



# FCC SAR TEST REPORT

FCC ID : QXO-AP510I  
Equipment : 802.11ax Access Point  
Brand Name : Extreme Networks  
Model Name : AP560i  
Applicant : Extreme Networks, Inc.  
6480 Via Del Oro, San Jose, CA 95119  
Manufacturer : Extreme Networks, Inc.  
6480 Via Del Oro, San Jose, CA 95119  
Standard : FCC 47 CFR Part 2 (2.1093)  
ANSI/IEEE C95.1-1992  
IEEE 1528-2013

The product was received on Mar. 14, 2019 and testing was started from Apr. 11, 2019 and completed on Apr. 18, 2019. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.

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Approved by: Cona Huang / Deputy Manager

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## History of this test report

| Report No.  | Version | Description             | Issued Date   |
|-------------|---------|-------------------------|---------------|
| FA8O1739-08 | 01      | Initial issue of report | Jul. 02, 2019 |
|             |         |                         |               |
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## 1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for Extreme Networks, Inc., 802.11ax Access Point, AP560i, are as follows.

| Equipment Class  | Frequency Band | Highest SAR Summary           | Highest Simultaneous Transmission<br>10g SAR (W/kg) |
|------------------|----------------|-------------------------------|-----------------------------------------------------|
|                  |                | Extremity<br>(Separation 0mm) |                                                     |
|                  |                | 10g SAR (W/kg)                |                                                     |
| DTS              | 2.4GHz WLAN    | 0.58                          | 2.62                                                |
| NII              | 5GHz WLAN      | 2.89                          | 3.25                                                |
| DSS              | Bluetooth      | < 0.01                        | 3.25                                                |
| DSS              | Thread         | 0.01                          | 3.25                                                |
| Date of Testing: |                | 2019/4/11 ~ 2019/4/18         |                                                     |

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 1190) and the FCC designation No. TW1190 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC test.. This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (4.0 W/kg for Extremity 10g SAR) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013 and FCC KDB publications

**Reviewed by: Jason Wang**

**Report Producer: Wan Liu**

## 2. Guidance Applied

The Specific Absorption Rate (SAR) testing specification, method, and procedure for this device is in accordance with the following standards:

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2013
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB 865664 D02 SAR Reporting v01r02
- FCC KDB 447498 D01 General RF Exposure Guidance v06
- FCC KDB 248227 D01 802.11 Wi-Fi SAR v02r02

### **3. Equipment Under Test (EUT) Information**

#### **3.1 General Information**

| Product Feature & Specification                                  |                                                                                                                                                                                                                                                                            |
|------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Equipment Name                                                   | 802.11ax Access Point                                                                                                                                                                                                                                                      |
| Brand Name                                                       | Extreme Networks                                                                                                                                                                                                                                                           |
| Model Name                                                       | AP560i                                                                                                                                                                                                                                                                     |
| FCC ID                                                           | QXO-AP510I                                                                                                                                                                                                                                                                 |
| Wireless Technology and Frequency Range                          | WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz<br>WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz<br>WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz<br>WLAN 5.5GHz Band: 5500 MHz ~ 5720 MHz<br>WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz<br>Bluetooth: 2402 MHz ~ 2480 MHz<br>Thread: 2405 MHz ~ 2480 MHz |
| Mode                                                             | WLAN 2.4GHz : 802.11b/g/ax HEW20/HEW40<br>WLAN 5GHz : 802.11a/n/ax HEW20/HEW40/HEW80<br>Bluetooth LE<br>Thread: O-QPSK                                                                                                                                                     |
| EUT Stage                                                        | Identical Prototype                                                                                                                                                                                                                                                        |
| <b>Remark:</b>                                                   |                                                                                                                                                                                                                                                                            |
| 1. The EUT has three radios, the information as following table. |                                                                                                                                                                                                                                                                            |

| Radio | Function    |           |                    |
|-------|-------------|-----------|--------------------|
|       | WLAN 2.4GHz | WLAN 5GHz | Bluetooth / Thread |
| 1     | V           | V         | -                  |
| 2     | -           | V         | -                  |
| 3     | -           | -         | V                  |



## 4. RF Exposure Limits

### 4.1 Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

### 4.2 Controlled Environment

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). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. The exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

**Limits for Occupational/Controlled Exposure (W/kg)**

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|------------|--------------|--------------------------------|
| 0.4        | 8.0          | 20.0                           |

**Limits for General Population/Uncontrolled Exposure (W/kg)**

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|------------|--------------|--------------------------------|
| 0.08       | 1.6          | 4.0                            |

1. Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

## **5. Specific Absorption Rate (SAR)**

### **5.1 Introduction**

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

### **5.2 SAR Definition**

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

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

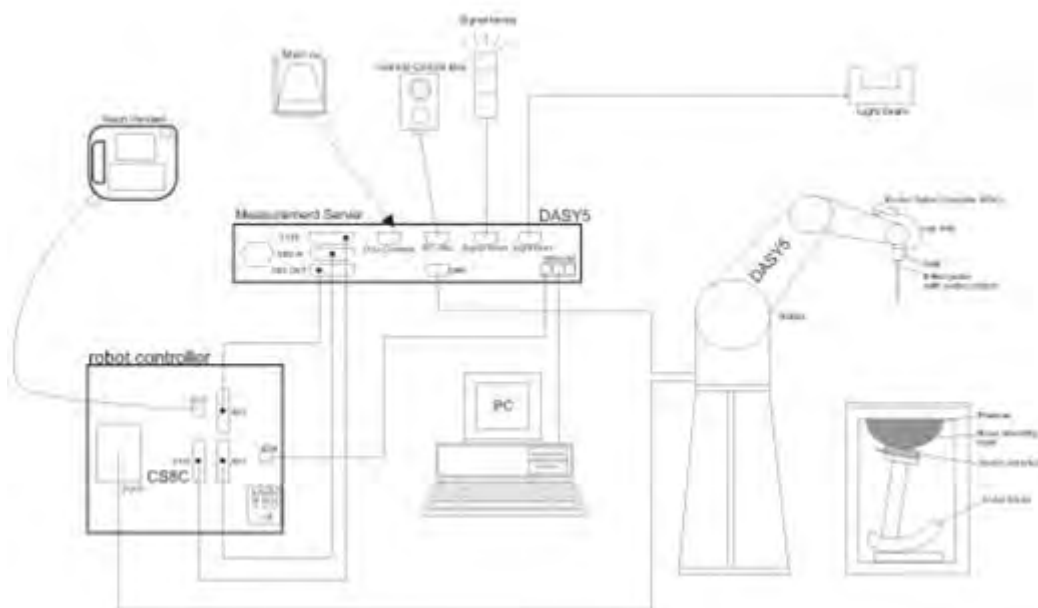
SAR is expressed in units of Watts per kilogram (W/kg)

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

Where:  $\sigma$  is the conductivity of the tissue,  $\rho$  is the mass density of the tissue and E is the RMS electrical field strength.

## 6. System Description and Setup

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



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## 6.1 E-Field Probe

The SAR measurement is conducted with the dosimetric probe (manufactured by SPEAG). The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. This probe has a built in optical surface detection system to prevent from collision with phantom.

### <ES3DV3 Probe>

|                      |                                                                                                                                                                                  |                                                                                    |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>Construction</b>  | Symmetric design with triangular core<br>Interleaved sensors<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |  |
| <b>Frequency</b>     | 10 MHz – 4 GHz;<br>Linearity: $\pm 0.2$ dB (30 MHz – 4 GHz)                                                                                                                      |                                                                                    |
| <b>Directivity</b>   | $\pm 0.2$ dB in TSL (rotation around probe axis)<br>$\pm 0.3$ dB in TSL (rotation normal to probe axis)                                                                          |                                                                                    |
| <b>Dynamic Range</b> | 5 $\mu$ W/g – >100 mW/g;<br>Linearity: $\pm 0.2$ dB                                                                                                                              |                                                                                    |
| <b>Dimensions</b>    | Overall length: 337 mm (tip: 20 mm)<br>Tip diameter: 3.9 mm (body: 12 mm)<br>Distance from probe tip to dipole centers: 3.0 mm                                                   |                                                                                    |

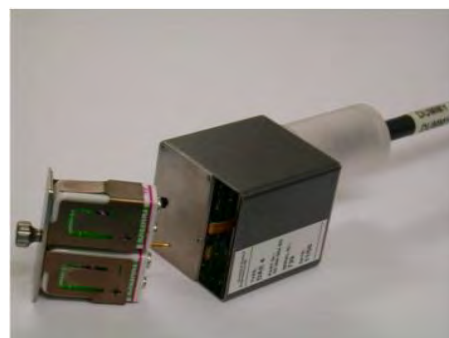
### <EX3DV4 Probe>

|                      |                                                                                                                                                           |                                                                                     |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Construction</b>  | Symmetric design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |  |
| <b>Frequency</b>     | 10 MHz – >6 GHz<br>Linearity: $\pm 0.2$ dB (30 MHz – 6 GHz)                                                                                               |                                                                                     |
| <b>Directivity</b>   | $\pm 0.3$ dB in TSL (rotation around probe axis)<br>$\pm 0.5$ dB in TSL (rotation normal to probe axis)                                                   |                                                                                     |
| <b>Dynamic Range</b> | 10 $\mu$ W/g – >100 mW/g<br>Linearity: $\pm 0.2$ dB (noise: typically <1 $\mu$ W/g)                                                                       |                                                                                     |
| <b>Dimensions</b>    | 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                      |                                                                                     |

## 6.2 Data Acquisition Electronics (DAE)

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

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



**Fig 5.1 Photo of DAE**

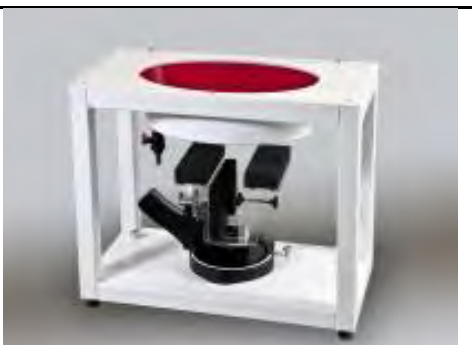
### 6.3 Phantom

#### <SAM Twin Phantom>

|                          |                                                         |                                                                                    |
|--------------------------|---------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>Shell Thickness</b>   | 2 ± 0.2 mm;<br>Center ear point: 6 ± 0.2 mm             |  |
| <b>Filling Volume</b>    | Approx. 25 liters                                       |                                                                                    |
| <b>Dimensions</b>        | Length: 1000 mm; Width: 500 mm; Height: adjustable feet |                                                                                    |
| <b>Measurement Areas</b> | Left Hand, Right Hand, Flat Phantom                     |                                                                                    |

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

#### <ELI Phantom>

|                        |                                                  |                                                                                     |
|------------------------|--------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Shell Thickness</b> | 2 ± 0.2 mm (sagging: <1%)                        |  |
| <b>Filling Volume</b>  | Approx. 30 liters                                |                                                                                     |
| <b>Dimensions</b>      | Major ellipse axis: 600 mm<br>Minor axis: 400 mm |                                                                                     |

The ELI phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with standard and all known tissue simulating liquids.

## **6.4 Device Holder**

### **<Mounting Device for Hand-Held Transmitter>**

In combination with the Twin SAM V5.0/V5.0c or ELI phantoms, the Mounting Device for Hand-Held Transmitters enables rotation of the mounted transmitter device to specified spherical coordinates. At the heads, the rotation axis is at the ear opening. Transmitter devices can be easily and accurately positioned according to IEC 62209-1, IEEE 1528, FCC, or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). And upgrade kit to Mounting Device to enable easy mounting of wider devices like big smart-phones, e-books, small tablets, etc. It holds devices with width up to 140 mm.



Mounting Device for Hand-Held Transmitters



Mounting Device Adaptor for Wide-Phones

### **<Mounting Device for Laptops and other Body-Worn Transmitters>**

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the mounting device in place of the phone positioned. The extension is fully compatible with the SAM Twin and ELI phantoms.



Mounting Device for Laptops

## **7. Measurement Procedures**

The measurement procedures are as follows:

### **<Conducted power measurement>**

- (a) For WWAN power measurement, use base station simulator to configure EUT WWAN transmission in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.
- (b) Read the WWAN RF power level from the base station simulator.
- (c) For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power in each supported wireless interface and frequency band
- (d) Connect EUT RF port through RF cable to the power meter, and measure WLAN/BT output power

### **<SAR measurement>**

- (a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.
- (b) Place the EUT in the positions as Appendix D demonstrates.
- (c) Set scan area, grid size and other setting on the DASY software.
- (d) Measure SAR results for the highest power channel on each testing position.
- (e) Find out the largest SAR result on these testing positions of each band
- (f) Measure SAR results for other channels in worst SAR testing position if the reported 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:

- (a) Power reference measurement
- (b) Area scan
- (c) Zoom scan
- (d) Power drift measurement

### **7.1 Spatial Peak SAR Evaluation**

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, 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 1g and 10g 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 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

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

## **7.2 Power Reference Measurement**

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

## **7.3 Area Scan**

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

Area scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

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

### 7.4 Zoom Scan

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

Zoom scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

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

### 7.5 Volume Scan Procedures

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

### 7.6 Power Drift Monitoring

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

## 8. Test Equipment List

| Manufacturer  | Name of Equipment             | Type/Model      | Serial Number | Calibration   |               |
|---------------|-------------------------------|-----------------|---------------|---------------|---------------|
|               |                               |                 |               | Last Cal.     | Due Date      |
| SPEAG         | 2450MHz System Validation Kit | D2450V2         | 736           | Aug. 31, 2018 | Aug. 30, 2019 |
| SPEAG         | 2450MHz System Validation Kit | D2450V2         | 929           | Mar. 06, 2019 | Mar. 05, 2020 |
| SPEAG         | 5GHz System Validation Kit    | D5GHzV2         | 1006          | Sep. 27, 2018 | Sep. 26, 2019 |
| SPEAG         | Data Acquisition Electronics  | DAE3            | 577           | Sep. 19, 2018 | Sep. 18, 2019 |
| SPEAG         | Data Acquisition Electronics  | DAE4            | 918           | Jun. 20, 2018 | Jun. 19, 2019 |
| SPEAG         | Dosimetric E-Field Probe      | ES3DV3          | 3270          | Sep. 24, 2018 | Sep. 23, 2019 |
| SPEAG         | Dosimetric E-Field Probe      | EX3DV4          | 7515          | Oct. 03, 2018 | Oct. 02, 2019 |
| RCPTWN        | Thermometer                   | HTC-1           | TM685-1       | Nov. 12, 2018 | Nov. 11, 2019 |
| RCPTWN        | Thermometer                   | HTC-1           | TM560-2       | Nov. 12, 2018 | Nov. 11, 2019 |
| R&S           | BT Base Station               | CBT32           | 100519        | May. 30, 2018 | May. 29, 2019 |
| SPEAG         | Device Holder                 | N/A             | N/A           | N/A           | N/A           |
| Anritsu       | Signal Generator              | MG3710A         | 6201502524    | Dec. 11, 2018 | Dec. 10, 2019 |
| Agilent       | ENA Network Analyzer          | E5071C          | MY46104758    | Sep. 19, 2018 | Sep. 18, 2019 |
| SPEAG         | Dielectric Probe Kit          | DAK-3.5         | 1126          | Sep. 19, 2018 | Sep. 18, 2019 |
| LINE SEIKI    | Digital Thermometer           | DTM3000-spezial | 3169          | Sep. 11, 2018 | Sep. 10, 2019 |
| Anritsu       | Power Meter                   | ML2495A         | 1419002       | May. 18, 2018 | May. 17, 2019 |
| Anritsu       | Power Sensor                  | MA2411B         | 1339124       | May. 18, 2018 | May. 17, 2019 |
| Anritsu       | Power Meter                   | ML2495A         | 1240001       | Sep. 13, 2018 | Sep. 12, 2019 |
| Anritsu       | Power Sensor                  | MA2411B         | 1207349       | Sep. 13, 2018 | Sep. 12, 2019 |
| Agilent       | Spectrum Analyzer             | E4408B          | MY44211028    | Aug. 28, 2018 | Aug. 27, 2019 |
| Anritsu       | Spectrum Analyzer             | MS2830A         | 6201396378    | Jun. 23, 2018 | Jun. 22, 2019 |
| Mini-Circuits | Power Amplifier               | ZVE-8G+         | 070501814     | Oct. 08, 2018 | Oct. 07, 2019 |
| Mini-Circuits | Power Amplifier               | ZVE-8G+         | 6382          | Aug. 09, 2018 | Aug. 08, 2019 |
| ATM           | Dual Directional Coupler      | C122H-10        | P610410z-02   | Note 1        |               |
| Woken         | Attenuator 1                  | WK0602-XX       | N/A           | Note 1        |               |
| PE            | Attenuator 2                  | PE7005-10       | N/A           | Note 1        |               |
| PE            | Attenuator 3                  | PE7005- 3       | N/A           | Note 1        |               |

**General Note:**

1. Prior to system verification and validation, the path loss from the signal generator to the system check source and the power meter, which includes the amplifier, cable, attenuator and directional coupler, was measured by the network analyzer. The reading of the power meter was offset by the path loss difference between the path to the power meter and the path to the system check source to monitor the actual power level fed to the system check source.

## 9. System Verification

### 9.1 Tissue Simulating Liquids

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 10.1. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 10.2.

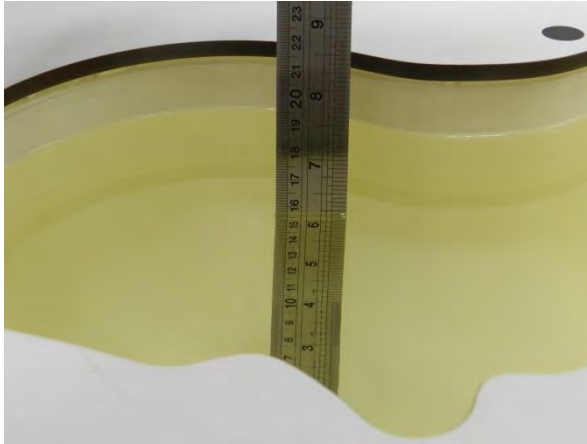


Fig 10.1 Photo of Liquid Height for Head SAR

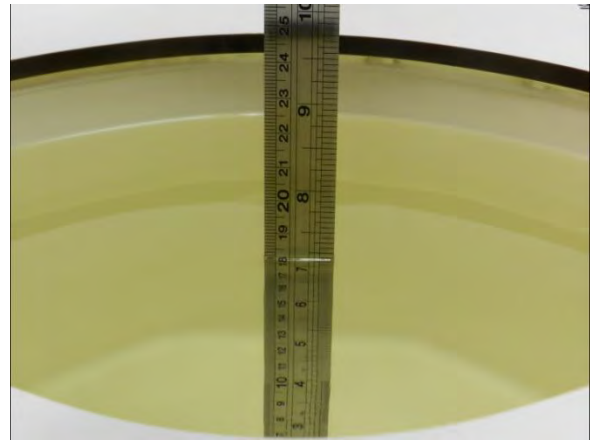


Fig 10.2 Photo of Liquid Height for Body SAR

## 9.2 Tissue Verification

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

| Frequency (MHz)  | Water (%) | Sugar (%) | Cellulose (%) | Salt (%) | Preventol (%) | DGBE (%) | Conductivity ( $\sigma$ ) | Permittivity ( $\epsilon_r$ ) |
|------------------|-----------|-----------|---------------|----------|---------------|----------|---------------------------|-------------------------------|
| For Head         |           |           |               |          |               |          |                           |                               |
| 750              | 41.1      | 57.0      | 0.2           | 1.4      | 0.2           | 0        | 0.89                      | 41.9                          |
| 835              | 40.3      | 57.9      | 0.2           | 1.4      | 0.2           | 0        | 0.90                      | 41.5                          |
| 900              | 40.3      | 57.9      | 0.2           | 1.4      | 0.2           | 0        | 0.97                      | 41.5                          |
| 1800, 1900, 2000 | 55.2      | 0         | 0             | 0.3      | 0             | 44.5     | 1.40                      | 40.0                          |
| 2450             | 55.0      | 0         | 0             | 0        | 0             | 45.0     | 1.80                      | 39.2                          |
| 2600             | 54.8      | 0         | 0             | 0.1      | 0             | 45.1     | 1.96                      | 39.0                          |
| For Body         |           |           |               |          |               |          |                           |                               |
| 750              | 51.7      | 47.2      | 0             | 0.9      | 0.1           | 0        | 0.96                      | 55.5                          |
| 835              | 50.8      | 48.2      | 0             | 0.9      | 0.1           | 0        | 0.97                      | 55.2                          |
| 900              | 50.8      | 48.2      | 0             | 0.9      | 0.1           | 0        | 1.05                      | 55.0                          |
| 1800, 1900, 2000 | 70.2      | 0         | 0             | 0.4      | 0             | 29.4     | 1.52                      | 53.3                          |
| 2450             | 68.6      | 0         | 0             | 0        | 0             | 31.4     | 1.95                      | 52.7                          |
| 2600             | 68.1      | 0         | 0             | 0.1      | 0             | 31.8     | 2.16                      | 52.5                          |

### Simulating Liquid for 5GHz, Manufactured by SPEAG

| Ingredients        | (% by weight) |
|--------------------|---------------|
| Water              | 64~78%        |
| Mineral oil        | 11~18%        |
| Emulsifiers        | 9~15%         |
| Additives and Salt | 2~3%          |

### <Tissue Dielectric Parameter Check Results>

| Frequency (MHz) | Liquid Temp. (°C) | Conductivity ( $\sigma$ ) | Permittivity ( $\epsilon_r$ ) | Conductivity Target ( $\sigma$ ) | Permittivity Target ( $\epsilon_r$ ) | Delta ( $\sigma$ ) (%) | Delta ( $\epsilon_r$ ) (%) | Limit (%) | Date      |
|-----------------|-------------------|---------------------------|-------------------------------|----------------------------------|--------------------------------------|------------------------|----------------------------|-----------|-----------|
| 2450            | 22.5              | 1.800                     | 38.606                        | 1.80                             | 39.20                                | 0.00                   | -1.52                      | ±5        | 2019/4/11 |
| 2450            | 22.3              | 1.799                     | 38.621                        | 1.80                             | 39.20                                | -0.06                  | -1.48                      | ±5        | 2019/4/18 |
| 5250            | 22.2              | 4.585                     | 35.103                        | 4.71                             | 35.95                                | -2.65                  | -2.36                      | ±5        | 2019/4/11 |
| 5250            | 22.4              | 4.568                     | 35.053                        | 4.71                             | 35.95                                | -3.01                  | -2.50                      | ±5        | 2019/4/14 |
| 5250            | 22.6              | 4.698                     | 36.852                        | 4.71                             | 35.95                                | -0.25                  | 2.51                       | ±5        | 2019/4/15 |
| 5600            | 22.2              | 4.941                     | 34.767                        | 5.07                             | 35.50                                | -2.54                  | -2.06                      | ±5        | 2019/4/11 |
| 5600            | 22.4              | 4.922                     | 34.717                        | 5.07                             | 35.50                                | -2.92                  | -2.21                      | ±5        | 2019/4/14 |
| 5600            | 22.6              | 5.050                     | 36.351                        | 5.07                             | 35.50                                | -0.39                  | 2.40                       | ±5        | 2019/4/15 |
| 5750            | 22.2              | 5.040                     | 34.420                        | 5.22                             | 35.35                                | -3.45                  | -2.63                      | ±5        | 2019/4/11 |
| 5750            | 22.4              | 5.020                     | 34.370                        | 5.22                             | 35.35                                | -3.83                  | -2.77                      | ±5        | 2019/4/14 |
| 5750            | 22.6              | 5.218                     | 36.128                        | 5.22                             | 35.35                                | -0.04                  | 2.20                       | ±5        | 2019/4/15 |





## **10. Conducted RF Output Power (Unit: dBm)**

### **<WLAN Conducted Power>**

#### **General Note:**

1. Per KDB 248227 D01v02r02, SAR test reduction is determined according to 802.11 transmission mode configurations and certain exposure conditions with multiple test positions. In the 2.4 GHz band, separate SAR procedures are applied to DSSS and OFDM configurations to simplify DSSS test requirements. For OFDM, in both 2.4 and 5 GHz bands, an initial test configuration must be determined for each standalone and aggregated frequency band, according to the transmission mode configuration with the highest maximum output power specified for production units to perform SAR measurements. If the same highest maximum output power applies to different combinations of channel bandwidths, modulations and data rates, additional procedures are applied to determine which test configurations require SAR measurement. When applicable, an initial test position may be applied to reduce the number of SAR measurements required for next to the ear, UMPC mini-tablet or hotspot mode configurations with multiple test positions.
2. For 2.4 GHz 802.11b DSSS, either the initial test position procedure for multiple exposure test positions or the DSSS procedure for fixed exposure position is applied; these are mutually exclusive. For 2.4 GHz and 5 GHz OFDM configurations, the initial test configuration is applied to measure SAR using either the initial test position procedure for multiple exposure test position configurations or the initial test configuration procedures for fixed exposure test conditions. Based on the reported SAR of the measured configurations and maximum output power of the transmission mode configurations that are not included in the initial test configuration, the subsequent test configuration and initial test position procedures are applied to determine if SAR measurements are required for the remaining OFDM transmission configurations. In general, the number of test channels that require SAR measurement is minimized based on maximum output power measured for the test sample(s).
3. For OFDM transmission configurations in the 2.4 GHz and 5 GHz bands, When the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel for each frequency band.
4. DSSS and OFDM configurations are considered separately according to the required SAR procedures. SAR is measured in the initial test position using the 802.11 transmission mode configuration required by the DSSS procedure or initial test configuration and subsequent test configuration(s) according to the OFDM procedures.18 The initial test position procedure is described in the following:
  - a. When the reported SAR of 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 802.11 transmission mode combinations within the frequency band or aggregated band.
  - b. When the reported SAR of the test position is  $> 0.4$  W/kg, SAR is repeated for the 802.11 transmission mode 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 report SAR is  $\leq 0.8$  W/kg or all required test position are tested.
  - c. For all positions/configurations, when the reported SAR is  $> 0.8$  W/kg, SAR is measured for these test 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 channels are tested.
5. Per 201904 TCBC workshops, General principles of FCC KDB Publication 248227 D01 can be applied to determine the SAR Initial Test Configurations and test reduction for 802.11ax SAR testing. For the table below the 802.11ax maximum power is SU (non-OFDMA), and the device does not supports RU (OFDMA)
6. In applying the test guidance, the IEEE 802.11 mode with the maximum output power (out of all modes) should be considered for testing
7. For modes with the same maximum output power, the guidance from section 5.3.2 a) of FCC KDB Publication 248227 D01 should be applied, with 802.11ax being considered as the highest 802.11 mode for the appropriate frequency bands
8. When SAR testing for 802.11ax is required
  - a. If the maximum output power is highest for OFDMA scenarios, choose the tone size with the maximum number of tones and the highest maximum output power
  - b. Otherwise, consider the fully allocated channel for SAR testing
  - c. When SAR testing is required on RU sizes less than the fully allocated channel, use the RU number closest to the middle of the channel, choosing the higher RU number when two RUs are equidistant to the middle of the channel

**<Non-beamforming mode>**
**<Radio 1>**
**<2.4GHz WLAN ANT1>**

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 2.4GHz WLAN | 802.11b 1Mbps       | 1       | 2412            | 22.04               | 22.50         | 94.60        |
|             |                     | 6       | 2437            | 22.93               | 23.00         |              |
|             |                     | 11      | 2462            | 21.46               | 21.50         |              |
|             | 802.11g 6Mbps       | 1       | 2412            | 17.45               | 17.50         | 95.20        |
|             |                     | 6       | 2437            | 20.91               | 21.00         |              |
|             |                     | 11      | 2462            | 16.33               | 16.50         |              |
|             | 802.11ax HEW20 Nss1 | 1       | 2412            | 16.94               | 17.00         | 98.60        |
|             |                     | 6       | 2437            | 21.03               | 21.50         |              |
|             |                     | 11      | 2462            | 14.58               | 15.00         |              |
|             | 802.11ax HEW40 Nss1 | 3       | 2422            | 16.31               | 16.50         | 97.00        |
|             |                     | 6       | 2437            | 17.03               | 17.50         |              |
|             |                     | 9       | 2452            | 15.93               | 16.00         |              |

**<2.4GHz WLAN ANT1+2>**

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 2.4GHz WLAN | 802.11ax HEW20 Nss2 | 1       | 2412            | 18.75               | 19.00         | 97.20        |
|             |                     | 6       | 2437            | 23.17               | 23.50         |              |
|             |                     | 11      | 2462            | 18.85               | 19.00         |              |
|             | 802.11ax HEW40 Nss2 | 3       | 2422            | 18.06               | 18.50         | 94.80        |
|             |                     | 6       | 2437            | 19.54               | 20.00         |              |
|             |                     | 9       | 2452            | 18.12               | 18.50         |              |

**<2.4GHz WLAN ANT1+2+3+4>**

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 2.4GHz WLAN | 802.11b 1Mbps       | 1       | 2412            | 26.99               | 27.00         | 94.90        |
|             |                     | 6       | 2437            | 28.09               | 28.50         |              |
|             |                     | 11      | 2462            | 26.40               | 26.50         |              |
|             | 802.11g 6Mbps       | 1       | 2412            | 21.05               | 21.50         | 95.50        |
|             |                     | 6       | 2437            | 24.60               | 25.00         |              |
|             |                     | 11      | 2462            | 20.99               | 21.00         |              |
|             | 802.11ax HEW20 Nss4 | 1       | 2412            | 20.69               | 21.00         | 95.30        |
|             |                     | 6       | 2437            | 25.11               | 25.50         |              |
|             |                     | 11      | 2462            | 20.74               | 21.00         |              |
|             | 802.11ax HEW40 Nss1 | 3       | 2422            | 20.10               | 20.50         | 97.30        |
|             |                     | 6       | 2437            | 21.31               | 21.50         |              |
|             |                     | 9       | 2452            | 19.79               | 20.00         |              |

**<5GHz WLAN ANT1>**

| 5.2GHz WLAN | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
|             | 802.11a 6Mbps       | 36      | 5180            | 18.54               | 19.00         | 95.50        |
|             |                     | 40      | 5200            | 20.12               | 20.50         |              |
|             |                     | 44      | 5220            | 20.08               | 20.50         |              |
|             |                     | 48      | 5240            | 18.37               | 18.50         |              |
|             | 802.11ax HEW20 Nss1 | 36      | 5180            | 18.15               | 18.50         | 98.40        |
|             |                     | 40      | 5200            | 20.19               | 20.50         |              |
|             |                     | 44      | 5220            | 20.14               | 20.50         |              |
|             |                     | 48      | 5240            | 18.75               | 19.00         |              |
|             | 802.11ax HEW40 Nss1 | 38      | 5190            | 16.32               | 16.50         | 96.30        |
|             |                     | 46      | 5230            | 18.32               | 18.50         |              |
|             | 802.11ax HEW80 Nss1 | 42      | 5210            | 15.90               | 16.00         | 94.40        |

| 5.3GHz WLAN | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
|             | 802.11a 6Mbps        | 52      | 5260            | 19.02               | 19.50         | 95.50        |
|             |                      | 56      | 5280            | 18.93               | 19.00         |              |
|             |                      | 60      | 5300            | 18.32               | 19.00         |              |
|             |                      | 64      | 5320            | 18.85               | 19.00         |              |
|             | 802.11ax HEW20 Nss1  | 52      | 5260            | 20.10               | 20.50         | 98.40        |
|             |                      | 56      | 5280            | 20.29               | 20.50         |              |
|             |                      | 60      | 5300            | 20.39               | 20.50         |              |
|             |                      | 64      | 5320            | 18.44               | 18.50         |              |
|             | 802.11ax HEW40 Nss1  | 54      | 5270            | 20.10               | 20.50         | 96.30        |
|             |                      | 62      | 5310            | 15.67               | 16.00         |              |
|             | 802.11ax HEW80 Nss1  | 58      | 5290            | 14.84               | 15.00         | 94.40        |
|             | 802.11ax HEW160 Nss1 | 50      | 5250            | 10.79               | 11.00         | 92.60        |

|             | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.5GHz WLAN | 802.11a 6Mbps        | 100     | 5500            | 17.88               | 18.00         | 95.50        |
|             |                      | 116     | 5580            | 15.40               | 15.50         |              |
|             |                      | 124     | 5620            | 15.23               | 15.50         |              |
|             |                      | 132     | 5660            | 15.25               | 15.50         |              |
|             |                      | 144     | 5720            | 13.59               | 14.00         |              |
|             | 802.11ax HEW20 Nss1  | 100     | 5500            | 18.02               | 18.50         | 98.40        |
|             |                      | 116     | 5580            | 15.30               | 15.50         |              |
|             |                      | 124     | 5620            | 15.27               | 15.50         |              |
|             |                      | 132     | 5660            | 15.20               | 15.50         |              |
|             |                      | 144     | 5720            | 11.24               | 11.50         |              |
|             | 802.11ax HEW40 Nss1  | 102     | 5510            | 15.95               | 16.00         | 96.30        |
|             |                      | 110     | 5550            | 17.14               | 17.50         |              |
|             |                      | 126     | 5630            | 17.06               | 17.50         |              |
|             |                      | 134     | 5670            | 16.58               | 17.00         |              |
|             |                      | 142     | 5710            | 15.03               | 15.50         |              |
|             | 802.11ax HEW80 Nss1  | 106     | 5530            | 15.78               | 16.00         | 94.40        |
|             |                      | 122     | 5610            | 17.99               | 18.00         |              |
|             |                      | 138     | 5690            | 17.44               | 17.50         |              |
|             | 802.11ax HEW160 Nss1 | 114     | 5570            | 14.07               | 14.50         | 92.60        |

