element

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# RF EXPOSURE PART 0 TEST REPORT

**Applicant Name:**
Apple, Inc.
One Apple Park Way
Cupertino, CA 95014

**Date of Testing:**
10/23/2024 – 11/23/2024
**Test Report Issue Date:**
01/24/2025
**Test Site/Location:**
Element, Morgan Hill, CA, USA
**Document Serial No.:**
1C2410210073-01.BCG

| | |
|---|---|
| **FCC ID:** | **BCGA3267** |
| **APPLICANT:** | **APPLE, INC.** |

| | |
|---|---|
| **Report Type:** | Part 0 SAR Characterization |
| **DUT Type:** | Tablet Device |
| **Model(s):** | A3267, A3270 |

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Test results reported herein relate only to the item(s) tested.

RJ Ortanez
Executive Vice President

ilac-MRA
ACCREDITED
CERT #2041.02

# TABLE OF CONTENTS

# 1 DEVICE UNDER TEST

## 1.1 Device Overview

This device uses the Qualcomm® Gen2 Smart Transmit feature to control and manage transmitting power in real time and to ensure the time-averaged RF exposure is in compliance with the FCC requirement at all times for 3G/4G/5G WWAN operations. Additionally, this device supports WLAN/BT/802.15.4/NB-UNII technologies, but the output power of these modems is not controlled by the Smart Transmit algorithm.

| Band & Mode | Operating Modes | Tx Frequency |
|---|---|---|
| UMTS 850 | Data | 826.4 - 846.6 MHz |
| UMTS 1750 | Data | 1712.4 - 1752.6 MHz |
| UMTS 1900 | Data | 1852.4 - 1907.6 MHz |
| LTE Band 71 | Data | 665.5 - 695.5 MHz |
| LTE Band 12 | Data | 699.7 - 715.3 MHz |
| LTE Band 17 | Data | 706.5 - 713.5 MHz |
| LTE Band 13 | Data | 779.5 - 784.5 MHz |
| LTE Band 14 | Data | 790.5 - 795.5 MHz |
| LTE Band 26 (Cell) | Data | 814.7 - 848.3 MHz |
| LTE Band 5 (Cell) | Data | 824.7 - 848.3 MHz |
| LTE Band 66 (AWS) | Data | 1710.7 - 1779.3 MHz |
| LTE Band 4 (AWS) | Data | 1710.7 - 1754.3 MHz |
| LTE Band 25 (PCS) | Data | 1850.7 - 1914.3 MHz |
| LTE Band 2 (PCS) | Data | 1850.7 - 1909.3 MHz |
| LTE Band 30 | Data | 2307.5 - 2312.5 MHz |
| LTE Band 7 | Data | 2502.5 - 2567.5 MHz |
| LTE Band 41 | Data | 2498.5 - 2687.5 MHz |
| LTE Band 48 | Data | 3552.5 - 3697.5 MHz |
| NR Band n71 | Data | 665.5 - 695.5 MHz |
| NR Band n12 | Data | 701.5 - 713.5 MHz |
| NR Band n14 | Data | 790.5 - 795.5 MHz |
| NR Band n26 (Cell) | Data | 816.5 - 846.5 MHz |
| NR Band n5 (Cell) | Data | 826.5 - 846.5 MHz |
| NR Band n70 | Data | 1697.5 - 1707.5 MHz |
| NR Band n66 (AWS) | Data | 1712.5 - 1777.5 MHz |
| NR Band n25 (PCS) | Data | 1852.5 - 1912.5 MHz |
| NR Band n2 (PCS) | Data | 1852.5 - 1907.5 MHz |
| NR Band n30 | Data | 2307.5 - 2312.5 MHz |
| NR Band n7 | Data | 2502.5 - 2567.5 MHz |
| NR Band n41 | Data | 2501.01 - 2685.0 MHz |
| NR Band n48 | Data | 3555.0 - 3694.98 MHz |
| NR Band n77 DoD | Data | 3455.01 - 3544.98 MHz |
| NR Band n77 C | Data | 3705.0 - 3975.0 MHz |
| 2.4 GHz WLAN | Voice/Data | 2412 - 2472 MHz |
| 5 GHz WIFI | Voice/Data | U-NII-1: 5180 - 5240 MHz<br>U-NII-2A: 5260 - 5320 MHz<br>U-NII-2C: 5500 - 5720 MHz<br>U-NII-3: 5745 - 5825 MHz |
| 6 GHz WIFI | Voice/Data | U-NII-5: 5935 - 6415 MHz<br>U-NII-6: 6435 - 6515 MHz<br>U-NII-7: 6535 - 6875 MHz<br>U-NII-8: 6895 - 7115 MHz |
| Bluetooth | Data | 2402 - 2480 MHz |
| 802.15.4 | Data | 2405 - 2475 MHz |
| NB UNII-1 | Data | 5162 - 5245 MHz |
| NB UNII-3 | Data | 5733 - 5844 MHz |
| WPT | N/A | 13.56 MHz |

## 1.2 Time-Averaging for SAR and Power Density

This device is enabled with Qualcomm® Gen2 Smart Transmit algorithm to control and manage transmitting power in real time and to ensure that the time-averaged RF exposure from 3G/4G/5G Sub-6 NR WWAN is in compliance with FCC requirements. This Part 0 report shows SAR characterization of WWAN radios for 3G/4G/5G Sub-6 NR. Characterization is achieved by determining $P_{Limit}$ for 3G/4G/5G Sub-6 NR that corresponds to the exposure design targets after accounting for all device design related uncertainties, i.e., SAR_design_target (< FCC SAR limit) for sub-6 radio. The SAR characterization is denoted as SAR Char in this report. Section 1.3 includes a nomenclature of the specific terms used in this report.

