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# TEST REPORT

| | |
|---|---|
| **Report No. ..... :** | **CHTEW19100093** |
| **Project No. ..... :** | **SHT1908007902EW** |
| **FCC ID ..... :** | **2ANWO-HS360** |
| **Applicant's name ..... :** | **HOT SHOT SYSTEMS INC.** |
| Address.....: | 1005 E. 17TH, HAYS, KS 67601, United States |
| Manufacturer.....: | Fujian Quanzhou MYT Electronics Co. Ltd. |
| Address.....: | Branch Road 1, Nan'an Optoelectronic Information Industry Base, Quanzhou city, Fujian 362302, China. |
| **Test item description ..... :** | **Hot Shot 360** |
| Trade Mark .....: | - |
| Model/Type reference.....: | HS-360 |
| Listed Model(s) .....: | - |
| **Standard ..... :** | **FCC 47 CFR Part2.1093**<br>**IEEE Std C95.1, 1999 Edition**<br>**IEEE 1528: 2013** |
| Date of receipt of test sample……: | Sep.23, 2019 |
| Date of testing……..: | Sep.23, 2019- Oct.16, 2019 |
| Date of issue……..: | Oct.17, 2019 |
| **Result..... ……..:** | **PASS** |

Report verificaiton:

| | | |
|---|---|---|
| Compiled by<br>( position+printed name+signature)..: | File administrators: Fanghui Zhu | Fanghui Zhu |
| Supervised by<br>( position+printed name+signature)..: | Test Engineer: Xiaodong Zhao | Xiaodong Zhao |
| Approved by<br>( position+printed name+signature)..: | Manager: Hans Hu | Hans Hu |

| | |
|---|---|
| **Testing Laboratory Name ..... :** | **Shenzhen Huatongwei International Inspection Co., Ltd** |
| Address.....: | 1/F, Bldg 3, Hongfa Hi-tech Industrial Park, Genyu Road, Tianliao, Gongming, Shenzhen, China |

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*The test report merely correspond to the test sample.*

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# 1 . Test Standards and Report version

## 1.1. Test Standards

The tests were performed according to following standards:

FCC 47 Part 2.1093: Radiofrequency Radiation Exposure Evaluation:Portable Devices
IEEE Std C95.1, 1999 Edition: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
IEEE Std 1528™-2013: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.

FCC published RF exposure KDB procedures:
KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04: SAR Measurement Requirements for 100 MHz to 6 GHz
KDB 865664 D02 RF Exposure Reporting v01r02: RF Exposure Compliance Reporting and Documentation Considerations
KDB 447498 D01 General RF Exposure Guidance v06: Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies

TCB workshop April, 2019; Page 19, Tissue Simulating Liquids (TSL)

## 1.2. Report version

| Revision No. | Date of issue | Description |
|---|---|---|
| N/A | 2019-10-17 | Original |
| | | |
| | | |
| | | |
| | | |

# 2. Summary

## 2.1. Client Information

| | |
|---|---|
| Applicant: | HOT SHOT SYSTEMS INC. |
| Address: | 1005 E. 17TH, HAYS, KS 67601, United States |
| Manufacturer: | Fujian Quanzhou MYT Electronics Co. Ltd. |
| Address: | Branch Road 1, Nan'an Optoelectronic Information Industry Base, Quanzhou city, Fujian 362302, China. |

## 2.2. Product Description

| | | |
|---|---|---|
| Name of EUT: | Hot Shot 360 | |
| Trade mark: | - | |
| Model/Type reference: | HS-360 | |
| Listed model(s): | - | |
| Accessories: | Belt Clip | |
| Device Category: | Portable | |
| RF Exposure Environment: | General Population/Uncontrolled | |
| Power supply: | DC 3.7V | |
| Hardtware Version: | 1.0 | |
| Software Version: | 1.0 | |
| Device Dimension: | Overall (Length x Width x Thickness):104 x 58 x 30mm<br>Antenna(Length): 90mm | |
| **Maximum SAR Value** | | |
| Separation Distance: | Front-of-face: | 25mm |
| | Body-worn: | 0mm |
| Maximun SAR Value(1g): | Front-of-face: | 0.196 W/kg |
| | Body-worn: | 0.660 W/kg |
| **RF Specification** | | |
| Operation Frequency Range: | 151.820MHz, 151.880MHz, 151.940MHz, 154.570MHz, 154.600MHz | |
| Rated Output Power: | 2W | |
| Modulation Type: | FM(Analog) | |
| Authorized Bandwidth: | 11.25kHz, 20kHz | |
| Antenna Type: | External | |

*Remark:*

1. *The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power.*
2. *EUT supports VOX functionality.*

## 2.3. Test frequency list

When the frequency channels required for SAR testing are not specified in the published RF exposure KDB procedures, the following should be applied to determine the number of required test channels. The test channels should be evenly spread across the transmission frequency band of each wireless mode:

$$N_c = Round\left\{\left[100\left(f_{high} - f_{low}\right)/f_c\right]^{0.5} \times \left(f_c/100\right)^{0.2}\right\},$$

$N_c$ is the number of test channels, rounded to the nearest integer,
$F_{high}$ and $f_{low}$ are the highest and lowest channel frequencies within the transmission band,
$F_c$ is the mid-band channel frequency,
all frequencies are in MHz.

| ModulationType | Authorized Bandwidth | Test Channel | Test Frequency(MHz) |
|---|---|---|---|
| | | | Tx |
| Analog | 11.25kHz | CH2 | 151.8800 |
| | 20kHz | CH5 | 154.6000 |

# 3. Test Environment

## 3.1. Test laboratory

Laboratory:Shenzhen Huatongwei International Inspection Co., Ltd.
Address: 1/F, Bldg 3, Hongfa Hi-tech Industrial Park, Genyu Road, Tianliao, Gongming, Shenzhen, China

## 3.2. Test Facility

**CNAS-Lab Code: L1225**

Shenzhen Huatongwei International Inspection Co., Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC17025: 2005 General Requirements) for the Competence of Testing and Calibration Laboratories.

**A2LA-Lab Cert. No.: 3902.01**

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

**FCC-Registration No.: 762235**

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FCC is maintained in our files. Registration 762235.

**IC-Registration No.: 5377A**

Two 3m Alternate Test Site of Shenzhen Huatongwei International Inspection Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for the performance of radiated measurements with Registration No. 5377A.

**ACA**

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory can also perform testing for the Australian C-Tick mark as a result of our A2LA accreditation.

## 3.3. Environmental conditions

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

| | |
|---|---|
| Ambient temperature | 18 °C to 25 °C |
| Ambient humidity | 30%RH to 70%RH |
| Air Pressure | 950-1050mbar |

# 4. Equipments Used during the Test

| Used | Test Equipment | Manufacturer | Model No. | Serial No. | Cal. date (YY-MM-DD) | Due date (YY-MM-DD) |
|---|---|---|---|---|---|---|
| ● | Data Acquisition Electronics DAEx | SPEAG | DAE4 | 1549 | 2019/03/19 | 2020/03/18 |
| ● | E-field Probe | SPEAG | EX3DV4 | 3842 | 2019/01/30 | 2020/01/29 |
| ○ | Universal Radio Communication Tester | R&S | CMW500 | 137681 | 2019/06/27 | 2020/06/26 |
| ● Tissue-equivalent liquids Validation | | | | | | |
| ○ | Dielectric Assessment Kit | SPEAG | DAK-3.5 | 1267 | N/A | N/A |
| ● | Dielectric Assessment Kit | SPEAG | DAK-12 | 1130 | N/A | N/A |
| ● | Network analyzer | Keysight | E5071C | MY46733048 | 2019/09/21 | 2020/09/20 |
| ● System Validation | | | | | | |
| ● | System Validation Antenna | SPEAG | CLA-150 | 4024 | 2018/02/21 | 2021/02/20 |
| ○ | System Validation Dipole | SPEAG | D450V3 | 1102 | 2018/02/23 | 2021/02/22 |
| ○ | System Validation Dipole | SPEAG | D750V3 | 1180 | 2018/02/07 | 2021/02/06 |
| ○ | System Validation Dipole | SPEAG | D835V2 | 4d238 | 2018/02/19 | 2021/02/18 |
| ○ | System Validation Dipole | SPEAG | D1750V2 | 1164 | 2018/02/06 | 2021/02/05 |
| ○ | System Validation Dipole | SPEAG | D1900V2 | 5d226 | 2018/02/22 | 2021/02/21 |
| ○ | System Validation Dipole | SPEAG | D2450V2 | 1009 | 2018/02/05 | 2021/02/04 |
| ○ | System Validation Dipole | SPEAG | D2600V2 | 1150 | 2018/02/05 | 2021/02/04 |
| ○ | System Validation Dipole | SPEAG | D5GHzV2 | 1273 | 2018/02/21 | 2021/02/20 |
| ● | Signal Generator | R&S | SMB100A | 114360 | 2019/08/15 | 2020/08/14 |
| ● | Power Viewer for Windows | R&S | N/A | N/A | N/A | N/A |
| ● | Power sensor | R&S | NRP18A | 101010 | 2019/08/15 | 2020/08/14 |
| ● | Power sensor | R&S | NRP18A | 101011 | 2019/08/15 | 2020/08/14 |
| ● | Power Amplifier | BONN | BLWA 0160-2M | 1811887 | 2018/11/15 | 2019/11/14 |
| ● | Dual Directional Coupler | Mini-Circuits | ZHDC-10-62-S+ | F975001814 | 2018/11/15 | 2019/11/14 |
| ● | Attenuator | Mini-Circuits | VAT-3W2+ | 1819 | 2018/11/15 | 2019/11/14 |
| ● | Attenuator | Mini-Circuits | VAT-10W2+ | 1741 | 2018/11/15 | 2019/11/14 |

