# FCC SAR TEST REPORT

| | | |
|---|---|---|
| **FCC ID** | : | **B94-RTL8852BER** |
| **Equipment** | : | **11ax RTL8852BE Combo module** |
| **Brand Name** | : | **REALTEK** |
| **Model Name** | : | **RTL8852BE** |
| **Applicant** | : | **HP Inc.<br>3390 East Hormony Road,<br>Fort Collins Colorado, USA 80528** |
| **Standard** | : | **FCC 47 CFR Part 2 (2.1093)** |

**The product was installed into Notebook PC (Brand Name: HP, Model Name: TPN-W155) during test.**

**The product was received on Oct. 14, 2022 and testing was started from Oct. 31, 2022 and completed on Oct. 31, 2022. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample provide by manufacturer and the test data has been evaluated in accordance with the test procedures given in 47 CFR Part 2.1093 and FCC KDB and has been pass the FCC requirement.**

**The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. Laboratory, the test report shall not be reproduced except in full.**

**Approved by: Cona Huang / Deputy Manager**

***Sporton International Inc. Wensan Laboratory***
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# History of this test report

| Report No. | Version | Description | Issued Date |
|---|---|---|---|
| FA1N2612-01 | 01 | Initial issue of report | Dec. 16, 2022 |
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# 1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) for HP Inc., 11ax RTL8852BE Combo module, RTL8852BE, are as follows.

| Equipment Class | Frequency Band | | Highest SAR Summary Body 1g SAR (W/kg) | Highest Simultaneous Transmission 1g SAR (W/kg) |
|---|---|---|---|---|
| DTS | WLAN | 2.4GHz WLAN | 0.65 | 0.65 |
| NII | | 5GHz WLAN | 0.87 | 0.93 |
| DSS | 2.4GHz Band | Bluetooth | 0.06 | 0.93 |
| Date of Testing: | | | 2022/10/31 | |

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation and the FCC designation No. TW3786 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC test. This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg for Partial-Body 1g SAR) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013 and FCC KDB publications.

**Reviewed by: Jason Wang**
**Report Producer: Carlie Tsai**

# 2. Guidance Applied

The Specific Absorption Rate (SAR) testing specification, method, and procedure for this device is in accordance with the following standards, the below KDB standard may not including in the TAF code without accreditation.

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2013
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB 865664 D02 SAR Reporting v01r02
- FCC KDB 447498 D01 General RF Exposure Guidance v06
- FCC KDB 248227 D01 802.11 Wi-Fi SAR v02r02
- FCC KDB 616217 D04 SAR for laptop and tablets v01r02

# 3. Equipment Under Test (EUT) Information

## 3.1 General Information

| Product Feature & Specification | |
|---|---|
| **Equipment Name** | 11ax RTL8852BE Combo module |
| **Brand Name** | REALTEK |
| **Model Name** | RTL8852BE |
| **FCC ID** | B94-RTL8852BER |
| **Wireless Technology and Frequency Range** | WLAN 2.4 GHz Band: 2400 MHz ~ 2483.5 MHz<br>WLAN 5.2 GHz Band: 5150 MHz ~ 5250 MHz<br>WLAN 5.3 GHz Band: 5250 MHz ~ 5350 MHz<br>WLAN 5.6 GHz Band: 5470 MHz ~ 5725 MHz<br>WLAN 5.8 GHz Band: 5725 MHz ~ 5850 MHz<br>WLAN 5.8G UNII4 Band: 5850 MHz ~ 5895 MHz<br>Bluetooth: 2400 MHz ~ 2483.5 MHz |
| **Mode** | WLAN: 802.11a/b/g/n/ac/ax HT20/HT40/VHT20/VHT40/VHT80/HE20/HE40/HE80<br>Bluetooth BR/EDR/LE |
| **Remark:**<br>1. Based on original report to adding WLAN 5.8G UNII4 SAR testing, other bands refer to Sporton SAR Report, Report number FA1N2612, the highest SAR results on each exposure position between original report was do Sim-Tx analysis<br>2. There are four kinds of samples as below. First RF exposure selects sample 1 to test all exposure position, sample 2~4 spot check worst case found sample 1.<br>3. This device is convertible type notebook PC, and there have Laptop and Tablet two usage way, when end user is used different mode which the device will according current mode to limit different maximum power. | |

| Host Information | |
|---|---|
| **Equipment Name** | Notebook PC |
| **Brand Name** | HP |
| **Model Name** | TPN-W155 |
| **EUT Stage** | Production Unit |

| Sample | Keyboard side Material | Antenna Vendor |
|---|---|---|
| Sample 1 | FF+ | Vendor 1 |
| Sample 2 | FF | Vendor 1 |
| Sample 3 | FF | Vendor 2 |
| Sample 4 | FF+ | Vendor 2 |

| Antenna Information(FF TB) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Tx1/ Rx1/Aux | Ant. Type | PIFA | connector | Vendor 1 | Tx2/ Rx2/Main | Ant. Type | PIFA | connector | Vendor 1 |
| | Model No. | 025.901ZV.0001 (0ACAR021015N) | | | | Model No. | 025.901ZU.0001 (0ACAR021016N) | | |
| | Peak Gain (dBi) | | | | | Peak Gain (dBi) | | | |
| | 2400~2483.5MHz | -0.84 | 5470~5725MHz | -0.35 | | 2400~2483.5MHz | -0.33 | 5470~5725MHz | -0.89 |
| | 5150~5250MHz | -1.3 | 5725~5850MHz | -0.79 | | 5150~5250MHz | -1.57 | 5725~5850MHz | -1.57 |
| | 5250~5350MHz | -1.21 | 5850~5895MHz | -0.79 | | 5250~5350MHz | -1.08 | 5850~5895MHz | -1.66 |
| | | | 5925~7125MHz | 1.91 | | | | 5925~7125MHz | 2.22 |
| Tx1/ Rx1/Aux | Ant. Type | PIFA | connector | Vendor 2 | Tx2/ Rx2/Main | Ant. Type | PIFA | connector | Vendor 2 |
| | Model No. | 025.90204.0001 (WA-P-LE-02-058) | | | | Model No. | 025.90205.0001 (WA-P-LE-02-059) | | |
| | Peak Gain (dBi) | | | | | Peak Gain (dBi) | | | |
| | 2400~2483.5MHz | 1.16 | 5470~5725MHz | -1.07 | | 2400~2483.5MHz | 2.3 | 5470~5725MHz | -0.83 |
| | 5150~5250MHz | 0.38 | 5725~5850MHz | -0.17 | | 5150~5250MHz | -0.25 | 5725~5850MHz | -0.2 |
| | 5250~5350MHz | -0.18 | 5850~5895MHz | 0.11 | | 5250~5350MHz | -0.34 | 5850~5895MHz | 2.32 |
| | | | 5925~7125MHz | 2.87 | | | | 5925~7125MHz | 2.3 |
| **Antenna Information(FF+ TB)** | | | | | | | | | |
| Tx1/ Rx1/Aux | Ant. Type | PIFA | connector | Vendor 1 | Tx2/ Rx2/Main | Ant. Type | PIFA | connector | Vendor 1 |
| | Model No. | 025.901ZV.0001 (0ACAR021015N) | | | | Model No. | 025.901ZU.0001 (0ACAR021016N) | | |
| | Peak Gain (dBi) | | | | | Peak Gain (dBi) | | | |
| | 2400~2483.5MHz | -0.84 | 5470~5725MHz | -0.75 | | 2400~2483.5MHz | -0.69 | 5470~5725MHz | -0.89 |
| | 5150~5250MHz | -1.56 | 5725~5850MHz | -0.79 | | 5150~5250MHz | -1.6 | 5725~5850MHz | -1.66 |
| | 5250~5350MHz | -1.26 | 5850~5895MHz | -0.79 | | 5250~5350MHz | -1.08 | 5850~5895MHz | -1.66 |
| | | | 5925~7125MHz | 1.91 | | | | 5925~7125MHz | 2.22 |
| Tx1/ Rx1/Aux | Ant. Type | PIFA | connector | Vendor 2 | Tx2/ Rx2/Main | Ant. Type | PIFA | connector | Vendor 2 |
| | Model No. | 025.90204.0001 (WA-P-LE-02-058) | | | | Model No. | 025.90205.0001 (WA-P-LE-02-059) | | |
| | Peak Gain (dBi) | | | | | Peak Gain (dBi) | | | |
| | 2400~2483.5MHz | 1.16 | 5470~5725MHz | -1.33 | | 2400~2483.5MHz | 2.3 | 5470~5725MHz | -1.14 |
| | 5150~5250MHz | 0.32 | 5725~5850MHz | -1.2 | | 5150~5250MHz | -0.01 | 5725~5850MHz | -0.2 |
| | 5250~5350MHz | -0.2 | 5850~5895MHz | -1.2 | | 5250~5350MHz | -0.66 | 5850~5895MHz | 2.32 |
| | | | 5925~7125MHz | 2.87 | | | | 5925~7125MHz | 2.3 |