The compliance test under the static transmission scenario and simultaneous transmission analysis are reported in Part 1 report. The validation of the time-averaging algorithm and compliance under the dynamic (time- varying) transmission scenario for WWAN technologies are reported in Part 2 report (report SN could be found in Section 1.4 – Bibliography).

## 1.3 Nomenclature for Part 0 Report

| Technology | Term | Description |
|---|---|---|
| 3G/4G/5G Sub-6 NR | $P_{limit}$ | Power level that corresponds to the exposure design target (*SAR_design_target)* after accounting for all device design related uncertainties |
| | $P_{max}$ | Maximum tune up output power |
| | *SAR_design_target* | Target SAR level < FCC SAR limit after accounting for all device design related uncertainties |
| | *SAR Char* | Table containing *Plimit* for all technologies and bands |

## 1.4 Bibliography

| Report Type | Report Serial Number |
|---|---|
| FCC SAR Evaluation Report | 1C2410210073-02.BCG |
| RF Exposure Part 2 Test Report | 1C2410210073-03.BCG |
| RF Exposure Compliance Summary | 1C2410210073-04.BCG |

# 2 SAR MEASUREMENTS

## 2.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Equation 2-1).

**Equation 2-1**
**SAR Mathematical Equation**

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

**SAR is expressed in units of Watts per Kilogram (W/kg).**

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

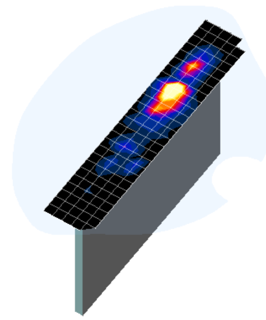
where:

| | | |
|---|---|---|
| σ | = | conductivity of the tissue-simulating material (S/m) |
| ρ | = | mass density of the tissue-simulating material (kg/m³) |
| E | = | Total RMS electric field strength (V/m) |

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relation to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.[6]

## 2.2 SAR Measurement Procedure

The evaluation was performed using the following procedure compliant to FCC KDB Publication 865664 D01v01r04 and IEEE 1528-2013:



**Sample SAR Area Scan**

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01r04 (See Table 2-1) and IEEE 1528-2013.
2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.
3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01r04 (See Table 2-1) and IEEE 1528-2013. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):
   a. SAR values at the inner surface of the phantom are extrapolated from the measured values along the line away from the surface with spacing no greater than that in Table . The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).
   b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the “Not a knot” condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.
   c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

**Table 2-1**
**Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r04***

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

*Also compliant to IEEE 1528-2013 Table 6

# 3 SAR CHARACTERIZATION

## 3.1 DSI and SAR Determination

This device uses different Device State Index (DSI) to configure different time averaged power levels based on certain exposure scenarios. Depending on the detection scheme implemented in the tablet, the worst-case SAR was determined by measurements for the relevant exposure conditions for that DSI. Detailed descriptions of the detection mechanisms are included in the operational description.

The device state index (DSI) conditions used in Table 3-1 represent different exposure scenarios.

**Table 3-1**
**DSI and Corresponding Exposure Scenarios**

| Scenario | Description | SAR Test Cases |
|---|---|---|
| (DSI = 1) | ▪ Device on body | *Tablet SAR per KDB Publication 616217 D04* |

## 3.2 SAR Design Target

*SAR_design_target* is determined by ensuring that it is less than FCC SAR limit after accounting for uncertainties specified by the manufacturer (see Table 3-2).

**Table 3-2**
***SAR_design_target* Calculations**

| 1g SAR (W/kg) | | | |
|---|---|---|---|
| **Mode/Band/Antenna** | ***Smart Tx Uncertainty*** | ***SAR_design_target*** | ***SAR_regulatory_limit*** |
| UMTS 850 Ant 3b | 0.7 dB | 0.86 W/kg | 1.6 W/kg |
| LTE Band 71 Ant 3b | 0.7 dB | 0.86 W/kg | |
| LTE Band 12 Ant 3b | 0.7 dB | 0.86 W/kg | |
| LTE Band 17 Ant 3b | 0.7 dB | 0.86 W/kg | |
| LTE Band 13 Ant 3b | 0.7 dB | 0.86 W/kg | |
| LTE Band 14 Ant 3b | 0.7 dB | 0.86 W/kg | |
| LTE Band 26 Ant 3b | 0.7 dB | 0.86 W/kg | |
| LTE Band 5 Ant 3b | 0.7 dB | 0.86 W/kg | |
| NR Band 71 Ant 3b | 0.7 dB | 0.86 W/kg | |
| NR Band 12 Ant 3b | 0.7 dB | 0.86 W/kg | |
| NR Band 14 Ant 3b | 0.7 dB | 0.86 W/kg | |
| NR Band 26 Ant 3b | 0.7 dB | 0.86 W/kg | |
| NR Band 5 Ant 3b | 0.7 dB | 0.86 W/kg | |
| UMTS 850 Ant 4 | 0.7 dB | 0.86 W/kg | |
| LTE Band 12 Ant 4 | 0.7 dB | 0.86 W/kg | |
| LTE Band 17 Ant 4 | 0.7 dB | 0.86 W/kg | |
| LTE Band 26 Ant 4 | 0.7 dB | 0.86 W/kg | |
| LTE Band 5 Ant 4 | 0.7 dB | 0.86 W/kg | |
| NR Band 12 Ant 4 | 0.7 dB | 0.86 W/kg | |
| NR Band 26 Ant 4 | 0.7 dB | 0.86 W/kg | |
| NR Band 5 Ant 4 | 0.7 dB | 0.86 W/kg | |
| All other modes/bands/antennas | 1.0 dB | 0.80 W/kg | |

