

## SAR Test Report

Product : Cordless Wi-Fi IP Phone  
Trade mark : GRANDSTREAM  
Model/Type reference : WP810  
Add. Model No. : N/A  
Report Number : 191026006SAR-1  
Date of Issue : November 26, 2019  
FCC ID : YZZWP810  
IC : 11964A-WP810  
Test Standards : FCC 47 CFR Part 2 §2.1093  
ANSI/IEEE C95.1-1992  
IEEE Std 1528-2013  
RSS-102 Issue 5:March 2015  
IEC 62209-1:2016/ IEC 62209-2:2010  
Test result : PASS

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UTTR-SAR-IEEE Std 1528-2013-V1.0

## Version

| Version No. | Date              | Description |
|-------------|-------------------|-------------|
| V1.0        | November 26, 2019 | Original    |

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## Contents

|                                                                                    | Page      |
|------------------------------------------------------------------------------------|-----------|
| <b>1 GENERAL INFORMATION .....</b>                                                 | <b>5</b>  |
| <b>1.1 STATEMENT OF COMPLIANCE .....</b>                                           | <b>5</b>  |
| <b>1.2 EUT DESCRIPTION .....</b>                                                   | <b>5</b>  |
| 1.2.1 General Description .....                                                    | 5         |
| 1.2.2 Wireless Technologies .....                                                  | 5         |
| 1.2.3 List of Accessory .....                                                      | 5         |
| <b>1.3 MAXIMUM CONDUCTED POWER .....</b>                                           | <b>6</b>  |
| <b>1.4 OTHER INFORMATION .....</b>                                                 | <b>7</b>  |
| <b>1.5 TESTING LOCATION .....</b>                                                  | <b>7</b>  |
| <b>1.6 TEST FACILITY .....</b>                                                     | <b>7</b>  |
| <b>1.7 GUIDANCE STANDARD .....</b>                                                 | <b>8</b>  |
| <b>2 SPECIFIC ABSORPTION RATE (SAR).....</b>                                       | <b>9</b>  |
| <b>2.1 INTRODUCTION .....</b>                                                      | <b>9</b>  |
| <b>2.2 SAR DEFINITION .....</b>                                                    | <b>9</b>  |
| <b>2.3 SAR LIMITS .....</b>                                                        | <b>9</b>  |
| <b>3 SAR MEASUREMENT SYSTEM .....</b>                                              | <b>10</b> |
| <b>3.1 SPEAG DASY SYSTEM .....</b>                                                 | <b>10</b> |
| 3.1.1 Robot .....                                                                  | 10        |
| 3.1.2 Probe .....                                                                  | 11        |
| 3.1.3 Data Acquisition Electronics (DAE) .....                                     | 11        |
| 3.1.4 Phantom .....                                                                | 12        |
| 3.1.5 Device Holder .....                                                          | 13        |
| 3.1.6 System Validation Dipoles .....                                              | 13        |
| <b>3.2 SAR SCAN PROCEDURE.....</b>                                                 | <b>14</b> |
| 3.2.1 SAR Reference Measurement (drift) .....                                      | 14        |
| 3.2.2 Area Scan .....                                                              | 14        |
| 3.2.3 Zoom Scan .....                                                              | 14        |
| 3.2.4 SAR Drift Measurement.....                                                   | 15        |
| <b>3.3 TEST EQUIPMENT .....</b>                                                    | <b>16</b> |
| <b>3.4 MEASUREMENT UNCERTAINTY .....</b>                                           | <b>17</b> |
| <b>3.5 TISSUE DIELECTRIC PARAMETER MEASUREMENT &amp; SYSTEM VERIFICATION .....</b> | <b>21</b> |
| 3.5.1 Tissue Simulating Liquids.....                                               | 21        |
| 3.5.2 System Check Description .....                                               | 23        |
| 3.5.3 Tissue Verification.....                                                     | 24        |
| 3.5.4 System Verification .....                                                    | 24        |
| 3.5.5 System Validation .....                                                      | 24        |
| <b>4 SAR MEASUREMENT EVALUATION .....</b>                                          | <b>25</b> |
| <b>4.1 EUT CONFIGURATION AND SETTING .....</b>                                     | <b>25</b> |
| 4.1.1 WLAN Configuration and Testing .....                                         | 25        |
| <b>4.2 EUT TESTING POSITION.....</b>                                               | <b>27</b> |
| 4.2.1 Head Exposure Conditions.....                                                | 27        |
| 4.2.2 Body-worn Accessory Exposure Conditions .....                                | 29        |
| <b>4.3 MEASURED CONDUCTED POWER RESULT .....</b>                                   | <b>30</b> |
| 4.3.1 Conducted Power of WLAN .....                                                | 30        |
| <b>4.4 SAR TEST EXCLUSION EVALUATIONS .....</b>                                    | <b>33</b> |
| 4.4.1 Standalone SAR Test Exclusion Considerations .....                           | 33        |
| 4.4.2 Estimated SAR Calculation .....                                              | 33        |
| <b>4.5 SAR TESTING RESULTS .....</b>                                               | <b>34</b> |
| 4.5.1 SAR Test Reduction Considerations .....                                      | 34        |
| 4.5.2 SAR Results for Head Exposure Condition.....                                 | 35        |

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|            |                                                                        |           |
|------------|------------------------------------------------------------------------|-----------|
|            | 4.5.3 SAR Results for Body-worn Exposure Condition .....               | 36        |
| <b>4.6</b> | <b>SAR MEASUREMENT VARIABILITY .....</b>                               | <b>37</b> |
|            | 4.6.1 Repeated Measurement.....                                        | 37        |
| <b>4.7</b> | <b>SIMULTANEOUS MULTI-BAND TRANSMISSION EVALUATION .....</b>           | <b>38</b> |
|            | 4.7.1 Simultaneous Transmission SAR Test Exclusion Considerations..... | 38        |
|            | 4.7.2 Simultaneous Transmission Possibilities.....                     | 38        |

**Appendix A. SAR Plots of System Verification**

**Appendix B. SAR Plots of SAR Measurement**

**Appendix C. Calibration Certificate for Probe and Dipole**

**Appendix D. Photographs of EUT and Setup**

## 1 General Information

### 1.1 Statement of Compliance

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

| Equipment Class | Mode      | Highest Reported Head SAR <sub>1g</sub> (W/kg) | Highest Reported Body-worn SAR <sub>1g</sub> (1.0 cm Gap) (W/kg) |
|-----------------|-----------|------------------------------------------------|------------------------------------------------------------------|
| DTS             | 2.4G WLAN | 0.23                                           | 0.07                                                             |
| NII             | 5.2G WLAN | N/A                                            | N/A                                                              |
|                 | 5.3G WLAN | 1.12                                           | 0.32                                                             |
|                 | 5.6G WLAN | 1.18                                           | 0.25                                                             |
|                 | 5.8G WLAN | 1.19                                           | 0.29                                                             |

### 1.2 EUT Description

#### 1.2.1 General Description

|                                |                                                                       |
|--------------------------------|-----------------------------------------------------------------------|
| Product Name                   | Cordless Wi-Fi IP Phone                                               |
| Trade mark                     | GRANDSTREAM                                                           |
| Model No.(EUT)                 | WP810                                                                 |
| Add. Model No.:                | N/A                                                                   |
| FCC ID                         | YZZWP810                                                              |
| IC                             | 11964A-WP810                                                          |
| HW Version                     | V1.3                                                                  |
| SW Version                     | 1.0.0.26                                                              |
| Tx Frequency Bands (Unit: MHz) | WLAN: 2412 ~ 2462, 5180 ~ 5240, 5260 ~ 5320, 5500 ~ 5700, 5745 ~ 5825 |
| Antenna Type                   | PIFA Antenna                                                          |
| EUT Stage                      | Identical Prototype                                                   |

#### 1.2.2 Wireless Technologies

|           |                                                                |
|-----------|----------------------------------------------------------------|
| 2.4G WLAN | 802.11b<br>802.11g<br>802.11n (HT20)                           |
| 5G WLAN   | 802.11a<br>802.11n (HT20/HT40)<br>802.11ac (VHT20/VHT40/VHT80) |

#### 1.2.3 List of Accessory

|         |              |                 |
|---------|--------------|-----------------|
| Battery | Model Name   | GS-01           |
|         | Power Rating | 3.8Vdc, 1500mAh |
|         | Type         | Li-ion          |

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### 1.3 Maximum Conducted Power

The maximum conducted average power (Unit: dBm) including tune-up tolerance is shown as below.

| Mode         | 2.4G WLAN |
|--------------|-----------|
| 802.11b      | 16.0      |
| 802.11g      | 15.5      |
| 802.11n HT20 | 15.0      |

| Mode           | 5.2G WLAN | 5.3G WLAN | 5.6G WLAN | 5.8G WLAN |
|----------------|-----------|-----------|-----------|-----------|
| 802.11a        | 16.5      | 17.5      | 17.3      | 17.4      |
| 802.11n HT20   | 16.5      | 17.0      | 17.0      | 17.0      |
| 802.11n HT40   | 16.5      | 16.5      | 16.5      | 16.5      |
| 802.11ac VHT20 | 16.5      | 17.0      | 17.0      | 17.0      |
| 802.11ac VHT40 | 16.5      | 16.5      | 16.5      | 16.5      |
| 802.11ac VHT80 | 12.5      | 12.5      | 15.5      | 15.5      |

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## 1.4 Other Information

|                       |                                       |
|-----------------------|---------------------------------------|
| Sample Received Date: | October 26, 2019                      |
| Sample tested Date:   | November 1, 2019 to November 25, 2019 |

## 1.5 Testing Location

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## 1.6 Test Facility

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

### CNAS-Lab Code: L9069

The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC/EN 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

### FCC Accredited Lab.

Designation Number: CN1194

Test Firm Registration Number: 259480

### A2LA-Lab Certificate No.: 4312.01

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

### ISED Wireless Device Testing Laboratories

CAB identifier: CN0032

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## 1.7 Guidance Standard

The tests documented in this report were performed in accordance with FCC 47 CFR Part 2 §2.1093, IEEE Std 1528-2013, ANSI/IEEE C95.1-1992, IC RSS-102 Issue 5, IEC 62209-1:2016, IEC 62209-2:2010, the following FCC Published RF exposure KDB procedures:

KDB 865664 D01 v01r04

KDB 865664 D02 v01r02

KDB 248227 D01 v02r02

KDB 447498 D01 v06

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## 2 Specific Absorption Rate (SAR)

### 2.1 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, by appropriate techniques, to produce specific absorption rates (SARs) as averaged over the whole-body, any 1 g or any 10 g of tissue (defined as a tissue volume in the shape of a cube). All SAR values are to be averaged over any six-minute period. When portable device was used within 20 cm of the user's body, SAR evaluation of the device will be required. The SAR limit in chapter 2.3.

### 2.2 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 (ρ). 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 measurement can be related to the electrical field in the tissue by

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

### 2.3 SAR Limits

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

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

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

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

**Note:**

1. Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1 gram 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.
2. At frequencies above 6.0 GHz, SAR limits are not applicable and MPE limits for power density should be applied at 5 cm or more from the transmitting device.
3. The SAR limit is specified in FCC 47 CFR Part 2 §2.1093, ANSI/IEEE C95.1-1992.