*Note:*

1. *The Probe,Dipole and DAE calibration reference to the Appendix B and C.*
2. *Referring to KDB865664 D01, the dipole calibration interval can be extended to 3 years with justifcatio. The dipole are also not physically damaged or repaired during the interval.*

# 5. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg. The expanded SAR measurement uncertainty must be ⩽ 30%, for a confidence interval of k = 2. If these conditions are met,extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval.

# 6. SAR Measurements System Configuration

## 6.1. 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.

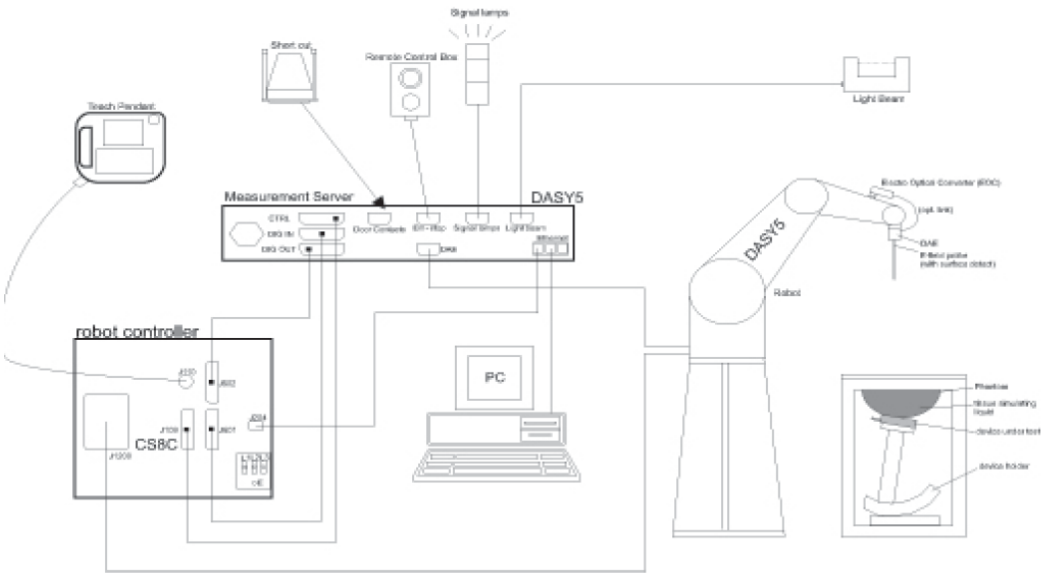
Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.

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.



## 6.2. DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe EX3DV4 (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)

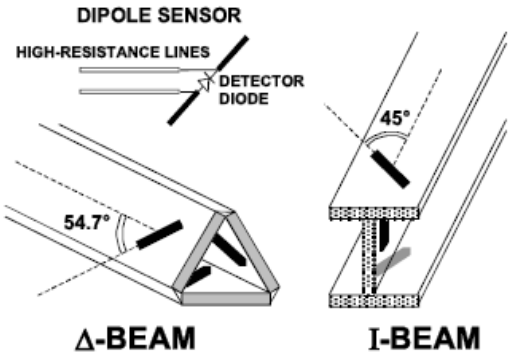
Calibration ISO/IEC 17025 calibration service available.

| | |
|---|---|
| Frequency | 10 MHz to 10 GHz;<br>Linearity: ± 0.2 dB (30 MHz to 10 GHz) |
| Directivity | ±0.1 dB in TSL (rotation around probe axis)<br>±0.3 dB in TSL (rotation normal to probe axis) |
| Dynamic Range | 10 µW/g to > 100 mW/g;<br>Linearity: ± 0.2 dB |
| Dimensions | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.0 mm |
| Application | General dosimetry up to 10 GHz<br>Dosimetry in strong gradient fields<br>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:



## 6.3. Phantoms

Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI isfully compatible with standard and all known tissuesimulating liquids. ELI has been optimized regarding its performance and can beintegrated into our standard phantom tables. A cover prevents evaporation ofthe liquid. Reference markings on the phantom allow installation of thecomplete setup, including all predefined phantom positions and measurementgrids, by teaching three points. The phantom is compatible with all SPEAGdosimetric probes and dipoles.

ELI4 Phantom

## 6.4. 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

# 7. SAR Test Procedure

## 7.1. 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. ± 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 ± 0.1mm). 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 ± 30°.)

**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**
After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the “Not a knot” condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm.

**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.

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

**Table 1: Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v04**

| | | | ≤ 3 GHz | > 3 GHz |
|---|---|---|---|---|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | | | 5 mm ± 1 mm | ½·$\delta$·ln(2) mm ± 0.5 mm |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location | | | 30° ± 1° | 20° ± 1° |
| Maximum area scan spatial resolution: $\Delta x_{Area}$, $\Delta y_{Area}$ | | | ≤ 2 GHz: ≤ 15 mm<br>2 – 3 GHz: ≤ 12 mm | 3 – 4 GHz: ≤ 12 mm<br>4 – 6 GHz: ≤ 10 mm |
| | | | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device. | |
| Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$, $\Delta y_{Zoom}$ | | | ≤ 2 GHz: ≤ 8 mm<br>2 – 3 GHz: ≤ 5 mm* | 3 – 4 GHz: ≤ 5 mm*<br>4 – 6 GHz: ≤ 4 mm* |
| Maximum zoom scan spatial resolution, normal to phantom surface | uniform grid: $\Delta z_{Zoom}(n)$ | | ≤ 5 mm | 3 – 4 GHz: ≤ 4 mm<br>4 – 5 GHz: ≤ 3 mm<br>5 – 6 GHz: ≤ 2 mm |
| | graded grid | $\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface | ≤ 4 mm | 3 – 4 GHz: ≤ 3 mm<br>4 – 5 GHz: ≤ 2.5 mm<br>5 – 6 GHz: ≤ 2 mm |
| | | $\Delta z_{Zoom}(n>1)$: between subsequent points | ≤ 1.5·$\Delta z_{Zoom}(n-1)$ mm | |
| Minimum zoom scan volume | x, y, z | | ≥ 30 mm | 3 – 4 GHz: ≥ 28 mm<br>4 – 5 GHz: ≥ 25 mm<br>5 – 6 GHz: ≥ 22 mm |

Note: $\delta$ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details.

* When zoom scan is required and the *reported* SAR from the *area scan based 1-g SAR estimation* procedures of KDB Publication 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

## 7.2. 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], [°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: | Dcpi |
| 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:

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

Vi: compensated signal of channel ( i = x, y, z )
Ui: input signal of channel ( 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:

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

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

Vi: compensated signal of channel ( i = x, y, z )
Normi: sensor sensitivity of channel ( 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]
Ei: electric field strength of channel i in V/m
Hi: 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.

