# ANSI/IEEE Std. C95.1-1992

**in accordance with the requirements of**
**FCC Report and Order: ET Docket 93-62, and OET Bulletin 65 Supplement C**

# FCC TEST REPORT

**For**

**LTE Module**

**Trade Name: Getac**

**Model: LTE7750**

*Issued to*

**Getac Technology Corp.**
**4F, No.1, R&D 2nd Road, Hsin-Chu Science-Based Industrial Park,**
**Hsin-Chu Hsien, Taiwan, R.O.C.**

*Issued by*

**Compliance Certification Services Inc.**
**No. 11, Wugong 6th Rd., Wugu Industrial Park,**
**Taipei Hsien 248, Taiwan.**
**http://www.ccsrf.com**
**service@ccsrf.com.**
**Issued Date: October 11, 2012**

# Revision History

| Rev. | | Issue Date | | Revisions | Effect Page | Revised By |
|---|---|---|---|---|---|---|
| 00 | | October 11, 2012 | | Initial Issue | ALL | Anson Lu |
| 01 | | November 15, 2012 | | Revised Attachments item 2 and 8 | Page 38 | Anson Lu |

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# 1 Certificate of Compliance (SAR Evaluation)

**Applicant:** Getac Technology Corp.

**Equipment Under Test:** LTE Module

**Trade Name:** Getac

**Model Number:** LTE7750

**Date of Test:** September 22 ~ September 27, 2012

**Device Category:** PORTABLE DEVICES

**Exposure Category:** GENERAL POPULATION/UNCONTROLLED EXPOSURE

| APPLICABLE STANDARDS | |
|---|---|
| FCC | • FCC OET 65 Supplement C<br>• IEEE 1528 2003<br>• KDB 447498 D01 Mobile Portable RF Exposure V04 ,Published on Nov 16 2009<br>• KDB 941225 SAR for LTE Devices DR05-41164<br>• KDB 941225 D01 SAR test for 3G devices v02<br>• KDB 388624 Permit But Ask DR02 |

| TEST RESULTS |
|---|
| **Pass** |
| The device was tested by Compliance Certification Services Inc. in accordance with the measurement methods and procedures specified in OET Bulletin 65 Supplement C (Edition 01-01). The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties. |

*Approved by:*

Alex Wu
Section Manager
Compliance Certification Services Inc.

*Tested by:*

Anson Lu
Test Engineer
Compliance Certification Services Inc.

# 2 Equipment under test

| | |
|---|---|
| **Product** | LTE Module |
| **Trade Name** | Getac |
| **Model Number** | LTE7750 |
| **EUT Description** | N/A |
| **Received Date** | June 08, 2012 |
| **Frequency Range** | CDMA / 1xRTT / 1xEVDO Cellular: 824.7 ~ 848.31 MHz<br>CDMA / 1xRTT / 1xEVDO PCS: 1851.25 ~ 1908.75 MHz<br>LTE Band 13: 779.5~784.5 MHz |
| **Maximum Output Power (Average)** | 1xEVDO Cellular: 24.93dBm<br>1xEVDO PCS: 24.81dBm<br>LTE Band 13(RB = 1,Start = 0): 23.8dBm |
| **Maximum SAR (1g):** | 1xEVDO Cellular: 0.111 W/kg<br>1xEVDO PCS: 0.199 W/kg<br>LTE Band 13(Edge1): 0.055 W/kg |
| **Modulation Technique** | 1xEDO Rev.0, Rev.A: QPSK<br>LTE Band 13: QPSK, 16QAM |
| **Antenna Specification** | Antenna Type:<br>LTE Main / Aux Antenna: PIFA Antenna |
| **Rechargeable Li-polymer Battery–alternate** | Sample 1: BP-LC3100/32-01PI / 10.8V, 6100 mAh, 65Wh<br>Sample 2: BP-LC3070/32-01PI / 10.8V, 6140 mAh, 66Wh |

## Equipment under test (Continued)

<table>
<tr><td>Normal operation</td><td><ul><li>Laptop mode (Notebook)</li><li>Tablet with Multiple display orientations supporting both primary landscape and secondary landscape, Secondary portrait.</li></ul></td></tr>
<tr><td>Antenna to edges<br>Separation distance</td><td><table>
<tr><th></th><th>LTE Main</th><th>LTE Aux</th></tr>
<tr><td>Edge 1</td><td>26mm</td><td>33.85mm</td></tr>
<tr><td>Edge 3</td><td>106mm</td><td>104mm</td></tr>
<tr><td>Edge 2</td><td>3.2mm</td><td>262.4mm</td></tr>
<tr><td>Edge 4</td><td>262.5mm</td><td>4.98mm</td></tr>
<tr><td>Rear Side</td><td>45.33mm</td><td>45.05mm</td></tr>
</table></td></tr>
<tr><td>Simultaneous<br>Transmission</td><td><ul><li>WWAN Radio (LTE Band 13) cannot transmit simultaneously with Wi-Fi/BT Radio.</li><li>WWAN Radio (LTE Band 13) cannot transmit simultaneously with CDMA /1xEV-DO.</li></ul></td></tr>
</table>

**Note:**

1. The sample selected for test was prototype that approximated to production product and was provided by manufacturer.

## 2.1 KDB941225 D05 SAR for LTE Devices

As per 3GPP 36.101 v9.11.0 (2012-03), Release 9

<table>
<tr><th>Item</th><th>Description</th><th>Information</th></tr>
<tr><td>1</td><td>identify the operating frequency range of each LTE transmission band used by the device</td><td>Band 13: Tx:<br>5MHz Bandwidth: 779.5 – 784.5 MHz<br>10MHz Bandwidth: 782MHz</td></tr>
<tr><td>2</td><td>identify the channel bandwidths used in each frequency band; 1.4, 3, 5, 10, 15, 20 MHz etc</td><td>5 MHz, 10 MHz</td></tr>
<tr><td>3</td><td>identify the high, middle and low (H, M, L) channel numbers and frequencies in each LTE frequency band</td><td>
<table>
<tr><th rowspan="3">Band 13</th><th colspan="2">Channel Bandwidth</th></tr>
<tr><th>10 MHz</th><th>5 MHz</th></tr>
<tr><th>Ch. / Freq.(MHz)</th><th>Ch. / Freq.(MHz)</th></tr>
<tr><td>Low</td><td></td><td>23205 / 779.5</td></tr>
<tr><td>Middle</td><td>23230 / 782.0</td><td>23230 / 782.0</td></tr>
<tr><td>High</td><td></td><td>23255 / 784.5</td></tr>
</table>
</td></tr>
<tr><td>4</td><td>specify the UE category and uplink modulations used</td><td>UE Category: 3<br>Uplink Modulations: QPSK, 16QAM</td></tr>
<tr><td>5</td><td>descriptions of the LTE transmitter and antenna implementation; and also identify whether it is a standalone transmitter operating independently of other wireless transmitters in the device or sharing hardware components and/or antenna(s) with other transmitters etc</td><td>● The LTE Main antenna is applied to LTE, CDMA / 1xEV-DO both transmit and receive<br>● The LTE Aux antenna is applied to LTE, CDMA / 1xEV-DO that for receive only</td></tr>
<tr><td>6</td><td>identify the LTE voice/data requirements in each operating mode and exposure condition with respect to head and body test configurations, antenna locations, handset flip-cover or slide positions, antenna diversity conditions etc</td><td>Data only device.<br>Exposure Conditions:<br>● Body – Rear side, Edge 1, Edge 2, Edge 3, Edge 4 of DUT at separation distance of 0 cm from the flat phantom</td></tr>
<tr><td>7</td><td>identify if Maximum Power Reduction (MPR) is optional or mandatory, i.e. built-in by design: a) only mandatory MPR may be considered during SAR testing, when the maximum output power is permanently limited by the MPR implemented within the UE; and only for the applicable RB (resource block) configurations specified in LTE standards b) A-MPR (additional MPR) must be disabled</td><td>As per 3GPP 36.101 v9.11.0 (2012-03), Release 9<br>
Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 3
<table>
<tr><th rowspan="2">Modulation</th><th colspan="6">Channel bandwidth / Transmission bandwidth ($N_{RB}$)</th><th rowspan="2">MPR (dB)</th></tr>
<tr><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></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>
</table>
MPR is permanently built-in by design<br>A-MPR was disabled</td></tr>
</table>

