ∞ |
| 24 | Temp.Unc.-Permittivity | B | 0.40% | R | $\sqrt{3}$ | 0.23 | 0.26 | 0.10% | 0.10% | ∞ |
| Combined standard uncertainty | $u_c = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$ | | / | / | / | / | / | 12.90% | 12.70% | ∞ |
| Expanded uncertainty (confidence interval of 95 %) | $u_e = 2u_c$ | | / | R | K=2 | / | / | 18.80% | 18.40% | ∞ |

5.10. System Check Results

System Performance Check at 450 MHz Head TSL

DUT: Dipole450 MHz; Type: D450V2; Serial: 1021

Date/Time: 11/13/2017

Communication System: DuiJiangJi; Frequency: 450 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 450 \text{ MHz}$; $\sigma = 0.88 \text{ S/m}$; $\epsilon_r = 44.4$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV4 – SN3836; ConvF(7.12, 7.12, 7.12); Calibrated: 07/07/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1315; Calibrated: 7/26/2017
- Phantom: ELI 4.0; Type: QDOVA001BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan (61x201x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.50 \text{ mm}$

Maximum value of SAR (interpolated) = 1.33 mW/g

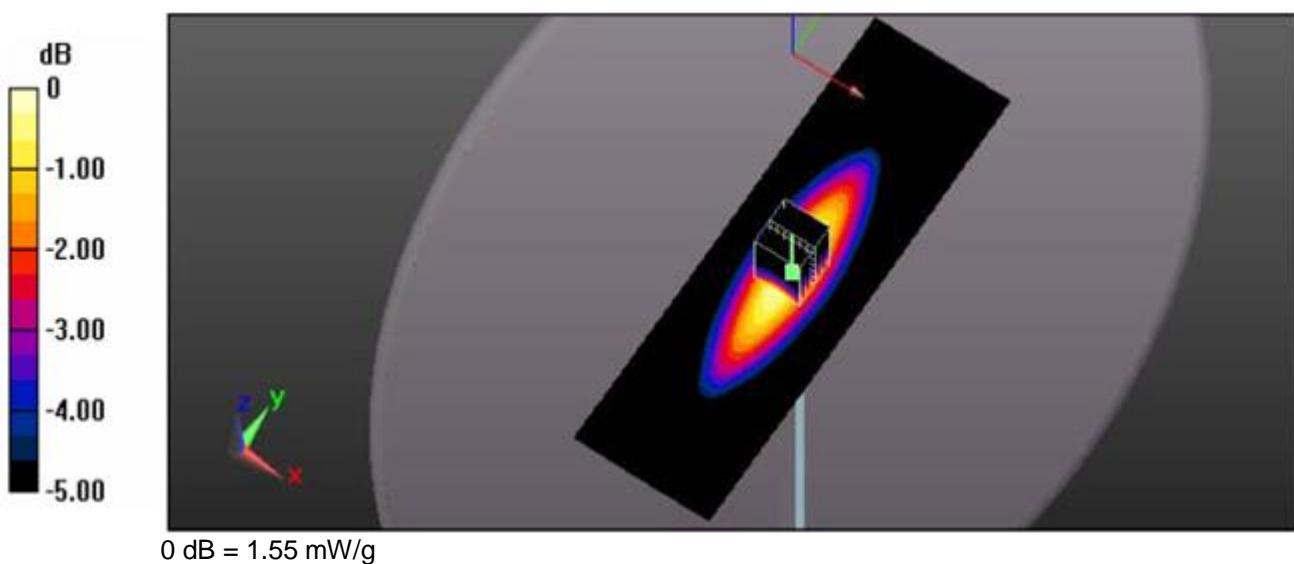
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 40.58 V/m; Power Drift = -0.05dB

Peak SAR (extrapolated) = 1.51 mW/g

SAR(1 g) = 1.251 mW/g; SAR(10 g) = 0.802 mW/g

Maximum value of SAR (measured) = 1.55 mW/g



System Performance Check 450MHz Body 250mW

System Performance Check at 450 MHz Body TSL

DUT: Dipole450 MHz; Type: D450V2; Serial: 1021

Date/Time: 11/13/2017

Communication System: DuiJiangJi; Frequency: 450 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 450 \text{ MHz}$; $\sigma = 0.95 \text{ S/m}$; $\epsilon_r = 57.6$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV4 – SN3836; ConvF(7.33, 7.33, 7.33); Calibrated: 07/07/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1315; Calibrated: 7/26/2017
- Phantom: ELI 4.0; Type: QDOVA001BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan (61x201x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.50 \text{ mm}$

Maximum value of SAR (interpolated) = 1.52 mW/g

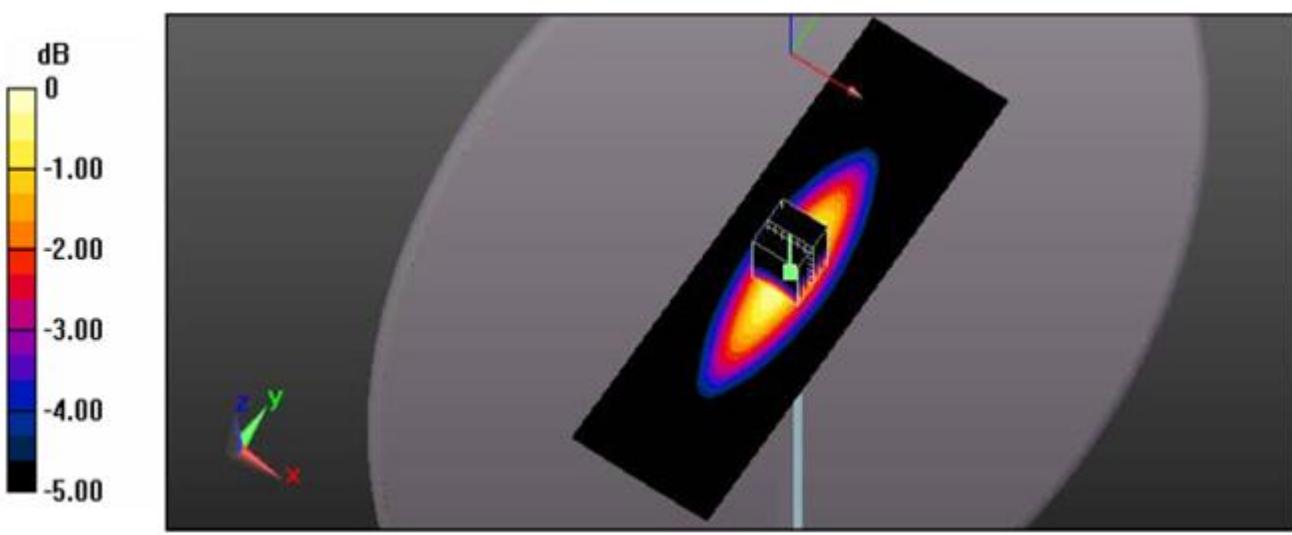
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 45.65 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 1.68 mW/g