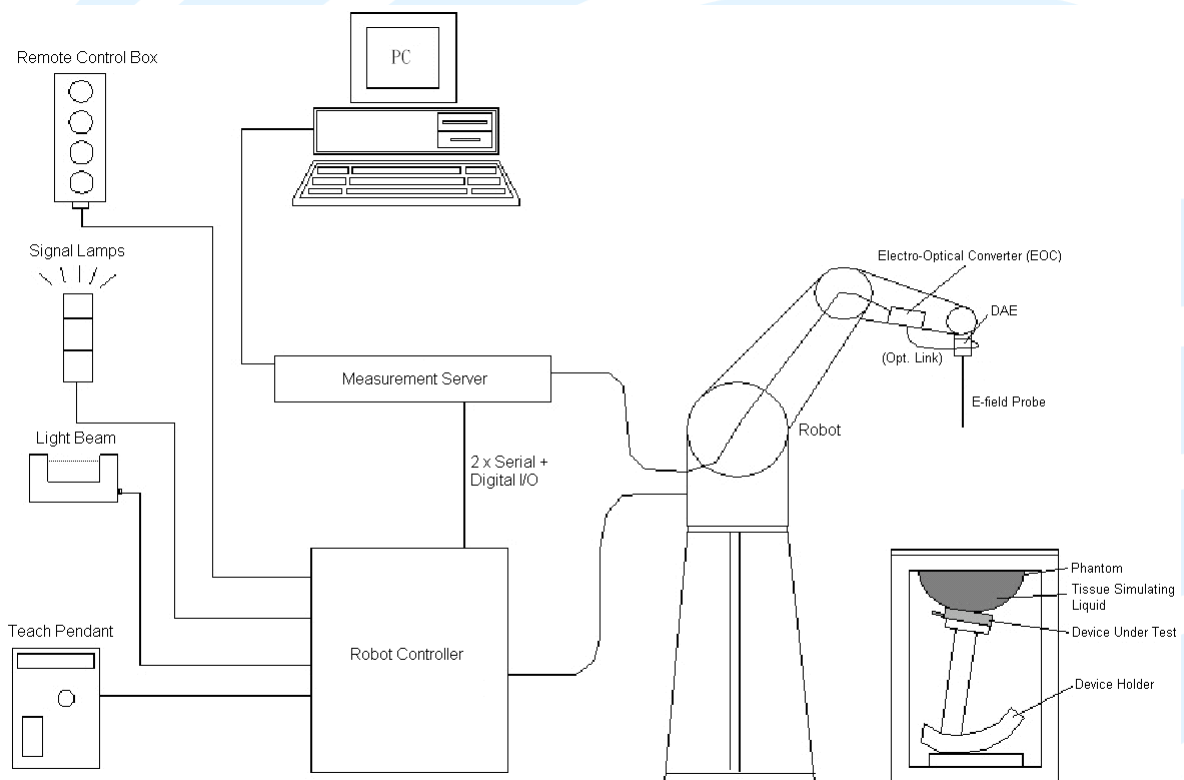
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### 3 SAR Measurement System

#### 3.1 SPEAG DASY System

DASY system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY5 software defined. The DASY software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC.



DASY Measurement System

##### 3.1.1 Robot

The DASY system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY4: CS7MB) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability  $\pm 0.02$  mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

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### 3.1.2 Probe

The SAR measurement is conducted with the dosimetric probe. 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.

|                      |                                                                                                                                                          |                                                                                     |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Model</b>         | EX3DV4                                                                                                                                                   |  |
| <b>Construction</b>  | Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE). |                                                                                     |
| <b>Frequency</b>     | 10 MHz to 6 GHz<br>Linearity: $\pm 0.2$ dB                                                                                                               |                                                                                     |
| <b>Directivity</b>   | $\pm 0.3$ dB in HSL (rotation around probe axis)<br>$\pm 0.5$ dB in tissue material (rotation normal to probe axis)                                      |                                                                                     |
| <b>Dynamic Range</b> | 10 $\mu$ W/g to 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                     |                                                                                     |

|                      |                                                                                                                                                                               |                                                                                      |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>Model</b>         | ES3DV3                                                                                                                                                                        |  |
| <b>Construction</b>  | Symmetrical design with triangular core. Interleaved sensors. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE). |                                                                                      |
| <b>Frequency</b>     | 10 MHz to 4 GHz<br>Linearity: $\pm 0.2$ dB                                                                                                                                    |                                                                                      |
| <b>Directivity</b>   | $\pm 0.2$ dB in HSL (rotation around probe axis)<br>$\pm 0.3$ dB in tissue material (rotation normal to probe axis)                                                           |                                                                                      |
| <b>Dynamic Range</b> | 5 $\mu$ W/g to 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: 2.0 mm                                                |                                                                                      |

### 3.1.3 Data Acquisition Electronics (DAE)

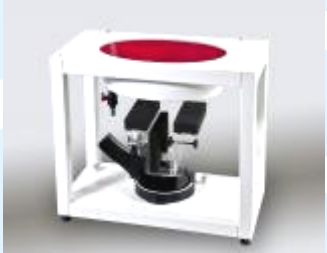
|                             |                                                                                                                                                                                                                                                     |                       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

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### 3.1.4 Phantom

|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                     |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Model</b>           | Twin SAM                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
| <b>Construction</b>    | The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot. |                                                                                     |
| <b>Material</b>        | Vinylester, glass fiber reinforced (VE-GF)                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                     |
| <b>Shell Thickness</b> | $2 \pm 0.2$ mm ( $6 \pm 0.2$ mm at ear point)                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                     |
| <b>Dimensions</b>      | Length: 1000 mm<br>Width: 500 mm<br>Height: adjustable feet                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                     |
| <b>Filling Volume</b>  | approx. 25 liters                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                     |

|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                      |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>Model</b>           | ELI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |
| <b>Construction</b>    | Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles. |                                                                                      |
| <b>Material</b>        | Vinylester, glass fiber reinforced (VE-GF)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                      |
| <b>Shell Thickness</b> | $2.0 \pm 0.2$ mm (bottom plate)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                      |
| <b>Dimensions</b>      | Major axis: 600 mm<br>Minor axis: 400 mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                      |
| <b>Filling Volume</b>  | approx. 30 liters                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                      |

### 3.1.5 Device Holder

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                     |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Model</b>        | Mounting Device                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| <b>Construction</b> | In combination with the Twin SAM Phantom or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). |                                                                                     |
| <b>Material</b>     | POM                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                     |

|                     |                                                                                                                                                                                                                                                                                         |                                                                                     |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Model</b>        | Laptop Extensions Kit                                                                                                                                                                                                                                                                   |  |
| <b>Construction</b> | Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. |                                                                                     |
| <b>Material</b>     | POM, Acrylic glass, Foam                                                                                                                                                                                                                                                                |                                                                                     |

### 3.1.6 System Validation Dipoles

|                         |                                                                                                                                                                      |                                                                                       |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Model</b>            | D-Serial                                                                                                                                                             |  |
| <b>Construction</b>     | Symmetrical dipole with 1/4 balun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions. |                                                                                       |
| <b>Frequency</b>        | 750 MHz to 5800 MHz                                                                                                                                                  |                                                                                       |
| <b>Return Loss</b>      | > 20 dB                                                                                                                                                              |                                                                                       |
| <b>Power Capability</b> | > 100 W (f < 1GHz), > 40 W (f > 1GHz)                                                                                                                                |                                                                                       |

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## 3.2 SAR Scan Procedure

### 3.2.1 SAR Reference Measurement (drift)

Prior to the SAR test, local SAR shall be measured at a stationary reference point where the SAR exceeds the lower detection limit of the measurement system.

### 3.2.2 Area Scan

Measurement procedures for evaluating the SAR of wireless device start with a coarse measurement grid to determine the approximate location of the local peak SAR values. This is known as the area-scan procedure. All antennas and radiating structures that may contribute to the measured SAR or influence the SAR distribution must be included in the area scan. The area scan measurement resolution must enable the extrapolation algorithms of the SAR system to correctly identify the peak SAR location(s) for subsequent zoom scan measurements to correctly determine the 1-g SAR. Area scans are performed at a constant distance from the phantom surface, determined by the measurement frequencies. When a measured peak is closer than  $\frac{1}{2}$  the zoom scan volume dimension (x, y) from the edge of the area scan region, unless the entire peak and gram-averaging volume are both captured within the zoom scan volume, the area scan must be repeated by shifting and expanding the area scan region to ensure all peaks are away from the area scan boundary. The area scan resolutions specified in the table below must be applied to the SAR measurements.

|                                                                                                        | $\leq 3$ GHz                                                                                                                                                                                                                                                           | $> 3$ GHz                                               |
|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | 5 mm $\pm$ 1 mm                                                                                                                                                                                                                                                        | $\frac{1}{2} \cdot \delta \cdot \ln(2)$ mm $\pm$ 0.5 mm |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location              | 30° $\pm$ 1°                                                                                                                                                                                                                                                           | 20° $\pm$ 1°                                            |
| 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. |                                                         |

### 3.2.3 Zoom Scan

To evaluate the peak spatial-average SAR values with respect to 1 g or 10 g cubes, fine resolution volume scans, called zoom scans, are performed at the peak SAR locations identified during the area scan. If the cube volume within the zoom scan chosen to calculate the peak spatial-average SAR touches any boundary of the zoom-scan volume, the zoom scan shall be repeated with the center of the zoom-scan volume shifted to the new maximum SAR location. For any secondary peaks found in the area scan that are within 2 dB of the maximum peak and are not within this zoom scan, the zoom scan shall be performed for such peaks, unless the peak spatial-average SAR at the location of the maximum peak is more than 2 dB below the applicable SAR limit (i.e., 1 W/kg for a 1.6 W/kg 1 g limit, or 1.26 W/kg for a 2 W/kg 10 g limit). The zoom scan resolutions specified in the table below must be applied to the SAR measurements.

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|                                                                                                                                                                                                                                                                                       |                                      |                                                                                             | ≤ 3 GHz                               | > 3 GHz                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------|----------------------------------------------------------------|
| Maximum zoom scan spatial resolution: Δx <sub>Zoom</sub> , Δy <sub>Zoom</sub>                                                                                                                                                                                                         |                                      |                                                                                             | ≤ 2 GHz: ≤ 8 mm<br>2 – 3 GHz: ≤ 5 mm* | 3 – 4 GHz: ≤ 5 mm*<br>4 – 6 GHz: ≤ 4 mm*                       |
| Maximum zoom<br>Scan spatial<br>resolution, normal<br>to phantom surface                                                                                                                                                                                                              | uniform grid: ΔZ <sub>Zoom</sub> (n) |                                                                                             | ≤ 5 mm                                | 3 – 4 GHz: ≤ 4 mm<br>4 – 5 GHz: ≤ 3 mm<br>5 – 6 GHz: ≤ 2 mm    |
|                                                                                                                                                                                                                                                                                       | graded<br>grid                       | ΔZ <sub>Zoom</sub> (1): between<br>1 <sup>ST</sup> two points closest<br>to phantom surface | ≤ 4 mm                                | 3 – 4 GHz: ≤ 3 mm<br>4 – 5 GHz: ≤ 2.5 mm<br>5 – 6 GHz: ≤ 2 mm  |
|                                                                                                                                                                                                                                                                                       |                                      | ΔZ <sub>Zoom</sub> (n>1):<br>between subsequent<br>points                                   | ≤ 1.5·ΔZ <sub>Zoom</sub> (n-1) mm     |                                                                |
| Minimum zoom<br>scan volume                                                                                                                                                                                                                                                           | x, y, z                              |                                                                                             | ≥ 30 mm                               | 3 – 4 GHz: ≥ 28 mm<br>4 – 5 GHz: ≥ 25 mm<br>5 – 6 GHz: ≥ 22 mm |
| Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details.                                                                                                                                                        |                                      |                                                                                             |                                       |                                                                |
| * When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB Publication 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. |                                      |                                                                                             |                                       |                                                                |

### 3.2.4 SAR Drift Measurement

The local SAR (or conducted power) shall be measured at exactly the same location as in 3.2.1 section. The absolute value of the measurement drift (the difference between the SAR measured in 3.2.1 and 3.2.4 section) shall be recorded. The SAR drift shall be kept within  $\pm 5\%$ .

