# FCC SAR Test Report

## FCC ID: BBP-WLEIG01

| | | |
|---|---|---|
| **Report No.** | : | BTL-FCC SAR-1-2207T020 |
| **Equipment** | : | Portable Monitor |
| **Model Name** | : | RICOH Portable Monitor 150BW |
| **Series Model** | : | RICOH Light Monitor 150BW |
| **Brand Name** | : | RICOH |
| **Applicant** | : | Ricoh Company Ltd. |
| **Address** | : | 2-7-1 Izumi Ebina, Kanagawa, 243-0460 Japan |
| **Date of Receipt** | : | Jul. 8, 2022 |
| **Date of Test** | : | Aug. 25, 2022 ~ Aug. 26, 2022 |
| **Issued Date** | : | Oct. 19, 2022 |

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

**Prepared by** :

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**BTL** represents to the client that testing is done in accordance with standard procedures as applicable and that test instruments used has been calibrated with standards traceable to international standard(s) and/or national standard(s).

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**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 Version | Description | Issued Date |
|---|---|---|
| R00 | Original Issue. | 2022/9/2 |
| R01 | Remove Simultaneous transmission condictions typo. | 2022/10/19 |

# 1. GENERAL INFORMATION

## 1.1. GENERAL DESCRIPTION OF EUT

| | | |
|---|---|---|
| **Equipment** | Portable Monitor | |
| **Modle Name** | RICOH Portable Monitor 150BW | |
| **Series Model** | RICOH Light Monitor 150BW | |
| **Brand Name** | RICOH | |
| **Model Difference** | Different model distribute to different area. | |
| **Battery Information** | Brand: Baicells Japan<br>Model:SQU-2103<br>Rating: 7.6V / 3740mAh | |
| **Frequency Range** | WLAN 2.4 GHz Band: | 2400 MHz ~ 2483.5 MHz |
| | RLAN 5 GHz Band: | 5150 MHz ~ 5250 MHz<br>5250 MHz ~ 5350 MHz<br>5470 MHz ~ 5725 MHz |
| **Standard(s)** | **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** SAR Reporting v01r02<br>**KDB616217 D04** SAR for laptop and Tablets<br>**FCC§2.1093** Radiofrequency radiation exposure evaluation: portable devices<br>**IEEE C95.1:1992** Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.<br>**IEC/IEEE 62209-1528:2020** Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 1528: Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz) | |

The above equipment has been tested and found compliance with the requirement of the relative standards by BTL Inc.
The test data, data evaluation, and equipment configuration contained in our test report (Ref No. BTL-FCC SAR-1-2207T020) were obtained utilizing the test procedures, test instruments, test sites that has been accredited by the Authority of TAF according to the ISO-17025 quality assessment standard and technical standard(s).

# 2. RF EMISSIONS MEASUREMENT

## 2.1. TEST FACILITY

The test facilities used to collect the test data in this report is **SAR Test room** at the location of No. 68-1, Ln. 169, Sec.2, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan.

## 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 | Rectangula | $\sqrt{3}$ | 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 | ± 1.15 % | ± 1.15 % | ∞ |
| **Test Sample Related** | | | | | | | | |
| Device Positioning | 1.6 1.8 | Normal | 1 | 1 | 1 | ± 1.6 % | ± 1.8 % | 145 |
| Device Holder | 1.5 1.7 | Normal | 1 | 1 | 1 | ± 1.5 % | ± 1.7 % | 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 | 3.52 | 3.52 | ∞ |
| SAR correction | 1.9 | Rectangular | $\sqrt{3}$ | 1 | 0.84 | 1.10 | 1.10 | |
| Liquid Conductivity (mea.) | 2.4 | Rectangular | $\sqrt{3}$ | 0.78 | 0.71 | 1.08 | 1.08 | ∞ |
| Liquid Permittivity (mea.) | 2.4 | Rectangular | $\sqrt{3}$ | 0.26 | 0.26 | 0.36 | 0.36 | ∞ |
| 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)** | | | | | | ± 10.42 % | ± 10.48 % | 361 |
| **Expanded Uncertainty (K = 2)** | | | | | | **± 20.84 %** | **± 20.97 %** | |

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 | 1.6 / 1.8 | Normal | 1 | 1 | 1 | ±1.6 % | ± 1.8 % | 145 |
| Device Holder | 1.5 / 1.7 | Normal | 1 | 1 | 1 | ± 1.5 % | ± 1.7 % | 5 |
| Power Drift | 5.0 | Rectangular | $\sqrt{3}$ | 1 | 1 | ± 2.9 % | ± 2.9 % | ∞ |
| **Phantom and Setup** | | | | | | | | |
| Phantom Production Tolerances | 6.6 | Rectangular | $\sqrt{3}$ | 1 | 1 | 3.81 | 3.81 | ∞ |
| SAR correction | 1.9 | Rectangular | $\sqrt{3}$ | 1 | 0.84 | 1.10 | 0.92 | |
| Liquid Conductivity (mea.) | 2.4 | Rectangular | $\sqrt{3}$ | 0.78 | 0.71 | 1.08 | 0.98 | ∞ |
| Liquid Permittivity (mea.) | 2.4 | Rectangular | $\sqrt{3}$ | 0.26 | 0.26 | 0.36 | 0.36 | ∞ |
| Temp. unc. - Conductivity | 3.4 | Rectangular | $\sqrt{3}$ | 0.78 | 0.71 | 1.53 | 1.39 | ∞ |
| Temp. unc. - Permittivity | 0.4 | Rectangular | $\sqrt{3}$ | 0.23 | 0.26 | 0.05 | 0.06 | ∞ |
| **Combined Standard Uncertainty (K = 1)** | | | | | | ± 11.65 % | ± 11.66 % | 361 |
| **Expanded Uncertainty (K = 2)** | | | | | | **± 23.29 %** | **± 23.33 %** | |

## 2.3. WLAN ANTENNA INFORMATION:

| Ant. | Manufacturer | Antenna Part number | Type | Frequency Range (MHz) | Gain (dBi) |
|---|---|---|---|---|---|
| Main | Pulse Electronics | TZ22940 | PIFA | 2400 - 2483.5 | 1.44 |
| | | | | 5150 - 5250 | 2.95 |
| | | | | 5250 - 5350 | 2.89 |
| | | | | 5470 - 5725 | 2.82 |
| Aux | Pulse Electronics | TZ22950 | PIFA | 2400 - 2483.5 | 1.23 |
| | | | | 5150 - 5250 | 2.97 |
| | | | | 5250 - 5350 | 2.28 |
| | | | | 5470 - 5725 | 2.52 |

## 2.4. THE MAXIMUM SAR 1G VALUES

| Band | Mode | Highest Body Reported SAR-1g(W/kg) |
|---|---|---|
| **DTS** | **Wi-Fi 2.4G** | **0.911** |
| **UNII** | **Wi-Fi 5.2 & 5.3G** | **0.838** |
| | **Wi-Fi 5.6G** | **1.100** |

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 C95.1:2019/IEEE C95.1:2019, the NCRP Report Number 86 for uncontrolled environment and had been tested in accordance with the measurement methods and procedures specified in IEC/IEEE 62209-1528:2020 .

