**KDB 865664 D01 SAR Measurement 100MHz to 6GHz**
**FCC 47 CFR part 2 (2.1093)**

# SAR EVALUATION REPORT

*For*

**Laptop Computer with IEEE 802.11a/b/g/n/ac (MIMO 2X2) and Bluetooth Radio**

**Model: A1932**
**FCC ID: BCGA1932**

**Report Number UL-SAR-RP12185761JD18A V1.0**
**ISSUE DATE: 15 October 2018**

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**REVISION HISTORY**

| Version | Issue Date | Revisions | Revised By |
|---|---|---|---|
| 1.0 | 15 October 2018 | Initial Issue | -- |
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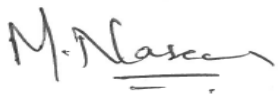
# 1. Attestation of Test Results

| | | | | | | |
|---|---|---|---|---|---|---|
| **Applicant Name** | Apple Inc. | | | | | |
| **Model** | A1932 | | | | | |
| **Test Device is** | A representative test sample | | | | | |
| **Device category** | Portable | | | | | |
| **Date Tested** | 19 September 2018 to 27 September 2018 | | | | | |
| **ICNIRP Guidelines Limits for SAR Exposure Characteristics** | General Population/Localised SAR (Head and trunk): 1g-SAR limit 1.6 W/kg | | | | | |
| **The highest reported SAR values** | RF Exposure Conditions | | Equipment Class | | | |
| | | | Licensed | DTS | U-NII | DSS |
| | Standalone | Body | N/A | 0.84 W/Kg | 0.89 W/Kg | 0.27 W/Kg |
| | Simultaneous Transmission | Body | N/A | N/A | 0.89 W/Kg | 0.85 W/Kg |
| **Applicable Standards** | FCC 47 CFR part 2 (2.1093)<br>KDB publication | | | | | |
| **Test Results** | Pass | | | | | |

UL Verification Services Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties are in accordance with the above standard and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note:** The results documented in this report apply only to the tested sample(s), under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by UKAS. This report is written to support regulatory compliance of the applicable standards stated above.

| Issued By: | Prepared By: |
|---|---|
|  |  |
| Naseer Mirza<br>Project Lead<br>UL VS Ltd. | Chanthu Thevarajah<br>Senior Engineer<br>UL VS Ltd. |

# 2. Test Specification, Methods and Procedures

## 2.1. Test Specification

| Reference: | KDB Publication Number: 865664 D01 SAR Measurement 100 MHz to 6 GHz |
|---|---|
| **Title:** | SAR Measurement Requirements for 100 MHz to 6 GHz |
| **Introduction:** | The SAR Measurement procedures for 100MHz to 6GHz are described in this document. Field probes, tissue dielectric properties, SAR scans, measurement accuracy and variability of the measured results are discussed. The field probe and SAR scan requirements are derived from criteria considered in standard IEEE 1528-2013. The wireless product and technology specific procedures in applicable KDB publications are required to be used unless further guidance has been approved by the FCC. |
| **Purpose of Test:** | To determine if the Equipment Under Test complies with the Specific Absorption Rate for general population/uncontrolled exposure limit of 1.6 W/kg as specified in FCC 47 CFR part 2 (2.1093). |

## 2.2. Methods and Procedures Reference Documentation

The methods and procedures used were as detailed in:

**IEEE 1528:2013**

IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques.

**FCC KDB Publication:**
KDB 248227 D01 802.11 Wi-Fi SAR v02r02
KDB 447498 D01 General RF Exposure Guidance v06
KDB 616217 D04 SAR for laptop and tablets v01r02
KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
KDB 865664 D02 RF Exposure Reporting v01r02

## 2.3. Definition of Measurement Equipment

The measurement equipment used complied with the requirements of the standards referenced in the methods & procedures section above. Section 4.3 contains a list of the test equipment used.

# 3. Facilities and Accreditation

The test sites and measurement facilities used to collect data are located at

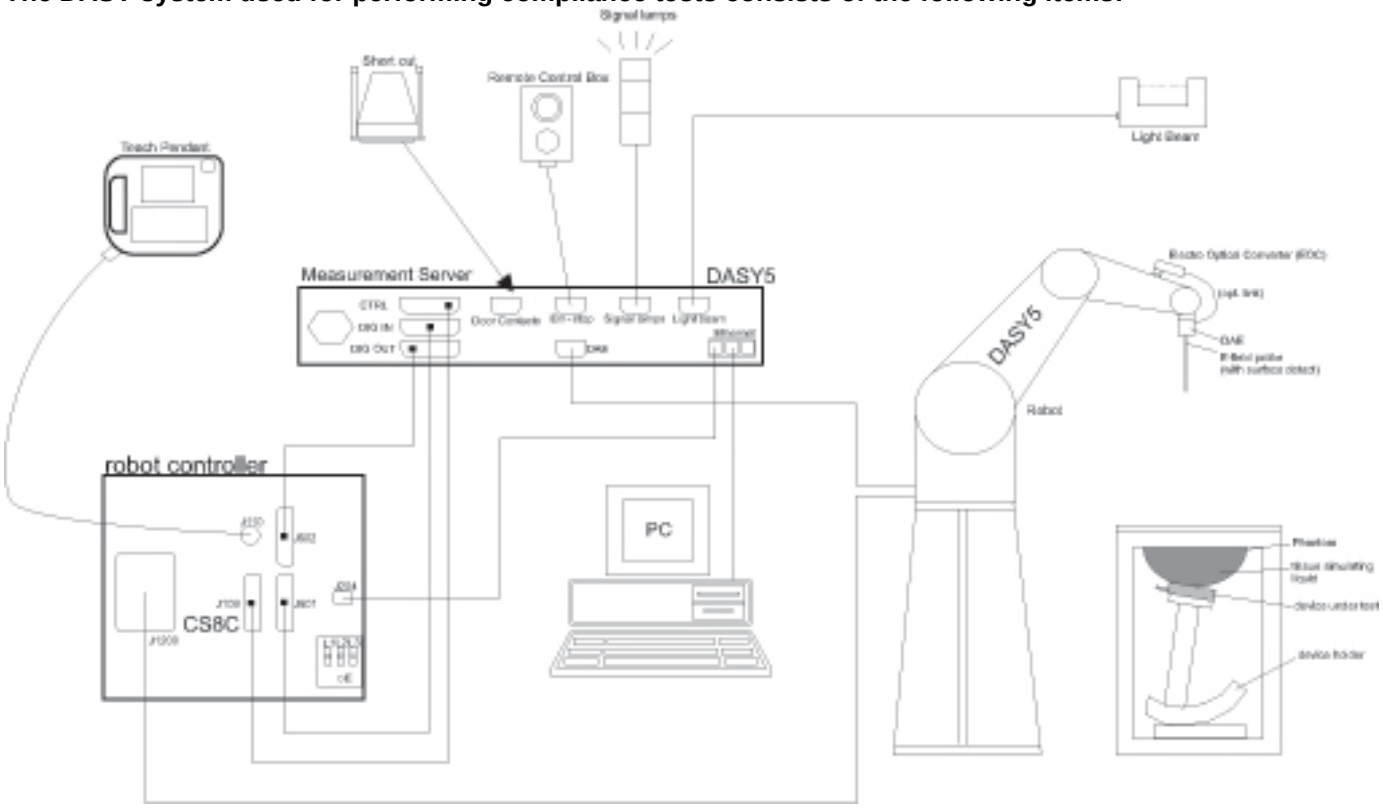
| Horizon Unit 1, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, UK | Facility Type |
|---|---|
| SAR Lab 59 | Controlled Environment Chamber |
| SAR Lab 60 | Controlled Environment Chamber |

UL Verification Services Ltd, is accredited by UKAS (United Kingdom Accreditation Service), Laboratory UKAS Code 0644.

# 4. SAR Measurement System & Test Equipment

## 4.1. SAR Measurement System

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




- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running Win 8.1 or Win 10 and the DASY software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## 4.2. SAR Measurement Procedure

### 4.2.1. Normal SAR Measurement Procedure

The following procedure shall be performed for each of the test conditions Measure the local SAR at a test point within 8 mm of the phantom inner surface that is closest to the DUT.

a) Measure the two-dimensional SAR distribution within the phantom (area scan procedure).
b) The boundary of the measurement area shall not be closer than 20 mm from the phantom side walls. The distance between the measurement points should enable the detection of the location of local maximum with an accuracy of better than half the linear dimension of the tissue cube after interpolation. A maximum grid spacing of 20 mm for frequencies below 3 GHz and (60/f [GHz]) mm for frequencies of 3 GHz and greater is recommended. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz and δ ln(2)/2 mm for frequencies of 3 GHz and greater, where δ is the plane wave skin depth and ln(x) is the natural logarithm. The maximum variation of the sensor-phantom surface distance shall be ± 1 mm for frequencies below 3 GHz and ± 0,5 mm for frequencies of 3 GHz and greater. At all measurement points the angle of the probe with respect to the line normal to the surface should be less than 5°. If this cannot be achieved for a measurement distance to the phantom inner surface shorter than the probe diameter, additional uncertainty evaluation is needed.
c) From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that will not be within the zoom scan of other peaks; additional peaks shall be measured only when the primary peak is within 2 dB 6 of the SAR compliance limit (e.g., 1 W/kg for 1,6 W /kg 1 g limit, or 1,26 W/kg for 2 W /kg, 10 g limit).
d) Measure the three-dimensional SAR distribution at the local maxima locations identified in step c) (zoom scan procedure). The horizontal grid step shall be (24 / f [GHz]) mm or less but not more than 8 mm. The minimum zoom scan size is 30 mm by 30 mm by 30 mm for frequencies below 3 GHz. For higher frequencies, the minimum zoom scan size can be reduced to 22 mm by 22 mm by 22 mm. The grid step in the vertical direction shall be (8-f [GHz]) mm or less but not more than 5 mm, if uniform spacing is used. If variable spacing is used in the vertical direction, the maximum spacing between the two closest measured points to the phantom shell shall be (12/f [GHz]) mm or less but not more than 4 mm, and the spacing between farther points shall increase by an incremental factor not exceeding 1,5. When variable spacing is used, extrapolation routines shall be tested with the same spacing as used in measurements. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz and δ ln(2)/2 mm for frequencies of 3 GHz and greater, where δ is the plane wave skin depth and ln(x) is the natural logarithm. Separate grids shall be centred on each of the local SAR maxima found in step c). Uncertainties due to field distortion between the media boundary and the dielectric enclosure of the probe should also be minimized, which is achieved if the distance between the phantom surface and physical tip of the probe is larger than probe tip diameter. Other methods may utilize correction procedures for these boundary effects that enable high precision measurements closer than half the probe diameter. For all measurement points, the angle of the probe with respect to the flat phantom surface shall be less than 5º.
e) Use post processing (e.g. interpolation and extrapolation) procedures to determine the local SAR values at the spatial resolution needed for mass averaging.
f) The local SAR should be measured at the same location as in Step a). SAR drift is assessed and reported in the uncertainty budget.
In the event that the evaluation of measurement drift exceeds the 5 % tolerance, it is required that SAR be reassessed following guidelines contained within this standard.
If the drift is larger than 5 %, then the measurement drift shall be considered a bias, not an uncertainty. A correction shall be applied to the measured SAR value. It is not necessary to record the drift in the uncertainty budget (i.e. ui = 0 %). The uncertainty budget reported in a measurement report should correspond to the highest SAR value reported (after correction, if applicable). Alternatively, the uncertainty budget reported should cover all measurements, i.e., it should report a conservative value.

