

# FCC SAR TEST REPORT

**Test File No : F690501-RF-SAR000534-A1**

|                      |                                                                                       |
|----------------------|---------------------------------------------------------------------------------------|
| Equipment Under Test | Telematics                                                                            |
| Model Name           | TFGMEIBBCD1                                                                           |
| Variant Model        | TFGMEIBBCD2, TFGMEIBBCD3, TFGMEIBBCD1_MY27, TFGMEIBBCD2_MY27, TFGMEIBBCD3_MY27        |
| Applicant            | LG Electronics USA, Inc.                                                              |
| Address of Applicant | 111 Sylvan Avenue, North Building, Englewood Cliffs, New Jersey, United States, 07632 |
| FCC ID               | BEJTFGMEIBBCD1                                                                        |
| Exposure Category    | General Population/Uncontrolled Exposure                                              |
| Standards            | FCC 47 CFR Part 2 (2.1093)<br>IEEE 1528, 2013                                         |
| Receipt No.          | GPRI2412001294SR, GPRI2504000811SR                                                    |
| Date of Receipt      | 2024-12-04, 2025-04-29                                                                |
| Date of SAR Test(s)  | 2024-12-20 ~ 2024-12-23                                                               |
| Date of Issue        | 2025-09-03                                                                            |
| Test Result          | Refer to the Page 06                                                                  |

In the configuration tested, the EUT complied with the standards specified above.

This test report does not assure KOLAS accreditation.

## Remarks:

- 1) The results of this test report are effective only to the items tested.
- 2) The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received.



Report prepared by /  
Jane Lee  
Test Engineer



Approved by /  
Minhyuk Han  
Technical Manager

Report File No : F690501-RF-SAR000534-A1

Date of Issue : 2025-09-03

(All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx>.)



**Revision history**

| Revision | Date of issue | Revisions                                                                                       | Revised By |
|----------|---------------|-------------------------------------------------------------------------------------------------|------------|
| -        | Jan 20, 2025  | Initial issue                                                                                   |            |
| A1       | Sep 03, 2025  | Revision Update<br>- Added LTE Band 25/71 and bandwidth information for 5G NR bands n7/n25/n41. | Jane Lee   |

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## 1 Testing Laboratory

|                                                                 |                                                                      |
|-----------------------------------------------------------------|----------------------------------------------------------------------|
| <b>Company Name</b>                                             | SGS Korea Co., Ltd. (Gunpo Laboratory)                               |
| <b>Address</b>                                                  | 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, 15807 Republic of Korea |
| <b>Laboratory Conformity Assessment Body Identifier (CABID)</b> | KR0150                                                               |
| <b>Telephone</b>                                                | +82 +31 428 5700                                                     |
| <b>FAX</b>                                                      | +82 +31 427 2371                                                     |

## 2 Details of Applicant

|                  |                                                                                       |
|------------------|---------------------------------------------------------------------------------------|
| <b>Applicant</b> | LG Electronics USA, Inc.                                                              |
| <b>Address</b>   | 111 Sylvan Avenue, North Building, Englewood Cliffs, New Jersey, United States, 07632 |
| <b>Email</b>     | heejae.cho@lge.com                                                                    |
| <b>Phone No.</b> | +1 201 470 2696                                                                       |

## 3 Details of Manufacturer

|                  |                                                                                             |
|------------------|---------------------------------------------------------------------------------------------|
| <b>Applicant</b> | LG Electronics Viet Nam Hai Phong Co., Ltd.                                                 |
| <b>Address</b>   | Lot CN2, Trang Due Industrial Park, Le Loi Ward, An Duong District, Hai Phong City, Vietnam |

## 4 Description of EUT(s)

|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>EUT Type</b>                                   | Telematics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
| <b>Model Name</b>                                 | TFGMEIBBCD1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
| <b>Variant Model</b>                              | TFGMEIBBCD2, TFGMEIBBCD3, TFGMEIBBCD1_MY27, TFGMEIBBCD2_MY27, TFGMEIBBCD3_MY27                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
| <b>TFGMEIBBCD1 &amp; Variant Model Difference</b> | <p>Same to RF module with Basic model except following function.</p> <table border="1"> <tr> <td>TFGMEIBBCD1</td><td> <ul style="list-style-type: none"> <li>- Dual GNSS is supported.</li> <li>- Ultra-super cruise service is supported.</li> </ul> </td></tr> <tr> <td>TFGMEIBBCD2</td><td> <ul style="list-style-type: none"> <li>- Same to RF module with basic model except following function.</li> <li>- Single GNSS is supported.</li> <li>- Ultra-super cruise service is not supported.</li> </ul> </td></tr> <tr> <td>TFGMEIBBCD3</td><td> <ul style="list-style-type: none"> <li>- Same to RF module with basic model except following function.</li> <li>- Single GNSS is supported.</li> <li>- Ultra-super cruise service is not supported.</li> <li>- eUICC part is different with TFGMEIBBCD2.</li> </ul> </td></tr> <tr> <td>TFGMEIBBCD1_MY27</td><td> <ul style="list-style-type: none"> <li>- Same as Basic model.</li> <li>- Only the model name differs for marketing purposes.</li> </ul> </td></tr> <tr> <td>TFGMEIBBCD2_MY27</td><td> <ul style="list-style-type: none"> <li>- Same to RF module with basic model except following function.</li> <li>- Single GNSS is supported.</li> <li>- Ultra-super cruise service is not supported.</li> </ul> </td></tr> <tr> <td>TFGMEIBBCD3_MY27</td><td> <ul style="list-style-type: none"> <li>- Same to RF module with basic model except following function.</li> <li>- Single GNSS is supported.</li> <li>- Ultra-super cruise service is not supported.</li> <li>- eUICC part is different with TFGMEIBBCD2.</li> </ul> </td></tr> </table> | TFGMEIBBCD1 | <ul style="list-style-type: none"> <li>- Dual GNSS is supported.</li> <li>- Ultra-super cruise service is supported.</li> </ul> | TFGMEIBBCD2 | <ul style="list-style-type: none"> <li>- Same to RF module with basic model except following function.</li> <li>- Single GNSS is supported.</li> <li>- Ultra-super cruise service is not supported.</li> </ul> | TFGMEIBBCD3 | <ul style="list-style-type: none"> <li>- Same to RF module with basic model except following function.</li> <li>- Single GNSS is supported.</li> <li>- Ultra-super cruise service is not supported.</li> <li>- eUICC part is different with TFGMEIBBCD2.</li> </ul> | TFGMEIBBCD1_MY27 | <ul style="list-style-type: none"> <li>- Same as Basic model.</li> <li>- Only the model name differs for marketing purposes.</li> </ul> | TFGMEIBBCD2_MY27 | <ul style="list-style-type: none"> <li>- Same to RF module with basic model except following function.</li> <li>- Single GNSS is supported.</li> <li>- Ultra-super cruise service is not supported.</li> </ul> | TFGMEIBBCD3_MY27 | <ul style="list-style-type: none"> <li>- Same to RF module with basic model except following function.</li> <li>- Single GNSS is supported.</li> <li>- Ultra-super cruise service is not supported.</li> <li>- eUICC part is different with TFGMEIBBCD2.</li> </ul> |
| TFGMEIBBCD1                                       | <ul style="list-style-type: none"> <li>- Dual GNSS is supported.</li> <li>- Ultra-super cruise service is supported.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
| TFGMEIBBCD2                                       | <ul style="list-style-type: none"> <li>- Same to RF module with basic model except following function.</li> <li>- Single GNSS is supported.</li> <li>- Ultra-super cruise service is not supported.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
| TFGMEIBBCD3                                       | <ul style="list-style-type: none"> <li>- Same to RF module with basic model except following function.</li> <li>- Single GNSS is supported.</li> <li>- Ultra-super cruise service is not supported.</li> <li>- eUICC part is different with TFGMEIBBCD2.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
| TFGMEIBBCD1_MY27                                  | <ul style="list-style-type: none"> <li>- Same as Basic model.</li> <li>- Only the model name differs for marketing purposes.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
| TFGMEIBBCD2_MY27                                  | <ul style="list-style-type: none"> <li>- Same to RF module with basic model except following function.</li> <li>- Single GNSS is supported.</li> <li>- Ultra-super cruise service is not supported.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
| TFGMEIBBCD3_MY27                                  | <ul style="list-style-type: none"> <li>- Same to RF module with basic model except following function.</li> <li>- Single GNSS is supported.</li> <li>- Ultra-super cruise service is not supported.</li> <li>- eUICC part is different with TFGMEIBBCD2.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
| <b>Antenna Information (Model / Manufacturer)</b> | 85846852(BT1FG) / YOKOWO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
| <b>Software Version</b>                           | SW180                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
| <b>Hardware Version</b>                           | Rev.G                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |
| <b>Serial Number</b>                              | 004400152020000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                                                                                                                                 |             |                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                     |                  |                                                                                                                                         |                  |                                                                                                                                                                                                                |                  |                                                                                                                                                                                                                                                                     |