## KDB941225 D05 SAR for LTE Devices (Continued)

<table>
<tr><th>Item</th><th>Description</th><th>Information</th></tr>
<tr><td>8</td><td>include the maximum average conducted output power measured on the required test channels for each channel bandwidth and UL modulation used in each frequency band:<br>a) 100% RB allocation<br>b) 1RB and also 50% allocation, offset to upper and lower edges of each required test channel and also to the middle of the channel</td><td>Appendix A (Table A-1)</td></tr>
<tr><td>9</td><td>identify all other U.S. wireless operating modes (3G, Wi-Fi, WiMax, Bluetooth etc), device/exposure configurations (head and body, antenna and handset flip-cover or slide positions, antenna diversity conditions etc.) and frequency bands used for these modes</td><td><table>
<tr><th>Band</th><th>Transmit Frequencies</th></tr>
<tr><td>Cellular</td><td>824.70 – 848.31 MHz</td></tr>
<tr><td>PCS</td><td>1851.25 – 1908.75 MHz</td></tr>
<tr><th>Mode</th><th>Uplink Modulations</th></tr>
<tr><td>EV-DO Rev.0/A</td><td>QPSK</td></tr>
</table>
Data only device.<br>Exposure Conditions:<br>Body – Rear side, Edge 1, Edge 2, Edge 3, Edge 4 of DUT at separation distance of 0 cm from the flat phantom.</td></tr>
<tr><td>10</td><td>include the maximum average conducted output power measured for the other wireless modes and frequency bands</td><td>Appendix B</td></tr>
<tr><td>11</td><td>identify the simultaneous transmission conditions for the voice and data configurations supported by all wireless modes, device configurations and frequency bands, for the head and body exposure conditions and device operating configurations (handset flip or cover positions, antenna diversity conditions etc.)</td><td>● Voice mode is not supported.<br>● WWAN Radio (LTE Band 13 cannot transmit simultaneously with CDMA/ 1xEV-DO).<br>● Without hotspot mode.</td></tr>
</table>

## KDB941225 D05 SAR for LTE Devices (Continued)

| Item | Description | Information |
|---|---|---|
| 12 | when power reduction is applied to certain wireless modes to satisfy SAR compliance for simultaneous transmission conditions, other equipment certification or operating requirements, include the maximum average conducted output power measured in each power reduction mode applicable to the simultaneous voice/data transmission configurations for such wireless configurations and frequency bands; and also include details of the power reduction implementation and measurement setup | Not application |
| 13 | include descriptions of the test equipment, test software, built-in test firmware etc. required to support testing the device when power reduction is applied to one or more transmitters/antennas for simultaneous voice/data transmission | Not application |
| 14 | when appropriate, include a SAR test plan proposal with respect to the above | Included in KDB 650041 |
| 15 | if applicable, include preliminary SAR test data and/or supporting information in laboratory testing inquiries to address specific issues and concerns or for requesting further test reduction considerations appropriate for the device; for example, simultaneous transmission configurations | Not application |

## 2.2 Description Of Antenna

The device has two cellular antennas located on the Edge 2 and Edge 4 of the device. The LTE Main Antenna is located on the Edge 2 of the device. The LTE Aux Antenna is located on the Edge 4 of the device.

The LTE Main Antenna is, by design, capable of LTE / CDMA transmission and reception, and the LTE Aux Antenna is only capable of LTE reception only.

| Ant. | Ant. Use | Ant. Type | Transmit/Receive | Tx Bands |
|---|---|---|---|---|
| 1 | LTE Main | PIFA | Transmit/Receive | 779.5 – 784.5 MHz<br>824.70 – 848.31 MHz<br>1851.25 – 1908.75 MHz |
| 2 | LTE Aux | PIFA | **Receive Only** | N/A |

## 2.3 Simultaneous Transmission Conditions

- The device is capable of transmitting simultaneously in certain allowed configurations.

# 3 Equipment List & Calibration Status

| Name of Equipment | Manufacturer | Type/Model | Serial Number | Calibration Cycle(days) | Calibration Due |
|---|---|---|---|---|---|
| S-Parameter Network Analyzer | Agilent | E8358A | US40260243 | 365 | 07/14/2013 |
| Electronic Probe kit | Hewlett Packard | 85070D | N/A | N/A | N/A |
| Amplifier | Mini-Circuit | ZVE-8G | 665500309 | N/A | N/A |
| Amplifier | Mini-Circuit | ZHL-1724HLN | D072602#2 | N/A | N/A |
| DC Power generator | ABM | 8301HD | N/A | N/A | N/A |
| Attenuator | Mini-Circuit | BW-S20W5 | N/A | N/A | N/A |
| Directional Coupler | Agilent | 778D | MY48220487 | N/A | N/A |
| Thermometer | Amarell | 4046 | 25060 | 3650 | 10/02/2014 |
| Signal Generator | Agilent | 83630B | 3844A01022 | 365 | 08/26/2013 |
| Spectrum  Analyzer | Agilent | E4446A | MY43360131 | 365 | 11/04/2012 |
| Power Meter | Anritsu | ML2495A | 1012009 | 365 | 03/27/2013 |
| Power Sensor | Anritsu | MA2411B | 0917072 | 365 | 03/08/2013 |
| Data Acquisition Electronics (DAE) | SPEAG | DAE4 | 558 | 365 | 07/18/2013 |
| Data Acquisition Electronics (DAE) | SPEAG | DAE4 | 877 | 365 | 03/15/2013 |
| Dosimetric E-Field Probe | SPEAG | EX3DV4 | 3554 | 365 | 09/28/2012 |
| Dosimetric E-Field Probe | SPEAG | EX3DV4 | 3665 | 365 | 04/26//2013 |
| 835 MHz System Validation Dipole | SPEAG | D835V2 | 4d015 | 365 | 03/13/2013 |
| 1900 MHz System Validation Dipole | SPEAG | D1900V2 | 5d056 | 365 | 02/21/2013 |
| Probe Alignment Unit | SPEAG | LB (V2) | 348 | N/A | N/A |
| Robot | Staubli | RX90B L | F02/5T69A1/A/01 | N/A | N/A |
| SAM Twin Phantom V4.0 | SPEAG | N/A | N/A | N/A | N/A |
| Devices Holder | SPEAG | N/A | N/A | N/A | N/A |
| Head/ Muscle 835 MHz | CCS | H/M 835A | N/A | N/A | N/A |
| Head/ Muscle 1900 MHz | CCS | H/M 1900A | N/A | N/A | N/A |

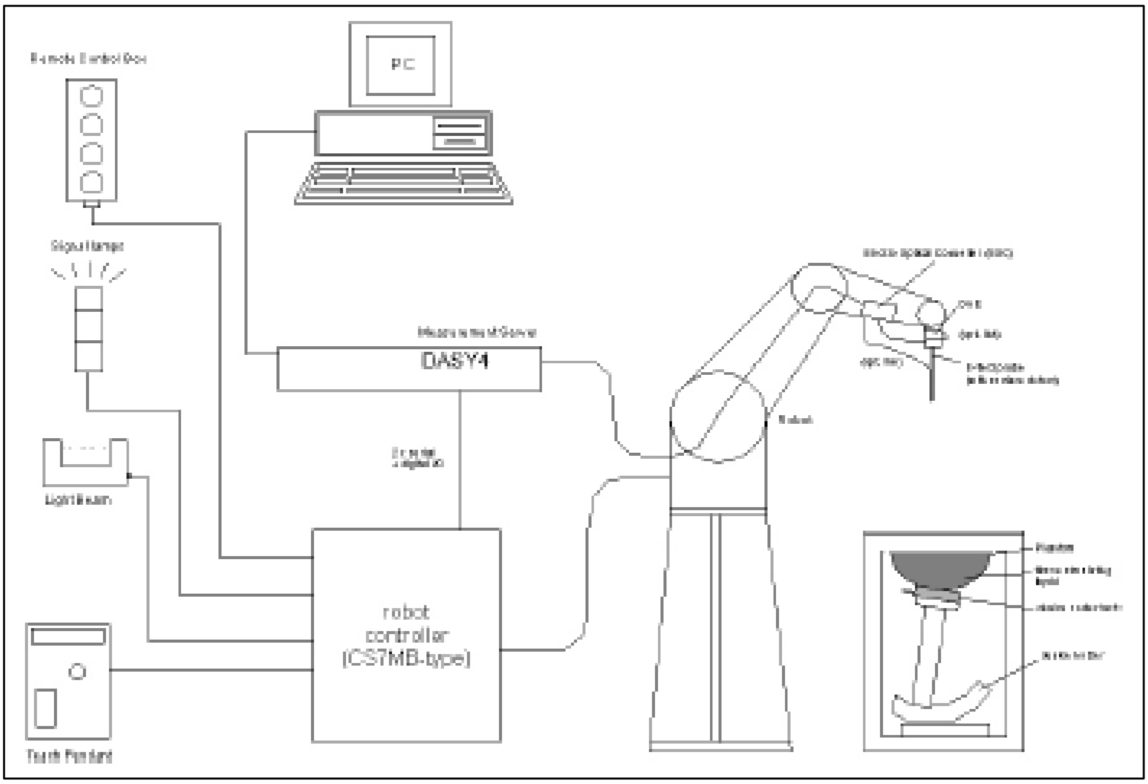
# 4 Requirements for Compliance Testing Defined By the FCC