### 3.3 Test Equipment

| Equipment                    | Manufacturer                                    | Model        | SN         | Cal. Date     | Cal. Interval |
|------------------------------|-------------------------------------------------|--------------|------------|---------------|---------------|
| System Validation Dipole     | SPEAG                                           | D2450V2      | 1014       | Jun. 07, 2018 | 3 Year        |
| System Validation Dipole     | SPEAG                                           | D5GHzV2      | 1280       | Jun. 24, 2019 | 3 Year        |
| Dosimetric E-Field Probe     | SPEAG                                           | EX3DV4       | 7506       | Jun. 27, 2019 | 1 year        |
| Data Acquisition Electronics | SPEAG                                           | DAE4         | 1557       | Jun. 18, 2019 | 1 year        |
| Dosimetric E-Field Probe     | SPEAG                                           | ES3DV3       | 3090       | Apr. 12, 2019 | 1 Year        |
| Data Acquisition Electronics | SPEAG                                           | DAE4         | 662        | Apr. 11, 2019 | 1 Year        |
| Radio Communication Analyzer | Anritsu                                         | MT8820C      | 6200918396 | Nov. 24, 2019 | 1 Year        |
| ENA Series Network Analyzer  | Agilent                                         | 8753ES       | US39170317 | Nov. 24, 2019 | 1 Year        |
| Dielectric Assessment Kit    | SPEAG                                           | DAK-3.5      | 1056       | N/A           | N/A           |
| USB/GPIB Interface           | Agilent                                         | 82357B       | N10149     | N/A           | N/A           |
| Signal Generator             | R&S                                             | SMT06        | 100796     | May. 14, 2019 | 1 Year        |
| POWER METER                  | R&S                                             | NRP          | 101293     | May. 14, 2019 | 1 Year        |
| Thermometer                  | Shanghai Gao Zhi Precision Instrument Co., Ltd. | HB6801       | 120100323  | May. 16, 2019 | 1 Year        |
| Coupler                      | REBES                                           | TC-05180-10S | 161221001  | N/A           | N/A           |
| Amplifier                    | Mini-Circuit                                    | ZHL42        | QA1252001  | N/A           | N/A           |
| DC Source                    | Agilent                                         | 66319B       | MY43000795 | N/A           | N/A           |

### 3.4 Measurement Uncertainty

| Source of Uncertainty                        | Tolerance<br>( $\pm$ %) | Probability<br>Distribution | Divisor    | Ci<br>(1g) | Ci<br>(10g) | Standard<br>Uncertainty<br>(1g) | Standard<br>Uncertainty<br>(10g) | Vi<br>Veff |
|----------------------------------------------|-------------------------|-----------------------------|------------|------------|-------------|---------------------------------|----------------------------------|------------|
| <b>Measurement System</b>                    |                         |                             |            |            |             |                                 |                                  |            |
| Probe Calibration                            | 6.55                    | Normal                      | 1          | 1          | 1           | $\pm 6.0$ %                     | $\pm 6.0$ %                      | $\infty$   |
| Axial Isotropy                               | 4.7                     | Rectangular                 | $\sqrt{3}$ | 0.7        | 0.7         | $\pm 1.9$ %                     | $\pm 1.9$ %                      | $\infty$   |
| Hemispherical Isotropy                       | 9.6                     | Rectangular                 | $\sqrt{3}$ | 0.7        | 0.7         | $\pm 3.9$ %                     | $\pm 3.9$ %                      | $\infty$   |
| Boundary Effects                             | 2                       | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 0.6$ %                     | $\pm 0.6$ %                      | $\infty$   |
| Linearity                                    | 4.7                     | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 2.7$ %                     | $\pm 2.7$ %                      | $\infty$   |
| Detection Limits                             | 0.25                    | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 0.1$ %                     | $\pm 0.1$ %                      | $\infty$   |
| Modulation Response                          | 2.4                     | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 1.4$ %                     | $\pm 1.4$ %                      | $\infty$   |
| Readout Electronics                          | 0.3                     | Normal                      | 1          | 1          | 1           | $\pm 0.3$ %                     | $\pm 0.3$ %                      | $\infty$   |
| Response Time                                | 0                       | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 0.0$ %                     | $\pm 0.0$ %                      | $\infty$   |
| Integration Time                             | 1.7                     | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 1.0$ %                     | $\pm 1.0$ %                      | $\infty$   |
| RF Ambient – Noise                           | 3                       | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 1.7$ %                     | $\pm 1.7$ %                      | $\infty$   |
| RF Ambient – Reflections                     | 3                       | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 1.7$ %                     | $\pm 1.7$ %                      | $\infty$   |
| Probe Positioner                             | 0.4                     | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 0.2$ %                     | $\pm 0.2$ %                      | $\infty$   |
| Probe Positioning                            | 6.7                     | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 1.7$ %                     | $\pm 1.7$ %                      | $\infty$   |
| Max. SAR Evaluation                          | 4                       | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 1.2$ %                     | $\pm 1.2$ %                      | $\infty$   |
| <b>Test Sample Related</b>                   |                         |                             |            |            |             |                                 |                                  |            |
| Device Positioning                           | 2.2 / 2.6               | Normal                      | 1          | 1          | 1           | $\pm 2.2$ %                     | $\pm 2.6$ %                      | 30         |
| Device Holder                                | 3.3 / 3.4               | Normal                      | 1          | 1          | 1           | $\pm 3.3$ %                     | $\pm 3.4$ %                      | 30         |
| Power Drift                                  | 5                       | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 2.9$ %                     | $\pm 2.9$ %                      | $\infty$   |
| Power Scaling                                | 0                       | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 0$ %                       | $\pm 0$ %                        | $\infty$   |
| <b>Phantom and Setup</b>                     |                         |                             |            |            |             |                                 |                                  |            |
| Phantom Uncertainty                          | 7.9                     | Rectangular                 | $\sqrt{3}$ | 1          | 1           | $\pm 4.3$ %                     | $\pm 4.3$ %                      | $\infty$   |
| SAR correction                               | 1.2 / 0.97              | Rectangular                 | $\sqrt{3}$ | 1          | 0.84        | $\pm 0.7$ %                     | $\pm 0.5$ %                      | $\infty$   |
| Liquid Conductivity (Meas.)                  | 2.5                     | Rectangular                 | $\sqrt{3}$ | 0.78       | 0.71        | $\pm 1.1$ %                     | $\pm 1$ %                        | $\infty$   |
| Liquid Permittivity (Meas.)                  | 2.5                     | Rectangular                 | $\sqrt{3}$ | 0.26       | 0.26        | $\pm 0.4$ %                     | $\pm 0.4$ %                      | $\infty$   |
| Temp. unc. - Conductivity                    | 3.4                     | Rectangular                 | $\sqrt{3}$ | 0.78       | 0.71        | $\pm 2.3$ %                     | $\pm 2.1$ %                      | $\infty$   |
| Temp. unc. - Permittivity                    | 0.4                     | Rectangular                 | $\sqrt{3}$ | 0.23       | 0.26        | $\pm 0.1$ %                     | $\pm 0.1$ %                      | $\infty$   |
| <b>Combined Standard Uncertainty (K = 1)</b> |                         |                             |            |            |             | $\pm 12.2$ %                    | $\pm 12.3$ %                     |            |
| <b>Expanded Uncertainty (K = 2)</b>          |                         |                             |            |            |             | $\pm 24.5$ %                    | $\pm 24.6$ %                     |            |

#### EXPOSURE ASSESSMENT UNCERTAINTY FOR HEAD SAR

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| Source of Uncertainty                        | Tolerance<br>(± %) | Probability<br>Distribution | Divisor | Ci<br>(1g) | Ci<br>(10g) | Standard<br>Uncertainty<br>(1g) | Standard<br>Uncertainty<br>(10g) | Vi<br>Veff |
|----------------------------------------------|--------------------|-----------------------------|---------|------------|-------------|---------------------------------|----------------------------------|------------|
| <b>Measurement System</b>                    |                    |                             |         |            |             |                                 |                                  |            |
| Probe Calibration                            | 6.55               | Normal                      | 1       | 1          | 1           | ± 6.0 %                         | ± 6.0 %                          | ∞          |
| Axial Isotropy                               | 4.7                | Rectangular                 | √3      | 0.7        | 0.7         | ± 1.9 %                         | ± 1.9 %                          | ∞          |
| Hemispherical Isotropy                       | 9.6                | Rectangular                 | √3      | 0.7        | 0.7         | ± 3.9 %                         | ± 3.9 %                          | ∞          |
| Boundary Effects                             | 2                  | Rectangular                 | √3      | 1          | 1           | ± 0.6 %                         | ± 0.6 %                          | ∞          |
| Linearity                                    | 4.7                | Rectangular                 | √3      | 1          | 1           | ± 2.7 %                         | ± 2.7 %                          | ∞          |
| Detection Limits                             | 0.25               | Rectangular                 | √3      | 1          | 1           | ± 0.1 %                         | ± 0.1 %                          | ∞          |
| Modulation Response                          | 2.4                | Rectangular                 | √3      | 1          | 1           | ± 1.4%                          | ± 1.4%                           | ∞          |
| Readout Electronics                          | 0.3                | Normal                      | 1       | 1          | 1           | ± 0.3 %                         | ± 0.3 %                          | ∞          |
| Response Time                                | 0                  | Rectangular                 | √3      | 1          | 1           | ± 0.0 %                         | ± 0.0 %                          | ∞          |
| Integration Time                             | 1.7                | Rectangular                 | √3      | 1          | 1           | ± 1.0 %                         | ± 1.0 %                          | ∞          |
| RF Ambient – Noise                           | 3                  | Rectangular                 | √3      | 1          | 1           | ± 1.7 %                         | ± 1.7 %                          | ∞          |
| RF Ambient – Reflections                     | 3                  | Rectangular                 | √3      | 1          | 1           | ± 1.7 %                         | ± 1.7 %                          | ∞          |
| Probe Positioner                             | 0.4                | Rectangular                 | √3      | 1          | 1           | ± 0.2 %                         | ± 0.2 %                          | ∞          |
| Probe Positioning                            | 6.7                | Rectangular                 | √3      | 1          | 1           | ± 1.7 %                         | ± 1.7 %                          | ∞          |
| Max. SAR Evaluation                          | 4                  | Rectangular                 | √3      | 1          | 1           | ± 1.2 %                         | ± 1.2 %                          | ∞          |
| <b>Test Sample Related</b>                   |                    |                             |         |            |             |                                 |                                  |            |
| Deviation of experimental dipole             | 5.0                | Rectangular                 | √3      | 1          | 1           | ± 2.9 %                         | ± 2.9 %                          | ∞          |
| Input power and SAR drift measurement        | 5.0                | Rectangular                 | √3      | 1          | 1           | ± 2.9 %                         | ± 2.9 %                          | ∞          |
| Dipole axis to liquid distance               | 2.0                | Rectangular                 | √3      | 1          | 1           | ± 1.2 %                         | ± 1.2 %                          | ∞          |
| <b>Phantom and Setup</b>                     |                    |                             |         |            |             |                                 |                                  |            |
| Phantom Uncertainty                          | 7.9                | Rectangular                 | √3      | 1          | 1           | ± 4.3 %                         | ± 4.3 %                          | ∞          |
| SAR correction                               | 1.2 / 0.97         | Rectangular                 | √3      | 1          | 0.84        | ± 0.7 %                         | ± 0.5 %                          | ∞          |
| Liquid Conductivity (Meas.)                  | 2.5                | Rectangular                 | √3      | 0.78       | 0.71        | ± 1.1 %                         | ± 1 %                            | ∞          |
| Liquid Permittivity (Meas.)                  | 2.5                | Rectangular                 | √3      | 0.26       | 0.26        | ± 0.4 %                         | ± 0.4 %                          | ∞          |
| Temp. unc. - Conductivity                    | 3.4                | Rectangular                 | √3      | 0.78       | 0.71        | ± 2.3 %                         | ± 2.1 %                          | ∞          |
| Temp. unc. - Permittivity                    | 0.4                | Rectangular                 | √3      | 0.23       | 0.26        | ± 0.1 %                         | ± 0.1 %                          | ∞          |
| <b>Combined Standard Uncertainty (K = 1)</b> |                    |                             |         |            |             | ± 12.0 %                        | ± 12.0 %                         |            |
| <b>Expanded Uncertainty (K = 2)</b>          |                    |                             |         |            |             | ± 24.0 %                        | ± 23.9 %                         |            |