**Area Scan Parameters:**

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

**Zoom Scan Parameters:**

| | | | ≤ 3 GHz | > 3 GHz |
|---|---|---|---|---|
| Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$, $\Delta y_{Zoom}$ | | | ≤ 2 GHz: ≤ 8 mm<br>2 – 3 GHz: ≤ 5 mm* | 3 – 4 GHz: ≤ 5 mm*<br>4 – 6 GHz: ≤ 4 mm* |
| Maximum zoom scan spatial resolution, normal to phantom surface | uniform grid: $\Delta z_{Zoom}(n)$ | | ≤ 5 mm | 3 – 4 GHz: ≤ 4 mm<br>4 – 5 GHz: ≤ 3 mm<br>5 – 6 GHz: ≤ 2 mm |
| | graded grid | $\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface | ≤ 4 mm | 3 – 4 GHz: ≤ 3 mm<br>4 – 5 GHz: ≤ 2.5 mm<br>5 – 6 GHz: ≤ 2 mm |
| | | $\Delta z_{Zoom}(n>1)$: between subsequent points | ≤ 1.5·$\Delta z_{Zoom}(n-1)$ | |
| Minimum zoom scan volume | x, y, z | | ≥ 30 mm | 3 – 4 GHz: ≥ 28 mm<br>4 – 5 GHz: ≥ 25 mm<br>5 – 6 GHz: ≥ 22 mm |

## 4.3. Test Equipment

The measuring equipment used to perform the tests documented in this report has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

| UL No. | Instrument | Manufacturer | Type No. | Serial No. | Date Last Calibrated | Cal. Interval (Months) |
|---|---|---|---|---|---|---|
| A2547 | Data Acquisition Electronics | SPEAG | DAE4 | 1438 | 18 Apr 2018 | 12 |
| A2546 | Data Acquisition Electronics | SPEAG | DAE4 | 1435 | 06 Feb 2018 | 12 |
| A2202 | 2440 MHz Dipole Kit | SPEAG | D2450V2 | 701 | 05 Feb 2018 | 12 |
| A1377 | 5.0 GHz Dipole Kit | SPEAG | D5GHzV2 | 1016 | 12 Feb 2018 | 12 |
| A2545 | Probe | SPEAG | EX3DV4 | 3995 | 24 Apr 2018 | 12 |
| PRE0178313 | Probe | SPEAG | EX3DV4 | 7496 | 16 Mar 2018 | 12 |
| G0610 | Robot Power Supply | SPEAG | DASY52 | F13/5SC6F1/C/01 | Calibrated as part of system | - |
| G0611 | Robot Power Supply | SPEAG | DASY52 | F14/5UA6A1/C/01 | Calibrated as part of system | - |
| M1875 | Robot Arm | Staubli | TX60 L | F13/5SC6F1/A/01 | Calibrated as part of system | - |
| M1876 | Robot Arm | Staubli | TX60 L | F14/5UA6A1/A/01 | Calibrated as part of system | - |
| A2808 | Head Handset Positioner | SPEAG | MD4HHTV5 | None | Calibrated before use | - |
| A2809 | Head Handset Positioner | SPEAG | MD4HHTV5 | None | Calibrated before use | - |
| A2440 | Body Handset Positioner | SPEAG | MD4HACV5 | None | Calibrated before use | - |
| A2811 | Body Handset Positioner | SPEAG | MD4HACV5 | None | Calibrated before use | - |
| M1755 | DAK Fluid Probe | SPEAG | SM DAK 040 CA | 1089 | Calibrated before use | - |
| M1855 | Power Sensor | R & S | NRP-Z51 | 103246 | 08 Nov 2017 | 12 |
| PRE0175232 | Power Sensor | R & S | NRP-Z51 | 104649-JG | 05 Feb 2018 | 12 |
| PRE0175234 | Power Sensor | R & S | NRP-Z51 | 103031-NV | 05 Feb 2018 | 12 |
| PRE0159220 | Power source | SPEAG | SE UMS 160 AB | 1025 | Calibrated as part of system | - |
| PRE0159221 | Power Sensor | SPEAG | SE UMS 160 AB | 1026 | Calibrated as part of system | - |
| PRE0151154 | Network Analyser | R&S | ZND | 100151 | 14 Dec 2017 | 12 |
| A2621 | Digital Camera | Nikon | S3600 | 41010357 | N/A | - |
| A2252 | Phantom | SPEAG | ELI Phantom | 1177 | Calibrated as part of system | - |
| A2550 | Phantom | SPEAG | ELI Phantom | 1252 | Calibrated as part of system | - |
| PRE0141347 | Phantom Support Structure | SPEAG | DASY6 Phantom Table | - | Calibrated as part of system | - |
| PRE0141348 | Phantom Support Structure | SPEAG | DASY6 Phantom Table | - | Calibrated as part of system | - |
| PRE0155857 | RS Hygrometer | RS Components | 408-6109 | 612Q19R(2) | 11 Apr 2018 | 12 |
| M1853 | RS Hygrometer | RS Components | 408-6109 | D10Q69 | 11 Apr 2018 | 12 |
| PRE0176840 | RF Coax Cable | Huber+Suhner | Superflex 126 | 503318 | Calibrated before use | - |
| PRE0176848 | RF Coax Cable | Huber+Suhner | Superflex 126 | 503319 | Calibrated before use | - |
| PRE0176855 | RF Coax Cable | Huber+Suhner | Superflex 126 | 503321 | Calibrated before use | - |

| UL No. | Instrument | Manufacturer | Type No. | Serial No. | Date Last Calibrated | Cal. Interval (Months) |
|---|---|---|---|---|---|---|
| PRE0176839 | RF Coax Cable | Huber+Suhner | Superflex 126 | 503324 | Calibrated before use | - |
| PRE0176843 | RF Coax Cable | Huber+Suhner | Superflex 126 | 503326 | Calibrated before use | - |
| PRE0176846 | RF Coax Cable | Huber+Suhner | Superflex 126 | 503322 | Calibrated before use | - |
| A2100 | Directional Coupler | RF-Lambda | RFDC5M06G15 | 11101300748 | Calibrated before use | - |
| PRE0141987 | Directional Coupler | RF-Lambda | RFDC5M06G15 | 12042502540 | Calibrated before use | - |
| PRE0141988 | Directional Coupler | RF-Lambda | RFDC5M06G15 | 12042502539 | Calibrated before use | - |
| A1938 | Amplifier | Mini-Circuits | ZHL-42 | QA0826002 | Calibrated before use | - |
| A2403 | Amplifier | Mini-Circuits | ZHL-42 | 15542 | Calibrated before use | - |
| A2620 | Amplifier | Mini-Circuits | ZHL-42 | D080900-14 | Calibrated before use | - |
| A2689 | Amplifier | Mini-Circuits | ZVE-8G | 910401427 | Calibrated before use | - |
| M1647 | Signal Generator | R & S | SME06 | 3537A01598 | 03 Oct 2017 | 12 |
| M1908 | Signal Generator | R & S | SME06 | 1125.555.03 | 09 Nov 2017 | 12 |
| M1838 | Signal Generator | R & S | SME06 | 1038.6002.06 | 22 Mar 2018 | 12 |
| M1841 | Dual Channel Power Meter | R & S | NRVD | 834501/069 | 22 Mar 2018 | 12 |
| M1840 | Dual Channel Power Meter | R & S | NRVD | 844860/040 | 22 Mar 2018 | 12 |
| M1847 | Power Sensor | R & S | NRV-Z1 | 831430/003 | 26 Oct 2017 | 12 |
| M1848 | Power Sensor | R & S | NRV-Z1 | 831430/004 | 26 Oct 2017 | 12 |
| M1842 | Power Sensor | R & S | NRV-Z1 | 890212/015 | 22 Mar 2018 | 12 |
| M1843 | Power Sensor | R & S | NRV-Z1 | 826515/018 | 22 Mar 2018 | 12 |

