# FCC SAR TEST REPORT

**FCC ID** : **HLEPA760BTNFL**
**Equipment** : **Rugged Handheld Computer**
**Brand Name** : **unitech**
**Model Name** : **PA760**
**Applicant** : **unitech electronics co., ltd.**
**5F, No. 136, Lane 235, Pao-Chiao Rd.,**
**Hsin-Tien Dist., New Taipei City, Taiwan**
**Manufacturer** : **unitech electronics co., ltd.**
**5F, No. 136, Lane 235, Pao-Chiao Rd.,**
**Hsin-Tien Dist., New Taipei City, Taiwan**
**Standard** : **FCC 47 CFR Part 2 (2.1093)**
**ANSI/IEEE C95.1-1992**
**IEEE 1528-2013**

**The product was received on Jul. 02, 2019 and testing was started from Jul. 05, 2019 and completed on Jul. 10, 2019. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.**

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

**The test results in this variant report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.**

Cona Huang

**Approved by: Cona Huang / Deputy Manager**

***SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory***

*No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)*

# Table of Contents

# History of this test report

| Report No. | Version | Description | Issued Date |
|---|---|---|---|
| FA8N0701-03 | 01 | Initial issue of report | Jul. 19, 2019 |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# 1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for unitech electronics co., ltd., Rugged Handheld Computer, PA760, are as follows.

| Equipment Class | Frequency Band | Highest SAR Summary | | | | Highest Simultaneous Transmission 1g SAR (W/kg) |
|---|---|---|---|---|---|---|
| | | Head (Separation 0mm) | Body-worn (Separation 10mm) | Hotspot (Separation 10mm) | Product Specific (Separation 0mm) | |
| | | 1g SAR (W/kg) | | | 10g SAR (W/kg) | |
| Licensed | GSM850 | 0.18 | 0.43 | 0.43 | | 1.59 |
| | GSM1900 | 0.20 | 0.62 | 0.62 | | |
| | WCDMA II | 0.34 | 1.11 | 1.11 | | |
| | WCDMA V | 0.19 | 0.41 | 0.41 | | |
| | LTE Band 2 | 0.34 | 1.12 | 1.12 | | |
| | LTE Band 4 | 0.14 | 0.69 | 0.69 | | |
| | LTE Band 5 | 0.15 | 0.36 | 0.36 | | |
| | LTE Band 7 | 0.52 | 0.64 | 0.71 | | |
| | LTE Band 17 | 0.07 | 0.24 | 0.24 | | |
| | LTE Band 38 / 41 | 0.34 | 0.44 | 0.44 | | |
| DTS | 2.4GHz WLAN | 0.42 | 0.22 | 0.22 | | 1.38 |
| NII | 5GHz WLAN | 0.07 | 0.43 | 0.39 | 0.20 | 1.59 |
| DSS | Bluetooth | 0.01 | 0.02 | 0.02 | | 1.46 |
| Date of Testing: | | 2019/7/5 ~ 2019/7/10 | | | | |

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 1190) and the FCC designation No. TW1190 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC test. This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg for Partial-Body 1g SAR, 4.0 W/kg for Product Specific 10g SAR) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013 and FCC KDB publications

**Reviewed by: Jason Wang**
**Report Producer: Wan Liu**

# 2. Guidance Applied

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

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2013
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB 865664 D02 SAR Reporting v01r02
- FCC KDB 447498 D01 General RF Exposure Guidance v06
- FCC KDB 648474 D04 SAR Evaluation Considerations for Wireless Handsets v01r03
- FCC KDB 248227 D01 802.11 Wi-Fi SAR v02r02
- FCC KDB 941225 D01 3G SAR Procedures v03r01
- FCC KDB 941225 D05 SAR for LTE Devices v02r05
- FCC KDB 941225 D06 Hotspot Mode SAR v02r01

# 3. Equipment Under Test (EUT) Information

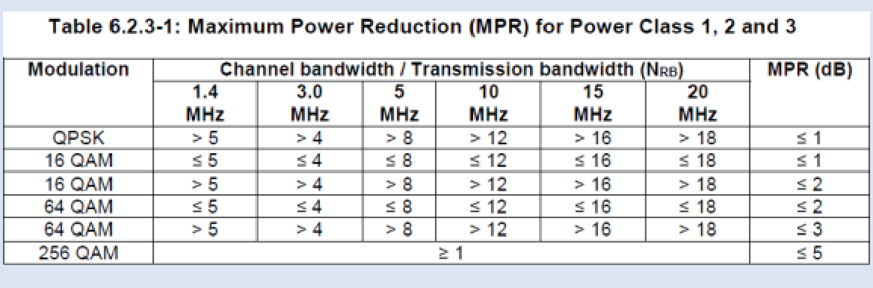
## 3.1 General Information

| Product Feature & Specification | |
|---|---|
| **Equipment Name** | Rugged Handheld Computer |
| **Brand Name** | unitech |
| **Model Name** | PA760 |
| **FCC ID** | HLEPA760BTNFL |
| **Wireless Technology and Frequency Range** | GSM850: 824.2 MHz ~ 848.8 MHz<br>GSM1900: 1850.2 MHz ~ 1909.8 MHz<br>WCDMA Band II: 1852.4 MHz ~ 1907.6 MHz<br>WCDMA Band V: 826.4 MHz ~ 846.6 MHz<br>LTE Band 2: 1850.7 MHz ~ 1909.3 MHz<br>LTE Band 4: 1710.7 MHz ~ 1754.3 MHz<br>LTE Band 5: 824.7 MHz ~ 848.3 MHz<br>LTE Band 7: 2502.5 MHz ~ 2567.5 MHz<br>LTE Band 17: 706.5 MHz ~ 713.5 MHz<br>LTE Band 38: 2572.5 MHz ~ 2617.5 MHz<br>LTE Band 41: 2498.5 MHz ~ 2687.5 MHz<br>WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz<br>WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz<br>WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz<br>WLAN 5.5GHz Band: 5500 MHz ~ 5720 MHz<br>WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz<br>Bluetooth: 2402 MHz ~ 2480 MHz<br>NFC : 13.56 MHz |
| **Mode** | GSM/GPRS/EGPRS<br>RMC/AMR 12.2Kbps<br>HSDPA<br>HSUPA<br>LTE: QPSK, 16QAM<br>WLAN: 802.11a/b/g/n/ac HT20 / HT40 / VHT20 / VHT40 / VHT80<br>Bluetooth BR/EDR/LE<br>NFC:ASK |
| **GSM / (E)GPRS Transfer mode** | Class B – EUT cannot support Packet Switched and Circuit Switched Network simultaneously but can automatically switch between Packet and Circuit Switched Network. |
| **EUT Stage** | Identical Prototype |

**Remark:**

1. Variant report to change 1D engine Barcode reader to 2D engine Barcode reader and includes verification worst case found in original report, Sporton SAR Report, Report No. FA8N0701-02 (FCC ID: HLEPA760BTNFL), the simultaneous transmission was not necessary, due to the worst transmit simultaneous configuration was not higher than original report, and the worst simultaneous transmission results from original report are showing section1

