

## SAR Report

Applicant : Toast, Incorporated  
Product Type : Handheld Tablet  
Trade Name : Toast Go <sup>TM</sup>  
Model Number : TG200  
Applicable Standard : ANSI/IEEE C95.1 / IEEE Std. 1528-2013  
47 CFR Part §2.1093  
KDB 865664 D01 / KDB 865664 D02  
KDB 447498 D01 / KDB 248227 D01  
KDB 616217 D04  
Received Date : Jan. 09, 2020  
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Issued Date : Feb. 26, 2020

### Issued by

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Taiwan Accreditation Foundation accreditation number: 1330  
Test Firm MRA designation number: TW0010

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### **Revision History**

| Rev. | Issued Date   | Revisions                                                                                                                                                                           | Revised By   |
|------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 00   | Feb. 20, 2020 | Initial Issue                                                                                                                                                                       | Jennifer Liu |
| 01   | Feb. 26, 2020 | Page 5 Revised RF Function.<br>Page 20 Revised Standalone SAR Test Exclusion Calculation.<br>Page 21 Revised Simultaneous Transmitting Evaluate.<br>Revised Test Setup Photographs. | Jennifer Liu |
|      |               |                                                                                                                                                                                     |              |
|      |               |                                                                                                                                                                                     |              |



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## 1. General Information

### 1.1 Reference Applicable Standard

| Standard            | Description                                                                                                                                                                       | Version |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| ANSI/IEEE C95.1     | American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 300 KHz to 100 GHz, New York.                                  | 1992    |
| IEEE 1528           | IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head From Wireless Communications Devices: Measurement Techniques. | 2013    |
| 47 CFR Part §2.1093 | Radiofrequency radiation exposure evaluation: portable devices.                                                                                                                   | -       |
| KDB 865664 D01      | SAR measurement requirement for 100 MHz to 6 GHz.                                                                                                                                 | v01r04  |
| KDB 865664 D02      | RF exposure compliance reporting and documentation considerations.                                                                                                                | v01r02  |
| KDB 447498 D01      | RF exposure procedures and equipment authorization policies for mobile and portable devices                                                                                       | v06     |
| KDB 248227 D01      | SAR guidance for IEEE 802.11 (Wi-Fi) transmitters                                                                                                                                 | v02r02  |
| KDB 616217 D04      | SAR evaluation considerations for laptop, notebook and tablet computers.                                                                                                          | v01r02  |

### 1.2 Test Site Environment

| Items            | Required (IEEE 1528-2013) | Actual |
|------------------|---------------------------|--------|
| Temperature (°C) | 18-25                     | 21-23  |

## 2. Summary of Maximum Reported SAR Value

| Equipment Class                       | Mode                | Highest Reported                                |
|---------------------------------------|---------------------|-------------------------------------------------|
|                                       |                     | Body SAR <sub>1g</sub> (W/kg)                   |
| DTS                                   | WLAN2.4GHz Ant Main | 0.41                                            |
| U-NII                                 | WLAN5GHz Ant Main   | 1.15                                            |
| Highest Simultaneous Transmission SAR |                     | Highest Simultaneous Transmission 1g SAR (W/kg) |
| At test position side2                |                     | 1.23                                            |

NOTE: 1. The SAR limit (Head & Body: SAR<sub>1g</sub> 1.6 W/kg) for general population / uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992.



### 3. Description of Equipment under Test (EUT)

| Applicant        | Toast, Incorporated<br>401 Park Drive, Suite 801, Boston, MA 02215., Boston, Massachusetts,<br>United States |                         |
|------------------|--------------------------------------------------------------------------------------------------------------|-------------------------|
| Manufacture      | InnoComm Mobile Technology Corp.,<br>3F, No. 6, HsinAnn Rd., Hsinchu Science Park, Hsinchu City 30078,Taiwan |                         |
| Product Type     | Handheld Tablet                                                                                              |                         |
| Trade Name       | Toast Go <sup>TM</sup>                                                                                       |                         |
| Model Number     | TG200                                                                                                        |                         |
| FCC ID           | 2AMNG-TG200                                                                                                  |                         |
| RF Function      | Operate Bands                                                                                                | Operate Frequency (MHz) |
|                  | IEEE 802.11b / 802.11g / 802.11n 2.4 GHz 20 MHz                                                              | 2412 - 2462             |
|                  | IEEE 802.11a                                                                                                 | 5180 - 5825             |
|                  | IEEE 802.11ac / 802.11n 5 GHz 20 MHz                                                                         | 5180 - 5825             |
|                  | IEEE 802.11ac / 802.11n 5 GHz 40 MHz                                                                         | 5190 - 5795             |
|                  | IEEE 802.11ac 80 MHz                                                                                         | 5210 - 5775             |
|                  | Bluetooth LE                                                                                                 | 2402 - 2480             |
| Antenna Type     | Monopole Antenna                                                                                             |                         |
| Battery Option   | Standard                                                                                                     |                         |
|                  | Trade Name: TOAST,INC.<br>Model: TGB200<br>Spec: DC 3.8 V / 5450 mAh                                         |                         |
| Device Category  | Portable Device                                                                                              |                         |
| Application Type | Certification                                                                                                |                         |

Note:The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

## 4. Introduction

The A Test Lab Techno Corp. has performed measurements of the maximum potential exposure to the user. The test procedures, as described in American National Standards, Institute C95.1-1999 [ 1 ] were employed and they specify the maximum exposure limit of 1.6 mW/g as averaged over any 1 gram of tissue for portable devices being used within 20 cm between user and EUT in the uncontrolled environment. A description of the product and operating configuration, detailed summary of the test results, methodology and procedures used in the equipment used are included within this test report.

### 4.1 SAR Definition

Specific Absorption Rate (SAR) is defined as the time derivative (rate) of the incremental energy (dw) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density ( $\rho$ ). The equation description is as below :

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

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

SAR measurement can be related to the electrical field in the tissue by

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

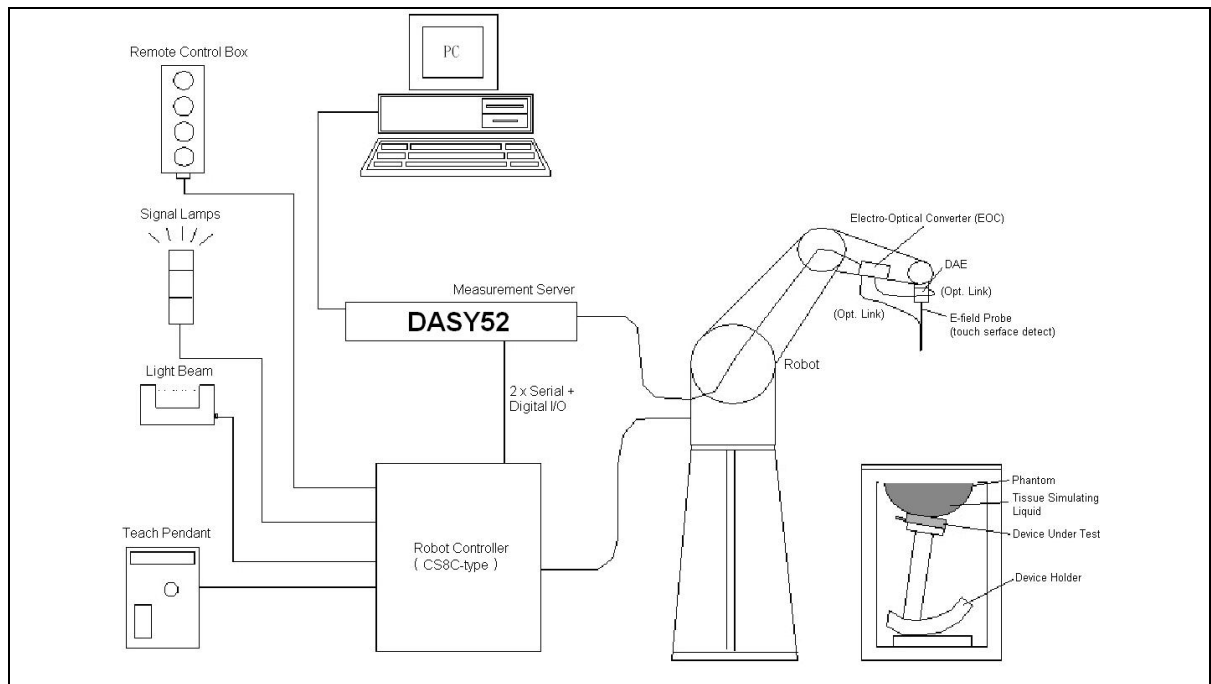
Where :

$\sigma$  = conductivity of the tissue (S/m)

$\rho$  = mass density of the tissue (kg/m<sup>3</sup>)

$E$  = RMS electric field strength (V/m)

## 5. SAR Measurement Setup



The DASY52 system for performing compliance tests consists of the following items:

1. A standard high precision 6-axis robot (Stäubli TX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
2. A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
3. 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.
4. 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.
5. A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
6. A computer operating Windows 2000 or Windows XP.
7. DASY52 software.
8. Remote controls with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
9. The SAM twin phantom enabling testing left-hand and right-hand usage.
10. The device holder for handheld mobile phones.
11. Tissue simulating liquid mixed according to the given recipes.
12. Validation dipole kits allowing validating the proper functioning of the system.

## 5.1 DASY E-Field Probe System

The SAR measurements were conducted with the dosimetric probe (manufactured by SPEAG), designed in the classical triangular configuration [ 3 ] and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped when reaching the maximum.

### 5.1.1 E-Field 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 service available                                                                                                                 |
| Frequency    | 10 MHz to > 6 GHz<br>Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)                                                                                              |
| Directivity  | $\pm 0.3$ dB in brain tissue (rotation around probe axis)<br>$\pm 0.5$ dB in brain tissue (rotation normal probe axis)                                      |
| Dimensions   | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm                        |

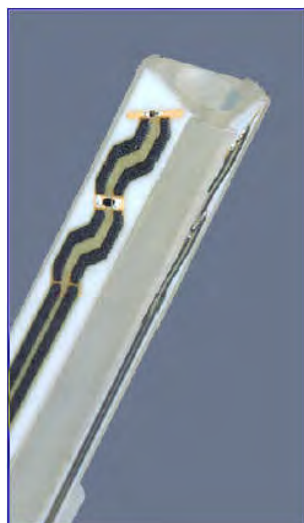


Figure 1. E-field Probe



Figure 2. Probe setup on robot

## 5.2 Data Acquisition Electronic (DAE) System

Model : DAE3, DAE4  
Construction : Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY4/5 embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.  
Measurement Range : -100 to +300 mV (16 bit resolution and two range settings: 4 mV, 400 mV)  
Input Offset Voltage : < 5  $\mu$ V (with auto zero)  
Input Bias Current : < 50 fA  
Dimensions : 60 x 60 x 68 mm

## 5.3 Robot

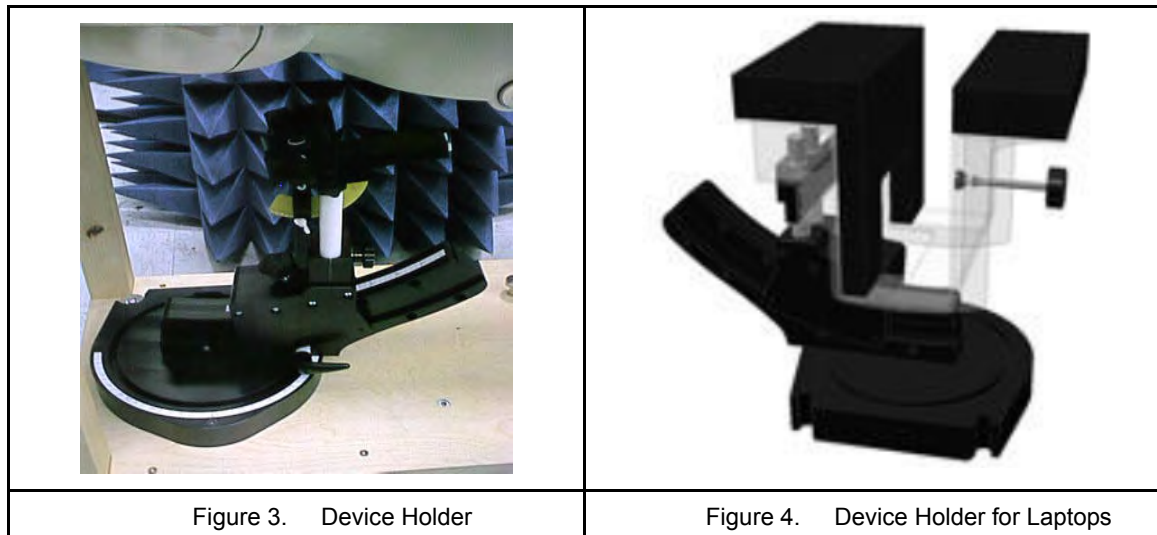
Positioner : Stäubli Unimation Corp. Robot Model: TX90XL  
Repeatability :  $\pm 0.02$  mm  
No. of Axis : 6

## 5.4 Measurement Server

Processor : PC/104 with a 400MHz intel ULV Celeron  
I/O-board : Link to DAE4 (or DAE3)  
16-bit A/D converter for surface detection system  
Digital I/O interface  
Serial link to robot  
Direct emergency stop output for robot

## 5.5 Device Holder

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



## 5.6 Oval Flat Phantom - ELI 4.0

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (Oval Flat) phantom defined in IEEE 1528-2013, CENELEC 50361 and IEC 62209. It enables the dosimetric evaluation of wireless portable device usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.

|                                   |                        |
|-----------------------------------|------------------------|
| Shell Thickness                   | $2 \pm 0.2$ mm         |
| Filling Volume                    | Approx. 30 liters      |
| Dimensions                        | 190×600×400 mm (H×L×W) |
| Table 1. Specification of ELI 4.0 |                        |

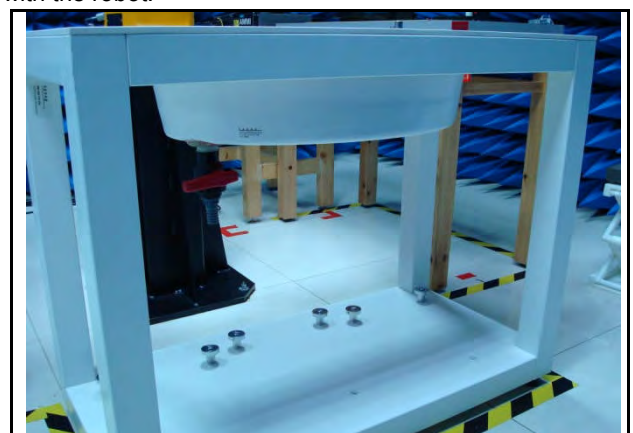


Figure 5. Oval Flat Phantom

## 6. Tissue Simulating Liquids

### IEEE SCC-34/SC-2 in 1528 recommended Tissue Dielectric Parameters

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in 1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in human head. Other head and body tissue parameters that have not been specified in 1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equation and extrapolated according to the head parameter specified in 1528.

| Target Frequency                                                                                      | Head         |                | Body         |                |
|-------------------------------------------------------------------------------------------------------|--------------|----------------|--------------|----------------|
| (MHz)                                                                                                 | $\epsilon_r$ | $\sigma$ (S/m) | $\epsilon_r$ | $\sigma$ (S/m) |
| 150                                                                                                   | 52.3         | 0.76           | 61.9         | 0.80           |
| 300                                                                                                   | 45.3         | 0.87           | 58.2         | 0.92           |
| 450                                                                                                   | 43.5         | 0.87           | 56.7         | 0.94           |
| 835                                                                                                   | 41.5         | 0.90           | 55.2         | 0.97           |
| 900                                                                                                   | 41.5         | 0.97           | 55.0         | 1.05           |
| 915                                                                                                   | 41.5         | 0.98           | 55.0         | 1.06           |
| 1450                                                                                                  | 40.5         | 1.20           | 54.0         | 1.30           |
| 1610                                                                                                  | 40.3         | 1.29           | 53.8         | 1.40           |
| 1800 - 2000                                                                                           | 40.0         | 1.40           | 53.3         | 1.52           |
| 2450                                                                                                  | 39.2         | 1.80           | 52.7         | 1.95           |
| 3000                                                                                                  | 38.5         | 2.40           | 52.0         | 2.73           |
| 5800                                                                                                  | 35.3         | 5.27           | 48.2         | 6.00           |
| ( $\epsilon_r$ = relative permittivity, $\sigma$ = conductivity and $\rho$ = 1000 kg/m <sup>3</sup> ) |              |                |              |                |