#### SYSTEM VALIDATION MEASUREMENT UNCERTAINTY FOR HEAD

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| Source of Uncertainty                        | Tolerance<br>(± %) | Probability<br>Distribution | Divisor | Ci<br>(1g) | Ci<br>(10g) | Standard<br>Uncertainty<br>(1g) | Standard<br>Uncertainty<br>(10g) | Vi<br>Veff |
|----------------------------------------------|--------------------|-----------------------------|---------|------------|-------------|---------------------------------|----------------------------------|------------|
| <b>Measurement System</b>                    |                    |                             |         |            |             |                                 |                                  |            |
| Probe Calibration                            | 6.55               | Normal                      | 1       | 1          | 1           | ± 6.0 %                         | ± 6.0 %                          | ∞          |
| Axial Isotropy                               | 4.7                | Rectangular                 | √3      | 0.7        | 0.7         | ± 1.9 %                         | ± 1.9 %                          | ∞          |
| Hemispherical Isotropy                       | 9.6                | Rectangular                 | √3      | 0.7        | 0.7         | ± 3.9 %                         | ± 3.9 %                          | ∞          |
| Boundary Effects                             | 2                  | Rectangular                 | √3      | 1          | 1           | ± 0.6 %                         | ± 0.6 %                          | ∞          |
| Linearity                                    | 4.7                | Rectangular                 | √3      | 1          | 1           | ± 2.7 %                         | ± 2.7 %                          | ∞          |
| Detection Limits                             | 0.25               | Rectangular                 | √3      | 1          | 1           | ± 0.1 %                         | ± 0.1 %                          | ∞          |
| Modulation Response                          | 2.4                | Rectangular                 | √3      | 1          | 1           | ± 1.4%                          | ± 1.4%                           | ∞          |
| Readout Electronics                          | 0.3                | Normal                      | 1       | 1          | 1           | ± 0.3 %                         | ± 0.3 %                          | ∞          |
| Response Time                                | 0                  | Rectangular                 | √3      | 1          | 1           | ± 0.0 %                         | ± 0.0 %                          | ∞          |
| Integration Time                             | 1.7                | Rectangular                 | √3      | 1          | 1           | ± 1.0 %                         | ± 1.0 %                          | ∞          |
| RF Ambient – Noise                           | 3                  | Rectangular                 | √3      | 1          | 1           | ± 1.7 %                         | ± 1.7 %                          | ∞          |
| RF Ambient – Reflections                     | 3                  | Rectangular                 | √3      | 1          | 1           | ± 1.7 %                         | ± 1.7 %                          | ∞          |
| Probe Positioner                             | 0.4                | Rectangular                 | √3      | 1          | 1           | ± 0.2 %                         | ± 0.2 %                          | ∞          |
| Probe Positioning                            | 6.7                | Rectangular                 | √3      | 1          | 1           | ± 1.7 %                         | ± 1.7 %                          | ∞          |
| Max. SAR Evaluation                          | 4                  | Rectangular                 | √3      | 1          | 1           | ± 1.2 %                         | ± 1.2 %                          | ∞          |
| <b>Test Sample Related</b>                   |                    |                             |         |            |             |                                 |                                  |            |
| Device Positioning                           | 2.2 / 2.6          | Normal                      | 1       | 1          | 1           | ± 2.2 %                         | ± 2.6 %                          | 30         |
| Device Holder                                | 3.3 / 3.4          | Normal                      | 1       | 1          | 1           | ± 3.3 %                         | ± 3.4 %                          | 30         |
| Power Drift                                  | 5                  | Rectangular                 | √3      | 1          | 1           | ± 2.9 %                         | ± 2.9 %                          | ∞          |
| Power Scaling                                | 0                  | Rectangular                 | √3      | 1          | 1           | ± 0 %                           | ± 0 %                            | ∞          |
| <b>Phantom and Setup</b>                     |                    |                             |         |            |             |                                 |                                  |            |
| Phantom Uncertainty                          | 7.9                | Rectangular                 | √3      | 1          | 1           | ± 4.3 %                         | ± 4.3 %                          | ∞          |
| SAR correction                               | 1.2 / 0.97         | Rectangular                 | √3      | 1          | 0.84        | ± 0.7 %                         | ± 0.5 %                          | ∞          |
| Liquid Conductivity (Meas.)                  | 2.5                | Rectangular                 | √3      | 0.78       | 0.71        | ± 1.1 %                         | ± 1 %                            | ∞          |
| Liquid Permittivity (Meas.)                  | 2.5                | Rectangular                 | √3      | 0.26       | 0.26        | ± 0.4 %                         | ± 0.4 %                          | ∞          |
| Temp. unc. - Conductivity                    | 3.4                | Rectangular                 | √3      | 0.78       | 0.71        | ± 2.3 %                         | ± 2.1 %                          | ∞          |
| Temp. unc. - Permittivity                    | 0.4                | Rectangular                 | √3      | 0.23       | 0.26        | ± 0.1 %                         | ± 0.1 %                          | ∞          |
| <b>Combined Standard Uncertainty (K = 1)</b> |                    |                             |         |            |             | ± 12.2 %                        | ± 12.3 %                         |            |
| <b>Expanded Uncertainty (K = 2)</b>          |                    |                             |         |            |             | ± 24.5 %                        | ± 24.6 %                         |            |

#### EXPOSURE ASSESSMENT UNCERTAINTY FOR Body SAR

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UTTR-SAR-IEEE Std 1528-2013-V1.0

| Source of Uncertainty                        | Tolerance<br>(± %) | Probability<br>Distribution | Divisor | Ci<br>(1g) | Ci<br>(10g) | Standard<br>Uncertainty<br>(1g) | Standard<br>Uncertainty<br>(10g) | Vi<br>Veff |
|----------------------------------------------|--------------------|-----------------------------|---------|------------|-------------|---------------------------------|----------------------------------|------------|
| <b>Measurement System</b>                    |                    |                             |         |            |             |                                 |                                  |            |
| Probe Calibration                            | 6.55               | Normal                      | 1       | 1          | 1           | ± 6.0 %                         | ± 6.0 %                          | ∞          |
| Axial Isotropy                               | 4.7                | Rectangular                 | √3      | 0.7        | 0.7         | ± 1.9 %                         | ± 1.9 %                          | ∞          |
| Hemispherical Isotropy                       | 9.6                | Rectangular                 | √3      | 0.7        | 0.7         | ± 3.9 %                         | ± 3.9 %                          | ∞          |
| Boundary Effects                             | 2                  | Rectangular                 | √3      | 1          | 1           | ± 0.6 %                         | ± 0.6 %                          | ∞          |
| Linearity                                    | 4.7                | Rectangular                 | √3      | 1          | 1           | ± 2.7 %                         | ± 2.7 %                          | ∞          |
| Detection Limits                             | 0.25               | Rectangular                 | √3      | 1          | 1           | ± 0.1 %                         | ± 0.1 %                          | ∞          |
| Modulation Response                          | 2.4                | Rectangular                 | √3      | 1          | 1           | ± 1.4%                          | ± 1.4%                           | ∞          |
| Readout Electronics                          | 0.3                | Normal                      | 1       | 1          | 1           | ± 0.3 %                         | ± 0.3 %                          | ∞          |
| Response Time                                | 0                  | Rectangular                 | √3      | 1          | 1           | ± 0.0 %                         | ± 0.0 %                          | ∞          |
| Integration Time                             | 1.7                | Rectangular                 | √3      | 1          | 1           | ± 1.0 %                         | ± 1.0 %                          | ∞          |
| RF Ambient – Noise                           | 3                  | Rectangular                 | √3      | 1          | 1           | ± 1.7 %                         | ± 1.7 %                          | ∞          |
| RF Ambient – Reflections                     | 3                  | Rectangular                 | √3      | 1          | 1           | ± 1.7 %                         | ± 1.7 %                          | ∞          |
| Probe Positioner                             | 0.4                | Rectangular                 | √3      | 1          | 1           | ± 0.2 %                         | ± 0.2 %                          | ∞          |
| Probe Positioning                            | 6.7                | Rectangular                 | √3      | 1          | 1           | ± 1.7 %                         | ± 1.7 %                          | ∞          |
| Max. SAR Evaluation                          | 4                  | Rectangular                 | √3      | 1          | 1           | ± 1.2 %                         | ± 1.2 %                          | ∞          |
| <b>Test Sample Related</b>                   |                    |                             |         |            |             |                                 |                                  |            |
| Deviation of experimental dipole             | 5.0                | Rectangular                 | √3      | 1          | 1           | ± 2.9 %                         | ± 2.9 %                          | ∞          |
| Input power and SAR drift measurement        | 5.0                | Rectangular                 | √3      | 1          | 1           | ± 2.9 %                         | ± 2.9 %                          | ∞          |
| Dipole axis to liquid distance               | 2.0                | Rectangular                 | √3      | 1          | 1           | ± 1.2 %                         | ± 1.2 %                          | ∞          |
| <b>Phantom and Setup</b>                     |                    |                             |         |            |             |                                 |                                  |            |
| Phantom Uncertainty                          | 7.9                | Rectangular                 | √3      | 1          | 1           | ± 4.3 %                         | ± 4.3 %                          | ∞          |
| SAR correction                               | 1.2 / 0.97         | Rectangular                 | √3      | 1          | 0.84        | ± 0.7 %                         | ± 0.5 %                          | ∞          |
| Liquid Conductivity (Meas.)                  | 2.5                | Rectangular                 | √3      | 0.78       | 0.71        | ± 1.1 %                         | ± 1 %                            | ∞          |
| Liquid Permittivity (Meas.)                  | 2.5                | Rectangular                 | √3      | 0.26       | 0.26        | ± 0.4 %                         | ± 0.4 %                          | ∞          |
| Temp. unc. - Conductivity                    | 3.4                | Rectangular                 | √3      | 0.78       | 0.71        | ± 2.3 %                         | ± 2.1 %                          | ∞          |
| Temp. unc. - Permittivity                    | 0.4                | Rectangular                 | √3      | 0.23       | 0.26        | ± 0.1 %                         | ± 0.1 %                          | ∞          |
| <b>Combined Standard Uncertainty (K = 1)</b> |                    |                             |         |            |             | ± 12.0 %                        | ± 12.0 %                         |            |
| <b>Expanded Uncertainty (K = 2)</b>          |                    |                             |         |            |             | ± 24.0 %                        | ± 23.9 %                         |            |

#### SYSTEM VALIDATION MEASUREMENT UNCERTAINTY FOR Body

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### 3.5 Tissue Dielectric Parameter Measurement & System Verification

#### 3.5.1 Tissue Simulating Liquids

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

The depth of tissue-equivalent liquid in a phantom must be  $\geq 15.0$  cm with  $\leq \pm 0.5$  cm variation for SAR measurements  $\leq 3$  GHz and  $\geq 10.0$  cm with  $\leq \pm 0.5$  cm variation for measurements  $> 3$  GHz. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in Table-3.1.



