



# SAR TEST REPORT

**Applicant** Imaxeon Pty.Ltd.  
**FCC ID** 2ASV8-TABLET01  
**Product** Salient Tablet 11.6"  
**Model** DC160  
**Report No.** R1904A0194-S1V1  
**Issue Date** June 13, 2019

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **IEEE 1528- 2013, ANSI C95.1: 1992/IEEE C95.1: 1991**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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# 1 Test Laboratory

## 1.1 Notes of the Test Report

This report shall not be reproduced in full or partial, without the written approval of **TA technology (shanghai) co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above.

## 1.2 Test facility

### **CNAS (accreditation number:L2264)**

TA Technology (Shanghai) Co., Ltd. has obtained the accreditation of China National Accreditation Service for Conformity Assessment (CNAS).

### **FCC (Designation number: CN1179, Test Firm Registration Number: 446626)**

TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

### **IC (recognition number is 8510A)**

TA Technology (Shanghai) Co., Ltd. has been listed by industry Canada to perform electromagnetic emission measurement.

### **VCCI (recognition number is C-4595, T-2154, R-4113, G-10766)**

TA Technology (Shanghai) Co., Ltd. has been listed by industry Japan to perform electromagnetic emission measurement.

### **A2LA (Certificate Number: 3857.01)**

TA Technology (Shanghai) Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

### 1.3 Testing Location

Company: TA Technology (Shanghai) Co., Ltd.  
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### 1.4 Laboratory Environment

|                                                                                                                                                                                                 |                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Temperature                                                                                                                                                                                     | Min. = 18°C, Max. = 25 °C |
| Relative humidity                                                                                                                                                                               | Min. = 30%, Max. = 70%    |
| Ground system resistance                                                                                                                                                                        | < 0.5 $\Omega$            |
| Ambient noise is checked and found very low and in compliance with requirement of standards.<br>Reflection of surrounding objects is minimized and in compliance with requirement of standards. |                           |

## 2 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for the EUT are as follows:

Table 1: Highest Reported SAR

| Mode                                                                                                                                                                                                                                                                                                                                                                                                | Highest Reported SAR (W/kg)                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                     | Product Specific 10-g SAR (Separation 0mm) |
| Wi-Fi (2.4G)                                                                                                                                                                                                                                                                                                                                                                                        | 0.572                                      |
| BT                                                                                                                                                                                                                                                                                                                                                                                                  | /                                          |
| Date of Testing:                                                                                                                                                                                                                                                                                                                                                                                    | May 12, 2019                               |
| Note: 1) The device is in compliance with SAR for Uncontrolled Environment /General Population exposure limits (1.6 W/kg and 4.0 W/kg) specified in ANSI C95.1: 1992/IEEE C95.1: 1991, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013.<br>2) Sand-alone SAR evaluation is not required for BT, more details information see section 10.2 |                                            |

Table 2: Highest Simultaneous Transmission SAR

| Exposure Configuration                                                                        | Product Specific 10-g SAR (Separation 0mm) |
|-----------------------------------------------------------------------------------------------|--------------------------------------------|
| Highest Simultaneous Transmission SAR (W/kg)                                                  | 0.614                                      |
| Note: 1. The detail for simultaneous transmission consideration is described in chapter 10.3. |                                            |

### 3 Description of Equipment under Test

#### Client Information

|                                   |                                                   |
|-----------------------------------|---------------------------------------------------|
| <b>Applicant</b>                  | Imaxeon Pty.Ltd.                                  |
| <b>Applicant address</b>          | 33 Huayuan Shiqiao Road, Pudong, Shanghai, China. |
| <b>Manufacturer</b>               | Shanghai Vigoure trading Co., Ltd.                |
| <b>Manufacturer address</b>       | 158 Puhuitang Rd, Shanghai, China                 |
| <b>Manufacturing site</b>         | ADLINK Technology (China) Co., Ltd.               |
| <b>Manufacturing site address</b> | 300 FangChun Road, Shanghai, China, 201203        |

#### General Technologies

|                             |                     |
|-----------------------------|---------------------|
| <b>Application Purpose:</b> | Original Grant      |
| <b>EUT Stage</b>            | Identical Prototype |
| <b>Model:</b>               | DC160               |
| <b>IMEI:</b>                | /                   |
| <b>Hardware Version:</b>    | /                   |
| <b>Software Version:</b>    | /                   |
| <b>Antenna Type:</b>        | Internal Antenna    |
| <b>Device Class:</b>        | C                   |
| <b>Wi-Fi Hotspot</b>        | Wi-Fi 2.4G          |

**Wireless Technology and Frequency Range**

| Wireless Technology |                                                                                                   | Modulation     | Operating mode   | Tx (MHz)    |
|---------------------|---------------------------------------------------------------------------------------------------|----------------|------------------|-------------|
| BT                  | 2.4G                                                                                              | Version 4.1 LE |                  | 2402 ~2480  |
| Wi-Fi               | 2.4G                                                                                              | DSSS,OFDM      | 802.11b/g/n HT20 | 2412 ~ 2462 |
|                     |                                                                                                   | OFDM           | 802.11n HT40     | 2422 ~ 2452 |
|                     | Does this device support MIMO <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |                |                  |             |



## 4 Test Specification, Methods and Procedures

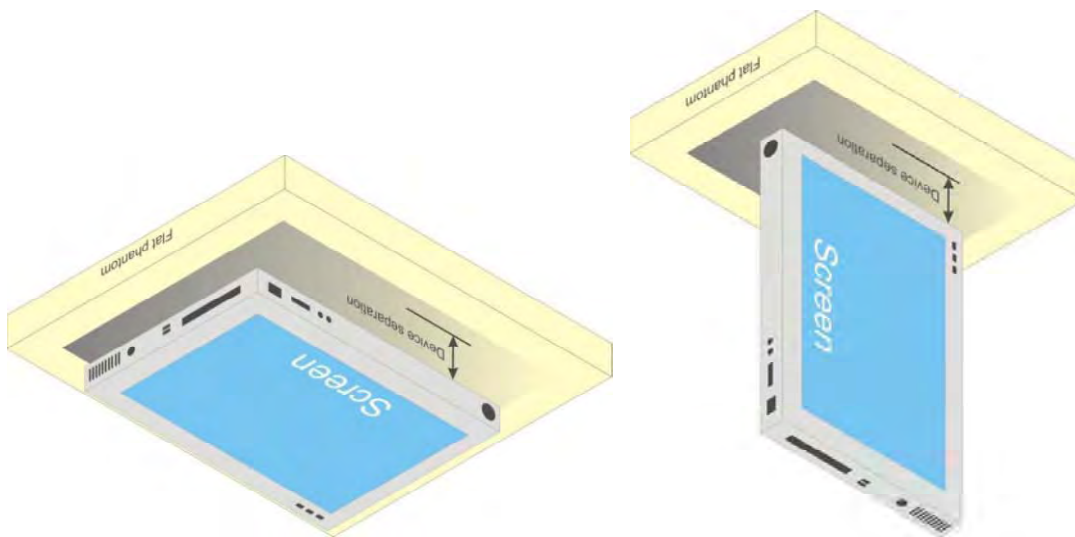
The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, IEEE 1528- 2013, ANSI C95.1: 1992/IEEE C95.1: 1991, the following FCC Published RF exposure KDB procedures:

248227 D01 802.11 Wi-Fi SAR v02r02  
447498 D01 General RF Exposure Guidance v06  
648474 D04 Handset SAR v01r03  
865664 D01 SAR measurement 100 MHz to 6 GHz v01r04  
865664 D02 RF Exposure Reporting v01r02  
941225 D06 Hotspot Mode v02r01  
616217 D04 SAR for laptop and tablets v01r02

## 5 Operational Conditions during Test

### 5.1 Test Positions

According to KDB 616217 D04, SAR evaluation is required for back surface and edges of the devices. The back surface and edges of the tablet are tested with the tablet touching the phantom. Exposures from antennas through the front surface of the display section of a tablet are generally limited to the user's hands. Exposures to hands for typical consumer transmitters used in tablets are not expected to exceed the extremity SAR limit; therefore, SAR evaluation for the front surface of tablet display screens are generally not necessary. When voice mode is supported on a tablet and it is limited to speaker mode or headset operations only, additional SAR testing for this type of voice use is not required.



**Fig-4.1 Illustration for Tablet Setup**

According to KDB 447498 D01, the SAR test exclusion condition is based on source-based time-averaged maximum conducted output power, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The SAR exclusion threshold is determined by the following formula.

(1) The SAR exclusion threshold for distances  $\leq 50\text{mm}$  is defined by the following equation:

$$\frac{(\text{max. power of channel, including tune-up tolerance, mW})}{(\text{min. test separation distance, mm})} * \sqrt{\text{Frequency (GHz)}} \leq 3.0$$

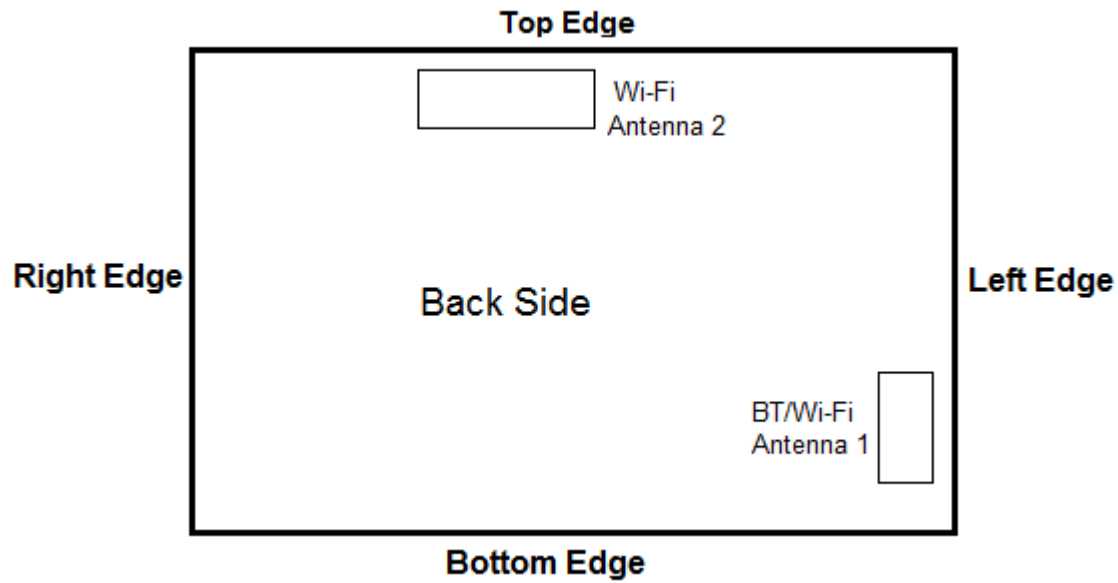
(2) The SAR exclusion threshold for distances  $> 50\text{mm}$  is defined by the following equation, as illustrated in KDB 447498 D01 Appendix B:

a) at 100 MHz to 1500 MHz

$$[\text{Power allowed at numeric Threshold at 50 mm in step 1}) + (\text{test separation distance} - 50 \text{ mm}) \cdot (f_{\text{(MHz)}}/150)] \text{ mW}$$

b) at  $> 1500 \text{ MHz}$  and  $\leq 6 \text{ GHz}$

$$[\text{Power allowed at numeric Threshold at 50 mm in step 1}) + (\text{test separation distance} - 50 \text{ mm}) \cdot 10] \text{ mW}$$



| Band                   | Frequency (MHz) | Max. Tune-up Power (dBm) | Back Side            |            |            | Left Edge            |            |            | Right Edge           |            |            | Top Edge             |            |            | Bottom Edge          |            |            |
|------------------------|-----------------|--------------------------|----------------------|------------|------------|----------------------|------------|------------|----------------------|------------|------------|----------------------|------------|------------|----------------------|------------|------------|
|                        |                 |                          | Ant. To Surgace (mm) | Evaluation | Conclusion | Ant. To Surgace (mm) | Evaluation | Conclusion | Ant. To Surgace (mm) | Evaluation | Conclusion | Ant. To Surgace (mm) | Evaluation | Conclusion | Ant. To Surgace (mm) | Evaluation | Conclusion |
| Wi-Fi 2.4G (Antenna 1) | 2462            | 15.50                    | 19                   | 2.93       | No         | 11                   | 5.06       | Yes        | 285                  | 2351.11    | No         | 141.5                | 916.11     | No         | 75.5                 | 256.11     | No         |
| Wi-Fi 2.4G (Antenna 2) | 2462            | 15.50                    | 19                   | 2.93       | No         | 204                  | 1541.11    | No         | 92                   | 421.11     | No         | 15                   | 3.71       | Yes        | 201                  | 1511.11    | No         |
| BT                     | 2480            | 4.00                     | 19                   | 0.21       | No         | 11                   | 0.36       | No         | 285                  | 2350.08    | No         | 141.5                | 915.08     | No         | 75.5                 | 255.08     | No         |

## 5.2 Measurement Variability

Per FCC KDB Publication 865664 D01, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR Measurement Variability was assessed using the following procedures for each frequency band:

- 1) When the original highest measured SAR is  $\geq 0.80$  W/kg, the measurement was repeated once.
- 2) A second repeated measurement was performed only if the ratio of largest to smallest SAR for the original and first repeated measurements was  $> 1.20$  or when the original or repeated measurement was  $\geq 1.45$  W/kg ( $\sim 10\%$  from the 1-g SAR limit).
- 3) A third repeated measurement was performed only if the original, first or second repeated measurement was  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .
- 4) Repeated measurements are not required when the original highest measured SAR is  $< 0.80$  W/kg

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.