SAR(1 g) = 1.162 mW/g; SAR(10 g) = 0.784 mW/g

Maximum value of SAR (measured) = 1.71 mW/g



5.11. SAR Test Graph Results

SAR plots for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination according to FCC KDB 865664 D02

Face Held for FM Modulation at 12.5KHz Channel Separation, Front towards Phantom 462.6375MHz

Date: 11/13/2017

Communication System: PTT 450; Frequency: 462.6375 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 450.0 \text{ MHz}$; $\sigma = 0.89 \text{ S/m}$; $\epsilon_r = 44.7$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV4 – SN3836; ConvF(7.12, 7.12, 7.12); Calibrated: 07/07/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1315; Calibrated: 7/26/2017
- Phantom: ELI 4.0; Type: QDOVA001BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan (51x81x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) = 1.47 W/kg

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 38.58 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 1.75 W/kg

SAR(1 g) = 0.94 W/kg; SAR(10 g) = 0.595 W/kg

Maximum value of SAR (measured) = 1.42 W/kg

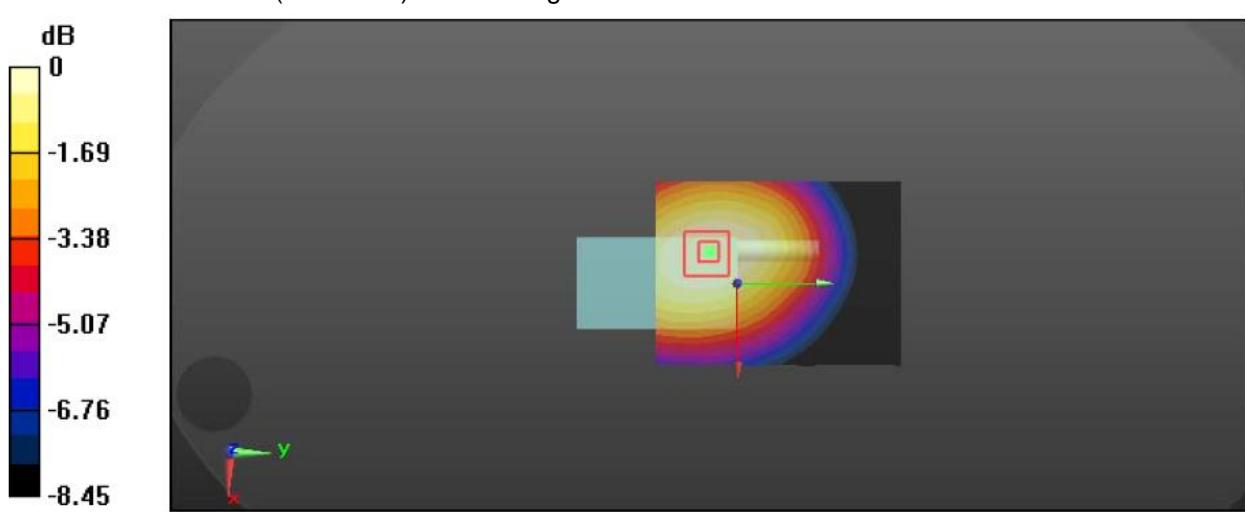


Figure 1: Face held for FM Modulation at 12.5KHz Channel Separation Front towards Phantom 462.6375 MHz

Body- Worn FM Modulation at 12.5KHz Channel Separation, Front towards Ground 462.6375MHz

Date: 11/13/2017

Communication System: PTT 450; Frequency: 462.6375 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 450.0 \text{ MHz}$; $\sigma = 0.97 \text{ S/m}$; $\epsilon_r = 58.85$; $\rho = 1000 \text{ kg/m}^3$

Phantom section : Flat Section

DASY5 Configuration:

- Probe: ES3DV4 – SN3836; ConvF(7.33, 7.33, 7.33); Calibrated: 07/07/2017;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn905; Calibrated: 07/16/2016
- Phantom: ELI 4.0; Type: QDOVA001BA;
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan (51x81x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) = 1.68 W/kg

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 43.37 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 1.99 W/kg

SAR(1 g) = 1.03 W/kg; SAR(10 g) = 0.71 W/kg

Maximum value of SAR (measured) = 1.60 W/kg

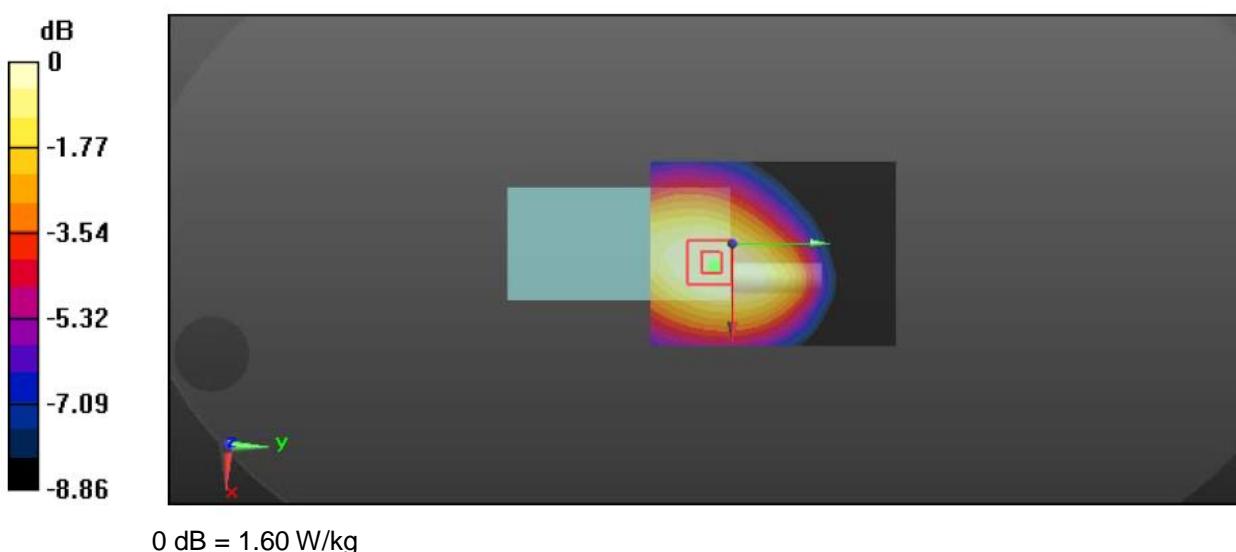


Figure 2: Body-worn for FM Modulation at 12.5KHz Channel Separation; Front towards Ground 462.6375 MHz