## 3.2 Sensor Triggering angle and power verification

**General Note:**

1. The following guidance should be applied to laptops/tablets that use Hall Effect or gravity sensors to detect lid angle for the purpose of power reduction:

   Step 1: With the lid is in closed mode (0 degrees), open the screen in 10 degree steps until laptop mode is obtained
   Step 2: Lower the screen 5 degrees. Closed mode should be reobtained. If not keep lowering in 5 degree steps
   Step 3: Open the screen in 1 degree steps until laptop mode is reobtained
   Step 4: Continue opening the screen in 1 degree steps until at least 5 degrees past where laptop mode was obtained
   Step 5: Then continue opening the screen in 10 degree steps until tablet mode is obtained
   Step 6: Power measurements should be taken at each step
   Step 7: Reverse this procedure going from tablet mode back down to closed mode

| when the screen angle is from 0 degree to 360 degree | | | |
|---|---|---|---|
| Screen angle (degree) v.s. power | Wireless | | WLAN Ant 1/2 |
| | Band | | 5.8GHz UNII4 WLAN |
| | Lid Close | 0 | standby |
| | | 10 | standby |
| | | 20 | standby |
| | | 30 | standby |
| | | 31 | standby |
| | | 32 | standby |
| | | 33 | standby |
| | | 34 | standby |
| | Laptop | 35 | 18.32 |
| | | 36 | 18.38 |
| | | 37 | 18.27 |
| | | 38 | 18.29 |
| | | 39 | 18.29 |
| | | 40 | 18.21 |
| | | 50 | 18.28 |
| | | 60 | 18.29 |
| | | 70 | 18.36 |
| | | 80 | 18.31 |
| | | 90 | 18.27 |
| | | 100 | 18.39 |
| | | 110 | 18.31 |
| | | 120 | 18.40 |
| | | 125 | 18.23 |
| | | 126 | 18.33 |
| | | 127 | 18.27 |
| | | 128 | 18.34 |
| | | 129 | 18.35 |
| | Tablet | 130 | 16.74 |
| | | 131 | 16.86 |
| | | 132 | 16.83 |
| | | 133 | 16.75 |
| | | 134 | 16.85 |
| | | 135 | 16.85 |
| | | 140 | 16.76 |
| | | 150 | 16.87 |
| | | 160 | 16.82 |
| | | 170 | 16.70 |

| | | | |
|---|---|---|---|
| | | 180 | 16.70 |
| | | 190 | 16.87 |
| | | 200 | 16.85 |
| | | 210 | 16.89 |
| | | 220 | 16.80 |
| | | 230 | 16.89 |
| | | 240 | 16.78 |
| | | 250 | 16.76 |
| | | 260 | 16.77 |
| | | 270 | 16.84 |
| | | 280 | 16.77 |
| | | 290 | 16.83 |
| | | 300 | 16.90 |
| | | 310 | 16.77 |
| | | 320 | 16.75 |
| | | 330 | 16.85 |
| | | 340 | 16.77 |
| | | 350 | 16.85 |
| | | 360 | 16.72 |
| | Tablet | 195 | 16.87 |
| | | 196 | 16.75 |
| | | 197 | 16.86 |
| | | 198 | 16.75 |
| | | 199 | 16.86 |
| | | 200 | 16.78 |
| | Stand mode (Screen orientation is set to 0° and base is horizontal) | 201 | 18.29 |
| | | 202 | 18.37 |
| | | 203 | 18.24 |
| | | 204 | 18.37 |
| | | 205 | 18.23 |
| | | 210 | 18.40 |
| | | 220 | 18.20 |
| | | 230 | 18.37 |
| | | 240 | 18.20 |
| | | 250 | 18.40 |
| | | 260 | 18.31 |
| | | 270 | 18.37 |
| | | 280 | 18.22 |
| | | 290 | 18.37 |
| | | 300 | 18.29 |
| | | 310 | 18.20 |
| | | 320 | 18.34 |
| | | 330 | 18.23 |
| | | 335 | 18.23 |
| | | 336 | 18.21 |
| | | 337 | 18.28 |
| | | 338 | 18.39 |
| | | 339 | 18.38 |
| | | 340 | 18.22 |
| | Tablet | 341 | 16.76 |
| | | 342 | 16.75 |
| | | 343 | 16.74 |

| | | | |
|---|---|---|---|
| | | 344 | 16.88 |
| | | 345 | 16.86 |
| | | 350 | 16.73 |
| | | 360 | 16.76 |
| | Tablet | 195 | 16.85 |
| | | 196 | 16.80 |
| | | 197 | 16.72 |
| | | 198 | 16.70 |
| | | 199 | 16.82 |
| | | 200 | 16.77 |
| | Tent mode (Screen orientation is set to 180° and base is not horizontal) | 201 | 16.78 |
| | | 202 | 16.73 |
| | | 203 | 16.71 |
| | | 204 | 16.81 |
| | | 205 | 16.87 |
| | | 210 | 16.85 |
| | | 220 | 16.72 |
| | | 230 | 16.84 |
| | | 240 | 16.84 |
| | | 250 | 16.79 |
| | | 260 | 16.83 |
| | | 270 | 16.78 |
| | | 280 | 16.76 |
| | | 290 | 16.90 |
| | | 300 | 16.70 |
| | | 310 | 16.88 |
| | | 320 | 16.76 |
| | | 330 | 16.82 |
| | | 335 | 16.84 |
| | | 336 | 16.85 |
| | | 337 | 16.79 |
| | | 338 | 16.72 |
| | | 339 | 16.83 |
| | | 340 | 16.79 |
| | Tablet | 341 | 16.76 |
| | | 342 | 16.83 |
| | | 343 | 16.70 |
| | | 344 | 16.79 |
| | | 345 | 16.83 |
| | | 350 | 16.85 |
| | | 360 | 16.76 |
| | Lid Close | 0 | standby |
| | | 10 | standby |
| | | 20 | standby |
| | | 30 | standby |
| | | 31 | standby |
| | | 32 | standby |
| | | 33 | standby |
| | | 34 | standby |
| | Book (screen orientation is 90° or 270°) | 35 | 16.89 |
| | | 36 | 16.83 |
| | | 37 | 16.77 |

| | | | |
|---|---|---|---|
| | | 38 | 16.85 |
| | | 39 | 16.71 |
| | | 40 | 16.75 |
| | | 50 | 16.89 |
| | | 60 | 16.80 |
| | | 70 | 16.85 |
| | | 80 | 16.79 |
| | | 90 | 16.89 |
| | | 100 | 16.80 |
| | | 110 | 16.74 |
| | | 120 | 16.86 |
| | | 120 | 16.84 |
| | | 130 | 16.70 |
| | | 140 | 16.85 |
| | | 150 | 16.78 |
| | | 160 | 16.70 |
| | | 170 | 16.90 |
| | | 180 | 16.74 |
| | | 190 | 16.77 |
| | | 195 | 16.81 |
| | | 196 | 16.79 |
| | | 197 | 16.88 |
| | | 198 | 16.82 |
| | | 199 | 16.72 |
| | | 200 | 16.70 |
| | Tablet | 201 | 16.76 |
| | | 202 | 16.88 |
| | | 203 | 16.74 |
| | | 204 | 16.78 |
| | | 205 | 16.85 |
| | | 210 | 16.71 |
| | | 220 | 16.71 |
| | | 230 | 16.85 |
| | | 240 | 16.81 |
| | | 250 | 16.86 |
| | | 260 | 16.73 |
| | | 270 | 16.71 |
| | | 280 | 16.75 |
| | | 290 | 16.85 |
| | | 300 | 16.84 |
| | | 310 | 16.84 |
| | | 320 | 16.75 |
| | | 330 | 16.71 |
| | | 340 | 16.86 |
| | | 350 | 16.82 |
| | | 360 | 16.70 |