## 3.2 General LTE SAR Test and Reporting Considerations

<table>
<tr><th colspan="2">Summarized necessary items addressed in KDB 941225 D05 v02r05</th></tr>
<tr><td>FCC ID</td><td>HLEPA760BTNFL</td></tr>
<tr><td>Equipment Name</td><td>Rugged Handheld Computer</td></tr>
<tr><td>Operating Frequency Range of each LTE transmission band</td><td>LTE Band 2: 1850.7 MHz ~ 1909.3 MHz<br>LTE Band 4: 1710.7 MHz ~ 1754.3 MHz<br>LTE Band 5: 824.7 MHz ~ 848.3 MHz<br>LTE Band 7: 2502.5 MHz ~ 2567.5 MHz<br>LTE Band 17: 706.5 MHz ~ 713.5 MHz<br>LTE Band 38: 2572.5 MHz ~ 2617.5 MHz<br>LTE Band 41: 2498.5 MHz ~ 2687.5 MHz</td></tr>
<tr><td>Channel Bandwidth</td><td>LTE Band 02:1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz, 20MHz<br>LTE Band 04:1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz, 20MHz<br>LTE Band 05:1.4MHz, 3MHz, 5MHz, 10MHz<br>LTE Band 07: 5MHz, 10MHz,<br>LTE Band 38: 5MHz, 10MHz, 15MHz, 20MHz<br>LTE Band 41: 5MHz, 10MHz, 15MHz, 20MHz</td></tr>
<tr><td>uplink modulations used</td><td>QPSK / 16QAM</td></tr>
<tr><td>LTE Voice / Data requirements</td><td>Data only</td></tr>
<tr><td>LTE MPR permanently built-in by design</td><td>
Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 1, 2 and 3
<table>
<tr><th>Modulation</th><th colspan="6">Channel bandwidth / Transmission bandwidth (N<sub>RB</sub>)</th><th>MPR (dB)</th></tr>
<tr><th></th><th>1.4 MHz</th><th>3.0 MHz</th><th>5 MHz</th><th>10 MHz</th><th>15 MHz</th><th>20 MHz</th><th></th></tr>
<tr><td>QPSK</td><td>> 5</td><td>> 4</td><td>> 8</td><td>> 12</td><td>> 16</td><td>> 18</td><td>≤ 1</td></tr>
<tr><td>16 QAM</td><td>≤ 5</td><td>≤ 4</td><td>≤ 8</td><td>≤ 12</td><td>≤ 16</td><td>≤ 18</td><td>≤ 1</td></tr>
<tr><td>16 QAM</td><td>> 5</td><td>> 4</td><td>> 8</td><td>> 12</td><td>> 16</td><td>> 18</td><td>≤ 2</td></tr>
<tr><td>64 QAM</td><td>≤ 5</td><td>≤ 4</td><td>≤ 8</td><td>≤ 12</td><td>≤ 16</td><td>≤ 18</td><td>≤ 2</td></tr>
<tr><td>64 QAM</td><td>> 5</td><td>> 4</td><td>> 8</td><td>> 12</td><td>> 16</td><td>> 18</td><td>≤ 3</td></tr>
<tr><td>256 QAM</td><td colspan="6">≥ 1</td><td>≤ 5</td></tr>
</table></td></tr>
<tr><td>LTE A-MPR</td><td>In the base station simulator configuration, Network Setting value is set to NS_01 to disable A-MPR during SAR testing and the LTE SAR tests was transmitting on all TTI frames (Maximum TTI)</td></tr>
<tr><td>Spectrum plots for RB configuration</td><td>A properly configured base station simulator was used for the SAR and power measurement; therefore, spectrum plots for each RB allocation and offset configuration are not included in the SAR report.</td></tr>
</table>

**Transmission (H, M, L) channel numbers and frequencies in each LTE band**

LTE Band 2

| | Bandwidth 1.4 MHz | | Bandwidth 3 MHz | | Bandwidth 5 MHz | | Bandwidth 10 MHz | | Bandwidth 15 MHz | | Bandwidth 20 MHz | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) |
| L | 18607 | 1850.7 | 18615 | 1851.5 | 18625 | 1852.5 | 18650 | 1855 | 18675 | 1857.5 | 18700 | 1860 |
| M | 18900 | 1880 | 18900 | 1880 | 18900 | 1880 | 18900 | 1880 | 18900 | 1880 | 18900 | 1880 |
| H | 19193 | 1909.3 | 19185 | 1908.5 | 19175 | 1907.5 | 19150 | 1905 | 19125 | 1902.5 | 19100 | 1900 |

LTE Band 4

| | Bandwidth 1.4 MHz | | Bandwidth 3 MHz | | Bandwidth 5 MHz | | Bandwidth 10 MHz | | Bandwidth 15 MHz | | Bandwidth 20 MHz | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) |
| L | 19957 | 1710.7 | 19965 | 1711.5 | 19975 | 1712.5 | 20000 | 1715 | 20025 | 1717.5 | 20050 | 1720 |
| M | 20175 | 1732.5 | 20175 | 1732.5 | 20175 | 1732.5 | 20175 | 1732.5 | 20175 | 1732.5 | 20175 | 1732.5 |
| H | 20393 | 1754.3 | 20385 | 1753.5 | 20375 | 1752.5 | 20350 | 1750 | 20325 | 1747.5 | 20300 | 1745 |

LTE Band 5

| | Bandwidth 1.4 MHz | | Bandwidth 3 MHz | | Bandwidth 5 MHz | | Bandwidth 10 MHz | |
|---|---|---|---|---|---|---|---|---|
| | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) |
| L | 20407 | 824.7 | 20415 | 825.5 | 20425 | 826.5 | 20450 | 829 |
| M | 20525 | 836.5 | 20525 | 836.5 | 20525 | 836.5 | 20525 | 836.5 |
| H | 20643 | 848.3 | 20635 | 847.5 | 20625 | 846.5 | 20600 | 844 |

LTE Band 7

| | Bandwidth 5 MHz | | Bandwidth 10 MHz | | Bandwidth 15 MHz | | Bandwidth 20 MHz | |
|---|---|---|---|---|---|---|---|---|
| | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) |
| L | 20775 | 2502.5 | 20800 | 2505 | 20825 | 2507.5 | 20850 | 2510 |
| M | 21100 | 2535 | 21100 | 2535 | 21100 | 2535 | 21100 | 2535 |
| H | 21425 | 2567.5 | 21400 | 2565 | 21375 | 2562.5 | 21350 | 2560 |

LTE Band 17

| | Bandwidth 5 MHz | | Bandwidth 10 MHz | |
|---|---|---|---|---|
| | Channel # | Freq.(MHz) | Channel # | Freq. (MHz) |
| L | 23755 | 706.5 | 23780 | 709 |
| M | 23790 | 710 | 23790 | 710 |
| H | 23825 | 713.5 | 23800 | 711 |

LTE Band 38

| | Bandwidth 5 MHz | | Bandwidth 10 MHz | | Bandwidth 15 MHz | | Bandwidth 20 MHz | |
|---|---|---|---|---|---|---|---|---|
| | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) |
| L | 37775 | 2572.5 | 37800 | 2575 | 37825 | 2577.5 | 37850 | 2580 |
| M | 38000 | 2595 | 38000 | 2595 | 38000 | 2595 | 38000 | 2595 |
| H | 38225 | 2617.5 | 38200 | 2615 | 38175 | 2612.5 | 38150 | 2610 |

LTE Band 41

| | Bandwidth 5 MHz | | Bandwidth 10 MHz | | Bandwidth 15 MHz | | Bandwidth 20 MHz | |
|---|---|---|---|---|---|---|---|---|
| | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) | Ch. # | Freq. (MHz) |
| L | 39675 | 2498.5 | 39700 | 2501 | 39725 | 2503.5 | 39750 | 2506 |
| LM | 40148 | 2545.8 | 40160 | 2547 | 40173 | 2548.3 | 40185 | 2549.5 |
| M | 40620 | 2593 | 40620 | 2593 | 40620 | 2593 | 40620 | 2593 |
| HM | 41093 | 2640.3 | 41080 | 2639 | 41068 | 2637.8 | 41055 | 2636.5 |
| H | 41565 | 2687.5 | 41540 | 2685 | 41515 | 2682.5 | 41490 | 2680 |