6. Calibration Certificate

6.1. Probe Calibration Certificate



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 CNAS L0570

Client

Sunway

Certificate No: Z16-97101

CALIBRATION CERTIFICATE

Object EX3DV4 - SN:3836

Calibration Procedure(s) FD-Z11-2-004-01
 Calibration Procedures for Dosimetric E-field Probes

Calibration date: July 07, 2017

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 | 27-Jun-17 (CTTL, No.J17X04777) | Jun-18 |
| Power sensor NRP-Z91 | 101547 | 27-Jun-17 (CTTL, No.J17X04777) | Jun-18 |
| Power sensor NRP-Z91 | 101548 | 27-Jun-17 (CTTL, No.J17X04777) | Jun-18 |
| Reference10dBAttenuator | 18N50W-10dB | 13-Mar-17(CTTL, No.J17X01547) | Mar-19 |
| Reference20dBAttenuator | 18N50W-20dB | 13-Mar-17(CTTL, No.J17X01548) | Mar-19 |
| Reference Probe EX3DV4 | SN 3617 | 26-Aug-16(SPEAG, No.EX3-3617_Aug15) | Aug-17 |
| DAE4 | SN 1331 | 21-Jan-17(SPEAG, No.DAE4-1331_Jan16) | Jan -18 |
| Secondary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| SignalGeneratorMG3700A | 6201052605 | 27-Jun-17 (CTTL, No.J17X04776) | Jun-18 |
| Network Analyzer E5071C | MY46110673 | 26-Jan-17 (CTTL, No.J17X00894) | Jan -18 |

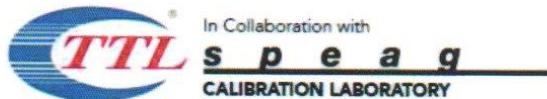
| Calibrated by: | Name | Function | Signature |
|----------------|-------------|-----------------------------------|-----------|
| | Yu Zongying | SAR Test Engineer | |
| Reviewed by: | Qi Dianyuan | SAR Project Leader | |
| Approved by: | Lu Bingsong | Deputy Director of the laboratory | |

Issued: July 08, 2017

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

Certificate No: Z16-97101

Page 1 of 11



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Glossary:

| | |
|-----------------------|---|
| TSL | tissue simulating liquid |
| NORMx,y,z | sensitivity in free space |
| ConvF | sensitivity in TSL / NORMx,y,z |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A,B,C,D | modulation dependent linearization parameters |
| Polarization Φ | Φ rotation around probe axis |
| Polarization θ | θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i $\theta=0$ 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:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)", February 2005
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z*: Assessed for E-field polarization $\theta=0$ ($f \leq 900\text{MHz}$ in TEM-cell; $f > 1800\text{MHz}$: waveguide). *NORMx,y,z* are only intermediate values, i.e., the uncertainties of *NORMx,y,z* does not effect the E^2 -field uncertainty inside TSL (see below ConvF).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- *DCPx,y,z*: DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- *Ax,y,z; Bx,y,z; Cx,y,z; VRx,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 *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from $\pm 50\text{MHz}$ 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 *NORMx* (no uncertainty required).



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Probe EX3DV4

SN: 3836

Calibrated: July 07, 2017

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)



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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3836

Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|--|----------|----------|----------|--------------|
| Norm($\mu\text{V}/(\text{V}/\text{m})^2$) ^A | 0.40 | 0.46 | 0.43 | $\pm 10.8\%$ |
| DCP(mV) ^B | 93.2 | 100.2 | 98.0 | |

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 | 167.8 | $\pm 2.0\%$ |
| | | Y | 0.0 | 0.0 | 1.0 | | 182.5 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 176.7 | |

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 E²-field uncertainty inside TSL (see Page 5 and Page 6).

^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.



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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3836

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) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 450 | 43.5 | 0.87 | 7.12 | 7.12 | 7.12 | 0.20 | 1.30 | ±13.3% |
| 750 | 41.9 | 0.89 | 9.43 | 9.43 | 9.43 | 0.30 | 0.80 | ±12% |
| 835 | 41.5 | 0.90 | 9.42 | 9.42 | 9.42 | 0.15 | 1.58 | ±12% |
| 900 | 41.5 | 0.9 | 9.03 | 9.03 | 9.03 | 0.15 | 1.46 | ±12% |
| 1750 | 40.1 | 1.37 | 8.04 | 8.04 | 8.04 | 0.14 | 1.63 | ±12% |
| 1900 | 40.0 | 1.40 | 7.60 | 7.60 | 7.60 | 0.16 | 1.59 | ±12% |
| 2300 | 39.5 | 1.67 | 7.45 | 7.45 | 7.45 | 0.53 | 0.68 | ±12% |
| 2450 | 39.2 | 1.80 | 7.07 | 7.07 | 7.07 | 0.54 | 0.71 | ±12% |
| 2600 | 39.0 | 1.96 | 6.96 | 6.96 | 6.96 | 0.61 | 0.66 | ±12% |
| 5200 | 36.0 | 4.66 | 5.32 | 5.32 | 5.32 | 0.40 | 1.42 | ±13% |
| 5300 | 35.9 | 4.76 | 5.13 | 5.13 | 5.13 | 0.40 | 1.40 | ±13% |
| 5500 | 35.6 | 4.96 | 4.85 | 4.85 | 4.85 | 0.40 | 1.35 | ±13% |
| 5600 | 35.5 | 5.07 | 4.59 | 4.59 | 4.59 | 0.40 | 1.45 | ±13% |
| 5800 | 35.3 | 5.27 | 4.71 | 4.71 | 4.71 | 0.40 | 1.45 | ±13% |

^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.