The US Federal Communications Commission has released the report and order “Guidelines for Evaluating the Environmental Effects of RF Radiation", ET Docket No. 93-62 in August 1996 [1]. The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 mW/g for an uncontrolled environment and 8.0 mW/g for an occupational/controlled environment as recommended by the ANSI/IEEE standard C95.1-1992 [6]. According to the Supplement C of OET Bulletin 65 “Evaluating Compliance with FCC Guide-lines for Human Exposure to Radio frequency Electromagnetic Fields", released on Jun 29, 2001 by the FCC, the device should be evaluated at maximum output power (radiated from the antenna) under “worst-case” conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

# 5 Dosimetric Assessment System

These measurements were performed with the automated near-field scanning system DASY4/DASY5 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9 m) which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit. The SAR measurements were conducted with the dosimetric probe EX3DV4-SN: 3554 and EX3DV4-SN: 3665 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure with accuracy of better than ±10%. The spherical isotropy was evaluated with the procedure and found to be better than ±0.25 dB. The phantom used was the SAM Twin Phantom as described in FCC supplement C, IEEE 1528 2003

## 5.1 Measurement System Diagram



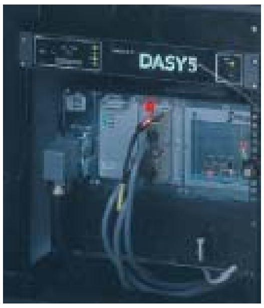

**The DASY4/DASY5 system for performing compliance tests consists of the following items:**

- A standard high precision 6-axis robot (St¨aubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- 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 between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected 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.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.
- DASY4/DASY5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing validating the proper functioning of the system

## 5.2 System Components

### DASY4/DASY5 Measurement Server


The DASY4/DASY5 measurement server is based on a PC/104 CPU board with a 166MHz low-power Pentium, 32MB chip disk and 64MB RAM. The necessary circuits for communication with either the DAE3 electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY4/DASY5 I/O-board, which is directly connected to the PC/104 bus of the CPU board.




The measurement server performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. The PC-operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with two expansion slots which are reserved for future applications. Please note that the expansion slots do not have a standardized pinout and therefore only the expansion cards provided by SPEAG can be inserted. Expansion cards from any other supplier could seriously damage the measurement server. Calibration: No calibration required.

### Data Acquisition Electronics (DAE)

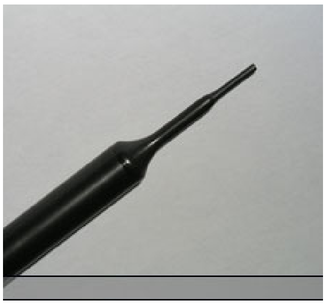
The data acquisition electronics (DAE3) consists of a highly sensitive electrometer grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock. The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE3 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.


### EX3DV4 Isotropic E-Field Probe for Dosimetric Measurements

| | |
|---|---|
| **Construction:** | Symmetrical design with triangular core Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |
| **Calibration:** | Basic Broad Band Calibration in air: 10-3000 MHz.<br>Conversion Factors (CF) for HSL 900 and HSL 1800<br>CF-Calibration for other liquids and frequencies upon request. |
| **Frequency:** | 10 MHz to > 6 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz) |
| **Directivity:** | ± 0.3 dB in HSL (rotation around probe axis)<br>± 0.5 dB in HSL (rotation normal to probe axis) |
| **Dynamic Range:** | 10 µW/g to > 100 mW/g; Linearity: ± 0.2 dB<br>(noise: typically < 1 µW/g) |

**Dimensions:** Overall length: 330 mm (Tip: 20 mm)
Tip diameter: 2.5 mm (Body: 12 mm)
Distance from probe tip to dipole centers: 1 mm

**Application:** High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.



Interior of probe

## SAM Phantom (V4.0)

**Construction:** The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-200X and IEC 62209. 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 manually teaching three points with the robot.

**Shell Thickness:** 2 ±0.2 mm

**Filling Volume:** Approx. 25 liters

**Dimensions:** Height: 810mm; Length: 1000mm; Width: 500mm

## SAM Phantom (ELI4)

**Description**

**Construction:** Phantom 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 the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 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 supported by software version DASY4/DASY5 and higher and is compatible with all SPEAG dosimetric probes and dipoles

**Shell Thickness:** 2.0 ± 0.2 mm (sagging: <1%)

**Filling Volume:** Approx. 25 liters

**Dimensions:** Major ellipse axis:600 mm

**Minor axis:** 400mm*500mm

## Device Holder for SAM Twin Phantom

**Construction:** In combination with the Twin SAM Phantom V4.0 or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, and flat phantom).

## System Validation Kits for SAM Phantom (V4.0)

**Construction:** Symmetrical dipole with l/4 balun Enables measurement of feed point impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

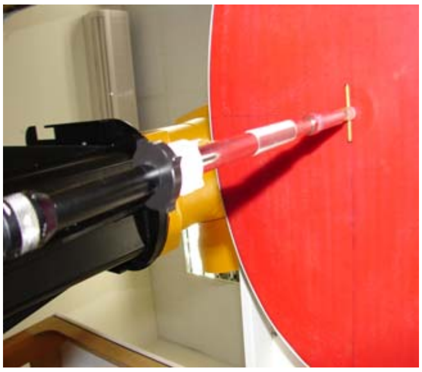
**Frequency:** 450, 900, 1800, 2450, 5800 MHz

**Return loss:** > 20 dB at specified validation position

**Power capability:** > 100 W (f < 1GHz); > 40 W (f > 1GHz)

**Dimensions:**
D450V2: dipole length: 270 mm; overall height: 330 mm
D835V2: dipole length: 161 mm; overall height: 340 mm
D900V2: dipole length: 148.5 mm; overall height: 340 mm
D1800V2: dipole length: 72.5 mm; overall height: 300 mm
D1900V2: dipole length: 67.7 mm; overall height: 300 mm
D1900V3: dipole length: 67.0 mm; overall height: 300 mm
D2450V2: dipole length: 51.5 mm; overall height: 290 mm
D5GHzV2: dipole length: 20.6 mm; overall height: 300 mm

## System Validation Kits for ELI4 phantom



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D1900V2: dipole length: 67.7 mm; overall height: 300 mm
D1900V3: dipole length: 67.0 mm; overall height: 300 mm
D2450V2: dipole length: 51.5 mm; overall height: 290 mm
D5GHzV2: dipole length: 20.6 mm; overall height: 300 mm

# 6 Evaluation Procedures

## DATA EVALUATION

The DASY4/DASY5 post processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

| | | |
|---|---|---|
| Probe parameters: | - Sensitivity | $Norm_i$, $a_{i0}$, $a_{i1}$, $a_{i2}$ |
| | - Conversion factor | $ConvF_i$ |
| | - Diode compression point | $dcp_i$ |
| Device parameters: | - Frequency | $f$ |
| | - Crest factor | $cf$ |
| Media parameters: | - Conductivity | $\sigma$ |
| | - Density | $\rho$ |

These parameters must be set correctly in the software. They can be found in the component documents or be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

| | | | |
|---|---|---|---|
| with $V_i$ | = Compensated signal of channel i | (i = x, y, z) |
| $U_i$ | = Input signal of channel i | (i = x, y, z) |
| $cf$ | = Crest factor of exciting field | (DASY parameter) |
| $dcp_i$ | = Diode compression point | (DASY parameter) |

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes: $$E_i = \sqrt{\frac{V_i}{Norm_i \bullet ConvF}}$$

H-field probes: $$H_i = \sqrt{Vi} \cdot \frac{a_{i10} + a_{i11} f + a_{i12} f^2}{f}$$

with $V_i$ = Compensated signal of channel i (i = x, y, z)

$Norm_i$ = Sensor sensitivity of channel i (i = x, y, z)

$\mu V/(V/m)^2$ for E0field Probes

$ConvF$ = Sensitivity enhancement in solution

$aij$ = Sensor sensitivity factors for H-field probes

$f$ = Carrier frequency (GHz)

$Ei$ = Electric field strength of channel i in V/m

$Hi$ = Magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with $SAR$ = local specific absorption rate in mW/g

$E_{tot}$ = total field strength in V/m

$\sigma$ = conductivity in [mho/m] or [Siemens/m]

$\rho$ = equivalent tissue density in g/cm$^3$

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

The power flow density is calculated assuming the excitation field as a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{3770} \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

with $P_{pwe}$ = Equivalent power density of a plane wave in mW/cm$^2$

$E_{tot}$ = total electric field strength in V/m

$H_{tot}$ = total magnetic field strength in A/m

## SAR MEASUREMENT PROCEDURES

The procedure for assessing the peak spatial-average SAR value consists of the following steps:

- **Power Reference Measurement**

  The reference and drift jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method.

- **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 locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing.

- **Zoom Scan**

  Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default zoom scan measures 7x7x9 points within a cube whose base faces are centered around the maximum found in a preceding area scan job within the same procedure. If the preceding Area Scan job indicates more then one maximum, the number of Zoom Scans has to be enlarged accordingly (The default number inserted is 1).

- **Power Drift measurement**

  The drift job measures the field at the same location as the most recent reference job within the same procedure, and with the same settings. The drift measurement gives the field difference in dB from the reading conducted within the last reference measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. In the properties of the Drift job, the user can specify a limit for the drift and have DASY4/DASY5 software stop the measurements if this limit is exceeded.