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Mode of Operation</b>  | WCDMA II / WCDMA IV / WCDMA V / LTE Band 2 / LTE Band 4 / LTE Band 5 / LTE Band 7 / LTE Band 12 / LTE Band 13 / LTE Band 14 / LTE Band 26 / LTE Band 66 / 5G NR n2 / 5G NR n5 / 5G NR n7 / 5G NR n12 / 5G NR n13 / 5G NR n14 / 5G NR n25 / 5G NR n26 / 5G NR n66 / 5G NR n71 / 5G NR n41 / 5G NR n77 / 5G NR n78                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Tx Frequency Range</b> | WCDMA II : 1850.0 ~ 1910 MHz<br>WCDMA IV : 1710.0 ~ 1755.0 MHz<br>WCDMA V : 824.0 ~ 849.0 MHz<br>LTE Band 2 : 1850.0 ~ 1910.0 MHz<br>LTE Band 4 : 1710.0 ~ 1755.0 MHz<br>LTE Band 5 : 824.0 ~ 849.0 MHz<br>LTE Band 7 : 2500.0 ~ 2570.0 MHz<br>LTE Band 12 : 699.0 ~ 716.0 MHz<br>LTE Band 13 : 777.0 ~ 787.0 MHz<br>LTE Band 14 : 788.0 ~ 798.0 MHz<br>LTE Band 25 : 1850.0 ~ 1915.0 MHz<br>LTE Band 26 : 814 ~ 849 MHz<br>LTE Band 66 : 1710.0 ~ 1780.0 MHz<br>LTE Band 71 : 663.0 ~ 698.0 MHz<br>5G NR n2 : 1850 ~ 1910 MHz<br>5G NR n5 : 824.0 ~ 849.0 MHz<br>5G NR n7 : 2500.0 ~ 2570.0 MHz<br>5G NR n12 : 699 ~ 716 MHz<br>5G NR n13 : 777.0 ~ 787.0 MHz<br>5G NR n14 : 788.0 ~ 798.0 MHz<br>5G NR n25 : 1850 ~ 1915 MHz<br>5G NR n26 : 814 ~ 849 MHz<br>5G NR n66 : 1710 ~ 1780 MHz<br>5G NR n71 : 663 ~ 698 MHz<br>5G NR n41 : 2496 ~ 2690 MHz<br>5G NR n77 DoD : 3450 ~ 3550 MHz<br>5G NR n77 : 3700 ~ 3980 MHz<br>5G NR n78 DoD : 3450 ~ 3550 MHz<br>5G NR n78 : 3700 ~ 3800 MHz |



## 5 The Highest Reported SAR Values

| Band           | Highest Reported SAR<br>1g (W/kg) |
|----------------|-----------------------------------|
| 5G NR n41      | <b>0.011</b>                      |
| 5G NR n41 MIMO | 0.005                             |

## 6 Test Methodology

ANSI/IEEE C95.1–1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. It specifies the maximum exposure limit of 1.6 W/kg as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

Test tests documented in this report were performed in accordance with IEEE Standard 1528-2013 and the following published KDB procedures.

|                                     |                             |                                                                                                    |
|-------------------------------------|-----------------------------|----------------------------------------------------------------------------------------------------|
| <input checked="" type="checkbox"/> | <b>KDB 865664 D01v01r04</b> | <b>SAR Measurement Requirements for 100 MHz to 6 GHz</b>                                           |
| <input checked="" type="checkbox"/> | <b>KDB 865664 D02v01r02</b> | <b>RF Exposure Compliance Reporting and Documentation Considerations</b>                           |
| <input type="checkbox"/>            | KDB 447498 D01v06           | Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies            |
| <input checked="" type="checkbox"/> | <b>KDB 447498 D04v01</b>    | <b>Interim General RF Exposure Guidance</b>                                                        |
| <input type="checkbox"/>            | KDB 447498 D02v02r01        | SAR Measurement Procedures for USB Dongle Transmitters                                             |
| <input type="checkbox"/>            | KDB 248227 D01v02r02        | SAR Guidance For IEEE 802.11 (Wi-Fi) Transmitters                                                  |
| <input type="checkbox"/>            | KDB 615223 D01v01r01        | 802.16e/WiMax SAR Measurement Guidance                                                             |
| <input type="checkbox"/>            | KDB 616217 D04v01r02        | SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers                   |
| <input type="checkbox"/>            | KDB 643646 D01v01r03        | SAR Test Considerations for Occupational PTT Radios                                                |
| <input type="checkbox"/>            | KDB 648474 D03v01r04        | Evaluation and Approval Considerations for Handsets with Specific Wireless Charging Battery Covers |
| <input type="checkbox"/>            | KDB 648474 D04v01r03        | SAR Evaluation Considerations for Wireless Handsets                                                |
| <input type="checkbox"/>            | KDB 680106 D01v03r01        | RF Exposure Considerations for Low Power Consumer Wireless Power Transfer Applications             |
| <input type="checkbox"/>            | KDB 941225 D01v03r01        | 3G SAR Measurement Procedures                                                                      |
| <input type="checkbox"/>            | KDB 941225 D05v02r05        | SAR Evaluation Considerations for LTE Devices                                                      |
| <input type="checkbox"/>            | KDB 941225 D06v02r01        | SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities                   |
| <input type="checkbox"/>            | KDB 941225 D07v01r02        | SAR Evaluation Procedures for UMPC Mini-Tablet Devices                                             |