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

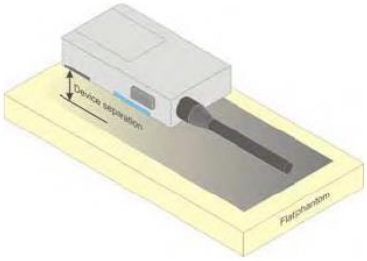
SAR: local specific absorption rate in mW/g
Etot: total field strength in V/m
σ: conductivity in [mho/m] or [Siemens/m]
ρ: equivalent tissue density in g/cm3

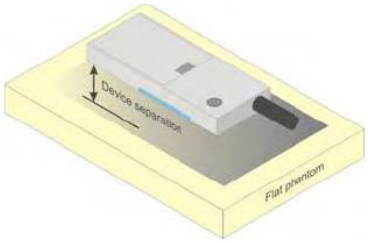
Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

# 8. Position of the wireless device in relation to the phantom

## 8.1. Front-of-face

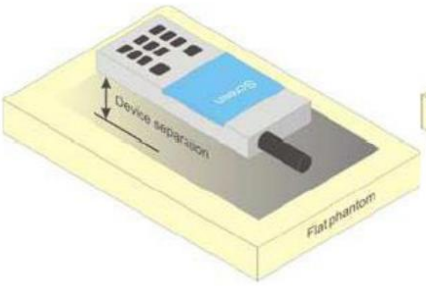
A typical example of a front-of-face device is a two-way radio that is held at a distance from the face of the user when transmitting. In these cases the device under test shall be positioned at the distance to the phantom surface that corresponds to the intended use as specified by the manufacturer in the user instructions. If the intended use is not specified, a separation distance of 25 mm between the phantom surface and the device shall be used.

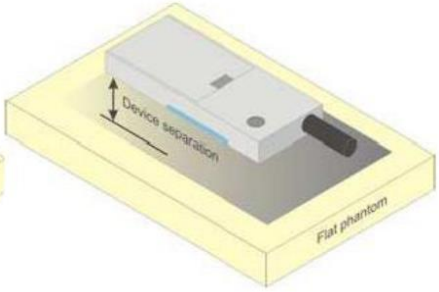



## 8.2. Body Position

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



# 9. Dielectric Property Measurements & System Check

## 9.1. Tissue Dielectric Parameters

It's satisfying the latest tissue dielectric parameters requirements proposed by the KDB865664 D01.

Targets for tissue simulating liquid

| Tissue dielectric parameters for head and body | | | | |
|---|---|---|---|---|
| Target Frequency | Head | | Body | |
| (MHz) | εr | σ(s/m) | εr | σ(s/m) |
| 150 | 52.3 | 0.76 | 61.9 | 0.80 |

**CheckResult:**

| **Dielectric performance of Head tissue simulating liquid** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | εr | | σ(s/m) | | Delta (εr) | Delta (σ) | Limit | Temp (℃) | Date |
| | Target | Measured | Target | Measured | | | | | |
| 150 | 52.30 | 53.22 | 0.760 | 0.753 | 1.76% | -0.92% | ±5% | 22.5 | 2019/10/11 |

## 9.2. SAR System Validation

Per FCC KDB 865664 D02,SAR system validadion status should be documented to confirm measurement accuracy.The SAR systems (including SAR probes,system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements.Reference dipoles were used with the required tissue-equivalent media for system validation,according to the procedures outlined in FCC KDB 865664 D01 and IEEE 1528-2013.Since SAR probe calibrations are frequency dependent,each probe calibration point,using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

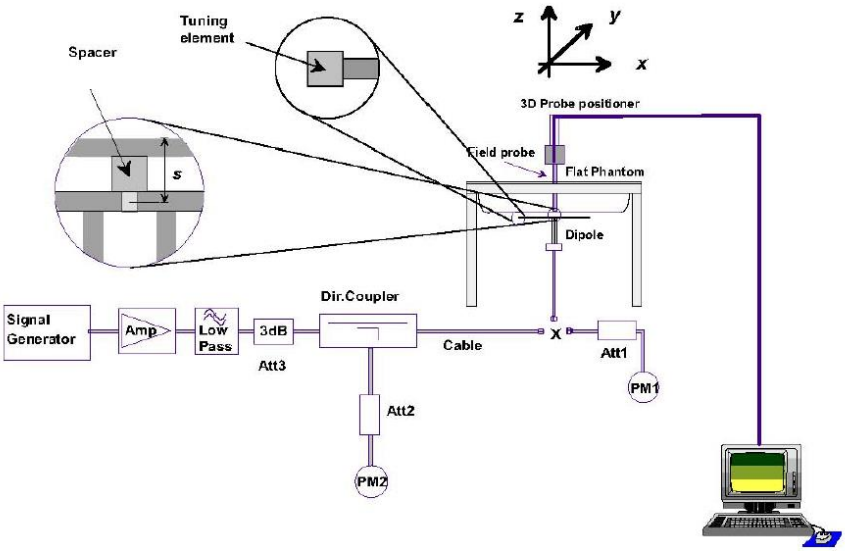
A tabulated summary of the system validation status including the validation date(s),measurement frequencies, SAR probes and tissue dielectric parameters has been included.

| Test Date | Probe S/N | Calibration Point | | Dielectric Parameters | | CW Validation | | | Modulation Validation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Conductivity | Permittivity | Sensitivity | Probe linearity | Probe Isotropy | Moduation type | Duty factor | PAR |
| 2019-04-01 | 3842 | Head | 150 | 0.75 | 52.75 | PASS | PASS | PASS | FM | PASS | PASS |

## 9.3. SAR System Verification

The purpose of the system check is to verify that the system operates within its specifications at the decice 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 (±10%).
System check is performed regularly on all frequency bands where tests are performed with the DASY5 system.




System Performance Check Setup

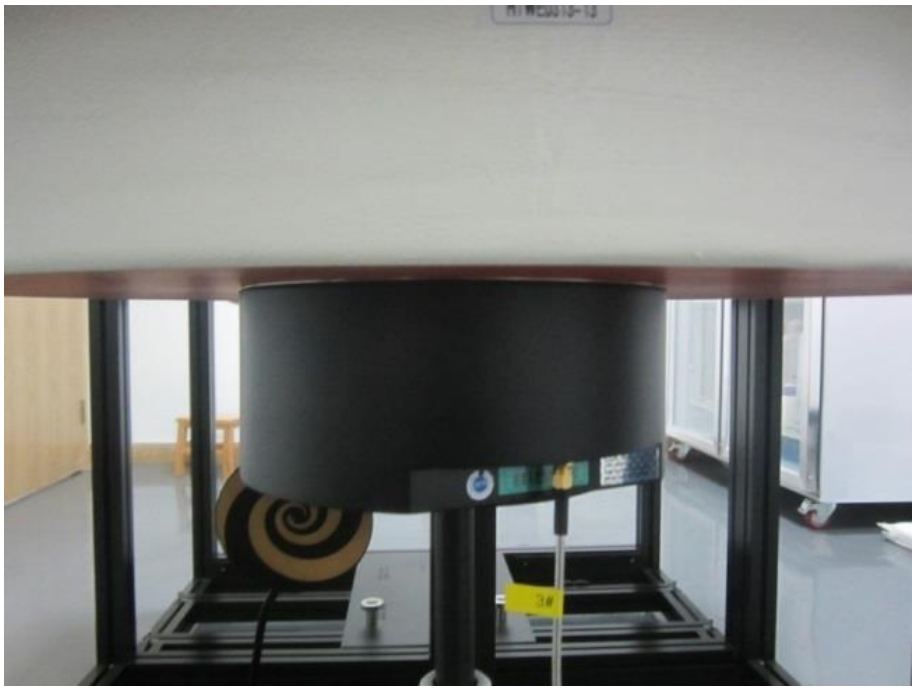


Photo of Dipole Setup

**Check Result:**

| Head | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | 1g SAR | | | 10g SAR | | | Delta (1g) | Delta (10g) | Limit | Temp (℃) | Date |
| | Target 1W | Normalize to 1W | Measured 1W | Target 1W | Normalize to 1W | Measured 1W | | | | | |
| 150 | 3.68 | 3.86 | 3.86 | 2.45 | 2.56 | 2.56 | 4.89% | 4.49% | ±10% | 22.5 | 2019/10/11 |