Table 2. Tissue dielectric parameters for head and body phantoms

## 6.1 The composition of the tissue simulating liquid

| Ingredients<br>(% by weight)           | Frequency (MHz) |       |       |       |       |       |       |       |       |       |       |       | Frequency<br>(GHz) |               |
|----------------------------------------|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------------------|---------------|
|                                        | 750             |       | 835   |       | 1750  |       | 1900  |       | 2450  |       | 2600  |       | 5 GHz              |               |
| Tissue Type                            | Head            | Body  | Head  | Body  | Head  | Body  | Head  | Body  | Head  | Body  | Head  | Body  | Head               | Body          |
| Water                                  | 39.28           | 51.30 | 41.45 | 52.40 | 54.50 | 40.20 | 54.90 | 40.40 | 62.70 | 73.20 | 60.30 | 71.40 | 65.5               | 78.6          |
| Salt (NaCl)                            | 1.47            | 1.42  | 1.45  | 1.50  | 0.17  | 0.49  | 0.18  | 0.50  | 0.50  | 0.10  | 0.60  | 0.20  | 0.00               | 0.00          |
| Sugar                                  | 58.15           | 46.18 | 56.00 | 45.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00               | 0.00          |
| HEC                                    | 1.00            | 1.00  | 1.00  | 1.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00               | 0.00          |
| Bactericide                            | 0.10            | 0.10  | 0.10  | 0.10  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00               | 0.00          |
| Triton X-100                           | 0.00            | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 17.2               | 10.7          |
| DGBE                                   | 0.00            | 0.00  | 0.00  | 0.00  | 45.33 | 59.31 | 44.92 | 59.10 | 36.80 | 26.70 | 39.10 | 28.40 | 0.00               | 0.00          |
| Dielectric<br>Constant                 | 41.88           | 54.60 | 42.54 | 56.10 | 40.10 | 53.60 | 39.90 | 54.00 | 39.80 | 52.50 | 39.80 | 52.50 | 35.1~<br>36.2      | 47.9~<br>49.3 |
| Conductivity<br>(S/m)                  | 0.90            | 0.97  | 0.91  | 0.95  | 1.39  | 1.49  | 1.42  | 1.45  | 1.88  | 1.78  | 1.88  | 1.78  | 4.45~<br>5.48      | 5.07~<br>6.23 |
| Diethylene<br>Glycol<br>Mono-hexlether | 0.00            | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 17.3               | 10.7          |

## 6.2 Liquid Parameters

The dielectric parameters of the liquids were verified prior to the SAR evaluation using an 85070C Dielectric Probe Kit and an E5071B Network Analyzer.

| Tissue Temp (°C) | Head / Body | Frequency (MHz) | Cond.    | Perm.        | target Cond. | target Perm. | $\sigma$ (Delta) (%) | $\epsilon_r$ (Delta) (%) | Limit (%) | Date          |
|------------------|-------------|-----------------|----------|--------------|--------------|--------------|----------------------|--------------------------|-----------|---------------|
|                  |             |                 | $\sigma$ | $\epsilon_r$ | $\sigma$     | $\epsilon_r$ |                      |                          |           |               |
| 22.2             | Head        | 5260 MHz        | 4.54     | 35.874       | 4.72         | 35.94        | -3.89                | -0.18                    | ±5        | Feb. 12, 2020 |
| 22.2             | Head        | 5270 MHz        | 4.54     | 35.844       | 4.73         | 35.93        | -3.96                | -0.24                    | ±5        | Feb. 12, 2020 |
| 22.2             | Head        | 5280 MHz        | 4.55     | 35.818       | 4.74         | 35.92        | -3.93                | -0.28                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5290 MHz        | 4.57     | 35.808       | 4.75         | 35.91        | -3.84                | -0.28                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5300 MHz        | 4.58     | 35.780       | 4.76         | 35.90        | -3.78                | -0.33                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5310 MHz        | 4.60     | 35.773       | 4.77         | 35.89        | -3.54                | -0.33                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5320 MHz        | 4.62     | 35.805       | 4.78         | 35.88        | -3.41                | -0.21                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5500 MHz        | 4.80     | 35.586       | 4.97         | 35.65        | -3.27                | -0.18                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5510 MHz        | 4.81     | 35.572       | 4.98         | 35.64        | -3.29                | -0.19                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5530 MHz        | 4.82     | 35.516       | 5.00         | 35.61        | -3.45                | -0.26                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5550 MHz        | 4.84     | 35.468       | 5.02         | 35.58        | -3.47                | -0.32                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5570 MHz        | 4.86     | 35.401       | 5.04         | 35.55        | -3.59                | -0.42                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5580 MHz        | 4.87     | 35.372       | 5.05         | 35.53        | -3.62                | -0.44                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5610 MHz        | 4.90     | 35.255       | 5.08         | 35.49        | -3.54                | -0.66                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5620 MHz        | 4.92     | 35.232       | 5.09         | 35.48        | -3.33                | -0.70                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5630 MHz        | 4.94     | 35.184       | 5.10         | 35.47        | -3.18                | -0.81                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5660 MHz        | 5.02     | 35.063       | 5.13         | 35.44        | -2.07                | -1.06                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5670 MHz        | 5.05     | 35.025       | 5.14         | 35.43        | -1.67                | -1.14                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5690 MHz        | 5.10     | 34.965       | 5.16         | 35.41        | -1.09                | -1.26                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5700 MHz        | 5.13     | 34.938       | 5.17         | 35.40        | -0.84                | -1.30                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5710 MHz        | 5.14     | 34.925       | 5.18         | 35.39        | -0.77                | -1.32                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5720 MHz        | 5.15     | 34.925       | 5.19         | 35.38        | -0.78                | -1.29                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5745 MHz        | 5.16     | 34.956       | 5.22         | 35.36        | -1.11                | -1.14                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5755 MHz        | 5.15     | 34.975       | 5.23         | 35.35        | -1.42                | -1.06                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5775 MHz        | 5.13     | 34.994       | 5.25         | 35.33        | -2.23                | -0.95                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5785 MHz        | 5.11     | 34.981       | 5.26         | 35.32        | -2.78                | -0.96                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5795 MHz        | 5.10     | 34.961       | 5.27         | 35.31        | -3.14                | -0.99                    | ±5        | Feb. 12, 2020 |
| 22.1             | Head        | 5825 MHz        | 5.10     | 34.852       | 5.30         | 35.28        | -3.79                | -1.21                    | ±5        | Feb. 12, 2020 |
| 22.2             | Head        | 2412 MHz        | 1.72     | 39.489       | 1.77         | 39.27        | -2.61                | 0.56                     | ±5        | Feb. 13, 2020 |
| 22.2             | Head        | 2422 MHz        | 1.73     | 39.452       | 1.78         | 39.25        | -2.44                | 0.52                     | ±5        | Feb. 13, 2020 |
| 22.2             | Head        | 2437 MHz        | 1.75     | 39.416       | 1.79         | 39.22        | -2.26                | 0.50                     | ±5        | Feb. 13, 2020 |
| 22.2             | Head        | 2452 MHz        | 1.77     | 39.379       | 1.80         | 39.20        | -1.96                | 0.46                     | ±5        | Feb. 13, 2020 |
| 22.2             | Head        | 2462 MHz        | 1.78     | 39.350       | 1.81         | 39.18        | -1.89                | 0.43                     | ±5        | Feb. 13, 2020 |

### 6.3 Liquid Depth

According to KDB865664 ,the depth of tissue-equivalent liquid in a phantom must be  $\geq 15.0$  cm with  $\leq \pm 0.5$  cm variation for SAR measurements  $\leq 3$  GHz and  $\geq 10.0$  cm with  $\leq \pm 0.5$  cm variation for measurements  $> 3$  GHz.

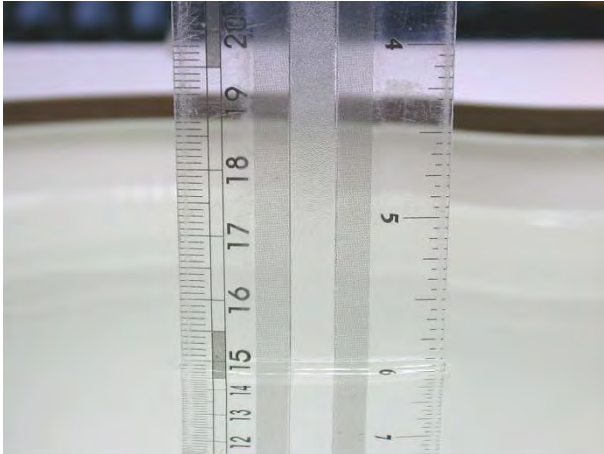


Figure 6. Liquid Height for Head SAR

## **7. SAR Testing with RF Transmitters**

### **7.1 SAR Testing with 802.11 Transmitters**

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.
- When the specified maximum output power is the same for both UNII 1 and UNII 2A, begin SAR measurements in UNII 2A with the channel with the highest measured output power. If the reported SAR for UNII 2A is  $\leq 1.2$  W/kg, SAR is not required for UNII 1; otherwise treat the remaining bands separately and test them independently for SAR.
- When the specified maximum output power is different between UNII 1 and UNII 2A, begin SAR with the band that has the higher specified maximum output. If the highest reported SAR for the band with the highest specified power is  $\leq 1.2$  W/kg, testing for the band with the lower specified output power is not required; otherwise test the remaining bands independently for SAR.

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.



## 7.2 Conducted Power

| Band                           | Data Rate | CH | Frequency (MHz) | Average Power (dBm) |
|--------------------------------|-----------|----|-----------------|---------------------|
| IEEE 802.11b                   | 1M        | 1  | 2412.0          | 12.24               |
|                                |           | 6  | 2437.0          | 14.23               |
|                                |           | 11 | 2462.0          | <b>16.56</b>        |
| IEEE 802.11g                   | 6M        | 1  | 2412.0          | 14.22               |
|                                |           | 6  | 2437.0          | 14.25               |
|                                |           | 11 | 2462.0          | 12.72               |
| IEEE 802.11n<br>2.4 GHz 20 MHz | 6.5M      | 1  | 2412.0          | 14.29               |
|                                |           | 6  | 2437.0          | 14.23               |
|                                |           | 11 | 2462.0          | 12.59               |



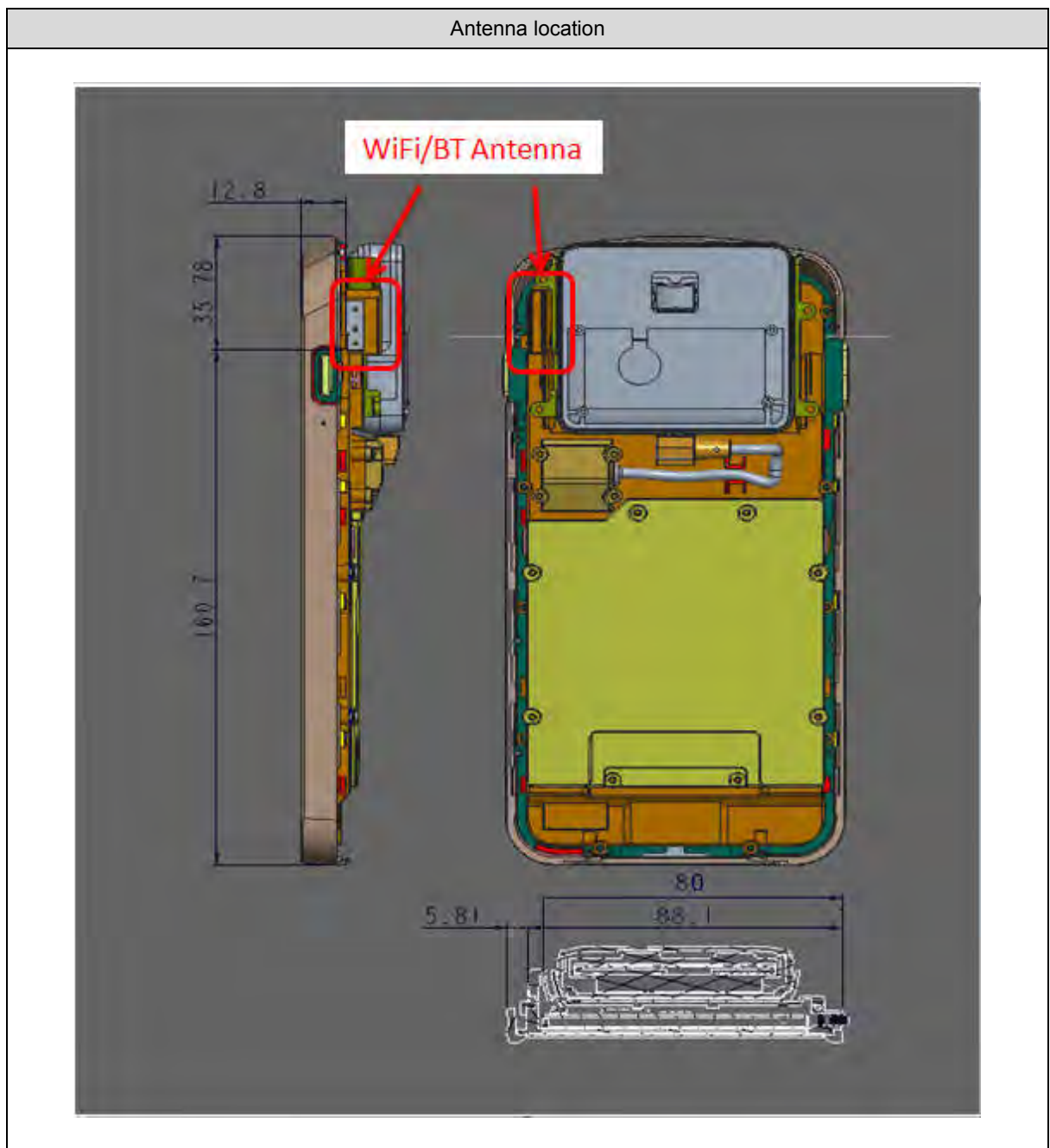
| Band                         | Data Rate | CH  | Frequency (MHz) | Average Power (dBm) |
|------------------------------|-----------|-----|-----------------|---------------------|
| IEEE 802.11a                 | 6M        | 36  | 5180.0          | 14.11               |
|                              |           | 40  | 5200.0          | 14.14               |
|                              |           | 44  | 5220.0          | 14.23               |
|                              |           | 48  | 5240.0          | 14.21               |
|                              |           | 52  | 5260.0          | 14.22               |
|                              |           | 56  | 5280.0          | 14.32               |
|                              |           | 60  | 5300.0          | 14.25               |
|                              |           | 64  | 5320.0          | 14.48               |
|                              |           | 100 | 5500.0          | <b>14.70</b>        |
|                              |           | 104 | 5520.0          | 14.12               |
|                              |           | 108 | 5540.0          | 14.11               |
|                              |           | 112 | 5560.0          | 14.22               |
|                              |           | 116 | 5580.0          | 14.61               |
|                              |           | 132 | 5660.0          | 14.60               |
|                              |           | 136 | 5680.0          | 14.50               |
|                              |           | 140 | 5700.0          | 14.43               |
|                              |           | 149 | 5745.0          | 14.35               |
|                              |           | 153 | 5765.0          | 14.38               |
|                              |           | 157 | 5785.0          | 14.36               |
|                              |           | 161 | 5805.0          | 14.37               |
|                              |           | 165 | 5825.0          | 14.28               |
| IEEE 802.11n<br>5 GHz 20 MHz | 6.5M      | 36  | 5180.0          | 13.62               |
|                              |           | 40  | 5200.0          | 13.44               |
|                              |           | 44  | 5220.0          | 13.48               |
|                              |           | 48  | 5240.0          | 13.43               |
|                              |           | 52  | 5260.0          | 13.57               |
|                              |           | 56  | 5280.0          | 13.48               |
|                              |           | 60  | 5300.0          | 13.44               |
|                              |           | 64  | 5320.0          | 13.43               |
|                              |           | 100 | 5500.0          | 13.76               |
|                              |           | 104 | 5520.0          | 13.73               |
|                              |           | 108 | 5540.0          | 13.82               |
|                              |           | 112 | 5560.0          | 13.80               |
|                              |           | 116 | 5580.0          | <b>13.83</b>        |
|                              |           | 132 | 5660.0          | 13.82               |
|                              |           | 136 | 5680.0          | 13.79               |
|                              |           | 140 | 5700.0          | 13.72               |
|                              |           | 149 | 5745.0          | 13.46               |
|                              |           | 153 | 5765.0          | 13.51               |
|                              |           | 157 | 5785.0          | 13.41               |
|                              |           | 161 | 5805.0          | 13.45               |
|                              |           | 165 | 5825.0          | 13.41               |



| Band                         | Data Rate | CH  | Frequency (MHz) | Average Power (dBm) |
|------------------------------|-----------|-----|-----------------|---------------------|
| IEEE 802.11n<br>5 GHz 40 MHz | 13.5M     | 38  | 5190.0          | 12.61               |
|                              |           | 46  | 5230.0          | 12.69               |
|                              |           | 54  | 5270.0          | 12.74               |
|                              |           | 62  | 5310.0          | 12.62               |
|                              |           | 102 | 5510.0          | 12.75               |
|                              |           | 110 | 5550.0          | 12.91               |
|                              |           | 134 | 5670.0          | <b>12.92</b>        |
|                              |           | 151 | 5755.0          | 12.52               |
|                              |           | 159 | 5795.0          | 12.53               |
| IEEE 802.11ac<br>80 MHz      | 29.3M     | 42  | 5210.0          | 8.74                |
|                              |           | 58  | 5290.0          | 9.26                |
|                              |           | 106 | 5530.0          | <b>12.75</b>        |
|                              |           | 155 | 5775.0          | 12.55               |

### 7.3 Antenna location

| Ant           | Antenna to user distance (mm) |      |        |        |        |        |
|---------------|-------------------------------|------|--------|--------|--------|--------|
|               | Front                         | Back | Side 1 | Side 2 | Side 3 | Side 4 |
| WLAN ANT      | 5                             | 5    | 5      | 5      | 160.7  | 80     |
| Bluetooth ANT | 5                             | 5    | 5      | 5      | 160.7  | 80     |