Photo of Liquid Height

Table-3.1 Tissue Dielectric Parameters for Head and Body

| Target Frequency<br>(MHz) | Head         |                | Body         |                |
|---------------------------|--------------|----------------|--------------|----------------|
|                           | $\epsilon_r$ | $\sigma$ (S/m) | $\epsilon_r$ | $\sigma$ (S/m) |
| 750                       | 41.9         | 0.89           | 55.5         | 0.96           |
| 835                       | 41.5         | 0.90           | 55.2         | 0.97           |
| 900                       | 41.5         | 0.97           | 55.0         | 1.05           |
| 1450                      | 40.5         | 1.20           | 54.0         | 1.30           |
| 1640                      | 40.3         | 1.29           | 53.8         | 1.40           |
| 1750                      | 40.1         | 1.37           | 53.4         | 1.49           |
| 1800                      | 40.0         | 1.40           | 53.3         | 1.52           |
| 1900                      | 40.0         | 1.40           | 53.3         | 1.52           |
| 2000                      | 40.0         | 1.40           | 53.3         | 1.52           |
| 2300                      | 39.5         | 1.67           | 52.9         | 1.81           |
| 2450                      | 39.2         | 1.80           | 52.7         | 1.95           |
| 2600                      | 39.0         | 1.96           | 52.5         | 2.16           |
| 3500                      | 37.9         | 2.91           | 51.3         | 3.31           |
| 5200                      | 36.0         | 4.66           | 49.0         | 5.30           |
| 5300                      | 35.9         | 4.76           | 48.9         | 5.42           |
| 5500                      | 35.6         | 4.96           | 48.6         | 5.65           |
| 5600                      | 35.5         | 5.07           | 48.5         | 5.77           |
| 5800                      | 35.3         | 5.27           | 48.2         | 6.00           |

( $\epsilon_r$  = relative permittivity,  $\sigma$  = conductivity and  $\rho = 1000$  kg/m<sup>3</sup>)

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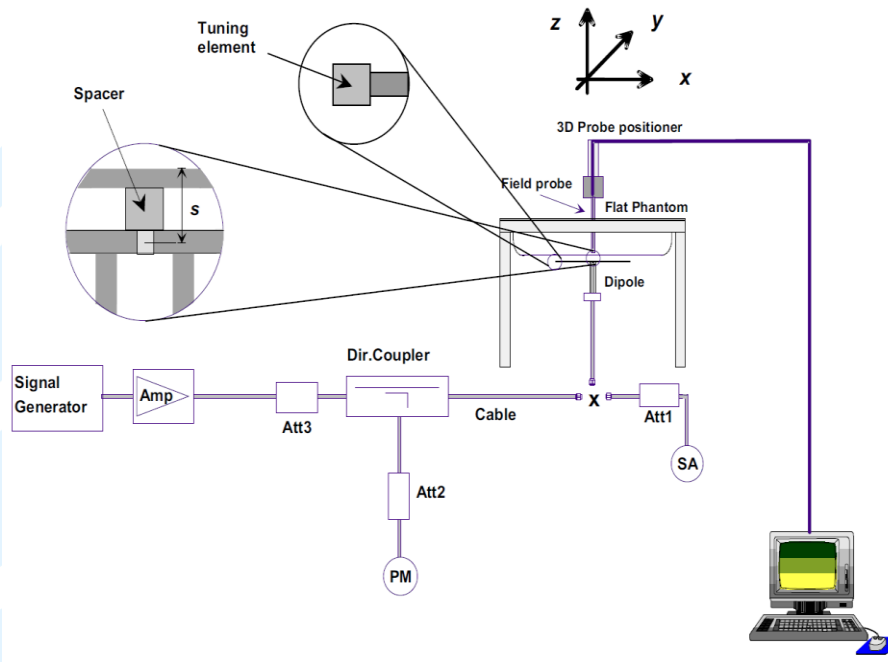
The following table gives the recipes for tissue simulating liquids.

Table-3.2 Recipes of Tissue Simulating Liquid

| Tissue Type | Bactericide | DGBE | HEC | NaCl | Sucrose | Triton X-100 | Water | Diethylene Glycol Mono-hexylether |
|-------------|-------------|------|-----|------|---------|--------------|-------|-----------------------------------|
| H750        | 0.2         | -    | 0.2 | 1.4  | 57.0    | -            | 41.1  | -                                 |
| H835        | 0.1         | -    | 1.0 | 1.4  | 57.0    | -            | 40.5  | -                                 |
| H900        | 0.1         | -    | 1.0 | 1.5  | 56.5    | -            | 40.9  | -                                 |
| H1450       | -           | 45.5 | -   | 0.7  | -       | -            | 53.8  | -                                 |
| H1640       | -           | 45.8 | -   | 0.5  | -       | -            | 53.7  | -                                 |
| H1750       | -           | 44.5 | -   | 0.3  | -       | -            | 55.2  | -                                 |
| H1800       | -           | 44.9 | -   | 0.2  | -       | -            | 54.9  | -                                 |
| H1900       | -           | 44.9 | -   | 0.2  | -       | -            | 54.9  | -                                 |
| H2000       | -           | 50   | -   | -    | -       | -            | 50    | -                                 |
| H2300       | -           | 44.9 | -   | 0.1  | -       | -            | 55.0  | -                                 |
| H2450       | -           | 45.0 | -   | 0.1  | -       | -            | 54.9  | -                                 |
| H2600       | -           | 45.1 | -   | 0.1  | -       | -            | 54.8  | -                                 |
| H3500       | -           | 8.0  | -   | 0.2  | -       | 20.0         | 71.8  | -                                 |
| H5G         | -           | -    | -   | -    | -       | 17.2         | 65.52 | 17.3                              |
| B750        | 0.2         | -    | 0.2 | 0.8  | 48.8    | -            | 50.0  | -                                 |
| B835        | 0.2         | -    | 0.2 | 0.9  | 48.5    | -            | 50.2  | -                                 |
| B900        | 0.2         | -    | 0.2 | 0.9  | 48.2    | -            | 50.5  | -                                 |
| B1450       | -           | 34.0 | -   | 0.3  | -       | -            | 65.7  | -                                 |
| B1640       | -           | 32.5 | -   | 0.3  | -       | -            | 67.2  | -                                 |
| B1750       | -           | 29.4 | -   | 0.4  | -       | -            | 70.2  | -                                 |
| B1800       | -           | 29.5 | -   | 0.4  | -       | -            | 70.1  | -                                 |
| B1900       | -           | 29.5 | -   | 0.3  | -       | -            | 70.2  | -                                 |
| B2000       | -           | 30.0 | -   | 0.2  | -       | -            | 69.8  | -                                 |
| B2300       | -           | 31.0 | -   | 0.1  | -       | -            | 68.9  | -                                 |
| B2450       | -           | 31.4 | -   | 0.1  | -       | -            | 68.5  | -                                 |
| B2600       | -           | 31.8 | -   | 0.1  | -       | -            | 68.1  | -                                 |
| B3500       | -           | 28.8 | -   | 0.1  | -       | -            | 71.1  | -                                 |
| B5G         | -           | -    | -   | -    | -       | 10.7         | 78.6  | 10.7                              |

### 3.5.2 System Check Description

The system check procedure provides a simple, fast, and reliable test method that can be performed daily or before every SAR measurement. The objective here is to ascertain that the measurement system has acceptable accuracy and repeatability. This test requires a flat phantom and a radiating source. The system verification setup is shown as below.



System Verification Setup

### 3.5.3 Tissue Verification

The measuring results for tissue simulating liquid are shown as below.

| Test Date     | Tissue Type | Frequency (MHz) | Liquid Temp. (°C) | Measured Conductivity ( $\sigma$ ) | Measured Permittivity ( $\epsilon_r$ ) | Target Conductivity ( $\sigma$ ) | Target Permittivity ( $\epsilon_r$ ) | Conductivity Deviation (%) | Permittivity Deviation (%) |
|---------------|-------------|-----------------|-------------------|------------------------------------|----------------------------------------|----------------------------------|--------------------------------------|----------------------------|----------------------------|
| Nov. 01, 2019 | Head        | 2450            | 22.1              | 1.780                              | 40.200                                 | 1.80                             | 39.20                                | -1.11                      | 2.55                       |
| Nov. 25, 2019 | Head        | 5250            | 22.2              | 4.735                              | 36.296                                 | 4.71                             | 35.90                                | 0.53                       | 1.10                       |
| Nov. 25, 2019 | Head        | 5600            | 22.2              | 5.092                              | 35.786                                 | 5.07                             | 35.50                                | 0.43                       | 0.81                       |
| Nov. 25, 2019 | Head        | 5750            | 22.2              | 5.305                              | 35.501                                 | 5.22                             | 35.40                                | 1.63                       | 0.29                       |
| Nov. 01, 2019 | Head        | 2437            | 22.1              | 1.760                              | 40.200                                 | 1.80                             | 39.20                                | -2.22                      | 2.55                       |
| Nov. 25, 2019 | Head        | 5300            | 22.2              | 4.788                              | 36.220                                 | 4.71                             | 35.90                                | 1.66                       | 0.89                       |
| Nov. 25, 2019 | Head        | 5320            | 22.2              | 4.804                              | 36.210                                 | 4.71                             | 35.90                                | 2.00                       | 0.86                       |
| Nov. 25, 2019 | Head        | 5520            | 22.2              | 5.009                              | 35.900                                 | 5.07                             | 35.50                                | -1.20                      | 1.13                       |
| Nov. 25, 2019 | Head        | 5580            | 22.2              | 5.071                              | 35.810                                 | 5.07                             | 35.50                                | 0.02                       | 0.87                       |
| Nov. 25, 2019 | Head        | 5700            | 22.2              | 5.199                              | 35.64                                  | 5.22                             | 35.40                                | -0.40                      | 0.68                       |
| Nov. 25, 2019 | Head        | 5785            | 22.2              | 5.286                              | 35.52                                  | 5.22                             | 35.40                                | 1.26                       | 0.34                       |

#### Note:

The dielectric properties of the tissue simulating liquid must be measured within 24 hours before the SAR testing and within  $\pm 5\%$  of the target values. The variation of the liquid temperature must be within  $\pm 2^\circ\text{C}$  during the test.

### 3.5.4 System Verification

The measuring result for system verification is tabulated as below.

| Test Date     | Tissue Type | Frequency (MHz) | 1W Target SAR-1g (W/kg) | Measured SAR-1g (W/kg) | Normalized to 1W SAR-1g (W/kg) | Deviation (%) | Dipole S/N | Probe S/N | DAE S/N |
|---------------|-------------|-----------------|-------------------------|------------------------|--------------------------------|---------------|------------|-----------|---------|
| Nov. 01, 2019 | Head        | 2450            | 52.40                   | 5.550                  | 55.50                          | 5.92          | 1014       | 3090      | 662     |
| Nov. 25, 2019 | Head        | 5250            | 78.90                   | 8.430                  | 84.30                          | 6.84          | 1280       | 7506      | 1557    |
| Nov. 25, 2019 | Head        | 5600            | 80.30                   | 8.260                  | 82.60                          | 2.86          | 1280       | 7506      | 1557    |
| Nov. 25, 2019 | Head        | 5750            | 79.30                   | 8.000                  | 80.00                          | 0.88          | 1280       | 7506      | 1557    |

#### Note:

Comparing to the reference SAR value, the validation data should be within its specification of 10%. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.