*Note:*

*1. the graph results see follow.*

## Plots of System Performance Check

**System Performance Check-Head 150MHz**

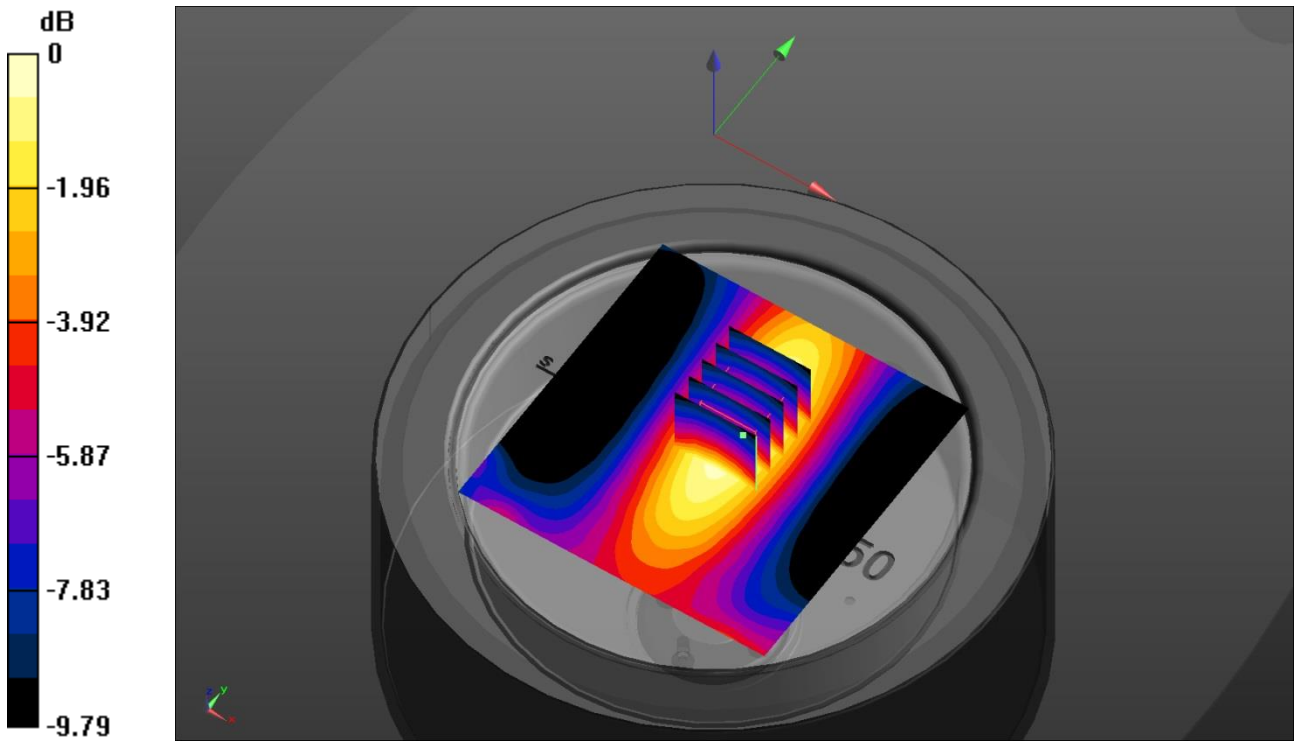
DUT: CLA-150; Type: CLA-150; Serial: 4024
Date: 2019-10-11
Communication System: UID 0, CW (0); Frequency: 150 MHz;Duty Cycle: 1:1
Medium parameters used: f = 150 MHz; σ = 0.753 S/m; $\varepsilon_r$ = 53.218; ρ = 1000 kg/$m^3$
Phantom section: Flat Section
Ambient Temperature:22.3℃;Liquid Temperature:22.0℃;

**DASY5 Configuration:**

- Probe: EX3DV4 – SN3842; ConvF(11.88, 11.88, 11.88) @ 150 MHz; Calibrated: 1/30/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1549; Calibrated: 4/25/2018
- Phantom: ELI V8.0 ; Type: QD OVA 004 AA ; Serial: 2078
- DASY52 52.10.1(1476); SEMCAD X 14.6.12(7450)

**Head/d=0mm, Pin=1W/Area Scan (81x81x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 5.50 W/kg

**Head/d=0mm, Pin=1W/Zoom Scan (5x5x7) /Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 81.34 V/m; Power Drift = -0.11 dB
Peak SAR (extrapolated) = 6.87 W/kg
**SAR(1 g) = 3.86 W/kg; SAR(10 g) = 2.56 W/kg**
Maximum value of SAR (measured) = 5.52 W/kg




0 dB = 5.52 W/kg = 7.42 dBW/kg

# 10. SAR Exposure Limits

SAR assessments have been made in line with the requirements of FCC 47 CFR § 2.1093.

| Type Exposure | Limit (W/kg) | |
|---|---|---|
| | General Population / Uncontrolled Exposure Environment | Occupational / Controlled Exposure Environment |
| Spatial Average SAR (whole body) | 0.08 | 0.4 |
| Spatial Peak SAR (1g cube tissue for head and trunk) | 1.6 | 8.0 |
| Spatial Peak SAR (10g for limb) | 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).

# 11. Conducted Power Measurement Results

| MURS | | | | |
|---|---|---|---|---|
| Mode | Authorized Bandwidth | Frequency | | Conducted Power (dBm) |
| | | Channel | MHz | |
| Analog | 11.25kHz | CH2 | 151.8800 | 32.13 |
| | 20kHz | CH5 | 154.6000 | 32.25 |

# 12. Maximum Tune-up Limit

This device operates using the following maximum output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB publication 447498 D01.

| MURS | | | |
|---|---|---|---|
| Mode | Authorized Bandwidth | Operation Frequency Range (MHz) | Maximum tune-up power (dBm) |
| Analog | 11.25kHz | 151.8800 | 33.00 |
| | 20kHz | 154.6000 | 33.00 |

# 13. SAR Measurement Results

| Front-of-face | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mode | Authorized Bandwidth | Frequency | | Conducted Power (dBm) | Tune-up limit (dBm) | Tune-up scaling factor | Power Drift (dB) | Measured SAR(1g) | Report SAR(1g) | 75% Duty factor SAR | Test Plot |
| | | CH | MHz | | | | | (W/kg) | (W/kg) | (W/kg) | |
| Analog | 11.25kHz | CH2 | 151.8800 | 32.13 | 33.00 | 1.22 | -0.18 | 0.162 | 0.198 | 0.148 | - |
| | 20kHz | CH5 | 154.6000 | 32.25 | 33.00 | 1.19 | -0.06 | 0.220 | 0.261 | 0.196 | 1 |

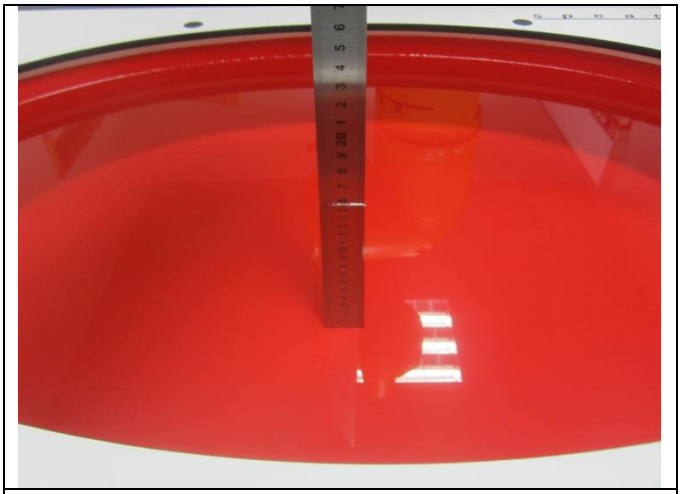
| Body-worn (Rear) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mode | Authorized Bandwidth | Frequency | | Conducted Power (dBm) | Tune-up limit (dBm) | Tune-up scaling factor | Power Drift (dB) | Measured SAR(1g) | Report SAR(1g) | 75% Duty factor SAR | Test Plot |
| | | CH | MHz | | | | | (W/kg) | (W/kg) | (W/kg) | |
| Analog | 11.25kHz | CH2 | 151.8800 | 32.13 | 33.00 | 1.22 | 0.13 | 0.718 | 0.877 | 0.658 | - |
| | 20kHz | CH5 | 154.6000 | 32.25 | 33.00 | 1.19 | -0.11 | 0.740 | 0.879 | 0.660 | 2 |

*Note:*

1. *Batteries are fully charged at the beginning of the SAR measurements.*
2. *The Body-worn SAR evaluation was performed with the Leather Case body-worn accessory attached to the DUT and touching the outer surface of the planar phantom.*

SAR Test Data Plots to the Appendix A.