## 7 Testing Environment

|                                       |                |
|---------------------------------------|----------------|
| Ambient temperature                   | : 18°C ~ 25°C  |
| Relative humidity                     | : 30% ~ 70%    |
| Liquid temperature of during the test | : <± 2°C       |
| Ambient noise & Reflection            | : < 0.012 W/kg |

## 8 Specific Absorption Rate (SAR)

### 8.1 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

### 8.2 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:

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

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

SAR measurement can be either related to the temperature elevation in tissue by

$$SAR = C \left( \frac{\delta T}{\delta t} \right)$$

Where: C is the specific heat capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

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

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

### 8.3 Test Standards and Limits

According to FCC 47CFR §2.1093(d) The limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate ("SAR") in Section 4.2 of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE C95.3-2003, Copyright 2003 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in "Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields," NCRP Report No. 86, Section 17.4.5. Copyright NCRP, 1986, Bethesda, Maryland 20814. 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. The criteria to be used are specified

in paragraphs (d)(1) and (d)(2) of this section and shall apply for portable devices transmitting in the frequency range from 100 kHz to 6 GHz. Portable devices that transmit at frequencies above 6 GHz are to be evaluated in terms of the MPE limits specified in § 1.1310 of this chapter. Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 GHz should be made at a minimum distance of 5 cm from the radiating source.

(1) Limits for Occupational/Controlled exposure: 0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over an 10 grams of tissue (defined as a tissue volume in the shape of a cube). Occupational/Controlled limits apply when persons are exposed as a consequence of their employment provided these persons are fully aware of and exercise control over their exposure. Awareness of exposure can be accomplished by use of warning labels or by specific training or education through appropriate means, such as an RF safety program in a work environment.

(2) Limits for General Population/Uncontrolled exposure: 0.08 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). General Population/Uncontrolled limits apply when the general public may be exposed, or when persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or do not exercise control over their exposure. Warning labels placed on consumer devices such as cellular telephones will not be sufficient reason to allow these devices to be evaluated subject to limits for occupational/controlled exposure in paragraph (d)(1) of this section.

| Human Exposure                                      | Uncontrolled Environment<br>General Population | Controlled Environment<br>Occupational |
|-----------------------------------------------------|------------------------------------------------|----------------------------------------|
| <b>Partial Peak SAR</b><br>(Partial)                | 1.60 mW/g                                      | 8.00 mW/g                              |
| <b>Partial Average SAR</b><br>(Whole Body)          | 0.08 mW/g                                      | 0.40 mW/g                              |
| <b>Partial Peak SAR</b><br>(Hands/Feet/Ankle/Wrist) | 4.00 mW/g                                      | 20.00 mW/g                             |

1. The spatial Peak value of the SAR averaged over any 1g 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.

## 9 The SAR Measurement System

A block diagram of the SAR measurement System is given in Fig. 1. This SAR Measurement System uses a Computer-controlled 3-D stepper motor system (SPEAG DASY system). The model EX3DV4 field probe is used to determine the internal electric fields. The SAR can be obtained from the equation  $SAR = \sigma (|E_i|^2) / \rho$  where  $\sigma$  and  $\rho$  are the conductivity and mass density of the tissue-simulant.

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

- A standard high precision 6-axis robot (Staubli TX family) with controller, teach pendant and software. An arm extension is for accommodating the data acquisition electronics (DAE).
- A dosimeter probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- 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.

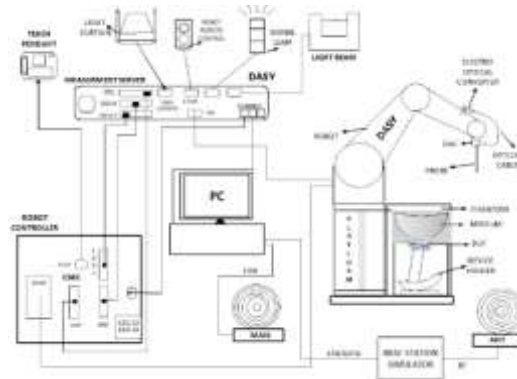


Fig a. The microwave circuit arrangement used for SAR system verification

- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected 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.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows.
- DASY software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Verification dipole kits allowing to validate the proper functioning of the system.

## 10 System Components

### 10.1 Probe

|                      |                                                                                                                                                                                                             |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Construction</b>  | : Symmetrical design with triangular core.<br>Built-in shielding against static charges.<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE)                                             |
| <b>Calibration</b>   | : Basic Broad Band Calibration in air Conversion Factors (CF) for HSL 835 and HSL1900.<br>Additional CF-Calibration for other liquids and frequencies upon request.                                         |
| <b>Frequency</b>     | : 10 MHz to 6 GHz; Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)                                                                                                                                                |
| <b>Directivity</b>   | : $\pm 0.3$ dB in HSL (rotation around probe axis)<br>$\pm 0.5$ dB in tissue material (rotation normal to probe axis)                                                                                       |
| <b>Dynamic Range</b> | : $10\mu\text{W/g}$ to $> 100$ mW/g;<br>Linearity: $\pm 0.2$ dB(noise: typically $< 1\mu\text{W/g}$ )                                                                                                       |
| <b>Dimensions</b>    | : Overall length: 337 mm (Tip length: 20 mm)<br>Tip diameter: 2.5 mm (Body diameter: 12 mm)<br>Distance from probe tip to dipole centers: 1 mm                                                              |
| <b>Application</b>   | : High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30% |



EX3DV4 E-Field Probe

#### NOTE:

1. The Probe parameters have been calibrated by the SPEAG. Please reference “APPENDIX D” for the Calibration Certification Report.

### 10.2 ELI Phantom

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Construction</b> | : Phantom for compliance testing of handheld and bodymounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles. |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

ELI V5.0 has the same shell geometry and is manufactured from the same material as ELI4, but has reinforced top structure



ELI Phantom

|                        |                                              |
|------------------------|----------------------------------------------|
| <b>Shell Thickness</b> | : 2.0 mm $\pm$ 0.1 mm                        |
| <b>Dimensions</b>      | : Major axis : 600 mm<br>Minor axis : 400 mm |

### 10.3 Device Holder

Construction: : In combination with the Twin SAM PhantomV4.0/V4.0C or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).