## SAR System Specifications

| | |
|---|---|
| **Robot System** | |
| **Positioner:** | Stäubli Unimation Corp. Robot Model: TX60L |
| **Repeatability:** | ±0.030 mm |
| **No. of Axis:** | 6 |
| **Serial Number(s):** | F13/5SC6F1/C/01; F14/5UA6A1/C/01; |
| **Reach:** | 800 mm |
| **Payload:** | 2.0 kg |
| **Control Unit:** | CS8C |
| **Programming Language:** | V+ |
| **Data Acquisition Electronic (DAE) System** | |
| **Serial Number:** | DAE4 SN: 1435, 1438 |
| **PC Controller** | |
| **PC:** | HP EliteDesk800 |
| **Operating System:** | Windows 10 |
| **Data Card:** | DASY5 Measurement Servers |
| **Data Converter** | |
| **Features:** | Signal Amplifier, multiplexer, A/D converted and control logic. |
| **Software:** | DASY5 PRO Software |
| **Connecting Lines:** | Optical downlink for data and status info.<br>Optical uplink for commands and clock. |
| **PC Interface Card** | |
| **Function:** | 24 bit (64 MHz) DSP for real time processing Link to DAE4 16 bit A/D converter for surface detection system serial link to robot direct emergency stop output for robot. |
| **Phantom** | |
| **Phantom:** | Eli Phantom |
| **Shell Material:** | Fibreglass |
| **Thickness:** | 2.0 ±0.1 mm |
| **E-Field Probe** | |
| **Model:** | EX3DV4 |
| **Serial No:** | 3995, 7496 |
| **Construction:** | Triangular core |
| **Frequency:** | 10MHz to >6GHz |
| **Linearity:** | ±0.2 dB (30 MHz to 6 GHz) |
| **Probe Length (mm):** | 337 |
| **Probe Diameter (mm):** | 10 |
| **Tip Length (mm):** | 9 |
| **Tip Diameter (mm):** | 2.5 |
| **Sensor X Offset (mm):** | 1 |
| **Sensor Y Offset (mm):** | 1 |
| **Sensor Z Offset (mm):** | 1 |

# 5. Measurement Uncertainty

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently, the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor, such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

| Test Name | Confidence Level | Calculated Uncertainty |
|---|---|---|
| Uncertainty- Freq. < 3 GHz Body Configuration 1g | 95 % | ±19.22 % |
| Uncertainty- Freq. > 3 GHz Body Configuration 1g | 95 % | ±16.37 % |

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty, the published guidance of the appropriate accreditation body is followed.

## 5.1. Uncertainty – Freq. < 3 GHz Body Configuration 1g

| Type | Source of uncertainty | + Value | - Value | Probability Distribution | Divisor | $c_{i\ (1g)}$ | Standard Uncertainty | | $\upsilon_i$ or $\upsilon_{eff}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | + u (%) | - u (%) | |
| B | Probe calibration | 5.050 | 5.050 | normal (k=1) | 1.0000 | 1.0000 | 5.050 | 5.050 | ∞ |
| B | Axial Isotropy | 0.250 | 0.250 | normal (k=1) | 1.0000 | 1.0000 | 0.250 | 0.250 | ∞ |
| B | Hemispherical Isotropy | 1.300 | 1.300 | normal (k=1) | 1.0000 | 1.0000 | 1.300 | 1.300 | ∞ |
| B | Spatial Resolution | 0.500 | 0.500 | Rectangular | 1.7321 | 1.0000 | 0.289 | 0.289 | ∞ |
| B | Boundary Effect | 0.769 | 0.769 | Rectangular | 1.7321 | 1.0000 | 0.444 | 0.444 | ∞ |
| B | Linearity | 0.300 | 0.300 | Rectangular | 1.7321 | 1.0000 | 0.173 | 0.173 | ∞ |
| B | Detection Limits | 0.200 | 0.200 | Rectangular | 1.7321 | 1.0000 | 0.115 | 0.115 | ∞ |
| B | Readout Electronics | 0.160 | 0.160 | normal (k=1) | 1.0000 | 1.0000 | 0.160 | 0.160 | ∞ |
| B | Response Time | 0.000 | 0.000 | Rectangular | 1.7321 | 1.0000 | 0.000 | 0.000 | ∞ |
| B | Integration Time | 8.520 | 8.520 | Rectangular | 1.7321 | 1.0000 | 4.919 | 4.919 | ∞ |
| B | RF Ambient conditions | 3.000 | 3.000 | Rectangular | 1.7321 | 1.0000 | 1.732 | 1.732 | ∞ |
| B | Probe Positioner Mechanical Restrictions | 4.000 | 4.000 | Rectangular | 1.7321 | 1.0000 | 2.309 | 2.309 | ∞ |
| B | Probe Positioning with regard to Phantom Shell | 2.850 | 2.850 | Rectangular | 1.7321 | 1.0000 | 1.645 | 1.645 | ∞ |
| B | Extrapolation and integration/ Maximum SAR evaluation | 5.080 | 5.080 | Rectangular | 1.7321 | 1.0000 | 2.933 | 2.933 | ∞ |
| A | Test Sample Positioning | 0.147 | 0.147 | normal (k=1) | 1.0000 | 1.0000 | 0.147 | 0.147 | 10 |
| A | Device Holder uncertainty | 0.154 | 0.154 | normal (k=1) | 1.0000 | 1.0000 | 0.154 | 0.154 | 10 |
| B | Phantom Uncertainty | 4.000 | 4.000 | Rectangular | 1.7321 | 1.0000 | 2.309 | 2.309 | ∞ |
| B | Drift of output power | 5.000 | 5.000 | Rectangular | 1.7321 | 1.0000 | 2.887 | 2.887 | ∞ |
| B | Liquid Conductivity (target value) | 5.000 | 5.000 | Rectangular | 1.7321 | 0.6400 | 1.848 | 1.848 | ∞ |
| A | Liquid Conductivity (measured value) | 2.470 | 2.470 | normal (k=1) | 1.0000 | 0.6400 | 1.581 | 1.581 | 5 |
| B | Liquid Permittivity (target value) | 5.000 | 5.000 | Rectangular | 1.7321 | 0.6000 | 1.732 | 1.732 | ∞ |
| A | Liquid Permittivity (measured value) | 2.430 | 2.430 | normal (k=1) | 1.0000 | 0.6000 | 1.458 | 1.458 | 5 |
| | Combined standard uncertainty | | | t-distribution | | | 9.81 | 9.81 | >500 |
| | Expanded uncertainty | | | k = 1.96 | | | 19.22 | 19.22 | >500 |

## 5.2. Uncertainty – Freq. > 3 GHz Body Configuration 1g

| Type | Source of uncertainty | + Value | - Value | Probability Distribution | Divisor | $c_{i\ (1g)}$ | Standard Uncertainty | | $\upsilon_i$ or $\upsilon_{eff}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | + u (%) | - u (%) | |
| B | Probe calibration | 5.050 | 5.050 | normal (k=1) | 1.0000 | 1.0000 | 5.050 | 5.050 | ∞ |
| B | Axial Isotropy | 0.250 | 0.250 | normal (k=1) | 1.0000 | 1.0000 | 0.250 | 0.250 | ∞ |
| B | Hemispherical Isotropy | 1.300 | 1.300 | normal (k=1) | 1.0000 | 1.0000 | 1.300 | 1.300 | ∞ |
| B | Spatial Resolution | 0.500 | 0.500 | Rectangular | 1.7321 | 1.0000 | 0.289 | 0.289 | ∞ |
| B | Boundary Effect | 0.769 | 0.769 | Rectangular | 1.7321 | 1.0000 | 0.444 | 0.444 | ∞ |
| B | Linearity | 0.300 | 0.300 | Rectangular | 1.7321 | 1.0000 | 0.173 | 0.173 | ∞ |
| B | Detection Limits | 0.200 | 0.200 | Rectangular | 1.7321 | 1.0000 | 0.115 | 0.115 | ∞ |
| B | Readout Electronics | 0.160 | 0.160 | normal (k=1) | 1.0000 | 1.0000 | 0.160 | 0.160 | ∞ |
| B | Response Time | 0.000 | 0.000 | Rectangular | 1.7321 | 1.0000 | 0.000 | 0.000 | ∞ |
| B | Integration Time | 0.000 | 0.000 | Rectangular | 1.7321 | 1.0000 | 0.000 | 0.000 | ∞ |
| B | RF Ambient conditions | 3.000 | 3.000 | Rectangular | 1.7321 | 1.0000 | 1.732 | 1.732 | ∞ |
| B | Probe Positioner Mechanical Restrictions | 4.000 | 4.000 | Rectangular | 1.7321 | 1.0000 | 2.309 | 2.309 | ∞ |
| B | Probe Positioning with regard to Phantom Shell | 2.850 | 2.850 | Rectangular | 1.7321 | 1.0000 | 1.645 | 1.645 | ∞ |
| B | Extrapolation and integration/ Maximum SAR evaluation | 5.080 | 5.080 | Rectangular | 1.7321 | 1.0000 | 2.933 | 2.933 | ∞ |
| A | Test Sample Positioning | 1.360 | 1.360 | normal (k=1) | 1.0000 | 1.0000 | 1.360 | 1.360 | 10 |
| A | Device Holder uncertainty | 0.154 | 0.154 | normal (k=1) | 1.0000 | 1.0000 | 0.154 | 0.154 | 10 |
| B | Phantom Uncertainty | 4.000 | 4.000 | Rectangular | 1.7321 | 1.0000 | 2.309 | 2.309 | ∞ |
| B | Drift of output power | 5.000 | 5.000 | Rectangular | 1.7321 | 1.0000 | 2.887 | 2.887 | ∞ |
| B | Liquid Conductivity (target value) | 5.000 | 5.000 | Rectangular | 1.7321 | 0.6400 | 1.848 | 1.848 | ∞ |
| A | Liquid Conductivity (measured value) | 0.770 | 0.770 | normal (k=1) | 1.0000 | 0.6400 | 0.493 | 0.493 | 5 |
| B | Liquid Permittivity (target value) | 5.000 | 5.000 | Rectangular | 1.7321 | 0.6000 | 1.732 | 1.732 | ∞ |
| A | Liquid Permittivity (measured value) | 0.990 | 0.990 | normal (k=1) | 1.0000 | 0.6000 | 0.594 | 0.594 | 5 |
| | Combined standard uncertainty | | | t-distribution | | | 8.35 | 8.35 | >500 |
| | Expanded uncertainty | | | k = 1.96 | | | 16.37 | 16.37 | >500 |