## 2.5. LABORATORY ENVIRONMENT

| | |
|---|---|
| Temperature | Min. = 18ºC, Max. = 25ºC |
| 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. | |

## 2.6. MAIN TEST INSTRUMENTS

| Item | Equipment | Manufacturer | Model | Serial No. | Cal. Date | Cal. Interval |
|---|---|---|---|---|---|---|
| 1 | Data Acquisition Electronics | Speag | DAE4 | 1486 | May. 31, 2022 | 1 Year |
| 2 | E-field Probe | Speag | EX3DV4 | 7369 | May. 28, 2022 | 1 Year |
| 3 | System Validation Dipole | Speag | D2450V2 | 973 | Feb. 08, 2021 | 3 Year |
| 4 | System Validation Dipole | Speag | D5GHzV2 | 1221 | Feb. 09, 2021 | 3 Year |
| 5 | ELI4 Phantom | Speag | ELI4 Phantom V8.0 | 2149 | N/A | N/A |
| 6 | ENA Network Analyzer | Agilent | E5071C | MY46524658 | Mar. 21, 2022 | 1 Year |
| 7 | Signal Generator | R&S | SMR40 | 100502 | Jan. 10, 2022 | 1 Year |
| 8 | Spectrum Analyzer | Keysight | N9020A | MY57120120 | Mar. 7, 2022 | 1 Year |
| 9 | Power Meter | Anritsu | ML2495A | 1128008 | Jun. 1, 2022 | 1 Year |
| 10 | Power Sensor | Anritsu | MA2411B | 1126001 | Jun. 1, 2022 | 1 Year |
| 11 | Dielectric Probe Kit | Agilent | 85070E | 2593 | N/A | N/A |
| 12 | Low pass filter | Mini-Circuits | SLP-2950+ | M108294 | N/A | N/A |
| 13 | Power Amplifier | Mini-Circuits | ZVE-2W-272+ | N650001538 | N/A | N/A |
| 14 | Power Amplifier | Mini-Circuits | ZVE-8G+ | N628801631 | N/A | N/A |
| 15 | Thermometer | PA | O-230PK | N/A | Mar. 10, 2022 | 1 Year |

Remark: “N/A” denotes no model name, serial No. or calibration specified.

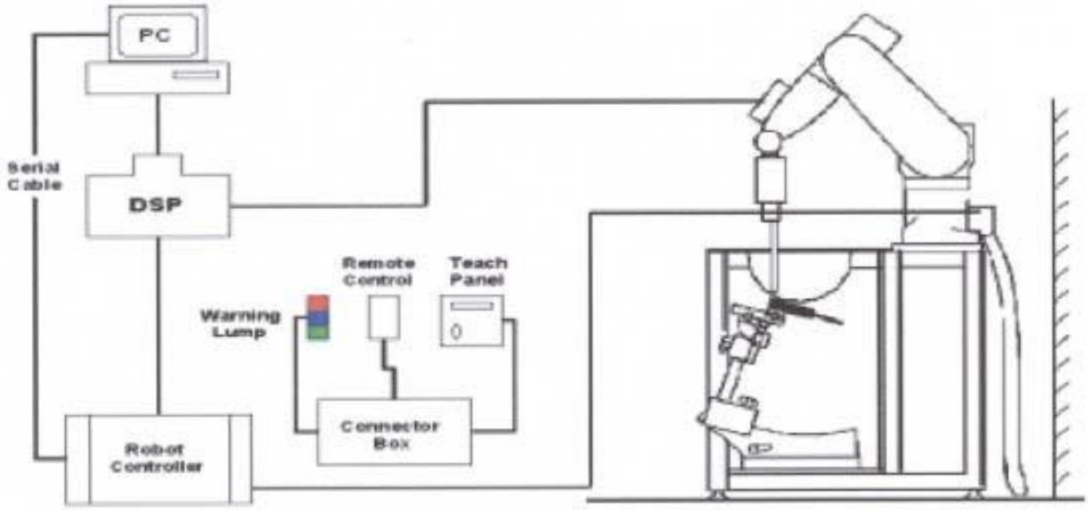
# 3. SAR MEASUREMENTS SYSTEM CONFIGURATION

## 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. The DASY5 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

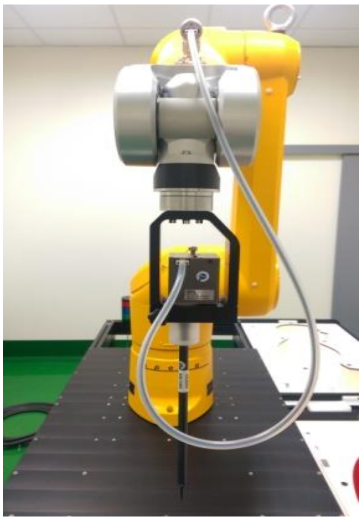


## 3.2. DASY5 E-FIELD PROBE SYSTEM

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. EX3DV4 PROBE SPECIFICATION

| | |
|---|---|
| **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 |



**EX3DV4 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.

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

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

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

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

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

Where: σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m3).

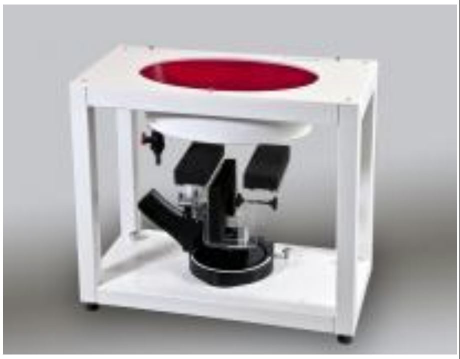
## 3.2.3. OTHER TEST EQUIPMENT

### 3.2.3.1. DEVICE HOLDER FOR TRANSMITTERS

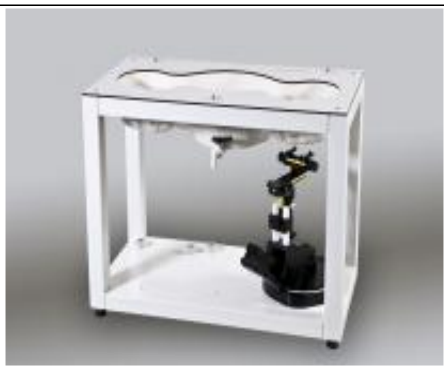
**Construction:** Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.) It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin SAM, ELI4 and SAM v6.0 Phantoms.
**Material:** POM, Acrylic glass, Foam