## 3.3 SAR Char

SAR test results corresponding to *Pmax* for each antenna/technology/band/DSI can be found in FCC SAR Part 1 Report.

*Plimit* is calculated by linearly scaling with the measured SAR at the Ppart0 to correspond to the *SAR_design_target*. When *Plimit* < *Pmax*, *Ppart0* was used as Plimit in the Smart Transmit EFS. When *Plimit* > *Pmax* and *Ppart0*=Pmax, calculated *Plimit* was used in the Smart Transmit EFS. All reported SAR obtained from the Ppart0 SAR tests was less than *SAR_Design_target* + Uncertainty. The final *Plimit* determination for each exposure scenario corresponding to *SAR_design_target* are shown in Table 3-3.

**Table 3-3**
***PLimit* Determination**

| Device State Index (DSI) | *PLimit* Determination Scenarios |
|---|---|
| 1 | The worst-case SAR exposure is determined as maximum SAR normalized to the limit among:<br>1. Tablet SAR measured at 0 mm for Back, Top, Bottom, Right, Left surfaces |

**Note:**

For DSI = 1, $P_{limit}$ is calculated by:

$P_{limit}$ corresponding to 1g Tablet SAR evaluation at 0 mm for back, top, bottom, left and right surfaces

# Table 3-4
# SAR Characterizations

| Exposure Scenario: | Ant 1a | Ant 1a Maximum Tune-up Output Power* | Ant 1b | Ant 1b Maximum Tune-up Output Power* | Ant 2a | Ant 2a Maximum Tune-up Output Power* | Ant 2b | Ant 2b Maximum Tune-up Output Power* | Ant 3a | Ant 3a Maximum Tune-up Output Power* | Ant 3b | Ant 3b Maximum Tune-up Output Power* | Ant 4 | Ant 4 Maximum Tune-up Output Power* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Averaging Volume: | 1g | | 1g | | 1g | | 1g | | 1g | | 1g | | 1g | |
| Spacing: | 0 mm | | 0 mm | | 0 mm | | 0 mm | | 0 mm | | 0 mm | | 0 mm | |
| DSI: | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | |
| Technology/Band | **Plimit corresponding to SAR design target** | Pmax | **Plimit corresponding to SAR design target** | Pmax | **Plimit corresponding to SAR design target** | Pmax | **Plimit corresponding to SAR design target** | Pmax | **Plimit corresponding to SAR design target** | Pmax | **Plimit corresponding to SAR design target** | Pmax | **Plimit corresponding to SAR design target** | Pmax |
| UMTS 850 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 16.40 | 24.50 | 18.00 | 25.00 |
| UMTS 1750 | N/A | N/A | 11.30 | 23.00 | N/A | N/A | 12.50 | 23.50 | 12.80 | 24.00 | N/A | N/A | 14.20 | 25.00 |
| UMTS 1900 | N/A | N/A | 11.80 | 23.00 | N/A | N/A | 12.90 | 23.50 | 13.80 | 24.00 | N/A | N/A | 13.80 | 25.00 |
| LTE Band 71 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 18.00 | 24.50 | 20.30 | 25.00 |
| LTE Band 12 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 17.10 | 24.50 | 18.70 | 25.00 |
| LTE Band 17 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 17.10 | 24.50 | 18.70 | 25.00 |
| LTE Band 13 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 16.50 | 24.50 | 18.20 | 25.00 |
| LTE Band 14 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 16.50 | 24.50 | 18.20 | 25.00 |
| LTE Band 26 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 16.40 | 24.50 | 18.00 | 25.00 |
| LTE Band 5 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 16.00 | 24.50 | 18.00 | 25.00 |
| LTE Band 5 ULCA | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 16.00 | 24.50 | 18.00 | 25.00 |
| LTE Band 4 | N/A | N/A | 12.10 | 24.00 | N/A | N/A | 12.50 | 25.00 | 12.80 | 24.00 | N/A | N/A | 14.20 | 25.00 |
| LTE Band 66 | N/A | N/A | 12.10 | 24.00 | N/A | N/A | 12.50 | 25.00 | 12.80 | 24.00 | N/A | N/A | 14.20 | 25.00 |