## 5.3 Test Configuration

### 5.3.1 Wi-Fi Test Configuration

SAR test reduction for 802.11 Wi-Fi transmission mode configurations are considered separately for DSSS and OFDM. An initial test position is determined to reduce the number of tests required for certain exposure configurations with multiple test positions. An initial test configuration is determined for each frequency band and aggregated band according to maximum output power, channel bandwidth, wireless mode configurations and other operating parameters to streamline the measurement requirements. For 2.4 GHz DSSS, either the initial test position or DSSS procedure is applied to reduce the number of SAR tests; these are mutually exclusive. For OFDM, an initial test position is only applicable to next to the ear, UMPC mini-tablet and hotspot mode configurations, which is tested using the initial test configuration to facilitate test reduction. For other exposure conditions with a fixed test position, SAR test reduction is determined using only the initial test configuration.

The multiple test positions require SAR measurements in head, hotspot mode or UMPC mini-tablet configurations may be reduced according to the highest reported SAR determined using the *initial test position(s)* by applying the DSSS or OFDM SAR measurement procedures in the required wireless mode test configuration(s). The *initial test position(s)* is measured using the highest measured maximum output power channel in the required wireless mode test configuration(s). When the *reported SAR* for the *initial test position* is:

- $\leq 0.4$  W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- 0.4 W/kg, SAR is repeated using the same wireless mode test configuration tested in the *initial test position* to measure the subsequent next closet/smallest test separation distance and maximum coupling test position, on the highest maximum output power channel, until the *reported SAR* is  $\leq 0.8$  W/kg or all required test positions are tested.
  - ✧ For subsequent test positions with equivalent test separation distance or when exposure is dominated by coupling conditions, the position for maximum coupling condition should be tested.
  - ✧ When it is unclear, all equivalent conditions must be tested.
- For all positions/configurations tested using the *initial test position* and subsequent test positions, when the *reported SAR* is  $> 0.8$  W/kg, measure the SAR for these positions/configurations on the subsequent next highest measured output power channel(s) until the *reported SAR* is  $\leq 1.2$  W/kg or all required test channels are considered.
  - ✧ The additional power measurements required for this step should be limited to those necessary for identifying subsequent highest output power channels to apply the test reduction.

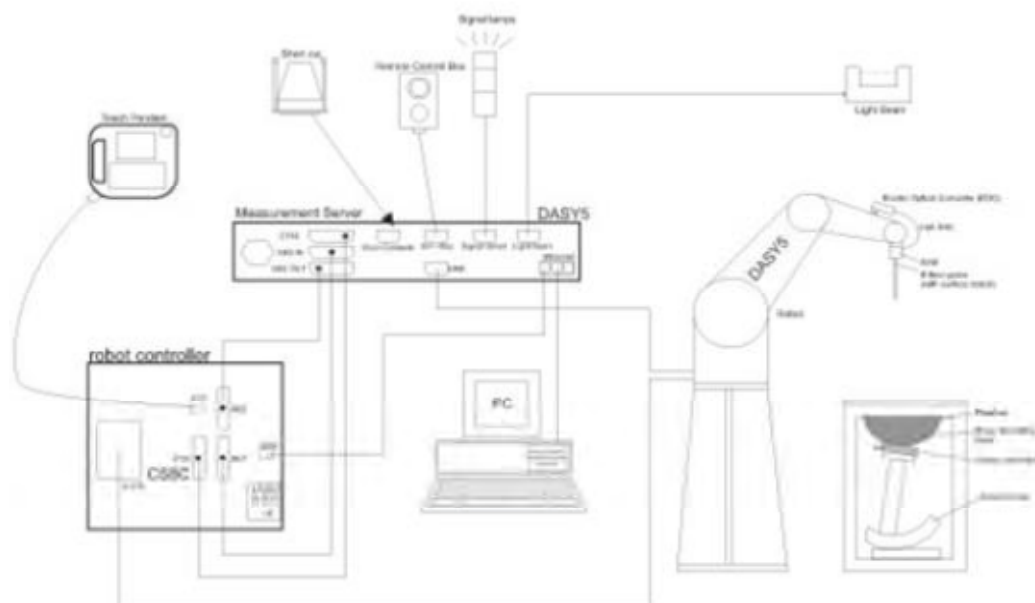
To determine the initial test position, Area Scans were performed to determine the position with the Maximum Value of SAR (measured). The position that produced the highest Maximum Value of SAR is considered the worst case position; thus used as the initial test position.

A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement.

## 6 SAR Measurements System Configuration

### 6.1 SAR Measurement Set-up

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



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## 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.

### EX3DV4 Probe Specification

|               |                                                                                                                                                                                                            |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Construction  | Symmetrical design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE)                                                |
| Calibration   | ISO/IEC 17025 calibration<br>service available                                                                                                                                                             |
| Frequency     | 10 MHz to > 6 GHz<br>Linearity: $\pm 0.2$ dB<br>(30 MHz to 6 GHz)                                                                                                                                          |
| Directivity   | $\pm 0.3$ dB in HSL (rotation around probe axis) $\pm 0.5$ dB in tissue material (rotation normal to probe axis)                                                                                           |
| Dynamic Range | 10 $\mu$ W/g to > 100 mW/g Linearity: $\pm 0.2$ dB (noise: typically < 1 $\mu$ W/g)                                                                                                                        |
| Dimensions    | Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm                                                                          |
| Application   | High precision dosimetric measurements in any exposure Scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%. |



### E-field Probe Calibration

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than  $\pm 10\%$ . The spherical isotropy was evaluated and found to be better than  $\pm 0.25$ dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a wave guide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

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

$$SAR = C \Delta T / \Delta t$$

Where:  $\Delta t$  = Exposure time (30 seconds),  
 $C$  = Heat capacity of tissue (brain or muscle),  
 $\Delta T$  = Temperature increase due to RF exposure.

Or

$$SAR = |E|^2 \sigma / \rho$$

Where:  $\sigma$  = Simulated tissue conductivity,  
 $\rho$  = Tissue density ( $\text{kg/m}^3$ ).

## 6.3 SAR Measurement Procedure

### Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

### Area Scan

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

|                                                                                                        | $\leq 3$ GHz                                                                                                                                                                                                                                                           | $> 3$ GHz                                              |
|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | $5 \pm 1$ mm                                                                                                                                                                                                                                                           | $\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm     |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location              | $30^\circ \pm 1^\circ$                                                                                                                                                                                                                                                 | $20^\circ \pm 1^\circ$                                 |
| Maximum area scan spatial resolution:<br>$\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$              | $\leq 2$ GHz: $\leq 15$ mm<br>$2 - 3$ GHz: $\leq 12$ mm                                                                                                                                                                                                                | $3 - 4$ GHz: $\leq 12$ mm<br>$4 - 6$ GHz: $\leq 10$ 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 $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device. |                                                        |

## Zoom Scan

Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the zoom scan evaluates the averaged SAR for 1 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

|                                                                                                                                                                                                                                                                            |                                           |                                                                                             | ≤3GHz                               | > 3 GHz                                               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------------------------------------------------------------------------------|-------------------------------------|-------------------------------------------------------|
| Maximum zoom scan spatial resolution: $\Delta x_{\text{zoom}}$<br>$\Delta y_{\text{zoom}}$                                                                                                                                                                                 |                                           |                                                                                             | ≤2GHz: ≤8mm<br>2 – 3GHz: ≤5mm*      | 3 – 4GHz: ≤5mm*<br>4 – 6GHz: ≤4mm*                    |
| Maximum zoom scan spatial resolution, normal to phantom surface                                                                                                                                                                                                            | Uniform grid: $\Delta z_{\text{zoom}}(n)$ |                                                                                             | ≤5mm                                | 3 – 4GHz: ≤4mm<br>4 – 5GHz: ≤3mm<br>5 – 6GHz: ≤2mm    |
|                                                                                                                                                                                                                                                                            | Graded grid                               | $\Delta z_{\text{zoom}}(1)$ : between 1 <sup>st</sup> two points closest to phantom surface | ≤4mm                                | 3 – 4GHz: ≤3mm<br>4 – 5GHz: ≤2.5mm<br>5 – 6GHz: ≤2mm  |
|                                                                                                                                                                                                                                                                            |                                           | $\Delta z_{\text{zoom}}(n>1)$ : between subsequent points                                   | ≤1.5• $\Delta z_{\text{zoom}}(n-1)$ |                                                       |
| Minimum zoom scan volume                                                                                                                                                                                                                                                   | X, y, z                                   |                                                                                             | ≥30mm                               | 3 – 4GHz: ≥28mm<br>4 – 5GHz: ≥25mm<br>5 – 6GHz: ≥22mm |
| Note: $\delta$ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.                                                                                                                          |                                           |                                                                                             |                                     |                                                       |
| * When zoom scan is required and the <u>reported</u> SAR from the <i>area scan based 1-g SAR estimation</i> procedures of KDB 447498 is ≤ 1.4W/kg, ≤8mm, ≤7mm and ≤5mm zoom scan resolution may be applied, respectively, for 2GHz to 3GHz, 3GHz to 4GHz and 4GHz to 6GHz. |                                           |                                                                                             |                                     |                                                       |

## Volume Scan Procedures

The volume scan is used to assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

## Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drifts more than 5%, the SAR will be retested.

## 7 Main Test Equipment

| Name of Equipment        | Manufacturer    | Type/Model | Serial Number | Last Cal.  | Cal. Due Date |
|--------------------------|-----------------|------------|---------------|------------|---------------|
| Network analyzer         | Agilent         | E5071B     | MY42404014    | 2018-05-20 | 2019-05-19    |
| Dielectric Probe Kit     | HP              | 85070E     | US44020115    | 2018-05-20 | 2019-05-19    |
| Power meter              | Agilent         | E4417A     | GB41291714    | 2018-05-21 | 2019-05-20    |
| Power sensor             | Agilent         | N8481H     | MY50350004    | 2018-05-21 | 2019-05-20    |
| Power sensor             | Agilent         | E9327A     | US40441622    | 2018-05-20 | 2019-05-19    |
| Dual directional coupler | Agilent         | 778D-012   | 50519         | 2018-05-21 | 2019-05-20    |
| Dual directional coupler | Agilent         | 777D       | 50146         | 2018-05-20 | 2019-05-19    |
| Amplifier                | INDEXSAR        | IXA-020    | 0401          | 2018-05-20 | 2019-05-19    |
| E-field Probe            | SPEAG           | EX3DV4     | 3677          | 2018-05-29 | 2019-05-28    |
| DAE                      | SPEAG           | DAE4       | 1291          | 2018-12-04 | 2019-12-03    |
| Validation Kit 2450MHz   | SPEAG           | D2450V2    | 786           | 2017-08-29 | 2020-08-28    |
| Temperature Probe        | Tianjin jinming | JM222      | AA1009129     | 2018-05-17 | 2019-05-16    |
| Hygrothermograph         | Anymetr         | NT-311     | 20150731      | 2018-05-17 | 2019-05-16    |
| Software for Test        | Speag           | DASY5      | 52.8.8.1222   | /          | /             |
| Softwarefor Tissue       | Agilent         | 85070      | E06.01.36     | /          | /             |

## 8 Tissue Dielectric Parameter Measurements & System Verification

### 8.1 Tissue Verification

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within  $\pm 2^\circ\text{C}$  of the temperature when the tissue parameters are characterized. The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance.