- **Z-Scan**

  The Z Scan job measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. A user can anchor the grid to the current probe location. As with any other grids, the local Z-axis of the anchor location establishes the Z-axis of the grid.

## SPATIAL PEAK SAR EVALUATION

The procedure for spatial peak SAR evaluation has been implemented according to the IEEE1528 standard. It can be conducted for 1 g and 10 g.

The DASY4/DASY5 system allows evaluations that combine measured data and robot positions, such as:

- Maximum search
- Extrapolation
- Boundary correction
- Peak search for averaged SAR

During a maximum search, global and local maximum searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard's method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

**Extrapolation**

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation.

Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Cube Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard's method for extrapolation. For a grid using 7x7x9 measurement points with 5mm resolution amounting to 441 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1 g and 10 g cubes.

**Boundary effect**

For measurements in the immediate vicinity of a phantom surface, the field coupling effects between the probe and the boundary influence the probe characteristics. Boundary effect errors of different dosimetric probe types have been analyzed by measurements and using a numerical probe model. As expected, both methods showed an enhanced sensitivity in the immediate vicinity of the boundary. The effect strongly depends on the probe dimensions and disappears with increasing distance from the boundary. The sensitivity can be approximately given as:

$$S \approx S_o + S_b exp(-\frac{z}{a}) cos(\pi \frac{z}{\lambda})$$

Since the decay of the boundary effect dominates for small probes ($a \ll \lambda$), the cos-term can be omitted. Factors *Sb* (parameter Alpha in the DASY4/DASY5 software) and *a* (parameter Delta in the DASY4/DASY5 software) are assessed during probe calibration and used for numerical compensation of the boundary effect. Several simulations and measurements have confirmed that the compensation is valid for different field and boundary configurations.

This simple compensation procedure can largely reduce the probe uncertainty near boundaries. It works well as long as:

- the boundary curvature is small
- the probe axis is angled less than 30_ to the boundary normal
- the distance between probe and boundary is larger than 25% of the probe diameter
- the probe is symmetric (all sensors have the same offset from the probe tip)

Since all of these requirements are fulfilled in a DASY4/DASY5 system, the correction of the probe boundary effect in the vicinity of the phantom surface is performed in a fully automated manner via the measurement data extraction during post processing.

# 7 Measurement Uncertainty

**DASY4:**

| Uncertainty Budget According to IEEE P1528 | | | | | | |
|---|---|---|---|---|---|---|
| **Error Description** | **Uncertainty Value ±%** | **Probability distribution** | **Divisor** | **$C_1$ 1g** | **Standard unc.(1g/10g) ±%** | **$V_1$ or $V_{eff}$** |
| **Measurement System** | | | | | | |
| Probe calibration | ±4.8 | normal | 1 | 1 | ±4.8 | ∞ |
| Axial isotropy of probe | ±4.6 | rectangular | √3 | $(1\text{-}Cp)^{1/2}$ | ±1.9 | ∞ |
| Sph. Isotropy of probe | ±9.7 | rectangular | √3 | $(Cp)^{1/2}$ | ±3.9 | ∞ |
| Probe linearity | ±4.5 | rectangular | √3 | 1 | ±2.7 | ∞ |
| Detection Limit | ±0.9 | rectangular | √3 | 1 | ±0.6 | ∞ |
| Boundary effects | ±8.5 | rectangular | √3 | 1 | ±4.8 | ∞ |
| Readoutelectronics | ±1.0 | normal | 1 | 1 | ±1.0 | ∞ |
| Response time | ±0.9 | rectangular | √3 | 1 | ±0.5 | ∞ |
| Integration time | ±1.2 | rectangular | √3 | 1 | ±0.8 | ∞ |
| Mech Constrains of robot | ±0.5 | rectangular | √3 | 1 | ±0.2 | ∞ |
| Probe positioning | ±2.7 | rectangular | √3 | 1 | ±1.7 | ∞ |
| Extrap. And integration | ±4.0 | rectangular | √3 | 1 | ±2.3 | ∞ |
| RF ambient conditiona | ±0.54 | rectangular | √3 | 1 | ±0.43 | ∞ |
| **Test Sample Related** | | | | | | |
| Device positioning | ±2.2 | normal | 1 | 1 | ±2.23 | 11 |
| Device holder uncertainty | ±5 | normal | 1 | 1 | ±5.0 | 7 |
| Power drift | ±5 | rectangular | √3 | 1 | ±2.9 | ∞ |
| **Phantom and Set up** | | | | | | |
| Phantom uncertainty | ±4 | rectangular | √3 | 1 | ±2.3 | ∞ |
| Liquid conductivity | ±5 | rectangular | √3 | 0.6 | ±1.7 | ∞ |
| Liquid conductivity | ±5 | rectangular | √3 | 0.6 | ±3.5/1.7 | ∞ |
| Liquid permittivity | ±5 | rectangular | √3 | 0.6 | ±1.7 | ∞ |
| Liquid permittivity | ±5 | rectangular | √3 | 0.6 | ±1.7 | ∞ |
| | | | | | | |
| **Combined Standard Uncertainty** | | | | | ±12.14/11.76 | |
| **Coverage Factor for 95%** | | kp=2 | | | | |
| **Expanded Standard Uncertainty** | | | | | ±24.29/23.51 | |

Notes:

1. Table: Worst-case uncertainty for DASY4/DASY5 assessed according to IEEE P1528.
2. The budget is valid for the frequency range 300 MHz to 6G Hz and represents a worst-case analysis.

**DSAY5:**

| Uncertainty Budget According to IEEE P1528 | | | | | | |
|---|---|---|---|---|---|---|
| **Error Description** | **Uncertainty Value ±%** | **Probability distribution** | **Divisor** | **$C_1$ 1g** | **Standard unc.(1g/10g) ±%** | **$V_1$ or $V_{eff}$** |
| **Measurement System** | | | | | | |
| Probe calibration | ±5.9 | normal | 1 | 1 | ±5.9 | ∞ |
| Axial isotropy of probe | ±4.7 | rectangular | √3 | $(1\text{-Cp})^{1/2}$ | ±1.9 | ∞ |
| Sph. Isotropy of probe | ±9.6 | rectangular | √3 | $(\text{Cp})^{1/2}$ | ±3.9 | ∞ |
| Probe linearity | ±4.7 | rectangular | √3 | 1 | ±2.7 | ∞ |
| Detection Limit | ±1.0 | rectangular | √3 | 1 | ±0.6 | ∞ |
| Boundary effects | ±1.0 | rectangular | √3 | 1 | ±0.6 | ∞ |
| Readoutelectronics | ±0.3 | normal | 1 | 1 | ±0.3 | ∞ |
| Response time | ±0.8 | rectangular | √3 | 1 | ±0.5 | ∞ |
| Integration time | ±2.6 | rectangular | √3 | 1 | ±1.5 | ∞ |
| Probe positioning | ±0.4 | rectangular | √3 | 1 | ±0.2 | ∞ |
| Extrap. And integration | ±4.0 | rectangular | √3 | 1 | ±2.3 | ∞ |
| RF ambient conditiona | ±3.0 | rectangular | √3 | 1 | ±1.7 | ∞ |
| RF ambient conditiona | ±3.0 | rectangular | √3 | 1 | ±1.7 | ∞ |
| **Test Sample Related** | | | | | | |
| Device positioning | ±2.9 | normal | 1 | 1 | ±2.9 | 145 |
| Device holder uncertainty | ±3.6 | normal | 1 | 1 | ±3.6 | 5 |
| Power drift | ±5.0 | rectangular | √3 | 1 | ±2.9 | ∞ |
| **Phantom and Set up** | | | | | | |
| Phantom uncertainty | ±4.0 | rectangular | √3 | 1 | ±2.3 | ∞ |
| Liquid conductivity | ±5.0 | rectangular | √3 | 0.6 | ±1.8/1.2 | ∞ |
| Liquid conductivity | ±1.5 | rectangular | √3 | 0.6 | ±0.6 | ∞ |
| Liquid permittivity | ±5.0 | rectangular | √3 | 0.6 | ±1.7/1.4 | ∞ |
| Liquid permittivity | ±1.0 | rectangular | √3 | 0.6 | ±0.4 | ∞ |
| | | | | | | |
| **Combined Standard Uncertainty** | | | | | ±10.375 | |
| **Coverage Factor for 95%** | | kp=2 | | | | |
| **Expanded Standard Uncertainty** | | | | | ±20.75 | |

Notes:

1. Table: Worst-case uncertainty for DASY5 assessed according to IEEE P1528.
2. The budget is valid for the frequency range 300 MHz to 6GHz and represents a worst-case analysis.

# 8 Exposure Limit

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

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|---|---|---|
| 0.4 | 8.0 | 2.0 |

(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: ***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.