# 4. RF Exposure Limits

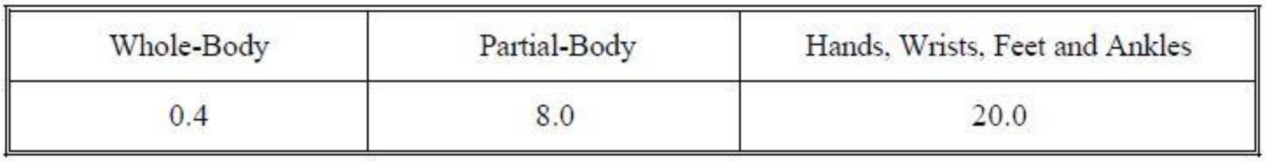
## 4.1 Uncontrolled Environment

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

## 4.2 Controlled Environment

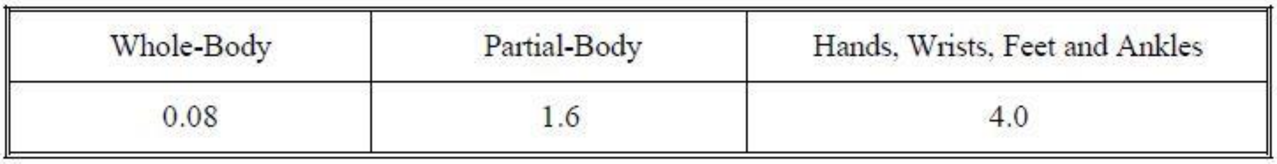
Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed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

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



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

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



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

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

# 5. Specific Absorption Rate (SAR)

## 5.1 Introduction

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

## 5.2 SAR Definition

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

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

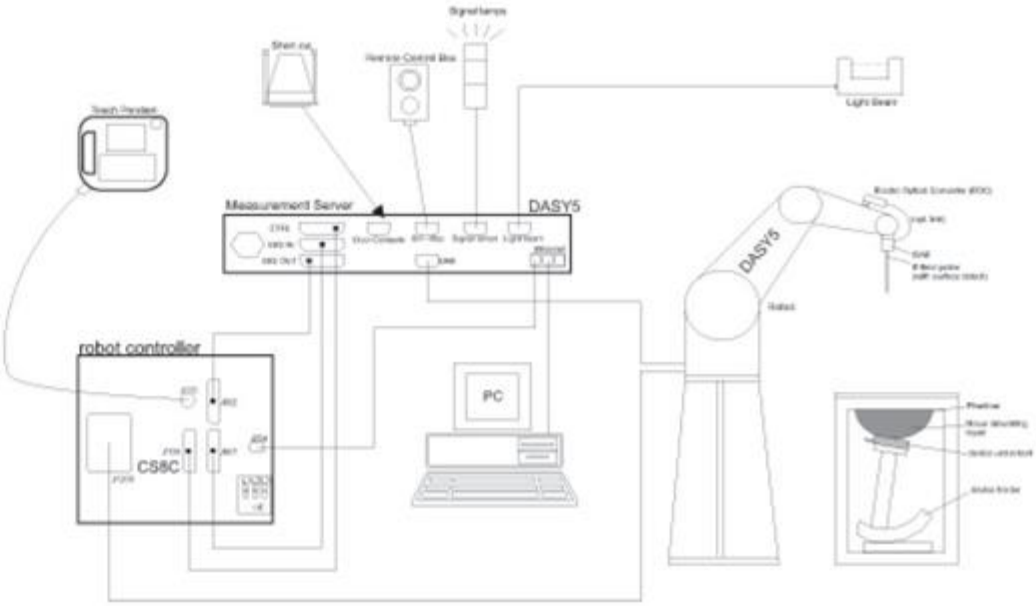
SAR is expressed in units of Watts per kilogram (W/kg)

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

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

# 6. System Description and Setup

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



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

## 6.1 E-Field Probe

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

**<ES3DV3 Probe>**

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

**<EX3DV4 Probe>**

| | | |
|---|---|---|
| **Construction** | Symmetric design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |  |
| **Frequency** | 10 MHz – >6 GHz<br>Linearity: ±0.2 dB (30 MHz – 6 GHz) | |
| **Directivity** | ±0.3 dB in TSL (rotation around probe axis)<br>±0.5 dB in TSL (rotation normal to probe axis) | |
| **Dynamic Range** | 10 µW/g – >100 mW/g<br>Linearity: ±0.2 dB (noise: typically <1 µW/g) | |
| **Dimensions** | Overall length: 337 mm (tip: 20 mm)<br>Tip diameter: 2.5 mm (body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm | |

## 6.2 Data Acquisition Electronics (DAE)

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

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

**Fig 5.1 Photo of DAE**

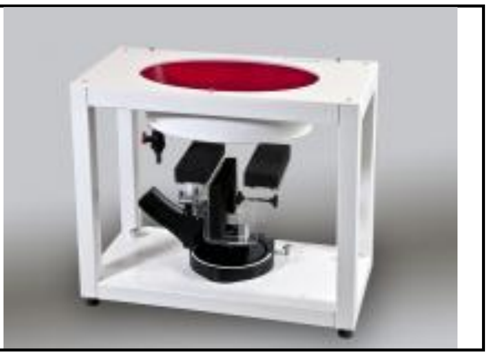
## 6.3 Phantom

**<SAM Twin Phantom>**

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

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

**<ELI Phantom>**

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

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

## 6.4 Device Holder

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

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

Mounting Device for Hand-Held Transmitters

Mounting Device Adaptor for Wide-Phones

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

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

Mounting Device for Laptops

# 7. Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

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

<SAR measurement>

(a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.
(b) Place the EUT in the positions as Appendix D demonstrates.
(c) Set scan area, grid size and other setting on the DASY software.
(d) Measure SAR results for the highest power channel on each testing position.
(e) Find out the largest SAR result on these testing positions of each band
(f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg

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

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

## 7.1 Spatial Peak SAR Evaluation

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

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

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

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

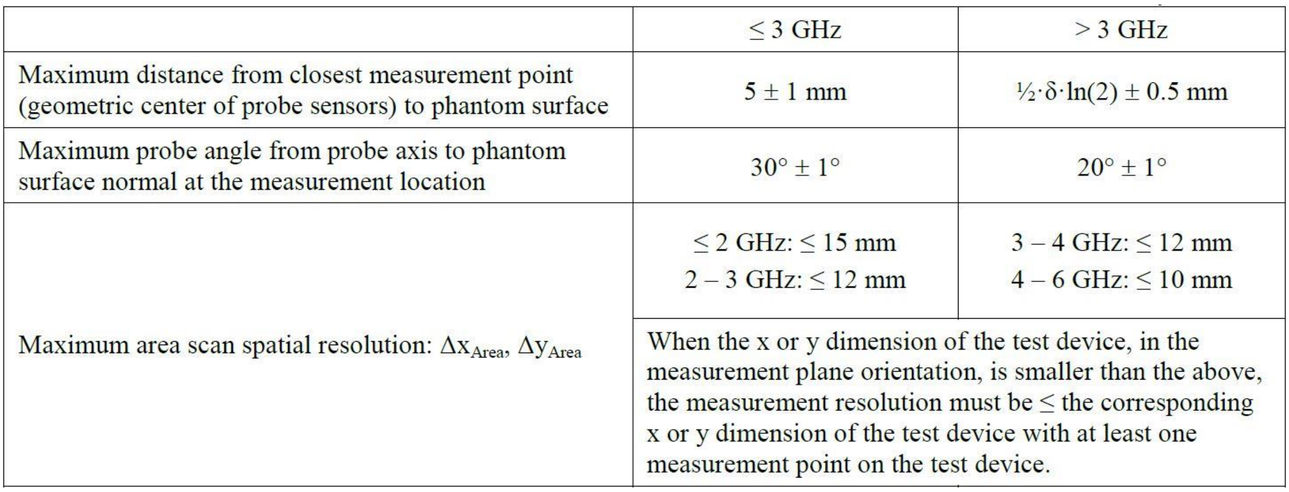
## 7.2 Power Reference Measurement

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

## 7.3 Area Scan

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB0 is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