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.8GHz WLAN | 802.11a 6Mbps       | 149     | 5745            | 18.60               | 19.00         | 95.50        |
|             |                     | 157     | 5785            | 18.02               | 18.50         |              |
|             |                     | 165     | 5825            | 19.39               | 19.50         |              |
|             | 802.11ax HEW20 Nss1 | 149     | 5745            | 19.55               | 20.00         | 98.40        |
|             |                     | 157     | 5785            | 19.22               | 19.50         |              |
|             |                     | 165     | 5825            | 21.47               | 21.50         |              |
|             | 802.11ax HEW40 Nss1 | 151     | 5755            | 20.33               | 20.50         | 96.30        |
|             |                     | 159     | 5795            | 20.95               | 21.00         |              |
|             | 802.11ax HEW80 Nss1 | 155     | 5775            | 20.73               | 21.00         | 94.40        |

**<5GHz WLAN ANT1+2>**

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.2GHz WLAN | 802.11ax HEW20 Nss2 | 36      | 5180            | 20.19               | 20.50         | 97.20        |
|             |                     | 40      | 5200            | 23.37               | 23.50         |              |
|             |                     | 44      | 5220            | 23.23               | 23.50         |              |
|             |                     | 48      | 5240            | 21.42               | 21.50         |              |
|             | 802.11ax HEW40 Nss2 | 38      | 5190            | 19.15               | 19.50         | 94.80        |
|             |                     | 46      | 5230            | 21.29               | 21.50         |              |
|             | 802.11ax HEW80 Nss2 | 42      | 5210            | 17.96               | 18.00         | 91.50        |

|             | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.3GHz WLAN | 802.11ax HEW20 Nss2  | 52      | 5260            | 23.46               | 23.50         | 97.20        |
|             |                      | 56      | 5280            | 23.41               | 23.50         |              |
|             |                      | 60      | 5300            | 23.55               | 24.00         |              |
|             |                      | 64      | 5320            | 19.83               | 20.00         |              |
|             | 802.11ax HEW40 Nss2  | 54      | 5270            | 22.87               | 23.00         | 94.80        |
|             |                      | 62      | 5310            | 18.79               | 19.00         |              |
|             | 802.11ax HEW80 Nss2  | 58      | 5290            | 18.74               | 19.00         | 91.50        |
|             | 802.11ax HEW160 Nss2 | 50      | 5250            | 13.27               | 13.50         | 90.10        |

|             | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.5GHz WLAN | 802.11ax HEW20 Nss2  | 100     | 5500            | 19.48               | 19.50         | 97.20        |
|             |                      | 116     | 5580            | 18.08               | 18.50         |              |
|             |                      | 124     | 5620            | 17.86               | 18.50         |              |
|             |                      | 132     | 5660            | 18.06               | 18.50         |              |
|             |                      | 144     | 5720            | 14.11               | 14.50         |              |
|             | 802.11ax HEW40 Nss2  | 102     | 5510            | 18.93               | 19.00         | 94.80        |
|             |                      | 110     | 5550            | 19.96               | 20.00         |              |
|             |                      | 126     | 5630            | 19.84               | 20.00         |              |
|             |                      | 134     | 5670            | 19.04               | 19.50         |              |
|             |                      | 142     | 5710            | 17.68               | 18.00         |              |
|             | 802.11ax HEW80 Nss2  | 106     | 5530            | 18.49               | 18.50         | 91.50        |
|             |                      | 122     | 5610            | 20.89               | 21.00         |              |
|             |                      | 138     | 5690            | 20.14               | 20.50         |              |
|             | 802.11ax HEW160 Nss2 | 114     | 5570            | 16.74               | 17.00         | 90.10        |

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.8GHz WLAN | 802.11ax HEW20 Nss2 | 149     | 5745            | 22.52               | 23.00         | 97.20        |
|             |                     | 157     | 5785            | 22.30               | 23.00         |              |
|             |                     | 165     | 5825            | 24.48               | 24.50         |              |
|             | 802.11ax HEW40 Nss2 | 151     | 5755            | 23.86               | 24.00         | 94.80        |
|             |                     | 159     | 5795            | 24.36               | 24.50         |              |
|             | 802.11ax HEW80 Nss2 | 155     | 5775            | 22.14               | 22.50         | 91.50        |

**<5GHz WLAN ANT1+2+3+4>**

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.2GHz WLAN | 802.11a 6Mbps       | 36      | 5180            | 23.38               | 24.00         | 95.60        |
|             |                     | 40      | 5200            | 24.38               | 24.50         |              |
|             |                     | 44      | 5220            | 24.28               | 24.50         |              |
|             |                     | 48      | 5240            | 23.86               | 24.00         |              |
|             | 802.11ax HEW20 Nss4 | 36      | 5180            | 22.60               | 23.00         | 95.30        |
|             |                     | 40      | 5200            | 25.88               | 26.00         |              |
|             |                     | 44      | 5220            | 25.77               | 26.00         |              |
|             |                     | 48      | 5240            | 24.10               | 24.50         |              |
|             | 802.11ax HEW40 Nss4 | 38      | 5190            | 19.95               | 20.50         | 92.30        |
|             |                     | 46      | 5230            | 24.14               | 24.50         |              |
|             | 802.11ax HEW80 Nss4 | 42      | 5210            | 19.95               | 20.00         | 89.00        |

|             | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.3GHz WLAN | 802.11a 6Mbps        | 52      | 5260            | 18.23               | 18.50         | 95.60        |
|             |                      | 56      | 5280            | 18.40               | 18.50         |              |
|             |                      | 60      | 5300            | 18.42               | 18.50         |              |
|             |                      | 64      | 5320            | 18.50               | 18.50         |              |
|             | 802.11ax HEW20 Nss4  | 52      | 5260            | 23.80               | 24.00         | 95.30        |
|             |                      | 56      | 5280            | 23.79               | 24.00         |              |
|             |                      | 60      | 5300            | 23.87               | 24.00         |              |
|             |                      | 64      | 5320            | 22.11               | 22.50         |              |
|             | 802.11ax HEW40 Nss4  | 54      | 5270            | 23.90               | 24.00         | 92.30        |
|             |                      | 62      | 5310            | 19.25               | 20.00         |              |
|             | 802.11ax HEW80 Nss4  | 58      | 5290            | 19.81               | 20.00         | 89.00        |
|             | 802.11ax HEW160 Nss4 | 50      | 5250            | 15.39               | 15.50         | 88.30        |

| 5.5GHz WLAN | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
|             | 802.11a 6Mbps        | 100     | 5500            | 18.27               | 18.50         | 95.60        |
|             |                      | 116     | 5580            | 18.36               | 18.50         |              |
|             |                      | 124     | 5620            | 18.28               | 18.50         |              |
|             |                      | 132     | 5660            | 18.26               | 18.50         |              |
|             |                      | 144     | 5720            | 17.43               | 17.50         |              |
|             | 802.11ax HEW20 Nss4  | 100     | 5500            | 22.23               | 22.50         | 95.30        |
|             |                      | 116     | 5580            | 21.78               | 22.00         |              |
|             |                      | 124     | 5620            | 21.65               | 22.00         |              |
|             |                      | 132     | 5660            | 21.76               | 22.00         |              |
|             |                      | 144     | 5720            | 17.53               | 18.00         |              |
|             | 802.11ax HEW40 Nss4  | 102     | 5510            | 19.89               | 20.00         | 92.30        |
|             |                      | 110     | 5550            | 23.34               | 23.50         |              |
|             |                      | 126     | 5630            | 23.23               | 23.50         |              |
|             |                      | 134     | 5670            | 20.66               | 21.00         |              |
|             |                      | 142     | 5710            | 20.85               | 21.00         |              |
|             | 802.11ax HEW80 Nss1  | 106     | 5530            | 19.76               | 20.00         | 94.50        |
|             |                      | 122     | 5610            | 22.21               | 22.50         |              |
|             |                      | 138     | 5690            | 23.43               | 23.50         |              |
|             | 802.11ax HEW160 Nss1 | 114     | 5570            | 19.36               | 19.50         | 88.30        |

| 5.8GHz WLAN | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
|             | 802.11a 6Mbps       | 149     | 5745            | 24.90               | 25.00         | 95.60        |
|             |                     | 157     | 5785            | 24.39               | 25.00         |              |
|             |                     | 165     | 5825            | 24.76               | 25.00         |              |
|             | 802.11ax HEW20 Nss1 | 149     | 5745            | 25.83               | 26.00         | 98.60        |
|             |                     | 157     | 5785            | 25.85               | 26.00         |              |
|             |                     | 165     | 5825            | 27.59               | 28.00         |              |
|             | 802.11ax HEW40 Nss1 | 151     | 5755            | 27.04               | 28.00         | 97.00        |
|             |                     | 159     | 5795            | 27.46               | 28.00         |              |
|             | 802.11ax HEW80 Nss4 | 155     | 5775            | 24.29               | 24.50         | 89.00        |

**<Radio 2>**
**<5GHz WLAN ANT1>**

|             | Mode                     | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|--------------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.2GHz WLAN | 802.11a 6Mbps            | 36      | 5180            | 19.16               | 19.50         | 94.40        |
|             |                          | 40      | 5200            | 20.06               | 20.50         |              |
|             |                          | 44      | 5220            | 20.03               | 20.50         |              |
|             |                          | 48      | 5240            | 18.69               | 19.00         |              |
|             | 802.11ax HEW20 Nss1 MCS0 | 36      | 5180            | 17.36               | 17.50         | 98.60        |
|             |                          | 40      | 5200            | 20.20               | 20.50         |              |
|             |                          | 44      | 5220            | 20.17               | 20.50         |              |
|             |                          | 48      | 5240            | 19.23               | 19.50         |              |
|             | 802.11ax HEW40 Nss1 MCS0 | 38      | 5190            | 15.44               | 15.50         | 97.30        |
|             |                          | 46      | 5230            | 19.91               | 20.00         |              |
|             | 802.11ax HEW80 Nss1 MCS0 | 42      | 5210            | 15.52               | 16.00         | 94.50        |

|             | Mode                      | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.3GHz WLAN | 802.11a 6Mbps             | 52      | 5260            | 18.55               | 19.00         | 94.40        |
|             |                           | 56      | 5280            | 20.51               | 21.00         |              |
|             |                           | 60      | 5300            | 20.67               | 21.00         |              |
|             |                           | 64      | 5320            | 19.60               | 20.00         |              |
|             | 802.11ax HEW20 Nss1 MCS0  | 52      | 5260            | 18.91               | 19.00         | 98.60        |
|             |                           | 56      | 5280            | 19.42               | 19.50         |              |
|             |                           | 60      | 5300            | 19.60               | 20.00         |              |
|             |                           | 64      | 5320            | 18.08               | 18.50         |              |
|             | 802.11ax HEW40 Nss1 MCS0  | 54      | 5270            | 18.12               | 18.50         | 97.30        |
|             |                           | 62      | 5310            | 16.88               | 17.00         |              |
|             | 802.11ax HEW80 Nss1 MCS0  | 58      | 5290            | 15.87               | 16.00         | 94.50        |
|             | 802.11ax HEW160 Nss1 MCS0 | 50      | 5250            | 11.56               | 12.00         | 91.20        |

|             | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.5GHz WLAN | 802.11a 6Mbps        | 100     | 5500            | 18.75               | 19.00         | 94.40        |
|             |                      | 116     | 5580            | 20.52               | 21.00         |              |
|             |                      | 124     | 5620            | 20.44               | 20.50         |              |
|             |                      | 132     | 5660            | 20.48               | 20.50         |              |
|             |                      | 144     | 5720            | 18.14               | 18.50         |              |
|             | 802.11ax HEW20 Nss1  | 100     | 5500            | 18.37               | 18.50         | 98.60        |
|             |                      | 116     | 5580            | 21.08               | 21.50         |              |
|             |                      | 124     | 5620            | 21.06               | 21.50         |              |
|             |                      | 132     | 5660            | 21.04               | 21.50         |              |
|             |                      | 144     | 5720            | 17.91               | 18.00         |              |
|             | 802.11ax HEW40 Nss1  | 102     | 5510            | 16.86               | 17.00         | 97.30        |
|             |                      | 110     | 5550            | 20.78               | 21.00         |              |
|             |                      | 126     | 5630            | 20.58               | 21.00         |              |
|             |                      | 134     | 5670            | 17.27               | 17.50         |              |
|             |                      | 142     | 5710            | 19.50               | 20.00         |              |
|             | 802.11ax HEW80 Nss1  | 106     | 5530            | 16.47               | 16.50         | 94.50        |
|             |                      | 122     | 5610            | 18.92               | 19.00         |              |
|             |                      | 138     | 5690            | 19.11               | 19.50         |              |
|             | 802.11ax HEW160 Nss1 | 114     | 5570            | 15.52               | 16.00         | 91.20        |

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.8GHz WLAN | 802.11a 6Mbps       | 149     | 5745            | 19.44               | 19.50         | 94.40        |
|             |                     | 157     | 5785            | 21.55               | 22.00         |              |
|             |                     | 165     | 5825            | 20.59               | 21.00         |              |
|             | 802.11ax HEW20 Nss1 | 149     | 5745            | 22.50               | 22.50         | 98.60        |
|             |                     | 157     | 5785            | 21.96               | 22.00         |              |
|             |                     | 165     | 5825            | 20.88               | 21.00         |              |
|             | 802.11ax HEW40 Nss1 | 151     | 5755            | 22.53               | 23.00         | 97.30        |
|             |                     | 159     | 5795            | 22.84               | 23.00         |              |
|             | 802.11ax HEW80 Nss1 | 155     | 5775            | 20.51               | 21.00         | 94.50        |

**<5GHz WLAN ANT1+2>**

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.2GHz WLAN | 802.11ax HEW20 Nss2 | 36      | 5180            | 19.22               | 19.50         | 97.00        |
|             |                     | 40      | 5200            | 23.25               | 23.50         |              |
|             |                     | 44      | 5220            | 23.21               | 23.50         |              |
|             |                     | 48      | 5240            | 22.26               | 22.50         |              |
|             | 802.11ax HEW40 Nss2 | 38      | 5190            | 17.78               | 18.00         | 94.80        |
|             |                     | 46      | 5230            | 22.54               | 23.00         |              |
|             | 802.11ax HEW80 Nss2 | 42      | 5210            | 17.17               | 17.50         | 91.20        |

| 5.3GHz WLAN | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
|             | 802.11ax HEW20 Nss2  | 52      | 5260            | 21.89               | 22.00         | 97.00        |
|             |                      | 56      | 5280            | 22.45               | 22.50         |              |
|             |                      | 60      | 5300            | 22.66               | 23.00         |              |
|             |                      | 64      | 5320            | 20.36               | 20.50         |              |
|             | 802.11ax HEW40 Nss2  | 54      | 5270            | 21.27               | 21.50         | 94.80        |
|             |                      | 62      | 5310            | 18.94               | 19.00         |              |
|             | 802.11ax HEW80 Nss2  | 58      | 5290            | 18.10               | 18.50         | 91.20        |
|             | 802.11ax HEW160 Nss2 | 50      | 5250            | 13.73               | 14.00         | 90.10        |

| 5.5GHz WLAN | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
|             | 802.11ax HEW20 Nss2  | 100     | 5500            | 20.11               | 20.50         | 97.00        |
|             |                      | 116     | 5580            | 23.76               | 24.00         |              |
|             |                      | 124     | 5620            | 23.68               | 24.00         |              |
|             |                      | 132     | 5660            | 23.61               | 24.00         |              |
|             |                      | 144     | 5720            | 21.26               | 21.50         |              |
|             | 802.11ax HEW40 Nss2  | 102     | 5510            | 19.20               | 19.50         | 94.80        |
|             |                      | 110     | 5550            | 23.28               | 23.50         |              |
|             |                      | 126     | 5630            | 23.10               | 23.50         |              |
|             |                      | 134     | 5670            | 19.62               | 20.00         |              |
|             |                      | 142     | 5710            | 22.36               | 22.50         |              |
|             | 802.11ax HEW80 Nss2  | 106     | 5530            | 18.31               | 18.50         | 91.20        |
|             |                      | 122     | 5610            | 21.21               | 21.50         |              |
|             |                      | 138     | 5690            | 22.06               | 22.50         |              |
|             | 802.11ax HEW160 Nss2 | 114     | 5570            | 16.59               | 17.00         | 90.10        |

| 5.8GHz WLAN | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
|             | 802.11ax HEW20 Nss2 | 149     | 5745            | 25.50               | 25.50         | 97.00        |
|             |                     | 157     | 5785            | 24.69               | 25.00         |              |
|             |                     | 165     | 5825            | 23.95               | 24.00         |              |
|             | 802.11ax HEW40 Nss2 | 151     | 5755            | 25.07               | 25.50         | 94.80        |
|             |                     | 159     | 5795            | 25.94               | 26.00         |              |
|             | 802.11ax HEW80 Nss2 | 155     | 5775            | 22.85               | 23.00         | 90.10        |

**<5GHz WLAN ANT1+2+3+4>**

| 5.2GHz WLAN | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
|             | 802.11a 6Mbps       | 36      | 5180            | 22.94               | 23.00         | 95.10        |
|             |                     | 40      | 5200            | 25.14               | 25.50         |              |
|             |                     | 44      | 5220            | 25.11               | 25.50         |              |
|             |                     | 48      | 5240            | 24.07               | 24.50         |              |
|             | 802.11ax HEW20 Nss4 | 36      | 5180            | 21.84               | 22.00         | 95.30        |
|             |                     | 40      | 5200            | 25.79               | 26.00         |              |
|             |                     | 44      | 5220            | 25.70               | 26.00         |              |
|             |                     | 48      | 5240            | 25.05               | 25.50         |              |
|             | 802.11ax HEW40 Nss1 | 38      | 5190            | 20.09               | 20.50         | 97.00        |
|             |                     | 46      | 5230            | 24.28               | 24.50         |              |
|             | 802.11ax HEW80 Nss1 | 42      | 5210            | 19.98               | 20.00         | 94.50        |

| 5.3GHz WLAN | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
|             | 802.11a 6Mbps        | 52      | 5260            | 19.14               | 19.50         | 95.10        |
|             |                      | 56      | 5280            | 19.21               | 19.50         |              |
|             |                      | 60      | 5300            | 19.34               | 19.50         |              |
|             |                      | 64      | 5320            | 19.35               | 19.50         |              |
|             | 802.11ax HEW20 Nss4  | 52      | 5260            | 23.81               | 24.00         | 95.30        |
|             |                      | 56      | 5280            | 23.92               | 24.00         |              |
|             |                      | 60      | 5300            | 23.96               | 24.00         |              |
|             |                      | 64      | 5320            | 22.35               | 22.50         |              |
|             | 802.11ax HEW40 Nss4  | 54      | 5270            | 23.83               | 24.00         | 92.30        |
|             |                      | 62      | 5310            | 20.55               | 21.00         |              |
|             | 802.11ax HEW80 Nss4  | 58      | 5290            | 20.33               | 20.50         | 89.00        |
|             | 802.11ax HEW160 Nss1 | 50      | 5250            | 15.72               | 16.00         | 88.10        |

| 5.5GHz WLAN | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
|             | 802.11a 6Mbps        | 100     | 5500            | 19.17               | 19.50         | 95.10        |
|             |                      | 116     | 5580            | 19.27               | 19.50         |              |
|             |                      | 124     | 5620            | 19.31               | 19.50         |              |
|             |                      | 132     | 5660            | 19.35               | 19.50         |              |
|             |                      | 144     | 5720            | 18.12               | 18.50         |              |
|             | 802.11ax HEW20 Nss4  | 100     | 5500            | 22.70               | 23.00         | 95.30        |
|             |                      | 116     | 5580            | 23.96               | 24.00         |              |
|             |                      | 124     | 5620            | 23.93               | 24.00         |              |
|             |                      | 132     | 5660            | 23.78               | 24.00         |              |
|             |                      | 144     | 5720            | 23.28               | 23.50         |              |
|             | 802.11ax HEW40 Nss4  | 102     | 5510            | 20.36               | 20.50         | 92.30        |
|             |                      | 110     | 5550            | 23.81               | 24.00         |              |
|             |                      | 126     | 5630            | 23.73               | 24.00         |              |
|             |                      | 134     | 5670            | 21.48               | 21.50         |              |
|             |                      | 142     | 5710            | 23.77               | 24.00         |              |
|             | 802.11ax HEW80 Nss4  | 106     | 5530            | 20.61               | 21.00         | 89.00        |
|             |                      | 122     | 5610            | 23.44               | 23.50         |              |
|             |                      | 138     | 5690            | 23.88               | 24.00         |              |
|             | 802.11ax HEW160 Nss1 | 114     | 5570            | 19.43               | 19.50         | 88.10        |

| 5.8GHz WLAN | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
|             | 802.11a 6Mbps       | 149     | 5745            | 25.48               | 25.50         | 95.10        |
|             |                     | 157     | 5785            | 27.63               | 28.00         |              |
|             |                     | 165     | 5825            | 26.12               | 26.50         |              |
|             | 802.11ax HEW20 Nss1 | 149     | 5745            | 28.52               | 29.00         | 97.00        |
|             |                     | 157     | 5785            | 27.93               | 28.00         |              |
|             |                     | 165     | 5825            | 27.05               | 27.50         |              |
|             | 802.11ax HEW40 Nss1 | 151     | 5755            | 26.63               | 27.00         | 94.50        |
|             |                     | 159     | 5795            | 27.98               | 28.00         |              |
|             | 802.11ax HEW80 Nss4 | 155     | 5775            | 24.18               | 24.50         | 89.00        |

**<Beamforming mode>**
**<Radio 1>**
**<2.4GHz WLAN ANT1+2+3+4>**

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 2.4GHz WLAN | 802.11ax HEW20 Nss1 | 1       | 2412            | 15.95               | 16.00         | 90.50        |
|             |                     | 6       | 2437            | 19.27               | 19.50         |              |
|             |                     | 11      | 2462            | 15.21               | 15.50         |              |
|             | 802.11ax HEW40 Nss1 | 3       | 2422            | 16.05               | 16.50         | 90.30        |
|             |                     | 6       | 2437            | 17.03               | 17.50         |              |
|             |                     | 9       | 2452            | 15.39               | 15.50         |              |

**<5GHz WLAN ANT1+2+3+4>**

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.2GHz WLAN | 802.11ax HEW20 Nss1 | 36      | 5180            | 18.24               | 18.50         | 88.60        |
|             |                     | 40      | 5200            | 22.19               | 22.50         |              |
|             |                     | 44      | 5220            | 22.08               | 22.50         |              |
|             |                     | 48      | 5240            | 23.94               | 24.00         |              |
|             | 802.11ax HEW40 Nss1 | 38      | 5190            | 17.42               | 17.50         | 88.50        |
|             |                     | 46      | 5230            | 23.50               | 24.00         |              |
|             | 802.11ax HEW80 Nss1 | 42      | 5210            | 18.94               | 19.00         | 92.50        |

|             | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.3GHz WLAN | 802.11ax HEW20 Nss1  | 52      | 5260            | 18.29               | 18.50         | 88.60        |
|             |                      | 56      | 5280            | 18.02               | 18.50         |              |
|             |                      | 60      | 5300            | 18.17               | 18.50         |              |
|             |                      | 64      | 5320            | 18.16               | 18.50         |              |
|             | 802.11ax HEW40 Nss1  | 54      | 5270            | 18.37               | 18.50         | 88.50        |
|             |                      | 62      | 5310            | 18.17               | 18.50         |              |
|             | 802.11ax HEW80 Nss1  | 58      | 5290            | 18.27               | 18.50         | 92.50        |
|             | 802.11ax HEW160 Nss1 | 50      | 5250            | 9.35                | 10.00         | 90.30        |

|             | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.5GHz WLAN | 802.11ax HEW20 Nss1  | 100     | 5500            | 18.16               | 18.50         | 88.60        |
|             |                      | 116     | 5580            | 18.23               | 18.50         |              |
|             |                      | 124     | 5620            | 18.06               | 18.50         |              |
|             |                      | 132     | 5660            | 18.02               | 18.50         |              |
|             |                      | 144     | 5720            | 17.51               | 18.00         |              |
|             | 802.11ax HEW40 Nss1  | 102     | 5510            | 17.09               | 17.50         | 88.50        |
|             |                      | 110     | 5550            | 18.24               | 18.50         |              |
|             |                      | 126     | 5630            | 18.09               | 18.50         |              |
|             |                      | 134     | 5670            | 18.19               | 18.50         |              |
|             |                      | 142     | 5710            | 18.38               | 18.50         |              |
|             | 802.11ax HEW80 Nss1  | 106     | 5530            | 18.26               | 18.50         | 92.50        |
|             |                      | 122     | 5610            | 18.16               | 18.50         |              |
|             |                      | 138     | 5690            | 18.21               | 18.50         |              |
|             | 802.11ax HEW160 Nss1 | 114     | 5570            | 18.19               | 18.50         | 90.30        |

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.8GHz WLAN | 802.11ax HEW20 Nss1 | 149     | 5745            | 24.27               | 24.50         | 88.60        |
|             |                     | 157     | 5785            | 24.39               | 24.50         |              |
|             |                     | 165     | 5825            | 24.38               | 24.50         |              |
|             | 802.11ax HEW40 Nss1 | 151     | 5755            | 24.40               | 24.50         | 88.50        |
|             |                     | 159     | 5795            | 24.22               | 24.50         |              |
|             | 802.11ax HEW80 Nss1 | 155     | 5775            | 23.10               | 23.50         | 92.50        |

**<Radio 2>**
**<5GHz WLAN ANT1+2+3+4>**

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.2GHz WLAN | 802.11ax HEW20 Nss1 | 36      | 5180            | 16.92               | 17.00         | 88.30        |
|             |                     | 40      | 5200            | 20.89               | 21.00         |              |
|             |                     | 44      | 5220            | 20.55               | 21.00         |              |
|             |                     | 48      | 5240            | 25.17               | 25.50         |              |
|             | 802.11ax HEW40 Nss1 | 38      | 5190            | 16.47               | 16.50         | 88.10        |
|             |                     | 46      | 5230            | 21.40               | 21.50         |              |
|             | 802.11ax HEW80 Nss1 | 42      | 5210            | 18.57               | 19.00         | 93.80        |

|             | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.3GHz WLAN | 802.11ax HEW20 Nss1  | 52      | 5260            | 19.15               | 19.50         | 88.30        |
|             |                      | 56      | 5280            | 19.01               | 19.50         |              |
|             |                      | 60      | 5300            | 19.13               | 19.50         |              |
|             |                      | 64      | 5320            | 19.87               | 20.00         |              |
|             | 802.11ax HEW40 Nss1  | 54      | 5270            | 18.96               | 19.00         | 88.10        |
|             |                      | 62      | 5310            | 19.07               | 19.50         |              |
|             | 802.11ax HEW80 Nss1  | 58      | 5290            | 19.14               | 19.50         | 93.80        |
|             | 802.11ax HEW160 Nss1 | 50      | 5250            | 10.08               | 10.50         | 91.20        |

|             | Mode                 | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|----------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.5GHz WLAN | 802.11ax HEW20 Nss1  | 100     | 5500            | 19.02               | 19.50         | 88.30        |
|             |                      | 116     | 5580            | 19.12               | 19.50         |              |
|             |                      | 124     | 5620            | 19.00               | 19.50         |              |
|             |                      | 132     | 5660            | 19.02               | 19.50         |              |
|             |                      | 144     | 5720            | 18.04               | 18.50         |              |
|             | 802.11ax HEW40 Nss1  | 102     | 5510            | 18.34               | 18.50         | 88.10        |
|             |                      | 110     | 5550            | 19.09               | 19.50         |              |
|             |                      | 126     | 5630            | 19.02               | 19.50         |              |
|             |                      | 134     | 5670            | 19.11               | 19.50         |              |
|             | 802.11ax HEW80 Nss1  | 142     | 5710            | 18.96               | 19.00         | 93.80        |
|             |                      | 106     | 5530            | 19.08               | 19.50         |              |
|             |                      | 122     | 5610            | 19.05               | 19.50         |              |
|             |                      | 138     | 5690            | 18.95               | 19.00         | 92.10        |
|             | 802.11ax HEW160 Nss1 | 114     | 5570            | 18.93               | 19.00         |              |

|             | Mode                | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
|-------------|---------------------|---------|-----------------|---------------------|---------------|--------------|
| 5.8GHz WLAN | 802.11ax HEW20 Nss1 | 149     | 5745            | 25.14               | 25.50         | 88.30        |
|             |                     | 157     | 5785            | 25.03               | 25.50         |              |
|             |                     | 165     | 5825            | 25.16               | 25.50         |              |
|             | 802.11ax HEW40 Nss1 | 151     | 5755            | 25.12               | 25.50         | 88.10        |
|             |                     | 159     | 5795            | 25.10               | 25.50         |              |
|             | 802.11ax HEW80 Nss1 | 155     | 5775            | 23.77               | 24.00         | 93.80        |

**<2.4GHz Bluetooth>**

| Mode          | Channel | Frequency (MHz) | Average power (dBm) |
|---------------|---------|-----------------|---------------------|
|               |         |                 | 1Mbps               |
| LE            | CH 00   | 2402            | 1.38                |
|               | CH 13   | 2440            | 1.67                |
|               | CH 27   | 2480            | 1.65                |
| Tune-up Limit |         |                 | 2.00                |

**General Note:**

- For 2.4GHz Bluetooth SAR testing was selected 1Mbps.

**<2.4GHz Thread>**

| Mode          | Channel | Frequency (MHz) | Average power (dBm) |
|---------------|---------|-----------------|---------------------|
| Thread        | CH11    | 2405            | 1.57                |
|               | CH18    | 2440            | 1.92                |
|               | CH26    | 2480            | -3.15               |
| Tune-up Limit |         |                 | 2.00                |

**General Note:**

- For 2.4GHz Thread SAR testing was selected 1Mbps.



## 11. SAR Test Results

### General Note:

1. Per KDB 447498 D01v06, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
  - a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
  - b. For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle)"
  - c. For Bluetooth/Thread: Reported SAR(W/kg)= Measured SAR(W/kg)\*Tune-up Scaling Factor
  - d. For WLAN: Reported SAR(W/kg)= Measured SAR(W/kg)\* Duty Cycle scaling factor \* Tune-up scaling factor
2. Per KDB 447498 D01v06, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the *reported* 1-g or 10-g SAR for the mid-band or highest output power channel is:
  - $\leq 0.8$  W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is  $\leq 100$  MHz
  - $\leq 0.6$  W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
  - $\leq 0.4$  W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is  $\geq 200$  MHz
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is  $\geq 0.8$  W/kg.

### WLAN Note:

1. Per KDB 248227 D01v02r02, for 2.4GHz 802.11g/n SAR testing is not required when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is  $\leq 1.2$  W/kg.
2. Per KDB 248227 D01v02r02, U-NII-1 SAR testing is not required when the U-NII-2A band highest reported SAR for a test configuration is  $\leq 1.2$  W/kg, SAR is not required for U-NII-1 band for Radio1 ANT 1+2.
3. Per KDB 248227 D01v02r02, U-NII-2A SAR testing is not required when the U-NII-1 band highest reported SAR for a test configuration is  $\leq 1.2$  W/kg, SAR is not required for U-NII-2A band for Radio2 ANT 1+2.
4. When the reported SAR of the test position is  $> 0.4$  W/kg, SAR is repeated for the 802.11 transmission mode 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 report SAR is  $\leq 0.8$  W/kg or all required test position are tested.
5. For all positions / configurations, when the reported SAR is  $> 0.8$  W/kg, SAR is measured for these test 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 channels are tested.
6. Per 201904 TCBC workshops, General principles of FCC KDB Publication 248227 D01 can be applied to determine the SAR Initial Test Configurations and test reduction for 802.11ax SAR testing. For the table below the 802.11ax maximum power is SU (non-OFDMA), and this device does not supports RU (OFDMA)
7. In applying the test guidance, the IEEE 802.11 mode with the maximum output power (out of all modes) should be considered for testing
8. For modes with the same maximum output power, the guidance from section 5.3.2 a) of FCC KDB Publication 248227 D01 should be applied, with 802.11ax being considered as the highest 802.11 mode for the appropriate frequency bands
9. During SAR testing the WLAN transmission was verified using a spectrum analyzer.