| when the screen angle is from 0 degree to 360 degree | | | |
|---|---|---|---|
| Screen angle (degree) v.s. power | Wireless | | WLAN Ant 1/2 |
| | Band | | 5.8GHz UNII4 WLAN |
| | Tablet Mode | 360 | 16.98 |
| | | 350 | 16.86 |
| | | 340 | 16.88 |
| | | 330 | 16.80 |
| | | 320 | 16.88 |
| | | 310 | 17.00 |
| | | 300 | 17.00 |
| | | 290 | 16.80 |
| | | 280 | 16.84 |
| | | 270 | 16.97 |
| | | 260 | 16.81 |
| | | 250 | 16.92 |
| | | 240 | 16.92 |
| | | 230 | 16.81 |
| | | 220 | 16.80 |
| | | 210 | 16.94 |
| | | 200 | 16.82 |
| | | 190 | 16.82 |
| | | 180 | 16.99 |
| | | 170 | 16.87 |
| | | 160 | 16.84 |
| | | 150 | 16.80 |
| | | 140 | 16.94 |
| | | 135 | 16.90 |
| | | 134 | 16.89 |
| | | 133 | 16.92 |
| | | 132 | 16.93 |
| | | 131 | 16.93 |
| | | 130 | 16.92 |
| | Laptop | 129 | 18.33 |
| | | 128 | 18.49 |
| | | 127 | 18.37 |
| | | 126 | 18.46 |
| | | 125 | 18.38 |
| | | 120 | 18.31 |
| | | 110 | 18.39 |
| | | 100 | 18.44 |
| | | 90 | 18.38 |
| | | 80 | 18.37 |
| | | 70 | 18.46 |
| | | 60 | 18.33 |
| | | 50 | 18.41 |
| | | 40 | 18.42 |
| | | 39 | 18.31 |
| | | 38 | 18.45 |
| | | 37 | 18.42 |
| | | 36 | 18.48 |
| | | 35 | 18.34 |

| | | | |
|---|---|---|---|
| | Lid Close | 34 | standby |
| | | 33 | standby |
| | | 32 | standby |
| | | 31 | standby |
| | | 30 | standby |
| | | 20 | standby |
| | | 10 | standby |
| | | 0 | standby |
| | Tablet | 360 | 17.00 |
| | | 350 | 16.99 |
| | | 345 | 16.80 |
| | | 344 | 16.83 |
| | | 343 | 17.00 |
| | | 342 | 16.82 |
| | | 341 | 16.80 |
| | Stand mode (Screen orientation is set to 0° and base is horizontal) | 340 | 18.43 |
| | | 339 | 18.32 |
| | | 338 | 18.45 |
| | | 337 | 18.38 |
| | | 336 | 18.39 |
| | | 335 | 18.32 |
| | | 330 | 18.48 |
| | | 320 | 18.37 |
| | | 310 | 18.48 |
| | | 300 | 18.46 |
| | | 290 | 18.37 |
| | | 280 | 18.44 |
| | | 270 | 18.32 |
| | | 260 | 18.44 |
| | | 250 | 18.42 |
| | | 240 | 18.48 |
| | | 230 | 18.44 |
| | | 220 | 18.31 |
| | | 210 | 18.46 |
| | | 205 | 18.46 |
| | | 204 | 18.44 |
| | | 203 | 18.37 |
| | | 202 | 18.44 |
| | | 201 | 18.36 |
| | Tablet | 200 | 16.84 |
| | | 199 | 16.85 |
| | | 198 | 16.90 |
| | | 197 | 16.99 |
| | | 196 | 16.96 |
| | | 195 | 17.00 |
| | Tablet | 360 | 16.80 |
| | | 350 | 16.87 |
| | | 345 | 16.88 |
| | | 344 | 16.94 |
| | | 343 | 16.92 |
| | | 342 | 16.89 |
| | | 341 | 16.88 |

| | | | |
|---|---|---|---|
| | Tent mode (Screen orientation is set to 180° and base is not horizontal) | 340 | 16.80 |
| | | 339 | 16.93 |
| | | 338 | 16.90 |
| | | 337 | 17.00 |
| | | 336 | 16.98 |
| | | 335 | 16.89 |
| | | 330 | 16.88 |
| | | 320 | 16.95 |
| | | 310 | 16.96 |
| | | 300 | 16.88 |
| | | 290 | 16.95 |
| | | 280 | 16.80 |
| | | 270 | 16.83 |
| | | 260 | 16.91 |
| | | 250 | 16.85 |
| | | 240 | 16.90 |
| | | 230 | 16.98 |
| | | 220 | 16.84 |
| | | 210 | 16.82 |
| | | 205 | 16.83 |
| | | 204 | 16.88 |
| | | 203 | 16.99 |
| | | 202 | 16.82 |
| | | 201 | 16.95 |
| | Tablet | 200 | 16.93 |
| | | 199 | 16.92 |
| | | 198 | 16.91 |
| | | 197 | 16.86 |
| | | 196 | 16.85 |
| | | 195 | 16.87 |
| | Tablet | 360 | 16.81 |
| | | 350 | 16.94 |
| | | 340 | 16.82 |
| | | 330 | 16.94 |
| | | 320 | 16.96 |
| | | 310 | 16.90 |
| | | 300 | 16.98 |
| | | 290 | 16.89 |
| | | 280 | 17.00 |
| | | 270 | 16.96 |
| | | 260 | 16.94 |
| | | 250 | 16.98 |
| | | 240 | 16.87 |
| | | 230 | 16.96 |
| | | 220 | 16.97 |
| | | 210 | 16.87 |
| | | 205 | 16.81 |
| | | 204 | 16.86 |
| | | 203 | 16.82 |
| | | 202 | 16.86 |
| | | 201 | 16.91 |
| | Book | 200 | 16.96 |

| | | | |
|---|---|---|---|
| | (screen orientation is 90° or 270°) | 199 | 16.80 |
| | | 198 | 16.90 |
| | | 197 | 16.86 |
| | | 196 | 16.82 |
| | | 195 | 16.88 |
| | | 190 | 16.91 |
| | | 180 | 16.90 |
| | | 170 | 16.95 |
| | | 160 | 16.99 |
| | | 150 | 16.99 |
| | | 140 | 16.89 |
| | | 130 | 16.94 |
| | | 120 | 16.87 |
| | | 110 | 16.84 |
| | | 100 | 16.85 |
| | | 90 | 16.89 |
| | | 80 | 16.82 |
| | | 70 | 16.92 |
| | | 60 | 16.98 |
| | | 50 | 16.80 |
| | | 40 | 16.88 |
| | | 39 | 16.91 |
| | | 38 | 16.81 |
| | | 37 | 16.93 |
| | | 36 | 16.86 |
| | | 35 | 16.84 |
| | Lid Close | 34 | standby |
| | | 33 | standby |
| | | 32 | standby |
| | | 31 | standby |
| | | 30 | standby |
| | | 20 | standby |
| | | 10 | standby |
| | | 0 | standby |

# 4. RF Exposure Limits

## 4.1 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.

## 4.2 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. The 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.

**Limits for Occupational/Controlled Exposure (W/kg)**

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|---|---|---|
| 0.4 | 8.0 | 20.0 |

**Limits for General Population/Uncontrolled Exposure (W/kg)**

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|---|---|---|
| 0.08 | 1.6 | 4.0 |

1. Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

# 5. Specific Absorption Rate (SAR)

## 5.1 Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

## 5.2 SAR Definition

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

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

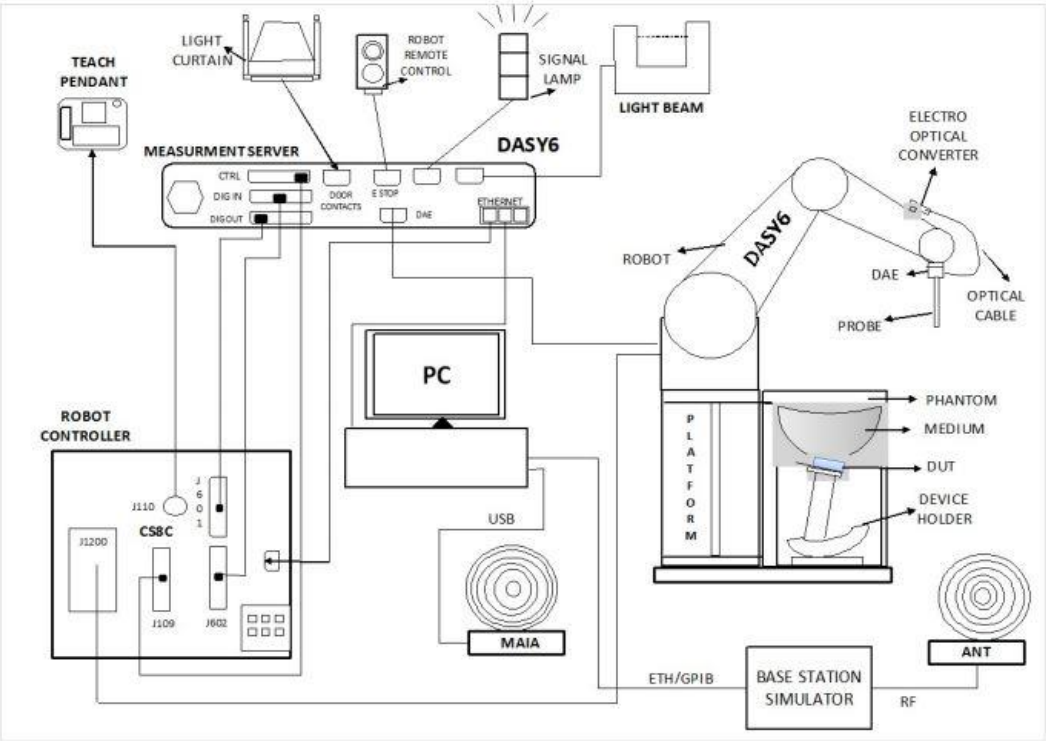
SAR is expressed in units of Watts per kilogram (W/kg)

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

# 6. System Description and Setup

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




- The DASY system in SAR Configuration is shown above
- 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 windows software 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.

## 6.1 Test Site Location

The SAR measurement facilities used to collect data are within both Sporton Lab list below test site location are accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 1190 and 3786) and the FCC designation No. TW1190 and TW3786 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC test.

| Test Site | EMC & Wireless Communications Laboratory | | Wensan Laboratory | | |
|---|---|---|---|---|---|
| Test Site Location | TW1190<br>No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan | | TW3786<br>No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan | | |
| Test Site No. | SAR01-HY | SAR03-HY | SAR08-HY | SAR09-HY | SAR15-HY |
| | SAR04-HY | SAR05-HY | SAR11-HY | SAR12-HY | SAR16-HY |
| | SAR06-HY | SAR10-HY | SAR13-HY | SAR14-HY | SAR17-HY |

## 6.2 E-Field Probe

The SAR measurement is conducted with the dosimetric probe (manufactured by SPEAG).The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. This probe has a built in optical surface detection system to prevent from collision with phantom.

**<ES3DV3 Probe>**

| | | |
|---|---|---|
| **Construction** | Symmetric design with triangular core<br>Interleaved sensors<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |  |
| **Frequency** | 10 MHz – 4 GHz;<br>Linearity: ±0.2 dB (30 MHz – 4 GHz) | |
| **Directivity** | ±0.2 dB in TSL (rotation around probe axis)<br>±0.3 dB in TSL (rotation normal to probe axis) | |
| **Dynamic Range** | 5 µW/g – >100 mW/g;<br>Linearity: ±0.2 dB | |
| **Dimensions** | Overall length: 337 mm (tip: 20 mm)<br>Tip diameter: 3.9 mm (body: 12 mm)<br>Distance from probe tip to dipole centers: 3.0 mm | |

**<EX3DV4 Probe>**

| | | |
|---|---|---|
| **Construction** | Symmetric design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |  |
| **Frequency** | 10 MHz – >6 GHz<br>Linearity: ±0.2 dB (30 MHz – 6 GHz) | |
| **Directivity** | ±0.3 dB in TSL (rotation around probe axis)<br>±0.5 dB in TSL (rotation normal to probe axis) | |
| **Dynamic Range** | 10 µW/g – >100 mW/g<br>Linearity: ±0.2 dB (noise: typically <1 µW/g) | |
| **Dimensions** | Overall length: 337 mm (tip: 20 mm)<br>Tip diameter: 2.5 mm (body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm | |

## 6.3 Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

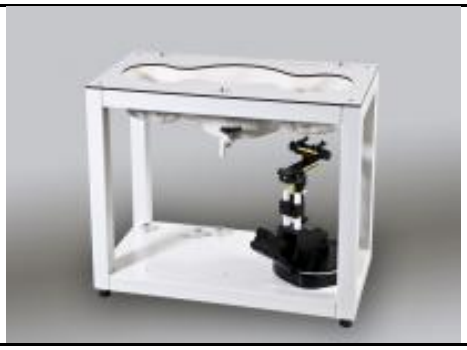
The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

**Fig 5.1 Photo of DAE**

## 6.4 Phantom

**<SAM Twin Phantom>**

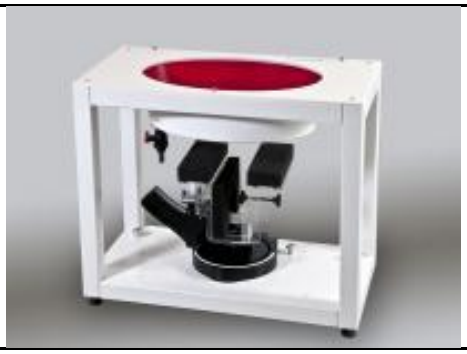
| | |
|---|---|
| **Shell Thickness** | 2 ± 0.2 mm;<br>Center ear point: 6 ± 0.2 mm |
| **Filling Volume** | Approx. 25 liters |
| **Dimensions** | Length: 1000 mm; Width: 500 mm; Height: adjustable feet |
| **Measurement Areas** | Left Hand, Right Hand, Flat Phantom |



The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

**<ELI Phantom>**

| | |
|---|---|
| **Shell Thickness** | 2 ± 0.2 mm (sagging: <1%) |
| **Filling Volume** | Approx. 30 liters |
| **Dimensions** | Major ellipse axis: 600 mm<br>Minor axis: 400 mm |



The ELI phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with standard and all known tissue simulating liquids.

## 6.5 Device Holder

**<Mounting Device for Hand-Held Transmitter>**

In combination with the Twin SAM V5.0/V5.0c or ELI phantoms, the Mounting Device for Hand-Held Transmitters enables rotation of the mounted transmitter device to specified spherical coordinates. At the heads, the rotation axis is at the ear opening. Transmitter devices can be easily and accurately positioned according to IEC 62209-1, IEEE 1528, FCC, or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). And upgrade kit to Mounting Device to enable easy mounting of wider devices like big smart-phones, e-books, small tablets, etc. It holds devices with width up to 140 mm.

Mounting Device for Hand-Held Transmitters

Mounting Device Adaptor for Wide-Phones

**<Mounting Device for Laptops and other Body-Worn Transmitters>**

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the mounting device in place of the phone positioned. The extension is fully compatible with the SAM Twin and ELI phantoms.

Mounting Device for Laptops

# 7. Measurement Procedures

The measurement procedures are as follows:

(a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.
(b) Place the EUT in the positions as Appendix D demonstrates.
(c) Set scan area, grid size and other setting on the DASY software.
(d) Measure SAR results for the highest power channel on each testing position.
(e) Find out the largest SAR result on these testing positions of each band
(f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

(a) Power reference measurement
(b) Area scan
(c) Zoom scan
(d) Power drift measurement

## 7.1 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

(a) Extraction of the measured data (grid and values) from the Zoom Scan
(b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
(c) Generation of a high-resolution mesh within the measured volume
(d) Interpolation of all measured values form the measurement grid to the high-resolution grid
(e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
(f) Calculation of the averaged SAR within masses of 1g and 10g

## 7.2 Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

## 7.3 Area Scan

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB0 is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

| | ≤ 3 GHz | > 3 GHz |
|---|---|---|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | 5 ± 1 mm | ½·δ·ln(2) ± 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. | |

## 7.4 Zoom Scan

Zoom scans are used assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube shoes base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the zoom scan evaluates the averaged SAR for 1 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

| | | | ≤ 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 |

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.

