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# SAR EVALUATION REPORT

**Applicant Name:**
iRhythm Technologies Inc.
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San Francisco, CA
94103 USA

**Date of Testing:**
10/08/2024
**Test Report Issue Date:**
02/12/2025
**Test Site/Location:**
Element Morgan Hill, CA, USA
**Document Serial No.:**
1C2408130047-01.2AFBP (Rev 4)

| | |
|---|---|
| **FCC ID:** | **2AFBP-AT18G** |
| **APPLICANT:** | **IRHYTHM TECHNOLOGIES INC.** |

| | |
|---|---|
| **DUT Type:** | Portable Transmitter |
| **Application Type:** | Class II Permissive Change |
| **FCC Rule Part(s):** | CFR §2.1093 |
| **Permissive Change(s):** | See FCC Change Document |
| **Model(s):** | Zio AT Gateway (ASB0004), Zio MCT Gateway (SB10051) |
| **Date of Original Certification:** | 06/06/2018 |

| Equipment Class | Band & Mode | Tx Frequency | SAR 1g Body (W/kg) |
|---|---|---|---|
| TNB | LTE Band 4 | 1710.7 - 1754.3 MHz | 0.90 |
| DTS | Bluetooth LE | 2402 - 2480 MHz | N/A |
| **Simultaneous SAR per KDB 690783 D01v01r03:** | | | 0.98 |

Note: This revised Test Report supersedes and replaces the previously issued test report on the sane subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

Only operations relevant to this permissive change were evaluated for compliance. Please see the original compliance evaluation in RF Exposure Technical Report S/N SAR-IRHYT-011-18001-ZIO-Gateway for complete evaluation of all other operating modes. The operational description includes a description of all changed items.

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE C95.1-1992 and has been tested in accordance with the measurement procedures specified in Section 1.8 of this report; for North American frequency bands only.

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

CERT #2041.02

The SAR Tick is an initiative of the Mobile & Wireless Forum (MWF). While a product may be considered eligible, use of the SAR Tick logo requires an agreement with the MWF. Further details can be obtained by emailing: sartick@mwfai.info.

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# 1 DEVICE UNDER TEST

## 1.1 Device Overview

| Band & Mode | Operating Modes | Tx Frequency |
|---|---|---|
| LTE Band 13 | Data | 779.5 - 784.5 MHz |
| LTE Band 4 (AWS) | Data | 1710.7 - 1754.3 MHz |
| Bluetooth LE | Data | 2402 - 2480 MHz |

## 1.2 Power Reduction for SAR

This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v06.

## 1.3 Nominal and Maximum Output Power Specifications

This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v06.

Only operations relevant to this permissive change were evaluated for compliance. No other target changes have been made. Targets for all other bands/exposure conditions can be found in the original filing.

### 1.3.1 4G Output Power for Portable Use Conditions

**Table 1-1**
**LTE Bands**

| Band | Modulated Average (dBm | |
|---|---|---|
| LTE Band 4 | Maximum | **24.00** |
| | Nominal | **23.00** |

## 1.4 DUT Antenna Locations

The overall diagonal dimension of the device is < 200 mm. A diagram showing the location of the device antennas can be found in Appendix F. Exact antenna dimensions and separation distances are shown in the Technical Descriptions in the FCC filings. More information about the configuration evaluated for SAR can be found in section 5.2.

See the original filing for all other operations that were not evaluated in this permissive change.

## 1.5 Simultaneous Transmission Capabilities

According to FCC KDB Publication 447498 D01v06, transmitters are considered to be operating simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds. This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB Publication 447498 D01v06 4.3.2 procedures.

## 1.6 Miscellaneous SAR Considerations

(A) Bluetooth LE

Per FCC KDB 447498 D01v06, the 1g SAR exclusion threshold for distances <50mm is defined by the following equation:

$$[(\textit{max. power of channel, including tune-up tolerance, mW}) / (\textit{min. test separation distance, mm})] \cdot [\sqrt{f_{(GHz)}}] \leq 3.0 \text{ for 1-g SAR, and} \leq 7.5 \text{ for 10-g extremity SAR}$$

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

Based on the maximum conducted power of Bluetooth (rounded to the nearest mW) and the antenna to user separation distance, body-worn Bluetooth SAR was not required; [(2/5)* √2.480] = 0.63< 3.0. Per KDB Publication 447498 D01v06, the maximum power of the channel was rounded to the nearest mW before calculation.