## 14. Test Setup Photos



Liquid depth in the ELI Phantom

Front-of-face(25mm)

Body-worn(0mm)

## 15. External and Internal Photos of the EUT

Please refer to the test report No.: CHTEW19110053

----------End of Report----------

Test Laboratory: Huatongwei International Inspection Co., Ltd.,SAR Lab Date: 10/11/2019

## MURS Front-of-face

Communication System: UID 0, Analog (0); Frequency: 154.6 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 154.6 MHz; $\sigma$ = 0.756 S/m; $\varepsilon_r$ = 53; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:22.4°C;Liquid Temperature:22.1°C;

DASY Configuration:

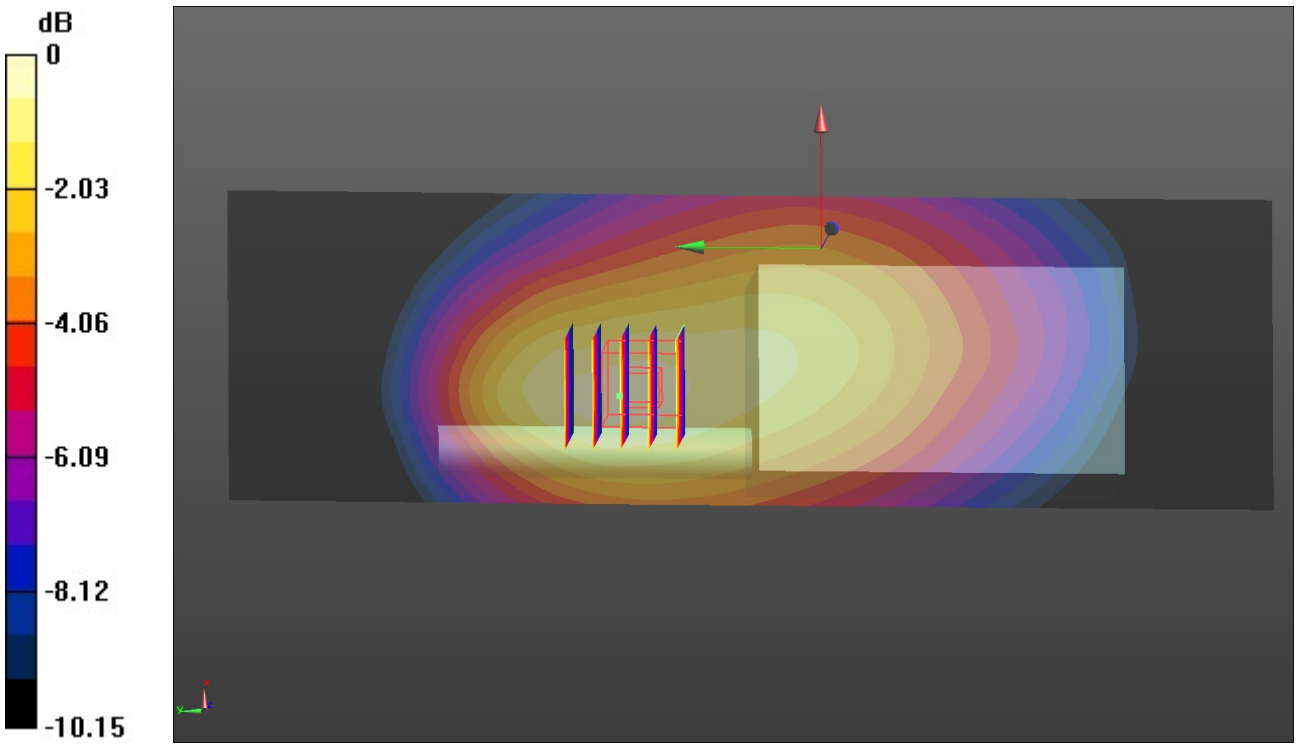
- Probe: EX3DV4 - SN3842; ConvF(11.88, 11.88, 11.88) @ 154.6 MHz; Calibrated: 1/30/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1549; Calibrated: 3/19/2019
- Phantom: ELI V8.0 ; Type: QD OVA 004 AA ; Serial: 2078
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

**Front/CH 5/Area Scan (61x201x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.312 W/kg

**Front/CH 5/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 18.97 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 0.467 W/kg
**SAR(1 g) = 0.220 W/kg; SAR(10 g) = 0.154 W/kg**

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.333 W/kg




0 dB = 0.333 W/kg = -4.78 dBW/kg

Test Laboratory: Huatongwei International Inspection Co., Ltd.,SAR Lab Date: 10/11/2019

## MURS Body-worn

Communication System: UID 0, Analog (0); Frequency: 154.6 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 154.6 MHz; $\sigma$ = 0.756 S/m; $\varepsilon_r$ = 53; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Ambient Temperature:22.6°C;Liquid Temperature:22.3°C;

DASY Configuration:

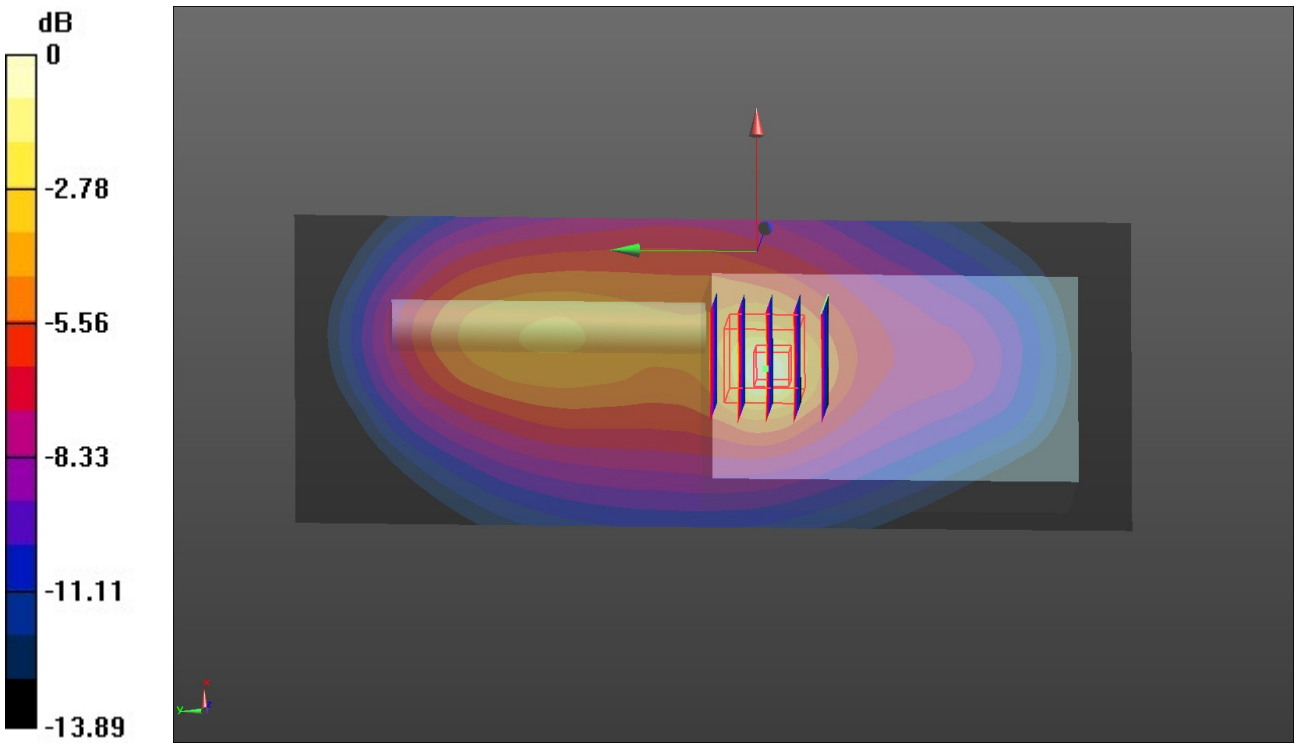
- Probe: EX3DV4 - SN3842; ConvF(11.88, 11.88, 11.88) @ 154.6 MHz; Calibrated: 1/30/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1549; Calibrated: 3/19/2019
- Phantom: ELI V8.0 ; Type: QD OVA 004 AA ; Serial: 2078
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