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

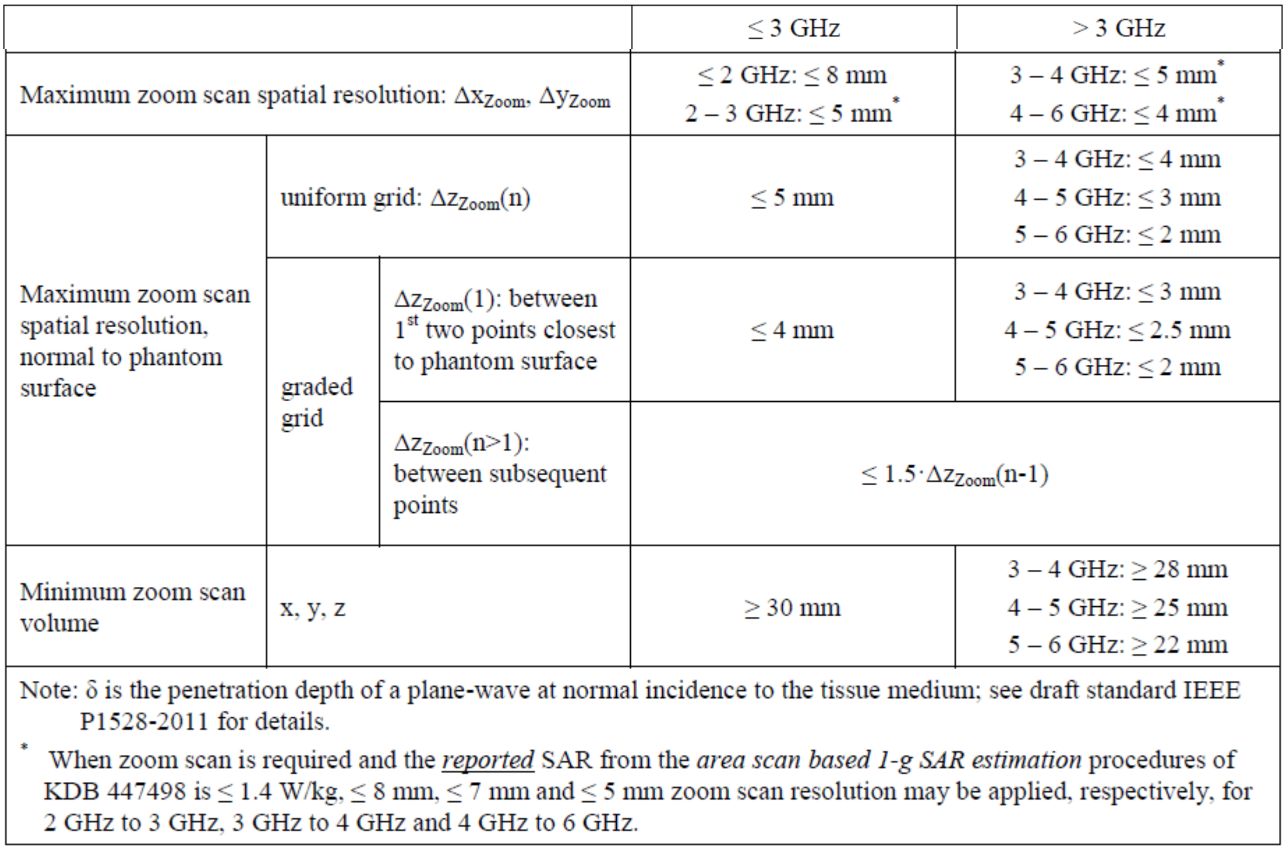


| | ≤ 3 GHz | > 3 GHz |
|---|---|---|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | 5 ± 1 mm | ½·δ·ln(2) ± 0.5 mm |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location | 30° ± 1° | 20° ± 1° |
| Maximum area scan spatial resolution: $\Delta x_{Area}$, $\Delta y_{Area}$ | ≤ 2 GHz: ≤ 15 mm<br>2 – 3 GHz: ≤ 12 mm | 3 – 4 GHz: ≤ 12 mm<br>4 – 6 GHz: ≤ 10 mm |
| | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device. | |

## 7.4 Zoom Scan

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

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



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

## 7.5 Volume Scan Procedures

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

## 7.6 Power Drift Monitoring

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

# 8. Test Equipment List

| Manufacturer | Name of Equipment | Type/Model | Serial Number | Calibration | |
|---|---|---|---|---|---|
| | | | | Last Cal. | Due Date |
| SPEAG | 750MHz System Validation Kit | D750V3 | 1107 | Mar. 08, 2019 | Mar. 07, 2020 |
| SPEAG | 835MHz System Validation Kit | D835V2 | 4d167 | Mar. 08, 2019 | Mar. 07, 2020 |
| SPEAG | 1750MHz System Validation Kit | D1750V2 | 1112 | Mar. 07, 2019 | Mar. 06, 2020 |
| SPEAG | 1900MHz System Validation Kit | D1900V2 | 5d041 | Sep. 11, 2018 | Sep. 10, 2019 |
| SPEAG | 2450MHz System Validation Kit | D2450V2 | 736 | Aug. 31, 2018 | Aug. 30, 2019 |
| SPEAG | 2600MHz System Validation Kit | D2600V2 | 1078 | Mar. 06, 2019 | Mar. 05, 2020 |
| SPEAG | 5GHz System Validation Kit | D5GHzV2 | 1006 | Sep. 27, 2018 | Sep. 26, 2019 |
| SPEAG | Data Acquisition Electronics | DAE3 | 495 | May. 21, 2019 | May. 20, 2020 |
| SPEAG | Data Acquisition Electronics | DAE4 | 1326 | Sep. 18, 2018 | Sep. 17, 2019 |
| SPEAG | Dosimetric E-Field Probe | ES3DV3 | 3169 | May. 24, 2019 | May. 23, 2020 |
| SPEAG | Dosimetric E-Field Probe | EX3DV4 | 3931 | Sep. 27, 2018 | Sep. 26, 2019 |
| RCPTWN | Thermometer | HTC-1 | TM685-1 | Nov. 12, 2018 | Nov. 11, 2019 |
| RCPTWN | Thermometer | HTC-1 | TM560-2 | Nov. 12, 2018 | Nov. 11, 2019 |
| Anritsu | Radio Communication Analyzer | MT8821C | 6201341950 | Apr. 21, 2019 | Apr. 20, 2020 |
| Agilent | Wireless Communication Test Set | E5515C | MY50266977 | May. 27, 2019 | May. 26, 2020 |
| R&S | BT Base Station | CBT32 | 100522 | Mar. 18, 2019 | Mar. 17, 2020 |
| SPEAG | Device Holder | N/A | N/A | N/A | N/A |
| Anritsu | Signal Generator | MG3710A | 6201502524 | Dec. 11, 2018 | Dec. 10, 2019 |
| Agilent | ENA Network Analyzer | E5071C | MY46104758 | Sep. 19, 2018 | Sep. 18, 2019 |
| SPEAG | Dielectric Probe Kit | DAK-3.5 | 1126 | Sep. 19, 2018 | Sep. 18, 2019 |
| LINE SEIKI | Digital Thermometer | DTM3000-spezial | 3169 | Sep. 11, 2018 | Sep. 10, 2019 |
| Anritsu | Power Meter | ML2495A | 1218006 | Oct. 08, 2018 | Oct. 07, 2019 |
| Anritsu | Power Sensor | MA2411B | 1207363 | Oct. 08, 2018 | Oct. 07, 2019 |
| Anritsu | Power Meter | ML2495A | 1419002 | May. 29, 2019 | May. 28, 2020 |
| Anritsu | Power Sensor | MA2411B | 1339124 | May. 29, 2019 | May. 28, 2020 |
| Agilent | Spectrum Analyzer | E4408B | MY44211028 | Aug. 28, 2018 | Aug. 27, 2019 |
| Anritsu | Spectrum Analyzer | MS2830A | 6201396378 | Jun. 27, 2019 | Jun. 26, 2020 |
| Mini-Circuits | Power Amplifier | ZVE-8G+ | 070501814 | Oct. 08, 2018 | Oct. 07, 2019 |
| Mini-Circuits | Power Amplifier | ZVE-8G+ | 6382 | Aug. 09, 2018 | Aug. 08, 2019 |
| ATM | Dual Directional Coupler | C122H-10 | P610410z-02 | Note 1 | |
| Woken | Attenuator 1 | WK0602-XX | N/A | Note 1 | |
| PE | Attenuator 2 | PE7005-10 | N/A | Note 1 | |
| PE | Attenuator 3 | PE7005- 3 | N/A | Note 1 | |