## 1.7 Variant Models

The following variant models were not tested as part of this evaluation but have been identified by the manufacturer as being electrically identical models, depopulated models, or with reasonable similarity to the model(s) tested. Element Material Technology does not make any claims of compliance for samples or variants which were not tested.

Per manufacturer’s declaration, both Zio AT Gateway (ASB0004) and Zio MCT Gateway (SB10051) models were evaluated with spot-check measurements in-house and determined that model Zio AT Gateway represents the worst case data for the purpose of compliance. This report represents measurement data for Zio AT Gateway model accordingly.

## 1.8 Guidance Applied

- FCC KDB Publication 447498 D01v06 (General SAR Guidance)
- FCC KDB Publication 865664 D01v01r04, D02v01r02 (SAR Measurements up to 6 GHz)
- FCC KDB Publication 941225 D05v02r05
- SPEAG DASY6 System Handbook
- IEEE 1528-2013

## 1.9 Device Serial Numbers

One sample was used to support SAR testing. The manufacturer has confirmed that the device tested has the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.

## 1.10 Bibliography

| Report Type | Report Serial Number |
|---|---|
| SAR Test Report (Original) | Original Filing |

# 2 LTE INFORMATION

| LTE Information | | | |
|---|---|---|---|
| Form Factor | Portable Transmitter | | |
| Frequency Range of each LTE transmission band | LTE Band 13 (779.5 - 784.5 MHz) | | |
| | LTE Band 4 (AWS) (1710.7 - 1754.3 MHz) | | |
| Channel Bandwidth | LTE Band 13: 1.4 MHz | | |
| | LTE Band 4 (AWS): 1.4 MHz | | |
| Channel Numbers and Frequencies (MHz) | Low | Mid | High |
| LTE Band 13 - 1.4 MHz | 779.5 (23205) | 782 (23230) | 784.5 (23255) |
| LTE Band 4 (AWS): 1.4 MHz | 1710.7 (19957) | 1732.5 (20175) | 1754.3 (20393) |
| UE Category | DL UE Cat 20 (QPSK, 16QAM) , UL UE Cat 18 (QPSK, 16QAM) | | |
| Modulations Supported in UL | QPSK, 16QAM | | |
| LTE MPR Permanently implemented per 3GPP TS 36.101 section 6.2.3~6.2.5? (manufacturer attestation to be provided) | YES | | |
| A-MPR (Additional MPR) disabled for SAR Testing? | YES | | |

# 3 INTRODUCTION

The FCC and Innovation, Science, and Economic Development Canada have adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 and Health Canada Safety Code 6 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices. [1]

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [22]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [4] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

## 3.1 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 ($\rho$). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Equation 3-1).

**Equation 3-1**
**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:

$\sigma$ = conductivity of the tissue-simulating material (S/m)
$\rho$ = mass density of the tissue-simulating material (kg/m$^3$)
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]

# 4 DOSIMETRIC ASSESSMENT

## 4.1 Measurement Procedure

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

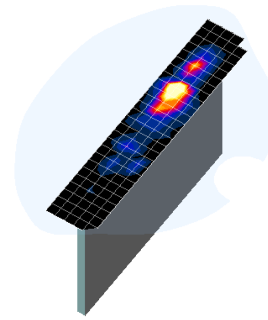

**Figure 4-1 Sample SAR Area Scan**

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 4-1) 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 4-1) 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 4-1. 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 4-1**
**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

# 5 TEST CONFIGURATION POSITIONS

## 5.1 Device Holder

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity ε = 3 and loss tangent δ = 0.02.

## 5.2 SAR Testing for Body-worn Configurations

The portable transmitter device is designed for body-worn usage, where it is clipped on the belt, or around the midsection of the body. The back and front side of the DUT was tested for SAR compliance with the DUT touching the phantom. SAR testing for back side was performed without the clip as it is most conservative with the minimum test separation distance. Body-worn operating configurations with the belt clip was also tested on the worst-case condition for back side. The front side of the DUT was tested additionally for SAR.