### 3.5.5 System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01. The validation status in tabulated summary is as below.

| Test Date     | Probe S/N | Calibration Point |      | Measured Conductivity ( $\sigma$ ) | Measured Permittivity ( $\epsilon_r$ ) | Validation for CW |                 |                | Validation for Modulation |             |      |
|---------------|-----------|-------------------|------|------------------------------------|----------------------------------------|-------------------|-----------------|----------------|---------------------------|-------------|------|
|               |           |                   |      |                                    |                                        | Sensitivity Range | Probe Linearity | Probe Isotropy | Modulation Type           | Duty Factor | PAR  |
| Apr. 23, 2019 | 3090      | Head              | 2450 | 1.825                              | 37.945                                 | Pass              | Pass            | Pass           | OFDM                      | N/A         | Pass |
| Aug. 05, 2019 | 7506      | Head              | 5250 | 4.696                              | 37.050                                 | Pass              | Pass            | Pass           | OFDM                      | N/A         | Pass |
| Aug. 05, 2019 | 7506      | Head              | 5600 | 4.819                              | 36.840                                 | Pass              | Pass            | Pass           | OFDM                      | N/A         | Pass |
| Aug. 05, 2019 | 7506      | Head              | 5750 | 5.199                              | 36.180                                 | Pass              | Pass            | Pass           | OFDM                      | N/A         | Pass |

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## 4 SAR Measurement Evaluation

### 4.1 EUT Configuration and Setting

#### 4.1.1 WLAN Configuration and Testing

In general, various vendor specific external test software and chipset based internal test modes are typically used for SAR measurement. These chipset based test mode utilities are generally hardware and manufacturer dependent, and often include substantial flexibility to reconfigure or reprogram a device. A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement. The test frequencies established using test mode must correspond to the actual channel frequencies. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. In addition, a periodic transmission duty factor is required for current generation SAR systems to measure SAR correctly. The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

According to KDB 248227 D01, this device has installed WLAN engineering testing software which can provide continuous transmitting RF signal. During WLAN SAR testing, this device was operated to transmit continuously at the maximum transmission duty with specified transmission mode, operating frequency, lowest data rate, and maximum output power.

#### Initial Test Configuration

An initial test configuration is determined for OFDM transmission modes in 2.4 GHz and 5 GHz bands according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. 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 in the initial test configuration, for each frequency band.

#### Subsequent Test Configuration

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units. Additional power measurements may be required to determine if SAR measurements are required for subsequent highest output power channels in a subsequent test configuration. When the highest reported SAR for the initial test configuration according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is  $\leq 1.2$  W/kg, SAR is not required for that subsequent test configuration.

#### SAR Test Configuration and Channel Selection

When multiple channel bandwidth configurations in a frequency band have the same specified maximum output power, the initial test configuration is using largest channel bandwidth, lowest order modulation, lowest data rate, and lowest order 802.11 mode (i.e., 802.11a is chosen over 802.11n then 802.11ac or 802.11g is chosen over

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802.11n). After an initial test configuration is determined, if multiple test channels have the same measured maximum output power, the channel chosen for SAR measurement is determined according to the following.

- 1) The channel closest to mid-band frequency is selected for SAR measurement.
- 2) For channels with equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.

#### **Test Reduction for U-NII-1 (5.2 GHz) and U-NII-2A (5.3 GHz) Bands**

For devices that operate in both U-NII bands using the same transmitter and antenna(s), SAR test reduction is determined according to the following.

- 1) When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is  $\leq 1.2$  W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition).
- 2) When different maximum output power is specified for the bands, begin SAR measurement in the band with higher specified maximum output power. The highest reported SAR for the tested configuration is adjusted by the ratio of lower to higher specified maximum output power for the two bands. When the adjusted SAR is  $\leq 1.2$  W/kg, SAR is not required for the band with lower maximum output power in that test configuration.

## 4.2 EUT Testing Position

### 4.2.1 Head Exposure Conditions

| RF Exposure Conditions | Test Position | Separation Distance | SAR test exclusion |
|------------------------|---------------|---------------------|--------------------|
| Head                   | Right Cheek   | 0 cm                | N/A                |
|                        | Right Tilted  |                     |                    |
|                        | Left Cheek    |                     |                    |
|                        | Left Tilted   |                     |                    |

Note:

1. Head exposure for voice mode of handset is limited to next to the ear exposure conditions.
2. Devices that are designed to transmit next to the ear must be tested using the SAM phantom.
3. Other head exposure conditions, for example, in-front-of the face, should be tested using a flat phantom according to the required published RF exposure KDB procedures.
4. When data mode operates in next to the ear configurations, either data alone or in conjunction with voice transmissions, SAR evaluation is required for such use conditions.
5. When device supports VoIP, SAR evaluation for head Exposure Conditions using the most appropriate wireless data mode configurations is required.

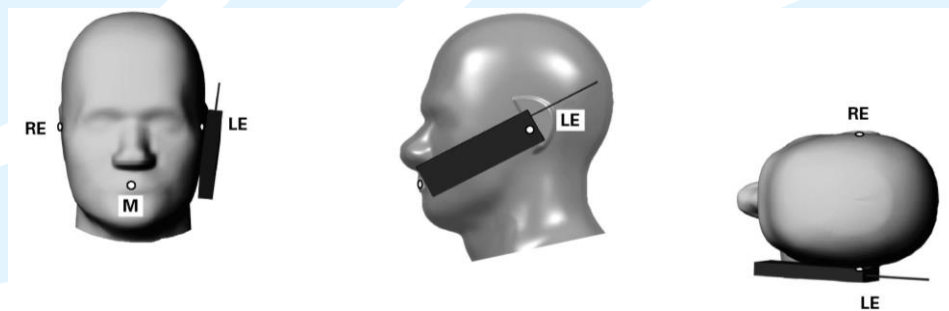


Fig-4.1 Cheek Position

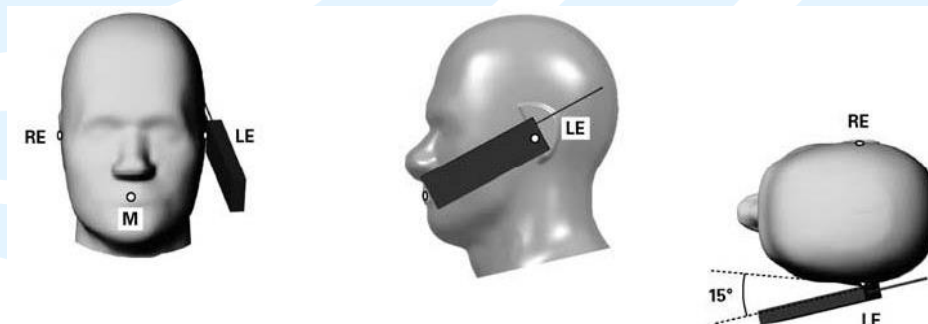


Fig-4.2 Tilted Position

Define two imaginary lines on the handset

- a) The vertical centerline passes through two points on the front side of the handset - the midpoint of the width  $w_t$  of the handset at the level of the acoustic output, and the midpoint of the width  $w_b$  of the bottom of the handset.
- b) The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output. The horizontal line is also tangential to the face of the handset at point A.
- c) The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output; however, the acoustic output may be located elsewhere on the horizontal line. Also note that

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the vertical centerline is not necessarily parallel to the front face of the handset, especially for clamshell handsets, handsets with flip covers, and other irregularly shaped handsets.

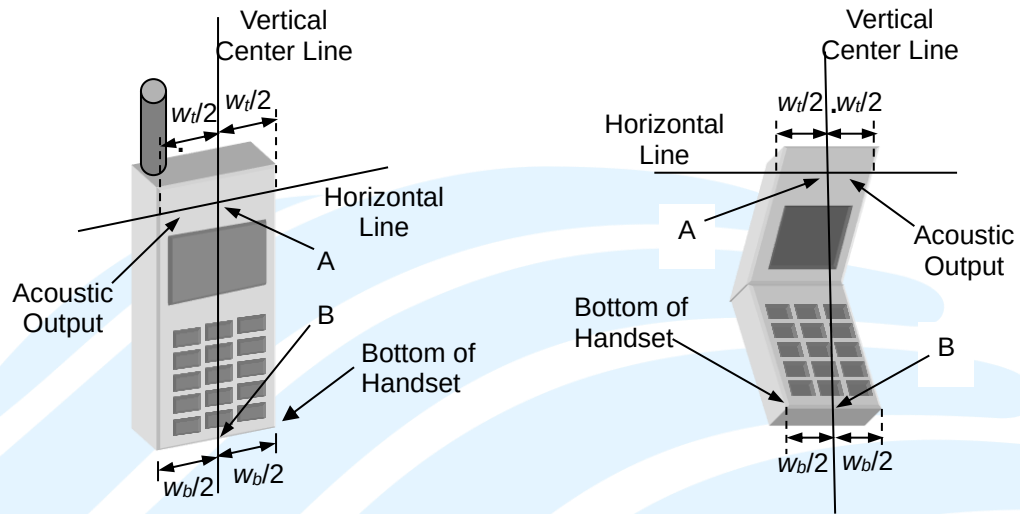


Fig-4.3 Handset Vertical and Horizontal Reference Lines

#### 4.2.2 Body-worn Accessory Exposure Conditions

| RF Exposure Conditions | Test Position | Separation Distance | SAR test exclusion |
|------------------------|---------------|---------------------|--------------------|
| Body-worn              | Front Face    | 0 ~ 2.5 cm          | N/A                |
|                        | Rear Face     |                     |                    |

Note:

1. Body-worn accessories that do not contain metallic or conductive components may be tested according to worst-case exposure configurations, typically according to the smallest test separation distance required for the group of body-worn accessories with similar operating and exposure characteristics. All body-worn accessories containing metallic components are tested in conjunction with the host device.
2. Body-worn accessory SAR compliance is based on a single minimum test separation distance for all wireless and operating modes applicable to each body-worn accessory used by the host, and according to the relevant voice and/or data mode transmissions and operations. If a body-worn accessory supports voice only operations in its normal and expected use conditions, testing of data mode for body-worn compliance is not required.
3. A conservative minimum test separation distance for supporting off-the-shelf body-worn accessories that may be acquired by users of consumer handsets should be used to test for body-worn accessory SAR compliance. This distance is determined by the handset manufacturer according to the typical body-worn accessories users may acquire at the time of equipment certification, but not more than 2.5 cm, to enable users to purchase aftermarket body-worn accessories with the required minimum separation.
4. Devices that are designed to operate on the body of users using lanyards and straps or without requiring additional body-worn accessories must be tested for SAR compliance using a conservative minimum test separation distance  $\leq 5$  mm to support compliance.
5. When device supports VoIP, SAR evaluation for body-worn accessory Exposure Conditions using the most appropriate wireless data mode configurations is required.
6. Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories.
7. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is  $> 1.2$  W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for the body-worn accessory with a headset attached to the handset.

