# FCC SAR Test Report

## FCC ID: 2AAGE-B48

| | | |
|---|---|---|
| **Project No.** | : | 2201H017 |
| **Equipment** | : | LTE Module |
| **Brand Name** | : | Vantron |
| **Test Model** | : | VT-MOD-CELL-B48 |
| **Series Model** | : | N/A |
| **Date of Receipt** | : | Feb. 14, 2022 |
| **Date of Test** | : | Mar. 09, 2022 ~ Apr. 14, 2022 |
| **Issued Date** | : | Apr. 19, 2022 |
| **Report Version** | : | R02 |
| **Test Sample** | : | Engineering Sample No.: SH2022012417. |
| **Standard(s)** | : | Please refer to page 2. |
| **Applicant** | : | Chengdu Vantron Technology Co., Ltd. |
| **Address** | : | No.5 GaoPeng Road, Hi-Tech Zone, Chengdu, SiChuan, P.R. China 610045 |
| **Manufacturer** | : | Chengdu Vantron Technology Co., Ltd. |
| **Address** | : | No.5 GaoPeng Road, Hi-Tech Zone, Chengdu, SiChuan, P.R. China 610045 |

The above equipment has been tested and found compliance with the requirement of the relative standards by BTL Inc.

**Prepared by :** Seven Lu

**Approved by :** Herbort Liu

TESTING CERT #5123.02

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| | | |
|---|---|---|
| **Standard(s)** | : | **FCC 47CFR §2.1093** Radio frequency Radiation Exposure Evaluation: Portable Devices<br><br>**ANSI Std C95.1-1992** Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz - 300 GHz. (IEEE Std C95.1-1991)<br><br>**IEEE Std 1528-2013** Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques<br><br>**KDB616217 D04** SAR for laptop and tablets v01r02<br>**KDB941225 D05** SAR for LTE Devices v02r05<br>**KDB941225 D05A** LTE Rel.10 KDB Inquiry Sheet v01r02<br>**KDB447498 D04** Interim General RF Exposure Guidance v01<br>**KDB248227 D01** 802.11 Wi-Fi SAR v02r02<br>**KDB865664 D01** SAR measurement 100 MHz to 6 GHz v01r04<br>**KDB865664 D02** RF Exposure Reporting v01r02<br>**KDB690783 D01** SAR Listings on Grants v01r03 |

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The information, data and test plan are provided by manufacturer which may affect the validity of results, so it is manufacturer's responsibility to ensure that the apparatus meets the essential requirements of applied standards and in all the possible configurations as representative of its intended use.

**Limitation**

For the use of the authority's logo is limited unless the Test Standard(s)/Scope(s)/Item(s) mentioned in this test report is (are) included in the conformity assessment authorities acceptance respective.

Please note that the measurement uncertainty is provided for informational purpose only and are not use in determining the Pass/Fail results.

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# REPORT ISSUED HISTORY

| Report No. | Version | Description | Issued Date | Note |
|---|---|---|---|---|
| BTL-FCC SAR-2-2201H017 | R00 | Original Report. | Mar. 24, 2022 | Invalid |
| BTL-FCC SAR-2-2201H017 | R01 | 1. Added the standard: KDB941225 D05A.<br>2. Added the data of CA. | Apr. 18, 2022 | Invalid |
| BTL-FCC SAR-2-2201H017 | R02 | Modified the comments of TCB. | Apr. 19, 2022 | Valid |

# 1. GENERAL INFORMATION

## 1.1 STATEMENT OF COMPLIANCE

| Mode | Highest Reported Body SAR-1g (W/kg) |
|---|---|
| LTE B48 | 0.620 |

Note:
1) The device is in compliance with Specific Absorption Rate (SAR) for general population uncontrolled exposure limits according to the FCC rule §2.1093, the ANSI C95.1:1992/IEEE C95.1:1991, the NCRP Report Number 86 for uncontrolled environment and had been tested in accordance with the measurement methods and procedures specified in IEEE Std 1528-2013.

## 1.2 LABORATORY ENVIRONMENT

| | |
|---|---|
| Temperature | Min. = 20ºC, Max. = 24ºC |
| Relative humidity | Min. = 30%, Max. = 70% |
| Ground system resistance | < 0.5Ω |
| Ambient noise is checked and found very low and in compliance with requirement of standards.<br>Reflection of surrounding objects is minimized and in compliance with requirement of standards. | |

## 1.3 GENERAL DESCRIPTION OF EUT

| | | |
|---|---|---|
| Equipment | LTE Module | |
| Test Model | VT-MOD-CELL-B48 | |
| Series Model | N/A | |
| Model Difference(s) | N/A | |
| Hardware Version | V1.1 | |
| Firmware Version | V100R001.F0000-03 | |
| Modulation | LTE(QPSK/16QAM) | |
| Operation Frequency Range(s) | Band | TX (MHz) |
| | LTE B48 | 3550~3700 |
| Power Class | 3, tested with power control "all Max" (LTE B48) | |
| Test Channels (low-mid-high) | 55340-55990-56640 (LTE B48 BW=20M) | |
| Antenna Gain (dBi) | Band | Ant 0 |
| | LTE B48 | 1.0 |
| **Other Information** | | |
| Battery | Model Name | GSP27103107 |
| | Power Rating | 8000mAh 3.8V 30.4Wh |

Note:
Host Information:
Product name: Tablet
Brand name: Vantron
Model name: VT-TABLET-5081S

The WLAN/BT module is also integrated into VT-TABLET-5081S host. In this report section 8.2 additional WLAN/BT SAR to evaluated Sim-Tx analysis with WWAN transmitter.

## 1.4 MAIN TEST INSTRUMENTS

| Item | Equipment | Manufacturer | Model | Serial No. | Cal. Date | Cal. Interval |
|---|---|---|---|---|---|---|
| 1 | Data Acquisition Electronics | Speag | DAE4 | 1390 | Dec. 29, 2021 | 1 Year |
| 2 | Data Acquisition Electronics | Speag | DAE4 | 1423 | Jan. 21, 2022 | 1 Year |
| 3 | E-field Probe | Speag | EX3DV4 | 7693 | Nov. 03, 2021 | 1 Year |
| 4 | E-field Probe | Speag | EX3DV4 | 7544 | Dec. 29, 2021 | 1 Year |
| 5 | System Validation Dipole | Speag | D3500V2 | 1095 | Jan. 24, 2020 | 3 Years |
| 6 | System Validation Dipole | Speag | D3700V2 | 1064 | Jan. 24, 2020 | 3 Years |
| 7 | ELI Phantom | Speag | ELI Phantom V5.0 | 1222 | N/A | N/A |
| 8 | ELI Phantom | Speag | ELI Phantom V5.0 | 1128 | N/A | N/A |
| 9 | Wideband Radio Communication Tester | R&S | CMW500 | 104462 | Jul. 27, 2021 | 1 Year |
| 10 | Power Amplifier | Mini-Circuits | ZHL-42W+ | QA1333003 | Dec. 26, 2021 | 1 Year |
| 11 | Power Amplifier | Mini-Circuits | ZVE-8G+ | 520701341 | Feb. 19, 2022 | 1 Year |
| 12 | DC Source metter | Iteck | IT6154 | 0061041267682 01001 | Jul. 24, 2021 | 1 Year |
| 13 | Signal Analyzer | R&S | FSV7 | 103120 | Jul. 10, 2021 | 1 Year |
| 14 | Vector Network Analyzer | Agilent | E5071C | MY46102965 | Feb. 19, 2022 | 1 Year |
| 15 | Signal Generator | Agilent | N5172B | MY53050758 | Feb. 19, 2022 | 1 Year |
| 16 | Smart Power Sensor | R&S | NRP-Z21 | 102209 | Feb. 19, 2022 | 1 Year |
| 17 | 3.5mm Economy Calibration Kit | Agilent | 85052D | MY43252246 | Dec. 14, 2021 | 1 Year |
| 18 | Dielectric Assessment Kit | Speag | DAK-3.5 | 1226 | N/A | N/A |
| 19 | Directional Coupler | Woken | TS-PCC0M-05 | 0107090019 | Feb. 19, 2022 | 1 Year |
| 20 | Coupler | Woken | 0110A05601O-10 | COM5BNW1A2 | Feb. 19, 2022 | 1 Year |
| 21 | Digital Themometer | TES | TES-1310 | 210706071 | Dec. 07, 2021 | 1 Year |

Remark:
1. “N/A” denotes no model name, serial No. or calibration specified.
2. 1) Per KDB865664 D01 requirements for dipole calibration, the test laboratory has adopted three-year extended calibration interval. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.
   a) There is no physical damage on the dipole;
   b) System check with specific dipole is within 10% of calibrated value;
   c) The most recent return-loss result, measured at least annually, deviates by no more than 20% from the previous measurement;
   d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.
   2) Network analyzer probe calibration against air, distilled water and a short block performed before measuring liquid parameters.