# 6 RF EXPOSURE LIMITS

## 6.1 Uncontrolled Environment

UNCONTROLLED ENVIRONMENTS are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

## 6.2 Controlled Environment

CONTROLLED ENVIRONMENTS are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

**Table 6-1**
**SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6**

| HUMAN EXPOSURE LIMITS | | |
|---|---|---|
| | UNCONTROLLED ENVIRONMENT<br>*General Population*<br>(W/kg) or (mW/g) | CONTROLLED ENVIRONMENT<br>*Occupational*<br>(W/kg) or (mW/g) |
| **Peak Spatial Average SAR**<br>Head | 1.6 | 8.0 |
| **Whole Body SAR** | 0.08 | 0.4 |
| **Peak Spatial Average SAR**<br>Hands, Feet, Ankle, Wrists, etc. | 4.0 | 20 |

1. The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2. The Spatial Average value of the SAR averaged over the whole body.
3. The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

# 7 FCC MEASUREMENT PROCEDURES

Power measurements for licensed transmitters are performed using a base station simulator under digital average power.

## 7.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v06, when SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as *reported* SAR. The highest *reported* SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r03.

# 8 RF CONDUCTED POWERS

## 8.1 LTE Conducted Powers

Notes per the manufacturer:

- Higher bandwidths for LTE Band 4 were not supported on the device listed in this report.
- Highest Order power setting on the device is preset to 16 QAM 5 RB Size 0 RB Offset.
- Conducted Sample SN: 354444119286278
- SAR measurements: 354444119420620

### 8.1.1 LTE Band 4

**Table 8-1**
**LTE Band 4 Measured - 1.4 MHz Bandwidth**

| LTE Band 4 (AWS) 1.4 MHz Bandwidth | | | | | | | |
|---|---|---|---|---|---|---|---|
| Modulation | RB Size | RB Offset | Low Channel 19957 (1710.7 MHz) Low Setting Conducted Power [dBm] | Mid Channel 20175 (1732.5 MHz) Low Setting Conducted Power [dBm] | High Channel 20393 (1754.3 MHz) Low Setting Conducted Power [dBm] | MPR Allowed per 3GPP [dB] | MPR [dB] |
| QPSK | 1 | 0 | 22.98 | 22.91 | 23.07 | 0 | 0 |
| | 1 | 2 | 23.03 | 22.98 | **23.14** | | 0 |
| | 1 | 5 | 22.99 | 22.89 | 23.09 | | 0 |
| | 3 | 0 | **22.28** | 22.21 | 22.21 | 0-1 | 1 |
| | 3 | 2 | 22.27 | 22.20 | 22.20 | | 1 |
| | 3 | 3 | 22.23 | 22.18 | 22.25 | | 1 |
| | 6 | 0 | 21.23 | 21.24 | 21.21 | 0-2 | 2 |
| 16QAM | 1 | 0 | 21.28 | 21.04 | 21.42 | 0-1 | 1 |
| | 1 | 2 | 21.28 | 21.26 | 21.37 | | 1 |
| | 1 | 5 | 21.29 | 21.28 | 21.41 | | 1 |
| | 3 | 0 | 21.22 | 21.17 | 21.24 | 0-2 | 1 |
| | 3 | 2 | 21.27 | 21.23 | 21.23 | | 1 |
| | 3 | 3 | 21.14 | 21.10 | 21.25 | | 1 |
| | 5 | 0 | 21.14 | 21.17 | 21.24 | | 1 |