* When zoom scan is required and the *reported* SAR from the *area scan based 1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

## 7.5 Volume Scan Procedures

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

## 7.6 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drifts more than 5%, the SAR will be retested.

# 8. Test Equipment List

| Manufacturer | Name of Equipment | Type/Model | Serial Number | Calibration | |
|---|---|---|---|---|---|
| | | | | Last Cal. | Due Date |
| SPEAG | 5GHz System Validation Kit(2) | D5GHzV2 | 1171 | Apr. 20, 2021 | Apr. 18, 2023 |
| SPEAG | Data Acquisition Electronics | DAE4 | 1424 | Jan. 20, 2022 | Jan. 19, 2023 |
| SPEAG | Dosimetric E-Field Probe | EX3DV4 | 7625 | Jan. 27, 2022 | Jan. 26, 2023 |
| RCPTWN | Thermometer | HTC-1 | TM560-2 | Mar. 15, 2022 | Mar. 14, 2023 |
| SPEAG | Device Holder | N/A | N/A | N/A | N/A |
| Anritsu | Signal Generator | MG3710A | 6201502524 | Oct. 12, 2022 | Oct. 11, 2023 |
| Keysight | ENA Network Analyzer | E5071C | MY46104758 | Sep. 22, 2022 | Sep. 21, 2023 |
| SPEAG | Dielectric Probe Kit | DAK-3.5 | 1146 | Jul. 25, 2022 | Jul. 24, 2023 |
| LINE SEIKI | Digital Thermometer | DTM3000-spezial | 3252 | Jul. 25, 2022 | Jul. 24, 2023 |
| Anritsu | Power Meter | ML2495A | 1419002 | Aug. 16, 2022 | Aug. 15, 2023 |
| Anritsu | Power Sensor | MA2411B | 1911176 | Aug. 16, 2022 | Aug. 15, 2023 |
| Anritsu | Power Meter | ML2495A | 1804003 | Oct. 17, 2022 | Oct. 16, 2023 |
| Anritsu | Power Sensor | MA2411B | 1726150 | Oct. 17, 2022 | Oct. 16, 2023 |
| Anritsu | Spectrum Analyzer | N9010A | MY53470118 | Jan. 12, 2022 | Jan. 11, 2023 |
| Agilent | Spectrum Analyzer | E4408B | MY44211028 | Aug. 19, 2021 | Aug. 17, 2023 |
| Mini-Circuits | Power Amplifier | ZVE-8G+ | 6418 | Oct. 14, 2022 | Oct. 13, 2023 |
| Mini-Circuits | Power Amplifier | ZVE-8G+ | 479102029 | Sep. 15, 2022 | Sep. 14, 2023 |
| ATM | Dual Directional Coupler | C122H-10 | P610410z-02 | Note 1 | |
| Woken | Attenuator 1 | WK0602-XX | N/A | Note 1 | |
| PE | Attenuator 2 | PE7005-10 | N/A | Note 1 | |
| PE | Attenuator 3 | PE7005- 3 | N/A | Note 1 | |

**General Note:**

1. Prior to system verification and validation, the path loss from the signal generator to the system check source and the power meter, which includes the amplifier, cable, attenuator and directional coupler, was measured by the network analyzer. The reading of the power meter was offset by the path loss difference between the path to the power meter and the path to the system check source to monitor the actual power level fed to the system check source.
2. The dipole calibration interval can be extended to 3 years with justification according to KDB 865664 D01. The dipoles are also not physically damaged, or repaired during the interval. The justification data in appendix C can be found which the return loss is < -20dB, within 20% of prior calibration, the impedance is within 5 ohm of prior calibration for each dipole.

# 9. System Verification

## 9.1 Tissue Verification

The tissue dielectric parameters of tissue-equivalent media used for SAR measurements must be characterized within a temperature range of 18℃ to 25℃, measured with calibrated instruments and apparatuses, such as network analyzers and temperature probes. The temperature of the tissue-equivalent medium during SAR measurement must also be within 18℃ to 25℃ and within ± 2℃ of the temperature when the tissue parameters are characterized. The tissue dielectric measurement system must be calibrated before use. The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements.
The liquid tissue depth was at least 15cm in the phantom for all SAR testing

**<Tissue Dielectric Parameter Check Results>**

| Frequency (MHz) | Liquid Temp. (℃) | Conductivity (σ) | Permittivity ($\varepsilon_r$) | Conductivity Target (σ) | Permittivity Target ($\varepsilon_r$) | Delta (σ) (%) | Delta ($\varepsilon_r$) (%) | Limit (%) | Date |
|---|---|---|---|---|---|---|---|---|---|
| 5850 | 22.6 | 5.320 | 35.533 | 5.32 | 35.25 | 0.00 | 0.80 | ±5 | 2022/10/31 |

## 9.2 System Performance Check Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

| Test Site | Date | Frequency (MHz) | Input Power (mW) | Dipole S/N | Probe S/N | DAE S/N | Measured 1g SAR (W/kg) | Targeted 1g SAR (W/kg) | Normalized 1g SAR (W/kg) | Deviation (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| SAR13 | 2022/10/31 | 5850 | 100 | D5GHzV2-1171 | EX3DV4 - SN7625 | DAE4 Sn1424 | 8.380 | 82.300 | 83.8 | 1.82 |

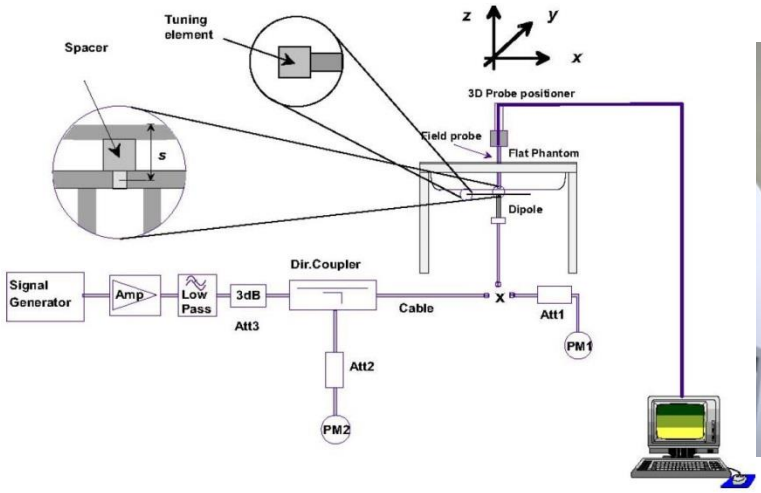



**Fig 8.3.1 System Performance Check Setup**

**Fig 8.3.2 Setup Photo**

# 10. RF Exposure Positions

## 10.1 SAR Testing for Tablet

This device can be used also in full sized tablet exposure conditions, due to its size. Per FCC KDB 616217, the back surface and edges of the tablet should be tested for SAR compliance with the tablet touching the phantom. The SAR exclusion threshold in KDB 447498 D01v06 can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an adjacent tablet edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned against the phantom and the edge containing the antenna positioned perpendicular to the phantom.