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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3836

Calibration Parameter Determined in Body 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) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 450 | 56.7 | 0.94 | 7.33 | 7.33 | 7.33 | 0.13 | 1.50 | ±13.3% |
| 750 | 55.5 | 0.96 | 9.38 | 9.38 | 9.38 | 0.30 | 0.85 | ±12% |
| 835 | 55.2 | 0.97 | 9.25 | 9.25 | 9.25 | 0.17 | 1.44 | ±12% |
| 900 | 55.0 | 1.05 | 8.95 | 8.95 | 8.95 | 0.14 | 1.60 | ±12% |
| 1750 | 53.4 | 1.49 | 7.64 | 7.64 | 7.64 | 0.17 | 1.71 | ±12% |
| 1900 | 53.3 | 1.52 | 7.33 | 7.33 | 7.33 | 0.18 | 1.80 | ±12% |
| 2300 | 52.9 | 1.81 | 7.45 | 7.45 | 7.45 | 0.51 | 0.80 | ±12% |
| 2450 | 52.7 | 1.95 | 7.20 | 7.20 | 7.20 | 0.62 | 0.70 | ±12% |
| 2600 | 52.5 | 2.16 | 6.99 | 6.99 | 6.99 | 0.52 | 0.79 | ±12% |
| 5200 | 49.0 | 5.30 | 4.83 | 4.83 | 4.83 | 0.50 | 1.25 | ±13% |
| 5300 | 48.9 | 5.42 | 4.60 | 4.60 | 4.60 | 0.50 | 1.35 | ±13% |
| 5500 | 48.6 | 5.65 | 4.32 | 4.32 | 4.32 | 0.50 | 1.35 | ±13% |
| 5600 | 48.5 | 5.77 | 4.20 | 4.20 | 4.20 | 0.50 | 1.40 | ±13% |
| 5800 | 48.2 | 6.00 | 4.30 | 4.30 | 4.30 | 0.50 | 1.30 | ±13% |

^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.

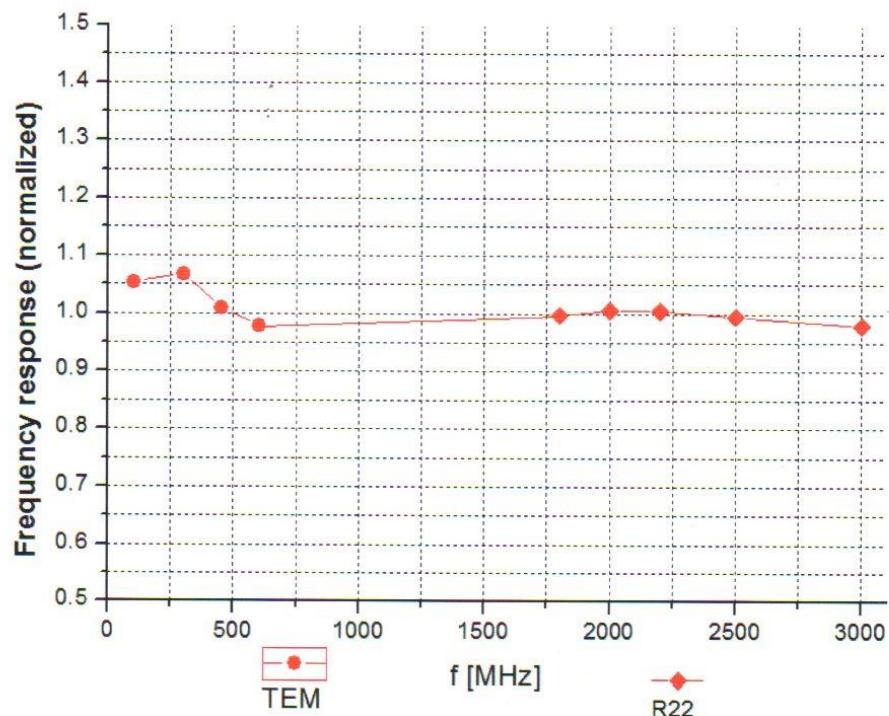
^F At frequency below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty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



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



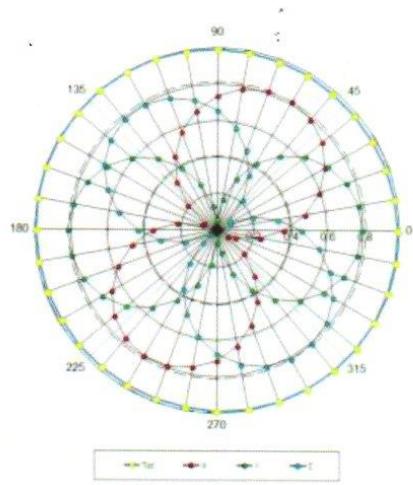
Uncertainty of Frequency Response of E-field: $\pm 7.5\%$ ($k=2$)



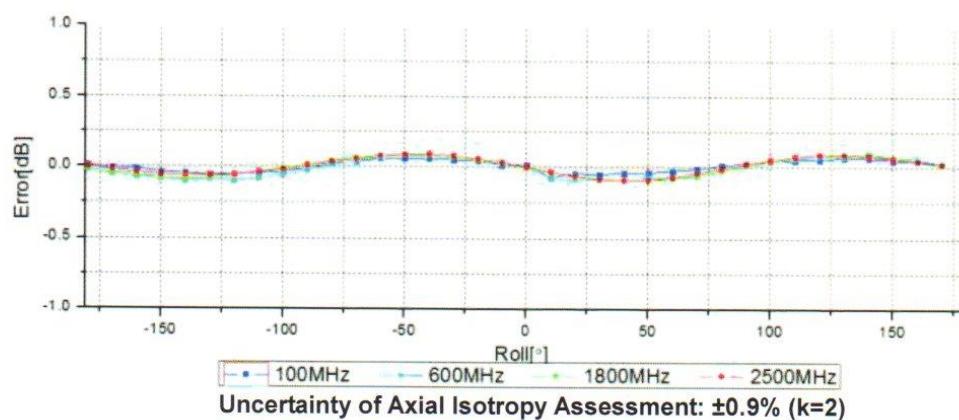
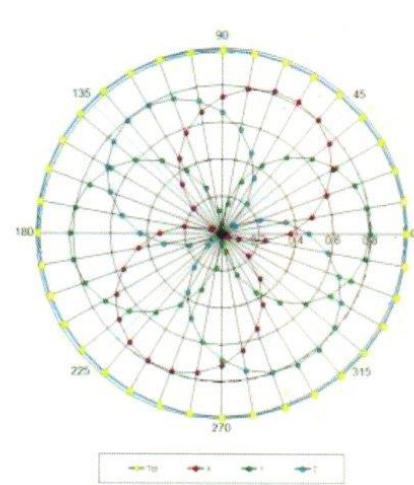
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E-mail: cttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