## 7.4 Standalone SAR Test Exclusion Calculation

Transmitter and antenna implementation as below:

| Condition(s) | Band         |            |           |
|--------------|--------------|------------|-----------|
|              | WLAN 2.4 GHz | WLAN 5 GHz | Bluetooth |
| 1            | V            | ---        | V         |
| 2            | ---          | V          | V         |

| Ant. Used         | Band                  | Frequency | Tune-Power |      | Distance of Ant. To User (mm) |       |       |       |       |
|-------------------|-----------------------|-----------|------------|------|-------------------------------|-------|-------|-------|-------|
|                   |                       | (GHz)     | (dBm)      | (mW) | Back                          | Side1 | Side2 | Side3 | Side4 |
| Bluetooth Antenna | BT                    | 2.480     | 2          | 2    | 5                             | 5     | 5     | 160.7 | 80    |
| WLAN Antenna      | 2.4 GHz WLAN Ant-Main | 2.462     | 17.5       | 56   | 5                             | 5     | 5     | 160.7 | 80    |
|                   | 5GHz WLAN Ant-Main    | 5.825     | 15         | 32   | 5                             | 5     | 5     | 160.7 | 80    |

| Ant. Used         | Band                  | Frequency | Tune-Power |      | Calculated value and evaluated result |         |         |        |        | exclusion threshold |
|-------------------|-----------------------|-----------|------------|------|---------------------------------------|---------|---------|--------|--------|---------------------|
|                   |                       | (GHz)     | (dBm)      | (mW) | Back                                  | Side1   | Side2   | Side3  | Side4  |                     |
| Bluetooth Antenna | BT                    | 2.480     | 2          | 2    | 0.6                                   | 0.6     | 0.6     | 1202.0 | 395.0  | 3                   |
|                   |                       |           |            |      | EXEMPT                                | EXEMPT  | EXEMPT  | EXEMPT | EXEMPT |                     |
| WLAN Antenna      | 2.4 GHz WLAN Ant-Main | 2.462     | 17.5       | 56   | 17.6                                  | 17.6    | 17.6    | 1203.0 | 396.0  | 3                   |
|                   |                       |           |            |      | MEASURE                               | MEASURE | MEASURE | EXEMPT | EXEMPT |                     |
|                   | 5 GHz WLAN Ant-Main   | 5.825     | 15         | 32   | 15.5                                  | 15.5    | 15.5    | 1169.0 | 362.0  | 3                   |
|                   |                       |           |            |      | MEASURE                               | MEASURE | MEASURE | EXEMPT | EXEMPT |                     |

Note:

1. The test reduction for distance less than 50mm and more than 50mm. Use the max power to make sure minimum distance by evaluated for SAR testing.
2. For 100 MHz to 6 GHz and test separation distances > 50 mm, According to KDB 447498, if the calculated Power threshold is less than the output power then SAR testing is required.
3. For 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following: According to KDB 447498, if the calculated threshold value are >3 then Body SAR and >7.5 then Limbs SAR testing are required.
4. When an antenna qualifies for the standalone SAR test exclusion of KDB 447498 section 4.3.1 and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to KDB 447498 section "4.3.2. Simultaneous transmission SAR test exclusion considerations b)"
5. We used highest frequency and power, that result should be evaluated the worst case.
6. Power and distance are rounded to the nearest mW and mm before calculation.
7. The result is rounded to one decimal place for comparison.

## 7.5 Simultaneous Transmitting Evaluate

### Estimated SAR

| Ant. Used         | Band                  | Frequency | Tune-Power |      | Estimated SAR 1-g (W/kg) |       |       |       |       |
|-------------------|-----------------------|-----------|------------|------|--------------------------|-------|-------|-------|-------|
|                   |                       | (GHz)     | (dBm)      | (mW) | Back                     | Side1 | Side2 | Side3 | Side4 |
| Bluetooth Antenna | BT                    | 2.480     | 2          | 2    | 0.08                     | 0.08  | 0.08  | 0.4   | 0.4   |
| WLAN Antenna      | 2.4 GHz WLAN Ant-Main | 2.462     | 17.5       | 56   | ---                      | ---   | ---   | 0.4   | 0.4   |
|                   | 5GHz WLAN Ant-Main    | 5.825     | 15         | 32   | ---                      | ---   | ---   | 0.4   | 0.4   |

### 7.5.1 SAR to peak location separation ratio (SPLSR)

When the sum of SAR is larger than the limit, SAR test exclusion is determined by the SAR to peak location separation ratio. The ratio is determined by  $(SAR_1 + SAR_2)^{1.5/R_i}$ , rounded to two decimal digits, and must be  $\leq 0.04$  for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion.

Sum of 1-g SAR of summary as below:

| Phantom Position |        | Spacing (mm) | ASSY | WLAN 2.4 GHz (1) |                             | Bluetooth (2) |                             | (1)+(2)<br>SAR <sub>1g</sub><br>(W/Kg) | Event |
|------------------|--------|--------------|------|------------------|-----------------------------|---------------|-----------------------------|----------------------------------------|-------|
|                  |        |              |      | Band             | SAR <sub>1g</sub><br>(W/Kg) | Band          | SAR <sub>1g</sub><br>(W/Kg) |                                        |       |
| Flat             | Back   | 0            | N/A  | IEEE 802.11      | 0.09                        | Bluetooth     | *0.08                       | 0.17                                   | <1.6  |
|                  | Side 1 | 0            | N/A  | IEEE 802.11      | 0.04                        | Bluetooth     | *0.08                       | 0.12                                   | <1.6  |
|                  | Side 2 | 0            | N/A  | IEEE 802.11      | 0.41                        | Bluetooth     | *0.08                       | 0.49                                   | <1.6  |

| Phantom Position |        | Spacing (mm) | ASSY | WLAN 5 GHz (3) |                             | Bluetooth (2) |                             | (3)+(2)<br>SAR <sub>1g</sub><br>(W/Kg) | Event |
|------------------|--------|--------------|------|----------------|-----------------------------|---------------|-----------------------------|----------------------------------------|-------|
|                  |        |              |      | Band           | SAR <sub>1g</sub><br>(W/Kg) | Band          | SAR <sub>1g</sub><br>(W/Kg) |                                        |       |
| Flat             | Back   | 0            | N/A  | IEEE 802.11    | 0.27                        | Bluetooth     | *0.08                       | 0.35                                   | <1.6  |
|                  | Side 1 | 0            | N/A  | IEEE 802.11    | 0.07                        | Bluetooth     | *0.08                       | 0.15                                   | <1.6  |
|                  | Side 2 | 0            | N/A  | IEEE 802.11    | 1.15                        | Bluetooth     | *0.08                       | 1.23                                   | <1.6  |

Note1 : \*=Estimated SAR

Note2 : \*\*The Estimated SAR 0.4W/Kg , test separation distances is > 50 mm .

Note3: When the sum of 1-g SAR of all simultaneously transmitting antennas in and operating mode and exposure condition combination is within the SAR limit, SAR test exclusion applies to that simultaneous transmission configuration.

## 7.6 SAR test reduction according to KDB

General:

- The test data reported are the worst-case SAR value with the position set in a typical configuration. Test procedures used were according to FCC, Supplement C [June 2001], IEEE1528-2013.
- All modes of operation were investigated, and worst-case results are reported.
- Tissue parameters and temperatures are listed on the SAR plots.
- Batteries are fully charged for all readings.
- When the Channel's SAR 1 g of maximum conducted power is  $> 0.8$  mW/g, low, middle and high channel are supposed to be tested.

KDB 447498:

- The test data reported are the worst-case SAR value with the position set in a typical configuration. Test procedures used were according to IEEE1528-2013.

KDB 865664:

- Repeated measurement is not required when the original highest measured SAR is  $< 0.80$  W/kg.
- When the original highest measured SAR is  $\geq 0.80$  W/kg, repeat that measurement once.
- Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is  $> 1.20$  or when the original or repeated measurement is  $\geq 1.45$  W/kg.
- Perform a third repeated measurement only if the original, first or second repeated measurement is  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .

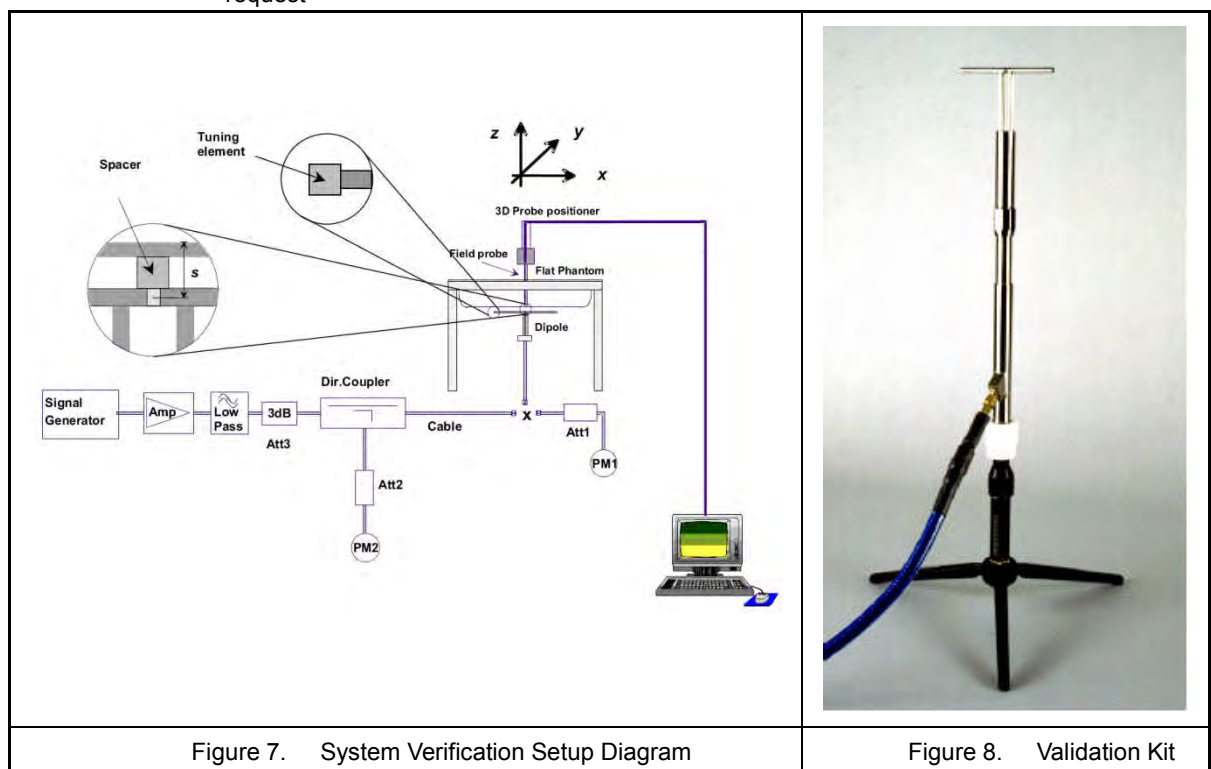
KDB 248227:

- Refer 7.1 SAR Testing with 802.11 Transmitters.

## 8. System Verification and Validation

### 8.1 Symmetric Dipoles for System Verification

|              |                                                                                                                                                                                                                                                                                                                                       |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Construction | Symmetrical dipole with 1/4 balun enables measurement of feed point impedance with NWA matched for use near flat phantoms filled with head simulating solutions Includes distance holder and tripod adaptor Calibration Calibrated SAR value for specified position and input power at the flat phantom in head simulating solutions. |
| Return Loss  | > 20 dB at specified verification position                                                                                                                                                                                                                                                                                            |
| Options      | Dipoles for other frequencies or solutions and other calibration conditions are available upon request                                                                                                                                                                                                                                |



## 8.2 Verification Summary

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of  $\pm 10\%$ . The measured SAR will be normalized to 1 W input power.

| Mixture Type | Frequency (MHz) | Power  | Probe              | Dipole             | SAR <sub>1g</sub> (W/Kg) | Normalize to 1 Watt 1 g (W/Kg) | 1 W Target SAR <sub>1g</sub> (W/Kg) | SAR <sub>10g</sub> (W/Kg) | Normalize to 1 Watt 10 g (W/Kg) | 1 W Target SAR <sub>10g</sub> (W/Kg) | Difference percentage 1 g | Difference percentage 10 g | Date          |
|--------------|-----------------|--------|--------------------|--------------------|--------------------------|--------------------------------|-------------------------------------|---------------------------|---------------------------------|--------------------------------------|---------------------------|----------------------------|---------------|
|              |                 |        | Model / Serial No. | Model / Serial No. |                          |                                |                                     |                           |                                 |                                      |                           |                            |               |
| Head         | 2450            | 250 mW | EX3DV4-SN3847      | D2450V2 – SN712    | 13.2                     | 52.8                           | 52.10                               | 6.2                       | 24.8                            | 24.00                                | 1.3%                      | 3.2%                       | Feb. 13, 2020 |
| Head         | 5250            | 100 mW | EX3DV4-SN3847      | D5250V2 – SN1021   | 8.01                     | 80.1                           | 76.10                               | 2.24                      | 22.4                            | 21.60                                | 5.0%                      | 3.6%                       | Feb. 12, 2020 |
| Head         | 5600            | 100 mW | EX3DV4-SN3847      | D5600V2 – SN1021   | 8.66                     | 86.6                           | 81.00                               | 2.33                      | 23.3                            | 22.70                                | 6.5%                      | 2.6%                       | Feb. 12, 2020 |
| Head         | 5750            | 100 mW | EX3DV4-SN3847      | D5750V2 – SN1021   | 8.32                     | 83.2                           | 76.10                               | 2.22                      | 22.2                            | 21.30                                | 8.5%                      | 4.1%                       | Feb. 12, 2020 |

## 9. Test Equipment List

Testing Engineer: Kris Pan , Jason Tsao

| Manufacturer  | Name of Equipment             | Type/Model                 | Serial Number   | Calibration |            |
|---------------|-------------------------------|----------------------------|-----------------|-------------|------------|
|               |                               |                            |                 | Cal. Date   | Cal.Period |
| SPEAG         | 2450MHz System Validation Kit | D2450V2                    | 712             | 2019/04/15  | 1 year     |
| SPEAG         | 5GHz System Validation Kit    | D5GHzV2                    | 1021            | 2019/04/19  | 1 year     |
| SPEAG         | Dosimetric E-Field Probe      | EX3DV4                     | 3847            | 2019/05/16  | 1 year     |
| SPEAG         | Data Acquisition Electronics  | DAE4                       | 541             | 2019/03/19  | 1 year     |
| SPEAG         | Measurement Server            | SE UMS 011 AA              | 1025            | NCR         |            |
| SPEAG         | Device Holder                 | N/A                        | N/A             | NCR         |            |
| SPEAG         | Phantom                       | ELI V4.0                   | 1036            | NCR         |            |
| SPEAG         | Robot                         | Staubli TX90XL             | F16/54FTA1/A/01 | NCR         |            |
| SPEAG         | Software                      | DASY52<br>V52.10 (3)       | N/A             | NCR         |            |
| SPEAG         | Software                      | SEMCAD X<br>V14.6.10(7331) | N/A             | NCR         |            |
| SPEAG         | Network Analyzer              | DAKS_VNA<br>R140           | 0010318         | 2019/05/03  | 1 year     |
| SPEAG         | Dielectric Probe Kit          | DAKS-3.5                   | 1101            | 2019/05/02  | 1 year     |
| HILA          | Digital Thermometer           | TM-906A                    | 1500033         | 2019/10/28  | 1 year     |
| Agilent       | Power Sensor                  | 8481H                      | 3318A20779      | 2019/06/11  | 1 year     |
| Agilent       | Power Meter                   | EDM Series<br>E4418B       | GB40206143      | 2019/06/11  | 1 year     |
| Agilent       | Signal Generator              | E8257D                     | MY44320425      | 2019/03/05  | 1 year     |
| Agilent       | Dual Directional Coupler      | 778D                       | 50334           | NCR         |            |
| Woken         | Dual Directional Coupler      | 0100AZ202008<br>01O        | 11012409517     | NCR         |            |
| Mini-Circuits | Power Amplifier               | EMC014225P                 | 980292          | NCR         |            |
| Mini-Circuits | Power Amplifier               | EMC2830P                   | 980293          | NCR         |            |
| Aisi          | Attenuator                    | IEAT 3dB                   | N/A             | NCR         |            |

Table 3. Test Equipment List

## 10. Measurement Uncertainty

Decision Rule

■ Uncertainty is not included.