#### Target values

| Frequency (MHz) |      | Water (%) | Salt (%) | Sugar (%) | Glycol (%) | Preventol (%) | Cellulose (%) | $\epsilon_r$ | $\sigma(\text{s/m})$ |
|-----------------|------|-----------|----------|-----------|------------|---------------|---------------|--------------|----------------------|
| Body            | 2450 | 73.2      | 0.1      | 0         | 26.7       | 0             | 0             | 52.7         | 1.95                 |

#### Measurements results

| Frequency (MHz) |      | Test Date | Temp $^\circ\text{C}$ | Measured Dielectric Parameters |                      | Target Dielectric Parameters |                      | Limit (Within $\pm 5\%$ ) |                  |
|-----------------|------|-----------|-----------------------|--------------------------------|----------------------|------------------------------|----------------------|---------------------------|------------------|
|                 |      |           |                       | $\epsilon_r$                   | $\sigma(\text{s/m})$ | $\epsilon_r$                 | $\sigma(\text{s/m})$ | Dev $\epsilon_r(\%)$      | Dev $\sigma(\%)$ |
| 2450            | Body | 5/12/2019 | 21.5                  | 52.5                           | 1.98                 | 52.7                         | 1.95                 | -0.38                     | 1.54             |

Note: The depth of tissue-equivalent liquid in a phantom must be  $\geq 15.0$  cm for SAR measurements  $\leq 3$  GHz and  $\geq 10.0$  cm for measurements  $> 3$  GHz.

The manufacturer calibrates the probes annually. Dielectric parameters of the tissue simulates were measured using the dielectric probe kit and the network analyzer. A system check measurement for every day was made following the determination of the dielectric parameters of the Tissue simulates, using the dipole validation kit. The dipole antenna was placed under the flat section of the twin SAM phantom.

[illegible]

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### Justification for Extended SAR Dipole Calibrations

Usage of SAR dipoles calibrated less than 3 years ago but more than 1 year ago were confirmed in maintaining return loss ( $< -20$  dB, within 20% of prior calibration) and impedance (within 5 ohm from prior calibration) requirements per extended calibrations in KDB 865664 D01:

| Dipole                       |        | Date of Measurement | Return Loss(dB) | $\Delta$ % | Impedance ( $\Omega$ ) | $\Delta\Omega$ |
|------------------------------|--------|---------------------|-----------------|------------|------------------------|----------------|
| Dipole<br>D2450V2<br>SN: 786 | Head   | 8/29/2017           | -25.5           | /          | 53.4                   | /              |
|                              | Liquid | 8/28/2018           | -23.0           | 9.80       | 57.2                   | 3.8            |
|                              | Body   | 8/29/2017           | -23.6           | /          | 51.0                   | /              |
|                              | Liquid | 8/28/2018           | -23.7           | -0.42      | 55.2                   | 4.2            |

### System Check results

| Frequency (MHz)                                                                               |      | Test Date | Temp $^{\circ}\text{C}$ | 250mW Measured SAR <sub>1g</sub> (W/kg) | 1W Normalized SAR <sub>1g</sub> (W/kg) | 1W Target SAR <sub>1g</sub> (W/kg) | $\Delta$ % (Limit $\pm 10\%$ ) | Plot No. |
|-----------------------------------------------------------------------------------------------|------|-----------|-------------------------|-----------------------------------------|----------------------------------------|------------------------------------|--------------------------------|----------|
| 2450                                                                                          | Body | 5/12/2019 | 21.5                    | 12.50                                   | 50.00                                  | 50.80                              | -1.57                          | 1        |
| Note: Target Values used derive from the calibration certificate Data Storage and Evaluation. |      |           |                         |                                         |                                        |                                    |                                |          |

## 9 Normal and Maximum Output Power

KDB 447498 D01 at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit.

### 9.1 WLAN Mode

| Wi-Fi 2.4G<br>Antenna 1<br>Mode | Channel<br>/Frequency(MHz) | Maximum Output Power (dBm) |       |              |
|---------------------------------|----------------------------|----------------------------|-------|--------------|
|                                 |                            | Tune-up                    | Meas. | TP Set Level |
| 802.11b<br>(1M)                 | 1/2412                     | 15.50                      | 14.42 | /            |
|                                 | 6/2437                     | 15.50                      | 15.16 | /            |
|                                 | 11/2462                    | 15.50                      | 14.53 | /            |
| 802.11g<br>(6M)                 | 1/2412                     | 15.00                      | 14.08 | /            |
|                                 | 6/2437                     | 15.00                      | 14.74 | /            |
|                                 | 11/2462                    | 15.00                      | 14.17 | /            |
| 802.11n-HT20<br>(MCS0)          | 1/2412                     | 15.00                      | 13.73 | /            |
|                                 | 6/2437                     | 15.00                      | 14.49 | /            |
|                                 | 11/2462                    | 15.00                      | 13.91 | /            |
| 802.11n-HT40<br>(MCS0)          | 3/2422                     | 13.00                      | 12.18 | /            |
|                                 | 6/2437                     | 13.00                      | 12.62 | /            |
|                                 | 9/2452                     | 13.00                      | 12.42 | /            |

Note: Initial test configuration is 802.11b mode, since the highest maximum output power.

| Wi-Fi 2.4G<br>Antenna 2<br>Mode | Channel<br>/Frequency(MHz) | Maximum Output Power (dBm) |       |              |
|---------------------------------|----------------------------|----------------------------|-------|--------------|
|                                 |                            | Tune-up                    | Meas. | TP Set Level |
| 802.11b<br>(1M)                 | 1/2412                     | 15.50                      | 13.75 | /            |
|                                 | 6/2437                     | 15.50                      | 15.25 | /            |
|                                 | 11/2462                    | 15.50                      | 14.75 | /            |
| 802.11g<br>(6M)                 | 1/2412                     | 15.00                      | 13.23 | /            |
|                                 | 6/2437                     | 15.00                      | 14.89 | /            |
|                                 | 11/2462                    | 15.00                      | 14.28 | /            |
| 802.11n-HT20<br>(MCS0)          | 1/2412                     | 15.00                      | 13.09 | /            |
|                                 | 6/2437                     | 15.00                      | 14.58 | /            |
|                                 | 11/2462                    | 15.00                      | 14.12 | /            |
| 802.11n-HT40<br>(MCS0)          | 3/2422                     | 13.00                      | 11.87 | /            |
|                                 | 6/2437                     | 13.00                      | 12.74 | /            |
|                                 | 9/2452                     | 13.00                      | 12.66 | /            |

Note: Initial test configuration is 802.11b mode, since the highest maximum output power.



| Wi-Fi 2.4G<br>MIMO<br>Mode | Channel<br>/Frequency(MHz) | Maximum Output Power (dBm) |       |              |
|----------------------------|----------------------------|----------------------------|-------|--------------|
|                            |                            | Tune-up                    | Meas. | TP Set Level |
| 802.11n-HT20<br>(MCS0)     | 1/2412                     | 18.00                      | 16.43 | /            |
|                            | 6/2437                     | 18.00                      | 17.55 | /            |
|                            | 11/2462                    | 18.00                      | 17.03 | /            |
| 802.11n-HT40<br>(MCS0)     | 3/2422                     | 16.00                      | 15.04 | /            |
|                            | 6/2437                     | 16.00                      | 15.69 | /            |
|                            | 9/2452                     | 16.00                      | 15.55 | /            |

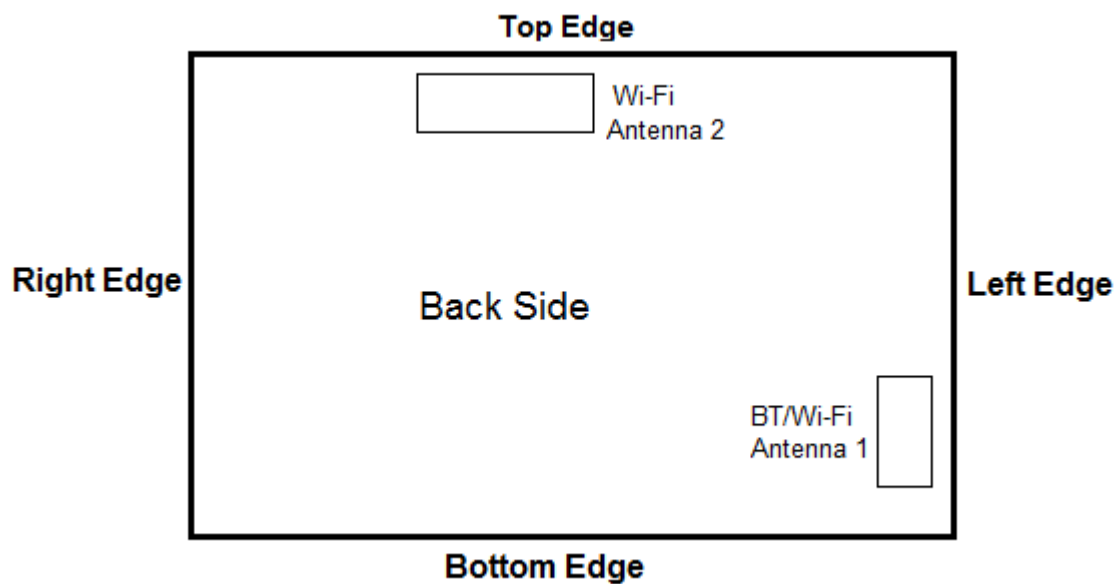
Note: Initial test configuration is 802.11n-HT20 mode, since the highest maximum output power.

## 9.2 Bluetooth Mode

| BT            | Conducted Power(dBm)   |                |                | Tune-up<br>Limit (dBm) |
|---------------|------------------------|----------------|----------------|------------------------|
|               | Channel/Frequency(MHz) |                |                |                        |
|               | Ch 0/2402 MHz          | Ch 39/2441 MHz | Ch 78/2480 MHz |                        |
| GFSK          | 1.83                   | 2.20           | 2.04           | 3.00                   |
| $\pi/4$ DQPSK | 3.22                   | 3.58           | 3.29           | 4.00                   |
| 8DPSK         | 3.42                   | 3.76           | 3.47           | 4.00                   |
| BLE           | Ch 0/2402 MHz          | Ch 19/2440 MHz | Ch 39/2480 MHz | Tune-up<br>Limit (dBm) |
| GFSK          | 2.71                   | 3.07           | 2.99           | 3.50                   |

## 10 Measured and Reported (Scaled) SAR Results

### 10.1 EUT Antenna Locations



Note: The location of the test is detailed in Section 5.1.

## 10.2 Standalone SAR test exclusion considerations

Per KDB 447498 D01, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances  $\leq 50$  mm are determined by:

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

- $f(\text{GHz})$  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

Per KDB 447498 D01, when the minimum test separation distance is  $< 5$  mm, a distance of 5 mm is applied to determine SAR test exclusion.

| Bluetooth                 | Distance (mm) | MAXPower (dBm) | Frequency (MHz) | Ratio | Evaluation |
|---------------------------|---------------|----------------|-----------------|-------|------------|
| Product Specific 10-g SAR | 5             | 4.00           | 2480            | 0.79  | No         |

## 10.3 Measured SAR Results

**Table 3: Wi-Fi 2.4G (ANT1)**

| Test Position                                                                  | Cover Type | Mode 802.11b | Duty Cycle | Channel/ Frequency (MHz) | Tune-up dBm) | Measured power (dBm) | Limit of SAR 1.6 W/kg (mW/g) |                  |                  |                |               | Plot No. |
|--------------------------------------------------------------------------------|------------|--------------|------------|--------------------------|--------------|----------------------|------------------------------|------------------|------------------|----------------|---------------|----------|
|                                                                                |            |              |            |                          |              |                      | Area Scan SAR 1g             | Zoom Scan SAR 1g | Power Drift (dB) | Scaling Factor | Report SAR 1g |          |
| Product Specific 10-g SAR (Distance 0mm) (ANT1)                                |            |              |            |                          |              |                      |                              |                  |                  |                |               |          |
| Back Side                                                                      | standard   | DSSS         | 100.0%     | 6/2437                   | 15.50        | 15.16                | 0.382                        | 0.380            | 0.020            | 1.08           | 0.411         | /        |
| Left Edge                                                                      | standard   | DSSS         | 100.0%     | 6/2437                   | 15.50        | 15.16                | 0.495                        | 0.529            | 0.132            | 1.08           | 0.572         | 2        |
| Right Edge                                                                     | N/A        | N/A          | N/A        | N/A                      | N/A          | N/A                  | N/A                          | N/A              | N/A              | N/A            | N/A           | N/A      |
| Top Edge                                                                       | N/A        | N/A          | N/A        | N/A                      | N/A          | N/A                  | N/A                          | N/A              | N/A              | N/A            | N/A           | N/A      |
| Bottom Edge                                                                    | N/A        | N/A          | N/A        | N/A                      | N/A          | N/A                  | N/A                          | N/A              | N/A              | N/A            | N/A           | N/A      |
| Note: 1. The value with blue color is the maximum SAR Value of each test band. |            |              |            |                          |              |                      |                              |                  |                  |                |               |          |