# 2. RF EMISSIONS MEASUREMENT

## 2.1 TEST FACILITY

The test facilities used to collect the test data in this report is SAR room at the location of Room 108, Building 2, No.1, Yile Road, Songshan Lake Zone, Dongguan City, Guangdong, People's Republic of China.
BTL's Designation Number for FCC: CN1240.

## 2.2 MEASUREMENT UNCERTAINTY

**Uncertainty Budget for Frequency range of 300 MHz to 3 GHz**

| Error Description | Uncertainty Value (± %) | Probability Distribution | Divisor | Ci (1g) | Ci (10g) | Standard Uncertainty (1g) | Standard Uncertainty (10g) | Vi $V_{eff}$ |
|---|---|---|---|---|---|---|---|---|
| **Measurement System** | | | | | | | | |
| Probe Calibration | 6.05 | Normal | 1 | 1 | 1 | ± 6.05 % | ± 6.05 % | ∞ |
| Axial Isotropy | 4.7 | Rectangular | $\sqrt{3}$ | 0.7 | 0.7 | ± 1.9 % | ± 1.9 % | ∞ |
| Hemispherical Isotropy | 9.6 | Rectangular | $\sqrt{3}$ | 0.7 | 0.7 | ± 3.9 % | ± 3.9 % | ∞ |
| Boundary Effects | 1 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 0.6 % | ± 0.6 % | ∞ |
| Linearity | 4.7 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 2.7 % | ± 2.7 % | ∞ |
| Detection Limits | 1 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 0.6 % | ± 0.6 % | ∞ |
| Modulation response | 2.4 | Rectangular | $\sqrt{3}$ | 1 | 1 | ±1.4 % | ±1.4 % | ∞ |
| Readout Electronics | 0.3 | Normal | 1 | 1 | 1 | ± 0.3 % | ± 0.3 % | ∞ |
| Response Time | 0.8 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 0.5% | ± 0.5 % | ∞ |
| Integration Time | 2.6 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 1.5 % | ± 1.5 % | ∞ |
| RF Ambient - Noise | 3 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 1.7 % | ± 1.7 % | ∞ |
| RF Ambient - Reflections | 3 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 1.7 % | ± 1.7 % | ∞ |
| Probe Positioner | 0.4 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 0.2 % | ± 0.2 % | ∞ |
| Probe Positioning | 2.9 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 1.7 % | ±1.7 % | ∞ |
| Max.SAR Evaluation | 2 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 2.3 % | ± 2.3 % | ∞ |
| **Test Sample Related** | | | | | | | | |
| Device Positioning | 1.58 1.57 | Normal | 1 | 1 | 1 | ± 2.3 % | ± 2.1 % | 145 |
| Device Holder | 1.83 2.01 | Normal | 1 | 1 | 1 | ± 2.2 % | ± 2.3 % | 5 |
| Power Drift | 5.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 2.9 % | ± 2.9 % | ∞ |
| **Phantom and Setup** | | | | | | | | |
| Phantom Production Tolerances | 6.1 | Rectangular | $\sqrt{3}$ | 1 | 1 | 2.31 | 2.31 | ∞ |
| SAR correction | 1.9 | Rectangular | $\sqrt{3}$ | 1 | 0.84 | 1.10 | 1.10 | |
| Liquid Conductivity (mea.) | 2.5 | Rectangular | $\sqrt{3}$ | 0.78 | 0.71 | 1.13 | 1.13 | ∞ |
| Liquid Permittivity (mea.) | 2.5 | Rectangular | $\sqrt{3}$ | 0.26 | 0.26 | 0.38 | 0.38 | ∞ |
| Temp. unc. - Conductivity | 3.4 | Rectangular | $\sqrt{3}$ | 0.78 | 0.71 | 1.53 | 1.53 | ∞ |
| Temp. unc. - Permittivity | 0.4 | Rectangular | $\sqrt{3}$ | 0.23 | 0.26 | 0.05 | 0.05 | ∞ |
| **Combined Standard Uncertainty (K = 1)** | | | | | | ± 10.5 % | ± 10.5 % | 361 |
| **Expanded Uncertainty (K = 2)** | | | | | | **± 21.0 %** | **± 21.0 %** | |

**Uncertainty Budget for Frequency range of 3 GHz to 6 GHz**

| Error Description | Uncertainty Value (± %) | | Probability Distribution | Divisor | Ci (1g) | Ci (10g) | Standard Uncertainty (1g) | Standard Uncertainty (10g) | Vi $V_{eff}$ |
|---|---|---|---|---|---|---|---|---|---|
| **Measurement System** | | | | | | | | | |
| Probe Calibration | 6.65 | | Normal | 1 | 1 | 1 | ± 6.65 % | ± 6.65 % | ∞ |
| Axial Isotropy | 4.7 | | Rectangular | $\sqrt{3}$ | 0.7 | 0.7 | ± 1.9 % | ± 1.9 % | ∞ |
| Hemispherical Isotropy | 9.6 | | Rectangular | $\sqrt{3}$ | 0.7 | 0.7 | ± 3.9 % | ± 3.9 % | ∞ |
| Boundary Effects | 2 | | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 1.2 % | ± 1.2 % | ∞ |
| Linearity | 4.7 | | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 2.7 % | ± 2.7 % | ∞ |
| Detection Limits | 1 | | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 0.6 % | ± 0.6 % | ∞ |
| Modulation response | 2.4 | | Rectangular | $\sqrt{3}$ | 1 | 1 | ±1.4 % | ±1.4 % | ∞ |
| Readout Electronics | 0.3 | | Normal | 1 | 1 | 1 | ± 0.3 % | ± 0.3 % | ∞ |
| Response Time | 0.8 | | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 0.5% | ± 0.5 % | ∞ |
| Integration Time | 2.6 | | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 1.5 % | ± 1.5 % | ∞ |
| RF Ambient - Noise | 3 | | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 1.7 % | ± 1.7 % | ∞ |
| RF Ambient - Reflections | 3 | | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 1.7 % | ± 1.7 % | ∞ |
| Probe Positioner | 0.4 | | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 0.2 % | ± 0.2 % | ∞ |
| Probe Positioning | 6.7 | | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 3.9 % | ±3.9 % | ∞ |
| Max.SAR Evaluation | 4 | | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 2.3 % | ± 2.3 % | ∞ |
| **Test Sample Related** | | | | | | | | | |
| Device Positioning | 1.53 | 3.21 | Normal | 1 | 1 | 1 | ± 2.3 % | ± 2.1 % | 145 |
| Device Holder | 2.27 | 3.54 | Normal | 1 | 1 | 1 | ± 2.2 % | ± 2.3 % | 5 |
| Power Drift | 5.0 | | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 2.9 % | ± 2.9 % | ∞ |
| **Phantom and Setup** | | | | | | | | | |
| Phantom Production Tolerances | 6.1 | | Rectangular | $\sqrt{3}$ | 1 | 1 | 2.31 | 2.31 | ∞ |
| SAR correction | 1.9 | | Rectangular | $\sqrt{3}$ | 1 | 0.84 | 1.10 | 1.10 | |
| Liquid Conductivity (mea.) | 2.5 | | Rectangular | $\sqrt{3}$ | 0.78 | 0.71 | 1.13 | 1.13 | ∞ |
| Liquid Permittivity (mea.) | 2.5 | | Rectangular | $\sqrt{3}$ | 0.26 | 0.26 | 0.38 | 0.38 | ∞ |
| Temp. unc. - Conductivity | 3.4 | | Rectangular | $\sqrt{3}$ | 0.78 | 0.71 | 1.53 | 1.53 | ∞ |
| Temp. unc. - Permittivity | 0.4 | | Rectangular | $\sqrt{3}$ | 0.23 | 0.26 | 0.05 | 0.05 | ∞ |
| **Combined Standard Uncertainty (K = 1)** | | | | | | | ± 11.1 % | ± 11.7 % | 361 |
| **Expanded Uncertainty (K = 2)** | | | | | | | **± 22.2 %** | **± 23.4 %** | |