| LTE Band 2 | N/A | N/A | 11.80 | 23.00 | N/A | N/A | 12.90 | 23.50 | 13.80 | 24.00 | N/A | N/A | 13.80 | 25.00 |
| LTE Band 25 | N/A | N/A | 11.80 | 23.00 | N/A | N/A | 12.90 | 23.50 | 13.80 | 24.00 | N/A | N/A | 13.80 | 25.00 |
| LTE Band 30 | N/A | N/A | 12.60 | 22.50 | N/A | N/A | 13.20 | 23.50 | 10.90 | 19.80 | N/A | N/A | 10.80 | 21.00 |
| LTE Band 7 | N/A | N/A | 12.50 | 22.50 | N/A | N/A | 13.20 | 23.50 | 10.30 | 24.00 | N/A | N/A | 11.40 | 25.00 |
| LTE Band 7 ULCA | N/A | N/A | 12.50 | 22.50 | N/A | N/A | 13.20 | 23.50 | 10.30 | 24.00 | N/A | N/A | 11.40 | 25.00 |
| LTE Band 41 (PC3) | N/A | N/A | 12.7 | 23.0 | N/A | N/A | 13.3 | 23.0 | 10.8 | 23.0 | N/A | N/A | 11.9 | 23.0 |
| LTE Band 41 (PC3) ULCA | N/A | N/A | 12.7 | 23.0 | N/A | N/A | 13.3 | 23.0 | 10.8 | 23.0 | N/A | N/A | 11.9 | 23.0 |
| LTE Band 41 (PC2) | N/A | N/A | 12.7 | 22.9 | N/A | N/A | 13.3 | 24.4 | 10.8 | 22.4 | N/A | N/A | 11.9 | 23.4 |
| LTE Band 41 (PC2) ULCA | N/A | N/A | 12.7 | 22.9 | N/A | N/A | 13.3 | 24.4 | 10.8 | 22.4 | N/A | N/A | 11.9 | 23.4 |
| LTE Band 48 | 10.5 | 19.5 | N/A | N/A | 8.0 | 16.9 | N/A | N/A | N/A | N/A | 11.9 | 16.2 | 11.5 | 20.0 |
| LTE Band 48 ULCA | 10.5 | 19.5 | N/A | N/A | 8.0 | 16.9 | N/A | N/A | N/A | N/A | 11.9 | 16.2 | 11.5 | 20.0 |
| NR Band n71 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 17.40 | 24.50 | 20.80 | 25.00 |
| NR Band n12 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 17.10 | 24.50 | 18.70 | 25.00 |
| NR Band n14 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 16.50 | 24.50 | 18.20 | 25.00 |
| NR Band n26 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 16.00 | 24.50 | 18.00 | 25.00 |
| NR Band n5 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 16.00 | 24.50 | 18.00 | 25.00 |
| NR Band n70 | N/A | N/A | 11.30 | 24.00 | N/A | N/A | 12.50 | 25.00 | 12.80 | 24.00 | N/A | N/A | 14.20 | 25.00 |
| NR Band n66 | N/A | N/A | 11.30 | 24.00 | N/A | N/A | 12.50 | 25.00 | 12.80 | 24.00 | N/A | N/A | 14.20 | 25.00 |
| NR Band n2 | N/A | N/A | 11.80 | 23.00 | N/A | N/A | 12.90 | 23.50 | 13.80 | 24.00 | N/A | N/A | 13.80 | 25.00 |
| NR Band n25 | N/A | N/A | 11.80 | 23.00 | N/A | N/A | 12.90 | 23.50 | 13.80 | 24.00 | N/A | N/A | 13.80 | 25.00 |
| NR Band n30 | N/A | N/A | 12.60 | 22.50 | N/A | N/A | 13.20 | 23.50 | 10.90 | 19.80 | N/A | N/A | 10.80 | 21.00 |
| NR Band n7 | N/A | N/A | 12.50 | 22.50 | N/A | N/A | 13.20 | 23.50 | 10.30 | 24.00 | N/A | N/A | 11.40 | 25.00 |
| NR Band n41 (PC3) | N/A | N/A | 12.20 | 25.00 | N/A | N/A | 12.80 | 25.00 | 11.00 | 25.00 | N/A | N/A | 11.40 | 25.00 |
| NR Band n41 (PC2) | N/A | N/A | 12.20 | 26.50 | N/A | N/A | 12.80 | 28.00 | 11.00 | 26.00 | N/A | N/A | 11.40 | 27.00 |
| NR Band n77 (PC3) | 8.50 | 22.50 | N/A | N/A | 7.20 | 22.50 | N/A | N/A | N/A | N/A | 10.50 | 24.70 | 8.80 | 24.70 |
| NR Band n77 (PC2) | 8.50 | 22.50 | N/A | N/A | 7.20 | 22.50 | N/A | N/A | N/A | N/A | 10.50 | 25.60 | 8.80 | 25.50 |
| NR Band n48 | 9.60 | 21.50 | N/A | N/A | 8.10 | 18.90 | N/A | N/A | N/A | N/A | 11.30 | 18.20 | 11.30 | 22.00 |

**Notes:**

1. *Maximum tune up output power Pmax is used to configure EUT during RF tune up procedure. The maximum allowed output power is equal to maximum Tune up output power +0.7/-1.0 dB conducted power tolerance and +1.0/-1.0 dB conducted power tolerance for UHB.
2. All $P_{limit}$ EFS and maximum tune up output power $P_{max}$ levels entered in above Table correspond to average power levels after accounting for duty cycle in the case of TDD modulation schemes (for e.g., LTE TDD).