### 3.2.3.2. PHANTOM

| Model | ELI4 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 |

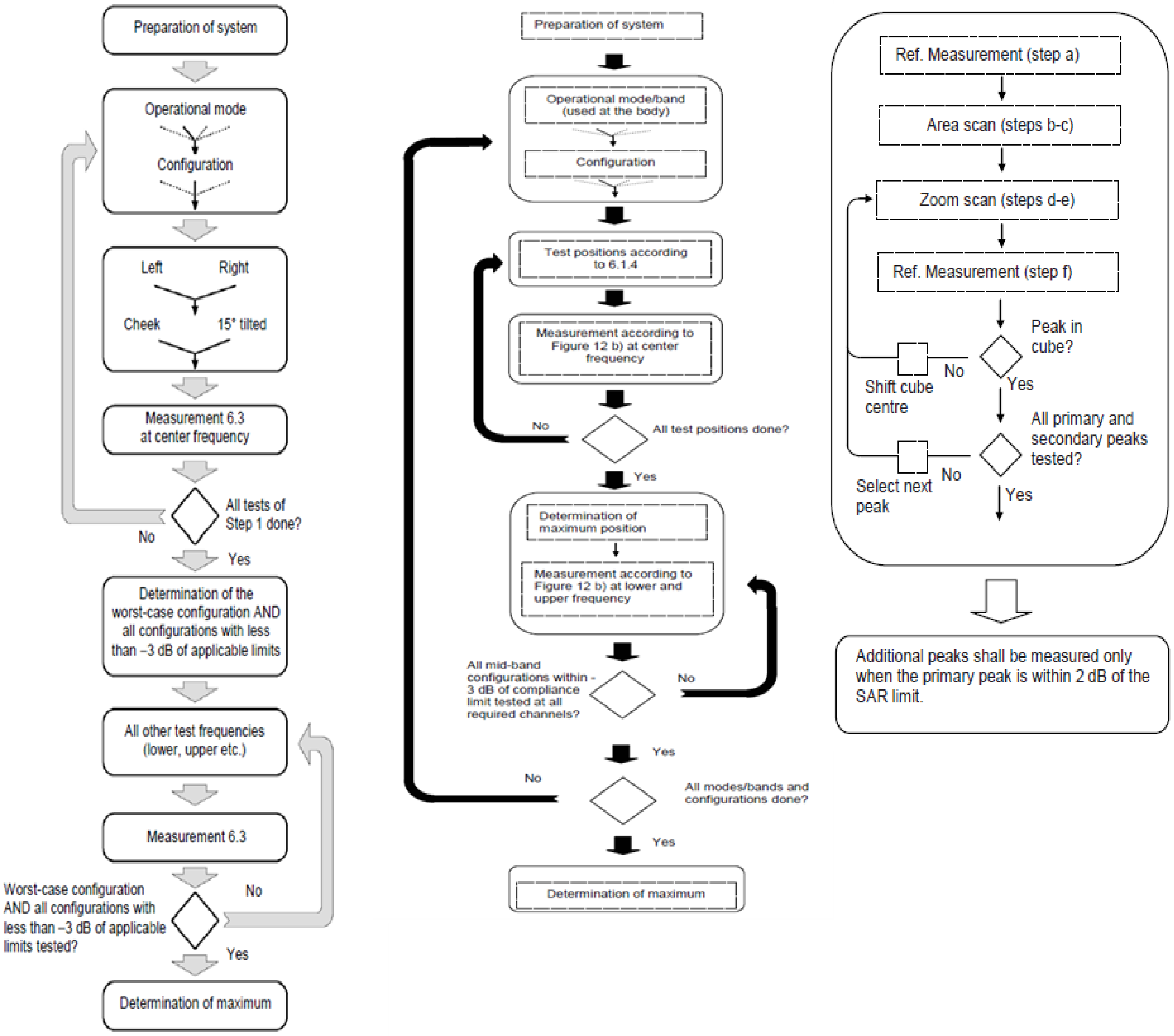


| Model | Twin SAM |
|---|---|
| Construction | The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot. |
| Shell Thickness | 2 ± 0.2 mm |
| Filling Volume | Approx. 25 liters |
| Dimensions | Length:1000mm; Width: 500mm<br>Height: adjustable feet |
| Aailable | Special |



### 3.2.4. SCANNING PROCEDURE

The SAR test against the head and body-worn phantom was carried out as follow:




After an area scan has been done at a fixed distance of 1.4mm from the surface of the phantom on the source side, a 3D scan is set up around the location of the maximum spot SAR. First, a point within the scan area is visited by the probe and a SAR reading taken at the start of testing. At the end of testing, the probe is returned to the same point and a second reading is taken. Comparison between these start and end readings enables the power drift during measurement to be assessed.

Above is the scanning procedure flow chart and table from the IEEE1528 standard.

This is the procedure for which all compliant testing should be carried out to ensure that all variations of the device position and transmission behavior are tested.

## 3.2.5. DATA STORAGE AND EVALUATION

### 3.2.5.1. 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 “DAE4”. 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.

### 3.2.6. 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 multimeter 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:

$$Vi = Ui + Ui2 \cdot cf / dcpi$$

| | | |
|---|---|---|
| With | Vi = compensated signal of channel i | ( i = x, y, z ) |
| | Ui = input signal of channel i | ( i = x, y, z ) |
| | cf = crest factor of exciting field | (DASY parameter) |
| | dcpi = diode compression point | (DASY parameter) |

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

E-field probes: Ei = ( Vi / Normi · ConvF )1/2

H-field probes: Hi = ( Vi )1/2 · ( ai0 + ai1 f + ai2f2 ) / f

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

Normi = 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]

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):

Etot = (EX2+ EY2+ EZ2)1/2

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

SAR = (Etot) 2 · σ / (ρ· 1000)

With SAR = local specific absorption rate in mW/g

Etot = total field strength in V/m

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

= equivalent tissue density in g/cm3

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.

Ppwe = Etot2 / 3770 or Ppwe = Htot2 · 37.7

With Ppwe = equivalent power density of a plane wave in mW/cm

Etot = total field strength in V/m

Htot = total magnetic field strength in A/m

# 4. TISSUE-EQUIVALENT LIQUID

## 4.1. TISSUE-EQUIVALENT LIQUID INGREDIENTS

The liquid is consisted of water, salt and Glycol, Sugar, Preventol and Cellulose. The liquid has previously been proven to be suited for worst-case. The measured conductivity and relative permittivity should be within ±5% of the target values. The below table shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEC 62209.

**Composition of the Tissue Equivalent Matter**

| Tissue Type | Bactericide | DGBE | HEC | NaCl | Sucrose | Triton X-100 | Water | Diethylene Glycol Mono-hexylether |
|---|---|---|---|---|---|---|---|---|
| Head 2450 | - | 45.0 | - | 0.1 | - | - | 54.9 | - |
| Head 5G | - | - | - | - | - | 17.2 | 65.5 | 17.3 |

## 4.2. TISSUE-EQUIVALENT LIQUID PROPERTIES

Dielectric Performance of Tissue Simulating Liquid

| Tissue Verification | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Tissue Type | Frequency (MHz) | Conductivity (σ) | Permittivity (εr) | Targeted Conductivity (σ) | Targeted Permittivity (εr) | Deviation Conductivity (σ) (%) | Deviation Permittivity (εr) (%) | Limit (%) ±5 |
| 2022/8/26 | Head | 2402 | 1.78 | 39.74 | 1.76 | 39.29 | 1.25 | 1.15 | ±5 |
| 2022/8/26 | Head | 2412 | 1.79 | 39.71 | 1.77 | 39.27 | 1.30 | 1.12 | ±5 |
| 2022/8/26 | Head | 2422 | 1.79 | 39.69 | 1.78 | 39.25 | 0.85 | 1.12 | ±5 |
| 2022/8/26 | Head | 2437 | 1.81 | 39.65 | 1.79 | 39.22 | 1.23 | 1.10 | ±5 |
| 2022/8/26 | Head | 2441 | 1.81 | 39.63 | 1.79 | 39.21 | 1.00 | 1.07 | ±5 |
| 2022/8/26 | Head | 2450 | 1.82 | 39.63 | 1.80 | 39.20 | 1.11 | 1.10 | ±5 |
| 2022/8/26 | Head | 2452 | 1.82 | 39.63 | 1.80 | 39.19 | 1.00 | 1.12 | ±5 |
| 2022/8/26 | Head | 2462 | 1.83 | 39.63 | 1.81 | 39.18 | 0.99 | 1.15 | ±5 |
| 2022/8/26 | Head | 2480 | 1.85 | 39.58 | 1.83 | 39.16 | 0.98 | 1.07 | ±5 |
| 2022/8/25 | Head | 5180 | 4.58 | 36.25 | 4.64 | 36.02 | -1.34 | 0.64 | ±5 |
| 2022/8/25 | Head | 5200 | 4.59 | 36.16 | 4.66 | 36.00 | -1.51 | 0.44 | ±5 |
| 2022/8/25 | Head | 5220 | 4.63 | 36.17 | 4.68 | 35.98 | -1.09 | 0.52 | ±5 |
| 2022/8/25 | Head | 5240 | 4.67 | 36.18 | 4.70 | 35.96 | -0.68 | 0.60 | ±5 |
| 2022/8/25 | Head | 5260 | 4.69 | 36.15 | 4.72 | 35.94 | -0.62 | 0.58 | ±5 |
| 2022/8/25 | Head | 5280 | 4.70 | 36.08 | 4.74 | 35.92 | -0.93 | 0.45 | ±5 |
| 2022/8/25 | Head | 5300 | 4.70 | 36.02 | 4.76 | 35.90 | -1.24 | 0.33 | ±5 |
| 2022/8/25 | Head | 5320 | 4.74 | 36.00 | 4.78 | 35.88 | -0.80 | 0.32 | ±5 |
| 2022/8/25 | Head | 5500 | 4.93 | 35.70 | 4.96 | 35.60 | -0.57 | 0.28 | ±5 |
| 2022/8/25 | Head | 5520 | 4.96 | 35.64 | 4.98 | 35.58 | -0.35 | 0.17 | ±5 |
| 2022/8/25 | Head | 5540 | 5.00 | 35.58 | 5.00 | 35.56 | -0.13 | 0.06 | ±5 |
| 2022/8/25 | Head | 5560 | 5.02 | 35.54 | 5.03 | 35.54 | -0.10 | 0.00 | ±5 |
| 2022/8/25 | Head | 5580 | 5.03 | 35.52 | 5.05 | 35.52 | -0.27 | 0.01 | ±5 |
| 2022/8/25 | Head | 5600 | 5.05 | 35.50 | 5.07 | 35.50 | -0.70 | 0.01 | ±5 |
| 2022/8/25 | Head | 5620 | 5.08 | 35.44 | 5.09 | 35.48 | -0.21 | -0.10 | ±5 |
| 2022/8/25 | Head | 5640 | 5.11 | 35.38 | 5.11 | 35.46 | 0.02 | -0.22 | ±5 |
| 2022/8/25 | Head | 5660 | 5.14 | 35.35 | 5.13 | 35.44 | 0.12 | -0.26 | ±5 |
| 2022/8/25 | Head | 5680 | 5.16 | 35.35 | 5.15 | 35.42 | 0.11 | -0.21 | ±5 |
| 2022/8/25 | Head | 5700 | 5.17 | 35.34 | 5.17 | 35.40 | 0.09 | -0.16 | ±5 |
| 2022/8/25 | Head | 5720 | 5.20 | 35.27 | 5.19 | 35.38 | 0.17 | -0.30 | ±5 |
| 2022/8/25 | Head | 5745 | 5.23 | 35.19 | 5.22 | 35.35 | 0.26 | -0.45 | ±5 |
| 2022/8/25 | Head | 5765 | 5.25 | 35.17 | 5.24 | 35.33 | 0.35 | -0.46 | ±5 |
| 2022/8/25 | Head | 5785 | 5.28 | 35.16 | 5.26 | 35.31 | 0.45 | -0.42 | ±5 |
| 2022/8/25 | Head | 5800 | 5.30 | 35.16 | 5.27 | 35.30 | 0.52 | -0.41 | ±5 |
| 2022/8/25 | Head | 5805 | 5.30 | 35.14 | 5.28 | 35.29 | 0.52 | -0.42 | ±5 |
| 2022/8/25 | Head | 5825 | 5.32 | 35.08 | 5.30 | 35.27 | 0.52 | -0.53 | ±5 |