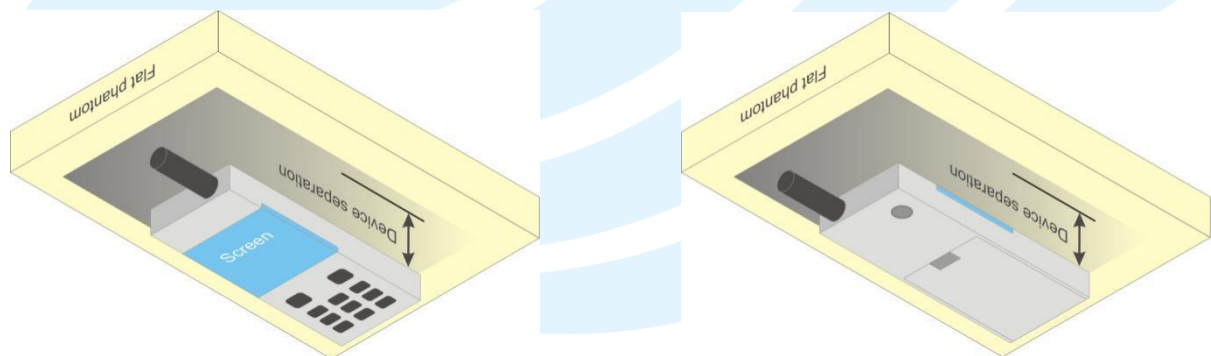


Fig-4.4 Body Worn Position

## 4.3 Measured Conducted Power Result

### 4.3.1 Conducted Power of WLAN

| Mode |                | Channel | Frequency (MHz) | Average Power (dBm) |
|------|----------------|---------|-----------------|---------------------|
| 2.4G | 802.11b        | 1       | 2412            | 15.06               |
|      |                | 6       | 2437            | 15.26               |
|      |                | 11      | 2462            | 15.19               |
|      | 802.11g        | 1       | 2412            | 14.65               |
|      |                | 6       | 2437            | 14.95               |
|      |                | 11      | 2462            | 15.07               |
|      | 802.11n (HT20) | 1       | 2412            | 14.01               |
|      |                | 6       | 2437            | 14.31               |
|      |                | 11      | 2462            | 14.48               |

| Mode    |      | Channel | Frequency (MHz) | Average Power (dBm) |
|---------|------|---------|-----------------|---------------------|
| 802.11a | 5.2G | 36      | 5180            | 15.89               |
|         |      | 40      | 5200            | 16.07               |
|         |      | 44      | 5220            | 15.92               |
|         |      | 48      | 5240            | 16.14               |
|         | 5.3G | 52      | 5260            | 16.79               |
|         |      | 56      | 5280            | 16.89               |
|         |      | 60      | 5300            | 16.94               |
|         |      | 64      | 5320            | 17.11               |
|         | 5.6G | 100     | 5500            | 16.62               |
|         |      | 104     | 5520            | 16.80               |
|         |      | 108     | 5540            | 16.70               |
|         |      | 112     | 5560            | 16.55               |
|         |      | 116     | 5580            | 16.71               |
|         |      | 132     | 5660            | 16.59               |
|         |      | 136     | 5680            | 16.34               |
|         |      | 140     | 5700            | 15.37               |
|         | 5.8G | 149     | 5745            | 16.93               |
|         |      | 153     | 5765            | 16.34               |
|         |      | 157     | 5785            | 16.58               |
|         |      | 161     | 5805            | 16.27               |
|         |      | 165     | 5825            | 16.03               |

| Mode              |      | Channel | Frequency (MHz) | Average Power (dBm) |
|-------------------|------|---------|-----------------|---------------------|
| 802.11n<br>(HT20) | 5.2G | 36      | 5180            | 15.68               |
|                   |      | 40      | 5200            | 15.44               |
|                   |      | 44      | 5220            | 15.74               |
|                   |      | 48      | 5240            | 15.50               |
|                   | 5.3G | 52      | 5260            | 16.66               |
|                   |      | 56      | 5280            | 16.52               |
|                   |      | 60      | 5300            | 16.58               |
|                   |      | 64      | 5320            | 16.43               |
|                   | 5.6G | 100     | 5500            | 16.36               |
|                   |      | 104     | 5520            | 16.34               |
|                   |      | 108     | 5540            | 16.26               |
|                   |      | 112     | 5560            | 16.20               |
|                   |      | 116     | 5580            | 16.24               |
|                   |      | 132     | 5660            | 16.01               |
|                   |      | 136     | 5680            | 16.07               |
|                   |      | 140     | 5700            | 14.81               |
|                   | 5.8G | 149     | 5745            | 16.63               |
|                   |      | 153     | 5765            | 16.10               |
|                   |      | 157     | 5785            | 16.19               |
|                   |      | 161     | 5805            | 16.03               |
|                   |      | 165     | 5825            | 15.58               |

| Mode              |      | Channel | Frequency (MHz) | Average Power (dBm) |
|-------------------|------|---------|-----------------|---------------------|
| 802.11n<br>(HT40) | 5.2G | 38      | 5190            | 13.18               |
|                   |      | 46      | 5230            | 16.26               |
|                   | 5.3G | 54      | 5270            | 16.19               |
|                   |      | 62      | 5310            | 13.51               |
|                   | 5.6G | 102     | 5510            | 13.46               |
|                   |      | 110     | 5550            | 16.30               |
|                   |      | 134     | 5670            | 16.01               |
|                   | 5.8G | 151     | 5755            | 16.25               |
|                   |      | 159     | 5795            | 15.83               |

| Mode                |      | Channel | Frequency (MHz) | Average Power (dBm) |
|---------------------|------|---------|-----------------|---------------------|
| 802.11ac<br>(VHT20) | 5.2G | 36      | 5180            | 15.43               |
|                     |      | 40      | 5200            | 15.65               |
|                     |      | 44      | 5220            | 15.49               |
|                     |      | 48      | 5240            | 15.71               |
|                     | 5.3G | 52      | 5260            | 16.36               |
|                     |      | 56      | 5280            | 16.52               |
|                     |      | 60      | 5300            | 16.61               |
|                     |      | 64      | 5320            | 16.41               |
|                     | 5.6G | 100     | 5500            | 16.27               |
|                     |      | 104     | 5520            | 16.33               |
|                     |      | 108     | 5540            | 16.41               |
|                     |      | 112     | 5560            | 16.36               |
|                     |      | 116     | 5580            | 16.31               |
|                     |      | 132     | 5660            | 16.30               |
|                     |      | 136     | 5680            | 16.05               |
|                     |      | 140     | 5700            | 14.95               |
|                     | 5.8G | 149     | 5745            | 16.58               |
|                     |      | 153     | 5765            | 16.10               |
|                     |      | 157     | 5785            | 16.29               |
|                     |      | 161     | 5805            | 16.06               |
|                     |      | 165     | 5825            | 15.61               |

| Mode                |      | Channel | Frequency (MHz) | Average Power (dBm) |
|---------------------|------|---------|-----------------|---------------------|
| 802.11ac<br>(VHT40) | 5.2G | 38      | 5190            | 13.24               |
|                     |      | 46      | 5230            | 16.26               |
|                     | 5.3G | 54      | 5270            | 16.28               |
|                     |      | 62      | 5310            | 13.41               |
|                     | 5.6G | 102     | 5510            | 13.35               |
|                     |      | 110     | 5550            | 16.28               |
|                     |      | 134     | 5670            | 16.01               |
|                     | 5.8G | 151     | 5755            | 16.24               |
|                     |      | 159     | 5795            | 15.85               |

| Mode                |      | Channel | Frequency (MHz) | Average Power (dBm) |
|---------------------|------|---------|-----------------|---------------------|
| 802.11ac<br>(VHT80) | 5.2G | 42      | 5210            | 11.58               |
|                     | 5.3G | 58      | 5290            | 11.98               |
|                     | 5.6G | 106     | 5530            | 12.63               |
|                     | 5.8G | 155     | 5775            | 15.20               |

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## 4.4 SAR Test Exclusion Evaluations

### 4.4.1 Standalone SAR Test Exclusion Considerations

According to KDB 447498 D01, the SAR test exclusion condition is based on source-based time-averaged maximum conducted output power, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The 1-g and 10-g SAR test exclusion thresholds are determined by the following:

- a) For 100 MHz to 6 GHz and test separation distances  $\leq 50$  mm:

$$\frac{\text{Max. Tune up Power}_{(mW)}}{\text{Min. Test Separation Distance}_{(mm)}} \times \sqrt{f_{(GHz)}} \leq 3.0 \text{ for SAR-1g, } \leq 7.5 \text{ for SAR-10g}$$

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

- b) For 100 MHz to 1500 MHz and test separation distances  $> 50$  mm:

$$\{[\text{Threshold for 50 mm in step a)}] + [(\text{test separation distance} - 50 \text{ mm}) \cdot (f_{(MHz)}/150)]\} \text{ mW}$$

- c) For  $> 1500$  MHz and  $\leq 6$  GHz and test separation distances  $> 50$  mm:

$$\{[\text{Threshold for 50 mm in step a)}] + [(\text{test separation distance} - 50 \text{ mm}) \cdot 10]\} \text{ mW}$$

When the calculated result in step a) is  $\leq 3.0$  for SAR-1g exposure condition, or  $\leq 7.5$  for SAR-10g exposure condition, the SAR testing exclusion is applied.

When the device output power is less than the calculated result (power threshold, mW) shown in in step b) and c), the SAR testing exclusion is applied.

### 4.4.2 Estimated SAR Calculation

According to KDB 447498 D01, when an antenna qualifies for the standalone SAR test exclusion and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to the following to determine the simultaneous transmission SAR test exclusion criteria:

- a) For test separation distances  $\leq 50$  mm:

$$\text{Estimated SAR} = \frac{\text{Max. Tune up Power}_{(mW)}}{\text{Min. Test Separation Distance}_{(mm)}} \times \frac{\sqrt{f_{(GHz)}}}{x}$$

Where  $x = 7.5$  for 1-g SAR and  $x = 18.75$  for 10-g SAR.

- b) For test separation distances  $> 50$  mm, 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR.

## 4.5 SAR Testing Results

### 4.5.1 SAR Test Reduction Considerations

#### KDB 447498 D01 General RF Exposure Guidance

Testing of other required channels within the operating mode of a frequency band is not required when the *reported* SAR for the mid-band or highest output power channel is:

- a)  $\leq 0.8$  W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is  $\leq 100$  MHz
- b)  $\leq 0.6$  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
- c)  $\leq 0.4$  W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is  $\geq 200$  MHz

#### KDB 941225 D01 3G SAR Procedures

##### a) 3G SAR Test Reduction Procedure

The mode tested for SAR is referred to as the primary mode. The equivalent modes considered for SAR test reduction are denoted as secondary modes. Both primary and secondary modes must be in the same frequency band. When the maximum output power and tune-up tolerance specified for production units in a secondary mode is  $\leq 1/4$  dB higher than the primary mode or when the highest reported SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is  $\leq 1.2$  W/kg, SAR measurement is not required for the secondary mode.

#### KDB 248227 D01 Wi-Fi SAR

- a) For handsets operating next to ear, hotspot mode or mini-tablet configurations, the initial test position procedures were applied. The test position with the highest extrapolated peak SAR will be used as the initial test position. When the reported SAR of initial test position is  $\leq 0.4$  W/kg, SAR testing for remaining test positions is not required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is  $\leq 0.8$  W/kg or all test positions are measured.
- b) For WLAN 2.4 GHz, the highest measured maximum output power channel for DSSS was selected for SAR measurement. When the reported SAR is  $\leq 0.8$  W/kg, no further SAR testing is required. Otherwise, SAR is evaluated at the next highest measured output power channel. When any reported SAR is  $> 1.2$  W/kg, SAR is required for the third channel. For OFDM modes (802.11g/n), SAR is not required when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and it is  $\leq 1.2$  W/kg.
- c) For WLAN 5 GHz, the initial test configuration was selected according to the transmission mode with the highest maximum output power. When the reported SAR of initial test configuration is  $> 0.8$  W/kg, SAR is required for the subsequent highest measured output power channel until the reported SAR result is  $\leq 1.2$  W/kg or all required channels are measured. For other transmission modes, SAR is not required when the highest reported SAR for initial test configuration is adjusted by the ratio of subsequent test configuration to initial test configuration specified maximum output power and it is  $\leq 1.2$  W/kg.