# 6. Device Under Test (DUT) Information

## 6.1. DUT Description

| | | | |
|---|---|---|---|
| **DUT Description:** | The EUT supports WLAN 2.4 GHz (802.11 b/g/n) with MIMO 2X2, WLAN 5.0 GHz {802.11a/n (HT20, HT40), 802.11ac (VHT20, VHT40, VHT80)} with MIMO 2x2, *Bluetooth* (BDR, EDR, BLE and HDR). The device supports CDD, TxBF and non-TxBF modes for WLAN 2.4GHz and 5.0GHz MIMO. | | |
| **Serial Number:** | C02X5002L3G0 | WLAN 2.4/5.3GHz | SAR Evaluation |
| | C02X5002L3HY | WLAN 5.8GHz; Bluetooth | SAR Evaluation |
| | C02X5001L3G3 | WLAN 2.4/ 5.3GHz/5.6GHz | SAR Evaluation |
| | C02X5007L3FX | WLAN 2.4/5GHz; Bluetooth | Conducted Power Measurements |
| **Hardware Version Number:** | EVT2 | | |
| **Firmware (WLAN):** | 9.130.19.4 | | |
| **Firmware (BT):** | V35 | | |
| **Country of Manufacture:** | China | | |
| **Device dimension** | 212.4 x 304.1 x 16.3 mm (Length x Width x Depth) | | |
| **Display Diagonal Dimension:** | 13 Inch (~ 330.2 mm) | | |
| **Date of Receipt:** | 20 August 2018 | | |

| | | |
|---|---|---|
| **Antenna Type:** | Internal integral | |
| **Antenna Length:** | Unknown | |
| **Number of Antenna Positions:** | Antenna 1 (WF1) - WLAN / WPAN ~ Wi-Fi 2.4 GHz / 5.0 GHz / BT | 1 fixed |
| | Antenna 2 (WF2) - WLAN ~ Wi-Fi 2.4 GHz / 5.0 GHz | 1 fixed |
| **Battery Type(s):** | Embedded Li-ion | |

## 6.2. Wireless Technologies

| Wireless technologies | Frequency bands | Operating mode | | Duty Cycle |
|---|---|---|---|---|
| Wi-Fi | 2.4 GHz | 802.11b<br>802.11g<br>802.11n (HT20) | | 100% |
| | 5.0 GHz | 802.11a<br>802.11n (HT20)<br>802.11n (HT40)<br>802.11ac (VHT20)<br>802.11ac (VHT40)<br>802.11ac (VHT80) | | 100% |
| Bluetooth | 2.4 GHz | ☐ Core Spec. 4.0<br>☐ Core Spec. 4.1<br>☐ Core Spec. 4.2<br>☒ Core Spec. 5.0<br>☒ Power Class 1<br>☐ Power Class 2<br>☐ Power Class 3 | Basic Rate (BDR)<br>Enhanced Data Rate (EDR)<br>Low Energy (BLE)<br>High Data Rate (HDR) | 77% (DH5, 720Kb/s)<br>77% (2-DH5/3-DH5, 2Mbps and 3Mbps)<br>60.5% (255 Bytes, 1Mbps)<br>(4-DH5/8-DH5, 4Mbps and 8Mbps) |

**Wireless Technologies (Continued):**

| Wi-Fi | | | | | | |
|---|---|---|---|---|---|---|
| Band | Description | | | | | |
| | 20 MHz BW Ch.# | Frq. (MHz) | 40 MHz BW Ch.# | Frq. (MHz) | 80 MHz BW Ch.# | Frq. (MHz) |
| Wi-Fi 2.4 GHz (802.11b/g/n) | 1 | 2412.0 | N/A | | | |
| | 2 | 2417.0 | | | | |
| | 6 | 2437.0 | | | | |
| | 10 | 2457.0 | | | | |
| | 11 | 2462.0 | | | | |
| | 12 | 2467.0 | | | | |
| | 13 | 2472.0 | | | | |
| Wi-Fi 5.0 GHz 5.2 (U-NII-1) (802.11a/n/ac) | 36 | 5180.0 | 38 | 5190.0 | - | |
| | 40 | 5200.0 | - | | 42 | 5210.0 |
| | 44 | 5220.0 | 46 | 5230.0 | | |
| | 48 | 5240.0 | - | | | |
| Wi-Fi 5.0 GHz 5.3 (U-NII-2A) (802.11a/n/ac) | 52 | 5260.0 | 54 | 5270.0 | - | |
| | 56 | 5280.0 | - | | 58 | 5290.0 |
| | 60 | 5300.0 | 62 | 5310.0 | | |
| | 64 | 5320.0 | - | | | |
| Wi-Fi 5.0 GHz 5.6 (U-NII-2C) (802.11a/n/ac) | 100 | 5500.0 | 102 | 5510.0 | - | |
| | 104 | 5520.0 | - | | 106 | 5530.0 |
| | 108 | 5540.0 | 110 | 5550.0 | | |
| | 112 | 5560.0 | - | | | |
| | 116 | 5580.0 | 118 | 5590.0 | - | |
| | 120 | 5600.0 | - | | 122 | 5610.0 |
| | 124 | 5620.0 | 126 | 5630.0 | - | |
| | 128 | 5640.0 | - | | | |
| | 132 | 5660.0 | 134 | 5670.0 | - | |
| | 136 | 5680.0 | - | | 138 | 5690.0 |
| | 140 | 5700.0 | 142 | 5710.0 | - | |
| | 144 | 5720.0 | - | | | |
| Wi-Fi 5.0 GHz 5.8 (U-NII-3) (802.11a/n/ac) | 149 | 5745.0 | 151 | 5755.0 | - | |
| | 153 | 5765.0 | - | | 155 | 5775.0 |
| | 157 | 5785.0 | 159 | 5795.0 | - | |
| | 161 | 5805.0 | - | | | |
| | 165 | 5825.0 | - | | | |

| Bluetooth | | | | |
|---|---|---|---|---|
| Band | Description | | | |
| | Frequency Range: 2402 - 2480 MHz | | | |
| | Mode | Channel Number | Channel Description | Frequency (MHz) |
| Bluetooth | BDR/EDR Mode | 0 | Low | 2402.0 |
| | | 39 | Middle | 2441.0 |
| | | 78 | High | 2480.0 |
| | LE Mode | 1 | Low | 2404.0 |
| | | 19 | Middle | 2440.0 |
| | | 38 | High | 2478.0 |

## 6.3.Nominal and Maximum Output power: Wi-Fi and Bluetooth

| | | | Target + Max. Tolerances (dBm) - applicable to all antenna's (WF1, WF2) | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Band** | **Channel** | **Centre Frequency (MHz)** | **802.11b (SISO)** | **802.11g (SISO)** | **802.11n HT20 (SISO)** | **802.11n HT20 (2 Tx, DSSS)** | **802.11n HT20 (2 Tx, non-TXBF)** | **802.11n HT20 (2 Tx, TXBF)** |
| Wi-Fi 2.4 GHz | 1 | 2412 | 19.50 | 14.00 | 14.00 | 18.50 | 14.00 | 13.50 |
| | 2 | 2417 | 20.00 | 18.50 | 18.50 | 20.00 | 17.50 | 16.75 |
| | 3 | 2422 | 20.00 | 19.25 | 19.25 | 20.00 | 18.00 | 17.50 |
| | 4 | 2427 | 20.00 | 20.00 | 20.00 | 20.00 | 19.25 | 18.75 |
| | 5 | 2432 | 20.00 | 20.00 | 20.00 | 20.00 | 19.75 | 19.75 |
| | 6 | 2437 | 20.00 | 20.00 | 20.00 | 20.00 | 19.75 | 19.75 |
| | 7 | 2442 | 20.00 | 20.00 | 20.00 | 20.00 | 19.25 | 19.25 |
| | 8 | 2447 | 20.00 | 19.00 | 19.00 | 20.00 | 18.00 | 17.50 |
| | 9 | 2452 | 20.00 | 17.75 | 17.75 | 20.00 | 17.25 | 17.25 |
| | 10 | 2457 | 20.00 | 17.00 | 17.00 | 19.50 | 15.25 | 15.25 |
| | 11 | 2462 | 18.75 | 13.25 | 13.25 | 18.00 | 11.25 | 11.25 |
| | 12 | 2467 | 16.00 | 11.00 | 11.00 | 15.25 | 9.00 | 9.00 |
| | 13 | 2472 | 13.00 | 1.50 | 1.50 | 12.50 | -2.00 | -3.00 |

| | | Target + Max. Tolerances (dBm) - applicable to WF1 antenna | | |
|---|---|---|---|---|
| **Band** | **Channel** | **BDR (SISO)** | **EDR (SISO)** | **BLE (SISO)** |
| Bluetooth iPA | ALL | 12.00 | 10.00 | 6.50 |
| Bluetooth ePA | ALL | N/A | 15.50 | N/A |