**11.1 Extremity SAR****<WLAN SAR>**

| Plot No. | Band       | Mode                | Test Position | Gap (mm) | Radio   | Antenna     | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 10g SAR (W/kg) | Reported 10g SAR (W/kg) |
|----------|------------|---------------------|---------------|----------|---------|-------------|-----|-------------|---------------------|---------------------|------------------------|--------------|---------------------------|------------------|-------------------------|-------------------------|
|          | WLAN2.4GHz | 802.11b 1Mbps       | Front Face    | 0mm      | Radio 1 | Ant 1       | 6   | 2437        | 22.93               | 23.00               | 1.016                  | 94.60        | 1.057                     | 0.01             | 0.485                   | 0.521                   |
|          | WLAN2.4GHz | 802.11b 1Mbps       | Edge 1        | 0mm      | Radio 1 | Ant 1       | 6   | 2437        | 22.93               | 23.00               | 1.016                  | 94.60        | 1.057                     | 0.06             | 0.263                   | 0.283                   |
|          | WLAN2.4GHz | 802.11b 1Mbps       | Edge 2        | 0mm      | Radio 1 | Ant 1       | 6   | 2437        | 22.93               | 23.00               | 1.016                  | 94.60        | 1.057                     | -0.01            | 0.071                   | 0.076                   |
|          | WLAN2.4GHz | 802.11b 1Mbps       | Edge 4        | 0mm      | Radio 1 | Ant 1       | 6   | 2437        | 22.93               | 23.00               | 1.016                  | 94.60        | 1.057                     | 0.03             | 0.303                   | 0.325                   |
|          | WLAN2.4GHz | 802.11ax HEW20 Nss2 | Front Face    | 0mm      | Radio 1 | Ant 1+2     | 6   | 2437        | 23.17               | 23.50               | 1.079                  | 97.20        | 1.029                     | 0.1              | 0.253                   | 0.281                   |
|          | WLAN2.4GHz | 802.11ax HEW20 Nss2 | Edge 1        | 0mm      | Radio 1 | Ant 1+2     | 6   | 2437        | 23.17               | 23.50               | 1.079                  | 97.20        | 1.029                     | -0.05            | 0.146                   | 0.162                   |
|          | WLAN2.4GHz | 802.11ax HEW20 Nss2 | Edge 2        | 0mm      | Radio 1 | Ant 1+2     | 6   | 2437        | 23.17               | 23.50               | 1.079                  | 97.20        | 1.029                     | 0.06             | 0.038                   | 0.042                   |
|          | WLAN2.4GHz | 802.11ax HEW20 Nss2 | Edge 4        | 0mm      | Radio 1 | Ant 1+2     | 6   | 2437        | 23.17               | 23.50               | 1.079                  | 97.20        | 1.029                     | 0.01             | 0.181                   | 0.201                   |
| 01       | WLAN2.4GHz | 802.11b 1Mbps       | Front Face    | 0mm      | Radio 1 | Ant 1+2+3+4 | 6   | 2437        | 28.09               | 28.50               | 1.099                  | 94.90        | 1.054                     | -0.06            | 0.499                   | 0.578                   |
|          | WLAN2.4GHz | 802.11b 1Mbps       | Edge 1        | 0mm      | Radio 1 | Ant 1+2+3+4 | 6   | 2437        | 28.09               | 28.50               | 1.099                  | 94.90        | 1.054                     | -0.17            | 0.482                   | 0.558                   |
|          | WLAN2.4GHz | 802.11b 1Mbps       | Edge 2        | 0mm      | Radio 1 | Ant 1+2+3+4 | 6   | 2437        | 28.09               | 28.50               | 1.099                  | 94.90        | 1.054                     | -0.05            | 0.291                   | 0.337                   |
|          | WLAN2.4GHz | 802.11b 1Mbps       | Edge 4        | 0mm      | Radio 1 | Ant 1+2+3+4 | 6   | 2437        | 28.09               | 28.50               | 1.099                  | 94.90        | 1.054                     | -0.12            | 0.441                   | 0.511                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss2 | Front Face    | 0mm      | Radio 2 | Ant 1+2     | 40  | 5200        | 23.25               | 23.50               | 1.059                  | 97.00        | 1.031                     | 0.05             | 0.721                   | 0.787                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss2 | Edge 1        | 0mm      | Radio 2 | Ant 1+2     | 40  | 5200        | 23.25               | 23.50               | 1.059                  | 97.00        | 1.031                     | -0.07            | 0.430                   | 0.470                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss2 | Edge 2        | 0mm      | Radio 2 | Ant 1+2     | 40  | 5200        | 23.25               | 23.50               | 1.059                  | 97.00        | 1.031                     | -0.18            | 0.314                   | 0.343                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss2 | Edge 4        | 0mm      | Radio 2 | Ant 1+2     | 40  | 5200        | 23.25               | 23.50               | 1.059                  | 97.00        | 1.031                     | -0.11            | 0.067                   | 0.073                   |
| 02       | WLAN5GHz   | 802.11ax HEW20 Nss4 | Front Face    | 0mm      | Radio 1 | Ant 1+2+3+4 | 40  | 5200        | 25.88               | 26.00               | 1.028                  | 95.30        | 1.049                     | -0.13            | 1.400                   | 1.510                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss4 | Edge 1        | 0mm      | Radio 1 | Ant 1+2+3+4 | 40  | 5200        | 25.88               | 26.00               | 1.028                  | 95.30        | 1.049                     | -0.11            | 0.094                   | 0.101                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss4 | Edge 2        | 0mm      | Radio 1 | Ant 1+2+3+4 | 40  | 5200        | 25.88               | 26.00               | 1.028                  | 95.30        | 1.049                     | 0.15             | 0.061                   | 0.066                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss4 | Edge 4        | 0mm      | Radio 1 | Ant 1+2+3+4 | 40  | 5200        | 25.88               | 26.00               | 1.028                  | 95.30        | 1.049                     | -0.15            | 0.092                   | 0.099                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss4 | Front Face    | 0mm      | Radio 2 | Ant 1+2+3+4 | 40  | 5200        | 25.79               | 26.00               | 1.050                  | 95.30        | 1.049                     | -0.16            | 0.740                   | 0.815                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss4 | Edge 1        | 0mm      | Radio 2 | Ant 1+2+3+4 | 40  | 5200        | 25.79               | 26.00               | 1.050                  | 95.30        | 1.049                     | -0.05            | 0.380                   | 0.418                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss4 | Edge 2        | 0mm      | Radio 2 | Ant 1+2+3+4 | 40  | 5200        | 25.79               | 26.00               | 1.050                  | 95.30        | 1.049                     | -0.18            | 0.326                   | 0.359                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss4 | Edge 4        | 0mm      | Radio 2 | Ant 1+2+3+4 | 40  | 5200        | 25.79               | 26.00               | 1.050                  | 95.30        | 1.049                     | -0.17            | 0.201                   | 0.221                   |
|          | WLAN5GHz   | 802.11ax HEW40 Nss1 | Front Face    | 0mm      | Radio 1 | Ant 1       | 54  | 5270        | 20.10               | 20.50               | 1.096                  | 96.30        | 1.038                     | 0.16             | 1.470                   | 1.673                   |
|          | WLAN5GHz   | 802.11ax HEW40 Nss1 | Edge 1        | 0mm      | Radio 1 | Ant 1       | 54  | 5270        | 20.10               | 20.50               | 1.096                  | 96.30        | 1.038                     | -0.03            | 0.048                   | 0.055                   |
|          | WLAN5GHz   | 802.11ax HEW40 Nss1 | Edge 2        | 0mm      | Radio 1 | Ant 1       | 54  | 5270        | 20.10               | 20.50               | 1.096                  | 96.30        | 1.038                     | 0.12             | 0.005                   | 0.006                   |
|          | WLAN5GHz   | 802.11ax HEW40 Nss1 | Edge 4        | 0mm      | Radio 1 | Ant 1       | 54  | 5270        | 20.10               | 20.50               | 1.096                  | 96.30        | 1.038                     | 0.03             | 0.028                   | 0.032                   |
|          | WLAN5GHz   | 802.11a 6Mbps       | Front Face    | 0mm      | Radio 2 | Ant 1       | 60  | 5300        | 20.67               | 21.00               | 1.079                  | 94.40        | 1.059                     | -0.04            | 0.712                   | 0.814                   |
|          | WLAN5GHz   | 802.11a 6Mbps       | Edge 1        | 0mm      | Radio 2 | Ant 1       | 60  | 5300        | 20.67               | 21.00               | 1.079                  | 94.40        | 1.059                     | -0.17            | 0.352                   | 0.402                   |
|          | WLAN5GHz   | 802.11a 6Mbps       | Edge 2        | 0mm      | Radio 2 | Ant 1       | 60  | 5300        | 20.67               | 21.00               | 1.079                  | 94.40        | 1.059                     | -0.08            | 0.273                   | 0.312                   |
|          | WLAN5GHz   | 802.11a 6Mbps       | Edge 4        | 0mm      | Radio 2 | Ant 1       | 60  | 5300        | 20.67               | 21.00               | 1.079                  | 94.40        | 1.059                     | -0.17            | 0.025                   | 0.029                   |
| 03       | WLAN5GHz   | 802.11ax HEW20 Nss2 | Front Face    | 0mm      | Radio 1 | Ant 1+2     | 60  | 5300        | 23.55               | 24.00               | 1.109                  | 97.20        | 1.029                     | 0.04             | 1.660                   | 1.895                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss2 | Edge 1        | 0mm      | Radio 1 | Ant 1+2     | 60  | 5300        | 23.55               | 24.00               | 1.109                  | 97.20        | 1.029                     | -0.15            | 0.060                   | 0.068                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss2 | Edge 2        | 0mm      | Radio 1 | Ant 1+2     | 60  | 5300        | 23.55               | 24.00               | 1.109                  | 97.20        | 1.029                     | 0.09             | 0.035                   | 0.040                   |
|          | WLAN5GHz   | 802.11ax HEW20 Nss2 | Edge 4        | 0mm      | Radio 1 | Ant 1+2     | 60  | 5300        | 23.55               | 24.00               | 1.109                  | 97.20        | 1.029                     | 0.16             | 0.056                   | 0.064                   |



| Plot No. | Band     | Mode                | Test Position | Gap (mm) | Radio   | Antenna     | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 10g SAR (W/kg) | Reported 10g SAR (W/kg) |
|----------|----------|---------------------|---------------|----------|---------|-------------|-----|-------------|---------------------|---------------------|------------------------|--------------|---------------------------|------------------|-------------------------|-------------------------|
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Front Face    | 0mm      | Radio 1 | Ant 1       | 100 | 5500        | 18.02               | 18.50               | 1.117                  | 98.40        | 1.016                     | 0.16             | 1.080                   | 1.226                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Edge 1        | 0mm      | Radio 1 | Ant 1       | 100 | 5500        | 18.02               | 18.50               | 1.117                  | 98.40        | 1.016                     | -0.06            | 0.019                   | 0.022                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Edge 2        | 0mm      | Radio 1 | Ant 1       | 100 | 5500        | 18.02               | 18.50               | 1.117                  | 98.40        | 1.016                     | 0                | 0.001                   | 0.001                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Edge 4        | 0mm      | Radio 1 | Ant 1       | 100 | 5500        | 18.02               | 18.50               | 1.117                  | 98.40        | 1.016                     | -0.03            | 0.021                   | 0.024                   |
| 04       | WLAN5GHz | 802.11ax HEW20 Nss1 | Front Face    | 0mm      | Radio 2 | Ant 1       | 116 | 5580        | 21.08               | 21.50               | 1.102                  | 98.60        | 1.014                     | 0                | 1.230                   | 1.374                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Edge 1        | 0mm      | Radio 2 | Ant 1       | 116 | 5580        | 21.08               | 21.50               | 1.102                  | 98.60        | 1.014                     | -0.11            | 0.331                   | 0.370                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Edge 2        | 0mm      | Radio 2 | Ant 1       | 116 | 5580        | 21.08               | 21.50               | 1.102                  | 98.60        | 1.014                     | -0.09            | 0.339                   | 0.379                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Edge 4        | 0mm      | Radio 2 | Ant 1       | 116 | 5580        | 21.08               | 21.50               | 1.102                  | 98.60        | 1.014                     | -0.11            | 0.028                   | 0.031                   |
|          | WLAN5GHz | 802.11ax HEW80 Nss2 | Front Face    | 0mm      | Radio 1 | Ant 1+2     | 122 | 5610        | 20.89               | 21.00               | 1.026                  | 91.50        | 1.093                     | -0.02            | 1.120                   | 1.256                   |
|          | WLAN5GHz | 802.11ax HEW80 Nss2 | Edge 1        | 0mm      | Radio 1 | Ant 1+2     | 122 | 5610        | 20.89               | 21.00               | 1.026                  | 91.50        | 1.093                     | -0.1             | 0.043                   | 0.048                   |
|          | WLAN5GHz | 802.11ax HEW80 Nss2 | Edge 2        | 0mm      | Radio 1 | Ant 1+2     | 122 | 5610        | 20.89               | 21.00               | 1.026                  | 91.50        | 1.093                     | -0.01            | 0.028                   | 0.031                   |
|          | WLAN5GHz | 802.11ax HEW80 Nss2 | Edge 4        | 0mm      | Radio 1 | Ant 1+2     | 122 | 5610        | 20.89               | 21.00               | 1.026                  | 91.50        | 1.093                     | 0.12             | 0.032                   | 0.036                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss2 | Front Face    | 0mm      | Radio 2 | Ant 1+2     | 116 | 5580        | 23.76               | 24.00               | 1.057                  | 97.00        | 1.031                     | 0.06             | 1.240                   | 1.351                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss2 | Edge 1        | 0mm      | Radio 2 | Ant 1+2     | 116 | 5580        | 23.76               | 24.00               | 1.057                  | 97.00        | 1.031                     | -0.1             | 0.281                   | 0.306                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss2 | Edge 2        | 0mm      | Radio 2 | Ant 1+2     | 116 | 5580        | 23.76               | 24.00               | 1.057                  | 97.00        | 1.031                     | -0.11            | 0.409                   | 0.446                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss2 | Edge 4        | 0mm      | Radio 2 | Ant 1+2     | 116 | 5580        | 23.76               | 24.00               | 1.057                  | 97.00        | 1.031                     | -0.12            | 0.073                   | 0.080                   |
|          | WLAN5GHz | 802.11ax HEW80 Nss1 | Front Face    | 0mm      | Radio 1 | Ant 1+2+3+4 | 138 | 5690        | 23.43               | 23.50               | 1.016                  | 94.50        | 1.058                     | -0.04            | 0.857                   | 0.921                   |
|          | WLAN5GHz | 802.11ax HEW80 Nss1 | Edge 1        | 0mm      | Radio 1 | Ant 1+2+3+4 | 138 | 5690        | 23.43               | 23.50               | 1.016                  | 94.50        | 1.058                     | -0.06            | 0.057                   | 0.061                   |
|          | WLAN5GHz | 802.11ax HEW80 Nss1 | Edge 2        | 0mm      | Radio 1 | Ant 1+2+3+4 | 138 | 5690        | 23.43               | 23.50               | 1.016                  | 94.50        | 1.058                     | -0.03            | 0.036                   | 0.039                   |
|          | WLAN5GHz | 802.11ax HEW80 Nss1 | Edge 4        | 0mm      | Radio 1 | Ant 1+2+3+4 | 138 | 5690        | 23.43               | 23.50               | 1.016                  | 94.50        | 1.058                     | -0.15            | 0.039                   | 0.042                   |
|          | WLAN5GHz | 802.11ax HEW80 Nss4 | Front Face    | 0mm      | Radio 2 | Ant 1+2+3+4 | 138 | 5690        | 23.88               | 24.00               | 1.028                  | 89.00        | 1.124                     | -0.13            | 0.768                   | 0.887                   |
|          | WLAN5GHz | 802.11ax HEW80 Nss4 | Edge 1        | 0mm      | Radio 2 | Ant 1+2+3+4 | 138 | 5690        | 23.88               | 24.00               | 1.028                  | 89.00        | 1.124                     | -0.03            | 0.269                   | 0.311                   |
|          | WLAN5GHz | 802.11ax HEW80 Nss4 | Edge 2        | 0mm      | Radio 2 | Ant 1+2+3+4 | 138 | 5690        | 23.88               | 24.00               | 1.028                  | 89.00        | 1.124                     | -0.11            | 0.202                   | 0.233                   |
|          | WLAN5GHz | 802.11ax HEW80 Nss4 | Edge 4        | 0mm      | Radio 2 | Ant 1+2+3+4 | 138 | 5690        | 23.88               | 24.00               | 1.028                  | 89.00        | 1.124                     | -0.12            | 0.267                   | 0.309                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Front Face    | 0mm      | Radio 1 | Ant 1       | 165 | 5825        | 21.47               | 21.50               | 1.007                  | 98.40        | 1.016                     | 0                | 1.830                   | 1.872                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Edge 1        | 0mm      | Radio 1 | Ant 1       | 165 | 5825        | 21.47               | 21.50               | 1.007                  | 98.40        | 1.016                     | 0.12             | 0.083                   | 0.085                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Edge 2        | 0mm      | Radio 1 | Ant 1       | 165 | 5825        | 21.47               | 21.50               | 1.007                  | 98.40        | 1.016                     | -0.06            | 0.007                   | 0.007                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Edge 4        | 0mm      | Radio 1 | Ant 1       | 165 | 5825        | 21.47               | 21.50               | 1.007                  | 98.40        | 1.016                     | -0.03            | 0.060                   | 0.061                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss1 | Front Face    | 0mm      | Radio 2 | Ant 1       | 159 | 5795        | 22.84               | 23.00               | 1.038                  | 97.30        | 1.028                     | 0.1              | 1.170                   | 1.248                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss1 | Edge 1        | 0mm      | Radio 2 | Ant 1       | 159 | 5795        | 22.84               | 23.00               | 1.038                  | 97.30        | 1.028                     | -0.1             | 0.324                   | 0.346                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss1 | Edge 2        | 0mm      | Radio 2 | Ant 1       | 159 | 5795        | 22.84               | 23.00               | 1.038                  | 97.30        | 1.028                     | -0.1             | 0.277                   | 0.295                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss1 | Edge 4        | 0mm      | Radio 2 | Ant 1       | 159 | 5795        | 22.84               | 23.00               | 1.038                  | 97.30        | 1.028                     | -0.18            | 0.015                   | 0.016                   |
| 05       | WLAN5GHz | 802.11ax HEW40 Nss2 | Front Face    | 0mm      | Radio 1 | Ant 1+2     | 159 | 5795        | 24.36               | 24.50               | 1.033                  | 94.80        | 1.055                     | -0.04            | 2.650                   | 2.887                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss2 | Front Face    | 0mm      | Radio 1 | Ant 1+2     | 165 | 5825        | 24.48               | 24.50               | 1.005                  | 97.20        | 1.029                     | -0.04            | 2.630                   | 2.719                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss2 | Edge 1        | 0mm      | Radio 1 | Ant 1+2     | 159 | 5795        | 24.36               | 24.50               | 1.033                  | 94.80        | 1.055                     | 0.17             | 0.127                   | 0.138                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss2 | Edge 2        | 0mm      | Radio 1 | Ant 1+2     | 159 | 5795        | 24.36               | 24.50               | 1.033                  | 94.80        | 1.055                     | -0.05            | 0.053                   | 0.058                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss2 | Edge 4        | 0mm      | Radio 1 | Ant 1+2     | 159 | 5795        | 24.36               | 24.50               | 1.033                  | 94.80        | 1.055                     | -0.09            | 0.092                   | 0.100                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss2 | Front Face    | 0mm      | Radio 2 | Ant 1+2     | 159 | 5795        | 25.94               | 26.00               | 1.014                  | 94.80        | 1.055                     | 0.15             | 1.730                   | 1.851                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss2 | Edge 1        | 0mm      | Radio 2 | Ant 1+2     | 159 | 5795        | 25.94               | 26.00               | 1.014                  | 94.80        | 1.055                     | -0.04            | 0.435                   | 0.465                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss2 | Edge 2        | 0mm      | Radio 2 | Ant 1+2     | 159 | 5795        | 25.94               | 26.00               | 1.014                  | 94.80        | 1.055                     | -0.1             | 0.691                   | 0.739                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss2 | Edge 4        | 0mm      | Radio 2 | Ant 1+2     | 159 | 5795        | 25.94               | 26.00               | 1.014                  | 94.80        | 1.055                     | -0.14            | 0.062                   | 0.066                   |

| Plot No. | Band     | Mode                | Test Position | Gap (mm) | Radio   | Antenna     | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 10g SAR (W/kg) | Reported 10g SAR (W/kg) |
|----------|----------|---------------------|---------------|----------|---------|-------------|-----|-------------|---------------------|---------------------|------------------------|--------------|---------------------------|------------------|-------------------------|-------------------------|
|          | WLAN5GHz | 802.11ax HEW40 Nss1 | Front Face    | 0mm      | Radio 1 | Ant 1+2+3+4 | 159 | 5795        | 27.46               | 28.00               | 1.132                  | 97.00        | 1.031                     | -0.11            | 2.090                   | 2.440                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss1 | Front Face    | 0mm      | Radio 1 | Ant 1+2+3+4 | 151 | 5755        | 27.04               | 28.00               | 1.247                  | 97.00        | 1.031                     | -0.09            | 2.120                   | 2.726                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss1 | Edge 1        | 0mm      | Radio 1 | Ant 1+2+3+4 | 159 | 5795        | 27.46               | 28.00               | 1.132                  | 97.00        | 1.031                     | 0.02             | 0.146                   | 0.170                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss1 | Edge 2        | 0mm      | Radio 1 | Ant 1+2+3+4 | 159 | 5795        | 27.46               | 28.00               | 1.132                  | 97.00        | 1.031                     | -0.04            | 0.099                   | 0.116                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss1 | Edge 4        | 0mm      | Radio 1 | Ant 1+2+3+4 | 159 | 5795        | 27.46               | 28.00               | 1.132                  | 97.00        | 1.031                     | -0.13            | 0.136                   | 0.159                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Front Face    | 0mm      | Radio 2 | Ant 1+2+3+4 | 149 | 5745        | 28.52               | 29.00               | 1.117                  | 97.00        | 1.031                     | 0                | 1.770                   | 2.038                   |
|          | WLAN5GHz | 802.11ax HEW40 Nss1 | Front Face    | 0mm      | Radio 2 | Ant 1+2+3+4 | 159 | 5795        | 27.98               | 28.00               | 1.005                  | 94.50        | 1.058                     | -0.17            | 1.680                   | 1.786                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Edge 1        | 0mm      | Radio 2 | Ant 1+2+3+4 | 149 | 5745        | 28.52               | 29.00               | 1.117                  | 97.00        | 1.031                     | -0.02            | 0.622                   | 0.716                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Edge 2        | 0mm      | Radio 2 | Ant 1+2+3+4 | 149 | 5745        | 28.52               | 29.00               | 1.117                  | 97.00        | 1.031                     | -0.17            | 0.616                   | 0.709                   |
|          | WLAN5GHz | 802.11ax HEW20 Nss1 | Edge 4        | 0mm      | Radio 2 | Ant 1+2+3+4 | 149 | 5745        | 28.52               | 29.00               | 1.117                  | 97.00        | 1.031                     | -0.16            | 0.659                   | 0.759                   |

### <Bluetooth SAR>

| Plot No. | Band      | Mode  | Test Position | Gap (mm) | Radio   | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Power Drift (dB) | Measured 10g SAR (W/kg) | Reported 10g SAR (W/kg) |
|----------|-----------|-------|---------------|----------|---------|-----|-------------|---------------------|---------------------|------------------------|------------------|-------------------------|-------------------------|
| 06       | Bluetooth | 1Mbps | Front Face    | 0mm      | Radio 3 | 13  | 2440        | 1.67                | 2.00                | 1.079                  | 0.09             | 0.002                   | 0.002                   |
|          | Bluetooth | 1Mbps | Edge 1        | 0mm      | Radio 3 | 13  | 2440        | 1.67                | 2.00                | 1.079                  | 0                | 0.001                   | 0.001                   |
|          | Bluetooth | 1Mbps | Edge 2        | 0mm      | Radio 3 | 13  | 2440        | 1.67                | 2.00                | 1.079                  | 0                | 0.001                   | 0.001                   |
|          | Bluetooth | 1Mbps | Edge 4        | 0mm      | Radio 3 | 13  | 2440        | 1.67                | 2.00                | 1.079                  | 0                | 0.001                   | 0.001                   |

### <Thread SAR>

| Plot No. | Band   | Mode  | Test Position | Gap (mm) | Radio   | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Power Drift (dB) | Measured 10g SAR (W/kg) | Reported 10g SAR (W/kg) |
|----------|--------|-------|---------------|----------|---------|-----|-------------|---------------------|---------------------|------------------------|------------------|-------------------------|-------------------------|
| 07       | Thread | 1Mbps | Front Face    | 0mm      | Radio 3 | 18  | 2440        | 1.92                | 2.00                | 1.019                  | 0.01             | 0.005                   | 0.005                   |
|          | Thread | 1Mbps | Edge 1        | 0mm      | Radio 3 | 18  | 2440        | 1.92                | 2.00                | 1.019                  | 0                | 0.001                   | 0.001                   |
|          | Thread | 1Mbps | Edge 2        | 0mm      | Radio 3 | 18  | 2440        | 1.92                | 2.00                | 1.019                  | 0                | 0.001                   | 0.001                   |
|          | Thread | 1Mbps | Edge 4        | 0mm      | Radio 3 | 18  | 2440        | 1.92                | 2.00                | 1.019                  | 0                | 0.001                   | 0.001                   |

## 11.2 Repeated SAR Measurement

| No. | Band     | Mode                | Test Position | Gap (mm) | Radio   | Antenna | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 10g SAR (W/kg) | Ratio | Reported 10g SAR (W/kg) |
|-----|----------|---------------------|---------------|----------|---------|---------|-----|-------------|---------------------|---------------------|------------------------|--------------|---------------------------|------------------|-------------------------|-------|-------------------------|
| 1st | WLAN5GHz | 802.11ax HEW40 Nss2 | Front Face    | 0mm      | Radio 1 | Ant 1+2 | 159 | 5795        | 24.36               | 24.50               | 1.033                  | 94.80        | 1.055                     | -0.04            | 2.650                   | -     | 2.887                   |
| 2nd | WLAN5GHz | 802.11ax HEW40 Nss2 | Front Face    | 0mm      | Radio 1 | Ant 1+2 | 159 | 5795        | 24.36               | 24.50               | 1.033                  | 94.80        | 1.055                     | -0.14            | 2.590                   | 1.02  | 2.822                   |

### General Note:

- Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is  $\geq 0.8$ W/kg.
- Per KDB 865664 D01v01r04, if the ratio among the repeated measurement is  $\leq 1.2$  and the measured SAR  $< 1.45$ W/kg, only one repeated measurement is required.
- Per KDB 865664 D01v01r04, if the extremity repeated SAR is necessary, the same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.
- The ratio is the difference in percentage between original and repeated *measured* SAR.
- All measurement SAR result is scaled-up to account for tune-up tolerance and is compliant.

## 12. Simultaneous Transmission Analysis

| NO. | Simultaneous Transmission Configurations                        | Extremity |
|-----|-----------------------------------------------------------------|-----------|
| 1.  | WLAN2.4GHz (Radio 1) + WLAN 5GHz (Radio 2) + Bluetooth (Radio3) | Yes       |
| 2.  | WLAN 5GHz (Radio 1) + WLAN 5GHz (Radio 2) + Bluetooth (Radio3)  | Yes       |
| 3.  | WLAN2.4GHz (Radio 1) + WLAN 5GHz (Radio 2) + Thread (Radio3)    | Yes       |
| 4.  | WLAN 5GHz (Radio 1) + WLAN 5GHz (Radio 2) + Thread (Radio3)     | Yes       |

### General Note:

- The Scaled SAR summation is calculated based on the same configuration and test position.
- Per KDB 447498 D01v06, simultaneous transmission SAR is compliant if,
  - Scalar SAR summation  $< 1.6$ W/kg.
  - $SPLSR = (SAR1 + SAR2)^{1.5} / (\min. \text{ separation distance, mm})$ , and the peak separation distance is determined from the square root of  $[(x1-x2)^2 + (y1-y2)^2 + (z1-z2)^2]$ , where  $(x1, y1, z1)$  and  $(x2, y2, z2)$  are the coordinates of the extrapolated peak SAR locations in the zoom scan.
  - If  $SPLSR \leq 0.04$ , simultaneously transmission SAR measurement is not necessary.
  - Simultaneously transmission SAR measurement, and the reported multi-band SAR  $< 1.6$ W/kg.
  - The SPLSR calculated results please refer to section 12.2.

**12.1 Extremity Exposure Conditions**

| Exposure Position | 1                                | 2                                  | 3                                | 4                 | 5                              | 1+3+4<br>Summed<br>10g SAR<br>(W/kg) | 2+3+4<br>Summed<br>10g SAR<br>(W/kg) | 1+3+5<br>Summed<br>10g SAR<br>(W/kg) | 2+3+5<br>Summed<br>10g SAR<br>(W/kg) |
|-------------------|----------------------------------|------------------------------------|----------------------------------|-------------------|--------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
|                   | Radio 1<br>5GHz<br>WLAN<br>Ant 1 | Radio 1<br>2.4GHz<br>WLAN<br>Ant 1 | Radio 2<br>5GHz<br>WLAN<br>Ant 1 | Radio 3<br>Thread | Radio 3<br>Bluetooth<br>BT 4.2 |                                      |                                      |                                      |                                      |
|                   | 10g SAR<br>(W/kg)                | 10g SAR<br>(W/kg)                  | 10g SAR<br>(W/kg)                | 10g SAR<br>(W/kg) | 10g SAR<br>(W/kg)              |                                      |                                      |                                      |                                      |
| Front Face at 0mm | 1.872                            | 0.521                              | 1.374                            | 0.005             | 0.002                          | <b>3.251</b>                         | <b>1.900</b>                         | <b>3.248</b>                         | <b>1.897</b>                         |
| Edge 1 at 0mm     | 0.085                            | 0.283                              | 0.402                            | 0.001             | 0.001                          | <b>0.488</b>                         | <b>0.686</b>                         | <b>0.488</b>                         | <b>0.686</b>                         |
| Edge 2 at 0mm     | 0.007                            | 0.076                              | 0.379                            | 0.001             | 0.001                          | <b>0.387</b>                         | <b>0.456</b>                         | <b>0.387</b>                         | <b>0.456</b>                         |
| Edge 4 at 0mm     | 0.061                            | 0.325                              | 0.031                            | 0.001             | 0.001                          | <b>0.093</b>                         | <b>0.357</b>                         | <b>0.093</b>                         | <b>0.357</b>                         |

| Exposure Position | 1                               | 2                                    | 3                                  | 4                 | 5                              | 1+3+4<br>Summed<br>10g SAR<br>(W/kg) | 2+3+4<br>Summed<br>10g SAR<br>(W/kg) | 1+3+5<br>Summed<br>10g SAR<br>(W/kg) | 2+3+5<br>Summed<br>10g SAR<br>(W/kg) | 1+3+4<br>SPLSR | 1+3+4<br>Case<br>No | 1+3+5<br>SPLSR | 1+3+5<br>Case<br>No |
|-------------------|---------------------------------|--------------------------------------|------------------------------------|-------------------|--------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|----------------|---------------------|----------------|---------------------|
|                   | Radio 1<br>5GHz WLAN<br>Ant 1+2 | Radio 1<br>2.4GHz<br>WLAN<br>Ant 1+2 | Radio 2<br>5GHz<br>WLAN<br>Ant 1+2 | Radio 3<br>Thread | Radio 3<br>Bluetooth<br>BT 4.2 |                                      |                                      |                                      |                                      |                |                     |                |                     |
|                   | 10g SAR<br>(W/kg)               | 10g SAR<br>(W/kg)                    | 10g SAR<br>(W/kg)                  | 10g SAR<br>(W/kg) | 10g SAR<br>(W/kg)              |                                      |                                      |                                      |                                      |                |                     |                |                     |
| Front Face at 0mm | 2.887                           | 0.281                                | 1.851                              | 0.005             | 0.002                          | <b>4.743</b>                         | <b>2.137</b>                         | <b>4.740</b>                         | <b>2.134</b>                         | <b>0.08</b>    | <b>Case 1</b>       | <b>0.08</b>    | <b>Case 2</b>       |
| Edge 1 at 0mm     | 0.138                           | 0.162                                | 0.470                              | 0.001             | 0.001                          | <b>0.609</b>                         | <b>0.633</b>                         | <b>0.609</b>                         | <b>0.633</b>                         |                |                     |                |                     |
| Edge 2 at 0mm     | 0.058                           | 0.042                                | 0.739                              | 0.001             | 0.001                          | <b>0.798</b>                         | <b>0.782</b>                         | <b>0.798</b>                         | <b>0.782</b>                         |                |                     |                |                     |
| Edge 4 at 0mm     | 0.100                           | 0.201                                | 0.080                              | 0.001             | 0.001                          | <b>0.181</b>                         | <b>0.282</b>                         | <b>0.181</b>                         | <b>0.282</b>                         |                |                     |                |                     |

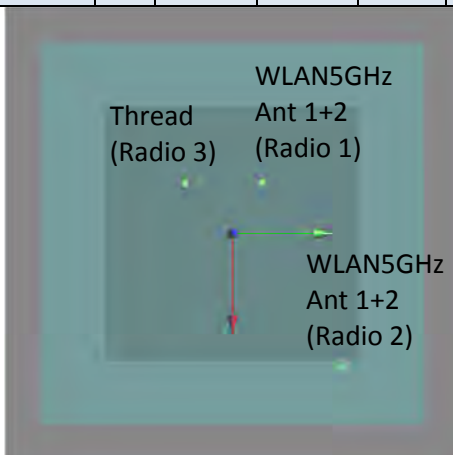
| Exposure Position | 1                                   | 2                                        | 3                                   | 4                 | 5                              | 1+3+4<br>Summed<br>10g SAR<br>(W/kg) | 2+3+4<br>Summed<br>10g SAR<br>(W/kg) | 1+3+5<br>Summed<br>10g SAR<br>(W/kg) | 2+3+5<br>Summed<br>10g SAR<br>(W/kg) | 1+3+4<br>SPLSR | 1+3+4<br>Case<br>No | 1+3+5<br>SPLSR | 1+3+5<br>Case<br>No |
|-------------------|-------------------------------------|------------------------------------------|-------------------------------------|-------------------|--------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|----------------|---------------------|----------------|---------------------|
|                   | Radio 1<br>5GHz WLAN<br>Ant 1+2+3+4 | Radio 1<br>2.4GHz<br>WLAN<br>Ant 1+2+3+4 | Radio 2<br>5GHz WLAN<br>Ant 1+2+3+4 | Radio 3<br>Thread | Radio 3<br>Bluetooth<br>BT 4.2 |                                      |                                      |                                      |                                      |                |                     |                |                     |
|                   | 10g SAR<br>(W/kg)                   | 10g SAR<br>(W/kg)                        | 10g SAR<br>(W/kg)                   | 10g SAR<br>(W/kg) | 10g SAR<br>(W/kg)              |                                      |                                      |                                      |                                      |                |                     |                |                     |
| Front Face at 0mm | 2.726                               | 0.578                                    | 2.038                               | 0.005             | 0.002                          | <b>4.769</b>                         | <b>2.621</b>                         | <b>4.766</b>                         | <b>2.618</b>                         | <b>0.08</b>    | <b>Case 3</b>       | <b>0.07</b>    | <b>Case 4</b>       |
| Edge 1 at 0mm     | 0.170                               | 0.558                                    | 0.716                               | 0.001             | 0.001                          | <b>0.887</b>                         | <b>1.275</b>                         | <b>0.887</b>                         | <b>1.275</b>                         |                |                     |                |                     |
| Edge 2 at 0mm     | 0.116                               | 0.337                                    | 0.709                               | 0.001             | 0.001                          | <b>0.826</b>                         | <b>1.047</b>                         | <b>0.826</b>                         | <b>1.047</b>                         |                |                     |                |                     |
| Edge 4 at 0mm     | 0.159                               | 0.511                                    | 0.759                               | 0.001             | 0.001                          | <b>0.919</b>                         | <b>1.271</b>                         | <b>0.919</b>                         | <b>1.271</b>                         |                |                     |                |                     |