Device Holder

## **11 SAR Measurement Procedures**

### **11.1 Normal SAR Measurement Procedure**

#### **Step 1: 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. The minimum distance of probe sensors to surface is 1.4 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties.

#### **Step 2 and 3: Area Scan & Zoom Scan Procedures**

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 1 g and 10 g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

1. The extraction of the measured data (grid and values) from the Zoom Scan.
2. The calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. The generation of a high-resolution mesh within the measured volume
4. The interpolation of all measured values from the measurement grid to the high-resolution grid
5. The extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. The calculation of the averaged SAR within masses of 1 g and 10 g.

#### **Step 4: Power drift measurement**

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1. SAR drift shall be kept within  $\pm 5\%$  and if it without  $\pm 5\%$ , SAR retest according to measurement procedure step 1~4.

## &lt; Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r04 &gt;

|                                                                                                                                                                                                                                                                                                                         |                                    |                                                                                      | $\leq 3$ GHz                                                                                                                                                                                                                                                           | $> 3$ GHz                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface                                                                                                                                                                                                                  |                                    |                                                                                      | 5 mm $\pm$ 1 mm                                                                                                                                                                                                                                                        | $\frac{1}{2} \cdot \delta \cdot \ln(2)$ mm $\pm$ 0.5 mm                       |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location                                                                                                                                                                                                                               |                                    |                                                                                      | $30^{\circ} \pm 1^{\circ}$                                                                                                                                                                                                                                             | $20^{\circ} \pm 1^{\circ}$                                                    |
| Maximum area scan spatial resolution: $\Delta x_{Area}$ , $\Delta y_{Area}$                                                                                                                                                                                                                                             |                                    |                                                                                      | $\leq 2$ GHz: $\leq 15$ mm<br>2 – 3 GHz: $\leq 12$ mm                                                                                                                                                                                                                  | 3 – 4 GHz: $\leq 12$ mm<br>4 – 6 GHz: $\leq 10$ 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 $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device. |                                                                               |
| Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$ , $\Delta y_{Zoom}$                                                                                                                                                                                                                                             |                                    |                                                                                      | $\leq 2$ GHz: $\leq 8$ mm<br>2 – 3 GHz: $\leq 5$ mm*                                                                                                                                                                                                                   | 3 – 4 GHz: $\leq 5$ mm*<br>4 – 6 GHz: $\leq 4$ mm*                            |
| Maximum zoom scan spatial resolution, normal to phantom surface                                                                                                                                                                                                                                                         | uniform grid: $\Delta z_{Zoom}(n)$ |                                                                                      | $\leq 5$ mm                                                                                                                                                                                                                                                            | 3 – 4 GHz: $\leq 4$ mm<br>4 – 5 GHz: $\leq 3$ mm<br>5 – 6 GHz: $\leq 2$ mm    |
|                                                                                                                                                                                                                                                                                                                         | graded grid                        | $\Delta z_{Zoom}(1)$ : between 1 <sup>st</sup> two points closest to phantom surface | $\leq 4$ mm                                                                                                                                                                                                                                                            | 3 – 4 GHz: $\leq 3$ mm<br>4 – 5 GHz: $\leq 2.5$ mm<br>5 – 6 GHz: $\leq 2$ mm  |
|                                                                                                                                                                                                                                                                                                                         |                                    | $\Delta z_{Zoom}(n>1)$ : between subsequent points                                   | $\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$ mm                                                                                                                                                                                                                               |                                                                               |
| Minimum zoom scan volume                                                                                                                                                                                                                                                                                                | x, y, z                            |                                                                                      | $\geq 30$ mm                                                                                                                                                                                                                                                           | 3 – 4 GHz: $\geq 28$ mm<br>4 – 5 GHz: $\geq 25$ mm<br>5 – 6 GHz: $\geq 22$ mm |
| Note: $\delta$ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details.                                                                                                                                                                                   |                                    |                                                                                      |                                                                                                                                                                                                                                                                        |                                                                               |
| * When zoom scan is required and the <u>reported</u> SAR from the <i>area scan based 1-g SAR estimation</i> procedures of KDB Publication 447498 is $\leq 1.4$ W/kg, $\leq 8$ mm, $\leq 7$ mm and $\leq 5$ 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. |                                    |                                                                                      |                                                                                                                                                                                                                                                                        |                                                                               |

## **12 Definition of Reference**

### **12.1 Other consumer electronic devices**

The exposure conditions of transmitters and modules incorporated in certain consumer electronic devices, such as printers, cameras, and camcorders may vary according to the installation and operating configurations required by the host products. Details of the transmitter and antenna configurations, antenna to user test separation distance, device operating configurations, etc., are required to determine SAR test exclusion or SAR measurement requirements for each host product. When SAR tests are required, a TCB inquiry is recommended to confirm the test setup. Unless the transmitter is used in a specific/dedicated host device, the standalone and simultaneous transmission SAR procedures for transmitters and modules should be applied. These must be fully explained in the permissive change documentation or equipment approval filing, whichever is applicable.

“Intended use distance” specified by the manufacturer: When there is no regulatory requirement, the intended use condition or distance specified by the manufacturer shall be used. This information shall be acquired from the user documentation accompanying the DUT. This device is mounted on the top of vehicle, and the physical distance from the device is 90mm. By manufacturer declaration, the test distance is 90mm. Testing of all six faces of the DUT might not be required; justification shall be provided when omitting testing of some faces. The SAR was tested only in one position, the Front.

### 13 SAR System Verification

The microwave circuit arrangement for system verification is sketched in Fig 1. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within  $\pm 10\%$  from the target SAR values. These tests were done at 2600 MHz. The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed in the table 1. (SAR values are normalized to 1W forward power delivered to the dipole). During the tests, the ambient temperature of the laboratory was in the range  $(22 \pm 2)^\circ\text{C}$ , the relative humidity was in the range  $(55 \pm 5)\%$  R.H and the liquid depth above the ear reference points was  $\geq 15\text{ cm} \pm 5\text{ mm}$  (frequency  $\leq 3\text{ GHz}$ ) or  $\geq 10\text{ cm} \pm 5\text{ mm}$  (frequency  $> 3\text{ GHz}$ ) in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.