# 11. WiFi Output Power (Unit: dBm)

**General Note:**

1. All of the wireless technology of this device only supports MIMO mode operation.
2. The maximum output power specified for production units are determined for all applicable 802.11 transmission modes in each standalone and aggregated frequency band. Maximum output power is measured for the highest maximum output power configuration(s) in each frequency band according to the default power measurement procedures. For “Not required”, SAR Test reduction was applied from KDB 248227 guidance, Sec. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, additional output power measurements were not necessary.
3. Per KDB 248227 D01v02r02, SAR test reduction is determined according to 802.11 transmission mode configurations and certain exposure conditions with multiple test positions. In the 2.4 GHz band, separate SAR procedures are applied to DSSS and OFDM configurations to simplify DSSS test requirements. For OFDM, in both 2.4 and 5 GHz bands, an initial test configuration must be determined for each standalone and aggregated frequency band, according to the transmission mode configuration with the highest maximum output power specified for production units to perform SAR measurements. If the same highest maximum output power applies to different combinations of channel bandwidths, modulations and data rates, additional procedures are applied to determine which test configurations require SAR measurement. When applicable, an initial test position may be applied to reduce the number of SAR measurements required for next to the ear, UMPC mini-tablet or hotspot mode configurations with multiple test positions.
4. For 2.4 GHz 802.11b DSSS, either the initial test position procedure for multiple exposure test positions or the DSSS procedure for fixed exposure position is applied; these are mutually exclusive. For 2.4 GHz and 5 GHz OFDM configurations, the initial test configuration is applied to measure SAR using either the initial test position procedure for multiple exposure test position configurations or the initial test configuration procedures for fixed exposure test conditions. Based on the reported SAR of the measured configurations and maximum output power of the transmission mode configurations that are not included in the initial test configuration, the subsequent test configuration and initial test position procedures are applied to determine if SAR measurements are required for the remaining OFDM transmission configurations. In general, the number of test channels that require SAR measurement is minimized based on maximum output power measured for the test sample(s).
5. For OFDM transmission configurations in the 2.4 GHz and 5 GHz bands, When the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel for each frequency band.
6. DSSS and OFDM configurations are considered separately according to the required SAR procedures. SAR is measured in the initial test position using the 802.11 transmission mode configuration required by the DSSS procedure or initial test configuration and subsequent test configuration(s) according to the OFDM procedures.18 The initial test position procedure is described in the following:
    a. When the reported SAR of the initial test position is ≤ 0.4 W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and 802.11 transmission mode combinations within the frequency band or aggregated band.
    b. When the reported SAR of the test position is > 0.4 W/kg, SAR is repeated for the 802.11 transmission mode configuration tested in the initial test position to measure the subsequent next closet/smallest test separation distance and maximum coupling test position on the highest maximum output power channel, until the report SAR is ≤ 0.8 W/kg or all required test position are tested.
    c. For all positions/configurations, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.
7. Per 201904 TCBC workshops, General principles of FCC KDB Publication 248227 D01 can be applied to determine the SAR Initial Test Configurations and test reduction for 802.11ax SAR testing. For the table below the 802.11ax maximum power is SU (non-OFDMA), and the SU maximum power also higher than RU (OFDMA)
8. In applying the test guidance, the IEEE 802.11 mode with the maximum output power (out of all modes) should be considered for testing
9. For modes with the same maximum output power, the guidance from section 5.3.2 a) of FCC KDB Publication 248227 D01 should be applied, with 802.11ax being considered as the highest 802.11 mode for the appropriate frequency bands
10. When SAR testing for 802.11ax is required
    a. If the maximum output power is highest for OFDMA scenarios, choose the tone size with the maximum number of tones and the highest maximum output power
    b. Otherwise, consider the fully allocated channel for SAR testing
    c. When SAR testing is required on RU sizes less than the fully allocated channel, use the RU number closest to the middle of the channel, choosing the higher RU number when two RUs are equidistant to the middle of the channel

**<Table Mode>**

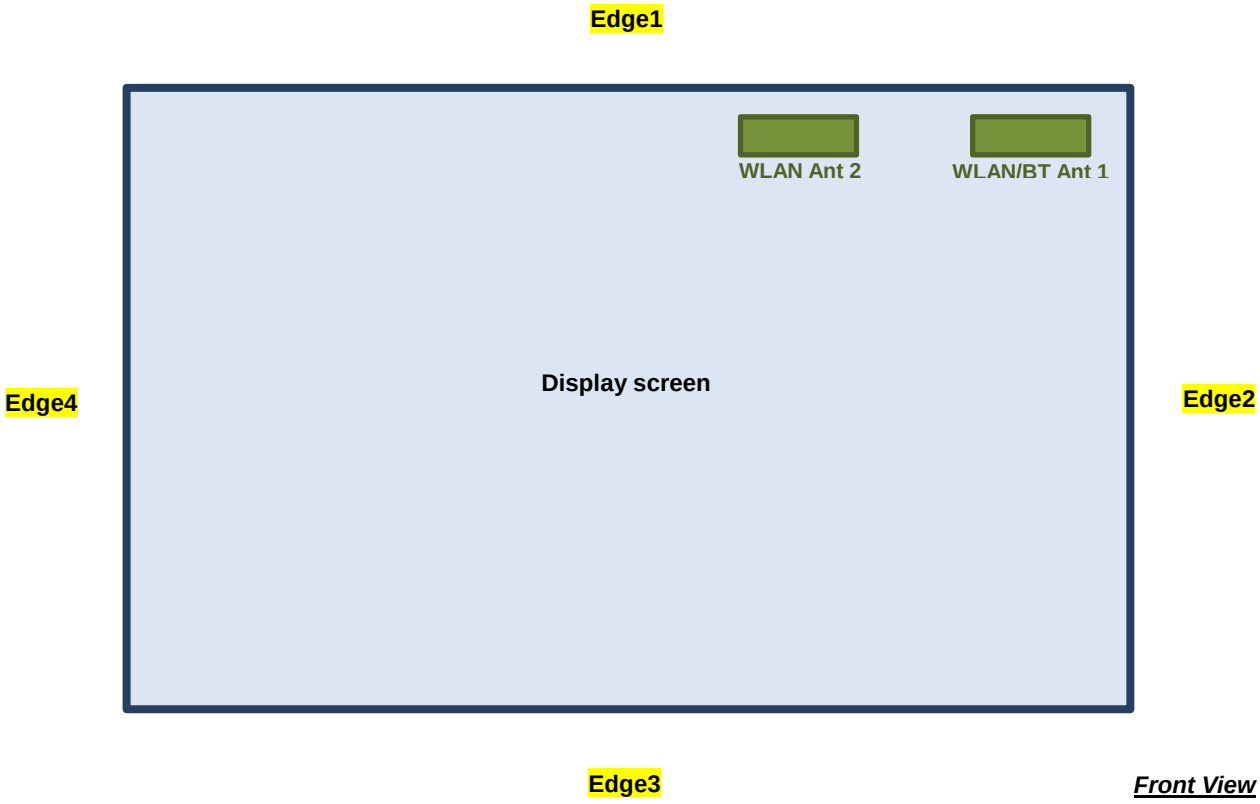
| 5.8GHz WLAN UNII4 | | | | Ant 1+2(1) | | Ant 1+2(2) | | Ant 1+2 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mode | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Average power (dBm) | Tune-Up Limit | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
| 5.8GHz WLAN UNII4 | 802.11a 6Mbps | 169 | 5845 | Not Required | 14.50 | Not Required | 14.50 | Not Required | 17.50 | Not Required |
| | | 173 | 5865 | | 14.50 | | 14.50 | | 17.50 | |
| | | 177 | 5885 | | 14.50 | | 14.50 | | 17.50 | |
| | 802.11n-HT20 MCS0 | 169 | 5845 | | 14.50 | | 14.50 | | 17.50 | |
| | | 173 | 5865 | | 14.50 | | 14.50 | | 17.50 | |
| | | 177 | 5885 | | 14.50 | | 14.50 | | 17.50 | |
| | 802.11n-HT40 MCS0 | 167 | 5835 | 12.60 | 14.50 | 14.30 | 14.50 | 16.54 | 17.50 | 98.20 |
| | | 175 | 5875 | 14.10 | 14.50 | 14.50 | 14.50 | 17.31 | 17.50 | |
| | 802.11ac-VHT20 MCS0 | 169 | 5845 | Not Required | 14.50 | Not Required | 14.50 | Not Required | 17.50 | Not Required |
| | | 173 | 5865 | | 14.50 | | 14.50 | | 17.50 | |
| | | 177 | 5885 | | 14.50 | | 14.50 | | 17.50 | |
| | 802.11ac-VHT40 MCS0 | 167 | 5835 | | 14.50 | | 14.50 | | 17.50 | |
| | | 175 | 5875 | | 14.50 | | 14.50 | | 17.50 | |
| | 802.11ac-VHT80 MCS0 | 171 | 5855 | 14.00 | 14.50 | 14.50 | 14.50 | 17.21 | 17.50 | 96.50 |
| | 802.11ax-HE20 MCS0 | 169 | 5845 | Not Required | 14.50 | Not Required | 14.50 | Not Required | 17.50 | Not Required |
| | | 173 | 5865 | | 14.50 | | 14.50 | | 17.50 | |
| | | 177 | 5885 | | 14.50 | | 14.50 | | 17.50 | |
| | 802.11ax-HE40 MCS0 | 167 | 5835 | | 14.50 | | 14.50 | | 17.50 | |
| | | 175 | 5875 | | 14.50 | | 14.50 | | 17.50 | |
| | 802.11ax-HE80 MCS0 | 171 | 5855 | | 14.50 | | 14.50 | | 17.50 | |