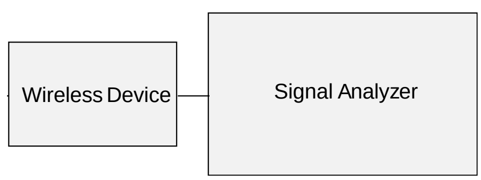


**Figure 8-1**
**Power Measurement Setup**

# 9 SYSTEM VERIFICATION

## 9.1 Tissue Verification

**Table 9-1**
**Measured Tissue Properties**

| Calibrated for Tests Performed on | Tissue Type | Tissue Temp During Calibration ('C) | Measured Frequency (MHz) | Measured Conductivity, σ (S/m) | Measured Dielectric Constant, ε | Target Conductivity, σ (s/M) | Target Dielectric Constant, ε | % dev σ | % dev ε |
|---|---|---|---|---|---|---|---|---|---|
| 10/8/2024 | 1750 Head | 22.0 | 1700 | 1.377 | 39.138 | 1.343 | 40.145 | 2.53% | -2.51% |
| | | | 1705 | 1.382 | 39.120 | 1.345 | 40.141 | 2.75% | -2.54% |
| | | | 1710 | 1.386 | 39.096 | 1.348 | 40.136 | 2.82% | -2.59% |
| | | | 1720 | 1.395 | 39.059 | 1.354 | 40.126 | 3.03% | -2.66% |
| | | | 1745 | 1.420 | 38.958 | 1.368 | 40.087 | 3.80% | -2.82% |
| | | | 1750 | 1.425 | 38.934 | 1.371 | 40.079 | 3.94% | -2.86% |
| | | | 1770 | 1.444 | 38.853 | 1.383 | 40.047 | 4.41% | -2.98% |
| | | | 1790 | 1.462 | 38.773 | 1.394 | 40.016 | 4.88% | -3.11% |

The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per KDB Publication 865664 D01v01r04 and IEEE 1528-2013 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.
Note: Per April 2019 TCB Workshop Notes, single head-tissue simulating liquid specified in IEC 62209-1 is permitted to use for all SAR tests.

## 9.2 Test System Verification

Prior to SAR assessment, the system is verified to ±10% of the SAR measurement on the reference dipole at the time of calibration by the calibration facility. Full system validation status and result summary can be found in the System Validation Appendix.

**Table 9-2**
**System Verification Results – 1g**

| System Verification TARGET & MEASURED | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAR System | Tissue Frequency (MHz) | Tissue Type | Date | Amb. Temp. (C) | Liquid Temp. (C) | Input Power (W) | Source SN | Probe SN | DAE | Measured SAR 1g (W/kg) | 1W Target SAR 1g (W/kg) | 1W Normalized SAR 1g (W/kg) | Deviation 1g (%) |
| AM14 | 1750 | Head | 10/08/2024 | 20.0 | 20.0 | 0.10 | 1104 | 7308 | 534 | 3.490 | 35.600 | 34.900 | -1.97% |