Fig 1. The microwave circuit arrangement used for SAR system verification

- A. Signal Generator
- B. RF Amplifier
- C. Power Meter
- D. Power Sensor
- E. Dual Directional Coupler
- F. Reference dipole Antenna

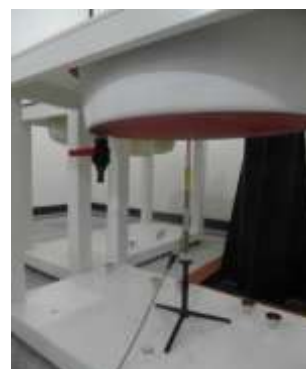


Photo of the dipole Antenna

#### SAR System Verification

| Dipole Validation Kits |      | Probe S/N | Freq. (MHz) | Input Power (W) | Target SAR values (W/Kg) | 1 W normalized Measured SAR (W/Kg) | SAR Deviation (%) | Date       | Temperature (°C) |        |
|------------------------|------|-----------|-------------|-----------------|--------------------------|------------------------------------|-------------------|------------|------------------|--------|
|                        |      |           |             |                 | 1g                       | 1g                                 | 1g                |            | Ambient          | Liquid |
| D2600V2                | 1124 | 3986      | 2600        | 0.10            | 54.50                    | 50.90                              | -6.61             | 2024-12-20 | 21.8             | 21.4   |
| D2600V2                | 1124 | 3986      | 2600        | 0.10            | 54.50                    | 52.50                              | -3.67             | 2024-12-23 | 21.7             | 21.4   |

Table 1 Results system verification



## 14 Tissue Simulant Fluid for the Frequency Band

The dielectric properties for this simulant fluid were measured by using the Speag Model DAK-3.5 in conjunction with Keysight E5063A Network Analyzer by using a procedure.

| Freq.<br>(MHz) | Target Value |                       | Measure Value |                       | Deviation (%) |                       | Date       | Liquid<br>Temperature<br>(°C) |
|----------------|--------------|-----------------------|---------------|-----------------------|---------------|-----------------------|------------|-------------------------------|
|                | Permittivity | Conductivity<br>(S/m) | Permittivity  | Conductivity<br>(S/m) | Permittivity  | Conductivity<br>(S/m) |            |                               |
| 2600*          | 39.00        | 1.96                  | 37.639        | 1.981                 | -3.49         | 1.07                  | 2024-12-20 | 21.4                          |
| 2592.99        | 39.00        | 1.96                  | 37.671        | 1.975                 | -3.41         | 0.77                  |            |                               |
| 2600*          | 39.00        | 1.96                  | 39.886        | 1.959                 | 2.27          | -0.05                 | 2024-12-23 | 21.4                          |
| 2592.99        | 39.00        | 1.96                  | 39.925        | 1.952                 | 2.37          | -0.41                 |            |                               |

Note: The data marked (\*) in this table was Permittivity/Conductivity results of Verification

The brain mixtures consist of a viscous gel using hydroxethylcellulose(HEC) gelling agent and saline solution. Preservation with a bactericide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation. The dielectric properties of the liquid material required to fill the phantom shell shall be target. For 3.4 to 10.0 GHz, the tests were done with using stimulating liquid made by SPEAG.

| Frequency (MHz)                                                                     | 450   | 835   | 900   | 1800-2000                                                 | 2450 | 2600 |
|-------------------------------------------------------------------------------------|-------|-------|-------|-----------------------------------------------------------|------|------|
| Tissue Type                                                                         | Body  |       |       |                                                           |      |      |
| Ingredient (% by weight)                                                            |       |       |       |                                                           |      |      |
| Water                                                                               | 38.91 | 40.29 | 40.29 | 55.24                                                     | 45.0 | 45.0 |
| Salt (NaCl)                                                                         | 3.79  | 1.38  | 1.38  | 0.31                                                      | 0    | 0    |
| Sugar                                                                               | 56.93 | 57.90 | 57.90 | 0                                                         | 0    | 0    |
| HEC                                                                                 | 0.25  | 0.24  | 0.24  | 0                                                         | 0    | 0    |
| Bactericide                                                                         | 0.12  | 0.18  | 0.18  | 0                                                         | 0    | 0    |
| Triton X-100                                                                        | 0     | 0     | 0     | 0                                                         | 0    | 0    |
| DGBE                                                                                | 0     | 0     | 0     | 44.45                                                     | 55.0 | 55.0 |
| Tissue parameter target by IEEE 1528-2013                                           |       |       |       |                                                           |      |      |
| Dielectric Constant                                                                 | 43.5  | 41.5  | 41.5  | 40.0                                                      | 39.2 | 39.0 |
| Conductivity (S/m)                                                                  | 0.87  | 0.90  | 0.97  | 1.40                                                      | 1.80 | 1.96 |
| Salt: 99+% Pure Sodium Chloride<br>Water: De-ionized, 16 M <sup>+</sup> resistivity |       |       |       | Sucrose: 98+% Pure Sucrose<br>HEC: Hydroxyethyl Cellulose |      |      |
| DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]             |       |       |       |                                                           |      |      |

## 15 Instruments List

| <b>Test Platform</b>      | SPEAG DASY System                                |                      |                 |                     |                |
|---------------------------|--------------------------------------------------|----------------------|-----------------|---------------------|----------------|
| <b>Manufacture</b>        | SPEAG                                            |                      |                 |                     |                |
| <b>Description</b>        | SAR Test System                                  |                      |                 |                     |                |
| <b>Software Reference</b> | DASY52: 52.10.4(1527)<br>SEMCAD X: 14.6.14(7483) |                      |                 |                     |                |
| <b>Equipment</b>          | <b>Type</b>                                      | <b>Serial Number</b> | <b>Cal Date</b> | <b>Cal Interval</b> | <b>Cal Due</b> |
| Phantom                   | ELI Phantom                                      | TP-1244              | N/A             | N/A                 | N/A            |
| Verification Dipole       | D2600V2                                          | 1124                 | 2024-07-22      | Biennial            | 2026-07-22     |
| Dielectric Assessment Kit | DAK-3.5                                          | 1107                 | 2024-05-21      | Annual              | 2025-05-21     |
| DAE                       | DAE3                                             | 567                  | 2024-02-16      | Annual              | 2025-02-16     |
| E-Field Probe             | EX3DV4                                           | 3986                 | 2024-01-24      | Annual              | 2025-01-24     |
| Network Analyzer          | E5063A                                           | MY54706220           | 2024-01-10      | Annual              | 2025-01-10     |
| Signal Generator          | N5173B                                           | MY62220611           | 2024-07-05      | Annual              | 2025-07-05     |
| Vector Signal Generator   | SMBV100A                                         | 262093               | 2024-05-14      | Annual              | 2025-05-14     |
| Power Meter               | N1914A                                           | MY56120017           | 2024-06-03      | Annual              | 2025-06-03     |
| Power Meter               | E4419B                                           | GB43311715           | 2024-02-19      | Annual              | 2025-02-19     |
| Power Meter               | E4416A                                           | GB41292123           | 2024-06-10      | Annual              | 2025-06-10     |
| Power Sensor              | E9300H                                           | MY41495307           | 2024-04-17      | Annual              | 2025-04-17     |
| Power Sensor              | E9300H                                           | MY41495314           | 2024-04-17      | Annual              | 2025-04-17     |
| Power Sensor              | N8481A                                           | MY63190004           | 2024-07-05      | Annual              | 2025-07-05     |
| Power Sensor              | N8481A                                           | MY63190005           | 2024-07-05      | Annual              | 2025-07-05     |
| RF Amplifier              | AMP2027                                          | 10008                | 2024-03-07      | Annual              | 2025-03-07     |
| Dual Directional Coupler  | 772D                                             | MY52180226           | 2024-03-05      | Annual              | 2025-03-05     |
| LP Filter                 | LA-30N                                           | LF03                 | 2024-03-05      | Annual              | 2025-03-05     |
| Attenuator                | 05AS102-K03                                      | A1                   | 2024-12-06      | Annual              | 2025-12-06     |
| Attenuator                | 05AS102-K20                                      | A4                   | 2024-12-06      | Annual              | 2025-12-06     |
| Attenuator                | 18N-20                                           | 21                   | 2024-11-27      | Annual              | 2025-11-27     |
| Digital Thermometer       | SDT25                                            | 23111500095          | 2024-01-09      | Annual              | 2025-01-09     |
| Hygro-Thermometer         | 303C                                             | 210609816            | 2024-01-30      | Annual              | 2025-01-30     |
| Signal Analyzer           | FSQ26                                            | 201057               | 2024-03-18      | Annual              | 2025-03-18     |