□ Uncertainty is included.

| Item                                          | Uncertainty Component                                                           | Uncertainty Value | Prob. Dist  | Div.       | $c_i$<br>(1 g) | $c_i$<br>(10 g) | Std. Unc.<br>(1-g) | Std. Unc.<br>(10-g) | $v_i$<br>or<br>$V_{eff}$ |
|-----------------------------------------------|---------------------------------------------------------------------------------|-------------------|-------------|------------|----------------|-----------------|--------------------|---------------------|--------------------------|
| Measurement System                            |                                                                                 |                   |             |            |                |                 |                    |                     |                          |
| u1                                            | Probe Calibration ( $k=1$ )                                                     | ±6.0 %            | Normal      | 1          | 1              | 1               | ±6.0 %             | ±6.0 %              | ∞                        |
| u2                                            | Axial Isotropy                                                                  | ±4.7 %            | Rectangular | $\sqrt{3}$ | 0.7            | 0.7             | ±1.9 %             | ±1.9 %              | ∞                        |
| u3                                            | Hemispherical Isotropy                                                          | ±9.6 %            | Rectangular | $\sqrt{3}$ | 0.7            | 0.7             | ±3.9 %             | ±3.9 %              |                          |
| u4                                            | Boundary Effect                                                                 | ±1.0 %            | Rectangular | $\sqrt{3}$ | 1              | 1               | ±0.6 %             | ±0.6 %              | ∞                        |
| u5                                            | Linearity                                                                       | ±4.7 %            | Rectangular | $\sqrt{3}$ | 1              | 1               | ±2.7 %             | ±2.7 %              | ∞                        |
| u6                                            | System Detection Limit                                                          | ±1.0 %            | Rectangular | $\sqrt{3}$ | 1              | 1               | ±0.6 %             | ±0.6 %              | ∞                        |
| u7                                            | Readout Electronics                                                             | ±0.3 %            | Normal      | 1          | 1              | 1               | ±0.3 %             | ±0.3 %              | ∞                        |
| u8                                            | Response Time                                                                   | ±0.8 %            | Rectangular | $\sqrt{3}$ | 1              | 1               | ±0.5 %             | ±0.5 %              | ∞                        |
| u9                                            | Integration Time                                                                | ±1.9 %            | Rectangular | $\sqrt{3}$ | 1              | 1               | ±1.1 %             | ±1.1 %              | ∞                        |
| u10                                           | RF Ambient Conditions                                                           | ±3.0 %            | Rectangular | $\sqrt{3}$ | 1              | 1               | ±1.7 %             | ±1.7 %              | ∞                        |
| u11                                           | RF Ambient Reflections                                                          | ±3.0 %            | Rectangular | $\sqrt{3}$ | 1              | 1               | ±1.7 %             | ±1.7 %              | ∞                        |
| u12                                           | Probe Positioner Mechanical Tolerance                                           | ±0.4 %            | Rectangular | $\sqrt{3}$ | 1              | 1               | ±0.2 %             | ±0.2 %              | ∞                        |
| u13                                           | Probe Positioning with respect to Phantom Shell                                 | ±2.9 %            | Rectangular | $\sqrt{3}$ | 1              | 1               | ±1.7 %             | ±1.7 %              | ∞                        |
| u14                                           | Extrapolation, interpolation and integration Algorithms for Max. SAR Evaluation | ±1.0 %            | Rectangular | $\sqrt{3}$ | 1              | 1               | ±0.6 %             | ±0.6 %              | ∞                        |
| Test sample Related                           |                                                                                 |                   |             |            |                |                 |                    |                     |                          |
| u15                                           | Test sample Positioning                                                         | ±2.9 %            | Normal      | 1          | 1              | 1               | ±2.9 %             | ±2.9 %              | 89                       |
| u16                                           | Device Holder Uncertainty                                                       | ±3.6 %            | Normal      | 1          | 1              | 1               | ±3.6 %             | ±3.6 %              | 5                        |
| u17                                           | Output Power Variation - SAR drift measurement                                  | ±5.0 %            | Rectangular | $\sqrt{3}$ | 1              | 1               | ±2.9 %             | ±2.9 %              | ∞                        |
| Phantom and Tissue Parameters                 |                                                                                 |                   |             |            |                |                 |                    |                     |                          |
| u18                                           | Phantom Uncertainty ( shape and thickness tolerances)                           | ±4.0 %            | Rectangular | $\sqrt{3}$ | 1              | 1               | ±2.3 %             | ±2.3 %              | ∞                        |
| u19                                           | Liquid Conductivity - deviation from target values                              | ±5.0 %            | Rectangular | $\sqrt{3}$ | 0.64           | 0.43            | ±1.8 %             | ±1.2 %              | ∞                        |
| u20                                           | Liquid Conductivity - measurement uncertainty                                   | ±2.5 %            | Normal      | 1          | 0.64           | 0.43            | ±1.6 %             | ±1.08 %             | 69                       |
| u21                                           | Liquid Permittivity - deviation from target values                              | ±5.0 %            | Rectangular | $\sqrt{3}$ | 0.6            | 0.49            | ±1.7 %             | ±1.4 %              | ∞                        |
| u22                                           | Liquid Permittivity - measurement uncertainty                                   | ±2.5 %            | Normal      | 1          | 0.6            | 0.49            | ±1.5 %             | ±1.23 %             | 69                       |
| Combined standard uncertainty                 |                                                                                 |                   | RSS         |            |                |                 | ±10.94 %           | ±10.71 %            | 380                      |
| Expanded uncertainty (95 % CONFIDENCE LEVEL ) |                                                                                 |                   | $k=2$       |            |                |                 | ±21.88 %           | ±21.41 %            |                          |

Table 4. Uncertainty Budget for frequency range 300 MHz to 3 GHz

| Item                                          | Uncertainty Component                                                           | Uncertainty Value | Prob. Dist  | Div.       | $c_i$<br>(1 g) | $c_i$<br>(10 g) | Std. Unc.<br>(1-g) | Std. Unc.<br>(10-g) | $V_i$<br>or<br>$V_{eff}$ |
|-----------------------------------------------|---------------------------------------------------------------------------------|-------------------|-------------|------------|----------------|-----------------|--------------------|---------------------|--------------------------|
| Measurement System                            |                                                                                 |                   |             |            |                |                 |                    |                     |                          |
| u1                                            | Probe Calibration ( $k=1$ )                                                     | $\pm 6.5 \%$      | Normal      | 1          | 1              | 1               | $\pm 6.5 \%$       | $\pm 6.5 \%$        | $\infty$                 |
| u2                                            | Axial Isotropy                                                                  | $\pm 4.7 \%$      | Rectangular | $\sqrt{3}$ | 0.7            | 0.7             | $\pm 1.9 \%$       | $\pm 1.9 \%$        | $\infty$                 |
| u3                                            | Hemispherical Isotropy                                                          | $\pm 9.6 \%$      | Rectangular | $\sqrt{3}$ | 0.7            | 0.7             | $\pm 3.9 \%$       | $\pm 3.9 \%$        |                          |
| u4                                            | Boundary Effect                                                                 | $\pm 2.0 \%$      | Rectangular | $\sqrt{3}$ | 1              | 1               | $\pm 1.2 \%$       | $\pm 1.2 \%$        | $\infty$                 |
| u5                                            | Linearity                                                                       | $\pm 4.7 \%$      | Rectangular | $\sqrt{3}$ | 1              | 1               | $\pm 2.7 \%$       | $\pm 2.7 \%$        | $\infty$                 |
| u6                                            | System Detection Limit                                                          | $\pm 1.0 \%$      | Rectangular | $\sqrt{3}$ | 1              | 1               | $\pm 0.6 \%$       | $\pm 0.6 \%$        | $\infty$                 |
| u7                                            | Readout Electronics                                                             | $\pm 0.0 \%$      | Normal      | 1          | 1              | 1               | $\pm 0.0 \%$       | $\pm 0.0 \%$        | $\infty$                 |
| u8                                            | Response Time                                                                   | $\pm 0.8 \%$      | Rectangular | $\sqrt{3}$ | 1              | 1               | $\pm 0.5 \%$       | $\pm 0.5 \%$        | $\infty$                 |
| u9                                            | Integration Time                                                                | $\pm 2.8 \%$      | Rectangular | $\sqrt{3}$ | 1              | 1               | $\pm 2.8 \%$       | $\pm 2.8 \%$        | $\infty$                 |
| u10                                           | RF Ambient Conditions                                                           | $\pm 3.0 \%$      | Rectangular | $\sqrt{3}$ | 1              | 1               | $\pm 1.7 \%$       | $\pm 1.7 \%$        | $\infty$                 |
| u11                                           | RF Ambient Reflections                                                          | $\pm 3.0 \%$      | Rectangular | $\sqrt{3}$ | 1              | 1               | $\pm 1.7 \%$       | $\pm 1.7 \%$        | $\infty$                 |
| u12                                           | Probe Positioner Mechanical Tolerance                                           | $\pm 0.7 \%$      | Rectangular | $\sqrt{3}$ | 1              | 1               | $\pm 0.7 \%$       | $\pm 0.7 \%$        | $\infty$                 |
| u13                                           | Probe Positioning with respect to Phantom Shell                                 | $\pm 9.9 \%$      | Rectangular | $\sqrt{3}$ | 1              | 1               | $\pm 5.7 \%$       | $\pm 5.7 \%$        | $\infty$                 |
| u14                                           | Extrapolation, interpolation and integration Algorithms for Max. SAR Evaluation | $\pm 3.0 \%$      | Rectangular | $\sqrt{3}$ | 1              | 1               | $\pm 1.7 \%$       | $\pm 1.7 \%$        | $\infty$                 |
| Test sample Related                           |                                                                                 |                   |             |            |                |                 |                    |                     |                          |
| u15                                           | Test sample Positioning                                                         | $\pm 2.9 \%$      | Normal      | 1          | 1              | 1               | $\pm 2.9 \%$       | $\pm 2.9 \%$        | 89                       |
| u16                                           | Device Holder Uncertainty                                                       | $\pm 3.6 \%$      | Normal      | 1          | 1              | 1               | $\pm 3.6 \%$       | $\pm 3.6 \%$        | 5                        |
| u17                                           | Output Power Variation - SAR drift measurement                                  | $\pm 5.0 \%$      | Rectangular | $\sqrt{3}$ | 1              | 1               | $\pm 2.9 \%$       | $\pm 2.9 \%$        | $\infty$                 |
| Phantom and Tissue Parameters                 |                                                                                 |                   |             |            |                |                 |                    |                     |                          |
| u18                                           | Phantom Uncertainty ( shape and thickness tolerances)                           | $\pm 4.0 \%$      | Rectangular | $\sqrt{3}$ | 1              | 1               | $\pm 2.3 \%$       | $\pm 2.3 \%$        | $\infty$                 |
| u19                                           | Liquid Conductivity - deviation from target values                              | $\pm 5.0 \%$      | Rectangular | $\sqrt{3}$ | 0.64           | 0.43            | $\pm 1.8 \%$       | $\pm 1.2 \%$        | $\infty$                 |
| u20                                           | Liquid Conductivity - measurement uncertainty                                   | $\pm 2.5 \%$      | Normal      | 1          | 0.64           | 0.43            | $\pm 1.6 \%$       | $\pm 1.08 \%$       | 69                       |
| u21                                           | Liquid Permittivity - deviation from target values                              | $\pm 5.0 \%$      | Rectangular | $\sqrt{3}$ | 0.6            | 0.49            | $\pm 1.7 \%$       | $\pm 1.4 \%$        | $\infty$                 |
| u22                                           | Liquid Permittivity - measurement uncertainty                                   | $\pm 2.5 \%$      | Normal      | 1          | 0.6            | 0.49            | $\pm 1.5 \%$       | $\pm 1.23 \%$       | 69                       |
| Combined standard uncertainty                 |                                                                                 |                   | RSS         |            |                |                 | $\pm 12.68 \%$     | $\pm 12.48 \%$      | 700                      |
| Expanded uncertainty (95 % CONFIDENCE LEVEL ) |                                                                                 |                   | $k=2$       |            |                |                 | $\pm 25.37 \%$     | $\pm 24.97 \%$      |                          |

Table 5. Uncertainty Budget for frequency range 3 GHz to 6 GHz

## **11. Measurement Procedure**

The measurement procedures are as follows:

1. For WLAN function, engineering testing software installed on DUTs can provide continuous transmitting signal.
2. Measure output power through RF cable and power meter
3. Set scan area, grid size and other setting on the DASY software
4. Find out the largest SAR result on these testing positions of each band
5. Measure SAR results for other channels in worst SAR testing position if the SAR of highest power channel is larger than 0.8 W/kg

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

1. Power reference measurement
2. Area scan
3. Zoom scan
4. Power drift measurement

### **11.1 Spatial Peak SAR Evaluation**

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1 g and 10 g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1 g and 10 g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1 g and 10 g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages

1. Extraction of the measured data (grid and values) from the Zoom Scan
2. Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. Generation of a high-resolution mesh within the measured volume
4. Interpolation of all measured values from the measurement grid to the high-resolution grid
5. Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. Calculation of the averaged SAR within masses of 1 g and 10 g

## 11.2 Area & Zoom Scan Procedures

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan measures points and step size follow as below. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g.

| Grid Type    | Frequency    |              | Step size (mm) |          |          | X*Y*Z<br>(Point) | Cube size |    |    | Step size |   |   |
|--------------|--------------|--------------|----------------|----------|----------|------------------|-----------|----|----|-----------|---|---|
|              |              |              | X              | Y        | Z        |                  | X         | Y  | Z  | X         | Y | Z |
| uniform grid | $\leq 3$ GHz | $\leq 2$ GHz | $\leq 8$       | $\leq 8$ | $\leq 5$ | 5*5*7            | 32        | 32 | 30 | 8         | 8 | 5 |
|              |              | 2 G - 3 G    | $\leq 5$       | $\leq 5$ | $\leq 5$ | 7*7*7            | 30        | 30 | 30 | 5         | 5 | 5 |
|              | 3 - 6 GHz    | 3 - 4 GHz    | $\leq 5$       | $\leq 5$ | $\leq 4$ | 7*7*8            | 30        | 30 | 28 | 5         | 5 | 4 |
|              |              | 4 - 5 GHz    | $\leq 4$       | $\leq 4$ | $\leq 3$ | 8*8*10           | 28        | 28 | 27 | 4         | 4 | 3 |
|              |              | 5 - 6 GHz    | $\leq 4$       | $\leq 4$ | $\leq 2$ | 8*8*12           | 28        | 28 | 22 | 4         | 4 | 2 |
|              |              |              |                |          |          |                  |           |    |    |           |   |   |

(Our measure settings are refer KDB Publication 865664 D01v01r04)

## 11.3 Volume Scan Procedures

The volume scan is used for 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 1 g aggregate SAR, the DUT 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.

## 11.4 SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation. Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

## 11.5 Power Drift Monitoring

All SAR testing is under the DUT 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 DUT 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 drift more than 5 %, the SAR will be retested.



## 12. SAR Test Results Summary

### 12.1 Body SAR Measurement

| Index. | Band        | Mode            | Frequency |        | Data Rate | Test Position | Spacing (mm) | SAR <sub>1g</sub> (W/kg) | Burst Avg Power | Max tune-up | Duty Cycle % | Reported SAR <sub>1g</sub> (W/kg) |
|--------|-------------|-----------------|-----------|--------|-----------|---------------|--------------|--------------------------|-----------------|-------------|--------------|-----------------------------------|
|        |             |                 | Ch.       | MHz    |           |               |              |                          |                 |             |              |                                   |
|        | WLAN 2.4GHz | 802.11b         | 11        | 2462.0 | 1 Mbps    | Back          | 0            | 0.072                    | 16.56           | 17.5        | 99.90        | 0.09                              |
|        | WLAN 2.4GHz | 802.11b         | 11        | 2462.0 | 1 Mbps    | Side 1        | 0            | 0.033                    | 16.56           | 17.5        | 99.90        | 0.04                              |
| #25    | WLAN 2.4GHz | 802.11b         | 11        | 2462.0 | 1 Mbps    | Side 2        | 0            | 0.327                    | 16.56           | 17.5        | 99.90        | <b>0.41</b>                       |
|        | WLAN 5GHz   | 802.11a         | 64        | 5320.0 | 6 Mbps    | Back          | 0            | 0.136                    | 14.48           | 15          | 99.90        | 0.15                              |
|        | WLAN 5GHz   | 802.11a         | 64        | 5320.0 | 6 Mbps    | Side 1        | 0            | 0.044                    | 14.48           | 15          | 99.90        | 0.05                              |
|        | WLAN 5GHz   | 802.11a         | 64        | 5320.0 | 6 Mbps    | Side 2        | 0            | 0.91                     | 14.48           | 15          | 99.90        | 1.03                              |
| #4     | WLAN 5GHz   | 802.11a         | 52        | 5260.0 | 6 Mbps    | Side 2        | 0            | 0.933                    | 14.22           | 15          | 99.90        | <b>1.12</b>                       |
|        | WLAN 5GHz   | 802.11a         | 56        | 5280.0 | 6 Mbps    | Side 2        | 0            | 0.911                    | 14.32           | 15          | 99.90        | 1.07                              |
|        | WLAN 5GHz   | 802.11a         | 60        | 5300.0 | 6 Mbps    | Side 2        | 0            | 0.892                    | 14.25           | 15          | 99.90        | 1.06                              |
|        | WLAN 5GHz   | 802.11ac 80 MHz | 106       | 5530.0 | VHT0      | Back          | 0            | 0.186                    | 12.75           | 13          | 99.90        | 0.20                              |
|        | WLAN 5GHz   | 802.11ac 80 MHz | 106       | 5530.0 | VHT0      | Side 1        | 0            | 0.049                    | 12.75           | 13          | 99.90        | 0.05                              |
| #10    | WLAN 5GHz   | 802.11ac 80 MHz | 106       | 5530.0 | VHT0      | Side 2        | 0            | 1.05                     | 12.75           | 13          | 99.90        | <b>1.11</b>                       |
|        | WLAN 5GHz   | 802.11ac 40 MHz | 134       | 5670.0 | VHT0      | Side 2        | 0            | 0.739                    | 12.92           | 13          | 99.90        | 0.75                              |
|        | WLAN 5GHz   | 802.11a         | 157       | 5785.0 | 6 Mbps    | Back          | 0            | 0.235                    | 14.36           | 15          | 99.90        | 0.27                              |
|        | WLAN 5GHz   | 802.11a         | 157       | 5785.0 | 6 Mbps    | Side 1        | 0            | 0.062                    | 14.36           | 15          | 99.90        | 0.07                              |
| #19    | WLAN 5GHz   | 802.11a         | 157       | 5785.0 | 6 Mbps    | Side 2        | 0            | 0.988                    | 14.36           | 15          | 99.90        | <b>1.15</b>                       |
|        | WLAN 5GHz   | 802.11a         | 149       | 5745.0 | 6 Mbps    | Side 2        | 0            | 0.957                    | 14.35           | 15          | 99.90        | 1.11                              |
|        | WLAN 5GHz   | 802.11a         | 165       | 5825.0 | 6 Mbps    | Side 2        | 0            | 0.923                    | 14.28           | 15          | 99.90        | 1.09                              |

### 12.2 SAR Variability Measurement

| Measurement Results |            |                 |           |        |           |               |              |                   |                                   |                                |                    |
|---------------------|------------|-----------------|-----------|--------|-----------|---------------|--------------|-------------------|-----------------------------------|--------------------------------|--------------------|
| Index               | Band       | Mode            | Frequency |        | Data Rate | Test Position | Spacing (mm) | Note              | Original SAR <sub>1g</sub> (W/Kg) | First SAR <sub>1g</sub> (W/Kg) | First Ratio SAR 1g |
|                     |            |                 | Ch.       | MHz    |           |               |              |                   |                                   |                                |                    |
| #7                  | WLAN 5 GHz | 802.11a         | 52        | 5260.0 | 6 Mbps    | Side 2        | 0            | original #4_once  | 0.933                             | 0.931                          | 1.00               |
| #11                 | WLAN 5 GHz | 802.11ac 80 MHz | 106       | 5530.0 | VHT0      | Side 2        | 0            | original #10_once | 1.05                              | 1.01                           | 1.04               |
| #22                 | WLAN 5 GHz | 802.11a         | 157       | 5785.0 | 6 Mbps    | Side 2        | 0            | original #19_once | 0.988                             | 0.958                          | 1.03               |

### 12.3 Std. C95.1-1992 RF Exposure Limit

| Human Exposure                                          | Population<br>Uncontrolled<br>Exposure<br>( W/kg ) or (mW/g) | Occupational<br>Controlled<br>Exposure<br>( W/kg ) or (mW/g) |
|---------------------------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------|
| Spatial Peak SAR*<br>(head)                             | 1.60                                                         | 8.00                                                         |
| Spatial Peak SAR**<br>(Whole Body)                      | 0.08                                                         | 0.40                                                         |
| Spatial Peak SAR***<br>(Partial-Body)                   | 1.60                                                         | 8.00                                                         |
| Spatial Peak SAR****<br>(Hands / Feet / Ankle / Wrist ) | 4.00                                                         | 20.00                                                        |

Table 6. Safety Limits for Partial Body Exposure

**Notes :**

- \* The Spatial Peak value of the SAR averaged over any 1 gram of tissue.  
( defined as a tissue volume in the shape of a cube ) and over the appropriate averaging time.
- \*\* The Spatial Average value of the SAR averaged over the whole – body.
- \*\*\* The Spatial Average value of the SAR averaged over the partial – body.
- \*\*\*\* The Spatial Peak value of the SAR averaged over any 10 grams of tissue.  
( defined as a tissue volume in the shape of a cube ) and over the appropriate averaging time.