Table 4: Wi-Fi 2.4G (ANT2)

| Test Position                                                                  | Cover Type | Mode 802.11b | Duty Cycle | Channel/ Frequency (MHz) | Tune-up dBm) | Measured power (dBm) | Limit of SAR 1.6 W/kg (mW/g) |                  |                  |                |               | Plot No. |
|--------------------------------------------------------------------------------|------------|--------------|------------|--------------------------|--------------|----------------------|------------------------------|------------------|------------------|----------------|---------------|----------|
|                                                                                |            |              |            |                          |              |                      | Area Scan SAR 1g             | Zoom Scan SAR 1g | Power Drift (dB) | Scaling Factor | Report SAR 1g |          |
| Product Specific 10-g SAR (Distance 0mm) (ANT2)                                |            |              |            |                          |              |                      |                              |                  |                  |                |               |          |
| Back Side                                                                      | standard   | DSSS         | 100.0%     | 6/2437                   | 15.50        | 15.25                | 0.189                        | 0.214            | 0.030            | 1.06           | 0.227         | /        |
| Left Edge                                                                      | N/A        | N/A          | N/A        | N/A                      | N/A          | N/A                  | N/A                          | N/A              | N/A              | N/A            | N/A           | N/A      |
| Right Edge                                                                     | N/A        | N/A          | N/A        | N/A                      | N/A          | N/A                  | N/A                          | N/A              | N/A              | N/A            | N/A           | N/A      |
| Top Edge                                                                       | standard   | DSSS         | 100.0%     | 6/2437                   | 15.50        | 15.25                | 0.413                        | 0.432            | -0.020           | 1.06           | 0.458         | 3        |
| Bottom Edge                                                                    | N/A        | N/A          | N/A        | N/A                      | N/A          | N/A                  | N/A                          | N/A              | N/A              | N/A            | N/A           | N/A      |
| Note: 1. The value with blue color is the maximum SAR Value of each test band. |            |              |            |                          |              |                      |                              |                  |                  |                |               |          |



Table 5: Wi-Fi 2.4G (MIMO)

| Test Position                                                                  | Cover Type | Mode 802.11n-HT20 | Duty Cycle | Channel/Frequency (MHz) | Tune-up dBm) | Measured power (dBm) | Limit of SAR 1.6 W/kg (mW/g) |                  |                  |                |               | Plot No. |
|--------------------------------------------------------------------------------|------------|-------------------|------------|-------------------------|--------------|----------------------|------------------------------|------------------|------------------|----------------|---------------|----------|
|                                                                                |            |                   |            |                         |              |                      | Area Scan SAR 1g             | Zoom Scan SAR 1g | Power Drift (dB) | Scaling Factor | Report SAR 1g |          |
| Product Specific 10-g SAR (Distance 0mm)(MIMO)                                 |            |                   |            |                         |              |                      |                              |                  |                  |                |               |          |
| Back Side                                                                      | standard   | DSSS              | 100.0%     | 6/2437                  | 18.00        | 17.55                | 0.206                        | 0.208            | 0.042            | 1.11           | 0.231         | /        |
| Left Edge                                                                      | standard   | DSSS              | 100.0%     | 6/2437                  | 18.00        | 17.55                | 0.371                        | 0.415            | -0.03            | 1.11           | 0.460         | 4        |
| Right Edge                                                                     | N/A        | N/A               | N/A        | N/A                     | N/A          | N/A                  | N/A                          | N/A              | N/A              | N/A            | N/A           | N/A      |
| Top Edge                                                                       | standard   | DSSS              | 100.0%     | 6/2437                  | 18.00        | 17.55                | 0.358                        | 0.370            | -0.07            | 1.11           | 0.410         | /        |
| Bottom Edge                                                                    | N/A        | N/A               | N/A        | N/A                     | N/A          | N/A                  | N/A                          | N/A              | N/A              | N/A            | N/A           | N/A      |
| Note: 1. The value with blue color is the maximum SAR Value of each test band. |            |                   |            |                         |              |                      |                              |                  |                  |                |               |          |



Table 6: BT

| Band                                                                                                                                                                                                                                                                                                                                                                                                                             | Configuration             | Frequency (MHz) | Maximum Power (dBm) | Separation Distance (mm) | Estimated SAR (W/kg) |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-----------------|---------------------|--------------------------|----------------------|
| Bluetooth                                                                                                                                                                                                                                                                                                                                                                                                                        | Product Specific 10-g SAR | 2480            | 4.00                | 5                        | 0.042                |
| <p>For simultaneous transmission analysis, Bluetooth SAR is estimated per KDB 447498 D01 based on the formula below.</p> <p><math display="block">(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm}) \cdot [\sqrt{f(\text{GHz})} / x] \text{ W/kg}</math></p> <p>for test separation distances <math>\leq 50</math> mm; where <math>x = 18.75</math> for 10-g SAR.</p> |                           |                 |                     |                          |                      |

## 10.4 Simultaneous Transmission Analysis

| Simultaneous Transmission Configurations | Product Specific 10-g SAR |
|------------------------------------------|---------------------------|
| Wi-Fi-2.4GHz(data) + Bluetooth(data)     | Yes                       |

**General Note:**

1. The Scaled SAR summation is calculated based on the same configuration and test position.
2. Per KDB 447498 D01, simultaneous transmission SAR is compliant if,
  - i) Scalar SAR summation  $< 1.6\text{W/kg}$ , simultaneously transmission SAR measurement is not necessary.
  - ii)  $\text{SPLSR} = (\text{SAR1} + \text{SAR2})^{1.5} / (\text{min. separation distance, mm})$ , and the peak separation distance is determined from the square root of  $[(x1-x2)^2 + (y1-y2)^2 + (z1-z2)^2]$ , where  $(x1, y1, z1)$  and  $(x2, y2, z2)$  are the coordinates of the extrapolated peak SAR locations in the zoom scan.
  - iii) If  $\text{SPLSR} \leq 0.04$ , simultaneously transmission SAR measurement is not necessary.

**About BT and Wi-Fi 2.4G**

| Test Position \ SAR <sub>1g</sub> (W/kg)                                                                                                                                                | BT    | Wi-Fi 2.4G |       |       | MAX. $\Sigma$ SAR <sub>1g</sub> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|-------|-------|---------------------------------|
|                                                                                                                                                                                         |       | ANT 1      | ANT 2 | MIMO  |                                 |
| Back Side                                                                                                                                                                               | 0.042 | 0.411      | 0.227 | 0.231 | 0.453                           |
| Left Edge                                                                                                                                                                               | 0.042 | 0.572      | N/A   | 0.460 | 0.614                           |
| Right Edge                                                                                                                                                                              | 0.042 | N/A        | N/A   | N/A   | 0.042                           |
| Top Edge                                                                                                                                                                                | 0.042 | N/A        | 0.458 | 0.410 | 0.500                           |
| Bottom Edge                                                                                                                                                                             | 0.042 | N/A        | N/A   | N/A   | 0.042                           |
| Note: 1. The value with blue color is the maximum $\Sigma$ SAR <sub>1g</sub> Value.<br>2. MAX. $\Sigma$ SAR <sub>1g</sub> = Unlicensed SAR <sub>MAX</sub> + Licensed SAR <sub>MAX</sub> |       |            |       |       |                                 |

MAX.  $\Sigma$ SAR<sub>1g</sub> = 0.614 W/kg < 4.0 W/kg, so the Simultaneous transimition SAR with volum scan are not required for BT and Wi-Fi 2.4G.



## 11 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 extensive SAR measurement uncertainty analysis described in IEEE Std 1528- 2013 is not required in SAR reports submitted for equipment approval.

## ANNEX A: Test Layout



### Tissue Simulating Liquids

For the measurement of the field distribution inside the flat phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For Body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Picture 3.



Picture 3: Liquid depth in the flat Phantom

## ANNEX B: System Check Results

### Plot 1 System Performance Check at 2450 MHz Body TSL

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2

Date: 5/12/2019

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.98$  mho/m;  $\epsilon_r = 52.5$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C Liquid Temperature: 21.5 °C

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(7.53, 7.53, 7.53); Calibrated: 5/29/2018;

Electronics: DAE4 SN1317; Calibrated: 3/23/2018

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

**d=10mm, Pin=250mW/Area Scan (41x71x1):** Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (interpolated) = 16 mW/g

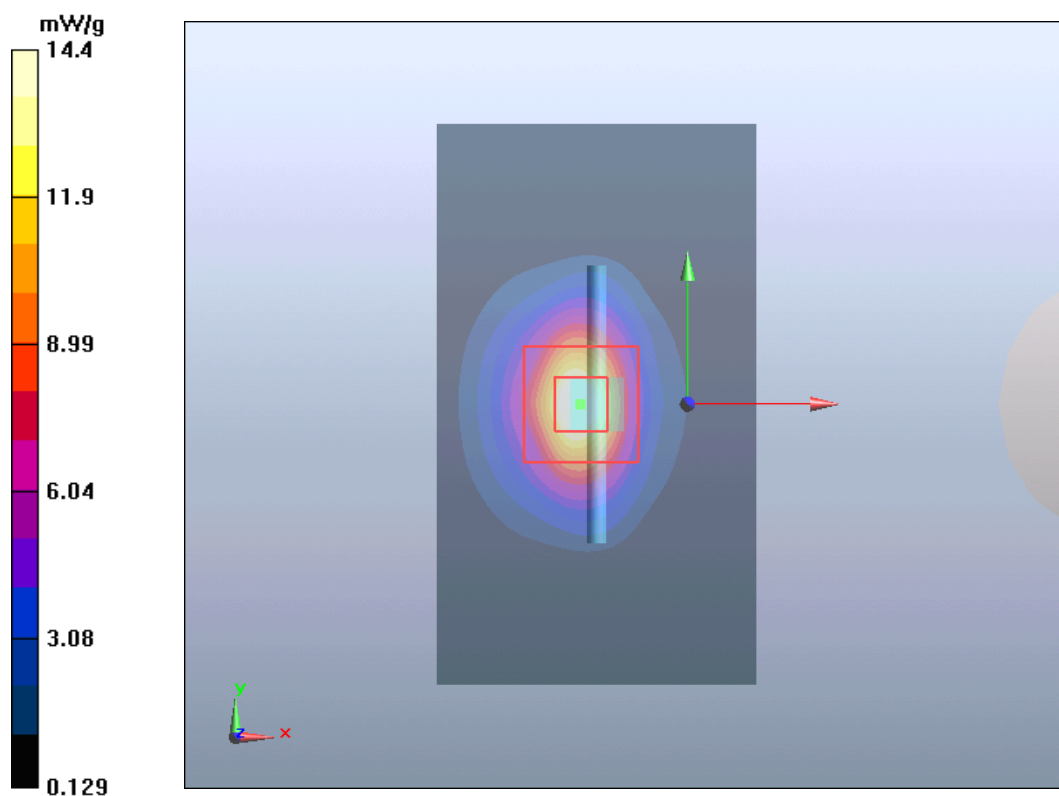
**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 81.2 V/m; Power Drift = 0.003 dB

Peak SAR (extrapolated) = 25.4 W/kg

**SAR(1 g) = 12.5 mW/g; SAR(10 g) = 6.20 mW/g**

Maximum value of SAR (measured) = 14.4 mW/g



## ANNEX C: Highest Graph Results

### Plot 2 802.11b Left Edge Middle (Distance 0mm, Antenna 1)

Date: 5/12/2019

Communication System: UID 0, 802.11b (0); Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.959$  S/m;  $\epsilon_r = 51.134$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C      Liquid Temperature: 21.5 °C

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(7.53, 7.53, 7.53); Calibrated: 5/29/2018;