## **16 FCC Power Measurement Procedures**

The SAR measurement Software calculates a reference point at the start and end of the test to check for power drifts. If conducted power deviations of more than 5 % occurred, the tests were repeated.

## **17 Measured and Reported SAR**

Per FCC KDB Publication 447498 D04v01, 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. Test highest reported SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r03.

## 18 5G NR FR1\*

### 18.1 5G NR FR1 Test Application

This device supports 5G NR FR1 Band n2, n5, n7, n12, n13, n25, n66, n71, n41, n77 and n78 is declared by the manufacturer used to configuration for frequency, SCS, Bandwidth, Target power, and etc. The RB Configuration was evaluated all using reference to SCS / Bandwidth / Modulation supported by Section 6.1-1 of TS38.521-1.

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 MPR is 3GPP TS38.101-1 Section 6.2.2.

NR test was evaluated under Maximum power in NR single mode. In NR standalone mode, NR power states in the highest power, and the SAR measurement is determined by measuring LTE and 5G NR respectively.

| 5G NR Band | Mode   | SCS (kHz) | Bandwidth (MHz)                     | Waveform                  | UL Modulation                                 | RB Configuration                                                                                                                      | EN-DC (LTE Band)        |
|------------|--------|-----------|-------------------------------------|---------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| n2         | NSA/SA | 15        | 5, 10, 15, 20                       | DFT-s-OFDM<br><br>CP OFDM | PI/2 BPSK<br>QPSK<br>16QAM<br>64QAM<br>256QAM | Inner 1RB left<br>Inner 1RB Right<br>Inner Full<br>Outer Full<br>Edge 1RB Left<br>Edge Full Left<br>Edge 1RB Right<br>Edge Full Right | 5, 12, 13, 14           |
| n5         | NSA/SA | 15        | 5, 10, 15, 20                       |                           |                                               |                                                                                                                                       | 2, 7, 66                |
| n7         | NSA/SA | 15        | 5, 10, 15, 20, 25, 30, 40           |                           |                                               |                                                                                                                                       | 5, 12                   |
| n12        | NSA/SA | 15        | 5, 10, 15                           |                           |                                               |                                                                                                                                       | 2, 66                   |
| n13        | NSA/SA | 15        | 5, 10                               |                           |                                               |                                                                                                                                       | 66                      |
| n25        | NSA/SA | 15        | 5, 10, 15, 20, 25, 30, 40           |                           |                                               |                                                                                                                                       | 12                      |
| n66        | NSA/SA | 15        | 5, 10, 15, 20, 40                   |                           |                                               |                                                                                                                                       | 5, 12, 13, 14           |
| n71        | NSA/SA | 15        | 5, 10, 15, 20                       |                           |                                               |                                                                                                                                       | 2, 7, 66                |
| n41        | NSA/SA | 30        | 20, 30, 40, 50, 60, 70, 80, 90, 100 |                           |                                               |                                                                                                                                       | 5, 26                   |
| n77        | NSA/SA |           | 20, 30, 40, 50, 60, 70, 80, 90, 100 |                           |                                               |                                                                                                                                       | 2, 5, 7, 12, 13, 14, 66 |
| n78        | NSA/SA |           | 20, 30, 40, 50, 60, 70, 80, 90, 100 |                           |                                               |                                                                                                                                       | 2, 5, 7, 12, 26, 66     |
| n41 MIMO   | SA     | 30        | 20, 30, 40, 50, 60, 70, 80, 90, 100 | CP OFDM                   | QPSK<br>16QAM<br>64QAM<br>256QAM              |                                                                                                                                       | -                       |
| n77 MIMO   | SA     |           | 20, 30, 40, 50, 60, 70, 80, 90, 100 |                           |                                               |                                                                                                                                       | -                       |
| n78 MIMO   | SA     |           | 20, 30, 40, 50, 60, 70, 80, 90, 100 |                           |                                               |                                                                                                                                       | -                       |

- The data marked \* in this report was provided by the customer and may affect the validity of the test results.

We are responsible for all the information of this test report except for the data(\*) provided by the customer.

## 19 Maximum Output Power Specifications

This device operates using the following maximum output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D04v01