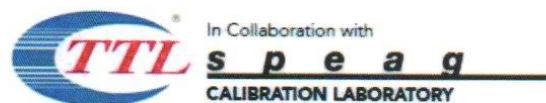
Receiving Pattern (Φ), $\theta=0^\circ$

f=600 MHz, TEM



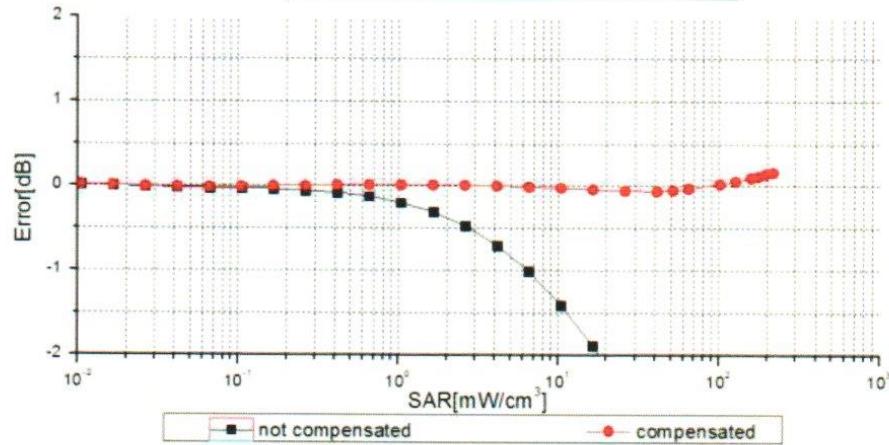
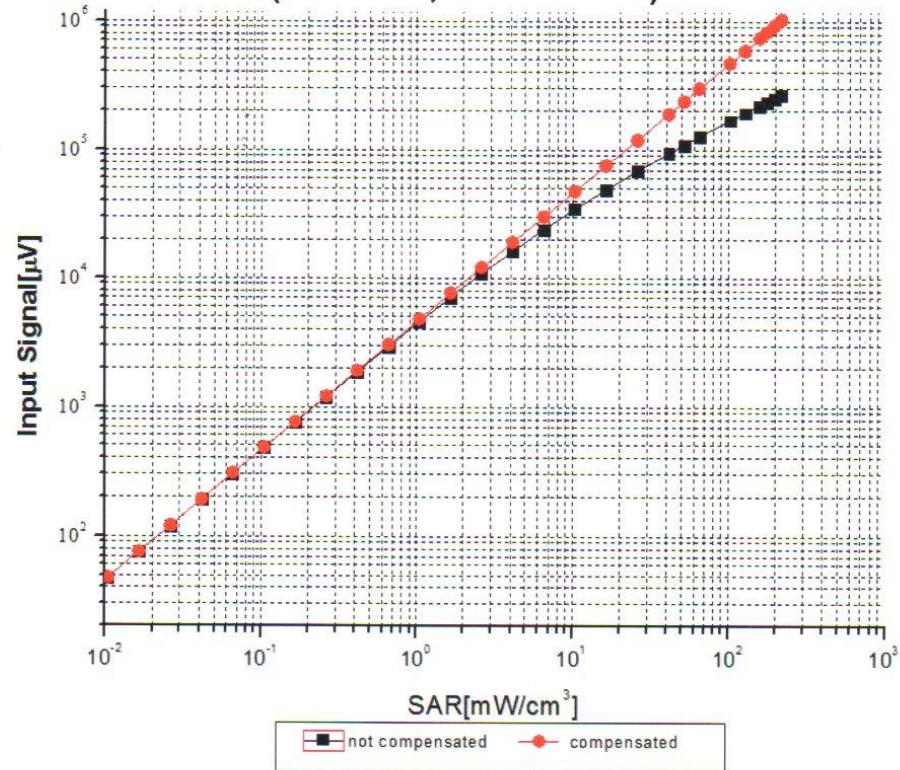
f=1800 MHz, R22





Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
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 E-mail: ctl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

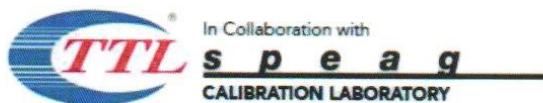
Dynamic Range f(SAR_{head}) (TEM cell, f = 900 MHz)