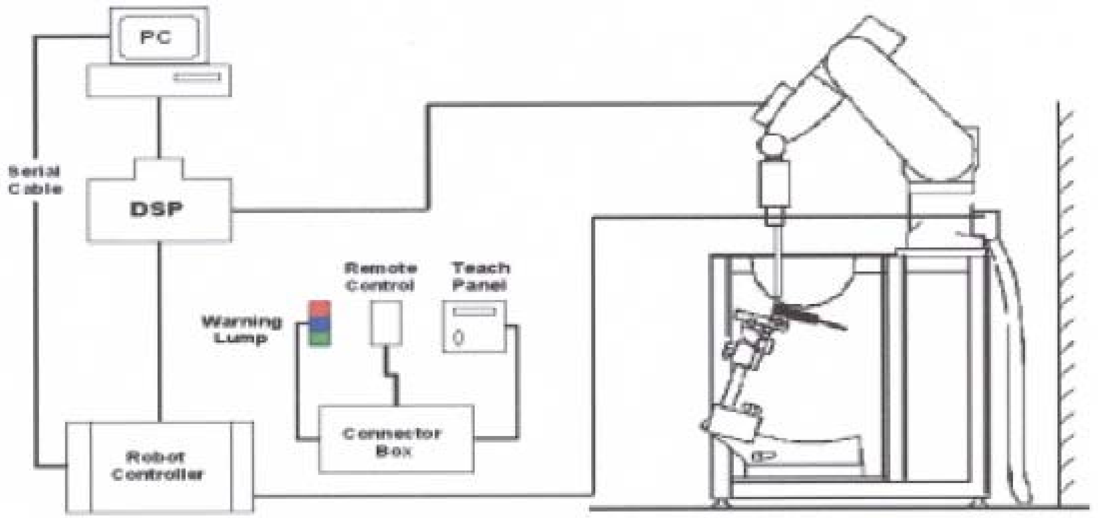
# 3. SAR MEASUREMENTS SYSTEM CONFIGURATION

## 3.1 SAR MEASUREMENT SET-UP

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

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).
2. A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
3. A data acquisition electronic (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
4. A unit to operate the optical surface detector which is connected to the EOC.
5. The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.
6. TheDASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows.
7. DASY5 software and SEMCAD data evaluation software.
8. Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling the testing of left-hand and right-hand usage.
10. The device holder for handheld mobile phones.
11. Tissue simulating liquid mixed according to the given recipes.
12. System validation dipoles allowing to validate the proper functioning of the system.

### 3.1.1 TEST SETUP LAYOUT



## 3.2 DASY5 E-FIELD PROBE SYSTEM

The SAR measurements were conducted with the dosimetric probe EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

### 3.2.1 PROBE SPECIFICATION

EX3DV4

| | |
|---|---|
| Construction | Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |
| Calibration | ISO/IEC 17025 calibration service available |
| Frequency | 10 MHz to 6 GHz<br>Linearity: ± 0.2 dB (30 MHz to 6 GHz) |
| Directivity | ± 0.3 dB in HSL (rotation around probe axis)<br>± 0.5 dB in tissue material (rotation normal to probe axis) |
| Dynamic Range | 10 μW/g to > 100 mW/g<br>Linearity:± 0.2dB |
| Dimensions | Overall length: 330 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm) Distance from probe tip to dipole centers: 1.0 mm |

**E-field Probe**

### 3.2.2 E-FIELD PROBE CALIBRATION

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than ±10%. The spherical isotropy was evaluated and found to be better than ± 0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1 GHz, and in a wave guide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$\mathbf{SAR} = \mathbf{C}\frac{\Delta T}{\Delta t}$$

Where: $\Delta t$ = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

$\Delta T$ = Temperature increase due to RF exposure.

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

Where: σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m3).

### 3.2.3 OTHER TEST EQUIPMENT

#### 3.2.3.1 Device Holder for Transmitters

**Construction:** Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices (e.g., laptops, cameras, etc.) It is light weight and fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin SAM, ELI and SAM v6.0 Phantoms.
**Material:** POM, Acrylic glass, Foam

#### 3.2.3.2 Phantom

| | | |
|---|---|---|
| Model | ELI Phantom |  |
| Construction | Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles. | |
| Shell Thickness | 2±0.1 mm | |
| Filling Volume | Approx. 30 liters | |
| Dimensions | Length: 600 mm; Width: 190mm<br>Height: adjustable feet | |
| Aailable | Special | |

### 3.2.4 SCANNING PROCEDURE

The DASY5 installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

The “reference” and “drift” measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT’s output power and should vary max. ± 5 %.

The “surface check” measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above ± 0.1mm). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within ± 30°.)

- Area Scan

The “area scan” measures the SAR above the DUT or verification dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strength is measured by the probe. The probe is touching the surface of the SAM during acquisition of measurement values. The standard scan uses large grid spacing for faster measurement. Standard grid spacing for head measurements is 15 mm in x- and y- dimension (≤2GHz), 12 mm in x- and y- dimension (2-4 GHz) and 10mm in x- and y- dimension (4-6GHz). If a finer resolution is needed, the grid spacing can be reduced. Grid spacing and orientation have no influence on the SAR result. For special applications where the standard scan method does not find the peak SAR within the grid, e.g. mobile phones with flip cover, the grid can be adapted in orientation.

- Zoom Scan

A “zoom scan” measures the field in a volume around the 2D peak SAR value acquired in the previous “coarse” scan. This is a fine grid with maximum scan spatial resolution: $\Delta x_{zoom}$, $\Delta y_{zoom}$≤2GHz -≤8mm, 2-4GHz -≤5 mm and 4-6 GHz-≤4mm; $\Delta z_{zoom}$≤3GHz -≤5 mm, 3-4 GHz-≤4mm and 4-6GHz-≤2mm where the robot additionally moves the probe along the z-axis away from the bottom of the Phantom. DASY is also able to perform repeated zoom scans if more than 1 peak is found during area scan. In this document, the evaluated peak 1g and 10g averaged SAR values are shown in the 2D-graphics in Appendix B. Test results relevant for the specified standard (see chapter 1.4.) are shown in table form in chapter 7.2.

A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 2 mm steps. This measurement shows the continuity of the liquid and can - depending in the field strength – also show the liquid depth.

The following table summarizes the area scan and zoom scan resolutions per FCC KDB 865664D01:

| Frequency | Maximun Area Scan resolution ($\Delta x_{area}$, $\Delta y_{area}$) | Maximun Zoom Scan spatial resolution ($\Delta x_{Zoom}$, $\Delta y_{Zoom}$) | Maximun Zoom Scan spatial resolution | | | Minimum zoom scan volume (x,y,z) |
|---|---|---|---|---|---|---|
| | | | Uniform Grid | Graded Grad | | |
| | | | $\Delta z_{Zoom}(n)$ | $\Delta z_{Zoom}(1)$* | $\Delta z_{Zoom}(n>1)$* | |
| ≤2GHz | ≤15mm | ≤8mm | ≤5mm | ≤4mm | ≤1.5*$\Delta z_{Zoom}(n-1)$ | ≥30mm |
| 2-3GHz | ≤12mm | ≤5mm | ≤5mm | ≤4mm | ≤1.5*$\Delta z_{Zoom}(n-1)$ | ≥30mm |
| 3-4GHz | ≤12mm | ≤5mm | ≤4mm | ≤3mm | ≤1.5*$\Delta z_{Zoom}(n-1)$ | ≥28mm |
| 4-5GHz | ≤10mm | ≤4mm | ≤3mm | ≤2.5mm | ≤1.5*$\Delta z_{Zoom}(n-1)$ | ≥25mm |
| 5-6GHz | ≤10mm | ≤4mm | ≤2mm | ≤2mm | ≤1.5*$\Delta z_{Zoom}(n-1)$ | ≥22mm |

### 3.2.5 SPATIAL PEAK SAR EVALUATION

The spatial peak SAR - value for 1 and 10 g is evaluated after the Cube measurements have been done. The basis of the evaluation are the SAR values measured at the points of the fine cube grid consisting of 5 x 5 x 7 points (with 8mm horizontal resolution) or 7 x 7 x 7 points (with 5mm horizontal resolution) or 8 x 8 x 7 points (with 4mm horizontal resolution). The algorithm that finds the maximal averaged volume is separated into three different stages.