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

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

### 13. References

- [1] Std. C95.1-1999, "American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 300KHz to 100GHz", New York.
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- [3] T. Schmid, O. Egger, and N. Kuster, "Automatic E-field scanning system for dosimetric assessments", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp, 105-113, Jan. 1996.
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- [6] N. Kuster, and Q. Balzano, "Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300MHz", IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.
- [7] Robert J. Renka, "Multivariate Interpolation Of Large Sets Of Scattered Data", University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988 , pp. 139-148.
- [8] N. Kuster, R. Kastle, T. Schmid, Dosimetric evaluation of mobile communications equipment with known precision, IEEE Transaction on Communications, vol. E80-B, no. 5, May 1997, pp. 645-652.
- [9] Std. C95.3-1991, "IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave, New York: IEEE, Aug. 1992.
- [10] CENELEC CLC/SC111B, European Prestandard (prENV 50166-2), Human Exposure to Electromagnetic Fields High-frequency: 10KHz-300GHz, Jan. 1995.
- [11] IEEE Std 1528™-2013 - IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head From Wireless Communications Devices: Measurement Techniques

## Appendix A - System Performance Check

Test Laboratory: A Test Lab Techno Corp.

Date: 2020/2/13

System Performance Check at 2450MHz\_20200213\_Head

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:712**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.764$  S/m;  $\epsilon_r = 39.385$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3847; ConvF(7.14, 7.14, 7.14) @ 2450 MHz; Calibrated: 2019/5/16
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn541; Calibrated: 2019/3/19
- Phantom: ELI V4.0 (20deg probe tilt); Type: QD OVA 001 BB; Serial: 1036
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.10 (7331)

**System Performance Check at 2450MHz/Area Scan (81x81x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 22.0 W/kg

**System Performance Check at 2450MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 111.8 V/m; Power Drift = 0.06 dB

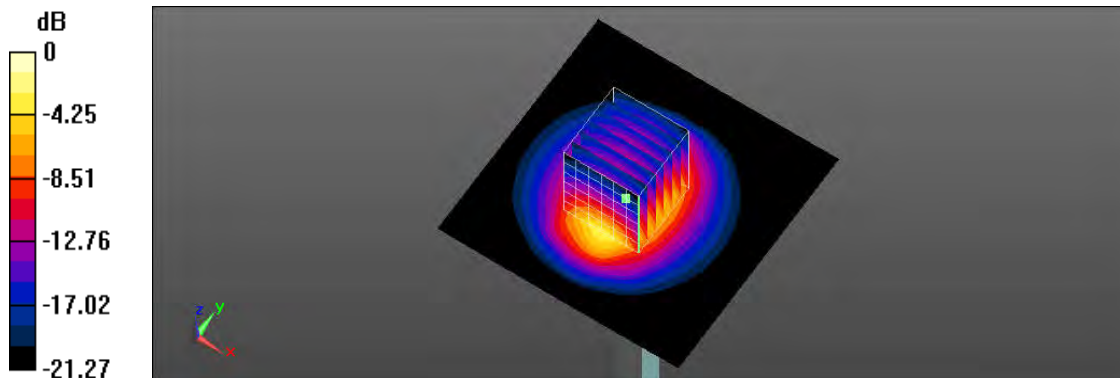
Peak SAR (extrapolated) = 26.5 W/kg

**SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.2 W/kg**

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 50.2%

Maximum value of SAR (measured) = 21.7 W/kg



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

Test Laboratory: A Test Lab Techno Corp.

Date: 2020/2/12

System Performance Check at 5250MHz\_20200212\_Head

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1021**

Communication System: UID 0, CW (0); Frequency: 5250 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 4.529$  S/m;  $\epsilon_r = 35.901$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3847; ConvF(5.22, 5.22, 5.22) @ 5250 MHz; Calibrated: 2019/5/16
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn541; Calibrated: 2019/3/19
- Phantom: ELI V4.0 (20deg probe tilt); Type: QD OVA 001 BB; Serial: 1036
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.10 (7331)

**System Performance Check at 5250MHz/Area Scan (91x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 18.9 W/kg

**System Performance Check at 5250MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 73.82 V/m; Power Drift = -0.05 dB

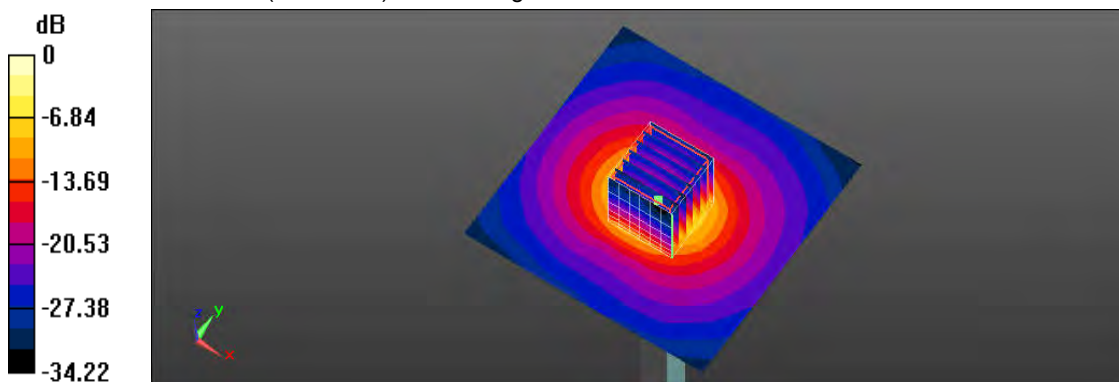
Peak SAR (extrapolated) = 31.6 W/kg

**SAR(1 g) = 8.01 W/kg; SAR(10 g) = 2.24 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.4 mm

Ratio of SAR at M2 to SAR at M1 = 65.7%

Maximum value of SAR (measured) = 19.4 W/kg



0 dB = 19.4 W/kg = 12.88 dBW/kg

Test Laboratory: A Test Lab Techno Corp.

Date: 2020/2/12

System Performance Check at 5600MHz\_20200212\_Head

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1021**

Communication System: UID 0, CW (0); Frequency: 5600 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5600$  MHz;  $\sigma = 4.891$  S/m;  $\epsilon_r = 35.283$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3847; ConvF(4.68, 4.68, 4.68) @ 5600 MHz; Calibrated: 2019/5/16
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn541; Calibrated: 2019/3/19
- Phantom: ELI V4.0 (20deg probe tilt); Type: QD OVA 001 BB; Serial: 1036
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.10 (7331)

**System Performance Check at 5600MHz/Area Scan (91x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 21.3 W/kg

**System Performance Check at 5600MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 74.80 V/m; Power Drift = -0.04 dB

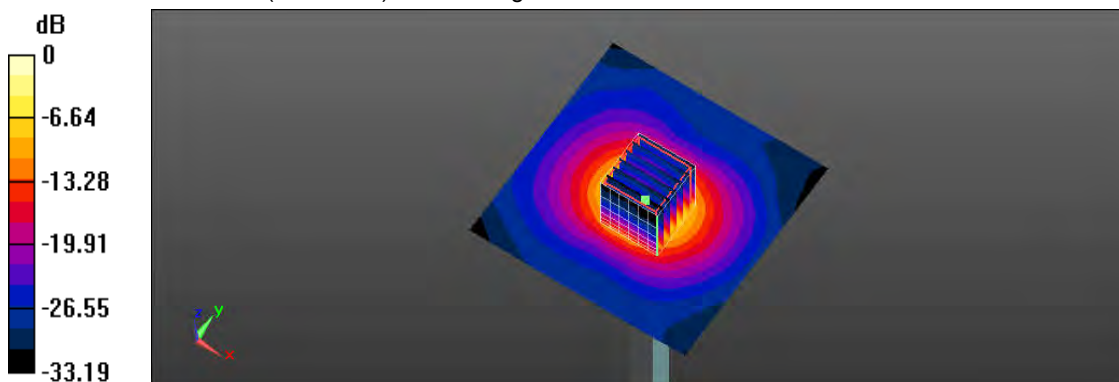
Peak SAR (extrapolated) = 36.1 W/kg

**SAR(1 g) = 8.66 W/kg; SAR(10 g) = 2.33 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.4 mm

Ratio of SAR at M2 to SAR at M1 = 63.5%

Maximum value of SAR (measured) = 22.4 W/kg



0 dB = 22.4 W/kg = 13.50 dBW/kg

Test Laboratory: A Test Lab Techno Corp.

Date: 2020/2/12

System Performance Check at 5750MHz\_20200212\_Head

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1021**

Communication System: UID 0, CW (0); Frequency: 5750 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 5750 \text{ MHz}$ ;  $\sigma = 5.155 \text{ S/m}$ ;  $\epsilon_r = 34.961$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3847; ConvF(4.66, 4.66, 4.66) @ 5750 MHz; Calibrated: 2019/5/16
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn541; Calibrated: 2019/3/19
- Phantom: ELI V4.0 (20deg probe tilt); Type: QD OVA 001 BB; Serial: 1036
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.10 (7331)

**System Performance Check at 5750MHz/Area Scan (91x91x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) = 20.9 W/kg

**System Performance Check at 5750MHz/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 72.47 V/m; Power Drift = -0.04 dB

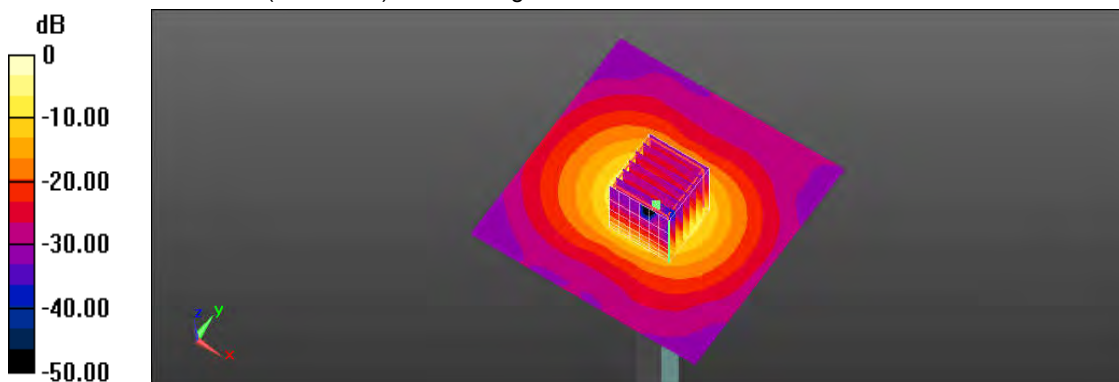
Peak SAR (extrapolated) = 36.9 W/kg

**SAR(1 g) = 8.32 W/kg; SAR(10 g) = 2.22 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 62.2%

Maximum value of SAR (measured) = 22.4 W/kg



0 dB = 22.4 W/kg = 13.50 dBW/kg

## Appendix B - SAR Measurement Data

Test Laboratory: A Test Lab Techno Corp.

Date: 2020/2/13

25\_IEEE 802.11b CH11\_1M\_Side 2\_0mm

**DUT: TG200; Type: Handheld Tablet**

Communication System: UID 0, IEEE 802.11b (0); Frequency: 2462 MHz; Duty Cycle: 1:1.001

Medium parameters used:  $f = 2462$  MHz;  $\sigma = 1.779$  S/m;  $\epsilon_r = 39.35$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3847; ConvF(7.14, 7.14, 7.14) @ 2462 MHz; Calibrated: 2019/5/16
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn541; Calibrated: 2019/3/19
- Phantom: ELI V4.0 (20deg probe tilt); Type: QD OVA 001 BB; Serial: 1036
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.10 (7331)

**Area Scan (41x131x1):** Interpolated grid:  $dx=1.200$  mm,  $dy=1.200$  mm

Maximum value of SAR (interpolated) = 0.591 W/kg

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

Reference Value = 16.30 V/m; Power Drift = -0.13 dB

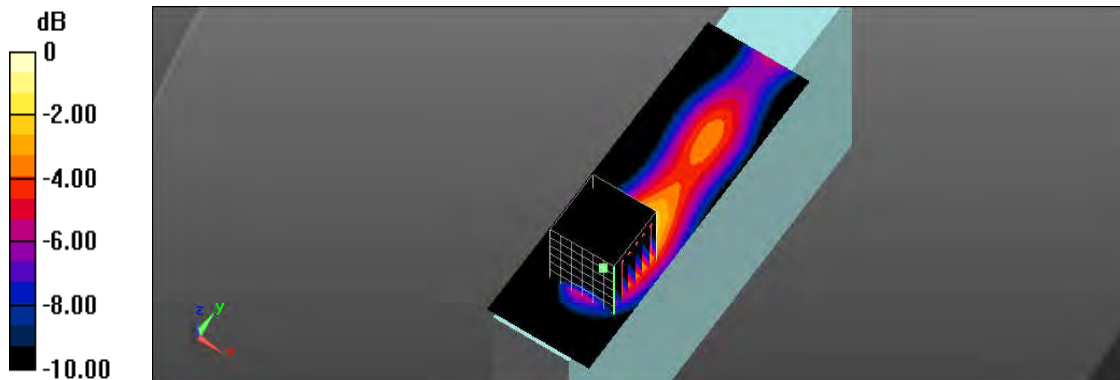
Peak SAR (extrapolated) = 0.692 W/kg

**SAR(1 g) = 0.327 W/kg; SAR(10 g) = 0.159 W/kg**

Smallest distance from peaks to all points 3 dB below = 9.8 mm

Ratio of SAR at M2 to SAR at M1 = 46.9%

Maximum value of SAR (measured) = 0.551 W/kg



0 dB = 0.551 W/kg = -2.59 dBW/kg

Test Laboratory: A Test Lab Techno Corp.

Date: 2020/2/12

04\_ IEEE 802.11a CH52\_6M\_Side 2\_0mm

**DUT: TG200; Type: Handheld Tablet**

Communication System: UID 0, IEEE 802.11a (0); Frequency: 5260 MHz; Duty Cycle: 1:1.001

Medium parameters used:  $f = 5260$  MHz;  $\sigma = 4.537$  S/m;  $\epsilon_r = 35.874$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3847; ConvF(5.22, 5.22, 5.22) @ 5260 MHz; Calibrated: 2019/5/16
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn541; Calibrated: 2019/3/19
- Phantom: ELI V4.0 (20deg probe tilt); Type: QD OVA 001 BB; Serial: 1036
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.10 (7331)

**Area Scan (51x91x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 2.32 W/kg

**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 19.66 V/m; Power Drift = -0.05 dB

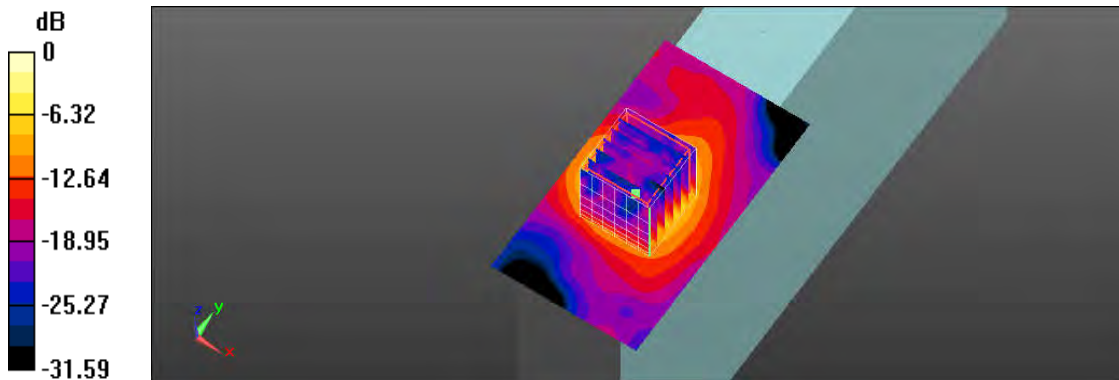
Peak SAR (extrapolated) = 3.67 W/kg

**SAR(1 g) = 0.933 W/kg; SAR(10 g) = 0.266 W/kg**

Smallest distance from peaks to all points 3 dB below = 6.9 mm

Ratio of SAR at M2 to SAR at M1 = 65.1%

Maximum value of SAR (measured) = 2.31 W/kg



0 dB = 2.31 W/kg = 3.64 dBW/kg

Test Laboratory: A Test Lab Techno Corp.