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

Certificate No: Z16-97101

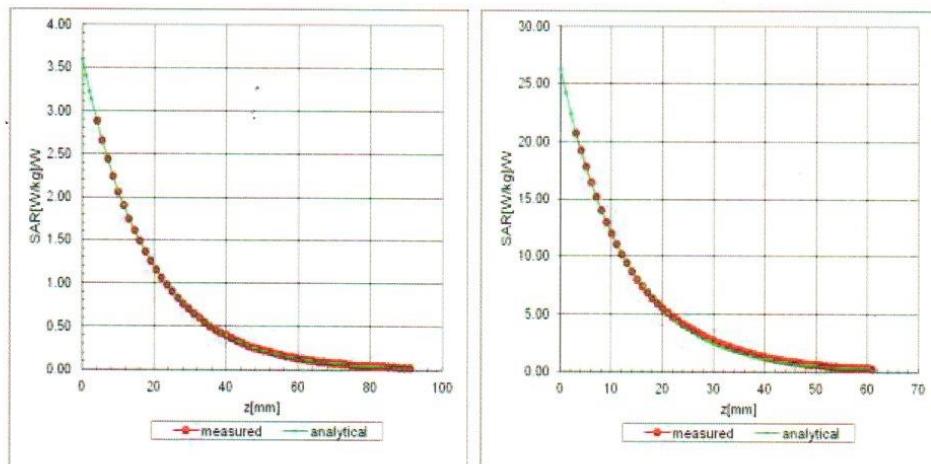
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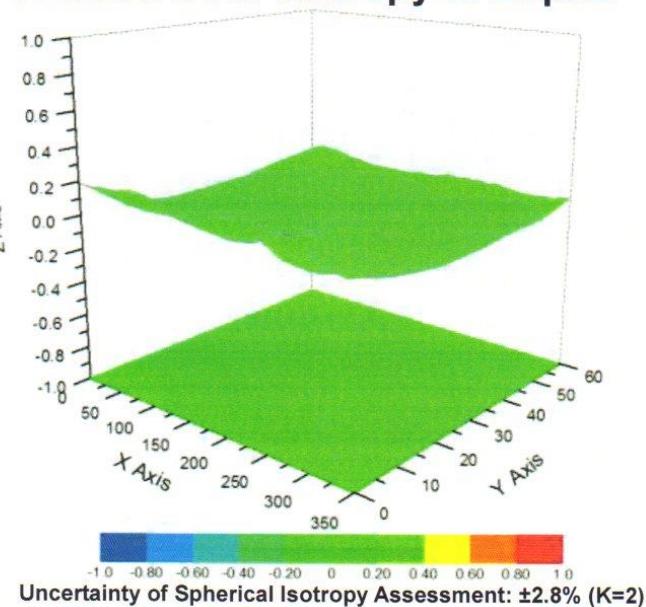
Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
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 E-mail: ctl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

Conversion Factor Assessment

f=900 MHz, WGLS R9(H_convF) f=1900 MHz, WGLS R22(H_convF)



Deviation from Isotropy in Liquid





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E-mail: ctl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3836

Other Probe Parameters

| | |
|---|------------|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 47.9 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disable |
| Probe Overall Length | 337mm |
| Probe Body Diameter | 10mm |
| Tip Length | 9mm |
| Tip Diameter | 2.5mm |
| Probe Tip to Sensor X Calibration Point | 1mm |
| Probe Tip to Sensor Y Calibration Point | 1mm |
| Probe Tip to Sensor Z Calibration Point | 1mm |
| Recommended Measurement Distance from Surface | 1.4mm |

6.2. D450V3 Dipole Calibration Certificate

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



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

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

Accreditation No.: SCS 0108

Client: Auden

Certificate No: D450V3-1072_Nov15

CALIBRATION CERTIFICATE

Object: D450V3 - SN: 1072

Calibrator procedure: QA CAL-15.v8
Calibration procedure for dipole validation kits below 700 MHz

Calibration date: November 25, 2015

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 (N/A/E critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|------------------------------|------------------------------|-----------------------------------|------------------------|
| Power meter E44190 | 00H1298074 | 01-Apr-15 (No. 217-02120) | Mar-16 |
| Power sensor E44123 | MY41498007 | 01-Apr-15 (No. 217-02120) | Mar-16 |
| Reference 3 dB Attenuator | SN: 55054 (3dB) | 01-Apr-15 (No. 217-02120) | Mar-16 |
| Reference 20 dB Attenuator | SN: 55056 (20dB) | 01-Apr-15 (No. 217-02120) | Mar-16 |
| Type-N mismatch compensation | SN: 5047.2/0532 ¹ | 01-Apr-15 (No. 217-02120) | Mar-16 |
| Reference Probe ET200VE | SN: 1907 | 30-Dec-14 (No. 633-1607_Rev14) | Dec-15 |
| DAE4 | SN: 034 | 08-Jul-15 (No. DAE4-034_Jul15) | Jul-16 |
| Secondary Standards | | | |
| PF generator HP 00400 | US3042U01700 | 04-Aug-15 (in house check Apr-15) | In house check: Apr-15 |
| Network Analyzer HP E7532E | US57390000-54205 | 19-Oct-15 (in house check Oct-15) | In house check: Oct-15 |

| Calibrated by: | Name: | Function: | Signature: |
|----------------|--------------|-----------------------|------------|
| | Lail Klysser | Laboratory Technician | |
| Approved by: | Kaja Polovic | Technical Manager | |

Issued: November 25, 2015

Certificate No: D450V3-1072_Nov15

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Calibration Laboratory of
Schmid & Partner
Engineering AG
Zouhausestrasse 43, 8094 Zurich, Switzerland



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

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

Accreditation No.: SCS 0108

Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1526-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 885684, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

| | | |
|-------------------------------------|------------------------|-----------------------------|
| DASY Version | DASYS | V52.6.6 |
| Extrapolation | Advanced Extrapolation | |
| Phantom | EL14 Flat Phantom | Shell thickness: 2 ± 0.2 mm |
| Distance Dipole Center - TSL | 15 mm | with Spacer |
| Zoom Scan Resolution | dx, dy, dz = 5 mm | |
| Frequency | 450 MHz ± 1 MHz | |

Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Head TSL parameters | 22.0 °C | 43.5 | 0.87 mho/m |
| Measured Head TSL parameters | (22.0 ± 0.2) °C | 44.0 ± 6 % | 0.89 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Head TSL

| | | |
|---|--------------------|--------------------------|
| SAR averaged over 1 cm ³ (1 g) of Head TSL | Condition | |
| SAR measured | 250 mW input power | 1.16 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 4.57 W/kg ± 18.1 % (k=2) |

| | | |
|---|--------------------|--------------------------|
| SAR averaged over 10 cm ³ (10 g) of Head TSL | condition | |
| SAR measured | 250 mW input power | 0.778 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | 3.07 W/kg ± 17.8 % (k=2) |

Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|--|-----------------|--------------|------------------|
| Nominal Body TSL parameters | 22.0 °C | 56.7 | 0.94 mho/m |
| Measured Body TSL parameters | (22.0 ± 0.2) °C | 56.3 ± 6 % | 0.95 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °C | ---- | ---- |

SAR result with Body TSL

| | | |
|---|--------------------|--------------------------|
| SAR averaged over 1 cm ³ (1 g) of Body TSL | Condition | |
| SAR measured | 250 mW input power | 1.13 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 4.48 W/kg ± 18.1 % (k=2) |

| | | |
|---|--------------------|--------------------------|
| SAR averaged over 10 cm ³ (10 g) of Body TSL | condition | |
| SAR measured | 250 mW input power | 0.744 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | 2.95 W/kg ± 17.6 % (k=2) |