Note: Bluetooth operates only on Antenna WF1

## Nominal and Maximum Output power: Wi-Fi (Continued)

| | | | Target + Max. Tolerances (dBm) - applicable to all antenna's (WF1, WF2) | | | | |
|---|---|---|---|---|---|---|---|
| **Band** | **Channel (20 MHz BW)** | **Center Frequency (MHz)** | **802.11a (SISO)** | **802.11n HT20 (SISO)** | **802.11n HT20 (2 Tx CDD, non-TXBF)** | **802.11n HT20 (2 Tx SDM, non-TXBF)** | **802.11n HT20 (2 Tx, TXBF)** |
| Sub Band 1 - 5.2 GHz | 36 | 5180 | 15.25 | 15.25 | 14.00 | 14.00 | 14.00 |
| | 40 | 5200 | 15.25 | 15.25 | 15.25 | 15.25 | 15.25 |
| | 44 | 5220 | 15.25 | 15.25 | 15.25 | 15.25 | 15.25 |
| | 48 | 5240 | 15.25 | 15.25 | 15.25 | 15.25 | 15.25 |
| Sub Band 2 - 5.3 GHz | 52 | 5260 | 15.50 | 15.50 | 15.50 | 15.50 | 15.50 |
| | 56 | 5280 | 15.50 | 15.50 | 15.50 | 15.50 | 15.50 |
| | 60 | 5300 | 15.50 | 15.50 | 15.50 | 15.50 | 15.50 |
| | 64 | 5320 | 15.50 | 15.50 | 15.00 | 15.50 | 15.00 |
| Sub Band 3 - 5.6 GHz | 100 | 5500 | 14.50 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 104 | 5520 | 14.50 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 108 | 5540 | 14.50 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 112 | 5560 | 14.50 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 116 | 5580 | 14.50 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 120 | 5600 | 14.50 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 124 | 5620 | 14.50 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 128 | 5640 | 14.50 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 132 | 5660 | 14.50 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 136 | 5680 | 14.50 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 140 | 5700 | 14.50 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 144 | 5720 | 14.50 | 14.50 | 14.50 | 14.50 | 14.50 |
| Sub Band 4 - 5.8 GHz | 149 | 5745 | 13.50 | 13.50 | 13.50 | 13.50 | 13.50 |
| | 153 | 5765 | 13.50 | 13.50 | 13.50 | 13.50 | 13.50 |
| | 157 | 5785 | 13.50 | 13.50 | 13.50 | 13.50 | 13.50 |
| | 161 | 5805 | 13.50 | 13.50 | 13.50 | 13.50 | 13.50 |
| | 165 | 5825 | 13.50 | 13.50 | 13.50 | 13.50 | 13.50 |

| | | | Target + Max. Tolerances (dBm) - applicable to all antenna's (WF1, WF2) | | | |
|---|---|---|---|---|---|---|
| **Band** | **Channel (40 MHz BW)** | **Centre Frequency (MHz)** | **802.11n HT40 (1 Tx)** | **802.11n HT40 (2 Tx CDD, non-TXBF)** | **802.11n HT40 (2 Tx SDM, non-TXBF)** | **802.11n HT40 (2 Tx, TXBF)** |
| Sub Band 1 - 5.2 GHz | 38 | 5190 | 13.50 | 12.00 | 12.00 | 11.00 |
| | 46 | 5230 | 15.25 | 15.25 | 15.25 | 15.25 |
| Sub Band 2 - 5.3 GHz | 54 | 5270 | 15.50 | 15.50 | 15.50 | 15.50 |
| | 62 | 5310 | 15.50 | 14.75 | 14.75 | 14.50 |
| Sub Band 3 - 5.6 GHz | 102 | 5510 | 14.50 | 14.50 | 14.50 | 13.50 |
| | 110 | 5550 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 118 | 5590 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 126 | 5630 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 134 | 5670 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 142 | 5710 | 14.50 | 14.50 | 14.50 | 14.50 |
| Sub Band 4 - 5.8 GHz | 151 | 5755 | 13.50 | 13.50 | 13.50 | 13.50 |
| | 159 | 5795 | 13.50 | 13.50 | 13.50 | 13.50 |

| | | | Target + Max. Tolerances (dBm) - applicable to all antenna's (WF1, WF2) | | | |
|---|---|---|---|---|---|---|
| **Band** | **Channel (80 MHz BW)** | **Centre Frequency (MHz)** | **802.11ac VHT80 (1 Tx)** | **802.11ac VHT80 (2 Tx CDD, non-TXBF)** | **802.11ac VHT80 (2 Tx SDM, non-TXBF)** | **802.11ac VHT80 (2 Tx, TXBF)** |
| Sub Band 1 - 5.2 GHz | 42 | 5210 | 13.00 | 11.50 | 11.50 | 11.00 |
| Sub Band 2 - 5.3 GHz | 58 | 5290 | 15.50 | 14.50 | 14.50 | 14.00 |
| Sub Band 3 - 5.6 GHz | 106 | 5530 | 14.50 | 14.00 | 14.00 | 12.50 |
| | 122 | 5610 | 14.50 | 14.50 | 14.50 | 14.50 |
| | 138 | 5690 | 14.50 | 14.50 | 14.50 | 14.50 |
| Sub Band 4 - 5.8 GHz | 155 | 5775 | 13.50 | 13.50 | 13.50 | 13.50 |

# 7. RF Exposure Conditions (Test Configurations)

## 7.1. Configuration Consideration

| Technology Antenna | Configuration | Antenna-to-User Separation | Position | Antenna-to-Edge Separation (mm) | Evaluation Considered |
|---|---|---|---|---|---|
| **WF1** WLAN / WPAN ~ (Wi-Fi 2.4 GHz/ Wi-Fi 5.0 GHz/BT) | Body | 0mm | Back | < 25 | Yes |
| | | | Right | > 25 | No |
| | | | Left | > 25 | No |
| | | | Display Side | < 25 | Yes |
| **WF2** WLAN ~ (Wi-Fi 2.4 GHz/ Wi-Fi 5.0 GHz) | Body | 0mm | Back | < 25 | Yes |
| | | | Right | > 25 | No |
| | | | Left | > 25 | No |
| | | | Display Side | < 25 | Yes |

**Note:** The Antenna to edge separation distances are indicated in the 'Antenna Schematics' located in Section 12.1 of this report.

## 7.2. SAR Test Exclusion Consideration

| Frequency Band | Configuration(s) | |
|---|---|---|
| | Body | |
| | SISO | MIMO |
| WLAN 2.4 GHz | No | No |
| WLAN 5.2 GHz | Yes[1] | Yes[1] |
| WLAN 5.3 GHz | No | No |
| WLAN 5.6 GHz | No | No |
| WLAN 5.8 GHz | No | No |
| *Bluetooth* | No | N/A |

**Note:**

1. As per KDB 248227, U-NII-2A was chosen for SAR evaluation as maximum rated power for U-NII-2A > U-NII-1. Based on the measurements obtained, SAR measurements on U-NII-1 band are not required as highest reported SAR from U-NII-2A band is ≤ 1.2 W/Kg.

# 8. Conducted Output Power Measurements

## 8.1. RF Output Average Power Measurement: Wi-Fi 2.4 GHz

**Note:** Additional Conducted power measurements are performed on adjacent Channels having same or higher Max. rated power than the standard Channels (i.e., 1, 6, and 11).

### 8.1.1. Wi-Fi 802.11b (2.4 GHz) - SISO

| | | Avg Power (dBm) | | |
|---|---|---|---|---|
| | | WF1 | WF2 | |
| Channel Number | Frequency (MHz) | 6Mbps | 6Mbps | Operating Mode |
| | | Body | Body | |
| 1 | 2412 | 19.20 | 19.30 | 802.11b |
| 2 | 2417 | 19.60 | 19.50 | |
| 6 | 2437 | 19.70 | 19.50 | |
| 10 | 2457 | 19.50 | 19.50 | |
| 11 | 2462 | 18.50 | 18.60 | |
| 12 | 2467 | 15.70 | 15.90 | |
| 13 | 2472 | 12.40 | 12.90 | |

### 8.1.2. Wi-Fi 802.11n (2.4 GHz) – MIMO
### WF1 + WF2

| | | Avg Power (dBm) | | |
|---|---|---|---|---|
| | | WF1 | WF2 | |
| Channel Number | Frequency (MHz) | 6.5Mbps | 6.5Mbps | Operating Mode |
| | | Body | Body | |
| 1 | 2412 | 17.80 | 17.90 | 802.11n, HT20 DSSS |
| 2 | 2417 | 18.90 | 18.80 | |
| 6 | 2437 | 19.10 | 19.40 | |
| 10 | 2457 | 18.80 | 18.80 | |
| 11 | 2462 | 17.50 | 17.80 | |
| 12 | 2467 | 14.60 | 14.80 | |
| 13 | 2472 | 11.70 | 12.10 | |

## 8.2. RF Output Average Power Measurement: Wi-Fi 5.0 GHz

### 8.2.1. Wi-Fi 802.11a/n/ac (5.0 GHz) – SISO Sub Band 1 (5.2 GHz U-NII-1)

| | | Avg Power (dBm) | | |
|---|---|---|---|---|
| | | WF1 | WF2 | |
| Channel Number | Frequency (MHz) | 13.5 Mbps | 13.5 Mbps | Operating Mode |
| | | Body | Body | |
| 36 | 5180 | 15.00 | 14.90 | 802.11a |
| 40 | 5200 | 14.90 | 14.80 | |
| 44 | 5220 | 14.90 | 14.70 | |
| 48 | 5240 | 14.90 | 14.60 | |

Note: Conducted power measurements for 802.11n HT20/ 802.11n (HT40)/ 802.11ac VHT80 (SISO) modes not required, as the Max. Rated Power for these mode was ≤ than higher bandwidth modes (HT40/VHT80).

### 8.2.2. Wi-Fi 802.11a/n/ac (5.0 GHz) – MIMO Sub Band 1 (5.2 GHz U-NII-1) WF1 + WF2

| | | Avg Power (dBm) | | |
|---|---|---|---|---|
| | | WF1 | WF2 | |
| Channel Number | Frequency (MHz) | 6.5 Mbps | 6.5 Mbps | Operating Mode |
| | | Body | Body | |
| 36 | 5180 | 13.40 | 13.20 | 802.11n HT20 (2 Tx CDD, non-TXBF) |
| 40 | 5200 | 14.70 | 14.40 | |
| 44 | 5220 | 14.60 | 14.30 | |
| 48 | 5240 | 14.70 | 14.30 | |
| Channel Number | Frequency (MHz) | 13.5 Mbps | 13.5 Mbps | Operating Mode |
| | | Body | Body | |
| 38 | 5190 | 11.90 | 11.60 | 802.11n HT40 CDD, non-TxBF |
| 46 | 5230 | 15.00 | 14.60 | |

**Note:** Conducted power measurements for 802.11ac VHT80 (MIMO) modes not required, as the Max. Rated Power for this mode was ≤ than 802.11n HT20/HT40.