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) According to FCC TCB workshop April, 2019 RF Exposure Procedures Update(Effective February 19,2019, FCC has permitted the use of single head-tissue simulating liquid specified in IEEE 62209-1- for all SAR tests.

# 5. SYSTEM CHECK

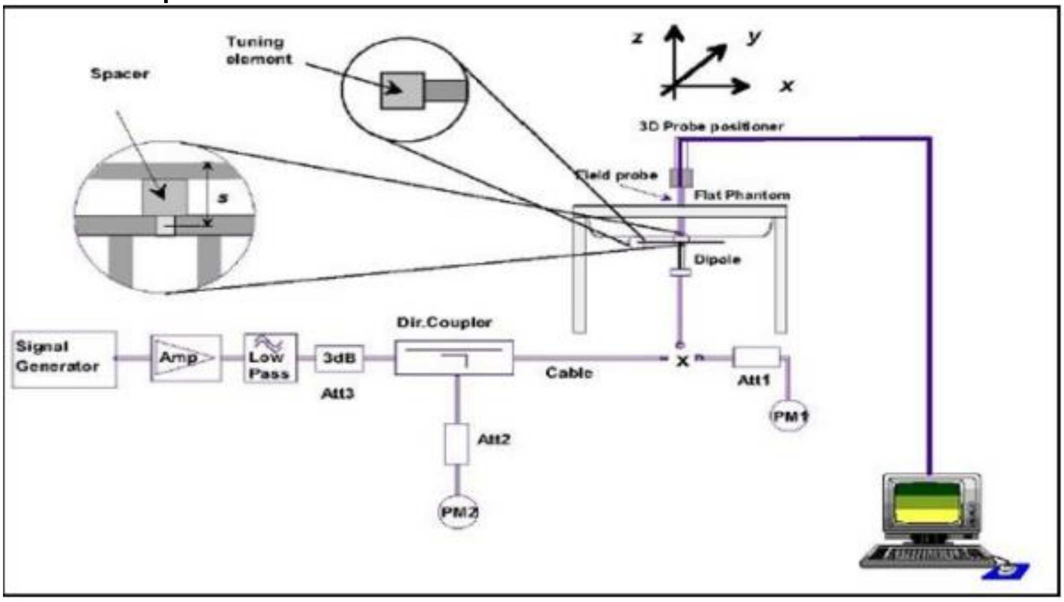
## 5.1. DESCRIPTION OF SYSTEM CHECK

The manufacturer calibrates the probes annually. Dielectric parameters of the tissue simulants were measured every day using the dielectric probe kit and the network analyzer. A system check measurement was made following the determination of the dielectric parameters of the simulant, using the dipole validation kit. A power level of 250 mW(below 3GHz) or 100mW(3-6GHz), which was placed under the flat section of the twin SAM phantom. The system check results (dielectric parameters and SAR values) are given in the 6.2.

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

System check is performed regularly on all frequency bands where tests are performed with the DASY5 system.

**System Check Set-up**



## 5.2. DESCRIPTION OF SYSTEM CHECK

### System Check in Tissue Simulating Liquid

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.

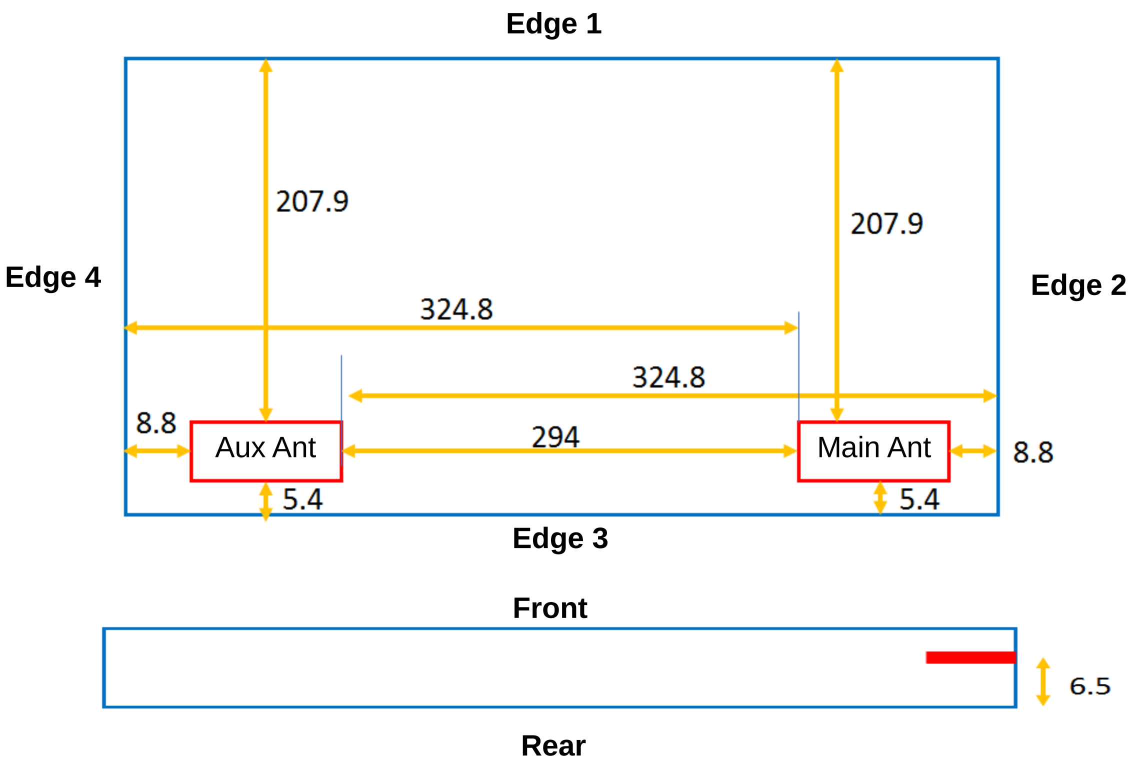
| Date | System Dipole | | | Parameters | Target [W/kg] | Measured [W/kg] | Deviation [%] | Limited [%] |
|---|---|---|---|---|---|---|---|---|
| | Type | Serial No. | Liquid | | | | | |
| 2022/8/26 | D2450V2 | 973 | Head | 1g SAR | 52.5 | 50.8 | -3.24 | ± 10 |
| 2022/8/25 | D5GHzV2 (5.2GHz) | 1221 | Head | 1g SAR | 79.8 | 78.7 | -1.38 | ± 10 |
| 2022/8/25 | D5GHzV2 (5.3GHz) | 1221 | Head | 1g SAR | 81.9 | 80.0 | -2.32 | ± 10 |
| 2022/8/25 | D5GHzV2 (5.6GHz) | 1221 | Head | 1g SAR | 84.5 | 77.4 | -8.40 | ± 10 |