Appendix (Additional assessments outside the scope of SCS 0108)**Antenna Parameters with Head TSL**

| | |
|--------------------------------------|-----------------|
| Impedance, transformed to feed point | 57.0 Ω - 4.4 jΩ |
| Return Loss | - 22.2 dB |

Antenna Parameters with Body TSL

| | |
|--------------------------------------|-----------------|
| Impedance, transformed to feed point | 53.0 Ω - 9.0 jΩ |
| Return Loss | - 20.6 dB |

General Antenna Parameters and Design

| | |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.356 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 semi-rigid 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 | SPEAQ |
| Manufactured on | November 25, 2009 |

DASY5 Validation Report for Head TSL

Date: 25.11.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN: 1072

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used: $f = 450 \text{ MHz}$; $\sigma = 0.89 \text{ S/m}$; $\epsilon_r = 44$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5 Configuration:

- Probe: ET3DV6 - SN 1501; ConvE6.58, 6.58, 6.58; Calibrated: 30.12.2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 08.07.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY5 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Head Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:

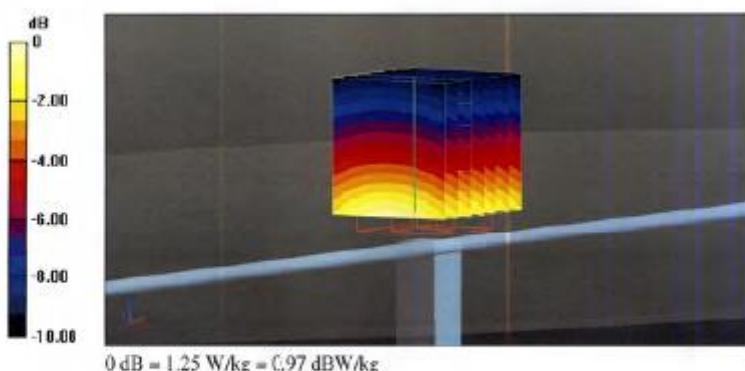
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 39.53 V/m; Power Drift = -0.04 dB

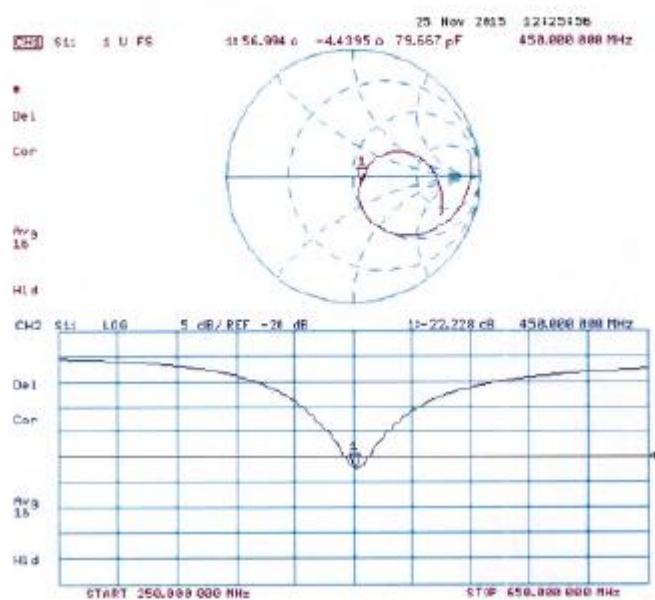
Peak SAR (extrapolated) = 1.67 W/kg

SAR(1 g) = 1.16 W/kg; SAR(10 g) = 0.778 W/kg

Maximum value of SAR (measured) = 1.25 W/kg



Impedance Measurement Plot for Head TSL



Certificate No: D46(V3-1072_Nov15

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DASY5 Validation Report for Body TSL

Date: 25.11.2015

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN: 1072

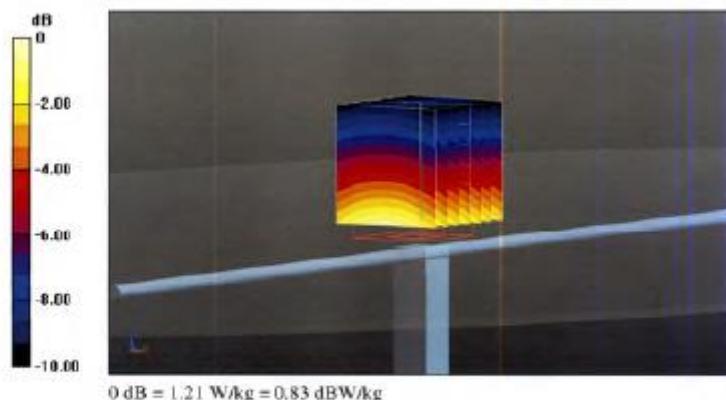
Communication System: UID 0 - CW; Frequency: 450 MHz
Medium parameters used: $\sigma = 0.95 \text{ S/m}$; $\epsilon_r = 56.3$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

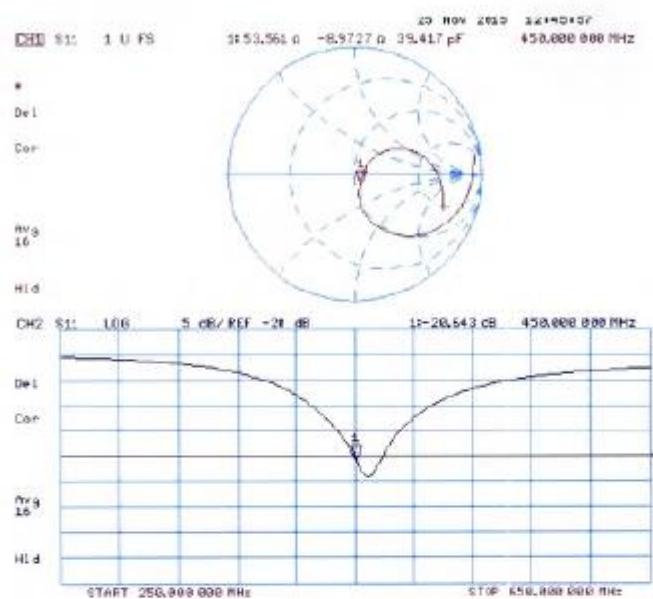
- Probe: ET3DV6 - SN 1507; ConvF(7.05, 7.05, 7.05); Calibrated: 30.12.2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 08.07.2015
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Body Tissue d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 36.53 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 1.81 W/kg
SAR(1 g) = 1.13 W/kg; SAR(10 g) = 0.744 W/kg
Maximum value of SAR (measured) = 1.21 W/kg



Impedance Measurement Plot for Body TSL.