**Rear/CH 5/Area Scan (61x161x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 1.57 W/kg

**Rear/CH 5/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 28.50 V/m; Power Drift = -0.11 dB
Peak SAR (extrapolated) = 2.45 W/kg
**SAR(1 g) = 0.740 W/kg; SAR(10 g) = 0.384 W/kg**

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.50 W/kg




0 dB = 1.50 W/kg = 1.76 dBW/kg

## 1.1. DAE4 Calibration Certificate

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中国认可
国际互认
校准
CALIBRATION
CNAS L0570

Client : HTW Certificate No: Z19-60066

### CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | DAE4 - SN: 1549 |
| Calibration Procedure(s) | FF-Z11-002-01<br>Calibration Procedure for the Data Acquisition Electronics (DAEx) |
| Calibration date: | March 19, 2019 |

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Process Calibrator 753 | 1971018 | 20-Jun-18 (CTTL, No.J18X05034) | June-19 |

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

Issued: March 20, 2019

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

Certificate No: Z19-60066 Page 1 of 3

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E-mail: cttl@chinattl.com Http://www.chinattl.cn

**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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E-mail: cttl@chinattl.com Http://www.chinattl.cn

## DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , 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 | 406.354 ± 0.15% (k=2) | 406.056 ± 0.15% (k=2) | 406.182 ± 0.15% (k=2) |
| Low Range | 3.98644 ± 0.7% (k=2) | 3.99365 ± 0.7% (k=2) | 3.99469 ± 0.7% (k=2) |

## Connector Angle

| | |
|---|---|
| **Connector Angle** to be used in DASY system | 18° ± 1 ° |

## 1.2. Probe Calibration Certificate-3842

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

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

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

**Accreditation No.: SCS 0108**

**Client** **CIQ (Auden)**

**Certificate No: EX3-3842_Jan19**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:3842 |
| Calibration procedure(s) | QA CAL-01.v9, QA CAL-12.v9, QA CAL-23.v5, QA CAL-25.v7<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | January 30, 2019 |

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 04-Apr-18 (No. 217-02672/02673) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-18 (No. 217-02672) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-18 (No. 217-02673) | Apr-19 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 04-Apr-18 (No. 217-02682) | Apr-19 |
| DAE4 | SN: 660 | 19-Dec-18 (No. DAE4-660_Dec18) | Dec-19 |
| Reference Probe ES3DV2 | SN: 3013 | 31-Dec-18 (No. ES3-3013_Dec18) | Dec-19 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB41293874 | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A | SN: MY41498087 | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A | SN: 000110210 | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| RF generator HP 8648C | SN: US3642U01700 | 04-Aug-99 (in house check Jun-18) | In house check: Jun-20 |
| Network Analyzer E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-18) | In house check: Oct-19 |

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

Issued: February 1, 2019

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Certificate No: EX3-3842_Jan19 Page 1 of 10

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Swiss Calibration Service

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

**Accreditation No.: SCS 0108**

## Glossary:

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

## Calibration is Performed According to the Following Standards:

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

## Methods Applied and Interpretation of Parameters:

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

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3842

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 0.34 | 0.51 | 0.41 | ± 10.1 % |
| DCP (mV)[B] | 104.3 | 98.1 | 102.3 | |

## Calibration Results for Modulation Response

| UID | Communication System Name | | A dB | B dB$\sqrt{\mu V}$ | C | D dB | VR mV | Max dev. | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 147.5 | ±2.5 % | ± 4.7 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 159.1 | | |
| | | Y | 0.0 | 0.0 | 1.0 | | 147.1 | | |

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

[A] The uncertainties of Norm X,Y,Z do not affect the $E^2$-field uncertainty inside TSL (see Pages 5 and 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.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3842

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 59.9 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 1.4 mm |

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3842

## 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) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 150 | 52.3 | 0.76 | 11.88 | 11.88 | 11.88 | 0.00 | 1.00 | ± 13.3 % |
| 450 | 43.5 | 0.87 | 10.30 | 10.30 | 10.30 | 0.13 | 1.20 | ± 13.3 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the 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. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies 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 frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3842

## Calibration Parameter Determined in Body Tissue Simulating Media

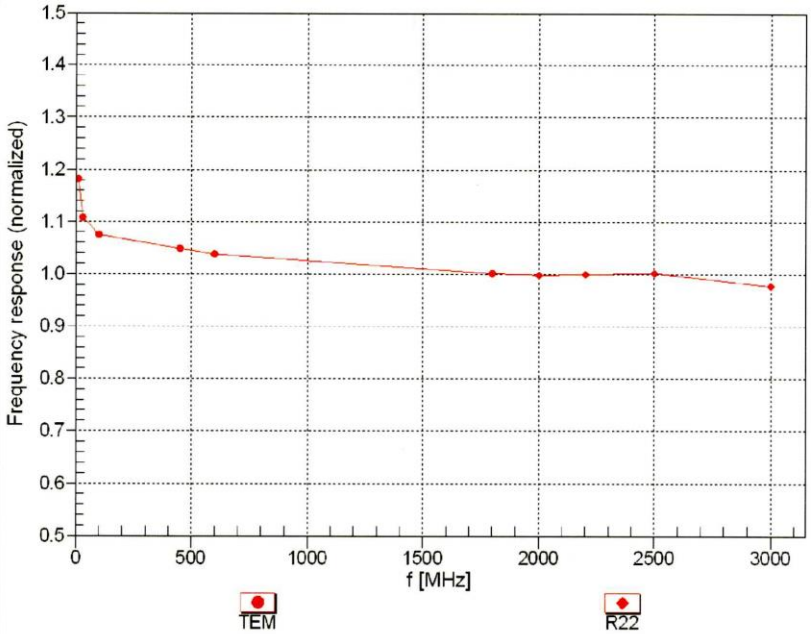
| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 150 | 61.9 | 0.80 | 11.13 | 11.13 | 11.13 | 0.00 | 1.00 | ± 13.3 % |
| 450 | 56.7 | 0.94 | 10.39 | 10.39 | 10.39 | 0.06 | 1.20 | ± 13.3 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the 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. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies 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 frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4– SN:3842 January 30, 2019

## Frequency Response of E-Field

**(TEM-Cell:ifi110 EXX, Waveguide: R22)**

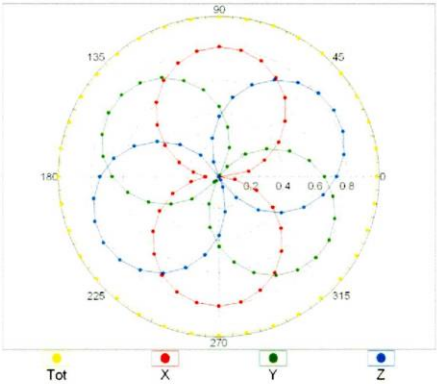



**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

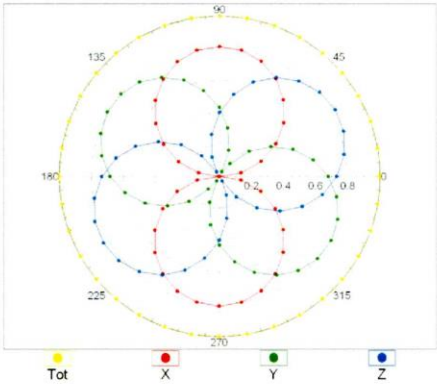
EX3DV4– SN:3842 January 30, 2019

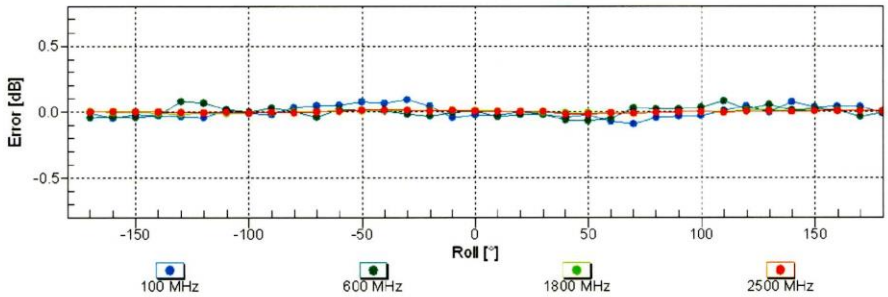
## Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM