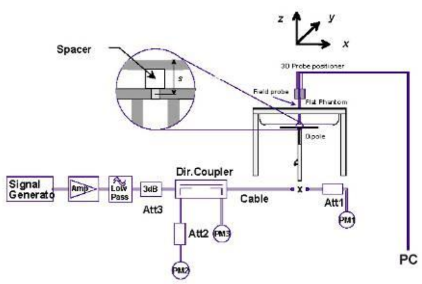


**Figure 9-1**
**System Verification Setup Diagram**

**Figure 9-2**
**System Verification Setup Photo**

# 10 SAR DATA SUMMARY

## 10.1 Standalone SAR Data

**Table 10-1**
**LTE Band 4 Body SAR**

| Exposure | Band / Mode | Service / Modulation | Duty Cycle | Power Drift [dB] | Frequency [MHz] | Channel # | Max Allowed Power [dBm] | Conducted Power [dBm] | RB Size | RB Offset | Test Position | Spacing [mm] | Clip Attachment | Measured 1g SAR [W/kg] | Power Scaling Factor | Reported 1g SAR [W/kg] | Plot # |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Body | LTE Band 4 | QPSK | 1:1 | -0.01 | 1710.7 | 19957 | 24.00 | 23.03 | 1 | 2 | Front | 0 | No | 0.718 | 1.250 | 0.898 | A1 |
| Body | LTE Band 4 | QPSK | 1:1 | -0.02 | 1732.5 | 20175 | 24.00 | 22.98 | 1 | 2 | Front | 0 | No | 0.694 | 1.265 | 0.878 | |
| Body | LTE Band 4 | QPSK | 1:1 | 0.01 | 1754.3 | 20393 | 24.00 | 23.14 | 1 | 2 | Front | 0 | No | 0.573 | 1.219 | 0.698 | |
| Body | LTE Band 4 | QPSK | 1:1 | -0.03 | 1710.7 | 19957 | 23.00 | 22.28 | 3 | 0 | Front | 0 | No | 0.554 | 1.180 | 0.654 | |
| Body | LTE Band 4 | QPSK | 1:1 | 0.01 | 1732.5 | 20175 | 23.00 | 22.21 | 3 | 0 | Front | 0 | No | 0.523 | 1.199 | 0.627 | |
| Body | LTE Band 4 | QPSK | 1:1 | 0.00 | 1754.3 | 20393 | 23.00 | 22.25 | 3 | 3 | Front | 0 | No | 0.479 | 1.189 | 0.570 | |
| Body | LTE Band 4 | QPSK | 1:1 | -0.01 | 1732.5 | 20175 | 22.00 | 21.24 | 6 | 0 | Front | 0 | No | 0.445 | 1.191 | 0.530 | |
| Body | LTE Band 4 | QPSK | 1:1 | 0.12 | 1754.3 | 20393 | 24.00 | 23.14 | 1 | 2 | Back | 0 | No | 0.553 | 1.219 | 0.674 | |
| Body | LTE Band 4 | QPSK | 1:1 | 0.16 | 1754.3 | 20393 | 24.00 | 23.14 | 1 | 2 | Back | 0 | Yes | 0.142 | 1.219 | 0.173 | |
| Body | LTE Band 4 | QPSK | 1:1 | 0.05 | 1710.7 | 19957 | 23.00 | 22.28 | 3 | 0 | Back | 0 | No | 0.476 | 1.180 | 0.562 | |
| ANSI/IEEE C95.1 1992 - SAFETY LIMIT<br>Spatial Peak<br>Uncontrolled Exposure/General Population | | | | | | | | | | Body<br>1.6 W/kg (mW/g)<br>averaged over 1 gram | | | | | | | |

SAR Sample SN: 354444119420620

## 10.2 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in FCC KDB Publication 447498 D01v06.
2. Batteries are fully charged at the beginning of the SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v06.
6. SAR tests are required for the back and front surface of the portable transmitter with the device shell touching the phantom. The SAR Exclusion Threshold in FCC KDB 447498 D01v06 was applied to determine SAR test exclusion for adjacent edge configurations.
7. The orange highlights throughout the report represent the highest scaled SAR per Equipment Class.
8. See the original filing for all other operations that were not evaluated in this permissive change.

LTE Notes:

1. LTE test configurations are determined according to SAR Evaluation Considerations for LTE Devices in FCC KDB Publication 941225 D05v02r04. The general test procedures used for testing can be found in Section 7.5.4.
2. MPR is permanently implemented for this device by the manufacturer. The specific manufacturer target MPR is indicated alongside the SAR results. MPR is enabled for this device, according to 3GPP TS36.101 Section 6.2.3 – 6.2.5 under Table 6.2.3-1.
3. A-MPR was disabled for all SAR tests by setting NS=01 and MCC=001 on the base station simulator. SAR tests were performed with the same number of RB and RB offsets transmitting on all TTI frames (maximum TTI).

# 11 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

## 11.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v06 are applicable to devices with built-in unlicensed transmitters such as Bluetooth LE which may simultaneously transmit with the licensed transmitter.

## 11.2 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore, simultaneous transmission analysis is required. Per FCC KDB Publication 447498 D01v06 4.3.2 and IEEE 1528-2013 Section 6.3.4.1.2, simultaneous transmission SAR test exclusion may be applied when the sum of the 1g SAR for all the simultaneous transmitting antennas in a specific physical test configuration is ≤1.6 W/kg. The different test positions in an exposure condition may be considered collectively to determine SAR test exclusion according to the sum of 1g or 10g SAR. When standalone SAR is not required to be measured, per FCC KDB 447498 D01v06 4.3.2 b), the following equation must be used to estimate the standalone 1g SAR for simultaneous transmission assessment involving that transmitter.

Only operations relevant to this permissive change were evaluated for compliance. No other target changes have been made. Targets for all other bands/exposure conditions can be found in the original filing.