**<Laptop Mode>**

| 5.8GHz WLAN UNII4 | | | | Ant 1+2(1) | | Ant 1+2(2) | | Ant 1+2 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mode | Channel | Frequency (MHz) | Average power (dBm) | Tune-Up Limit | Average power (dBm) | Tune-Up Limit | Average power (dBm) | Tune-Up Limit | Duty Cycle % |
| 5.8GHz WLAN UNII4 | 802.11a 6Mbps | 169 | 5845 | Not Required | 15.50 | Not Required | 15.50 | Not Required | 18.50 | Not Required |
| | | 173 | 5865 | | 15.50 | | 15.50 | | 18.50 | |
| | | 177 | 5885 | | 15.50 | | 15.50 | | 18.50 | |
| | 802.11n-HT20 MCS0 | 169 | 5845 | | 16.00 | | 16.00 | | 19.00 | |
| | | 173 | 5865 | | 16.00 | | 16.00 | | 19.00 | |
| | | 177 | 5885 | | 16.00 | | 16.00 | | 19.00 | |
| | 802.11n-HT40 MCS0 | 167 | 5835 | | 15.50 | | 15.50 | | 18.50 | |
| | | 175 | 5875 | | 15.00 | | 15.00 | | 18.00 | |
| | 802.11ac-VHT20 MCS0 | 169 | 5845 | | 16.00 | | 16.00 | | 19.00 | |
| | | 173 | 5865 | | 16.00 | | 16.00 | | 19.00 | |
| | | 177 | 5885 | | 16.00 | | 16.00 | | 19.00 | |
| | 802.11ac-VHT40 MCS0 | 167 | 5835 | | 15.50 | | 15.50 | | 18.50 | |
| | | 175 | 5875 | | 15.00 | | 15.00 | | 18.00 | |
| | 802.11ac-VHT80 MCS0 | 171 | 5855 | | 16.00 | | 16.00 | | 19.00 | |
| | 802.11ax-HE20 MCS0 | 169 | 5845 | | 16.00 | | 16.00 | | 19.00 | |
| | | 173 | 5865 | | 16.00 | | 16.00 | | 19.00 | |
| | | 177 | 5885 | | 16.00 | | 16.00 | | 19.00 | |
| | 802.11ax-HE40 MCS0 | 167 | 5835 | | 15.50 | | 15.50 | | 18.50 | |
| | | 175 | 5875 | | 15.00 | | 15.00 | | 18.00 | |
| | 802.11ax-HE80 MCS0 | 171 | 5855 | | 16.00 | | 16.00 | | 19.00 | |

# 12. Antenna Location

**<Tablet mode>**

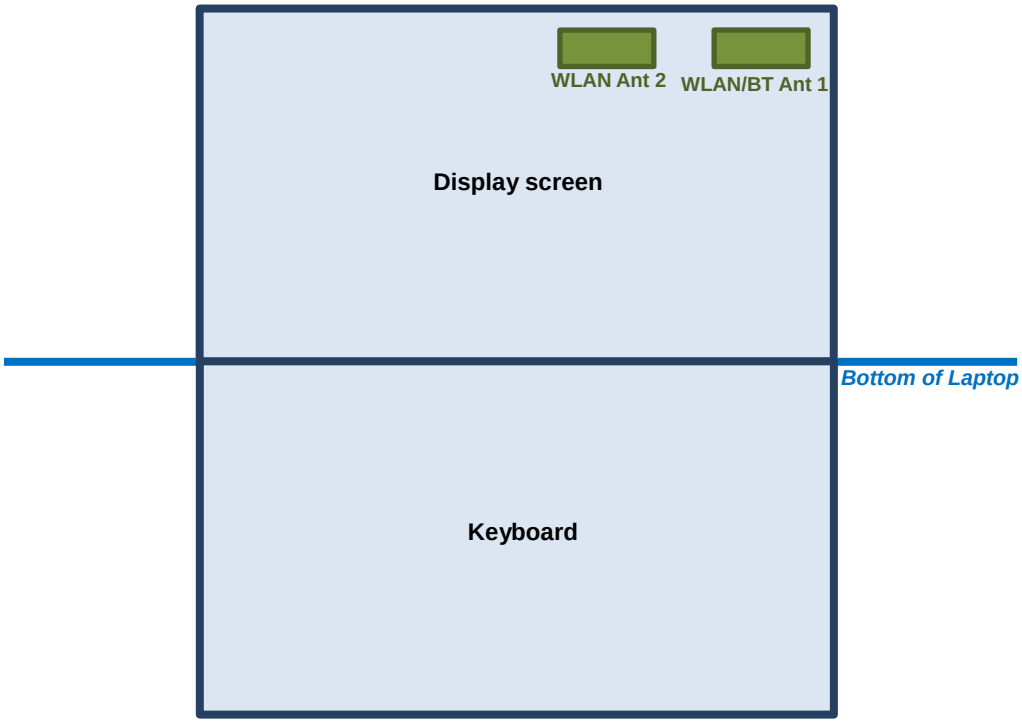



***Front View***

The separation distance for antenna to edge :

| Antenna | To Edge1 (mm) | To Edge2 (mm) | To Edge3 (mm) | To Edge4 (mm) |
|---|---|---|---|---|
| WLAN/BT Antenna 1 | 3.1 | 4 | 201.8 | 272 |
| WLAN Antenna 2 | 3.1 | 69 | 201.8 | 214.5 |

**<Laptop mode>**




The separation distance for antenna to edge :

| Antenna | To Bottom of Laptop (mm) |
|---|---|
| WLAN/BT Antenna 1 | 202.7 |
| WLAN Antenna 2 | 202.7 |

# 13. SAR Test Results

**General Note:**

1. Per KDB 447498 D01v06, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
   a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
   b. For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle)"
   c. For WLAN: Reported SAR(W/kg)= Measured SAR(W/kg)* Duty Cycle scaling factor * Tune-up scaling factor
2. Per KDB 447498 D01v06, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the *reported* 1-g or 10-g SAR for the mid-band or highest output power channel is:
   - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
   - ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
   - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg.

**WLAN Note:**

1. When the reported SAR of the test position is > 0.4 W/kg, SAR is repeated for the 802.11 transmission mode configuration tested in the initial test position to measure the subsequent next closet/smallest test separation distance and maximum coupling test position on the highest maximum output power channel, until the report SAR is ≤ 0.8 W/kg or all required test position are tested.
2. For all positions / configurations, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions / configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.
3. For determination of the scaling factor for report SAR of MIMO mode, if the hot spots are separated the scaling factors are individually determined from each transmit chain. If the hot spots are not spatially separated, the scaling factor is determined from the worst number of each transmit chain
4. During SAR testing the WLAN transmission was verified using a spectrum analyzer.