### 8.2.6. Wi-Fi 802.11a/n/ac (5.0 GHz) – SISO Sub Band 2 (5.3 GHz U-NII-2A)

| | | Avg Power (dBm) | | |
|---|---|---|---|---|
| | | WF1 | WF2 | |
| Channel Number | Frequency (MHz) | 29.3 Mbps | 29.3 Mbps | Operating Mode |
| | | Body | Body | |
| 58 | 5290 | 15.20 | 15.00 | 802.11ac VHT80 |

**Note:** Conducted power measurements for 802.11a/802.11n HT20/802.11n HT40 (SISO) modes not required, as the Max. Rated Power for this mode was ≤ than higher bandwidth mode (VHT80).

### 8.2.7. Wi-Fi 802.11a/n/ac (5.0 GHz) – MIMO Sub Band 2 (5.3 GHz U-NII-2A) WF1 + WF2

| | | Avg Power (dBm) | | |
|---|---|---|---|---|
| | | WF1 | WF2 | |
| Channel Number | Frequency (MHz) | 6.5 Mbps | 6.5 Mbps | Operating Mode |
| | | Body | Body | |
| 52 | 5260 | 14.90 | 14.60 | 802.11n HT20 (2 Tx CDD, non-TXBF) |
| 56 | 5280 | 14.90 | 14.60 | |
| 60 | 5300 | 14.90 | 14.50 | |
| 64 | 5320 | 14.60 | 14.00 | |
| Channel Number | Frequency (MHz) | 13.5 Mbps | 13.5 Mbps | Operating Mode |
| | | Body | Body | |
| 54 | 5270 | 15.30 | 14.80 | 802.11n HT40 CDD, non-TxBF |
| 62 | 5310 | 14.20 | 13.80 | |

**Note:** Conducted power measurements for 802.11ac VHT80 (MIMO) modes not required, as the Max. Rated Power for this mode was ≤ than 802.11ac VHT80

## 8.2.11. Wi-Fi 802.11a/n/ac (5.0 GHz) – SISO Sub Band 3 (5.6 GHz U-NII-2C)

| Channel Number | Frequency (MHz) | 29.3 Mbps | 29.3 Mbps | Operating Mode |
|---|---|---|---|---|
| | | Body | Body | |
| 106 | 5530 | 14.20 | 14.10 | 802.11ac VHT80 |
| 122 | 5610 | 14.20 | 14.10 | |
| 138 | 5690 | 14.10 | 14.00 | |

**Note:** Conducted power measurements for 802.11a/802.11n HT20/ 802.11n HT40 (SISO), modes not required, as the Max. Rated Power for this mode was ≤ than higher bandwidth modes (HT40/VHT80).

## 8.2.12. Wi-Fi 802.11a/n/ac (5.0 GHz) – MIMO Sub Band 3 (5.6 GHz U-NII-2C) WF1 + WF2

| | | Avg Power (dBm) | | |
|---|---|---|---|---|
| | | WF1 | WF2 | |
| Channel Number | Frequency (MHz) | 13.5 Mbps | 13.5 Mbps | Operating Mode |
| | | Body | Body | |
| 102 | 5510 | 14.00 | 13.70 | 802.11n HT40 SDM, non-TxBF |
| 110 | 5550 | 14.10 | 13.60 | |
| 118 | 5590 | 13.90 | 13.70 | |
| 126 | 5630 | 14.10 | 13.60 | |
| 134 | 5670 | 14.10 | 13.60 | |
| 142 | 5710 | 14.00 | 13.70 | |
| Channel Number | Frequency (MHz) | 29.3 Mbps | 29.3 Mbps | Operating Mode |
| | | Body | Body | |
| 106 | 5530 | 13.60 | 13.40 | 802.11ac VHT80 CDD, non-TxBF |
| 122 | 5610 | 14.40 | 14.30 | |
| 138 | 5690 | 14.40 | 14.40 | |

**Note:** Conducted power measurements for 802.11n HT20 (SISO) modes not required, as the Max. Rated Power for this mode was ≤ than higher bandwidth modes (HT40/VHT80).

## 8.2.16. Wi-Fi 802.11a/n/ac (5.0 GHz) – SISO Sub Band 4 (5.8 GHz U-NII-3)

| | | Avg Power (dBm) | | |
|---|---|---|---|---|
| | | WF1 | WF2 | |
| Channel Number | Frequency (MHz) | 29.3 Mbps | 29.3 Mbps | Operating Mode |
| | | Body | Body | |
| 155 | 5775 | 13.40 | 13.10 | **802.11ac VHT80** |

**Note:** Conducted power measurements for 802.11a/ 802.11n HT20/ 802.11m HT40 (SISO) modes not required, as the Max. Rated Power for this mode was ≤ lower bandwidth modes (HT40/VHT80).

## 8.2.17. Wi-Fi 802.11a/n/ac (5.0 GHz) – MIMO Sub Band 4 (5.8 GHz U-NII-3) WF1 + WF2

| | | Avg Power (dBm) | | |
|---|---|---|---|---|
| | | WF1 | WF2 | |
| Channel Number | Frequency (MHz) | 29.3 Mbps | 29.3 Mbps | Operating Mode |
| | | Body | Body | |
| 155 | 5775 | 13.50 | 13.20 | **802.11ac VHT80 CDD, non-TxBF** |

**Note:** Conducted power measurements for 802.11a/802.11n HT20/HT40 (SISO) modes not required, as the Max. Rated Power for this mode was ≤ higher bandwidth modes (VHT80).

## 8.3. RF Output Average Power Measurement: Bluetooth

### 8.3.1. Bluetooth 2.4GHz – ePA

| | | Avg Power (dBm) | |
|---|---|---|---|
| | | WF1 | |
| **Channel Number** | **Frequency (MHz)** | **Body** | **Operating Mode** |
| 0 | 2402 | 15.00 | **EDR (GFSK DH5)** |
| 39 | 2441 | 15.20 | |
| 78 | 2480 | 15.30 | |

**Notes:**

1. Conducted power measurements were not performed on iPA (low power mode) as max. rated powers including tolerances for all operating modes are < 20 mW.

2. Conducted power measurements on ePA continuous BDR and BLE operating modes were not performed, as not supported by DUT.

# 9. Dielectric Property Measurements & System Check

## 9.1.Tissue Dielectric Parameters

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized.
The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.
Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.

**IEEE 1528:2013**

| Target Frequency (MHz) | Head | | Body (FCC only) | |
|---|---|---|---|---|
| | $\varepsilon_r$ | σ (S/m) | $\varepsilon_r$ | σ (S/m) |
| 150 | 52.3 | 0.76 | 61.9 | 0.80 |
| 300 | 45.3 | 0.87 | 58.2 | 0.92 |
| 450 | 43.5 | 0.87 | 56.7 | 0.94 |
| 750 | 41.9 | 0.89 | - | - |
| 835 | 41.5 | 0.90 | 55.2 | 0.97 |
| 900 | 41.5 | 0.97 | 55.0 | 1.05 |
| 915 | 41.5 | 0.98 | 55.0 | 1.06 |
| 1450 | 40.5 | 1.20 | 54.0 | 1.30 |
| 1500 | 40.4 | 1.23 | - | - |
| 1610 | 40.3 | 1.29 | 53.8 | 1.40 |
| 1640 | 40.2 | 1.31 | - | - |
| 1750 | 40.1 | 1.37 | - | - |
| 1800 | 40 | 1.40 | 53.3 | 1.52 |
| 1900 | 40 | 1.40 | 53.3 | 1.52 |
| 2000 | 40 | 1.40 | 53.3 | 1.52 |
| 2100 | 39.8 | 1.49 | - | - |
| 2300 | 39.5 | 1.67 | - | - |
| 2450 | 39.2 | 1.80 | 52.7 | 1.95 |
| 2600 | 39 | 1.96 | - | - |
| 3000 | 38.5 | 2.40 | 52.0 | 2.73 |
| 3500 | 37.9 | 2.91 | - | - |
| 4000 | 37.4 | 3.43 | - | - |
| 4500 | 36.8 | 3.94 | - | - |
| 5000 | 36.2 | 4.45 | 49.3 | 5.07 |
| 5100 | 36.1 | 4.55 | 49.1 | 5.18 |
| 5200 | 36.0 | 4.66 | 49.0 | 5.30 |
| 5250 | 35.9 | 4.71 | 48.9 | 5.36 |
| 5300 | 35.9 | 4.76 | 48.9 | 5.42 |
| 5400 | 35.8 | 4.86 | 48.7 | 5.53 |
| 5500 | 35.6 | 4.96 | 48.6 | 5.65 |
| 5600 | 35.5 | 5.07 | 48.5 | 5.77 |
| 5700 | 35.4 | 5.17 | 48.3 | 5.88 |
| 5750 | 35.4 | 5.22 | 48.3 | 5.94 |
| 5800 | 35.3 | 5.27 | 48.2 | 6.00 |
| 6000 | 35.1 | 5.48 | - | - |

**NOTE**: For convenience, permittivity and conductivity values at some frequencies that are not part of the original data from Drossos et al. [B60] or the extension to 5800 MHz are provided (i.e., the values shown in italics). These values were linearly interpolated between the values in this table that are immediately above and below these values, except the values at 6000 MHz that were linearly extrapolated from the values at 3000 MHz and 5800 MHz.