- The data between the dipole center of the probe and the surface of the phantom are extrapolated. This data cannot be measured since the center of the dipole is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is about 1 mm (see probe calibration sheet). The extrapolated data from a cube measurement can be visualized by selecting “Graph Evaluated”.
- The maximum interpolated value is searched with a straight-forward algorithm. Around this maximum the SAR - values averaged over the spatial volumes (1g or 10 g) are computed using the 3d-spline interpolation algorithm. If the volume cannot be evaluated (i.e., if a part of the grid was cut off by the boundary of the measurement area) the evaluation will be started on the corners of the bottom plane of the cube.
- All neighboring volumes are evaluated until no neighboring volume with a higher average value is found.

**Extrapolation**

The extrapolation is based on a least square algorithm [W. Gander, Computer mathematic, p.168-180]. Through the points in the first 3 cm along the z-axis, polynomials of order four are calculated. These polynomials are then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1 mm from each other.

**Interpolation**

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of three one-dimensional splines with the "Not a knot"-condition [W. Gander, Computer mathematic, p.141-150] (x, y and z -direction) [Numerical Recipes in C, Second Edition, p.123ff].

**Volume Averaging**

At First the size of the cube is calculated. Then the volume is integrated with the trapezoidal algorithm. 8000 points (20x20x20) are interpolated to calculate the average.

**Advanced Extrapolation**

DASY5 uses the advanced extrapolation option which is able to compensate boundary effects on E-field probes.

### 3.2.6 DATA STORAGE AND EVALUATION

#### 3.2.6.1 Data Storage

The DASY5 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension “DAE”. The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

### 3.2.7 DATA EVALUATION BY SEMCAD

The SEMCAD software 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 | Normi, $a_{i0}$, $a_{i1}$, $a_{i2}$ |
| | Conversion factor | $ConvF_i$ |
| | Diode compression point | $Dcp_i$ |
| Device parameters: | Frequency | f |
| | Crest factor | cf |
| Media parameters: | Conductivity | |
| | Density | |

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY5 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:

$$V_i = U_i + U_i^2 \cdot cf / dcp_i$$

| | | |
|---|---|---|
| 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: $E_i = ( V_i \,/\, Norm_i \cdot ConvF )^{1/2}$

H-field probes: $H_i = ( V_i )^{1/2} \cdot ( a_{i0} + a_{i1} f + a_{i2} f^2 ) / f$

With $V_i$ = compensated signal of channel i ( i = x, y, z )

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

$[mV/(V/m)^2]$ for E-field Probes

ConvF = sensitivity enhancement in solution

aij = sensor sensitivity factors for H-field probes

f = carrier frequency [GHz]

$E_i$ = electric field strength of channel i in V/m

$H_i$ = magnetic field strength of channel i in A/m

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

$$E_{tot} = (E_X^2 + E_Y^2 + E_Z^2)^{1/2}$$

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

$$SAR = (E_{tot})^2 \cdot \boldsymbol{\sigma} / (\boldsymbol{\rho} \cdot 1000)$$

With SAR = local specific absorption rate in mW/g

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

= conductivity in [mho/m] or [Siemens/m]

= 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 to be a free space field.

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

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

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

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

# 4. SYSTEM VERIFICATION PROCEDURE

## 4.1 TISSUE VERIFICATION

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectic parameter are within the tolerances of the specified target values. The measured conductivity and relative permittivity should be within ± 5% of the target values.

The following materials are used for producing the tissue-equivalent materials.

| Tissue Type | Bactericide | DGBE | HEC | NaCl | Sucrose | Triton X-100 | Water | Diethylene Glycol Mono-hexylether |
|---|---|---|---|---|---|---|---|---|
| Head 3500 | - | 7.99 | - | 0.16 | - | 19.97 | 71.88 | - |
| Head 3700 | - | 7.99 | - | 0.16 | - | 19.97 | 71.88 | - |

Salt: 99+% Pure Sodium Chloride; Sugar: 98+% Pure Sucrose; Water: De-ionized, 16M + 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

| Tissue Verification | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Tissue Type | Frequency (MHz) | Liquid Temp. (℃) | Conductivity (σ) | Permittivity (εr) | Targeted Conductivity (σ) | Targeted Permittivity (εr) | Deviation Conductivity (σ) (%) | Deviation Permittivity (εr) (%) | Date |
| Head | 3500 | 22.1 | 2.966 | 38.014 | 2.91 | 37.9 | 1.92 | 0.30 | Mar. 10, 2022 |
| Head | 3700 | 22.1 | 3.198 | 37.377 | 3.12 | 37.7 | 2.50 | -0.86 | Mar. 10, 2022 |
| Head | 3700 | 22.5 | 3.110 | 38.533 | 3.12 | 37.7 | -0.32 | 2.21 | Apr. 14, 2022 |

Note:
1) The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.
2) KDB 865664 was ensured to be applied for probe calibration frequencies greater than or equal to 50MHz of the EUT frequencies.
3) The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies. The SAR test plots may slightly differ from the table above since the DASY rounds to three significant digits.

## 4.2 SYSTEM CHECK

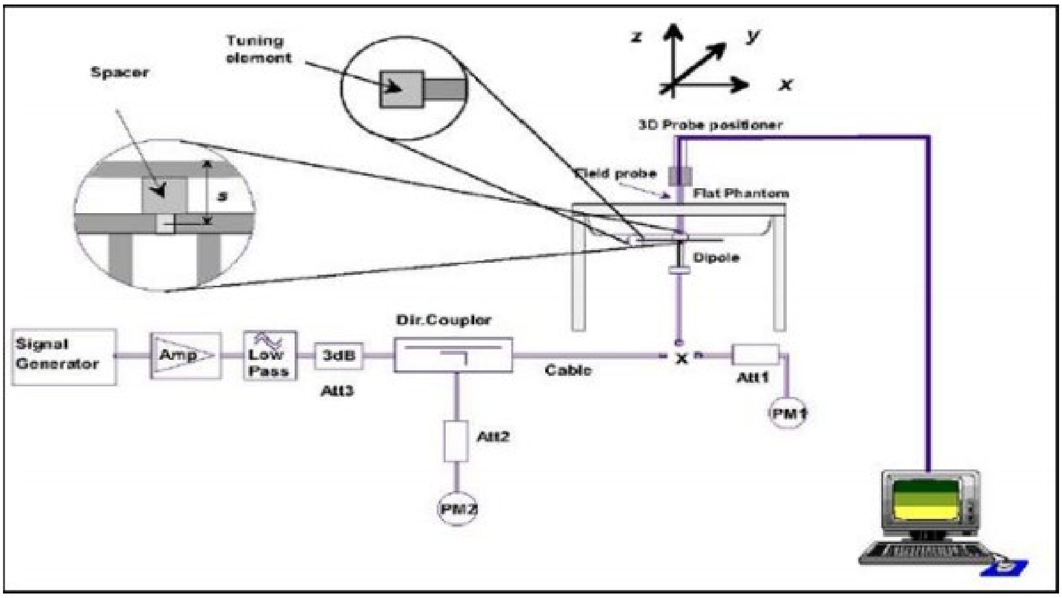
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE P1528 (described above). The following table shows system check results for all frequency bands and tissue liquids used during the tests.

| System Check | Date | Frequency (MHz) | Targeted SAR 1g (W/kg) | Measured SAR 1g (W/kg) | normalized SAR 1g (W/kg) | Deviation 1g (%) | Dipole S/N |
|---|---|---|---|---|---|---|---|
| Head | Mar. 10, 2022 | 3500 | 66.10 | 6.49 | 64.90 | -1.82 | 1095 |
| Head | Mar. 10, 2022 | 3700 | 67.40 | 6.82 | 68.20 | 1.19 | 1064 |
| Head | Apr. 14, 2022 | 3700 | 67.40 | 6.78 | 67.80 | 0.59 | 1064 |

## 4.3 SYSTEM CHECK PROCEDURE

The system check is performed by using a system check dipole which is positioned parallel to the planar part of the SAM phantom at the reference point. The distance of the dipole to the SAM phantom is determined by a plexiglass spacer. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 250mW (below 3GHz) or 100mW (3-6GHz). To adjust this power a power meter is used.
The power sensor is connected to the cable before the system check to measure the power at this point and do adjustments at the signal generator. At the outputs of the directional coupler both return loss as well as forward power are controlled during the system check to make sure that emitted power at the dipole is kept constant. This can also be checked by the power drift measurement after the test.

System check results have to be equal or near the values determined during dipole calibration (target SAR in table above) with the relevant liquids and test system (±10 %).



# 5. SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

## 5.1 SAR MEASUREMENT VARIABILITY

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.

The detailed repeated measurement results are shown in Section 7.2.