# 6. OPERATIONAL CONDITIONS DURING TEST

## 6.1. General Description of Test Procedures

Connection to the EUT is established via air interface with base station An, and the EUT is Set to maximum output power by base station. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output. The antenna connected to the output of the base station simulator shall be placed at least 50cm away from the EUT. The signal transmitted by the simulator to the antenna feeding point shall be lower than the output power level of the EUT by at least 30dB.

## 6.2. Test position Antenna Location




## 6.3. Test Position of Portable Devices

| Minimum Separation Distance | | | |
|---|---|---|---|
| Antenna | Position | Distance (mm) | Evaluation Test |
| Main | Rear | 6.5 | Yes |
| | Edge 1 | 207.9 | No |
| | Edge 2 | 8.8 | Yes |
| | Edge 3 | 5.4 | Yes |
| | Edge 4 | 324.8 | No |
| Aux | Rear | 6.5 | Yes |
| | Edge 1 | 207.9 | No |
| | Edge 2 | 324.8 | No |
| | Edge 3 | 5.4 | Yes |
| | Edge 4 | 8.8 | Yes |

## 6.4. TEST CONFIGURATION

The SAR Exclusion Threshold in KDB 447498 D04 can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an EUT 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 is defined by the following equation:

$$P_{\text{th}}\ (\text{mW}) = \begin{cases} ERP_{20\text{ cm}}(d/20\text{ cm})^{x} & d \leq 20\text{ cm} \\ ERP_{20\text{ cm}} & 20\text{ cm} < d \leq 40\text{ cm} \end{cases} \qquad (\text{B.2})$$

where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\text{ cm}}\sqrt{f}}\right)$$

and $f$ is in GHz, $d$ is the separation distance (cm), and $ERP_{20\text{cm}}$ is per Formula (B.1).

Example values shown in Table B.2 are for illustration only.

Table B.2—Example Power Thresholds (mW)

| Frequency (MHz) | Distance (mm) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| 300 | 39 | 65 | 88 | 110 | 129 | 148 | 166 | 184 | 201 | 217 |
| 450 | 22 | 44 | 67 | 89 | 112 | 135 | 158 | 180 | 203 | 226 |
| 835 | 9 | 25 | 44 | 66 | 90 | 116 | 145 | 175 | 207 | 240 |
| 1900 | 3 | 12 | 26 | 44 | 66 | 92 | 122 | 157 | 195 | 236 |
| 2450 | 3 | 10 | 22 | 38 | 59 | 83 | 111 | 143 | 179 | 219 |
| 3600 | 2 | 8 | 18 | 32 | 49 | 71 | 96 | 125 | 158 | 195 |
| 5800 | 1 | 6 | 14 | 25 | 40 | 58 | 80 | 106 | 136 | 169 |

| Mode | Ant | Position | Distance (mm) | f (MHz) | Max Power (dBm) | Max Power (mW) | SAR Exclusion threshold(mW) | Test required |
|---|---|---|---|---|---|---|---|---|
| 2.4GHz | Main | Rear | 6.5 | 2437 | 14.00 | 25.12 | 3 | Yes |
| 2.4GHz | Main | Edge 1 | 207.9 | 2437 | 14.00 | 25.12 | 219 | No |
| 2.4GHz | Main | Edge 2 | 8.8 | 2437 | 14.00 | 25.12 | 3 | Yes |
| 2.4GHz | Main | Edge 3 | 5.4 | 2437 | 14.00 | 25.12 | 3 | Yes |
| 2.4GHz | Main | Edge 4 | 324.8 | 2437 | 14.00 | 25.12 | 219 | No |
| 2.4GHz | Aux | Rear | 6.5 | 2437 | 14.00 | 25.12 | 3 | Yes |
| 2.4GHz | Aux | Edge 1 | 207.9 | 2437 | 14.00 | 25.12 | 219 | No |
| 2.4GHz | Aux | Edge 2 | 324.8 | 2437 | 14.00 | 25.12 | 219 | No |
| 2.4GHz | Aux | Edge 3 | 5.4 | 2437 | 14.00 | 25.12 | 3 | Yes |
| 2.4GHz | Aux | Edge 4 | 8.8 | 2437 | 14.00 | 25.12 | 3 | Yes |

| Mode | Ant | Position | Distance (mm) | f (MHz) | Max Power (dBm) | Max Power (mW) | SAR Exclusion threshold(mW) | Test required |
|---|---|---|---|---|---|---|---|---|
| 5.2GHz | Main | Rear | 6.5 | 5210 | 10.00 | 10.00 | 1 | Yes |
| 5.2GHz | Main | Edge 1 | 207.9 | 5210 | 10.00 | 10.00 | 169 | No |
| 5.2GHz | Main | Edge 2 | 8.8 | 5210 | 10.00 | 10.00 | 1 | Yes |
| 5.2GHz | Main | Edge 3 | 5.4 | 5210 | 10.00 | 10.00 | 1 | Yes |
| 5.2GHz | Main | Edge 4 | 324.8 | 5210 | 10.00 | 10.00 | 169 | No |
| 5.2GHz | Aux | Rear | 6.5 | 5210 | 10.00 | 10.00 | 1 | Yes |
| 5.2GHz | Aux | Edge 1 | 207.9 | 5210 | 10.00 | 10.00 | 169 | No |
| 5.2GHz | Aux | Edge 2 | 324.8 | 5210 | 10.00 | 10.00 | 169 | No |
| 5.2GHz | Aux | Edge 3 | 5.4 | 5210 | 10.00 | 10.00 | 1 | Yes |
| 5.2GHz | Aux | Edge 4 | 8.8 | 5210 | 10.00 | 10.00 | 1 | Yes |

| Mode | Ant | Position | Distance (mm) | f (MHz) | Max Power (dBm) | Max Power (mW) | SAR Exclusion threshold(mW) | Test required |
|---|---|---|---|---|---|---|---|---|
| 5.3GHz | Main | Rear | 6.5 | 5290 | 10.00 | 10.00 | 1 | Yes |
| 5.3GHz | Main | Edge 1 | 207.9 | 5290 | 10.00 | 10.00 | 169 | No |
| 5.3GHz | Main | Edge 2 | 8.8 | 5290 | 10.00 | 10.00 | 1 | Yes |
| 5.3GHz | Main | Edge 3 | 5.4 | 5290 | 10.00 | 10.00 | 1 | Yes |
| 5.3GHz | Main | Edge 4 | 324.8 | 5290 | 10.00 | 10.00 | 169 | No |
| 5.3GHz | Aux | Rear | 6.5 | 5290 | 10.00 | 10.00 | 1 | Yes |
| 5.3GHz | Aux | Edge 1 | 207.9 | 5290 | 10.00 | 10.00 | 169 | No |
| 5.3GHz | Aux | Edge 2 | 324.8 | 5290 | 10.00 | 10.00 | 169 | No |
| 5.3GHz | Aux | Edge 3 | 5.4 | 5290 | 10.00 | 10.00 | 1 | Yes |
| 5.3GHz | Aux | Edge 4 | 8.8 | 5290 | 10.00 | 10.00 | 1 | Yes |