## 9.2. System Check

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device. The same SAR probe(s) and tissue-equivalent media combinations used with each specific SAR system for system verification must be used for device testing. When multiple probe calibration points are required to cover substantially large transmission bands, independent system verifications are required for each probe calibration point. A system verification must be performed before each series of SAR measurements using the same probe calibration point and tissue-equivalent medium. Additional system verification should be considered according to the conditions of the tissue-equivalent medium and measured tissue dielectric parameters, typically every three to four days when the liquid parameters are re-measured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

## 9.3. Reference Target SAR Values

The reference SAR values are obtained from the calibration certificate of system validation dipoles. The measured values are normalised to 1 Watt.

| System Dipole | Serial No. | Cal. Date | Freq. (MHz) | Target SAR Values (mW/g) | |
|---|---|---|---|---|---|
| | | | | 1g/10g | Body |
| D2440V2 | 701 | 07 Feb 2018 | 2450 | 1g | 50.2 |
| | | | | 10g | 23.4 |
| D5GHzV2 | 1016 | 12 Feb 2018 | 5250 | 1g | 73.9 |
| | | | | 10g | 20.7 |
| | | | 5600 | 1g | 76.7 |
| | | | | 10g | 21.5 |
| | | | 5750 | 1g | 73.5 |
| | | | | 10g | 20.5 |

## 9.4. Dielectric Property Measurements & System Check Results

The 1-g SAR and 10-g SAR measured with a reference dipole, using the required tissue-equivalent medium at the test frequency, must be within ±10% of the manufacturer calibrated dipole SAR target. The internal limit is set to ±10%.

### Site 59

**System check 5250 Body**

Date: 19/09/2018
Validation dipole and Serial Number: D5GHzV2 / SN: 1016

| Simulant | Frequency (MHz) | Room Temp (℃) | Liquid Temp (℃) | Parameters | Target Value | Measured Value | Deviation (%) | Limit (%) |
|---|---|---|---|---|---|---|---|---|
| Body | 5250.00 | 21.9 | 22.9 | εr | 48.90 | 47.22 | -3.43 | 10.00 |
| | | | | Σ | 5.36 | 5.30 | -1.19 | 10.00 |
| | | | | 1g (W/kg) | 73.90 | 74.42 | 0.70 | 10.00 |
| | | | | 10g (W/kg) | 20.70 | 20.95 | 1.20 | 10.00 |

**System check 5600 Body**

Date: 19/09/2018
Validation dipole and Serial Number: D5GHzV2 / SN: 1016

| Simulant | Frequency (MHz) | Room Temp (℃) | Liquid Temp (℃) | Parameters | Target Value | Measured Value | Deviation (%) | Limit (%) |
|---|---|---|---|---|---|---|---|---|
| Body | 5600.00 | 21.9 | 22.9 | εr | 48.50 | 46.61 | -3.90 | 10.00 |
| | | | | Σ | 5.77 | 5.78 | 0.20 | 10.00 |
| | | | | 1g (W/kg) | 76.70 | 82.60 | 7.69 | 10.00 |
| | | | | 10g (W/kg) | 21.50 | 23.14 | 7.65 | 10.00 |

Date: 24/09/2018
Validation dipole and Serial Number: D5GHzV2 / SN: 1016

| Simulant | Frequency (MHz) | Room Temp (℃) | Liquid Temp (℃) | Parameters | Target Value | Measured Value | Deviation (%) | Limit (%) |
|---|---|---|---|---|---|---|---|---|
| Body | 5600.00 | 21.0 | 21.0 | εr | 48.50 | 47.71 | -1.63 | 10.00 |
| | | | | Σ | 5.77 | 5.88 | 1.95 | 10.00 |
| | | | | 1g (W/kg) | 76.70 | 79.50 | 3.65 | 10.00 |
| | | | | 10g (W/kg) | 21.50 | 22.50 | 4.65 | 10.00 |

### Site 60

**System check 2450 Body**

Date: 19/09/2018
Validation dipole and Serial Number: D2440V2 / SN: 701

| Simulant | Frequency (MHz) | Room Temp (℃) | Liquid Temp (℃) | Parameters | Target Value | Measured Value | Deviation (%) | Limit (%) |
|---|---|---|---|---|---|---|---|---|
| Body | 2450.00 | 21.9 | 21.9 | εr | 52.70 | 51.06 | -3.11 | 10.00 |
| | | | | Σ | 1.95 | 2.09 | 7.00 | 10.00 |
| | | | | 1g (W/kg) | 50.20 | 52.07 | 3.73 | 10.00 |
| | | | | 10g (W/kg) | 23.40 | 24.34 | 4.02 | 10.00 |

Date: 26/09/2018
Validation dipole and Serial Number: D2440V2 / SN: 701

| Simulant | Frequency (MHz) | Room Temp (℃) | Liquid Temp (℃) | Parameters | Target Value | Measured Value | Deviation (%) | Limit (%) |
|---|---|---|---|---|---|---|---|---|
| Body | 2450.00 | 22.0 | 22.0 | εr | 52.70 | 49.49 | -6.08 | 10.00 |
| | | | | Σ | 1.95 | 2.04 | 4.83 | 10.00 |
| | | | | 1g (W/kg) | 50.20 | 51.27 | 2.14 | 10.00 |
| | | | | 10g (W/kg) | 23.40 | 23.74 | 1.46 | 10.00 |

**System check 5750 Body**

Date: 19/09/2018
Validation dipole and Serial Number: D5GHzV2 / SN: 1016

| Simulant | Frequency (MHz) | Room Temp (℃) | Liquid Temp (℃) | Parameters | Target Value | Measured Value | Deviation (%) | Limit (%) |
|---|---|---|---|---|---|---|---|---|
| Body | 5750.00 | 22.0 | 21.9 | **εr** | 48.30 | 47.62 | -1.40 | 10.00 |
| | | | | **Σ** | 5.94 | 6.11 | 2.86 | 10.00 |
| | | | | **1g (W/kg)** | 73.50 | 76.30 | 3.80 | 10.00 |
| | | | | **10g (W/kg)** | 20.50 | 21.30 | 3.90 | 10.00 |

# 10. Measurements, Examinations and Derived Results

## 10.1. General Comments

SAR test was performed in accordance with the criteria in KDB 248227.

In the 2.4 GHz band, separate SAR procedures were applied to DSSS and OFDM configurations to simplify DSSS test requirements. SAR test was evaluated on the mode with the highest rated power, which is in this case was 802.11b mode. OFDM mode was not evaluated because when the highest reported SAR for DSSS was adjusted by the ratio of OFDM to DSSS specified maximum output power, the adjusted SAR obtained was < 1.2W/kg.

In the 5.0 GHz band, the initial test configuration transmission mode was determined by the 802.11 configuration with the highest maximum output power specified for production units, including upper tune-up tolerance, in each standalone and aggregated frequency band. Since multiple channel bandwidth configuration modes have the same specified maximum output power, SAR test was performed on the largest channel bandwidth with the lowest order modulation.

For the cases where the power was not flat throughout the mode to test, additional runs were also performed on the next highest bandwidth provided the power response was identical. This was performed in order to assess the SAR response throughout the frequency band and establish that all worst cases have been evaluated.

Note: SAR Values represented by “-“ indicate no SAR peaks were detected during area scans.

## 10.2. Specific Absorption Rate - Test Results - WiFi

### 10.2.1.WLAN 2.4GHz Body 1g - SISO
**Max Reported SAR = 0.70 (W/kg)**

| | | | | | Power (dBm) | | 1g: SAR Results (W/kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mode | Dist. (mm) | EUT Position | Channel Number | Freq (MHz) | Tune Up Limit | Meas. | Meas. SAR Level | Reported SAR | Transmitting Antenna | Notes | Plot No. |
| 802.11b | 0 | Back | 6 | 2437.0 | 20.00 | 19.70 | 0.65 | 0.70 | WF1 | - | |
| 802.11b | 0 | Display Side | 6 | 2437.0 | 20.00 | 19.70 | 0.09 | 0.09 | WF1 | - | |
| 802.11b | 0 | Back | 6 | 2437.0 | 20.00 | 19.50 | 0.50 | 0.56 | WF2 | - | |
| 802.11b | 0 | Display Side | 6 | 2437.0 | 20.00 | 19.50 | 0.06 | 0.07 | WF2 | - | |

**Note(s):**

### 10.2.2.WLAN 2.4GHz Body 1g - MIMO
**Max Reported SAR = 0.84 (W/kg)**

| | | | | | Power (dBm) | | 1g: SAR Results (W/kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mode | Dist. (mm) | EUT Position | Channel Number | Freq (MHz) | Tune Up Limit | Meas. | Meas. SAR Level | Reported SAR | Transmitting Antenna | Notes | Plot No. |
| 802.11n HT20 | 0 | Back | 6 | 2437.0 | 20.00 | 19.10 | 0.65 | 0.80 | WF1 | - | 1 |
| | | | | | 20.00 | 19.40 | 0.73 | 0.84 | WF2 | | |
| 802.11n HT20 | 0 | Back | 1 | 2412.0 | 18.50 | 17.80 | - | - | WF1 | - | |
| | | | | | 18.50 | 17.90 | 0.24 | 0.28 | WF2 | | |
| 802.11n HT20 | 0 | Back | 2 | 2417.0 | 20.00 | 18.90 | 0.46 | 0.59 | WF1 | 1 | |
| | | | | | 20.00 | 18.80 | 0.46 | 0.61 | WF2 | | |
| 802.11n HT20 | 0 | Back | 10 | 2457.0 | 19.50 | 18.80 | 0.42 | 0.49 | WF1 | 1 | |
| | | | | | 19.50 | 18.80 | 0.34 | 0.39 | WF2 | | |
| 802.11n HT20 | 0 | Back | 11 | 2462.0 | 18.00 | 17.50 | 0.34 | 0.38 | WF1 | - | |
| | | | | | 18.00 | 17.80 | - | - | WF2 | | |

**Note(s):**

1. Additional test were performed on adjacent Channels having same or higher Max. rated power than the standard Channels (i.e., 1, 6, and 11).

### 10.2.3.WLAN 5.3GHz Body 1g - SISO

As per KDB 248227, U-NII-1 was chosen for SAR evaluation as maximum rated power for U-NII-1 < U-NII-2A. Based on the measurements obtained, SAR measurements on U-NII-1 band are not required as highest reported SAR from U-NII-2A band is ≤ 1.2 W/Kg.