### 5G NR Maximum Power

| Mode               | Maximum / Normal | Maximum Output Power (dBm) |
|--------------------|------------------|----------------------------|
| 5G NR n2           | <b>Maximum</b>   | <b>25.00</b>               |
|                    | Normal           | 24.00                      |
| 5G NR n5           | <b>Maximum</b>   | <b>25.00</b>               |
|                    | Normal           | 24.00                      |
| 5G NR n7           | <b>Maximum</b>   | <b>25.00</b>               |
|                    | Normal           | 24.00                      |
| 5G NR n12          | <b>Maximum</b>   | <b>25.00</b>               |
|                    | Normal           | 24.00                      |
| 5G NR n13          | <b>Maximum</b>   | <b>25.00</b>               |
|                    | Normal           | 24.00                      |
| 5G NR n14          | <b>Maximum</b>   | <b>25.00</b>               |
|                    | Normal           | 24.00                      |
| 5G NR n25          | <b>Maximum</b>   | <b>25.00</b>               |
|                    | Normal           | 24.00                      |
| 5G NR n26          | <b>Maximum</b>   | <b>25.00</b>               |
|                    | Normal           | 24.00                      |
| 5G NR n66          | <b>Maximum</b>   | <b>24.50</b>               |
|                    | Normal           | 23.50                      |
| 5G NR n71          | <b>Maximum</b>   | <b>25.00</b>               |
|                    | Normal           | 24.00                      |
| 5G NR n41          | <b>Maximum</b>   | <b>26.00</b>               |
|                    | Normal           | 25.00                      |
| 5G NR n77 DoD      | <b>Maximum</b>   | <b>26.00</b>               |
|                    | Normal           | 25.00                      |
| 5G NR n77          | <b>Maximum</b>   | <b>26.00</b>               |
|                    | Normal           | 25.00                      |
| 5G NR n78 DoD      | <b>Maximum</b>   | <b>26.00</b>               |
|                    | Normal           | 25.00                      |
| 5G NR n78          | <b>Maximum</b>   | <b>26.00</b>               |
|                    | Normal           | 25.00                      |
| 5G NR n41 MIMO     | <b>Maximum</b>   | <b>26.00</b>               |
|                    | Normal           | 25.00                      |
| 5G NR n77 DoD MIMO | <b>Maximum</b>   | <b>26.00</b>               |
|                    | Normal           | 25.00                      |
| 5G NR n77 MIMO     | <b>Maximum</b>   | <b>26.00</b>               |
|                    | Normal           | 25.00                      |
| 5G NR n78 DoD MIMO | <b>Maximum</b>   | <b>26.00</b>               |
|                    | Normal           | 25.00                      |
| 5G NR n78 MIMO     | <b>Maximum</b>   | <b>26.00</b>               |
|                    | Normal           | 25.00                      |

## 20 RF Conducted Power

- Refer to Appendix E.

## 21 SAR Test Exclusion Applied

Following the FCC's guidance, SAR testing was only performed on the 5G band of the total bands supported by the original report, and Based on the maximum tune-up tolerance limit and the antenna to use separation distance, Table “Exempt” SAR was not required and Table “Measure” SAR was required.

The threshold power for frequency bands below 6 GHz was calculated with the SAR-based Exemption formula shown in 447498 D04.

$$P_{th} \text{ (mW)} = ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

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

where

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

| Band               | Frequency (MHz) | Pth (mW) | Output Power |           |          | Separation distance (mm) | SAR Exemption | Ant Gain |
|--------------------|-----------------|----------|--------------|-----------|----------|--------------------------|---------------|----------|
|                    |                 |          | TuneUp (dBm) | ERP (dbm) | ERP (mW) |                          |               |          |
| 5G NR n5           | 849             | 555.2    | 25.0         | 20.7      | 116.1    | 90                       | Exempt        | -2.2     |
| 5G NR n12          | 716             | 511.6    | 25.0         | 21.6      | 142.9    | 90                       | Exempt        | -1.3     |
| 5G NR n13          | 787             | 535.3    | 25.0         | 21.2      | 130.3    | 90                       | Exempt        | -1.7     |
| 5G NR n14          | 798             | 538.9    | 25.0         | 21.2      | 130.3    | 90                       | Exempt        | -1.7     |
| 5G NR n26          | 849             | 555.2    | 25.0         | 20.7      | 116.1    | 90                       | Exempt        | -2.2     |
| 5G NR n71          | 698             | 505.4    | 25.0         | 21.4      | 136.5    | 90                       | Exempt        | -1.5     |
| 5G NR n2           | 1910            | 699.6    | 25.0         | 23.7      | 231.7    | 90                       | Exempt        | 0.8      |
| 5G NR n7           | 2570            | 664.5    | 25.0         | 20.2      | 103.5    | 90                       | Exempt        | -2.7     |
| 5G NR n25          | 1915            | 699.2    | 25.0         | 23.7      | 231.7    | 90                       | Exempt        | 0.8      |
| 5G NR n66          | 1780            | 708.2    | 24.5         | 23.6      | 226.5    | 90                       | Exempt        | 1.2      |
| 5G NR n41          | 2690            | 659.2    | 26.0         | 29.0      | 785.2    | 90                       | Measure       | 5.1      |
| 5G NR n41 MIMO     | 2690            | 659.2    | 26.0         | 28.8      | 762.1    | 90                       | Measure       | 4.97     |
| 5G NR n77          | 3980            | 615.9    | 26.0         | 25.1      | 319.9    | 90                       | Exempt        | 1.2      |
| 5G NR n77 MIMO     | 3980            | 615.9    | 26.0         | 27.6      | 571.5    | 90                       | Exempt        | 3.72     |
| 5G NR n77 DoD      | 3550            | 628.3    | 26.0         | 25.7      | 367.3    | 90                       | Exempt        | 1.8      |
| 5G NR n77 DoD MIMO | 3550            | 628.3    | 26.0         | 27.6      | 571.5    | 90                       | Exempt        | 3.72     |

## 22 SAR Data Summary

### 22.1 SAR data

| 5G NR n41 Body SAR |            |      |           |          |             |        |         |           | Ambient Temperature (°C) |            | 21.8                |                        |                     |                      |                        |
|--------------------|------------|------|-----------|----------|-------------|--------|---------|-----------|--------------------------|------------|---------------------|------------------------|---------------------|----------------------|------------------------|
|                    |            |      |           |          |             |        |         |           | Liquid Temperature (°C)  |            | 21.4                |                        |                     |                      |                        |
|                    |            |      |           |          |             |        |         |           | Date                     |            | 2024-12-20          |                        |                     |                      |                        |
| Position           | Waveform   | Mod. | SCS (kHz) | BW (MHz) | Freq. (MHz) | Ch.    | RB Size | RB Offset | Sensor State (Grip)      | Space (mm) | Measure Power (dBm) | Measure 1 g SAR (W/kg) | Tune-Up Limit (dBm) | Power Scaling Factor | Scaling 1 g SAR (W/kg) |
| Front              | DFT-s-OFDM | BPSK | 30        | 100      | 2592.99     | 518598 | 135     | 67        | N/A                      | 90         | 25.83               | 0.011                  | 26.00               | 1.040                | 0.011                  |

| 5G NR n41 MIMO Body SAR |          |      |           |          |             |        |         |           | Ambient Temperature (°C) |            | 21.7                |                        |                     |                      |                        |
|-------------------------|----------|------|-----------|----------|-------------|--------|---------|-----------|--------------------------|------------|---------------------|------------------------|---------------------|----------------------|------------------------|
|                         |          |      |           |          |             |        |         |           | Liquid Temperature (°C)  |            | 21.4                |                        |                     |                      |                        |
|                         |          |      |           |          |             |        |         |           | Date                     |            | 2024-12-23          |                        |                     |                      |                        |
| Position                | Waveform | Mod. | SCS (kHz) | BW (MHz) | Freq. (MHz) | Ch.    | RB Size | RB Offset | Sensor State (Grip)      | Space (mm) | Measure Power (dBm) | Measure 1 g SAR (W/kg) | Tune-Up Limit (dBm) | Power Scaling Factor | Scaling 1 g SAR (W/kg) |
| Front                   | CP-OFDM  | QPSK | 30        | 100      | 2592.99     | 518598 | 137     | 68        | N/A                      | 90         | 24.79               | 0.001                  | 26.00               | 1.321                | 0.005                  |



**General Notes:**

1. The test data reported are the worst-case SAR values according to test procedures specified in FCC KDB Publication 447498 D04v01.
2. Liquid tissue depth was at least 15 cm for all frequencies.
3. All modes of operation were investigated, and worst-case results are reported.
4. The EUT is tested 2<sup>nd</sup> hot-spot peak, if it is less than 2 dB below the highest peak.
5. 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.
6. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D04v01.