# 13 EQUIPMENT LIST

## For SAR measurements

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | E4404B | Spectrum Analyzer | N/A | N/A | N/A | MY45113242 |
| Agilent | E4438C | ESG Vector Signal Generator | 10/23/2024 | Annual | 10/23/2025 | MY45093852 |
| Agilent | E4438C | ESG Vector Signal Generator | 3/25/2024 | Annual | 3/25/2025 | MY47270002 |
| Agilent | N5182A | MXG Vector Signal Generator | 7/9/2024 | Annual | 7/9/2025 | MY48180366 |
| Agilent | N5182A | MXG Vector Signal Generator | 3/7/2024 | Annual | 3/7/2025 | MY47420603 |
| Agilent | 8753ES | S-Parameter Vector Network Analyzer | 1/10/2024 | Annual | 1/10/2025 | MY40001472 |
| Agilent | 8753ES | S-Parameter Vector Network Analyzer | 9/25/2024 | Annual | 9/25/2025 | MY40003841 |
| Agilent | E5515C | Wireless Communications Test Set | CBT | N/A | CBT | GB46310798 |
| Agilent | E5515C | Wireless Communications Test Set | CBT | N/A | CBT | US41140256 |
| Agilent | N4010A | Wireless Connectivity Test Set | N/A | N/A | N/A | GB46170464 |
| Amplifier Research | 15S1G6 | Amplifier | CBT | N/A | CBT | 433973 |
| Amplifier Research | 15S1G6 | Amplifier | CBT | N/A | CBT | 433974 |
| Amplifier Research | 150A100C | Amplifier | CBT | N/A | CBT | 350132 |
| Anritsu | MN8110B | I/O Adaptor | CBT | N/A | CBT | 6261747881 |
| Anritsu | ML2496A | Power Meter | 7/15/2024 | Annual | 7/15/2025 | 1138001 |
| Anritsu | ML2496A | Power Meter | 6/24/2024 | Annual | 6/24/2025 | 1840005 |
| Anritsu | MA2411B | Pulse Power Sensor | 9/5/2024 | Annual | 9/5/2025 | 1726262 |
| Anritsu | MA2411B | Pulse Power Sensor | 10/21/2024 | Annual | 10/21/2025 | 1027293 |
| Anritsu | MT8821C | Radio Communication Analyzer MT8821C | 12/15/2023 | Annual | 12/15/2024 | 6200901190 |
| Anritsu | MT8821C | Radio Communication Analyzer MT8821C | 5/15/2024 | Annual | 5/15/2025 | 6262150047 |
| Anritsu | MT8000A | Radio Communication Test Station | 4/23/2024 | Annual | 4/23/2025 | 6272337439 |
| Anritsu | MT8000A | Radio Communication Test Station | 5/14/2024 | Annual | 5/14/2025 | 6272337419 |
| Anritsu | MA24106A | USB Power Sensor | 7/10/2024 | Annual | 7/10/2025 | 1827530 |
| Anritsu | MA24106A | USB Power Sensor | 12/4/2023 | Annual | 12/4/2024 | 1520501 |
| Control Company | 4052 | Long Stem Thermometer | 2/27/2024 | Biennial | 2/27/2026 | 240174346 |
| Control Company | 4052 | Long Stem Thermometer | 2/27/2024 | Biennial | 2/27/2026 | 240171096 |
| Control Company | 4040 | Therm./ Clock/ Humidity Monitor | 4/15/2024 | Biennial | 4/15/2026 | 240310280 |
| Control Company | 4040 | Therm./ Clock/ Humidity Monitor | 4/15/2024 | Biennial | 4/15/2026 | 240310282 |
| Mitutoyo | 500-196-30 | CD-6"ASX 6Inch Digital Caliper | 2/16/2022 | Triennial | 2/16/2025 | A20238413 |
| Keysight Technologies | N9020A | MXA Signal Analyzer | 7/8/2024 | Annual | 7/8/2025 | MY48010233 |
| Agilent | N9020A | MXA Signal Analyzer | 6/14/2024 | Annual | 6/14/2025 | MY56470202 |
| MCL | BW-N6W5+ | 6dB Attenuator | CBT | N/A | CBT | 1139 |
| Mini-Circuits | VLF-6000+ | Low Pass Filter DC to 6000 MHz | CBT | N/A | CBT | N/A |
| Mini-Circuits | VLF-6000+ | Low Pass Filter DC to 6000 MHz | 7/10/2024 | Annual | 7/10/2025 | 31634 |
| Mini-Circuits | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-1200+ | Low Pass Filter DC to 1000 MHz | CBT | N/A | CBT | N/A |
| Mini-Circuits | NLP-2950+ | Low Pass Filter DC to 2700 MHz | CBT | N/A | CBT | N/A |
| Mini-Circuits | BW-N20W5 | Power Attenuator | CBT | N/A | CBT | 1226 |
| Mini-Circuits | ZUDC10-83-S+ | Directional Coupler | CBT | N/A | CBT | 2050 |
| Narda | 4772-3 | Attenuator (3dB) | CBT | N/A | CBT | 9406 |
| Narda | BW-S3W2 | Attenuator (3dB) | CBT | N/A | CBT | 120 |
| Seekonk | NC-100 | Torque Wrench | CBT | N/A | CBT | 22217 |
| Seekonk | NC-100 | Torque Wrench | 4/2/2024 | Biennial | 4/2/2026 | 1262 |
| Rohde & Schwarz | CMW500 | Wideband Radio Communication Tester | 1/10/2024 | Annual | 1/10/2025 | 131453 |
| Rohde & Schwarz | CMW500 | Wideband Radio Communication Tester | 7/8/2024 | Annual | 7/8/2025 | 166818 |