## 12.2 SPLSR Evaluation and Analysis

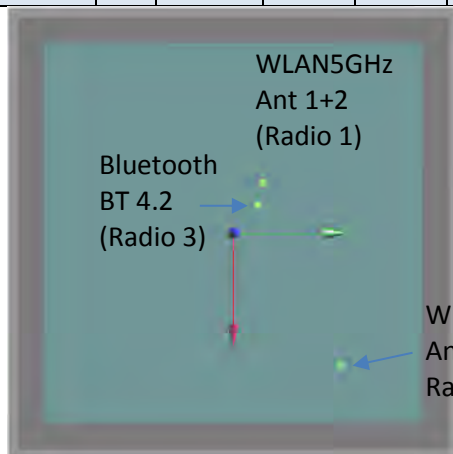
**General Note:**

1.  $SPLSR = (SAR_1 + SAR_2)^{1.5} / (\text{min. separation distance, mm})$ . If  $SPLSR \leq 0.04$ , simultaneously transmission SAR measurement is not necessary

|        | Band                       | Position   | SAR (W/kg) | Gap  | SAR peak location (mm) |       |      | 3D distance (mm) | Summed SAR (W/kg) | SPLSR Results | Simultaneous SAR |
|--------|----------------------------|------------|------------|------|------------------------|-------|------|------------------|-------------------|---------------|------------------|
|        |                            |            |            | (mm) | X                      | Y     | Z    |                  |                   |               |                  |
| Case 1 | WLAN5GHz Ant 1+2 (Radio 1) | Front Face | 2.887      | 0mm  | -40.4                  | 32    | 0.37 | 134.3            | 4.74              | 0.08          | Not required     |
|        | WLAN5GHz Ant 1+2 (Radio 2) |            | 1.851      | 0mm  | 88.8                   | 68.8  | 1.35 |                  |                   |               |                  |
|        | WLAN5GHz Ant 1+2 (Radio 2) | Front Face | 1.851      | 0mm  | 88.8                   | 68.8  | 1.35 | 164.1            | 1.86              | 0.02          | Not required     |
|        | Thread (Radio 3)           |            | 0.005      | 0mm  | -35.6                  | -38.2 | -1.3 |                  |                   |               |                  |
|        | WLAN5GHz Ant 1+2 (Radio 1) | Front Face | 2.887      | 0mm  | -40.4                  | 32    | 0.37 | 70.4             | 2.89              | 0.07          | Not required     |
|        | Thread (Radio 3)           |            | 0.005      | 0mm  | -35.6                  | -38.2 | -1.3 |                  |                   |               |                  |



| Case | Band                                                                      | Position   | SAR (W/kg) | Gap (mm) | SAR peak location (cm) |      |      | 3D distance (mm) | Summed SAR (W/kg) | SPLSR Results | Simultaneous SAR |
|------|---------------------------------------------------------------------------|------------|------------|----------|------------------------|------|------|------------------|-------------------|---------------|------------------|
|      |                                                                           |            |            |          | X                      | Y    | Z    |                  |                   |               |                  |
| 2    | WLAN5GHz<br>Ant 1+2<br>(Radio 1)<br>+<br>Bluetooth<br>BT 4.2<br>(Radio 3) | Front Face | 2.889      | 0mm      | -40.4                  | 32   | 0.37 | 134.3            | 4.74              | 0.08          | Not required     |
|      | WLAN5GHz<br>Ant 1+2<br>Radio 2                                            |            | 1.851      | 0mm      | 88.8                   | 68.8 | 1.35 |                  |                   |               |                  |



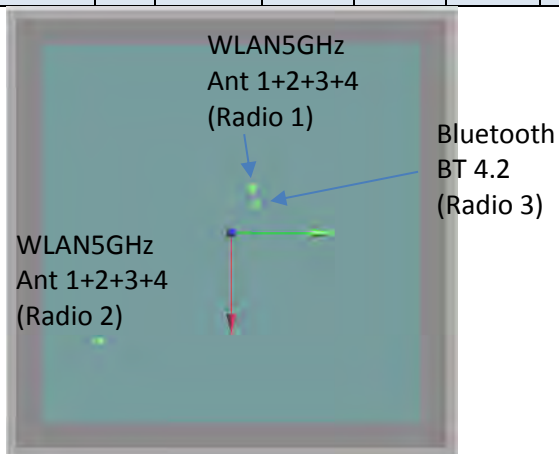
| Case 3                               | Band                                 | Position   | SAR (W/kg) | Gap   | SAR peak location (mm) |       |      | 3D distance | Summed SAR | SPLSR Results | Simultaneous SAR |
|--------------------------------------|--------------------------------------|------------|------------|-------|------------------------|-------|------|-------------|------------|---------------|------------------|
|                                      |                                      |            |            | (mm)  | X                      | Y     | Z    | (mm)        | (W/kg)     |               |                  |
|                                      | WLAN5GHz<br>Ant 1+2+3+4<br>(Radio 1) | Front Face | 2.726      | 0mm   | -21.2                  | 17.2  | -1.1 | 141.0       | 4.76       | 0.07          | Not required     |
|                                      | WLAN5GHz<br>Ant 1+2+3+4<br>(Radio 2) |            | 2.038      | 0mm   | 68                     | -92   | 0.86 |             |            |               |                  |
|                                      | WLAN5GHz<br>Ant 1+2+3+4<br>(Radio 2) | Front Face | 2.038      | 0mm   | 68                     | -92   | 0.86 | 116.8       | 2.04       | 0.03          | Not required     |
|                                      | Thread<br>(Radio 3)                  |            | 0.005      | 0mm   | -35.6                  | -38.2 | -1.3 |             |            |               |                  |
| WLAN5GHz<br>Ant 1+2+3+4<br>(Radio 1) | Front Face                           | 2.726      | 0mm        | -21.2 | 17.2                   | -1.1  | 57.2 | 2.73        | 0.08       | Not required  |                  |
| Thread<br>(Radio 3)                  |                                      | 0.005      | 0mm        | -35.6 | -38.2                  | -1.3  |      |             |            |               |                  |

WLAN5GHz  
Ant 1+2+3+4  
(Radio 2)

Thread  
(Radio 3)

WLAN5GHz  
Ant 1+2+3+4  
(Radio 1)

| Case | Band                                                                          | Position   | SAR (W/kg) | Gap (mm) | SAR peak location (cm) |      |      | 3D distance (mm) | Summed SAR (W/kg) | SPLSR Results | Simultaneous SAR |
|------|-------------------------------------------------------------------------------|------------|------------|----------|------------------------|------|------|------------------|-------------------|---------------|------------------|
|      |                                                                               |            |            |          | X                      | Y    | Z    |                  |                   |               |                  |
| 4    | WLAN5GHz<br>Ant 1+2+3+4<br>(Radio 1)<br>+<br>Bluetooth<br>BT 4.2<br>(Radio 3) | Front Face | 2.728      | 0mm      | -21.2                  | 17.2 | -1.1 | 141.0            | 4.77              | 0.07          | Not required     |
|      | WLAN5GHz<br>Ant 1+2+3+4<br>(Radio 2)                                          |            | 2.038      | 0mm      | 68                     | -92  | 0.86 |                  |                   |               |                  |



**Test Engineer :** Carter Jhuang Randy Lin Neil Hsiang Willy Yu Jay Jian and White Huang

### **13. Uncertainty Assessment**

Per KDB 865664 D01 SAR measurement 100MHz to 6GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg and the measured 10-g SAR within a frequency band is < 3.75 W/kg. The expanded SAR measurement uncertainty must be  $\leq 30\%$ , for a confidence interval of  $k = 2$ . If these conditions are met, extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. For this device, the highest measured 10-g SAR is less 3.75W/kg. Therefore, the measurement uncertainty table is not required in this report.

### **14. References**

- [1] FCC 47 CFR Part 2 "Frequency Allocations and Radio Treaty Matters; General Rules and Regulations"
- [2] ANSI/IEEE Std. C95.1-1992, "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz", September 1992
- [3] 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", Sep 2013
- [4] SPEAG DASY System Handbook
- [5] FCC KDB 248227 D01 v02r02, "SAR Guidance for IEEE 802.11 (WiFi) Transmitters", Oct 2015.
- [6] FCC KDB 447498 D01 v06, "Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies", Oct 2015
- [7] FCC KDB 865664 D01 v01r04, "SAR Measurement Requirements for 100 MHz to 6 GHz", Aug 2015.
- [8] FCC KDB 865664 D02 v01r02, "RF Exposure Compliance Reporting and Documentation Considerations" Oct 2015.

## System Check\_Head\_2450MHz

### DUT: D2450V2-736

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

Medium: HSL\_2450\_190411 Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.8$  S/m;  $\epsilon_r = 38.606$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.5 °C; Liquid Temperature : 22.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(7.42, 7.42, 7.42) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Pin=250mW/Area Scan (71x71x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 22.7 W/kg

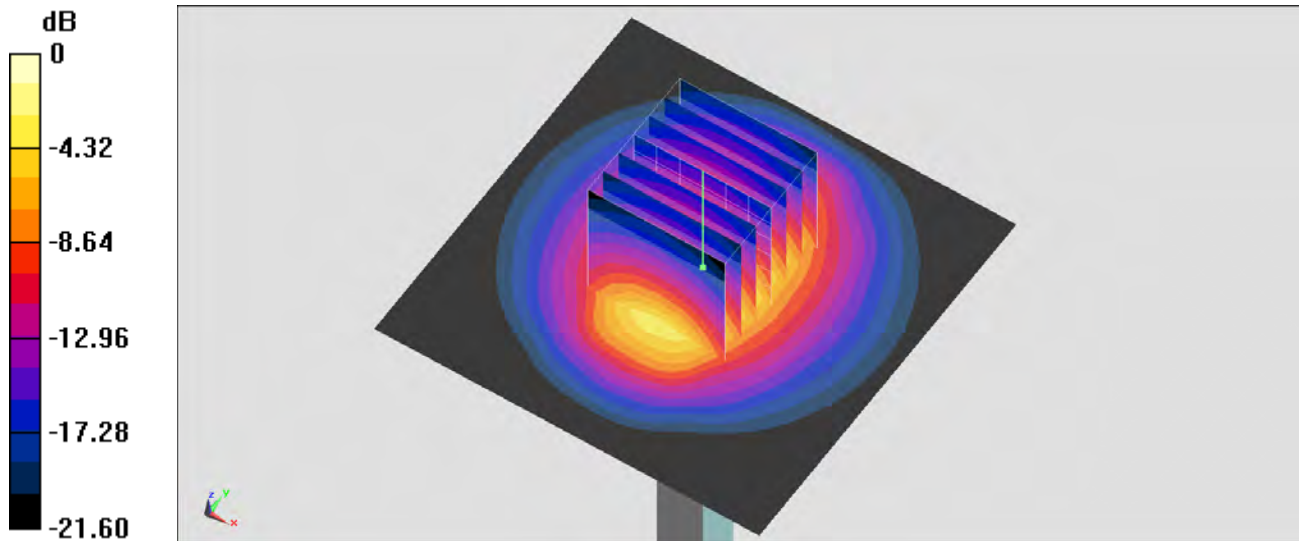
**Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 115.8 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 27.4 W/kg

**SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.41 W/kg**

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



0 dB = 22.3 W/kg = 13.48 dBW/kg

## System Check\_Head\_2450MHz

### DUT: D2450V2-929

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

Medium: HSL\_2450\_190418 Medium parameters used :  $f = 2450$  MHz;  $\sigma = 1.799$  S/m;  $\epsilon_r = 38.621$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.3 °C; Liquid Temperature : 22.3 °C

#### DASY5 Configuration:

- Probe: ES3DV3 - SN3270; ConvF(4.6, 4.6, 4.6) ; Calibrated: 2018/9/24
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 2018/9/19
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Pin=250mW/Area Scan (61x61x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 18.7 W/kg

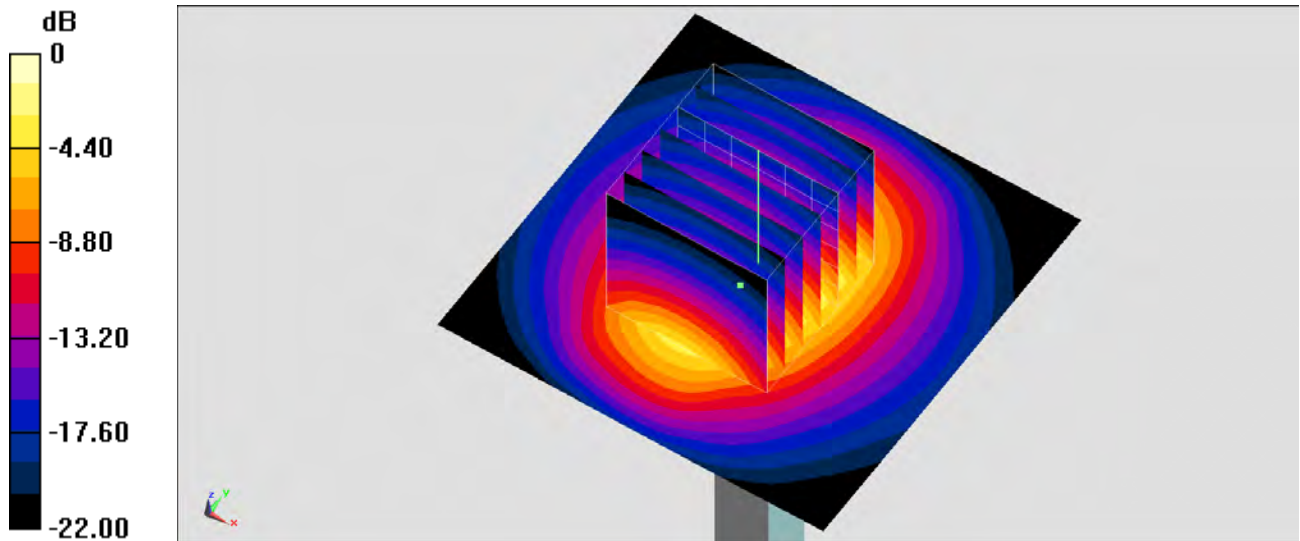
**Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 105.1 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 28.4 W/kg

**SAR(1 g) = 13.6 W/kg; SAR(10 g) = 6.26 W/kg**

Maximum value of SAR (measured) = 17.7 W/kg



0 dB = 17.7 W/kg = 12.48 dBW/kg

## System Check\_Head\_5250MHz

### DUT: D5GHzV2-1006

Communication System: CW; Frequency: 5250 MHz; Duty Cycle: 1:1

Medium: HSL\_5G\_190411 Medium parameters used :  $f = 5250$  MHz;  $\sigma = 4.585$  S/m;  $\epsilon_r = 35.103$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.2 °C; Liquid Temperature : 22.2 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(5.45, 5.45, 5.45) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Pin=100mW/Area Scan (71x71x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

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

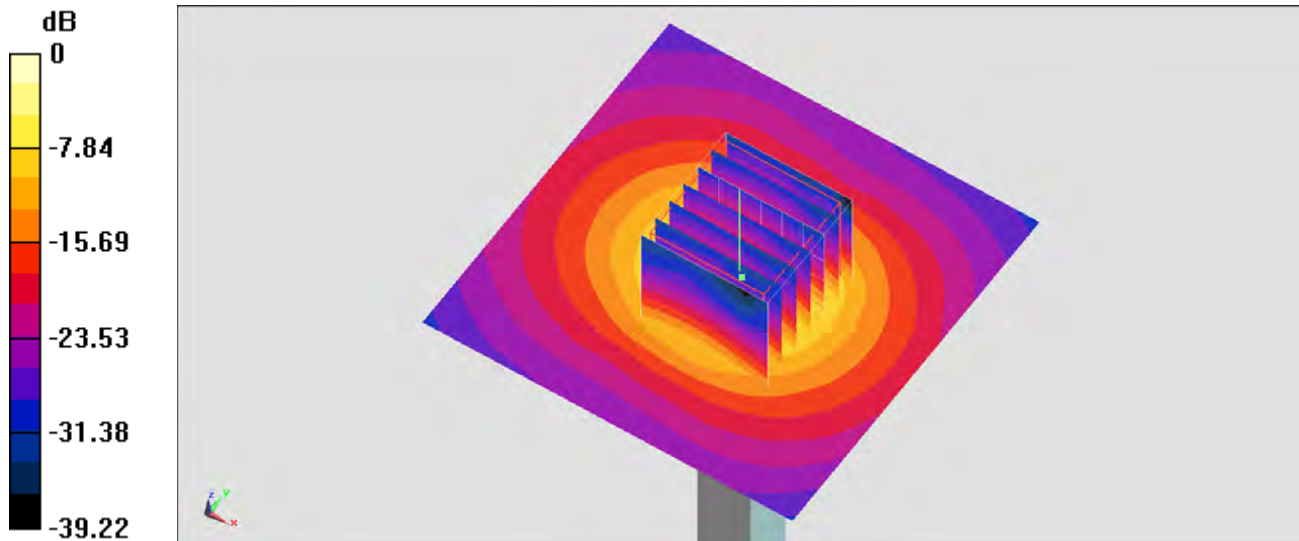
**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.94 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 32.6 W/kg

**SAR(1 g) = 8.04 W/kg; SAR(10 g) = 2.21 W/kg**

Maximum value of SAR (measured) = 19.8 W/kg



0 dB = 19.8 W/kg = 12.97 dBW/kg

## System Check\_Head\_5250MHz

### DUT: D5GHzV2-1006

Communication System: CW ; Frequency: 5250 MHz;Duty Cycle: 1:1

Medium: HSL\_5G\_190414 Medium parameters used:  $f = 5250$  MHz;  $\sigma = 4.568$  S/m;  $\epsilon_r = 35.053$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.4 °C ; Liquid Temperature : 22.4 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(5.45, 5.45, 5.45) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2);SEMCAD X Version 14.6.12 (7450)

**Pin=100mW/Area Scan (71x71x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 18.0 W/kg

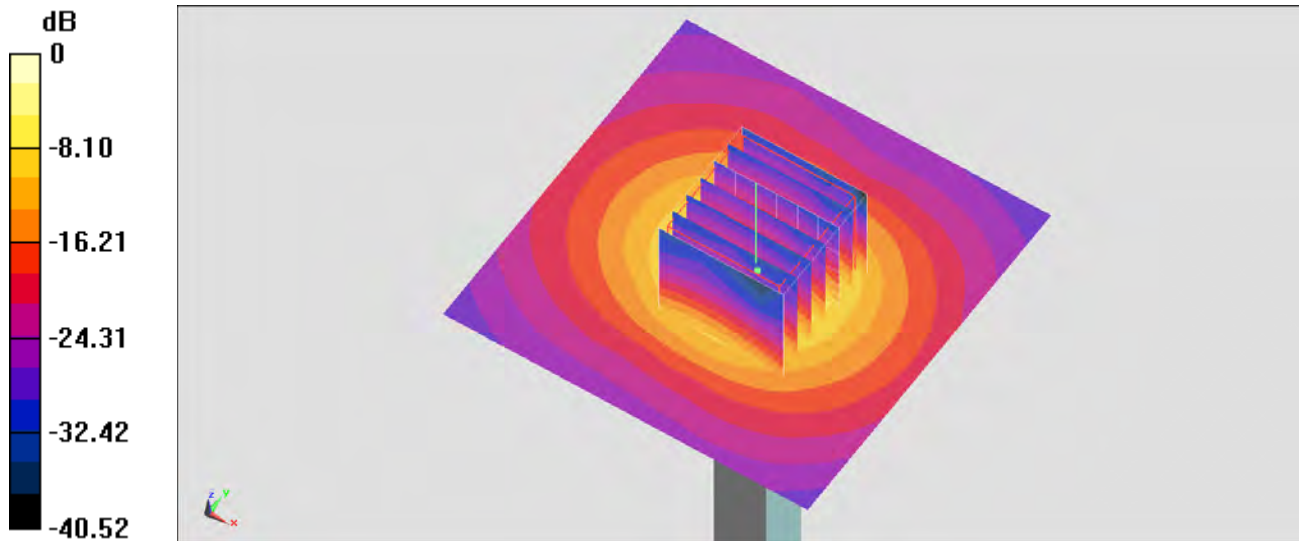
**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.94 V/m; Power Drift = -0.18 dB

Peak SAR (extrapolated) = 32.5 W/kg

**SAR(1 g) = 8.01 W/kg; SAR(10 g) = 2.2 W/kg**

Maximum value of SAR (measured) = 19.7 W/kg



0 dB = 19.7 W/kg = 12.94 dBW/kg

## System Check\_Head\_5250MHz

### DUT: D5GHzV2-1006

Communication System: CW; Frequency: 5250 MHz; Duty Cycle: 1:1

Medium: HSL\_5G\_190415 Medium parameters used :  $f = 5250$  MHz;  $\sigma = 4.698$  S/m;  $\epsilon_r = 36.852$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.6 °C; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(5.45, 5.45, 5.45) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Pin=100mW/Area Scan (71x71x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 17.2 W/kg

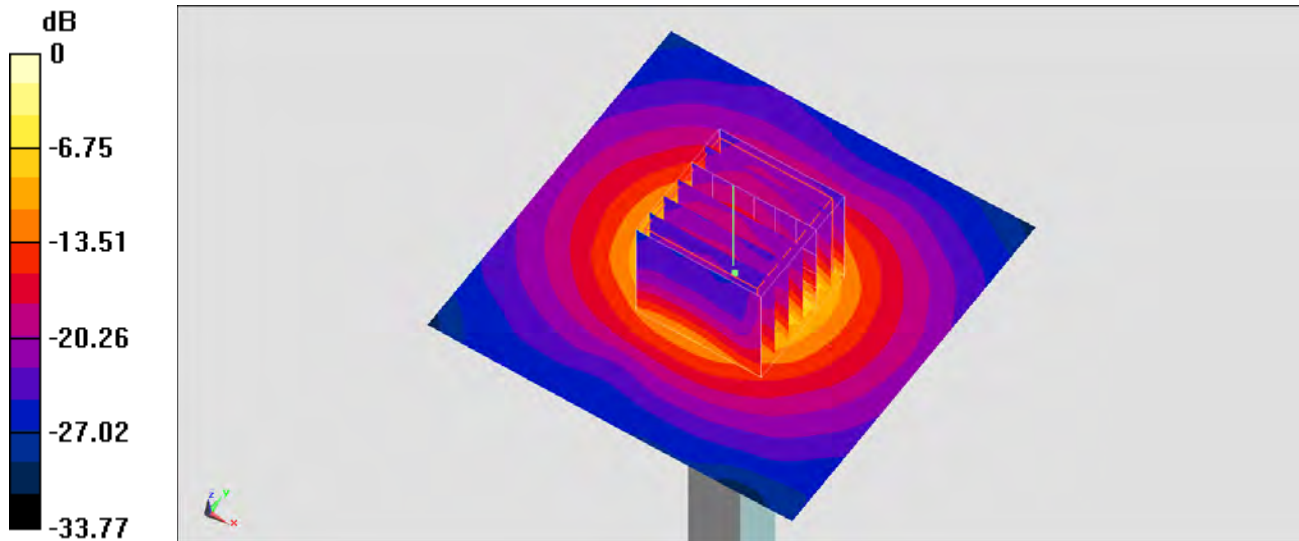
**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 69.35 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 32.2 W/kg

**SAR(1 g) = 8.39 W/kg; SAR(10 g) = 2.39 W/kg**

Maximum value of SAR (measured) = 20.4 W/kg



0 dB = 20.4 W/kg = 13.10 dBW/kg

## System Check\_Head\_5600MHz

### DUT: D5GHzV2-1006

Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1

Medium: HSL\_5G\_190411 Medium parameters used:  $f = 5600$  MHz;  $\sigma = 4.941$  S/m;  $\epsilon_r = 34.767$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.2 °C; Liquid Temperature : 22.2 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(4.83, 4.83, 4.83) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Pin=100mW/Area Scan (71x71x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

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

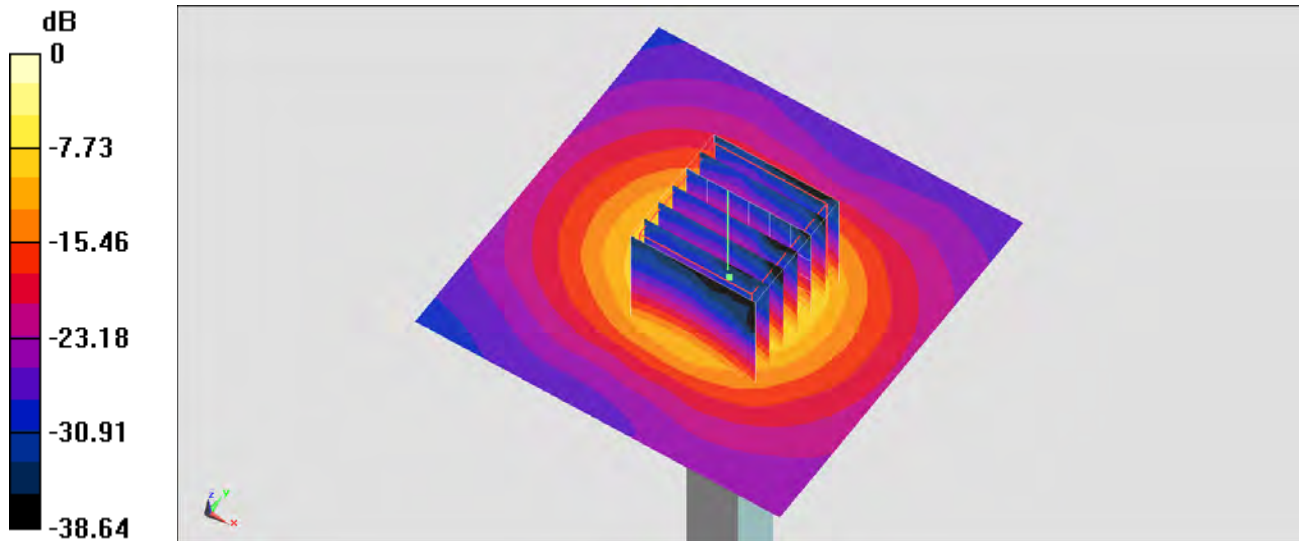
**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.54 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 36.6 W/kg

**SAR(1 g) = 8.28 W/kg; SAR(10 g) = 2.24 W/kg**

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



0 dB = 21.1 W/kg = 13.24 dBW/kg

## System Check\_Head\_5600MHz

### DUT: D5GHzV2-1006

Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1

Medium: HSL\_5G\_190414 Medium parameters used:  $f = 5600$  MHz;  $\sigma = 4.922$  S/m;  $\epsilon_r = 34.717$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.4 °C; Liquid Temperature : 22.4 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(4.83, 4.83, 4.83) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Pin=100mW/Area Scan (71x71x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 20.6 W/kg

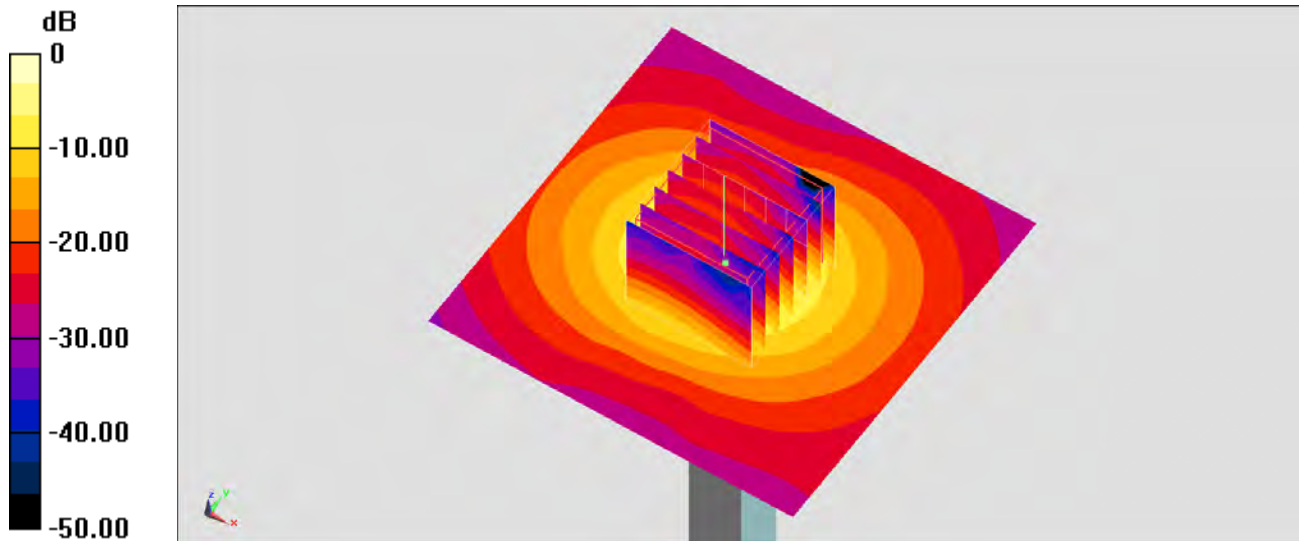
**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.30 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 36.2 W/kg

**SAR(1 g) = 8.49 W/kg; SAR(10 g) = 2.35 W/kg**

Maximum value of SAR (measured) = 21.4 W/kg



0 dB = 21.4 W/kg = 13.30 dBW/kg

## System Check\_Head\_5600MHz

### DUT: D5GHzV2-1006

Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1

Medium: HSL\_5G\_190415 Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.05$  S/m;  $\epsilon_r = 36.351$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.6 °C ; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(4.83, 4.83, 4.83) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Pin=100mW/Area Scan (71x71x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

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

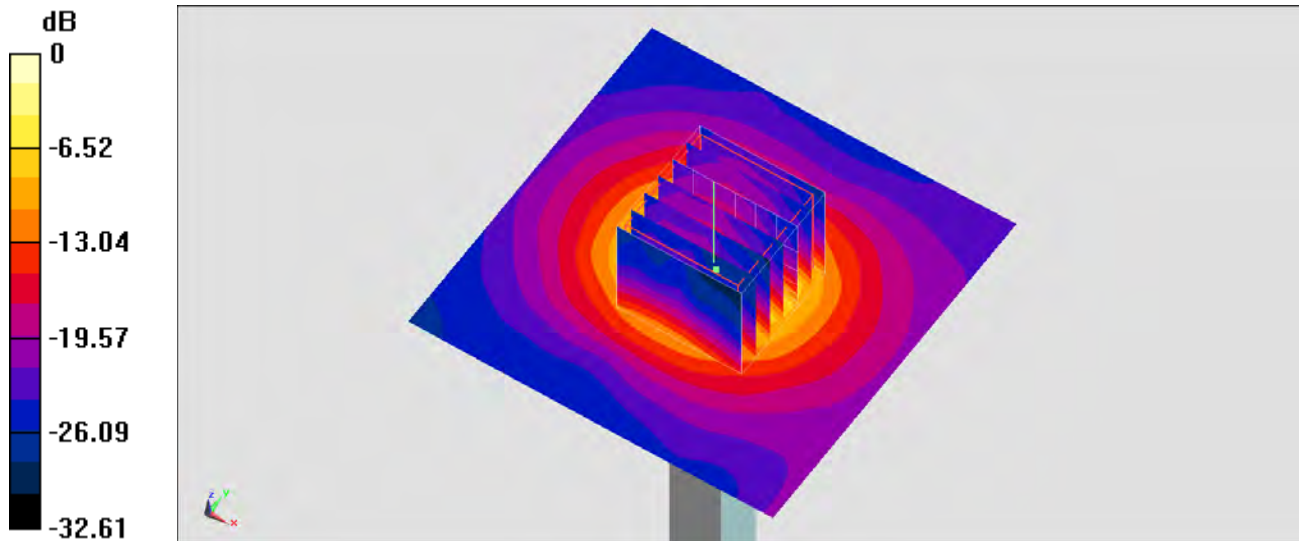
**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 72.78 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 35.5 W/kg