Electronics: DAE4 SN1317; Calibrated: 3/23/2018

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

**Left Edge Middle/Area Scan (381x51x1):** Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 0.585 W/kg

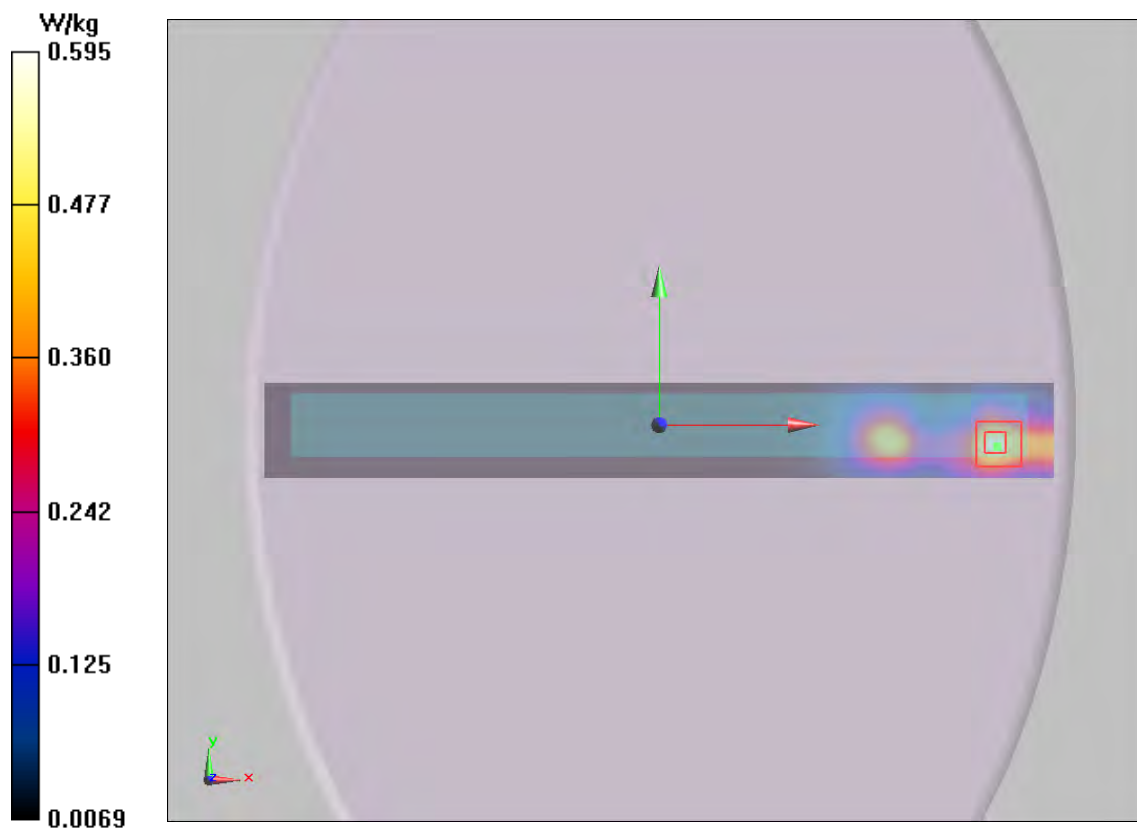
**Left Edge Middle/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 1.374 V/m; Power Drift = 0.132 dB

Peak SAR (extrapolated) = 1.05 W/kg

**SAR(1 g) = 0.529 W/kg; SAR(10 g) = 0.267 W/kg**

Maximum value of SAR (measured) = 0.595 W/kg



### Plot 3 802.11b Top Edge Middle (Distance 0mm, Antenna 2)

Date: 5/12/2019

Communication System: UID 0, 802.11b (0); Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.959$  S/m;  $\epsilon_r = 51.134$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C      Liquid Temperature: 21.5 °C

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(7.53, 7.53, 7.53); Calibrated: 5/29/2018;

Electronics: DAE4 SN1317; Calibrated: 3/23/2018

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

**Top Edge Middle/Area Scan (61x211x1):** Interpolated grid: dx=10 mm, dy=10mm

Maximum value of SAR (interpolated) = 0.498 W/kg

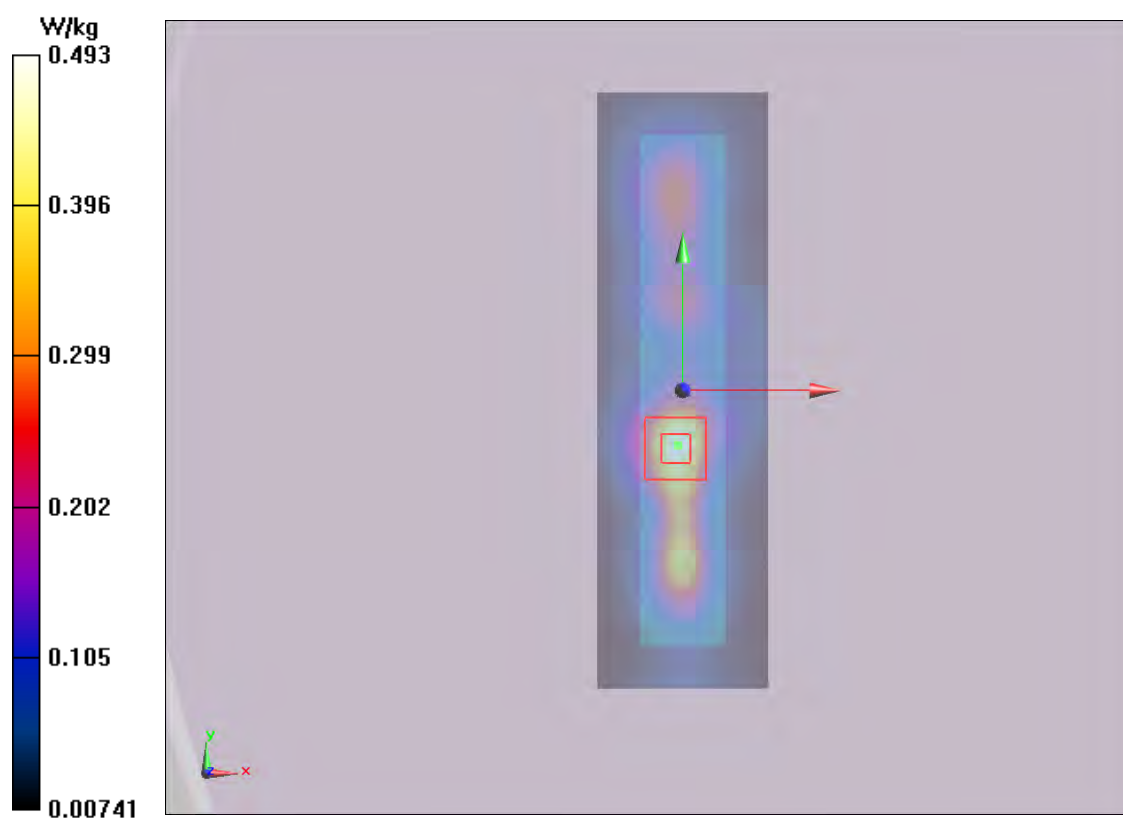
**Top Edge Middle/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 9.839 V/m; Power Drift = -0.020 dB

Peak SAR (extrapolated) = 0.814 W/kg

**SAR(1 g) = 0.432 W/kg; SAR(10 g) = 0.215 W/kg**

Maximum value of SAR (measured) = 0.493 W/kg



# Plot 4 802.11n-HT20 Left Edge Middle (Distance 0mm, MIMO)

Date: 5/12/2019

Communication System: UID 0, 802.11n HT20 (0); Frequency: 2437 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.959$  S/m;  $\epsilon_r = 51.134$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C Liquid Temperature: 21.5 °C

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(7.53, 7.53, 7.53); Calibrated: 5/29/2018;

Electronics: DAE4 SN1317; Calibrated: 3/23/2018

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

**Left Edge Middle /Area Scan(381x51x1):** Interpolated grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 0.431 W/kg

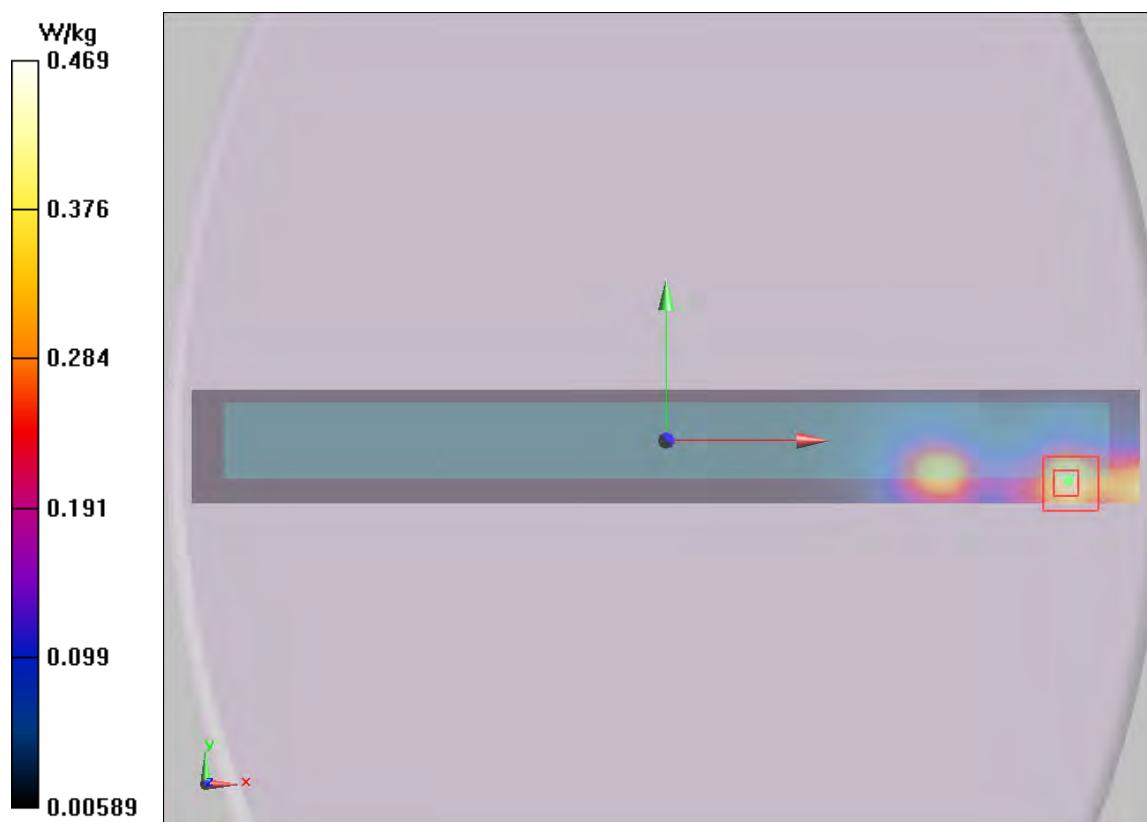
**Left Edge Middle/Zoom Scan(7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 2.127 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 0.824 W/kg

**SAR(1 g) = 0.415 W/kg; SAR(10 g) = 0.210 W/kg**

Maximum value of SAR (measured) = 0.469 W/kg





## ANNEX D: Probe Calibration Certificate



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CNAS L0570

Client **TA(shanghai)**
Certificate No: **Z18-60093**

### CALIBRATION CERTIFICATE

Object: **EX3DV4 - SN:3677**

Calibration Procedure(s): **FF-Z11-004-01**  
**Calibration Procedures for Dosimetric E-field Probes**

Calibration date: **May 29, 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)℃ 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.J17X05857)           | Jun-18                |
| Power sensor NRP-Z91    | 101547      | 27-Jun-17 (CTTL, No.J17X05857)           | Jun-18                |
| Power sensor NRP-Z91    | 101548      | 27-Jun-17 (CTTL, No.J17X05857)           | Jun-18                |
| Reference10dBAttenuator | 18N50W-10dB | 09-Feb-18(CTTL, No.J18X01133)            | Feb-20                |
| Reference20dBAttenuator | 18N50W-20dB | 09-Feb-18(CTTL, No.J18X01132)            | Feb-20                |
| Reference Probe EX3DV4  | SN 3846     | 25-Jan-18(SPEAG,No.EX3-3846_Jan18)       | Jan-19                |
| DAE4                    | SN 777      | 15-Dec-17(SPEAG, No.DAE4-777_Dec17)      | Dec -18               |

| Secondary Standards     | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|------------------------------------------|-----------------------|
| SignalGeneratorMG3700A  | 6201052605 | 27-Jun-17 (CTTL, No.J17X05858)           | Jun-18                |
| Network Analyzer E5071C | MY46110673 | 14-Jan-18 (CTTL, No.J18X00561)           | Jan -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: May 31, 2018

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

Certificate No: Z18-60093

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# Glossary:

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

Connector Angle information used in DASY system to align probe sensor X to the robot coordinate system

## Calibration is Performed According to the Following Standards:

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

## Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\theta=0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- NORM( $f$ )<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* frequency\_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; VR<sub>x,y,z</sub>; 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  $f \leq 800$  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 valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* 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  $\pm 50$  MHz to  $\pm 100$  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 NORM<sub>x</sub> (no uncertainty required).