#### 4.5.2 SAR Results for Head Exposure Condition

| Plot No. | Band    | Mode | Test Position | Ch. | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaling Factor | Scaled SAR-1g (W/kg) |
|----------|---------|------|---------------|-----|--------------------------|--------------------------------|------------------|------------------------|----------------|----------------------|
| 1        | 802.11b | -    | Right Cheek   | 6   | 16.0                     | 15.26                          | 0.02             | 0.137                  | 1.19           | 0.16                 |
|          | 802.11b | -    | Right Tilted  | 6   | 16.0                     | 15.26                          | -0.10            | 0.104                  | 1.19           | 0.12                 |
|          | 802.11b | -    | Left Cheek    | 6   | 16.0                     | 15.26                          | -0.09            | 0.198                  | 1.19           | 0.23                 |
|          | 802.11b | -    | Left Tilted   | 6   | 16.0                     | 15.26                          | 0.17             | 0.118                  | 1.19           | 0.14                 |
| 2        | 802.11a | -    | Right Cheek   | 64  | 17.5                     | 17.11                          | -0.08            | 0.89                   | 1.09           | 0.97                 |
|          | 802.11a | -    | Right Tilted  | 64  | 17.5                     | 17.11                          | -0.10            | 0.907                  | 1.09           | 0.99                 |
|          | 802.11a | -    | Left Cheek    | 64  | 17.5                     | 17.11                          | -0.04            | 0.91                   | 1.09           | 1.00                 |
|          | 802.11a | -    | Left Tilted   | 64  | 17.5                     | 17.11                          | 0.07             | 0.879                  | 1.09           | 0.96                 |
|          | 802.11a | -    | Right Cheek   | 60  | 17.5                     | 16.94                          | 0.03             | 0.872                  | 1.14           | 0.99                 |
|          | 802.11a | -    | Right Tilted  | 60  | 17.5                     | 16.94                          | 0.01             | 0.915                  | 1.14           | 1.04                 |
|          | 802.11a | -    | Left Cheek    | 60  | 17.5                     | 16.94                          | -0.12            | 0.983                  | 1.14           | 1.12                 |
|          | 802.11a | -    | Left Tilted   | 60  | 17.5                     | 16.94                          | 0.05             | 0.886                  | 1.14           | 1.01                 |
| 3        | 802.11a | -    | Left Cheek    | 60  | 17.5                     | 16.94                          | -0.03            | 0.962                  | 1.14           | 1.09                 |
|          | 802.11a | -    | Right Cheek   | 104 | 17.3                     | 16.80                          | -0.07            | 1.01                   | 1.12           | 1.13                 |
|          | 802.11a | -    | Right Tilted  | 104 | 17.3                     | 16.80                          | -0.02            | 0.907                  | 1.12           | 1.02                 |
|          | 802.11a | -    | Left Cheek    | 104 | 17.3                     | 16.80                          | 0.05             | 0.965                  | 1.12           | 1.08                 |
|          | 802.11a | -    | Left Tilted   | 104 | 17.3                     | 16.80                          | 0.06             | 0.82                   | 1.12           | 0.92                 |
|          | 802.11a | -    | Right Cheek   | 116 | 17.3                     | 16.71                          | -0.08            | 1.03                   | 1.15           | 1.18                 |
|          | 802.11a | -    | Right Tilted  | 116 | 17.3                     | 16.71                          | 0.02             | 0.912                  | 1.15           | 1.04                 |
|          | 802.11a | -    | Left Cheek    | 116 | 17.3                     | 16.71                          | 0.04             | 0.974                  | 1.15           | 1.12                 |
| 4        | 802.11a | -    | Left Tilted   | 116 | 17.3                     | 16.71                          | 0.15             | 0.846                  | 1.15           | 0.97                 |
|          | 802.11a | -    | Right Cheek   | 116 | 17.3                     | 16.71                          | 0.03             | 0.993                  | 1.15           | 1.14                 |
|          | 802.11a | -    | Right Cheek   | 149 | 17.4                     | 16.93                          | -0.03            | 0.92                   | 1.11           | 1.03                 |
|          | 802.11a | -    | Right Tilted  | 149 | 17.4                     | 16.93                          | -0.05            | 0.85                   | 1.11           | 0.95                 |
|          | 802.11a | -    | Left Cheek    | 149 | 17.4                     | 16.93                          | -0.07            | 1.07                   | 1.11           | 1.19                 |
|          | 802.11a | -    | Left Tilted   | 149 | 17.4                     | 16.93                          | -0.01            | 0.936                  | 1.11           | 1.04                 |
|          | 802.11a | -    | Right Cheek   | 157 | 17.4                     | 16.58                          | 0.02             | 0.878                  | 1.21           | 1.06                 |
|          | 802.11a | -    | Right Tilted  | 157 | 17.4                     | 16.58                          | 0.03             | 0.841                  | 1.21           | 1.02                 |
|          | 802.11a | -    | Left Cheek    | 157 | 17.4                     | 16.58                          | -0.05            | 0.892                  | 1.21           | 1.08                 |
|          | 802.11a | -    | Left Tilted   | 157 | 17.4                     | 16.58                          | 0.09             | 0.862                  | 1.21           | 1.04                 |
|          | 802.11a | -    | Left Cheek    | 165 | 17.4                     | 16.03                          | 0.07             | 0.867                  | 1.37           | 1.19                 |
|          | 802.11a | -    | Left Cheek    | 149 | 17.4                     | 16.93                          | 0.02             | 1.03                   | 1.11           | 1.15                 |

#### 4.5.3 SAR Results for Body-worn Exposure Condition

| Plot No. | Band    | Mode | Test Position | Separation Distance (cm) | Ch. | Belt Clip | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaling Factor | Scaled SAR-1g (W/kg) |
|----------|---------|------|---------------|--------------------------|-----|-----------|--------------------------|--------------------------------|------------------|------------------------|----------------|----------------------|
| 5        | 802.11b | -    | Front Face    | 1                        | 6   | w/o       | 16.0                     | 15.26                          | 0.06             | 0.062                  | 1.19           | 0.07                 |
|          | 802.11b | -    | Rear Face     | 0                        | 6   | w/        | 16.0                     | 15.26                          | 0.02             | 0.053                  | 1.19           | 0.06                 |
|          | 802.11a | -    | Front Face    | 1                        | 64  | w/o       | 17.5                     | 17.11                          | 0.08             | 0.258                  | 1.09           | 0.28                 |
| 6        | 802.11a | -    | Rear Face     | 0                        | 64  | w/        | 17.5                     | 17.11                          | 0.08             | 0.293                  | 1.09           | 0.32                 |
|          | 802.11a | -    | Rear Face     | 0                        | 52  | w/        | 17.5                     | 16.79                          | 0.02             | 0.275                  | 1.18           | 0.32                 |
|          | 802.11a | -    | Rear Face     | 0                        | 60  | w/        | 17.5                     | 16.94                          | 0.11             | 0.274                  | 1.14           | 0.31                 |
| 7        | 802.11a | -    | Front Face    | 1                        | 104 | w/o       | 17.3                     | 16.80                          | 0.01             | 0.227                  | 1.12           | 0.25                 |
|          | 802.11a | -    | Rear Face     | 0                        | 104 | w/        | 17.3                     | 16.80                          | 0.08             | 0.226                  | 1.12           | 0.25                 |
| 8        | 802.11a | -    | Front Face    | 1                        | 149 | w/o       | 17.3                     | 16.93                          | 0.09             | 0.268                  | 1.09           | 0.29                 |
|          | 802.11a | -    | Rear Face     | 0                        | 149 | w/        | 17.3                     | 16.93                          | 0.02             | 0.172                  | 1.09           | 0.19                 |

Note: w/o means test without belt clip, w/ means test with belt clip.

## 4.6 SAR Measurement Variability

### 4.6.1 Repeated Measurement

According to KDB 865664 D01, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are  $\leq 1.45$  W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is  $\leq 1.10$ , the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR repeated measurement procedure:

1. When the highest measured SAR is  $< 0.80$  W/kg, repeated measurement is not required.
2. When the highest measured SAR is  $\geq 0.80$  W/kg, repeat that measurement once.
3. If the ratio of largest to smallest SAR for the original and first repeated measurements is  $> 1.20$ , or when the original or repeated measurement is  $\geq 1.45$  W/kg, perform a second repeated measurement.
4. If the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ , and the original, first or second repeated measurement is  $\geq 1.5$  W/kg, perform a third repeated measurement.

| Band                    | Mode | Test Position | Ch. | Original Measured SAR-1g (W/kg) | 1st Repeated SAR-1g (W/kg) | L/S Ratio | 2nd Repeated SAR-1g (W/kg) | L/S Ratio | 3rd Repeated SAR-1g (W/kg) | L/S Ratio |
|-------------------------|------|---------------|-----|---------------------------------|----------------------------|-----------|----------------------------|-----------|----------------------------|-----------|
| Head Exposure Condition |      |               |     |                                 |                            |           |                            |           |                            |           |
| 802.11a                 | -    | Left Cheek    | 60  | 0.983                           | 0.962                      | 1.02      | N/A                        | N/A       | N/A                        | N/A       |
| 802.11a                 | -    | Right Cheek   | 116 | 1.03                            | 0.993                      | 1.04      | N/A                        | N/A       | N/A                        | N/A       |
| 802.11a                 | -    | Left Cheek    | 149 | 1.07                            | 1.03                       | 1.04      | N/A                        | N/A       | N/A                        | N/A       |

## 4.7 Simultaneous Multi-band Transmission Evaluation

### 4.7.1 Simultaneous Transmission SAR Test Exclusion Considerations

a) Sum of SAR

Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneous transmitting antenna. When the sum of SAR<sub>1g</sub> of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit (SAR<sub>1g</sub> 1.6 W/kg), the simultaneous transmission SAR is not required. When the sum of SAR<sub>1g</sub> is greater than the SAR limit (SAR<sub>1g</sub> 1.6 W/kg), SAR test exclusion is determined by the SPLSR.

b) SAR to Peak Location Separation Ratio

The simultaneous transmitting antennas in each operating mode and exposure condition combination are considered one pair at a time to determine the SPLSR.

$$SPLSR = (SAR_1 + SAR_2)^{1.5} / R_i$$

The ratio is rounded to two decimal digits, and must be  $\leq 0.04$  for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion. When 10-g SAR applies, the ratio must be  $\leq 0.10$ .

SAR<sub>1</sub> and SAR<sub>2</sub> are the highest reported or estimated SAR values for each antenna in the pair, and  $R_i$  is the separation distance in mm between the peak SAR locations for the antenna pair

$$\text{peak location separation distance} = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$$

Where  $(x_1, y_1, z_1)$  and  $(x_2, y_2, z_2)$  are the coordinates of the extrapolated peak SAR locations in the area or zoom scans.

When standalone test exclusion applies, SAR is estimated; the peak location is assumed to be at the feed-point or geometric center of the antenna. Due to curvatures on the SAM phantom, when SAR is estimated for one of the antennas in an antenna pair, the measured peak SAR location will be translated onto the test device to determine the peak location separation for the antenna pair.

When SAR is estimated for both antennas, the peak location separation should be determined by the closest physical separation of the antennas, according to the feed-point or geometric center of the antennas.

c) Volume Scan

When the SPLSR is  $\leq 0.04$  for 1-g SAR and  $\leq 0.10$  for 10-g SAR, the simultaneous transmission SAR is not required. Otherwise, the enlarged zoom scan and volume scan post-processing procedures will be performed.

### 4.7.2 Simultaneous Transmission Possibilities

The 2.4G WLAN and 5G WLAN cannot transmit simultaneously.

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

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## Appendix A. SAR Plots of System Verification

The plots for system verification with largest deviation for each SAR system combination are shown as follows.



## Appendix B. SAR Plots of SAR Measurement

The SAR plots for highest measured SAR in each exposure configuration, wireless mode and frequency band combination, and measured SAR > 1.5 W/kg are shown as follows.



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## Appendix C. Calibration Certificate for Probe and Dipole

The calibration certificates are shown as follows.



## **Appendix D. Photographs of EUT and Setup**