**General Note:**

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

# 9. System Verification

## 9.1 Tissue Simulating Liquids

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

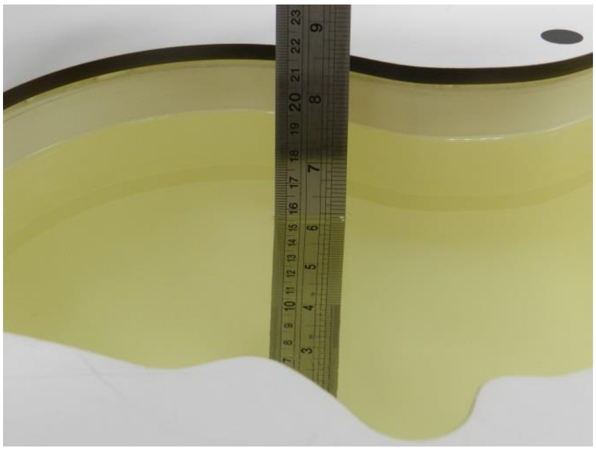


**Fig 10.1Photo of Liquid Height for Head SAR**

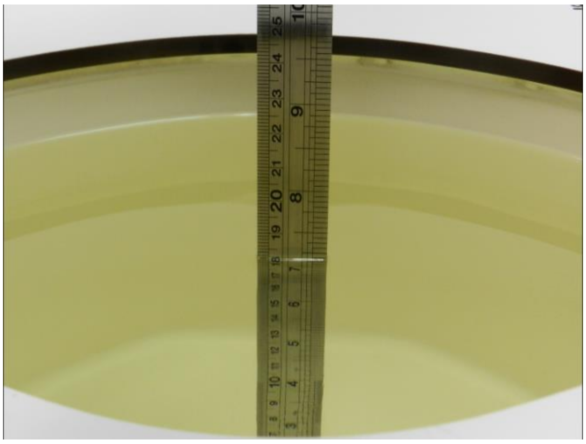


**Fig 10.2 Photo of Liquid Height for Body SAR**

## 9.2 Tissue Verification

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

| Frequency (MHz) | Water (%) | Sugar (%) | Cellulose (%) | Salt (%) | Preventol (%) | DGBE (%) | Conductivity (σ) | Permittivity (εr) |
|---|---|---|---|---|---|---|---|---|
| 750 | 41.1 | 57.0 | 0.2 | 1.4 | 0.2 | 0 | 0.89 | 41.9 |
| 835 | 40.3 | 57.9 | 0.2 | 1.4 | 0.2 | 0 | 0.90 | 41.5 |
| 900 | 40.3 | 57.9 | 0.2 | 1.4 | 0.2 | 0 | 0.97 | 41.5 |
| 1800, 1900, 2000 | 55.2 | 0 | 0 | 0.3 | 0 | 44.5 | 1.40 | 40.0 |
| 2450 | 55.0 | 0 | 0 | 0 | 0 | 45.0 | 1.80 | 39.2 |
| 2600 | 54.8 | 0 | 0 | 0.1 | 0 | 45.1 | 1.96 | 39.0 |

Simulating Liquid for 5GHz, Manufactured by SPEAG

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

### <Tissue Dielectric Parameter Check Results>

| Frequency (MHz) | Liquid Temp. (℃) | Conductivity (σ) | Permittivity ($\varepsilon_r$) | Conductivity Target (σ) | Permittivity Target ($\varepsilon_r$) | Delta (σ) (%) | Delta ($\varepsilon_r$) (%) | Limit (%) | Date |
|---|---|---|---|---|---|---|---|---|---|
| 750 | 22.4 | 0.897 | 43.389 | 0.89 | 41.90 | 0.79 | 3.55 | ±5 | 2019/7/6 |
| 835 | 22.4 | 0.873 | 40.700 | 0.90 | 41.50 | -3.00 | -1.93 | ±5 | 2019/7/6 |
| 1750 | 22.5 | 1.392 | 39.377 | 1.37 | 40.10 | 1.61 | -1.80 | ±5 | 2019/7/5 |
| 1900 | 22.5 | 1.413 | 40.386 | 1.40 | 40.00 | 0.93 | 0.97 | ±5 | 2019/7/5 |
| 2450 | 22.5 | 1.803 | 38.577 | 1.80 | 39.20 | 0.17 | -1.59 | ±5 | 2019/7/9 |
| 2600 | 22.5 | 1.967 | 38.161 | 1.96 | 39.00 | 0.36 | -2.15 | ±5 | 2019/7/8 |
| 5250 | 22.8 | 4.603 | 36.809 | 4.71 | 35.95 | -2.27 | 2.39 | ±5 | 2019/7/10 |
| 5600 | 22.8 | 4.948 | 36.368 | 5.07 | 35.50 | -2.41 | 2.45 | ±5 | 2019/7/10 |
| 5750 | 22.8 | 5.110 | 36.167 | 5.22 | 35.35 | -2.11 | 2.31 | ±5 | 2019/7/10 |

## 9.3 System Performance Check Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

| Date | Frequency (MHz) | Input Power (mW) | Dipole S/N | Probe S/N | DAE S/N | Measured 1g SAR (W/kg) | Targeted 1g SAR (W/kg) | Normalized 1g SAR (W/kg) | Deviation (%) |
|---|---|---|---|---|---|---|---|---|---|
| 2019/7/6 | 750 | 250 | D750V3-1107 | ES3DV3 - SN3169 | DAE3 Sn495 | 2.11 | 8.32 | 8.44 | 1.44 |
| 2019/7/6 | 835 | 250 | D835V2-4d167 | ES3DV3 - SN3169 | DAE3 Sn495 | 2.24 | 9.50 | 8.96 | -5.68 |
| 2019/7/5 | 1750 | 250 | D1750V2-1112 | ES3DV3 - SN3169 | DAE3 Sn495 | 8.97 | 36.70 | 35.88 | -2.23 |
| 2019/7/5 | 1900 | 250 | D1900V2-5d041 | ES3DV3 - SN3169 | DAE3 Sn495 | 10.00 | 40.20 | 40 | -0.50 |
| 2019/7/9 | 2450 | 250 | D2450V2-736 | EX3DV4 - SN3931 | DAE4 Sn1326 | 13.60 | 52.70 | 54.4 | 3.23 |
| 2019/7/8 | 2600 | 250 | D2600V2-1078 | EX3DV4 - SN3931 | DAE4 Sn1326 | 14.50 | 57.60 | 58 | 0.69 |
| 2019/7/10 | 5250 | 100 | D5GHzV2-1006-5250 | EX3DV4 - SN3931 | DAE4 Sn1326 | 8.50 | 80.70 | 85 | 5.33 |
| 2019/7/10 | 5600 | 100 | D5GHzV2-1006-5600 | EX3DV4 - SN3931 | DAE4 Sn1326 | 8.54 | 83.30 | 85.4 | 2.52 |
| 2019/7/10 | 5750 | 100 | D5GHzV2-1006-5750 | EX3DV4 - SN3931 | DAE4 Sn1326 | 8.24 | 80.40 | 82.4 | 2.49 |

| Date | Frequency (MHz) | Input Power (mW) | Dipole S/N | Probe S/N | DAE S/N | Measured 10g SAR (W/kg) | Targeted 10g SAR (W/kg) | Normalized 10g SAR (W/kg) | Deviation (%) |
|---|---|---|---|---|---|---|---|---|---|
| 2019/7/10 | 5250 | 100 | D5GHzV2-1006-5250 | EX3DV4 - SN3931 | DAE4 Sn1326 | 2.44 | 23.20 | 24.4 | 5.17 |
| 2019/7/10 | 5600 | 100 | D5GHzV2-1006-5600 | EX3DV4 - SN3931 | DAE4 Sn1326 | 2.41 | 23.80 | 24.1 | 1.26 |