**SAR(1 g) = 8.49 W/kg; SAR(10 g) = 2.36 W/kg**

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



0 dB = 21.3 W/kg = 13.28 dBW/kg

## System Check\_Head\_5750MHz

### DUT: D5GHzV2-1006

Communication System: CW; Frequency: 5750 MHz; Duty Cycle: 1:1

Medium: HSL\_5G\_190411 Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.04$  S/m;  $\epsilon_r = 34.42$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.2 °C; Liquid Temperature : 22.2 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(4.95, 4.95, 4.95) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Pin=100mW/Area Scan (71x71x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 20.6 W/kg

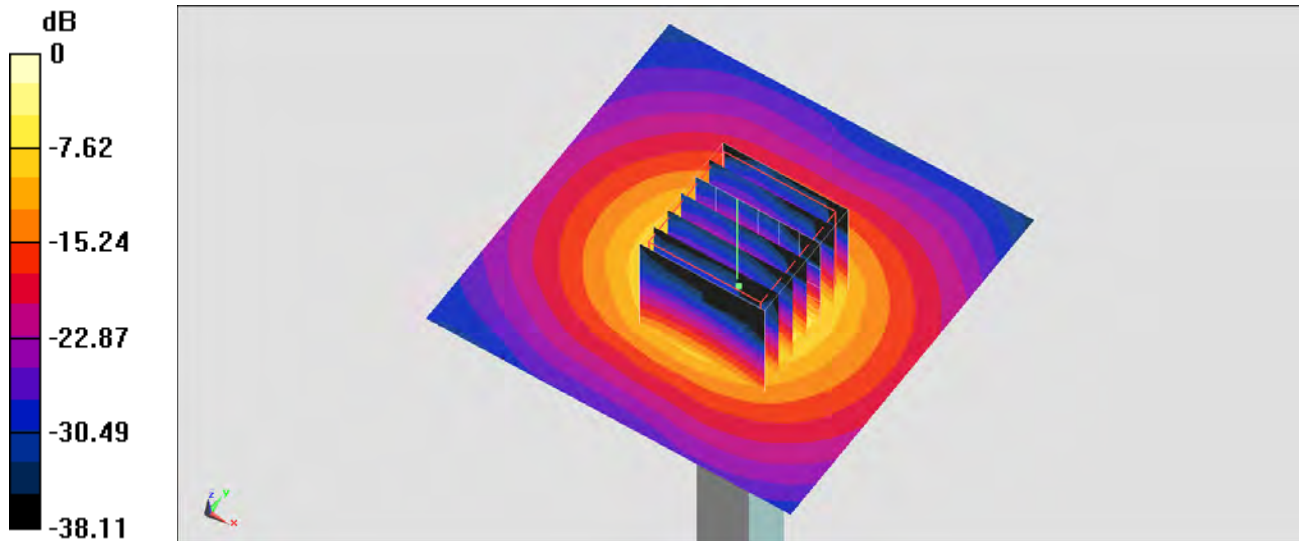
**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 70.36 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 35.2 W/kg

**SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.14 W/kg**

Maximum value of SAR (measured) = 20.4 W/kg



0 dB = 20.4 W/kg = 13.10 dBW/kg

## System Check\_Head\_5750MHz

### DUT: D5GHzV2-1006

Communication System: CW; Frequency: 5750 MHz; Duty Cycle: 1:1

Medium: HSL\_5G\_190414 Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.02$  S/m;  $\epsilon_r = 34.37$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.4 °C; Liquid Temperature : 22.4 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(4.95, 4.95, 4.95) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Pin=100mW/Area Scan (71x71x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 19.3 W/kg

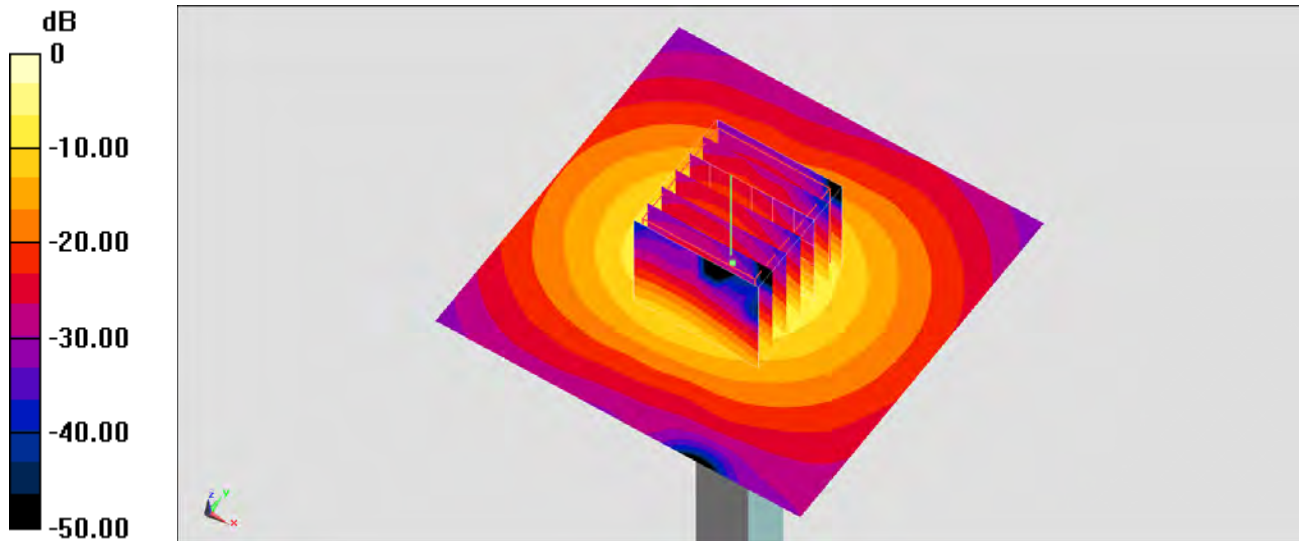
**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 68.99 V/m; Power Drift = 0.15 dB

Peak SAR (extrapolated) = 34.9 W/kg

**SAR(1 g) = 7.9 W/kg; SAR(10 g) = 2.2 W/kg**

Maximum value of SAR (measured) = 20.1 W/kg



0 dB = 20.1 W/kg = 13.03 dBW/kg

## System Check\_Head\_5750MHz

### DUT: D5GHzV2-1006

Communication System: CW; Frequency: 5750 MHz; Duty Cycle: 1:1

Medium: HSL\_5G\_190415 Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.218$  S/m;  $\epsilon_r = 36.128$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.6 °C ; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(4.95, 4.95, 4.95) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Pin=100mW/Area Scan (71x71x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 20.1 W/kg

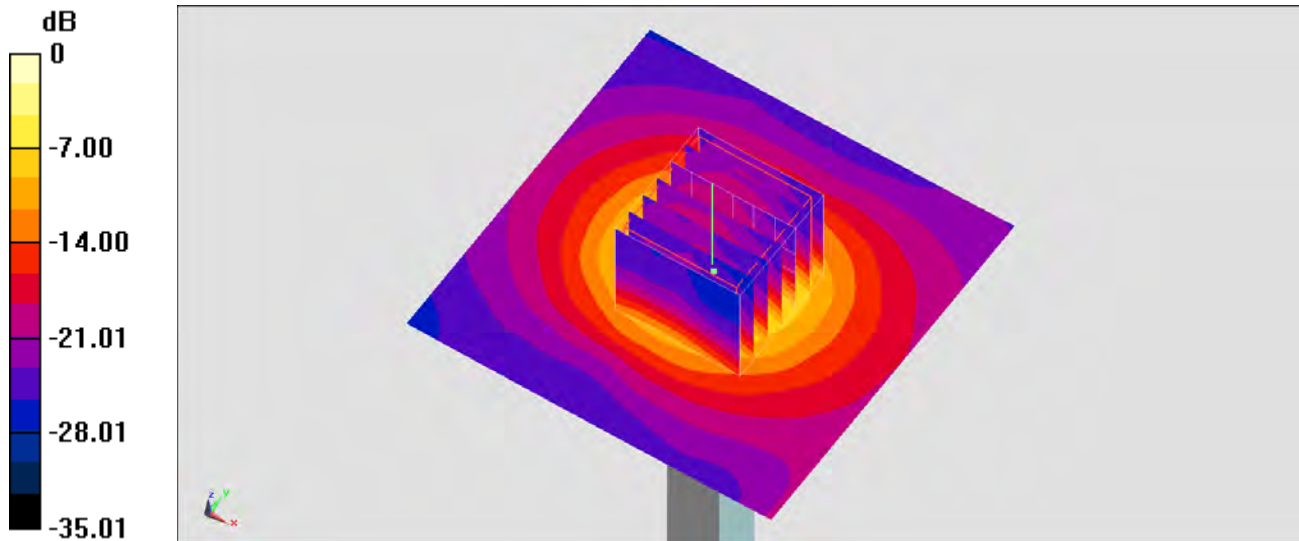
**Pin=100mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 70.44 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 35.2 W/kg

**SAR(1 g) = 8.15 W/kg; SAR(10 g) = 2.29 W/kg**

Maximum value of SAR (measured) = 20.7 W/kg



0 dB = 20.7 W/kg = 13.16 dBW/kg

**#01\_WLAN2.4GHz\_802.11b 1Mbps\_Front Face\_0mm\_Ch6;Ant 1+2+3+4**

Communication System: 802.11b ; Frequency: 2437 MHz; Duty Cycle: 1:1.054

Medium: HSL\_2450\_190411 Medium parameters used:  $f = 2437$  MHz;  $\sigma = 1.787$  S/m;  $\epsilon_r = 38.656$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.5 °C ; Liquid Temperature : 22.5 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(7.42, 7.42, 7.42) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Area Scan (261x261x1):** Interpolated grid:  $dx=1.200$  mm,  $dy=1.200$  mm

Maximum value of SAR (interpolated) = 1.18 W/kg

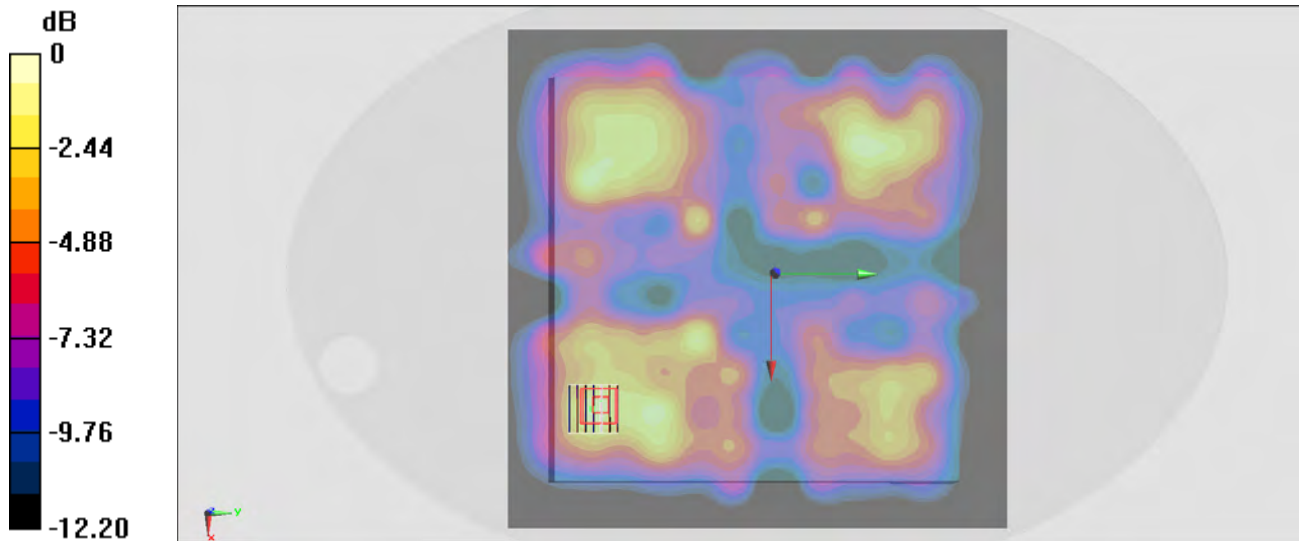
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 24.68 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 1.70 W/kg

**SAR(1 g) = 0.920 W/kg; SAR(10 g) = 0.499 W/kg**

Maximum value of SAR (measured) = 1.38 W/kg



0 dB = 1.38 W/kg = 1.40 dBW/kg

**#02\_WLAN5GHz\_802.11ax HEW20 Nss4\_Front Face\_0mm\_Ch40;Ant 1+2+3+4**

Communication System: 802.11ax; Frequency: 5200 MHz; Duty Cycle: 1:1.049

Medium: HSL\_5G\_190411 Medium parameters used:  $f = 5200$  MHz;  $\sigma = 4.496$  S/m;  $\epsilon_r = 35.202$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.2 °C; Liquid Temperature : 22.2 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(5.45, 5.45, 5.45) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Area Scan (301x301x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 5.19 W/kg

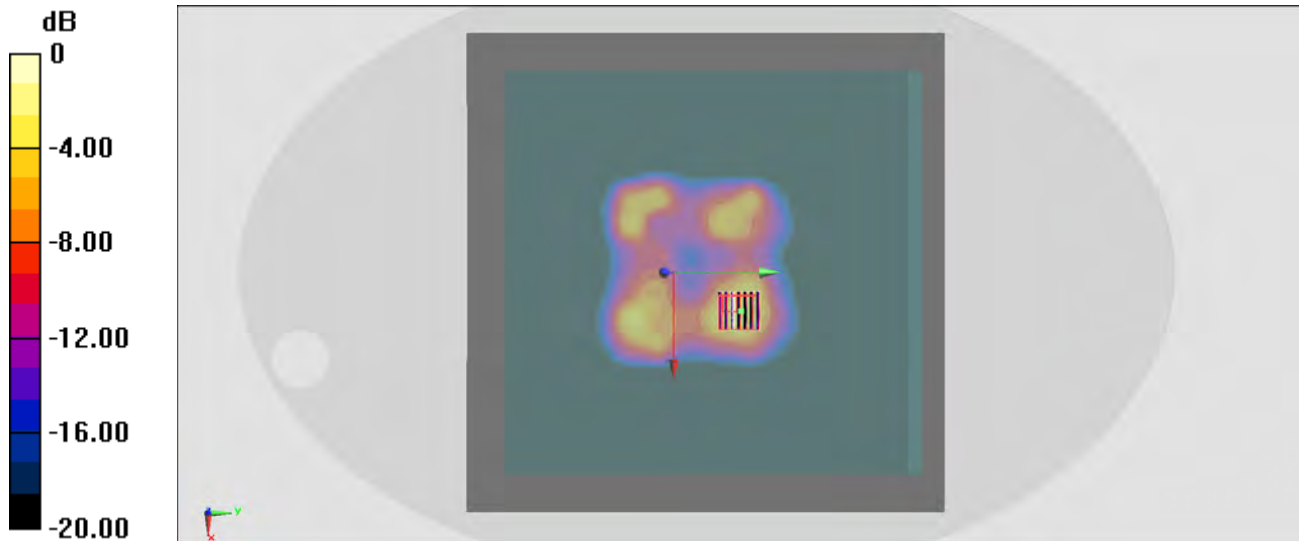
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 40.21 V/m; Power Drift = -0.13 dB

Peak SAR (extrapolated) = 16.1 W/kg

**SAR(1 g) = 4.23 W/kg; SAR(10 g) = 1.4 W/kg**

Maximum value of SAR (measured) = 10.1 W/kg



**#03\_WLAN5GHz\_802.11ax HEW20 Nss2\_Front Face\_0mm\_Ch60;Ant 1+2**

Communication System: 802.11ax; Frequency: 5300 MHz; Duty Cycle: 1:1.029

Medium: HSL\_5G\_190415 Medium parameters used :  $f = 5300$  MHz;  $\sigma = 4.744$  S/m;  $\epsilon_r = 36.749$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.6 °C; Liquid Temperature : 22.6 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(5.45, 5.45, 5.45) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Area Scan (301x301x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 6.42 W/kg

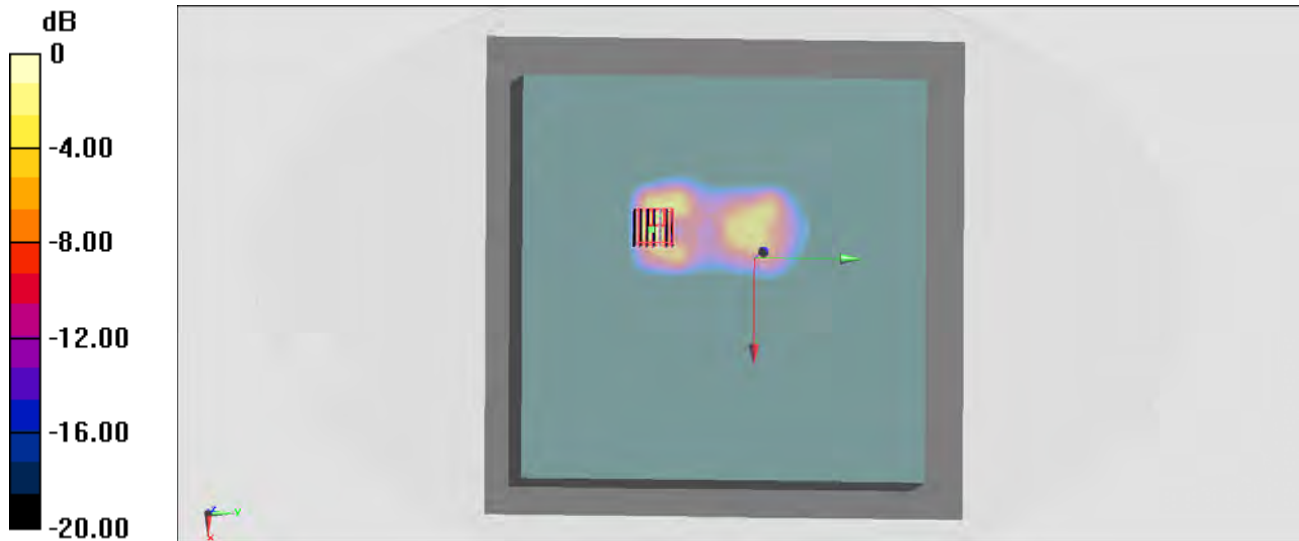
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 38.03 V/m; Power Drift = 0.04 dB

Peak SAR (extrapolated) = 20.5 W/kg

**SAR(1 g) = 5.56 W/kg; SAR(10 g) = 1.66 W/kg**

Maximum value of SAR (measured) = 13.6 W/kg



0 dB = 13.6 W/kg = 11.34 dBW/kg

**#04\_WLAN5GHz\_802.11ax HEW20 Nss1\_Front Face\_0mm\_Ch116;Ant 1**

Communication System: 802.11ax; Frequency: 5580 MHz; Duty Cycle: 1:1.0134

Medium: HSL\_5G\_190414 Medium parameters used:  $f = 5580$  MHz;  $\sigma = 4.837$  S/m;  $\epsilon_r = 34.499$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.4 °C ; Liquid Temperature : 22.4 °C

DASY5 Configuration:

- Probe: EX3DV4 - SN7515; ConvF(4.83, 4.83, 4.83) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Area Scan (301x301x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 8.00 W/kg

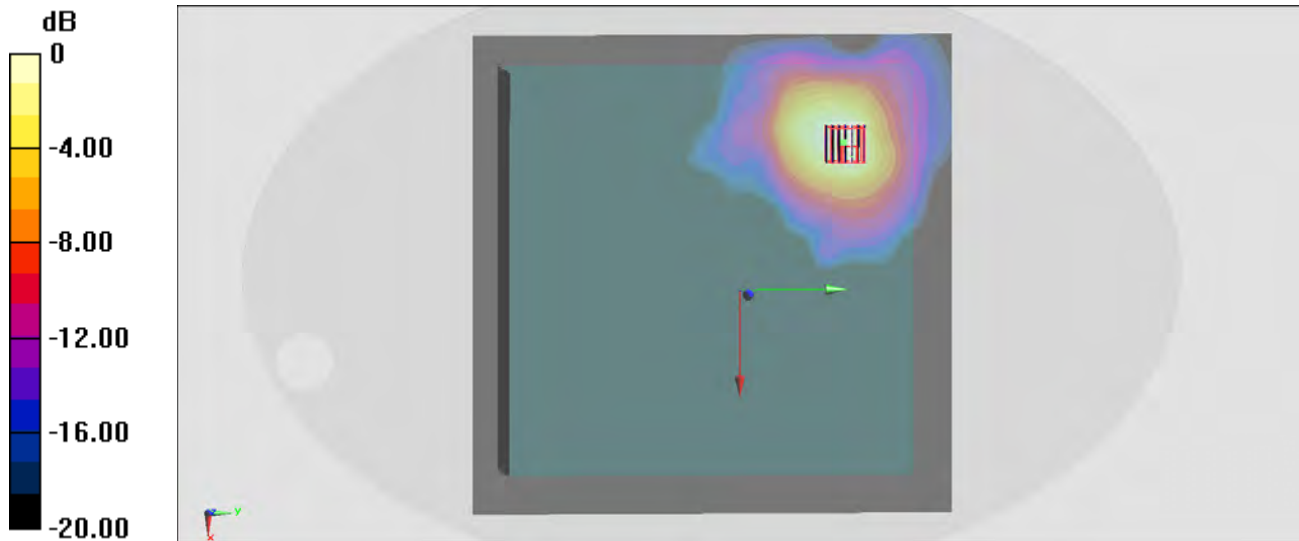
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=4$ mm,  $dy=4$ mm,  $dz=1.4$ mm

Reference Value = 19.96 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 12.8 W/kg

**SAR(1 g) = 3.21 W/kg; SAR(10 g) = 1.23 W/kg**

Maximum value of SAR (measured) = 7.19 W/kg



0 dB = 7.19 W/kg = 8.57 dBW/kg

**#05\_WLAN5GHz\_802.11ax HEW40 Nss2\_Front Face\_0mm\_Ch159;Ant 1+2**

Communication System: 802.11ax; Frequency: 5795 MHz; Duty Cycle: 1:1.055

Medium: HSL\_5G\_190415 Medium parameters used :  $f = 5795$  MHz;  $\sigma = 5.259$  S/m;  $\epsilon_r = 36.114$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.6 °C ; Liquid Temperature : 22.6 °C

**DASY5 Configuration:**

- Probe: EX3DV4 - SN7515; ConvF(4.95, 4.95, 4.95) ; Calibrated: 2018/10/3
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn918; Calibrated: 2018/6/20
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Area Scan (301x301x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 10.4 W/kg

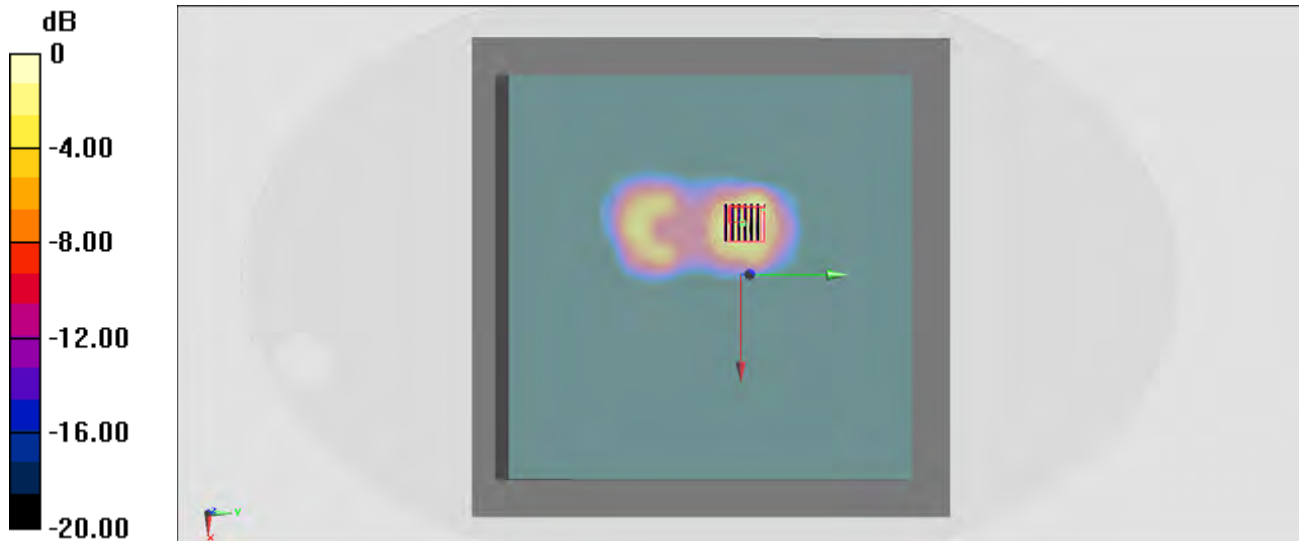
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 52.54 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 38.1 W/kg

**SAR(1 g) = 7.72 W/kg; SAR(10 g) = 2.65 W/kg**

Maximum value of SAR (measured) = 21.8 W/kg



0 dB = 21.8 W/kg = 13.38 dBW/kg

**#06\_Bluetooth\_1Mbps\_Front Face\_0mm\_Ch13**

Communication System: Bluetooth Thread; Frequency: 2440 MHz; Duty Cycle: 1:1

Medium: HSL\_2450\_190418 Medium parameters used:  $f = 2440$  MHz;  $\sigma = 1.789$  S/m;  $\epsilon_r = 38.66$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.3 °C ; Liquid Temperature : 22.3 °C

DASY5 Configuration:

- Probe: ES3DV3 - SN3270; ConvF(4.6, 4.6, 4.6) ; Calibrated: 2018/9/24
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 2018/9/19
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Area Scan (241x241x1):** Interpolated grid:  $dx=1.200$  mm,  $dy=1.200$  mm

Maximum value of SAR (interpolated) = 0.0113 W/kg

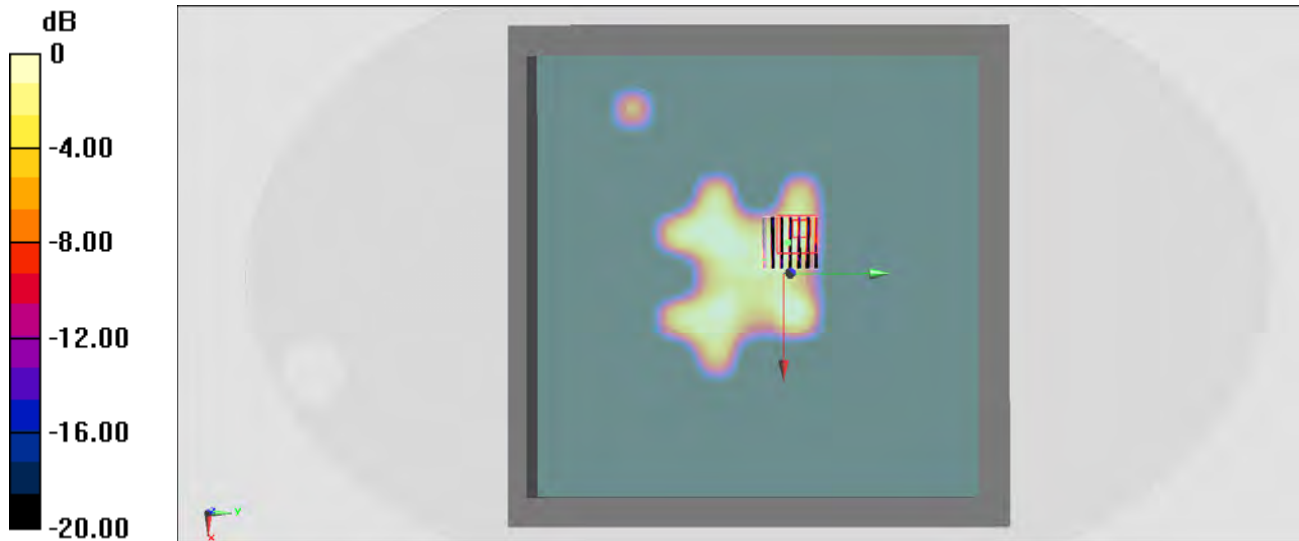
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 1.639 V/m; Power Drift = 0.09 dB

Peak SAR (extrapolated) = 0.0170 W/kg

**SAR(1 g) = 0.00567 W/kg; SAR(10 g) = 0.0021 W/kg**

Maximum value of SAR (measured) = 0.00834 W/kg



0 dB = 0.00834 W/kg = -20.79 dBW/kg

**#07\_Thread\_1Mbps\_Front Face\_0mm\_Ch18**

Communication System: Bluetooth Thread; Frequency: 2440 MHz; Duty Cycle: 1:1

Medium: HSL\_2450\_190418 Medium parameters used:  $f = 2440$  MHz;  $\sigma = 1.789$  S/m;  $\epsilon_r = 38.66$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature : 23.3 °C ; Liquid Temperature : 22.3 °C

**DASY5 Configuration:**

- Probe: ES3DV3 - SN3270; ConvF(4.6, 4.6, 4.6) ; Calibrated: 2018/9/24
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn577; Calibrated: 2018/9/19
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1164
- Measurement SW: DASY52, Version 52.10 (2); SEMCAD X Version 14.6.12 (7450)

**Area Scan (141x141x1):** Interpolated grid:  $dx=1.200$  mm,  $dy=1.200$  mm

Maximum value of SAR (interpolated) = 0.0196 W/kg

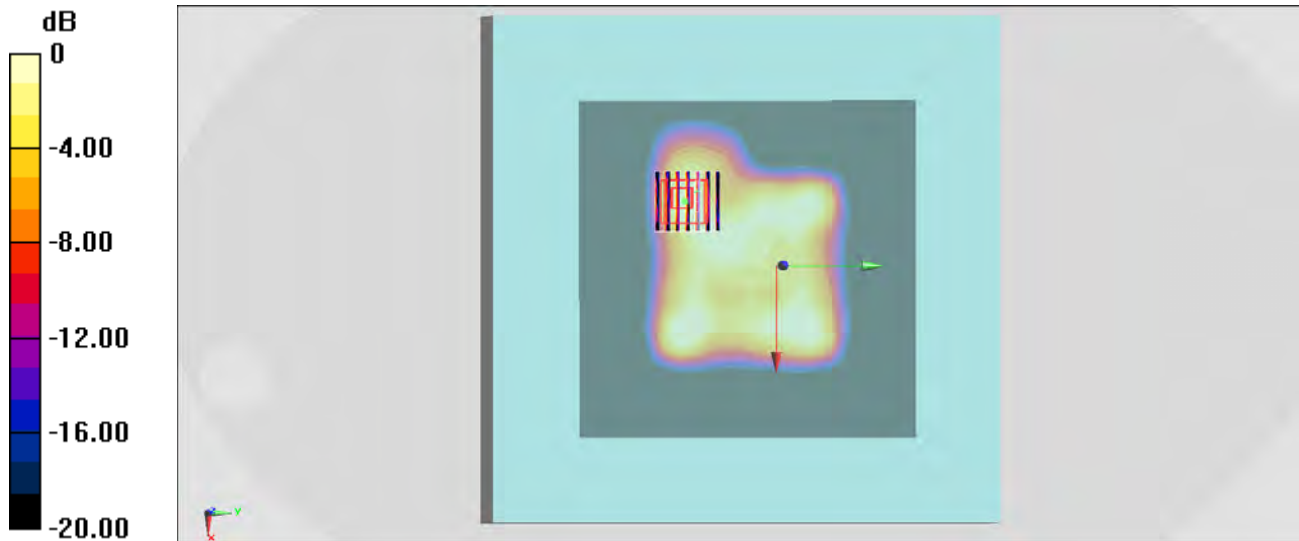
**Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 1.468 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 0.0200 W/kg

**SAR(1 g) = 0.00981 W/kg; SAR(10 g) = 0.00453 W/kg**

Maximum value of SAR (measured) = 0.0127 W/kg



0 dB = 0.0127 W/kg = -18.96 dBW/kg



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Client **Sporton**

Certificate No: **Z18-60326**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 736**

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

Calibration date: **August 31, 2018**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature( $22\pm 3$ ) $^{\circ}\text{C}$  and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards       | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|------------------------------------------|-----------------------|
| Power Meter NRVD        | 102083     | 01-Nov-17 (CTTL, No.J17X08756)           | Oct-18                |
| Power sensor NRV-Z5     | 100542     | 01-Nov-17 (CTTL, No.J17X08756)           | Oct-18                |
| Reference Probe EX3DV4  | SN 7464    | 12-Sep-17(SPEAG,No.EX3-7464_Sep17)       | Sep-18                |
| DAE4                    | SN 1524    | 13-Sep-17(SPEAG,No.DAE4-1524_Sep17)      | Sep-18                |
| Secondary Standards     | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
| Signal Generator E4438C | MY49071430 | 23-Jan-18 (CTTL, No.J18X00560)           | Jan-19                |
| NetworkAnalyzer E5071C  | MY46110673 | 24-Jan-18 (CTTL, No.J18X00561)           | Jan-19                |

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

Signature

Issued: September 3, 2018

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



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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.

|                                     |                          |              |
|-------------------------------------|--------------------------|--------------|
| <b>DASY Version</b>                 | DASY52                   | 52.10.1.1476 |
| <b>Extrapolation</b>                | Advanced Extrapolation   |              |
| <b>Phantom</b>                      | Triple Flat Phantom 5.1C |              |
| <b>Distance Dipole Center - TSL</b> | 10 mm                    | with Spacer  |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm        |              |
| <b>Frequency</b>                    | 2450 MHz $\pm$ 1 MHz     |              |

## Head TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 39.2           | 1.80 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 38.8 $\pm$ 6 % | 1.80 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             | ----           | ----                 |