**Population/Uncontrolled Environments:**

are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

**Occupational/Controlled Environments:**

are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

**NOTE**
**GENERAL POPULATION/UNCONTROLLED EXPOSURE**
**PARTIAL BODY LIMIT**
**1.6 W/kg**

# 9 RF Output Power Measurement

## 9.1 LTE Band 13

| Band | BW | Ch | Freq. (MHz) | Mode | UL RB Allocation | UL RB Start | Target MPR | Measure MPR | Conducted Power(dBm) |
|---|---|---|---|---|---|---|---|---|---|
| 13 | 10 | 23230 | 782 | QPSK | 25 | 12 | 1 | 0.90 | 22.90 |
| | | | | | 1 | 0 | 0 | 0.00 | 23.80 |
| | | | | | 1 | 25 | 0 | 0.30 | 23.50 |
| | | | | | 1 | 49 | 0 | 0.30 | 23.50 |
| | | | | | 50 | 0 | 1 | 1.00 | 22.80 |
| | | | | 16QAM | 1 | 0 | 1 | 0.90 | 22.90 |
| | | | | | 1 | 25 | 1 | 1.00 | 22.80 |
| | | | | | 1 | 49 | 1 | 0.90 | 22.90 |
| | | | | | 50 | 0 | 2 | 1.98 | 21.82 |
| 13 | 5 | 23205 | 779.5 | QPSK | 1 | 0 | 0 | 0.00 | 23.50 |
| | | | | | 1 | 12 | 0 | 0.10 | 23.40 |
| | | | | | 1 | 24 | 0 | 0.10 | 23.40 |
| | | | | 16QAM | 1 | 0 | 1 | 0.80 | 22.70 |
| | | | | | 1 | 12 | 1 | 0.89 | 22.61 |
| | | | | | 1 | 24 | 1 | 0.68 | 22.82 |
| | | 23230 | 782 | QPSK | 1 | 0 | 0 | 0.00 | 23.80 |
| | | | | | 1 | 12 | 0 | 0.30 | 23.50 |
| | | | | | 1 | 24 | 0 | 0.30 | 23.50 |
| | | | | 16QAM | 1 | 0 | 1 | 0.90 | 22.90 |
| | | | | | 1 | 12 | 1 | 1.00 | 22.80 |
| | | | | | 1 | 24 | 1 | 1.00 | 22.80 |
| | | 23255 | 784.5 | QPSK | 1 | 0 | 0 | 0.00 | 23.50 |
| | | | | | 1 | 12 | 0 | 0.00 | 23.50 |
| | | | | | 1 | 24 | 0 | 0.00 | 23.60 |
| | | | | 16QAM | 1 | 0 | 1 | 0.80 | 22.70 |
| | | | | | 1 | 12 | 1 | 0.80 | 22.70 |
| | | | | | 1 | 24 | 1 | 0.66 | 22.84 |

## 9.2 CDMA Cellular / PCS Band

| Mode | FWD (RC/TAP) | (REV SO/TAP) | Cellular Band | | | PCS Band | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1013 | 384 | 777 | 25 | 600 | 1175 |
| | | | 824.7 (MHz) | 836.52 (MHz) | 848.31 (MHz) | 1851.25 (MHz) | 1880 (MHz) | 1908.75 (MHz) |
| 1xRTT | RC1 | SO2 | 24.26 | 24.05 | 23.91 | 23.55 | 23.61 | 24.23 |
| | RC1 | SO55 | 24.31 | 24.10 | 23.94 | 23.60 | 23.59 | 24.26 |
| | RC2 | SO9 | 24.30 | 24.11 | 23.96 | 23.62 | 23.62 | 24.27 |
| | RC2 | SO55 | 24.35 | 24.13 | 23.99 | 23.63 | 23.65 | 24.27 |
| | RC3 | SO55 | 24.36 | 24.15 | 23.98 | 23.75 | 23.67 | 24.29 |
| | RC3 | SO32 | 24.39 | 24.15 | 23.99 | 23.79 | 23.66 | 24.30 |
| 1xEVDO (Rev.0) | FTAP/307 kbps | 9.6 kbps /RTAP | 24.80 | 24.58 | 24.46 | 24.10 | 23.80 | 24.50 |
| | | 19.2 kbps /RTAP | 24.83 | 24.61 | 24.48 | 24.30 | 23.83 | 24.66 |
| | | 38.4 kbps /RTAP | 24.88 | 24.64 | 24.50 | 24.42 | 23.91 | 24.70 |
| | | 76.8 kbps/RTAP | 24.90 | 24.67 | 24.55 | 24.50 | 24.00 | 24.73 |
| | | 153.6 kbps/RTAP | 24.93 | 24.70 | 24.60 | 24.60 | 24.15 | 24.81 |
| 1xEVDO (Rev.A) | EFTAP/307 kbps | RETAP=128 | 24.25 | 24.10 | 24.07 | 24.00 | 23.58 | 24.25 |
| | | RETAP=256 | 24.33 | 24.20 | 24.10 | 24.01 | 23.60 | 24.30 |
| | | RETAP=512 | 24.40 | 24.23 | 24.18 | 24.08 | 23.65 | 24.44 |
| | | RETAP=768 | 24.48 | 24.30 | 24.19 | 24.10 | 23.70 | 24.49 |
| | | RETAP=1024 | 24.50 | 24.35 | 24.21 | 24.18 | 23.80 | 24.51 |
| | | RETAP=1536 | 24.61 | 24.40 | 24.33 | 24.20 | 23.88 | 24.55 |
| | | RETAP=2048 | 24.65 | 24.45 | 24.35 | 24.22 | 23.90 | 24.60 |
| | | RETAP=3072 | 24.73 | 24.50 | 24.40 | 24.30 | 23.94 | 24.65 |
| | | RETAP=4096 | 24.81 | 24.60 | 24.45 | 24.50 | 24.00 | 24.72 |

# 10 Tissue Dielectric Properties

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectric parameters are within the tolerances of the specified target values

The relative permittivity and conductivity of the tissue material should be within ± 5% of the values given in the table below. 5% may not be easily achieved at certain frequencies. Under such circumstances, 10% tolerance may be used until more precise tissue recipes are available

### IEEE SCC-34/SC-2 P1528 2003Recommended Tissue Dielectric Parameters

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in IEEE 1528 2003

| Target Frequency (MHz) | Head | | Body | |
|---|---|---|---|---|
| | $\varepsilon_r$ | σ (S/m) | $\varepsilon_r$ | σ (S/m) |
| 150 | 52.3 | 0.76 | 61.9 | 0.80 |
| 300 | 45.3 | 0.87 | 58.2 | 0.92 |
| 450 | 43.5 | 0.87 | 56.7 | 0.94 |
| 835 | 41.5 | 0.90 | 55.2 | 0.97 |
| 900 | 41.5 | 0.97 | 55.0 | 1.05 |
| 915 | 41.5 | 0.98 | 55.0 | 1.06 |
| 1450 | 40.5 | 1.20 | 54.0 | 1.30 |
| 1610 | 40.3 | 1.29 | 53.8 | 1.40 |
| 1800-2000 | 40.0 | 1.40 | 53.3 | 1.52 |
| 2450 | 39.2 | 1.80 | 52.7 | 1.95 |
| 3000 | 38.5 | 2.40 | 52.0 | 2.73 |
| 5800 | 45.3 | 5.27 | 48.2 | 6.00 |

## 10.1 Typical Composition of Ingredients for Liquid Tissue Phantoms

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.

| Ingredients (% by weight) | Frequency (MHz) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 450 | | 835 | | 915 | | 1900 | | 2450 | |
| **Tissue Type** | **Head** | **Body** | **Head** | **Body** | **Head** | **Body** | **Head** | **Body** | **Head** | **Body** |
| **Water** | 38.56 | 51.16 | 41.45 | 52.4 | 41.05 | 56.0 | 54.9 | 40.4 | 62.7 | 73.2 |
| **Salt (NaCl)** | 3.95 | 1.49 | 1.45 | 1.4 | 1.35 | 0.76 | 0.18 | 0.5 | 0.5 | 0.04 |
| **Sugar** | 56.32 | 46.78 | 56.0 | 45.0 | 56.5 | 41.76 | 0.0 | 58.0 | 0.0 | 0.0 |
| **HEC** | 0.98 | 0.52 | 1.0 | 1.0 | 1.0 | 1.21 | 0.0 | 1.0 | 0.0 | 0.0 |
| **Bactericide** | 0.19 | 0.05 | 0.1 | 0.1 | 0.1 | 0.27 | 0.0 | 0.1 | 0.0 | 0.0 |
| **Triton X-100** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 36.8 | 0.0 |
| **DGBE** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 44.92 | 0.0 | 0.0 | 26.7 |
| **Dielectric Constant** | 43.42 | 58.0 | 42.54 | 56.1 | 42.0 | 56.8 | 39.9 | 54.0 | 39.8 | 52.5 |
| **Conductivity (S/m)** | 0.85 | 0.83 | 0.91 | 0.95 | 1.0 | 1.07 | 1.42 | 1.45 | 1.88 | 1.78 |