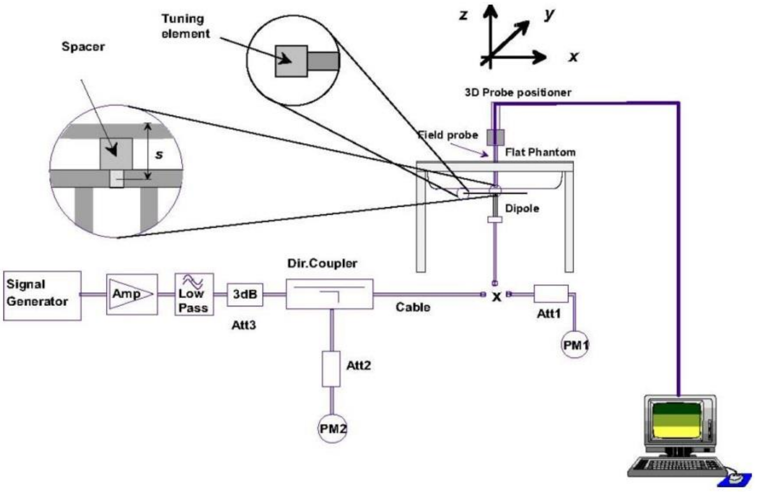
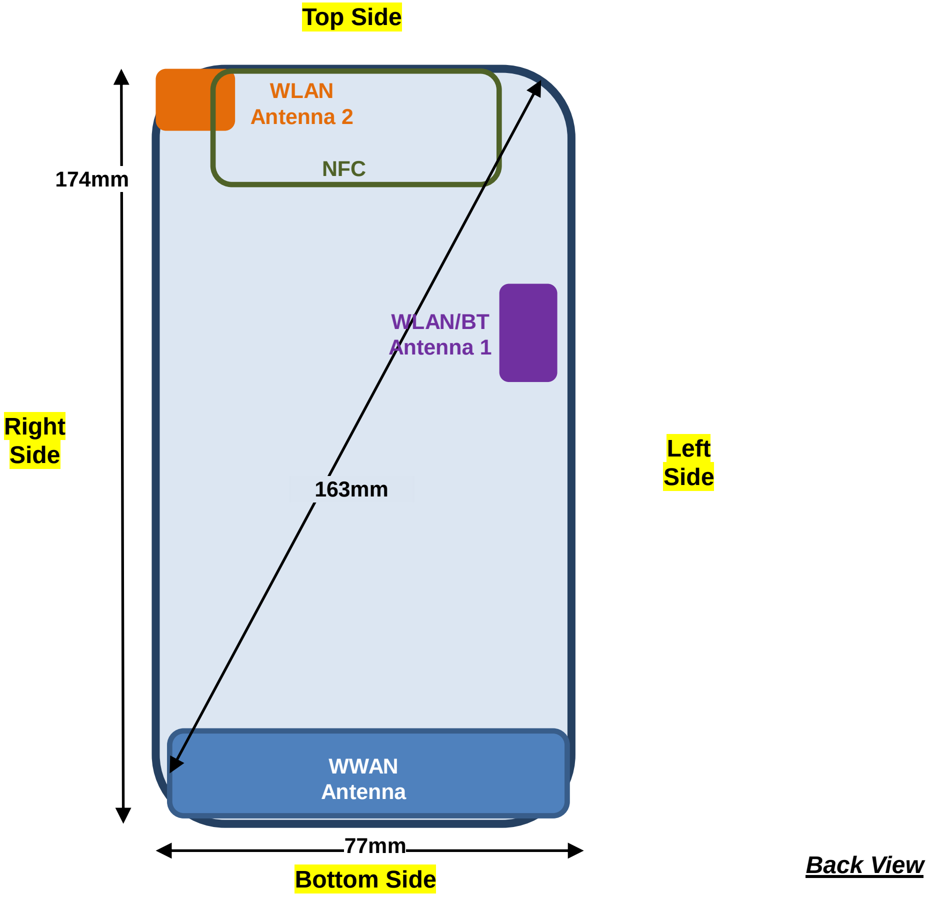


Fig 8.3.1 System Performance Check Setup

Fig 8.3.2 Setup Photo

# 10. Antenna Location

**<Mobile Phone>**



| Distance of the Antenna to the EUT surface/edge | | | | | | |
|---|---|---|---|---|---|---|
| Antennas | Back | Front | Top Side | Bottom Side | Right Side | Left Side |
| WWAN | ≤ 25mm | ≤ 25mm | >25mm | ≤ 25mm | ≤ 25mm | ≤ 25mm |
| WLAN/BT ANT1 | ≤ 25mm | ≤ 25mm | >25mm | >25mm | >25mm | ≤ 25mm |
| WLANT ANT2 | ≤ 25mm | ≤ 25mm | ≤ 25mm | >25mm | ≤ 25mm | >25mm |

| Positions for SAR tests; Hotspot mode | | | | | | |
|---|---|---|---|---|---|---|
| Antennas | Back | Front | Top Side | Bottom Side | Right Side | Left Side |
| WWAN | Yes | Yes | No | Yes | Yes | Yes |
| WLAN/BT ANT1 | Yes | Yes | No | No | No | Yes |
| WLANT ANT2 | Yes | Yes | Yes | No | Yes | No |

**General Note:**

1. Referring to KDB 941225 D06 v02r01, when the overall device length and width are ≥ 9cm*5cm, the test distance is 10 mm. SAR must be measured for all sides and surfaces with a transmitting antenna located within 25mm from that surface or edge

# 11. SAR Test Results

**General Note:**

1. Per KDB 447498 D01v06, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
    a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
    b. For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle)"
    c. For WWAN: Reported SAR(W/kg)= Measured SAR(W/kg)*Tune-up Scaling Factor
    d. For WLAN/Bluetooth: Reported SAR(W/kg)= Measured SAR(W/kg)* Duty Cycle scaling factor * Tune-up scaling factor
    e. For TDD LTE SAR measurement, the duty cycle 1:1.59 (62.9 %) was used perform testing and considering the theoretical duty cycle of 63.3% for extended cyclic prefix in the uplink, and the theoretical duty cycle of 62.9% for normal cyclic prefix in uplink, a scaling factor of extended cyclic prefix 63.3%/62.9% = 1.006 is applied to scale-up the measured SAR result. The Reported TDD LTE SAR = measured SAR (W/kg)* Tune-up Scaling Factor* scaling factor for extended cyclic prefix.
2. Per KDB 447498 D01v06, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the *reported* 1-g or 10-g SAR for the mid-band or highest output power channel is:
    - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
    - ≤ 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
    - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg.
4. Per KDB 648474 D04v01r03, when the reported SAR for a body-worn accessory measured without a headset connected to the handset is ≤ 1.2 W/kg, SAR testing with a headset connected to the handset is not required.
5. For 5.3GHz / 5.5GHz WLAN product specific SAR is necessary too, due to an overall diagonal dimension is > 16cm.