Certificate No: D46CV3-1072_Nov15

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6.3. DAE4 Calibration Certificate



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Client : CIQ(Shenzhen)

Certificate No: Z17-97120

CALIBRATION CERTIFICATE

Object DAE4 - SN: 1315 JP467

Calibration Procedure(s) FD-Z11-2-002-01

Calibration Procedure for the Data Acquisition Electronics (DAEx)

Calibration date: July 26, 2017

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 | 27-June-17 (CTTL, No:J16X04778) | June-18 |

| Calibrated by: | Name | Function | Signature |
|----------------|-------------|-----------------------------------|-----------|
| | Yu Zongying | SAR Test Engineer | |
| Reviewed by: | Qi Dianyuan | SAR Project Leader | |
| Approved by: | Lu Bingsong | Deputy Director of the laboratory | |

Issued: July 27, 2016

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



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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 = $6.1\mu V$, full range = $-100...+300 mV$

Low Range: 1LSB = $61nV$, full range = $-1.....+3mV$

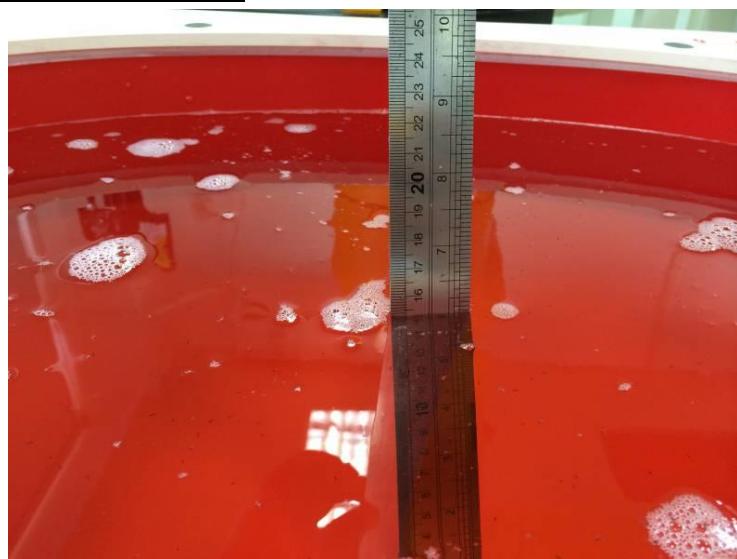
DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

| Calibration Factors | X | Y | Z |
|---------------------|----------------------------|----------------------------|---------------------------|
| High Range | $405.179 \pm 0.15\% (k=2)$ | $405.018 \pm 0.15\% (k=2)$ | $404.98 \pm 0.15\% (k=2)$ |
| Low Range | $3.99015 \pm 0.7\% (k=2)$ | $3.98549 \pm 0.7\% (k=2)$ | $3.98861 \pm 0.7\% (k=2)$ |

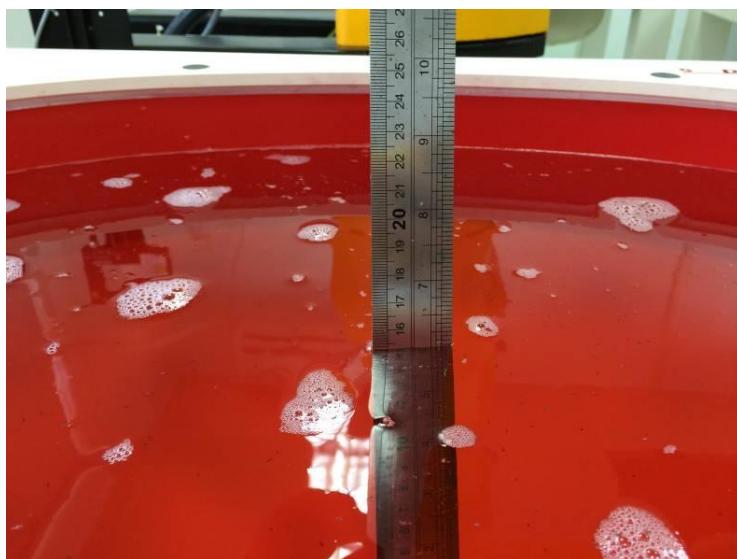
Connector Angle

| | |
|---|--------------------------|
| Connector Angle to be used in DASY system | $20.5^\circ \pm 1^\circ$ |
|---|--------------------------|

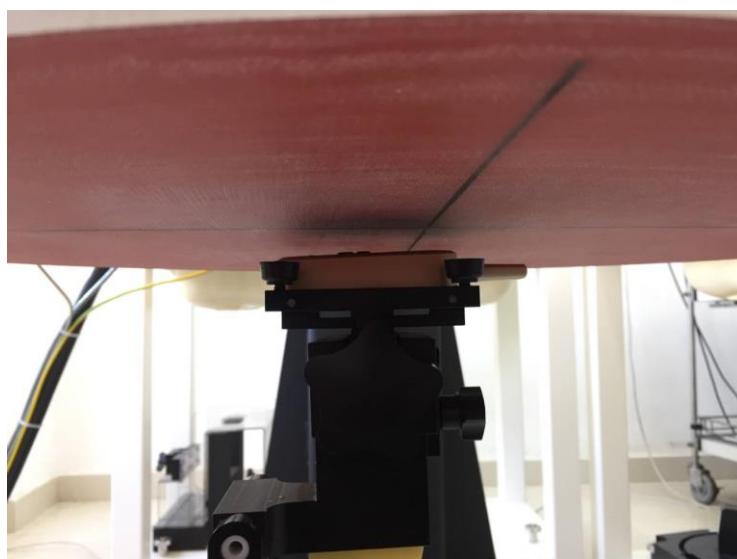
7. Test Setup Photos



Photograph of the depth in the Head Phantom (450MHz)



Photograph of the depth in the Body Phantom (450MHz)



Face-held, the front of the EUT towards phantom (The distance was 25mm)



Body-worn, the front of the EUT towards ground (The distance was 0mm)

***** End of Report *****