| SPEAG | DAK-3.5 | Dielectric Assessment Kit | 11/5/2024 | Annual | 11/5/2025 | 1277 |
| SPEAG | DAKS-3.5 | Portable Dielectric Assessment Kit | 8/7/2024 | Annual | 8/7/2025 | 1041 |
| SPEAG | MAIA | Modulation and Audio Interference Analyzer | N/A | N/A | N/A | 1237 |
| SPEAG | MAIA | Modulation and Audio Interference Analyzer | N/A | N/A | N/A | 1331 |
| SPEAG | DAK-12 | Dielectric Assessment Kit (4MHz - 3GHz) | 3/11/2024 | Annual | 3/11/2025 | 1102 |
| SPEAG | 5G Verification Source 10GHz | 10GHz System Verification Antenna | 8/6/2024 | Annual | 8/6/2025 | 1004 |
| SPEAG | D1750V2 | 1750 MHz SAR Dipole | 9/6/2023 | Biennial | 9/6/2025 | 1104 |
| SPEAG | D1750V2 | 1750 MHz SAR Dipole | 5/10/2022 | Triennial | 5/10/2025 | 1083 |
| SPEAG | D1900V2 | 1900 MHz SAR Dipole | 9/7/2023 | Biennial | 9/7/2025 | 5d181 |
| SPEAG | D2300V2 | 2300 MHz SAR Dipole | 3/11/2024 | Annual | 3/11/2025 | 1038 |
| SPEAG | D2450V2 | 2450 MHz SAR Dipole | 5/11/2022 | Triennial | 5/11/2025 | 750 |
| SPEAG | D2450V2 | 2450 MHz SAR Dipole | 11/15/2022 | Triennial | 11/15/2025 | 855 |
| SPEAG | D2600V2 | 2600 MHz SAR Dipole | 5/11/2022 | Triennial | 5/11/2025 | 1042 |
| SPEAG | D3500V2 | 3500 MHz SAR Dipole | 6/10/2024 | Annual | 6/10/2025 | 1126 |
| SPEAG | D3700V2 | 3700 MHz SAR Dipole | 6/10/2024 | Annual | 6/10/2025 | 1097 |
| SPEAG | D3900V2 | 3900 MHz SAR Dipole | 12/21/2023 | Annual | 12/21/2024 | 1062 |
| SPEAG | D5GHzV2 | 5 GHz SAR Dipole | 6/12/2024 | Annual | 6/12/2025 | 1163 |
| SPEAG | D6.5GHzV2 | 6.5 GHz SAR Dipole | 10/10/2024 | Annual | 10/10/2025 | 1019 |
| SPEAG | D750V3 | 750 MHz SAR Dipole | 9/13/2023 | Biennial | 9/13/2025 | 1097 |
| SPEAG | D750V3 | 750 MHz SAR Dipole | 5/16/2022 | Triennial | 5/16/2025 | 1057 |
| SPEAG | D835V2 | 835 MHz SAR Dipole | 5/16/2022 | Triennial | 5/16/2025 | 460 |
| SPEAG | CLA13 | Confined Loop Antenna | 11/11/2024 | Annual | 11/11/2025 | 1004 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 4/9/2024 | Annual | 4/9/2025 | 501 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 3/6/2024 | Annual | 3/6/2025 | 604 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 9/4/2024 | Annual | 9/4/2025 | 1684 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 8/8/2024 | Annual | 8/8/2025 | 1681 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 9/4/2024 | Annual | 9/4/2025 | 1403 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 5/8/2024 | Annual | 5/8/2025 | 701 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 4/10/2024 | Annual | 4/10/2025 | 1402 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 5/8/2024 | Annual | 5/8/2025 | 1683 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 9/3/2024 | Annual | 9/3/2025 | 1646 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 4/9/2024 | Annual | 4/9/2025 | 1582 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 5/8/2024 | Annual | 5/8/2025 | 1676 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 2/9/2024 | Annual | 2/9/2025 | 467 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 10/9/2024 | Annual | 10/9/2025 | 1333 |
| SPEAG | EX3DV4 | SAR Probe | 9/9/2024 | Annual | 9/9/2025 | 7639 |
| SPEAG | EX3DV4 | SAR Probe | 3/11/2024 | Annual | 3/11/2025 | 7421 |
| SPEAG | EX3DV4 | SAR Probe | 5/13/2024 | Annual | 5/13/2025 | 7682 |
| SPEAG | EX3DV4 | SAR Probe | 9/9/2024 | Annual | 9/9/2025 | 3949 |
| SPEAG | EX3DV4 | SAR Probe | 4/16/2024 | Annual | 4/16/2025 | 7357 |
| SPEAG | EX3DV4 | SAR Probe | 4/16/2024 | Annual | 4/16/2025 | 7546 |
| SPEAG | EX3DV4 | SAR Probe | 5/13/2024 | Annual | 5/13/2025 | 7552 |
| SPEAG | EX3DV4 | SAR Probe | 9/4/2024 | Annual | 9/4/2025 | 7668 |
| SPEAG | EX3DV4 | SAR Probe | 2/9/2024 | Annual | 2/9/2025 | 7427 |
| SPEAG | EX3DV4 | SAR Probe | 5/13/2024 | Annual | 5/13/2025 | 7416 |
| SPEAG | EX3DV4 | SAR Probe | 4/16/2024 | Annual | 4/16/2025 | 7532 |
| SPEAG | EX3DV4 | SAR Probe | 9/12/2024 | Annual | 9/12/2025 | 7782 |
| SPEAG | EUmmWV4 | EUmmWV4 Probe | 4/8/2024 | Annual | 4/8/2025 | 9487 |