**Equation 11-1**
**Bluetooth LE Estimated SAR Calculation**

$$\text{Estimated SAR} = \frac{\sqrt{f(GHz)}}{7.5} * \frac{\text{(Max Power of channel, mW)}}{\text{Min. Separation Distance, mm}}$$

Note: the maximum power of the channel was rounded to the nearest mW before calculation

**Table 11-1**
**Bluetooth LE Estimated Body SAR**

| Mode | Frequency | Maximum Allowed Power | Seperation Distance (Body) | Estimated SAR (Body) |
|---|---|---|---|---|
| | [MHz] | [mW] | [mm] | [W/kg] |
| Bluetooth LE | 2480 | 1.6 | 0 | 0.084 |

## 11.3 Body SAR Simultaneous Transmission Analysis

**Table 11-2**
**Cellular Band Simultaneous Transmission Scenario with 2.4 GHz Bluetooth LE**

| Simult Tx | Configuration | Cellular Band SAR (W/kg) | 2.4 GHz Bluetooth LE SAR (W/kg) | ΣSAR (W/kg) |
|---|---|---|---|---|
| | | 1 | 2 | 1+2 |
| Body SAR | Front | 0.898 | 0.084 | 0.982 |
| | Back | 0.674 | 0.084 | 0.758 |

# 12 SAR MEASUREMENT VARIABILITY

## 12.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01, SAR measurement variability was not assessed for each frequency band since all measured SAR values are < 0.8 W/kg for 1g SAR and < 2.0 W/kg for 10g SAR.

## 12.2 Measurement Uncertainty

The measured SAR was <1.5 W/kg for 1g and <3.75 W/kg for 10g for all frequency bands. Therefore, per KDB Publication 865664 D01v01r04, the extended measurement uncertainty analysis per IEEE 1528-2013 was not required.

# 13 EQUIPMENT LIST

| Manufacturer | Model | Description | Cal Date | Cal Interval | Cal Due | Serial Number |
|---|---|---|---|---|---|---|
| Agilent | E4438C | ESG Vector Signal Generator | 11/14/2023 | Annual | 11/14/2024 | MY45093852 |
| Agilent | N5182A | MXG Vector Signal Generator | 5/16/2024 | Annual | 5/16/2025 | MY47420837 |
| Agilent | 8753ES | S-Parameter Vector Network Analyzer | 9/25/2024 | Annual | 9/25/2025 | US39170118 |
| Agilent | E5515C | Wireless Communications Test Set | CBT | N/A | CBT | US41140256 |
| Amplifier Research | 150A100C | Amplifier | CBT | N/A | CBT | 350132 |
| Anritsu | MN8110B | I/O Adaptor | CBT | N/A | CBT | 6261747881 |
| Anritsu | MA24106A | USB Power Sensor | 12/4/2023 | Annual | 12/4/2024 | 1520501 |
| Control Company | 4052 | Long Stem Thermometer | 10/16/2023 | Biennial | 10/16/2025 | 230703247 |
| Control Company | 4040 | Therm./ Clock/ Humidity Monitor | 1/15/2024 | Annual | 1/15/2025 | 160574418 |
| Mitutoyo | 500-196-30 | CD-6"ASX 6Inch Digital Caliper | 2/16/2022 | Triennial | 2/16/2025 | A20238413 |
| Agilent | N9020A | MXA Signal Analyzer | 9/27/2024 | Annual | 9/27/2025 | MY53280290 |
| 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 | BW-N20W5+ | DC to 18 GHz Precision Fixed 20 dB Attenuator | 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 |
| Seekonk | NC-100 | Torque Wrench | CBT | N/A | CBT | 22217 |
| Rohde & Schwarz | FSP-7 | Spectrum Analyzer | 6/27/2024 | Annual | 6/27/2025 | 100288 |
| Rohde & Schwarz | CMW500 | Wideband Radio Communication Tester | 6/10/2024 | Annual | 6/10/2025 | 168543 |
| SPEAG | DAK-3.5 | Dielectric Assessment Kit | 5/14/2024 | Annual | 5/14/2025 | 1070 |
| SPEAG | DAKS-3.5 | Portable Dielectric Assessment Kit | 9/10/2024 | Annual | 9/10/2025 | 1045 |
| SPEAG | MAIA | Modulation and Audio Interference Analyzer | N/A | N/A | N/A | 1237 |
| SPEAG | D1750V2 | 1750 MHz SAR Dipole | 9/6/2023 | Biennial | 9/6/2025 | 1104 |
| SPEAG | DAE4 | Dasy Data Acquisition Electronics | 3/6/2024 | Annual | 3/6/2025 | 534 |
| SPEAG | EX3DV4 | SAR Probe | 2/9/2024 | Annual | 2/9/2025 | 7308 |