f=1800 MHz,R22

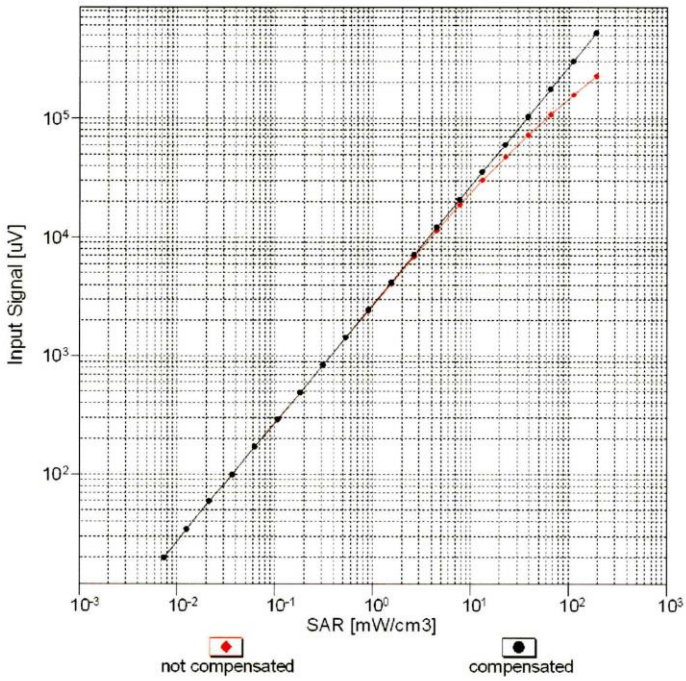


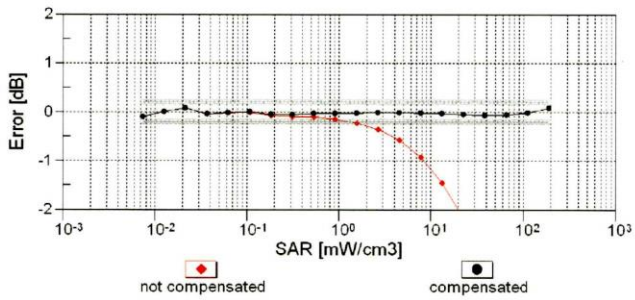




**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

EX3DV4– SN:3842 January 30, 2019

## Dynamic Range f(SAR$_{head}$)
**(TEM cell , $f_{eval}$= 1900 MHz)**



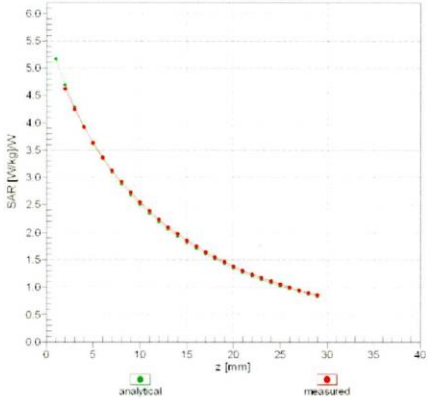

**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

Certificate No: EX3-3842_Jan19 Page 9 of 10

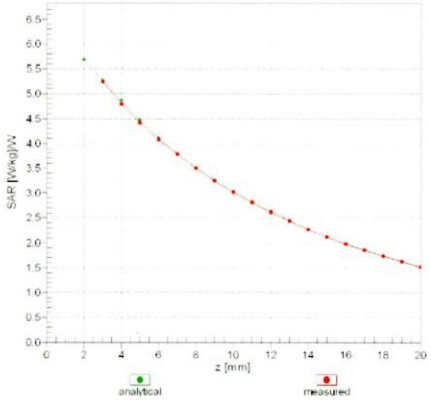
EX3DV4– SN:3842 January 30, 2019

## Conversion Factor Assessment

f = 150 MHz,WGLS Flat Phantom 4.4

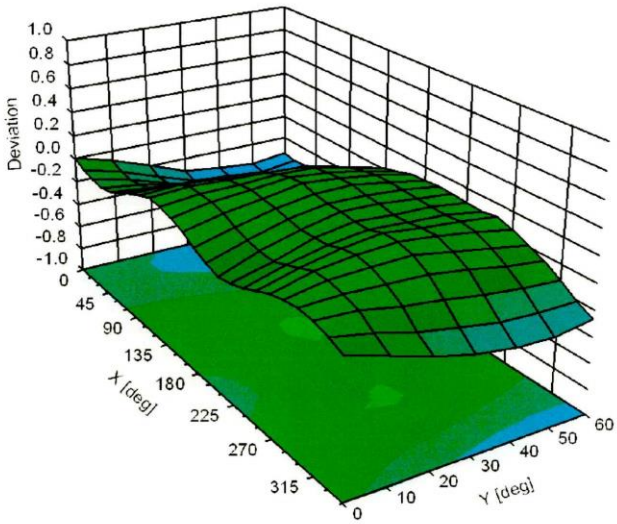


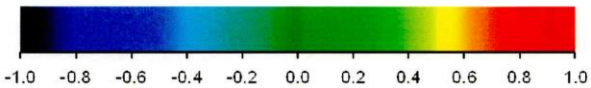

f = 450 MHz,WGLS Flat Phantom 4.4




## Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




**Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)**

Certificate No: EX3-3842_Jan19 Page 10 of 10

## 1.1. 150 Dipole Calibration Certificate

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

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

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

**Accreditation No.: SCS 0108**

**Client** CCIC-HTW (Auden)

**Certificate No: CLA150-4024_Feb18**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | CLA150 - SN: 4024 |
| Calibration procedure(s) | QA CAL-15.v8<br>Calibration procedure for system validation sources below 700 MHz |
| Calibration date: | February 21, 2018 |

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02522) | Apr-18 |
| Reference 20 dB Attenuator | SN: 5277 (20x) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529) | Apr-18 |
| Reference Probe EX3DV4 | SN: 3877 | 30-Dec-17 (No. EX3-3877_Dec17) | Dec-18 |
| DAE4 | SN: 654 | 24-Jul-17 (No. DAE4-654_Jul17) | Jul-18 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power meter E4419B | SN: GB41293874 | 06-Apr-16 (No. 217-02285/02284) | In house check: Jun-18 |
| Power sensor E4412A | SN: MY41498087 | 06-Apr-16 (No. 217-02285) | In house check: Jun-18 |
| Power sensor E4412A | SN: 000110210 | 06-Apr-16 (No. 217-02284 | In house check: Jun-18 |
| RF generator HP 8648C | SN: US3642U01700 | 04-Aug-99 (in house check Jun-16) | In house check: Jun-18 |
| Network Analyzer HP 8753E | SN: US37390585 | 18-Oct-01 (in house check Oct-17) | In house check: Oct-18 |

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

Issued: February 23, 2018

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

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

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

**Additional Documentation:**

e) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The source is mounted in a touch configuration below the center marking of the flat phantom.
- *Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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

## Measurement Conditions

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

| | | |
|---|---|---|
| **DASY Version** | DASY5 | V52.10.0 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | ELI4 Flat Phantom | Shell thickness: 2 ± 0.2 mm |
| **EUT Positioning** | Touch Position | |
| **Zoom Scan Resolution** | dx, dy = mm, dz = mm | Graded Ratio = 1.4 (Z direction) |
| **Frequency** | 150 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 52.3 | 0.76 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 50.3 ± 6 % | 0.76 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 1 W input power | 3.71 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **3.68 W/kg ± 18.4 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 1 W input power | 2.47 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **2.45 W/kg ± 18.0 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 61.9 | 0.80 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 62.1 ± 6 % | 0.81 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 1 W input power | 3.78 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **3.75 W/kg ± 18.4 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 1 W input power | 2.52 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **2.50 W/kg ± 18.0 % (k=2)** |

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

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 44.4 Ω + 3.2 jΩ |
| Return Loss | - 23.2 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 48.7 Ω + 7.0 jΩ |
| Return Loss | - 22.9 dB |