Note:

1. CBT (Calibrated Before Testing). Prior to testing, the measurement paths containing a cable, amplifier, attenuator, coupler or filter were connected to a calibrated source (i.e. a signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to the system verification and output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements.
2. Each equipment item was used solely within its respective calibration period.

# 14 MEASUREMENT UNCERTAINTIES

Applicable for SAR measurements < 6 GHz:

| a | b | c | d | e= f(d,k) | f | g | h = c x f/e | i = c x g/e | k |
|---|---|---|---|---|---|---|---|---|---|
| **Uncertainty Component** | IEEE 1528 Sec. | Tol. (± %) | Prob. Dist. | Div. | $c_i$ 1gm | $c_i$ 10 gms | 1gm $u_i$ (± %) | 10gms $u_i$ (± %) | $v_i$ |
| **Measurement System** | | | | | | | | | |
| Probe Calibration | E2.1 | 7 | N | 1 | 1 | 1 | 7.0 | 7.0 | ∞ |
| Axial Isotropy | E2.2 | 0.25 | N | 1 | 0.7 | 0.7 | 0.2 | 0.2 | ∞ |
| Hemishperical Isotropy | E2.2 | 1.3 | N | 1 | 0.7 | 0.7 | 0.9 | 0.9 | ∞ |
| Boundary Effect | E2.3 | 2 | R | 1.732 | 1 | 1 | 1.2 | 1.2 | ∞ |
| Linearity | E2.4 | 0.3 | N | 1 | 1 | 1 | 0.3 | 0.3 | ∞ |
| System Detection Limits | E2.4 | 0.25 | R | 1.732 | 1 | 1 | 0.1 | 0.1 | ∞ |
| Modulation Response | E2.5 | 4.8 | R | 1.732 | 1 | 1 | 2.8 | 2.8 | ∞ |
| Readout Electronics | E2.6 | 0.3 | N | 1 | 1 | 1 | 0.3 | 0.3 | ∞ |
| Response Time | E2.7 | 0.8 | R | 1.732 | 1 | 1 | 0.5 | 0.5 | ∞ |
| Integration Time | E2.8 | 2.6 | R | 1.732 | 1 | 1 | 1.5 | 1.5 | ∞ |
| RF Ambient Conditions - Noise | E6.1 | 3 | R | 1.732 | 1 | 1 | 1.7 | 1.7 | ∞ |
| RF Ambient Conditions - Reflections | E6.1 | 3 | R | 1.732 | 1 | 1 | 1.7 | 1.7 | ∞ |
| Probe Positioner Mechanical Tolerance | E6.2 | 0.8 | R | 1.732 | 1 | 1 | 0.5 | 0.5 | ∞ |
| Probe Positioning w/ respect to Phantom | E6.3 | 6.7 | R | 1.732 | 1 | 1 | 3.9 | 3.9 | ∞ |
| Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation | E5 | 4 | R | 1.732 | 1 | 1 | 2.3 | 2.3 | ∞ |
| **Test Sample Related** | | | | | | | | | |
| Test Sample Positioning | E4.2 | 3.12 | N | 1 | 1 | 1 | 3.1 | 3.1 | 35 |
| Device Holder Uncertainty | E4.1 | 1.67 | N | 1 | 1 | 1 | 1.7 | 1.7 | 5 |
| Output Power Variation - SAR drift measurement | E2.9 | 5 | R | 1.732 | 1 | 1 | 2.9 | 2.9 | ∞ |
| SAR Scaling | E6.5 | 0 | R | 1.732 | 1 | 1 | 0.0 | 0.0 | ∞ |
| **Phantom & Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty (Shape & Thickness tolerances) | E3.1 | 7.6 | R | 1.73 | 1.0 | 1.0 | 4.4 | 4.4 | ∞ |
| Liquid Conductivity - measurement uncertainty | E3.3 | 4.3 | N | 1 | 0.78 | 0.71 | 3.3 | 3.0 | 76 |
| Liquid Permittivity - measurement uncertainty | E3.3 | 4.2 | N | 1 | 0.23 | 0.26 | 1.0 | 1.1 | 75 |
| Liquid Conductivity - Temperature Uncertainty | E3.4 | 3.4 | R | 1.732 | 0.78 | 0.71 | 1.5 | 1.4 | ∞ |
| Liquid Permittivity - Temperature Unceritainty | E3.4 | 0.6 | R | 1.732 | 0.23 | 0.26 | 0.1 | 0.1 | ∞ |
| Liquid Conductivity - deviation from target values | E3.2 | 5.0 | R | 1.73 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid Permittivity - deviation from target values | E3.2 | 5.0 | R | 1.73 | 0.60 | 0.49 | 1.7 | 1.4 | ∞ |
| **Combined Standard Uncertainty (k=1)** | | | RSS | | | | 12.2 | 12.0 | 191 |
| **Expanded Uncertainty** (95% CONFIDENCE LEVEL) | | | k=2 | | | | 24.4 | 24.0 | |