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# Probe EX3DV4

## SN: 3677

Calibrated: May 29, 2018

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)



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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3677

### Basic Calibration Parameters

|                                      | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|--------------------------------------|----------|----------|----------|-----------|
| Norm( $\mu V/(V/m)^2$ ) <sup>A</sup> | 0.41     | 0.46     | 0.41     | ±10.0%    |
| DCP(mV) <sup>B</sup>                 | 99.9     | 102.7    | 102.1    |           |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A dB | B dB· $\mu V$ | C   | D dB | VR mV | Unc <sup>E</sup> (k=2) |
|-----|---------------------------|---|------|---------------|-----|------|-------|------------------------|
| 0   | CW                        | X | 0.0  | 0.0           | 1.0 | 0.00 | 152.4 | ±2.4%                  |
|     |                           | Y | 0.0  | 0.0           | 1.0 |      | 161.7 |                        |
|     |                           | Z | 0.0  | 0.0           | 1.0 |      | 152.2 |                        |

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%.

<sup>A</sup> The uncertainties of Norm X, Y, Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 5 and Page 6).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> 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: 3677

### Calibration Parameter Determined in Head Tissue Simulating Media

| f [MHz] <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750                  | 41.9                               | 0.89                            | 9.40    | 9.40    | 9.40    | 0.40               | 0.80                    | ± 12.1%     |
| 835                  | 41.5                               | 0.90                            | 9.10    | 9.10    | 9.10    | 0.15               | 1.41                    | ± 12.1%     |
| 1750                 | 40.1                               | 1.37                            | 8.19    | 8.19    | 8.19    | 0.21               | 1.15                    | ± 12.1%     |
| 1900                 | 40.0                               | 1.40                            | 7.96    | 7.96    | 7.96    | 0.25               | 1.01                    | ± 12.1%     |
| 2300                 | 39.5                               | 1.67                            | 7.91    | 7.91    | 7.91    | 0.40               | 0.78                    | ± 12.1%     |
| 2450                 | 39.2                               | 1.80                            | 7.57    | 7.57    | 7.57    | 0.53               | 0.76                    | ± 12.1%     |
| 2600                 | 39.0                               | 1.96                            | 7.28    | 7.28    | 7.28    | 0.64               | 0.70                    | ± 12.1%     |
| 5250                 | 35.9                               | 4.71                            | 5.60    | 5.60    | 5.60    | 0.40               | 1.15                    | ± 13.3%     |
| 5600                 | 35.5                               | 5.07                            | 4.87    | 4.87    | 4.87    | 0.45               | 1.05                    | ± 13.3%     |
| 5750                 | 35.4                               | 5.22                            | 4.99    | 4.99    | 4.99    | 0.45               | 1.35                    | ± 13.3%     |

<sup>C</sup> 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.

<sup>F</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) 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 ( $\epsilon$  and  $\sigma$ ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> 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: 3677

### Calibration Parameter Determined in Body Tissue Simulating Media

| f [MHz] <sup>C</sup> | Relative Permittivity <sup>F</sup> | Conductivity (S/m) <sup>F</sup> | ConvF X | ConvF Y | ConvF Z | Alpha <sup>G</sup> | Depth <sup>G</sup> (mm) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 750                  | 55.5                               | 0.96                            | 9.79    | 9.79    | 9.79    | 0.40               | 0.80                    | ±12.1%      |
| 835                  | 55.2                               | 0.97                            | 9.32    | 9.32    | 9.32    | 0.15               | 1.51                    | ±12.1%      |
| 1750                 | 53.4                               | 1.49                            | 7.91    | 7.91    | 7.91    | 0.23               | 1.09                    | ±12.1%      |
| 1900                 | 53.3                               | 1.52                            | 7.70    | 7.70    | 7.70    | 0.20               | 1.18                    | ±12.1%      |
| 2300                 | 52.9                               | 1.81                            | 7.65    | 7.65    | 7.65    | 0.53               | 0.82                    | ±12.1%      |
| 2450                 | 52.7                               | 1.95                            | 7.53    | 7.53    | 7.53    | 0.37               | 1.10                    | ±12.1%      |
| 2600                 | 52.5                               | 2.16                            | 7.16    | 7.16    | 7.16    | 0.55               | 0.80                    | ±12.1%      |
| 5250                 | 48.9                               | 5.36                            | 5.04    | 5.04    | 5.04    | 0.50               | 1.55                    | ±13.3%      |
| 5600                 | 48.5                               | 5.77                            | 4.27    | 4.27    | 4.27    | 0.51               | 1.66                    | ±13.3%      |
| 5750                 | 48.3                               | 5.94                            | 4.43    | 4.43    | 4.43    | 0.50               | 1.81                    | ±13.3%      |

<sup>C</sup> 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.

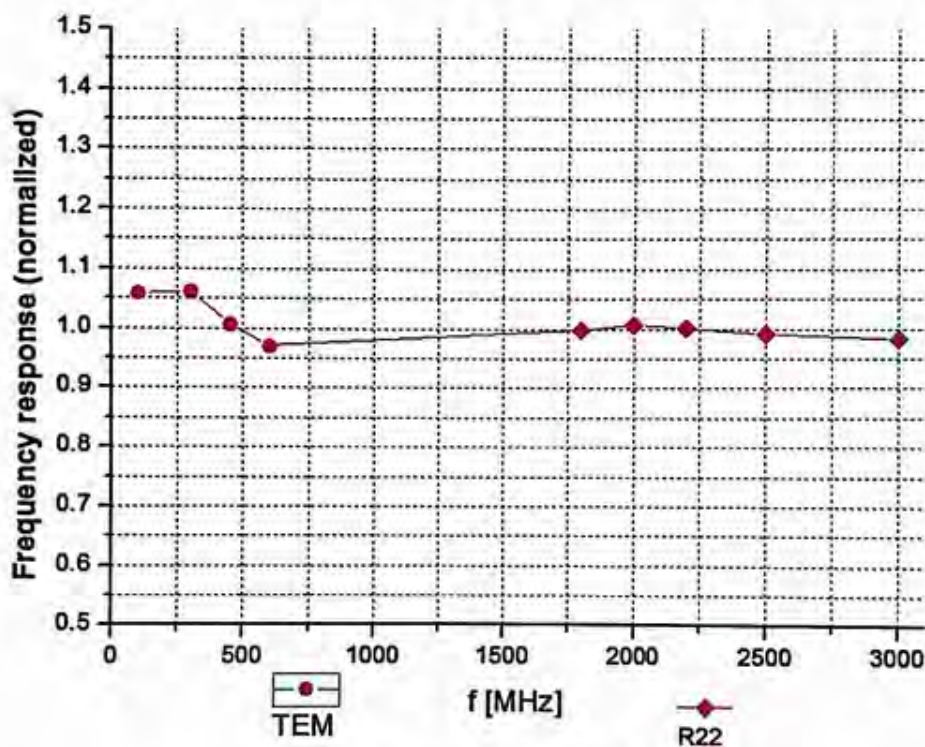
<sup>F</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> 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:  $\pm 7.4\%$  (k=2)

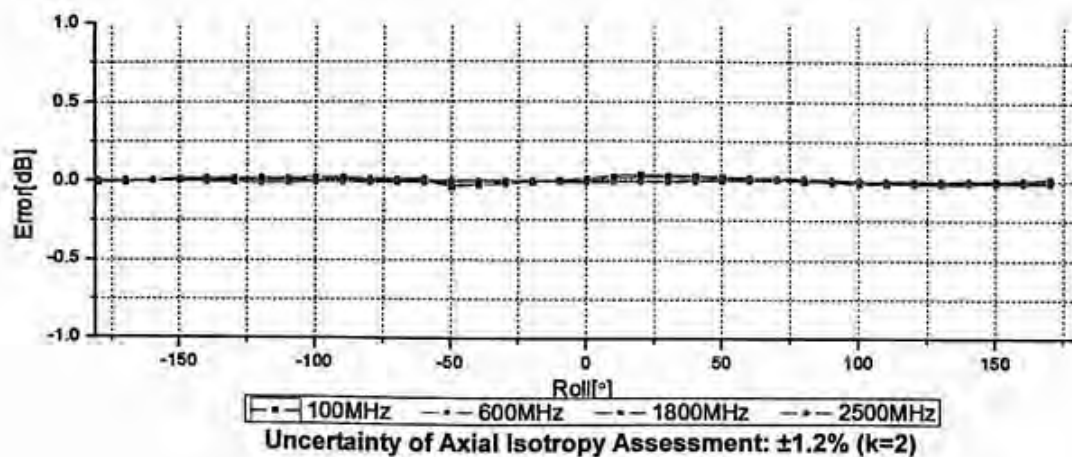
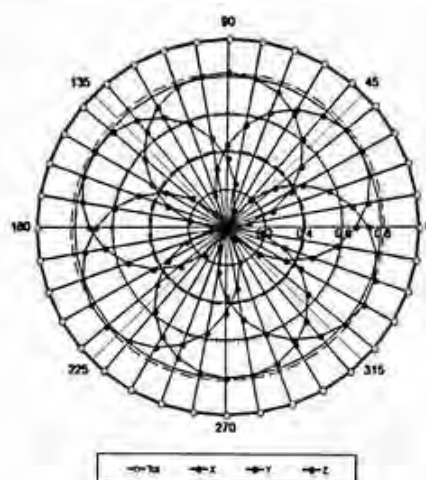
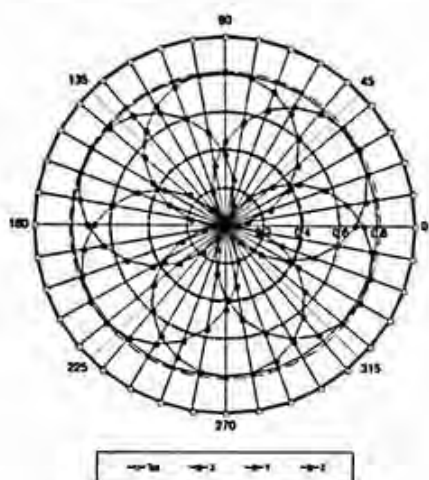


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## Receiving Pattern ( $\Phi$ ), $\theta=0^\circ$

f=600 MHz, TEM

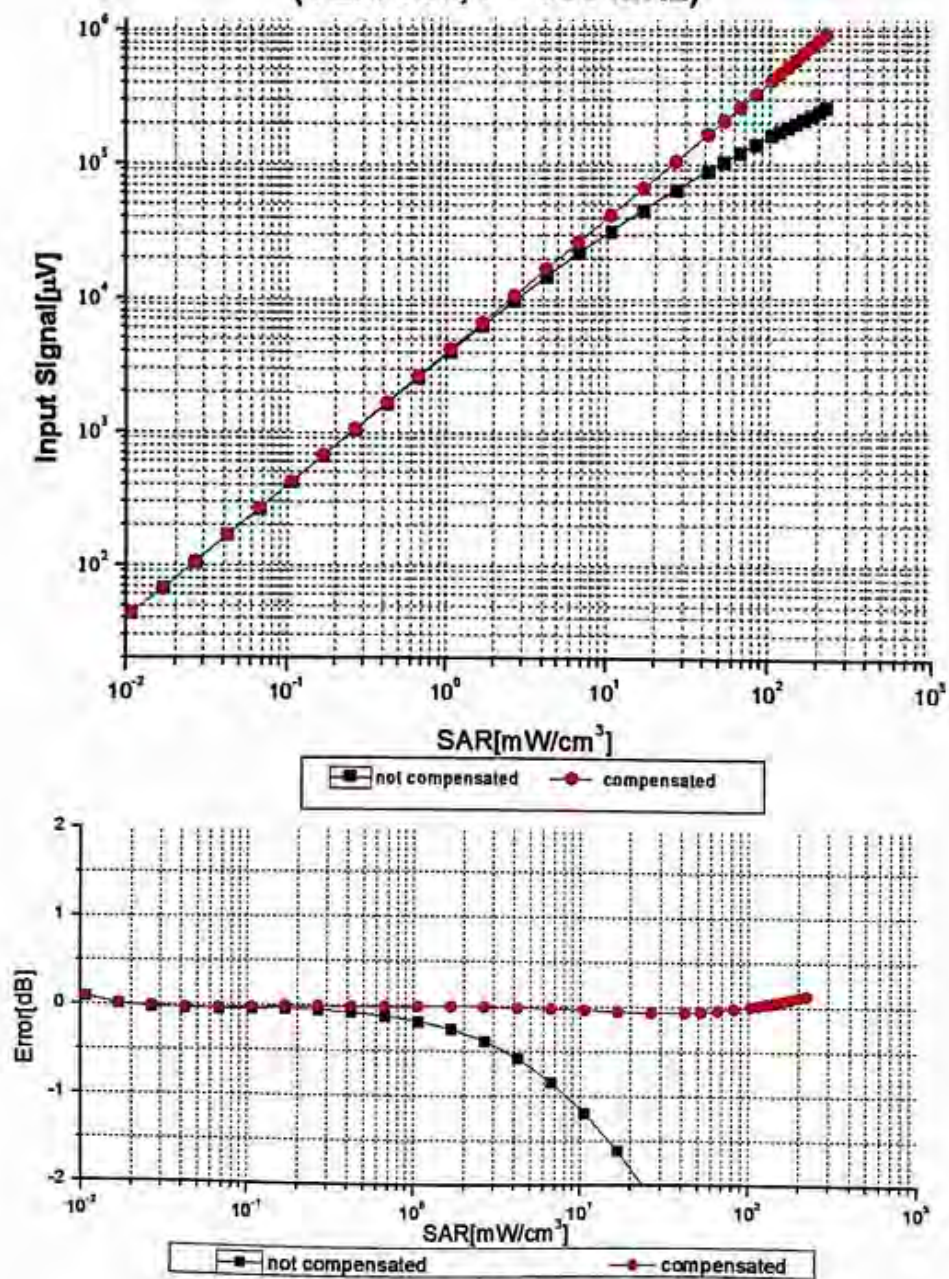
f=1800 MHz, R22





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### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f = 900 \text{ MHz}$ )