# 6. OPERATIONAL CONDITIONS DURING TEST

## 6.1 TEST CONFIGURATION

### 6.1.1 LTE TEST CONFIGURATION

SAR for LTE band exposure configurations is measured according to the procedures of KDB 941225 D05 SAR for LTE Devices. The CMW500 Wide Band Radio Communication Tester was used for LTE output power measurements and SAR testing. Closed loop power control was used so the UE transmits with maximum output power during SAR testing. SAR test were performed with the same number of RB and RB offsets transmitting on all TTI frames (Maximum TTI)

**1. Spectrum Plots for RB configurations**

A properly configured base station simulator was used for LTE output power measurements and SAR testing. Therefore, spectrum plots for RB configurations were not required to be included in this report.

**2. MPR**

When MPR is implemented permanently within the UE, regardless of network requirements, only those RB configurations allowed by 3GPP for the channel bandwidth and modulation combinations may be tested with MPR active. Configurations with RB allocations less than the RB thresholds required by 3GPP must be tested without MPR.
The allowed Maximum Power Reduction (MPR) for the maximum output power due to higher order modulation and transmit bandwidth configuration (resource blocks) is specified in Table 6.2.3-1 of the 3GPP TS36.101:

**Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 3**

| Modulation | Channel bandwidth / Transmission bandwidth ($N_{RB}$) | | | | | | MPR (dB) |
|---|---|---|---|---|---|---|---|
| | 1.4 MHz | 3.0 MHz | 5 MHz | 10 MHz | 15 MHz | 20 MHz | |
| QPSK | > 5 | > 4 | > 8 | > 12 | > 16 | > 18 | ≤ 1 |
| 16 QAM | ≤ 5 | ≤ 4 | ≤ 8 | ≤ 12 | ≤ 16 | ≤ 18 | ≤ 1 |
| 16 QAM | > 5 | > 4 | > 8 | > 12 | > 16 | > 18 | ≤ 2 |

**3. A-MPR**

A-MPR (Additional MPR) has been disabled for all SAR tests by using Network Signaling Value of “NS_01” on the base station simulator.

## 4. LTE procedures for SAR testing

**A) Largest channel bandwidth standalone SAR test requirements**

i) QPSK with 1 RB allocation

Start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel. When the reported SAR is ≤ 0.8 W/kg, testing of the remaining RB offset configurations and required test channels is not required for 1 RB allocation; otherwise, SAR is required for the remaining required test channels and only for the RB offset configuration with the highest output power for that channel. When the reported SAR of a required test channel is > 1.45 W/kg, SAR is required for all three RB offset configurations for that required test channel.

ii) QPSK with 50% RB allocation

The procedures required for 1 RB allocation in i) are applied to measure the SAR for QPSK with 50% RB allocation

iii) QPSK with 100% RB allocation

For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation in i) and ii) are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.

iv) Higher order modulations

For each modulation besides QPSK; e.g., 16-QAM, 64-QAM, apply the QPSK procedures in above sections to determine the QAM configurations that may need SAR measurement. For each configuration identified as required for testing, SAR is required only when the highest maximum output power for the configuration in the higher order modulation is > ½ dB higher than the same configuration in QPSK or when the reported SAR for the QPSK configuration is > 1.45 W/kg.

**B) Other channel bandwidth standalone SAR test requirements**

For the other channel bandwidths used by the device in a frequency band, apply all the procedures required for the largest channel bandwidth in section A) to determine the channels and RB configurations that need SAR testing and only measure SAR when the highest maximum output power of a configuration requiring testing in the smaller channel bandwidth is > ½ dB higher than the equivalent channel configurations in the largest channel bandwidth configuration or the reported SAR of a configuration for the largest channel bandwidth is > 1.45 W/kg.

**LTE (TDD) Test Configuration**

According to KDB 941225 D05 SAR for LTE Devices V02r05, for Time-Division Duplex (TDD) systems, SAR must be tested using a fixed periodic duty factor according to the highest transmission duty factor implemented for the device and supported by the defined 3GPP LTE TDD configurations.
TDD LTE B48 supports 3GPP TS 36 for Time-Division Duplex (TDD) systems, SAR must be tested using a fixed periodic duty factor according to the highest transmission duty factor implemented for the device and supported by the defined 3GPP LTE TDD configurations.
TDD LTE B48 supports 3GPP TS 36.211 section 4.2 for Type 2 Frame Structure and Table 4.2-2 for uplink-downlink configurations and Table 4.2-1 for Special subframe configurations.

**Figure 4.2-1: Frame structure type 2**

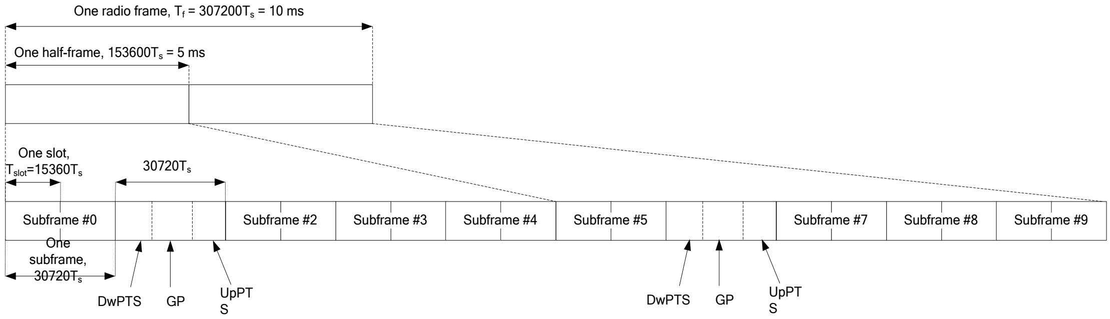



**Table 4.2-1: Configuration of special subframe (lengths of DwPTS/GP/UpPTS)**

<table>
<tr><th rowspan="3">Special subframe configuration</th><th colspan="3">Normal cyclic prefix in downlink</th><th colspan="3">Extended cyclic prefix in downlink</th></tr>
<tr><th>DwPTS</th><th colspan="2">UpPTS</th><th>DwPTS</th><th colspan="2">UpPTS</th></tr>
<tr><th></th><th>Normal cyclic prefix in uplink</th><th>Extended cyclic prefix in uplink</th><th></th><th>Normal cyclic prefix in uplink</th><th>Extended cyclic prefix in uplink</th></tr>
<tr><td>0</td><td>$6592 \cdot T_s$</td><td rowspan="5">$2192 \cdot T_s$</td><td rowspan="5">$2560 \cdot T_s$</td><td>$7680 \cdot T_s$</td><td rowspan="4">$2192 \cdot T_s$</td><td rowspan="4">$2560 \cdot T_s$</td></tr>
<tr><td>1</td><td>$19760 \cdot T_s$</td><td>$20480 \cdot T_s$</td></tr>
<tr><td>2</td><td>$21952 \cdot T_s$</td><td>$23040 \cdot T_s$</td></tr>
<tr><td>3</td><td>$24144 \cdot T_s$</td><td>$25600 \cdot T_s$</td></tr>
<tr><td>4</td><td>$26336 \cdot T_s$</td><td>$7680 \cdot T_s$</td><td rowspan="4">$4384 \cdot T_s$</td><td rowspan="4">$5120 \cdot T_s$</td></tr>
<tr><td>5</td><td>$6592 \cdot T_s$</td><td rowspan="5">$4384 \cdot T_s$</td><td rowspan="5">$5120 \cdot T_s$</td><td>$20480 \cdot T_s$</td></tr>
<tr><td>6</td><td>$19760 \cdot T_s$</td><td>$23040 \cdot T_s$</td></tr>
<tr><td>7</td><td>$21952 \cdot T_s$</td><td>$12800 \cdot T_s$</td></tr>
<tr><td>8</td><td>$24144 \cdot T_s$</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>9</td><td>$13168 \cdot T_s$</td><td>-</td><td>-</td><td>-</td></tr>
</table>

**Table 4.2-2: Uplink-downlink configurations**

| Uplink-downlink configuration | Downlink-to-Uplink Switch-point periodicity | Subframe number | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | 5 ms | D | S | U | U | U | D | S | U | U | U |
| 1 | 5 ms | D | S | U | U | D | D | S | U | U | D |
| 2 | 5 ms | D | S | U | D | D | D | S | U | D | D |
| 3 | 10 ms | D | S | U | U | U | D | D | D | D | D |
| 4 | 10 ms | D | S | U | U | D | D | D | D | D | D |
| 5 | 10 ms | D | S | U | D | D | D | D | D | D | D |
| 6 | 5 ms | D | S | U | U | U | D | S | U | U | D |

According to Figure 4.2-1, one radio frame is configured by 10 subframes, which consist of Uplink-subframe, Downlink-subframe and Special subframe. For TDD-LTE, the Duty Cycle should be calculated on Uplink-subframes and Special subframes, due to Special subframe containing both Uplink transmissions. So for one radio frame, Duty Cycle can be calculated with formula as below. The count of Uplink subframes are according to Table 4.2-2:

Duty cycle =(30720Ts*Ups+Uplink Component*Specials)/(307200Ts)

About the uplink component of Special subframes, we can figure out by Table 4.2-1:

Uplink Component=UpPTS

In conclusion, for the TDD LTE B48, Duty Cycle can be calculated with formula as below. All these sets are ok when we test, or we can set as below.