Date: 2020/2/12

10\_ IEEE 802.11ac80 CH138\_VHT0\_Side 2\_0mm

**DUT: TG200; Type: Handheld Tablet**

Communication System: UID 0, IEEE 802.11ac(5GHz)VHT80 (0); Frequency: 5530 MHz;Duty Cycle: 1:1.001

Medium parameters used:  $f = 5530 \text{ MHz}$ ;  $\sigma = 4.824 \text{ S/m}$ ;  $\epsilon_r = 35.516$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within:2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3847; ConvF(4.68, 4.68, 4.68) @ 5530 MHz; Calibrated: 2019/5/16
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn541; Calibrated: 2019/3/19
- Phantom: ELI V4.0 (20deg probe tilt); Type: QD OVA 001 BB; Serial: 1036
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.10 (7331)

**Area Scan (51x91x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) = 2.61 W/kg

**Zoom Scan (8x8x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 19.96 V/m; Power Drift = -0.15 dB

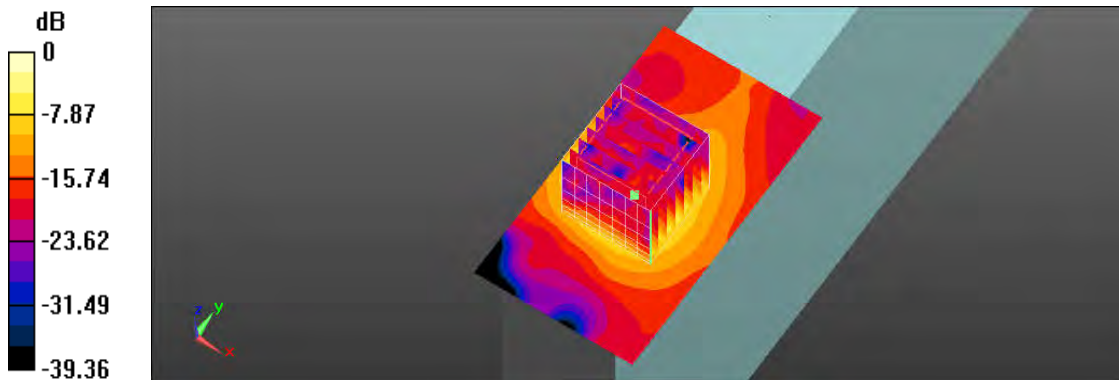
Peak SAR (extrapolated) = 4.15 W/kg

**SAR(1 g) = 1.05 W/kg; SAR(10 g) = 0.330 W/kg**

Smallest distance from peaks to all points 3 dB below = 7.9 mm

Ratio of SAR at M2 to SAR at M1 = 64.3%

Maximum value of SAR (measured) = 2.56 W/kg



0 dB = 2.56 W/kg = 4.08 dBW/kg

Test Laboratory: A Test Lab Techno Corp.

Date: 2020/2/12

19\_ IEEE 802.11a CH157\_6M\_Side 2\_0mm

**DUT: TG200; Type: Handheld Tablet**

Communication System: UID 0, IEEE 802.11a (0); Frequency: 5785 MHz; Duty Cycle: 1:1.001

Medium parameters used:  $f = 5785 \text{ MHz}$ ;  $\sigma = 5.109 \text{ S/m}$ ;  $\epsilon_r = 34.981$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY5.2 Configuration:

- Area Scan setting - Find Secondary Maximum Within: 2.0dB and with a peak SAR value greater than 0.5 W/Kg
- Probe: EX3DV4 - SN3847; ConvF(4.66, 4.66, 4.66) @ 5785 MHz; Calibrated: 2019/5/16
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn541; Calibrated: 2019/3/19
- Phantom: ELI V4.0 (20deg probe tilt); Type: QD OVA 001 BB; Serial: 1036
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.10 (7331)

**Area Scan (51x91x1):** Interpolated grid:  $dx=1.000 \text{ mm}$ ,  $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) = 2.51 W/kg

**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=4\text{mm}$ ,  $dy=4\text{mm}$ ,  $dz=1.4\text{mm}$

Reference Value = 18.76 V/m; Power Drift = 0.04 dB

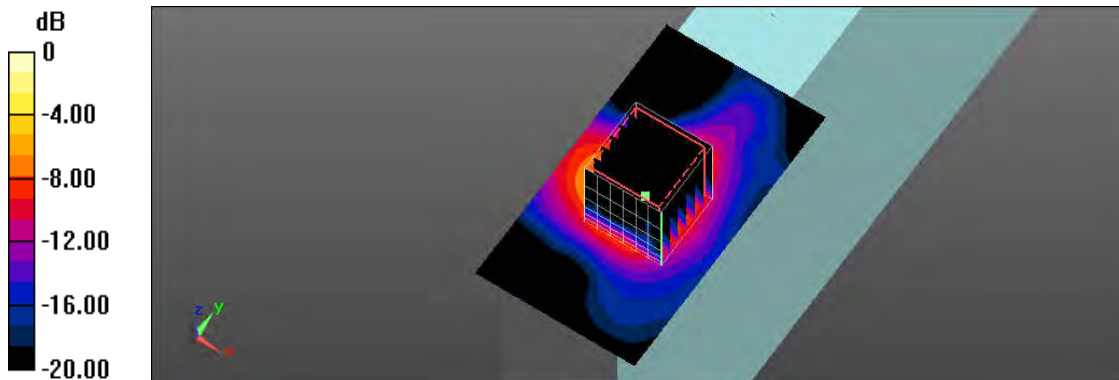
Peak SAR (extrapolated) = 4.04 W/kg

**SAR(1 g) = 0.988 W/kg; SAR(10 g) = 0.286 W/kg**

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 62.9%

Maximum value of SAR (measured) = 2.46 W/kg



0 dB = 2.46 W/kg = 3.91 dBW/kg



## ***Appendix C - Calibration***

All of the instruments Calibration information are listed below.

- Dipole \_ D2450V2 SN:712
- Dipole \_ D5GHzV2 SN:1021
- Probe \_ EX3DV4 SN:3847
- DAE \_ DAE4 SN:541



ST-002-19-082

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  中国认可  
国际互认  
校准  
CALIBRATION  
CNAS L0570

Client **ATL**

Certificate No: **Z19-60129**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 712**

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

Calibration date: **April 15, 2019**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards       | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|------------------------------------------|-----------------------|
| Power Meter NRP2        | 106277     | 20-Aug-18 (CTTL, No.J18X06862)           | Aug-19                |
| Power sensor NRP8S      | 104291     | 20-Aug-18 (CTTL, No.J18X06862)           | Aug-19                |
| Reference Probe EX3DV4  | SN 3617    | 31-Jan-19(SPEAG,No.EX3-3617_Jan19)       | Jan-20                |
| DAE4                    | SN 1331    | 06-Feb-19(SPEAG,No.DAE4-1331_Feb19)      | Feb-20                |
| Secondary Standards     | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 23-Jan-19 (CTTL, No.J19X00336)           | Jan-20                |
| NetworkAnalyzer E5071C  | MY46110673 | 24-Jan-19 (CTTL, No.J19X00547)           | Jan-20                |

|                | 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: April 20, 2019

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

Certificate No: Z19-60129

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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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### Measurement Conditions

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

|                              |                          |              |
|------------------------------|--------------------------|--------------|
| DASY Version                 | DASY52                   | 52.10.2.1495 |
| 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 | 40.4 $\pm$ 6 % | 1.85 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 | 13.1 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 52.1 W/kg $\pm$ 18.8 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | Condition          |                              |
| SAR measured                                            | 250 mW input power | 6.02 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 24.0 W/kg $\pm$ 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 | 54.3 $\pm$ 6 % | 2.01 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 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 50.5 W/kg $\pm$ 18.8 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | Condition          |                              |
| SAR measured                                            | 250 mW input power | 5.88 W/kg                    |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 23.5 W/kg $\pm$ 18.7 % (k=2) |

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E-mail: cttl@chinattl.com http://www.chinattl.cn**Appendix (Additional assessments outside the scope of CNAS L0570)****Antenna Parameters with Head TSL**

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 52.4Ω+ 3.38 jΩ |
| Return Loss                          | - 27.9dB       |

**Antenna Parameters with Body TSL**

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 47.9Ω+ 5.55 jΩ |
| Return Loss                          | - 24.4dB       |

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.022 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: 04.15.2019

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 712**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.85$  S/m;  $\epsilon_r = 40.35$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.62, 7.62, 7.62) @ 2450 MHz; Calibrated: 1/31/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2/6/2019
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

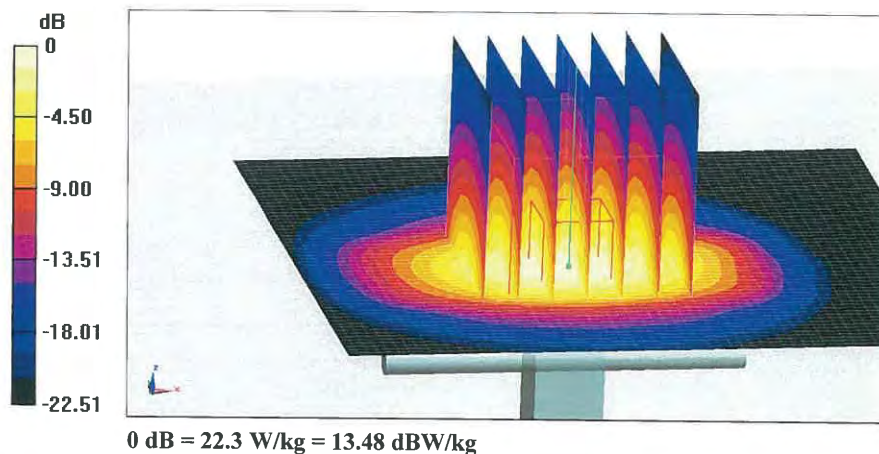
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 87.05 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 28.1 W/kg

**SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.02 W/kg**

Maximum value of SAR (measured) = 22.3 W/kg

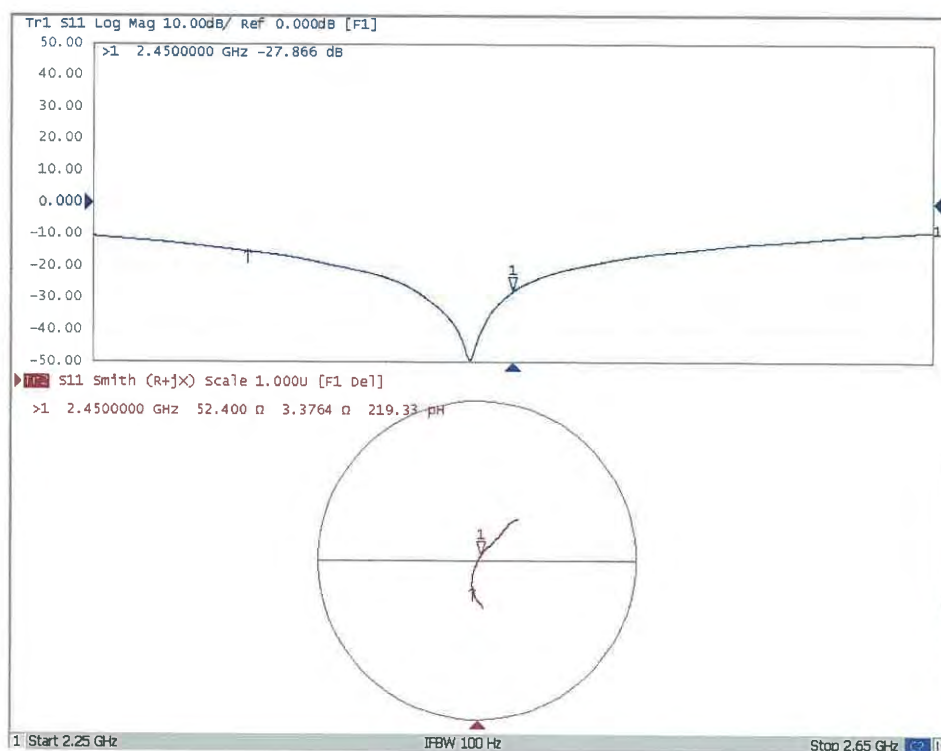




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### Impedance Measurement Plot for Head TSL





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# **DASY5 Validation Report for Body TSL**

Date: 04.15.2019

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 712**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.005$  S/m;  $\epsilon_r = 54.25$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.79, 7.79, 7.79) @ 2450 MHz; Calibrated: 1/31/2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2/6/2019
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

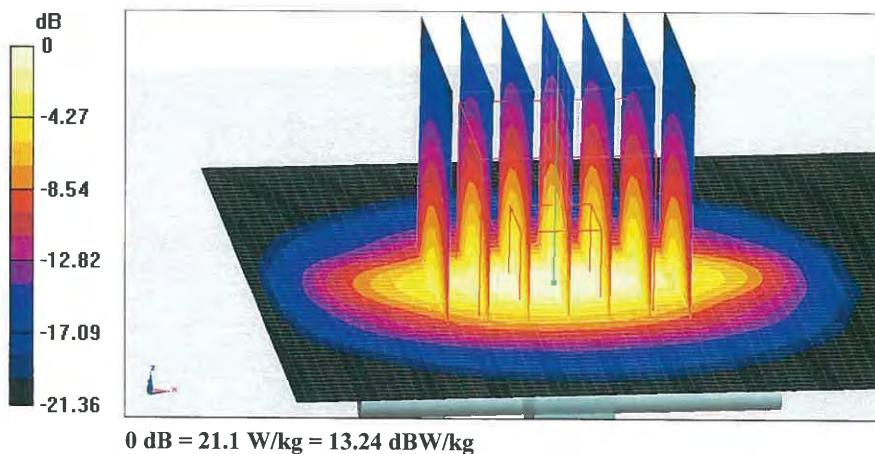
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm**

Reference Value = 94.06 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 26.5 W/kg

**SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.88 W/kg**

Maximum value of SAR (measured) = 21.1 W/kg

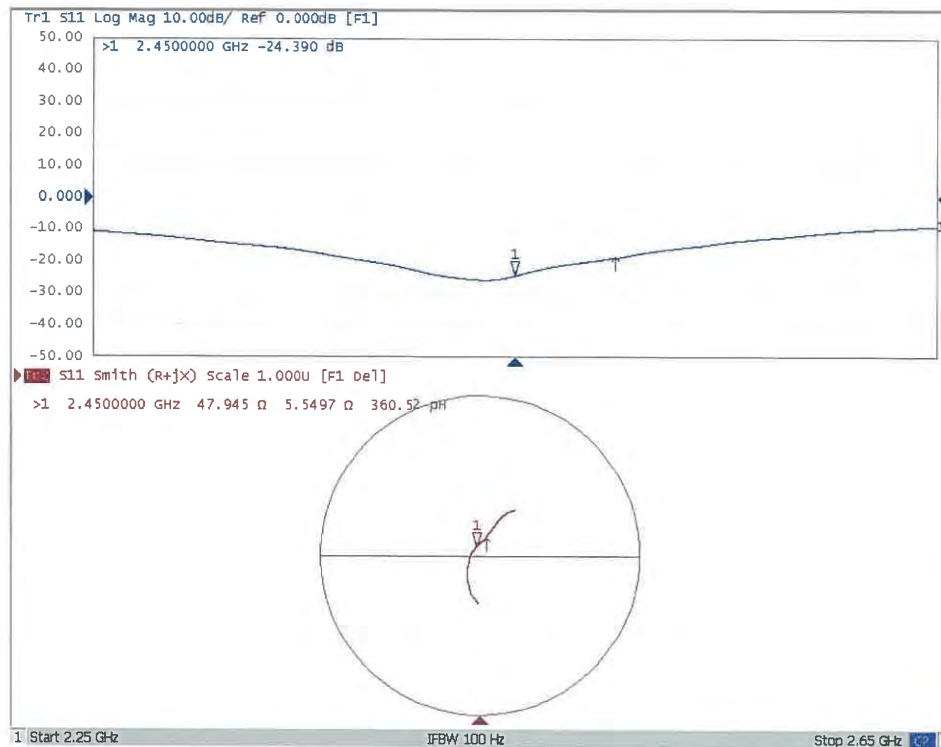




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### Impedance Measurement Plot for Body TSL