## 11.1 Head SAR

### <GSM SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | GSM850 | GPRS (1 Tx slots) | Right Cheek | 0mm | 251 | 848.8 | 33.53 | 34.00 | 0.19 | 0.161 | 0.179 |
| 02 | GSM1900 | GPRS (4 Tx slots) | Left Cheek | 0mm | 512 | 1850.2 | 24.11 | 25.00 | 0.14 | 0.163 | 0.200 |

### <WCDMA SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 03 | WCDMA II | RMC 12.2Kbps | Left Cheek | 0mm | 9262 | 1852.4 | 22.99 | 24.00 | 0.17 | 0.271 | 0.342 |
| 04 | WCDMA V | RMC 12.2Kbps | Right Cheek | 0mm | 4182 | 836.4 | 23.80 | 24.00 | 0.19 | 0.179 | 0.187 |

### <FDD LTE SAR>

| Plot No. | Band | BW (MHz) | Modulation | RB Size | RB offset | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05 | LTE Band 2 | 20M | QPSK | 1 | 99 | Left Cheek | 0mm | 18700 | 1860 | 22.50 | 23.50 | 0.12 | 0.270 | 0.340 |
| 06 | LTE Band 4 | 20M | QPSK | 1 | 49 | Left Cheek | 0mm | 20175 | 1732.5 | 22.42 | 23.50 | 0.18 | 0.111 | 0.142 |
| 07 | LTE Band 5 | 10M | QPSK | 1 | 25 | Right Cheek | 0mm | 20525 | 836.5 | 22.93 | 23.50 | 0.17 | 0.132 | 0.151 |
| 08 | LTE Band 7 | 20M | QPSK | 1 | 99 | Left Cheek | 0mm | 21100 | 2535 | 23.21 | 24.00 | -0.12 | 0.437 | 0.524 |
| 09 | LTE Band 17 | 10M | QPSK | 1 | 49 | Right Cheek | 0mm | 23790 | 710 | 22.98 | 24.00 | -0.01 | 0.054 | 0.068 |

### <TDD LTE SAR>

| Plot No. | Band | BW (MHz) | Modulation | RB Size | RB offset | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | LTE Band 41 | 20M | QPSK | 1 | 0 | Left Cheek | 0mm | 40340 | 2565 | 23.71 | 24.00 | 62.9 | 1.006 | 0.17 | 0.317 | 0.341 |

### <WLAN SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Antenna | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | WLAN2.4GHz | 802.11b 1Mbps | Right Cheek | 0mm | Ant 1 | 6 | 2437 | 16.60 | 17.00 | 99.02 | 1.010 | 0.12 | 0.039 | 0.043 |
| 11 | WLAN2.4GHz | 802.11b 1Mbps | Left Cheek | 0mm | Ant 2 | 6 | 2437 | 16.80 | 17.00 | 99.19 | 1.008 | -0.02 | 0.398 | 0.420 |
| | WLAN5GHz | 802.11n-HT40 MCS0 | Left Cheek | 0mm | Ant 1 | 62 | 5310 | 13.30 | 14.00 | 90.73 | 1.102 | -0.02 | 0.010 | 0.013 |
| 12 | WLAN5GHz | 802.11n-HT40 MCS0 | Right Tilted | 10mm | Ant 2 | 62 | 5310 | 13.30 | 14.00 | 89.11 | 1.122 | -0.02 | 0.045 | 0.059 |
| | WLAN5GHz | 802.11n-HT40 MCS0 | Left Cheek | 0mm | Ant 1 | 126 | 5630 | 13.70 | 14.00 | 90.73 | 1.102 | 0.1 | 0.033 | 0.039 |
| 13 | WLAN5GHz | 802.11n-HT40 MCS0 | Right Tilted | 0mm | Ant 2 | 110 | 5550 | 13.70 | 14.00 | 89.11 | 1.122 | -0.06 | 0.052 | 0.063 |
| | WLAN5GHz | 802.11n-HT40 MCS0 | Left Cheek | 0mm | Ant 1 | 151 | 5755 | 13.60 | 14.00 | 90.73 | 1.102 | 0.19 | 0.032 | 0.039 |
| 14 | WLAN5GHz | 802.11n-HT40 MCS0 | Right Tilted | 0mm | Ant 2 | 151 | 5755 | 13.60 | 14.00 | 89.11 | 1.122 | -0.02 | 0.053 | 0.065 |

### <Bluetooth SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Antenna | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | Bluetooth | 1Mbps | Right Cheek | 0mm | Ant 1 | 0 | 2402 | 11.15 | 11.50 | 77.13 | 1.297 | 0.18 | 0.009 | 0.013 |

## 11.2 Hotspot SAR

### <GSM SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | GSM850 | GPRS (1 Tx slots) | Back | 10mm | 251 | 848.8 | 33.53 | 34.00 | 0.04 | 0.382 | 0.426 |
| 17 | GSM1900 | GPRS (4 Tx slots) | Back | 10mm | 512 | 1850.2 | 24.11 | 25.00 | 0.01 | 0.501 | 0.615 |

### <WCDMA SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | WCDMA II | RMC 12.2Kbps | Back | 10mm | 9400 | 1880 | 22.98 | 24.00 | 0.01 | 0.877 | 1.109 |
| 19 | WCDMA V | RMC 12.2Kbps | Back | 10mm | 4182 | 836.4 | 23.80 | 24.00 | -0.01 | 0.388 | 0.406 |

### <FDD LTE SAR>

| Plot No. | Band | BW (MHz) | Modulation | RB Size | RB offset | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | LTE Band 2 | 20M | QPSK | 1 | 0 | Back | 10mm | 19100 | 1900 | 22.41 | 23.50 | 0 | 0.873 | 1.122 |
| 21 | LTE Band 4 | 20M | QPSK | 1 | 49 | Back | 10mm | 20175 | 1732.5 | 22.42 | 23.50 | 0.01 | 0.535 | 0.686 |
| 22 | LTE Band 5 | 10M | QPSK | 1 | 25 | Back | 10mm | 20525 | 836.5 | 22.93 | 23.50 | 0.01 | 0.313 | 0.357 |
| 23 | LTE Band 7 | 20M | QPSK | 1 | 99 | Left Side | 10mm | 21100 | 2535 | 23.21 | 24.00 | -0.07 | 0.595 | 0.714 |
| 24 | LTE Band 17 | 10M | QPSK | 1 | 49 | Back | 10mm | 23790 | 710 | 22.98 | 24.00 | -0.04 | 0.187 | 0.237 |

### <TDD LTE SAR>

| Plot No. | Band | BW (MHz) | Modulation | RB Size | RB offset | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | LTE Band 41 | 20M | QPSK | 1 | 0 | Back | 10mm | 41140 | 2645 | 23.33 | 24.00 | 62.9 | 1.006 | -0.01 | 0.373 | 0.438 |

### <WLAN SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Antenna | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | WLAN2.4GHz | 802.11b 1Mbps | Back | 10mm | Ant 1 | 6 | 2437 | 16.60 | 17.00 | 99.02 | 1.010 | 0.04 | 0.069 | 0.076 |
| 26 | WLAN2.4GHz | 802.11b 1Mbps | Back | 10mm | Ant 2 | 6 | 2437 | 16.80 | 17.00 | 99.19 | 1.008 | -0.06 | 0.204 | 0.215 |
|  | WLAN5GHz | 802.11n-HT40 MCS0 | Back | 10mm | Ant 1 | 46 | 5230 | 13.30 | 14.00 | 90.73 | 1.102 | 0.02 | 0.184 | 0.238 |
| 27 | WLAN5GHz | 802.11n-HT40 MCS0 | Back | 10mm | Ant 2 | 46 | 5230 | 13.70 | 14.00 | 89.11 | 1.122 | -0.17 | 0.312 | 0.375 |
|  | WLAN5GHz | 802.11n-HT40 MCS0 | Left Side | 10mm | Ant 1 | 151 | 5755 | 13.60 | 14.00 | 90.73 | 1.102 | 0.04 | 0.096 | 0.116 |
| 28 | WLAN5GHz | 802.11n-HT40 MCS0 | Back | 10mm | Ant 2 | 151 | 5755 | 13.60 | 14.00 | 89.11 | 1.122 | 0.04 | 0.316 | 0.389 |

### <Bluetooth SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Antenna | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | Bluetooth | 1Mbps | Back | 10mm | Ant 1 | 0 | 2402 | 11.15 | 11.50 | 77.13 | 1.080 | 0.17 | 0.017 | 0.020 |