Duty cycle =[(30720Ts*Ups)+ UpPTS *Specials]/(307200Ts)

And we can get different Duty cycles under different configurations:

| Uplink-downlink configuration | Subframe number | | | Configuration of special subframe | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Normal cyclic prefix in downlink | | | | Extended cyclic prefix in downlink | | | |
| | | | | Normal cyclic prefix in uplink | | Extended cyclic prefix in uplink | | Normal cyclic prefix in uplink | | Extended cyclic prefix in uplink | |
| | D | S | U | configuration 0-4 | configuration 5-9 | configuration 0-4 | configuration 5-9 | configuration 0-3 | configuration 4-7 | configuration 0-3 | configuration |
| 0 | 2 | 2 | 6 | 61.43% | 62.85% | 61.67% | 63.33% | 61.43% | 62.85% | 61.67% | 63.33% |
| 1 | 4 | 2 | 4 | 41.43% | 42.85% | 41.67% | 43.33% | 41.43% | 42.85% | 41.67% | 43.33% |
| 2 | 6 | 2 | 2 | 21.43% | 22.85% | 21.67% | 23.33% | 21.43% | 22.85% | 21.67% | 23.33% |
| 3 | 6 | 1 | 3 | 30.71% | 31.43% | 30.83% | 31.67% | 30.71% | 31.43% | 30.83% | 31.67% |
| 4 | 7 | 1 | 2 | 20.71% | 21.43% | 20.83% | 21.67% | 20.71% | 21.43% | 20.83% | 21.67% |
| 5 | 8 | 1 | 1 | 10.71% | 11.43% | 10.83% | 11.67% | 10.71% | 11.43% | 10.83% | 11.67% |
| 6 | 3 | 2 | 5 | 51.43% | 52.85% | 51.67% | 53.33% | 51.43% | 52.85% | 51.67% | 53.33% |

For TDD LTE, SAR should be tested with the highest transmission duty factor (63.33%) using Uplink-downlink configuration 0 and Special subframe configuration 7 for Frame structure type 2.

### 6.1.2 LTE CARRIER AGGREGATION POWER

As the KDB 941225 D05A, when downlink carrier aggregation is active uplink maximum output power remains within the specified tune-up tolerance limits and not more than 1/4dB higher than the maximum output power measured when downlink carrier aggregation is inactive, the CA test is not required.

E-UTRA CA configurations and bandwidth combination sets defined for intra-band contiguous CA

| E-UTRA CA configuration / Bandwidth combination set | | | | | |
|---|---|---|---|---|---|
| **E-UTRA CA configuration** | **Uplink CA configurations** | **Component carriers in order of increasing carrier frequency** | | **Maximum aggregated bandwidth [MHz]** | **Bandwidth combination set** |
| | | **Channel bandwidths for carrier [MHz]** | **Channel bandwidths for carrier [MHz]** | | |
| CA_48C | CA_48C | 5, 10, 15, 20 | 20 | 40 | 0 |
| | | 20 | 5, 10, 15 | | |
| NOTE 1: The CA configuration refers to an operating band and a CA bandwidth class specified in Table 5.6A-1 (the indexing letter). Absence of a CA bandwidth class for an operating band implies support of all classes.<br>NOTE 2: For the supported CC bandwidth combinations, the CC downlink and uplink bandwidths are equal.<br>NOTE 3: Uplink CA configurations are the configurations supported by the present release of specifications. | | | | | |

Note:
1) For the inter-band CA combinations, all the listed bands above can be used as PCC or SCC.
2) The channel spacing and aggregated channel bandwidth for CA are identical to the associated specification in 3GPP TS 36.101.
3) The reference test frequencies for CA refers to3GPP TS 36.508.

1. Carrier Aggregation power test results

| E-UTRA CA configuration | | PCC | | | | | | SCC | | | | | | Tune-up For LTE CA TX Power | LTE CA TX Power |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Band | Band width [MHZ] | Modul ation | Chan nel (UL) | Frequ ency [MHZ] | RB Size/ Offset | Band | Band width [MHZ] | Modul ation | Chan nel (UL) | Frequ ency [MHZ] | RB Size/ Offset | | |
| CA_48C | Low | LTE B48 | 20 | QPSK | 55340 | 3560 | 1/99 | LTE B48 | 20 | QPSK | 55538 | 3579.8 | 1/0 | 20.00 | 19.29 |
| CA_48C | Mid | LTE B48 | 20 | QPSK | 55891 | 3615.1 | 1/99 | LTE B48 | 20 | QPSK | 56089 | 3634.9 | 1/0 | 20.00 | 18.89 |
| CA_48C | High | LTE B48 | 20 | QPSK | 56442 | 3670.2 | 1/99 | LTE B48 | 20 | QPSK | 56640 | 3690 | 1/0 | 20.00 | **19.70** |

Note: The tested channel results are marks in bold.

## 6.2 TEST POSITION

### 6.2.1 BODY TEST CONFIGURATION

The overall diagonal dimension of the display section of a tablet is 27.3cm>20cm, per FCC KDB 616217, the back surface and edges of the tablet should be tested for SAR compliance with the Tablet touching the phantom. SAR evaluation for the front surface of tablet display screens is generally not necessary. The SAR Exclusion Threshold in KDB 447498 D01 can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an adjacent tablet edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned adjacent the phantom and the edge containing the antenna positioned perpendicular to the phantom.

**SAR test reduction and exclusion guidance**

(1) The SAR exclusion threshold for distances<50mm is defined by the following equation:

$$\frac{\text{(max. power of channel, including tune-up tolerance, mW)}}{\text{(min. test separation distance, mm)}} \cdot \sqrt{\text{Frequency (GHz)}} \leq 3.0$$

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

(2) The SAR exclusion threshold for distances>50mm is defined by the following equation, as illustrated in KDB 447498 D01 Appendix B:

a) at 100 MHz to1500 MHz

**[Power allowed at numeric Threshold at 50 mm in step 1) + (test separation distance - 50 mm) · (f $_{(MHz)}$/150)] mW**

b) at >1500MHz and ≤6GHz

**[Power allowed at numeric Threshold at 50 mm in step 1) + (test separation distance - 50 mm) ·10] mW**

The location of the antenna inside EUT and standalone SAR test exclussion, please refer to Appendix E.