## 13.1 Body SAR

**<WLAN SAR>**

| Plot No. | Band | Mode | Test Position | Gap (mm) | Antenna | Sample | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | WLAN5GHz | 802.11ac-VHT80 MCS0 | Bottom Face | 0mm | Ant 1+2(1) | Sample 1 | 171 | 5855 | 14.00 | 14.50 | 1.122 | 96.5 | 1.036 | -0.14 | 0.022 | 0.026 |
| | WLAN5GHz | 802.11ac-VHT80 MCS0 | Bottom Face | 0mm | Ant 1+2(2) | Sample 1 | 171 | 5855 | 14.50 | 14.50 | 1.000 | 96.5 | 1.036 | -0.14 | 0.034 | 0.035 |
| | WLAN5GHz | 802.11ac-VHT80 MCS0 | Edge 1 | 0mm | Ant 1+2(1) | Sample 1 | 171 | 5855 | 14.00 | 14.50 | 1.122 | 96.5 | 1.036 | -0.13 | 0.338 | 0.393 |
| | WLAN5GHz | 802.11ac-VHT80 MCS0 | Edge 1 | 0mm | Ant 1+2(2) | Sample 1 | 171 | 5855 | 14.50 | 14.50 | 1.000 | 96.5 | 1.036 | -0.13 | 0.517 | 0.536 |
| | WLAN5GHz | 802.11ac-VHT80 MCS0 | Edge 2 | 0mm | Ant 1+2(1) | Sample 1 | 171 | 5855 | 14.00 | 14.50 | 1.122 | 96.5 | 1.036 | 0.18 | 0.166 | 0.193 |
| | WLAN5GHz | 802.11ac-VHT80 MCS0 | Edge 2 | 0mm | Ant 1+2(2) | Sample 1 | 171 | 5855 | 14.50 | 14.50 | 1.000 | 96.5 | 1.036 | 0.18 | 0.255 | 0.264 |
| | WLAN5GHz | 802.11ac-VHT80 MCS0 | Edge 1 | 0mm | Ant 1+2(1) | Sample 2 | 171 | 5855 | 14.00 | 14.50 | 1.122 | 96.5 | 1.036 | -0.16 | 0.432 | 0.502 |
| | WLAN5GHz | 802.11ac-VHT80 MCS0 | Edge 1 | 0mm | Ant 1+2(2) | Sample 2 | 171 | 5855 | 14.50 | 14.50 | 1.000 | 96.5 | 1.036 | -0.16 | 0.662 | 0.686 |
| | WLAN5GHz | 802.11ac-VHT80 MCS0 | Edge 1 | 0mm | Ant 1+2(1) | Sample 3 | 171 | 5855 | 14.00 | 14.50 | 1.122 | 96.5 | 1.036 | 0.12 | 0.507 | 0.589 |
| | WLAN5GHz | 802.11ac-VHT80 MCS0 | Edge 1 | 0mm | Ant 1+2(2) | Sample 3 | 171 | 5855 | 14.50 | 14.50 | 1.000 | 96.5 | 1.036 | 0.12 | 0.778 | 0.806 |
| 01 | WLAN5GHz | 802.11n-HT40 MCS0 | Edge 1 | 0mm | Ant 1+2(1) | Sample 3 | 175 | 5875 | 14.10 | 14.50 | 1.096 | 98.2 | 1.018 | 0.13 | 0.542 | 0.605 |
| | WLAN5GHz | 802.11n-HT40 MCS0 | Edge 1 | 0mm | Ant 1+2(2) | Sample 3 | 175 | 5875 | 14.50 | 14.50 | 1.000 | 98.2 | 1.018 | 0.13 | 0.836 | 0.851 |
| | WLAN5GHz | 802.11ac-VHT80 MCS0 | Edge 1 | 0mm | Ant 1+2(1) | Sample 4 | 171 | 5855 | 14.00 | 14.50 | 1.122 | 96.5 | 1.036 | -0.03 | 0.368 | 0.428 |
| | WLAN5GHz | 802.11ac-VHT80 MCS0 | Edge 1 | 0mm | Ant 1+2(2) | Sample 4 | 171 | 5855 | 14.50 | 14.50 | 1.000 | 96.5 | 1.036 | -0.03 | 0.563 | 0.583 |

## 13.2 Repeated SAR Measurement

| No. | Band | Mode | Test Position | Gap (mm) | Antenna | Sample | Ch. | Freq. (MHz) | Average Power (dBm) | Tune-Up Limit (dBm) | Tune-up Scaling Factor | Duty Cycle % | Duty Cycle Scaling Factor | Power Drift (dB) | Measured 1g SAR (W/kg) | Ratio | Reported 1g SAR (W/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1st | WLAN5GHz | 802.11n-HT40 MCS0 | Edge 1 | 0mm | Ant 1+2(1) | Sample 3 | 175 | 5875 | 14.10 | 14.50 | 1.096 | 98.2 | 1.018 | 0.13 | 0.542 | - | 0.605 |
| | WLAN5GHz | 802.11n-HT40 MCS0 | Edge 1 | 0mm | Ant 1+2(2) | Sample 3 | 175 | 5875 | 14.50 | 14.50 | 1.000 | 98.2 | 1.018 | 0.13 | 0.836 | | 0.851 |
| 2nd | WLAN5GHz | 802.11n-HT40 MCS0 | Edge 1 | 0mm | Ant 1+2(1) | Sample 3 | 175 | 5875 | 14.10 | 14.50 | 1.096 | 98.2 | 1.018 | 0.13 | 0.513 | 1.06 | 0.573 |
| | WLAN5GHz | 802.11n-HT40 MCS0 | Edge 1 | 0mm | Ant 1+2(2) | Sample 3 | 175 | 5875 | 14.50 | 14.50 | 1.000 | 98.2 | 1.018 | 0.13 | 0.791 | | 0.805 |

**General Note:**

1. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg.
2. Per KDB 865664 D01v01r04, if the ratio among the repeated measurement is ≤ 1.2 and the measured SAR <1.45W/kg, only one repeated measurement is required.
3. The ratio is the difference in percentage between original and repeated *measured SAR*.
4. All measurement SAR result is scaled-up to account for tune-up tolerance and is compliant.

# 14. Simultaneous Transmission Analysis

| NO. | Simultaneous Transmission Configurations | Body |
|---|---|---|
| 1. | WLAN5GHz Ant 1+2 + Bluetooth Ant 1 | Yes |

**General Note:**

1. The worst case WLAN reported SAR for each configuration was used for SAR summation. Therefore, the following summations represent the absolute worst cases for simultaneous transmission with WLAN.
2. The Scaled SAR summation is calculated based on the same configuration and test position.
3. Per KDB 447498 D01v06, simultaneous transmission SAR is compliant if,
   i) Scalar SAR summation < 1.6W/kg.
   ii) SPLSR = (SAR1 + SAR2)^1.5 / (min. separation distance, mm), and the peak separation distance is determined from the square root of $[(x1-x2)^2 + (y1-y2)^2 + (z1-z2)^2]$, where (x1, y1, z1) and (x2, y2, z2) are the coordinates of the extrapolated peak SAR locations in the zoom scan.
   iii) If SPLSR ≤ 0.04, simultaneously transmission SAR measurement is not necessary.
   iv) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg.

## 14.1 Body Exposure Conditions

| Exposure Position | 1 | 2 | 3 | 2+3 Summed 1g SAR (W/kg) |
|---|---|---|---|---|
| | WLAN2.4GHz Ant 1+2 | WLAN5GHz Ant 1+2 | Bluetooth Ant 1 | |
| | 1g SAR (W/kg) | 1g SAR (W/kg) | 1g SAR (W/kg) | |
| Bottom Face at 0mm | 0.116 | 0.056 | 0.001 | **0.057** |
| Edge 1 at 0mm | 0.650 | 0.870 | 0.062 | **0.932** |
| Edge 2 at 0mm | 0.158 | 0.277 | 0.007 | **0.284** |

**Test Engineer：** Randy Lin

## 15. Uncertainty Assessment

Per KDB 865664 D01 SAR measurement 100MHz to 6GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg and the measured 10-g SAR within a frequency band is < 3.75 W/kg. The expanded SAR measurement uncertainty must be ≤ 30%, for a confidence interval of k = 2. If these conditions are met, extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. For this device, the highest measured 1-g SAR is less 1.5W/kg. Therefore, the measurement uncertainty table is not required in this report.

Declaration of Conformity:
The test results with all measurement uncertainty excluded is presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

## 16. References


[1] FCC 47 CFR Part 2 “Frequency Allocations and Radio Treaty Matters; General Rules and Regulations”

[2] ANSI/IEEE Std. C95.1-1992, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”, September 1992

[3] 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”, Sep 2013

[4] SPEAG DASY System Handbook

[5] FCC KDB 248227 D01 v02r02, “SAR Guidance for IEEE 802.11 (WiFi) Transmitters”, Oct 2015.

[6] FCC KDB 447498 D01 v06, “Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies”, Oct 2015

[7] FCC KDB 616217 D04 v01r02, “SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers”, Oct 2015

[8] FCC KDB 865664 D01 v01r04, "SAR Measurement Requirements for 100 MHz to 6 GHz", Aug 2015.

[9] FCC KDB 865664 D02 v01r02, “RF Exposure Compliance Reporting and Documentation Considerations” Oct 2015.