| Mode | Ant | Position | Distance (mm) | f (MHz) | Max Power (dBm) | Max Power (mW) | SAR Exclusion threshold(mW) | Test required |
|---|---|---|---|---|---|---|---|---|
| 5.6GHz | Main | Rear | 6.5 | 5530 | 10.00 | 10.00 | 1 | Yes |
| 5.6GHz | Main | Edge 1 | 207.9 | 5530 | 10.00 | 10.00 | 169 | No |
| 5.6GHz | Main | Edge 2 | 8.8 | 5530 | 10.00 | 10.00 | 1 | Yes |
| 5.6GHz | Main | Edge 3 | 5.4 | 5530 | 10.00 | 10.00 | 1 | Yes |
| 5.6GHz | Main | Edge 4 | 324.8 | 5530 | 10.00 | 10.00 | 169 | No |
| 5.6GHz | Aux | Rear | 6.5 | 5530 | 10.00 | 10.00 | 1 | Yes |
| 5.6GHz | Aux | Edge 1 | 207.9 | 5530 | 10.00 | 10.00 | 169 | No |
| 5.6GHz | Aux | Edge 2 | 324.8 | 5530 | 10.00 | 10.00 | 169 | No |
| 5.6GHz | Aux | Edge 3 | 5.4 | 5530 | 10.00 | 10.00 | 1 | Yes |
| 5.6GHz | Aux | Edge 4 | 8.8 | 5530 | 10.00 | 10.00 | 1 | Yes |

# 7. SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

## 7.1.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.
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 8.2.

## 7.2. WIFI TEST CONFIGURATION

For WLAN SAR testing, WLAN engineering testing software installed on the DUT can provide continuous transmitting RF signal.

**WLAN 2.4G**

| Mode | 802.11b | 802.11g | 802.11n HT20 |
|---|---|---|---|
| Duty cycle | 100% | | |
| Crest factor | 1 | | |

**RLAN 5G**

| Mode | 802.11a | 802.11n HT20 | 802.11n HT40 | 802.11 ac20 | 802.11 ac40 | 802.11 ac80 |
|---|---|---|---|---|---|---|
| Duty cycle | 100% | | | | | |
| Crest factor | 1 | | | | | |

For WiFi SAR testing, a communication link is set up with the test mode software for WiFi mode test. During the test, at the each test frequency channel, the EUT is operated at the RF continuous emission mode. The RF signal utilized in SAR measurement has 100% duty cycle and its crest factor is 1. The test procedures in KDB 248227 D01 are applied.

### 7.2.1. WLAN 2.4G SAR TEST REQUIREMENTS

**802.11b DSSS SAR Test Requirements**
SAR is measured for 2.4 GHz 802.11b DSSS using either a fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:
1) When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
2) When the reported SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

**2.4 GHz 802.11g/n OFDM SAR Test Exclusion Requirements**
When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied. SAR is not required for the following 2.4 GHz OFDM conditions.
1) When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.
2) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg. **SAR Test Requirements for OFDM configurations**
When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, each standalone and frequency aggregated band is considered separately for SAR test reduction. In applying the initial test configuration and subsequent test configuration procedures, the 802.11 transmission configuration with the highest specified maximum output power and the channel within a test configuration with the highest measured maximum output power should be clearly distinguished to apply the procedures.

### 7.2.2. WLAN 5G SAR TEST REQUIREMENTS

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

**U-NII-2C, Band**
The frequency range covered by these bands is 380 MHz (5.47 – 5.85 GHz), which requires a minimum of at least two SAR probe calibration frequency points to support SAR measurements. When Terminal Doppler Weather Radar (TDWR) restriction applies, the channels at 5.60 – 5.65 GHz in U-NII-2C band must be disabled with acceptable mechanisms and documented in the equipment certification.
Unless band gap channels are permanently disabled, they must be considered for SAR testing.
To maintain SAR measurement accuracy and to facilitate test reduction, the channels in U-NII-2C band above 5.65 GHz may be grouped with the 5.8 GHz channels in U-NII-3 or §15.247 band to enable two SAR probe calibration frequency points to cover the bands, including the band gap channels.11 When band gap channels are supported and the bands are not aggregated for SAR testing, band gap channels must be considered independently in each band according to the normally required OFDM SAR measurement and probe calibration frequency points requirements.

### 7.2.3. OFDM TRANSMISSION MODE AND SAR TEST CHANNEL SELECTION

For the 2.4GHz and 5GHz bands, when the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration with the largest channel bandwidth, lowest order modulation and lowest data rate. When the maximum output power of a channel is the same for equivalent OFDM configurations(for example 802.11a,802.11n and 802.11ac,or 802.11g and 802.11n,with the same channel bandwidth, modulation, and data rate, etc.), the lower order 802.11 mode(i.e.802.11a then 802.11n and 802.11ac,or 802.11g then 802.11n) is used for SAR measurement. When the maximum output power are the same for multiple test channels, either according to the default or additional power measurement requirements, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

### 7.2.4. INITIAL TEST CONFIGURATION PROCEDURE

For OFDM, in both 2.4G and 5GHz bands, an initial test configuration is determined for each frequency band and aggregated band, according to the transmission mode with the highest maximum output power specified for SAR measurements. When the same maximum output power is specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration(s) with the largest channel bandwidth, lowest order modulation, and lowest data rate. If the average RF output powers of the highest identical transmission modes are within 0.25 dB of each other, mid channel of the transmission mode with highest average RF output powers is the initial test channel. Otherwise, the channel of the transmission mode with the highest average RF output power will be the initial test configuration.
When the reported SAR is ≤ 0.8 W/kg, no additional measurements on other test channels are required. Otherwise, SAR is evaluated using the subsequent highest average RF output channel until the reported SAR result is ≤1.2 W/kg or all channels are measured. When there are multiple untested channels having the same subsequent highest average RF output power, the channel with higher frequency from the lowest 802.11 mode is considered for SAR measurement.

# 8. CONDUCTED POWER RESULTS

## 8.1. CONDUCTED POWER MEASUREMENT RESULTS OF 2.4G BAND

| Band | Mode | Channe | Frequenc (MHz) | Data Rate | Max Tune-U Power (dBm | AVG Power (dBm | |
|---|---|---|---|---|---|---|---|
| | | | | | | Main | Aux |
| 2.4G | 802.11b | 1 | 2412 | 1 | 14.00 | 13.87 | |
| | 802.11b | 6 | 2442 | 1 | 14.00 | 13.92 | |
| | 802.11b | 11 | 2472 | 1 | 14.00 | 13.88 | |
| | 802.11g | 1-11 | 2412-2462 | 6 | 14.00 | Not Required | |
| | 802.11n20 | 1-11 | 2412-2462 | HT0 | 14.00 | | |
| | 802.11b | 1 | 2412 | 1 | 14.00 | | 13.76 |
| | 802.11b | 6 | 2442 | 1 | 14.00 | | 13.88 |
| | 802.11b | 11 | 2472 | 1 | 14.00 | | 13.74 |
| | 802.11g | 1-11 | 2412-2462 | 6 | 14.00 | Not Required | |
| | 802.11n20 | 1-11 | 2412-2462 | HT0 | 14.00 | | |

Note:

1. As per FCC OET KDB 248227 D01, conducted output power and SAR testing are not required for 802.11b/g/n20 channels when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2W/kg.