# 7. TEST RESULT

## 7.1 CONDUCTED POWER RESULTS

### 7.1.1 CONDUCTED POWER MEASUREMENTS OF LTE

1. Conducted power measurement of LTE B48

| LTE B48/BW=5M | | Average Conducted Power(dBm) | | | | LTE B48/BW=10M | | Average Conducted Power(dBm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Modula-tion | RB Size/ Offset | Max. Tune-up | Channel/Frequency(MHz) | | | Modula-tion | RB Size/ Offset | Max. Tune-up | Channel/Frequency(MHz) | | |
| | | | 55265/ 3552.5 | 55990/ 3625 | 56715/ 3697.5 | | | | 55290/ 3555 | 55990/ 3625 | 56690/ 3695 |
| QPSK | 1/0 | 20.00 | 18.12 | 18.03 | 18.94 | QPSK | 1/0 | 20.00 | 18.25 | 18.46 | 19.27 |
| | 1/12 | 20.00 | 18.10 | 18.04 | 18.91 | | 1/24 | 20.00 | 18.01 | 18.36 | 19.21 |
| | 1/24 | 20.00 | 18.03 | 18.07 | 18.86 | | 1/49 | 20.00 | 18.13 | 18.44 | 19.22 |
| | 12/0 | 20.00 | 18.21 | 18.27 | 19.12 | | 25/0 | 20.00 | 18.08 | 18.16 | 19.10 |
| | 12/6 | 20.00 | 18.18 | 18.02 | 18.96 | | 25/12 | 20.00 | 18.06 | 18.25 | 19.13 |
| | 12/13 | 20.00 | 18.18 | 18.04 | 18.94 | | 25/25 | 20.00 | 18.01 | 18.21 | 19.05 |
| | 25/0 | 20.00 | 18.18 | 18.03 | 18.95 | | 50/0 | 20.00 | 18.18 | 18.18 | 19.08 |
| 16QAM | 1/0 | 20.00 | 18.03 | 18.23 | 18.85 | 16QAM | 1/0 | 20.00 | 18.25 | 18.21 | 19.31 |
| | 1/12 | 20.00 | 18.18 | 18.24 | 18.86 | | 1/24 | 20.00 | 18.01 | 18.14 | 19.27 |
| | 1/24 | 20.00 | 18.10 | 18.27 | 18.82 | | 1/49 | 20.00 | 18.25 | 18.33 | 19.25 |
| | 12/0 | 20.00 | 18.16 | 18.25 | 19.12 | | 25/0 | 20.00 | 18.10 | 18.20 | 19.18 |
| | 12/6 | 20.00 | 18.08 | 18.00 | 18.87 | | 25/12 | 20.00 | 18.08 | 18.28 | 19.23 |
| | 12/13 | 20.00 | 18.14 | 18.01 | 18.85 | | 25/25 | 20.00 | 18.04 | 18.23 | 19.16 |
| | 25/0 | 20.00 | 18.15 | 18.01 | 18.91 | | 50/0 | 20.00 | 18.00 | 18.19 | 19.17 |
| LTE B48/BW=15M | | Average Conducted Power(dBm) | | | | LTE B48/BW=20M | | Average Conducted Power(dBm) | | | |
| Modula-tion | RB Size/ Offset | Max. Tune-up | Channel/Frequency(MHz) | | | Modula-tion | RB Size/ Offset | Max. Tune-up | Channel/Frequency(MHz) | | |
| | | | 55315/ 55340 | 55990/ 3625 | 56665/ 3692.5 | | | | 55340/ 3560 | 55990/ 3625 | 56640/ 3690 |
| QPSK | 1/0 | 20.00 | 18.21 | 18.69 | 19.66 | QPSK | 1/0 | 20.00 | 18.38 | 18.68 | **19.90** |
| | 1/37 | 20.00 | 18.01 | 18.58 | 19.44 | | 1/50 | 20.00 | 18.15 | 18.51 | 19.60 |
| | 1/74 | 20.00 | 18.49 | 19.01 | 19.60 | | 1/99 | 20.00 | 18.64 | 19.00 | 19.80 |
| | 36/0 | 20.00 | 18.05 | 18.45 | 19.49 | | 50/0 | 20.00 | 18.05 | 18.51 | **19.53** |
| | 36/19 | 20.00 | 18.28 | 18.50 | 19.40 | | 50/25 | 20.00 | 18.04 | 18.50 | 19.44 |
| | 36/39 | 20.00 | 18.01 | 18.53 | 19.27 | | 50/50 | 20.00 | 18.18 | 18.63 | 19.48 |
| | 75/0 | 20.00 | 18.29 | 18.52 | 19.29 | | 100/0 | 20.00 | 18.11 | 18.47 | 19.48 |
| 16QAM | 1/0 | 20.00 | 18.20 | 18.58 | 19.72 | 16QAM | 1/0 | 20.00 | 18.25 | 18.70 | 19.79 |
| | 1/37 | 20.00 | 18.25 | 18.44 | 19.50 | | 1/50 | 20.00 | 18.00 | 18.53 | 19.73 |
| | 1/74 | 20.00 | 18.43 | 18.87 | 19.68 | | 1/99 | 20.00 | 18.51 | 18.99 | 19.89 |
| | 36/0 | 20.00 | 18.03 | 18.30 | 19.33 | | 50/0 | 20.00 | 18.09 | 18.53 | 19.50 |
| | 36/19 | 20.00 | 18.26 | 18.33 | 19.44 | | 50/25 | 20.00 | 18.07 | 18.51 | 19.42 |
| | 36/39 | 20.00 | 18.00 | 18.36 | 19.30 | | 50/50 | 20.00 | 18.21 | 18.61 | 19.44 |
| | 75/0 | 20.00 | 18.28 | 18.36 | 19.36 | | 100/0 | 20.00 | 18.18 | 18.54 | 19.50 |

Note: The tested channel results are marks in bold.

## 7.2 SAR TEST RESULTS

**General Notes:**
1) Per KDB447498 D04, all measurement SAR results are scaled to the maximum tune-up tolerance limit to demonstrate compliant.
2) Per KDB447498 D04, 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. When the maximum output power variation across the required test channels is > ½ dB, instead of the middle channel, the highest output power channel must be used.
3) Per KDB865664 D01, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥ 0.8W/kg; if the deviation among the repeated measurement is ≤ 20%, and the measured SAR < 1.45W/kg, only one repeated measurement is required.
4) Per KDB865664 D02, SAR plot is only required for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination; Plots are also required when the measured SAR is > 1.5 W/kg, or > 7.0 W/kg for occupational exposure. The published RF exposure KDB procedures may require additional plots; for example, to support SAR to peak location separation ratio test exclusion and/or volume scan post-processing.

**LTE notes:**
1) The LTE test configurations are determined according to KDB941225 D05 SAR for LTE Devices. The general test procedures used for SAR testing can be found in Section 6.1.3.
2) A-MPR was disabled for all SAR test by setting NS_01 on the base station simulator. SAR tests were performed with the same number of RB and RB offsets transmitting on all TTI frames (maximum TTI)

### 7.2.1 SAR MEASUREMENT RESULT

1. SAR measurement result of LTE

| Test No. | Band | Mode | Channel | RB | offset | Test Position | Separation Distance (cm) | Ant | Maximum Tune-up (dBm) | Conducted Power (dBm) | Power Drift (dB) | SAR 1g (W/kg) | SAR 10g (W/kg) | Reported 1g SAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L01 | LTEB48 | QPSK20M | 56640 | 1 | 0 | Rear Face | 0 | 0 | 20 | 19.90 | 0.07 | 0.204 | 0.073 | 0.209 |
| L02 | LTEB48 | QPSK20M | 56640 | 1 | 0 | Top Side | 0 | 0 | 20 | 19.90 | -0.05 | **0.606** | **0.219** | **0.620** |
| L03 | LTEB48 | QPSK20M | 56640 | 1 | 0 | Right SIde | 0 | 0 | 20 | 19.90 | 0.01 | 0.221 | 0.089 | 0.226 |
| L04 | LTEB48 | QPSK20M | 56640 | 50 | 0 | Rear Face | 0 | 0 | 20 | 19.53 | 0.08 | 0.142 | 0.059 | 0.158 |
| L05 | LTEB48 | QPSK20M | 56640 | 50 | 0 | Top Side | 0 | 0 | 20 | 19.53 | 0.1 | 0.541 | 0.194 | 0.603 |
| L06 | LTEB48 | QPSK20M | 56640 | 50 | 0 | Right SIde | 0 | 0 | 20 | 19.53 | -0.02 | 0.192 | 0.077 | 0.214 |

Note: The value with boldface is the maximum SAR Value of each test band.

2. SAR measurement result of CA

| Test No. | PCC | | | | | SCC | | | | | Tune-up For LTE CA TX Power | LTE CA TX Power | Test Position | Separation Distance (cm) | Ant | Power Drift | SAR 1g | SAR 10g | Reported 1g SAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Band | Band width [MHZ] | Modul ation | Chan nel (UL) | RB Size/ Offset | Band | Band width [MHZ] | Modul ation | Chan nel (UL) | RB Size/ Offset | | | | | | | | | |
| C1 | LTE B48 | 20 | QPSK | **56442** | 1/99 | LTE B48 | 20 | QPSK | **56640** | 1/0 | 20 | 19.70 | Top Side | 0 | 0 | 0.1 | **0.532** | **0.197** | **0.570** |

Note: The value with boldface is the maximum SAR Value of each test band.

# 8. MULTIPLE TRANSMITTER EVALUATION

The following tables list information which is relevant for the decision if a simultaneous transmit evaluation is necessary according to FCC KDB 447498D01 General RF Exposure Guidance v06.

The location of the antenna inside EUT and standalone SAR test exclusion, please refer to Appendix E.

The data of WLAN/BT as below are refer to report: BTL-FCC SAR-1-2201H017.