The above measurement uncertainties are according to IEEE Std. 1528-2013

Applicable for SAR measurements > 6 GHz:

| a | b | c | d | e= f(d,k) | f | g | h = c x f/e | i = c x g/e | k |
|---|---|---|---|---|---|---|---|---|---|
| **Uncertainty Component** | IEEE 1528 Sec. | Tol. (± %) | Prob. Dist. | Div. | $c_i$ 1gm | $c_i$ 10 gms | 1gm $u_i$ (± %) | 10gms $u_i$ (± %) | $v_i$ |
| **Measurement System** | | | | | | | | | |
| Probe Calibration | E2.1 | 9.3 | N | 1 | 1 | 1 | 9.3 | 9.3 | ∞ |
| Axial Isotropy | E2.2 | 0.25 | N | 1 | 0.7 | 0.7 | 0.2 | 0.2 | ∞ |
| Hemishperical Isotropy | E2.2 | 1.3 | N | 1 | 0.7 | 0.7 | 0.9 | 0.9 | ∞ |
| Boundary Effect | E2.3 | 2 | R | 1.732 | 1 | 1 | 1.2 | 1.2 | ∞ |
| Linearity | E2.4 | 0.3 | N | 1 | 1 | 1 | 0.3 | 0.3 | ∞ |
| System Detection Limits | E2.4 | 0.25 | R | 1.732 | 1 | 1 | 0.1 | 0.1 | ∞ |
| Modulation Response | E2.5 | 4.8 | R | 1.732 | 1 | 1 | 2.8 | 2.8 | ∞ |
| Readout Electronics | E2.6 | 0.3 | N | 1 | 1 | 1 | 0.3 | 0.3 | ∞ |
| Response Time | E2.7 | 0.8 | R | 1.732 | 1 | 1 | 0.5 | 0.5 | ∞ |
| Integration Time | E2.8 | 2.6 | R | 1.732 | 1 | 1 | 1.5 | 1.5 | ∞ |
| RF Ambient Conditions - Noise | E6.1 | 3 | R | 1.732 | 1 | 1 | 1.7 | 1.7 | ∞ |
| RF Ambient Conditions - Reflections | E6.1 | 3 | R | 1.732 | 1 | 1 | 1.7 | 1.7 | ∞ |
| Probe Positioner Mechanical Tolerance | E6.2 | 0.8 | R | 1.732 | 1 | 1 | 0.5 | 0.5 | ∞ |
| Probe Positioning w/ respect to Phantom | E6.3 | 6.7 | R | 1.732 | 1 | 1 | 3.9 | 3.9 | ∞ |
| Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation | E5 | 4 | R | 1.732 | 1 | 1 | 2.3 | 2.3 | ∞ |
| **Test Sample Related** | | | | | | | | | |
| Test Sample Positioning | E4.2 | 3.12 | N | 1 | 1 | 1 | 3.1 | 3.1 | 35 |
| Device Holder Uncertainty | E4.1 | 1.67 | N | 1 | 1 | 1 | 1.7 | 1.7 | 5 |
| Output Power Variation - SAR drift measurement | E2.9 | 5 | R | 1.732 | 1 | 1 | 2.9 | 2.9 | ∞ |
| SAR Scaling | E6.5 | 0 | R | 1.732 | 1 | 1 | 0.0 | 0.0 | ∞ |
| **Phantom & Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty (Shape & Thickness tolerances) | E3.1 | 7.6 | R | 1.73 | 1.0 | 1.0 | 4.4 | 4.4 | ∞ |
| Liquid Conductivity - measurement uncertainty | E3.3 | 4.3 | N | 1 | 0.78 | 0.71 | 3.3 | 3.0 | 76 |
| Liquid Permittivity - measurement uncertainty | E3.3 | 4.2 | N | 1 | 0.23 | 0.26 | 1.0 | 1.1 | 75 |
| Liquid Conductivity - Temperature Uncertainty | E3.4 | 3.4 | R | 1.732 | 0.78 | 0.71 | 1.5 | 1.4 | ∞ |
| Liquid Permittivity - Temperature Unceritainty | E3.4 | 0.6 | R | 1.732 | 0.23 | 0.26 | 0.1 | 0.1 | ∞ |
| Liquid Conductivity - deviation from target values | E3.2 | 5.0 | R | 1.73 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid Permittivity - deviation from target values | E3.2 | 5.0 | R | 1.73 | 0.60 | 0.49 | 1.7 | 1.4 | ∞ |
| **Combined Standard Uncertainty (k=1)** | | | RSS | | | | 13.8 | 13.6 | 191 |
| **Expanded Uncertainty** (95% CONFIDENCE LEVEL) | | | k=2 | | | | 27.6 | 27.1 | |

The above measurement uncertainties are according to IEEE Std. 1528-2013