**5G NR Notes:**

1. A-MPR was disabled for all SAR tests by setting NS=01 on the base station simulator.
2. According to FCC guidance, NR modulations and RB sizes/offsets were selected for testing such that configurations with the highest output power were evaluated for SAR tests.
3. This device supports 5G FR1 capabilities with overlapping transmission frequency ranges. When the supported frequency range of an NR band falls completely within an NR band with a larger transmission frequency range, both NR bands have the same target power (or the band with the larger transmission frequency range has a higher target power), and both NR bands share the same transmission path and signal characteristics, SAR was only assessed for the band with the larger transmission frequency range.
4. 5G NR n41 MIMO only support CP-OFDM.
5. 5G NR n41 is synchronized using maximum duty cycle of 100 %. SAR testing was performed using FTM mode with a 100 % duty cycle applied to match final duty cycle.

## **23 SAR Measurement Variability**

### **23.1 Measurement Variability**

Per FCC KDB Publication 865664 D01v01r04, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the power supply before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR Measurement Variability was assessed using the following procedures for each frequency band:

1. When the original highest measured SAR is  $\geq 0.80$  W/kg, the measurement was repeated once.
2. A second repeated measurement was performed only if the ratio of largest to smallest SAR for the original and first repeated measurements was  $> 1.20$  or when the original or repeated measurement was  $\geq 1.45$  W/kg ( $\sim 10\%$  from the 1-g SAR limit).
3. A third repeated measurement was performed only if the original, first or second repeated measurement was  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .
4. Repeated measurements are not required when the original highest measured SAR is  $< 0.80$  W/kg

## 24 Uncertainty Analysis

| a                                                                                | c         | d      | e =<br>f(d,k) | f    | g     | h =          | i =          | k       |
|----------------------------------------------------------------------------------|-----------|--------|---------------|------|-------|--------------|--------------|---------|
|                                                                                  |           |        |               |      |       | cxg/e        | cxg/e        |         |
| Uncertainty Component                                                            | Tol       | Prob . | Div.          | Ci   | Ci    | 1g           | 10g          | Vi      |
|                                                                                  | (%)       | Dist.  |               | (1g) | (10g) | ui (%)       | ui (%)       | (Veff)  |
| Probe calibration                                                                | 6.55      | N      | 1.00          | 1.00 | 1.00  | 6.55         | 6.55         | ∞       |
| Axial Isotropy                                                                   | 4.70      | R      | 1.73          | 0.71 | 0.71  | 1.92         | 1.92         | ∞       |
| Hemispherical Isotropy                                                           | 9.60      | R      | 1.73          | 0.71 | 0.71  | 3.92         | 3.92         | ∞       |
| Boundary Effects                                                                 | 2.00      | R      | 1.73          | 1.00 | 1.00  | 1.15         | 1.15         | ∞       |
| Linearity                                                                        | 4.70      | R      | 1.73          | 1.00 | 1.00  | 2.71         | 2.71         | ∞       |
| System Detection Limits                                                          | 0.25      | R      | 1.73          | 1.00 | 1.00  | 0.14         | 0.14         | ∞       |
| Modulation Response                                                              | 4.80      | R      | 1.73          | 1.00 | 1.00  | 2.77         | 2.77         | ∞       |
| Readout Electronics                                                              | 0.30      | N      | 1.00          | 1.00 | 1.00  | 0.30         | 0.30         | ∞       |
| Response Time                                                                    | 0.80      | R      | 1.73          | 1.00 | 1.00  | 0.46         | 0.46         | ∞       |
| Integration Time                                                                 | 2.60      | R      | 1.73          | 1.00 | 1.00  | 1.50         | 1.50         | ∞       |
| RF Ambient Noise                                                                 | 3.00      | R      | 1.73          | 1.00 | 1.00  | 1.73         | 1.73         | ∞       |
| RF Ambient Reflections                                                           | 3.00      | R      | 1.73          | 1.00 | 1.00  | 1.73         | 1.73         | ∞       |
| Probe Positioner mechanical tolerance                                            | 0.40      | R      | 1.73          | 1.00 | 1.00  | 0.23         | 0.23         | ∞       |
| Probe Positioning with respect to phantom shell                                  | 6.70      | R      | 1.73          | 1.00 | 1.00  | 3.87         | 3.87         | ∞       |
| Extrapolation, interpolation, and integration algorithms for max. SAR evaluation | 4.00      | R      | 1.73          | 1.00 | 1.00  | 2.31         | 2.31         | ∞       |
| Test sample positioning                                                          | 1.35/2.10 | N      | 1.00          | 1.00 | 1.00  | 1.35         | 2.10         | 35      |
| Device holder uncertainty                                                        | 3.98/3.17 | N      | 1.00          | 1.00 | 1.00  | 3.98         | 3.17         | 3       |
| Output power variation - SAR drift measurement                                   | 5.00      | R      | 1.73          | 1.00 | 1.00  | 2.89         | 2.89         | ∞       |
| Phantom uncertainty                                                              | 6.60      | R      | 1.73          | 1.00 | 1.00  | 3.81         | 3.81         | ∞       |
| Liquid conductivity-measurement                                                  | 2.89      | N      | 1.00          | 0.78 | 0.71  | 2.25         | 2.05         | 59      |
| Liquid permittivity-measurement                                                  | 2.47      | N      | 1.00          | 0.23 | 0.26  | 0.57         | 0.64         | 59      |
| Liquid conductivity-temperature                                                  | 1.65      | R      | 1.73          | 0.78 | 0.71  | 0.74         | 0.68         | 20      |
| Liquid permittivity – temperature                                                | 1.47      | R      | 1.73          | 0.23 | 0.26  | 0.20         | 0.22         | 20      |
| Combined standard uncertainty                                                    |           |        | RSS           |      |       | 12.40        | 12.24        | 281/660 |
| Expanded uncertainty<br>(95% CONFIDENCE INTERVAL)                                |           |        | k=2           |      |       | <b>24.80</b> | <b>24.48</b> |         |



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## 25 Appendixes List

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| <b>Appendix B</b> | Appendix B Test Plots                                     |
| <b>Appendix C</b> | Appendix C Photograph                                     |
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| <b>Appendix E</b> | Appendix E RF Conducted Power                             |

**-THE END-**