## 8.2. CONDUCTED POWER MEASUREMENTS OF 5G UNII_1

| Band | Mode | Channe | Frequency (MHz) | Data Rate | Max Tune-Up Power (dBm) | AVG Power (dBm | |
|---|---|---|---|---|---|---|---|
| | | | | | | Main | Aux |
| UNII_1 | 802.11a | 36-48 | 5180-5240 | 6 | 10.00 | Not Required | |
| | 802.11 n20 | 36-48 | 5180-5240 | HT0 | 10.00 | | |
| | 802.11 n40 | 38-46 | 5190-5230 | HT0 | 10.00 | | |
| | 802.11 ac20 | 36-48 | 5180-5240 | VHT0 | 10.00 | | |
| | 802.11 ac40 | 38-46 | 5190-5230 | VHT0 | 10.00 | | |
| | 802.11 ac80 | 42 | 5210 | VHT0 | 10.00 | 9.92 | |
| UNII_1 | 802.11a | 36-48 | 5180-5240 | 6 | 10.00 | Not Required | |
| | 802.11 n20 | 36-48 | 5180-5240 | HT0 | 10.00 | | |
| | 802.11 n40 | 38-46 | 5190-5230 | HT0 | 10.00 | | |
| | 802.11 ac20 | 36-48 | 5180-5240 | VHT0 | 10.00 | | |
| | 802.11 ac40 | 38-46 | 5190-5230 | VHT0 | 10.00 | | |
| | 802.11 ac80 | 42 | 5210 | VHT0 | 10.00 | | 9.89 |

Note:
1. When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band (see §B.5.2 in this document).
2. The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple transmission modes (802.11a/g/n/ac/ax) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, ac then ax).

## 8.3. CONDUCTED POWER MEASUREMENTS OF 5G UNII_2A

| Band | Mode | Channel | Frequency (MHz) | Data Rate | Max Tune-Up Power (dBm) | AVG Power (dBm) | |
|---|---|---|---|---|---|---|---|
| | | | | | | Main | Aux |
| UNII_2a | 802.11a | 52-64 | 5260-5320 | 6 | 10.00 | Not Required | |
| | 802.11 n20 | 52-64 | 5260-5320 | HT0 | 10.00 | | |
| | 802.11 n40 | 54-62 | 5270-5310 | HT0 | 10.00 | | |
| | 802.11 ac20 | 52-64 | 5260-5320 | VHT0 | 10.00 | | |
| | 802.11 ac40 | 54-62 | 5270-5310 | VHT0 | 10.00 | | |
| | 802.11 ac80 | 58 | 5290 | VHT0 | 10.00 | 9.96 | |
| UNII_2a | 802.11a | 52-64 | 5260-5320 | 6 | 10.00 | Not Required | |
| | 802.11 n20 | 52-64 | 5260-5320 | HT0 | 10.00 | | |
| | 802.11 n40 | 54-62 | 5270-5310 | HT0 | 10.00 | | |
| | 802.11 ac20 | 52-64 | 5260-5320 | VHT0 | 10.00 | | |
| | 802.11 ac40 | 54-62 | 5270-5310 | VHT0 | 10.00 | | |
| | 802.11 ac80 | 58 | 5290 | VHT0 | 10.00 | | 9.93 |

Note:
1. When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band (see §B.5.2 in this document).
2. The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple transmission modes (802.11a/g/n/ac/ax) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, ac then ax).
3. Largest channel bandwidth is worse than lowest order modulation.

## 8.4. CONDUCTED POWER MEASUREMENTS OF 5G UNII_2C

| Band | Mode | Channe | Frequency (MHz) | Data Rate | Max Tune-Up Power (dBm) | AVG Power (dBm | |
|---|---|---|---|---|---|---|---|
| | | | | | | Main | Aux |
| UNII_2 | 802.11a | 100-140 | 5500-5700 | 6 | 10.00 | Not Required | |
| | 802.11 n20 | 100-140 | 5500-5700 | HT0 | 10.00 | | |
| | 802.11 n40 | 102-134 | 5510-5670 | HT0 | 10.00 | | |
| | 802.11 ac20 | 100-140 | 5500-5700 | VHT0 | 10.00 | | |
| | 802.11 ac40 | 100-140 | 5500-5700 | VHT0 | 10.00 | | |
| | 802.11 ac80 | 106 | 5530 | VHT0 | 10.00 | 9.97 | |
| | 802.11 ac80 | 138 | 5690 | VHT0 | 10.00 | 9.84 | |
| UNII_2 | 802.11a | 100-140 | 5500-5700 | 6 | 10.00 | Not Required | |
| | 802.11 n20 | 100-140 | 5500-5700 | HT0 | 10.00 | | |
| | 802.11 n40 | 102-134 | 5510-5670 | HT0 | 10.00 | | |
| | 802.11 ac20 | 100-140 | 5500-5700 | VHT0 | 10.00 | | |
| | 802.11 ac40 | 100-140 | 5500-5700 | VHT0 | 10.00 | | |
| | 802.11 ac80 | 106 | 5530 | VHT0 | 10.00 | | 9.96 |
| | 802.11 ac80 | 138 | 5690 | VHT0 | 10.00 | | 9.88 |

Note:
1. When band gap channels between U-NII-2C and U-NII-3 band are supported channels in U-NII-2C band below 5.65 GHz are considered as one band and channels above 5.65 GHz, together with channels in 5.8 GHz U-NII-3 or §15.247 band, are considered as a separate band
2. The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple transmission modes (802.11a/g/n/ac/ax) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, ac then ax).
3. Largest channel bandwidth is worse than lowest order modulation.

## 8.5. 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 D04,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.

**WLAN Notes:**

1. For exposure conditions with multiple test positions, such as handset operating next to the ear, devices with hotspot mode, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all positions in an exposure condition. The test position with the highest extrapolated(peak) SAR is used as the initial test position. When the reported SAR of the initial test position is ≤ 0.4 W/kg, further SAR measurement is not required for the other (remaining) test positions. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.

2. Justification for test configurations for WLAN per KDB Publication 248227 for 2.4GHz WIFI single transmission chain operations, the highest measured maximum output power Channel for DSSS was selected for SAR measurement. SAR for OFDM modes(2.4GHz 802.11g/n) was not required due to the maximum allowed powers and the highest reported DSSS SAR. See Section7.1.4 for more information.

3. Justification for test configurations for WLAN per KDB Publication 248227 for 5GHz WIFI single transmission chain operations, the initial test configuration was selected according to the transmission mode with the highest maximum allowed power. Other transmission mode was not investigated since the highest reported SAR for initial test configuration adjusted by the ratio of maximum output powers is less than1.2W/kg. See Section 7.1.4 for more information.

# 9. SAR TEST RESULTS

## 9.1. BODY SAR TEST RESULTS

SAR test results of 2.4G WiFi_separation distance=0 mm

| Mode | Channel | Test Position | Ant | Max une-up (dBm) | AVG Power (dBm) | Area Scan | SAR 1g | Reported SAR 1g | Note |
|---|---|---|---|---|---|---|---|---|---|
| 802.11b | 6 | Rear | Main | 14.00 | 13.92 | 0.447 | 0.450 | 0.458 | |
| | 6 | Edge 2 | Main | 14.00 | 13.92 | 0.147 | 0.144 | 0.147 | |
| | 6 | Edge 3 | Main | 14.00 | 13.92 | 0.472 | 0.502 | 0.511 | |
| | 1 | Rear | Main | 14.00 | 13.87 | 0.569 | 0.507 | **0.522** | |
| | 11 | Rear | Main | 14.00 | 13.88 | 0.445 | 0.433 | 0.445 | |
| 802.11b | 6 | Rear | Aux | 14.00 | 13.88 | 0.928 | 0.877 | 0.902 | |
| | 6 | Edge 3 | Aux | 14.00 | 13.88 | 0.617 | 0.641 | 0.659 | |
| | 6 | Edge 4 | Aux | 14.00 | 13.88 | 0.173 | 0.189 | 0.194 | |
| | 1 | Rear | Aux | 14.00 | 13.76 | 0.920 | 0.862 | **0.911** | 1 |
| | 11 | Rear | Aux | 14.00 | 13.74 | 0.800 | 0.768 | 0.815 | 1 |
| 802.11b | 1 | Rear | Aux | 14.00 | 13.76 | 0.769 | 0.737 | 0.779 | 2 |