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CALIBRATION  
CNAS L0570

Client **ATL**

Certificate No: **Z19-60131**

## CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN: 1021**

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

Calibration date: **April 19, 2019**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards       | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|------------------------------------------|-----------------------|
| Power Meter NRP2        | 106277     | 20-Aug-18 (CTTL, No.J18X06862)           | Aug-19                |
| Power sensor NRP8S      | 104291     | 20-Aug-18 (CTTL, No.J18X06862)           | Aug-19                |
| ReferenceProbe EX3DV4   | SN 7514    | 27-Aug-18(SPEAG,No.EX3-7514_Aug18/2)     | Aug-19                |
| DAE4                    | SN 1331    | 06-Feb-19(SPEAG,No.DAE4-1331_Feb19)      | Feb-20                |
| Secondary Standards     | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 23-Jan-19 (CTTL, No.J19X00336)           | Jan-20                |
| NetworkAnalyzerE5071C   | MY46110673 | 24-Jan-19 (CTTL, No.J19X00547)           | Jan-20                |

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

Issued: April 25, 2019

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

Certificate No: Z19-60131

Page 1 of 14



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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:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for 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
- c) 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
- d) KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

#### Additional Documentation:

- e) DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

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

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



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### Measurement Conditions

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

|                              |                                                                      |                                  |
|------------------------------|----------------------------------------------------------------------|----------------------------------|
| DASY Version                 | DASY52                                                               | 52.10.2.1495                     |
| Extrapolation                | Advanced Extrapolation                                               |                                  |
| Phantom                      | Triple Flat Phantom 5.1C                                             |                                  |
| Distance Dipole Center - TSL | 10 mm                                                                | with Spacer                      |
| Zoom Scan Resolution         | dx, dy = 4 mm, dz = 1.4 mm                                           | Graded Ratio = 1.4 (Z direction) |
| Frequency                    | 5250 MHz $\pm$ 1 MHz<br>5600 MHz $\pm$ 1 MHz<br>5750 MHz $\pm$ 1 MHz |                                  |

### Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 35.9           | 4.71 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 34.9 $\pm$ 6 % | 4.58 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | <1.0 °C             | ----           | ----                 |

### SAR result with Head TSL at 5250 MHz

|                                                         |                    |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL   | Condition          |                              |
| SAR measured                                            | 100 mW input power | 7.66 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 76.1 W/kg $\pm$ 24.4 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | Condition          |                              |
| SAR measured                                            | 100 mW input power | 2.18 W/kg                    |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 21.6 W/kg $\pm$ 24.2 % (k=2) |



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#### Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Head TSL parameters             | 22.0 °C         | 35.5         | 5.07 mho/m       |
| Measured Head TSL parameters            | (22.0 ± 0.2) °C | 34.5 ± 6 %   | 4.92 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C         | ----         | ----             |

#### SAR result with Head TSL at 5600 MHz

|                                                         |                    |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL   | Condition          |                          |
| SAR measured                                            | 100 mW input power | 8.16 W/kg                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 81.0 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | Condition          |                          |
| SAR measured                                            | 100 mW input power | 2.29 W/kg                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 22.7 W/kg ± 24.2 % (k=2) |

#### Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Head TSL parameters             | 22.0 °C         | 35.4         | 5.22 mho/m       |
| Measured Head TSL parameters            | (22.0 ± 0.2) °C | 34.4 ± 6 %   | 5.07 mho/m ± 6 % |
| Head TSL temperature change during test | <1.0 °C         | ----         | ----             |

#### SAR result with Head TSL at 5750 MHz

|                                                         |                    |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL   | Condition          |                          |
| SAR measured                                            | 100 mW input power | 7.66 W/kg                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 76.1 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | Condition          |                          |
| SAR measured                                            | 100 mW input power | 2.15 W/kg                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 21.3 W/kg ± 24.2 % (k=2) |



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### Body TSL parameters at 5250 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 48.9         | 5.36 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 50.3 ± 6 %   | 5.49 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C         | ----         | ----             |

### SAR result with Body TSL at 5250 MHz

|                                                         |                    |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL   | Condition          |                          |
| SAR measured                                            | 100 mW input power | 7.39 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 74.4 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | Condition          |                          |
| SAR measured                                            | 100 mW input power | 2.09 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 21.1 W/kg ± 24.2 % (k=2) |

### Body TSL parameters at 5600 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 48.5         | 5.77 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 49.9 ± 6 %   | 5.94 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C         | ----         | ----             |

### SAR result with Body TSL at 5600 MHz

|                                                         |                    |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL   | Condition          |                          |
| SAR measured                                            | 100 mW input power | 7.65 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 77.0 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | Condition          |                          |
| SAR measured                                            | 100 mW input power | 2.16 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 21.8 W/kg ± 24.2 % (k=2) |



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### Body TSL parameters at 5750 MHz

The following parameters and calculations were applied.

|                                         | Temperature     | Permittivity | Conductivity     |
|-----------------------------------------|-----------------|--------------|------------------|
| Nominal Body TSL parameters             | 22.0 °C         | 48.3         | 5.94 mho/m       |
| Measured Body TSL parameters            | (22.0 ± 0.2) °C | 49.7 ± 6 %   | 6.11 mho/m ± 6 % |
| Body TSL temperature change during test | <1.0 °C         | ----         | ----             |

### SAR result with Body TSL at 5750 MHz

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL   | Condition          |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR measured                                            | 100 mW input power | 7.41 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 74.6 W/kg ± 24.4 % (k=2) |
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | Condition          |                          |
| SAR measured                                            | 100 mW input power | 2.08 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 21.0 W/kg ± 24.2 % (k=2) |



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

### Antenna Parameters with Head TSL at 5250 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 51.9Ω - 4.22jΩ |
| Return Loss                          | - 26.9dB       |

### Antenna Parameters with Head TSL at 5600 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 58.4Ω - 0.27jΩ |
| Return Loss                          | - 22.2dB       |

### Antenna Parameters with Head TSL at 5750 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 56.7Ω + 1.19jΩ |
| Return Loss                          | - 23.9dB       |

### Antenna Parameters with Body TSL at 5250 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 52.3Ω - 2.82jΩ |
| Return Loss                          | - 28.9dB       |

### Antenna Parameters with Body TSL at 5600 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 58.7Ω + 1.14jΩ |
| Return Loss                          | - 21.8dB       |

### Antenna Parameters with Body TSL at 5750 MHz

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 57.5Ω + 1.49jΩ |
| Return Loss                          | - 23.0dB       |



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### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.064 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: 04.17.2019

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1021**

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz,  
Frequency: 5750 MHz,

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 4.576$  S/m;  $\epsilon_r = 34.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>,  
Medium parameters used:  $f = 5600$  MHz;  $\sigma = 4.923$  S/m;  $\epsilon_r = 34.46$ ;  $\rho = 1000$   
kg/m<sup>3</sup>, Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.066$  S/m;  $\epsilon_r = 34.4$ ;  $\rho =$   
1000 kg/m<sup>3</sup>,

Phantom section: Center Section

#### DASY5 Configuration:

- Probe: EX3DV4 - SN7514; ConvF(5.02, 5.02, 5.02) @ 5250 MHz; Calibrated: 8/27/2018, ConvF(4.41, 4.41, 4.41) @ 5600 MHz; Calibrated: 8/27/2018, ConvF(4.47, 4.47, 4.47) @ 5750 MHz; Calibrated: 8/27/2018,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2/6/2019
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

#### Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan,

**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 70.41 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 33.3 W/kg

**SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.18 W/kg**

Maximum value of SAR (measured) = 18.1 W/kg

#### Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan,

**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 61.17 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 38.8 W/kg

**SAR(1 g) = 8.16 W/kg; SAR(10 g) = 2.29 W/kg**

Maximum value of SAR (measured) = 21.0 W/kg

#### Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan,

**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 63.86 V/m; Power Drift = 0.03 dB

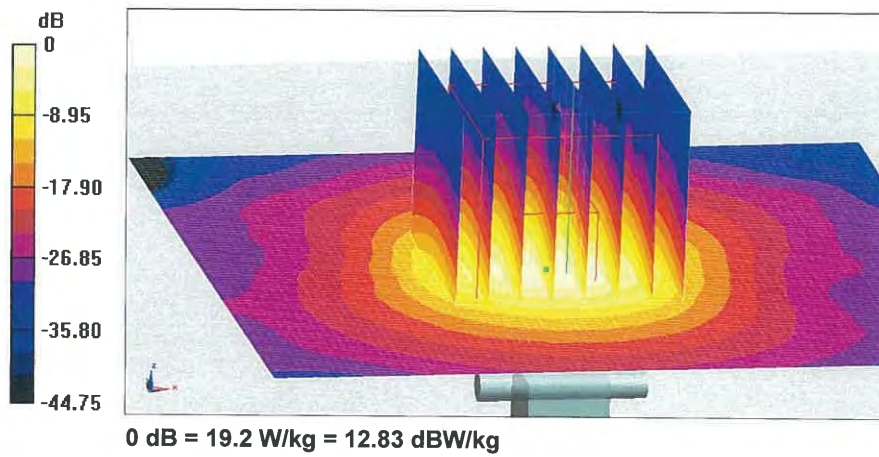
Peak SAR (extrapolated) = 38.0 W/kg

**SAR(1 g) = 7.66 W/kg; SAR(10 g) = 2.15 W/kg**

Maximum value of SAR (measured) = 19.2 W/kg



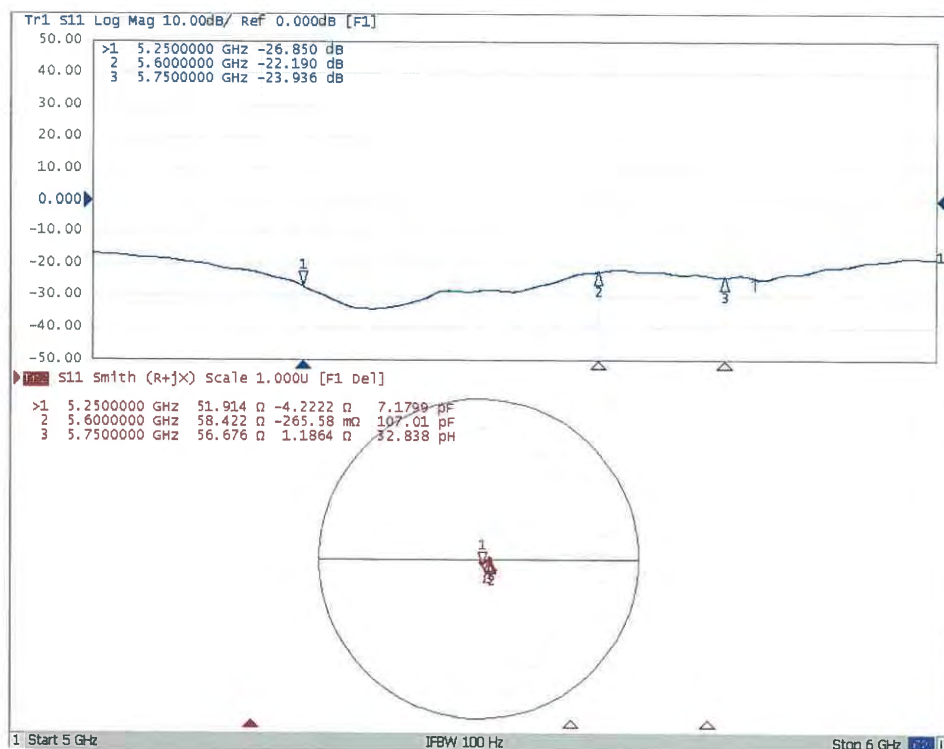
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### Impedance Measurement Plot for Head TSL





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**DASY5 Validation Report for Body TSL**

Date: 04.19.2019

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1021**

Communication System: CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz,

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 5.492$  S/m;  $\epsilon_r = 50.32$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.937$  S/m;  $\epsilon_r = 49.85$ ;  $\rho = 1000$  kg/m<sup>3</sup>, Medium parameters used:  $f = 5750$  MHz;  $\sigma = 6.109$  S/m;  $\epsilon_r = 49.74$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Phantom section: Right Section

**DASY5 Configuration:**

- Probe: EX3DV4 - SN7514; ConvF(4.54, 4.54, 4.54) @ 5250 MHz; Calibrated: 8/27/2018, ConvF(4, 4, 4) @ 5600 MHz; Calibrated: 8/27/2018, ConvF(3.98, 3.98, 3.98) @ 5750 MHz; Calibrated: 8/27/2018,
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1331; Calibrated: 2/6/2019
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Dipole Calibration /Pin=100mW, d=10mm, f=5250 MHz/Zoom Scan,****dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 58.99 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 29.9 W/kg

**SAR(1 g) = 7.39 W/kg; SAR(10 g) = 2.09 W/kg**

Maximum value of SAR (measured) = 17.3 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan,****dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 54.86 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 35.6 W/kg

**SAR(1 g) = 7.65 W/kg; SAR(10 g) = 2.16 W/kg**

Maximum value of SAR (measured) = 19.2 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5750 MHz/Zoom Scan,****dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 55.96 V/m; Power Drift = 0.02 dB

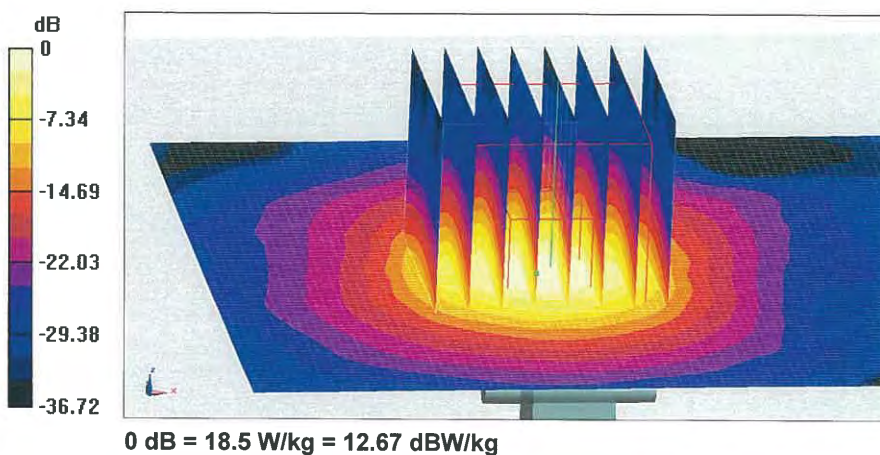
Peak SAR (extrapolated) = 35.0 W/kg

**SAR(1 g) = 7.41 W/kg; SAR(10 g) = 2.08 W/kg**

Maximum value of SAR (measured) = 18.5 W/kg



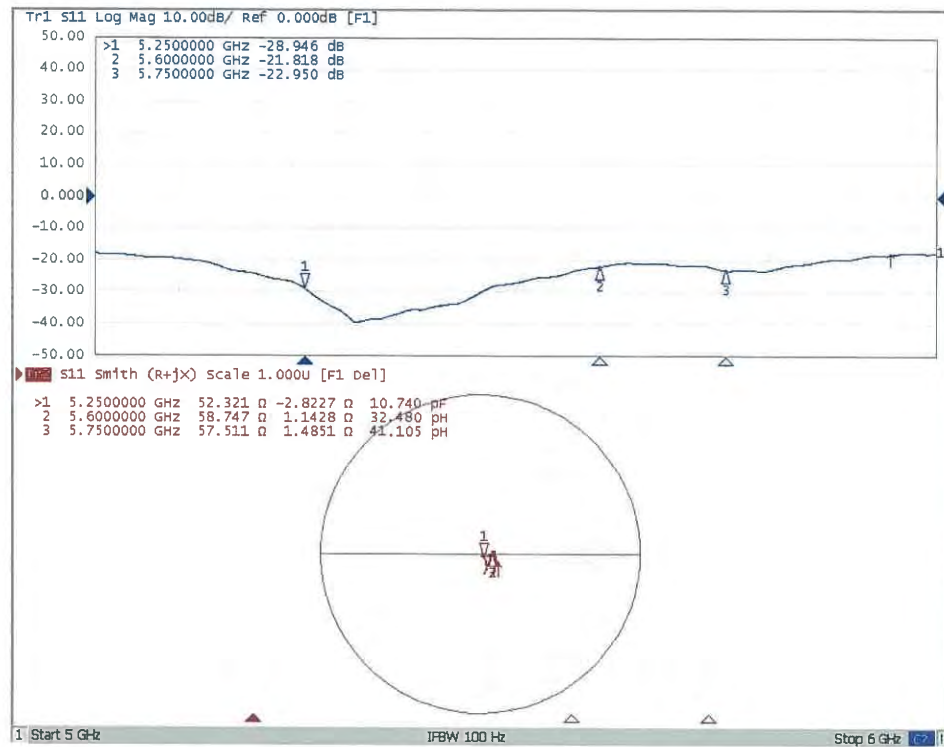
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### Impedance Measurement Plot for Body TSL




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CALIBRATION  
CNAS L0570

Client **ATL**

Certificate No: **Z19-60136**

## CALIBRATION CERTIFICATE

Object **EX-045-19-119**
**EX3DV4 - SN:3847**

Calibration Procedure(s)

**FF-Z11-004-01**
**Calibration Procedures for Dosimetric E-field Probes**

Calibration date:

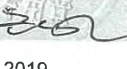
**May 16, 2019**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards       | ID #        | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|-------------|------------------------------------------|-----------------------|
| Power Meter NRP2        | 101919      | 20-Jun-18 (CTTL, No.J18X05032)           | Jun-19                |
| Power sensor NRP-Z91    | 101547      | 20-Jun-18 (CTTL, No.J18X05032)           | Jun-19                |
| Power sensor NRP-Z91    | 101548      | 20-Jun-18 (CTTL, No.J18X05032)           | Jun-19                |
| 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 7514     | 27-Aug-18(SPEAG,No.EX3-7514_Aug18/2)     | Aug-19                |
| DAE4                    | SN 1555     | 20-Aug-18(SPEAG, No.DAE4-1555_Aug18)     | Aug -19               |
| Secondary Standards     | ID #        | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| SignalGeneratorMG3700A  | 6201052605  | 21-Jun-18 (CTTL, No.J18X05033)           | Jun-19                |
| Network Analyzer E5071C | MY46110673  | 24-Jan-19 (CTTL, No.J19X00547)           | Jan -20               |

|                | 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 18, 2019

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Certificate No: Z19-60136

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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), $\theta=0$ 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  $\theta=0$  ( $f \leq 900\text{MHz}$  in TEM-cell;  $f > 1800\text{MHz}$ : 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.
- DCPx,y,z**: DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- 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  $f \leq 800\text{MHz}$ ) and inside waveguide using analytical field distributions based on power measurements for  $f > 800\text{MHz}$ . The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<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  $\pm 50\text{MHz}$  to  $\pm 100\text{MHz}$ .
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).