Note: 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.
Note: All equipment was used solely within its respective calibration period

# 14 MEASUREMENT UNCERTAINTIES

| 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 | E.2.1 | 7 | N | 1 | 1 | 1 | 7.0 | 7.0 | ∞ |
| Axial Isotropy | E.2.2 | 0.25 | N | 1 | 0.7 | 0.7 | 0.2 | 0.2 | ∞ |
| Hemishperical Isotropy | E.2.2 | 1.3 | N | 1 | 0.7 | 0.7 | 0.9 | 0.9 | ∞ |
| Boundary Effect | E.2.3 | 2 | R | 1.73 | 1 | 1 | 1.2 | 1.2 | ∞ |
| Linearity | E.2.4 | 0.3 | N | 1 | 1 | 1 | 0.3 | 0.3 | ∞ |
| System Detection Limits | E.2.4 | 0.25 | R | 1.73 | 1 | 1 | 0.1 | 0.1 | ∞ |
| Modulation Response | E.2.5 | 4.8 | R | 1.73 | 1 | 1 | 2.8 | 2.8 | ∞ |
| Readout Electronics | E.2.6 | 0.3 | N | 1 | 1 | 1 | 0.3 | 0.3 | ∞ |
| Response Time | E.2.7 | 0.8 | R | 1.73 | 1 | 1 | 0.5 | 0.5 | ∞ |
| Integration Time | E.2.8 | 2.6 | R | 1.73 | 1 | 1 | 1.5 | 1.5 | ∞ |
| RF Ambient Conditions - Noise | E.6.1 | 3 | R | 1.73 | 1 | 1 | 1.7 | 1.7 | ∞ |
| RF Ambient Conditions - Reflections | E.6.1 | 3 | R | 1.73 | 1 | 1 | 1.7 | 1.7 | ∞ |
| Probe Positioner Mechanical Tolerance | E.6.2 | 0.8 | R | 1.73 | 1 | 1 | 0.5 | 0.5 | ∞ |
| Probe Positioning w/ respect to Phantom | E.6.3 | 6.7 | R | 1.73 | 1 | 1 | 3.9 | 3.9 | ∞ |
| Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation | E.5 | 4 | R | 1.73 | 1 | 1 | 2.3 | 2.3 | ∞ |
| **Test Sample Related** | | | | | | | | | |
| Test Sample Positioning | E.4.2 | 3.12 | N | 1 | 1 | 1 | 3.1 | 3.1 | 35 |
| Device Holder Uncertainty | E.4.1 | 1.67 | N | 1 | 1 | 1 | 1.7 | 1.7 | 5 |
| Output Power Variation - SAR drift measurement | E.2.9 | 5 | R | 1.73 | 1 | 1 | 2.9 | 2.9 | ∞ |
| SAR Scaling | E.6.5 | 0 | R | 1.73 | 1 | 1 | 0.0 | 0.0 | ∞ |
| **Phantom & Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty (Shape & Thickness tolerances) | E.3.1 | 7.6 | R | 1.73 | 1.0 | 1.0 | 4.4 | 4.4 | ∞ |
| Liquid Conductivity - measurement uncertainty | E.3.3 | 4.3 | N | 1 | 0.78 | 0.71 | 3.3 | 3.0 | 76 |
| Liquid Permittivity - measurement uncertainty | E.3.3 | 4.2 | N | 1 | 0.23 | 0.26 | 1.0 | 1.1 | 75 |
| Liquid Conductivity - Temperature Uncertainty | E.3.4 | 3.4 | R | 1.73 | 0.78 | 0.71 | 1.5 | 1.4 | ∞ |
| Liquid Permittivity - Temperature Unceritainty | E.3.4 | 0.6 | R | 1.73 | 0.23 | 0.26 | 0.1 | 0.1 | ∞ |
| Liquid Conductivity - deviation from target values | E.3.2 | 5.0 | R | 1.73 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid Permittivity - deviation from target values | E.3.2 | 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

# 15 CONCLUSION

## 15.1 Measurement Conclusion

The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of the FCC and Innovation, Science, and Economic Development Canada, with respect to all parameters subject to this test. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [3]

# 16 REFERENCES

[1] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation, Aug. 1996.