Salt: $99^{+}$% Pure Sodium Chloride Sugar: $98^{+}$% Pure Sucrose
Water: De-ionized, 16 $M\Omega^{+}$ resistivity HEC: Hydroxyethyl Cellulose
DGBE: $99^{+}$% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]
Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1, 1, 3, 3-tetramethylbutyl)phenyl]ether

## 10.2 Simulating Liquids Parameter Check Results

**Date:** September 22, 2012 **Ambient condition:** Temperature 24.2°C; Relative humidity: 52%

| Body Simulating Liquid | | | Parameters | Target | Measured | Deviation[%] | Limited[%] |
|---|---|---|---|---|---|---|---|
| f (MHz) | Temp. [°C] | Depth (cm) | | | | | |
| 750.00 | 23.20 | 15.00 | Permitivity: | 55.50 | 54.89 | -1.10 | ± 5 |
| | | | Conductivity: | 0.96 | 0.94 | -2.60 | ± 5 |
| 779.50 | 23.20 | 15.00 | Permitivity: | 55.39 | 54.63 | -1.38 | ± 5 |
| | | | Conductivity: | 0.96 | 0.97 | 0.42 | ± 5 |
| 782.00 | 23.20 | 15.00 | Permitivity: | 55.39 | 54.60 | -1.42 | ± 5 |
| | | | Conductivity: | 0.96 | 0.97 | 0.62 | ± 5 |
| 784.50 | 23.20 | 15.00 | Permitivity: | 55.38 | 54.58 | -1.45 | ± 5 |
| | | | Conductivity: | 0.96 | 0.97 | 0.93 | ± 5 |

**Date:** September 25, 2012 **Ambient condition:** Temperature 24.2°C; Relative humidity: 52%

| Body Simulating Liquid | | | Parameters | Target | Measured | Deviation[%] | Limited[%] |
|---|---|---|---|---|---|---|---|
| f (MHz) | Temp. [°C] | Depth (cm) | | | | | |
| 750.00 | 23.20 | 15.00 | Permitivity: | 55.50 | 54.89 | -1.10 | ± 5 |
| | | | Conductivity: | 0.96 | 0.94 | -2.60 | ± 5 |
| 779.50 | 23.20 | 15.00 | Permitivity: | 55.39 | 54.63 | -1.38 | ± 5 |
| | | | Conductivity: | 0.96 | 0.97 | 0.42 | ± 5 |
| 782.00 | 23.20 | 15.00 | Permitivity: | 55.39 | 54.60 | -1.42 | ± 5 |
| | | | Conductivity: | 0.96 | 0.97 | 0.62 | ± 5 |
| 784.50 | 23.20 | 15.00 | Permitivity: | 55.38 | 54.58 | -1.45 | ± 5 |
| | | | Conductivity: | 0.96 | 0.97 | 0.93 | ± 5 |

**Date:** September 27, 2012 **Ambient condition:** Temperature 24.2°C; Relative humidity: 52%

| Body Simulating Liquid | | | Parameters | Target | Measured | Deviation[%] | Limited[%] |
|---|---|---|---|---|---|---|---|
| f (MHz) | Temp. [°C] | Depth (cm) | | | | | |
| 824.20 | 23.20 | 15.00 | Permitivity: | 55.24 | 55.34 | 0.18 | ± 5 |
| | | | Conductivity: | 0.97 | 0.97 | 0.25 | ± 5 |
| 835.00 | 23.20 | 15.00 | Permitivity: | 55.20 | 55.28 | 0.14 | ± 5 |
| | | | Conductivity: | 0.97 | 0.98 | 1.24 | ± 5 |
| 836.00 | 23.20 | 15.00 | Permitivity: | 55.20 | 55.27 | 0.14 | ± 5 |
| | | | Conductivity: | 0.97 | 0.98 | 1.12 | ± 5 |
| 848.80 | 23.20 | 15.00 | Permitivity: | 55.16 | 54.99 | -0.30 | ± 5 |
| | | | Conductivity: | 0.99 | 1.00 | 1.72 | ± 5 |

**Date:** September 27, 2012 **Ambient condition:** Temperature 24.2°C; Relative humidity: 52%

| Body Simulating Liquid | | | Parameters | Target | Measured | Deviation[%] | Limited[%] |
|---|---|---|---|---|---|---|---|
| f (MHz) | Temp. [°C] | Depth (cm) | | | | | |
| 1852.00 | 23.20 | 15.00 | Permitivity: | 53.30 | 53.31 | 0.02 | ± 5 |
| | | | Conductivity: | 1.52 | 1.52 | 0.00 | ± 5 |
| 1880.00 | 23.20 | 15.00 | Permitivity: | 53.30 | 53.25 | -0.09 | ± 5 |
| | | | Conductivity: | 1.52 | 1.55 | 1.97 | ± 5 |
| 1900.00 | 23.20 | 15.00 | Permitivity: | 53.30 | 53.19 | -0.21 | ± 5 |
| | | | Conductivity: | 1.52 | 1.56 | 2.63 | ± 5 |
| 1907.60 | 23.20 | 15.00 | Permitivity: | 53.30 | 53.17 | -0.24 | ± 5 |
| | | | Conductivity: | 1.52 | 1.57 | 3.29 | ± 5 |

# 11 System Performance Check

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications. The system performance check results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

## 11.1 System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the SAM twin phantom filled with Body simulating liquid of the following parameters.
- The DASY4/DASY5 system with an E-field probe EX3DV4 SN:3554 was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15 mm (below 1 GHz) and 10 mm (above 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 10mm was aligned with the dipole.
- Special 7x7x7 fine cube was chosen for cube integration (dx= 5 mm, dy= 5 mm, dz= 5 mm).
- Distance between probe sensors and phantom surface was set to 2.5 mm.
- The dipole input power (forward power) depends on certification calibration report.
- The results are normalized to 1 W input power.

### System Performance Check Results

**Dipole:** D750V3 SN: 1020
**Date:** September 22, 2012 **Ambient condition:** Temperature 24.2°C; Relative humidity: 52%

| Body Simulating Liquid | | | Parameters | Target | Measured | Deviation[%] | Limited[%] |
|---|---|---|---|---|---|---|---|
| f(MHz) | Temp. [°C] | Depth [cm] | | | | | |
| 750.00 | 23.20 | 15.00 | Permitivity: | 55.50 | 54.89 | -1.10 | ± 5 |
| | | | Conductivity: | 0.96 | 0.94 | -2.60 | ± 5 |
| | | | 1g SAR: | 8.76 | 8.60 | -1.83 | ± 10 |

**Dipole:** D750V3 SN: 1020
**Date:** September 25, 2012 **Ambient condition:** Temperature 24.2°C; Relative humidity: 52%

| Body Simulating Liquid | | | Parameters | Target | Measured | Deviation[%] | Limited[%] |
|---|---|---|---|---|---|---|---|
| f(MHz) | Temp. [°C] | Depth [cm] | | | | | |
| 750.00 | 23.20 | 15.00 | Permitivity: | 55.50 | 54.89 | -1.10 | ± 5 |
| | | | Conductivity: | 0.96 | 0.94 | -2.60 | ± 5 |
| | | | 1g SAR: | 8.76 | 8.44 | -3.65 | ± 10 |

**Dipole:** D835V2 SN: 4d015
**Date:** September 27, 2012 **Ambient condition:** Temperature 24.2°C; Relative humidity: 52%

| Body Simulating Liquid | | | Parameters | Target | Measured | Deviation[%] | Limited[%] |
|---|---|---|---|---|---|---|---|
| f(MHz) | Temp. [°C] | Depth [cm] | | | | | |
| 835.00 | 23.20 | 15.00 | Permitivity: | 55.20 | 55.28 | 0.14 | ± 5 |
| | | | Conductivity: | 0.97 | 0.98 | 1.24 | ± 5 |
| | | | 1g SAR: | 9.53 | 9.20 | -3.46 | ± 10 |

**Dipole:** D1900V2 SN: 5d056
**Date:** September 27, 2012 **Ambient condition:** Temperature 24.2°C; Relative humidity: 52%

| Body Simulating Liquid | | | Parameters | Target | Measured | Deviation[%] | Limited[%] |
|---|---|---|---|---|---|---|---|
| f(MHz) | Temp. [°C] | Depth [cm] | | | | | |
| 1900.00 | 23.20 | 15.00 | Permitivity: | 53.30 | 53.19 | -0.21 | ± 5 |
| | | | Conductivity: | 1.52 | 1.56 | 2.63 | ± 5 |
| | | | 1g SAR: | 39.04 | 40.00 | 2.46 | ± 10 |