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# Probe EX3DV4

SN: 3847

Calibrated: May 16, 2019

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)



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## DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3847

### Basic Calibration Parameters

|                                      | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|--------------------------------------|----------|----------|----------|-----------|
| Norm( $\mu V/(V/m)^2$ ) <sup>A</sup> | 0.55     | 0.50     | 0.44     | ±10.0%    |
| DCP(mV) <sup>B</sup>                 | 98.3     | 99.1     | 102.0    |           |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A dB | B dB/μV | C   | D dB | VR mV | Unc <sup>E</sup> (k=2) |
|-----|---------------------------|---|------|---------|-----|------|-------|------------------------|
| 0   | CW                        | X | 0.0  | 0.0     | 1.0 | 0.00 | 176.8 | ±2.2%                  |
|     |                           | Y | 0.0  | 0.0     | 1.0 |      | 168.2 |                        |
|     |                           | Z | 0.0  | 0.0     | 1.0 |      | 156.2 |                        |

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: 3847

### 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                            | 9.67    | 9.67    | 9.67    | 0.17               | 1.19                    | ± 12.1%     |
| 835                  | 41.5                               | 0.90                            | 9.35    | 9.35    | 9.35    | 0.16               | 1.18                    | ± 12.1%     |
| 900                  | 41.5                               | 0.97                            | 9.29    | 9.29    | 9.29    | 0.17               | 1.17                    | ± 12.1%     |
| 1750                 | 40.1                               | 1.37                            | 8.15    | 8.15    | 8.15    | 0.26               | 1.02                    | ± 12.1%     |
| 1900                 | 40.0                               | 1.40                            | 7.72    | 7.72    | 7.72    | 0.29               | 0.93                    | ± 12.1%     |
| 2000                 | 40.0                               | 1.40                            | 7.93    | 7.93    | 7.93    | 0.24               | 1.18                    | ± 12.1%     |
| 2300                 | 39.5                               | 1.67                            | 7.52    | 7.52    | 7.52    | 0.59               | 0.72                    | ± 12.1%     |
| 2450                 | 39.2                               | 1.80                            | 7.14    | 7.14    | 7.14    | 0.61               | 0.72                    | ± 12.1%     |
| 2600                 | 39.0                               | 1.96                            | 7.11    | 7.11    | 7.11    | 0.69               | 0.69                    | ± 12.1%     |
| 3500                 | 37.9                               | 2.91                            | 6.61    | 6.61    | 6.61    | 0.60               | 1.05                    | ± 13.3%     |
| 3700                 | 37.7                               | 3.12                            | 6.51    | 6.51    | 6.51    | 0.60               | 0.90                    | ± 13.3%     |
| 5250                 | 35.9                               | 4.71                            | 5.22    | 5.22    | 5.22    | 0.50               | 1.30                    | ± 13.3%     |
| 5600                 | 35.5                               | 5.07                            | 4.68    | 4.68    | 4.68    | 0.55               | 1.22                    | ± 13.3%     |
| 5750                 | 35.4                               | 5.22                            | 4.66    | 4.66    | 4.66    | 0.55               | 1.25                    | ± 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: 3847

### 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                            | 9.58    | 9.58    | 9.58    | 0.40               | 0.80                    | ± 12.1%     |
| 835                  | 55.2                               | 0.97                            | 9.33    | 9.33    | 9.33    | 0.17               | 1.42                    | ± 12.1%     |
| 900                  | 55.0                               | 1.05                            | 9.30    | 9.30    | 9.30    | 0.26               | 1.16                    | ± 12.1%     |
| 1750                 | 53.4                               | 1.49                            | 7.84    | 7.84    | 7.84    | 0.23               | 1.13                    | ± 12.1%     |
| 1900                 | 53.3                               | 1.52                            | 7.61    | 7.61    | 7.61    | 0.23               | 1.12                    | ± 12.1%     |
| 2000                 | 53.3                               | 1.52                            | 7.56    | 7.56    | 7.56    | 0.24               | 1.17                    | ± 12.1%     |
| 2300                 | 52.9                               | 1.81                            | 7.41    | 7.41    | 7.41    | 0.58               | 0.80                    | ± 12.1%     |
| 2450                 | 52.7                               | 1.95                            | 7.37    | 7.37    | 7.37    | 0.68               | 0.72                    | ± 12.1%     |
| 2600                 | 52.5                               | 2.16                            | 7.20    | 7.20    | 7.20    | 0.68               | 0.70                    | ± 12.1%     |
| 3500                 | 51.3                               | 3.31                            | 6.47    | 6.47    | 6.47    | 0.55               | 1.03                    | ± 13.3%     |
| 3700                 | 51.0                               | 3.55                            | 6.35    | 6.35    | 6.35    | 0.55               | 0.98                    | ± 13.3%     |
| 5250                 | 48.9                               | 5.36                            | 4.80    | 4.80    | 4.80    | 0.50               | 1.46                    | ± 13.3%     |
| 5600                 | 48.5                               | 5.77                            | 4.11    | 4.11    | 4.11    | 0.55               | 1.60                    | ± 13.3%     |
| 5750                 | 48.3                               | 5.94                            | 4.15    | 4.15    | 4.15    | 0.55               | 1.45                    | ± 13.3%     |

<sup>C</sup> Frequency validity above 300 MHz of  $\pm 100$  MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to  $\pm 50$  MHz. 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  $\pm 10, 25, 40, 50$  and  $70$  MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to  $\pm 110$  MHz.

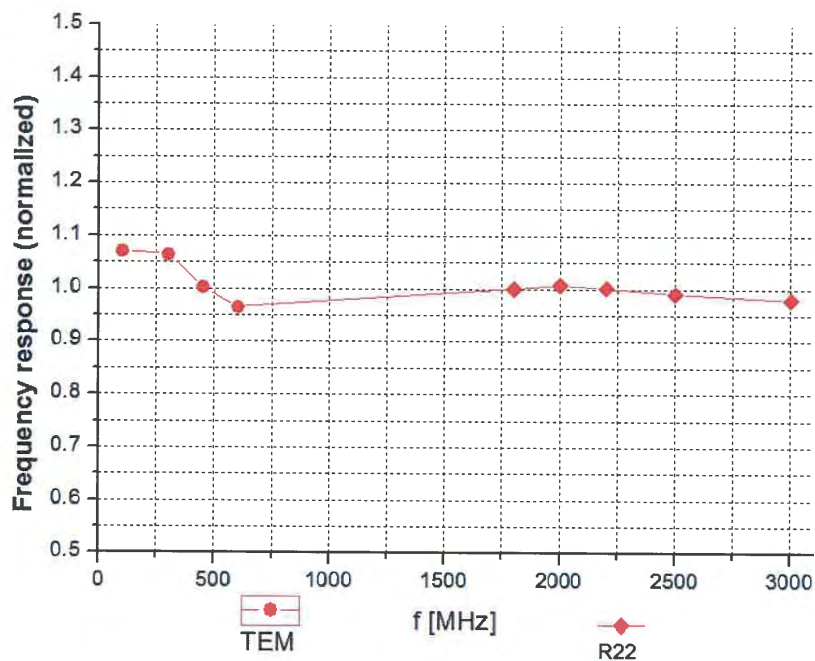
<sup>F</sup> At frequency below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to  $\pm 10\%$  if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to  $\pm 5\%$ . 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  $\pm 1\%$  for frequencies below 3 GHz and below  $\pm 2\%$  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)

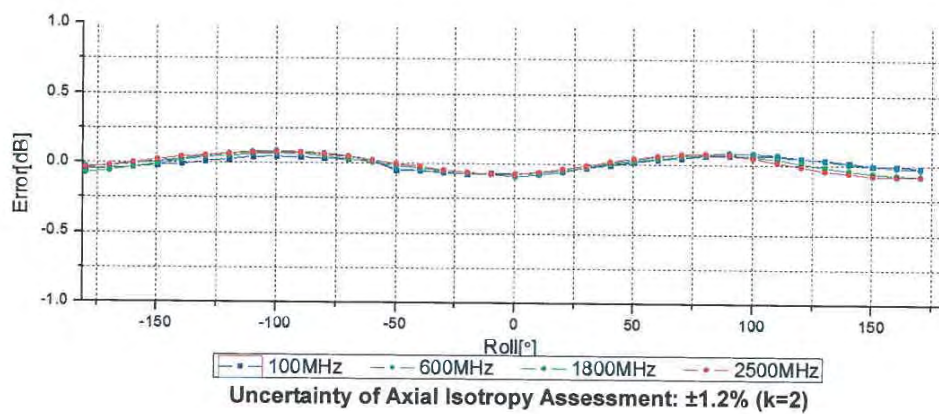
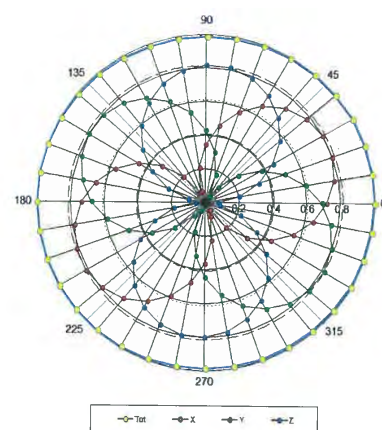
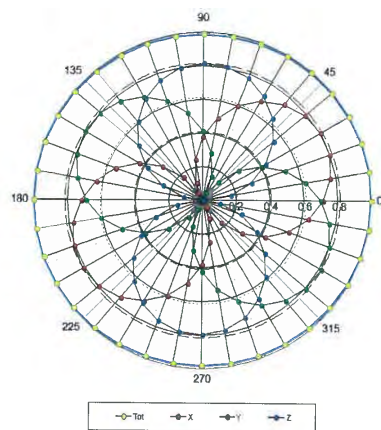


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## Receiving Pattern ( $\Phi$ ), $\theta=0^\circ$

**f=600 MHz, TEM**

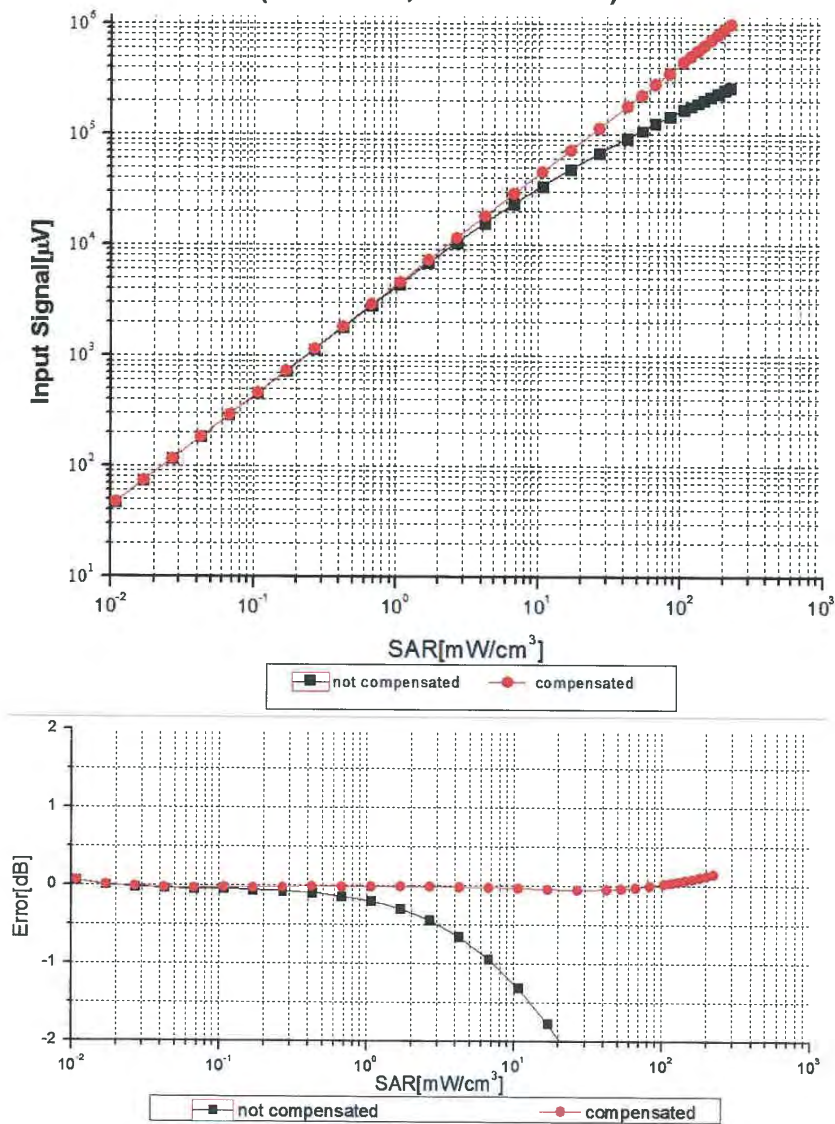
**f=1800 MHz, R22**





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



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

Certificate No: Z19-60136

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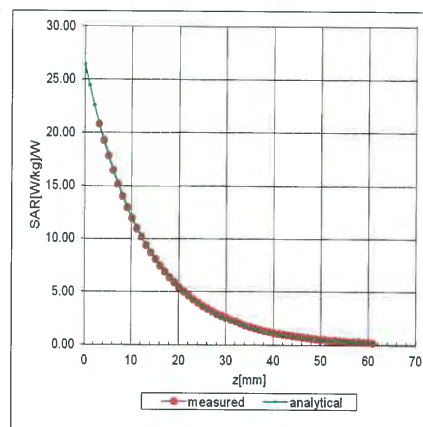
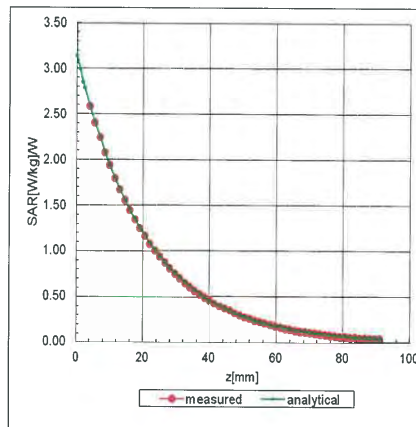


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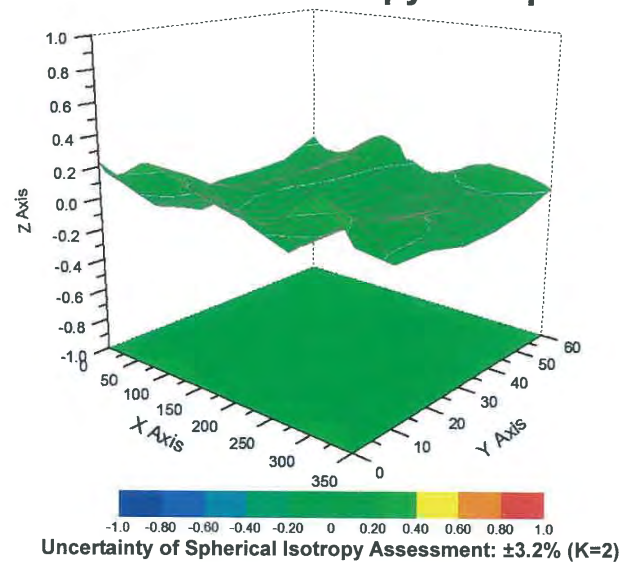
## Conversion Factor Assessment

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: 3847

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | 101.2      |
| 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      |



MR-008-19-056



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## CALIBRATION CERTIFICATE

Object: **DAE4 - SN: 541**

Calibration Procedure(s): **FF-Z11-002-01**  
**Calibration Procedure for the Data Acquisition Electronics (DAEx)**

Calibration date: **March 19, 2019**

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

Issued: March 20, 2019

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**Glossary:**

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

**Methods Applied and Interpretation of Parameters:**

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



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### DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1 $\mu$ V, full range = -100...+300 mV

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

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

| Calibration Factors | X                         | Y                         | Z                         |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range          | 404.544 $\pm$ 0.15% (k=2) | 404.406 $\pm$ 0.15% (k=2) | 404.170 $\pm$ 0.15% (k=2) |
| Low Range           | 3.96863 $\pm$ 0.7% (k=2)  | 3.93444 $\pm$ 0.7% (k=2)  | 3.97515 $\pm$ 0.7% (k=2)  |

### Connector Angle

|                                           |                  |
|-------------------------------------------|------------------|
| Connector Angle to be used in DASY system | 288.5° $\pm$ 1 ° |
|-------------------------------------------|------------------|