### Additional EUT Data

| | |
|---|---|
| Manufactured by | SPEAG |
| Manufactured on | July 10, 2017 |

**DASY5 Validation Report for Head TSL**

Date: 21.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4024**

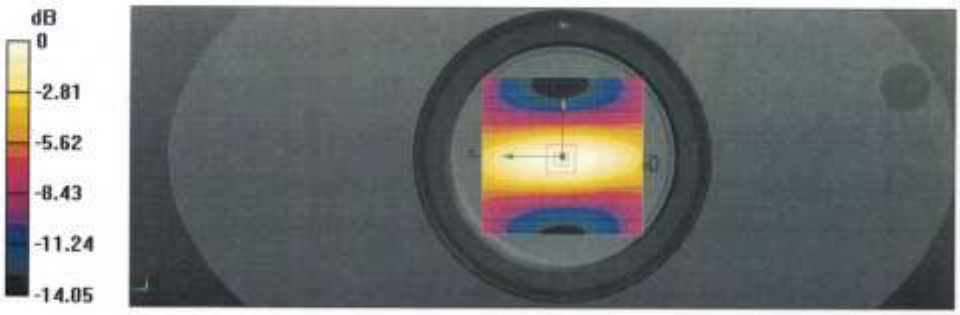
Communication System: UID 0 - CW; Frequency: 150 MHz
Medium parameters used: f = 150 MHz; $\sigma$ = 0.76 S/m; $\varepsilon_r$ = 50.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(12.12, 12.12, 12.12); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 24.07.2017
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

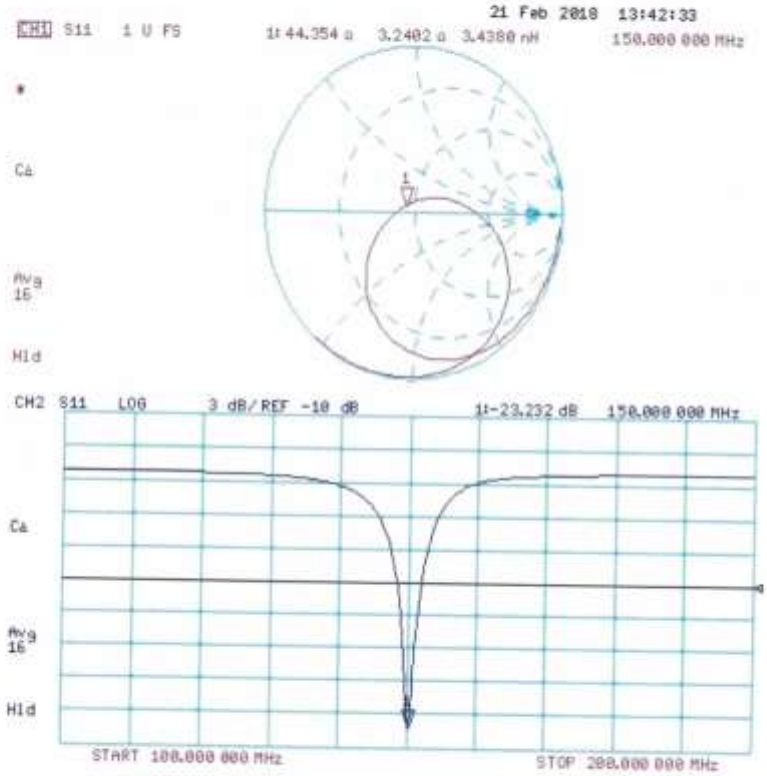
**CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan (81x81x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 5.21 W/kg

**CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan, dist=1.4mm (8x10x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 82.22 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 6.91 W/kg
**SAR(1 g) = 3.71 W/kg; SAR(10 g) = 2.47 W/kg**
Maximum value of SAR (measured) = 5.18 W/kg




0 dB = 5.21 W/kg = 7.17 dBW/kg

**Impedance Measurement Plot for Head TSL**



## DASY5 Validation Report for Body TSL

Date: 21.02.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4024**

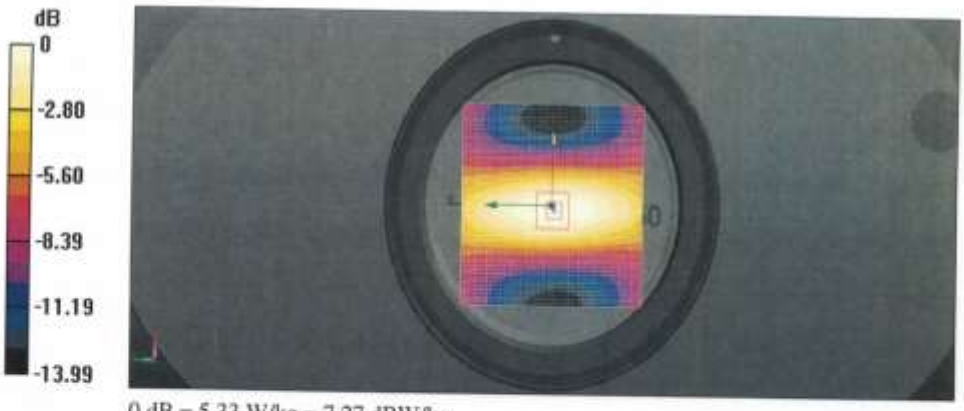
Communication System: UID 0 - CW; Frequency: 150 MHz
Medium parameters used: f = 150 MHz; $\sigma$ = 0.81 S/m; $\varepsilon_r$ = 62.1; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(11.57, 11.57, 11.57); Calibrated: 30.12.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 24.07.2017
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

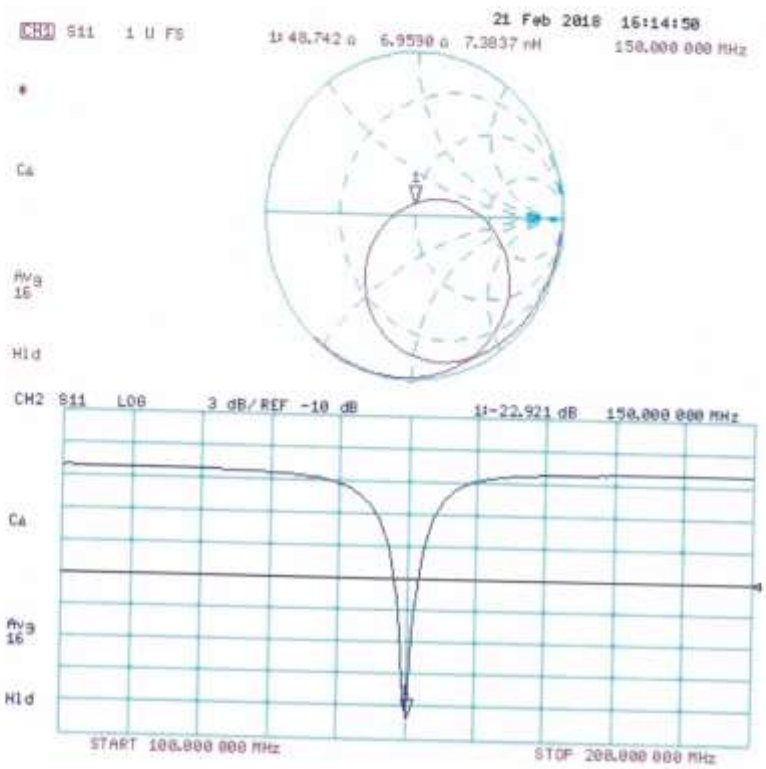
**CLA Calibration for MSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan (81x81x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 5.33 W/kg

**CLA Calibration for MSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan, dist=1.4mm (8x10x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 80.56 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 7.08 W/kg
**SAR(1 g) = 3.78 W/kg; SAR(10 g) = 2.52 W/kg**
Maximum value of SAR (measured) = 5.28 W/kg




0 dB = 5.33 W/kg = 7.27 dBW/kg

**Impedance Measurement Plot for Body TSL**



# Extended Dipole Calibrations

Referring to KDB865664 D01, 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.

| **Head** | | | | | | |
|---|---|---|---|---|---|---|
| Date of measurement | Return-loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Imaginary impedance (ohm) | Delta (ohm) |
| 2018-02-21 | -23.2 | | 44.4 | | 3.2 | |
| 2019-02-20 | -22.9 | 1.31 | 44.7 | 0.3 | 2.8 | 0.4 |

| **Body** | | | | | | |
|---|---|---|---|---|---|---|
| Date of measurement | Return-loss (dB) | Delta (%) | Real Impedance (ohm) | Delta (ohm) | Imaginary impedance (ohm) | Delta (ohm) |
| 2018-02-23 | -22.9 | | 48.7 | | 7.0 | |
| 2019-02-20 | -23.3 | 1.75 | 48.2 | 0.5 | 6.5 | 0.5 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5ohm of prior calibration. Therefore the verification result should support extended calibration.