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

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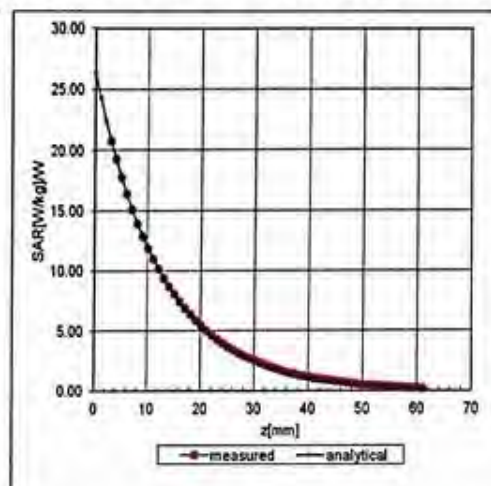
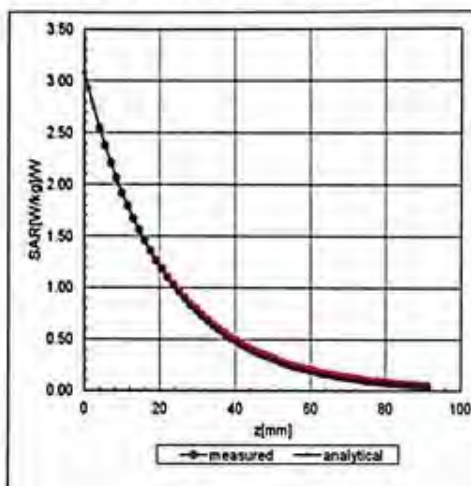


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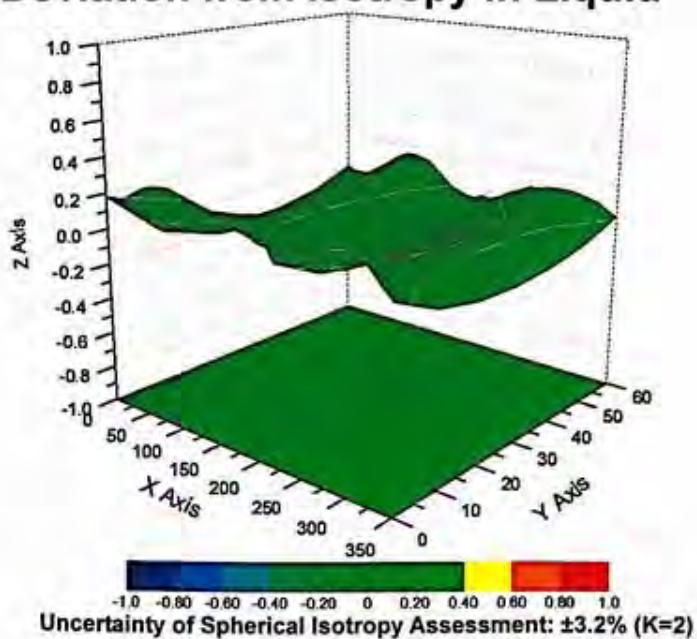
## Conversion Factor Assessment

f=750 MHz, WGLS R9(H\_convF)

f=1750 MHz, WGLS R22(H\_convF)



## Deviation from Isotropy in Liquid



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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3677

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | 118.3      |
| 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      |



## ANNEX E: D2450V2 Dipole Calibration Certificate

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Client

TA(Shanghai)

Certificate No: Z17-97116

## CALIBRATION CERTIFICATE

Object D2450V2 - SN: 786

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

Calibration date: August 29, 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)℃ and humidity<70%.

Calibration Equipment used (M&amp;TE critical for calibration)

| Primary Standards       | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|------------------------------------------|-----------------------|
| Power Meter NRVD        | 102083     | 22-Sep-16 (CTTL, No.J16X06809)           | Sep-17                |
| Power sensor NRV-Z5     | 100595     | 22-Sep-16 (CTTL, No.J16X06809)           | Sep-17                |
| Reference Probe EX3DV4  | SN 3617    | 23-Jan-17(SPEAG,No.EX3-3617_Jan17)       | Jan-18                |
| DAE4                    | SN 1331    | 19-Jan-17(CTTL-SPEAG,No.Z17-97015)       | Jan-18                |
| Secondary Standards     | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 13-Jan-17 (CTTL, No.J17X00286)           | Jan-18                |
| Network Analyzer E5071C | MY46110673 | 13-Jan-17 (CTTL, No.J17X00285)           | Jan-18                |

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

Issued: September 1, 2017

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#### Glossary:

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

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

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

#### Additional Documentation:

- DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

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

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



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

### Measurement Conditions

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

|                              |                          |              |
|------------------------------|--------------------------|--------------|
| DASY Version                 | DASY52                   | 52.10.0.1446 |
| Extrapolation                | Advanced Extrapolation   |              |
| Phantom                      | Triple Flat Phantom 5.1C |              |
| Distance Dipole Center - TSL | 10 mm                    | with Spacer  |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm        |              |
| Frequency                    | 2450 MHz $\pm$ 1 MHz     |              |

### Head TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 39.2           | 1.80 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 39.7 $\pm$ 6 % | 1.82 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | <1.0 °C             | ---            | ---                  |

### SAR result with Head TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL   | Condition          |                                |
|---------------------------------------------------------|--------------------|--------------------------------|
| SAR measured                                            | 250 mW input power | 13.2 mW / g                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 52.6 mW / g $\pm$ 18.8 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | Condition          |                                |
| SAR measured                                            | 250 mW input power | 6.16 mW / g                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 24.6 mW / g $\pm$ 18.7 % (k=2) |

### Body TSL parameters

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 52.7           | 1.95 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 52.5 $\pm$ 6 % | 1.94 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | <1.0 °C             | ---            | ---                  |

### SAR result with Body TSL

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL   | Condition          |                                |
|---------------------------------------------------------|--------------------|--------------------------------|
| SAR measured                                            | 250 mW input power | 12.7 mW / g                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 50.8 mW / g $\pm$ 18.8 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | Condition          |                                |
| SAR measured                                            | 250 mW input power | 5.87 mW / g                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 23.5 mW / g $\pm$ 18.7 % (k=2) |



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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 53.4Ω+ 4.29jΩ |
| Return Loss                          | - 25.5dB      |

### Antenna Parameters with Body TSL

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 51.0Ω+ 6.61jΩ |
| Return Loss                          | - 23.6dB      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.265 ns |
|----------------------------------|----------|

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

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

### Additional EUT Data

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



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# DASY5 Validation Report for Head TSL

Date: 08.29.2017

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 786

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.822$  S/m;  $\epsilon_r = 39.65$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

## DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.74, 7.74, 7.74); Calibrated: 1/23/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 1/19/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

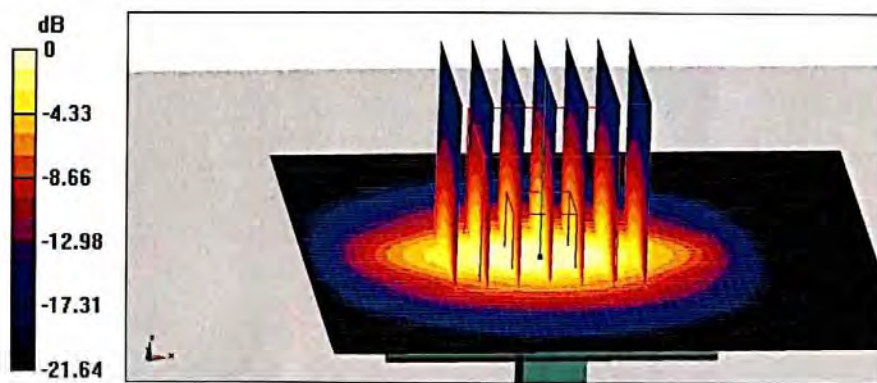
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.1 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 27.5 W/kg

SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.16 W/kg

Maximum value of SAR (measured) = 22.2 W/kg



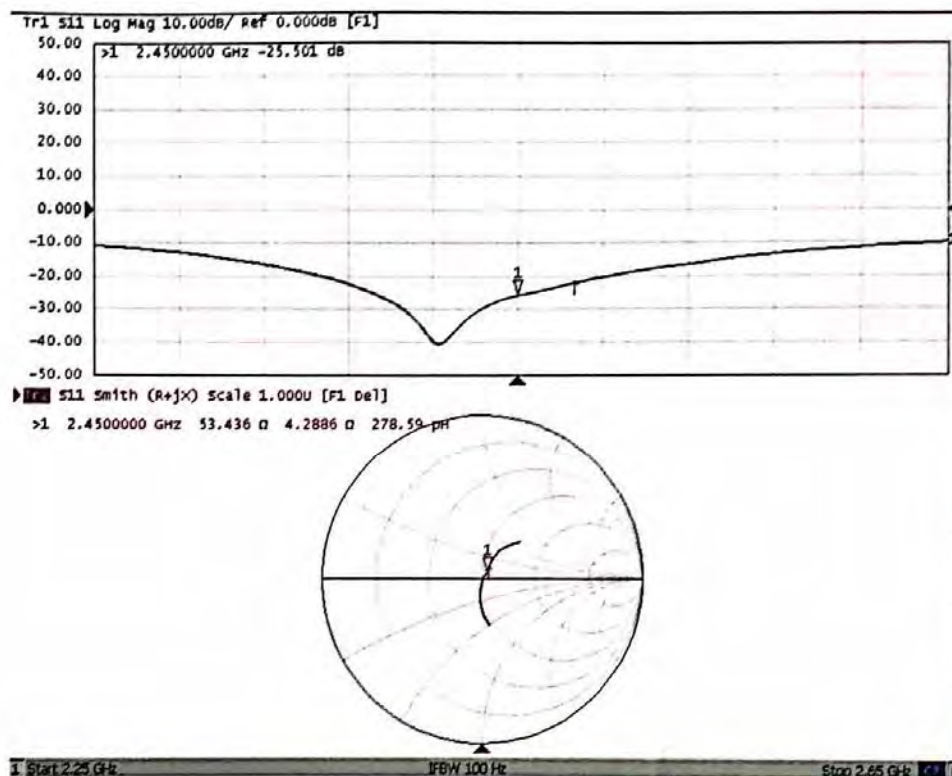
0 dB = 22.2 W/kg = 13.46 dBW/kg



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### Impedance Measurement Plot for Head TSL





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# DASY5 Validation Report for Body TSL

Date: 08.29.2017

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 786

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.943$  S/m;  $\epsilon_r = 52.45$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

## DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.8, 7.8, 7.8); Calibrated: 1/23/2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 1/19/2017
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

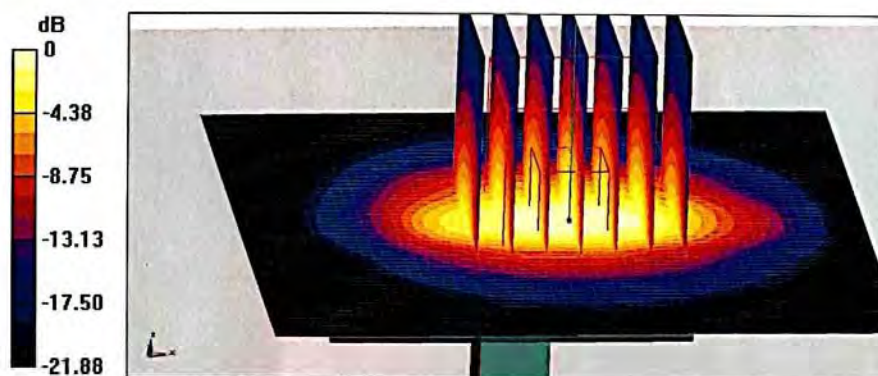
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 92.28 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 27.0 W/kg

SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.87 W/kg

Maximum value of SAR (measured) = 21.5 W/kg



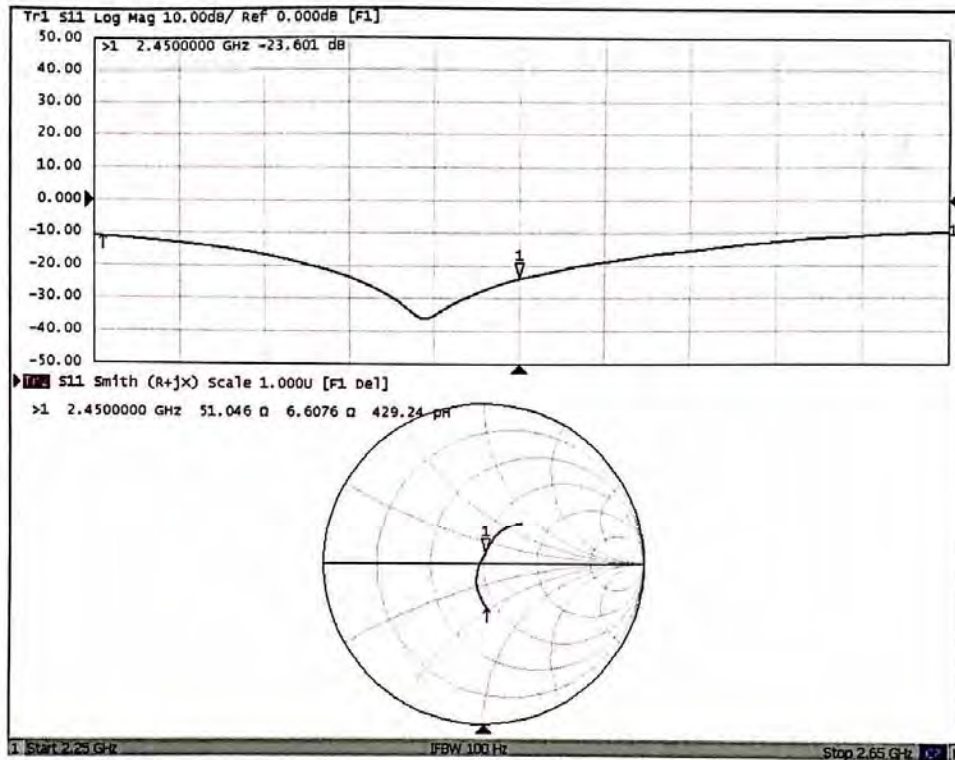
0 dB = 21.5 W/kg = 13.32 dBW/kg



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### Impedance Measurement Plot for Body TSL



# ANNEX F: DAE4 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 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 **TA-SH (Auden)**

Certificate No: **DAE4-1291\_Dec18**

## CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BM - SN: 1291**

Calibration procedure(s) **QA CAL-06.v29**  
 Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **December 04, 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  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards             | ID #               | Cal Date (Certificate No.) | Scheduled Calibration  |
|-------------------------------|--------------------|----------------------------|------------------------|
| Keithley Multimeter Type 2001 | SN: 0810278        | 03-Sep-18 (No:23488)       | Sep-19                 |
| Secondary Standards           | ID #               | Check Date (in house)      | Scheduled Check        |
| Auto DAE Calibration Unit     | SE UWS 053 AA 1001 | 04-Jan-18 (in house check) | In house check: Jan-19 |
| Calibrator Box V2.1           | SE UMS 006 AA 1002 | 04-Jan-18 (in house check) | In house check: Jan-19 |

|                |                   |                       |           |
|----------------|-------------------|-----------------------|-----------|
|                | Name              | Function              | Signature |
| Calibrated by: | Dominique Steffen | Laboratory Technician |           |
| Approved by:   | Sven Kühn         | Deputy Manager        |           |

Issued: December 4, 2018

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

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



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

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

Accreditation No.: **SCS 0108**

## 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 following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - **DC Voltage Measurement Linearity:** Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - **Common mode sensitivity:** Influence of a positive or negative common mode voltage on the differential measurement.
  - **Channel separation:** Influence of a voltage on the neighbor channels not subject to an input voltage.
  - **AD Converter Values with inputs shorted:** Values on the internal AD converter corresponding to zero input voltage
  - **Input Offset Measurement:** Output voltage and statistical results over a large number of zero voltage measurements.
  - **Input Offset Current:** Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - **Input resistance:** Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - **Low Battery Alarm Voltage:** Typical value for information. Below this voltage, a battery alarm signal is generated.
  - **Power consumption:** Typical value for information. Supply currents in various operating modes.

**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          | 402.580 $\pm$ 0.02% (k=2) | 403.249 $\pm$ 0.02% (k=2) | 403.163 $\pm$ 0.02% (k=2) |
| Low Range           | 3.97560 $\pm$ 1.50% (k=2) | 3.97886 $\pm$ 1.50% (k=2) | 3.97558 $\pm$ 1.50% (k=2) |

**Connector Angle**

|                                           |                                     |
|-------------------------------------------|-------------------------------------|
| Connector Angle to be used in DASY system | 164.5 $^{\circ}$ $\pm$ 1 $^{\circ}$ |
|-------------------------------------------|-------------------------------------|

## Appendix (Additional assessments outside the scope of SCS0108)

### 1. DC Voltage Linearity

| High Range        | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 200038.51                 | 1.95                         | 0.00      |
| Channel X + Input | 20006.61                  | 1.29                         | 0.01      |
| Channel X - Input | -20003.34                 | 2.94                         | -0.01     |
| Channel Y + Input | 200036.77                 | 0.05                         | 0.00      |
| Channel Y + Input | 20003.65                  | -1.54                        | -0.01     |
| Channel Y - Input | -20006.11                 | 0.22                         | -0.00     |
| Channel Z + Input | 200035.08                 | -1.41                        | -0.00     |
| Channel Z + Input | 20002.62                  | -2.58                        | -0.01     |
| Channel Z - Input | -20006.40                 | -0.06                        | 0.00      |

| Low Range         | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 2001.29                   | 0.31                         | 0.02      |
| Channel X + Input | 201.13                    | 0.32                         | 0.16      |
| Channel X - Input | -198.59                   | 0.30                         | -0.15     |
| Channel Y + Input | 2000.40                   | -0.49                        | -0.02     |
| Channel Y + Input | 200.21                    | -0.66                        | -0.33     |
| Channel Y - Input | -199.89                   | -0.99                        | 0.50      |
| Channel Z + Input | 2000.44                   | -0.41                        | -0.02     |
| Channel Z + Input | 199.70                    | -1.05                        | -0.52     |
| Channel Z - Input | -200.88                   | -1.78                        | 0.89      |

### 2. Common mode sensitivity

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

|           | Common mode Input Voltage (mV) | High Range Average Reading ( $\mu\text{V}$ ) | Low Range Average Reading ( $\mu\text{V}$ ) |
|-----------|--------------------------------|----------------------------------------------|---------------------------------------------|
| Channel X | 200                            | 10.02                                        | 7.91                                        |
|           | - 200                          | -6.52                                        | -8.20                                       |
| Channel Y | 200                            | 14.18                                        | 13.58                                       |
|           | - 200                          | -15.10                                       | -15.62                                      |
| Channel Z | 200                            | -17.07                                       | -17.23                                      |
|           | - 200                          | 14.74                                        | 14.83                                       |

### 3. Channel separation

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

|           | Input Voltage (mV) | Channel X ( $\mu\text{V}$ ) | Channel Y ( $\mu\text{V}$ ) | Channel Z ( $\mu\text{V}$ ) |
|-----------|--------------------|-----------------------------|-----------------------------|-----------------------------|
| Channel X | 200                | -                           | -0.01                       | -4.47                       |
| Channel Y | 200                | 7.58                        | -                           | 0.48                        |
| Channel Z | 200                | 11.17                       | 4.87                        | -                           |

#### 4. AD-Converter Values with inputs shorted

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

|           | High Range (LSB) | Low Range (LSB) |
|-----------|------------------|-----------------|
| Channel X | 16117            | 16241           |
| Channel Y | 15930            | 16718           |
| Channel Z | 16177            | 17128           |

#### 5. Input Offset Measurement

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

Input 10M $\Omega$

|           | Average ( $\mu$ V) | min. Offset ( $\mu$ V) | max. Offset ( $\mu$ V) | Std. Deviation ( $\mu$ V) |
|-----------|--------------------|------------------------|------------------------|---------------------------|
| Channel X | -0.59              | -1.81                  | 0.89                   | 0.47                      |
| Channel Y | 1.17               | -0.04                  | 2.05                   | 0.45                      |
| Channel Z | -1.12              | -2.70                  | 0.51                   | 0.57                      |

#### 6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

#### 7. Input Resistance (Typical values for information)

|           | Zeroing (kOhm) | Measuring (MOhm) |
|-----------|----------------|------------------|
| Channel X | 200            | 200              |
| Channel Y | 200            | 200              |
| Channel Z | 200            | 200              |

#### 8. Low Battery Alarm Voltage (Typical values for information)

| Typical values | Alarm Level (VDC) |
|----------------|-------------------|
| Supply (+ Vcc) | +7.9              |
| Supply (- Vcc) | -7.6              |

#### 9. Power Consumption (Typical values for information)

| Typical values | Switched off (mA) | Stand by (mA) | Transmitting (mA) |
|----------------|-------------------|---------------|-------------------|
| Supply (+ Vcc) | +0.01             | +6            | +14               |
| Supply (- Vcc) | -0.01             | -8            | -9                |

## ANNEX G: The EUT Appearances and Test Configuration



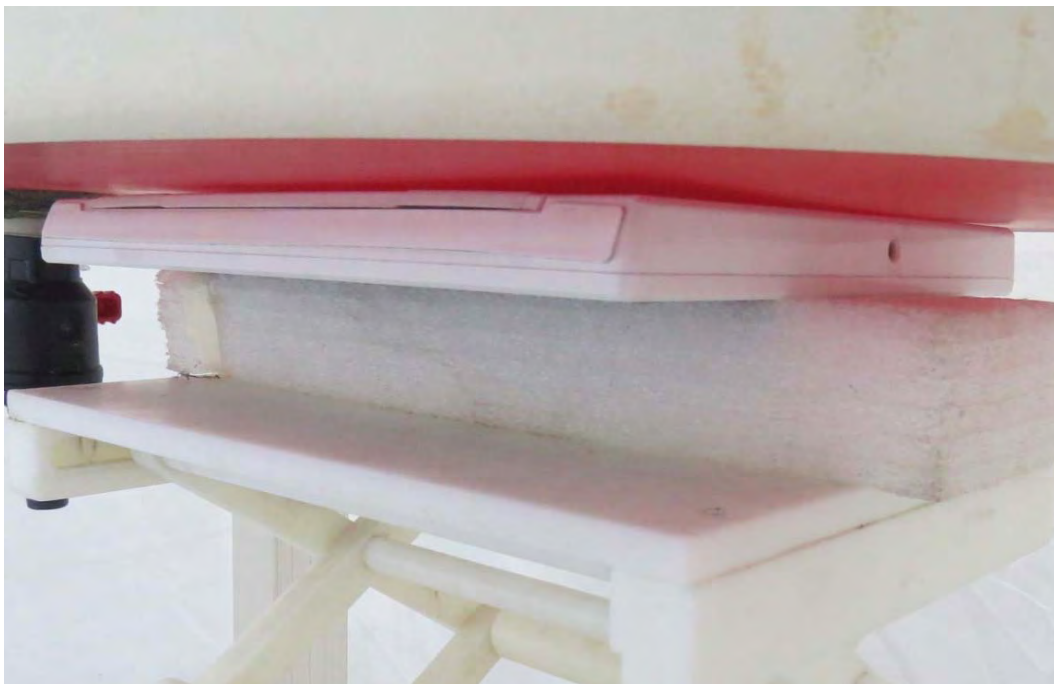
Front Side



Back Side

a: EUT

Picture 4: Constituents of EUT



Picture 5: Back Side, the distance from handset to the bottom of the Phantom is 0mm



Picture 6: Left Side, the distance from handset to the bottom of the Phantom is 0mm



Picture 7: Top Side, the distance from handset to the bottom of the Phantom is 0mm