Note:

1. Highest reported SAR is > 0.8 W/kg. Added second highest power channel for this test position
2. Repeated measurements are required only when the measured SAR is ≥0.80 W/kg. If the measured SAR values are < 1.45 W/kg with ≤20% variation, only one repeated measurement is required to reaffirm that the results are not expected to have substantial variations, which may introduce significant compliance concerns. (Per KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04)
   Original SAR = 0.862 W/kg, therefore second times repeat SAR is required.
   Repeat SAR = 0.737W/kg < 1.45W/kg
   SAR variation= -14.50% < 20%

SAR test results of 5G WiFi_separation distance=0 mm

| Band | Mode | Channel | Test Position | Ant | Max une-up (dBm) | AVG Power (dBm) | Area Scan | SAR 1g | Reported SAR 1g | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| UNII 1&2a | 802.11 ac80 | 58 | Rear | Main | 10.00 | 9.96 | 0.441 | 0.553 | **0.558** | |
| | | 42 | Rear | | 10.00 | 9.92 | 0.434 | 0.543 | 0.553 | |
| | | 58 | Edge 2 | | 10.00 | 9.96 | 0.102 | 0.107 | 0.108 | |
| | | 58 | Edge 3 | | 10.00 | 9.96 | 0.110 | 0.099 | 0.100 | |
| | | 58 | Rear | Aux | 10.00 | 9.93 | 0.694 | 0.812 | 0.825 | |
| | | 42 | Rear | | 10.00 | 9.89 | 0.681 | 0.817 | **0.838** | 1 |
| | | 58 | Edge 3 | | 10.00 | 9.93 | 0.105 | 0.099 | 0.101 | |
| | | 58 | Edge 4 | | 10.00 | 9.93 | 0.140 | 0.128 | 0.130 | |
| UNII 2c | 802.11 ac80 | 106 | Rear | Main | 10.00 | 9.97 | 0.722 | 0.817 | 0.823 | |
| | | 138 | Rear | | 10.00 | 9.84 | 0.817 | 0.956 | **0.992** | 1 |
| | | 106 | Edge 2 | | 10.00 | 9.97 | 0.179 | 0.173 | 0.174 | |
| | | 106 | Edge 3 | | 10.00 | 9.97 | 0.188 | 0.174 | 0.175 | |
| | | 106 | Rear | Aux | 10.00 | 9.96 | 0.884 | 1.090 | **1.100** | |
| | | 138 | Rear | | 10.00 | 9.88 | 0.859 | 1.050 | 1.079 | 1 |
| | | 106 | Edge 3 | | 10.00 | 9.96 | 0.182 | 0.154 | 0.155 | |
| | | 106 | Edge 4 | | 10.00 | 9.96 | 0.180 | 0.175 | 0.177 | |
| UNII 2C | 802.11ac80 | 106 | Rear | Aux | 10.00 | 9.96 | 0.596 | 0.987 | 0.996 | 2 |

Note:

1. Highest reported SAR is > 0.8 W/kg. Added second highest power channel for this test position
2. Repeated measurements are required only when the measured SAR is ≥0.80 W/kg. If the measured SAR values are < 1.45 W/kg with ≤20% variation, only one repeated measurement is required to reaffirm that the results are not expected to have substantial variations, which may introduce significant compliance concerns. (Per KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04)
   Original SAR = 1.090 W/kg, therefore second times repeat SAR is required.
   Repeat SAR = 0.987W/kg < 1.45W/kg
   SAR variation= -9.45% < 20%

# 10. SIMULTANEOUS TRANSMISSION CONDITIONS

## 10.1. STAND-ALONE SAR TEST EXCLUSION

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. | Configuration |
|---|---|
| 1 | WLAN 2.4G(Main) |
| 2 | RLAN 5G(Main) |
| 3 | WLAN 2.4G(Main)+ WLAN 2.4G(Aux) |
| 4 | RLAN 5G(Main)+ RLAN 5G(Aux) |

## 10.2. SIMULTANEOUS TRANSMISSION CONDITIONS

KDB 447498 D04 introduces a new formula for calculating the SAR to Peak Location Ratio (SPLSR) between pairs of simultaneously transmitting antennas:

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

***$SAR_1$*** is the highest Reported or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition

***$SAR_2$*** is the highest Reported or estimated SAR for the second of a pair of simultaneous transmitting antennas, in the same test operating mode and exposure condition as the first

***$R_i$*** is the separation distance between the pair of simultaneous transmitting antennas. When the SAR is measured, for both antennas in the pair, it is determined by the actual x, y and z coordinates in the 1-g SAR for each SAR peak location, based on the extrapolated and interpolated result in the zoom scan measurement, using the formula of $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$

A new threshold of 0.04 is also introduced in the KDB. Thus, in order for a pair of simultaneous transmitting antennas with the sum of 1-g SAR > 1.6 W/kg to qualify for exemption from Simultaneous Transmission SAR measurements, it has to satisfy the condition of:
$(SAR_1 + SAR_2)^{1.5} / R_i \leq 0.04$

## 10.3. SIMULTANEOUS TRANSMISSION CONDITIONS

| Test Position / SAR1g(W/kg) | Rear | Edge 2 | Edge 3 | Edge 4 |
|---|---|---|---|---|
| WLAN 2.4G WiFi_Main | 0.522 | 0.147 | 0.511 | |
| WLAN 2.4G WiFi_Aux | 0.911 | | 0.659 | 0.194 |
| UNII_1 & 2a WiFi_Main | 0.558 | 0.108 | 0.100 | |
| UNII_1 & 2a WiFi_Aux | 0.838 | | 0.101 | 0.130 |
| UNII_2c WiFi_Main | 0.992 | 0.174 | 0.175 | |
| UNII_2c WiFi_Aux | 1.100 | | 0.155 | 0.177 |
| WLAN 2.4G_Main+WLAN 2.4G_Aux MAX∑SAR1g | 1.433 | 0.147 | 1.17 | 0.194 |
| RLAN 5G_Main+RLAN 5G_Aux MAX∑SAR1g | 2.092 | 0.174 | 0.33 | 0.177 |

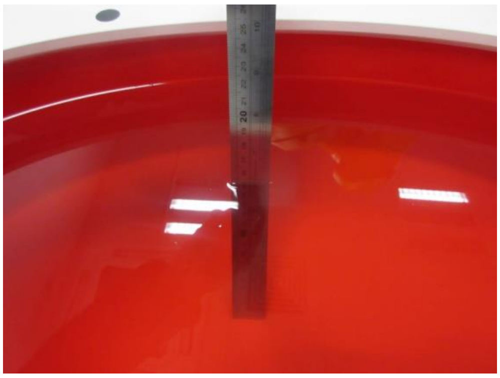
Note:
1. MAX. $\sum SAR_{1g}$= 2.092 W/Kg>1.6 W/Kg, so Peak location SAR are required.
2. Peak location SAR are 0.01 that refer Appendix E .

# 11. TEST LAYOUT

**Specific Absorption Rate Test Layout**

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

HSL(2450MHz) HSL(5GHz)



# Appendix A. SAR Plots of System Verification

**(Pls See BTL-FCC SAR-1-2207T020_Appendix A.)**

# Appendix B. SAR Plots of SAR Measurement

**(Pls See BTL-FCC SAR-1-2207T020_Appendix B.)**

# Appendix C. Calibration Certificate

**(Pls See BTL-FCC SAR-1-2207T020_Appendix C.)**

# Appendix D. Photographs of the Test Set-Up

**(Pls See BTL-FCC SAR-1-2207T020_Appendix D.)**

# Appendix E. SAR SPLSR

**(Pls See BTL-FCC SAR-1-2207T020_Appendix E.)**

**End of Test Report**