## SAR result with Head TSL

|                                                               |                    |                                                  |
|---------------------------------------------------------------|--------------------|--------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                  |
| SAR measured                                                  | 250 mW input power | 13.2 mW / g                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>52.7 mW / g <math>\pm</math> 18.8 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                  |
| SAR measured                                                  | 250 mW input power | 6.17 mW / g                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>24.6 mW / g <math>\pm</math> 18.7 % (k=2)</b> |

## Body TSL parameters

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Body TSL parameters</b>             | 22.0 °C             | 52.7           | 1.95 mho/m           |
| <b>Measured Body TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 52.3 $\pm$ 6 % | 1.98 mho/m $\pm$ 6 % |
| <b>Body TSL temperature change during test</b> | <1.0 °C             | ----           | ----                 |

## SAR result with Body TSL

|                                                               |                    |                                                  |
|---------------------------------------------------------------|--------------------|--------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>   | Condition          |                                                  |
| SAR measured                                                  | 250 mW input power | 13.0 mW / g                                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>51.5 mW / g <math>\pm</math> 18.8 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | Condition          |                                                  |
| SAR measured                                                  | 250 mW input power | 6.14 mW / g                                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>24.4 mW / g <math>\pm</math> 18.7 % (k=2)</b> |



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

### Antenna Parameters with Head TSL

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 53.9Ω+ 2.56jΩ |
| Return Loss                          | - 26.9dB      |

### Antenna Parameters with Body TSL

|                                      |               |
|--------------------------------------|---------------|
| Impedance, transformed to feed point | 50.0Ω+ 4.22jΩ |
| Return Loss                          | - 27.5dB      |

### 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: 08.31.2018

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 736**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.802$  S/m;  $\epsilon_r = 38.84$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Right Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(7.89, 7.89, 7.89) @ 2450 MHz; Calibrated: 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1524; Calibrated: 9/13/2017
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

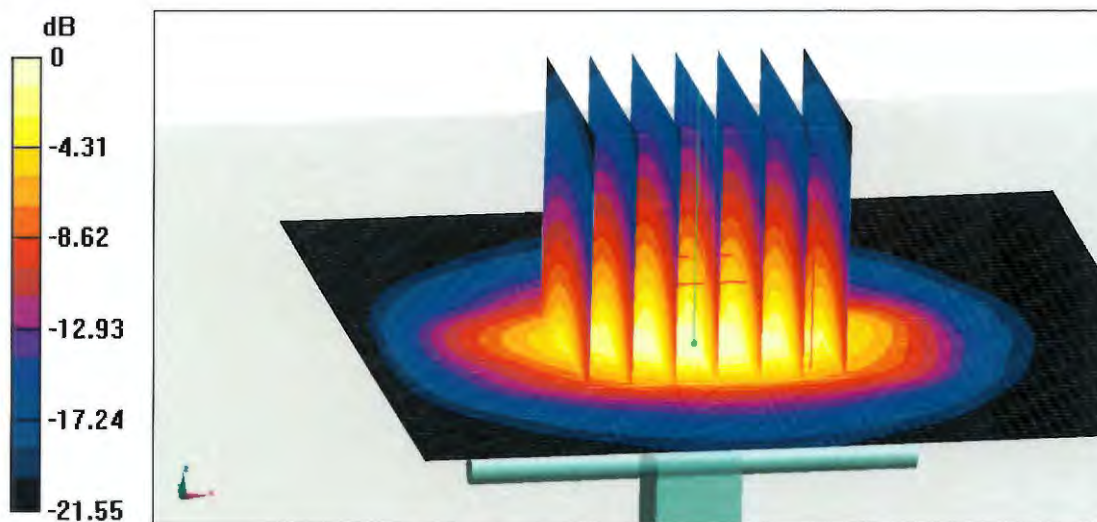
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm**

Reference Value = 100.2 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 27.6 W/kg

**SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.17 W/kg**

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



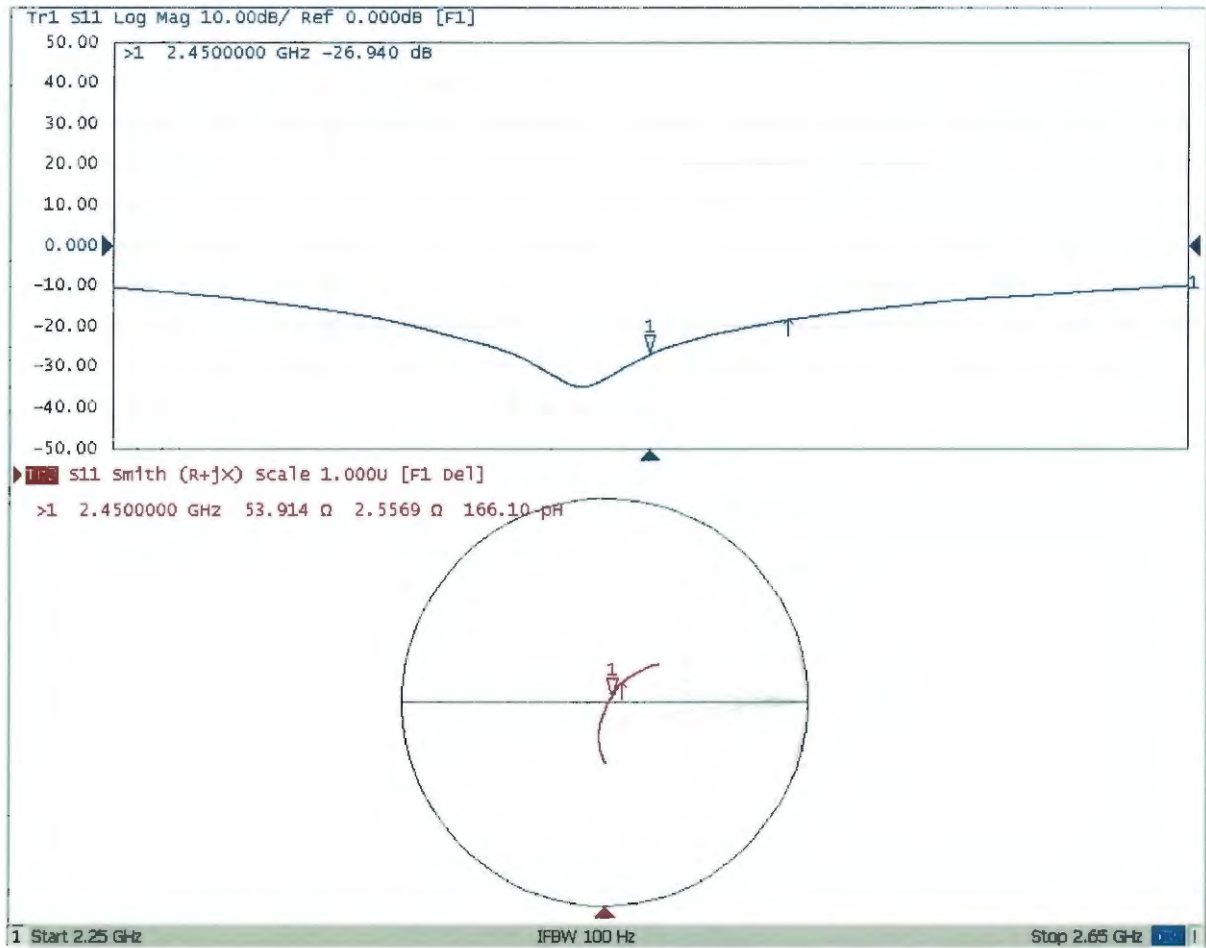
0 dB = 22.2 W/kg = 13.46 dBW/kg



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## Impedance Measurement Plot for Head TSL





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## DASY5 Validation Report for Body TSL

Date: 08.30.2018

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 736**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.982$  S/m;  $\epsilon_r = 52.34$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Center Section

### DASY5 Configuration:

- Probe: EX3DV4 - SN7464; ConvF(8.09, 8.09, 8.09) @ 2450 MHz; Calibrated: 9/12/2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1524; Calibrated: 9/13/2017
- Phantom: MFP\_V5.1C ; Type: QD 000 P51CA; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (1); SEMCAD X Version 14.6.11 (7439)

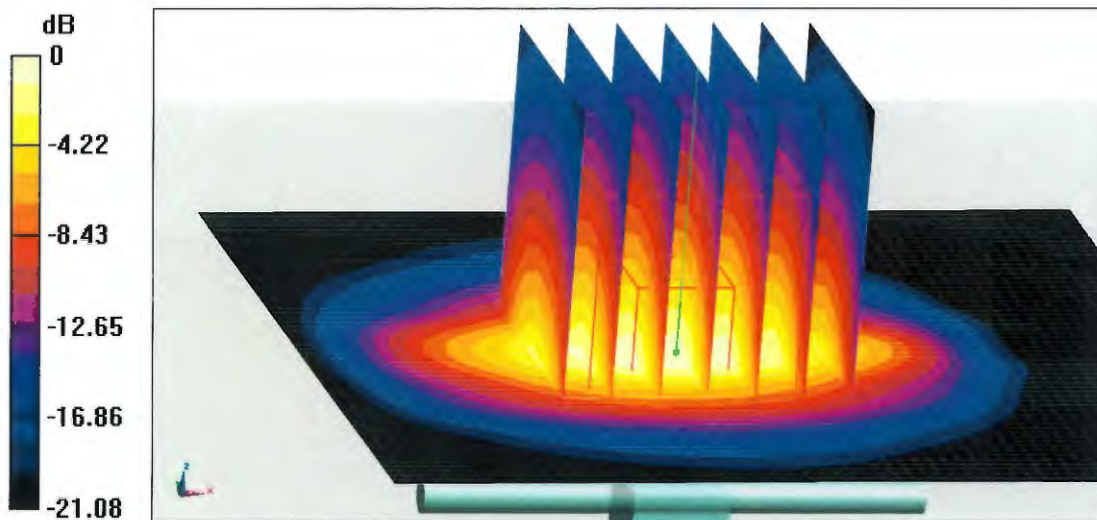
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.71 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 26.0 W/kg

**SAR(1 g) = 13 W/kg; SAR(10 g) = 6.14 W/kg**

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

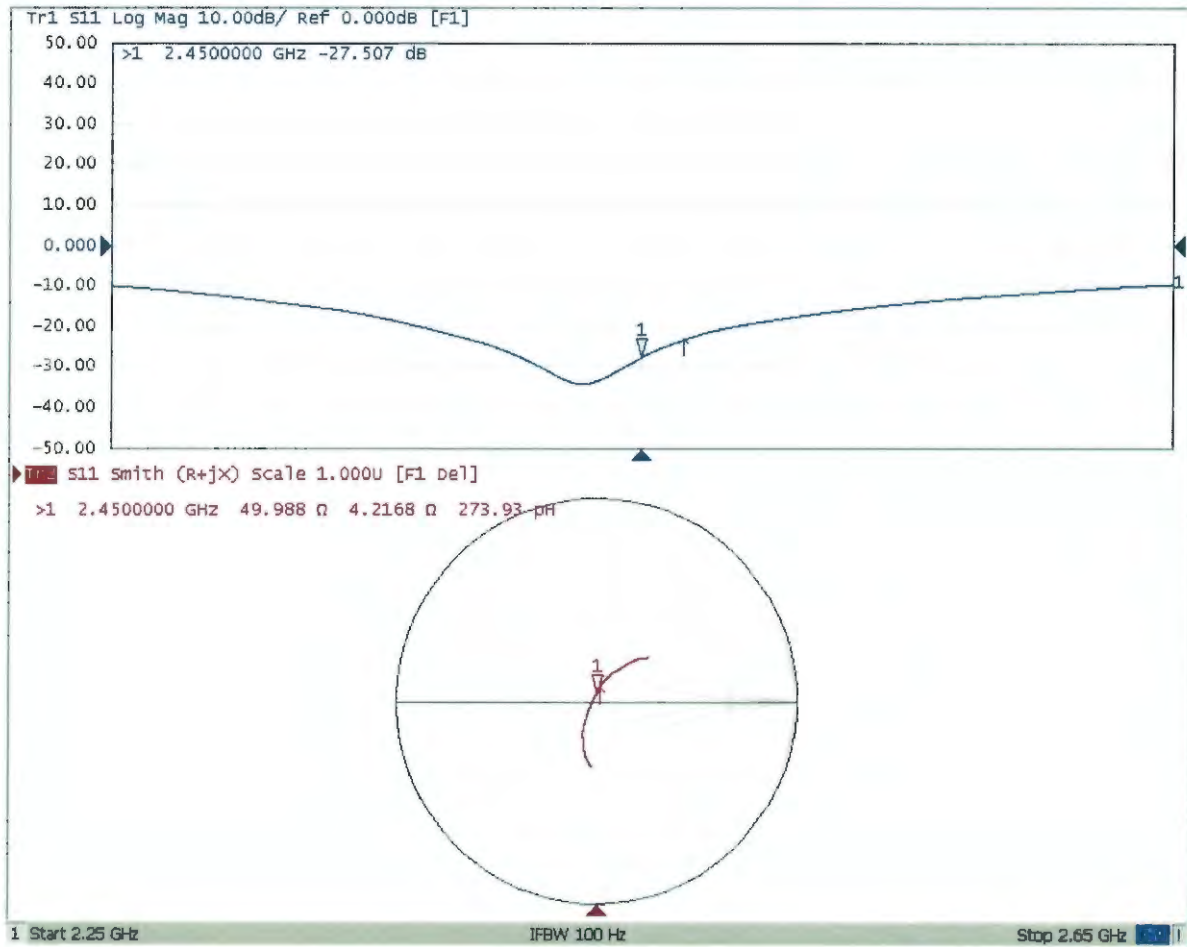




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### Impedance Measurement Plot for Body TSL





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Client

**Sporton**

Certificate No: **Z19-60059**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 929**

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

Calibration date: **March 6, 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( $22\pm 3$ ) $^{\circ}\text{C}$  and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards       | ID #       | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|-------------------------|------------|------------------------------------------|-----------------------|
| Power Meter NRP2        | 106277     | 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: March 8, 2019

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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.

|                                     |                          |              |
|-------------------------------------|--------------------------|--------------|
| <b>DASY Version</b>                 | DASY52                   | 52.10.2.1495 |
| <b>Extrapolation</b>                | Advanced Extrapolation   |              |
| <b>Phantom</b>                      | Triple Flat Phantom 5.1C |              |
| <b>Distance Dipole Center - TSL</b> | 10 mm                    | with Spacer  |
| <b>Zoom Scan Resolution</b>         | dx, dy, dz = 5 mm        |              |
| <b>Frequency</b>                    | 2450 MHz $\pm$ 1 MHz     |              |

**Head TSL parameters**

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Head TSL parameters</b>             | 22.0 °C             | 39.2           | 1.80 mho/m           |
| <b>Measured Head TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 39.1 $\pm$ 6 % | 1.85 mho/m $\pm$ 6 % |
| <b>Head TSL temperature change during test</b> | <1.0 °C             | ----           | ----                 |

**SAR result with Head TSL**

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>   | Condition          |                                                |
| SAR measured                                                  | 250 mW input power | 13.2 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>52.1 W/kg <math>\pm</math> 18.8 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b> | Condition          |                                                |
| SAR measured                                                  | 250 mW input power | 6.08 W/kg                                      |
| SAR for nominal Head TSL parameters                           | normalized to 1W   | <b>24.1 W/kg <math>\pm</math> 18.7 % (k=2)</b> |

**Body TSL parameters**

The following parameters and calculations were applied.

|                                                | Temperature         | Permittivity   | Conductivity         |
|------------------------------------------------|---------------------|----------------|----------------------|
| <b>Nominal Body TSL parameters</b>             | 22.0 °C             | 52.7           | 1.95 mho/m           |
| <b>Measured Body TSL parameters</b>            | (22.0 $\pm$ 0.2) °C | 52.2 $\pm$ 6 % | 2.00 mho/m $\pm$ 6 % |
| <b>Body TSL temperature change during test</b> | <1.0 °C             | ----           | ----                 |

**SAR result with Body TSL**

|                                                               |                    |                                                |
|---------------------------------------------------------------|--------------------|------------------------------------------------|
| <b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>   | Condition          |                                                |
| SAR measured                                                  | 250 mW input power | 13.0 W/kg                                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>51.2 W/kg <math>\pm</math> 18.8 % (k=2)</b> |
| <b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b> | Condition          |                                                |
| SAR measured                                                  | 250 mW input power | 6.03 W/kg                                      |
| SAR for nominal Body TSL parameters                           | normalized to 1W   | <b>23.9 W/kg <math>\pm</math> 18.7 % (k=2)</b> |



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

### Antenna Parameters with Head TSL

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 52.0Ω+ 4.44 jΩ |
| Return Loss                          | - 26.5dB       |

### Antenna Parameters with Body TSL

|                                      |                |
|--------------------------------------|----------------|
| Impedance, transformed to feed point | 49.5Ω+ 6.70 jΩ |
| Return Loss                          | - 23.4dB       |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.025 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: 03.05.2019

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 929**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.852$  S/m;  $\epsilon_r = 39.14$ ;  $\rho = 1000$  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)

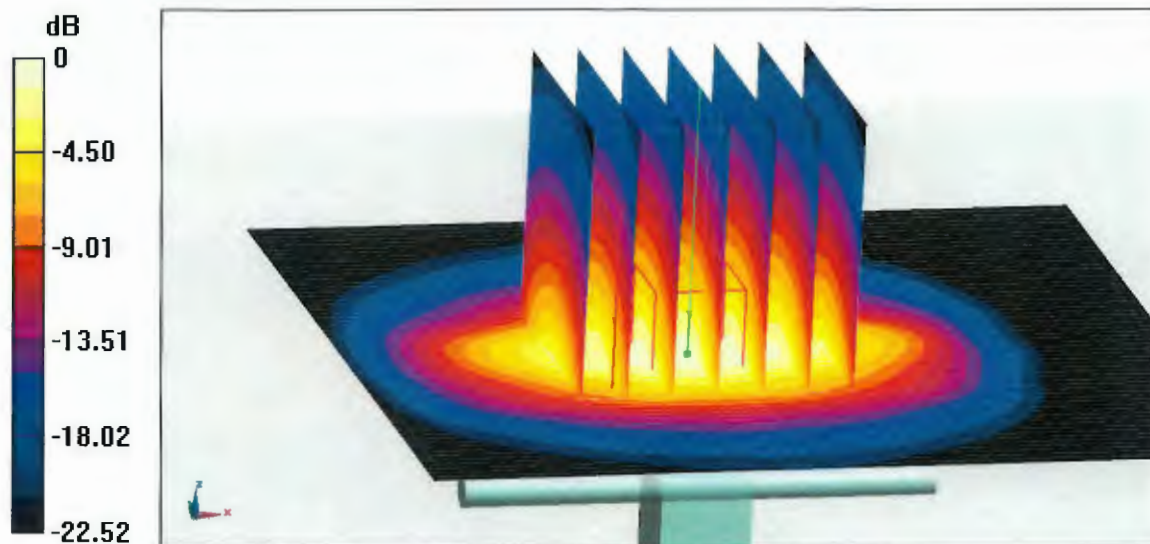
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 100.8 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 28.1 W/kg

**SAR(1 g) = 13.2 W/kg; SAR(10 g) = 6.08 W/kg**

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



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



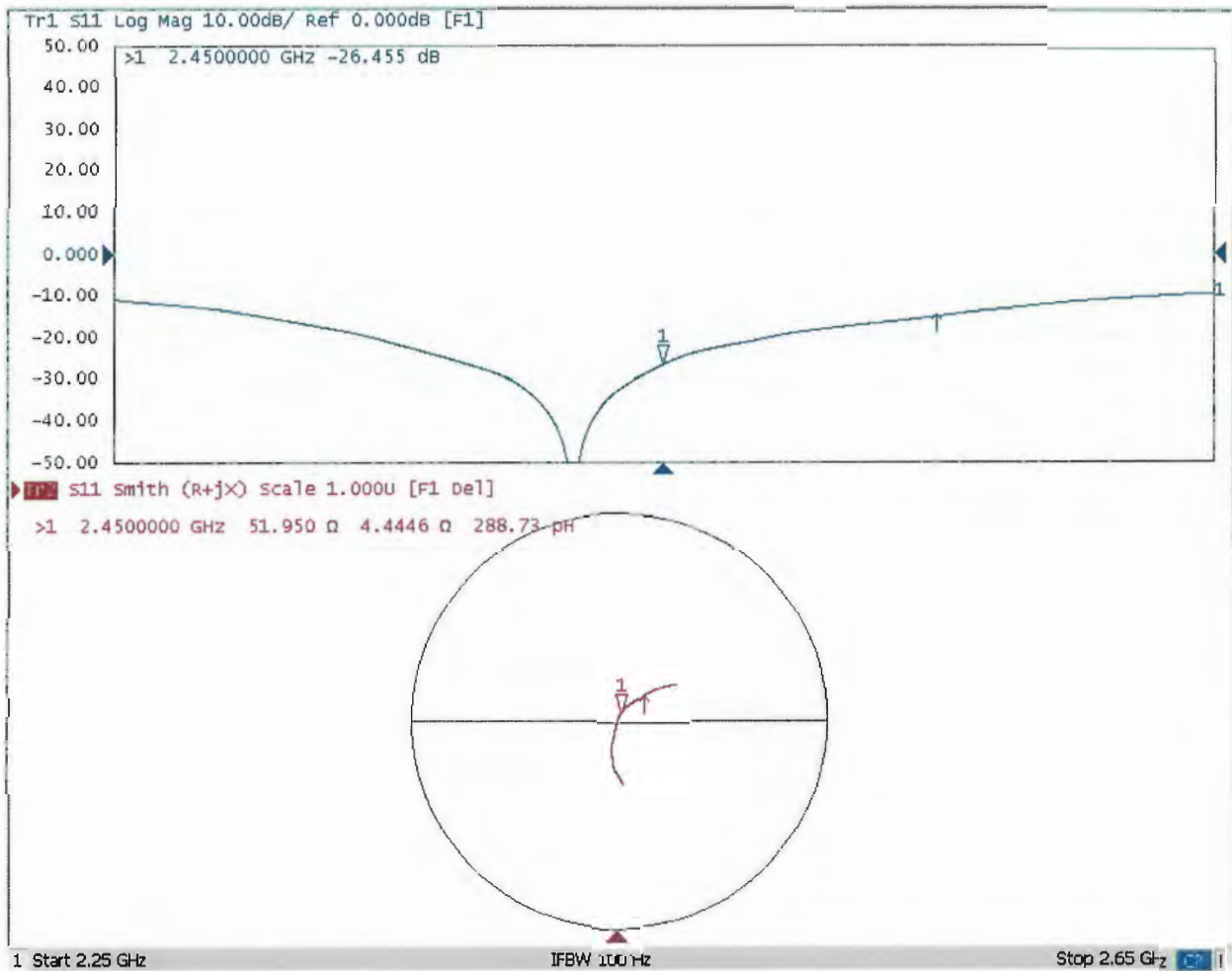
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## Impedance Measurement Plot for Head TSL





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## DASY5 Validation Report for Body TSL

Date: 03.06.2019

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 929**

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

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 2.004$  S/m;  $\epsilon_r = 52.22$ ;  $\rho = 1000$  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)

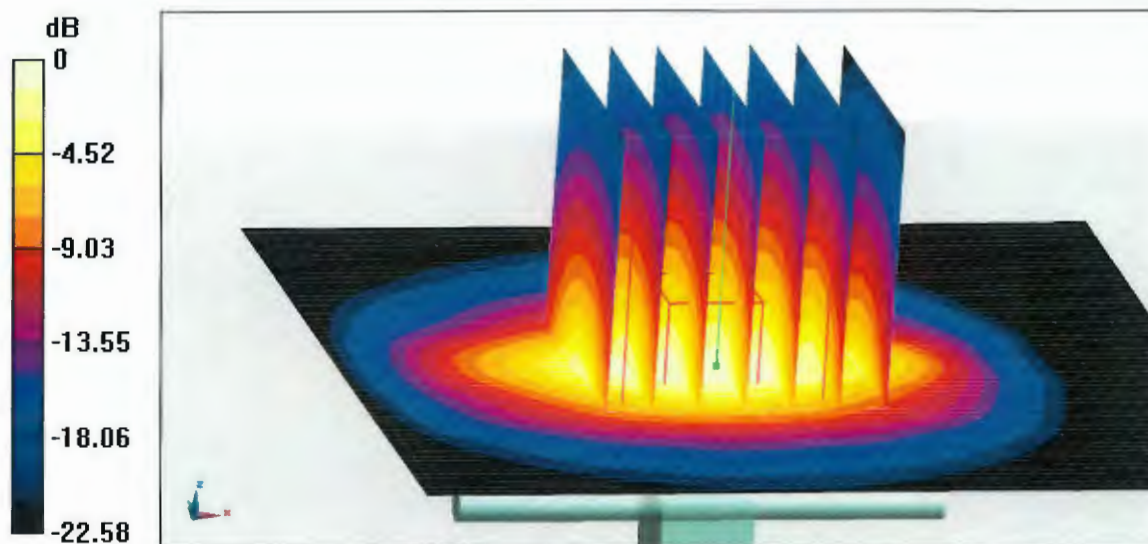
**Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 97.11 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 27.3 W/kg

**SAR(1 g) = 13 W/kg; SAR(10 g) = 6.03 W/kg**

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



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

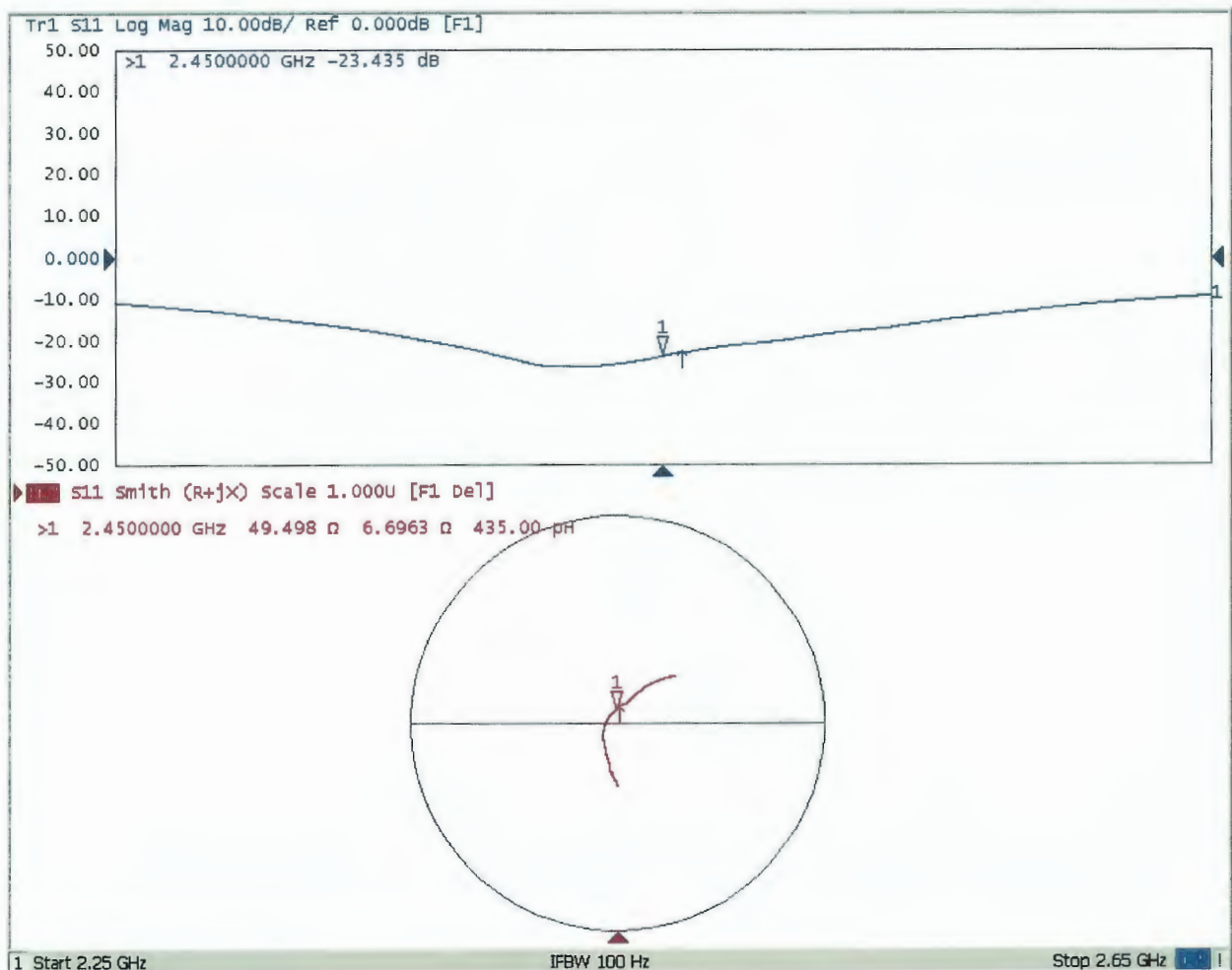


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## Impedance Measurement Plot for Body TSL





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Accreditation No.: **SCS 0108**

Client **Sporton**

Certificate No: **D5GHzV2-1006\_Sep18**

## CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1006**

Calibration procedure(s) **QA CAL-22.v3**  
**Calibration procedure for dipole validation kits between 3-6 GHz**

Calibration date: **September 27, 2018**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)      | Scheduled Calibration |
|-----------------------------|--------------------|---------------------------------|-----------------------|
| Power meter NRP             | SN: 104778         | 04-Apr-18 (No. 217-02672/02673) | Apr-19                |
| Power sensor NRP-Z91        | SN: 103244         | 04-Apr-18 (No. 217-02672)       | Apr-19                |
| Power sensor NRP-Z91        | SN: 103245         | 04-Apr-18 (No. 217-02673)       | Apr-19                |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 04-Apr-18 (No. 217-02682)       | Apr-19                |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-18 (No. 217-02683)       | Apr-19                |
| Reference Probe EX3DV4      | SN: 3503           | 30-Dec-17 (No. EX3-3503_Dec17)  | Dec-18                |
| DAE4                        | SN: 601            | 26-Oct-17 (No. DAE4-601_Oct17)  | Oct-18                |

| Secondary Standards             | ID #           | Check Date (in house)             | Scheduled Check        |
|---------------------------------|----------------|-----------------------------------|------------------------|
| Power meter EPM-442A            | SN: GB37480704 | 07-Oct-15 (in house check Oct-16) | In house check: Oct-18 |
| Power sensor HP 8481A           | SN: US37292783 | 07-Oct-15 (in house check Oct-16) | In house check: Oct-18 |
| Power sensor HP 8481A           | SN: MY41092317 | 07-Oct-15 (in house check Oct-16) | In house check: Oct-18 |
| RF generator R&S SMT-06         | SN: 100972     | 15-Jun-15 (in house check Oct-16) | In house check: Oct-18 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-17) | In house check: Oct-18 |

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

Issued: September 28, 2018

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Accreditation No.: **SCS 0108**

### Glossary:

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

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

- 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"

### 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%.

## Measurement Conditions

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

|                              |                                                                      |                                  |
|------------------------------|----------------------------------------------------------------------|----------------------------------|
| DASY Version                 | DASY5                                                                | V52.10.1                         |
| Extrapolation                | Advanced Extrapolation                                               |                                  |
| Phantom                      | Modular Flat Phantom V5.0                                            |                                  |
| Distance Dipole Center - TSL | 10 mm                                                                | with Spacer                      |
| Zoom Scan Resolution         | dx, dy = 4.0 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 | 36.0 $\pm$ 6 % | 4.61 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | < 0.5 °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 | 8.07 W/kg                                      |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | <b>80.7 W/kg <math>\pm</math> 19.9 % (k=2)</b> |

|                                                         |                    |                                                |
|---------------------------------------------------------|--------------------|------------------------------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                                                |
| SAR measured                                            | 100 mW input power | 2.32 W/kg                                      |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | <b>23.2 W/kg <math>\pm</math> 19.5 % (k=2)</b> |

### 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 | 35.4 ± 6 %   | 4.98 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °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 | 8.34 W/kg                  |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 83.3 W / kg ± 19.9 % (k=2) |

|                                                         |                    |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                          |
| SAR measured                                            | 100 mW input power | 2.38 W/kg                |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 23.8 W/kg ± 19.5 % (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 | 35.2 ± 6 %   | 5.14 mho/m ± 6 % |
| Head TSL temperature change during test | < 0.5 °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 | 8.05 W/kg                |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 80.4 W/kg ± 19.9 % (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   | 22.9 W/kg ± 19.5 % (k=2) |

### 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 | 46.9 ± 6 %   | 5.46 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °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 | 7.89 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 78.3 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR measured                                            | 100 mW input power | 2.19 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 21.7 W/kg ± 19.5 % (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 | 46.3 ± 6 %   | 5.93 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °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 | 8.17 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 81.0 W/kg ± 19.9 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR measured                                            | 100 mW input power | 2.28 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 22.5 W/kg ± 19.5 % (k=2) |

## 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 | 46.0 ± 6 %   | 6.14 mho/m ± 6 % |
| Body TSL temperature change during test | < 0.5 °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 | 7.81 W/kg                |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 77.4 W/kg ± 19.9 % (k=2) |

|                                                         |                    |                          |
|---------------------------------------------------------|--------------------|--------------------------|
| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                          |
| SAR measured                                            | 100 mW input power | 2.15 W/kg                |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 21.3 W/kg ± 19.5 % (k=2) |

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

### Antenna Parameters with Head TSL at 5250 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.6 $\Omega$ - 7.6 j $\Omega$ |
| Return Loss                          | - 21.5 dB                      |

### Antenna Parameters with Head TSL at 5600 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 57.2 $\Omega$ - 6.3 j $\Omega$ |
| Return Loss                          | - 21.0 dB                      |