[2] ANSI/IEEE C95.1-2005, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, 2006.

[3] ANSI/IEEE C95.1-1992, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, Sept. 1992.

[4] ANSI/IEEE C95.3-2002, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave, New York: IEEE, December 2002.

[5] IEEE Standards Coordinating Committee 39 –Standards Coordinating Committee 34 – IEEE Std. 1528-2013, IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.

[6] NCRP, National Council on Radiation Protection and Measurements, Biological Effects and Exposure Criteria for RadioFrequency Electromagnetic Fields, NCRP Report No. 86, 1986. Reprinted Feb. 1995.

[7] T. Schmid, O. Egger, N. Kuster, Automated E-field scanning system for dosimetric assessments, IEEE Transaction on Microwave Theory and Techniques, vol. 44, Jan. 1996, pp. 105-113.

[8] K. Pokovic, T. Schmid, N. Kuster, Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies, ICECOM97, Oct. 1997, pp. 1 -124.

[9] K. Pokovic, T. Schmid, and N. Kuster, E-field Probe with improved isotropy in brain simulating liquids, Proceedings of the ELMAR, Zadar, Croatia, June 23-25, 1996, pp. 172-175.

[10] Schmid & Partner Engineering AG, Application Note: Data Storage and Evaluation, June 1998, p2.

[11] V. Hombach, K. Meier, M. Burkhardt, E. Kuhn, N. Kuster, The Dependence of EM Energy Absorption upon Human Modeling at 900 MHz, IEEE Transaction on Microwave Theory and Techniques, vol. 44 no. 10, Oct. 1996, pp. 1865-1873.

[12] N. Kuster and Q. Balzano, Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300MHz, IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.

[13] G. Hartsgrove, A. Kraszewski, A. Surowiec, Simulated Biological Materials for Electromagnetic Radiation Absorption Studies, University of Ottawa, Bioelectromagnetics, Canada: 1987, pp. 29-36.

[14] Q. Balzano, O. Garay, T. Manning Jr., Electromagnetic Energy Exposure of Simulated Users of Portable Cellular Telephones, IEEE Transactions on Vehicular Technology, vol. 44, no.3, Aug. 1995.

[15] W. Gander, Computermathematick, Birkhaeuser, Basel, 1992.

[16] W.H. Press, S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, Second edition, Cambridge University Press, 1992.

[17] N. Kuster, R. Kastle, T. Schmid, Dosimetric evaluation of mobile communications equipment with known precision, IEEE Transaction on Communications, vol. E80-B, no. 5, May 1997, pp. 645-652.

[18] CENELEC CLC/SC111B, European Prestandard (prENV 50166-2), Human Exposure to Electromagnetic Fields High-frequency: 10kHz-300GHz, Jan. 1995.

[19] Prof. Dr. Niels Kuster, ETH, Eidgenössische Technische Hoschschule Zürich, Dosimetric Evaluation of the Cellular Phone.

[20] IEC 62209-1, Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 1: Devices used next to the ear (Frequency range of 300 MHz to 6 GHz), July 2016.

[21] Innovation, Science, Economic Development Canada RSS-102 Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands) Issue 5, March 2015.

[22] Health Canada Safety Code 6 Limits of Human Exposure to Radio Frequency Electromagnetic Fields in the Frequency Range from 3 kHz – 300 GHz, 2015

[23] FCC SAR Test Procedures for 2G-3G Devices, Mobile Hotspot and UMPC Devices KDB Publications 941225, D01-D07

[24] SAR Measurement Guidance for IEEE 802.11 Transmitters, KDB Publication 248227 D01

[25] FCC SAR Considerations for Handsets with Multiple Transmitters and Antennas, KDB Publications 648474 D03-D04

[26] FCC SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers, FCC KDB Publication 616217 D04

[27] FCC SAR Measurement and Reporting Requirements for 100MHz – 6 GHz, KDB Publications 865664 D01-D02

[28] FCC General RF Exposure Guidance and SAR Procedures for Dongles, KDB Publication 447498, D01-D02

[29] Anexo à Resolução No. 533, de 10 de Septembro de 2009.

[30] IEC 62209-2, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz), Mar. 2010.