## 8.1 STAND-ALONE SAR TEST EXCLUSION

Per FCC KDB 447498D01, SAR compliance for simultaneous transmission must be considered when the maximum duration of overlapping transmissions, including network hand-offs, is greater than 30 seconds. This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis.

The Simultaneous Transmission Possibilities of this device are as below:

| NO. | Simultaneous Tx Combination | Body |
|---|---|---|
| 1 | LTE + WiFi 2.4G (Ant 1) | Yes |
| 2 | LTE + WiFi 5G (Ant 1) | Yes |
| 3 | LTE + BT (Ant 1) | Yes |
| 4 | LTE + WiFi 2.4G (Ant 2) | Yes |
| 5 | LTE + WiFi 5G (Ant 2) | Yes |
| 6 | WiFi 2.4G (Ant1) + WiFi 2.4G (Ant 2) | Yes |
| 8 | WiFi 5G (Ant 1) + WiFi 5G (Ant 2) | Yes |
| 9 | LTE + WiFi 2.4G (Ant 1) + WiFi 2.4G (Ant 2) | Yes |
| 10 | LTE + WiFi 5G (Ant 1) + WiFi 5G (Ant 2) | Yes |

Note: Only WiFi Ant 1 supports BT function.

## 8.2 SAR SUMMATION SCENARIO

LTE and BT / WiFi Ant 1

| Position | Rear Face (0cm) | Left Side (0cm) | Right Side (0cm) | Top Side (0cm) |
|---|---|---|---|---|
| LTE B48 | 0.209 | / | 0.226 | 0.620 |
| WiFi 2.4G | 0.260 | 1.279 | / | <0.001 |
| WiFi 5.2G | 0.317 | 1.192 | / | 0.013 |
| WiFi 5.8G | 0.470 | 0.973 | / | <0.001 |
| Bluetooth | 0.131 | 0.739 | / | <0.001 |
| MAX $\sum SAR_{1g}$ | **0.679** | **1.279** | **0.226** | **0.633** |

LTE and WiFi Ant 2

| Position | Rear Face (0cm) | Left Side (0cm) | Right Side (0cm) | Top Side (0cm) |
|---|---|---|---|---|
| LTE B48 | 0.209 | / | 0.226 | 0.620 |
| WiFi 2.4G | 0.262 | / | 1.361 | 0.008 |
| WiFi 5.2G | 0.461 | / | 1.222 | <0.001 |
| WiFi 5.8G | 0.601 | / | 1.160 | <0.001 |
| MAX $\sum SAR_{1g}$ | **0.810** | **0.000** | **1.587** | **0.628** |

WiFi 2.4G (Ant1) + WiFi 2.4G (Ant2)

| Position | Rear Face (0cm) | Left Side (0cm) | Right Side (0cm) | Top Side (0cm) |
|---|---|---|---|---|
| WiFi 2.4G (Ant 1) | 0.260 | 1.279 | / | <0.001 |
| WiFi 2.4G (Ant 2) | 0.262 | / | 1.361 | 0.008 |
| MAX $\sum SAR_{1g}$ | **0.522** | **1.279** | **1.361** | **0.008** |

WiFi 5G (Ant1) + WiFi 5G (Ant2)

| Position | Rear Face (0cm) | Left Side (0cm) | Right Side (0cm) | Top Side (0cm) |
|---|---|---|---|---|
| WiFi 5.2G (Ant 1) | 0.317 | 1.192 | / | 0.013 |
| WiFi 5.8G (Ant 1) | 0.470 | 0.973 | / | <0.001 |
| WiFi 5.2G (Ant 2) | 0.461 | / | 1.222 | <0.001 |
| WiFi 5.8G (Ant 2) | 0.601 | / | 1.160 | <0.001 |
| MAX $\sum SAR_{1g}$ | **1.071** | **1.192** | **1.222** | **0.013** |

LTE and WiFi Ant 1 + Ant 2

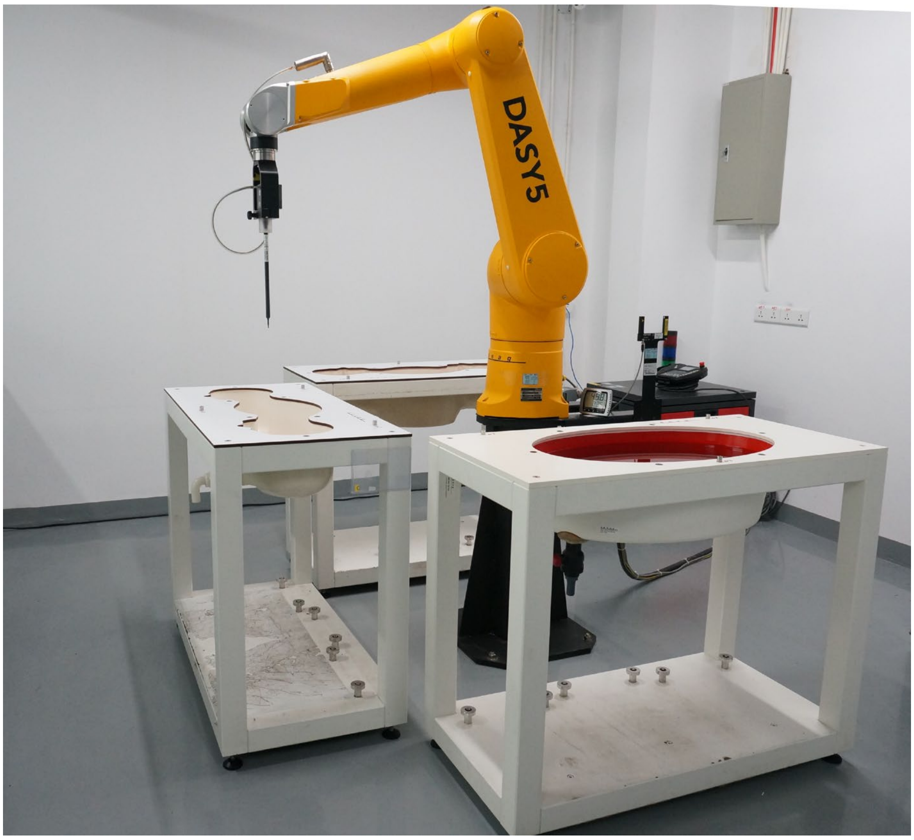
| Position | Rear Face (0cm) | Left Side (0cm) | Right Side (0cm) | Top Side (0cm) |
|---|---|---|---|---|
| LTE B48 | 0.209 | / | 0.226 | 0.620 |
| WiFi 2.4G (MIMO) | 0.522 | 1.279 | 1.361 | 0.008 |
| WiFi 5G (MIMO) | 1.071 | 1.192 | 1.222 | 0.013 |
| MAX $\sum SAR_{1g}$ | **1.280** | **1.279** | **1.587** | **0.633** |

Note: Thus $SAR_{MAX.total}$= 1.587W/kg<1.6W/kg, it is compliant with 1999/519/EC, so Simultaneous SAR are not required for LTE and WiFi (Ant 1/Ant 2) antenna.

# APPENDIX

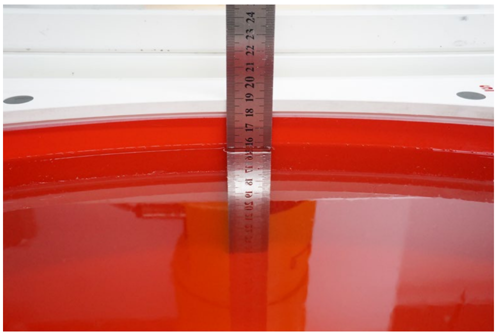
## 1. TEST LAYOUT

**Specific Absorption Rate Test Layout**




**Liquid depth in the flat Phantom (≥15cm depth)**

HSL_3300MHz-4200MHz_Body_15.7cm



# Appendix A. SAR Plots of System Verification

**(Pls See BTL-FCC SAR-2-2201H017_Appendix A.)**

# Appendix B. SAR Plots of SAR Measurement

**(Pls See BTL-FCC SAR-2-2201H017_Appendix B.)**

# Appendix C. Calibration Certificate

**(Pls See BTL-FCC SAR-2-2201H017_Appendix C.)**

# Appendix D. Photographs of the Test Set-Up

**(Pls See BTL-FCC SAR-2-2201H017_Appendix D.)**

# Appendix E. Antenna location and standalone SAR test exclusion

**(Pls See BTL-FCC SAR-2-2201H017_Appendix E.)**

**End of Test Report**