### Antenna Parameters with Head TSL at 5750 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 60.0 $\Omega$ + 4.5 j $\Omega$ |
| Return Loss                          | - 20.1 dB                      |

### Antenna Parameters with Body TSL at 5250 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.2 $\Omega$ - 5.6 j $\Omega$ |
| Return Loss                          | - 23.5 dB                      |

### Antenna Parameters with Body TSL at 5600 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 58.2 $\Omega$ - 5.3 j $\Omega$ |
| Return Loss                          | - 20.9 dB                      |

### Antenna Parameters with Body TSL at 5750 MHz

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 59.6 $\Omega$ + 5.6 j $\Omega$ |
| Return Loss                          | - 19.9 dB                      |

### General Antenna Parameters and Design

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.201 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           |
| Manufactured on | August 28, 2003 |

## DASY5 Validation Report for Head TSL

Date: 27.09.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1006**

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 4.61$  S/m;  $\epsilon_r = 36$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5600$  MHz;  $\sigma = 4.98$  S/m;  $\epsilon_r = 35.4$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5750$  MHz;  $\sigma = 5.14$  S/m;  $\epsilon_r = 35.2$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.51, 5.51, 5.51) @ 5250 MHz, ConvF(5.05, 5.05, 5.05) @ 5600 MHz, ConvF(4.98, 4.98, 4.98) @ 5750 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

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

Reference Value = 79.28 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 26.7 W/kg

**SAR(1 g) = 8.07 W/kg; SAR(10 g) = 2.32 W/kg**

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

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

Reference Value = 76.15 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 30.2 W/kg

**SAR(1 g) = 8.34 W/kg; SAR(10 g) = 2.38 W/kg**

Maximum value of SAR (measured) = 19.3 W/kg

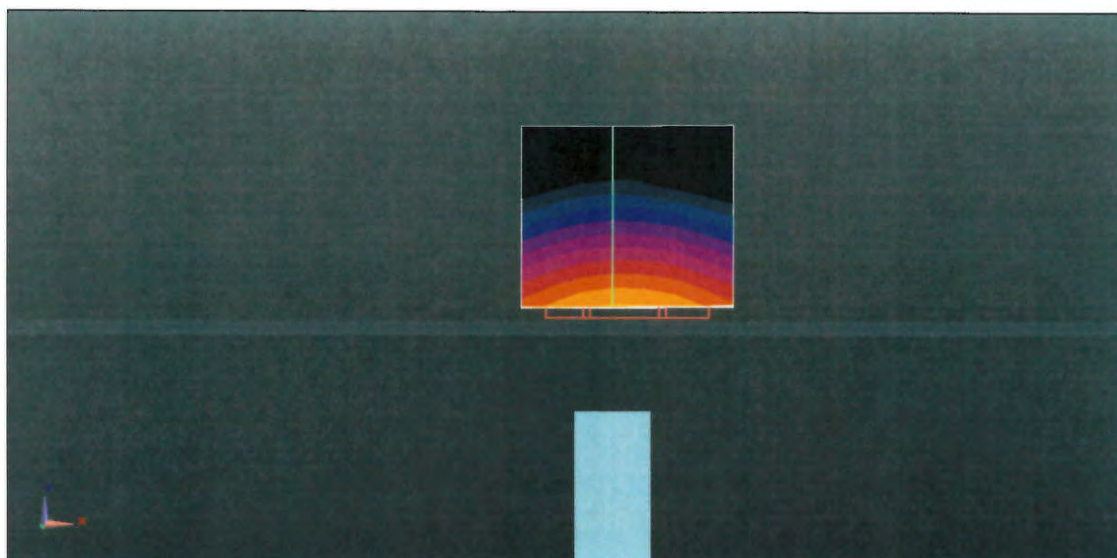
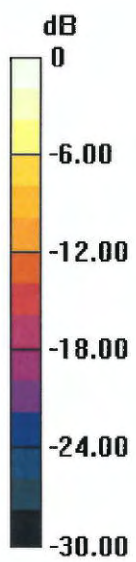
**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 74.61 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 29.8 W/kg

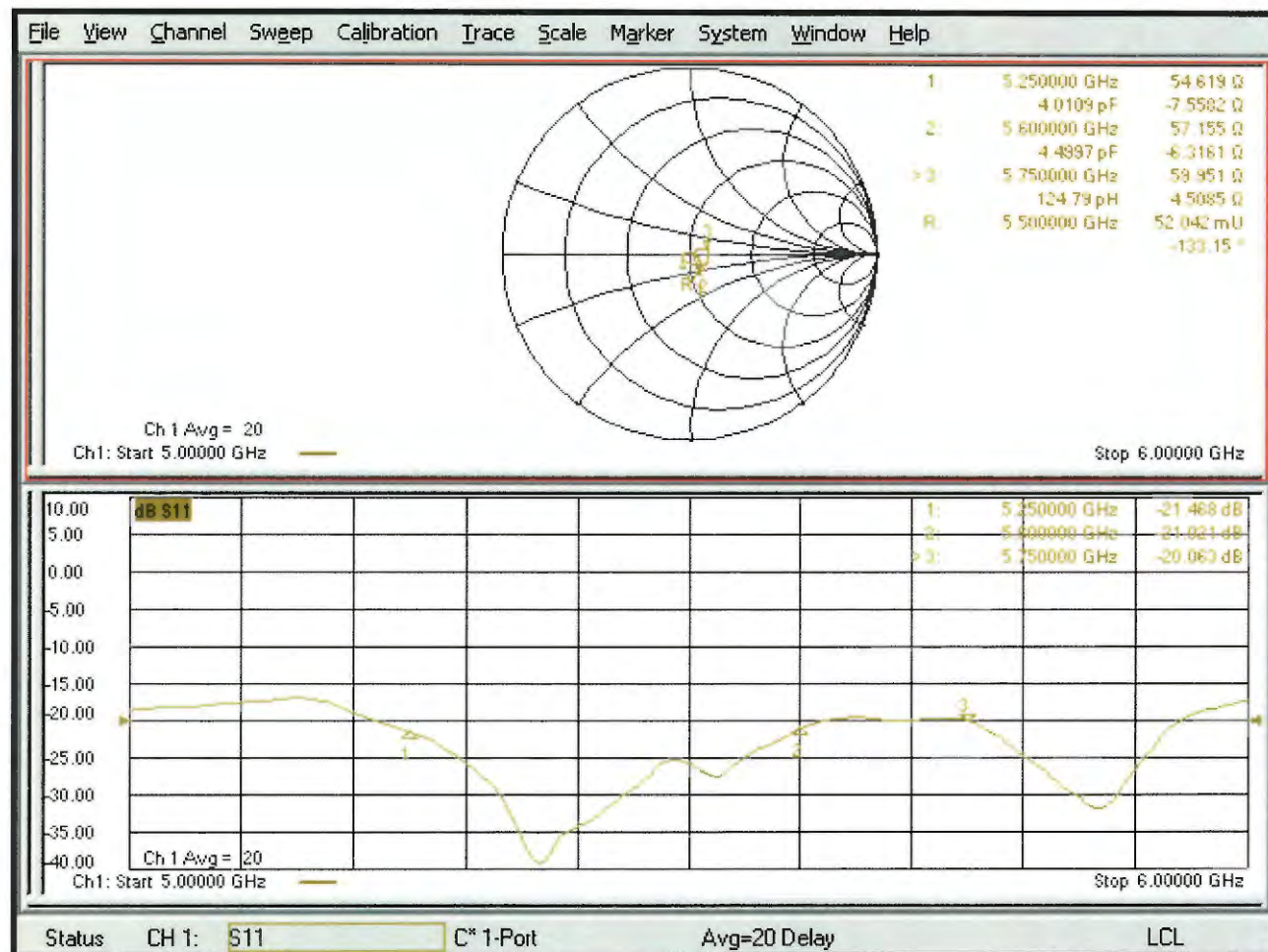
**SAR(1 g) = 8.05 W/kg; SAR(10 g) = 2.29 W/kg**

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



0 dB = 18.1 W/kg = 12.58 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 25.09.2018

Test Laboratory: SPEAG, Zurich, Switzerland

### DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1006

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz

Medium parameters used:  $f = 5250$  MHz;  $\sigma = 5.46$  S/m;  $\epsilon_r = 46.9$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.93$  S/m;  $\epsilon_r = 46.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>,

Medium parameters used:  $f = 5750$  MHz;  $\sigma = 6.14$  S/m;  $\epsilon_r = 46$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

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

#### DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.26, 5.26, 5.26) @ 5250 MHz, ConvF(4.65, 4.65, 4.65) @ 5600 MHz, ConvF(4.57, 4.57, 4.57) @ 5750 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.1(1476); SEMCAD X 14.6.11(7439)

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

Reference Value = 69.77 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 30.6 W/kg

**SAR(1 g) = 7.89 W/kg; SAR(10 g) = 2.19 W/kg**

Maximum value of SAR (measured) = 18.6 W/kg

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

Reference Value = 69.30 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 34.2 W/kg

**SAR(1 g) = 8.17 W/kg; SAR(10 g) = 2.28 W/kg**

Maximum value of SAR (measured) = 19.8 W/kg

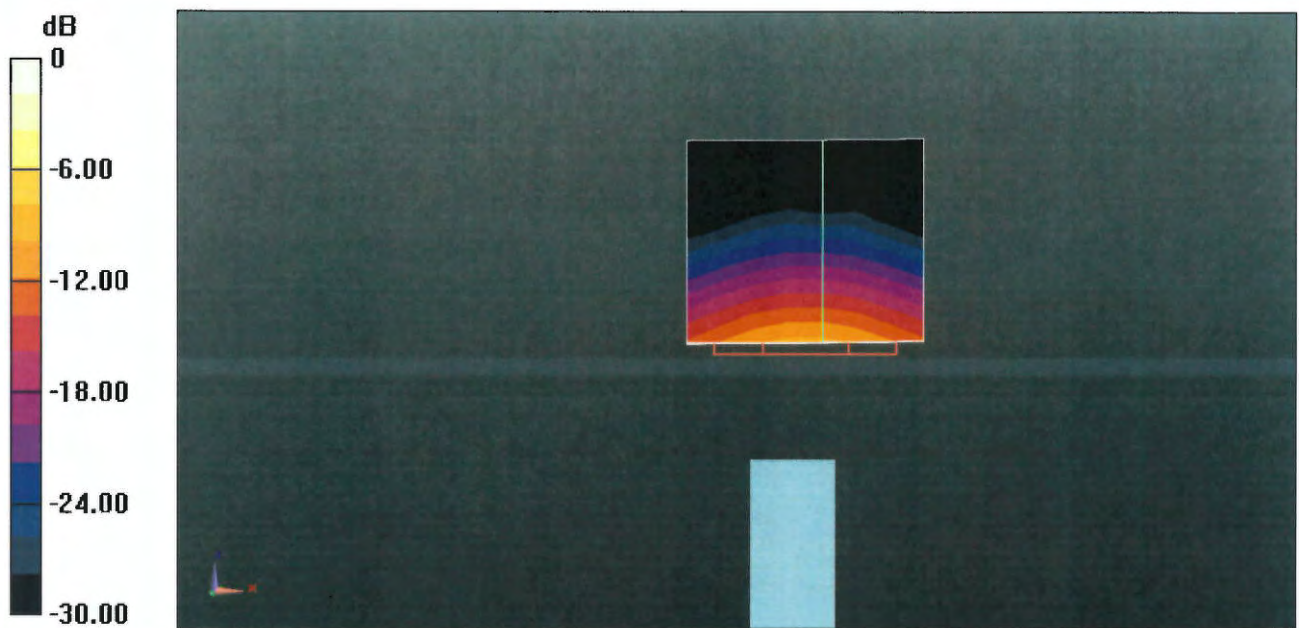
### Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 67.65 V/m; Power Drift = -0.07 dB

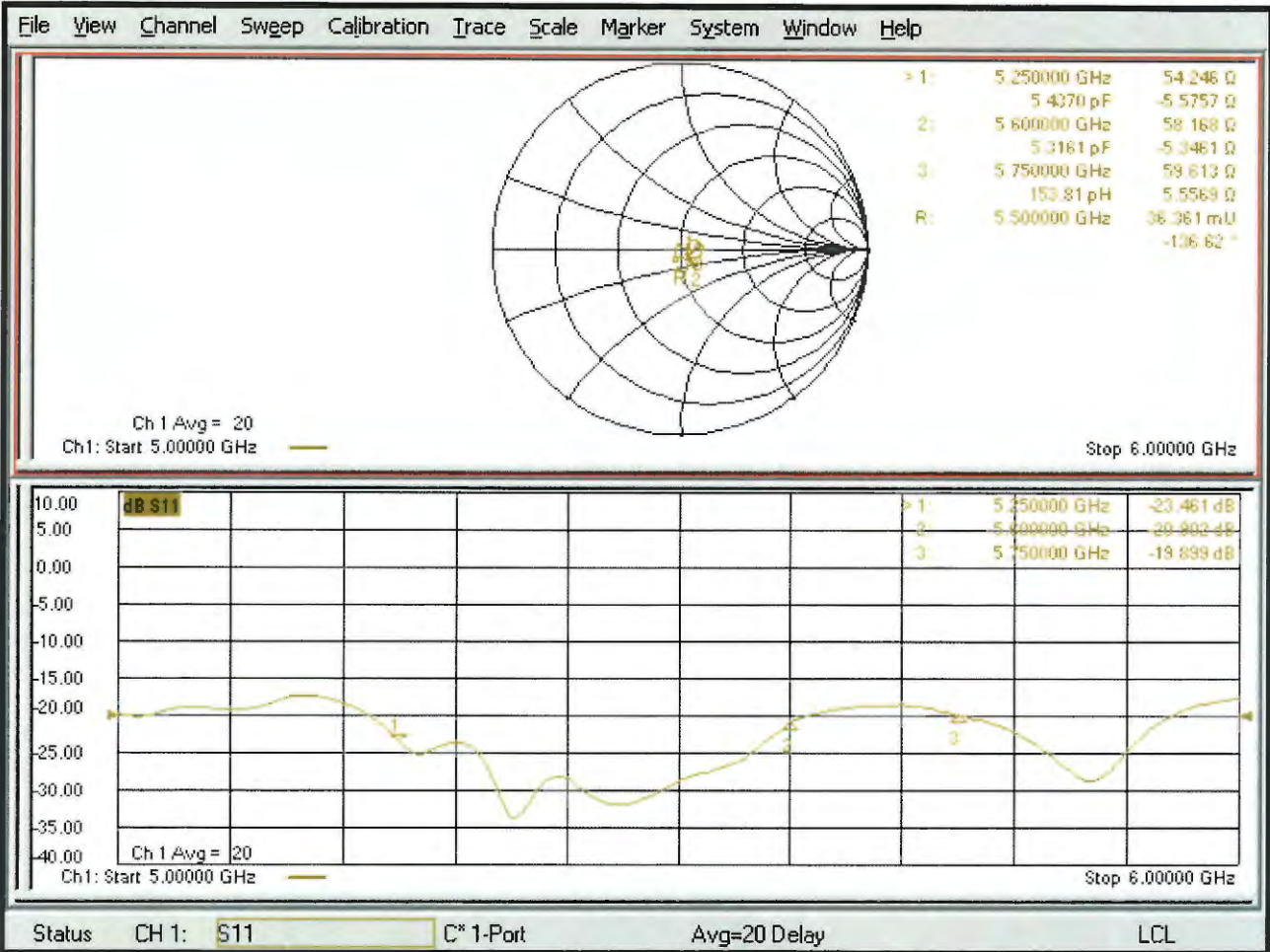
Peak SAR (extrapolated) = 34.0 W/kg

**SAR(1 g) = 7.81 W/kg; SAR(10 g) = 2.15 W/kg**

Maximum value of SAR (measured) = 19.3 W/kg



Impedance Measurement Plot for Body TSL





Accredited by the Swiss Accreditation Service (SAS)

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Sporton**

Certificate No: **DAE3-577\_Sep18**

## CALIBRATION CERTIFICATE

Object **DAE3 - SD 000 D03 AA - SN: 577**

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

Calibration date: **September 19, 2018**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

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

Calibrated by: **Name**  
**Dominique Steffen** **Function**  
**Laboratory Technician**

Signature

Approved by: **Sven Kühn** **Deputy Manager**

Issued: September 20, 2018

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Accreditation No.: **SCS 0108**

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Multilateral Agreement for the recognition of calibration certificates

## Glossary

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

## Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement:* Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

## DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

| Calibration Factors | X                         | Y                         | Z                         |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range          | 403.570 $\pm$ 0.02% (k=2) | 403.555 $\pm$ 0.02% (k=2) | 403.860 $\pm$ 0.02% (k=2) |
| Low Range           | 3.92675 $\pm$ 1.50% (k=2) | 3.94171 $\pm$ 1.50% (k=2) | 3.96140 $\pm$ 1.50% (k=2) |

## Connector Angle

|                                           |                   |
|-------------------------------------------|-------------------|
| Connector Angle to be used in DASY system | 190.5 ° $\pm$ 1 ° |
|-------------------------------------------|-------------------|

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

### 1. DC Voltage Linearity

| High Range        | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 200038.36                 | -0.72                        | -0.00     |
| Channel X + Input | 20010.00                  | 4.45                         | 0.02      |
| Channel X - Input | -20002.48                 | 3.65                         | -0.02     |
| Channel Y + Input | 200036.35                 | -3.15                        | -0.00     |
| Channel Y + Input | 20005.24                  | -0.27                        | -0.00     |
| Channel Y - Input | -20004.72                 | 1.39                         | -0.01     |
| Channel Z + Input | 200037.49                 | -1.39                        | -0.00     |
| Channel Z + Input | 20007.74                  | 2.29                         | 0.01      |
| Channel Z - Input | -20007.40                 | -1.18                        | 0.01      |

| Low Range         | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 2001.09                   | -0.01                        | -0.00     |
| Channel X + Input | 201.09                    | 0.05                         | 0.02      |
| Channel X - Input | -198.69                   | 0.26                         | -0.13     |
| Channel Y + Input | 2000.84                   | -0.17                        | -0.01     |
| Channel Y + Input | 200.20                    | -0.73                        | -0.36     |
| Channel Y - Input | -200.34                   | -1.25                        | 0.63      |
| Channel Z + Input | 2000.71                   | -0.11                        | -0.01     |
| Channel Z + Input | 199.32                    | -1.41                        | -0.70     |
| Channel Z - Input | -200.63                   | -1.49                        | 0.75      |

### 2. Common mode sensitivity

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

|           | Common mode<br>Input Voltage (mV) | High Range<br>Average Reading ( $\mu\text{V}$ ) | Low Range<br>Average Reading ( $\mu\text{V}$ ) |
|-----------|-----------------------------------|-------------------------------------------------|------------------------------------------------|
| Channel X | 200                               | -2.17                                           | -4.31                                          |
|           | - 200                             | 6.00                                            | 3.83                                           |
| Channel Y | 200                               | -14.14                                          | -14.03                                         |
|           | - 200                             | 13.56                                           | 12.87                                          |
| Channel Z | 200                               | 2.59                                            | 2.79                                           |
|           | - 200                             | -5.24                                           | -5.55                                          |

### 3. Channel separation

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

|           | Input Voltage (mV) | Channel X ( $\mu\text{V}$ ) | Channel Y ( $\mu\text{V}$ ) | Channel Z ( $\mu\text{V}$ ) |
|-----------|--------------------|-----------------------------|-----------------------------|-----------------------------|
| Channel X | 200                | -                           | -1.77                       | -2.83                       |
| Channel Y | 200                | 8.18                        | -                           | 0.21                        |
| Channel Z | 200                | 4.82                        | 4.96                        | -                           |

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

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

|           | High Range (LSB) | Low Range (LSB) |
|-----------|------------------|-----------------|
| Channel X | 16134            | 16282           |
| Channel Y | 16103            | 16704           |
| Channel Z | 16112            | 15003           |

#### 5. Input Offset Measurement

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

Input 10M $\Omega$

|           | Average ( $\mu$ V) | min. Offset ( $\mu$ V) | max. Offset ( $\mu$ V) | Std. Deviation ( $\mu$ V) |
|-----------|--------------------|------------------------|------------------------|---------------------------|
| Channel X | 0.90               | -0.00                  | 1.82                   | 0.37                      |
| Channel Y | 2.88               | 1.81                   | 4.92                   | 0.52                      |
| Channel Z | -1.31              | -2.47                  | 0.13                   | 0.43                      |

#### 6. Input Offset Current

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

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

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

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

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

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

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



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **Auden**

Certificate No: **DAE4-918\_Jun18**

## CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BK - SN: 918**

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

Calibration date: **June 20, 2018**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards             | ID #               | Cal Date (Certificate No.) | Scheduled Calibration  |
|-------------------------------|--------------------|----------------------------|------------------------|
| Keithley Multimeter Type 2001 | SN: 0810278        | 31-Aug-17 (No:21092)       | Aug-18                 |
| Secondary Standards           | ID #               | Check Date (in house)      | Scheduled Check        |
| Auto DAE Calibration Unit     | SE UWS 053 AA 1001 | 04-Jan-18 (in house check) | In house check: Jan-19 |
| Calibrator Box V2.1           | SE UMS 006 AA 1002 | 04-Jan-18 (in house check) | In house check: Jan-19 |

Calibrated by: Name **Eric Hainfeld** Function **Laboratory Technician** Signature

Approved by: **Sven Kühn** Deputy Manager

Issued: June 20, 2018

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Accreditation No.: **SCS 0108**

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Multilateral Agreement for the recognition of calibration certificates

## Glossary

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

## Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement:* Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

## DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

| Calibration Factors | X                         | Y                         | Z                         |
|---------------------|---------------------------|---------------------------|---------------------------|
| High Range          | 404.292 $\pm$ 0.02% (k=2) | 404.471 $\pm$ 0.02% (k=2) | 404.000 $\pm$ 0.02% (k=2) |
| Low Range           | 4.01048 $\pm$ 1.50% (k=2) | 3.99008 $\pm$ 1.50% (k=2) | 4.00845 $\pm$ 1.50% (k=2) |

## Connector Angle

|                                           |                   |
|-------------------------------------------|-------------------|
| Connector Angle to be used in DASY system | 320.5 ° $\pm$ 1 ° |
|-------------------------------------------|-------------------|

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

### 1. DC Voltage Linearity

| High Range        | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 199995.21                 | -2.10                        | -0.00     |
| Channel X + Input | 20001.90                  | -0.02                        | -0.00     |
| Channel X - Input | -19998.43                 | 2.67                         | -0.01     |
| Channel Y + Input | 199997.45                 | 0.04                         | 0.00      |
| Channel Y + Input | 20000.13                  | -1.84                        | -0.01     |
| Channel Y - Input | -20002.53                 | -1.31                        | 0.01      |
| Channel Z + Input | 199998.07                 | 0.90                         | 0.00      |
| Channel Z + Input | 20000.07                  | -1.82                        | -0.01     |
| Channel Z - Input | -20002.88                 | -1.51                        | 0.01      |

| Low Range         | Reading ( $\mu\text{V}$ ) | Difference ( $\mu\text{V}$ ) | Error (%) |
|-------------------|---------------------------|------------------------------|-----------|
| Channel X + Input | 2002.15                   | 0.71                         | 0.04      |
| Channel X + Input | 201.89                    | 0.17                         | 0.09      |
| Channel X - Input | -198.28                   | -0.11                        | 0.06      |
| Channel Y + Input | 2000.77                   | -0.64                        | -0.03     |
| Channel Y + Input | 201.50                    | -0.14                        | -0.07     |
| Channel Y - Input | -198.61                   | -0.36                        | 0.18      |
| Channel Z + Input | 2001.31                   | -0.10                        | -0.01     |
| Channel Z + Input | 200.36                    | -1.18                        | -0.59     |
| Channel Z - Input | -199.37                   | -1.01                        | 0.51      |

### 2. Common mode sensitivity

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

|           | Common mode Input Voltage (mV) | High Range Average Reading ( $\mu\text{V}$ ) | Low Range Average Reading ( $\mu\text{V}$ ) |
|-----------|--------------------------------|----------------------------------------------|---------------------------------------------|
| Channel X | 200                            | 4.32                                         | 2.70                                        |
|           | - 200                          | -2.19                                        | -4.37                                       |
| Channel Y | 200                            | 11.36                                        | 11.41                                       |
|           | - 200                          | -12.35                                       | -12.96                                      |
| Channel Z | 200                            | -13.98                                       | -14.32                                      |
|           | - 200                          | 13.11                                        | 12.07                                       |

### 3. Channel separation

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

|           | Input Voltage (mV) | Channel X ( $\mu\text{V}$ ) | Channel Y ( $\mu\text{V}$ ) | Channel Z ( $\mu\text{V}$ ) |
|-----------|--------------------|-----------------------------|-----------------------------|-----------------------------|
| Channel X | 200                | -                           | -0.68                       | -5.41                       |
| Channel Y | 200                | 7.71                        | -                           | 0.61                        |
| Channel Z | 200                | 10.01                       | 5.69                        | -                           |

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

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

|           | High Range (LSB) | Low Range (LSB) |
|-----------|------------------|-----------------|
| Channel X | 15930            | 14966           |
| Channel Y | 16009            | 15983           |
| Channel Z | 16005            | 17407           |

#### 5. Input Offset Measurement

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

Input 10M $\Omega$

|           | Average ( $\mu$ V) | min. Offset ( $\mu$ V) | max. Offset ( $\mu$ V) | Std. Deviation ( $\mu$ V) |
|-----------|--------------------|------------------------|------------------------|---------------------------|
| Channel X | -0.01              | -2.00                  | 1.96                   | 0.70                      |
| Channel Y | 1.43               | 0.40                   | 2.68                   | 0.39                      |
| Channel Z | -0.70              | -1.89                  | 0.85                   | 0.46                      |

#### 6. Input Offset Current

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

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

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

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

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

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

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



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

Accreditation No.: **SCS 0108**

Client **Sporton**

Certificate No: **ES3-3270\_Sep18**

## CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3270**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-23.v5, QA CAL-25.v6  
Calibration procedure for dosimetric E-field probes**

Calibration date: **September 24, 2018**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|------------------|-----------------------------------|------------------------|
| Power meter NRP            | SN: 104778       | 04-Apr-18 (No. 217-02672/02673)   | Apr-19                 |
| Power sensor NRP-Z91       | SN: 103244       | 04-Apr-18 (No. 217-02672)         | Apr-19                 |
| Power sensor NRP-Z91       | SN: 103245       | 04-Apr-18 (No. 217-02673)         | Apr-19                 |
| Reference 20 dB Attenuator | SN: S5277 (20x)  | 04-Apr-18 (No. 217-02682)         | Apr-19                 |
| Reference Probe ES3DV2     | SN: 3013         | 30-Dec-17 (No. ES3-3013_Dec17)    | Dec-18                 |
| DAE4                       | SN: 660          | 21-Dec-17 (No. DAE4-660_Dec17)    | Dec-18                 |
|                            |                  |                                   |                        |
| Secondary Standards        | ID               | Check Date (in house)             | Scheduled Check        |
| Power meter E4419B         | SN: GB41293874   | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A        | SN: MY41498087   | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A        | SN: 000110210    | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| RF generator HP 8648C      | SN: US3642U01700 | 04-Aug-99 (in house check Jun-18) | In house check: Jun-20 |
| Network Analyzer E8358A    | SN: US41080477   | 31-Mar-14 (in house check Oct-17) | In house check: Oct-18 |

|                                                                                                                 | Name          | Function              | Signature |
|-----------------------------------------------------------------------------------------------------------------|---------------|-----------------------|-----------|
| Calibrated by:                                                                                                  | Michael Weber | Laboratory Technician |           |
| Approved by:                                                                                                    | Katja Pokovic | Technical Manager     |           |
|                                                                                                                 |               |                       |           |
| Issued: September 29, 2018                                                                                      |               |                       |           |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |               |                       |           |



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

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

# Probe ES3DV3

## SN:3270

Manufactured: February 25, 2010  
Calibrated: September 24, 2018

Calibrated for DASY/EASY Systems  
(Note: non-compatible with DASY2 system!)

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3270

### Basic Calibration Parameters

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|-----------------------------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 1.08     | 1.17     | 1.19     | ± 10.1 %  |
| DCP (mV) <sup>B</sup>                                     | 101.7    | 104.7    | 101.9    |           |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc <sup>E</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 191.7    | ±3.3 %                    |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 209.4    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 199.9    |                           |

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  $E^2$ -field uncertainty inside TSL (see Pages 5 and 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.

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3270

### 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) | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 750                  | 41.9                               | 0.89                            | 6.56    | 6.56    | 6.56    | 0.50               | 1.55                    | ± 12.0 %  |
| 835                  | 41.5                               | 0.90                            | 6.39    | 6.39    | 6.39    | 0.43               | 1.56                    | ± 12.0 %  |
| 900                  | 41.5                               | 0.97                            | 6.20    | 6.20    | 6.20    | 0.44               | 1.54                    | ± 12.0 %  |
| 1750                 | 40.1                               | 1.37                            | 5.42    | 5.42    | 5.42    | 0.40               | 1.75                    | ± 12.0 %  |
| 1900                 | 40.0                               | 1.40                            | 5.17    | 5.17    | 5.17    | 0.80               | 1.16                    | ± 12.0 %  |
| 2000                 | 40.0                               | 1.40                            | 5.13    | 5.13    | 5.13    | 0.56               | 1.46                    | ± 12.0 %  |
| 2100                 | 39.8                               | 1.49                            | 5.03    | 5.03    | 5.03    | 0.80               | 1.23                    | ± 12.0 %  |
| 2450                 | 39.2                               | 1.80                            | 4.60    | 4.60    | 4.60    | 0.74               | 1.30                    | ± 12.0 %  |
| 2600                 | 39.0                               | 1.96                            | 4.43    | 4.43    | 4.43    | 0.80               | 1.31                    | ± 12.0 %  |

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

<sup>F</sup> At frequencies 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 frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3270

### 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) | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 750                  | 55.5                               | 0.96                            | 6.29    | 6.29    | 6.29    | 0.41               | 1.65                    | ± 12.0 %  |
| 835                  | 55.2                               | 0.97                            | 6.11    | 6.11    | 6.11    | 0.38               | 1.70                    | ± 12.0 %  |
| 1750                 | 53.4                               | 1.49                            | 4.97    | 4.97    | 4.97    | 0.58               | 1.49                    | ± 12.0 %  |
| 1900                 | 53.3                               | 1.52                            | 4.77    | 4.77    | 4.77    | 0.55               | 1.56                    | ± 12.0 %  |
| 2450                 | 52.7                               | 1.95                            | 4.36    | 4.36    | 4.36    | 0.80               | 1.25                    | ± 12.0 %  |
| 2600                 | 52.5                               | 2.16                            | 4.24    | 4.24    | 4.24    | 0.85               | 1.20                    | ± 12.0 %  |

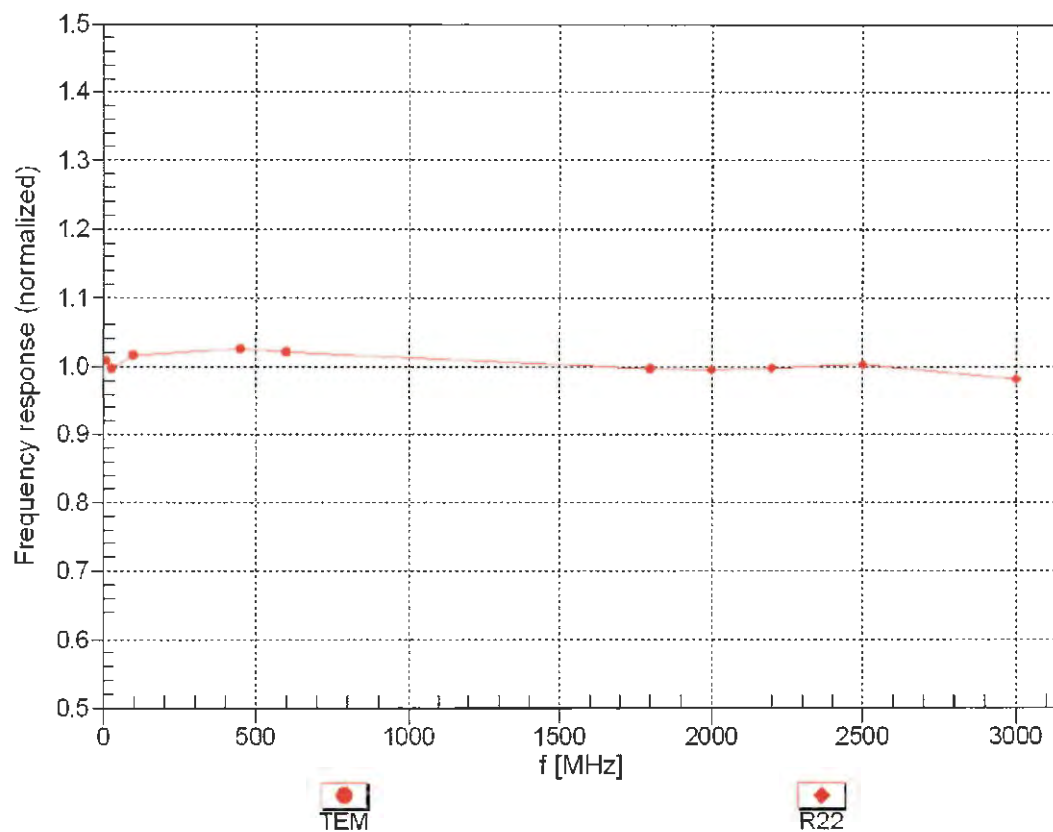
<sup>C</sup> Frequency validity above 300 MHz of  $\pm 100$  MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to  $\pm 50$  MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is  $\pm 10$ , 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 frequencies 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 frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