# 12 SAR MEASUREMENTS RESULTS

## 12.1 LTE Band 13 (V100)

| EUT Position | Mode | BW | Frequency | | RB Size | RB Offset | Target MPR | MPR | Avg Pwr (dBm) | **SAR** (1g) (W/kg) | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Channel | MHz | | | | | | | |
| Edge 1 | QPSK | 10M | 23230 | 782 | 25 | 12 | 1 | 0.90 | 22.90 | 0.046 | 2 |
| | QPSK | | 23230 | 782 | 1 | 0 | 0 | 0.00 | 23.80 | 0.055 | 2 |
| | QPSK | | 23230 | 782 | 1 | 25 | 0 | 0.30 | 23.50 | 0.059 | 2 |
| | QPSK | | 23230 | 782 | 1 | 49 | 0 | 0.30 | 23.50 | 0.062 | 2 |
| | QPSK | | 23230 | 782 | 50 | 0 | 1 | 1.00 | 22.80 | 0.045 | 2 |
| | 16QAM | | 23230 | 782 | 1 | 0 | 1 | 0.90 | 22.90 | 0.045 | 2 |
| | 16QAM | | 23230 | 782 | 1 | 25 | 1 | 1.00 | 22.80 | 0.048 | 2 |
| | 16QAM | | 23230 | 782 | 1 | 49 | 1 | 0.90 | 22.90 | 0.051 | 2 |
| | 16QAM | | 23230 | 782 | 50 | 0 | 2 | 1.98 | 21.82 | 0.036 | 2 |
| | QPSK | 5M | 23205 | 779.5 | 1 | 0 | 0 | 0.00 | 23.50 | 0.060 | 2 |
| | QPSK | | 23205 | 779.5 | 1 | 12 | 0 | 0.10 | 23.40 | 0.055 | 2 |
| | QPSK | | 23205 | 779.5 | 1 | 24 | 0 | 0.10 | 23.40 | 0.061 | 2 |
| | 16QAM | | 23205 | 779.5 | 1 | 0 | 1 | 0.80 | 22.70 | 0.050 | 2 |
| | 16QAM | | 23205 | 779.5 | 1 | 12 | 1 | 0.89 | 22.61 | 0.052 | 2 |
| | 16QAM | | 23205 | 779.5 | 1 | 24 | 1 | 0.68 | 22.82 | 0.047 | 2 |
| | QPSK | | 23230 | 782 | 1 | 0 | 0 | 0.00 | 23.80 | 0.052 | 2 |
| | QPSK | | 23230 | 782 | 1 | 12 | 0 | 0.30 | 23.50 | 0.058 | 2 |
| | QPSK | | 23230 | 782 | 1 | 24 | 0 | 0.30 | 23.50 | 0.061 | 2 |
| | 16QAM | | 23230 | 782 | 1 | 0 | 1 | 0.90 | 22.90 | 0.058 | 2 |
| | 16QAM | | 23230 | 782 | 1 | 12 | 1 | 1.00 | 22.80 | 0.052 | 2 |
| | 16QAM | | 23230 | 782 | 1 | 24 | 1 | 1.00 | 22.80 | 0.057 | 2 |
| | QPSK | | 23255 | 784.5 | 1 | 0 | 0 | 0.00 | 23.50 | 0.061 | 2 |
| | QPSK | | 23255 | 784.5 | 1 | 12 | 0 | 0.00 | 23.50 | 0.065 | 2 |
| | QPSK | | 23255 | 784.5 | 1 | 24 | 0 | 0.00 | 23.60 | 0.064 | 2 |
| | 16QAM | | 23255 | 784.5 | 1 | 0 | 1 | 0.80 | 22.70 | 0.052 | 2 |
| | 16QAM | | 23255 | 784.5 | 1 | 12 | 1 | 0.80 | 22.70 | 0.053 | 2 |
| | 16QAM | | 23255 | 784.5 | 1 | 24 | 1 | 0.66 | 22.84 | 0.056 | 2 |

**Note(s):**
1. Please refer to attachment for the result presentation in plot format.
2. Using Battery Sample 2 testing.

## 12.2 LTE Band 13 (V200)

| EUT Position | Mode | BW | Frequency | | RB Size | RB Offset | Target MPR | MPR | Avg Pwr (dBm) | **SAR** (1g) (W/kg) | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Channel | MHz | | | | | | | |
| Edge 1 | QPSK | 10M | 23230 | 782 | 25 | 12 | 1 | 0.90 | 22.90 | 0.022 | |
| | QPSK | | 23230 | 782 | 1 | 0 | 0 | 0.00 | 23.80 | 0.029 | |
| | QPSK | | 23230 | 782 | 1 | 25 | 0 | 0.30 | 23.50 | 0.025 | |
| | QPSK | | 23230 | 782 | 1 | 49 | 0 | 0.30 | 23.50 | 0.031 | |
| | QPSK | | 23230 | 782 | 50 | 0 | 1 | 1.00 | 22.80 | 0.025 | |
| | 16QAM | | 23230 | 782 | 1 | 0 | 1 | 0.90 | 22.90 | 0.026 | |
| | 16QAM | | 23230 | 782 | 1 | 25 | 1 | 1.00 | 22.80 | 0.026 | |
| | 16QAM | | 23230 | 782 | 1 | 49 | 1 | 0.90 | 22.90 | 0.025 | |
| | 16QAM | | 23230 | 782 | 50 | 0 | 2 | 1.98 | 21.82 | 0.020 | |
| | QPSK | 5M | 23205 | 779.5 | 1 | 0 | 0 | 0.00 | 23.50 | 0.032 | |
| | QPSK | | 23205 | 779.5 | 1 | 12 | 0 | 0.10 | 23.40 | 0.031 | |
| | QPSK | | 23205 | 779.5 | 1 | 24 | 0 | 0.10 | 23.40 | 0.027 | |
| | 16QAM | | 23205 | 779.5 | 1 | 0 | 1 | 0.80 | 22.70 | 0.024 | |
| | 16QAM | | 23205 | 779.5 | 1 | 12 | 1 | 0.89 | 22.61 | 0.024 | |
| | 16QAM | | 23205 | 779.5 | 1 | 24 | 1 | 0.68 | 22.82 | 0.024 | |
| | QPSK | | 23230 | 782 | 1 | 0 | 0 | 0.00 | 23.80 | 0.035 | |
| | QPSK | | 23230 | 782 | 1 | 12 | 0 | 0.30 | 23.50 | 0.028 | |
| | QPSK | | 23230 | 782 | 1 | 24 | 0 | 0.30 | 23.50 | 0.029 | |
| | 16QAM | | 23230 | 782 | 1 | 0 | 1 | 0.90 | 22.90 | 0.033 | |
| | 16QAM | | 23230 | 782 | 1 | 12 | 1 | 1.00 | 22.80 | 0.031 | |
| | 16QAM | | 23230 | 782 | 1 | 24 | 1 | 1.00 | 22.80 | 0.029 | |
| | QPSK | | 23255 | 784.5 | 1 | 0 | 0 | 0.00 | 23.50 | 0.036 | |
| | QPSK | | 23255 | 784.5 | 1 | 12 | 0 | 0.00 | 23.50 | 0.031 | |
| | QPSK | | 23255 | 784.5 | 1 | 24 | 0 | 0.00 | 23.60 | 0.033 | |
| | 16QAM | | 23255 | 784.5 | 1 | 0 | 1 | 0.80 | 22.70 | 0.026 | |
| | 16QAM | | 23255 | 784.5 | 1 | 12 | 1 | 0.80 | 22.70 | 0.026 | |
| | 16QAM | | 23255 | 784.5 | 1 | 24 | 1 | 0.66 | 22.84 | 0.030 | |

**Note(s):**

3. Please refer to attachment for the result presentation in plot format.

## 12.3 EVDO Rev.0 (V100)

### Cellular Band

| EUT Position | Antenna | Frequency | | Conducted Power (dBm) | **SAR** (1g) (W/kg) | Note |
|---|---|---|---|---|---|---|
| | | Channel | MHz | | | |
| Edge 1 | Chain 0 | 1013 | 824.7 | 24.93 | 0.111 | 2 |

**Note(s):**
(1) Please refer to attachment for the result presentation in plot format.

### PCS Band

| EUT Position | Antenna | Frequency | | Conducted Power (dBm) | **SAR** (1g) (W/kg) | Note |
|---|---|---|---|---|---|---|
| | | Channel | MHz | | | |
| Edge 1 | Chain 0 | 1175 | 1908.75 | 24.81 | 0.199 | 2 |

**Note(s):**
1. Please refer to attachment for the result presentation in plot format
2. Using Battery Sample 2 testing.

## 12.4 EVDO Rev.0 (V200)

### Cellular Band

| EUT Position | Antenna | Frequency | | Conducted Power (dBm) | **SAR** (1g) (W/kg) | Note |
|---|---|---|---|---|---|---|
| | | Channel | MHz | | | |
| Edge 1 | Chain 0 | 1013 | 824.7 | 24.93 | 0.080 | |

**Note(s):**
(1) Please refer to attachment for the result presentation in plot format.

### PCS Band

| EUT Position | Antenna | Frequency | | Conducted Power (dBm) | **SAR** (1g) (W/kg) | Note |
|---|---|---|---|---|---|---|
| | | Channel | MHz | | | |
| Edge 1 | Chain 0 | 1175 | 1908.75 | 24.81 | 0.269 | |