## 11.3 Body Worn Accessory SAR

### <GSM SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | GSM850 | GPRS (1 Tx slots) | Back | 10mm | 251 | 848.8 | 33.53 | 34.00 | 0.04 | 0.382 | 0.426 |
| 31 | GSM1900 | GPRS (4 Tx slots) | Back | 10mm | 512 | 1850.2 | 24.11 | 25.00 | 0.01 | 0.501 | 0.615 |

### <WCDMA SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 32 | WCDMA II | RMC 12.2Kbps | Back | 10mm | 9400 | 1880 | 22.98 | 24.00 | 0.01 | 0.877 | 1.109 |
| 33 | WCDMA V | RMC 12.2Kbps | Back | 10mm | 4182 | 836.4 | 23.80 | 24.00 | -0.01 | 0.388 | 0.406 |

### <FDD LTE SAR>

| Plot No. | Band | BW (MHz) | Modulation | RB Size | RB offset | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | LTE Band 2 | 20M | QPSK | 1 | 0 | Back | 10mm | 19100 | 1900 | 22.41 | 23.50 | 0 | 0.873 | 1.122 |
| 35 | LTE Band 4 | 20M | QPSK | 1 | 49 | Back | 10mm | 20175 | 1732.5 | 22.42 | 23.50 | 0.01 | 0.535 | 0.686 |
| 36 | LTE Band 5 | 10M | QPSK | 1 | 25 | Back | 10mm | 20525 | 836.5 | 22.93 | 23.50 | 0.01 | 0.313 | 0.357 |
| 37 | LTE Band 7 | 20M | QPSK | 1 | 99 | Back | 10mm | 21350 | 2560 | 23.14 | 24.00 | 0.05 | 0.528 | 0.644 |
| 38 | LTE Band 17 | 10M | QPSK | 1 | 49 | Back | 10mm | 23790 | 710 | 22.98 | 24.00 | -0.04 | 0.187 | 0.237 |

### <TDD LTE SAR>

| Plot No. | Band | BW (MHz) | Modulation | RB Size | RB offset | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 39 | LTE Band 41 | 20M | QPSK | 1 | 0 | Back | 10mm | 41140 | 2645 | 23.33 | 24.00 | 62.9 | 1.006 | -0.01 | 0.373 | 0.438 |

### <WLAN SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Antenna | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | WLAN2.4GHz | 802.11b 1Mbps | Back | 10mm | Ant 1 | 6 | 2437 | 16.60 | 17.00 | 99.02 | 1.010 | 0.04 | 0.069 | 0.076 |
| 40 | WLAN2.4GHz | 802.11b 1Mbps | Back | 10mm | Ant 2 | 6 | 2437 | 16.80 | 17.00 | 99.19 | 1.008 | -0.06 | 0.204 | 0.215 |
|  | WLAN5GHz | 802.11n-HT40 MCS0 | Back | 10mm | Ant 1 | 62 | 5310 | 13.30 | 14.00 | 90.73 | 1.102 | 0.03 | 0.172 | 0.223 |
| 41 | WLAN5GHz | 802.11n-HT40 MCS0 | Back | 10mm | Ant 2 | 62 | 5310 | 13.30 | 14.00 | 89.11 | 1.122 | -0.07 | 0.328 | 0.432 |
|  | WLAN5GHz | 802.11n-HT40 MCS0 | Back | 10mm | Ant 1 | 126 | 5630 | 13.70 | 14.00 | 90.73 | 1.102 | 0.05 | 0.153 | 0.181 |
| 42 | WLAN5GHz | 802.11n-HT40 MCS0 | Back | 10mm | Ant 2 | 110 | 5550 | 13.70 | 14.00 | 89.11 | 1.122 | -0.18 | 0.248 | 0.298 |
|  | WLAN5GHz | 802.11n-HT40 MCS0 | Back | 10mm | Ant 1 | 151 | 5755 | 13.60 | 14.00 | 90.73 | 1.102 | 0.07 | 0.075 | 0.091 |
| 43 | WLAN5GHz | 802.11n-HT40 MCS0 | Back | 10mm | Ant 2 | 151 | 5755 | 13.60 | 14.00 | 89.11 | 1.122 | 0.04 | 0.316 | 0.389 |

### <Bluetooth SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Antenna | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44 | Bluetooth | 1Mbps | Back | 10mm | Ant 1 | 0 | 2402 | 11.15 | 11.50 | 77.13 | 1.080 | 0.17 | 0.017 | 0.020 |

## 11.4 Product Specific SAR

### <WLAN SAR>

| Plot No. | Band | Mode | Test Position | Gap (mm) | Antenna | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 10g SAR (W/kg) | Reported 10g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | WLAN5GHz | 802.11n-HT40 MCS0 | Left Side | 0mm | Ant 1 | 62 | 5310 | 13.30 | 14.00 | 90.73 | 1.102 | -0.08 | 0.156 | 0.202 |
|  | WLAN5GHz | 802.11n-HT40 MCS0 | Right Side | 0mm | Ant 2 | 62 | 5310 | 13.30 | 14.00 | 89.11 | 1.122 | -0.1 | 0.145 | 0.191 |
|  | WLAN5GHz | 802.11n-HT40 MCS0 | Back | 0mm | Ant 1 | 126 | 5630 | 13.70 | 14.00 | 90.73 | 1.102 | 0.16 | 0.070 | 0.083 |
| 46 | WLAN5GHz | 802.11n-HT40 MCS0 | Right Side | 0mm | Ant 2 | 110 | 5550 | 13.70 | 14.00 | 89.11 | 1.122 | -0.01 | 0.110 | 0.132 |

## 11.5 Repeated SAR Measurement

| No. | Band | Mode | Test Position | Gap (mm) | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Power Drift (dB) | Measured 1g SAR (W/kg) | Ratio | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1st | WCDMA II | RMC 12.2Kbps | Back | 10mm | 9400 | 1880 | 22.98 | 24.00 | 0.01 | 0.877 | - | 1.109 |
| 2nd | WCDMA II | RMC 12.2Kbps | Back | 10mm | 9400 | 1880 | 22.98 | 24.00 | 0.09 | 0.853 | 1.03 | 1.079 |

**General Note:**

1. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg.
2. Per KDB 865664 D01v01r04, if the ratio among the repeated measurement is ≤ 1.2 and the measured SAR <1.45W/kg, only one repeated measurement is required.
3. The ratio is the difference in percentage between original and repeated *measured SAR*.
4. All measurement SAR result is scaled-up to account for tune-up tolerance and is compliant.

**Test Engineer :** Carter Jhuang and Randy Lin

## 12. Uncertainty Assessment

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

## 13. References

[1] FCC 47 CFR Part 2 “Frequency Allocations and Radio Treaty Matters; General Rules and Regulations”

[2] ANSI/IEEE Std. C95.1-1992, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”, September 1992

[3] IEEE Std. 1528-2013, “IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”, Sep 2013

[4] SPEAG DASY System Handbook

[5] FCC KDB 248227 D01 v02r02, “SAR Guidance for IEEE 802.11 (WiFi) Transmitters”, Oct 2015.

[6] FCC KDB 447498 D01 v06, “Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies”, Oct 2015

[7] FCC KDB 648474 D04 v01r03, “SAR Evaluation Considerations for Wireless Handsets”, Oct 2015.

[8] FCC KDB 941225 D01 v03r01, “3G SAR MEAUREMENT PROCEDURES”, Oct 2015

[9] FCC KDB 941225 D05 v02r05, “SAR Evaluation Considerations for LTE Devices”, Dec 2015

[10] FCC KDB 941225 D06 v02r01, "SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities", Oct 2015.

[11] FCC KDB 865664 D01 v01r04, "SAR Measurement Requirements for 100 MHz to 6 GHz", Aug 2015.

[12] FCC KDB 865664 D02 v01r02, “RF Exposure Compliance Reporting and Documentation Considerations” Oct 2015.