## Frequency Response of E-Field

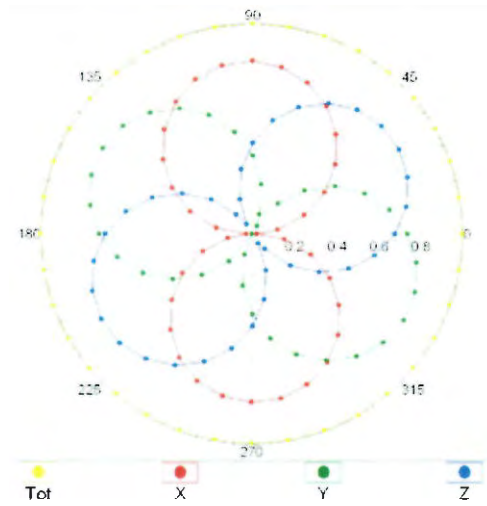
(TEM-Cell:ifi110 EXX, Waveguide: R22)



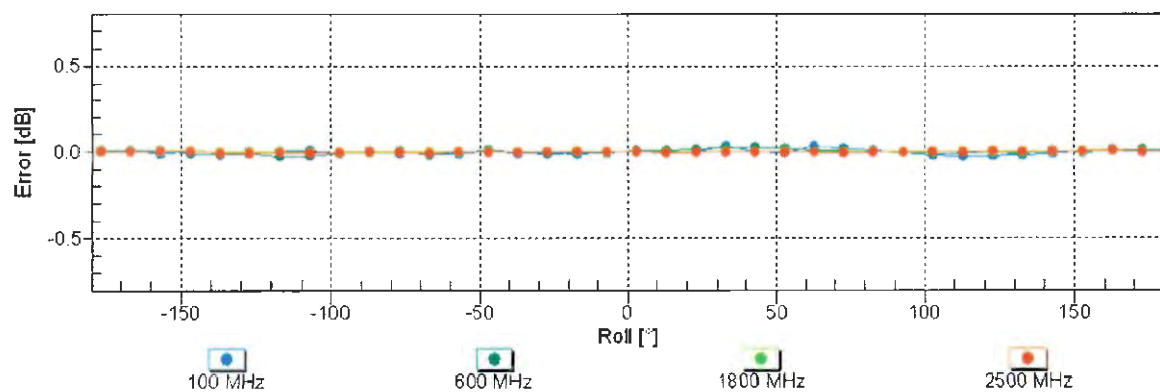
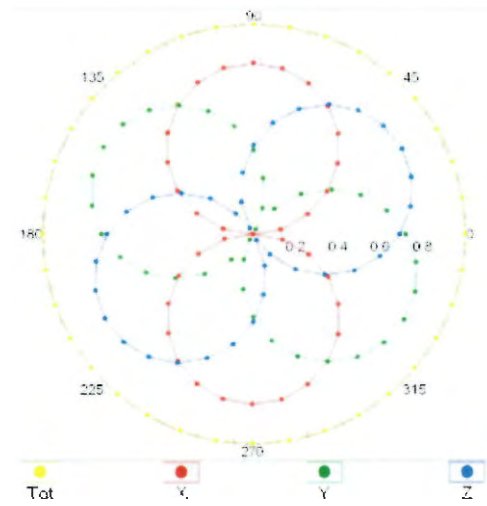
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

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

f=600 MHz,TEM

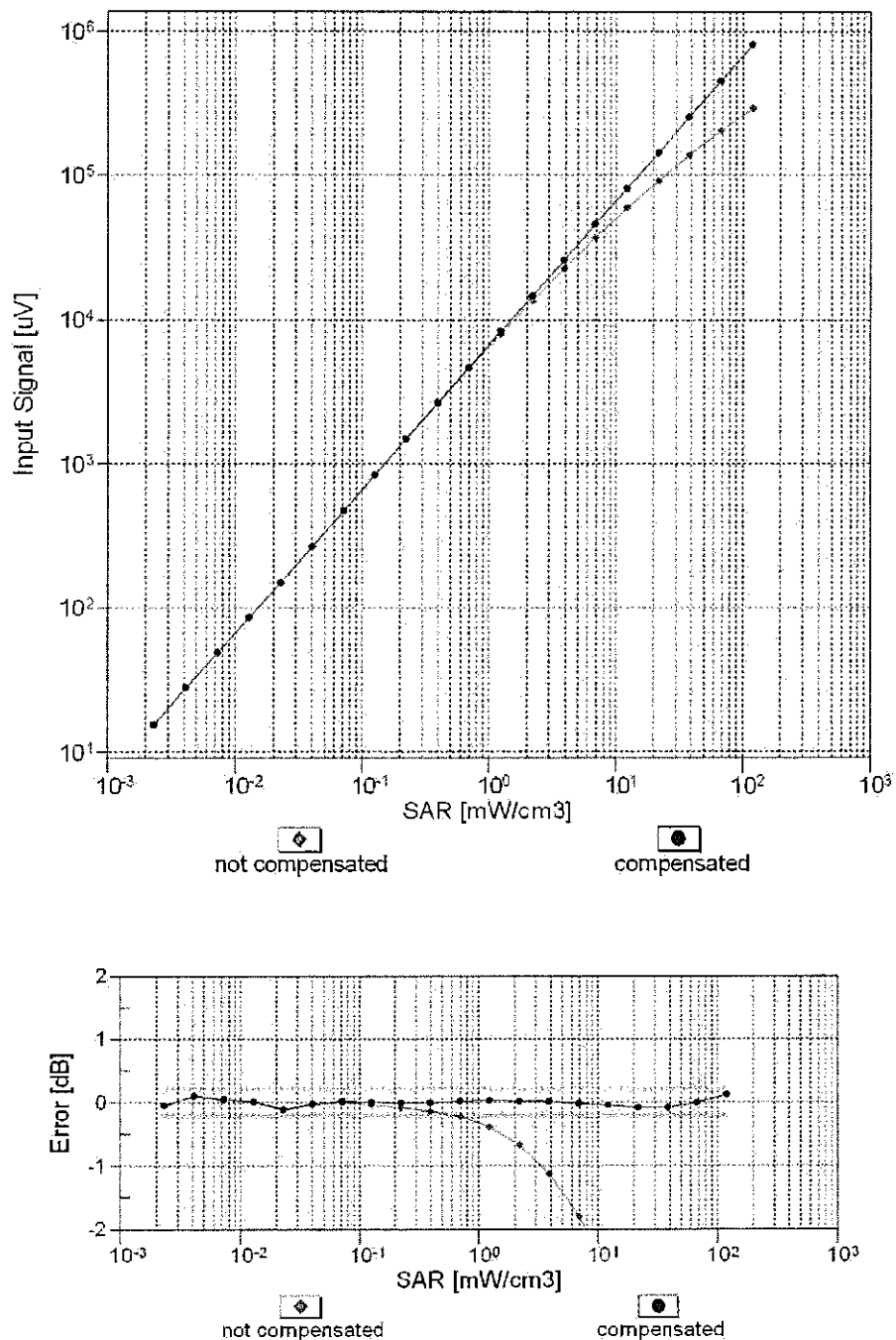


f=1800 MHz,R22



**Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )**

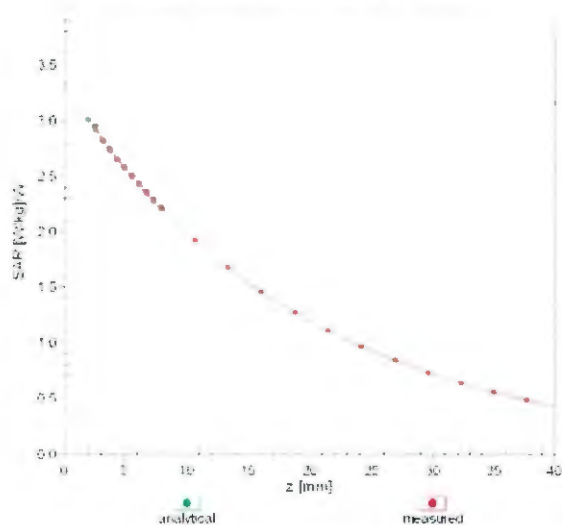
# Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell , $f_{\text{eval}} = 1900 \text{ MHz}$ )



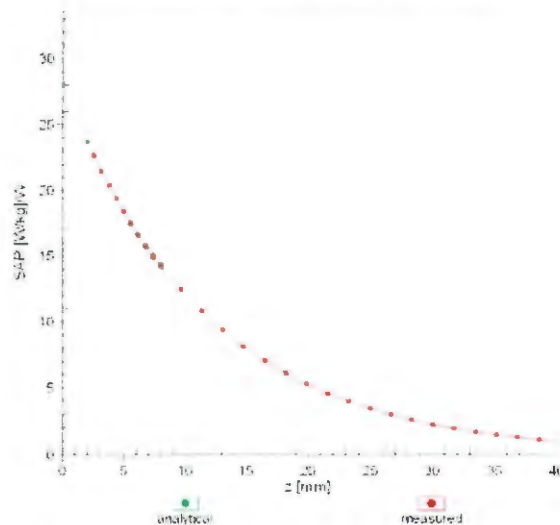
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

## Conversion Factor Assessment

$f = 835 \text{ MHz}$ , WGLS R9 (H\_convF)

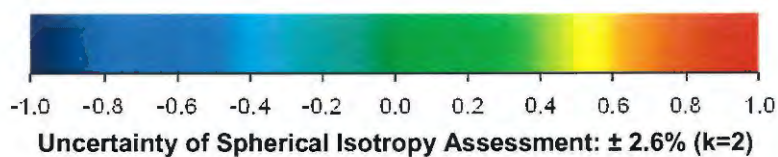
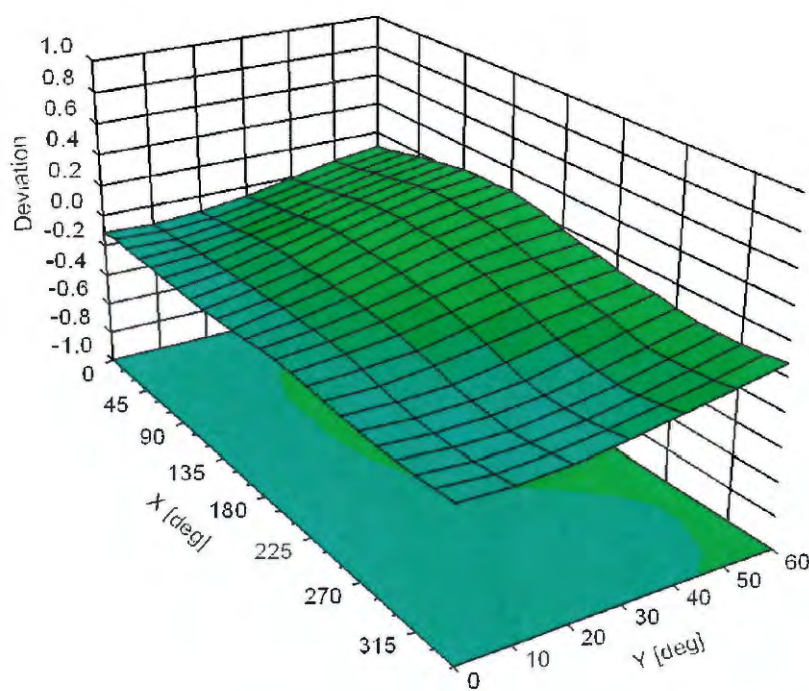


$f = 1900 \text{ MHz}$ , WGLS R22 (H\_convF)



## Deviation from Isotropy in Liquid

Error ( $\phi$ ,  $\theta$ ),  $f = 900 \text{ MHz}$



## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3270

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -17.1      |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disabled   |
| Probe Overall Length                          | 337 mm     |
| Probe Body Diameter                           | 10 mm      |
| Tip Length                                    | 10 mm      |
| Tip Diameter                                  | 4 mm       |
| Probe Tip to Sensor X Calibration Point       | 2 mm       |
| Probe Tip to Sensor Y Calibration Point       | 2 mm       |
| Probe Tip to Sensor Z Calibration Point       | 2 mm       |
| Recommended Measurement Distance from Surface | 3 mm       |



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **Auden**

Certificate No: **EX3-7515\_Oct18**

## CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:7515**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6**  
**Calibration procedure for dosimetric E-field probes**

Calibration date: **October 3, 2018**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|------------------|-----------------------------------|------------------------|
| Power meter NRP            | SN: 104778       | 04-Apr-18 (No. 217-02672/02673)   | Apr-19                 |
| Power sensor NRP-Z91       | SN: 103244       | 04-Apr-18 (No. 217-02672)         | Apr-19                 |
| Power sensor NRP-Z91       | SN: 103245       | 04-Apr-18 (No. 217-02673)         | Apr-19                 |
| Reference 20 dB Attenuator | SN: S5277 (20x)  | 04-Apr-18 (No. 217-02682)         | Apr-19                 |
| Reference Probe ES3DV2     | SN: 3013         | 30-Dec-17 (No. ES3-3013_Dec17)    | Dec-18                 |
| DAE4                       | SN: 660          | 21-Dec-17 (No. DAE4-660_Dec17)    | Dec-18                 |
| Secondary Standards        | ID               | Check Date (in house)             | Scheduled Check        |
| Power meter E4419B         | SN: GB41293874   | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A        | SN: MY41498087   | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A        | SN: 000110210    | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| RF generator HP 8648C      | SN: US3642U01700 | 04-Aug-99 (in house check Jun-18) | In house check: Jun-20 |
| Network Analyzer E8358A    | SN: US41080477   | 31-Mar-14 (in house check Oct-17) | In house check: Oct-18 |

Calibrated by: **Jeton Kastrati**

Function  
**Laboratory Technician**

Signature

Approved by: **Katja Pokovic**

Technical Manager

Issued: October 3, 2018

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



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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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 $\varphi$   | $\varphi$ rotation around probe axis                                                                                                                    |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center),<br>i.e., $\vartheta = 0$ 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:

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- 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.
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- 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>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  MHz) and inside waveguide using analytical field distributions based on power measurements for  $f > 800$  MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50$  MHz to  $\pm 100$  MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).

# Probe EX3DV4

## SN:7515

Manufactured: March 28, 2018  
Calibrated: October 3, 2018

Calibrated for DASY/EASY Systems  
(Note: non-compatible with DASY2 system!)

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:7515

### Basic Calibration Parameters

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2)     |
|-----------------------------------------------------------|----------|----------|----------|---------------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup> | 0.42     | 0.50     | 0.46     | $\pm 10.1 \%$ |
| DCP (mV) <sup>B</sup>                                     | 97.1     | 97.7     | 95.7     |               |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc <sup>E</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 169.5    | $\pm 2.2 \%$              |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 156.2    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 176.6    |                           |

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

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

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:7515

### 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) | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 750                  | 41.9                               | 0.89                            | 10.11   | 10.11   | 10.11   | 0.54               | 0.80                    | ± 12.0 %  |
| 835                  | 41.5                               | 0.90                            | 9.75    | 9.75    | 9.75    | 0.41               | 0.88                    | ± 12.0 %  |
| 900                  | 41.5                               | 0.97                            | 9.68    | 9.68    | 9.68    | 0.55               | 0.85                    | ± 12.0 %  |
| 1750                 | 40.1                               | 1.37                            | 8.65    | 8.65    | 8.65    | 0.34               | 0.88                    | ± 12.0 %  |
| 1900                 | 40.0                               | 1.40                            | 8.33    | 8.33    | 8.33    | 0.25               | 0.90                    | ± 12.0 %  |
| 2000                 | 40.0                               | 1.40                            | 8.28    | 8.28    | 8.28    | 0.29               | 0.88                    | ± 12.0 %  |
| 2300                 | 39.5                               | 1.67                            | 7.86    | 7.86    | 7.86    | 0.35               | 0.87                    | ± 12.0 %  |
| 2450                 | 39.2                               | 1.80                            | 7.42    | 7.42    | 7.42    | 0.36               | 0.88                    | ± 12.0 %  |
| 2600                 | 39.0                               | 1.96                            | 7.37    | 7.37    | 7.37    | 0.33               | 0.97                    | ± 12.0 %  |
| 5250                 | 35.9                               | 4.71                            | 5.45    | 5.45    | 5.45    | 0.40               | 1.80                    | ± 13.1 %  |
| 5600                 | 35.5                               | 5.07                            | 4.83    | 4.83    | 4.83    | 0.40               | 1.80                    | ± 13.1 %  |
| 5750                 | 35.4                               | 5.22                            | 4.95    | 4.95    | 4.95    | 0.40               | 1.80                    | ± 13.1 %  |

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

<sup>F</sup> At frequencies 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 frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:7515

### 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) | Unc (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-----------|
| 750                  | 55.5                               | 0.96                            | 10.15   | 10.15   | 10.15   | 0.46               | 0.84                    | ± 12.0 %  |
| 835                  | 55.2                               | 0.97                            | 9.99    | 9.99    | 9.99    | 0.38               | 1.01                    | ± 12.0 %  |
| 900                  | 55.0                               | 1.05                            | 9.69    | 9.69    | 9.69    | 0.52               | 0.80                    | ± 12.0 %  |
| 1750                 | 53.4                               | 1.49                            | 8.20    | 8.20    | 8.20    | 0.36               | 0.93                    | ± 12.0 %  |
| 1900                 | 53.3                               | 1.52                            | 7.93    | 7.93    | 7.93    | 0.31               | 0.96                    | ± 12.0 %  |
| 2000                 | 53.3                               | 1.52                            | 7.89    | 7.89    | 7.89    | 0.38               | 0.87                    | ± 12.0 %  |
| 2300                 | 52.9                               | 1.81                            | 7.75    | 7.75    | 7.75    | 0.36               | 0.90                    | ± 12.0 %  |
| 2450                 | 52.7                               | 1.95                            | 7.53    | 7.53    | 7.53    | 0.36               | 0.94                    | ± 12.0 %  |
| 2600                 | 52.5                               | 2.16                            | 7.48    | 7.48    | 7.48    | 0.28               | 0.97                    | ± 12.0 %  |
| 5250                 | 48.9                               | 5.36                            | 4.96    | 4.96    | 4.96    | 0.50               | 1.90                    | ± 13.1 %  |
| 5600                 | 48.5                               | 5.77                            | 4.39    | 4.39    | 4.39    | 0.50               | 1.90                    | ± 13.1 %  |
| 5800                 | 48.2                               | 6.00                            | 4.42    | 4.42    | 4.42    | 0.50               | 1.90                    | ± 13.1 %  |

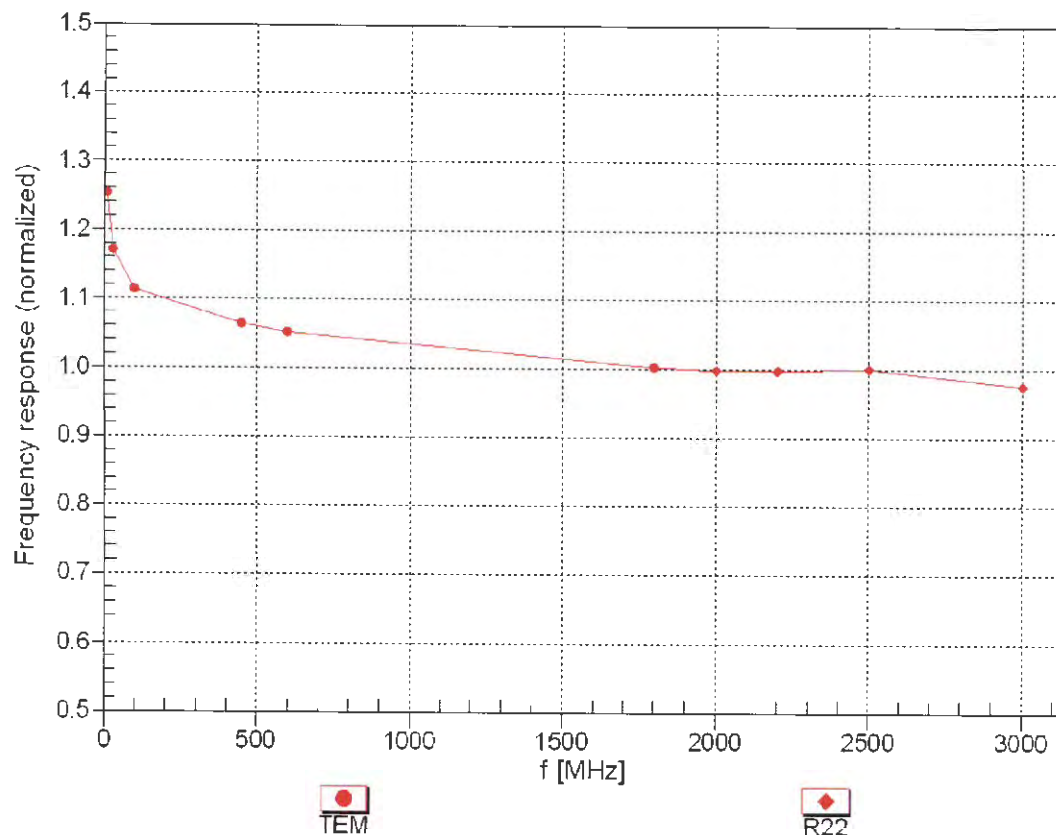
<sup>C</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below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

<sup>F</sup> At frequencies 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 frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

## Frequency Response of E-Field

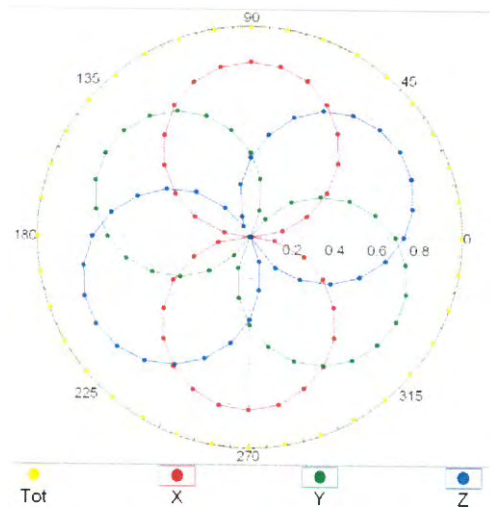
(TEM-Cell:ifi110 EXX, Waveguide: R22)



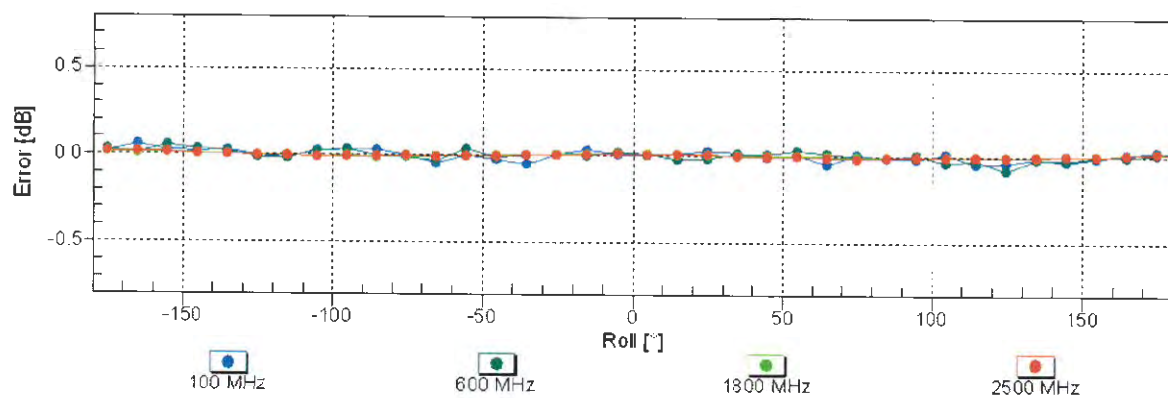
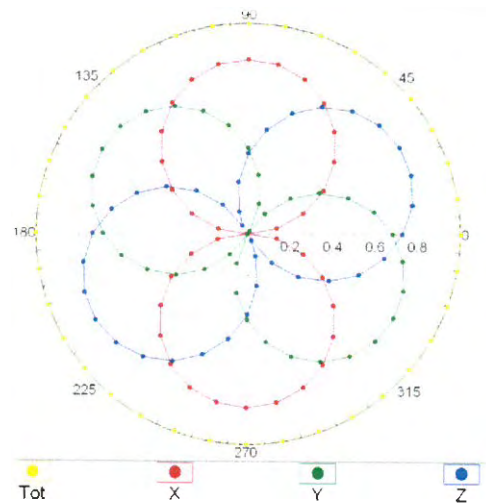
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  ( $k=2$ )

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

f=600 MHz,TEM

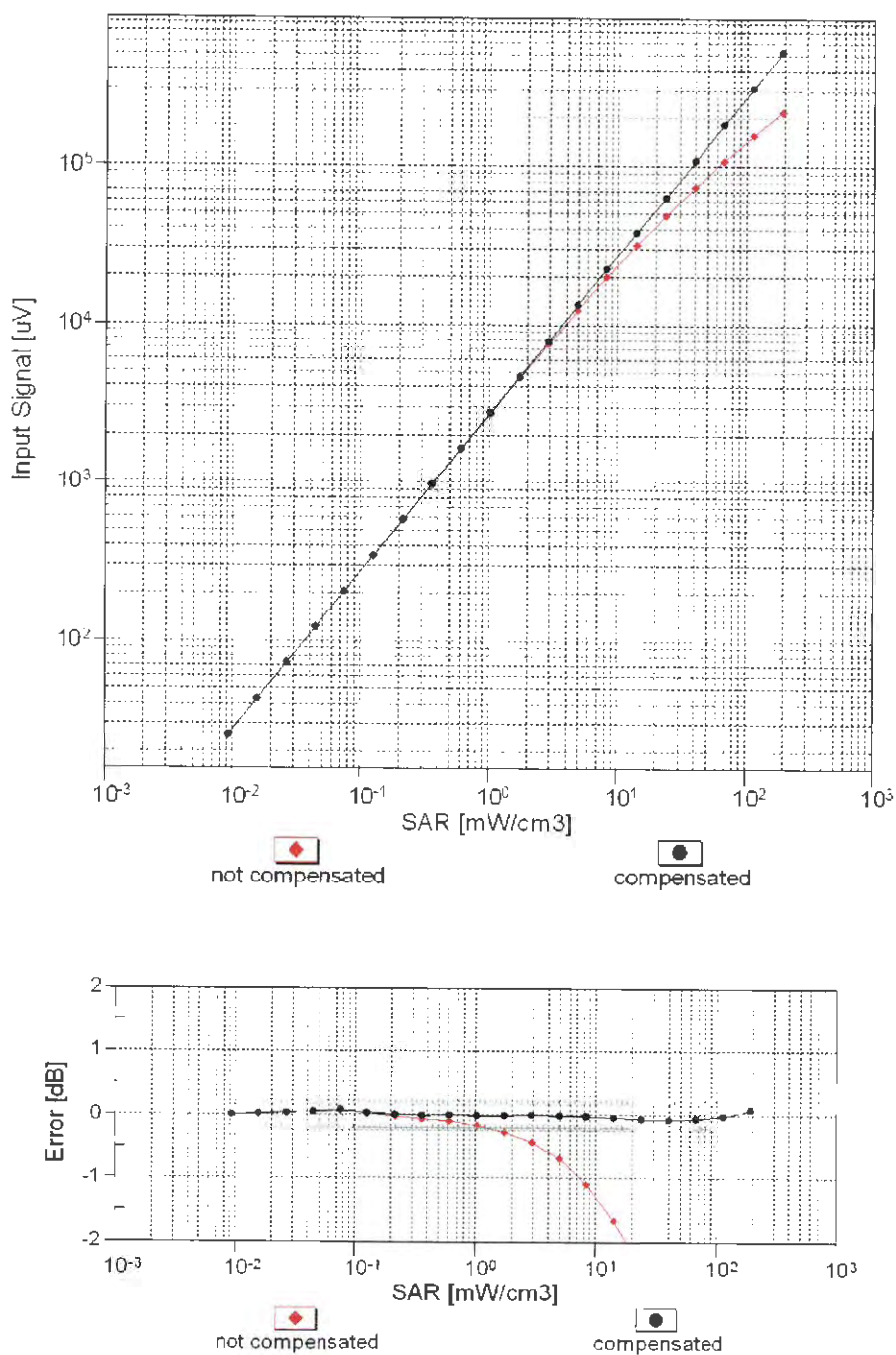


f=1800 MHz,R22



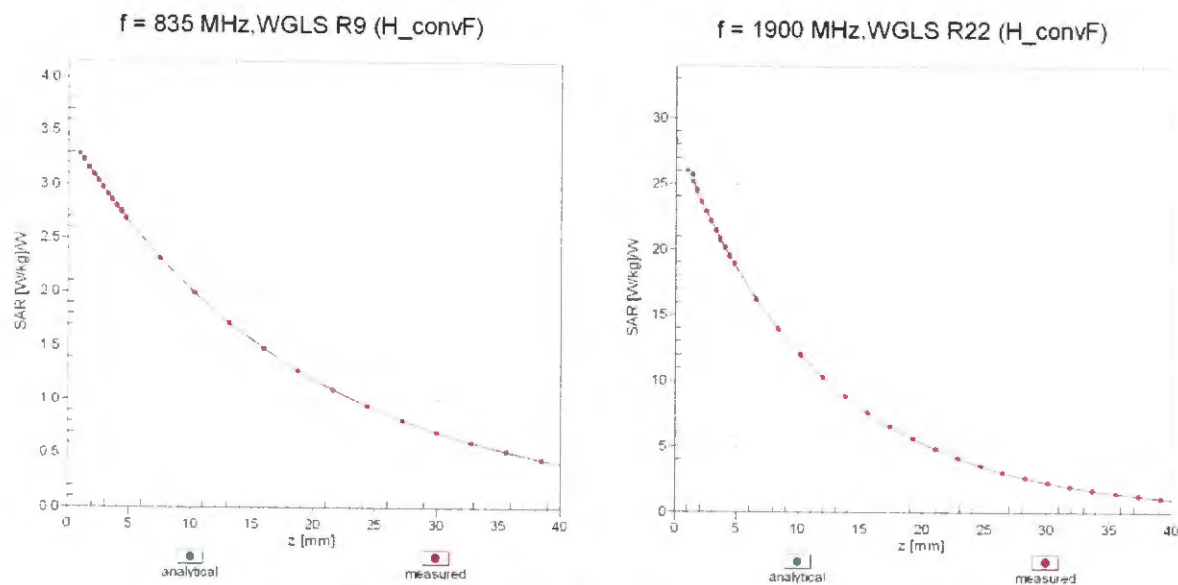
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

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



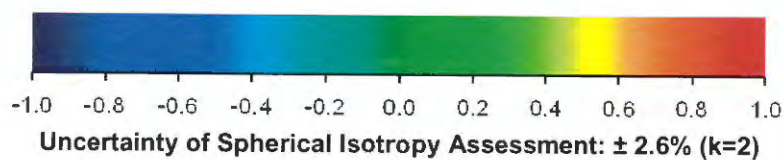
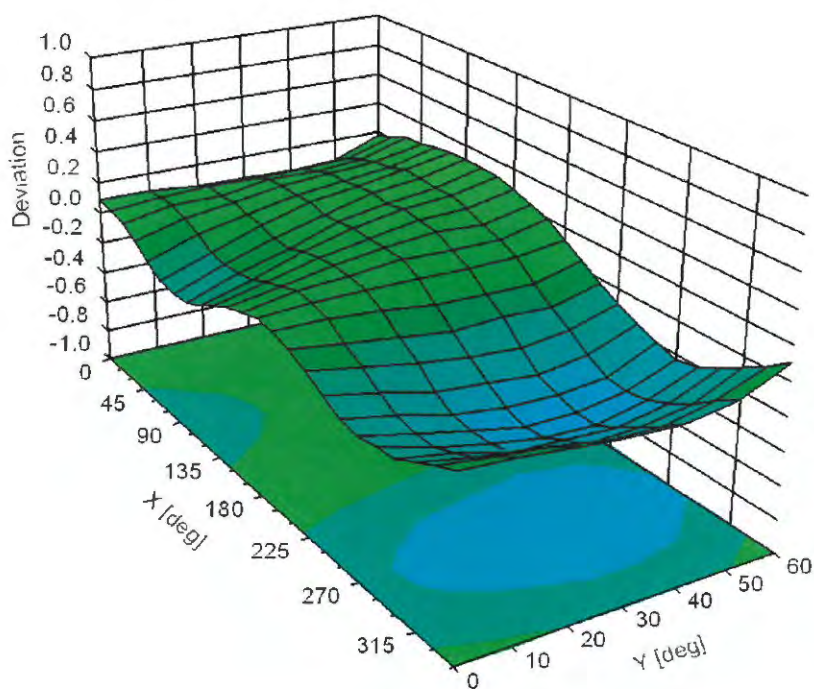
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

## Conversion Factor Assessment



## Deviation from Isotropy in Liquid

Error ( $\phi, \theta$ ),  $f = 900 \text{ MHz}$



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### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | -5.4       |
| Mechanical Surface Detection Mode             | enabled    |
| Optical Surface Detection Mode                | disabled   |
| Probe Overall Length                          | 337 mm     |
| Probe Body Diameter                           | 10 mm      |
| Tip Length                                    | 9 mm       |
| Tip Diameter                                  | 2.5 mm     |
| Probe Tip to Sensor X Calibration Point       | 1 mm       |
| Probe Tip to Sensor Y Calibration Point       | 1 mm       |
| Probe Tip to Sensor Z Calibration Point       | 1 mm       |
| Recommended Measurement Distance from Surface | 1.4 mm     |