### 10.2.4.WLAN 5.3GHz Body 1g – MIMO

As per KDB 248227, U-NII-1 was chosen for SAR evaluation as maximum rated power for U-NII-1 < U-NII-2A. Based on the measurements obtained, SAR measurements on U-NII-1 band are not required as highest reported SAR from U-NII-2A band is ≤ 1.2 W/Kg.

## 10.2.5.WLAN 5.3GHz Body 1g - SISO

**Max Reported SAR = 0.54 (W/kg)**

| | | | | | Power (dBm) | | 1g: SAR Results (W/kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mode | Dist. (mm) | EUT Position | Channel Number | Freq (MHz) | Tune Up Limit | Meas. | Meas. SAR Level | Reported SAR | Transmitting Antenna | Notes | Plot No. |
| 802.11a c VHT80 | 0 | Back | 58 | 5290.0 | 15.50 | 15.20 | 0.39 | 0.42 | WF1 | - | |
| 802.11a c VHT80 | 0 | Display Side | 58 | 5290.0 | 15.50 | 15.20 | 0.06 | 0.06 | WF1 | - | |
| 802.11a c VHT80 | 0 | Back | 58 | 5290.0 | 15.50 | 15.00 | 0.48 | 0.54 | WF2 | - | 2 |
| 802.11a c VHT80 | 0 | Display Side | 58 | 5290.0 | 15.50 | 15.00 | 0.40 | 0.44 | WF2 | - | |

**Note(s):**

## 10.2.6.WLAN 5.3GHz Body 1g - MIMO

**Max Reported SAR = 0.48 (W/kg)**

| | | | | | Power (dBm) | | 1g: SAR Results (W/kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mode | Dist. (mm) | EUT Position | Channel Number | Freq (MHz) | Tune Up Limit | Meas. | Meas. SAR Level | Reported SAR | Transmitting Antenna | Notes | Plot No. |
| 802.11n HT40 | 0 | Back | 54 | 5270.0 | 15.50 | 15.30 | - | - | WF1 | - | |
| | | | | | 15.50 | 14.80 | 0.38 | 0.45 | WF2 | | |
| 802.11n HT20 | 0 | Back | 56 | 5280.0 | 15.50 | 14.90 | 0.42 | 0.48 | WF1 | - | |
| | | | | | 15.50 | 14.60 | - | - | WF2 | | |

**Note(s):**

## 10.2.7.WLAN 5.6GHz Body 1g - SISO
**Max Reported SAR = 0.89 (W/kg)**

| | | | | | Power (dBm) | | 1g: SAR Results (W/kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mode | Dist. (mm) | EUT Position | Channel Number | Freq (MHz) | Tune Up Limit | Meas. | Meas. SAR Level | Reported SAR | Transmitting Antenna | Notes | Plot No. |
| 802.11a c VHT80 | 0 | Back | 106 | 5530.0 | 14.50 | 14.20 | 0.39 | 0.42 | WF1 | - | |
| 802.11a c VHT80 | 0 | Back | 106 | 5530.0 | 14.50 | 14.10 | 0.66 | 0.73 | WF2 | - | |
| 802.11a c VHT80 | 0 | Back | 122 | 5610.0 | 14.50 | 14.10 | 0.79 | 0.87 | WF2 | - | |
| 802.11a c VHT80 | 0 | Back | 138 | 5690.0 | 14.50 | 14.00 | 0.79 | 0.89 | WF2 | - | 3 |

**Note(s):**

## 10.2.8.WLAN 5.6GHz Body 1g - MIMO
**Max Reported SAR = 0.62 (W/kg)**

| | | | | | Power (dBm) | | 1g: SAR Results (W/kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mode | Dist. (mm) | EUT Position | Channel Number | Freq (MHz) | Tune Up Limit | Meas. | Meas. SAR Level | Reported SAR | Transmitting Antenna | Notes | Plot No. |
| 802.11a c VHT80 | 0 | Back | 122 | 5610.0 | 14.50 | 14.40 | - | - | WF1 | - | |
| | | | | | 14.50 | 14.30 | 0.59 | 0.62 | WF2 | - | |

**Note(s):**

## 10.2.9.WLAN 5.8GHz Body 1g - SISO
**Max Reported SAR = 0.62 (W/kg)**

| | | | | | Power (dBm) | | 1g: SAR Results (W/kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mode | Dist. (mm) | EUT Position | Channel Number | Freq (MHz) | Tune Up Limit | Meas. | Meas. SAR Level | Reported SAR | Transmitting Antenna | Notes | Plot No. |
| 802.11a c VHT80 | 0 | Back | 155 | 5775.0 | 13.50 | 13.40 | 0.57 | 0.58 | WF1 | - | |
| 802.11a c VHT80 | 0 | Back | 155 | 5775.0 | 13.50 | 13.10 | 0.57 | 0.62 | WF2 | - | 4 |

**Note(s):**

## 10.2.10.WLAN 5.8GHz Body 1g - MIMO
**Max Reported SAR = 0.43 (W/kg)**

| | | | | | Power (dBm) | | 1g: SAR Results (W/kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mode | Dist. (mm) | EUT Position | Channel Number | Freq (MHz) | Tune Up Limit | Meas. | Meas. SAR Level | Reported SAR | Transmitting Antenna | Notes | Plot No. |
| 802.11a c VHT80 | 0 | Back | 155 | 5775.0 | 13.50 | 13.50 | 0.43 | 0.43 | WF1 | - | |
| | | | | | 13.50 | 13.20 | 0.39 | 0.42 | WF2 | - | |

**Note(s):**

## 10.3. Specific Absorption Rate - Test Results - Bluetooth

### 10.3.1.Bluetooth Body 1g – SISO (ePA)

**Max Reported SAR = 0.27 (W/kg)**

| | | | | | Power (dBm) | | 1g: SAR Results (W/kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mode | Dist. (mm) | EUT Position | Channel Number | Freq (MHz) | Tune Up Limit | Meas. | Meas. SAR Level | Reported SAR | Transmitting Antenna | Notes | Plot No. |
| EDR | 0 | Back | 78 | 2480.0 | 15.50 | 15.30 | 0.17 | 0.18 | WF1 | - | |
| EDR | 0 | Display Side | 78 | 2480.0 | 15.50 | 15.30 | 0.04 | 0.04 | WF1 | - | |
| EDR | 0 | Back | 39 | 2441.0 | 15.50 | 15.20 | 0.26 | 0.27 | WF1 | - | 5 |
| EDR | 0 | Back | 0 | 2402.0 | 15.50 | 15.00 | 0.12 | 0.14 | WF1 | - | |

**Note(s):**

## 10.4. SAR Measurement Variability

In accordance with published RF Exposure KDB procedure 865664 D01 SAR measurement 100 MHz to 6 GHz. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

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.

**Note:** SAR variability measurement not required as all measured 1g-SAR values are below 0.8 W/Kg.

# 11. Simultaneous Transmission Analysis

## 11.1. Highest Standalone Reported SAR

### Individual Transmitter Evaluation per Band:

| Exposure Configuration | Technology Band | Reported 1g - SAR (W/Kg) | | | | Equipment Class | Highest Reported 1g - SAR (W/Kg) |
|---|---|---|---|---|---|---|---|
| | | SISO | | MIMO | | | |
| | | WF1 | WF2 | WF1 | WF2 | | |
| BODY (Separation Distance 0mm) | WLAN 2.4 GHz | 0.70 | 0.56 | 0.80 | 0.84 | DTS | 0.84 |
| | WLAN 5.3 GHz | 0.42 | 0.54 | 0.45 | 0.48 | U-NII | 0.54 |
| | WLAN 5.6 GHz | 0.42 | 0.89 | - | 0.62 | U-NII | 0.89 |
| | WLAN 5.8 GHz | 0.58 | 0.62 | 0.43 | 0.42 | U-NII | 0.62 |
| | Bluetooth | 0.27 | N/A | N/A | N/A | DSS | 0.27 |

## 11.2. Simultaneous Transmission analysis

Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the *reported* standalone SAR of each applicable simultaneous transmitting antenna. The worst case simultaneous transmission analysis is considered for the following cases:

| # | Simultaneous Transmission Conditions | | | | | | |
|---|---|---|---|---|---|---|---|
| | WLAN | | | | | | WPAN |
| | Wi-Fi 802.11b/g/n (2.4 GHz) | | | Wi-Fi 802.11a/n/ac (5.0 GHz) | | | *BT* |
| | SISO | | MIMO | SISO | | MIMO | SISO |
| | WF1 | WF2 | WF1+ WF2 | WF1 | WF2 | WF1 + WF2 | WF1 |
| 1 | | | | x | | | X |
| 2 | | | | | x | | X |
| 3 | | | | | | x | X |

### Worst Case Simultaneous Transmission SAR Analysis:

| Exposure Configuration | Case(s) | Technology Band | Highest Reported 1g SAR (W/kg) | Equipment Class | Highest Reported Sum-SAR 1g-SAR (W/kg) | SPLSR Ratio |
|---|---|---|---|---|---|---|
| BODY (Separation Distance 0mm) | 1 | WLAN 5.0GHz (WF1) | 0.58 | U-NII | 0.85 | N/A |
| | | Bluetooth (WF1) | 0.27 | DSS | | |
| | 2 | WLAN 5.0GHz (WF2) | N/A | U-NII | 0.27 | N/A |
| | | Bluetooth (WF1) | 0.27 | DSS | | |
| | 2 | WLAN 5.0GHz (WF2) | 0.89 | U-NII | 0.89 | N/A |
| | | Bluetooth (WF1) | N/A | DSS | | |
| | 3 | WLAN 5.0GHz (WF1) | 0.45 | U-NII | 0.72 | N/A |
| | | Bluetooth (WF1) | 0.27 | DSS | | |