**Note(s):**
3. Please refer to attachment for the result presentation in plot format.

# 13 Simultaneous Transmission SAR Analysis

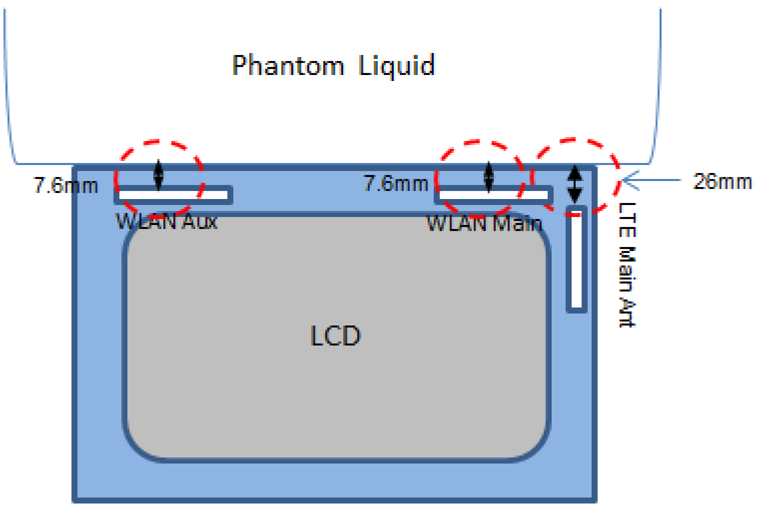
1. The device is capable of transmitting simultaneously in certain allowed configurations.
2. The LTE Band 13 cannot transmit simultaneously with Wi-Fi antenna
3. The CDMA/ 1xEV-DO cannot transmit simultaneously with Wi-Fi antenna
4. The WLAN can transmit simultaneously with Bluetooth

As Bluetooth's max average power is 2.49 mW [<60/f(GHz) mW] standalone SAR is not required. Therefore, Bluetooth simultaneous transmission SAR evaluation with WiFi 2.4 GHz band and WiFi 5 GHz bands is not required.

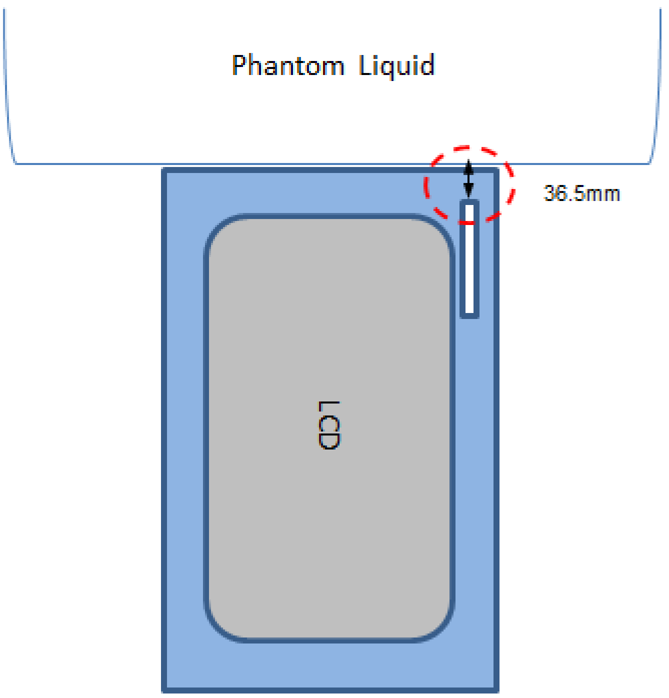
# 14 Setup Diagram

This DUT was tested in three different positions. They are rear side of tablet, Edge 4 and Edge 2. In these positions, the surface of DUT is touching with phantom 0cm air gap. Please refer to Attachment (T120605S04-SF PHOTOs) for the test setup photos.

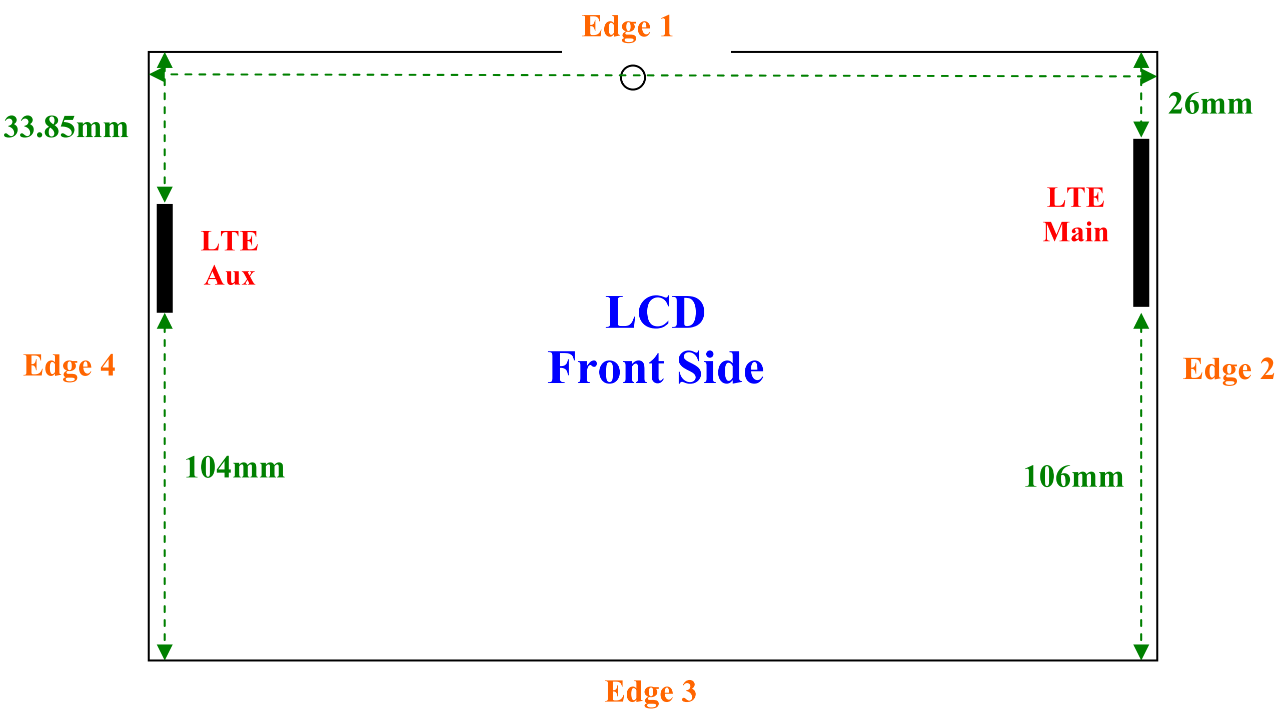
**Edge 1:**




**Edge 4**



# 15 Antenna Location and Separation Distance




Antenna Location and Antenna-to-Antenna and Antenna-to-Edge (User) distance is below:

| | LTE Main | LTE Aux |
|---|---|---|
| Edge 1 | 26mm | 33.85mm |
| Edge 2 | 3.2mm | 262.4mm |
| Edge 3 | 106mm | 104mm |
| Edge 4 | 262.5mm | 4.98mm |
| Front Side | 26mm | 33.85mm |
| Rear Side | 45.33mm | 45.05mm |
| | LTE Aux | LTE Main |
| LTE Aux | | 262.87mm |
| LTE Main | 262.87mm | |
| Wi-Fi Aux | 46.94mm | 181.57mm |
| Wi-Fi Main | 182.30mm | 43.56mm |

**LTE Antenna**

1. The separation distance from LTE Main Antenna to Edge 1 is 26 mm less than 50mm, Therefore LTE Main Antenna for Edge 1 SAR is required; The Edge 1 most conservative, therefore the other Edge can be exempted.
2. The LTE Aux Antenna is only for receiving only. Therefore SAR is not required.

## 16 Facilities

All measurement facilities used to collect the measurement data are located at

☐ No.81-1, Lane 210, Bade 2nd Rd., Lujhu Township, Taoyuan County 33841, TAIWAN, R.O.C.

☒ No.11, Wu-Gong 6th Rd., Wugu Industrial Park, New Taipei City 248, Taiwan (R.O.C.)

☐ No. 199, Chunghsen Road, Hsintien City, Taipei Hsien, Taiwan, R.O.C.

## 17 References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# 18 Attachments

| Exhibit | Content |
|---|---|
| 1 | System Performance Check Plots_MAU050 |
| 2 | SAR TestPlots_MAU050 1105 revised |
| 3 | SAR_Probe_EX3DV4_sn3554_20110929c |
| 4 | SAR_Probe_EX3DV4_sn3665_20120427c |
| 5 | SAR_Dipole_D835V2_sn4d015_20120314s |
| 6 | SAR_Dipole_D1900v2_sn5d056_20120222c |
| 7 | T121008S01-SF PHOTOs 1105 revised |
| 8 | Thermometer |

**END OF REPORT**